

RESOLUTION A.184(VI) adopted on 28 October 1969
ADOPTION OF GRAIN REGULATIONS AS AN EQUIVALENT TO CHAPTER VI OF THE INTERNATIONAL
CONVENTION FOR THE SAFETY OF LIFE AT SEA, 1960

INTER-GOVERNMENTAL MARITIME
CONSULTATIVE ORGANIZATION



Distr.
GENERAL

A VI/Res.184
29 October 1969

Original: ENGLISH

IMCO

ASSEMBLY - 6th session
Agenda item 11

ADOPTION OF GRAIN REGULATIONS AS AN EQUIVALENT
TO CHAPTER VI OF THE INTERNATIONAL CONVENTION
FOR THE SAFETY OF LIFE AT SEA, 1960

RESOLUTION A.184(VI)
adopted on 28 October 1969

THE ASSEMBLY,

TAKING NOTE of Article 16(i) of the Convention on
the Inter-Governmental Maritime Consultative Organization
concerning the function of the Assembly,

BEARING IN MIND the Regulations of Chapter VI -
Carriage of Grain - of the International Convention for
the Safety of Life at Sea, 1960,

FURTHER BEARING IN MIND Regulation 5 of Chapter I
of that Convention concerning equivalents,

HAVING CONSIDERED the recommendation of the
Maritime Safety Committee at its nineteenth session on
the adoption of Grain Regulations as an equivalent to
Chapter VI of the International Convention for the
Safety of Life at Sea, 1960,

- 2 -

A VI/Res.184

RECOMMENDS that the Governments concerned accept the total application of the Grain Regulations set out in the Appendix to this Resolution as being equivalent to and a total alternative to the provisions of Chapter VI of the International Convention for the Safety of Life at Sea, 1960,

INVITES Governments, through the Secretariat, to exchange information on the action taken in this respect,

RECOMMENDS that Governments, through the Secretariat, should exchange data compiled as a result of using these Regulations,

REQUESTS the Maritime Safety Committee to study data compiled as the result of use of these Regulations with a view to practical evaluation of the Regulations and determining their suitability as an amendment to Chapter VI of the International Convention for the Safety of Life at Sea, 1960.

APPENDIX

EQUIVALENT TO CHAPTER VI - CARRIAGE OF GRAIN - OF THE INTERNATIONAL CONVENTION FOR THE SAFETY OF LIFE AT SEA, 1960

GRAIN REGULATIONS

Regulation 1

Application

These Regulations, including Schedules I and II, may be applied to any ship to which the International Convention for the Safety of Life at Sea, 1960, applies.

Regulation 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" refers to any compartment in which after loading and trimming, the level of the bulk grain therein is as high as possible.
- (c) The term "partly filled" refers to any compartment wherein bulk grain is not loaded in the manner prescribed in paragraph (b) of this Regulation.

Regulation 3

Trimming

- (a) All necessary and reasonable trimming shall be performed to minimize the effect of grain shifting. In any compartment

- 4 -

A VI/Res.184

which is filled with bulk grain, the 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 trimmed level and the ship shall be upright when proceeding to sea.

Regulation 4

Intact Stability Requirements

(a) 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 manner described in Schedule I, the heeling moments due to grain shift:

- (i) the angle of heel due to the shift of grain shall 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 θ_f (*), whichever is the least, shall in all conditions of loading, be not less than 0.075 metre-radians; and

(*) θ_f is an angle of heel at which openings in the hull, superstructures or 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.

- (iii) the initial metacentric height, after correction for the free surface effects of liquids in tanks, shall be not less than 0.30 metres.
- (b) Before loading bulk grain the master shall, if so required by the Contracting Government of the country of the port of loading, demonstrate the ability of the ship to comply with the stability criteria required by paragraph (a) of this Regulation.

Regulation 5

Longitudinal Divisions and Saucers

- (a) In both "filled" 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 Part I of Schedule II.
- (b) In a "filled" compartment, a division, if fitted, shall extend downwards from the underside of the deck or hatch covers to a distance below the deck line of at least one-eighth of the maximum breadth of the compartment. Except in the case of oil seeds, a longitudinal division beneath a hatchway may be replaced by a saucer of bagged grain or other suitable cargo. Such a saucer shall be formed in the manner described in Part I of Schedule II.
- (c) In a "partly filled" compartment, a division, if fitted, shall extend from one-eighth 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 shall be not less than 0.61 metres above the grain surface.

- 6 -

A VI/Res.184

(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.

Regulation 6

Securing

(a) Unless account is taken of the adverse heeling effect due to grain shift in accordance with these Regulations, the surface of the bulk grain in any "partly filled" compartment shall 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 shall 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.

Regulation 7

Feeders and/or Trunks

If feeders and/or trunks are fitted, proper account shall 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.

A VI/Res.184

Regulation 8

Combination Arrangements

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.

Regulation 9

Application of Schedule I

In those cases where the actual conditions differ from the assumptions contained in Schedule I, an Administration, or a Contracting Government on behalf of an Administration, may authorize departure from Schedule I in respect of those conditions, provided the stability criteria contained in Regulation 4(a) are met.

Regulation 10

Authorization

(a) A document of authorization issued for a ship, whether by the Administration or by a Contracting Government on behalf of the Administration, shall be accepted as evidence that the ship is capable of complying with the requirements of these Regulations.

(b) Such a document shall be issued after taking into account the requirements of these Regulations. It shall indicate typical loading conditions including the main characteristics of any fittings necessary to meet the requirements of these Regulations. The document shall accompany and refer to the stability data for the ship and heeling moments induced by the grain cargo, and shall be in such form as will enable the master to meet the requirements of Regulation 4(b).

A VI/Res.184

(c) Such a document, stability data and associated plans may be drawn up in the official language or languages of the issuing country. If the language used is neither English nor French, the text shall include a translation into one of these languages.

(d) A copy of such a document shall be placed on board in order that the master, if so required, shall produce it for the inspection of the Contracting Government of the country of the port of loading.

(e) A ship which does not produce such a document shall not load grain until the master demonstrates to the satisfaction of the Administration or the Contracting Government of the port of loading the ability of his ship in its proposed loaded condition to comply with the requirements of these Regulations.

Regulation 11

Exemptions

Regulation 16 of Chapter VI of the International Convention for the Safety of Life at Sea, 1960, shall apply to Regulations 3 to 10 inclusive of these Regulations. Where exemptions to these Regulations are granted full details thereof shall be included in the document of authorization.

A VI/Res.184

SCHEDULE 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

A VI/Res.184

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 shall be assumed that:

- (i) In filled compartments of ships with hatch side girder depths between 500 and 600 mm, the average depth of the underdeck 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:

$$Vd = Vd_1 + 0.75 (d-600) \text{ mm}$$

where Vd = Average void depth in mm;

Vd₁ = Standard void depth from the Table I below;

d = Actual girder depth in mm.

In no case shall Vd be assumed to be less than 100 mm.

TABLE I

Distance from hatch end or hatch side to boundary of compartment <u>metres</u>	Standard void depth Vd ₁ <u>mm</u>
0.5	570
1.0	530
1.5	500
2.0	480
2.5	450
3.0	440
3.5	430
4.0	430
4.5	430
5.0	430
5.5	450
6.0	470
6.5	490
7.0	520
7.5	550
8.0	590

- (iii) No voids will exist under 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 shall be used in calculating the assumed heeling moments.

(b) The ship's stability calculations will 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 only be necessary 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 underdeck voids when calculating the ship's righting arm curve, the net effects of the vertical component shifts of grain shall also be included in the total assumed heeling moment curve (see Fig.1).

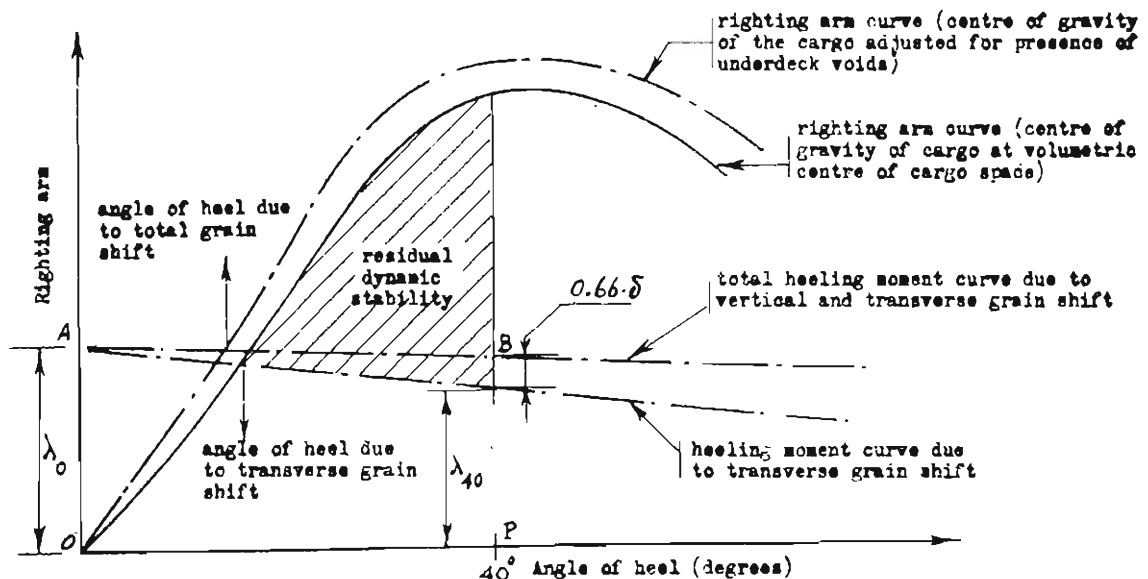


FIG. 1

A VI/Res.184

Where:

λ_0 = Assumed Volumetric Heeling Moment Due to Transverse Shift
Stowage Factor x Displacement

λ_{40} = 0.80 x λ_0 .

δ = Assumed Volumetric Heeling Moment Due to Vertical Shift
Stowage Factor x Displacement

Stowage 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
ordinates are:

OA = λ_0 and PB = (λ_{40} + 0.66 δ) respectively.

PART II - DETERMINATION OF THE ASSUMED VOLUMETRIC HEELING MOMENT OF A FILLED COMPARTMENT

(A) General

(a) The methods described hereunder will determine the assumed volumetric heeling moment per unit length.

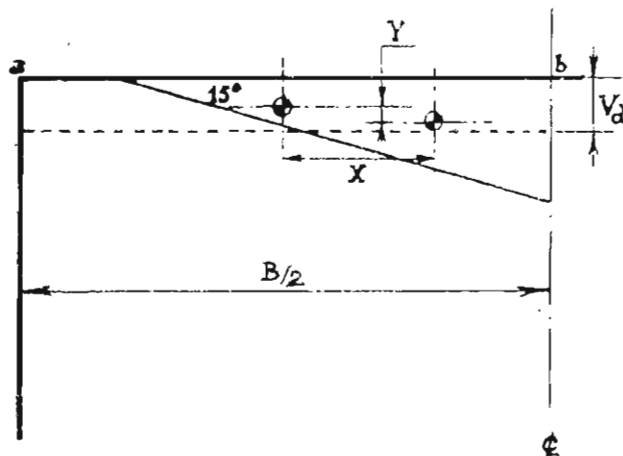
(b) In the Figures the moments are calculated in accordance with the change in shape and/or position of voids.

(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) Forward of and Aft the Hatchway

(a) With Centreline Division (See Fig. 2)



The moments arise directly from a change of shape of the cross-section through the void, which is originally a rectangle of area A ($ab \times V_d$) and which becomes a triangle.

FIG. 2

Assumed horizontal volumetric heeling moment = $A \times X \times 2$
for both sides

Assumed vertical volumetric heeling moment = $A \times Y \times 2$
for both sides

Where X = Transverse shift of centre of void due to change of shape, and

Y = Vertical shift of centre of void due to change of shape

A VI/Res.184

(b) Without Centreline Division (See Fig. 3)

- (i) If the effect of the underdeck longitudinal girders is to be taken into account, the moments shall be calculated according to the pattern of grain behaviour shown in Fig. 3.

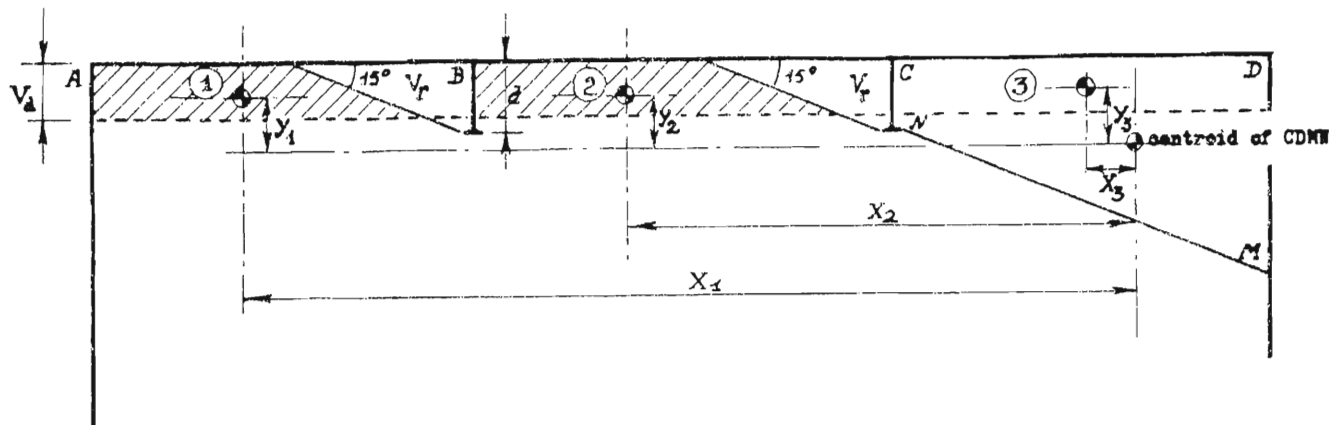


FIG 3

Suggested formulae: (1) = (AB x Vd) - V_r
 where $V_r = -\frac{d^2}{2 \tan 15^\circ}$

$$(2) = (BC \times Vd) - V_r$$

$$(3) = CD \times Vd$$

Assumed horizontal volumetric heeling moment =

$$((1) \times X_1) + ((2) \times X_2) + ((3) \times X_3)$$

Assumed vertical volumetric heeling moment =

$$((1) \times y_1) + ((2) \times y_2) + ((3) \times y_3)$$

- (ii) If the effect of longitudinal girders is not to be taken into account the moment shall 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 Centreline Division in the Hatchway
(See Fig. 4)

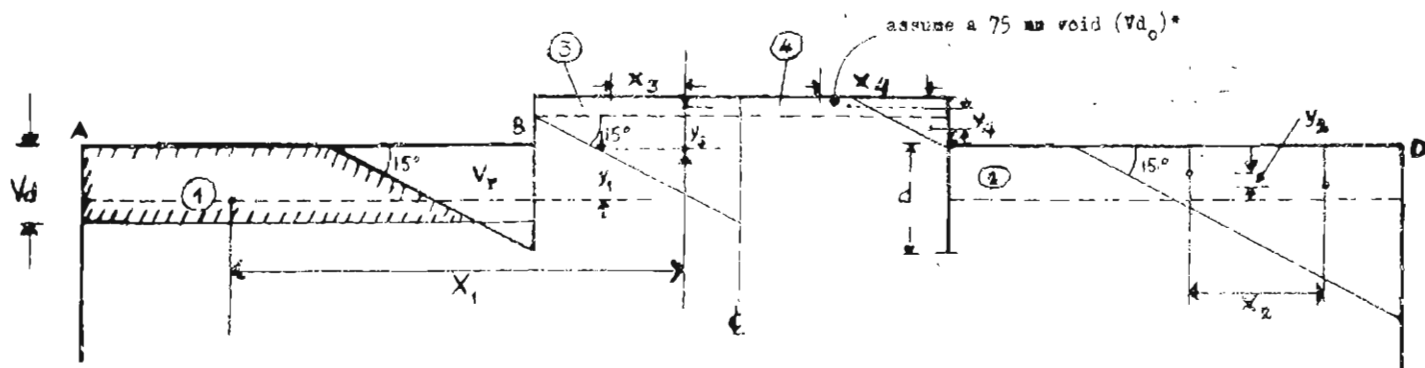


FIG 4

Suggested formulae: (1) = (AB x Vd) - V_r , where $V_r = \frac{d^2}{2 \tan 15^\circ}$

$$(2) = CD \times Vd$$

$$(3) = (4) = \frac{1}{2} \times BC \times Vd_0$$

(1) transfers to the centroid of the final void on the low side of the hatchway

(3) transfers to the centroid of the final void on the low side of the hatchway

(2) (4) transfer from rectangular to triangular shapes.

Assumed horizontal volumetric heeling moment =

$$((1) \times X_1) + ((2) \times X_2) + ((3) \times X_3) + ((4) \times X_4)$$

Assumed vertical volumetric heeling moment =

$$((1) \times y_1) + ((2) \times y_2) + ((3) \times y_3) + ((4) \times y_4)$$

* See Part I (A)(a)(iv)

A VI/Res.184

(b) When there is no Centreline Division in the Hatchway.

The calculation will be similar to that in (C)(a) above except that the transverse lever X_1 will increase due to the formation of the void against the girder at C instead of against the centreline 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

- (1) Except where included in a pattern of deck perforations accepted by the Administration approving the grain loading arrangements, it is considered that trimming hatches of normal dimensions, even though open, have no significant effect in reducing the volume of the underdeck voids.

(ii) Two Deck Arrangement without Centreline Divisions
(See Fig. 5)

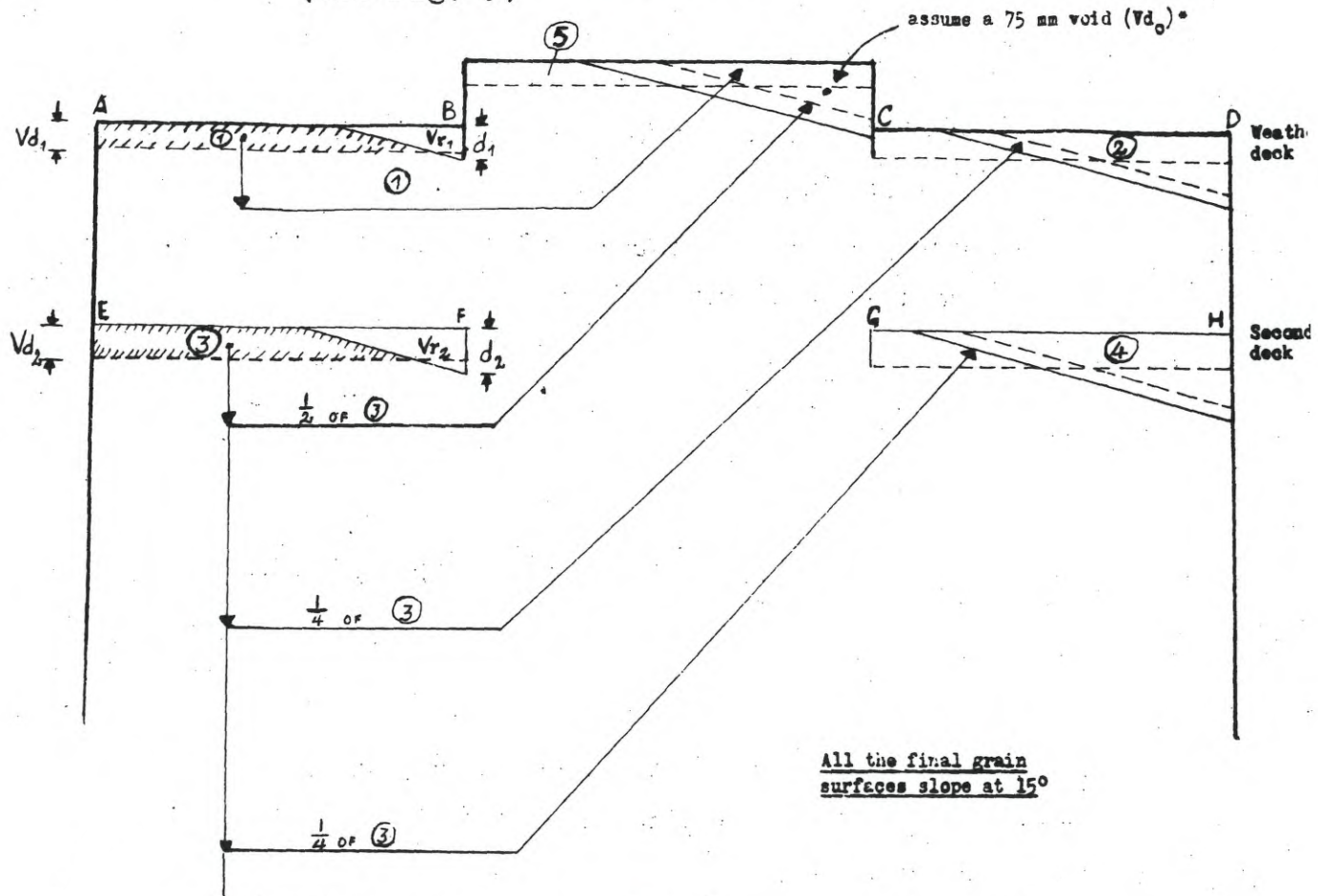


FIG. 5.

The 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;
- 1/2 of ③ transfers to the final void under the weather deck hatch cover;
- 1/4 of ③ transfers to the final void under the weather deck on the high side;
- 1/4 of ③ transfers to the final void under the second deck on the high side;

* See Part I(A)(a)(iv).

- 18 -

A VI/Res.184

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:

$$\textcircled{1} = (AB \times Vd_1) - V_{r_1}, \text{ where } V_{r_1} = \frac{d_1^2}{2 \tan 15^\circ}$$

$$\textcircled{2} = CD \times Vd_1$$

$$\textcircled{3} = (EF \times Vd_2) - V_{r_2}, \text{ where } V_{r_2} = \frac{d_2^2}{2 \tan 15^\circ}$$

$$\textcircled{4} = GH \times Vd_2$$

$$\textcircled{5} = BC \times Vd_0$$

The volume of the final void under the weather deck hatch cover will be ⑤ plus ① plus 1/2 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 1/4 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 1/4 of ③ and its centroid positioned accordingly.

(iii) Two Deck Arrangement with Tween Deck Centreline Division (See Fig. 6)

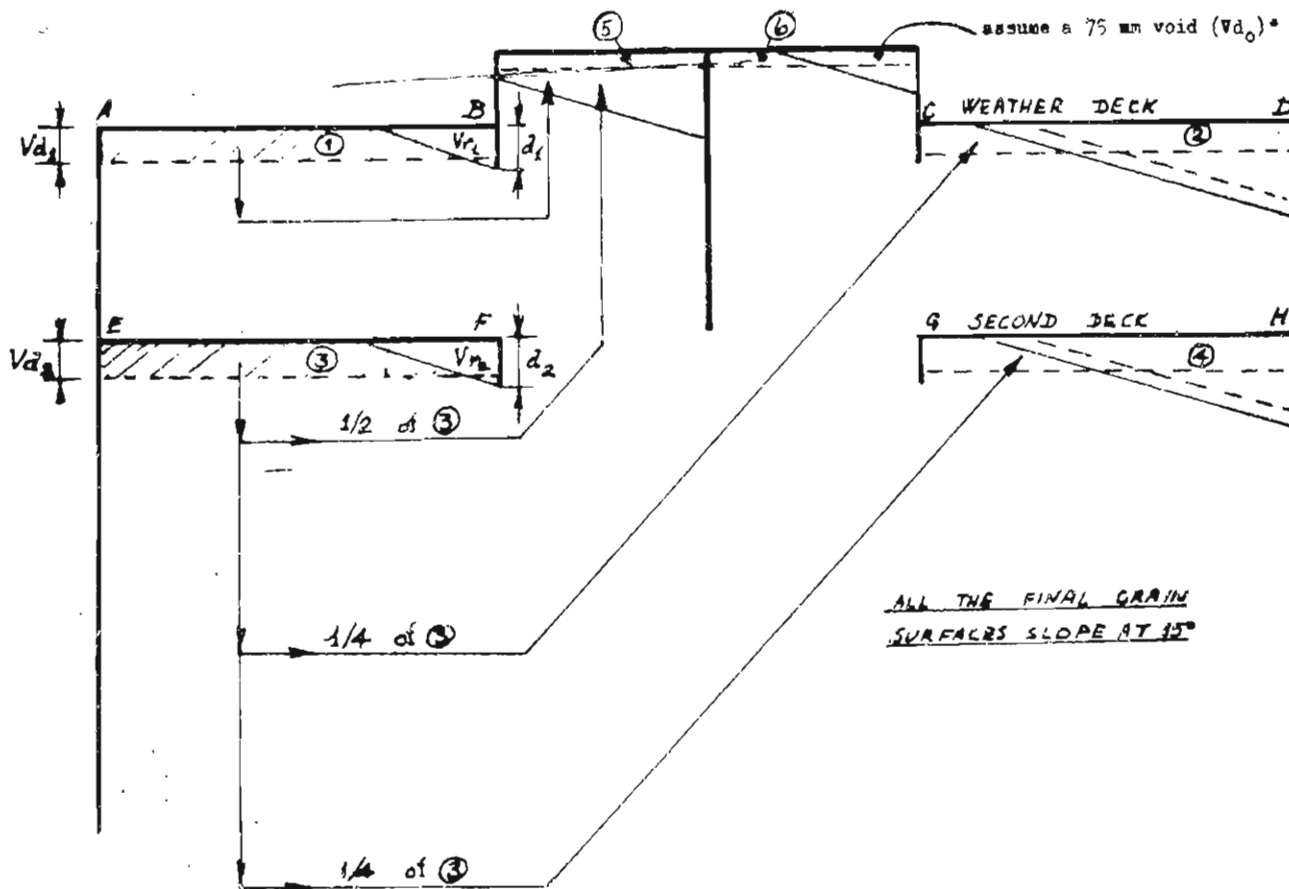


FIG. 6

The transfer of voids in this arrangement shall 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.

*See Part I(A)(a)(iv).

A VI/Res.184

(iv) Three Deck Arrangement (See Fig. 7)

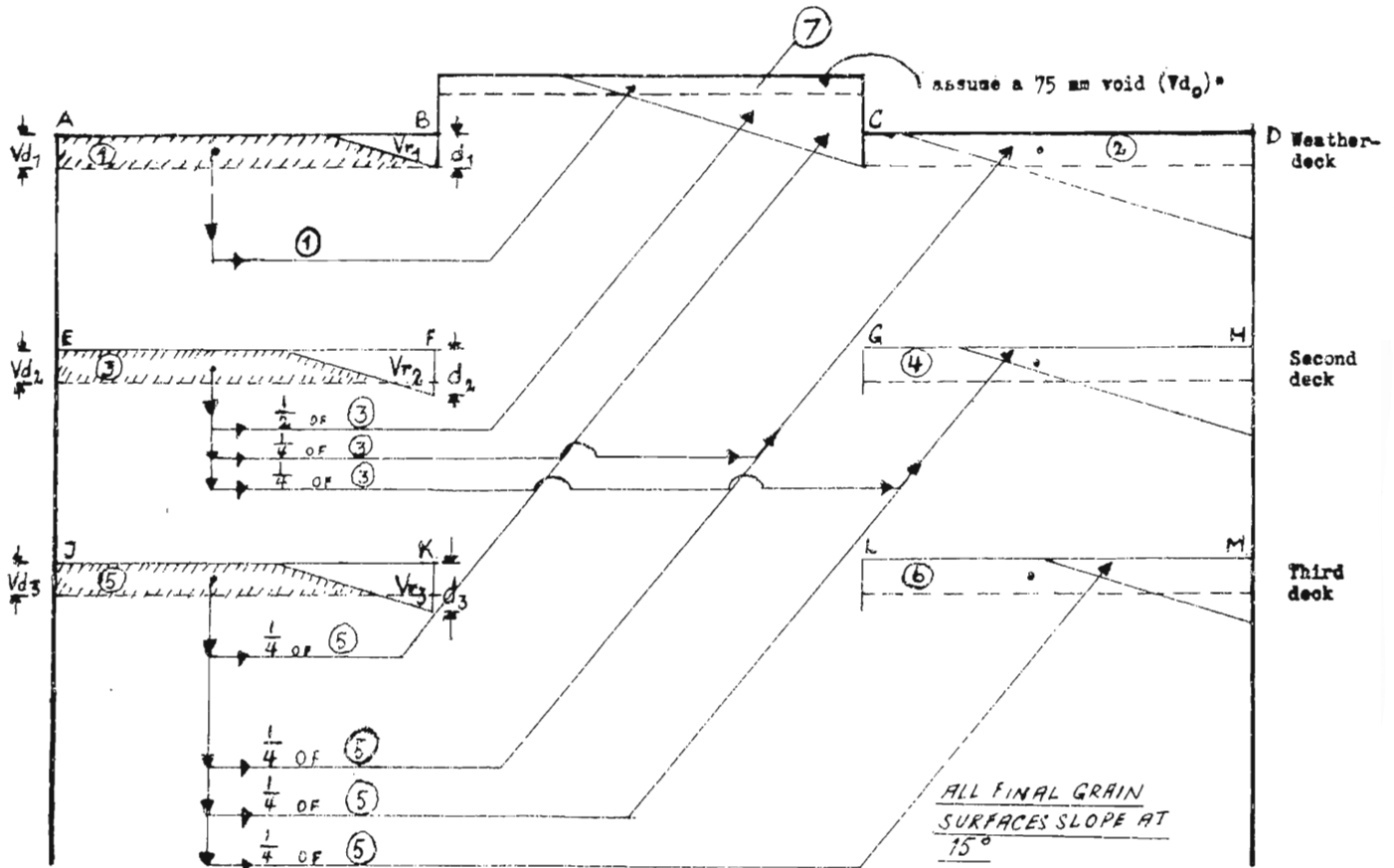


FIG. 7

The 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;
- 1/2 of ③ transfers to the final void under the weather deck hatch cover;

*See Part I(A)(a)(iv).

- 1/4 of (3) transfers to the final void under the weather deck on the high side;
- 1/4 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;
- 1/4 of (5) transfers to the final void under the weather deck hatch cover;
- 1/4 of (5) transfers to the final void under the weather deck on the high side;
- 1/4 of (5) transfers to the final void under the second deck on the high side;
- 1/4 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:

$$(1) = (AB \times Vd_1) - V_{r_1}, \text{ where } V_{r_1} = \frac{d_1^2}{2 \tan 15^\circ}$$

$$(2) = CD \times Vd_1$$

$$(3) = (EF \times Vd_2) - V_{r_2}, \text{ where } V_{r_2} = \frac{d_2^2}{2 \tan 15^\circ}$$

A VI/Res.184

$$\textcircled{4} = GH \times Vd_2$$

$$\textcircled{5} = (JK \times Vd_3) - V_{r_3}, \text{ where } V_{r_3} = \frac{d_3^2}{2 \tan 15^\circ}$$

$$\textcircled{6} = LM \times Vd_3$$

$$\textcircled{7} = BC \times Vd_0$$

The volume of the final void under the weather deck hatch cover will be $\textcircled{7} + \textcircled{1} + 1/2$ of $\textcircled{3} + 1/4$ of $\textcircled{5}$ and its centroid positioned accordingly.

The volume of the final void under the weather deck on the high side will be $\textcircled{2}$ plus $1/4$ of $(\textcircled{3} + \textcircled{5})$ and its centroid positioned accordingly.

The volume of the final void under the second deck on the high side will be $\textcircled{4}$ plus $1/4$ of $(\textcircled{3} + \textcircled{5})$ and its centroid positioned accordingly.

The volume of the final void under the third deck on the high side will be $\textcircled{6} + 1/4$ of $\textcircled{5}$ and its centroid positioned accordingly.

(v) Further Multiple Deck Arrangements

For such arrangements it shall 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 that 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 shall be obtained from Figure 12.
- (ii) Under the influence of ship motion it may be assumed that these voids are eventually completely filled transversely between perforations. The Administration shall be satisfied that these perforations are so distributed throughout the longitudinal extent of the deck as to achieve effective void filling. The heeling moments shall 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.

- 24 -

A VI/Res.184

PART III - FEEDERS AND TRUNKS

(A) Suitably Placed Wing Feeders (see Fig. 8)

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:

- (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 underdeck void outboard of the hatch side girder and its continuation.

A VI/Res.184

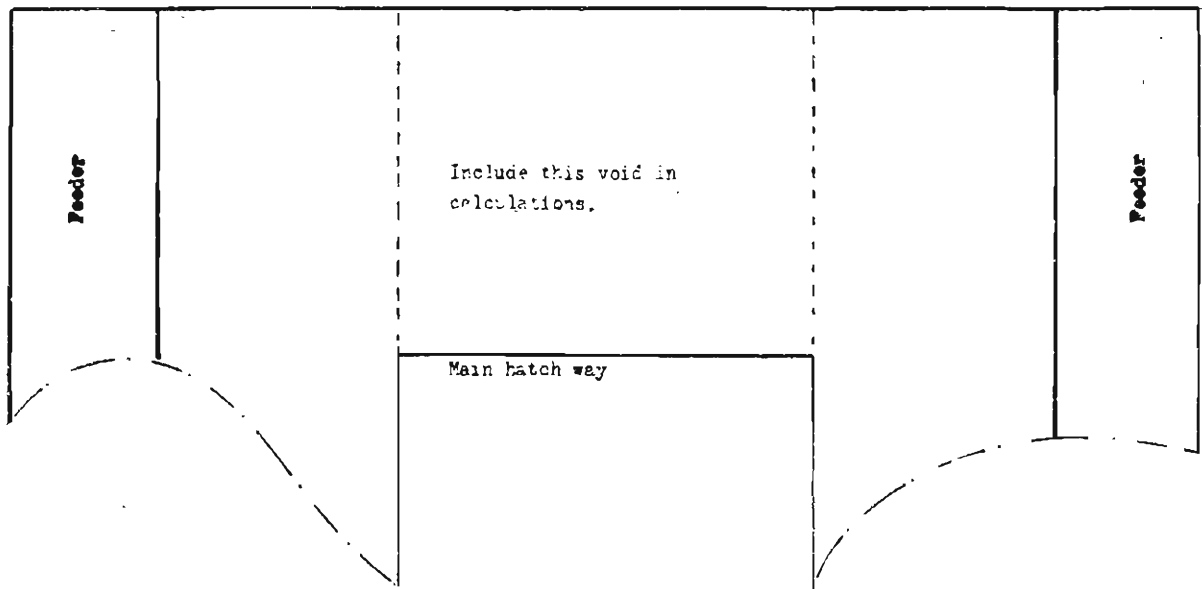


FIG. 8

(B) Trunks Situated over Main Hatchways

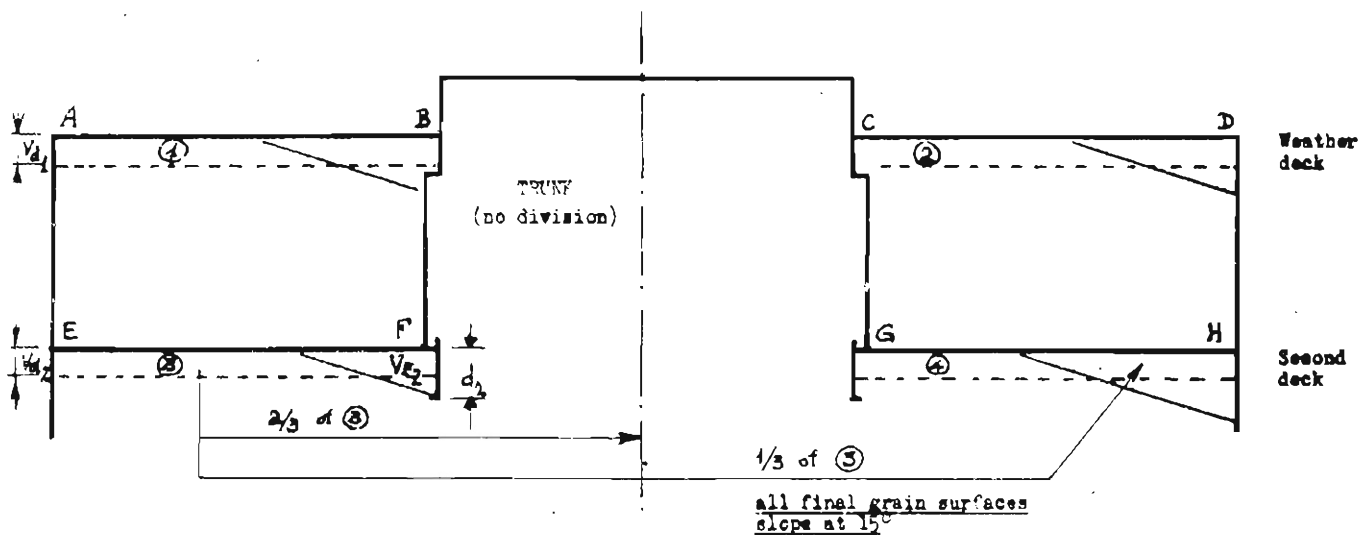


FIG. 9

The transfer of voids in this arrangement shall be assumed to have taken place as follows:

A VI/Res.184

- 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 = $AB \times Vd_1$
- ② = $CD \times Vd_1$
- ③ = $(EF \times Vd_2) - V_{r2}$, where $V_{r2} = \frac{a_2^2}{2 \tan 15^\circ}$
- ④ = $GH \times Vd_2$

The 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 trunk itself the heeling moment shall be assumed to be that arising from a full wedge transfer of 25 degrees.

Where a trunk is situated over lower 'tween decks the assumed pattern of void transfers shall be in accordance with the principles of Part II (D)(a)(ii), (iii) or (iv) of this Schedule.

PART IV -- PARTLY FILLED COMPARTMENTS

(A) General

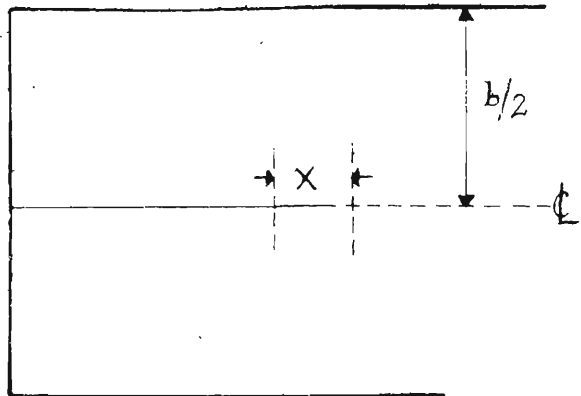
When the free surface of the bulk grain has not been secured in accordance with Regulation 6 it shall be assumed that a transfer takes place over all surfaces with an angle of surface shift (wedge angle) of 25 degrees.

(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, shall 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 ship's side. (see Fig. 10 and 11).

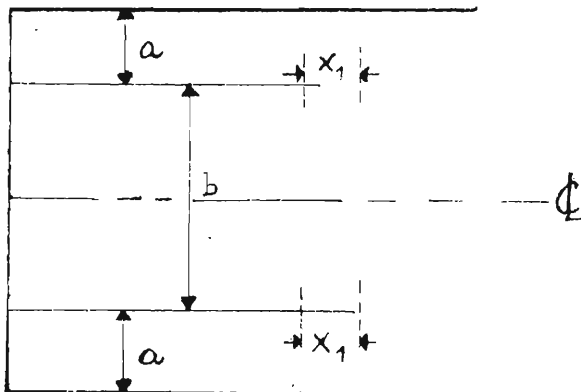
- 28 -

A VI/Res.184



Reduction $X = \frac{2}{7} \times \frac{b}{2}$ i.e. $\frac{b}{7}$ where b = breadth of hold

FIG. 10.



Reduction $X_1 = \frac{2}{7} \times (a \text{ or } b \text{ whichever is the greater})$

FIG. 11.

PERCENTAGE OF ORIGINAL VOID REMAINING
(These diagrams are based on an assumed
under deck depth of 450 mm)

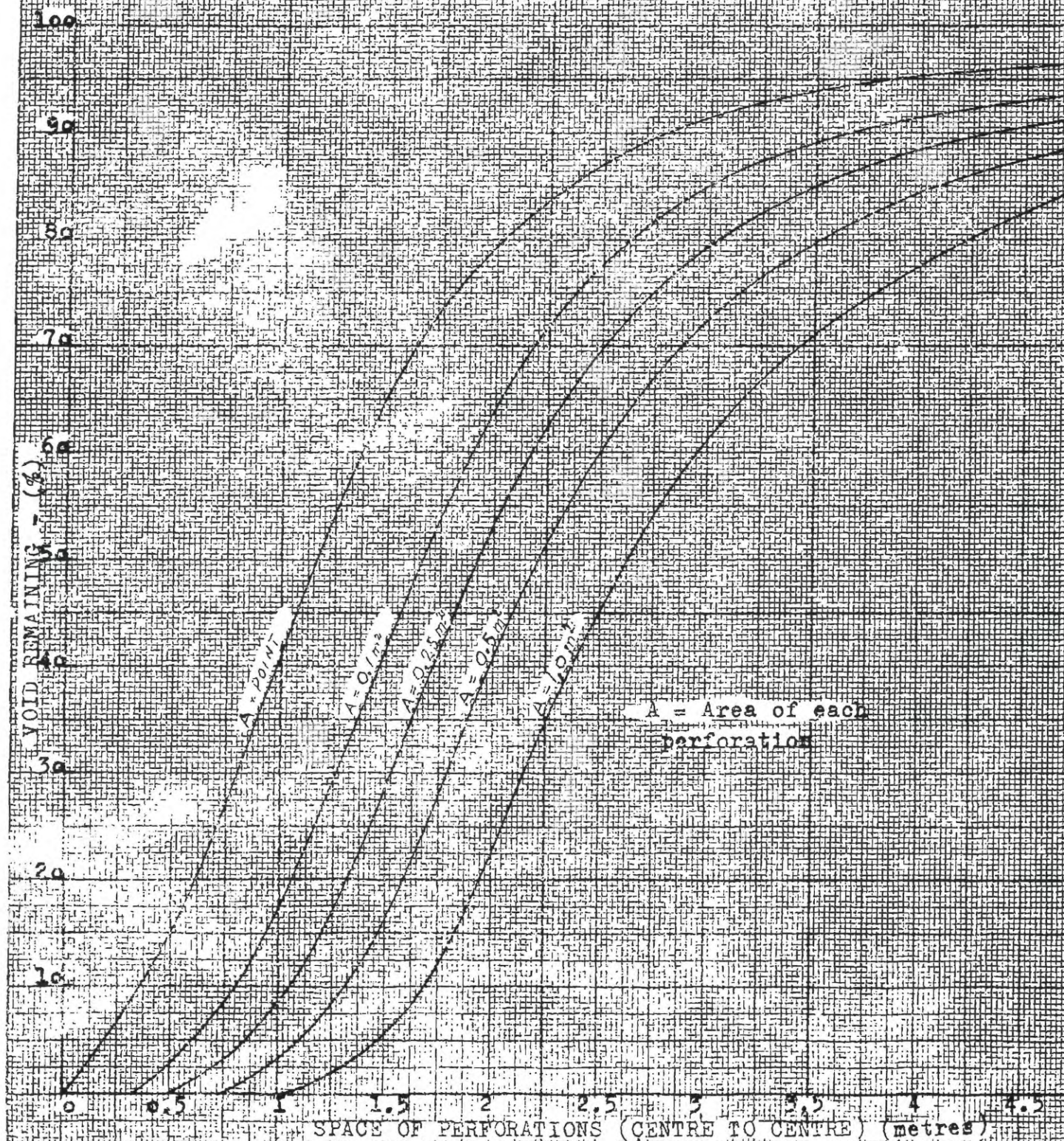


FIG. 12

A VI/Res.184

SCHEDULE 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 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 Schedule. Plywood of an exterior type bonded with waterproof glue and fitted so 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 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:

For divisions of steel.....2000 kg per square cm

For divisions of wood.....160 kg 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 uppermost 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 an Administration 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 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 shall 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 shall be supported or stayed so as to be as efficient as those which do extend to the full depth of the hold.

A VI/Res.184

(B) Divisions Loaded on Both Sides

(a) Shifting Boards

(i) Shifting boards shall 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 thicknesses shall be as follows:

<u>Thickness</u>	<u>Maximum Unsupported Span</u>
50 mm	2.5 metres
60 mm	3.0 metres
70 mm	3.5 metres
80 mm	4.0 metres

If thicknesses 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 housed 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 (B) (a) above.

(c) Uprights

(i) Steel uprights used to support divisions loaded on both sides shall have a section modulus given by

$$W = a.W_1$$

Where:

W = Section modulus in cm^3 ;

a = Horizontal span between uprights in metres.

The section modulus per metre span W_1 , shall be not less than that given by the formula:

$$W_1 = 14.8 (h_1 - 1.22) \text{ cm}^3 \text{ per metre};$$

h_1 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 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 shall be determined by multiplying by 12.7 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 (a) (ii) of this Part of the Schedule.

(d) Shores

(i) Wood shores, when used, shall 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.

A VI/Res.184

(ii) Subject to the provisions of sub-paragraphs (iii) and (iv) below, the minimum size of wood shores shall be as follows:

Length of Shore in metres	Rectangular Section mm	Diameter of Circular Section mm
Not exceeding 3 m	150 x 100	140
Over 3 m but not exceeding 5 m	150 x 150	165
Over 5 m but not exceeding 6 m	150 x 150	180
Over 6 m but not exceeding 7 m	200 x 150	190
Over 7 m but not exceeding 8 m	200 x 150	200
Exceeding 8 m	200 x 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 shall 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

A VI/Res.184

determined assuming that the divisions and upright which the stay supports is uniformly loaded at 500 kg/m^2 . 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*
B (m)

h m	2	3	4	5	6	7	8	10
1.5	850	900	1010	1225	1500	1770	2060	2645
2.0	1390	1505	1710	1985	2295	2605	2930	3590
2.5	1985	2160	2430	2740	3090	3435	3800	4535
3.0	2615	2845	3150	3500	3885	4270	4670	5480
3.5	3245	3525	3870	4255	4680	5100	5540	6425
4.0	3890	4210	4590	5015	5475	5935	6410	7370
4.5	4535	4890	5310	5770	6270	6765	7280	8315
5.0	5185	5570	6030	6530	7065	7600	8150	9260
6.0	6475	6935	7470	8045	8655	9265	9890	11150
7.0	7765	8300	8910	9560	10245	10930	11630	13040
8.0	9055	9665	10350	11075	11835	12595	13370	14930
9.0	10345	11030	11790	12590	13425	14260	15110	16820
10.0	11635	12395	13230	14105	15015	15925	16850	18710

h = height of grain in metres**

B = transverse extent of the bulk grain in metres

For other values of h and/or B the loads shall be determined by linear interpolation or extrapolation as necessary.

* 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 tons per foot length.

** Where the distance from a division to a feeder or hatchway is 1 metre or less, the height - h - shall be taken to the level of the grain within that hatchway or feeder. In all other cases the height shall be taken to the overhead deck in way of the division.

A VI/Res.184

(b) Transverse Divisions The load in kg per metre length of the divisions shall be taken to be as follows:

TABLE II*

L(m)

h 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
2.0	1040	1100	1170	1245	1325	1400	1470	1575	1640	1660	1660
2.5	1460	1565	1675	1780	1880	1980	2075	2210	2285	2305	2305
3.0	1925	2065	2205	2340	2470	2590	2695	2845	2925	2950	2950
3.5	2425	2605	2770	2930	3075	3205	3320	3480	3570	3595	3595
4.0	2950	3160	3355	3535	3690	3830	3950	4120	4210	4235	4240
4.5	3495	3725	3940	4130	4295	4440	4565	4750	4850	4880	4885
5.0	4050	4305	4535	4735	4910	5060	5190	5385	5490	5525	5530
6.0	5175	5465	5720	5945	6135	6300	6445	6655	6775	6815	6825
7.0	6300	6620	6905	7150	7365	7445	7700	7930	8055	8105	8115
8.0	7425	7780	8090	8360	8590	8685	8950	9200	9340	9395	9410
9.0	8550	8935	9275	9565	9820	9930	10205	10475	10620	10685	10705
10.0	9680	10095	10460	10770	11045	11270	11460	11745	11905	11975	11997
h = height of grain in metres**											
L = longitudinal extent of the bulk grain in metres											

For other values of h and/or L the loads shall be determined by linear interpolation or extrapolation as necessary.

* 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 tons per foot length.

** Where the distance from a division to a feeder or hatchway is 1 metre, the height - h - shall be taken to the level of the grain within that hatchway or feeder. In all other cases the height shall be taken to the overhead deck in way of the division.

(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 shall be taken to be those shown in Tables III and IV.

A VI/Res.184

LONGITUDINAL DIVISIONS LOADED ON ONE SIDE ONLY

TABLE III

Bearing 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	48.8	48.8	48.8	48.8	48.8
3	46.0	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	47.0	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	49.4	50.1	50.2	50.2	50.2	50.2	50.2
6	47.9	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 shall
 be determined by linear interpolation or extrapolation
 as necessary.

TRANSVERSE DIVISIONS LOADED ON ONE SIDE ONLY

TABLE IV

Bearing Reaction at the Upper End of Upright
as Percentage of Load (Table II)

L (m)

h (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	45.0
2	39.6	40.6	41.4	42.1	42.7	43.1	43.6	44.3	44.7	45.0	45.2
2.5	41.0	41.8	42.5	43.0	43.5	43.8	44.2	44.7	45.0	45.2	45.2
3	42.1	42.8	43.3	43.8	44.2	44.5	44.7	45.0	45.2	45.3	45.3
3.5	42.9	43.5	43.9	44.3	44.6	44.8	45.0	45.2	45.3	45.3	45.3
4	43.5	44.0	44.4	44.7	44.9	45.0	45.2	45.4	45.4	45.4	45.4
5	43.9	44.3	44.6	44.8	45.0	45.2	45.3	45.5	45.5	45.5	45.5
6	44.2	44.5	44.8	45.0	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 values of h and/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 or uprights may be calculated on the basis of the maximum load likely to be imposed at either end. These loads are as follows:

Longitudinal Divisions Maximum load at the top.....50% of the appropriate
total load from Table I

Maximum load at the bottom...55% of the appropriate
total load from Table I

Transverse Divisions Maximum load at the top.....45% of the appropriate
total load from Table II

Maximum load at the bottom...60% of the appropriate
total load from Table II

A VI/Res.184

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

$$t = 10 a \sqrt{\frac{p \times k}{h \times 213.3}}$$

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

$k = 1.0 + 0.06 (50-R)$, where

R 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 full compartment, its depth, measured from the bottom of the saucer to the deck line, shall be as follows:

- 41 -

A VI/Res.184

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, the minimum depth of the saucer shall be calculated by interpolation.

As far as is practicable the top (mouth) of the saucer shall be formed by the underdeck structure in the way of the hatchway, i.e. hatch side 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 portable hatchway beams if the latter are in place.

A VI/Res.184

PART II - SECURING OF PARTLY FILLED COMPARTMENTS

(A) Strapping or Lashing

(a) When, in order to eliminate heeling moments in partly filled compartments, strapping or lashing is utilized, 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) Two solid floors of 25 mm lumber shall be laid with the top floor running longitudinally and nailed to an athwartships bottom floor. Alternatively, one solid 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 instead of the two floors of 25 mm lumber. The bottom bearers shall extend the full breadth of the compartment and shall be spaced not more than 2.44 metres apart. Arrangements utilizing other materials and deemed by an Administration to be equivalent to the foregoing may be accepted.
- (iv) Flaw 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

A VI/Res.184

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 wire is used, not less than four clips shall be used for forming 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 2.44 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.

(B) Constructional Details of Securing Arrangements

Where bagged grain or other suitable cargo is utilized for the purpose of securing partly filled compartments, the free grain surface shall be covered with a separation cloth or equivalent and/or by a suitable platform. Such platforms shall consist of bearers spaced not more than 1.22 metres apart and 25 mm boards laid thereon spaced not more than 100 mm apart. Platforms may be constructed of other materials provided they are deemed by an Administration to be equivalent.

(C) Bagged Grain

Bagged grain shall be carried in sound bags which shall be well filled and securely closed.

RESOLUTION A.184(VI) adopted on 28 October 1969
ADOPTION OF GRAIN REGULATIONS AS AN EQUIVALENT TO CHAPTER VI OF THE INTERNATIONAL
CONVENTION FOR THE SAFETY OF LIFE AT SEA, 1960