Part 3 Hull

Chapter 12 Opening and closing appliances
FOREWORD

DNV GL rules for classification contain procedural and technical requirements related to obtaining and retaining a class certificate. The rules represent all requirements adopted by the Society as basis for classification.

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CHANGES – CURRENT

This is a new document.

The rules enter into force 1 January 2016.
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SECTION 1 GENERAL

1 Application
In this chapter the requirements for the arrangement of openings and closing appliances have been collected. In general, the closing appliances shall have at least the strength corresponding to the required strength of that part of the hull in which they are fitted.

2 Documentation requirements

2.1 General
The documents to be submitted are indicated in Ch.1 Sec.3.

2.2 Operating and maintenance manual (OMM)

2.2.1 General
Large shell doors, such as bow doors and inner doors, side doors and stern doors, shall be provided with an operational maintenance manual that shall have a content as described in [2.2.2].

2.2.2 Required content for OMM

a) Main particulars and design drawings
   — special safety precautions
   — details of vessel, class
   — equipment and design loading (for ramps)
   — key plan of equipment (doors and ramps)
   — manufacturer's recommended testing for equipment
   — 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) Service conditions
   — limiting heel and trim of ship for loading/unloading
   — limiting heel and trim for door operations
   — doors/ramps operating instructions
   — doors/ramps emergency operating instructions

c) Maintenance
   — schedule and extent of maintenance
   — trouble-shooting
   — acceptance/rejection criteria, acceptable clearances
   — manufacturer's maintenance procedures

d) Register of inspections, including:
— inspection of locking, securing and supporting devices
— repairs and renewals.

2.2.3 The operating and maintenance manual shall be submitted for approval with respect to the items listed above being contained in the manual. In addition, the inclusion of the necessary information with regard to inspections, trouble-shooting and acceptance/rejection criteria in the maintenance part shall be verified.

Guidance note 1:
It is recommended that recorded inspections of the door supporting and securing devices are 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 damage recorded during such inspections should be reported. This should also to be stated in the operating and maintenance manual.

Guidance note 2:
Reference is made to the safety management system described in the ISM Code.

2.2.4 On board documentation
The operation and maintenance manuals for the shell doors shall be provided on board.

2.3 Testing

2.3.1 Function testing
All weathertight/watertight doors and hatch covers shall be function tested.

2.3.2 Container ships
For ships exclusively intended for the carriage of containers in the cargo holds, for which an exemption to the ICLL, Reg.16 (see Sec.4) has been granted by the flag administration, and which complies with the requirements given in Sec.4 [4.3.3] and Sec.4 [6.1.6], the required testing for weather tightness given in Pt.2 Ch.4 Sec.2 may be dispensed with. If non-weathertight hatch covers are fitted, this will be noted in the appendix to classification certificate with the implication that hose testing for weather tightness in accordance with Pt.2 Ch.4 Sec.2 will not be carried out.

2.3.3 Damage condition
Doors and hatch covers which become immersed by an equilibrium or an intermediate water plane in a damaged condition shall be subjected to a hydrostatic pressure test. The head of water used for the pressure test shall correspond at least to the head, measured from the lower edge of the door opening, at the location in which the door is fitted in the vessel, to the most unfavourable damage waterplane. The acceptance criteria for the test is no leakage.

For large doors, above 6 m², structural analysis may be accepted in lieu of pressure testing. Where such doors utilise gasket seals, a prototype pressure test of the gasket seal shall be carried out to confirm that the compression of the gasket material is capable of accommodating maximum deflection, revealed by the structural analysis. After installation of such door or hatch, the initial gasket compression shall be documented.

2.4 Certification requirements
The components to be certified are indicated in Ch.1 Sec.3 [2.3].
SECTION 2 SMALL HATCHWAYS AND WEATHERTIGHT DOORS

Symbols
For symbols not defined in this section, refer to Ch.1 Sec.4.
Standard tier height is defined in Ch.1 Sec.4 [3.3.1].

1 General

1.1 Application

1.1.1 The requirements given in [1.2] to [1.6] apply to small hatchways on weather deck in positions 1 and 2 as defined in Ch.1 Sec.4 [3.2]. The requirements given in [2] apply to small hatchways fitted on the exposed fore deck over the forward 0.25 L.

1.2 Materials

1.2.1 Materials used for the construction of steel hatch covers shall comply with the applicable requirements of the Society.

1.2.2 The use of materials other than steel will be considered by the Society on a case-by-case basis.

1.3 Height of hatch coamings

1.3.1 The height above the deck of hatch coamings shall not be less than:
— 600 mm in position 1.
— 450 mm in position 2.

1.3.2 The height, given in [1.3.1], of hatch coamings closed by steel covers provided with gaskets and securing devices may be reduced or the coamings may be omitted entirely, on condition that the flag administration is satisfied that the safety of the ship is not thereby impaired in any sea conditions. In such cases the scantlings of the covers, their gasketing, their securing arrangements and the drainage of recesses in the deck are considered by the Society on a case-by-case basis.

1.4 Small hatchways

1.4.1 Small hatches are hatches designed for access to spaces below the deck and are capable of being closed weathertight or watertight, as applicable. Their opening is generally equal to or less than 2.5 m².

Hatch covers on exposed decks shall be weathertight.
Hatch covers fitted in way of ballast tanks, fuel oil tanks or other tanks shall be watertight.

1.4.2 Securing arrangements and stiffening of hatch cover edges shall be such that weather tightness can be maintained in any sea condition. At least one securing device shall be fitted at each side. Circular hole hinges are considered equivalent to securing devices.

1.4.3 Hatchways of special design will be considered by the Society on a case-by-case basis.

1.4.4 The gross thickness of covers shall be not less than 8 mm. This thickness shall be increased, or an efficient stiffening shall be fitted, where the largest dimension of the cover exceeds 0.6 m.
1.4.5 The gross thickness of coaming plate shall not be less than the lesser of the following values:
— the required gross thickness for the deck in way of hatch coaming, assuming as spacing of stiffeners the lesser of the values of the height of the coaming and the distance between its stiffeners — 10 mm.

Coamings shall be strengthened where their height exceeds 0.8 m or their greatest horizontal dimension exceeds 1.2 m, unless their shape ensures an adequate rigidity.

1.5 Cargo tank access hatchways

1.5.1 Requirements given in [1.2] to [1.4] are considered as minimum requirements for cargo tank hatchways.

The requirements given in [1.5.4] do not apply to dished covers or covers of other specially approved design.

1.5.2 Covers for access hatches, tank cleaning and other openings for cargo tanks and adjacent spaces shall be manufactured from the following material:

a) Normal strength steel in accordance with Ch.3 Sec.1.
b) Non-ferrous material may be considered, such as bronze or brass. For oil tankers, Aluminium alloy shall not be used for covers of any opening to cargo tanks and spaces adjacent thereto.
c) Synthetic materials may be considered, taking into account their fire resistance and their physical and chemical properties in relation to the intended operating conditions. Details of the properties of the material, the design of the cover, and the method of manufacture shall be submitted for approval.

The hatch cover packing material shall be compatible with the cargoes that are intended to be carried and shall be effectively held in place.

1.5.3 The height of the hatch coaming above the upper surface of the freeboard deck shall not be less than 600 mm. Lower hatch coaming height may be accepted upon granted exemption from the flag administration. In addition, the top of the hatch coaming shall not be lower than the highest point of the tank over which it is fitted and shall be of sufficient height for the purpose of damage stability.

The gross thickness of the coaming plate shall not be less than 10 mm. Where the coaming height, as fitted, exceeds 600 mm, the thickness may be required to be increased or edge stiffening fitted. The scantlings of coaming plates of tank access coamings that enclose an area of 1.2 m² or more, and/or those that are not configured with a well rounded shape, may be subject to additional requirements.

1.5.4 The gross thickness of unstiffened plate covers with an area less than 1.2 m² shall not be less than 12.5 mm. The gross thickness of covers of a larger area will need to be increased or the cover will require stiffening.

Flat and unstiffened covers on circular hatchways shall be secured by fastenings with a spacing of not more than 600 mm.

On rectangular hatchways, the spacing of fastenings is generally not to be greater than 450 mm and the distance between hatch corners and adjacent fastenings shall not be greater than 230 mm.

Where the cover is hinged, adequate stiffening of the coaming and cover in way of the hinge shall be provided. In general, hinges shall not be considered securing devices for the cover and shall be designed so as to prevent the gasket from being over-tightened.

1.6 Gaskets

1.6.1 The sealing shall be obtained by a continuous gasket of relatively soft elastic material compressed to achieve the necessary weathertightness.

1.6.2 Coamings and steel parts of hatch covers in contact with gaskets shall have no sharp edges.
2 Small hatchways fitted on the exposed fore deck

2.1 Application

2.1.1 These requirements apply to vessels with $L > 80$ m. (IACS UR S26)

2.2 General

2.2.1 These requirements apply to small hatchways (generally openings $2.5 \text{ m}^2$ or less) on the exposed deck within $0.25 \ L$ from the F.E. and located at a height less than $0.1 \ L$ or $22$ m, whichever is less, from the summer load water line at the location of the hatch.

2.2.2 Hatchways designed for emergency escape need not comply with the requirements given in [2.4.1] items (a) and (b), [2.5.3] and [2.6.1].

2.2.3 Securing devices of hatches designed for emergency escape shall be of a quick-acting type (e.g. one action wheel handles are provided as central locking devices for latching/unlatching of hatch cover) operable from both sides of the hatch cover.

In addition, the emergency escape hatches shall comply with the following:

— the maximum force needed to open the hatch cover shall not exceed 150 N
— a spring equalizing, counterbalance or other suitable device on the ring side to reduce the force needed for opening shall be provided.

2.3 Strength

2.3.1 For small rectangular steel hatch covers, the gross plate thickness, stiffener arrangement and scantlings shall be not less than those obtained, in mm, from Table 1 and Figure 1. Stiffeners, where fitted, shall be aligned with the metal-to-metal contact points, required in [2.5.1] and shown in Figure 1. Primary stiffeners shall be continuous. All stiffeners shall be welded to the inner edge stiffener, see Figure 2.

Table 1 Gross scantlings for small steel hatch covers on the fore deck

<table>
<thead>
<tr>
<th>Nominal size, in mm</th>
<th>Cover plate thickness, in mm</th>
<th>Primary stiffeners</th>
<th>Ordinary stiffeners</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Flat bar, in mm; number</td>
<td></td>
</tr>
<tr>
<td>630 × 630</td>
<td>8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>630 × 830</td>
<td>8</td>
<td>100 × 8; 1</td>
<td>-</td>
</tr>
<tr>
<td>830 × 630</td>
<td>8</td>
<td>100 × 8; 1</td>
<td>-</td>
</tr>
<tr>
<td>830 × 830</td>
<td>8</td>
<td>100 × 10; 1</td>
<td>-</td>
</tr>
<tr>
<td>1030 × 1030</td>
<td>8</td>
<td>120 × 12; 1</td>
<td>80 × 8; 2</td>
</tr>
<tr>
<td>1330 × 1330</td>
<td>8</td>
<td>150 × 12; 2</td>
<td>100 × 10; 2</td>
</tr>
</tbody>
</table>

2.3.2 The upper edge of the hatchway coaming shall be suitably reinforced by a horizontal member, normally not more than 190 mm from the upper edge of the coaming.
2.3.3 For small hatch covers of circular or similar shape, the cover plate thickness and reinforcement shall provide strength and stiffness equivalent to the requirements for small rectangular hatches.

2.3.4 For small hatch covers constructed of materials other than normal strength steel, the required scantlings shall provide equivalent strength and stiffness.

2.4 Primary securing devices

2.4.1 The primary securing devices shall be fitted such that the hatch cover can be secured in place and be made weathertight by means of a closing mechanism employing any one of the following methods:
   a) butterfly nuts tightening onto forks (clamps)
   b) quick acting cleats, or
   c) a central locking device.
   Dogs (twist tightening handles) with wedges are not acceptable.

2.5 Requirement to primary securing

2.5.1 The hatch cover shall be fitted with a gasket of elastic material. This shall be designed to allow a metal to metal contact at a designed compression and to prevent over compression of the gasket by green sea forces that may cause the securing devices to be loosened or dislodged. The metal-to-metal contacts shall be arranged close to each securing device in accordance with Figure 1 and of sufficient capacity to withstand the bearing force.
Figure 1 Arrangement of stiffeners

2.5.2 The primary securing method shall be designed and manufactured such that the designed compression pressure is achieved by one person without the need of any tools.

2.5.3 For a primary securing method using butterfly nuts, the forks (clamps) shall be of robust design. They shall be designed to minimise the risk of butterfly nuts being dislodged while in use; by means of curving the forks upward, a raised surface on the free end, or a similar method. The plate thickness of unstiffened steel forks shall be not less than 16 mm. An example arrangement is shown in Figure 2.
Figure 2 Example or primary securing device

2.5.4 For small hatch covers located on the exposed deck forward of the foremost cargo hatch, the hinges shall be fitted such that the predominant direction of green seas will cause the cover to close, which means that the hinges are normally to be located on the fore edge.

2.5.5 On small hatches located between the main hatches, for example between No. 1 and No. 2, the hinges shall be placed on the fore edge or outboard edge, whichever is practicable for protection from green water in beam sea and bow quartering conditions.

2.6 Secondary securing devices

2.6.1 Small hatches on the fore deck shall be fitted with an independent secondary securing device, e.g. by means of a sliding bolt, a hasp or a backing bar of slack fit, which is capable of keeping the hatch cover in place, even in the event that the primary securing device became loosened or dislodged. It shall be fitted on the side opposite to the hatch cover hinges.

3 Weathertight doors

3.1 General

3.1.1 All access openings in bulkheads at ends of enclosed superstructures shall be fitted with doors of steel or other equivalent material, permanently and strongly attached to the bulkhead, and framed, stiffened and fitted so that the whole structure is of equivalent strength to the unpierced bulkhead and weathertight when closed. The means for securing these doors weathertight shall consist of gaskets and clamping devices or other equivalent means and shall be permanently attached to the bulkhead or to the doors themselves, and the doors shall be so arranged that they can be operated from both sides of the bulkhead.

(ICLL Reg.12)

3.1.2 Weathertight doors in Load Line position 1 and 2 according to ICLL shall be generally equivalent to the ISO 6042.

3.1.3 Except pilot doors, which shall open inwards, weathertight doors should generally open outwards to provide additional security against the impact of the sea. Doors which open inwards shall be especially approved.
3.1.4 Weathertight doors as specified above shall be fitted in all access openings in:
— bulkheads at ends of superstructures
— bulkheads of deckhouses on freeboard deck protecting openings in the freeboard deck
— companionways on freeboard deck and superstructure deck
— bulkheads of deckhouses on superstructure deck protecting openings in the superstructure deck
— companionways and bulkheads of deckhouse upon another deckhouse on freeboard deck protecting openings in the freeboard deck.

3.2 Sill heights

3.2.1 Except as otherwise provided in these rules, the height of the sills of access openings in bulkheads at ends of enclosed superstructures shall be at least 380 millimetres above the deck.

3.2.2 Portable sills should be avoided. However, in order to facilitate the loading/unloading of heavy spare parts or similar, portable sills may be fitted on the following conditions:
   a) they must be installed before the ship leaves port
   b) sills shall be gasketed and fastened by closely spaced through bolts
   c) whenever the sills are replaced after removal, the weathertightness of the sills and the related doors must be verified by hose testing. The dates of removal, replacing and hose testing shall be recorded in the ship’s log book.

3.3 Scantlings and structural arrangement

3.3.1 For weathertight doors the minimum required door blade gross thickness, in mm, corresponding to lateral pressure shall be calculated by the following formula:

\[
t_{gr} = 0.0158 \, \alpha_p \, b \, \frac{|P|}{0.85 \, R_{eH}}
\]

The gross section modulus requirement, in cm$^3$, for stiffeners is given by:

\[
Z_{gr} = \frac{|P| \, s_{bdg}^2}{7.6 \, R_{eH}}
\]

assuming simply supported ends.

\( s_{bdg} \) = effective bending span, in m, as defined in Ch.3 Sec.7 [1.1.2]
\( P \) = relevant design pressure taken from Ch.4, in kN/m$^2$.

3.3.2 The number of the cleats shall comply with ISO6042(1998). The cleats may be individual or centrally operated.
3.3.3 A hinged watertight door that opens inwards is acceptable in lieu of a weathertight door that opens outwards.

3.4 Sill heights

3.4.1 Openings as mentioned in [3.1] are in general to have sill heights not less than 380 mm. The following openings in position 1 shall have sill heights not less than 600 mm:

— companionways
— where access is not provided from the deck above: openings in poop front bulkhead, bulkheads at ends of midships superstructures and bulkheads at ends and sides of deckhouses
— openings in forecastle end bulkhead covering entrance to space below the deck
— openings in engine casings.

3.4.2 In ships which have their freeboard assignment based upon a flooding calculation (type «A», «B-60» or «B-100»), the sill heights for the superstructure bulkhead openings may require to be adjusted according to the calculated damage waterline. In such ships where engine casings are not protected by outer structures, two weathertight doors in series are required, the sill height of the inner door shall not be less than 230 mm.

Guidance note:
"If the door to the engine room can be accessed from the deck above, inside the deck house or superstructure, then the engine casing is considered protected by outer structures. Accordingly two weather tight doors in series are not required."

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

3.4.3 Openings which are used only when the ship is in harbour (for handling of spare parts, etc.), may have a reduced sill height.

3.4.4 For vessels trading in domestic waters reduced sill height may be accepted in accordance with Pt.1 Ch.1 Sec.2 [1.3].

4 Access openings in freeboard and superstructure decks

4.1 General

4.1.1 Manholes and flush scuttles in position 1 or 2 or within superstructures other than enclosed superstructures shall be closed by substantial covers capable of being made watertight. Unless secured by closely spaced bolts, the covers shall be permanently attached.

4.1.2 Openings in freeboard decks other than hatchways, machinery space openings, manholes and flush scuttles shall be protected by an enclosed superstructure, or by a deckhouse or companionway of equivalent strength and weathertightness. Any such opening in an exposed superstructure deck or in the top of a deckhouse on the freeboard deck which gives access to a space below the freeboard deck or a space within an enclosed superstructure shall be protected by an efficient deckhouse or companionway. Doorways in such deckhouses or companionways shall be fitted with doors complying with the requirements given in[3.1] and [3.2].

4.1.3 Regarding the requirement for protecting openings in superstructures, as described in [4.1.2], it is considered that openings in the top of a deckhouse on a raised quarterdeck having a height equal to or greater than a standard height raised quarterdeck shall be provided with an acceptable means of closing but need not be protected by an efficient deckhouse or companionway as defined in the regulation provided the height of the deckhouse is at least the height of a full superstructure.

(IACS UI LL46)
4.1.4 Only those doorways in deckhouses leading to or giving access to companionways leading below, need to be fitted with doors in accordance with [3.1.1]. Alternatively, if stairways within a deckhouse are enclosed within properly constructed companionways fitted with doors complying with [3.1.1], the external doors need not be weathertight. (IACS UI LL8)

4.1.5 Where an opening in a superstructure deck or in the top of a deckhouse on the freeboard deck which gives access to a space below the freeboard deck or to a space within an enclosed superstructure is protected by a deckhouse, then it is considered that only those side scuttles fitted in spaces which give direct access to an open stairway need be fitted with deadlights in accordance with [3.1] and [3.2]. A cabin is considered to provide adequate protection against the minimal amount of water which will enter through a broken side scuttle glass fitted on the second tier. In the application of [4.1.1] and [4.1.2] it is understood that:

— where access is provided from the deck above as an alternative to access from the freeboard then the height of sills into a bridge or poop shall be 380 mm. The same consideration shall apply to deckhouses on the freeboard deck
— where access is not provided from above the height of the sills to doorways in a poop bridge or deckhouse on the freeboard deck shall be 600 mm
— where the closing appliances of access openings in superstructures and deckhouses are not in accordance with [1.2.1], interior deck openings shall be considered exposed, i.e. situated in the open deck. (IACS UI LL8)

4.2 Sill height

4.2.1 In position 1 the height above the deck of sills to the doorways in companionways shall be at least 600 millimetres. In position 2 it shall be at least 380 millimetres. (ICLL Reg.18)
SECTION 3 INTERNAL DOORS AND HATCHES

Symbols

For symbols not defined in this section, refer to Ch.1 Sec.4.

\[ P = \text{design pressure for the considered design load set, see Ch.6 Sec.2 [2], calculated at the load calculation point defined in Ch.3 Sec.7 [2.2], in kN/m}^2. \]

1 Internal doors and hatches

1.1 Arrangement

1.1.1 The weight of covers and any cargo stowed thereon, together with inertial forces generated by ship motions, shall be transmitted to the ship structure through steel to steel contact.

Guidance note:
This may be achieved by continuous steel to steel contact of the cover skirt plate with the ships structure or by means of defined bearing pads.

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

1.1.2 The sealing shall be obtained by a continuous gasket of relatively soft, elastic material compressed to achieve the necessary tightness. Similar sealing shall be arranged between cross-joint elements. Where fitted, compression flat bars or angles shall be well rounded where in contact with the gasket and shall be made of a corrosion-resistant material.

1.2 Strength

1.2.1 Minimum thickness
The gross plate thickness, in mm, shall not be less than:

\[ t_{min-gr} = max[6.0; 0.01b] \]

1.2.2 Plates and stiffeners
Plates and stiffeners shall fulfil yield requirements according to Ch.6 Sec.4 and Ch.6 Sec.5 respectively, with \( \sigma_{hg} = 0 \).

1.2.3 Primary supporting members
Primary supporting members shall fulfil yield requirements according to Ch.6 Sec.4.
2 Watertight doors and hatches

2.1 General

2.1.1 General requirements for internal openings in connection with watertight integrity are given in Ch.2 Sec.2 [1.2]. For pipe tunnel openings, see also Ch.2 Sec.4 [1.2]. Requirements for watertight hatches above 6 m² are given in Sec.4.

2.1.2 Watertight doors or hatches may be of the following types:
— hinged doors or hatches, dividing cargo spaces, shall be of an approved type with mechanical securing devices and may be fitted 'tween decks in approved positions. Such doors shall not be used where remote control is required. Hinged doors for passage shall be of quick acting or single acting type. Indication open/closed shall be fitted on the bridge (IACS UI SC156, table 1)
— rolling doors, guided and supported by steel rollers, and with mechanical or hydraulic securing devices
— sliding doors, moving along and supported by track-way grooves and with mechanical locking due to taper and friction. A positive force shall be required to re-open the doors. These types of door may be only hand operated or both power and hand operated. Sliding doors shall have an indication (i.e., a red light) placed locally on both sides showing that the door is in the remote control mode. Signboards and instructions shall be placed in way of the door advising how to act when the door is in the "door closed" mode. In passenger areas and areas of high ambient noise, audible alarms shall be supplemented by visual signals on both sides of the door (IACS UI SC156).

2.2 Operation

2.2.1 All watertight doors and access hatches shall be operable from both sides of the bulkhead or deck.

2.2.2 Remotely controlled doors shall also be locally operable. Indicators shall be provided at the control position to indicate whether the doors are open or closed.

2.3 Strength

2.3.1 Watertight doors and hatches shall be designed with a strength equivalent to that of the structure in which they are positioned. They shall withstand the design pressure from both sides.

2.3.2 Plating
The gross plate thickness, in mm, shall not be less than:

\[ t_{gr} = 0.02 \alpha_p b \sqrt{\frac{P}{C_a R_{eH}}} \]

where:
\( C_a = 0.7 \) for collision bulkhead
\( C_a = 0.95 \) for other bulkheads.

The thickness shall in no case be less than the minimum bulkhead thickness.
2.3.3 Stiffeners
The gross section modulus, in cm\(^3\), shall not be less than:

\[
Z_{gr} = \frac{|P| s f_{bdg}}{f_{bdg} C_s R_{eH}}
\]

where:
\(f_{bdg} = 8\) when both ends considered free.
\(f_{bdg} = 10\) for other cases
\(C_s = 0.85\) for collision bulkhead
\(C_s = 0.95\) for other bulkheads.

2.3.4 Edge stiffeners of doors shall have a gross moment of inertia, in cm\(^4\), not less than:

\[
I_{gr} = 8 p_e d^4
\]

where:
\(d\) = distance between closing devices, in m, to be measured along door edge
\(P_e\) = packing line pressure along edges, in N/mm, not to be taken less than 5 N/mm
\(P\) = design pressure, in kN/m\(^2\), as given in Ch.4 Sec.6
\(b\) = load breadth, in m, normally taken as \(h/3\) or \(w/2\), whichever is the less.

The coaming of watertight doors (door frame) shall be designed with the necessary stiffness in order to avoid large deflections resulting in leakage in the damaged condition.

2.3.5 As an alternative to [2.3.3], a direct structural analysis using either a beam analysis program or a finite element program may be carried out to assess the structural strength of the door or hatch, the following allowable stress levels apply:

- Bending stress in collision bulkhead = \(0.8 R_{eH}\)
- Bending stress in other bulkheads = \(0.92 R_{eH}\)
- Shear stress in collision bulkhead = \(0.75 \tau_{eH}\)
- Shear stress in other bulkheads = \(0.9 \tau_{eH}\)

2.3.6 A structural analysis as described in [2.3.5] shall include the flexibility of the surrounding structure. Test to be made according to Sec.1 [2.3.3].
The door frames shall have no groove at the bottom in which dirt might lodge and prevent the door from closing properly.

2.3.7 Securing devices shall be designed for the load acting also on the opposite side of where they are positioned. Allowable stresses in securing devices are as follows:
Normal stress = 0.7 \( R_{elH} \)
Shear stress = 0.8 \( \tau_{elH} \)
SECTION 4 CARGO HATCH COVERS - COAMINGS AND CLOSING ARRANGEMENTS OF CARGO HOLD OF SHIPS (UR S21A)

Symbols

For symbols not defined in this section, refer to Ch.1 Sec.4.

\( a_v \) = acceleration addition, to be taken as:
\[ a_v = F \cdot m \]

\( F \) = coefficient, to be taken as:
\[ F = 0.11 \frac{v_0}{\sqrt{L}} \]
with \( v_0 \geq \sqrt{L} \)

\( m \) = coefficient, to be taken as:
\[ m = m_0 - 5(m_0 - 1) \frac{X}{L} \]
for \( 0 < \frac{X}{L} \leq 0.2 \)
\[ m = 1.0 \]
for \( 0.2 < \frac{X}{L} \leq 0.7 \)
\[ m = 1.0 + \frac{(m_0 + 1) \frac{X}{L} - 0.7}{0.3} \]
for \( 0.7 < \frac{X}{L} \leq 1.0 \)

\( m_0 \) = coefficient, to be taken as:
\[ m_0 = 1.5 + F \]

\( v_0 \) = maximum speed, in kn, at summer load line with:
\[ v_0 \geq \sqrt{L} \]

\( h_N \) = superstructure standard height, in m, according to ICLL, to be taken as:
\[ h_N = 1.05 + 0.01L_{LL} \text{ with } 1.8 \leq h_N \leq 2.3 \]

\( R_{eh} \) = yield strength, in N/mm\(^2\) = \( \min \left( R_{eh}; 0.7R_m \right) \)

\( R_m \) = ultimate tensile strength in N/mm\(^2\)

\( e \) = exponent, to be taken as:
\[ e = 0.75 \text{ for } R_{eh} > 235 \text{ N/mm}^2 \]
\[ e = 1.00 \text{ for } R_{eh} \leq 235 \text{ N/mm}^2 \]

\( L_{LL340} \) = corresponds to the length of the ship as \( L_{LL} \), but \( L_{LL340} \) shall not be taken greater than 340 m.

\( \ell \) = unsupported span, in m, of stiffener, to be taken as the spacing of main girders or the distance between a main girder and the edge support for hatch covers and as the spacing of coaming stays for hatch coamings, as applicable

\( P_A \) = pressure, in kN/m\(^2\), on end bulkheads of superstructures and deckhouse walls, as defined in Ch.4 Sec.5 [3.4]

\( P_D \) = pressure, in kN/m\(^2\), on exposed decks, as defined in Ch.4 Sec.5 [2]

\( P_H \) = pressure, in kN/m\(^2\), on weather deck hatches, as defined in Table 2

\( P \) = load/pressure, in kN/m\(^2\), on cargo decks, as defined in [2.3]

\( P_{ln} \) = pressure, in kN/m\(^2\), due to liquids, as defined in Ch.4 Sec.6 [1]

\( t_c \) = corrosion addition, in mm, as defined in Table 1
Part 3 Chapter 12 Section 4

Opening and closing appliances

\[ x = \text{distance, in m, of mid point of the assessed hatch cover from aft end of length } L \text{ or } L_{LL}, \text{ as applicable.} \]

1 General

1.1 Definitions

Table 1 Definitions

<table>
<thead>
<tr>
<th>Terms</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>single skin cover</td>
<td>a hatch cover made of steel or equivalent material that is designed to comply with ICLL Regulation 16. The cover has continuous top and side plating, but is open underneath with the stiffening structure exposed. The cover is weathertight and fitted with gaskets and clamping devices unless such fittings are specifically excluded (IACS UR S21A.1.2.1)</td>
</tr>
<tr>
<td>double skin cover</td>
<td>a hatch cover as above but with continuous bottom plating such that all the stiffening structure and internals are protected from the environment (IACS UR S21A.1.2.1)</td>
</tr>
<tr>
<td>pontoon type cover</td>
<td>a special type of portable cover, secured weathertight by tarpaulins and battening devices. Such covers shall be designed in accordance with ICLL Regulation 15 and are not covered by this section (IACS UR S21A.1.2.1)</td>
</tr>
</tbody>
</table>

Guidance note:
Modern hatch cover designs of lift-away-covers are in many cases called pontoon covers. This definition does not fit to the definition above. Modern lift-away hatch cover designs should belong to one of the two categories single skin covers or double skin cover.

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

1.2 Application

These requirements apply to all ships except bulk carriers, ore carriers and combination carriers, as defined in Pt.5 Ch.1 Sec.7 [10], and are for all cargo hatch covers and coamings on exposed decks.

The strength requirements are applicable to hatch covers and hatch coamings of stiffened plate construction and their closing arrangements.

This section is applicable to hatch covers and hatch coamings made of steel. Use of alternative materials and innovative designs will be considered on a case by case basis.

This section does not apply to portable covers secured weathertight by tarpaulins and battening devices, or pontoon covers, as defined in ICLL Regulation 15.
(IACS UR S21A.1.1)
(IACS UR S21A.1 Rev.5)

Guidance note:
Special requirements of the flag administration regarding hatchways, hatch covers, tightening and securing arrangements shall be observed.

---e-n-d---of---g-u-i-d-a-n-c-e---n-o-t-e---
1.3 Structural arrangement

1.3.1 Primary supporting members and secondary stiffeners of hatch covers shall be continuous over the breadth and length of hatch covers, as far as practical. When this is impractical, snipped end connections shall not be used and appropriate arrangements shall be adopted to provide sufficient load carrying capacity. The spacing of primary supporting members parallel to the direction of secondary stiffeners shall not exceed 1/3 of the span of primary supporting members. When strength calculation is carried out by FE analysis according to [3.3.5], this requirement can be waived.

Secondary stiffeners of hatch coamings shall be continuous over the breadth and length of hatch coamings.

(IACS UR S21A.1.4)

(IACS UR S21.1 Rev.5)

1.4 Material

1.4.1 Hatch covers and coamings shall be made of material in accordance with the definitions of Ch.3 Sec.1.

(IACS UR S21A.1.3)

(IACS UR S21.1 Rev.5)

1.4.2 A material class I shall be applied for hatch covers.

(IACS UR S21A.1.3)

1.4.3 For hatch covers the application of steel with $R_{eh} > 355\,\text{N/mm}^2$ will be considered on a case by case basis.

1.5 Net scantling approach

Unless otherwise noted, the thicknesses of the following requirements are net thicknesses. The net thicknesses are the member thicknesses necessary to obtain the minimum net scantlings required by [2.7] and [5].

The required gross thicknesses are obtained by adding corrosion additions, $t_K$ in mm, according to Table 1.

Strength calculations using beam theory, grillage analysis or FEM shall be performed with net scantlings.

(IACS UR S21A.1.5 and IACS UR S21A.7.1)

(IACS UR S21.1 Rev.5, IACS UR S21.6.1 Rev.5 and IACS UR S21.6.2 Rev.5)

Table 2 Corrosion additions for hatch coamings and hatch covers, $t_c$

<table>
<thead>
<tr>
<th>Application</th>
<th>Structure</th>
<th>$t_c$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weather deck hatches of container ships, car carriers, paper carriers, passenger vessels</td>
<td>Hatch covers</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>Hatch coamings</td>
<td>according to Ch.3 Sec.3</td>
</tr>
<tr>
<td>Weather deck hatches of all other ship types ($t_c$ - values in brackets shall be applied to bulk carriers according to Pt.5 Ch.1)</td>
<td>Hatch covers in general</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>Weather exposed plating and bottom plating of double skin hatch covers</td>
<td>1.5 (2.0)</td>
</tr>
<tr>
<td></td>
<td>Internal structure of double skin hatch covers and closed box girders</td>
<td>1.0 (1.5)</td>
</tr>
<tr>
<td>Application</td>
<td>Structure</td>
<td>$t_c$</td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Hatch coamings not part of the</td>
<td>longitudinal hull structure</td>
<td>1.5</td>
</tr>
<tr>
<td>Hatch coamings part of the longitudinal</td>
<td>according to Ch.3 Sec.3</td>
<td></td>
</tr>
<tr>
<td>Coaming stays and stiffeners</td>
<td></td>
<td>1.5</td>
</tr>
</tbody>
</table>

### Table 3 Design load of weather deck hatches, $P_H$

<table>
<thead>
<tr>
<th>Position</th>
<th>Design load $P_H$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\frac{x}{L_{LL}} \leq 0.75$</td>
</tr>
<tr>
<td></td>
<td>for $L_{LL} \leq 100$ m</td>
</tr>
<tr>
<td>1</td>
<td>on freeboard deck</td>
</tr>
<tr>
<td></td>
<td>$P_H = \frac{9.81}{76} (1.5L_{LL} + 116)$</td>
</tr>
<tr>
<td></td>
<td>upon exposed superstructure decks located at least one</td>
</tr>
<tr>
<td></td>
<td>superstructure standard height $h_N$ above the freeboard</td>
</tr>
<tr>
<td></td>
<td>$P_H = \frac{9.81}{76} (1.5 + 116)$</td>
</tr>
<tr>
<td>1</td>
<td>for $L_{LL} &gt; 100$ m</td>
</tr>
<tr>
<td></td>
<td>on freeboard deck for type B ships according to ICLL</td>
</tr>
<tr>
<td></td>
<td>$P_H = 9.81 \left( 0.0296L_{LL,340} + 3.04 \frac{x}{L_{LL}} - 0.0222L_{LL,340} + 1.22 \right)$</td>
</tr>
<tr>
<td></td>
<td>on freeboard deck for ships with less freeboard than</td>
</tr>
<tr>
<td></td>
<td>type B according to ICLL</td>
</tr>
<tr>
<td></td>
<td>$P_H = 9.81 \left( 0.1452L_{LL,340} - 8.52 \frac{x}{L_{LL}} - 0.1089L_{LL,340} + 9.89 \right)$</td>
</tr>
<tr>
<td></td>
<td>upon exposed superstructure decks located at least one</td>
</tr>
<tr>
<td></td>
<td>superstructure standard height $h_N$ above the freeboard</td>
</tr>
<tr>
<td></td>
<td>$P_H = 9.81 \cdot 3.5$</td>
</tr>
<tr>
<td>Position</td>
<td>Design load $P_H$</td>
</tr>
<tr>
<td>----------</td>
<td>-------------------</td>
</tr>
<tr>
<td></td>
<td>$\frac{x}{L_{LL}} \leq 0.75$</td>
</tr>
<tr>
<td>for $L_{LL} \leq 100\text{m}$</td>
<td>$P_H = \frac{9.81}{76} (1.1L_{LL} + 87.6)$</td>
</tr>
</tbody>
</table>

upon exposed superstructure decks located at least one superstructure standard height $h_N$ above the lowest Position 2 deck

$P_H = 9.81 \cdot 2.1$

---

**Figure 1 Positions 1 and 2**

* Reduced load upon exposed superstructure decks located at least one superstructure standard height above the freeboard deck
** Reduced load upon exposed superstructure decks of vessels with $L_c > 100\text{m}$ located at least one superstructure standard height above the lowest Position 2 deck
2 Loads on hatch cover and coaming

2.1 Application

2.1.1 Structural assessment of hatch covers and hatch coamings shall be carried out using the design load cases, defined in [2.2] – [2.6].

(IACS UR S21A.2)

2.2 Load case A: Vertical and horizontal weather design load

2.2.1 Vertical weather design load

The vertical weather design load, \( P_H \) needs not to be combined with load cases B and C according to [2.3] and [2.4].

Where an increased freeboard is assigned, the design load for hatch covers according to Table 2 on the actual freeboard deck may be as required for a superstructure deck, provided the summer freeboard is such that the resulting draught will not be greater than that corresponding to the minimum freeboard calculated from an assumed freeboard deck situated at a distance equal to a standard superstructure height \( h_N \) below the actual freeboard deck, refer to Figure 4.

Where two or more panels are connected by hinges, each individual panel shall be considered separately.

(IACS UR S21A.2.1)

(IACS UR S21.2 Rev.5)

The vertical design load, \( P_H \) in \( \text{kN/m}^2 \), is in no case to be less than the deck design load \( P_D \). Instead of the deck height \( z \) the height of hatch cover plating above baseline is then to be inserted.

2.2.2 Horizontal weather design load

The horizontal weather design load, \( P_A \) in \( \text{kN/m}^2 \), for determining the scantlings of outer edge girders (skirt plates) of weather deck hatch covers and of hatch coamings shall be obtained analogously as for the aft and
forward external bulkheads of superstructures and deckhouse walls in the respective position, as defined in Ch.4 Sec.5 [3.4.1].
(IACS UR S21A.2.2)

2.3 Load case B: Cargo loads

2.3.1 Distributed loads
The load on hatch covers due to cargo loads, in kN/m², resulting from heave and pitch shall be obtained from the following formula:

\[ P = P_C (1 + a_v) \]

where:

- \( P_C \) = uniform cargo load, in kN/m².

(IACS UR S21A.2.3.1)

2.3.2 Point loads
The loads due to single forces, in kN, resulting from heave and pitch shall be obtained from the following formula:

\[ P = P_S (1 + a_v) \]

where:

- \( P_S \) = single force, in kN.

(IACS UR S21A.2.3.2)

2.4 Load case C: Container loads

2.4.1 Where containers are stowed on hatch covers the following support forces, \( A_Z, B_Z \) and \( B_Y \) in kN, in y- and z-direction at the forward and aft stack corners due to heave, pitch, and the ship’s rolling motion shall be considered and shall be obtained by the following formulae, see also Figure 3.

\[ A_Z = 9.81 \frac{M}{2} (1 + a_v) \left( 0.45 - 0.42 \frac{h_m}{b} \right) \]
\[ B_Z = 9.81 \frac{M}{2} (1 + a_v) \left( 0.45 - 0.42 \frac{h_m}{b} \right) \]
\[ B_Y = 2.4M \]

where:

- \( M \) = maximum designed mass, in t, of container stack
- \( h_m \) = designed height, in m, of centre of gravity of stack above hatch cover supports
- \( b \) = distance, in m, between foot points.

Guidance note:
For $M$ and $h_m$, it is recommended to apply the values used for the calculations of cargo securing (container lashing). If different assumptions are made for $M$ and $h_m$, the designer should verify that the calculation model for the hatch cover structure is loaded by values not less than those recommended.

When the strength of the hatch cover structure is assessed by FE analysis according to [3.3.5], $h_m$ may be taken as the designed height of centre of gravity of stack above the hatch cover top plate.

Values of $M$ and $h_m$ applied for the assessment of hatch cover strength shall be provided by the designer.

In case of container stacks secured to lashing bridges or carried in cell guides the forces acting on the hatch cover may be specially considered.

(IACS UR S21A.2.4)

2.4.2 The design load for other cargo than containers subject to lifting forces shall be determined separately.

![Figure 3 Forces due to container loads](image)

2.5 Load case D: Loads due to liquids in hold

2.5.1 Hatch covers of hold spaces intended to be filled with liquids shall be designed for the load $P_{in}$ irrespective of the filling height of hold spaces.

2.6 Load cases with partial loading

2.6.1 The load cases B and C shall also be considered for partial non homogeneous loading which may occur in practice, e.g. where specified container stack places are empty.

The load case ‘partial loading of container hatch covers’ can be evaluated using a simplified approach, where the hatch cover is loaded without the outermost stacks, see Figure 4.

(IACS UR S21A.2.4.1)
2.7 Load case E: Loads due to elastic deformations of the ship's hull

2.7.1 Hatch covers, which in addition to the load cases A to D are loaded in the ship’s transverse direction by forces due to elastic deformations of the ship’s hull, shall be designed such that the sum of stresses does not exceed the permissible values given in [3.1].

(IACS UR S21A.2.5)

3 Hatch cover strength criteria

3.1 Permissible stresses and deflections

3.1.1 Permissible stresses
The von Mises stress, in N/mm$^2$, in steel hatch cover structures based on the net thickness shall satisfy:

$$\sigma_{vm} \leq 0.8 R_{eH}$$

For load cases B to E according to [2], the von Mises stress, in N/mm$^2$, based on the net thickness with the stresses assessed by means of FEM according to [3.3.5], the following applies:

$$\sigma_{vm} \leq 0.9 R_{eH}$$

For steels with $R_{eH} > 355$ N/mm$^2$, the value of $R_{eH}$ to be applied throughout this section will be considered on a case by case basis.

For beam element calculations and grillage analysis, the von Mises stress, in N/mm$^2$, may be obtained from the following formula.
where:

\[ \sigma = \text{combined bending and normal stress, in } \text{N/mm}^2, \text{ to be taken as:} \]
\[ \sigma = \sigma_b + \sigma_n \]
\[ \sigma_b = \text{bending stress, in } \text{N/mm}^2 \]
\[ \sigma_n = \text{normal stress, in } \text{N/mm}^2 \]
\[ \tau = \text{shear stress, in } \text{N/mm}^2. \]

For FEM calculations, the von Mises stress, in N/mm², may be obtained from the following formula.

\[ \sigma_{vm} = \sqrt{\sigma_x^2 - \sigma_x \sigma_y + \sigma_y^2 + 3 \tau^2} \]

where:

\[ \sigma_x = \text{normal stress, in } \text{N/mm}^2, \text{ in } x\text{-direction} \]
\[ \sigma_y = \text{normal stress, in } \text{N/mm}^2, \text{ in } y\text{-direction} \]
\[ \tau = \text{shear stress, in } \text{N/mm}^2, \text{ in the } x-y \text{ plane.} \]

Indices \( x \) and \( y \) denominate axes of a two-dimensional cartesian coordinate system in the plane of the considered structural element.

(IACS UR S21A.3.1.1)

(IACS UR S21.3.1 Rev.5)

3.1.2 Permissible deflections

Load bearing connections between the hatch cover panels shall be fitted with the purpose of restricting the relative vertical displacements.

The vertical deflection, in m, of primary supporting members due to the vertical weather design load according to [2.2] shall comply with the following formula:

\[ f \leq 0.0056 \cdot l_g \]

where:

\[ l_g = \text{largest span, in m, of girders.} \]

Guidance note:
Where hatch covers are arranged for carrying containers and mixed stowage is allowed, i.e. a 40'-container on stowages places for two 20'-containers, particular attention should be paid to the deflections of hatch covers. Further the possible contact of deflected hatch covers with in hold cargo should be observed.

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

(IACS UR S21A.3.1.2)
3.2 Local scantlings

3.2.1 Local net plate thickness of hatch cover top plating

The net thickness, in mm, of the hatch cover top plating shall be obtained from the calculation according to [3.3]. under consideration of permissible stresses according to [3.1.1].

However, the local net thickness, in mm, shall not be less than:

\[ t = 16.2 F_P b \sqrt{ \frac{P_d}{R_{eH}} } \cdot 10^{-3} \text{ with } t \geq t_{min} \]

where:

\[ F_P = 1.5 + 2.5 \left( \frac{\sigma}{R_{eH}} - 0.64 \right) \geq 1.5 \text{ for } P_d = P_H \text{ or } P \]

\[ F_P = 1.0 + 2.5 \left( \frac{\sigma}{R_{eH}} - 0.64 \right) \geq 1.5 \text{ for } P_d = P_D, P_{in} \text{ or } P_{ST} \]

\( \sigma \) = normal stress, in N/mm\(^2\), of main girders

\( P_d \) = design load, in kN/m\(^2\), to be taken as:

\[ P_d = \max(P; P_D; P_H; P_{in}) \text{ as applicable} \]

\( t_{min} \) = minimum net thickness, in mm, to be taken as:

\[ t_{min} = \max(6.0; 10b) \]

For flange plates under compression sufficient buckling strength according to [3.3.6] shall be verified.

(IACS UR S21A.3.2)

(IACS UR S21.3.3 Rev.5)

3.2.2 Local net plate thickness of hatch covers for wheel loading

For hatch covers subject to wheel loading the plate thickness shall not be less than according to Ch.10 Sec.5.

(IACS UR S21A.3.2.1 Rev.5)
3.2.3 Lower plating of double skin hatch covers and box girders

The net thickness, \( t \) in mm, shall be obtained from the calculation according to [3.3] under consideration of permissible stresses according to [3.1.1].

The net thickness, in mm, shall not be less than:

\[
t = \max(0.0065b; 5.0)
\]

(IACS UR S21A.3.2.2)

The lower plating of hatch covers for spaces in which liquids are carried shall be designed for the liquid pressure and the thickness shall be determined according to [3.2.1].

3.2.4 Net scantlings of secondary stiffeners

The net section modulus, in \( cm^3 \), and net shear area, in \( cm^2 \), of uniformly loaded hatch cover stiffeners constraint at both ends shall not be less than:

\[
Z = \frac{104}{R_{eH}} \cdot s \cdot \ell^2 \cdot P_d
\]

\[
A_s = \frac{10 \cdot s \cdot \ell \cdot P_d}{R_{eH}}
\]

where:

\( P_d = \) design load, in kN/m², to be taken as:

\[ P_d = \max(P; P_D; P_H; P_{in}) \]

as applicable

The net section modulus of the stiffeners shall be determined based on an attached plate width assumed equal to the stiffener spacing.

For flat bar stiffeners and buckling stiffeners, the ratio \( h/t_w \) shall be not greater than \( 15 \times \sqrt{k} \), where:

\( h = \) height of the stiffener

\( t_w = \) net thickness of the stiffener.

Stiffeners parallel to main girder webs and arranged within the effective breadth according to [3.3.3] shall be continuous at crossing transverse girders and may be regarded for calculating the cross sectional properties of main girders. It shall be verified that the resulting combined stress of those stiffeners, induced by the bending of main girders and lateral pressures, does not exceed the permissible stress according to [3.1.1].

For hatch cover stiffeners under compression sufficient safety against lateral and torsional buckling according to [3.3.6] shall be verified.

For hatch covers subject to wheel loading stiffener scantlings shall be determined by direct calculations under consideration of the permissible stresses according to [3.1.1].

(IACS UR S21A.3.3)

(IACS UR S21.3.4 Rev.5)
3.2.5 Primary supporting members
Scantlings of main girders are obtained from the calculation according to [3.3] under consideration of permissible stresses according to [3.1.1].

For all components of main girders sufficient safety against buckling shall be verified according to [3.3.6]. For biaxially compressed flange plates this shall be verified within the effective widths according to [3.3.3].

The net thickness, in mm, of webs of primary supporting members shall not be less than:

\[ t = \max(0.0065b; 5.0) \]

where:

\[ b = \text{breadth, in mm, as defined in Ch.3 Sec.7 [2.1.1] and the Society's document DNVGL-CG-0128Buckling analysis, [3.2.4.3].} \]

The breadth of the primary supporting member flange shall be not less than 40% of their depth for laterally unsupported spans greater than 3.0 m. Tripping brackets attached to the flange may be considered as a lateral support for primary supporting members.

The flange outstand shall not exceed 15 times the flange thickness.

At intersections of flanges from two girders, notch stresses shall be observed.

(IACS UR S21A.3.4.1)

(IACS UR S21.3.5 Rev.5)

3.2.6 Edge girders (Skirt plates)
Scantlings of edge girders are obtained from the calculations according to [3.3] under consideration of permissible stresses according to [3.1.1].

The net thickness, in mm, of the outer edge girders exposed to wash of sea shall not be less than:

\[ t = \max(0.0162b\left(\frac{P_A}{R_{eh}}\right)^{0.5}; 0.0085b; 5.0) \]

The stiffness of edge girders of weather deck hatch covers shall be sufficient to maintain adequate sealing pressure between securing devices. The net moment of inertia, in cm⁴, of edge girders shall not be less than:

\[ I = 6q \cdot s_{SD}^{4} \]

where:

\[ q = \text{packing line pressure, in N/mm, with:} \]

\[ q \geq 5 \]

\[ s_{SD} = \text{spacing, in m, of securing devices.} \]

(IACS UR S21A.3.4.2)
3.2.7 Cantilevers, load transmitting elements
Cantilevers and load transmitting elements which are transmitting the forces exerted by hydraulic cylinders into the hatchway covers and the hull shall be designed for the forces stated by the manufacturer. The permissible stresses according to [3.1.1] shall not be exceeded.
Particular attention shall be paid to the structural design in way of locations where loads are introduced into the structure.

3.3 Strength calculation

3.3.1 General
Strength calculation for hatch covers may be carried out by either, using beam theory, grillage analysis or FEM.
(IACS UR S21A.1.5 and S21A.3.5)
(IACS UR S21.3.1 Rev.5)

3.3.2 Large cutouts
In way of larger cutouts in girder webs it may be required to consider second order bending moments.

3.3.3 Effective cross-sectional properties for calculation by beam theory or grillage analysis
Cross-sectional properties shall be determined considering the effective breadth. Cross sectional areas of stiffeners parallel to the primary supporting members under consideration within the effective breadth can be included, refer Figure 5.
The effective breadth of plating, $e_m$, of primary supporting members shall be determined according to Table 3, considering the type of loading. Special calculations may be required for determining the effective breadth of one-sided or non-symmetrical flanges.
The effective cross sectional area of plates shall not be less than the cross sectional area of the face plate.
For flange plates under compression with secondary stiffeners perpendicular to the web of the primary supporting member, the effective width shall be determined according to the Society's document DNVGL-CG-0128 Buckling analysis, Sec 3 [2.3.5].
(IACS UR S21A.3.5.1)
(IACS UR S21.3.2 Rev.5)
3.3.4 The actual cross-sectional properties of unsymmetrical primary supporting members shall be considered.

Table 4 Effective breadth of plating of primary supporting members, \( e_m \)

<table>
<thead>
<tr>
<th>( \ell/e )</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>( e_{m1}/e )</td>
<td>0</td>
<td>0.36</td>
<td>0.64</td>
<td>0.82</td>
<td>0.91</td>
<td>0.96</td>
<td>0.98</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>( e_{m2}/e )</td>
<td>0</td>
<td>0.20</td>
<td>0.37</td>
<td>0.52</td>
<td>0.65</td>
<td>0.75</td>
<td>0.84</td>
<td>0.89</td>
<td>0.90</td>
</tr>
</tbody>
</table>

\( e_{m1} \) shall be applied where primary supporting members are loaded by uniformly distributed loads or else by not less than 6 equally spaced single loads.

\( e_{m2} \) shall be applied where primary supporting members are loaded by 3 or less single loads.

Intermediate values may be obtained by direct interpolation.

\( \ell = \) length of zero-points of bending moment curve:

\[ \ell = \begin{cases} t_0 & \text{for simply supported primary supporting members} \\ 0.6t_0 & \text{for primary supporting members with both ends constraint,} \end{cases} \]

where \( t_0 \) is the unsupported length of the primary supporting member.

\( e = \) width of plating supported, measured from centre to centre of the adjacent unsupported fields.

3.3.5 General requirements for FEM calculations

For strength calculations of hatch covers by means of finite elements, the cover geometry shall be idealised as realistically as possible. Element size shall be appropriate to account for effective breadth. The element width shall in no case be larger than stiffener spacing. In way of force transfer points, cutouts and one-sided
or non-symmetrical flanges, the mesh shall be refined where applicable. The ratio of element length to width shall not exceed 4.

The element height of webs of primary supporting members shall not exceed one-third of the web height. Stiffeners, supporting plates against pressure loads, shall be included in the idealization. Buckling stiffeners may be disregarded for the stress calculation.

When a beam or a grillage analysis is used, the secondary stiffeners shall not be included in the attached flange area of the primary members.

(IACS UR S21A.3.5.2)
(IACS UR S21.3.1 Rev.5)

3.3.6 Buckling strength of hatch cover structures
For hatch cover structures sufficient buckling strength shall be demonstrated. Verifications of buckling strength according to Ch.8 shall be based on the net thicknesses corresponding applying the following safety factors $S$:

$S = 1.25$ for hatch covers when subjected to the load case A according to [2.2]

$S = 1.10$ for hatch covers when subjected to the load case A according to [2.2] as well as to load cases B to E according to [2.3] through [2.7].

For verification of buckling strength of plate panels stiffened with U-type stiffeners a correction factor $F_1 = 1.3$ may be applied.

(IACS UR S21A.3.6)
(IACS UR S21.3.1 Rev.5)

4 Details of hatch covers

4.1 Container foundations on hatch covers

4.1.1 Container foundations and their substructures shall be designed for the loads according to [2], load cases B and C, respectively, applying the permissible stresses according to [3.1.1].

(IACS UR S21A.4.1)

4.2 Weather tightness

4.2.1 General

Further to the following requirements IACS Rec. 14 is applicable to hatch covers.

(IACS UR S21A.4.2)

4.2.2 Tightness test, trials

The self-tightening steel hatch covers on weather decks and within open superstructures shall be hose tested. The water pressure in the hose nozzle shall not be less than 2 bar and the hose nozzle shall be held at a distance of not more than 1.5 m from the hatch cover to be tested. The nozzle diameter shall not be less than 12 mm. During frost periods equivalent tightness tests may be carried out to the satisfaction of the surveyor.

Upon completion of the hatchway cover, system trials for proper functioning shall be carried out in presence of the surveyor.

(IACS UR S14.4.1 and IACS UR S14.4.4.3)
4.3 Packing

4.3.1 Application
For weather deck hatch covers packings shall be provided, for exceptions see [4.3.3].

4.3.2 Material
The packing material shall be suitable for all expected service conditions of the ship and shall be compatible with the cargoes to be transported. The packing material shall be selected with regard to dimensions and elasticity in such a way that expected deformations can be carried. Forces shall be carried by the steel structure only.

The packings shall be compressed so as to give the necessary tightness effect for all expected operating conditions. Special consideration shall be given to the packing arrangement in ships with large relative movements between hatch covers and coamings or between hatch cover sections.

(IACS UR S21A.4.2.1)

4.3.3 Dispensation of weather tight gaskets
For hatch covers of cargo holds solely for the transport of containers, upon request by the customer and subject to compliance with the following conditions the fitting of weather tight gaskets according to [4.3.1] may be dispensed with:

— The hatchway coamings shall be not less than 600 mm in height.
— The exposed deck on which the hatch covers are located is situated above a depth, in m, which shall be shown to comply with the following calculated criteria:

\[ H(x) \geq T_{fb} + f_b + h \]

where:

\[ T_{fb} \] = draught, in m, corresponding to the assigned summer load line
\[ f_b \] = minimum required freeboard, in m, determined in accordance with ICLL
\[ h \] = height, in m, to be taken as:

\[ h = \begin{align*}
4.6 & \text{ for } \frac{x}{L} \leq 0.75 \\
6.9 & \text{ for } \frac{x}{L} > 0.75 
\end{align*} \]

— labyrinth or equivalents shall be fitted proximate to the edges of each panel in way of the coamings, the clear profile of these openings shall be kept as small as possible
— where a hatch is covered by several hatch cover panels the clear opening of the gap in between the panels shall not wider than 50 mm
— the labyrinths and gaps between hatch cover panels shall be considered as unprotected openings with respect to the requirements for intact and damage stability calculations
— with regard to drainage of cargo holds and the necessary fire-fighting system reference is made to the Pt.4 Ch.6 Sec.4 and Pt.4 Ch.11 Sec.3
— bilge alarms shall be provided in each hold fitted with non-weathertight covers
— furthermore, the requirements for the carriage of dangerous goods shall be complied with, refer to Chapter 3 of IMO MSC/Circ. 1087.

(IACS UR S21A.4.2.2)

4.3.4 Drainage arrangement
Cross-joints of multi-panel covers shall be provided with efficient drainage arrangements.
5 Hatch coaming design and strength criteria

5.1 General

5.1.1 Hatchways on freeboard and superstructure decks shall have coamings, the minimum height of which above the deck shall be as follows:
— in position 1: 600 mm
— in position 2: 450 mm

5.1.2 A deviation from the requirements given in [5.1.1] can only be granted for hatchways on exposed decks which are closed by weathertight, self tightening steel covers. In accordance with ICLL Regulation 14-1, exemptions shall, in advance, be applied for from the flag administration.

5.1.3 Where an increased freeboard is assigned, the height of hatchway coamings according to [5.1.1] on the actual freeboard deck may be as required for a superstructure deck, provided the summer freeboard is such that the resulting draught will not be greater than that corresponding to the minimum freeboard calculated from an assumed freeboard deck situated at a distance equal to a standard superstructure height \( h_N \) below the actual freeboard deck.

5.1.4 Coamings are not required for hatchways below the freeboard deck or within weathertight closed superstructures unless they are required for strength purposes.

5.1.5 Coamings which are 600 mm or more in height shall be stiffened by a horizontal stiffener. Where the unsupported height of a coaming exceeds 1.2 m additional stiffeners shall be arranged. Additional stiffeners may be dispensed with if this is justified by the ship's service and if sufficient strength is verified, e.g. in case of container ships.

5.1.6 The connection of the coamings to the deck at the hatchway corners shall be carried out with special care.

5.2 Local net plate thickness of coamings

5.2.1 The net thickness, in mm, of weather deck hatch coamings shall not be less than:

\[
t = c \cdot \sqrt[3]{\frac{P}{R_c H}} \text{ with } t \geq t_{\text{min}}
\]

where:

\( t_{\text{min}} \) = Minimum net thickness, in mm, to be taken as:

\[
t_{\text{min}} = 9.5 \quad \text{for bulk carrier according to Pt.5 Ch.1}
\]

\[
t_{\text{min}} = 6.0 + \frac{L_2}{100} \quad \text{for all other ships}
\]

\( c \) = coefficient, to be taken as:
\[ c = 16.4 \text{ for bulk carrier according to Pt.5 Ch.1} \]
\[ c = 14.6 \text{ for all other ships} \]

(IACS UR S21A.5.1)

(IACS UR S21.1 Rev.5 and IACS UR S21.4.2 Rev.5)

5.3 Net scantling of secondary stiffeners of coamings

5.3.1

The stiffeners shall be continuous at the coaming stays. For stiffeners with both ends constraint the elastic net section modulus, in cm\(^3\), and net shear area, in cm\(^2\), shall not be less than:

\[ Z = \frac{c \cdot s \cdot \ell^2 \cdot P_A}{f_p \cdot R_{eH}} \]
\[ A_s = \frac{10 \cdot s \cdot \ell \cdot P_A}{R_{eH}} \]

where:

\[ c \quad (= \text{coefficient, to be taken as:}) \]
\[ c = 75 \text{ for bulk carrier according to Pt.5 Ch.1} \]
\[ c = 83 \text{ for all other ships} \]

\[ f_p \quad (= \text{ratio of plastic and elastic section modulus, to be taken as:}) \]
\[ f_p = 1.16 \text{ can be used in the absence of more precise evaluation} \]
\[ f_p = 1.00 \text{ for ships other than bulk carrier according to Pt.5 Ch.1} \]

\[ Z_{pl} \quad (= \text{plastic section modulus, in cm}^3) \]
\[ Z_{el} \quad (= \text{elastic section modulus, in cm}^3) \]

For snipped stiffeners at coaming corners section modulus and shear area at the fixed support shall be increased by 35%. The gross thickness, in mm, of the coaming plate at the snipped stiffener end shall not be less than:

\[ t_{gr} = 19.6 \sqrt[3]{\frac{P_A \cdot s(\ell - 0.5s)}{R_{eH}}} \]

Horizontal stiffeners on hatch coamings, which are part of the longitudinal hull structure, shall be designed analogously to longitudinals according to Ch.6 Sec.5 [1].
5.4 Coaming stays

5.4.1 General
Coaming stays shall be designed for the loads transmitted through them and permissible stresses according to [3.1.1].

5.4.2 Coaming stay section modulus
The net section modulus, in $cm^3$, of coaming stays with a height of $h_s < 1.6$ m when designed as beams with flange connected to the deck or snipped and fitted with a bracket and which shall be designed for the load $P_A$, shall not be less than:

$$Z = \frac{526}{R_{efh}} \cdot e \cdot h_s^2 \cdot P_A$$

where:
- $e$ = spacing, in m, of coaming stays
- $h_s$ = height, in m, of coaming stays.

Coamings stays of coamings having a height of 1.6 m or more shall be designed using direct calculations under consideration of the permissible stresses according to [3.1.1]. For the calculation of $Z$ the effective breadth of the coaming plate shall not be larger than the effective plate width according to [3.3.3].

Coamings stays shall be supported by appropriate structures. Face plates may only be included in the calculation if an appropriate substructure is provided and welding ensures an adequate joint.

5.4.3 Web thickness of coaming stays
The net web thickness, in mm, of coaming stays at its lower end shall not be less than:

$$t_w = \frac{2}{R_{eh}} \cdot \frac{e \cdot h_s \cdot P_A}{h_w}$$

where:
- $e$ = spacing, in m, of coaming stays
- $h_s$ = height, in m, of coaming stays
- $h_w$ = web height, in m, of coaming stay at its lower end.

Webs shall be connected to the decks by fillet welds on both sides with a throat thickness of $a = 0.44 \cdot t_w$. For toes of stay webs within $0.15h_w$ the throat thickness shall be increased to $a = 0.7 \cdot t_w$ for $t_w \leq 10$ mm. For $t_w > 10$ mm deep penetration double bevel welds shall be provided in this area.
5.4.4 Coaming stays under friction load
For coaming stays, which transfer friction forces at hatch cover supports, sufficient fatigue strength according to Ch.9 shall be verified.
(IACS UR S21A.5.3.3)

5.5 Further requirements for hatch coamings

5.5.1 Longitudinal strength
Hatch coamings which are part of the longitudinal hull structure shall be designed according to Pt.5 Ch.1. For structural members welded to coamings and for cutouts in the top of coaming sufficient fatigue strength according to Ch.9 shall be verified. Longitudinal hatch coamings with a length exceeding 0.1 L shall be provided with tapered brackets or equivalent transitions and a corresponding substructure at both ends. At the end of the brackets they shall be connected to the deck by full penetration welds of minimum 300 mm in length.
(IACS UR S21A.5.4.1)

5.5.2 Local details
Hatch coamings and supporting structures shall be adequately stiffened to accommodate the loading from hatch covers, in longitudinal, transverse and vertical directions. Structures under deck shall be checked against the load transmitted by the stays. Weld connections and materials shall be dimensioned and selected in accordance with Ch.3 Sec.1 and Ch.13. Double continuous welding shall be adopted for the connections of stay webs with deck plating and the weld throat shall be not less than 0.44 tW, where tW is the gross thickness of the stay web. Toes of stay webs shall be connected to the deck plating with deep penetration double bevel welds extending over a distance not less than 15% of the stay width.
(IACS UR S21A.5.4.2)
(IACS UR S21A.5.4.3)

5.5.3 Stays
On ships carrying cargo on deck, such as timber, coal or coke, the stays shall be spaced not more than 1.5 m apart.
(IACS UR S21A.5.4.3)

5.5.4 Extent of coaming plates
Coaming girders shall extend to the lower edge of the deck beams; they shall be flanged or fitted with face bars or half-round bars.
(IACS UR S21A.5.4.4)

5.5.5 Drainage arrangement at the coaming
If drain channels are provided inside the line of gasket by means of a gutter bar or vertical extension of the hatch side and end coaming, drain openings shall be provided at appropriate positions of the drain channels. Drain openings in hatch coamings shall be arranged with sufficient distance to areas of stress concentration, e.g. hatch corners, transitions to crane posts. Drain openings shall be arranged at the ends of drain channels and shall be provided with non-return valves to prevent ingress of water from the outside. It is unacceptable to connect fire hoses to the drain openings for this purpose.
If a continuous outer steel contact between cover and ship structure is arranged, drainage from the space between the steel contact and the gasket shall also be provided for.

(IACS UR S21A.5.4.5)

### 6 Closing arrangement

#### 6.1 Securing devices

##### 6.1.1 General
Securing devices between cover and coaming and at cross-joints shall be provided to ensure weathertightness. Sufficient packing line pressure shall be maintained. Packing line pressures greater than 5 N/mm shall be specified in the drawings.

Securing devices shall be appropriate to bridge displacements between cover and coaming due to hull deformations.

Securing devices shall be of reliable construction and effectively attached to the hatchway coamings, decks or covers. Individual securing devices on each cover shall have approximately the same stiffness characteristics.

Sufficient number of securing devices shall be provided at each side of the hatch cover considering the requirements given in [3.2.6]. This applies also to hatch covers consisting of several parts.

Specifications of materials of securing devices and their weldings shall be shown in the drawings of the hatch covers.

Panel hatch covers shall be secured by appropriate devices (bolts, wedges or similar) suitably spaced alongside the coamings and between cover elements.

Arrangement and spacing shall be determined with due attention to the effectiveness for weather-tightness, depending upon the type and the size of the hatch cover, as well as on the stiffness of the cover edges between the securing devices.

(IACS UR S21A.6.1.1)

(IACS UR S21.5.1 Rev.5)

##### 6.1.2 Rod cleats
Where rod cleats are fitted, resilient washers or cushions shall be incorporated.

(IACS UR S21A.6.1.2)

(IACS UR S21.5.1 Rev.5)

##### 6.1.3 Hydraulic cleats
Where hydraulic cleating is adopted, a positive means shall be provided to ensure that it remains mechanically locked in the closed position in the event of failure of the hydraulic system.

(IACS UR S21A.6.1.3)

(IACS UR S21.5.1 Rev.5)

##### 6.1.4 Cross sectional area of the securing devices
The gross cross-sectional area, in cm\(^2\), of the securing devices shall not be less than:

\[
A_{\text{gr}} = 0.28 \cdot q \cdot s_{SP} \cdot k_f
\]

where:

\[ q = \text{packing line pressure, in N/mm, with:} \]

\[ q \geq 5 \]
Opening and closing appliances

\[ s_{SD} = \text{spacing, in m, between securing devices, with:} \]
\[ s_{SD} \geq 2 \]
\[ k_\ell = \frac{235}{R_e H} \]

Rods or bolts shall have a gross diameter not less than 19 mm for hatchways exceeding 5 m² in area.

Securing devices of special design in which significant bending or shear stresses occur may be designed according to [6.1.5]. As load the packing line pressure \( q \) multiplied by the spacing between securing devices \( s_{SD} \) shall be applied.

(IACS UR S21A.6.1.4)

(IACS UR S21.5.1 Rev.5)

6.1.5 Anti lifting devices

The securing devices of hatch covers, on which cargo shall be lashed, shall be designed for the lifting forces according to [2.4], load case C, refer to Figure 6. Unsymmetrical loadings, which may occur in practice, shall be considered. Under these loadings the von Mises stress, in N/mm², in the securing devices shall not exceed:

\[ \sigma_{vm} = \frac{150}{k_\ell} \]

(IACS UR S21A.6.1.5)

Figure 6 Lifting forces at a hatch cover

Securing devices of hatch covers for spaces in which liquids are carried shall be designed for the lifting forces according to [2.5], load case D.

Cargo deck hatch covers consisting of several parts shall be secured against accidental lifting.

6.1.6 Non-weathertight hatch covers

In the context of [4.3.3] an equivalence to [6.1.1] can be considered subject to:

— the proof that in accordance with [2.4] (load case C) securing devices shall not be required and additionally

— the transverse cover guides are effective up to a height \( h_E \) above the cover supports, see Figure 7. The height \( h_E \), in m, shall not be less than:
The transverse guides and their substructure shall be dimensioned in accordance with the loads given in [6.2.2] acting at the position $h_E$ using the von Mises stress level $\sigma_{vm} = R_{eh}$. 

![Figure 7 Height of transverse cover guides](image)

### 6.2 Hatch cover supports, stoppers and supporting structures

#### 6.2.1 General arrangement

Supports and stoppers of hatch covers are in general to be so arranged that no constraints due to hull deformations occur in the hatch cover structure and at stoppers respectively, see also load case E according to [2.7].

If two or more deck panels are arranged on one hatch, clearances in force transmitting elements between panels have generally to be observed.

#### 6.2.2 Horizontal mass forces

For the design of the securing devices against shifting, the horizontal mass forces, in kN, shall be obtained from the following formula.

$$F_h = m \cdot a_i$$

where:

- $a_i$ = acceleration, in m/s$^2$, to be taken as:
  - $a_i = 0.2g$ for acceleration in longitudinal direction
  - $a_i = 0.5g$ for acceleration in transverse direction
- $m$ = sum of mass, in t, of cargo lashed on the hatch cover and of the hatch cover.
6.2.3 Hatch cover supports

For the transmission of the support forces resulting from the load cases specified in [2] and of the horizontal mass forces specified in [6.2.2], supports shall be provided which shall be designed such that the nominal surface pressures in general do not exceed the following maximum values, $P_{n\text{-max}}$ in N/mm$^2$:

- $P_{n\text{-max}} = d \cdot P_n$ in general
- $P_{n\text{-max}} = 3 \cdot P_n$ for metallic supporting surfaces not subjected to relative displacements

where:

\[ d = \text{factor, to be taken as:} \]
\[ d = 3.75 - 0.015 L \text{ with } d_{\text{min}} \leq d \leq 3.0 \]

\[ d_{\text{min}} = \text{minimum factor, to be taken as:} \]
\[ d_{\text{min}} = 1.0 \text{ in general} \]
\[ d_{\text{min}} = 2.0 \text{ for partial loading conditions (see [2.6])} \]

\[ P_n = \text{permissible nominal surface pressure, in N/mm}^2, \text{ as defined in Table 4.} \]

### Table 5 Permissible nominal surface pressure, $P_n$

<table>
<thead>
<tr>
<th>Support material</th>
<th>$P_n$ when loaded by</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vertical force</td>
</tr>
<tr>
<td>Hull structural steels</td>
<td>25</td>
</tr>
<tr>
<td>Hardened steels</td>
<td>35</td>
</tr>
<tr>
<td>Plastic materials on steel</td>
<td>50</td>
</tr>
</tbody>
</table>

Where large relative displacements of the supporting surfaces shall be expected, the use of material having low wear and frictional properties is recommended.

If necessary, sufficient abrasive strength may be shown by tests demonstrating an abrasion of support surfaces of not more than 0.3 mm per one year in service at a total distance of shifting of 15 000 m/year.

The substructures of the supports shall be of such a design, that a uniform pressure distribution is achieved.

Irrespective of the arrangement of stoppers, the supports shall be able to transmit the force, in kN, in the longitudinal and transverse direction, obtained by the following formula:

\[ R = \mu \cdot \frac{P}{\sqrt{d}} \]

where:

\[ \mu = \text{frictional coefficient, to be taken as:} \]
\[ \mu = 0.50 \text{ for steel on steel} \]
\[ \mu = 0.35 \text{ for non-metallic, low-friction support materials on steel} \]

\[ P_v = \text{vertical supporting force, in kN.} \]

Supports as well as the adjacent structures and substructures shall be designed such that the permissible stresses according to [3.1.1] are not exceeded.

For substructures and adjacent structures of supports subjected to horizontal forces \( P_h \), a fatigue strength analysis shall be carried out according to Ch.9 by using the stress spectrum B and applying the horizontal force \( P_h \).

Drawings of the supports shall be submitted. In the drawings of the supports the permitted maximum pressure given by the material manufacturer related to long time stress shall be specified.

(IACS UR S21A.6.2.2)

6.2.4 Hatch cover stoppers

Hatch covers shall be sufficiently secured against shifting. Stoppers shall be provided for hatch covers on which cargo is carried as well as for hatch covers, which edge girders shall be designed for \( P_A \geq 175 \text{ kN/m}^2 \) according to [2.2.2].

The greater of the loads resulting from [2.2.2] and [6.2.2] shall be applied for the dimensioning of the stoppers and their substructure.

The permissible stress in stoppers and their substructures, in the cover, and of the coamings shall be determined according to [3.1.1]. In addition, the provisions in [6.2.3] shall be observed.

(IACS UR S21A.6.2.3)

(IACS UR S21.5.2 Rev.5)
SECTION 5 SIDE, STERN AND BOW DOORS - RAMPS

Symbols
For symbols not defined in this section, refer to Ch.1 Sec.4.

1 Side and stern doors/ ramps

1.1 Application

1.1.1 These requirements cover cargo and service doors in the ship side (abaft the collision bulkhead) and stern area, below the freeboard deck and in enclosed superstructures.

1.2 General

1.2.1 The side and stern doors shall be fitted as to ensure tightness and structural integrity commensurate with their location and the surrounding structure.

The number of such openings shall be the minimum compatible with the design and proper working of the ship.

All external openings leading to compartments assumed intact in the damage analysis, which are below the final damage waterline, are required to be watertight.

(2006/05 SOLAS Am/II-1/B-2/15-1)

1.2.2 The lower edge of any cargo or service door, if located below the freeboard deck, shall not be below a line drawn parallel to the freeboard deck at side, which at its lowest point is 230 mm above the upper edge of the uppermost load line. Special consideration shall be given to preventing the spread of any leakage water over the deck. A flatbar welded to the deck and provision of scuppers would be an acceptable arrangement.

1.2.3 Where the sill of any cargo or service door is below the line defined in [1.2.2], the arrangements will require to be specially considered to ascertain that the safety of the ship is in no way impaired. It is considered that the fitting of a second door of equivalent strength and watertightness is one acceptable arrangement. In that case leakage detection device should be provided in the compartment between the two doors. Further, drainage of this compartment to the bilges controlled by an easily accessible screw down valve, should be arranged. The outer door should preferably open outwards.

(IACS UI LL21)

1.2.4 Doors should preferably open outwards.

1.3 Structural arrangement

1.3.1 Door openings in the shell shall have well rounded corners and adequate compensation shall be arranged with web frames at sides and stringers or equivalent above and below.

1.3.2 Doors shall be adequately stiffened, and means shall be provided to prevent movement of the doors when closed. Adequate strength shall be provided in the connections of the lifting/manoeuvring arms and hinges to the doors structures and to the ship structure.

1.3.3 Doors with light opening area $A \geq 12 \, \text{m}^2$ shall be such that the sea pressure is transferred directly to the hull coamings.

1.3.4 For doors with light opening area $A < 12 \, \text{m}^2$ securing bolts or similar devices may be accepted as carriers of sea pressure to the coamings, if an arrangement as required in [1.3.3] is not feasible.
1.3.5 If a door is divided into separate sections, each section shall have full strength independent of the other sections.

1.3.6 Where doors also serve as vehicle ramps, the design of the hinges shall take into account the ship angle of trim and heel, which may result in uneven loading on the hinges.

1.4 Design loads at sea

1.4.1 Application
[1.4.2] and [1.4.4] apply in general, while [1.4.3] only applies to RO/RO Passenger ships and RO/RO Cargo ships.

1.4.2 Sea pressure
External sea pressure, \( P \), according to Ch.4 Sec.5.

Additional design loads for RoRo space (IACS UR S9)
1.4.3

The design force, in kN, for securing bolts and other closing devices, supporting members and surrounding structure is given by:

\[
F_1 = A \cdot P_e + F_p
\]

or

\[
F_2 = F_0 + 10W + F_p
\]

\( F_1 \) is applicable for ports opening inwards.

\( F_2 \) is applicable for ports opening outwards.

\[
P_e = \text{Design pressure in damaged condition in kN/m}^2
\]

\[
P_e = 10 \ h_b + 25 \ , \text{minimum 25}
\]

\( h_b \) = vertical distance in metres from the load point to the deepest equilibrium or intermediate waterline in damaged condition, obtained from applicable damage stability calculations.

\[
P_p = \text{total packing force in kN}
\]

\[
F_0 = \text{the greater of } F_C \text{ and } 5A \text{ in kN}
\]

\[
F_C = \text{accidental force in kN due to loose cargo or similar, to be uniformly distributed over the area } A \text{ and not to be taken less than 300 kN.}
\]

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 rampway is fitted, which is capable of protecting the door from accidental forces due to loose cargo or similar.

\[
A = \text{area of door opening in m}^2 \text{ to be determined on the basis of the loaded area taking account of the direction of the pressure}
\]

\[
W = \text{mass of door in kg.}
\]

\( P_e \) is normally to be calculated at the midpoint of \( A \).

Packing force shall be decided depending on type and hardness of packing. For calculation purpose, however, the packing line pressure shall not be taken less than 5 N/mm. The packing line pressure shall be specified.

1.4.4 Damaged condition
If the ramp is required to be watertight in damaged condition, design pressure according to Ch.4 Sec.6 [1.2.7] applies.
1.5 Design loads in port

1.5.1 Vehicle loads
Where doors also serve as vehicle ramps, relevant design loads are defined in Ch.10 Sec.5 [2].

1.5.2 Load combinations under port operations
The ramps shall have their strength checked for all possible combinations of design loads during loading/off-loading operations, e.g., vehicle placement on the ramp, driving on the ramp of more than one vehicle at a time etc.

A loading condition simulating the closing operation for the door shall be studied. More than one load case may be required to determine the worst condition for the girder system and for the reaction loads at the supports.

Ramps shall have sufficient flexibility for resting on the quay during loading/off-loading operations with a minimum heel/trim of 3 degrees. A direct stress analysis may have to be carried out to demonstrate that stresses are acceptable.

1.6 Plating

1.6.1 Minimum thickness
The gross thickness is in no case to be less than the net minimum shell plate thickness plus the applicable corrosion addition.

Seagoing condition
1.6.2
Plate thickness requirement due to sea pressure shall be calculated according to Ch.6 Sec.4 [1.1] with:

\[ C_a = 1.0 \ (AC-II) \]

Vehicle loads
1.6.3
Where doors also serve as vehicle ramps, plate thickness requirement given in Ch.10 Sec.5 [3.1] applies.

1.7 Stiffeners

Seagoing condition
1.7.1
Yield criteria based on sea pressure shall be calculated according to Ch.6 Sec.5 [1.1] with:

\[ C_a \text{ and } C_t = 0.9 \ (AC-II) \]

Edge stiffeners
1.7.2
Edge stiffeners of doors shall have a net moment of inertia, in cm^4, not less than:

\[ I = 8p_{\ell} \cdot d^4 \]

for cover edges connected to a rigid ship structure member or adjacent door coaming.

where:
Part 3 Chapter 12 Section 5

1.8 Girders

1.8.1 Grillage systems
The strength of primary structural members that form part of a grillage system shall be determined by direct strength analysis either by the use of beam- or FE model. Prescriptive requirement given in [1.8.2] and [1.8.4], may then be disregarded.

Loads and load combinations are given in [1.4] and [1.5] and acceptance criteria in [1.9].

Section modulus
1.8.2
Yield criteria based on sea pressure shall be calculated according to Ch.6 Sec.5 [1.1] with:
\[ C_a \text{ and } C_t = 0.85 \text{ (AC-II)} \]

Web stiffeners
1.8.3
The webs of girders and stringers shall be adequately stiffened, preferably in a direction perpendicular to the shell plating.

Edge girders
1.8.4
The girder system shall be given sufficient stiffness to ensure integrity of the boundary support of the door. Edge girders should be adequately stiffened against rotation and shall have a net moment of inertia, in cm\(^4\), not less than:

\[
l = 8 p \ell \cdot d^4
\]

\[ d \text{ = distance between closing devices in m}\]
\[ p \ell \text{ = packing line pressure in N/mm, see [1.4.3]}\]

For edge girders supporting main door girders between securing devices, the moment of inertia shall be increased in relation to the additional force.

1.9 Acceptance criteria for direct calculations

1.9.1 Sea pressure and damaged condition
For sea pressure according to [1.4.2], the stresses, in N/mm\(^2\), shall not exceed the following permissible values:

\[ Bending \text{ stress (normal membrane stress)} = 0.9 R_{eH} \]
\[ Shear \text{ stress} = 0.9 \tau_{eH} \]
\[ von \text{ Mises stress (for FE only)} = R_{eH} \]
1.9.2 Additional sea pressure for RORO space (IACS UR S9)
For additional seagoing load cases according to [1.4.3], the stresses, in N/mm², shall not exceed the following permissible values:

\[ \text{Bending stress (normal membrane stress)} = 0.5 R_{eh} \]
\[ \text{Shear stress} = 0.6 \tau_{eh} \]
\[ \text{von Mises stress (for FE only)} = 0.65 R_{eh} \]

1.10 Closing arrangement, general

1.10.1 Closing devices shall be simple to operate and easily accessible. Where hinges are used as closing devices they shall be well integrated into the door structure.

1.10.2 Packing material shall be of a comparatively soft type, and the supporting forces shall be carried by the steel structure only. Other types of packing will be specially considered.

1.10.3 For side or stern door opening inwards, which in damaged condition can be immersed at equilibrium or intermediate water plane, the deflections of the door frame shall be documented to not affect the watertight capacity. The structural analysis shall include the flexibility of the surrounding structure. Test to be made according to Sec.1 [2.3.3].

1.10.4 Flat bar or similar fastening devices for packings shall have scantlings and welds determined with simple considerations to wear and tear.

1.10.5 Devices shall be arranged for the doors to be secured in open position.

1.10.6 Documented operating procedures for closing and securing of side shell, bow and stern doors shall be kept on board and posted at the appropriate places.

1.10.7 Openings in the shell plating below an equilibrium or intermediate water plane in damaged condition shall be fitted with a device that prevents unauthorized opening if they are accessible during the voyage. (2006/05 SOLAS Am/II-1/B-2/15-1)

1.11 Closing arrangement, strength

1.11.1 Side and stern doors shall be fitted with adequate means of closing and securing, commensurate with the strength of the surrounding structure.

1.11.2 The number of devices is generally to be the minimum practical whilst taking into account the requirement for redundant provision given in [1.11.6] and the available space for adequate support in the surrounding hull structure which may limit the size of each device.

1.11.3 Only supports having an effective stiffness in a given direction shall be included in a calculation of the load carrying capacity of the devices. The total external or internal force, as given in [1.4], may normally be considered as equally distributed between the devices. However, the distribution of the total forces acting on the supports may, for doors with a complex closing arrangement, be required calculated by a direct calculation taking into account the flexibility of the door and surrounding hull structure and the position of the supports. Maximum design clearance for effective supports shall normally not exceed 3 mm. Design clearances shall be included in the Operating and Maintenance Manual as given in Sec.1 [2.2]. Allowable normal, shear and von Mises stresses in closing and supporting elements are as given in [1.9].
1.11.4 The nominal tensile stress in way of threads of bolts shall not exceed 125/k N/mm². The arrangement of securing and supporting devices shall be such that threaded bolts do not carry support forces.

1.11.5 For steel to steel bearings in closing and supporting devices, the nominal bearing pressure calculated by dividing the design force by the projected area shall not exceed 0.8 \( R_{eh} \), where \( R_{eh} \) is the yield stress of the bearing material. For other bearing materials, the permissible bearing pressure shall be determined according to the manufacturer's specification.

1.11.6 For side and stern 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 as given in [1.9] may be increased by 20%.

1.11.7 All load transmitting elements in the design load path, from the door through securing and supporting devices into the ship structure, including welded connections, shall be to the same strength standard as required for the securing and supporting devices.

1.12 Closing arrangement, system for operation and indication/monitoring

1.12.1 Cleats and support devices shall be equipped with mechanical locking arrangement (self locking or separate arrangement) or to be of the gravity type.

1.12.2 Where hydraulic operating systems are applied, cleats and support devices shall remain locked in closed position in case of failure in the hydraulic system.

1.12.3 Systems for opening and closing of the door, operation of cleats and support devices and, where applicable, for locking arrangement shall be interlocked in such a way that they can only operate in the proper sequence. Hydraulic operating systems shall be isolated from other circuits and to be blocked when doors and closing arrangement are in closed/locked position.

1.12.4 Signboards giving instructions to the effect that the doors shall be closed and all the closing devices locked before leaving quay side (or terminal), shall be placed at the operating panel (or for small doors at the door when no operating panel) and on the bridge, and shall be supplemented by warning indicator lights on the panel and on the bridge.

1.12.5 Doors with clear opening area greater than 6 m² shall be provided with an arrangement for remote control, from a convenient position above the freeboard deck, of:

— the closing and opening of the doors
— associated cleats, support and locking devices.

For doors which are required to be equipped with a remote control arrangement, the open/closed position of the door and every closing device (cleats, support and locking device) shall be indicated at the remote control station.

The operating panel for remote controlled doors shall be inaccessible to unauthorised persons.

1.12.6 The requirements given in [1.12.7] to [1.12.11] apply to doors in the boundary of special category spaces or ro-ro spaces, 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 6 m², then the requirements given in [1.12.7] to [1.12.11] need not be applied.

1.12.7 Separate indicator lights shall be provided on each operating panel to indicate that the doors are closed and that their cleats, support and locking devices as applicable are properly positioned. Indication panels shall be provided with a lamp test function.
1.12.8 Separate indicator lights and audible alarms shall be provided on the navigation bridge to show and monitor that each of the doors is properly positioned and that cleats, support and locking devices as applicable are properly positioned.

The indicator system shall show by visual indication if any of the doors are not fully closed and not fully locked, and by audible alarms if securing devices become open or locking devices become unsecured.

The indication panel on the navigation bridge shall 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 quay side (or terminal) with any side shell or stern door not closed or with any of the cleats, support and locking devices, as applicable, not in the correct position.

When a mechanical lock is placed inside the hydraulic cylinder operating a cleat or support, indication of the open or closed position of the cleat or support shall be made on the lock inside the cylinder.

1.12.9 The indicator and alarm system on the navigation bridge shall be designed on the fail-to-safe principle in compliance with the following:

— The indication panel shall be provided with:
  — a power failure alarm, provided for both power sources
  — an earth failure alarm
  — a lamp test device
  — for each door, separate indications for door closed / not closed, door locked / not locked.
  — a dimmer (however, it shall not be possible to turn off the indicator lights completely).

— The electrical circuits used for indicating door position shall be normally closed when the door is completely closed and completely open. When more limit switches are provided for each door they may be connected in series.

— The electrical circuit used for indicating securing arrangements position shall be normally closed when the securing arrangements are completely locked and completely un-locked. When more limit switches are provided for each door they may be connected in series.

— Separate circuits shall be arranged for indication of door position (closed / not closed) and for securing arrangements position (locked / not locked). Multicore cable is permitted.

— In case of dislocation of limit switches, this shall be indicated by not closed / not locked / securing arrangement not in place - as appropriate.

1.12.10 The power supply for indicator and alarm systems shall be independent of the power supply for the operating and closing arrangements and shall be provided with a backup power supply from the emergency source of power or secure power supply, e.g. UPS (Uninterrupted Power Supply) with a minimum capacity of 30 minutes.

Sensors for the indicator system shall be protected from water, ice formation and mechanical damage.

1.12.11 For passenger ships, a water leakage detection system with audible alarm and television surveillance shall 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 shall be arranged to provide an indication to the navigation bridge.

1.12.12 For Ro/Ro passenger ships, the special category spaces and Ro/Ro spaces shall be continuously patrolled or monitored by effective means, such as television surveillance, so that any movement of vehicles in adverse weather conditions and unauthorised access by passengers thereto can be detected whilst the ship is underway.
2 Bow doors

2.1 Application and definitions

2.1.1 The requirements given below are for the arrangement, strength and securing of bow doors and inner doors leading to a complete or long forward enclosed superstructure. In case bow impact loads for ships with service area restriction are reduced according to [2.4.2], conditions established in this respect shall be presented in the Operating and Maintenance Manual.

2.1.2 For outer bow doors, the requirements apply to the following two types of doors:
   a) Visor doors opened by rotating upwards on the horizontal axis through hinges located near the top of the door and connected to the primary structure of the door by longitudinally arranged lifting arms
   b) Side hinged doors opened by rotating outwards on a vertical axis through two or more hinges located near the outboard edges. It is anticipated that side hinged doors are arranged by pairs.

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

2.1.3 The closing arrangements for bow doors normally encompass:
   — doors
   — ramps
   — hinges
   — packings
   — cleats
   — supports
   — locking arrangement.

2.2 Arrangement

2.2.1 Bow doors shall 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.

2.2.2 Where bow doors are leading to a complete or long forward enclosed superstructure, an inner door shall be fitted. The inner door shall 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 Ch.2 Sec.2 [4]. 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.

2.2.3 Outer doors shall 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 shall be weather tight over the full height of the cargo space and shall be arranged with supports on the aft side of the doors.

2.2.4 Bow doors shall 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 [2.2.4] it is advised that the hinges of the outer bow door should not be attached to structural elements being part of the collision bulkhead or to the upper deck at a position aft of the collision bulkhead at the point of attachment. If the above mentioned solution is not possible, due attention should be given to the design of the hinge pin (axle) and fastening of this to ensure this is the weak link compared to the fastening/support of the hinge-plate (lug) to the ship structure.
This shall ensure that any possible damage occurs in the hinge pin or in way of this, and not the hinge-plate fastening/support or adjacent ship structure which in turn may lead to damage of the collision bulkhead.

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

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

2.2.5 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, shall be capable of sustaining the sea loads as given in [2.4.3] for the inner door.

2.2.6 The requirements for inner doors are based on the assumption that the vehicles are effectively lashed and secured against movement in stowed position.

2.3 Materials

2.3.1 The structural materials for bow doors shall satisfy the requirements given for hull materials.

2.3.2 Steel forgings or castings used in the closing arrangement and manoeuvring components shall be of approved ductile materials, tested in accordance with the requirements given in Pt.2.

The material factor $k$ shall not be taken less than 0.72 unless a direct fatigue analysis is carried out.

2.4 Design loads

2.4.1 Outer doors, ordinary design sea pressure:

$$P_e = \text{external sea pressure as given in Ch.4 Sec.5 [1], in kN/m}^2.$$ 

2.4.2 Outer doors, design bow impact pressure:

$$P_{se} = \text{as given for } P_{FB} \text{ in Ch.10 Sec.1 [2] with } \gamma = 0, \text{ in kN/m}^2.$$ 

For ships with service area restrictions $\text{R2}$ to $\text{RE}$ the wave coefficient, $C_w$, may be reduced as follows for calculations of bow door impact pressure:

— service area notation $\text{R2}$: 10%
— service area notation $\text{R3}$: 20%
— service area notation $\text{R4}$: 30%
— service area notation $\text{RE}$: 40%.

2.4.3 For inner doors including surrounding structures forming part of the collision bulkhead above the freeboard deck, the design sea pressure, in kN/m$^2$, shall be taken as the greater of:

$$P_e = 0.6 \ L$$

$L$ = ship’s length, in m, as given in Ch.1 Sec.4 [3.1.1], but need not be taken greater than 200 m or

$$P_h = 10 \ h_b$$

$h_b$ = vertical distance, in m, from load point to top of cargo space.

2.4.4 The internal design pressure, in kN/m$^2$, for bow doors shall not be taken less than:
$P_i = 25$

2.4.5 The design forces, in kN, on each half of the outer door for support devices, including supporting structural members and surrounding structures, are given in Figure 1:

![Figure 1 Bow Doors](image)

External forces, in kN:

- total longitudinal force:
  
  $$F_x = 0.375 P_{se} A_x \text{ or } 1.3 P_e A_x, \text{ if greater}$$

- total transverse force:
  
  $$F_y = 0.375 P_{se} A_y \text{ or } 1.3 P_e A_y, \text{ if greater}$$

- total vertical force:
  
  $$F_z = 0.375 P_{se} A_z \text{ or } 1.3 P_e A_z, \text{ if greater}$$

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

$A_x = \text{area, in m}^2, \text{ of the transverse vertical projection of the outer door at one side of the centre line, between the levels of the bottom of the door and the top of the upper deck bulwark, or between the bottom of the door and the top of the door, including the bulwark, where it is part of the door, whichever is lesser.}$
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.

In determining the height from the bottom of the door to the upper deck or to the top of the door, the bulwark shall be excluded.

\[ A_y = \text{area, in m}^2, \text{of the longitudinal vertical projection of the outer door between the levels of the bottom of the door and the top of the upper deck bulwark, or between the bottom of the door and the top of the door, including the bulwark, where it is part of the door, whichever is lesser.} \]

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.

\[ A_x = \text{area, in m}^2, \text{of the horizontal projection of the outer door at one side of the centre line, between the bottom of the door and the top of the upper deck bulwark, or between the bottom of the door and the top of the door, including the bulwark, where it is part of the door, whichever is lesser.} \]

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.

The design pressures shall 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, in kN:
- total longitudinal force: \( F_{xi} = P_x A_x \)
- total transverse force: \( F_{yi} = P_y A_y \).

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

External force, in kN:
- total longitudinal force:
  \[ F_x = P_e A_x \text{ or } P_t A_x, \text{ if greater.} \]

Internal force, in kN:
- total longitudinal force:
  \[ F_{xi} = P_r A_x \]

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

2.5 Strength criteria

2.5.1 In connection with direct strength calculations as stipulated in [2.9.3], scantlings of primary members and supports of bow doors shall be determined to withstand the design pressures using the following allowable stresses:
### Table 1 Allowable stresses, outer doors, including supporting members and surrounding structure

<table>
<thead>
<tr>
<th>Design pressure in kN/m² ( P )</th>
<th>Shear stress in N/mm² ( \tau )</th>
<th>Bending or normal stress in N/mm² ( \sigma )</th>
<th>von Mises stress in N/mm² ( \sigma_{vm} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.375 ( P_{se} ) or ( P_e )</td>
<td>105 /k</td>
<td>160 /k</td>
<td>200 /k</td>
</tr>
</tbody>
</table>

### Table 2 Allowable stresses, inner doors, including supporting members and surrounding structure

<table>
<thead>
<tr>
<th>Design pressure in N/mm² ( P )</th>
<th>Shear stress in N/mm² ( \tau )</th>
<th>Bending or normal stress in N/mm² ( \sigma )</th>
<th>von Mises stress in N/mm² ( \sigma_{vm} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( P_{e}, P_h ) or ( P_i )</td>
<td>105 /k</td>
<td>160 /k</td>
<td>200 /k</td>
</tr>
</tbody>
</table>

2.5.2 The nominal tension in way of threads of bolts not carrying support forces shall not exceed 125/k in N/mm².

2.5.3 Nominal bearing pressure, determined by dividing the design force by the projected bearing area, shall not exceed 0.8 \( R_{eh} \), in N/mm², for steel material where \( R_{eh} \) is the yield stress for the bearing material. For other bearing materials the nominal bearing pressure will be specially considered.

### 2.6 Structural arrangement

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

2.6.2 For outer doors the structural arrangement and the member scantlings shall comply with the requirements for bow impact in Ch.10 Sec.1 [2].

### 2.7 Plating

2.7.1 The gross thickness requirement for the bow door plating, in mm, corresponding to lateral pressure is given by the greater of:

a) inner and outer doors:

\[
t_{1-gr} = 0.0158 \alpha P b \sqrt{\frac{P}{160 /k}}
\]

where:

\( = P_{se} \) for outer doors
\( = P \max(P_{e}, P_h, P_i) \) for inner doors

b) outer doors:
$P_{FB}$ = bow impact pressure, in kN/m$^2$, as given in Ch.10 Sec.1 [2].

The gross thickness of the inner door shall not be less than the minimum net thickness for the collision bulkhead according to Ch.6 Sec.3 [1.1], plus applicable corrosion addition according to Ch.3 Sec.3 [1.2].

### 2.8 Stiffeners

#### 2.8.1 The gross section modulus, in cm$^3$, of horizontal or vertical stiffeners shall not be less than the greater of:

- inner and outer doors:

\[
Z_{1-gr} = \frac{f_{bdg}^2 s \cdot P}{f_{bdg}(160/k)}
\]

where:

- $P = P_e$ for outer doors
- $P = \max(P_e, P_h, P_i)$ for inner doors

- outer doors:

The gross plastic section modulus of shell stiffeners, in cm$^3$, calculated in accordance with Ch.3 Sec.7 [1.4.5], shall not be less than the requirement as given in Ch.10 Sec.1 [3.2.1].

#### 2.8.2 The stiffener web plate at the ends shall have a gross sectional thickness, in mm, not less than the greater of:

- inner and outer doors:

\[
t_{w-gr} = \frac{0.7 P \cdot s \cdot d_{shr}}{d_{shr}(105/k)}
\]

where:

- $P = P_e$ for outer doors
- $P = \max(P_e, P_h, P_i)$ for inner doors
- $d_{shr}$ = effective web depth of stiffener in mm, as defined in Ch.3 Sec.7 [1.4.3].

- outer doors:

\[t_{w-gr} = t_w\] required net web thickness, in mm, for stiffeners as given in Ch.10 Sec.1 [3.2.1].
2.9 Girders

2.9.1 The gross elastic section modulus of single girders, in cm$^3$, shall not be less than the greater of:

a) Inner and outer doors:

$$Z_{1-gr} = 0.8P \cdot S \cdot \ell_{bdg}^2 k$$

where:

\[
P = P_e \text{ for outer doors}
\]
\[
P = \max(P_e, P_n, P_i) \text{ for inner doors}
\]
\[
d_{shr} \text{ effective web depth of stiffener in mm, as defined in Ch.3 Sec.7 [1.4.3].}
\]

b) outer doors:

$$Z_{2-gr} = Z_{n50} , \text{ required net section modulus, in cm}^3, \text{ as given in Ch.10 Sec.1 [3.3.2].}$$

2.9.2 The gross web area requirement (after deduction of cut-outs), in cm$^2$, at the girder ends is given by the greater of:

a) inner and outer doors:

$$A_{1-gr} = \frac{0.007P \cdot S \cdot \ell_{shr}^{105/k}}{105/k}$$

where:

\[
P = P_e \text{ for outer doors}
\]
\[
P = \max(P_e, P_n, P_i) \text{ for inner doors}
\]

b) outer doors:

$$A_{2-gr} = A_{shr-n50} , \text{ required net shear area of the web, in cm}^2, \text{ as given in Ch.10 Sec.1 [3.3.2].}$$

2.9.3 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 [2.5].

2.9.4 The buckling strength of primary members shall be verified as found adequate.

2.9.5 The arrangement, scantlings and stiffening of girders and diaphragms supporting shell stiffeners of outer bow doors shall comply with requirements given in Ch.10 Sec.1 [3.3].

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

2.9.7 Where inner doors serve as vehicle ramps wheel loads shall be considered as given in Ch.10 Sec.5.
2.10 Closing arrangement, general

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

2.10.2 Devices provided for closing of bow doors shall be simple to operate and easily accessible.

2.10.3 Closing arrangement for bow doors shall be provided with devices arranged for remote control from a convenient position above the freeboard deck. The operating panel for remotely controlled bow doors shall be inaccessible for unauthorised persons.

2.10.4 Notice plates, giving instructions that bow doors shall be closed and all closing devices are locked before leaving quay-side (or terminal) shall be placed at the operating panel and on the navigation bridge.

2.10.5 For outer doors of the side-hinged type thrust bearings shall 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 Figure 2). The two parts shall be kept together by means of cleats. Other arrangement serving the same purpose may be considered.

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

where:

\[ a = \text{vertical distance, in m, from visor hinge to position } h/2 \]
\[ b = \text{horizontal distance, in m, from visor hinge to position } t/2 \]
2.10.7 Devices shall be arranged for the bow doors to be secured in open position. Bow doors of the visor type shall be mechanically secured in open position.

2.10.8 Where packing is required the packing material shall be of a comparatively soft type, and the supporting forces shall be carried by the steel structure only. Other types of packing may be considered. Flat bars or similar fastening devices for packing shall have scantlings and welds determined with ample consideration to wear and tear.

2.10.9 Documented operating procedures for closing and securing the bow doors shall be kept on board and posted at the appropriate places.

2.11 Closing arrangement, strength

2.11.1 Only supports having an effective stiffness in a given direction shall be included in calculation of the load carrying capacity of the devices. The distribution of the total forces acting on the supports may, for doors with a complex closing arrangement, be required calculated by a direct calculation taking into account the flexibility of the door and surrounding hull structure and the position of the supports. The number of supports is generally to be the minimum practical taking into account the requirements for redundant provision as given in [2.11.3] 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 shall normally not exceed 3 mm. Design clearances shall be included in the Operating and Maintenance Manual as given in Sec.1 [2.2].

2.11.2 In general the maximum forces acting on the supports shall be established on the basis of the external and internal forces as given in [2.4.5] and [2.4.6]. The following cases shall be considered:

1) For outer doors of the visor type the forces acting on the supports shall be determined for the following combination of simultaneous design forces:
   a) $2F_x$ and $2F_z$
   b) $1.4F_x$, $0.7F_y$ and $1.4F_z$, with $0.7F_y$ acting alternatively from either side.

2) For outer doors of the side hinged type the forces acting on the supports shall be determined for the following combination of simultaneous design forces:
   a) $F_x$, $F_y$ and $F_z$, with each force acting on both doors
   b) $0.7F_x$, $0.7F_y$ and $0.7F_z$, acting on each door separately.

Guidance note:
The support forces as determined according to 1 a) and 2 a) shall in general give rise to a zero moment in the longitudinal vertical plane about the transverse axis at $h/2$ and $t/2$.

2.11.3 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 1 in [2.5.1] may be increased by 20%.

2.11.4 For outer doors of the visor type, at least two securing devices shall 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 1 in [2.5.1]. The opening moment, in kNm, to be balanced by the said reaction force shall not be taken less than:

$$M = 1.3(10W \cdot d + 5A_q \cdot a)$$
where:

\[ W = \text{mass of the door in t} \]
\[ a = \text{vertical distance, in m, from visor hinge to the centroid of the vertical projected area of the bow visor} \]
\[ d = \text{vertical distance, in m, from hinge axis to the centre of gravity of the door.} \]

\[ A_r \text{ as defined in [2.4.5].} \]

2.11.5 All load transmitting elements in the design load path, from the door through supports into the ship structure, including welded connections, shall be to the same strength standard as required for the supports.

2.11.6 The lifting arms of a visor type outer door and its connections to the door and hull structure shall be dimensioned for the static and dynamic forces applied during lifting and lowering operations. A minimum wind pressure of 1.5 kN/m² shall be taken into account.

2.12 Closing arrangement, system for operation and indication and monitoring

2.12.1 Cleats and support devices shall be equipped with locking arrangement (self locking or separate arrangement) or shall be of the gravity type.

**Guidance note:**
Alternative locking arrangements may be accepted depending upon the location and reliability of the arrangement.

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

2.12.2 Where hydraulic operating systems are applied, cleats and support devices shall remain locked in the closed position in case of failure in the hydraulic system.

2.12.3 Systems for operation of cleats and support devices and, where applicable, for locking arrangement shall be interlocked in such a way that they can only operate in the proper sequence. Hydraulic operating systems shall be isolated from other circuits and shall be inhibited when doors and closing arrangement are in the closed or locked position.

2.12.4 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 shall be provided at the operating panel for remote control. The indication panel shall be provided with a lamp test function.

When a mechanical lock is placed inside the hydraulic cylinder operating a cleat or support, indication of the open or closed position of the cleat or support shall be made on the lock inside the cylinder.

2.12.5 Separate indicator lights and audible alarms shall be provided on the navigation bridge to show and monitor that each of the bow doors is properly closed and that cleats, support and locking devices as applicable are properly positioned.

The indicator system shall show by visual indication if any of the bow doors are not fully closed and not fully locked, and by audible alarms if securing devices become open or locking devices become unsecured.

2.12.6 The alarm and indication panel on the navigation bridge shall be equipped with a mode selection function “harbour/sea voyage” so arranged that audible alarm is given on the navigation bridge 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.

2.12.7 The indicator and alarm systems on the navigation bridge mentioned under [2.12.7] shall be designed on the fail-to-safe principle in compliance with the following:
1) The indication panel shall be provided with:
   — a power failure alarm, provided for both power sources
   — an earth failure alarm
   — a lamp test device
   — for each door, separate indications for door closed/not closed, door locked/not locked.
   — a dimmer (however, it shall not be possible to turn off the indicator lights completely).

2) The electrical circuits used for indicating door position shall be normally closed when the door is completely closed and completely open. When more limit switches are provided for each door they may be connected in series.

3) The electrical circuit used for indicating securing arrangements position shall be normally closed when the securing arrangements are completely locked and completely un-locked. When more limit switches are provided for each door they may be connected in series.

4) Separate circuits shall be arranged for indication of door position (closed/not closed) and for securing arrangements position (locked/not locked). Multicore cable is permitted.

5) In case of dislocation of limit switches, this shall be indicated by not closed/not locked/secure arrangement not in place - as appropriate.

2.12.8 The power supply for indicator and alarm systems for operating and closing doors shall be independent of the power supply for the operating and closing arrangements and shall be provided with a backup power supply from the emergency source of power or other secure power supply, e.g. UPS (Uninterrupted Power Supply) with a minimum capacity of 30 minutes.

2.12.9 Sensors for the indicator system shall be protected from water, ice formation and mechanical damage with degree of protection of at least IP 56.

2.12.10 A water leakage detection system with audible alarm and television surveillance shall be arranged to provide an indication to the navigation bridge and to the engine control room of leakage through the inner door.

2.12.11 In the space between the outer and the inner doors a television surveillance system shall be arranged with monitors on the navigation bridge and in the engine control room. The system shall monitor the position of the doors and a sufficient number of devices for the closing arrangement. Special consideration shall be given for the lighting and contrasting colour of objects under surveillance.

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

2.12.13 Special category spaces and ro-ro spaces shall be continuously patrolled or monitored by effective means, such as television surveillance, so that any movement of vehicles in adverse weather conditions and unauthorised access by passengers thereto can be detected whilst the ship is underway.

Guidance note:
Items [2.12.4] to [2.12.12] apply to shell doors, loading doors and other closing appliances for all passenger ships with ro-ro spaces or special category spaces as defined in Ch.1 Sec.4 Table 7 which, if left open or not properly closed and locked, could lead to a major flooding of such spaces.

---end---of---guidance---note---
SECTION 6 WINDOWS, SIDE SCUTTLES AND SKYLIGHTS

Symbols
For symbols not defined in this section, refer to Ch.1 Sec.4.

1 Application and general requirements

1.1 Application and general requirements

1.1.1 The requirements given in this section apply to side scuttles, windows and skylights located on the shell, external bulkheads of superstructures and deckhouse and weather decks of ship structures.

1.1.2 The section gives requirements for the arrangement and strength of the glass and frame structure of items in [1.1.1] together with methods of securing the glass to the frames.

1.1.3 Side scuttles and windows together with their glasses, deadlights and storm covers, if fitted, shall be of an approved design and substantial construction. Non-metallic frames are not acceptable.

Guidance note:
Deadlights are fitted to the inside of windows and side scuttles while ‘storm covers’ are fitted to the outside of windows, where accessible, and may be hinged or portable.

1.1.4 Side scuttles and windows, made and tested according to ISO 1751 for side scuttles and ISO 3903 for windows, with glass according to ISO 21005 and glass tested and marked according to ISO 614 will normally be accepted. The same applies for other international or national standards equivalent to the ISO-standards.

1.1.5 Window designs which have an opening area above 1 m² and are not covered by a recognized standard or a type approval certificate, shall be subject to testing as described in [6.1].

1.1.6 The glass panes of windows and side scuttles shall be made either by single pane toughened safety glass or laminated toughened safety glass. Toughened safety glass shall be made according to ISO 21005.

1.1.7 Laminated toughened safety glass shall be bonded over its entire mating surfaces by an adhesive, e.g. polyvinyl butyral (PVB).

1.1.8 In case of chemically toughened glass, the depth of chemical toughening shall not be less than 30 µm. The glass batches shall be qualified by testing in accordance with EN 1288-3. The ISO 614, 1095 and 21005 shall be observed. The use of chemically toughened glass shall not be permitted in a position below the 4th tier and in the shell.

1.1.9 Heated glass panes shall be in accordance with ISO 3434.

2 Definitions

2.1 Definitions

2.1.1 Side scuttles are defined as being round or oval openings with an area not exceeding 0.16 m². Round or oval openings having areas exceeding 0.16 m² shall be treated as windows.

2.1.2 Windows are defined as being rectangular openings generally, having a radius at each corner relative to the window size and round or oval, openings with an area exceeding 0.16 m².
2.1.3 The 1st tier is normally that tier which is situated directly above the freeboard deck. However, where there is an excess in freeboard, the tier directly over the weather deck can be defined as an upper tier. It is recommended that “excess in freeboard” be that which exceeds the minimum tabular freeboard by more than one standard tier height of the superstructure.

3 Arrangement and positioning

3.1 Arrangement and positioning

3.1.1 Side scuttles to the following spaces shall be fitted with hinged inside deadlights:
   a) spaces below freeboard deck
   b) spaces within the first tier of enclosed superstructures
   c) first tier deckhouses on the freeboard deck protecting openings leading below or considered buoyant in stability calculations.

3.1.2 Deadlights shall be capable of being closed and secured watertight if fitted below the freeboard deck and weathertight if fitted above.

3.1.3 Side scuttles shall not be fitted in such a position that their sills are below a line drawn parallel to the freeboard deck at side and having its lowest point 2.5 percent of the breadth $B$, or 500 mm, whichever is the greatest distance, above the summer load line (or timber summer load line if assigned).

3.1.4 If required damage calculations indicate that side scuttles would become immersed in any intermediate stage of flooding or the final equilibrium waterlines they shall be of the non-opening type.

3.1.5 Windows shall not be fitted in the following locations:
   a) below the freeboard deck
   b) in the first tier end bulkheads or sides of enclosed superstructures
   c) in first tier deckhouses that are considered buoyant in the stability calculations.

3.1.6 Side scuttles and windows at the side shell in the second tier shall be provided with hinged inside deadlights capable of being closed and secured weathertight if the superstructure protects direct access to an opening leading below or is considered buoyant in the stability calculations.

3.1.7 Side scuttles and windows in side bulkheads set inboard from the side shell in the second tier, which protecting direct access below to spaces listed in paragraph (1), shall be provided with either hinged inside deadlights or, where they are accessible, permanently attached external storm covers which are capable of being closed and secured weathertight.

3.1.8 Cabin bulkheads and doors in the second tier and above separating side scuttles and windows from a direct access leading below or the second tier considered buoyant in the stability calculations, may be accepted in place of deadlights or storm covers fitted to the side scuttles and windows.

3.1.9 Deckhouses situated on a raised quarter deck or on the deck of a superstructure of less than standard height, may be regarded as being in the second tier as far as the requirements for deadlights are concerned, provided the height of the raised quarter deck or superstructure is equal to or greater than the standard quarter deck height.

3.1.10 Fixed or opening skylights shall have glass thickness appropriate to their size and position as required for side scuttles and windows. Skylight glasses in any position shall be protected from mechanical damage and where fitted in positions 1 or 2, shall be provided with permanently attached deadlights or storm covers.

Guidance note:
Deviation for the fitting of deadlights may be accepted for vessels trading in domestic waters only, in accordance with Pt.1 Ch.1 Sec.2 [1.3].

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(IACS UI LL62, ICLL Reg. 23)

4 Glass thickness

4.1 Glass thickness

4.1.1 The required glass thickness for single pane windows and side scuttles, in mm, can be calculated from the following formulae:

\[
t_r = \frac{b}{200} \sqrt{\beta \cdot P} \text{ for windows}
\]

\[
t_r = \frac{N}{362} \sqrt{P} \text{ for side scuttles}
\]

where:

- \( N \) = nominal diameter/light opening of side scuttle in mm
- \( b \) = the minor dimension of the window in mm
- \( \beta \) = factor obtained from the graph in Figure 1
- \( P \) = design load in kN/m² as given in Ch.4 Sec.5 [1]. For ships with a length \( L_{LL} \) equal to or greater than 100 m, loads in accordance with ISO 5779 and ISO 5780 shall be calculated additionally. The greater value shall be considered up to the third tier
- \( t_r \) = required glass thickness in mm.

The thickness of windows shall not be less than:

- 8.0 mm for windows with area less than 1.0 m²
- 10.0 mm for windows of 1.0 m² or more.
- For windows with design load as per Ch.4 Sec.5 [3.5.5], minimum thickness is 6.0 mm for windows with area less than 1.0 m² and 8.0 mm for windows of 1.0 m² or more.
4.1.2 For laminated safety glass, the total required thickness, in mm, will need to be increased in accordance with the following formula:

\[
  t_e = \sqrt{t_1^2 + t_2^2 + \ldots + t_n^2} \geq t_r
\]

where:

- \(n\) = number of laminated layers
- \(t_1, t_2, \ldots, t_n\) = thickness of each glass pane layer in the laminate in mm
- \(t_e\) = equivalent thickness of laminated toughened safety glass in mm.

The minimum thickness however for any glass pane layer shall not be less than 4 mm.

4.1.3 The thickness of the glass panes may be reduced from that calculated by [4.1.1] or [4.1.2], provided that testing, as per [6], is done. The requirements for minimum thicknesses in [4.1.1] or [4.1.2] shall be followed in any case.
5 Mounting frame design

5.1 Strength

5.1.1 Metallic frames may be bolted or welded to the ship structure. The distance of the screws used for fastening the metal frames to the ship structure shall be not more than 100 mm for window frames. Minimum 12 bolts, with minimum size M8, to be provided for side scuttles.

5.1.2 The stress levels in all load carrying members of the frame shall not exceed 60% of the yield strength of the material, under the design pressure. Thickness of metal frames shall not be less than 5 mm.

5.1.3 The overlap between the glass pane and the mounting frame shall be at least $b/75$ mm and not to be less than 10 mm.

5.1.4 Glass panes can be fastened to the mounting frames by mechanical means or by adhesive bonding.

5.2 Adhesive bonding

5.2.1 When adhesive bonding is used to secure the glass panes to the retaining frame the following rules shall be followed:

1) The arrangement of the adhesive bond shall be such to prevent tension forces in the adhesive.
2) Mechanical fastening shall be provided to keep glass panes in place, in case of adhesive bonding failure.
3) The weight of the glass pane shall be supported at the lower edge by stiffening arrangement. For inclined windows, additional supporting is necessary at the top or sides also.
4) The adhesive used shall be suitable for marine use and type approved.
5) Adhesive bonding in windows on fire rated A or B boundaries, shall have low flame spread properties as per IMO FTP code.
6) The adhesive bonding shall be protected from UV-light exposure, water and high and low temperatures. A sealing compound is normally to be used for this reason.
7) $d = \frac{b \cdot P}{2000 \sigma_t}$

The width of the adhesive bond shall not be less than:

- $d =$ width of adhesive bond, in mm
- $b =$ the length of the smaller side of the light opening of a rectangular window, in mm
- $P =$ design pressure
- $\sigma_t =$ allowable tensile stress for the adhesive, in N/mm$^2$, taken as the stress at 12.5% strain.

8) The thickness of the adhesive shall not be smaller than:

$t_{adh} = 1.5 \ell \cdot 10^{-3}$

- $t_{adh} =$ thickness of adhesive, in mm
- $\ell =$ the length of the longer side of the light opening of a rectangular window, in mm
$t_{adh}$ shall not be smaller than 6 mm and need not be larger than $d/2$.

6 Testing requirements

6.1 Introduction

Where testing is required by the rules for window designs, the window manufacturer shall verify the strength as described in [6.2] - [6.4]. A test report shall be provided describing the following:

— description of test setup, including drawing of window and attachment to frame,
— test parameters, including load applied, temperature, duration of load application
— results.

The test shall be carried out in the presence and to the satisfaction of a surveyor.

Guidance note:

On a case-by-case basis, one test can be used to cover a range of window sizes, e.g. if the largest window size is selected for testing among windows subjected to similar load.

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6.2 Test arrangement

1) During testing the glass pane shall be fixed to the window frame with an arrangement similar to that onboard the vessel.
2) The test pressure shall be uniform and at least four times that of the design load $P$ as given in [4.1].
3) Load shall be applied for at least 10 minutes.
4) Test will be considered successful if:
   — no visible damage to the glass and the retaining frame occurs
   — no leakage occurs.

6.3 Test temperature for laminated glass

In case of laminated windows, the ambient test temperature shall not be below 25°C.
6.4 Hose testing

Hose testing as per Pt.2 Ch.4 Sec.2 shall be performed after installation to verify the weathertight performance of the window.

Guidance note:
For windows of same type and arrangement, hose testing may be done on a random basis to limit the amount of testing.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---
SECTION 7 TANK ACCESS, ULLAGE AND VENTILATION OPENINGS

For symbols not defined in this section, refer to Ch.1 Sec.4.

1 General

1.1 Introduction

1.1.1 The number of hatchways and other openings in the tank deck shall not be larger than necessary for reasonable access to and ventilation of each compartment.

1.1.2 Hatchways, openings for ventilation, ullage plugs or sighting ports, etc. shall not be placed in enclosed compartments where there is a danger of accumulation of gases.

Ullage plugs or sighting ports shall be fitted as high above the deck as practicable, for instance in the cover of access hatches.

Access hatches to holds or other openings, for example for tank cleaning devices, shall be of substantial construction, and may be arranged in the main hatch covers.

1.1.3 Striking plates of adequate thickness or other equivalent arrangements shall be provided under sounding pipes to prevent the sounding rod from damaging the plating.

2 Hatchways

2.1 Scantlings

2.1.1 The gross thickness of the hatch coaming, in mm, shall not be less than given in Ch.6 Sec.8 [3] for a deckhouse in the same position.

2.1.2 The gross thickness of hatch covers shall not be less than:

\[ t_{gr} = \begin{cases} 12.5 & \text{for hatch cover area of } 0.5 \text{ m}^2 \text{ and above} \\ 10.0 & \text{for hatch cover area of } 0.25 \text{ m}^2 \text{ and below} \end{cases} \]

For intermediate areas the thickness may be linearly varied.

2.1.3 Where the area of the hatchway exceeds 1.25 m², the hatch covers shall be stiffened.

2.1.4 Covers shall be secured to the hatch coamings by fastenings spaced not more than 380 mm apart and not more than 250 mm from the corners. For circular covers the fastenings shall not be spaced more than 450 mm apart.

2.1.5 Other types of hatch covers may be approved, provided their construction is considered satisfactory.

3 Air pipes

3.1 General

3.1.1 Where air pipes to ballast and other tanks extend above the freeboard or superstructure decks, the exposed parts of the pipes shall be of substantial construction; the height from the deck to the point where
Opening and closing appliances

3.1.2 Air pipes shall be provided with automatic closing appliances.

3.1.3 Pressure-vacuum valves (PV valves) may be accepted on tankers.

Guidance note:
The member Societies in formulating this interpretation realise that pressure-vacuum valves (PV valves) presently installed on tankers do not theoretically provide complete watertightness. In view, however, of experience of this type of valve and the position in which they are normally fitted it was considered they could be accepted.

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

3.1.4 In cases where air pipes are led through the side of superstructures, the height of their openings to be at least 2.3 metres above the summer water line. Automatic vent heads of approved design shall be provided.

3.1.5 The height of air pipes may be required to be increased on ships of type "A", type "B-100" and type "B-60" where this is shown to be necessary by the floatability calculation.

3.1.6 The automatic closing appliances shall be permanently attached and of approved design. The closing appliances shall be so constructed that damage to the tanks by over pumping or occasionally possible vacuum by discharging is prevented.

3.1.7 All air pipes in cargo spaces shall be well protected.

3.1.8 For arrangement and size of air pipes, see also Pt.4 Ch.6 Sec.4 [11].

3.2 Scantlings

3.2.1 Above the deck the gross thickness of air pipe coamings made of stainless steel shall not be less than given in the following table:

<table>
<thead>
<tr>
<th>External diameter in mm</th>
<th>Wall gross thickness in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>d ≤ 60</td>
<td>2.7</td>
</tr>
<tr>
<td>60 &lt; d ≤ 120</td>
<td>3.0</td>
</tr>
<tr>
<td>120 &lt; d ≤ 200</td>
<td>3.4</td>
</tr>
<tr>
<td>200 &lt; d ≤ 250</td>
<td>3.7</td>
</tr>
<tr>
<td>250 &lt; d ≤ 300</td>
<td>4.1</td>
</tr>
<tr>
<td>300 &lt; d ≤ 350</td>
<td>4.5</td>
</tr>
<tr>
<td>350 &lt; d ≤ 500</td>
<td>4.7</td>
</tr>
</tbody>
</table>
3.2.2 The gross thickness of air pipe coamings in steel other than stainless shall not be less than given in the following table:

**Table 2**

<table>
<thead>
<tr>
<th>Location</th>
<th>External diameter in mm</th>
<th>Wall gross thickness in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position 1 and 2</td>
<td>≤ 80</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>≥ 165</td>
<td>8.5</td>
</tr>
<tr>
<td>Above Position 2</td>
<td>≤ 155</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td>≥ 230</td>
<td>6.0</td>
</tr>
</tbody>
</table>

For intermediate external diameter the wall thickness is obtained by linear interpolation. Coamings with heights exceeding 900 mm shall be additionally supported.

(IACS UI LL36)

**4 Strength requirements for fore deck air pipes**

**4.1 Application**

4.1.1 For vessels with \( L > 80 \) m:
The air pipes located on the exposed deck over the forward 0.25 \( L \), where the height of the exposed deck in way of the item is less than 0.1 \( L \) or 22 m above the summer load waterline, whichever is the lesser, shall comply with the requirements given in below.

For tankers:
The requirements given below are not applicable for cargo tank venting systems and the inert gas systems.

(IACS UR S27)

**4.2 Design loads**

4.2.1 The pressures, in kN/m² acting on air pipes and their closing devices shall be calculated from:

\[
P = 0.5 \cdot \rho \cdot V^2 \cdot C_d \cdot C_s \cdot C_p
\]

where:

\( \rho \) = density of sea water (1.025 t/m³)
\( V \) = velocity of water over the fore deck
\( = 13.5 \) m/sec for \( d \leq 0.5 d_1 \)
\[ \sqrt{\frac{L}{2} \left(1 - \frac{d}{d_1}\right)} \text{ m/sec for } 0.5d_1 < d < d_1 \]

d = distance from summer load waterline to exposed deck
\[ d_1 = 0.1L \text{ or } 22 \text{ m whichever is the lesser} \]
\[ C_d = \text{shape coefficient: } 0.5 \text{ for pipes, } 1.3 \text{ for ventilator heads in general, } 0.8 \text{ for an air pipe or ventilator head of cylindrical form with its axis in the vertical direction} \]
\[ C_s = \text{slamming coefficient (3.2)} \]
\[ C_p = \text{protection coefficient: } 0.7 \text{ for pipes and ventilator heads located immediately behind a wave breaker or forecastle, } 1.0 \text{ elsewhere and immediately behind a bulwark.} \]

4.2.2 Forces acting in the horizontal direction on the pipe and its closing device may be calculated from [4.2.1] using the largest projected area of each component.

4.3 Scantlings

4.3.1 Bending moments and stresses in air pipes shall be calculated at critical positions:
— at penetration pieces
— at weld or flange connections
— at toes of supporting brackets.

Bending stresses, in N/mm\(^2\), in the net section shall not exceed:

\[ \sigma_b = 0.8R_{eh} \]

Irrespective of corrosion protection, a corrosion addition to the net section of \( t_c = 2.0 \) mm shall be be applied.

4.3.2 For standard air pipes of 760 mm height closed by heads of not more than the tabulated projected area, pipe thicknesses and bracket heights are specified in Table 3. Where brackets are required, three or more radial brackets shall be fitted. Brackets shall be of gross thickness 8 mm or more, of minimum length 100 mm, and height according to Table 3, but do not need to extend over the joint flange of the head. Bracket toes at the deck shall be suitably supported.

4.3.3 For other configurations, loads according to [4.2.1] shall be applied, and means of support determined in order to comply with the requirements given in [4.3.1]. Brackets, where fitted, shall be of suitable thickness and length according to their height. Pipe gross thickness shall not be taken less than as required in [3.2.2].

4.3.4 All component parts and connections of the air pipe shall be capable of withstanding the loads defined in [4.2.1].

**Table 3 760 mm air pipe gross thickness and bracket standards**

<table>
<thead>
<tr>
<th>Nominal pipe diameter (mm)</th>
<th>Minimum fitted gross thickness, LL36(c) (mm)</th>
<th>Maximum projected area of head (cm(^2))</th>
<th>Height (^1) of brackets (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40A(^3)</td>
<td>6.0</td>
<td>–</td>
<td>520</td>
</tr>
<tr>
<td>50A(^3)</td>
<td>6.0</td>
<td>–</td>
<td>520</td>
</tr>
<tr>
<td>65A</td>
<td>6.0</td>
<td>–</td>
<td>480</td>
</tr>
<tr>
<td>Nominal pipe diameter (mm)</td>
<td>Minimum fitted gross thickness, LL36(c) (mm)</td>
<td>Maximum projected area of head (cm²)</td>
<td>Height 1) of brackets (mm)</td>
</tr>
<tr>
<td>---------------------------</td>
<td>---------------------------------------------</td>
<td>-------------------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>80A</td>
<td>6.3</td>
<td>–</td>
<td>460</td>
</tr>
<tr>
<td>100A</td>
<td>7.0</td>
<td>–</td>
<td>380</td>
</tr>
<tr>
<td>125A</td>
<td>7.8</td>
<td>–</td>
<td>300</td>
</tr>
<tr>
<td>150A</td>
<td>8.5</td>
<td>–</td>
<td>300</td>
</tr>
<tr>
<td>175A</td>
<td>8.5</td>
<td>–</td>
<td>300</td>
</tr>
<tr>
<td>200A</td>
<td>8.5 2)</td>
<td>1900</td>
<td>300 2)</td>
</tr>
<tr>
<td>250A</td>
<td>8.5 2)</td>
<td>2500</td>
<td>300 2)</td>
</tr>
<tr>
<td>300A</td>
<td>8.5 2)</td>
<td>3200</td>
<td>300 2)</td>
</tr>
<tr>
<td>350A</td>
<td>8.5 2)</td>
<td>3800</td>
<td>300 2)</td>
</tr>
<tr>
<td>400A</td>
<td>8.5 2)</td>
<td>4500</td>
<td>300 2)</td>
</tr>
</tbody>
</table>

1) Brackets (see [4.3.2]) need not extend over the joint flange for the head.
2) Brackets are required where the as fitted gross thickness is less than 10.5 mm, or where the tabulated projected area is exceeded.
3) For minimum permitted internal diameter, see Pt.4 Ch.6 Sec.4.

Note: For other air pipe heights, the relevant requirements given in [4.3.1] to [4.3.3] shall be applied.

## 5 Ventilators

### 5.1 Coaming and closing arrangement

**5.1.1** Ventilators in position 1 or 2 to spaces below freeboard deck or decks of enclosed superstructures shall have coamings of steel or other equivalent material, substantially constructed and efficiently connected to the deck. Where the coamings of any ventilators exceed 900 millimetres in height it shall be specially supported.

**5.1.2** Ventilators passing through superstructures other than enclosed superstructures shall have substantially constructed coamings of steel or other equivalent material at the freeboard deck.

**5.1.3** Ventilators in position 1 the coamings of which extend to more than 4.5 metres above the deck, and in position 2 the coamings of which extend to more than 2.3 metres above the deck, need not be fitted with closing arrangements unless specifically required by the Society.

**5.1.4** Except as provided in [5.1.3] ventilator openings shall be provided with efficient weathertight closing appliances. In ships of not more than 100 metres in length the closing appliances shall be permanently attached; where not so provided in other ships, they shall be conveniently stowed near the ventilators to which they shall be fitted. Ventilators in position 1 shall have coamings of a height of at least 900 millimetres above the deck; in position 2 the coamings shall be of a height of at least 760 millimetres above the deck.

**5.1.5** In exposed positions, the height of coamings may be required to be increased to the satisfaction of the Society.

(ICLL Reg.19)

**5.1.6** Ventilators of cargo holds shall not have any connection with other spaces.
5.2 Scantlings

5.2.1 The gross thickness of ventilator coamings shall not be less than given in the following table:

Table 4

<table>
<thead>
<tr>
<th>Location</th>
<th>External diameter in mm</th>
<th>Wall gross thickness in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position 1 and 2</td>
<td>≤ 80</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>≥ 165</td>
<td>8.5</td>
</tr>
<tr>
<td>Above Position 2</td>
<td>≤ 155</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td>≥ 230</td>
<td>6.0</td>
</tr>
</tbody>
</table>

For intermediate external diameter the wall gross thickness is obtained by linear interpolation.

(IACS UI LL36)

5.2.2 The thickness of the ventilator posts plates shall be minimum 7.5 mm where the clear sectional area of the ventilator coaming is 300 cm² or less, and minimum 10 mm where the clear opening area exceeds 1600 cm². Intermediate values shall be determined by direct interpolation. A thickness of 6 mm will generally be sufficient within not permanently closed superstructures.

5.2.3 The wall thickness of ventilator posts of a clear sectional area exceeding 1600 cm² shall be increased according to the expected loads.

5.3 Arrangement and support

5.3.1 Where required by [5.1], weathertight closing appliances for all ventilators in positions 1 and 2 shall be of steel or other equivalent materials.

Wood plugs and canvas covers are not acceptable in these positions.

(IACS UI LL52)

5.3.2 The deck plate in way of deck openings for ventilator coamings shall be of sufficient thickness, and efficiently stiffened between ordinary beams or longitudinals. Coamings with heights exceeding 900 mm shall be additionally supported.

5.3.3 Where ventilators are proposed to be led overboard in an enclosed superstructure deck house or shipside the closing arrangement shall be submitted for approval. If such ventilators are lead overboard more than 4.5 m above the freeboard deck, closing appliances may be omitted, provided that satisfactory baffles and drainage arrangements are provided.

5.3.4 Ventilators necessary to continuously supply the machinery space shall have coamings of sufficient height to comply with [5.1.3], without having to fit weather tight closing appliances. Ventilators necessary to continuously supply the emergency generator room, if it is considered buoyant in the stability calculation, or protecting openings leading below shall have coamings of sufficient height to comply with [5.1.3], without having to fit weather tight closing appliances.

Alternatively, depending on vessel's size and arrangement, lesser coaming heights may be accepted if weather-tight closing appliances are provided, in accordance with [5.1] and in combination with suitable means arranged to ensure uninterrupted and adequate supply of air to these spaces.

**Guidance note:**
The term suitable means is meant e.g. that direct and sufficient supply of air is provided through open skylights, hatches or doors at a higher level than the heights required by [5.1].

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

5.3.5 The height of ventilators may be required to be increased depending on where these flooding points are in relation to the damaged waterline in the stability calculation.

5.3.6 Generally, the coamings and posts shall be pass through the deck and shall be be welded to the deck plating from above and below. Where coamings or posts are welded onto the deck plating, fillet welds shall be adopted for welding inside and outside.

6 Strength requirements for fore deck ventilators

6.1 Application

6.1.1 For vessels with \( L > 80 \) m:
The ventilators located on the exposed deck over the forward 0.25 \( L \), where the height of the exposed deck in way of the item is less than 0.1 \( L \) or 22 m above the summer load waterline, whichever is the lesser, shall comply with the requirements given below.
(IACS UR S27)

6.2 Design loads

6.2.1 The pressures \( P \), in kN/m\(^2\) acting on ventilator pipes and their closing devices to be calculated from:

\[
P = 0.5 \cdot \rho \cdot V^2 \cdot C_d \cdot C_s \cdot C_p
\]

where:

\( \rho \) = density of sea water taken equal to 1.025 t/m\(^3\)
\( V \) = velocity of water over the fore deck taken equal to 13.5 m/sec
\( C_d \) = shape coefficient:

\[
C_d = \begin{cases} 
0.5 & \text{for pipes} \\
1.3 & \text{for ventilator heads in general} \\
0.8 & \text{for an air pipe or ventilator head of cylindrical form with its axis in the vertical direction}
\end{cases}
\]

\( C_s \) = slamming coefficient:

\[
C_s = 3.2
\]

\( C_p \) = protection coefficient:

\[
C_p = \begin{cases} 
0.7 & \text{for pipes and ventilator heads located immediately behind a wave breaker or forecastle} \\
1.0 & \text{elsewhere and immediately behind a bulwark}
\end{cases}
\]

6.2.2 Forces acting in the horizontal direction on the pipe and its closing device may be calculated from [6.2.1] using the largest projected area of each component.
6.3 Scantlings

6.3.1 Bending moments and stresses in air pipes shall be calculated at critical positions:
— at penetration pieces
— at weld or flange connections
— at toes of supporting brackets.

Bending stresses, in N/mm$^2$, in the net section shall not exceed:

$$\sigma_b = 0.8R_{eH}$$

Irrespective of corrosion protection, a corrosion addition to the net section of $t_c = 2.0$ mm shall be be applied.

6.3.2 For standard ventilators of 900 mm height closed by heads of not more than the tabulated projected area, pipe thicknesses and bracket heights are specified in Table 5. Where brackets are required, three or more radial brackets shall be fitted. Brackets shall be of gross thickness 8 mm or more, of minimum length 100 mm, and height according to Table 5, but need not extend over the joint flange for the head. Bracket toes at the deck shall be suitably supported.

6.3.3 For ventilators of height greater than 900 mm, brackets or alternative means of support shall be fitted according to the requirements given in [5.3.2]. Pipe gross thickness shall not be taken less than as required in [3.2.2].

6.3.4 All component parts and connections of the ventilator shall be capable of withstanding the loads defined in [6.2.1].

6.3.5 Rotating type mushroom ventilator heads are unsuitable for application in the areas defined in [6.1].

Table 5 900 mm ventilator pipe gross thickness and bracket standards

<table>
<thead>
<tr>
<th>Nominal pipe diameter (mm)</th>
<th>Minimum fitted gross thickness, LL36(c) (mm)</th>
<th>Maximum projected area of head (cm$^2$)</th>
<th>Height of brackets (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80A</td>
<td>6.3</td>
<td>–</td>
<td>460</td>
</tr>
<tr>
<td>100A</td>
<td>7.0</td>
<td>–</td>
<td>380</td>
</tr>
<tr>
<td>150A</td>
<td>8.5</td>
<td>–</td>
<td>300</td>
</tr>
<tr>
<td>200A</td>
<td>8.5</td>
<td>550</td>
<td>–</td>
</tr>
<tr>
<td>250A</td>
<td>8.5</td>
<td>880</td>
<td>–</td>
</tr>
<tr>
<td>300A</td>
<td>8.5</td>
<td>1200</td>
<td>–</td>
</tr>
<tr>
<td>350A</td>
<td>8.5</td>
<td>2000</td>
<td>–</td>
</tr>
<tr>
<td>400A</td>
<td>8.5</td>
<td>2700</td>
<td>–</td>
</tr>
<tr>
<td>450A</td>
<td>8.5</td>
<td>3300</td>
<td>–</td>
</tr>
<tr>
<td>500A</td>
<td>8.5</td>
<td>4000</td>
<td>–</td>
</tr>
</tbody>
</table>

Note: For other ventilator heights, the relevant requirements given in [6.3.1] to [6.3.4] shall be applied.
SECTION 8 MACHINERY SPACE OPENINGS

Symbols
For symbols not defined in this section, refer to Ch.1 Sec.4.

1 Machinery space openings

1.1 Openings

1.1.1 Machinery space openings in position 1 or 2 shall be properly framed and efficiently enclosed by steel casings of ample strength, and where the casings are not protected by other structures their strength shall be specially considered. Access openings in such casings shall be fitted with doors complying with the requirements of Sec.2 [3.1.1], the sills shall be at least 600 millimetres above the deck in position 1, and at least 380 millimetres above the deck in position 2. Other openings in such casings shall be fitted with equivalent covers, permanently attached in their proper positions.

1.1.2 Coamings of any machinery space ventilator in an exposed position shall be in accordance with Sec.7 [5.3]

(ICLL Reg. 17)

1.1.3 Where casings are not protected by other structures, double doors is required for ships assigned freeboards less than those based on Table B in the ICLL. An inner sill of 230 mm in conjunction with the outer sill of 600 mm shall be provided.

(ICLL Reg. 17 (2))

1.1.4 Doorways in engine and boiler casings shall be arranged in positions which afford the greatest possible protection.

1.1.5 Fixed or opening skylights shall have a glass thickness appropriate to their size and position as required for side scuttles and windows. Skylight glasses in any position shall be protected from mechanical damage and, where fitted in position 1 or 2, shall be provided with permanently attached deadlights or storm covers.

(ICLL Reg. 23 (12))

For skylights in position 1 or 2 the coaming height shall not be less than given for hatchway coamings. For skylights in position 1, deadlights shall be fitted.

1.1.6 Side scuttles in engine casings shall be provided with fireproof glass.
SECTION 9 SCUPPERS, INLETS AND DISCHARGES

Symbols
For symbols not defined in this section, refer to Ch.1 Sec.4.

1 Inlets and discharges

1.1 General

1.1.1 Discharges led through the shell either from spaces below the freeboard deck or from within
superstructures and deckhouses on the freeboard deck fitted with doors complying with the requirements
given in Sec.2 [3.1.1] shall be fitted with efficient and accessible means for preventing water from passing
inboard. Normally each separate discharge shall have one 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; where that vertical distance exceeds 0.02 $L$ a single
automatic non return valve without positive means of closing may be accepted subject to the approval of the
Society. 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.

All shell fittings, and the valves required by this rule shall be of steel, bronze or other approved ductile
material. Valves of ordinary cast iron or similar material are not acceptable. All pipes to which this rule refers
shall be of steel or other equivalent material to the satisfaction of the Society, see Pt.4 Ch.6 Sec.2.

(ICLL Reg.22)

1.1.2 It is considered that the position of the inboard end of discharges should be related to the timber
summer load waterline when timber freeboard is assigned.

(IACS UI LL22)
Table 1 Acceptable arrangements of discharges with inboard ends

<table>
<thead>
<tr>
<th>Discharges coming from below the freeboard deck or enclosed spaces above the freeboard deck***</th>
<th>Discharges coming from other spaces</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General requirements</strong>&lt;br&gt;(Reg.22 (1))&lt;br&gt;Discharges through machinery space</td>
<td>Alternatives where inboard end is&lt;br&gt;&lt; 0.01 L above SWL</td>
</tr>
<tr>
<td>Superstructure or deckhouse deck</td>
<td><strong>Outside end</strong> &gt; 450 mm below FB DECK or &lt; 600 mm above SWL (Reg.22(4))</td>
</tr>
<tr>
<td>FB DECK</td>
<td>FB DECK</td>
</tr>
<tr>
<td>SWL</td>
<td>SWL</td>
</tr>
<tr>
<td><strong>Controls in Approved Position</strong> *1</td>
<td><strong>2nd. TIER AND ABOVE</strong></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*)The control shall be so sited as to allow adequate time for operation in case of influx of water to the space having regard to the time which could be taken to reach and operate such controls
***)Substantial pipe thickness from the shell and up to the freeboard deck and in cases further up in closed superstructure to a height at least 600 mm above the summer water line
****)References: ICLL regulations.

1.1.3 For vessels subject to SOLAS requirements each discharge led through the shell plating from spaces below the freeboard deck shall be provided with either one automatic non-return valve with positive means of closing it from above the freeboard deck or two automatic non-return valves, where the inboard valve shall always be accessible under service conditions. Where a valve with positive means of closing is fitted, the operating position above the freeboard deck shall always be readily accessible and means shall be provided for indicating whether the valve is open or closed.
1.1.4 It is considered that an acceptable equivalent to one automatic non-return valve with a positive means of closing from a position above the freeboard deck would be one automatic non-return valve and one sluice valve controlled from above the freeboard deck. Where two automatic non-return valves are required, the inboard valve shall always be accessible under service conditions, i.e. the inboard valve shall be above the level of the tropical load water line. If this is not practicable, then, provided a locally controlled sluice valve is interposed between the two automatic non-return valves, the inboard valve need not to be fitted above the SWL.

Where sanitary discharges and scuppers lead overboard through the shell in way of machinery spaces, the fitting to shell of a locally operated positive closing valve, together with a non-return valve inboard, is considered to provide protection equivalent to the requirements given in [1.1.1].

It is considered that the requirements given in [1.1.1] for non-return valves are applicable only to those discharges which remain open during the normal operation of a vessel. For discharges which must necessarily be closed at sea, such as gravity drains from topside ballast tanks, a single screw down valve operated from the deck is considered to provide efficient protection.

The inboard end of a gravity discharge which leads overboard from an enclosed superstructure or space shall be located above the water line formed by a 5 degree heel, to port or starboard, at a draught corresponding to the assigned summer freeboard.

See Table 1 for the acceptable arrangement of scuppers, inlets, and discharges.

1.1.5 Discharges with inboard opening located lower than the ship’s uppermost load line may be accepted when a loop of the pipe is arranged between the inboard opening and the outlet in hull. The top of the loop shall be regarded as the position of the inboard opening, and the pipeline shall be provided with valves according to Table 1.

1.1.6 Discharges from spaces above the freeboard deck shall be of steel or material specially resistant to corrosion.

1.1.7 Adequate protection shall be provided to protect valves or pipes from being damaged by cargo, etc.

1.1.8 Plastic pipes may be used for sanitary discharges and scuppers as permitted by Pt.4 Ch.6 Sec.2 [1.7].

1.1.9 The portion of discharge line from the shell to the first valve as well as shell fittings and valves shall be of steel, bronze or other approved ductile material.

1.1.10 In manned machinery spaces main and auxiliary sea inlets and discharges in connection with the operation of machinery may be controlled locally. The controls shall be readily accessible and shall be provided with indicators showing whether the valves are open or closed.

1.1.11 Scuppers and discharge pipes originating from any level and penetrating the shell either more than 450 millimetres below the freeboard deck or less than 600 millimetres above the summer load waterline shall be provided with a non-return valve at the shell. This valve, unless required by [1.1.1], may be omitted if the piping is of substantial thickness.
2 Pipes

2.1 Pipe thickness

2.1.1 The wall gross thickness of steel piping between hull plating and closeable or non-return valve shall not be less than given in Table 2.

Table 2 Wall gross thickness of steel piping

<table>
<thead>
<tr>
<th>External diameter in mm</th>
<th>Wall gross thickness in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 80</td>
<td>7.0</td>
</tr>
<tr>
<td>= 180</td>
<td>10.0</td>
</tr>
<tr>
<td>≥ 220</td>
<td>12.5</td>
</tr>
</tbody>
</table>

For intermediate external diameter the wall gross thickness is obtained by linear interpolation.

For wall gross thickness of distance piece for discharge coming from an inert gas scrubber, see Pt.5 Ch.5 4 Sec.6.

2.1.2 The wall gross thickness of steel piping inboard of the valve shall not be less than given in Table 3.

Table 3 Wall gross thickness of steel piping

<table>
<thead>
<tr>
<th>External diameter in mm</th>
<th>Wall gross thickness in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 155</td>
<td>4.5</td>
</tr>
<tr>
<td>≥ 230</td>
<td>6.0</td>
</tr>
</tbody>
</table>

For intermediate external diameter the wall gross thickness is obtained by linear interpolation.

(IACS UI LL36)

3 Scuppers

3.1 Scuppers

3.1.1 A sufficient number of scuppers, arranged to provide effective drainage, shall be fitted on all decks.

3.1.2 Scuppers on weather portions of decks and scuppers leading from superstructures or deckhouses not fitted with doors complying with Sec.2 [3.1.1] shall be led overboard.

3.1.3 Scuppers led through the shell from enclosed superstructures used for the carriage of cargo shall be permitted only where the edge of the freeboard deck is not immersed when the ship heels 5 degrees either way. In other cases the drainage shall be led inboard in accordance with the requirements of SOLAS in force.

3.1.4 Scuppers led through the deck or shell, shall comply with requirements for material and thickness as given for discharges.

3.1.5 Scupper pipes shall be well stayed to prevent any vibrations. However, sufficient possibility for expansion of the pipes to be provided when necessary.
3.1.6 Scuppers from spaces below the freeboard deck or spaces within closed superstructures, may be led to bilges. For drainage of cargo deck spaces, see Pt.4 Ch.6 Sec.4 [4].

3.1.7 Scuppers leading overboard from spaces mentioned in [3.1.6], shall comply with the requirements given for discharges. Scuppers from exposed superstructure deck, led through the ship’s sides and not having closeable valves, shall have wall thickness as required in [2.1.1] and [2.1.2].

3.1.8 Gravity discharges from top wing tanks may be arranged. The drop valves shall be of substantial construction and of ductile material, and they shall be closeable from an always accessible position. It shall be possible to blank-flange the discharge or to lock the valves in closed position when the tanks are used for carrying cargo.

The thickness of the pipe or box leading from the tank through the shell shall comply with the requirements given for discharges.

3.1.9 Drainage from refrigerated cargo spaces shall comply with the requirements for class notation RM. Drain pipes from other compartments shall not be led to the bilges in refrigerated chambers.

3.1.10 Drainage from helicopter decks shall comply with the requirements for the class notation HELDK(S).

4 Periodically unmanned machinery space

4.1 Periodically unmanned machinery space

4.1.1 The location of the controls of any valve serving a sea inlet, a discharge below the waterline or a bilge injection system shall be so sited as to allow adequate time for operation in case of influx of water to the space, having regard to the time likely to be required in order to reach and operate such controls. If the level to which the space could become flooded with the ship in the fully loaded condition so requires, arrangements shall be made to operate the controls from a position above such level.

(SOLAS Ch. II-1/48.3)

4.1.2 If it can be documented by calculation of filling time that the water level is not above the tank top floor after 10 minutes from the initiation of the uppermost bilge level alarm, it will be accepted that the valves are operated from the tanktop floor.

Guidance note:
Various flag administrations have worked out their own interpretations of this regulation.

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

5 Garbage chutes

5.1 General

5.1.1 Two gate valves controlled from the working deck of the chute instead of the non-return valve with a positive means of closing from a position above the freeboard deck which comply with the following requirements are acceptable:

a) the lower gate valve shall be controlled from a position above the freeboard deck. An interlock system between the two valves shall be arranged;

b) the inboard end shall be located above the waterline formed by an 8.5° heel to port or starboard at a draft corresponding to the assigned summer freeboard, but not less than 1000 mm above the summer waterline. Where the inboard end exceeds 0.01 L above the summer waterline, valve control from
the freeboard deck is not required, provided the inboard gate valve is always accessible under service conditions; and

c) alternatively, the upper and lower gate valves may be replaced by a hinged weathertight cover at the inboard end of the chute together with a discharge flap. The cover and flap shall be arranged with an interlock so that the discharge flap cannot be operated until the hopper cover is closed.

5.1.2 The entire chute, including the cover, shall be constructed of material of substantial thickness. This implies that the entire chute shall be of at least equivalent strength as the hull it is penetrating.

5.1.3 The controls for the gate valves and/or hinged covers shall be clearly marked: "Keep closed when not in use".

5.1.4 Where the inboard end of the chute is below the freeboard deck of a passenger ship or the equilibrium waterlines of a cargo ship to which damage stability requirements apply, then:

a) the inboard end hinged cover/valve shall be watertight;

b) the valve shall be a screw-down non-return valve fitted in an easily accessible position above the deepest load line; and

c) the screw-down non-return valve shall be controlled from a position above the bulkhead deck and provided with open/closed indicators. The valve control shall be clearly marked: "Keep closed when not in use".

(ICLL Reg. 22-1)
SECTION 10 FREEING PORTS

Symbols
For symbols not defined in this section, refer to Ch.1 Sec.4.

1 Definitions

1.1 Definitions

1.1.1 Where bulwarks on the weather portions of freeboard or superstructure decks form wells, ample provision shall be made for rapidly freeing the decks of water and for draining them.

2 Freeing ports

2.1 Freeing port area

2.1.1 Except as provided in [2.1.2] and [2.1.3], the minimum freeing port area, in m$^2$, on each side of the ship for each well on the freeboard deck shall be as given by the following formula in cases where the sheer in way of the well is standard or greater than standard. The minimum area, in m$^2$, for each well on superstructure decks shall be one-half of the area given by the formula:

\[
A = 0.7 + 0.035 \ell_b \quad \text{for} \quad \ell_b \leq 20\,\text{m}
\]

\[
A = 0.07\ell_b \quad \text{for} \quad \ell_b > 20\,\text{m}
\]

where:

$\ell_b = \text{length of bulwark in m, max 0.7 } L$

If the bulwark is more than 1.2 metres in average height the required area shall be increased by 0.004 square metres per metre of length of well for each 0.1 metre difference in height. If the bulwark is less than 0.9 metre in average height, the required area may be decreased by 0.004 square metres per metre of length of well for each 0.1 metre difference in height.

2.1.2 In ships with no sheer the area calculated according to [2.1.1] shall be increased by 50 per cent. Where the sheer is less than the standard the percentage shall be obtained by linear interpolation.

2.1.3 Where a ship fitted with a trunk which does not comply with the requirements given in ICLL Regulations 36 (1)(e) or where continuous or substantially continuous hatchway side coaming are fitted between detached superstructures the minimum area of the freeing port openings shall be calculated from the following table:

Table 1

<table>
<thead>
<tr>
<th>Breadth of hatchway or trunk in relation to the breadth of ship</th>
<th>Area of freeing ports in relation to the total area of the bulwarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>40% or less</td>
<td>20%</td>
</tr>
<tr>
<td>75% or more</td>
<td>10%</td>
</tr>
</tbody>
</table>
The area of freeing ports at intermediate breadths shall be obtained by linear interpolation.

2.1.4 In ships having superstructures which are open at either or both ends to wells formed by bulwarks on the open deck, adequate provision for freeing the open spaces shall be provided as follows:

The freeing port area, in $m^2$, for the open well shall not be less than:

$$A_w = (0.07l_w + A_c)S_c\left(\frac{0.5h_s}{h_w}\right)$$

The freeing port area, in $m^2$, for the open superstructure shall not be less than:

$$A_s = 0.07l_s S_c \frac{b_o}{l_t} \left(1 - \left(\frac{l_w}{l_t}\right)^2 \left(\frac{0.5h_s}{h_w}\right)\right)$$  \quad \text{for } l_t > 20m$$

$$A_s = (0.7 + 0.035l_t)$$  \quad \text{for } l_t \leq 20m$$

where:

- $l_w$ = the length of the open deck enclosed by bulwarks in m
- $l_s$ = the length of the common space within the open superstructure, in m
- $l_t = l_w + l_s$
- $S_c$ = sheer correction factor, max 1.5 as defined in [2.1.2]
- $b_o$ = breadth of openings in the end bulkhead of the superstructure, in m
- $h_w$ = distance of the well deck above the freeboard deck, in m
- $h_s$ = one standard superstructure height, in m
- $h_b$ = height of bulwark, in m, not to be taken as greater than $h_s$
- $A_c$ = bulwark height correction factor taken as:
  - $A_c = 0$ for bulwarks between 0.9 and 1.2 m in height
  - $A_c = 0.04l_w(h_b - 1.2)$ m$^2$ for bulwarks of height greater than 1.2 m
  - $A_c = 0.04l_w(h_b - 0.9)$ m$^2$ for bulwarks of height less than 0.9 m.

2.1.5 The resulting freeing port areas for the open superstructure ($A_s$) and for the open well ($A_w$) shall be provided along each side of the open space covered by the open superstructure and each side of the open well, respectively.

2.1.6 On ships with continuous longitudinal hatch coamings, where water may accumulate between the transverse coamings, freeing ports shall be provided at both sides, with a minimum section area in $m^2$:

$$A_q = 0.07b_Q$$
where:

\[ b_Q = \text{breadth of transverse box girder in m.} \]

In case of a partial closed structures the area \( A_q \) may be reduced by the ratio of clear opening of the transverse hatch coaming and the total area of enclosed space.

### 2.1.7 Gutter bars greater than 300 mm in height fitted around the weather decks of tankers shall be treated as bulwarks and freeing ports arranged as required by this section. Closures for use during loading and discharge operations shall be arranged in such a way that jamming cannot occur while at sea.

**Guidance note:**
Reduced freeing port area may be accepted for vessels trading in domestic waters only, in accordance with Pt.1 Ch.1 Sec.2 [1.3].

### 3 Location and protection of openings

#### 3.1 Location and protection of openings

**3.1.1** The lower edges of the freeing ports shall be as near the deck as practicable. Two-thirds of the freeing port area required shall be provided in the half of the well nearest the lowest point of the sheer curve.

**3.1.2** All such openings in the bulwarks shall be protected by rails or bars spaced approximately 230 millimetres apart. If shutters are fitted to freeing ports, ample clearance shall be provided to prevent jamming. Hinges shall have pins or bearings of non-corrodible material. If shutters are fitted with securing appliances, these appliances shall be of approved construction.

(ICLL Reg.24)

#### 4 Multiple wells

On a flush deck ship with a substantial deckhouse amidships it is considered that the deckhouse provides sufficient break to form two wells and that each could be given the required freeing port area based upon the length of the «well». It would then not be allowed to base the area upon \( 0.7 L \).

In defining a substantial deckhouse, the breadth of the deckhouse shall be at least 80\% of the beam of the vessel, and that the passageways along the side of the ship should not exceed 1.5 m in width.

Where a screen bulkhead is fitted completely across the vessel, at the forward end of a midship deckhouse, this would effectively divide the exposed deck into wells and no limitation on the breadth of the deckhouse is considered necessary in this case.

It is considered that wells on raised quarterdecks should be treated as being on freeboard decks.

With zero or little sheer on the exposed freeboard deck or an exposed superstructure deck, the freeing port area should be evenly distributed along the length of the well.

(IA CS UI LL13)

#### 5 Free flow area

The effectiveness of the freeing area in bulwarks required by [2.1.1] and [2.1.2] depends on free flow across the deck of a ship. Where there is no free flow due to the presence of a continuous trunk or hatchway coaming, the freeing area in bulwarks is calculated in accordance with [2.1.3].

The free flow area on deck is the net area of gaps between hatchways, and between hatchways and superstructures and deckhouses up to the actual height of the bulwark.

The freeing port area in bulwarks should be assessed in relation to the net flow area as follows:
a) if the free flow area is not less than the freeing area calculated from [2.1.3] as if the hatchway coamings were continuous, then the minimum freeing port area calculated from [2.1.1] and [2.1.2] should be deemed sufficient
b) if the free flow area is equal to, or less than the area calculated from [2.1.1] and [2.1.2] minimum freeing area in the bulwarks should be determined from [2.1.3]
c) if the free flow area is smaller than calculated from [2.1.3] but greater than calculated from [2.1.1] and [2.1.2], the minimum freeing area, in m², in the bulwark should be determined from the following formula:

\[ F = F_1 + F_2 - f_p \]

where:

- \( F_1 \) = the minimum freeing area calculated from [2.1.1] and [2.1.2], in m²
- \( F_2 \) = the minimum freeing area calculated from [2.1.3], in m²
- \( f_p \) = the total net area of passages and gaps between hatch ends and superstructures or deckhouses up to the actual height of bulwark, in m².

(IACS UI LL44)

6 Type «A», «B-100» and «B-60» ships

6.1 General

6.1.1 Requirements for freeing arrangements for Type «A» ships are given in [6.2].

6.1.2 Type «B-100» ships with bulwarks shall have open rails fitted for at least half the length of the exposed parts of the weather deck or a freeing port area, in the lower part of the bulwarks, of 33% of the total area of the bulwarks. For Type «B-60» ships there shall be freeing port area in the lower part of the bulwarks equal to at least 25% of the total area of the bulwarks.

6.2 Special requirements for Type «A» ships

6.2.1 Machinery casings
Machinery casings on Type «A» ships shall be protected by an enclosed poop or bridge of at least standard height, or by a deckhouse of equal height and equivalent strength, provided that machinery casings may be exposed if there are no openings giving direct access from the freeboard deck to the machinery space. A door complying with the requirements given in Sec.2 [3.1.1] and Sec.2 [3.2.1] may, however, be permitted in the machinery casing, provided that it leads to a space or passageway which is as strongly constructed as the casing and is separated from the stairway to the engine room by a second weather tight door of steel or other equivalent material.

6.2.2 Gangway and access
An efficiently constructed fore and aft permanent gangway of sufficient strength shall be fitted on Type «A» ships at the level of the superstructure deck between the poop and the midship bridge or deckhouse where fitted, or equivalent means of access shall be provided to carry out the purpose of the gangway, such as passages below deck. Elsewhere, and on Type «A» ships without a midship bridge, arrangements to the satisfaction of the Society shall be provided to safeguard the crew in reaching all parts used in the necessary work of the ship, see Ch.11 Sec.3.

Safe and satisfactory access from the gangway level shall be available between separate crew accommodations and also between crew accommodations and the machinery space.
6.2.3 Hatchways
Exposed hatchways on the freeboard and forecastle decks or on the tops of expansion trunks on Type «A» ships shall be provided with efficient watertight covers of steel or other equivalent material.

6.2.4 Freeing arrangements
Type «A» ships with bulwarks shall have open rails fitted for at least half the length of the exposed parts of the weather deck or a freeing port area, in the lower part of the bulwarks, of 33% of the total area of the bulwarks. The upper edge of the sheer strake shall be kept as low as practicable.
Where superstructures are connected by trunks, open rails shall be fitted for the whole length of the exposed parts of the freeboard deck.

(ICLL Reg.26)
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