PART 5 CHAPTER 2

PASSENGER AND DRY CARGO SHIPS

JANUARY 2003

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This is a re-print with the relevant amendments and corrections, shown in the current Pt.0 Ch.1 Sec.3, inserted into the body of the text.
Changes in the Rules

General

The present edition of the rules includes additions and amendments decided by the Board as of December 2002, and supersedes the January 2001 edition of the same chapter, including later amendments.

The rule changes come into force on 1 July 2003.

This chapter is valid until superseded by a revised chapter.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 P.0 Ch.1 Sec.3. P.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 P.0 Ch.1 Sec.1 to ensure that the chapter is current.

Main Changes

- General

IACS UR S25 is applicable to “Bulk Carriers” as defined in UR Z11.2.2, having length as defined in UR S2.1 of 150 m or above. Bulk carriers will be assigned one of the new unified class notations BC-A, BC-B or BC-C replacing HC-E, HC and Bulk Carrier, respectively. The combination of empty holds for vessels with the new BC-A notation shall be indicated as Holds a, b, ... may be empty. In order to maintain DNV specific requirements for vessels that have been designed for “any hold empty condition”, the notation BC-B* shall replace HC-EA, applicable for double hull (notation found unsuitable for single hull) bulk or general cargo carriers.

- Sec.1 General Requirements

- In item A201 the following class notations have been deleted: HC, HC-E or HC-EA for Bulk Carrier ESP and Bulk Carrier and replaced with BC-A, BC-B, BC-C, BC-B*.
- In item A203 the definitions for notations HC, HC-E or HC-EA have been deleted and replaced with definitions for: BC-A, BC-B*, BC-C, BC-B*. No MP and Max Cargo Density x.y. (t/m²).

- Sec.2 Passenger Ships

- Items A103, A104, A105, A106 and A107, concerning convention text have been deleted.
- Sub-section element A200 (A201 to A205), concerning definitions, has been added.
- Sub-section elements B200 and B300, concerning convention text in italics, have been deleted and replaced with normal font text giving reference to relevant statutory requirements.
- Item B301 8), concerning definitions only, has been moved to A200.
- Sub-section element B400, concerning steering arrangement, has been deleted.
- In item C101 the SOLAS requirement has been updated to SOLAS Reg. II-1/21.1, and moved to a Guidance note.
- Items E301, E302 and E303 concerning documentation, have been deleted and replaced with more general requirements.
- Table E1, requirements for documentation, has been deleted.
- Sub-section element E400 “Structure” has been deleted.
- Previous sub-element E500 has been renumbered to E400.
- Renumbered item E401 has additional text concerning spaces that are considered to have little or no fire risk.
- Renumbered item E406 has additional text concerning the location of service and stowage spaces for stores on ro-ro decks.
- New items E408 and E409, concerning vertical and horizontal zoning in accordance with SOLAS Reg. II-2/20.2.1, have been added.
- Sub-section element E500 “Protection of stairways and lifts in accommodation area” (SOLAS Reg. II-2/9.2.2.5) has been added.
- Sub-section element E600 “Means of escape from accommodation spaces, service spaces and control stations” (SOLAS Reg. II-2/13.3.2.1 – 13.3.2.4) has been added.
- Sub-section element E700 “Means of escape from machinery spaces” (SOLAS Reg. II-2/13.4.1) has been added.
- Sub-section element E800 “Means of escape from special category and open ro-ro spaces to which passengers carried can have access” (SOLAS Reg. II-2/13.5) has been added.
- Previous sub-section element E900 “Additional requirements to means of escape for ro-ro passengers ships” (SOLAS Reg. II-2/13.7) has been added.
- Previous sub-section elements E600 to E2100 have been deleted.
- A new sub-section F “Stability and Watertight Integrity” has been added.
- Previous sub-sections F “Protection of Special Category Spaces”, G “Protection of Cargo Spaces Other Than Special Category Spaces”, H “Fixed Fire-Extinguishing Arrangements in Cargo Spaces”, I “Fire Patrols, Detection Alarms and Public Address Systems”, J “Special Requirements for Ships Carrying Dangerous Goods” and K “Stability and Watertight Integrity” have been removed.
- Previous sub-section L “Life Saving Appliances and Arrangements” has been renumbered G and re-written.
- Sub-section M “Chapter IV, Radiocommunications part C, Ship Requirements” has been deleted.

- Sec.3 Ferries

- In item A302 a new sub-item element d), concerning arrangements of accesses to and exits from the ro-ro deck, has been added.
- Items A403 and A404, concerning definitions of ro-ro cargo spaces and special category spaces (SOLAS Reg. II-2/3) have been added.
- Sub-section element B “Hull Arrangement and Strength” has been deleted. Sub-section elements B100 and B200 have been moved to C. Sub-section elements B300, B400 and B500 have been deleted.
- A new sub-section C “Openings and Closing Appliances” has been added. (SOLAS Reg. II-1 20 and 23).
- Previous sub-section C “Bow Doors” becomes sub-section D.
- Previous sub-section E “Stability and Watertight Integrity” becomes sub-section F “Stability”.
- In item F101 a Guidance note concerning SOLAS II-1 Regs. 2.3, 5, 6, 7 and 8 has been added.
- Previous item F102 and F103 has been deleted and replaced with a new item F102, concerning ships in domestic trade.
- Sub-section element E200 “Definitions” has been deleted.
- Sub-section element E300 and E400 have been deleted and moved to C300 and C400, respectively.
- Previous sub-section F “Life Saving Appliances and Arrangement” becomes sub-section G.
- In G200 items 1.2, 1.3, 2.1, 2.2, 3.4, 3.4.1, 3.4.2 and 3.4.3 have been deleted.
- F300 “Helicopter landing and pick up areas” has been deleted.
• **Sec. 4 General Cargo Carriers**
  — Item A106 is a new item concerning the requirements for dry bulk carriers being given the class notation General Cargo Carrier BC-A or (BC-B, BC-C, BC-B*).

• **Sec. 5 Dry Bulk Cargo Carriers**
  — In items A101 and A102 the text “dry bulk cargoes” has been deleted and replaced with “solid bulk cargoes”.
  — Item A102 has been amended to introduce the mandatory ship type notation Bulk Carrier.
  — Item A103, concerning the class notation ESP ES(_,.), has been completely rewritten.
  — New item A106 concerns criteria regarding longitudinal strength, including local strength, capacity and disposition of ballast tanks and stability in accordance with IACS UR S25.2.2.
  — The last bullet point and the last paragraph in item A113 have been completely rewritten concerning longitudinal strength and ballasting.
  — Item A117 has been amended concerning the mass of cargo and fuel oil in double bottom tanks.
  — Items A104 to A115 are new and concern requirements for the new class notations.
  — Items A116 to A119, concerning requirements for the new class notations, have been completely rewritten.
  — Items A120 and A121 are new and concern the new class notations.
  — Items A122 and A124, concerning requirements for the new class notations, have been completely rewritten.
  — In item A201 the following class notations gave been deleted: HC-E or HC-EA and replaced with BC-A, BC-B, BC-C, BC-B*.
  — Item A202 has been amended concerning design pressure load for inner bottom of holds.
  — Item A203, concerning design loading criteria for local strength, has been completely rewritten. A reference to IACS UR S25.5.7 has been added.
  — Item B101, concerning design loads for cargo holds, has been amended.
  — Items B103 and B104, concerning the re-definition of formulae, have been rewritten.
  — Sub-section element B300 “Steel Coils” has been deleted and subsumed into B200.
  — Items C301, C304, C305 and C306 have been amended to show the new class notations.
  — Item C404, concerning heavy cargo in holds, has been rewritten and includes new figures 1 to 9.
  — Item C405 is a new item concerning Fuel oil and water tanks in double bottoms.
  — The class notation No MP has been added to item C407.
  — Item D302, concerning heavy ore cargo, has been completely rewritten to include new figures 11 to 13.

• **Sec. 6 Container Carriers**
  — Item C101 has been amended to include the class notation B-CA.
  — Sub section element K200 has been renamed to read “Bilge level alarms”.
  — Item K202, concerning the requirement for a dedicated bilge pump, has been deleted in line with IACS UI LL64 (Rev.2 June 2000). (Load Line Convention 1996 Regulations 2 (5) and 14 (2)).

• **Sec. 8 Enhanced Strength for Bulk Carriers**
  — In item A301 c) the last sentence, concerning partial filling of peak tanks, has been deleted in accordance with IACS UR S1A.2.2 c) (Rev.4 Nov. 2001).
  — Item A301 e., concerning partial filling of ballast tanks, has been deleted.
  — Text concerning alternate and multiple port loading has been deleted from the Guidance note to item A301.
  — The class notations BC-A and BC-B* have been added to the Guidance note to item D201.
  — In item D301 (a) and (c) new paragraphs have been inserted concerning, corrugated bulkhead plating (strength criteria – lower stool and alignment, respectively), in accordance with IACS UR S18.4.1 (a) and (c) (Rev.4 Nov. 2001).
  — In item D301 a new Fig.8 has been inserted, showing full penetration or deep penetration welds, in accordance with IACS UR S18.4.1. Previous Figs.8 to 15 have been renumbered to Figs.9 to 16.

• **Previous Sec. 8 Subdivision and Damage Stability of Cargo Ships**
  — Whole section has been deleted.

• **Previous Sec. 9 Grain carriers**
  — Whole section has been deleted.

• **Previous Sec. 10 Enhanced Strength for Bulk Carriers**
  — Section 10 has been renumbered to Sec.8.

• **Previous Sec. 11 Ships Specialised for the Carriage of a Single Type of Dry Bulk Cargo**
  — Section 11 has been renumbered to Sec.9.

**Corrections and Clarifications**

In addition to the above stated rule requirements, a number of detected errors, corrections and clarifications have been made in the existing rule text.
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.

102 Statutory text that has been adopted in the rules will be written in normal rule text font (not italics) with a reference to the corresponding statutory regulation. Adopting statutory requirements by reference alone will not be used. Statutory requirements that are outside the scope of class but important to consider in association with the rules shall in some cases be referred to in Guidance notes.

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)
General Cargo Carrier (RO/RO) (See Sec.4)
Bulk Carrier ESP (BC-A, BC-B, BC-C, BC-B*) (See Sec.5)
Bulk Carrier (BC-A, BC-B, BC-C, BC-B*) (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.9)

202 The notations:

PWDK permanent decks for wheel loading (See Sec.4)
Container arranged for carriage of containers (See Sec.6)
MCDK arranged with movable car decks (See Sec.7)
PET arranged for lift on/lift off cargo handling and arranged for carriage of vehicles (See Sec.4)
...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
(previous HC-E)
BC-A designed to carry dry bulk cargoes of density 1.0 t/m³ and above with specified holds empty, at maximum draught in addition to BC-B conditions.
(Previous HC)
BC-B designed to carry dry bulk cargoes of density 1.0 t/m³ and above with all cargo holds loaded in addition to BC-C conditions.
BC-C designed to carry dry bulk cargoes of cargo density less than 1.0 t/m³.
BC-B* (Previous HC-EA)
designed to carry dry bulk cargoes of density 1.0 t/m³ and above with any hold empty at maximum draught. Applicable for double hull vessels and General Cargo Carriers.

HOLDS...EMPTY combination of empty holds (See Sec.5)
No MP not strengthened for multiport loading, i.e. not designed to carry maximum allowable cargo hold design mass at reduced draught.

Max Cargo Density x.y. (t/m³) designed for a cargo density less than 3 t/m³
ES(O) enhanced strength for ore carriers (See Sec.5)
ES(S) enhanced strength for single side skin bulk carriers (See Sec.8)
ES(D) enhanced strength for double side skin bulk carriers (See Sec.8)

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. Definitions

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

σf = minimum upper yield stress in N/mm², not to be taken greater than 70% of the ultimate tensile strength. If not specified on the drawings, σf is taken as 50% of the ultimate tensile stress.

a = 0.75 for σf > 235
= 1.0 for f < 235
f₂ = stress factor *)
= 1.0 when midship hull girder strength in accordance with minimum section modulus.

σ₁ = minimum upper yield stress in N/mm², not to be taken greater than 70% of the ultimate tensile strength. If not specified on the drawings, σ₁ is taken as 50% of the ultimate tensile strength.

a = 0.75 for σ₁ > 235
f₂ = stress factor *)
= 1.0 when midship hull girder strength in accordance with minimum section modulus.

tk = corrosion addition in mm *)
wk = section modulus corrosion addition in cm³ *)
L₁ = L but need not be taken greater than 300 m.
s = stiffener spacing in m measured along the plating.
l = stiffener span in m measured along the top flange of the stiffener.

z₁ = vertical distance in m from the baseline or deckline to the neutral axis of the hull girder, whichever is relevant.
\[ z_a = \text{vertical distance in m from the baseline or deckline to the point in question below or above the neutral axis respectively.} \]

*) 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 all ships intended for transport or accommodation of passengers. 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.

A 200 Definitions

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

202 Deepest subdivision load line is the waterline, which corresponds to the greatest draught permitted by the subdivision requirements, which are applicable.

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

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

205 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.

(SOLAS Reg. II-1/2)

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 strength 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 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.

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.

(SOLAS Reg. II-1/12).

202 202 Where a double bottom is required to be fitted its depth shall be to the satisfaction of the Society 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.

(SOLAS Reg. II-1/12).

203 203 Small wells constructed in the double bottom in connection with drainage arrangements of holds, etc., shall not extend downward 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 Society if satisfied that the arrangements give protection equivalent to that afforded by a double bottom complying with this Regulation.

(SOLAS Reg. II-1/12).

204 204 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 Society, thereby impaired.

(SOLAS Reg. II-1/12).

B 300 Peak and machinery space bulkheads, shaft tunnels

301 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.

(SOLAS Reg. II-1/10).

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---

302 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:

— at the mid-length of such extension; or
— at a distance 1.5 per cent of the length of the ship forward of the forward perpendicular; or
— at a distance 3 m forward of the forward perpendicular; whichever gives the smallest measurement.

(SOLAS Reg. II-1/10).
303 Where a long forward superstructure is fitted, the fore-
peak or collision bulkhead on all passenger ships shall be ex-
tended weathertight to the next full deck above the bulkhead
deck. The extension shall be so arranged as to preclude the pos-
sibility of the bow door causing damage to it in the case of
damage to, or detachment of, a bow door.
(SOLAS Reg. II-1/10).

304 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 spec-
ified in paragraph 1 or paragraph 2.
(SOLAS Reg. II-1/10).

305 Ramps not meeting the above requirements shall be dis-
regarded as an extension of the collision bulkhead.
(SOLAS Reg. II-1/10).

306 An afterpeak bulkhead, and bulkheads dividing the ma-
achinery 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
can, however, be stepped below the bulkhead deck. The after-
peak bulkhead may, however, be stepped below the bulkhead
deck, provided the degree of safety of the ship as regards sub-
division is not thereby diminished.
(SOLAS Reg. II-1/10).

307 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.
(SOLAS Reg. II-1/10).

C. Machinery and Systems

C 100 General

101 For ships with class notation Passenger Ship the ma-
achinery and systems are in general to be as required for the
main class.

Guidance note:
Requirements to bilge pumping in passenger ships are given in
SOLAS Reg. II-1/21.2

102 Electrical distribution systems are to be so arranged that
fire in any main vertical zone, as defined in Pt.3 Ch.3 Sec.10,
will not interfere with services essential for safety in any other
such zone. This requirement will be met if main and emergen-
cy 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

101 Statutory text that has been adopted in the rules will be
written in normal rule text font (not italics) with a reference to
the corresponding statutory regulation. Adopting statutory re-
quirements by reference alone will not be used. Statutory re-
quirements that are outside the scope of class but important to
consider in association with the rules shall in some cases be re-
ferred to in Guidance notes.

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

103 The emergency source of electrical power, associated
transforming equipment, if any, transitional source of emerg-
ency 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.

104 The location of the emergency source of electrical pow-
er and associated transforming equipment, if any, the transi-
tional 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 electric-
ical 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 emer-
gency electrical power. As far as practicable, the space con-
taining the emergency source of electrical power, associated
transforming equipment, if any, the transitional 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.

105 Provided that suitable measures are taken for safeguard-
ing 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 con-
nected to the emergency switchboard.

D 200 Services to be supplied

201 The electrical power available shall be sufficient to sup-
ply all those services that are essential for safety in an emer-
gency, due regard being paid to such services as may have to
be operated simultaneously. The emergency source of electric-
ical power shall be capable, having regard to starting currents
and the transitory nature of certain loads, of supplying simul-
taneously at least the following services for the periods speci-
fied 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.3
Sec.11);
2) in alleyways, stairways and exits giving access to the mus-
ter and embarkation stations, as required by regulation III/
11.5 (Pt.3 Ch.3 Sec.11);
3) in all service and accommodation alleyways, stairways
and exits, personnel lift cars;
4) in the machinery spaces and main generating stations in-
cluding 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 Inter-
national Regulations for Preventing Collisions at Sea in
force; and

DET NORSKE VERITAS
2) the VHF radio installation required by regulation IV/7.1.1 and IV/7.1.2; 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;
   2.2 the ship earth station required by regulation IV/10.1.1.; and
   2.3 the MF/HF radio installation required by regulations IV/10.2.1, IV/10.2.2 and IV/11.1.
   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 equipment as required by regulation V/12.
   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;
   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 SOLAS Reg. II-1/15 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 generator 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 SOLAS Reg. II-1/15, 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 SOLAS Reg. II-1/15, 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, 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 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 for 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.3 Ch.3 Sec.10.

202 For fire technical and space definitions, see Pt.3 Ch.3 Sec.10 C.

E 300 Documentation

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

— General arrangement plan showing main vertical zone arrangement including steps and recesses, stairways and doors.

— Arrangement of means of escape from different compartments and escape calculations.

E 400 Main vertical zones and horizontal zones (SOLAS Reg. II-2/9.2.2.1)

401 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. Open deck spaces, sanitary or similar spaces, tanks, voids and auxiliary machinery spaces having little or no fire risk on one side or where fuel oil tanks are on both sides of the division the standard may be reduced to “A-0”.

402 In 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.

403 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.

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

405 Where a main vertical zone is subdivided by horizontal "A" class divisions into horizontal zones for the purpose of providing an appropriate barrier between a zone with sprinklers and a zone without sprinklers, the divisions shall extend between adjacent main vertical zone bulkheads and to the shell or exterior boundaries of the ship.

406 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 by the Society. Service spaces and ship stores are not to be located on ro-ro decks unless protected in accordance with the applicable requirements.

407 However, in a ship with special category spaces, any such space is to comply with the applicable requirements to such spaces and where such compliance would be inconsistent with other requirements for passenger ships specified in this Part, the requirements for special category spaces are to prevail.

408 The basic principle underlying the provisions of this paragraph is that the main vertical zoning required by 401 and 402 may not be practicable in vehicle spaces of passenger ships and, therefore, equivalent protection is to be obtained in such spaces on the basis of a horizontal zone concept and by the provision of an efficient fixed fire-extinguishing system. Based on this concept, a horizontal zone may include special category spaces on more than one deck provided that the total overall clear height for vehicles does not exceed 10 m.

(SOLAS Reg. II-2/20.2.2.1)

409 The basic principle underlying the provisions of paragraph 408 is also applicable to ro-ro spaces.

(SOLAS Reg. II-2/20.2.2.2)

E 500 Protection of stairways and lifts in accommodation area (SOLAS Reg. II-2/9.2.2.5)

501 Stairways are to 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 bulkheads or self-closing doors in one 'tween-deck space. When a stairway is closed in one 'tween-deck space, the stairway enclosure is to be protected in accordance with the requirements for decks; and

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

502 Lift trunks are to be so fitted as to prevent the passage of smoke and flame from one 'tween-deck to another and are to be provided with means of closing so as to permit the control of draught and smoke. Machinery for lifts located within stairway enclosures are to be arranged in a separate room, surrounded by steel boundaries, except that small passages for lift cables are permitted. Lifts which open into spaces other than corridors, public spaces, special category spaces, stairways and external areas are not to open into stairways included in the means of escape.

E 600 Means of escape from accommodation spaces, service spaces and control stations (SOLAS Reg. II-2/13.3.2.1 - 13.3.2.4)

601 Below the bulkhead deck two means of escape, at least one of which shall be independent of watertight doors, are to 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 for crew spaces that are entered only occasionally, if the required escape route is independent of watertight doors.

602 Where the Society has granted dispensation under the provisions of 601, this sole means of escape are to provide safe escape. However, stairways are not to be less than 800 mm in clear width with handrails on both sides.

603 Above the bulkhead deck there are to 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 is to give access to a stairway forming a vertical escape.

604 Stairway enclosures in accommodation and service spaces are to have direct access from the corridors and be of a sufficient area to prevent congestion, having in view 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 non-hazardous safety equipment and open information counters are permitted. Only public spaces, corridors, lifts, public toilets, special category spaces and open ro-ro spaces to which any passengers carried can have access, other escape stairways required by 605 and external areas are permitted to have direct access to these stairway enclosures. Small corridors or "lobbies" used to separate an enclosed stairway from galleys or main laundries may have direct access to the stairway provided they have a minimum deck area of 4.5 m², a width of no less than 900 mm and contain a fire hose station.

605 At least one of the means of escape required by 601 and 603 are to consist of a readily accessible enclosed stairway, which are to 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 are to be provided and are to have emergency lighting and slip-free surfaces underfoot. 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 are to have fire integrity, including insulation values, in accordance with appropriate requirements.

606 Protection of access from the stairway enclosures to the lifeboat and liferaft embarkation areas are to be provided either directly or through protected internal routes which have fire integrity and insulation values as required for stairway enclosures.

607 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.

608 Each level within an atrium is to have two means of escape, one of which is to give direct access to an enclosed vertical means of escape meeting the requirements of 605.

609 The widths, number and continuity of escapes are to be in accordance with the requirements in the Fire Safety Systems Code.

E 700 Means of escape from machinery spaces (SOLAS Reg. II-2/13.4.1)

701 Where the space is below the bulkhead deck the two means of escape are to consist of either:
.1 two sets of steel ladders as widely separated as possible, leading to doors in the upper part of the space similar separated and from which access is provided to the appropriate lifeboat and liferaft embarkation decks. One of these ladders is to be located within a protected enclosure from the lower part of the space it serves to a safe position outside the space. Self-closing fire doors of the same fire integrity standards are to be fitted in the enclosure. The ladder is to be fixed in such a way that heat is not transferred into the enclosure through non-insulated fixing points. The protected enclosure is to have minimum internal dimensions of at least 800 mm x 800 mm, and is to have emergency lighting provisions; or

.2 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 and 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.

702 Where the space is above the bulkhead deck, the two means of escape are to be as widely separated as possible and the doors leading from such means of escape are to 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 are to be of steel.

703 In a ship of less than 1 000 gross tonnage, the Society may dispense with one of the means of escape, 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, the Society may dispense with one means of escape from any such space, including a normally unattended auxiliary machinery space, 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. In the steering gear space, a second means of escape is to be provided when the emergency steering position is located in that space unless there is direct access to the open deck.

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

E 800 Means of escape from special category and open ro-ro spaces to which any passengers carried can have access (SOLAS Reg. II-2/13.5)

801 In special category and open ro-ro spaces to which any passengers carried can have access, the number and locations of the means of escape both below and above the bulkhead deck are to be to the satisfaction of the Society and, in general, the safety of access to the embarkation deck are to be at least equivalent to that provided for under 601, 603, 605 and 606. Such spaces are to be provided with designated walkways to the means of escape with a breadth of at least 600 mm. The parking arrangements for the vehicles are to maintain the walkways clear at all times.

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

E 900 Additional requirements to means of escape for ro-ro passenger ships

901 Escape routes are to be provided from every normally occupied space on the ship to an assembly station. These escape routes are to be arranged so as to provide the most direct route possible to the assembly station, and are to be marked with symbols.

(F) SOLAS Reg. II-2/13.7.1.1

Guidance note:
Refer to “Symbols related to life-saving appliances and arrangements” adopted by IMO by Res. A.760(18).

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902 The escape route from cabins to stairway enclosures are to be as direct as possible, with a minimum number of changes in direction. It is not to be necessary to cross from one side of the ship to the other to reach an escape route. It is not to 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.

(SOLAS Reg. II-2/13.7.1.2)

903 External routes are to be provided from open decks, as referred to in 902, to the survival craft embarkation stations.

(SOLAS Reg. II-2/13.7.1.3)

904 Where enclosed spaces adjoin an open deck, openings from the enclosed space to the open deck are, where practicable, to be capable of being used as emergency exits.

(SOLAS Reg. II-2/13.7.1.4)

905 Escape routes are not to 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 are to be secured in place to prevent shifting if the ship rolls or lists. Floor coverings are also to be secured in place. When the ship is underway, escape routes are to be kept clear of obstructions such as cleaning carts, bedding, luggage and boxes of goods.

(SOLAS Reg. II-2/13.7.1.5)

906 Escape routes are to be evaluated by an evacuation analysis early in the design process. The analysis is to 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 is to 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.

(SOLAS Reg. II-2/13.7.4)

Guidance note:
Refer to the “Interim Guidelines for a Simplified Evacuation Analysis on Ro-Ro Passenger Ships” developed by IMO (MSC/Circ.909)

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F. Stability and Watertight Integrity

F 100 Application

101 Ships with class notation Passenger Ship are to comply with the requirements according to 300 and 400.

102 The class requirements may be considered complied with when a national authority has carried out the approval in accordance with the SOLAS Reg. II-1, Part B.

103 For ships in domestic trade and with service restrictions, alternative stability requirements may be accepted after considerations in each separate case.
Guidance note:

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F 200 Documentation
201 The following documentation is to be submitted for approval:
— preliminary damage stability calculations
— final damage stability calculations
— damage control plan.

F 300 Intact stability
301 Passenger ships are to comply with Pt.3 Ch.3 Sec.9 with the supplementing requirements as given in 302 to 304.

302 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 with full stores and fuel and the full number of passengers and their luggage, but without cargo
— 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 only 10% stores and fuel and the full number of passengers and their luggage, but without cargo.

303 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:

\[ MR = 0.02 \left( V_o^2 \left( KG - \frac{d}{2}\right) / L \right) \]

where:
- \( MR \) = heeling moment (tm)
- \( V_o \) = service speed (m/s)
- \( L \) = length of ship at waterline (m)
- \( D \) = displacement (t)
- \( d \) = draught (m)
- \( KG \) = height of centre of gravity above keel (m).

304 When applying the additional criteria in 303 the following is to be assumed:

1) A mass 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 mass 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.

F 400 Subdivision and damage stability
401 Passenger ships are to comply with the applicable regulations of SOLAS Reg. II-1, Part B.
G. Life Saving Appliances and Arrangements

G 100 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 Society may permit the substitution of lifeboats by liferafts of equivalent total capacity provided that there shall never be less than sufficient lifeboats on each side of the ship 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; and

1.1.2 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 1.1.1 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.

1.2 Passenger ships engaged on short international voyages and complying with the special standards of subdivision prescribed by regulation II-1/6.5 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.

1.3 Passenger ships engaged on short international voyages and not complying with the special standards of subdivision prescribed by regulation II-1/6.5, shall carry survival craft complying with the requirements of paragraph 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 engaged on short international voyages and complying with the special standards of subdivision prescribed by regulation II-1/6.5 shall be sufficient to ensure that in providing for abandonment by the total number of persons on board not more than nine liferafts need be marshalled by each lifeboat or rescue boat.
G 200 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.3 Sec.11), 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.

G 300 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.3 Sec.11), the escape provisions of regulation II-2/28 (E900), 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.

G 400 Muster Stations (Regulation III/25)

1 Every passenger ship shall, in addition to complying with the requirements of regulation 11, 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.
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.
— systematic maintenance and function testing
— identification of faults
— register of inspections and possible repairs.

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

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d) Arrangement of accesses from the ro-ro deck (bulkhead deck) to spaces below (showing all doors, ramps, hatches etc.).

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, cleating 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.

h) Types of locking arrangements used on cleats and support devices on doors with clear opening > 12m², (Ref. D1201).

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 A1  Requirements for documentation of instrumentation systems

<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>040 System block diagrams (T)</td>
</tr>
<tr>
<td>GAL General alarm/public address system</td>
<td>050 System diagrams (P&amp;IDS, D&amp;IDS, etc.)(T)</td>
</tr>
<tr>
<td></td>
<td>070 Power supply arrangement (T)</td>
</tr>
<tr>
<td></td>
<td>080 Arrangement and layout (T)</td>
</tr>
<tr>
<td></td>
<td>090 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>

For class notations Car Ferry A (or B) and Train Ferry A (or B):

<table>
<thead>
<tr>
<th>BDO</th>
<th>FDO</th>
<th>GAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>X X X</td>
<td>X X X</td>
<td>X X X</td>
</tr>
</tbody>
</table>

T  Required also for type approved systems
**A 400 Definitions**

401 Symbols

- \( t \) = rule thickness in mm of plating
- \( Z \) = rule section modulus in \( \text{cm}^3 \) of stiffeners and simple girders
- \( s \) = stiffener spacing in m, measured along the plating
- \( l \) = 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 cord 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
- \( f_1 \) = 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 **)
- \( l_m \) = stiffener spacing in m, measured along the topflange of the member. For definition of span point, see Pt.3 Ch.1 Sec.3 C100.
- \( \alpha \) = exponent in the equation for loading breadth of girders

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:

\[
p_m \leq \frac{p_m + p_a + p_b}{2}
\]

where \( p_m \), \( p_a \) and \( p_b \) are calculated pressures at the midpoint and at each end respectively.

c) **For girders**

Midpoint of load area.

403 **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.

404 **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 vehicles can be driven and to which passengers have access.

(SOLAS Reg. II-2/3)

---

**B. Hull Arrangement and Strength**

**B 100 Vehicle decks, ramps and lifts**

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

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

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

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

**B 200 Securing of vehicles**

201 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 B800.

202 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 300 Transverse strength**

301 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 as given for complex girder systems in Pt.3 Ch.1 Sec.13.

---

**C. Openings and Closing Appliances**

**C 100 Doors**

101 Arrangements and scantlings of doors in ship’s side and ends are in general to satisfy the requirements given for main class, with relevant additions as given in 102 to 402.

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

103 Arrangement, scantlings and securing of side and stern doors are given in Pt.3 Ch.3 Sec.6 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.

**C 200 Access openings**

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

**C 300 Watertight integrity from the ro-ro deck (bulkhead deck) to spaces below**

301 Subject to the provisions of subparagraphs 302 and 303 all accesses that lead to spaces below the bulkhead deck shall have a lowest point which is not less than 2.5 m above the bulkhead deck.

(SOLAS Reg. II-1/20-2.1)

302 Where vehicle ramps are installed to give access to spaces below the bulkhead deck, their openings shall be able to be closed watertight to prevent ingress of water below, alarmed and indicated to the navigation bridge. Signboard marked “To be closed at sea” to be fitted.

(SOLAS Reg. II-1/20-2.1)

303 The Society may permit the fitting of particular accesses
to spaces below the bulkhead deck provided they are necessary for the essential working of the ship, e.g. the movement of machinery and stores, subject to such accesses being made watertight, alarmed and indicated to the navigation bridge. Signboard marked “To be closed at sea” to be fitted.

(SOLAS Reg. II-1/20-2.1)

304 Subject to the approval by flag-state, the Society may accept equivalent solutions to the requirements specified in 301 and 303.

C 400 Integrity of the hull and superstructure, damage prevention and control

401 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 Society, 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 "harbour or 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 the power supply for operating and securing the doors. The indicator systems, approved by the Society, which were installed on ships constructed before 1 July 1997 need not be changed.

(SOLAS Reg. II-1/23-2)

Guidance note:
Regarding indicator systems, see Pt.7 Ch.1 Sec.3 B100.

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

402 Television surveillance and a water leakage detection system 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.

(SOLAS Reg. II-1/23-2)

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

D. Bow Doors

D 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 outside 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.

D 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 weathertight 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 hingepin (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 hingepin 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.

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

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.

D 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 $f_1$ for forgings (including rolled round bars) and castings may be taken as:

$$ f_1 = \left( \frac{\sigma_f}{235} \right)^{0.75} $$

$\sigma_f = \text{minimum upper yield stress in N/mm}^2, \text{not to be taken greater than 70\% for the ultimate tensile strength.}$

The material factor $f_1$ is not to be taken greater than 1.39 unless a direct fatigue analysis is carried out.

D 400 Design Loads

401 Outer doors, ordinary design sea pressure:

$$ p_e = \text{as given for } p_2 \text{ in Pt.3 Ch.1 Sec.4 C.} $$

402 Outer doors, design bow impact pressure:

$$ p_{se} = \text{as given for } p_s \text{ in Pt.3 Ch.1 Sec.7 E with } \gamma = 0. $$

For ships with service area restrictions R2 to RE, the wave coefficient, $C_w$, 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:

$$ p_b = 0.6 \times L \times (\text{kN/m}^2) $$

$L = \text{ship's length, as given in Pt.3 Ch.1 Sec.1 B, need not be taken greater than 200 m}$

or

$$ p_b = 10 \times h_b \times (\text{kN/m}^2) $$

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

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:

$$ F_x = 0.375 \times p_{se} \times A_x \text{ or } 1.3 \times p_e \times A_x, \text{ if greater} $$

- Total transverse force:

$$ F_y = 0.375 \times p_{se} \times A_y \text{ or } 1.3 \times p_e \times A_y, \text{ if greater} $$

- Total vertical force:

$$ F_z = 0.375 \times p_{se} \times A_z \text{ or } 1.3 \times p_e \times A_z, \text{ if greater.} $$

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

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

$A_y = \text{area (m}^2) \text{ of the vertical side view projection of the outer door, between the levels of the bottom of the door and the weather deck or between the bottom of the door and the top of the door, whichever is the lesser.}$

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

The design pressures are to be calculated at the position $h/2$ above the bottom of the door and $l/2$ 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: $F_{xi} = p_i \times A_x$

- Total transverse force: $F_{yi} = p_i \times A_y$

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:
\[ F_x = p \cdot A_x \text{ or } p_h \cdot A_x, \text{ if greater} \]

Internal force:
— total longitudinal force:
\[ F_{xi} = p_i \cdot A_x \]

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

D 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 D1 Allowable stresses, outer doors

<table>
<thead>
<tr>
<th>Design pressure</th>
<th>Shear stress ( t ) (N/mm(^2))</th>
<th>Bending or normal stress ( \sigma ) (N/mm(^2))</th>
<th>Equivalent stress ( \sigma_e ) (N/mm(^2))</th>
</tr>
</thead>
<tbody>
<tr>
<td>( p_e ) or ( p_i )</td>
<td>80 ( f_1 )</td>
<td>120 ( f_1 )</td>
<td>150 ( f_1 )</td>
</tr>
<tr>
<td>0.375 ( p_e )</td>
<td>105 ( f_1 )</td>
<td>160 ( f_1 )</td>
<td>200 ( f_1 )</td>
</tr>
</tbody>
</table>

Table D2 Allowable stresses, inner doors

<table>
<thead>
<tr>
<th>Design pressure</th>
<th>Shear stress ( t ) (N/mm(^2))</th>
<th>Bending or normal stress ( \sigma ) (N/mm(^2))</th>
<th>Equivalent stress ( \sigma_e ) (N/mm(^2))</th>
</tr>
</thead>
<tbody>
<tr>
<td>( p_e, p_h ) or ( p_i )</td>
<td>105 ( f_1 )</td>
<td>160 ( f_1 )</td>
<td>200 ( f_1 )</td>
</tr>
</tbody>
</table>

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

Table D3 Allowable stresses, outer doors

<table>
<thead>
<tr>
<th>Design pressure</th>
<th>Shear stress ( t ) (N/mm(^2))</th>
<th>Bending or normal stress ( \sigma ) (N/mm(^2))</th>
<th>Equivalent stress ( \sigma_e ) (N/mm(^2))</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.375 ( p_e ), 1.3 ( p_e ) or 1.3 ( p_i )</td>
<td>105 ( f_1 )</td>
<td>160 ( f_1 )</td>
<td>200 ( f_1 )</td>
</tr>
</tbody>
</table>

Table D4 Allowable stresses, inner doors

<table>
<thead>
<tr>
<th>Design pressure</th>
<th>Shear stress ( t ) (N/mm(^2))</th>
<th>Bending or normal stress ( \sigma ) (N/mm(^2))</th>
<th>Equivalent stress ( \sigma_e ) (N/mm(^2))</th>
</tr>
</thead>
<tbody>
<tr>
<td>( p_e, p_h ) or ( p_i )</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/mm\(^2\)).**

504  **Nominal bearing pressure, determined by dividing the design force by the projected bearing area, is not to exceed 0.8 \( \sigma_p \) (N/mm\(^2\)) for steel material where \( \sigma_p \) is the yield stress for the bearing material. For other bearing materials the nominal bearing pressure will be specially considered.**

D 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.**

D 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:

\[ t_1 = \frac{1.58k_a \cdot s_{e} \cdot \sqrt{p_e}}{f_1^2} \text{ (mm)} \]

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

— outer doors:

\[ t_2 = \frac{13.8k_s \cdot s \cdot p_{sl}}{\sqrt{\sigma_f}} \text{ (mm)} \]

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

\( k_s = \text{ correction factor for aspect ratio of plate field} \)

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

\( = \text{ maximum 1.0 for } s/l = 0.4 \)

\( = \text{ minimum 0.72 for } s/l = 1.0 \)

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.

D 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:

\[ Z_1 = \frac{0.8s^2 \cdot p_e}{f_1} \text{ (cm}^3\text{)} \]

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

— outer doors:

The plastic section modulus, \( Z_{pl} \), 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:

\[ A_1 = \frac{0.08s \cdot p_e}{f_1} \text{ (cm}^2\text{)} \]

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

— 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.**

D 900  **Girders**

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

— outer doors:

\[ Z_1 = \frac{1.05S^2 \cdot b \cdot p_e}{f_1} \text{ (cm}^3\text{)} \]

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

\[ Z_1 = \frac{0.8S^2 \cdot b \cdot p_e}{f_1} \text{ (cm}^3\text{)} \]
Z_2 = Z, 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:
  \[
  A_1 = \frac{0.08 \, S \, b \, p_e}{f_1} \quad \text{(cm}^2\text{)}
  \]
  (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:

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

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.

D 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:

\[
\alpha = \frac{F_x a - F_z b}{\sqrt{F_x^2 + F_z^2} \sqrt{a^2 + b^2}} \geq 0.10
\]

a = vertical distance (m) from visor hinge to position \( h/2 \)

b = horizontal distance (m) from visor hinge to position \( l/2 \)

\( F_x, F_z, h \) and \( l \) 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.

D 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 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 \( 2 \, F_z \)
b) 1.4 Fx, 0.7 Fy and 1.4 Fz, with 0.7 Fy acting alternatively from either side.

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) Fx, Fy and Fz, with each force acting on both doors
b) 0.7 Fx, 0.7 Fy and 0.7 Fz, 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 D3 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 D3. The opening moment to be balanced by the said reaction force is not to be taken less than:

\[ M_0 = 1.3 \times (10 \times W \times d + 5 \times A_x \times a) \times (kN\text{m}) \]

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.

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.

D 1200 Closing arrangement, system for operation and indication and monitoring

1201 Cleats and support devices are to be equipped with 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 interlocked in such a way that they can only operate in the proper sequence. Hydraulic operating systems are to be isolated from other circuits and to be blocked when doors and closing arrangement are in the closed or locked position.

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 a mechanical lock is placed inside the hydraulic cylinder moving the cleat, indication of the open or closed position of any of the cleats, support and the locking device shall 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.3 Ch.3 Sec.10 which, if left open or not properly closed and locked, could lead to a major flooding of such spaces.

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

E. Inlets and Drainage Arrangement

E 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 weathertight 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.
E 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.

E 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.3 Sec.6 M.

F. Stability

F 100 General

101 Ships with class notation Car Ferry, Train Ferry or Car and Train Ferry are to comply with the requirements of Pt.3 Ch.3 Sec.9 as well as the requirements of Sec.2 K for Passenger Ships.

Guidance note:
For vessels arranged with a lower ro-ro cargo hold below the bulkhead deck Regulation 4, 5, 6 and 7 of SOLAS Reg. II-1, Part B are not considered applicable. For such ferries two alternatives are considered applicable:

Compliance with IMO Res. A.265(VIII) when applied in its entirety.

The inboard penetration of SOLAS damages in way of the lower ro-ro cargo hold, including damages involving the boundary bulkheads, are extended to the centreline. The lower ro-ro cargo hold should be assumed to have a permeability equal to 0.90 unless a lesser value can be demonstrated by calculation. For this damage conditions the vessel should meet the criteria according to SOLAS Reg. II-1, Part B, Reg. 2.3. It is recommended that a double bottom in way of the lower cargo hold has a value of at least B/10.

---end of Guidance note---

102 For ships in domestic trade and with service restrictions, alternative stability requirements may be accepted after considerations in each separate case.

G. Life Saving Appliances and Arrangements

G 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 G for passenger ships.

G 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, 5.

2 Liferafts

2.3 Every liferaft on ro-ro passenger ships shall be of a type fitted 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 automatically self-righting or be a canopied reversible liferaft which is stable in a seaway and is capable of operating safely whichever way it is floating. Alternatively, the ship shall carry automatically self-righting liferafts or canopied reversible liferafts, in addition to its normal complement of liferafts, of such aggregate 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 approved by the Administration having regard to the recommendations 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 having regard to the recommendations adopted by the Organization.***

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 capsizing.

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 and 22.2, 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)
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 arranged for lift on and or lift off cargo handling and arranged for carriage of vehicles are to comply with requirements given in SOLAS Reg. II-2/20 and will be given the class notation PET.

105 Ships intended for carriage of dry bulk and built in appliance with requirements given in Sec.5 will be given the class notation General Cargo Carrier BC-A (or BC-B, BC-C, BC-B*)

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. Direct stress analysis of deck and bottom structure in way of pillars may be necessary.

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 evenly 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.
When the cantilever may be considered as a simple girder the section modulus in sections M-M and N-N is not to be less than:

\[ Z = \frac{6}{f_1} l (P + 0.5Q) \] (cm³)

\[ l = \text{as given in Fig. 1 in m} \]
\[ P = \text{point load in kN at side coaming (from cargo on hatch cover and transversely stiffened deck)} \]
\[ Q = \text{distributed load in kN (from cargo on longitudinally stiffened deck)} \]

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 0.4l. 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:

\[ A = \frac{0.12}{f_1} \left( P + \frac{Q}{l} \right) \] (cm²)

\[ x = \text{distance in m from end of cantilever} \]
\[ P \text{ and } Q = \text{as given in 202} \]

206 The thickness of the corner plate between the sections M-M and N-N is not to be less than:

\[ t = \frac{0.012}{f_1} (P + 0.5Q) \frac{l}{ag} \] (mm)

The corner plate in Fig. 1 (Alt. I and Alt. II) is to be additionally stiffened if a and g is greater than 70t.

\[ P \text{ and } Q = \text{as given in 202} \]
\[ l, a \text{ and } g = \text{as given in Fig. 1} \]

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 sufficient strength for the specified design working loads and maximum loads during hoisting operation. After end ramps are to have sufficient flexibility for resting on the quay during loading/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 requirements 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 analysis 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) position 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:

\[ P = k Q g_0 \]

\[ Q = \text{maximum axle load in t} \]
\[ g_0 = \text{number of loads areas on the axle} \]
\[ a = \text{extent in m of the load area parallel to the stiffeners (See Fig. 2)} \]
\[ b = \text{extent in m of the load area perpendicular to the stiffeners (see Fig. 2)} \]

\[ P = k \left( Q + 0.5a \right) b \]

where:
- \( P \) = maximum allowed lashing load
- \( k \) = 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%.

B 900 Steel coils
901 For vessels intended to carry steel coils, the inner bottom platting and inner bottom longitudinals will be especially considered.
902 An acceptable calculation method is given in Classification Note No. 31.1.

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 tire pressure of pneumatic tire 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 is in general to be taken as:
\[ p = \frac{Q}{n_0 a b} \]

\[ Q = \text{maximum axle load in t} \]
\[ n_0 = \text{number of loads areas on the axle} \]
\[ a = \text{extent in m of the load area parallel to the stiffeners (See Fig. 2)} \]
\[ b = \text{extent in m of the load area perpendicular to the stiffeners (see Fig. 2)} \]

\[ p = \frac{Q}{n_0 a b} \]

\[ = (9.81 + 0.5a) \] (kN/m²)
The load area as indicated in Fig. 2 are defined as:

<table>
<thead>
<tr>
<th>Number of wheels in group</th>
<th>Footprint dimensions (real contact areas between tyres and deck)</th>
<th>Design load area for axle perpendicular to stiffeners</th>
<th>Design load area for axle parallel to stiffeners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single wheel</td>
<td><img src="image" alt="Single wheel diagram" /></td>
<td><img src="image" alt="Single wheel diagram" /></td>
<td><img src="image" alt="Single wheel diagram" /></td>
</tr>
<tr>
<td>Double wheels</td>
<td><img src="image" alt="Double wheels diagram" /></td>
<td><img src="image" alt="Double wheels diagram" /></td>
<td><img src="image" alt="Double wheels diagram" /></td>
</tr>
<tr>
<td>Triple wheels</td>
<td><img src="image" alt="Triple wheels diagram" /></td>
<td><img src="image" alt="Triple wheels diagram" /></td>
<td><img src="image" alt="Triple wheels diagram" /></td>
</tr>
</tbody>
</table>

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 b₁ of the prints, the load area may normally be calculated for the group of wheels only.

\[ p = \frac{p_o (9.81 + 0.5a_v)}{9.81w} \]  (kN/m²)

- \( p_o \) = maximum tyre pressure in kN/m²
- \( p_o = 1000 \) for cargo handling vehicles unless otherwise specified
- \( p_o = 120 \sqrt{Q} + 3 \) for road transporters unless otherwise specified

In the formula:

- \( a_v = 6/\sqrt{Q} \) for moving cargo handling vehicles, harbour conditions.
- \( a_v = \sqrt{\text{vertical acceleration as defined in Pt.3 Ch.1 Sec.4 for stowed vehicles, sea going conditions}} \)

The footprint area of individual wheels or the rectangular enveloped area of footprints of a wheel group.

---

**Fig. 2**

Definition of load area
w = 1.0 in general
= 1.20 when double wheels are specified
= 1.27 when triple wheels are specified
av = as given in 201.
The load area dimensions are in general to be taken as:
\[ a = \sqrt{kA} \text{ (m)} \]
\[ b = \sqrt{A/k} \text{ (m)} \]

k = k₁ in general
= k₂ for plating when k₂ < k₁ and:
\[ \frac{wQ}{n_0s^2} > -100 \]

k₁ = 2.0 for single wheel
= 2.0 for multiple wheels with axle parallel to stiffeners
= 0.8 for double wheels with axle perpendicular to stiffeners
= 0.5 for triple wheels with axle perpendicular to stiffeners

k₂ = \[ \frac{\sqrt{A}}{2s} \]
A = \[ \frac{9.81wQ}{n_0p_o} \text{ (m}^2\text{)} \]
Q and n₀₃ = as defined in 201
n₀₈ = 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:
\[ t = \frac{77.4k_a\sqrt{k_w}\sigma_p}{\sqrt{m\sigma}} + t_k \text{ (mm)} \]

kₐ = 1.1 – 0.25 s/l
maximum 1.0 for s/l = 0.4
minimum 0.85 for s/l = 1.0

kₜ = 1.3 – \[ \frac{4.2}{(a + 1.8)^2} \]
maximum 1.0 for a ≥ 1.94 s
b = b for b < s
s for b > s

\[ m = \sqrt{\left(\frac{b}{s}\right)^2 + 4.7\frac{b}{s} + 6.5} \]
\[ m = 13.57 \text{ for } \frac{b}{s} > 1.0. \]
Between specified values of b/s the m-value may be varied linearly. The m-value may also be obtained from Fig. 3.

\[ \sigma = 320 f_1 \text{ N/mm}^2\text{(maximum)} \text{ in general for seagoing conditions.} \]
\[ = 370 f_1 \text{ N/mm}^2\text{(maximum)} \text{ in general for harbour conditions.} \]
\[ = \text{as given in Table C1, but not exceeding the above general maximum values, for upper deck within 0. L amidships} \]

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 C1 Allowable bending stress for upper deck plating within 0.4 L amidships

<table>
<thead>
<tr>
<th>Arrangement</th>
<th>Condition</th>
<th>( \sigma ) in N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitudinally stiffened</td>
<td>Seagoing</td>
<td>280 f₁ + 60 (f₁ – f₂)</td>
</tr>
<tr>
<td>Longitudinally stiffened</td>
<td>Harbour</td>
<td>355 f₁ + 20 (f₁ – f₂)</td>
</tr>
<tr>
<td>Transversely stiffened</td>
<td>Seagoing</td>
<td>185 f₁ + 135 (f₁ – f₂)</td>
</tr>
<tr>
<td>Transversely stiffened</td>
<td>Harbour</td>
<td>285 f₁ + 85 (f₁ – f₂)</td>
</tr>
</tbody>
</table>

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: \( p_o = 800 \text{ kN/m}^2 \)
- aspect ratio of plate field: \( l/s ≥ 2.5 \)
- 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:
\[ Z = \frac{1000 \, k_z \, c \, d \, p \, w_k}{m \, \sigma} \quad (\text{cm}^3) \]

\[ k_z = \begin{cases} 1.0 & \text{for } b/s < 0.6 \text{ and } b/s > 3.4 \\ \left(1.15 - 0.25 \frac{b}{s}\right) & \text{for } 0.6 < b/s < 1.0 \\ \left(1.15 - 0.25 \frac{b}{s}\right)^2 & \text{for } 1.0 < b/s < 3.4 \end{cases} \]

\[ c = \text{as given in 301.} \]

\[ d = \begin{cases} a & \text{for } a < l \\ l & \text{for } a \geq l \end{cases} \]

\[ a, b, \text{ and } p = \text{as given in 200} \]

\[ m = \begin{cases} \frac{r}{\left(\frac{a}{l}\right)^2 - 4.7 \frac{a}{l} + 6.5} & \text{for } \frac{a}{l} \leq 1.0 \\ \frac{87}{\left(\frac{a}{l}\right)^2 - 6.3 \frac{a}{l} + 10.9} & \text{for } 1.2 < \frac{a}{l} \leq 2.5 \\ 12 & \text{for } \frac{a}{l} \geq 3.5 \end{cases} \]

\[ r = \text{factor depending on the rigidity of girders supporting continuous stiffeners, taken as 29 unless better support conditions are demonstrated} \]

\[ = 38 \text{ when continuous stiffener may be considered as rigidly supported at each girder.} \]

Between specified values of \(a/l\) the \(m\) value may be varied linearly. The \(m\) value may also be obtained from Fig. 3.

\[ \sigma = \begin{cases} 160 \, f_1 \, N/mm^2 \quad \text{(maximum) in general for seagoing conditions} \\ 180 \, f_1 \, N/mm^2 \quad \text{(maximum) in general for harbour conditions} \end{cases} \]

\[ = \text{as given in Table C2, but not exceeding the general maximum values, for longitudinals within 0.4 L amidships.} \]

For longitudinals between 0.4 L amidships and 0.1 L from the perpendiculars \(\sigma\) is to be varied linearly.

For longitudinals in ‘tweendecks \(\sigma\) may be found by interpolation as given for plating in 301.

<table>
<thead>
<tr>
<th>Condition</th>
<th>(\sigma) in N/mm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seagoing</td>
<td>(225f_1 - 130f_2 \frac{Z_n - Z_a}{Z_n})</td>
</tr>
<tr>
<td>Harbour</td>
<td>(225f_1 - 85f_2 \frac{Z_n - Z_a}{Z_n})</td>
</tr>
</tbody>
</table>

402 If 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

\[ P_V = Q_W (9.81 + 0.5 a_v) \quad (\text{kN}) \]

\[ a_v = \text{vertical acceleration as given in 201} \]

\[ Q_W = \text{load on wheel group or single wheel in t.} \]

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 be exceed 100 N/mm² in the members to be joined and 115 N/mm² 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 solid bulk cargoes. Relevant requirements for general cargo ships given in Sec. 4 are also to be complied with.

102 The mandatory ship type notation Bulk Carrier is to be assigned to ships with the following characteristics:

Sea-going single deck ships with cargo holds of single and or double side skin construction, with a double bottom, hopper side tanks and top-wing tanks fitted below the upper deck, and intended for the carriage of solid bulk cargoes.

For cargo holds of double side skin construction, the breadth of the double side measured perpendicular to the shell at any location within the length of the hold is not to be less than 1000 mm. Ships where all cargo holds are of double side skin construction are denoted as double side skin bulk carriers. Typical cargo hold cross-sections are given in Fig. 1.

103 The mandatory notation ESP ES( ) is to be assigned to ships built in compliance with the requirements in this section and the additional requirements given in Sec. 8 as specified in Table A1.

The notation may be given to vessels built in compliance with the requirements in this section and the additional requirements given in Sec. 8 as specified in Table A1, with structural arrangement different from that defined in 102.

104 One of the notations BC-A, BC-B or BC-C is mandatory for bulk carriers as defined in UR Z11.2.2, having length L ≥ 150 m and contracted for new construction on or after 1 July 2003. L = ship length as given by Pt. 3 Ch. 1 Sec. 1 B101. (IACS UR S25.2)

105 One of the notations BC-A, BC-B or BC-C is mandatory for all bulk carriers not defined in 104, and General Cargo Carriers intended for carrying solid bulk cargoes.

The notation BC-B* may be assigned to Double Hull Bulk Carriers or General Cargo Carriers, intended for carrying solid bulk cargoes.

106 The loading conditions listed in 107 to 110 and 112 to 113 are to be used for the checking of Rules criteria regarding longitudinal strength, as required by Sec. 8 C and Pt. 3 Ch. 1 Sec. 5, local strength, capacity and disposition of ballast tanks and stability. (IACS UR S25.2.2)

107 The notation BC-C implies that the vessel is designed to carry solid bulk cargoes of cargo density less than 1.0 t/m³.

A homogenous cargo loaded condition where the cargo density...
specified empty holds shall have the additional notation:

**In addition to** design loading conditions required for notation **BC-C** (ref. 107), a homogeneous cargo loaded condition with cargo density 3.0 t/m³ and the same filling rate (cargo mass / holds cubic capacity) in all cargo holds at maximum draught with all ballast tanks empty, is required. In cases where the cargo density applied is less than 3.0 t/m³, the max. density of the cargo that the vessel is allowed to carry shall be indicated with the additional notation: **Maximum Cargo Density x.y t/m³**.

(IACS UR S25.4.2).

**109** The notation **BC-A** implies that the vessel is designed to carry solid bulk cargoes of any density, with specified holds empty at maximum draught. **In addition to** design loading conditions required for **BC-B** (ref. 108), at least one cargo loaded condition with specified holds empty with cargo density 3.0 t/m³, and the same filling rate (cargo mass / holds cubic capacity) in all loaded holds at maximum draught with all ballast tanks empty, is required.

The combination of specified empty holds shall be indicated with the additional notation:

**Holds a, b,...may be empty.**

Vessels which are designed with more than one combination of specified empty holds shall have the additional notation: **Holds a, b,...OR c, d,...may be empty.**

In cases where the cargo density applied is less than 3.0 t/m³, the maximum density of the cargo that the vessel is allowed to carry shall be indicated with the additional notation: **Maximum Cargo Density x.y t/m³**.

(IACS UR S25.4.3).

**110** The notation **BC-B** implies that the vessel is designed to carry solid bulk cargoes of any density with any hold empty at maximum draught. This requirement is in addition to design loading conditions required for **BC-B** (ref. 108).

**111** The additional notation **No MP** shall be assigned to vessels, which have not been designed for loading and unloading in multiple ports in accordance with 117. I.e. the vessel is not designed to carry maximum allowable cargo hold design mass at reduced draughts. (IACS UR S25.3.i.)

**112** The vessel is to have a normal ballast (no cargo) condition where:

- the ballast tanks may be full, partially full or empty. Where partially full option is exercised, the conditions in Pt.3 Ch.1 Sec.5 F201 are to be complied with
- any cargo hold or holds adapted for the carriage of water ballast at sea are to be empty
- the propeller is to be fully immersed
- the trim is to be by the stern and is not to exceed 0.015L
- the structures of bottom forward are to be strengthened in accordance with Pt.3 Ch.1 Sec.6 against slamming for the condition listed above at the lightest forward draught.
- the longitudinal strength requirements are to be met for the conditions listed above.
- the longitudinal strength requirements are to be met with all ballast tanks 100% full.

(IACS UR S25.4.4.1a and 4.4.2a)

**113** The vessel is to have a heavy ballast (no cargo) condition where:

- the ballast tanks may be full, partially full or empty. Where partially full option is exercised, the conditions in the last paragraph of Pt.3 Ch.1 Sec.5 F201 are to be complied with.
- at least one cargo hold adapted for carriage of water ballast at sea, where required or provided, is to be 100% full.
- the propeller immersion I/D is to be at least 60%
- the trim is to be by the stern and not to exceed 0.015L
- the moulded forward draught in the heavy ballast condition is not to be less than the smaller of 0.03 L or 8 m
- the longitudinal strength requirements are to be met for the conditions above
- the longitudinal strength requirements are to be met under a condition with all ballast tanks 100% full and one cargo hold adapted and designated for the carriage of water ballast at sea, where provided, 100% full
- where more than one hold is adapted and designated for the carriage of water ballast at sea, it will not be required that two or more holds be assumed 100% full simultaneously in the longitudinal strength assessment, unless such conditions are expected in the heavy ballast condition. Unless each hold is individually investigated, the designated heavy ballast hold and any/all restrictions for the use of other ballast hold(s) are to be indicated in the loading manual.

I = distance from propeller centerline to the waterline
D = the propeller diameter

(IACS UR S25.4.4.1b and 4.4.2b)

**114** The loading conditions given in 107-110 and 112-113 are to be included in the loading manual and are to be separated into one departure and one arrival condition, where:

- departure condition: with bunker tanks not less than 95% full and other consumables 100%
- arrival condition: with 10% of consumables.

(IACS UR S25.4.5)

**115** The following design loading conditions apply for consideration of local strength as given in C, where:

- **M_H** = the actual cargo mass in a cargo hold corresponding to a homogeneously loaded condition at maximum draught
- **M_FULL** = the cargo mass in a cargo hold corresponding to cargo with virtual density (homogeneous mass/hold cubic capacity, minimum 1.0 t/m³) filled to the top of the hatch coaming, **M_FULL** shall not be less than **M_H**
- **M HD** = the maximum cargo mass allowed to be carried in a cargo hold according to design loading condition(s) with specified holds empty at maximum draught.

(IACS UR S25.5.1)

**116** General conditions, applicable for all bulk carriers:

- any cargo hold is to be capable of carrying **M FULL** with fuel oil tanks in double bottom, if any, 100% filled, and ballast water tanks in double bottom in way of cargo holds empty, at maximum draught
- any cargo hold is to be capable of carrying minimum 50% of **M_H** with all double bottom tanks in way of the cargo hold being empty, at maximum draught
- any cargo hold is to be capable of being empty, with all double bottom tanks in way of cargo hold being empty, at the deepest ballast draught.

(IACS UR S25.5.2)
117 Condition applicable for all notations, except when notation **No MP** is assigned:
- any cargo hold is to be capable carrying $M_{FULL}$ with fuel oil tanks in double bottom in way of the cargo hold, if any, being 100% full and ballast water tanks in the double bottom in way of the cargo hold being empty, at 67% of maximum draught
- any cargo hold is to be capable being empty with all double bottom tanks in way of the cargo hold being empty, at 83% of maximum draught
- any two adjacent cargo holds are to be capable of carrying $M_{FULL}$ with fuel oil tanks in double bottom in way of the cargo hold, if any, being 100% full and ballast water tanks in the double bottom in way of the cargo hold being empty, at 67% of maximum draught
- any two adjacent cargo holds are to be capable of being empty with all double bottom tanks in way of the cargo hold being empty, at 75% of maximum draught.

(IACS UR S25.5.3)

118 Additional conditions applicable for **BC-A** notation only:
- cargo holds, which are intended to be empty at maximum draught, are to be capable of being empty with all double bottom tanks in way of cargo hold also being empty
- cargo holds, which are intended to be loaded with high density cargo, are to be capable of carrying $M_{HD}$ plus 10% of $M_{H}$, with fuel oil tanks in double bottom, if any, 100% filled, and ballast water tanks in double bottom in way of cargo holds empty, at maximum draught.

In operation, the maximum allowable cargo mass shall be limited to $M_{HD}$.
- any two adjacent cargo holds which according to a design loading condition may be loaded with the next holds being empty, are to be capable of carrying 10% of $M_{H}$ in each hold in addition to the maximum cargo load according to that design loading condition, at maximum draught. Fuel oil tanks in double bottom, if any, are to be 100% filled, and ballast water tanks in double bottom in way of cargo holds are to be empty. In operation the maximum allowable mass shall be limited to the maximum cargo load according to the design condition.

(IACS UR S25.5.4)

119 Conditions applicable for notation **BC-B** only:
- any cargo hold is to be capable of carrying 1.2 $M_{FULL}$ with fuel oil tanks in double bottom in way of the cargo hold, if any, being 100% full and ballast water tanks in the double bottom being empty in way of the cargo hold, both at 67% of maximum draught
- any cargo hold is to be capable of being empty with all double bottom tanks in way of the cargo hold also being empty, at maximum draught
- any two adjacent cargo holds are to be capable of carrying 1.1 $M_{FULL}$ with fuel oil tanks in the double bottom in way of the cargo hold, if any being 100% full and ballast water tanks in the double bottom in way of the cargo hold being empty, at 67% of the maximum draught.
- any two adjacent cargo holds are to be capable of being empty, with all double bottom tanks in way of the cargo hold being empty, at 75% of maximum draught.

120 Additional conditions applicable during loading and unloading in harbour only:
- any single cargo hold is to be capable of holding the maximum allowable seagoing mass at 67% of maximum draught, in harbour condition
- any two adjacent cargo holds are to be capable of carrying $M_{FULL}$, with fuel oil tanks in the double bottom in way of the cargo hold, if any, being 100% full and ballast water tanks in the double bottom in way of the cargo hold being empty at 67% of maximum draught, in harbour condition
- at reduced draught during loading and unloading in harbour, the maximum allowable mass in a cargo hold may be increased by 15% of the maximum mass allowed at the maximum draught in sea-going condition, but shall not exceed the mass allowed at maximum draught in the sea-going condition. The minimum required mass may be reduced by the same amount.

(IACS UR S25.5.5)

121 Additional conditions applicable for ballast holds if any:
- Cargo holds, which are designed as ballast water holds, are to be capable of being 100% full of ballast water including hatchways, with all double bottom tanks in way of the cargo hold being 100% full, at any heavy ballast draught. For ballast holds adjacent to topside wing, hopper and double bottom tanks, it shall be strengthwise acceptable that the ballast holds are filled when the topside wing, hopper and double bottom tanks are empty.

(IACS UR S25.5.6)

122 The additional notation **NAUTICUS(Newbuilding)** is mandatory for bulk carriers with class notations and length as described below:
- **BC-B** or **BC-C** with length $L$ greater than 190 m.
- **BC-B** or **BC-A** 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.

123 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. 2.

The ships are to be built in accordance with the requirements in B and D and the additional requirements given in Sec.8 as specified in Table A2.
Ships built in compliance with the requirements in Ch.11 may be given the class notation DG-B.

A 200 Documentation

201 For ships with class notations BC-A, BC-B, BC-C, and BC-B*, the loading conditions (separated into one departure and one arrival condition, ref. A114) are to be submitted for approval. The associated longitudinal strength calculation(s) and possible special still water bending moment limit (hogging 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 \( M_{\text{FULL}} \) or \( M_{\text{HD}} \) in hold in t, design pressure load \( p \) for inner bottom in kN/m², or maximum cargo stowage rate \( \rho \) 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:

\[
\rho = \frac{p}{g_0 H} \quad (\text{t/m}^3)
\]

\( H \) = 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:

\[
\rho_c = \rho \tan^2 \left( \frac{45 - \delta}{2} \right) \quad (\text{t/m}^3)
\]

where

\( \delta \) = 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 Based on the design loading criteria for local strength as given in A115 - A120, on submitted information given in accordance with 200 and on the direct calculations as required in C400, hold mass curves are to be included in the loading manual and the loading instrument (see Pt.3 Ch.1 Sec.5).

The curves are to show:

- maximum allowable and minimum required mass as a function of draught, still water bending moment limit etc., in sea-going condition as well as during loading and unloading in harbour.

- hold mass curves for each single hold, as well as for any two adjacent holds, are to be included.

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”. (IACS UR S25.5.7)
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, \( M_H \) or \( M_{HD} \) (as defined in A115), according to the submitted loading conditions, see A200, for the hold considered, but is in any case not to be taken less than as given by:

\[
\frac{M_{FULL}}{V_H} = (t/m^3)
\]

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 \( \rho = 1.35 t/m^3 \)).

103 For the calculation of plates and stiffeners the cargo density of any hold is to be taken as:

For BC-A (ore hold):
\[
\rho = \frac{M_{HD} + 0.1 M_H}{V_H} (t/m^3)
\]

For BC-A (empty hold), BC-B and BC-C:
\[
\rho = \frac{M_{FULL}}{V_H} (t/m^3)
\]
\[
\rho = \min 1.0 t/m^3
\]

For BC-B*:
\[
\rho = \frac{1.2 M_{FULL}}{V_H} (t/m^3)
\]

104 For the direct calculation of girder structures, the design cargo density of any hold is to be taken as the greater of:

For BC-A (ore hold):
\[
\rho = \frac{M_{HD} + 0.1 M_H}{V} (t/m^3)
\]

For BC-A (empty hold), BC-B and BC-C:
\[
\rho = \frac{M_{FULL}}{V} (t/m^3)
\]

For BC-B*:
\[
\rho = \frac{1.2 M_{FULL}}{V} (t/m^3)
\]

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:

\[
t = 0.0036 f_i L_1^{1/3} \sqrt{B} \quad (mm)
\]

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 BC-A, the stress factor \( f_{2sp} \) (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 \( (\approx 0.5 \ M_{so}) \) 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 L₂ + tₖ (mm) 
= \frac{h}{g + tₖ}

h = profile height in mm

20 for flat bar profiles

L₂ = length of ship in metres, need not be taken greater than 200 m.

The thickness of inner bottom plating between hopper or side tanks in ships with class notation BC-A, BC-B, BC-C and BC-B* 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:

\[ t = 9.0 + \frac{0.03L₁}{\sqrt{f₁}} + tₖ \ (mm) \]

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 BC-A, BC-B, BC-C or BC-B* is not to be less than according to the requirements given in Pt.3 Ch.1 Sec.6 with:

\[ \sigma = 245 f₁ - 40 f₂BH - 0.7 \sigmaₘ h \text{ in empty holds} \]
\[ = 245 f₁ - 40 f₂BS - 0.7 \sigmaₘ s \text{ in ore loaded holds} \]
\[ = 160 f₁ \text{ maximum} \]

\[ f₁ = \text{material factor as given in Sec.1 B100 with respect to the bottom longitudinal} \]
\[ \sigma_{gb} = 190 f₁B, \text{ but need not be taken larger than} \]
\[ \sigma_{DB} + 130 f₂BH \]
\[ \sigma_{gs} = 190 f₁B, \text{ but need not be taken larger than} \]
\[ \sigma_{DB} + 130 f₂BS \]
\[ f₁B = \text{material factor f₁ as given in Sec.1 B100 with respect to the bottom platting} \]
\[ \sigma_{DB} = \text{longitudinal double bottom girder stress at middle of hold in N/mm² with respect to the bottom platting according to direct calculation as described in Classification Note No. 31.1} \]
\[ f₂BH = f₂B \text{ as given in Pt.3 Ch.1 Sec.6 A with respect to hogging still water bending moment (see also 302)} \]
\[ f₂BS = f₂B \text{ as given in Pt.3 Ch.1 Sec.6 A with respect to sagging still water bending moment (see also 302)} \]

306 The section modulus of inner bottom longitudinals in ships with class notation BC-A, BC-B, BC-C or BC-B* is for ore pressure loads not to be less than according to the requirement given in Pt.3 Ch.1 Sec.6 with:

\[ \sigma = 265 f₁ - 30 f₂BH - 0.7 \sigmaₘ \]
\[ = 160 f₁ \text{ maximum} \]

\[ f₁ = \text{material factor as given in Sec.1 B100 with respect to the inner bottom longitudinal} \]
\[ \sigmaₘ = 190 f₁B, \text{ but need not be taken larger than} \]
\[ \sigma_{DB} + 100 f₂BH \]
\[ f₁B = \text{material factor f₁ as given in Sec.1 B100 with respect to the inner bottom platting} \]
\[ \sigma_{DB} = \text{longitudinal double bottom girder stress at middle of hold in N/mm² with respect to the inner bottom platting according to direct calculation as described in Classification Note No. 31.1} \]
\[ f₂BH = \text{as given in 305}. \]

307 For vessels as mentioned in A122 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 A122 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 load cases are generally to be considered:

a) 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 condition(s) with untrimmed ore cargo filling the volume \( V_{HR} \) as given in B104 of the hold need be considered, see Fig.3. The mass and draught varies depending on the class notation. Details are stated in the Classification Note 31.1.

Fig. 3 Heavy cargo in hold

b) Heavy cargo filling the volume \( V_{HR} \) (as given in B104) of two adjacent holds, see A100, with respect to cross-deck and bulkhead shear strength, see Fig.4. The mass and draught varies depending on the class notation. Details are stated in the Classification Note 31.1.
c) Heavy cargo as given in A100 filling the entire cargo hold with respect to cargo bulkhead strength for lateral load. See Fig. 5. The mass and draught varies depending on the class notation. Details are stated in the Classification Note 31.1.

d) Ballast in ballast hold (with adjacent holds empty), with all double bottom tanks in way of cargo hold being 100% full, at ballast draught, \( T_{BH} \), and with respect to double bottom, transverse bulkhead and top wing tank/ship side strength. It shall also be strengthwise acceptable that ballast holds are filled when the topside wing, hopper and double bottom tanks are empty. For the top wing tank and side structures also the heeled condition is to be considered, see also Fig. 6.

e) Ballast in top wing tank with respect to top wing tank strength in the upright and heeled conditions, see Fig. 7.

f) 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. 8.

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

---e-n-d---of---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:

\[
t = 9.0 + \frac{k}{\sqrt{I_t}} + t_k \quad \text{(mm)}
\]

\[\quad k = 12 s = 0.03 L_t, \text{ whichever is the larger.}\]

D 300 Girder 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) Heavy ore cargo filling volume \( V_{HR} \) (as given in B104) of holds with other spaces empty at draught \( T \), see Fig.10.

b) Ore cargo filling hold completely with adjacent holds/spaces empty at draught \( T \), see Fig.11.

c) Ballast in ballast tanks with adjacent cargo holds empty at ballast draught \( T_B \), see Fig. 12.

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 \( L < 100 \text{ m} \).

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.
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. Longitudinal and Local Strength

B 100 Definitions

101 Symbols

\[ f_1 \quad \text{as given in Sec.1 B with respect to the considered member} \]
\[ \gamma^*_2 \quad \text{longitudinal stress parameter, applicable for transversely stiffened plates and longitudinal stiffeners of the hull cross-section, given by:} \]
\[ f^*_2 = \frac{5.7(M_1 + M_2)}{Z_B} \]

The value of \( \gamma^*_2 \) 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 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.

\[ f^*_2B = \gamma^*_2 f_2 \text{with respect to the hull girder section modulus at bottom} \]
\[ f^*_2D = \gamma^*_2 f_2 \text{with respect to the hull girder modulus at deck} \]
\[ k_f = \text{parameter for determination of allowable stresses for laterally loaded plates} = 3.5 (1 - f^*_2 / f_1). \text{The } k_f \text{ is, however, not to be taken larger than: } 5 x/l - 1 \]
\[ x = \text{distance in m from L/2 to considered position} \]
\[ = 0.2 L \text{ minimum} \]
\[ = 0.4 L \text{ maximum} \]
\[ k_lD = \text{minimum for } f^*_2D \]
\[ k_lB = \text{with respect to } f^*_2B \]
\[ Z_B = \text{section modulus at bottom or deck in cm}^3 \]
\[ M_S = \text{design still water bending moment at considered section in kNm. The } M_S \text{ is generally not to be taken less than } 0.5 k_{sm}M_{SO} \]
\[ k_{sm} \cdot M_{SO} = \text{as given in Pt.3 Ch.1 Sec.5 B100} \]
\[ M_{W} = \text{Rule wave bending moment at considered section in kNm given in Pt.3 Ch.1 Sec.5 B. Hoggarding or sagging moment is to be chosen in relation to the applied still water moment.} \]

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 \( \sigma_f = 175 f_1 \text{ (N/mm}^2) \).

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---
204 The combined normal stress of vertical and horizontal hull girder bending and of torsional moment is at any position not to exceed 195 \text{f}^*_{1} \text{N/mm}^2. The combined stress may be taken as:

\[ \sigma = |\sigma_{\text{STAT}} + \sigma_{\text{DYN}}| \quad (\text{N/mm}^2) \]

205 The curvatures of upper deck hatch corners are in general to be taken as given in Pt.3 Ch.1 Sec.5 E500 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.

206 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:

\[ a = 0.020B \sqrt{f_{1}} \quad (\text{m}) \]

\[ f_{1} = \text{as given in B for deck plating in area considered} \]

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.

207 For cross decks, the radius of rounded corners is generally not to be less than:

\[ r = k(w + 0.8) \sqrt{f_{1}} \quad (\text{m}) \]

\[ k = \text{0.16 for hatch corners at side} \]

\[ k = \text{0.10 for hatch corners for longitudinal deck girders} \]

\[ f_{1} = f_{1} \text{as given in B for deck plating in area considered} \]

\[ w = \text{width of cross deck in m.} \]

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.

208 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:

\[ \sigma = (175 + 40k_{p}) f_{1} - 110 f^*_{2B}, \text{maximum} \]

\[ (120 + 40k_{p}) f_{1} \text{ where transversely stiffened} \]

\[ (120 + 40k_{lB}) f_{1} \text{ where longitudinally stiffened} \]

C401:

\[ \sigma = (200 + 20k_{p}) f_{1} - 110 f^*_{2B}, \text{maximum} \]

\[ (140 + 20k_{p}) f_{1} \text{ where transversely stiffened} \]

\[ (140 + 20k_{lB}) f_{1} \text{ where longitudinally stiffened} \]

C501:

\[ \sigma = (190 + 30k_{p}) f_{1} - 120 f^*_{2B}, \text{maximum} \]

\[ (130 + 30k_{p}) f_{1} \text{ where transversely stiffened} \]

\[ (130 + 30k_{lB}) f_{1} \text{ where longitudinally stiffened} \]

\[ 160 f_{1} \text{ for floors} \]

C701:

\[ \sigma = \text{allowable stress, maximum 160} f_{1} \]

\[ = 225 f_{1} - 130 f^*_{2B} (z_{n} - z_{a})/v_{n} \text{ for single bottom longitudinals} \]

\[ = 225 f_{1} - 130 f^*_{2B} - 0.7 \sigma_{db} \text{ for double bottom longitudinals} \]

\[ = \text{as given in C307 (this chapter) for bottom longitudinals of double bottoms in cellular container holds} \]
C301:
\[ \sigma = \text{allowable stress, maximum } 160 \ f_1 \]
\[ = 225 \ f_1 - 100 \ t_{2B}^{*} - 0.7 \ \sigma_{db}, \text{with } \sigma_{db} = 20 \ f_1 \ \text{N/mm}^2 \text{ in general} \]

C901:
\[ \sigma = \text{allowable stress, maximum } 160 \ f_1 \]
\[ = 225 \ f_1 - 110 \ t_{2B}^{*} \text{ for longitudinal stiffeners} \]
\[ = 160 \ f_1 \text{ for transverse and stiffeners in general.} \]

303 Side longitudinals are to be designed as given in Pt.3 Ch.1 Sec.7 C301 with allowable stresses taken as follows:
\[ \sigma = 225 \ f_1 - 130 \ t_{2D}^{*} \left( \frac{z_a}{z_n} \right), \text{ maximum } 160 \ f_1, \]
\[ = 130 \ f_1, \text{ maximum for longitudinals supported by side verticals in single deck constructions.} \]

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:
\[ \sigma = \text{allowable stress} \]
\[ = (175 + 40 \ k_{1D}) f_1 - 120 \ t_{2D}^{*}, \text{ maximum} \]
\[ = (120 + 40 \ k_{1D}) f_1 \text{ where transversely stiffened} \]
\[ = (120 + 40 \ k_{1D}) f_1 \text{ where longitudinally stiffened} \]

C301:
\[ \sigma = \text{allowable stress} \]
\[ = 225 \ f_1 - 130 \ t_{2D}^{*}, \text{ maximum } 160 \ f_1 \text{ for strength deck and long superstructures and effective deck houses above strength deck} \]
\[ = 225 \ f_1 - 130 \ t_{2D}^{*} \left( \frac{z_a}{z_n} \right), \text{ maximum } 160 \ f_1 \text{ for continuous decks below strength deck} \]

In combination with heeled condition pressures \( p_9 \) 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:
\[ \sigma = 225 \ f_1 - 130 \ t_{2D}^{*} \left( \frac{z_a}{z_n} \right), \text{ maximum } 160 \ f_1 \]

For longitudinals, \( \sigma = 160 \ f_1 \) may be used in any case in combination with heeled condition pressures \( p_9 \) 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:
\[ \sigma = 190 \ f_1 - 130 \ t_{2D}^{*} \left( \frac{z_a}{z_n} \right), \text{ maximum } 160 \ f_1 \]

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 BC-A, or Bulk Carrier BC-A).

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 the half 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.6 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:
\[ t = 5.0 + \frac{k}{\sqrt{f_1}} + t_k \text{ (mm)} \]
\[ k = 0.01 \ L_1 \]

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 longitudinal 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:

$$\sigma = 245 f_1 - 40 f^*_{2BH} - 0.7 \sigma_g$$

$$f_1 = \text{material factor as given in Sec.1 B100 with respect to the bottom longitudinal}$$

$$\sigma_g = 190 f_{1B}, \text{but need not be taken larger than} \sigma_{DB} + 130 f^*_{2BH}$$

$$f_{1B} = \text{material factor f}_1 \text{as given in Sec.1 B100 with respect to the bottom plating}$$

$$\sigma_{DB} = \text{longitudinal double bottom stress with respect to the bottom plating in the middle of the minimum loaded hold for load case LC2 as given in 404}$$

$$f^*_{2BH} = f^*_{2B} \text{as given in B with respect to the hogging still water bending moment.}$$

**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:

$$\sigma_{DB} = 350 f_1 - 1.43 (\sigma + 130 f^*_{2BH}) \ (N/mm^2)$$

$$\sigma = \frac{837^2 spw_k}{Z}$$

$Z = \text{section modulus (cm}^3\text{)}\text{ of proposed bottom longitudinal}\ l, s, p, w_k = \text{as given in Pt.3 Ch.1 Sec.6}$

In addition it is assumed that the $\sigma_{DB}$ based on the direct calculation shall not exceed the following limit:

$$\sigma_{DB} = 190 f_1 - 130 f^*_{2BH} \ (N/mm^2)$$

---end of Guidance note---

For ships as mentioned in A105 fatigue strength assessment is in general to be carried out for end structures of longitudinal 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.

**G400 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 mesh finite element model of the entire ship hull length may be assumed. The fatigue evaluation of longitudinals required in 308. 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. The 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.

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 design load cases are in general to be considered, see also Fig. 3 and 4:

- **LC1:** Maximum mass of cargo (20 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 container cargo as relevant).

- **LC3:** Seagoing ballast 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 pillars 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.

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

---end---of---G-u-i-d-a-n-c-e---n-o-t-e---
**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:

\[
p = 10y \tan(\phi/2) - z_s \text{ (kN/m}^2\text{) on submerged side}
\]
\[
= 0.0 \text{ minimum}
\]
\[
p = z_e, \text{ but not less than} - 10y \tan(\phi/2) \text{ (kN/m}^2\text{) on emerged side}
\]
\[
z_s = 10(z - T_A), \text{ minimum} = 0.0
\]
\[
z_e = 10(z - T_A), \text{ maximum} = 0.0
\]
\[
y = \text{transverse distance in m from centre line}
\]
\[
\phi = \text{as given in Pt.3 Ch.1 Sec.4 B}
\]
\[
z = \text{vertical distance in m from base line to considered position}
\]

**408** The transverse acceleration is to be taken as:

\[
a_t = 0.5 a_t \text{ where:}
\]
\[
a_t = \text{dynamic transverse acceleration}
\]
\[
0.4a_y + g_x \sin \phi + a_{xy} \text{ (m/s}^2\text{)}
\]
\[
a_y, a_{xy} = \text{as given in Pt.3 Ch.1 Sec.4 with } R_R \text{ taken with a negative sign for positions below the centre of rolling. The centre of rolling is generally not to be taken at a higher level than the considered draught}
\]
\[
\phi = \text{as given in 407.}
\]
Fig. 3
Design load conditions
The longitudinal acceleration is to be taken as \(0.5 a_l\), where:

\[ a_l = 0.6 a_x + g_o \sin \theta + a_{px} \]

\(a_x, a_{px}, \theta = \) 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.

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.

The nominal dynamic normal stress, \(\sigma\), (of support bulkhead structures) is for load cases LC4 and LC5 generally not to exceed the limit:

\[ \sigma = 100 \text{ (N/mm}^2\text{)} \text{ in way of dry areas} \]
\[ \sigma = 85 \text{ (N/mm}^2\text{)} \text{ in way of coated ballast tanks.} \]

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:

\[ \tau = 60 f_1 \text{ (N/mm}^2\text{)}. \]
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:

$$\sigma = 130 f_{2BH}^* + \sigma_{DB}$$

$f_{2BH}^* = f_{2DB}^*$ as given in B with respect to the hogging still water bending moment

$$\sigma_{DB} = \text{longitudinal double bottom bending stress (with respect to the bottom flange) at mid-region of the considered hold with respect to load cases LC2 and LC3 as given in 404.}$$

414 For the upper cross deck structures the nominal bending stresses due to hull girder still water torsional deformation, $\sigma_{sc}$, (due to the torsional loading $M_{WT}$) are generally not to exceed the following limits:

$$\sigma_{sc} = 160 f_1 - 0.5 \sigma_{wc} \quad (\text{N/mm}^2)$$

$$\sigma_{sc} = 160 f_1 - \sigma_{gl} \quad (\text{N/mm}^2)$$

$\sigma_{wc} =$ bending stresses of cross decks induced by wave torsional deformation of deck structure according to torsional loading $M_{WT}$ as given in Pt.3 Ch.1 Sec.5 B

$\sigma_{gl} =$ bending stress in cross deck structure due to load case LC5 of 404.

Guidance note:
The stresses $\sigma_{sc}$ and $\sigma_{gl}$ 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:

$$\sigma = \sigma_l + \sigma_{at}$$

$\sigma_l = 130 f^*_{2DH}$ and $\sigma_{stat} + 0.5 \sigma_{dyn}$ whichever is the largest

$f^*_{2DH} = f^*_{2D}$ as given in B with respect to the hogging condition

$\sigma_{stat} =$ as given in B204 for the member considered

$\sigma_{gl} =$ 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 $\sigma_{at}$ 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

$\sigma_{gl} =$ 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 weld, 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.

![Graph](image)

**Fig. 5** Charpy V-notch, requirements for steel

**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, heat treated 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 each batch, 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, heat treated in the same furnace charge and with a total mass not exceeding 2 tonnes.

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. 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 tensional 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.

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- ly, 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 securings 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 containers 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 g (kN).

M = 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 shoring 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:

\[
a_t = \frac{9}{B^{0.25}} \text{ (m/s}^2)\]

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.

I 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 members are to be taken into account.

302 Nominal shear stresses in support fittings for containers and container lashings and other non-rigid container securing members are not to exceed:

\[
\sigma = 210 f_1 \text{ N/mm}^2.
\]

303 In structures also subjected to longitudinal stresses (e.g. deck longitudinals 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 cargo holds with non-weathertight arrangement of hatch covers in accordance with Pt.3 Ch.3 Sec.6 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 ICLL Reg. 33) as calculated in K103.

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

**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 level alarms**

**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.

**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.3 Sec.9 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.45-6 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.
- **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.

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:

— 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:

\[ p = (q_c + q_o) (9.81 + 0.5 a_v) \text{ (kN/m}^2) \]

\( q_c = \) specified distributed cargo load in t/m²
\( q_o = \) distributed mass of deck structure in t/m²
\( a_v = \) vertical acceleration as defined in Pt.3 Ch.1 Sec.4

\( c_c + q_o \) 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:

\[ m = \frac{8}{2 - a/l} \]

\( l = \) 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:

\[ Z = \frac{6.25 S^2 b p}{m f_1} \text{ (cm}^3) \]

\( S = \) girder span in m
\( b = \) breadth in m of area supported by the girder
\( m = 12 \) for girders fixed at both ends
\( = 8 \) for girders simply supported at both ends (pontoon edges).

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:

\[ A = \frac{0.065 S b p}{f_1} \text{ (cm}^2) \]

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: \( \sigma = 160 f_1 \text{ N/mm}^2 \)
— shear stress: \( \tau = 90 f_1 \text{ N/mm}^2 \).

304 Girders are to have a moment of inertia not less than:

\[ I = C_1 Z f_1 S \text{ (cm}^4) \]

\( C_1 = 1.1 \) for steel
\( C_1 = 3.0 \) for aluminium alloy
\( Z = \) section modulus of the girder in cm³
\( S = \) girder span in m

305 The critical buckling stress of plating acting as girder flange is not to be less than:
\[ \sigma_c = \frac{\sigma_a}{0.87} \text{ (N/mm}^2\text{)} \]

\( \sigma_a \) = calculated compressive design stress.

Tripping brackets and local stiffening of plating are to be provided where necessary.

**B 400** Securing points for lashing of cars

To be less than:

**304**

The weld connection between beams and top plating is not to be scalloped.

**306** The ship is to have stowing arrangement for all movable deck pontoons.

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):
  \[ \sigma = 110 f_1 \text{ N/mm}^2 \]

- shear stress:
  \[ \tau = 65 f_1 \text{ N/mm}^2 \]

- equivalent stress (equivalent to \( \sqrt{\sigma^2 + 3\tau^2} \)):
  \[ \sigma_e = 120 f_1 \text{ N/mm}^2 \]

**303** Due attention is to be given to the local stress concentrations.

**304** If slender supports are loaded in compression, it may be necessary to consider the allowable stress specially.

**305** For wire suspensions the minimum breaking load is not to be less than:

\[ P_m = 4 P_a \text{ (kN)} \]

\( P_a \) = 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 towlines and mooring lines.

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.
point considered, minimum B/4

\[ k_s = 2 + \frac{3.1}{\sqrt{C_B}} \text{ at A.P. and abaft} \]

\[ = 2 \text{ between 0.2 } L \text{ and 0.7 } L \text{ from A.P.} \]

\[ = 2 + \frac{4.7}{C_B} \text{ at F.P. and forward} \]

\[ C_w = \text{ wave coefficient as given in Pt.3 Ch.1 Sec.4.} \]

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 \( 5Q \text{ kN} \)
- vertical force not less than \( 13Q \text{ kN} \)
- longitudinal force not less than \( 2.5 \text{ kN} \).

\( Q \) = 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 \( 120 f_1 \text{ N/mm}^2 \).

402 Strength members subjected to buckling loads, are to have a safety factor against buckling not less than 1.7.
SECTION 8
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 A100.

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 A1 Class notations

<table>
<thead>
<tr>
<th>Ship Type</th>
<th>Subsection</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>Applicable class notation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double side skin bulk carrier or combination carrier</td>
<td>x</td>
<td>1)</td>
<td>-</td>
<td>-</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>ES(D, S18, S20)</td>
</tr>
</tbody>
</table>

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 C200.

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 A202, 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 Sec.5 A107 to 110 and A112 to 113 and 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.

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.

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). 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) may be considered as complying with requirements as given in 501.

B. Side Structure

B 100 Application

101 These requirements apply to side structure of cargo holds of single side construction.

B 200 Plating and stiffeners

201 Thickness and cross section properties are in general to be calculated as given in Pt.3 Ch.1 Sec.7.

202 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.
B 300 Main frames

301 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.

302 The section modulus requirement is given by:

\[ Z = \frac{1000f_{\text{p}w_k}}{m \sigma} \text{ (cm}^3\text{) } \]

Where:
- \( Z \) = section modulus
- \( f \) = point loads
- \( w_k \) = 1.05 when calculating sectional modulus for midspan and upper end
- \( w_k \) = 1.15 when calculating sectional modulus for lower end
- \( \sigma \) = 130 \( f_1 \) for internal loads \( p_1 \) to \( p_8 \)
- \( \sigma \) = 150 \( f_1 \) for external loads \( p_1 \) to \( p_8 \) and \( p_{\min} \) given above
- \( m \) = 12 in general
- \( m \) = 18 at upper end (including bracket) in combination with internal loads, \( p_3 \) to \( p_8 \)
- \( m \) = 9 at lower end (including bracket) and for upper end in combination with external loads \( p_1 \), \( p_2 \) and \( p_{\min} \).

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.

303 The minimum thickness of frame webs within the cargo area is not to be less than \( t_{w_{\min}} \) in mm, as given by:

\[ t_{w_{\min}} = 7.0 + 0.03 L \]

Where \( L \) is as defined in Pt.3 Ch.1, but need not be taken greater than 200 m.

304 The minimum thickness of frame webs in way of the foremost hold is not to be taken less than \( t_{w_{1_{\min}}} \) in mm, given by:

\[ t_{w_{1_{\min}}} = 1.15 t_{w_{\min}} \]

305 The web depth to thickness ratio of frames is not to exceed the following values:

\[ \frac{h}{t_w} \leq 60 \sqrt{f_1} \] for symmetrical flanged frame

\[ \frac{h}{t_w} \leq 50 \sqrt{f_1} \] for asymmetrical flanged frame

For outstanding flanges the flange breadth, \( b_c \), is not to exceed:
b_f \leq 10 \sqrt{\frac{1}{f_1 f_1}}

The face plate or flange of bracket is to be snipped at ends. Brackets are to be arranged with soft toes. To control the stress concentration at end of snipped flanges the total snipping angle, $\phi$, of the top flange or bracket stiffener is not to exceed:

\[ \phi < 35 \frac{t_w}{t_f} \] (degrees)

\[ \text{h} = \text{as defined in Fig. 1} \]
\[ f_1 = \text{as defined in Pt.3 Ch.1 Sec.2} \]
\[ t_w = \text{web thickness} \]
\[ t_f = \text{flange thickness}. \]

306 The thickness of the frame lower brackets is not to be less than the greater of $t_w$, $t_w_{\min}$ and $t_{w1_{\min}}$ as given in 303 and 304 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 $t_w$, $t_w_{\min}$ and $t_{w1_{\min}}$ as given in 303 and 304. The welded length of brackets, $l_b$, as shown in Fig. 1 is not to be less than:

\[ l_b = \frac{60 (t_w - t_{kw}) w_k}{\sin \alpha} \] (mm)

$Z$, $w_k$ as defined as in 302
\[ t_w \text{ as defined above and } \alpha \text{ as defined in Fig. 1} \]
\[ t_{kw} = 3 \text{ mm for the lower bracket and } 1 \text{ mm for upper bracket} \]

In no case are the dimensions of the lower and upper brackets to be less than those shown in Fig. 2.

307 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.

308 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 Prt.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 308, one enlarged supporting bracket may be arranged midway between frames and connected to the next longitudinal.

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309 Frames are to be fabricated symmetrical sections with integral upper and lower brackets and are to be arranged with soft toes. See also 311.

310 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:

\[ r = \frac{0.4 b_f^2}{t_f} \]

$b_f$ and $t_f$ are the flange width and thickness, respectively, in mm.

311 In ships less than 190 m in length, mild steel frames may be asymmetric and fitted with separate brackets.

312 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).

Fig. 4
Positioning of tripping brackets

313 Double continuous welding is to be adopted for the connections of frames and brackets to side shell, hopper and upper wing tank plating and web to face plates. For this purpose, the weld throat, a, is to be (see Fig. 1):

\[
a = 0.44 \, \text{t in Zone "a"}
\]

\[
a = 0.40 \, \text{t in Zone "b"}
\]

where t is the thinner of the two connected members and represent the as fitted thickness.

Where the hull form prohibits an effective fillet weld, edge preparation of the web of frame and bracket may be required, in order to ensure the same efficiency as the weld connection stated above. The weld throat thickness for the connecting bracket is to be according to Pt.3 Ch.1 Sec.12, using a C-factor of 0.52.

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 Flooded conditions

201 Each cargo hold except cargo holds of double side skin construction in accordance with Sec.5 A102 is to be considered individually flooded 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 300 Flooding criteria

301 To calculate the mass of water ingress, 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 400 Stress assessment

401 Bending stress assessment

The actual hull girder bending stress \( \sigma_{f ld} \), in N/mm², at any location is given by:

\[
\sigma_{f ld} = \frac{M_{sf} + 0.8M_{w}}{Z_{z}} \times 10^{3}
\]

\( M_{sf} \) = 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.

\( \sigma_{f ld} \leq 175 \, f_{l} \, \text{N/mm}^{2} \) 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 \( \tau_{f ld} \), in N/mm², at any location is given by:

\[
\tau_{f ld} = \frac{0.5(Q_{sf} + 0.8Q_{w}) + 0.5\Delta Q_{sf} S_{N}}{t} \times 10^{2}
\]

\( Q_{sf} \) = 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. \( \Delta Q_{sf} \) 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:

\[
P_{H} = M + V_{cargo} \text{ perm} \times 1.025 + (V_{dam} - V_{cargo}) \times 0.95 \cdot 1.025
\]

\( M \) = weight of cargo for hold in question (t)

\( \rho_{\text{perm}} \) = corresponding cargo density in (t/m³)

\( \text{perm} \) = permeability, as given in 301

\( V_{dam} \) = cargo hold volume below damaged waterline

\( V_{cargo} \) = \( M/\rho \), Maximum V_{dam}

\( \tau_{f ld} \leq 110 \, f_{l} \, \text{N/mm}^{2} \).

D. Corrugated Transverse Watertight Bulkheads, Considering Hold Flooding

D 100 Application and definition

101 These requirements apply to vertically corrugated transverse watertight bulkheads. These requirements are to be complied with respect to the flooding of any cargo hold except cargo holds of double side skin construction in accordance with Sec.5 A102.
The net thickness \( t_{\text{net}} \) 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 \( t_{\text{s}} \) given in 500, to the net thickness \( t_{\text{net}} \).

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/m\(^3\), 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 BC-A and BC-B*, 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.

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

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:

\[-D \quad \text{for the foremost transverse corrugated bulkhead} \]
\[-0.9 \, D \quad \text{for the other bulkheads}. \]

Where the ship is to carry cargoes having bulk density less than 1.78 t/m\(^3\) in non-homogeneous loading conditions, the following values can be assumed:

\[-0.95 \, D \quad \text{for the foremost transverse corrugated bulkhead} \]
\[-0.85 \, D \quad \text{for the other bulkheads}. \]

b) for ships less than 50 000 tonnes deadweight with Type B freeboard:

\[-0.95 \, D \quad \text{for the foremost transverse corrugated bulkhead} \]
\[-0.85 \, D \quad \text{for the other bulkheads}. \]

Where the ship is to carry cargoes having bulk density less than 1.78 t/m\(^3\) in non-homogeneous loading conditions, the following values can be assumed:

\[-0.9 \, D \quad \text{for the foremost transverse corrugated bulkhead} \]
\[-0.8 \, D \quad \text{for the other bulkheads}. \]

\( D \) is the distance, in m, from the baseline to the freeboard deck at side amidships (see Fig. 5).
Fig. 5
Definition of D, h₁ and d₁.

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:

$$p_c = \rho_c \cdot g \cdot h_1 \cdot K$$

- $\rho_c =$ bulk cargo density, in t/m³
- $g =$ 9.81 m/s², gravity acceleration
- $h_1 =$ 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 $d_1$, in m, from the baseline
- $K =$ $\sin^2 \alpha \tan^2 (\delta - 0.5 \delta) + \cos^2 \alpha$
- $\alpha =$ angle between panel in question and the horizontal plane, in degrees

$\delta =$ 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:

$$F_c = \frac{\rho_c \cdot g \cdot s_1 \cdot (d_1 - h_{DB} - h_{LS})^2}{2} \cdot K$$

- $\rho_c, g, d_1, K =$ as given above
- $s_1 =$ spacing of corrugations, in m (see Fig. 6)
- $h_{LS} =$ mean height of the lower stool, in m, from the inner bottom
- $h_{DB} =$ height of the double bottom, in m.

$V =$ Volume of cargo

$P =$ Calculation point
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/m$^2$, is given by:

$$p_{c,f} = \rho g h_f$$

where:

- $\rho$ = sea water density, in t/m$^3$
- $g$ = as given in 203
- $h_f$ = 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/m$^2$, is given by:

$$p_{c,f} = \rho g h_f + [ \rho_c - \rho (1 - \text{perm}) ] g h_1 K$$

where:

- $h_f$ = as given above
- $\rho_c$, $g$, $h_1$, $K$ = as given in 203

---

**Fig. 6**
Spacing of corrugations
perm = permeability of cargo, to be taken as 0.3 for ore (corresponding bulk cargo density for iron ore may generally be taken as 3.0 t/m³), 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:

$$\Phi_{c,f} = s_1 \left[ \rho \left( \frac{(d_f - d_1)^2}{2} \right) + \frac{p_c f (\rho_c g h_1 K + (p_c f) le)(d_f - h_{DB} - h_{LS})}{2} \right]$$

where:
- $\rho = \text{as given above}$
- $s_1, g, d_1, h_{DB}, h_{LS} = \text{as given in 203}$
- $d_f = \text{as given in 202}$
- $(p_c f) le = \text{pressure, in kN/m}^2, \text{at the lower end of the corrugation.}$

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:

$$p_{c,f} = \rho_c g h_1 K$$

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:

$$p_{c,f} = \rho g h_1 + [\rho_c h_1 - \rho (1 - \text{perm}) h_1] g K$$

The force $F_{c,f}$ in kN, acting on a corrugation is given by:

$$F_{c,f} = s_1 \left[ \rho \left( \frac{(d_f - d_1)^2}{2} \right) K + \frac{\rho g(d_f - d_1)K + (p_c f) le(d_f - h_{DB} - h_{LS})}{2} \right]$$

where:
- $s_1, \rho_c, g, d_1, h_{DB}, h_{LS}, K = \text{as given in 203}$
- $d_f = \text{as given in 202}$

### 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:

$$F_f = s_1 \rho g \left( \frac{(d_f - h_{DB} - h_{LS})^2}{2} \right)$$

where:
- $s_1, \rho, h_{DB}, h_{LS} = \text{as given in 203}$
- $\rho = \text{as given in 204 a)}$
- $d_f = \text{as given in 202}$

### 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:

$$M = \frac{F l}{8}$$

where:
- $F = \text{resultant force, in kN, as given in 205, 206 or 207 as relevant}$
- $l = \text{span of the corrugation, in m, to be taken according to Fig. 6 and Fig. 7.}$
Definition of \( l \)

The shear force \( Q \), in kN, at the lower end of the bulkhead corrugations is given by:

\[
Q = 0.8 \, F
\]

\( F \) = 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 in accordance with Fig.13. 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. Scallop 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, corrugated bulkhead plating is to be connected to the stool top plate by full penetration welds. The stool side plating is to be connected to the stool top plate and the inner bottom plating by either full penetration or deep penetration welds (See Fig.8). The su-
porting floors are to be connected to the inner bottom by either full penetration or deep penetration welds (see Fig.8).

(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 gussets 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 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 coamings and corrosion additions are to be in compliance with Pt.3 Ch.1 Sec.2 D. 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 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 coamings 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 coamings and corrosion additions are to be in compliance with Pt.3 Ch.1 Sec.2 D.

(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. Corrugated bulkhead plating is to be connected to the inner bottom plating by full penetration welds. The plating of supporting floors is to be connected to the inner bottom by either full penetration or deep penetration welds (see Fig.8).

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-outs for connections of the inner bottom longitudinals 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:

\[
10^3 \frac{M}{Z_{l e}} \sigma_{l e} + \frac{Z_{m}}{Z_g} \sigma_{m} \leq 0.95
\]

where:
- \( M \) is the bending moment, in kNm, as given in 208
- \( Z_{l e} \) is the section modulus, in cm\(^3\), at the lower end of corrugations
- \( Z_m \) is the section modulus, in cm\(^3\), at the midspan of corrugations
- \( \sigma_{l e} \) is the allowable stress, in N/mm\(^2\), as given in 305, for the lower end of corrugations
- \( \sigma_{m} \) is the allowable stress, in N/mm\(^2\), as given in 305

In no case is \( Z_m \) to be taken greater than the lesser of 1.15 \( Z_{l e} \) and 1.15 \( Z_{l e} \), for calculation of the bending capacity, \( Z_{l e} \) 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 \( Z_{g} \), in cm\(^3\), is to be taken not larger than the value \( Z_{l e} \), in cm\(^3\), given by:

\[
Z_{l e} = Z_g + 10^3 \frac{Q_{h_g} - 0.5 h_g^2 s_{1p_g}}{\sigma_{s}}
\]

where:
- \( Q \) is the shear force, in kN, as given in 209
- \( h_g \) is the height, in m, of shedders or gusset plates, as applicable

Fig. 8
Full penetration or deep penetration welds

Root Face (f) : 3 mm to 7/3 mm
Groove Angle (\( \alpha \)) : 40° to 60°
(see Fig. 9, Fig. 10, Fig. 11 and Fig. 12)

\[ s_1 = \text{as given in 203} \]

\[ P_g = \text{resultant pressure, in kN/m}^2, \text{as defined in 206 or 207} \]

\[ \sigma_a = \text{allowable stress, in N/mm}^2, \text{as given in 305}. \]

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. 9 and Fig. 10), when calculating the section modulus of corrugations at the lower end (cross-section (1) in Fig. 9 and Fig. 10), the area of flange plates, in \( \text{cm}^2 \), may be increased by \( (2.5 a \sqrt{t_{sh} t_f}) \) (not to be taken greater than 2.5 \( a \phi \)) where:

\[ a = \text{width, in m, of the corrugation flange (see Fig.6)} \]

\[ t_{sh} = \text{net shedder plate thickness, in mm} \]

\[ t_f = \text{net flange thickness, in mm}. \]

b) Provided that effective gusset plates, as defined in 302, are fitted (see Fig. 11 and Fig. 12) when calculating the section modulus of corrugations at the lower end (cross-section (1) in Fig. 11 and Fig. 12), the area of flange plates, in \( \text{cm}^2 \), may be increased by \( (7 h_g t_f) \) where:

\[ h_g = \text{height of gusset plate in m, see Fig.11 and Fig.12, not to be taken greater than:} \]

\[ \left( \frac{10}{7} s_{gu} \right) \]

\[ s_{gu} = \text{width of the gusset plates, in m} \]

\[ t_f = \text{net flange thickness, in mm, based on the as built condition}. \]

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 \( \sigma \) and \( \tau \), are not to exceed the allowable values \( \sigma_a \) and \( \tau_a \), in N/mm\(^2\), given by:

\[ \sigma_a = \sigma_F \]

\[ \tau_a = 0.5 \sigma_F \]

\( \sigma_F \) being the minimum upper yield stress, in N/mm\(^2\), of the material.
Fig. 11
Symmetric gusset/shedder plates

Fig. 12
Asymmetric gusset/shedder plates

Fig. 13
Permitted distance, d, from edge of stool top plate to surface of corrugation flange

**306 Effective width of compression flange of corrugations**

The effective width $b_{ef}$, in m, of the corrugation flange is given by:

$$b_{ef} = C_e a$$

where:

- $C_e = \frac{2.25}{\beta} - \frac{1.25}{\beta^2}$ for $\beta > 1.25$
- $C_e = 1.0$ for $\beta \leq 1.25$
- $\beta = \frac{10^3 a}{t_f \sqrt{\sigma_F E}}$
- $t_f$ = net flange thickness, in mm
- $a$ = width, in m, of the corrugation flange (see Fig.6)
- $\sigma_F$ = minimum upper yield stress, in N/mm$^2$, of the material
- $E$ = modulus of elasticity of the material, in N/mm$^2$, to be assumed equal to 2.06·10$^5$ 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/mm\(^2\), as given in Pt.3 Ch.1 Sec.14, assuming a buckling factor \( k_t = 6.34 \) 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/m\(^2\), 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 shadders, if shadder or gusset/shedder plates are fitted

\( \sigma_F \) = minimum upper yield stress, in N/mm\(^2\) 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

\[
t_w = \frac{440 s_w^2}{\sigma_F^{n^2}} + t_{ap}^2
\]

where \( t_{ap} \) ≤ 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**

**401** 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 shadder 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 except of cargo holds of double side skin construction in accordance with Sec.5 A102.

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 no 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.
**Definition of flooding head and D**

202 *Inner bottom flooding head*

The flooding head $h_f$ (see Fig.14) 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 $d_f$, in m, from the baseline equal to:

a) in general:

- $D$ for the foremost hold
- $0.9 \times D$ for the other holds

b) for ships less than 50,000 tonnes deadweight with Type B freeboard:

- $0.95 \times D$ for the foremost hold
- $0.85 \times D$ for the other holds.

$D$ is the distance, in m, from the baseline to the freeboard deck at side amidships (see Fig.14).

**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.15)
- 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 inadequate, 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 $t_{net}$, in mm, is given by:

$$t_{net} = t - 2.5$$

$t$ = thickness, in mm, of floors and girders.
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

$$\tau_a = \frac{162 \sigma_F^{0.6}}{(s/\eta_{net})^{0.8}} \text{ and } \frac{\sigma_F}{\sqrt{3}}$$

For floors adjacent to the stools or transverse bulkheads, as identified in 301, $\tau_a$ may be taken as:

$$\sigma_F \frac{\eta_1}{s}$$

$\sigma_F$ = minimum upper yield stress, in N/mm$^2$, of the material
$s$ = spacing of stiffening members, in mm, of panel under consideration
$\eta_1$ = 1.10

$\eta_2$ = 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
$\eta_2$ = 1.15
$\eta_2$ may be reduced down to 1.10 when appropriate reinforcements 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 V F

F = 1.1 in general
   = 1.05 for steel mill products
\rho_c = bulk cargo density, in t/m³ (see 201). For steel products, \rho_c is to be taken as the density of steel
V = volume, in m³, occupied by cargo at a level h₁

h₁ = X / \rho_{cg}
X = for bulk cargoes, the lesser of X₁ and X₂ given by:

X₁ = \frac{Z + \rho g (E - h₁)}{1 + \frac{\rho}{\rho_c} (\text{perm} - 1)}
X₂ = Z + \rho g (E - h₁ \text{ perm})

\rho = sea water density, in t/m³
\rho g = 9.81 m/s², gravity acceleration
E = ship immersion in m for flooded hold condition
= d_f - 0.1 D
\rho / g = as given in 202
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 Z₁ and Z₂ given by:

Z₁ = \frac{C_h}{A_{DB, h}}
Z₂ = \frac{C_e}{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 S₁ and S₂ (see 302) and, for each girder, the lesser of the shear strengths S₁ and S₂ (see 303)
C_e = shear capacity of double bottom, in kN, as defined in 301, considering, for each floor, the shear strength S₁ (see 302) and, for each girder, the lesser of the shear strengths S₁ and S₂ (see 303)

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)

B_{DB, h} = distance, in m, between the two considered openings (see Fig.16)
s_i = spacing, in m, of double bottom longitudinals adjacent to hoppers

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

The net thickness, t_{net}, is the thickness necessary to obtain the below net minimum scantlings.
The required thickness is obtained by adding the corrosion addition t_{cor}, given in 500 to the net thickness t_{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.3 Sec.6.

F 200 Load model

The pressure p, in kN/m², to be considered as acting on the hatch covers is given by:

p = 19.6 \sqrt{H}

H = l \left( 14 A_i \frac{V L}{C_B} - d_f \right)
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_f = vertical distance, in m, from the summer load line
draught to the top of the hatch coaming.

<table>
<thead>
<tr>
<th>Table F1 Values of A_i</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance from the FP</td>
</tr>
<tr>
<td>FP</td>
</tr>
<tr>
<td>0.05 L</td>
</tr>
<tr>
<td>0.10 L</td>
</tr>
<tr>
<td>0.15 L</td>
</tr>
<tr>
<td>0.20 L</td>
</tr>
<tr>
<td>0.25 L</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 $\sigma_a$ and $\tau_a$, in N/mm$^2$, given by:

$$\sigma_a = 0.80 \sigma_F$$
$$\tau_a = 0.45 \sigma_F,$$

$\sigma_F$ being the minimum upper yield stress, in N/mm$^2$, 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.3 Sec.6 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 $b_{ef,l}$, in m, of the compression panel is given by:

$$b_{ef,l} = C_{e,l} s$$

$$\frac{C_{e,l}}{\beta} = \frac{1.80}{\beta} - \frac{0.80}{\beta^2} \quad \text{for } \beta > 1.0$$

$$C_{e,l} = 1.0 \quad \text{for } \beta \leq 1.0$$

$$\beta = \frac{10^{3.5} s}{t \sqrt{E}}$$

$b =$ net thickness of plate panel, in mm
$s =$ shorter edge of plate panel, in m
$\sigma_F =$ minimum upper yield stress, in N/mm$^2$, of the material
$E =$ modulus of elasticity of the material, in N/mm$^2$, to be assumed equal to 2.06 $\cdot 10^5$ for steel.

(b) **Effective width for primary member at right angle to stiffening direction**

The effective width $b_{ef,t}$, in m, of the compression panel, is given by:

$$b_{ef,t} = C_{e,t} l$$

$$C_{e,t} = C_{e,l}^s + 0.115 \left( \frac{1 - s}{l} \right) \left( 1 + \frac{1}{\beta} \right)^2 \leq 1.0$$

$l, s =$ longer and shorter edges of the panel, in m, respectively
$C_{e,l, \beta} =$ as given in (a) above.

**303 Local net plate thickness**

The local net plate thickness $t$, in mm, of the hatch cover plating is given by:

$$t = S_t 14.9 s \sqrt{\frac{p}{\sigma_F}}$$

$S_t =$ safety factor, to be taken equal to 1.20
$s =$ stiffener spacing, in m
$p =$ pressure, in kN/m$^2$, as defined in 201
$\sigma_F =$ minimum upper yield stress, in N/mm$^2$, 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.3 Sec.6.**

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 9
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 \( \sigma_{db} = 20 f_1 \text{ N/mm}^2 \). 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).