MV MARELLA

STABILITY ADDENDUM REPORT

NAGANO CX 29 CRAWLER CRANE OPERATION ON DECK
VESSEL IN PARTIALLY SMOOTH WATERS

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1.0 SUMMARY

This report is intended to be read in conjunction with the original approved stability book for the vessel dated December 1983. It presents additional loading conditions for carriage of an operating crane in partially smooth waters.

Lightship particulars for the vessel are based on those derived from a displacement check experiment performed on the 8th of April 2009 and assuming a conservatively over-estimated vertical centre of gravity equivalent to main deck level.

All notes and warnings presented in the original stability book shall be adhered to.

The loading conditions presented in this report are compliant with the Uniform Shipping Laws Code.

Any deviations from the loading conditions as presented in this report will be required to be assessed separately.

2.0 NOTES TO THE MASTER

The master of the vessel is reminded that although the vessel exceeds the USL stability requirements, this does not mean that the vessel cannot capsize. Care must be taken to ensure that the vessel is properly handled in the weather and conditions prevailing at the time.

It is the responsibility of the master to ensure that all deck cargo is properly secured and crane operation is within recommended guidelines. This report does not assess safety of operation of crane, only vessel response to maximum crane operation.

The master shall endeavour to keep the vessel at level trim and heel commensurate with operations.

3.0 STABILITY COMPLIANCE CRITERIA

USL Code section 8C.3.3

Barges and lighters and similar vessels operating within partially smooth waters shall have a minimum GM allowing for any free surface corrections which is greater than the following:

(a) $GM = \frac{0.036 \times A \times h}{\Delta \times \tan\theta} + 0.15$

where A = *projected lateral area above the waterline (m^2)*
h = *vertical distance from centre of area above the waterline and centre of lateral resistance below the waterline (m)*
Δ = *displacement (t)*
θ = *angle of heel to one half of the freeboard being immersed or five (5) degrees whichever is less*

(b) $GM = \frac{0.0053 \times V^2 \times d}{L \times \sin\theta} + 0.15$

where V = *service speed (knots)*
L = *waterline length (m)*
d = *vertical distance between VCG and the centre of underwater lateral area (m)*
θ = *as above*

applicable for $V/L^{1/2} < 4$ *only*

(c) If a derrick, deck crane or cranes are fitted onboard, the vessel must have sufficient GM to ensure that it does not heel any more than an angle equivalent to one half the freeboard, in the condition being considered, or five (5) degrees whichever is the less, when the cranes have their working loads extended their maximum outreach over the side.

(d) GM = 1 metre

Note that for small angles of heel (less than five degrees) the initial righting lever GM is equivalent to the righting lever curve GZ for the vessel. This report shows and assesses the vessel's response to the crane heeling influence with the initial righting lever GM.

4.0 LOADING CONDITIONS

4.1 DEPARTURE CONDITION

Loading Table

ITEMS	Weight (t)	L.C.G (m)	L.Mom (t-m)	V.C.G (m)	V.Mom (t-m)	F.S.M. (t-m)
Aft F.W.Tk	8.80	-11.93	-104.97	2.47	21.74	51.60
F.O.Tk No.1 & 2	7.30	6.48	47.30	0.73	5.33	4.08
F.O.Tk No.3 & 4	9.80	0.80	7.84	0.70	6.86	7.58
Crew (6 persons)	0.45	0.00	0.00	4.25	1.91	0.00
Container	2.68	-3.00	-8.04	4.55	12.19	0.00
Dive compressor	1.15	-6.00	-6.90	3.75	4.31	0.00
Steel structural cargo	3.00	-4.50	-13.50	14.25	42.75	0.00
Crawler crane	5.00	-3.00	-15.00	4.50	22.50	0.00
Lightship	**120.03**	**0.46**	**55.21**	**3.25**	**390.10**	**0.00**
TOTAL	**158.21**	**-0.24**	**-38.05**	**3.21**	**507.69**	**63.26**
Free Surface Correction				**0.40**		
KGf				**3.61**		

Hydrostatics (from original stability book)

Δ	=	158.2	t
KMt	=	10.15	m
MTC	=	2.83	m
LCB	=	-0.25	m
Draft	=	2.11	m

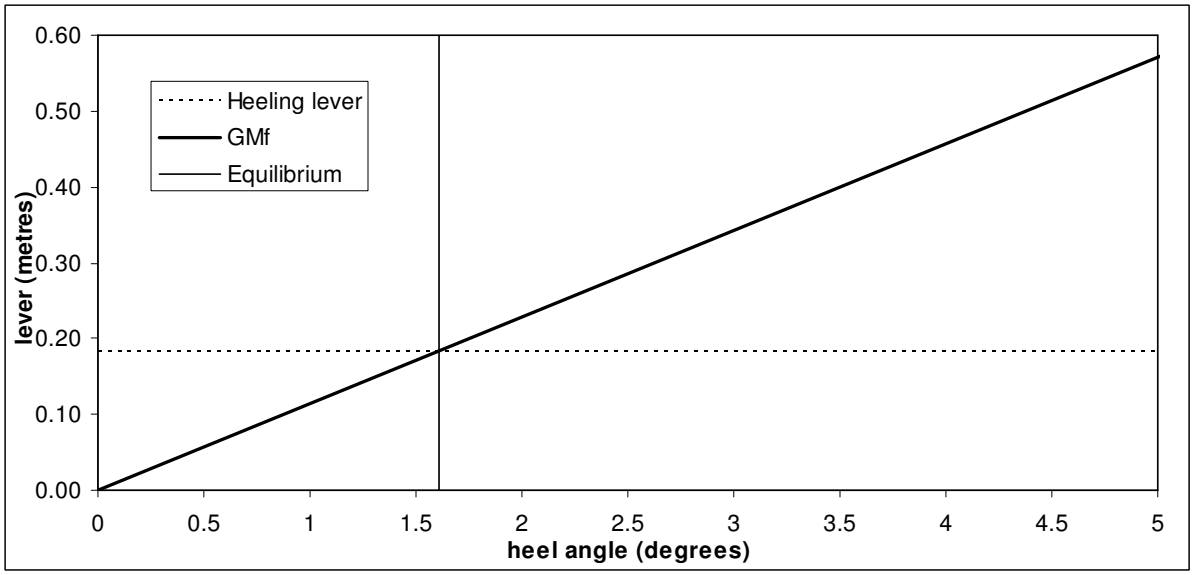
Level trim check

LCB	=	-0.25	m	
LCG	=	-0.24	m	
Lever	=	-0.01	m	
Δ	=	158.2	t	
Trim moment	=	-1.65	t-m	
MTC	=	2.83	t-m	
Trim change	=	-0.01	m	(negligible – original hydrostatics applicable)

GMf Calculation

GMf	=	KM - KGf	
	=	6.54	m

Levers Plot



Stability Criteria Compliance

(a) $GM_{required} = \frac{0.036 \times A \times h}{\Delta \times \tan\theta} + 0.15$

$A = 94.1\ m^2$

$h = 3.05\ m$

$\Delta = 158.2\ t$

$\theta = 5\ deg$

$GM_{required} = 0.90\ m$

(b) $GM_{required} = \frac{0.0053 \times V^2 \times d}{L \times \sin\theta} + 0.15$

$V/L^{1/2} = 4$

$V^2/L = 16$

$d = 2.55\ m$

$GM_{required} = 2.64\ m$

(c) *If a derrick, deck crane or cranes are fitted onboard, the vessel must have sufficient GM to ensure that it does not heel any more than an angle equivalent to one half the freeboard, in the condition being considered, or five (5) degrees whichever is the less, when the cranes have their working loads extended their maximum outreach over the side.*

Freeboard	=	*1.14 m*
Heel due to crane	=	*1.6 deg*
Loss of freeboard	=	*13 %*

(d) $GM_{required}$ = *1.00 m*

ACTUAL GMf = 6.54 m

Additional check – loss of freeboard due to trim

Check to see loss of freeboard with crane operating at and over transom:

Trimming moment	=	66.8	t-m
MTC	=	2.83	t-m
Trim change	=	0.24	m
Freeboard	=	1.14	m
Loss of freeboard	=	21 %	(less than half)

Vessel passes all criteria with comfortable margin for this loading condition

4.2 ARRIVAL CONDITION

Loading Table

ITEMS	Weight (t)	L.C.G (m)	L.Mom (t-m)	V.C.G (m)	V.Mom (t-m)	F.S.M. (t-m)
Aft F.W.Tk	0.88	-11.928	-10.50	1.727	1.52	51.6
F.O.Tk No.1 & 2	0.73	6.26	4.57	0.16	0.12	4.08
F.O.Tk No.3 & 4	0.98	0.8	0.78	0.25	0.25	7.58
Crew (6 persons)	0.45	0.00	0.00	4.25	1.91	0.00
Container	2.68	-3.00	-8.04	4.55	12.19	0.00
Dive compressor	1.15	-6.00	-6.90	3.75	4.31	0.00
Steel structural cargo	3.00	-4.50	-13.50	14.25	42.75	0.00
Crawler crane	5.00	-3.00	-15.00	4.50	22.50	0.00
Lightship	**120.03**	**0.46**	**55.21**	**3.25**	**390.10**	**0.00**
TOTAL	**134.90**	**0.05**	**6.63**	**3.53**	**475.65**	**63.26**
Free Surface Correction				**0.47**		
KGf				**3.99**		

Hydrostatics (from original stability book)

Δ	=	134.9	t
KMt	=	11.43	m
MTC	=	2.68	m
LCB	=	-0.09	m
Draft	=	1.96	m

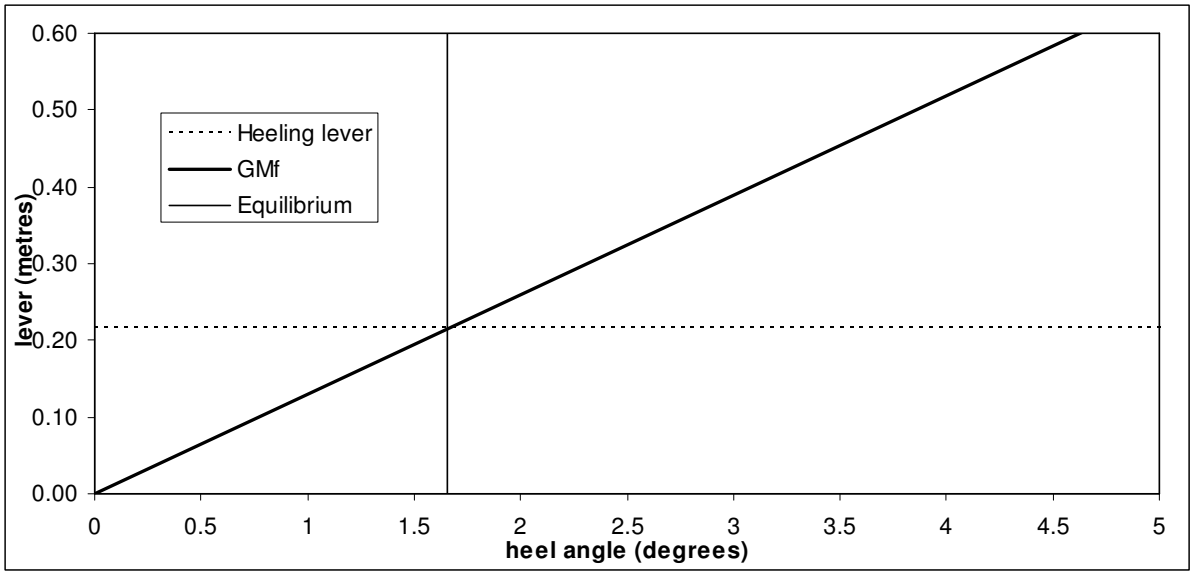
Level trim check

LCB	=	-0.09	m	
LCG	=	0.05	m	
Lever	=	0.14	m	
Δ	=	134.9	t	
Trim moment	=	-18.4	t-m	
MTC	=	2.68	t-m	
Trim change	=	-0.07	m	(negligible – original hydrostatics applicable)

GMf Calculation

GMf	=	KM - KGf	
	=	7.43	m

Levers Plot



Stability Criteria Compliance

(a) $GM_{required} = \frac{0.036 \times A \times h}{\Delta \times \tan\theta} + 0.15$

$A = 97.7\ m^2$

$h = 3.05\ m$

$\Delta = 134.9\ t$

$\theta = 5\ deg$

$GM_{required} = 1.06\ m$

(b) $GM_{required} = \frac{0.0053 \times V^2 \times d}{L \times \sin\theta} + 0.15$

$V/L^{1/2} = 4$

$V^2/L = 16$

$d = 3.02\ m$

$GM_{required} = 3.08\ m$

(c) *If a derrick, deck crane or cranes are fitted onboard, the vessel must have sufficient GM to ensure that it does not heel any more than an angle equivalent to one half the freeboard, in the condition being considered, or five (5) degrees whichever is the less, when the cranes have their working loads extended their maximum outreach over the side.*

Freeboard	=	*1.29 m*
Heel due to crane	=	*1.7 deg*
Loss of freeboard	=	*14 %*

(d) $GM_{required}$ = *1.00 m*

ACTUAL GMf = 7.43 m

Additional check – loss of freeboard due to trim

Check to see loss of freeboard with crane operating at and over transom:

Trimming moment	=	66.8	t-m
MTC	=	2.68	t-m
Trim change	=	0.25	m
Freeboard	=	1.29	m
Loss of freeboard	=	19 %	(less than half)

Vessel passes all criteria with comfortable margin for this loading condition

5.0 WINDAGE

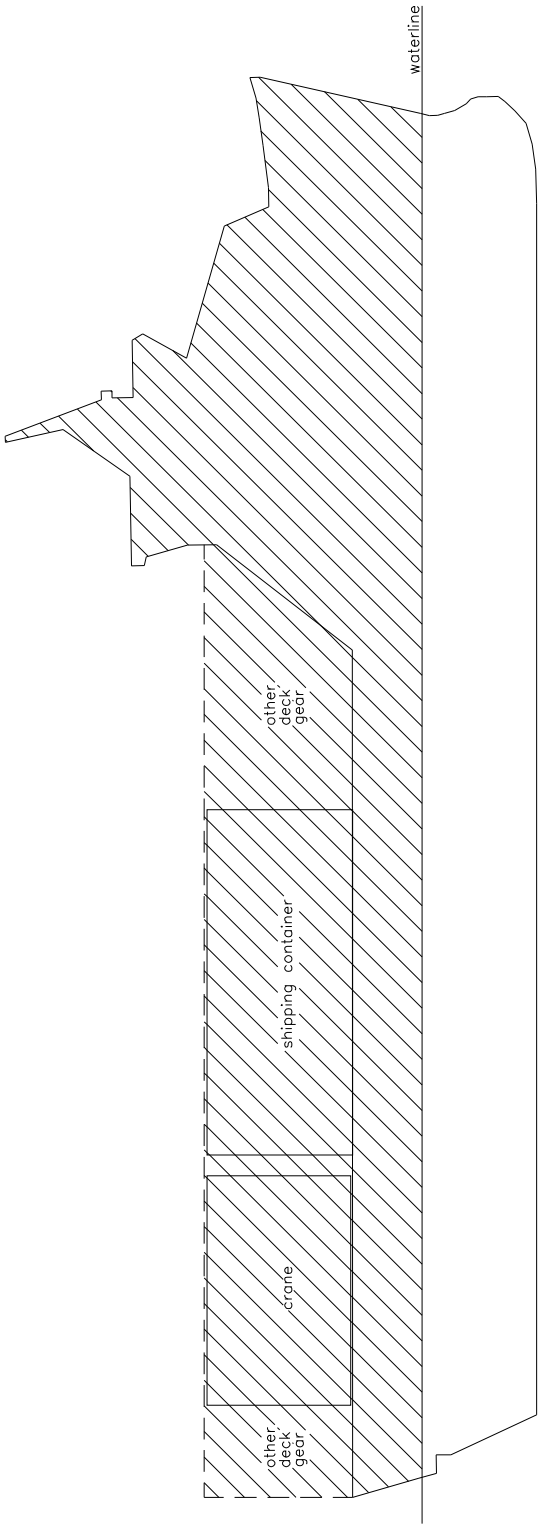
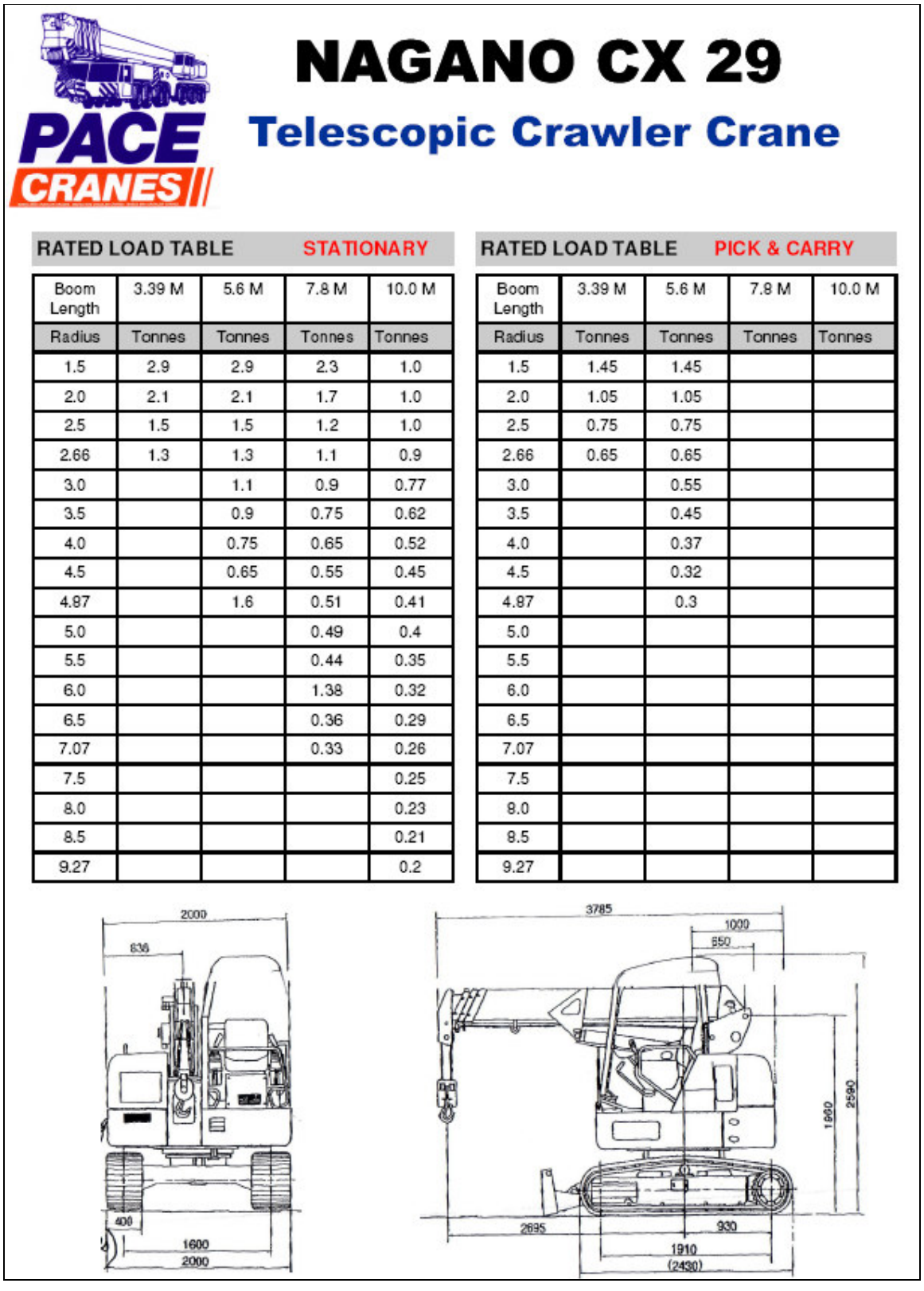


Figure 1 – Windage reference diagram

6.0 CRANE DETAILS

Figure 2 – NAGANO CX 29 Telescopic Crawler Crane Specifications



PACE CRANES

NAGANO CX 29

Telescopic Crawler Crane

RATED LOAD TABLE **STATIONARY**

Boom Length	3.39 M	5.6 M	7.8 M	10.0 M
Radius	Tonnes	Tonnes	Tonnes	Tonnes
1.5	2.9	2.9	2.3	1.0
2.0	2.1	2.1	1.7	1.0
2.5	1.5	1.5	1.2	1.0
2.66	1.3	1.3	1.1	0.9
3.0		1.1	0.9	0.77
3.5		0.9	0.75	0.62
4.0		0.75	0.65	0.52
4.5		0.65	0.55	0.45
4.87		1.6	0.51	0.41
5.0			0.49	0.4
5.5			0.44	0.35
6.0			1.38	0.32
6.5			0.36	0.29
7.07			0.33	0.26
7.5				0.25
8.0				0.23
8.5				0.21
9.27				0.2

RATED LOAD TABLE **PICK & CARRY**

Boom Length	3.39 M	5.6 M	7.8 M	10.0 M
Radius	Tonnes	Tonnes	Tonnes	Tonnes
1.5	1.45	1.45		
2.0	1.05	1.05		
2.5	0.75	0.75		
2.66	0.65	0.65		
3.0		0.55		
3.5		0.45		
4.0		0.37		
4.5		0.32		
4.87		0.3		
5.0				
5.5				
6.0				
6.5				
7.07				
7.5				
8.0				
8.5				
9.27				

Figure 3 – NAGANO CX 29 Telescopic Crawler Crane Load Tables

7.0 MOMENT CALCULATIONS

7.1 HEELING MOMENT

From crane operation (refer to figure 2):

Maximum load	2.9 t	
At lever	1.5 m	
Operational heeling moment	4.35 t-m	

From crane offset from vessel CL:

Mass of crane	5.2 t	
Offset distance	4.75 m	(half breadth – overestimated)
Offset moment	24.7 t-m	
Total heeling moment	29.1 t-m	

This is the heeling moment that is used to derive the heeling levers in the loading conditions presented.

7.1 TRIMMING MOMENT

From crane operation (refer to figure 2):

Maximum load	2.9 t
At lever	1.5 m
Operational heeling moment	4.35 t-m

From crane shift from vessel midships:

Mass of crane	5.2 t
Shift distance	12.0 m
Shift moment	62.4 t-m
Total trimming moment	66.8 t-m

This is the trimming moment that is used to determine loss of freeboard due to trimming in the loading conditions presented.

8.0 OCEANIC YACHT DESIGN PTY LTD BACKGROUND

Oceanic Yacht Design (OYD) was established in 2001 to provide a specialised design, survey and consultancy service to the greater marine community. Our focus is to provide clientele with professional and reliable service that delivers superior results.

OYD's qualified and experienced team has extensive knowledge in all areas of the design and survey of aluminium, steel and composite vessel ranging up to 60 meters in length. Our portfolio covers a diverse range of vessels of both recreational and commercial design and includes monohull and low wash catamarans of both power and sail capabilities.

OYD is a sister company to Sea Transport Solutions (STS) which was formed in 1976 as an independent company to provide marine design and consultancy services to the Australian maritime industry. To date, over 33 countries have built STS designs, or have used STS consulting services.

For more information refer to our website www.oceanicdesign.com.au

9.0 CONFIDENTIALITY

This report is prepared for the exclusive use of the client as described on page 2 of this report and shall not be reproduced, copied or communicated to any other party unless explicit permission is obtained.

10.0 REFERENCES

1. Uniform Shipping Laws Code

2. M.V. "MARELLA" – TRIM & STABILTY BOOKLET (DECEMBER 1983)

3. TRIM AND STABILTY BOOKLET ADDENDUM
   Oceanic Yacht Design (April 2009)