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CONTAINERS AND CARGOES

CARRIAGE OF GRAIN

Guidance on interpretations and equivalences

Foreword

Experience with the application of chapter VI of SOLAS 1974 over a period of twelve years has indicated that it would be beneficial to clarify, expand upon, or otherwise explain certain regulations and sections thereof, in order to insure uniform implementation on all ships subject thereto. The following guidelines have been prepared to accomplish this purpose. They are not intended as new or additional regulations but, instead, are furnished for the guidance of approval agencies, port authorities, surveyors, and others responsible for the utilization of chapter VI.

Introduction

The organization and format of the guidelines are based upon the following precepts:

1 A guideline is not provided for each and every regulation and section.

2 The guidelines, when provided, are listed in the same order as the pertinent regulations or sections as set forth in chapter VI, and are serially numbered for identification.

3 Each guideline is further identified by a title appropriate to its specific subject and not by the title of the regulation or section to which it applies. However, the latter designation is always included as a reference.

4 A table of contents listed in titles of the guidelines and an index is provided to cross reference the guidelines to the affected regulations or sections in chapter VI.

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1 Filled compartment, untrimmed

(Reference: Regulation 2 - Definitions)

BACKGROUND

To facilitate interpretation of regulation 3(c) with regard to granting a dispensation from trimming grain surfaces under certain conditions, the following additional definition is appropriate in regulation 2.

GUIDELINE

A "filled compartment, untrimmed" is a compartment which is filled to the maximum extent possible in way of the hatch opening but which has been granted a dispensation from trimming outside the periphery of the hatch opening either by the provisions of regulation VI/3(c) for all ships, or by MSC/Circ.323 on the dispensation from trimming under-deck voids in filled cargo holds of specially suitable ships. For other information applying to such compartments, refer to guideline No.2.

2 Dispensation from trimming "filled" compartments

(Reference: Regulation 3 - Trimming of grain)

GUIDELINE

In addition to the provisions of regulation VI/3(c), dispensation from trimming the under-deck spaces forward and aft of the hatchway on specially suitable ships, as defined in part B, section V(B) of chapter VI, may be granted in accordance with the provisions of MSC/Circ.323 which is appended to these guidelines.

3 Outdated reference

(Reference: Regulation 4 - Intact stability requirements)

GUIDELINE

Due to the renumbering of certain regulations when the 1981 amendments to SOLAS 74 were issued, the regulation cited in regulation 4(a) is incorrect. Instead of regulation II-19 of SOLAS 60 and 74, the correct reference should be regulation II-1/22 of SOLAS 74, as amended. See, also, guideline No.11.

4 Deck edge immersion

(Reference: Regulation 4(b)(i) - Intact stability requirements)

BACKGROUND

The stability requirements in regulation 4(b) are based upon statistical evidence that a vessel which meets these standards will survive if circumstances cause it to assume a permanent list of 12° in still water recognizing that, at sea, the vessel will roll an additional amount to port and starboard of this new axis. However, the statistical evidence was based on a sample of ships which, when listed to 12°, did not immerse the deck edge. Deck edge immersion has a strong relation to range of stability and this factor is not, explicitly, included in the requirements set forth in regulation 4(b). The footnote to regulation 4(b)(i) is a reminder of this point. The following guideline is intended to emphasize that precaution.

GUIDELINE

To ensure an adequate range of stability after a shift of grain, it is recommended that the permissible angle of heel be limited to the angle of deck edge immersion if that is less than 12°.

5 Effect of longitudinal structure in "filled" or "partly filled" compartments

(Reference: Regulation 5 - Longitudinal divisions and saucers
Part B, section II - Assumed volumetric heeling moment of a filled compartment)

BACKGROUND

When a grain shift occurs in a "filled" compartment, structural members such as longitudinal girders and hatch side girders impede the transverse movement of the grain and, therefore, reduce the grain heeling moment attributable to the transverse shift. Regulations 5(b)(i) and (b)(ii), and part B, section II, address this effect, but experience indicates that these rules have been interpreted in significantly different ways. It is evident that there is confusion as to their intent. For example, is there a difference in effect when one of these barriers is installed as part of the structural support system of the ship as opposed to being provided for the

express purpose of impeding the transverse movement of the grain? Or, whether the member is ineffective if it is installed on a location other than the centreline? A generally accepted interpretation, in effect authorized by regulation 9, has developed over time and is set forth in the following guideline.

GUIDELINE

5.1 In "filled compartments" and in "filled compartments, untrimmed", all graintight longitudinal members either permanent or temporary may be considered as effective over their full depth for the purpose of limiting the transverse shift of grain. If such a member is discontinuous longitudinally, it should be considered effective over its actual length.

5.2 The division referred to in regulation 5(c) should be understood to mean a temporary construction which is installed for the express purpose of reducing the grain heeling moment by limiting the transverse shift of grain and, as such, it should comply with the dimensional parameters described in that regulation in order to be considered effective. With respect to permanent longitudinal structures, such as girders, partial bulkheads, etc., whether on the centreline or not, these may be considered as effective for their full depth for the purpose of preparing the volumetric heeling moment curves for partly filled compartments.

6 Securing holds loaded in combination

(Reference: Regulation 8 - Combination arrangements
Part C, section I (D) - Saucers
Part C, section I (E) - Bundling of bulk
Part C, section II(A) - Strapping or lashing

BACKGROUND

When holds are loaded in combination, void spaces exist beneath the deck which are within the stow, as shown in figure 1 for a "filled" hold or figure 2 for a "partly filled" hold.

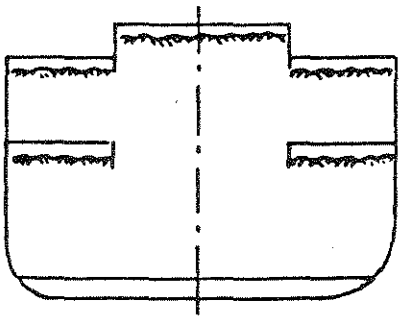

Figure 1

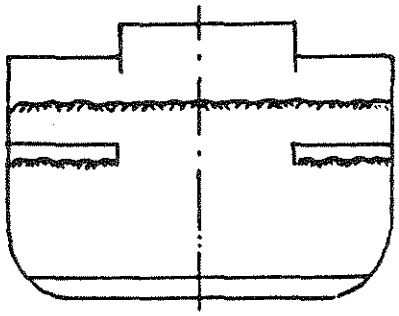

Figure 2

In the case of figure 1, it is not permissible to reduce the grain heeling moment by placing a saucer or a bundle within the coaming of the upper hatchway. Similarly, in the case of figure 2, if the stability of the ship cannot tolerate the grain heeling moment of the arrangement shown, it is not permissible to eliminate the grain heeling moment by securing the upper surface by means of strapping or lashing. The reason is that, in both situations, the redistribution of some of the void spaces from beneath the lower decks to the upper compartment (as described in part B, section II(C)), has the potential for dropping the bundle or saucer from the confines of the hatch coaming, or loosening the strapping arrangement and thereby diminishing or defeating their effectiveness as a mechanism for reducing the grain heeling moment.

GUIDELINE

It is recommended that compartments which are loaded in combination should not utilize saucers, bundling of bulk, or securing by means of strapping or lashing.

7 Volumetric heeling moments

(Reference: Regulation 11(a)(i) - Grain loading information)

BACKGROUND

Stability calculations deal with a heeling moment which is the product of a weight times a distance. Therefore, regulation 11(a)(i) requires the grain heeling moments be furnished as part of the grain loading information. This

is cumbersome because each of several weights of grain would require a separate grain heeling moment curve or tabulation for each cargo compartment. To reduce the amount of data furnished, it has become the practice in most grain loading booklets to provide curves or tables of volumetric heeling moments in lieu of grain heeling moments. This reduces the size of the booklet without loss of information because grain heeling moment is simply volumetric heeling moment divided by the stowage factor of whatever specific type of grain is being loaded. Therefore, to interpret regulation 11(a)(i) so as to conform with general practice, the following guideline is given.

GUIDELINE

It is recommended that in the grain loading information furnished to the master, heeling moment data for each cargo compartment be provided as volumetric heeling moments rather than as actual grain heeling moments. Instructions on how to accomplish the required conversion should also be provided.

8 Preparation of volumetric heeling moment curves

(Reference: Regulation 11(a)(i) - Grain loading information)

BACKGROUND

The volumetric heeling moment for a cargo hold which is "filled" and trimmed in accordance with regulation 3(a), is based on a grain shift of 15°. It is to be especially noted that there is only one condition which is deemed to be "filled". Any other condition, even one which is only minimally different, is considered to be "partly filled", and the volumetric heeling moment should be based upon a 25° grain shift. It is evident that the volumetric heeling moment curves in some grain loading booklets do not recognize this distinction. They show the uppermost point on the volumetric heeling moment curve for the partly filled compartment to be coincident with the volumetric heeling moment for the filled compartment. The following guideline is intended to caution those involved in the preparation of grain loading booklets, against making this error.

GUIDELINE

The uppermost point on a curve of volumetric heeling moment versus either depth of grain or ullage, in a partly filled compartment, should be based on the void in the filled condition shifted 25°. In other words, the curve of volumetric heeling moments for the partly filled condition should not be terminated at the point, at zero ullage, which represents the volumetric heeling moment based on a 15° shift as the moment applies only to the filled condition.

9 Permissible heeling moment table

(Reference: Regulation 11(a)(ii) - Grain loading information)

BACKGROUND

Regulation 11(a)(ii) permits alternatives to the use of maximum permissible heeling moments. However, experience now indicates that most grain loading booklets contain curves or tables of maximum permissible heeling moments. Thus, ships using alternative methods are a small minority and suffer additional training problems due to use of non-standard methods and, also, a lack of facilitation whenever compliance with the regulations is verified by port authorities.

GUIDELINE

It is strongly recommended that grain stability information be presented in the form of tables or curves of maximum permissible heeling moments versus displacement and KG corrected for a liquid-free surface.

10 Examples of calculations

(Reference: Regulation 11(a)(iv) and (a)(v) - Grain loading information)

BACKGROUND

The intent of regulations 11(a)(iv) and (a)(v) is to illustrate the correct use of the information furnished in the grain loading booklet by providing meaningful, worked-out examples. This intention has not always been fulfilled. Some grain loading booklets provide several examples which are

essentially the same in that they merely demonstrate a single stowage arrangement at various displacements. While it is not intended that the grain loading booklet should include examples of every arrangement permitted by the regulations, it should include both filled and partly filled holds. Also, if data for "filled compartments, untrimmed" is furnished, examples of this capability should be included.

GUIDELINE

The typical loading conditions required to be furnished in the grain loading booklet should demonstrate the proper use of all the grain loading information which is provided in the booklet.

11 Required stability information

(Reference: Regulation 11(b) - Grain loading information)

BACKGROUND

Regulation II-1/22 requires that stability information be furnished to the master but it is non-specific. With respect to ships loading bulk grain, regulation 11(b) provides a specific listing of stability information but it is incomplete in that it does not include all the information needed to perform the stability calculations required by this chapter. Accordingly, the following guideline is provided to complete the list.

GUIDELINE

In addition to the stability information listed in regulation 11(b), the following data should be provided:

(v) hydrostatic curves or tables; and

(vi) cross curves of stability calculated by either free trim or constant trim method.

12 Angle of flooding

(Reference: Regulation 11 - Grain loading information
Regulation 2 - Definitions)

BACKGROUND

Experience now indicates that it has not been the usual practice to identify the "angle of flooding" in the grain loading information furnished to the master. Although this information is basic to the calculations which are made to demonstrate compliance with regulation 4(b), it is not readily obtained by direct observation of the types and arrangements of openings above the weather deck on a ship. The following guideline is given to remedy this omission.

GUIDELINE

The opening or openings into the ship accepted by the Administration as establishing the "angle of flooding" should be identified in the grain loading information furnished to the master. Such identification should include its dimensional location with reference to the principal axes of the ship. Alternatively, a table or curve of angle of flooding versus displacement may be furnished.

13 Ballasting and deballasting

(Reference: None)

BACKGROUND

Sometimes, when the ballasting of a ship laden with bulk grain is necessary in order to meet the stability requirements of this chapter, ballast cannot be taken at the point of loading because of a water depth limitation or the unsuitability of the harbour water. In such cases, the ship takes on ballast after leaving the loading berth but before proceeding on the high seas. The reverse situation also occurs with respect to deballasting upon completion of a voyage. The regulations, neither in chapter VI nor in any other part of the Convention, identify a point in the voyage at which full compliance commences. The following guideline is intended to describe the usual practice with respect to this question.

GUIDELINE

When ballasting, necessary to meet the stability requirements of chapter VI, cannot be accomplished at the loading berth any proposal to defer ballasting should be approved by the port authority. However, at no time during the ballasting operation should the GM corrected for a free liquid surface, including the free surface in the ballast tank which is in the process of being filled, be less than 0.3 m. Similarly, deballasting at the end of a voyage should be subject to the same requirement.

14 Boundary distance

(Reference: Part B, section I(A) - Description of assumed voids and method of calculating intact stability)

BACKGROUND

Boundary distance, the dimension from the perimeter of the hatchway to the boundary of the compartment, is used to calculate the average depth (Vd) of the void in a "filled" compartment. Although it is a specific dimension when measured perpendicularly to the periphery of the hatchway, it is not explicitly defined as to how it should be measured in the corners of the compartment. Refer to figure 3, which shows the forward end of a 'tween-deck compartment in a general cargo ship.

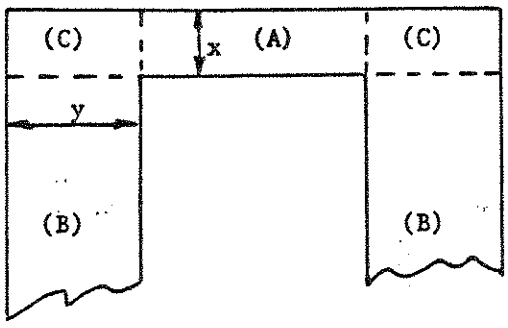

Figure 3

Dimension x is clearly the boundary distance in area (A). Dimension y is the boundary distance in area (B). The question is - what is the boundary distance in area (C), i.e. in the corners, and which girder depth (d) is to be applied in the calculation of (Vd), the depth of the hatch end beam or the hatch side girder. The following guideline addresses this question.

GUIDELINE

When calculating the average void depth (Vd) in accordance with part B, section I(A), the boundary distance in the corner of a compartment should be the distance from the hatch end beam or from the hatch side girder to the boundary of the compartment, whichever is the greater. The girder depth (d) should be taken to be the depth of the hatch end beam or the depth of the hatch side girder, whichever is the least.

15 Stowage factor

(Reference: Part B, section I(A)(c) - Description of assumed voids and method of calculating intact stability)

BACKGROUND

For the purposes of calculating the stability of a ship carrying bulk grain, the regulations in part B, section I(A)(e)(1), defines "STOWAGE FACTOR" as the volume per unit weight of grain cargo. This terminology is different from usual merchant shipping practice whereby the stowage factor makes allowance for "broken stowage", i.e. the fraction of the hold volume which is not occupied by the cargo for various reasons such as interference of structure, shape of cargo units, etc. This difference in meaning for a commonly used shipping term has, from time to time, caused problems in the grain trade with regard to its correct application. The grain heeling moment is the product of a weight multiplied by a distance. The weight under consideration is the weight of a solid mass of grain which shifts laterally across the ship. The weight of this mass is not reduced by any lost volume due to "broken stowage" within the mass. The following guideline is intended to emphasize the stated intention of this regulation.

GUIDELINE

When calculating the grain heeling moment as the quotient of the volumetric heeling moment divided by the stowage factor, stowage factor should be taken to mean the volume per unit weight of the grain cargo as mandated by part B, section I(A), and without any adjustment thereto. This value should be calculated from the test weight of the grain as furnished by the loading facility.

16 Length measured to a corrugated bulkhead

(Reference: Part B, section II(A)(a) - Assumed volumetric heeling moment of a filled compartment)

BACKGROUND

Since a corrugated bulkhead has more than one transverse, plane surface a question arises as to where to measure length when a corrugated bulkhead is a boundary of a compartment loaded with bulk grain. The following guideline is intended to define the interpretation that, most generally, has been used.

GUIDELINE

When measuring length to a corrugated bulkhead, the length should be deemed to be the distance to the midpoint between the outer and the inner transverse, plane surfaces as shown in figure 4.

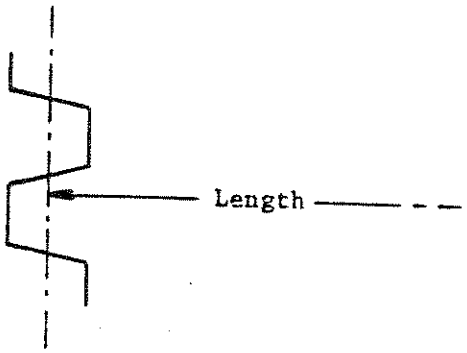

Figure 4

17 Assumed volumetric heeling moment of a filled compartment, untrimmed

(Reference: Part B, section II(A)(c) - Assumed volumetric heeling moment of a filled compartment)

BACKGROUND

In a "filled" compartment which is trimmed as required by regulation VI/3(a), the above referenced section states that the resulting grain surface after shifting shall be assumed to be at an angle 15° to the horizontal. It is implicit in this regulation that the void area above the trimmed surface will be minimal as described by the average void depth (Vd) assumption in part B, section I(A)(a). However, when the compartment is

filled but is exempted from trimming by regulation VI/3(c) because there is additional filling, by means of feeding ducts or deck perforations, into the void above grain surface at its natural angle of repose; there is no implication as to the size of the remaining void. It may be greater than or less than the standard void. If it is greater, this raises the question as to whether the 15° shift should still be applied. The regulations are silent on this point. The following guideline pertains to this latter situation only.

GUIDELINE

Where dispensation from trimming of under-deck void spaces is granted in accordance with the provisions of regulation 3(c), the angle of grain shift should be assumed to be 25° to the horizontal. However, if any section of the hold, i.e. forward abaft, or abreast of the hatchway, the mean, transverse area of the void in that section is equal to or less than the void area which would obtain if the section was trimmed as required by regulation 3(a), then the angle of grain shift in that section may be assumed to be at 15° to the horizontal.

18 Angle of grain shift in a filled compartment, untrimmed

(Reference: Part B, section IV(A) - Assumed volumetric heeling moments of a partly filled compartment)

BACKGROUND

The existence of an untrimmed grain surface within a filled compartment, as permitted when a dispensation from trimming has been granted, raises a question as to the angle of the surface after a grain shift has occurred. Part B, section I(A)(a)(ii), states that the untrimmed surface before the shift will be at an angle of 30°. Also, part B, section IV(A), states that, after shift, the surface shall be assumed to be at an angle of 25°. But for any part of the surface to change its angle from 30° before shifting to 25° after shifting implies that the grain, in that part, has moved against gravity, i.e. "uphill". The sketches below illustrate the question. Figure 5 is the alternative where part of the surface remains at 30° after shift and the remainder is at 25° - there is no "uphill" movement of the grain. Figure 6 is the alternative where the entire shifted surface is at 25°, implying that some of the grain has moved "uphill". It is to be noted that

the latter alternative is the assumption which is mandated by the regulations. The following guideline is directed at emphasizing this intent of the regulation.

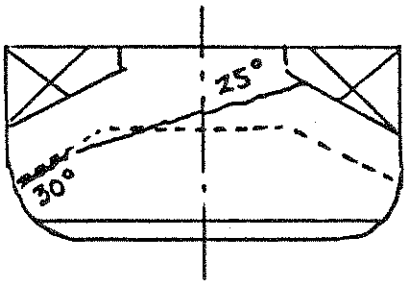

Figure 5

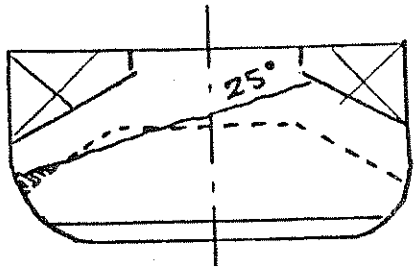

Figure 6

GUIDELINE

When the free surface of the bulk grain has not been secured in accordance with regulation 6 of this chapter, it should be assumed that the grain surface after shifting will be at an angle of 25° to the horizontal regardless of the initial angle of the surface of the grain before the grain shift occurred.

19 Strength of grain divisions loaded on one side

(Reference: Part C, section I(C) - Grain fittings and securing)

GUIDELINE

It has been determined that there are deficiencies in the loadings given in tables I and II of part C, section I(C), pertaining to the strength of grain divisions loaded on one side. Therefore, when it is necessary to use these tables, reference should be made to MSC/Circ.363, a copy of which is appended to these guidelines. Also, it should be noted that the loads specified in the tables in MSC/Circ.363 are expressed in Newtons per metre length and not kN as marked.

20 Retaining saucers or bundles

(Reference: Part C, section I(D) - Saucers
Part C, section I(E) - Bundling of bulk)

BACKGROUND

The referenced regulations indicate that saucers or bundles shall be placed within the coaming structure of the hatchway. However, casualty experience indicates that there have been instances where the saucer or bundle slipped beneath the retaining structure and thereby became largely ineffective. The following guideline is intended to prevent this from occurring.

GUIDELINE

In order to insure that a saucer or bundle is adequately anchored against movement, stowage of the saucer/bundle tightly against adjacent structure should be interpreted to mean having a bearing contact with such structure to a depth equal to or greater than one half the depth specified for the depth to the bottom of the saucer. If hull structure to provide such bearing surface is not available, the saucer/bundle should be fixed in position by steel wire rope, chain, or double steel strapping as specified by part C, section II(A)(a)(iv), spaced not more than 2.4 m apart.

21 'Tween-deck hatch covers

(Reference: Part C, section I(F) - Securing hatch covers of filled compartments)

BACKGROUND

When bulk grain is stowed on several levels in the same cargo hold with the openings between decks closed so as to form separate compartments, it is possible for the grain to be transferred vertically from an upper level to a lower level through openings in the joints of the 'tween-deck hatch covers. This change of configuration of the void spaces can generate heeling moments which were not provided for in the stability calculations.

GUIDELINE

When bulk grain is loaded on top of closed, 'tween-deck hatch covers which are not grain-tight, such covers shall be made grain-tight by taping the joints, covering the entire hatchway with tarpaulins or separation cloths, or other suitable means.

It is recommended that an instruction to this effect be included in the grain loading booklets of ships to which this caution would apply.

APPENDIX

STRENGTH OF GRAIN DIVISIONS LOADED ON ONE SIDE

1 The Maritime Safety Committee's attention was earlier drawn to deficiencies in the loadings given in tables I and II of section 1 of part C in chapter VI of the 1974 SOLAS Convention, and authorized the issue of MSC/Circ.310 which circular indicated that tables I and II were only suitable for divisions where the height of grain did not exceed 3 m and gave guidance for grain heights in excess of 3 m.

2 Subsequent discussion has indicated, however, that tables I and II may be used for determining the load on grain divisions for grain heights of up to 6 m. The tables, in SI units, are attached.

3 For heights of grain in excess of 6 m, the tables of P/h^2, as given herein, may be used as guidance in determining the load on a division. Administrations should be guided by established engineering practice when deriving the scantlings of high temporary divisions.

4 For clarification, an example of the use of the tables of P/h^2 is given hereunder:

To find Force (P) for a transverse division where h = 9.00 m
l = 18.00 m

L/h = 2. From table II.L, $P/h^2 = 1846$.

Force (P) = $1846 \times 9.0^2 = 149526$ kN/m.

5 MSC/Circ.310 and Corr.1 is hereby revoked.

A. Longitudinal divisions

The load in kN per metre length of the divisions shall be taken to be as follows:

Table I

				B (m)				
h(m)	2	3	4	5	6	7	8	10
1.50	8336	8826	9905	12013	14710	17358	20202	25939
2.00	13631	14759	16769	19466	22506	25546	28733	35206
2.50	19466	21182	23830	26870	30303	33686	37265	44473
3.00	25644	27900	30891	34323	38099	41874	45797	53740
3.50	31823	34568	37952	41727	45895	50014	54329	63008
4.00	38148	41286	45013	49180	53691	58202	62861	72275
4.50	44473	47955	52073	56584	61488	66342	71392	81542
5.00	50847	54623	59134	64037	69284	74531	79924	90810
6.00	63498	68009	73256	78894	84877	90859	96988	109344

h = height of grain in metres from bottom of the division.[1/]

B = transverse extent of the bulk grain in metres.

a. For values of h equal or less than 6.00 m the force shall be determined by linear interpolation or extrapolation as necessary.

b. For values of h exceeding 6.00 m the force shall be determined using the values of p/h^2 given in table I.1.

1/ Where the distance from a division to a feeder or hatchway is 1 m or less, the height 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.

B. Transverse divisions

The load in kN per metre length of the division shall be taken to be as follows:

Table II

	L (m)										
h(m)	2	3	4	5	6	7	8	10	12	14	16
1.50	6570	6767	7159	7649	8189	8728	9169	9807	10199	10297	10297
2.00	10199	10787	11474	12209	12994	13729	14416	15445	16083	16279	16279
2.50	14318	15347	16426	17456	18437	19417	20349	21673	22408	22604	22604
3.00	18878	20251	21624	22948	24222	25399	26429	27900	28684	28930	28930
3.50	23781	25546	27164	28733	30155	31430	32558	34127	35010	35255	35255
4.00	28930	30989	32901	34667	36187	37559	38736	40403	41286	41531	41580
4.50	34274	36530	38638	40501	42120	43542	44767	46582	47562	47856	47905
5.00	39717	42218	44473	46434	48151	49622	50897	52809	53839	54182	54231
6.00	50749	53593	56094	58301	60164	61782	63204	65263	66440	66832	66930

h = height of grain in metres from the bottom of the divisions.[1/]

L = longitudinal extent of the bulk grain in metres.

a. For values of h equal or less than 6.00 m the force shall be determined by linear interpolation or extrapolation as necessary.

b. For values of h exceeding 6.00 m the force shall be determined using the values of p/h^2 given in table I.1.

1/ Where the distance from a division to a feeder or hatchway is 1 m or less, the height 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.

Values of P/h^2

Table I.1.

B/h	P/h^2
0.2	1687
0.3	1742
0.4	1809
0.5	1889
0.6	1976
0.7	2064
0.8	2159
1.0	2358
1.2	2556
1.4	2762
1.6	2968
1.8	3174
2.0	3380
2.2	3586
2.4	3792
2.6	3998
2.8	4204
3.0	4410
3.5	4925
4.0	5440
5.0	6469
6.0	7499
8.0	9559

Table II.1

L/h	P/h^2
0.2	1334
0.3	1395
0.4	1444
0.5	1489
0.6	1532
0.7	1571
0.8	1606
1.0	1671
1.2	1725
1.4	1769
1.6	1803
1.8	1829
2.0	1846
2.2	1853
2.4	1857
2.6	1859
2.8	1859
3.0	1859
3.5	1859
4.0	1859
5.0	1859
6.0	1859
8.0	1859