PART 5 CHAPTER 2

PASSENGER AND DRY CARGO SHIPS

JANUARY 2001

CONTENTS

Sec. 1 General Requirements ................................................................................................................ 7
Sec. 2 Passenger Ships ............................................................................................................................ 8
Sec. 3 Ferries ........................................................................................................................................... 37
Sec. 4 General Cargo Carriers ................................................................................................................ 46
Sec. 5 Dry Bulk Cargo Carriers .............................................................................................................. 53
Sec. 6 Container Carriers ....................................................................................................................... 60
Sec. 7 Car Carriers .................................................................................................................................. 74
Sec. 8 Subdivision and Damage Stability of Cargo Ships ...................................................................... 77
Sec. 9 Grain Carriers ............................................................................................................................... 81
Sec. 10 Enhanced Strength for Bulk Carriers ......................................................................................... 85
Sec. 11 Ships Specialised for the Carriage of a Single Type of Dry Bulk Cargo ............................... 102
CHANGES IN THE RULES

General

The present edition of the rules includes additions and amendments decided by the Board as of December 2000, and supersedes the July 1999 edition of the same chapter, including later amendments. The rule changes come into force on 1 July 2001.

This chapter is valid until superseded by a revised chapter. Supplements will not be issued except for an updated list of minor amendments and corrections presented in Pt.0 Ch.1 Sec.3. Pt.0 Ch.1 is normally revised in January and July each year.

Revised chapters will be forwarded to all subscribers to the rules. Buyers of reprints are advised to check the updated list of rule chapters printed in Pt.0 Ch.1 Sec.1 to ensure that the chapter is current.

Main Changes

- **Sec.5 Dry Bulk Cargo Carriers**
  - A new item A300 “Structural and leak testing” has been added, concerning testing and the associated references.

Corrections and Clarifications

In addition to the above stated rule amendments, some detected errors have been corrected, and some clarifications have been made in the existing rule wording.

Comments to the rules may be sent by e-mail to rules@dnv.com
For subscription orders or information about subscription terms, please use distribution@dnv.com
Comprehensive information about DNV and the Society's services is found at the Web site http://www.dnv.com

© Det Norske Veritas
Computer Typesetting (FM+SGML) by Det Norske Veritas
Printed in Norway by GCS AS.

If any person suffers loss or damage which is proved to have been caused by any negligent act or omission of Det Norske Veritas, then Det Norske Veritas shall pay compensation to such person for his proved direct loss or damage. However, the compensation shall not exceed an amount equal to ten times the fee charged for the service in question, provided that the maximum compensation shall never exceed USD 2 million.

In this provision "Det Norske Veritas" shall mean the Foundation Det Norske Veritas as well as all its subsidiaries, directors, officers, employees, agents and any other acting on behalf of Det Norske Veritas.
CONTENTS

SEC. 1 GENERAL REQUIREMENTS .......................... 7
A. Classification............................................. 7
A 100 Application......................................... 7
A 200 Class notations...................................... 7
B. Definitions............................................... 7
B 100 Symbols............................................. 7
C. Documentation.......................................... 7
C 100 General............................................... 7

SEC. 2 PASSENGER SHIPS ................................. 8
A. General................................................... 8
A 100 Classification....................................... 8
B. Hull Arrangement and Strength..................... 8
B 100 Double bottoms in passenger ships .......... 8
B 200 Peak and machinery space bulkheads, shaft tunnels .. 8
B 400 Steering arrangement............................ 9
C. Machinery and Systems............................... 9
C 100 General............................................... 9

D. Emergency Source of Electrical Power and Emergency Installations........................................ 9
D 100 General............................................... 9
D 200 Services to be supplied.......................... 10
D 300 Arrangement of emergency source(s) of power........ 10
D 400 Transitional source of emergency power...... 11
D 500 Low-location lighting................................ 11
D 600 Supplementary emergency lighting for ro-ro passenger ships (Reg. II-1/42-1) ....... 11
D 700 Location of emergency switchboard, distribution ... 11
D 800 Inclinations (list and trim of ship) ............. 11
D 900 Periodical testing.................................... 11
D 1000 Starting arrangements for emergency generating sets .... 11

E. Fire Safety Measures for Passenger Ships ....... 11
E 100 Application......................................... 11
E 200 Rule references and definitions.................. 11
E 300 Documentation....................................... 11
E 400 Structure (Reg. II-2/23)........................... 12
E 500 Main vertical zones and horizontal zones (Reg. II-2/24)... 12
E 600 Bulkheads within a main vertical zone (Reg. II-2/25)... 12
E 700 Fire integrity of bulkheads and decks in ships carrying more than 36 passengers (Reg. II-2/26)........ 13
E 800 Fire integrity of bulkheads and decks in ships carrying not more than 36 passengers (Reg. II-2/27)..... 14
E 900 Means of escape (Reg. II-2/28).................... 17
E 1000 Protection of stairways and lifts in accommodation and service spaces (Reg. II-2/29)........ 18
E 1100 Openings in «A» class divisions (Reg. II-2/30).... 18
E 1200 Openings in «B» class divisions (Reg. II-2/31).... 19
E 1300 Ventilation systems for passenger ships carrying more than 36 passengers (Reg. II-2/32.1)........ 19
E 1400 Ventilation systems for passenger ships carrying not more than 36 passengers (Reg. II-2/32.2)........ 20
E 1500 Windows and sidescuttes (Reg. II-2/33)........... 20
E 1600 Restricted use of combustible materials (Reg. II-2/34)........ 20
E 1700 Details of construction (Reg. II-2/35)............ 20
E 1800 Fixed fire detection and fire alarm systems. Automatic sprinkler, fire detection and fire alarm systems (Reg. II-2/36)........ 21
E 1900 Requirements applicable to all ro-ro passenger ships (Reg. II-2/28-1.1)........ 21
E 2000 Requirements applicable to ro-ro passenger ships constructed on or after 1 July 1997 (Reg. II-2/28-1.2)........ 21
E 2100 Requirements applicable to ro-ro passenger ships constructed on or after 1 July 1999 (Reg. II-2/28-1.3)........ 21

F. Protection of Special Category Spaces (Reg. II-2/37) ..... 21
F 100 Application......................................... 21
F 200 General............................................. 22
F 300 Structural protection.................................. 22
F 400 Fixed fire-extinguishing system.................... 22
F 500 Patrols and detection ................................ 22
F 600 Fire-extinguishing equipment....................... 22
F 700 Ventilation system.................................... 22
F 800 Additional provisions applicable only to special category spaces above the bulkhead deck .... 22
F 900 Additional provisions applicable only to special category spaces below the bulkhead deck .... 22
F 1000 Permanent opening for ventilation ............ 22

G. Protection of Cargo Spaces, Other Than Special Category Spaces (Reg. II-2/38, II-2/38-1) .................. 23
G 100 Application......................................... 23
G 200 Fixed fire detection.................................. 23
G 300 Fire-extinguishing arrangements................... 23
G 400 Ventilation system.................................... 23
G 500 Precautions against ignition of flammable vapours ... 23
G 600 Protection of cargo spaces, permanent opening for ventilation ................. 23
G 700 Structural protection of cargo spaces.............. 23
G 800 Protection of closed and open ro-ro cargo spaces, general ........................................ 23
G 900 Protection of closed ro-ro cargo spaces .......... 23
G 1000 Protection of open ro-ro cargo spaces .......... 23

H. Fixed Fire-Extinguishing Arrangements in Cargo Spaces (Reg. II-2/39) .................................... 23
H 100 General............................................. 23

I. Fire Patrols, Detection, Alarms and Public Address Systems (Reg. II-2/40) ...................................... 24
I 100 General............................................. 24

J. Special Requirements for Ships Carrying Dangerous Goods (Reg. II-2/41)....................................... 24
J 100 General............................................. 24

K. Stability and Watertight Integrity....................... 24
K 100 Application......................................... 24
K 300 Documentation....................................... 25
K 400 Intact stability....................................... 25
K 500 Subdivision and damage stability ............... 25
K 600 Watertight integrity................................ 30
K 700 Internal watertight integrity survey ............. 34

L. Life Saving Appliances and Arrangements .......... 34
L 100 General............................................. 34
L 200 Exemption (Regulation III/2)....................... 34
L 300 Survival craft and rescue boats (Regulation III/21).... 34
L 400 Personal life-saving appliances (Regulation III/22).... 35
L 500 Survival Craft and Rescue Boat Embarkation Arrangements (Regulation III/23)......................... 35
L 600 Stowage of Survival Craft (Regulation III/24) ....... 35
L 700 Muster Stations (Regulation III/25)................. 35

M. Chapter IV, Radiocommunications Part C. Ship Requirements ....................................................... 36
M 100 Additional requirements applicable to passenger ships .......................................................... 36

SEC. 3 FERRIES.............................................. 37
A. General................................................... 37
A 100 Classification........................................ 37
A 200 Assumptions......................................... 37
A 300 Documentation....................................... 37
A 400 Definitions........................................... 37

B. Hull Arrangement and Strength.......................... 38
B 100 Doors.................................................. 38
B 200 Access openings..................................... 38
SECTION 1
GENERAL REQUIREMENTS

A. Classification

A 100 Application

101 The rules in this chapter apply to ships intended for passengers and/or carriage of various dry cargoes. The requirements are to be regarded as supplementary to those given for the assignment of main class.

A 200 Class notations

201 Ships complying with relevant additional requirements of this chapter will be assigned one of the following class notations:

Passenger Ship  (See Sec.2)
Car Ferry A (or B)  (See Sec.3)
Train Ferry A (or B)  (See Sec.3)
Car and Train Ferry A (or B)  (See Sec.3)
General Cargo Carrier (RO/RO)  (See Sec.4)
Bulk Carrier ESP (HC, HC-E or HC-EA)  (See Sec.5)
Bulk Carrier (HC, HC-E or HC-EA)  (See Sec.5)
Ore Carrier ESP  (See Sec.5)
Container Carrier  (See Sec.6)
Car Carrier  (See Sec.7)
GRAIN (grain carriers)  (See Sec.9)
X Carrier  (See Sec.11)

202 The notations:

PWDK permanent decks for wheel loading (See Sec.4)
Container arranged for carriage of containers (See Sec.6)
MCDK arranged for carriage of motor vehicles with fuel in their tanks for their own propulsion (See Pt.4 Ch.10 Sec.15 E300)

...TEU number of twenty-foot containers (See Sec.6)
may be added to relevant class notations given in 201.

Ships arranged with movable car decks are to satisfy relevant design requirements regardless of the assignment of class notation.

203 The notations:

RO/RO arranged for roll on/roll off cargo handling
HC strengthened for heavy cargo
HC-E strengthened for heavy cargo, empty holds permitted on full draught
HC-EA any hold may be empty on full draught.
HOLDS...EMPTY combination of empty holds (See Sec.5)
ES(S) enhanced strength for single skin bulk carriers (See Sec.10)
ES(D) enhanced strength for double skin bulk carriers (See Sec.10)

are primarily applicable to general cargo carriers and bulk carriers respectively as indicated in 201, but may be added to other class notations after special consideration.

B 100 Symbols

101 General

L = rule length in m *)
B = rule breadth in m *)
D = rule depth in m *)
T = rule draught in m *)
f1 = material factor *)

= 1,0 for NV-NS steel
= 1,08 for NV-27 steel
= 1,28 for NV-32 steel
= 1,39 for NV-36 steel
= 1,43 for NV-40 steel

= \( \frac{\sigma_t}{235} \) \( \ast \) for steel forgings

\( \sigma_t \) = minimum upper yield stress in N/mm\(^2\), not to be taken greater than 70% of the ultimate tensile strength. If not specified on the drawings, \( \sigma_t \) is taken as 50% of the ultimate tensile strength.

a = 0.75 for \( \sigma_t > 235 \)
= 1.0 for \( f < 235 \)
\( f_2 \) = stress factor *)

= 1.0 when midship hull girder strength in accordance with minimum section modulus.

\( I_k \) = corrosion addition in mm *)

\( \sigma_k \) = section modulus corrosion addition in cm\(^3\) *)

\( l \) = stiffener spacing in m measured along the plating.

\( l_1 \) = stiffener span in m measured along the top flange of the stiffener.

\( z_n \) = vertical distance in m from the baseline or deckline to the neutral axis of the hull girder, whichever is relevant.

\( z_a \) = vertical distance in m from the baseline or deckline to the point in question below or above the neutral axis respectively.

*) For details see Pt.3 Ch.1

C. Documentation

C 100 General

101 Details related to additional classes regarding design, arrangement and strength are in general to be included in the plans specified for the main class.

102 Additional documentation not covered by the main class are specified in appropriate sections of this chapter.
SECTION 2
PASSENGER SHIPS

A. General

A 100 Classification

101 The requirements in this section apply to ships intended for transport or accommodation of passengers engaged on international voyages. For domestic trade, see Pt.1 Ch.1 Sec.2 B900.

102 Ships arranged for transport of more than 12 passengers are to be built in compliance with the relevant requirements in this section, and will be assigned one of the mandatory service and type notations Passenger Ship, Car Ferry A (or B), Train Ferry A (or B) or Car and Train Ferry A (or B). See also Sec.3.

103 The requirements in this section are in compliance with the relevant parts of the International Convention for the Safety of Life at Sea (SOLAS), with the latest amendments in force, as follows:

SOLAS Ch.II-1, Part B: subsections B and K
Ch.II-1, Part D: subsection D
Ch.II-2, Part B: subsections E, F, G, H, I, and J
Ch.III: subsection L

104 SOLAS texts are printed in italics. References to SOLAS Regulations are given.

105 Where any regulation refers ‘to the satisfaction of the Administration’, the Society’s interpretations are given in connection with the item in question.

106 Wherever the term ‘the Administration’ is used, this is to be read as ‘the Society’.

107 If any parts of the rules are subject to discussion or misunderstanding, the SOLAS text shall prevail.

B. Hull Arrangement and Strength

B 100 General

101 Sufficient effective side plating area is to be provided so as to transmit the shear forces and vertical forces to the strength deck. If the ship’s sides are arranged with rows of windows which will significantly reduce the shear strength, the shear deck may be defined as a lower deck than according to the definition given for the main class. The hull structural strength is otherwise to be as required for the main class assuming design loads for passenger spaces as for accommodation deck or weather deck whichever is applicable.

B 200 Double bottoms in passenger ships

201 SOLAS Ch.II-1 Regulation 12.

1) A double bottom shall be fitted extending from the forepeak bulkhead to the afterpeak bulkhead as far as this is practicable and compatible with the design and proper working of the ship.

1.1 In ships of 50 m and upwards but less than 61 m in length a double bottom shall be fitted at least from the machinery space to the forepeak bulkhead, or as near thereto as practicable.

1.2 In ships of 61 m and upwards but less than 76 m in length a double bottom shall be fitted at least outside the machinery space, and shall extend to the fore and after peak bulkheads, or as near thereto as practicable.

1.3 In ships of 76 m in length and upwards, a double bottom shall be fitted amidships, and shall extend to the fore and after peak bulkheads, or as near thereto as practicable.

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

3) Small wells constructed in the double bottom in connexion with drainage arrangements of holds, etc., shall not extend downwards more than necessary. The depth of the well shall in no case be more than the depth less 460 mm of the double bottom at the centre line, nor shall the well extend below the horizontal plane referred to in paragraph 2. A well extending to the outer bottom is, however, permitted at the after end of the shaft tunnel. Other wells (e.g., for lubricating oil under main engines) may be permitted by the Administration if satisfied that the arrangements give protection equivalent to that afforded by a double bottom complying with this Regulation.

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

5) In the case of ships to which the provisions of Reg. 1.5 apply (ships in special trade and with large numbers of special trade passengers) and which are engaged on regular service within the limits of a short international voyage as defined in Reg. III/3.16 (Pt.3 Ch.6 Sec.1 C100.22), the Administration may permit a double bottom to be dispensed with in any part of the ship which is subdivided by a factor not exceeding 0.50, if satisfied that the fitting of a double bottom in that part would not be compatible with the design and proper working of the ship.

B 300 Peak and machinery space bulkheads, shaft tunnels

301 SOLAS Ch.II-1 Regulation 10.

1) A forepeak or collision bulkhead shall be fitted which shall be watertight up to the bulkhead deck. This bulkhead shall be located at a distance from the forward perpendicular of not less than 5 per cent of the length of the ship and not more than 3 m plus 5 per cent of the length of the ship.

Guidance note:
The ship length definition given in SOLAS assumes the perpendiculars at the extremities of the deepest subdivision load line. Preliminary calculations can be based on the complete waterline length at the given summer freeboard.

---end-of---Guidance---note---

2) Where any part of the ship below the waterline extends forward of the forward perpendicular, e.g. a bulbous bow, the distances stipulated in paragraph 1 shall be measured from a point either:

2.1 at the mid-length of such extension; or

2.2 at a distance 1.5 per cent of the length of the ship forward of the forward perpendicular; or

2.3 at a distance 3 m forward of the forward perpendicular; whichever gives the smallest measurement.
3) Where a long forward superstructure is fitted, the forepeak or collision bulkhead on all passenger ships shall be extended watertight to the next full deck above the bulkhead deck. The extension shall be so arranged as to preclude the possibility of the bow door causing damage to it in the case of damage to, or detachment of, a bow door.

4) The extension required in paragraph 3 need not be fitted directly above the bulkhead below, provided that all parts of the extension are not located forward of the forward limit specified in paragraph 1 or paragraph 2. However, in ships constructed before 1 July 1997:

.1 where a sloping ramp forms part of the extension, the part of the extension, which is more than 2.3 m above the bulkhead deck, may extend no more than 1 m forward of the forward limits specified in paragraph 1 or paragraph 2; and

.2 where the existing ramp does not comply with the 6 requirements for acceptance as an extension to the collision bulkhead and the position of the ramp prevents the siting of such extension within the limits specified in paragraph 1 or paragraph 2, the extension may be sited within a limited distance aft of the aft limit specified in paragraph 1 or paragraph 2. The limited distance aft should be no more than is necessary to ensure non interferences and comply with the requirements of paragraph 3 and shall be so arranged as to preclude the possibility of the ramp causing damage to it in the case of damage to, or detachment of, the ramp.

5) Ramps not meeting the above requirements shall be disregarded as an extension of the collision bulkhead.

6) In ships constructed before 1 July 1997, the requirements of paragraphs 3 and 4 shall apply not later than the date of the first periodical survey after 1 July 1997.

7) An afterpeak bulkhead, and bulkheads dividing the machinery space, as defined in regulation 2, from the cargo and passenger spaces forward and aft, shall also be fitted and made watertight up to the bulkhead deck. The afterpeak bulkhead may, however, be stepped below the bulkhead deck. The afterpeak bulkhead may, however, be stepped below the bulkhead deck, provided the degree of safety of the ship as regards subdivision is not thereby diminished.

8) In all cases stern tubes shall be enclosed in watertight spaces of moderate volume. The stern gland shall be situated in a watertight shaft tunnel or other watertight space separate from the stern tube compartment and of such volume that, if flooded by leakage through the stern gland, the margin line will not be submerged.

The following definitions given in SOLAS Reg.II-1/2 are relevant:

— Length of the ship is the length measured between perpendiculars taken at the extremities of the deepest subdivision load line.
— Deepest subdivision load line is the waterline which corresponds to the greatest draught permitted by the subdivision requirements which are applicable.
— Bulkhead deck is the uppermost deck up to which the transverse watertight bulkheads are carried.
— Margin line is a line drawn at least 76 mm below the upper surface of the bulkhead deck at side.
— Machinery space is to be taken as extending from the moulded base line to the margin line and between the extreme main transverse watertight bulkheads, bounding the spaces containing the main and auxiliary propulsion machinery, boilers serving the needs of propulsion, and all permanent coal bunkers. In the case of unusual arrangements, the Society will consider the limits of the machinery spaces.

B 400 Steering arrangement

401 For ships not equipped with means of propulsion (i.e. class notation Barge included in the main class), rudder or other steering appliances will not be required.

C. Machinery and Systems

C 100 General

101 For ships with class notation Passenger Ship the machinery and systems are in general to be as required for the main class. In addition the requirements to bilge pumping arrangements given in SOLAS 1981 Amendments Ch. II-1 Regulations 21 are to be complied with as well as the requirements given in D.

102 Electrical distribution systems are to be so arranged that fire in any main vertical zone as defined in Pt.4 Ch.10 Sec.1 C301 will not interfere with services essential for safety in any other such zone. This requirement is not applicable to main and emergency feeders passing through any such zone are separated both vertically and horizontally as widely as is practicable.

D. Emergency Source of Electrical Power and Emergency Installations

D 100 General

Guidance note:

Note that rule text quoted from 1981 SOLAS Amendments Chapter II-1 Part D and relevant later SOLAS Amendments are typewritten in italics, while primary rule typography (Times) is applied for rewritten SOLAS texts and additional clarifying DNV texts. Cross references within the rules are given when such necessary references cover the pertinent SOLAS requirements. In other cases cross references to SOLAS are given as necessary.

101 A self-contained emergency source of electrical power shall be provided.

102 The emergency source of electrical power, associated transforming equipment, if any, transient source of emergency power, emergency switchboard and emergency lighting switchboard shall be located above the uppermost continuous deck and shall be readily accessible from the open deck. They shall not be located forward of the collision bulkhead.

103 The location of the emergency source of electrical power and associated transforming equipment, if any, the transient source of emergency power, the emergency switchboard and the emergency electric lighting switchboards in relation to the main source of electrical power, associated transforming equipment, if any, and the main switchboard shall be such as to ensure to the satisfaction of the Administration that a fire or other casualty in spaces containing the main source of electrical power, associated transforming equipment, if any, and the main switchboard or in any machinery space of category A will not interfere with the supply, control and distribution of emergency electrical power. As far as practicable, the space containing the emergency source of electrical power, associated transforming equipment, if any, the transient source of emergency electrical power and the emergency switchboard shall not be contiguous to the boundaries of machinery spaces of category A or those spaces containing the main source of electrical power, associated transforming equipment, if any, or the main switchboard.

104 Provided that suitable measures are taken for safeguarding independent emergency operation under all circumstances, the emergency generator may be used exceptionally, and for short periods, to supply non-emergency circuits.

Non essential domestic supplies should not be directly connected to the emergency switchboard.
D 200 Services to be supplied

201 The electrical power available shall be sufficient to supply all those services that are essential for safety in an emergency, due regard being paid to such services as may have to be operated simultaneously. The emergency source of electrical power shall be capable, having regard to starting currents and the transitory nature of certain loads, of supplying simultaneously at least the following services for the periods specified hereinafter, if they depend upon an electrical source for their operation, as stated in the following items 202 to 207.

202 For a period of 36 hours, emergency lighting:

1) at every muster and embarkation station and over the sides as required by regulations III/11.4 and III/16.7 (Pt.3 Ch.6 Sec.2, items E100 and J100);
2) in alleyways, stairways and exits giving access to the muster and embarkation stations, as required by regulation III/11.5 (Pt.3 Ch.6 Sec.2 E100);
3) in all service and accommodation alleyways, stairways and exits, personnel lift cars;
4) in the machinery spaces and main generating stations including their control positions;
5) in all control stations, machinery control rooms, and at each main and emergency switchboard;
6) at all stowage positions for firemen’s outfits;
7) at the steering gear; and
8) at the fire pump, the sprinkler pump and the emergency bilge pump referred to in 205 and at the starting position of their motors.

203 For a period of 36 hours:

1) the navigation lights and other lights required by the International Regulations for Preventing Collisions at Sea in force; and
2) on ships constructed on or after 1 February 112125, the VHF radio installation required by regulation IV/7.1.1 and IV/7.1.2 (Pt.4 Ch.12 Sec.1 B300); and, if applicable:
   2.1 the MF radio installation required by regulations IV/12.1.1, IV/12.1.2, IV/10.1.2 and IV/10.1.3 (Pt.4 Ch.12 Sec.1 B500 and Pt.4 Ch.12 Sec.1 B600);
   2.2 the ship earth station required by regulation IV/10.1.1. (Pt.4 Ch.12 Sec.1 B600); and
   2.3 the MF/HF radio installation required by regulations IV/10.2.1, IV/10.2.2 and IV/11.1 (Pt.4 Ch.12 Sec.1 B600 and Pt.4 Ch.12 Sec.1 B700).

204 For a period of 36 hours:

1) all internal communication equipment required in an emergency shall include:
   i) The means of communication which is provided between the navigating bridge and the steering gear compartment.
   ii) The means of communication which is provided between the navigating bridge and the position in the machinery space or control room from which the engines are normally controlled.
   iii) The means of communication which is provided between the bridge and the radio telegraph or radio telephone stations.
   iv) The means of communication which is provided between the officer of the watch and the person responsible for closing any watertight door which is not capable of being closed from a central control station.
   v) The public address system or other effective means of communication which is provided throughout the accommodation, public and service spaces.
   vi) The means of communication which is provided between the navigating bridge and the main fire control station;
2) the shipborne navigational bridge equipment as required by regulation V/12 (Pt.4 Ch.11 Sec.3 A200);
3) the fire detection and fire alarm system, and the fire door holding and release system; and
4) for intermittent operation of the daylight signalling lamp, the ship’s whistle, the manually operated call points and all internal signals that are required in an emergency; unless such services have an independent supply for the period of 36 hours from an accumulator battery suitably located for use in an emergency.

205 For a period of 36 hours:

1) one of the fire pumps required by regulation II-2/4.3.1 and 4.3.3 (Pt.4 Ch.10 Sec.2 B200);
2) the automatic sprinkler pump, if any; and
3) the emergency bilge pump, and all the equipment essential for the operation of electrically powered remote controlled bilge valves.

206 For the period of time required by regulation 29.14 (Pt.3 Ch.3 Sec.2 J900) the steering gear if required to be so supplied by that subsection.

207 For a period of half an hour:

1) any watertight doors required by regulation 15 (K604) to be power operated together with their indicators and warning signals.
2) the emergency arrangements to bring the lift cars to deck level for the escape of persons. The passenger lift cars may be brought to deck level sequentially in an emergency.

208 In a ship engaged regularly on voyages of short duration, the Administration if satisfied that an adequate standard of safety would be attained may accept a lesser period than the 36 hour period specified in items 202 to 206 but not less than 12 hours.

D 300 Arrangement of emergency source(s) of power

301 The emergency source of electrical power may be either a generator or an accumulator battery, which shall comply with the following:

302 Where the emergency source of electrical power is a generator, it shall be:

1) driven by a suitable prime-mover with an independent supply of fuel having a flashpoint (closed cup test) of not less than 43°C;
2) started automatically upon failure of the electrical supply from the main source of electrical power and shall be automatically connected to the emergency switchboard; those services referred to in 400 shall then be transferred automatically to the emergency generating set. The automatic starting system and the characteristic of the prime-mover shall be such as to permit the emergency generator to carry its full rated load as quickly as is safe and practicable, subject to a maximum of 45 seconds; unless a second independent means of starting the emergency generating set is provided, the single source of stored energy shall be protected to preclude its complete depletion by the automatic starting system; and
3) provided with a transitional source of emergency electrical power according to 400.

303 Where the emergency source of electrical power is an accumulator battery, it shall be capable of:

1) carrying the emergency electrical load without recharging while maintaining the voltage of the battery throughout the discharge period within 12 per cent above or below its nominal voltage;
2) automatically connecting to the emergency switchboard in the event of failure of the main source of electrical power; and
3) immediately supplying at least those services specified in 400.

D 400 Transitional source of emergency power

401 The transitional source of emergency electrical power required by item 302.3 shall consist of an accumulator battery suitably located for use in an emergency which shall operate without recharging while maintaining the voltage of the battery throughout the discharge period within 12 per cent above or below its nominal voltage and be of sufficient capacity and so arranged as to supply automatically in the event of failure of either the main or emergency source of electrical power at least the following services, if they depend upon an electrical source for their operation:

402 For half an hour:
1) the lighting required by items 202 and 203.1;
2) all services required by items 204.1), 204.3) and 204.4), unless such services have an independent supply for the period specified from an accumulator battery suitably located for use in an emergency.

403 Power to operate the watertight doors, as required by regulation 15.7.3.3 (K604.7.3.3), but not necessarily all of them simultaneously, unless an independent temporary source of stored energy is provided. Power to the control, indication and alarm circuits as required by regulation 15.7.2 (K604.7.3.2), for half an hour.

D 500 Low-location lighting

501 Passenger ships are to be provided with low-location lighting (LLL) complying with IMO Res. A.752(18).

D 600 Supplementary emergency lighting for ro-ro passenger ships (Reg. II-1/42-1)

1) In addition to the emergency lighting required by regulation 42.2 (200), on every passenger ship with ro-ro cargo spaces or special category spaces as defined in regulation II-2/3 (F101):
   1.1 all passenger public spaces and alleyways shall be provided with supplementary electric lighting that can operate for at least three hours when all other sources of electric power have failed and under any condition of heel. The illumination provided shall be such that the approach to the means of escape can be readily seen. The source of power for the supplementary lighting shall consist of accumulator batteries located within the lighting units that are continuously charged, where practicable, from the emergency switchboard. Alternatively, any other means of lighting which is at least as effective may be accepted by the Administration. The supplementary lighting shall be such that any failure of the lamp will be immediately apparent. Any accumulator battery provided shall be replaced at intervals having regard to the specified service life in the ambient conditions that they are subject to in service; and
   1.2 a portable rechargeable battery operated lamp shall be provided in every crew space alleyway, recreational space and every working space which is normally occupied unless supplementary emergency lighting, as required by subparagraph 1.1, is provided.

D 700 Location of emergency switchboard, distribution

701 The emergency switchboard shall be installed as near as is practicable to the emergency source of electrical power.

702 Where the emergency source of electrical power is a generator, the emergency switchboard shall be located in the same space unless the operation of the emergency switchboard would thereby be impaired.

703 No accumulator battery fitted in accordance with this Regulation shall be installed in the same space as the emergency switchboard. An indicator shall be mounted in a suitable place on the main switchboard or in the machinery control room to indicate when the batteries constituting either the emergency source of electrical power or the transitional source of emergency electrical power referred to in item 302.3) or 400 are being discharged.

704 The emergency switchboard shall be supplied during normal operation from the main switchboard by an interconnector feeder which is to be adequately protected at the main switchboard against overload and short circuit and which is to be disconnected automatically at the emergency switchboard upon failure of the main source of electrical power. Where the system is arranged for feedback operation, the interconnector feeder is also to be protected at the emergency switchboard at least against short circuit.

705 In order to ensure ready availability of the emergency source of electrical power, arrangements shall be made where necessary to disconnect automatically non-emergency circuits from the emergency switchboard to ensure that power shall be available to the emergency circuits.

706 The arrangement of the emergency electric lighting system shall be such that a fire or other casualty in spaces containing the emergency source of electrical power, associated transforming equipment, if any, the emergency switchboard and the emergency lighting switchboard will not render the main electric lighting system required by this regulation (Pt.4 Ch.8 Sec.2 F201c) inoperative.

See also Pt.4 Ch.8 Sec.2 F.

D 800 Inclinations (list and trim of ship)

801 The emergency generator and its prime-mover and any emergency accumulator battery shall be so designed and arranged as to ensure that they will function at full rated power when the ship is upright and when inclined at any angle of list up to 22.5° or when inclined up to 10° either in the fore or aft direction, or is in any combination of angles within those limits.

D 900 Periodical testing

901 Provision shall be made for the periodic testing of the complete emergency system and shall include the testing of automatic starting arrangements.

D 1000 Starting arrangements for emergency generating sets

1001 Starting arrangements for emergency generating sets are to comply with the requirements given for cargo ships in Pt.4 Ch.8 Sec.2 C300.

E. Fire Safety Measures for Passenger Ships

E 100 Application

101 The requirements to fire protection in this section apply to any ship which carries more than twelve passengers.

E 200 Rule references and definitions

201 These requirements are given in addition to those applicable for the main class, as given in Pt.4 Ch.10 Sec.1 to Sec.14.

202 For fire technical and space definitions, see Pt.4 Ch.10 Sec.1 C.

E 300 Documentation

301 The following plans and particulars are to be submitted for approval:
   — Bulkheads and decks within main fire zones. General arrangement plan showing main fire zones, key numbers according to 700 or 800 for all rooms, the fire insulation and draught stops. Details of insulation and specification of materials.
   — Fire doors in different types of bulkheads and specification of doors.
— Deck coverings and surface materials specification and positions. Calculation of restricted use of combustible materials.
— Furniture and textile materials specification and positions.
— Means of escape from different compartments and escape calculations.
— Fire patrols system routing.
— Protection of special category spaces with positions, means of escape, ventilation, water spray, fire main, extinguishers, door indicator on bridge and precaution against ignition of flammable vapours.

| Table E1 Requirements for documentation of instrumentation systems |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                | 020            | 030            | 040            | 050            | 060            | 070            | 080            | 090            | 100            | 110            | 115            | 120            | 130            | 140            | 150            | 160            | 170            | 180            | 190            | 200            |
| **For class notation** | **Passenger Ship** |
| FDO             | X              | X              | X              | X              | X              |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |
| GAL             | X              | X              | X              | X              | X              |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |
| TVS             | X              | X              | X              | X              | X              |                |                |                |                |                |                |                |                |                |                |                |                |                |                |                |

<table>
<thead>
<tr>
<th><strong>Documentation types</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>030 Functional description</td>
</tr>
<tr>
<td>040 System block diagrams (T)</td>
</tr>
<tr>
<td>070 Power supply arrangement (T)</td>
</tr>
<tr>
<td>080 Arrangement and layout (T)</td>
</tr>
<tr>
<td>090 Cable routing layout drawing (T)</td>
</tr>
<tr>
<td>100 Instrument and equipment list (T)</td>
</tr>
<tr>
<td>110 Data sheets with environmental specifications</td>
</tr>
</tbody>
</table>

**E 400 Structure (Reg. II-2/23)**

**401** The hull, superstructure, structural bulkheads, decks and deckhouses shall be constructed of steel or other equivalent material. For the purpose of applying the definition of steel or other equivalent material as given in reg. 3.7 (Pt.4 Ch.10 Sec.1 C207), the «applicable fire exposure» shall be according to the integrity and insulation standards given in the tables in 700 and 800. For example where divisions such as decks or sides and ends of deckhouses are permitted to have «B-0» fire integrity, the «applicable fire exposure» shall be half an hour.

**402** However, in cases where any part of the structure is of aluminium alloy, the following shall apply:

1) The insulation of aluminium alloy components of «A» or «B» class divisions, except structure which is non-load-bearing, shall be such that the temperature of the structural core does not rise more than 200°C above the ambient temperature at any time during the applicable fire exposure to the standard fire test.

2) Special attention shall be given to the insulation of aluminium alloy components of columns, stanchions and other structural members required to support lifeboat and liferaft stowage, launching and embarkation areas, and «A» and «B» class divisions to ensure:

i) that for such members supporting lifeboat and liferaft areas and «A» class divisions, the temperature rise limitation specified in 1) shall apply at the end of one hour, and

ii) that for such members required to support «B» class divisions, the temperature rise limitation specified in 1) shall apply at the end of half an hour.

**403** Crowns and casings of machinery spaces of category A shall be of steel construction adequately insulated and openings therein, if any, are to be suitably arranged and protected to prevent the spread of fire.

**E 500 Main vertical zones and horizontal zones (Reg. II-2/24)**

**501** In ships carrying more than 36 passengers, the hull, superstructure and deckhouses shall be subdivided into main vertical zones by «A-60» class divisions. Steps and recesses shall be kept to a minimum but where they are necessary, they shall also be «A-60» class divisions. Where a category (5), (9) or (10) space is on one side or where fuel oil tanks are on both sides of the division the standard may be reduced to «A-0».

**502** For ships carrying not more than 36 passengers, the hull, superstructure and deckhouses in way of accommodation and service spaces shall be subdivided into main vertical zones by «A» class divisions. These divisions are to have insulation values in accordance with tables in 800.

**503** As far as practicable, the bulkheads forming the boundaries of the main vertical zones above the bulkhead deck shall be in line with watertight subdivision bulkheads situated immediately below the bulkhead deck. The length and width of main vertical zones may be extended to a maximum of 48 m in order to bring the ends of main vertical zones to coincide with watertight subdivision bulkheads or in order to accommodate a large public space extending for the whole length of the main vertical zone provided that the total area of the main vertical zone is not greater than 1,600 m² on any deck. The length or width of a main vertical zone is the maximum distance between the furthest points of the bulkheads bounding it.

**504** Such bulkheads shall extend from deck to deck and to the shell or other boundaries.

**505** Where a main vertical zone is subdivided by horizontal «A» class divisions into horizontal zones for the purpose of providing an appropriate barrier between sprinklered and non-sprinklered zones of the ship, the divisions shall extend between adjacent main vertical zone bulkheads and to the shell or exterior boundaries of the ship and shall be insulated in accordance with the fire insulation and integrity values given in table 27.1 (Table E4) or in table 26.2 (Table E3).

**506** On ships designed for special purposes, such as automobile or railroad car ferries, where the provision of main vertical zone bulkheads would defeat the purpose for which the ship is intended, equivalent means for controlling and limiting a fire is to be substituted and specifically approved.

**507** However, in a ship with special category spaces, any such space is to comply with the applicable provisions of F and in so far as such compliance would be inconsistent with compliance with other requirements of this part, the requirements of F prevail.

**E 600 Bulkheads within a main vertical zone (Reg. II-2/25)**

**601** For ships carrying more than 36 passengers all bulkheads which are not required to be «A» class divisions shall be...
at least «B» class or «C» class divisions as prescribed in the tables in 700.

602 For ships carrying not more than 36 passengers all bulkheads within accommodation and service spaces which are not required to be «A» class divisions shall be at least «B» class or «C» class divisions as prescribed in the tables in 800.

603 All such divisions may be faced with combustible materials in accordance with the provisions of 1600.

604 In ships not carrying more than 36 passengers, all corridor bulkheads where not required to be «A» class shall be «B» class divisions which are to extend from deck to deck except:

1) when continuous «B» class ceilings or linings are fitted on both sides of the bulkhead, the portion of the bulkhead behind the continuous ceiling or lining shall be of material which, in thickness and composition, is acceptable in the construction of «B» class divisions but which shall be required to meet «B» class integrity standards only in so far as is reasonable and practicable;

2) in the case of a ship protected by an automatic sprinkler system complying with the provisions of reg. 12 (Pt.4 Ch.10 Sec.8) the corridor bulkheads of «B» class materials may terminate at a ceiling in the corridor provided such a ceiling is of material which, in thickness and composition, is acceptable in the construction of «B» class divisions. Notwithstanding the requirements of 700 and 900 such bulkheads and ceilings shall be required to meet «B» class integrity standards only in so far as is reasonable and practicable. All doors and frames in such bulkheads shall be of non-combustible materials and shall be so constructed and erected as to provide substantial fire resistance.

605 All bulkheads required to be «B» class division, except corridor bulkheads prescribed in 604), shall extend from deck to deck and to the shell or other boundaries unless the continuous «B» class ceilings or linings fitted on both sides of the bulkheads are at least of the same fire resistance as the bulkhead, in which case the bulkhead may terminate at the continuous ceiling or lining.

E 700 Fire integrity of bulkheads and decks in ships carrying more than 36 passengers (Reg. II-2/26)

701 In addition to complying with the specific provisions for fire integrity of bulkheads and decks mentioned elsewhere in this section, the minimum fire integrity of all bulkheads and decks shall be as prescribed in table 26.1 (Table E2) and table 26.2 (Table E3). Where, due to any particular structural arrangements in the ship, difficulty is experienced in determining from the tables the minimum fire integrity value of any divisions, such values are to be determined to the satisfaction of the Society.

702 The following requirements shall govern application of the tables:

1) Table 26.1 (Table E2) shall apply to bulkheads not bounding either main vertical zones or horizontal zones. Table 26.2 (Table E3) shall apply to decks not forming steps in main vertical zones nor bounding horizontal zones.

2) For determining the appropriate fire integrity standards to be applied to boundaries between adjacent spaces, such spaces are classified according to their fire risk as shown in categories (1) to (14) below. Where the contents and use of a space are such that there is a doubt as to its classification for the purpose of this regulation, it shall be treated as a space within the relevant category having the most stringent boundary requirements. The title of each category is intended to be typical rather than restrictive. The number in parentheses preceding each category refers to the applicable column or row in the tables.

(1) Control stations
Spaces containing emergency sources of power and lighting.
Wheelhouse and chartroom.
Spaces containing the ship’s radio equipment.

Fire-extinguishing rooms, fire control rooms and fire-recording stations.
Control room for propulsion machinery when located outside the propulsion machinery space.
Spaces containing centralized fire alarm equipment.
Spaces containing centralized emergency public address system stations and equipment.

(2) Stairways
Interior stairways, lifts and escalators (other than those wholly contained within the machinery spaces) for passen-
gers and crew and enclosures thereto.

In this connection a stairway which is enclosed at only one level is to be regarded as part of the space from which it is not separated by a fire door.

(3) Corridors
Passenger and crew corridors.

(4) Evacuation stations and external escape routes.
Survival craft stowage area.
Open deck spaces and enclosed promenades forming lifeboat and liferaft embarkation and lowering stations.
Muster stations, internal and external.
External stairs and open decks used for escape routes.
The ship’s side to the waterline in the lightest seagoing condition, superstructure and deckhouse sides situated below and adjacent to the liferaft’s and evacuation slide’s embarkation areas.

(5) Open deck spaces
Open deck spaces and enclosed promenades clear of lifeboat and liferaft embarkation and lowering stations.

Air spaces (the space outside superstructures and deckhouses).

(6) Accommodation spaces of minor fire risk
Cabins containing furniture and furnishings of restricted fire risk.
Offices and dispensaries containing furniture and furnishings of restricted fire risk.
Public spaces containing furniture and furnishings of restricted fire risk and having a deck area of less than 50 m².

(7) Accommodation spaces of moderate fire risk
Spaces as in category (6) above but containing furniture and furnishings of other than restricted fire risk.
Public spaces containing furniture and furnishings of restricted fire risk and having a deck area of 50 m² or more. Isolated lockers and small store-rooms in accommodation spaces.

Sale shops.
Motion picture projection and film stowage rooms.
Diet kitchens (containing no open flame).
Cleaning gear lockers (in which flammable liquids are not stowed).
Laboratories (in which flammable liquids are not stowed).
Pharmacies.
Small drying rooms (having a deck area of 4 m² or less).
Specie rooms.
Operating rooms.

(8) Accommodation spaces of greater fire risk
Public spaces containing furniture and furnishings of other than restricted fire risk and having a deck area of 50 m² or more. Barber shops and beauty parlours.

(9) Sanitary and similar spaces
Communal sanitary facilities, showers, baths, water clos-
e, etc.
Small laundry rooms.
Indoor swimming pool area.

Isolated pantries containing no cooking appliances in accommodation spaces.

Private sanitary facilities are to be considered a portion of the space in which they are located.

(10) Tanks, voids and auxiliary machinery spaces having little or no fire risk

Water tanks forming part of the ship's structure.

Voids and cofferdams.

Auxiliary machinery spaces which do not contain machinery having a pressure lubrication system and where storage of combustibles is prohibited, such as:

ventilation and air-conditioning rooms; windlass room; steering gear room; stabilizer equipment room; electrical propulsion motor room; rooms containing section switchboards and purely electrical equipment other than oil-filled electrical transformers (above 10 kVA); shaft alleys and pipe tunnels; spaces for pumps and refrigeration machinery (not handling or using flammable liquids).

Closed trunks serving the spaces listed above.

Other closed trunks such as pipe and cable trunks.

(11) Auxiliary machinery spaces, cargo spaces, cargo and other oil tanks and other similar spaces of moderate fire risk

Cargo oil tanks.

Cargo holds, trunkways and hatchways.

Refrigerated chambers.

Oil fuel tanks (where installed in a separate space with no machinery).

Shaft alleys and pipe tunnels allowing storage of combustibles.

Auxiliary machinery spaces as in category (10) which contain machinery having a pressure lubrication system or where storage of combustibles is permitted.

Oil fuel filling stations.

Spaces containing oil-filled electrical transformers (above 10 kVA).

Spaces containing turbine and reciprocating steam engine driven auxiliary generators and small internal combustion engines of power output up to 110 kW driving generators, sprinkler, drencher or fire pumps, bilge pumps, etc.

Closed trunks serving the spaces listed above.

(12) Machinery spaces and main galleys

Main propulsion machinery rooms (other than electric propulsion motor rooms) and boiler rooms.

Auxiliary machinery spaces other than those in categories (10) and (11) which contain internal combustion machinery or other oil-burning, heating or pumping units.

Main galleys and annexes.

Trunks and casings to the spaces listed above.

(13) Store-rooms, workshops, pantries, etc.

Main pantries not annexed to galleys.

Main laundry.

Large drying rooms (having a deck area of more than 4 m²).

Miscellaneous stores.

Mail and baggage rooms.

Garbage rooms.

Workshops (not part of the machinery spaces, galleys, etc.).

(14) Other spaces in which flammable liquids are stowed

Lamp rooms.

Paint rooms.

Store-rooms containing flammable liquids (including dyes, medicines, etc.)

Laboratories (in which flammable liquids are stowed).

3) Where a single value is shown for the fire integrity of a boundary between two spaces, that value shall apply in all cases.

4) Notwithstanding the provisions of 600 there are no special requirements for material or integrity of boundaries where only a dash appears in the tables.

5) The Society shall determine in respect of category (5) spaces whether the insulation values in table 26.1 (Table E2) shall apply to ends of deckhouses and superstructures, and whether the insulation values in table 26.2 (Table E3) shall apply to weather decks. In no case shall the requirements of category (5) of table 26.1 (Table E2) or table 26.2 (Table E3) necessitate enclosure of spaces which in the opinion of the Society need not be enclosed.

703 Continuous «B» class ceilings or linings, in association with the relevant decks or bulkheads, may be accepted as contributing wholly or in part, to the required insulation and integrity of a division.

704 In the construction of structural fire protection details, risk of heat transmission at intersections and terminal points of required thermal barriers is to be taken into consideration. Unless otherwise specified, insulated "A" class divisions are to be insulated 450 mm outside their boundaries.

E 800 Fire integrity of bulkheads and decks in ships carrying not more than 36 passengers (Reg. II-2/27)

801 In addition to complying with the specific provisions for fire integrity of bulkheads and decks mentioned elsewhere in this part, the minimum fire integrity of bulkheads and decks shall be as prescribed in table 27.1 (Table E4) and table 27.2 (Table E5).

802 The following requirements shall govern application of the tables:

1) Tables 27.1 (Table E4) and table 27.2 (Table E5) shall apply respectively to the bulkheads and decks separating adjacent spaces.

2) For determining the appropriate fire integrity standards to be applied to divisions between adjacent spaces, such spaces are classified according to their fire risk as shown in categories (1) to (11) below. The title of each category is intended to be typical rather than restrictive. The number in parentheses preceding each category refers to the applicable column or row in the tables.

(1) Control stations

Spaces containing emergency sources of power and lighting.

Wheelhouse and chartroom.

Spaces containing the ship's radio equipment.

Fire-extinguishing rooms, fire control rooms and fire-re-cording stations.

Control room for propulsion machinery when located outside the machinery space.

Spaces containing centralized fire alarm equipment.

(2) Corridors

Passenger and crew corridors and lobbies.

(3) Accommodation spaces

Spaces as defined in reg. 3.10 (Pt.4 Ch.10 Sec.1 C302) excluding corridors.

(4) Stairways

Interior stairways, lifts and escalators (other than those wholly contained within the machinery spaces) and enclosures thereto.

In this connection, a stairway which is enclosed only at one level shall be regarded as part of the space from which it is not separated by a fire door.
(5) Service spaces (low risk)
Lockers and store-rooms not having provisions for the storage of flammable liquids and having areas of less than 4 m², drying rooms and laundries.

(6) Machinery spaces of category A
Spaces as defined in reg. 3.19 (Pt.4 Ch.10 Sec.1 C311).

(7) Other machinery spaces
Spaces as defined in reg. 3.20 (Pt.4 Ch.10 Sec.1 C312) excluding machinery spaces of category A.

(8) Cargo spaces
All spaces used for cargo (including cargo oil tanks) and trunkways and hatchways to such spaces, other than special category spaces.

(9) Service spaces (high risk)
Galleys, pantries containing cooking appliances, paint and lamp rooms, lockers and store-rooms having areas of 4 m² or more, spaces for the storage of flammable liquids, and workshops other than those forming part of the machinery spaces.

(10) Open decks
Open deck spaces and enclosed promenades having no main deck spaces, and enclosed escape routes.

(11) Special category spaces
Spaces as defined in reg. 3.18 (Pt.4 Ch.10 Sec.1 C310).

3) In determining the applicable fire integrity standard of a boundary between two spaces within a main vertical zone or horizontal zone which is not protected by an automatic sprinkler system complying with the provisions of reg. 12 (Pt.4 Ch.10 Sec.8) or between such zones neither of which is so protected, the higher of the two values given in the tables shall apply.

4) In determining the applicable fire integrity standard of a boundary between two spaces within a main vertical zone or horizontal zone which is protected by an automatic sprinkler system complying with the provisions of reg. 12 (Pt.4 Ch.10 Sec.8) or between such zones both of which are so protected, the lesser of the two values given in the tables shall apply. Where a sprinklered zone and a non-sprinklered zone meet within accommodation and service spaces, the higher of the two values given in the tables shall apply to the division between the zones.

Table E2 Bulwarks not bounding either main vertical zones or horizontal zones (Table 26.1)

<table>
<thead>
<tr>
<th>Spaces</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
<th>(9)</th>
<th>(10)</th>
<th>(11)</th>
<th>(12)</th>
<th>(13)</th>
<th>(14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control stations</td>
<td>B-0²</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-60</td>
<td>A-60</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-60</td>
<td>A-60</td>
<td>A-60</td>
<td>A-60</td>
</tr>
<tr>
<td>Stairways</td>
<td>A-0²</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-60</td>
<td>A-60</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-60</td>
<td>A-60</td>
<td>A-60</td>
<td>A-60</td>
</tr>
<tr>
<td>Evacuation stations and external escape routes</td>
<td>A-0</td>
<td>A-60</td>
<td>A-60</td>
<td>A-0</td>
<td>A-60</td>
<td>A-0</td>
<td>A-60</td>
<td>A-0</td>
<td>A-60</td>
<td>A-0</td>
<td>A-60</td>
<td>A-0</td>
<td>A-60</td>
<td></td>
</tr>
<tr>
<td>Open deck spaces</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
</tr>
<tr>
<td>Accommodation spaces of minor fire risk</td>
<td>B-0</td>
<td>B-0</td>
<td>B-0</td>
<td>B-0</td>
<td>B-0</td>
<td>C</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td></td>
</tr>
<tr>
<td>Accommodation spaces of moderate fire risk</td>
<td>B-0</td>
<td>B-0</td>
<td>B-0</td>
<td>C</td>
<td>A-0</td>
<td>A-30</td>
<td>A-60</td>
<td>A-15</td>
<td>A-60</td>
<td>A-15</td>
<td>A-60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accommodation spaces of greater fire risk</td>
<td>B-0</td>
<td>B-0</td>
<td>C</td>
<td>A-0</td>
<td>A-30</td>
<td>A-60</td>
<td>A-15</td>
<td>A-60</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sanitary and similar spaces</td>
<td>C</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tanks, voids and auxiliary machinery spaces having little or no fire risk</td>
<td>A-0²</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auxiliary machinery spaces, cargo spaces, cargo and other oil tanks and other similar spaces of moderate fire risk</td>
<td>A-0²</td>
<td>A-0</td>
<td>A-0</td>
<td>A-15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machinery spaces and main galleys</td>
<td>A-0²</td>
<td>A-0</td>
<td>A-0</td>
<td>A-60</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Store-rooms, workshops, pantries etc.</td>
<td>A-0²</td>
<td>A-0</td>
<td>A-0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other spaces in which flammable liquids are stowed</td>
<td>A-30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

See notes following Table 26.2 (E3)
Rules for Ships, January 2001
Pt.5 Ch.2 Sec.2 – Page 16

Table E3 Decks not forming steps in main vertical zones nor bounding horizontal zones (Table 26.2)

<table>
<thead>
<tr>
<th>Spaces below ↓ above →</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stairways</td>
</tr>
<tr>
<td>Evacuation stations and external escape routes</td>
</tr>
<tr>
<td>Open accommodation</td>
</tr>
<tr>
<td>Accommodation spaces of minor fire risk</td>
</tr>
<tr>
<td>Sanitary and similar spaces</td>
</tr>
<tr>
<td>Tanks, voids and auxiliary machinery spaces having little or no fire risk</td>
</tr>
<tr>
<td>Machinery spaces and main galley spaces</td>
</tr>
<tr>
<td>Store-rooms, workshops, pantries etc.</td>
</tr>
<tr>
<td>Other spaces in which flammable liquids are stored</td>
</tr>
</tbody>
</table>

a Where adjacent spaces are in the same numerical category and superscript a appears, a bulkhead or deck between such spaces need not be fitted if deemed unnecessary by the Administration. For example, in category (12) a bulkhead need not be required between a galley and its annexed pantries provided the pantry bulkhead and decks maintain the integrity of the galley boundaries. A bulkhead is, however, required between a galley and a machinery space even though both spaces are in category (12).
b The ship’s side, to the waterline in the lightest seagoing condition, superstructure and deckhouse sides situated below and adjacent to the liferafts and evacuation slides may be reduced to «A-30».

Table E4 Fire integrity of bulkheads separating adjacent spaces (Table 27.1)

<table>
<thead>
<tr>
<th>Spaces</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
<th>(9)</th>
<th>(10)</th>
<th>(11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control stations</td>
<td>(1)</td>
<td>A-0 a)</td>
<td>A-0</td>
<td>A-60</td>
<td>A-0</td>
<td>A-15</td>
<td>A-60</td>
<td>A-15</td>
<td>A-60</td>
<td>A-60</td>
<td>*)</td>
</tr>
<tr>
<td>Corridors</td>
<td>(2)</td>
<td>C e)</td>
<td>B-0 e)</td>
<td>A-0 a)</td>
<td>B-0 e)</td>
<td>B-0 e)</td>
<td>A-60</td>
<td>A-0</td>
<td>A-0</td>
<td>A-15</td>
<td>A-0 d)</td>
</tr>
<tr>
<td>Accommodation spaces</td>
<td>(3)</td>
<td>C e)</td>
<td>A-0 a)</td>
<td>B-0 e)</td>
<td>A-0 a)</td>
<td>B-0 e)</td>
<td>A-60</td>
<td>A-0</td>
<td>A-0</td>
<td>A-15</td>
<td>A-0 d)</td>
</tr>
<tr>
<td>Stairways</td>
<td>(4)</td>
<td>A-0 a)</td>
<td>B-0 e)</td>
<td>A-0 a)</td>
<td>B-0 e)</td>
<td>A-60</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-15</td>
<td>A-0 d)</td>
</tr>
<tr>
<td>Service spaces (low risk)</td>
<td>(5)</td>
<td>C e)</td>
<td>A-60</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>*)</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>*)</td>
</tr>
<tr>
<td>Machinery spaces of category A</td>
<td>(6)</td>
<td>*)</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-60</td>
<td>*)</td>
<td>A-60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other machinery spaces</td>
<td>(7)</td>
<td>A-0 b)</td>
<td>A-0</td>
<td>A-0</td>
<td>*)</td>
<td>A-0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cargo spaces</td>
<td>(8)</td>
<td>*)</td>
<td>A-0</td>
<td>*)</td>
<td>A-0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service spaces (high risk)</td>
<td>(9)</td>
<td>A-0 b)</td>
<td>*)</td>
<td>A-30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open decks</td>
<td>(10)</td>
<td>A-0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special category spaces</td>
<td>(11)</td>
<td>A-0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

See notes under Table 27.2 (E5).
Table E5 Fire integrity of decks separating adjacent spaces (Table 27.2)

<table>
<thead>
<tr>
<th>Spaces below ↓ above →</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
<th>(9)</th>
<th>(10)</th>
<th>(11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control stations</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-60</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-30</td>
</tr>
<tr>
<td>Corridors</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
</tr>
<tr>
<td>Accommodation spaces</td>
<td>A-60</td>
<td>A-0</td>
<td>*)</td>
<td>A-0</td>
<td>*)</td>
<td>A-60</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-30</td>
</tr>
<tr>
<td>Stairways</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>*)</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-30</td>
<td></td>
</tr>
<tr>
<td>Service spaces (low risk)</td>
<td>A-15</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-60</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
</tr>
<tr>
<td>Machinery spaces of category A</td>
<td>A-60</td>
<td>A-60</td>
<td>A-60</td>
<td>A-60</td>
<td>*)</td>
<td>A-60</td>
<td>*)</td>
<td>A-30</td>
<td>A-60</td>
<td>*)</td>
<td>A-60</td>
</tr>
<tr>
<td>Other machinery spaces</td>
<td>A-15</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>*)</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
</tr>
<tr>
<td>Cargo spaces</td>
<td>A-60</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>*)</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
</tr>
<tr>
<td>Service spaces (high risk)</td>
<td>A-60</td>
<td>A-30</td>
<td>A-0</td>
<td>A-0</td>
<td>*)</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-30</td>
</tr>
<tr>
<td>Open decks</td>
<td>A-0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To be applied to both Tables 27.1 (E4) and 27.2 (E5), as appropriate.

a) For clarification as to which applies see 600 and 1000.
b) Where spaces are of the same numerical category and superscript b) appears, a bulkhead or deck of the ratings shown in the tables is only required when the adjacent spaces are for a different purpose, e.g. in category (9). A gallery next to a gallery does not require a bulkhead but a gallery next to a paint room requires an A-0 bulkhead.
c) Bulkheads separating the wheelhouse and chartroom from each other may be <B-0> rating.
d) See 802.3 and 802.4.
e) For the application of 502, <B-0> and <C> where appearing in Table 27.1 E4 shall be read as «A-0».

Fire insulation need not be fitted if the machinery space of category (7) has little or no fire risk.

*) Where an asterisk appears in the tables, the division is required to be of steel or other equivalent material but is not required to be of «A» class standard. For the application of 502, an asterisk, where appearing in Table 27.2 E5 except for categories (8) and (10), shall be read as «A-0».

E 900 Means of escape (Reg. II-2/28)

901 Stairways and ladders shall be arranged to provide ready means of escape to the lifeboat and liferaft embarkation deck from all passenger and crew spaces and from spaces in which the crew is normally employed, other than machinery spaces. In particular, the following provisions shall be complied with:

1) Below the bulkhead deck two means of escape, at least one of which shall be independent of watertight doors, shall be provided from each watertight compartment or similarly restricted space or group of spaces. Exceptionally, the Society may dispense with one of the means of escape, due regard being paid to the nature and location of spaces and to the number of persons who might normally be accommodated or employed there.

2) Above the bulkhead deck there shall be at least two means of escape from each main vertical zone or similarly restricted space or group of spaces at least one of which shall give access to a stairway forming a vertical escape.

3) If a raditelegraph station has no direct access to the open deck, two means of escape from or access to such station shall be provided, one of which may be a porthole or window of sufficient size or another satisfactory means to provide an emergency escape.

4) A corridor, lobby, or part of a corridor from which there is only one route of escape shall be prohibited.

5) At least one of the means of escape required by 901 1) and 901 2) shall consist of a readily accessible enclosed stairway, which shall provide continuous fire shelter from the level of its origin to the appropriate lifeboat and liferaft embarkation decks, or to the uppermost weather deck if the embarkation deck does not extend to the main vertical zone being considered. In the latter case, direct access to the embarkation deck by way of external open stairways and passageways shall be provided and shall have emergency lighting in accordance with reg. III/11.5 (Pt.3 Ch.6 Sec.2 E100) and slip-free surfaces under-foot. Boundaries facing external open stairways and passageways forming part of an escape route and boundaries in such a position that their failure during a fire would impede escape to the embarkation deck shall have fire integrity, including insulation values, in accordance with the table 26.1 (Tables E2) and table 26.2 (Table E3). The widths, number and continuity of escapes shall be as follows:

1) Stairways shall not be less than 900 mm in clear width. Stairways shall be fitted with handrails on each side. The minimum clear width of stairways shall be increased by 10 mm for every one person provided for in excess of 90 persons. The maximum clear width between handrails where stairways are wider than 900 mm shall be 1,800 mm. The total number of persons to be evacuated by such stairways shall be assumed to be two thirds of the crew and the total number of passengers in the areas served by such stairways. The width of the stairways shall conform to the standards not inferior to those adopted in IMO res. A.757(18).

2) All stairways sized for more than 90 persons shall be aligned fore and aft.

3) Doorways and corridors and intermediate landings included in means of escape shall be sized in the same manner as stairways.

4) Stairways shall not exceed 3.5 m in vertical rise without the provision of a landing and shall not have an angle of inclination greater than 45°.

5) Landings at each deck level shall be not less than 2 m² in area and shall increase by 1 m² for every 10 persons provided for in excess of 20 persons but need not exceed 16 m², except for those landings servicing public spaces having direct access onto the stairway enclosure.

6) Protection of access from the stairway enclosures to the lifeboat and liferaft embarkation areas will be specially considered.

7) Stairways serving only a space and a balcony in that space are not to be considered as forming one of the required means of escape.

8) Where public spaces span three or more decks and contain combustibles such as furniture and enclosed spaces such as shops, offices and restaurants, each level within the space shall have two means of escape, one of which shall give direct access to an enclosed vertical means of escape meeting the requirements of paragraph 5 (901 5).

9) Where the Society has granted dispensation under the provisions of 901 1), this sole means of escape shall provide...
safe escape. However, stairways shall not be less than 800 mm in clear width with handrails on both sides.

10) In addition to the emergency lighting required by regulations II-1/42 (Sec.2.1) and II-11/5.3 (Ch.3.6 Sec.2.2), the means of escape including stairways and exits, shall be marked by lighting or photoluminescent strip indicators placed not more than 0.3 m above the deck at all points of the escape route including angles and intersections. The marking must enable passengers to identify all the routes of escape and readily identify the escape exits. If electric illumination is used, it shall be supplied by the emergency source of power and it shall be so arranged that the failure of any single light or cut in a lighting ship, will not result in the marking being ineffective. Additionally, all escape route signs and fire equipment location markings shall be of photoluminescent material or marked by lighting. The Society shall ensure that such lighting or photoluminescent equipment have been evaluated, tested and applied in accordance with the guidelines developed by IMO in res. A.752(18), and

11) In all passenger ships carrying more than 36 passengers, the requirement of 1.10 (901.10) and regulation 41-2.4.7 shall also apply to the crew accommodation area.

902 In special category spaces the number and disposition of the means of escape both below and above the bulkhead deck will be specially considered and in general the safety of access to the embarkation deck shall be at least equivalent to that provided in 901.1, 2, 5) and 6).

903 One of the escape routes from the machinery spaces where the crew is normally employed shall avoid direct access to any special category space.

904 Two means of escape shall be provided from each machinery space. In particular, the following provisions shall be complied with:

1) Where the space is below the bulkhead deck the two means of escape shall consist of either:

i) two sets of steel ladders as widely separated as possible, leading to doors in the upper part of the space similarly separated and from which access is provided to the appropriate lifeboat and liferaft embarkation decks. One of these ladders shall provide continuous steel fire shelter with self-closing doors from the lower part of the space to a safe position outside the space; or

ii) one steel ladder leading to a door in the upper part of the space from which access is provided to the embarkation deck and additionally, in the lower part of the space in a position well separated from the ladder referred to, a steel door capable of being operated from each side and which provides access to a safe escape route from the lower part of the space to the embarkation deck.

2) Where the space is above the bulkhead deck, the two means of escape shall as widely separated as possible and the doors leading from such means of escape shall be in a position from which access is provided to the appropriate lifeboat and liferaft embarkation decks. Where such means of escape require the use of ladders, these shall be of steel.

905 In a ship of less than 1,000 gross tonnage, one of the means of escape required in 904 may be dispensed with due regard being paid to the width and disposition of the upper part of the space. In a ship of 1,000 gross tonnage and above one means of escape from certain auxiliary machinery spaces may be dispensed with so long as either a door or a steel ladder provides a safe escape route to the embarkation deck, due regard being paid to the nature and location of the space and whether persons are normally employed in that space.

906 Two means of escape shall be provided from a machinery control room located within a machinery space, at least one of which will provide continuous fire shelter to a safe position outside the machinery space.

907 In no case shall lifts be considered as forming one of the required means of escape.

E 1000 Protection of stairways and lifts in accommodation and service spaces (Reg. II-2/29)

1001 All stairways shall be of steel frame construction or other equivalent material, and shall be within enclosures formed of "A" class divisions, with positive means of closure at all openings, except that:

1) a stairway connecting only two decks need not be enclosed, provided the integrity of the deck is maintained by proper bulkhead or doors in one "tweendeck" space. When a stairway is closed in one "tweendeck" space, the stairway enclosure shall be protected in accordance with the tables for decks in 700 or 800.

2) stairways may be fitted in the open in a public space, provided they lie wholly within such public space.

1002 Stairway enclosures shall have direct access with the corridors and be of a sufficient area to prevent congestion, having regard to the number of persons likely to use them in an emergency. Within the perimeter of such stairway enclosures, only public toilets, lockers of non-combustible material providing storage for safety equipment and open information counters are permitted. Only public spaces, corridors, public toilets, special category spaces, other escape stairways required by 901 5) and external areas are permitted to have direct access to these stairway enclosures.

1003 Lift trunks shall be so fitted as to prevent the passage of smoke and flame from one "tweendeck" to another and shall be provided with means of closing so as to permit the control of draught and smoke.

E 1100 Openings in "A" class divisions (Reg. II-2/30)

1101 Except for hatches between cargo, special category, store, and baggage spaces, and between such spaces and the weather decks, all openings shall be provided with permanently attached means of closing which shall be at least as effective for resisting fires as the divisions in which they are fitted.

1102 The construction of all doors and door frames in "A" class divisions, with the means of securing them when closed, shall provide resistance to fire as well as to the passage of smoke and flame, as far as practicable, equivalent to that of the bulkheads in which the doors are situated. Such doors and door frames shall be constructed of steel or other equivalent material. Watertight doors need not be insulated.

1103 It shall be possible for each door to be opened and closed from each side of the bulkhead by one person only.

1104 Fire doors in main vertical zone bulkheads, galley boundaries and stairway enclosures other than power-operated watertight doors and those which are normally locked, shall satisfy the following requirements:

1) the doors shall be self-closing and be capable of closing with an angle of inclination of up to 3.5° opposing closure;

2) the approximate time of closure for hinged fire doors shall be no more than 40 s and not less than 10 s from the beginning of their movement with the ship in the upright position. The approximate uniform rate of closure for sliding fire doors shall be of no more than 0.2 m/s and no less than 0.1 m/s with the ship in the upright position;

3) the doors shall be capable of remote release from the continuously manned central control station, either simultaneously or in groups and shall be capable of release also individually from a position at both sides of the door. Release switches shall have an on-off function to prevent automatic resetting of the system;

4) hold-back hooks not subject to central control station release are prohibited.

5) a door closed remotely from the central control station shall be capable of being re-opened at both side of the door by local control. After such local opening, the door shall automatically close again;
6) indication shall be provided at the fire door indicator panel in the continuously manned central control station whether each of the remote-released doors are closed;

7) the release mechanism shall be so designed that the door will automatically close in the event of disruption of the control system or main source of electric power;

8) local power accumulators for power-operated doors shall be provided in the immediate vicinity of the doors to enable the doors to be operated after disruption of the control system or main source of electric power at least ten times (fully opened and closed) using the local controls;

9) disruption of the control system or main source of electric power at one door shall not impair the safe functioning of the other doors;

10) remote-released sliding or power-operated doors shall be equipped with an alarm that sounds for at least 5 s but no more than 10 s after the door is released from the central control station and before the door begins to move and continue sounding until the door is completely closed;

11) a door designed to re-open upon contacting an object in its path shall re-open not more than 1 m from the point of contact;

12) double-leaf doors equipped with a latch necessary to their fire integrity shall have a latch that is automatically activated by the operation of the doors when released by the control system;

13) doors giving direct access to special category spaces which are power-operated and automatically closed need not be equipped with alarms and remote-release mechanisms required in 3) and 10);

14) the components of the local control system shall be accessible for maintenance and adjusting; and

15) power-operated doors shall be provided with a control system of an approved type which shall be able to operate in case of fire, this being determined in accordance with the Fire Test Procedures Code. This system shall satisfy the following requirements:

i) the control system shall be able to operate the door at the temperature of at least 200°C for at least 60 min, served by the power supply;

ii) the power supply for all other doors not subject to fire shall not be impaired; and

iii) at temperatures exceeding 200°C the control system shall be automatically isolated from the power supply and shall be capable of keeping the door closed up to at least 945°C.

1105 In ships not carrying more than 36 passengers, where a space is protected by an automatic sprinkler system complying with the provision of reg. 12 (Pt.4 Ch.10 Sec.5) or fitted with a continuous B class ceiling, openings in decks not forming steps in main vertical zones nor bounding horizontal zones shall be closed reasonably tight and such decks shall meet the A class integrity requirements in so far as is reasonable and practicable.

1106 The requirements for "A" class integrity of the outer boundaries of a ship shall not apply to glass partitions, windows and sidescuttles. The requirements for "A" class integrity of the outer boundaries of the ship shall not apply to exterior doors, except for those in superstructures and deckhouses facing life-saving appliances, embarkation and external muster station areas, external stairs and open decks used for escape routes. Stairway enclosure doors need not meet this requirement.

1107 All «A» class doors located in stairways, public spaces and main vertical zone bulkheads in escape routes shall be equipped with a self-closing hose port of material, construction and fire resistance which is equivalent to the door into which it is fitted, and shall be a 150 mm square clear opening with the door closed and shall be inset into the lower edge of the door, opposite the door hinges, or in the case of sliding doors, nearest the opening.

E 1200 Openings in «B» class divisions (Reg. II-2/31)

1201 Doors and door frames in «B» class divisions and means of securing them shall provide a method of closure which shall have resistance to fire equivalent to that of the divisions except that ventilation openings may be permitted in the lower portion of such doors. Where such opening is in or under a door the total net area of any such opening or openings shall not exceed 0,05 m². When such opening is cut in a door it shall be fitted with a grill made of non-combustible material. Doors shall be non-combustible.

Cabin doors in «B» class divisions shall be of a self-closing type. Hold-backs are not permitted.


1202 The requirements for «B» class integrity of the outer boundaries of a ship shall not apply to glass partitions, windows and sidescuttles. Similarly, the requirements for «B» class integrity shall not apply to exterior doors in superstructures and deckhouses. For ships carrying not more than 36 passengers, the use of combustible materials in doors separating cabins from the individual interior sanitary spaces such as showers will be considered.

1203 In ships not carrying more than 36 passengers, where an automatic sprinkler system complying with the provisions of reg. 12 (Pt.4 Ch.10 Sec.5) is fitted:

1) openings in decks not forming steps in main vertical zones nor bounding horizontal zones shall be closed reasonably tight and such decks shall meet the «B» class integrity requirements in so far as is reasonable and practicable; and

2) openings in corridor bulkheads of «B» class materials shall be protected in accordance with the provisions of reg. 25 (600).

E 1300 Ventilation systems for passenger ships carrying more than 36 passengers (Reg. II-2/32.1)

1301 The ventilation system of a passenger ship carrying more than 36 passengers shall, in addition to this insulation also be in compliance with the requirements of reg. 16.2 to 16.6, 16.8, 16.9 and 16.11 (Pt.4 Ch.10 Sec.10 A102 to A106, A109, A110 and A112).

1302 In general, the ventilation fans shall be so disposed that the ducts reaching the various spaces remain within the main vertical zone.

1303 Where ventilation systems penetrate decks, precautions shall be taken, in addition to those relating to the fire integrity of the deck required in reg. 18.1.1 (Pt.4 Ch.10 Sec.12 A101) and 30.5 (1105) to reduce the likelihood of smoke and hot gases passing from one tweendeck space to another through the system. In addition to insulation requirements contained in this regulation, vertical ducts shall, if necessary, be insulated as required by the appropriate tables in 700.

1304 Except in cargo spaces, ventilation ducts shall be constructed of the following materials:

1) ducts not less than 0,075 m² in sectional area and all vertical ducts serving more than a single tweendeck space shall be constructed of steel or other equivalent material;

2) ducts not less than 0,075 m² in sectional area other than the vertical ducts referred in 1304 1), shall be constructed of non-combustible materials. Where such ducts penetrate «A» or «B» class divisions due regard shall be given to ensuring the fire integrity of the division;

3) short lengths of duct, not in general exceeding 0,02 m² in sectional area nor 2 m in length, need not be non-combustible provided that all of the following conditions are met:

i) the duct is constructed of a material which has low flame spread characteristics;

ii) the duct is used only at the terminal end of the ventilation system; and
the duct is not located closer than 600 mm measured along its length to a penetration of an «A» or «B» class division, including continuous «B» class ceilings.

1305 Stairway enclosures shall be ventilated and shall be served by an independent fan and duct system which shall not serve any other spaces in the ventilation system.

1306 All power ventilation, except machinery space and cargo space ventilation and any alternative system which may be required in reg. 16.6 (Pt.4 Ch.10 Sec.10 A106), shall be fitted with controls so grouped that all fans may be stopped from either of two separate positions which shall be situated as far apart as practicable. Controls provided for the power ventilation serving machinery spaces shall also be grouped so as to be operable from two positions, one of which is to be outside such spaces. Fans serving power ventilation systems to cargo spaces shall be capable of being stopped from a safe position outside such spaces.

1307 Where public spaces span three or more open decks and contain combustibles such as furniture and enclosed spaces such as shops, offices and restaurants, the space shall be equipped with a smoke extraction system. The smoke extraction system shall be activated by the required smoke detection system and be capable of manual control. The fans shall be sized such that the entire volume within the space can be exhausted in 10 min or less.

1308 Ventilation ducts shall be provided with suitably located hatches for inspection and cleaning, where reasonable and practicable.

1309 Exhaust ducts from galley ranges in which grease or fat is likely to accumulate shall meet requirements of reg. 16.3.2.1 and 16.3.2.2 (Pt.4 Ch.10 Sec.10 A103) and shall be fitted with:

1) a grease trap readily removable for cleaning unless an alternative approved grease removal system is fitted
2) a fire damper located in the lower end of the duct which is automatically and remotely operated, and in addition a remotely operated fire damper located in the upper end of the duct
3) a fixed means for extinguishing a fire within the duct
4) remote control arrangements for shutting off the exhaust fans and supply fans, for operating the fire dampers mentioned in (2) and for operating the fire-extinguishing system, which shall be placed in a position close to the entrance to the galley. Where a multi-branch system is installed, means shall be provided to close all branches exhausting through the same main duct before an extinguishing medium is released into the system; and
5) suitably located hatches for inspection and cleaning.

E 1400 Ventilation systems for passenger ships carrying not more than 36 passengers (Reg. II-2/32.2)

1401 The ventilation system of passenger ships carrying not more than 36 passengers shall be in compliance with reg. 16 (Pt.4 Ch.10 Sec.10).

E 1500 Windows and sidescuttles (Reg. II-2/33)

1501 All windows and sidescuttles in bulkheads within accommodation and service spaces and control stations other than to those to which the provisions of reg. 30.6 (1106) and reg. 31.2 (1202) apply, shall be so constructed as to preserve the integrity requirements of the type of bulkheads in which they are fitted.

1502 Notwithstanding the requirements of the tables in regulations 700 and 800, all windows and sidescuttles in bulkheads separating accommodation and service spaces and control stations from weather shall be constructed with frames of steel or other suitable material. The glass shall be retained by a metal glazing bead or angle.

1503 Windows facing life-saving savings, embarkation and muster areas, external stairs and open decks used for escape routes, and windows situated below liferaft and escape slide embarkation areas shall have the fire integrity as required in the tables in 700. Where automatic dedicated sprinkler heads are provided for windows, «A-0» windows may be accepted as equivalent. Windows located in the ship's side below the lifeboat embarkation areas shall have the fire integrity at least equal to «A-0» class.

E 1600 Restricted use of combustible materials (Reg. II-2/34)

1601 Except in cargo spaces, mail rooms, baggage rooms, or refrigerated compartments of service spaces, all linings, grounds, draught stops, ceilings and insulations shall be of non-combustible materials. Partial bulkheads or decks used to subdivide a space for utility or artistic treatment shall also be of non-combustible material.

1602 Vapour barriers and adhesives used in conjunction with insulation, as well as insulation of pipe fittings, for cold service systems need not be non-combustible, but they shall be kept to the minimum quantity practicable and their exposed surfaces shall have low flame spread characteristics.

1603 The following surfaces shall have low flame spread characteristics (see Pt.4 Ch.10 Sec.1 C208):

1) exposed surfaces in corridors and stairway enclosures, and of bulkheads, wall and ceiling linings in all accommodation and service spaces and control stations;
2) concealed or inaccessible spaces in accommodation, service spaces and control stations.

1604 The total volume of combustible facings, moldings, decorations and veneers in any accommodation and service space shall not exceed a volume equivalent to 2.5 mm veneer on the combined area of the route. They may permit additional seating in the main reception area within a stairway enclosure if it is fixed, non-combustible and does not restrict the passenger escape route. Furniture shall not be permitted in passenger and crew corridors forming escape routes in cabin areas. In addition to the above, lockers of non-combustible material, providing storage for safety equipment required by regulations, may be permitted *. * The gross calorific value measured in accordance with ISO standard 1716 - “Building Materials - Determination of Calorific Potential”, should be quoted.

1606 Furniture in stairway enclosures shall be limited to seating. It shall be fixed, limited to six seats on each deck in each stairway enclosure, be of restricted fire risk, and shall not restrict the passenger escape route. The Society may permit additional seating in the main reception area within a stairway enclosure if it is fixed, non-combustible and does not restrict the passenger escape route. Furniture shall not be permitted in passenger and crew corridors forming escape routes in cabin areas. In addition to the above, lockers of non-combustible material, providing storage for safety equipment required by regulations, may be permitted *. * Refer to the Recommendation on Fire Test Procedures for Upholstered Furniture, adopted by IMO by resolution A.652(16), and to the Fire Test Procedures for Ignitability of Bedding Components, adopted by IMO by resolution A.688(17).

1607 Paints, varnishes and other finishes used on exposed interior surfaces shall not be capable of producing excessive quantities of smoke and toxic products, this being determined in accordance with the Fire Test Procedures Code.

1608 Primary deck coverings, if applied within accommodation and service spaces and control stations, shall be of approved material which will not readily ignite, or give rise to toxic or explosive hazards at elevated temperatures, this being determined in accordance with the Fire Test Procedures Code.

E 1700 Details of construction (Reg. II-2/35)

1701 In accommodation and service spaces, control stations, corridors and stairways:

1) air spaces enclosed behind ceilings, paneling or linings shall be suitably divided by close-fitting draught stops not more than 14 m apart;
2) in the vertical direction, such enclosed air spaces, including those behind linings of staircases, trunks, etc., shall be closed at each deck.

1702 The construction of ceiling and bulkheading shall be such that it will be possible, without impairing the efficiency of the fire protection, for the fire patrols to detect any smoke originating in concealed and inaccessible places, except where there is no risk of fire originating in such places.

E 1800 Fixed fire detection and fire alarm systems. Automatic sprinkler, fire detection and fire alarm systems (Reg. II-2/36)

1801 In passenger ships carrying not more than 36 passengers there shall be installed throughout each separate zone, whether vertical or horizontal, in all accommodation and service spaces and, where it is considered necessary by the Society, in control stations, except spaces which afford no substantial fire risk such as void spaces, sanitary spaces, etc., either:

1) a fixed fire detection and fire alarm system of an approved type and complying with the requirements of regulation 13 (Pt.4 Ch.10 Sec.9 A) and so installed and arranged as to be capable of being used as an emergency exit.

2) an automatic sprinkler, fire detection and fire alarm system of an approved type and complying with the requirements of reg. 12 (Pt.4 Ch.10 Sec.8) or the guidelines developed by IMO in res. A.755(18) for an approved equivalent sprinkler system so installed and arranged as to protect such spaces and, in addition, a fixed fire detection and fire alarm system of an approved type complying with the requirements of reg. 13 (Pt.4 Ch.10 Sec.9 A) and so installed and arranged as to provide smoke detection in corridors, stairways and escape routes within accommodation spaces.

1802 Passenger ships carrying more than 36 passengers shall be equipped with an automatic sprinkler, fire detection and fire alarm system of an approved type complying with the requirements of reg. 12 (Pt.4 Ch.10 Sec.8), or the guidelines developed by IMO in res. A.755(18) for an approved equivalent sprinkler system in all service spaces, control stations and accommodation spaces, including corridors and stairways. Alternatively, control stations where water may cause damage to essential equipment may be fitted with an approved fixed fire-extinguishing system of another type. A fixed fire detection and fire alarm system of an approved type shall be installed, complying with the requirements of reg. 13 (Pt.4 Ch.10 Sec.9 A) also installed and arranged as to provide smoke detection in service spaces, control stations and accommodation spaces, including corridors and stairways.

Optional equipment may be fitted with an Approval System so installed and arranged as to protect such spaces and, in addition, a fixed fire detection and fire alarm system of an approved type complying with the requirements of reg. 13 (Pt.4 Ch.10 Sec.9 A) and so installed and arranged as to provide smoke detection in corridors, stairways and escape routes within accommodation spaces.

E 1900 Requirements applicable to all ro-ro passenger ships (Reg. II-2/28-1.1)

1901 This paragraph shall apply to all ro-ro passenger ships. For ships constructed before 1 July 1997 the requirements of the regulation shall apply not later than the date of the first periodical survey after 1 July 1997.

1902 Handrails or other handholds shall be provided in all corridors along the entire escape route, so that a firm handhold is available every step of the way, where possible, to the assembly stations and embarkation stations. Such handrails shall be provided on both sides of longitudinal corridors more than 1.8 m in width and transverse corridors more than 1 m in width. Particular attention shall be paid to the need to be able to cross lobbies, atriums and other large open spaces along escape routes. Handrails and other handholds shall be of such strength as to withstand a distributed horizontal load of 750 N/m applied in the direction of the centre of the corridor or space, and a distributed vertical load of 750 N/m applied in the downward direction. The two loads need not be applied simultaneously.

1903 Escape routes shall not be obstructed by furniture and other obstructions. With the exception of tables and chairs which may be cleared to provide open space, cabinets and other heavy furnishings in public spaces and along escape routes shall be secured in place to prevent shifting if the ship rolls or lists. Floor coverings shall also be secured in place. When the ship is underway, escape routes shall be kept clear of obstructions such as cleaning carts, bedding, luggage and boxes of goods.

1904 Escape routes shall be provided from every normally occupied space on the ship to an assembly station. These escape routes shall be arranged so as to provide the most direct route possible to the assembly station, and shall be marked with symbols in accordance with the recommendations of the Organization.*

* Refer to Symbols related to life-saving appliances and arrangements, adopted by the Organization by resolution A.760(18) as amended.

1905 Where enclosed spaces adjoin an open deck, openings from the enclosed space to the open deck shall, where practicable, be capable of being used as an emergency exit.

1906 Decks shall be sequentially numbered, starting with "1" at the tank top or lowest deck. These numbers shall be prominently displayed at stair landings and lift lobbies. Decks may also be named, but the deck number shall always be displayed in the same place.

1907 Simple "micmic" plans showing the "you are here" position and escape routes marked by arrows, shall be prominently displayed on the inside of each cabin door and in public spaces. The plan shall show the directions of escape, and shall be properly oriented in relation to its position on the ship.

1908 Cabin and steward's rooms shall not require keys to unlock them from inside the room. Neither shall there be any doors along any designed escape route which require keys to unlock them when moving in the direction of escape.

E 2000 Requirements applicable to ro-ro passenger ships constructed on or after 1 July 1997 (Reg. II-2/28-1.2)

2001 The lowest 0.5 m of bulkheads and other partitions forming vertical divisions along escape routes shall be able to sustain a load of 750 N/m to allow them to be used as walking surfaces from the side of the escape route with the ship at large angles of heel.

2002 The escape route from cabins to stairway enclosures shall be as direct as possible, with a minimum number of changes in direction. It shall not be necessary to cross from one side of the ship to the other to reach an escape route. It shall not be necessary to climb more than two decks up or down in order to reach an assembly station or open deck from any passenger space.

2003 External routes shall be provided from open decks, referred to in paragraph 2.2 (2002), to the survival craft embarkation stations.

E 2100 Requirements applicable to ro-ro passenger ships constructed on or after 1 July 1999 (Reg. II-2/28-1.3)

2101 For ro-ro passenger ships constructed on or after 1 July 1999, escape routes shall be evaluated by an evacuation analysis early in the design process. The analysis shall be used to identify and eliminate, as far as practicable, congestion which may develop during an abandonment, due to normal movement of passengers and crew along escape routes, including the possibility that crew may need to move along these routes in a direction opposite the movement of passengers. In addition, the analysis shall be used to demonstrate that escape arrangements are sufficiently flexible to provide for the possibility that certain escape routes, assembly stations, embarkation stations or survival craft may not be available as a result of a casualty.

F. Protection of Special Category Spaces (Reg. II-2/37)

F 100 Application

101 These additional requirements apply for those enclosed spaces above or below the bulkhead deck intended for the car-
riage of motor vehicles with fuel in their tanks for their own propulsion into and from which such vehicles can be driven and to which passengers have access.

F 200 General

201 The basic principle underlying the provisions of this subsection is that as normal main vertical zoning may not be practicable in special category spaces, equivalent protection must be obtained in such spaces on the basis of a horizontal zone concept and by the provision of an efficient fixed fire-extinguishing system. Under this concept a horizontal zone for the purpose of this regulation may include special category spaces on more than one deck provided that the total overall clear height for vehicles does not exceed 10 m.

202 The requirements of reg. 16, 18, 30 and 32 (E1100, E1300, E1400 and Pt.4 Ch.10 Sec.10, Sec.12) for maintaining the integrity of vertical zones shall be applied equally to decks and bulkheads forming the boundaries separating horizontal zones from each other and from the remainder of the ship.

F 300 Structural protection

301 In passenger ships carrying more than 36 passengers the boundary bulkheads and decks of special category spaces shall be insulated as required for category (11) spaces in table 26.1 (Table E2) and the horizontal boundaries as required for category (11) spaces in table 26.2 (Table E3).

302 In passenger ships carrying not more than 36 passengers the boundary bulkheads of special category spaces shall be constructed of approved type complying with the requirements in table 26.1 (Table E2) and the horizontal boundaries as required for category (11) spaces in table 26.2 (Table E3).

303 Indicators shall be provided on the navigating bridge which shall indicate when any fire door leading to or from the special category spaces is closed.

F 400 Fixed fire-extinguishing system

401 Each special category space is to be fitted with a fixed pressure water-spraying system for manual operation in accordance with Pt.4 Ch.10 Sec.6 E. All parts of any deck and vehicle platform in such space are to be protected, provided that the use of any other fixed fire-extinguishing system that has been shown by full-scale test in conditions simulating a flowing petrol fire in a special category space to be not less effective in controlling fires likely to occur in such a space may be permitted.

F 500 Patrois and detection

501 An efficient patrol system shall be maintained in special category spaces. In any such space in which the patrol is not maintained by a continuous fire watch at all times during the voyage there shall be provided a fixed fire detection and alarm system of an approved type complying with the requirements in reg. 13 (Pt.4 Ch.10 Sec.9 A). The fixed fire detection system shall be capable of rapidly detecting the onset of fire. The spacing and location of detectors shall be satisfactory tested taking into account the effects of ventilation and other relevant factors.

502 Manually operated call points shall be provided as necessary throughout the special category spaces and one shall be placed close to each exit from such spaces.

F 600 Fire-extinguishing equipment

601 There shall be provided in each special category space:

1) at least three water fog applicators;
2) one portable foam applicator unit complying with reg. 6.4 (Pt.4 Ch.10 Sec.4 B101) provided that at least two such units are available in the ship for use in such spaces; and
3) Portable extinguishers are to be provided at each deck level in each compartment spaced not more than 20 m apart on each side of the ship. At least one of these portable extinguishers shall be located at each access to such spaces.

F 700 Ventilation system

701 There shall be provided an effective power ventilation system for the special category spaces sufficient to give at least 10 air changes per hour. The system for such spaces shall be entirely separated from other ventilation systems and shall be operating at all times when vehicles are in such spaces. An increased number of air changes when vehicles are being loaded and unloaded may be required. Ventilation ducts serving special category spaces capable of being effectively sealed shall be separated for each such space. The system shall be capable of being controlled from a position outside such spaces.

702 The ventilation shall be such as to prevent air stratification and the formation of air pockets.

703 Means shall be provided to indicate on the navigating bridge any loss or reduction of the required ventilating capacity.

704 Arrangements shall be provided to permit a rapid shut down and effective closure of the ventilation system in case of fire, taking into account the weather and sea conditions.

705 Ventilation ducts, including dampers, shall be made of steel.

F 800 Additional provisions applicable only to special category spaces above the bulkhead deck

801 In view of the serious loss of stability which could arise due to large quantities of water accumulating on the deck or decks consequent on the operation of the fixed pressure water-spraying system, scuppers shall be fitted so as to ensure that such water is rapidly discharged directly overboard (see Pt.4 Ch.6).

802 On any deck or platform, if fitted, on which vehicles are carried and on which explosive vapours might be expected to accumulate, except platforms with openings of sufficient size permitting penetration of petrol gases downwards, equipment which may constitute a source of ignition of flammable vapours and, in particular, electrical equipment and wiring, shall be installed at least 450 mm above the deck or platform. Electrical equipment installed at more than 450 mm above the deck or platform shall be of a type so enclosed and protected as to prevent the escape of sparks. Equipment having an enclosure of minimum IP 55 may be installed. However, if the Society is satisfied that the installation of electrical equipment and wiring at less than 450 mm above the deck or platform is necessary for the safe operation of the ship, such electrical equipment and wiring may be installed provided that it is of certified safe type suitable for use in Zone 1 as defined in IEC 79 (Gas Group IIA and Temperature Class T3).

803 Electrical equipment and wiring, if installed in an exhaust ventilation duct, is to be of certified safe type according to 802. The outlet from any exhaust duct shall be sited in a safe position, having regard to other possible sources of ignition.

F 900 Additional provisions applicable only to special category spaces below the bulkhead deck

901 In view of the serious loss of stability which could arise due to large quantities of water accumulating on the deck or tank top consequent on the operation of the fixed pressure water-spraying system, pumping and drainage facilities to be provided according to reg. II-2/1 (Pt.4 Ch.6).

902 Electrical equipment and wiring, if fitted, is to be of certified safe type suitable for use in Zone 1 as defined in IEC 79 (Gas Group IIA and Temperature class T3). Other equipment which may constitute a source of ignition of flammable vapours shall not be permitted.

903 Electrical equipment and wiring fitted in exhaust ventilation duct to comply with 803.

F 1000 Permanent opening for ventilation

1001 Permanent openings in the side plating, the ends or deckhead of special category spaces shall be so situated that a fire in the special category space does not endanger stowage areas and embarkation stations for survival craft and accommodation spaces, service spaces and control stations in superstructures and deckhouses above the special category spaces.
G. Protection of Cargo Spaces, Other Than Special Category Spaces (Reg. II-2/38, II-2/38-1)

G 100 Application

101 In any cargo space (other than special category spaces) containing motor vehicles with fuel in their tanks for their own propulsion, the following provisions shall be complied with.

G 200 Fixed fire detection

201 There shall be provided a fixed fire detection and fire alarm system complying with the requirements of reg. 13 (Pt.4 Ch.10 Sec.9 A) or a sample extraction smoke detection system complying with the requirements of reg. 13-1 (Pt.4 Ch.10 Sec.9 B). The design and arrangements of this system shall be considered in conjunction with the ventilation requirements referred to in 400.

G 300 Fire-extinguishing arrangements

301 There shall be fitted a fixed fire-extinguishing system which shall comply with reg. 5 (Pt.4 Ch.10 Sec.3), except that, if a carbon dioxide system is fitted, the quantity of gas available shall be at least sufficient to give a minimum volume of free gas equal to 45 per cent of the gross volume of the largest such cargo space which is capable of being sealed, and the arrangement shall be such as to ensure that at least two thirds of the gas required for the relevant space shall be introduced during 10 minutes. Any other fixed gas fire-extinguishing system or fixed high expansion foam fire-extinguishing system may be fitted provided it gives equivalent protection. Furthermore, any cargo space designated only for vehicles which are not carrying any cargo may be fitted with fixed halogenated hydrocarbon fire-extinguishing systems which shall comply with reg. 5 (Pt.4 Ch.10 Sec.3). Steam smothering systems would not be acceptable.

302 As an alternative, a system meeting the requirements in F400 may be fitted, provided that F801 or F901, as appropriate, is also complied with.

303 There shall be provided for use in any such space at each level portable fire extinguishers spaced not more than 20 m apart on both sides of the ship. At least one of these portable extinguishers shall be located at each access to such spaces.

G 400 Ventilation system

401 There shall be provided an effective power ventilation system sufficient to give at least 10 air changes per hour for ships carrying more than 36 passengers, and 6 air changes per hour for ships carrying not more than 36 passengers. The system for such cargo spaces shall be entirely separate from other ventilation systems and shall be operating at all times when vehicles are in such spaces. Ventilation ducts serving such cargo spaces capable of being effectively sealed shall be separated for each such space. The system shall be capable of being controlled from a position outside such spaces.

402 Ventilation shall be such as to prevent air stratification and the formation of air pockets.

403 Means shall be provided to indicate on the navigating bridge any loss or reduction of the required ventilating capacity.

404 Arrangements shall be provided to permit a rapid shut-down and effective closure of the ventilation system in case of fire, taking into account the weather and sea conditions.

405 Ventilation ducts including dampers, shall be made of steel.

G 500 Precautions against ignition of flammable vapours

501 Electrical equipment and wiring, if fitted, is to be of certified safe type suitable for use in Zone 1 as defined in IEC 79 (Gas Group II A and Temperature class T3). Other equipment which may constitute a source of ignition of flammable vapours shall not be permitted.

502 Electrical equipment and wiring, if installed in an exhaust ventilation duct, is to be of certified safe type according to 501, and the outlet from any exhaust duct is to be sited in a safe position, having regard to other possible sources of ignition.

503 Scuppers shall not be led to machinery or other spaces where sources of ignition may be present.

G 600 Protection of cargo spaces, permanent opening for ventilation

601 Permanent openings in the side plating, the ends or deckhead of cargo spaces shall be so situated that a fire in the cargo space does not endanger stowage areas and embarkation stations for survival craft and accommodation spaces, service spaces and control stations in superstructures and deckhouses above the cargo spaces.

G 700 Structural protection of cargo spaces

701 For ro-ro cargo spaces of ships constructed on or after 1 July 1998, the requirements of paragraph 1.1, 1.2 and 1.3 of regulation II-2/38-1 (801 to 803) shall be complied with.

G 800 Protection of closed and open ro-ro cargo spaces, general

801 The basic principles underlying regulation 37.1.1 (F200) also apply to this regulation.

802 In passenger ships carrying more than 36 passengers, the boundary bulkheads and decks of closed and open ro-ro cargo spaces shall be insulated to “A-60” class standard. However, where a category (5), (9) or (10) space is on one side of the division, the standard may be reduced to “A-0”. Where fuel oil tanks are below a ro-ro cargo space, the integrity of the deck between such spaces may be reduced to “A-0” standard.

803 In passenger ships carrying not more than 36 passengers, the boundary bulkheads and decks of closed and open ro-ro cargo spaces shall have a fire integrity as required for category (8) spaces in table 27.1(Table E4) and the horizontal boundaries are required for category (8) spaces in table 27.2 (Table E5).

804 Permanent openings in the side plating, the ends or deckhead of closed and open ro-ro cargo spaces shall be so situated that a fire in the cargo space does not endanger stowage areas and embarkation stations for survival craft and accommodation spaces, service spaces and control stations in superstructures and deckhouses above the cargo spaces.

G 900 Protection of closed ro-ro cargo spaces

901 Closed ro-ro cargo spaces shall comply with the requirements of regulation 38 (G), except for paragraph 4 (600).

G 1000 Protection of open ro-ro cargo spaces

1001 Open ro-ro cargo spaces shall comply with the requirements of regulations 37.1.3 (F400), 37.2.1 (F800), 38.1(200), except that a sample extraction smoke detection system is not permitted, and 38.2.3 (303).

H. Fixed Fire-Extinguishing Arrangements in Cargo Spaces (Reg. II-2/39)

H 100 General

101 Except as provided for in 103, the cargo spaces of ships of 1,000 gross tonnage and upwards shall be protected by a fixed gas fire-extinguishing system complying with reg. 5 (Pt.4 Ch.10 Sec.3), or by a fixed high expansion foam fire-extinguishing system which gives equivalent protection.

102 Where a ship is engaged on voyages of such short duration that it would be unreasonable to apply the requirements in 101 and also in ships of less than 1,000 gross tonnage, the arrangements in cargo spaces will be specially considered.

103 A ship engaged in the carriage of dangerous goods shall be provided in any cargo spaces with a fixed gas fire-extinguishing system complying with reg. 5 (Pt.4 Ch.10 Sec.3) or with a fire-extinguishing system which gives equivalent protection for the cargoes carried.
I. Fire Patrols, Detection, Alarms and Public Address Systems (Reg. II-2/40)

I 100 General

101 Manually operated call points complying with the requirements of reg. 13 (Pt.4 Ch.10 Sec.9 A) shall be installed.

102 A fixed fire detection and fire alarm system complying with the requirements of reg. 13 (Pt.4 Ch.10 Sec.9 A) or a sample extraction smoke detection system complying with the requirements of reg. 13-1 (Pt.4 Ch.10 Sec.9 B) shall be provided in any cargo space which is not accessible, except where the ship is engaged on voyages of such short duration that it would be unreasonable to apply this requirement.

103 All ships shall, at all times when at sea, or in port (except when out of service), be so manned or equipped as to ensure that any initial fire alarm is immediately received by a responsible member of the crew.

104 A special alarm, operated from the navigating bridge or fire control station, shall be fitted to summon the crew. This alarm may be part of the ship’s general alarm system but it shall be capable of being sounded independently of the alarm to the passenger spaces.

105 A public address system in accordance with Pt.4 Ch.12 Sec.2 B204, is to be provided. Each member of the fire patrol shall be provided with a two-way portable radio telephone apparatus.

106 For ships carrying more than 36 passengers an efficient patrol system shall be maintained so that an outbreak of fire may be promptly detected. Each member of the fire patrol shall be trained to be familiar with the arrangements of the ship as well as the location and operation of any equipment he may be called upon to use.

107 Where public spaces span three or more open decks and contain combustibles such as furniture and enclosed spaces such as shops, offices and restaurants, the entire main vertical zone containing the space shall be protected throughout with a smoke detection system complying with regulation 13 (Pt.4 Ch.10 Sec.9 A), with the exception of paragraph 1.9 (Pt.4 Ch.10 Sec.9 A110).

108 Passenger ships carrying more than 36 passengers shall have the detection alarms for the systems required by reg. 36.2 (Pt.4 Ch.10 Sec.8 A, 9 A or B) centralized in a continuously manned central control station. In addition, controls for remote closing of the fire doors and shutting down the ventilation fans, shall be centralized in the same location. The ventilation fans shall be capable of reactivation by the crew at the continuously manned control station. The control panels in the central control station shall be capable of indicating open or closed positions of fire doors, closed or off status of the detectors, alarms and fans. The control panel shall be continuously powered and should have an automatic change-over to standby power supply in case of loss of normal power supply. The control panel shall be powered from the main source of electrical power and the emergency source of electrical power defined by reg. II-1/42 (Sec.2 D) unless other arrangements are permitted by the regulations, as applicable.

109 The control panel shall be designed on the fail-safe principle, e.g. an open detector circuit shall cause an alarm condition, as noted in regulations II-2/13.1.3 (Pt.4 Ch.10 Sec.9 A104) and II-1/51.1.4 (Pt.6 Ch.3 Sec.2 C)

J. Special Requirements for Ships Carrying Dangerous Goods (Reg. II-2/41)

J 100 General

101 The requirements in SOLAS Chapter II-2, regulation 54 are to apply, as appropriate, to passenger ships carrying dangerous goods, see Ch.11 Sec.3.

K. Stability and Watertight Integrity

K 100 Application

101 Ships with class notation Passenger Ship are to comply with the requirements of Pt.3 Ch.4 as well as the requirements of this subsection.

K 200 Definitions

201 Definitions (Regulation 2)

1.1 Subdivision load line

is a water-line used in determining the subdivision of the ship.

1.2 Deepest subdivision load line

is the water-line which corresponds the greatest draught permitted by the subdivision requirements which are applicable.

2 Length of the ship

is the length measured between perpendiculars taken at the extremities of the deepest subdivision load line.

3 Breadth of the ship

is the extreme width from outside of frame to outside of frame at or below the deepest subdivision load line.

4 Draught

is the vertical distance from the moulded base line amidships to the subdivision load line in question.

5 Bulkhead deck

is the uppermost deck up to which the transverse watertight bulkheads are carried.

6 Margin line

is a line drawn at least 76 mm below the upper surface of the bulkhead deck at side.

7 Permeability of a space

is the percentage of that space which can be occupied by water. The volume of a space which extends above the margin line shall be measured only to the height of that line.

8 Machinery space

is to be taken as extending from the moulded base line to the margin line and between the extreme main transverse watertight bulkheads, bounding the spaces containing the main and auxiliary propulsion machinery, boilers serving the needs of propulsion, and all permanent coal bunkers. In the case of unusual arrangements, the Administration may define the limits of the machinery spaces.

9 Passenger spaces

are those spaces which are provided for the accommodation and use of passengers, excluding baggage, store, provision and mail rooms. For the purposes of Regulations 5 and 6, spaces provided below the margin line for the accommodation and use of the crew shall be regarded as passenger spaces.

10 In all cases volumes and areas shall be calculated to moulded lines.

11 Weathertight

means that in any sea conditions water will not penetrate into the ship.

12 An oil tanker


13 Ro-ro passenger ship

means a passenger ship with ro-ro cargo spaces or special category spaces as defined in regulation II-2/3 (Sec.3 E200)

202 Terms:

Internal watertight integrity

The capability of internal structures and their closing appliances to prevent progressive flooding to volumes assumed buoyant or intact.
The internal watertight integrity includes position and type of closing appliance, alarms, indicators, remote controls and signboards fitted to such appliances.

Further, watertight closing of pipes, ducts and tunnels in the damage penetration zone is regarded as a part of the internal watertight integrity.

**Progressive flooding**

Ingress of water through internal openings to compartments assumed to be intact.

**Downflooding angle related to intact stability**

The minimum heel angle where an external opening without weathertight closing appliance is submerged.

**Downflooding angle related to damage stability**

The minimum heel angle where an external opening without watertight closing appliance is submerged.

**Damage zone**

The zone of the ship where the stipulated damage can be assumed. The stipulated damage is defined in the applicable damage stability requirements.

**Residual stability**

The positive range of the righting lever curve after damage, with external heeling levers taken into account.

**Rudder heeling lever**

Equals the rudder heeling moment (MR) divided by the ship's displacement.

203 General definitions are given in Pt.3 Ch.4 Sec.1.

K 300 Documentation

301 Documentation for approval:

— preliminary damage stability calculations
— final damage stability calculations
— damage control plan.

1) Not required in case of approved limit curves, or if approved lightweight data are not less favourable than estimated lightweight data.

302 Documentation for information:

— internal watertight integrity plan

**Guidance note:**

Details of above documentation are given in Classification Note No. 20.1 'Stability Documentation—Ships'.

---end---of---Guidance---note---

K 400 Intact stability

401 Passenger ships are to comply with Pt.3 Ch.4 as far as applicable and supplemented by 402 to 404.

402 Loading conditions

The following standard loading conditions are to be included:

— ship in the fully loaded departure condition with full cargo, stores and fuel and the full number of passengers and their luggage
— ship in the fully loaded arrival condition, with full cargo and the full number of passengers and their luggage but with only 10% stores and fuel remaining
— ship with full stores and fuel and the full number of passengers and their luggage, but without cargo
— ship with only 10% stores and fuel and the full number of passengers and their luggage, but without cargo.

403 Additional criteria

— the angle of heel on account of crowding of passengers to one side is not to exceed 10 degrees
— the angle of heel on account of turning should not exceed 10 degrees when calculated using the following formula:

\[ \text{MR} = 0.02 V_c^2 \Delta (\text{KG} - d/2)/L \]

\[ M_{R} = \text{heeling moment in tm} \]

\[ V_c = \text{service speed in m/s} \]

\[ L = \text{length of ship at waterline in m} \]

\[ \Delta = \text{displacement in t} \]

\[ d = \text{draught in m} \]

\[ \text{KG} = \text{height of centre of gravity above keel in m}. \]

404 When applying the additional criteria in 403 the following is to be assumed:

1) A weight of 75 kg is to be assumed for each passenger except that this value may be reduced to not less than 60 kg where this can be justified. In addition the weight and distribution of the luggage are to be taken into account.

2) The height of the centre of gravity for the passengers is to be assumed equal to:

— 1,0 m above deck level for passengers standing upright. Account may be taken, if necessary, of camber and sheer of deck
— 0,3 m above the seat in respect of seated passengers.

3) Passengers without luggage are to be considered as distributed to produce the most unfavourable combination of passenger heeling moment and/or initial metacentric height, which may be obtained in practice. A value of not less than 4 persons per square metre is to be applied.

K 500 Subdivision and damage stability

501 Application

DNV does normally not require calculation of floodable length according to SOLAS regulations 4, 5 and 7. Calculation of the factor of subdivision according to regulation 6 and damage stability calculations according to regulation 8 are to be performed.

**Guidance note:**

Instead of the requirements in this part, the Regulations on Subdivision and Stability of Passenger Ships as an Equivalent to Part B of Chapter II of the International Convention for the Safety of Life at Sea, 1960, adopted by the Organization by resolution A.265(VIII), may be used, if applied in their entirety.

---end---of---Guidance---note---

502 Floodable length (Regulation 4)

1 The floodable length at any point of the length of a ship shall be determined by a method of calculation which takes into consideration the form, draught and other characteristics of the ship in question.

2 In a ship with a continuous bulkhead deck, the floodable length at a given point is the maximum portion of the length of the ship, having its centre at the point in question, which can be flooded under the definite assumptions set forth in Reg. 5 without the ship being submerged beyond the margin line.

3.1 In the case of a ship not having a continuous bulkhead deck, the floodable length at any point may be determined to an assumed continuous margin line which at no point is less than 76 mm below the top of the deck (at side) to which the bulkheads concerned and the shell are carried watertight.

3.2 Where a portion of an assumed margin line is appreciably below the deck to which bulkheads are carried, the Administration may permit a limited relaxation in the watertightness of those portions of the bulkheads which are above the margin line and immediately under the higher deck.
2.1 The uniform average permeability throughout the machinery space as defined in Reg. 2 (201); the portion forward of the machinery space; and the portion abaft the machinery space.

2.2 Where it is shown to the satisfaction of the Administration that the average permeability as determined by detailed calculation is less than that given by the formula, the detailed calculation shall be taken as the factor of subdivision.

2.3 The variations of the factor A and B shall be expressed as the length of the ship increases, and from a factor A, applicable to ships primarily engaged in the carriage of cargo, to a factor B, applicable to ships primarily engaged in the carriage of passengers.

3.1 For a ship of given length the appropriate factor of subdivision shall be determined by the following formulae (1) and (2) where:

\[
A = \frac{58.2}{L - 60} + 0.18 \quad (L=131 \text{ m and upwards}) \quad [1]
\]

\[
B = \frac{30.3}{L - 42} + 0.18 \quad (L=79 \text{ m and upwards}) \quad [2]
\]

3.2 Where the value of KN is greater than the sum of P and the whole volume of the actual passenger spaces above the margin line, the figure to be taken as P1 is that sum or two-thirds KN, whichever is the greater.

When \( P_1 \) is greater than P:

\[
C_S = \frac{M + 2P_1}{V + P_1 - P} \quad [3]
\]

and in other cases:
3.3 For ships not having a continuous bulkhead deck the volumes are to be taken up to the actual margin lines used in determining the floodable lengths.

4 Rules for subdivision of ships other than those covered by paragraph 5

4.1 The subdivision abaft the forepeak of ships of 131 m in length and upwards having a criterion numeral of 23 or less shall be governed by the factor A given by formula (1); of those having a criterion numeral of 123 or more by the factor B given by formula (2); and of those having a criterion numeral between 23 and 123 by the factor F obtained by linear interpolation between the factors A and B, using the formula:

\[ F = A - \frac{(A - B)(C_S - 23)}{100} \]  \[ [5] \]

Nevertheless, where the criterion numeral is equal to 45 or more and simultaneously the computed factor of subdivision as given by formula (5) is 0.65 or less, but more than 0.50, the subdivision abaft the forepeak shall be governed by the factor 0.50.

4.2 Where the factor F is less than 0.40 and it is shown to the satisfaction of the Administration to be impracticable to comply with the factor F in a machinery compartment of the ship, the subdivision of such compartment may be governed by an increased factor, which, however, shall not exceed 0.40.

4.3 The subdivision abaft the forepeak of ships of less than 131 m but not less than 79 m in length having a criterion numeral equal to S, where:

\[ S = 3,574 - 25L \]

\[ 13 \]

shall be governed by the factor unity; of those having a criterion numeral of 123 or more by the factor B given by the formula (2), of those having a criterion numeral between S and 123 by the factor F obtained by linear interpolation between unity and the factor B using the formula:

\[ F = 1 - \frac{(1 - B)(C_S - S)}{123 - S} \]  \[ [6] \]

4.4 The subdivision abaft the forepeak of ships of less than 131 m but not less than 79 m in length and having a criterion numeral less than S, and of ships of less than 79 m in length shall be governed by the factor unity, unless, in either case, it is shown to the satisfaction of the Administration to be impracticable to comply with this factor in any part of the ship, in which case the Administration may allow such relaxation as may appear to be justified, having regard to all the circumstances.

4.5 The provisions of paragraph 4.4 shall apply also to ships of whatever length, which are to be certified to carry a number of passengers exceeding 12 but not exceeding:

\[ \frac{L^2}{650} \cdot 50, \text{ whichever is the less} \]

5 Special subdivision standards for ships complying with Reg. III/21.1.2 (L300).

5.1 In the case of ships primarily engaged in the carriage of passengers, the subdivision abaft the forepeak shall be governed by a factor of 0.50 or by the factor determined according to paragraphs 3 and 4, if less than 0.50.

5.1.2 In the case of such ships of less than 91.5 m in length, if the Administration is satisfied that compliance with such factor would be impracticable in a compartment, it may allow the length of that compartment to be governed by a higher factor provided the factor used is the lowest that is practicable and reasonable in the circumstances.

5.2 Where, in the case of any ship whether of less than 91.5 m or not, the necessity of carrying appreciable quantities of cargo makes it impracticable to require the subdivision abaft the forepeak to be governed by a factor not exceeding 0.50, the standard of subdivision to be applied shall be determined in accordance with the following sub-paragraphs. to .5, subject to the condition that where the Administration is satisfied that insistence on strict compliance in any respect would be unreasonable, it may allow such alternative arrangements of the watertight bulkheads as appears to be justified on merits and will not diminish the general effectiveness of the subdivision.

.1 The provisions of paragraph 3 relating to the criterion numeral shall apply with the exception that in calculating the value of \( P_F \) for berthed passengers \( K \) is to have the value defined in paragraph 3 or 3.5 \( m^2 \), whichever is the greater, and for unberthed passengers \( K \) is to have the value 3.5 \( m^2 \).

.2 The factor \( B \) in paragraph 2 shall be replaced by the factor \( BB \) determined by the following formula:

\[ BB = \frac{17,6}{L - 33} + 0,20 \quad (L = 55 m \text{ and upwards}) \]

.3 The subdivision abaft the forepeak of ships of 131 m in length and upwards having a criterion numeral of 23 or less shall be governed by the factor A given by formula (1) in paragraph 2.3; of those having a criterion numeral of 123 or more by the factor BB given by the formula in paragraph 5.2.2; and of those having a criterion numeral between 23 and 123 by the factor BB obtained by linear interpolation between the factors A and BB, using the formula:

\[ F = A - \frac{(A - BB)(C_S - 23)}{100} \]

except that if the factor F so obtained is less than 0.50 the factor to be used shall be either 0.50 or the factor calculated according to the provisions of paragraph 4.1, whichever is the smaller.

.4 The subdivision abaft the forepeak of ships of less than 131 m but not less than 55 m in length having a criterion numeral equal to S1 where:

\[ S_1 = 3,712 - 25L \]

\[ 19 \]

shall be governed by the factor unity; of those having a criterion numeral of 123 or more by the factor BB given by the formula in paragraph 5.2.2; of those having a criterion numeral between S1 and 123 by the factor F obtained by linear interpolation between unity and the factor BB using the formula:

\[ F = 1 - \frac{(1 - BB)(C_S - S_1)}{123 - S_1} \]

except that in either of the two latter cases if the factor so obtained is less than 0.50 the subdivision may be governed by a factor not exceeding 0.50.

.5 The subdivision abaft the forepeak of ships of less than 131 m but not less than 55 m in length and having a criterion numeral less than S1 and of ships of less than 55 m in length shall be governed by the factor unity, unless it is shown to the satisfaction of the Administration to be impracticable to comply with this factor in any part of the ship, in which case the Administration may allow such relaxation as appear to be justified, having regard to all the circumstances, provided that the aftermost compartment and as many as possible of the forward compartments (between the forepeak and the after end of the machinery space) shall be kept within the floodable length.

5.3 The special provisions regarding permeability given in Reg. 5.4 (503) shall be employed when calculating the floodable length curves.

5.4 Where the Administration is satisfied that, having regard to the nature and conditions of the intended voyages compliance with the other provisions of this chapter and of chapter II-2 (E and Pt.4 Ch.10) is sufficient, the requirements of this paragraph need not be complied with.
505 Special requirements concerning subdivision (Regulation 7)

1 Where in a portion or portions of a ship the watertight bulkheads are carried to a higher deck than in the remainder of the ship and it is desired to take advantage of this higher extension of the bulkheads in calculating the floodable length, separate margin lines may be used for each such portion of the ship provided that:

.1 the sides of the ship are extended throughout the ship's length to the deck corresponding to the upper margin line and all openings in the shell plating below this deck throughout the length of the ship are treated as being below a lower margin line, for the purposes of Reg. 17 (565);

.2 the two compartments adjacent to the «step» in the bulkhead deck are each within the permissible length corresponding to their respective margin lines, and, in addition, their combined length does not exceed twice the permissible length based on the lower margin line.

2.1 A compartment may exceed the permissible length determined by the rules of Reg. 6 (504) provided the combined length of each pair of adjacent compartments to which the compartment in question is common does not exceed either the floodable length or twice the permissible length, whichever is the less.

2.2 If one of the two adjacent compartments is situated inside the machinery space, and the second is situated outside the machinery space, and the average permeability of the portion of the ship in which the second is situated differs from that of the machinery space, the combined length of the two compartments shall be adjusted to the mean average permeability of the two portions of the ship in which the compartments are situated.

2.3 Where the two adjacent compartments have different factors of subdivision, the combined length of the two compartments shall be determined as follows:

3 In ships of 100 m in length and upwards, one of the main transverse bulkheads abate the forecastle shall be fitted at a distance from the forward perpendicular which is not greater than the permissible length.

4 A main transverse bulkhead may be recessed provided that all parts of the recess lie inboard of vertical surfaces on both sides of the ship, situated at a distance from the shell plating equal to one-fifth the breadth of the ship, as defined in Reg. 2 (201), and measured at right angles to the centre line at the level of the deepest subdivision load line. Any part of a recess which lies outside these limits shall be dealt with as a step in accordance with paragraph 5.

5 A main transverse bulkhead may be stepped provided that it meets one of the following conditions:

.1 the combined length of the two compartments, separated by the bulkhead in question, does not exceed either 90 per cent of the floodable length or twice the permissible length, except that, in ships having a factor of subdivision greater than 0.9, the combined length of the two compartments in question shall not exceed the permissible length;

.2 additional subdivision is provided in the step to maintain the same measure of safety as that secured by a plane bulkhead;

.3 the compartment over which the step extends does not exceed the permissible length corresponding to a margin line taken 76 mm below the step.

6 Where a main transverse bulkhead is recessed or stepped, an equivalent plane bulkhead shall be used in determining the subdivision.

7 If the distance between two adjacent main transverse bulkheads, or their equivalent plane bulkheads, or the distance between the transverse planes passing through the nearest stepped portions of the bulkheads, is less than 3.0 m plus 3 per cent of the length of the ship, or 11.0 m whichever is the less, only one of these bulkheads shall be regarded as forming part of the subdivision of the ship in accordance with the provisions of Reg. 6 (504).

8 Where a main transverse watertight compartment contains local subdivision and it can be shown to the satisfaction of the Administration that, after any assumed side damage extending over a length of 3.0 m plus 3 per cent of the length of the ship, or 11.0 m whichever is the less, the whole volume of the main compartment will not be flooded, a proportionate allowance may be made in the permissible length otherwise required for such compartment. In such a case the volume of effective buoyancy assumed on the undamaged side shall not be greater than that assumed on the damaged side.

9 Where the required factor of subdivision is 0.50 or less, the combined length of any two adjacent compartments shall not exceed the floodable length.

506 Stability in damaged condition. * (Regulation 8)

* Refer to MSC/Circ.541 (as may be revised): Guidance notes on the integrity of flooding boundaries above the bulkhead deck of passenger ships for proper application of regulations II-1/8 and 20 (607), paragraph 1 of SOLAS 1974, as amended.

1.1 Sufficient intact stability shall be provided in all service conditions so as to enable the ship to withstand the final stage of flooding of any one main compartment which is required to be within the floodable length.

1.2 Where two adjacent main compartments are separated by a bulkhead which is stepped under the conditions of Reg. 7.5.1 (505) the intact stability shall be adequate to withstand the flooding of those two adjacent main compartments.

1.3 Where the required factor of subdivision is 0.50 or less but more than 0.33 intact stability shall be adequate to withstand the flooding of any two adjacent main compartments.

1.4 Where the required factor of subdivision is 0.33 or less the intact stability shall be adequate to withstand the flooding of any three adjacent main compartments.

2.1 The requirements of paragraph 1 shall be determined by calculations which are in accordance with paragraphs 3, 4 and 6 and which take into consideration the proportions and design characteristics of the ship and the arrangement and configuration of the damaged compartments. In making these calculations the ship is to be assumed in the worst anticipated service condition as regards stability.

2.2 Where it is proposed to fit decks, inner skins or longitudinal bulkheads of sufficient tightness to seriously restrict the flow of water, the Administration shall be satisfied that proper consideration is given to such restrictions in the calculations.

2.3 The stability required in the final condition after damage, and after equalization where provided, shall be determined as follows:

2.3.1 The positive residual righting lever curve shall have a minimum range of 15° beyond the angle of equilibrium.

This range may be reduced to a minimum of 10°, in the case where the area under the righting lever curve is that specified in 2.3.2, increased by the ratio:

\[
\frac{15}{\text{Range}}
\]

where the range is expressed in degrees.

2.3.2 The area under the righting lever curve shall be at least 0.015 metre-radians, measured from the angle of equilibrium to the lesser of:

.1 the angle at which progressive flooding occurs;

.2 22° (measured from the upright) in the case of one-compartment flooding, or 27° (measured from the upright) in the case of the simultaneous flooding of two or more adjacent compartments.

2.3.3 A residual righting lever is to be obtained within the range of positive stability, taking into account the greatest of the following heeling moments:

.1 the crowding of all passengers towards one side;
2.4 In intermediate stages of flooding, the maximum righting lever shall be at least 0.05 m and the range of positive righting lever only one free surface need be assumed.

2.3.4 For the purpose of calculating the heeling moments in intermediate stages of flooding, the maximum righting lever shall be at least 0.10 m.

3 For the purpose of making damage stability calculations, the volume and surface permeabilities shall be in general as follows:

<table>
<thead>
<tr>
<th>Spaces</th>
<th>Permeability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appropriated to cargo, coal or stores</td>
<td>60</td>
</tr>
<tr>
<td>Occupied by accommodation</td>
<td>95</td>
</tr>
<tr>
<td>Occupied by machinery</td>
<td>85</td>
</tr>
<tr>
<td>Intended for liquids</td>
<td>0 or 95*</td>
</tr>
</tbody>
</table>

* Whichever results in the more severe requirements.

Higher surface permeabilities are to be assumed in respect of spaces which, in the vicinity of the damage waterplane, contain no substantial quantity of accommodation or machinery and spaces which are not generally occupied by any substantial quantity of cargo or stores.

4 Assumed extent of damage shall be as follows:

- The longitudinal extent of damage shall be increased as necessary so as to include any two consecutive main transverse watertight bulkheads;
- The transverse extent (measured inboard from the ship’s side, at right angles to the centre line at the level of the deepest subdivision load line) shall be at least 0.20 m.
- The vertical extent shall be as follows:
  - From the base line upwards without limit;
  - Above the keel line to 0.10 m for fully laden ships;
  - Above the keel line to 0.20 m for ships not fully laden;
  - Above the waterline to 0.20 m.

However, no case is this righting lever to be less than 0.10 m.

2.3.4 For the purpose of calculating the heeling moments in intermediate stages of flooding, the maximum righting lever shall be at least 0.05 m and the range of positive righting lever only one free surface need be assumed.

5 Unsymmetrical flooding is to be kept to a minimum consistent with efficient arrangements. Where it is necessary to correct large angles of heel, the means adopted shall, where practicable, be self-acting, but in any case where controls to cross-flooding fittings are provided they shall be operable from above the bulkhead deck. These fittings together with their controls shall be acceptable to the Administration. The maximum angle of heel after flooding but before equalization shall not exceed 12°. Where cross-flooding fittings are required the time to equalization shall not exceed 15 minutes. Suitable information concerning the use of cross-flooding fittings shall be supplied to the master of the ship.

6 The final conditions of the ship after damage and, in the case of unsymmetrical flooding, after equalization measures have been taken shall be as follows:

- In the case of symmetrical flooding there shall be a positive residual metacentric height of at least 50 mm as calculated by the constant displacement method.
- In the case of unsymmetrical flooding, the angle of heel for one-compartment flooding shall not exceed 7°.
- For the simultaneous flooding of two or more adjacent compartments, a heel of 12° may be permitted by the Administration.
- In no case shall the margin line be submerged in the final stage of flooding. If it is considered that the margin line may become submerged during an intermediate stage of flooding, the Administration may require such investigations and arrangements as it considers necessary for the safety of the ship.

7.1 The master of the ship shall be supplied with the data necessary to maintain sufficient intact stability under service conditions to enable the ship to withstand the critical damage. In the case of ships requiring cross-flooding, the master of the ship shall be informed of the conditions of stability on which the calculations are based and be warned that excessive heeling might result should the ship sustain damage when in a less favourable condition.

7.2 The data referred to in paragraph 7.1, to enable the master to maintain sufficient intact stability, shall include information which indicates the maximum permissible height of the ship’s centre of gravity above keel (KG), or alternatively the minimum permissible metacentric height (GM) for a range of draughts or displacements sufficient to include all service conditions. The information shall show the influence of various trims taking into account the operational limits.

7.3 Each ship shall have scales of draughts marked clearly at marks, then the ship shall also be fitted with a reliable draught indicating system by which the bow and stern draughts can be determined.
istcation may accept the use of an electronic loading and stability computer or equivalent means for this purpose.

8.1 No relaxation from the requirements for damage stability may be considered by the Administration unless it is shown that the intact metacentric height in any service condition necessary to meet these requirements is excessive for the service intended.

8.2 Relaxations from the requirements for damage stability shall be permitted only in exceptional cases and subject to the condition that the Administration is to be satisfied that the proportions, arrangements and other characteristics of the ship are the most favourable to stability after damage which can practically and reasonably be adopted in the particular circumstances.

507 For passenger ships with service area restriction R3, R4 or R6 the Society may accept requirements other than those specified in 506 after consideration in each separate case.

K 600 Watertight integrity

601 As far as practicable, tunnels, ducts or pipes which may cause progressive flooding in case of damage, are to be avoided within the assumed extent of damage. If this is not possible, arrangements are to be made to prevent progressive flooding to compartments assumed intact. Alternatively, these compartments are to be assumed flooded in the damage stability calculations.

602 The scantlings of tunnels, ducts, pipes, doors, staircases, bulkheads and decks, forming watertight boundaries, are to be adequate to withstand the pressure heights corresponding to the deepest equilibrium waterline in damaged condition.

603 Requirements to watertight integrity, openings and closing appliances as given in SOLAS Ch.II-1 Part B, and quoted in 604 to 609, are to be complied with.

604 Openings in watertight bulkheads (Regulation 15).

1 The number of openings in watertight bulkheads shall be reduced to the minimum compatible with the design and proper working of the ship; satisfactory means shall be provided for closing these openings.

2.1 Where pipes, scuppers, electric cables, etc., are carried through watertight subdivision bulkheads, arrangements shall be made to ensure the watertight integrity of the bulkheads.

2.2 Valves not forming part of a piping system shall not be permitted in watertight subdivision bulkheads.

2.3 Lead or other heat sensitive materials shall not be used in systems which penetrate watertight subdivision bulkheads, where deterioration of such systems in the event of fire would impair the watertight integrity of the bulkheads.

3.1 No doors, manholes, or access openings are permitted:

1 in the collision bulkhead below the margin line;

2 in watertight transverse bulkheads dividing a cargo space from an adjoining cargo space or from a permanent or reserve bunker, except as provided in paragraph 10.1 and in Reg. 16 (605).

3.2 Except as provided in paragraph 3.3, the collision bulkhead may be pierced below the margin line by not more than one pipe for dealing with fluid in the forepeak tank, provided that the pipe is fitted with a screwdown valve capable of being operated from above the bulkhead deck, the valve chest being secured inside the forepeak to the collision bulkhead. The Administration may, however, authorize the fitting of this valve on the after side of the collision bulkhead provided that the valve is readily accessible under all service conditions and the space in which it is located is not a cargo space.

3.3 If the forepeak is divided to hold two different kinds of liquids the Administration may allow the collision bulkhead to be pierced below the margin line by two pipes, each of which is fitted as required by paragraph 3.2, provided the Administration is satisfied that there is no practical alternative to the fitting of such a second pipe and that, having regard to the additional subdivision provided in the forepeak, the safety of the ship is maintained.

4.1 Watertight doors fitted in bulkheads between permanent and reserve bunkers shall always be accessible, except as provided in paragraph 9.4 for between-deck bunker doors.

4.2 Satisfactory arrangements shall be made by means of screens or otherwise to prevent the coal from interfering with the closing of watertight bunker doors.

5 Subject to paragraph 11, not more than one door, apart from the doors to bunkers and shaft tunnels, may be fitted in each main transverse bulkhead within spaces containing the main and auxiliary propulsion machinery including boilers serving the needs of propulsion and all permanent bunkers. Where two or more shafts are fitted, the tunnels shall be connected by an intercommunicating passage. There shall be only one door between the machinery space and the tunnel spaces where two shafts are fitted and only two doors where there are more than two shafts. All these doors shall be of the sliding type and shall be so located as to have their sills as high as practicable. The hand gear for operating these doors from above the bulkhead deck shall be situated outside the spaces containing the machinery.

6.1 Watertight doors, except as provided in paragraph 10.1 or Reg. 16 (605), shall be power-operated sliding doors complying with the requirements of paragraph 7 capable of being closed simultaneously from the central operating console at the navigating bridge in not more than 60 seconds with the ship in the upright position.

6.2 The means of operation whether by power or by hand of any power-operated sliding watertight door shall be capable of closing the door with the time limit to 15° either way. Consideration shall also be given to the forces which may act on either side of the door as may be experienced when water is flowing through the opening applying a static head equivalent to a water height of at least 1 m above the sill on the centreline of the door.

6.3 Watertight door controls, including hydraulic piping and electric cables, shall be kept as close as practicable to the bulkhead in which the doors are fitted, in order to minimize the likelihood of them being involved in any damage which the ship may sustain. The positioning of watertight doors and their controls shall be such that if the ship sustains damage within one fifth of the breadth of the ship, as defined in Reg. 2 (201), such distance being measured at right angles to the centreline at the level of the deepest subdivision load line, the operation of the watertight doors clear of the damaged portion of the ship is not impaired.

6.4 All power-operated sliding watertight doors shall be provided with means of indication which will show at all remote operating positions whether the doors are open or closed. Remote operating positions shall only be at the navigating bridge as required by paragraph 7.1.5 and, at the location where hand operation above the bulkhead deck is required by paragraph 7.1.4.

6.5 In ships constructed before 1 January 1992, doors which do not comply with paragraphs 6.1 to 6.4 shall be closed before the voyage commences, and may be kept closed during navigation; the time of opening such doors in port and of closing them before the ship leaves port shall be entered into the log-book.

7.1 Each power-operated sliding watertight door:

1 shall have a vertical or horizontal motion;

2 shall, subject to paragraph 11, be normally limited to a maximum clear opening width of 1.2 m. The Administration may permit larger doors only to the extent considered necessary for the effective operation of the ship provided that other safety measures, including the following, are taken into consideration:

2.1 special consideration shall be given to the strength of the door and its closing appliances in order to prevent leakage;

2.2 the door shall be located outside the damage zone B/5;

2.3 the door shall be kept closed when the ship is at sea, except for limited periods when absolutely necessary as determined by the Administration;
.3 shall be fitted with the necessary equipment to open and close the door using electric power, hydraulic power, or any other form of power that is acceptable to the Administration;

.4 shall be provided with an individual hand-operated mechanism. It shall be possible to open and close the door by hand at the door itself from either side, and in addition, can be operated from an accessible position above the bulkhead deck with an all round crank motion or some other movement providing the same degree of safety acceptable to the Administration. Direction of rotation or other movement is to be clearly indicated at all operating positions. The time necessary for the complete closure of the door, when operating by hand gear, shall not exceed 90 seconds with the ship in the upright position;

.5 shall be provided with controls for opening and closing the door by power from both sides of the door and also for closing the door by power from the central operating console at the navigating bridge;

.6 shall be provided with an audible alarm, distinct from any other alarm in the area, which will sound whenever the door is closed remotely by power and which shall sound for at least 5 seconds but no more than 10 seconds before the door begins to move and shall continue sounding until the door is completely closed. In the case of remote hand operation, a sufficient alarm to sound when the door is moving. Additionally, in passenger areas and areas of high ambient noise the Administration may require the audible alarm to be supplemented by an intermittent visual signal at the door; and

.7 shall have an approximately uniform rate of closure under power. The closure time, from the time the door begins to move to the time it reaches the completely closed position, shall in no case be less than 20 seconds or more than 40 seconds with the ship in the upright position.

7.2 The electrical power required for power-operated sliding watertight doors shall be supplied from the emergency switchboard either directly or by a dedicated distribution board situated above the bulkhead deck. The associated control, indication and alarm circuits shall be supplied from the emergency switchboard either directly or by a dedicated distribution board situated above the bulkhead deck and be capable of being automatically supplied by the transitional source of emergency electrical power required by regulation 42.4.2 (D403) - in the event of failure of either the main or emergency source of electrical power and with sufficient capacity to operate the door at least three times, i.e. closed-open-closed against an adverse list of 15°.

For the systems specified in 7.3.1, 7.3.2 and 7.3.3, provision should be made as follows:

Power systems for power-operated watertight sliding doors shall be separate from any other power system. A single failure in the electric or hydraulic power-operated systems excluding the hydraulic actuator shall not prevent the hand operation of any door.

7.4 Control handles shall be provided at each side of the bulkhead at a minimum height of 1.6 m above the floor and shall be so arranged as to enable persons passing through the doorway to hold both handles in the open position without being able to set the power closing mechanism in operation accidentally. The direction of movement of the handles in opening and closing the door shall be in the direction of door movement and shall be clearly indicated.

7.5 As far as practicable, electrical equipment and components for watertight doors shall be situated above the bulkhead deck and outside hazardous areas and spaces.

7.6 The enclosures of electrical components necessarily situated below the bulkhead deck shall provide suitable protection against the ingress of water.

Refer to the following IEC publication 592, 1976:

.1 electrical motors, associated circuits and control components; protected to IPX7 standard;

.2 door position indicators and associated circuit components; protected to IPX8 standard; and

.3 door movement warning signals; protected to IPX6 standard.

Other arrangements for the enclosures of electrical components may be fitted provided the Administration is satisfied that an equivalent protection is achieved. The water pressure testing of the enclosures protected to IPX8 shall be based on the pressure that may occur at the location of the component during flooding for a period of 36 h.

See also Pt.4 Ch.4 Sec.13 A900.

7.7 Electric power, control, indication and alarm circuits shall be protected against fault in such a way that a failure in one door circuit will not cause a failure in any other door circuit. Short circuits or other faults in the alarm or indicator circuits of a door shall not result in a loss of power operation of that door. Arrangements shall be such that leakage of water into the electrical equipment located below the bulkhead deck will not cause the door to open.

7.8 A single electrical failure in the power operating or control system of a power-operated sliding watertight door shall not result in a closed door opening. Availability of the power supply should be continuously monitored at a point in the electrical circuit as near as practicable to each of the motors required by paragraph 7.3. Loss of any such power supply should activate an audible and visual alarm at the central operating console at the navigating bridge.

8.1 The central operating console at the navigating bridge shall have a «master mode» switch with two modes of control: a «local control» mode which shall allow any door to be locally opened and locally closed after use without automatic closure, and a «doors closed» mode which shall automatically close any door that is opened. The «doors closed» mode shall permit doors to be opened locally and shall automatically reclose the doors upon release of the local control mechanism. The «master mode» switch shall normally be in the «local control» mode.
The «doors closed» mode shall only be used in an emergency or for testing purposes. Special consideration shall be given to the reliability of the «master mode» switch.

8.2 The central operating console at the navigating bridge shall be provided with a diagram showing the location of each door, with visual indicators to show whether each door is open or closed. A red light shall indicate a door is fully open and a green light shall indicate a door is fully closed. When the doors are closed remotely, a red light shall indicate the intermediate position by flashing. The indicating circuit shall be independent of the control circuit for each door.

8.3 It shall not be possible to remotely open any door from the central operating console.

9.1 All watertight doors shall be kept closed during navigation except that they may be opened during navigation as specified in paragraphs 9.2, 9.3 and 9.4. Watertight doors of width of more than 1.2 m permitted by paragraph 11 may only be opened in the circumstances detailed in that paragraph. Any door which is opened in accordance with this paragraph shall be ready to be immediately closed.

9.2 A watertight door may be opened during navigation to permit the passage of passengers or crew, or when work in the immediate vicinity of the door necessitates it being opened. The door shall be immediately closed when transit through the door is complete or when the task which necessitated it being open is finished.

9.3 Certain watertight doors may be permitted to remain open during navigation only if considered absolutely necessary; that is, being open is determined essential to the safe and effective operation of the ship's machinery or to permit passengers normal unrestricted access throughout the passenger area. Such determination shall be made by the Administration only after careful consideration of the impact on ship operations and survivability. A watertight door permitted to remain open shall be clearly indicated in the ship's stability information and shall always be ready to be immediately closed.

9.4 Sliding watertight doors fitted between bunkers in the between-decks below the bulkhead deck may sometimes be open at sea for the purpose of trimming coal. The opening and closing of these doors shall be recorded in such log book as may be prescribed by the Administration.

10.1 If the Administration is satisfied that such doors are essential, watertight doors of satisfactory construction may be fitted in watertight bulkheads dividing cargo between deck spaces. Such doors may be hinged, rolling or sliding doors but shall not be remotely controlled. They shall be fitted at the highest level and as far from the shell plating as practicable, but in no case shall the outward vertical edges be situated at a distance of more than 1 m from the shell plating, the permissible opening defined in Regulation 3.18, being measured at right angles to the centreline of the ship from a point 2.5 m below the shell plating.

10.2 Such doors shall be closed before the voyage commences and shall be kept closed during navigation; the time of opening such doors in port and of closing them before the ship leaves port shall be entered in the log book. Should any of the doors be accessible during the voyage, they shall be fitted with a device which prevents unauthorized opening. When it is proposed to fit such doors, the number and arrangements shall receive the special consideration of the Administration.

11 Portable plates on bulkheads shall not be permitted except in machinery spaces. Such plates shall always be in place before the ship leaves port, and shall not be removed during navigation except in case of urgent necessity at the discretion of the master. The times of removal and replacement of any such portable plates shall be recorded in the log book, and the necessary precautions shall be taken in replacing them to ensure that they are watertight. The Administration may require that no more than one power-operated sliding watertight door in each main transverse bulkhead larger than those specified in paragraph 7.1.2 to be substituted for these portable plates, provided these doors are closed before the ship leaves port and remain closed during navigation except in case of urgent necessity at the discretion of the master. These doors need not meet the requirements of paragraph 7.1.4 regarding complete closure by hand-operated gear in 90 seconds. The time of opening and closing these doors, whether the ship is at sea or in port, shall be recorded in the log book.

12.1 Where trunkways or tunnels for access from crew accommodation to the stokehold, for piping, or for any other purpose are carried through main transverse watertight bulkheads, they shall be watertight and in accordance with the requirements of Regulation 19. The access to at least one end of each such tunnel or trunkway, if used as a passage at sea, shall be through a trunk extending watertight to a height sufficient to permit access above the margin line. The access to the other end of the trunkway or tunnel may be through a watertight door of the type required by its location in the ship. Such trunkways or tunnels shall extend through the first subdivision bulkhead abaft the collision bulkhead.

12.2 Where it is proposed to fit tunnels piercing main transverse watertight bulkheads, these shall receive the special consideration of the Administration.

12.3 Where trunkways in connection with refrigerated cargo and ventilation or forced draught trunks are carried through more than one watertight bulkhead, the means of closure at such openings shall be operated by power and be capable of being closed from a central position situated above the bulkhead deck.

605 Passenger ships carrying goods vehicles and accompanying personnel (Regulation 16)

1 This Reg. applies to passenger ships designed or adapted for the carriage of goods vehicles and accompanying personnel where the total number of passengers on board exceeds 12.

2 If in such a ship the total number of passengers which include personnel accompanying vehicles does not exceed N = 12 + A/25, where A = total deck area (square metres) of spaces available for the stowage of goods vehicles and where the clear height above the stowage position and at the entrance to such spaces is not less than 4 m, the provisions of Reg. 15.10 (604) in respect of watertight doors apply except that the doors may be fitted at any level in watertight bulkheads dividing cargo spaces. Additionally, indicators are required on the navigating bridge to show automatically when each door is closed and all door fastenings are secured.

3 When applying the provisions of this Chapter to such a ship, N shall be taken as the maximum number of passengers for which the ship may be certified in accordance with this Regulation.

4 In applying Reg. 8 (506) for the worst operating conditions, the permeability for cargo spaces intended for the stowage of goods vehicles and containers shall be derived by calculation in which the goods vehicles and containers shall be assumed to be non-watertight and their permeability taken as 65. For ships engaged in dedicated services the actual value of permeability for goods vehicles or containers may be applied. In no case shall the permeability of the cargo spaces in which the goods vehicles and containers are carried be taken as less than 60.

606 Openings in the shell plating of passenger ships below the margin line (Regulation 17).

1 The number of openings in the shell plating shall be reduced to the minimum compatible with the design and proper working of the ship.

2 The arrangement and efficiency of the means for closing any opening in the shell plating shall be consistent with its intended purpose and the position in which it is fitted and generally to the satisfaction of the Administration.

3.1 Subject to the requirements of the International Convention on Load Lines in force (Pt.3 Ch.5), no sidescuttle shall be fitted in such a position that its sill is below a line drawn parallel to the bulkhead deck at side and having its lowest point 2.5 m per cent of the breadth of the ship above the deepest subdivision load line, or 500 mm, whichever is the greater.

3.2 All sidescuttles the sills of which are below the margin line, as permitted by paragraph 3.1 shall be of such construction as will effectively prevent any person opening them without the consent of the master of the ship.
3.3.1 Where in a between decks, the sills of any of the side-scuttles referred to in paragraph 3.2 are below a line drawn parallel to the bulkhead deck at side and having its lowest point 1.4 m plus 2.5 per cent of the breadth of the ship above the water when the ship departs from any port, all the side-scuttles in that between decks shall be closed watertight and locked before the ship leaves port, and they shall not be opened before the ship arrives at the next port. In the application of this paragraph the appropriate allowance for fresh water may be made when applicable.

3.3.2 The time of opening such side-scuttles in port and of closing and locking them before the ship leaves port shall be entered in such log book as may be prescribed by the Administration.

3.3.3 For any ship that has one or more side-scuttles so placed that the requirements of paragraph 3.3.1 would apply when it was floating at its deepest subdivision load line, the Administration may indicate the limiting mean draught at which these side-scuttles will have their sills above the line drawn parallel to the bulkhead deck at side, and having its lowest point 1.4 m plus 2.5 per cent of the breadth of the ship above the water-line corresponding to the limiting mean draught, and at which it will therefore be permissible to depart from port without previously closing and locking them and to open them at sea on the responsibility of the master during the voyage to the next port. In tropical zones as defined in the International Convention on Load Lines in force, this limiting draught may be increased by 0.3 m.

4. Efficient hinged inside deadlights so arranged that they can be easily and effectively closed and secured watertight, shall be fitted to all side-scuttles except that abaat one-eighth of the ship’s length from the forward perpendicular and above a line drawn parallel to the bulkhead deck at side and having its lowest point 3,7 m plus 2,5 per cent of the breadth of the ship above the deepest subdivision load line, the deadlights may be portable in passenger accommodation other than that for steerage passengers, unless the deadlights are required by the International Convention on Load Lines in force to be permanently attached in their proper positions. Such portable deadlights shall be stowed adjacent to the side-scuttles they serve.

5. Side-scuttles and their deadlights which will not be accessible during navigation shall be closed and secured before the ship leaves port.

6. No side-scuttles shall be fitted in any spaces which are appropriated exclusively to the carriage of cargo or coal.

6.2 Side-scuttles may, however, be fitted in spaces appropriated alternatively to the carriage of cargo or passengers, but they shall be of such construction as will effectively prevent any person opening them or their deadlights without the consent of the master.

6.3 If cargo is carried in such spaces, the side-scuttles and their deadlights shall be closed watertight and locked before the cargo is shipped and such closing and locking shall be recorded in such log book as may be prescribed by the Administration.

7. Automatic ventilating side-scuttles shall not be fitted in the shell plating below the margin line without the special sanction of the Administration.

8. The number of scuppers, sanitary discharges and other similar openings in the shell plating shall be reduced to the minimum either by making each discharge serve for as many as possible of the sanitary and other pipes, or in any other satisfactory manner.

9.1 All inlets and discharges in the shell plating shall be fitted with efficient and accessible arrangements for preventing the accidental admission of water into the ship.

9.2.1 Subject to the requirements of the International Convention on Load Lines in force (Pt.3 Ch.5), and except as provided in paragraph 9.3, each separate discharge led through the shell plating from spaces below the margin line shall be provided with either one automatic non-return valve fitted with a positive means of closing it from above the bulkhead deck or with two automatic non-return valves without positive means of closing, provided that the inboard valve is situated above the deepest subdivision load line and is always accessible for examination under service conditions. Where a valve with positive means of closing is fitted, the operating position above the bulkhead deck shall always be readily accessible and means shall be provided for indicating whether the valve is open or closed.

9.2.2 The requirements of the International Convention on Load Lines in force (Pt.3 Ch.5) shall apply to discharges led through the shell plating from spaces above the margin line.

9.3 Machinery space main and auxiliary sea inlets and discharges in connexion with the operation of machinery shall be fitted with readily accessible valves between the pipes and the shell plating or between the pipes and fabricated boxes attaching the shell plating. The valves may be controlled locally and shall be provided with indicators showing whether they are open or closed.

9.4 All shell fittings and valves required by this Reg. shall be of steel, bronze or other approved ductile material. Valves of ordinary cast iron or similar material are not acceptable. All pipes to which this Reg. refers shall be of steel or other equivalent material to the satisfaction of the Administration.

10.1 Gangway, cargo and coaling ports fitted below the margin line shall be of sufficient strength. They shall be effectively closed and secured watertight before the ship leaves port, and shall be kept closed during navigation.

10.2 Such ports shall in no case be so fitted as to have their lowest point below the deepest subdivision load line.

11.1 The inboard opening of each ash-shoot, rubbish-shoot, etc. shall be fitted with an efficient cover.

11.2 If the inboard opening is situated below the margin line, the cover shall be watertight, and in addition an automatic non-return valve shall be fitted in the shoot in an easily accessible position above the deepest subdivision load line. When the shoot is not in use both the cover and the valve shall be kept closed and secured.

607. Watertight integrity of passenger ships above the margin line (Regulation 20).

1. The Administration may require that all reasonable and practicable measures shall be taken to limit the entry and spread of water above the bulkhead deck. Such measures may include partial bulkheads or webs. When partial watertight bulkheads and webs are fitted on the bulkhead deck, above or in the immediate vicinity of main subdivision bulkheads, they shall have watertight shell and bulkhead deck connections so as to restrict the flow of water along the deck when the ship is in a heeled damaged condition. Where the partial watertight bulkhead does not line up with the bulkhead below, the bulkhead deck between shall be made effectively watertight *. 

* Refer to MSC/Circ.541 (as may be amended): Guidance notes on the integrity of flooding boundaries above the bulkhead deck of passenger ships for proper application of regulations 8-1/8 (SOLAS 1960) and 20, paragraph 1, of SOLAS 1974, as amended.

2. The bulkhead deck or a deck above it shall be weathertight. All openings in the exposed weather deck shall have coamings of ample height and strength and shall be provided with efficient means for expeditiously closing them weather tight. Freeing ports, open rails and scuppers shall be fitted as necessary for rapidly clearing the weather deck of water under all weather conditions.

3. In passenger ships constructed on or after 1 July 1997, the open end of air pipes terminating within a superstructure shall be at least 1 m above the waterline when the ship heels to an angle of 15 degrees, or the maximum angle of heel during intermediate stages of flooding, as determined by direct calculation, whichever is the greater. Alternatively, air pipes to tanks other than oil tanks may discharge through the side of the superstructure. The provisions of this paragraph are without prejudice to the provisions of the International Convention on Load Lines in force.

4. Side-scuttles, gangway, cargo and coaling ports and other means for closing openings in the shell plating above the margin line shall be of efficient design and construction and of sufficient strength having regard to the spaces in which they are fitted and their positions relative to the deepest subdivision load line.
5 Efficient inside deadlights, so arranged that they can be easily and effectively closed and secured watertight, shall be provided for all side-scuttles to spaces below the first deck above the bulkhead deck.

608 The watertight doors and all mechanisms and indicators connected therewith, all valves, the closing of which is necessary to make a compartment watertight, and all valves, the operation of which is necessary for damage control cross connections, are to be suitably marked to ensure that they may be properly used to provide maximum safety.

(SOLAS Ch.II-1 Reg. 24-3.2).

609 Damage control plans (Regulation 23)

There shall be permanently exhibited for the guidance of the officer in charge of the ship, plans showing clearly for each deck and hold the boundaries of the watertight compartments, the openings therein with the means of closure and position of any controls thereof, and the arrangements for the correction of any list due to flooding. In addition, booklets containing the aforementioned information shall be made available to the officers of the ship.

K 700 Internal watertight integrity survey

701 An internal watertight integrity survey is to be carried out.

The scope of the survey:
Verification of the internal watertight integrity plan with respect to internal watertight subdivision, position and type of internal closing appliances together with alarms, indicators, remote controls and signboards.
Pipes, ducts and tunnels in the damage penetration zone, if any, are to be verified to be in accordance with the plan.

L. Life Saving Appliances and Arrangements

L 100 General

101 For applications for all ships see Pt.3 Ch.6 Sec.1 A100. Requirements given in this subsection are additional to the general requirements given in Pt.3.

L 200 Exemption (Regulation III/2)

1 The Administration may, if it considers that the sheltered nature and conditions of the voyage are such as to render the application of any specific requirements of this chapter unreasonable or unnecessary, exempt from those requirements individual ships or classes of ships which, in the course of their voyage, do not proceed more than 20 miles from the nearest land.

2 In the case of passenger ships which are employed in special trades for the carriage of large numbers of special trade passengers, such as the pilgrim trade, the Administration, if satisfied that it is impracticable to enforce compliance with the requirements of this chapter, may exempt such ships from those requirements, provided that such ships comply fully with the provisions of:

2.1 the rules annexed to the Special Trade Passenger Ships Agreement, 1971; and

2.2 the rules annexed to the Protocol on Space Requirements for Special Trade Passenger Ships, 1973.

201 Exemption certificate should be issued. (SLS.14/Circ.54, 14 December 1984) (IMO interpretation). The Society will consider the actual conditions in each case.

L 300 Survival craft and rescue boats (Regulation III/21)

1 Survival craft

1.1 Passenger ships engaged on international voyages which are not short international voyages shall carry:

1.1.1 partially or totally enclosed lifeboats complying with the requirements of section 4.5 or 4.6 of the Code on each side of such aggregate capacity as will accommodate not less than 50% of the total number of persons on board. The Administration may permit the substitution of lifeboats by liferafts of equivalent total capacity provided that they shall be of sufficient capacity to accommodate 37.5% of the total number of persons on board. The inflatable or rigid liferafts shall comply with the requirements of section 4.2 or 4.3 of the Code and shall be served by launching appliances equally distributed on each side of the ship;

1.1.2 in addition, inflatable or rigid liferafts complying with the requirements of section 4.2 or 4.3 of the Code and such aggregate capacity as will accommodate at least 25% of the total number of persons on board. These liferafts shall be served by at least one launching appliance on each side which may be those provided in compliance with the requirements of paragraph 1.1.1 or equivalent approved appliances capable of being used on both sides. However, stowage of these liferafts need not comply with the requirements of regulation 13.5 (Pt.3 Ch.6 Sec.2 G100).

1.2 Passenger ships engaged on short international voyages and complying with the special standards of subdivision prescribed by regulation II-16.5 (K304.5) shall carry:

1.2.1 partially or totally enclosed lifeboats complying with the requirements of section 4.5 or 4.6 of the Code of such aggregate capacity as will accommodate at least 30% of the total number of persons on board. The lifeboats shall, as far as practicable, be equally distributed on each side of the ship. In addition inflatable or rigid liferafts complying with the requirements of section 4.2 or 4.3 of the Code shall be carried of such aggregate capacity that, together with the lifeboat capacity, the survival craft will accommodate the total number of persons on board. The liferafts shall be served by launching appliances equally distributed on each side of the ship; and

1.2.2 in addition, inflatable or rigid liferafts complying with the requirements of section 4.2 or 4.3 of the Code of such aggregate capacity as will accommodate at least 25% of the total number of persons on board. These liferafts shall be served by at least one launching appliance on each side which may be those provided in compliance with the requirements of paragraph 1.2.1 or equivalent approved appliances capable of being used on both sides. However, stowage of these liferafts need not comply with the requirements of regulation 13.5 (Pt.3 Ch.6 Sec.2 G100).

1.3 Passenger ships engaged on short international voyages and not complying with the special standards of subdivision prescribed by regulation II-16.5 (K304.5), shall carry survival craft complying with the requirements of paragraph 1.1.1.

1.4 All survival craft required to provide for abandonment by the total number of persons on board shall be capable of being launched with their full complement of persons and equipment within a period of 30 min from the time the abandon ship signal is given.

1.5 In lieu of meeting the requirements of paragraph 1.1, 1.2 or 1.3, passenger ships of less than 500 gross tonnage where the total number of persons on board is less than 200, may comply with the following:

1.5.1 they shall carry on each side of the ship, inflatable or rigid liferafts complying with the requirements of section 4.2 or 4.3 of the Code and of such aggregate capacity as will accommodate the total number of persons on board;

1.5.2 unless the liferafts required by paragraph 1.5.1 are stowed in a position providing for easy side-to-side transfer at a single open deck level, additional liferafts shall be provided so that the total capacity available on each side will accommodate 150% of the total number of persons on board;

1.5.3 if the rescue boat required by paragraph 2.2 is also a partially or totally enclosed lifeboat complying with the requirements of section 4.5 or 4.6 of the Code, it may be included in the aggregate capacity required by paragraph 1.5.1, provided that the total capacity available on either side of the ship is at least 150% of the total number of persons on board; and

1.5.4 in the event of any one survival craft being lost or rendered unserviceable, there shall be sufficient survival craft available for use on each side, including those which are
stowed in a position providing for easy side-to-side transfer at a single open deck level, to accommodate the total number of persons on board.

1.6 A marine evacuation system or systems complying with section 6.2 of the Code may be substituted for the equivalent capacity of liferafts and launching appliances required by paragraph 1.1.1 or 1.2.1.

2 Rescue boats

2.1 Passenger ships of 500 gross tonnage and over shall carry at least one rescue boat complying with the requirements of section 5.1 of the Code on each side of the ship.

2.2 Passenger ships of less than 500 gross tonnage shall carry at least one rescue boat complying with the requirements of section 5.1 of the Code.

2.3 A lifeboat may be accepted as a rescue boat provided it also complies with the requirements for a rescue boat.

3 Marshalling of liferafts

3.1 The number of lifeboats and rescue boats that are carried on passenger ships shall be sufficient to ensure that in providing for abandonment by the total number of persons on board not more than six liferafts need be marshalled by each lifeboat or rescue boat.

The number of lifeboats and rescue boats that are carried on passenger ships with short international voyages and complying with the special standards of subdivision prescribed by regulation II-2/28(E/900), the escape provisions of regulation II-2/28(E/900), the size of the ship, and the weather conditions likely to be encountered in its intended area of operation. For a davit-launched survival craft, the height of the davit head with the survival craft in embarkation position, shall, as far as practicable, not exceed 15 m to the waterline when the ship is in its lightest seagoing condition.

(SOLAS Reg. III/22)

L 500 Survival Craft and Rescue Boat Embarkation Arrangements (Regulation III/23)

1 On passenger ships, survival craft embarkation arrangements shall be designed for:

1.1 all lifeboats to be boarded and launched either directly from the stowed position or from an embarkation deck but not both; and

1.2 davit-launched liferafts to be boarded and launched from a position immediately adjacent to the stowed position or from a position to which, in compliance with the requirements of regulation 13.5 (Pt.3 Ch.6 Sec.2 G100), the liferaft is transferred prior to launching.

2 Rescue boat arrangements shall be such that the rescue boat can be boarded and launched directly from the stowed position with the number of persons assigned to crew the rescue boat on board. Notwithstanding the requirements of paragraph 1.1, if the rescue boat is also a lifeboat and the other lifeboats are boarded and launched from an embarkation deck, the arrangements shall be such that the rescue boat can also be boarded and launched from the embarkation deck.

(SOLAS Reg. III/23)

L 600 Stowage of Survival Craft (Regulation III/24)

The stowage height of a survival craft on a passenger ship shall take into account the requirements of regulation 13.1.2 (Pt.3 Ch.6 Sec.2 G100), the escape provisions of regulation II-2/28(E/900), the size of the ship, and the weather conditions likely to be encountered in its intended area of operation. For a davit-launched survival craft, the height of the davit head with the survival craft in embarkation position, shall, as far as practicable, not exceed 15 m to the waterline when the ship is in its lightest seagoing condition.

(SOLAS Reg. III/24)

L 700 Muster Stations (Regulation III/25)

1 Every passenger ship, shall, in addition to complying with the requirements of regulation 11 (Pt.3 Ch.6 Sec.2 E), have passenger muster stations which shall:

1.1 be in the vicinity of, and permit ready access for the passengers to, the embarkation stations unless in the same location; and

1.2 have ample room for marshalling and instruction of the passengers, but at least 0.35 m² per passenger.

(SOLAS Reg. III/25)
M. Chapter IV, Radiocommunications Part C, Ship Requirements

M 100 Additional requirements applicable to passenger ships

101 Regulation 6, Radio installations

4 In passenger ships, a distress panel shall be installed at the conning position. This panel shall contain either one single button which, when pressed, initiates a distress alert using all radiocommunication installations required on board for that purpose or one button for each individual installation. The panel shall clearly and visually indicate whenever any button or buttons have been pressed. Means shall be provided to prevent inadvertent activation of the button or buttons. If the satellite EPIRB is used as the secondary means of distress alerting and is not remotely activated, it shall be acceptable to have an additional EPIRB installed in the wheelhouse near the conning position.

5 In passenger ships, information on the ship’s position shall be continuously and automatically provided to all relevant radiocommunication equipment to be included in the initial distress alert when the button or buttons on the distress panel is pressed.

6 In passenger ships, a distress alarm panel shall be installed at the conning position. The distress alarm panel shall provide visual and aural indication of any distress alert or alerts received on board and shall also indicate through which radiocommunication service the distress alerts have been received.

(SOLAS reg. IV/6.4 to 6.6)

102 Regulation 7.5 Radio equipment - General

5 Every passenger ship shall be provided with means for two-way on-scene radiocommunications for search and rescue purposes using the aeronautical frequencies 121.5 MHz and 123.1 MHz from the position from which the ship is normally navigated.

(SOLAS reg. IV/7.5)

Guidance note:
These requirements are repeated in Pt.4 Ch.12.

---end-of-Guidance-note---
SECTION 3
FERRIES

A. General

A 100 Classification

101 The requirements in this section apply to ships intended for regular transport of passengers and vehicles. The requirements for passenger ships given in Sec.2 are also to be complied with.

102 Ships arranged for carriage of vehicles on enclosed decks and built in compliance with relevant requirements specified in the following will be given one of the class notations Car Ferry A, Train Ferry A or Car and Train Ferry A whichever is applicable.

103 Ships arranged for carriage of vehicles on weather deck only and built in compliance with relevant requirements specified in the following will be given one of the class notations Car Ferry B, Train Ferry B or Car and Train Ferry B whichever is applicable.

A 200 Assumptions

201 The requirements for the class notation B are based on the assumption that service restriction notation R2 or stricter are included in the main class.

A 300 Documentation

301 The following plans and particulars are normally to be submitted for approval:

a) Stern, side shell and bow doors (outer and inner) including force carrying structures of door cleat and support devices and their supporting structure of the hull.

b) Closing arrangement for doors including system for operation.

c) Operating and maintenance manual for bow, side shell and stern doors.

The operating and maintenance manual shall contain necessary information on:

— copies of plans and particulars referred to in 301 and 302

— conditions that were established or presumed at the time of design regarding e.g. service area restrictions, maximum acceptable clearances in supports etc.

Guidance note:
Reference is made to the safety management system described in the ISM Code.

302 The following plans and particulars are normally to be submitted for information:

a) An arrangement plan showing the position of watertight doors in the stern, sides, bow and collision bulkhead in relation to the watertight subdivision of the hull.

b) Arrangement of doors including hydraulic and mechanical supporting, clearing and locking arrangements as relevant. For doors with clear opening >12 m², the design support forces considered/determined for each support is to be stated on the arrangement drawing and submitted together with design calculations carried out. For bow doors the longitudinal, transverse and vertical projections are to be shown.

c) Arrangement of air intakes, ventilators etc.

d) Arrangement of doors from vehicle deck.

e) Drainage openings/freeing ports for vehicle deck and space between outer and inner bow door.

f) Arrangement of wheels and axles or bogies for heavy vehicles, stating maximum axle/bogie load.

g) Fastening and securing appliances of vehicles to the hull structure.

303 For general requirements related to documentation of instrumentation and automation, including computer based control and monitoring, see Pt.4 Ch.9 Sec.1.

304 For the instrumentation systems listed below, documentation is to be submitted according to Table A1. The upper row of Table A1 refers to the documentation types defined in Pt.4 Ch.9 Sec.1 C200.

<table>
<thead>
<tr>
<th>Table A1 Requirements for documentation of instrumentation systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>For class notations Car Ferry A (or B) and Train Ferry A (or B):</td>
</tr>
<tr>
<td>BDO</td>
</tr>
<tr>
<td>FDO</td>
</tr>
<tr>
<td>GAL</td>
</tr>
</tbody>
</table>

Instrumentation systems Documentation types

<table>
<thead>
<tr>
<th>Instrumentation systems</th>
<th>Documentation types</th>
</tr>
</thead>
<tbody>
<tr>
<td>BDO Bow doors monitoring system</td>
<td>020 Functional description</td>
</tr>
<tr>
<td>FDO Fire doors control and monitoring</td>
<td>030 System block diagrams (T)</td>
</tr>
<tr>
<td>GAL General alarm/public address system</td>
<td>040 System diagrams (P&amp;IDS, D&amp;IDS, etc.) (T)</td>
</tr>
<tr>
<td></td>
<td>050 Power supply arrangement (T)</td>
</tr>
<tr>
<td></td>
<td>060 Arrangement and layout (T)</td>
</tr>
<tr>
<td></td>
<td>070 Cable routing layout drawing (T)</td>
</tr>
<tr>
<td></td>
<td>100 Instrument and equipment list (T)</td>
</tr>
<tr>
<td></td>
<td>110 Data sheets with environmental specifications</td>
</tr>
</tbody>
</table>

T Required also for type approved systems

A 400 Definitions

401 Symbols

= rule thickness in mm of plating
Z = rule section modulus in cm³ of stiffeners and simple girders
s = stiffener spacing in m, measured along the platings
l = stiffener span in m, measured along the topflange of the member. For definition of span point, see Pt.3 Ch.1 Sec.3 C100. For curved stiffeners l may be taken as the chord length
S = girder span in m. For definition of span point, see Pt.3 Ch.1 Sec.3 C100
b = loading breadth for girders in m
f₁ = material factor
  = 1.0 for NV-NS steel *)
  = 1.08 for NV-27 steel *)
  = 1.28 for NV-32 steel *)
  = 1.39 for NV-36 steel *)
  = 1.43 for NV-40 steel *)

*) For details see Pt.3 Ch.1 Sec.2 B to C

402 The load point where the design pressure is to be calculated is defined for various strength members as follows:

a) For plates
   Midpoint of horizontally stiffened plate field.
   Half of the stiffener spacing above the lower support of vertically stiffened plate field, or at lower edge of plate when the thickness is changed within the plate field.

b) For stiffeners
   Midpoint of span.
   When the pressure is not varied linearly over the span, the design pressure is to be taken as the greater of:
   \[ p_m \text{ and } \frac{p_a + p_b}{2} \]
   \( p_m \), \( p_a \) and \( p_b \) are calculated pressures at the midpoint and at each end respectively.

c) For girders
   Midpoint of load area.

B. Hull Arrangement and Strength

B 100 Doors

101 Arrangements and scantlings of doors in ship’s side and ends are in general to satisfy the requirements given for the main class, with relevant additions as given below.

102 Arrangement, scantlings and securing of bow doors are given in C.

103 Arrangement, scantlings and securing of side and stern doors are given in Pt.3 Ch.1 Sec.11 C.

104 For ferries with the class notation B, openings in sides and ends leading to the vehicle deck need not have closing appliances.

105 Doors also used as driving ramps for vehicles are to satisfy relevant requirements given in Sec.4 B and Sec.4 C.

B 200 Access openings

201 Doors and sill heights are in general to satisfy the requirements given for the main class.

202 Doors leading from vehicle deck to engine room are to have sill heights not less than 380 mm. Other doors leading from vehicle deck within a closed superstructure to spaces below freeboard deck, are in no case to have sill heights less than 230 mm.

B 300 Vehicle decks, ramps and lifts

301 Plating with supporting stiffeners and girders for direct wheel loads are to satisfy the requirements for the class notation PWDK given in Sec.4 C. Decks where the free height exceeds 2.5 m, are to be designed for an axle load not less than 10 t.

302 Movable car decks, if fitted, are to satisfy relevant requirements given in Sec.7.

303 External ramps, internal ramps and lift platforms are also to satisfy the requirements given in Sec.4 B.

304 Scantlings of decks, ramps, lifts etc. for railway carriages will be considered in each case.

B 400 Securing of vehicles

401 Appliances are to be provided for securing of road vehicles and railway carriages. Strength and fastening of the securing points are to satisfy the requirements given in Sec.4 B 800.

402 For ships with restricted service notation R3, R4 or RE, the requirements with respect to securing appliances may be reduced or discarded based upon special consideration of the intended service area.

B 500 Transverse strength

501 A sufficient number of vertical side girders and/or transverse bulkheads in casing(s) are to be fitted between the vehicle deck(s) and the superstructure above. Transverse and longitudinal bulkheads are to be effectively supported below the vehicle deck(s). Calculations necessary to demonstrate that the stresses are acceptable, are to be carried out for the ship also in heeled conditions. Design loads, calculation methods and allowable stresses are to be given for complex girder systems in Pt.3 Ch.1 Sec.13.

C. Bow Doors

C 100 Application and definitions

101 The requirements given below are applicable for bow doors in ships with unrestricted service. For possible reduced bow impact loads for ships with service area restriction, see 402. Conditions established in this respect are to be presented in the Operating and Maintenance Manual.

102 For outer bow doors, the requirements apply to the following two types of doors:

  a) Visor doors opened by rotating upwards on the horizontal axis through hinges located near the top of the door and connected to the primary structure of the door by longitudinally arranged lifting arms

  b) Side hinged doors opened by rotating outwards on a vertical axis through two or more hinges located near the outboard edges. It is anticipated that side hinged doors are arranged by pairs.

Other types of outer door will be specially considered in association with the applicable requirements given below.

103 The closing arrangements for bow doors normally encompass:

  - doors
  - ramps
  - hinges
  - packings
  - cleats
  - supports
  - locking arrangement.

104 Definitions:
Bow doors:  Collective term for the outer and the inner bow door normally leading to a complete or long forward enclosed superstructure.

Cleats:  Devices for pre-compression of packings and steel to steel contact (not load carrying devices).

Supports:  Load carrying devices designed for transfer of acting forces from door- to hull structures. These may include hinges, welded supports, bolts / eye plates etc.

Locking arrangement: Preventive measures ensuring that cleats and supports as applicable always remain in position when engaged.

C 200  Arrangement

201  Bow doors are to be situated above the freeboard deck. A watertight recess in the freeboard deck located forward of the collision bulkhead and above the deepest waterline fitted for arrangements of ramps or other related mechanical devices may be regarded as a part of the freeboard deck for the purpose of this requirement.

202  Where bow doors are leading to a complete or long forward enclosed superstructure, an inner door is to be fitted. The inner door is to be part of the collision bulkhead. The inner door needs not to be fitted directly above the bulkhead below, provided the requirements concerning the position of the collision bulkhead are complied with, see Sec.2 B. A vehicle ramp may be arranged to serve the purpose of an inner door, provided no part of the ramp protrudes forward of the location range of the collision bulkhead.

203  Outer doors are to be so fitted as to ensure tightness consistent with operational conditions and to give effective protection to inner doors. Inner doors forming part of the collision bulkhead are to be weather tight over the full height of the cargo space and are to be arranged with supports on the aft side of the doors.

204  Bow doors are to be arranged so as to preclude the possibility of the outer door causing structural damage to the collision bulkhead and the inner door in the case of damage to or detachment of the door.

Guidance note:
In order to comply with requirements given in 204 it is advised that the hinges of the outer bow door should not be attached to structural elements being part of the collision bulkhead or to the upper deck at a position aft of the collision bulkhead at the point of attachment. If the above mentioned solution is not possible, due attention should be given to the design of the hinge pin (axle) and fastening of this to ensure this is the weak link compared to the fastening/support of the hinge-plate (lug) to the ship structure. This is to ensure that any possible damage occurs in the hinge pin or in way of this, and not the hinge-plate fastening/support or adjacent ship structure which in turn may lead to damage of the collision bulkhead.

Furthermore, no part of the inner door (or combined inner door/ ramp) should protrude forward of the adjacent hull structures.

---e-n-d---o-f---G-u-i-d-a-n-c-e---n-o-t-e---

205  The whole steel construction between the outer and inner door, i.e. deck construction, the sides and bulkheads forming the space between the outer and inner door, is to be capable of sustaining the sea loads as given in 403 for the inner door.

C 300  Materials

301  The structural materials for bow doors are to satisfy the requirements given for hull materials.

302  Steel forgings or castings used in the closing arrangement and manoeuvring components are to be of approved ductile materials, tested in accordance with the requirements in Pt.2 Ch.2. The material factor \( f_i \) for forgings (including rolled round bars) and castings may be taken as:

\[
f_i = \left( \frac{\sigma_F}{235} \right)^{0.75} \]

\( \sigma_F = \) minimum upper yield stress in N/mm\(^2\), not to be taken greater than 70 % for the ultimate tensile strength.

The material factor \( f_i \) is not to be taken greater than 1.39 unless a direct fatigue analysis is carried out.

C 400  Design Loads

401  Outer doors, ordinary design sea pressure:

\( p_e = \) as given for \( p_2 \) in Pt.3 Ch.1 Sec.4 C.

402  Outer doors, design bow impact pressure:

\( p_{se} = \) as given for \( p_3 \) in Pt.3 Ch.1 Sec.7 E with \( \gamma = 0 \).

For ships with service area restrictions R2 to RE the wave coefficient, Cw, may be reduced as follows for calculations of bow door impact pressure:

- service area notation R2:10%
- service area notation R3:20%
- service area notation R4:30%
- service area notation RE:40%.

403  For inner doors including surrounding structures forming part of the collision bulkhead above the freeboard deck, the design sea pressure is to be taken as the greater of:

\[ p_e = 0.6 \, L \, (\text{kN/m}^2) \]

\( L = \) ship’s length, as given in Pt.3 Ch.1 Sec.1 B, need not be taken greater than 200 m or

\[ p_b = 10 \, h_b \, (\text{kN/m}^2) \]

\( h_b = \) vertical distance (m) from load point to top of cargo space.

404  The internal design pressure for bow doors is not to be taken less than:

\[ p_i = 25 \, \text{kN/m}^2 \]

405  The design forces (kN) on each half of the outer door for support devices, including supporting structural members and surrounding structures, are given by (see Fig. 1):
External forces:

— total longitudinal force: \( F_x = 0.375 \frac{p_{se}}{2} A_x \) or \( p_e A_x \) if greater

— total transverse force: \( F_y = 0.375 \frac{p_{se}}{2} A_y \) or \( p_e A_y \), if greater

— total vertical force: \( F_z = 0.375 \frac{p_{se}}{2} A_z \) or \( p_e A_z \), if greater.

The vertical force is not to be taken less than \( 3.3 \times \frac{b}{l} \times h \), where \( b, l \) and \( h \) are breadth, length and height, respectively, of the outer door in \( m \) as given in Fig. 1.

\[ A_x = \text{area (m}^2\text{)} \text{ of the vertical front view projection of the}\]
\[ \text{outer door at one side of the centre line, between the levels of}\]
\[ \text{the bottom of the door and the weather deck or between the}\]
\[ \text{bottom of the door and the top of the door, whichever is the}\]

\[ A_y = \text{area (m}^2\text{)} \text{ of the vertical side view projection of the} \]
\[ \text{outer door, between the levels of the bottom of the door and the}\]
\[ \text{weather deck or between the bottom of the door and the}\]

\[ A_z = \text{area (m}^2\text{)} \text{ of the horizontal projection of the outer door}\]
\[ \text{at one side of the centre line, between the levels of}\]
\[ \text{the bottom of the door and the weather deck or between the}\]
\[ \text{bottom of the door and the top of the door, whichever is the}\]

The design pressures are to be calculated at the position \( h/2 \) above the bottom of the door and \( h/2 \) aft of the stem line.

For outer doors, including bulwark, of unusual form or proportions, the areas and angles used for determination of the design values of external forces may require special consideration.

Internal forces:

— total longitudinal force: \( F_{si} = p_i A_x \)

— total transverse force: \( F_{yi} = p_i A_y \)

406 The design force (kN) on the inner door for support devices, including supporting structural members and surrounding structures, is given by:

External force:

— total longitudinal force: \( F_x = p_e A_x \) or \( p_h A_x \) if greater

Internal force:

— total longitudinal force: \( F_{si} = p_i A_x \)

\( A_x = \text{inner door area (m}^2\text{)}. \)

C 500 Strength criteria

501 In connection with direct strength calculations as stipulated in 903, scantlings of primary members and supports of bow doors are to be determined to withstand the design pressures using the following allowable stresses:

<table>
<thead>
<tr>
<th>Design pressure</th>
<th>Shear stress</th>
<th>Bending or normal stress</th>
<th>Equivalent stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>( p_{se} ) or ( p_e )</td>
<td>( 0,375 ) ( f_1 )</td>
<td>( 105 f_1 )</td>
<td>( 200 f_1 )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Design pressure</th>
<th>Shear stress</th>
<th>Bending or normal stress</th>
<th>Equivalent stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>( p_{e, ph} ) or ( p_i )</td>
<td>( 0,375 ) ( \frac{p_e}{2} )</td>
<td>( 105 f_1 )</td>
<td>( 200 f_1 )</td>
</tr>
</tbody>
</table>

502 Allowable stresses in support devices and supporting members and surrounding structure:

<table>
<thead>
<tr>
<th>Design pressure</th>
<th>Shear stress</th>
<th>Bending or normal stress</th>
<th>Equivalent stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>( 0,375 ) ( p_{se} ) or ( 1.3 ) ( p_e )</td>
<td>( 105 f_1 )</td>
<td>( 160 f_1 )</td>
<td>( 200 f_1 )</td>
</tr>
</tbody>
</table>

503 The nominal tension in way of threads of bolts not carrying support forces is not to exceed \( 125 f_1 \) (N/mm²).

504 Nominal bearing pressure, determined by dividing the design force by the projected bearing area, is not to exceed \( 0.8 \sigma_T \) (N/mm²) for steel material where \( \sigma_T \) is the yield stress for the bearing material. For other bearing materials the nominal bearing pressure will be specially considered.

C 600 Structural arrangement

601 Bow doors are to be adequately stiffened, and means are to be provided to prevent lateral or vertical movement of the doors when closed. For outer doors of the visor type adequate strength is to be provided in the connections of lifting arms to the door and the ship structure.

C 700 Plating

701 The thickness requirement of the bow door plating corresponding to lateral pressure is given by the greater of:

— inner and outer doors:
\[ t_1 = \frac{1.58 k_a s \sqrt{P_{\text{e}}}}{\sqrt{f_i}} \text{ (mm)} \]

(for calculation of \( t_1 \) for inner doors, \( p_e \) to be taken as the greatest of \( p_e, p_h \) or \( p_i \));

— outer doors:

\[ t_2 = \frac{13.8 k_a s \sqrt{P_{\text{e}}}}{\sqrt{\sigma_l}} \text{ (mm)} \]

\( P_{\text{sd}} \) = as given in Pt.3 Ch.1 Sec.7 E303.

\( k_a \) = correction factor for aspect ratio of plate field

\( = (1.1 - 0.25 s/l)^2 \)

\( = \) maximum 1.0 for \( s/l = 0.4 \)

\( = \) minimum 0.72 for \( s/l = 1.0 \)

The arrangement of stiffening of the bow shell is as be as given in Pt.3 Ch.1 Sec.7 E306.

The thickness of the inner door is not to be less than the minimum thickness for the collision bulkhead as given in Pt.3 Ch.1 Sec.9 C.

C 800 Stiffeners

801 The elastic/plastic section modulus of horizontal or vertical stiffeners is not to be less than the greater of:

— inner and outer doors. The elastic section modulus, \( Z_1 \) is not to be less than:

\[ Z_1 = \frac{0.8 l^2 s p_e}{l_i} \text{ (cm}^3) \]

(for calculation of \( Z_1 \) for inner doors, \( p_e \) to be taken as the greatest of \( p_e, p_h \) or \( p_i \));

— outer doors:

The plastic section modulus, \( Z_{\text{pl}} \), as defined in Pt.3 Ch.1 Sec.3 C1005 is not to be less than as given in Pt.3 Ch.1 Sec.7 E306.

802 The stiffener web plate at the ends is to have a net sectional area not less than the greater of:

— inner and outer doors:

\[ A_1 = \frac{0.08 l s p_e}{l_i} \text{ (cm}^2) \]

(for calculation of \( A_1 \) for inner doors, \( p_e \) to be taken as the greatest of \( p_e, p_h \) or \( p_i \));

— outer doors:

\[ A_2 = A_S \text{ as given in Pt.3 Ch.1 Sec.7 E306 with } t_k = 0. \]

803 Tripping brackets are to be fitted for shell frames as given in Pt.3 Ch.1 Sec.7 E308.

C 900 Girders

901 The section modulus of single girders is not to be less than the greater of:

— outer doors:

\[ Z_1 = \frac{1.05 S^2 b p_e}{l_i} \text{ (cm}^3) \]

— inner doors (\( p_e \) to be taken as the greatest of \( p_e, p_h \) or \( p_i \))

\[ Z_1 = \frac{0.8 S^2 b p_e}{l_i} \text{ (cm}^3) \]

— outer doors:

\[ Z_2 = Z \text{, as given in Pt.3 Ch.1 Sec.7 E313 with } w_k = 1.0. \]

902 The web area requirement (after deduction of cut-outs) at the girder ends is given by the greater of:

— inner and outer doors:

\[ A_1 = \frac{0.08 S b p_e}{l_i} \text{ (cm}^2) \]

(for calculation of \( A_1 \) for inner doors, \( p_e \) to be taken as the greatest of \( p_e, p_h \) or \( p_i \));

— outer doors:

\[ A_2 = A \text{ as given in Pt.3 Ch.1 Sec.7 E313 with } t_k = 1.0. \]

903 For large doors with a complex girder system a direct stress analysis of the door structure including supports may be required. Allowable stresses are given in 501 and 502.

904 The buckling strength of primary members is to be verified as being adequate.

905 The arrangement, scantlings and stiffening of girders and diaphragms supporting shell frames of bow doors are to comply with requirements given in Pt.3 Ch.1 Sec.7 E310 to 312.

906 The girder system is to be given sufficient stiffness to ensure integrity of the boundary support of the door. The stiffness of the edge girders is to be related to the distance between supports and to the loads from the main door girders.

907 Where inner doors serve as vehicle ramps wheel loads are to be considered as given in B300.

C 1000 Closing arrangement, general

1001 Adequate provisions are to be arranged for closing of bow doors so as to be commensurate with the strength and stiffness of the surrounding structure.

1002 Devices provided for closing of bow doors are to be simple to operate and easily accessible.

1003 Closing arrangement for bow doors is to be provided with devices arranged for remote control from a convenient position above the freeboard deck. The operating panel for remotely controlled bow doors is to be inaccessible for unauthorised persons.

1004 Notice plates, giving instructions that bow doors are to be closed and all devices provided for closing are closed and locked before leaving quay-side (or terminal) are to be placed at the operating panel and on the navigation bridge.

1005 For outer doors of the side-hinged type thrust bearings are to be provided in way of girder ends at the closing of the two leaves to prevent one leaf shifting towards the other one under the effect of asymmetrical forces (see example on Fig. 2). The two parts are to be kept together by means of cleats. Any other arrangement serving the same purpose may be considered.
1006 For outer doors of the visor type, the hinge arrangement is generally to be such that the door is effectively self closing under external loads given by:

\[
\alpha = \frac{F_a - F_b}{\sqrt{F_x^2 + F_z^2}} \geq 0, 10
\]

where:

- \(a\) = vertical distance (m) from visor hinge to position h/2
- \(b\) = horizontal distance (m) from visor hinge to position l/2
- \(F_x, F_z, h, l\) as given in 405.

1007 Devices are to be arranged for the bow doors to be secured in open position.

1008 Where packing is required the packing material is to be of a comparatively soft type, and the supporting forces are to be carried by the steel structure only. Other types of packing may be considered. Flat bars or similar fastening devices for packing are to have scantlings and welds determined with ample consideration to wear and tear.

1009 A drainage system is to be arranged in the space between the outer and inner door.

C 1100 Closing arrangement, strength

1101 Only supports having an effective stiffness in a given direction are to be included in calculation of the load carrying capacity of the devices. The distribution of the total forces acting on the supports may, for doors with a complex closing arrangement, be required calculated by a direct calculation taking into account the flexibility of the door and surrounding hull structure and the position of the supports. The number of supports are generally to be the minimum practical taking into account the requirements for redundant provision as given in 1103 and the available space for adequate support in the surrounding hull structure which may limit the size of each device. Maximum design clearance for effective supports should normally not exceed 3 mm. Design clearances are to be included in the Operating and Maintenance Manual as given in A302.

1102 In general the maximum forces acting on the supports are to be established on the basis of the external and internal forces as given in 405 and 406. The following cases are to be considered:

1) For outer doors of the visor type the forces acting on the supports are to be determined for the following combination of simultaneous design forces:
   a) \(2 F_x\) and \(2 F_z\)

2) For outer doors of the side hinged type the forces acting on the supports are to be determined for the following combination of simultaneous design forces:
   a) \(F_x, F_y, F_z\), with each force acting on both doors
   b) \(0.7 F_x, 0.7 F_y, 0.7 F_z\), acting on each door separately.

Guidance note:
The support forces as determined according to 1 a) and 2 a) shall in general give rise to a zero moment in the longitudinal vertical plane about the transverse axis at h/2 and l/2.

---end---of---Guidance---note---

1103 For outer doors effective supports including surrounding door and hull structural members are, in the case of failure of any single support, to have sufficient capacity to withstand the total design forces. In this case the allowable stresses given in Table C3 in 502 may be increased by 20%.

1104 For outer doors of the visor type, at least two securing devices are to be provided at the bottom of the door, each capable of providing the full reaction force required to prevent opening of the door within the allowable stresses given in Table C3. The opening moment to be balanced by the said reaction force is not to be taken less than:

\[
M_0 = 1.3 \left(10 W d + 5 A_x a\right) (\text{kNm})
\]

where:

- \(W\) = mass of the door (t)
- \(a\) = vertical distance (m) from visor hinge to the centroid of the vertical projected area of the bow visor
- \(d\) = vertical distance (m) from hinge axis to the centre of gravity of the door
- \(A_x\) as defined in 405.

1105 All load transmitting elements in the design load path, from the door through supports into the ship structure, including welded connections, are to be to the same strength standard as required for the supports.

1106 The lifting arms of a visor type outer door and its connections to the door and hull structure are to be dimensioned for the static and dynamic forces applied during lifting and lowering operations. A minimum wind pressure of 0,0015 N/mm² is to be taken into account.

C 1200 Closing arrangement, system for operation and indication and monitoring

1201 Cleats and support devices are to be equipped with mechanical locking arrangement (self locking or separate arrangement) or to be of the gravity type.

1202 Where hydraulic operating systems are applied, cleats and support devices are to remain locked in closed position in case of failure in the hydraulic system.

1203 Systems for operation of cleats and support devices and, where applicable, for locking arrangement are to be isolated from other circuits and to be blocked when doors and closing arrangement are in the closed or locked position. Hydraulic cylinders are to be arranged so that the bigger area of the piston is used for closing.

1204 Indication of the open or closed position of any of the bow doors and indication that cleats, support and locking devices as applicable are properly positioned are to be provided at the operating panel for remote control. The indication panel is to be provided with a lamp test function.

When the mechanical lock is placed inside the hydraulic cylinder moving the cleat, and this lock is non-duplicated, indica-
tion of the open or closed position of any of the cleats, support and locking device is to be made on the lock inside the cylinder.

1205 Separate indicator lights and audible alarms are to be provided on the navigation bridge to show and monitor that any of the bow doors are properly closed and that cleats, support and locking devices as applicable are properly positioned.

1206 The alarm and indication panel on the navigation bridge is to be equipped with a mode selection function <harbour/sea voyage> so arranged that audible alarm is given if the vessel departs the quay side (or terminal) with any of the bow doors not properly closed or any of the cleats, support and locking devices not properly positioned.

1207 The indicator and alarm system on the navigation bridge is to be designed on the fail to safe principle. The panel is to be provided with a function test facility and a separate alarm for power failure to the indicator lights and audible alarm system.

1208 The power supply for indicator and alarm systems is to be independent of the power supply for the operating and closing arrangements. It shall not be possible to turn off indicator lights and alarms.

1209 Sensors for the indicator system are to be protected from water, ice formation and mechanical damage.

1210 A water leakage detection system with audible alarm and television surveillance is to be arranged to provide an indication to the navigation bridge and to the engine control room of leakage through the inner door.

1211 In the space between the outer and the inner doors a television surveillance system is to be arranged with monitors on the navigation bridge and in the engine control room. The system is to monitor the position of the outer door and a sufficient number of devices for the closing arrangement. Special consideration is to be given for lighting and contrasting colour of objects under surveillance. An indication system for high water level is to be arranged with alarm to the navigation bridge.

1212 Special category spaces and Ro-Ro cargo spaces are either to be patrolled or monitored by effective means, such as television surveillance, so that movement of vehicles in adverse weather and unauthorised access by passengers can be observed whilst the ship is underway.

Guidance note:
Items 1204 to 1211 apply to shell doors, loading doors and other closing appliances for all passenger ships with Ro-Ro cargo spaces or special category spaces as defined in Pt.4 Ch.10 Sec.1 C which, if left open or not properly closed and locked, could lead to a major flooding of such spaces.

---end of Guidance note---

D. Inlets and Drainage Arrangement

D 100 Air intakes, ventilators, etc

101 Location of air intakes for engines will be considered in each case.

102 In ships with the class notation A the following apply:

a) If air intakes for engines are led through superstructure sides, the distance from the lower side of the opening to the freeboard deck is not to be less than 4,5 m, and a drainage box is to be fitted between the ship's side and the engine room, draining directly overboard.

b) If ventilators, etc. without weather tight closing appliances are led through superstructure sides, the distance from the lower side of the ventilator opening to the freeboard deck is not to be less than 4,5 m.

D 200 Drainage of vehicle deck (class notation A)

201 In addition to the requirements in 202 and 203, drainage of vehicle decks within superstructures is to comply with the requirements given in Pt.4 Ch.6.

202 If the drainage openings in the vehicle deck will be lower than the waterline when the ship loaded to summer freeboard has a list of 5°, the outlets are to be led down to a separate tank.

203 Each scupper is to have an automatic non-return valve with a positive means of closing it from a position above the freeboard deck. Where, however, the vertical distance from the summer load waterline to the inboard end of the discharge pipe exceeds 0,01 L, the discharge may have two automatic non-return valves without positive means of closing, provided that the inboard valve is always accessible for examination under service conditions. The means for operating the positive action valve shall be readily accessible and provided with an indicator showing whether the valve is open or closed.

D 300 Freeing ports (class notation B)

301 The vehicle deck freeing port area is not to be less than required for an open freeboard deck according to Pt.3 Ch.1 Sec.11 M.

E. Stability and Watertight Integrity

E 100 Application

101 Ships with class notation Car Ferry, Train Ferry or Car and Train Ferry are to comply with the requirements of Pt.5 Ch.4 as well as the requirements of Sec.2 K for Passenger Ships.

102 Notwithstanding the provisions of regulations B (Sec.2 K506) and D-1 (Pt.7 Ch.1 Sec.3 C100):

.1 Ro-ro passenger ships certified to carry 400 persons 6 or more constructed on or after 1 July 1997 shall comply with the provisions of paragraph 2.3 of regulation B (Sec.2 K506), assuming the damage applied anywhere within the ship's length L.

(Regulation II-1/8.2.1)

103 For ferries with service area restriction R3, R4 or RE or with additional notation B the Society may accept requirements other than those specified in Sec.2 K506 after consideration in each separate case.

E 200 Definitions

201 The following definitions from SOLAS Regulation II-2/3 relate to ferries:

14 Ro-ro cargo spaces

are spaces not normally subdivided in any way and extending to either a substantial length or the entire length of the ship in which goods (packaged or in bulk, in or on rail or road cars, vehicles (including road or rail tankers), trailers, containers, pallets, demountable tanks or in or on similar stowage units or other receptacles) can be loaded and unloaded normally in a horizontal direction.

15 Open ro-ro cargo spaces

are ro-ro cargo spaces either open at both ends, or open at one end and provided with the adequate natural ventilation effective over their entire length through permanent openings in the side plating or deckhead to the satisfaction of the Administration.

16 Closed ro-ro cargo spaces

are ro-ro cargo spaces which are neither open ro-ro cargo spaces nor weather decks.

17 Weather deck

is a deck which is completely exposed to the weather from above and from at least two sides.
18 Special category spaces
are those enclosed spaces above or below the bulkhead deck
intended for the carriage of motor vehicles with fuel in
their tanks for their own propulsion, into and from which such vehi-
cles can be driven and to which passengers have access.

E 300 Watertight integrity from the ro-ro deck (bulk-
head deck) to spaces below

301 In ro-ro passenger ships constructed on or after 1 July
1997:
.1 subject to the provisions of subparagraphs .2 and .3, all
accesses to spaces below the bulkhead deck shall have a lowest point which is not less than 2.5 m above
the bulkhead deck;
.2 where vehicle ramps are installed to give access to 6
spaces below the bulkhead deck, their openings shall be
able to be closed weathertight to prevent ingress of water
below, alarmed and indicated to the navigation bridge;
.3 the Administration may permit the fitting of particular
6 accesses to spaces below the bulkhead deck provided they are necessary for the effective working of the
ship, e.g. the movement of machinery and stores, subject to
2 such accesses being made watertight, alarmed and indi-
cated to the navigation bridge;
.4 the accesses referred to in subparagraphs .2 and .3 shall
be closed before the ship leaves the berth on any voy-
age and shall remain closed until the ship is at its next
berth;
.5 the master shall ensure that an effective system of su-
 pervision and reporting of the closing and opening of such
accesses referred to in subparagraphs .2 and .3 is imple-
mented; and
.6 the master shall ensure, before the ship leaves the berth on any voyage, that an entry in the log-book, as re-
quired by regulation 25 (Pt.7 Ch.4 Sec.1 A50(6)), is made of
the time of the last closing of the accesses referred to in
paragraphs .2 and .3.
(Rule II-1/23-2)

E 400 Integrity of the hull and superstructure, damage
prevention and control

401 This regulation applies to all ro-ro passenger ships, ex-
cept that for ships constructed before 1 July 1997, paragraph 2
shall apply not later than the date of the first periodical survey after 1 July 1997.

1) Indicators shall be provided on the navigation bridge for all
shell doors, loading doors and other closing appliances which, if left open or not properly secured, could, in the opinion of the
Administration, lead to flooding of a special category space or ro-ro cargo space.> The indicator system shall be designed on
the fail-safe principle and shall show by visual alarms if the door
is not fully closed or if any of the securing arrangements are not
in place and fully locked and by audible alarms if such door or
closing appliances become open or the securing arrangements
become unsecured. The indicator panel on the navigation
bridge shall be equipped with a mode selection function “har-
bour/sea voyage” so arranged that an audible alarm is given on
the navigation bridge if the ship leaves harbour with the bow
doors, inner doors, stern ramp or any other side shell doors not
closed or any closing device not in the correct position. The
power supply for the indicator system shall be independent of
indicator systems, approved by the Administration, which were
installed on ships constructed before 1 July 1997 need not be
changed.

Guidance note:
Regarding indicator systems, reference is made to Pt.7 Ch.1
Sec.3 B100.

2) Television surveillance and a water leakage detection sys-
tem shall be arranged to provide an indication to the navigation
bridge and to the engine control station of any leakage through
inner and outer bow doors, stern doors or any other shell doors
which could lead to flooding of special category spaces or ro-ro
cargo spaces.

3) Special category spaces and ro-ro cargo spaces shall be
continuously patrolled or monitored by effective means, such as
television surveillance, so that any movement of vehicles in
adverse weather conditions and unauthorized access by pas-
sengers thereto can be detected whilst the ship is underway.

4) Documented operating procedures for closing and securing
all shell doors, loading doors and other closing appliances
which, if left open or not properly secured, could, in the opinion
of the Administration, lead to flooding of a special category space or ro-ro cargo space, shall be kept on board and posted
at an appropriate place.

(Rule II-1/23-2)

F. Life Saving Appliances and Arrangements

F 100 Application

101 Ships with class notation Car Ferry, Train Ferry or
Car and Train Ferry are to comply with the requirements of
subsection F as well as the requirements of Sec.2 L for passenger
ships.

F 200 Additional requirements for ro-ro passenger
ships (Regulation III/26)

1 This regulation applies to all ro-ro passenger ships. Ro-ro
passenger ships constructed:
1.1 on or after 1 July 1998 shall comply with the requirements of paragraphs 2.3, 2.4, 3.1, 3.2, 3.3, 4 and 5;
1.2 on or after 1 July 1998 and before 1 July 1999 shall comply with
the requirements of paragraph 5 not later than the first pe-
riodical survey after 1 July 1998 and with the requirements of
paragraphs 2.3, 2.4, 3 and 4 not later than the first periodical
survey after 1 July 2000; and
1.3 before 1 July 1998 shall comply with the requirements of
paragraph 5 not later than the first periodical survey after 1 July
1998 and with the requirements of paragraphs 2.1, 2.2, 2.3, 2.4, 3
and 4 not later than the first periodical survey after 1 July
2000.

2 Liferafts
2.1 The ro-ro passenger ship's liferafts shall be served by ma-
rine evacuation systems complying with the requirements of
section 5.2 of the Code or launching appliances complying with
the requirements of paragraph 6.1.5 of the Code, equally dis-
tributed on each side of the ship.

2.2 Every liferaft on ro-ro passenger ships shall be provided
with float-free stowage arrangements complying with the re-
quirements of regulation 13.4 (Pt.3 Ch.6 Sec.2 G100).

2.3 Every liferaft on ro-ro passenger ships shall be of a type fit-
ted with a boarding ramp complying with the requirements of
paragraph 4.2.4.1 or 4.3.4.1 of the Code, as appropriate.

2.4 Every liferaft on ro-ro passenger ships shall either be auto-
matically self-righting or be a canopied reversible liferaft which
is stable in a seaway and is capable of operating safely which-
ever way up it is floating. Alternatively, the ship shall carry au-
tomatically self-righting liferafts or canopied reversible liferafts,
in addition to its normal complement of liferafts, of such aggre-
gate capacity as will accommodate at least 50% of the persons
not accommodated in lifeboats. This additional liferaft capacity
shall be determined on the basis of the difference between the
total number of persons on board and the number of persons
accommodated in lifeboats. Every such liferaft shall be ap-
proved by the Administration having regard to the recommen-
dations adopted by the Organization.

3 Fast rescue boats
3.1 At least one of the rescue boats on a ro-ro passenger ship
shall be a fast rescue boat approved by the Administration hav-
ing regard to the recommendations adopted by the Organiza-
tion.

---end-of-guidance-note---
3.2 Each fast rescue boat shall be served by a suitable launching appliance approved by the Administration. When approving such launching appliances, the Administration shall take into account that the fast rescue boat is intended to be launched and retrieved even under severe adverse weather conditions, and also shall have regard to the recommendations adopted by the Organization.* **

3.3 At least two crews of each fast rescue boat shall be trained and drilled regularly having regard to the Seafarers Training, Certification and Watchkeeping (STCW) Code and recommendations adopted by the Organization,*** including all aspects of rescue, handling, manoeuvring, operating these craft in various conditions, and righting them after capsize.

3.4 In the case where the arrangement or size of a ro-ro passenger ship, constructed before 1 July 1997, is such as to prevent the installation of the fast rescue boat required by paragraph 3.1, the fast rescue boat may be installed in place of an existing lifeboat which is accepted as a rescue boat or, in the case of ships constructed prior to 1 July 1986, boats for use in an emergency, provided that all of the following conditions are met:

3.4.1 the fast rescue boat installed is served by a launching appliance complying with the provisions of paragraph 3.2;

3.4.2 the capacity of the survival craft lost by the above substitution is compensated by the installation of liferafts capable of carrying at least an equal number of persons served by the lifeboat replaced; and

3.4.3 such liferafts are served by the existing launching appliances or marine evacuation systems.

4 Means of rescue

4.1 Each ro-ro passenger ship shall be equipped with efficient means for rapidly recovering survivors from the water and transferring survivors from rescue units or survival craft to the ship.

4.2 The means of transfer of survivors to the ship may be part of a marine evacuation system, or may be part of a system designed for rescue purposes.

4.3 If the slide of a marine evacuation system is intended to provide the means of transfer of survivors to the deck of the ship, the slide shall be equipped with handlines or ladders to aid in climbing up the slide.

5 Lifejackets

5.1 Notwithstanding the requirements of regulations 7.2 (Pt. 3 Ch. 6 Sec. 2 B100) and 22.2 (Sec. 2 L400.2), a sufficient number of lifejackets shall be stowed in the vicinity of the muster stations so that passengers do not have to return to their cabins to collect their lifejackets.

5.2 In ro-ro passenger ships, each lifejacket shall be fitted with a light complying with the requirements of paragraph 2.2.3 of the Code.

* Refer to the requirements for automatically self-righting liferafts and canopied reversible liferafts, MSC/Circ.809.

** Refer to recommendations to be adopted by the Organization.

*** Refer to the Recommendation on training requirements for crews of fast rescue boats, adopted by the Organization by resolution A.771(18) and section A-VI/2, table A-VI/2-2 “Specification of the minimum standard of competence in fast rescue boats” of the Seafarers’ Training, Certification and Watchkeeping (STCW) Code.

(SOLAS Reg. III/26)

F 300 Helicopter landing and pick-up areas (Regulation III/28)

1 All ro-ro passenger ships shall be provided with a helicopter pick-up area approved by the Administration having regard to the recommendations adopted by the Organization.*

2 Passenger ships of 130 m in length and upwards, constructed on or after 1 July 1999, shall be fitted with a helicopter landing area approved by the Administration having regard to the recommendations adopted by the Organization. **

* Refer to the Merchant Ship Search and Rescue Manual (MERSAR), adopted by the Organization by resolution A.229(VII), as amended and as it may be amended.

** Refer to recommendations to be developed by the Organization.

(SOLAS Reg. III/28)
SECTION 4
GENERAL CARGO CARRIERS

A. General

A 100 Classification

101 The requirements in this section apply to ships intended for carriage of general dry cargoes.

102 Ships arranged for lift on/lift off cargo handling and built in compliance with relevant requirements specified in the following may be given the class notation General Cargo Carrier.

103 Ships arranged for roll on/roll off cargo handling and built in compliance with relevant requirements specified in the following may be given the class notation General Cargo Carrier RO/RO.

104 Ships given the class notation RO/RO are to comply with requirements given in Pt.4 Ch.10 Sec.15 E for carriage of vehicles with fuel in their tanks for their own propulsion.

105 Ships arranged for lift on/lift off cargo handling and arranged for carriage of motor vehicles with fuel in their tanks for their own propulsion are to comply with requirements given in Pt.4 Ch.10 Sec.15 E300 and will be given the class notation PET.

A 200 Documentation

201 For the approval of structures subjected to wheel loading the following information is to be submitted:

— make and type of cargo handling vehicles including maximum axle load and details of wheel and/or foot print arrangement
— stowage and securing arrangement for road transporters and other vehicles to be carried. Maximum axle load to be stated.

202 For the approval of ramps for shore connections, the following information is to be submitted:

— maximum number of vehicles with loads and/or the most unfavourable combination of vehicles which may be situated on the ramp
— maximum lifting force and hinge forces, including force direction
— hoisting and securing arrangement in working and stowed position
— tightening arrangement if relevant
— proposed procedure for functional testing
— plans and supplementary documentation giving pertinent particulars of the hoisting/lowering mechanical gear arrangement
— schematic diagrams of hydraulic systems, electrical systems and pneumatic systems
— braking systems.

B. Hull Arrangement and Strength

B 100 General

101 Where direct stress analysis is required in the following, the design loads, calculation methods and allowable stresses are in general to be as given for complex girder systems in Pt.3 Ch.1 Sec.13.

102 In ships with cargo hatchways the upper deck and 'tween deck(s) are normally supported by deck transverses (hatch side cantilevers) extending from a side vertical to the hatch side coaming. The scantlings are to be as given in B200.

103 If cargo decks are supported by pillars, the pillars are to extend to the bottom structure or a supporting bulkhead. Direct stress analysis of deck and bottom structure in way of pillars may be necessary.

104 Double bottoms in ships with decks supported by pillars on the double bottom are to be investigated for relevant seagoing draught, minimum 0,6T, with no loads on decks above.

105 Double bottoms not supported by pillars or vertical pillar bulkheads are to be investigated for relevant draught, normally maximum draught, with no load on the inner bottom.

106 Girder structure of cargo decks may be required to be investigated for specified eveny and/or unevenly distributed design load at relevant seagoing draught.

107 Decks and inner bottom, ramps and lifts in ships for roll on/roll off cargo handling (class notation RO/RO) are to satisfy the strength requirements given in C.

108 If decks and inner bottom in ships for lift on/lift off cargo handling have been strengthened in accordance with the requirements given in C the additional class notation PWDK may be given.

109 For open type ships (total width of weather deck hatch openings in one transverse section exceeding 65% of the breadth B and length of hatch opening exceeding 75% of the hold length) the combined effects of hull girder bending and torsion related to possible local bending and shear may have to be specially considered as outlined in Classification Note No. 31.1 «Strength Analysis of Hull Structures in Bulk Carriers and Container Ships».

110 In ships with a limited number of effective transverse bulkheads in the cargo region (class notation RO/RO) the vertical side girders and framing are to give the hull girder sufficient transverse strength, also with the ship in heeled conditions. A direct stress analysis is to be carried out to demonstrate that the stresses are acceptable. An acceptable calculation method is given in Classification Note No. 31.2 «Strength Analysis of Hull Structure in Roll on/Roll off Ships».

111 Movable car decks, if fitted, are to satisfy relevant requirements given in Sec.7.

B 200 Hatch side cantilevers

201 Hatch side cantilevers and side verticals are shown in Fig. 1.
202 When the cantilever may be considered as a simple gird-
er the section modulus in sections M-M and N-N is not to be
less than:

\[ Z = \frac{6}{f_1} l (P + 0.5Q) \text{ (cm}^3\text{)} \]

\[ l = \text{as given in Fig. 1 in m} \]
\[ P = \text{point load in kN at side coaming (from cargo on hatch} \]
\[ \text{cover and transversely stiffened deck)} \]
\[ Q = \text{distributed load in kN (from cargo on longitudinally} \]
\[ \text{stiffened deck).} \]

The design pressures from cargo loads are to be calculated as
given for the main class.

203 For rounded corners shown in Fig. 1 (Alt. III), the effective
width of the face plate is to be taken as given in Pt.3 Ch.1
Sec.3 C400.

For corner designs according to Fig. 1 (Alt. I or Alt. II), the
effective width of the face plate is to be taken equal to the actual
width.

204 The total effective width of the attached area of deck and
shell plating may be taken as 0.4 \( l \). The width is, however, not
to be taken greater than the cantilever spacing or the distance \( g \)
in Fig. 1.

205 The net web area of the cantilever is not to be less than:

\[ A = \frac{0.12}{f_1} (P + Q x) \text{ (cm}^2\text{)} \]

\( x = \text{distance in m from end of cantilever} \)

\( P \) and \( Q = \text{as given in 202.} \)

206 The thickness of the corner plate between the sections
M-M and N-N is not to be less than:

\[ t = \frac{0.012}{f_1} (P + 0.5Q) \frac{l}{ag} \text{ (mm)} \]

The corner plate in Fig. 1 (Alt. I and Alt. II) is to be addition-
ally stiffened if \( a \) and \( g \) is greater than 70t.

\( P \) and \( Q = \text{as given in 202} \)

\( l, a \) and \( g = \text{as given in Fig. 1.} \)

B 300  **External vehicle ramps**

301 Vehicle ramps for shore connection are normally to be
built with a grillage system of girders, and local stiffeners in
the vehicle’s moving direction. The ramps are to have suffi-
cient strength for the specified design working loads and max-
imum loads during hoisting operation. After end ramps are to
have sufficient flexibility for resting on the quay during load-
ing/unloading operations with a minimum list of 3 degrees. A
direct stress analysis may have to be carried out to demonstrate
that stresses and flexibility are acceptable.

302 Plates and stiffeners are to satisfy the strength require-
ments given in C.

303 If the ramp is also acting as a watertight door, relevant
requirements given for the main class are to be satisfied.

304 The support structure for large ramps in stowed position
will have to be specially considered based on design loads as
given for heavy units in Pt.3 Ch.1 Sec..4 C. A direct stress an-
alysis may have to be carried out.

305 Satisfactory functional tests are to be carried out.

306 Control handles for winches or operation devices are to
be so arranged that they quickly revert to the neutral (stop) po-
sition when released. Provision is to be made to lock handles in the neutral position when the operating gear is unattended.

B 400 Internal ramps and lifts

401 Internal ramps and lift platforms are to have sufficient strength for the specified design working load. For hoistable ramps and lifts also the maximum loads during hoisting conditions are to be considered.

402 Plates and stiffeners are to satisfy the strength requirements given in C for permanent decks for wheel loading.

403 Ramps or lift platforms acting as deck opening covers are to satisfy the relevant requirements to the deck according to the main class.

404 Satisfactory functional tests are to be carried out.

B 500 Ceilings and cargo battens

501 Ships with single bottom in cargo holds are to be fitted with ceiling on top of floors, extending to the upper part of the bilges. Limber boards are to be arranged to provide easy access for inspection of the bottom structures.

502 Any wooden ceiling on inner bottom is to be fitted either directly in a layer of tightening and preserving composition or on battens of thickness at least 12.5 mm. The thickness of wooden ceiling is not to be less than 63 mm. In way of the bilges removable ceiling is to be fitted. Deck composition as mentioned in 304 instead of wooden ceiling is to be satisfactory strengthened. There is to be effective drain to the bilges.

503 In spaces for general dry cargo, battens are normally to be fitted on ship's sides from upper turn of bilge (or from deck in between deck spaces and superstructures) up to the under side of beam knees. The clear space between adjacent rows of battens is not to exceed 300 mm. The thickness of wooden battens is not to be less than 50 mm.

504 Deck compositions are subject to approval by the Society. See "Register of Type Approved Products No.3: Containers, Cargo Handling, Lifting Appliances and Miscellaneous Equipment."

B 600 Protection of cargo

601 It is assumed that adequate precautions are taken when necessary to prevent hazards from cargoes which are subject to gassing, oxidation, self-heating or spontaneous combustion in connection with heating, moisture or other detrimental affecting of the cargo. The above mentioned assumption will be stated in the appendix to the classification certificate for the ship.

B 700 Support of cargo handling equipment

701 Masts and posts are to be efficiently supported and connected to at least two decks or to one deck and a mast house top above. If the latter arrangement is adopted, the mast house top is to be of sufficient size and adequately stiffened. A winch house of usual size and scantlings is not considered to meet the requirements.

702 At fastenings for standing rigging and for guys and topping lifts, the deck is to be securely stiffened and reinforced for the additional loading.

703 The support of other lifting arrangement will be specially considered.

B 800 Securing points for lashing

801 Decks intended for carriage of vehicles are to be equipped with a satisfactory number of securing points for lashing. The arrangement of securing is left to the discretion of the Owner, provided the following minimum requirements are satisfied.

802 Unless otherwise specified each lashing point is to be able to withstand the minimum working load P without any permanent deformation:

\[ P = k Q g_0, \text{ min. } 120 \, \text{kN in decks for road transporters} \]
\[ P = 15 \, \text{kN in decks for cars only} \]

\[ k = n/r \]
\[ r = \text{number of effective lashing points at each side of the vehicle for the number n of axles in group.} \]

If \( r \) is different from 1, \( k \) to be increased by 10%.

\[ Q = \text{as given in C201.} \]

If the securing point is designed to accommodate more than one lashing simultaneously, the working load \( P \) is to be multiplied by the number of lashings.

The requirements for materials, strength, testing and documentation of such securing points are to be according to Sec.6.

803 Nominal normal and shear stresses in local structures of hull structural steel, supporting sockets for lashing are not to exceed:

\[ \sigma = 210 f_1 \, \text{N/mm}^2 \]
\[ \tau = 120 f_1 \, \text{N/mm}^2 \]

In structures also subjected to longitudinal stresses (e.g. deck longitudinals and girders) in combination with such stresses as given in Pt.3 Ch.1 Sec.8, the allowable bending stresses in Pt.3 Ch.1 Sec.8 Table C1 and D201 may be increased by 30%.

C. Permanent Decks for Wheel Loading

C 100 General

101 Ships strengthened in accordance with the following requirements may have the additional class notation PWDK.

102 The requirements cover wheel loads from cargo handling vehicles and from cargo transporting vehicles kept onboard supported on their wheels when the ship is at sea. Vehicles supported by crutches, horses etc. will be specially considered.

103 The strength requirements are based on the assumption that the considered element (plating or stiffener) is subjected to one load area only, and that the element is continuous in both directions across several evenly spaced supports. Requirements for other loads and/or boundary conditions will be specially considered.

104 Signboards stating the maximum permissible axle load, the maximum tyre pressure of pneumatic tyre wheels, wheel arrangement on axles, and specially approved vehicles are to be fitted in suitable positions onboard. Detailed information of the basis for approval will be stated in the appendix to the classification certificate.

C 200 Design loads

201 For individual vehicles with specified arrangement and dimensions of footprints, the design pressure in general is to be taken as:

\[ p = \frac{Q}{n_0 ab (9, 81 + 0, 5a_v)} \, (\text{kN/m}^2) \]

\[ Q = \text{maximum axle load in t} \]
\[ n_0 = \text{number of loads areas on the axle} \]
\[ a = \text{extent in m of the load area parallel to the stiffeners} \]
\[ (\text{See Fig. 2}) \]
\[ b = \text{extent in m of the load area perpendicular to the stiffeners} \]
\[ (\text{see Fig. 2}) \]
\[ a_v = 6/\sqrt{Q} \text{ for moving cargo handling vehicles, harbour conditions.} \]
\[ = \text{vertical acceleration as defined in Pt.3 Ch.1 Sec.4 for stowed vehicles, sea going conditions} \]
The load area as indicated in Fig. 2 are defined as:

— the footprint area of individual wheels or
— the rectangular enveloped area of footprints of a wheel group.

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of wheels in group</td>
<td>Footprint dimensions (real contact areas between tyres and deck)</td>
<td>Design load area for axle perpendicular to stiffeners</td>
<td>Design load area for axle parallel to stiffeners</td>
</tr>
<tr>
<td><strong>Single wheel</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Double wheels</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Triple wheels</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Fig. 2**

**Definition of load area**

In general the scantlings are to be checked according to both definitions. If, however, the distance e between individual footprints is less than the breadth b of the prints, the load area may normally be calculated for the group of wheels only.

202 If the arrangement and dimensions of footprints are not available for vehicles with pneumatic tyres, the design pressure may normally be taken as:

\[
p = \frac{p_o (9, 81 + 0, 5a_v)}{9, 81w} \quad \text{(kN/m}^2)\]

- \(p_o\) = maximum tyre pressure in kN/m\(^2\)
- \(= 1000\) for cargo handling vehicles unless otherwise specified
- \(= 120\sqrt{Q+3}\) for road transporters unless otherwise specified
- \(w\) = 1.0 in general
- \(= 1.20\) when double wheels are specified
- \(= 1.27\) when triple wheels are specified
- \(a_v\) = as given in 201.
The load area dimensions are in general to be taken as:

\[ a = \sqrt{kA} \quad (m) \]

\[ b = \sqrt{\frac{A}{k}} \quad (m) \]

\[ k = k_1 \text{ in general} \]

\[ k_2 = \text{for plating when } k_2 < k_1 \text{ and:} \]

\[ \frac{wQ}{n_0s^2} > -100 \]

\[ k_1 = \begin{cases} 2.0 & \text{for single wheel} \\ 2.0 & \text{for multiple wheels with axle parallel to stiffeners} \\ 0.8 & \text{for double wheels with axle perpendicular to stiffeners} \\ 0.5 & \text{for triple wheels with axle perpendicular to stiffeners} \end{cases} \]

\[ k_2 = \frac{\sqrt{A}}{2s} \]

\[ A = \frac{9.81wQ}{n_0p_0} \quad (m^2) \]

Q and \( n_0 \) as defined in 201

\( n_0 = 2 \) unless otherwise specified.

203 For heavy vehicles where the stowing and lashing arrangement may significantly affect the load distribution at sea, the design pressure for individual load areas will be specially considered.

204 Deck areas for wheel loads from cargo handling vehicles, which are frequently operating in all directions, are to be checked for design loads with axle parallel and perpendicular to stiffeners.

C 300 Plating

301 The thickness of deck plating subjected to wheel loading is not to be less than:

\[ t = \frac{77.4k_a\sqrt{kwsp}}{\sqrt{m\sigma}} + t_k \quad (mm) \]

\[ k_a = 1.1 - 0.25 s/l \]

- maximum 1.0 for \( s/l = 0.4 \)
- minimum 0.85 for \( s/l = 1.0 \)

\[ k_w = 1.3 - \frac{4.2}{(a/s + 1,8)^2} \]

- maximum 1.0 for \( a \geq 1.94 s \)

\[ c = b \text{ for } b < s \]

\[ = s \text{ for } b > s \]

\[ p, a \text{ and } b = \text{as given in 200} \]

\[ m = \frac{38}{(\frac{b}{s})^2 - 4.7 \frac{b}{s} + 6.5} \quad \text{for } \frac{b}{s} \leq 1.0 \]

\[ m = 13.57 \quad \text{for } \frac{b}{s} > 1.0 \].

Between specified values of \( b/s \) the \( m \)-value may be varied linearly. The \( m \)-value may also be obtained from Fig. 3.

\[ \sigma = 320 f_1 N/mm^2 \text{(maximum) in general for seagoing conditions.} \]

\[ = 370 f_1 \text{ N/mm}^2 \text{(maximum) in general for harbour conditions.} \]

\[ = \text{as given in Table C1, but not exceeding the above general maximum values, for upper deck within 0.4 L amidships} \]

For upper deck between 0.4 L amidships and 0.1 L from the perpendiculars, \( \sigma \) is to be varied linearly.

For ’tweendecks \( \sigma \) is to be found by linear interpolation between upper deck value and general maximum value taken at the neutral axis.

<table>
<thead>
<tr>
<th>Table C1</th>
<th>Allowable bending stress for upper deck plating within 0.4 L amidships</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrangement</td>
<td>Condition</td>
</tr>
<tr>
<td>Longitudinally stiffened</td>
<td>Seagoing</td>
</tr>
<tr>
<td>Longitudinally stiffened</td>
<td>Harbour</td>
</tr>
<tr>
<td>Transversely stiffened</td>
<td>Seagoing</td>
</tr>
<tr>
<td>Transversely stiffened</td>
<td>Harbour</td>
</tr>
</tbody>
</table>

Fig. 3

Bending moment factor (m-values)

\[ x = \frac{b}{s} \quad \text{not greater than 1.0 for plating} \]

\[ x = \frac{a}{l} \quad \text{for stiffeners.} \]

302 In Fig. 4 a — d the general thickness requirements of deck plating subjected to various wheel loading from pneumatic tyres are given. The following parameter values have been assumed:

- tyre pressure: \( p_0 = 800 \text{ kN/m}^2 \)
- aspect ratio of plate field: \( l/s \geq 2.5 \)
- allowable stress: \( \sigma = 370 \text{ N/mm}^2 \)
- corrosion addition: \( t_k = 0 \text{ mm.} \)

C 400 Stiffeners

401 The section modulus for deck beams and longitudinals subjected to wheel loading is not to be less than:

\[ Z = \frac{1000k_jcspw_k}{m\sigma} \quad (\text{cm}^3) \]

\[ k_z = 1.0 \quad \text{for } b/s < 0.6 \text{ and } b/s > 3.4 \]
\[
\begin{align*}
\sigma &= \left(1, 15 - \frac{b}{s}\right) \text{ for } 0.6 < \frac{b}{s} < 1.0 \\
\sigma &= \left(1, 15 - \frac{b}{s}\right) \text{ for } 1.0 < \frac{b}{s} < 3.4 \\
c &= \text{ as given in 301.} \\
d &= a \text{ for } a < l \\
d &= l \text{ for } a > l \\
a, b \text{ and } p &= \text{ as given in 200} \\
m &= \frac{a}{l} \text{ for } \frac{a}{l} \leq 1.0 \\
m &= \frac{87}{\left(\frac{a}{l}\right)^2 - 4, 7\frac{a}{l} + 6, 5} \\
m &= 12 \text{ for } \frac{a}{l} \geq 3, 5 \\
r &= \text{ factor depending on the rigidity of girders supporting continuous stiffeners, taken as 29 unless better support conditions are demonstrated} \\
r &= 38 \text{ when continuous stiffener may be considered as rigidly supported at each girder.} \\
\end{align*}
\]

Between specified values of \(a/l\) the \(m\)-value may be varied linearly. The \(m\)-value may also be obtained from Fig. 3.

For longitudinal between 0.4 \(L\) amidships and 0.1 \(L\) from the perpendiculars \(\sigma\) is to be varied linearly.

For longitudinal in ‘tween decks \(\sigma\) may be found by interpolation as given for plating in 301.

<table>
<thead>
<tr>
<th>Condition</th>
<th>(\sigma) in (N/mm^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seagoing</td>
<td>(225f_1 - 130f_2 \frac{z_n - z}{z_n})</td>
</tr>
<tr>
<td>Harbour</td>
<td>(225f_1 - 85f_2 \frac{z_n - z}{z_n})</td>
</tr>
</tbody>
</table>

For more than one load area can be positioned simultaneously on the same stiffener span or adjacent spans, the sections modulus will be specially considered, based on direct stress analysis.

C 500 Girders

501 The scantlings of girders will be specially considered based on the most severe condition of moving or stowed vehicles. Allowable stresses are as given in Pt.3 Ch.1 Sec.13 B400.

The vehicle loads are to be taken as forces

\[
P_V = Q_W (9.81 + 0.5 a_v) \quad (\text{kN})
\]

\(a_v\) = vertical acceleration as given in 201

\(Q_W\) = load on wheel group or single wheel in t.

502 The scantlings of girders being part of a complex system are normally to be based on a direct stress analysis, see Pt.3 Ch.1 Sec.13.

C 600 Details

601 Girders and stiffeners are not to be scalloped. Double continuous fillet welds are normally to be used between the plating and the strength member. Chain welds may be accepted after special consideration when vehicles are fitted with pneumatic or solid rubber tyres.

602 The necessary connection areas between stiffeners and girders will be specially considered. The shear stresses are not to exceed 100 \(N/mm^2\) in the members to be joined and 115 \(N/mm^2\) in the weld material.
a) SINGLE WHEEL, GENERAL

b) DOUBLE WHEELS, AXLE PARALLEL TO STIFFENERS

c) DOUBLE WHEELS, AXLE PERPENDICULAR TO STIFFENERS

d) TRIPLE WHEELS, AXLE PARALLEL TO STIFFENERS

Fig. 4
Plate thickness for wheel loadings
SECTION 5
DRY BULK CARGO CARRIERS

A. General

A 100 Classification

101 The requirements in this section apply to ships intended for carriage of dry bulk cargoes. Relevant requirements for general cargo ships given in Sec.4 are also to be complied with.

102 The mandatory ship type and service notation Bulk Carrier ESP ES(...) is to be assigned to ships built in compliance with the requirements given in subsections B and C, the additional requirements in Sec.10, as specified in Table A1, and with the following characteristics:

Sea-going single deck ships of single or double side skin construction, with a double bottom, hopper side tanks and topping tanks fitted below the upper deck, and intended for the carriage of dry cargoes in bulk. Typical midship sections are given in Fig. 1.

Fig. 1
Typical midship sections
a) Single side skin bulk carrier
b) Double side skin bulk carrier or combination carrier

<table>
<thead>
<tr>
<th>Ship type</th>
<th>Length, L (m)</th>
<th>Subsection A</th>
<th>Subsection B</th>
<th>Subsection C</th>
<th>Subsection D</th>
<th>Subsection E</th>
<th>Subsection F</th>
<th>Applicable class notation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single side skin bulk carrier</td>
<td>L ≥ 150</td>
<td>x</td>
<td>x</td>
<td>x 2)</td>
<td>x 2)</td>
<td>x 2)</td>
<td>x</td>
<td>ES(S)</td>
</tr>
<tr>
<td>Double side skin bulk carrier</td>
<td>L ≥ 150</td>
<td>x 1)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>x</td>
<td>ES(D)</td>
</tr>
<tr>
<td></td>
<td>L ≤ 150</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>x</td>
<td>ES(D)</td>
</tr>
</tbody>
</table>

x Applicable
x 1) Applicable except requirements relating to application of subsection C
x 2) Applicable for vessels intended to carry bulk cargo with density of 1,0 t/m³ or above
- Not applicable

(S) Single side skin bulk carrier
(D) Double side skin bulk carrier

Subsection A refers to IACS Unified Requirement, S1A, regarding loading manual/loading instrument.
Subsection B refers to IACS Unified Requirement, S12, regarding side frames.
Subsection C refers to IACS Unified Requirement, S17, regarding hull girder strength in flooded condition.
Subsection D refers to IACS Unified Requirement, S18, regarding transverse bulkhead strength in flooded condition.
Subsection E refers to IACS Unified Requirement, S20, regarding allowable hold loading considering flooding.
Subsection F refers to IACS Unified Requirement, S21, regarding hatch cover strength.

103 The notation Bulk Carrier ESP ES(...) may be given to ships built in compliance with the requirements in subsections B, C, the additional requirements in Sec.10 as specified in Table A1, and with structural arrangement different from that defined in 102.

The additional notations HC, HC-E or HC-EA may be given to all bulk carriers.

104 The notation Bulk Carrier implies that the ship is designed for largely homogeneous loading conditions as implied by the following load assumptions:

— any cargo hold may be filled with bulk cargo of the homogeneous stowage rate at a minimum draught which is not larger than 0,6 T
— any hold may be empty at a maximum draught which is not less than 0,6 T.

105 The notation HC implies in addition that heavy bulk cargo may be unevenly distributed among the cargo holds. By consideration of local strength as given in C300 and C400, the following load assumptions apply:
— any single hold may be filled with bulk cargo with density exceeding the homogeneous stowage rate by not less than 25% at a minimum draught which is not larger than 0.8 T
— any hold may be empty at a maximum draught which is not less than 0.8 T
— any two adjacent holds may be filled with bulk cargo with density exceeding the homogeneous stowage rate by not less than 12.5% at full draught.

106 The notation HC-E implies in addition to HC that a non-homogeneous loading condition with empty holds on full draught has been approved. The full draught condition(s) for HC-E notation are to be achieved without the use of ballast. A notation of the combination of empty holds will be added, e.g. HOLDS 2, 4, 6 EMPTY.

107 The notation HC-EA implies that by consideration of local strength as given in C300 and C400, the following load limitations apply:

— any single hold may be filled with bulk cargo with a density exceeding the homogeneous stowage rate by not less than 50% at full draught
— any hold may be empty at full draught
— any two adjacent holds may be filled with bulk cargo with density exceeding the homogeneous stowage rate by not less than 25% at full draught.

For approved loading condition(s) with empty cargo holds on full draught, a notation of the combination(s) of empty holds will be added, e.g. HOLDS 2, 4, 6, 8 EMPTY or ...... EMPTY.

Guidance note:
In order that the ship is ensured sufficient loading flexibility (in way of its hull girder bending and shear strength), longitudinal strength calculations as required under Pt.3 Ch.1 Sec.1 C201 should include all desired non-homogeneous cargo conditions with empty cargo holds.

108 The additional notation NAUTICUS(Newbuilding) is mandatory for bulk carriers with class notations and length as described below:

— Ships with class notation Bulk Carrier ESP or Bulk Carrier ESP HC with length L greater than 190 m.
— Ships with class notation Bulk Carrier ESP HC-E or Bulk Carrier ESP HC-EA with length L greater than 170 m.

L = Ship length as given in Pt.3 Ch.1 Sec.1 B101.

The notation NAUTICUS(Newbuilding) is described in Pt.3 Ch.1 Sec.16 and comprises extended fatigue - and direct strength calculations. Areas for fatigue calculations are further described in C307, and areas for direct strength calculations are described in C403.

109 For bulk carriers (which are equipped with a loading computer system, see Pt.3 Ch.1 Sec.5) generalised limitations for loading of single cargo holds or combinations of holds at varying draught etc. are normally to be determined based on the load assumptions stated in 104 to 107, on submitted information given in accordance with 200 and on the direct calculations as required in C400.

110 After special consideration, the class notation HC, HC-E or HC-EA may be given to ships other than bulk carriers.

111 The mandatory ship type and service notation Ore Carrier ESP ES(O) is to be assigned to sea-going single deck ships having two longitudinal bulkheads and a double bottom throughout the cargo region, and intended for the carriage of ore cargoes in the centre holds only. Typical midship sections are given in Fig. 2a and Fig. 2b.

The ships are to be built in accordance with the requirements in B and D and the additional requirements given in Sec.10 as specified in Table A2.

---

**Fig. 2**

**Typical midship sections**

a) Ore Carrier
b) Combination Carriers

---

**Table A2 Reference to applicable requirements given in Section 10**

<table>
<thead>
<tr>
<th>Ship type</th>
<th>Length (m)</th>
<th>Subsection A</th>
<th>Subsection B</th>
<th>Subsection C</th>
<th>Subsection D</th>
<th>Subsection E</th>
<th>Subsection F</th>
<th>Applicable class notation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ore carrier or combination carrier</td>
<td>L ≥ 150</td>
<td>x 1)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>ES(O)</td>
</tr>
<tr>
<td></td>
<td>L &lt; 150</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

x 1) Applicable except requirements relating to application of subsection C

1) Not applicable

O Ore carrier

Subsection A refers to IACS Unified Requirement, S1A, regarding loading manual/loading instrument.

Subsection B refers to IACS Unified Requirement, S12, regarding side frames.

Subsection C refers to IACS Unified Requirement, S17, regarding hull girder strength in flooded condition.

Subsection D refers to IACS Unified Requirement, S18, regarding transverse bulkhead strength in flooded condition.

Subsection E refers to IACS Unified Requirement, S20, regarding allowable hold loading considering flooding.

Subsection F refers to IACS Unified Requirement, S21, regarding hatch cover strength.

---

112 Ships built in compliance with the requirements in Ch.11 may be given the class notation DG-B. A list of dangerous solid bulk cargoes for which the ship is found suitable, will be included in the appendix to the classification certificate.

A 200 Documentation

201 For ships with class notations HC-E and HC-EA, loading condition(s) (maximum bunker and minimum bunker) with combination(s) of empty and loaded holds at full draught are to
be submitted for approval. The associated longitudinal strength calculation(s) and possible special still water bending moment limit (hoggling and sagging), see C300, are to be submitted for information in accordance with Pt.3 Ch.1 Sec.1 C200.

202 Design loads are to be submitted for information in accordance with Pt.3 Ch.1 Sec.1 C200 as follows:

— design load for holds in terms of maximum cargo mass (M_H) in hold t, design pressure load (p) for inner bottom in kN/m², or maximum cargo stowage rate (ρ) filling the hold and hatch in t/m³. Note that the design cargo stowage rate is generally assumed to be related to the design pressure load for the inner bottom by the following formula:

\[ \rho = \frac{p}{g_H H} \quad (t/m^3) \]

H = height from inner bottom to top of hatch coaming in m

— lateral design load for cargo bulkheads in terms of stowage rate and angle of repose of bulk cargoes. Note that the maximum lateral bulkhead load is generally given by a cargo filling the complete hold with the largest bulkhead lateral pressure density, \( \rho_c \) defined as:

\[ \rho_c = \rho \tan^2 (45 - \delta / 2) \quad (t / m^3) \]

\( \rho = \) cargo stowage rate in t/m³
\( \delta = \) associated angle of repose of cargo in degrees

— design load for cargo on deck and hatch covers in kN/m² as applicable

— load limitations for tanks as applicable.

203 Applicable limits to mass of cargo in holds as given by the ship strength, defined in terms of diagrams and/or formulae are to be submitted for approval. The approved limits are to be included in the ships’ loading manual and included into the loading computer system in accordance with Pt.3 Ch.1 Sec.5. Load limitations to be considered are:

— allowable mass of cargo in hold in relation to ship draught, still water bending moment limit etc.

— allowable mass of cargo in hold in relation to angle of repose of cargo (Note normally no special limit need be formulated for cargo holds designed for cement cargo filling the complete hold)

— allowable mass of cargo in two adjacent holds in relation to ship draught.

Accepted procedures for the determination of load limitations are given in Classification Note No. 31.1 «Strength Analysis of Hull Structures in Bulk Carriers and Container Ships».

Guidance note:

204 is not relevant for vessels complying with requirements given in Sec.10, items A200, A300 and A400.

---end---of---Guidance---note---

205 Specifications for corrosion prevention systems for water ballast tanks, comprising selection, application and maintenance, as defined in Table A1 in Pt.3 Ch.1 Sec.18 or Table A1 in Pt.3 Ch.2 Sec.14, as applicable, are to be submitted for information for Bulk Carrier ESP and Ore Carrier ESP.

A 300 Structural and leak testing

301 Testing is to be in accordance with Pt.3 Ch.1 Sec.1 Table D1 or Pt.3 Ch.2 Sec.1 Table D1.

B. Design Loads

B 100 Design cargo density and angle of repose

101 The design load for cargo hold is to be based on the largest cargo mass, \( M_H \), according to the submitted loading conditions, see A200, for the hold considered, but in any case not to be taken less than as given by:

\[ M_H = k \rho_{DC} V_H \quad (t) \]

k = 1.0 for ships with class notations Bulk Carrier or Ore Carrier

= 1.25 for ships with additional class notation HC or HC-E

= 1.50 for ships with additional class notation HC-EA

\( \rho_{DC} = \) Ship cargo deadweight capacity \( (t/m^3) \)

\( V_H = \) total cargo hold volume

= 0.7 minimum

102 The design angle of repose, \( \delta \), of bulk cargo is generally not to be taken greater than:

Light bulk cargo (grain etc.): \( \delta = 20 \) degrees

Heavy bulk cargo: \( \delta = 35 \) degrees

Cement cargo: \( \delta = 25 \) degrees (associated cargo density 1.35 t/m³).

103 For the calculation of plates and stiffeners the cargo density of any hold is to be taken as given by:

\[ \rho = \frac{M_H}{V_H} \quad (t/m^3) \]

104 For the direct calculation of girder structures, the design cargo density of any hold is to be taken as given by:

\[ \rho = \frac{M_H}{V} \quad (t/m^3) \]

\( V = V_H \) for calculation of cargo bulkhead structures.

= \( V_{HR} \) for calculation of hold girder structure other than cargo bulkheads

\( M_H, V_H \) as given in 101.

B 200 Lateral pressure loads

201 The design pressures for local elements (i.e. plates and stiffeners) are to be determined as given in Pt.3 Ch.1 Sec.4 using parameters given in 100.
202 For direct calculation of girder structures, design pressures are to be determined as given in Pt.3 Ch.1 Sec.13 using parameters given in 100.

C. Bulk Carriers (full breadth holds)

C 100 Hull arrangement

101 The ship is to have a double bottom in way of the cargo holds, and is in general arranged with a single deck.

Larger bulk carriers (> 100 000 DWT) with hopper and top wing tanks, are to be arranged with strength bulkheads (tank or wash bulkheads) in line with the cargo bulkhead upper and lower stool.

102 The strength requirements are given for cargo holds extending over the full breadth of the ship (or between double side structures).

103 A longitudinal stiffening system is assumed applied for the bottom- and inner bottom panels within the cargo region.

C 200 Longitudinal strength

201 The longitudinal strength is to be determined as given in Pt.3 Ch.1 Sec.5 (Ch.2 Sec.4 for ships with L < 100 m).

202 In the region between fore bulkhead in after cargo hold and after bulkhead in fore cargo hold, the side plating thickness is not to be less than:

\[ t = \frac{0.0036}{f_1} L \cdot \sqrt[3]{B} \] (mm)

In way of double side skin regions, the thickness t may be taken to represent the combined thickness of the side and the inner side plating.

If the ratio between the cargo hold length and ship's breadth exceeds 1.0, the side plating thickness will be specially considered.

Outside the region mentioned above, the side plating thickness can be varied linearly to give the shear area required by the main class at fore end of machinery spaces and after end of fore peak or adjacent deep tank.

C 300 Plating and stiffeners

301 Thicknesses and cross-sectional properties are in general to be calculated as given for the main class using design pressure according to B200 where applicable.

302 For the design of structural members of the double bottom of ships with class notations HC-E and HC-EA, the stress factor \( f_{2BH} \) (in hogging and sagging) as given in Pt.3 Ch.1 Sec.6 A may for the loading conditions with empty holds on full draught as defined in A100 be based on reduced still water bending moment limits. The limits are defined by the maximum moments in hogging and sagging (= 0.5 \( M_{so} \) as given in Pt.3 Ch.1 Sec.5 B, minimum occurring for these loading conditions, unless higher limits are specified to be used.

303 The thickness of web and flange of main frames situated within cargo holds is not to be less than the larger of:

\[ t = 6.0 + 0.03 \frac{L_2 + t_k}{h/g + t_k} \] (mm)

\( h/g + t_k \) = profile height in mm
\( g \) = 70 for flanged profile webs
\( t_k = 20 \) for flat bar profiles
\( L_2 \) = length of ship in metres, need not be taken greater than 200 m.

(IACS UR S12)

304 The thickness of inner bottom plating between hopper or side tanks in ships with class notation HC. HC-E and HC-EA is not to be less than as required in Pt.3 Ch.1 Sec.6 C400. The thickness is in no case to be less than:

\[ t = 9.0 + \frac{0.036 L_2}{\sqrt{f_1}} + t_k \] (mm)

305 The section modulus of bottom longitudinals (except in way of hopper and side tanks) for sea pressure loads in ore loading conditions in ships with class notation HC. HC-E or HC-EA is not to be less than according to the requirements given in Pt.3 Ch.1 Sec.6 with:

\[ \sigma = 245 f_1 - 40 f_{2BH} - 0.7 \sigma \text{ in empty holds} \]
\[ = 245 f_1 - 40 f_{2BS} - 0.7 \sigma \text{ in ore loaded holds} \]
\[ = 160 f_1 \text{ maximum} \]

\( f_1 \) = material factor as given in Sec.1 B100 with respect to the bottom longitudinal

\( \sigma \text{gh} = 190 f_{1BH}, \text{but need not be taken larger than} \)

\( \sigma \text{DB} + 130 f_{2BH} \)

\( \sigma \text{gs} = 190 f_{1BH}, \text{but need not be taken larger than} \)

\( \sigma \text{DB} + 130 f_{2BS} \)

\( f_{1BH} \) = material factor \( f_1 \) as given in Sec.1 B100 with respect to the bottom plating

\( \sigma \text{DB} = \text{longitudinal double bottom girder stress at middle of hold in N/mm}^2 \text{ with respect to the bottom plating according to direct calculation as described in Classification Note No. 31.1} \]

\( f_{2BH} = f_{2BH} \) as given in Pt.3 Ch.1 Sec.6 A with respect to hogging still water bending moment (see also 302)

\( f_{2BS} = f_{2BS} \) as given in Pt.3 Ch.1 Sec.6 A with respect to sagging still water bending moment (see also 302).

306 The section modulus of inner bottom longitudinals in ships with class notation HC. HC-E and HC-EA is for ore pressure loads not to be less than according to the requirement given in Pt.3 Ch.1 Sec.6 with:

\[ \sigma = 265 f_1 - 30 f_{2BH} - 0.7 \sigma \text{ in empty holds} \]
\[ = 160 f_1 \text{ maximum} \]

\( f_1 \) = material factor as given in Sec.1 B100 with respect to the inner bottom longitudinal

\( \sigma \text{gs} = 190 f_{1BH}, \text{but need not be taken larger than} \)

\( \sigma \text{DB} + 100 f_{2BH} \)

\( f_{1BH} \) = material factor \( f_1 \) as given in Sec.1 B100 with respect to the inner bottom plating

\( \sigma \text{DB} = \text{longitudinal double bottom girder stress at middle of hold in N/mm}^2 \text{ with respect to the inner bottom plating according to direct calculation as described in Classification Note No 31.1} \]

\( f_{2BH} = f_{2BH} \) as given in 305.

307 For vessels as mentioned in A108 fatigue strength assessment is in general to be carried out for end structures of longitudinals in bottom, inner bottom, side, inner side, longitudinal bulkheads and strength deck in the cargo area, as described in Pt.3 Ch.1 Sec.17.

C 400 Girder systems

401 For girders which are parts of a complex 2- or 3-dimensional structural system, a complete structural analysis may have to be carried out to demonstrate that the stresses are acceptable when the structure is loaded as described in 404.

402 Calculations as mentioned in 401 are applicable for:

- double bottom structures in way of full breadth holds/tanks intended for ballast or liquid cargo
- top wing tank, side and hopper tank structure in long bulk cargo holds
— transverse bulkhead structure in bulk cargo holds
— transverse web frame structures in ships with a small number of transverse bulkheads
— deck and cargo hold structures in open type ships
— other structures as required elsewhere in the rules or otherwise when deemed necessary by the Society.

403 For vessels as described in A108 direct strength calculations performed by the finite element method apply. These calculations shall follow the principles described in Pt.3 Ch.1 Sec.16 B, in addition to the principles described in this section, and shall determine stresses and deformations in the main framing and girder system, in areas as given below:

— typical longitudinal girder in double bottom/ side.
— typical web frames in hopper and top wing tanks, including floors and main frames at midhold in midship area
— typical corrugation of transverse bulkhead with connection to upper and lower stool
— transverse section in the duct keel in line with the lower transverse bulkhead stool side

In addition, stresses in laterally loaded longitudinals subject to relative deformation between supports are normally to be considered.

The effect of relative deformation is to be taken into account in the fatigue evaluation of longitudinals required in 307.

404 The following cases are generally to be considered:

a) Ballast in ballast hold (with adjacent holds empty) at ballast draught, $T_B$, and with respect to double bottom, transverse bulkhead and top wing tank/ship side strength. For the top wing tank and side structures also the heeled condition is to be considered, see also Fig. 3.

b) Ballast in top wing tank with respect to top wing tank strength in the upright and heeled conditions, see Fig. 4.

c) Cargo on deck (as specified) and external sea pressure on deck (in particular forward holds) with respect to deck (and top wing tank) strength, see Fig. 5.

d) Heavy cargo in hold (with adjacent hold empty), see A100, with respect to strength of double bottom of the loaded and adjacent empty holds. Generally only conditions(s) with untrimmed ore cargo filling the volume $V_{HR}$ (as given in B104) of the hold need be considered, see Fig. 6.

e) $V_{HR}$Heavy cargo filling the volume (as given in B104) of two adjacent holds, see A100, with respect to cross-deck and bulkhead shear strength, see Fig. 7.
f) Heavy cargo as given in A100 filling the entire cargo hold with respect to cargo bulkhead strength for lateral load.

405 For vessels as mentioned in A108 the fatigue calculation of dynamic stresses and relative deformations for the fatigue evaluation of longitudinals, shall be carried out with load cases as given in Pt.3 Ch.1 Sec.17.

406 Harbour conditions need normally not be specially considered provided the minimum draught in harbour with filled cargo hold is not less than two thirds of the draught in the associated approved seagoing condition.

407 Allowable stresses are generally to be taken as given in Pt.3 Ch.1 Sec.13. For double bottom longitudinal girders, the girder bending stresses are not to exceed the following limits:

- bottom plate at middle of empty hold (and at transverse bulkhead of loaded or ballasted hold):
  \[ \sigma = 190 f_1 - 130 f_{2BH} \]
- inner bottom plate at middle of loaded holds (and at transverse bulkhead of empty hold):
  \[ \sigma = 190 f_1 - 100 f_{2BH} \]
- bottom plate at middle of loaded or ballasted hold (and at transverse bulkhead of empty hold):
  \[ \sigma = 190 f_1 - 130 f_{2BS} \]
- inner bottom plate at middle of empty hold (and at transverse bulkhead of loaded or ballasted hold):
  \[ \sigma = 190 f_1 - 100 f_{2BS} \]

\[ f_{2BH} \] as given in 305
\[ f_{2BS} \] as given in 305.

408 Acceptable calculation methods are given in Classification Note No. 31.1 «Strength Analysis of Hull Structures in Bulk Carriers and Container Ships».

C 500 Corrosion prevention

501 Specifications for corrosion prevention systems for water ballast tanks, comprising selection, application and maintenance, are to be submitted as defined in Table A1 in Pt.3 Ch.1 Sec.18 or Table A1 in Pt.3 Ch.2 Sec.14, as applicable.

502 All internal and external surfaces of hatch coamings and hatch covers and all internal surfaces of the cargo holds, excluding the flat tank top areas and the hopper tanks sloping plating and transverse bulkheads bottom stool approximately 300 mm below the side shell frame and brackets, are to have an efficient protective coating (epoxy or equivalent) applied in accordance with the manufacturer's and builder's recommendation. (See Fig.8)

Guidance note:
In the selection of coating, due consideration should be given by the owner to intended cargo conditions expected in service.

---e-n-d-o-f-G-u-i-d-a-n-c-e-n-o-t-e---

D. Ore Carriers (holds between longitudinal bulkheads)

D 100 Hull arrangement

101 The ship is to have two effective longitudinal bulkheads.

102 It is assumed that only spaces between the longitudinal bulkheads are used as cargo holds.

103 A double bottom is to be fitted in way of the cargo holds.

D 200 Plating and stiffeners

201 Thicknesses and cross-sectional properties are in general to be calculated as given for the main class using design pressure according to B, where applicable.

202 The thickness of inner bottom plating in cargo holds is not to be less than:

\[ t = 9.0 + \frac{k}{\sqrt{10}} + t_k \] (mm)

\[ k = 12 \text{ s} \]
\[ = 0.03 L_t, \text{ whichever is the larger.} \]

D 300 Girders systems

301 The transverse strength of the double bottom, wing tank and deck structures considered as a complete structure and transverse bulkhead structures are to be based on direct stress analysis as outlined for the main class.

302 The following cases are generally to be considered:

a) Ballast in ballast tanks with adjacent cargo holds empty at ballast draught \( T_B \), see Fig. 9.
c) Ore cargo filling hold completely with adjacent holds/spaces empty at draught $T$, see Fig. 11.

303 A special grillage calculation of the double bottom will normally not be required.
SECTION 6
CONTAINER CARRIERS

A. General

A 100 Classification

101 The requirements in this section apply to ships intended for carriage of standard freight containers for general cargo at predetermined positions on board, in holds and/or on weather deck. Relevant requirements for general cargo ships given in Sec.4 are also to be complied with.

Subsection B need in general not be considered for container carriers with length L < 100 m.

102 Ships exclusively intended for the carriage of containers and arranged with cell guides in holds and built in compliance with relevant requirements specified in the following may be given the class notation Container Carrier.

103 Ships intended also for other purposes, while arranged, strengthened and equipped for carriage of containers on deck and/or in holds and built in compliance with relevant requirements specified in the following, may be given the class notation General Cargo Carrier Container.

Containers carried on deck or in holds on such ships are to be secured by an approved method. The securing arrangement is to be approved and only equipment certified or type approved by the Society is to be used for securing. However, loose container securing equipment need only be carried onboard to the extent the ship is carrying containers.

Ships intended to carry containers with dangerous goods (packed goods, dry bulk or portable tanks) are to comply with the requirements of Ch.11.

104 For ships with class notations as given in 102 and 103, a notation of the maximum number of twenty-foot equivalent units (TEU) that may be carried will be added, e.g. 1750 TEU.

105 The additional notation NAUTICUS(Newbuilding) is mandatory for ships with the class notation: Container Carrier with length, L, greater than 190 m.

L = Ship length as given in Pt.3 Ch.1 Sec.1 B101.

The notation NAUTICUS(Newbuilding) is described in Pt.3 Ch.1 Sec.16 and comprises extended fatigue - and direct strength calculations. Areas for fatigue calculations are further described in C308, and areas for direct strength calculations are described in C402.

A 200 Scope

201 The following matters are covered by the classification:

— arrangements for stowing and securing of containers in holds and on weather deck
— design, construction and installation of permanent supporting fittings and structures for the containers
— design and construction of removable container securing equipment For equipment produced in series the Society’s Type Approval scheme may be applied
— instructions (Manual) for stowing and securing of the containers
— hull structure of ships intended for carriage of standard freight containers for general cargo in cellular cargo holds as given in B.

202 When an instrument is installed as a supplement to the Stowage and Securing manual, this is to be approved by the Society.

A 300 Assumptions

301 The classification of the ship is based on the assumptions that:

— the approved «Container Stowage and Securing Manual» is kept available on board for the stowage and securing of container cargo
— all required equipment for the securing of containers are of strength, design and make approved by the Society for its purpose
— the containers are stowed and secured in accordance with the approved Manual and the approved stowage and securing plans
— all container securing equipment is properly maintained and repaired
— damaged equipment is replaced by equipment which is type approved and of at least the same strength rating
— the approved instrument for stowage and securing of containers is checked at regular intervals.

302 The above assumptions for the classification are to be stated in the approved «Container Stowage and Securing Manual» onboard.

A 400 Definitions

401 Terms:

— Container: Freight container according to ISO-standard, or other specially approved container.
— Container stack: Containers which are stacked vertically and secured horizontally by stackers, lashings etc., see Fig. 1.
— Container block: A number of container stacks interconnected and secured horizontally by bridge stackers, see Fig. 2.
— Minimum breaking load: Tested minimum breaking strength of wire rope, chain, rod or other member in accordance with rule specifications.
— Non-rigid securing arrangements: Securing arrangements where the stiffnesses of containers influence support forces and internal forces in the containers, e.g. lashing arrangements.
— Rigid securing arrangements: Securing arrangements where the stiffnesses of the containers do not influence support forces and internal forces in the containers, e.g. cellular containment arrangements.
— Container securing equipment: Loose and fixed equipment used for securing and supporting of containers.
— Container support fittings: Fittings welded into tank tops, decks, bulkheads or hatch covers (i.e. fittings that form an integral part of the ship structure).
— Cell guides: An arrangement in holds or on deck of fixed vertical guide rails for support of containers.
— Working load: Calculated maximum force in supporting member according to analysis as described in the rule requirements.
A 500 Documentation

501 In connection with the longitudinal strength calculations and design load conditions to be submitted for information according to Pt.3 Ch.1 Sec.1 C200, information is to be submitted as relevant regarding:

— maximum hull girder still water torsional moments
— unsymmetrical design loading conditions.

502 Load data relating to the design approval of the hull structure including supporting structures and securing arrangements for containers are to be submitted for information. The following generally are to be considered:

a) Mass limitations applicable for:

— containers of given locations and size categories
— container stacks of given locations
— mean container mass for given bays of cargo holds or deck locations
— total container mass for given hatch covers.

b) Design load limitations for cargo holds such as:

— full draught condition with minimum mass of cargo in cargo hold or part of cargo hold
— reduced (minimum) draught condition with cargo hold or part of cargo hold fully loaded.

c) Mass limitations in relation to specified GM limitations.

503 The following plans are to be submitted for approval for each container stowing space in holds and each stowing area on decks and on hatch covers:

a) A container stowage plan including specification of:

— sizes of containers to be transported
— applicable mass limitations for loaded containers and container stacks etc.
— strength standard for containers in relation to location etc.

b) A container securing plan showing arrangements of loose and fixed equipment for the securing and support of containers, including:

— container securing equipment with data regarding type, dimensions, allowable working load and specified pre-stressing
— support fittings with data regarding position, type, dimensions and allowable working load.

c) Drawings and specifications of structure or fitting with adjoining supporting structures in hull or hatch covers of:

— cell guides
— permanent support fittings.

504 A «Container Stowage and Securing Manual» is to be submitted for approval. The Manual is to include copies of the container stowage and securing plans as well as an inventory list for all container securing equipment required for the ship. The inventory list is to be supplemented by product certificates as specified in 604 for each item. The inventory list is to be updated and new product certificates added if items are replaced by alternative equipment makes or types. Instructions and sketches showing proper stowing and securing of the containers and use of securing equipment are also to be included in the Manual.

505 Calculations of maximum forces and stresses in container supports, and adjoining hull structures (e.g. hatch covers and supporting coamings and girders), cell guides, lashings, containers etc. are to be submitted for consideration. Such calculations may be based on principles and methods outlined in Classification Note No. 32.2 «Strength Analysis of Container Securing Arrangements».

506 A drawing showing nominal cell guide/container clearances and specified building tolerances of container cell guides is normally to be submitted for information. When cargo loading conditions which are unsymmetrical about the ships’ centre line are intended, information on the minimum diagonal cell guide/container clearance required for loading/unloading purpose may be requested to be submitted for information.

507 For ships furnished with an instrument for the stowage and securing of containers, see 700.

A 600 Certification

601 Container support fittings and cell guides are to be delivered with Det Norske Veritas’ material certificates.

602 Type approval will be according to the general scheme outlined in Pt.1 Ch.1 Sec.3 A900 and in Certification Note 1.1. The Society will issue a Type Approval Certificate valid for 4 years and the product will be entered in the «List of Type Approved Products».
603 Container securing equipment may be delivered with works material certificates from the manufacturer.
604 In addition to the material certificates required in 601 and 603, all loose and fixed container securing equipment and support fittings are to be delivered with product certificates. The certificates should contain at least the following information:

— name of manufacturer
— type designation of item
— material(s)
— identification marking
— test procedure
— test results of strength tests (breaking load and proof load) if applicable
— results of non-destructive examination if applicable
— allowable working load.

Equipment may be type approved or case-by-case approved.

If it is agreed in a Manufacturing Survey Arrangement with the Society, the Product Certificate may be issued by the manufacturer. Otherwise, the Product Certificate is to be issued by the Society.

A 700 Container stowage and securing instrument

701 The container stowage and securing instrument is subject to approval and certification.

702 For general requirements related to documentation of instrumentation and automation, including computer based control and monitoring, see Pt.4 Ch.9 Sec.1.

703 The documentation is to include:

— definition of container stowage positions and associated (alternative) securing arrangements
— strength standard of containers, securing equipment and supports
— limitations to loading condition (e.g. mass of containers at given locations, or hull girder torsional moment by container cargo etc.) as applicable
— test conditions (at least 5) with printout showing internal forces in containers, and securing and support forces etc. in relation to the allowable limits. The test conditions are to be supplemented with checks by independent calculation
— references to applicable load limitations which are not included in the instrument itself.

704 The operation manual for the container stowage and securing instrument is always to be available on board.

705 The operation manual and the instrument output must be prepared in a language understood by the users. If this language is not English a translation into English is to be included.

706 The instrument is to control that applicable requirements of the rules are complied with for given container mass and securing configuration with respect to:

— internal forces in containers
— forces in securing equipment
— forces in supports.

707 The determination of forces in containers, securing equipment and supports must be based on accepted calculation methods, see also Classification Note No. 32.2.

B 100 Definitions

101 Symbols

\[ f_1 = \text{as given in Sec.1 B with respect to the considered member} \]
\[ f^*_2 = \text{longitudinal stress parameter, applicable for transversely stiffened plates and longitudinal stiffeners of the hull cross-section, given by:} \]
\[ f^*_2 = \frac{5.7 (M_1 + M_2)}{Z_B} \]

The value of \( f^*_2 \) may in general be taken equal to the \( f_2 \) as given in Pt.3 Ch.1 Sec.6 A and Sec.8 A within 0.4 L amidship. The \( f^*_2 \) is to be determined for hull cross-sections at positions where the hull girder section modulus has been checked according to 202\( f^*_2 \). The \( f^*_2 \) may be taken equal to 0.5 \( f_1 \) within 0.1 L from AP or FP unless the hull girder section modulus has been checked in this area according to 202.

Between the given positions, \( f^*_2 \), may be determined by linear interpolation.

\[ f^*_{2B} = f^*_2 \text{with respect to the hull girder section modulus at bottom} \]
\[ f^*_{2D} = f^*_2 \text{with respect to the hull girder modulus at deck} \]

\( k_j \) parameter for determination of allowable stresses for laterally loaded plates

\[ = 3.5 (1 - f^*_2 / f_1) \]

\( x \) = distance in m from L/2 to considered position

\( = 0.2 \text{ L minimum} \]

\( = 0.4 \text{ L maximum} \]

\( = k_j \text{ with respect to } f^*_{2D} \]

\( = k_j \text{ with respect to } f^*_{2B} \)

\( Z_B \) = section modulus at bottom or deck in cm\(^3\) of hull girder as built at section considered

\( M_S \) = design still water bending moment at considered section in kNm. The \( M_S \) is generally not to be taken less than 0.5 \( k_{sm} \cdot M_{SO} \)

\( k_{sm} \cdot M_{SO} \) = as given in Pt.3 Ch.1 Sec.5 B100

\( M_W \) = Rule wave bending moment at considered section in kNm given in Pt.3 Ch.1 Sec.5 B. Hogging or sagging moment is to be chosen in relation to the applied still water moment.

B 200 Longitudinal and buckling strength

201 The longitudinal and buckling hull girder strength are in general to be determined as given in Pt.3 Ch.1 Sec.5 and Sec.14.

202 The requirements given in 203 and 204 will normally be satisfied if calculated with respect to the midship section and characteristic sections of the end ship regions. Cross- sections where the arrangement of longitudinal material changes is of particular interest. As a minimum sections at or close to the aft- and forward quarterlength positions and at the ends of the open cargo region must be evaluated.

203 The requirement for section modulus of the hull girder about the transverse axis is for any section to be taken as given in Pt.3 Ch.1 Sec.5 C303 with \( \sigma_f = 175 \text{ f_1} \text{ (N/mm}^2\text{).} \)

The \( M_S \) may, subject to acceptance in each case, be based on the envelope curve representing all relevant full- and part load cargo- and ballast conditions as given in Pt.3 Ch.3 Sec.5 A101.

Guidance note:
It is advised that the still water bending moment \( M_S \) values, if based on Pt.3 Ch.1 Sec.5 A101, are taken with a margin of, say 5%, relative to the moment envelope of the ship's design loading conditions.

---end---of---Guidance---note---
The combined normal stress of vertical and horizontal girder bending and of torsional moment is at any position not to exceed 195 f1 N/mm². The combined stress may be taken as:

\[
\sigma = |\sigma_{\text{STAT}} + \sigma_{\text{DYN}}| \quad (N/mm^2)
\]

\[
\sigma_{\text{STAT}} = \sigma_S + \sigma_{\text{ST}}
\]

\[
\sigma_{\text{DYN}} = \sigma_W + \sigma_{\text{WH}} + \sigma_{\text{WT}}
\]

\[
\sigma_S = M_S (z_n - z_a) 10^5 / I
\]

\[
\sigma_W = M_{\text{WR}} (z_n - z_a) 10^5 / I
\]

M_WR = reduced vertical wave bending moment to be considered for the combined response

I = moment of inertia in cm⁴ of hull girder about the horizontal axis at section considered

z₀ and z_a = as given in Sec. 1 B

σ_WH = M WH y_a 10⁵ / I_H

I_H = moment of inertia in cm⁴ of hull girder about the vertical axis at section considered

y_a = distance in m from centreline to position considered

M_WH = as given in Pt.3 Ch.1 Sec.5 B205

σ_ST = warping stress in N/mm² at position considered for the given water vertical moment distribution, M_S

σ_WT = warping stress at position considered due to the wave torque, M_WT

M_WT = as given in Pt.3 Ch.1 Sec.5 B206

M_ST = design still water torsional moment in kNm over ship length

= 0,15 LB² (kNm) minimum.

Guidance note:
The still water- and wave induced warping stresses may be determined based on prismatic beam- or global coarse mesh finite element calculations. According to the prismatic beam calculation, the warping stresses may be expressed as:

\[
\sigma_{\text{ST}} = \frac{M_{\text{BST}} \omega}{I_{\text{ST}}} + \sigma_{\text{bsw}}
\]

\[
\sigma_{\text{WT}} = \frac{M_{\text{BWT}} \omega}{I_{\text{WT}}} + \sigma_{\text{bw}}
\]

M_BST, M_BWT = calculated bending moments due to the still water- and wave torsional moments at the section considered

\[
\int M_{\text{ST}} dx, \int M_{\text{WT}} dx
\]

\int M_{\text{ST}} dx, \int M_{\text{WT}} dx = the integrated value of the still water and wave warping torques to the section considered.

I_\omega = sectorial moment of inertia of considered cross-section

\omega = unit warping factor for the position considered.

σ_bsw, σ_bw = calculated bending stress related to the torsional deformation and structural discontinuities of the deck structure (e.g. hatch openings)

= 0,0 for other structures than the upper deck and adjacent members

The sum of the σ_WH and σ_WT shall in general be made with due consideration of sign. For a global finite element calculation, the combined horizontal bending- and torsional load shall therefore be applied on the model.

---o-nd---o---G-a-id-a-a-c-e---n-o-t-e---

The curvatures of upper deck hatch corners are in general to be taken as given in Pt.3 Ch.1 Sec.5 ES00 and in 206-207 below. In special cases the stress level in the corner region may be required to be documented to be acceptable by special calculations.

The curvature of streamlined hatch corners at side at the aft end of the open deck region is generally to be as given in Pt.3 Ch.1 Sec.5 E501 with transverse extension not less than:

\[
a = 0,020B \sqrt{f_1} (m)
\]

f_1 = as given in B for deck plating in area considered

Alternatively double (or single) curvature corner shapes may be accepted provided the radius of curvature at the hatch side is not less than 1,8 a (m)

For extent of local reinforcement of deck plating at hatch corners, see Pt.3 Ch.1 Sec.8 A405.

For cross decks, the radius of rounded corners is generally not to be less than:

\[
r = k(w + 0,8) \sqrt{f_1} (m)
\]

k = 0,16 for hatch corners at side

w = 0,10 for hatch corners for longitudinal deck girders

f_1 = f_1 as given in B for deck plating in area considered

For extent of local reinforcement of deck plating at hatch corners, see Pt.3 Ch.1 Sec.8 A405.

When a corner with double curvature is desired, a reduction of the inside radius may be considered.

The compressive stress in relation to the critical buckling stress, in accordance with Pt.3 Ch.1 Sec.14 B205, is not to be taken less than as given in 204. This is limited, in general, to members of the ship’s bottom and side shell, the upper deck and including continuous hatch coamings.

B 300 Plating and stiffeners

301 Thicknesses and cross-sectional properties are in general to be calculated as given for the main class, considering also the requirements given for cellular container holds given in C.

302 Bottom plating and stiffeners are to be designed as given in Pt.3 Ch.1 Sec.6 with allowable stresses for applicable rule items taken as follows (reference to said section given):

C302:

\[
\sigma = (175 + 40 \text{kib}) f_1 - 120 \text{ f* 2B, maximum}
\]

\[
(120 + 40 \text{kib}) f_1 \text{ where transversely stiffened}
\]

\[
(120 + 40 \text{kib}) f_1 \text{ where longitudinally stiffened}
\]

C401:

\[
\sigma = (200 + 20 \text{kib}) f_1 - 110 \text{ f* 2B, maximum}
\]

\[
(140 + 20 \text{kib}) f_1 \text{ where transversely stiffened}
\]

\[
(140 + 20 \text{kib}) f_1 \text{ where longitudinally stiffened}
\]

C501:

\[
\sigma = (190 + 30 \text{kib}) f_1 - 120 \text{ f* 2B, maximum}
\]

\[
(130 + 30 \text{kib}) f_1 \text{ where transversely stiffened}
\]

\[
(130 + 30 \text{kib}) f_1 \text{ where longitudinally stiffened}
\]

\[
160 f_1 \text{ for floors}
\]

C701:

\[
\sigma = \text{allowable stress, maximum 160 f_1}
\]

\[
225 f_1 - 130 \text{ f* 2B (z_n - z_a)/z_n for single bottom longitudinals}
\]

\[
225 f_1 - 130 \text{ f* 2B - 0.7 \sigma_{ib} for double bottom longitudinals}
\]

\[
\text{as given in C307 (this chapter) for bottom longitudinals of double bottoms in cellular container holds}
\]
C801:
\[ \sigma = \text{allowable stress, maximum } 160 f_1 \]
\[ = 225 f_1 - 100 f^*_2 + 0.7 \sigma_{db} \text{ with } \sigma_{db} = 20 f_1 \text{ N/mm}^2 \text{ in general} \]

C901:
\[ \sigma = \text{allowable stress, maximum } 160 f_1 \]
\[ = 225 f_1 - 110 f^*_2 \text{ for longitudinal stiffeners} \]
\[ = 160 f_1 \text{ for transverse and vertical stiffeners in general.} \]

303 Side longitudinals are to be designed as given in Pt.3 Ch.1 Sec.7 C301 with allowable stresses taken as follows:
\[ = 225 f_1 - 130 f_{1}^* (z_n - z_v) / z_n \text{, maximum } 160 f_1. \]
\[ = 130 f_1 \text{, maximum for longitudinals supported by side verticals in single deck constructions.} \]

304 Deck plating and stiffeners are to be designed as given in Pt.3 Ch.1 Sec.8 with allowable stresses for applicable rule items taken as follows (references to said section given):

C102:
\[ \sigma = \text{allowable stress} \]
\[ = (175 + 40 k_D^* f_1 - 120 f^*_2, \text{ maximum} \]
\[ = (120 + 40 k_D^* f_1) \text{ where transversely stiffened} \]
\[ = (120 + 40 k_D^*) \text{ f}_{1} \text{ where longitudinally stiffened} \]

C301:
\[ \sigma = \text{allowable stress} \]
\[ = 225 f_1 - 130 f_{1}^* (z_n - z_v) / z_n \text{, maximum } 160 f_1 \text{ for strength deck and long superstructures and effective deck houses above strength deck} \]
\[ = 225 f_1 - 130 f_{1}^* (z_n - z_v) / z_n \text{, maximum } 160 f_1 \text{ for continuous decks below strength deck} \]

In combination with heeled condition pressures \( p_b \) and \( p_{11} \), \( \sigma = 160 f_1 \) may generally be used.

305 The arrangement of longitudinal stiffeners of the strength deck is to be taken as given in Pt.3 Ch.1 Sec.8 A403 with longitudinals arranged to be continuous within the complete open cargo hold length for ship lengths > 100 m.

306 Bulkhead plating and stiffeners are to be designed as given in Pt.3 Ch.1 Sec.9 with allowable stresses for applicable rule items taken as follows:

C201:
\[ \sigma = 225 f_1 - 130 f_{1}^* (z_n - z_v) / z_n \text{, maximum } 160 f_1 \]

For longitudinals, \( \sigma = 160 f_1 \) may be used in any case in combination with heeled condition pressures \( p_b \) and \( p_{11} \).

307 Simple girders are to be designed as given in Pt.3 Ch.1 with allowable stresses for applicable rule items taken as follows:

Sec.8 D201 and Sec.9 D201:
\[ \sigma = 190 f_1 - 130 f_{1}^* (z_n - z_v) / z_n \text{, maximum } 160 f_1 \text{ for continuous longitudinal girders} \]
\[ = 160 f_1 \text{ for other girders} \]

For longitudinal girders, \( \sigma = 160 f_1 \) may in any case be used in combination with heeled condition pressures.

C. Cellular Container Hold Structures

C 100 General

101 The structural requirements given in C200 to C400 are primarily applicable for container ships with cellular container holds and with a predominantly hogging hull girder still water bending moment. For other ship types with container transportation capability, e.g. open hatch bulk carriers, the structural design is mainly to be based on the rule requirements for the principal type and service class notation (e.g. General Cargo Carrier, or Bulk Carrier HC-E).

C 200 Design loads

201 Cargo holds for container cargo are generally to be considered for design loads and design load assumptions as given in 202 to 205.

202 It is assumed that the maximum allowable stack weight is defined for every 20’ and 40’ container stack position of every cargo space. If the maximum stack weight has not been specified, the maximum allowable stack weight is to be taken equal to max. container weight multiplied with no of tiers.

203 The maximum cargo mass of any hold, deck area or cargo space is, unless a lower mass limit is specified, to be taken as the sum of maximum 20’ (if applicable) container stack weights for the cargo space considered.

204 It is generally assumed that the heaviest containers are stowed in the lower positions of each container stack. A uniform distribution of container mass within each container stack may therefore generally be assumed, unless differing mass distributions are specified.

205 In the full draught condition with minimum mass of cargo in a given hold, the minimum cargo mass is to be assumed for the container hold and deck region between any two adjacent transverse watertight bulkheads. Outside of this region container hold and deck spaces are to be assumed to have maximum cargo mass in accordance with 203.

Within the minimum cargo region, any one 40’ container bay of a cargo hold (or equivalent) and any deck area are in general to be assumed empty. In the remaining spaces of the minimum cargo region, the container mass is in general not to be taken larger than half the maximum cargo mass based on 40’ container stowage (if applicable) given according to 203. Alternative specified minimum cargo limits may generally be considered.

C 300 Plates and stiffeners

301 Thicknesses and cross-section properties are with the exceptions given in 302 to 307 to be as given for the main class.

302 The minimum thickness of web and flange of stiffeners of ballast tanks may be taken as given in Pt.3 Ch.1 Sec.7 C302 and Sec.9 C202 with \( k = 0.01 L_1 \).

For sea chest boundaries (including top and partial bulkheads), see Pt.3 Ch.1 Sec.6 C500 and C900.

303 The thickness of webs, flanges and brackets of girders other than the centreline girder of double bottom tanks may be taken as given in Pt.3 Ch.1 Sec.3 C502 with:
\[ k = 0.015 L_1 \text{ in general} \]
\[ k = 0.05 L_1 \text{ for sea chest boundaries (including top and partial bulkheads).} \]

304 The thickness of stiffeners and girders including webs, flanges and brackets of ballast tanks of the side- and bulkhead structures of the cargo region as otherwise given by the requirements in Pt.3 Ch.1 Sec.7 D101 and Sec.9 D101 is not to be less than:
\[ t = 5, 0 + \frac{k}{\sqrt{f_1}} + t_k \text{ (mm)} \]
\[ k = 0.1 L_1 \]

305 The thickness of the inner shell plating is to be as given in Pt.3 Ch.1 Sec.9 C100 with \( k = 0.01 \), and the requirement of C104 disregarded.
The minimum plate thickness of transverse bulkheads which are required for gas tightness only, may be taken as given in Pt.3 Ch.1 Sec.9 C102 with \( k = 0 \).

The section modulus of bottom longitudinals within the width of the double bottom is not to be less than according to the requirements given in Pt.3 Ch.1 Sec.6 with:

\[
\sigma = 245 f_1 - 40 f_{2BH} - 0.7 \sigma_g
\]

\[ f_1 = \text{material factor as given in Sec.1 B100 with respect to the bottom longitudinal} \]

\[ \sigma_g = 190 f_{1B}, \text{but need not be taken larger than} \]

\[ \sigma_{DB} = 130 f_{2BH} \]

\[ f_{1B} = \text{material factor } f_1 \text{ as given in Sec.1 B100 with respect to the bottom plating} \]

\[ \sigma_{DB} = \text{longitudinal double bottom stress with respect to} \]

\[ \text{the bottom plating in the middle of the minimum loaded} \]

\[ \text{hold for load case LC2 as given in 404} \]

\[ f_{2BH} = f_{2B} \text{as given in B with respect to the hogging still water bending moment.} \]

**Guidance note:**
If a direct double bottom calculation has not been carried out and the bottom longitudinal section modulus requirement based on the standard rule formulation given in Pt.3 Ch.1 Sec.6 C701 has not been complied with, the bottom longitudinal profile as proposed may still be accepted provided the calculated longitudinal double bottom stress \( \sigma_{DB} \) of the bottom plating in the mid part of the hold for the load cases LC2, LC3 as given in 404 does not exceed the following limit:

\[
\sigma_{DB} = 350 f_1 - 1.43 (\sigma + 130 f_{2BH}) \text{ (N/mm}^2\text{)}
\]

\[ \sigma = \frac{8f^2 \text{sp}_w}{Z} \]

\[ Z = \text{section modulus (cm}^3\text{) of proposed bottom longitudinal} \]

\[ f_{1}, f_{1B}, f_{2BH}, \text{as given in Pt.3 Ch.1 Sec.6} \]

In addition it is assumed that the \( \sigma_{DB} \) based on the direct calculation shall not exceed the following limit:

\[
\sigma_{DB} = 190 f_1 - 130 f_{2BH} \text{ (N/mm}^2\text{)}
\]

For ships as mentioned in A105 fatigue strength assessment is in general to be carried out for end structures of longitudinals in bottom, inner, side, inner side, longitudinal bulkheads and strength deck in the cargo area, as described in Pt.3 Ch.1 Sec.17.

**C 400 Girder systems**

**401** The scantlings of the girder structures of the double bottom, transverse bulkhead and side structure of container holds may have to be based on direct stress analysis in accordance with Pt.3 Ch.1 Sec.13.

**Guidance note:**

The direct calculations should generally be carried out as three-dimensional beam and/or finite element calculations covering double bottom and sides and transverse bulkhead structures as applicable. For unsymmetrical loading conditions a full breadth model (extending from side to side) may be required unless the symmetric boundary condition may be assumed for the dynamic loads of LC4 given in 404.

For the model, vertical supports may generally be assumed at the intersection of the elements representing the transverse watertight bulkheads and the double side structure.

The longitudinal extent of the model should cover the considered container hold length and extending to the middle of the adjacent holds where the symmetry boundary condition may generally be assumed. The symmetry condition may be assumed for structure and loads at the mid-length position of the considered hold, the total model length need only extend over two half hold lengths.

**402** Direct calculations by use of finite element methods are mandatory for vessels described in A105 and are to be carried out in accordance with principles described in Pt.3 Ch.1 Sec.16 B, in addition to the principles described here and elsewhere in the rules.

The following calculations are at least to be considered:

- support bulkhead including panel girder and pillar structures
- typical web frame at position between support bulkhead and watertight bulkhead
- longitudinal double bottom girders.

In addition, stresses in laterally loaded local stiffeners subject to relative deformation between girders are normally to be considered.

The effect of relative deformation is to be taken into account in the fatigue evaluation of longitudinals required in 308.

**403** For ships which give rise to warping response, a coarse mesh finite element model of the entire ship hull length may be required for torsional calculations.

**404** The following load cases are in general to be considered, see also Fig. 3 and 4:

- **LC1:** Maximum mass of cargo (20 \(^\prime\) containers as relevant) in considered hold in seagoing upright condition at reduced draught, for dimensioning of bottom transverse members of support bulkheads. The adjacent holds are to be assumed to be empty, and the reduced draught is generally not to be considered larger than 0.6T.

- **LC2:** Minimum mass of cargo in hold between adjacent watertight bulkheads combined with empty deck above in the seagoing upright full draught condition, for dimensioning of double bottom and supporting pillar bulkhead(s). The adjacent cargo holds are then to be assumed filled with maximum mass of cargo (20 \(^\prime\) container cargo as relevant).

- **LC3:** Seagoing ballast condition with cargo spaces empty and ballast tanks filled, for dimensioning of double bottom and support bulkhead.

- **LC4:** Maximum mass of cargo in considered hold and on deck between watertight bulkheads in heeled condition, for dimensioning of side structure and support bulkhead(s). The adjacent holds are to be assumed empty.

The transverse acceleration is to be taken as given in 408 (and is combined with the vertical acceleration of gravity). It is advised to consider the load condition LC4 split up into separate still water- and dynamic load conditions.

- **LC5:** Maximum mass cargo in hold and on deck with dynamic longitudinal acceleration, for dimensioning of pillar- and watertight bulkheads.

The longitudinal acceleration is to be taken as given in 409 (and is combined with the vertical acceleration of gravity). It is advised to consider the load condition LC5 split up into separate still water- and dynamic load conditions.

- **LC6:** Maximum specified mass of cargo on deck with minimum cargo in hold below in upright seagoing condition.
at full draught for dimensioning of the pillars of the support bulkheads.

**LC7:** Flooded damage condition, for dimensioning of watertight bulkheads.

\[ T_B = \text{deepest ballast draught (m).} \]

**405** For designs with a longitudinal girder arranged for support of upper deck hatch covers, the following additional loading conditions are generally to be considered:

**LC8:** Upright seagoing full draught condition with maximum mass of deck cargo combined with maximum cargo mass in hold below, for dimensioning of longitudinal deck girders.

**LC9:** Upright seagoing full draught condition with maximum mass of deck cargo combined with minimum cargo mass in hold below, for dimensioning of pillars supporting longitudinal deck girders.

**LC10:** Condition similar to condition LC8 and/or LC9 with unsymmetrical deck cargo load with maximum mass of cargo on one hatch cover panel and the adjacent panel empty. This condition may be of importance for the combined torsional and bending response of the longitudinal deck girder, and/or the combined axial and bending response of hold pillars.

**406** For vessels as mentioned in A105 load cases for calculation of dynamic stresses and relative deformations for the fatigue evaluation of longitudinals are to be taken as given in Pt.3 Ch.1 Sec.17.

**407** The sea pressure in upright condition is to be taken as given in Pt.3 Ch.1 Sec.13 B300. The dynamic sea pressure in the heeled condition is to be taken as:

\[ p = 10 \cdot y \cdot \tan(\phi/2) - z_s \quad (\text{kN/m}^2) \text{ on submerged side} \]
\[ p = z_c \quad \text{but not less than} - 10 y \cdot \tan(\phi/2) \quad (\text{kN/m}^2) \text{ on emerged side} \]
\[ z_s = 10 \cdot (z - T_A), \quad \text{minimum} = 0 \]
\[ z_c = 10 \cdot (z - T_A), \quad \text{maximum} = 0 \]
\[ y = \text{transverse distance in m from centre line} \]
\[ \phi = \text{as given in Pt.3 Ch.1 Sec.4 B} \]
\[ z = \text{vertical distance in m from base line to considered position}. \]

**408** The transverse acceleration is to be taken as:

\[ a_t = \text{dynamic transverse acceleration} \]
\[ = 0,4 \cdot a_y + g \cdot \sin(\phi) + a_{ty} \quad (\text{m/s}^2) \]
\[ a_y, a_{ty} = \text{as given in Pt.3 Ch.1 Sec.4 with} R_R \text{taken with a negative sign for positions below the centre of rolling. The centre of rolling is generally not to be taken at a higher level than the considered draught} \]
\[ \phi = \text{as given in 407}. \]
Fig. 3
Design load conditions
Fig. 4
Design load conditions, continued

409 The longitudinal acceleration is to be taken as $0.5 \, a_l$, where:

$$a_l = 0.6 \, a_x \, + \, g_0 \, \sin \, \theta \, + \, a_{px}$$

$a_x$, $a_{px}$, $\theta$ = as given in Pt.3 Ch.1 Sec.4 with $R_P$ taken with a negative sign for positions below the centre of pitching. The centre is generally not to be taken at a higher level than the considered draught.

410 Allowable stresses are in general to be taken as given in Pt.3 Ch.1 Sec.13 B400, with due consideration of the requirements given in 411 to 416.

411 The nominal dynamic normal stress, $\sigma$, (of support bulkhead structures) is for the load cases LC4 and LC5 generally not to exceed the limit:

$$\sigma = 100 \, (N/mm^2) \text{ in way of dry areas}$$
$$\sigma = 85 \, (N/mm^2) \text{ in way of coated ballast tanks.}$$

In way of stress concentration areas special (soft) brackets and/or inserts with increased plating thickness etc. are to be introduced as necessary to keep notch effects and stress concentrations to an acceptable level.

The nominal dynamic shear stress, $\tau$, is for load cases LC4 and LC5 not to exceed:

$$\tau = 60 \, f_1 \, (N/mm^2).$$

In areas with significant dynamic shear stresses combined with structural discontinuities (holes and openings etc.) it is assumed that the dynamic normal stresses are controlled to be within the allowable limits given above.

412 Plates of support bulkheads are to be evaluated for buckling according to Pt.3 Ch.1 Sec.14, paragraphs B205 and B303 for $\eta = 0.5$ for stresses based on dynamic loads only.
413 The combined compressive longitudinal bottom stress, \( \sigma \), is generally not to exceed the limit given in Pt.3 Ch.1 Sec.13 B402, where:

\[
\sigma = 130 f_{2DH} + \sigma_{DB}
\]

\( f_{2DH} \) as given in B with respect to the hogging still water bending moment

\( \sigma_{DB} \) = longitudinal double bottom bending stress (with respect to the bottom flange) at mid-region of the considered hold with respect to load cases LC2 and LC3 as given in 404.

414 For the upper cross deck structures the nominal bending stresses due to hull girder still water torsional deformation, \( \sigma_{tc} \) (due to the torsional loading \( M_{ST} \)) are generally not to exceed the following limits:

\[
\sigma_{tc} = 160 f_1 - 0.5 \sigma_{wc} \quad \text{(N/mm}^2\text{)}
\]

\[
\sigma_{tc} = 160 f_1 - \sigma_{sl} \quad \text{(N/mm}^2\text{)}
\]

\( \sigma_{wc} \) = bending stresses of cross decks induced by wave torsional deformation of deck structure according to torsional loading MWT as given in Pt.3 Ch.1 Sec.5 B

\( \sigma_{sl} \) = bending stress in cross deck structure due to load case LC5 of 404.

**Guidance note:**
The stresses \( \sigma_{tc} \) and \( \sigma_{wc} \) may normally be determined based on a prismatic beam calculation of the torsional deformation response.

415 For the upper deck longitudinal members the combined longitudinal tensile stress, \( \sigma \), as given in the following, is generally not to exceed the limit given in Pt.3 Ch.1 Sec.13 B402:

\[
\sigma = \sigma_f + \sigma_{gl}
\]

\( \sigma_f \) = 130 \( f_{2DH} \) and \( \sigma_{stat} + 0.5 \sigma_{dyn} \), whichever is the largest

\( f_{2DH} \) as given in B with respect to the hogging condition

\( \sigma_{stat} \) and \( \sigma_{dyn} \) = as given in B204 for the member considered

\( \sigma_{sl} \) = stress in longitudinal deck structure due to load case LC4 of 404

Furthermore the combination of stresses as given above, including the dynamic components only, is not to exceed the dynamic stress limit given in 411.

**Guidance note:**
The stresses \( \sigma_{sl} \) and \( \sigma_{gl} \) may normally be determined based on a prismatic beam calculation of the torsional deformation response.

416 For upper deck longitudinal girders supporting hatch covers the combined normal stress, \( \sigma \), as given in the following is generally not to exceed the limit given in Pt.3 Ch.1 Sec.13 B402:

\[
\sigma = 130 k f_{2DH} + \sigma_{gl}
\]

130 \( k f_{2DH} \) = reduced longitudinal stress of longitudinal upper deck girder

\( f_{2DH} \) as given in B with respect to the hogging still water bending moment

\( k \) = reduction factor for effectivity of longitudinal deck girder

\( \sigma_{gl} \) = normal tensile stress in longitudinal deck girder as calculated for the load case LC8 (and LC10) of 405.

D. Materials and Welding

D 100 Support fittings welded into the hull structure

101 Container supports and fittings intended for welding into the hull structure may be made of forged or cast carbon or carbon-manganese steels or may be cut from rolled materials of normal or high strength hull structural steel.

The materials are to comply with the relevant chapter/section of Pt.2 and with the additional requirements given in this subsection.

102 The carbon content of cast and forged steel is not to exceed 0.24%.

103 Specified minimum yield stress for castings and forgings is not to exceed 400 N/mm^2. Charpy V-notch tests for castings and forgings are to be carried out at the temperature required for hull structural materials in the adjacent area or at 0°C, whichever is the lower. Minimum absorbed energy is to comply with the requirements given in the relevant chapter/section of Pt.2.

D 200 Container securing equipment

201 Container securing equipment (not intended for welding into the hull structure) may be made of forged or cast steel or machined from rolled material. For devices and members produced without any welds, ferritic nodular cast iron may be used, subject to special approval. The materials are to comply with a recognised national or international standard, and are also to meet the additional requirements given in this subsection. Specifications deviating from the requirements given in this subsection may be evaluated on the basis of documented experience or comprehensive test results.

It may be required that the materials are delivered from manufacturers approved by the Society.

202 Carbon and carbon-manganese steels are to be fully killed.

203 For items produced without any welding the following apply:

For carbon and carbon-manganese steels the C-content is not to exceed 0.40%.

For alloy steels the C-content is not to exceed 0.45%.

When welding is used in the production, the chemical composition is to be appropriate for the welding process, dimensions and heat treatment process in question.

For thicknesses up to about 30 mm, when flash welded and heat treated according to 300 after welding, a carbon content up to 0.35% for carbon and carbon-manganese steels and 0.40% for alloy steels may be accepted.

In other respects the chemical composition is to comply with the recognised standard.

204 Specified minimum yield stress for carbon and carbon-manganese steels is not to exceed 400 N/mm^2 when normalised, and 480 N/mm^2 when quenched and tempered. For alloy steels the specified minimum yield stress is not to exceed 750 N/mm^2. Alloy steel with specified yield stress up to 800 N/mm^2 may, however, be accepted upon special consideration of the material properties and its application in each case.

Charpy V-notch impact test is to be carried out at 0°C and the average value of the absorbed energy is to be at least as shown in Fig. 5. At least 3 specimens are to be tested. One individual value may be less than the required average value, however, not less than 70% of this average. For rolled and forged materials, test specimens may be taken in the longitudinal direction. In castings the direction of test specimens is optional.

In other respects the mechanical properties are to comply with the recognised standard.
E. Type Approval, Testing and Marking of Container Securing Equipment and Support Fittings

E 100 Type approval

101 Type approval is based on plan approval and prototype testing. Plans are to be submitted for approval for each equipment item. In addition to detailed drawings, plans are to show material specification and heat treatment. The required minimum breaking load is to be stated.

One type approval certificate may cover different variations of the same basic equipment type. Variations may include e.g. different materials, lengths or breaking loads. Each variation may have to be prototype tested.

Type approval certificates are issued after satisfactory prototype tests are carried out. The prototype testing may upon special consideration be discarded for support fittings for welding into the hull structure in cases where the support arrangement for the fitting is subject to special approval in each case.

E 200 Prototype testing

201 Prototype testing of each item is to be performed on at least 2 samples. Test loads are to be applied in a test rig simulating the actual service conditions. All test samples are to withstand at least the specified minimum breaking strength. A test result report is to be issued in accordance with A604 above.

202 When the item is to be welded into the hull structure, the test condition is to conform with actual welded in condition.

203 The prototype testing may be replaced by suitable calculation in cases where the testing is impractical, e.g. for items to be welded into the hull structure.

E 300 Production testing

301 Production testing is to be carried out as follows:

For items produced in large quantities, at least 0.5% of all items is to be proof tested. At least one item from each lot (including prototypes) is to be tested. For items with welded parts subject to tensile loads at least 2% of all items is to be proof tested. For lashing chain cables, each length is to be subjected to the proof load.

The test load to be applied in proof tests is normally to be taken as 1.1 times allowable working load.

On completion of the proof test, each item is to be examined and is to be free of any deformations or significant defects.

For highly loaded parts such as lashing bars, turnbuckles, and shoring devices, breaking load tests may in addition be required to be performed on at least 0.5% of all items.

A list of production testing requirements for typical container securing equipment is given in Certification Notes No. 2.7-2.

302 For chain cables additional breaking load tests are to be performed as follows:

A breaking test specimen consists of at least 3 links connected together, and they are to be manufactured at the same time and in the same way as well as with the same heat treatment as the chain cable. One breaking test is to be made for every 1000 m of chain cable or fraction thereof, produced in continuous length from the same steel cast.

For wires the relevant requirements according to Pt.3 Ch.3 Sec.3 G apply.

The breaking test is considered passed if no sign of fracture has occurred after application of the desired load.

303 The certification may alternatively to the production testing according to 301 and 302 be based on a scheme for Non-Destructive Examination. The details of such a scheme is to be agreed in a Manufacturing Survey Arrangement.

D 300 Heat treatment

301 Castings and forgings of carbon and carbon-manganese steel are to be supplied in the normalised or quenched and tempered condition. Rolled materials are to be supplied in the heat treatment condition prescribed in the recognised specification.

Alloy steels are to be quenched and tempered. Ferritic nodular cast iron is to be subjected to a satisfactory heat treatment if not otherwise agreed.

D 400 Mechanical tests

401 Testing is to be carried out in accordance with relevant chapters of Pt.2 or with recognised standards taking into consideration the additional requirements given in 402 to 404.

402 When a number of pieces are heat treated in the same furnace charge, a batch testing procedure may be adopted, using pieces from each batch for test purposes. One tensile test and one set of impact tests are to be made from each batch. The batch is to consist of pieces of about the same size and from the same cast, heated in the same furnace charge and with a total mass not exceeding 2 tonnes.

403 For chain cables produced in continuous lengths one tensile test and one set of impact tests are to be taken from cable produced from the same steel cast unless the length is more than 1000 metres, in which case tests are to be taken from every 1000 m or fraction thereof. Of the impact tests are to be taken clear of the weld. Test materials are obtained by supplying the cable with extra links.

404 Impact testing is to be carried out as Charpy V-notch tests according to Pt.2 Ch.1 Sec.2.

D 500 Steel wire ropes

501 The strength and construction of steel wire ropes for lashings are to comply with the requirements specified in Pt.3 Ch.3 Sec.3.

D 600 Welding

601 The relevant requirements concerning welding given in Pt.2 Ch.3 apply. Welding procedure specifications and welding procedure qualification tests may be required.

602 For carbon and carbon-manganese steel with carbon content exceeding 0.18% and for alloy steel, preheating and elevated interpass temperature may be required, except when members fulfil the requirements given in Pt.2 Ch.2 Sec.1 for hull structural steels.

603 When structural members and fittings are welded into the strength deck and other highly stressed structures, full penetration welds are required.

Flush supports are to be welded directly to stiffeners or girders below.
E 400 Marking

401 Each item is to be marked with suitable identification marking such as to allow traceability to the product certificate. Marking should include the manufacturer/supplier’s name or mark, type designation and, if relevant, charge or heat number.

F. Arrangements for Stowing and Lashing of Containers

F 100 General

101 Containers may be stowed longitudinally or transverse, and are to be effectively supported by the ship structure.

102 The containers are to be effectively prevented from sliding, lifting or tilting by a system of fixed supports or detachable lashing equipment.

103 The support fittings and securing are to withstand the loads specified in G, and is to be arranged and dimensioned in such a way that the supporting forces and internal forces in the containers are within the minimum capabilities of the container to be used.

F 200 Containers in cell guides

201 Cell guide structures in holds or on weather deck may be permanently fastened (welded) to the hull structure, or be arranged detachable (screwed on).

202 The vertical guide rails are normally to consist of equal angles with thickness not less than 12.5 mm. On top of the rails are to be fitted strong and efficient guide heads. The guide rail angles are preferably to be connected by web plates at the levels of the container corners.

203 The vertical guide rails are in general to be supported by a system of transverse- and/or longitudinal ties transferring the transverse and longitudinal forces to the hull structure, if possible at the level of the container corners.

204 The total clearance between containers and cell guides is not to exceed 25 mm and 40 mm in the transverse and longitudinal directions respectively.

205 The net clearance between cell guides and containers, building tolerances and deformations imposed by the still water torsional loading etc. of the ship deducted, is generally to be larger than the minimum value specified for operational purpose.

F 300 Containers secured by lashings and other removable equipment

301 For containers on weather deck a combination of stacking cones (to prevent sliding), locking cones or lock stackers (to prevent tilting or lifting) and lashing is to be applied. For one or two tiers of containers lock stackers alone are normally sufficient. When more tiers are required, lashings may have to be provided in addition. Due to buoyancy forces from shipped water, all containers not secured by lashings are to be secured by lock stackers.

302 Lock stackers need not in general be applied for containers in cargo hold provided transverse shorings and lashings are fitted such that possible overturning is prevented for any relevant combination of stack height and container mass distribution. Thus container stacks or part of such must (unless secured by lashings or shorings) generally be secured by lock stackers at level considered if the compressive vertical support force at any one of the container corners as calculated in accordance with H200 is less than 0,05 M g₀ (kN).

\[ M = \text{total mass (t) of the containers of the considered stack at and above the container level considered.} \]

303 For containers stowed in blocks several tiers high on inner bottom adequate support below each bottom container corner is to be provided. Lateral shearing may be obtained by fixed shoring elements supported at ship’s side, decks or transverse bulkheads, and/or lashing. At each level of horizontal supports interconnecting stackers are to be fitted between each stack. Large blocks (several stacks) may be split vertically when special shoring elements taking both compression and tension are used.

304 Interconnecting stackers may either be of a type that transfers only horizontal forces (e.g. spectacle bridges, screw bridge fittings or separate stackers with removable connectors), or of a type that may transfer horizontal forces as well as vertical shearing forces (e.g. double stackers).

Shearing forces caused by possible variation in the container height are to be considered.

If the clearance between container stacks exceeds 30 mm, interconnecting stackers should preferably be of a type which transfers only horizontal forces. Plate thickness in double stackers is to be at least 13 mm.

305 For container positions with supports which may move relative to each other, the supports are as necessary to be such arranged that the relative movement does not lead to permanent deformation of the containers stowed.

G. Design Loads

G 100 General

101 Securing arrangements for containers are to be based on analysis of support and lashing forces for the most severe realistic static load conditions in combination with extreme dynamic loads.

102 When the arrangement of securing of containers is such that significant forces are generated in the containers and/or the securing members by variations in container dimension etc. in accordance with the tolerances stipulated by the ISO-standard, such forces are to be taken into consideration by the evaluation of the securing arrangement.

G 200 Static loads

201 The static conditions which give the largest support forces, lashing forces and the largest internal forces in the container structure are to be considered.

Reduction in forces due to friction between container layers are not to be considered.

202 Unless otherwise specified, the maximum mass of 20’ and 40’ ISO containers in any given location are to be taken as 24 000 kg and 30 480 kg, respectively.

203 When limitations regarding the maximum total mass of containers in a particular location (e.g. in a container block stack) are specified, the assumed mass of individual containers is to be such that the most severe realistic load condition is obtained.

204 Prestressing of lashings should normally be kept as small as possible. If prestressing is an integral part of a securing system, this will be subject to special consideration.

G 300 Dynamic loads

301 For evaluation of forces acting on and within containers and forces in non-rigid containment arrangements, acceleration loads are to be taken in accordance with the combined vertical, transverse and longitudinal design accelerations specified in Pt.3 Ch.1 Sec.4 B, i.e. extreme dynamic loads are to be used.

The value of the transverse dynamic acceleration, \( a_t \), is, however, not to be taken less than the minimum value:
\[ a_1 = \frac{9}{B^{0.25}} \text{ (m/s}^2 \text{)} \]

302 All containers in a stack or a group of stacks are assumed to be subjected to the acceleration of gravity in combination with a uniform vertical acceleration according to 301.

303 The containers in a stack or group of stacks are assumed to be subjected to transverse or longitudinal acceleration in accordance with 301.

304 For non-rigid securing arrangements, acceleration loads according to 303 are to be combined with the acceleration of gravity acting downwards.

305 Containers, the side walls of which will be exposed to wind (windward side only), are to be considered for a wind force \( P_w \) which for ISO standard containers may be taken as follows:

\[ P_w = 18.5 \text{ kN for } 20' \text{ containers} \]
\[ = 37.0 \text{ kN for } 40' \text{ containers} \]
\[ = 7.5 \text{ kN for container ends}. \]

306 For containers in positions which may be exposed to wind, the acceleration loads according to 303 are to be combined with wind forces according to 305.

307 For evaluation of cell guide structures, acceleration loads are to be taken as given in Pt.3 Ch.1 Sec.4 B.

H. Strength Analysis

H 100 Rigid containment arrangements

101 Cellular containment structures and containment arrangements with numerous sideway supports may normally be considered as rigid containment arrangements.

102 Normally, the racking stiffnesses of the containers may be disregarded in the analysis of the overall response of the containment structure. Deflections in the supporting structure should be taken into account.

103 The analysis is to determine:

- nominal stresses in the containment structure
- vertical and horizontal support forces
- relevant internal forces in containers.

104 The calculation of stresses in cell guide structures and supporting structures for cell guide structures is in general to be based on the load cases LC4 and LC5 as given in C.

H 200 Non-rigid containment arrangements

201 Securing arrangements including lashings and other flexible securing members or a small number of rigid horizontal supports may normally be considered as non-rigid containment arrangements.

202 The analysis is to take duly account of the flexibilities of containers and of the securing members as well as possible deflections in the supporting structure.

203 Possible effects of clearances between stacks of containers and between containers and supports are to be taken into account.

204 The analysis is to determine:

- vertical and horizontal support forces
- forces in lashings and other securing members
- internal forces in containers.

For further details, see Classification Note No. 32.2.

H 300 Support fittings

301 The strength of support fittings is generally to be analysed for maximum support forces as determined under 100 and 200.

302 The analysis is to include the support fitting with local supporting structures. It is to show the nominal member capacities with respect to shear force, bending moment and axial force.

I. Allowable Forces and Stresses

I 100 Forces acting on and within container structures

101 Unless otherwise specified, calculated internal reaction forces in containers and external forces on the container structure are not to exceed the tested minimum capabilities stated in the appropriate ISO-standard for freight containers.

Applicable container strength ratings according to this standard are given in Classification Note No. 32.2.

I 200 Forces in container securing equipment

201 Working loads in container securing equipment are not to exceed:

\[ P = 0.5 P_m \]

\( P_m \) = minimum breaking load of considered equipment item.

Possible influence on the breaking load of fixed equipment by welding to the underlying structure is to be taken into account.

202 Members of other materials subjected to tensile loads will be specially considered.

I 300 Stresses in supporting structures

301 Nominal normal stresses in support fittings for containers and container lashings and other non-rigid container securing structures (and in their local supporting structures) in hull structural steel, or as steel forgings or castings are not to exceed:

\[ \sigma = 210 \left( f_1 \right) N/mm^2. \]

302 Nominal shear stresses in support fittings for containers and container lashings and other non-rigid container securing structures (and in their local supporting structures) in hull structural steel, or as steel forgings or castings are not to exceed:

\[ \tau = 120 \left( f_1 \right) N/mm^2. \]

303 In structures also subjected to longitudinal stresses (e.g. deck longitudinal and girders) combination with such stresses as given in Pt.3 Ch.1 Sec.8 is only to be performed for vertical container loads (rolling excluded). Allowable bending stresses may be increased by 30%.

304 Compression members are to be controlled for buckling in accordance with Pt.3 Ch.1 Sec.14.

305 Corrosion additions for supporting members being part of hull structures (in tanks) are to be in accordance with requirements given in Pt.3 Ch.1 Sec.2.

306 The allowable nominal dynamic stress of cell guide structures as calculated in accordance with H104 is not to exceed the limit given in C411.

307 The compressive dynamic stress of cell guide structures is in general to be considered with respect to the lateral buckling mode according to Pt.3 Ch.1 Sec.14 C203 with k = 0.5.
J. Signboards

J 100 General

101 As far as found suitable for the ship in question, stowage and securing plans showing typical arrangements and giving further reference to the «Stowage and Securing Manual» is to be posted at suitable locations in each cargo space and in deck office.

K. Non-Weathertight Arrangement for Weather Deck Hatch Covers

K 100 General

101 For ships intended exclusively for the carriage of containers in holds with non-weathertight arrangement of hatch covers in accordance with Pt.3 Ch.1 Sec.11 A, the requirements given under K are to be complied with.

102 A wave breaker is to be arranged for the protection of the forward non-weathertight hatch covers. Alternatively, the wave breaker may be omitted if the hatch covers forward of, or partly forward of, 0,15 L from FP are weathertight.

Guidance note:
The height of the wave breaker should normally be 5 m above the hatch cover top plate to cover two tiers of standard containers. A reduced height may be satisfactory in cases of large freeboard, i.e. when the top of the hatch cover plate is more than 3 standard superstructure heights (see Pt.3 Ch.5 Sec.3 G) as calculated in K103.

103 Non-weathertight hatch covers may be fitted to hatchways located on weather decks, which are to be at least two standard superstructure heights above an actual freeboard deck, or an assumed freeboard deck, from which a freeboard can be calculated. The calculated freeboard shall result in a draught of not less than that corresponding to the actual freeboard assigned. Where any part of a hatchway is forward of a point located one quarter of the ship’s length (0.25 L) from the forward perpendicular, then that hatchway is to be located on a weather deck, at least three standard superstructure heights above the actual or assumed freeboard deck. It is to be understood that the assumed freeboard deck is used only for the purpose of measuring the height of the deck on which the hatchways are situated. The assumed freeboard deck may be an imaginary, or virtual deck and is not to be used for the actual assignment of the freeboard. The vessel’s freeboard is to be assigned from an actual deck, designated as the freeboard deck, which is to be determined in accordance with the ICLL.

104 The hatch coaming height is not to be less than 600 mm.

105 The non-weathertight joints of hatch covers are to be designed to minimise the possible rate of water ingress by the arranging of labyrinths, gutter bars or equivalent.

106 The containers in cargo holds with non-weathertight arrangement of hatch covers are to be positioned on doubling plates or equivalent fitted on the inner bottom (or deck) with a height normally not less than 25 mm.

K 200 Bilge pumping arrangement

201 High water level alarms are to be installed for the bilge wells of container holds with non-weathertight hatch covers. The volume of each bilge well is not to be less than 1 m³.

202 One bilge pump as required in Pt.4 Ch.6 Sec.4 H is to be dedicated to bilging purposes, only.

K 300 Stability and damage stability

301 Any non-weathertight joints of hatch covers are to be considered as unprotected openings with respect to the requirements to stability and damage stability given in Pt.3 Ch.4 Sec.3 and in Ch.2 Sec.8.

Guidance note:
Bilge pumping capacity: The bilge capacity of container holds with non-weathertight hatch covers may in general be taken as given in Pt.4 Ch.6.

Damage stability: Non-weathertight hatch covers are to be considered as unprotected openings when determining the upper limit of the range of residual stability according to SOLAS Reg.25-6 of Chapter II-1, Part B1, see Ch.2. I.e. the range of positive stability is to be determined at the angle at which these openings become submerged.

Intact stability: Non-weathertight hatch covers must be taken into consideration when determining the angle of flooding for the intact stability criteria according to IMO resolutions A.749(18), A.562(14), etc.

Fire fighting: Fire fighting by CO₂ as given in Pt.4 Ch.10 is generally acceptable in container holds with non-weathertight hatch covers.

Dangerous goods: Facilities for carriage of dangerous goods may in general be arranged as for a vessel with weathertight hatches as given in Ch.11.

Note that possible questions related to perishable cargo is outside the scope of classification.

---end---of---Guidance---note---
SECTION 7
CAR CARRIERS

A. General

A 100 Classification

101 The requirements in this section apply to ships intended for carriage of cars. Relevant requirements for general cargo ships given in Sec.4 are also to be complied with.

102 Ships built in compliance with relevant requirements specified in the following may be given the class notation Car Carrier. The design requirements for the class notation given in 103 apply regardless of the assignment of this class notation.

103 Ships with movable car decks are to be built in compliance with relevant requirements in B, C and D. Such ships may be given the class notation MCDK.

104 Ships with fire protection, ventilation system and electrical equipment for carriage of vehicles with fuel in their tanks, see subsection E.

A 200 Documentation

201 For ships with movable car decks the following plans and particulars are to be submitted for approval:

— car deck pontoons and their weights
— supports or suspensions
— connections to hull structure with information on reaction forces from hoisting devices
— stowing arrangement on weather deck or in cargo hold for deck pontoons not in use, including all stressed strength members, such as racks on deck, securing devices, reinforcement of supporting hull structures, etc.

202 For ships built for carriage of vehicles with fuel in their tanks the following plans and particulars are to be submitted for approval:

— plans and specifications for the fire alarm system, the extinguishing system and the ventilation system specified in Pt.4 Ch.10
— arrangement plan(s) as specified in Pt.4 Ch.8 showing all electrical equipment in spaces where vehicles are carried, with specification of make, type and rating of all such equipment and of cable types.

B. Car Decks

B 100 General

101 Permanent car decks are normally to be built as grillage systems of girders and stiffeners integrated in the hull structure with deck plating welded to the supporting strength members. Alternatively plating of equivalent strength (e.g. plywood) bolted to the supporting members may be approved after special consideration.

102 Movable car decks are normally to be built as pontoons consisting of a grillage system of girders and stiffeners with deck plating welded to the supporting strength members. The pontoon may be made of steel or aluminium alloys suitable for marine use.

103 Other types and combinations of car decks and materials may be approved after special consideration.

B 200 Design loads

201 The scantlings are to be based on the most severe conditions of moving or stowed vehicles.

202 For plating and stiffeners the local pressure due to direct wheel loads from individual vehicles will normally be decisive. Design conditions are to be as given for the additional class notation PWDK in Sec.4 C.

203 For girders the total load including the mass of deck structure may normally be regarded as evenly distributed. The design pressure is given by:

\[ p = (q_c + q_0) (9.81 + 0.5 a_v) \text{ (kN/m²)} \]

where:

- \( q_c \) = specified distributed cargo load in t/m²
- \( q_0 \) = distributed mass of deck structure in t/m²
- \( a_v \) = vertical acceleration as defined in Pt.3 Ch.1 Sec.4

The value of \( c_c + q_0 \) is not to be taken less than 0,25 t/m².

B 300 Strength requirements

301 Plating and stiffeners are to satisfy the requirements for the additional class notation PWDK given in Sec.4 C.

For the calculation of section modulus of stiffeners on movable car decks the following m-value normally apply:

\[ m = \frac{8}{2 - a/l} \]

where:

- \( l \) = span in m of stiffeners
- \( a \) = extent in m of load in direction of stiffener.

The m-value (corresponding to stiffener simply supported at ends) may be adjusted after special consideration based on direct stress analysis.

302 For simple girders the section modulus is given by:

\[ Z = \frac{6.25S^2 bp}{mf_1} \text{ (cm³)} \]

For effective plate flange, see Pt.3 Ch.1 Sec.3 C.

The web area requirement (after deduction of cut-outs) at the girder end is given by:

\[ A = \frac{0.06Sbp}{f_1} \text{ (cm²)} \]

The web area at the middle of the span is not to be less than 0.5 A.

303 For complex girder systems and/or loads not being evenly distributed, the scantlings are to be based on direct stress analysis.

Allowable stresses are:

— normal stress: \( \sigma \leq 160 f_1 \text{ N/mm²} \)
— shear stress: \( \tau \leq 90 f_1 \text{ N/mm²} \).

304 Girders are to have a moment of inertia not less than:

\[ I = C_1 Z f_1 S \text{ (cm}^4 \text{)} \]

where:

- \( C_1 = 1.1 \) for steel
- \( C_1 = 3.0 \) for aluminium alloy
D. Stowing Arrangement for Deck Pontoons not in Use (Class Notation MCDK)

D 100 General

101 The ship is to have stowing arrangement for all movable deck pontoons.

102 The stowing devices are to be of such design that the pontoons can be fastened and secured by means which will not slacken or loosen by the stresses arising when the ship is at sea. Hoisting equipment for pontoons is normally not to be stressed when the pontoons are in stowed position. If the hoisting equipment will be stressed by the stowed pontoons, its scantlings are to be determined accordingly.

D 200 Arrangement on weather deck

201 In racks for stowing of movable deck pontoons on weather deck the clearance between pontoon and racks is not to be greater than necessary for pontoon handling. Pontoons in contact with the securing arrangement are to be lockable in racks.

202 The requirements to drainage given in 203 and 204 are generally to be complied with for all cargo hatches on weather deck. If the pontoon stacks at the foremost 30% of the ship's length L extend higher than top of nearest cargo hatch, a significant increase of the drainage area as calculated from 203 and 204 may be required, upon consideration in each case.

203 At forward and after ends of pontoon stacks (or continuous row of stacks) and below these, there is to be a total free transverse drainage area on each side of the ship, taken to top of pontoon stacks, not less than:

\[ a = \frac{v}{30 \sqrt{h}} \quad \text{(m}^2) \]

\[ v = \text{volume in m}^3 \text{of the quantity of water which can fill the space between pontoon stacks on each side of the ship to top of stacks, taken over a length of deck between midpoints of openings at forward and after ends of stacks (or continuous row). The length is, however, not to be taken to extend more than the stack height h beyond the forward and after end of stacks} \]

\[ h = \text{height in m from deck to top of pontoon deck.} \]

204 Outside pontoon stacks, passages overboard for water, are to be provided. Any bulwark is to have openings with area as calculated from 203, and such that the volume v is increased by the quantity of water which can fill the space between bulwark and pontoon stacks up to top of bulwark. The area between top of bulwark and top of stacks at their ends, which is included in the calculation of v from 203, may be deducted from the requirement to openings in bulwark.

D 300 Design loads

301 For determination of scantlings of racks on weather deck and supporting structures, the pontoon stacks are to be regarded as subjected to the following one-sided pressure:

\[ p = a [p_{a} + \frac{135y}{B + 75} - 4h_{0}] \quad \text{(kN/m}^2) \]

minimum 12.5 kN/m²

\[ a = 1.7 \text{ in transverse direction} \]

\[ = 1.3 \text{ in longitudinal direction for ends protected by another stack or bulkhead} \]

\[ = 2.0 \text{ in longitudinal direction for unprotected ends (e.g. forward end in ships not having a forecastle terminating forward of the foremost cargo hatch) \]

\[ p_{a} = k_{p} C_{W} + f \quad \text{in general} \]

C. Supports and Suspensions for Deck Pontoons (Class Notation MCDK)

C 100 General

101 Deck pontoons are to be effectively supported at the ship's sides and bulkheads and by pillars or suspensions.

102 Pillars or suspensions carrying several tiers of decks, are to be designed for the number of decks they carry.

103 Supports for pillars are to be designed to withstand tensile forces also.

C 200 Design loads

201 For calculation of supports and suspensions the total load on the pontoon including the mass of the pontoon itself is to be considered. The design pressure p is to be taken as given in B203.

C 300 Strength requirements

301 The scantlings are to be based on direct stress analysis.

302 Allowable nominal stresses in support elements are:

- normal stress (tensile, compressive):

\[ \sigma = 110 \text{ f}_{t} \text{ N/mm}^2 \]

- shear stress:

\[ \tau = 65 \text{ f}_{t} \text{ N/mm}^2 \]

- equivalent stress \( \sqrt{\sigma^2 + 3\tau^2} \)

\[ \sigma_{e} = 120 \text{ f}_{t} \text{ N/mm}^2 \]

303 Due attention is to be given to the local stress concentrations.

304 If slender attention is to be given to the allowable stress specially.

305 For wire suspensions the minimum breaking load is not to be less than:

\[ P_{m} = 4 \text{ p}_{a} \quad \text{(kN)} \]

\[ \text{p}_{a} = \text{calculated design force in kN of wire.} \]

The construction and testing of steel wire suspensions are to comply with the requirements given in Pt.3 Ch.3 Sec.3 for towhandles and mooring lines.

Z = section modulus of the girder in cm³

S = girder span in m

\( \sigma_{c} = \frac{\sigma_{a}}{0.87} \quad \text{(N/mm}^2 \) }

\( \sigma_{a} = \text{calculated compressive design stress.} \)

Tripping brackets and local stiffening of plating are to be provided where necessary.

306 The weld connection between beams and top plating is not to be scalloped.

B 400 Securing points for lashing of cars

401 For arrangement, working loads and allowable stresses, see Sec.4 B800. See also Sec.3 B400.
\[
(ksC_W + f) \left[ 0, 8 + 0, 15 \frac{V}{\sqrt{L}} \right] \text{ when } \frac{V}{\sqrt{L}} > 1.5
\]

- \( f \) = vertical distance in m from the waterline to top of ship's side at transverse section considered, maximum \( C_W \)
- \( y \) = horizontal distance in m from the centre line to the point considered, minimum B/4
- \( k_s \) = \( 2 + \frac{3,1}{\sqrt{C_B}} \) at A.P. and abaft
  - = 2 between 0,2 L and 0,7 L from A.P.
  - = \( 2 + \frac{4,7}{C_B} \) at F.P. and forward
- \( C_W \) = wave coefficient as given in Pt.3 Ch.1 Sec.4.

Between specified areas \( k_s \) is to be varied linearly. Transverse and longitudinal pressures need not be considered as acting simultaneously.

**302** For pontoons stowed under deck, stowing and securing devices are to be designed for:

- transverse force not less than 5Q kN
- vertical force not less than 13Q kN
- longitudinal force not less than 2,5 kN.

Q = total load in t of pertinent stowed pontoons.

**D 400** **Allowable stresses**

**401** Calculated, nominal combined stresses in stowing devices and their connections to supporting structures are not to exceed \( 120 f_1 \) N/mm².

**402** Strength members subjected to buckling loads, are to have a safety factor against buckling not less than 1,7.

**E. Fire Protection in Cargo Area**

**E 100** **General**

**101** The fire protection measures for the cargo area of car carriers are to comply with the relevant requirements given in Pt.4 Ch.10 Sec.15 E.
SECTION 8
SUBDIVISION AND DAMAGE STABILITY OF CARGO SHIPS

A. General

A 100 Application

101 The requirements of this section apply to cargo ships over 80 m in length (Ls). Those ships which are shown to comply with subdivision and damage stability regulations of other instruments developed by IMO, however, may be excluded.

Guidance note:
Ships shown to comply with one of the following regulations may be excluded from the application of this section:
— Annex I to MARPOL 73/78 (class notation Tanker for Oil)
— International Bulk Chemical Code (class notation Tanker for Chemicals)
— International Gas Carrier Code (class notation Tanker for Liquefied Gas)
— Guidelines for the Design and Construction of Offshore Supply Vessels (Resolution A.469(XIII)) (class notation SF)
— Code of Safety for Special Purpose Ships (Resolution A.534(13) (no class equivalent is available)
— Damage stability requirements of regulation 27 of the 1966 Load Line Convention as applied in compliance with resolutions A.320(IX) and A.514(13), provided that in the case of ships to which regulation 27(9) applies, main transverse watertight bulkheads, to be considered effective, are spaced according to paragraph (12)(f) of resolution A.320(IX) (Pt.3 Ch.5 Sec.3 A)

---end---of---Guidance---note---

Guidance note:
In order to ensure uniform application, the requirements of this section should be applied in conjunction with the explanatory notes developed by IMO in Resolution A.684(17).

---end---of---Guidance---note---

102 Alternative arrangements which provide at least the same degree of safety as represented by this section may be considered.

103 The requirements in this section are in compliance with relevant parts of SOLAS Ch.II-1, with the latest amendments in force.

SOLAS texts directly quoted are printed in Italic, with references.

A 200 Definitions

201 Terms and symbols (Regulation 25-2)

1.1 Subdivision load line
is a waterline used in determining the subdivision of the ship.

1.2 Deepest subdivision load line
is the subdivision load line which corresponds to the summer draught to be assigned to the ship.

1.3 Partial load line
is the light ship draught plus 60% of the difference between the light ship draught and deepest subdivision load line.

2.1 Subdivision length
of the ship (Ls) is the greatest projected moulded length of that part of the ship at or below deck or decks limiting the vertical extent of flooding with the ship at the deepest subdivision load line.

2.2 Mid-length
is the mid point of the subdivision length of the ship.

2.3 Att terminal
is the aft limit of the subdivision length.

2.4 Forward terminal
is the forward limit of the subdivision length.

3 Breadth (B)
is the greatest moulded breadth of the ship at or below the deepest subdivision load line.

4 Draught (d)
is the vertical distance from the moulded baseline at mid-length to the waterline in question.

5 Permeability (μ)
of a space is the proportion of the immersed volume of that space which can be occupied by water.

A 300 Documentation

301 The following documentation is to be submitted for approval:
— calculation of subdivisions indices R and A
— damage stability calculations for the flooding cases included in the calculation of A
— stability information as required in regulation 25-8.1 (B601)
— damage control plan.

302 The following documentation is to be submitted for information:
— internal watertight integrity plan.

Guidance note:
Reference is made to Classification Note No. 20.1 «Stability Documentation — Ships, Newbuildings» regarding description of the documentation.

---end---of---Guidance---note---

B 100 Regulation 25-3

101 Required subdivision index R

1 These regulations are intended to provide ships with a minimum standard of subdivision.

2 The degree of subdivision to be provided shall be determined by the required subdivision index «R», as follows:

1. for ships over 100 m in Ls:

\[ R = \left( \frac{0.002 + 0.0009 L_S}{L_S} \right)^{1/3} \]

where Ls is in metre; and

2. for ships of 80 m in Ls and upwards but not exceeding 100 m in length Ls:

\[ R = 1 - \left( \frac{1}{1 + \frac{L_S}{100} \frac{R_O}{1 - R_O}} \right) \]

where R0 is the value R as calculated in accordance with the formula in subparagraph .1.
B 200 Regulation 25-4

201 Attained subdivision index A

1 The attained subdivision index A, calculated in accordance with this regulation, shall not be less than the required subdivision index R, calculated in accordance with paragraph 2 of regulation 25-3 (100).

2 The attained subdivision index A shall be calculated for the ship by the following formula:

\[ A = \sum p_i s_i \]

where:

\[ i \] represents each compartment or group of compartments under consideration,
\[ p_i \] accounts for the probability that only the compartment or group of compartments under consideration may be flooded, disregarding any horizontal subdivision, and accounts for the probability of survival after flooding the compartment or group of compartments under consideration, including the effects of any horizontal subdivision.
\[ s_i \]

3 In calculating A, level trim shall be used.

4 This summation covers only those cases of flooding which contribute to the value of the attained subdivision index A.

5 The summation indicated by the above formula shall be taken over the ship’s length for all cases of flooding in which a single compartment or two or more adjacent compartments are involved.

6 Wherever wing compartments are fitted, contribution to the summation indicated by the formula shall be taken for all cases of flooding in which wing compartments are involved; and additionally, for all cases of simultaneous flooding of a wing compartment or compartments and the adjacent inboard compartment or compartments, assuming a rectangular penetration which extends to the ship’s centreline, but excludes damage to any centreline bulkhead.

7 The assumed vertical extent of damage is to extend from the baseline upwards to any watertight horizontal subdivision above the waterline or higher. However, if a lesser extent will give a more severe result, such extent is to be assumed.

8 If pipes, ducts or tunnels are situated within assumed flooded compartments, arrangements are to be made to ensure that progressive flooding cannot thereby extend to compartments other than those assumed flooded. However, the Administration may permit minor progressive flooding if it is demonstrated that its effects can be easily controlled and the safety of the ship is not impaired.

9 In the flooding calculations carried out according to the regulations, only one breach of the hull need be assumed.

B 300 Regulation 25-5

301 Calculation of the factor \( p_i \)

1 The factor \( p_i \) shall be calculated according to paragraph 1.1 as appropriate, using the following notations:

\[ x_1 = \text{the distance from the aft terminal of } L_s \text{ to the foremost portion of the aft end of the compartment being considered;} \]
\[ x_2 = \text{the distance from the aft terminal of } L_s \text{ to the aftermost portion of the forward end of the compartment being considered;} \]
\[ E_1 = \frac{x_1}{L_s} \]
\[ E_2 = \frac{x_2}{L_s} \]
\[ E = E_1 + E_2 - 1 \]
\[ J = E_2 - E_1 \]
\[ J' = J - E, \text{ if } E \geq 0 \]

The maximum nondimensional damage length

\[ J_{\text{max}} = \frac{48}{L_s}, \text{ but not more than 0.24.} \]

The assumed distribution density of damage location along the ship’s length

\[ a \] = 1.2 + 0.8E, but not more than 1.2.

The assumed distribution function of damage location along the ship’s length

\[ F = 0.4 + 0.25 E (1.2 + a) \]
\[ y = \frac{J}{J_{\text{max}}} \]
\[ p = F_1 J_{\text{max}} \]
\[ q = 0.4 F_2 (J_{\text{max}})^2 \]

\[ F_1 = y^2 - \frac{y^3}{3}, \text{ if } y < 1, \]
\[ = \frac{1}{3} y \quad \text{ otherwise;} \]
\[ F_2 = \frac{\sqrt{3}}{2} y^2 - \frac{y^3}{12}, \text{ if } y < 1, \]
\[ = \frac{1}{3} y - \frac{1}{12} \quad \text{ otherwise.} \]

1.1 The factor \( p_i \) is determined for each single compartment:

1.1.1 Where the compartment considered extends over the entire ship length, \( L_s \):

\[ p_i = 1 \]

1.1.2 Where the aft limit of the compartment considered coincides with the aft terminal:

\[ p_i = F + 0.5 a p + q \]

1.1.3 Where the forward limit of the compartment considered coincides with the forward terminal:

\[ p_i = 1 - F + 0.5 a p \]

1.1.4 When both ends of the compartment considered are inside the aft and forward terminals of the ship length, \( L_s \):

\[ p_i = a p \]

1.1.5 In applying the formulae of paragraphs 1.1.2, 1.1.3 and 1.1.4, where the compartment considered extends over the «mid-length», these formulae values shall be reduced by an amount determined according to the formula for \( q \), in which \( F_2 \) is calculated taking \( y \) to be \( J' / J_{\text{max}} \).

2. Wherever wing compartments are fitted, the \( p_i \)-value for a wing compartment shall be obtained by multiplying the value, as determined in paragraph 3, by the reduction factor \( r \) according to subparagraph 2.2, which represents the probability that the inboard spaces will not be flooded.

2.1 The \( p_i \)-value for the case of simultaneous flooding of a wing and adjacent inboard compartment shall be obtained by using the formulae of paragraph 3, multiplied by the factor \((1-r)\).

2.2 The reduction factor \( r \) shall be determined by the following formulae:

For \( J \geq 0.2 \frac{b}{B} \):

\[ r = \begin{cases} 
\frac{b}{B} (2.3 + \frac{0.08}{J + 0.02}) + 0.1, & \text{if } \frac{b}{B} \leq 0.2 \\
0.016 + \frac{b}{B} + 0.36, & \text{if } \frac{b}{B} > 0.2 
\end{cases} \]

For \( J < 0.2 \frac{b}{B} \) the reduction factor \( r \) shall be determined by linear interpolation between
For compartments taken by pairs:

\[ r = 1 \text{, for } J = 0 \]

and

\[ r = \text{as for the case where } J \geq 0, \frac{2b}{B} \text{, for } J = 0, \frac{2b}{B} \]

where:

\[ b = \text{the mean transverse distance in metres measured at right angles to the centreline at the deepest subdivision load line between the shell and a plane through the outermost portion of and parallel to that part of the longitudinal bulkhead which extends between the longitudinal limits used in calculating the factor } p. \]

3 To evaluate \( p_1 \) for compartments taken singly the formulae in paragraphs 1 and 2 shall be applied directly.

3.1 To evaluate the \( p_i \)-values attributable to groups of compartments according to the following:

3.2 The factor \( p_i \) for a group of three or more adjacent compartments shall be obtained by multiplying the value as determined in subparagraph 3.1 by the reduction factor \( v \) according to subparagraph 3.3, which represents the probability that the spaces above the horizontal subdivision will not be flooded.

3.2 In cases of positive contribution to index A due to simultaneous flooding of the spaces above the horizontal subdivision, the resulting \( s \)-value for such a compartment or group of compartments shall be obtained by an increase of the value as determined in subparagraph 3.3.1 by the reduction factor \( v \) according to subparagraph 3.3, which represents the probability that the spaces above the horizontal subdivision will not be flooded.

3.3 The probability factor \( v \) shall be calculated according to:

\[ v = \frac{H - d}{H_{max} - d} \]

for the assumed flooding up to the horizontal subdivision above the subdivision load line, where \( H \) is to be restricted to a height of \( H_{max} \),

\[ v = 1 \text{ if the uppermost horizontal subdivision in way of the assumed damaged region is below } H_{max} \]

where:

\[ H = \text{the height of the horizontal subdivision above the baseline (in metres) which is assumed to limit the vertical extent of damage}, \]

\[ H_{max} = \text{the maximum possible vertical extent of damage above the baseline (in metres), or} \]

\[ H_{max} = d + 0, 056L_s\left(1 - \frac{L_s}{500}\right), \text{if } L_s \leq 250 \text{ m} \]

\[ H_{max} = d + 7, \text{ if } L_s > 250 \text{ m} \]

whichever is less.

B 500 Regulation 25-7

501 Permeability
For the purpose of the subdivision and damage stability calculations of the regulations, the permeability of each space or part of a space shall be as follows:

<table>
<thead>
<tr>
<th>Spaces</th>
<th>Permeability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appropriated to stores</td>
<td>0,60</td>
</tr>
<tr>
<td>Occupied by accommodation</td>
<td>0,95</td>
</tr>
<tr>
<td>Occupied by machinery</td>
<td>0,85</td>
</tr>
<tr>
<td>Void spaces</td>
<td>0,95</td>
</tr>
<tr>
<td>Dry cargo spaces</td>
<td>0,70</td>
</tr>
<tr>
<td>Intended for liquid</td>
<td>0 or 0,95*</td>
</tr>
</tbody>
</table>

* Whichever results in the more severe requirements.

B 600 Regulation 25-8

601 Stability information

1 The master of the ship shall be supplied with such reliable information as is necessary to enable him by rapid and simple means to obtain accurate guidance as to the stability of the ship under varying conditions of service. The information shall include:

1.1 a curve of minimum operational metacentric height (GM) versus draught which assures compliance with the relevant intact stability requirements and the requirements of regulations 25-1 (A101) to 25-6 (400), alternatively a corresponding curve of the maximum allowable vertical centre of gravity (KG) versus draught, or with the equivalents of either of these curves;

1.2 instructions concerning the operation of cross flooding arrangements; and

1.3 all other data and aids which might be necessary to maintain stability after damage.

2 There shall be permanently exhibited, or readily available on the navigating bridge, for the guidance of the officer in charge of the ship, plans showing clearly for each deck and hold the boundaries of the watertight compartments, the openings therein with the means of closure and position of any controls thereof, and the arrangements for the correction of any list due to flooding. In addition, booklets containing the aforementioned information shall be made available to the officers of the ship.

3 In order to provide the information referred to in 1.1, the limiting GM (or KG) values to be used, if they have been determined from considerations related to the subdivision index, the limiting GM shall be varied linearly between the deepest subdivision load line and the partial load line. In such cases, for draughts below the partial load line if the minimum GM requirement at this draught results from the calculation of the subdivision index, then this GM value shall be assumed for lesser draughts, unless the intact stability requirements apply.

B 700 Regulation 25-9

701 Openings in watertight bulkheads and internal decks in cargo ships

1 The number of openings in watertight subdivisions is to be kept to a minimum compatible with the design and proper working of the ship. Where penetrations of watertight bulkheads and internal decks are necessary for access, piping, ventilation, electrical cables, etc., arrangements are to be made to maintain the watertight integrity. The Administration may permit relaxation in the watertightness of openings above the freeboard deck, provided that it is demonstrated that any progressive flooding can be easily controlled and that the safety of the ship is not impaired.

2 Doors provided to ensure the watertight integrity of internal openings which are used while at sea are to be sliding watertight doors capable of being remotely closed from the bridge and are also to be operable locally from each side of the bulkhead. Indicators are to be provided at the control position showing whether the doors are open or closed, and an audible alarm is to be provided at the door closure. The power, control and indicators are to be operable in the event of main power failure. Particular attention is to be paid to minimise the effect of control system failure. Each power-operated sliding watertight door shall be provided with an individual hand-operated mechanism. It shall be possible to open and close the door by hand at the door itself from both sides.

3 Access doors and access hatch covers normally closed at sea, intended to ensure the watertight integrity of internal openings, shall be provided with means of indication locally and on the bridge showing whether these doors or hatch covers are open or closed. A notice is to be affixed to each such door or hatch cover to the effect that it is not to be left open. The use of such doors and hatch covers shall be authorised by the officer of the watch.

4 Watertight doors or ramps of satisfactory construction may be fitted to internally subdivide large cargo spaces, provided that the Administration is satisfied that such doors or ramps are essential. These doors or ramps may be hinged, rolling or sliding doors or ramps, but shall not be remotely controlled. Such doors or ramps shall be closed before the voyage commences and shall be kept closed during navigation; the time of opening such doors or ramps in port and of closing them before the ship leaves port shall be entered in the log book. Should any of the doors or ramps be accessible during the voyage, they shall be fitted with a device which prevents unauthorised opening.

5 Other closing appliances which are kept permanently closed at sea to ensure the watertight integrity of internal openings shall be provided with a notice which is to be affixed to each such closing appliance to the effect that it is to be kept closed. Manholes fitted with closely bolted covers need not be so marked.

Guidance note:
The scantlings of tunnels, ducts, pipes, doors, stairway casings, bulkheads and decks, forming watertight bulkheads, must be adequate to withstand the pressure height corresponding to the deepest equilibrium waterline in damaged condition. Refer also to Pt.3 Ch.1 Sec.8 and 9.

---end-of-Guidance-note---

B 800 Regulation 25-10

801 External openings in cargo ships

1 All external openings leading to compartments assumed intact in the damage analysis, which are below the final damage waterline, are required to be watertight.

2 External openings required to be watertight in accordance with paragraph 1 shall be of sufficient strength and, except for cargo hatch covers, shall be fitted with indicators on the bridge.

3 Openings in the shell plating below the deck limiting the vertical extent of damage shall be kept permanently closed while at sea. Should any of these openings be accessible during the voyage, they shall be fitted with a device which prevents unauthorised opening.

4 Notwithstanding the requirements of paragraph 3, the Administration may authorise that particular doors may be opened at the discretion of the master, if necessary for the operation of the ship and provided that the safety of the ship is not impaired.

5 Other closing appliances which are kept permanently closed at sea to ensure the watertight integrity of external openings shall be provided with a notice affixed to each appliance to the effect that it is to be kept closed. Manholes fitted with closely bolted covers need not be so marked.
SECTION 9
GRAIN CARRIERS

A. General

A 100 Application

101 The requirements of this section apply to ships intended for the carriage of grain in bulk, except ships which require shifting boards or other removable divisions to reduce the adverse heeling effect of grain shift.

Guidance note:
The requirements of this section are considered to be in accordance with the revised chapter VI of SOLAS 74/78 as adopted by resolution MSC.22(59), except that ships which require shifting boards or other removable divisions may be issued with document of authorisation for carriage of bulk grain according to the revised chapter VI of SOLAS 74/78 as adopted by resolution MSC.22(59). The revised chapter VI of SOLAS 74/78 refers to the «International Code for the safe carriage of Grain in Bulk», adopted by resolution MSC.23(59).

102 Ships which are found to comply with the requirements of this section may be given the additional class notation GRAIN.

103 Ships which are found also to comply with the requirements for dispensation from trimming in B 200 may be given the additional class notation GRAIN-U.

A 200 Definitions

201 The term grain covers wheat, maize (corn), oats, rye, barley, rice, pulses, seeds and processed forms thereof, whose behaviour is similar to that of grain in its natural state.

202 The term filled compartment, trimmed refers to any compartment in which, after loading and trimming, the bulk grain is at its highest possible level.

203 The term filled compartment, untrimmed refers to a cargo space which is filled to the maximum extent possible in way of the hatch opening but which has not been trimmed outside the periphery of the hatch opening by either of the provisions specified in B 200.

204 The term partly filled compartment refers to any compartment wherein the bulk grain is not loaded in the manner prescribed in 202 or 203.

205 The term angle of flooding ($\theta$) means the angle of heel at which openings in the hull, superstructures or deckhouses, which cannot be closed weathertight, immerse. In applying this definition, small openings through which progressive flooding cannot take place need not be considered as open.

206 The term stowage factor, for the purposes of calculating the grain heeling moment caused by a shift of grain, means the volume per unit weight of the cargo as attested by the loading facility, i.e. no allowance shall be made for lost space when the cargo space is nominally filled.

207 The term specially suitable compartment refers to a cargo space which is constructed with at least two vertical or sloping, longitudinal, grain-tight divisions which are coincident with the hatch side girders or are so positioned as to limit the effect of any transverse shift of grain. If sloping, the divisions shall have an inclination of not less than 30° to the horizontal.

A 300 Documentation

301 The following documentation is to be submitted for approval:

— preliminary grain manual, including grain heeling moment calculations
— final grain manual.

Guidance note:
Details of the documentation in 301 is given in Classification Note No 20.1 Stability Documentation — Ships Newbuildings.

B. General Requirements

B 100 Grain stability booklet

101 An approved grain stability booklet is to be provided onboard. The grain stability booklet is to include information as necessary to enable the master to determine that the ship complies with the requirements of this section. The booklet is to include the information in 103 and 104.

102 Stability data and associated plans are to include a translation into English, if English is not used as official language.

103 Information in the grain stability booklet is to include:

— ship's particulars
— lightship displacement and the vertical distance from the intersection of the moulded base line and midship section to the centre of gravity (KG)
— table of liquid free surface corrections
— capacities and centres of gravity
— curve or table of angle of flooding, where less than 40°, at all permissible displacements
— curves or tables of hydrostatic properties suitable for the range of operating drafts
— cross curves of stability which are sufficient for the purpose of the requirements in C100 and which include curves at 12° and 40°.

104 Information for approval is to include:

— curves or tables of volumes, vertical centres of volumes, and assumed volumetric heeling moments for every compartment, filled or partly filled, or combination thereof, including the effects of temporary fittings
— tables or curves of maximum permissible heeling moments for varying displacements and varying vertical centres of gravity to allow the master to demonstrate compliance with the requirements of C100
— details of the scantlings of any temporary fittings and, where applicable, the provisions necessary to meet the requirements of C100
— loading instructions in the form of notes summarizing the requirements of this Section
— a worked example for the guidance of the master
— typical loaded service departure and arrival conditions and where necessary intermediate worst service conditions.

Guidance note:
It is recommended that loading conditions be provided for three representative stowage factors, e.g. 1.25, 1.50 and 1.75 cubic metre per metric tonne.

B 200 Dispensation from trimming

201 Dispensation from trimming may be given if the requirements in 202 or 203 are complied with.
202 The underdeck void geometry resulting from free flowing grain into a compartment is taken into account when calculating the void depth. The compartment may be provided with feeder ducts, perforated decks or other similar means.

203 The compartment is specially designed as defined in A 207, in which case dispensation may be granted from trimming the ends of that compartment.

C. Stability Requirements

C 100 Intact stability requirements

101 The intact stability characteristics of any ship carrying bulk grain are to be shown to meet, throughout the voyage, at least the following criteria after taking into account, in the manner described in D and in Fig. 1, the heeling moments due to grain shift:

![Righting arm curve](image)

**Fig. 1** Righting arm curve

Notes to Fig. 1:

1) Where:

\[ \lambda_0 = \text{assumed volumetric heeling moment due to transverse shift} \]

\[ \lambda_{40} = 0.8 \lambda_0 \]

Stowage factor = volume per unit weight of grain cargo;

Displacement = weight of ship, fuel, fresh water, stores etc. and cargo.

2) The righting arm curve shall be derived from cross-curves which are sufficient in number to accurately define the curve for the purpose of these requirements and shall include cross-curves at 12° and 40°:

- the angle of heel due to the shift of grain shall not be greater than 12° or the angle at which the deck edge is immersed, whichever is the lesser

- in the statical stability diagram, the net or residual area between the heeling arm curve and the righting arm curve up to the angle of heel of maximum difference between the ordinates of the two curves, or 40° or the angle of flooding (\( \theta_f \)), whichever is the least, shall in all conditions of loading be not less than 0,075 metre-radians

- the initial metacentric height, after correction for the free surface effects of liquids in tanks, shall be not less than 0,30 m.

**D. Calculation of Assumed Heeling Moments**

**D 100 General assumptions**

101 For the purpose of calculating the adverse heeling moment due to a shift of cargo surface in ships carrying bulk grain it shall be assumed that:

a) In filled compartments which have been trimmed, a void exists under all boundary surfaces having an inclination to the horizontal less than 30° and that the void is parallel to the boundary surface having an average depth calculated according to the formula:

\[ V_d = V_{d1} + 0.75 (d - 600) \text{ mm} \]

where:

- \( V_d \) = average void depth in mm
- \( V_{d1} \) = standard void depth from table D1
- \( d \) = actual girder depth in mm.

In no case shall \( V_d \) be assumed to be less than 100 mm.

b) Within filled hatchways and in addition to any open void within the hatch cover there is a void of average depth of 1,50 mm measured down to the grain surface from the lowest part of the hatch cover or the top of the hatch side coaming, whichever is the lower.

c) In a **filled compartment, untrimmed** which is exempted from trimming outside the periphery of the hatchway by the provisions of B202, it shall be assumed that the surface of the grain after loading will slope into the void space underdeck, in all directions, at an angle of 30° to the horizontal from the edge of the opening which establishes the void.

<table>
<thead>
<tr>
<th>Table D1 Standard void depth</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Distance from hatch end or hatch side to boundary of compartment (m)</strong></td>
</tr>
<tr>
<td>0,5</td>
</tr>
<tr>
<td>1,0</td>
</tr>
<tr>
<td>1,5</td>
</tr>
<tr>
<td>2,0</td>
</tr>
<tr>
<td>2,5</td>
</tr>
<tr>
<td>3,0</td>
</tr>
<tr>
<td>3,5</td>
</tr>
<tr>
<td>4,0</td>
</tr>
<tr>
<td>4,5</td>
</tr>
<tr>
<td>5,0</td>
</tr>
<tr>
<td>5,5</td>
</tr>
<tr>
<td>6,0</td>
</tr>
<tr>
<td>6,5</td>
</tr>
<tr>
<td>7,0</td>
</tr>
<tr>
<td>7,5</td>
</tr>
<tr>
<td>8,0</td>
</tr>
</tbody>
</table>

1) For boundary distances greater than 8,0 m the standard void depth \( (V_{d1}) \) shall be linearly extrapolated at 80 mm increase for each 1,0 m increase in length.

2) In the corner area of a compartment the boundary distance shall be the perpendicular distance from the line of the hatch side girder or the line of the hatch end beam to the boundary of the compartment, whichever is the greater. The girder depth \( (d) \) shall be taken to be the depth of the hatch side girder or the hatch end beam, whichever is the less.

3) Where there is a raised deck clear of the hatchway the average void depth measured from the underside of the raised deck shall be calculated using the standard void depth in association with a girder depth of the hatch end beam plus the height of the raised deck.

In a **filled compartment, untrimmed** which is exempted from trimming in the ends of the compartment under the provisions...
of B203, it shall be assumed that the surface of the grain after loading will slope in all directions away from the filling area at an angle of 30° from the lower edge of the hatch end beam. However, if feeding holes are provided in the hatch end beams in accordance with Table D2, then the surface of the grain after loading shall be assumed to slope in all directions, at an angle of 30° from a line on the hatch end beam which is the mean of the peaks and valleys of the actual grain surface as shown in Fig. 2.

**Table D2** Size and spacing of feeding holes

<table>
<thead>
<tr>
<th>Diameter (mm) Minimum</th>
<th>Area (cm²)</th>
<th>Spacing (m) Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>90</td>
<td>63.6</td>
<td>0.60</td>
</tr>
<tr>
<td>100</td>
<td>78.5</td>
<td>0.75</td>
</tr>
<tr>
<td>110</td>
<td>95.0</td>
<td>0.90</td>
</tr>
<tr>
<td>120</td>
<td>113.1</td>
<td>1.07</td>
</tr>
<tr>
<td>130</td>
<td>133.0</td>
<td>1.25</td>
</tr>
<tr>
<td>140</td>
<td>154.0</td>
<td>1.45</td>
</tr>
<tr>
<td>150</td>
<td>177.0</td>
<td>1.67</td>
</tr>
<tr>
<td>160</td>
<td>201.0</td>
<td>1.90</td>
</tr>
<tr>
<td>170 or above</td>
<td>227.0</td>
<td>2.00 maximum</td>
</tr>
</tbody>
</table>

![Fig. 2](image)

**Fig. 2**

Grain surface

102 The description of the pattern of grain surface behaviour to be assumed in partly filled compartments is contained in 400.

103 For the purpose of demonstrating compliance with the stability criteria in C100, the ship’s stability calculations are normally to be based upon the assumption that the centre of gravity of the cargo in a filled compartment, trimmed is at the volumetric centre of the whole cargo space.

The Society may accept that account is taken of the effect of assumed underdeck voids on the vertical position of the centre of gravity of the cargo in filled compartments, trimmed, if the adverse effect of the vertical shift of grain surfaces by increasing the assumed heeling moment due to the transverse shift of grain is compensated for, as follows:

\[
\text{total heeling moment} = 1.06 \times \text{calculated transverse heeling moment.}
\]

In all cases the weight of cargo in a filled compartment, trimmed is to be the volume of the whole cargo space divided by the stowage factor.

104 The centre of gravity of the cargo in a filled compartment, untrimmed is to be taken to be the volumetric centre of the whole cargo compartment with no account being allowed for voids. In all cases the weight of cargo is to be the volume of the cargo (resulting from the assumptions in 101 for filled compartments, untrimmed) divided by the stowage factor.

105 In partly filled compartments the adverse effect of the vertical shift of grain surfaces shall be taken into account as follows:

\[
\text{total heeling moment} = 1.12 \times \text{calculated transverse heeling moment.}
\]

106 Any other equally effective method may be adopted to make the compensation required in 103 and 104.

D 200 Assumed volumetric heeling moment of a filled compartment, trimmed

201 The following are general assumptions and basis for the calculation of the volumetric grain heeling moment:

a) The pattern of grain surface movement relates to a transverse section across the portion of the compartment being considered and the resultant heeling moment should be multiplied by the length to obtain the total moment for that portion.

b) The assumed transverse heeling moment due to grain shifting is a consequence of final changes of shape and position of voids after grain has moved from the high side to the low side.

c) The resulting grain surface after shifting shall be assumed to be at 15° to the horizontal.

d) In calculating the maximum void area that can be formed against a longitudinal structural member, the effects of any horizontal surfaces, e.g. flanges or face bars, shall be ignored.

e) The total areas of the initial and final voids shall be equal.

f) Longitudinal structural members which are grain-tight may be considered effective over their full depth except where they are provided as a device to reduce the adverse effect of grain shift, in which case the provisions of res. MSC.23(59) A 10.9 shall apply.

g) A discontinuous longitudinal division may be considered effective over its full length.

202 The total heeling moment for a compartment is to be obtained by adding the results of separate consideration of 203 and 204.

203 Before and abaft hatchways:

a) If a compartment has two or more main hatchways through which loading may take place, the depth of the underdeck void for the portion or portions between such hatchways shall be determined using the fore and aft distance to the midpoint between the hatchways.

b) After the assumed shift of grain the final void pattern shall be as shown in Fig. 3.

![Fig. 3](image)

**Fig. 3**

Void pattern

Notes to Fig. 3:

1) If the maximum void area which can be formed against the girders at B is less than the initial area of the void under AB, i.e. AB x Vd, the excess area shall be assumed to transfer to the final void on the high side.
204 In and abreast of hatchways without longitudinal division:

After the assumed shift of grain the final void pattern shall be as shown in Fig. 4:

![Void pattern](image)

**Fig. 4**

**Void pattern**

Notes to Fig. 4:

1) AB: Any area in excess of that which can be formed against the girder at B shall transfer to the final void area in the hatchway.

2) CD: Any area in excess of that which can be formed against the girder at E shall transfer to the final void area on the high side.

205 For compartments loaded in combination the pattern of void behaviour is to be assumed as specified in 206.

206 Without effective centreline divisions:

a) Under the upper deck — as for the single deck arrangement described in 203 and 204.

b) Under the second deck — the area of void available for transfer from the low side, i.e. original void area less area against the hatch side girder, shall be assumed to transfer as follows:

   one half to the upper deck hatchway and one quarter each to the high side under the upper and second deck.

c) Under the third and lower decks — the voids available for transfer from the low side of each of these decks shall be assumed to transfer in equal quantities to all the voids under the decks on the high side and the void in the upper deck hatchway.

D 300 Assumed volumetric heeling moment of a filled compartment, untrimmed

301 All the provision for filled compartments, trimmed set forth in 200 shall also apply to filled compartments, untrimmed except as noted in 302 and 303.

302 In filled compartments, untrimmed which are exempted from trimming outside the periphery of the hatchway under the provisions of B202:

   - the resulting grain surface after shifting shall be assumed to be at an angle of 25° to the horizontal. However, if in any section of the compartment, forward, aft, or abreast of the hatchway the mean transverse area of the void in that section is equal to or less than the area which would be obtained by application of 101, then the angle of grain surface after shifting in that section shall be assumed to be 15° to the horizontal

   - the void area at any transverse section of the compartment shall be assumed to be the same both before and after the grain shift, i.e. it shall be assumed that additional feeding does not occur at the time of the grain shift.

303 In filled compartments, untrimmed which are exempted from trimming in the ends, forward and aft of the hatchway, under the provisions of B203:

   - the resulting grain surface abreast of the hatchway after shifting shall be assumed to be at an angle of 15° to the horizontal; and

   - the resulting grain surface in the ends, forward and aft of the hatchway after shifting shall be assumed to be at an angle of 25° to the horizontal.

D 400 Assumed volumetric heeling moment in trunks

401 After the assumed shift of grain the final void pattern shall be as shown in Fig. 5.

![Void pattern](image)

**Fig. 5**

**Void pattern**

Note to Fig. 5:

1) If the wing spaces in way of the trunk cannot be properly trimmed, it shall be assumed that a 25° surface shift takes place.

D 500 Assumed volumetric heeling moment of a partly filled compartment

501 When the free surface of the bulk grain has not been secured by overstowing, strapping or lashing as detailed in Pt.7 Ch.4 App.A, it shall be assumed that the grain surface after shifting shall be at 25° to the horizontal.
SECTION 10
ENHANCED STRENGTH FOR BULK CARRIERS

A. Classification

A 100  Application

101 The requirements in this section are mandatory for vessels as defined in Sec.5 A 100.

102 Provided the vessels being built in compliance with the relevant requirements as given in Sec.5 Table A1 or Table A2 as relevant, the vessel may be given the additional class notation ES(.,) as outlined in above referred tables.

<table>
<thead>
<tr>
<th>Table A1 Class notations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ship Type</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>Double side skin bulk carrier or combination carrier</td>
</tr>
<tr>
<td>x</td>
</tr>
</tbody>
</table>

x Applicable
x 1)Applicable except requirements relating to application of subsection C
(D) Double side skin bulk carrier

Subsection A refers to IACS Unified Requirement, S1A, regarding loading manual/loading instrument.
Subsection B refers to IACS Unified Requirement, S12, regarding side frames
Subsection C refers to IACS Unified Requirement, S17, regarding hull girder strength in flooded condition
Subsection D refers to IACS Unified Requirement, S18, regarding transverse bulkhead strength in flooded condition.
Subsection E refers to IACS Unified Requirement, S20, regarding allowable hold loading considering flooding.
Subsection F refers to IACS Unified Requirement, S21, regarding hatch covers.

A 200  Documentation

201 The loading manual is to describe the following:

a) The loading conditions on which the design of the ship has been based, including permissible limits of still water bending moments and shear forces.

b) The results of calculations of still water bending moments, shear forces and where applicable, limitations due to torsional loads.

c) Envelope results and permissible limits to still water bending moments and shear forces in the hold flooded conditions are also to be included. See C300.

d) The cargo hold(s) or combination of holds that might be empty at full draught. If no cargo hold is allowed to be empty on full draught, this is to be clearly stated in the loading manual.

e) Maximum allowable and minimum required mass of cargo and double bottom contents of each hold as a function of the draught at mid-hold position.

f) Maximum allowable and minimum required mass of cargo and double bottom contents of any two adjacent holds as a function of mean draught in way of these holds. This mean draught may be calculated by averaging the draught of the two mid-hold positions.

g) Maximum allowable load on tank top together with specification of the nature of the cargo for cargoes other than bulk cargoes.

h) Maximum allowable load on deck and hatch covers. If the vessel is not approved to carry load on deck or hatch covers, this is to be clearly stated in the loading manual.

i) The maximum rate of ballast change together with the advice that a load plan is to be agreed with the terminal on the basis of achievable rates of change of ballast.

202 The loading computer system is to be an approved digital system as given in Pt.3 Ch.1 Sec.5 and Pt.6 Ch.9. The Loading computer system is, in addition to requirements given in Pt.3 Ch.1 Sec.5 A 202, to ascertain as applicable that:

— the mass of cargo and double bottom contents in way of each hold as a function of the draught at mid-hold position

— the mass of cargo and double bottom contents of any two adjacent holds as a function of the mean draught in way of these holds

— the still water bending moments and shear forces in the hold flooded conditions

are within permissible values.

A 300  Conditions of approval of loading manuals

301 The loading manual is, in addition to the requirements as given in Pt.3 Ch.1 Sec.5 F200, to include the following loading conditions, subdivided into departure and arrival:

a) Alternate light and heavy cargo loading conditions at maximum draught, where applicable.

b) Homogeneous light and heavy cargo loading conditions at maximum draught.

c) Ballast conditions. For vessels having ballast holds adjacent to topside wing, hopper and double bottom tanks, it is to be strengthwise acceptable that the ballast holds are filled when the topside wing, hopper and double bottom tanks are empty. Partial filling of the peak tanks is not acceptable in the design ballast conditions, unless effective means are provided to prevent accidental overfilling.

d) Short voyage conditions where the vessel is to be loaded to maximum draught but with limited amount of bunkers.

e) Multiple port loading and unloading conditions.

f) Deck cargo conditions, where applicable.
g) Typical loading sequences where the vessel is loaded from commencement of cargo loading to reaching full deadweight capacity, for homogeneous conditions, relevant part load conditions and alternate conditions where applicable.

Typical unloading sequences for these conditions shall also be included. The typical loading and unloading sequences shall be developed to not exceed applicable strength limitations. The typical loading sequences shall also be developed paying due attention to the loading rate, and the de-ballasting capability.

h) Typical sequences for change of ballast at sea, where applicable.

Guidance note:
The above listed loading conditions should be considered as mandatory for all vessels as applicable, i.e. loading conditions, which are not applicable or not intended to be used, need not be considered in the design, e.g.

— The alternate load conditions need not to be included for designs not intended to be operated in this condition.
— Multiple port loading conditions need only be included to the extent that the Owner wants to utilise such conditions in the operation of the vessel.

Furthermore, the specification of e.g. short voyage and multiple port conditions are in general subject to agreement between Owner and builder. This relates to the specification of the design loading conditions, which should take into consideration the intended modes and areas of operation. A short voyage condition may be a homogeneous or an alternate condition where the cargo deadweight is increased with approximately 50% of the bunker weight.

However, if some or all of the above conditions are not included in the Loading Manual a note to this effect is to be given in the Loading Manual.

---end---of---Guidance---note---

A 400 Condition of approval of loading instrument
401 The loading instrument is subject to approval. The approval of loading instrument is to include as applicable:

— acceptance of hull girder bending moments limits for all read-out points
— acceptance of hull girder shear force limits for all read-out points
— acceptance of limits for mass of cargo and double bottom contents of each hold as a function of draught
— acceptance of limits for mass of cargo and double bottom contents in any two adjacent holds as a function of draught
— acceptance of shear force corrections.

A 500 Damage stability
501 Paragraphs 502 to 504 apply to bulk carriers with single side skin construction.

502 The vessel is, when loaded to the summer load line, to be able to withstand flooding of any one cargo hold in all loading conditions and remain afloat in a satisfactory condition of equilibrium as specified in 502.

503 The condition of equilibrium after flooding is to satisfy the condition of equilibrium laid down in the annex to resolution A.320(IX) - Regulation equivalent to regulation 27 of the International Convention on Load Lines, 1966, as amended by resolution A.514(13), (see Pt.3 Ch.5 Sec.3 A100). The assumed flooding need to take into account flooding of the cargo hold space only. The permeability of the loaded hold is to be assumed as 0.9 and the permeability of an empty hold is to be assumed as 0.95, unless a permeability relevant to a particular cargo is assumed for the volume of a flooded hold occupied by cargo and a permeability of 0.95 is assumed for the remaining empty volume of the hold.

504 Vessels which have been assigned a reduced freeboard in compliance with the provisions of regulation 27(8) of the annex to resolution A.320(IX), as amended by resolution A.514(13), (see Pt.3 Ch.5 Sec.3 A100) may be considered as complying with requirements as given in 501.

B. Side Structure

B 100 Plating and stiffeners
101 Thickness and cross section properties are in general to be calculated as given in Pt.3 Ch.1 Sec.7.

102 The minimum thickness of side plating, located between hopper and top wing tanks and extending in length over the whole cargo area, is not to be less than:

$$ t = \sqrt{L} $$

when L is as defined in Pt.3 Ch.1 Sec.1 B.
Fig. 1
Typical main frame

B 200 Main frames

201 Main frames are frames located outside the peak tanks, connected to hopper tanks and extended to the top wing tank on the ship side, see Fig. 1. Main frames, including brackets built in compliance with the requirements given in this subsection need not to be checked for the requirements as given in Pt.3 Ch.1 Sec.7 C400.

202 The section modulus requirement is given by:

\[ Z = \frac{1000t^2spw_k}{m\sigma} \ (\text{cm}^3) \]

- \( p = p_1 \text{ to } p_8 \) whichever is relevant, as given in Pt.3 Ch.1 Sec.7 Table B1
- \( w_k = 1.05 \) when calculating sectional modulus for midspan and upper end
- \( \sigma = 1.15 \) when calculating sectional modulus for lower end
- \( \sigma = 130f_1 \) for internal loads \( p_1 \text{ to } p_8 \)
- \( \sigma = 150f_1 \) for external loads \( p_1, p_2 \) and \( p_{\text{min}} \) given above
- \( m = 18 \) in general
- \( m = 12 \) at upper end (including bracket) in combination with internal loads, \( p_3 \text{ to } p_8 \)
- \( m = 9 \) at lower end (including bracket) and for upper end in combination with external loads \( p_1, p_2 \) and \( p_{\text{min}} \).

For main frames situated next to plane transverse bulkheads, e.g. at the ends of the cargo region, the section modulus of the mid portion of the frame is generally to exceed the section modulus of the adjacent frame by a factor 3\( h_a/h \) where:

- \( h_a = \) web height of adjacent frame
- \( h = \) web height of considered frame.

The increased section modulus of the main frame adjacent to plane transverse bulkheads need not be fitted if other equivalent means are applied to limit the deflection of these frames.

203 The minimum thickness of frame webs within the cargo area is not to be less than \( t_{w, \text{min}} \) in mm, as given by:

\[ t_{w, \text{min}} = 7.0 + 0.03L \]

where \( L \) is as defined in Pt.3 Ch.1, but need not be taken greater than 200 m.

204 The minimum thickness of frame webs in way of the foremost hold is not to be taken less than \( t_{w1, \text{min}} \) in mm, given by:

\[ t_{w1, \text{min}} = 1.15t_{w, \text{min}} \]

205 The web depth to thickness ratio of frames is not to exceed the following values:

\[ \frac{h}{t_w} \leq 60 \left( \frac{1}{f_1} \right) \] for symmetrical flanged frame

\[ \frac{h}{t_w} \leq 50 \left( \frac{1}{f_1} \right) \] for asymmetrical flanged frame

For outstanding flanges the flange breadth, \( b_c \), is not to exceed:
\[ b_f \leq 10 \frac{1}{f_1} \]

The face plate or flange of bracket is to be sniped at ends. Brackets are to be arranged with soft toes. To control the stress concentration at end of sniped flanges the total sniping angle, \( \phi \), of the top flange or bracket stiffener is not to exceed:

\[ \phi < 35 \frac{t_w}{t_f} \text{ (degrees)} \]

\( h \) = as defined in Fig. 1

\( f_1 \) = as defined in Pt.3 Ch.1 Sec.2

\( t_w \) = web thickness

\( t_f \) = flange thickness.

206 The thickness of the frame lower brackets is not to be less than the greater of \( t_w, t_{w, \text{min}} \) and \( t_{w1, \text{min}} \) as given in 203 and 204 plus 2 mm, where \( t_w \) is the as fitted thickness of side frame web. The thickness of the frame upper brackets is not to be less than the greater of \( t_w, t_{w, \text{min}} \) and \( t_{w1, \text{min}} \) as given in 203 and 204. The welded length of brackets, \( l_b \), as shown in Fig. 1 is not to be less than:

\[ l_b = \frac{60}{Z} \frac{Z}{(t_w - t_{k_w})t_{w_k}} \text{ (mm)} \]

\( Z, t_{w_k} \) = as defined in 202

\( t_{k_w} = 3 \text{ mm for the lower bracket and 1 mm for upper bracket} \)

In no case are the dimensions of the lower and upper brackets to be less than those shown in Fig. 2.

![Fig. 2](image)

**Fig. 2** Minimum dimensions of brackets

207 Structural continuity with the upper and lower end connections of side frames is to be ensured within top sides and hopper tanks by connecting brackets. The brackets are to be in accordance with Fig. 3 and are to be adequately stiffened against buckling.

\[ \begin{align*}
0.5h \\
0.125h
\end{align*} \]

**Web height**

208 The section modulus of the side and sloping bulkhead longitudinals which support the connecting brackets (at top and bottom) are to be determined according to Pt.3 Ch.1 Sec.7 C300 and Pt.3 Ch.1 Sec.9 C200 with the span taken between the transverses.

Alternatively, the scantlings of side and sloping bulkhead longitudinals may be based on direct strength calculations. In such cases the most extreme loading for the supporting bracket/longitudinal connection (at top and bottom) are to be applied. The calculations should also reflect any relative deformation between connection supporting bracket/longitudinal and the adjacent transverse frame/transverse bulkhead.

**Guidance note:**

As a guidance to the bracket size the bracket length \( a \) may be taken as:

\[ a \geq a' = 0.3 \cdot l - 0.5 \cdot b \]

\( a, b \) and \( l \) are as defined in Fig. 1. When checking the supporting longitudinals, the spacing should be taken as:

\[ s = \frac{a' + b}{2} \]

As a mean to reduce the relative deformation as described in 208, one enlarged supporting bracket may be arranged midway between frames and connected to the next longitudinal.

---end---of---Guidance---note---

209 Frames are to be fabricated symmetrical sections with integral upper and lower brackets and are to be arranged with soft toes. See also 211.

210 The side frame flange is to be curved (not knuckled) at the connection with the end brackets. The radius of curvature is not to be less than \( r \), in mm, given by:

\[ r = 0.4b_f^2 \frac{t_f}{t_f} \]

\( b_f \) and \( t_f \) are the flange width and thickness, respectively, in mm.

211 In ships less than 190 m in length, mild steel frames may be asymmetric and fitted with separate brackets.

212 In way of foremost hold, side frames of asymmetrical section are to be fitted with tripping brackets at every two frames, as shown in Fig. 4. (see also Pt.3 Ch.1 Sec.7 E200).
C. Longitudinal Strength in Flooded Condition

C 100 General

101 The hull girder strength is to be checked for specified flooded conditions in each of the cargo and ballast conditions considered in the intact longitudinal strength calculations.

C 200 Flooding criteria

201 To calculate the weight of ingressed water, the following assumptions are to be made:

a) The permeability of empty cargo spaces and volume left in loaded cargo spaces above any cargo is to be taken as 0.95.

b) Appropriate permeabilities and bulk densities are to be used for any cargo carried. For iron ore, a minimum permeability of 0.3 with a corresponding bulk density of 3.0 t/m³ is to be used. For cement, a minimum permeability of 0.3 with a corresponding bulk density of 1.3 t/m³ is to be used. In this respect, "permeability" for bulk cargo means the ratio between the voids within the cargo mass and the volume occupied by the cargo.

For packed cargo conditions (such as steel mill products), the actual density of the cargo should be used with a permeability of zero.

The still water loads in flooded conditions are to be calculated for the cargo and ballast conditions on which the design of the ship has been based.

Guidance note:
In order to check the longitudinal strength in flooded condition a permeability of 0.3 is considered generally acceptable also for light cargoes.

---end--of--Guidance--note---

C 300 Flooded conditions

301 Each cargo hold is to be considered individually flooded up to the equilibrium waterline. The wave loads in the flooded conditions are assumed to be equal to 80% of the most probable maximum lifetime wave load, as given in Pt.3 Ch.1 Sec.5 B200.

C 400 Stress assessment

401 Bending stress assessment

The actual hull girder bending stress \( \sigma_{ld} \), in N/mm², at any location is given by:

\[
\sigma_{ld} = \frac{M_{sf} + 0.8 M_{w}}{Z_{z}} 10^{3}
\]

\( M_{sf} \) = still water bending moment, in kNm, in the flooded conditions for the section under consideration

\( M_{w} \) = wave bending moment as given in Pt.3 Ch.1 Sec.5 B200

\( Z_{z} \) = section modulus, in cm³, for the corresponding location in the hull girder.

\( \sigma_{ld} \leq 175 f_{1} N/mm² \) within the cargo area.

The damaged structure is assumed to remain fully effective in resisting the applied loads. Uniaxial buckling capacity to be checked according to Pt.3 Ch.1 Sec.14.

402 Shear stress assessment

The actual hull girder shear stress \( \tau_{ld} \), in N/mm³, at any location is given by:

\[
\tau_{ld} = \frac{0.5(Q_{sf} + 0.8 Q_{w}) + 0.5\Delta Q_{sf} S_{N} \pm \frac{S_{N}}{10^{2}}}{\mu}
\]

\( Q_{sf} \) = still water shear force, in kN, in the flooded condition for the section under consideration

\( Q_{w} \) = vertical wave shear force as given in Pt.3 Ch.1 Sec.5 B200

\( \Delta Q_{sf} \) = shear force correction due to shear carrying longitudinal bottom members. A \( Q_{sf} \) may be calculated according to Pt.3 Ch.1 Sec.5 D201 where \( P_{H} \) is substituted by the weight of mixed cargo and water on top for the flooded hold, as follows:

\[
P_{H} = M + V_{cargo} \text{ perm} \ 1.025 + (V_{dam} \cdot V_{cargo}) \ 0.95 \cdot 1.025
\]

\( M \) = weight of cargo for hold in question (t)

\( \rho \) = corresponding cargo density in (t/m³)

\( \text{perm} \) = permeability, as given in 201

\( V_{dam} \) = cargo hold volume below damaged waterline

\( V_{cargo} \) = Maximum \( V_{dam} \)

\( \tau_{ld} \leq 110 f_{1} N/mm² \).

D. Corrugated Transverse Watertight Bulkheads, Considering Hold Flooding

D 100 Application and definition

101 These requirements apply to vertically corrugated transverse watertight bulkheads.

The net thickness \( t_{net} \) is the thickness obtained by applying the strength criteria as given in 300 to 308.
The required thickness is obtained by adding the corrosion addition $\delta_c$, given in 500, to the net thickness $t_{net}$.

In this requirement, homogeneous loading condition means a loading condition in which the ratio between the highest and the lowest filling ratio, evaluated for each hold, does not exceed 1.2 (corrected for different cargo densities).

For non-corrugated bulkheads, scantlings for plates, stiffeners and girders are not to be less than required in Pt.3 Ch.1 Sec.9, applying the pressure loads as given in 201 to 207.

Vertically corrugated bulkheads built in compliance with the requirements given in this subsection need not to be checked for the requirements relating to watertight bulkhead loads given in Pt.3 Ch.1 Sec.9.

D 200 Load model

201 General

The loads to be considered as acting on the bulkheads are those given by the combination of the cargo loads with those induced by the flooding of one hold adjacent to the bulkhead under examination. In any case, the pressure due to the flooding water alone is to be considered. The most severe combinations of cargo induced loads and flooding loads are to be used for the check of the scantlings of each bulkhead, depending on the loading conditions included in the loading manual:

- homogeneous loading conditions
- non-homogeneous loading conditions

considering the individual flooding of both loaded and empty holds.

The specified design load limits for the cargo holds are to be represented by loading conditions defined by the designer in the loading manual.

Non-homogeneous part loading conditions associated with multi port loading and unloading operations for homogeneous loading conditions need not be considered according to these requirements.

Holds carrying packed cargoes are to be considered as empty holds for this application.

Unless the ship is intended to carry, in non-homogeneous conditions, only iron ore or cargo having bulk density equal or greater than 1.78 t/m³, the maximum mass of cargo which may be carried in the hold is also to be considered to fill that hold up to the upper deck level at centreline.

Guidance note:

Bulk Carriers as defined in Sec.5 A100 without class notation HC-E and HC-EA, and only to be homogeneously loaded as defined in 101, may have their bulkheads checked for homogeneous loading and flooding water alone only, provided this limitation is explicitly stated in the ship's Loading Manual.

---end---of---Guidance---note---

202 Bulkhead corrugation flooding head

The flooding head $h_f$ (see Fig. 5) is the distance, in m, measured vertically with the ship in the upright position, from the calculation point to a level located at a distance $d_f$ in m, from the baseline equal to:

a) in general:

- $D$ for the foremost transverse corrugated bulkhead
- $0.9D$ for the other bulkheads.

Where the ship is to carry cargoes having bulk density less than 1.78 t/m³ in non-homogeneous loading conditions, the following values can be assumed:

- $0.95D$ for the foremost transverse corrugated bulkhead
- $0.85D$ for the other bulkheads.

b) for ships less than 50,000 tonnes deadweight with Type B freeboard:

- $0.95D$ for the foremost transverse corrugated bulkhead
- $0.85D$ for the other bulkheads.

Where the ship is to carry cargoes having bulk density less than 1.78 t/m³ in non-homogeneous loading conditions, the following values can be assumed:

- $0.9D$ for the foremost transverse corrugated bulkhead
- $0.8D$ for the other bulkheads

D is the distance, in m, from the baseline to the freeboard deck at side amidships (see Fig. 5).
**Definition of** $D$, $h_1$, and $d_1$.

203 Pressure in non-flooded bulk cargo loaded holds

At each point of the bulkhead, the pressure $p_c$, in kN/m², is given by:

$$p_c = \rho_c g h_1 K$$

$
\rho_c = \text{bulk cargo density, in t/m}^3$

$g = 9.81 \text{ m/s}^2$, gravity acceleration

$h_1 = \text{vertical distance, in m, from the calculation point to horizontal plane corresponding to the volume of the cargo (see Fig. 5), located at a distance } d_1, \text{ in m, from the baseline}$

$K = \sin^2 \alpha \tan^2 (45 - 0.5 \delta) + \cos^2 \alpha$

$\alpha = \text{angle between panel in question and the horizontal plane, in degrees}$

$\delta = \text{angle of repose of the cargo, in degrees, that may generally be taken as 35° for iron ore and 25° for cement.}$

The force $F_c$, in kN, acting on a corrugation is given by:

$$F_c = \rho_c g s_1 \frac{(d_1 - h_{DB} - h_{LS})^2}{2} K$$

$\rho_c$, $g$, $d_1$, $K$ = as given above

$s_1 = \text{spacing of corrugations, in m (see Fig. 6)}$

$h_{LS} = \text{mean height of the lower stool, in m, from the inner bottom}$

$h_{DB} = \text{height of the double bottom, in m.}$
Spacing of corrugations

**204 Pressure in flooded bulk cargo holds**

Two cases are to be considered, depending on the values of $d_1$ and $d_f$:

a) $d_f \geq d_1$

At each point of the bulkhead located at a distance between $d_1$ and $d_f$ from the baseline, the pressure $p_{c,f}$, in kN/m², is given by:

$$p_{c,f} = \rho g h_f$$

$$\rho = \text{sea water density, in t/m}^3$$

$$g = \text{as given in 203}$$

$$h_f = \text{flooding head as defined in 202.}$$

At each point of the bulkhead located at a distance lower than $d_1$ from the baseline, the pressure $p_{c,f}$, in kN/m², is given by:

$$p_{c,f} = \rho g h_f + [\rho_c - \rho (1 - \text{perm})] g h_1 K$$

$$\rho_c, g, h_1, K = \text{as given above}$$

$$\rho, h_f = \text{as given in 203}$$

$$\text{perm} = \text{permeability of cargo, to be taken as 0.3 for iron ore (corresponding bulk cargo density for iron ore may generally be taken as 3.0 t/m}^3\text{), coal cargoes and for cement (corresponding...}$$
bulk cargo density for cement may generally be taken as 1.3 t/m³

The force $F_{c,f}$ in kN, acting on a corrugation is given by:

$$
\Phi_{c,f} = s_1 \left[ \rho g \frac{(d_f - d_1)^2}{2} + \rho g (d_f - d_1) + (p_{c,1})_H (\delta_1 - \eta_D - \eta_L) \right]
$$

$\rho$ = as given above

$s_1$, $g$, $d_1$, $h_D$, $h_L$ = as given in 203

$d_f$ = as given in 202

$(p_{c,1})_H$ = pressure, in kN/m², at the lower end of the corrugation.

b) $d_f < d_1$

At each point of the bulkhead located at a distance between $d_f$ and $d_1$ from the baseline, the pressure $p_{c,f}$, in kN/m², is given by:

$$
p_{c,f} = \rho_c g h_1 K
$$

$\rho_c$, $g$, $h_1$, $K$ = as given in 203.

At each point of the bulkhead located at a distance lower than $d_f$ from the baseline, the pressure $p_{c,f}$, in kN/m², is given by:

$$
p_{c,f} = \rho g h_1 + [ \rho_c h_1 - \rho (1 - \text{perm}) h_L ] g K
$$

rho, $h_1$, perm = as given in a) above

$\rho_c$, $g$, $h_1$, $K$ = as given in 203.

The force $F_{c,f}$, in kN, acting on a corrugation is given by:

$$
F_{c,f} = s_1 \left[ \rho_c g \frac{(d_f - d_1)^2}{2} - K + \rho_c g (d_f - d_1)K + (p_{c,1})_H (d_f - h_D - h_L) \right]
$$

$s_1$, $\rho_c$, $g$, $d_1$, $h_D$, $h_L$, $K$ = as given in 203

$d_f$ = as given in 202

$(p_{c,1})_H$ = pressure, in kN/m², at the lower end of the corrugation.

---

205 Empty holds and pressure due to flooding water alone

At each point of the bulkhead, the hydrostatic pressure $p_f$ induced by the flooding head $h_f$ is to be considered.

The force $F_f$, in kN, acting on a corrugation is given by:

$$
F_f = s_1 \rho g \frac{(d_f - h_D - h_L)^2}{2}
$$

$s_1$, $g$, $h_D$, $h_L$ = as given in 203

$\rho$ = as given in 204 a)

$d_f$ = as given in 202.

206 Resultant pressure and force - Homogeneous loading conditions

At each point of the bulkhead structures, the resultant pressure $p$, in kN/m², to be considered for the scantlings of the bulkhead is given by:

$$
p = p_{c,f} - 0.8 p_c
$$

The resultant force $F$, in kN, acting on a corrugation is given by:

$$
F = F_{c,f} - 0.8 F_c
$$

207 Resultant pressure and force - Non-homogeneous loading conditions

At each point of the bulkhead structures, the resultant pressure $p$, in kN/m², to be considered for the scantlings of the bulkhead is given by:

$$
p = p_{c,f}
$$

The resultant force $F$, in kN, acting on a corrugation is given by:

$$
F = F_{c,f}
$$

208 Bending moment in the bulkhead corrugation

The design bending moment $M$, in kNm, for the bulkhead corrugation is given by:

$$
M = \frac{F l}{8}
$$

$F$ = resultant force, in kN, as given in 205, 206 or 207 as relevant

$l$ = span of the corrugation, in m, to be taken according to Fig. 6 and Fig. 7.
209 Shear force in the bulkhead corrugation

The shear force $Q$, in kN, at the lower end of the bulkhead corrugations is given by:

$$Q = 0.8 F$$

$$F = \text{as given in 208.}$$

D 300 Strength criteria

301 General

The following criteria are applicable to transverse bulkheads with vertical corrugations (see Fig. 6 and Fig. 7). For ships of 190 m of length and above, these bulkheads are to be fitted with a bottom stool, and generally with a top stool below deck. For smaller ships, corrugations may extend from inner bottom to deck.

The corrugation angle $\phi$ shown in Fig. 6 is not to be less than 55°.

Requirements for local net plate thickness are given in 308.

In addition, the criteria as given in 302 and 305 are to be complied with.

The thickness of the lower part of corrugations considered in the application of 302 and 303 is to be maintained for a distance from the inner bottom (if no lower stool is fitted), or the top of the lower stool not less than 0,15 $l$.

The thickness of the middle part of corrugations as considered in the application of 302 and 304 is to be maintained to a distance from the deck (if no upper stool is fitted), or the bottom of the upper stool not greater than 0,3 $l$.

The section modulus of the corrugation in the remaining upper part of the bulkhead is not to be less than 75% of that required for the middle part, corrected for different yield stresses.

(a) Lower stool

The height of the lower stool is generally to be not less than 3 times the depth of the corrugations. The thickness and material of the stool top plate is not to be less than those required for the bulkhead plating above. The thickness and material of the upper portion of vertical or sloping stool side plating within the depth equal to the corrugation flange width from the stool top is not to be less than the required flange plate thickness and material to meet the bulkhead stiffness requirement at lower end of corrugation. However, the thickness of the stool side plating and the section modulus of the stool side stiffeners is not to be less than those required in Pt.3 Ch.1 Sec.9 C, on the basis of loads as given in 201 to 207. Corresponding allowable stresses to be used in combination with above loads is given in Pt.3 Ch.1 Sec.9 C as for watertight bulkheads and corrosion additions are to be in compliance with Pt.3 Ch.1 Sec.2 D. The ends of stool side vertical stiffeners are to be attached to brackets at the upper and lower ends of stool.

The distance from the edge of the stool top plate to the surface of the corrugation flange is to be not less than 1,5 times the corrugation flange plate thickness in order to have adequate space for proper welding. The stool bottom is to be installed in line with double bottom floors and is to have a width not less than 2,5 times the mean depth of the corrugation. The stool is to be fitted with diaphragms in line with the longitudinal double bottom girders for effective support of the corrugated bulkhead. Scallops in the brackets and diaphragms in way of the connections to the stool top plate are to be avoided.

Where corrugations are cut at the bottom stool, corrugations and stool side plating are generally to be connected to the stool.
top plate by full penetration welds. The plating of the lower stool and supporting floors is generally to be connected to the inner bottom by full penetration welds.

(b) Upper stool

The upper stool, where fitted, is to have a height generally between 2 and 3 times the depth of corrugations. Rectangular stools are to have a height generally equal to 2 times the depth of corrugations, measured from the deck level and at hatch side girders. The upper stool is to be properly supported by girders or deep brackets between the adjacent hatch-end beams.

The width of the stool bottom plate is generally to be the same as that of the lower stool top plate. The stool top of non-rectangular stools is to have a width not less than 2 times the depth of corrugations. The thickness and material of the stool bottom plate are to be the same as those of the bulkhead plating below.

The thickness of the lower portion of stool side plating, within the depth equal to the corrugation flange width from the stool bottom plate, is not to be less than 80% of that required for the upper part of the bulkhead plating where the same material is used. However, the thickness of the stool side plating and the section modulus of the stool side stiffeners are not to be less than those required in Pt.3 Ch.1 Sec.9 C, on the basis of pressure loads as given in 201 to 207. Corresponding allowable stresses to be used in combination with above loads is given Pt.3 Ch.1 Sec.9 C as for watertight bulkheads and corrosion additions are to be in compliance with Pt.3 Ch.1 Sec.2 D.

The ends of stool side stiffeners are to be attached to brackets at upper and lower end of the stool. Diaphragms are to be fitted inside the stool in line with and effectively attached to longitudinal deck girders extending to the hatch end coaming girders for effective support of the corrugated bulkhead. Scallop in the brackets and diaphragms in view of the connection to the stool bottom plate are to be avoided.

(c) Alignment

At deck, if no stool is fitted, two transverse reinforced beams are to be fitted in line with the corrugation flanges.

At bottom, if no stool is fitted, the corrugation flanges are to be in line with the supporting floors. Corrugations and floors are generally to be connected to the inner bottom plating by full penetration welds. The thickness and material properties of the supporting floors are to be at least equal to those provided for the corrugation flanges. Moreover, the cut-out for connections of the inner bottom longitudinal to double bottom floors are to be closed by collar plates. The supporting floors are to be connected to each other by suitably designed shear plates.

Stool side plating is to align with the corrugation flanges and stool side vertical stiffeners and their brackets in lower stool are to align with the inner bottom longitudinals to provide appropriate load transmission between these stiffening members. Stool side plating is not to be knuckled anywhere between the inner bottom plating and the stool top.

302 Bending capacity and shear stress \( \tau \)

The bending capacity is to comply with the following relationship:

\[
M = 10^3 \frac{1}{0,5Z'_{le}a_{le} + Z_m a_m} \leq 0,95
\]

\( M \) = bending moment, in kNm, as given in 208

\( Z'_{le} \) = section modulus, in cm³, at the lower end of corrugations, to be calculated according to 303

\( Z_m \) = section modulus, in cm³, at the midspan of corrugations, to be calculated according to 304

\( a_{le} \) = allowable stress, in N/mm², as given in 305, for the lower end of corrugations

\( a_m \) = allowable stress, in N/mm², as given in 305, for the mid-span of corrugations.

In no case is \( Z_m \) to be taken greater than the lesser of 1.15 \( Z_{le} \) and 1.15 \( Z'_g \), for calculation of the bending capacity, \( Z'_g \) as being defined below.

In case shedder plates are fitted which:

- are not knuckled
- are welded to the corrugations and the top of the lower stool by one side penetration welds or equivalent
- are fitted with a minimum slope of 45° and their lower edge is in line with the stool side plating
- have thickness not less than 75% of that provided by the corrugation flanges
- and material properties at least equal to those provided by the flanges

or gusset plates are fitted which:

- are in combination with shedder plates having thickness, material properties and welded connections in accordance with the above requirements
- have a height not less than half of the flange width
- are fitted in line with the stool side plating
- are generally welded to the top of the lower stool by full penetration welds, and to the corrugations and shedder plates by one side penetration welds or equivalent
- have thickness and material properties at least equal to those provided for the flanges

the section modulus \( Z_{le} \), in cm³, is to be taken not larger than the value \( Z'_g \), in cm³, given by:

\[
Z'_g = Z_g + 10^3 \frac{Q_{h g} - 0.5h_g^2 s_1 p_g}{\sigma_g}
\]

\( Z_g \) = section modulus, in cm³, of the corrugations calculated, according to 304, in way of the upper end of shedder or gusset plates, as applicable

\( Q \) = shear force, in kN, as given in 209

\( h_g \) = height, in m, of shedders or gusset plates, as applicable (see Fig. 8, Fig. 9, Fig. 10 and Fig. 11)

\( s_1 \) = as given in 203

\( p_g \) = resultant pressure, in kN/m², as defined in 206 or 207 as relevant calculated in way of the middle of the shedders or gusset plates, as applicable

\( \sigma_g \) = allowable stress, in N/mm², as given in 305.

Stresses, \( \tau \), are obtained by dividing the shear force, \( Q \), by the shear area. The shear area is to be reduced in order to account for possible non-perpendicularity between the corrugation webs and flanges. In general, the reduced shear area may be obtained by multiplying the web sectional area by \( (\sin \phi) \phi \), being the angle between the web and the flange.

When calculating the section modulus and the shear area, the net plate thickness is to be used.

The section modulus of corrugations are to be calculated on the bases of the following requirements given in 303 and 304.

303 Section modulus at the lower end of corrugations

The section modulus is to be calculated with the compression flange having an effective flange width, \( b_{ef} \), not larger than as given in 306.

If the corrugation webs are not supported by local brackets below the stool top (or below the inner bottom) in the lower part, the section modulus of the corrugations is to be calculated considering the corrugation webs 30% effective.

a) Provided that effective shedder plates, as defined in 302, are fitted (see Fig. 8 and Fig. 9), when calculating the section modulus of corrugations at the lower end (cross-section (1) in Fig. 8 and Fig. 9), the area of flange plates, in
cm², may be increased by \(2, 5a \sqrt{t_{sh} t_f}\) (not to be taken greater than 2,5 \(a t_f\)) where:

\[\begin{align*}
\text{a} &= \text{width, in m, of the corrugation flange (see Fig. 6)} \\
\text{t}_{sh} &= \text{net shedder plate thickness, in mm} \\
\text{t}_f &= \text{net flange thickness, in mm}
\end{align*}\]

b) Provided that effective gusset plates, as defined in 302, are fitted (see Fig. 10 and Fig. 11) when calculating the section modulus of corrugations at the lower end (cross-section (1) in Fig. 10 and Fig. 11), the area of flange plates, in cm², may be increased by \((7 h_g t_f)\) where:

\[ h_g = \text{height of gusset plate in m, see Fig. 10 and Fig. 11, not to be taken greater than:} \]

\[\left(\frac{10}{\pi} s_{gu}\right) \]

\[s_{gu} = \text{width of the gusset plates, in m} \\
t_f = \text{net flange thickness, in mm, based on the as built condition.}\]

c) If the corrugation webs are welded to a sloping stool top plate which have an angle not less than 45 degrees with the horizontal plane, the section modulus of the corrugations may be calculated considering the corrugation webs fully effective. In case effective gusset plates are fitted, when calculating the section modulus of corrugations the area of flange plates may be increased as specified in b) above. No credit can be given to shedder plates only.

For angles less than 45 degrees, the effectiveness of the web may be obtained by linear interpolation between 30% for zero degrees and 100% for 45 degrees.

304 **Section modulus of corrugations at cross-sections other than the lower end**

The section modulus is to be calculated with the corrugation webs considered effective and the compression flange having an effective flange width, \(b_{ef}\), not larger than as given in 306.

305 **Allowable stress check**

The normal and shear stresses \(\sigma_1\) and \(\tau_2\) are not to exceed the allowable values \(\sigma_a\) and \(\tau_a\), in N/mm², given by:

\[\begin{align*}
\sigma_a &= \sigma_F \\
\tau_a &= 0.5 \sigma_F
\end{align*}\]

\(\sigma_F\) being the minimum upper yield stress, in N/mm², of the material.
\[ \beta = 10^3 \frac{a}{t_f} \frac{\sqrt{\sigma_F}}{E} \]

- \( t_f \) = net flange thickness, in mm
- \( a \) = width, in m, of the corrugation flange (see Fig. 6)
- \( \sigma_F \) = minimum upper yield stress, in N/mm², of the material
- \( E \) = modulus of elasticity of the material, in N/mm², to be assumed equal to 2,06·10⁵ for steel.

### 307 Shear buckling

The buckling check is to be performed for the web plates at the corrugation ends.

The shear stress, \( \tau \), as obtained by applying forces as given in 209, is not to exceed the critical value \( \tau_c \), in N/mm², as given in Pt.3 Ch.1 Sec.14, assuming a buckling factor \( k_4 = 6.34 \) and net plate thickness as defined in this subsection.

### 308 Local net plate thickness

The bulkhead local net plate thickness \( t \), in mm, is given by:

\[ t = 14, 9 s_w \sqrt{\frac{1.05 p}{\sigma_F}} \]

- \( s_w \) = plate width, in m, to be taken equal to the width of the corrugation flange or web, whichever is the greater (see Fig. 6)
- \( p \) = resultant pressure, in kN/m², as defined in 206 or 207 as relevant, at the bottom of each strake of plating. In all cases, the net thickness of the lowest strake is to be determined using the resultant pressure at the top of the lower stool, or at the inner bottom, if no lower stool is fitted or at the top of shedders, if shedder or gusset/shedder plates are fitted
- \( \sigma_F \) = minimum upper yield stress, in N/mm² of the material.

For built-up corrugation bulkheads, when the thickness of the flange and web are different, the net thickness of the narrower plating is to be not less than \( t_n \), in mm, given by:

\[ t_n = 14, 9 s_n \sqrt{\frac{1.05 p}{\sigma_F}} \]

- \( s_n \) being the width, in mm, of the narrower plating.

The net thickness of the wider plating, in mm, is not to be taken less than the maximum of the following values:

\[ t_w = 14, 9 s_w \sqrt{\frac{1.05 p}{\sigma_F}} \]

and

\[ t_w = \frac{440 s_w^2 1.05 p}{\sigma_F} - t_{np}^2 \]

where \( t_{np} \leq \) actual net thickness of the narrower plating and not to be greater than:

\[ 14, 9 s_w \sqrt{\frac{1.05 p}{\sigma_F}} \]

### D 400 Local details

The design of local details, for the purpose of transferring the corrugated bulkhead forces and moments to the boundary structures, are to reflect local stress concentration due to abrupt change in stiffness. Areas of concern are in particular connection to double bottom, cross-deck structures and connection of stool construction (upper and lower) to top-wing and hopper tank construction.
The thickness and stiffening of effective gusset and shudder plates, as defined in 302, are to comply with Pt.3 Ch.1 Sec.9, on the basis of the pressure load as given in 201 to 207.

Unless otherwise stated, weld connections and materials are to be dimensioned and selected in accordance with Pt.3 Ch.1.

D 500 Corrosion addition
501 The corrosion addition, \( t_c \), is to be taken equal to 3,5 mm.

E Limit to Hold Loading, Considering Hold Flooding

E 100 Application and definition
101 These requirements apply to the double bottom structure of all cargo holds.

The loading in each hold is not to exceed the limit to hold loading in flooded condition, calculated as per 401, using the loads given in 201 to 202 and the shear capacity of the double bottom given in 301 to 303.

In any case is the loading in each hold to exceed design hold loading in intact condition.

E 200 Loading model

201 General

The loads to be considered as acting on the double bottom are those given by the external sea pressures and the combination of the cargo loads with those induced by the flooding of the hold which the double bottom belongs to.

The most severe combinations of cargo induced loads and flooding loads are to be used, depending on the loading conditions included in the loading manual:

- homogeneous loading conditions
- non-homogeneous loading conditions
- packed cargo conditions (such as steel mill products).

For each loading condition, the maximum bulk cargo density to be carried is to be considered in calculating the allowable hold loading limit.

![Diagram of hold loading](image)

\[ V = \text{Volume of cargo} \]

Fig. 12
Definition of flooding head and D

202 Inner bottom flooding head

The flooding head \( h_e \) (see Fig. 12) is the distance, in m, measured vertically with the ship in the upright position, from the inner bottom to a level located at a distance \( h_f \), in m, from the baseline equal to:

a) in general:
   - \( D \) for the foremost hold
   - 0,9 \( D \) for the other holds

b) for ships less than 50,000 tonnes deadweight with Type B freeboard:
   - 0,95 \( D \) for the foremost hold
   - 0,85 \( D \) for the other holds.

D is the distance, in m, from the baseline to the freeboard deck at side amidships (see Fig. 12).

E 300 Shear capacity

301 Shear capacity of the double bottom

The shear capacity, \( C \), of the double bottom is defined as the sum of the shear strength at each end of:

- all floors adjacent to both hoppers, less one half of the strength of the two floors adjacent to each stool, or transverse bulkhead if no stool is fitted (see Fig. 13)
- all double bottom girders adjacent to both stools, or transverse bulkheads if not stool is fitted.

In the end holds, where girders or floors run out and are not directly attached to the boundary stool or hopper girder, their strength is to be evaluated for the one end only.

Note that the floors and girders to be considered are those inside the hold boundaries formed by the hoppers and stools (or transverse bulkheads if no stool is fitted). The hopper side girders and the floors directly below the connection of the bulkhead stools (or transverse bulkheads if no stool is fitted) to the inner bottom are not to be included.

When the geometry and/or the structural arrangement of the double bottom are such to make the above assumptions inade-
quate, the shear capacity $C$ of double bottom will be subject to special consideration.

In calculating the shear strength, the net thickness of floors and girders is to be used. The net thickness $t_{\text{net}}$, in mm, is given by:

$$t_{\text{net}} = t - 2.5$$

$t$ = thickness, in mm, of floors and girders.

$$\sigma_F = \text{minimum upper yield stress, in N/mm}^2, \text{ of the material}$$

$s$ = spacing of stiffening members, in mm, of panel under consideration

$$\eta_1 = 1.10 \quad \eta_2 = 1.20$$

$\eta_2$ may be reduced down to 1.10 when appropriate reinforcements are fitted around openings.

**303 Girder shear strength**

The girder shear strength in way of the girder panel adjacent to stools (or transverse bulkheads, if no stool is fitted) $S_{g1}$, in kN, and the girder shear strength in way of the largest opening in the outmost bay (i.e. that bay which is closer to stool, or transverse bulkhead, if no stool is fitted) $S_{g2}$, in kN, are given by the following expressions:

$$S_{g1} = 10^{-3} A_g \frac{\tau_a}{\eta_1}$$

$$S_{g2} = 10^{-3} A_{g,h} \frac{\tau_a}{\eta_2}$$

$A_g$ = minimum sectional area, in mm$^2$, of the girder panel adjacent to stools (or transverse bulkheads, if no stool is fitted)

$A_{g,h}$ = net sectional area, in mm$^2$, of the girder panel in way of the largest opening in the outmost bay (i.e. that bay which is closer to stool, or transverse bulkhead, if no stool is fitted)

$\tau_a$ = allowable shear stress, in N/mm$^2$, as given in 302

$\eta_1 = 1.10$

**Fig. 13**

Arrangement of double bottom

---

**302 Floor shear strength**

The floor shear strength in way of the floor panel adjacent to hoppers $S_{f1}$, in kN, and the floor shear strength in way of the openings in the outmost bay (i.e. that bay which is closer to hopper) $S_{f2}$, in kN, are given by the following expressions:

$$S_{f1} = 10^{-3} A_f \frac{\tau_a}{\eta_1}$$

$$S_{f2} = 10^{-3} A_{f,h} \frac{\tau_a}{\eta_2}$$

$A_f$ = sectional area, in mm$^2$, of the floor panel adjacent to hoppers

$A_{f,h}$ = net sectional area, in mm$^2$, of the floor panels in way of the openings in the outmost bay (i.e. that bay which is closer to hopper)

$\tau_a$ = the allowable shear stress, in N/mm$^2$, to be taken equal to the lesser of

$$\tau_a = \frac{162 \sigma_F}{s} 0.6 \quad \text{and} \quad \frac{\sigma_F}{\sqrt{s}}$$

For floors adjacent to the stools or transverse bulkheads, as identified in 301, $\tau_a$ may be taken as:

$$\tau_a = \frac{\sigma_F}{\sqrt{s}}$$
\[ \eta_2 = 1.15 \]
\[ \eta_2 \text{ may be reduced down to 1.10 when appropriate reinforcement are fitted around openings.} \]

**E 400 Limit to hold loading, considering flooding**

**401** The limit to hold loading, \( W \), in tonnes, is given by:

\[ W = \rho_c \sqrt{\frac{E}{F}} \]

\( F = 1,1 \) in general
\( = 1,05 \) for steel mill products
\( \rho_c = \) bulk cargo density, in t/m\(^3\) (see 201). For steel products, \( \rho_c \) is to be taken as the density of steel
\( V = \) volume, in m\(^3\), occupied by cargo at a level \( h_1 \)

\[ h_1 = \frac{X}{\rho_{cg}} \]

\( X = \) for bulk cargoes, the lesser of \( X_1 \) and \( X_2 \) given by:

\[ X_1 = \frac{Z + \rho g (E - \eta_2)}{1 + \rho (\text{perm} - 1)} \]

\[ X_2 = Z + \rho g (E - \eta_2 \text{ perm}) \]

\( \rho = \) sea water density, in t/m\(^3\)
\( g = 9.81 \text{ m/s}^2, \) gravity acceleration
\( E = \) ship immersion in m for flooded hold condition

\( d_f = 0.1D \)

\( h_f = \) flooding head, in m, as defined in 202

\( \text{perm} = \) cargo permeability (i.e. the ratio between the voids within the cargo mass and the volume occupied by the cargo), needs not be taken greater than 0.3

\( Z = \) the lesser of \( Z_1 \) and \( Z_2 \) given by:

\[ Z_1 = \frac{C}{A_{DB,h}} \]

\[ Z_2 = \frac{C}{A_{DB,e}} \]

\( C_h = \) shear capacity of the double bottom, in kN, as defined in 301, considering, for each floor, the lesser of the shear strengths \( S_{f1} \) and \( S_{f2} \) (see 302) and, for each girder, the lesser of the shear strengths \( S_{g1} \) and \( S_{g2} \) (see 303)

\( C_e = \) shear capacity of double bottom, in kN, as defined in 301, considering, for each floor, the shear strength \( S_{f1} \) (see 302) and, for each girder, the lesser of the shear strengths \( S_{g1} \) and \( S_{g2} \) (see 303)

\[ i = n \]
\[ A_{DB,h} = \sum_{i=1}^{n} S_i B_{DB,i} \]

\[ A_{DB,e} = \sum_{i=1}^{n} S_i (B_{DB} - s_i) \]

\( n = \) number of floors between stools (or transverse bulkheads, if no stool is fitted)
\( S_i = \) space of \( i \)-th floor, in m
\( B_{DB,i} = B_{DB} - s_i \) for floors whose shear strength is given by \( S_{f} \) (see 302)

\( B_{DB,h} = B_{DB,hl} \) for floors whose shear strength is given by \( S_{f2} \) (see 302)
\( B_{DB} = \) breadth of double bottom, in m, between hoppers (see Fig. 14)
\( B_{DB,hl} = \) distance, in m, between the two considered opening (see Fig. 14)

\( s_i = \) spacing, in m, of double bottom longitudinals adjacent to hoppers

---

**F. Hatch Covers of Bulk Carrier Cargo Holds**

**F 100 Application and definition**

**101** These requirements apply to hatch covers located forward of 0.25 \( L \) from the fore perpendicular, where \( L \) is the rule length, as defined in Pt.3 Ch.1 Sec.1. The scantlings are to be taken as given by Pt.3 Ch.1 Sec.11. However, for the external sea pressure condition, \( P_1 \), the design pressure is to be taken as given in 200 and the allowable stresses taken as given in 301 for the determination of stiffener section modulus, girder section modulus and shear area. Effective flange breadth, where relevant, is to be taken as given in 300 and corrosion additions as given in 500.

**Guidance note:**

The following references apply: Pt.3 Ch.1 Sec.11, E401, E501 and E700. Where the pressure \( P_1 \) is to be substituted by pressure figures given in this section.

Furthermore, for the external sea pressure, the hatch cover top plate thickness is as given in 303.

The net thickness, \( t_{\text{net}} \), is the thickness necessary to obtain the below net minimum scantlings.

The required thickness is obtained by adding the corrosion addition \( t_c \), given in 500 to the net thickness \( t_{\text{net}} \).

Material for the hatch covers is to be steel according to the requirements for ship’s hull.

The design of closing arrangements for all hatch covers is to comply with Pt.3 Ch.1 Sec.11.

**F 200 Load model**

**201** The pressure \( p \), in kN/m\(^2\), to be considered as acting on the hatch covers is given by:

\[ p = 19, 6 \sqrt{\frac{H}{A_i}} \]

\( H = 0, 14 A_i \sqrt{\frac{V L}{C_B}} - d_f \)

\( A_i = \) coefficient depending on the longitudinal position of the hatch cover mid length, given in Table F1
\( V = \) ship's design speed, in knots, to be taken not less than 13 knots
\( L = \) rule length, in m, as defined in Pt.3 Ch.1 Sec.1
\( C_B = \) block coefficient
d_{L} = vertical distance, in m, from the summer load line draught to the top of the hatch coaming.

Table F1 Values of $A_{i}$

<table>
<thead>
<tr>
<th>Distance from the FP</th>
<th>$A_{i}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>FP</td>
<td>2.70</td>
</tr>
<tr>
<td>0.05 L</td>
<td>2.16</td>
</tr>
<tr>
<td>0.10 L</td>
<td>1.70</td>
</tr>
<tr>
<td>0.15 L</td>
<td>1.43</td>
</tr>
<tr>
<td>0.20 L</td>
<td>1.22</td>
</tr>
<tr>
<td>0.25 L</td>
<td>1.00</td>
</tr>
</tbody>
</table>

NOTE: For intermediate positions, $A_{i}$ is obtained by linear interpolation between table values.

F 300 Strength criteria

301 Allowable stress check

The normal and shear stresses $\sigma$ and $\tau$ in the hatch cover secondary stiffeners, primary supporting members and their attached plating are not to exceed the allowable values $\sigma_{u}$ and $\tau_{u}$, in N/mm², given by:

$$\sigma_{u} = 0.80 \sigma_{F},$$

$$\tau_{u} = 0.45 \sigma_{F}.$$

$\sigma_{F}$ being the minimum upper yield stress, in N/mm², of the material.

When calculating the stresses $\sigma$ and $\tau$, the net scantlings are to be used.

For determination of the section modulus of primary supporting members, the effective width of compression panel flange is not to be taken larger than as given in 302.

In case of stiffeners of variable cross section, see Pt.3 Ch.1 Sec.11 E400.

302 Effective width of compression panel flanges

The effective width is generally to be taken as given in the following (a) and (b). The effective width is in case of biaxial compression to be specially considered.

(a) Effective width for primary member parallel to the stiffening direction

The effective width $b_{ef,i}$, in m, of the compression panel is given by:

$$b_{ef,i} = C_{e,f} s$$

$$C_{e,f} = \frac{1.80}{\beta} \frac{0.80}{\beta^2} \text{ for } \beta > 1.0,$$

$$C_{e,f} = 1.0 \text{ for } \beta \leq 1.0,$$

$$\beta = 10^{3} \frac{\sigma_{F}}{E}.$$

(b) Effective width for primary member at right angle to stiffening direction

The effective width $b_{ef,i}$, in m, of the compression panel, is given by:

$$b_{ef,i} = C_{e,t} l f$$

$$C_{e,t} = C_{e,t} \left( 1 - \frac{s}{f} \right) \left( 1 + \frac{1}{\beta} \right)^2 \leq 1.0,$$

$l$, $s$ = longer and shorter edges of the panel, in m, respectively

$C_{e,t} \beta$ = as given in (a) above.

303 Local net plate thickness

The local net plate thickness $t$, in mm, of the hatch cover plat- ing is given by:

$$t = \frac{S_{t} 14.9 s}{P} \frac{E}{\sigma_{F}},$$

$S_{t}$ = safety factor, to be taken equal to 1.20

$s$ = stiffener spacing, in m

$p$ = pressure, in kN/m², as defined in 201

$\sigma_{F}$ = minimum upper yield stress, in N/mm², of the material.

F 400 Local details

401 The design of local details for the purpose of transferring the pressure on the hatch covers to the hatch coamings and, through them, to the deck structures below, are to comply with requirements given in Pt.3 Ch.1 Sec.11.

For ships without forecastle or breakwater, the scantlings of the coamings for the foremost hold are not to be less than that required by Pt.3 Ch.1 Sec.10 for front bulkheads of deckhouses at that position.

Unless otherwise stated, weld connections and materials are to be dimensioned and selected in accordance with Pt.3 Ch.1.

F 500 Corrosion addition

501 Corrosion addition

For all the structures (plating and stiffeners) of single skin hatch cover, the corrosion addition $t_{c}$ is to be 2.0 mm.

For pontoon hatch covers, the corrosion addition is to be taken equal to:

- 2.0 mm for the top and bottom plating
- 1.5 mm for the internal structures.
SECTION 11
SHIPS SPECIALISED FOR THE CARRIAGE OF A SINGLE TYPE OF DRY BULK CARGO

A. General

A 100 Classification
101 The requirements in this section apply to ships intended for the carriage of a single cargo type. The notation X Carrier may be given to ships built in compliance with the requirements in this section, where X denotes the type of cargo to be carried, e.g. Alumina, Cement, Sugar etc.

102 The cargo holds are to be arranged with a closed loading and unloading arrangement. Documentation of the intended loading and unloading system is to be submitted for information.

103 The ship is, in general, to have a double bottom within the cargo region and have double sides and a single deck. Hatches to cargo holds are to be arranged as required for access only, and for the closed loading and unloading arrangement.

A 200 Documentation
201 Data regarding properties of the cargo, relevant to the design (e.g. bulk density, angle of repose, humidity limit, etc.) are to be submitted for information.

202 Information regarding the intended cargo and ballast conditions, including typical loading and unloading sequences, are to be submitted for approval. This is to include conditions with uneven distribution of cargo between holds, e.g. part loading conditions with empty cargo holds, as applicable.

A 300 Design loads
301 The design pressures for local elements, i.e. plates and stiffeners, are to be as given in Pt.3 Ch.1 Sec.4, using parameters as given in 200, as applicable.

302 In the direct calculations, design pressures are to be as given in Pt.3 Ch.1 Sec.13, using the information given in 200.

A 400 Longitudinal strength
401 The longitudinal strength is to be determined as given in Pt.3 Ch.1 Sec.5 or Pt.3 Ch.2 Sec.4. The ships shall belong to category I, see Pt.3 Ch.1 Sec.5 D or Pt.3 Ch.2 Sec.4. A. Ships intended for the carriage of homogeneous loads only, may upon request, be considered according to the requirements for ships in category II.

A 500 Plating and stiffeners
501 The plate thickness and the cross-sectional properties of stiffeners are in general to be calculated as given in Pt.3 Ch.1 or Pt.3 Ch.2, using design pressures according to 200 where applicable.

502 The minimum thickness of the inner bottom plating of the double bottom of cargo holds, is to be taken as given in Pt.3 Ch.1 Sec.6 C402 or Pt.3 Ch.2 Sec.5 C302 for ships with length less than 100 m, with $t_b = 5$ mm.

503 The section modulus of longitudinal stiffeners of double bottom structures is to be calculated, as given in Pt.3 Ch.1 Sec.6, with double bottom stress $\sigma_{db} = 20 f_1$ N/mm². For ships designed for non-homogeneous seagoing loading conditions, the section modulus of double bottom longitudinals is also to be calculated, as given in Sec.5 C300, based on double bottom stresses as is determined according to 600.

A 600 Girder systems
601 Scantlings of girder structures of the bottom, sides, transverse bulkheads and deck of the cargo region may have to be determined, based on a direct stress analysis, as considered necessary by the Society.

602 In cases where direct calculations are considered necessary, the following cases are normally to be considered:

a) Cargo unevenly distributed between the holds (harbour). The design condition is to be based on the intended loading and unloading sequence.

b) Cargo unevenly distributed between the holds, as applicable, according to the ship’s loading manual (seagoing).

c) Ballast condition (seagoing).