PART 8

ADDITIONAL INFORMATION AND REQUIREMENTS RELATING TO PARTICULAR SHIP TYPES, CARGOES AND TRADING AREAS

8.1 General

Reference should be made to the Merchant Shipping (Carriage of Cargoes) Regulations 1999 (SI 1999/336), for requirements on the arrangements for specific ship types and cargoes, and also for details of the "Cargo Securing Manual" which is mandatory for most ships. See Marine Guidance Note MGN 107(M).

Types of Ship

8.2 Container Ships

8.2.1 *General*

Experience shows that there are two main problems associated with container ships which require consideration if the stability of any such ship is not to be seriously affected. They are:

8.2.1.1 failure of the container securing arrangements due to the combined effects of heavy weather, rolling, pitching and heaving; this could lead to the movement or total loss of containers with the resultant listing of the ship due to unsymmetrical loading; and

8.2.1.2 the large angles of heel which may be produced by beam winds upon the large lateral areas of these ships due to their high freeboard and the tiers of cargo containers likely to be stowed on the deck.

Accordingly Surveyors should pay particular attention to the following points when examining the stability of these ships:

8.2.2 *Strength of container securing arrangements*

When assessing the provision of securing arrangements builders should be advised to take into account the probable ship motions as given in the IMO Code of Safe Practice for Cargo Stowage and Securing, as amended. Alternatively direct calculation methods or model test data may be used.

8.2.3 *Heeling due to strong beam winds*

When the height of the lateral windage area measured from the load waterline to the top of the cargo containers situated on the weather deck is greater than 30% of the beam, the shipbuilders should prepare a curve of statical stability for the ship

In the 'worst service condition' having regard to paragraph 8.2.4. The windage area and its centre of gravity and lever to mid draught should be stated.

8.2.3.1 In this 'worst service condition' the following information should then be superimposed on the curve of righting moments:

(a) Θ_1- the angle of heel under a steady wind load of 48.5 kg/ m2 applied to the lateral windage area, the lever for this moment being measured to an axis at mid draught; and

(b) Θ_{dy}- the angle of dynamic heel assuming a 15 degrees roll to windward from Θ_1 " in association with a gusting wind condition which is 50% in excess of the steady wind condition in (a) above. An example is given at Figure 17.

8.2.3.2 The minimum values for the following angles of inclination for the immersion in still water should also be given:

(a) the upper deck edge-say Θ_{de} ;

(b) the openings which cannot be closed watertight-say Θ_f (i.e. angle at which flooding could occur);

It is not possible at present to lay down precise criteria for the relationship between these angles but the Surveyor should draw attention to any condition if:

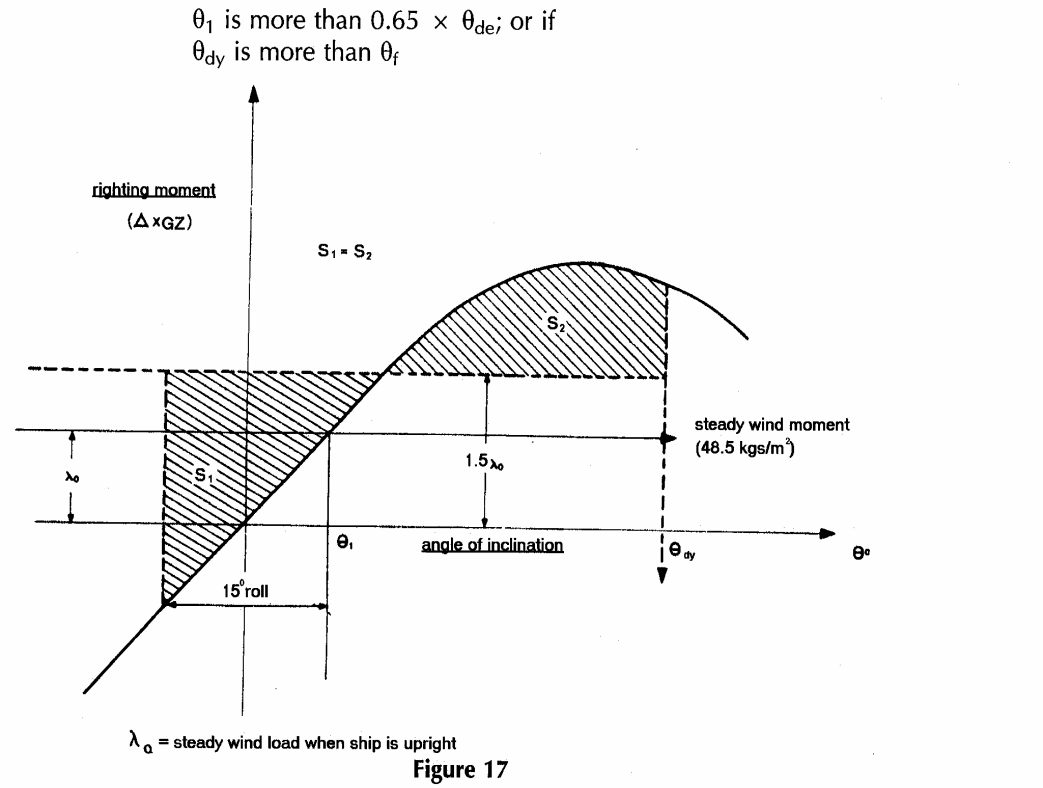


Figure 17

The Surveyor should also report upon those constructional features which would allow the upper limits of Θ_1 and Θ_{dy} to be accepted without placing the ship at a greater risk.

No allowance is to be given for the buoyancy of the containers stowed on deck in the derivation of the cross-curves of stability, and the centre of gravity of a container should be assumed to be at the geometric Centre or at an agreed lower point in the case of loaded containers for stability calculation purposes.

8.2.4 *Formation of ice on exposed structures and containers*

When container ships are likely to trade in areas where the formation of ice may be expected regard should be paid to paragraph 8.28 in conjunction with the foregoing.

8.3 Dredgers-General

Such ships are usually engaged in the dredging of sand and gravel from the sea bed for commercial use or the maintenance of channels in rivers or harbours and the dumping of spoil at sea.

8.3.1 *Operating with hold spaces open*

When these ships require to be assigned freeboards in accordance with the Regulations they may qualify for exemption from the provision to fit hatchway covers to their holds provided it can be shown to the satisfaction of Headquarters that when operating at that freeboard they cannot be overloaded and the stability and safety are not impaired when the hold is filled with water, cargo*, or a mixture of water and cargo (see paragraphs 8.3.1.1 to 8.3.1.4 below).

8.3.1.1 *Loading arrangements*

(a) As operational and weather conditions at sea may preclude the accurate checking of draught marks, it is essential to ensure that whenever cargo is being carried the maximum draught permitted cannot be exceeded.

(b) The maximum volume of cargo that can be carried should be determined by multiplying the total cargo dead-weight by the anticipated maximum saturated cargo stowage rate (it might be noted for dredgings lifted from the sea bed around the coast of the UK a stowage rate as low as 0.445 cubic metre per tonne (16 cubic feet per ton) saturated and 0.530 cubic metre per tonne (19 cubic ft per ton) drained has been recorded). If these calculations show that the maximum volume of cargo to be

* Cargo means either dredgings recovered for commercial use or spoil recovered in the maintenance of harbours and rivers

carried is such that the cargo space (hold and coaming) is not completely filled when the ship is at the assigned freeboard, it will be necessary to introduce spillways in the hold or the hatch coamings or to provide other suitable means to prevent possible overloading.

8.3.1.2 *Loading trials*

A loading trial at sea will be required to prove the efficiency of the arrangements provided to prevent overloading on all ships which are not of the 'hopper' type, i.e. those not fitted with bottom doors in the shell or which do not have other means by which the cargo can be speedily jettisoned.

The Surveyor should witness and report upon such trials. The distribution and area of spillways provided should be sufficient to prevent an excessive build up of cargo in the hold and should also be capable of freeing any accumulation of water due to heavy seas breaking over the hatchway. To ascertain that the vessel is not overloaded during the trial it may be necessary to inspect the draught marks from a boat positioned alongside the ship, especially in ships which are not fitted with accurate draught indicators.

For this trial a cargo of the maximum density it is intended to carry should be loaded. The loading should continue to the point when solid material begins to overflow through the spillways prior to the commencement of draining the cargo. At no stage during the trial should the draught associated with the assigned freeboard be exceeded.

8.3.1.3 *Investigation of stability*

The following 'spill out' method should normally be adopted to investigate the stability of these ships. This method takes account of the spillage of saturated cargo and water overboard as the ship heels and may be developed either by direct means or by computer as indicated in sub-paragraphs (a) and (d). Where however an owner can demonstrate that this method is not wholly appropriate to a particular case the MCA will be prepared to consider an alternative method of investigating the stability of the ship.

(a) When the investigation is done by direct means curves should be prepared for the ship at various angles of inclination (see Figure 18) representing:

- the effective volume of the cargo hold to the top of the hatch coaming;
- the cargo heeling lever (y); and
- the KN lever, i.e. horizontal distance between the keel and the centre of buoyancy.

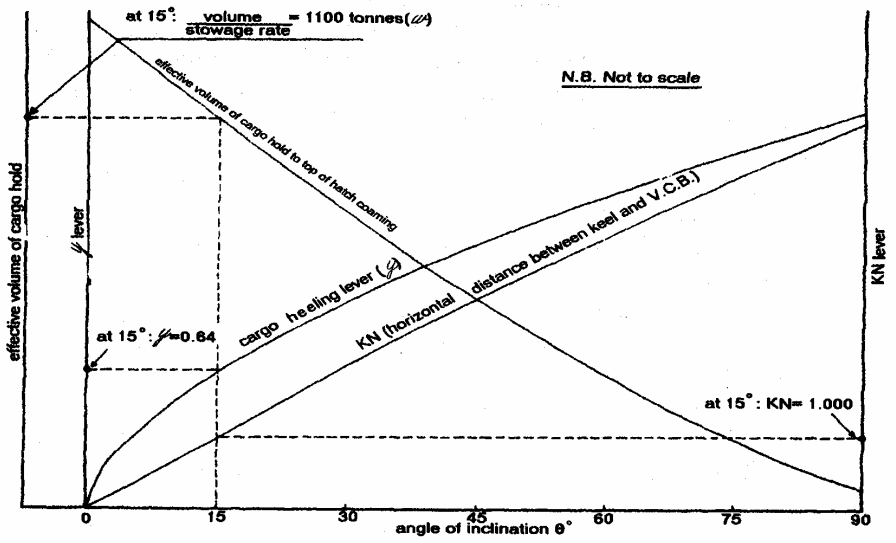
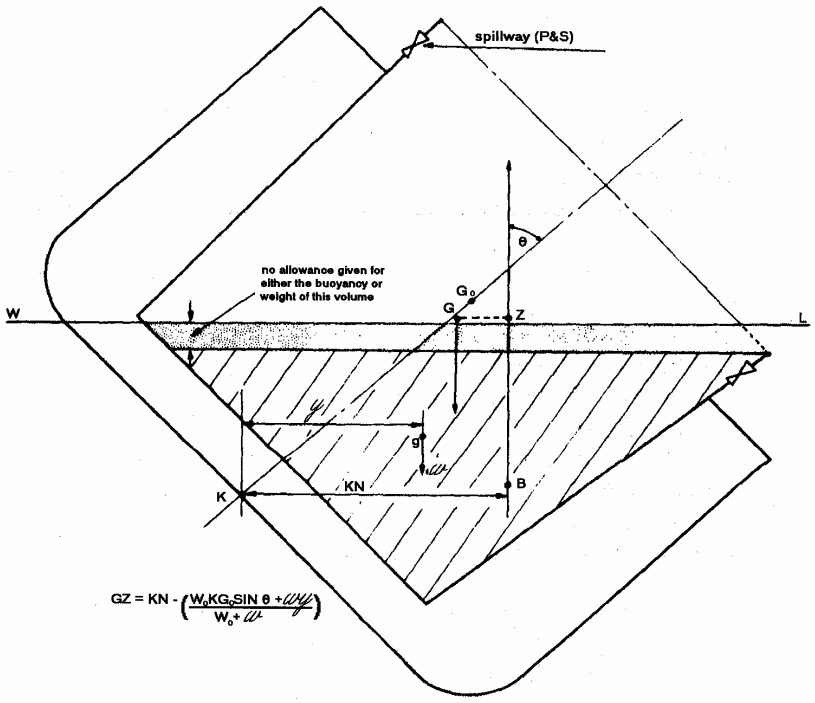


Figure 18



W_o = Displacement of lightship plus O/F, F/W, stores etc
G_o = Centre of gravity of ship at displacement W_o
w = Weight of cargo at angle of inclination θ
g = Centre of gravity at angle of inclination θ
G = Centre of gravity of ship at loaded displacment of $W_o + w$
B = Centre of buoyancy of inclined ship at laoded displacment of $W_o + w$

Figure 19

(b) In developing these curves the cargo surface should normally be assumed to remain horizontal (i.e. parallel to the sea level) and to be touching the top of the hatch coaming. The Surveyor should be satisfied that unrestrained flow will take place over the coaming and no ensuing build up on deck will occur due to constraining structural items. The provision of adequate spillways in order to prevent over-loading and to assist drainage of shipped water is one of the requirements for dispensation from fitting hatch covers. These should not be regarded as effective in rapidly releasing cargo at large angles of keel. The KN lever curve (i.e. cross curve) is derived from calculations which assume that the top of the hold is open and that the buoyancy above the level of the horizontal cargo surface beyond the line of the hatch coaming does not exist (see Figure 19).

(c) An allowance may be given for all erections which have weathertight means of closure and comply with Schedule 6, paragraph 9(4) and (5). The stability conditions prepared for the vessel should include an allowance to take account of the maximum water and sand/gravel in the landers, screens and flumes during dredging operations in the arrival condition. The suction pipes suspended in their operating positions overside and containing spoil should also be taken into account in order to determine whether any substantial difference in vertical moment exists when compared with the pipes in their normal stowed position. In the inclining test account should be taken of the below-water suction pump intakes. The water should be excluded from the intakes or appropriate allowance made.

With this information, curves of righting levers (GZ) for various loaded conditions can be prepared. The initial stability of the ship in the upright condition should be calculated in the normal manner with the metacentric height (GM) corrected for the effect of all free surfaces including that in the main cargo hold where account should be taken of the actual density of the contents therein; normally a specific gravity the mean of that for saltwater and the cargo will be acceptable. This method of investigating the stability characteristics is illustrated by a typical calculation.

Typical calculation of statical stability in loaded condition

1. Initial stability (Ship upright)

Item	Weight (tonnes)	VCG (metres)	Vertical moment	Free surface correction (metres)
Light ship	500	3.35	1675	0.027
Oil fuel	10	1.52	15	0.027
Diesel oil	2	4.57	9	0.015
Lubricating oil	1	4.87	5	0.009
Fresh water	4	2.74	10	0.012
Stores etc	2	0.30	1	–
Light ship, fuel, stores etc (W_o)	519	3.30	1715	0.063
Cargo (w)	1200	2.59	3108	0.610
Load displacement ($W_o + w$)	1719	2.81	4823	0.673

KM	=	4.13
GM (solid)	=	1.32
Free Surface	=	0.673
GM (fluid)	=	0.647

2. Righting lever when $\theta = 15°$

Item	Weight	Lever	Horizontal moment
Light ship, fuel, stores etc (W_o)	519	0.87 (3.363 Sin 15°)	451
Cargo (w)	1100	0.64 (ψ from Figure 18)	704
Loaded ship ($W_o + w$)	1619	0.713	1155

Then GZ at 15° = 1.000 (KN Figure 18) – 0.713
= 0.287 metre

3. Righting lever when $\theta = 30°$

Item	Weight	Lever	Horizontal moment
Light ship, fuel, stores etc (W_o)	519	1.681 (3.363 Sin 30°)	872
Cargo (w)	906	1.210 (ψ from Figure 18)	1096
Loaded ship ($W_o + w$)	1425	1.381	1968

Then GZ at 30° = 1.880 (KN from Figure 18) – 1.381
= 0.499 metre

In the above calculations the value of KG for the light ship, fuel, stores etc, (W_o) is increased by the free surface correction for liquids in oil and water tanks i.e.

3.30 + 0.063 = 3.363 metres

(d) When employing a computer to develop the stability information the following procedure may be adopted.

Stage 1

The basic ship should be considered to consist of two different hull forms ie:

Hull Form 'A'

The volume of the whole ship below the top of the hatchway coaming (see Figure 20). (V_A)

Hull Form 'B'

The volume of the ship as Hull Form 'A' but excluding the volume of the cargo hold (see Figure 21). (V_B)

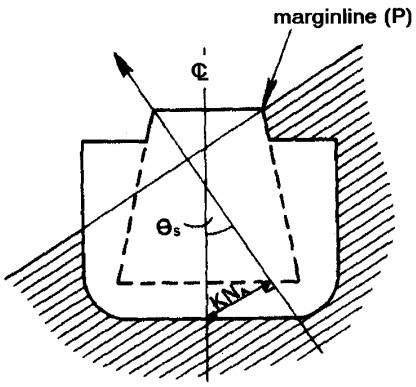


Figure 20

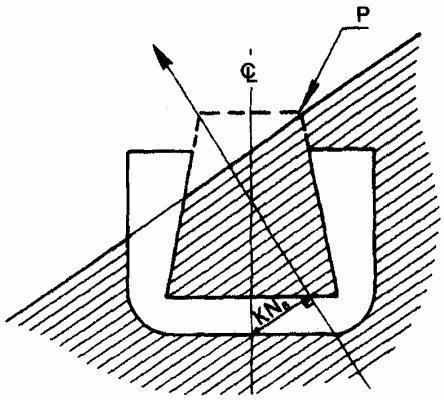


Figure 21

Stability data (ie volume and KN levers of the two hull forms) is derived at different draughts and angles of inclination. Additionally θ_s, the angle at which the top of the hatch coaming (margin line) is submerged, is also given.

From these results curves of volume and KN cross curves are drawn (see Figures 22 and 23).

Stage 2

From the volume curves shown in Figure 22, for any angle $\ominus$

$V_A - V_B$ = volume of cargo in hold = v

and $v \times$ specific gravity of cargo = weight of cargo = w

If W = total displacement of ship in a given loaded condition, then it follows that $W = W_o + w$

where W_o = displacement of ship in 'light' condition with fuel and stores.

w = weight of cargo

and if V = volume of displacement of the ship in the loaded condition then

$$V = \frac{W}{\text{specific gravity of sea water (normally 1.025)}}$$

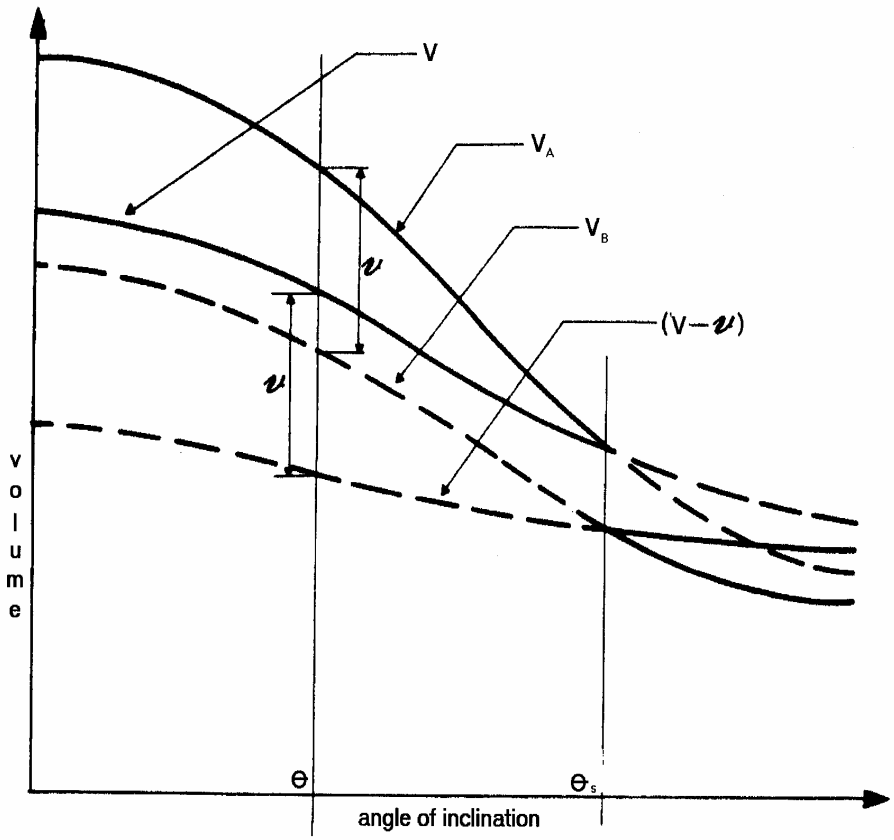
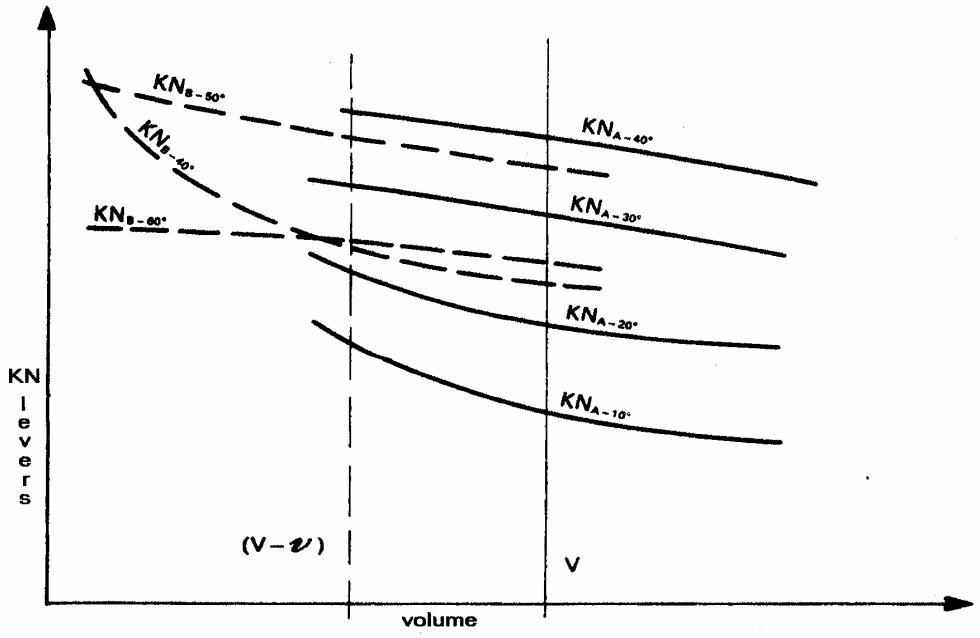


Figure 22



Note: These curves are diagrammatic only as the angle of submersion θ_s can vary from ship to ship and condition to condition.

Figure 23

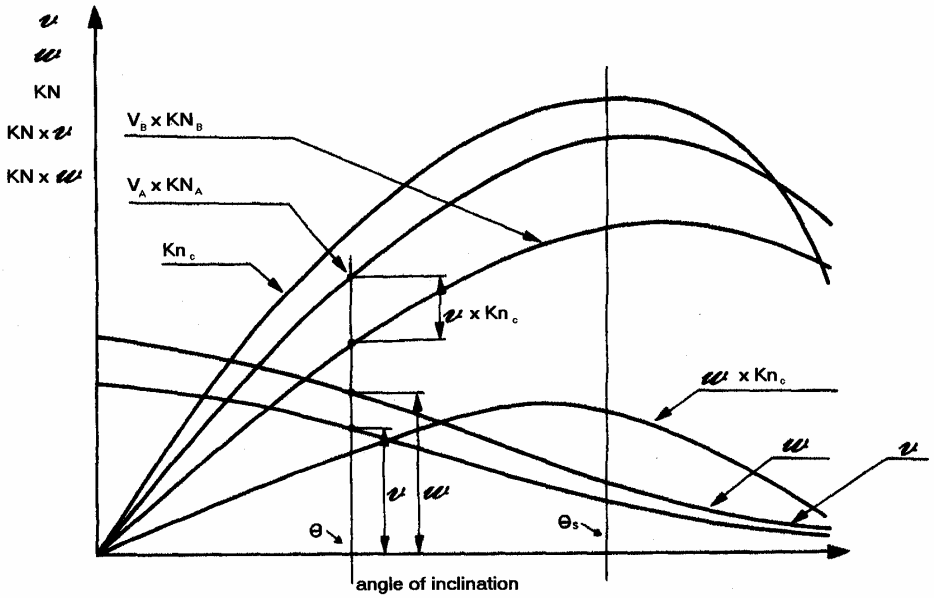


Figure 24

Also, in Figure 22 the point of intersection of the curves $V_A$and V, or V_B and (V-u) indicates the angle θ_s at which the margin line (top of hatch coaming) is submerged for the particular loaded condition V.

Stage 3

Curves of V_A x KN_A, V_B x KN_B , v x Kn_c, w x Kn_c, v,w and Kn_C, are drawn in Figure 24, the values for V_A x KN_A and V_B x KN_B being obtained from Figures 22 and 23.

The difference between these curves will represent the 'moment of volume of load', ie:

(V_A x KN_A) -(V_B x KN_B) = v x KN_C

Stage 4

Using the following formula:

$$GZ = KN - \frac{(W_O \times KG_O \times Sin\theta\ ) + \omega \times Kn_C}{W}$$

the curve of righting levers (GZ) for a particular 'loaded' condition can now be developed observing that the values for KN of Hull Form A are used for angles of θ which are less than θ_s (angle at which the margin line is submerged) and of Hull Form B for angles of θ which are greater than θ_s so that:

KN values for angles of θ less than θs are those KNA values lifted at value V on Figure 23;

and

KN values for angles of θ greater than θ_s are those KNB values lifted at value (V - v) on Figure 23. (These values have to be modified, however, to allow for the buoyancy given by the cargo that remains in the hold). Therefore KN values for angles of θ greater than θ_s are obtained by the formula:

$$KN = \frac{(V - v\ )KN_B + (v \times Kn_C)}{V}$$

With this information all values and curves for any particular 'loaded' condition can be prepared (see Figure 25).

(Note Stage 4 and Figure 23 to derive KN levers and Figure 24 for Kn_C levers).

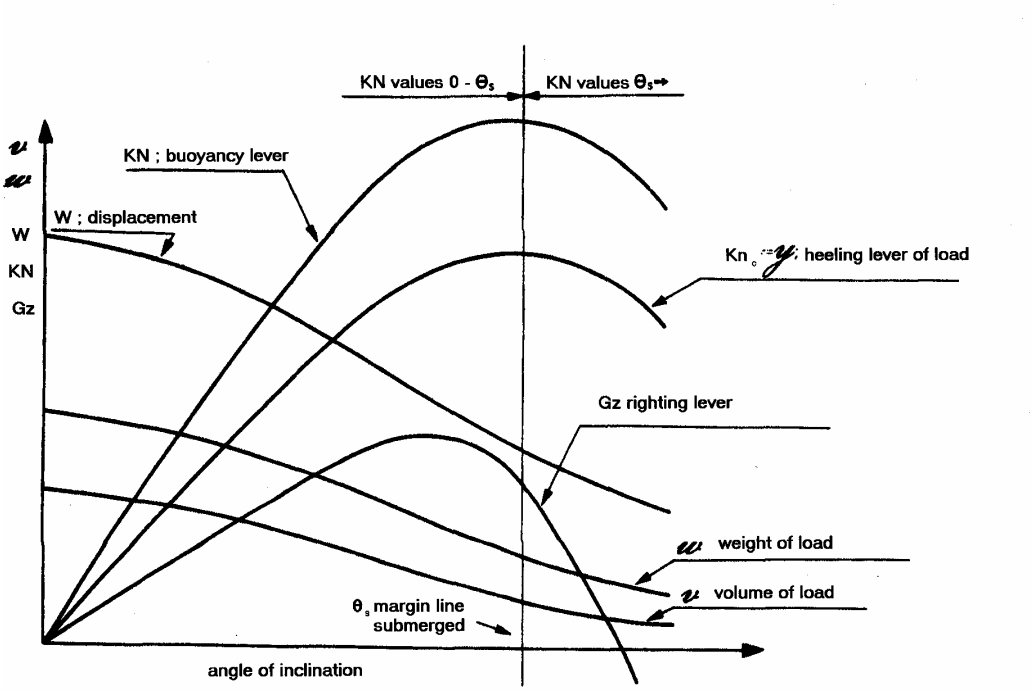


Figure 25

8.3.1.4 *Stability information required*

The stability of the ship is to be fully investigated, and the following minimum number of conditions should be calculated and presented in the Stability Information Booklet;

(a) light ship (if the ship is fitted with bottom doors water should be assumed to be in the hold space); and

(b) the arrival and departure condition for the ship loaded with:

- water ballast;
- cargo of the anticipated maximum density; and -cargo of the anticipated minimum density.

Due to the large volume of water and the resultant free surface effect which exists in the early stages of loading a suction type dredger a more onerous condition may then exist than when the ship is fully loaded. The GZ curves for the final conditions of loading should therefore have superimposed upon them curves indicating the statical stability of the ship in the early stages of loading i.e. when the hold contains only 1/3 of the intended load of dredgings plus the relative quantity of water.

(c) In a ship fitted with double bottom doors or other similar means of jettisoning cargo a condition to indicate the heeling effect should the doors on one side fail to open when the ship is

in its worst condition as regards to stability, e.g. as in paragraph 8.3.1.4(b) above.

8.3.1.5 *Survey of hopper type ship*

The Surveyor should ensure that in hopper type ships the bottom doors or other arrangements for the jettisoning of cargo are fitted with controls which are readily accessible for use in an emergency and these items should be regularly surveyed and seen to operate efficiently.

8.3.1.6 At least two cases of foundering whilst dredging for sea aggregate have been attributed to negligence in maintaining the integrity of the buoyancy spaces. The unique operation of such vessels involving the loading of cargo at sea should be accompanied by special care to ensure that all void spaces are checked at regular intervals during the loading operations as well as throughout the voyage to confirm that the bilge water is minimal: scrupulous use should be made of all means of preventing the entry of water. Efficient maintenance of all equipment associated with the integrity of these spaces should be ensured; in particular this applies to hatchway, ventilator and air pipe closures and bilge, ballast and dredging pipe systems. Where closing devices are in vulnerable positions secondary as well as primary means should be provided where practicable, e.g. ball valves and plugs for air pipes near the ship's side and screw down closure for non-return valves through the shell.

It is essential that Masters maintain constant vigilance to ensure that water does not get into void spaces even though special equipment has been provided for detecting flooding.

8.3.2 *Operating with hold spaces closed*

8.3.2.1 For ships designed to operate with their hold spaces closed with either hatch covers or by permanent means, the investigation of the stability by the 'spill-out' method is inappropriate. In such cases the normal free surface correction should be applied for the cargo in the hold (suitably amended for density) when calculating the stability for various conditions of loading.

8.3.2.2 The MCA is prepared however to consider dispensing with the free surface correction for the cargo in the hold provided either the shipbuilders or their consultants can show to the satisfaction of Headquarters that during the collection of dredgings the water content is removed expeditiously. In this case the ship's stability should be investigated by assuming the cargo of dredgings to shift as the ship rolls. The intact stability could then be considered adequate if after taking account of any cargo shift the following maintains:

(a) the angle of heel does not exceed 65% of the angle at which the deck edge is immersed in water; and

(b) the residual dynamic stability measured up to 30 degrees beyond that angle of heel is not less than 0.10 meter radian.

The cargo shift moments for anyone continuous section of the hold should be calculated as follows:

$$\text{horizontal heeling moment} = \frac{1}{12} p \tan \alpha \int_o^l b^3$$

$$\text{*Vertical moment} = \frac{1}{24} p \tan^2 \alpha \int_o^l b^3$$

Where ℓ = length of section of hold

b = breadth of section of hold

p = density of cargo

α= surface angle shift (to be taken as 20 degrees).

The ship will be required to comply in all other respects with the requirements of paragraphs 8.3.1.1, .2, .4 and .5.

8.3.3 *Less than statutory minimum freeboards*

The MCA is prepared to consider applications for the assignment of a freeboard reduced to 5/8 (table B), 1/2 (Table B-60) or 1/2 (Table B-l00) subject to the minimum freeboard of 150 mm and to the following:

8.3.3.1 the strength of the ship being shown to be adequate at the draught associated with the decreased freeboard;

8.3.3.2 the ship being of the 'hopper' type, i.e. fitted with bottom doors in the shell or have other means of jettisoning the cargo quickly under all seagoing conditions and in an emergency. The cargo releasing arrangements on a ship assigned a freeboard less than 5/8 (Table B) should be capable of jettisoning sufficient cargo within 4 minutes to enable the requirements of sub-paragraph (e) below to be complied with. In each case details of the arrangements are to be submitted to Headquarters for examination and approval;

8.3.3.3 the operational limits (normally not exceeding 15 miles from land) and favourable weather (i.e. fine, clear settled weather with a sea state such as to cause only moderate foiling and/or pitching). Where other weather criteria are proposed, or a ship is to operate in foreign waters, reference should be made to Headquarters;

* This value divided by the ship's displacement will give the resultant rise in the ship's KG

8.3.3.4 the intact stability criteria given in paragraph 5.6 of these Instructions, being achieved at the proposed decreased freeboard; and

8.3.3.5 (a) in any ship where a freeboard equivalent to 1/2 (Table B- 60) is assigned, the ship being capable of surviving in a manner stated in paragraph 5.7.4 of these Instructions after sustaining damage to the total extent indicated in Schedule 4 paragraph 5(7) or 5(8) depending upon the date of build, and paragraphs 5.7.4.3 to 5.7.4.8 inclusive of these Instructions to anyone compartment, including the machinery space;

(b) in the case of a ship built before 8 June 2000 where a freeboard equivalent to 1/2 (Table B-100) is assigned, the ship being capable of surviving in a manner stated in paragraph 5.7.4 of these Instructions after sustaining damage to the total extent indicated in Schedule 4 paragraph 5(7) and paragraphs 5.7.4.3 to 5.7.4.8 inclusive of these Instructions to the machinery space alone, or to any other two adjacent fore and aft compartments;

(c) in the case of a ship built on or after 8 June 2000 where a freeboard equivalent to 1/2 (Table B-100) is assigned, the ship being capable of surviving in a manner stated in paragraph 5.7.4 of these Instructions after sustaining damage to the total extent indicated in Schedule 4 paragraph 5(8) and paragraphs 5.7.4.4 to 5.7.4.8 inclusive of these Instructions to anyone bulkhead such that any two adjacent fore and aft compartments are flooded simultaneously, except that such damage will not apply to the boundary bulkheads of a machinery space. Additionally such ships must be capable of surviving flooding of the machinery space alone;

(d) in the damage stability calculations it may be assumed that a proportion of the cargo is capable of being jettisoned immediately after the collision provided the cargo releasing arrangements are so designed that they will operate after the ship has sustained the total assumed damage.

(e) draught indicators being fitted to ships requiring freeboards of 1/2 (B-60) or less.

8.4 Dredgers-Bucket

8.4.1 When bucket dredgers and similar type ships undertake coastal or international voyages, either under their own power or under tow, special consideration should be given to the preparation of the ship for the intended voyage to ensure that there will be adequate stability. Surveyors should take into account the following:

8.4.1.1these ships usually have high ‘beam to draught’ ratios and relatively small freeboards;

8.4.1.2 owing to the large amount of top weight normally carried they are very susceptible to rolling;

8.4.1.3 the necessity to prepare a 'curve of statical stability' for seagoing conditions when investigating the stability characteristics; and

8.4.1.4 the following stability standard which is recommended as a minimum for such ships:

(a) the voyage freeboard should be sufficient to prevent the freeboard deck edge becoming immersed before an angle of heel of 12.5 degrees is reached;

(b) the range of stability should be at least 45 degrees;

(c) the maximum GZ value should be at least 0.61 meters; and

(d) the maximum GM value should be at least 1.22 meters.

8.4.2 Wherever any such ship is required to make an extended voyage details of the preparation of the ship and stability characteristics should be approved by the Marine Office;

8.4.3 The bucket ladder of a dredger not in service should be raised so that the lowest bucket on the ladder does not project below the underside of the keel. It is recommended that the weight of the ladder and associated buckets in such circumstances should be taken on an athwartship bar fitted across the bucket well. This will ensure that the ladder will not touch ground first on a falling tide and give rise to stability problems.

8.5 Mobile Offshore Drilling Units and Ships

8.5.1 Load line and stability (both intact and damaged) criteria for Mobile Offshore Drilling Units are contained in the Code for the Construction and Equipment of Mobile Offshore Drilling Units (MODU Code).

8.5.2 Ships specially constructed for drilling operations should satisfy the requirements of Regulation 32, Schedule 2 Part 1 paragraph 2 (2) and Schedule 6 for all conditions of operation, i.e. when proceeding to or from a drilling location, drilling afloat etc.

8.5.3 In addition it will be necessary to ensure that these ships comply with intact and damaged stability criteria contained in the (MODU Code).

8.6 Floating Cranes, Tin Dredgers, Grain Elevators and Units of Similar Type

Units of the above types have large top structures above the pontoon or freeboard deck and are not normally intended for sea service. Special attention should therefore be paid to the probable effect of strong winds upon the lateral

areas when such craft are required to make occasional coastal or international voyages and Surveyors should be guided by the following:

8.6.1 all practical efforts should be made to reduce the height of the centre of gravity to ensure that at an angle of 15 degrees, a vertical line through the KG would not lie beyond the line of the deck edge (see figure 28);

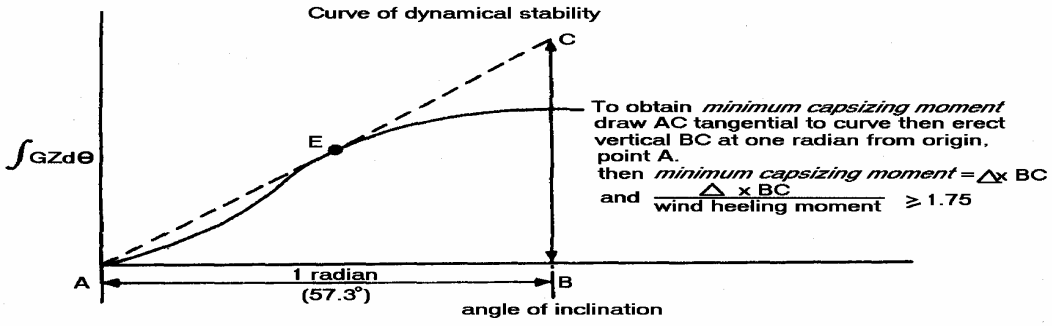


Figure 27

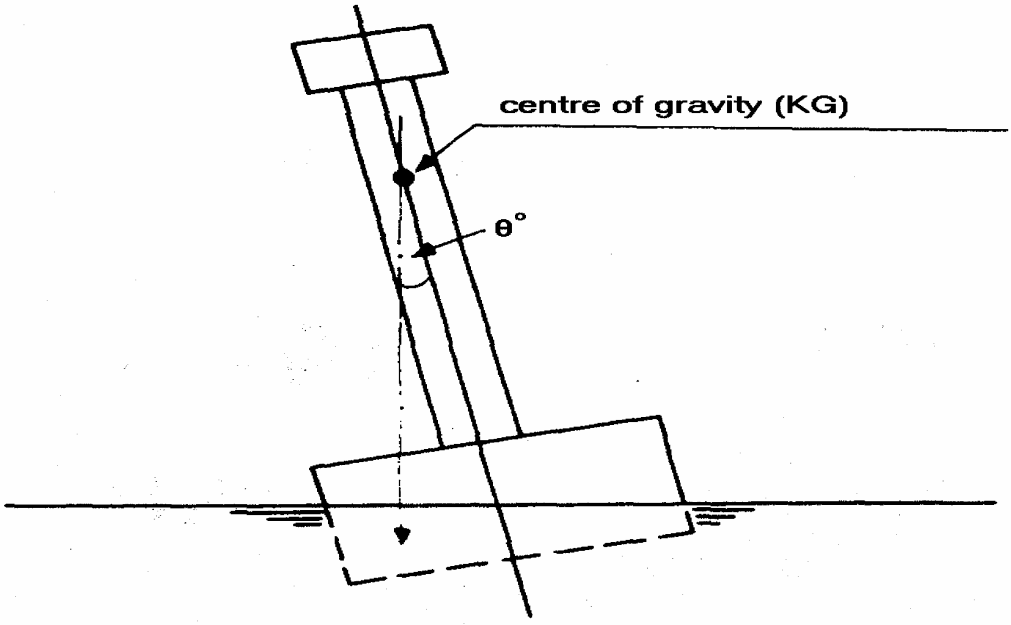


Figure 28

8.6.2 the ratio between the 'minimum capsizing moment' (as determined from the dynamical stability curve) and the heeling moment produced by a wind - pressure associated with the Beaufort Scale 10, i.e. 48.5 kg/m applied to the , lateral windage area (the lever for this moment being measured to an axis at mid-draught) should not be less than 1.75 (see figure 27);

8.6.3 the windage area, its centre of gravity and the lever to mid draught is to be stated in the stability report;

8.6.4 when subjected to a wind moment equal to that in paragraph (b) above the craft should not heel to an angle where a vertical line through the KG (in the inclined position) would lie beyond the deck edge or to an angle of 15 degrees, whichever is the lesser (see figure 28); and

8.6.5 the final preparation of the unit prior to its departure should be to the Surveyor's satisfaction.

8.7 Fishing Boats which Carry Cargo

8.7.1 If the vessel is clearly no longer operating as a fishing vessel because no appropriate national certification is on board or there have been structural conversions from fishing capabilities to facilitate carriage of cargo other than fish or fishing gear has been removed or the vessel is for the time being carrying cargo other than fish, the vessel must be regarded as a cargo vessel.

8.7.2 In the case of a vessel built or adapted to carry live fish as cargo in a free-flooding hold it is appropriate to treat it as a load line exemption case. The operating conditions and stability characteristics would require special consideration and information and this should be obtained from Headquarters.

8.7.3 Fishery research vessels which are equipped for the catching of commercial quantities of fish should be required to satisfy intact stability criteria appropriate to such vessels.

8.8 High Speed Craft including Hydrofoils and Multi Hulled Craft

These vessels are generally subject to the Merchant Shipping (High Speed Craft) Regulation 5 and therefore should comply with the provisions of the International Code of Safety for High Speed Craft. Load line exemption certificates will normally be issued. Reference should be made to paragraph 1.8.3 and to International Code of Safety for High-Speed Craft: Instructions for the Guidance of Surveyors.

8.9 Passenger Ships

8.9.1 Passenger ships of Classes I, II and II(A), are required to comply with the relevant parts of the Merchant Shipping (Passenger Ship Construction: Ships of Classes I, II and II(A)) Regulations 1998 and the associated Merchant Shipping Notices in respect of stability, subdivision and damaged stability.

8.9.2 Passenger ships of Classes III to VI(A) are required to comply with Merchant Shipping (Passenger Ship Construction: Ships of Classes III to VI(A)) Regulations 1998 and the associated Merchant Shipping Notices in respect of stability, subdivision and damaged stability.

8.9.3 Ro-Ro passenger ships should additionally comply with the Merchant Shipping (Ro-Ro Passenger Ship Survivability) Regulations 1997.

8.9.4 *The status of persons carried on United Kingdom ships*

8.9.4.1 The legal status of persons on board a UK ship has come under close scrutiny; in particular the distinction between 'persons engaged on the business of the ship' and 'passengers'.

8.9.4.2 The current legal definition of a passenger is given in Regulation 2(2) of the Merchant Shipping (Passenger Ship Construction: Ships of Classes I, II and II(A)) Regulations 1998 which states:

in these Regulations the expression 'passenger' means any person carried in a ship, except:-

(a) a person employed or engaged in any capacity on board the ship on the business of the ship;

(b) a person on board the ship either in pursuance of the obligation laid upon the master to carry shipwrecked, distressed or other persons, or by reason of any circumstance that neither the master nor the owner nor the charterer (if any) could have prevented; and

(c) a child under one year of age".

and 'passenger ship' means a ship carrying more than 12 passengers and propelled by electricity or other mechanical power".

8.9.4.3 The only persons who should be considered as being lawfully "employed or engaged on the business of the ship" are those over the minimum school leaving age (about 16 years) who:

(a) have a contractually binding agreement to serve on the ship in some defined capacity and which could include carrying out such duties under training or are:

(b) duly signed on members of the crew.

8.10 Sail Training Ships

The Code of Practice for Safety of Large Commercial Sailing and Motor Vessels contains the stability requirements for such ships over 24 metres in length.

8.11 Tugs

8.11.1 For tugs which proceed to sea and subject to the requirements of the Merchant Shipping (Load Line) Regulations 1998. The stability criteria to be achieved and approved by the MCA are as laid down in Schedule 2 Part 1, paragraph 2 of MSN 1752(M).

8.11.2 The MCA wishes to emphasise the danger of capsizing which may occur when the tow rope reaches a large angle to the centre line of the tug and therefore any tug cannot be slipped (a position commonly known as 'girting'). In vessels having towing hooks forward of the propulsion devices(usually rear amidships) girting may be difficult to recover from).

Contributory causes leading to a capsize under such circumstances are:

- small freeboard
- poor curve of righting levers
- closing appliances to spaces leading below not secured.

In order to reduce the grave dangers associated with such conditions, particularly with smaller tugs engaged on harbour duties, the MCA make the following recommendations:

8.11.2.1 The design of the towing gear should be such to minimise the overturning moment due to the lead of the towline and that the towing hook should have a positive means of quick release which can be relied upon to function correctly under all operating conditions. It is desirable that the release mechanism should be controlled from the wheelhouse, the after control position (if fitted) and at the hook itself. The local control at the hook should preferably be of the direct mechanical type capable of independent operation. It is also essential that the greatest care should be taken in the maintenance of the towing gear at all times. In tugs where the propulsive thrust acts other than at the stern, special consideration should be given to the position of the tow hook or towing winch.

8.11.2.2 Openings in superstructures, deckhouses and exposed machinery casings situated on the weather deck, which provide access to spaces below that deck, should be fitted with doors which comply with requirements for weathertight doors contained in paragraph 1, Schedule 2 of MSN 1752(M). Such doors should be kept closed during towing operations. Engine room ventilation should be arranged by means of high coaming ventilators and air pipes should be fitted with automatic means of closure.

8.11.2.3 Stability criteria for tugs not subject to the requirements of the Merchant Shipping (Load Line) Regulations 1998:

In the normal working condition, the freeboard should be such that the deck edge is not immersed at an angle of less than 10 degrees, and the GM in the worst anticipated service condition should not be less than:-

$$\frac{0.076K}{f.C_B}$$

Where: K = 1.524 + 0.08L –0.45R

L = Length of vessel between perpendiculars (metres)

R = Length of radial arm of towing hook (metres)

f = Freeboard (metres)

C_B= Block coefficient

Any existing tug which cannot attain the GM calculated in accordance with the above might nevertheless gain some improvement in her stability by having structures on the weather deck properly closed in accordance with paragraph 8.11.2.2 above.

8.11.2.4 In some cases where compliance with the recommendations in sub-paragraphs 8.11.2.2 and 8.11.2.3 above cannot readily be attained consideration should be given to:

- substitution of permanent ballast for water ballast and conversion of peak ballast spaces to dry spaces; and/or

- fitting a permanent device to minimise the possibility of the tow lead coming into the athwart position.

8.12 Safety of Towed Ships and Other Floating Objects.

8.12.1 The towage at sea of ships and other floating objects has become a common practice, particularly as offshore oil and gas reserves have been exploited and shipbreaking yards have developed the capacity to handle large ships. Many of these tows have been carried out in circumstances of potential danger to navigation and the environment. Various types of towing vessels have evolved to carry out these tows to ensure that, so far as is practicable, the operations are safe.

8.12.2 The Maritime Safety Committee of the International Maritime Organisation, in order to encourage high standards of safety in towing operations, has approved recommendations for such operations. These recommendations are drawn to the attention of all UK operators engaged in the towing of ships and other floating objects, as follows.

8.12.2.1 Planning

(a) The route to be followed should be planned in advance taking into account such factors as the weather, tidal streams and currents, and the size, shape and displacement of the tow and the navigational hazards to be avoided. Weather routing advice should be used where available. Careful consideration is to be given to the number and effective bollard pull of towing ship or ships to be employed.

(b) There should be a contingency plan to cover the onset of adverse weather, particularly in respect to arrangements for heaving to or taking shelter.

(c) Where the towing operation falls under the jurisdiction of an approved authority, any certificate issued should specify the intended route and indicate any special conditions.

8.12.2.2 Preparation

(a) Tows must exhibit the navigation lights, shapes and, if manned make the sound signals required by the International Regulations for Preventing Collisions at Sea, 1972 as amended. Due consideration should be given to the reliability of the lights and sound signals and their ability to function for the duration of the voyage. It is most desirable that a duplicate system of the lights be provided.

(b) Prior to sailing, the watertight integrity of the tow should be confirmed by an inspection of the closing arrangements for all hatches, valves, air pipes, and other openings through which water might enter. It should also be confirmed that any watertight doors or other closing arrangements within the hull are securely closed and that any portable closing plates are in place.

(c) The securing arrangements and weather protection for the cargo, equipment and stores carried on the tow should be carefully examined to ensure that they are adequate for the voyage.

(d) When appropriate, the rudder should be secured in the amidships position and measures taken to prevent the propeller shaft from turning.

(e) The tow should be suitable draught for the intended voyage.

(f) The tow should have adequate intact stability in all the loading and ballast conditions to be used during the voyage.

(g) The tow should be equipped with an anchor, suitable for holding the tow in severe weather conditions, that is securely attached to a cable or wire and is arranged for release in an emergency either by persons on the tow or who board the tow for this purpose.

(h) Life-saving appliances in the form of lifejackets and lifebuoys should be provided whenever personnel are likely to be on board the tow even if only for short periods. When personnel are expected to remain on board for longer periods

of time, liferafts should be provided. Other life-saving appliances, including distress signals, fire appliances and radio equipment, including means of communication with the towing ship, should be provided whenever the tow is continually manned.

(i) Boarding facilities should be provided so that personnel from the towing ship can board in an emergency.

(j) To reduce the risk of pollution, the amount of oil carried on the tow should be limited to the amount that is required for the safety of the tow and for its normal operations.

8.12.2.3 Towing Arrangements

(a) The towing arrangements and procedures should be such as to reduce to a minimum any danger to personnel during the towing operation.

(b) The towing arrangements should be suitable for the particular tow and they should be of adequate strength.

(c) The design and arrangements of towing fittings should take into account both normal and emergency conditions.

(d) Sufficient spare equipment to completely remake the towing arrangements should be available.

(e) Secondary or emergency towing arrangements should be fitted on board the tow so as to be easily recoverable by the towing ship in the event of a parting of the main towing wire or a failure of ancillary equipment.

8.12.2.4 The Towing Operation

(a) The towing operation should be in the charge of a competent towing master. Other towing personnel should be suitably experienced and sufficient in number.

(b) The tow should not proceed to sea until a satisfactory inspection has been carried out by the towing master and, when considered to be necessary, by another competent person, of the towing vessel, towage arrangements on the tow and towing equipment.

(c) In special cases, where particular circumstances or factors signify a increased risk to the tow, or where the risk cannot be evaluated on the basis of seafaring and nautical knowledge and experience alone, the towing master should apply for survey in accordance with the guidelines of a competent organisation or authority as appropriate.

(d) In the special cases referred to in 4.3, coastal state authorities should be informed in advance of a tow, after departure, coast radio stations or coastguard should be kept informed of the progress.

8.12.2.5 In an emergency

(a) Should the tow present a direct danger to navigation, offshore structures or coastlines through breaking adrift or for some other cause, the master of the towing ship is obliged by the Merchant Shipping (Navigational Warnings) Regulations 1996 (SI 1996 No. 1815) to communicate the information by all the means at his disposal to ships in the vicinity, and also to the competent authorities at the first point on the coast with which he can communicate.

(b) In all cases, the arrangements for recovering the tow, should it break adrift, are to be made in accordance with good seamanship bearing in mind the seasonal weather conditions and areas of operation.

8.12.3 When a manned tow is planned, the MCA should be advised in good time. It will be necessary to comply with all statutory safety requirements including those for life-saving appliances, fire appliances and radio.

8.12.4 Whether manned or not, any vessel towed to sea must be issued with a load line or load line exemption certificate unless it is a warship, a fishing vessel, a pleasure vessel not engaged in trade, an unregistered Government ship or a vessel exempt under the Merchant Shipping (Load Line) Regulations 1998, which is towed within the limits specified in respect of such exemption in Regulation 4. In those cases where a load line exemption certificate is not required, it is essential for the owner and the person in charge of the tow (the towing master) to ensure that the vessel has been properly prepared, in order that the voyage may be made in safety and without presenting a hazard to other shipping or offshore installations.

8.12.5 The exceptions listed in paragraph 8.12.4 above do not apply when such vessels are sold for breaking up and are no longed owned by Her Majesty's Government or registered under the Merchant Shipping Acts. Under those circumstances they will require to be issued with load line or load line exemption certificates.

8.13 Chemical Tankers

Requirements for damage stability of ships carrying dangerous chemicals in bulk are imposed by the Merchant Shipping (Dangerous or Noxious Liquid Substances in Bulk) Regulations 1996 and the Merchant Shipping (Dangerous Goods and Marine Pollutants) Regulations 1997.

8.14 Gas Carriers

Requirements for damage stability of ships carrying liquefied gases in bulk are imposed by the Merchant Shipping (Gas Carriers) Regulations 1994 and the Merchant Shipping (Dangerous Goods and Marine Pollutants) Regulations 1997.

8.15 Offshore Supply Vessels

Due to the hull form typically used for these vessels, intact stability criteria contained in IMO Resolution A 469(XII) may be substituted as an equivalence to Schedule 2 of MSN 1752(M).

8.16 Offshore Standby Vessels

8.16.1 These vessels attending offshore installations which are provided with enclosed reception areas into which survivors can be recovered from the sea are typically fitted with shell doors leading to a special watertight compartment close to the waterline.

8.16.2 In order to reduce the risk of serious flooding occurring whilst the shell door(s) is open, the following safeguards should be taken in respect on those operational UK stand-by vessels fitted with shell doors in the ship plating having the Survivor Reception Area on the freeboard deck. These safeguards are:

8.16.2.1 the minimum assigned freeboard (which may be treated as an all seasons freeboard) is not less than 600mm. Where, however, the access doors are fitted in a protected position clear of the shipside, or where due the sheer/trim the actual distance between the water line and the point of embarkation exceeds 750mm, consideration may be given to the assignment of a lesser freeboard;

8.16.2.2 the shell door(s) to be substantially constructed, fitted with efficient means of closure and with a sill of at least 150mm in height. In addition the shell door(s) to be fitted with an electronic device which indicates in the wheelhouse when it is in the open position;

8.16.2.3 The shell doors give direct access to the 'Survivor Reception Area' i.e. a totally enclosed water-tight compartment. Whenever practicable the means of exit from the Survivor Reception Area into the ship's accommodation spaces to be via vertically rising companionway. If this is not practicable an inward opening (i.e. into the Reception Area) weathertight door with sill of at least 600mm in height to be fitted in one of the enclosing bulkheads.

8.16.2.4 The Survivor Reception Area is provided with efficient means of drainage.

8.16.2.5 Telephonic communications are provided between the Survivors Reception Area and the wheelhouse.

8.16.3 Classification Societies have been asked to ensure that these safeguards are incorporated in any operational UK Stand-by Vessel before the issue of a Load Line Certificate.

8. 1 7 Pontoon Barges

8.1 7.1 *Scope*

A pontoon is considered to be normally:

- non self-propelled;
- unmanned;
- carrying only deck cargo;
- having a block coefficient of 0.9 or greater;
- having a breadth/depth ratio of greater than 3.0; and
- having no hatchways in the deck except small manholes closed with gasketed covers.

8.17.2 *Stability Test*

An inclining experiment is not normally required for a pontoon, provided a conservative value of the lightship vertical centre of gravity (KG) is assumed for the stability calculations. The KG can be assumed at the level of the main deck although it is recognised that a lesser value could be acceptable if fully documented. The lightship displacement and longitudinal centre of gravity should be determined by calculation based on draught and water density readings.

8.17.3 *Stability drawings and calculations*

8.17.3.1 The following information is typical of that required to be submitted to the MCA for approval:

(a) lines drawings;

(b) hydrostatic curves;

(c) cross curves;

(d) report of draught and density readings and calculation of lightship displacement and longitudinal centre of gravity;

(e) calculations of the lightship and vertical centre of gravity where an inclining test is not carried out;

(f) calculations demonstrating compliance with the intact stability criteria; and

(g) simplified stability guidance such as a loading diagram, so that the pontoon may be loaded in compliance with the stability criteria.

8.17.3.2 Calculations should take into account the following:

(a) no account should be taken of the buoyancy of deck cargo (unless buoyancy credit for adequately secured timber);

(b) special consideration should be given to such factors as water absorption (e.g. timber), trapped water in cargo (e.g. pipes), and ice accretion;

(c) assumptions for wind heeling effect calculations:-

- the wind pressure should be constant and for general operations be considered to act on a sol id mass extending over the length of the cargo deck and to an assumed height above the deck.
- the centre of gravity of the cargo should be assumed at a point mid-height of the cargo; and
- the wind lever arm should be taken from the centre of the deck cargo to a point at one half the draught;

(d) calculations should be performed covering the full range of operating draughts; and

(e) The downflooding angle should be taken as the angle at which an opening through which progressive flooding may take place is immersed. This would not be an opening closed by a watertight manhole cover or vent fitted with an automatic closure.

8.17.4 *Intact Stability Criteria*

In the case of vessels whose characteristics render compliance with paragraph 2(2)(c) of Schedule 2 of MSN 1752(M) impossible, the following criteria may be applied.

8.17.4.1 The area under righting lever curve up to the angle of maximum righting lever should not be less than 0.08 metre-radians.

8.17.4.2 The static angle of heel due to a uniformly distributed wind load of 0.54 kPa (wind speed 30m/sec) should not exceed an angle corresponding to half the freeboard for the relevant loading condition, where the lever of wind heeling moment is measured from the centroid of the windage areas to half the draught.

8.17.4.3 The minimum range of stability should be:

For L <100 metres 20 degrees

For L > 150 metres 1 5 degrees

For intermediate lengths by interpolation.

8.18 Multiple Pontoon Units

8.18.1 The use at sea of multiple pontoon units linked together is typically found in civil engineering projects in inshore waters. Subject to appropriate survey arrangements this type of unit may be dealt with by the issue of a load line exemption certificate. (See paragraph 1.8)

8.18.2 Having established the nature of the proposed activity, taking into account the area of operation, how the unit reaches the area, whether the unit is self-propelled or not and the number of personnel carried at each stage, the Surveyor should obtain from the Owners the following information:

8.18.2.1 plans showing the form of construction and general arrangements of the complete unit. Details of each type of pontoon and the means by which connections between pontoons are made;

8.18.2.2 the intended operating draught and displacement of the unit in its fully loaded condition;

8.18.2.3 calculations to show the stability of the unit when in its transit and working conditions.

8.18.2.4 details of any working procedures carried out whilst the unit is afloat or involving the use of "spuds" resting on the sea bed; and

8.18.2.5 details of any anchoring arrangements provided.

8.18.3 The initial survey of the unit for issue of the load line exemption certificate should comprise internal and external inspection of all component pontoons and their coupling links. The power unit, if any, should be surveyed as would be a conventional powered vessel under the load line regulations, paying attention to the protection of openings in the deck, coaming heights, ventilator and airpipe closures and shell inlets and discharges, all having regard to the intended service.

8.18.4 Having been satisfied with the matters described above, the Surveyor should ensure that the stability characteristics of the unit are established by witnessing a lightweight check carried out by a competent team. A trim and stability statement should be prepared, based on the results of the lightweight check. The minimum permissible freeboard in the loaded condition should be marked at amidships on each side of the unit by means of a "draught limiting mark" consisting of a painted white line 1800mm long by 150mm deep. Before proceeding to sea the unit should comply additionally with the following:

8.18.4.1 guardrails and stanchions should be fitted at the periphery of deck working areas;

8.18.4.2 all items carried on deck should be provided with efficient means of securing;

8.18.4.3 adequate lifesaving and firefighting equipment should be carried;

8.18.4.4 regulation light and sound signals should be carried with suitable power sources;

8.18.4.5 anchoring and mooring equipment should be carried;

8.18.4.6 appropriate navigation aids should be carried;

8.18.4.7 for units designed to be beached a ladder for embarkation should be provided; and

8.18.4.8 for units without self-propulsion the recommendations of paragraph 8.12 should be observed.

8.18.5 A regime of periodical inspection of the unit, for the purpose of annual review of the certification by the Marine Office, should comprise a formal agreement with the Owners as follows:

8.18.5.1 each pontoon intended for use at sea shall be maintained in sound structural and watertight condition and regularly examined by the Owners' Superintendent as follows:

(a) externally every two years;

(b) externally, with an air-pressure test before being used;

(c) externally immediately after being used;

(d) internally, with an air-pressure test every five years; and

(e) internally and externally each year in the case of a power unit, including closing appliances and shell fittings in the inspection.

8.18.5.2 the Owners should maintain the records of inspections, tests and repairs carried out on each pontoon. Copies of the records should be forwarded at annual intervals to the Marine Office, or earlier if a change of use is proposed.

8.18.5.3 When such a change is proposed the Owners should apply for a new load line exemption certificate, to the appropriate Marine Office in good time, stating in their application:

(a) the name/configuration of the unit, with copies of the inspection/maintenance records of each pontoon being employed;

(b) the place where and the time when the unit will be assembled ready for use;

(c) the intended area, period and nature of the new operation;

(d) details, including weights, of the items to be carried; and

(e) the maximum number of personnel to be employed on the unit whilst afloat.

8.18.5.4 The Surveyor should then check the Owners records to ensure they apply to the actual pontoons used, examine the pontoons externally, and in the case of a powered pontoon, internally as well. The marking of the unit and provision of equipment appropriate to the intended service should then be verified prior to the issue of the new certificate.

8.18.5.5 A similar procedure may be followed when a simple renewal without a change of service is required at an anniversary date.

8.18.5.6 The wording on the exemption certificate should include:

(a) the stipulated operating area, including any transit voyages;

(b) appropriate weather limits; and

(c) a prohibition on submerging the "draught limiting mark" at any time.

Types of Cargo

8.19 Ballast

All ships make occasional voyages in a ballast condition and the type of ballast (solid or liquid) carried will affect the ship's stability and is of particular concern to the Master. Regard should therefore be paid to the following:

8.19.1 liquid ballast e.g. water, oil or liquid mud should always be carried in preference to solid ballast, and when carried account must always be taken of the free surface effects;

8.19.2 the amount of ballast carried should be dependant upon the provision of adequate stability to ensure that the ship will be both safe and comfortable in a seaway;

8.19.3 solid ballast should always be trimmed level and, as even a well reputed type (e.g. pig iron) 'properly trimmed' shifts very rapidly when inclined to an angle of 30 degrees, shifting boards of adequate strength, properly supported and effectively secured, should be fitted;

8.19.4 solid ballast carried in the hold is less liable to shift than when carried in the 'tween decks or on open decks and only the minimum quantity necessary to prevent the ship from being unduly 'stiff' should be carried in these latter spaces. It is essential however to ensure that the ballast is so positioned that there is an adequate reserve of stability as this will have the effect of minimising any list which may result from a shift of ballast and will also improve the ship's performance against the dynamic forces of wind and weather; and

8.19.5 the fore and aft distribution of the solid ballast should be arranged to ensure the even distribution of weight throughout the ship and to avoid overloading the hatches and 'tween deck structures.

8.20 Coal in Bulk

8.20.1 Ships specifically designed for solid bulk cargoes are dealt with in the Merchant Shipping (Carriage of Cargoes) Regulations 1999, as amended.

8.20.2 If they have not been specially constructed to carry dry bulk cargoes due regard should be paid to the geometric proportions and cargo carrying capacity of ships carrying coal in bulk and to the grade of coal to be carried.

8.20.3 When the ship's proportions are less than those indicated in the following table the cargo should be adequately trimmed and during the winter months, i.e. October to April (inclusive) be so trimmed that the coal surface fore and aft and athwartships lies considerably below the angle of repose.

Registered breadth 'RB'	Ships with double bottoms in cargo holds	Ships with single bottoms in cargo holds
Metres	RB/d ratio	RB/d ratio
6.10	2.24	2.17
7.62	2.15	2.09
9.15	2.09	2.04
10.67	2.05	
12.20	2.03	
13.72	2.01	

(Where d = draught to bottom of flat keel plate or, in ships with bar keels, draught to top of bar keel.)

8.20.4 When ships, particularly small ships, have (a), large cargo carrying capacities, (b) are fitted with hatchways whose breadths are less than 60% of the registered breadth of the ship and (c), carrying coal in the grades of nuts, peas or beans they should be provided with adequate means for limiting the shift of the cargo e.g. centre line shifting boards or wing boards.

8.21 Grain in Bulk

Refer to the Merchant Shipping (Carriage of Cargoes) Regulations 1999, as amended, which implement the International Code for the Carriage of Grain in Bulk

8.22 Specialised Cargoes of Iron, Steel or Wood Pulp

The following points should be observed and where appropriate shipowners should be advised accordingly:

8.22.1 steel or iron formed into regular shapes (e.g. plates, sections, pipes, coils and billets) should be stowed so as to prevent shifting. Overstowing with another suitable cargo is an effective way to secure such cargoes but where this is not possible they should be secured by the use of dunnage, shores or wires set up with rigging screws. When mixed cargoes, e.g. plates and pipes, are carried they should be stowed in a manner which will ensure that the vertical centre of gravity (KG) of the ship is as low as possible;

8.22.2 pig iron which is not overstowed or which does not cover the whole of 8 the compartment should be stowed in bins of adequate strength;

8.22.3 iron and steel swarf should normally be carried in closed steel drums in accordance with the Merchant Shipping (Carriage of Cargoes) Regulations 1999 but there is no objection to carriage of this material in bulk within the limited European Trading Area, subject to satisfactory inspection by a Surveyor. If proposals are received for bulk shipments outside the Limited European Trading Area, details should be submitted to Headquarters for consideration. It should be noted that these cargoes are liable to self heating when contaminated by oily rags or paper, or saturated with cutting oil etc; and

8.22.4 wood pulp should be carried only in compartments where the entry of water can be prevented. In particular, the air pipes and ventilators leading to such compartments must be effectively closed and protected against possible damage by deck cargo.

8.23 Mineral Concentrates and Ore in Bulk

8.23.1 Refer to the Merchant Shipping (Carriage of Cargoes) Regulations 1999, as amended. When carrying these types of cargo, in addition to complying with such regulations, the MCA has recommended that the Shipping Industry should comply with the IMO Code of Safe Practice for Solid Bulk Cargoes. The Code divides such cargoes as regards mechanical behaviour, into two groups which are considered below.

> **8.23.1.1** The first group consists of those materials which are relatively dry and whose tendency to shift is related to their internal frictional characteristics as represented by the natural angle of repose. When the natural angle of repose of the material exceeds 35 degrees no specific recommendations are considered necessary apart from adequate

trimming athwartships (but see paragraph 8.23.3 below for cement cargoes).

8.23.1.2 Therefore when cargoes are loaded in the lower holds only it is generally sufficient to trim out so as to fully cover the tank top and reduce the height of the peak. When in addition cargoes are loaded in the 'tween decks it becomes necessary to trim the cargo in the lower holds to a much greater extent. The cargo in the 'tween decks should be trimmed reasonably level and should extend over the whole compartment. If the natural angle of repose is 35 degrees or less particular attention should be paid to trimming and as many compartments as possible should be completely filled with cargo. When the 'case history' of the cargo indicates that shifting is probable, the need for shifting boards etc, should be judged against the ship's relevant intact stability characteristics (see paragraph 8.23.2 below).

8.23.1.3 The scantlings for any divisions it is proposed to fit should be based upon the density of the cargo.

8.23.1.4 The second group consists of those materials in which moisture is held in free suspension between the very small individual particles. When this free moisture content exceeds a critical level (usually expressed as a percentage by weight of the sample) the cargo, e.g. metallic concentrates, metal residues and coal slurries, may shift or flow under the stimulus of vibration and/or motion. Cargoes of concentrate or similar materials of the group may be loaded in any type of ship without additional consideration of the adverse effects of the presence of free moisture provided the actual 'moisture content' of the cargo does not exceed the 'safe transportable moisture limit.' For such cargoes the recommendations made under the first group for dry cargoes will apply to their natural angles of repose.

8.23.1.5 Where it is proposed to carry in specially suitable ships bulk cargoes having a 'moisture content' in excess of the 'safe transportable moisture limit' the prior agreement of Headquarters should be sought. The strength of the hull structure forming the boundaries of the cargo compartment, details of the intended cargo and the ship's intact stability characteristics in the anticipated loaded conditions should be examined (see paragraph 8.23.2 below).

8.23.1.6 At the time of loading there should be available for the inspection of the Master and/or the Surveyor approving the loading, two certificates of 'moisture content'; one showing the 'critical moisture content' and the other showing the 'actual moisture content' of the proposed cargo. The following definitions apply to cargoes in this latter group:

(a) 'moisture content' is the degree of moisture in the material and should be determined in accordance with the method prescribed in the IMO Code. If after the moisture content has been taken a cargo is subjected to adverse weather conditions,

e.g. snow or rain, a further analysis should be made before loading commences.

(b) 'critical moisture content' or 'flow moisture point' is the moisture level at which a 'flow state' commences and is determined by special laboratory test employing a vibration stimulus. (It is recommended that the manufacturer conducts these test at six monthly intervals).

(c) 'safe transportable moisture limit' is 90% of the 'critical moisture content'.

8.23.2 Where shifting of the cargo is probable (i.e. where the natural angle of repose is 35 degrees or less or where the moisture content exceeds the 'safe transportable limit' the intact stability of the ship may be considered adequate if, after taking account of any cargo shift, the following obtains:

8.23.2.1 the angle of heel does not exceed 65% of the angle at which the deck cargo is immersed in still water; and

8.23.2.2 the residual dynamic stability, measured up to 30 degrees beyond the angle of heel is not less than 0.10 metre-radians.

The cargo shift moments for anyone continuous section of the hold should be calculated as follows:

$$\text{horizontal heeling moment} = \frac{1}{12}\, p \tan^2 \alpha \int_o^{l} b^3$$

$$\text{*Vertical moment} = \frac{1}{12}\, p \tan^2 \alpha \int_o^{l} b^3$$

Where l = length of section of hold

b = breadth of section of hold

p = density of cargo

α = surface angle shift (this to be taken as 35 degrees minus the natural angle of repose or 20 degrees in the case of cargoes which exceed the safe transportable moisture limit).

These ships should always be in an upright condition prior to proceeding to sea and great care should be exercised when unloading to ensure that the stability always remains positive. Guidance notes concerning these points should be included in the Stability Information Booklet.

* This value divided by the ship's displacement will give the resultant rise in the ship's KG

8.23.3 Whilst cement normally has an angle of repose greater than 35 degrees, if it is loaded by an aerated process it is possible for the upper layer of cargo to move or 'flow' should the ship make any sudden movements before the cement has settled. A note should therefore be added in the Stability Information Booklet advising the master not to sail until sufficient time (about 1 hour) has elapsed to allow the cement to aerate and settle.

8.24 Timber Deck Cargo

8.24.1 In order to ensure that ships which are assigned timber load lines or are engaged in the carriage of timber deck cargoes maintain adequate stability during all the stages of their voyages particular regard should be paid to the following when preparing stability information:

8.24.1.1 the vertical distribution of the deck cargo;

8.24.1.2 the effect of strong winds which may normally be encountered in the trading area e.g. 48.5 kg/m2; (the windage area, its centre of effort and the lever to mid draught are to be stated in the stability information booklet) ;

8.24.1.3 the reduction in the displacement of the ship due to the consumption of fuel, stores and water producing a corresponding rise in the position of the centre of gravity;

8.24.1.4 the increase in the displacement and the resultant rise in the position of the centre of gravity due to the absorption of water by the timber cargo deck(a 15% increase in weight in the timber deck cargo due to this water absorption should be assumed when evaluating all arrival conditions); and

8.24.1.5 the formation of ice on the exposed structures and cargo (see paragraph 8.28).

8.24.2 In the preparation of cross curves of stability for ships assigned timber load lines or carrying timber deck cargoes the buoyancy of all structures given in Schedule 6 paragraph 9(2) and (3) may be taken into account. Furthermore, provided the timber deck cargo is properly secured and compactly stowed it may be taken as providing the ship with an additional measure of buoyancy as follows:

8.24.2.1 Single deck ships

The actual volume of timber carried on deck assuming a permeability of 25%.

8.24.2.2 Two deck ships

As for single deck ships. It should be noted, however, that it may not be necessary to take into account any buoyancy provided by the timber

deck cargo when the ship has a large freeboard as it is unlikely that such cargoes will be immersed at angles of less than 25 degrees.

In all cases the diagram of cross curves should carry a warning note stating that the values shown are only valid when the quantity of deck timber carried is at least equal to that for which the curves were developed and the timber is correctly stowed.

8.24.3 Whenever superstructures or timber deck cargoes have been used in the derivation of the cross curves of stability the actual trim should be taken into account in ships:

8.24.3.1 not fitted with a superstructure amidships; and

8.24.3.2 not carrying timber deck cargoes amidships.

8.24.4 when an allowance has been made for the buoyancy of a timber deck cargo two curves of righting levers (GZ) should be drawn; one with and one

without the allowance (see Schedule 6 paragraph 10(2)(c))

8.24.5 Curves of righting moments should be prepared showing the effects of strong winds and/or, in the case of ships trading in the areas indicated in paragraph 8.28, the formation of ice.

8.24.6 Due regard should also be paid to the Merchant Shipping (Carriage of Cargoes) Regulations 1999, as amended, and paragraph 8.26 below.

8.25 Vehicles on the Open Decks of Small Coastal Ferries (65 Metres in length or less)

In addition to such ships having adequate stability when vehicles are carried on their open decks it is essential that no uncontrolled movement of the vehicles can occur when the ship is in a seaway. When assessing the adequacy of the stability and the means for securing the vehicles Surveyors should be guided by the following: 18

8.25.1 *Stability*

The intact stability of the ship should at least fulfil the requirements of Schedule 2, paragraph 2(2) in any service condition no matter what arrangement of deck cargo is carried. The Surveyor should have regard to this and ensure that the Stability Information Booklet indicates the maximum quantity of deck cargo (i.e. vehicles, trailers etc) that may be carried for any given draught together with the maximum height above the keel at which this amount of deck cargo could be stowed. This quantity of deck cargo should be stated as a 'deck cargo vertical moment' relative to the underside of the keel and the Master should be provided with data suitably prepared to enable him to ascertain quickly the weight of deck cargo that should be carried and the value of the 'deck cargo vertical moment' for any particular condition of loading. In determining the 'deck cargo vertical moment' the height of the centre of gravity of vehicles should be assumed to be 2/3H, where H is the maximum height of the vehicle.

8.25.2 Vehicle securing arrangements

8.25.2.1 A vehicle exceeding 2 tons in gross weight should be provided with satisfactory means to prevent sideways tipping and transverse sliding (e.g. chains with 'elephants feet' attachments to deck'). The approximate maximum force likely to occur in any lashing used to resist tipping may be determined from the following formula:

$$\frac{W\ (O.47h\ -1\ .2a)}{(a + b)\ \sin \Theta}$$

where W = gross weight of vehicle
h = total height of vehicle a = half width of vehicle
b = horizontal distance between the centreline of vehicle and the attachment of the lashing deck
Θ = angle of lashing with the deck

The anti-tipping lashings fitted to vehicles of over two tonnes in weight should generally be adequate to cope with any tendency to slide transversely. In the case of articulated trailers carried without their towing units however the forward ends of the trailers should be supported on trestles or jacks which are to be fitted into sockets in the chassis and resting on friction pads on the deck unless diagonal lashings (i.e. port side to starboard side of deck and vice versa) are also provided. The appropriate maximum force in a lashing used to resist sliding may be determined by the formula:

$$\frac{O.2W}{\cos \Theta}$$

where W = weight borne by the supporting device and
Θ = angle of lashing with the deck

8.25.2.2 For a vehicle not exceeding 2 tons gross weight the Surveyor should either be satisfied that the movement of the vehicle will be restrained by the natural friction between the deck and the vehicle's tyres or ensure that adequate securing arrangements are provided (e.g. the wheels of the vehicle lashed to a fixed wire on deck). Full details of the appliances used to secure the vehicles on deck should be recorded on form FRE 7. Reference should be made to the general requirements given in the Merchant Shipping (Carriage of Cargoes) Regulations 1999, as amended, paragraph 5.8.4 and paragraph 8.26 of these Instructions.

8.26 Deck Cargoes-General

8.26.1 The stability information for ships normally intended to carry deck cargoes should include particulars of the ship in both the departure and arrival conditions when loaded to the summer load waterline carrying the maximum anticipated load of deck cargo (the extent and weight of the deck cargo to be

specified by the ship owner or his representative) and with all cargo spaces filled with homogenous cargo. It should be assumed that:

8.26.1.1 in the departure condition the total capacity of fuel and stores are carried; and

8.26.1.2 in the arrival condition 90% of the fuel and stores have been consumed.

Whenever the stability of a ship loaded as indicated above does not meet the criteria given in Schedule 2, paragraph 2(2) the case should be submitted to Headquarters for consideration as to the ship's suitability for the carriage of deck cargoes.

8.26.2 Where the intended deck cargo consists of heavy individual, e.g. vehicles, trailers, rail cars and large boxes, a cautionary statement should be included in the Stability Information Booklet advising the Master of the necessity to secure such cargoes in the most effective and efficient manner in order to prevent any movement of the deck cargo when the ship is in a seaway which would put the ship at risk.

When severe weather conditions (i.e. a sea state equal to or worse than that associated with Beaufort Scale 6) are likely to be experienced in service the following principles should be observed in the design of the deck cargo securing arrangements:

8.26.2.1 Suitable physical means (e.g. cross bracing at sides and ends using chain lashings fitted with rigging screw) to prevent the cargo, especially wheeled vehicles, from sliding or tipping should be provided.

8.26.2.2 Where practicable on vehicles having leaf type springs the total weight carried by the springs should be transferred from the axles to the deck jacks.

8.26.2.3 When cargo is carried on vehicles or trailers it should be securely attached to the chassis of the vehicle/trailer. The means of securing the cargo should include cross bracing at the ends to prevent it tipping when subjected to racking action.

8.26.2.4 (a) Lashings used to secure cargo vehicles should have a breaking load of at least 3 times the design load, the design load being the total weight of the cargo or the cargo plus vehicle subjected to the accelerations of:

0.7 'g' athwartships,
1.0 'g' vertically and
0.3 'g' longitudinally,
relative to the principal axis of the ship.

(b) When sea state conditions worse than those associated with Beaufort Scale 6 are unlikely to be experienced in service,

a lesser standard of securing such items of cargo might be acceptable subject to approval by Headquarters. The equipment and fittings used to secure deck cargoes should be regularly maintained and inspected.

8.26.3 Reference should also be made to the general requirements given in the. Merchant Shipping (Carriage of Cargoes) Regulations 1999, as amended.

Trading areas

8.27 The St Lawrence Seaway and the Great Lakes

Ships trading in these areas may be subjected to the following wind and sea conditions during the midsummer and winter seasons:

8.27.1 wind speeds in excess of 53 kph measured on shore which are regularly recorded. These winds can occur very suddenly and are usually associated with steep short seas; and

8.27.2 wind speeds in excess of 96 kph coupled with seas having a wave height of 6 metres with 15 to 21 metres between crests which are occasionally recorded.

The stability information for the ship when loaded to a draught equal to the tropical to the tropical fresh water load line mark should therefore be prepared having regard to the foregoing. It is recommended that items 8.27.1 and 8.27.2 above should be included in the Stability Information Booklet as guidance notes to the Master.

8.28 Areas Where the Formation of Ice Should be Taken into

Account

8.28.1 A ship which may trade in such an area during winter should be in possession of stability information which indicates the effect of the formation of ice on the exposed hull, superstructure and deck cargo.

8.28.2 This effect should be taken as either a 'full icing allowance' or 'half icing allowance' depending upon the particular areas of operation. These allowances and areas of operation are as follows:

8.28.3 *Full icing allowance*

8.28.3.1 All exposed horizontal surfaces (decks, house tops and tops of deck cargo etc) should be assumed to carry an ice weight of 30kg/m2

8.28.3.2 To account for the weight of ice considered likely to form on all exposed vertical surfaces it should be assumed that this weight equates to that which would result if the lateral area of one side of the ship (and any deck cargo) above the waterline was subjected to an ice weight of 15 kg/m2.

8.28.3.3 The position of the centre of gravity should be calculated having regard to the respective heights of the assumed ice covered areas. In the case of the projected lateral area the effect of sundry booms, rails, wires etc (which will not have been included in the area calculated) should be taken into account by increasing the *calculated weight by 5% and the calculated moment of this weight by 10%.*

8.28.3.4 *Areas where* a *'full icing allowance' should be applied*

(a) The area north of latitude 66°30N between longitudes 1 OOW and the Norwegian Coast.

(b) The area north of latitude 63°N between longitudes 28°W and 100W.

(c) The area north of latitude 45N between the North American continent and longitude 28W.

(d) All sea areas north of the European, Asian, and North American continents east and west of the areas defined in (a), (b) and (c) above.

(e) The Okhotsk and Bering Seas and the Gulf of Tatary. (f) All areas south of Latitude 600S.

8.28.4 *Half icing allowance*

This should be taken as one half of the full icing allowance.

8.28.4.1 *Areas where* a *'half icing allowance' should be applied*

All areas north of latitude 61°N between longitude 28°W and the Norwegian Coast which are south of the areas which require a 'full icing allowance'. Other areas within the Seasonal Winter Zone (as defined in the Regulations) agreed between owners and the MCA when warranted by experience.

8.29 The Dangers of Flooding

8.29.1 Flooding is a constant source of danger to the safe and efficient operation of any ship.

8.29.1.1 Flooding has on various occasions caused contamination of fuel, and loss of engine power and damage to cargo.

8.29.1.2 In addition, flooding has caused fluidisation of cargo, loss of buoyancy, and loss of stability which in turn has caused serious listing sometimes leading to capsize and the total loss of the ship. Yet, as is often shown by subsequent investigation of the individual incidents and casualties, these dangers have not been appreciated or they have been

underestimated by those on board and therefore not always effectively guarded against.

8.29.2 In particular, it is essential to ensure that 'good seamanship' is always exercised regardless of the type of ship or its area of operation. As a consequence the MCA recommends that the operational procedures listed below should be adopted, whenever appropriate, on an individual ship basis.

8.29.2.1 Before departure, ensure that:

(a) cargo hatches, access hatches, weathertight doors in exposed positions, internal watertight doors and spurling pipes are effectively closed;

(b) void spaces are empty of any water resulting from leakage or inadvertent pumping operations;

(c) the bilge pumping system is in sound working condition; and

(d) all bilge alarms are fully operational.

8.29.2.2 Before departure, or as soon thereafter as possible, ensure that cargo loading doors and loading ramps are effectively closed.

8.29.2.3 During the voyage, in good or seasonal weather, make regular inspections to ensure that:

(a) the hatches, doors and loading ramps referred to above, remain effectively closed and are opened only in accordance with the explicit instructions of the master;

(b) the bilges in engine rooms and auxiliary engine rooms, especially if such rooms are normally unmanned, are free of water;

(c) the bilges in the cargo holds are free of water;

(d) the sea inlet valves and sea water circulating systems are in sound condition; and

(e) the vehicle spaces in ro/ro ships are free of water.

8.29.2.4 During the voyage, when heavy weather is expected:

(a) inspect the items referred to in sub-paragraph 8.29.2.3(a) above to confirm they are effectively closed; and

(b) where necessary, and provided this can be carried out without introducing other risks, close or protect ventilators and outlets to air pipes, particularly those to fuel oil tanks.

8.29.2.5 During the voyage, in heavy weather, and provided it is safe and practicable to do so, make frequent inspections of:

(a) unmanned engine rooms and auxiliary engine rooms;

(b) vehicle spaces in Ro/Ro ships;

(c) the fuel oil service tanks for the presence of water; and

(d) void spaces for the presence of water.

8.29.3 While adoption of the procedures described in paragraph 8.29.2 above will not necessarily prevent a ship from being flooded they should at least greatly reduce the risk of a dangerous flooding situation arising by permitting early corrective action to be taken. 'Check-off lists' would prove most valuable in ensuring the systematic application of the procedures listed above.