DAMAGE STABILITY MANUAL

Intended for
Deterministic Damage Stability
(Assessment)

MSC.235 (Offshore Supply Vessel)

IBC Code
IGC Code
MARPOL 73/78 Annex I
Mega Yacht acc, MCA (LY2)
Load Line Reg. 27
Stockholm Agreement 'water on deck'
National Regulation

Delete and amend relevant remarks and criteria in red

SHIPTYPE

SHIP NAME

SHIPYARD

Newbuilding No. XXXX

IMO No. XXXX

Published : 11/11/2013
Project :
Document : XXXXX.PDF
Prepared :
Checked :

TABLE OF CONTENTS

Revision No.	Revision Summary	Date
0	Final edition	xxxxxx

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Computer calculations for the present data have been prepared by:

xxxxxxxxx

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Data list

NAPA Release Bxxxxx
NAPA project no. XXXX/ Arrangement xxxxxx

XXX/t&s.doc

XXX/t&s.pdf

Reference list:

Included in this booklet: (Section XXX)

Lines plan	xxxxxxx rev. xx
Freeboard plan	xxxxxxx rev. xx
Capacity plan	xxxxxxx rev. xx
Draught marks and position	xxxxxxx rev. xx
Wind profile and area	

General arrangement	xxxxxxx rev. xx
Intact stability manual	xxxxxxx rev. xx
Damage control Manual	xxxxxxx rev. xx
Cargo loading manual	xxxxxxx rev. xx
Cargo securing manual	xxxxxxx rev. xx
Ballast water management plan	xxxxxxx rev. xx

1 MAIN PARTICULARS

Ship type	:	SHIP TYPE
Ship's name	:	SHIPNAME
Flag	:	XXXX
IMO number	:	xxxxxx
Call signal	:	xxxx
Builders	:	XXXX
Yard No.	:	XXXX
Keel laying date	:	XXXXX
Rules and Regulations	:	xxxxx Damage stability are according to xxxxx
Class	:	XXXX
Class identification	:	XXXX

Main dimensions

Length overall	approx. xxxxxx	m
Length Load Line	approx. xxxxxx	m
Length pp (Centre of rudder stock to forward perpendicular).	xxxxx	m
Breadth moulded	xxxxx	m
Depth to bulkhead deck moulded	xxxxx	m
Draught at design moulded	xxxxx	m
Draught at summer LL moulded	xxxxx	m
Draught extreme, to underside propeller/ Dome	xxxxx	m
Scantling draught moulded	xxxxx	m
Keel plate thickness	xxxxx	m
Displacement to design draught	xxxxx	t
Displacement to summer LL draught	xxxxx	t
Propeller diameter	xxxxx	m
Number of passengers	xxxxx	
Number of persons on board	xxxxx	

Light ship and COG

Weight	x	t
LCG from AP	x	m
TCG from CL (positive to PS)	x	m
VCG from BL	x	m

Deadweight

Deadweight to design draught (even keel and density of seawater of 1.025 t/m³)	xxxxx	t
Deadweight to summer LL draught		

(even keel and density of seawater of 1.025 t/m³).....xxxxx t

Units

Lengths are measured in metres (m)
Weights are measured in tons (t) each 1000 kg

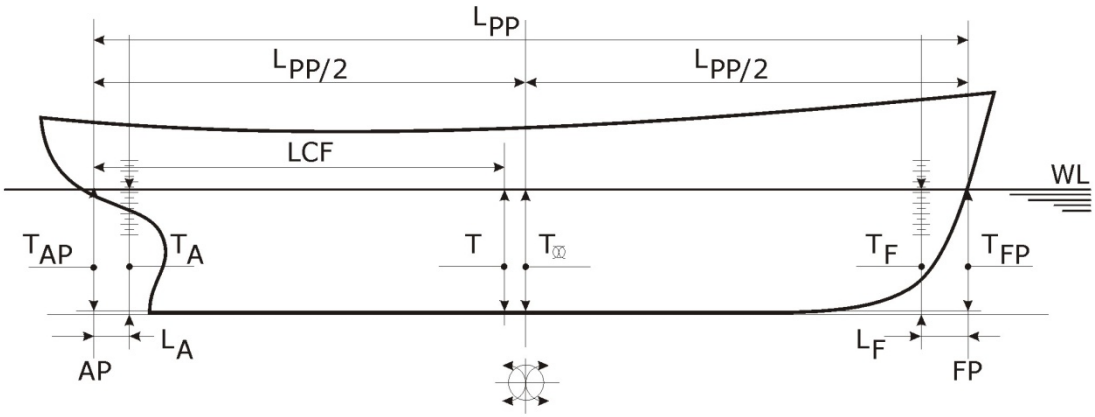
2 NOMECLATURE AND CONVERSION TABLE

The metric system is used in the definitions and assumptions, which apply in this Damage Stability Manual. The following definitions and assumptions apply:
TO BE ADJUSTED TO THE GIVEN PROJECT.....

SYMBOL	DESCRIPTION	UNIT
A	Area	m^2
AP	Aft perpendicular	
ATTV	Attained value	-
B	Moulded breath	m
Base line	Base line (BL) of the ship is the upper side of the keel	
BD	Buoyancy distribution	t
BEND	Bending moment	t*m
CB	Block coefficient at actual draught	-
CI	Common angle in interval	degrees
CM	Midship section coefficient at actual draught	-
CP	Prismatic coefficient at actual draught	-
CW	Waterplane coefficient at actual draught	-
BD	Depth to freeboard deck (moulded)	m
Delta	Angle of heel	degrees
Delta-f	Flooding angle	degrees
Delta-max	Angle where GZ occurs at maximum level	degrees
DGM	Reduction in GM	m
DGZ	Reduction in GZ	m
Disp	Displacement including shell plating and appendage	t
DW	Deadweight	t
EPHI	Area below GZ curve	t
FA	Flooding angle	degrees
FP	Forward perpendicular	m
FRA	Total frame area	m^2
FRSM	Free surface moment	m^4, t*m
FSM	Free surface moment	m^4, t*m
FSMOM	Free surface moment	m^4, t*m
GM	Metacentric height corrected for free surface	m
GM0	Initial Metacentric height	m
GT	Gross tonnage	-
GZ	Righting lever	m
HPHI	Righting lever curve	m
IMAX	Maximum moment	degrees
IMMA	Immersion angle to marginline, deckedge, opening,	degrees
IMMR	Reserve freeboard to immersion of marginline, deckedge, opening, etc.	m

KG	Distance from keel to centre of gravity (moulded)	m
KGmax	Maximum Distance from keel to centre of gravity	m
KM	Transverse metacentre above BL (KM_T) (moulded)	m
KN	Distance from base line to metacentric axis	m
L	Length 'International Load Line convention'	m
L_A	Distance from AP to aft draught mark. Positive value if draft mark is positioned forward of AP.	m
LCF	Longitudinal centre of flotation (from orig. 0)	m
LCB	Longitudinal centre of buoyancy (from orig. 0)	m
LCG	Longitudinal centre of gravity (from orig. 0)	m
L_F	Distance from FP to fwd draft mark. Positive value if draft mark is positioned aft of FP	m
L_M	Distance from Load Line mark to draft mark amid ship. Positive value if draft mark is positioned aft of LL	m
LPP	Length between perpendiculars	m
LREF	Distance between AP and FP	m
LWL	Length of waterline at actual draught	m
MCT	Moment to change trim one centimetre	t*m/cm
MINGM	Minimum metacentric height	m
ML	Longitudinal moment of weights	t*m
MS	Residual stability	m
MT	Transversal moment of weights	m
MV	Vertical moment of weight	t*m
NT	Net tonnage	-
PHI	Angle of heel	degrees
PI	Propeller Immersion	metre
REDPD	Reduction per 1 degree	metre
REQ	Requirement	-
RHO	Density of Liquid	t/m^3
Shell Plating	The average thickness of the shell plates is estimated at xxx mm and has been used as allowance in the hydrostatic calculations together with the keel plate thickness.	m
SHEAR	Shear force	t
SM	Simpsons multiplicator	
SWL	Draught at summer water line (moulded)	m
T	Draught at midship (moulded)	m
TA	Draught at aft draft mark from underside keel	m
TAP	Draught at AP (moulded)	m
TCG	Transversal centre of gravity from CL	m
TPC	Weight to change draught one centimetre	t/cm
TF	Draught at forward draft mark from underside keel	m
TFP	Draught at FP mld.	m

TK	Draught to underside keel	m
TRF	Trim factor = Disp/(100*MCT)	-
V	Volume	m^3
VCB	Vertical centre of buoyancy above base line	m
VCG	Vertical centre of gravity above base line	m
VOLT	Total volume/ Displacement in fresh water	m^3, t
WD	Weight distribution	t
WLA	Waterline area	m^2
WSA	Wetted surface area	m^2
X	Distance in longitudinal direction	m
XM	Longitudinal centre of gravity of load	m
XREF	Distance from AP to midship	m
Y	Distance in transverse direction	m
YM	Transversal centre of gravity of load	m
Z	Distance in vertical direction	m
ZM	vertical centre of gravity of load	m



Metric Conversion Table

Multiply by	To convert from	To obtain	
0.03937	mm	inch	25.4
0.3937	cm	inch	2.54
3.2808	m	feet	0.3048
2.2046	kg	lb	0.45359
0.9842	metric ton	long tons (2440 lbs)	1.0160
2.4998	metric ton per centi-metre of immersion	tonnes per inch (immersion)	0.40
8.2014	moment to change trim one centimetre	moment to change trim one inch	0.1220
187.9767	metre*radians	feet*degrees	0.0053
0.01745	metre*degrees	metre*radians	57.30
35.3147	Cubic metre	Cubic feet	0.0283
	To obtain	**To convert from**	**Multiply by**

Relationship between weight and volume:

1000 cubic millimetres		=	1 cubic centimetre
1 cubic centimetre of fresh water	(RHO =1.0)	=	1 gram
1000 cubic centimetre of fresh water	(RHO =1.0)	=	1 kilogram
1 cubic metre of fresh water	(RHO =1.0)	=	1 t
1 cubic metre of seawater	(RHO =1.025)	=	1.025 t
1 ton of seawater	(RHO =1.025)	=	0.975 m^3

Conversion between cubic feet per tonnes or long tonnes and tonnes per cubic metre:

$1/(0.0283 * x \text{ cu.ft/t}) = y \text{ t/m}^3$
$1/(0.0279 * x \text{ cu.ft/lt}) = y \text{ t/m}^3$

$35.316 * (1/x \text{ t/m}^3) = y \text{ cu.ft/t}$
$35.881 * (1/x \text{ t/m}^3) = y \text{ cu.ft/lt}$

3 GENERAL INTRODUCTION

This damage stability Manual is prepared for the ship's master to provide information and guidance in relation to different damage cases, calculated in accordance with the relevant rules and regulations applicable. This manual is to be used in conjunction with stability information manual (doc. no. xxxxxx.xxxx.xxx) and the ships damage control booklet and plan (doc. no. xxxxxx.xxxx.xxx and drawing no. xxxxxx.xxxx.xxx).

The manual compromises the following contents:

1. General information and assumptions on which the calculations have been carried out. This includes information on position of watertight boundaries such as bulkheads and decks, all relevant openings including doors, hatches and ventilation openings, summary of damage cases, applicable rules and regulations, results of damage stability calculations and conclusion.

2. General hydrostatic data of the ship, such as displacement, deadweight, centre of buoyancy, centre of flotation, metacentric height, displacement to change draught one centimetre etc., are tabulated against the vessel's mean moulded draught, unless stated otherwise. Cross curves of stability, excesses of buoyancy effects of timber deck cargoes or similar, are provided therein.

The reference systems for the ship in this manual are as follows:
Origin is positioned as follows

X-direction:	*Frame 0 (Aft perpendicular), Positive forward*
Y-direction:	Centreline. *Right-handed coordinate system (PS Positive)*
Z-direction:	Base line in Z = 0 i.e. upper side of keel plate

Trim: Positive trim by stern when draft at AP is greater than draft at FP

Frame spacing:

Aft to fr.20	0.600 m
fr.20 to fr.167	0.800 m
fr.167 to fr.200	0.700 m
fr.200 to fwd.	0.600 m

The damage stability calculations in this booklet have been carried out using relevant software package from:
NAPA OY version 2010.1.
Project no./ Arrangement vers.

The calculations of the stability curves and the transverse metacentric height GM take the actual floating position into account, including trim and heel, hence small deviations from manual calculations cannot be avoided.

The ship is has been calculated for compliance with the applicable rule:
xxxx.....IMO Res. MSC.235(82) – Adoption of the guidelines for the design and construction of offshore supply vessels.

The damage stability has been calculated for draft and trim range covering draft from x.xx to x.xx and
trim from x.xx to x.xx m
Further, direct calculations has been carried out on the loading conditions in the Stability Manual.

4 BASIC INPUT AND ASSUMPTIONS

4.1 Hull and compartment definition

The hull and compartment definition is based upon the following drawings and assumptions:

Drw. no.	Rev.	Denomination
xxxxxx.xxxx.xxx	-	Lines plan
xxxxxx.xxxx.xxx	-	General arrangement
xxxxxx.xxxx.xxx	-	Capacity plan
xxxxxx.xxxx.xxx	-	Midship section
xxxxxx.xxxx.xxx	-	Profile and deck I
xxxxxx.xxxx.xxx	-	Profile and deck II
xxxxxx.xxxx.xxx	-	Fore body appendix
xxxxxx.xxxx.xxx	-	Aft body appendix
xxxxxx.xxxx.xxx	-	Watertight integrity plan
xxxxxx.xxxx.xxx	-	Measurement plan
xxxxxx.xxxx.xxx	-	Door plan
xxxxxx.xxxx.xxx	-	Air & sounding plan
xxxxxx.xxxx.xxx	-	Damage control plan
xxxxxx.xxxx.xxx	-	Fuel oil overflow system
xxxxxx.xxxx.xxx	-	-
xxxxxx.xxxx.xxx	-	Other plans relevant for damage stability calculations

The hull defined, from keel to upper deck, excluding:
sea chest
tunnel thrusters

and including the following items:
rudder and shaft
poop deck
forecastle deck
hatch covers and coamings

For plot of the calculation hull see section 12.

The following permeabilities have been used in the calculations:

Appropriated to stores	0.60
Occupied by accommodation	0.95
Occupied by machinery	0.85
Voids	0.95
Intended for consumable liquids	0 to 0.95
Intended for other liquids	0 to 0.95

4.2 Watertight bulkheads and doors

The ship has watertight bulkheads (i.e. from side to side) at frame
Xx, xx, xx, xx, xx, xx, xx, xx, xx, xx, xx, xx, xx, xx, xx, xx.

Additional bulkhead not extending from side to side are positioned at frame

Xx, xx, xx, xx, xx

In the table below, the watertight doors are listed with information about location and approved pressure head.

Watertight door no.	Position	Note	Pressure head
1	#xx PS	Steering Gear/Boiler room	10 m
2	#xx SB		
3	#xx		
4	#xx		
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

4.3 Openings included

In order to calculate the stability range, all openings, in both PS and SB, which cannot be closed weatertight/watertight have been taken into account and considered as down flooding openings:

A total of xx representative air pipes in both PS and SB side have been taken into account. These air pipes are provided with class-approved weathertight, self-closing air caps.

Note that the air pipes from the double bottom tanks are located as close as possible to the inner shell. When damaging the wing tanks only, it is therefore theoretically possible to damage an air pipe, which leads to an undamaged double bottom tank, and to fill this DB tank through the damaged pipe. But as the pipe is positioned so close to the inner shell, it is in practice not possible to damage the pipe only, without damaging the inner shell.

Openings for accommodation doors and top of cargo hatch coamings, which can be closed weathertight, have been taken into account and defined not to be submerged in equilibrium stage after flooding.

Unprotected ventilation openings, which cannot be closed weathertight have been taken into account and have therefore been considered as downflooding openings.

Relevant openings are presented in section 10.

4.4 Draft and trim range

The damage stability has been calculated for a draft and trim range covering from
Draft from x.xx to x.xx and
Trim from xx.xx to xx.xx m.

Furthermore, direct calculations have been carried out on the loading conditions presented in the stability information manual.

4.5 Damage numbering, calculations and zones

The ship is subdivided into a number of zones numbered from the aft to forward, The length of the zone is determined by the longitudinal damage extent. The boundaries can be seen on the damage control plan

Transverse subdivision
The ship is divided into a number zones position at watertight bulkheads.

ZONE	Aft fr.	Forw. fr.
01	-	*xx*
02	*xx*	*xx*
03	*xx*	*xx*
04	*xx*	*xx*
05	*xx*	*xx*
06	*xx*	*xx*
07	*xx*	*xx*
08	*xx*	*xx*
09	*xx*	*xx*
10	*xx*	*xx*
11	*xx*	*xx*
12	*xx*	*xx*
13	*xx*	*xx*
14	*xx*	*xx*
15	*xx*	*xx*
16	*xx*	-

Longitudinal subdivision
The ship has 2 watertight longitudinal bulkheads which are situated as follows:

1 Longitudinal bulkhead position xx m of CL
2 Longitudinal bulkhead position xx m of CL

Horizontal subdivision
The following decks are modelled

1 Tank top x.x m above BL

2	Tween deck	x.x m above BL
3	Bulkhead deck (Main deck)	x.x m above BL

Damage Cases

All damage cases are given a unique name DAMCASE which describes the position of the damage.

DAMCASE = (S, W, F).P.NZZ.tv-c

S	Damage case,- standard
W	Damage case to determine water on deck, IMO circular letter No. 1891
F	Damage case with flooding through damaged pipes
P	Position of damage. P = port side, S = starboard side
N	The number of zones taken into consideration
ZZ	The zone with lowest number (The ship is divided into zones from aft to forw.)
t	The transverse extent of damage to:

t-value

1	First longitudinal bulkhead from side shell
2	Second longitudinal bulkhead from side shell
n	"n" longitudinal bulkhead from side shell

v — The vertical extent of the damage. This digit indicates vertical extent of damage from a deck to full height

v-value

0	N/A
1	Damage above tank top
2	Damage above tween deck
n	Damage above "n" deck

c

1	Damage of lesser extent no. 1
2	Damage of lesser extent no. 2
n	Damage of lesser extent no. n

The calculation of a damage case consists of a number of intermediate stages until the final equilibrium is met. Hence, in the following, damage cases have been deviated into 4 stages.

Example of damage case name is S.P.203.11

S	=	standard damage case.
P	=	position of damage is port side.
203	=	it is 2 zone damage case making damage to zone 3 and 4.
1	=	damage occur to first longitudinal bulkhead.
1	=	damage is above tank top.

4.6 Cross flooding

Delete and amend
For damcase xxxx cross flooding is included and filling will occur as follows

Stage	Intermediate phase (volume filling in stage)	% of total volume in stage
1 filling before cross flooding	1	25
	2	50
	3	75
2 filling during flooding		
	1	25
	2	50
	3	75
	Final	100

4.7 Progressive flooding

Delete and amend
For damcase xxxx progressive flooding is included and filling will occurs as follows

Stage	Intermediate phase (volume filling in stage)	% of total volume in stage
1 filling before progressive flooding	1	25
	2	50
	3	75
2 filling during progres-seiveflooding		
	1	25
	2	50
	3	75
	Final	100

The criteria are split into two groups, where the first group applies to ship during intermediate stages of flooding, and the second, to the final stage of flooding.

Please include any information on A-class i.e. bulkheads which does not have the sufficient strength to sustain maximum water pressure in the event of flooding.

4.8 Flooding of damage compartments

Delete and amend
In damage cases, except for those mentioned in section 3.4 and 3.5, filling will occur as follows:

Stage	% of total volume at equilibrium
1	25
2	50
3	75
Final	100

5 CONCLUSION

The ship has been investigated for compliance with
MSC.235 (Offshore Supply Vessel)
IBC Code
IGC Code
MARPOL
Mega Yacht acc, MCA (LY2)
LoadLine regulation 27
IMO circular letter No. 1891 'water on deck' based upon the assumptions made in this report. Provided that KG/ GM for a actual condition is shown to comply with the limiting KG maximum/ minimum GM value, the ship will resist the rule damage of any two adjacent main compartments including water on cargo deck for the investigated condition.
The condition's actual KG/GM value must always be corrected for free surface moments

The results of the damage stability calculations can be found in the chapter 6 as limiting KG/GM curves and tables.

The worst cases are listed below for the given trim:

Trim forw.= 0.25 m
The worst damage involves

Trim even keel
The worst damage involves

Trim aft = 0.50 m
The worst damage involves

Trim aft = 1.00 m
The worst damage involves

Trim forw. 1.50 m
The worst damage involves

6 DAMAGE STABILITY RESULTS

The first section includes the limiting KG/ GM tables and curves.

Second section includes direct calculations based on loading conditions in the Stability Manual.
All calculated damage cases should include GZ curve.

7 RULES AND REGULATIONS

DELETE AND AMEND AS APPROPRIATE SECTIONS 7.X AND 7.X RELEVANT FOR THE SHIP IN QUESTION.
IT IS ESSENTIAL TO MAKE SURE THAT THE RULE REFERED TO INCLUDES THE LATEST AMENDMENTS.

7.1 Damage extent acc. to IMO Res. MSC.235

IMO Res. MSC.235 Adoption of guidelines for the design and construction of offshore supply vessels, 2006

Damage should occur anywhere in the ship's length between transverse watertight bulkheads.

a. Longitudinal extent of damage for ships with a length (L) greater than 43 m is 3 m plus 3% of the ship's length. For those with length (L) not greater than 43 m, 10% of the ship's length.

b. The transverse extent of damage should be assumed to be 760 mm, measured inboard from the side of the ship perpendicular to the centreline at the level of the summer load waterline.

c. The vertical extent of damage should be assumed to be from the underside of the cargo deck or the continuation thereof, for the full depth of the ship.

d. A transverse watertight bulkhead extending from the ship's side to a distance inboard of 760 mm or more at the level of the summer load line joining longitudinal watertight bulkheads may be considered as a transverse watertight bulkhead for the purpose of the damage calculations.

e. If pipes, ducts or tunnels are situated within the assumed extent of damage, arrangements should be made to ensure that progressive flooding cannot thereby extend to compartments other than those assumed to be floodable, for each case of damage.

f. If damage of lesser extent than those specified above results in a more severe condition, such lesser extent should be assumed.

The term 'Length (L) of ship' has the meaning as defined in the ICLL'66 as amended.

7.2 Damage criteria acc. to IMO Res. MSC.235

IMO Res. MSC.235 Adoption of guidelines for the design and construction of offshore supply vessels, 2006

The final waterline, taking into account sinkage, heel and trim, should be below the lower edge of any opening through which progressive flooding may take place. Such openings should include air pipes and those which are capable of being closed by means of weather tight doors or hatch covers and may exclude those openings closed by means of watertight manhole covers and flush scuttles, small watertight cargo tank hatch covers which maintain the high integrity of the deck, remotely operated watertight sliding doors and side scuttles of the non-opening type.

In the final stage of flooding, the angle of heel due to unsymmetrical flooding should not exceed 15°. This angle may be increased up to 17°. If no deck immersion occurs.

The stability in the final stage of flooding should be investigated and may be regarded as sufficient, if the righting lever curve has at least a range of 20° beyond the position of equilibrium in association with a maximum residual righting lever of at least 100 mm within this range. Unprotected openings should not become immersed at an angle of heel within the prescribed minimum range of residual stability, unless the space in question has been included as a floodable space in calculations for damage stability. With this range, immersion of any of the openings referred to in section a and any other opening being closed weathertight, may be authorized.

7.3 Damage extent acc. to IBC-code

IBC Code

IBC code - International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk. The damage assumptions according to the code are summarized below:

Side damage:

a. The longitudinal extent

whichever is less	whichever is less
Vertical extent:	Vertical extent:

If any damage of lesser extent than those specified above results in a more severe condition, such damage should be taken into consideration.

As a type 1 ship, it should be assumed to sustain damage anywhere in its length

As a type 2 ship of more than 150 m in length, it should be assumed to sustain damage anywhere in its length.

As a type 2 ship of 150 m in length or less, it should be assumed to sustain damage anywhere in its length, except involving either of the bulkheads bounding a machinery space located aft.

As a type 3 ship of more than 225 m in length, it should be assumed to sustain damage anywhere in its length.

As a type 3 ship of 125 m in length or more but not exceeding 225 m in length, it should be assumed to sustain damage anywhere in its length except involving either of the bulkheads bounding a machinery space located aft.

As a type 3 ship below 125 m in length, it should be assumed to sustain damage anywhere in its length except involving damage to the machinery space when located aft. However the ability to survive the flooding of the machinery space should be considered by the administration.

7.4 Damage criteria acc. to IBC-code

IBC-Code

Ships subject to the IBC code should be capable of surviving the assumed damage extension and satisfy the following criteria:

In intermediate stages of flooding:

a. the final waterline, taking into account sinkage, heel and trim, should be below the lower edge of any opening through which progressive flooding may take place. Such openings should include air pipes and those which are capable of being closed by means of weathertight doors or hatch covers and may exclude those openings closed by means of watertight manhole covers and flush scuttles, small watertight cargo-tank hatch covers which maintain the high integrity of the deck, remotely operated watertight sliding doors and side scuttles of the non-opening type.

b. The maximum angle of heel due to unsymmetrical flooding should not exceed 25°, provided that this angle may be increased up to 30° if no deck edge immersion occurs.

c. The residual stability during intermediate stages of flooding should be to the satisfaction of the administration. However, it should never be significantly less than required in final equilibrium.

At final equilibrium after flooding:

a. The positive residual righting lever curve shall have a minimum range of 20° beyond the angle of equilibrium.

b. The righting lever shall be at least 0.1 m within the 20° range.

c. The area under the righting lever curve within 20° range shall be at least 0.0175 mrad.

d. Unprotected openings shall not be immersed within the 20° unless the space concerned is assumed flooded. Openings cable of being closed weathertight may be permitted.

7.5 Damage extent acc. to IGC-code

IGC Code

IGC Code – International Code for the Construction and and Equipment of Ships Carrying Liquefied Gases in Bulk. The Code applies to ships regardless of size, including those of less than 500 tons gross tonnage, engaged in carriage of liquefied gases having vapour pressure exceeding 2.8 bar absolute at a temperature of 37.8°C, and other products (ref Ch. 19 in the Code), when carried in bulk.

The damage assumptions according to the code are summarized below:

Side damage:

a. The longitudinal extent

14.5 m, whichever is less	whichever is less
Transverse extent:	Transverse extent:
Vertical extent:	Vertical extent:

Other damage:

If any damage of lesser extent than those specified above results in a more severe condition, such damage should be assumed.

Local side damage anywhere in the cargo area extending inboard 760 mm measured normal to the hull shell should be considered and transverse bulkheads should be assumed damaged when also required by the applicable the following:

a. A type 1G ship should be assumed to sustain damage anywhere in its length.

b. A type 2G ship of more than 150 m in length should be assumed to sustain damage anywhere in its length.

c. A type 2G ship of 150 m in length or less should be assumed to sustain damage anywhere in its length except involving either of the bulkheads bounding a machinery space located aft.

d. A type 2PG ship should be assumed to sustain damage anywhere in its length except involving transverse bulkheads spaced further apart than the longitudinal extent of damage speciefied above.

e. A type 3G ship of 125 m in length or more should assume to sustain damage anywhere in its length except involving bulkheads spaced further apart than the longitudinal extent of damage specified above.

f. A type 3G ship less 125 m in length, it should be assumed to sustain damage anywhere in its length except involving transverse bulkheads spaced further apart than the longitudinal extent of damage specified in above and except damage involving machinery space when located aft. However, the ability to survive the flooding of the machinery space should be considered by the administration.

g. In the case of small type 2G/2PG and 3G ships which do not comply in all respects with the appropriate requirements of c. d. and f., special dispensations may only be considered by the Administration provided that alternative measures can be taken which maintain the same degree of safety. The nature of the alternative measures should be approved and clearly stated and be available to the port Administration. Any such dispensation should be duly noted on the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk.

7.6 Flooding assumptions acc. To IGC Code

The requirements of the Code should be confirmed by calculations which take into consideration the design characteristics of the ship; the arrangements, configuration and contents of the damaged compartments; the distribution, relative densities and the free surface effects of liquids; and the draught and trim for all conditions of loading.

The permeabilities of spaces assumed to be damaged should be as follows:

Spaces	Permeabilities
Appropriated to stores	0.60
Occupied by accommodation	0.95
Occupied by machinery	0.85
Voids	0.95
Intended for consumable liquids	0 to 0.95
Intended for other liquids	0 to 0.95

Wherever damage penetrates a tank containing liquids, it should be assumed that the contents are completely lost from that compartment and replaced by salt water up to the level of the final plane of equilibrium.

Where the damage between transverse watertight bulkheads is envisaged, transverse bulkheads should be spaced at least at a distance equal to the longitudinal extent of damage specified in Ch. 7.5 in order to be considered effective. Where transverse bulkheads are spaced at a lesser distance, one or more of these bulkheads within such extent of damage should be assumed as non-existent for the purpose of determining flooded compartments. Further, any portion of a transverse bulkhead bounding side compartments or double bottom compartments should be assumed damaged if the watertight bulkhead boundaries are within the extent of vertical or horizontal penetration required. Also, any transverse bulkhead should be assumed damaged if it contains a step or recess of more than 3 m in length located within the extent of penetration of assumed damage. The step formed by the after peak bulkhead and after peak tank top should not be regarded as a step for the purpose of this paragraph.

The ship should be so designed as to keep unsymmetrical flooding to the minimum consistent with efficient arrangements.

Equalization arrangements requiring mechanical aids such as valves or cross-levelling pipes, if fitted, should not be considered for the purpose of reducing an angle of heel or attaining the minimum range of residual stability to meet the damage criteria and sufficient residual stability should be maintained during all stages where equalization is used. Spaces which are linked by ducts of large cross-sectional area may be considered to be common.

If pipes, ducts, trunks or tunnels are situated within the assumed extent of damage penetration, as defined in under damage extent arrangements should be such that progressive flooding cannot thereby extend to compartments other than those assumed to be flooded for each case of damage.

The buoyancy of any superstructure directly above the side damage should be disregarded. The unflooded parts of superstructures beyond the extent of damage, however, may be taken into consideration provided that:

a. they are separated from the damaged space by watertight divisions and the requirements of 7.7.1 in respect of these intact spaces are complied with; and

b. openings in such divisions are capable of being closed by remotely operated sliding watertight doors and unprotected openings are not immersed within the minimum range of residual stability.

7.7 Damage criteria acc. to IGC-code

IGC-Code

Ships subject to the IGC code should be capable of surviving the assumed damage extension and flooding, satisfy the following criteria:

In any stage of flooding:

1. the waterline, taking into account sinkage, heel and trim, should be below the lower edge of any opening through which progressive flooding or downflooding may take place. Such openings should include air pipes and openings which are closed by means of weathertight doors or hatch covers and may exclude those openings closed by means of watertight manhole covers and watertight flush scuttles, small watertight cargo tank hatch covers which maintain the high integrity of the deck, remotely operated watertight sliding doors, and sidescuttles of the non-opening type;

2. the maximum angle of heel due to unsymmetrical flooding should not exceed 30°; and

3. the residual stability during intermediate stages of flooding should be to the satisfaction of the Administration. However, it should never be significantly less than that required by 7.7.4.

At final equilibrium after flooding:

4. the righting lever curve should have a minimum range of 20° beyond the position of equilibrium in association with a maximum residual righting lever of at least 0.1 m within the 20° range; the area under the curve within this range should not be less than 0.0175 m.rad. Unprotected openings should not be immersed within this range unless the space concerned is assumed to be flooded. Within this range, the immersion of any of the openings listed in 7.7.1 and other openings capable of being closed weathertight may be permitted; and

5. the emergency source of power should be capable of operating.

7.8 Damage extent acc. to Marpol 73/78 Annex I

MARPOL 73/78 Annex I

Every new oil tanker shall comply with the subdivision and damage criteria as specified in Annex I. Damage extent should be applied as follows:

a. In tankers of more than 225 m in length, anywhere in the ship's length.

b. In tankers of more than 150 m, but not exceeding 225 m in length, anywhere in the ship's length except involving either aft or forward bulkhead bounding the machinery space located aft. The machinery space shall be treated as a single floodable compartment.

c. In tankers not exceeding 150 m in length, anywhere in the ship's length between adjacent transverse bulkheads with exception of the machinery space. (for tankers of 100 m or less in length where all criteria cannot be met without materially impairing the operational qualities of the ship, administration may allow relaxations from these requirements.)

The following damage extent applies:

Side damage:

a. The longitudinal extent

If any damage of lesser extent than those specified above results in a more severe condition, such damage should be taken into consideration.

7.9 Damage criteria acc. to Marpol 73/78 Annex I

MARPOL 73/78 Annex I

The stability in final condition after damage and after equalization, where provided, shall be determined as follows:

The final waterline, taking into account sinkage, heel and trim, should be below the lower edge of any opening through which progressive flooding may take place. Such openings should include air pipes and those which are capable of being closed by means of weathertight doors or hatch covers and may exclude those openings closed by means of watertight manhole covers and flush scuttles, small watertight cargo tank hatch covers which maintain the high integrity of the deck, remotely operated water-tight sliding doors and side scuttles of the non-opening type.

a. In the final stage of flooding, the angel of heel due to unsymmetrical flooding shall not exceed 25°, provided that this angle may be increased up to 30° if no deck edge immersion occurs.

b. The positive residual righting lever curve shall have a minimum range of 20° be-yond the angle of equilibrium.

c. The righting lever is to be at least 0.1 m within the 20° range.

d. The area under the righting lever curve shall be at least 0.0175 mrad within 20° range.

Unprotected openings shall not be immersed within the 20° range, unless the space concerned is assumed flooded. Openings capable of being closed weathertight may be permitted.

7.10 Additional requirements

FURTHER TO THE ABOVE, IT IS IMPORT TO CHECK REQUIREMENTS IN MARPOL ANNEX I Ch. 23, 24 AND 25 REGARDING ‘ACCIDENTAL AND HYPHOTHETICAL OIL OUTFLOW PERFORMANCE’

7.11 Damage extent acc. to MCA - LY2-code

MCA-LY2 The Large Commercial Yacht Code

Compliance with MCA LY2 is not required for ships that obtain full compliance with ICLL Reg. 27 as amended.

a. The watertight bulkheads of the ship should be so arranged that minor hull damage that results in the free flooding of any compartments, will cause the ship to float at a waterline which, at any point, is not less than 75mm below the weather deck, or bulkhead deck, if not concurrent.

b. Minor damage should be assumed to occur anywhere in the length of the ship, between watertight bulkheads.

c. A ship of 85 metres and above should meet a SOLAS one compartment standard of subdivision, calculated using deterministic damage stability methodology.

7.12 Damage criteria acc. to MCA - LY2-code

MCA-LY2 The Large Commercial Yacht Code

a. In the damage condition, the residual stability should be such that any angle of equilibrium does not exceed 7° from upright.

b. The resulting righting lever curve shall have a range of at least 15° from equilibrium to downflooding.

c. The maximum righting lever within the resulting lever curve is not to be less than 100 mm and the area under the curve is not to be less than 0.015 metre radians.

7.13 Damage extent acc. to ICLL'66 Reg. 27

ICLL'66 as amended Reg.27

The following is applicable to Type 'A' ships, if over 150 metres, with an assigned freeboard of less than type 'B'.

a. The vertical extent of damage in all cases is assumed from the base line and upwards without limitation.

b. The transverse extent measured inboard from the ships at right angles to the centre line measured at the summer loadline, should be B/5 or 11.5, whichever is the lesser.

c. If damage of a lesser extent than the specified above results in a more severe condition, such lesser extent shall be assumed

Except where otherwise required by Reg.27 para. 10(a), the flooding shall be confined to a single compartment between adjacent transverse bulkheads, provided the inner longitudinal boundary of the compartment is not in a position within the transverse extent of assumed damage. Transverse boundary bulkheads of wing tanks, which do not extend over the full breath of the ship, shall be assumed not to be damaged, provided they extend beyond the transverse extent of assumed damage prescribed in b.

If in a transverse bulkhead there are steps or recesses of not more than 3 m in length located within the transverse extent of assumed damage as defined in b., such transverse bulkhead may be considered intact and the adjacent compartment may be floodable singly. If, however, within the transverse extent of assumed damage there is a step recess of more than 3 m in length in a transverse bulkhead, the two compartment adjacent to this bulkhead shall be considered as flooded. The step formed by the aft peak bulkhead and the afterpeak tank top shall not be regarded as a step for the purpose of this regulation.

Where a main transverse bulkhead is located within the transverse extent of assumed damage and is stepped in way of a double bottom or side tank by more than 3 m, the double bottom or side tanks adjacent to the stepped portion of the main transverse bulkhead shall be considered as flooded simultaneously. If this side tank has openings into one or several holds, such as grain feeding holes, such hold or holds shall be considered as flooded simultaneously. Similarly in a ship designed for the carriage of fluid cargoes, if a side tank has openings into adjacent compartments, such adjacent compartments shall be considered as empty and as being flooded simultaneously. This provision is applicable even where such openings are fitted with closing appliances, except in the case of sluice valves fitted in bulkheads between tanks and where the valves are controlled from the deck. Manhole covers with closely spaced bolts are considered equivalent to the unpierced bulkhead, except in the case of openings in topside tanks making the topside tanks common to the holds.

Where the flooding of any two adjacent fore and aft compartments is envisaged, main transverse watertight bulkheads shall be spaced at least 1/3 $L^{2/3}$ or 14.5 m, whichever is lesser, in order to be considered effective. Where transverse bulkheads are spaced at lesser distance, one or more of these bulkheads shall be assumed as non-existent in order to achieve the minimum spacing between bulkheads.

If pipes, ducts or tunnels are situated within the assumed extent of damage penetration as defined, arrangement shall be made to so that progressive flooding cannot thereby extend to compartments other than those assumed to be floodable in the calculation, for each case of damage.

7.14 Damage criteria acc. to ICLL'66 Reg. 27

ICLL'66 as amended Reg.27

The condition of equilibrium after flooding shall be regarded as satisfactorily provided:

a. The final waterline after flooding, taking into account sinkage, heel and trim, is below the lower edge of any opening through which progressive downflooding may take place. Such openings include unprotected and weathertight openings.

b. The angle of heel due to unsymmetrical flooding does not exceed 15° if no part of the deck is immersed, an angle of heel of up to 17° may be accepted.

c. The metacentric height in the flooded condition is positive.

d. When any part of the deck outside the compartment assumed flooded in a particular case of damage is immersed, or in any case where the margin of stability in flooded condition may be considered doubtful, the residual stability is to be investigated. It may be regarded as sufficient, if the righting lever curve has a minimum range of 20° beyond the position of equilibrium with a maximum righting lever of at least 0.1m within this range. The area under the righting lever curve within this range shall be not less than 0.0175 metre radians. The administration shall give consideration to the potential hazard presented by protected or unprotected openings which may become temporarily immersed within the range of residual stability.

Stockholm Agreement 'water on deck'

7.15 Damage Extent acc. IMO circ. letter No.1891 (water on deck calculation)/ EU directive 2003/25/EF

The following is in accordance with IMO Circular letter No.1891 'Agreement concerning specific stability requirements for ro-ro passenger ships undertaking regular scheduled international voyages between, to or from designated ports in north west Europe and the Baltic sea'.

a. The longitudinal extent should be 3m plus 3% of the length of the ship(L) or 11 m, whichever is less. Damage should occur anywhere in the ship's length and include flooding of two adjacent compartments.

b. The transverse extent measured inboard from the ship's side or sponsons at right angles to the centre line measured at the deepest subdivision load line, should be B/5

c. The vertical extent of damage should be assumed from the base line and upwards without limitation.

d. if damage of lesser extent than those specified above results in a more severe condition, such damage should be included in the calculations.

Subdivision draught mld. (two comp.)	x.xx	m
Calculation Length (SOLAS '90)	xxx.xx	m
Longitudinal extent (SOLAS '90)	x.xx	m
Transverse extent of damage	x.xx	m

The hypothetical volume of seawater which is assumed to have accumulated on the first deck above the designed waterline shall be kept the same at all trim and heeling angles and be calculated with the following distribution density as for a significant wave height (hs) of 4.0 m:

- 0.5 m^3/m^2 , if the residual freeboard (fr) is 0.3 m or less.
- 0.0 m^3/m^2 , if the residual freeboard (fr) is 2 m or more.
- intermediate values to be determined by linear interpolation.

- fr is the minimum distance between the damage ro-ro deck and the final waterline at the location of the damage in the damage case being considered without taking into account the effect of the volume of assumed accumulated seawater on the damage ro-ro deck.

Assessing the effect of the accumulated seawater on the damage ro-ro deck, the following should be followed:

- A transverse or longitudinal bulkhead shall be considered intact, if all parts of it lie inboard of a vertical surface on both sides of the ship, which are situated at a distance from the shell plating equal to B/5 measured right angles to the centreline at the deepest subdivision load line.
- The tightness of transverse or longitudinal bulkheads, which are taken into account as effective to confine the accumulated seawater, should be capable of withstanding hydrostatic pressure in accordance with the results of the damage calculation.
- In calculating the effect of the water on the damage ro-ro deck the volume and surface effect of the water shall be reduced by 10% to account for the permeability of the ro-ro spaces.

Stockholm Agreement 'water on deck'

7.16 Damage criteria acc. to IMO circ. letter No.1891 (water on deck calculations)/ EU directive 2003/25/EF

The stability in final condition after damage and after equalization where provided shall be determined as follows:

a. The positive residual righting lever curve shall have a minimum range of 15° beyond the angle of equilibrium. This range may be reduced to a minimum of 10° in case where the area under the righting lever curve specified in section b. is increased by the ration 15/range.

b. The area under the righting lever curve shall be at least 0.015 metre radians, measured from the angle of equilibrium to the lesser of: 1) angle of which progressive flooding occurs. 2) 22° measured from upright for one compartment flooding, or 27° measured from upright for two compartments flooding.

c. The righting lever is to be greater than 0.1 m within the range of positive stability and be derived as

Wind pressure	120	N/m^2
Acting on projected lateral area of the ship above waterline in intact condition	Derived by NAPA	m^2
Moment arm shall be the vertical distance from a point at one half of the mean draft corresponding to the intact condition to the centre of gravity of lateral area	Derived by NAPA	m
The heeling moment will vary with the draft of the ship and be calculated and for each intact condition before damage	Derived by NAPA	tm

Definition in NAPA:

MOM,	SOLASWIND
TYPE,	WIND
PARA	C=0.01223, TP2, PROF=PROFILE

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7.18 Cross and down flooding calculations

The position of cross- and downflooding points can be found in chapter 10 together with the type of opening
In the table below the information on cross flooding pipes can be found

Cross Connection no.	Connection Compartment	Cross Section area [m^2]	Length of connection
1	R21 – R25		
2			
3			
4			
5			
6			
7			
8			

Calculations according to MSC.245(83)

7.19 Calculation of downflooding angles

Calculation of downflooding for various draughts and trims can be found in chapter 10.
Include below is the worst opening and respective angles.

7.20 National requirements and/ or interpretations

Include national regulations if any.

8 REFERENCE DATA AND FRAME SPACING TABLE

9 CRITERIA DEFINITION

10 RELEVANT OPENINGS AND CROSS CONNECTIONS

11 DAMAGE CASES: PLOTS AND TABLES

12 HYDROSTATIC TABLES AND PLOT OF HULL

13 MS/ KN TABLES

14 CAPACITY AND TANK TABLES

15 DRAWINGS

15.1 Lines plan

15.2 General arrangement

15.3 Tank plan

15.4 Principale measurement plan

15.5 Watertight integrity plan

15.6 Door plan

15.7 Air & sounding plan

15.8 Fuel oil overflow plan

15.9 Damage control plan

15.10 Other relevant drawings