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## SECTION SCANTLINGS

### Hull Section Scantlings according to DNV Rules for ships with $L < 100$ m

Rule edition ..... : Jan. 2012  
Program version ... : 18.5.3278

#### **Ship Identification** **Vessel ID: Brønnbåt**

ID No ..... : Brønnbåt  
Date/Sign ..... : 2020-03-30 ingried

#### **Cross Section Identification** **Section 2**

Midship section? ..... : No  
Distance from AP ..... (m) : 12.000  
Date/Sign ..... : 2020-04-16 ingried

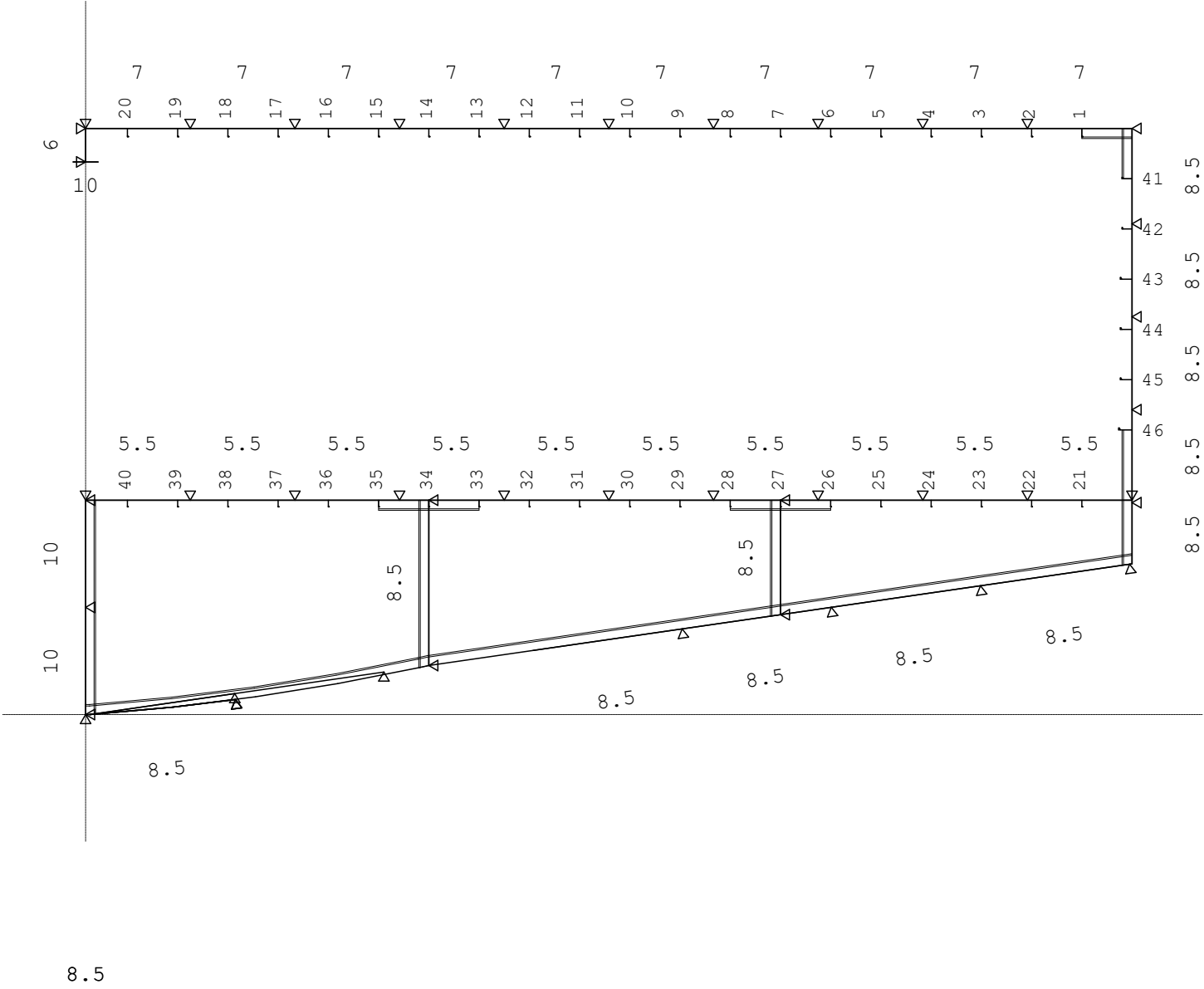
Database: C:\Documents\DNV\Nauticus\Vessels\Brønnbåt\WFDepot\Aft Machinery #20.pw

#### **Main Dimensions**

Length betw. perpendiculars, Lbp .....	(m) :	84.350
Rule length, L .....	(m) :	84.350
Breadth moulded, B .....	(m) :	25.000
Depth moulded, D .....	(m) :	9.450
Draught moulded, T .....	(m) :	7.000
Block coefficient, Cb .....	:	0.798
Min. design draught at AP .....	(m) :	3.464
Min. design draught at FP .....	(m) :	1.395
Waterplane area coefficient, Cwp .....	:	0.954

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## 1 Rule Reference

NOTE: THE FOLLOWING REQUIREMENTS ARE NOT INCLUDED:

- Floors and brackets
- Ice strengthening of hull
- Slamming and bow impact
- Tugs, Supply vessels and other offshore/harbour vessels
- Class notation ICM (Increased corrosion margins)

## 2 Input Data

### Main Dimensions

Length betw. perpendiculars, Lbp .....	(m) :	84.350
Rule length, L .....	(m) :	84.350
Breadth moulded, B .....	(m) :	25.000
Depth moulded, D .....	(m) :	9.450
Draught moulded, T .....	(m) :	7.000
Block coefficient, Cb .....	:	0.798
Min. design draught at AP .....	(m) :	3.464
Min. design draught at FP .....	(m) :	1.395
Waterplane area coefficient, Cwp .....	:	0.954

### General Ship Data

Maximum service speed, V .....	(knots) :	9.000
Bilge keel? .....	:	Yes
Active roll damping facility? .....	:	No
Period of roll, Tr .....	(s) :	0.000
Metacentric height, GM .....	(m) :	0.000
Homogeneous stowage rate, roDC .....	(t/m3) :	0.000
No of decks above 0.7D from baseline .....	:	2
Height from base to top of ship side .....	(mm) :	9450

Areas forward of 0.2L from FP:

- Projected area of the upper deck .....	(m2) :	0.000
- Area of the waterplane .....	(m2) :	0.000
Height from base to deck line at FP .....	(mm) :	0
Speed/flare factor, Caf .....	:	0.000

### Continuous Strength Members above Strength Deck

None

### Class notations

### Hull Section Material

Location	Amidships			Current cross section		
	Group	Yield N/mm2	f1	Group	Yield N/mm2	f1
- Above strength deck .....	NV-NS	235	1.00	NV-NS	235	1.00
- Strength deck .....	NV-NS	235	1.00	NV-NS	235	1.00
- Between bottom and deck .....	NV-NS	235	1.00	NV-NS	235	1.00
- Bottom .....	NV-NS	235	1.00	NV-NS	235	1.00

### Transverse Bulkhead Positions (Frame No)

Aft peak bulkhead .....	: Not given.
Engine room bulkhead .....	: Not given.
Fore peak bulkhead .....	: Not given.

### Hull girder Bending Moments

(From curves given as input in Brix Explorer)  
Considered cross-section: 12.000 m from AP.

Hull girder bending moments:		Amidships	Current cross section
- Still water, sagging .....	(kNm) :	0	0
- Still water, hogging .....	(kNm) :	206381	97869
- Wave, sagging .....	(kNm) :	0	0
- Wave, hogging .....	(kNm) :	0	0
- Wave, horizontal .....	(kNm) :	0	0
Hull girder shear forces			
- Still water, positive .....	(kN) :	0	0
- Still water, negative .....	(kN) :	0	0

***Spacing between Transverse Frames***

(Where the frame spacing changes along the ship)

Position of frame 0: 0 mm aft of A.P..

Frame Nos where the spacing changes:

Frame No	Spacing forward (mm)
0	600

### 3 Panel Geometry

Node No	y (mm)	z (mm)	Radius (mm)	Position
---------	-----------	-----------	----------------	----------

#### Outer Shell

0	2450			
50	2450			Bottom
4100	3036	28524		Bilge
8300	3643			Bilge
12500	4250			Bilge
12500	5010			Side
12500	9450			Side
8300	9450			Strength deck
4100	9450			Strength deck
0	9450			Strength deck

#### 'tween deck 5010

-0	5010			
4100	5010			'tween deck
8300	5010			'tween deck
12500	5010			'tween deck

#### Long. girder 0

0	9450			
-0	9050			Strength deck - Long. girder

#### Flange

150	9050			
-0	9050			Strength deck - Girder flange
-150	9050			Strength deck - Girder flange

#### Long. Bulkhead 0

0	2450			
-0	5010			Longitudinal bulkhead

#### Long. Bulkhead 4100

4100	3036			
4100	5010			Longitudinal bulkhead

#### Long. Bulkhead 8300

8300	3643			
8300	5010			Longitudinal bulkhead



4 Node Co-ordinates

Node No	y  (mm)	z  (mm)
	8300	5010
	8300	9450
	8300	3643
	4100	5010
	4100	9450
	4100	3036
	-150	9050
	150	9050
	-0	9050
	12500	5010
	-0	5010
	12500	9450
	0	9450
	12500	4250
	50	2450
	0	2450

## 5 Layout of Plates and Profiles

Plate		Y <sub>1</sub> (mm)	Z <sub>1</sub> (mm)	Y <sub>2</sub> (mm)	Z <sub>2</sub> (mm)	—	B (mm)	BCUT (mm)	T (mm)	Steel	Area cm <sup>2</sup>
Stiff	No	Y	Z	Y <sub>CG</sub>	Z <sub>CG</sub>	Typ	H	BF	T	TF (mm)	Area

### Outer Shell (Bending efficiency: 100%)

PL	1	0	2450	1791	2629		1800	0	8.5	std	153.00
PL	2	1782	2700	1791	2629		1800	0	8.5	std	153.00
PL	3	3563	2958	1791	2629		1800	0	8.5	std	153.00
PL	4	5345	3216	7126	3473		1800	0	8.5	std	153.00
PL	5	7126	3473	8908	3731		1800	0	8.5	std	153.00
PL	6	8908	3731	10689	3988		1800	0	8.5	std	153.00
PL	7	10689	3988	12471	4246		1800	0	8.5	std	153.00
PL	8	12471	4246	12500	4981		760	0	8.5	std	64.60
PL	9	12500	4981	12500	6091		1110	0	8.5	std	94.35
PL	10	12500	6091	12500	7201		1110	0	8.5	std	94.35
PL	11	12500	7201	12500	8311		1110	0	8.5	std	94.35
PL	12	12500	8311	12500	9450		1139	0	8.5	std	96.85
PL	13	12500	9450	11250	9450		1250	0	7.0	std	87.50
PL	14	11250	9450	10000	9450		1250	0	7.0	std	87.50
PL	15	10000	9450	8750	9450		1250	0	7.0	std	87.50
PL	16	8750	9450	7500	9450		1250	0	7.0	std	87.50
PL	17	7500	9450	6250	9450		1250	0	7.0	std	87.50
PL	18	6250	9450	5000	9450		1250	0	7.0	std	87.50
PL	19	5000	9450	3750	9450		1250	0	7.0	std	87.50
PL	20	3750	9450	2500	9450		1250	0	7.0	std	87.50
PL	21	2500	9450	1250	9450		1250	0	7.0	std	87.50
PL	22	1250	9450	0	9450		1250	0	7.0	std	87.50
ST	46	12500	5850	12403	5853	20	160	0	7.0	0.0	14.60
ST	45	12500	6450	12417	6452	20	140	0	7.0	0.0	12.43
ST	44	12500	7050	12415	7053	20	140	0	6.0	0.0	11.03
ST	43	12500	7650	12415	7653	20	140	0	6.0	0.0	11.03
ST	42	12500	8250	12430	8252	20	120	0	8.0	0.0	11.72
ST	41	12500	8850	12429	8852	20	120	0	7.0	0.0	10.52
ST	1	11900	9450	11902	9392	20	100	0	8.0	0.0	9.75
ST	2	11300	9450	11302	9391	20	100	0	7.0	0.0	8.75
ST	3	10700	9450	10702	9391	20	100	0	7.0	0.0	8.75
ST	4	10100	9450	10102	9391	20	100	0	7.0	0.0	8.75
ST	5	9500	9450	9502	9390	20	100	0	6.0	0.0	7.75
ST	6	8900	9450	8902	9390	20	100	0	6.0	0.0	7.75
ST	7	8300	9450	8302	9390	20	100	0	6.0	0.0	7.75
ST	8	7700	9450	7702	9390	20	100	0	6.0	0.0	7.75
ST	9	7100	9450	7102	9390	20	100	0	6.0	0.0	7.75
ST	10	6500	9450	6502	9390	20	100	0	6.0	0.0	7.75
ST	11	5900	9450	5902	9390	20	100	0	6.0	0.0	7.75
ST	12	5300	9450	5302	9390	20	100	0	6.0	0.0	7.75
ST	13	4700	9450	4702	9390	20	100	0	6.0	0.0	7.75
ST	14	4100	9450	4102	9390	20	100	0	6.0	0.0	7.75
ST	15	3500	9450	3502	9390	20	100	0	6.0	0.0	7.75
ST	16	2900	9450	2902	9390	20	100	0	6.0	0.0	7.75
ST	17	2300	9450	2302	9390	20	100	0	6.0	0.0	7.75
ST	18	1700	9450	1702	9390	20	100	0	6.0	0.0	7.75
ST	19	1100	9450	1102	9390	20	100	0	6.0	0.0	7.75
ST	20	500	9450	502	9390	20	100	0	6.0	0.0	7.75

### 'tween deck 5010 (Bending efficiency: 100%)

PL	1	0	5010	1250	5010		1250	0	5.5	std	68.75
PL	2	1250	5010	2500	5010		1250	0	5.5	std	68.75
PL	3	2500	5010	3750	5010		1250	0	5.5	std	68.75
PL	4	3750	5010	5000	5010		1250	0	5.5	std	68.75
PL	5	5000	5010	6250	5010		1250	0	5.5	std	68.75
PL	6	6250	5010	7500	5010		1250	0	5.5	std	68.75
PL	7	7500	5010	8750	5010		1250	0	5.5	std	68.75
PL	8	8750	5010	10000	5010		1250	0	5.5	std	68.75
PL	9	10000	5010	11250	5010		1250	0	5.5	std	68.75
PL	10	11250	5010	12500	5010		1250	0	5.5	std	68.75
ST	40	500	5010	502	4962	20	80	0	6.0	0.0	6.21
ST	39	1100	5010	1102	4962	20	80	0	6.0	0.0	6.21
ST	38	1700	5010	1702	4962	20	80	0	6.0	0.0	6.21
ST	37	2300	5010	2302	4962	20	80	0	6.0	0.0	6.21
ST	36	2900	5010	2902	4962	20	80	0	6.0	0.0	6.21
ST	35	3500	5010	3502	4962	20	80	0	6.0	0.0	6.21
ST	34	4100	5010	4102	4962	20	80	0	6.0	0.0	6.21
ST	33	4700	5010	4702	4962	20	80	0	6.0	0.0	6.21
ST	32	5300	5010	5302	4962	20	80	0	6.0	0.0	6.21
ST	31	5900	5010	5902	4962	20	80	0	6.0	0.0	6.21
ST	30	6500	5010	6502	4962	20	80	0	6.0	0.0	6.21
ST	29	7100	5010	7102	4962	20	80	0	6.0	0.0	6.21

## Layout of Plates and Profiles (cont.)

Plate		Y <sub>1</sub> (mm)	Z <sub>1</sub> (mm)	Y <sub>2</sub> (mm)	Z <sub>2</sub> (mm)	—	B (mm)	BCUT (mm)	T (mm)	Steel	Area cm <sup>2</sup>
Stiff	No	Y	Z	Y <sub>CG</sub>	Z <sub>CG</sub>	Typ	H	BF	T	TF (mm)	Area
ST	28	7700	5010	7702	4962	20	80	0	6.0	0.0	6.21
ST	27	8300	5010	8302	4962	20	80	0	6.0	0.0	6.21
ST	26	8900	5010	8902	4962	20	80	0	6.0	0.0	6.21
ST	25	9500	5010	9502	4962	20	80	0	6.0	0.0	6.21
ST	24	10100	5010	10102	4962	20	80	0	6.0	0.0	6.21
ST	23	10700	5010	10702	4962	20	80	0	6.0	0.0	6.21
ST	22	11300	5010	11302	4962	20	80	0	6.0	0.0	6.21
ST	21	11900	5010	11902	4962	20	80	0	6.0	0.0	6.21

### Long. girder 0 (Bending efficiency: 100%)

PL	1	0	9450	-0	9050		400	0	6.0	std	24.00
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### Flange (Bending efficiency: 100%)

PL	1	150	9050	-150	9050		300	0	10.0	std	30.00
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### Long. Bulkhead 0 (Bending efficiency: 100%)

PL	1	0	2450	-0	3730		1280	0	10.0	std	128.00
PL	2	-0	3730	-0	5010		1280	0	10.0	std	128.00

### Long. Bulkhead 4100 (Bending efficiency: 100%)

PL	1	4100	3036	4100	5010		1974	0	8.5	std	167.83
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### Long. Bulkhead 8300 (Bending efficiency: 100%)

PL	1	8300	3643	8300	5010		1367	0	8.5	std	116.21
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## 6 Layout of transverse stiffeners

Stiffener		y1	z1	y2	z2	Type		h	bf	t	tf
Bracket	(mm) Arm1	(mm) h1	(mm) bf1	(mm) t1	(mm) tf1		(mm) Arm2	(mm) h2	(mm) bf2	(mm) t2	(mm) tf2

### Outer Shell

Tstif		0	2450	4100	3036	20		120		7.0	
Tstif		4100	3036	8300	3643	20		120		7.0	
Tstif		8300	3643	12500	4250	20		120		7.0	
Mframe		12500	4250	12500	5010	20		120		7.0	
Mframe		12500	5010	12500	5850	20		120		7.0	
Tstif		12500	8850	12500	9450	20		120		7.0	
Tstif		12500	9450	11900	9450	20		120		7.0	

### 'tween deck 5010

Tdkfrm		3500	5010	4100	5010	20		120		7.0	
Tdkfrm		4100	5010	4700	5010	20		120		7.0	
Girder		7700	5010	8300	5010	20		120		7.0	
Girder		8300	5010	8900	5010	20		120		7.0	

### Long. Bulkhead 0

Girder		0	2450	-0	5010	20		120		7.0	
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### Long. Bulkhead 4100

Girder		4100	3036	4100	5010	20		120		7.0	
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### Long. Bulkhead 8300

Girder		8300	3643	8300	5010	20		120		7.0	
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## 7 Cross-Sectional Area

### Plates

Panels:	NS-Steel		HS-Steel		Total	
	Effective cm <sup>2</sup>	Gross cm <sup>2</sup>	Effective cm <sup>2</sup>	Gross cm <sup>2</sup>	Effective cm <sup>2</sup>	Gross cm <sup>2</sup>
Outer Shell	4781.0	4781.0	0.0	0.0	4781.0	4781.0
'tween deck 5010	1375.0	1375.0	0.0	0.0	1375.0	1375.0
Long. girder 0	24.0	24.0	0.0	0.0	24.0	24.0
Flange	30.0	30.0	0.0	0.0	30.0	30.0
Long. Bulkhead 0	256.0	256.0	0.0	0.0	256.0	256.0
Long. Bulkhead 4100	335.7	335.7	0.0	0.0	335.7	335.7
Long. Bulkhead 8300	232.4	232.4	0.0	0.0	232.4	232.4
<b>TOTAL AREA</b>	<b>7034.1</b>	<b>7034.1</b>	<b>0.0</b>	<b>0.0</b>	<b>7034.1</b>	<b>7034.1</b>

### Profiles

Panels:	NS-Steel		HS-Steel		Total	
	Effective cm <sup>2</sup>	Gross cm <sup>2</sup>	Effective cm <sup>2</sup>	Gross cm <sup>2</sup>	Effective cm <sup>2</sup>	Gross cm <sup>2</sup>
Outer Shell	462.7	462.7	0.0	0.0	462.7	462.7
'tween deck 5010	248.6	248.6	0.0	0.0	248.6	248.6
Long. girder 0	0.0	0.0	0.0	0.0	0.0	0.0
Flange	0.0	0.0	0.0	0.0	0.0	0.0
Long. Bulkhead 0	0.0	0.0	0.0	0.0	0.0	0.0
Long. Bulkhead 4100	0.0	0.0	0.0	0.0	0.0	0.0
Long. Bulkhead 8300	0.0	0.0	0.0	0.0	0.0	0.0
<b>TOTAL AREA</b>	<b>711.2</b>	<b>711.2</b>	<b>0.0</b>	<b>0.0</b>	<b>711.2</b>	<b>711.2</b>

#### DESCRIPTION:

Gross Results based on the given scantlings.

Effective Results based on the effective cross-sectional area, as follows:  
Possible cut-outs are subtracted (plates only).  
The area of plates and stiffeners are multiplied by the given bending efficiency for the related panel.

## 8 Cross-Sectional Data

	EFFECTIVE Cut-outs subtracted	GROSS Cut-outs disreg.
Cross sectional area of the longitudinal elements ..... (cm2) :	7745.3	7745.3
Position of the centroid: Ycg ..... (mm) :	-0	-0
Position of the centroid: Zcg ..... (mm) :	5876	5876
Moment of inertia about the horz. neutral axis, I <sub>h</sub> ..... (m4) :	5.033	5.033
Moment of inertia about the vert. neutral axis, I <sub>v</sub> ..... (m4) :	47.934	47.934
Product of inertia about the neutral axes, I <sub>hv</sub> ..... (m4) :	0.000	0.000
<hr/>		
SECTION MODULUS, BOTTOM (z = 2450 mm) ..... (m3) :	1.469	1.469
SECTION MODULUS, DECK LINE (z = 9449 mm) ..... (m3) :	1.408	1.408
SECTION MODULUS, TOP (z = 9450 / 9450 mm) * ..... (m3) :	1.408	1.408
SECTION MODULUS, AT SIDE (y = 12500 mm) ..... (m3) :	3.835	3.835
<hr/>		
First moment of the area above the neutral axis, S ..... (cm3) :	883869.0	883869.0
I/S ..... (cm) :	569	569

### DESCRIPTION:

Gross Results based on the given scantlings.

Effective Results based on the effective cross-sectional area, as follows:  
Possible cut-outs are subtracted (plates only).  
The area of plates and stiffeners are multiplied by the given bending efficiency for the related panel.

## 9 Design Bending Moments

AMIDSHIPS	SAGGING (kNm)	HOGGING (kNm)
Still water bending moments:		
- Standard values according to Rules, M <sub>so</sub> .....	116872	116872
- Given as input in Brix Explorer (curves) .....	0	206381
Design still water bending moments, M <sub>s</sub>	116872	206381
Design wave bending moments, M <sub>w</sub> .....	195806 (Rules)	180168 (Rules)
AT ACTUAL POSITION (12.0 m from AP)	SAGGING (kNm)	HOGGING (kNm)
Still water bending moments:		
- Standard values according to Rules, M <sub>s</sub> .....	55422	55422
- Given as input in Brix Explorer (curves) .....	0	97869
- Given as input (Design Bending Moments dialog).....	0	0
Design still water bending moments, M <sub>s</sub>	55422	97869
Design wave bending moments, M <sub>w</sub> .....	69640 (Rules)	64079 (Rules)
Design wave bending moments, M <sub>w</sub> for buckling check .....	69640 (Rules)	64079 (Rules)

## 10 Hull Girder Strength Requirements

	BOTTOM	DECK	ABOVE DECK	SIDE
Material strength group .....	NV-NS	NV-NS	NV-NS	NV-NS
Yield point of material ..... (N/mm <sup>2</sup> ) :	235	235	235	235
Material factor, f1.....	1.00	1.00	1.00	1.00
Section modulus ratio, Za/Zr.....	1.000	1.000		

Based on:

Za	0.000	0.000
Zr	2.209	2.209

Note: Za/Zr must be specified for sections outside the 0.4 L midship area.

Speed factor, Cav .....	0.000
Speed/flare factor, Caf .....	0.000
Wave coefficient, Cw .....	6.681
Wave coefficient, Cwo .....	7.556
Wave coefficient, Cwu .....	6.681

MIDSHIP SECTION	BOTTOM	DECK
Minimum section modulus, Zo .....	(m3) : 2.01325	2.01325
Section modulus based on given moments (kNm):		
- Sagging (still w = 116872, wave = 195806) .....	(m3) : 1.78673	1.78673
- Hogging (still w = 206381, wave = 180168) .....	(m3) : 2.20885	2.20885
Rule section modulus amidships .....	(m3): 2.20885	2.20885

AT ACTUAL POSITION ( 12.0 m from AP) (Not a midship section)

	BOTTOM	DECK
Rule section modulus (reduced outside 0.4L amidships).....	(m3) : 1.04747	1.04747
Rule section modulus .....	(m3): 1.04747	1.04747

### GUIDANCE:

The required section modulus along the hull girder will normally be satisfied when calculated for the midship section only, provided the following rules for tapering are complied with:

- Scantlings at bottom and deck are kept unaltered within 0.4L amidships.
- Scantlings outside 0.4L amidships are gradually reduced to the local requirements at the ends, and the same material strength group is applied over the full length of the ship.



## 11 Hull Girder Strength Summary

	ACTUAL	RULE	STATUS (%) (100=Rule)
Cross-sectional area ..... (cm2) :	7745		
Height to the neutral axis ..... (mm) :	5876		
Section modulus, bottom ..... (m3) :	1.469	1.047	140.3
Section modulus, deck line (z = 9450 mm)..... (m3) :	1.408	1.047	134.4
Material factor, f1, strength deck .....	1.00		
Material factor, f1, bottom .....	1.00		

### 11.1 Variation of the section modulus and moment of inertia

Change at bottom	dZb dZd dl	Change at deck				
		-100 cm2	-1 mm	0	+ 1 mm	+100 cm2
-100 cm2	dZb	-0.052	-0.080	-0.035	0.005	-0.018
	dZd	-0.061	-0.141	-0.007	0.128	0.047
	dl	-0.198	-0.395	-0.071	0.232	0.053
-1 mm	dZb	-0.110	-0.137	-0.093	-0.055	-0.078
	dZd	-0.072	-0.152	-0.019	0.115	0.035
	dl	-0.317	-0.508	-0.194	0.099	-0.075
0	dZb	-0.018	-0.047	0.000	0.041	0.017
	dZd	-0.054	-0.135	0.000	0.135	0.054
	dl	-0.129	-0.330	0.000	0.309	0.126
+1 mm	dZb	0.073	0.042	0.092	0.136	0.110
	dZd	-0.037	-0.119	0.017	0.153	0.071
	dl	0.047	-0.163	0.182	0.507	0.314
+100 cm2	dZb	0.016	-0.013	0.035	0.077	0.052
	dZd	-0.048	-0.129	0.007	0.142	0.061
	dl	-0.062	-0.266	0.070	0.385	0.198

Bottom plating: 1 mm = 267.2 cm2. 100 cm2 = 0.4 mm.  
Deck plating: 1 mm = 250.0 cm2. 100 cm2 = 0.4 mm.

EXPLANATION:  
Change at bottom Assumed change to the bottom and bilge plating  
Change at deck Assumed change to the deck plating

dZb Resulting change in section modulus, bottom  
dZd do., deck  
dl Resulting change in moment of inertia

## 12 Compartments and Loads

### 12.1 Compartment Data I

Ref.	Comp. group (Comp. type)	Comp No	Frame No aft	Frame No fwd	Restr. filling (*)	Coated (*)	Volume (m3)	Contents WB / Oil / Liq / Hliq / Bulk
1	machinery						0	
1	machinery						0	
2	machinery						0	
3	Machinery						0	

### 12.2 Compartment Data II

Ref.	Comp. No	Length (mm)	Sloshing length (mm)	Sloshing breadth (mm)	Hatch length (mm)	Hatch breadth (mm)	Top of hatch (mm)	Top of air pipe (mm)	WL in dam'gd cond (mm)	Heated cargo?	Over- pressure dpDyn (kN/m2)
1		11273	0	0	0	0	0	0	0	No	0.0
1		11273	0	0	0	0	0	0	0	No	0.0
2		11273	0	0	0	0	0	0	0	No	0.0
3		13200	0	0	0	0	0	0	0	No	0.0

### 12.3 Compartment Data III

Ref.	Comp. No	Designed for BWE with flow- through?	Centre of gravity (m)			Accelerations in the centre of gravity (m/s <sup>2</sup> )					
			From A.P. x	From CL y	Above baseline z	Full load			Ballast		
						Vert. a <sub>v</sub>	Horz. a <sub>t</sub>	Long. a <sub>ing</sub>	Vert. a <sub>v</sub>	Horz. a <sub>t</sub>	Long. a <sub>ing</sub>
1		No	7.500	6.073	4.165	5.761	4.319	1.565	5.761	4.319	1.565
1		No	7.500	10.200	4.464	5.761	4.342	1.516	5.761	4.342	1.516
2		No	7.500	1.963	3.844	5.761	4.294	1.618	5.761	4.294	1.618
3		No	8.100	0.000	7.230	5.688	4.555	1.892	5.688	4.555	1.892

### 12.4 Bulk Cargo and Liquid Loads

Ref.	Comp. group (Comp type)	Comp. No	Load No	Load type	Density t/m <sup>3</sup>	Filling height mm	Pressure valve setting kN/m <sup>2</sup>		Mass t	Angle of repose degrees	Perme- ability
							S	S+D			
1	machinery										
1	machinery										
2	machinery										
3	Machinery										

### 12.5 Double Bottom Stresses and Hull Girder Bending Moments

Ref.	Comp. group (Comp. type)	Comp. No	Load No	Load type	Dbl. bottom stresses		Still water bending moments - = sagging, + = hogging kNm
					Bottom N/mm <sup>2</sup>	Inner bot. N/mm <sup>2</sup>	
1	machinery						
1	machinery						
2	machinery						
3	Machinery						

### 13 Deck loads (general cargo)

Load No.	Stowage rate, $ro$ $t/m^3$	Stowage height, $H$ mm	Extent (dist. from CL)		Panel
			$y_1$ mm	$y_2$ mm	
1	0.10	2450	50	12497	Outer Shell
2	0.02	5200	4	12500	Outer Shell
1	0.09	2600	0	12500	'tween deck 5010

## 14 Summary of data used in the Local Rule Requirements

Distance from AP to considered section .....	(m) :	12.000		
Moment of inertia about the horz. neutral axis, $I_h$ .....	(m <sup>4</sup> ) :	5.033		
Moment of inertia about the vert. neutral axis, $I_v$ .....	(m <sup>4</sup> ) :	47.934		
Section modulus, bottom .....	(m <sup>3</sup> ) :	1.469		
Section modulus, deck line ( $z = 9450$ mm).....	(m <sup>3</sup> ) :	1.408		
Height from base line to the neutral axis .....	(mm) :	5876		
Section modulus ratio, $Z_a/Z_r$				
$Z_a/Z_r$ , bottom.....	(Rules) :	1.000		
$Z_a/Z_r$ , deck.....	(Rules) :	1.000		
DESIGN BENDING MOMENTS:				
Still water bending moment, sagging .....	(kNm) :	55422	(Rules)	
Still water bending moment, hogging .....	(kNm) :	97869	(Input)	
Wave bending moment, sagging .....	(kNm) :	69640	(Rules)	
Wave bending moment, hogging .....	(kNm) :	64079	(Rules)	
Wave bending moment for buckling check, sagging .....	(kNm) :	69640	(Rules)	
Wave bending moment for buckling check, hogging .....	(kNm) :	64079	(Rules)	
Shear forces, seagoing condition:				
Positive shear forces (still water / wave / total).....	(kN) :	0 /	0 /	0
Negative shear forces (still water / wave / total).....	(kN) :	0 /	-0 /	-0

### NOTE - Sloshing pressure

There are tanks where the sloshing length  $L_s > 0.13L$ .  
The sloshing pressure acc. to DNV Rules is valid for  $L_s$  in the range 10 m to  $0.13L$ ,  
so  $L_s$  is outside the range where the sloshing pressure is valid.  
However, the sloshing pressure is included in the calculations.

The sloshing pressure is applicable within  $L_s/4$  from the tank ends, but is used in this cross-section also.

### NOTE - Impact pressure

The impact pressure is not included in the calculations (ref. DNV Rules Pt.3 Ch.1 Sec.4 C305).  
Here the sloshing length  $L_s > 0.13L$  and/or the sloshing breadth  $B_s > 0.56B$ .  
The impact pressure should therefore be considered by the user.

## 15 Local Rule Requirements - Plates

Plate No	ACT	t <sub>act</sub> mm	Steel	t <sub>k</sub> mm	t <sub>kb</sub> mm		Ω m <sup>2</sup>	Eff (%)	Span mm	Spac mm	τ N/mm <sup>2</sup>	σ <sub>F</sub> N/mm <sup>2</sup>	f <sub>1</sub>
LOC			t <sub>loc</sub> mm	Pos		Load Ref.		Loc. ref.	y <sub>l</sub> mm	z <sub>l</sub> mm	Comp ref.	σ N/mm <sup>2</sup>	p kN/m <sup>2</sup>
BUC			t <sub>buc</sub> mm	η	ψ	k	c	Buc. ref.	y <sub>b</sub> mm	z <sub>b</sub> mm	σ <sub>L</sub> N/mm <sup>2</sup>	σ <sub>c</sub> or τ <sub>c</sub> N/mm <sup>2</sup>	σ <sub>cr</sub> or τ <sub>cr</sub> N/mm <sup>2</sup>

### Outer Shell

#### Bilge

1	ACT LOC BUC	8.5	std 8.37 12.87 *	0.0 Bilge 1.00	0.0	Sea	-	100 Min compr	4146 299 0	600 t 2469 2450	0.0 110.2	235.0 138.9 48.1	1.00 70.3 110.2
2	ACT LOC BUC	8.5	std 8.37 12.87 *	0.0 Bilge 1.00	0.0	Sea	-	100 Min compr	4146 299 0	600 t 2469 2450	0.0 110.2	235.0 138.9 48.1	1.00 70.3 110.2
3	ACT LOC BUC	8.5	std 8.37 12.87 *	0.0 Bilge 1.00	0.0	Sea	-	100 Min compr	4146 299 0	600 t 2469 2450	0.0 110.2	235.0 138.9 48.1	1.00 70.3 110.2
4	ACT LOC BUC	8.5	std 8.37 11.35 *	0.0 Bilge 1.00	0.0	Sea	-	100 Min compr	4244 5345 5345	600 t 3216 3216	0.0 85.6	235.0 138.9 48.0	1.00 63.7 85.6
5	ACT LOC BUC	8.5	std 8.37 10.79 *	0.0 Bilge 1.00	0.0	Sea	-	100 Min compr	4244 8597 7126	600 t 3686 3473	0.0 77.3	235.0 138.9 48.0	1.00 62.7 77.3
6	ACT LOC BUC	8.5	std 8.37 10.19 *	0.0 Bilge 1.00	0.0	Sea	-	100 Min compr	4244 8908 8908	600 t 3731 3731	0.0 69.0	235.0 138.9 48.0	1.00 62.8 69.0
7	ACT LOC BUC	8.5	std 8.37 9.56 *	0.0 Bilge 1.00	0.0	Sea	-	100 Min compr	4244 10689 10689	600 t 3988 3988	0.0 60.7	235.0 138.9 48.0	1.00 62.9 60.7

#### Side

8	ACT LOC BUC	8.5	std 8.37 5.50	0.0 Side 0.90	0.0 0.53	Sea 3.73	- 1.10	100 Min compr	760 12500 12500	600 t 4550 4250	0.0 52.3	235.0 148.7 135.5	1.00 60.4 58.1
9	ACT LOC BUC	8.5	std 8.37 3.59	0.0 Side 0.90	0.0 0.03	Sea 4.66	- 1.10	100 Min compr	2400 12500 12500	600 6091 5010	0.0 27.9	235.0 155.5 155.4	1.00 46.8 31.0
10	ACT LOC BUC	8.5	std 8.37 3.89	0.0 Side 1.00	0.0 0.89	Sea 4.23	- 1.10	100 Min compr	2400 12500 12500	600 6150 7201	0.0 32.9	235.0 155.4 147.3	1.00 46.3 32.9
11	ACT LOC BUC	8.5	std 8.37 5.02	0.0 Side 1.00	0.0 0.75	Sea 4.55	- 1.10	100 Min compr	2400 12500 12500	600 7350 8250	0.0 59.0	235.0 154.0 153.4	1.00 37.2 59.0
12	ACT LOC BUC	8.5	std 8.37 6.33	0.0 Side 0.90	0.0 0.83	Sea 4.78	- 1.10	100 Min compr	2400 12500 12500	600 8550 9450	0.0 88.8	235.0 152.6 157.4	1.00 31.7 98.7

#### Strength deck

13	ACT LOC BUC	7.0	std 6.34 6.57	0.0 Strdk 1.00	0.0 1.00	Sea 4.00	- 1.10	100 Min compr	2400 11600 11300	600 9450 9450	0.0 88.8	235.0 151.5 100.9	1.00 21.1 88.8
14	ACT LOC BUC	7.0	std 6.34 6.57	0.0 Strdk 1.00	0.0 1.00	Sea 4.00	- 1.10	100 Min compr	2400 11000 11250	600 9450 9450	0.0 88.8	235.0 151.5 100.9	1.00 20.5 88.8
15	ACT LOC BUC	7.0	std 6.34 6.57	0.0 Strdk 1.00	0.0 1.00	Sea 4.00	- 1.10	100 Min compr	2400 9800 10000	600 9450 9450	0.0 88.8	235.0 151.5 100.9	1.00 19.2 88.8
16	ACT LOC BUC	7.0	std 6.34 6.57	0.0 Strdk 1.00	0.0 1.00	Sea 4.00	- 1.10	100 Min compr	2400 8600 8750	600 9450 9450	0.0 88.8	235.0 151.5 100.9	1.00 17.9 88.8

## Local Rule Requirements - Plates (cont)

Plate No	ACT	t <sub>act</sub> mm	Steel	t <sub>k</sub> mm	t <sub>kb</sub> mm		Ω m <sup>2</sup>	Eff (%)	Span mm	Spac mm	τ N/mm <sup>2</sup>	σ <sub>F</sub> N/mm <sup>2</sup>	f <sub>1</sub>
LOC			t <sub>loc</sub> mm	Pos		Load Ref.		Loc. ref.	y <sub>l</sub> mm	z <sub>l</sub> mm	Comp ref.	σ N/mm <sup>2</sup>	p kN/m <sup>2</sup>
BUC			t <sub>buc</sub> mm	η	ψ	k	c	Buc. ref.	y <sub>b</sub> mm	z <sub>b</sub> mm	σ <sub>L</sub> N/mm <sup>2</sup>	σ <sub>c</sub> or τ <sub>c</sub> N/mm <sup>2</sup>	σ <sub>cr</sub> or τ <sub>cr</sub> N/mm <sup>2</sup>
17	ACT	7.0	std	0.0	0.0		-	100	2400	600	0.0	235.0	1.00
	LOC		6.34	Strdk		Sea		Min	7400	9450		151.5	16.6
	BUC		6.57	1.00	1.00	4.00	1.10	compr	7500	9450	88.8	100.9	88.8
18	ACT	7.0	std	0.0	0.0		-	100	2400	600	0.0	235.0	1.00
	LOC		6.34	Strdk		Sea		Min	6200	9450		151.5	15.3
	BUC		6.57	1.00	1.00	4.00	1.10	compr	6250	9450	88.8	100.9	88.8
19	ACT	7.0	std	0.0	0.0		-	100	2400	600	0.0	235.0	1.00
	LOC		6.34	Strdk		Sea		Min	5000	9450		151.5	15.3
	BUC		6.57	1.00	1.00	4.00	1.10	compr	5000	9450	88.8	100.9	88.8
20	ACT	7.0	std	0.0	0.0		-	100	2400	600	0.0	235.0	1.00
	LOC		6.34	Strdk		Sea		Min	3750	9450		151.5	15.3
	BUC		6.57	1.00	1.00	4.00	1.10	compr	3750	9450	88.8	100.9	88.8
21	ACT	7.0	std	0.0	0.0		-	100	2400	600	0.0	235.0	1.00
	LOC		6.34	Strdk		Sea		Min	2500	9450		151.5	15.3
	BUC		6.57	1.00	1.00	4.00	1.10	compr	1250	9450	88.8	100.9	88.8
22	ACT	7.0	std	0.0	0.0		-	100	2400	600	0.0	235.0	1.00
	LOC		6.34	Strdk		Sea		Min	800	9450		151.5	15.3
	BUC		6.57	1.00	1.00	4.00	1.10	compr	500	9450	88.8	100.9	88.8

### 'tween deck 5010

1	ACT	5.5	std	0.0	0.0		-	100	2400	600	0.0	235.0	1.00
	LOC		5.50	'twdk		Gen		Min	800	5010	2	160.0	3.0
	BUC		3.68	1.00	1.00	4.00	1.10	compr	1100	5010	27.9	62.3	27.9
2	ACT	5.5	std	0.0	0.0		-	100	2400	600	0.0	235.0	1.00
	LOC		5.50	'twdk		Gen		Min	1400	5010	2	160.0	3.0
	BUC		3.68	1.00	1.00	4.00	1.10	compr	1250	5010	27.9	62.3	27.9
3	ACT	5.5	std	0.0	0.0		-	100	2400	600	0.0	235.0	1.00
	LOC		5.50	'twdk		Gen		Min	2600	5010	2	160.0	3.0
	BUC		3.68	1.00	1.00	4.00	1.10	compr	2500	5010	27.9	62.3	27.9
4	ACT	5.5	std	0.0	0.0		-	100	2400	600	0.0	235.0	1.00
	LOC		5.50	'twdk		Gen		Min	5000	5010	1	160.0	3.0
	BUC		3.68	1.00	1.00	4.00	1.10	compr	3750	5010	27.9	62.3	27.9
5	ACT	5.5	std	0.0	0.0		-	100	2400	600	0.0	235.0	1.00
	LOC		5.50	'twdk		Gen		Min	5000	5010	1	160.0	3.0
	BUC		3.68	1.00	1.00	4.00	1.10	compr	5000	5010	27.9	62.3	27.9
6	ACT	5.5	std	0.0	0.0		-	100	2400	600	0.0	235.0	1.00
	LOC		5.50	'twdk		Gen		Min	6250	5010	1	160.0	3.0
	BUC		3.68	1.00	1.00	4.00	1.10	compr	6250	5010	27.9	62.3	27.9
7	ACT	5.5	std	0.0	0.0		-	100	2400	600	0.0	235.0	1.00
	LOC		5.50	'twdk		Gen		Min	7500	5010	1	160.0	3.0
	BUC		3.68	1.00	1.00	4.00	1.10	compr	7500	5010	27.9	62.3	27.9
8	ACT	5.5	std	0.0	0.0		-	100	2400	600	0.0	235.0	1.00
	LOC		5.50	'twdk		Gen		Min	9200	5010	1	160.0	3.0
	BUC		3.68	1.00	1.00	4.00	1.30	compr	8750	5010	27.9	62.3	27.9
9	ACT	5.5	std	0.0	0.0		-	100	2400	600	0.0	235.0	1.00
	LOC		5.50	'twdk		Gen		Min	10400	5010	1	160.0	3.0
	BUC		3.68	1.00	1.00	4.00	1.10	compr	10700	5010	27.9	62.3	27.9
10	ACT	5.5	std	0.0	0.0		-	100	2400	600	0.0	235.0	1.00
	LOC		5.50	'twdk		Gen		Min	11600	5010	1	160.0	3.0
	BUC		3.68	1.00	1.00	4.00	1.10	compr	11900	5010	27.9	62.3	27.9

### Long. girder 0

1	ACT	6.0	std	0.0	0.0		-	100	2400	400	0.0	235.0	1.00
	LOC		5.84					Min	0	0		0.0	0.0
	BUC		4.26	1.00	0.89	4.23	1.30	compr	0	9450	88.8	156.7	88.8

## Local Rule Requirements - Plates (cont)

Plate No	ACT	t <sub>act</sub> mm	Steel	t <sub>k</sub> mm	t <sub>kb</sub> mm		Ω m <sup>2</sup>	Eff (%)	Span mm	Spac mm	τ N/mm <sup>2</sup>	σ <sub>F</sub> N/mm <sup>2</sup>	f <sub>1</sub>
LOC			t <sub>loc</sub> mm	Pos		Load Ref.		Loc. ref.	y <sub>l</sub> mm	z <sub>l</sub> mm	Comp ref.	σ N/mm <sup>2</sup>	p kN/m <sup>2</sup>
BUC			t <sub>buc</sub> mm	η	ψ	k	c	Buc. ref.	y <sub>b</sub> mm	z <sub>b</sub> mm	σ <sub>L</sub> N/mm <sup>2</sup>	σ <sub>c</sub> or τ <sub>c</sub> N/mm <sup>2</sup>	σ <sub>cr</sub> or τ <sub>cr</sub> N/mm <sup>2</sup>

### Flange

1	ACT	10.0	std	0.0	0.0		-	100	2400	150	0.0	235.0	1.00
	LOC		10.00					Min	0	0		0.0	0.0
	BUC		To be specially considered.										

### Long. Bulkhead 0

1	ACT	10.0	std	0.0	0.0		-	100	2560	600	0.0	235.0	1.00
	LOC		5.84					Min	0	0		0.0	0.0
	BUC		9.76	1.00	0.25	2.25	1.30	compr	0	2450	110.2	115.7	110.2
2	ACT	10.0	std	0.0	0.0		-	100	2560	600	0.0	235.0	1.00
	LOC		5.84					Min	0	0		0.0	0.0
	BUC		8.15	1.00	0.40	2.02	1.30	compr	-0	3730	69.1	104.1	69.1

### Long. Bulkhead 4100

1	ACT	8.5	std	0.0	0.0		-	100	1974	600	0.0	235.0	1.00
	LOC		5.84					Min	0	0		0.0	0.0
	BUC		8.75	1.00	0.30	2.32	1.30	compr	4100	3036	91.4	86.3	91.4

### Long. Bulkhead 8300

1	ACT	8.5	std	0.0	0.0		-	100	1367	600	0.0	235.0	1.00
	LOC		5.84					Min	0	0		0.0	0.0
	BUC		7.31	1.00	0.39	2.61	1.30	compr	8300	3643	71.9	97.1	71.9

## 16 Local Rule Requirements - Stiffeners

Stiff. No	ACT ACT	Pos Z <sub>a</sub> cm <sup>3</sup>	K c	Type Type	h t (mm)	b <sub>f</sub> t <sub>f</sub> (mm)	y z (mm)	σ <sub>F</sub> f <sub>1</sub> N/mm <sup>2</sup>	m w <sub>k</sub>	t <sub>kw</sub> t <sub>kf</sub> (mm)	t <sub>pl</sub> (mm)	span spac (mm)
LOC			Z <sub>r</sub> cm <sup>3</sup>	excess (%)	t <sub>min</sub> (mm)	Load Ref.		σ N/mm <sup>2</sup>	σ <sub>DB</sub> N/mm <sup>2</sup>	p kN/m <sup>2</sup>	Comp ref.	a <sub>con</sub> cm <sup>2</sup>
FAT/BUC			Z <sub>rf</sub> cm <sup>3</sup>	excess (%)	p <sub>d</sub> kN/m <sup>2</sup>	σ <sub>d</sub> N/mm <sup>2</sup>		σ <sub>L</sub> N/mm <sup>2</sup>	Lat N/mm <sup>2</sup>	Torsion N/mm <sup>2</sup>	Web N/mm <sup>2</sup>	b <sub>f</sub> /t <sub>f</sub>

### Outer Shell

#### Side

46	ACT	Side	0.00	20	160	0	12500	235.0	12.0	0.0	8.5	2400
	ACT	109	0.0	HPbulb	7.0	0.0	5850	1.00	1.00	0.0		720
	LOC		105	3	5.3	Sea		160.0	0.0	49.0		9.0
	FAT/BUC		0		0.0	0.0		30.0	219.2	0.0	0.0	0.0
45	ACT	Side	0.00	20	140	0	12500	235.0	12.0	0.0	8.5	2400
	ACT	79	0.0	HPbulb	7.0	0.0	6450	1.00	1.00	0.0		600
	LOC		78	1	5.3	Sea		160.0	0.0	43.7		6.9
	FAT/BUC		0		0.0	0.0		30.0	214.3	0.0	0.0	0.0
44	ACT	Side	0.00	20	140	0	12500	235.0	12.0	0.0	8.5	2400
	ACT	73	0.0	HPbulb	6.0	0.0	7050	1.00	1.00	0.0		600
	LOC		69	5	5.3	Sea		160.0	0.0	38.6		6.1
	FAT/BUC		0		0.0	0.0		30.0	213.4	0.0	0.0	0.0
43	ACT	Side	0.00	20	140	0	12500	235.0	12.0	0.0	8.5	2400
	ACT	73	0.0	HPbulb	6.0	0.0	7650	1.00	1.00	0.0		600
	LOC		64	13	5.3	Sea		160.0	0.0	35.9		5.6
	FAT/BUC		0		0.0	0.0		44.1	213.4	0.0	0.0	0.0
42	ACT	Side	0.00	20	120	0	12500	235.0	12.0	0.0	8.5	2400
	ACT	62	0.0	HPbulb	8.0	0.0	8250	1.00	1.00	0.0		600
	LOC		59	4	5.3	Sea		159.9	0.0	33.1		5.2
	FAT/BUC		0		0.0	0.0		59.0	205.0	0.0	0.0	0.0
41	ACT	Side	0.00	20	120	0	12500	235.0	12.0	0.0	8.5	2400
	ACT	58	0.0	HPbulb	7.0	0.0	8850	1.00	1.00	0.0		600
	LOC		57	1	5.3	Sea		153.1	0.0	30.4		4.8
	FAT/BUC		0		0.0	0.0		73.9	203.7	0.0	0.0	0.0

#### Strength deck

1	ACT	Strdk	0.00	20	100	0	11900	235.0	12.0	0.0	7.0	2400
	ACT	43	0.0	HPbulb	8.0	0.0	9450	1.00	1.00	0.0		600
	LOC		42	1	5.3	Sea		146.3	0.0	21.4		3.4
	FAT/BUC		0		0.0	0.0		88.8	191.8	0.0	0.0	0.0
2	ACT	Strdk	0.00	20	100	0	11300	235.0	12.0	0.0	7.0	2400
	ACT	40	0.0	HPbulb	7.0	0.0	9450	1.00	1.00	0.0		600
	LOC	*	41	-2	5.3	Sea		146.3	0.0	20.8		3.3
	FAT/BUC		0		0.0	0.0		88.8	189.9	0.0	0.0	0.0
3	ACT	Strdk	0.00	20	100	0	10700	235.0	12.0	0.0	7.0	2400
	ACT	40	0.0	HPbulb	7.0	0.0	9450	1.00	1.00	0.0		600
	LOC		40	0	5.3	Sea		146.3	0.0	20.1		3.2
	FAT/BUC		0		0.0	0.0		88.8	189.9	0.0	0.0	0.0
4	ACT	Strdk	0.00	20	100	0	10100	235.0	12.0	0.0	7.0	2400
	ACT	40	0.0	HPbulb	7.0	0.0	9450	1.00	1.00	0.0		600
	LOC		38	3	5.3	Sea		146.3	0.0	19.5		3.1
	FAT/BUC		0		0.0	0.0		88.8	189.9	0.0	0.0	0.0
5	ACT	Strdk	0.00	20	100	0	9500	235.0	12.0	0.0	7.0	2400
	ACT	36	0.0	HPbulb	6.0	0.0	9450	1.00	1.00	0.0		600
	LOC	*	37	-1	5.3	Sea		146.3	0.0	18.8		3.0
	FAT/BUC		0		0.0	0.0		88.8	187.6	0.0	0.0	0.0
6	ACT	Strdk	0.00	20	100	0	8900	235.0	12.0	0.0	7.0	2400
	ACT	36	0.0	HPbulb	6.0	0.0	9450	1.00	1.00	0.0		600
	LOC		36	1	5.3	Sea		146.3	0.0	18.2		2.9
	FAT/BUC		0		0.0	0.0		88.8	187.6	0.0	0.0	0.0
7	ACT	Strdk	0.00	20	100	0	8300	235.0	12.0	0.0	7.0	2400
	ACT	36	0.0	HPbulb	6.0	0.0	9450	1.00	1.00	0.0		600
	LOC		34	5	5.3	Sea		146.3	0.0	17.6		2.8
	FAT/BUC		0		0.0	0.0		88.8	187.6	0.0	0.0	0.0



## Local Rule Requirements - Stiffeners (cont.)

Stiff. No	ACT ACT	Pos Z <sub>a</sub> cm <sup>3</sup>	K c	Type Type	h t (mm)	b <sub>f</sub> t <sub>f</sub> (mm)	y z (mm)	σ <sub>F</sub> f <sub>1</sub> N/mm <sup>2</sup>	m w <sub>k</sub>	t <sub>kw</sub> t <sub>kf</sub> (mm)	t <sub>pl</sub> (mm)	span spac (mm)
LOC			Z <sub>r</sub> cm <sup>3</sup>	excess (%)	t <sub>min</sub> (mm)	Load Ref.		σ N/mm <sup>2</sup>	σ <sub>DB</sub> N/mm <sup>2</sup>	p kN/m <sup>2</sup>	Comp ref.	a <sub>conn</sub> cm <sup>2</sup>
FAT/BUC			Z <sub>rf</sub> cm <sup>3</sup>	excess (%)	p <sub>d</sub> kN/m <sup>2</sup>	σ <sub>d</sub> N/mm <sup>2</sup>		σ <sub>L</sub> N/mm <sup>2</sup>	Lat N/mm <sup>2</sup>	Torsion N/mm <sup>2</sup>	Web N/mm <sup>2</sup>	b <sub>f</sub> /t <sub>f</sub>
8	ACT	Strdk	0.00	20	100	0	7700	235.0	12.0	0.0	7.0	2400
	ACT	36	0.0	HPbulb	6.0	0.0	9450	1.00	1.00	0.0		600
	LOC		33	9	5.3	Sea		146.3	0.0	16.9		2.7
	FAT/BUC		0		0.0	0.0		88.8	187.6	0.0	0.0	0.0
9	ACT	Strdk	0.00	20	100	0	7100	235.0	12.0	0.0	7.0	2400
	ACT	36	0.0	HPbulb	6.0	0.0	9450	1.00	1.00	0.0		600
	LOC		32	14	5.3	Sea		146.3	0.0	16.3		2.6
	FAT/BUC		0		0.0	0.0		88.8	187.6	0.0	0.0	0.0
10	ACT	Strdk	0.00	20	100	0	6500	235.0	12.0	0.0	7.0	2400
	ACT	36	0.0	HPbulb	6.0	0.0	9450	1.00	1.00	0.0		600
	LOC		31	18	5.3	Sea		146.3	0.0	15.6		2.5
	FAT/BUC		0		0.0	0.0		88.8	187.6	0.0	0.0	0.0
11	ACT	Strdk	0.00	20	100	0	5900	235.0	12.0	0.0	7.0	2400
	ACT	36	0.0	HPbulb	6.0	0.0	9450	1.00	1.00	0.0		600
	LOC		30	20	5.3	Sea		146.3	0.0	15.3		2.4
	FAT/BUC		0		0.0	0.0		88.8	187.6	0.0	0.0	0.0
12	ACT	Strdk	0.00	20	100	0	5300	235.0	12.0	0.0	7.0	2400
	ACT	36	0.0	HPbulb	6.0	0.0	9450	1.00	1.00	0.0		600
	LOC		30	20	5.3	Sea		146.3	0.0	15.3		2.4
	FAT/BUC		0		0.0	0.0		88.8	187.6	0.0	0.0	0.0
13	ACT	Strdk	0.00	20	100	0	4700	235.0	12.0	0.0	7.0	2400
	ACT	36	0.0	HPbulb	6.0	0.0	9450	1.00	1.00	0.0		600
	LOC		30	20	5.3	Sea		146.3	0.0	15.3		2.4
	FAT/BUC		0		0.0	0.0		88.8	187.6	0.0	0.0	0.0
14	ACT	Strdk	0.00	20	100	0	4100	235.0	12.0	0.0	7.0	2400
	ACT	36	0.0	HPbulb	6.0	0.0	9450	1.00	1.00	0.0		600
	LOC		30	20	5.3	Sea		146.3	0.0	15.3		2.4
	FAT/BUC		0		0.0	0.0		88.8	187.6	0.0	0.0	0.0
15	ACT	Strdk	0.00	20	100	0	3500	235.0	12.0	0.0	7.0	2400
	ACT	36	0.0	HPbulb	6.0	0.0	9450	1.00	1.00	0.0		600
	LOC		30	20	5.3	Sea		146.3	0.0	15.3		2.4
	FAT/BUC		0		0.0	0.0		88.8	187.6	0.0	0.0	0.0
16	ACT	Strdk	0.00	20	100	0	2900	235.0	12.0	0.0	7.0	2400
	ACT	36	0.0	HPbulb	6.0	0.0	9450	1.00	1.00	0.0		600
	LOC		30	20	5.3	Sea		146.3	0.0	15.3		2.4
	FAT/BUC		0		0.0	0.0		88.8	187.6	0.0	0.0	0.0
17	ACT	Strdk	0.00	20	100	0	2300	235.0	12.0	0.0	7.0	2400
	ACT	36	0.0	HPbulb	6.0	0.0	9450	1.00	1.00	0.0		600
	LOC		30	20	5.3	Sea		146.3	0.0	15.3		2.4
	FAT/BUC		0		0.0	0.0		88.8	187.6	0.0	0.0	0.0
18	ACT	Strdk	0.00	20	100	0	1700	235.0	12.0	0.0	7.0	2400
	ACT	36	0.0	HPbulb	6.0	0.0	9450	1.00	1.00	0.0		600
	LOC		30	20	5.3	Sea		146.3	0.0	15.3		2.4
	FAT/BUC		0		0.0	0.0		88.8	187.6	0.0	0.0	0.0
19	ACT	Strdk	0.00	20	100	0	1100	235.0	12.0	0.0	7.0	2400
	ACT	36	0.0	HPbulb	6.0	0.0	9450	1.00	1.00	0.0		600
	LOC		30	20	5.3	Sea		146.3	0.0	15.3		2.4
	FAT/BUC		0		0.0	0.0		88.8	187.6	0.0	0.0	0.0
20	ACT	Strdk	0.00	20	100	0	500	235.0	12.0	0.0	7.0	2400
	ACT	36	0.0	HPbulb	6.0	0.0	9450	1.00	1.00	0.0		550
	LOC		28	31	5.3	Sea		146.3	0.0	15.3		2.2
	FAT/BUC		0		0.0	0.0		88.8	190.2	0.0	0.0	0.0
<b>'tween deck 5010</b>												
40	ACT	'twdk	0.00	20	80	0	500	235.0	12.0	0.0	5.5	2400
	ACT	23	0.0	HPbulb	6.0	0.0	5010	1.00	1.00	0.0		550
	LOC		15	54	5.3	Gen		146.3	0.0	3.0	2	0.4
	FAT/BUC		0		0.0	0.0		27.9	165.5	0.0	0.0	0.0

## Local Rule Requirements - Stiffeners (cont.)

Stiff. No	ACT ACT	Pos Z <sub>a</sub> cm <sup>3</sup>	K c	Type Type	h t (mm)	b <sub>f</sub> t <sub>f</sub> (mm)	y z (mm)	σ <sub>F</sub> f <sub>1</sub> N/mm <sup>2</sup>	m w <sub>k</sub>	t <sub>kw</sub> t <sub>kf</sub> (mm)	t <sub>pl</sub> (mm)	span spac (mm)
LOC			Z <sub>r</sub> cm <sup>3</sup>	excess (%)	t <sub>min</sub> (mm)	Load Ref.		σ N/mm <sup>2</sup>	σ <sub>DB</sub> N/mm <sup>2</sup>	p kN/m <sup>2</sup>	Comp ref.	a <sub>conh</sub> cm <sup>2</sup>
FAT/BUC			Z <sub>rf</sub> cm <sup>3</sup>	excess (%)	p <sub>d</sub> kN/m <sup>2</sup>	σ <sub>d</sub> N/mm <sup>2</sup>		σ <sub>L</sub> N/mm <sup>2</sup>	Lat N/mm <sup>2</sup>	Torsion N/mm <sup>2</sup>	Web N/mm <sup>2</sup>	b <sub>f</sub> /t <sub>f</sub>
39	ACT ACT LOC FAT/BUC	'twdk 23	0.00 0.0 15 0	20 HPbulb 54	80 6.0 5.3 0.0	0 0.0 Gen 0.0	1100 5010	235.0 1.00 146.3 27.9	12.0 1.00 0.0 161.5	0.0 0.0 3.0 0.0	5.5 2 0.0	2400 600 0.5 0.0
38	ACT ACT LOC FAT/BUC	'twdk 23	0.00 0.0 15 0	20 HPbulb 54	80 6.0 5.3 0.0	0 0.0 Gen 0.0	1700 5010	235.0 1.00 146.3 27.9	12.0 1.00 0.0 161.5	0.0 0.0 3.0 0.0	5.5 2 0.0	2400 600 0.5 0.0
37	ACT ACT LOC FAT/BUC	'twdk 23	0.00 0.0 15 0	20 HPbulb 54	80 6.0 5.3 0.0	0 0.0 Gen 0.0	2300 5010	235.0 1.00 146.3 27.9	12.0 1.00 0.0 161.5	0.0 0.0 3.0 0.0	5.5 2 0.0	2400 600 0.5 0.0
36	ACT ACT LOC FAT/BUC	'twdk 23	0.00 0.0 15 0	20 HPbulb 54	80 6.0 5.3 0.0	0 0.0 Gen 0.0	2900 5010	235.0 1.00 146.3 27.9	12.0 1.00 0.0 161.5	0.0 0.0 3.0 0.0	5.5 2 0.0	2400 600 0.5 0.0
35	ACT ACT LOC FAT/BUC	'twdk 23	0.00 0.0 15 0	20 HPbulb 54	80 6.0 5.3 0.0	0 0.0 Gen 0.0	3500 5010	235.0 1.00 146.3 27.9	12.0 1.00 0.0 161.5	0.0 0.0 3.0 0.0	5.5 2 0.0	2400 600 0.5 0.0
34	ACT ACT LOC FAT/BUC	'twdk 23	0.00 0.0 15 0	20 HPbulb 54	80 6.0 5.3 0.0	0 0.0 Gen 0.0	4100 5010	235.0 1.00 146.3 27.9	12.0 1.00 0.0 161.5	0.0 0.0 3.0 0.0	5.5 1 0.0	2400 600 0.5 0.0
33	ACT ACT LOC FAT/BUC	'twdk 23	0.00 0.0 15 0	20 HPbulb 54	80 6.0 5.3 0.0	0 0.0 Gen 0.0	4700 5010	235.0 1.00 146.3 27.9	12.0 1.00 0.0 161.5	0.0 0.0 3.0 0.0	5.5 1 0.0	2400 600 0.5 0.0
32	ACT ACT LOC FAT/BUC	'twdk 23	0.00 0.0 15 0	20 HPbulb 54	80 6.0 5.3 0.0	0 0.0 Gen 0.0	5300 5010	235.0 1.00 146.3 27.9	12.0 1.00 0.0 161.5	0.0 0.0 3.0 0.0	5.5 1 0.0	2400 600 0.5 0.0
31	ACT ACT LOC FAT/BUC	'twdk 23	0.00 0.0 15 0	20 HPbulb 54	80 6.0 5.3 0.0	0 0.0 Gen 0.0	5900 5010	235.0 1.00 146.3 27.9	12.0 1.00 0.0 161.5	0.0 0.0 3.0 0.0	5.5 1 0.0	2400 600 0.5 0.0
30	ACT ACT LOC FAT/BUC	'twdk 23	0.00 0.0 15 0	20 HPbulb 54	80 6.0 5.3 0.0	0 0.0 Gen 0.0	6500 5010	235.0 1.00 146.3 27.9	12.0 1.00 0.0 161.5	0.0 0.0 3.0 0.0	5.5 1 0.0	2400 600 0.5 0.0
29	ACT ACT LOC FAT/BUC	'twdk 23	0.00 0.0 15 0	20 HPbulb 54	80 6.0 5.3 0.0	0 0.0 Gen 0.0	7100 5010	235.0 1.00 146.3 27.9	12.0 1.00 0.0 161.5	0.0 0.0 3.0 0.0	5.5 1 0.0	2400 600 0.5 0.0
28	ACT ACT LOC FAT/BUC	'twdk 23	0.00 0.0 15 0	20 HPbulb 54	80 6.0 5.3 0.0	0 0.0 Gen 0.0	7700 5010	235.0 1.00 146.3 27.9	12.0 1.00 0.0 161.5	0.0 0.0 3.0 0.0	5.5 1 0.0	2400 600 0.5 0.0
27	ACT ACT LOC FAT/BUC	'twdk 23	0.00 0.0 15 0	20 HPbulb 54	80 6.0 5.3 0.0	0 0.0 Gen 0.0	8300 5010	235.0 1.00 146.3 27.9	12.0 1.00 0.0 161.5	0.0 0.0 3.0 0.0	5.5 1 0.0	2400 600 0.5 0.0
26	ACT ACT LOC FAT/BUC	'twdk 23	0.00 0.0 15 0	20 HPbulb 54	80 6.0 5.3 0.0	0 0.0 Gen 0.0	8900 5010	235.0 1.00 146.3 27.9	12.0 1.00 0.0 161.5	0.0 0.0 3.0 0.0	5.5 1 0.0	2400 600 0.5 0.0
25	ACT ACT LOC FAT/BUC	'twdk 23	0.00 0.0 15 0	20 HPbulb 54	80 6.0 5.3 0.0	0 0.0 Gen 0.0	9500 5010	235.0 1.00 146.3 27.9	12.0 1.00 0.0 161.5	0.0 0.0 3.0 0.0	5.5 1 0.0	2400 600 0.5 0.0

## Local Rule Requirements - Stiffeners (cont.)

Stiff. No	ACT ACT	Pos $Z_a$ cm <sup>3</sup>	K c	Type Type	$h$ $t$ (mm)	$b_f$ $t_f$ (mm)	$y$ $z$ (mm)	$\sigma_F$ $f_1$ N/mm <sup>2</sup>	$m$ $w_k$	$t_{kw}$ $t_{kf}$ (mm)	$t_{pl}$ (mm)	span spac (mm)
LOC			$Z_r$ cm <sup>3</sup>	excess (%)	$t_{min}$ (mm)	Load Ref.		$\sigma$ N/mm <sup>2</sup>	$\sigma_{DB}$ N/mm <sup>2</sup>	$p$ kN/m <sup>2</sup>	Comp ref.	$a_{conn}$ cm <sup>2</sup>
FAT/BUC			$Z_{rf}$ cm <sup>3</sup>	excess (%)	$p_d$ kN/m <sup>2</sup>	$\sigma_d$ N/mm <sup>2</sup>		$\sigma_L$ N/mm <sup>2</sup>	Lat N/mm <sup>2</sup>	Torsion N/mm <sup>2</sup>	Web N/mm <sup>2</sup>	$b_f/t_f$
24	ACT	'twdk	0.00	20	80	0	10100	235.0	12.0	0.0	5.5	2400
	ACT	23	0.0	HPbulb	6.0	0.0	5010	1.00	1.00	0.0		600
	LOC		15	54	5.3	Gen		146.3	0.0	3.0	1	0.5
	FAT/BUC		0		0.0	0.0		27.9	161.5	0.0	0.0	0.0
23	ACT	'twdk	0.00	20	80	0	10700	235.0	12.0	0.0	5.5	2400
	ACT	23	0.0	HPbulb	6.0	0.0	5010	1.00	1.00	0.0		600
	LOC		15	54	5.3	Gen		146.3	0.0	3.0	1	0.5
	FAT/BUC		0		0.0	0.0		27.9	161.5	0.0	0.0	0.0
22	ACT	'twdk	0.00	20	80	0	11300	235.0	12.0	0.0	5.5	2400
	ACT	23	0.0	HPbulb	6.0	0.0	5010	1.00	1.00	0.0		600
	LOC		15	54	5.3	Gen		146.3	0.0	3.0	1	0.5
	FAT/BUC		0		0.0	0.0		27.9	161.5	0.0	0.0	0.0
21	ACT	'twdk	0.00	20	80	0	11900	235.0	12.0	0.0	5.5	2400
	ACT	23	0.0	HPbulb	6.0	0.0	5010	1.00	1.00	0.0		600
	LOC		15	54	5.3	Gen		146.3	0.0	3.0	1	0.5
	FAT/BUC		0		0.0	0.0		27.9	161.5	0.0	0.0	0.0

## 17 Local Rule Requirements - Transverse stiffeners

Stiff. No	ACT ACT	Pos Z <sub>a</sub> cm <sup>3</sup>	K c	Type Type	h t (mm)	b <sub>f</sub> t <sub>f</sub> (mm)	y z (mm)	σ <sub>F</sub> f <sub>1</sub> N/mm <sup>2</sup>	m w <sub>k</sub>	t <sub>kw</sub> t <sub>kf</sub> (mm)	t <sub>pl</sub> (mm)	span spac (mm)
	LOC		Z <sub>r</sub> cm <sup>3</sup>	excess (%)	t <sub>min</sub> (mm)	Load Ref.		σ N/mm <sup>2</sup>	ang_PL deg	p kN/m <sup>2</sup>	Comp ref.	a <sub>conn</sub> cm <sup>2</sup>

### Outer Shell

1	Bilge (Trv. stiffener). End points (y,z) = (0, 2450)-(4100, 3036).											
	ACT	Bilge	0.00	20	120	0.0	2061	235.0	10.0	0.0	8.5	4141
	ACT	58		HPbulb	7.0	0.0	2666	1.00	1.00	0.0		600
	LOC	*	444	-87	5.8	Sea		146.3	90	68.5		0.0
2	Bilge (Trv. stiffener). End points (y,z) = (4100, 3036)-(8300, 3643).											
	ACT	Bilge	0.00	20	120	0.0	6200	235.0	10.0	0.0	8.5	4243
	ACT	58		HPbulb	7.0	0.0	3339	1.00	1.00	0.0		600
	LOC	*	426	-86	5.8	Sea		146.3	90	62.6		0.0
3	Bilge (Trv. stiffener). End points (y,z) = (8300, 3643)-(12500, 4250).											
	ACT	Bilge	0.00	20	120	0.0	10400	235.0	10.0	0.0	8.5	4243
	ACT	58		HPbulb	7.0	0.0	3946	1.00	1.00	0.0		600
	LOC	*	428	-87	5.8	Sea		146.3	90	62.9		0.0
4	Side (Trv. stiffener). End points (y,z) = (12500, 8850)-(12500, 9450).											
	ACT	Side	0.00	20	120	0.0	12500	235.0	10.0	0.0	8.5	600
	ACT	58		HPbulb	7.0	0.0	9150	1.00	1.00	0.0		600
	LOC		15	284	5.3	Sea		160.0	90	29.0		0.0
5	Strength deck (Trv. stiffener). End points (y,z) = (12500, 9450)-(11900, 9450).											
	ACT	Strdk	0.00	20	120	0.0	12200	235.0	10.0	0.0	7.0	599
	ACT	57		HPbulb	7.0	0.0	9450	1.00	1.00	0.0		600
	LOC		15	277	5.3	Sea		160.0	90	21.8		0.0

### 'tween deck 5010

1	'tween deck ('tween deck frame). End points (y,z) = (3500, 5010)-(4100, 5010).										
	ACT 'twdk	0.00	20	120	0.0	3800	235.0		0.0	5.5	600
	ACT 55		HPbulb	7.0	0.0	5010	1.00	1.00	0.0		600
	LOC 15	268	5.3	Gen				90	3.0	2	0.0
2	'tween deck ('tween deck frame). End points (y,z) = (4100, 5010)-(4700, 5010).										
	ACT 'twdk	0.00	20	120	0.0	4400	235.0		0.0	5.5	600
	ACT 55		HPbulb	7.0	0.0	5010	1.00	1.00	0.0		600
	LOC 15	268	5.3	Gen				90	3.0	1	0.0

## 18 Local Rule Requirements - Main frames

ACT	webPP alpha deg	Za cm <sup>3</sup>	K c	Type Type	h t (mm)	bf tf (mm)	y z (mm)	sigF f <sub>1</sub> N/mm <sup>2</sup>	m wk	tkw tkf (mm)	tplate lb (mm)	span spac (mm)
LOC			Zr cm <sup>3</sup>	excess %	tmin (mm)	Load Ref.		sigma N/mm <sup>2</sup>	tweld (mm)	p kN/m <sup>2</sup>	Comp ref.	lbmin (mm)
LOC			Zrf cm <sup>3</sup>	excess %	pd kN/m <sup>2</sup>	sigd N/mm <sup>2</sup>						

### Main frame

In foremost cargo hold? No  
Adjacent plane trv. bulkhead? No

#### Mid-length

ACT	0			20	120	0	12500	235.0		0.0	8.5	839
ACT		58		HPbulb	7.0	0.0	4630	1.00	1.00	0.0		600
LOC			13	356	5.3	Sea			2.8	59.7		

#### Upper end

ACT			0.00	43	0	0	12500	235.0		0.0	8.5	839
ACT	90	0	0.00	Tbar	0.0	0.0	5010	1.00	1.00	0.0	0.0	600
LOC		*	21	-100	0.0	Sea			2.0	59.7		59
LOC			0		0.0	0.0						

#### Lower end

ACT			0.00	43	0	0	12500	235.0		0.0	8.5	839
ACT	82	0	0.00	Tbar	0.0	0.0	4250	1.00	1.00	0.0	0.0	600
In foremost cargo hold? No*			25	-100	0.0	Sea			2.0	59.7		101
Adjacent plane trv. bulkhead? No			0		0.0	0.0						

#### Mid-length

ACT	0			20	120	0	12500	235.0		0.0	8.5	839
ACT		58		HPbulb	7.0	0.0	5430	1.00	1.00	0.0		600
LOC			11	418	5.3	Sea			2.8	52.7		

#### Upper end

ACT			0.00	43	0	0	12500	235.0		0.0	8.5	839
ACT	90	0	0.00	Tbar	0.0	0.0	5850	1.00	1.00	0.0	0.0	600
LOC		*	19	-100	0.0	Sea			2.0	52.7		59
LOC			0		0.0	0.0						

#### Lower end

ACT			0.00	43	0	0	12500	235.0		0.0	8.5	839
ACT	90	0	0.00	Tbar	0.0	0.0	5010	1.00	1.00	0.0	0.0	600
LOC		*	22	-100	0.0	Sea			2.0	52.7		101
LOC			0		0.0	0.0						

RULE REFERENCE: DNV Rules for ships  
Pt.3 Ch.1 Sec.7 C 400 (if L > 100 m),  
Pt.3 Ch.2 Sec.6 C 400 (if L < 100 m).

### ABBREVIATIONS

webPP	The angle between the web and a perpendicular to the plate (degrees). 0=web is perp. to plate.
alpha	The bracket connection angle with the vertical (degrees)
K	Stress concentration factor for the end connection. Used for the fatigue control.
c	The coating factor c, used in the fatigue strength calculations.
lb	Length of the end bracket (mm)
lbmin	Minimum length of the end bracket (mm)
tweld	Throat thickness requirement of the weld (mm)