The Merchant Shipping (Equivalent Arrangements For Carriage Of Grain) Order, 1977

UNION OF INDIA
India

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Rule
THE-MERCHANT-SHIPPING-EQUIVALENT-ARRANGEMENTS-FOR-CA of 1977

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1909.

S.O. 2251, dated the 9th May, 1977. - Whereas the Central Government has prescribed, under the Merchant Shipping (Carriage of Grain) Rules, 19742, certain fittings and provisions as "necessary and reasonable precautions", or the purposes of section 332 of the Merchant Shipping Act, 1958 (44 of 1958), to be followed by :-(a)all Indian ships, and(b)ships other than Indian ships(i)when they are loaded with grain at any port or place in India or within the territorial water of India, or(ii)when they enter any port or place in India or come within the territorial waters of India laden with grain;And whereas the Central Government is otherwise satisfied that the fittings provisions, recommended by the Inter-Governmental Maritime Consultative Organisation and set out in Appendices I and II to this Order are as effective as those required by the Merchant Shipping (Carriage of Grain) Rules, 1974;And Whereas the Central Government considers it expedient to permit the alternative fittings or provisions set out in the said Appendices I and H to this Order, be fitted or made in any of the ships aforesaid;Now, therefore, in exercise of the powers conferred by section 454A of the Merchant Shipping Act, 1958 (44 of 1958); the Central Government hereby makes the following Order, namely :-

1. Short title and commencement.

(1)This Order may be called the Merchant Shipping (Equivalent Arrangements for Carriage of Grain) Order, 1977.(2)It shall come into force on the date of its publication in the Official Gazette.

2. Equivalent arrangements for carriage of grain.

- A ship to which the Merchant Shipping (Carriage of Grain) Rules, 1974, apply may, instead of complying with the requirements of the said rules comply with the requirements specified in either Appendix I or Appendix II to this Order :Provided that no such ship shall be permitted to comply(i)partly with the requirements specified in the said rules and partly with the requirements specified in any of the said two Appendices;(ii)party with the requirements specified in the said Appendix I and partly with requirements specified in the said Appendix II.Appendix IEquivalent arrangements to those prescribed in the Merchant Shipping (Carriage of Grain) Rules, 1974.Definitions :

1. In this Appendix, unless the context otherwise requires, the following expressions have the following meanings respectively :

"Compartment"	meansa hold or a cargo space bounded by bulkheads at each end andhaving decks above and below.
"Filledcompartment"	meansany compartment in which after loading and trimming the level ofthe bulk grain is as high as possible.
"Partlyfilled compartment"	meansany compartment loaded with bulk grain not being a filledcompartment.
"Grain"	includeswheat, maize, oats, rye, barley, rice pulses and seeds.
"Metacentricheight"	meansthe distance between the transverse metacentre (M) and thecentre of gravity (G) corrected for the free effects of liquidsin tanks.
"Schedule"	meansa Schedule in this Appendix.
"Shiftingboards"	meansshifting boards constructed in accordance with the requirementsof (B) Part I. Schedule II of this Appendix.

Trimming :

2. (a) All necessary and reasonable trimming should be performed to minimize the effect of grain shifting. In any compartment which is filled with bulk grain, the grain should be trimmed so as to fill all the spaces : under the decks and hatch covers to the maximum extent possible.

(b)After loading all free grain surfaces in partly filled compartments should be trimmed level and the ship shall be upright when proceeding to sea.Intact stability requirements :

3. (a) The intact stability characteristics of any ship carrying bulk grain should be shown to meet, throughout the voyage, at least the following criteria after taking into account in the manner described in Schedule I, the heeling moments due to grain Shift:

(i)The angle of heel due to the shift of grain should be not greater than 12 degrees;(ii)in the statical stability diagram, the net or residual area between the heeling arm curve and the righting arm curve up to the angle of heel of maximum difference between the ordinates of the two curves, or 40 degrees or the angle of flooding.* whichever is the least, should in all conditions of loading, be not less than 0.075 metreradians; and(iii)the initial metacentric height, after correction for the free surface effects of liquids in tanks, should be not less than 0.30 metres.Longitudinal divisions and saucers :

4. (a) In both "filled" and "partly filled" compartments, longitudinal divisions may be provided as a device either to refuse the adverse heeling effect of grain shift or to limit the depth of cargo used for securing the cain surface. Such divisions should be fitted grain-tight and constructed accordance with the provisions of part I of Schedule II.

(b)In a "filled" compartment a division, if fitted, should extent downwards from the underside of the deck or hatch covers to a distance below the deck line of at least one-eight of the maximum breadth of the compartment. Except in the case of oil seeds, a longitudinal division beneath of hatchway may be replaced by a saucer of bagged grain or other suitable cargo, such a saucer should be formed in the manner described in Part I of Schedule H.(c)In a "partly filled" compartment, a division, if fitted should extend from one-eight of the maximum breadth of the compartment above the level of the grain surface and to the same distance below the grain surface. When used to limit the depth of the cargo used for securing the height of the centreline division should be not less than 0.61 metres above the grain surface.(d)Furthermore, the adverse heeling effects of grain shift may be reduced by tightly stowing the wings and ends of a compartment with bagged grain or other suitable cargo adequately restrained from shifting.Securing :

5. (a) Unless account is taken of the adverse heeling effect due to grain shift in accordance with these provisions, the surface of the bulk grain in any "partly filled" compartment should be trimmed level and topped off with bagged grain tightly stowed and extending to a height of not less than one-sixteenth of the breadth of the free grain surface or 1.22 metres whichever is the greater. Instead of bagged grain, other suitable cargo exerting at least the same pressure may be used.

(b)The bagged grain or other suitable cargo should be supported in the manner described in Part II of Schedule II. Alternatively, the bulk grain surface may be secured by strapping or lashing as

described in Part II of Schedule II.Feeders and/or trunks :

6. If feeders and/or trunks are fitted proper account should be taken of the effects thereof when calculating the heeling moments as described in Part III of Schedule I. The strength of the divisions forming the boundaries of such feeders shall conform with the provisions of Part I of Schedule II.

Combination arrangements :

7. Lower holds and tween deck spaces in way thereof may be loaded as one compartment provided that, in calculating heeling moments, proper account is taken of the flow of grain into the lower spaces.

Is an angle of heel at which openings in the hull, superstructures of deckhouses, which cannot be closed weathertight, immerse. In applying this definition, small openings through which progressive flooding cannot take place need not be considered as open.

I

Calculation of Assumed Heeling Moments

Part I – Description of the assumed pattern of grain surface behaviour and method of calculating intact stability.

Part II – Determination of the assumed volumetric heeling moment of a filled compartment.

Part III – Feeders and trunks.

Part IV – Partly filled compartments.

Part I – Description of the assumed pattern of grain surface behaviour and method of calculating intact stability.

(A)General.(a)For the purpose of calculating the stability of ships carrying grain in bulk it should be assumed that :(i)In filled compartments of ships with hatch side girder depths between 500 and 600 mm. the average depth of the under deck void (Vd) is 460 mm.(ii)When the depth of the hatch side girder is not between 500 and 600 mm, the average void depth shall be calculated according to the formula.Vd = Vdl+0.75 (d-600) mm.where Vd = Average void depth in mm;Vd1= Standard void

depth from the Table I belowd = Actual girder depth in mm.In no case shall Vd be assumed to be less than 100 mm.Table I

Distancefrom hatch end or hatch side to boundary of compartment metres	Standardvoid depth VdI
0.5	570
1	530
1.5	500
2	480
2.5	450
3	440
3.5	430
4	430
4.5	430
5	430
5.5	450
6	470
6.5	490
7	520
7.5	550
8	590

(iii)No voids will exist surfaces whose inclination to the horizontal is 30 degrees or greater.(iv)Within filled hatches there is an average void depth of 75 mm measured from the lower part of the hatch cover to the grain surface. If the hatchway is not completely filled this void in combination with any other void arising from incomplete filling of the hatch should be used in calculating the assumed heeling moments.(b)The ship's stability calculations should be based upon the assumption that the centre of gravity of the cargo is at the volumetric centre of the whole cargo space and in such cases it will be necessary only to calculate the adverse heeling moment due to transverse shifts of grain. However, if it is considered necessary to take into account the reduction in the ship's vertical centre of gravity due to the existence of the under deck voids when calculating the ships righting arm curve, the net effects of the vertical component shifts of grain should also be included in the total assumed heeling moment curve (see Fig. 1).Figure 1where :no = assumed volumetric heeling moment due to transverse shift

stowagefactor x displacement

n40= 0.80 x no

=assumed volumetric heeling moment due to vertical shift

stowage factor x displacementStowage factor = Volume per unit weight of grain cargo.Displacement = Weight of ship, fuel fresh water, stores, etc. and cargo.The total assumed heeling moment curve can be approximately represented by the straight line through A and B whose ordinance are :OA = and PB = (40 + 0.66) respectively.

Part II – Determination of the assumed volumetric heeling movement of a filled compartment.

(A)General(a)The methods described hereunder should be used to determine the assumed volumetric heeling moment per unit length.(b)In the figures the moments are calculated in accordance with the change in shape and/or position of voids.(c)The angle of surface shift of the bulk grain (or wedge angle) is assumed to be 15 degrees.Note : When the final centroid of the void is higher or lower than its initial centroid, the vertical volumetric heeling moment has to be respectively subtracted or added.(B)Forwarded of and abaft the hatchway.(a)With centre line division (see Fig. 2)Figure 2Assumed horizontal volumetric heeling moment = A × X × 2 for both sides.Assumed vertical volumetric heeling moment= A × Y × 2 for both sides.Where X = Transverse shift of centre of void due to change of space, andY = Vertical shift of centre of void due to change of shape.(b)Without centre line division (see Fig. 3).(i)If the effect of the under deck longitudinal girders is to be taken into account, the moments should be calculated according to the pattern of grain behaviour shown in Fig. 3.Formulae : (1) = (AB × VD)-Vr where Vr = d2/2 tan 15°(2)= (BC × Vd)-Vr(3)=CD × VdAssumed horizontal volumetric heeling moment =((1) × X1)+ ((2) × X2)+((3) × X1)Assumed vertical volumetric heeling moment =((1) × Y1)+ ((2) × Y2)+((3) × Y2)(ii)If the effect of longitudinal girders is not to be taken into account the moment should be calculated in the same manner as described in (B)(a) above where B/2 becomes-B in the calculations.(C)Abreast the hatchway.(a)When there is a centre line division in the hatchway (see Fig. 4).Formulae : (1) = (AB × VD)-Vr where Vr = d²/22 tan 15°(2)= CD × Vd(3)= (4) = 1/2 × BC × Vdo(1)transfers to the centroid of the final void on the low side of the hatchway.(3)transfers to the centred of the final void on the low side of the hatchway.(2)(4) transfer from rectangular to triangular shapes.Assumed horizontal volumetric heeling moment =((1) × X1)+((2) × X2)+((3) × X3)+((4) × X4)Assumed vertical volumetric heeling moment =((1) × Y1)+ ((2) × Y2)+((3) × Y3)+((4) × Y4)(b)When there is no centre line division in the hatchway. The calculation should be similar to that in (C) (a) above except that the transverse lever X1 will increase due to the formation of the void against the girder at C instead of against the centre line division and (3) and (4) will combine to form a single initial void.(D)Multiple decks in association with combination arrangements of loading.(a)No deck perforations(i)Except where included in a pattern of deck performations accepted by the Departments, it is considered that trimming hatches of normal dimensions, even though open, have no significant effect in reducing the volume of the under deck voids.(ii)Two deck arrangement without centre line divisions (see Fig. 5).Figure 5The transfer of voids in this arrangement shall be assumed to have taken place as follows:(1)transfers to the centroid of the final void under the weather deck hatch cover;(2)transfers to the centroid of the final void under the weather deck on the high side;½ of (3) transfers to the final void under the weather deck hatch cover;¼ of (3) transfers to the final void under the weather deck on the high side;¼ of (3) transfers to the final void under the second deck on the high side;(4)transfers to the centroid of the final void under the second deck on the high side;(5)transfers to the centroid of the final void under the weather deck hatch cover;Where:

(1) = (AB x Vd1)-Vr1, where Vr1=| d122 tan 15
(2)= VD × Vd1

(3) = (EF × Vd2)-Vr2, where Vr2 =| d212 tan 15

(4)= GH × Vd2(5)= BC × VdoThe volume of the final void under the weather deck hatch cover will be (5) plus (1) plus ½ of (3) and its centroid positioned accordingly.The volume of the final void under the weather deck on the high side will be (2) plus ¼ of (3) and its centroid positioned accordingly.The volume of the final void under the second deck on the high side will be(4) plus/¼ of (3) and its centroid positioned accordingly.(iii)Two deck arrangement with tween deck centreline division (see Fig. 6).The transfer of voids in this arrangement should be assumed to have taken place as shown in Fig. 6 which follows the principles outlined in (D) (a) (ii) above except that the presence of the centreline division will reduce the transverse shift of (1) and part of (3).(iv)Three deck arrangement (see Fig. 7).The transfer of voids in this arrangement should be assumed to have taken place as follows(1)transfers to the centroid of the final void under the weather deck hatch cover;(2)transfers to the centroid of the final void under the weather deck on the high side;½ of (3) transfers to the final void under the weather deck hatch cover;¼ of (3) transfers to the final void under the weather deck on the high side;¼ of (3) transfers to the final void under the second deck on the high side;(4)transfers to the centroid of the final void under the second deck on the high side;¼ of (5) transfers to the final void under the weather deck hatch cover;¼ of (5) transfers to the final void under the weather deck on the high side;¼ of (5) transfers to the final void under the second deck on the high side;¼ of (5) transfers to the final void under the third deck on the high side;(6)transfers to the centroid of the final void under the third deck on the high side;(7)transfers to the centroid of the final void under the weather deck hatch cover;Where :

(1) = (AB × Vd1)-Vr1, where Vr1=| d122 tan 15

(2)=CD×Vd1

(3) = (EF × Vd2)-Vr2, where Vr2=| d122 tan 15

(4)= GH × Vd2

(5) = (JK × Vd3)-Vr3, where Vr3=| d122 tan 15

(6)= LM × Vd1(7)= BC × Vd2The volume of the final void under the weather deck hatch cover will be (7) + (1) + 1/2 of (3) + 1/4 of (5) and its centroid positioned accordingly.The volume of the final void under the weather deck on the high side will be (2) plus 1/4 of [(3)+(5)] and its centroid positioned accordingly.The volume of the final void under the second deck on the high side will be (4) plus 1/4 of [(3) + (5)] and its centroid positioned accordingly.The volume of the final void under the third deck on the high side will be (6) +'A of (5) and its centroid positioned accordingly.(v)Further multiple deck arrangements.For such arrangements it should be assumed that the voids on the low side under each additional deck are equally distributed to all the voids on the high side. For example, if a fourth deck was added to fig. 7 the void on the low side under the deck would be assumed to be equally transferred to each of the five voids on the high side (viz. hatchway, weather deck second deck, third deck and fourth deck respectively.).(b)With deck perforations :(i)Where decks are perforated the voids under such decks will be reduced during loading. The percentage of the original voids remaining should be obtained from Fig. 12.Figure 12Figure 12(ii)Under the influence of ship motion it may be assumed that these voids are eventually completely filled transversely between perforations. The Department should be satisfied that these perforations are so distributed throughout the longitudinal extent of the deck as to achieve effective void filling. The heeling moments should be calculated in the manner described in (a) above with due regard to the increase in volume of the higher voids and any voids remaining under the perforated deck.

Part III – Feeders and trunks

(A)Suitably placed wing feeders (See Fig. 8).Figure 8It may be assumed that under the influence of ship motion under deck voids will be substantially filled by the flow of grain from a pair of longitudinal feeders providedthat-(1)the feeders extend for the full length of the deck, and that the perforations therein are adequately spaced;(2)the volume of each feeder is equal to the volume of the under deck void out-board of the hatch side girder and its continuation.(B)Trunks situated over main hatchways (see Fig. 9)Figure 9The transfer of voids in this arrangement should be assumed to have taken place as follows:(1)Transfers to the centroid of the final void against the trunk side;(2)Transfers to the centroid of the final void under the weather deck on the high side;

2.

/3 of (3) transfers to the bottom of the trunk on the centreline;

1.

/3 of (3) transfers to the void under the second deck on the high side;(4)Transfers to the centroid of the final void under the second deck on the high side.Where :(1)= AB1 Vd1(2)= CDz Vd1

(3) = (EFxVd2)-Vr2, where Vr2=| dz22 tan 15
(4)= GHz Vd2The volume of the final void under the second deck on the high side will be (4) plus 1/3 of (3) and its centroid positioned accordingly.Within the frunk itself the heeling moment should be assumed to be that arising from a full wedge transfer of 25 degrees.Where a trunk is situated over lower between decks the assumed pattern of void transfers should be in accordance with the principles of Part 11(D)(a)(ii), (iii) or NO of this Schedule.

Part IV – Partly Filled Compartments

(A)General.When the free surface of the bulk grain has not been secured in accordance with Section 5 of the Appendix it should be assumed that a transfer takes place over all surfaces with an angle of surface shift (wedge angle) of 25 degrees.(B)Discontinuous longitudinal divisions.In a compartment in which the longitudinal divisions are not continuous between the transverse boundaries, the length over which any such divisions are effective as devices to prevent full width shifts of grain surfaces, should be taken to be the actual length of the portion of the division under consideration less two-sevenths of the greater of the two transverse distances between the division and the adjacent division or ships side (see Figs. 10 and 11.).Figure 10Figure 11Figure 12The word "space" occurring in foot-note below diagram should read as "spacing".

II

Part I – Strength of grain fittings.

(A)General (including working stresses).(B)Divisions loaded on both sides.(C)Divisions loaded on one side only.(D)Saucers.

Part II – Securing of partly filled compartments

(A)Strapping or lashing.(B)Constructional details of securing arrangements.(C)Bagged grain.

Part I – Strength of Grain Fittings

(A)General :(a)Timber. - All timber used for grain fittings should be of good sound quality and of a type and grade which has been proved to be satisfactory for this purpose. The actual finished dimensions of the timber should be in accordance with the dimensions herein after specified in this Schedule. Plywood of an exterior type bonded with water-proof glue and fitted so that the direction of the grain in the face plies is parpendicular to the supporting uprights or binder may be used provided that its strength is equivalent to that of solid timber of the appropriate scantlings.(b)Working stresses. - When calculating the dimensions of divisions loaded on one side, using the Tables in paragraphs (c), (a) and (b) of this Part of the Schedule, the following working stresses should be adopted.

Fordivisions of steel	2,000Kg. per square cm.
Fordivisions of wood	160Kg. per square cm.

(c)Other materials. - Materials other than wood or steel, may be approved for such divisions provided, that proper regard has been paid to their mechanical properties.(d)Uprights. - (i) Unless means are provided to prevent the ends of uprights being dislodged from their sockets, the depth of housing at each end of each upright should be not less than 75 mm. If an upright is not secured at the top the uppermost shore or stay should be fitted as near thereto as is practicable.(ii)The arrangements provided for inserting shifting boards by removing a part of the crow-section of an upright should be such that the local level of stresses is not unduly high.(iii)The maximum bending moment imposed upon an upright supporting a division loaded on one side should normally be calculated assuming that the ends of the uprights are freely supported. However, if the Department are satisfied that any degree of fixity assumed will be achieved in practice, account may be taken of any reduction in the maximum bending moment arising from any degree of fixity providedat the ends of the upright.(e)Composite sections. - Where uprights, binders, or any other strength members are formed by two separate sections one fitted on each side of a division and inter-connected by through bolts at adequate spacing, the effective section modulus should be taken as the sum of the two moduli of the separate sections.(f)Partial division. - Where divisions do not extend to the full depth of the hold, such divisions and their uprights should be supported or stayed so as to be as efficient as those which do extend to the full depth of the hold.(B)Divisions loaded on both sides.(a)Shifting boards. - (i) Shifting boards should have a thickness of not less than 50 mm and should be fitted grain-tight and where necessary supported by uprights.(ii)The maximum

unsupported span for shifting boards of various thickness should be as follows :

Thickness	Maximumunsupported span
50mm	2.5metres
60mm	3.0metres
70mm	3.5metres
80mm	4.0metres

If thickness greater than these are provided the maximum unsupported span should vary in direct proportion with the increase in thickness.(iii)The ends of all shifting boards should be securely housed with 75 mm minimum bearing length.(b)Other materials.-Divisions formed by using materials other than wood should have a strength equivalent to the shifting boards required in (B) (a) above.(c)Uprights. - (i) Steel uprights used to support divisions loaded on both sides should have a section modulus given by W = a, W1Where :W = Section modulus in cm^3a = Horizontal span between uprights in metres.The section modulus per metres span W1 should be not less than that given bythe formula :W1 = 14.8 (hr.-1.22) cm^3 per metre;h1 is the vertical unsupported span in metres and should be taken as the maximum value of the distance between any two adjacent stays or between the stay or either end of the upright. Where this distance is less than 2.44 metres the respective modulus shall be calculated as if the actual value was 2.44 metres.(ii)The moduli of wood uprights should be determined by multiplying by 12.7 the corresponding moduli for steel uprights. If other materials are used their moduli should be at least that required for steel increased in proportion to the ratio of the permissible stresses for steel to that of the material used. In such cases attention should be paid also to the relative rigidity of each upright to ensure that the deflection is not excessive.(iii)The horizontal distance between uprights should be such that the unsupported spans of the shifting boards do not exceed the maximum span specified in paragraph (a)(ii) of this Part of the Schedule.(d)Shores. - (i) Wood shores, when used, should be in a single piece and should be securely fixed at each end and heeled against the permanent structure of the ship except that they shall not bear directly against the side plating of the ship.(ii)Subject to the provisions of sub-paragraphs (iii) and (iv) the minimum size of wood shores shall be as follows :

Lengthof Shoremetres	Rectangularsectionmm	Diameterof circular sectionmm
Notexceeding 3 m	150x 100	140
Over3 m but not exceeding 5 m	150x 150	165
Over5 m but not exceeding 6 m	150x 150	180
Over6 m but not exceeding 7 m	200x 150	190
Over7 m but not exceeding 8 m	200x 150	200
Exceeding8 m	200x 150	215

Shores of 7 metres or more in length should be securely bridged at approximately mid-length.(iii)When the horizontal distance between the uprights differs significantly from 4 metres, the moments of inertia of the shores may be changed in direct proportion.(iv)Where the angle of the shore to the horizontal exceeds 10 degrees the next larger shore to that required by sub-paragraph (ii) of this paragraph should be fitted provided that in no case shall the angle between any shore and the horizontal exceed 45 degrees.(e)Stays. - Where stays are used to support divisions loaded on both sides, they should be fitted horizontally or as near thereto as practicable, well secured at each end and formed of steel wire rope. The sizes of the wire rope should be

determined assuming that the divisions and upright which the stay supports is uniformly loaded at 500 kg/m2. The working load so assumed in the stay should not exceed one-third of its breaking load.(C)Divisions, loaded on one side only.(a)Longitudinal divisions. - The loan in Kg. per metre length of the divisionshould be taken to be as follows:TABLE I [*] [For the purpose of converting the above loads into British units (ton/ft) 1 kg. per metre length should be taken to be equivalent to 0.0003 tons per foot length]

h(m)	B(m)							
	2	3	4	5	6	7	8	10
1.5	850	900	1010	1225	1500	1770	2060	2645
2	1390	1505	1710	1985	2295	2605	2930	3590
2.5	1985	2160	2430	2740	3090	3435	3800	4535
3	2615	3845	3150	3500	3885	4270	4670	5480
3.5	3245	3525	3870	4255	4680	5100	5540	6425
4	3890	4210	4590	5015	5475	5935	6410	7370
4.5	4535	4890	5310	5770	6270	6765	7280	8315
5	5185	5570	6030	6530	7065	7600	8150	9260
6	6475	6935	7470	8045	8655	9265	9890	11150
7	7765	8300	8910	9560	10245	10930	11630	13040
8	9055	9665	10350	11075	11835	12595	13370	14930
9	10345	11030	11790	12590	13425	14260	15110	16820
10	11635	12395	13230	14105	15015	15925	16850	18710

h = height of grain in metres [**] [There the distance from a division to a feeder or hatchway is I metre the height should be taken to the level of the grain within that hatchway or feeder. In all other cases the height should be taken to the overhead deck in way of the division.]B = transverse extent of the bulk grain in metres.For other value of h and/or B the loads should be determined by linear interpolation or extrapolation as necessary.(b)Transverse divisions.-The loan in kg. per metre length of the divisions should be taken to be as follows:TABLE II [*] [For the purpose of converting the above loads into British units (ton/ft) 1 kg. per metre length should be taken to be equivalent to 0.0003 tons per foot length.]

h(rn)	L(m)										
	2	3	4	5	6	7	8	10	12	14	16
1.5	670	690	730	780	835	890	935	1000	1040	1050	1050
2	1040	1100	1170	1245	1325	1400	1470	1575	1640	1660	1660
2.5	1460	1565	1675	1780	1880	1980	2075	2210	2285	2305	2305
3	1925	2065	2205	2340	2470	2590	2695	2845	2925	2950	2950
3.5	2425	2605	2770	2930	3075	3205	3320	3480	3570	3595	3595
4	2950	3160	3355	3535	3690	3830	3950	4120	4210	4235	4240
4.5	3495	3725	3940	4130	4295	4440	4565	4750	4850	4880	4885
5	4050	4305	4535	4735	4910	5060	5190	5385	5490	5525	5530

6	5175	5465	5720	5945	6135	6300	6445	6655	6775	6815	6825
7	6300	6620	6905	7150	7365	7445	7700	7930	8055	8105	8115
8	7425	7780	8090	8360	8590	8685	8950	9200	9340	9395	9410
9	8550	8935	9275	9565	9820	9930	10205	10475	10620	10685	10705
10	9680	10095	10460	10770	11045	11270	11460	11745	11905	11975	11997

h= height of grain in metres[**] [Where the distance from a division to a feeder or hatchway is I metre the height should be taken to the level of the grain within that hatchway or feeder. In all other cases the height should be taken to the overhead deck in way of the division.]

L= lengitudinal extent of the bulk grain in metres.

For other values of h and/or L the loads should be determined by linear interpolation or extrapolation as necessary.(c)Vertical distribution of the loads. - The total load per unit length of divisions shown in the Tables I and II above, may, if considered necessary, be assumed to have a trapezoidal distribution with height. In such cases the reaction loads at the upper and lower ends of a vertical member or upright are not equal. The reaction loads at the upper end expressed as percentages of the total load supported by the vertical member or upright should be taken to be those shown in Tables III and IV.Longitudinal Divisions Loaded On One Side OnlyTable IIIBearing Reaction at the Upper End of Upright as Percentage of Load(Table I)

h(m) B(m)	2	3	4	5	6	7	8	10
1.5	43.3	45.1	45.9	46.2	46.2	46.2	46.2	46.2
2	44.5	46.7	47.6	47.8	47.8	47.8	47.8	47.8
2.5	45.4	47.6	48.6	48.6	48.6	48.6	48.6	48.6
3	46	48.3	49.2	49.4	49.4	49.4	49.4	49.4
3.5	46.5	48.8	49.7	49.8	49.8	49.8	49.8	49.8
4	47	49.1	49.9	50.1	50.1	50.1	50.1	50.1
4.5	47.4	49.4	50.1	50.2	50.2	50.2	50.2	50.2
5	47.7	49.5	50.1	50.2	50.2	50.2	50.2	50.2
6	47.7	49.5	50.1	50.2	50.2	50.2	50.2	50.2
7	47.9	49.5	50.1	50.2	50.2	50.2	50.2	50.2

8	47.9	49.5	50.1	50.2	50.2	50.2	50.2	50.2	
9	47.9	49.5	50.1	50.2	50.2	50.2	50.2	50.2	
10	47.9	49.5	50.1	50.2	50.2	50.2	50.2	50.2	

B = transverse extent of the bulk grain.For other values of h and/or B the reaction loads should be determined by linear interpolation or extrapolation as necessary.Transverse Divisions Loaded On One Side OnlyTable IVBearing Reaction at the Upper End of Upright as Percentage of Load(Table II)

h(m)	L(m)										
1	2	3	4	5	6	7	8	10	12	14	16
1.5	37.3	38.7	39.7	40.6	41.4	42.1	42.6	43.6	44.3	44.8	45
2	39.6	40.6	41.4	42.1	42.7	43.1	43.6	44.3	44.7	45	45.2
2.5	41	41.8	42.5	43	43.5	43.8	44.2	44.7	45	45.2	45.2
3	42.1	42.8	43.3	43.8	44.2	44.5	44.7	45	45.2	45.3	45.3
3.5	42.9	43.5	43.9	44.3	44.6	44.8	45	45.2	45.3	45.3	45.3
4	43.5	44	44.4	44.7	44.9	45	45.2	45.4	45.4	45.4	45.4
5	43.9	44.3	44.5	44.8	45	45.2	45.3	45.5	45.5	45.5	45.5
6	44.2	44.5	44.8	45	45.2	45.3	45.4	45.6	45.6	45.6	45.6
7	44.3	44.6	44.9	45.1	45.3	45.4	45.5	45.6	45.6	45.6	45.6
8	44.3	44.6	44.9	45.1	45.3	45.4	45.5	45.6	45.6	45.6	45.6
9	44.3	44.6	44.9	45.1	45.3	45.4	45.5	45.6	45.6	45.6	45.6
10	44.3	44.6	44.9	45.1	45.3	45.4	45.5	45.6	45.6	45.6	45.6

L = Longitudinal extent of the bulk grain.For other value of h and/or L the reactions loads shall be determined by linear interpolation or extrapolation as necessary.The strength of the end connections of such vertical members or uprights may be calculated on the basis of the maximum load likely to be imposed at either end. These loads are as follows :

Maximumload at the top.	50%of the appropriate total load from Table I.
LongitudinalDivisions	
Maximumload at the bottom	55%of the appropriate total load from Table I.
Maximumload at the top.	45%of the appropriate total load from Table II.
TransverseDivisions	
Maximumload at the bottom	60%of the appropriate total load from Table H.

The thickness of horizontal wooden boards may also be determined having regard to the vertical distribution of the loading represented by Tables III and IV above and in such cases :Where :t = Thickness of board in mm;a = Horizontal span of the board, i.e., distance between uprights in metresh = Head of grain to the bottom of the divisions in metres;p = Total load per unit length derived from Table I or II in kg.k = Factor dependent upon vertical distribution of the loading.When

the vertical distribution of the loading is assumed to be uniform, i.e., rectangular, k should be taken as equal to 1.0.For a trapezoidal distribution.k = 1.0 + 0.06 (50-R), whereR is the upper end bearing reaction taken from Table III or IV.(d)Stays or shores. - The sizes of stays and shores should be so determined that the loads derived from Tables I and II in the preceding paragraphs (a) and (b) should not exceed one-third of the breaking loads.(D)Saucers.When a saucer is used to reduce the heeling moments in a full compartment, its depth measured from the bottom of the saucer to the deck line, should be as follows :For ships with a moulded breadth of up to 9.14 metres not less than 1.22 metres.For ships with a moulded breadth of up to 18.29 metres or more, not less than 1.83 metres.For ships with a moulded breadth between 9.14 metres and 18.29 metres, theminimum depth of the saucer should be calculated by interpolation.As far as is practicable the top (mouth) of the saucer should be formed by the under deck structure in the way of the hatchway, i.e., hatch side girders or coamings and hatch end beams. The saucer and hatchway above should be completely filled with bagged grain or other suitable cargo laid down on a separation cloth or its equivalent and stowed tightly against adjacent structures and the portable hatchway beams if the latter are in place.

Part II – Securing or Partly filled Compartments

(A)Strapping or lashing.(a)When, in order to eliminate heeling moments in partly filled compartments, strapping or lashing is utilised, the securing should be accomplished as follows :-(i)The grain should be trimmed and levelled to the extent that it is very slightly crowned and covered with burlap separation cloths, tarpaulins or the equivalent.(ii)The separation cloths and/or tarpaulins shall overlap at least 1.83 metres.(iii)Two solid floors of 25 mm timber shall be laid with the top floor running longitudinally and nailed to an athwarthships bottom floor. Alternately, one solid floor of 50 mm timber, running longitudinally and nailed over the top of a 50 mm bottom bearer not less than 150 mm wide, may be used instead of the two floors of 25 mm timber. 'The bottom bearers should extend the full breadth of the compartment and should be spaced not more than 2.44 metres apart. Arrangements utilising other materials and considered by the Department to be equivalent to the foregoing may be accepted.(iv)Steel wire (19 mm diameter or equivalent), doubled strapping (50 mm x 1.3 mm) or chain, each having a breaking load of at least 5,000 kg and set tight by means of a 32 mm turnbuckle, may be used for lashings. A winch tightener, used in co-injunction with a locking arm, may be substituted for the 32 mm turnbuckle when steel strapping is used, provided suitable wrenches are available for setting up as necessary. When steel strapping is used, not less than three crimp seals should be used for securing the ends. When wire is used, not less than four clips should be used for foming eyes in the lashings.(v)Prior to the completion of loading the lashing should be positively attached to the framing at a point approximately 450 mm below the anticipated final grain surface by means of either a 25 mm shackle or beam clamp of equivalent strength.(vi)The lashings should be spaced not more than 2.44 metres apart and each shall be supported by a bearer nailed over the top of the fore and aft floor. This bearer should consist of not less than 25 mm by 150 mm timber or its equivalent and should extend the full breadth of the compartment.(B)Constructional details of securing arrangements.Where bagged grain or other suitable cargo is utilised for the purpose of securing partly filled compartments, the free grain surface should be covered with a separation cloth or equivalent and/or by a suitable platform. Such plateforms should consist of wooden bearers spaced not more than 1.22 metres apart and 25 mm wooden boards laid thereon spaced not more than 100 mm apart. Platforms may be constructed of

other materials provided they are considered by the Department to be equivalent.(C)Bagged grain.Bagged grain shall be carried in sound bags which should be well filled and securely closed.Appendix II(See Clause 2)Equivalent Arrangements to those prescribed in the Merchant Shipping (Carriage of Grain) Rules, 1974Part-I

Part A – General Provisions

1. Application. - Unless expressly provided otherwise, this Appendix, including Parts A, B and C, applies to the carriage of grain in all ships to which the Merchant Shipping (Carriage of Grain) Rules, 1974 apply.

2. Definitions.--

(a)The term "grain" includes wheat, maize (corn), oats, rye barley, rice, pulses, seeds and processed forms thereof, whose behaviour is similar to that of grain in its natural state.(b)The term "filled compartment" refers to any compartment in which, after loading and trimming as required under para 3, the bulk grain is at its highest possible level.(c)The term "partly filled compartment" refers to any compartment wherein bulk grain is not loaded in the manner prescribed in paragraph (b) of this para.(d)The term "angle of flooding" means an angle of heel at which openings in the hulls, superstructures or deck-houses, which cannot be closed weathertight, immerse. In applying this definition, small openings through which progressive flooding cannot take place need not be considered as open.

3. Trimming of Grain. - All necessary and reasonable trimming shall be performed to level all free grains surfaces and to minimise the effect of grain shifting.

(a)In any "filled compartment" the bulk grain shall be trimmed so as to fill all the spaces under the decks and hatch covers to the maximum extent possible.(b)After loading, all free grain surfaces in "partly filled compartments" shall be level.(c)The Central Government may grant dispensation from trimming in those cases where the under deck void geometry resulting from flowing grain into a compartment, which may be provided with feeding ducts, perforated decks or other similar means, is taken into account to satisfaction when calculating the void depths.

4. Intact Stability Requirements. - (a) The calculations required by this paragraph shall be based upon the stability information provided in accordance with the Merchant Shipping (Cargo-ship Construction and Survey) Rules, 1974.

(b)The intact stability characteristics of any ship carrying bulk grain shall be shown to meet, throughout the voyage, at least the following criteria after taking into account in the matter described in Part B. the heeling moments due to grain shift :(i)the angle of heel of the vessel due to

the shift of grain shall not be greater than 12 degrees except that the Central Government may require a lesser angle of heel if it considers that experience shows this to be necessary*;(ii)in the statical stability diagram, the net or residual area between the heeling arm curve and the righting arm curve up to the angle of heel of maximum difference between the ordinates of the two curves, or 40 degrees or the "angle of flooding (of)" whichever is the least, shall in all conditions of loading be not less than 0.075 metres radians; and(iii)the initial metacentric height, after correction for the free surface effects of liquids in tanks, shall be not less than 0.30 metre.(c)Before loading bulk grain the master shall, if so required by the Government of the country of the port of loading, demonstrate the ability of the ship at all stages of any voyage to comply with the stability criteria required by Sub-paragraph (b) using the information approved and issued under paragraphs 10 and 11.(d)After loading the master shall ensure that the ship shall be upright before proceeding to sea.

5. Longitudinal Divisions and Saucers. - (a) In both "filled compartments" and "partly filled compartments," longitudinal divisions may be provided as a device either to reduce the adverse heeling effect of grain shift or to limit the depth of cargo used for securing the grain surface. Such divisions shall be fitted grain-tight and constructed in accordance with the provisions of Section I of the Part C.

For example, the permissible angle of heel might be limited to the angle of feel at which the edge of the weather deck would be immersed in still water.(b)In a "filled compartment," a division, if fitted to reduce the adverse effects of grain shift shall;(i)in a tween deck compartment extend from deck to deck; and(ii)in a hold extend downwards from the underside of the deck of hatch covers as described in section II of Part B.Except in the case of linseed and other seeds having similar properties, a longitudinal division beneath a hatchway may be replaced by a saucer formed in the manner described in section I of Part C.(c)In a "partly filled compartments," a division, if fitted, shall extend from one-eight of the maximum breadth of the compartment above the level of the grain surface and to the same distance below the grain surface. When used to limit the depth of overs towing, the height of the centreline division shall be at least 0.6 metre above the level grain, surface.(d)Furthermore, the adverse heeling effects of grain shift may be reduced by tightly stowing the wings and ends of a compartment with bagged grain or other suitable cargo adequately restrained from shifting.

6. Securing. - (a) Unless account is taken of the adverse heeling effect due to grain shift in accordance with these provisions, the surface of the bulk grain in any "partly filled compartment"shall be level and topped off with bagged grain tightly stowed and extending to a height of not less than one-sixteenth of the maximum breadth of the free grain surface or 1.2 metres, whichever is the greater, instead of bagged grain, other suitable cargo exerting at least the same pressure may be used.

(b)The bagged grain or such other suitable cargo shall be supported in the manner described in section II of Part C. Alternatively, the bulk grain surface may be secured by strapping or lashing as described in section II of Part C.

7. Feeders and Trunks. - If feeders or trunks are fitted proper account shall be taken of the effect thereof when calculating the heeling moments as described in section III of Part B. The strength of the divisions forming the boundaries of such feeders shall conform with the provisions of section I of Part C.

8. Combination Arrangements. - Lower holds and tween deck spaces in way thereof may be loaded as one compartment provided that in calculating transverse heeling moments, proper account is taken of the flow of grain into the lower spaces.

9. Application of Parts B and C. - The Central Government may authorize departure from the assumptions contained in Parts B and C in those cases where it considers this to be justified having regard to the provisions for loading or the structured arrangements, provided the stability criteria in Part 4(b) are met. Where such authorisation is granted under this para. all particulars shall be included in the grain loading data.

10. Authorisation. - (a) A document of authorisation shall be issued for every ship loaded in accordance with this appendix.

(b)The document shall accompany and refer to the grain loading stability booklet provided to enable the master to meet the requirements of Paragraph 4(c). This booklet shall meet the requirements of Para 11.(c)A copy of such a document, grain loading stability data and associated plan shall be placed on board in order that the master, if so required, shall produce them for the inspection of the Government of the country of the port of loading.(d)A ship without such a document of authorisation shall not load grain until the master demonstrates to the satisfaction of the Central Government or the Government of the port of loading on behalf of the Central Government that the ship in its proposed loaded condition will comply with the requirements of this Appendix.

11. Grain Loading Information. - This information shall be sufficient to allow the master to determine in all reasonable loading conditions the heeling moments due to grain shift calculated in accordance with Part B. It shall include the following :

(a)Information which shall be approved by the Central Government :(i)Curves of tables of grain heeling moments for every compartment, filled or partly filled or combination thereof, including the effects of temporary fittings;(ii)tables of maximum permissible heeling moments or other information sufficient to allow the master to demonstrate compliance with the requirements of Paragraph 4(c);(iii)details of the scantlings of any temporary fittings and where applicable the provisions necessary to meet the requirements of section I(E) of Part C.(iv)typical loaded service departure and arrival conditions and where necessary, intermediate worst service conditions;(v)a worked example for the guidance of the master;(vi)loading instructions in the form of notes summarizing the requirements of this Appendix.(b)Information which shall be acceptable to the Central Government :-(i)ship's particulars;(ii)lightship displacement and the vertical distance from the intersection of the moulded base line and midship section of the centre of gravity (KG);(iii)table of free surface corrections;(iv)capacities and centres of gravity.Part-B--Calculation of Assumed Heeling Moments Section I-Description of the assumed voids and method of calculating intact stability.(A)General(a)For the purpose of calculating the adverse heeling moment due to a shift of cargo surface in ships carrying bulk grain it shall be assumed that :(i)In "filled compartments" which have been trimmed in accordance with Para 3 avoid exists under all boundary surfaces having an inclination to the horizontal less than 30 degrees and that the void is parallel to the boundary surface having an average depth calculated according to the formula :Vd = Vd1+0.75 (d-600) mm.WhereVD = Average void depth in mm;Vd1 = Standard void depth from Table I below;d = Actual girder depth in mm.In no case shall Vd be assumed to be less than 100 mm.Table I

Distancefrom hatched or Standard void hatchside boundary of compartment		
	metres	depthVd1
0.5	0.5	570
1	1	530
2	1.5	500
2.5	2	480
3	2.5	450
3.5	3	440
4	3.5	430
4.5	4	430
5	4.5	430
	5	430
5.5	5.5	450
	6	470
	6.5	490
	7	520
	7.5	550
	8	590

Notes on Table IFor distances greater than 8.0 metres the standard void depth Vd1 shall be linearly extrapolated at 80 mm increase for each 1.0 metre increase in distance. Where there is a difference

in depth between the hatchside girder or its continuation and the hatched beam the greater depth shall be used except that :(1)when the hatchside girder or its continuation is shallower than the hatched beam the voids abreast the hatchway may be calculated using the lesser depth; and(2)when the hatched beam is shallower than the hatchside girder or its continuation the voids fore and aft of the hatchway inboard of the continuation of the hatchside girder may be calculated using the lesser depth;(3)where there is a raised deck clear of a hatchway the average void depth measured from the underside of the raised deck shall be calculated using the standard void depth in association with the girder depth of the hatched beam plus the height of the raised deck.(ii)In "filled compartments" which are not trimmed in accordance with paragraph 3 and where the boundary surface has an inclination to the horizontal which is less than 30 degrees, the cargo surface has an inclination of 30 degrees to the horizontal after loading.(iii)Within filled hatchways and in addition to any open void within the hatch cover there is a void of average depth of 150 mm measured down to the grain surface from the lowest part of the hatch cover or the top of the hatchside coaming, whichever is the lower.(b)The description of the pattern of grain surface behaviour to be assumed in "partly filled compartments" is shown in section IV of this Part.(c)For the purpose of demonstrating compliance with the stability criteria in paragraph 4(b) (see Figure 1), the ships stability calculations shall be normally passed upon the assumption that the centre of gravity of cargo in a "filled compartment" is at the volumetric centre of the whole cargo space. In those cases where the Central Government authorises account to be taken of the effect of assumed underdeck voids on the vertical position of the centre of gravity of the cargo in "filled compartments" it will be necessary to compensate for the adverse effect of the vertical shift of grain surface by increasing the assumed heeling moment due to the transverse shift of grain as follows :Total heeling moment = 1.06 × calculated transverse heeling moment.In all cases the weight of cargo in a "filled compartment" shall be the volume of the whole cargo space divided by the stowage factor.(d)In "partly filled compartments" the adverse effect of the vertical shift of grain surfaces shall be taken into account as follows :(e)Total heeling moment =1.12 × calculated transverse heeling moment.(f)Any other equally effective method may be adopted to make the compensation required in paragraphs (c) and (d) above.Notes on Figure 1

1. Where :

ho= Assumed Volumetric Heeling Moment due to Transverse Shift:

StowageFactor x Displacement

h40 = 0.8 x ho;Stowage factor = Volume per unit weight of grain cargo;Displacement = Weight of ship, fuel, fresh water, stores etc. and cargo.

2. The righting arm curve shall be derived from cross = curves which are sufficient in number to accurately define the curve for the purpose of these requirements and shall include cross curves at 12 degrees and 40 degrees.

1. Where :

ho= Assumed Volumetric Heeling Moment due to Transverse Shift:

StowageFactor x Displacement

h40 = 0.8 × ho;Stowage factor = Volume per unit weight of grain cargo;Displacement = Weight of ship, fuel, fresh water, stores etc. and cargo.Section 11-Assumed Volumetric Heeling of a filled compartment(A)General(a)The pattern of grain surface moment relates to a transverse section across the portion of the compartment being considered and the resultant heeling moment should be multiplied by the length to obtain the total moment for that portion.(b)The assumed transverse heeling moment due to grain shifting is a consequence of final changes of shape and position of voids after grain has moved from the high side to the low side.(c)The resulting grain surface after shifting shall he assumed to be at 15 degrees to the horizontal.(d)In calculating the maximum void area that can be formed against a longitudinal structural member, the effects of any horizontal surfaces, e.g. flanges or face bars, shall be ignored.(e)The total areas of the initial and final voids shall be equal.(f)A discontinuous longitudinal division shall be considered effective over its full length.(B)AssumptionsIn the following paragraphs it is assumed that the total heeling moment for a compartment is obtained by adding the results of separate considerations of the following portions;(a)Before and abaft hatchways;(i)If a compartment has two or more main hatchways through which loading may take place the depth of the underdeck void for the portion (s) between such hatchways shall be determined using the fore and aft distance to the midpoint between the hatchways.(ii)After the assumed shift of grain the final void pattern shall be as shown in Figure 2 below :-Notes on figure 2

1. If the maximum void area which can be formed against the girder at B is less than the initial area of the void under AB, i.e., AB x Vd, the excess area shall be assumed to transfer to the final void on the high side.

2. If the longitudinal division at C is one which has been provided in accordance with Paragraph 5(b)(ii) it shall extend to at least 0.6 m below D or E whichever gives the greater depth.

(b)In and abreast hatchways:After the assumed shift of grain the final void pattern shall be as shown in the following Figure 3 or Figure 4.(1)AB any area in excess of that which can be formed against the girder at B shall transfer to the final void area in the hatchway.(2)CD any area in excess of that which can be formed against the girder at E shall transfer to the final void area in the high side.Notes on Figure 4(1)If the centreline division is one which has been provided in accordance with Paragraph 5(b)(ii) it shall extend to at least 0.6 m below H or J whichever gives the greater depth.(2)The excess void area from AB shall transfer to the low side half of the hatchway in which two separate final void areas will be formed viz. one against the centreline division and the other against the hatchside coaming and girder on the high side.(3)If a bagged saucer or bulk bundle is formed in a hatchway it shall be assumed for the purpose of calculating transverse heeling moment, that such a device is at least equivalent to centreline division.(4)Compartments Loaded in CombinationThe following paragraphs describe the pattern of void behaviour which shall be assumed when compartments are loaded in combination :(a)Without effective centreline divisions :(i)Under the upper deck-as for the single deck arrangement described in Section II(B) of this Part.(ii)Under the second deck-the area of void available for transfer from the low side, i.e., original

void area less area against the hatchside girder, shall be assumed to transfer as follows :one half to the upper deck hatchway and one quarter each to the high side under the upper and second deck.(iii)Under the third and lower decks-the void areas available for transfer from the low side of each of these decks shall be assumed to transfer in equal quantities to all the voids under the decks on the high side and the void in the upper deck hatchway.(b)With effective centreline divisions which extend into the upper deck hatchway:(i)At all deck levels abreast the division the void areas available for transfer from the low side shall be assumed to transfer to the void under the low side half of the upper deck hatchway.(ii)At the deck level immediately below the bottom of the division the void area available for transfer from the low side shall be assumed to transfer as follows:one half to the void under the low side half of the upper deck hatchway and the remainder in equal quantities to the voids under the decks on the high side.(iii)At deck levels lower than those described in sub-paragraphs (i) and (ii) above the void area available for transfer from the low side of each of those decks shall be assumed to transfer in equal quantities to the voids in each of the two halves of the upper deck hatchway on each side of the division and the voids under the decks on the high side.(c)With effective centreline divisions which do not extend into the upper deck hatchway:Since no horizontal transfer of voids may be assumed to take place at the same deck level as the division the void area available for transfer from the low side at this level shall be assumed to transfer above the division to voids on the high sides in accordance with the principles of paragraphs (a) and (b) above.Section III-Assumed Volumetric Heeling moment of Feeders and Trunks(A)Suitably Placed Wing Feeders (See Figure 5)It may be assumed that under the influence of ship motion underdeck voids will be substantially filled by the flow of grain from a pair of longitudinal feeders provided that:(a)the feeders extend for the full length of the deck and that the perforations therein are adequately spaced;(b)the volume of each feeder is equal to the volume of the under deck void outboard of the hatchside girder and its continuation.(B)Trunks situated over Main HatchwaysAfter the assumed shift of grain the final void pattern shall be as shown in Figure 6.Note on Figure 6If the wing spaces in way of the trunk cannot be properly trimmed in accordance with Para 3 it shall be assumed that a 25 degree surface shift takes place.Section IV-Assumed Volumetric Heeling Moment of Partly Filled Compartments(A)GeneralWhen the free surface of the bulk grain has not been secured in accordance with Para 6 it shall be assumed that the grain surface after shirting shall at 25° to the horizontal.(B)Discontinuous Longitudinal DivisionsIn a compartment in which the longitudinal divisions are not continuous between the transverse boundaries, the length over which any such divisions are effective as devices to prevent full width shifts of grain surfaces shall be taken to be the actual length of the portion of the division under consideration less two-sevenths of the greater of the transverse distances between the division and its adjacent division or ship side.This correction does not apply in the lower compartments of any combination loading in which the upper compartment is either a "filled compartment" or a "partly filled compartment".Section V - Alternative Loading Arrangements for Existing Ships(A)GeneralA ship loaded in accordance with either sub-section (B) or sub-section (C) below shall be considered to have intact stability characteristics at least equivalent to the requirements of Paragraph 4(b).For the purpose of this Part, the term "Existing Ship" means at ship the keel of which is laid before the date of coming into force of this Chapter.(B)Stowage of Specially Suitable Ships(a)Notwithstanding anything contained in Part B of this Chapter, bulk grain may be carried without regard to the requirements, specified therein in ships which are constructed with two or more vertical or sloping grain tight longitudinal divisions suitably disposed to limit the effect of any transverse shift of grain under the following

conditions :(i)as many holds and compartments as possible shall be full and trimmed full :(ii)for any specified arrangement of stowage the ship will not list to an angle greater than 5 degrees at any stage of the voyage where :(1)in holds or compartments which have been trimmed full the grain surface settled 2 per cent. by volume from the original surface and shifts to an angle of 12 degrees with that surface under all boundaries of these holds and compartments which have an inclination of less than 30 degrees to the horizontal :(2)in "partly filled compartments or holds" free grain surfaces settled and shift as in sub-paragraph (ii) (1) of this paragraph or to such larger angle as may be deemed necessary by the Central Government and grain surfaces if overstoyed in accordance with para 5 of this appendix shift to an angle of 8 degrees with the original levelled surfaces. For the purpose of sub-paragraph (ii) of this paragraph shifting boards, if fitted, will be considered to limit the transverse shift of the surface of the grain :(iii)the master is provided with a grain loading plan covering the stowage arrangements to be adopted and a stability booklet both approved by the Central Government, showing the stability conditions upon which the calculations given in sub-paragraph (ii) of this paragraph are based.(b)Central Government shall prescribe the precautions to be taken against shifting in all other conditions of loading of ships designed in accordance with paragraph (B)(a) of this section which meet the requirements of sub-paragraphs (ii) and (iii) of that paragraph.(C)Ships Without Documents of AuthorisationA ship not having on board documents of authorisation issued in accordance with paras 4 and 10 may be permitted to load bulk grain under the requirements of sub-section (B) above or provided that :(a)All "filled compartments" shall be fitted with centreline divisions extending for the full length of such compartments which extend downwards from the underside of the deck or hatch of the maximum breadth of the compartment or 2.4 metres. whichever is the greater except that saucers constructed in accordance with section II of Part C may be accepted in lieu of a centreline division in and beneath a hatchway.(b)All hatches to "filled compartments" shall be closed and covers secured in place.(c)All free grain surfaces in "partly filled compartments" shall be trimmed level and secured in accordance with section II of Part C.(d)Throughout the voyage the metacentric height after correction for the free surface effects of liquids in tanks shall be 0.3 metre or that given by the following formula, whichever is the greater :Where :L = total combined length of all full compartments;B = moulded breadth of vessel;SF = stowage factor;Vd = calculated average void depth as per paragraph (a)(i) of section I(A) of thisPart;displacement.

Part C – Grain Fittings and Securing Section I-Strength of Grain Fittings

(A)General :(a)Timber. - All timber used for grain fittings shall be of good sound quality and of a type and grade which has been proved to be satisfactory for this purpose. The actual finished dimensions of the timber shall be in accordance with the dimensions hereinafter specified in this Part. Plywood of an exterior type bounded with water-proof glue and fitted to that the direction of the grain in the face plies is perpendicular to the supporting uprights or binder may be used provided that its strength is equivalent to that of solid timber of the appropriate scantlings.(b)Working stresses. - When calculating the dimensions loaded on one side, using the Tables in paragraphs (C),(a) and (b) of this Part the following working stresses should be adopted :

Fordivisions of steel.	2,000Kg. per square cm.
Fordivisions of wood	160Kg. per square cm.

(c)Other materials. - Materials other than wood or steel, may be approved for such divisions provided, that proper regard has been paid to their mechanical properties.(d)Uprights.(i)Unless means are provided to prevent the ends of uprights being dislodged from their sockets, the depth of housing at each end of each upright shall be not less than 75 mm. If an upright is not secured at the top the super most shore or stay shall be fitted as near thereto as is practicable.(ii)The arrangements provided for inserting shifting boards by removing a part of the cross-section of an upright shall be such that the local level of stresses is not unduly high.(iii)The maximum bending moment imposed upon an upright supporting a division loaded on one side shall normally be calculated assuming that the ends of the uprights are freely supported. However, if the Central Government is satisfied that any degree of fixity assumed will be achieved in practice, account may be taken of any reduction in the maximum bending moment arising from any degree of fixity provided at the ends of the upright.(e)Composite section. - Where uprights, binders, or any other strength members are formed by two separate sections one fitted on each side of a division and inter connected by through bolds at adequate spacing, the effective section modules shall be taken as the sum of the two moduli of the separate section.(f)Partial division. - Where divisions do not extend to the full depth of the hold, such divisions and their uprights shall be supported or stayed so as to be as efficient as those which do extend to the full depth of the hold.(B)Divisions loaded on both sides.(a)Shifting boards.(i)Shifting boards should have a thickness of not less than 50 mm and shall be fitted grain-tight and where necessary supported by uprights.(ii)The maximum unsupported span for shifting boards of various thickness shall be as follows:

Thickness	Maximumunsupported span
50mm	2.5metres
60mm	3.0metres
70mm	3.5metres
80mm	4.0metres

If thickness greater than these are provided the maximum unsupported span will vary directly with the increase in thickness.(iii)The ends of all shifting boards shall be securely boused with 75 mm minimum bearing length.(b)Other materials. - Divisions formed by using materials other than wood shall have a strength equivalent to the shifting boards required in paragraph (B) (a) above.(c)Uprights.(i)Steel uprights used to support divisions loaded on both sides shall have a section modulus given byW = a x W1Where :W = Section modulus in cm3;a = horizontal span between uprights in metres.The Section modulus per metre span W, shall be not less than that given by the formula :W1 = 14.8 (h1.-1.2) cm3; per metre;Where :h1 is the vertical unsupported span in metres and shall be taken as the maximum value of the distance between any two adjacent stays or between the say or either end of the upright. Where this distance is less than 2.4 metres the respective modulus shall be calculated as if the actual value was 2.4 metres.(ii)The moduli of wood uprights shall be determined by multiplying by 12.5 the corresponding moduli for steel uprights. If other materials are used their moduli shall be at least that required for steel increased in proportion to the ratio of the permissible stresses for steel to that of the material used. In such cases attention shall be paid also to the relative rigidity of each upright to ensure that the deflection is not excessive.(iii)The horizontal distance between uprights shall be such that the unsupported spans of

the shifting boards do not exceed the maximum span specified in paragraph (B)(a)(ii) of this section.(d)Shores.(i)Wood shores, when used, should be in a single piece and shall be securely fixed at each end and heeled against the permanent structure of the ship except that they shall not bear directly against the side plating of the ship.(ii)Subject to the provision of sub-paragraphs (iii) and (iv) below the minimum size of wood shores shall be as follows :

Lengthof Shore in metres	Rectangularsectionmm	Diameterof circular sectionmm
Notexceeding 3 m	150x 100	140
Over3 m but not exceeding 5 m	150x 150	165
Over5 m but not exceeding 6 m	150x 150	180
Over6 m but not exceeding 7 m	200x 150	190
Over7 m but not exceeding 8 m	200x 150	200
Exceeding8 m	200x 150	215

Shores of 7 metres or more in length shall be securely bridged at approximately mid-length.(iii)When the horizontal distance between the uprights differs significantly from 4 metres, the moments of inertia of the shores may be changed in direct proportion.(iv)Where the angle of the shore to the horizontal exceeds 10 degrees the next larger shore to that required by sub-paragraph (ii) of this paragraph should be fitted provided that in no case shall the angle between any shore and the horizontal exceed 45 degrees.(e)Stays. - Where stays are used to support divisions loaded on both sides, they shall be fitted horizontally or as near thereto as practicable well secured at each end and formed of steel wire rope. The sizes of the wire rope shall be determined assuming that the divisions and upright which the stay supports are uniformly loaded at 500 kg/m&sub2;. The working load so assumed in the stay shall not exceed one-third of its breaking load.(C)Divisions, loaded on one side only.(a)Longitudinal divisions. - The load in Kg. per metre length of the division shall be taken to be as follows:TABLE I [*] [For the purpose of converting the above loads into British units (ton/ft) 1 kg. per metre length should be taken to be equivalent to 0.0003 ton per foot length]

h(m)	B(m)							
1	2	3	4	5	6	7	8	10
1.5	850	900	1010	1225	1500	1770	2060	2645
2	1390	1505	1710	1985	2295	2605	2930	3590
2.5	1985	2160	2430	2740	3090	3435	3800	4535
3	2615	3845	3150	3500	3885	4270	4670	5480
3.5	3245	3525	3870	4255	4680	5100	5540	6425
4	3890	4210	4590	5015	5475	5935	6410	7370
4.5	4535	4890	5310	5770	6270	6765	7280	8315
5	5185	5570	6030	6530	7065	7600	8150	9260
6	6475	6935	7470	8045	8655	9265	9890	11150
7	7765	8300	8910	9560	10245	10930	11630	13040
8	9055	9665	10350	11075	11835	12595	13370	14930
9	10345	11030	11790	12590	13425	14260	15110	16820

10	11625	12395	13230	14105	15015	15925	16850	18710

h = height of grain in metres from the bottom of the division.[**] [Where the distance from a division to a feeder or hatchway is I metre or loss the height shall be taken to the level of the grain within that hatchway or feeder. In all cases the height shall be taken to the overhead deck in way of the division.]B = transverse extent of the bulk grain in metres.For other value of h or B the loads shall be determined by linear interpolation or extrapolation as necessary.(b)Transverse divisions. - The loan in kg. per metre length of the divisions shall he taken to be as follows:TABLE II [*] [For the purpose of converting the above loads into British units (ton/ft)1 kg. per metre length shall be taken to be equivalent to 0.0003 ton per foot length.]

h(m)	L(m)										
	2	3	4	5	6	7	8	10	12	14	16
1.5	670	690	730	780	835	890	935	1000	1040	1050	1050
2	1040	1100	1170	1245	1325	1400	1470	1575	1640	1660	1660
2.5	1460	1565	1675	1780	1880	1980	2075	2210	2285	2305	2305
3	1925	2065	2205	2340	2470	2590	2695	2845	2925	2950	2950
3.5	2425	2605	2770	2930	3075	3205	3320	3480	3570	3595	3595
4	2950	3160	3355	3535	3690	3830	3950	4120	4210	4235	4240
4.5	3495	3725	3940	4130	4295	4440	4565	4750	4850	4880	4885
5	4050	4305	4535	4735	4910	5060	5190	5385	5490	5525	5530
6	5175	5465	5720	5945	6135	6300	6445	6655	6775	6815	6825
7	6300	6620	6905	7150	7365	7445	7700	7930	8055	8105	8115
8	7425	7780	8060	8590	8685	8950	9200	9340	9395	9410	9410
9	8550	8935	9275	9565	9820	9930	10205	10475	10620	10685	10705
10	9680	10095	10460	10770	11045	11270	11460	11745	11905	11975	11997

h = height of grain in metres from the bottom of the division.[**] [Where the distance from a division to a feeder or hatchway is I metre or less the height shall be taken to the level of the grain within that hatchway or feeder. In all cases the height shall be taken to the overhead deck in way of the division.]L = lengitudinal extent of the bulk grain in metres.For other values of h or L the loads shall be determined by linear interpolation or extrapolation as necessary.(c)Vertical distribution of the loads. - The total load per unit length of divisions shown in the Tables I and H above, may, if considered necessary, be assumed to have a trapezoidal distribution with height. In such cases the reaction loads at the upper and lower ends of a vertical member or upright are not equal. The reaction loads at the upper end expressed as percentages of the total load supported by the vertical member or upright shall be taken to be those shown in Table III and IV below:-Table IIILongitudinal Divisions Loaded On The One Side OnlyBearing Reaction at the Upper End of Upright as Percentage of Load(Table I)

h(m)	B(m)							
1	2	3	4	5	6	7	8	10
1.5	43.3	45.1	45.9	46.2	46.2	46.2	46.2	46.2
2	44.5	46.7	47.6	47.8	47.8	47.8	47.8	47.8

2.5	45.4	47.6	48.6	48.6	48.8	48.8	48.8	48.8	
3	46	48.3	49.2	49.4	49.4	49.4	49.4	49.4	
3.5	46.5	48.8	49.7	49.8	49.8	49.8	49.8	49.8	
4	47	49.1	49.9	50.1	50.1	50.1	50.1	50.1	
4.5	47.4	49.4	50.1	50.2	50.2	50.2	50.2	50.2	
5	47.4	49.4	50.1	50.2	50.2	50.2	50.2	50.2	
6	47.4	49.5	50.1	50.2	50.2	50.2	50.2	50.2	
7	47.4	49.5	50.1	50.2	50.2	50.2	50.2	50.2	
8	47.4	49.5	50.1	50.2	50.2	.50.2	50.2	50.2	
9	47.4	49.5	50.1	50.2	50.2	50.2	50.2	50.2	
10	47.4	49.5	50.1	50.2	50.2	50.2	50.2	50.2	

B = transverse extent of the bulk grain in metres.For other values of h or B the reaction loads shall be determined by linear interpolation or extrapolation as necessary.Table IVTransverse Divisions Loaded On The One Side OnlyBearing Reaction at the Upper End of Upright as Percentage of Load(Table II)

h(m)	L(m)									
	2	3	4	5	6	7	8	10	12	14	16
1.5	37.3	38.7	39.7	40.6	41.4	42.1	42.6	43.6	44.3	44.8	45
2	39.6	40.6	41.4	42.1	42.7	43.1	43.6	44.3	44.7	45	45.2
2.5	41	41.8	42.5	43	43.5	43.8	44.2	44.7	45	45.2	45.2
3	42.1	42.8	43.3	43.8	44.2	44.5	44.7	45.9	45.2	45.3	45.3
3.5	42.9	43.5	43.9	44.3	44.6	44.8	45	45.2	45.3	45.3	45.3
4	43.5	44	44.4	44.7	44.9	45	45.2	45.4	45.4	45.4	45.4
5	43.9	44.3	44.6	44.8	45	45.2	45.3	45.5	45.5	45.5	45.5
6	44.2	44.5	44.8	45	45.2	45.3	45.4	45.6	45.6	45.6	45.6
7	44.3	44.6	44.9	45.1	45.3	45.4	45.5	45.6	45.6	45.6	45.6
8	44.3	44.6	44.9	45.1	45.3	45.4	45.5	45.6	45.6	45.6	45.6
9	44.3	44.6	44.9	45.1	45.3	45.4	45.5	45.6	45.6	45.6	45.6
10	44.3	44.6	44.9	45.1	45.3	45.4	45.5	45.6	45.6	45.6	45.6

L = Longitudinal extent of the bulk grain in metres.For other values of h or L the reaction loads shall be determined by linear interpolation or extrapolation as necessary.The strength of the end connections of such vertical members of uprights may be calculated on the basis of the maximum load likely to be imposed at eight end. These loads are as follows :

LongitudinalDivisions

Maximumload at the top.	50%of the appropriate total load from Table I.
Maximumload at the bottom	55%of the appropriate total load from Table I.

TransverseDivisions

Maximumload at the top	45%of the appropriate total load from Table 11.
Maximumload at the bottom	60%of the appropriate total load from Table 11.

The thickness of horizontal wooden boards may also be determined having regard to the vertical distribution of the loading.Represented by Tables III and IV above and in such cases :Where :t = thickness of board in mm;a = horizontal span of the board, i.e., distance between uprights in metres;h = head of grain to the bottom of the division in metres;p = total load per unit length derived from Table I or II in kg.k = factor dependent upon vertical distribution of the loading.When the vertical distribution of the loading is assumed to be uniform, i.e., rectangular, k shall be taken as equal to 1.0. For a trapezoidal distribution.k = 1.0 + 0.06 (50-R), whereR is the upper end bearing reaction taken from Table III or IV.(d)Stays or shores. - The sizes of stays and shores shall be so determined that the loads derived from Tables I and II in the preceding paragraphs (a) and (b) shall not exceed one-third of the breaking loads.(D)Saucers.When a saucer is used to reduce the heeling moments in a filed compartment, its depth, measured from the bottom of the saucer to the deck line, should be as follows:-For ships with a moulded breadth of up to 9.1 metres not less than 1.2 metres.For ships with a moulded breadth of upto 18.3 metres or more, not less than 1.8 metres.For ships with a moulded breadth between 9.1 metres and 18.3 metres, the minimum depth of the saucer should be calculated by interpolation.The top (mouth) of the saucer shall be formed by the underdeck structure in the way of the hatchway, i.e., hatchside girders or coamings and hatch-end beams. The saucer and hatchway above shall be completely filled with bagged grain or other suitable cargo laid down on a separation cloth or its equivalent and stowed tightly against adjacent structures and the port-table hatchway beams if the latter are in place.(E)Bundling of BulkAs an alternative to filling the saucer with begged grain or suitable cargo abundle of bulk grain may be used provided that :(a)The saucer is lined with a material acceptable to the Central Government having a tensile strength of not less than 274 kg per 5 cm strip and which is provided with suitable means for securing at the top.(b)As an alternative to paragraph (a) above a material acceptable to the Central Government having a tensile strength of not less than 137 Kg per 5 cm strip may be used if the saucer is constructed as follows :-Authwartship lashings shall be placed inside the saucer formed in the bulk grain at intervals of not more than 2.4. metres. These lashings shall be of sufficient length to permit being drawn up light secured at the top of the saucer.Dunnage not less than 25 mm in thickness or other suitable material of equal strength and between 150 to 300 mm in width shall be placed fore and aft over these lashings to prevent the cutting or chafing of the material which shall be placed thereon to line the saucer.(c)The saucer shall be filled with bulk grain and secured at the top except that when using material approved under paragraph (h) above further dunnage shall be laid on top after tapping the material before the saucer is secured by setting up the lashings.(d)If more than one sheet of material is used to line the saucer they shall be joined at the bottom either by sewing or a double lap.(e)The top of the saucer shall be coincidental with the bottom of the beams when these are in place and suitable general cargo or bulk grain may be placed between the beams on top of the saucer.(F)Securing Hatch Covers of Filled CompartmentIf there is no bulk grain or other cargo above a "filled compartment" the hatch covers shall be secured in an approved manner having regard to the weight and permanent arrangements provided for securing such covers.The documents of authorisation issued under para 10 shall include reference to the manner of securing considered necessary by the Central Government.Section II-Securing or Partly

filled Compartments(A)Strapping or lashing.(a)When, in order to eliminate heeling moments in partly filled compartments', strapping or lashing is utilised, the securing shall be accomplished as follows-(i)The grain shall be trimmed and levelled to the extent that it is very slightly crowned and covered with burlap separation cloths, tarpaulins or the equivalent.(ii)The separation cloths and/or tarpaulins shall overlap at least 1.83 metres.(iii)The solid floors of rough 25 mm by 150 mm to 300 mm lumber shall be laid with the top floor running longitudinally and nailed to an athwartships bottom floor. Alternately, one soid floor of 50 mm lumber, running longitudinally and nailed over the top of a 50 mm bottom bearer not less than 150 mm wide, may be used. The bottom bearers shall extend the full breadth of the compartment and shall be spaced not more than 2.4 metres apart. Arrangements utilizing other materials and deemed to be equivalent to the foregoing may be accepted.(iv)Steel wire (19 mm diameter or equivalent), doubled steel strapping (50 mm x 1.3 mm and having a breaking load of at least 5000 kg) or chain of equivalent strength, each of which shall be set tight by means of a 32 mm turnbuckle, may be used for lashings. A winch tightener, used in conjunction with a locking arm, may be substituted for the 32 mm turnbuckle when steel strapping is used, provided suitable wrenches are available for setting up as necessary. When steel strapping is used, not less than three crimp seals shall be used for securing the ends. When were is used, not less than four clips shall be used for foming eyes in the lashings.(v)Prior to the completion of loading the lashing shall be positively attached to the framing at a point approximately 450 mm below the anticipated final grain surface by means of either a 25 mm shackle or beam clamp of equivalent strength.(vi)The lashings shall be spaced not more than 2.4 metres apart and each shall be supported by a bearer nailed over the top of the fore and aft floor. This bearer shall consist of not less than 25 mm by 150 mm lumber or its equivalent and shall extend the full breadth of the compartment.(vii)During the voyage the strapping shall be regularly inspected and set up where necessary.(B)Overstowing ArrangementsWhere bagged grain or other suitable cargo is utilised for the purpose of securing "partly filled compartments" the free grain surface shall be covered with a separation cloth or equivalent or by a suitable platform. Such platforms shall consist of bearers spaced not more than 1.2 metres apart and 25 mm boards laid there on spaced not more than 100 mm apart. Platforms may be constructed of other materials provided they are deemed to be equivalent.(C)Bagged GrainBagged grain shall be carried in sound bages which shall be well filled and securely closed.