

**PART II RULES FOR THE CONSTRUCTION
AND CLASSIFICATION OF SHIPS
IDENTIFIED BY THEIR MISSION**

TITLE 15 ROLL ON - ROLL OFF CARGO SHIPS

SECTION 3 HULL EQUIPMENT

CHAPTERS

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CHAPTER A SCOPE

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A1. APPLICATION

A2. DEFINITIONS

A1. APPLICATION

100. Additional requirements for roll on / roll off vessels

101. In addition to the requirements of Part II, Title 11, Section 3, and those in the present Title, electrical installations in spaces intended for the carriage of motor vehicles with fuel in their tanks are to comply with those of Part II, Title 11, Section 3, Chapter E, Subchapter E14.

102. Roll on – roll off vessels with notation to carry dangerous goods are to be in compliance with the requirements of Part II, Title 104, Section 7.

A2. DEFINITIONS

100. Terms

101. In addition to the terms set out in Part II, Title 11, Section 3 here are used:

101. **Lashing** - acts and devices used for securing vehicles in the position in which they are stowed on board.

102. **Vehicle ramp** – a ramp for the embarkation / disembarkation of vehicles.

103. **Securing device** - a device used to keep the door closed by preventing it from rotating about its hinges.

104. **Supporting device** - a device used to transmit external or internal loads from the door to a securing device and from the securing device to the ship's structure, or a device other than a securing device, such as a hinge, stopper or other fixed device, that transmits loads from the door to the ship's structure.

105. **Locking device** - a device that locks a securing device in the closed position.

106. **Roll on / roll off passenger ship** - a passenger ship with Roll on / roll off spaces or special category spaces.

107. **Roll on / roll off spaces** - are spaces not normally sub-divided in any way and normally extending to either a substantial length or the entire length of the ship, in which motor vehicles with fuel in their tanks for their own propulsion and/or goods (packaged or in bulk, in or on rail or road cars, vehicles (including road or rail tankers), trailers, con-

tainers, pallets, demountable tanks or in or on similar stowage units or, other receptacles) can be loaded and unloaded normally in a horizontal direction.

108. **Special category spaces** - are those enclosed vehicle spaces above or below the bulkhead deck, into and from which vehicles can be driven and to which passengers have access. Special category spaces may be accommodated on more than one deck provided that the total overall clear height for vehicles does not exceed 10m.

CHAPTER B DOCUMENTS, REGULATIONS AND STANDARDS

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B1. DOCUMENTATION TO RBNA

B2. REGULATIONS

B3. STANDARDS - See Part II, Title 11, Section 3

B1. DOCUMENTATION TO RBNA

100. Cargo or service handling system

101. The following additional documentation shall be submitted to RBNA for approval:

a. Structure of the external and internal vehicle ramps and bow, side and stern doors including:

a.1. Locking devices

a.2. Securing devices

a.3. Supporting devices

a.4. Lifting devices

102. Drawings and specifications of lifting appliances for cargo and containers, including load diagram of the lifting and supporting devices and the loads transmitted to the ship's structure.

103. Movable vehicle ramps, if fitted, with means of stowage and securing.

B2. REGULATIONS

100. Regulations and standards

101. **National regulations:** the requirements of NORMAM 01 for Brazilian Flag vessels and National Admin-

istration requirements for foreign flag vessels are to be complied with for ships with GT < 500;

102. **International regulations:** IMO Conventions and Resolutions are to be complied with for ships with GT ≥ 500.

103. **Dangerous Goods:** Roll on/Roll off vessels where the carriage of dangerous goods is allowed are to comply with the requirements of Part II, title 104.

CHAPTER D REQUIREMENTS FOR SYSTEMS

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D1. CARGO OR SERVICE HANDLING GEAR

D2. ANCHORING, MOORING AND TOWING
- See Part II, Title 11, Section 3

D3. MANOEUVERING SYSTEM
- See Part II, Title 11, Section 3

D4. LIFE SAVING APPLIANCES (LSA)
- See Part II, Title 11, Section 3

D5. FIRE FIGHTING EQUIPMENT
- See Part II, Title 11, Section 3

D6. BOW DOORS AND INNER DOORS

D7. SIDE SHELL DOORS AND STERN DOORS

D1. CARGO OR SERVICE HANDLING GEAR

100. Embarkation/disembarkation ramp

101. The vehicle ramp is calculated as a set of beams supported at the shore ends and pins connected to the hull with the wheeled load in the middle of the span.

102. The wheeled load configuration is given below in Part II, Title 15, Section 2 Chapter E, E3.101, applied to the vehicle ramp according to the length of the ramp and of the vehicle.

103. The loads on the structure of the vehicle ramp are the static loads as per Part II, Title 15, Section 2, Chapter F.

104. The locking and securing devices are to be in compliance with Chapter D, subchapter D6 below.

105. The supporting device and accessories for the vehicle ramp and/or the doors of the plank is calculated according to

the RBNA Guide for Lifting Appliances taking into account the vehicle ramp / movable deck own empty weight.

106. The structure of the hull is to be locally reinforced to receive loads transmitted by the supporting device.

D6. BOW DOORS AND INNER DOORS [IACS UR S8]

100. General

101. Application:

a. These requirements are for the arrangement, strength and securing of bow doors and inner doors leading to a complete or long forward enclosed superstructures, or to a long non-enclosed superstructure, where fitted to attain minimum bow height equivalence. The requirements apply to:

a.1. all Roll on / roll off passenger ships engaged on international voyages, covered by Part II, Titles 22 and 26;

a.2. and Roll on / roll off cargo ships engaged on international voyages covered by the present Title 15;

a.3. and also to Roll on / roll off passenger ships and Roll on / roll off cargo ships engaged only in domestic (non-international) voyages covered by Titles 15, 22 and 26, except where specifically indicated otherwise herein;

a.4. The requirements are not applicable to high speed, light displacement craft as defined in the IMO Code of Safety for High Speed Craft.

b. Two types of bow door are provided for:

b.1 **Visor doors** opened by rotating upwards and outwards about a horizontal axis through two or more hinges located near the top of the door and connected to the primary structure of the door by longitudinally arranged lifting arms,

b.2 **Side-opening doors** opened either by rotating outwards about a vertical axis through two or more hinges located near the outboard edges or by horizontal translation by means of linking arms arranged with pivoted attachments to the door and the ship. It is anticipated that side-opening bow doors are arranged in pairs. Other types of bow door will be specially considered in association with the applicable requirements of these rules.

102. Arrangement

- a. 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 arrangement of ramps or other related mechanical devices may be regarded as a part of the freeboard deck for the purpose of this requirement.

Guidance:

This subchapter D6 should be uniformly applied to new ships as soon as possible but not later than 1 June 2012 and, with immediate effect, when approving plans for bow arrangements on new ships. The requirements as set out in this sub chapter D6 must be complied in full. The inner door needs not be fitted directly above the bulkhead below, provided it is located within the limits specified for the position of the collision bulkhead, refer to regulation II-1/12 of the SOLAS Convention. A vehicle ramp may be arranged for this purpose, provided its position complies with regulation II-1/12 of the SOLAS Convention. If this is not possible a separate inner weathertight door is to be installed, as far as practicable within the limits specified for the position of the collision bulkhead.

End of guidance

- b. An inner door is to be fitted. The inner door is to be part of the collision bulkhead. The inner door needs not be fitted directly above the bulkhead below, provided it is located within the limits specified for the position of the collision bulkhead, refer to regulation II-1/12 of the SOLAS Convention. A vehicle ramp may be arranged for this purpose, provided its position complies with regulation II-1/12 of the SOLAS Convention. If this is not possible a separate inner weathertight door is to be installed, as far as practicable within the limits specified for the position of the collision bulkhead.
- c. Bow 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 arranged with fixed sealing supports on the aft side of the doors.
- d. Bow doors and inner doors are to be arranged so as to preclude the possibility of the bow door causing structural damage to the inner door or to the collision bulkhead in the case of damage to or detachment of the bow door. If this is not possible, a separate inner weathertight door is to be installed, as indicated in D6.102b above.
- e. The requirements for inner doors are based on the assumption that vehicle are effectively lashed and secured against movement in stowed position.

200. Strength Criteria

201. Primary structure and Securing and Supporting devices

- a. Scantlings of the primary members, securing and supporting devices of bow doors and inner doors are to be determined to withstand the design loads defined in D6.300 below, using the following permissible stresses:

$$\text{sheer stress: } \tau = \frac{80}{k} \text{ N/mm}^2$$

$$\text{bending stress: } \sigma = \frac{120}{k} \text{ N/mm}^2$$

$$\text{equivalent stress: } \sigma_c = \sqrt{\sigma^2 + 3\tau^2} = \frac{150}{k}$$

where

k is the material factor as given below but is not to be taken less than 0.72 unless a direct fatigue analysis is carried out:

$$k = 0.78 \text{ for steel with } Y = 315 \text{ N/mm}^2$$

$$k = 0.72 \text{ for steel with } Y = 355 \text{ N/mm}^2$$

$$k = 0.68 \text{ for steel with } Y = 390 \text{ N/mm}^2$$

provided that the moment of inertia of the midship section is not less than:

$$I_{\min} = 3 W_{\min} L \text{ (cm}^4\text{)}$$

Y = minimum yield stress

L = Rule length of ship (m)

W_{\min} = minimum mild steel section modulus (cm²) as given for a new ship in Part II, Title 11, Section 2, Chapter H, Subchapter H3. Any reduction for corrosion control is not to be taken account of.

- b. The buckling strength of primary members is to be verified as being adequate.
- c. For steel to steel bearings in securing and supporting devices, the nominal bearing pressure calculated by dividing the design force by the projected bearing area is not to exceed 0.8σF, where σF is the yield stress of the bearing material. For other bearing materials, the permissible bearing pressure is to be determined according to the manufacturer's specification.
- d. The arrangement of securing and supporting devices is to be such that threaded bolts do not carry support forces. The maximum tension in way of threads of bolts not carrying support forces is not to exceed:

$$\frac{125}{k} \text{ N/mm}^2$$

300. Design loads

301. Bow doors

- a. The design external pressure, in kN/m^2 , to be considered for the scantlings of primary members, securing and supporting devices of bow doors is not to be less than the pressure normally used by the Society nor than:

$$P_e = 2.75\lambda C_H(0.22 + 0.15\tan\alpha)(0.4\sin\beta + 0.6L^{0.5})^2$$

where:

V contractual ship's speed, in knots,

L ship's length, in m, but need not be taken greater than 200 metres,

λ coefficient depending on the area where the ship is intended to be operated:

$\lambda = 1$ for seagoing ships,

$\lambda = 0.8$ for ships operated in coastal waters,

$\lambda = 0.5$ for ships operated in sheltered waters,

Note: Coastal waters and sheltered waters are defined according to the practice of each Classification Society. As an example, coastal waters may be defined as areas where significant wave heights do not exceed 4m for more than three hours a year and sheltered waters as areas where significant wave heights do not exceed 2m for more than three hours a year.

$$C_H = 0.0125 L \quad \text{for } L < 80\text{m}$$

$$C_H = 1 \quad \text{for } L \geq 80\text{m}$$

α - flare angle at the point to be considered, defined as the angle between a vertical line and the tangent to the side shell plating, measured in a vertical plane normal to the horizontal tangent to the shell plating,

β - entry angle at the point to be considered, defined as the angle between a longitudinal line parallel to the centreline and the tangent to the shell plating in a horizontal plane.

- b. The design external forces, in kN, considered for the scantlings of securing and supporting devices of bow doors are not to be less than:

$$F_x = P_e A_x$$

$$F_y = P_e A_y$$

$$F_z = P_e A_z$$

where:

A_x =- area, in m^2 , of the transverse vertical projection of the door between the levels of the bottom of the door and the top of the upper deck bulwark, or

between the bottom of the door and the top of the door, including the bulwark, where it is part 15 degrees less than the flare angle of the adjacent shell plating, the height from the bottom of the door may be measured to the upper deck or to the top of the door, whichever is lesser. In determining the height from the bottom of the door to the upper deck or to the top of the door, the bulwark is to be excluded.

A_y = area, in m^2 , of the longitudinal vertical projection of the door between the levels of the bottom of the door and the top of the upper deck bulwark, or between the bottom of the door and the top of the door, including the bulwark, where it is part of the door, whichever is lesser. Where the flare angle of the bulwark is at least 15 degrees less than the flare angle of the adjacent shell plating, the height from the bottom of the door may be measured to the upper deck or to the top of the door, whichever is lesser.

A_z = area, in m^2 , of the horizontal projection of the door between the bottom of the door and the top of the upper deck bulwark, or between the bottom of the door and the top of the door, including the bulwark, where it is part of the door, whichever is the lesser. Where the flare angle of the bulwark is at least 15 degrees less than the flare angle of the adjacent shell plating, the height from the bottom of the door may be measured to the upper deck or to the top of the door, whichever is lesser.

h = height, in m, of the door between the levels of the bottom of the door and the upper deck or between the bottom of the door and the top of the door, whichever is the lesser,

l = length, in m, of the door at a height h/2 above the bottom of the door,

W = breadth, in m, of the door at a height h/2 above the bottom of the door,

P_e - external pressure, in kN/m^2 , as given in D6.301.a with angles α and β defined as follows:

α - flare angle measured at the point on the bow door, l / 2 aft of the stem line on the plane h/2 above the bottom of the door, as shown in Figure F.D6.301.1.

β = entry angle measured at the same point as α .

For bow doors, including bulwark, of unusual form or proportions, e.g. ships with a rounded nose and large stem angles, the areas and angles used for determination of the design values of external forces may require to be specially considered.

- c. For visor doors the closing moment M_y , under external loads, in kN.m, is to be taken as:

$$M_y = F_x a + 10 W c - F_z b$$

where:

W - mass of the visor door, in t,

- a.1. vertical distance, in m, from visor pivot to the centroid of the transverse vertical projected area of the visor door, as shown in Figure F.D6.301.2,
 - a.2. horizontal distance, in m, from visor pivot to the centroid of the horizontal projected area of the visor door, as shown in Figure F.D6.301.2,
 - a.3. horizontal distance, in m, from visor pivot to the centre of gravity of visor mass, as shown in Figure F.D6.301.2.
- d. Moreover, the lifting arms of a visor door and its supports are to be dimensioned for the static and dynamic forces applied during the lifting and lowering operations, and a minimum wind pressure of 1.5kN/m² is to be taken into account.

FIGURE F.D6.301.1 DEFINITION OF α AND β

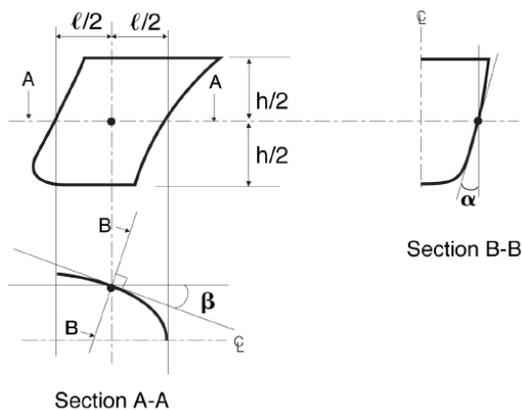


FIGURE F.D6.301.2. BOW DOOR OF VISOR TYPE

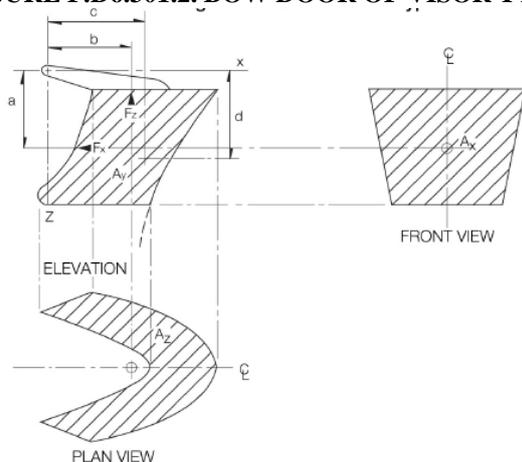
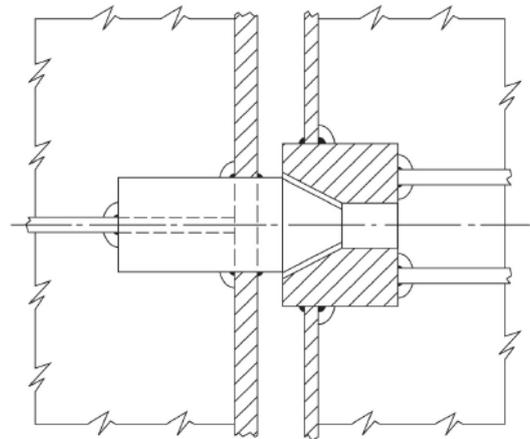


FIGURE F.D6.301.3 THRUST BEARING



302. Inner doors

- a. The design external pressure p_e , in kN/m², considered for the scantlings of primary members, securing and supporting devices and surrounding structure of inner doors is to be taken as the greater of the following:

taken as the greater of the following:

- a.1. $p_e = 0.45 L$,
 - a.2. hydrostatic pressure $p_h = 10h$, where h is the distance, in m, from the load point to the top of the cargo space, where L is the ship's length, as defined in D6.301a above.
- b. The design internal pressure p_i , in kN/m², considered for the scantlings of securing devices of inner doors is not to be less than:

$$p_i = 25$$

400. Scantlings of bow doors

401. The strength of bow doors is to be commensurate with that of the surrounding structure. 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 visor doors adequate strength for the opening and closing operations is to be provided in the connections of the lifting arms to the door structure and to the ship structure.

402. Plating and secondary stiffeners

- a. The thickness of the bow door plating is not to be less than that required for the side shell plating, using bow door stiffener spacing, but in no case less than the minimum required thickness of fore end shell plating.
- b. The section modulus of horizontal or vertical stiffeners is not to be less than that required for end framing. Consideration is to be given, where necessary,

to differences in fixity between ship's frames and bow doors stiffeners.

- c. The stiffener webs are to have a net sectional area, in cm^2 , not less than:

$$A = \frac{Qk}{10}$$

where:

Q - shear force, in kN, in the stiffener calculated by using uniformly distributed external pressure p_e as given in D6.301a above.

403. Primary structure

- a. The bow door secondary stiffeners are to be supported by primary members constituting the main stiffening of the door.
- b. The primary members of the bow door and the hull structure in way are to have sufficient stiffness to ensure integrity of the boundary support of the door.
- c. Scantlings of the primary members are generally to be supported by direct strength calculations in association with the external pressure given in D6.301a and permissible stresses given in D6.201a. Normally, formulae for simple beam theory may be applied to determine the bending stress. Members are to be considered to have simply supported end connections.

500. Scantlings of inner doors

501. General

- a. Scantlings of the primary members are generally to be supported by direct strength calculations in association with the external pressure given in D6.302a and permissible stresses given in D6.201a. Normally, formulae for simple beam theory may be applied.
- b. Where inner doors also serve as a vehicle ramps, the scantlings are not to be less than those required for vehicle decks.
- c. The distribution of the forces acting on the securing and supporting devices is generally to be supported by direct calculations taking into account the flexibility of the structure and the actual position and stiffness of the supports.

600. Securing and supporting of bow doors

601. General

- a. Bow doors are to be fitted with adequate means of securing and supporting so as to be commensurate with the strength and stiffness of the surrounding

structure. The hull supporting structure in way of the bow doors is to be suitable for the same design loads and design stresses as the securing and supporting devices. 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. Maximum design clearance between securing and supporting devices is not generally to exceed 3 mm. A means is to be provided for mechanically fixing the door in the open position.

- b. Only the active supporting and securing devices having an effective stiffness in the relevant direction are to be included and considered to calculate the reaction forces acting on the devices. Small and/or flexible devices such as cleats intended to provide load compression of the packing material are not generally to be included in the calculations called for in D6.602e. The number of securing and supporting devices is generally to be the minimum practical whilst taking into account the requirements for redundant provision given in D6.602f and D6.602g and the available space for adequate support in the hull structure.
- c. For opening outwards visor doors, the pivot arrangement is generally to be such that the visor is self-closing under external loads, that is $M_y > 0$. Moreover, the closing moment M_y , as given in D6.301c is to be not less than:

$$M_{yo} = 10Wc + 0.1(a^2 + b^2)^{0.5} (F_x^2 + F_z^2)^{0.5}$$

602. Scantlings

- a. Securing and supporting devices are to be adequately designed so that they can withstand the reaction forces within the permissible stresses given in D6.201a.
- b. For visor doors the reaction forces applied on the effective securing and supporting devices assuming the door as a rigid body are determined for the following combination of external loads acting simultaneously together with the self-weight of the door:
- b.1. case 1 F_x and F_z
- b.2. case 2 $0.7F_y$ acting on each side separately together with $0.7F_x$ and $0.7F_z$, where F_x , F_y and F_z are determined as indicated in D6.301b and applied at the centroid of projected areas.
- c. together with the self-weight of the door:
- c.1. case 1 F_x , F_y and F_z acting on both doors
- c.2. case 2 $0.7 F_x$ and $0.7F_z$ acting on both doors and $0.7F_y$ acting on each door separately, where F_x , F_y and F_z are determined as indi-

cated in D6.301b and applied at the centroid of projected areas.

- d. The support forces as determined according to D6.602b i) and D6.602c i) shall generally give rise to a zero moment about the transverse axis through the centroid of the area A_x . For visor doors, longitudinal reaction forces of pin and/or wedge supports at the door base contributing to this moment are not to be of the forward direction.
- e. The distribution of the reaction forces acting on the securing and supporting devices may require to be supported by direct calculations taking into account the flexibility of the hull structure and the actual position and stiffness of the supports.
- f. The arrangement of securing and supporting devices in way of these securing devices is to be designed with redundancy so that in the event of failure of any single securing or supporting device the remaining devices are capable to withstand the reaction forces without exceeding by more than 20 per cent the permissible stresses as given in D6.201.
- g. For visor doors, two securing devices are to be provided at the lower part of the door, each capable of providing the full reaction force required to prevent opening of the door within the permissible stresses given in D6.201a. The opening moment M_o , in kN.m, to be balanced by this reaction force, is not to be taken less than:
- $$M_o = 10 W d + 5 A_x a$$
- where:
d - vertical distance, in m, from the hinge axis to the centre of gravity of the door, as shown in Figure F.D6.301.2,
a - as defined in D6.301c.
- h. For visor doors, the securing and supporting devices excluding the hinges should be capable of resisting the vertical design force ($F_z - 10W$), in kN, within the permissible stresses given in D6.201a.
- i. All load transmitting elements in the design load path, from door through securing and supporting devices into the ship structure, including welded connections, are to be to the same strength standard as required for the securing and supporting devices. These elements include pins, supporting brackets and back-up brackets.
- j. For side-opening doors, thrust bearing has to be provided in way of girder ends at the closing of the two leaves to prevent one leaf to shift towards the other one under effect of unsymmetrical pressure (see example of Figure F.D6.301.3). Each part of the thrust bearing has to be kept secured on the other part by means of securing devices. Any other arrangement serving the same purpose may be proposed.

700. Securing and locking arrangement

701. Systems for operation

- a. Securing devices are to be simple to operate and easily accessible. Securing devices are to be equipped with mechanical locking arrangement (self-locking or separate arrangement), or to be of the gravity type. The opening and closing systems as well as securing and locking devices are to be interlocked in such a way that they can only operate in the proper sequence.
- b. Bow doors and inner doors giving access to vehicle decks are to be provided with an arrangement for remote control, from a position above the freeboard deck, of:
- b.1. the closing and opening of the doors, and
 - b.2. associated securing and locking devices for every door.

Indication of the open/closed position of every door and every securing and locking device is to be provided at the remote control stations. The operating panels for operation of doors are to be inaccessible to unauthorized persons. A notice plate, giving instructions to the effect that all securing devices are to be closed and locked before leaving harbour, is to be placed at each operating panel and is to be supplemented by warning indicator lights.

- c. Where hydraulic securing devices are applied, the system is to be mechanically lockable in closed position. This means that, in the event of loss of the hydraulic fluid, the securing devices remain locked. The hydraulic system for securing and locking devices is to be isolated from other hydraulic circuits, when in closed position.

702. Systems for indication/monitoring

- a. Separate indicator lights and audible alarms are to be provided on the navigation bridge and on the operating panel to show that the bow door and inner door are closed and that their securing and locking devices are properly positioned. The indication panel is to be provided with a lamp test function. It shall not be possible to turn off the indicator light.
- b. The indicator system is to be designed on the fail safe principle and is to show by visual alarms if the door is not fully closed and not fully locked and by audible alarms if securing devices become open or locking devices become unsecured. The power supply for the indicator system for operating and closing doors is to be independent of the power supply for operating and closing the doors and is to be provided with a back-up power supply from the emergency source of power or other secure power supply e.g. UPS. The sensors of the indicator system are to be

protected from water, ice formation and mechanical damage.

iv. separate indication for door closed, door locked, door not closed and door not locked.

Note: The indicator system is considered designed on the fail - safe principal when:

d.2. Limit switches electrically closed when the door is closed (when more limit switches are provided they may be connected in series).

b.1. The indication panel is provided with:

d.3. Limit switches electrically closed when securing arrangements are in place (when more limit switches are provided they may be connected in series).

i. a power failure alarm

ii. an earth failure alarm

iii. a lamp test

iv. separate indication for door closed, door locked, door not closed and door not locked.

d.4. Two electrical circuits (also in one multicore cable), one for the indication of door closed / not closed and the other for door locked / not locked.

b.2. Limit switches electrically closed when the door is closed (when more limit switches are provided they may be connected in series).

d.5. In case of dislocation of limit switches, indication to show: not closed / not locked / securing arrangement not in place - as appropriate.

b.3. Limit switches electrically closed when securing arrangements are in place (when more limit switches are provided they may be connected in series).

e. Between the bow door and the inner door a television surveillance system is to be fitted with a monitor on the navigation bridge and in the engine control room. The system is to monitor the position of the doors and a sufficient number of their securing devices. Special consideration is to be given for the lighting and contrasting colour of objects under surveillance.

b.4. Two electrical circuits (also in one multicore cable), one for the indication of door closed / not closed and the other for door locked / not locked.

Note: The indicator system is considered designed on the fail - safe principal when:

b.5. In case of dislocation of limit switches, indication to show: not closed / not locked / securing arrangement not in place as appropriate.

e.1. The indication panel is provided with:

i. a power failure alarm

ii. an earth failure alarm

iii. a lamp test

iv. separate indication for door closed, door locked, door not closed and door not locked.

c. The 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 on the navigation bridge if the vessel leaves harbour with the bow door or inner door not closed or with any of the securing devices not in the correct position.

d. 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.

e.2. Limit switches electrically closed when the door is closed (when more limit switches are provided they may be connected in series).

e.3. Limit switches electrically closed when securing arrangements are in place (when more limit switches are provided they may be connected in series).

Note: The indicator system is considered designed on the fail - safe principal when:

d.1. indication panel is provided with:

e.4. Two electrical circuits (also in one multicore cable), one for the indication of door closed / not closed and the other for door locked / not locked.

i. a power failure alarm

ii. an earth failure alarm

iii. a lamp test

e.5. In case of dislocation of limit switches, indication to show: not closed / not locked / securing arrangement not in place - as appropriate.

f. A drainage system is to be arranged in the area between bow door and ramp, or where no ramp is fitted, between the bow door and inner door. The system is to be equipped with an audible alarm function to the navigation bridge being set off when the water levels in these areas exceed 0.5m or the high water level alarm, whichever is lesser.

Note: The indicator system is considered designed on the fail - safe principal when:

- f.1. The indication panel is provided with:
 - i. a power failure alarm
 - ii. an earth failure alarm
 - iii. a lamp test
 - iv. separate indication for door closed, door locked, door not closed and door not locked.
- f.2. Limit switches electrically closed when the door is closed (when more limit switches are provided they may be connected in series).
- f.3. Limit switches electrically closed when securing arrangements are in place (when more limit switches are provided they may be connected in series).
- f.4. Two electrical circuits (also in one multicore cable), one for the indication of door closed / not closed and the other for door locked / not locked.
- f.5. In case of dislocation of limit switches, indication to show: not closed / not locked / securing arrangement not in place - as appropriate.

g. For Roll on / roll off passenger ships on international voyages, the special category spaces and Roll on / roll off spaces are to be continuously patrolled or monitored by effective means, such as television surveillance, so that any movement of vehicles in adverse weather conditions or unauthorized access by passengers thereto, can be detected whilst the ship is underway.

800. Operating and Maintenance Manual

801. An Operating and Maintenance Manual for the bow door and inner door is to be provided on board and is to contain necessary information on:

- a.
 - a.1. main particulars and design drawings
 - a.2. special safety precautions

- a.3. details of vessel
- a.4. equipment and design loading (for ramps)
- a.5. key plan of equipment (doors and ramps)
- a.6. manufacturer's recommended testing for equipment
- a.7. description of equipment for: bow doors; inner bow doors; bow ramp/doors; side doors; stern doors; central power pack; bridge panel; engine control room panel
- b.
 - b.1. service conditions
 - b.2. limiting heel and trim of ship for loading/unloading
 - b.3. limiting heel and trim for door operations
 - b.4. doors/ramps operating instructions
 - b.5. doors/ramps emergency operating instructions
- c.
 - c.1. maintenance
 - c.2. schedule and extent of maintenance
 - c.3. trouble shooting and acceptable clearances
 - c.4. manufacturer's maintenance procedures
- d.
 - d.1. register of inspections, including inspection of locking, securing and supporting devices,
 - d.2. repairs and renewals.

802. This Manual is to be submitted for approval that the above mentioned items are contained in the OMM and that the maintenance part includes the necessary information with regard to inspections, troubleshooting and acceptance / rejection criteria. *Note:* It is recommended that recorded inspections of the door supporting and securing devices be carried out by the ship's staff at monthly intervals or following incidents that could result in damage, including heavy weather or contact in the region of the shell doors. Any damages recorded during such inspections are to be reported to the Classification Society.

803. Documented operating procedures for closing and securing the bow door and inner door are to be kept on board and posted at appropriate place.

**D7. SIDE SHELL DOORS AND STERN DOORS
[IACS UR S9]**

100. General

101. Application

- a. These requirements are for the arrangement, strength and securing of side shell doors, abaft the collision bulkhead, and of stern doors leading to enclosed spaces.

The requirements apply to all Roll on / roll off passenger ships and Roll on / roll off cargo ships engaged on international voyages and also to Roll on / roll off passenger ships and Roll on / roll off cargo ships engaged only in domestic (non international) voyages, except where specifically indicated otherwise herein.

The requirements are not applicable to high speed, light displacement craft as defined in the IMO Code of Safety for High Speed Craft.

102. Arrangement

- a. Stern doors for passenger vessels are to be situated above the freeboard deck. Stern doors for Roll on / roll off cargo ships and side shell doors may be either below or above the freeboard deck.
- b. Side shell doors and stern doors are to be so fitted as to ensure tightness and structural integrity commensurate with their location and the surrounding structure.
- c. Where the sill of any side shell door is below the uppermost load line, the arrangement is to be specially considered (*see IACS Interpretation LL 21*).
- d. Doors should preferably open outwards.

200. Strength Criteria

201. Primary structure and Securing and Supporting devices

- a. Scantlings of the primary members, securing and supporting devices of side shell doors and stern doors are to be determined to withstand the design loads defined in D7.300 below, using the following permissible stresses:

$$\text{shear stress: } \tau = \frac{80}{k} \text{ N/mm}^2$$

$$\text{bending stress: } \sigma = \frac{120}{k} \text{ N/mm}^2$$

$$\text{equivalent stress: } \sigma_c = \sqrt{\sigma^2 + 3\tau^2} = \frac{150}{k}$$

where k is the material factor as given in Part II, Title 11, Section 2, Chapter C, but is not to be taken less than 0.72 unless a direct strength analysis with regard to relevant modes of failures is carried out.

- b. The buckling strength of primary members is to be verified as being adequate.
- c. For steel to steel bearings in securing and supporting devices, the nominal bearing pressure calculated by dividing the design force by the projected bearing area is not to exceed $0.8\sigma_F$, where σ_F is the yield stress of the bearing material. For other bearing materials, the permissible bearing pressure is to be determined according to the manufacturer's specification.
- d. The arrangement of securing and supporting devices is to be such that threaded bolts do not carry support forces. The maximum tension in way of threads of bolts not carrying support forces is not to exceed $125/k \text{ N/mm}^2$, with k defined in D7.201.a.

300. Design loads

301. The design forces, in kN, considered for the scantlings of primary members, securing and supporting devices of side shell doors and stern doors are to be not less than:

- a. Design forces for securing or supporting devices of doors opening inwards:
- a.1. external force: $F_e = A p_e + F_p$
- a.2. internal force: $F_i = F_o + 10 W$
- b. Design forces for securing or supporting devices of doors opening outwards:
- b.1. external force: $F_e = A p_e$
- b.2. internal force: $F_i = F_o + 10 W + F_p$
- c. Design forces for primary members:
- c.1. external force: $F_e = A p_e$
- c.2. internal force: $F_i = F_o + 10 W$

whichever is the greater, where:

A area, in m², of the door opening,

W mass of the door, in t,

F_p total packing force in kN. Packing line pressure is normally not to be taken less than 5N/mm,

F_o the greater of F_c and 5 A (kN),

F_c accidental force, in kN, due to loose of cargo etc., to be uniformly distributed over the area A and not to

be taken less than 300kN. For small doors such as bunker doors and pilot doors, the value of F_c may be appropriately reduced. However, the value of F_c may be taken as zero, provided an additional structure such as an inner ramp is fitted, which is capable of protecting the door from accidental forces due to loose cargoes.

p_e external design pressure, in kN/m², determined at the centre of gravity of the door opening and not taken less than:

$$10(T - Z_G) + 25 \quad \text{for } Z_G < T$$

$$25 \quad \text{for } Z_G \geq T$$

Moreover, for stern doors of ships fitted with bow doors, P_e is not to be taken less than:

$$p_e = 0.6\lambda C_H (0.8 + 0.6L^{0.5})^2$$

λ coefficient depending on the area where the ship is intended to be operated:

$\lambda = 1$ for sea going ships,
 $\lambda = 0.8$ for ships operated in coastal waters,
 $\lambda = 0.5$ for ships operated in sheltered waters.

Note: Coastal waters and sheltered waters are defined according to the practice of each Classification Society. As an example, coastal waters may be defined as areas where significant wave heights do not exceed 4m for more than three hours a year and sheltered waters as areas where significant wave heights do not exceed 2m for more than three hours a year.

$C_H = 0.0125 L$ for $L < 80m$
 $C_H = 1$ for $L \geq 80m$

L ship's length, in m, but need not be taken greater than 200 metres,

T draught, in m, at the highest subdivision load line,

Z_G height of the centre of area of the door, in m, above the baseline.

400. Scantlings of side shell doors and stern doors

401. General

- a. The strength of side shell doors and stern doors is to be commensurate with that of the surrounding structure.
- b. Side shell doors and stern doors are to be adequately stiffened and means are to be provided to prevent any lateral or vertical movement of the doors when closed. Adequate strength is to be provided in the connections of the lifting/manoeuvring arms and hinges to the door structure and to the ship's structure.

- c. Where doors also serve as vehicle ramps, the design of the hinges should take into account the ship angle of trim and heel which may result in uneven loading on the hinges.
- d. Shell door openings are to have well-rounded corners and adequate compensation is to be arranged with web frames at sides and stringers or equivalent above and below.

402. Plating and secondary stiffeners

- a. The thickness of the door plating is not to be less than the required thickness for the side shell plating, using the door stiffener spacing, but in no case less than the minimum required thickness of shell plating. Where doors serve as vehicle ramps, the plating thickness is to be not less than required for vehicle decks.
- b. The section modulus of horizontal or vertical stiffeners is not to be less than that required for side framing. Consideration is to be given, where necessary, to differences in fixity between ship's frames and door stiffeners. Where doors serve as vehicle ramps, the stiffener scantlings are not to be less than required for vehicle decks.

403. Primary Structure

- a. The secondary stiffeners are to be supported by primary members constituting the main stiffening of the door.
- b. The primary members and the hull structure in way are to have sufficient stiffness to ensure structural integrity of the boundary of the door.
- c. Scantlings of the primary members are generally to be supported by direct strength calculations in association with the design forces given in D7.300 above and permissible stresses given in D7.201a. Normally, formulae for simple beam theory may be applied to determine the bending stresses. Members are to be considered to have simply supported end connections.

500. Securing and Supporting of Doors

501. General

- a. Side shell doors and stern doors are to be fitted with adequate means of securing and supporting so as to be commensurate with the strength and stiffness of the surrounding structure. The hull supporting structure in way of the doors is to be suitable for the same design loads and design stresses as the securing and supporting devices. 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. Maximum design clearance between

securing and supporting devices is not generally to exceed 3mm. A means is to be provided for mechanically fixing the door in the open position.

- b. Only the active supporting and securing devices having an effective stiffness in the relevant direction are to be included and considered to calculate the reaction forces acting on the devices. Small and/or flexible devices such as cleats intended to provide local compression of the packing material are not generally to be included in the calculations called for in D7.502b. The number of securing and supporting devices are generally to be the minimum practical whilst taking into account the requirement for redundant provision given in D7.502c and the available space for adequate support in the hull structure.

502. Scantlings

- a. Securing and supporting devices are to be adequately designed so that they can withstand the reaction forces within the permissible stresses given in D7.201a.
- b. The distribution of the reaction forces acting on the securing devices and supporting devices may require to be supported by direct calculations taking into account the flexibility of the hull structure and the actual position of the supports.
- c. The arrangement of securing devices and supporting devices in way of these securing devices is to be designed with redundancy so that in the event of failure of any single securing or supporting device the remaining devices are capable to withstand the reaction forces without exceeding by more than 20 per cent the permissible stresses as given in D7.201a.
- d. All load transmitting elements in the design load path, from the door through securing and supporting devices into the ship's structure, including welded connections, are to be to the same strength standard as required for the securing and supporting devices. These elements include pins, support brackets and back-up brackets.

600. Securing and Locking Arrangement

601. Systems for operation

- a. Securing devices are to be simple to operate and easily accessible. Securing devices are to be equipped with mechanical locking arrangement (self locking or separate arrangement), or are to be of the gravity type. The opening and closing systems as well as securing and locking devices are to be interlocked in such a way that they can only operate in the proper sequence.
- b. Doors which are located partly or totally below the freeboard deck with a clear opening area greater than 6m² are to be provided with an arrangement for remote control, from a position above the freeboard deck, of:

- b.1. the closing and opening of the doors,
- b.2. associated securing and locking devices.

For doors which are required to be equipped with a remote control arrangement, indication of the open/closed position of the door and the securing and locking device is to be provided at the remote control stations. The operating panels for operation of doors are to be inaccessible to unauthorized persons. A notice plate, giving instructions to the effect that all securing devices are to be closed and locked before leaving harbour, is to be placed at each operating panel and is to be supplemented by warning indicator lights.

- c. Where hydraulic securing devices are applied, the system is to be mechanically lockable in closed position. This means that, in the event of loss of the hydraulic fluid, the securing devices remain locked.

The hydraulic system for securing and locking devices is to be isolated from other hydraulic circuits, when closed position.

602. Systems for indication/monitoring

- a. The following requirements apply to doors in the boundary of special category spaces or Roll on / roll off spaces, as defined in D7.103, through which such spaces may be flooded. For cargo ships, where no part of the door is below the uppermost waterline and the area of the door opening is not greater than 6m², then the requirements of this section need not be applied.
- b. Separate indicator lights and audible alarms are to be provided on the navigation bridge and on each operating panel to indicate that the doors are closed and that their securing and locking devices are properly positioned. The indication panel is to be provided with a lamp test function. It shall not be possible to turn off the indicator light.
- c. The indicator system is to be designed on the fail safe principle and is to show by visual alarms if the door is not fully closed and not fully locked and by audible alarms if securing devices become open or locking devices become unsecured. The power supply for the indicator system is to be independent of the power supply for operating and closing the doors and is to be provided with a backup power supply from the emergency source of power or secure power supply e.g. UPS.

Note: see D6.702b above for fail safe principal design.

The sensors of the indicator system are to be protected from water, ice formation and mechanical damages.

- d. The 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 on the navigation bridge if the vessel leaves harbour with any side shell or stern door not closed or with any of the securing devices not in the correct position.
- e. For passenger ships, 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 any leakage through the doors. For cargo ships, a water leakage detection system with audible alarm is to be arranged to provide an indication to the navigation bridge.
- f. For Roll on / roll off passenger ships, on international voyages, the special category spaces and Roll on / roll off spaces are to be continuously patrolled or monitored by effective means, such as television surveillance, so that any movement of vehicles in adverse weather conditions and unauthorized access by passengers thereto, can be detected whilst the ship is underway.

700. Operating and Maintenance Manual

701. An Operating and Maintenance Manual for the side shell doors and stern doors is to be provided on board and is to contain the necessary information on:

- a. **main particulars and design drawings**
 - a.1. special safety precautions
 - a.2. details of vessel
 - a.3. equipment and design loading (for ramps)
 - a.4. key plan of equipment (doors and ramps)
 - a.5. manufacturer's recommended testing for equipment
 - a.6. description of equipment for
 - a.7. bow doors
 - a.8. inner bow doors
 - a.9. bow ramp/doors
 - a.10. side doors
 - a.11. stern doors
 - a.12. central power pack
 - a.13. bridge panel
 - a.14. engine control room panel

- b. **service conditions**
 - b.1. limiting heel and trim of ship for loading/unloading
 - b.2. limiting heel and trim for door operations
 - b.3. doors/ramps operating instructions
 - b.4. doors/ramps emergency operating instructions
- c. **maintenance**
 - c.1. schedule and extent of maintenance
 - c.2. trouble shooting and acceptable clearances
 - c.3. manufacturer's maintenance procedures
- d. **register of inspections**, including inspection of locking, securing and supporting devices, repairs and renewals.

This Manual is to be submitted for approval that the above mentioned items are contained in the OMM and that the maintenance part includes the necessary information with regard to inspections, troubleshooting and acceptance / rejection criteria.

Note: It is recommended that recorded inspections of the door supporting and securing devices be carried out by the ship's staff at monthly intervals or following incidents that could result in damage, including heavy weather or contact in the region of side shell and stern doors. Any damage recorded during such inspections is to be reported to the Classification Society.

702. Documented operating procedures for closing and securing side shell and stern doors are to be kept on board and posted at the appropriate places.

Explanatory Note: The external pressure applied on stern doors is derived from the formula considered in Part II, Title 15, Section 2, Subchapter D6 above for bow doors, assuming:

$$\alpha = 0 \text{ degree}$$

$$\beta = 90 \text{ degrees}$$

$$V = 2 \text{ knots}$$

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