RULES AND REGULATIONS FOR THE CLASSIFICATION OF SHIPS

OTHER SHIP TYPES AND SYSTEMS

JULY 2007

PART 7

Lloyd's Register

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Section

■ *Section 1* General requirements

1.1 General

1.1.1 The requirements of this Chapter apply to refrigerated cargo ships where a Controlled Atmosphere **(CA)** notation is requested.

1.1.2 The requirements are additional to the classification requirements for refrigerated cargo installations contained in Pt 6, Ch 3.

1.1.3 Ships provided with CA systems which are approved, installed and tested in accordance with the following requirements will be eligible for the applicable class notation specified in Pt 1, Ch 2,2.5.2.

1.1.4 An example of a typical class notation on a refrigeration installation classed with Lloyd's Register (hereinafter referred to as 'LR'), fitted with a CA system built under Special Survey, would be:

✠ **Lloyd's RMC** to maintain a temperature –29°C to +14°C with sea temperature 35°C maximum.

✠ **CA (1–12% O_2, 0–25% CO_2) RH**

1.2 Novel arrangements and design

1.2.1 Where the proposed construction of the CA system, or CA zones, is novel in design, or involves the use of unusual materials or equivalent arrangements to those specified in the following sections, special tests may be required, and a suitable descriptive note may be assigned.

1.3 Definitions

1.3.1 **CA zone** means one or more cargo chambers enclosed in an air-tight envelope.

1.3.2 **Gas** means a suitable gaseous mixture to retard the metabolic process of fresh products.

1.3.3 **Gas system** means a system which controls the levels of oxygen and/or carbon dioxide.

1.3.4 **Adjacent space** means an enclosed space adjoining a CA zone separated by watertight bulkheads or decks penetrated by pipes, cables, ducts, doors, 'tween deck, etc.

■ *Section 2* Plans and documentation

2.1 Plans of CA zones and adjacent spaces

2.1.1 The following plans and particulars of the CA zones and adjacent spaces are to be submitted in triplicate for approval before construction is commenced:

(a) Capacity plan.
(b) Location and installation of CA equipment.
(c) Arrangement of CA zones in elevation and plan view.
(d) Access arrangement.
(e) Arrangement and use of spaces adjacent to CA zones.
(f) Details of securing weather deck and 'tween deck hatch lids.
(g) Details of securing gratings in way of hatch lids.
(h) Details of weather deck and access hatch seals.
(j) Door seals, scuppers, pipes, cables and ducts penetrating the decks, bulkheads, etc., together with proposed design conditions in the CA zones.
(k) Specified leakage rate and proposals for its measurement.
(l) Location of sampling points for CA gas and/or sensors in the CA zones and adjacent spaces.
(m) Details of the gas supply piping system.
(n) Details of gas freeing arrangements, including fans, valves, ducts and any interlocks.
(o) Details of pressure/vacuum valves for protecting devices in CA zones, location of outlets from P/V valves and capacity calculations.
(p) Details of security locks provided on entry to the hatch and manhole covers, and doors leading to CA zones and adjacent spaces.
(q) Arrangements of ventilation systems for the gas generator compartment and other adjacent spaces adjoining CA zones.

2.2 Gas supply system

2.2.1 The following plans and particulars of the gas supply system, etc., are to be submitted in triplicate for approval, before construction is commenced:

(a) Schematic arrangements of the proposed gas supply systems and, where applicable, details of compressors, pressure vessels, membranes, storage tanks, gas cylinders, control and relief valves and safety arrangements, including pressure set points of alarm and safety devices.

(b) Capacities of gas supply systems at different oxygen and carbon dioxide levels, if applicable.

2.3 Humidifiers

2.3.1 Where applicable, the following plans and particulars of the humidification system, etc., are to be submitted in triplicate for approval, before construction is commenced:

(a) Specification and capacity of the system.

(b) Principles of operation and control of relative humidities under different operating conditions.

(c) Details of proposed equipment, nozzles, pads, heaters, pumps, steam generator, compressors, water tanks, etc.

(d) Layouts of the equipment and the positioning of sensors and controls.

2.4 Control equipment

2.4.1 The following plans and details of the control, alarm and safety systems for CA zones, gas supply compartment and other adjacent spaces, are to be submitted in triplicate before construction is commenced:

(a) Line diagrams of all control circuits.

(b) List of monitored, control and alarm points.

(c) Details of computer systems, if fitted.

(d) Location of control panels and consoles.

(e) Controls of all valves and dampers fitted to CA zones.

(f) Details of oxygen and carbon dioxide analysers and arrangements for calibration.

(g) Relative humidity (RH) sensors and details of calibration.

(h) Details of alarm system, including location of central control panel and audible and visual warning devices.

2.5 Electrical

2.5.1 In addition to the applicable requirements of Pt 6, Ch 2,1.2, the following information and plans specific to the installed CA system are to be submitted in triplicate for approval, before construction is commenced:

(a) Main power supply arrangement to the CA system.

(b) Single-line diagram of the CA system which is to include rating of electrical machines, insulation type, size and current loading of cables and make, type and rating of protective devices.

(c) A schedule of normal operating loads of CA system, estimated for the different operating conditions expected.

2.6 Testing

2.6.1 Details of the testing programme are to be submitted, including instrumentation to be used with range and calibration.

■ *Section 3* CA zones and adjacent spaces

3.1 Air-tightness of CA zones

3.1.1 The CA zones are to be made air-tight in accordance with the requirements in 9.3. Particular attention is to be paid to sealing of hatches, plugs and access doors in each CA zone. Double seals are to be fitted to each opening.

3.1.2 Openings for pipes, ducts, cables, sensors, sampling lines and other fittings passing through the decks and bulkheads are to be suitably sealed and made air-tight.

3.1.3 The liquid sealed traps from bilges and drains from the cooler trays are to be deep enough to withstand, when filled with liquid which will not evaporate or freeze, the design pressure in each CA zone when taking account of the ship's motion.

3.1.4 Air refreshing inlets and outlets are to be provided with isolating arrangements.

3.2 CA zone protection

3.2.1 Means are to be provided to protect CA zones against the effect of overpressure or vacuum.

3.2.2 At least two P/V valves are to be fitted in each CA zone. They are to be set for the design conditions of the CA zone.

3.2.3 Consideration will be given to the use of a single valve in combination with other suitable means of overpressure or vacuum protection.

3.2.4 The proposed P/V valves for each zone are to be of adequate size to release any excess pressure and to relieve the vacuum at maximum cooling rate.

3.2.5 P/V valve discharges are to be located at least 2 m above deck and 10 m away from any ventilation inlets. Discharge piping is to be arranged to preclude ingress of water, dirt or debris which may cause the equipment to malfunction.

3.2.6 Pressure sensors are to be installed in locations necessary to monitor pressure of all CA zones. Pressure sensors are to be installed away from fans, air inlets and outlets.

3.3 Gas freeing of CA zones

3.3.1 The arrangements for gas freeing of CA zones are to be capable of purging all parts of the zone to ensure a safe atmosphere.

3.3.2 Cargo air cooling fans and the air refreshing arrangements may be used for gas freeing operations.

3.3.3 Gas freeing outlets are to be led to a safe place in the atmosphere 2 m above the deck, away from accommodation spaces and intakes of the fans for accommodation.

3.4 Ventilation of adjacent spaces

3.4.1 Deckhouses and other adjacent spaces which require to be entered regularly are to be fitted with a positive pressure type mechanical ventilation system with a capacity of at least 10 air changes per hour capable of being controlled from outside these spaces.

3.4.2 Adjacent spaces not normally entered are to be provided with a mechanical ventilation system which can be permanent or portable to gas free the space prior to entry.

3.4.3 Ventilation inlets are to be arranged so as to minimize recycling any gas and are to be at least 10 m in the horizontal direction away from the ventilation outlets.

■ *Section 4* Gas systems

4.1 General

4.1.1 Means are to be provided to achieve and maintain the required oxygen and/or carbon dioxide levels in the CA zones. This may be accomplished by the use of stored gas, portable or fixed gas generating equipment or other equivalent arrangements. The arrangements are to be such that a single failure will not cause a complete loss of gas supply to the CA zones.

4.1.2 The gas system is to have sufficient capacity to make good any gas loss from the CA zones and to maintain a positive pressure in all CA zones.

4.1.3 The gas system is also to be able to:

(a) Deliver gas at 125 per cent of the specified flow rate with two compressors operating.

(b) Maintain the specified gas levels in all CA zones when operating 24 hours per day with one unit on stand-by.

4.1.4 Air intakes are to be located to ensure that contaminated air is not drawn into the compressors.

4.1.5 Where it is intended to supply gas by means of stored gas bottles, the arrangements are to be such that depleted bottles may be readily and safely disconnected and charged bottles readily connected.

4.2 Location

4.2.1 Fixed gas generating equipment, gas bottles or portable gas generators are to be located in a compartment reserved solely for their use. Such compartments are to be separated by a gastight bulkhead and/or deck from accommodation, service and control station spaces. Access to such compartments is to be only from the open deck.

4.2.2 Gas piping systems are not to be led through accommodation, service and machinery spaces or control stations.

4.3 Gas supply

4.3.1 The gas systems are to be designed so that the pressure which they can exert on any CA zone will not exceed the design pressure of the zone.

4.3.2 During initial operation, arrangements are to be made to vent the gas outlets from each generator to the atmosphere. All vents from gas generators are to be led to a safe location on the open deck.

4.3.3 Where gas generators use positive displacement compressors, a pressure relief device is to be provided to prevent excess pressure being developed on the discharge side of the compressor.

4.3.4 Suitable arrangements are to be provided to enable the supply main to be connected to an external supply.

4.3.5 Where it is intended that gas systems are to be operated unattended, the required CA zone environment is to be automatically controlled.

4.3.6 Means of controlling inadvertent release of nitrogen into CA zones, such as locked valves, are to be provided.

4.4 Gas supply compartment ventilation and alarm

4.4.1 The gas supply compartment is to be fitted with a mechanical extraction ventilation system providing a rate of at least 20 air changes per hour based on the total empty volume of the compartment.

4.4.2 Ventilation ducts from the gas generator/supply compartment are not to be led through accommodation, service and machinery spaces or control stations.

4.4.3 The air outlet duct is to be led to a safe place on the open deck.

4.4.4 The gas supply compartment is to be provided with a low oxygen alarm system.

Section 5
Relative humidity (RH)

5.1 Humidification

5.1.1 Where a humidification system is fitted, the following requirements are to be complied with:

(a) The supply of fresh water for humidification is to be such as to minimize the risk of corrosion and contamination of the cargo.

(b) To prevent damage or blockage in the humidification system caused by water freezing, the air, steam or water pipelines in the cargo chambers are to be installed to facilitate ease of drainage and are to be provided with suitable heating arrangements.

Section 6
Electrical installation

6.1 General

6.1.1 In addition to the requirements of Pt 6, Ch 2, the following requirements are to be complied with:

(a) The electrical power for the CA plant is to be provided from a separate feeder circuit from the main switchboard.

(b) Under sea-going conditions, the number and rating of service generators are to be sufficient to supply the cargo refrigeration machinery and CA equipment in addition to the ship's essential services, when any one generating set is out of action.

Section 7
Control instrumentation and alarms

7.1 General

7.1.1 An alarm system for monitoring the atmosphere in CA zones is to be installed which may be integral with the machinery space alarm system as required by Pt 6, Ch 1,2.3.

7.1.2 Where alarms are displayed as group alarms in the main machinery space alarm system, provision is to be made to identify individual alarms at the refrigerated cargo control station.

7.1.3 The pressure in each CA zone is to be monitored and an alarm initiated when the pressure is too high or too low.

7.1.4 Where the **RH** notation is to be assigned, humidity sensors are to be installed in each of the CA zones and are to initiate an alarm when the relative humidity (RH) falls below or exceeds the predetermined set values.

7.1.5 Gas sensors or analysers are to be provided to monitor gas content in CA zones, *see* 7.3 and 7.4.

7.1.6 Gas analysers and sensors are to be calibrated automatically once in every 24 hours. An alarm is to be initiated if accuracy is outside tolerance limits.

7.1.7 Direct readout of the gas quality within any CA zone is to be available to the operating staff on demand.

7.1.8 At least one automatic recorder is to be provided for the remote monitoring and recording of O_2 and CO_2 levels in each CA zone.

7.1.9 Alarms are to be initiated in the event of O_2 or CO_2 levels in each CA zone falling below or exceeding the predetermined set values.

7.2 Gas systems

7.2.1 Where air compressors are to be used for gas production, alarms are to be initiated for the following conditions:

- High lubricating oil temperature.
- High differential pressure across the filters.
- Electric supply failure.

The compressors are to shutdown automatically in the event of:

- High discharge air temperature.
- High discharge air pressure.
- Low lubricating oil pressure.
- High pressure in CA zone.

7.2.2 Instrumentation is to be fitted for indicating continuously:

(a) Gas pressure.
(b) Gas temperature.
(c) Gas content.
(d) Gas flow.

7.3 Gas analysers and sampling

7.3.1 Where analysers are fitted, at least two analysers for oxygen and carbon dioxide having a tolerance of ±0,1 per cent by volume are to be provided to determine the content of the circulated gas within the CA zones.

7.3.2 Two separate sampling points are to be located in each CA zone and one sampling point in each of the adjacent spaces. The arrangements are to be such as to prevent water condensing and freezing in the sampling lines under normal operating conditions. Filters are to be provided at the inlet to sampling point lines.

7.3.3 Arrangements of the gas sampling points are to be such as to facilitate representative sampling of the gas in the space.

7.3.4 Where gas is extracted from the CA zones via a sampling tube to analysers outside the space, the sample gas is to be discharged safely to the open deck.

7.3.5 Provision is to be made for gas sampling by means of portable equipment as required by 9.6.3.

7.3.6 The sampling frequency is to be at least once per hour.

7.4 Gas sensors

7.4.1 Where sensors are fitted, at least two sensors for each of O_2 and CO_2, having a tolerance of ±0,1 per cent are to be installed in each CA zone to monitor gas levels.

7.4.2 Gas sensors may be used for indication and alarm.

■ *Section 8* Safety requirements

8.1 Personnel safety

8.1.1 CA zones are to be clearly labelled with 'Caution' and 'Danger' signs to alert personnel.

8.1.2 Entry hatch and manhole covers, doors leading to the CA zones and adjacent spaces are to be fitted with acceptable security-type locks and alarms activated when covers and doors are opened. The alarms are to be placed in a manned location.

8.1.3 All doors and access hatches to CA zones which may be under pressure are to open outwards and are to be fitted with secondary catches to prevent injury or damage during opening.

8.1.4 At least two portable oxygen sensors are to be provided to sample the oxygen level in all CA zones and adjacent spaces.

8.1.5 A means of communication is to be provided between CA zones and an attended location on deck.

8.1.6 Medical first aid equipment, including at least one set of oxygen resuscitation equipment, is to be provided on board.

■ *Section 9* Inspection and testing on completion

9.1 General

9.1.1 CA system trials are to be witnessed on board by the LR Surveyor, before the system is put into service and before a certificate is issued. These trials are in addition to any tests which may have been carried out at the manufacturer's works.

9.1.2 An Operating and Safety Manual for the guidance of the ship's staff is to be provided, covering the following topics:

(a) Principal information on the use of CA.
(b) Complete description of the CA installation on board.
(c) Hazards of low oxygen atmospheres and consequential effects on human life.
(d) Countermeasures when exposed to low oxygen atmospheres.
(e) Instructions for operation, maintenance and calibration of all gas detectors.
(f) Instructions for use of portable oxygen analysers with alarm for personal protection.
(g) Prohibition of entry to spaces under CA.
(h) Loading instructions prior to injection of gas.
(j) Procedure for checking security of CA zones, doors and access hatches prior to injection of gas.
(k) Gas freeing procedure for all CA zones.
(l) Procedure for checking atmosphere of CA zones before entry.

9.2 Gas supply and sampling systems

9.2.1 The gas supply main and branches are to be pressure and leak tested. The test pressures are to be 1,5 and 1,0 times the design pressure respectively.

9.2.2 All gas sampling lines are to be leak tested using a vacuum or overpressure method.

9.3 Air-tightness of CA zones

9.3.1 Air-tightness of each CA zone is to be tested and the results entered on the certificate. The measured leakage rate of each zone is to be compared with the specified value.

9.3.2 Either a constant pressure method or a pressure decay method is to be used to determine the degree of air-tightness.

9.3.3 If the constant pressure method is used, the test is to be carried out at the design pressure of the CA zones.

9.3.4 If the pressure decay method is used, the time for the pressure to drop from 350 Pa to 150 Pa is to be measured and the leakage is to be calculated using the following formula:

$$A.L. = \frac{7{,}095 \times V}{t}$$

where

$A.L.$ = air leakage, in m^3/h
V = volume of zone, in m^3
t = time, in seconds
7,095 = constant for 200 Pa pressure decay.

During this test, adjacent zones are to be kept at atmospheric pressure.

9.4 Gas system performance

9.4.1 Capability of the gas system to supply the gas at the specified flow rate and condition is to be verified by tests.

9.4.2 If the notation conditions cannot be verified during testing, assignment of the notation is to be deferred until log book entries confirm the achievement of the specified conditions in every CA zone during a loaded passage.

9.5 Gas freeing

9.5.1 The gas freeing arrangements are to be tested to demonstrate that they are effective.

9.6 Safety, alarms and instrumentation

9.6.1 The control, alarm and safety systems are to be tested to demonstrate overall satisfactory performance of the control engineering installation. Testing is also to take account of the electrical power supply arrangements, *see also* Pt 6, Ch 1,2.3.

9.6.2 Locking arrangements of all CA zones and adjacent spaces where gas may accumulate, provision of warning notices at all entrances to such spaces, communication arrangements and operation of alarms, controls, etc., are to be examined.

9.6.3 The provision of portable gas detectors and personnel oxygen monitors are to be verified by the LR Surveyor. Suitable calibrated instruments for measuring the levels of O_2, CO_2 and humidity, gas pressure and gas flow to the CA zones, are to be provided for testing. Their accuracy is to be verified.

Ships with Installed Process Plant for Chemicals, Liquefied Gases and Related Products

Section

■ *Section 1* Introduction

1.1 Scope

1.1.1 This Chapter is intended for the classification of self-propelled or non-self-propelled ships with specialized structures which have plant installed on board for the processing of chemicals, liquefied gases and related products, and which fall into one of the following environmental categories:

1A Ships which have plants operable while navigating at sea.

1B Ships which have plants operable at sea, but only while the ship is attached to an offshore mooring facility.

2 Ships which can navigate at sea, but whose plants are intended to be operated only while the ships are in harbour or similarly protected waters.

3 Specialized ships, including pontoons, barges and similar structures which are designed as sea transportation vehicles to carry non-operative process plants, but which are specially constructed to be fully supported by the sea bed when the plants are operative.

1.1.2 Each category in 1.1.1 may include provision for the storage of the products used in the process or processes concerned.

1.2 General

1.2.1 The Rules are framed on the understanding that ships will not be operated in environmental conditions more severe than those agreed for the design basis and approval, without the prior agreement of Lloyd's Register (hereinafter referred to as 'LR').

1.2.2 Except as indicated in this Chapter, the hull, propulsion machinery, auxiliary machinery, equipment for essential services of the ship, electrical installations and control engineering systems are to comply with the relevant Sections of Parts 3, 4, 5 and 6, the *Rules for Ships for the Carriage of Liquid Chemicals in Bulk* and the *Rules for Ships for Liquefied Gases*, where applicable. Hulls made of reinforced or prestressed concrete will be specially considered.

1.2.3 The additional hull structural requirements for Category 3 ships to enable them to be satisfactorily grounded on prepared foundations will be specially considered. Full details of the intended foundations and the local conditions at the site are to be submitted for use in assessing the hull structural capability, etc.

1.2.4 Where the process plant is intended to operate in close proximity to bulk storage of feedstocks and/or products, further consideration may be necessary in addition to that contained in this Chapter, particularly with regard to the provision of effective separation, methods of storage, loading and discharging arrangements.

1.2.5 For ships of all categories in 1.1.1 except Category 1A, provision is to be made for purging, gas freeing, inerting or otherwise rendering safe the plant and process storage facilities before the ship proceeds to sea or changes location. The provisions to be adopted, if any, when a ship of Category 1A enters harbour will be specially considered.

1.2.6 In addition to the requirements for periodical surveys, a general examination of the ship, machinery and process plant is to be carried out by LR's Surveyors before and after a ship, of any category other than 1A, changes location. Every precaution is to be taken to ensure safety during such examination.

1.2.7 Requirements additional to those of this Chapter may be imposed by the National Authority with whom the ship is registered and/or by the Administration within whose territorial jurisdiction the process plant is intended to operate.

1.3 Classification of ship

1.3.1 A ship built in accordance with the requirements of this Chapter, or in accordance with requirements equivalent thereto, will be assigned an appropriate class in the *Register Book*, as indicated in Section 2, and will continue to be classed so long as it is found, upon examination at the prescribed surveys, to be maintained in a safe and efficient condition, *see also* 1.4.6.

1.3.2 For each category described in 1.1.1, classification covers the hull, containment systems for stored products, propulsion machinery, auxiliary machinery used for essential services, and equipment necessary to maintain a suitable environment within which the plant may safely operate.

1.3.3 In general, classification will not be extended to the process plant itself, and the classification requirements do not relate to the specialized machinery, equipment and associated piping, etc., which is solely concerned with the production operations, except where the design and/or arrangements of such equipment and piping may affect the safety of the vessel.

1.3.4 When the reliquefaction plant is installed, and the plant and equipment are in accordance with the requirements of the *Rules for Ships for Liquefied Gases*, consideration will be given to classing the plant in accordance with Pt 1, Ch 2,2.5.

1.4 Certification of process plant

1.4.1 Process plant will be required to be certified by LR, and a note to the effect that this has been carried out will be appended to the class notation in the *Register Book*.

1.4.2 The certificate will include a brief description of the process plant, indicating the chemical(s) processed and the end products.

1.4.3 The certificate of the plant will cease to be valid if a significant alteration is made to the plant or the arrangements on board without the written approval of LR. This provision does not exclude the direct replacement of any item by a substitute part which has been approved and tested by LR.

1.4.4 The process plant will be required to be surveyed by LR's Surveyors at intervals to be prescribed by the Committee, dependent on the process involved.

1.4.5 The class notation for the ship will, in general, state that the process plant is not classed but certificated by LR and periodically surveyed by LR's Surveyors.

1.4.6 The maintenance of the class of the ship while the plant is in operation will be dependent upon a valid certificate and the plant being found, upon examination at the prescribed surveys, to be maintained in a safe and efficient condition.

1.4.7 The plant certificate is not to be taken as a recommendation for, or an approval of, the process or processes.

■ *Section 2* Class notations

2.1 Ship notations

2.1.1 Ships of Category 1A, which have chemical process plants designed to operate while the ship is navigating at sea, will be eligible to be classed '100A1 Chemical Process Factory', *see also* 1.4.5.

2.1.2 Ships of Category 1B, which have chemical plants designed for operation at sea while the ship is specially moored, anchored or otherwise linked to the shore, sea bed or other stationary vessel or structure, will be eligible to be classed '100A1(T) moored (oil, ammonia, etc.) processing (tanker, barge, etc.) for service at . . .', *see also* 1.4.5.

2.1.3 Ships of Category 2, which have chemical plants installed and designed for operation while the ship is in harbour, will be eligible to be classed '100A(T) chemical process plant installed – for operation only when moored in harbour', *see also* 1.4.5.

2.1.4 Specialized ships of Category 3 which have chemical plants designed to operate only while the ship is fully supported on the sea bed, will be eligible to be classed 'A chemical process plant pontoon/platform – to be operated only when grounded on prepared foundations at...', *see also* 1.4.5.

2.2 Additional notations

2.2.1 A special chemical cargoes notation may be assigned to ships where raw materials or products are stored or retained on board in bulk.

2.2.2 The Committee may append details of process, product storage, safety or other particulars to the notation as it considers necessary.

2.2.3 Ships of Category 1B or 2 which have process plants installed solely for the purposes of the physical liquefaction of impure feedstock gases at low temperatures and the storage of the purified liquefied gases (where the chemical treatment of the impurities is an incidental process) will be assigned additional notations to those stated in 2.1.2 or 2.1.3, such as 'for liquefaction and storage of methane, etc., in independent tanks Type B, etc. – maximum pressure – minimum temperature'.

2.3 Special mooring and linking arrangements

2.3.1 Where the process plant is operable only when the ship is specially moored, anchored or otherwise linked to the shore, sea bed or other stationary vessel, and the equipment and/or other linking arrangements and components have been approved by the Committee as suitable and sufficient for the intended service, an equipment character, T, will be assigned in addition, or as an alternative, to the equipment character, 1, as appropriate.

2.3.2 For the purpose of the Rules, the word 'linked' is to be taken to include spuds, retractable legs, floating or submerged pipelines connecting directly to the ship, ship to shore electrical connections, etc., which restrain the ship in its operating position, or which require such restraint to be applied and the failure of which could hazard the ship.

Section 3
Plans and particulars

3.1 General

3.1.1 Before the work is commenced, plans in triplicate, together with the relevant information as detailed in this Section, are to be submitted for consideration. Any subsequent modifications are subject to approval before being put into operation.

3.1.2 Any alterations to basic design, construction, materials, manufacturing procedure, equipment, fittings or arrangements of the process are to be re-submitted for approval.

3.1.3 For Category 1 ships, the plant is to be capable of sustaining an emergency condition at full operating temperatures and pressures with the hull statically listed to an angle of $22^1/_2°$ and statically trimmed to an angle of 10° beyond the maximum normal operating trim. These angles may be modified by the Committee in particular cases as it considers necessary. The stress calculations for the plant and the supporting structure are to take account of this condition. Wind loads need not be considered to be acting during this emergency condition.

3.1.4 For Category 2 ships, the plant is to be capable of sustaining an emergency condition at full operating temperatures and pressures with the hull statically listed to an angle of 15° and statically trimmed to an angle of 5° beyond the maximum normal operating trim. These angles may be modified by the Committee in particular cases as it considers necessary. The stress calculations for the plant and the supporting structure are to take account of this condition. Wind loads need not be considered to be acting during this emergency condition.

3.2 Hull construction

3.2.1 For all categories of ship, the plans and information detailed in 3.2.2 to 3.2.6 are to be submitted, in addition to those required by Pt 3, Ch 1,5, Chapter IV of the *Rules for Ships for the Carriage of Liquid Chemicals in Bulk* or Chapter IV of the *Rules for Ships for Liquefied Gases*, as applicable.

3.2.2 Plans showing the general arrangement of the ship are to be submitted, giving the location of the following:

- Hatches and other openings to enclosed plant spaces and adjacent cofferdams.
- Doors, hatches, ventilation and other openings to crew accommodation, stations essential for operation at sea, control stations, store rooms and workshops.
- Coated tanks or tanks constructed of special material.
- Additional structure associated with the plant above the deck.
- Proposed grouping of areas within the plant for segregation purposes.

3.2.3 Plans for mooring, anchoring and linking, as applicable, together with relevant wind and sea data are to be submitted for information.

3.2.4 Plans outlining the containment arrangements in the event of an accident, together with all relevant information, are to be submitted.

3.2.5 Particulars of the marine environment and safety arrangements associated with the process plant are to be submitted, including:

- Arrangements for preventing the ingress of water into the ship or structure where the process plant and equipment protrude through the weather deck.
- Proposed emergency flooding procedures and their control.

3.2.6 Particulars of the proposed storage arrangements of hazardous and/or toxic substances, feedstocks and products in bulk, on the ship or structure, are to be submitted.

3.3 Process plant

3.3.1 A description of the expected method of operation of the process plant and a diagram showing the process flow are to be submitted.

3.3.2 General arrangement plans of the process plant showing the hazardous and safe zones and spaces are to be submitted, indicating the following:

- Spaces where toxic gases or vapours may accumulate.
- Spaces where flammable gases or vapours may accumulate.
- Areas maintained at an over-pressure to prevent the ingress of such gases or vapours.

3.3.3 Details of the flammability, toxicity, corrosivity and reactivity of the substances entering, being processed and leaving, or stored in, each compartment, together with details of any exothermic and hazardous reactions particularly with regard to sea-water and other materials normally found in the marine environment, are to be submitted.

3.3.4 Plans of the layout of the process plant indicating the hatches and other openings to enclosed plant spaces and cofferdams are to be submitted.

3.3.5 Details and arrangements of the blow-down systems, including quantities of materials and the capacity and working pressure of the containers installed for the reception of the materials to be blown down, are to be submitted.

3.3.6 Proposals for de-watering blow-down tanks in which hot oils and/or chemicals are discharged are to be submitted.

3.3.7 Proposals for the purging, gas freeing, inerting or otherwise rendering safe of the process plant and storage facilities are to be submitted.

3.3.8 Particulars of the arrangements for protecting the process plant systems and vessels against temperature, over-pressure and vacuum are to be submitted.

3.3.9 Proposals for the disposal of hazardous or toxic gases and liquid effluents during normal plant operation, including any proposed flare systems, are to be submitted.

3.3.10 Particulars of the proposals for isolating the ship or structure from the shore installation and/or lightering ships or vessels, where applicable, and from the supply of fuel to boilers, etc., in the process plant and the return flow of chemicals or process effluent, are to be submitted, including:

- Feedstock supply and product discharge, with details of the arrangements showing the location of shut-off valves and of the control and indicating stations.
- The process plant parameters and analysis of transient conditions under which emergency shutdown will be initiated and the time estimated to obtain a safe environment.
- The proposed emergency procedures for controlled shutdown of the process plant, i.e. depressurizing, inerting, etc., and the arrangements for the continued operation of the essential services necessary to allow for such controlled shutdown under the emergency conditions of 3.1.3 or 3.1.4, as applicable.

3.3.11 Plans for the ventilation of process plant compartments are to be submitted, together with the following information:

- Location of hazardous and safe zones and spaces.
- Location of all possible sources of ignition.
- Location of air inlets and outlets.
- Number of complete air changes per hour.
- Estimated maximum and minimum ambient temperatures for the regions in which the plant is to operate.
- Expected heat loss of the process plant to the compartment environment.

3.3.12 Particulars of any dust or gas explosion hazard in the enclosed compartments of the process plant are to be submitted.

3.3.13 Proposals for the decontamination of the process plant compartments are to be submitted.

3.3.14 Proposals for the detection of vapour or gas and of oxygen deficiency in the process plant compartments are to be submitted.

3.4 Mechanical equipment associated with the process plant

3.4.1 A list of mechanical equipment associated with the process plant, with the exception of any boilers and other pressure vessels, to be installed in the ship or structure is to be submitted.

3.4.2 Details of safety and relief devices and their discharge arrangements are to be submitted.

3.4.3 When required, in order to facilitate inspection, plans showing the materials of construction, working pressures and temperatures, maximum power and revolutions per minute, as applicable, are to be submitted before the work is commenced.

3.4.4 Calculations of the torsional vibration characteristics of the shafting systems, where applicable, are to be submitted in accordance with the requirements of Pt 5, Ch 8.

3.5 Boilers and other pressure vessels associated with the process plant

3.5.1 Plans of the boilers and other pressure vessels, including the proposals for the support of the vessels, are to be submitted.

3.5.2 Details of the safety and relief devices and their discharge arrangements are to be submitted.

3.5.3 Stress calculations are to be submitted, taking into account the ship linear and angular accelerations, roll and pitch amplitudes, ship flexure and wind loads appropriate to any condition which may normally arise at sea. Where applicable, calculations for the emergency condition in 3.1.3 or 3.1.4 are to be submitted. Due consideration is to be given to the effects of thermal expansion and contraction on the support points of the vessels.

3.5.4 Outline plans of all types of fired equipment, ventilation arrangements with projected casing temperatures, uptake arrangements, gas and/or oil fuel burning arrangements and controls are to be submitted.

3.6 Pumping and piping systems associated with the process plant

3.6.1 Plans of the process plant piping systems, showing the materials of construction, scantlings, support and expansion arrangements, together with the calculations, are to be submitted for consideration.

3.6.2 The following diagrammatic plans for systems associated with the process plant are to be submitted, in addition to those required by Pt 5, Ch 13 and Ch 15 or Chapter V of the *Rules for Ships for Liquefied Gases*, as applicable:

- The Shipbuilder's plan of the general pumping arrangements, including air and sounding pipes and any cross flooding pipes and fittings.
- Pumping arrangements at the fore and aft ends, drainage of cofferdams and process spaces.
- Bilge, ballast and oil fuel pumping arrangements in the process plant machinery space, including the capacities of the pumps on bilge service.
- Arrangement of oil fuel pipes and fittings at settling and service tanks.
- Arrangement of gas and/or oil fuel piping in connection with gas and/or oil burning arrangements.

- Oil fuel overflow systems, where fitted.
- Arrangement of boiler feed system.
- Arrangement of compressed air systems for the process plant.
- Arrangements of lubricating oil and cooling water systems, oil fuel settling, service and other oil tanks not forming part of the ship's structure.

3.6.3 Plans showing the arrangement and dimensions of main steam pipes, with details of flanges, bolts and weld attachments and particulars of the materials of the pipes, flanges, bolts and welding consumables, are to be submitted for consideration.

3.6.4 Details of the safety and relief devices and their discharge arrangements are to be submitted.

3.7 Electrical equipment for the process plant

3.7.1 Details of the electrical system(s) are to be submitted, including the following:

- A statement quoting the standard or Code of Practice in accordance with which the installation has been designed.
- A statement quoting the standard of design and/or manufacture of electrical equipment, e.g. BS, NEMA, VDE, etc.,
- A schedule of the normal operational loads on the system, estimated for the different operating conditions expected.
- Expected range of ambient temperature.

3.7.2 The following line diagram plans and particulars are to be submitted:

- General arrangement plan of the process plant showing the location of the major items of electrical equipment.
- Line diagram of the installation(s) indicating the rating of the various items of rotating machinery, converters, transformers and protective devices, together with the types and sizes of cables and the makes and types of protective devices.
- Arrangement plans and circuit diagrams of the switchboards.
- Calculations of short-circuit currents at the main switchboards, sub-switchboards and the secondary side of transformers.
- General arrangement plan of the process plant showing the location of electrical equipment in hazardous zones, together with the Code of Practice on which they are based.
- A schedule of safe-type electrical equipment located in hazardous zones, giving details of the type of equipment employed, the certifying authority and the certificate number.

3.7.3 Written confirmation and Works' Test Certificates that all items of electrical equipment comply with the relevant standard or Code of Practice are to be supplied.

3.8 Control equipment for the process plant

3.8.1 Details of the control system(s) are to be submitted, together with the following line diagrams and particulars:

- Line diagrams of any control system(s) fitted.
- General arrangement plan of the process plant showing the locations of items of control equipment and the locations of hazardous zones.
- Schedule of the parameters which are monitored and controlled, including alarms and shutdown devices.

3.9 Fire protection, detection and extinction

3.9.1 Plans of fire protection, detection and extinction arrangements, together with details of the fire and explosion hazards involved, are to be submitted.

■ *Section 4*
Materials

4.1 General

4.1.1 The materials used in the construction are to be manufactured and tested in accordance with the requirements of the *Rules for the Manufacture, Testing and Certification of Materials* (hereinafter referred to as the Rules for Materials) and of Chapter 6 of the *Rules for Ships for Liquefied Gases*, as applicable. Materials for which provision is not made in those requirements may be accepted, provided that they comply with an approved specification and such tests as may be considered necessary.

4.1.2 Materials of construction are to be suitable for the intended service, having regard to the substances, process and temperatures involved. For materials unsuitable for use with certain chemicals, and for the protection of materials, *see* Chapter 6 of the *Rules for Ships for the Carriage of Liquid Chemicals in Bulk*.

4.1.3 Details of the materials proposed for all types of construction are to be submitted for approval.

■ *Section 5*
Process plant characteristics

5.1 Design

5.1.1 The design and arrangements are to comply with the requirements of this Chapter and with relevant statutory regulations of the National Authority of the country in which the ship or structure is registered and/or in which it is to operate.

5.1.2 The process plant is to be designed for normal operation in accordance with recognized and agreed codes suitably modified to take into account the ship-borne environment in all its aspects. Except for emergency conditions, as detailed in 3.1.3 or 3.1.4, the total stress in any component of the plant is not to exceed the code value at the temperature concerned, unless expressly agreed otherwise by LR, whether the plant is operative or non-operative, when subjected to any possible combination of the following loads:

(a) Static and dynamic loads due to wave-induced ship motions.
(b) Loads resulting from hull flexural effects at the plant support points.
(c) Direct wind loads.
(d) Normal process weights and pressures.
(e) Thermal loads.

5.1.3 For the emergency conditions in 3.1.3 or 3.1.4, the stress levels are to be agreed with LR.

5.2 Separation from ship machinery

5.2.1 Where, during operation, process plant spaces contain or are likely to contain hazardous and/or toxic substances, they are to be kept separate and distinct from the main propulsion and auxiliary machinery and essential ship services, and also the power generating machinery for the process plant.

5.2.2 Notwithstanding the requirements of 5.2.1, this does not exclude the use of the ship's main, auxiliary and/or essential services, for process plant operation in suitable cases. Where, for reason of hazard, essential ship services have to be duplicated within the process plant space, they are to comply with the requirements of Section 9 and Parts 5 and 6, as applicable.

■ *Section 6* Hull construction

6.1 General

6.1.1 The hull structure is to comply with the relevant requirements of Parts 3 and 4, except as stated otherwise in this Section. The containment of liquefied gas products is to comply with Chapter 4 of the *Rules for Ships for Liquefied Gases*.

6.1.2 All chemical product and effluent tank structures and their location relative to the ship's hull are to comply with the *Rules for Ships for Liquefied Gases*, or with the *Rules for Ships for the Carriage of Liquid Chemicals in Bulk*, as applicable. Where necessary, the probable temperature variations during operations and the thermal stress considerations are to be stated.

6.1.3 Materials for the hull structures subjected to low temperature are to comply with Pt 3, Ch 2,2.2 relating to refrigerated spaces and adjacent structures, or with Chapter 6 of the *Rules for Ships for Liquefied Gases*, as applicable.

6.1.4 Subdivision and damage stability are not covered by these Rules. However, attention must be given to any relevant statutory regulations of the National Authority of the country in which the ship is to be registered or in which the plant is to be operated.

6.2 Location of accommodation, service and control spaces

6.2.1 All accommodation and other compartments not directly essential to the operation of the plant are to be arranged well clear of plant spaces, and feedstock and product tanks.

6.2.2 Service and control stations essential to the operation of the plant must be made 'gas-safe' in accordance with internationally accepted codes and standards, and should, wherever possible, be so located that access thereto is from a defined safe space. If such location is not possible, the station is to be specially ventilated.

6.3 Integrity of gastightness between compartments

6.3.1 Where integrity of gastightness is required between compartments containing the plant, this is to be maintained in way of pipe tunnels or duct keels where these traverse such compartments.

6.4 Cofferdams

6.4.1 Cofferdams are to be sited as required by the *Rules for Ships for Liquefied Gases*, or by the *Rules for Ships for the Carriage of Liquid Chemicals in Bulk*, as applicable, segregating any spaces in which raw materials or products are stored or retained in bulk.

6.4.2 Cofferdams are to be arranged around independent tanks containing chemical products or effluents where these are separate from the ship structure, but permanently connected thereto. Such cofferdams are to be mechanically ventilated using portable or permanent systems as required by Chapter 12 of the *Rules for Ships for the Carriage of Liquid Chemicals in Bulk*, and are to be of sufficient size to allow effective inspection of all the tank and ship structure in way.

6.5 Access and openings to spaces

6.5.1 Access openings, windows, side scuttles and ventilation openings to accommodation, service and control stations essential for the operation of the ship, and similar safe spaces are to be located and arranged, as required by the *Rules for Ships for Liquefied Gases*, or by the *Rules for Ships for the Carriage of Liquid Chemicals in Bulk*, as applicable.

6.5.2 Arrangements are to be made to provide easy access to, or escape from, plant working spaces. In general, ladders are not to be arranged vertically, and intermediate platforms are to be fitted at vertical intervals of about 6 m. Ladders and platforms are to have guard rails and permanent provision made for attaching hoists for use in emergencies. The arrangements for the emergency hoists are to allow a clear, unobstructed lift to the outside deck.

6.5.3 Two separate means of access from the open deck are generally to be provided to the cofferdams required by 6.4.1.

6.6 Longitudinal strength

6.6.1 Longitudinal strength calculations are to be made in accordance with Pt 3, Ch 4 for the following conditions, and the Loading Manual required by Pt 3, Ch 4,8 is to include this information:

(a) **Sea-going conditions**:
These conditions are to take account of the weights and disposition of all ballast, plant items including any working fluids, other substances, spare gear, etc., and any special support bracing where thermal effects are considered, which will be on board during any sea-going condition of the plant appropriate to the category of ship.

(b) **Harbour condition**:
This condition is to take account of the weights and disposition of all ballast and plant items, including all working and other substances (in all intended stowage dispositions) and spare gear which will be on board during operation of the plant in harbour.

6.7 Plant support structure

6.7.1 Decks and other structure supporting the plant are, in general, to comply with the requirements of Part 3. Such structure can, however, be considered on the basis of an agreed uniformly distributed loading in association with local loads at plant support points, provided that adequate transverse strength of the ship is maintained.

6.7.2 Where the nature and dispositions of heavy plant items are such that forces on the ship and support structure due to ship motions are significant (whether underway with or without working fluids, or moored with working fluids), calculations of the loading and the structural response are to be submitted. In this respect, the guidance formulae for accelerations as given in the *Rules for Ships for Liquefied Gases* can be used where appropriate. Details of the mass distribution and support points of the plant items are to be submitted in all cases.

6.7.3 Where model tests or reliable direct calculation procedures are used to estimate wave-induced responses and which may indicate accelerations and motion amplitudes differing from those arising from the application of the Rules, such values will be taken into account in the approval of support structure.

6.7.4 If the vessel is intended for limited service at sea (e.g. a 'once only' voyage from port of build to service location), a reduction in the Rule accelerations and motion amplitudes may be permitted. In order to apply such a reduction, details of the intended service limitation should be submitted.

6.8 Loading due to wave-induced motions

6.8.1 In cases where the mass distribution of large columnar plant items is such that the centre of action of the dynamic force differs significantly from the centre of gravity of the item, due account of this is to be taken in the calculation of the forces and moments at the support positions.

6.9 Additional loads

6.9.1 The structure supporting the plant is also to be capable of withstanding forces arising from the following:

(a) Wind loads (in all conditions of service and all categories of ships).

(b) The angle of static heel arising from the emergency condition referred to in 3.1.3 or 3.1.4, as applicable.

(c) For a Category 1A ship, a collision force acting on the tank corresponding to one-half of the weight of the item with or without working fluids, as appropriate, to the approved sea-going conditions from forward and one-quarter of the weight of the item from aft.

(d) For all other categories of ship, a collision force from any horizontal direction of one-fifth of the weight of the item.

6.9.2 Wind loading, which is to be applied to the plant items and supporting structure protruding above the weather deck, should be considered to act simultaneously with wave-induced loading. Loadings 6.9.1(b), (c) and (d) need not be combined with wind loads or wave-induced loads.

6.10 Allowable stresses in support structure

6.10.1 The following stress levels are applicable in conjunction with the loading on the support structure:

(a) Support members above or below the weather deck which are not subject to main hull girder loading:
direct stress:
$\sigma_a + \sigma_b = 0{,}6\sigma_y$
shear stress:
$\tau = 0{,}6\tau_y$ or $0{,}35\sigma_y$ whichever is the smaller combined stress:

$$\sigma_c = 0{,}75\sigma_y = \sqrt{(\sigma_a + \sigma_b)^2 + 3\tau^2}$$

where

$\sigma_a + \sigma_b$ = the algebraic sum of the axial and bending stresses at the point under consideration

σ_y = specified minimum tensile yield stress or 0,2 per cent proof stress at room temperature

τ_y = shear yield stress

(b) Support members directly connected to hull structure and subject to transference of loading therefrom:
- the maximum allowable direct, shear and combined stresses as defined in (a), but with member local loading increased by a factor of 1,30, or
- when the stresses in such structure are determined using methods which satisfactorily take into account any ship deflection and load transference in way of supports, no load factor need be applied.

(c) Primary members forming an integral ship structural and plant support system:
- in general, the allowable stresses in such a system will be especially considered on the basis of the degree of refinement employed in the load prediction, structural response and stress analysis methods. Structural response calculations should include the interaction effects of the hull and plant item.

6.10.2 In general, all seatings, platform decks, girders and pillars supporting plant items are to be arranged to align with the main hull structure, which is to be suitably reinforced, where necessary, to carry the appropriate loads. Attention should be paid to the capability of the support structure to withstand buckling.

6.11 Integrity of weather deck

6.11.1 The integrity of the weather deck is to be maintained. Where items of plant equipment penetrate the weather deck and are intended to constitute the structural barrier to prevent the ingress of water to spaces below the freeboard deck, their structural strength is to be equivalent to the Rule requirements for this purpose. Otherwise, such items are to be enclosed in superstructures or deckhouses fully complying with the Rules. Full details are to be submitted for approval.

6.12 Equipment

6.12.1 Anchors and chain cables for ships navigating at sea are to comply with the requirements of Pt 3, Ch 13,7. Special consideration will be given to the equipment required for ships of Categories 1B and 2.

6.13 Gangways and freeing arrangements

6.13.1 Gangways are to be sufficient to provide proper access to all areas necessary for ship safety while the ship is operational and while it is at sea, and are to be to the Surveyor's satisfaction.

6.13.2 Freeing ports are to be fitted in accordance with the requirements of Pt 3, Ch 8,5.3.

Section 7
Mechanical equipment for the process plant

7.1 General

7.1.1 The requirements of this Section are applicable to all types of mechanical equipment associated with the process plant, with the exception of boilers and other pressure vessels.

7.1.2 The mechanical plant and equipment are to be designed and constructed in accordance with the relevant Sections of Part 5 and Pt 6, Ch 3, as applicable, and/or with agreed codes and specifications, suitably modified where necessary to suit shipboard conditions. The design is to be capable of accommodating the forces and moments stated in 6.7, 6.8 and 6.9, as applicable, generated at the support points.

7.2 Safety precautions

7.2.1 Oil engines, air compressors and associated air starting piping, concerned with supplying services not essential to the safety of the vessel or structure, are to comply with the requirements of Pt 5, Ch 2, where applicable.

7.2.2 Air intakes for internal combustion engines are to be led from a safe space. Where internal combustion engines, other than gas turbines, are used in association with plant processing flammable substances, the air intakes are to be fitted with an automatic device to prevent overspeeding in the event of accidental ingestion of flammable gases and/or vapours.

7.2.3 Exhaust pipes from internal combustion engines are to be led well clear of hazardous areas and, where such engines are used in association with plant processing flammable substances, are to be fitted with efficient spark arresters.

7.2.4 In general, air compressors are not to be installed in hazardous areas. Where this is not practicable, alternative arrangements may be accepted, provided that the air inlets are trunked or ducted from a safe space and that such trunking/ducting is fitted with gas detectors arranged to give audible and visible alarms and to shutdown the compressor in the event of flammable and/or toxic gas or vapour entering the air inlets.

7.2.5 The gas detectors are to be capable of continuously sampling the air supply and are to be so arranged as to prevent cross-communication between hazardous and safe spaces, such as control rooms, etc.

7.3 Inspection and installation

7.3.1 The scope of the inspection to be carried out at the manufacturers' works by the Surveyors is to be agreed before the work is commenced.

7.3.2 The mechanical plant and equipment are to be installed to the Surveyor's satisfaction. Proposals to site internal combustion engines in hazardous areas will be the subject of special consideration.

■ *Section 8*
Boilers and other pressure vessels for the process plant

8.1 General

8.1.1 The requirements of this Section are applicable to fired and unfired pressure vessels associated with the process plant.

8.1.2 The pressure vessels are to be made in accordance with the requirements of the relevant Sections of Pt 5, Ch 10 or Ch 11, as applicable, or with agreed codes and specifications normally used for similar plant in land installations suitably modified and/or adapted for the marine environment. The design is to be capable of accommodating the forces and moments stated in 6.7, 6.8 and 6.9, as applicable, generated at the support points.

8.1.3 Stress calculations are to take account of the emergency conditions in 3.1.3 or 3.1.4, as applicable, in addition to the normal operational loadings. Due consideration is to be given to the effects of thermal expansion and contraction on the support points of the vessels.

8.2 Construction and installation

8.2.1 The pressure vessels are to be constructed, installed and tested to the Surveyor's satisfaction.

8.2.2 Suitable access is to be provided to the vessels for inspection, including checks on the operation of mountings, fittings, controls and pressure relief devices.

8.3 Safety devices

8.3.1 Where necessary, a test rig is to be supplied to enable the pressure setting of the safety and relief devices to be checked.

8.3.2 Where required, an additional pressure relieving device, with sufficient capacity (a) to prevent pressure vessels becoming liquid-full during fire engulfment and/or (b) to discharge vapours generated under fire exposure, is to be fitted in accordance with the relevant *Rules for Ships for Liquefied Gases*.

8.3.3 The arrangement of safety and relief discharges is to be such that there is no possibility of hazardous reaction between the substances involved.

8.3.4 Where provision is made for the isolation of safety relief devices from vessels and/or systems for maintenance purposes, not less than two such safety devices are to be fitted.

8.3.5 The isolating or blocking valves are to be so arranged that at least one safety relief device will remain in communication with the vessel or system under all conditions.

■ *Section 9*
Pumping and piping systems for the process plant

9.1 General

9.1.1 Arrangements are to be made in the process plant spaces, in order that substances which are flammable, toxic or are likely to present a hazard due to reaction when mixed are kept separate.

9.2 Process plant piping systems

9.2.1 Process plant piping systems are to be designed and constructed in accordance with agreed codes and specifications normally used for similar plants in land installations, suitably modified and/or adapted where necessary to suit the marine environment.

9.2.2 Sections of piping which may contain hazardous liquids or gases and which can be isolated are to be suitably protected, *see* 8.3.2.

9.3 Lubricating oil and oil fuel piping

9.3.1 Lubricating oil and oil fuel pipes, fittings, associated equipment, oil fuel burning arrangements and their materials of construction are to comply with the requirements of Pt 5, Ch 14, where applicable.

9.4 Gas fuel supply systems

9.4.1 The gas fuel supply systems are to comply with the requirements of the relevant Sections of the *Rules for Ships for Liquefied Gases*, where applicable.

9.4.2 Provision to shut off the gas is to be made in the gas firing supply lines immediately before the lines enter the compartment in which the equipment is installed. The shut-off arrangements are to be of the double block and vent type, and are to be operable at the equipment or the equipment control position and at a position in a safe area remote from the equipment.

9.5 Air and sounding pipes

9.5.1 Details of air and sounding pipes to tanks containing chemical products are to be submitted for approval.

9.6 Bilge and effluent arrangements

9.6.1 The arrangements for the storage on board ship, and the disposal of bilge and effluent from the process plant spaces, are to be submitted for consideration, and due recognition is to be given to the requirements of the appropriate National Authority.

9.6.2 Bilge and effluent pumping and piping systems in the process plant spaces are to be constructed of material suitable for the substances processed or produced or any combination of the substances which might result from accidental admixture.

9.6.3 Arrangements are to be provided for the control of the bilge and effluent pumping and piping system installed in the process plant spaces from within these spaces and also from a position outside the spaces.

9.6.4 The bilge and effluent pumping and piping systems handling hazardous materials should, wherever possible, be installed in the space associated with the particular hazard. Spaces containing pumps and piping systems that take their suction from a hazardous space may also be considered as hazardous spaces where a pipeline is not of an all-welded construction without flanges, valve glands and bolted connections, etc., and the pumps are not totally enclosed.

9.6.5 Where, during operation, process plant spaces contain or are likely to contain hazardous and/or toxic substances, they are to be kept separate and distinct from the ship's main bilge pumping and piping system. This does not, however, preclude the use of the ship's main bilge system when the process plant is shutdown, gas freed or otherwise made safe.

9.6.6 Pumping and piping systems for the ship services and process plant are to be constructed and installed to the Surveyor's satisfaction.

■ *Section 10*
Firing arrangements of steam boilers, fired pressure vessels, heaters, reformers, etc.

10.1 General

10.1.1 The requirements of this Section are applicable to all types of fired equipment associated with the process plant. The equipment is to be constructed, installed and tested to the Surveyor's satisfaction.

10.2 Design and construction

10.2.1 Details of the design and construction of the fuel gas burning equipment for steam boilers, oil and gas heater furnaces, reformers, etc., are to be in accordance with the *Rules for Ships for Liquefied Gases*, or with agreed codes and specifications normally used for similar plants in land installations, suitably modified and/or adapted for the marine environment. Ignition of the burners is to be by means of permanently installed igniters, or properly located and interlocked pilot burners and main burners arranged for sequential ignition.

10.2.2 Gas or gas/air mixtures having relative densities compared with that of air at the same temperature greater than one are not to be used as fuels for fired pressure vessels situated below deck. Proposals to burn such mixtures above deck will be specially considered in each case.

10.2.3 Proposals for the furnace purging arrangements prior to ignition of the burners are to be submitted. Such arrangements are to ensure that any accidental leakage of product liquid or gas into the furnace, from a liquid or gas heating element, or from the accidental ingestion of flammable gases and/or vapours, does not result in hazardous conditions.

10.2.4 Compartments containing fired pressure vessels, heaters, reformers, etc., for heating or processing hazardous substances are to be so arranged that the compartment in which the fired equipment is installed is maintained at a higher pressure than the combustion chamber of the equipment. For this purpose, induced draught fans or a closed stokehold system of forced draught may be employed. Alternatively, the fired equipment may be enclosed in a pressurized air casing.

10.2.5 The fired equipment is to be suitably lagged. The clearance spaces between the fired equipment and any tanks containing oil are to be not less than 760 mm. The compartments in which the fired equipment is installed are to be provided with an efficient ventilating system.

10.2.6 Smoke box and header box doors of fired equipment are to be well-fitting and shielded, and the uptake joints made gastight. Where it is proposed to install dampers in the uptake gas passages of fired equipment, the details are to be submitted. Dampers are to be provided with a suitable device whereby they may be securely locked in the fully open position.

10.2.7 Each item of fired equipment is to have a separate uptake to the top of the stack casing. Where it is proposed to install process fired equipment with separately fixed furnaces converging into a convection section common to two or more furnaces and/or a secondary radiant section at the confluence of the fired furnace uptake to the convection section, the proposed arrangements, together with the details of the furnace purging and combustion controls, are to be submitted.

Section 11
Electrical equipment for the process plant

11.1 Design of installation

11.1.1 Installations are to be designed in accordance with Pt 6, Ch 2, or with a recognized National or International Standard or Code of Practice.

11.1.2 Attention must be given to any relevant statutory regulations of the National Authority of the country in which the ship is to be registered or in which the process plant is to be operated.

11.2 Equipment suitability for environment

11.2.1 Electrical equipment is to be constructed so that it is suitable for use in the environmental conditions envisaged, e.g. in areas of high ambient temperature, derating may be necessary.

11.3 Hazardous zones

11.3.1 Where flammable gases and vapours are involved, the defining of hazardous zones is to be in accordance with a National or International Standard or Code of Practice.

11.4 Certified safe-type equipment

11.4.1 Where safe-type equipment is permitted in hazardous zones, e.g.:

- Intrinsically-safe (symbol i),
- Flameproof (symbol d),
- Increased safety (symbol e),
- Pressurized enclosure (symbol p),

such equipment is to be certified for the gases and vapours involved. The construction and type testing are to be in accordance with IEC 60079: *Electrical Apparatus for Explosive Gas Atmospheres*, or an equivalent National Standard.

11.5 Survey and testing

11.5.1 All electrical equipment is to be installed and tested to the Surveyor's satisfaction.

Section 12
Control engineering for the process plant

12.1 Design of installation

12.1.1 Normal good engineering practice and standards are to be employed in any control system(s) fitted.

12.1.2 Due to the wide variety of types of process plant, it is not possible to lay down precise details of control scheme(s), since any control scheme is affected by the nature of, and the operating procedures of, the process plant. A description of the expected method of operation of the process plant is to be submitted.

12.2 Equipment

12.2.1 Control equipment is to be compatible with the materials involved in the plant process.

12.2.2 Where flammable gases or vapours are involved, control equipment located in hazardous zones is to be of certified safe-type.

12.3 Survey and testing

12.3.1 Control system(s) are to be installed and tested to the Surveyor's satisfaction.

Section 13
Plant blow-down systems

13.1 General

13.1.1 Where a liquid blow-down system is provided in the process plant, the design and installation are to make adequate provision for the effects of back pressure in the system and vapour flash off when the pressures of liquids in the blow-down system are reduced.

13.1.2 Substances which will react with each other are to be provided with separate systems.

Section 14
Plant flare gas systems

14.1 General

14.1.1 Details of any flare gas stack system and proposals for installation on board the ships, including safety arrangements, are to be submitted for consideration.

14.1.2 The protection zone around the nozzle of the flare gas stack is dependent upon the limiting radiation intensity under all conditions and, also, whether suitable radiation screens are provided. The flare gas stack is to be located so that the nozzle is situated not less than the radius of the protection zone or 50 m, whichever is the greater, from equipment and manned stations, etc.

14.1.3 The arrangements are to ensure that combustion of the flare gas is complete and safe at all times.

Section 15
Supply and discharge arrangements for feedstock and product

15.1 General

15.1.1 Arrangements are to be made to isolate the ship from the supply of feedstock for processing, the supply of oil fuel or gas to boilers, heaters, etc., and the return flow of product, chemicals or process effluent, blow-down or flare gas, etc.

15.1.2 The arrangements are to provide for valves installed at the shore connection, where applicable, and on board ship which are to be operable from shut-off control and indicating stations on the ship, on the shore, and at the valves.

15.2 Emergency procedures

15.2.1 Detailed instructions of the emergency shutdown and evacuation procedure are to be posted in a prominent position at the ship and shore control stations, where applicable.

Section 16
Ventilation of the process plant and other spaces associated with the process plant operation

16.1 General

16.1.1 An efficient means of ventilation is to be provided for all enclosed compartments associated with the operation of the process plant.

16.1.2 The capacity of the ventilation systems is to comply with the requirements of Pt 5, Ch 15,1.7 or the *Rules for Ships for Liquefied Gases*, or Chapter 12 of the *Rules for Ships for the Carriage of Liquid Chemicals in Bulk*, where applicable, or to an acceptable Code of Practice suitably modified and/or adapted where necessary to suit the marine environment. It is to be related to the hazard and/or environmental consideration of manned spaces during normal operation, and take into account additional requirements which may be necessary during start-up procedures.

16.2 Design and construction

16.2.1 Hazardous compartments where flammable and/or toxic substances are being processed or produced are to be arranged for underpressure ventilation, except as stated in 10.2.4.

16.2.2 Safe compartments, including control rooms, are to be arranged for overpressure ventilation.

16.2.3 The number and capacity of fans are to be such that the minimum ventilation capacity required in each compartment is maintained at all times, with one unit out of service. If internal combustion engines are proposed, their fuel supply is to be kept separate from any other system. Electric motors are to be supplied by two alternative circuits, each of which is capable of supplying all the motors which are normally connected to that circuit and which are operated simultaneously.

16.2.4 The mechanical ventilation system is to be capable of being controlled from a position outside the compartment being ventilated.

16.2.5 Reduction of ventilation capacity below the required level should be indicated in the compartment and also in the control room by an audible and visible alarm.

16.2.6 The parts of the rotating body and of the casing of each fan situated in a hazardous space are to be made of recognized spark-proof materials. If non-metallic materials are used, they are to have anti-static properties.

16.2.7 Ventilation trunking or ducting is to be suitably coated or painted, or made from material suitable for the substances processed or produced, or any combination of the substances which might result from accidental admixture.

16.3 Air inlets and discharges

16.3.1 The air inlets for the ventilation systems are to be located in a designated safe area.

16.3.2 The air inlets and discharges of the ventilation system are to be so situated that recirculation of the vented vapours does not occur.

16.3.3 The discharges from ventilation systems which may contain vapours that present a hazard due to reaction with each other are to be effectively segregated.

16.3.4 The discharges from ventilation systems which may contain hazardous vapours are to be located not less than 10 m from the nearest air intake or opening to accommodation, service and control station spaces or other safe spaces, and from all possible sources of ignition.

16.3.5 Air intakes and openings into the accommodation spaces and all service and control station spaces are to be fitted with closing devices. For toxic gases, these devices are to be operable from inside the space.

16.3.6 Where it is impracticable to locate a plant service or control station so that any access thereto is from a safe space, the service or control station is to be maintained at an overpressure of not less than 5 mm water gauge above the surrounding spaces. Details of the arrangements to ensure that this pressure differential is maintained are to be submitted.

16.3.7 Airlocks for intercompartmental access doors and emergency escape trunks are to have separate ventilation systems so arranged that an overpressure of 5 mm water gauge is maintained above the adjacent compartments. Details of the arrangements to ensure that this pressure differential is maintained are to be submitted.

16.4 Installation and inspection

16.4.1 The ventilation systems are to be installed to the Surveyor's satisfaction.

16.4.2 The Surveyors are to be satisfied that the ventilation system is capable of maintaining a safe environment during process plant operation. This may require monitoring over an extended period to prove its effectiveness.

■ *Section 17* Gas detection

17.1 General

17.1.1 An efficient gas detection system, suitable for the gases and/or vapours being processed or produced, and for the measurement of oxygen levels in the process plant compartments, is to be provided. Gas detector systems are also to comply with the requirements of Section 17 or of Chapter 13 of the *Rules for Ships for Liquefied Gases*, where applicable.

17.2 Design and construction

17.2.1 The equipment is to consist of a permanently fixed installation and at least two sets of portable equipment suitable for the process or products involved.

17.2.2 The position and number of fixed sampling points should be determined with due regard to the density of the gases and/or vapours of the substances processed or produced, and the dilution resulting from compartment ventilation. In each case, a sufficient number of sampling points are to be provided to give efficient selective sequential sampling to maintain a safe environment.

17.2.3 Unmanned or closed compartments, such as cofferdams, etc., associated with plant processing or producing flammable or toxic substances, are to have permanently installed sampling points suitable for use with portable detection equipment to be used before entry of the spaces by personnel and thereafter continuously while occupied by them.

17.2.4 Arrangements of the sampling point pipe runs are to be such that there is no possibility of hazardous gases and/or vapours entering a safe space. Common sampling lines to the detection equipment are not to be fitted.

17.2.5 The permanently installed gas detection system is to give audible and visible alarm, both in the control station and within the compartment, during hazardous conditions.

17.2.6 Except where continuous sampling is required (i.e. as in 7.2.5), the gas detection equipment should be capable of sampling and analysing from each sampling point at agreed intervals, which are in no case to exceed 30 minutes.

17.2.7 The gas detection equipment is to be designed so that it may be readily and regularly tested and calibrated. Suitable equipment and span gas is to be provided for this purpose. In addition, regular checking procedures with portable equipment are to be provided, particularly for closed or unmanned spaces during process plant operation.

17.2.8 Where equipment for detecting the specific flammable, toxic or asphyxiate substances which may be present in process plant spaces cannot be provided, full details are to be submitted, including personnel protection requirements and arrangements for decontaminating such spaces if necessary.

17.3 Installation

17.3.1 The gas detection system is to be installed to the Surveyor's satisfaction.

■ *Section 18* Fire protection, detection and extinction

18.1 General

18.1.1 The requirements of SOLAS Chapter II-2 and the *Rules for Ships for Liquefied Gases* are to be complied with, so far as they are applicable. Additional protection, consistent with the fire hazard involved, may be required for process plant control stations, and accommodation spaces. For the position of accommodation spaces relative to the process plant, *see* 6.2.

18.1.2 Where the design of the process plant is such that it may be operated only while the vessel or floating structure is specially moored, anchored or otherwise linked close to the shore, consideration will be given to a shore-based fire-fighting facility, taking account of the particular hazards involved.

18.2 Design arrangements

18.2.1 Arrangements are to be made in enclosed process plant spaces to prevent contact of dangerously interreactive substances and of flammable materials with sources of ignition. In general, compartments containing process plant are not to exceed 40 m in length, and the boundary bulkheads are to be 'A' Class divisions.

18.2.2 Where, during operation, process plant spaces or adjacent hazardous zones contain or are likely to contain flammable and/or explosive mixtures, special consideration is to be given to the exclusion of all possible sources of ignition.

18.2.3 All heated surfaces, e.g. exhaust pipes, boiler uptakes and steam pipes, are to be effectively lagged or cooled, so that the maximum temperature, °C, of the surfaces is, in general, not to exceed 70 per cent of the auto-ignition temperature, °C, of any substances which may be present in the compartment. In no case is the difference in these temperatures to be less than 50°C.

18.2.4 Compartments where a fire hazard exists and which are not continuously manned are to be provided with an approved fire detection system which shall give visible and audible warning of the location of the fire in the control station and, for plant operating at sea (Category 1A), at the navigating bridge control position.

18.2.5 The fire main is to be so arranged, and hoses and nozzles provided, that any part of the compartments or structure associated with the process plant can be reached with two powerful jets of water, one of which shall be produced by a single length of hose. The hoses are to be provided with dual-purpose nozzles capable of producing a jet or a spray. Special consideration will be given to an exemption from this requirement in respect of compartments where the use of water would in itself constitute a hazard.

18.2.6 Each compartment where the fire hazard so demands is to be provided with an approved fixed fire-extinguishing system capable of extinguishing fires involving the materials present. Operation of such a system at its required output is not to prevent the simultaneous use of the required jets of water from the fire main. Where carbon dioxide systems and Halon systems are fitted, due consideration should be given to the danger of static electricity.

18.2.7 An adequate number of portable fire extinguishers are to be provided in each compartment where a fire hazard exists. The number of such extinguishers will be decided in relation to the nature of the hazard and the layout of the compartment, but shall not be less than two, one of which is to be positioned near the entrance. The extinguishing medium is to be considered in relation to the nature of the hazard involved.

18.2.8 Means are to be provided for stopping all fans and, where practicable, closing all openings which might admit air to the compartment. Such means should be capable of being operated from a position outside the compartment and not likely to be rendered inaccessible by a fire in the compartment.

18.2.9 Means are to be provided for stopping the supply of combustible materials to the compartment in the event of fire.

18.2.10 The provision of additional fireman's outfits, each complying with the requirements of SOLAS Reg. II-2/A, 17, and the necessity for protective clothing, will be specially considered in relation to the layout of the process plant and the hazards involved.

Section

Section 1 General

1.1 Application

1.1.1 The requirements of this Chapter apply to ships intended for fire-fighting operations and are additional to those applicable in other Parts.

1.1.2 A ship provided with fire protection and fire-fighting equipment in accordance with these Rules will be eligible for an appropriate class notation which will be recorded in the *Register Book*.

1.1.3 Requirements additional to these Rules may be imposed by the National Authority with whom the ship is registered and/or by the Administration within whose territorial jurisdiction the fire-fighting ship is intended to operate.

1.2 Classification and class notations

1.2.1 The class notations which may be assigned are:

- '**Fire-fighting ship 1** (total monitor discharge capacity in brackets)',
- '**Fire-fighting ship 2** (total monitor discharge capacity in brackets)',
- '**Fire-fighting ship 3** (total monitor discharge capacity in brackets)',
- '**Fire-fighting ship 1** (total monitor discharge capacity in brackets) **with water spray**',
- '**Fire-fighting ship 2** (total monitor discharge capacity in brackets) **with water spray**',
- '**Fire-fighting ship 3** (total monitor discharge capacity in brackets) **with water spray**'.

1.2.2 The notation **Fire-fighting ship 1**, **Fire-fighting ship 2** or **Fire-fighting ship 3** signifies that a ship complies with these Rules and is provided with the appropriate fire-fighting equipment described in Table 3.1.1, with the total discharge capacity of monitors in m^3/h shown in brackets.

1.2.3 The addition of the words '**with water spray**' to the notations referred to in 1.2.1 signifies that a ship is provided with a water spray system, which will provide an effective cooling spray of water over the vertical surfaces of the ship to enable it to approach a burning installation for fire-fighting purposes. The requirements for such a system are set out in 4.2.

Table 3.1.1 Fire-fighting equipment

Equipment	Fire-fighting ship 1	2	3
Minimum total pump capacity, m^3/h	2400	7200	10 000
Minimum number of water monitors	2	3	4
Minimum discharge rate per monitor, m^3/h	1200	1800	1800
Minimum height of trajectory of jets of monitors above sea level, metres	45	70	70
Minimum range of monitor jets, m	120	150	150
Minimum fuel capacity for monitors, hours	24	96	96
Number of hose connections each side of ship	4	8	8
Number of fireman's outfits	4	8	8

1.3 Surveys

1.3.1 The arrangements and equipment referred to in this Chapter are to be examined and tested under working conditions on completion of the installation and, subsequently, annually.

1.4 Submission of plans

1.4.1 The following plans and information are to be submitted:

- A general arrangement showing the disposition of all fire-fighting equipment required by this Chapter.
- Details of major items of fire-fighting equipment, such as pumps and monitors, including their capacity, range and trajectory of delivery.
- A general arrangement plan showing the disposition of fire divisions and their class.
- Detailed plans of the fire divisions and, where applicable, copies of the certificates of approval for the insulating materials proposed.
- A plan of the construction of the fire doors.
- Plans showing the layout and capacity of the water spray system.
- A plan of the seating arrangements for the water monitors.
- Particulars of the means of keeping the ship in position during fire-fighting operations.
- A plan showing the fire pumps, the fire water main, the hydrants, hoses and hose nozzles and the monitors, together with particulars of their delivery capability.
- Details of the fireman's outfits provided.
- Plans of any other fire-fighting systems provided.

1.5 Definitions

1.5.1 'A-60 standard' means a fire-resisting construction of steel or other equivalent material, which is suitably stiffened and so constructed as to be capable of preventing the passage of smoke and flame for the complete period of the one-hour standard fire test. It is to be insulated with approved non-combustible materials, so that the average temperature on the unexposed side will not rise by 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 within 60 minutes.

1.5.2 'Steel or other equivalent material'. In this context, 'equivalent material' means any material which, by itself or due to insulation provided, has structural and integrity properties equivalent to steel at the end of the applicable standard fire test exposure period (e.g. aluminium with appropriate insulation).

1.5.3 'The standard fire test' is one in which specimens of the relevant bulkheads or decks, having a surface area of approximately 4,65 m^2 and a height of 2,44 m, resembling as closely as possible the intended construction and including, where appropriate, at least one joint, are exposed in a test furnace to heat on a time-temperature relationship, approximately as follows:

- At the end of the first 5 minutes, 538°C.
- At the end of the first 10 minutes, 704°C.
- At the end of the first 30 minutes, 843°C.
- At the end of the first 60 minutes, 927°C.

1.5.4 A 'non-combustible material' means a material which neither burns nor gives off flammable vapours in sufficient quantity for self-ignition when heated to approximately 750°C. Any other material is a 'combustible material'.

■ *Section 2* **Construction**

2.1 Hull

2.1.1 The structure of the ship is to be strengthened as necessary to withstand the forces imposed by the fire-extinguishing systems when operating at their maximum capacity.

2.2 Sea suctions

2.2.1 The sea suctions of the fire pumps are to be arranged as low as practicable in the ship's structure to avoid icing or the ingress of oil from the surface of the sea.

2.2.2 All sea inlet valves are to be provided with a low pressure steam or compressed air connection for clearing purposes.

2.3 Stability

2.3.1 Each ship is to comply with the draught and stability requirements of the National Authority and is to have on board sufficient stability data to enable the ship to be properly loaded and handled. This data is to take full account of the effect of the monitors when they are operating at their maximum output in all possible directions of use.

2.4 Manoeuvrability

2.4.1 Arrangements are to be provided to enable the ship to maintain position, so that the monitors may be effectively deployed.

2.5 Bunkering

2.5.1 The Owner should ensure that any fuel which may be required while the ship is operating on station can be safely received on board.

■ *Section 3* **Fire-extinguishing**

3.1 Water monitors

3.1.1 The minimum number of monitors, their discharge rate, their range and their height of trajectory above sea level are to comply with the requirements of Table 3.1.1.

3.1.2 The monitors are to be so arranged that the required direction, range and height of trajectory can be achieved separately, with the required number of monitors operating simultaneously.

3.1.3 The monitors are to be capable of adequate adjustment in the vertical and horizontal direction and are to be so positioned that the jets will be unimpeded within the required range of operation.

3.1.4 Means are to be provided for preventing the monitor jets from impinging on the ship's structure and equipment.

3.1.5 The monitors are to be capable of being activated and manoeuvred by remote control from a protected position providing a good view of the monitors and the operating area of the water jets.

3.1.6 The monitors are to be of robust construction and their seating arrangements are to be of adequate strength for all modes of operation, particular attention being paid to shock loading when all the monitors are activated simultaneously.

3.1.7 For the class notations **Fire-fighting ship 2** and **Fire-fighting ship 3,** an arrangement with one less monitor than required in Table 3.1.1 may be considered as an equivalent solution. In such cases the total pump capacity is to be as required in Table 3.1.1. The minimum range of monitor jets and minimum height of trajectory of jets of monitors above sea level are to be 180 m and 110 m, respectively.

3.2 Pumps

3.2.1 The pumps and their piping system which are intended for serving the monitors are not to be available for services other than fire-extinguishing and water spraying. They are to be provided with independent sea inlets.

3.2.2 Where the pumps are used for fixed water spray systems, the piping is to be independent of that supplying the monitors. The water spray systems are to be adequately protected against overpressure.

3.2.3 The minimum total pump capacities required are shown in Table 3.1.1.

3.2.4 For assignment of the notations **Fire-fighting ship 2** or **Fire-fighting ship 3**, there are to be at least two pumps serving the monitors and they should be of approximately equal capacity. For assignment of the notation **Fire-fighting ship 1**, one pump only need be provided.

3.3 Hose stations

3.3.1 Hose stations are to be provided on each side of the ship in accordance with Table 3.1.1.

3.3.2 Each hose station is to be provided with a hydrant, a hose and a nozzle capable of producing a jet or a spray and simultaneously a jet and a spray. The hoses are to be 15 m in length and not less than 38 mm nor more than 65 mm in diameter. Where hose stations are connected to the monitor supply lines, provision is to be made to reduce the water pressure at the hydrants to an amount at which each fire hose nozzle can be safely handled by one man. The water pressure shall be sufficient to produce a water jet throw of at least 12 m.

3.4 Fireman's outfits

3.4.1 The number of fireman's outfits provided, in addition to those provided in accordance with Pt 6, Ch 4,12 or SOLAS Reg. II-2/A, 17 as applicable, is to be in accordance with Table 3.1.1. They are to be stored in a safe position which is readily accessible from the open deck.

3.4.2 The composition of a fireman's outfit is to be as follows:

- Protective clothing of material to protect the skin from heat radiating from the fire and from burns and scalding by steam. The outer surface is to be water-resistant.
- Boots and gloves of rubber or other electrically non-conducting material.
- A rigid helmet providing effective protection against impact.
- An electric safety lamp (hand lantern) of an approved type with a minimum operating period of three hours.
- An axe having an insulated handle.
- A self-contained breathing apparatus, which is to be capable of functioning for a period of at least 30 minutes and having a capacity of at least 1200 litres of free air. Spare, fully charged air bottles are to be provided at the rate of at least one set per required apparatus.
- For each breathing apparatus, a fireproof lifeline of sufficient 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 life-line is operated.

3.5 Recharging of equipment

3.5.1 A suitable air compressor for recharging the bottles used in the breathing apparatus of the fireman's outfits is to be provided. It is to be capable of recharging the bottles of the breathing apparatus required to be carried, in accordance with Table 3.1.1, in a time not exceeding 30 minutes.

■ *Section 4* Fire protection

4.1 General

4.1.1 In ships which are not provided with a water spray system as described in 4.2 all windows and port lights are to be provided with efficient deadlights or external steel shutters, except in the wheelhouse.

4.2 Water spray systems

4.2.1 Ships which are intended to operate in close proximity to a large fire will require protection from the heat radiated from the fire. Such protection may be afforded by a system which provides a water spray over the surface of the ship, or by a combination of insulation and a water spray system.

4.2.2 The water spray system is to be a fixed system which is capable of delivering a spray of water over all the exposed external vertical surfaces of the hull in the lightest sea-going condition, including the superstructures and deck-houses and over the monitor position. The water spray system will also be required to cover the areas of deck which form the crowns of machinery spaces and other spaces containing combustible materials.

4.2.3 The system is to have a capacity of 10 litres/min per m^2 of the protected area of uninsulated steel and 5 litres/min per m^2 of the protected area which is insulated internally to A-60 standard.

4.2.4 The system is to be divided into sections, so that it will be possible to close down sections covering surfaces which are not exposed to radiant heat.

4.2.5 The nozzles are to be arranged to give an even distribution of water spray over the protected area.

4.2.6 The pumping capacity is to be sufficient to supply simultaneously at the required pressure the sections which serve the maximum area which may be exposed to radiant heat from a fire. If the main fire pumps are used for this purpose, they are to be capable of operating this system and the monitors and hose stations simultaneously at the required pressures, *see also* 3.2.2.

4.2.7 Deck scuppers and freeing ports are to be of sufficient area to ensure efficient drainage of water from decks and horizontal surfaces in all conditions when the water spray system is in operation.

■ *Section 5* **Lighting**

5.1 General

5.1.1 Two searchlights should be provided for illuminating the burning structure and facilitate the effective deployment of the water monitors at night.

5.1.2 The searchlights are to be capable of providing at a range of 250 m in clear atmospheric conditions a level of illumination of 50 lux within an area of not less than 11 m diameter. They are to be capable of being adjusted in the horizontal and vertical directions.

■ *Section 1* General

1.1 Application

1.1.1 The requirements of this Chapter apply to ships with installed dynamic positioning systems and are additional to those applicable in other Parts of these Rules.

1.1.2 A ship provided with a dynamic positioning system in accordance with these Rules will be eligible for an appropriate class notation which will be recorded in the *Register Book*.

1.1.3 Requirements, additional to these Rules, may be imposed by the National Administration with whom the ship is registered and/or by the administration within whose territorial jurisdiction it is intended to operate. Where national legislative requirements exist, compliance with such regulations shall also be necessary.

1.1.4 For the purpose of these Rules, dynamic positioning means the provision of a hydrodynamic system with automatic and/or manual control capable of maintaining the heading and position of the ship during operation within specified limits and environmental conditions.

1.1.5 For the purpose of these Rules, the area of operation is the specified allowable position deviation from a set point, *see* 1.3.2.

1.1.6 Special consideration will be given where the dynamic positioning system is used primarily for purposes other than position keeping, e.g. track following. A descriptive note may be entered in column 6 of the *Register Book* to this effect.

1.2 Classification notations

1.2.1 Ships complying with the requirements of this Chapter will be eligible for one of the following class notations, as defined in Pt 1, Ch 2:

DP(CM) *See* Section 2.
DP(AM) *See* Section 3.
DP(AA) *See* Section 4.
DP(AAA) *See* Section 5.

1.2.2 The notations given in 1.2.1 may be supplemented with a Performance Capability Rating (PCR). This rating indicates the calculated percentage of time that a ship is capable of maintaining heading and position under a standard set of environmental conditions (North Sea), *see* Section 6.

1.2.3 Additional descriptive notes may be entered in column 6 of the *Register Book* indicating the type of position reference system, control system, etc.

1.2.4 Where a **DP** notation is not requested, dynamic positioning systems are to be installed in accordance with the requirements of Section 2 as far as is practicable.

1.3 Information and plans required to be submitted

1.3.1 The information and plans specified in 1.3.2 to 1.3.7 are to be submitted in triplicate. The Operation Manuals specified in 1.3.8 are to be submitted in a single set.

1.3.2 Details of the limits of the area of operation and heading deviations, together with proposals for redundancy and segregation provided in the machinery, electrical installations and control systems, are to be submitted. These proposals are to take account of the possible loss of performance capability should a component fail or in the event of fire or flooding, *see also* 1.3.6 and Sections 4 and 5.

1.3.3 Where a common power source is utilised for thrusters, details of the total maximum load required for dynamic positioning are to be submitted.

1.3.4 Plans of the following, together with particulars of ratings in accordance with the relevant Parts of the Rules, are to be submitted for:

(a) Prime movers, gearing, shafting, propellers and thrust units.
(b) Machinery piping systems.
(c) Electrical installations.
(d) Pressure vessels for use with dynamic positioning system.

1.3.5 Plans of control, alarm and safety systems, including the following, are to be submitted:

(a) Functional block diagrams of the control system(s).
(b) Functional block diagrams of the position reference systems and the environmental sensors.
(c) Details of the electrical supply to the control system(s), the position reference system(s) and the environmental sensors.

(d) Details of the monitoring functions of the controllers, sensors and reference system, together with a description of the monitoring functions.
(e) List of equipment with identification of the manufacturer, type and model.
(f) Details of the control stations, e.g. control panels and consoles, including the location of the control stations.
(g) Test schedules (for both works testing and sea trials) that are to include the methods of testing and the test facilities provided.

1.3.6 For assignment of a **DP(AA)** or **DP(AAA)** notation, a Failure Mode and Effect Analysis (FMEA) is to be submitted, demonstrating that adequate segregation and redundancy of the machinery, the electrical installation and the control systems have been achieved in order to maintain position in the event of equipment failure (*see* Section 4); or fire or flooding, *see* Section 5. The FMEA is to take a formal and structured approach and is to be performed in accordance with an acceptable and relevant national or international standard, e.g. IEC 60812.

1.3.7 Where the **DP** notation is to be supplemented with a Performance Capability Rating (PCR) (*see* 1.2.2), the following information is to be submitted for assignment of a PCR:
(a) Lines plan.
(b) General arrangement.
(c) Details of thruster arrangement.
(d) Thruster powers and thrusts.

1.3.8 Operation Manuals, including details of the dynamic positioning system operation, installation of equipment, maintenance and fault finding procedures, together with a section on the procedure to be adopted in emergency, are to be submitted. A copy of the manual is to be placed and retained on board the ship.

■ *Section 2*
Class notation DP(CM)

2.1 General

2.1.1 For assignment of **DP(CM)** notation, the requirements of 2.1.2 and 2.2 to 2.4 are to be complied with.

2.1.2 Control engineering systems, electrical and piping installations and machinery items are to be designed, constructed, installed and tested in accordance with the relevant requirements of Parts 5 and 6.

2.2 Thrust units

2.2.1 Thruster installations are to be designed, constructed, installed and tested in accordance with the requirements of Pt 5, Ch 20, as applicable.

2.2.2 Thruster installations are to be designed to minimize potential interference with other thrusters, sensors, hull or other surfaces, which could be encountered in the service for which the ship is intended.

2.2.3 Thruster intakes are to be located at sufficient depth to reduce the possibility of ingesting floating debris and vortex formation.

2.2.4 The response and repeatability of thrusters to changes in propeller pitch or propeller speed/direction of rotation are to be suitable for maintaining the area of operation and heading within specified limits.

2.3 Electrical systems

2.3.1 This Section applies to the electrical generation and distribution system associated with the Dynamic Positioning System, whether this generating system is dedicated to the DP system or forms a central generating arrangement for all loads on the ship.

2.3.2 The electrical installation is to be designed, constructed and installed, in accordance with the requirements of Pt 6, Ch 2, together with the requirements of 2.3.3 to 2.3.12.

2.3.3 Where thruster units are electrically driven, the relevant requirements, including surveys, of Pt 6, Ch 2,15 are to be complied with.

2.3.4 Essential services are those defined in Pt 6, Ch 2,1.5, as applicable, together with thruster auxiliaries, computers, generator and thruster control equipment, reference systems, environmental sensors and electrically driven thruster units.

2.3.5 The number and rating of generator sets, transformers and converter equipment are to be sufficient to ensure the operation of essential services, even when one generating set, transformer or converter equipment is out of action.

2.3.6 For electrically driven thruster systems, the generator rating is to be determined by the maximum dynamic positioning load, together with the maximum ancillary load.

2.3.7 There are to be arrangements to prevent overloading of the running generator(s). The tripping of non-essential loads and the temporary reduction in the load demands of electrically driven thrusters may form part of these arrangements.

2.3.8 An alarm is to be initiated when the total electrical load exceeds a preset percentage of the running generator(s) capacity. This alarm is to be adjustable between 50 and 100 per cent of the running capacity and is to be set with regard to the number of generators in service and the effect of the loss of any one generator.

2.3.9 On loss of power due to the failure of the operating generator(s), there is to be provision for the automatic starting and connection to the switchboard of a standby set and the automatic sequential restarting of essential services.

2.3.10 Any loads that require an uninterrupted electrical power supply are to be provided with uninterruptible power systems (UPS) having a capacity for a minimum of 30 minutes' operation following loss of the main supply.

2.3.11 An indication of the absorbed power and the available on-line generating capacity is to be provided at the main dynamic positioning control station.

2.3.12 Essential services are to be served by individual feeders. Services that are duplicated are to be supplied from opposite sides of the main switchboard busbar circuit-breaker and their cables are to be separated throughout their length as widely as practical and without the use of common feeders, transformers, converters, protective devices or control panels and circuits.

2.4 Control stations

2.4.1 Control stations from which the dynamic positioning system may be operated are to be designed in accordance with sound ergonomic principles, and are to be provided with sufficient instrumentation to provide effective control and indicate that the systems are functioning correctly. Colour schemes and screen layouts are to be selected such that necessary information is readily available and clearly displayed. *See also* Pt 6, Ch 1,2.10 for general ergonomic requirements.

2.4.2 Control station(s) are to be located such that the operator has a good view of the ship's exterior limits and surrounding area.

2.4.3 Indication of the following is to be provided at each station from which it is possible to control the dynamic positioning system:
(a) The heading and location of the ship relative to the desired reference point or course.
(b) Vectorial thrust output, individual and total.
(c) Operational status of position reference systems and environmental sensors.
(d) Environmental conditions, e.g. wind speed and direction.
(e) Availability status of standby thruster units.

2.4.4 At least one position reference system, heading reference sensor and wind sensor are to be provided to ensure that the specified area of operation and heading can be effectively maintained.

2.4.5 Position reference systems are to incorporate measurement techniques suitable for the service conditions for which the ship is intended.

2.4.6 Where necessary for the correct functioning of a position reference system, a vertical reference sensor is to be provided to correct for the pitch and roll of the ship. There are to be at least as many vertical reference units as there are associated position reference systems.

2.4.7 Alarms, in accordance with the requirements of Pt 6, Ch 1,2.3, are to be provided for the following fault conditions as applicable:
(a) When the ship deviates from the area of operation.
(b) When the heading exceeds the allowable deviation.
(c) Position reference system fault (for each reference system).
(d) Heading reference sensor fault.
(e) Vertical reference sensor fault.
(f) Wind sensor fault.
(g) Taut wire excursion limit.
(h) Automatic changeover to a standby position reference system or environmental sensor.

2.5 Control system

2.5.1 A centralized remote manual control system is to be provided such that changes in the vectorial thrust output may be readily effected by a single operator action.

2.5.2 Suitable processing and comparative techniques are to be provided to validate the control system inputs from position and other sensors. Abnormal signal errors revealed by the validity checks are to operate alarms.

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

2.5.4 Automatic controls are to be provided to maintain the heading of the ship within specified limits.

2.5.5 The allowable deviation from the desired heading is to be adjustable, but should not exceed the specified limits, *see* 1.1.4. Arrangements are to be provided to fix and identify the set point for the desired heading.

2.5.6 Alarms, in accordance with the requirements of Pt 6, Ch 1,2.3, are to be provided for the following fault conditions:
(a) Control computer system fault.
(b) Automatic changeover to a standby control computer system, as applicable, *see* 4.1.7.

■ *Section 3* Class notation DP(AM)

3.1 Requirements

3.1.1 For assignment of **DP(AM)** notation, the applicable requirements of Section 2, together with 3.1.2 to 3.1.7, are to be complied with.

3.1.2 An automatic and a manual control system are to be provided and arranged to operate independently, so that failure in one system will not render the other system inoperative. Arrangements for manual control are to satisfy the requirements of Section 2 when the automatic system is inoperative.

3.1.3 At least two position reference systems suitable for the intended service conditions and incorporating different measurement techniques, are to be provided and arranged, so that a failure in one system will not render the other system inoperative. Special consideration will be given where the use of different techniques would not be practicable during DP operations.

3.1.4 At least two heading reference sensors and two wind sensors are to be provided and arranged, so that a failure of one sensor will not render the other sensor(s) inoperative.

3.1.5 In the event of a single failure of a position reference, heading reference, or wind sensor, the control systems are to continue operating on signals from the remaining sensors without manual intervention.

3.1.6 The area of operation is to be adjustable, but is not to exceed the specified limits based on a percentage of water depth, or as applicable, a defined absolute or relative surface movement. Arrangements are to be provided to fix and identify the set point for the area of operation.

3.1.7 In the event of failure of any single thruster, the ship is to be capable of maintaining its area of operation and desired heading in the environmental conditions in which the DP system is intended to operate.

■ *Section 4* Class notation DP(AA)

4.1 Requirements

4.1.1 For assignment of **DP(AA)** notation, the applicable requirements of Sections 2 and 3, together with 4.1.2 to 4.1.9 are to be complied with.

4.1.2 Power, control and thruster systems and other systems necessary for the correct functioning of the DP system are to be provided and configured such that a fault in any active component or system will not result in a loss of position. This is to be verified by means of a FMEA (*see* 1.3.6). Such components may include, but are not restricted to, the following:

- Prime movers (e.g. auxiliary engines).
- Generators and their excitation equipment.
- Gearing.
- Pumps.
- Fans.
- Switchgear.
- Thrusters.
- Valves (where power actuated).

4.1.3 Cables, pipes and other components essential for correct functioning of the DP system are to be located and protected, where necessary, such that the risk of fire or mechanical damage is minimized.

4.1.4 The generation and distribution arrangements are to be such that no single fault will result in the loss of more than 50 per cent of the generating capacity or of any duplicated essential services. However, when electrically driven thrusters are employed, a reduction in position keeping capability may be accepted, but this is not to result in a loss of position in the environmental conditions in which the DP system is intended to operate.

4.1.5 For electrically driven thruster systems, provision is to be made for the automatic starting, synchronizing and load sharing of a non-running generator before the load reaches the alarm level required by 2.3.8.

4.1.6 Two automatic control systems are to be provided and arranged to operate independently, so that failure in one system will not render the other system inoperative.

4.1.7 Control systems are to be arranged such that, in the event of failure of the working control system, the standby system takes control automatically without manual intervention and without any adverse effect of the ship's station keeping performance.

4.1.8 At least three position reference systems incorporating at least two different measurement techniques are to be provided and arranged so that a failure in one system will not render the other systems inoperative.

4.1.9 At least three heading reference sensors are to be provided and arranged so that a failure of one sensor will not render the other sensors inoperative.

■ *Section 5* Class notation DP(AAA)

5.1 Requirements

5.1.1 For assignment of **DP(AAA)** notation, the applicable requirements of Sections 2, 3 and 4, together with 5.1.2 to 5.1.12 are to be complied with.

5.1.2 The DP system is to be arranged such that failure of any component or system necessary for the continuing correct functioning of the DP system, or the loss of any one compartment as a result of fire or flooding, will not result in a loss of position. This is to be verified by means of a FMEA. *See* 1.3.6.

5.1.3 Thruster units are to be installed in separate machinery compartments, separated by a watertight A–60 class division.

5.1.4 Generating sets, switchboards and associated equipment are to be located in at least two compartments separated by an A–60 class division, so that at least half of the equipment will be available following a fire or similar fault in one of the compartments. If the equipment is located below the operational waterline, the division is also to be watertight. There is to be provision to connect the switchboard sections together by means of circuit-breakers.

5.1.5 Duplicated cables and pipes for services essential for the correct functioning of the DP system are not to be routed through the same compartments. If this is not practicable, then they are to be carried in A–60 protected ducts. The termination arrangements are also to take due account of the degree of protection. Alternative arrangements will be considered.

5.1.6 An additional/emergency automatic control unit is to be provided at an emergency control station, in a compartment separate from that for the main control station, and is to be arranged to operate independently from the working and standby control units required by 4.1.7.

5.1.7 Arrangements are to be provided such that, in the event of a failure of the working and standby control units, a smooth transfer of control to the emergency control unit may be effected from the emergency control station by manual means.

5.1.8 Arrangements are to be provided at the emergency control station so that changes in the resultant vectorial thrust output may be readily effected by a single operator action.

5.1.9 The control/indication unit of one of the position reference systems required by 4.1.8 is to be located at the emergency control station. A repeater control/indication unit from this system is to be located at the main control station.

5.1.10 One of the heading reference sensors required by 4.1.9 is to be located at the emergency control station.

5.1.11 One wind sensor is to directly supply the additional/emergency control unit.

5.1.12 The additional/emergency control unit is to be supplied from its own independent UPS, *see* 2.3.10.

■ *Section 6* **Performance Capability Rating (PCR)**

6.1 Requirements

6.1.1 Where the **DP** notation is to be supplemented with a Performance Capability Rating (PCR) (*see* 1.2.2), the calculation will be carried out using the information specified in 1.3.7.

6.1.2 Two rating numerals are calculated:

(a) The first numeral represents the percentage of time that the ship can remain on station when subjected to a set of standard environmental conditions (North Sea fully developed) with all thrusters operating.

(b) The second numeral represents the percentage of time that the ship can remain on station when subjected to a set of standard environmental conditions (North Sea fully developed) with the most effective thruster being inoperative.

A typical rating might be (95), (70).

6.1.3 In calculating the PCR, the following parameters are considered:

(a) Thruster force vectors.

(b) Thruster/thruster, thruster/hull and thruster/current interactions.

(c) Sea current loads on the ship.

(d) Wind force on the ship.

(e) Wave drift force on the ship.

6.1.4 Where the ship has been subject to alteration or addition, which may affect the performance characteristics of the DP system, the PCR is to be recalculated.

■ *Section 7* **Testing**

7.1 General

7.1.1 Control units are to be surveyed at the manufacturer's works and are to be tested in accordance with the approved test schedule to the Surveyor's satisfaction, *see* 1.3.5(g).

7.1.2 Before a new installation (or any existing installation, which has been subject to alteration or addition which may affect the performance characteristics of the system) is put into service, sea trials are to be carried out to the approved schedule and to the Surveyor's satisfaction, *see* 1.3.5(g).

7.1.3 The suitability of the dynamic positioning system is to be demonstrated during sea trials, observing the following:

(a) Response of the system to simulated failures of major items of control and mechanical equipment, including loss of electrical power, verifying the findings of the FMEA where required.

(b) Response of the system under a set of predetermined manoeuvres for changing:
  (i) Location of area of operation.
  (ii) Heading of the ship.

(c) Continuous operation of the system over a period of four to six hours.

7.1.4 Two copies of the dynamic positioning system sea trial test schedules, as required by 1.3.5(g), each signed by the Surveyor and Builder, are to be provided on completion of the survey. One copy is to be placed and retained on board the ship and the other submitted to Lloyd's Register (hereinafter referred to as 'LR').

7.1.5 Records and data regarding the performance capability of the dynamic positioning system are to be maintained on board the ship and are to be made available at the time of the Annual Survey, *see* Pt 1, Ch 3,2.2.15.

Section

■ *Section 1* General

1.1 Application

1.1.1 The requirements of this Chapter apply to ships equipped for the recovery of oil floating on the sea and are additional to other applicable Parts of the Rules.

1.1.2 For ships of less than 500 gross tons, also fishing vessels of 12 m length and over, but less than 45 m length, and ships not fitted with propelling machinery, the arrangements for fire protection and extinction are to comply with Section 6. Consideration will be given to the acceptance of the fire safety measures for oil recovery ships prescribed and approved by the Government of the Flag State.

1.1.3 For ships of 500 gross tons and over, also fishing vessels of 45 m length and over, it is the responsibility of the Government of the Flag State to give effect to the fire safety measures, *see* Pt 6, Ch 4,1.1. Where the Government of the Flag State has no National Requirements for oil recovery ships, Lloyd's Register (hereinafter referred to as 'LR') will apply the fire safety measures required by Section 6 for classification purposes.

1.1.4 Requirements additional to these Rules may be imposed by the National Authority with whom the ship is registered and/or by the Administration within whose territorial jurisdiction the ship is intended to operate.

1.2 Classification and class notations

1.2.1 A ship primarily intended for oil recovery operations and complying with the requirements of this Chapter will be eligible for the class notation **Oil Recovery Ship** which will be recorded in the *Register Book*.

1.2.2 A ship not primarily intended for oil recovery operations, which has structural arrangements in accordance with 3.1.7, and which complies with the relevant requirements of this Chapter, will be eligible for the class notation **Occasional Oil Recovery Duties** which will be recorded in the *Register Book*.

1.3 Surveys

1.3.1 The arrangements and equipment referred to in this Chapter are to be examined and tested on completion of the installation and, subsequently, annually.

1.4 Plans and supporting documentation

1.4.1 In addition to the supporting documentation required for classification as specified in other Parts of the Rules, details relevant to oil recovery operations are to be submitted.

1.4.2 Plans covering the following items are to be submitted for approval:

- Structural support in way of equipment.
- Structural arrangement of recovered oil tanks including access.
- Piping system arrangements for recovered oil including venting.
- Power supply, electrical protection and cabling for oil recovery equipment.
- Hazardous areas and spaces.
- Electrical equipment located in hazardous areas and spaces.
- Structural fire protection and extinguishing equipment.

1.4.3 The following supporting documents are to be submitted:

- General arrangement of recovery equipment, including portable items, handling facilities, access, ventilation details, arrangement of other openings to hazardous spaces and adjacent compartments, machinery exhaust outlet positions.
- Gas detection equipment specification.
- Operating Manual.

1.4.4 The following supporting calculations are to be submitted:

- Deck equipment support structure loadings.
- Schedule of loads on the electrical system for oil recovery operations.

■ *Section 2* Oil recovery

2.1 General

2.1.1 The ship is to be capable of performing the following functions at a safe distance from the source of oil spill:

(a) Separation of the oil film from the surface of the sea.

(b) Handling, storage and transportation of the recovered oil.

2.2 Equipment and principal deck arrangement

2.2.1 The arrangements for collection, handling and transfer of recovered oil are to be such that the probability of oil spill on deck and overflow is minimized and the operation is to be performed as far away from the accommodation spaces as practicable. These arrangements are to include hand rails and gratings or other non-slip surfaces to ensure suitable working conditions.

2.2.2 Means are to be provided to keep deck spills away from the accommodation and service areas. This may be accomplished by provision of a permanent continuous coaming not less than 150 mm high.

2.2.3 At least two portable instruments are to be available on board for gas detection.

2.2.4 For engines used in oil recovery operations, *see* 4.4.

2.2.5 Masts and derricks, etc., are to comply with the appropriate sections of Chapters 2 and 3 of LR's *Code for Lifting Appliances in a Marine Environment*.

■ *Section 3* **Ship structure**

3.1 Structural arrangement

3.1.1 The position of bulkheads is to comply with the requirements of Pt 3, Ch 3,4.

3.1.2 Any tanks not utilized during oil recovery operations are to be arranged so that recovered oil cannot be transferred to them inadvertently.

3.1.3 In tanks intended for recovered oil, internal obstructions are to be avoided to prevent the entrapment of foreign objects usually present in recovered oil. Adequate drainage openings are to be provided to ensure free flow of residues to assist in cleaning and gas freeing on completion of recovery operations.

3.1.4 Tanks used for the storage of recovered oil are to be located outside the accommodation and machinery spaces.

3.1.5 Except where permitted by 3.1.6 and 3.1.7, tanks intended for the storage of recovered oil are to be separated from accommodation and machinery spaces by cofferdams. Cofferdams are to be at least one frame spacing in length (600 mm minimum) and are to cover the whole area of the boundary under consideration.

3.1.6 A pump room, oil fuel bunker, water ballast tank or other closed space where oil recovery handling equipment is stored will be accepted in lieu of a cofferdam.

3.1.7 On ships to which 1.2.2 applies, cofferdams may be impractical to arrange. In these cases, tanks arranged adjacent to machinery spaces may be accepted for storage of recovered oil. Acceptance will be conditional upon the tank boundary bulkheads being readily accessible for inspection. The bulkheads are to be carried continuously through joining structure to the top of the tank, where full penetration welding is to be carried out. Such tanks will require to be pressure tested at every Periodical Survey, *see* Table 1.8.2 in Pt 3, Ch 1, as applicable to oil tankers. Special consideration will be given to arrangements incorporating double bottom tanks in these locations.

3.1.8 All openings to tanks for recovered oil are to be located on the open deck. This includes sounding pipes, vent pipes, and hatches for the deployment of portable pumps and hoses. Suitable access hatches, not less than 600 mm x 600 mm, are to be similarly arranged to facilitate tank cleaning and gas freeing. Dual access hatches, as widely separated as practicable, are to be provided for tanks of a cellular nature.

3.1.9 Removable manhole covers are to be avoided where practicable, except for access from open deck or void spaces to ballast or fresh water tanks.

3.1.10 Where there is a risk of significant sloshing induced loads, additional strength calculations may be required, *see* Pt 3, Ch 3,5.4.

3.1.11 Where recovered oil temperatures are to be increased significantly above 65°C during transit voyages, attention is drawn to Pt 4, Ch 9,12 regarding thermal stress considerations.

3.2 Scantlings

3.2.1 The scantlings will receive individual consideration on the basis of Pt 4, Ch 9 and Ch 10, as applicable.

■ *Section 4* **Machinery arrangements**

4.1 Piping arrangements

4.1.1 Piping arrangements for the recovered oil system are to be located outside machinery spaces and are to have no connections to such spaces.

4.1.2 When the ship is in oil recovery mode, means are to be provided to isolate the oil recovery system from any other system to which it may be connected.

4.1.3 Ventilation outlets from the recovered oil tanks are to have a minimum height of 2,4 m above deck and be fitted with flame screens. Temporary pipe sections may be used for this purpose. Outlets are to be located not less than 5 m measured horizontally from the nearest air intakes and openings to accommodation and enclosed spaces containing a source of ignition and from deck machinery and equipment which may constitute an ignition hazard.

4.1.4 Each recovered oil tank is to be fitted with suitable means of ascertaining the liquid level in the tank. Sounding pipes or other approved devices are acceptable for this purpose.

4.2 Pump room for recovered oil

4.2.1 Pump rooms are to be fitted with a permanent ventilation system of the mechanical extraction type.

4.2.2 The ventilation system is to be capable of being operated from outside the compartment being ventilated and a notice is to be fixed near the entrance stating that no person is to enter the space until the ventilation system has been in operation for a specified period, sufficient to achieve at least five air changes based on the gross volume of the space.

4.2.3 The ventilation system is to be capable of at least six air changes per hour, based on the gross volume of the space.

4.2.4 Protection screens of not more than 13 mm square mesh are to be fitted outside openings of ventilation ducts, and ventilation intakes are to be so arranged as to minimize the possibility of recycling hazardous vapours from any ventilation discharge opening. Vent exhausts are to be arranged to discharge upwards.

4.2.5 The vent exhausts from pump rooms are to discharge at least 3 m above deck, and from the nearest air intakes or openings to accommodation and enclosed working spaces, and from possible sources of ignition.

4.2.6 Ventilation fans to be constructed in accordance with Pt 5, Ch 15,1.8.

4.2.7 Pump rooms are to have no direct communication with machinery spaces.

4.2.8 Bilge drainage of the pump room is to be effected by pumps or bilge ejector suctions. For ships of less than 500 gross tons, the pump room bilge may be drained by a hand pump having a 50 mm bore suction.

4.3 Ventilation of machinery spaces

4.3.1 Where machinery spaces adjacent to recovered oil tanks are permitted by 3.1.7, the ventilation arrangements are to comply with 5.4.1(a) and (b).

4.4 Exhaust systems

4.4.1 The exhaust lines of diesel engines, boilers and equipment containing sources of ignition and the vents of diesel engine crank cases are to be led to a position outside any hazardous area as defined in 5.3. In addition, suitable spark arrestors are to be fitted.

4.5 Miscellaneous

4.5.1 Low sea suctions are to be provided to supply water for the machinery and all fire pumps.

4.5.2 Means are to be provided to enable heating coils in recovered oil tanks and adjacent tanks to be blanked off during recovery operations.

4.5.3 The heating medium supply and return lines are not to penetrate the recovered oil tank plating, other than at the top of the tank, and the main supply lines are to run above the weather deck.

4.5.4 If required to facilitate discharge operations, steam returns are to be led to an observation tank which is to be in a well-ventilated and well-lighted part of the machinery space remote from the boilers.

■ *Section 5* Electrical equipment

5.1 General

5.1.1 The electrical installation is to comply with the relevant requirements of Pt 6, Ch 2, with the specific exceptions of 13.1, 13.2, 13.4, 13.6, 13.7 and 13.9, which are replaced by 5.3 to 5.6 of this Chapter.

5.2 Systems of supply and distribution

5.2.1 Only the systems of generation and distribution, listed under Pt 6, Ch 2,5.1.2, are acceptable.

5.3 Hazardous zones and spaces

5.3.1 The following zones or spaces are regarded as hazardous during and on completion of oil recovery operations, until proven gas-safe:

(a) The interiors of tanks intended for the storage of recovered oil.
(b) The interiors of piping systems intended for the handling of recovered oil.
(c) Spaces separated by a single bulkhead, deck or other tank boundary, from the interior of a tank intended for recovered oil, or having a bulkhead immediately above or below and in line with a bulkhead of a tank intended for recovered oil, unless protected by a diagonal plate in accordance with Pt 4, Ch 9,1.2.7 or the arrangements comply with the requirements of 3.1.7.
(d) Spaces housing piping systems or other equipment containing or contaminated with recovered oil and having flanged joints or glands or other openings from which leakage of fluid may occur under normal operating conditions.
(e) Zones on open deck within a 3 metre radius of the ventilation outlets, or inspection hatches permitted to be opened under normal operating conditions, of tanks intended for recovered oil.

(f) Zones on open deck within a 1,5 m radius of any sampling or sounding point of a tank intended for recovered oil.
(g) Zones on open deck within a 1,5 m radius of any flanged joints, glands or other parts of any equipment containing or contaminated with recovered oil from which leakage may occur under normal operating conditions.
(h) Zones on open deck within the confines of, and extending 1,5 m beyond, any bund or barrier intended to contain a spillage of recovered oil, up to a height of 1,5 m.
(j) Zones on open deck within a 1,5 m radius of any opening into a space described by (c) or (d).
(k) Zones on open deck over all tanks intended for recovered oil, where the tops of the tanks are exposed to the weather, to the full width of the ship plus 3 m fore and aft of the forwardmost and aftmost tank bulkhead, up to a height of 0,45 m above the deck or to the height of any bulwarks.
(l) Zones on open deck extending 1,5 m beyond those defined by 5.3.1(e) to (j).
(m) Any enclosed or semi-enclosed space having a direct opening into a hazardous zone or space identified above, unless the space is protected by pressurization in accordance with 5.5.1 or 5.5.2, or the opening is a ventilation outlet arranged in compliance with 5.4.2.

5.4 Ventilation

5.4.1 The extent of any hazardous zone within an enclosed or semi-enclosed space may be limited to that defined for an equivalent situation on open deck, provided that the ventilation arrangements fulfil all the following conditions:
(a) Mechanical ventilation is provided, with the air intake and outlet located outside any hazardous area defined by 5.3.1, ensuring at least 12 air changes per hour, and leaving no region of stagnant air.
(b) Ventilation air flow is continuously monitored and so arranged that, in the event of failure of ventilation, an alarm is given at an attended station.

5.4.2 An enclosed or semi-enclosed space having a ventilation outlet situated in a hazardous zone, as defined under 5.3.1(k) or (l), may be regarded as non-hazardous if fulfilling all the following conditions:
(a) The space has mechanical ventilation with the air intake located outside any hazardous area defined by 5.3.1.
(b) The ventilation outlet is equipped with a self-closing flap or other suitable means of closure operating automatically on loss of ventilation airflow.
(c) The space contains no equipment of a type described in 5.3.1(d), or vent from or opening into any hazardous space or zone defined by 5.3.1, other than the ventilation outlet under consideration.
(d) The space is separated by at least two gastight bulkheads from the interior of any tank intended for recovered oil.

5.5 Pressurization

5.5.1 A space having access to a hazardous space or zone, as defined under 5.3.1(c) to (j), may be regarded as non-hazardous if it fulfils all of the following conditions:
(a) Access is by means of an air-lock, having gastight doors, the inner of which, as a minimum, is self-closing without any hold-back arrangement.
(b) It is maintained at an over-pressure of at least 50 Pa relative to the external hazardous area by ventilation from a non-dangerous area.
(c) The relative air pressure within the space is continuously monitored and so arranged that, in the event of loss of over-pressure, an alarm is given at an attended station.
(d) It contains no piping system or equipment of a type described in 5.3.1(d), and no vent from or opening into any hazardous space or zone defined by 5.3.1, other than the access under consideration.
(e) It is separated by at least two gastight bulkheads from the interior of any tank intended for recovered oil.

5.5.2 A space having access to a hazardous zone, as defined under 5.3.1(k) or (l), may be regarded as non-hazardous if it fulfils all of the following conditions:
(a) Access is by means of a gastight self-closing door without any hold back arrangement.
(b) It is maintained at an overpressure in accordance with 5.5.1(b).
(c) The air pressure within the space is monitored in accordance with 5.5.1(c).
(d) It contains no piping system or equipment of a type described in 5.3.1(d), and no vent from or opening into any hazardous space or zone defined by 5.3.1, other than the access under consideration.
(e) It is separated from the interior of any tank intended for recovered oil in accordance with 5.5.1(e).

5.5.3 A space having access to a hazardous space or zone, as defined under 5.3.1(c) to (j), and fulfilling the conditions given under 5.5.2(a) to (e) may be regarded, for the purposes of selection of electrical equipment, as equivalent to an open-deck hazardous area, such as defined under 5.3.1(k).

5.6 Selection of electrical equipment for installation in hazardous areas

5.6.1 The installation of electrical equipment in hazardous areas is to be minimized as far as is consistent with operational necessity and the provision of lighting, monitoring, alarm or control facilities enhancing the overall safety of the ship.

5.6.2 When electrical equipment is to be installed in hazardous areas, unless permitted otherwise by 5.6.3 or 5.6.4, it is to be of a 'safe type', as listed below, certified or approved by a competent authority for Group IIA, temperature class T3. The construction and type testing is to be in accordance with IEC 60079: *Electrical Equipment for Explosive Gas Atmospheres*, or an acceptable and relevant National Standard.
- Intrinsically safe Ex 'i'
- Increased safety Ex 'e'

- Flameproof Ex 'd'
- Pressurized enclosure Ex 'p'
- Powder filled Ex 'q'
- Encapsulated Ex 'm'

5.6.3 Consideration may additionally be given to the use of equipment of the following types:

(a) Equipment such as control panels, protected by purging and pressurization and capable of being verified by inspection as meeting the requirements of IEC 60079-2.
(b) Simple non-energy-storing apparatus having negligible surface temperature rise in normal operation, such as limit switches, strain gauges, etc., incorporated in intrinsically-safe circuits.
(c) Submersible pumps, having at least two independent methods of shutting down automatically in the event of low liquid level.
(d) Radio aerials having robust construction, meeting the relevant requirements of IEC 60079-15. Additionally, in the case of transmitter aerials, it is to be shown, by detailed study or measurement, or by limiting the peak radiated power and field strength to 1 W and 30 V/m, respectively, that they present negligible risk of inducing incendive sparking in adjacent structures or equipment.
(e) Electrical apparatus having a special type of protection (Ex's'), certified or approved by a competent authority.
(f) Electrical apparatus having the type of protection Ex'n' (or Ex'N'), that, in normal operation, is not capable of igniting a surrounding explosive gas atmosphere, and in which a fault capable of causing ignition is not likely to occur.

5.6.4 Equipment not meeting the requirements of 5.6.5 to 5.6.14 may be installed in hazardous zones or spaces, or locations rendered non-hazardous by ventilation or pressurization, if not required to be energized during oil recovery operations, and not essential for the safety of the ship or crew. Such equipment is to be controlled by multi-pole switches or circuit breakers situated outside any hazardous area. Provision is to be made for the complete isolation of these circuits and locking the means of control in the off position.

5.6.5 In tanks and piping systems defined by 5.3.1(a) and (b), only the following electrical equipment will be permitted:

(a) Intrinsically-safe apparatus of category 'ia'.
(b) Simple apparatus, as defined under 5.6.3(b), incorporated in an intrinsically-safe circuit of category 'ia'.
(c) Submersible pumps, as defined under 5.6.3(c).
(d) Ex's' apparatus, certified for use in Zone 0, as defined by IEC 60079-10.
(e) Cable required for the operation of the equipment installed.

5.6.6 In spaces adjacent to tanks, as defined by 5.3.1(c), with no mechanical ventilation, only the following electrical equipment will be permitted:

(a) That described in 5.6.5(a), (b), (d) and (e).
(b) Ex'd' lighting fittings.
(c) Ex'p' lighting fittings of either the air-driven type, or pressurized from an external source of protective gas and arranged to be de-energized automatically on loss of pressurization.
(d) Gas detector heads having sinter-type flametrap protection, included within an intrinsically-safe circuit, all of which is to be certified as a system.
(e) Ex'd' alarm sounders, without internal sparking contacts.
(f) Cables for impressed current cathodic protection systems (for external hull protection only) installed in heavy gauge steel pipes with gastight joints up to the upper deck; the arrangements are to comply with Pt 3, Ch 2,3.5.3.
(g) Through runs of cables, installed in heavy gauge steel pipes with gastight joints.

The electrical equipment described in (b), (c) and (e) will be permitted only where personnel are required to have access to the space during oil recovery operations.

5.6.7 In spaces adjacent to tanks, as defined by 5.3.1(c) having mechanical ventilation, and in spaces and zones containing piping systems, equipment, etc., or close to vents, flanges, etc., and other zones as defined by 5.3.1(d) to (j), only the following electrical equipment will be permitted:

(a) That described in 5.6.6.
(b) Intrinsically-safe apparatus of category 'ib'.
(c) Simple apparatus, as defined under 5.6.3(b), incorporated in an intrinsically-safe circuit of category 'ib'.
(d) Other apparatus certified as Ex'e', Ex'd', Ex'q', Ex'm' or Ex's'.
(e) Pressurized equipment, certified Ex'p', or as described in 5.6.3(a), arranged to be de-energized automatically on loss of pressurization.
(f) Through runs of cable in spaces and zones described in 5.3.1(d) to (j) only.

5.6.8 In zones defined by 5.3.1(k) and (l), only the following electrical equipment will be permitted:

(a) That described in 5.6.7.
(b) Pressurized equipment, certified Ex'p', or as described in 5.6.3(b), arranged to give an audible and visual alarm at a manned station in the event of loss of pressurization.
(c) Equipment as described in 5.6.3(d) and (f).

5.6.9 Electrical installations in enclosed or semi-enclosed spaces, as described in 5.3.1(m), are to comply with the requirements for the space or zone into which the opening leads, unless ventilated in accordance with 5.4.1 or 5.4.2.

5.6.10 Electrical installations in enclosed or semi-enclosed spaces, ventilated as described in 5.4.1, are to comply with the requirements for hazardous zones, as described in 5.3.1(e) to (l), within the radii or distances from adjacent sources of hazard or sources within the space specified by these paragraphs. Equipment within a radius of 3 m from any ventilation outlet of such a space is to be of a type described in 5.6.8. Equipment not of a type described in 5.6.7 is to be provided with a means of disconnection capable of being controlled from an attended station in the event of ventilation failure. Where the means of disconnection is located within the space, then it is to be of a 'safe type'.

5.6.11 Electrical installations in machinery spaces adjacent to recovered oil tanks, where permitted by 3.1.7, are to comply with the requirements of 5.6.10, and the additional requirement that equipment within 0,45 m of the tank bulkhead or the bottom of the space is to be of a type described in 5.6.8.

5.6.12 In pressurized spaces defined by 5.5.1, electrical equipment not of a type described in 5.6.8 is to be automatically disconnected in the event of loss of overpressure. Other equipment is to be provided with a means of disconnection capable of being controlled from an attended station in the event of loss of overpressure. Where the means of disconnection is located within the space, it is to be of a 'safe type'. Emergency lighting, pressure monitoring equipment and any alarm sounders or lights are to be of types described in 5.6.6.

5.6.13 In pressurized spaces defined by 5.5.2, any equipment not of a type described in 5.6.8 is to be provided with a means of disconnection capable of being controlled from an attended station in the event of loss of overpressure.

5.6.14 In pressurized spaces defined by 5.5.3, only electrical equipment as described in 5.6.8 may be permitted. Any equipment that is not of a type described in 5.6.7 is to be provided with a means of disconnection capable of being controlled from an attended station in the event of loss of overpressure. Emergency lighting, pressure monitoring equipment and any alarm sounders or lights are to be of types described in 5.6.6.

■ *Section 6* Fire protection and extinction

6.1 Structural fire protection

6.1.1 Exterior boundaries of superstructures and deckhouses enclosing accommodation and service spaces, including any overhanging decks which support such accommodation and service spaces, are to be insulated to 'A-60' standard for all parts which face deck areas where there are arrangements for collection, handling and transfer of recovered oil and for a distance 3 m aft or forward thereof.

6.1.2 Windows and side scuttles in the exterior boundaries, referred to in 6.1.1, are to be provided with permanently installed inside covers of steel. Aluminium alloy components are not to be used in the construction of the windows and side scuttles.

6.1.3 As an alternative to compliance with 6.1.1 and 6.1.2, a fixed water spraying system may be accepted. The system is to be capable of delivering water at a rate of 10 litres/m^2/min. on all boundaries, windows and side scuttles, that would otherwise be required to comply with 6.1.1 and 6.1.2.

6.2 Fire-extinguishing arrangements

6.2.1 Deck areas, where there are arrangements for the collection, handling and transfer of recovered oil, are to be provided with the following fire-extinguishing equipment:

(a) Two dry powder fire-extinguishers, each at least 50 kg capacity.
(b) At least one portable low expansion foam applicator.

6.2.2 The fire-extinguishers are to be located near the working deck identified in 6.2.1 and are to be fitted with discharge hoses.

6.2.3 The foam installation is to be capable of applying foam to any part of the working deck. The capacity of any applicator is to be not less than 400 litres/min. of foam solution and the applicator throw in still air conditions is to be not less than 15 m. Sufficient foam concentrate is to be provided for at least 0,4 litres/m^2 of the working deck area with a minimum quantity of 200 litres.

6.3 Fireman's outfits

6.3.1 At least two fireman's outfits, additional to those required by Pt 6, Ch 4,12 or SOLAS Reg II-2/A, 17.3 as applicable, are to be provided.

■ *Section 7* Operating Manual

7.1 General

7.1.1 Information regarding the safe use of the ship with respect to the oil recovery and subsequent operations is to be prepared.

7.1.2 The Operating Manual is, in general, to contain information regarding procedures for:

(a) establishing and maintaining a safe atmosphere in any space(s) liable to become hazardous during oil recovery and subsequent operations;
(b) isolation, where necessary, of electrical equipment in zones or spaces considered hazardous during oil recovery and subsequent operations, and in spaces described in 7.1.2(a) prior to carrying out, or on failure of, the measures required to establish and maintain a safe atmosphere;
(c) fire-fighting;
(d) gas measurements;
(e) recovery and storage of oil;
(f) ballasting;
(g) transfer of recovered oil;
(h) tank cleaning;
(j) gas freeing; and
(k) contacts in the event of an emergency.

Section 1 General

1.1 Application

1.1.1 The requirements of this Chapter apply to tankers equipped with bow/stern loading arrangements to facilitate the transfer of cargo oil from offshore loading terminals, such as loading platforms, loading buoys, FPSOs and FSUs, and are additional to those applicable in other Parts of the Rules. These requirements also apply to submerged turret loading systems where applicable.

1.1.2 Requirements additional to these Rules may be imposed by the National Authority with whom the ship is registered and/or by the Administration within whose territorial jurisdiction the ship is intended to operate.

1.1.3 The materials used are to be suitable for the intended service conditions.

1.2 Class notations

1.2.1 Ships complying with the requirements of this Chapter will be eligible to have one of the following special features notations included in the class notation:

(a) Ships fitted with a bow loading system, **BLS**.
(b) Ships fitted with a stern loading system, **SLS**.
(c) Ships fitted with submerged turret loading systems, **TLS**.

1.3 Surveys

1.3.1 The survey of these items is to be arranged to coincide with hull and machinery surveys, *see* Pt 1, Ch 3.

1.4 Submission of plans and documentation

1.4.1 In addition to the plans and information required by other relevant Sections of the Rules, the plans and information detailed below are to be submitted:

(a) **Bow/stern loading**:
Detail drawing(s) showing:
- Cargo loading equipment.
- Manifold position and pipeline connections.
- Mooring equipment layout, including design loads and supporting structure.
- Fire safety arrangements.
- Control station(s).

(b) **Systems and arrangements**:
General arrangement. Plans showing the general arrangement of all areas where the piping systems are located, together with ventilation arrangements and details of openings for any enclosed spaces at the fore and/or aft part of the ship.
Diagrammatic arrangement. Plans indicating all piping systems arrangements associated with loading systems between cargo tank area and manifold. The plans are to include details of means of isolation, manifold arrangement, means of draining, inerting, cleaning and gas freeing of the cargo piping. Also details of manifold drip tray arrangements with means of drainage, together with any stripping line arrangements, are to be submitted. If the ship is to be installed with a vapour emission control system, plans showing details of piping arrangements are also to be submitted.
Piping system specification. Piping design information which includes the materials specifications, design pressure, maximum allowable transfer rate, corrosion allowance, and design ambient weather conditions. Also the design forces and moments for which the presentation manifold, together with the terminal flange and associated supporting arrangements, have been designed are to be submitted.
Operating Manuals. Operating Manuals are to be submitted for approval and provided on board. The Manuals are to include the following information:
- Particulars of piping arrangements and control systems.
- Operating criteria.
- Procedures for connecting/disconnecting the cargo hose, isolation arrangements, inerting, cleaning, gas freeing of the pipe line and drainage of the drip tray.
- Procedures to be followed during cargo handling operations. These are to include guidance on procedures to be followed in the event of sudden closure of the terminal valve.
- Detailed communication sequence concerning pre-mooring, mooring, pre-loading, loading and tanker departure phases.

Where the ship is fitted with dynamic positioning and/or a positional mooring system(s), the information required by Ch 4,1.3.7 and Ch 8,1.5.6 is also to be submitted as applicable.

(c) **Submerged turret loading**:
Detail drawing(s) showing:
- Arrangement of turret room, including receiving structure, locking mechanism and traction winch equipment with associated supporting structure and design loadings.
- Turret hatch and operating equipment, including hydraulic power pack and control systems, and cargo loading equipment.
- Turret room fire safety arrangements.

- Turret room electrical installations.
- Piping arrangements for all systems associated with the turret loading.

■ *Section 2* Arrangements

2.1 Mooring arrangements

2.1.1 The ship is to be provided with sufficient mooring arrangements, which may be combined with the ship's manoeuvring system, to ensure adequate alignment and security during bow, stern or submerged turret loading operations.

2.1.2 The mooring/positioning system is to be arranged to prevent mooring forces being transmitted to the loading line connector.

2.1.3 Suitable single point mooring arrangements are indicated in Pt 3, Ch 13,8.

2.1.4 Particular attention is to be given to operational requirements and conditions in the design and mounting of securing devices and fittings. Seatings for equipment are to be designed to avoid the formation of pockets or recesses which may lead to excessive corrosion in service.

2.2 Materials for mooring fittings

2.2.1 Where mooring fittings are used as part of a positional mooring system, they are to comply with the requirements of Chapter 8.

2.3 Strength of mooring fittings

2.3.1 The strength of the mooring arrangements associated with the bow/stern loading system is to be considered on the basis of Pt 3, Ch 13,8, and Chapter 8 as applicable.

2.4 Enclosed spaces adjacent to manifold connection

2.4.1 In addition to the arrangements required by Section 4, the following are to be complied with:

(a) Spaces where an explosive gas atmosphere may be present are to be suitably ventilated prior to entry.

(b) Spaces required to be entered during normal operations are to be provided with permanent ventilation arrangements capable of being operated from outside the compartment.

2.4.2 The ventilation arrangements are to provide a minimum of eight air changes per hour, *see* Pt 6, Ch 2,13.

■ *Section 3* Positioning, monitoring and control arrangements

3.1 General

3.1.1 The requirements of this Section are additional to those given in Pt 6, Ch 1, and Chapter 4 and Chapter 8.

3.1.2 If the ship is fitted with a dynamic positioning system, it is at least to comply with the DP(AM) requirements, *see* Chapter 4.

3.2 Control station

3.2.1 A control station for offshore loading may be arranged within the bow area or on the navigation bridge. All operations concerning positioning of the ship and monitoring of mooring and loading parameters are to be capable of being performed from this station.

3.3 Instrumentation

3.3.1 Bow/stern mooring instrumentation is to monitor:

(a) Mooring line traction.

(b) Chain stopper.

(c) Data logger system for recording of mooring and load parameters.

3.3.2 The mooring system is to be provided with a tension meter capable of continuously indicating the tension during the bow loading operation. Consideration may be given to waiving this requirement for ships fitted with a dynamic positioning system.

3.3.3 Bow/stern/submerged turret loading instrumentation is to be provided as follows:

(a) Indicator for loading connector coupling position.

(b) Cargo valve position indicators.

(c) Cargo tank level indicators and high level alarm.

(d) A system for automatic transfer of signals from the control and safety system, to enable personnel on the offshore terminal to effect control of cargo transfer pump(s) and closing of valve(s) on the terminal.

3.4 Emergency disconnect arrangements for pipeline and mooring

3.4.1 In addition to any automatic disconnection systems, a manually operated backup emergency disconnection system is to be provided. This system is to make possible individual operation of the chain stopper and coupling by-pass locks located in the bow control station.

3.4.2 Where an emergency quick-release system is fitted for the mooring system, an equivalent arrangement is to be provided to release the cargo loading hose outboard of the ship.

3.5 Communication

3.5.1 Main and emergency means of communication are to be provided between the bow control station and the offshore loading terminal. The communication equipment is to be intrinsically-safe.

3.5.2 Continuous communication is to be maintained between the control station and the offshore terminal at all times.

■ *Section 4* Fire protection, detection and extinction

4.1 General

4.1.1 The fire protection and extinction arrangements are to comply with the requirements of the *International Convention for the Safety of Life at Sea, 1974*, as amended, or as required by the National Authority.

4.1.2 When Lloyd's Register (hereinafter referred to as 'LR') is authorized to act on behalf of the National Authority in giving effect to the fire safety measures on non-convention tankers or the application of SOLAS for convention ships, LR will also apply the *Guidelines for bow and stern loading and unloading arrangements on oil tankers* as given in IMO MSC/Circ.474, dated 19 June 1987.

4.1.3 Tankers of less than 500 gross tons will be specially considered.

■ *Section 5* Piping systems

5.1 Materials

5.1.1 All materials used in the piping systems are to be suitable for use with the intended cargoes and ambient weather conditions, and are to comply with the relevant requirements of Pt 5, Ch 12 and the applicable requirements of the *Rules for the Manufacture, Testing and Certification of Materials* (Part 2).

5.2 Piping system design

5.2.1 All piping, valves and fittings are to be suitable for the design operating and environmental conditions.

5.2.2 The piping is to comply with the requirements for manufacture, testing and certification of Class II piping systems.

5.2.3 The pipelines and associated piping systems and equipment forward and/or aft of the cargo area are to have only full penetration butt welded joints, except at the loading station where valve connections may be flanged. The pipes are not to pass through enclosed spaces and are to be, as far as possible, self-draining.

5.2.4 Means of mechanical isolation are to be provided in the cargo area, where any pipes used for cargo handling are branched off from the cargo system. Such isolation is to be as near as possible to the boundary of the aftmost, in the case of stern loading, or forwardmost, in the case of bow loading, cargo tank bulkhead and within the cargo area.

5.2.5 A manually operated shut-off terminal valve is to be provided at the manifold. In addition, a blank flange, or equivalent arrangement, is to be provided at the bow and/or stern pipe line end connection.

5.2.6 The terminal pipe, valves and other fittings to which the cargo hose is directly connected are to be of steel or other approved ductile material. They are to be of robust construction, adequately supported and suitable for the stated design conditions. Attention is drawn to the *Recommendations for Oil Tanker Manifolds and Associated Equipment*, published by OCIMF.

5.2.7 Means of emptying, cleaning, inerting and gas-freeing the pipe lines used for cargo handling are to be provided. The venting arrangements are to be located in the cargo deck area. Isolation similar to that described in 5.2.4 is also to be provided.

5.2.8 A drip tray of adequate size, together with means of drainage, are to be provided at the manifold. Suitable spray shields are to be fitted in way of the terminal manifolds where leakage may occur at valves and pipe joints.

5.2.9 Zones on open deck within 3 m of loading manifolds or pipe joints, and within 3 m of the spillage drip tray, are to be regarded as dangerous with regard to machinery or other equipment which could constitute a possible source of ignition, *see also* Pt 6, Ch 2,13.4 and 13.9.

5.2.10 Air vent pipes to the tanks and enclosed spaces, and mechanical ventilation outlets are to be located as far as possible, but in no case less than 3 m, from the terminal manifold or the nearest barrier of the spillage drip tray, whichever is closer.

5.3 Piping system testing and non-destructive examination

5.3.1 Testing and non-destructive examination of the piping system is to comply with the relevant requirements for Class II piping.

■ *Section 6*
Trials and testing

6.1 General

6.1.1 The arrangements and equipment referred to in this Chapter are to be examined and tested on completion of the installation, including calibration of coupling equipment.

6.1.2 Examination and testing is to include witnessing of the initial hook-up trials and the implementation of operational procedures for the range of actions covered by the Operating Manual.

Burning of Coal in Ships' Boilers

Section

Section 1
General

1.1 Application

1.1.1 The requirements of this Chapter apply to ships using coal as a primary source of heat for the generation of steam for main and essential auxiliary services.

1.1.2 The relevant requirements of the Rules and those of the National Authority with whom the ship is registered, together with any special requirements of the Administration within whose territorial jurisdiction the ship is intended to operate, are to be complied with. Attention is drawn to the statutory requirements concerning intact and damaged stability of the ship.

1.1.3 For the purpose of these requirements, it is assumed that no manual handling of coal for the transportation from bunkers to boiler, or for actual firing of the boiler, will be employed. The emphasis has been placed on the presumption that the boiler firing will be by some form of moving grate. Special consideration will be given to other forms of firing, such as pulverized fuel, slurries of coal-oil-water mixtures or fluidized bed firing, if submitted.

1.1.4 For single main boiler installation, *see* Pt 5, Ch 3,5.3.

1.2 Submission of plans

1.2.1 The plans and information required by 1.2.2 to 1.2.4 are to be submitted in triplicate for consideration.

1.2.2 General arrangement plans and specification of the storing, handling and burning equipment and ash handling plant.

1.2.3 Structural plans showing details and arrangements in way of coal bunkers, and support arrangements for coal handling and ash disposal plants.

1.2.4 A general arrangement plan showing details of construction, fire protection and extinction for coal bunkers and coal handling systems, supplemented as necessary, by detailed plans and calculations for fire-extinguishing, explosion suppression, temperature monitoring and carbon monoxide detection systems.

1.3 Surveys

1.3.1 Coal bunkering, coal handling, burning and ash disposal plants are to be built, installed, and tested under operating conditions to the Surveyors' satisfaction and subsequently at each Boiler Survey. Fire-extinguishing, explosion suppression, temperature monitoring and carbon monoxide detection systems are to be installed and tested to the Surveyors' satisfaction and subsequently examined annually as required by Pt 1, Ch 3,2.2.

1.4 Additional bilge drainage

1.4.1 It should be noted that, under the provision of SOLAS 1974, additional bilge drainage is required for passenger ships burning coal, as detailed in 1.4.2 and 1.4.3.

1.4.2 In passenger ships there shall be provided in the boiler room, in addition to the other suctions required by the Rules, a flexible suction hose of suitable diameter and sufficient length capable of being connected to the suction side of an independent power pump.

1.4.3 In passenger ships where there is no watertight bulkhead between the engine and the boiler spaces, a direct discharge overboard or, alternatively, a by-pass shall be fitted from any circulating pump discharge used for emergency bilge pumping duties.

Section 2
Coal storage, handling, ash collection and disposal arrangements

2.1 Coal storage

2.1.1 The arrangements for coal bunkers, including hatchways, ventilation, monitoring and their design characteristics regarding intact and damaged stability are to comply with the requirements detailed in Sections 4 and 7, as applicable.

2.1.2 Coal is to be stored in not less than two bunkers. Vessels on restricted routes having a voyage time less than the capacity of the daily service hoppers, or where the boiler has the alternative means of firing, or where alternative means of propulsion are fitted, may be provided with only one bunker.

2.1.3 The clearance spaces between the boilers, other heated surfaces and the coal bunkers are to be adequate for the free circulation of air necessary to avoid transmission of heat to the coal.

2.1.4 A daily service storage hopper is to be provided for each coal-fired boiler.

2.1.5 Coal bunkers and daily service storage hoppers are to be designed to avoid dead spots and areas where coal can accumulate and impede the normal flow or can provide the conditions to promote spontaneous combustion.

2.1.6 Bunker and daily service storage hopper outlet gravity-fed discharges are to be provided with shut-off devices. Stopping the transfer device will be acceptable in lieu where a bunker delivers to transfer arrangements and stopping the transfer device effectively prevents flow from the bunker, *see* 2.2.4.

2.1.7 Shut-off devices on the coal bunker and daily service storage hopper outlets are to be capable of being operated locally and also from an accessible position outside the compartment in which they are situated.

2.1.8 The arrangements for loading coal into bunkers or during transfer into daily service storage hoppers should, in general, avoid the tendency of the coal to segregate. For this purpose, multiple loading points should be used if necessary.

2.2 Coal handling

2.2.1 Each daily service storage hopper is to be provided with a separate system for transferring coal from the bunker(s). In the case of a single boiler installation, more than one transfer system from the bunker(s) to the daily service storage hopper are to be provided, unless alternative means of firing the boiler is available.

2.2.2 Adequate access facilities are to be provided in the coal feeder systems to permit maintenance and removal of blockages.

2.2.3 Where coal screens or crushers are necessary for the efficient operation of the coal burning equipment, they are to be provided in each boiler coal feed arrangement.

2.2.4 The coal handling plant is to be capable of being stopped locally and from an accessible position outside the compartment in which it is situated, *see* 2.1.6.

2.2.5 The use of milling systems for the production of pulverized fuel will be specially considered.

2.3 Ash collection and disposal arrangements

2.3.1 Each coal fired boiler is to be provided with a bottom ash and fly ash collecting and disposal arrangement.

2.3.2 Where both bottom ash and fly ash collecting and disposal arrangements are operated by either pneumatic or water systems, then these may be made common.

2.3.3 Two independent means of supplying the operating medium for ash collection and disposal systems are to be provided.

2.3.4 Heated ash storage and transfer systems are to be efficiently lagged to minimize risk of fire and to prevent damage by heat.

2.3.5 Where wet ash water transfer systems are used, consideration is to be given to the effects of corrosion and erosion on the collection, transfer and storage equipment.

2.3.6 Ash transfer systems employing water separation arrangements are to be such that water will drain naturally back to the de-watering bins or into a collection tank. Such drainage facilities should not, in general, be led directly to bilge wells.

2.3.7 Where a dry ash collection system is proposed, the arrangement of conveyors, pipes and chutes should avoid condensation due to excessive cooling to prevent solidification of the ash.

2.3.8 Adequate ash storage capacity, with access facilities to permit maintenance and removal of blockages, is to be provided for systems using boilers which have no alternative means of firing. Certain National Authorities or local Administrations prohibit the direct discharge of ash overboard.

■ *Section 3*
Coal burning equipment

3.1 Operating conditions

3.1.1 The design and arrangements for coal burning equipment are to be such that it can be manually controlled from a suitable position local to the boiler fronts.

3.1.2 Burning arrangements for solid fuel firing:

(a) The arrangements should permit a sufficient level of control of coal feed to the grates or bed to avoid uneven firing conditions likely to cause damage to the grate or bed, due to excessive heat or coal build-up, under all operating conditions.

(b) In addition to the adequate supplies of air for efficient combustion, sufficient capacity and means of control of the combustion air supply below the grates or beds are to be provided to ensure cooling of the grate or bed under all conditions of coal or alternative means of firing.

(c) When the coal bed is not fully incandescent, i.e. during low steaming conditions when coal-fired beds are banked or reduced in output, sufficient purging sequences to sweep the furnace volumes are to be provided before any alternative means of firing is attempted.

3.1.3 Where it is proposed to provide means of firing the boiler simultaneously on coal and oil, details of the arrangements for furnace purging and ignition of oil burners are to be submitted and will be the subject of special consideration.

3.2 Forced and induced draught air fans

3.2.1 In boilers fitted with forced and induced draught fans, suitable bias is to be maintained to avoid gas leakage into the boiler room.

3.2.2 In the event of induced draught fan failure, the forced draught fan should be arranged to stop automatically. Alternative arrangements which will permit the forced draught fan to be controlled to reduce the supply of air may be considered.

3.3 Fuel characteristics and specification

3.3.1 In general, the coal burning equipment is to be designed to utilize the various grades of coal likely to be encountered.

3.4 Alternative means of firing

3.4.1 Where it is proposed to use an alternative means of firing, such as oil or coal/oil slurry mixtures, the arrangements are to be in accordance with the requirements for oil burning, *see* Pt 5, Ch 14.

3.4.2 Particular attention is drawn to the requirements concerning arrangements for securely locking up-take dampers in the fully open position when burning oil fuel.

3.4.3 Where it is proposed to use oil fuel burners for lighting up coal fires, details are to be submitted of the pre-purging sequences of the boiler before lighting-up burners are introduced into the furnace.

3.4.4 Where it is proposed to employ lighting-up burners using diesel oil or similar marine distillate fuels, they are to be provided with their own combustion air supply.

3.4.5 Where it is proposed to use steam purging or steam atomizing oil burners with coal-fired boilers, particular attention is to be given to furnace purging arrangements. Details of the purging sequences are to be submitted.

3.4.6 The arrangements for purging the oil burners are to be such that the minimum practicable volume of oil will be introduced into the boiler furnace.

■ *Section 4* Ship structure

4.1 General

4.1.1 The requirements of this Section are additional to those given in other parts of these Rules and in separate Rules for specific ship types.

4.1.2 Other than as permitted in 4.3.2, separation between coal bunkers and adjacent spaces is to be gastight. In oil or chemical tankers, coal bunkers are to be separated from cargo tanks by means of cofferdams.

4.1.3 Boiler room access doors are to comply with Pt 3, Ch 11,6.4, as applicable.

4.1.4 Coaling ports on the side shell are to comply with parts of Pt 3, Ch 11,8 as applicable.

4.1.5 No side scuttles are to be fitted in spaces appropriated exclusively for the carriage of coal.

4.1.6 All openings from coal bunkers are to be located clear of the defined hazardous area for the particular ship type.

4.2 Coal bunker hatchways

4.2.1 Coal bunker hatchways are to be provided with gasketed steel covers and coamings, complying with Pt 3, Ch 11, as applicable.

4.2.2 Coal bunker hatchways are to be located clear of the defined hazardous area for the particular ship type.

4.3 Coal bunker bulkheads

4.3.1 The scantlings of main coal bunker boundary bulkheads which are counted towards the number of bulkheads required by Pt 3, Ch 3,4, or which form the boundary of deep tanks, are to satisfy the requirements of Pt 4, Ch 1,9. Other boundaries are to satisfy the requirements of Pt 4, Ch 1,9, but the load head may be taken to the top of the bunker. The scantlings of cofferdam bulkheads not forming the boundaries of a cargo tank in oil or chemical tankers are to satisfy the requirements of Pt 4, Ch 9,7. In all cases when flooding is envisaged as a means of fire-extinction, the moduli of stiffening members on bunker bulkhead boundaries are to be increased by 25 per cent.

4.3.2 Where the coal bunker is situated immediately forward of the engine room, the aft coal bunker bulkhead may be non-watertight. The scantlings for this bulkhead are to be as required for watertight bulkheads (Pt 4, Ch 1,9) but the load head may be taken to the top of the tank. With this arrangement, the forward end of the coal bunker may, if appropriate, be regarded as the engine room forward bulkhead.

4.3.3 The thickness of the plating in way of the bulkhead knuckles in the region of the hoppers and the plating of the hopper apexes is to be increased by 1,5 mm over that derived from 4.3.1 and 4.3.2. However, the minimum thickness of the lowest strake in the coal hopper is to be not less than 9 mm. Where solid stainless steel is employed, the plate thickness may be reduced by 10 per cent or 1 mm, whichever is the lesser.

4.3.4 Non-watertight coal bunker bulkhead scantlings are to be as required by Table 1.4.8 in Pt 4, Ch 1, but the thickness of the lowest strake is to be not less than 9 mm.

4.3.5 The scantlings of the boundaries of compartments intended for the storage of ash in liquid or slurry form will be specially considered.

4.3.6 Watertight doors may be fitted in watertight bulkheads between permanent and reserve bunkers, and may be of the sliding, hinged or equivalent type. They are to be accessible at all times, *see also* Pt 3, Ch 11,9.

4.3.7 Arrangements are to be made by means of screens or otherwise to prevent the coal from interfering with the closing of watertight doors.

4.4 Longitudinal strength

4.4.1 For the purpose of longitudinal strength, the requirements for the relevant ship types are to be applied.

4.4.2 The calculation of still-water shear forces and bending moments are to cover both departure and arrival conditions, and any special mid-voyage conditions caused by variation in coal bunkering and ballast distribution. Details of typical coal stowage rates are to be submitted, as well as trim and stability data for these conditions.

4.4.3 Where local reduction of double bottom depth is proposed to accommodate coal handling equipment, the strength of the double bottom and scarfing arrangements will require special consideration. Adequate scarfing of longitudinal material in way of double bottom and hopper tanks should be arranged.

4.5 Ventilation

4.5.1 Ventilators serving coal bunkers or boiler rooms are to comply with Pt 3, Ch 12,2 as applicable. In addition, the atmosphere in the bunkers is to be sampled by means of fixed or portable monitors as follows:

(a) prior to entering the space – for oxygen deficiency,
(b) prior to opening the hatchways – for accumulation of flammable gases.

4.5.2 Ventilator exits from main coal bunkers and coal processing spaces are to discharge clear of the defined hazardous area for the particular ship type and not less than 3 m from the nearest intake or opening to accommodation and enclosed working spaces, and from possible source of ignition.

■ *Section 5* Electrical equipment

5.1 General

5.1.1 All electrical equipment should be situated in positions where it is not exposed to concentration of coal dust. Where this is not practicable, the enclosure of the equipment should be designed and installed such that:

(a) Dust cannot enter the interior of the enclosure. An ingress protection rating of at least I.P. 55 in accordance with IEC 60529, if not of a safe-type, is considered to be acceptable.
(b) Dust will not collect on the surface of the enclosure to such an extent that proper cooling is prevented, thus causing a dangerous rise in temperature.
(c) The maximum surface temperature of the enclosure is not capable of igniting the dust, and should be limited to 165°C for equipment not subjected to overloading and 120°C for equipment such as motors, that may be overloaded.

5.2 Arrangements in coal bunkers

5.2.1 Electrical equipment located within the coal bunkers is to be of a safe-type certified for Group II A atmospheres and temperatures Class T1 in accordance with IEC 60079, *Electrical Apparatus for Explosive Atmospheres*, or an equivalent National Standard.

5.2.2 The switches and protective devices for such equipment are to interrupt all lines or phases and are to be located outside the coal bunker spaces. Provision is to be made for the complete isolation of these circuits and locking the means of control in the off position.

■ *Section 6* Control engineering systems

6.1 General

6.1.1 The requirements of Pt 6, Ch 1 are applicable. The additional requirements for boilers which are coal grate-fired and under normal operation are remotely controlled or are automatic in operation, are given in Table 7.6.1.

6.1.2 In general, ships complying with the relevant requirements of Pt 6, Ch 1,4 or Ch 1,5 will be eligible for the notations **UMS** (unattended machinery space) or **CCS** (centralized control station) respectively.

Table 7.6.1 Coal burning: Alarms and safeguards

Item	Alarm	Note
Drum water level	Low	Combustion air; coal spreaders and/or any alternative fuel supply to be shut-off automatically
Daily service hopper level	High/Low	—
Coal feed plant	Failure	—
Primary combustion air system	Failure	Coal spreaders to be stopped automatically
Secondary combustion air system	Failure	—
Coal supply controller (if separate from spreader)	Failure	Per controller
Spreader drive	Failure/ Overload	Per drive. *See also* primary combustion air system failure
Grate drive	Failure/ Overload	Per drive
Localized overheating of the grate	Excessive	—
Induced draught fan	Failure	Coal spreaders to be stopped automatically, *see also* 3.2.2
Ash disposal system	Failure	—

NOTE
Interlocks are to be provided to prevent the burning of oil fuel, unless dampers in the gas passages of uptakes have been securely locked in the fully-open position, *see also* 3.4.2.

■ *Section 7*
Fire protection and extinction

7.1 Fire protection

7.1.1 In general, the coal bunkers are to be separated from adjacent spaces by 'AO' divisions, but where such spaces are intended to contain highly flammable substances, such as the cargo tanks of an oil tanker, they are to be separated from the coal bunkers by a cofferdam or equivalent space.

7.1.2 The spaces above the coal in the coal bunkers and coal processing spaces are to be adequately ventilated to prevent the accumulation of flammable gases. The ventilators are to be provided with means of closure which are readily accessible at all times. Where mechanical ventilation is provided, means are to be provided for stopping the fans from a position which will be readily accessible at all times.

7.2 Fire-extinction

7.2.1 A fixed fire-extinguishing system should be provided in the coal bunkers. This system should discharge CO_2, but alternative arrangements such as water flooding will be considered, *see also* 4.3.

7.2.2 Where, due to operating conditions, it is considered likely that coal dust in significant quantities will be present in the coal crushing and conveying system, an explosion suppression system is to be provided in the coal crushing and conveying system. Activation of the explosion suppression system is to operate an audible and visual alarm.

7.2.3 A fixed fire-extinguishing system should be provided in the ready-use coal hopper and this should be extended to the boiler room, if there is any danger of the spread of fire to that space. The system should depend on $C0_2$, but alternative extinguishing media will be considered. Where it can be shown that the residence time, of the coal in the hopper, is of sufficiently short duration that a fire in the hopper is unlikely to be sustained, consideration will be given to dispensing with this requirement.

Positional Mooring and Thruster-Assisted Positional Mooring Systems

Section

Section 1
General

1.1 Application

1.1.1 The requirements of this Chapter apply to Lloyd's Register (hereinafter referred to as 'LR') classed ships with positional mooring systems or thruster-assisted positional mooring systems and are additional to those applicable in other Parts of the Rules. The Rules are not intended to apply to vessels which have station-keeping capabilities, but which are not required to remain on station in adverse weather conditions. This normally precludes the Rules being applicable to small ships.

1.1.2 Compliance with this Chapter is not mandatory, but ships provided with a positional mooring system or thruster-assisted positional mooring system which do comply will be eligible for an appropriate class notation which will be recorded in the *Register Book* at the specific request of an Owner.

1.1.3 The mooring system will be considered for classification with LR on the basis of operating constraints and procedures specified by the Owner and recorded in the Operations Manual.

1.1.4 Requirements additional to these Rules may be imposed by the National Authority with whom the ship is registered and/or by the administration within whose territorial jurisdiction it is intended to operate.

1.2 Classification notations

1.2.1 Ships provided with a positional mooring system which complies with the requirements of this Chapter will be eligible to have included in the class notation one of the following special features notations:

(a) For ships fitted with a positional mooring system:
PM (Positional mooring system), or
PMC (Positional mooring system for mooring in close proximity to other ships or installations. This notation will apply in particular to any ship operating in conjunction with a fixed installation, e.g. crane barge, accommodation unit, maintenance vessel, etc.)

(b) For ships fitted with a thruster-assisted positional mooring system:
PM Ⓣ1 [or Ⓣ2 or Ⓣ3]
or
PMC Ⓣ1 [or Ⓣ2 or Ⓣ3]
The numeral in the circled supplementary notation, Ⓣ1, etc., defines the thruster allowance which may be permitted in the design of the positional mooring system, and is determined by the capacity/redundancy of the thrust/machinery installation, *see* Table 8.3.2.

1.2.2 Additional descriptive notes may be given and entered in column 6 of the *Register Book* indicating the type of positional mooring system, reference system, control system, limiting environmental criteria, etc.

1.3 Surveys

1.3.1 The positional mooring and thruster-assisted positional mooring systems and their associated equipment are to be examined and tested during construction and under working conditions on completion of the installation. The Periodical Survey of these items is to be arranged to coincide with Hull and Machinery Surveys as required by other Parts of these Rules.

1.4 Definitions

1.4.1 Positional mooring is a method of station keeping by means of multiple anchor lines laid out in catenary array. Each positional mooring system is to consist of the following:
(a) Anchors or anchor piles.
(b) Anchor lines.
(c) Anchor line fittings (shackles, connecting links, wire rope terminations, quick release devices, etc.).
(d) Fairleads.
(e) Winches or windlasses.
(f) Chain or wire rope stoppers.
Where applicable, the structural or mechanical connection of these items to the ship is also considered to be part of the positional mooring system.

1.4.2 'Thruster-assisted Mooring' is the use of thrusters and main propulsion, if so designed, to supplement the ship's anchoring system.

1.5 Plans and data submission

1.5.1 The information and plans specified in 1.5.2 to 1.5.5 are to be submitted in triplicate. One copy of the Operations Manual referred to in 1.5.6 is to be forwarded for information.

1.5.2 Plans and data dealing with positional mooring arrangements and the associated equipment are to be submitted, including the following:

(a) Mooring arrangements with details of mooring patterns, anchor lines and fittings, etc.
(b) Mooring equipment with details of anchors, fairleads and cable stoppers.
(c) Winches or windlasses with details of gearing shafting, brake systems, ratchet and pawl, drum/cable lifter and frame.

1.5.3 For thruster-assisted positional mooring systems, plans of the following, together with particulars of ratings, in accordance with the relevant Parts of these Rules are to be submitted for the following:

(a) Prime movers, gearing, shafting, propellers and thrust units, *see also* Pt 5, Ch 8.
(b) Machinery piping systems.
(c) Electrical installations.

In addition, details of proposals for the redundancy provided in machinery, electrical installations and control systems are to be submitted. These proposals are to take account of the possible loss of performance capability should a component fail. Where a common power source is utilized for thrusters, details of the total maximum load required for thruster-assist are to be submitted.

1.5.4 Plans of control, alarm and safety systems, including the following, are to be submitted:

(a) Functional block diagrams of the control system(s).
(b) Functional block diagrams of the position reference systems and the environmental sensors.
(c) Details of the electrical supply to the control system(s), the position reference system(s) and the environmental sensors.
(d) Details of the monitoring functions of the controllers, sensors and reference system, together with a description of the monitoring functions.
(e) List of equipment with identification of the manufacturer, type and model.
(f) Details of the overall alarm system linking the centralized control station, subsidiary control stations, relevant machinery spaces and operating areas.
(g) Details of the control stations, e.g. control panels and consoles, including the location of the control stations.
(h) Test schedules which are to include the methods of testing and the test facilities provided.

1.5.5 The following supporting plans, data, calculations or documents are to be submitted:

(a) General arrangement showing plan views, side elevations and sections of the ship.
(b) Design criteria showing operating and survival environment, water depth range and required station keeping limits.
(c) Environmental forces on ship showing wind, current and wave drift. These forces are to be verified by direct calculation, model test reports, or full-scale data, etc.
(d) Ship motions showing first order wave motions, surge, sway and yaw. Tank test data or equivalent to be provided.
(e) Mooring analysis, including computer printout where relevant.
(f) Strength calculations for anchors, fairleads, winches/windlasses, cable stoppers and special fittings.
(g) Thruster arrangements for thruster-assist systems, including powers, thrusts and interactions between thrusters, thruster and hull, thruster and current.

1.5.6 An Operations Manual for the system is to be placed on board the ship. This Manual is to contain all necessary information and instructions regarding positional mooring and, where relevant, thruster-assisted positional mooring. It would normally also contain descriptions of the following:

- Mooring systems.
- Laying the mooring system.
- Anchor pre-loading.
- Pre-tensioning anchor lines.
- Tension adjustment.
- Winch performance.
- Winch operation.
- Procedure in event of failure or emergency.
- Procedure for operating thrusters.
- Fault-finding procedures for thruster-assist system.

Section 2
Environmental criteria – Forces and motions

2.1 Limiting environmental criteria

2.1.1 Limiting criteria in the form of maximum operating and survival environmental conditions are to be specified by the Owner or Designer.

2.1.2 The limiting criteria are to be defined in terms of wind and current speeds, wave heights and periods, and water depth range.

2.1.3 As water depth will have a large influence on a ship's mooring capability, the limiting environmental criteria may be varied according to water depth.

2.1.4 **Maximum operating conditions** will be those in which the ship is able to carry out its primary operational activities, while anchor line tensions remain within designated operating limits. *See* 3.2 for required factors of safety in operating conditions.

2.1.5 **Survival conditions** are to be based on an average recurrence period of not less than 50 years. The mooring system is to be such that maximum line tensions will be limited in these conditions to designated survival levels. *See* 3.2 for required factors of safety.

2.2 Design environmental criteria

2.2.1 **Wind**. The design wind speed for wind force determination can normally be taken as the one-hour mean value referenced to 10 m above sea level. Account is to be taken of the variation of wind speed with height above sea level. The wind velocity gradient can be calculated from the following:

$$V_H = V_{10}\left(\frac{H}{10}\right)^{0,125}$$

where

V_H = wind velocity at H height above sea level

V_{10} = 1 hour mean wind speed referenced to 10 m above sea level.

2.2.2 **Current**. The design current speed is to be taken as the sum of wind-induced and tidal current velocities. For calculation purposes, tidal current velocity can be assumed constant over water depth, and wind-induced current velocity can be taken to reduce linearly from its maximum value at the surface to zero at 50 m below sea level.

2.2.3 **Wave**. The significant wave height and period range is to be defined for each relevant design case.

2.3 Environmental forces

2.3.1 In determining environmental forces, it is to be assumed that the defined limiting environment of wind, waves and current will act concurrently. For fixed azimuth mooring systems, these forces are considered to act in the same direction.

2.3.2 Environmental loading on the ship (and the corresponding catenary system motions analysis to determine anchor loads and line tensions, etc.) will require to be investigated for a sufficient number of directions to establish the critical cases.

2.3.3 It is generally to be assumed that the maximum specified environmental conditions can come from any direction relative to the ship's heading. However, in cases where a ship is to be restricted to specific defined locations, consideration will be given to the acceptance of an environmental rosette (allowing the ship to be headed in the most favourable direction with respect to mooring loads).

2.3.4 Where quasi-static methods of analysis are adopted (*see* 3.1.2), at least the wind, current, and mean wave drift forces acting on the ship in the various relevant design conditions are to be calculated or determined. In addition, any significant yawing moments induced by these effects are to be taken into account when carrying out the mooring system motions analysis.

2.3.5 Environmental forces and moments can be determined by suitable methods of direct calculation or by model testing. In either case, account must be taken of all significant load generating structural elements or equipment. In the case of wind force and moment determination, all deck structures, fittings, cranes, towers, superstructures, etc., are to be considered, and for current force, account is to be taken of thrusters, nozzles, propellers, etc.

2.3.6 First order wave motions – the oscillatory motions of the ship – are to be determined. Surge and sway are the most relevant motions in terms of quasi-static mooring analysis, *see* 3.1.2 and Fig. 8.3.1.

2.3.7 The first order wave motions of the ship are to be determined from appropriate wave spectra, either by use of tank testing or by suitable direct calculation methods.

2.3.8 Account is to be taken of the effects of shallow water on the ship's first order wave motions.

■ *Section 3*
Mooring system – Design and analysis

3.1 General

3.1.1 The positional mooring system is to be designed to meet the specified limiting environmental criteria (*see* 2.1), and any associated operational constraints (restricted offset of ship, etc.) as contained in the Operations Manual.

3.1.2 This Section in general, and the anchor line factors of safety in particular, relate principally to the quasi-static approach to mooring analysis. This method of analysis takes wind, current and wave drift forces to be steady effects which will displace the moored ship from its original equilibrium position to a new mean position where the mooring system will have developed sufficient restoring force to 'balance' the steady applied force. Wave-induced oscillatory vessel motions take place about this new mean position. In quasi-static analysis, maximum anchor line tensions are taken to occur at the extremity of vessel offset, *see also* Fig. 8.3.1.

3.1.3 Consideration will be given to the adoption of alternative methods of design for the mooring system, including the use of part-dynamic or full-dynamic analysis techniques. In such cases, factors of safety, etc., will be specially considered.

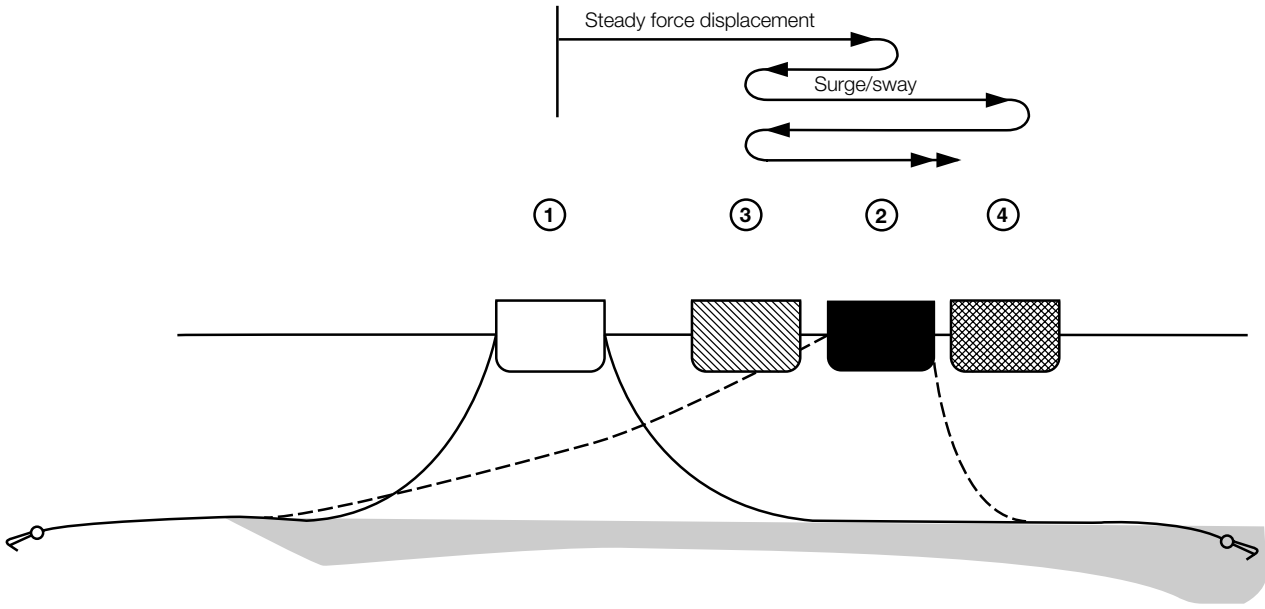
3.1.4 For ships which intend to utilize thruster assistance, as an aid to position-keeping or as a means of reducing anchor line tensions, the extent of thruster allowance which is permitted in calculations is given in Table 8.3.2.

3.1.5 Anchor line length is to be sufficient to avoid uplift forces occurring at the anchors in the worst damaged survival condition.

3.1.6 Account is to be taken in the mooring analysis of the elastic stretch of anchor lines.

3.2 Design cases and factors of safety

3.2.1 The design cases which require to be considered, and the associated minimum anchor line factors of safety are given in Table 8.3.1.



Position 1: Zero environmental force on ship. Anchor lines under pre-tension only.

Position 2: New mean position taken up by ship under the action of steady forces – wind, current and wave drift.

Positions 3 & 4: The inner and outer limits of vessel motion at wave frequency. Maximum quasi-static anchor line tension occurs at position 4.

NOTE
Mooring lines and anchor lines omitted in position 3 and position 4 for clarity.

Fig. 8.3.1 Quasi-static analysis

Table 8.3.1 Minimum anchor line factors of safety

Design case	Description	Factor of safety	
		Class notation	
		PM, **PM** (T1) etc.	**PMC**, **PMC** (T1) etc.
1	Operating – Intact The ship in an operating mode with its mooring system intact, subject to specified operating constraints (limiting environment and permissible offset of the ship).	2,7	3,0
2	Survival – Intact The ship in survival mode with mooring system intact, subject to maximum (survival) environmental conditions.	1,8	2,0
3	Operating – Damaged As Case 1, but with loss of restraint of any one anchor line, *see also* Note 3.	1,8	2,0
4	Survival – Damaged As Case 2, but with loss of restraint of any one anchor line.	1,25	2,0/1,4 (*See* Note 5)

NOTES

1. In the context of this Chapter, Cases 1 and 2 ('Intact' Cases) refer to the mooring system with all anchor lines intact. Cases 3 and 4 ('Damaged' Cases) refer to the mooring system with the loss of any one anchor line.
2. Anchor line factor of safety = $\frac{\text{Minimum rated break strength}}{\text{Maximum line tension}}$
3. The factors of safety given in Table 8.3.1 are to be based on maximum line tensions resulting from steady force offset of the ship, plus maximum first order wave motion. In Design Cases 3 and 4, the factors relate to the ship in its post-damage settled position, following the loss of restraint from an anchor line, (i.e. neglecting transient effects, but *see* Note 4).
4. In addition to the 'static' considerations in Design Cases 3 and 4 (*see* Note 3), account is also to be taken of transient vessel motions following anchor or line failure. The motion path taken by the vessel in moving to a new static equilibrium position is to be determined for each line breakage case to ensure that:
   (a) The ship maintains adequate clearance from any adjacent installation (applicable where **PMC** or **PMC** (T1) etc. notation is to be assigned). A minimum dimensional clearance of 10 m will normally be required.
   (b) The ship remains within its required operational excursion limits.
   (c) Successive line failures will not occur. In calculating factors of safety, the maximum anchor line tensions in this case are to be those resulting from the extreme point of transient motion, with the ship subject to steady force and significant wave motion.
5. The factor of safety of 2,0 applies to critical lines maintaining separation between the moored ship and an adjacent installation.

Table 8.3.2 Thruster allowance

Case	Thruster allowance		
	(T1)	(T2)	(T3)
Operating (Intact)	None	70% of all thrusters, less one	All thrusters, less one
Survival (Intact)	70% of all thrusters	All thrusters	All thrusters
Operating (Damaged)	None	70% of all thrusters, less one	All thrusters, less one
Survival (Damaged)	70% of all thrusters	All thrusters	All thrusters

NOTES

1. The conditions for assignment of supplementary notations (T1), (T2) and (T3) are defined in Section 8.
2. Where all thrusters are permitted, the net effect of all thrusters can be included in calculations.
3. Where all thrusters except one are permitted, the net effect of all thrusters, less the single most effective one, can be included in calculations.

■ *Section 4* **Mooring equipment**

4.1 Anchors

4.1.1 Anchors for positional mooring are to be sufficient in number and holding power, and are to have adequate structural strength, for the intended service. It is the Owners'/ Operators' responsibility to ensure adequate anchor holding power for each location or holding ground.

4.1.2 The anchors are to be of an approved type. Supporting calculations to verify the structural strength of the anchor under proof test loading are to be submitted.

4.1.3 The anchors are to be manufactured in accordance with the requirements of Chapter 10 of the *Rules for the Manufacture, Testing and Certification of Materials* (hereinafter referred to as the Rules for Materials (Part 2)).

4.1.4 The anchors are to be proof tested in the manner laid down in Chapter 10 of the Rules for Materials (Part 2). The level of proof test loading for positional mooring anchors is to be the greater of the following:

(a) 50 per cent of the minimum rated break strength of the intended anchor line; or
(b) the value given in Table 10.1.1 in Chapter 10 of the Rules for Materials (Part 2).

4.2 Fairleads

4.2.1 Fairleads are to be designed to permit free movement of the anchor line in all mooring configurations. Fig. 8.4.1 shows the minimum operating range of the fairlead to be considered in conjunction with the design load.

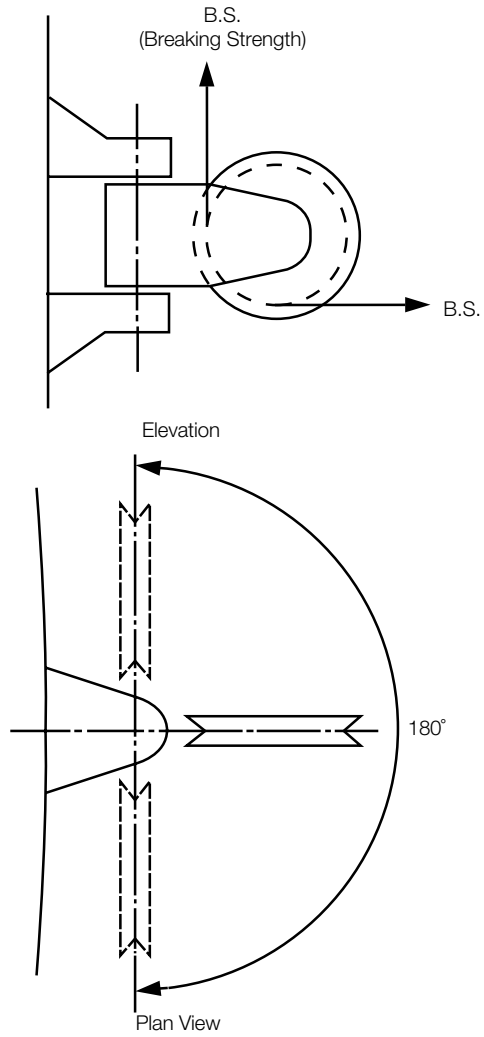


Fig. 8.4.1
Minimum operating range and design loading of fairlead

4.2.2 Fairleads and their supporting structures are to be designed for a load equivalent to the rated minimum break strength of the anchor line.

4.2.3 Maximum allowable stresses for the design criteria given in 4.2.1 and 4.2.2 are to be based on the following factors of safety:

Shear	1,89	Factors relate to tensile yield stress
Tension, compression or bending	1,25	
Combined	1,11	

$$\left(\text{combined stress} = \sqrt{\sigma_X^2 + \sigma_Y^2 - \sigma_X\sigma_Y + 3\tau^2}\right)$$

Where σ_X and σ_Y are the combined axial and bending stresses in the X and Y directions respectively and τ is the combined shear stress due to torsion and/or bending in the X-Y plane.

4.2.4 Materials and steel grades are generally to comply with the requirements given in 5.2 for Type P components.

4.2.5 Chain cable fairleads are to have a minimum of five pockets.

4.2.6 Wire rope fairleads are generally to have a minimum diameter of 20 times the wire rope diameter.

4.3 Stoppers

4.3.1 Stoppers may require to be provided depending on the winch arrangements, *see* Section 5.

4.3.2 Where stoppers are fitted, they are to comply with Section 5 in respect to mechanical and strength aspects, and Section 6 for release arrangements.

4.4 Anchor lines

4.4.1 Anchor lines are generally to be of stud link chain cable, steel wire rope or a combination of both. Special consideration will be given to proposals for the use of alternative materials.

4.4.2 Stud link chain cable is to be either of unified grade (U2 or U3) meeting the requirements of Chapter 10 of the Rules for Materials (Part 2), or an approved special grade.

4.4.3 Wire rope for anchor lines is to have a suitable construction for its purpose (6 x 37 construction with independent wire rope core is generally acceptable).

4.4.4 Steel wire ropes are generally to comply with Ch 10,5 of the Rules for Materials (Part 2), or with an equivalent recognized National or International Standard.

4.4.5 Wire rope terminal fittings are to comply with an acceptable code or standard. The strength of terminations, connecting fittings, shackles or links is not to be less than that of the anchor line.

■ *Section 5*
Anchor winches and windlasses

5.1 General

5.1.1 Machinery items are to be constructed, installed and tested in accordance with the relevant requirements of Part 5. For electrical and control equipment, *see* Section 6.

5.2 Materials

5.2.1 Materials are generally to comply with the requirements of Pt 5, Ch 1,2.2.

5.2.2 Components have been categorized in this Section as Type P (Primary) and Type S (Secondary) for material selection purposes:

(a) **Type P**: Components where failure would result in the loss of a primary function of the winch or windlass, e.g.:
Winch drum.
Windlass cable lifter.
Reduction gears.
Shafts.
Brakes.
Pawl stoppers.
Bedplates.

NOTE
Consideration will be given to designating any of the above components as Type S (*see* below), provided adequate redundancy of operation exists.

(b) **Type S**: Secondary, stressed items, not categorized as Type P, and where failure would not result in the loss of a primary winch function.

5.2.3 Steel materials for Type P or Type S components are generally to comply with the following Chapters and Sections of the Rules for Materials (Part 2):

(a) Plates and bars: Chapter 3, Sections 1 and 2, 3 or 6, as appropriate.
(b) Castings: Chapter 4, Sections 1 and 7.
(c) Forgings: Chapter 5, Sections 1 and 8.

Consideration will be given to the acceptance of suitable equivalent National Standards.

5.2.4 Material grades are to be selected to provide the necessary notch toughness. *See* Table 8.5.1 for suitable Grades.

5.2.5 The requirements of 5.2.3 and 5.2.4 apply where the minimum design air temperature is within the range 0°C to minus 15°C. Requirements for design temperatures outside this range will be subject to special consideration.

Table 8.5.1 Material grades

Component type	Thickness (mm)	Grade					
		Plate		Castings		Forgings	
		AW (*see* Note 1)	PWHT (*see* Note 2)	AW	PWHT	AW	PWHT
P	$t \leq 25$	D, DH32, DH36	AH, B	C-Mn	C-Mn	LT20	LT0
	$25 < t \leq 50$	E, EH32, EH36	DH32, DH36	C-Mn	C-Mn	LT40	LT20
	$50 < t \leq 60$	E, EH32, EH36	E, EH32, EH36* *(*See* Note 5)	C-Mn	C-Mn	LT40	LT40 (*See* Note 5)
	$60 < t \leq 80$	LT60 (*See* Note 3)	E, EH32, EH36	$2^1/_4$ Ni (*See* Note 3)	C-Mn	LT60 (*See* Note 3)	LT40
	$80 \leq t \leq 100$	LT60	LT60 (*See* Note 3)	$2^1/_4$ Ni	$2^1/_4$ Ni (*See* Note 3)	LT60	LT60 (*See* Note 3)
	$100 < t \leq 130$	(*See* Note 4)	LT60	$3^1/_2$ Ni	$2^1/_4$ Ni	(*See* Note 4)	LT60
	$130 < t \leq 160$	$1^1/_2$ Ni	(*See* Note 4)	(*See* Note 7)	(*See* Note 7)	$1^1/_2$ Ni	(*See* Note 4)
S	$t \leq 60$	DH32, EH36	Not normally applied (*See* Note 6)				
	$60 < t \leq 80$	E, EH32, EH36* *(*See* Note 5)					
	$80 < t \leq 100$	E, EH32, EH36					
	$100 < t \leq 130$	LT60 (*See* Note 3)					
	$130 < t \leq 160$	LT60					

NOTES
1. AW. Without post-weld heat treatment.
2. PWHT. With post-weld heat treatment or not welded.
3. Impact test temperature may be raised to –50°C.
4. Use either $^1/_2$ Ni or $1^1/_2$ Ni with impact test at –70°C.
5. Impact test temperature may be raised to –30°C.
6. If PWHT is used, grades will be specially considered.
7. To be specially considered.

5.2.6 For components such as gears, shafts and boltings made from rolled or forged bar materials not subject to welding, the material composition and heat treatment, etc. may be submitted for approval as an alternative to the requirements of Table 8.5.1.

5.2.7 Non-ductile materials are not to be used for torque transmitting items or for those elements subject to tensile/bending stresses.

5.2.8 Spheroid graphite iron castings are to comply with Ch 7,3 of the Rules for Materials (Part 2), Grades 370/17 or 400/12, or to an equivalent National Standard.

5.2.9 The use of grey iron castings will be subject to special consideration. Where approved, they are to comply with the requirements of Ch 7,2 of the Rules for Materials (Part 2). This material is not to be used for gear components.

5.2.10 Brake lining materials are to be compatible with operating environmental conditions.

5.3 Brakes

5.3.1 Each anchor winch or windlass is required to have one primary braking system and one secondary braking system. The two systems are to operate independently.

5.3.2 The braking action of the motor unit may be used for secondary braking purposes where the design is suitable.

5.3.3 A residual braking force of at least 50 per cent of the maximum braking force required by 5.5.1 is to be immediately available and automatically applied in the event of a power failure.

5.4 Stoppers

5.4.1 If the winch motor is to be used as a secondary brake, then a stopper is to be provided to take the anchor line load during maintenance of the primary brake.

5.4.2 The stopper may be one of two different types – a pawl stopper fitted at the cable lifter/drum shaft, or a stopper acting directly on the anchor line.

5.4.3 Where the stopper acts directly on the cable, its design is to be such that the cable will not be damaged by the stopper at a load equivalent to the rated breaking strength of the cable.

5.4.4 *See also* 6.2.1 and 6.2.2 for stopper control station requirements, and 6.4.5 for emergency release of stoppers.

5.5 Winch/Windlass performance

5.5.1 The primary brake is required to hold a static load equal to the minimum break strength of the anchor line (at the intended outer working layer of wire rope on storage drum winches). The static load capacity of the primary brake can be reduced to 80 per cent of that value when a stopper capable of holding 100 per cent of the breaking strength of the line is fitted.

5.5.2 The secondary brake is required to hold a static load equal to 50 per cent of the minimum breaking strength of the anchor line.

5.5.3 The anchor winch or windlass is to have adequate dynamic braking capability. The two brake systems in joint operation are to be capable of fully controlling, without overheating, the anchor lines during:

(a) all anchor handling operations;

(b) adjustment of anchor line tensions. (This is particularly relevant where the mooring system has been designed and sized, on the basis of active adjustment of anchor lines in extreme conditions, to minimize line tensions).

5.5.4 *See also* 6.2 for control of winches, windlasses, stoppers and pawls, and 6.4 for brake fail safe requirements and standby power for operation of brakes and release of stoppers in the event of a failure of normal power supply.

5.5.5 The pulling force of the winches or windlasses is to be sufficient to carry out anchor pre-loading on location, to the necessary level. A minimum low-speed pull equal to 40 per cent of the anchor line breaking strength is recommended.

5.6 Strength

5.6.1 Design load cases for the winch or windlass assembly and the stopper when fitted are given in Table 8.5.2. The associated maximum allowable stresses are to be based on the factors of safety given in Table 8.5.3.

Table 8.5.2 Design load cases

Load case	Condition	Anchor line load percentage of break strength
1 2 3	Winch braked Stopper engaged Winch pulling	100% (*See* Note) 100% 40% or specified duty pull if greater
NOTE Where stopper is fitted, anchor line load in Case 1 can be taken as brake slipping load, but is not to be less than 80 per cent break strength.		

Table 8.5.3 Safety factors for design load cases

Stress	Load case	
	1 & 2	3
	Factor of safety	
Shear	1,89	2,5
Tension, compression, bending	1,25	1,67
Combined	1,11	1,43

NOTES
1. Factors of safety relate to tensile yield stress.
2. Combined stress = $\sqrt{\sigma_X^2 + \sigma_Y^2 - \sigma_X\sigma_Y + 3\tau^2}$

Where σ_X and σ_Y are the combined axial and bending stresses in the X and Y directions respectively and τ is the combined shear stress due to torsion and/or bending in the X-Y plane.

5.7 Testing

5.7.1 Works tests are to be carried out in the presence of the Surveyor, on at least one of the winch or windlass units out of the total outfit for the vessel. The tests to be carried out are given in Table 8.5.4. Alternatively, where a prototype winch has been suitably tested, consideration will be given to the acceptance of these results.

Table 8.5.4 Works test

Test	Test load
Static brake – Primary	100% Anchor line break strength (or 80% where stopper fitted. *See* 5.5.1)
Static brake – Secondary	50% Anchor line break strength
Stopper (where fitted)	100% Anchor line break strength
Motor stall test	Specified stall load

5.7.2 The residual braking capability (*see* 5.5.4) is to be verified.

5.7.3 Each winch or windlass is to be tested on board the vessel, in the presence of the Surveyor, to demonstrate that all main aspects, including dynamic brakes, function satisfactorily. The proposed test programme is to be submitted.

5.8 Type approval

5.8.1 Winches or windlasses may be type approved in accordance with LR's Type Approval Scheme. Where this type approval is obtained, the requirements of 5.7.1 may not be applicable.

■ *Section 6* Electrical and control equipment

6.1 General

6.1.1 The electrical installation is to be designed, constructed and installed in accordance with the relevant requirements of Pt 6, Ch 2.

6.1.2 Control, alarm and safety systems are to be designed, constructed and installed, in accordance with the relevant requirements of Pt 6, Ch 1, together with the requirements of 6.2 to 6.4.

6.2 Control stations

6.2.1 The operation of winches, windlasses and associated brakes, chainstoppers and pawls is to be controlled locally from weather-protected control stations which provide good visibility of the equipment and associated anchor handling operations.

6.2.2 A central control station, which may be located on the bridge or a separate manned control room, is to be provided from which brakes, chainstoppers and pawls can be remotely released.

6.2.3 For each anchor winch, the respective local control station is to be provided with a means of indicating the following:
(a) Line tension.
(b) Length of line paid out.
(c) Line speed.

6.2.4 The indication required by 6.2.3(a) and (b) is to be repeated to the central control station and, in addition, a means of indicating the following is to be provided at this position:
(a) Mooring patterns and anchor line catenaries.
(b) Status of winch operation.
(c) Position and heading, *see also* 6.4.6.
(d) Gangway angle and extension, when applicable.
(e) Riser angle, when applicable.
(f) Wind speed and direction, *see also* 6.4.9.

6.2.5 Means of voice communication are to be provided between the central control station, each local control station and anchor handling vessels, when applicable.

6.3 Alarms

6.3.1 Alarms are to be provided at the local and central control stations for the following fault conditions:
(a) Excessive line tension.
(b) Loss of line tension.
(c) Excessive gangway angle and extension, when applicable.
(d) Excessive riser angle, when applicable.

6.3.2 Alarms are to be provided adjacent to the winches and windlasses to warn personnel prior to and during any remote operation.

6.3.3 Alarms are to be provided at the central control station for the following fault conditions:

(a) When the ship deviates from its predetermined area of operation.

(b) When the ship deviates from its predetermined heading limits.

These alarms are to be adjustable, but should not exceed specified limits. Arrangements are to be provided to fix and identify their set points.

6.4 Controls

6.4.1 Adequate controls are to be provided at the local control station for satisfactory operation of the winch(es).

6.4.2 The braking system is to be arranged so that the brakes, when applied, are not released in the event of a failure of the normal power supply.

6.4.3 Standby power is to be provided to enable winch brakes to be released within 15 seconds in an emergency. The release arrangements are to be operable locally at each winch and from the central control position, and are to be such that the entire anchor line can be lowered in a controlled manner.

6.4.4 The standby power is to be such that, during lowering of the anchor line, it is possible to apply the brakes once and then release them again in a controlled manner.

6.4.5 Standby power is to be provided, so that any anchor line stoppers or pawl mechanisms may be released from either the local or central control stations up to a line tension equal to the minimum rated break strength of the anchor line. These mechanisms are to be capable of release at the maximum angles of heel and trim under the damage stability and flooding conditions for which the ship is designed.

6.4.6 At least one position reference system and one gyrocompass or equivalent is to be provided, when applicable, to ensure the specified area of operation and heading deviation can be effectively monitored.

6.4.7 Position reference systems are to incorporate suitable position measurement techniques which may be by means of acoustic devices, radio, radar, taut wire, riser angle, gangway extension and angle or other acceptable means depending on the service conditions for which the ship is intended.

6.4.8 A vertical reference sensor is to be provided, if applicable, to measure the pitch and roll of the ship.

6.4.9 Means are to be provided to ascertain the wind speed and direction acting on the ship.

■ *Section 7* Thruster-assisted positional mooring

7.1 General

7.1.1 When the positional mooring system is supplemented by thrusters, the requirements of Pt 7, Ch 4, are to be generally complied with in respect of the machinery, electrical and control engineering arrangements. In applying these requirements, the arrangements for the notations **DP(CM)**, **DP(AM)** and **DP(AA)** may be regarded as equivalent to those for supplementary notations (T1), (T2) and (T3) respectively, unless otherwise stated in this Chapter.

7.2 Control systems

7.2.1 Suitable processing and comparative techniques are to be provided at the central control station to validate the control system inputs, thereby ensuring optimum performance of the thruster-assisted mooring system.

7.2.2 Abnormal signal errors revealed by the validity checks required by 7.2.1 are to initiate alarms.

7.2.3 The control system is to be stable throughout its operational range and is to meet the specified performance and accuracy criteria.

7.2.4 An alarm is to be provided for a control computer system fault.

7.2.5 Sufficient instrumentation is to be fitted at the central control station to ensure effective control and indicate that the system is functioning correctly, *see also* 6.2.

7.2.6 The deviation from the desired heading and/or position is to be adjustable, but should not exceed the specified limits. Arrangements are to be provided to fix and identify the set points for the desired heading and/or position.

■ *Section 8* Thruster-assisted mooring – Classification notation requirements

8.1 Notation (T1)

8.1.1 For assignment of notation (T1), the applicable requirements of Sections 6 and 7, together with 8.1.2, are to be complied with.

8.1.2 Centralized automated manual control of the thrusters is to be provided to supplement the position mooring system. The manual control system is to provide output signals to the thrusters, via the manual controller, to change the speed, pitch and azimuth angle, as applicable, thereby optimizing line tension, as indicated at the central control station, *see* 6.2.4.

8.2 Notation (T2)

8.2.1 For assignment of notation (T2), the applicable requirements of Sections 6 and 7, together with 8.2.2 to 8.2.5, are to be complied with.

8.2.2 Automatic and manual control systems are to be provided to supplement the positional mooring systems and arranged to operate independently, so that failure in one system will not render the other system inoperative. *See also* 8.1.2 for manual control.

8.2.3 The automatic control system is to utilize automatic input(s) from the position reference system, the environmental sensors and line tensions, and automatically provide output signals to the thrusters to change the speed, pitch and azimuth angle, as applicable, thereby optimizing line tension.

8.2.4 In the event of line failure or failure of the most effective thruster, the ship is to be capable of maintaining its predetermined area of operation and desired heading in the environmental conditions for which the ship is designed and/or classed.

8.2.5 Control, alarm and safety systems are to incorporate a computer-based consequence analysis, which may be continuous or at predetermined intervals, and is to analyse the consequence of predetermined failures to verify that the anchor line tensions and position/heading deviations remain within acceptable limits. In the event of a possible hazardous condition, arising as a result of the consequence analysis, an alarm is to be initiated at the central control station.

8.3 Notation (T3)

8.3.1 For assignment of notation (T3), the applicable requirements of Sections 6 and 7, together with 8.2.3 to 8.2.5 and 8.3.2 to 8.3.5, are to be complied with.

8.3.2 Two automatic control systems are to be provided and arranged to operate independently, so that failure in one system will not render the other system inoperative.

8.3.3 In the event of failure of the working system, the standby automatic control system is to be arranged to changeover automatically without manual intervention and without any adverse effect on the ship's station keeping capability. The automatic changeover is to initiate an alarm.

8.3.4 At least two position reference systems, as defined by 6.4.7, are to be provided.

8.3.5 At least two of each of the environmental sensors, as required by 6.4.8 and 6.4.9, are to be provided.

■ *Section 9* Trials

9.1 General

9.1.1 Before a new installation (or any alteration or addition to an existing installation) is put into service, trials are to be carried out. These trials are in addition to any acceptance tests which may have been carried out at the manufacturers' works and are to be based on the approved test schedules list as required by 1.5.4(h).

9.1.2 The suitability of the positional mooring and/or thruster-assisted positional mooring system is to be demonstrated during sea trials, observing the following:

(a) Response of the system to simulated failures of major items of control and mechanical equipment, including loss of electrical power.
(b) Response of the system under a set of predetermined manoeuvres for changing:
  (i) Location of area of operation.
  (ii) Heading of the ship.
(c) Automatic thruster control and line tension optimization.
(d) Monitoring and consequence analyses.
(e) Simulation of line breakage and damping.
(f) Continuous operation of the thruster-assisted positional mooring system over a period of four to six hours.

9.1.3 Two copies of the test schedules, as required by 1.5.4(h), signed by the Surveyor and Builder, are to be provided on completion of the survey. One copy is to be placed on board the ship and the other submitted to LR.

Navigational Arrangements for Periodic One Man Watch

Section

Section 1 General requirements

1.1 General

1.1.1 The requirements of this Chapter apply to ships where an optional class notation for optimizing environment on the bridge for navigational tasks including periodic operation of the ship under the supervision of a single watchkeeper on the bridge is requested, and are additional to those applicable in other Parts of the Rules.

1.1.2 The requirements of this Chapter are based on the understanding that the *International Regulations for Preventing Collisions at Sea* and all other relevant Regulations relating to Radio Communications and Safety of Navigation required by Chapters IV and V respectively of SOLAS are complied with.

1.1.3 Requirements additional to those in this Chapter may be imposed by the National Authority with whom the ship is registered and/or by the Administration within whose territorial jurisdiction it is intended to operate.

1.1.4 The requirements of this Chapter are framed on the understanding that contingency plans for emergencies are specified and the conditions under which one man watch is permitted are clearly defined in an operations manual which is acceptable to the Administration with which the ship is registered.

1.1.5 In general, ships complying with the requirements of this Chapter will be eligible for the notation **NAV1**.

1.1.6 Section 5 of this Chapter states additional requirements which apply where the navigational functions are integrated. In general, ships complying with the requirements of Section 5 will be eligible for the notation **IBS**, *see* Pt 1, Ch 2,2.4.

1.2 Information and plans required to be submitted

1.2.1 The following information and plans are to be submitted in triplicate:

- Details of the intended area of operation of the ship.
- List of navigational equipment detailing manufacturer, and model and National Authority approval (where applicable).
- Functional block diagrams and descriptions of the navigational equipment, internal communications systems and watch safety system indicating their relationship to each other.
- Details of the electrical power supplies to the navigational equipment, internal communications systems, watch safety system, and clear view arrangements.
- A general arrangement of the ship showing the fields of vision from the bridge.
- A general arrangement of the bridge and wheelhouse showing the positions of consoles, panels, handrails, seating, windows and clear view arrangements.
- A profile view of the wheelhouse detailing the inclination of windows, heights of upper and lower edges of windows, and dimensions of consoles.
- Detailed arrangements of consoles and panels showing the layout of equipment.
- Test schedules which should include methods of testing and test facilities provided.
- A schedule of the electrical and electronic equipment referred to in 2.2.10 giving details of:
  - equipment description;
  - manufacturer;
  - type and/or model; and
  - Evidence of electromagnetic compatibility.

1.3 Definitions

1.3.1 The following definitions are applicable to these Rules:

(a) **Workstation:**
A position at which one or several tasks, constituting a particular activity, is carried out.

(b) **Navigation workstation:**
A workstation at which the navigator may carry out all tasks relevant for deciding, executing and maintaining course and speed in relation to waters and traffic. The instrumentation and controls at the navigation workstation should allow the navigator to:

- analyse the traffic situation;
- monitor position, course, track, speed, time, propeller revolutions and pitch, rudder angle, depth of water, rate of turn, and wind speed and direction;
- alter course and speed;
- effect internal and external communications;
- give and receive sound signals;
- control navigational lights;
- monitor and acknowledge navigational alarms;
- confirm his well-being and watch-keeping awareness; and
- record navigational data.

(c) **Main steering position:**
That part of the navigation workstation where those controls and instrumentation relevant to controlling the ship's course are located.

(d) **Conning position:**
A place on the bridge which is used by navigators when commanding, manoeuvring and controlling a ship.

(e) **Voyage planning workstation:**
A workstation at which the navigator may carry out the following tasks without affecting the actual navigation of the vessel:
- examine and update charts and other relevant documentation;
- plan a voyage as a series of waypoints, courses, speeds and turns;
- calculate an estimated time of arrival at various points on the voyage; and
- determine and plot the ship's position.

■ *Section 2*
Physical conditions

2.1 Bridge and wheelhouse arrangement

2.1.1 The bridge configuration, arrangement of consoles and equipment location are to be such as to enable the officer of the watch to perform navigational tasks and other functions allocated to the bridge, as well as maintain an effective lookout. The following tasks are to be supported:
- navigation and manoeuvring;
- monitoring;
- manual steering;
- docking;
- planning;
- safety;
- communications; and
- conning.

2.1.2 Equipment and associated displays and indicators are to be sited at clearly defined workstations.

2.1.3 Consoles, including the chart table, are to be positioned, so that the instrumentation they contain is mounted in such a manner as to face a person looking forward. As far as practicable, operating surfaces are to be normal to the operator's line of sight.

2.1.4 From other workstations within the wheelhouse it is to be possible to monitor the navigation workstation and to maintain an effective lookout.

2.1.5 The main access to the bridge is to be by means of an internal stairway. Secondary external access is also to be provided.

2.1.6 Clear passage of at least 700 mm width is to be available to allow movement around the bridge with a minimum of inconvenience. Particular attention is to be paid to the following routes which are to be as direct as possible:

(a) From bridge wing to bridge wing, a clear passage of at least 1200 mm in width.

(b) Between the internal entrance to the bridge and the route in (a) a clear passage of at least 700 mm in width is to be provided.

(c) Between adjacent workstations, a clear passage of at least 700 mm is to be provided.

(d) Between the bridge front bulkhead or any consoles and installations placed against the front bulkhead, to any consoles or installations placed away from the bridge front, a clear passage of at least 800 mm is to be provided.

Space necessary for operating at a workstation is to be considered as part of the workstation and is not to be part of the passageway.

2.1.7 The clear height between the wheelhouse deck surface covering and the underside of the deckhead is to be at least 2250 mm. The lower edge of deckhead mounted equipment is to be at least 2100 mm in open areas, passageways and at standing workstations.

2.1.8 Toilet facilities are to be provided on or adjacent to the bridge.

2.2 Environment

2.2.1 The bridge is to be free of physical hazards to personnel. There are to be no sharp edges or protuberances and wheelhouse, bridge wing and upper bridge decks are to be free of trip hazards and have non-slip surfaces whether wet or dry.

2.2.2 Sufficient hand-rails or equivalent are to be fitted inside the wheelhouse and around workstations to enable personnel to move or stand safely in bad weather. Protection of stairway openings is to be given special consideration.

2.2.3 Provision for seating is to be made in the wheelhouse. Means for securing the seating are to be provided having regard to storm conditions.

2.2.4 Glare and reflections from surfaces are to be minimized. In this respect, walls, ceilings, consoles, chart tables and other major fittings are to be provided with a suitable low reflective finish. Arrangements are to be provided to prevent the obscuration of information presented on visual display units and instruments which are fitted with transparent covers.

2.2.5 Entrance doors to the wheelhouse are to be securable from the inside, and operable with one hand. Bridge wing doors are not to be self-closing, and are to be provided with means to hold them open.

2.2.6 An adequate air conditioning or mechanical ventilation system, together with sufficient heating according to climatic conditions, is to be provided in order to maintain the temperature of the wheelhouse within the range of 14°C to 30°C and the humidity within the range 20 per cent to 60 per cent. The discharge of hot or cold air is not to be directed towards bridge personnel. Control of this system is to be provided in the wheelhouse.

2.2.7 The noise level on the bridge is not to interfere with verbal communication, mask audible alarms, or be uncomfortable to bridge personnel. In this respect, the ambient noise level in the wheelhouse in good weather is not to exceed 65 dB(A).

2.2.8 A sound reception system or alternative means is to allow external sound signals to be heard and their direction determined within the wheelhouse.

2.2.9 Permanently installed electrical and electronic equipment is to be installed so that electromagnetic interference does not affect the proper function of the navigational systems and equipment. Installation of the equipment in accordance with the guidelines and recommendations included in IEC 60533: *Electrical and electronic installations in ships – Electromagnetic compatibility*, or an acceptable equivalent standard, would generally be considered to meet the requirement.

2.2.10 Permanently installed electrical and electronic equipment, on the bridge and in the vicinity of the bridge, that is not subject to the approval required by 3.1.13, is to have undergone electromagnetic compatibility testing that demonstrates the equipment satisfies the conducted and radiated emission requirements of:

- IEC 60533: *Electrical and electronic installations in ships – Electromagnetic compatibility; or*
- IEC 60945: *Maritime navigation and radio communication equipment and systems – General requirements – Methods of testing and required test results.*

Testing in accordance with other appropriate standards is subject to consideration and details are to be submitted.

2.2.11 To demonstrate compliance with 2.2.10, a schedule of applicable equipment is to be compiled, *see* 1.2.1. Where it is proposed to add to or modify the equipment referred to in 2.2.10 the schedule is to be maintained accordingly, *see also* 6.1.1. A copy of the schedule documentation is to be placed on board the vessel and a copy is to be made available to the LR Surveyor on request.

2.2.12 Passive electromagnetic equipment, considered not liable to cause or be susceptible to electromagnetic disturbances, may be provided with an exemption statement in place of evidence of electromagnetic compatibility for the purposes of 2.2.11. Examples of passive electromagnetic equipment include cables, purely resistive loads and batteries.

2.3 Lighting

2.3.1 The level of lighting is to enable bridge personnel to perform all bridge tasks, including maintenance and chart and office work, by day and night. Controls, indicators, instruments, keyboards, etc., on the bridge are to be capable of being seen in the dark, either by means of internal lighting within the equipment or the wheelhouse lighting system. A satisfactory level of flexibility within the lighting system is to be available to enable the bridge personnel to adjust the lighting in brightness and direction as required in different areas of the bridge and by the needs of individual instruments and controls.

2.3.2 All illumination and lighting of instruments, keyboards and controls are to be adjustable down to zero, except the lighting of alarm indicators and the controls of dimmers which are to remain readable.

2.3.3 Two separate circuits are to be provided for wheelhouse lighting, such that failure of any one of the circuits does not leave the space in darkness, *see* Pt 6, Ch 2,5.7.

2.3.4 Emergency lighting is to be provided for the wheelhouse, stairways and exits, *see* Pt 6, Ch 2,3.

2.3.5 Lighting used in areas and at items of equipment requiring illumination, whilst the ship is navigating, is to be such that night vision is not impaired, e.g. red lighting. Such lighting is to be arranged, so that it cannot be mistaken for a navigation light by another ship, and to prevent glare and stray image reflections.

2.3.6 In order to avoid possible confusion in colour discrimination, red lighting is not to be fitted over chart tables.

2.3.7 To avoid unnecessary light sources in the front area of the bridge, only instruments necessary for the safe navigation and manoeuvring of the ship are to be located in this area.

2.3.8 Means are to be provided to prevent the sudden flooding of light onto the bridge from alleyways, accommodation areas and the chart table area.

2.3.9 Deck and superstructure lights which may impair safe navigation are to be controlled from the bridge.

2.3.10 Each navigation light is to be provided with an audible and visual alarm to indicate failure of the light, *see* Pt 6, Ch 2,14.5.

2.3.11 Means are to be provided to test alarm and indicator lamps.

2.4 Windows

2.4.1 All wheelhouse windows are to be constructed of shatterproof toughened glass having a strength commensurate with the degree of exposure of the bridge to storm conditions and complying with a recognized National or International Standard, e.g. ISO 3254 *Shipbuilding and marine structures – Toughened safety glass for rectangular windows*.

2.4.2 Windows are to be as wide as possible and divisions between them are to be kept to a minimum. No division is to be positioned immediately forward of any workstation or on the ship's centreline.

2.4.3 To reduce reflections from internal lighting, etc., the bridge windows are to be inclined from the vertical plane top out, at an angle of not less than 10° and not more than 25°. Alternative arrangements will be specially considered.

2.4.4 The height of the lower edge of the front windows is to allow a forward view over the bow for a person at the navigation workstation and is not to obstruct any of the required fields of vision, *see* 2.5. In this respect, the height of the lower edge of the front windows above the deck is to be kept as low as possible and, as far as practicable, is not to be more than 1000 mm above the deck surface.

2.4.5 The upper edge of the front windows is to allow a forward view of the horizon for a person with an eyeheight of 1800 mm at the conning position when the ship is pitching in heavy seas and, as far as practicable, is not to be less than 2000 mm above the deck surface.

2.4.6 Clear views through the windows in front of the conning position, navigation workstation, and, where applicable, bridge wings are to be provided at all times regardless of weather conditions. At least two windows are to provide such a view.

2.4.7 To ensure a clear view in bright sunshine, sunscreens with minimum colour distortion are to be provided. Such screens are to be readily removable and not permanently installed. Polarized and tinted windows are not to be fitted.

2.4.8 Heavy duty wipers, preferably provided with an interval function and a fresh water wash, are to be fitted.

2.4.9 Efficient cleaning, de-icing and de-misting systems are to be fitted.

2.4.10 Suitable safe external access arrangements fitted under the bridge windows are to be provided to enable cleaning in the event of failure of the above systems.

2.5 Fields of vision

2.5.1 It is to be possible to observe all objects necessary for navigation, including other traffic and navigation marks, in any direction from inside the wheelhouse. In this respect, there is to be a field of view around the ship of 360° obtained by an observer moving within the confines of the wheelhouse.

2.5.2 The view of the sea surface from the conning position and the navigation workstation is not to be obscured by more than two ship lengths, or 500 m, whichever is less, forward of the bow to 10° on either side, irrespective of the ship's draught, trim and deck cargo, *see* Fig. 9.2.1.

2.5.3 Blind sectors caused by cargo, cargo gear and other obstructions outside of the wheelhouse forward of the beam obstructing the view of the sea surface as seen from the conning position and the navigation workstation are not to exceed 10° each. The total arc of blind sectors is not to exceed 20° and the clear sector between blind sectors shall be at least 5°. However, in the view described in the preceding paragraph, each individual blind sector is not to exceed 5°.

2.5.4 The horizontal field of vision from the conning position and the navigation workstation is to extend over an arc from more than 22,5° abaft the beam on one side, through forward, to more than 22,5° abaft the beam on the other side, *see* Fig. 9.2.2.

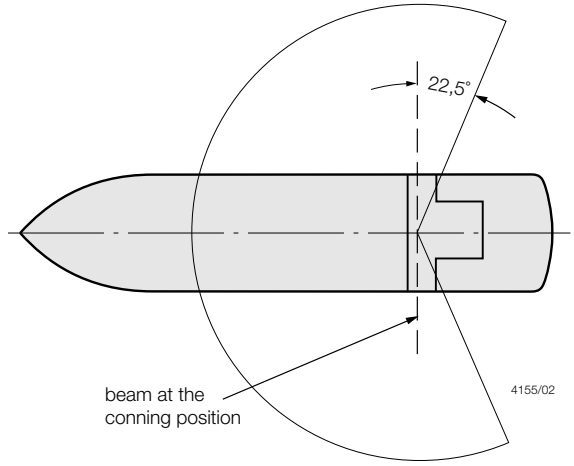


Fig. 9.2.2
Horizontal field of view from conning position and navigation workstation

2.5.5 From the main steering position, the field of vision is to extend over an arc from dead ahead to at least 60° on each side, *see* Fig. 9.2.3.

2.5.6 From each bridge wing, the field of vision is to extend over an arc from at least 45° on the opposite bow through dead ahead and then aft to 180° from dead ahead, *see* Fig. 9.2.4.

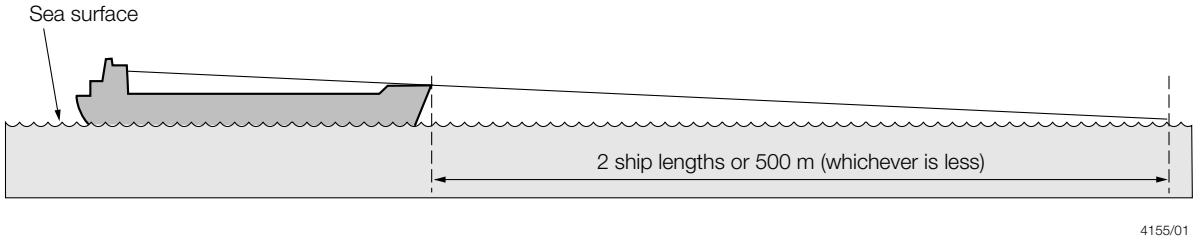


Fig. 9.2.1 View of sea surface from conning position and navigation workstation

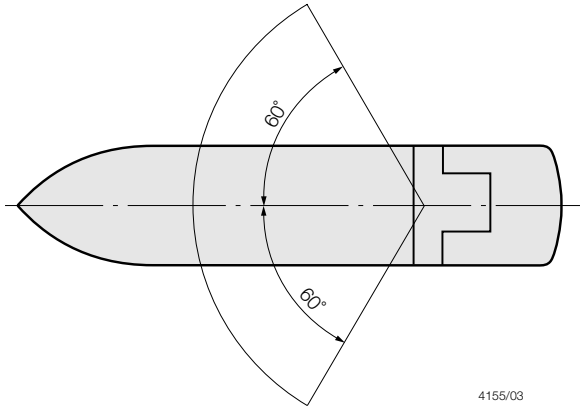


Fig. 9.2.3 Field of view from main steering position

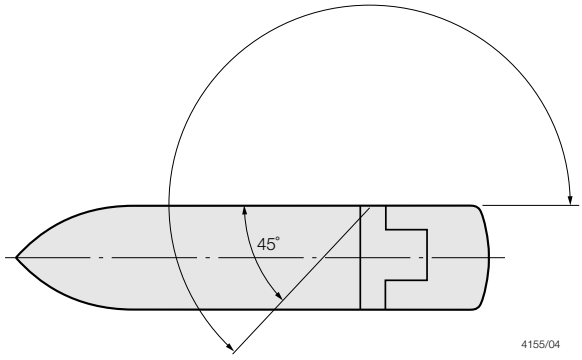


Fig. 9.2.4 Field of view from starboard bridge wing

2.5.7 There is to be a line of sight from the port wing to the starboard wing through the wheelhouse.

2.5.8 The ship's side is to be visible from the bridge wing.

2.5.9 From workstations for functions other than navigation, the field of vision is to enable an effective lookout to be maintained and, in this respect, is to extend at least over an arc from 90° on the port bow, through forward, to 22,5° abaft the beam on the starboard side, *see* Fig. 9.2.5.

2.5.10 The height of consoles is not to interfere with the fields of vision defined above and is not to exceed 1350 mm.

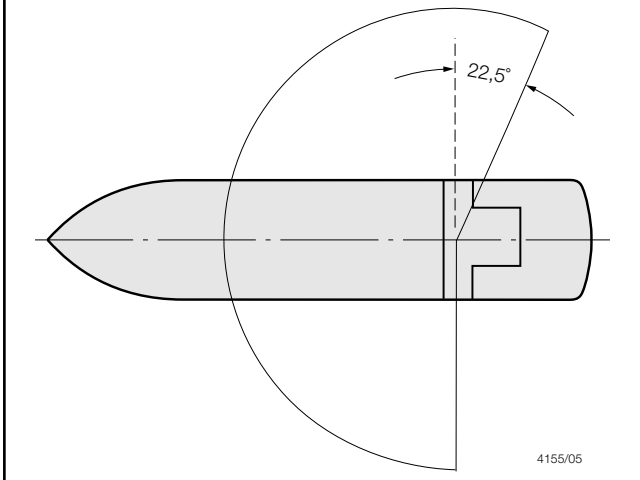


Fig. 9.2.5
Field of view from workstation other than for navigation

■ *Section 3* Workstations

3.1 Navigation workstation

3.1.1 A workstation for navigation is to be arranged to enable efficient operation by one person under normal operating conditions. The workstation area is to be sufficient to allow at least two operators to use the equipment simultaneously. The arrangement of instruments and controls is to allow the use of all instruments and controls necessary for navigating and manoeuvring in any normal working position.

3.1.2 An adequate conning position is to be provided close to the forward centre window. If the view in the centreline is obstructed by large masts, cranes, etc., two additional conning positions giving a clear view ahead are to be provided, one on the port side and one on the starboard side of the centreline, no more than 5 m apart. In addition to the conning position, a second position with a view of the area immediately in front of the bridge superstructure is to be provided close to a forward window or, alternatively, the conning position is to be wide enough to accommodate two persons.

3.1.3 The main steering position is to be located on the ship's centreline, unless the view ahead is obstructed by large masts, cranes, etc. In this case, the steering position is to be located a distance to starboard of the centreline sufficient to obtain a clear view ahead and special steering references for use by day and night are to be provided, e.g. sighting marks forward.

3.1.4 The following facilities are to be provided at the navigation workstation:

- Radar and radar plotting facilities, *see* 3.1.5.
- Position-fixing system displays, *see* 3.1.6.
- Echo sounder display.
- Speed and distance indications, *see* 3.1.11 and 3.1.12.
- Gyrocompass displays, *see* 3.1.7.
- Magnetic compass display.
- Wind speed and direction indication.
- Steering controls and indication, *see* Pt 5, Ch 19,5.
- Rate of turn indication.
- Course/track controls and indications, *see* 3.1.8 to 3.1.10.
- Main propulsion and thruster controls and indication, *see* Pt 6, Ch 1,2.6 and 3.10.
- Watch safety system acknowledge.
- Watch safety system manual initiation.
- Internal communications system.
- VHF radiotelephone.
- Time indication.
- Window clear view controls.
- Navigation lights controls.
- Whistle control.
- Morse light keys.
- Wheelhouse/equipment lighting controls.
- Automatic ship identification system (AIS) information.
- Sound reception system where fitted, *see* 2.2.8.

3.1.5 Two functionally independent radars or alternative means are to be provided to determine and display the range and bearing of radar transponders and other surface craft, obstructions, buoys, shorelines and navigational marks. One of the radars is to operate in the X-band (9 GHz) and the other is to operate in the S-band (3 GHz). Both radars are to include automatic plotting aids to determine collision risks, and at least one radar is to be equipped with an automatic radar plotting aid (ARPA), capable of tracking at least 20 targets, while the other is to be either ARPA or an automatic tracking aid (ATA).

3.1.6 At least two different automatic position-fixing systems giving a continuous display of latitude and longitude are to be provided. One of these is to be GPS or equivalent. The other is to be Loran C or equivalent, depending on the area of operation.

3.1.7 A gyrocompass or alternative means for determining, displaying and transmitting the ship's heading by shipborne, nonmagnetic means, is to be provided and is to be clearly readable by the helmsman at the main steering position. The heading information is to be used directly by the radars, radar plotting aids and automatic identification system, *see* 3.1.5 and 3.1.13. The gyrocompass is to be provided with a gyrocompass heading repeater located at the emergency steering position in the steering gear compartment and a gyrocompass bearing repeater allowing bearings to be taken over 360°.

3.1.8 An autopilot, track control system or alternative means of automatically maintaining the ship's heading or a straight track is to be provided. At any time, it is to be possible to immediately restore manual control.

3.1.9 Heading monitoring is to be provided to monitor the actual heading information by independent heading sources. An off-course warning is to be given if the actual heading of the ship deviates from the track course beyond a pre-set value. The pre-set off-course warning limit is to be large enough to prevent unnecessary alarms.

3.1.10 Where automatic track following is provided, sufficient warning is to be given of the approach of a waypoint, so that, in the event of no acknowledgement from the officer of the watch, there is adequate time for the backup navigator to reach the bridge and accept the change of course.

3.1.11 A speed log or alternative means of indicating the ship's speed and distance through water is to be provided. The speed through water measurement is to be used directly by the ARPA as an aid to collision avoidance.

3.1.12 A speed log or alternative means of indicating the ship's speed and distance over ground is to be provided. Speed over ground is to be indicated in both the fore-aft and athwartships directions.

3.1.13 Navigational systems and equipment are to be of a type approved by the national administration and in conformity with appropriate performance standards not inferior to those adopted by IMO from time to time. Documentary evidence to this effect is to be submitted. *See* SOLAS 1974 as amended, Ch V, Reg. 18.

3.1.14 Where alternative means of fulfilling the navigational requirements are permitted, the means are to be approved by the national administration and in conformity with appropriate performance standards.

3.2 Voyage planning workstation

3.2.1 A voyage planning workstation is to be provided at which the following facilities are available:

- Chart table with instruments.
- Position-fixing systems.
- Time indication.

3.2.2 Time indication at the voyage planning workstation is to be derived from the same system as used at the navigation workstation.

3.2.3 The chart table is to be large enough to accommodate all chart sizes normally used internationally for maritime traffic and is to have facilities for illuminating the chart, *see also* 2.3.8.

■ *Section 4* Systems

4.1 Alarm and warning systems

4.1.1 Alarms associated with navigation equipment are to be both audible and visual and are to be centralized for efficient identification. Repeater displays may be fitted on the bridge wings and at other appropriate positions on the bridge where necessary.

4.1.2 The following alarms are to be provided:

- Closest point of approach.
- Shallow depth.
- Waypoint approaching (where automatic track following is provided).
- Off-course.
- Off-track (where automatic track following is provided).
- Steering alarms, *see* Table 19.5.1 in Pt 5, Ch 19 or Table 20.4.1 in Pt 5, Ch 20, as applicable.
- Navigation light failure.
- Gyrocompass failure.
- Watch safety system failure.
- Failure of any power supply to the distribution panels referred to in 4.4.1.

4.1.3 Audible signals are to be designed not to startle operators. Suitable types are shown in Table 9.4.1.

Table 9.4.1 Suitable audible signals

Type	Typical characteristics	Considerations
Buzzer	Low intensity and frequencies	Good alerting in quiet environment without startling
Bell	Moderate intensity and frequencies	Penetrates low frequency noise well, abrupt onset has a high alert value
Chime	Moderate intensity and frequencies	Good in quiet environment, non-startling
Tone	Moderate intensity and limited frequency range	Convenient for intercom transmission, high alert value if intermittent

4.2 Watch safety system

4.2.1 A watch safety system satisfying the requirements of the IMO performance standards for a bridge navigational watch alarm system (BNWAS) and approved by the national administration is to be provided to monitor the well-being and awareness of the watchkeeper. The system is not to cause undue interference with the performance of bridge functions.

4.2.2 The watch safety system is to automatically become operational whenever the ships heading or track control system is activated.

4.2.3 The system is to be such that, at a predetermined time, the watchkeeper receives warning that he must indicate his well-being by accepting the warning.

4.2.4 The time interval between warnings is to be adjustable up to a maximum of 12 minutes.

4.2.5 It is to be possible to acknowledge the warning at the navigation workstation and at other appropriate locations on the bridge where an effective look-out may be kept. Acknowledgement of any alarm is automatically to reset the time interval between warnings. Manual adjustment of controls may also be used for this purpose.

4.2.6 Visual warning indications are to be visible, and audible warning indications are to be audible, from all operational positions on the bridge where the watchkeeper may reasonably be expected to be stationed. The colour of visual indicators is not to impair night vision.

4.2.7 In the event that the watchkeeper fails to respond and accept the warning or if any alarm has not been acknowledged on the bridge, within a period of 30 seconds, the system is to immediately initiate a watch alarm to warn the Master and the appointed backup navigator through a fixed installation.

4.2.8 In the event that the watch alarm is not acknowledged, the system is to initiate the watch alarm at the locations of further crew members capable of taking corrective actions following a time delay sufficient to allow the Master or backup navigator to reach the bridge. The time interval is to be adjustable between 90 seconds up to a maximum of 3 minutes. In ships, other than passenger ships, the watch alarm to warn the further crew members may be initiated at the same time as the watch alarm to warn the Master and backup navigator.

4.2.9 The watch alarms which sound in the locations of the Master, officers and further crew members capable of taking corrective action should be easily identifiable by its sound and should indicate urgency. The volume of this alarm should be sufficient for it to be heard throughout the locations above and to wake sleeping persons.

4.2.10 Manual initiation of the watch alarm from the bridge is to be possible at any time.

4.2.11 The system is to be designed and arranged such that only the ship's Master has access for enabling and disabling it and setting the appropriate intervals, so as to prevent accidental or unauthorized operation, e.g. removing the fuses or keeping the acknowledgement button permanently depressed either accidentally or deliberately.

4.2.12 The fixed installation is to be connected to the Master's and navigating officers' cabins, offices, mess and public rooms.

4.2.13 Acknowledgement of the watch alarm is only to be possible on the bridge.

4.2.14 If, depending upon the shipboard work organization, the backup navigator may attend locations not connected to the alarm transfer system, a wireless portable device is to be provided enabling both the transfer of alarms and two-way speech communication with the bridge. An audible warning from the portable device is to be provided in the event of loss of the wireless link with the bridge. Alternative arrangements will be considered.

4.2.15 Failure of the watch alarm system is to activate an audible and visual alarm at the centralized alarm system.

4.3 Communications

4.3.1 A telephone system is to be provided to enable two-way speech communication between the wheelhouse and at least the following locations:

- machinery control station space, *see* Pt 6, Ch 1,2.6.8;
- emergency steering position in the steering gear compartment;
- Master's and Navigating Officers' cabins, offices, mess and public rooms.

4.3.2 The bridge is to have priority over the system.

4.3.3 A list of extension numbers is to be clearly displayed adjacent to each telephone.

4.4 Power supplies

4.4.1 Local distribution panels are to be provided for all items of electrically operated navigational equipment, the telephone system, the watch safety system and the clear view systems. These panels are to be supplied by two exclusive circuits, one fed from the main source of electrical power and one fed from an emergency source of electrical power. Each item of equipment is to be individually connected to its distribution panel. The power supplies to the distribution panels are to be arranged with automatic changeover facilities between the two sources, *see also* Pt 6, Ch 2,14.6. Failure of any power supply to the distribution panels is to initiate an audible and visual alarm. This alarm should be included in the ship's alarm system, as required by Pt 6, Ch 1,4.2, where applicable.

4.4.2 The watch safety system and the telephone system are to remain operational during blackout conditions.

4.4.3 Following a loss of power which has lasted for 45 seconds or less, all navigation functions are to be readily re-instated. In this respect, all navigational equipment is to recover within five minutes, with minimum operator intervention, by virtue of the emergency source and, where necessary, an uninterruptible power source.

■ *Section 5* Integrated Bridge Navigation System – IBS notation

5.1 General

5.1.1 Where it is proposed that the bridge navigation functions are so arranged as to form an integrated bridge system, the requirements of 5.2 to 5.6 are to be complied with.

5.2 General requirements

5.2.1 For assignment of the notation **IBS**, the layout of the bridge and the equipment on the bridge are to satisfy the requirements for assignment of the notation **NAV1** (Sections 1 to 4). Where the layout of the bridge and the equipment located on the bridge satisfy the requirements of a relevant international or national ergonomic or human centred design standard or an acceptable equivalent, compliance with the requirements of Sections 1 to 4 may be relaxed.

5.2.2 The design features for computer hardware, local area networks and software required by Pt 6, Ch 1,2.10, 2.11, 2.12 and 2.13 respectively are to be complied with. Alarms associated with hardware and data communication are to be incorporated in the centralized alarm system required by 4.1.

5.2.3 Failure of a part of the integrated bridge navigation system is not to affect other parts except for those that directly depend upon the information from the defective part. Following such a failure, it is to be possible to operate each other part of the system separately.

5.3 Equipment

5.3.1 Two independent gyrocompasses are to be available to provide heading information to the system. The heading signal from each gyrocompass is to be continuously available for display and for providing input to all relevant items of navigational equipment.

5.3.2 Only one gyrocompass is to be used by the integrated bridge system at any time for main display and control purposes. The navigating officer is to be able to switch between compasses at any time. The non-selected compass is to be used automatically as the independent heading source for the off-course warning required by 3.1.9.

5.3.3 It is to be possible to compare readings from each gyrocompass via the navigation workstation displays.

5.3.4 Automatic comparison between the gyrocompasses is to be provided and an alarm given if the difference between heading signals exceeds a pre-set value.

5.3.5 The capability to receive and utilize differential GPS corrections (or an equivalent) is to be included in the integrated bridge system.

5.3.6 As a minimum, the following information is to be displayed at the navigation workstation via visual display units:

- Steering mode.
- Gyro heading.
- Course to steer.
- Rate of turn.
- Rate of turn order.
- Speed and distance (from log and from GPS).
- Speed order.
- Waypoint bearing, distance and ETA.
- Water depth and alarm setpoint.
- Position fix from each available system.
- Main propulsion and thruster indication, *see* Pt 6, Ch 1,2.6 and Pt 6, Ch 1,3.10.
- Steering indication, *see* Pt 5, Ch 19,5.
- Wind speed and direction.
- Time, *see* 3.2.2.

5.3.7 Additional information such as machinery monitoring, fire detection, cargo control, etc., may also be provided via additional pages on the visual display units.

5.3.8 The centralized alarm system and the watch safety system required by 4.1 and 4.2 respectively are to be incorporated as functions of the integrated bridge system and are to be presented to the navigating officer via the conning display.

5.3.9 A route planning capability is to be provided by the integrated bridge system. This is to allow a voyage to be pre-planned as a series of waypoints and turn radii. It is to be possible to edit a voyage plan at any time without affecting route control and monitoring.

5.3.10 An automatic track following capability is to be provided in conjunction with the pre-planned route. The position fix used by the system is to be based at least upon GPS or equivalent, and is to be cross-checked by dead-reckoning, based upon speed over ground provided by the ship's log. In areas where differential corrections are available, it is to be possible to utilize these in the track following system.

5.3.11 In the event of failure of the track following capability, the current heading or rate of turn is to be maintained until manually altered by the navigating officer. The quality of position fix input to the system is to be monitored, *see also* 3.1.10 and 4.1.2.

5.3.12 The integrated bridge system is to incorporate an electronic chart display, which combines simultaneously a high resolution colour representation of a nautical chart with a continuously updated record of own ship's position, pre-planned track, and radar targets in the vicinity. The entire tactical situation is to be displayed for the navigating officer in such a way that any risk from approaching, overtaking or crossing vessels may be assessed. Factors affecting the vessel's freedom to manoeuvre, such as water depths, channel boundaries, separation zones and other traffic are to be shown on the display.

5.3.13 The following alarms are to be provided and included in the centralized alarm system specified by 4.1.1:

- Off-track.
- Waypoint approaching, *see* 3.1.10.
- Position fix inaccurate/lost.
- Loss of heading input.
- Loss of log input.
- Equipment or sub-system failure.
- Gyro mis-match.

5.3.14 Manual adjustment of any of the facilities of the integrated bridge system is to reset automatically the watch safety interval timer.

5.4 Operator interface

5.4.1 Integrated display and control functions are to adopt a consistent man-machine interface philosophy and strategy. Particular consideration is to be paid to symbols, colours, controls, and information priorities.

5.4.2 The size, colour and density of text and graphic information displayed on a visual display unit is to be such that it may be read easily from the normal operator position under all operational lighting conditions.

5.4.3 Means are to be provided for the manual adjustment of the brightness of each visual display unit.

5.4.4 All information is to be presented on a background of high contrast, emitting as little light as possible by night.

5.4.5 Paged displays are to be presented in a way which allows the operator to find quickly the information needed. An overview page is to be easily available to remind the operator of the paging system.

5.4.6 Pages are to have a standardized format. Particular types of information and functional areas should be presented in a consistent manner, e.g. in the same position on different pages.

5.4.7 Each page is to have a unique identifying label on the screen.

5.4.8 Keyboards are to be divided logically into areas enabling rapid access to a desired function. Alphanumeric, paging and specific system keys are to be grouped separately and grouping is to be identical at all operator interfaces.

5.4.9 Soft keys may be used for display control and operation of systems non-critical to the safe operation of the vessel, otherwise dedicated controls are to be used.

5.4.10 Functions requested by the operator are to be acknowledged and confirmed by the system on completion.

5.4.11 Default values, where applicable, are to be indicated by the system when requesting operator input.

5.4.12 If an input error is detected by the system, it is to allow the operator to correct the error immediately.

5.4.13 The system is to require confirmation from the operator for critical actions, e.g. they should not rely on single keystrokes.

5.4.14 Input error messages are to guide the correct responses, e.g.:

use Invalid entry: re-enter set point between 0 and 10

not Invalid entry.

5.4.15 All functions of the integrated bridge system are to remain available in the event of a single failure of an operator interface. This is to be achieved through redundancy in the integrated bridge system interfaces.

5.5 Alarm management

5.5.1 All alarms provided on the bridge are to be included in the centralized alarm system required by 4.1.1.

5.5.2 In general, the alarm system is to be in accordance with Pt 6, Ch 1,2.3.

5.5.3 Alarm management on priority and functional levels is to be provided within the integrated bridge system, including distribution and recording of alarms, as required. Priorities are to be as follows:

(a) **Emergency alarms** – alarms which indicate that immediate danger to human life, or to the ship and its machinery exists and that immediate action must be taken.

(b) **Distress, urgency and safety alarms** – alarms which indicate that a caller is in distress or has an urgent message to transmit.

(c) **Primary alarms** – alarms which indicate a condition that requires prompt attention to prevent an emergency condition.

(d) **Secondary alarms** – all other alarms.

5.5.4 Appropriate alarm management on general and functional levels is to be provided. This includes prioritization, distribution and recording of alarms as required.

5.5.5 Within each priority, alarms are to be arranged in groups, in order to reduce the quantity of information presented to the operator. More detailed information on the group alarm is to be readily available from the integrated bridge system on request.

5.5.6 The following alarms are not to be grouped:

- Emergency alarms.
- Alarms associated with faults requiring speed or power reduction or the automatic shutdown of propulsion machinery.
- Steering gear alarms.

5.5.7 Alarms are to be displayed in order of priority. Within the priorities, alarms are to be displayed in the order in which they occur. The visual display units are to provide immediate display of new alarm information, regardless of the information display page currently selected. This may be achieved by provision of a dedicated alarm monitor, a dedicated area of screen for alarms or other suitable means.

5.5.8 Unacknowledged alarms are to be distinguished by either flashing text or a flashing marker adjacent to the text, and not merely by a change of colour. Acknowledged alarms are to be distinguished by either steady illuminated text or a steady illuminated marker adjacent to the text.

5.6 Power supplies

5.6.1 All equipment forming part of the integrated bridge navigation system is to be regarded as navigational equipment and, as such, is to have power supplies in accordance with 4.4.

■ *Section 6* Trials

6.1 General

6.1.1 Before a new installation (or any alteration or addition to an existing installation) is put into service, tests are to be carried out to ensure satisfactory operation of the navigational equipment. These tests are in addition to any acceptance tests which may have been carried out at the manufacturers' works and are based on the approved test schedule as required by 1.2.1.

6.1.2 Two copies of the test schedule, signed by the Surveyor and Builder, are to be provided on completion of the survey. One copy is to be placed on board the ship and the other submitted to Lloyd's Register.

■ *Section 1*
General requirements

1.1 General

1.1.1 The requirements of this Chapter apply to ships where the class notation **CRC** 'carriage of refrigerated containers' is requested.

1.1.2 This notation may be applied to any ship which has the ability to carry refrigerated containers. The requirements of this Chapter cover refrigerated containers stowed on deck as well as in a hold space. A descriptive notation may be assigned in addition to the **CRC** notation giving details of electrical power and type of cargo.

1.1.3 The requirements are additional to the classification requirements for ships contained in other applicable parts of the Rules.

1.1.4 Ships which comply with the requirements of this Chapter will be eligible for the applicable class notation specified in Pt 1, Ch 2,2.5.

1.1.5 An example of a typical class notation for a container ship classed with LR, fitted with a ventilation system built under Special Survey and fitted with electrical plug-in points for deck stowed refrigerated containers, would be:

✠ **CRC 230/140** to maintain 230 hold-stowed and 140 deck-stowed refrigerated containers operating at their design condition with a 24 hour average external ambient air temperature of 35°C.

1.1.6 An example of a typical class notation for a reefer ship classed with LR, fitted with electrical plug-in points for deck stowed refrigerated containers, would be:

✠ **CRC -/110** to maintain 110 deck-stowed refrigerated containers operating at their design condition with a 24 hour average external ambient air temperature of 35°C.

1.1.7 In addition to any class notation, an appropriate descriptive notation may be assigned to provide additional information about the ship's ability to carry refrigerated containers.

1.1.8 An example of a typical descriptive notation, which may be assigned in addition to the class notation, would be:

crc 2,800 kW provided with a power generating capacity of 2,800 kW dedicated to supplying the container plug-in points.

crc 60%/40% stowage ratio of 60% deep frozen and 40% chilled cargoes

1.1.9 These Rules do not cover any requirements for alarm and monitoring systems that may be fitted to container refrigeration units.

1.2 Novel arrangement and designs

1.2.1 Where the proposed ventilation arrangement is novel in design, or the ventilation system involves the use of an arrangement different from that specified in the following sections, special tests may be required and a suitable descriptive note may be assigned.

1.2.2 The carriage of refrigerated containers in the hold spaces of ships other than dedicated container ships will be given special consideration. The **CRC** and descriptive notations will be assigned provided that the ventilation system is approved, installed and tested in accordance with the requirements of this Chapter.

1.2.3 Where a dedicated fresh water circulation system is installed to supply cooling water to containers fitted with an optional water cooled condenser, the fresh water system will also need to comply with the relevant sections of Pt 5, Ch 12 of the Rules.

1.3 Definitions

1.3.1 **Balanced ventilation system** means a ventilation system consisting of a combination of forced draught and induced or natural draught, to produce a pressure condition in the hold space approximately equal to atmospheric pressure.

1.3.2 **Blackout** means that the main and auxiliary machinery installations, including the main power supply, are out of operation but the services for bringing them into operation (e.g. compressed air, starting current from batteries etc.) are available.

1.3.3 **Container cell** means the position of an individual container. This is usually within a set of vertical cell guides and is normally enclosed by transverse stringers located above and below the container.

1.3.4 **Container electrical power supply** means the generated power supply which is dedicated to supplying the total number of refrigerated containers and the hold ventilation system fan motors.

1.3.5 **Container plug-in point** means an electrical socket located at each applicable container location on deck and each cell location below deck being in accordance with Annex L of ISO 1496-2 : 1996.

1.3.6 **Design conditions** means the lowest design internal container temperature and the design maximum hold space temperature.

1.3.7 **Hold space** means an enclosed space containing refrigerated containers. The containers are usually restrained within cell guides. For hatch coverless ships, hold space means the space below the hatch coamings.

1.3.8 **Independent ventilation system** means a ventilation system that is in no way connected to another ventilation system and there is no provision available to allow connection to another ventilation system.

1.3.9 **Refrigerated container** means a standard container with a self-contained refrigeration system, located within the outer dimensions of the container, which can be driven by electrical power fed from an external power supply. The refrigeration system may be either a 'clip-on' or an integral type of cooling unit.

1.3.10 **Stack factor** means the ratio of the actual heat flowing into the containers forming the stack, to the heat which would flow into the same containers if all their surfaces were completely exposed to the hold temperature.

1.3.11 **Standard container** means a forty-foot equivalent unit (FEU) standard production container constructed in compliance with LR's *Container Certification Scheme*, or another recognized Container Certification Scheme in accordance with ISO 1492/2 requirements. The container may be of the normal or 'high-cube' type.

1.3.12 **Stowage ratio** means the proportion of deep-frozen cargo in relation to banana or chilled cargoes. Unless specifically stated, the stowage ratio will be deemed to be 50 per cent deep-frozen and 50 per cent chilled cargo.

1.3.13 **Ventilation system** means a forced ventilation arrangement using mechanical fans to supply and/or extract air from the hold space.

■ *Section 2*
Plans and documentation

2.1 General

2.1.1 The following plans and information regarding the hold ventilation systems and the electrical supplies to container plug-in points are to be submitted in triplicate for appraisal before construction is commenced:

(a) **Plans of ventilation arrangements**:
- Location and installation details of each hold space ventilation system showing duct arrangement and sizes.
- Details of all mechanical ventilation fans including locations, number, duty at design conditions and power consumption.
- Details of air inlets including number, type, size and locations.
- Details of air outlets including number, type, size and locations.
- Details and locations of dampers and flaps, if applicable.

(b) **Plans of hold spaces**:
- Refrigerated container stowage plans, including sectional elevation and plan views.
- Design pressure or vacuum in each hold space.
- Details of hatch cover sealing arrangements.
- Personnel access arrangements.
- Details and locations of hold temperature measurement sensors.
- Details of any pressure/vacuum safety valves if applicable.

(c) **Ventilation throughput**:
- Specified air throughput rate and proposed method of measurement.
- Design temperature rise in the hold space and corresponding diurnal external ambient air temperature and relative humidity.
- Schematic arrangement of the ventilation system showing proposed air volume and velocity at junctions.

(d) **Plans of deck-stowed containers**:
- Refrigerated container stowage plans, including sectional elevation and plan views.
- Details of access arrangements for maintenance and monitoring of refrigeration units fitted to deck-stowed containers.

(e) **Hull structure**:
- Details of associated openings through the hull structure are to be submitted.

(f) **Electrical**. In addition to the applicable requirements of Pt 6, Ch 2,1.2, the following information and plans specific to the container plug-in points and ventilation system are to be submitted:
- Power supply arrangements to the deck stowed refrigerated containers.
- Power supply arrangements to the hold space stowed refrigerated containers.
- Power supply arrangements to the ventilation system.
- Single-line diagram of the ventilation system. This is to include rating of motors, insulation type, size and current loading of cables and make, type and rating of protective devices.

- A schedule of normal operating loads of the ventilation system estimated for the design conditions expected.

(g) **Control equipment**. In addition to the applicable requirements of Pt 6, Ch 1,1.2, the following information and plans specific to the ventilation system are to be submitted:
- Line diagram of control circuits.
- List of monitored, control and alarm points.
- Locations of control panels and consoles.
- Details of alarm system, including location of control panel and audible and visual warning devices.

(h) **Testing**:
- Details of the testing and commissioning programme, including instrumentation to be used, are to be submitted.

■ *Section 3* Ventilation and hold temperature

3.1 Ventilation system

3.1.1 Means are to be provided to maintain the hold space at an acceptable temperature. This can be achieved by either; the direct removal of the waste heat from the refrigerant equipment of each container, or by the dissipation of the waste heat using large quantities of external ambient air. In each case the system is to be arranged in such a way as to minimize its effect on the hold space temperature. This may be accomplished by the use of a ventilation system of a mechanical supply and/or extract type.

3.1.2 The selection of a maximum allowable hold temperature is to be agreed between the designer and Operator/Owner. Whilst the recommendations given in these Rules do not stipulate a maximum allowable hold temperature, generally it should not exceed 45°C dry bulb. Guidance should be sought from container manufacturers on the maximum allowable ambient air temperature. When determining the maximum allowable hold temperature, the maximum number of refrigerated containers within the hold space, operating at their design condition, is to be taken into consideration.

3.1.3 The ventilation system is to have sufficient capacity to remove or dissipate the heat from each designated refrigerated container cell and maintain the hold temperature at or below the maximum allowable hold temperature.

3.1.4 The volume of air to be supplied or exhausted from a hold space per refrigerated container is at the discretion of the ventilation system designer. For guidance purposes, an indication of the amount of air required for a standard FEU having an air cooled condenser operating at the example notation as stated in 1.1.5 is as follows:

Simple supply only system	90 m^3/min
Supply and exhaust duct system	75 m^3/min
Sealed exhaust system	37 m^3/min

3.1.5 The design of the hold space is to be compatible with the type of ventilation system proposed. For example, for supply and ducted exhaust systems, the semi enclosure of each stringer level may be beneficial. For a simple supply only system the provision of multiple gratings in each stringer level would benefit the free circulation and removal of warm air.

3.1.6 Only container cells served by the ventilation system are to be used for the transportation of refrigerated containers.

3.1.7 The design heat rejection for each container cell and the total hold space heat rejection, including any heat imparted from the ventilation system fans, if applicable, are to be stated. Guidance on heat rejection values which may be used is given below.

3.1.8 The minimum quantity of air supplied or extracted for each container cell and for each hold space is dependent on the type of system proposed and to be stated.

3.1.9 The ventilation system designer is to stipulate the maximum allowable back pressure occurring within the hold space. Due regard needs to be given to this value when selecting the ventilation fans and their ability to operate efficiently again the proposed maximum back pressure. The lower the back pressure, the more efficient the system and, hence, the lower the electrical power requirement to drive the fan motors for a given air throughput.

3.1.10 For supply air systems, the air outlet at each container location is to be such as to provide a flow of air towards the container's integral refrigeration system. Consideration should be given to the use of movable spigot outlets or ducting to allow both standard and high-cube containers to be stowed in any location.

3.1.11 The positions of supply air inlets and exhaust air outlets are to be such as to reduce the possibility of short-cycling. An adequate distance is to be maintained between inlet and outlet vents on the open deck.

3.1.12 The effect of warm exhaust air on deck-stowed refrigerated containers is to be taken into consideration. Similarly, the effect of warm exhaust air from deck-stowed refrigerated containers on the inlet air to the hold is to be considered.

3.1.13 Arrangements are to be provided to permit a rapid shutdown and effective closure of the ventilation system in each hold space in case of fire.

3.1.14 Ventilation ducts which penetrate the deck and/or hatch coaming, including dampers and/or closures, are to be made of steel and their arrangement is to be to the satisfaction of the relevant Administration. The use of non-metallic flexible ducts, local to each container location, will be acceptable provided the material demonstrates suitable low flame spread characteristics.

3.2 Heat balance

3.2.1 The amount of heat absorbed from the hold space by each container, which is used to determine the design air change rate, is to be stated.

3.2.2 The heat gain or loss from all adjacent spaces, such as fuel oil tanks, ballast tanks, engine room, etc., is to be stated.

3.2.3 The heat rejection from the refrigeration unit of a standard TEU or FEU container when working at low temperature (minus 18°C), chill temperature (2°C) and banana carriage temperature (13°C), used to determine the design air change rate, is to be stated. The following FEU values may be used for guidance purposes:

Frozen cargo (minus 18°C/38°C)	7,0 kW
Chill cargo (2°C/38°C)	10,0 kW
Banana cargo (13°C/38°C)	13,0 kW

3.2.4 The above heat rejection values are for the container during normal operation after the cooling down period of a non-precooled cargo.

3.2.5 The stowage ratio, for the carriage of containers at different internal temperatures, which is used to determine the design air change rate, is to be stated.

3.2.6 When an extraction ventilation system is proposed, a stack factor of 0,9 may be used in the heat balance calculations. If a ventilation system using supply air only is proposed, then no stack factor can be allowed.

3.3 Fan redundancy

3.3.1 A single supply or exhaust fan is not to be used for multiple container stack locations.

3.3.2 Individual container cells may be fed by a system having a single mechanical fan or fans to supply and/or extract air.

3.3.3 Installed standby fans are not required. However, a minimum of one replacement fan, or fan blade assembly and motor, of each size is to be carried onboard. Fans are to be arranged to enable each to be replaced whilst the remaining systems remain in operation.

3.4 Hull structures

3.4.1 Special consideration will be given to installations using hull spaces for air distribution, rather than dedicated ductwork.

3.4.2 Consideration is to be given to measures to prevent ingress of water into air inlets and exhaust outlets, where applicable.

■ *Section 4* Electrical, including container plug-in sockets

4.1 General

4.1.1 In addition to the requirements of Pt 6, Ch 2, the following are to be complied with:

(a) Electrical power for the ventilation system is to be provided by one or more separate feeder circuit(s) from the main switchboard.

(b) Under sea-going conditions, the number and rating of service generators are to be sufficient to supply all container plug-in socket outlets and the hold space ventilation system in addition to the ship's essential services, when any one generating set is out of action.

4.1.2 The choice between a low (440 V) or high (6,600 V) distribution system serving the container plug-in point is considered a purely commercial decision. Consideration needs to be given to the fault level of the generating equipment selected and the total generating capacity of the ship. Independent of the system voltage, only the dedicated plug-in socket outlet kW value will be stated in the notation.

4.1.3 Where a distribution system exceeding 1000 V a.c. is employed, the plug-in socket outlets for each hold space may be fed from a local transformer and the following are to be complied with:

(a) Transformers are to be fed from individual circuits divided between different sections of the main switchboard.

(b) The electrical power for the ventilation system may be fed locally from each transformer.

4.1.4 Container plug-in socket outlets are to comply with the requirements of Pt 6, Ch 2,12.6.

4.2 Plug-in socket outlet supply transformers

4.2.1 A standby transformer serving the container plug-in socket outlets is to be provided. However, if the CRC notation is not assigned, then there is no specific requirement covering the installation of a standby power supply.

4.2.2 If a standby transformer is to be provided, then the exact requirements are open to interpretation and consideration should be given to the contents of IACS Unified Interpretation SC 83 with regard to the equipment provided.

4.3 Container plug-in socket outlets

4.3.1 The distribution and sub-circuit cabling for the container plug-in socket outlets is to be rated at the full load capacity (maximum rated capacity).

4.3.2 Groups of container plug-in socket outlets may be fed from a number of independent sub circuits.

4.3.3 Sub circuits are to be able to be individually switched, thus allowing a sequential start up after a prolonged (12 hours) blackout. A suitable procedure is to be proposed and approved that takes into consideration the requirements of 4.4 in addition to the requirements of Pt 6, Ch 2.

4.4 Generated power for plug-in socket outlets

4.4.1 When determining the dedicated generating power for the plug-in socket outlets, the electrical power drawn by the refrigeration unit of a standard TEU and FEU refrigerated container when working at both low temperature (minus 18°C) and chill temperature (2°C), is to be stated.

4.4.2 The following values for various cargoes operating at normal design conditions may be used for guidance purposes:

4.4.3 Twenty foot equivalent unit (TEU):

Frozen cargo (minus 18°C/38°C)	5,5 kW
Chill cargo (2°C/38°C)	7,5 kW
Banana cargo (13°C/38°C)	*see* 4.4.5

4.4.4 Forty foot equivalent unit (FEU) including high-cube containers:

Frozen cargo (minus 18°C/38°C)	8,5 kW
Chill cargo (2°C/38°C)	11,0 kW
Banana cargo (13°C/38°C)	*see* 4.4.5

4.4.5 If the Owner, charterer or operator has operational data indicating that, for the ship's specific trade (for example banana only cargoes), the power provision for the refrigerated containers requirements exceeds those stated above, then these higher values should be substituted and submitted for consideration.

4.4.6 The above values are for the container during normal operation after the cooling-down period of a non-pre-cooled cargo.

4.4.7 An overall diversity factor may be applied to the container's total power requirement. Consideration is to be given to Pt 6, Ch 2,5.6. This diversity factor is to be applied to all refrigerated container cell locations. For guidance purposes, the diversity factor is not generally to be less than 0,75.

■ *Section 5*
Instrumentation, control and alarm systems

5.1 General

5.1.1 The alarm system is to indicate failure of each independent ventilation system in each hold space. If a balanced ventilation system is proposed, indication of failure for each individual part is to be given. The alarm system may be integral with the machinery space alarm system or, if fitted, the refrigerated container monitoring system.

5.1.2 Alarms are to be initiated in a manned location. Where alarms are displayed as group alarms in the main machinery space alarm system, provision is to be made to identify individual alarms at a separate control panel.

5.1.3 Alarms are to give both an audible and visual warning.

5.2 Hold space temperature monitoring

5.2.1 A minimum of two temperature sensors are to be provided in each hold space carrying refrigerated containers. The sensors are to be positioned to give an indication of the mean air temperature occurring in the hold space used for the carriage of refrigerated containers. Sensors are to be positioned so as not to be directly affected by warm air from the condensers.

5.2.2 The hold temperature is to be continually monitored. Temperatures are to be recorded, either automatically or manually as a hold temperature log. If temperatures are to be logged manually, then the mean temperature in each hold space is to be recorded.

5.2.3 If the mean hold space temperature rises above the design maximum, then an alarm is to be initiated.

5.3 Container refrigeration system alarms

5.3.1 These Rules do not cover any requirements for alarm and monitoring systems fitted to containers. It is acceptable to utilise the container power supply cables to transmit signals to a suitable receiver or data logger.

■ *Section 6*
Hold access and maintenance access arrangements

6.1 Hold pressure/vacuum

6.1.1 The maximum permitted pressure or vacuum that may occur in the hold space is to be stated. It is proposed that a value, in accordance with the contents of Pt 3, Ch 1,8.3.4, may be considered as a maximum value. An overpressure of 0,15 bar may be used for guidance purposes. If the ventilation system is capable of producing a positive pressure or vacuum in excess of the design allowable figure, then means are to be provided to protect the hold space against the effect of over pressure or vacuum. If axial supply fans are proposed, even if aerofoil fan blades are fitted, it is unlikely that the fans will be able to produce a pressure above 0,025 bar (250 mm water gauge).

6.1.2 If required, consideration is to be given to the use of a pressure or vacuum relief device or other arrangement set to operate below the maximum allowable hold pressure or vacuum.

6.1.3 The proposed pressure or vacuum relief device for each hold space is to be of adequate size.

6.2 Hold access arrangements

6.2.1 Suitable means are to be provided to allow personnel safe access to each hold space when the ventilation system is in operation. Consideration is to be given to the possible over pressure or partial vacuum that may occur in the hold space. The use of an airlock arrangement may need to be considered.

6.3 Maintenance access arrangements

6.3.1 Free access to each applicable container cell and hold space is to be provided to allow replacement of refrigeration equipment in the event of failure or malfunction.

6.3.2 Adequate access is to be provided to allow plugging in, data recording or retrieval and general maintenance of all deck- and hold-stowed refrigerated containers. Suitable means are to be provided to allow the removal of the compressor and electric motor from each refrigerated container.

6.3.3 Suitable safe access is to be provided to each tier of deck-stowed refrigerated containers to allow electrical connection, monitoring and maintenance. The use of fixed platforms, such as lashing bridges, should be proposed where possible.

■ *Section 7* Water cooler refrigeration units

7.1 Cooling water system

7.1.1 A minimum of two independently operated circulation pumps are to be installed. One of the pumps may be used for other services, such as a general service pump.

7.1.2 The capacity of each pump should be sufficient to supply each container at the required flow rate with an excess capacity of at least 10 per cent. This required flow rate should be obtained from the container manufacturer.

7.1.3 The fresh water system is to provide sufficient flow and even distribution to each container location. This is to be achieved using all possible combinations of fresh water pumps and dedicated refrigerated container cells.

7.1.4 The temperature of the cooling water is to be maintained in accordance with the container manufacturer's recommendations.

7.1.5 Flexible hoses are to be utilized for connecting the water supply and return pipes. The connectors on the ends of the flexible hoses are to be of a type that self-closes on disconnection. Adequate valves are to be provided to allow isolation of each cargo hold sub-circuit in the event of a leak or pipe fracture.

7.1.6 A minimum of two fresh-water to sea-water heat exchangers are to be provided. Each is to be rated at 100 per cent of the required cooling duty at the notation conditions. The second heat exchanger may be a standby or part of a common central system such as that used for main engine cooling duties. The heat exchangers are to be supplied by a minimum of two separate sea-water pumps.

7.1.7 If metal pipes are used, the contents of Pt 5, Ch 12,9.8 are to be given due consideration.

■ *Section 8* Deck-stowed refrigerated containers

8.1 General

8.1.1 Consideration is to be given to the effect of the warm air discharged from the condenser of each deck-stowed refrigerated container. When refrigerated containers are stowed on only two tiers high, it is considered that the warm air from each condenser is dissipated without any undue effect on adjacent containers.

8.1.2 If containers are to be carried three or more tiers high, then consideration is to be given to limiting the effect of short-cycling warm discharge air within the central section of the stack. The proposed method or methods for dealing with this effect are to be stated. Possible options would include reserving the central cells of each stack for non-refrigerated containers, to reduce the block effect or providing fans and ductwork to supply ambient temperature air to the bottom of each vertical stack. Trials of any proposed system are to be undertaken.

8.1.3 Any adverse effect that the warm air discharged from the hold space ventilation system has on the deck stowed refrigerated containers is to be minimised. Similarly, the warm air discharged from the deck stowed refrigerated containers is to be shielded from entering the hold space ventilating system.

Section 9
Inspection and testing on completion

9.1 General

9.1.1 On completion of construction and all appropriate safety checks, the acceptance tests prescribed in 9.2 are to be carried out. Their purpose is to verify the correct functioning of the installation and its ability to maintain the air throughput required for the assignment of the intended class notation.

9.1.2 The proposed test schedules, including methods of testing and details of the test equipment to be provided are to be submitted to LR before the tests commence. The proposed test methods are to be appropriate for the design of the system installed and are to include such acceptance criteria as:

(a) Volume of air to be supplied and/or exhausted at each container cell location.
(b) Maximum allowable deviation from this air volume.
(c) Maximum allowable pressure within the hold space when the system is under normal operating conditions.

9.1.3 Trials of the air distribution system within the hold spaces are to be witnessed by LR surveyors before the ship is put into service and prior to the **CRC** notation certificate being issued. These trials are to be in addition to any tests which may have been carried out whilst commissioning the system.

9.2 Acceptance tests

9.2.1 The acceptance tests (*see also* 9.2.2 and 9.2.3) are to comprise the following:

(a) Control and alarm systems are to be tested to demonstrate that they operate correctly, *see also* Pt 6, Ch 1,2.3.
(b) The accuracy, calibration and functioning of all instrumentation is to be verified.
(c) For supply air systems: Verification of each supply fan's output when running at maximum speed. Verification of the air discharge rate and operation of any distribution arrangements at each individual container cell location. During the test, all supply fans serving the hold space are to be operated simultaneously, thus replicating normal operating conditions. If a common or multiple supply fan distribution system is fitted, then the arrangements are to be verified; firstly, with all supply fans in operation and, secondly, with any one fan out of action.
(d) For exhaust air systems: Verification of each exhaust fan's output when running at maximum speed. The volume of air being extracted from each individual container cell location is to be verified with each exhaust fan running at maximum speed. All exhaust fans serving the same hold space are to be operated simultaneously thus replicating normal operating conditions.
(e) For combined supply and exhaust air systems: Verification of each supply and exhaust fan's output when both are running at maximum speed. The volume of air being supplied and extracted from each individual container cell location is to be verified. All fans serving the same hold space are to be operated simultaneously thus replicating normal operating conditions.
(f) If the supply and/or exhaust ductwork is prefabricated and installed in one piece testing at the manufacturer's works may be accepted provided the following are considered:
    - Any change in the supply and/or exhaust fan(s) output due to differences in electricity supply.
    - Any de-rating of the fan throughput due to a back pressure or partial vacuum occurring within the hold space during normal operating conditions.
    - Verification of the test results is to be undertaken in a single hold space.
(g) Where the air volume required to meet the class notation cannot be verified during testing for practical reasons, assignment of the notation is to be deferred until it is demonstrated that the system is able to achieve the specified air throughput within each hold space during a loaded passage.

9.2.2 Where a number of identical fan and ductwork installations are constructed and fitted within each hold space, the acceptance trials required in 9.2.1 need only be carried out in two separate hold spaces, provided that the results are satisfactory.

9.2.3 Where the same system is installed on a number of identical sister ships for the same Owner and by the same shipyard, the testing in accordance with 9.2.1 will only be required on the first ship of the series, provided that the results are satisfactory.

9.2.4 The effect of exhausting warm hold space ventilation air on the operation of the integral air-cooled condensers of deck stowed containers is to be established under normal operational conditions. The discharge from hold space discharges is to be suitably modified if necessary.

9.3 Testing of cooling water system

9.3.1 Cooling water piping that is welded *in situ* is to be hydraulically strength tested at 1,5 times the design pressure, but in no case less than 3,5 bar g.

9.3.2 A distribution test is to be carried out to ensure that even fresh water distribution to each container as well as sufficient flow is achieved. As the fresh water system may be somewhat complicated, this test should be carried out with care, using all possible combinations of fresh water pumps installed.

9.3.3 If required, the distribution test can be carried out without containers, utilizing flexible hoses for connecting the water supply and return pipes together. The return valves should be partly closed or flexible pipe may be crimped to represent the condenser pressure drop. Water flow meters are to be installed at the highest and the lowest container levels to verify equal water flow.

9.3.4 The capacity of each pump should be measured by a flow meter with an accuracy of ±3 per cent. Alternatively, this capacity could be obtained from the manufacturer's curves if the static pressure difference across a pump under test conditions is measured.

9.3.5 Sea-water pumps and heat exchangers are normally subjected to a functional test only.

■ *Section 10*
Spare gear

10.1 General

10.1.1 Adequate spares, together with the tools necessary for maintenance or repair of the ventilation systems are to be carried. The spares are to be determined by the Owner according to the design and intended service.

10.1.2 A minimum of one replacement fan, or complete fan impeller and motor assembly for each size fitted is to be carried onboard.

10.1.3 The maintenance of the spares is the responsibility of the Owner.

Arrangements and Equipment for Environmental Protection

Section

■ *Section 1* General requirements

1.1 Application

1.1.1 This Chapter contains requirements for the control of operational pollution.

1.1.2 Compliance with this Chapter is optional. A ship meeting the requirements of this Chapter will be eligible for the **EP** class notation, which will be recorded in the *Register Book*.

1.1.3 Where a ship is classed with another IACS Member and all the requirements of this Chapter are met, a Statement of Compliance will be issued. At the specific request of the Owner, the descriptive note (**EP**) may be recorded in the *Register Book*.

1.1.4 Additional requirements may be imposed by the National Authority with which the ship is registered and/or by the Administration within whose territorial jurisdiction it is intended to operate. Where such additional requirements are relevant to the ship, compliance with such Regulations is the responsibility of the Owner. If specifically requested, Lloyd's Register (hereinafter referred to as 'LR') may provide suitable certification or statement of compliance.

1.1.5 LR is to be advised of any matter that relates to the environmental performance of the ship that would affect the assignment of the **EP** class notation.

1.2 EP class notation

1.2.1 Section 2 states the minimum requirements to be met for assignment of the **EP** notation.

1.2.2 Section 3 contains additional requirements. Ships complying with these requirements will be eligible for one or more of the following associated supplementary characters, as applicable:

A Anti-fouling coatings.
B Ballast water management.
G Grey water.
N Oxides of nitrogen (NO_x) exhaust emissions.
P Protected oil tanks.
R Refrigeration systems.
S Oxides of sulphur (SO_x) exhaust emissions.
V Vapour emission control systems (tankers only).
O Oily bilge water.

1.3 Information to be submitted

1.3.1 The following are to be submitted:
(a) One copy of all plans and information listed in 1.3.4.
(b) Two copies of the Operational Procedures listed in 1.3.3.
(c) One copy of every Certificate listed in 1.3.2.

1.3.2 Certificates:
(a) MARPOL certificates, as applicable.
(b) Safety Management Certificate (SMC) and Document of Compliance (DOC) in accordance with the International Safety Management Code (ISM Code).
(c) Interim Engine International Air Pollution Prevention (EIAPP) Certificate or statement of compliance with the NO_x emission requirements of MARPOL Annex VI.
(d) Incinerator certificate or statement of compliance with the requirements of MARPOL Annex VI, Regulation 16.
(e) Vapour emission control system certificate or statement of compliance with the requirements of USCG 46 CFR 39 or the IMO Standards for Vapour Emission Control Systems (MSC Circular 585) (supplementary character **V** only).
(f) Sewage system and, where fitted, sewage treatment system statement of compliance with the requirements of USCG 33 CFR 159 and/or MARPOL 73/78 Annex IV.

1.3.3 Operational procedures:
(a) NO_x emission control, as applicable.
(b) Oil fuel management for the control of SO_x emissions.
(c) Refrigerant management.
(d) Oil pollution prevention measures.
(e) Garbage management.
(f) Sewage treatment and discharge control.
(g) Precautionary measures to minimize the transfer of non-native organisms in ballast water.
(h) Ballast water management, as applicable.

1.3.4 Information and plans:
(a) SERS registration number or statement of membership of alternative scheme from IACS Member service provider.
(b) Details of engine type, rated power and intended use for all installed engines.
(c) Details of NO_x control arrangements, as applicable.
(d) Arrangements of permanently installed refrigeration systems (including those used for cargo temperature control, air conditioning, domestic store rooms and chiller units).
(e) Capacity of refrigeration system.
(f) Details of intended refrigerant(s).
(g) Details of fire-extinguishing media to be used in fixed fire-fighting systems and portable extinguishers.
(h) Bilge holding, waste oil and sludge tank capacities and piping arrangements.
(j) Arrangements of non-cargo oil loading and discharge connections together with associated drip trays and drainage systems.
(k) Oil fuel storage, settling and service tank high level alarms/overflow systems.

(l) Cargo and ballast tank arrangements (tankers only).
(m) Cargo and ballast piping system plans, including cargo tank overfill prevention arrangements (tankers only).
(n) Arrangements of tanker cargo manifolds together with associated drip trays and drainage systems.
(o) Details of sewage treatment and handling systems.
(p) Capacity of sewage holding and/or treatment system.
(q) Maximum numbers of crew and passengers.
(r) Details of incinerator arrangements, as applicable, associated piping systems, control and monitoring equipment.
(s) Hull coating system and leaching rate.
(t) Ballast water treatment arrangements, as applicable (for supplementary **B** character only).
(u) Arrangements for protected oil tanks (for supplementary **P** character only).
(v) Details of grey water treatment plant and effluent quality (for supplementary **G** character only).
(w) Details of self-contained vapour recovery systems, where fitted (for supplementary **V** character only).
(x) Any information relating to the environmental performance of the ship, which may influence the assignment of the **EP** notation.

1.4 Alterations and additions

1.4.1 When an alteration or addition to the approved arrangements and procedures is proposed, appropriate details are to be submitted for approval.

1.5 In-service records

1.5.1 Records demonstrating the effective implementation of the operational procedures specified in 1.3.3, as applicable, are to be maintained.

1.5.2 These records are to be kept on board for a minimum period of three years, in a readily accessible form, and are to be available for inspection by LR Surveyors, as required.

■ *Section 2* Environmental Protection (EP) class notation

2.1 General

2.1.1 It is a prerequisite for assignment of the **EP** notation that the ship:
(a) complies with all adopted Annexes of MARPOL, whether ratified or not, relevant to the ship;
(b) has a valid Safety Management Certificate (SMC), in accordance with the ISM Code issued by the Flag State Administration with which the ship is registered or a duly authorized organisation complying with Resolution A.739(18) and authorized by the National Authority with which the ship is registered; and
(c) is enrolled in LR's Ship Emergency Response Service (SERS) or the equivalent scheme of another IACS Member.

2.1.2 Where a ship, by virtue of its gross tonnage, is not required by the MARPOL Convention to have MARPOL Certification, the following are to be maintained:
(a) An Oil Record Book in accordance with MARPOL Annex I.
(b) A garbage management plan and record book in accordance with MARPOL Annex V.

2.1.3 Where a ship, by virtue of its gross tonnage is not required to have a SMC, it is exempt from this requirement.

2.1.4 High speed craft, as defined in LR's *Rules and Regulations for the Classification of Special Service Craft,* will be the subject of special consideration.

2.2 Oxides of nitrogen (NO_x)

2.2.1 These requirements apply to all installed diesel engines with an individual output power greater than 130 kW, other than those used solely for emergency purposes. There are no specific requirements relating to NO_x emissions from boilers, incinerators or gas turbine installations.

2.2.2 All engines falling within the scope of MARPOL Annex VI, Regulation 13 are to comply with its provisions and be certified accordingly. Certification is to be issued by a Flag State Administration or a duly authorized organisation, complying with IMO Resolutions A739(18) and A789(19).

2.2.3 Engines over 130 kW, other than those used solely for emergency purposes, not falling under the requirements of MARPOL Annex VI, Regulation 13, are also to comply with the applicable emission values detailed in paragraph 3(a) of that Regulation. The test procedure and measurement method are to be in accordance with either the Simplified Measurement Method or Direct Measurement and Monitoring Method as detailed in Chapter 6 of the NO_x Technical Code.

2.2.4 Where the NO_x emission limits specified in MARPOL Annex VI, Regulation 13 are exceeded, an emission reduction plan is to be developed and agreed with LR.

2.2.5 Equipment and systems used to control NO_x emission levels are to:
(a) be arranged so that failure will not prevent continued safe operation of the engine;
(b) be operated in accordance with manufacturer's instructions;
(c) be designed, constructed and installed to ensure structure integrity and freedom from significant vibration;
(d) be designed to include adequate hatches for inspection and maintenance purposes; and
(e) be instrumented to record operation. Records of operation and the degree of control are to be maintained.

Alternative control arrangements will be given special consideration.

2.2.6 Procedures covering the use and maintenance of the equipment and systems specified in 2.2.5 are to be established and effectively implemented. Records are to be maintained which demonstrate the operation of the equipment and systems and the resultant level of NO_x emissions to the atmosphere.

2.3 Oxides of sulphur (SO_x)

2.3.1 Emission of SO_x is to be controlled by limiting the sulphur content of oil fuels used on board.

2.3.2 The maximum sulphur content of oil fuel to be used on board will be dependent upon area of operation and bunkering ports. The maximum permissible fuel sulphur content will not exceed 3,5 per cent.

2.3.3 Where the grade of fuel normally used cannot be obtained with the appropriate fuel sulphur level, then a better grade of fuel meeting this requirement will need to be purchased.

2.3.4 An oil fuel management system is to detail the maximum sulphur content to be specified when ordering oil fuels and the means adopted to verify that the sulphur content of oil fuels supplied meets that requirement. This management system is to include the practices to be adopted to ensure that appropriate low sulphur oil fuels are used when the ship is within IMO designated 'SO_x Emission Control Areas', as applicable.

2.3.5 Where testing to determine the sulphur content of fuel received on board is to be carried out, a representative sample is to be drawn at the time of delivery from the ship's bunker manifold using the manual or automatic sampling methods defined in ISO 3170 or 3171, or their national respective equivalents. Fuel sulphur content is to be subsequently determined using the laboratory test method ISO 8754 or an equivalent National Standard based on ISO 8754.

2.4 Refrigeration systems

2.4.1 These requirements apply to refrigeration and air conditioning installations on all ships. This includes refrigeration installations on conventional refrigerated cargo ships, container ships carrying produce in containers cooled by ducted air, and gas carriers fitted with reliquefaction plants. These requirements do not apply to the domestic stand-alone refrigerators used in galleys, pantries, bars and crew accommodation.

2.4.2 The use of chlorofluorocarbons (CFC) in refrigeration or air conditioning installations is prohibited.

2.4.3 Systems are to be arranged with suitable means of isolation so that maintenance, servicing or repair work may be undertaken without releasing the refrigerant charge into the atmosphere. Unavoidable minimal releases are acceptable when using recovery units.

2.4.4 For the purposes of refrigerant recovery, the compressors are to be capable of evacuating a system charge into a liquid receiver. Additionally, recovery units are to be provided to evacuate a system either into the existing liquid receiver or into cylinders dedicated for this purpose. The number of cylinders is to be sufficient to contain the complete charge between points of isolation in the system.

2.4.5 Where different refrigerants are in use they are not to be mixed during evacuation of systems.

2.4.6 Refrigerant leakage is to be minimised by leak prevention and periodic leak detection procedures. The annual refrigerant leakage rate for each system shall be less than 10 per cent of its total charge.

2.4.7 A leak detection system appropriate to the applicable refrigerant is to be provided to monitor continuously the spaces into which the refrigerant could leak. An alarm is to be given in a permanently manned location when the concentration of refrigerant in the space exceeds a predetermined limit (25 ppm for ammonia; 300 ppm for halogenated fluorocarbons). Remedial measures to repair the leakage are to be implemented as soon as practicable after an alarm is activated.

2.4.8 Procedures detailing the means to be adopted to control the loss, leakage, venting and disposal of refrigerants are to be established and implemented effectively.

2.4.9 Refrigerant inventory and log book records are to be maintained covering:

(a) Refrigerant added to each system.
(b) Refrigerant leaks, including remedial actions.
(c) Refrigerant recovered and where stored.
(d) Refrigerant disposal.

2.5 Fire-fighting systems

2.5.1 The use of halon or halo-carbons as the fire-extinguishing medium in fixed fire-fighting systems or extinguishers is not permitted.

2.6 Oil pollution prevention

2.6.1 All ships are to comply with the requirements of 2.6.2 to 2.6.11. In addition, tankers are to comply with the requirements of 2.6.12 to 2.6.18.

2.6.2 Drainage from machinery space bilges may be discharged to sea in accordance with the requirements of MARPOL 73/78, Annex I.

2.6.3 The oil-in-water content of the water discharged is to be less than 15 ppm. Oily bilge water is to be discharged through approved oil filtering equipment and a 15 ppm alarm combined with a device for automatically stopping any discharge to sea when the oil content in the discharge exceeds 15 ppm. Full records of all discharges are to be kept.

2.6.4 Oil fuel, lubricating oil and other oil loading or discharge connections on deck are to be fitted with drip trays. Drip trays are to be fitted with closed drainage systems.

2.6.5 Oil fuel storage, settling and service tanks are to be fitted with high level alarms and/or acceptable overflow systems.

2.6.6 Leakages and waste oil from machinery and equipment are to be collected in a dedicated waste oil tank prior to disposal ashore or incineration. This waste oil tank is to be separate from the sludge tank specified in MARPOL Annex I, Regulation 2. The volume of the waste oil tank is to be of sufficient capacity to hold a complete lubricating oil charge from the largest engine used for propulsion or electrical generating purposes.

2.6.7 For those ships which only operate on distillate fuel, the waste oil and sludge tanks may be combined to form a single tank. Where such a combined tank is fitted, the total capacity is to be equal to or greater than the aggregated total of the required individual tank capacities.

2.6.8 The bilge holding tank, the waste oil tank and the sludge tank are to be arranged to facilitate the periodic removal of accumulated sediments and other material.

2.6.9 Discharge piping systems to deck from the bilge holding tank, and the waste oil tank, are to be separate from the oil fuel loading and transfer systems. The bilge holding tank and waste oil tank piping systems are to be terminated with the standard discharge connections specified in MARPOL Annex I, Regulation 13. The sludge tank may be discharged through the same piping system as the waste oil tank.

2.6.10 Means are to be provided for the collection and recovery of any oil spilled on decks.

2.6.11 Procedures covering the handling of all oils and oily wastes are to be established and implemented effectively. As a minimum, these are to cover:

(a) loading, storage and transfer of oil fuels, lubricants, hydraulic oil, thermal heating oil and drummed oil products;
(b) storage, transfer, discharge and disposal of oily mixtures contained in the ship's sludge, bilge holding and waste oil tanks and machinery space bilges; and
(c) recovery of any oil spilled on decks.

2.6.12 The constructional requirements of MARPOL Annex I, Regulations 19 and 20 as applicable, are to apply to all oil tankers greater than 600 tonnes deadweight.

2.6.13 Cargo tanks are to be fitted with high level alarms and/or acceptable overflow systems.

2.6.14 The cargo tanks are to be fitted with arrangements to prevent the possible outflow of oil under overfilling conditions.

2.6.15 Cargo tank ballasting arrangements and segregated ballast systems are to be connected to separate and distinct sea chests.

2.6.16 A screw-down non-return valve is to be provided to isolate the cargo piping system from the sea connections.

2.6.17 Cargo manifold connections are to be fitted with drip trays with closed drainage systems.

2.6.18 Cargo manifold terminal pieces are to be designed, where practicable, in accordance with the relevant Oil Companies International Marine Forum (OCIMF) Recommendations for oil tanker manifolds and associated equipment.

2.7 Garbage handling and disposal

2.7.1 Procedures covering garbage management are to be established and effectively implemented. As a minimum, these procedures are to include:

(a) identification of the sources of garbage;
(b) means of minimising garbage production;
(c) procedures for the safe and hygienic collection, segregation, storing, processing and disposal of garbage, including the use of the equipment (compactors, comminuters, incinerators or other devices) on board. These procedures are to cover all garbage generated during the normal operation of the ship. The disposal of the following materials is to be specifically covered:
    - Cargo residues.
    - Cargo associated wastes.
    - Waste oil.
    - Paint and painting materials.
    - Medical wastes.
    - Large metal objects such as oil drums and machinery components.
    - Ropes: metal, synthetic or natural fibre.
    - Rust/scale debris.
    - Ballast tank sediments.
    - Equipment containing refrigerants.

2.7.2 Where fitted, incinerators are to be designed and constructed in accordance with the requirements of IMO Resolution MEPC 76(40). A certificate of compliance issued by LR, another IACS Member or the relevant Flag State Administration is to be provided.

2.7.3 Where incineration is to be carried out, procedures are to be developed and implemented covering:

(a) operation in accordance with the requirements of MARPOL Annex VI, Regulation 16; and
(b) prevention of incineration within areas where incineration is prohibited by the Coastal State Administration.

2.8 Sewage treatment

2.8.1 The capacity of the sewage treatment system, where fitted, is to be sufficient for the maximum number of persons on board. Where 'black water' only is treated, the minimum capacity is to be 115 litres/person/day for a conventional flushing system or 15 litres/person/day for a vacuum system. Where both 'black water' and 'grey water' are treated, an additional allowance of 135 litres/person/day is to be made.

2.8.2 Procedures for the operation of a sewage treatment system, including the certification of performance, are to be established and effectively implemented. Records are to be maintained of maintenance, repair, remedial work and disinfectant closing rates.

2.8.3 The manufacturer's restriction on materials, which may be disposed of through the sewage treatment system, are to be clearly displayed at each input point.

2.8.4 The disinfectant dosing points of the sewage treatment system are to be readily accessible. Ready access is also to be provided for the taking of samples.

2.8.5 As an alternative to treatment, sewage may be retained onboard. The sewage holding tank is to be of adequate capacity taking into account the operation of the ship, the number of persons on board and other relevant factors. The tank is to be fitted with a visual contents gauge and a high level alarm.

2.8.6 Records are to be maintained detailing discharges from the holding tank. These should include:

(a) the date, location and quantity of sewage discharged from the holding tank either ashore or at sea;
(b) distance from land and ship's speed, when sewage is discharged to sea.

2.8.7 Ventilation pipes from the sewage system are to be independent of other vent systems.

2.9 Hull anti-fouling systems

2.9.1 Prior to 1 January 2003, the application of anti-fouling systems containing tributyltin (TBT) is acceptable provided that the leaching rate does not exceed 4 μg/cm^2/day, as determined by ASTM Method 5108-90.

2.9.2 From 1 January 2003, the application of anti-fouling systems containing TBT is prohibited. Ships to which TBT-based anti-fouling systems have been applied prior to this date will be accepted until 1 January 2008, provided the TBT leaching rate does not exceed 4 μg/cm^2/day, as determined by ASTM Method 5108-90.

2.10 Ballast water

2.10.1 All ships carrying ballast water are to implement precautionary measures to minimize the translocation of non-native organisms in their ballast water unless it can be demonstrated that the risk of translocation of non-native organisms in their ballast water and sediments is minimal.

2.10.2 As a minimum, precautionary measures to minimize the translocation of non-native organisms are to include:

(a) minimizing the uptake of aquatic organisms, pathogens and sediments during ballasting, by limiting (or minimizing) ballasting in situations where the numbers of aquatic organisms are likely to be increased locally. For example:
    - in darkness, when bottom-dwelling organisms may rise up the water column;
    - in very shallow water;
    - where propellers may stir up sediment;
    - in areas specified by the Port State for avoidance or restriction of ballasting;
(b) monitoring of sediment build up and, where practical, routine cleaning of ballast tanks to remove sediments;
(c) planning uptake and discharge of ballast water such that where ballast needs to be taken on and discharged in the same port, discharge of ballast loaded in another port is to be avoided, where practicable.

Section 3
Supplementary characters

3.1 Hull anti-fouling systems – A character

3.1.1 For assignment of the **A** character, the anti-fouling system applied to the ship's hull is to be non-biocidal.

3.2 Ballast water management – B character

3.2.1 Where ballast water management is undertaken, for assignment of the **B** character, a ballast water management plan approved by the Administration with which the ship is registered, is to be in place and implemented effectively.

3.2.2 The ballast water management plan is to be developed in accordance with IMO Resolution MEPC 127(53) and take note of the safety considerations in IMO Resolution MEPC 124(53).

3.2.3 For new ships, the guidance within IMO Resolutions MEPC 149(55) and MEPC 150(55) is to be taken account of, as far as is practicable.

3.3 Grey water – G character

3.3.1 Where plant for the treatment of grey water is installed and utilized effectively, the **G** character will be assigned, subject to the plant effluent meeting the standards specified in 3.3.2 or 3.3.3, as applicable.

3.3.2 Where it is not intended that the effluent is recycled or re-used for any purpose, the effluent of the grey water treatment plant is to meet the following standards:

(a) Faecal coliforms: Content is not to exceed 250/100 ml M.P.N. (most probable number) as determined by a multiple tube fermentation analysis or an equivalent procedure.
(b) Suspended solids:
    - Where the equipment is tested onshore, the geometric mean of the total suspended solids content of the samples of effluent taken during the test period is not to exceed 50 mg/l.

- Where the equipment is tested onboard the ship, the geometric mean of the total suspended solids content of the samples of effluent taken during the test period is not to exceed the suspended solids content of the ambient water used onboard plus 100 mg/l.

(c) Biochemical Oxygen Demand (BOD_5):

- The geometric mean of a 5-day Biochemical Oxygen Demand is not to exceed 50 mg/l.
- When testing onboard the ship, if insufficient time is available for obtaining a number of samples over a period of days, a BOD_5 not exceeding 100 mg/l on a single sample will be accepted providing that suspended solids are within the value stated above.

3.3.3 Where it is intended that the effluent of the grey water treatment plant is to be re-used or recycled for any purpose, the effluent is to meet the potable water quality standards of the Flag or Port State Administration, as appropriate.

3.4 Oxides of nitrogen (NO_x) – N character

3.4.1 For assignment of the **N** character, the total weighted value of NO_x emissions from all installed diesel engines defined within 2.2.1 is not to exceed 80 per cent of the total weighted NO_x emission limits specified in MARPOL Annex VI, Regulation 13.

3.4.2 The total weighted emission value for the ship (*WV*) is to be calculated as follows:

$$WV_{[ship]} = \frac{WAEV_{[cert]}}{WAEV_{[IMO]}}$$

where

$$WAEV_{[cert]} = \frac{\sum_{n=1}^{n} (NO_{x[cert]} . P}{\sum_{n=1}^{n} (P)}$$

$$WAEV_{[IMO]} = \frac{\sum_{n=1}^{n} (NO_{x[IMO]} . P}{\sum_{n=1}^{n} (P)}$$

n = the number of individual engines on board the ship

P = the rated power, in kW, of each individual installed engine

$NO_{x[cert]}$ = the certified NO_x emission value, in g/kWh, for each individual engine

$NO_{x[IMO]}$ = the NO_x emission limit value, in g/kWh, of each individual engine as specified in Regulation 13 of Annex VI to MARPOL.

3.4.3 The N character will be assigned when:

$$\frac{WAEV_{[cert]}}{WAEV_{[IMO]}} \leq 0,8$$

3.4.4 The test procedure and measurement method are to be in accordance with either the Simplified Measurement Method or Direct Measurement and Monitoring Method given in Chapter 6 of the IMO NO_x Technical Code.

3.4.5 Systems and equipment used to control the NO_x emissions are to comply with the requirements specified in 2.2.5.

3.4.6 In the case where the individual engines are 'family' or 'group' engines, as defined in the NOx Technical Code, the certified emission value may be based on that of the parent engine.

3.5 Oily bilge water – O character

3.5.1 For assignment of the **O** character, all drainage from machinery space bilges is to be discharged ashore, except under exceptional circumstances.

3.5.2 Alternatively, discharge to sea is permitted where it can be demonstrated that the oil-in-water content of the water discharged is less than 5 ppm.

3.5.3 Full records of all discharges are to be kept.

3.6 Protected oil tanks – P character

3.6.1 For assignment of the **P** character, oil fuel and lubricating oil tanks are to be located in a protected location away from the ship's side or bottom shell plating.

3.6.2 The location of tanks is to be in accordance with the requirements relating to oil fuel tank protection given in IMO Resolution MEPC.141(54).

3.6.3 The requirements apply to oil fuel and lubricating oil tanks. Main engine lubricating oil drain tanks are excluded.

3.6.4 Arrangements providing equivalent protection will be given special consideration.

3.6.5 Suction wells may protrude below oil fuel tanks provided they are as small as possible and the distance between the tank bottom and the ship's bottom shell plating is not reduced by more than 50 per cent.

3.7 Refrigeration systems – R character

3.7.1 For assignment of the **R** character, in addition to compliance with the requirements of 2.4, all refrigerants used onboard are to have an Ozone Depleting Potential (ODP) rating of zero and a Global Warming Potential (GWP) of less than 1950, based on a 100-year time horizon.

3.8 Oxides of sulphur (SO_x) – S character

3.8.1 For assignment of the **S** character, all gas oil used onboard is to have a sulphur content of less than 0,20 per cent m/m. All heavy fuel oil is to have a sulphur content of less than 1,5 per cent m/m.

3.8.2 The sampling, fuel sulphur analysis methods and verification requirements stipulated in 2.3.4 and 2.3.5 are to be complied with.

3.9 Vapour emission control systems – Vc and Vp characters

3.9.1 Tankers carrying crude oil, petroleum products or chemicals having a flash point not exceeding 60ºC (closed-cup test) will be assigned the **Vc** or **Vp** character provided the provisions of either 3.9.2 or 3.9.3 are complied with.

3.9.2 For assignment of the **Vc** character, a vapour emission control system is to be fitted. The system is to be designed and constructed in accordance with the requirements of USCG 46, CFR 39 or the IMO Standards for Vapour Emission Control Systems (MSC Circular 585). A certificate or statement of compliance issued by LR or a competent authority recognized by LR is to be provided. As an alternative, a self-contained vapour recovery system, which is of a type approved by LR and which achieves equivalent performance to the systems above, may be fitted.

3.9.3 For assignment of the **Vp** character, a self-contained system capable of preventing vapour emission formation during loading is to be fitted. This vapour emission prevention system is to be of a type approved by LR and is to reduce vapour emission formation by at least 75 per cent (v/v) as compared to an equivalent ship to which no vapour emissions prevention system has been fitted.

■ *Section 4* Survey requirements

4.1 Initial Survey and Audit

4.1.1 Following satisfactory review of the plans and other information submitted (*see* 1.3), an EP Initial Survey is to be undertaken for ships under construction or in service.

4.1.2 At the EP Initial Survey, the Surveyor is to be satisfied that the requirements of these Rules, including those relating to any requested supplementary characters, are complied with. The Surveyor is to verify that the hull and machinery arrangements are in accordance with the approved documentation. The installed equipment, together with associated control and alarm systems, is to be demonstrated under working conditions.

4.1.3 Following the successful completion of the Initial Survey, the EP notation may be assigned to a ship. The EP notation will be valid, in the first instance, for a period not exceeding 12 months. During this period, an audit of the procedures as required by these Rules is to be undertaken. This audit is to be performed after the procedures have been fully implemented, subjected to internal audit and have generated at least 3 months of records under in-service conditions.

4.1.4 Audits are to confirm by direct observation, examination of internal audit reports and scrutiny of records that each of the procedures have been implemented effectively over the preceding period. It is also to be verified that:

(a) the required resources and equipment have been provided; and
(b) the ship's staff are aware of their duties and responsibilities, and can perform the assigned tasks.

4.2 Periodical Surveys and Audits

4.2.1 EP Annual Surveys and Audits are to be held on all ships to which the EP notation applies within three months of each anniversary of assignment of the full **EP** notation.

4.2.2 At the EP Annual Survey and Audit, the Surveyor is to be satisfied that the arrangements and equipment comply with these Rules and operating procedures have been implemented effectively. As far as possible, the installed equipment, together with associated control and alarm systems, are to be demonstrated under working conditions. Additionally:

(a) where changes to arrangements or equipment fitted to meet the requirements of these Rules have been made, it is to be verified that these changes are in accordance with approved documentation; and
(b) records for the preceding 12 months are to be reviewed.

4.2.3 EP Audits are to be undertaken in accordance with the requirements given in 4.1.4.

4.3 Change of company

4.3.1 Where the company (as defined in the ISM Code) changes, the **EP** notation will be suspended.

4.3.2 The new company may adopt the previously approved procedures as required by these Rules or may compile new procedures which would need to be submitted for approval.

4.3.3 Following implementation of the approved procedures, an audit, in accordance with the requirements in 4.1.3 and 4.1.4, is to be undertaken.

4.3.4 The **EP** notation will be re-assigned following successful completion of the audit provided that the ship has a valid Safety Management Certificate (SMC) and the general requirements given in 2.1.1 are complied with.

■ *Section 1* General

1.1 Application

1.1.1 The requirements of this Chapter apply to ships where an optional class notation is requested for the control and monitoring of all active fire protection and fixed fire-extinguishing systems from a centralized fire-control station, implemented by means of an Integrated Fire Protection system. The requirements are additional to those applicable in other Parts of the Rules.

1.1.2 Ships provided with arrangements complying with the requirements of this Chapter will be eligible for the class notation **IFP** – Integrated Fire Protection.

1.1.3 Requirements additional to these Rules may be imposed by the National Authority with whom the ship is registered and/or by the Administration within whose territorial jurisdiction it is intended to operate.

1.1.4 It is the responsibility of the National Authority to give effect to the fire safety and other ship, passenger and crew safety measures required by the *International Convention for the Safety of Life at Sea,* 1974, as amended (SOLAS).

1.1.5 Special consideration will be given where control and monitoring arrangements prescribed and approved by the National Authority give rise to deviation from the requirements of these Rules.

1.2 Submission of plans and information

1.2.1 The following plans and information are to be submitted:

- A plan showing the location and physical arrangement of the centralized fire-control station.
- A list of systems and equipment that are to be controlled and monitored from the centralized fire-control station, *see* 1.2.2.
- Details of controls, alarms, instrumentation and monitoring including line diagrams of control circuits, descriptions of operation and programmable electronic systems details required by Pt 6, Ch 1,1.2.5.
- Details of the power supply arrangements.
- Remote stopping arrangements for independently driven oil pumps and remote oil valve closing arrangements.
- Test schedules including methods of testing and required test results.
- Failure Mode and Effects Analysis (FMEA) report, including worksheets.

1.2.2 Plans for the control and monitoring arrangements of active fire protection, fire-fighting and other integrated systems are to be submitted, including as applicable:

- Fixed fire detection and fire-alarm systems.
- Fire-pumps and fire main systems.
- Fixed water-based fire-extinguishing systems
- Fixed gas fire-extinguishing systems.
- Dry extinguishing powder systems.
- Protected space openings and ventilation systems, including related crew and passenger emergency systems, *see* Pt 6, Ch 2,17.

1.3 Definitions

1.3.1 The definitions given in Pt 6, Ch 4,2 are relevant with regard to the requirements of this Chapter.

■ *Section 2* Centralized fire-control station

2.1 General

2.1.1 A centralized fire control station is to be located on the navigating bridge or in some other suitable compartment that is readily accessible from the accommodation spaces and is provided with two escape routes from the compartment, one of which is to lead directly to an open deck.

2.1.2 A copy of the fire-control plan is to be permanently displayed at the centralized fire-control station.

2.1.3 An Integrated Fire Protection system is to be located at the centralized control station, *see* Section 3. The system is to enable efficient control and indication of all essential parameters necessary for the safe and effective operation of the active fire protection and fixed fire-extinguishing systems, including the operational status of running and standby machinery.

2.2 Communication

2.2.1 At the centralized fire-control station, fixed means of two-way speech communication is to be provided to all the accommodation and service spaces and other control stations, including the main machinery control station and bridge, if applicable. This means of communication is to be independent of the main source of electrical power.

2.2.2 In addition to the communication required by 2.2.1, a public address system is to be provided that is clearly audible throughout the accommodation and service spaces and other control stations, including the main machinery control station and navigating bridge, if applicable. The public address system is to be operable from the centralized fire-control station and comply with Pt 6, Ch 2,17.3.

2.2.3 Each required breathing apparatus is to incorporate effective means of communication to enable individual fire fighters to communicate easily with each other and the centralized fire-control station during fire-fighting operations.

Section 3
Control and monitoring of active fire protection and fixed fire-extinguishing systems

3.1 General

3.1.1 The Integrated Fire Protection system is to comply with relevant requirements of the Rules, in particular:

- Pt 6, Ch 1,2 in respect of control, alarm and programmable electronic systems;
- Pt 6, Ch 2, 3 in respect of power supply arrangements;
- Pt 6, Ch 2,16 in respect of fire safety systems;
- Pt 6, Ch 2,17 and 18 in respect of crew, passenger and ship safety systems (where applicable, *see* Section 4).

3.1.2 The Integrated Fire Protection system is to provide a consistent and common user interface to control and monitoring functions by means of multi-function displays and controls. Functions are to be logically grouped to minimise operator workload with means provided to ensure ease of navigation, e.g. hot-keys to emergency functions, overview pages, etc.

3.1.3 The number of user interfaces is to be sufficient to ensure that the operator can simultaneously display all information necessary to enable safe and effective control and monitoring, with due regard to any functions required to be continuously available.

3.1.4 Means are to be provided to override any safety functions automatically initiated by the Integrated Fire Protection system.

3.1.5 A Failure Mode and Effects Analysis (*see* Pt 6, Ch 1,2.13.5) is to be carried out, which is to demonstrate that:

(a) failure of any part of the Integrated Fire Protection system will not result in a loss or degradation of centralized control and monitoring functions for more than one active fire protection or fixed fire-extinguishing system,

(b) failure of any active fire protection or fixed fire-extinguishing system will not result in the loss or degradation of another system as a result of their interconnection through the Integrated Fire Protection system, and

(c) any such failures are evident at the centralized fire-control station, by means of audible and visual alarms.

NOTE:
The FMEA is to be carried out to the level of identifiable hardware and software component parts providing defined functions, e.g. display unit, network interface card, etc. and is to consider the effects of:

(i) random failures of hardware components, and,

(ii) common mode failures of hardware and software components, unless these components have been certified for use in safety applications, *see* Pt 6, Ch 1,2.

3.1.6 The Integrated Fire Protection system is to be provided with two independent sources of power, one of which is to be the emergency source, with automatic changeover and audible and visual alarm in the event of any power supply failure.

3.1.7 Where the automatic changeover between supplies may affect operation of the Integrated Fire Protection system, a local transitional source of power of not less than thirty minutes capacity is to be provided. The transitional source is to be arranged such that a fault will not affect the supply of main and emergency power to the system, or the changeover arrangement between them. *See also* 4.1.3.

3.1.8 Control and monitoring functions for active fire protection and fixed fire-extinguishing systems are to be provided by the Integrated Fire Protection system in accordance with 3.2 to 3.7.

3.2 Fixed fire detection and fire-alarm systems

3.2.1 The Integrated Fire Protection system is to provide means to indicate the status of each detector head and manual call point and their location in relation to the spaces and fire zones served.

3.2.2 Audible and visual indication is to be provided automatically and immediately in the event of a detector or manual call point being operated.

3.2.3 Information is to be available detailing the location of each section in relation to the spaces and fire zones served.

3.2.4 System faults resulting in the loss or degradation of fire detection and fire-alarm functions are to be automatically indicated by audible and visual alarms at the centralized fire control station, which are to be clearly distinguishable from those required by 3.2.2.

3.3 Fixed water-based fire-extinguishing systems, including local application systems

3.3.1 Alarms and monitoring arrangements are indicated in Table 12.3.1.

Table 12.3.1 Alarms and monitoring arrangements for fixed water based systems

Item	Alarm	Indication	Note
Fire pumps	—	Running/stopped	—
Fire pumps electric power supply	Failure	—	—
System water pressure	Low	Pressure	—
Sea valves serving fire pumps	—	Open/closed	—
System isolating valves	—	Open/closed	—
Distribution control valves	—	Open/closed	—
Activation of system	Warning	Section activated	Not more than one minute after activation
Lubricating oil inlet temperature for diesel-driven pumps	High	—	—
Pump engine lubricating oil pressure	Low	—	—
Pump engine coolant engines temperature	High	—	For >220 kW
Pump engine coolant pressure or flow	Low	—	—
Pump engine service oil fuel tank level	Low	—	—
Pump engine overspeed	High	—	*See* Pt 5, Ch 2,5
Pump engine starting air pressure	Low	Pressure	—
Pump engine electrical starting battery charge level	Low	—	—

3.3.2 Controls are to be provided for the following:

- The starting and stopping of all fire pumps.
- The opening and closing of all sea valves serving the fire pumps.
- The opening and closing of all system(s) isolating valves and distribution control valves for water and foam solution.
- The effective operation of foam monitors. Where a clear view of foam monitor nozzles is not available from the centralized fire-control station, television surveillance or other suitable means for observing the monitors may be accepted.

3.4 Fixed gas fire-extinguishing systems

3.4.1 Alarms and monitoring arrangements are indicated in Table 12.3.2.

3.4.2 Controls are to be provided for the release of the extinguishing media and the opening and closing of the distribution control valves for conveying the media into selected protected spaces. These controls are to be protected against misuse.

Table 12.3.2 Alarms and monitoring arrangements for fixed gas fire-extinguishing systems

Item	Alarm	Indication	Note
Operation of medium release	Warning	Instructions relating to the operation of the system having regard to the safety of personnel	An audible warning is to be given automatic-ally of the release of the medium into any space in which personnel normally work or have access and is to operate for a suitable period before the medium is released
Distribution control valves	—	Open/closed	—
Electric power for medium release	Failure	—	—
Hydraulic or pneumatic pressure for medium release	Low	—	—
Discharge manifold pressure	High	Pressure	—

3.4.3 Means are to be provided to stop all ventilation fans serving the selected protected space before the extinguishing medium is released, *see also* 3.6.

3.4.4 The requirements of 3.4.2 and 3.4.3 need not be applied to systems protecting cargo spaces except where a limit is placed on the duration of the discharge.

3.5 Dry extinguishing powder fire-extinguishing systems

3.5.1 Alarms and monitoring arrangements are indicated in Table 12.3.3.

Table 12.3.3 Alarms and monitoring arrangements for dry extinguishing powder fire-extinguishing systems

Item	Alarm	Indication	Note
Dry extinguishing powder container pressure	—	System energised	—
Monitor flow control valve(s)s	—	Open/closed	—

3.5.2 Controls are to be provided for the following:
- Energising the system in readiness for discharge.
- The opening and closing of monitor flow control valve(s).
- The effective operation of the monitor nozzle(s), where applicable. Where the monitor nozzle(s) is required to be aimed remotely, and a clear view of the monitor(s) is not available from the centralized fire-control station, television surveillance or other suitable means for observing the monitor nozzle(s) may be accepted.

3.6 Protected space openings and ventilation systems

3.6.1 Alarms and monitoring arrangements are indicated in Table 12.3.4.

Table 12.3.4 Alarms and monitoring arrangements for protected space openings and ventilation systems

Item	Alarm	Indication	Note
Ventilation fans	—	Running/stopped	—
Forced and included draught fans	—	Running/stopped	—
Inlets and outlets in ventilation systems	—	Open/closed	—
Miscellaneous openings	—	Open/closed	*See* 3.6.2(c), (e) and (f)
Loss of ventilating capacity in Ro-Ro cargo spaces	Warning	—	—
Operation of remote release devices for self-closing doors	—	Hold-back arrangements released	—

3.6.2 Controls are to be provided for the following:
(a) The start and stop of all ventilation fans.
(b) The start and stop of all forced and induced draught fans.
(c) The opening and closing of openings into spaces protected by fixed gas fire-extinguishing systems.
(d) The opening and closing of all main inlets and outlets of ventilation systems, including fire dampers.
(e) The opening and closing of machinery space skylights and openings in funnels.
(f) Remote release devices for self-closing doors provided with hold-back arrangements.
(g) Manual operation of escape route or low location lighting, *see* Pt 6, Ch 2,17.4.

3.7 Oil storage, transfer and pumping arrangements in machinery spaces

3.7.1 Alarms and monitoring arrangements are indicated in Table 12.3.5.

Table 12.3.5 Alarms and monitoring arrangements for oil storage, transfer and pumping systems

Item	Alarm	Indication	Note
Deep tank valves	—	Open/closed	—
Oil pumps	—	Running/stopped	*See* 3.7.2(b)
High pressure fuel delivery lines	Failure	—	See Pt 6, Ch 1,3.1.5

3.7.2 Controls are to be provided for the following:
(a) The closure of valves on all pipes that, if damaged, could allow oil to escape from storage, settling or daily service tanks situated above the double bottom.
(b) The stopping of oil fuel transfer pumps, oil fuel unit pumps lubricating oil pumps, piston cooling pumps, hydraulic oil pumps and other similar types of pumps.

■ *Section 4* Integration of other systems

4.1 General

4.1.1 The Integrated Fire Protection system is to provide functions required for fire protection purposes only, excepting where permitted below.

4.1.2 Other ship, passenger or crew safety systems, *see* Pt 6, Ch 2,17 and 18, may be integrated such that control and monitoring functions are accessed via the common user interface, subject to 1.1.4. Any such arrangements are to be in accordance with the general requirements of 3.1, and comply with any Rules applicable to these systems.

4.1.3 Where watertight door control and indication functions are included, the power supply arrangements are to be in accordance with Pt 6, Ch 2,3.2.7 or 3.3.7 as applicable. In this case, the requirement of 3.1.7 will be waived.

4.1.4 The **IP** (Integrated Propulsion, *see* Pt 5, Ch 18), **ICC** (Integrated Computer Control, *see* Pt 6, Ch 1,6) or **IBS** (Integrated Bridge Navigational System, *see* Pt 7, Ch 9,5) class notations may be applicable to ships where other control and monitoring functions are implemented by an integrated system.

■ *Section 5* Testing, trials and maintenance

5.1 General

5.1.1 The Integrated Fire Protection system is to be examined and tested at the manufacturer's works in accordance with the approved test schedule, *see* 1.2.1.

5.1.2 The factory acceptance test is to demonstrate that:
(a) the system is correct with regard to its specification (i.e. verification tests);
(b) as far as applicable, the system fulfils the requirements of these Rules (i.e. validation tests).

Where sample testing of hardware or software modules is proposed, records of prior verification testing are to be made available to the attending Surveyor.

5.1.3 The arrangements are to be subject to examination and functional testing on completion of the installation. These validation tests are to be based on the approved test schedule and are to demonstrate that the requirements of these Rules have been satisfied. In addition, details of commissioning tests for verification purposes are to be made available to the attending Surveyor.

5.1.4 The arrangements are to be examined and a sample of functions tested at Annual and Special Surveys.

5.2 Modifications

5.2.1 Where any modification of the Integrated Fire Protection system is to be carried out, details are to be submitted to Lloyd's Register for consideration. A suitable testing program is to be submitted for consideration, demonstrating that the system will continue to provide required functions.

5.2.2 All modifications are to be carried out in accordance with a traceable change control procedure. Software versions and relevant documentation are to be updated.

Section 1 Water ingress detection arrangements

1.1 General requirements

1.1.1 Equipment for detecting the ingress of water is to be fitted in accordance with the requirements of SOLAS 1974 as amended, Chapter XII, Regulation 12.

1.1.2 Bulk carriers are to be fitted with water level detectors:

(a) In each cargo hold, giving audible and visual alarms, one when the water level above the inner bottom in any hold reaches a height of 0,5 m and another at a height not less than 15 per cent of the depth of the cargo hold but not more than 2 m. The water level detectors are to be fitted in the aft end of the cargo holds. For cargo holds which are used for water ballast, an alarm overriding device may be installed. The visual alarms are to clearly discriminate between the two different water levels detected in each hold;

(b) in any ballast tank forward of the collision bulkhead required by Pt 3, Ch 3,4, giving an audible and visual alarm when the liquid in the tank reaches a level not exceeding 10 per cent of the tank capacity. An alarm overriding device may be installed to be activated when the tank is in use; and

(c) in any dry or void space other than a chain cable locker, any part of which extends forward of the foremost cargo hold, giving an audible and visual alarm at a water level of 0,1 m above the deck. Such alarms need not be provided in enclosed spaces the volume of which does not exceed 0,1 per cent of the ship's maximum displacement volume.

1.1.3 The audible and visual alarms specified in 1.1.2 are to be located on the navigation bridge.

Section 2 Drainage and pumping arrangements

2.1 General requirements

2.1.1 Arrangements for drainage and pumping are to be in accordance with the requirements of SOLAS 1974 as amended, Chapter XII, Regulation 13.

2.1.2 On bulk carriers, the means for draining and pumping ballast tanks forward of the collision bulkhead and bilges of dry spaces any part of which extends forward of the foremost cargo hold are to be capable of being brought into operation from a readily accessible enclosed space, the location of which is accessible from the navigation bridge or propulsion machinery control position without traversing exposed freeboard or superstructure decks. Where pipes serving such tanks or bilges pierce the collision bulkhead, valve operation by means of remotely operated actuators may be accepted, as an alternative to the valve control specified in Pt 5, Ch 13,3.5.6, provided that the location of such valve controls complies with this requirement.

2.2 Dewatering capability

2.2.1 The dewatering system for ballast tanks located forward of the collision bulkhead, and for bilges of dry spaces any part of which extends forward of the foremost cargo hold, is to be designed to remove water from the forward spaces at a rate of not less than $320A$ m^3/h, where A is the cross-sectional area in m^2 of the largest air pipe or ventilator pipe connected from the exposed deck to a closed forward space that is required to be dewatered by these arrangements.

Section 1
General requirements

1.1 Scope

1.1.1 These Rules set down the criteria for the assessment of the noise and vibration on ships and are applied in addition to the other relevant requirements of the *Rules and Regulations for the Classification of Ships* (hereinafter referred to as the Rules for Ships).

1.1.2 Compliance with these Rules is optional.

1.1.3 These Rules provide for two alternatives:
(a) **Class Notations** which indicate that the ship has been assessed and complies with noise and vibration criteria in these Rules and that a periodic survey regime has been established for the lifetime of the ship.
(b) **Certificate of Compliance** which provides evidence that the ship has been assessed and found to comply with the noise and vibration criteria in these Rules.

1.1.4 These Rules recognize existing National and International Standards and specify levels of noise and vibration currently achievable using good engineering practice. Compliance with these requirements will be assessed by review of procedures, inspection and measurement of the relevant parameters and pre-survey reviews. Inspections and measurements are to be conducted, witnessed or assessed by LR's Surveyors unless otherwise agreed by Lloyd's Register (hereinafter referred to as LR).

1.1.5 Accommodation comfort is a function of ship type and layout. These Rules address two types of ship:
(a) Passenger (e.g. cruise ships, ro-ro ferries).
(b) Cargo (e.g. container ships, tankers).

1.1.6 These Rules include levels of noise and vibration which should be verified by measurements following completion of the ship. It is recommended that the Builders undertake calculations of noise and vibration characteristics so that any potential problem areas can be identified and control measures implemented.

1.1.7 The sound pressure levels for audible alarms and public address systems fitted in accordance with other sections of the Rules are to satisfy IMO Resolution A.830(19) Code on Alarms and Indicators.

1.2 Definitions

1.2.1 **Passenger spaces** are defined as all areas intended for passenger use, and include the following:
(a) Passenger cabins.
(b) Public spaces (e.g. restaurants, hospital, lounges, reading and games rooms, gymnasiums, corridors, shops).
(c) Open deck recreation areas.

1.2.2 **Crew spaces** are defined as all areas intended for crew use only, and include the following:
(a) Accommodation spaces (e.g. cabins, offices, mess rooms, recreation rooms).
(b) Work spaces.
(c) Navigation spaces.

1.2.3 **Noise level** is defined as the A-weighted sound pressure level measured in accordance with ISO 2923.

1.2.4 **Vibration level** is defined by the application of either of the two versions of the ISO 6954 standard:
(a) Where ISO 6954:1984 is applied, the vibration level is defined as the single amplitude peak value of deck structure vibration during a period of steady state vibration, representative of maximum repetitive behaviour, in mm/s, over the frequency range 5 to 100 Hz. For frequencies below 5 Hz, the requirements for vibration levels follow constant acceleration curves corresponding to the acceleration at 5 Hz.
(b) Where ISO 6954:2000 is applied, the vibration level is defined as the overall frequency weighted r.m.s. value of vibration during a period of steady-state operation over the frequency range 1 to 80 Hz.

In general, ISO 6954-2000 is the preferred standard to be applied, however ISO 6954-1984 may be applied where there are practical difficulties in application of ISO 6954-2000 and this has been agreed between the Owner and Builder.

1.3 Class notations

1.3.1 The class notations described in 1.3.2 to 1.3.6 provide standards for noise and vibration levels in different spaces at the time of delivery and during the ships life if substantial changes to the machinery installation or interior arrangements are made.

1.3.2 The **PAC** (Passenger Accommodation Comfort), **CAC** (Crew Accommodation Comfort) and **PCAC** (Passenger and Crew Accommodation Comfort) notations are optional and are primarily intended to apply to passenger ships. If requested, however, any ship can be assessed for compliance, using these requirements as the basis for the assessment and a LR Certificate of Compliance issued (*see* 1.1.3(b) and 1.4).

1.3.3 The **PAC** notation indicates that the passenger accommodation meets the acceptance criteria whilst the **CAC** notation indicates that the crew accommodation and work areas meet the acceptance criteria. The **PCAC** notation indicates that the passenger and crew spaces both meet the acceptance criteria.

1.3.4 For ships which achieve the noise and vibration comfort standards specified in these Rules, the notation **PAC**, **CAC** or **PCAC** will be assigned.

1.3.5 Following the **PAC** or **CAC** notation, numerals **1**, **2** or **3** will indicate the acceptance criteria to which the noise and vibration levels have been assessed. In the case of the **PCAC** notation, two numerals will be assigned. The first will indicate the acceptance criteria for passenger accommodation, whilst the second will indicate the crew comfort criteria.

1.3.6 For particular vessels, impact insulation and transient noise in accordance with 2.5 and 2.6 together with any additional or more stringent noise and vibration criteria may be assessed within the scope of the notations where agreed between the Owner, Builder and LR.

1.4 Certificate of Compliance

1.4.1 A Certificate of Compliance records that a ship has been designed and constructed to satisfy the noise and vibration criteria contained in these Rules. This is to be confirmed by measurements and reporting in accordance with Sections 4 and 5.

1.4.2 A Certificate of Compliance is optional and if requested, any ship can be assessed for compliance using the Rule requirements as basis for assessment.

1.4.3 Where noise and vibration levels are at variance with those prescribed by these Rules, these will be added to the certificate for information purposes.

1.4.4 A Certificate of Compliance will be issued after the initial survey required by Section 6.

■ *Section 2* **Noise**

2.1 Assessment criteria

2.1.1 Where a space is occupied by both passengers and crew, the more stringent of the relevant requirements apply unless agreed between the Builder and Owner and advised to LR.

2.2 Passenger accommodation and public spaces

2.2.1 Under test conditions specified in 4.2, the applicable noise levels specified in Table 14.2.1 should not generally be exceeded. *See* 2.2.3.

Table 14.2.1 Passenger ships – Maximum noise levels in dB(A)

Location		Acceptance Numeral		
		1	2	3
Passenger cabins:	Standard Superior	49 45	52 47	55 50
Public spaces:	Excluding shops Shops	55 60	58 62	62 65
Medical centre:		50	55	60
Theatre/auditorium		50	55	60
Open deck recreation areas (excluding swimming pools and similar)		67	72	72
Swimming pools and similar		70	75	75

NOTES
1. The levels may be exceeded by 5dB(A) within 3 m of a ventilation inlet/outlet or machinery intake/uptake on open decks.
2 The levels may be exceeded by 3dB(A) in accommodation above the propellers for three decks above the mooring deck.
3. The levels for open deck recreation areas refer to ship generated noise only. On open deck spaces the noise generated from the effects of wind and waves can be considered separately to limits agreed between the Builder and Owner and advised to LR for the trial conditions.

2.2.2 For cabins bordering discotheques and similar entertainment areas, the deck and bulkhead sound insulation is to be sufficient to ensure that the maximum cabin noise levels are not exceeded even when high external noise levels prevail.

2.2.3 Acceptance of noise levels greater than those specified in Table 14.2.1 may be considered where agreed between the Owner and Builder. Not more than 20 per cent of the passenger cabins, 30 per cent of the public spaces and 20 per cent of the crew cabins should exceed the relevant noise criteria by more than 3 dB(A).

2.2.4 Acoustic insulation of bulkheads and decks between passenger spaces is to be generally in accordance with the values of the weighted apparent sound reduction index R_W as given in Table 14.2.2, calculated using ISO 717/1. *See also* 2.2.6.

2.2.5 For the purpose of selecting acoustic sound insulation, the following sound noise levels may be used with the agreement of the Owner and Builder:

(a) Cabins – 80 dB(A).
(b) Dining Rooms – 85 dB(A).
(c) Corridors – 90 dB(A).
(d) Discotheques, Theatres, Entertainment Areas – 105 dB(A).

2.2.6 Acceptance of bulkhead and deck acoustic insulation values less than those specified in Table 14.2.2 may be considered where agreed between the Owner and Builder. Not more than 20 per cent of the interfaces tested should have airborne sound insulation indices, R_w, more than 3 dB(A) lower than the minimum specified values.

Table 14.2.2 Minimum air-borne sound insulation indices, R_w

Location		Acceptance Numeral		
		1	2	3
Passenger cabins:	Standard Superior	40 45	38 42	37 40
Cabin to corridor:	Standard Superior	38 42	36 40	34 37
Cabin to stairway:	Standard Superior	47 50	45 47	43 45
Cabin to public space (excluding corridors/stairwells and discotheques):	Standard Superior	52 55	48 50	48 50
Discotheques to cabins		60	60	60
Discotheques to stairwells and public spaces		52	52	52
Cabin to machinery rooms and engine casing		55	53	50

2.3 Crew accommodation and work areas

2.3.1 Under the applicable test conditions specified in 4.2, the noise levels specified in Tables 14.2.3 and 14.2.4 are not to be exceeded.

2.3.2 Crew space insulation is to comply with the requirements of IMO Resolution A.468(XII).

Table 14.2.3 Crew accommodation – Maximum noise levels in dB(A)

Location	Acceptance Numeral		
	1	2	3
Sleeping cabins, hospitals	52	55	60
Day cabins	55	60	60
Office conference rooms	55	60	65
Mess rooms, lounges, reception areas: Within accomodation	57	60	65
On open decks	67	72	75
Alleyways, changing rooms, bathrooms, lockers	70	75	75
NOTE The levels may be exceeded by 5 dB(A) within 3 m of a ventilation inlet/outlet or machinery intake/uptake on open decks.			

Table 14.2.4 Crew work areas – maximum noise levels in dB(A)

Location	dB(A) level
Machinery space (continuously manned) e.g. stores	90
Machinery space (not continuously manned) e.g. pump, refrigeration, thrusters or fan rooms	110
Workshops	85
Machinery control rooms	75
Wheelhouse	65
Bridge wing, additional limits: • 250 Hz band • 500 Hz band	 68 63
Radio room	60
Galleys and pantries: • Equipment not working • Individual items at 1 metre	 75 85
Normally unoccupied spaces (e.g. holds, decks)	90
Ship's whistle, on bridge or forecastle	110

2.4 Maximum noise levels

2.4.1 Where the measured noise level exceeds the specified criterion by 3 dB(A), or contains subjectively annoying low frequency or tonal components, the noise rating (NR) number is to be established in accordance with the graph shown in Fig. 14.2.1. This is achieved by plotting the linear octave band levels on the graph; the NR number is that NR curve to which the highest plotted octave band level is anywhere tangent. The specified criterion may be considered satisfied if the NR number does not exceed the specified A-weighted value minus 5 dB(A).

2.4.2 Guidance on maximum acceptable sound pressure levels and noise exposure limits for crew spaces is given in IMO Resolution A.468(XII).

2.5 Impact insulation

2.5.1 Where agreed between the Owner, Builder and LR, enhanced criteria for noise levels recognising the effects of impact sound pressures may be applied in accordance with 2.5.2 to 2.5.5.

2.5.2 For passenger and crew cabins located below or adjacent to dance floors, stages, aerobics and gymnasium areas, jogging tracks or other areas where impact noise is generated, the normalised impact sound pressure level measured within the cabins is not to exceed 45 dB.

2.5.3 For public rooms under dance floors, stages, aerobics and gymnasium areas, jogging tracks or other areas where impact noise is generated, the normalised impact sound pressure level within the space is not to exceed 55 dB.

2.5.4 For passenger cabins, the normalised impact sound pressure level, $L_{n,w}$, calculated using ISO 717/2, is to be generally in accordance with the values stated in Table 14.2.5. *See also* 2.5.5.

Table 14.2.5 Passenger cabins normalized impact maximum sound pressure level $L_{n,w}$

Location	dB
Below decks covered with carpet and soft materials	50
Below decks covered in hard materials (such as wood, marble or similar)	60
Below dance floors, theatre or sports rooms	47

2.5.5 Acceptance of normalised impact sound pressure levels greater than those specified in Table 14.2.5 may be considered for assignment of the applicable class notation where agreed between the Owner, Builder and LR. No more than 20 per cent of the passenger cabins tested should exceed the levels specified by more than 3 dB.

2.6 Transient noise

2.6.1 Where agreed between the Owner, Builder and LR, enhanced criteria for transient noise levels may be applied in accordance with 2.6.2.

2.6.2 The maximum sound pressure level (L_{max}) emanating from any machinery or system caused by a single event that produces a noise 'spike' compared to the reference condition sound level (such as vacuum systems or valve operations) is not to cause an increase in noise in comparison with the reference condition as below:

(a) Passenger cabins and public areas: +2 dB(A)
(b) Officer cabins: +2 dB(A)
(c) Crew cabins and public areas: +3 dB(A)

A tolerance of +1 dB(A) may be applied to 5 per cent of cabins and public areas in each fire zone on each deck. This criterion is generally applicable to the specified maximum noise levels for the space concerned.

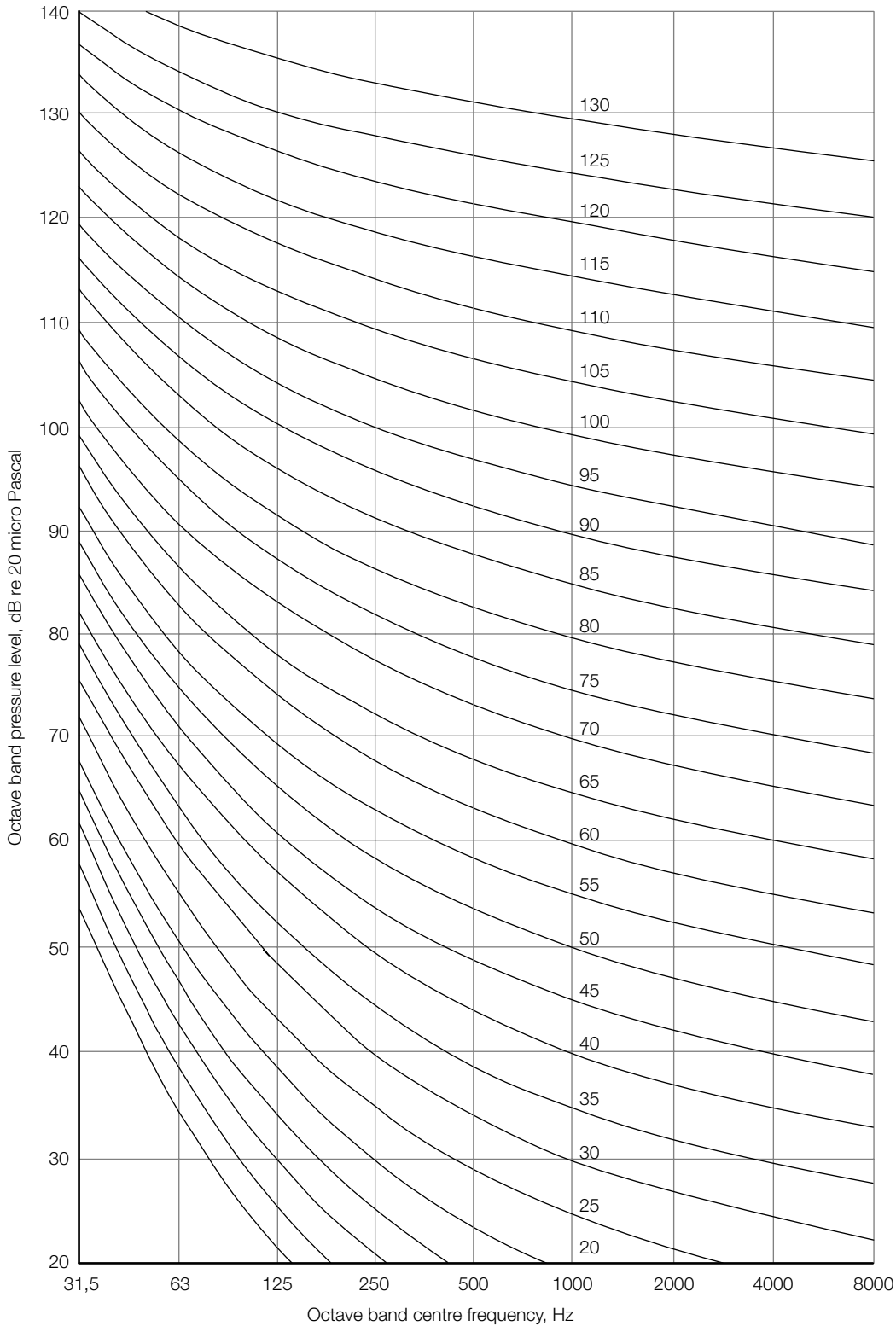


Fig. 14.2.1 Noise rating curves

■ *Section 3* **Vibration**

3.1 Assessment criteria

3.1.1 Where a space is occupied by both passengers and crew, the more stringent of the relevant requirements apply unless agreed between the Builder and Owner and this agreement advised to LR.

3.1.2 The limits apply to vertical, fore and aft and athwartship vibrations which are to be assessed separately.

3.1.3 Under test conditions specified in 4.2, the applicable vibration levels specified in Tables 14.3.1 and 14.3.2 should not be exceeded.

Table 14.3.1 Passenger ship – Maximum vibration levels

Standard	ISO 6954:1984			ISO 6954:2000		
Units:	Peak velocity (5–100 Hz)			Peak velocity (5–80 Hz) velocity mm/s rms		
	Acceptance Numeral					
Location	1	2	3	1	2	3
Passenger cabin Luxury	1,5	2,0	2,5	1,5	1,8	2,1
Passenger cabin Standard	1,5	2,5	4,0	1,8	2,1	2,4
Public spaces	1,5	2,5	4,0	2,0	2,5	3,0
Open recreation decks	2,5	3,5	5,0	2,5	3,0	3,5
NOTE The vibration level may be exceeded by 0,3 mm/s in the ship's aft body directly above the propellers.						

Table 14.3.2 Crew spaces – Maximum vibration levels

Standard:	ISO 6954:1984	ISO 6954:2000
Units:	Peak velocity (5–100 Hz)	Frequency weighted (1–80 Hz) velocity mm/s rms
Location		
Accommodation and navigation spaces	5,0	3,5
Work spaces	6,0	5,0

3.1.4 Acceptance of vibration levels greater than those specified in Tables 14.3.1 and 14.3.2 may be considered for assignment of the applicable class notation where agreed between the Owner, Builder and LR.

3.1.5 The vibration levels for ISO 6954:1984 are stated as peak vibration velocity amplitude. If root mean square levels are measured, each frequency component may be converted to peak vibration velocity amplitude by application of a 1.41 multiplication factor where the ISO 6954:1984 is used for assessment against Tables 14.3.1 and 14.3.2. An approximation of maximum repetitive values may be obtained for direct comparison with the graph in ISO 6954-1984 by further application of the 1,8 conversion factor as stated in the 'Interim guidelines' note of the standard.

3.2 Passenger accommodation and public spaces

3.2.1 Passenger spaces are to comply with the overall vibration levels specified in Tables 14.3.1 and 14.3.2.

3.2.2 No more than 20 per cent of all passenger spaces/areas and public spaces should exceed the relevant vibration criteria specified in Tables 14.3.1 and 14.3.2 by more than 0,3 mm/s whether using ISO 6954:2000 or ISO 6954:1984.

3.3 Crew accommodation and work spaces

3.3.1 Crew spaces are to comply with the overall vibration levels specified in Table 14.3.2.

■ *Section 4* **Testing**

4.1 Measurement procedures

4.1.1 These requirements take precedence where quoted standards may differ.

4.1.2 The trial measurements may be undertaken by an approved technical organisation as defined in 4.7 or by LR. In the former case, the measurements are to be witnessed by a LR Surveyor.

4.1.3 Subject to agreement by LR and the Owner/ Operator, the measurements may be undertaken by the Builder. In this case, the measurements are to be witnessed by a LR Surveyor.

4.2 Test conditions

4.2.1 Test conditions for the surveys are to be in accordance with those detailed in ISO 2923 and ISO 6954:1984 or ISO 6954:2000 as applicable.

4.2.2 The intended operating and loading conditions of the ship during assessment surveys are to be submitted to LR for agreement, prior to commencement of surveys.

4.2.3 Surveys are to be conducted when the ship is fully outfitted and all systems contributing to noise and vibration levels are operational.

NOTE

All systems operational are to include those systems that may operate simultaneously with others during normal ship operation.

4.2.4 The test conditions required for the vibration and noise measurements are to be in accordance with the following conditions:

(a) For passenger ships, prior to measurement surveys being carried out, the ship operating condition where the worst conditions are experienced between 0 and 85 per cent maximum continuous rating of the propulsion machinery is to be determined. To establish this condition, four measurement positions are to be defined with the agreement of LR and measurements taken of the parameters of interest at ship speeds corresponding to percentages of the maximum continuous rating of the propulsion machinery increasing up to 40 per cent MCR in 10 per cent intervals and from 40 per cent in 5 per cent intervals up to the 85 per cent maximum continuous rating of the propulsion machinery. If the 85 per cent maximum continuous rating condition is found to be the worst condition, then this will form the trial operating conditions. However, if a lower speed condition is found to be worse than the 85 per cent maximum continuous rating condition then both that condition and the 85 per cent maximum continuous rating condition will form the trial operating conditions. Where unavoidable any barred range within the values required for the trial operating condition may be excluded on agreement between Owner and Builder subject to approval by LR.

(b) The power absorbed by the propeller(s) is to be that defined in 4.2.4(a). Alternatively, by special agreement, some lesser power could be accepted if it can be demonstrated by the Owner that this would correspond to a more representative normal service condition.

(c) Auxiliary machinery essential for the ship's operating conditions together with HVAC systems are to be running at their normal rated capacity during the noise and vibration trials. Combinations of auxiliary machinery operation may be necessary. In addition, the following equipment is to be running if appropriate: stabilizers, waste treatment equipment, swimming pool and jacuzzi equipment.

(d) For sea-going ships, measurements are to be taken with the ship proceeding ahead, at a constant speed and course, in a depth of water not less than five times the draught of the ship. For other ships, an appropriate water depth is to be agreed with LR prior to the trials.

(e) Trials are to be conducted in sea conditions not greater than sea state 3 on the WMO sea state code. In addition, noise measurements should not be taken when the wind force exceeds 4 on the Beaufort scale.

(f) The ship is to be at a displacement and trim representative of an operating condition.

(g) Rudder angle variations are to be limited to ±2° of the midship position and rudder movements are to be kept to a minimum throughout the measurement periods.

(h) In addition, for ships which are designed to spend a considerable period of time in harbour, the noise and vibration, are to be measured for this condition, with the auxiliary machinery and HVAC systems running at their normal rated capacity.

(j) For passenger ships, intermittently run equipment such as transverse propulsion units are to be operated at 60 per cent of their rated power for additional measurements in surrounding ship areas.

4.2.5 Prior to survey, a test programme is to be submitted for approval by LR. This programme is to contain details of the following:

(a) Measurement locations indicated on a general arrangement of the ship.

(b) The ship's loading condition during survey.

(c) The machinery operating condition, including HVAC system, during survey.

(d) Noise and vibration measuring equipment.

4.3 Noise measurements

4.3.1 Noise measurements are to be conducted in accordance with ISO 2923 and IMO Resolution A.468(XII). Measurements of noise levels are to be carried out using precision grade sound level meters conforming to IEC 60651, Type 1 or 2. Subject to demonstration, equivalent standards are acceptable.

4.3.2 Where the measured noise level exceeds the relevant criterion by 3 dB(A), or contains subjectively annoying low frequency noise or obvious tonal components, octave band readings are to be taken, with centre frequencies from 31,5 Hz to 8 kHz.

4.3.3 When outfitting is complete, and all soft furnishings are in place, sound insulation indices for passenger spaces are to be determined in accordance with ISO 140. Cabin to cabin indices are to be determined from a minimum of three locations within the passenger accommodation, the number of test locations being agreed with LR.

4.3.4 If required, impact sound measurements are to be carried out in accordance with ISO 140/7 and presented in accordance with ISO 717/2. *See* 4.4.4.

4.4 Noise measurement locations

4.4.1 Measurement locations are to be chosen so that the assessment represents the overall noise environment on board the ship. In addition to the requirements of IMO Resolution A.468(XII) for crew spaces, all public spaces and at least 50 per cent of passenger cabins in the after third of the ship, and 25 per cent elsewhere, are to be surveyed. Distribution of the measurement locations is to be agreed by LR.

4.4.2 During measurement trials, recognized noise sources are to be operated at their normal level of noise output (e.g. machinery at design rating).

4.4.3 In larger sized spaces, where noise levels may vary considerably, such as restaurants, lounges, atria and open deck recreation areas, measurements are to be taken at locations not greater than 7 m apart.

4.4.4 The number of and locations for impact noise measurements are to be agreed between the Builder, Owner and LR. The measurements are to be carried out when the ship is in harbour. The number and location of measurements are to take account of all different combinations of construction, areas of application, types of cabin and spaces below.

4.5 Vibration measurements

4.5.1 Vibration measurements are to be conducted in accordance with ISO 6954:1984 or ISO 6954:2000.

4.5.2 Measurements are to be made with instrumentation meeting the requirements of ISO 8041.

4.5.3 Vibration levels are to be given in terms of the velocity measurement appropriate to the version of the standard being used and should be measured over a period of not less than one minute.

4.6 Vibration measurement locations

4.6.1 Measurement locations are to be chosen so that the assessment represents the overall vibration environment onboard the ship. To minimize survey times, readings may be taken at the locations previously defined for the noise assessment part of the survey.

4.6.2 In cabins, vibration readings are to be taken in the centre of the floor area. The measurements are to indicate the vibration of the deck structure. In large spaces, such as restaurants, sufficient measurements are required to define the vibration profile.

4.6.3 Where deck coverings make transducer attachment impracticable, use of a small steel plate having a mass of at least 1 kg, with spikes as appropriate, is permissible.

4.6.4 At all locations, vibrations in the vertical direction are to be assessed. Sufficient measurements in the athwartships and fore and aft directions are to be taken to define global deck vibrations.

4.7 Approved technical organisation

4.7.1 An approved technical organisation for the purposes of these Rules is one that is acceptable to the Owner and LR with proven capability in noise and vibration measurement and satisfies all the criteria set out below:

(a) Have instrumentation whose calibration, both before and after the measurements, can be traced back to National Standards and, hence, back to International Standards.
(b) Have analysis procedures capable of data reduction to the requirements and standards set out in these Rules.
(c) Be able to provide a written report in English with contents as defined by Section 5.

■ *Section 5* Noise and vibration survey reporting

5.1 General

5.1.1 Prior to survey, a noise and vibration measurement plan is to be agreed by the Owner, Builder and LR.

5.1.2 The survey report is to comprise the data and analysis for both noise and vibration and is to be submitted to LR for consideration.

5.1.3 The survey report is to be prepared by the organisation undertaking the trial measurements, which may be an approved technical organisation or LR.

5.1.4 The survey report is to be submitted to LR's London Office (MCS/TID) for evaluation and confirmation that the results are in accordance with the noise and vibration levels specified in these Rules and/or agreed between the Owner and Builder. The assignment of a Class Notation or the issue of a Statement of Compliance will be subject to confirmation by LR MCS/TID.

5.2 Noise

5.2.1 The reporting of results is to comply with ISO 2923, and is to include:

(a) Measurement locations indicated on a general arrangement plan including, where possible, the measured dB(A) level.
(b) Tabulated dB(A) noise levels, together with octave band analysis for positions where the level exceeds the specified criterion by 3 dB(A), or where subjectively annoying low frequency or tonal components were present. The Noise Rating number is also to be given where octave band analyses have been conducted.
(c) Ship and machinery details.

(d) Trial details:
- Loading condition.
- Machinery operating condition.
- Speed.
- Average water depth under keel.
- Weather conditions.
- Sea state.

(e) Details of measuring and analysis equipment (e.g. manufacturer, type and serial numbers), including frequency analysis parameters (e.g. resolution, averaging time, window function).

(f) Copies of the relevant instrument calibration certificates, together with the results of field calibration checks

5.3 Vibration

5.3.1 The report is to contain the following information:

(a) Measurement positions indicated on a general arrangement plan.

(b) Where ISO 6964:2000 is used, the frequency-weighted overall r.m.s. vibration levels tabulated for all measurement locations calculated using the weighting functions and methodology stated in the standard.

(c) Where ISO 6954:1984 is used, the maximum peak vibration levels and their corresponding frequencies taken from the frequency spectra, tabulated for all measurement locations.

(d) Ship and machinery details.

(e) Trial details:
- Loading condition.
- Machinery operating condition.
- Speed.
- Average water depth under keel.
- Weather conditions.
- Sea state.

(f) Frequency analysis parameters (e.g. resolution, averaging time and window function), if the analysis is done in the frequency domain.

(g) Copies of the relevant instrument calibration certificates, together with the results of field calibration.

■ *Section 6* Non-periodical survey requirements

6.1 Class notation assignment

6.1.1 Where the assignment of a Class Notation or a Statement of Compliance is requested, an Initial Survey is to comprise sea trial or initial in-service testing, reporting and assessment against the criteria set out in these Rules.

6.1.2 The sea trial or initial in-service testing requirements are set out in Section 4, and are to be reported in accordance with Section 5 and evaluated against the requirements of Sections 2 and 3.

6.2 Maintenance of class notation through-life and following modifications

6.2.1 Where an Owner has requested assignment of a Class Notation, arrangements are to be agreed between LR and the Owner to record observations/complaints of excessive noise and vibration that have been such as to disturb the comfort of passengers and crew. The records of the observations are to be made available to the attending LR Surveyor at each Annual Survey.

6.2.2 Where the observations indicate that the noise and/or vibration levels may exceed the criteria relating to the Class Notation requirements and those measured at the Initial Survey, a measurement programme is to be agreed between the Owner and LR and measurements taken in accordance with these Rules.

6.2.3 A Renewal Survey may be required following modifications, alterations or repairs including replacement of major machinery items. It is the responsibility of the Owner to advise LR of such modifications.

■ *Section 7* Referenced standards

7.1 Noise

7.1.1 The following National and International Standards for noise are referred to in these Rules:

- ISO 2923, *Acoustics – Measurement of noise on board vessels*.
- ISO 717/1, *Acoustics – Rating of sound insulation in buildings and of building elements; Part 1: Airborne sound insulation*.
- ISO 717/2, *Acoustics – Rating of sound insulation in buildings and of building elements; Part 2: Impact sound insulation*.
- IMO Resolution A.468(XII), *Code on noise levels on board ships*.
- IEC Publication 651, *Sound level meters*.
- ISO140/4, *Acoustics – Measurement of sound insulation in buildings and of building elements; Part 4: Field measurements of airborne sound insulation between rooms*.
- ISO 140/7, *Acoustics – Measurement of sound insulation in buildings and of building elements; Part 7: Field measurements of impact sound insulation of floors*.

7.2 Vibration

7.2.1 The following National and International Standards for vibration are referred to in these Rules:

- ISO 6954:1984, *Mechanical vibration and shock – Guidelines for the overall evaluation of vibration in merchant ships*.
- ISO 6954:2000, *Mechanical vibration and shock – Guidelines for the measurement, reporting and evaluation of vibration with regard to habitability on passenger and merchant ships*.
- ISO 8041, *Human response to vibration. Measuring instrumentation*.

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