RULES FOR CLASSIFICATION OF

Ships

PART 7 CHAPTER 2

SHIPS IN OPERATION

Retroactive Requirements

JANUARY 2011

This chapter has been amended since the main revision (January 2011), most recently in July 2011.
See "Changes" on page 3.

DET NORSKE VERITAS AS

FOREWORD

DET NORSKE VERITAS (DNV) is an autonomous and independent foundation with the objectives of safeguarding life, property and the environment, at sea and onshore. DNV undertakes classification, certification, and other verification and consultancy services relating to quality of ships, offshore units and installations, and onshore industries worldwide, and carries out research in relation to these functions.

The Rules lay down technical and procedural requirements related to obtaining and retaining a Class Certificate. It is used as a contractual document and includes both requirements and acceptance criteria.

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CHANGES

General

As of October 2010 all DNV service documents are primarily published electronically.

In order to ensure a practical transition from the "print" scheme to the "electronic" scheme, all rule chapters having incorporated amendments and corrections more recent than the date of the latest printed issue, have been given the date January 2011.

An overview of DNV service documents, their update status and historical "amendments and corrections" may be found through http://www.dnv.com/resources/rules_standards/.

Amendments July 2011

- **General**
  - The restricted use legal clause found in Pt.1 Ch.1 Sec.5 has been added also on the front page.

Main changes

Since the previous edition (July 2007), this chapter has been amended, most recently in January 2010. All changes previously found in Pt.0 Ch.1 Sec.3 have been incorporated and a new date (January 2011) has been given as explained under "General".

In addition, the layout has been changed to one column in order to improve electronic readability.

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SECTION 1
BULK CARRIERS

A. Corrugated Transverse Watertight Bulkhead considering Cargo Hold Flooding

A 100 Application and definition

101 These requirements apply to all bulk carriers of 150 m in length and above, in the foremost hold, subject to mandatory class notation **Bulk Carrier ESP**, intending to carry solid bulk cargoes having a density of 1.78 t/m^3 or above, with single deck, topside tanks and hopper tanks and fitted with vertically corrugated transverse bulkheads between cargo holds no. 1 and 2. Where:

a) the foremost hold is bounded by the side shell only for ships which were contracted for construction prior to 1 July 1998, and have not been constructed in compliance with IACS Unified Requirement S18
b) the foremost hold is double side skin construction of less than 760 mm breadth measured perpendicular to the side shell in ships, the keel of which was laid, or which was at a similar stage of construction, before 1 July 1999 and has not been constructed in compliance with IACS Unified Requirement S18. (Rev.2, Sept. 2000).

These requirements apply to vertically corrugated transverse watertight bulkheads between cargo hold no. 1 and 2.

The net thickness t_{net} is the thickness obtained by applying the strength criteria as given in 301 to 308.

The required thickness is obtained by adding the corrosion addition t_s, given in 500, to the net thickness t_{net}.

In this requirement, homogeneous loading condition means a loading condition in which the ratio between the highest and the lowest filling ratio, evaluated for each cargo hold, does not exceed 1.2 (corrected for different cargo densities).

The requirements shall, at the latest, be complied with as follows:

a) for ships which were 20 years of age or more on 1 July 1998, by the due date of the first intermediate, or the due date of the first renewal survey to be held after 1 July 1998, whichever comes first
b) for ships which were 15 years of age or more but less than 20 years of age on 1 July 1998, by the due date of the first renewal survey to be held after 1 July 1998, but not later than 1 July 2002
c) for ships which were 10 years of age or more but less than 15 years of age on 1 July 1998, by the due date of the first intermediate or the first renewal survey to be held after the date on which the ship reaches 15 years of age but not later than the date on which the ship reaches 17 years of age
d) for ships which were 5 years of age or more but less than 10 years of age on 1 July 1998, by the due date, after 1 July 2003, of the first intermediate or first renewal survey after the date on which the ship reaches 10 years of age, whichever occurs first
e) for ships which were less than 5 years of age on 1 July 1998, by the date on which the ship reaches 10 years of age.

Thickness measurements shall be taken according to Ch.1 Sec.4 B prior to the relevant compliance deadline.

A 200 Load model

201 *General*

The loads to be considered as acting on the bulkhead are those given by the combination of the cargo loads with those induced by the flooding of cargo hold no. 1. The most severe combinations of cargo induced loads and flooding loads shall be used for the check of the scantlings of the bulkhead, depending on the loading conditions included in the loading manual:

— homogeneous loading conditions
— non-homogeneous loading conditions.

Non-homogeneous part loading conditions associated with multiport loading and unloading operations for homogeneous loading conditions need not be considered according to these requirements.

202 *Bulkhead corrugation flooding head*

The flooding head h_f (see Fig.1) is the distance in m, measured vertically with the ship in the upright position, from the calculation point to a level located at a distance d_f, in m, from the baseline equal to:

a) in general:
D for the foremost transverse corrugated bulkhead

b) for ships less than 50 000 tonnes deadweight with B freeboard:
0.95 D for the foremost transverse corrugated bulkhead

c) for ships to be operated at an assigned load line draught T_r less than the permissible load line draught T, the flooding head defined in a) and b) above may be reduced by $T - T_r$.

203 *Pressure in non-flooded bulk cargo loaded hold*

At each point of the bulkhead, the pressure p_c, in kN/m^2, is given by:

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

ρ_c = bulk cargo density, in t/m^3
g = 9.81 m/s^2, gravity acceleration
h_1 = vertical distance, in m, from the calculation point to horizontal plane corresponding to the volume of the cargo (see Fig.1), located at a distance d_1, in m, from the baseline
K = $\sin^2 \alpha \tan^2 (45 - 0.5\,\delta) + \cos^2 \alpha$
α = angle between panel in question and the horizontal plane, in degrees
δ = angle of repose of the cargo, in degrees, that may generally be taken as 35° for iron ore.

$$d_1 = \frac{M_c}{\rho_c l_c B} + \frac{V_{LS}}{l_c B} + (h_{HT} - h_{DB})\frac{b_{HT}}{B} + h_{DB}$$

M_c = mass of cargo, in tonnes, in cargo hold no. 1
ρ_c = bulk cargo density, in t/m^3
l_c = length of cargo hold no. 1, in m
V_{LS} = volume, in m^3, of the bottom stool above the inner bottom
h_{HT} = height of the hopper tanks amidship, in m, from the base line
h_{DB} = height of the double bottom, in m
b_{HT} = breadth of the hopper tanks amidship, in m
B = ships breadth amidship.

The force F_c, in kN, acting on a corrugation is given by:

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

ρ_c, g, d_1, K = as given above

s_1 = spacing of corrugations, in m (see Fig.2)
h_{LS} = mean height of the lower stool, in m, from the inner bottom
h_{DB} = height of the double bottom, in m.

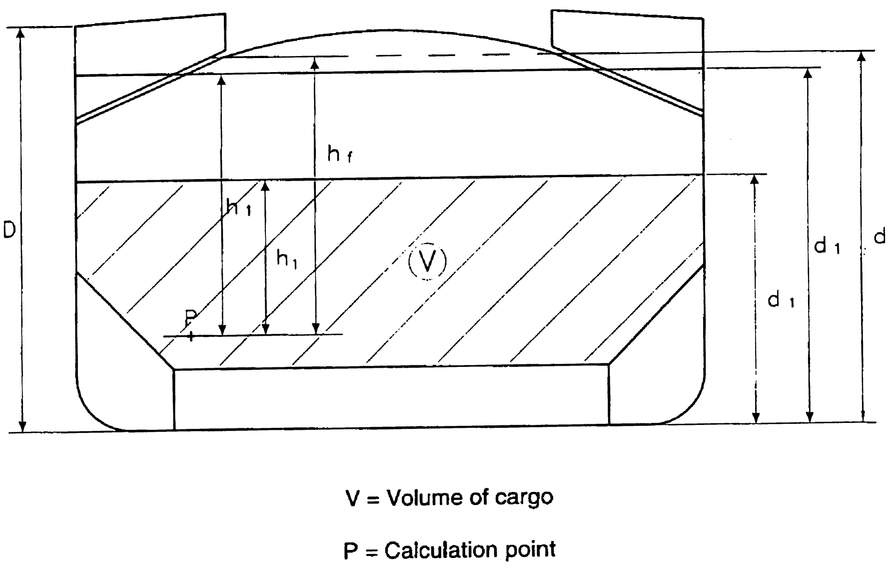


Fig. 1
Definition of D, h_1 and d_1

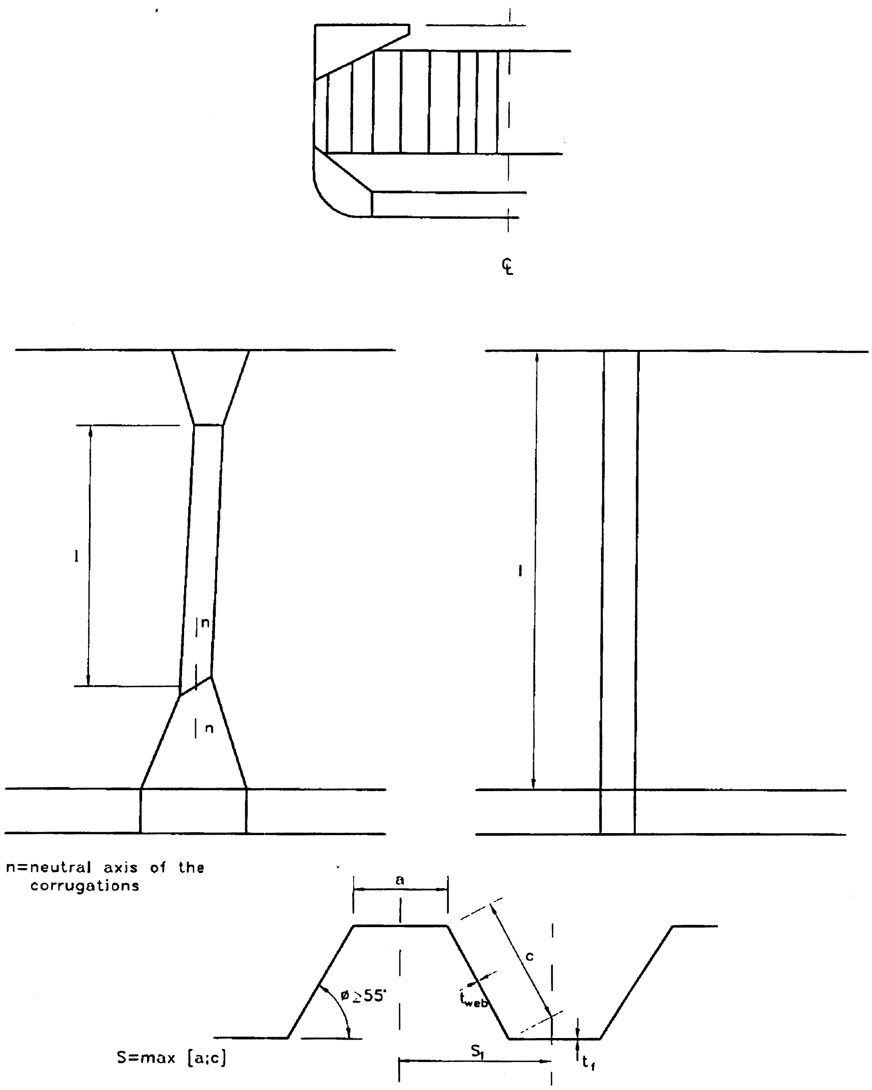


Fig. 2
Spacing of corrugations

204 *Pressure in flooded bulk cargo holds*

Two cases shall be considered, depending on the values of d_1 and d_f.

a) $d_f \geq d_1$

At each point of the bulkhead located at a distance between d_1 and d_f from the baseline, the pressure $p_{c,f}$, in kN/m^2, is given by:

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

ρ = sea water density, in t/m^3
g = as given in 203
h_f = flooding head as defined in 202.

At each point of the bulkhead located at a distance lower than d_1 from the baseline, the pressure $p_{c,f}$, in kN/m^2, is given by:

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

ρ, h_f = as given above
ρ_c, g, h_1, K = as given in 203
perm = permeability of cargo, to be taken as 0.3 for ore (corresponding bulk cargo density for iron ore may generally be taken as 3.0 t/m^3).

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

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

ρ = as given above
s_1, g, d_1 = as given in 203
h_{DB}, h_{LS} = as given in 203
d_f = as given in 202
$(P_{c,f})_{le}$ = pressure, in kN/m^2, at the lower end of the corrugation.

b) $d_f < d_1$

At each point of the bulkhead located at a distance between d_f and d_1 from the baseline, the pressure $p_{c,f}$, in kN/m^2, is given by:

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

ρ_c, g, h_1, K = as given in 203.

At each point of the bulkhead located at a distance lower than d_f from the baseline, the pressure $p_{c,f}$, in kN/m^2, is given by:

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

ρ, h_f, perm = as given in a) above
ρ_c, g, h_1, K = as given in 203.

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

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

s_1, ρ_c, g, d_1 = as given in 203
h_{DB}, h_{LS}, K = as given in 203
d_f = as given in 202
$(P_{c,f})_{le}$ = pressure, in kN/m^2, at the lower end of the corrugation.

205 *Empty cargo holds and pressure due to flooding water alone*

At each point of the bulkhead, the hydrostatic pressure p_f induced by the flooding head h_f shall be considered.

The force F_f, in kN, acting on a corrugation is given by:

$$F_1 = s_1\rho\, g\frac{(d_f - h_{DB} - h_{LS})^2}{2}$$

s_1, g, h_{DB}, h_{LS} = as given in 203
ρ = as given in 204 a)
d_f = as given in 202.

206 *Resultant pressure and force - Homogeneous loading conditions*

At each point of the bulkhead structures, the resultant pressure p, in kN/m^2, to be considered for the scantlings of the bulkhead is given by:

$$p = p_{c,f} - 0.8\, p_c$$

The resultant force F, in kN, acting on a corrugation is given by:

$$F = F_{c,f} - 0.8\, F_c$$

207 *Resultant pressure and force - Non-homogeneous loading conditions*

At each point of the bulkhead structures, the resultant pressure p, in kN/m^2, to be considered for the scantlings of the bulkhead is given by:

$$p = p_{c,f}$$

The resultant force F, in kN, acting on a corrugation is given by:

$$F = F_{c,f}$$

In case cargo hold no. 1, in non-homogeneous loading conditions, is not allowed to be loaded, the resultant pressure p, in kN/m^2, to be considered for the scantlings of the bulkhead is given by:

$$p = p_f$$

and the resultant force F, in kN, acting on a corrugation is given by:

$$F = F_f$$

208 *Bending moment in the bulkhead corrugation*

The design bending moment M, in kNm, for the bulkhead corrugation is given by:

$$M = \frac{Fl}{8}$$

F = resultant force, in kN, as given in 206 or 207 as relevant
l = span of the corrugation, in m, to be taken according to Fig.2 and Fig.3.

209 *Shear force in the bulkhead corrugation*

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

Q = 0.8 F

F = as given in 208.

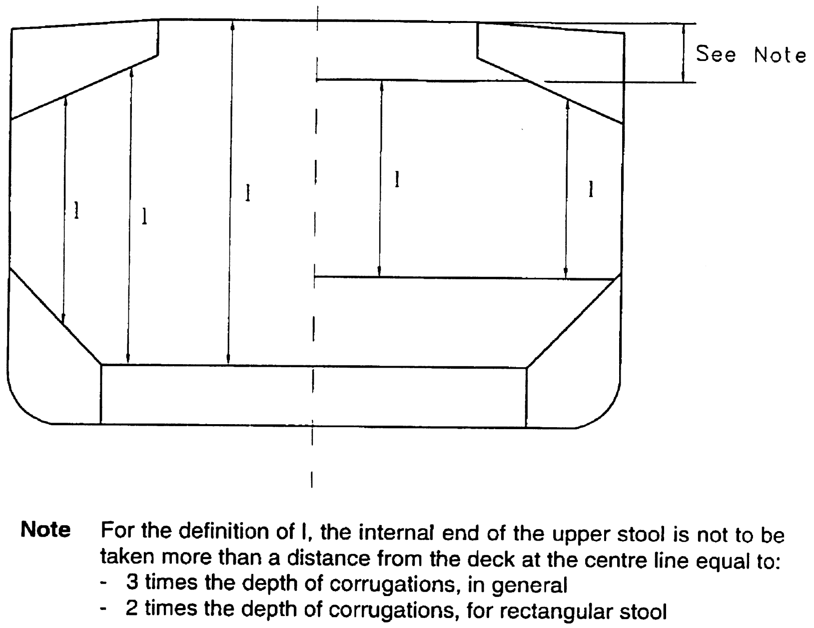


Fig. 3
Definition of *l*

A 300 Strength criteria

301 *General*

The following criteria are applicable to transverse bulkheads with vertical corrugations (see Fig.2 and Fig.3).

Where the corrugation angle ϕ shown in Fig.2 is less than 50°, an horizontal row of staggered shedder plates to be fitted at approximately mid depth of the corrugations (see Fig.2) to help preserve dimensional stability of the bulkhead under flooding loads. The shedder plates shall be welded to the corrugations by double continuous welding, but they shall not be welded to the side shell.

Requirements for local net plate thickness are given in 308.

In addition, the criteria as given in 302 and 305 shall be complied with.

The thickness of the lower part of corrugations considered in the application of 302 and 303 shall be maintained for a distance from the inner bottom, or the top of the lower stool not less than 0.15 l.

The thickness of the middle part of corrugations as considered in the application of 302 and 304 shall be maintained to a distance from the deck, or the bottom of the upper stool not greater than 0.3 l.

302 *Bending capacity and shear stress τ*

The bending capacity shall comply with the following relationship:

$$10^3 \frac{M}{0.5\, Z_{le}\sigma_{a,\,le} + Z_m \sigma_{a,\,m}} \leq 1.0$$

M = bending moment, in kNm, as given in 208
Z_{le} = section modulus, in cm^3, at the lower end of corrugations, to be calculated according to 303
Z_m = section modulus, in cm^3, at the midspan of corrugations, to be calculated according to 304
$\sigma_{a,le}$ = allowable stress, in N/mm^2, as given in 305, for the lower end of corrugations
$\sigma_{a,m}$ = allowable stress, in N/mm^2, as given in 305, for the mid-span of corrugations.

In no case is Z_m to be taken greater than the lesser of 1.15 Z_{le} and 1.15 Z'_{le} for calculation of the bending capacity, Z'_{le} as being defined below.

In case shedder plates are fitted which:

— are not knuckled
— are welded to the corrugations and the top of the lower stool by one side penetration welds or equivalent
— are fitted with a minimum slope of 45° and their lower edge is in line with the stool side plating,

or gusset plates are fitted which:

— have a height not less than half of the flange width
— are fitted in line with the stool side plating
— have thickness and material properties at least equal to those provided for the flanges,

the section modulus Z_{le}, in cm^3, shall be taken not larger than the value Z'_{le}, in cm^3, given by:

$$Z'_{le} = Z_g + 10^3 \frac{Qh_g - 0.5\, h_g^2 s_1 p_g}{\sigma_a}$$

Z_g = section modulus, in cm^3, of the corrugations calculated, according to 304, in way of the upper end of shedder or gusset plates, as applicable
Q = shear force, in kN, as given in 209
h_g = height, in m, of shedders or gusset plates, as applicable (see Fig.4, Fig.5, Fig.6 and Fig.7)
s_1 = as given in 203
p_g = resultant pressure, in kN/m^2, as defined in 206 or 207 as relevant calculated in way of the middle of the shedders or gusset plates, as applicable
σ_a = allowable stress, in N/mm^2, as given in 305.

Stresses, τ, are obtained by dividing the shear force, Q, by the shear area. The shear area shall be reduced in order to account for possible non-perpendicularity between the corrugation webs and flanges. In general, the reduced shear area may be obtained by multiplying the web sectional area by (sin ϕ), ϕ being the angle between the web and the flange.

When calculating the section modulus and the shear area, the net plate thickness shall be used.

The section modulus of corrugations shall be calculated on the bases of the following requirements given in 303 and 304.

303 *Section modulus at the lower end of corrugations*

The section modulus shall be calculated with the compression flange having an effective flange width, b_{ef}, not larger than as given in 306.

If the corrugation webs are not supported by local brackets below the stool top (or below the inner bottom) in the lower part, the section modulus of the corrugations shall be calculated considering the corrugation webs 30% effective.

a) Provided that effective shedder plates, as defined in 302, are fitted (see Fig.4 and Fig.5), when calculating the section modulus of corrugations at the lower end (cross- section (1) in Fig.4 and Fig.5), the area of flange plates, in cm^2, may be increased by:

$$\left(2.5\ a\ \sqrt{t_f t_{sh}}\ \sqrt{\frac{\sigma_{Fsh}}{\sigma_{Ffl}}}\right)$$

(not to be taken greater than 2.5 a t_f)
where:

a = width, in m, of the corrugation flange (see Fig.2)
t_{sh} = net shedder plate thickness, in mm
t_f = net flange thickness, in mm.
σ_{Fsh} = minimum upper yield stress, in N/mm^2 of the material used for the shedder plates
σ_{Ffl} = minimum upper yield stress, in N/mm^2 of the material used for the corrugation flanges.

b) Provided that effective gusset plates, as defined in 302, are fitted (see Fig.6 and Fig.7) when calculating the section modulus of corrugations at the lower end (cross-section (1) in Fig.6 and Fig.7), the area of flange plates, in cm^2, may be increased by ($7\ h_g\ t_{gu}$) where:

h_g = height of gusset plate in m, see Fig.6 and Fig.7, not to be taken greater than:

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

s_{gu} = width of the gusset plates, in m
t_f = net flange thickness, in mm, based on the as built condition.
t_{gu} = net gusset plate thickness, in mm not to be taken greater than t_f

c) If the corrugation webs are welded to a sloping stool top plate, which is at an angle not less than 45° with the horizontal plane, the section modulus of the corrugations may be calculated considering the corrugation webs fully effective. In case effective gusset plates are fitted, when calculating the section modulus of corrugations the area of flange plates may be increased as specified in b) above. No credit can be given to shedder plates only.

For angles less than 45°, the effectiveness of the web may be obtained by linear interpolation between 30% for 0° and 100% for 45°.

304 *Section modulus of corrugations at cross-sections other than the lower end*

The section modulus shall be calculated with the corrugation webs considered effective and the compression flange having an effective flange width, b_{ef}, not larger than as given in 306.

305 *Allowable stress check*

The normal and shear stresses σ and τ, shall not exceed the allowable values σ_a and τ_a, in N/mm^2, given by:

$\sigma_a = \sigma_F$
$\tau_a = 0.5\ \sigma_F$

σ_F being the minimum upper yield stress, in N/mm^2, of the material.

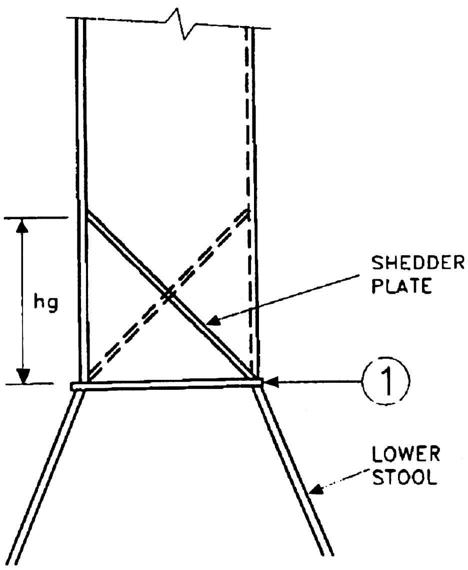


Fig. 4
Symmetric shedder plates

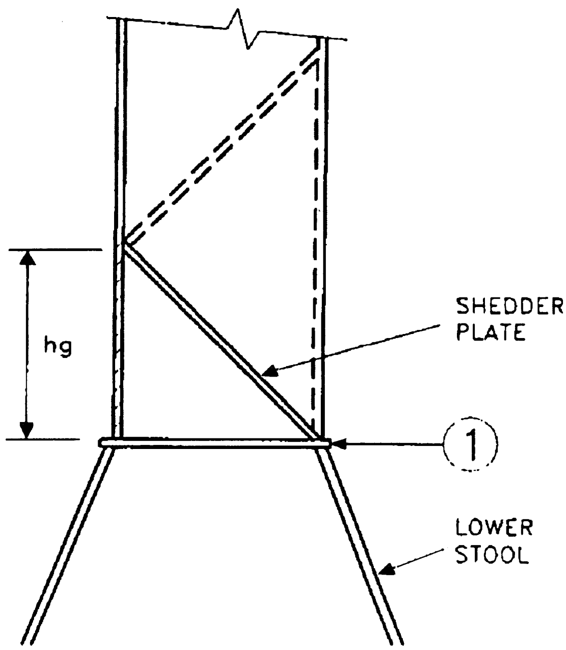


Fig. 5
Asymmetric shedder plates

306 *Effective width of compression flange of corrugations*

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

$$b_{ef} = C_e a$$

where:

$C_e = \frac{2.25}{\beta} - \frac{1.25}{\beta^2}$ for $\beta > 1.25$

$C_e = 1.0$ for $\beta \leq 1.25$

$\beta = 10^3 \frac{a}{t_f} \sqrt{\frac{\sigma_F}{E}}$

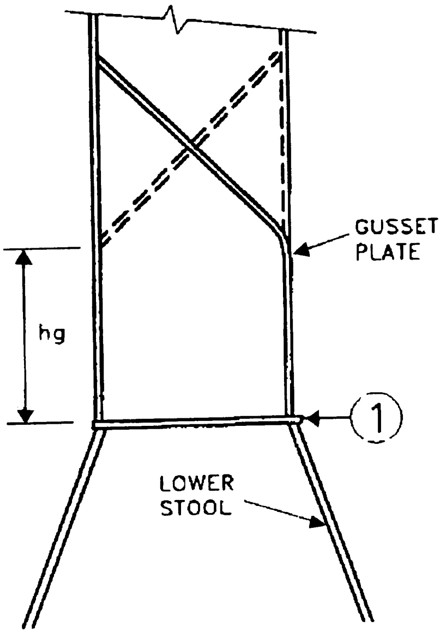


Fig. 6
Symmetric gusset or shedder plates

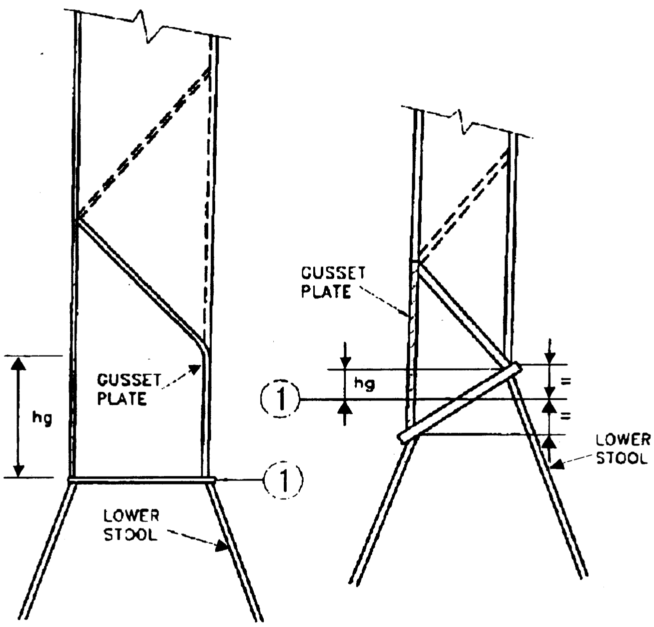


Fig. 7
Asymmetric gusset or shedder plates

t_f = net flange thickness, in mm
a = width, in m, of the corrugation flange (see Fig.2)
σ_F = minimum upper yield stress, in N/mm^2, of the material
E = modulus of elasticity of the material, in N/mm^2, to be assumed equal to $2.06 \cdot 10^5$ for steel.

307 *Shear buckling*

The buckling check shall be performed for the web plates at the corrugation ends.

The shear stress, τ, shall not exceed the critical value τ_c, in N/mm^2, as given in Pt.3 Ch.1 Sec.13, assuming a buckling factor k_t = 6.34 and net plate thickness as defined in this subsection.

308 *Local net plate thickness*

The bulkhead local net plate thickness t, in mm, is given by:

$$t = 14.9\, s_w \sqrt{\frac{1.0p}{\sigma_F}}$$

s_W = plate width, in m, to be taken equal to the width of the corrugation flange or web, whichever is the greater (see Fig.2)

p = resultant pressure, in kN/m^2, as defined in 206 or 207 as relevant, at the bottom of each strake of plating. In all cases, the net thickness of the lowest strake shall be determined using the resultant pressure at the top of the lower stool, or at the inner bottom, if no lower stool is fitted or at the top of shedders, if shedder or gusset or shedder plates are fitted

σ_F = minimum upper yield stress, in N/mm^2 of the material.

For built-up corrugation bulkheads, when the thickness of the flange and web are different, the net thickness of the narrower plating shall be not less than t_n, in mm, given by:

$$t_n = 14.9\, s_n \sqrt{\frac{1.0p}{\sigma_F}}$$

s_n being the width, in mm, of the narrower plating.

The net thickness of the wider plating, in mm, shall not be taken less than the maximum of the following values:

$$t_w = 14.9\, s_w \sqrt{\frac{1.0p}{\sigma_F}}$$

and

$$t_w = \sqrt{\frac{440 s_w^2\, 1.0p}{\sigma_F} - t_{np}^2}$$

t_{np} ≤ actual net thickness of the narrower plating and not to be greater than:

$$14.9\, s_w \sqrt{\frac{1.0p}{\sigma_F}}$$

A 400 Local details

401 The design of local details, for the purpose of transferring the corrugated bulkhead forces and moments to the boundary structures, shall reflect local stress concentration due to abrupt change in stiffness. Areas of concern are in particular connection to double bottom, cross-deck structures and connection of stool construction (upper and lower) to top-wing and hopper tank construction.

The thickness and stiffening of effective gusset and shedder plates, as defined in 303, shall comply with Pt.3 Ch.1 Sec.9, based on the pressure load as given in 201 to 207.

Unless otherwise stated, weld connections and materials shall be dimensioned and selected in accordance with Pt.3 Ch.1.

A 500 Corrosion addition and steel renewal

501 Steel renewal is required where the gauged thickness is less than t_{net} + 0.5 mm, t_{net} being the thickness used for the calculation of bending capacity and shear stresses as given in 302 or the local net plate thickness as given in 308. Alternatively, reinforcing doubling strips may be used providing the net thickness is not dictated by shear strength requirements for web plates (see 305 and 307) or by local pressure requirements for web and flange plates (see 308).

Where the gauged thickness is within the range t_{net} + 0.5 mm and t_{net} + 1.0 mm, coating (applied in accordance with the coating manufacturer's requirements) or annual gauging may be adopted as an alternative to steel renewal.

502 Where steel renewal or reinforcement is required, a minimum thickness of t_{net} + 2.5 mm shall be replenished for the renewed or reinforced parts.

503 When:

$$0.8\,(\sigma_{Ffl}\, t_{fl}) \geq \sigma_{FS}\, t_{st}$$

σ_{Ffl} = minimum upper yield stress, in N/mm^2, of the material used for the corrugation flanges

σ_{FS} = minimum upper yield stress, in N/mm^2, of the material used for the lower stool side plating or floors (if no stool is fitted)

t_{fl} = flange thickness, in mm, which is found to be acceptable based on the criteria specified in 501 above or, when steel renewal is required, the replenished thickness according to the criteria specified in 502 above. The above flange thickness dictated by local pressure requirements (see 308) need not be considered for this purpose

t_{st} = as built thickness, in mm, of the lower stool side plating or floors (if no stool is fitted).

Gussets with shedder plates, extending from the lower end of corrugations up to 0.1 *l*, or reinforcing doubling strips (on bulkhead corrugations and stool side plating) shall be fitted.

If gusset plates are fitted, the material of such gusset plates shall be the same as that of the corrugation flanges. The gusset plates shall be connected to the lower stool shelf plate or inner bottom (if no lower stool is fitted) by deep penetration welds (see Fig.8).

504 Where steel renewal is required, the bulkhead connections to the lower stool shelf plate or inner bottom (if no stool is fitted) shall be at least made by deep penetration welds (see Fig.8).

505 Where gusset plates shall be fitted or renewed, their connections with the corrugations and the lower stool shelf plate or inner bottom (if no stool is fitted) shall be at least made by deep penetration welds (see Fig.8).

B. Limit to Hold Loading considering Hold Flooding

B 100 Application and definition

101 These requirements apply to the double bottom structure of cargo hold no. 1 for all bulk carriers of 150 m in length and above, in the foremost hold, subject to mandatory class notation **Bulk Carrier ESP**, intending to carry solid bulk cargoes having a density of 1.78 t/m^3 or above with single deck, topside tanks and hopper tanks. Where:

a) the foremost hold is bounded by the side shell only for ships which were contracted for construction prior to 1 July 1998, and have not been constructed in compliance with IACS Unified Requirement S20
b) the foremost hold is double side skin construction of less than 760 mm breadth measured perpendicular to side shell in ships, the keel of which were laid, or which were at a similar stage of construction, before 1 July 1999 and have not been constructed in compliance with IACS Unified Requirement S20. (Rev.2, Sept. 2000).

The requirements shall, at the latest, be complied with as follows:

a) for ships which were 20 years of age or more on 1 July 1998, by the due date of the first intermediate, or the due date of the first renewal survey to be held after 1 July 1998, whichever comes first
b) for ships which were 15 years of age or more but less than 20 years of age on 1 July 1998, by the due date of the first renewal survey to be held after 1 July 1998, but not later than 1 July 2002
c) for ships which were 10 years of age or more but less than 15 years of age on 1 July 1998, by the due date of the first intermediate or the first renewal survey to be held after the date on which the ship reaches 15 years of age but not later than the date on which the ship reaches 17 years of age
d) for ships which were 5 years of age or more but less than 10 years of age on 1 July 1998, by the due date, after 1 July 2003, of the first intermediate or first renewal survey after the date on which the ship reaches 10 years of age, whichever occurs first
e) for ships which were less than 5 years of age on 1 July 1998, by the date on which the ship reaches 10 years of age.

The loading in cargo hold no. 1 shall not exceed the limit to hold loading in flooded condition, calculated as per 401, using the loads given in 201 and 202 and the shear capacity of the double bottom given in 301 to 303.

In no case is the loading in each cargo hold to exceed design hold loading in intact condition.

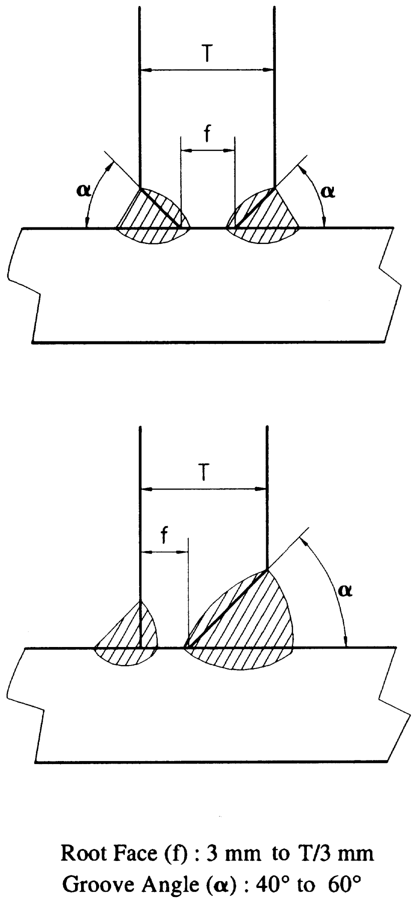


Fig. 8
Deep penetration welds

B 200 Load model

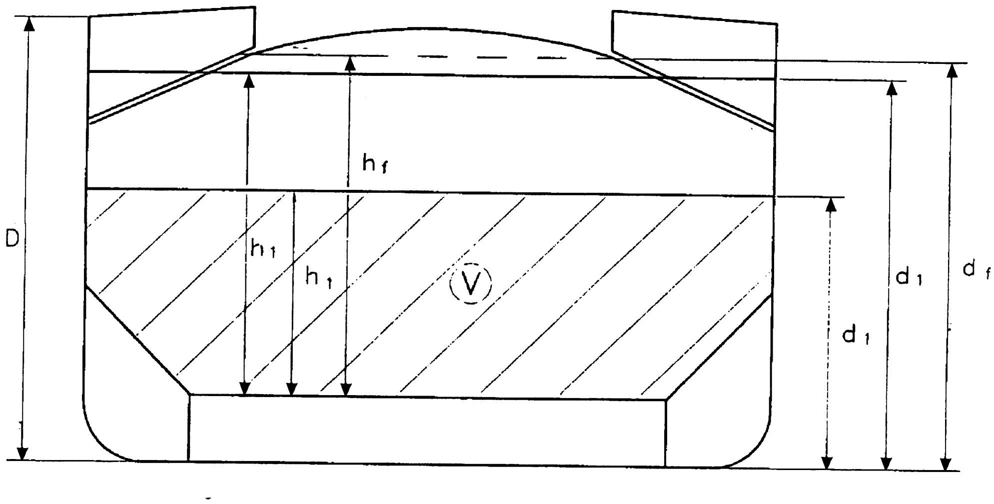
201 *General*

The loads to be considered as acting on the double bottom of cargo hold no.1 are those given by the external sea pressures and the combination of the cargo loads with those induced by the flooding of cargo hold no.1.

The most severe combinations of cargo induced loads and flooding loads shall be used, depending on the loading conditions included in the loading manual:

— homogeneous loading conditions
— non-homogeneous loading conditions
— packed cargo conditions (such as steel mill products).

For each loading condition, the maximum bulk cargo density to be carried shall be considered in calculating the allowable hold loading limit.



V = Volume of cargo

Fig. 9
Definition of flooding head and D

202 *Inner bottom flooding head*

The flooding head h_f (see Fig.9) is the distance, in m, measured vertically with the ship in the upright position, from the inner bottom to a level located at a distance d_f, in m, from the baseline equal to:

a) in general:

— D for the foremost cargo hold

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

— 0.95 D for the foremost cargo hold.

D being the distance, in m, from the baseline to the freeboard deck at side amidships (see Fig.9).

B 300 Shear capacity

301 *Shear capacity of the double bottom*

The shear capacity, C, of the double bottom of cargo hold no.1 is defined as the sum of the shear strength at each end of:

— all floors adjacent to both hoppers, less one half of the strength of the two floors adjacent to each stool, or transverse bulkhead if no stool is fitted (see Fig.10)
— all double bottom girders adjacent to both stools, or transverse bulkheads if not stool is fitted.

The strength of girders or floors which run out and are not directly attached to the boundary stool or hopper girder shall be evaluated for the one end only.

Note that the floors and girders to be considered are those inside the cargo hold boundaries formed by the hoppers and stools (or transverse bulkheads if no stool is fitted). The hopper side girders and the floors directly below the connection of the bulkhead stools (or transverse bulkheads if no stool is fitted) to the inner bottom shall not be included.

When the geometry and/or the structural arrangement of the double bottom are such to make the above assumptions inadequate, the shear capacity C of double bottom will be subject to special consideration.

In calculating the shear strength, the net thickness of floors and girders shall be used. The net thickness t_{net}, in mm, is given by:

$$t_{net} = t - 2.0$$

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

302 *Floor shear strength*

The floor shear strength in way of the floor panel adjacent to hoppers S_{f1}, in kN, and the floor shear strength in way of the openings in the outmost bay (i.e. that bay which is closer to hopper) S_{f2}, in kN, are given by the following expressions:

$$S_{f1} = 10^{-3} A_f \frac{\tau_a}{\eta_1}$$

$$S_{f2} = 10^{-3} A_{f,h} \frac{\tau_a}{\eta_2}$$

A_f = sectional area, in mm^2, of the floor panel adjacent to hoppers
$A_{f,h}$ = net sectional area, in mm^2, of the floor panels in way of the openings in the outmost bay (i.e. that bay which is closer to hopper)
τ_a = the allowable shear stress, in N/mm^2, to be taken equal to:

$$\frac{\sigma_F}{\sqrt{3}}$$

σ_F = minimum upper yield stress, in N/mm^2, of the material
η_1 = 1.10
η_2 = 1.20

η_2 may be reduced to 1.10 when appropriate reinforcements are fitted around openings.

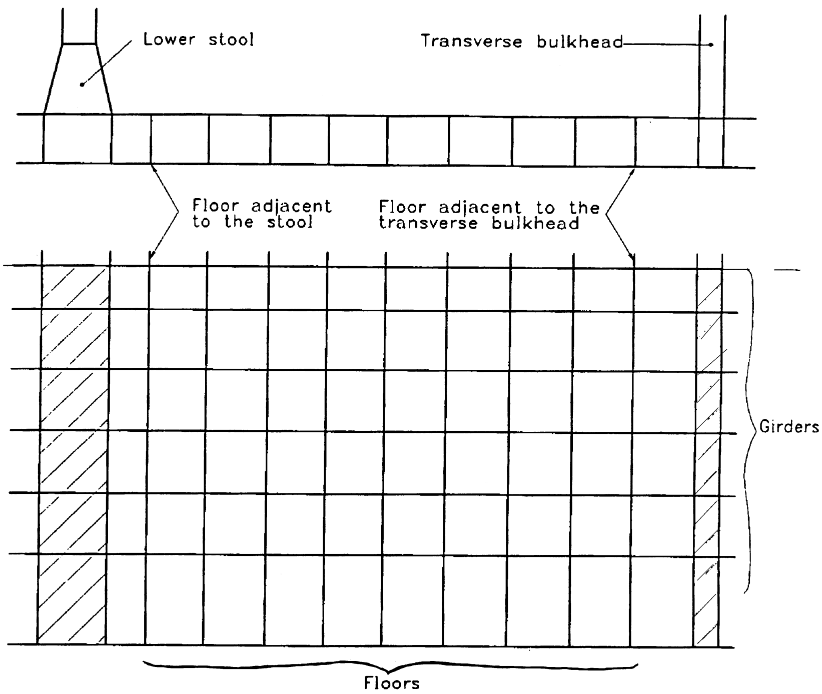


Fig. 10
Arrangement of double bottom

303 *Girder shear strength*

The girder shear strength in way of the girder panel adjacent to stools (or transverse bulkheads, if no stool is fitted) S_{g1}, in kN, and the girder shear strength in way of the largest opening in the outmost bay (i.e. that bay which is closer to stool, or transverse bulkhead, if no stool is fitted) S_{g2}, in kN, are given by the following expressions:

$$S_{g1} = 10^{-3} A_g \frac{\tau_a}{\eta_1}$$

$$S_{g2} = 10^{-3} A_{g,h} \frac{\tau_a}{\eta_2}$$

where:

A_g = minimum sectional area, in mm^2, of the girder panel adjacent to stools (or transverse bulkheads, if no stool is fitted)

$A_{g,h}$ = net sectional area, in mm^2, of the girder panel in way of the largest opening in the outmost bay (i.e. that bay which is closer to stool, or transverse bulkhead, if no stool is fitted)
τ_a = allowable shear stress, in N/mm^2, as given in 302
η_1 = 1.10
η_2 = 1.15

η_2 may be reduced to 1.10 when appropriate reinforcements are fitted around openings.

B 400 Limit to cargo hold loading, considering flooding

401 The limit to cargo hold loading, W, in tonnes, is given by:

$$W = \rho_c V \frac{1}{F}$$

F = 1.1 in general
= 1.05 for steel mill products
ρ_c = bulk cargo density, in t/m^3 (see 201).
V = volume, in m^3, occupied by cargo at a level h_1
$h_1 = \dfrac{X}{\rho_c g}$

X = the lesser of X_1 and X_2 given by

$$X_1 = \frac{Z + \rho g(E - h_f)}{1 + \frac{\rho}{\rho_c}(\text{perm} - 1)}$$

$$X_2 = Z + \rho\, g\, (E - h_f\, \text{perm})$$

ρ = sea water density, in t/m^3
g = 9.81 m/s^2, gravity acceleration
E = ship immersion in m for flooded hold condition
= $d_f - 0.1\,D$
d_f, D = as given in 202
h_f = flooding head, in m, as defined in 202
Z = the lesser of Z_1 and Z_2 given by:

$$Z_1 = \frac{C_h}{A_{DB,h}}$$

$$Z_2 = \frac{C_e}{A_{DB,e}}$$

C_h = shear capacity of the double bottom, in kN, as defined in 301, considering, for each floor, the lesser of the shear strengths S_{f1} and S_{f2} (see 302) and, for each girder, the lesser of the shear strengths S_{g1} and S_{g2} (see 303)
C_e = shear capacity of double bottom, in kN, as defined in 301, considering, for each floor, the shear strength S_{f1} (see 302) and, for each girder, the lesser of the shear strengths S_{g1} and S_{g2} (see 303)

$$A_{DH,h} = \sum_{i=1}^{i=n} S_i B_{DB,i}$$

$$A_{DB,c} = \sum_{i=1}^{i=n} S_i (B_{DB} - s_l)$$

n = number of floors between stools (or transverse bulkheads, if no stool is fitted)
S_i = space of i th-floor, in m
$B_{DB,i}$ = $B_{DB} - s_l$ for floors whose shear strength is given by S_{f1} (see 302)
$B_{DB,i}$ = $B_{DB,h}$ for floors whose shear strength is given by S_{f2} (see 302)
B_{DB} = breadth of double bottom, in m, between hoppers (see Fig.11)
$B_{DB,h}$ = distance, in m, between the two considered opening (see Fig.11)

s_l = spacing, in m, of double bottom longitudinals adjacent to hoppers

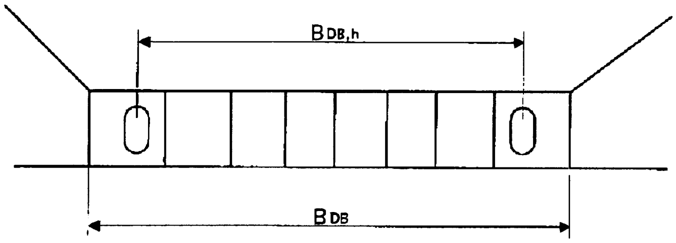


Fig. 11
Dimensions of double bottom

C. Damage Stability

C 100 Application

101 Vessels subject to rule requirements in subsections A and B shall, when loaded to the summer load line, be able to withstand flooding of the foremost cargo hold in all loading conditions and remain afloat in a satisfactory condition of equilibrium as specified in 102.

102 The condition of equilibrium after flooding shall satisfy the condition of equilibrium laid down in the annex to resolution A.320(IX) - Regulation equivalent to regulation 27 of the International Convention on Load Lines, 1966, as amended by resolution A.514(13). The assumed flooding need take into account flooding of the cargo hold space only. The permeability of the loaded hold shall be assumed as 0.9 and the permeability of an empty cargo hold shall be assumed as 0.95, unless a permeability relevant to a particular cargo is assumed for the volume of a flooded hold occupied by cargo and a permeability of 0.95 is assumed for the remaining empty volume of the hold.

103 Bulk carriers which have been assigned a reduced freeboard in compliance with the provisions of regulation 27(8) of the annex to resolution A.320(IX), as amended by resolution A.514(13) may be considered as complying with requirements as given in 101.

104 Vessels not satisfying the requirements given in 101 or 103 shall be provided with detailed information on specific cargo hold flooding scenarios. This information shall be accompanied by detailed instructions on evacuation preparedness under the provisions of Section 8 of the International Safety Management (ISM) Code and be used as the basis for crew training and drills. (SOLAS Ch. XII/9.3).

D. Loading Information

D 100 Loading computer system

101 All vessels with one of the following class notations shall be provided with an approved loading computer system:

Bulk Carrier ESP

Ore Carrier ESP

Bulk Carrier or Tanker for Oil ESP

Ore Carrier or Tanker for Oil ESP.

This is applicable for vessels of 150 m in length (L) and above, that were contracted for construction before 1 July 1998. The loading computer system shall be installed, in approved order, not later than their entry into service or 1 January 1999, whichever occurs later.

102 The loading computer system shall be of a multipoint type and be able to easily and quickly ascertain that, at specified read-out points, the still water bending moment, shear forces and still water torsional and lateral loads, where applicable, in any load or ballast condition will not exceed the specified permissible values.

D 200 Loading sequences

201 All single side skin vessels with class notation:

Bulk Carrier ESP

of 150 m in length (L) and above, that were contracted for construction before 1 July 1998 shall be provided, before 1 July 1999 or their entry into service, whichever occurs later, with an approved loading manual with typical loading and unloading sequences. The loading sequences should describe the loading from commencement of cargo loading to reaching full deadweight capacity, for homogenous conditions, relevant part-load conditions and alternate conditions where applicable.

E. Detection of Water Ingress into Cargo Holds, Ballast and Dry Spaces and Availability of Drainage

E 100 Application and definition

101 The requirements in 200 apply to vessels subject to the damage stability requirements in C, but which do not satisfy either C101 or C103 due to having been constructed with an insufficient number of transverse watertight bulkheads.

102 The requirements in 200 shall be complied with as follows:

a) for ships that were 20 years of age or more on 1 July 1998, by the due date of the first intermediate, or the due date of first complete periodical survey to be held after 1 July 1998, whichever comes first
b) for ships that were 15 years of age or more but less than 20 years of age on 1 July 1998, by due date of the first complete periodical survey to be held after 1 July 1998, but not later than 1 July 2002
c) for ships that were 10 years of age or more but less than 15 years of age on 1 July 1998, by the due date of the next complete periodical survey after the date on which the ship reaches 15 years of age but not later than the date on which the ship reaches 17 years of age, and
d) for ships that were less than 10 years of age on 1 July 1998, by the date on which the ship reaches 15 years of age.

(IACS UR S23.1)

However, ships that have already passed their due date shall comply not later than the first intermediate or the first complete periodical survey.

103 The requirements in 300 and 400 shall apply to all bulk carriers constructed before 1 July 2004 not later than the date of the annual, intermediate or renewal survey of the ship to be carried out after 1 July 2004, whichever comes first.

104 The requirements in 500 shall apply to all bulk carriers constructed before 1 July 2004 not later than the date of the first intermediate or renewal survey of the ship to be carried out after 1 July 2004, but in no case later than 1 July 2007.

E 200 Detection of water ingress

201 The vessel shall be provided with an approved bilge well high water level alarm in all cargo holds, or in cargo conveyor tunnels, as appropriate, giving an audible and visual alarm on the navigation bridge.

(SOLAS Ch. XII/9.2)

202 In addition, the vessel shall be provided with an approved permanent means of detecting the presence of water in the cargo holds, in excess of the small amounts which may be normally expected in the bilge wells.

(IACS UR S24.2)

E 300 Hold, ballast and dry space water level detectors

301 Bulk carriers shall be fitted with water level detectors:

a) In each cargo hold, giving audible and visual alarms, one when the water level above the inner bottom in any hold reaches a height of 0.5 m and another at a height not less than 15% of the depth of the cargo hold but not more than 2.0 m. Detectors with only the latter alarm need be installed on bulk carriers for which 200 applies.
b) In any ballast tank forward of the collision bulkhead, giving an audible and visual alarm when the liquid in the tank reaches a level not exceeding 10% of the tank capacity.
c) In any dry or void space other than a chain cable locker, any part of which extends forward of the foremost cargo hold, giving an audible and visual alarm at a water level of 0.1 m above the deck. Such alarms need not be provided in enclosed spaces the volume of which does not exceed 0.1% of the ship's maximum displacement volume.

(SOLAS Ch. XII/12)

302 The installation shall be in accordance with Pt.5 Ch.2 Sec.5.

E 400 Installation, testing and survey

401 The system shall be installed and tested in accordance with the manufacturer's specifications. At the initial installation and at each subsequent complete periodical survey the surveyor shall verify the proper operation of the water detection system.

(IACS UR S24.5).

E 500 Availability of drainage

501 On bulk carriers, the means for draining and pumping ballast tanks forward of the collision bulkhead, and bilges of dry spaces any part of which extends forward of the foremost cargo hold, shall be capable of being brought into operation from a readily accessible enclosed space, the location of which is accessible from the navigation bridge or propulsion machinery control position without traversing exposed freeboard or superstructure decks. This does not apply to the enclosed spaces the volume of which does not exceed 0.1% of the ship's maximum displacement volume and to the chain cable locker. Where pipes serving such tanks or bilges pierce the collision bulkhead, as an alternative to the valve control specified in Pt.4 Ch.6 Sec.3 A402, valve operation by means of remotely operated actuators may be accepted, provided that the location of such valve controls complies with this regulation.

(SOLAS Ch. XII/13)

F. Renewal Criteria for Side Shell Frames and Brackets in Single Side Skin Bulk Carriers, which were not built in accordance with the Society's Rules July 1998 or subsequent Rules

F 100 Application and definitions

101 These requirements apply to the side shell frames and brackets of cargo holds bounded by the single side shell of bulk carriers constructed with single deck, topside tanks and hopper tanks in cargo spaces intended primarily to carry dry cargo in bulk, which were not built in accordance with the Society's rules July 1998 or subsequent rules (IACS UR S12 Rev.1 or subsequent revisions).

These requirements also apply to the side shell frames and brackets of cargo holds bounded by the single side shell of Oil/Bulk/Ore (OBO) carriers, as defined in IACS UR Z11, but of single side skin construction.

In the case where a vessel does not satisfy the definition in one or more holds, the requirements in this Sub-section shall not apply to these individual holds.

Ships subject to these requirements shall be assessed for compliance with the requirements of these rules (IACS UR S31) and steel renewal, reinforcement or coating, where required in accordance with these rules (IACS UR S31), shall be carried out in accordance with the following schedule and at subsequent intermediate and special surveys:

- for ships which will be 15 years of age or more on 1 January 2004 by date of the first intermediate or special survey after that date
- for ships which will be 10 years of age or more on 1 January 2004 by the due date of the first special survey after that date
- for ships which will be less than 10 years of age on 1 January 2004 by the date on which the ship reaches 10 years of age.

Completion prior to 1 January 2004 of an intermediate or special survey with a due date after 1 January 2004 cannot be used to postpone compliance. However, completion prior to 1 January 2004 of an intermediate survey the window for which straddles 1 January 2004 can be accepted.

These requirements define steel renewal criteria or other measures to be taken for the webs and flanges of side shell frames and brackets as per 200.

Reinforcing measures of side frames are also defined as per 203.

102 *Ice strengthened ships*

Where bulk carriers are reinforced to comply with an ice class notation, the intermediate frames shall not be included when considering compliance with these rules (IACS UR S31).

If the ice class notation is requested to be withdrawn, the additional ice strengthening structure, with the exception of tripping brackets, ref. 209, is not considered to contribute to compliance with these rules (IACS UR S31).

F 200 Renewal or other measures

201 *Definitions*

t_M = thickness as measured (mm)

t_{REN} = thickness at which renewal is required, see 202
$t_{REN,\ d/t}$ = thickness criteria based on d/t ratio, see 203
$t_{REN,S}$ = thickness criteria based on strength, see 204
t_{COAT} = 0.75 t_{S12}
t_{S12} = thickness (mm) of frame and bracket webs as required according to Pt.5 Ch.2 Sec.8 B300
t_{AB} = thickness as built (mm)
t_C = defined in Table F1

Table F1 t_C values (mm)

Ship length L (m)	*Holds other than No.1*		*Hold No.1*	
	Span and upper brackets	*Lower brackets*	*Span and upper brackets*	*Lower brackets*
100 or less	2.0	2.5	2.0	3.0
150	2.0	3.0	3.0	3.5
200 or more	2.0	3.0	3.0	4.0
Note: For intermediate ship lengths, t_C is obtained by linear interpolation between the above values.				

202 *Criteria for webs*

The webs of the side shell frames and brackets shall be renewed when the measured thickness T_M is equal to or less than the thickness (t_{REN}) as defined below:

t_{REN} is the greatest of:

a) $t_{COAT} - t_C$
b) 0.75 t_{AB}
c) $t_{REN,d/t}$ (Applicable to Zones A and B only)
d) $t_{REN,S}$ (where required by 204)

203 *Thickness criteria based on d/t ratio*

Subject to b) and c) below, $t_{REN,d/t}$ is given by the following equation:

$$t_{REN,\ d/t} = \text{(web depth in mm)}/R$$

where:

For frames:

R = 65 $k^{0.5}$ for symmetrically flanged frames
= 55 $k^{0.5}$ for asymmetrically flanged frames

For lower brackets (see a) below):

R = 87 $k^{0.5}$ for symmetrically flanged frames
= 73 $k^{0.5}$ for asymmetrically flanged frames

where k = $1/f_1$.

For f_1 see Pt.5 Ch.2 Sec.1 B100.

In no instance is $t_{REN,d/t}$ for lower integral brackets to be taken as less than $t_{REN,d/t}$ for the frames they support.

a) Lower brackets

Lower brackets shall be flanged or face plate shall be fitted.

In calculating the web depth of the lower brackets, the following will apply:

— The web depth of lower bracket may be measured from the intersection of the sloped bulkhead of the hopper tank and the side shell plate, perpendicularly to the face plate of the lower bracket.
— Where stiffeners are fitted on the lower bracket plate, the web depth may be taken as the distance between the side shell and the stiffener, between the stiffeners or between the outermost stiffener and the face plate of the brackets, whichever is the greatest.

b) Tripping bracket alternative

When t_M is less than $t_{REN,d/t}$ at section b) of the side frames, tripping brackets in accordance with 209 may be fitted as an alternative to the requirements for the web depth to thickness ratio of side frames. Then $t_{REN,d/t}$ may be disregarded in the determination of t_{REN} in 202.

The value of t_m shall be based on Zone B according to IACS URZ10.2, Annex V, see Fig.12.

c) *Immediately abaft collision bulkhead*

For the side frames including the lower bracket, located immediately abaft the collision bulkhead, whose scantlings are increased in order that their moment of inertia is such to avoid undesirable flexibility of the side shell, when their web as built thickness t_{AB} is greater than 1.65 $t_{REN,S}$, the thickness $t_{REN,d/t}$ may be taken as the value $t'_{REN,d/t}$ obtained from the following equation:

$$t'_{REN,d/t} = (t_{REN,d/t}^2 \, t_{REN,S})^{1/3}$$

where $t_{REN,S}$ shall be obtained from 304.

204 *Thickness criteria based on shear strength check*

Where t_M in the lower part of the side frames, as defined in Fig. 12, is equal to or less than t_{COAT}, $t_{REN,S}$ shall be determined in accordance with 304.

205 *Thickness of renewed webs of frames and lower brackets*

Where steel renewal is required, the renewed webs shall be of a thickness not less than t_{AB}, 1.2 t_{COAT}, or 1.2 t_{REN}, whichever is greatest.

206 *Criteria for other measures*

When $t_{REN} < t_M \leq t_{COAT}$, measures shall be taken, consisting of all the following:

— sand blasting, or equivalent, and coating (see 208)
— fitting tripping brackets (see 209)
— maintaining the coating in "as-new" condition (i.e. without breakdown or rusting), at renewal and intermediate surveys.

The above measures may be waived if the structural members show no thickness diminution with respect to the as built thicknesses and coating is in "as-new" condition (i.e. without breakdown or rusting).

When the measured frame webs thickness t_M is such that $t_{REN} < t_M \leq t_{COAT}$ and the coating is in GOOD condition, sand blasting and coating as required in a) above may be waived even if not found in "as-new" condition, as defined above, provided that tripping brackets are fitted and the coating damaged in way of the tripping bracket welding is repaired.

207 *Bending check criteria for frames and brackets*

When lower end brackets were not fitted with flanges at the design stage, flanges shall be fitted so as to meet the bending strength requirements in 305. The full width of the bracket flange shall extend up and beyond the point at which the frame flange reaches full width. Adequate back-up structure in the hopper shall be ensured, and the bracket shall be aligned with the bracket structure.

Where the length or depth of the lower bracket does not meet the requirements in the Society's rules from July 1998 to January 2003 (IACS UR S12 Rev.3), a bending strength check in accordance with 305 shall be carried out and renewals or reinforcements of frames and/or brackets effected as required therein.

The bending check need not to be carried out in the case the bracket geometry is modified so as to comply with Pt.5 Ch.2 Sec.8 (IACS URS12 Rev.3).

208 *Thickness measurements, steel renewal, sand blasting and coating*

For the purpose of steel renewal, sand blasting and coating, four zones A, B, C and D are defined, as shown in Fig.12.

Representative thickness measurements shall be taken for each zone and shall be assessed against the criteria in 202-207.

When zone B is made up of different plate thicknesses, the requirements shall be based on the lesser thickness.

In case of integral brackets, when the criteria in 202-207 are not satisfied for zone A or B, steel renewal, sand blasting and coating, as applicable shall be done for both zones A and B.

In case of separate brackets, when the criteria in 202-207 are not satisfied for zone A or B, steel renewal, sand blasting and coating shall be done for each one of these zones, as applicable.

When steel renewal is required for zone C according to 202-207, it shall be done for both zones B and C. When sand blasting and coating is required for zone C according to 202-207, it shall be done for both zones B, C and D.

When steel renewal is required for zone D according to 202-207 it needs only to be done for this zone. When sand blasting and coating is required for zone D according to 202-207, it shall be done for zones C and D.

Special consideration may be given by the society to zones previously renewed or re-coated, if found in "as-new" condition (i.e. without breakdown or rusting).

When adopted, on the basis of the renewal thickness criteria in 202-207, in general coating shall be applied in compliance with the requirements of Pt.5 Ch.2 Sec.5 C500 (IACS UR Z9), as applicable.

Where, according to the requirements in 202-207, a limited number of side frames are shown to require coating over part of their length, the following criteria apply:

a) The part to be coated includes:

— the web and the face plate of the side frames and brackets
— the hold surface of side shell, hopper tank and topside tank plating, as applicable, over a width not less than 100 mm from the web of the side frame.

b) Epoxy coating or equivalent shall be applied.

In all cases, all the surfaces to be coated shall be sand blasted prior to coating application.

When flanges of frames or brackets shall be renewed according to this Sub-section the outstanding breadth to thickness ratio shall comply with the requirements in Pt.5 Ch.2 Sec.8 B305.

(IACS UR S31)

209 *Reinforcing measures*

Reinforcing measures are constituted by tripping brackets, located at the lower part and at mid-span of side frames (see Fig.14). Tripping brackets may be located at every two frames, but lower and mid-span brackets shall be fitted in line between alternate pairs of frames.

The thickness of the tripping brackets shall be not less than the as-built thickness of the side frame webs to which they are connected.

Double continuous welding shall be adopted for the connections of tripping brackets to the side shell frames and shell plating.

210 *Weld throat thickness*

In case of steel renewal the welded connections shall comply with Pt.5 Ch.2 Sec.8 B.

211 *Pitting and grooving*

If pitting intensity is higher than 15% in area (see Fig.15), thickness measurement shall be taken to check pitting corrosion.

The minimum acceptable remaining thickness in pits or grooves is equal to:

— 75% of the as built thickness, for pitting or grooving in the frame and bracket webs and flanges
— 70% of the as built thickness, for pitting or grooving in the side shell, hopper tank and topside tank plating attached to the side frame, over a width up to 30 mm each side of it.

212 *Renewal of all frames in one or more cargo holds*

When all frames in one or more holds are required to be renewed according to IACS UR S31, the compliance with the requirements in Pt.5 Ch.2 Sec.8 B may be accepted in lieu of the compliance with the requirements in this Sub-section, provided that:

— It is applied at least to all the frames of the hold(s)
— The coating requirements for side frames of “new ships” are complied with
— The section modulus of side frames is calculated according to the Classification Society Rules.

213 *Renewal of damaged frames*

In case of renewal of a damaged frame already complying with these rules (IACS URS31), the following requirements apply:

— The conditions accepted in compliance with these rules shall, as a minimum, be restored.
— For localised damage, the extension of the renewal shall be carried out according to the standard practice of the individual classification society.

F 300 Strength check criteria

301 In general, loads shall be calculated and strength checks shall be carried out for the aft, middle and forward frames of each hold. The scantlings required for frames in intermediate positions shall be obtained by linear interpolation between the results obtained for the above frames.

When scantlings of side frames vary within a hold, the required scantlings are also to be calculated for the mid frame of each group of frames having the same scantlings. The scantlings required for frames in intermediate positions shall be obtained by linear interpolation between the results obtained for the calculated frames.

302 *Load model*

The following loading conditions shall be considered:

— Homogeneous heavy cargo (density greater than 1.78 t/m^3)
— Homogeneous light cargo (density less than 1.78 t/m^3)
— Non homogeneous heavy cargo, if allowed

— Multi port loading/unloading conditions need not to be considered.

The forces $P_{fr,a}$ and $P_{fr,b}$ (kN) to be considered for the strength checks at sections a) and b) of side frames (specified in Fig.13; in the case of separate lower brackets, section b) is at the top of the lower bracket), are given by:

$$P_{fr,a} = P_S + \max(P_1, P_2)$$
$$P_{fr,b} = P_{fr,a}(h - 2h_B)/h$$

P_S = still water force (kN)
= sh $[(p_{S,U} + p_{S,L})/2]$, when the upper end of the side frame span h (see Fig.12) is below the load water line
= sh' $[(p_{S,L})/2]$, when the upper end of the side frame span h (see Fig.12) is at or above the load water line

P_1 = wave force (kN) in head sea
= sh $[(p_{1,U} + p_{1,L})/2]$

P_2 = wave force (kN) in beam sea
= sh $[(p_{2,U} + p_{2,L})/2]$

h, h_B = side frame span and lower bracket length, in metres, defined in Fig.12 and 13, respectively

h' = distance (m) between the lower end of side frame and the load water line

s = frame spacing (m)

$p_{S,U}$, $p_{S,L}$ = still water pressure (kN/m^2) at the upper and lower end of the side frame span h (see Fig.12), respectively

$p_{1,U}$, $p_{1,L}$ = wave pressure (kN/m^2) as defined in *1) Wave pressure p_1* below for the upper and lower end of the side frame span h, respectively

$p_{2,U}$, $p_{2,L}$ = wave pressure (kN/m^2) as defined in *2) Wave pressure p_2* below for the upper and lower end of the side frame span h, respectively

1) Wave pressure p_1

— The wave pressure p_1 (kN/m^2) at and below the waterline is given by:
$p_1 = 1.50 \{p_{11} + 135 [(B/ 2 (B + 75)] - 1.2(T - z)\}$
where:
$p_{11} = 3k_SC + k_f$

— The wave pressure p_1 (kN/m^2) above the water line is given by:
$p_1 = p_{1w1} - 7.50 (z - T)$

2) Wave pressure p_2

— The wave pressure p_2 (kN/m^2) at and below the waterline is given by:

$p_2 = 13.0 \{0.5B [50c_r / 2(B + 75)] + C_B [(0.5B + k_f)/14][0.7 + 2 z/T]\}$

— The wave pressure p_2 (kN/m^2) above the water line is given by:
$p_2 = p_{2wl} 5.0 - (z - T)$

where:

p_{1w1} = p_1 wave sea pressure at the waterline
p_{2w1} = p_2 wave sea pressure at the waterline
L = rule length (m) as defined in Pt.3 Ch.1Sec.1 B (IACS UR S2)
B = greatest moulded breadth (m)
C_B = block coefficient, as defined in Pt.3 Ch.1 Sec.1 B (IACS UR S2), but not to be taken less than 0.6
T = maximum design draught (m)
C = coefficient
= $10.75 - [(300 - L)/100]^{1.5}$ for $90 \le L \le 300$ m
= 10.75 for L > 300 m
C_r = $[1.25 - 0.025 (2 k_r/(GM)^{1/2})]$ k
k = 1.2 for ships without bilge keel
= 1.0 for ships with bilge keel

k_r = roll radius of gyration. If the actual value of k_r is not available:

= 0.39 B for ships with even distribution of mass in transverse section (e.g. alternate heavy cargo loading or homogeneous light cargo loading)

= 0.25 B for ships with uneven distribution of mass in transverse section (e.g. homogeneous heavy cargo distribution)

GM = 0.12 B if the actual value of GM is not available

z = vertical distance (m) from the baseline to the load point

k_S = $C_B + 0.83/(C_B)^{1/2}$ at aft end of L

= C_B between 0.2 L and 0.6 L from aft end of L

= $C_B + 1.33/C_B$ at forward end of L
Between the above specified points, k_s shall be interpolated linearly.

k_f = 0.8 C

303 *Allowable stresses*

The allowable normal and shear stresses σ_a and τ_a (kN/m^2) in the side shell frames are given by:

$$\sigma_a = 0.90\ \sigma_F$$

$$\tau_a = 0.40\ \sigma_F$$

where σ_F is the minimum upper yield stress (kN/m^2) of the material.

304 *Shear strength check*

Where t_M in the lower part of the side frames, as defined in Fig. 12, is equal to or less than t_{COAT}, shear strength check shall be carried out in accordance with the following.

The thickness $t_{REN,S}$ (mm) is the greater of the thicknesses $t_{REN,Sa}$ and $t_{REN,Sb}$ obtained from the shear strength check at sections a) and b) (see Fig.13 and 302) given by the following, but need not be taken in excess of 0.75 t_{S12}:

— at section a): $t_{REN,Sa} = 1\,000\ k_S\ P_{fr,a} / d_a \sin\varphi\ \tau_a$
— at section b): $t_{REN,Sb} = 1\,000\ k_S\ P_{fr,b} / d_b \sin\varphi\ \tau_a$

where:

k_S = shear force distribution factor to be taken equal to 0.6
$P_{fr,a}$, $P_{fr,b}$ = pressures forces defined in 302
d_a, d_b = bracket and frame web depth (mm) at sections a) and b), respectively (Fig.13); in case of separate (non integral) brackets, d_b shall be taken as the minimum web depth deducting possible scallops
φ = angle between frame web and shell plate
τ_a = allowable shear stress (kN/m^2) defined in 303.

305 *Bending strength check*

Where the lower bracket length or depth does not meet the requirements in Pt.5 Ch.2 Sec.8 [IACS UR S12(Rev.3)], the actual section modulus, in cm3, of the brackets and side frames at sections a) and b) shall be not less than:

— at section a): $Z_a = 1\,000\ P_{fr,a}\ h / m_a\ \sigma_a$
— at section b): $Z_b = 1\,000\ P_{fr,a}\ h / m_b \sigma_a$

where:

$P_{fr,a}$ = pressures force defined in 302
h = side frame span (m) defined in Fig.1
σ_a = allowable normal stress (kN/m^2) defined in 303
m_a m_b= bending moment coefficient defined in Table F2.

The actual section modulus of the brackets and side frames shall be calculated about an axis parallel to the attached plate, based on measured thicknesses. For pre-calculations, alternative thickness values may be used, provided they are not less than:

— t_{REN}, for the web thickness
— the minimum thicknesses allowed by the Society renewal criteria for flange and attached plating.

The attached plate breadth is equal to the frame spacing, measured along the shell at midspan h.

If the actual section moduli at sections a) and b) are less than the values Z_a and Z_b, the frames and brackets shall be renewed or reinforced in order to obtain actual section moduli not less than 1.2 Z_a and 1.2 Z_b, respectively.

In such a case, renewal or reinforcements of the flange shall be extended over the lower part of side frames, as defined in Fig.12.

Table F2 Bending moment coefficients m_a and m_b

	m_a	m_b		
		$h_B \le 0.08\ h$	$h_B = 0.1\ h$	$h_B \ge 0.125\ h$
Empty holds of ships approved to operate in non homogeneous loading conditions	10	17	19	22
Other cases	12	20	22	26

Note 1: Non homogeneous loading condition means a loading condition in which the ratio between the highest and the lowest filling ratio, evaluated for each hold, exceeds 1.20 corrected for different cargo densities.

Note 2: For intermediate values of the bracket length hB, the coefficient mb is obtained by linear interpolation between the table values.

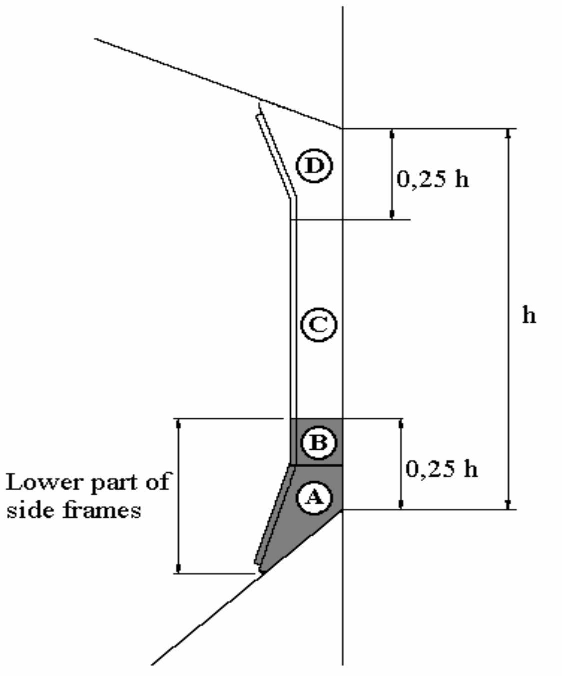


Fig. 12
Lower part of side frames

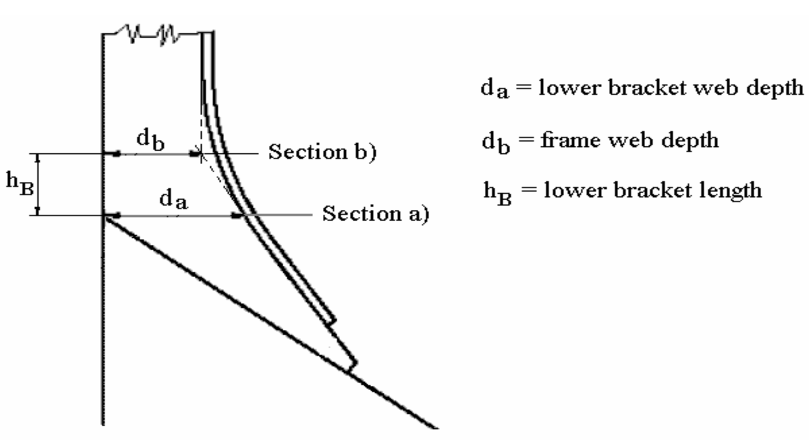


Fig. 13
Sections a) and b)

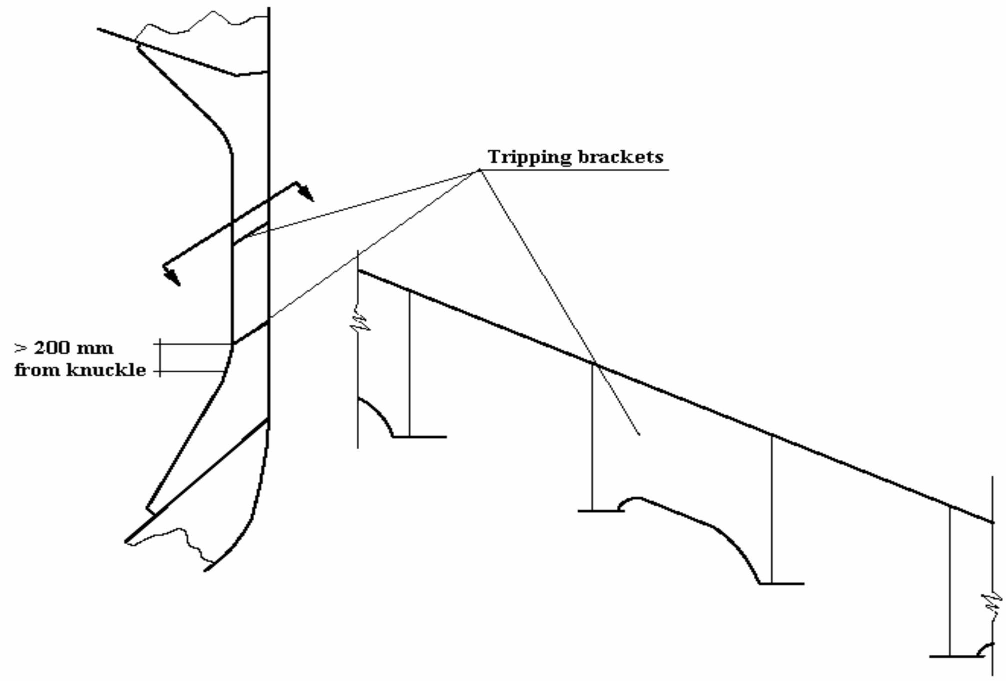


Fig. 14
Tripping brackets

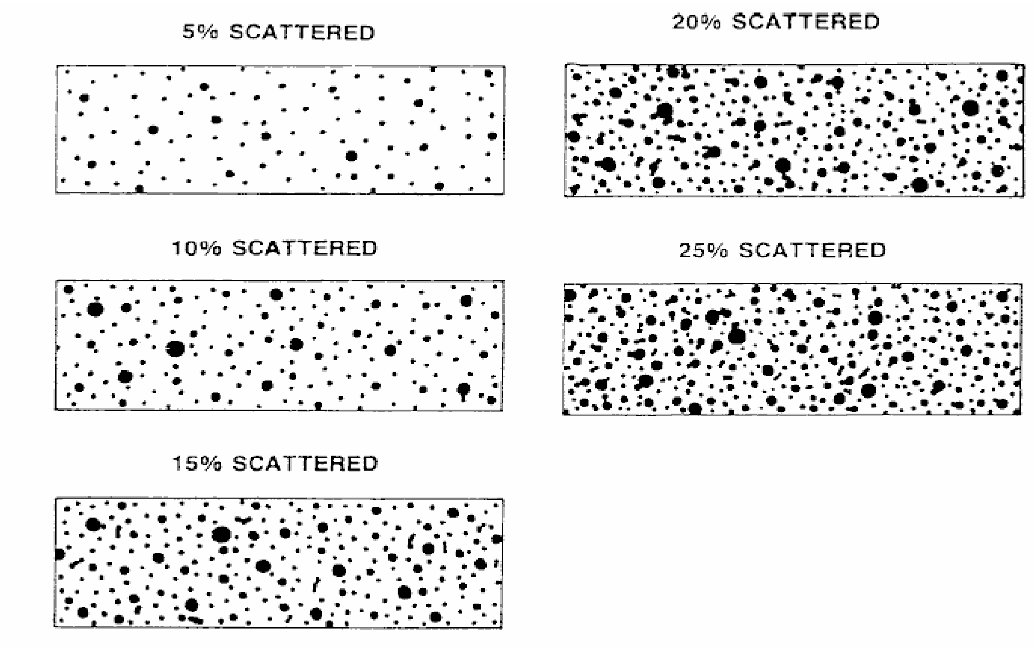


Fig. 15
Pitting intensity diagrams (from 5% to 25% intensity)

(IACS UR S31)

G. Cargo Hatch Cover Securing Arrangements for Bulk Carriers not Built in accordance with UR S21 (Rev.3)

G 100 Application and implementation

101 These requirements apply to all bulk carriers, as defined in Pt.5 Ch.2 Sec.5 A (UR Z11.2.2), which were not built in accordance with IACS UR S21 (Rev.3) and are for steel hatch cover securing devices and stoppers for cargo hold hatchways No. 1 and No. 2 which are wholly or partially within 0.25 L of the fore perpendicular, except pontoon type hatch cover.

Guidance note:

Pontoon covers in terms of S30 application are steel covers, either double plates or single plate, secured by tarpaulins and battening devices. Any other steel cover fitted with gaskets and clamping devices should comply with the S30 requirements.

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102 All bulk carriers not built in accordance with IACS UR S21 (Rev.3) shall comply with the requirements of these rules (IACS UR S30) in accordance with the following schedule:

- for ships which will be 15 years of age or more on 1 January 2004 by the due date of the first intermediate or special survey after that date
- for ships which will be 10 years of age or more on 1 January 2004 by the due date of the first special survey after that date
- for ships which will be less than 10 years of age on 1 January 2004 by the date on which the ship reaches 10 years of age.

103 Completion prior to 1 January 2004 of an intermediate or special survey with a due date after 1 January 2004 cannot be used to postpone compliance.

However, completion prior to 1 January 2004 of an intermediate survey the window for which straddles 1 January 2004 can be accepted.

G 200 Securing devices

201 The strength of securing devices shall comply with the following requirements:

1) 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.

2) The net sectional area of each securing device shall not be less than:

$$A = 1.4\ a / f \quad (cm^2)$$

   a = spacing between securing devices not to be taken less than 2 meters
   f = $(\sigma_Y / 235)^e$
   σ_Y = specified minimum upper yield stress (N/mm^2) of the steel used for fabrication, not to be taken greater than 70% of the ultimate tensile strength.
   e = 0.75 for $\sigma_Y > 235$
   = 1.0 for $\sigma_Y \leq 235$

   Rods or bolts shall have a net diameter not less than 19 mm for hatchways exceeding 5 m^2 in area.

3) Between cover and coaming and at cross-joints, a packing line pressure sufficient to obtain weather tightness shall be maintained by the securing devices.

   For packing line pressures exceeding 5 N/mm, the cross section area shall be increased in direct proportion. The packing line pressure shall be specified.

4) The cover edge stiffness shall be sufficient to maintain adequate sealing pressure between securing devices. The moment of inertia I of edge elements shall not be less than:

   I = $6\ p\ a^4$ (cm^4)
   P = packing line pressure (N/mm) minimum 5 N/mm
   a = spacing (m) of securing devices.

5) Securing devices shall be of reliable construction and securely attached to the hatchway coamings, decks or covers. Individual securing devices on each cover shall have approximately the same stiffness characteristics.
6) Where rod cleats are fitted, resilient washers or cushions shall be incorporated.
7) 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.

G 300 Stoppers

301 No. 1 and 2 hatch covers shall be effectively secured, by means of stoppers, against the transverse forces arising from a pressure of 175 kN/m^2.

302 No. 2 hatch covers shall be effectively secured, by means of stoppers, against the longitudinal forces acting on the forward end arising from a pressure of 175 kN/m^2.

303 No. 1 hatch cover shall be effectively secured, by means of stoppers, against the longitudinal forces acting on the forward end arising from a pressure of 230 kN/m^2.

This pressure may be reduced to 175 kN/m^2 if a forecastle is fitted.

304 The equivalent stress in:

— in stoppers and their supporting structures, and
— calculated in the throat of the stopper welds shall not exceed the allowable value of 0.8 σ_Y.

G 400 Materials and welding

401 Where stoppers or securing devices are fitted to comply with these rules, they shall be manufactured of materials, including welding electrodes, meeting relevant requirements in Pt.2.

(IACS UR S30)

SECTION 2
MISCELLANEOUS REQUIREMENTS

A. Ice Class ICE-1A and ICE-1A* - Minimum Power Requirement

A 100 General

101 For general information and definitions, see Pt.5 Ch.1 Sec.3 J101, J102 and J103, respectively.

102 The propulsion power requirements for existing ships as defined in following Guidance Note are not mandatory for maintenance of the Society's ice class notations **ICE-1A** and **ICE-1A***.

Guidance note:

To comply with the equivalent Finnish-Swedish ice classes **1A** or **1A Super** a ship the keel of which has been laid or which has been at a similar stage of construction before 1 September 2003 shall comply with the new minimum power requirements by:

— 1 January 2005
— 1 January in the year when 20 years has elapsed since the year the ship was delivered, whichever occurs the latest.

The new requirements are equivalent to those in Pt.5 Ch.1 Sec.3 J104.

When, for an existing ship, values for some of the hull parameters required for the calculating method in Pt.5 Ch.1 Sec.3 J104 are difficult to obtain, then the following alternative formulae can be used:

$$R_{CH} = C_1 + C_2 + C_3(H_F + H_M)^2(B + 0.658H_F)$$

$$+ C_4 L H_F^{\,2} + C_5\left(\frac{LT}{B^2}\right)^3\frac{B}{4} \quad \text{(N)}$$

For ice class **ICE-1A**, C_1 and C_2 can be taken as zero. For ice class **ICE-1A***, ship without bulb, the following apply:

$$C_1 = f_1\frac{BL}{2\frac{T}{B}+1} + 1.84(f_2B + f_3L + f_4BL)$$

$$C_2 = 3.52(g_1 + g_2B) + g_3\left(1 + 1.2\frac{T}{B}\right)\frac{B^2}{\sqrt{L}}$$

For ice class **ICE-1A***, ship with bulb, C_1 and C_2 shall be calculated as follows:

$$C_1 = f_1\frac{BL}{2\frac{T}{B}+1} + 2.89(f_2B + f_3L + f_4BL)$$

$$C_2 = 6.67(g_1 + g_2B) + g_3\left(1 + 1.2\frac{T}{B}\right)\frac{B^2}{\sqrt{L}}$$

f_1 = 10.3 N/m^2
f_2 = 45.8 N/m
f_3 = 2.94 N/m
f_4 = 5.8 N/m^2
g_1 = 1 530 N
g_2 = 170 N/m
g_3 = 400 N/m$^{1.5}$
C_3 = 460 kg/(m^{2}s^2)
C_4 = 18.7 kg/(m^{2}s^2)
C_5 = 825 kg/s^2

$\left(\frac{LT}{B^2}\right)^3$ shall not be taken less than 5 and not more than 20.

Other methods of determining K_e or RCH:

The Finnish and Swedish maritime administrations may for an individual ship, in lieu of the K_e or RCH values defined in Pt.5 Ch.1 Sec.3 J, approve the use of K_e values based on more exact calculations or RCH values based on model tests. Such an approval will be given on the understanding that it can be revoked if experience of the ship's performance in practice motivates this.

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B. Fore Deck Fittings

B 100 Strength and securing of small hatches on the exposed fore deck, and strength requirements for fore deck fittings.

101 These requirements shall apply to bulk carriers, general dry cargo ships (excluding container vessels, vehicle carriers, Ro-Ro ships and woodchip carriers), and combination carriers (e.g. OBO ships, Ore/Oil Carriers) of length 100 m or more, constructed prior to 1 January 2004.

Air pipes and ventilators with their closing appliances, and small hatches on the exposed deck serving spaces or giving access to spaces forward of the collision bulkhead, and to spaces which extend over this line aft wards, shall comply with the requirements given in Pt.3 Ch.3 Sec.6.

102 The requirements shall, at the latest, be complied with as follows:

- for ships which will be 15 years of age or more on 1 January 2004 by the due date of the first intermediate or renewal survey after that date
- for ships which will be 10 years of age or more on 1 January 2004 by the due date of the first renewal survey after that date
- for ships which will be less than 10 years of age on 1 January 2004 by the date on which the ship reaches 10 years of age.

(IACS UR S26 and S27)

C. Existing Convention Ships – Oil Fuel Arrangement

C 100 Application

101 These requirements apply to all SOLAS convention ships from 1 July 2003 (all SOLAS references are to Consolidated edition 2001).

Guidance note:
For guidance, refer to MSC/Circulars 647, 851 and 1083.

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C 200 Technical requirements

201 All external high pressure fuel delivery lines between the high pressure fuel pumps and fuel injectors shall be protected with a jacketed piping system capable of containing fuel from a high pressure line failure. A jacketed pipe incorporates an outer pipe into which the high pressure fuel pipe is placed forming a permanent assembly. The jacketed piping system shall include a means for leak collection and arrangements shall be provided for an alarm to be given in the event of a failure in a fuel line.

(SOLAS II-2/15.2.9)

202 For ships constructed before 1 July 1998, a suitable enclosure may be used as an alternative to 201 provided the diesel engine:

- output is 375 kW or less, and
- has fuel injection pumps serving more than one injector.

(SOLAS II-2/15.2.12)

203 All surfaces with temperatures above 220°C which may be impinged as a result of a fuel system failure shall be properly insulated.

(SOLAS II-2/15.2.10)

204 Oil fuel lines shall be screened or otherwise suitably protected to avoid, as far as practicable, oil spray or oil leakage onto hot surfaces, into machinery air intakes, or other sources of ignition. The number of joints in such piping systems shall be kept to a minimum.

(SOLAS II-2/15.2.11)

D. Water level detectors on single hold cargo ships

D 100 Application and definition

101 These requirements apply to single hold cargo ships having a length (L) of less than 80 m, or 100 m if constructed before 1 July 1998, and a single cargo hold below the freeboard deck or cargo holds below the freeboard deck which are not separated by at least one bulkhead made watertight up to that deck.

(SOLAS II-1/23-3)

102 The requirements in 201 and 202 shall apply to all single hold cargo ships other than bulk carriers constructed before 1 January 2007 not later than the date of the intermediate or renewal survey of the ship to be carried out after 1 January 2007, whichever comes first.

D 200 Cargo hold water level detectors

201 Single hold cargo ships shall be fitted with water level detectors giving an audible and visual alarm at the navigation bridge when the water level above the inner bottom in the cargo hold reaches a height of not less than 0.3 m, and another when such level reaches not more than 15% of the mean depth of the cargo hold.

202 The installation shall be in accordance with Pt.5 Ch.2 Sec.4.

D 300 Installation, testing and survey

301 The system shall be installed and tested in accordance with the manufacturer's specifications. At the initial installation and at each subsequent complete periodical survey the surveyor shall verify the proper operation of the water detection system.

E. Ice Class Draught Marks and Warning Triangle

E 100 Application

101 Ships built before 1 July 2007 and having any ice class notation shall be provided with marking, as required in Pt.5 Ch.1 Sec.1 D, not later than the first scheduled dry-docking after 1 July 2007, if the UIWL (Upper Ice Water Line) is below the Summer Load Line.

Guidance note 1:

Ships with length <100 m and built in accordance with 1972 - 1986 rules, or equivalent to the Finnish-Swedish 1971 Ice Class Rules, need not to be marked and amended with draught limitation in their ice class notation.

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Guidance note 2:

For new ships the draught limitation shall be included in the ships' ice class notation.

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