Elliott Bay Design Group - North Carolina, PLLC
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MEMORANDUM

Vessel: NCDOT Pedestrian Ferry

Engineer: R Charles Barrett

Refer To: 16109-003-061-0-

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Subject: Scantling Calculations

PURPOSE

Calculate the hull structural scantlings to Lloyd's Rules. The proposed vessel, a 92 ft x 26 ft x 11.5 ft, 100 passenger aluminum catamaran ferry, will be operated by the North Carolina Department of Transportation.

PROCEDURE

The subject vessel has been designed to the current Lloyd's Rules and regulations for the Classification of Special Service Craft, July 2016. The vessel is a high-speed and light weight craft. The top speed is 33 knots and the slow service speed is 12 knots. The vessel loads were checked in displacement and non-displacement modes.

These calculations do not include longitudinal strength analysis and do not include direct calculations.

The structure of the vessel design meets the requirements of Lloyd's Rules as detailed in the calculations below.

Scantling Summary - Lloyds Special Service Craft, July 2016

PLATING

Hull Plating - mm

Member	Rule Requirement			Scantling	Offered	Units
Bottom Shell	fr 11	fr 5	fr 20	t =	**7.94**	mm
	6.40	5.50	4.75			
CVK - Web	7.57	7.57	7.57			
Side Inbd Shell	fr 11	fr 5	fr 20	t =	**6.35**	mm
	5.76	4.95	4.95			
Haunch Shell Insert	fr 11	fr 5	fr 20	t =	**9.53**	mm
	8.64	7.42	7.42			
Side Outbd Shell	fr 11	fr 5	fr 20	t =	**6.35**	mm
	5.76	4.95	4.27			
Wet Deck	fr 11	fr 5	fr 20	t =	*6.35*	mm
	2.96	3.58	3.75			
Main Deck	fr 11	fr 5	fr 20	t =	*4.76*	mm
	3.00	3.58	3.58			
Fuel Tank End Bhd	Ends				*6.35*	mm
	4.12					

Superstructure Plating - mm

Member	Rule Requirement	Scantling	Offered	Units
House Top	fr 11	t =	*4.76*	mm
	3.00			
House Side	fr 11	t =	*4.76*	mm
	3.00			
House Front	fr 18	t =	**4.76**	mm
	4.50			
Pillothouse Top	fr 12	t =	*4.76*	mm
	3.00			
Pilothouse Side	fr 12	t =	*4.76*	mm
	3.00			
Pilothouse Front	fr 15	t =	**4.76**	mm
	3.90			

STANCHIONS

House Stanchions Fr 3.5, 10, 13, 16	3" sch 80 aluminum pipe	A =	**2.25**	in^2
		r =	**0.92**	in
Upr Dk Stanchions Fr 10	2.5" sch 40 aluminum pipe	A =	**1.70**	in^2
		r =	**0.95**	in

FRAMING - Units are INCHES

Member	Requirement			Offered	Scantling Offered		
Bottom	SM	I	A		SM	I	Aweb
Long'l - fr 11	1.94	1.89	0.35	FB 4.5 x 5/16" on 5/16"	2.05	8.0	1.41
Bottom Xvrs fr 11	27.89	48.39	4.03	web 9x3/8"	29.5	186	3.38
				flange 5x1/2"			
Long'l - fr 5	1.43	1.40	0.26	FB 4 x 5/16" on 5/16"	1.65	5.8	1.25
Bottom Xvrs fr 5	18.91	31.46	2.85	web 6x1/2"	19.13	84	3.00
				flange 5x1/2"			
Long'l - fr 20	1.07	1.04	0.19	FB 3x3/8" on 5/16"	1.15	3.1	1.13
Bottom Xvrs fr 20	15.36	26.66	2.22	web 10x1/4"	17.11	136	2.50
				flange 4x1/4"			
CVK			1.40	web 6x5/16"			
			flange	flange 4x3/8"		A flg =	1.50
Outboard Side	SM	I	A		SM	I	Aweb
Long'l - fr 11	1.40	1.89	0.35	T 2.5x2x1/4" on 1/4"	1.74	3.9	1.24
Side Xvrs fr 11	37.96	76.85	4.70	web 10x3/8" on 1/4"	43.0	211	3.75
				flange 6x1/2"			
Long'l - fr 5	1.03	1.40	0.26	T 2x2x1/4" on 1/4"	1.34	2.5	0.50
Side Xvrs fr 5	36.61	84.72	3.96	web 9x3/8" on 1/4"	37.4	156	3.38
				flange 5x1/2"			
Long'l - fr 20	0.77	1.04	0.19	FB 3x3/8" on 1/4"	1.11	2.9	1.13
Side Xvrs fr 20	10.67	15.43	1.85	web 9x1/4"	14.3	94	2.25
				flange 4x1/4"			
Inboard Side	SM	I	A		SM	I	Aweb
Long'l - fr 11	1.68	1.89	0.35	T 2.5x2x1/4" on 1/4"	1.74	3.9	1.24
Side Xvrs fr 11	32.73	61.53	4.36	web 10x3/8"	37.7	309	4.13
				flange 5x1/2"			
Long'l - fr 5	1.24	1.40	0.26	T 2x2x1/4" on 1/4"	1.34	2.5	0.50
Side Xvrs fr 5	24.17	45.44	3.22	web 7x3/8"	26.4	93	2.63
				flange 5x1/2"			
Long'l - fr 20	0.92	1.04	0.19	FB 3x3/8" on 1/4"	1.11	2.9	1.13
Side Xvrs fr 20	10.67	15.43	1.85	web 9x1/4"	14.3	94	2.25
				flange 4x1/4"			
Wet Deck	SM	I	A		SM	I	Aweb
Long'l - fr 11	0.36	0.40	0.07	T 2.5x2x1/4" on 1/4"	1.74	3.9	1.24
Bottom Xvrs fr 11	9.31	20.19	1.07	Xvrs is wet dk bhd	85	1,199	9.00
Long'l - fr 5	0.36	0.40	0.07	T 2x2x1/4" on 1/4"	1.34	2.5	0.50
Bottom Xvrs fr 5	6.99	13.14	0.93	Xvrs is wet dk bhd			
Long'l - fr 20	0.58	0.65	0.12	FB 3x3/8" on 1/4"	1.11	2.5	0.50
Main Deck - outbd	SM	I	A		SM	I	Aweb
Long'l - fr 11	0.08	0.09	0.02	T 1.5x1.5x3/16" on 3/16"	0.66	1.0	0.66
Deck Xvrs fr 11	1.86	4.66	0.23	web 6x3/8"	29.5	186	3.38
				flange 5x1/2"			
Long'l - fr 5	0.10	0.11	0.02	T 1.5x1.5x3/16" on 3/16"	0.66	1.0	0.66
Deck Xvrs fr 5	2.18	5.47	0.27	web 6x3/8"	15.5	53	2.25
				flange 5x1/2"			
Long'l - fr 20	0.14	0.15	0.03	T 1.5x1.5x3/16" on 3/16"	0.66	1.0	0.66
Deck Xvrs fr 20	2.68	6.24	0.36	web 9x1/4"	13.4	76	3.38
				flange 4x1/4"			

FRAMING – Units are INCHES

House Top (Coach)	SM	I	A		SM	I	Aweb
Long'l - fr 11	0.09	0.09	0.01	T 1.5x1.5x3/16" on 3/16"	0.66	1.0	0.66
Deck Xvrs fr 11	2.74	6.73	0.24	web 5x3/16"	4.93	18	0.94
				flange 3x1/4"			
Deck Longl Girder	10.91	37.86	2.05	web 7x5/16"	10.94	49	2.19
				flange 3x3/8"			
House Side	SM	I	A		SM	I	Aweb
Long'l - fr 11	0.08	0.09	0.01	L 2x1.5x3/16 on 3/16	0.71	1.2	0.38
Side Xvrs fr 11	2.59	6.37	0.23	SqTb 4x4x1/4"	4.11	8	2.00
House Front fr 18	SM	I	A		SM	I	Aweb
Horiz Stiffs	0.17	0.18	0.03	FB 3x1/4" on 3/16"	0.73	1.9	0.75
Main Verticals	5.37	13.19	0.47	SqTb 5x4x1/4"	5.65	14	2.50
House Aft bhds	SM	I	A		SM	I	Aweb
Vert Stiffs	0.44	1.17	0.03	L 2x1.5x3/16 on 3/16	0.71	1.2	0.38
Pilothouse Top	SM	I	A		SM	I	Aweb
Long'l - fr 12	0.09	0.09	0.01	T 1.5x1.5x3/16" on 3/16"	0.66	1.0	0.66
Deck Xvrs fr 12	3.79	10.95	0.28	web 5x3/16"	4.93	18	0.94
				flange 3x1/4"			
Pilothouse Side	SM	I	A		SM	I	Aweb
Long'l - fr 12	0.06	0.07	0.01	L 2x1.5x3/16 on 3/16	0.71	1.2	0.38
Side Xvrs fr 12	1.84	4.25	0.17	web 4x1/4"	2.96	7	1.00
				flange 2x5/16"			
Pilothouse Front	SM	I	A		SM	I	Aweb
Stiffener	0.14	0.17	0.02	T 1.5x1.5x3/16" on 3/16"	0.66	1.0	0.66
Girder	2.87	6.64	0.27	web 4x1/4"	2.96	7	1.00
				flange 2x5/16"			
Fuel Tank End Bhd	SM	I	A		SM	I	Aweb
Stiffener	1.28	1.80	0.21	T 2x2x1/4" on 1/4"	1.34	2.5	0.50

Pt. 3, Ch. 1, Sec. 6: Definitions

6.2 Principal Particulars

6.2.1 Rule Length (L_R)

In craft without rudders, the rule length L_R is to be taken as 97 % of the extreme length on the summer load line.

SLL =	26.73 m	87.7	ft
L_R =	25.93 m	85.1	ft

6.2.2 Length between perpendiculars (L_{pp})

Length between perpendiculars L_{PP} is the distance on the summer load line from the front of the stem to the aft side of the rudder post. Unusual stern to be specially considered.

L_{PP} = 26.73 m 87.7 ft

6.2.5 Length Waterline (L_{WL})

Length waterline L_{WL} is the distance on the static load waterline from the front of the stem to the aft side of the transom.

L_{WL} = 25.98 m 85.2 ft

6.2.7 Breadth

For multi-hull craft it is to be taken as the sum of the breadths of the individual hulls.

B = 5.40 m 17.73 ft

6.2.8 Depth

Depth D is measured at the middle of L_R from the top of the keel to the top of the deck beam at side side on the uppermost continuous deck.

D = 3.51 m 11.50 ft

6.2.9 Draft

Draft T is the summer draft measured fromt top of keel.

T = 1.22 m 4.00 ft

6.2.10 Block Coefficient

Block Coefficient Cb is the molded block coefficient at draft T at summer load waterline based on rule

Cb = 0.51 Vol = 3,160 Cu Ft = 86.30 m^3

Pt. 5, Ch. 2, Sec. 2: Definitions and Symbols

2.1 Parameters to be used for the determination of load and design criteria

2.1.1 Air Gap (G_A)

Air Gap, G_A is the minimum vertical distance from the static waterline to the wet deck. See fig 2.2.1 for clarification.

G_A = 1.68 m 5.5 ft

2.1.7 Froude Number (Fn)

$$F_n = \frac{0,515V_m}{\sqrt{gL_{WL}}}$$

where

= g is the acceleration due to gravity and is taken to be 9,81 m/s^2.

= L_{WL} is defined in *Pt 5, Ch 2, 2.1 Parameters to be used for the determination of load and design criteria 2.1.19*.

= V_m is the appropriate speed in knots.

F_n = 0.71

V = **33.0**
V_m = 22.0 knots
g = 9.81 m/s^2

2.1.14 Significant Wave Height ($H_{1/3}$)

Significant Wave Height, $H_{1/3}$ is the wave height used in determining craft motions and loads, defined as the average of the one third highest waves in a short term measurement record.

$H_{1/3}$ = 1.00 m per Table 2.2.1

2.1.16 Surviving Wave Height (H_{03})

Surviving Wave Height, H_{03} is the wave height with a 3% probability of exceedance. If this value is unknown, the following equation is to be used. $H_{03} = 1.29H_{1/3}$

H_{03} = 1.29 m

2.1.17 Taylor Quotient (Γ)

$$\Gamma = \frac{V}{\sqrt{L_{WL}}}$$

where V is defined in *Pt 5, Ch 2, 2.1 Parameters to be used for the determination of load and design criteria 2.1.2* and L_{WL} is defined in *Pt 5, Ch 2, 2.1 Parameters to be used for the determination of load and design criteria 2.1.19*.

V = 33.00 knots
L_{WL} = 25.98 m

Γ = 6.47

5-2-3: Motion Response

3.1 Relative Vertical Motion

3.1.1 The relative vertical motion is to be taken as:

$$H_{rm} = C_{w,min}\left(1 + \frac{k_r}{(C_b + 0,2)}\left(\frac{x_{wl}}{L_{WL}} - x_m\right)^2\right)$$

where

k_r = *see Table 2.3.1 Hull form wave pressure factor*

$C_{w,min}$ = $\frac{C_w}{k_m}$

k_m = $1 + \frac{k_r(0,5 - x_m)^2}{(C_b + 0,2)}$

x_m = 0,45 – 0,6F_n but not less than 0,2

C_w = wave head, in metres

= $0,0771 L_{WL}\,(C_b + 0,2)^{0,3}\, e^{(-0,0044 L_{WL})}$

x_{wl} = distance from aft end of L_{WL}, in metres, *see Pt 5, Ch 2, 2.2 Symbols 2.2.1*

L_{WL} = waterline length, in metres, *see Pt 5, Ch 2, 2.1 Parameters to be used for the determination of load and design criteria 2.1.19*

C_b = block coefficient, *see Pt 5, Ch 2, 2.2 Symbols*

F_n = Froude Number, *see Pt 5, Ch 2, 2.1 Parameters to be used for the determination of load and design criteria 2.1.7*, where V_m = 2/3V

V = as defined in *Pt 5, Ch 2, 2.1 Parameters to be used for the determination of load and design criteria 2.1.2*.

k_r	=	2.55	table 2.3.1
C_b	=	0.51	
L_{WL}	=	25.98	m
C_W	=	1.61	m
V_m	=	22.00	knots (2/3 V)
F_n	=	0.71	
X_m	=	0.2	not less than 0.2
k_m	=	1.33	
$C_{W,min}$	=	1.21	
X_{wl}	=	varies	m dist fwd of xsm

Location	*Xwl* (m)	H_{rm} (m)
Midship	**13.0**	1.61
Fr 3.5	**3.0**	1.24
Fr 20	**24.4**	3.61
Fr 5	**6.1**	1.22
Fr 16.5	**20.1**	2.66

3.2 Vertical Acceleration

3.2.1 The instantaneous accelerations determined in accordance with the formulae in this section are to be used to estimate the relationship between allowable speed, V, in knots, wave height, H 1/3, in metres, and displacement, Δ, in tonnes, and they will form the operational envelope.

3.2.2 Where the Taylor Quotient, Γ, is greater than 10.8, the motion response criteria are to be specially considered.

3.2.3 The vertical acceleration at the LCG (longitudinal center of gravity), a v, is defined as the average of the 1/100 highest accelerations at the LCG.

3.2.5 The vertical acceleration in the non-displacement mode for multi-hull craft is to be taken as:

$$a_v = \frac{f_a L_{WL}}{\Delta}\left(B_M H_{1/3} + 0,084 B^2_M\right)\left(5 - 0,1\,\theta_D\right)\Gamma^2 \times 10^{-3}$$

where

= a_v is the vertical acceleration at the LCG in terms of *g*.

Γ = Taylor Quotient, *see Pt 5, Ch 2, 2.1 Parameters to be used for the determination of load and design criteria 2.1.17*

f_a = hull form acceleration factor

= 2,7 for craft supported mainly by hydrodynamic lift provided by foils or other lifting devices

= 3,6 for Swaths and multi-hull craft with fully submerged hulls

= 4,5 for catamarans and multi-hull craft with partially submerged hulls

B_M = total breadth of hulls or struts at LCG at the waterline, in metres, excluding tunnels

Δ = displacement, in tonnes.

$H_{1/3}$ = design significant wave height, in metres

θ_D = deadrise angle at the LCG, in degrees, but is not to be taken as greater than 30°, *see Pt 5, Ch 2, 2.1 Parameters to be used for the determination of load and design criteria 2.1.5*

L_{WL} = waterline length, in metres, *see Pt 5, Ch 2, 2.1 Parameters to be used for the determination of load and design criteria 2.1.19*

Γ =	6.47	< 10.8 OK	
f_a =	**4.50**		
B_M =	5.40	m	wetted breadth at waterline
Δ =	**88.45**	metric tonnes seawater	
$H_{1/3}$ =	1.00	m	
θ_D =	**10.0**	deg	deadrise
L_{WL} =	25.98	m	

a_v = $\boxed{1.74}$ m/s^2

3.2.6 The vertical acceleration in the displacement mode for all craft is to be taken as:

$$a_v = 0{,}2\,G + \frac{34}{L_{WL}}$$

typo - G = Γ

where

= a_v is the vertical acceleration at the LCG in terms of g

L_{WL} = waterline length, in metres, *see Pt 5, Ch 2, 2.1 Parameters to be used for the determination of load and design criteria 2.1.19*

Γ = Taylor's Quotient, *see Pt 5, Ch 2, 2.1 Parameters to be used for the determination of load and design criteria 2.1.17*

V = **12.0** knots in displacement mode

Γ = 2.35

a_v = $\boxed{1.78}$ m/s^2

3.2.7 The vertical acceleration, a_x, at any given location distance x_a from the AP along the hull may be taken as:

$$a_x = a_v\left(0{,}86 - 0{,}32\frac{x_a}{L_{WL}} + 1{,}76\left(\frac{x_a}{L_{WL}}\right)^2 + \xi_a\right)$$

where

a_v = vertical acceleration at LCG in terms of g, as appropriate.

a_x = is the vertical acceleration at distance x_a from AP on the static load waterline, in terms of g

x_a = distance from aft end of the static load waterline, in metres, to the point at which the vertical acceleration is calculated

x_{LCG} = distance from aft end of the static load waterline, in metres, to the LCG

L_{WL} = waterline length, in metres, *see Pt 5, Ch 2, 2.1 Parameters to be used for the determination of load and design criteria 2.1.19*

$$\xi_a = 0{,}14 + 0{,}32\frac{x_{LCG}}{L_{WL}} - 1{,}76\left(\frac{x_{LCG}}{L_{WL}}\right)^2.$$

	L_{WL}	=	25.98 m
	X_{LCG}	=	**11.58** m
non-displacement	a_v	=	1.74
displacement	a_v	=	1.78
	ζ_a	=	-0.07

Location	X_a (m)	a_V max	a_X
Midship	13.00	1.78	1.91
Fr 3.5	3.05	1.78	1.39
Fr 20	24.38	1.78	3.64
Fr 5	6.10	1.78	1.45

5-2-4: Load on Shell Envelope

4.1 Pressure on Shell Envelope

4.1.1 The design pressures for the shell envelope including exposed decks are to include the effects of combined static and dynamic load components. In addition, the effects of impact or slamming loads are also to be considered, but these are to be treated separately, see Pt 5, Ch 2, 5 Impact Loads.
4.1.2 The individual pressure components are given in Pt 5, Ch 2, 4.3 Hydrostatic pressure on the shell plating and the combined pressure to be applied to the shell envelope is given in Pt 5, Ch 2, 4.2 Combined hydrostatic and hydrodynamic pressure on the shell plating. The pressure to be applied to exposed and weather decks is given in Pt 5, Ch 2, 4.5 Pressure on weather and interior decks.

4.2 Combined hydrostatic and hydrodynamic pressure on the shell plating

4.2.1 The total pressure distribution, P s, in kN/m2 acting on the shell plating envelope due to hydrostatic and hydrodynamic pressures is illustrated in Figure 2.4.1 Combined pressure distribution, P s and is to be taken as specified in Table 2.4.1 Combined pressure distribution, P s .

Location	P_h kN/m^2	P_w kN/m^2	P_d kN/m^2	P_S kN/m^2
Midship Bottom	8.84	30.58		39.42
Midship T/2	6.10	30.58		36.68
Midship Waterline	0.00	30.58		30.58
Jet Rm Bhd fr3.5 Btm	7.62	30.58		38.20
Collision Bhd fr20 Btm	6.10	49.18		55.28
Collision Bhd fr20 Waterline	0.00	49.18		49.18
Frame 5 Bottom	7.59	30.58		38.17
Frame 5 Waterline	0.00	30.58		30.58
Frame 16.5 Bottom (0.75L_{WL})	9.14	30.77		39.91

4.3 Hydrostatic pressure on the shell plating

4.3.1 The pressure, P_h, acting on the shell plating up to the operating waterline due to hydrostatic pressure is to be taken as:

$$P_h = 10(T_x - (z - z_k)) \text{ kN/m}^2$$

where

T_x, z and z_k are defined in *Pt 5, Ch 2, 2.2 Symbols*.

Location	x_{WL} (m)	T_x (m)	z (m)	z_k (m)	P_h kN/m^2
Midship Bottom	**13.0**	**1.14**	**0.34**	**0.08**	8.84
Midship T/2	**13.0**	**1.14**	**0.61**	**0.08**	6.10
Midship Waterline	**13.0**	**1.14**	**1.22**	**0.08**	0.00
Jet Rm Bhd fr3.5 Btm	**3.0**	**0.76**	**0.46**	**0.46**	7.62
Collision Bhd fr20 Btm	**24.4**	**1.22**	**0.61**	**0.00**	6.10
Collision Bhd fr20 Waterline	**24.4**	**1.22**	**1.22**	**0.00**	0.00
Frame 5 Bottom	**6.1**	**0.81**	**0.46**	**0.41**	7.59
Frame 5 Waterline	**6.1**	**0.81**	**1.22**	**0.41**	0.00
Frame 16.5 Bottom (0.75LWL)	**20.1**	**1.22**	**0.30**	**0.00**	9.14

4.4 Hydrodynamic wave pressure

4.4.1 The hydrodynamic wave pressure distribution due to relative motion, P_w, around the shell envelope up to the operating waterline, i.e. $z \le T$ is to be taken as the greater of the following:

$$P_m \text{ kN/m}^2$$

as defined in *Pt 5, Ch 2, 4.4 Hydrodynamic wave pressure 4.4.2*

$$P_p \text{ kN/m}^2$$

as defined in *Pt 5, Ch 2, 4.4 Hydrodynamic wave pressure 4.4.3*.

SEE TABLE BELOW

4.4.2 The distribution of hydrodynamic pressure up to the operating waterline, P_m, is to be taken as:

$$P_m = 10 f_z H_{rm} \text{ kN/m}^2$$

where

f_z = the vertical distribution factor

$= k_z + (1 - k_z)\left(\frac{z - z_k}{T_x}\right)$

$k_z = e^{-u}$

$u = \left(\frac{2\pi T_x}{L_{WL}}\right)$

H_{rm} is defined in *Pt 5, Ch 2, 3.1 Relative vertical motion 3.1.1*

z, z_k, T_x and L_{WL} are defined in *Pt 5, Ch 2, 2.2 Symbols*.

L_{WL} = 25.98 m

Location	x_{WL} (m)	T_x (m)	u	k_z	f_z	H_{rm}	P_m kN/m^2
Midship Bottom	13.0	1.14	0.276	0.758	0.813	1.61	13.09
Midship T/2	13.0	1.14	0.276	0.758	0.871	1.61	14.03
Midship Waterline	13.0	1.14	0.276	0.758	1.000	1.61	16.10
Jet Rm Bhd fr3.5 Btm	3.0	0.76	0.184	0.832	0.832	1.24	10.35
Collision Bhd fr20 Btm	24.4	1.22	0.295	0.745	0.872	3.61	31.48
Collision Bhd fr20 Waterline	24.4	1.22	0.295	0.745	1.000	3.61	36.08
Frame 5 Bottom	6.1	0.81	0.196	0.822	0.833	1.22	10.16
Frame 5 Waterline	6.1	0.81	0.196	0.822	1.000	1.22	12.19
Frame 16.5 Bottom (0.75LWL)	20.1	1.22	0.295	0.745	0.808	2.66	21.52

Values for z and z_k are reused as previously defined in 5-2-4/4.3.1

4.4.3 The distribution of hydrodynamic pressure up to the operating waterline Pp, is to be taken as:

$$P_p = 10H_{pm} \text{ kN/m}^2$$

where

H_{pm} = $1,1\left(\frac{2x_{wl}}{L_{WL}} - 1\right)\sqrt{L_{WL}}$

= but not less than $f_L\sqrt{L_{WL}}$

where

f_L = 0,6 for $L_{WL} < 60$

= 1,5 - 0,015L_{WL} for $60 \le L_{WL} \le 80$

= 0,3 for $L_{WL} > 80$

L_{WL} = as defined in *Pt 5, Ch 2, 2.1 Parameters to be used for the determination of load and design criteria 2.1.19*, but not greater than 150m x_{wl} is defined in *Pt 5, Ch 2, 3.1 Relative vertical motion.*

x_{wl} and L_{WL} are defined in *Pt 5, Ch 2, 3.1 Relative vertical motion.*

4.4.4 The nominal wave limit height, H_w, above the design draft, T_x, is to be taken as:

$$H_w = 2H_{rm} \text{ m}$$

where

H_{rm} is given in *Pt 5, Ch 2, 3.1 Relative vertical motion 3.1.1.*

SEE TABLE BELOW

L_{WL} = 25.98 m

Location	x_{WL} (m)	T_x (m)	H_{pm} (o)	f_L	H_{pm} (f_L)	H_{pm}	P_p kN/m^2
Midship Bottom	13.0	1.14	0.005	**0.60**	3.058	3.058	30.58
Midship T/2	13.0	1.14	0.005	**0.60**	3.058	3.058	30.58
Midship Waterline	13.0	1.14	0.005	**0.60**	3.058	3.058	30.58
Jet Rm Bhd fr3.5 Btm	3.0	0.76	-4.291	**0.60**	3.058	3.058	30.58
Collision Bhd fr20 Btm	24.4	1.22	4.918	**0.60**	3.058	4.918	49.18
Collision Bhd fr20 Waterline	24.4	1.22	4.918	**0.60**	3.058	4.918	49.18
Frame 5 Bottom	6.1	0.81	-2.975	**0.60**	3.058	3.058	30.58
Frame 5 Waterline	6.1	0.81	-2.975	**0.60**	3.058	3.058	30.58
Frame 16.5 Bottom (0.75LWL)	20.1	1.22	3.077	**0.60**	3.058	3.077	30.77

4.4.4 The nominal wave limit height, H w, above the design draft, T x, is to be taken as:

$$H_w = 2H_{rm} \text{ m}$$

where

H_{rm} is given in *Pt 5, Ch 2, 3.1 Relative vertical motion 3.1.1*.

Location	H_{rm} (m)	H_W (m)
Midship	1.6	3.22
Fr 3.5	1.2	2.49
Fr 20	3.6	7.22
Fr 5	1.2	2.44
Fr 16.5	2.7	5.32

4.4.1 The hydrodynamic wave pressure distribution due to relative motion, Pw, around the shell envelope up to the operating waterline, i.e. z ≤ T is to be taken as the greater of the following: (Pm and Pw)

Location	x_{WL} (m)	T_x (m)	P_m kN/m^2	P_p kN/m^2	P_W kN/m^2
Midship Bottom	13.0	1.14	13.09	30.58	30.58
Midship T/2	13.0	1.14	14.03	30.58	30.58
Midship Waterline	13.0	1.14	16.10	30.58	30.58
Jet Rm Bhd fr3.5 Btm	3.0	0.76	10.35	30.58	30.58
Collision Bhd fr20 Btm	24.4	1.22	31.48	49.18	49.18
Collision Bhd fr20 Waterline	24.4	1.22	36.08	49.18	49.18
Frame 5 Bottom	6.1	0.81	10.16	30.58	30.58
Frame 5 Waterline	6.1	0.81	12.19	30.58	30.58
Frame 16.5 Bottom (0.75LWL)	20.1	1.22	21.52	30.77	30.77

4.5 Pressure on weather and interior decks

4.5.1 The pressure acting on weather decks, P d, is to be taken as specified in Pt 5, Ch 2, 4.5 Pressure on weather and interior decks 4.5.2 or Pt 5, Ch 2, 4.5 Pressure on weather and interior decks 4.5.3 as applicable.

4.5.2 The pressure acting on weather and interior decks, P wh, in the displacement mode is to be taken

$$P_{wh} = f_L(6 + 0,01L_{WL})(1 + 0,05\,\Gamma) + E\ \text{kN/m}^2$$

where

f_L = the location factor for weather decks

= 1,0 from aft end to 0,88L_R

= 1,25 from 0,88L_R to 0,925L_R

= 1,50 from 0,925L_R to forward end

f_L = 1,0 for interior decks

$E = \dfrac{0,7 + 0,08L_{WL}}{D - T}\ \text{kN/m}^2$ for exposed decks but need not be taken greater than 3 kN/m^2

E = 0,0 for sheltered decks

Γ = Taylor Quotient as defined in *Pt 5, Ch 2, 2.1 Parameters to be used for the determination of load and design criteria 2.1.17*, and

Δ = the displacement as defined in *Pt 5, Ch 2, 2.2 Symbols*

L_{WL} =	25.98	m
f_L =	varies	as per 4.5.2
Γ =	2.35	displ mode
Δ =	88.45	metric tonnes SW
D =	3.51	m
T =	1.22	m

Location	*E* kN/m^2	a_v	f_L	P_{wh} kN/m^2
Foredeck	1.22	1.74	**1.50**	11.71
Mn Dk Interior	**0.00**	1.00	**1.00**	7.00
Mn Dk Aft	1.22	1.74	**1.00**	8.21
Upper Deck	1.22	1.74	**1.00**	8.21
Pilothouse Top	1.22	1.74	**1.00**	8.21

4.5.3 The pressure acting on weather and interior decks, Pwl, in the non-displacement mode is to be

$$P_{wl} = f_L(5 + 0,01L_{WL})(1 + 0,5a_v) + E \text{ kN/m}^2$$

where f_L and E are as defined in *Pt 5, Ch 2, 4.5 Pressure on weather and interior decks 4.5.2*, and a_v is as defined in *Pt 5, Ch 2, 3 Motion response*.

- a_v is not to be taken less than 1,0, but need not be taken greater than 4,0 for weather decks.
- a_v need not be taken greater than 1,0 for interior decks.

L_{WL} is as defined in *Pt 5, Ch 2, 2.1 Parameters to be used for the determination of load and design criteria 2.1.19.*

L_{WL} =	25.98	m
f_L =	varies	as per 4.5.2
a_v =	1.74	x g m/s^2
E =	varies	as per 4.5.2
D =	3.51	m
T =	1.22	m

Location	*E* kN/m^2	a_v	f_L	P_{wl} kN/m^2	*Pd* kN/m^2
Foredeck	1.22	1.74	**1.50**	15.97	15.97
Mn Dk Interior	**0.00**	1.00	**1.00**	7.89	7.89
Mn Dk Aft	1.22	1.74	**1.00**	11.05	11.05
Upper Deck	1.22	1.74	**1.00**	11.05	11.05
Pilothouse Top	1.22	1.74	**1.00**	11.05	11.05

5.2 Impact pressure for non-displacement mode

5.2.1 The impact pressure, PdI, for mono-hull and multi-hull craft is to be taken as specified in Pt 5, Ch 2, 5.2 Impact pressure for non-displacement mode 5.2.2 and Pt 5, Ch 2, 5.2 Impact pressure for non-displacement mode 5.2.3 as applicable.

5.2.2 The bottom impact pressure due to slamming, Pdlb is given by the following expression:

$$P_{\text{dlb}} = \frac{f_{\text{d}}\,\Delta\,\Phi\left(1+a_v\right)}{L_{\text{WL}}G_{\text{o}}}\ \text{kN/m}^2$$

where

G_{o} = support girth or girth distance, in metres, as defined in *Table 2.5.1 Definition of G_{o} for the determination of bottom impact pressure, P_{dl} for different regions of the hull*

L_{WL} = waterline length, in metres, *see Pt 5, Ch 2, 2.1 Parameters to be used for the determination of load and design criteria 2.1.19*

a_{v} = vertical acceleration as defined in *Pt 5, Ch 2, 3.1 Relative vertical motion*

Δ = displacement, in tonnes, *see Pt 5, Ch 2, 2.2 Symbols 2.2.2*

f_{d} = hull form pressure factor

= 54 for mono-hull craft

= $\frac{81}{N_{\text{H}}}$ for catamarans and multi-hull craft, where

= N_{H} is the number of hulls, but it is not to be taken as greater than four

= For craft in continuous contact with water:

Φ = 0,5 at L_{WL} from aft end of L_{WL}

= 1,0 at 0,75L_{WL} from aft end of L_{WL}

= 1,0 at 0,5L_{WL} from aft end of L_{WL}

= 0,5 at aft end of L_{WL}

Intermediate values to be determined by linear interpolation.

Otherwise, Φ = 1,0

L_{WL} = 25.98 m
a_v = 1.741
Δ = 88.45 metric tonnes SW
f_d = **40.50**
Φ = varies
G_o = varies

Location	x_{WL} (m)	Φ	G_o (m)	P_{dlb} kN/m^2
Midship Bottom	13.0	**1.00**	**2.64**	143.16
Midship T/2	13.0	**1.00**	**2.64**	143.16
Midship Waterline	13.0	**1.00**	**2.64**	143.16
Jet Rm Bhd fr3.5 Btm	3.0	**0.61**	**2.51**	92.29
Collision Bhd fr20 Btm	24.4	**0.64**	**3.05**	78.87
Frame 5 Bottom	6.1	**0.68**	**2.44**	105.73
Frame 5 Waterline	6.1	**0.60**	**2.44**	93.01
Frame 16.5 Bottom (0.75LWI	20.1	**1.00**	**3.22**	117.38

5.2.3 The side shell impact pressure due to slamming is to be taken as:

$$P_{dls} = P_{dlb} \frac{\operatorname{Tan}(40 - \theta_B)}{\operatorname{Tan}(\theta_S - 40)} \text{ kN/m}^2$$

but is not to be taken as greater than P_{dlb}

where

θ_B = mean deadrise angle of bottom plating, in degrees at local section,

θ_S = mean deadrise angle of side plating, in degrees at local section,

$(40 - \theta_B)$ is not to be taken as less than 10°

$(\theta_S - 40)$ is not to be taken as less than 10°

P_{dls} is to be taken as constant from the chine to a point half G_o from the chine, or the weather deck if this is reached first. Multiple chines will be subject to special consideration based on the above principle. *See Figure 2.5.1 Angles used in determination of side shell pressure for planing craft, P_{dls}* .

θ_B = **varies** degrees

θ_S = **varies** degrees

Location	x_{WL} (m)	P_{dlb} kN/m^2	40 - θ_B degrees	θ_S - 40 degrees	P_{dls} kN/m^2
Midship Bottom	13.0	143.16	**25**	**45**	66.76
Midship T/2	13.0	143.16	**25**	**45**	66.76
Midship Waterline	13.0	143.16	**25**	**45**	66.76
Jet Rm Bhd fr3.5 Btm	3.0	92.29	**38**	**45**	72.10
Collision Bhd fr20 Btm	24.4	78.87	**10**	**26**	28.51
Frame 5 Bottom	6.1	105.73	**36**	**45**	76.81
Frame 5 Waterline	6.1	93.01	**36**	**45**	67.58
Frame 16.5 Bottom (0.75LWI	20.1	117.38	**10**	**26**	42.43

5.5 Forebody impact pressure for non-displacement mode

5.5.1 Forebody and bow slamming pressure, P f, at the load waterline due to relative motion is to be

P_f = the greater of $P_{d/s}$ or $f_f L_{WL}$ (0,8 + 0,15Γ)2 kN/m² at FP

= $P_{d/s}$ at 0,75L_{WL} from aft end of L_{WL}

= P_m at < 0,5L_{WL} from aft end of L_{WL}

= 0,0 between aft end of L_{WL} and 0,5L_{WL} from aft end of L_{WL}

Intermediate values to be determined by linear interpolation.

where

f_f = forebody impact pressure factor as defined in *Table 2.5.2 Forebody impact pressure factor*

L_{WL} = waterline length, in metres, *see Pt 5, Ch 2, 2.1 Parameters to be used for the determination of load and design criteria 2.1.19*

Γ = Taylor Quotient, *see Pt 5, Ch 2, 2.1 Parameters to be used for the determination of load and design criteria 2.1.17*.

Γ = 6.47 non-displ mode

f_1 = **1.0**

L_{WL} = 25.98 m

Location	x_{WL} (m)	P_m kN/m²	P_{dls} kN/m²	P_f kN/m²		x/LWL
Midship Bottom	13.0			0		
Midship T/2	13.0			0		
Midship Waterline	13.0			0		
Jet Rm Bhd fr3.5 Btm	3.0			0		
Collision Bhd fr20 Btm	24.4	31.48	28.51	48.43		0.9
Stem (FP)	**26.0**			54.43		1.0
0.75 x L_{WL}	**0.8**	21.52	42.43	42.43		0.75

5-2-6: Cross-Deck Structure for Multi-Hull Craft

6.1 Cross-deck structure clearance

6.1.1 For craft with multi-hulls linked by cross-deck structure, sufficient clearance is to be provided between the cross-deck structure and water surface to limit impact loads.
6.1.2 Where part or all of the cross-deck is intended to provide additional buoyancy to limit craft motion, the loading will be specially considered.
6.1.3 In the determination of the clearance, the following factors are to be considered:
(a) Relative motion in waves.
(b) The wave generated between the hulls when running.
(c) The bow sinkage.
6.1.4 The submitted clearance must be validated either by calculations according to accepted theories, model tests, full scale.
6.1.5 Where it is not possible to provide sufficient clearance to avoid slamming of the cross-deck structure, the equation given in Pt 5, Ch 2, 6.2 Impact pressure is to be used for the assessment of the impact pressures.

6.2 Impact Pressure

6.2.1 The impact pressure, P pc, acting on the underside of the cross deck (`wet deck') is to be taken as:

$$P_{\mathrm{pc}} = \nabla_{\mathrm{pc}} K_{\mathrm{pc}} V_{\mathrm{R}} V \left(1 - \frac{G_{\mathrm{A}}}{H_{03}}\right) \mathrm{kN/m^2}$$

where

K_{pc} = longitudinal distribution factor

= 1,0 between the aft end of the L_{WL} and 0,75L_{WL}

= 2,0 at the L_{WL} from the aft end of L_{WL}, intermediate values to be determined by linear interpolation

∇_{pc} = cross-deck Impact Factor

= 1/6 for protected structures, as defined in *Pt 5, Ch 2, 2.1 Parameters to be used for the determination of load and design criteria 2.1.20*

= 1/3 for unprotected structures, as defined in *Pt 5, Ch 2, 2.1 Parameters to be used for the determination of load and design criteria 2.1.21*

G_A = air gap, as defined in *Pt 5, Ch 2, 2.1 Parameters to be used for the determination of load and design criteria 2.1.1*

H_{03} = surviving waveheight, as defined in *Pt 5, Ch 2, 2.1 Parameters to be used for the determination of load and design criteria 2.1.16*

V = allowable speed, as defined in *Pt 5, Ch 2, 2.1 Parameters to be used for the determination of load and design criteria 2.1.2*

V_R is the relative vertical speed of the craft at impact, in knots. If this value is unknown, then the following equation is to be used:

$$V_{\mathrm{R}} = \frac{8H_{1/3}}{\sqrt{L_{\mathrm{WL}}}} + 2\ knots$$

L_{WL} =	25.98	m
∇_{pc} =	**0.33**	
K_{pc} =	varies	
G_A =	1.68	m
$H_{1/3}$ =	1.00	m
H_{03} =	1.29	m
V =	33.0	knots
V_R =	3.6	knots

Location	x_{WL} (m)	K_{pc}	P_{pc} kN/m^2	x/LWL
Midship Bottom	13.0	**1.00**	-11.8	
Midship T/2	13.0	**1.00**	-11.8	
Midship Waterline	13.0	**1.00**	-11.8	
Jet Rm Bhd fr3.5 Btm	3.0	**1.00**	-11.8	
Collision Bhd fr20 Btm	24.4	**1.45**	-17.1	0.9
Stem (FP)	**26.0**	**2.00**	-23.5	1.0
0.75 x L_{WL}	**19.5**	**1.00**	-11.8	0.75

negative numbers indicate sufficient air gap

5-2-7: Component Design Loads

7.1 Deckhouses, bulwarks and superstructures

7.1.1 The design pressure, P dhp, for the plating of deckhouses, bulwarks and first tier and above superstructures is given by:

$$P_{\mathrm{dhp}} = C_1 P_d \ \mathrm{kN/m^2}$$

G_f and S_f are defined in *Pt 5, Ch 3 Local Design Criteria for Craft Operating in Non-Displacement Mode* or *Pt 5, Ch 4 Local Design Criteria for Craft Operating in Displacement Mode* as appropriate.

P_d is defined in *Pt 5, Ch 2, 4.5 Pressure on weather and interior decks*.

For structures other than windows:

C_1 = 1,25 for deckhouse and superstructure fronts on upper deck within the forward third of L_R

= 1,15 for deckhouse and superstructure fronts on upper deck outside the forward third of L_R and exposed machinery casings on the upper deck

= 1,0 for deckhouse and superstructure fronts above the lowest tier

= 0,8 for superstructure sides. A value of 0,64 may be used where the sides of the superstructure are stepped in from the sides of the craft by 1,0 m or more

= 0,5 elsewhere

L_R = Rule length in metres, *see Pt 5, Ch 2, 2.2 Symbols 2.2.1*

For windows of toughened safety glass:

$$C_1 = W_1 W_2 W_3$$

In no case is the design pressure for windows of toughened safety glass to be taken less than $P_{\mathrm{dhp,min}}$ as given by:

$$P_{\mathrm{dhp,\,min}} = W_1 G_f S_f (10 + 0{,}04 L_{\mathrm{WL}}) \ \mathrm{kN/m^2}$$

where

W_1 = 2,0 for the lowest tier of unprotected front

= 1,5 for superstructure fronts above the lowest tier

= 1,0 for superstructure sides. A value of 0,8 may be used where the sides of the superstructure are stepped in from the sides of the craft by 1,0 metre or more

= 0,67 elsewhere

W_2 = $0{,}67 + 0{,}33\,(x_b/L_{WL})$ where $x_b > 0{,}5 L_{WL}$ from AP

= 0,67 elsewhere

W_3 = $1 - (y - F)/y$

x_b = distance, in metres, from AP

y = vertical distance, in metres, from the static load waterline at the deepest design draught to the structural element considered

F = $(D - T)$ in metres

L_{WL} = waterline length, in metres, *see Pt 5, Ch 2, 2.1 Parameters to be used for the determination of load and design criteria 2.1.19.*

G_f and S_f are defined in *Pt 5, Ch 3 Local Design Criteria for Craft Operating in Non-Displacement Mode* or *Pt 5, Ch 4 Local Design Criteria for Craft Operating in Displacement Mode* as appropriate. P_d is defined in *Pt 5, Ch 2, 4.5 Pressure on weather and interior decks.*

C_1 = varies

HOUSE SIDES AND FRONT

Location	x_{WL} (m)	C_1	P_d kN/m^2	P_{dhp} kN/m^2
House Side	**13.0**	**0.80**	**11.05**	8.8
Pilot House Side	**14.6**	**0.64**	**11.05**	7.1
House Front	**21.9**	**1.25**	**15.97**	20.0
Pilothouse Front	**17.1**	**1.00**	**11.05**	11.1

F = 2.29
G_f = 0.75
S_f = 1.00

WINDOWS

Location	x_{WL} (m)	y (m)	F (m)	W_1	W_2	W_3	C_1
House Side fwd of Fr 12	**19.1**	**3.7**	2.29	0.80	0.91	0.62	0.46
House Side aft of Fr 12	**14.6**	**3.7**	2.29	0.80	0.86	0.62	0.43
Pilothouse Side	**14.6**	**6.6**	2.29	1.00	0.86	0.35	0.30
House Front	**21.9**	**3.7**	2.29	2.00	0.95	0.62	1.19
Pilothouse Front	**17.1**	**6.6**	2.29	1.50	0.89	0.35	0.46
Skylights Fwd	**19.7**	**4.8**	2.29	1.50	0.92	0.48	0.66

Location	$P_{dhp.min}$ kN/m^2	P_d kN/m^2	P_{dhp} kN/m^2	$P_{dhp.req}$ kN/m^2
House Side fwd of Fr 12	6.62	**11.05**	5.04	**6.62**
House Side aft of Fr 12	6.62	**11.05**	4.73	**6.62**
Pilothouse Side	8.28	**11.05**	3.28	**8.28**
House Front	16.56	**15.97**	18.94	**18.94**
Pilothouse Front	12.42	**11.05**	5.10	**12.42**
Skylights Fwd	12.42	**11.05**	7.27	**12.42**

7.2 Watertight and deep tank bulkheads

7.2.1 The design pressure, Pbh, on watertight and deep tank bulkheads is to be taken as:

P_{bh} = 11,2 h_b kN/m^2 for:

- deep tank bulkheads,
- watertight bulkhead doors and
- stiffening supporting watertight bulkheads in way of watertight doors

where

h_b = load head in metres, measured as described in (b)

= 7,2 h_b kN/m^2 for:

- watertight bulkhead plating and
- stiffening clear of watertight doors

where

h_b = load head in metres, measured as described below in (a) for deep tank bulkheads and (c) for doors

(a) Watertight bulkheads:

(i) Plating: the distance from a point one-third of the height of the plate above its lower edge to the bulkhead deck at side.

(ii) Stiffeners: the distance from the mid-point of the stiffener span to the bulkhead deck at side.

(b) Deep tank bulkheads:

For determination of head, the overflow is to be taken as not less than 1,8 m above the crown of the tank.

(i) Plating: the greater of:

- the distance from the point one-third of the height of the plate above its lower edge to the top of the tank
- half the distance from a point one third of the height of the plate above its lower edge to the top of the overflow.

(ii) Stiffeners: the greater of:

- the distance from the mid-point of the span to the top of the tank
- half the distance from mid-point of span to the top of the overflow.

(c) Watertight door and supporting construction

(i) Plating: the distance from the point one-third of the height of the plate above its lower edge to the main deck

(ii) Stiffeners: the distance from the mid-point of the span the main deck

Location	x_{WL} (m)	h_b (m)	P_{bh} kN/m^2
Bulkhead 9	**9.8**	**2.24**	16.1
Fuel Tank End Bhd	**15.2**	**2.59**	29.0

7.3 Pillars

7.3.1 The design load, P PI, supported by a pillar is to be taken as:

$$P_{PI} = S_{gt}\, b_{gt}\, P_c + P_a \text{ kN}$$

where

P_c = basic deck girder design pressure, as appropriate, plus any other loadings directly above the pillar, in kN/m^2

P_a = load, in kN, from pillar or pillars above, assumed zero if there are no pillars over

S_{gt} = spacing, or mean spacing, of girders or transverses, in metres

b_{gt} = distance between centres of two adjacent spans of girders or transverses supported by the pillar, in metres

P_{Pl} is not to be taken less than 5 kN.

Location	S_{gt} (m)	b_{gt} (m)	P_c kN/m^2	P_a kN/m^2	P_{Pl} kN
Pillar Fr 13 P/S	**3.30**	**3.80**	11.1	**0.0**	138.6
Upper Dk fr 10	**1.2**	**1.45**	11.1	**0.0**	19.5

5-3: Local Design Criteria for Craft Operating in Non-Displacement Mode

1.1 Application

This vessel is a high speed, light-displacement catmaran.

2.1 Nomenclature

2.1.1 The nomenclature used in this Chapter is given below:

P_p =	varies	pitching pressure, see Pt 5, Ch 2, 4.4 Hydrodynamic wave pressure
P_{dl} =	varies	impact pressure see Pt 5, Ch 2, 5.2 Impact pressure for non-displacement ı
P_s =	varies	shell envelope pressure, see Pt 5, Ch 2, 4.2 Combined hydrostatic and hydrodynamic pressure on the shell plating
P_f =	varies	forebody impact pressure, see Pt 5, Ch 2, 5.5 Forebody impact pressure for non-displacement mode
P_{dhp} =	varies	deckhouse, bulwalks and superstructure pressure, see Pt 5, Ch 2, 7.1 Deckhouses, bulwarks and superstructures
P_{bh} =	varies	watertight and deep tank bulkhead pressure, see Pt 5, Ch 2, 7.2 Watertight and deep tank bulkheads
P_{pc} =	varies	impact pressure acting on the cross-deck structure, see Pt 5, Ch 2, 6.2 Impact pressure
P_{wl} =	varies	pressure on weather deck, see Pt 5, Ch 2, 4.5 Pressure on weather and interior decks

2.2 Design Factors

2.2.2 In general, the design pressure, in kN/m2, for a particular structural component is to be determined as follows:

Design pressure = $\delta_f H_f G_f S_f C_f$ x load criterion

where

H_f = hull notation factor given in *Table 3.2.1 Hull notation factor, H_f*

G_f = service area restriction notation factor given in *Table 3.2.2 Service area notation factor, G_f*

S_f = service type factor notation given in *Table 3.2.3 Service type notation factor, S_f*

C_f = craft type notation factor given in *Table 3.2.4 Craft type notation factor, C_f*

δ_f = stiffening type factor as given in *Table 3.2.5 Stiffening type factor, δ_f*

H_f =	**1.0**	for HSC & LDC
G_f =	**0.75**	for G2 Service Area
S_f =	**1.0**	for Passenger
C_f =	**1.0**	for Catamaran
δ_f =	**0.5**	for ordinary longitudinals
δ_f =	**0.8**	for ring frames & transverses

3.1 Hull Structures

3.1.1 The design pressures, in kN/m2, to be used to determine the scantlings of structural elements are to be taken as

Bottom shell	Basic craft	P_{BP}	Greater of $H_f S_f P_s$ $H_f S_f C_f P_{dl}$ $H_f S_f G_f C_f P_f$		P_{BF}	Greater of $\delta_f H_f S_f P_s$ $\delta_f H_f S_f C_f P_{dl}$ $\delta_f H_f S_f G_f C_f P_f$

							plating	stiffs	girders
Location	P_S kN/m^2	P_{dl} kN/m^2	P_f kN/m^2	P_{BPs} kN/m^2	P_{BPdl} kN/m^2	P_{BPf} kN/m^2	P_{BP} kN/m^2	P_{BP} kN/m^3	P_{BP} kN/m^4
Btm Shell - Midship	39.4	143.2	**1.00**	39.4	143.2	0.8	143.2	71.6	114.5
Btm Shell Fr 5	38.2	105.7	**1.00**	28.6	105.7	0.8	105.7	52.9	84.6
Btm Shell Fr 20	55.3	78.9	48.4	55.3	78.9	36.3	78.9	39.4	63.1

Outboard side shell		P_{SP}	P_{BP}		P_{SF}	$\delta_f P_{BP}$
Inboard side shell		P_{SP}	Greater of P_{BP} 1,6 P_{WDP} at wet deck		P_{SF}	Greater of $\delta_f P_{BP}$ 1,9 P_{WDP} at wet deck
Wet deck		P_{CP}	Greater of $H_f S_f P_s$ $H_f S_f P_{pc}$		P_{CF}	Greater of $\delta_f H_f S_f P_s$ $\delta_f H_f S_f P_{pc}$

							plating	stiffs	girders
Location	P_{BP} kN/m^2	P_{WDP} kN/m^2	*1.6* P_{WDP} kN/m^2	*1.9* P_{WDP} kN/m^2	P_s kN/m^2	P_{pc} kN/m^2	P_{SP} kN/m^2	P_{SP} kN/m^3	P_{SP} kN/m^4
Outbd Side Shell - Midship	143.2						143.2	71.6	114.5
Outbd Side Shell - Fr 5	105.7						105.7	52.9	84.6
Outbd Side Shell - Fr 20	78.9						78.9	39.4	63.1
Inbd Side Shell - Midship	143.2	7.0	11.2	13.3			143.2	71.6	114.5
Inbd Side Shell - Fr 5	105.7	8.2	13.1	15.6			105.7	52.9	84.6
Inbd Side Shell - Fr 20	78.9	11.7	18.7	22.2			78.9	39.4	63.1
							P_{CP}	P_{CP}	P_{CP}
Wet Deck - Midship @WL					30.6	0.0	30.6	15.3	24.5
Wet Deck - Fr 5 @WL					30.6	0.0	30.6	15.3	24.5
Wet Deck - Fr 20 @WL					49.2	0.0	49.2	24.6	39.3

Weather deck see Note 1		P_{WDP}	Greater of $H_f S_f G_f C_f P_{wl}$ P_{cd}	7	P_{WDF}	Greater of $\delta_f H_f S_f G_f C_f P_{wl}$ P_{cd}
Coachroof deck, see Note 1		P_{CRP}	$H_f S_f G_f C_f P_{wl}$	7	P_{CRF}	$\delta_f H_f S_f G_f C_f P_{wl}$
Interior deck		P_{IDP}	Greater of $H_f S_f C_f P_{wl}$ P_{cd}	3,5	P_{IDF}	Greater of $\delta_f H_f S_f C_f P_{wl}$ P_{cd}
Deckhouses, bulwarks and superstructure		P_{DHP}	$H_f S_f G_f C_f P_{dhp}$		P_{DHF}	$\delta_f H_f S_f G_f C_f P_{dhp}+P_h$

				plating	stiffs	girders
Location	P_{wl} kN/m^2	P_{dhp} kN/m^2	G_f	P_{WDP} kN/m^2	P_{WDP} kN/m^3	P_{WDP} kN/m^4
Weather Dk - midship	7.0		1.0	7.0	3.5	5.6
Weather Dk - Fr 5	8.2		1.0	8.2	4.1	6.6
Weather Dk - Fr 20	11.7		1.0	11.7	5.9	9.4
				P_{CRP}	P_{CRP}	P_{CRP}
Coachroof Dk - Midship	8.2		1.0	7.0	3.5	5.6
				P_{IDP}	P_{IDP}	P_{IDP}
Interior Dk - Midship	7.0			7.0	3.5	5.6
				P_{DHP}	P_{DHP}	P_{DHP}
Deckhouse Side - Midship		8.8		6.6	3.3	5.3
Deckhouse Front - Fr 18		20.0		15.0	7.5	12.0
Pilothouse Side		7.1		5.3	2.7	4.2
Pilothouse front - Fr 16		11.1		8.3	4.1	6.6

Watertight and deep tank bulkheads		P_{BHP}	P_{bh}		P_{BHF}	P_{bh}

Note 1. G_f is not to be taken less than 1,0.

Note 2. The result of each row in each cell is found as the product of all items on that row in that cell.

			plating	stiffs	girders
Location	P_{bh} kN/m^2	P_{dhp} kN/m^2	P_{BHP} kN/m^2	P_{BHP} kN/m^3	P_{BHP} kN/m^4
Watertight Bhd 9	16.1		16.1	16.1	16.1
Fuel Tank End Bhd	29.0		29.0	29.0	29.0

7-4: Scantling Determination for Multi-Hull Craft

1.2 General

1.2.1 Except as otherwise specified within this Chapter, the scantlings and arrangements of multi-hull craft are to be determined in accordance with the procedures described in, or required by Pt 7, Ch 3 scantling Determination for Mono-Hull Craft, using the pressures from Pt 5 Design and Load Criteria appropriate to multi-hulls.

1.5 Symbols & DefinitionsApplication

1.5.1 The symbols used in this Chapter are defined below and in the appropriate Section:

k_a = alloy factor

= $125/\sigma_a$

σ_a = 0,2 per cent proof stress of the alloy in the welded condition, in N/mm^2

k_a =	0.83	for 5083-0 plate	
k_a =		for 6061-T6 shapes	
σ_a =	**151**	N/mm^2	for 5083-H321-H116 - welded
σ_a =	**131**	N/mm^2	for 6061-T6 shapes - welded

k_m = $385/(\sigma_A + \sigma_u)$

σ_A = specified minimum yield stress or 0,2% proof stress of the alloy in unwelded condition, in N/mm^2

σ_u = specified minimum ultimate tensile strength of the alloy in unwelded condition, in N/mm^2

σ_u =	**317**	N/mm^2	for 5083-H116 plate - unwelded
σ_u =	**310**	N/mm^2	for 6061-T6 shapes - unwelded
k_m =	0.82	for 5083-H116 plate	
k_m =		for 6061-T6 shapes	

ω =	**1.0**	from table 4.2.2 for passenger vessels
L_R =	25.93	m
E =	**69,000**	modulus of elasticity

7-3-3 Shell Envelope Plating

3.4.1 The thickness of the bottom shell plating is to be determined from the general plating equation given in Pt 7, Ch 3, 1.16 Plating general using the design pressure from Pt 5, Ch 3, 3.1 Hull structures or Pt 5, Ch 4, 3.1 Hull structures for nondisplacement or displacement craft as appropriate.

GENERAL PLATING EQUATION

1.16.1 The requirements for the thickness of plating, t_p, is, in general, to be in accordance with the following:

$$t_p = 22,4\, s\, \gamma\, \beta \sqrt{\frac{p}{f_\sigma\, \sigma_a}} \times 10^{-3} \text{ mm}$$

where

f_σ = limiting bending stress coefficient for the plating element under consideration is given in *Table 7.3.1 Limiting stress coefficients for local loading* in Chapter 7.

s, γ, β, p, σ_a are as defined in *Pt 7, Ch 3, 1.5 Symbols and definitions 1.5.1*.

Bottom Shell
minimum thickness

Bottom shell plating	$\omega \sqrt{k_m}\left(0,7\sqrt{L_R} + 1,0\right) \geq 4,0\,\omega$

k_m = 0.82
ω = 1.0
L_R = 25.93 m
s = varies mm
γ = **1.0**
β = varies aspect ratio factor
p = varies kN/m^2 design pressure
σ_a = 151 N/mm^2
f_σ = varies per table7.3.1

Location	*s* mm	*l* mm	*β*	*P BP* kN/m^2	*f σ*	*t MIN* mm	*t p* mm
Btm Shell - Midship	**254**	**1,219**	1.0	143.2	**0.75**	4.1	6.4
Btm Shell Fr 5	**254**	**1,219**	1.0	105.7	**0.75**	4.1	5.5
Btm Shell Fr 20	**254**	**1,219**	1.0	78.9	**0.75**	4.1	4.7

3.5 Side Outboard / 3.6 Side Inboard

3.5.1 The thickness of the side outboard plating is to be determined from the general plating equation given in Pt 7, Ch 3, 1.16 Plating general using the design pressure from Pt 5, Ch 3, 3.1 Hull structures or Pt 5, Ch 4, 3.1 Hull structures for nondisplacement or displacement craft as appropriate.

Side shell plating	$\omega \sqrt{k_{\mathrm{m}}}\left(0,5\sqrt{L_{\mathrm{R}}}+1,4\right) \geq 3,5\ \omega$

Location	s mm	l mm	β	P_{SP} kN/m^2	f_σ	t_{MIN} mm	t_p mm
Outbd Side Shell - Midship	**229**	**1,219**	1.0	143.2	**0.75**	3.6	5.8
Outbd Side Shell - Fr 5	**229**	**1,219**	1.0	105.7	**0.75**	3.6	4.9
Outbd Side Shell - Fr 20	**229**	**1,219**	1.0	78.9	**0.75**	3.6	4.3
Inbd Side Shell - Midship	**229**	**1,219**	1.0	143.2	**0.75**	3.6	5.8
Inbd Side Shell - Fr 5	**229**	**1,219**	1.0	105.7	**0.75**	3.6	4.9
Inbd Side Shell - Fr 20	**229**	**1,219**	1.0	78.9	**0.75**	3.6	4.3

3.7 Wet-Deck

3.7.1 The thickness of the wet-deck plating is to be determined from the general plating equation given in Pt 7, Ch 3, 1.16 Plating general using the design pressure from Pt 5, Ch 3, 3.1 Hull structures or Pt 5, Ch 4, 3.1 Hull structures for nondisplacement or displacement craft as appropriate.

3.7.2 Additionally, the thickness of the wet-deck plating is in no case to be less than the thickness of the side inboard shell plating determined from Pt 7, Ch 4, 3.6 Side inboard.

Wet-deck plating	$\omega \sqrt{k_{\mathrm{m}}}\left(0,5\sqrt{L_{\mathrm{R}}}+1,4\right) \geq 3,5\ \omega$

Location	s mm	l mm	β	P_{CP} kN/m^2	f_σ	t_{MIN} mm	t_p mm
Wet Deck - Midship @WL	**254**	**1,219**	1.0	30.6	**0.75**	3.6	3.0
Wet Deck - Fr 5 @WL	**254**	**1,219**	1.0	30.6	**0.75**	3.6	3.0
Wet Deck - Fr 20 @WL	**254**	**1,219**	1.0	49.2	**0.75**	3.6	3.7

but not less than side inboard shell plating

7-3-4 Shell Envelope Framing

4.2.4 The requirements for section modulus, inertia and web area are to be determined from the general equations given in Pt 7, Ch 3, 1.17 Stiffening general, using the design pressures from Pt 5, Ch 3, 3.1 Hull structures or Pt 5, Ch 4, 3.1 Hull structures for non-displacement or displacement craft as appropriate, and the coefficients Φ Z, Φ I, and Φ A as detailed in Table 3.1.1 Section modulus, inertia and web area coefficients in Chapter 3 for the load model (b).

GENERAL FRAMING EQUATIONS

1.17.1 The requirements for section modulus, inertia and web area of stiffening members are in general to be in accordan with the following:

(a) Section modulus:

$$Z = F_Z \frac{psl^2{}_e}{f_\sigma \sigma_a} \quad \text{cm}^3$$

where

Φ_Z = section modulus coefficient dependent on the loading model assumption taken from *Table 3.1.1 Section modulus, inertia and web area coefficients*

f_σ = limiting bending stress coefficient for stiffening member given in *Table 7.3.1 Limiting stress coefficients fo local loading* in Chapter 7.

p, *s*, l_e and σ_a are as defined in *Pt 7, Ch 3, 1.5 Symbols and definitions*.

(b) Inertia:

$$I = F_I f_\delta \frac{psl^3{}_e}{E} \times 100 \quad \text{cm}^4$$

where

Φ_I = inertia coefficient dependent on the loading model assumption taken from *Table 3.1.1 Section modulus, inertia and web area coefficients*

f_δ = limiting deflection coefficient for stiffener member given in *Table 7.2.1 Limiting deflection ratio* in Chapter 7.

p, *s*, l_e, and *E* are as defined in *Pt 7, Ch 3, 1.5 Symbols and definitions 1.5.1*.

(c) Web area:

$$A_w = F_A \frac{psl_e}{100 f_\tau \tau_a} \quad \text{cm}^2$$

where

Φ_A = web area coefficient dependent on the loading model assumption taken from *Table 3.1.1 Section modulus, inertia and web area coefficients*

f_τ = limiting shear stress coefficient for stiffener member given in *Table 7.3.1 Limiting stress coefficients for local loading*

p, *s*, l_e, and τ_a are as defined in *Pt 7, Ch 3, 1.5 Symbols and definitions 1.5.1*.

4.2 Bottom Longitudinal Stiffeners

4.2.4 The requirements for section modulus, inertia and web area are to be determined from the general equations given in Pt 7, Ch 3, 1.17 Stiffening general, using the design pressures from Pt 5, Ch 3, 3.1 Hull structures or Pt 5, Ch 4, 3.1 Hull structures for non-displacement or displacement craft as appropriate, and the coefficients ΦZ, ΦI, and ΦA as detailed in Table 3.1.1 Section modulus, inertia and web area coefficients for the load model (b).

Φ_Z =	varies	per table 3.1.1	
Φ_I =	varies	per table 3.1.2	
Φ_A =	varies	per table 3.1.3	
s =	varies	mm	spacing
l =	varies	mm	span
f_σ =	varies	per table 7.3.1	
f_δ =	varies	per table 7.2.1	
f_τ =	varies	per table 7.3.1	
σ_a =	131	N/mm^2	for stiffeners - weldec
τ_a =	75.6		
p =	varies	kN/m^2	design pressure
E =	69,000	N/mm^2	modulus of elasticity

Location	Φ_Z	Φ_I	Φ_A	*s* mm	*l* m	P_{BPs} kN/m^2
Bottom Long'l Frs - Midship	**0.10**	**0.0035**	**0.50**	**254**	**1.22**	71.6
Bottom Long'l Frs - Fr 5	**0.10**	**0.0035**	**0.50**	**254**	**1.22**	52.9
Bottom Long'l Frs - Fr 20	**0.10**	**0.0035**	**0.50**	**254**	**1.22**	39.4

Location	f_σ	f_δ	f_τ	*Z* cm^3	*I* cm^4	*A* cm^2
Bottom Long'l Frs - Midship	**0.65**	**475**	**0.65**	31.7	78.7	2.3
Bottom Long'l Frs - Fr 5	**0.65**	**475**	**0.65**	23.4	58.2	1.7
Bottom Long'l Frs - Fr 20	**0.65**	**475**	**0.65**	17.5	43.4	1.2

4.6 Bottom Transverse Web frames

4.6.3 The requirements for section modulus, inertia and web area are to be determined from the general equations given in Pt 7, Ch 3, 1.17 Stiffening general, using the design pressures from Pt 5, Ch 3, 3.1 Hull structures or Pt 5, Ch 4, 3.1 Hull structures for non-displacement or displacement craft as appropriate, and the coefficients ΦZ, ΦI, and ΦA as detailed in Table 3.1.1 Section modulus, inertia and web area coefficients for the load model (a).

s =	varies	mm	spacing
σ_a =	131	N/mm^2	for stiffeners - welded
τ_a =	75.6		
p =	varies	kN/m^2	design pressure
E =	69,000	N/mm^2	modulus of elasticity

Location	Φ_Z	Φ_I	Φ_A	*s* mm	*l* m	P_{BPg} kN/m^2
Bottom Xvrs Web - Fr 11	**0.08**	**0.0026**	**0.50**	**1,219**	**1.83**	114.5
Bottom Xvrs Web - Fr 5	**0.08**	**0.0026**	**0.50**	**1,219**	**1.75**	84.6
Bottom Xvrs Web - Fr 20	**0.08**	**0.0026**	**0.50**	**1,219**	**1.83**	63.1

Location	f_σ	f_δ	f_τ	*Z* cm^3	*I* cm^4	*A* cm^2
Bottom Xvrs Web - Fr 11	**0.65**	**625**	**0.65**	457.0	2,014.3	26.0
Bottom Xvrs Web - Fr 5	**0.65**	**625**	**0.65**	310.0	1,309.3	18.4
Bottom Xvrs Web - Fr 20	**0.65**	**625**	**0.65**	251.8	1,109.7	14.3

4.12 Side Outboard Longitudinal Stiffeners

4.12.4 The requirements for section modulus, inertia and web area are to be determined from the general equations given in Pt 7, Ch 3, 1.17 Stiffening general, using the design pressures from Pt 5, Ch 3, 3.1 Hull structures or Pt 5, Ch 4, 3.1 Hull structures for non-displacement or displacement craft as appropriate, and the coefficients Φ Z, Φ I, and Φ A as detailed in Table 3.1.1 Section modulus, inertia and web area coefficients in Chapter 3 for the load model (b).

s =	varies	mm	spacing
l =	varies	mm	span
σ_a =	131	N/mm^2	for stiffeners - welded
τ_a =	75.6		
p =	varies	kN/m^2	design pressure
E =	69,000	N/mm^2	modulus of elasticity

Location	Φ_Z	Φ_I	Φ_A	*s* mm	*l* m	P_{SPs} kN/m^2
Outboard Side Long'ls - Fr 11	**0.08**	**0.0035**	**0.50**	**254**	**1.22**	71.6
Outboard Side Long'ls - Fr 5	**0.08**	**0.0035**	**0.50**	**254**	**1.22**	52.9
Outboard Side Long'ls - Fr 20	**0.08**	**0.0035**	**0.50**	**254**	**1.22**	39.4

Location	f_σ	f_δ	f_τ	*Z* cm^3	*I* cm^4	*A* cm^2
Outboard Side Long'ls - Fr 11	**0.75**	**475**	**0.65**	22.9	78.7	2.3
Outboard Side Long'ls - Fr 5	**0.75**	**475**	**0.65**	16.9	58.2	1.7
Outboard Side Long'ls - Fr 20	**0.75**	**475**	**0.65**	12.6	43.4	1.2

4.16 Side Outboard Transverse Web Frames

4.16.3 The requirements for section modulus, inertia and web area are to be determined from the general equations given in Pt 7, Ch 3, 1.17 Stiffening general, using the design pressures from Pt 5, Ch 3, 3.1 Hull structures or Pt 5, Ch 4, 3.1 Hull structures for non-displacement or displacement craft as appropriate, and the coefficients Φ Z, Φ I, and Φ A as detailed in Table 3.1.1 Section modulus, inertia and web area coefficients in Chapter 3 for the load model (a).

s =	varies	mm	spacing
l =	varies	mm	span
σ_a =	131	N/mm^2	for stiffeners - welded
τ_a =	75.6		
p =	varies	kN/m^2	design pressure
E =	69,000	N/mm^2	modulus of elasticity

Location	Φ_Z	Φ_I	Φ_A	*s* mm	*l* m	P_{SPg} kN/m^2
Side Outbd Web - Fr 11	**0.08**	**0.0026**	**0.50**	**1,219**	**2.13**	114.5
Side Outbd Web - Fr 5	**0.08**	**0.0026**	**0.50**	**1,219**	**2.44**	84.6
Side Outbd Web - Fr 20	**0.08**	**0.0026**	**0.50**	**1,219**	**1.52**	63.1

Location	f_σ	f_δ	f_τ	*Z* cm^3	*I* cm^4	*A* cm^2
Side Outbd Web - Fr 11	**0.65**	**625**	**0.65**	622.0	3,198.7	30.3
Side Outbd Web - Fr 5	**0.65**	**625**	**0.65**	600.0	3,526.1	25.6
Side Outbd Web - Fr 20	**0.65**	**625**	**0.65**	174.8	642.2	11.9

4.17 Side Inboard Longitudinal Stiffeners

4.17.1 The scantlings and arrangements for side inboard longitudinal stiffeners are to be determined in accordance with the procedures described in Pt 7, Ch 4, 4.12 Side outboard longitudinal stiffeners using the side inboard design pressure from Pt 5, Ch 3, 3.1 Hull structures or Pt 5, Ch 4, 3.1 Hull structures for non-displacement or displacement craft as appropriate.

s =	varies	mm	spacing
l =	varies	mm	span
σ_a =	131	N/mm^2	for stiffeners - weldec
τ_a =	75.6		
p =	varies	kN/m^2	design pressure
E =	69,000	N/mm^2	modulus of elasticity

Location	Φ_Z	Φ_I	Φ_A	*s* mm	*l* m	P_{SPs} kN/m^2
Inboard Side Long'ls - Fr 11	**0.10**	**0.0035**	**0.50**	**254**	**1.22**	71.6
Inboard Side Long'ls - Fr 5	**0.10**	**0.0035**	**0.50**	**254**	**1.22**	52.9
Inboard Side Long'ls - Fr 20	**0.10**	**0.0035**	**0.50**	**254**	**1.22**	39.4

Location	f_σ	f_δ	f_τ	*Z* cm^3	*I* cm^4	*A* cm^2
Inboard Side Long'ls - Fr 11	**0.75**	**475**	**0.65**	27.5	78.7	2.3
Inboard Side Long'ls - Fr 5	**0.75**	**475**	**0.65**	20.3	58.2	1.7
Inboard Side Long'ls - Fr 20	**0.75**	**475**	**0.65**	15.2	43.4	1.2

4.21 Side Inboard Transverse Web Frames

4.21.1 The scantlings and arrangements for side inboard transverse web frames are to be determined in accordance with the procedures described in Pt 7, Ch 4, 4.16 Side outboard transverse web frames using the side inboard design pressure from Pt 5, Ch 3, 3.1 Hull structures or Pt 5, Ch 4, 3.1 Hull structures for non-displacement or displacement craft as appropriate.

Location	Φ_Z	Φ_I	Φ_A	s mm	l m	P_{SPg} kN/m^2
Side Inbd Web - Fr 11	**0.08**	**0.0026**	**0.50**	**1,219**	**1.98**	114.5
Side Inbd Web - Fr 5	**0.08**	**0.0026**	**0.50**	**1,219**	**1.98**	84.6
Side Inbd Web - Fr 20	**0.08**	**0.0026**	**0.50**	**1,219**	**1.52**	63.1

Location	f_σ	f_δ	f_τ	Z cm^3	I cm^4	A cm^2
Side Inbd Web - Fr 11	**0.65**	**625**	**0.65**	536.3	2,561.0	28.1
Side Inbd Web - Fr 5	**0.65**	**625**	**0.65**	396.1	1,891.3	20.8
Side Inbd Web - Fr 20	**0.65**	**625**	**0.65**	174.8	642.2	11.9

4.22 Wet-Deck Longitudinal Stiffeners

4.22.4 The requirements for section modulus, inertia and web area are to be determined from the general equations given in Pt 7, Ch 3, 1.17 Stiffening general, using the design pressures from Pt 5, Ch 3, 3.1 Hull structures or Pt 5, Ch 4, 3.1 Hull structures for non-displacement or displacement craft as appropriate, and the coefficients Φ Z, Φ I, and Φ A as detailed in Table 3.1.1 Section modulus, inertia and web area coefficients in Chapter 3 for the load model (b).

4.22.5 In no case are the scantlings and arrangements for the wet-deck longitudinal stiffeners to be taken as less than those required for the side inboard longitudinal stiffeners detailed in Pt 7, Ch 4, 4.17 Side inboard longitudinal stiffeners.

s =	varies	mm	spacing
l =	varies	mm	span
σ_a =	131	N/mm^2	for stiffeners - weldec
τ_a =	75.6		
p =	varies	kN/m^2	design pressure
E =	69,000	N/mm^2	modulus of elasticity

Location	Φ_Z	Φ_I	Φ_A	*s* mm	*l* m	P_{CPs} kN/m^2
Wet Deck Long'ls - Fr 11	**0.10**	**0.0035**	**0.50**	**254**	**1.22**	15.3
Wet Deck Long'ls - Fr 5	**0.10**	**0.0035**	**0.50**	**254**	**1.22**	15.3
Wet Deck Long'ls - Fr 20	**0.10**	**0.0035**	**0.50**	**254**	**1.22**	24.6

Location	f_σ	f_δ	f_τ	*Z* cm^3	*I* cm^4	*A* cm^2
Wet Deck Long'ls - Fr 11	**0.75**	**475**	**0.65**	5.9	16.8	0.5
Wet Deck Long'ls - Fr 5	**0.75**	**475**	**0.65**	5.9	16.8	0.5
Wet Deck Long'ls - Fr 20	**0.75**	**475**	**0.65**	9.4	27.1	0.8

4.26 Wet-Deck Transverse Web Frames

4.26.3 The requirements for section modulus, inertia and web area are to be determined from the general equations given in Pt 7, Ch 3, 1.17 Stiffening general, using the design pressures from Pt 5, Ch 3, 3.1 Hull structures or Pt 5, Ch 4, 3.1 Hull structures for non-displacement or displacement craft as appropriate, and the coefficients Φ Z, Φ I, and Φ A as detailed in Table 3.1.1 Section modulus, inertia and web area coefficients in Chapter 3 for the load model (a).

4.26.4 In no case are the scantlings and arrangements for the wet-deck transverse web frames to be taken as less than those required for the side inboard transverse web frames detailed in Pt 7, Ch 4, 4.21 Side inboard transverse web frames.

Location	Φ_Z	Φ_I	Φ_A	*s* mm	*l* m	P_{CPg} kN/m^2
Wet Deck Xvrs Web - Fr 11	**0.08**	**0.0026**	**0.50**	**1,219**	**2.29**	24.5
Wet Dk Xvrs Outbd - Fr 5	**0.08**	**0.0026**	**0.50**	**1,219**	**1.98**	24.5
Wet Dk Xvrs Outbd - Fr 20	**0.08**	**0.0026**	**0.50**	**1,219**	**1.83**	39.3

Location	f_σ	f_δ	f_τ	*Z* cm^3	*I* cm^4	*A* cm^2
Wet Deck Xvrs Web - Fr 11	**0.65**	**625**	**0.65**	152.5	840.4	6.9
Wet Dk Xvrs Outbd - Fr 5	**0.65**	**625**	**0.65**	114.6	547.0	6.0
Wet Dk Xvrs Outbd - Fr 20	**0.65**	**625**	**0.65**	157.0	692.0	8.9

4.26.6 Particular care is to be taken to ensure that the continuity of transverse structural strength is maintained. All primary transverse members are to be continuous through the inboard side structure and integrated into transverse bulkheads or other primary structure within each hull (see Figure 4.4.1 End connection details, wet-deck structure). In the case of trimaran type craft the primary transverse members are to be continuous through the centre hull. Additionally the side inboard shell plating in way of the intersection is to be increased locally by not less than 50 per cent.

5.3 Center Girder

5.3.1 Centerline girders are to be fitted throughout the length of each hull and are generally to be fitted in association with transverse frames, transverses supporting longitudinals or where the breadth of floors at the upper edge is greater than 1.5 m.
5.3.2 Centreline girders may be formed with intercostal or continuous plate webs. In all cases the face flat is to be continuous. Where girder webs are intercostal, additional bracketing and local reinforcement are to be provided to maintain the continuity of structural strength.
5.3.3 The web depth of the centre girder is, in general, to be equal to the depth of the floors at the centreline as specified in Pt 7, Ch 4, 5.5 Floors general 5.5.3.
5.3.4 The web thickness, t w, of the centre girder is to be taken as not less than:

$$t_w = \sqrt{k_a}\left(\sqrt{1,9L_R} + 1,3\right) \text{ mm}$$

where k_a and L_R are as defined in *Pt 7, Ch 4, 1.5 Symbols and definitions 1.5.1.*

5.3.5 The face flat area, A_f, of the centre girder is to be not less than:

$$A_f = 0,42 k_a L_R \text{ cm}^2$$

where k_a and L_R are as defined in *Pt 7, Ch 4, 1.5 Symbols and definitions 1.5.1.*

5.3.6 The geometric section properties of the centre girder are to be in accordance with Pt 7, Ch 3, 1.18 Geometric properties and proportions of stiffener sections.
5.3.7 The face flat area of the centre girder outside 0.5L R may be 80 per cent of the value given in Pt 7, Ch 4, 5.3 Centre girder 5.3.5.
5.3.8 The face flat thickness, t w, is to be not less than the thickness of the web.
5.3.9 The ratio of the width to thickness of the face flat is to be not less than eight but is not to exceed 16.

L_R = 25.9 m
k_a = 0.8

Location	t_w mm	A_f cm^2
Keel - Midship	7.6	9.0

t_w in	A_f in^2
0.298	1.40

7-4-7 Bulkheads and Deep Tanks

7.1.1 Unless otherwise specified in this section, the scantlings and arrangements for bulkheads and deep tanks are to be determined in accordance with the procedures described in, or as required by Pt 7, Ch 3, 3 Shell envelope plating for mono-hull craft using the pressures from Pt 5 Design and Load Criteria appropriate to multi-hulls.

7-3-7 Bulkheads

7.2 Watertight bulkhead plating

7.2.1 The thickness of the watertight bulkhead plating is to be determined from the general plating equation given in Pt 7, Ch 3, 1.16 Plating general using the design pressure from Pt 5, Ch 3, 3.1 Hull structures or Pt 5, Ch 4, 3.1 Hull structures for nondisplacement or displacement craft as appropriate.

Watertight bulkhead plating	$\omega\sqrt{k_m}\left(0,43\sqrt{L_R}+1,2\right)\geq 3,0\,\omega$
Deep tank bulkhead plating	$\omega\sqrt{k_m}\left(0,5\sqrt{L_R}+1,4\right)\geq 3,5$

Location	s mm	l mm	β	P_{BHP} kN/m^2	f_σ	t_{MIN} mm	t_p mm
Watertight Bhd 9	**254**	**2,134**	1.0	16.1	**1.00**	3.1	3.1
Fuel Tank End Bhd	**419**	**1,448**	1.0	29.0	**1.00**	3.6	4.1

7.3 Watertight bulkhead stiffening

7.3.1 The rule requirements for section modulus, inertia and web area are to be determined from the general equations given in Pt 7, Ch 3, 1.17 Stiffening general, using the design pressure from Pt 5, Ch 3, 3.1 Hull structures or Pt 5, Ch 4, 3.1 Hull structures for non-displacement or displacement craft as appropriate, and the coefficients ΦZ, ΦI, and ΦA as detailed in Table 3.1.1 Section modulus, inertia and web area coefficients using the appropriate load model.

watertight bulkhead stiffeners will be corrugated plate

s =	varies	mm	spacing
l =	varies	mm	span
σ_a =	131	N/mm^2	for stiffeners - welded
τ_a =	75.6		
p =	varies	kN/m^2	design pressure
E =	69,000	N/mm^2	modulus of elasticity

Location	Φ_Z	Φ_I	Φ_A	s mm	l m	P_{BHP} kN/m^2
Bhd 9 Corrugation	**0.10**	**0.0035**	**0.50**	**267**	**2.13**	16.1
Fuel Tank End Bhd	**0.10**	**0.0035**	**0.50**	**305**	**1.52**	29.0

Location	f_σ	f_δ	f_τ	Z cm^3	I cm^4	A cm^2
Bhd 9 Corrugation	**0.75**	**475**	**0.65**	19.9	99.6	0.9
Fuel Tank End Bhd	**0.75**	**475**	**0.65**	20.9	74.8	1.4

7.11 Corrugated Bulkheads

7.11.1 The plating thickness and section modulus for symmetrical corrugated bulkheads are to be in accordance with watertight bulkheads or deep tank bulkheads as appropriate. The spacing, s, is to be taken as s_c, as defined in Figure 2.3.1 Corrugation.

3.2.4 The effective section modulus of a corrugation over a spacing, s_c, is to be calculated from the dimensions and, for symmetrical corrugations, may be taken as:

$$z = \frac{d_w(3bt_p + ct_w)}{6000} \text{cm}^3$$

where d_w, b, t_p, c and t_w are measured, in mm, and are as shown in *Figure 2.3.1 Corrugation*. The value of b is to be taken not greater than:

$50t_p\sqrt{\frac{235}{\sigma_o}}$ for welded corrugations

$60t_p\sqrt{\frac{235}{\sigma_0}}$ for cold formed corrugations

where σ_0 is defined in *Pt 3, Ch 3, 1.2 General*.

The value of θ is not to be taken less than 40°. The moment of inertia is to be calculated from:

$$I = 0,05\, d_w Z \text{ cm}^4$$

Location	d_w mm	b mm	b_{max} mm	t_p mm	t_w mm	c mm	θ deg
Bhd 9 Corrugation	**64**	**203**	444.7	**4.76**	**4.76**	**80**	

Location	Z cm^3	I cm^4
Bhd 9 Corrugation	34.8	110.4

7-4-8 Deck Structures

8.1.1 Unless otherwise specified in this section, the scantlings and arrangements for deck structures are to be determined in accordance with the procedures described in, or as required by, Pt 7, Ch 3, 8 Deck structures for mono-hull craft using the pressures from Pt 5 Design and Load Criteria appropriate to multi-hulls.

7-3-8 Deck Structures

8.3 Lower deck/inside deckhouse plating

8.3.1 The thickness of the lower deck/inside deckhouse plating is to be determined from the general plating equation given in Pt 7, Ch 3, 1.16 Plating general using the design pressure head from Pt 5, Ch 3, 3.1 Hull structures or Pt 5, Ch 4, 3.1 Hull structures for non-displacement or displacement craft as

Lower deck/Inside deckhouse	$\omega\sqrt{k_m}\left(0,3\sqrt{L_R}+1,3\right)\geq 3,0\,\omega$
Strength/Main deck plating	$\omega\sqrt{k_m}\left(0,5\sqrt{L_R}+1,4\right)\geq 3,5\,\omega$

Location	*s* mm	*l* mm	*β*	P_{IDP} kN/m^2	f_σ	t_{MIN} mm	t_p mm
Interior Dk - Midship	**254**	**1,219**	1.0	7.0	**0.65**	3.0	3.0
Weather Dk - Midship	**254**	**1,219**	1.0		**0.65**	3.6	
Weather Dk - Fr 5	**254**	**1,219**	1.0	8.2	**0.75**	3.6	3.6
Weather Dk - Fr 20	**254**	**1,219**	1.0	11.7	**0.75**	3.6	3.6
				P_{CRP}			
Coachroof Dk - Midship	**254**	**1,219**	1.0	7.0	**0.65**	3.0	3.0

8.4 Cross Deck Stiffening

8.4.1 The rule requirements for section modulus, inertia and web area for the cross-deck primary stiffeners are to be determined from the general equations given in Pt 7, Ch 3, 1.17 Stiffening general, using the design pressures from Pt 5, Ch 3, 3.1 Hull structures or Pt 5, Ch 4, 3.1 Hull structures for non-displacement or displacement craft as appropriate, and the coefficients Φ Z, Φ I, and Φ A as detailed in Table 3.1.1 Section modulus, inertia and web area coefficients in Chapter 3 for the load model (a).

s =	varies	mm	spacing
l =	varies	mm	span
σ_a =	131	N/mm^2	for stiffeners - welded
τ_a =	75.6		
p =	varies	kN/m^2	design pressure
E =	69,000	N/mm^2	modulus of elasticity

Location	Φ_Z	Φ_I	Φ_A	*s* mm	*l* m	P_{SPs} kN/m^2
Main Deck Xvrs - Fr 11	**0.08**	**0.0026**	**0.50**	**1,219**	**2.13**	5.6
Main Deck Xvrs - Fr 5	**0.08**	**0.0026**	**0.50**	**1,219**	**2.13**	6.6
Main Deck Xvrs - Fr 20	**0.08**	**0.0026**	**0.50**	**1,219**	**1.98**	9.4

Location	f_σ	f_δ	f_τ	*Z* cm^3	*I* cm^4	*A* cm^2
Main Deck Xvrs - Fr 11	**0.65**	**775**	**0.65**	30.4	193.8	1.5
Main Deck Xvrs - Fr 5	**0.65**	**775**	**0.65**	35.7	227.5	1.7
Main Deck Xvrs - Fr 20	**0.65**	**775**	**0.65**	43.9	259.8	2.3

8.4.2 The Rule requirements for section modulus, inertia and web area of the strength/weather deck secondary stiffening are to be determined from the general equations given in Pt 7, Ch 3, 1.17 Stiffening general, using the design pressures from Pt 5, Ch 3, 3.1 Hull structures or Pt 5, Ch 4, 3.1 Hull structures for non-displacement or displacement craft as appropriate, and the coefficients Φ Z, Φ I, and Φ A as detailed in Table 3.1.1 Section modulus, inertia and web area coefficients in Chapter 3 for the load model (b). Special consideration will be given to the application of other load models subject to the structural arrangement and degree of end fixity provided.

s =	varies	mm	spacing
l =	varies	mm	span
σ_a =	131	N/mm^2	for stiffeners - welded
τ_a =	75.6		
p =	varies	kN/m^2	design pressure
E =	69,000	N/mm^2	modulus of elasticity

Location	Φ_Z	Φ_I	Φ_A	*s* mm	*l* m	P_{SPs} kN/m^2
Cross Dk Long'ls - Fr 11	**0.10**	**0.0035**	**0.50**	**254**	**1.22**	3.5
Cross Dk Long'ls - Fr 5	**0.10**	**0.0035**	**0.50**	**254**	**1.22**	4.1
Cross Dk Long'ls - Fr 20	**0.10**	**0.0035**	**0.50**	**254**	**1.22**	5.9

Location	f_σ	f_δ	f_τ	*Z* cm^3	*I* cm^4	*A* cm^2
Cross Dk Long'ls - Fr 11	**0.75**	**475**	**0.65**	1.3	3.8	0.1
Cross Dk Long'ls - Fr 5	**0.75**	**475**	**0.65**	1.6	4.5	0.1
Cross Dk Long'ls - Fr 20	**0.75**	**475**	**0.65**	2.2	6.4	0.2

7-4-9 Superstructures, deckhouses, pillars and bulwarks

9.1.1 The scantlings and arrangements for superstructures, deckhouses and bulwarks are to be determined in accordance with the procedures described in, or as required by, Pt 7, Ch 3, 9 Superstructures, deckhouses and bulwarks for mono-hull craft.

9.1.2 The scantlings and arrangements for pillars and pillar bulkheads are to be determined in accordance with the procedures described in, or as required by, Pt 7, Ch 3, 10 Pillars and pillar bulkheads for mono-hull craft.

7-3-9 Superstructures, deckhouses and bulwarks

9.3 House side plating

9.3.1 The thickness of house side plating is to be determined from the general plating equation given in Pt 7, Ch 3, 1.16 Plating general using the design pressure from Pt 5, Ch 3, 3.1 Hull structures or Pt 5, Ch 4, 3.1 Hull structures for nondisplacement or displacement craft as appropriate.

Superstructure side plating	$\omega \sqrt{k_m}\left(0,4\sqrt{L_R}+1,1\right) \geq 3,0\ \omega$

Location	*s* mm	*l* mm	*β*	*P DHP* kN/m^2	*f σ*	*t MIN* mm	*t p* mm
Deckhouse Side - Midship	**254**	**1,219**	1.0	6.6	**0.75**	3.0	3.0
Pilothouse Side	**254**	**1,219**	1.0	5.3	**0.75**	3.0	3.0

9.4 House Front Plating

9.4.1 The thickness of house side plating is to be determined from the general plating equation given in Pt 7, Ch 3, 1.16 Plating general using the design pressure from Pt 5, Ch 3, 3.1 Hull structures or Pt 5, Ch 4, 3.1 Hull structures for nondisplacement or displacement craft as appropriate.

Deckhouse front 1st tier	$\omega \sqrt{k_m}\left(0,62\sqrt{L_R}+1,8\right) \geq 3,5\ \omega$
Deckhouse front upper tiers	$\omega \sqrt{k_m}\left(0,55\sqrt{L_R}+1,5\right) \geq 3,0\ \omega$

Location	*s* mm	*l* mm	*β*	*P DHP* kN/m^2	*f σ*	*t MIN* mm	*t p* mm
Deckhouse Front - Fr 18	**279**	**1,118**	1.0	15.0	**0.75**	4.5	4.5
Pilothouse Front - Fr 16	**279**	**1,219**	1.0	8.3	**0.75**	3.9	3.9

9.10 House Side Stiffeners

9.10.1 The rule requirements for section modulus, inertia and web area for the house side primary stiffening are to be determined from the general equations given in Pt 7, Ch 3, 1.17 Stiffening general, using the design pressures from Pt 5, Ch 3, 3.1 Hull structures or Pt 5, Ch 4, 3.1 Hull structures for non-displacement or displacement craft as appropriate, and the coefficients Φ Z, Φ I, and Φ A as detailed in Table 3.1.1 Section modulus, inertia and web area coefficients for the load model (a).

s =	varies	mm	spacing
l =	varies	mm	span
σ_a =	131	N/mm^2	for stiffeners - weldec
τ_a =	75.6		
p =	varies	kN/m^2	design pressure
E =	69,000	N/mm^2	modulus of elasticity

Location	Φ_Z	Φ_I	Φ_A	*s* mm	*l* m	P_{DHPs} kN/m^2
House Side Long'ls	**0.10**	**0.0035**	**0.50**	**254**	**1.22**	3.3
House Aft Vert Stiffs	**0.10**	**0.0035**	**0.50**	**254**	**2.90**	3.3
House Front Stiffs	**0.10**	**0.0035**	**0.50**	**279**	**1.14**	7.5
Pilothouse Side Long'ls	**0.10**	**0.0035**	**0.50**	**254**	**1.22**	2.7
Pilothouse Front Stiffs	**0.10**	**0.0035**	**0.50**	**279**	**1.37**	4.1

Location	f_σ	f_δ	f_τ	*Z* cm^3	*I* cm^4	*A* cm^2
House Side Long'ls	**0.75**	**475**	**0.75**	1.3	3.6	0.1
House Aft Vert Stiffs	**0.75**	**475**	**0.75**	7.2	48.9	0.2
House Front Stiffs	**0.75**	**475**	**0.75**	2.8	7.5	0.2
Pilothouse Side Long'ls	**0.75**	**475**	**0.75**	1.0	2.9	0.1
Pilothouse Front Stiffs	**0.75**	**475**	**0.75**	2.2	7.1	0.1

9.10 House Side Girders - Primary

9.10.2 The Rule requirements for section modulus, inertia and web area for house side secondary stiffening are to be determined from the general equations given in Pt 7, Ch 3, 1.17 Stiffening general, using the design pressures from Pt 5, Ch 3, 3.1 Hull structures or Pt 5, Ch 4, 3.1 Hull structures for non-displacement or displacement craft as appropriate, and the coefficients Φ Z, Φ I, and Φ A as detailed in Table 3.1.1 Section modulus, inertia and web area coefficients for the load model (b). Special consideration will be given to the application of other load models subject to the structural arrangement

Location	Φ_Z	Φ_I	Φ_A	s mm	l m	P_{DHPg} kN/m^2
House Side Frame - Fr 11	**0.08**	**0.0026**	**0.50**	**1,219**	**2.59**	5.3
House Front Girder	**0.08**	**0.0026**	**0.50**	**1,118**	**2.59**	12.0
Pilothouse Side Frame - Fr 12	**0.08**	**0.0026**	**0.50**	**1,219**	**2.44**	4.2
Pilothouse Front Girder	**0.08**	**0.0026**	**0.50**	**1,219**	**2.44**	6.6

Location	f_σ	f_δ	f_τ	Z cm^3	I cm^4	A cm^2
House Side Frame - Fr 11	**0.65**	**625**	**0.75**	42.5	265.3	1.5
House Front Girder	**0.65**	**625**	**0.75**	87.9	549.1	3.1
Pilothouse Side Frame - Fr 12	**0.65**	**625**	**0.75**	30.1	176.9	1.1
Pilothouse Front Girder	**0.65**	**625**	**0.75**	47.0	276.5	1.7

9.6 House Top Plating

9.6.1 The thickness of the house top plating is to be determined from the general plating equation given in Pt 7, Ch 3, 1.16 Plating general using the design pressure from Pt 5, Ch 3, 3.1 Hull structures or Pt 5, Ch 4, 3.1 Hull structures for nondisplacement or displacement craft as appropriate.

Lower deck/Inside deckhouse	$\omega \sqrt{k_m}\left(0,3\sqrt{L_R}+1,3\right) \geq 3,0\ \omega$

Location	*s* mm	*l* mm	*β*	*P CRP* kN/m^2	*f σ*	*t MIN* mm	*t p* mm
House Top	**254**	**1,219**	1.0	7.0	**0.75**	3.0	3.0
Pilothouse Top	**254**	**1,219**	1.0	7.0	**0.75**	3.0	3.0

9.13 House top stiffeners

9.13.3 The Rule requirements for section modulus, inertia and web area for house top secondary stiffening are to be determined from the general equations given in Pt 7, Ch 3, 1.17 Stiffening general, using the design pressures from Pt 5, Ch 3, 3.1 Hull structures or Pt 5, Ch 4, 3.1 Hull structures for non-displacement or displacement craft as appropriate, and the coefficients Φ Z, Φ I, and Φ A as detailed in Table 3.1.1 Section modulus, inertia and web area coefficients for the load model (b). Special consideration will be given to the application of other load models subject to the structural arrangement

s =	varies	mm	spacing
l =	varies	mm	span
σ_a =	131	N/mm^2	for stiffeners - welded
τ_a =	75.6		
p =	varies	kN/m^2	design pressure
E =	69,000	N/mm^2	modulus of elasticity

Location	Φ_Z	Φ_I	Φ_A	*s* mm	*l* m	*P CRPs* kN/m^2
House Top Long'ls	**0.10**	**0.0035**	**0.50**	**254**	**1.22**	3.5
Pilothouse Top long'ls	**0.10**	**0.0035**	**0.50**	**254**	**1.22**	3.5

Location	*f σ*	*f δ*	*f τ*	*Z* cm^3	*I* cm^4	*A* cm^2
House Top Long'ls	**0.65**	**475**	**0.75**	1.6	3.9	0.1
Pilothouse Top long'ls	**0.65**	**475**	**0.75**	1.6	3.9	0.1

9.13 House Top Frames - Primary

9.13.2 The rule requirements for section modulus, inertia and web area for house top primary stiffening are to be determined from the general equations given in Pt 7, Ch 3, 1.17 Stiffening general, using the design pressures from Pt 5, Ch 3, 3.1 Hull structures or Pt 5, Ch 4, 3.1 Hull structures for non-displacement or displacement craft as appropriate, and the coefficients Φ Z, Φ I, and Φ A as detailed in Table 3.1.1 Section modulus, inertia and web area coefficients for the load model (a).

Location	Φ_Z	Φ_I	Φ_A	*s* mm	*l* m	P_{CRPg} kN/m^2
House Top Xvrs - Fr 11	**0.08**	**0.0026**	**0.50**	**1,219**	**2.59**	5.6
House Top Long'l Girder	**0.08**	**0.0026**	**1.50**	**2,438**	**3.66**	5.6
Pilothouse Top Xvrs - Fr 12	**0.08**	**0.0026**	**0.50**	**1,219**	**3.05**	5.6

Location	f_σ	f_δ	f_τ	*Z* cm^3	*I* cm^4	*A* cm^2
House Top Xvrs - Fr 11	**0.65**	**625**	**0.75**	44.8	280.0	1.6
House Top Long'l Girder	**0.65**	**625**	**0.75**	178.8	1,575.9	13.2
Pilothouse Top Xvrs - Fr 12	**0.65**	**625**	**0.75**	62.1	456.0	1.8

10 Pillars and Pillar Bulkheads

10.6 Design Loads

See Part 5, Chapter 2, 7.3 Pillars

10.7 Scantling Determination

10.7.1 The cross-sectional area of the pillar, A p, is not to be less than:

$$A_p = 10\frac{P_p}{\sigma_p}\ \text{cm}^2$$

where

P_p = design load, in kN, supported by the pillar as determined from *Pt 7, Ch 3, 10.6 Design loads*

σ_p = permissible compressive stress, in N/mm²

$$= \frac{f_p \sigma_A}{1 + 0{,}015\,\sigma_A k_f \left(\frac{l_{ep}}{r}\right)^2}\ \text{N/mm}^2$$

where

f_p = pillar location factor defined in *Table 3.10.1 Pillar location factors*

σ_A = 0,2 per cent proof stress of the alloy in the unwelded condition, in N/mm²

k_f = pillar end fixity factor

= 0,25 for full fixed/bracketed

= 0,50 for partially fixed

= 1,0 for free ended

r = least radius of gyration of pillar cross-section, in cm, and may be taken as:

$$r = \sqrt{\frac{I_p}{A_p}}\ \text{cm}$$

I_p = least moment of inertia of cross-section of pillar or stiffener/plate combination, in cm⁴

l_{ep} = effective span of pillar or bulkhead, in metres, as defined in *Pt 7, Ch 3, 10.2 Determination of span length*.

f_p =	varies	factor from table 3.10.1	
σ_a =	310	N/mm^2	for stiffeners - unwelded
k_f =	varies	pillar end fixity	
r =	varies	cm	least radius of gyration
A_p =	varies	cm^2	area for member chosen
l_{ep} =	varies	m	effective span
$\sigma_p *A_p$ =		kN	allowed load for member

Location	f_p	k_f	l_{ep} m	A_p cm^2	r cm	σ_p N/mm^2	available $\sigma_p *A_p/10$ kN	req'd P_p kN
Hse Fr 13, 4" sch40	**1.00**	**0.50**	**2.67**	**20.5**	**3.84**	145.9	298.5	138.6
Hse Fr 13, 3" sch40	**1.00**	**0.50**	**2.67**	**14.4**	**2.95**	106.7	153.5	138.6
Hse Fr 13, 3" sch80	**1.00**	**0.50**	**2.67**	**19.5**	**2.90**	104.3	203.2	138.6
Hse Fr 13, 4x4x1/4 tube	**1.00**	**0.50**	**2.67**	**23.2**	**3.84**	145.9	338.0	138.6
Upr Dk Fr 10, 2.5" sch40	**1.00**	**0.50**	**2.29**	**11.0**	**2.41**	100.0	109.7	19.5