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CODE OF SAFE PRACTICE FOR SOLID BULK CARGOES

THE ASSEMBLY,

RECALLING Article 16(i) of the Convention on the Inter-Governmental Maritime Consultative Organization concerning the functions of the Assembly,

RECALLING ALSO resolution A.82(IV) by which it adopted the Code of Safe Practice for Bulk Cargoes,

RECALLING FURTHER that authority was given to the Maritime Safety Committee to adopt, where necessary, amendments to the Code which did not affect the principles on which the Code is based

TAKING INTO ACCOUNT the adoption by the Maritime Safety Committee of revised editions of the Code in 1972 and 1977,

RECOGNIZING the desirability of including in the Code provisions for the carriage of solid dangerous cargoes in bulk,

RECOGNIZING ALSO that a revised edition of the Code to achieve this aim has now been prepared and approved by the Maritime Safety Committee,

1. APPROVES the revised Code of Safe Practice for Solid Bulk Cargoes the text of which is set out in the Annex to the present resolution;

2. RENEWS the authorization of the Maritime Safety Committee to consider and, where necessary, adopt amendments for updating of the Code as required;

3. RECOMMENDS the Code to Governments for adoption or as a basis for national regulations;

4. REQUESTS the Secretary-General to publish the Code complete with Appendices for distribution to Member Governments and for general sale and to publish revised editions as necessary after approval by the Maritime Safety Committee;

5. REVOKES resolution A.82(IV).

ANNEX

CODE OF SAFE PRACTICE FOR SOLID BULK CARGOES

(including cargoes which may liquefy and
those possessing chemical hazards)

CONTENTS

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* "Flammable" has the same meaning as "inflammable". In common with the usage in other IMCO codes and in recent conventions adopted under the auspices of IMCO, the term "flammable" has been used in preference to "inflammable" throughout the present Code as being more widely accepted internationally and less liable to misinterpretation.

FOREWORD

For more than 100 years cargoes such as grain and coal have been shipped in bulk. However, in recent years there has been a marked development in the variety of bulk cargoes carried by sea and they now constitute a significant proportion of international seaborne trade.

Millions of tonnes of these cargoes – coals, concentrates, grains, fertilizers, animal foodstuffs, minerals and ores – are shipped in bulk every year across the oceans of the world. While the vast majority of these shipments are made without incident there have unfortunately been a number of serious casualties which resulted not only in the loss of the ship but also in loss of life.

The problems involved in the carriage of bulk cargoes were recognised by the delegates to the 1960 International Conference on Safety of Life at Sea but at that time it was not possible to frame detailed requirements except for the carriage of grain cargoes. The Conference did recommend, however, in paragraph 55 of Annex D to the Convention, that an internationally acceptable code of safe practice for the shipment of bulk cargoes should be drawn up under the sponsorship of the Inter-Governmental Maritime Consultative Organization (IMCO).

This work was undertaken by the Organization's Sub-Committee on Containers and Cargoes and four editions of the Code have been produced, the first one appearing in 1965. The Code is a recommended guide to Administrations, shipowners, shippers and masters on the standards to be applied in the safe stowage and shipment of solid bulk cargoes excluding grain which is dealt with under separate rules. The Code includes general advice on the procedures to be followed whenever bulk cargoes are to be shipped, a description of the hazards associated with certain cargoes, lists of typical products currently shipped in bulk and details of recommended test procedures to determine various characteristics of bulk cargo materials.

It should be carefully noted, however, that the list of products appearing in Appendices A, B and C to the Code is by no means exhaustive and the physical properties attributed to them are intended only for guidance. Consequently, before loading any bulk cargo it is essential to ascertain – normally from the shipper – the current physical and chemical properties of the cargo.

Since valuable information leading to improvements in this Code may be obtained from voyage reports it is recommended that masters should be encouraged to notify their Administrations of the behaviour of various types of bulk cargoes and, in particular, to report the circumstances of any incidents involving such cargoes.

INTRODUCTION

1 The primary aim of this Code is to promote the safe stowage and shipment of bulk cargoes by:

.1 highlighting the dangers associated with the shipment of certain types of bulk cargoes;

.2 giving guidance on the procedures to be adopted when the shipment of bulk cargoes is contemplated;

.3 listing typical products currently shipped in bulk together with advice on their properties and handling; and

.4 describing test procedures to be employed to determine various characteristics of the bulk cargo materials.

2 Definitions of the terms used throughout the Code are given in Section 1.

3 In general the hazards associated with the shipment of bulk cargoes may be considered as falling into the following categories:

.1 ***Structural damage due to improper distribution of the cargo***
Advice on this subject will be found in Section 2 and Appendix C.

.2 ***Loss or reduction of stability during a voyage***
This usually results from:

.2.1 A shift of cargo in heavy weather due to the cargo having been inadequately trimmed or improperly distributed;

(Advice on this subject will be found in Sections 2, 3 and 5 and in Appendices C and D.2.)

.2.2 Cargoes liquefying under the stimulus of vibration and motion of a ship in a seaway and then sliding or flowing to one side of the cargo hold. Such cargoes are normally finely grained materials, including fine coal, which are shipped in a damp condition;

(Advice on this subject will be found in Sections 6 and 8 and Appendices A and D.1.)

.3 ***Chemical reactions*** (e.g. emission of toxic or explosive gases, spontaneous combustion or severe corrosive effects).
Advice on these subjects will be found in Sections 4, 9 and 10 and Appendices B and D.4).

4 Unless the physical and/or chemical properties of the material presented for shipment are available it will be difficult to determine what precautions, if any, should be taken to ensure safe shipment. It is therefore essential that ***the shipper should provide adequate information*** about the cargo to be shipped. Advice on this subject will be found in Section 7.

5 The need for all personnel involved to exercise great care in preparation for and during loading or unloading bulk cargoes and in particular when entering spaces which may be deficient in oxygen, or which may contain toxic gases, is given special mention in Section 4.

6 Lists of typical products currently shipped in bulk, together with advice on their properties and methods of handling, are given in Appendices A, B and C. It is emphasized however that these lists are not exhaustive and that the properties attributed to the products are given only for guidance. Consequently, before loading it is essential to obtain currently valid information on the physical and chemical properties of the products presented for shipment.

7 Details of three test procedures together with advice on methods of sampling to obtain representative samples for test purposes are given in Appendix D.

8 The three laboratory test procedures described are used for determining the following:

.1 the moisture content, flow moisture point and transportable moisture limit of materials which may liquefy;

.2 the angle of repose of granular materials;

.3 the self-sustaining exothermic decomposition of fertilizers containing nitrates (the trough test).

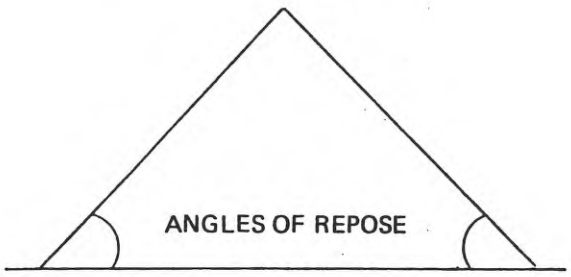
9 It is strongly recommended that these tests are conducted only by suitably trained personnel. In the cases of 8.1 and 8.2 above, auxiliary check tests which may be employed by the ship's personnel are described. These tests should only be employed in circumstances where the master doubts whether the condition of the cargo is such as to ensure safe shipment.

10 An index listing all the materials mentioned in the Code and indicating the appropriate Appendix in which further information will be found is given in Appendix E. Again, it is emphasized that this list of products is not exhaustive.

N.B. *If a cargo not listed in this Code is offered for bulk carriage the master should consult the appropriate competent authority for further information.*

Section 1 – Definitions

1.1 Angle of repose – is the angle between a horizontal plane and the cone slope of such cargo.



1.2 Cargoes which may liquefy – are cargoes which are subject to moisture migration and subsequent liquefaction if shipped with a moisture content in excess of the transportable moisture limit.

1.3 Concentrates – are materials obtained from a natural ore by a process of purification by physical or chemical separation and removal of unwanted constituents.

1.4 Cargo space – any space in the ship appropriated for the carriage of cargo.

1.5 Flow moisture point – is the percentage moisture content (wet weight basis) at which a flow state develops under the prescribed method of test in a representative sample of the material (see Appendix D.1).

1.6	Flow state	— is a state that occurs when a mass of granular material is saturated with liquid to an extent that under the influence of prevailing external forces such as vibration, impaction or ship's motion, it loses its internal shear strength and behaves as a liquid.
1.7	Moisture content	— is that portion of a representative sample consisting of water, ice or other liquid* expressed as a percentage of the total wet weight of that sample.
1.8	Moisture migration	— is the movement of moisture contained in a bulk cargo by settling and consolidation of the cargo due to vibration and ship's motion. Water is progressively displaced which may result in some portions or all of the bulk cargo developing a flow state.
1.9	Representative test sample	— is a sample of sufficient quantity for the purpose of testing physical and/or chemical properties of the consignment to meet specified requirements. It should be collected by means of an appropriate systematic sampling procedure. See 7.3.
1.10	Shipper	— for the purposes of this Code the term "shipper" means any person by whom or in whose name or on whose behalf a contract of carriage of goods by sea has been concluded with a carrier, or any person by whom or in whose name or on whose behalf the goods are actually delivered to the carrier in relation to the contract of carriage by sea.
1.11	Solid bulk cargo	— is any cargo, other than liquid or gas, consisting of a combination of particles, granules or any larger pieces of materials, generally uniform in composition, which is loaded directly into the cargo spaces of a ship without any intermediate form of containment.
1.12	Stowage factor	— the stowage factor of bulk cargo is the figure which expresses the number of cubic metres which one tonne of cargo will occupy.
1.13	Transportable moisture limit	— of a cargo which may liquefy, represents the maximum moisture content of that cargo, which is considered safe for carriage in ships not complying with the special provisions of 6.2.2 and 6.2.3. It is derived from the flow moisture point (flow table test Appendix D.1) or from data obtained from other test methods approved by the appropriate authority of the port State as being equally reliable.
1.14	Trimming	— for the purposes of this Code trimming means any levelling of the cargo within a cargo space, either partial or total, by means of loading spouts or chutes, portable machinery, equipment or manual labour.

* Procedures given in the Code apply only to the usual cases wherein the moisture consists almost entirely of water or ice.

Section 2 – General precautions

2.1 *Cargo distribution*

2.1.1 *General*

2.1.1.1 It is very important to ensure that bulk cargoes are properly distributed throughout the ship in order that the structure will never be overstressed and that the ship will have an adequate standard of stability. To do this effectively however the master needs to be provided, by the shipper, with adequate information about the cargo to be shipped, e.g. stowage factor, history of shifting, any particular problems, etc.

2.1.2 *To prevent the structure being overstressed*

2.1.2.1 When loading a high density bulk cargo having a stowage factor of about 0.56 cubic metres per tonne or lower, the loaded conditions are different from those found normally and it is important to pay particular attention to the distribution of weights so as to avoid excessive stresses. A general cargo ship is normally constructed to carry cargoes of about 1.39–1.67 cubic metres per tonne when loaded to full bale cubic and deadweight capacity. Because of the high density of some bulk cargoes, it is possible, by improper distribution of loading, to stress very highly either the structure locally under the load or the entire hull. It is not practicable to set out exact rules for the distribution of loading in all ships since the structural arrangements may vary greatly. It is therefore recommended that the master be provided with sufficiently comprehensive loading information to enable him to arrange the loading aboard his ship so as not to overstress the structure. In general, masters should be guided by the loading information provided in the ship's stability information booklet and by the results obtained by the use of loading calculators, if available.

2.1.2.2 When detailed information is not available for high density bulk cargoes, then the following precautions are recommended:

.1 the general fore and aft distribution of cargo by weight should not differ appreciably from that found satisfactory for general cargoes;

.2 the maximum number of tonnes of cargo loaded in any cargo space should not exceed

$$0.9\ LBD \text{ tonnes} \qquad (2.1.2.2.2)$$

where

L = length of the hold in metres
B = average breadth of hold in metres
D = summer load draught in metres.

.3 where cargo is untrimmed or only partially trimmed the corresponding height of cargo pile peak above the cargo space floor should not exceed

$$1.1 \times D \times \text{stowage factor} \qquad (2.1.2.2.3)$$

where the stowage factor is given in cubic metres per tonne;

.4 if the cargo is trimmed entirely level the maximum number of tonnes of cargo loaded in any lower hold cargo space may be increased by 20 per cent over the amount calculated by formula (2.1.2.2.2), subject however to full compliance with 2.1.2.2.1;

.5 because of the stiffening effect of a shaft tunnel on the ship's bottom, lower hold cargo spaces abaft the machinery space may be loaded somewhat more deeply than provided for in 2.1.2.2.2, 2.1.2.2.3 and 2.1.2.2.4, up to about 10 per cent in excess, provided that such additional loading is consistent with 2.1.2.2.1.

2.1.3 *To aid stability*

2.1.3.1 Having regard to Regulation 19(a) of Chapter II-1 of the International Convention for the Safety of Life at Sea, 1974, a stability information booklet should be provided aboard all ships which are subject to that Convention. Where bulk cargoes referred to in this Code, and requiring any of the loading and operational precautions specified therein, are to be carried, the information supplied to the master should include all necessary data relative thereto. The master must be able to calculate the stability for the anticipated worst conditions during the voyage as well as that on departure and show that the stability is adequate.

2.1.3.2 In general, high density cargoes should normally be loaded in the lower hold cargo spaces rather than in 'tweendeck cargo spaces.

2.1.3.3 When, however, it is necessary to carry high density cargoes in 'tweendecks or higher cargo spaces, care must be exercised to ensure that the deck area is not overstressed and that the ship's stability is not reduced below the minimum acceptable level as laid down in the ship's stability information booklet supplied to the master.

2.1.3.4 In transport of high density cargo a particularly careful evaluation should be made of the consequences of sailing with an excessively high GM with consequential violent movement in a seaway.

2.1.3.5 Shifting divisions and bins, of adequate strength, should be erected whenever bulk cargoes, which are suspected of readily shifting, are carried in 'tweendeck cargo spaces or only partially fill a cargo space.

2.2 *Loading and unloading*

2.2.1 Before loading, the cargo spaces should be inspected and prepared for the particular bulk cargo which it is intended to load.

2.2.2 The master should ensure that bilge lines, sounding pipes and other service lines within the cargo space are in good order. Because of the velocity at which some high density bulk cargoes are loaded into the cargo space, special care may be necessary to protect cargo space fittings from damage. For this reason it is also prudent to sound bilges after the completion of loading.

2.2.3 Attention is particularly drawn to bilge wells and strainer plates which should be specially prepared to facilitate drainage and to prevent entry of the cargo into the bilge system.

2.2.4 The master is advised that precautions should be taken to minimize the extent to which dust may come into contact with the moving parts of deck machinery and external navigational aids.

2.2.5 Wherever possible, ventilation systems should be shut down or screened and air conditioning systems, if any, placed on recirculation during loading or discharge, in order to minimize the entry of dust into the living quarters or other interior spaces of the ship.

Section 3 – Trimming procedures

3.1 ***Bulk cargoes having an angle of repose* less than or equal to 35 degrees***

3.1.1 Such cargoes should be trimmed reasonably level and cargo spaces in which they are loaded should be filled as fully as is practicable without resulting in an excessive cargo weight on the supporting bottom structure or deck.

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* For recommended methods of determining the angle of repose refer to Section 5.

3.1.2 Where dry bulk cargoes which flow freely like grain are to be carried, the provisions applicable to the stowage of grain cargoes should be followed. However, account should be taken of the density of the cargo when determining:

.1 the scantlings and securing arrangements of divisions and bin bulkheads; and

.2 the stability effect of free cargo surfaces.

3.2 *Bulk cargoes having an angle of repose* greater than 35 degrees*

3.2.1 When cargo is loaded only in lower cargo spaces it should be trimmed sufficiently to cover all of the tank top out to the ship's side, and otherwise as necessary in order to reduce the pile peak height and equalize the weight distribution on the bottom structure.

3.2.2 Such trimming as is necessary may generally be accomplished by levelling within the hatch square (see 3.2.3) with the remaining cargo sloped approximately uniformly to the lower cargo space sides, and to the end bulkheads. Provided that there is no conflict with the 1966 Load Line Convention, and if an excessive peak height does not result, cargo may extend up through the 'tweendeck hatchway which should then be left uncovered. In such case, the pile should be sufficiently clear of the hatchway edges so that any possible slide of the pile peak will remain in the cargo space.

3.2.3 Notwithstanding the above or the provisions in Section 2, the importance of trimming as an effective means of reducing the possibility of a shift of cargo can never be overstressed. This advice applies especially to smaller ships, i.e. ships of 100 metres in length or less. Consequently the loading of smaller ships requires careful supervision. In such ships the aim should be to distribute the cargo in a manner which eliminates the formation of wide, steeply sloped voids beyond the trimmed surface within the area of the hatch square.

3.2.4 In any ship where it is necessary to load cargo in the 'tweendecks, the 'tweendeck hatch should be closed. The 'tweendeck cargo should be trimmed reasonably level and should either extend from side to side and bulkhead to bulkhead, or should be secured in bins. Because of the reduced stability when cargo is carried in the 'tweendecks it is also generally necessary that the cargo in the lower cargo space be trimmed to a greater extent than when cargo is carried only in the lower cargo space.

Section 4 – Safety of personnel

4.1 *General requirements*

4.1.1 Prior to, and during, loading, transport and unloading of bulk cargoes, all necessary safety precautions including any appropriate national regulations or requirements should be observed and, in particular, the following recommendations should also be taken into account:

.1 ILO Convention 32 – Convention concerning the Protection against Accidents of Workers Employed in Loading or Unloading Ships (Revised), 1932;

.2 ILO Code of Practice – Accident Prevention on board Ship at Sea and in Port, 1978;

.3 ILO Code of Practice – Safety and Health in Dock Work, 1977.

4.2 *Poisoning and asphyxiation hazards*

4.2.1 Certain bulk cargoes are liable to oxidation which in turn may result in oxygen reduction, emission of toxic fumes and self-heating. Other bulk cargoes may not oxidise but may emit toxic fumes.

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* For recommended methods of determining the angle of repose refer to Section 5.

4.2.2 It is important therefore that the shipper informs the master prior to loading as to whether chemical hazards exist. The master should also refer to Appendix B and the necessary precautions, especially those pertaining to ventilation, should be taken.

4.2.3 Ships' masters are warned that cargo spaces and adjacent spaces may be depleted in oxygen or may contain toxic or asphyxiating gases. This may happen due to oxidation, other chemical reactions or the evolution of absorbed gases. An empty cargo space which has remained closed for some time may have insufficient oxygen to support life.

4.2.4 Unless adequate ventilation and air circulation throughout the free space above the cargo have been effected, entry by personnel should not be permitted until tests have been carried out and it has been established that the oxygen content has been restored to normal levels throughout the space and that no toxic gas is present.

4.2.5 Other cargoes may emit toxic gases when wetted. In these cases the ship should be provided with the appropriate gas detection equipment.

4.2.6 It should be noted that a flammable gas detector is suitable only for testing the explosive nature of gas mixtures.

4.2.7 Emergency entry into a cargo space should be undertaken only by trained personnel wearing self-contained breathing apparatus, and protective clothing if considered necessary, and always under the supervision of a responsible officer.

4.2.8 In the event of emergency entry into a cargo space, in addition to the requirement in 4.2.4, spare self-contained breathing apparatus, safety belts and safety lines should be readily available.

4.3 *Health hazards due to dust*

4.3.1 To minimize the chronic risks due to exposure to the dust of certain materials carried in bulk the need for a high standard of personal hygiene of those exposed to the dust cannot be too strongly emphasized. The precautions should include not only the use of appropriate protective clothing and barrier creams when needed but also adequate personal washing and laundering of outer clothing. Although these precautions are good standard practice they are particularly relevant for those materials identified as toxic by the Code.

4.4 *Flammable atmosphere*

4.4.1 Dust created by certain cargoes may constitute an explosion hazard, especially while loading, unloading and cleaning. This risk can be minimized at such times by ensuring that ventilation is sufficient to prevent the formation of a dust-laden atmosphere and by hosing down rather than sweeping.

4.4.2 Some cargoes may emit flammable gases in sufficient quantities to constitute a fire explosion hazard. Where this is indicated in the entries in Appendix B the cargo spaces and adjacent enclosed spaces should be effectively ventilated at all times. It may be necessary to monitor the atmosphere in such spaces by means of combustible gas indicators. It should be recognized that, in general, combustible gas measuring instruments are not suitable for checking an atmosphere for the presence of toxic gases.

4.5 *Ventilation systems*

4.5.1 Where cargoes are carried which may emit toxic or flammable gases the cargo spaces should be provided with effective ventilation.

Section 5 — Methods of determining the angle of repose*

5.1 There are various methods in use to determine the angle of repose for bulk materials and several are listed below for information purposes.

5.1.1 Tilting box method. This method was developed mainly for laboratory use and is suitable for non-cohesive granular materials having a grain size not greater than 10 mm. A full description of the equipment and procedure is given in Appendix D.2.1.

5.1.2 For use on board ship, or when a tilting box is not available, an auxiliary method for use with non-cohesive granular materials having a grain size not greater than 10 mm is given in Appendix D.2.2. It should be noted however that results thus obtained are generally lower than those obtained by the tilting box method.

5.1.3 On-site method. This method may be used to determine the angle of repose for all bulk materials when a stockpile of the material to be loaded is available. The angle subtended by the surface of the stockpile and the ground is measured (see Section 1). A minimum of six such measurements should be taken around the circumference of the stockpile and the mean of such measurements will provide the angle of repose. Where a stockpile is not available, a cone of the material as deposited by grab, truck or similar means may be utilized. It should, however, be recognized that the larger the cone so obtained the more accurately the angle of repose will equate with the on-board situation.

5.2 Where masters are in doubt as to which method should be, or has been, used, they should consult the port authority for advice.

Section 6 — Cargoes which may liquefy

6.1 *Properties, characteristics and hazards*

6.1.1 Cargoes which may liquefy include concentrates, certain coals and other materials having similar physical properties. Appendix A contains a list of such cargoes which generally consist of a mixture of small particles as contrasted with natural ores which include a considerable percentage of large particles or lumps.

6.1.2 At a moisture content above that of the transportable moisture limit shift of cargo may occur as a result of liquefaction.

6.1.3 The major purpose of the sections of this Code dealing with these cargoes is to draw the attention of masters and others to the latent risk of cargo shift and to describe the precautions which are deemed necessary to minimize this risk. Such cargoes may appear to be in a relatively dry granular state when loaded, and yet may contain sufficient moisture to become fluid under the stimulus of compaction and the vibration which occurs during a voyage.

6.1.4 In the resulting viscous fluid state, cargo may flow to one side of the ship with a roll one way but not completely return with a roll the other way. Thus, the ship may progressively reach a dangerous heel and capsize.

6.1.5 To prevent subsequent shifting and also to decrease the effects of oxidation when the material has a predisposition to oxidize, these cargoes should be trimmed reasonably level on completion of loading irrespective of the stated angle of repose.

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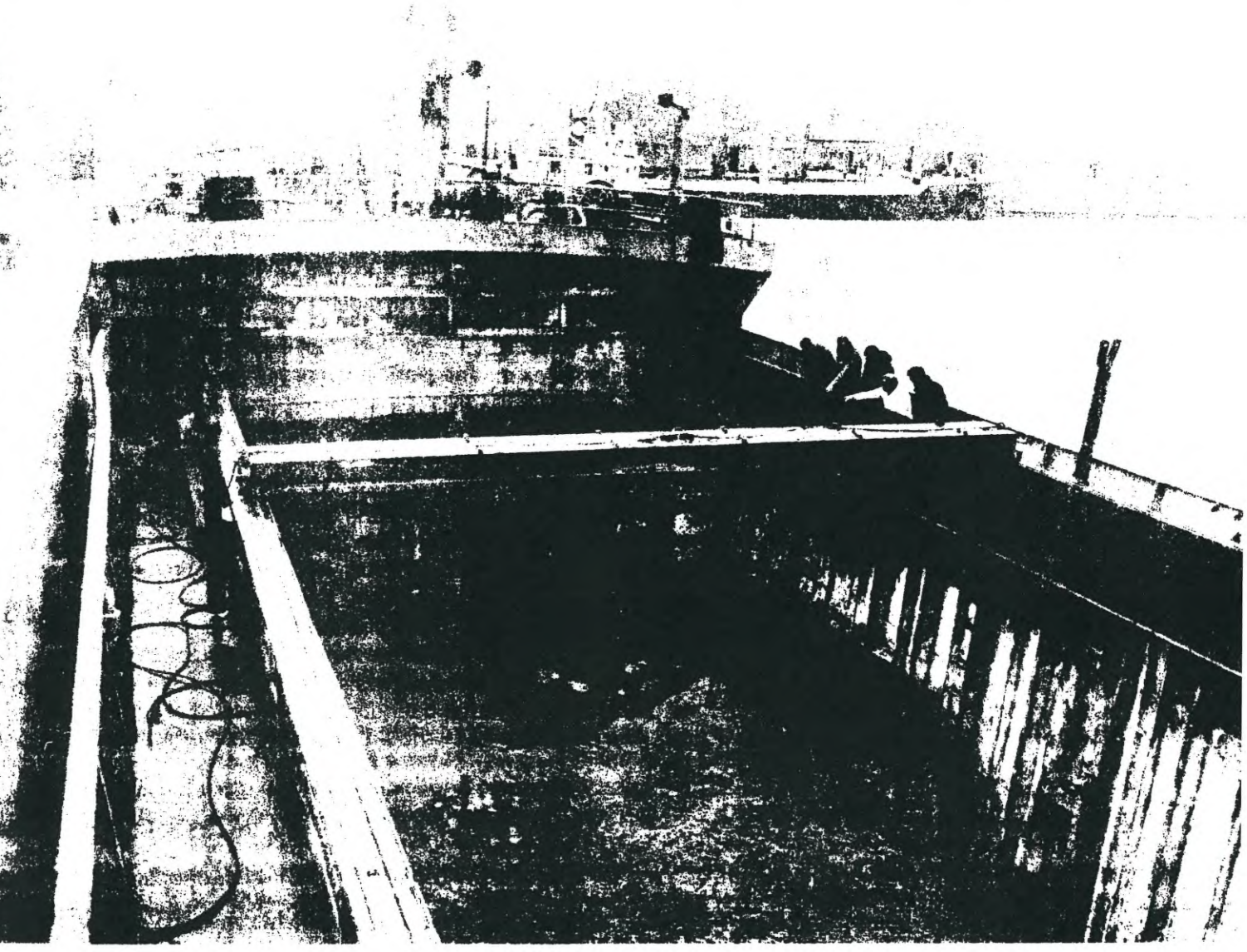
* NOTE: Generally a lower angle of repose will result in a greater shifting potential in cargoes other than those which may liquefy.



6.2 *Precautions*

6.2.1 *General*

6.2.1.1 Ships other than specially constructed or fitted ships (see 6.2.2 and 6.2.3) should carry only those cargoes having a moisture content not in excess of the transportable moisture limit as defined in this Code.

6.2.1.2 Cargoes which contain liquids, other than packaged canned goods or the like, should not be stowed in the same cargo space above or adjacent to a consignment of these cargoes.

6.2.1.3 Adequate precautions to prevent liquids entering the cargo space in which these cargoes are stowed should be maintained during the voyage. Such precautions are of paramount importance in the case of some of these cargoes where contact with sea water could lead to serious problems or corrosion to either the hull or machinery items.

6.2.1.4 Masters are cautioned of the possible danger in using water to cool a shipment of these cargoes while the ship is at sea since the admission of water in quantity may well bring the moisture content of these cargoes to a flow state. Water is most effectively applied in the form of a spray.

6.2.2 *Specially fitted cargo ships*

6.2.2.1 Cargoes having a moisture content in excess of the transportable moisture limit may be carried in cargo ships which are fitted with specially designed portable divisions to confine any shift of cargo to an acceptable limit.

6.2.2.2 The design and positioning of such special arrangements must adequately provide for not only the restraint of the immense forces generated by the flow movement of high density bulk cargoes, but also the need to reduce to an acceptable safe level the potential heeling moments arising out of a cargo flow transversely across the cargo space. Divisions provided to meet these requirements should not be constructed of wood.

6.2.2.3 It may also be necessary for elements of the ship's structure bounding such cargo to be strengthened.

6.2.2.4 The plan of special arrangements deemed necessary and details of the stability conditions on which the design has been based should have been approved by the Administration of the country of the ship's registry. In such cases the ship concerned should carry evidence of approval by its Administration.

6.2.3 *Specially constructed cargo ships*

6.2.3.1 Cargoes having a moisture content in excess of the transportable moisture limit may be carried in specially constructed cargo ships which have permanent structural boundaries, so arranged as to confine any shift of cargo to an acceptable limit. The ship concerned should carry evidence of approval by its Administration.

6.2.4 *Submission of data*

6.2.4.1 A submission made to the Administration for approval of such a ship under 6.2.2 or 6.2.3 should include:

.1 scaled longitudinal and transverse sections, drawings and relevant structural drawings;

.2 stability calculations, taking into account loading arrangements and possible shift of the cargo, showing the distribution of cargo and liquids in tanks, and of cargo which may become fluid;

.3 any other information which may assist in the assessment of the submission.

Section 7 – The assessment of acceptability of consignments for safe shipment

7.1 *The provision of information*

7.1.1 Prior to shipment the shipper should provide details regarding the nature of the cargo.

7.1.2 Prior to loading, the shipper or his appointed agent should provide to the master details, as appropriate, of the characteristics and properties, e.g. chemical hazards, flow moisture point, stowage factor, moisture content, angle of repose, etc., of any material constituting bulk cargo in order that any safety precautions which may be necessary can be put into effect.

7.1.3 To do this the shipper will need to arrange, possibly in consultation with the producers, for the cargo to be properly sampled and tested. Furthermore the shipper should provide the ship's master with the appropriate certificates of test, as applicable for a given cargo.

7.2 *Certificates of test*

7.2.1 A certificate or certificates stating the relevant characteristics of the material to be loaded should be provided to the master at the loading point.

7.2.2 Certificates stating the transportable moisture limits should contain, or be accompanied, by a statement by the shipper that the moisture content specified in the certificate of moisture content is, to the best of his knowledge and belief, the average moisture content of the cargo at the time the certificate is presented to the master. When cargo is to be loaded into more than one cargo space of a ship the certificate of moisture content should certify the moisture content of each type of finely grained material loaded into each cargo space. However, if sampling according to the procedures recommended in this Code indicates that the moisture content is uniform throughout the consignment, then one certificate of average moisture content for all cargo spaces should be acceptable.

7.2.3 Where certification is required by Appendix B for materials possessing chemical hazards, the certificate should contain or be accompanied by a statement from the shipper that the chemical characteristics of the material are, to the best of his knowledge, those existing at the time of the ship's loading.

7.3 *Sampling procedures*

7.3.1 It is evident that any physical property tests on the bulk cargo material will be meaningless unless they are conducted on test samples which are established as truly representative of the consignment, prior to loading.

7.3.2 Sampling should be conducted only by persons who have been suitably trained in sampling procedures and who are under the supervision of someone who is fully aware of the properties of the material and also the applicable principles and practices of sampling.

7.3.3 Prior to taking samples, and within the limits of practicability, a visual inspection of the material which is to form the ship's cargo should be carried out. Any substantial portions of material which appear to be contaminated or significantly different in characteristics or moisture content from the bulk of the consignment should be sampled and analysed separately.

Depending upon the results obtained in these tests it may be necessary to reject those particular portions as unfit for shipment.

7.3.4 Representative samples should be obtained by employing techniques which take the following factors into account:

.1 the type of material;

.2 the particle size distribution;

.3 composition of the material and its variability;

.4 the manner in which the material is stored, in stockpiles, rail wagons or other containers, and transferred or loaded by material handling systems such as conveyors, loading chutes, crane grabs, etc.;

.5 the characteristics which have to be determined: moisture content, flow moisture point, bulk density/stowage factor, angle of repose, etc.;

.6 variations in moisture distribution throughout the consignment which may occur due to weather conditions, natural drainage, e.g. to lower levels of stockpiles or containers, or other forms of moisture migration.

7.3.5 Throughout sampling procedures, the utmost care should be taken to prevent changes in quality and characteristics. Samples should be immediately placed in suitable sealed containers which are properly marked.

7.3.6 Useful guidance on the method of sampling to be employed may be obtained from internationally or nationally recognized procedures such as those listed in 7.5.

7.4 *Frequency of sampling and testing for "flow moisture point" and "moisture content" determination*

7.4.1 A test to determine the "flow moisture point" of cargoes which may liquefy should be conducted at regular intervals. Even in the case of materials of consistent composition this test should be conducted at least once every six months. However, where the composition or characteristics are variable for any reason, more frequent testing is necessary. In such cases testing once every three months and possibly more frequently is essential as such variations could have a significant effect on the value of the flow moisture point. In certain cases it will be necessary to test every shipment.

7.4.2 Sampling and testing for "moisture content" should be conducted as near as possible to the time of loading, but in any event, the time interval between sampling/testing and loading should never be more than seven days unless the consignment is adequately protected to ensure that no change occurs in its moisture content. Furthermore, whenever there has been significant rain or snow between the time of testing and loading, check tests should be conducted to ensure that the material is still in a safe state to load.

7.5 ***Standardized sampling procedures***

ISO 3081-1973	— Iron ores — Increment sampling — Manual method
ISO 1988-1975	— Hard coal — Sampling
ASTM D 2234	— The American Standard Procedures for Sampling Coal
B.S. 1017	— Part 1 — The British Standard for Sampling Coal
The Canadian Standard Sampling Procedure for Concentrate Stockpiles	
The European Communities Method of Sampling for the Control of Fertilizers	
J.I.S. M 8100	— Japanese General Rules for Methods of Sampling of Bulk Materials
Polish Standard Sampling Procedure for:	
Iron and Manganese Ores	— Ref. No. PN-67/H-04000
Non Ferrous Metals	— Ref. No. PN-70/H-04900
The USSR Standard Sampling Procedure for the Determination of Moisture Content in Ore Concentrates	

Section 8 – Cargoes which may liquefy: test procedures

8.1 The recommended test procedures given in Appendix D provide for the laboratory determination of:

.1 the moisture content of representative samples of the cargo to be loaded;

.2 the flow moisture point and the transportable moisture limit of the cargo.

8.2 Appendix D.1 is divided into two subsections: D.1.1 which applies to concentrates and similar materials and D.1.2 which applies to coals.

8.3 If the circumstances are such that a laboratory test cannot be made of the cargo about to be loaded and a suitable drying oven and a weighing scale are available on board ship, an auxiliary check test of the moisture content of the cargo about to be loaded may be carried out according to the procedures specified in Appendix D.1.1.4.4. Other methods for direct measurement of moisture content approved by the appropriate authority for specific cargoes may be used for this purpose. Where the moisture content is above or near the transportable moisture limit, the cargo should not be accepted until proper laboratory tests have been completed.

8.4 If the master has doubts as regards the appearance or condition of the cargo for safe shipment, a check test for approximately determining the possibility of flow may be carried out on board ship or at the dockside by the following auxiliary method:

.1 Half fill a cylindrical can or similar container (0.5–1 litre capacity) with a sample of cargo. Take the can in one hand and bring it down sharply to strike a hard surface such as a solid table from a height of about 0.2 m. Repeat the procedure 25 times at one or two second intervals. Examine the surface for free moisture or fluid conditions. If free moisture or a fluid condition appears, arrangements should be made to have additional laboratory tests on the cargo conducted before it is accepted for loading.

8.5 The recommended test procedures given in Appendix D reflect the majority opinion of those countries participating in its preparation. However, other methods which have been approved by the appropriate authorities as being equally reliable may be used.

Section 9 – Materials possessing chemical hazards: description of hazards

9.1 *General*

Appendix B contains the list of materials currently carried in bulk which, because of their chemical nature or properties, can present a hazard during transport. Some of these materials are classified as dangerous goods in the IMDG Code; also included are other cargoes which, when carried in bulk, may give rise to a hazardous situation. It should be carefully noted, however, that this list of materials is not exhaustive and that the hazardous properties attributed to them are for guidance only. Consequently, whenever the shipment of a bulk cargo is contemplated, it is essential to obtain currently valid information about its potential hazards prior to loading.

9.2 *Classes of hazard*

The classes of hazard likely to be presented by the cargoes listed in Appendix B as given in the 1974 SOLAS Convention, Chapter VII, are listed below together with notes which will assist in the interpretation of these definitions.

.1 **Class 4.1** Flammable* solids

Materials of this Class possess the common property of being easily ignited by external sources, such as sparks or flame, and of being readily combustible.

.2 **Class 4.2** Flammable solids, or substances, liable to spontaneous combustion

Materials of this Class possess the common property of being liable spontaneously to heat and to ignite.

.3 **Class 4.3** Flammable solids, or substances which, in contact with water, emit flammable gases

Materials of this Class possess the common property, when in contact with water, of evolving flammable gases. In some cases these gases are liable to spontaneous ignition.

.4 **Class 5.1** Oxidizing substances

Materials in this Class while in themselves not necessarily combustible may, generally by yielding oxygen, cause or contribute to the combustion of other material (and as a result may stimulate combustion, and increase the violence of a fire). Neither sealing off the cargo space nor the use of steam, CO_2 or other inert gas extinguishers is therefore likely to be effective against fire. The prompt use of large quantities of water is probably the most effective means of controlling fire in these cargoes.

.5 **Class 6.1** Poisonous (toxic) substances

Materials of this Class possess the common property of being liable to cause death or serious injury to human health if swallowed, inhaled or by skin contact.

.6 **Class 7** Radioactive substances

Materials of this Class possess the common property of spontaneously emitting significant radiation and of which the specific activity is greater than 0.002 microcuries per gram.

.7 **Class 8** Corrosives

Materials of this Class possess in their original state the common property of being able more or less severely to damage living tissues, and may also cause damage to other cargo or the ship by corrosion.

.8 **Class 9** Miscellaneous dangerous substances, that is any other substance which experience has shown, or may show, to be of such a dangerous character that the provisions of Chapter VII of the 1974 SOLAS Convention should apply to it.

Materials of this Class possess hazards which cannot properly be brought under the other classes listed above.

9.3 *Materials hazardous only in bulk (MHB)*

Materials of this type while they may not necessarily be listed in the IMDG Code may, when carried in bulk, present a sufficient hazard to require some degree of caution. For example, materials which reduce the oxygen content of a cargo space and those which are prone to self-heating are regarded as belonging to this group.

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* The 1974 SOLAS Convention consistently uses the term "inflammable" rather than "flammable", which has the same meaning. For the reasons given in the footnote on page 2, the term "flammable" is used throughout the present Code.

Section 10 – Materials possessing chemical hazards

10.1 *Identification*

10.1.1 The majority of such materials are included in Appendix B and their hazard class will be listed as described in Section 9 (i.e. IMCO Class or "MHB" – materials hazardous only in bulk).

10.1.2 The non-appearance of a material in Appendix B should not be taken as an absolute guarantee of its non-hazardous nature. Current valid information should always be obtained prior to loading.

10.2 *Segregation*

10.2.1 Stowage of such materials should be so arranged at all times that dangerous or hazardous materials carried in bulk are kept segregated from dangerous goods carried in packaged or unitized form in accordance with the information given under their individual entries and in the case of explosives as shown in the explosives segregation table.

10.2.2 When two or more different bulk commodities possessing chemical hazards are to be carried, the segregation between them shall be at least equivalent to that described under 10.4.2 "separated from". Segregation is not necessary between different grades of the same material. However where different grades are carried in the same cargo space the most stringent stowage provisions applicable to any of the different grades shall apply to all. When loading different solid bulk materials which are incompatible, such cargoes should not be loaded simultaneously. Similarly, toxic bulk materials and bulk food and feedstuffs should not be loaded simultaneously. Upon completion of loading one such material the hatch covers of every cargo space containing it should be closed and the decks cleared of residues before loading of other materials is commenced. When unloading, the same procedures should be followed. Such cleaning is essential where bulk flammable materials and bulk materials of Class 5.1 are carried, to prevent combustion.

10.2.3 Boundaries, e.g. bulkheads or decks used for the segregation of bulk dangerous cargoes from other dangerous cargoes, in either bulk or packaged form, need be resistant to the passage of fire and liquid only where indicated under individual entries.

10.3 *Cargo distribution and trimming*

10.3.1 The provisions of Section 2, 3 and 4 of this Code relating to cargo distribution, trimming and personnel safety apply as much to cargoes dealt with under this section as to any others.

10.4 ***Segregation table to be used when loading bulk cargoes possessing chemical hazards and explosives in packaged form***

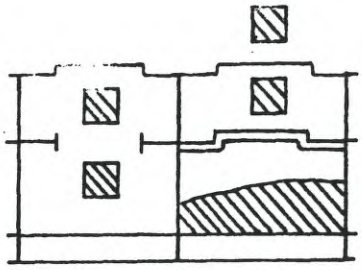
Bulk materials possessing chemical hazards	Explosives in packaged form			
	1.1–1.5 Explosives	1.2 Explosives	1.3 Explosives	1.4 Explosives
4.1	4	4	3	2
4.2	4	4	3	2
4.3	4	4	4	2
5.1	4	4	4	2
6.1	2	2	2	2
7	2	2	2	2
8	4	4	2	2
9	2	2	2	2
MHB	2	2	2	2

10.4.1 *Explanation of the segregation table*

Numbers in the above table relate to the following terms, as defined in sub-section 15.8 of the general introduction to the IMDG Code.

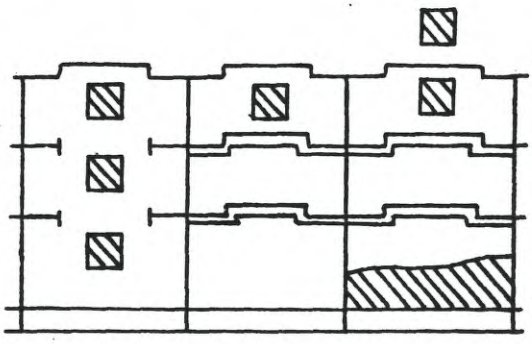
10.4.2 *"Separated from:"* (2)

In different cargo spaces when stowed under deck. Provided an intervening deck is resistant to fire and liquid, a vertical separation, i.e. in different cargo spaces may be accepted as equivalent to this segregation.



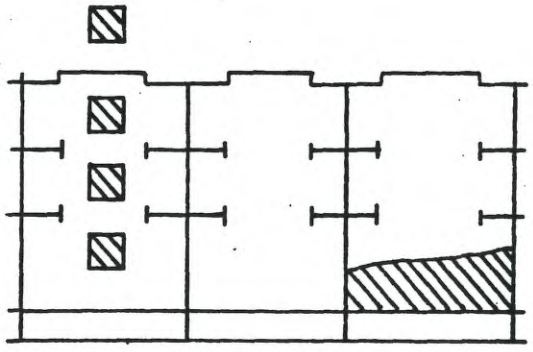
10.4.3 *"Separation by a complete cargo space or hold from:"* (3)

Means either a vertical or a horizontal separation. If the decks are not resistant to fire and liquid, then only a longitudinal separation, i.e. by an intervening complete hold, is acceptable.



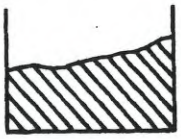
10.4.4 *"Separated longitudinally by an intervening complete hold from:"* (4)

Vertical separation alone does not meet this requirement for "on deck" stowage; this segregation means a separation by the corresponding distance.



LEGEND:

Reference bulk cargo:



Incompatible packaged explosives:

Deck resistant to fire and water:
(see 10.2.3)

Section 11 – Stowage factor conversion tables

11.1 Cubic metres per metric tonne to cubic feet per long ton (2240 lb, 1016 kg)

Factor: 1 m^3/t 35.87 ft^3/ton (rounded to the nearest hundredth of a ft^3/ton)

m^3/t	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
					ft^3/ton					
0	–	0.36	0.72	1.08	1.43	1.79	2.15	2.51	2.87	3.23
0.10	3.59	3.95	4.30	4.66	5.02	5.38	5.74	6.10	6.46	6.82
0.20	7.17	7.53	7.89	8.25	8.61	8.97	9.33	9.68	10.04	10.40
0.30	10.76	11.12	11.48	11.84	12.20	12.55	12.91	13.27	13.63	13.99
0.40	14.35	14.71	15.07	15.42	15.78	16.14	16.50	16.86	17.22	17.58
0.50	17.94	18.29	18.65	19.01	19.37	19.73	20.09	20.45	20.80	21.16
0.60	21.52	21.88	22.24	22.60	22.96	23.32	23.67	24.03	24.39	24.75
0.70	25.11	25.47	25.83	26.19	26.54	26.90	27.26	27.62	27.98	28.34
0.80	28.70	29.05	29.41	29.77	30.13	30.49	30.85	31.21	31.57	31.92
0.90	32.28	32.64	33.00	33.36	33.72	34.08	34.44	34.79	35.15	35.51
1.00	35.87	36.23	36.59	36.95	37.31	37.66	38.02	38.38	38.74	39.10
1.10	39.46	39.82	40.17	40.53	40.89	41.25	41.61	41.97	42.33	42.69
1.20	43.04	43.40	43.76	44.12	44.48	44.84	45.20	45.56	45.91	46.27
1.30	46.63	46.90	47.35	47.71	48.07	48.43	48.78	49.14	49.50	49.86
1.40	50.22	50.58	50.94	51.29	51.65	52.01	52.37	52.73	53.09	53.45
1.50	53.81	54.16	54.52	54.88	55.24	55.60	55.96	56.32	56.67	57.03
1.60	57.39									

11.2 Cubic feet per long ton (ft^3/ton) (2240 lb, 1016 kg) to cubic metre per metric tonne (m^3/t) tonne (2204 lb, 1000 kg)

Factor: 1 ft^3/ton 0.02788 m^3/t (rounded to the nearest ten thousandth of a m^3/t)

ft^3/ton	0	1	2	3	4	5	6	7	8	9
					m^3/t					
0	–	0.0279	0.0558	0.0836	0.1115	0.1394	0.1673	0.1952	0.2230	0.2509
10	0.2788	0.3067	0.3346	0.3624	0.3903	0.4182	0.4461	0.4740	0.5018	0.5297
20	0.5576	0.5855	0.6134	0.6412	0.6691	0.6970	0.7249	0.7528	0.7806	0.8085
30	0.8364	0.8643	0.8922	0.9200	0.9479	0.9758	1.0037	1.0316	1.0594	1.0873
40	1.1152	1.1431	1.1710	1.1988	1.2267	1.2546	1.2825	1.3104	1.3382	1.3661
50	1.3940	1.4219	1.4498	1.4776	1.5055	1.5334	1.5613	1.5892	1.6170	1.6449
60	1.6728	1.7007	1.7286	1.7564	1.7843	1.8122	1.8401	1.8680	1.8958	1.9237
70	1.9516	1.9795	2.0074	2.0352	2.0631	2.0910	2.1189	2.1468	2.1746	2.2025
80	2.2304	2.2583	2.2862	2.3140	2.3419	2.3698	2.3977	2.4256	2.4534	2.4818
90	2.5092	2.5371	2.5650	2.5928	2.6207	2.6486	2.6765	2.7044	2.7322	2.7601
100	2.7880									

APPENDIX A

LIST OF CARGOES WHICH MAY LIQUEFY

A.1 General

A.1.1 This Appendix lists materials which may liquefy and which, if shipped "wet", may shift transversely during the voyage due to the effects of moisture migration.

A.1.2 It should be carefully noted that this list of materials is not exhaustive and that the physical and/or chemical properties attributed to them are for guidance only. Consequently, whenever the shipment of a bulk cargo is contemplated, it is essential to obtain currently valid information about its physical properties prior to loading.

A.2 **Mineral concentrates**

A.2.1 Varying terminology exists to describe mineral concentrates. All known terms are listed below but the list is not exhaustive.

A.2.2 The stowage factor of these materials is generally low; from 0.33 to 0.57 m^3/t.

BLENDE (zinc sulphide)
CHALCO PYRITE
COPPER ORE CONCENTRATE
COPPER NICKEL
COPPER PRECIPITATES
GALENA (lead)
ILMENITE ("dry" and "moist")
IRON ORE CONCENTRATE
IRON ORE (magnetite)
IRON ORE (pellet feed)
IRON ORE (sinter feed)
IRON PYRITE
LEAD AND ZINC CALCINES (mixed)
LEAD AND ZINC MIDDLINGS
LEAD ORE CONCENTRATE
LEAD ORE RESIDUE
LEAD SILVER ORE
LEAD SULPHIDE
LEAD SULPHIDE (galena)
MAGNETITE
MAGNETITE-TACONITE
MANGANIC CONCENTRATE (manganese)
NEFELIN SYENITE (mineral)
NICKEL ORE CONCENTRATE
PENTAHYDRATE CRUDE
PYRITE
PYRITES (cupreous)
PYRITES (fine)
PYRITES (flotation)
PYRITES (sulphur)
PYRITIC ASHES (iron)
PYRITIC CINDERS
SILVER LEAD ORE CONCENTRATE
SLIG (iron ore)
ZINC AND LEAD CALCINES
ZINC AND LEAD MIDDLINGS
ZINC ORE CONCENTRATE
ZINC ORE (burnt ore)
ZINC ORE (calamine)
ZINC ORE (crude)
ZINC SINTER
ZINC SLUDGE
ZINC SULPHIDE
ZINC SULPHIDE (blende)

A.2.3 When loading the above materials reference should also be made to the entry "CONCENTRATES" in Appendix B.

A.3 **Other materials**

A.3.1 Many fine particle materials, if possessing a sufficiently high moisture content, are liable to moisture migration. Thus any fine particle cargo appearing excessively wet should be treated with caution and, if considered necessary, should be tested for flow characteristics prior to loading.

A.3.2 The list below contains only materials (other than cargoes which may liquefy) that have been reported as capable of attaining a flow state and is not exhaustive.

Material	Approximate stowage factor m^3/t
COAL (fine particled)	
COAL SLURRY (watery silt, material normally under 1 mm in size)	0.98 to 1.15
COKE BREEZE	1.8

APPENDIX B

LIST OF BULK MATERIALS POSSESSING CHEMICAL HAZARDS

1 This Appendix lists materials which were known at the time of publication to be carried in bulk and which possess a chemical hazard which could give rise to a dangerous situation on board ship.

2 It should be carefully noted that this list of products is not exhaustive and that the physical and chemical properties attributed to them are for guidance only. Consequently, whenever the shipment of a bulk cargo is contemplated, it is essential to obtain currently valid information about its physical and chemical properties prior to loading.

3 In circumstances where consultation with the competent authority is required prior to bulk shipment of materials, it is equally important to consult authorities at the ports of loading and discharge, concerning requirements which may be in force.

4 At the earliest opportunity, prior to completion of loading, the angle of repose of the material to be loaded should be determined (see Section 5) so as to determine which provisions of the Code relating to trimming apply (see Section 3).

5 Where required, the Medical First Aid Guide for Use in Accidents Involving Dangerous Goods (MFAG) should be consulted prior to loading.

Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
ALUMINIUM DROSS	– MHB –			Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquids. Separated from food and feedstuffs. Separated from all packaged dangerous goods.	**Properties** Contact with water (may cause heating) with possible evolution of flammable and toxic gases such as hydrogen, ammonia and acetylene. **Observations** **Special requirements** Keep dry. Before loading, cargo should be as dry as possible and loading should not be permitted when the material is hot or during rain. Hatches should be closed and sealed during shipment. Bilges should be sift-proof and kept dry during voyage. Ventilation should be to an atmosphere where no toxic or explosive gas pockets may form.
ALUMINIUM FERROSILICON, powder	1395 4.3 –			Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquids as well as gas-tight. Separated from food and feedstuffs. Separated from all packaged dangerous goods, except those within same Class.	**Properties** In contact with water, caustic alkalis and acids, evolves hydrogen, a flammable gas. Impurities may, under similar circumstances, produce phosphine and arsine, which are highly toxic gases. **Observations** Requires a special certificate from the maker or shipper stating that the shipment was stored under cover, but exposed to the weather for not less than three days prior to shipment. Alternatively a sample should be examined to ensure that there is no tendency to give off toxic gases. **Special requirements** Keep dry. Loading should not be permitted during rain. Hatches to be closed and sealed during voyage. Bilges to be sift-proof and kept dry during voyage.

* For comprehensive information on transport of any cargo listed, refer to Sections 1–11 of this Code.

Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
ALUMINIUM SILICON, powder, uncoated	1398 4.3 —			Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquids as well as gas-tight. Separated from all packaged dangerous goods. Separated from food and feedstuffs. Compatible with packaged dangerous goods within the same Class.	**Properties** In contact with water, caustic alkalis or acids generates heat and evolves hydrogen, a flammable gas. May also evolve silanes which are toxic and may ignite spontaneously. **Observations** The provisions of this Code should not apply to coated aluminium silicon powder. Requires a certificate from the maker or shipper stating that the shipment was stowed under cover, but exposed to the weather for not less than three days prior to shipment. Alternatively a sample should be examined to ensure that there is no tendency to give off toxic gases. **Special requirements** Keep dry. Before loading, the cargo should be as dry as possible. Loading should not be permitted during rain. Bilges to be sift-proof and kept dry during voyage. Hatches should be closed and sealed during shipment. Stow well away from living quarters. Ventilation should be such that any escaping gas cannot reach living quarters.
AMMONIUM NITRATE FERTILIZERS (a) Type A (A1) Uniform non-segregating mixtures of ammonium nitrate with added matter which is inorganic and chemically inert towards ammonium nitrate, containing not less than 90% of ammonium nitrate and not more than 0.2% of combustible material (including organic material calculated as carbon), or containing less than 90% but more than 70% of ammonium nitrate and not more than 0.4% of total combustible material	2067 5.1 740	27° to 45°	1.00	Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquids. Separated from all other materials. Not to be stowed in direct contact with soft wood. Stowage above or below materials of Class 4.1 prohibited.	**Properties** (for all Type A) Crystals, granules or prills. Wholly or partly soluble in water. Supporters of combustion. A major fire aboard a ship carrying these substances may involve a risk of explosion in the event of contamination (e.g. by fuel oil) or strong confinement. An adjacent detonation may also involve a risk of explosion. If heated strongly, they decompose, giving off toxic gases and gases which support combustion. **Observations** (for all Type A) For "trough" test for determination of the self-sustaining exothermic decomposition of fertilizers containing nitrates, see Appendix D.4. Fire-fighting: On detection of fire, the cargo spaces should be opened up to provide maximum ventilation and the fire fought with large quantities of water. Steam or inert gases should not be used. Independent breathing apparatus should be worn whenever such fires are fought. The possible need to apply water in an emergency and the

* For comprehensive information on transport of any cargo listed, refer to Sections 1–11 of this Code.

Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
AMMONIUM NITRATE FERTILIZERS (a) Type A (continued)		27° to 45°	1.00		**Observations** (continued) consequent risk to the stability of the ship through fluidization of the cargo should be considered before loading. **Special requirements** (for all Type A) Stowage: In a clean cargo space capable of being opened up in an emergency. Away from sources of heat, separated from combustible material (particularly liquids), chlorates, chlorites, hypochlorites, nitrates, permanganates and metallic powders. Note: Shipment in bulk in ships specially equipped to carry ammonium nitrate in bulk, and in large receptacles, may be permitted under conditions to be laid down by the competent authority. Precautions should be taken to avoid penetration of the material into other cargo spaces, bilges, etc. which may contain combustible materials.
(A2) Uniform non-segregating mixtures of ammonium nitrate with calcium carbonate and/or dolomite, containing more than 80% but less than 90% of ammonium nitrate and not more than 0.4% of total combustible material	2068 5.1 740	27° to 45°	1.00	Same as (A1)	General notes: (1) All nitrate ions for which there is present in the mixture a molecular equivalent of ammonium ions must be calculated as ammonium nitrate. (2) Ammonium nitrate products which are liable to self-heating sufficient to initiate a decomposition are prohibited.
(A3) Uniform non-segregating mixtures of ammonium nitrate/ammonium sulphate containing more than 45% but not more than 70% of ammonium nitrate and containing not more than 0.4% of total combustible material	2069 5.1 740	27° to 45°	1.00	Same as (A1)	

* For comprehensive information on transport of any cargo listed, refer to Sections 1–11 of this Code.

Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
AMMONIUM NITRATE FERTILIZERS (a) Type A (continued)					
(A4) Uniform non-segregating mixtures of nitrogen phosphate or nitrogen/potash types or complete fertilizers of nitrogen/phosphate/potash type, containing more than 70% but less than 90% of ammonium nitrate and not more than 0.4% of total combustible material	2070 5.1 740	27° to 45°	1.00	Same as (A1)	
AMMONIUM NITRATE FERTILIZERS (b) Type B Uniform non-segregating mixtures of nitrogen/phosphate or nitrogen/potash types or complete fertilizers of nitrogen/phosphate/potash type, containing not more than 70% of ammonium nitrate and not more than 0.4% of total added combustible material or containing not more than 45% of ammonium nitrate with unrestricted combustible material. These fertilizers are accepted for bulk transport if as a result of testing in the trough	2071 9 740	27° to 45°	1.00	Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquids. Separated from all packaged dangerous goods. Separated from food and feedstuffs. Not to be stowed in direct contact with soft wood.	**Properties** Usually granules. Wholly or partly soluble in water. These mixtures may be subject to self-sustaining decomposition if heated; the temperature in such a reaction can reach 500°C. Decomposition, once initiated, may spread throughout the remainder producing gases which are toxic. None of these mixtures is subject to the explosion hazard. **Observations** For "trough" test for determination of the self-sustaining exothermic decomposition of fertilizers containing nitrates see Appendix D.4. Fire-fighting: On detection of fire, the cargo spaces should be opened up to provide maximum ventilation and the fire fought with large quantities of water applied to the seat of the reaction. Steam, inert gases, foam, chemical extinguishers and the exclusion of air are useless and may even increase the rate of decomposition. Independent breathing apparatus should be used when fighting such fire. The possible need to apply water in an emergency and the consequent risk to the stability of the ship through fluidization of the cargo should be considered before loading. If

* For comprehensive information on transport of any cargo listed, refer to Sections 1–11 of this Code.

Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
AMMONIUM NITRATE FERTILIZERS (b) Type B (continued) test their liability to self-sustaining decomposition shows a decomposition rate not greater than 25 cm/h.		27° to 45°	1.00		**Observations** (continued) suppression of decomposition should prove impracticable (e.g. in bad weather) there would not necessarily be immediate danger to the structure of the ship. However, the residue left after decomposition may have only half the weight of the original cargo; this loss of weight may also affect the stability of the ship and should be considered before loading. **Special requirements** Stowage: In a clean cargo space capable of being opened up in an emergency. Away from all sources of heat, viz: (a) electric lamps, cables, or other electrical equipment (cables leading into the cargo space should be disconnected wherever possible); (b) steam pipes, even when insulated (steam pipes leading into the cargo space should be blanked off wherever possible); (c) any tank or double bottom containing fuel oil immediately adjacent to the cargo space if heated to more than 50°C; (d) any other source of heat likely to initiate decomposition. Fertilizers of this type should be stowed out of direct contact with a metal engine room boundary. (In the case of bagged material this may be done, for example, by using wooden boards to provide an air space between the bulkhead and the cargo. In the case of bulk shipment, all parts of the boundaries should be isolated from the cargo by, for example, flame-retardant bags containing inert materials or by an equivalent barrier approved by the competent authority.) This requirement need not apply to coastal voyages. In the case of ships not fitted with smoke or other suitable detecting devices, arrangements should be made during the voyage to inspect cargo spaces containing Type B mixtures at intervals not exceeding 4 hours (e.g. to sniff at the ventilators serving them) to ensure early detection of decomposition, should that occur.

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Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
AMMONIUM NITRATE FERTILIZERS (b) Type B (continued)		27° to 45°	1.00		**Special requirements** (continued) General notes: (1) All nitrate ions for which there is present in the mixture a molecular equivalent of ammonium ions must be calculated as ammonium nitrate. (2) Ammonium nitrate products which are liable to self-heating sufficient to initiate a decomposition are prohibited. (3) The compatibility of non-hazardous ammonium nitrate mixtures with other materials which may be stowed in the same cargo spaces should be considered before loading.
ANTIMONY ORE (STIBNITE) and RESIDUE	1549 6.1 160	40°	0.34 to 0.42	Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquids. Separated from food and feedstuffs. Compatible with all packaged dangerous goods.	**Properties** Toxic if swallowed or by dust inhalation. May evolve toxic gases if wet e.g. stibine, arsine or phosphine. **Observations** **Special requirement** Loading and unloading should be closely supervised to prevent exposure to dust.
BARIUM NITRATE	1446 5.1 140			Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquids. Separated from all other materials. Not to be stowed in direct contact with soft wood. Stowage above or below materials of Class 4.1 prohibited.	**Properties** Toxic if swallowed or by dust inhalation. If involved in a fire will greatly intensify the burning of combustible materials and will yield toxic nitrous fumes. Although non-combustible, mixtures with combustible material are easily ignited and may burn fiercely. **Observations** Fire-fighting: Use flooding amounts of water. In early stages of fire the nitrate may fuse or melt in which condition application of water may result in extensive scattering of molten materials. Wear self-contained breathing apparatus.

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Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
BARIUM NITRATE (continued)					**Special requirements** Precautions should be taken to avoid penetration of the material into other cargo spaces, bilges, etc. which may contain combustible materials. Loading and unloading operations should be closely supervised to prevent exposure to dust.
CEREALS and CEREAL PRODUCTS ALFALFA PELLETS BAKERY MATERIALS BARLEY MALT PELLETS BEET PULP PELLETS BRAN PELLETS BREWERS GRAIN PELLETS CITRUS PULP PELLETS GLUTEN PELLETS MAIZE MILFEED PELLETS POLLARD PELLETS RICE BRAN PELLETS RICE BROKEN STRUSSA PELLETS TOASTED MEALS	– MHB –			Separated from materials of Classes 5, 6 7 and 8.	**Properties** Liable to oxidation causing possible slight rise in temperature and a subsequent reduction of oxygen in the cargo space, with a subsequent increase of carbon dioxide. **Observations** **Special requirements** Entry into any cargo space carrying this material should not be permitted until the master of the ship, or a responsible officer, is satisfied that it is safe to do so after taking into account all safety considerations.
CHARCOAL (charcoal briquettes)	– MHB –			Separated from Classes 2, 3, 4 and 5.	**Properties** Liable to ignite spontaneously. Contact with water may cause self-heating. **Observations**

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Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
CHARCOAL (charcoal briquettes) (continued)					**Special requirements** Requires certification from shipper that material is not Class 4.2. Transport of charcoal Class 4.2 not permitted in bulk.
CHROMIUM ORE	– MHB –			Compatible with all packaged dangerous goods. Separated from food and feedstuffs.	**Properties** Toxic by dust inhalation. **Observations** **Special requirements** Loading and unloading operations should be closely supervised to prevent exposure to dust.
COAL (see also Appendix A)	– MHB –	30° to 65°	0.79 to 1.53	Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquids. Separated from materials of Classes 2, 3, 4 and 5. Stowage of Class 5.1 materials above or below prohibited.	**Properties** 1. Coals may emit methane, a flammable gas. A methane/air mixture containing between 5% and 15% methane constitutes an explosive atmosphere which can be ignited by sparks or naked flames, e.g. electrical or frictional sparks, a match or lighted cigarette. 2. Some coals may be liable to spontaneous combustion and could cause a cargo space fire. **Observations** **Special requirements** Prior to loading, the shipper should advise the master whether the coal is liable to emit methane or be subject to spontaneous combustion. 1.A If the cargo is liable to emit methane, then the master should take the following precautions:

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Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
COAL (continued)					**Special requirements** (continued) (i) Warning notices against smoking and the use of naked flames should be posted in the cargo space area. (ii) All electrical cables and components situated in cargo spaces and adjoining spaces should be free from defects and safe for use in a methane/dust atmosphere. (iii) All cargo spaces and bilge wells should be clean, dry and any residue of waste material of previous cargo be removed, including cargo battens, before loading. (iv) Ensure as far as is possible that any gases which may be emitted from the cargo do not have the opportunity of accumulating in adjacent enclosed spaces. (v) Ensure that the surface of the cargo is trimmed reasonably level to avoid the formation of gas pockets. (vi) Where available, a system of surface ventilation should be utilized to allow the free escape of explosive gases. (vii) Ensure that working spaces (e.g. deck stores, carpenter's shop etc.) are regularly monitored for the presence of methane. (viii) Personnel should not be allowed to enter a space where methane may accumulate unless the space has been tested and found to be safe. 1.B Where for any reason it has not been possible to ventilate a cargo space prior to unloading, care should be taken to ensure that any accumulated gas cannot be ignited. 2.A If the cargo is liable to spontaneous combustion then the following precautions should be observed: (i) All cargo spaces and bilges should be clean and dry before loading. (ii) Air should not be permitted to permeate into the body of the coal. (iii) For long sea voyages, suitable means should be provided to enable temperatures to be taken at least

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Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
COAL (continued)					**Special requirements** (continued) once daily at: (a) near the bottom of the stow, (b) the middle depth, (c) and such means to be evenly situated in at least three locations in the cargo space. (iv) Warning notices against smoking and the use of naked flames should be posted in the cargo space area. (v) All electrical cables and components situated in cargo spaces and adjoining spaces should be free from defects and safe for use in a methane/dust atmosphere. (vi) Personnel should not be allowed to enter a space where the presence of carbon monoxide may develop due to spontaneous combustion of the coal, unless they are wearing breathing apparatus or the space has been tested and found to be gas-free. The breathing apparatus should be worn only by personnel trained in its use. 2.B Where the cargo has not been ventilated prior to unloading, care should be taken to ensure that any accumulated gas cannot be ignited. 2.C Should a coal cargo be suspected of spontaneously combusting, e.g. if a rise in temperature occurs, then the cargo space should be completely closed down to prevent the entry of air. 2.D If the temperature should rise to 55°C a potential fire situation is developing and the ship should make for the nearest suitable port. Water should not be used at sea. Early application of an inert gas to a smouldering situation may be effective. In port, copious quantities of water may be used but due consideration should be given to stability.

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Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
CONCENTRATES (ORE) (see also Appendix A)	– MHB –	Large variations from: 30° to 60°	0.31 to 0.56	Separated from materials of Class 8 and all liquids. Separated from food and feedstuffs.	**Properties** Some sulphide concentrates are liable to oxidation with associated heating and oxygen reduction. Some concentrates are toxic by dust inhalation and skin exposure. **Observations** It should be ascertained prior to loading whether the competent authority has detailed information concerning specific hazards and precautions to be followed, based on the history of carriage of the concentrates to be loaded. **Special requirements** Loading and unloading operations should be closely supervised to prevent exposure to dust. Depending upon the advice of the competent authority the following precautions should be followed: (1) Uninhibited oxygen access to the cargo stimulates the process of oxidation and self-heating, and thus ventilation of the concentrate should be avoided. Oxidation may also be inhibited by compaction of the cargo by mechanical means and/or restricting the ingress of air as far as possible by carefully covering the concentrate with plastics sheeting. (2) Entry by personnel into cargo space containing concentrates subject to oxidation, self-heating, or likely to otherwise cause reduction of oxygen or emit toxic fumes, should not be permitted until the master of the ship or the responsible officer is satisfied that it is safe to do so after taking into account all safety considerations. (3) Emergency entry into the cargo space under other circumstances should be undertaken only by trained personnel wearing self-contained breathing apparatus and protective clothing if considered necessary. (4) To prevent subsequent shifting, and also to decrease the effects of oxidation, concentrates should be trimmed reasonably level on completion of loading.

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Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
COPRA, dry	1363 4.2 –			Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquids. Separated from all packaged dangerous goods.	**Properties** Dried kernels of coconuts. Liable to heat, and to ignite spontaneously. **Observations** Refuse shipment when wet. **Special requirements** Provide good surface ventilation. Keep as dry as reasonably practicable.
DIRECT REDUCED IRON (HIGH IRON BRIQUETTES and PELLETS)	– MHB –			Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquids. Separated from materials of Classes 2, 3, 4 and 5 and Class 8 acids.	**Properties** *Pellets* Average pellet size 6 mm to 20 mm. Fines, 1 to 5% less than 3.35† mm in size – 90% or more pure iron. Material oxidizes when in contact with air until formation of a rust coating inhibiting further oxidation. Liable to spontaneous heating when wet and may evolve hydrogen, a flammable gas. *Briquettes* Average size: length 65 mm width 40 mm thickness 20 mm **Observations** During loading temperature may slightly increase due to breakage of material. **Special requirements** Keep dry. Bulk shipment is subject to approval by the competent authority of the country concerned.

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† 3.35 mm is nearest ISO screen size.

Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
FERROPHOSPHORUS	– MHB –			Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquid. Separated from food and feedstuffs. Separated from all packaged dangerous goods. Separated from all acids and aqueous liquids.	**Properties** May evolve toxic gases on contact with water. **Observations** These requirements are not applied to ferrophosphorus briquettes. **Special requirements** Keep dry. Stow away from living quarters. Ventilate so that any escaping gases cannot reach living quarters.
FERROSILICON, containing between 30% and 70% silicon	1408 4.3 –	45°	0.48 to 0.72	Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquid as well as gas-tight. Separated from food and feedstuffs. Separated from all packaged dangerous goods except those within the same Class.	**Properties** In contact with water, alkalis or acids may evolve hydrogen, an extremely flammable gas, also phosphine and arsine which are highly toxic gases. **Observations** Requires a certificate from the maker or shipper specifying the percentage of silicon and stating that, after manufacture, the shipment was stored under cover, but exposed to the weather, for not less than 10 days prior to shipment. These requirements do not apply to ferrosilicon briquettes. **Special requirements** Keep dry. Protect from bilge water, deck drainage and spray. Hatches should be closed and sealed during shipment. Bilges to be sift-proof and kept dry during voyage. Separate from alkalis and acids. Stow well away from living quarters. Ventilation shall be such that any escaping gases cannot reach living quarters. The shipments must be made in ships approved by the competent authority.

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Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
FISHMEAL, FISHSCRAP, low hazard Moisture content greater than 6% but not exceeding 12%, by weight. Fat content not exceeding 12%, by weight.	1374 9 –			Separated from all packaged dangerous goods.	**Properties** Light brown to greenish-brown product derived from oily fish. Liable to heat spontaneously. **Observations** (a) This substance should be weathered for not less than 14 days before shipment. (b) Curing should be such that the product is sufficiently stable to air oxidation as to present no self-heating hazard. Appropriate approved testing should be carried out to the satisfaction of the competent authority. (c) The temperature of the cargo at the time of loading should not exceed 35°C or the ambient temperature, whichever is the higher. The provisions of this Code should not apply to fishmeal manufactured from white fish containing not more than 11% moisture and 5% fat content, by weight. **Special requirements** Bulk:† (a) Fishmeal may be carried in bulk for voyages in temperate waters only and not exceeding 21 days duration, provided the surface of the cargo is effectively covered with plastics sheeting to provide an effective air barrier. (b) All fishmeals covered by this entry, other than those excluded under the provisions of paragraph (a) above, may be carried in bulk, provided the cargo is protected by inert gas by a method approved by the competent authority such that the oxygen content in the cargo space is less than 2% by volume.

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† Approved by the competent authority of the country concerned.

Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
FISHMEAL, FISHSCRAP, anti-oxidant treated Moisture content: between 5% and 11%, by weight. Fat content: not more than 18%, by weight.	2216 9 —			Separated from all packaged dangerous goods.	**Properties** Brown to greenish-brown product obtained through heating and drying of fish. Strong odour which may affect other cargo. Liable to heat spontaneously unless of low fat content or effectively anti-oxidant treated. **Observations** (a) Stabilization of fishmeal should be achieved to prevent spontaneous combustion: by effective application of between 400 and 1000 mg/kg (ppm) ethoxyquin, or between 1000 and 4000 mg/kg (ppm) (butylated hydroxytoluene) at the moment of production, the said application occurring no longer than twelve months prior to shipment. Anti-oxidant remnant concentration should be not less than 100 mg/kg (ppm) at the time of shipment. (b) Certificates from a recognized authority should state: moisture content, fat content, details of anti-oxidant treatment for meals older than 6 months, anti-oxidant concentration at the time of shipment should be stated and must exceed 100 mg/kg (ppm), total weight of the consignment, temperature of fishmeal at the time of dispatch from the factory, and the date of production. Note: No weathering/curing is required prior to loading. **Special requirements** (a) The temperature of the cargo should not, at the time of loading exceed 35°C or 5°C above ambient temperature, whichever is higher. (b) Temperature readings should be taken 3 times a day during the voyage and recorded. (c) If the temperature of the cargo exceeds 55°C and continues to increase, ventilation to the cargo space should be restricted. If self-heating continues, then carbon dioxide or inert gas should be introduced.

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Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
FLUORSPAR (CALCIUM FLUORIDE)	– MHB –	Dry: 28° to 35° Wet: 50° to 60°	Dry: 0.56 to 0.70 Wet: 0.47 to 0.56	Separated from food and feedstuffs. Separated from strong acids.	**Properties** Toxic by dust inhalation. **Observations** Shipped as a coarse dust. Used in the manufacture of hydrofluoric acid, glass and ceramics. **Special requirements** Loading and unloading operations should be closely supervised to prevent exposure to dust.
IRON OXIDE, spent IRON SPONGE, spent	1376 4.2 –	30° to 35°	0.45	Separated from all packaged dangerous goods. Separated from food and feedstuffs. Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquids.	**Properties** Obtained from coal gas purification. Liable to heat and ignite spontaneously, especially if contaminated with oil or moisture. May evolve hydrogen sulphide, sulphur dioxide and hydrogen cyanide which are toxic gases. Fine dust particles suspended in air present a dust explosion risk. **Observations** Has strong odour which may taint other cargo. **Special requirements** Must be cooled and then weathered for not less than eight weeks prior to shipment.
IRON SWARF, STEEL SWARF e.g. borings cuttings drillings filings shavings turnings	2793 4.2 –			Separated from all packaged dangerous goods. Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquids.	**Properties** Bulk cargoes of iron or steel swarf are liable to self-heating and to ignite spontaneously, particularly when in a finely divided form, wet or contaminated with such materials as unsaturated cutting oil, oily rags and other combustible matter. Self-heating or inadequate ventilation may cause dangerous depletion of oxygen in the cargo spaces.

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Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
IRON SWARF, STEEL SWARF (continued)					**Observations** Excessive amounts of cast iron borings or organic materials may encourage heating. The swarf should be protected from moisture prior to and after loading. If, during loading, the weather is inclement, hatches should be closed and otherwise protected to keep the material dry. **Special requirements** (1) Prior to loading, temperature of the swarf should not exceed 55°C. Wooden sweat battens, dunnage and debris should be removed from the cargo space before the swarf is loaded. (2) Surface temperature of the swarf should be taken prior to, during and after loading and daily during the voyage. If the surface temperature exceeds 90°C during loading, further loading should cease and should not recommence until the temperature has fallen to at least 85°C. The ship should not sail on an international voyage unless the temperature is below 65°C and has shown a steady or downward trend in temperature for at least eight hours. During loading and carriage the bilge of each cargo space in which the swarf is stowed should be as dry as practicable. During loading the swarf should be compacted in the cargo space as frequently as practicable with a bulldozer or other means. After loading, the swarf should be trimmed to eliminate peaks and should be compacted. (3) Whilst at sea any rise in surface temperature of the swarf indicates a self-heating reaction problem. If the temperature should rise to 80°C, a potential fire situation is developing and the ship should make for the nearest suitable port. Water should not be used at sea. Early application of an inert gas to a smouldering situation may be effective. In port, copious quantities of water may be used but due consideration should be given to stability. (4) Entry into cargo spaces containing swarf should be made only with the main hatches open and after adequate ventilation or when using breathing apparatus

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Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
LEAD NITRATE	1469 5.1 130			Separated from all other materials. Storage above or below materials of Class 4.1 prohibited. Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquids.	**Properties** Although not combustible, mixtures with combustible material are easily ignited and may burn fiercely. **Observations** Fire-fighting: Use flooding amounts of water. In early stages of fire the nitrate may fuse or melt in which condition application of water may result in extensive scattering of molten materials. Wear self-contained breathing apparatus. **Special requirements** Precautions should be taken to avoid penetration into other cargo spaces, bilges, etc. which may contain combustible material. Loading and unloading operations should be closely supervised to prevent exposure to dust.
LOW SPECIFIC ACTIVITY SUBSTANCE (LSA) 1 (RADIOACTIVE)	2912 7 –			Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquids. Separated from food and feedstuffs. Separated from all packaged dangerous goods.	**Properties** Includes: (a) Uranium/thorium ores or concentrates. (b) Unirradiated natural or depleted uranium or unirradiated natural thorium metals. (c) Material of low radioactive concentration, if the estimated radioactive concentration does not exceed 0.001 millicuries per gram. Radiation hazard from ingestion, inhalation and contact with mucous membranes. **Observations** There should be no leakage outside the cargo space in which they are stowed. **Special requirements** Cargo spaces used for the conveyance of LSA substances should not be used for other goods until decontaminated as prescribed by the competent authority.

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Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
MAGNESIUM NITRATE	1474 5.1 620			Stowage above or below materials of Class 4.1 prohibited. Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquids. Separated from all other materials.	**Properties** Although non-combustible, mixtures with combustible material are easily ignited and may burn fiercely. **Observations** Fire-fighting: Use flooding amounts of water. In early stages of fire the nitrate may fuse or melt in which condition application of water may result in extensive scattering of molten materials. Wear self-contained breathing apparatus. **Special requirements** Cargo spaces should be clean and free from all debris and oil residue before loading. Precautions should be taken to avoid penetration of the material into other cargo spaces, bilges, etc., which may contain combustible material. Should be separate from fine particled food products.
PENCIL PITCH	— MHB —	22°	1.67	See PITCH PRILL.	**Properties** See PITCH PRILL. **Observations** See PITCH PRILL. **Special requirements** See PITCH PRILL.

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Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
PETROLEUM COKE (a) calcined	– MHB –	33° to 42°	1.25 to 1.67	Stowage above or below materials of Class 5.1 prohibited. If at a temperature of more than 54°C, separated by one complete cargo space from all packaged dangerous goods. If at a temperature below 54°C, separated from all packaged dangerous goods.	**Properties** Is transported hot. **Observations** Not hazardous if loaded below 54°C. **Special requirements** (1) Should not be loaded when temperature exceeds 107°C. (2) In cargo spaces over tanks containing fuel or material having a flashpoint under 93°C, a layer of 0.6–1.0 metre of the material at a temperature not greater than 44°C should first be loaded into the cargo space Only then may the material, at 54°C or above, be loaded into that cargo space. (3) The loading of the material should be as follows: (a) For shipments in cargo spaces over fuel tanks, the loading of the 0.6–1.0 metre of the material at a temperature not greater than 44°C (as required by paragraph (2)) in these cargo spaces should be completed prior to the loading of the material at 54°C or above in any cargo space of the ship. (b) Upon completion of the loading described in paragraph (3)(a) a layer of 0.6–1.0 metre of the material at 54°C or above should first be loaded in each cargo space (including those cargo spaces, if any, already containing a layer of the material at a temperature not greater than 44°C) in which the material is to be loaded in accordance with this section. (c) Upon the completion of the loading of the 0.6–1.0 metre layer of the material at 54°C or above in each cargo space (as required in paragraph (3)(b)) the normal loading of the material at 54°C or above may proceed to completion. (4) Personnel should be warned by the master of the ship, or his authorized representative, that calcined petroleum coke loaded and transported under this section is hot and that injury due to burns is possible if precautions are not taken.

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Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
PETROLEUM COKE (b) uncalcined	– MHB –	33° to 42°	1.25 to 1.67	Separated from all packaged dangerous goods. Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquids.	**Properties** Black, finely divided residue from petroleum refining in the form of powder and small pieces. Liable to heat and ignite spontaneously. **Observations** **Special requirements** Should not be accepted if temperature of material exceeds 54°C. Remove wooden sweat battens and dunnage and clean cargo space before loading. If temperature exceeds 44°C the shipment should be monitored and recorded during voyage.
PITCH PRILL, PRILLED COAL TAR	– MHB –	34° to 38°	1.25	Stowage above and below materials of Class 5.1 prohibited.	**Properties** Exists in various sizes. Melts when heated. Combustible, burns with dense black smoke. Hazard according to flammability. Dust may cause skin and eye irritation. **Observations** In extremely warm weather loading/discharging may not be possible due to dust irritation. **Special requirements** Precautions should be taken to avoid either skin or eye exposure. Decks should be washed down frequently to remove dust deposits. Loading and unloading operations should be closely supervised to prevent exposure to dust.

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Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
POTASSIUM NITRATE (SALTPETRE)	1486 5.1 —	30° to 31°	0.88	Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquids. Separated from all other materials. Stowage above or below materials of Class 4.1 prohibited.	**Properties** Although non-combustible, mixtures with combustible material are easily ignited and may burn fiercely. **Observations** Fire-fighting. Use flooding amounts of water. **Special requirements** Cargo spaces should be clean and free from combustible material before loading. Clean all cargo spaces after discharge. Stow separated from fine particled food products. Precautions should be taken to avoid penetration into other cargo spaces, bilges, etc. which may contain combustible material.
SAWDUST	— MHB —			Separated from materials of Class 5 and strong acids.	**Properties** Susceptible to fire from open flame or sparks. Can cause oxygen depletion within cargo space. If not shipped clean, dry and free from oil, liable to spontaneous combustion. **Observations** Should only be shipped when clean, dry and free from oil. **Special requirements** Keep dry. Entry into any cargo space carrying this material should not be permitted until the master of the ship, or a responsible officer, is satisfied that it is safe to do so after taking into account all safety considerations.

* For comprehensive information on transport of any cargo listed, refer to Sections 1–11 of this Code.

Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
SEED CAKE, containing vegetable oil (a) mechanically expelled seeds, containing more than 10% of oil or more than 20% of oil and moisture combined. MEAL, oily, OIL CAKE, SEED EXPELLERS, oily	1386 4.2 —	Varies greatly from: 25° to 45°	1.39 to 2.09	Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquids. Separated from all packaged dangerous goods.	**Properties** Residue remaining after oil has been expelled mechanically from oil-bearing seeds. Used mainly as animal feed or fertilizer. The most common seed cakes include those derived from coconut (copra), cottonseed, groundnut (peanut), linseed, maize (hominy chop), niger seed, palm kernel, rape seed, rice bran, soya bean and sunflower seed and they may be shipped in the form of cake, flakes, pellets, meal, etc. May self-heat slowly and, if wet or containing an excessive proportion of unoxidized oil, ignite spontaneously. Liable to oxidation causing subsequent reduction of oxygen in the cargo space. Carbon dioxide may also be produced. **Observations** Before shipment this cargo should be properly aged; the duration of ageing required varies with the oil content. If satisfied as a result of tests that such relaxation is justified, the competent authority may permit the seed cakes described in this schedule to be carried under conditions governing SEED CAKE (b) (see following entry). Certificates from a recognized authority should state oil content and moisture content. For seed cakes with other oil and moisture content, see following entries. **Special requirements** Seed cakes of this type should be carried in bulk only with special permission from the competent authority. Entry into any cargo space carrying this material should not be permitted until the master of the ship, or a responsible officer, is satisfied that it is safe to do so after taking into account all safety considerations.

* For comprehensive information on transport of any cargo listed, refer to Sections 1–11 of this Code.

Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
SEED CAKE, containing vegetable oil, (b) solvent extractions and expelled seeds, containing not more than 10% of oil and, when the amount of moisture is higher than 10%, not more than 20% of oil and moisture combined. MEAL, oily, OIL CAKE, SEED EXPELLERS, oily	1386 4.2 –	Varies greatly from: 25° to 45°	1.39 to 2.09	Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquids. Separated from all packaged dangerous goods.	**Properties** Residue remaining after oil has been extracted by a solvent process or expelled mechanically from oil-bearing seeds. Used mainly as animal feed or fertilizer. The most common seed cakes include those derived from coconut (copra), cottonseed, groundnut (peanut), linseed, maize (hominy chop), niger seed, palm kernel, rape seed, rice bran, soya bean and sunflower seed and they may be shipped in the form of cake, flakes, pellets, meal, etc. May self-heat slowly and, if wet or containing an excessive proportion of unoxidized oil, ignite spontaneously. Liable to oxidation causing subsequent reduction of oxygen in the cargo space. Carbon dioxide may also be produced. **Observations** Before shipment this cargo should be properly aged; the duration of ageing required varies with the oil content. If satisfied as a result of tests that such relaxation is justified, the competent authority may permit the seed cakes described in this schedule to be carried under conditions governing SEED CAKE (c) (see following entry). Certificates from a recognized authority should state oil content and moisture content. For seed cakes with other oil and moisture contents, see preceding and following entries **Special requirements** (i) If solvent extracted, the seed cake should be substantially free from flammable solvent. (ii) Surface ventilation is required. In cases where the product is solvent extracted, this will assist in removing any residual solvent vapour. (iii) The seed cake should be kept dry. (iv) The seed cake should not be allowed to come into contact with pipes or boundaries which are liable to become heated (e.g. engine room bulkhead).

* For comprehensive information on transport of any cargo listed, refer to Sections 1–11 of this Code.

Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
SEED CAKE, containing vegetable oil (b) (continued)					**Special requirements** (continued) (v) If the voyage exceeds 5 days the ship should be equipped with facilities for introducing carbon dioxide or inert gas into the cargo spaces. (vi) No dangerous goods should be stowed directly above the seed cake but at a safe distance away from the common boundaries in the adjacent cargo space. (vii) Regular temperature readings should be taken at varying depths in the cargo spaces and recorded. If the temperature of the cargo exceeds 55°C and continues to increase, ventilation to the cargo space should be restricted. If self-heating continues, then carbon dioxide or inert gas should be introduced. In the case of solvent extracted seed cakes the use of carbon dioxide should be withheld until fire is apparent to avoid the possibility of ignition of solvent vapours by the generation of static electricity. (viii) Smoking and the use of naked lights should be prohibited during loading and unloading and on entry to the cargo spaces at any other time. (ix) Cargo space fuses should be extracted and spark-arresting screens fitted to ventilators. (x) Entry into any cargo space carrying this material should not be permitted until the master of the ship, or a responsible officer, is satisfied that it is safe to do so after taking into account all safety considerations.
SEED CAKE, containing vegetable oil (c) solvent extractions containing not more than 1.5% of oil and 11% of moisture MEAL, oily OIL CAKE, SEED EXPELLERS, oily	2217 4.2 –	Varies greatly from: 25° to 45°	1.39 to 2.09	Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquids. Separated from all packaged dangerous goods.	**Properties** Residue remaining after oil has been extracted by a solvent process from oil-bearing seeds. Used mainly as animal feed or fertilizer. The most common seed cakes include those derived from coconut (copra), cottonseed, groundnut (peanut), linseed, maize (hominy chop), niger seed, palm kernel, rape seed, rice bran, soya bean and sunflower seed and they may be shipped in the form of cake, flakes, pellets, meal, etc. May self-heat slowly if wet and ignite spontaneously. Liable to oxidation causing subsequent reduction

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Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
SEED CAKE, containing vegetable oil (c) (continued)					**Properties** (continued) of oxygen in the cargo spaces. Carbon dioxide may also be produced. **Observations** For SEED CAKE with other oil and moisture contents, see preceding entries. **Special requirements** (i) The seed cake should be substantially free from flammable solvent. (ii) Surface ventilation is required to assist in removing any residual solvent vapour. (iii) The seed cake should be kept dry. (iv) The seed cake should not be allowed to come into contact with pipes or boundaries which are liable to become heated (e.g. engine room bulkhead). (v) If the voyage exceeds 5 days the ship should be equipped with facilities for introducing carbon dioxide or inert gas into the cargo spaces. (vi) No dangerous goods should be stowed directly above the seed cake but at a safe distance away from the common boundaries in the adjacent cargo spaces. (vii) Regular temperature readings should be taken at varying depths in the cargo space and recorded. If the temperature of the cargo exceeds 55°C and continues to increase, ventilation to the cargo space should be restricted. If self-heating continues, then carbon dioxide or inert gas should be introduced. The use of carbon dioxide should be withheld until fire is apparent to avoid the possibility of ignition of solvent vapours by the generation of static electricity. (viii) Smoking and the use of naked lights should be prohibited during loading and unloading and on entry to the cargo spaces at any other time.

* For comprehensive information on transport of any cargo listed, refer to Sections 1–11 of this Code.

Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
SEED CAKE, containing vegetable oil (c) (continued)					**Special requirements** (continued) (ix) Cargo space fuses should be extracted and spark-arresting screens fitted to ventilators. (x) Entry into any cargo space carrying this material should not be permitted until the master of the ship, or a responsible officer, is satisfied that it is safe to do so after taking into account all safety considerations.
SILICAMANGANESE	– MHB –			Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquids. Separated from all packaged dangerous goods. Separated from food and feedstuffs.	**Properties** In contact with water, alkalis or acids may evolve hydrogen, an extremely flammable gas, also phosphine and arsine which are highly toxic gases. **Observations** Requires a certificate from the maker or shipper stating that the percentage of silicon and specifying that, after manufacture, the shipment was stored under cover, but exposed to the weather, for not less than 10 days prior to shipment. These requirements do not apply to silicamanganese briquettes. **Special requirements** Keep dry. Protect from bilge water, deck drainage and spray. Hatches should be closed and sealed during shipment. Bilges to be sift-proof and kept dry during voyage. Separate from alkalis and acids. Stow well away from living quarters. Ventilation shall be such that any escaping gases cannot reach living quarters. The shipments should be made in ships approved by the competent authority.

* For comprehensive information on transport of any cargo listed, refer to Sections 1–11 of this Code.

Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
SODIUM NITRATE (CHILEAN NATURAL NITRATE)	1498 5.1 620	30° to 31°	0.88	Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquids. Separated from all other materials. Stowage above or below materials of Class 4.1 prohibited.	**Properties** Although non-combustible, mixtures with combustible material are easily ignited and may burn fiercely. **Observations** Fire-fighting. Use flooding amounts of water. **Special requirements** Cargo spaces should be clean and free from combustible material before loading. Clean all cargo spaces after discharge. Stow separate from fine particled food products. Precautions should be taken to avoid penetration of the material into other cargo spaces, bilges, etc. which may contain combustible materials.
SODIUM NITRATE and POTASSIUM NITRATE, mixture (CHILEAN NATURAL POTASSIC NITRATE)	1499 5.1	30°	0.88	Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquids. Separated from all other materials. Stowage above or below materials of Class 4.1 prohibited.	**Properties** Although non-combustible, mixtures with combustible material are easily ignited and may burn fiercely. **Observations** **Special requirements** Cargo space should be clean and free from combustible material before loading. Stow separated from all combustible materials, explosives, flammable liquids and acids. Clean all cargo spaces after use of this material. Stow separated from fine particled food products. Precautions should be taken to avoid penetration of the material into other cargo spaces, bilges, etc. which may contain combustible materials.

* For comprehensive information on transport of any cargo listed, refer to Sections 1–11 of this Code.

Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
SULPHUR (lump or coarse grained powder)	1350 4.1 –	35° to 40°	0.74	Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquids. Separated from all packaged dangerous goods. Stowage above or below materials of Class 5.1 prohibited.	**Properties** Ignites readily. When involved in a fire toxic and very irritating and suffocating gas is evolved. Forms explosive and sensitive mixtures with most oxidizing materials. **Observations** Fine grained sulphur (flowers of sulphur) should ***not*** be carried in bulk. Bulk sulphur has a liability to dust explosion which may occur especially after discharge and during cleaning. Risk of such explosions may be minimized by preventing the atmosphere becoming dust laden by adequate ventilation or by hosing down instead of sweeping, preferably with fresh water. **Special requirements** Protect from sparks and open fire.
TANKAGE GARBAGE TANKAGE (containing 8% or more moisture) ROUGH AMMONIA TANKAGE (containing 7% or more moisture) TANKAGE FERTILIZER (containing 8% or more moisture)	– MHB –			Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquids. Separated from food and feedstuffs. Compatible with all packaged dangerous goods.	**Properties** Subject to spontaneous heating and possible ignition. Possibly infectious. **Observations** **Special requirements** Do not load if temperature is above 38°C. Observe temperature during voyage for possible heating trend

* For comprehensive information on transport of any cargo listed, refer to Sections 1–11 of this Code.

Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
VANADIUM ORE	– MHB –			Separated from food and feedstuffs. Compatible with all packaged dangerous goods.	**Properties** Dust contains toxic constituents. **Observations** **Special requirements** Loading and unloading operations to be closely supervised to prevent exposure to dust.
WOODCHIPS	– MHB –	45°	3.07	Separated from materials of Class 5.	**Properties** Some consignments of woodchips may be subject to oxidation causing subsequent reduction of oxygen in the cargo space with a subsequent increase in carbon dioxide. **Observations** **Special requirements** Entry into any cargo space carrying this material should not be permitted until the master of the ship, or a responsible officer, is satisfied that it is safe to do so after taking into account all safety considerations.
WOOD PULP PELLETS	– MHB –			Separated from materials of Class 5.	**Properties** Some consignments of pellets may be subject to oxidation causing subsequent reduction of oxygen in the cargo space with a subsequent increase in carbon dioxide. **Observations** **Special requirements** Entry into any cargo space carrying this material should not be permitted until the master of the ship, or a responsible officer, is satisfied that it is safe to do so after taking into account all safety considerations.

* For comprehensive information on transport of any cargo listed, refer to Sections 1–11 of this Code.

Material	UN number, IMCO Class, MFAG table number	Approximate angle of repose	Approximate stowage factor m^3/t	Segregation and stowage requirements	Properties, observations and special requirements*
ZINC ASHES	1435 4.3 —			Boundaries of cargo spaces where bulks are carried should be resistant to fire and liquids as well as gas-tight. Separated from food and feedstuffs. Separated from all packaged dangerous goods.	**Properties** In contact with moisture or water is liable to give off hydrogen, a flammable gas, and toxic gases. **Observations** **Special requirements** Keep dry. Protect from spray, bilges to be sift-proof and kept dry during voyage. A sample of the zinc ashes to be carried should have been submitted to and found satisfactory by the competent authority. Loading and discharging operations should be closely supervised to prevent exposure to dust.

* For comprehensive information on transport of any cargo listed, refer to Sections 1–11 of this Code.

APPENDIX C

LIST OF BULK CARGOES WHICH ARE NEITHER LIABLE TO LIQUEFY (APPENDIX A) NOR POSSESS CHEMICAL HAZARDS (APPENDIX B)

1 It should be carefully noted that this list of materials is not exhaustive and that the physical and chemical properties attributed to them are for guidance only. Consequently, whenever the shipment of a bulk cargo is contemplated, it is essential to obtain from the shipper currently valid information about its physical and chemical properties prior to loading.

2 At the earliest opportunity, prior to completion of loading, the "angle of repose" of the material to be loaded should be determined (see Section 5) so as to determine which provisions of the Code relating to trimming apply (see Section 3).

Material	Approximate angle of repose	Approximate stowage factor m^3/t	Properties, observations and special requirements*
ALUMINA	15° to 40°	0.92 to 1.28	Fine white crystalline powder. Insoluble in water and organic liquids. Used in preparation of paint, dying calico print. Moisture: 0–5%, abrasive.
ALUMINA, calcined (CALCINED CLAY)	38° to 40°	0.61	Consists of lumps, particles and pieces with small amount of powder, dusty. Moisture: none. Light to dark grey.
ALUMINA SILICA	35°	0.70	Consisting of alumina and silica crystals – 60% lumps, 40% coarse grain powder. Moisture: 1–5%. White.
ALUMINA SILICA, pellets	35°	0.78 to 0.84	Length 6.4 mm to 25.4 mm. Diameter: 6.4 mm. Moisture: none. Off-white.
AMMONIUM NITRATE FERTILIZERS	27° to 45°	0.83 to 1.00	(a) Uniform non-segregating mixtures of ammonium nitrate with calcium carbonate and/or dolomite, containing not more than 80% of ammonium nitrate, provided they contain not less than 20% of these carbonates (of minimum purity 90%) and not more than 0.4% of total combustible material. (b) Uniform non-segregating mixtures of ammonium nitrate/ammonium sulphate containing not more than 45% of ammonium nitrate and not more than 0.4% of total combustible material. (c) Uniform non-segregating mixtures of nitrogen/phosphate or nitrogen/potash types or complete fertilizers of nitrogen/phosphate/potash type containing not more than 70% of ammonium nitrate and not more than 0.4% of total combustible material or containing not more than 45% of ammonium nitrate with unrestricted combustible matter. These mixtures are considered non-hazardous when, as a result of testing by the trough test method, they are found to be free from the risk of self-sustaining decomposition, provided they do not contain an excess of nitrate calculated as potassium nitrate above the ammonium nitrate content calculated in the notes below greater than 10% by weight of the mixture. Mixtures in which excess nitrate is present in greater proportion than this should be referred to the competent authority. *Notes* (1) All nitrate ions for which there is present in the mixture a molecular equivalent of ammonium ions should be calculated as ammonium nitrate.

* For comprehensive information on transport of any cargo listed, refer to Sections 1–11 of this Code.

Material	Approximate angle of repose	Approximate stowage factor m^3/t	Properties, observations and special requirements*
AMMONIUM NITRATE FERTILIZERS (continued)			*Notes* (continued) (2) Ammonium nitrate materials which are liable to self-heating sufficient to initiate a decomposition are prohibited. (3) The compatibility of non-hazardous ammonium nitrate mixtures with other materials which may be stowed in the same cargo space should be considered before loading.
AMMONIUM SULPHATE	28° to 35°	0.95 to 1.06	Chemical fertilizers. A crystalline solid, which readily absorbs moisture. Moisture: 0.04% to 0.5%. Liable to cake as a result of absorption of moisture. Carried in bulk. Danger of heavy corrosion of framing, side plating, etc. is present if sweating of cargo space develops. Ammonia odour. Subject to natural loss in weight.
BARYTES	37°	0.34	Crystalline ore mineral. A sulphate of barium. Used in paints, textiles and as filler for paper. 80% lumps: 6.4 mm to 101.6 mm. 20% fines: 6.4 mm. Moisture: 1% to 6%.
BAUXITE	28° to 55°	0.72 to 0.84	Clay-like and earthy ore. The principal ore of aluminium. 70% to 90% lumps: 2.5 mm to 500 mm. 10% to 30% powder. Moisture: 0% to 10%. Brownish yellow.
BORAX ANHYDROUS (crude or refined)	35°	0.78	Uniform granular material less than 1.4 mm† in size. Highly refined is of white crystalline appearance. The crude material is normally of yellow white appearance; can be dusty; dust is irritating but not toxic, if inhaled. Hygroscopic and will cake if wet; very abrasive.
BORAX (PENTAHYDRITE CRUDE, "RASORITE 46")	37°	0.92	Fine powder and granules less than 2.36 mm‡ in size; grey colour; dusty; dust is irritating if inhaled but not toxic. Hygroscopic and will cake if wet. Used as the major source of borax and boron products.
CALCIUM NITRATE	28°	0.91 to 1.12	Fertilizer. Granules: 1 mm to 3 mm. Consisting mainly of a double salt with ammonium nitrate and water. Not more than 15.5% total nitrogen and at least 12% water.
CARBORUNDUM	40°	0.56	A hard crystalline compound of carbon and silicon. Slight toxicity by inhalation. Used as an abrasive and for refractory purposes. 75% lumps: 203.2 mm. 25% lumps: 12.7 mm. Moisture: none. Odourless. Black.

* For comprehensive information on transport of any cargo listed, refer to Sections 1–11 of this Code.

† 1.4 mm is nearest ISO screen size.

‡ 2.36 mm is nearest ISO screen size.

Material	Approximate angle of repose	Approximate stowage factor m^3/t	Properties, observations and special requirements*
CEMENT	8° to 90°	0.67 to 1.00	Fine grey powder. Maximum particle size: 0.1 mm. Both specific gravity and angle of repose are dependent upon the amount of air in the cargo. Cement contracts approximately 12% from an aerated to a non-aerated state. Normally cement is carried in specially designed ships and trimming is carried out with special equipment. Masters of vessels not specially fitted for the carriage of cement should consult local authorities for advice. Cargo should however be trimmed reasonably level and consideration should be given either to remaining alongside for 12 hours to allow the escape of entrained air or the fitting of shifting board/feeder arrangements. After the cargo has settled shifting should not normally occur unless the angle of the surface with the horizontal plane exceeds 30 degrees. Should be kept dry prior to loading, bilges should be made siftproof and cargo spaces thoroughly cleaned. Contamination of cement renders it useless as a binding agent.
CEMENT CLINKERS	24° to 45°	0.61 to 0.84	Unground cement. Size: 0 to 40 mm. Moisture: 0% to 5%.
CHAMOTTE	32°	1.50	Burned clay. Shipped in the form of fine crushed stone. Used by zinc smelters and in manufacture of firebrick (road metal). Size: up to 10 mm. Grey.
CHROME ORE	33° to 40°	0.33 to 0.45	Ore. Size: 6.4 mm to 265 mm. Hard, compact, granular, crystalline. Bluish black.
CHROME PELLETS	23°	0.60	Pellets. Size: 10 mm to 25 mm. Moisture: up to 2% maximum.
CLAY	30° to 55°	0.66 to 1.34	Powdery to 100 mm. Moisture: up to 18%. Odourless. Whitish to beige.
COKE (coal origin)	33° to 45°	1.25 to 2.93	Used for furnace work and as a fuel. From fines up to 120 mm. Moisture: 5% to 20%

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Material	Approximate angle of repose	Approximate stowage factor m^3/t	Properties, observations and special requirements*
COLEMANITE	47°	0.61	A natural hydrated calcium borate. Used in boric acid and sodium borate. Fine to large lumps: 300 mm. Moisture: approximately 7%. Light grey appearance similar to clay.
COPPER GRANULES	25° to 30°	0.22 to 0.25	Sphere-shaped pebbles; fines up to 10 mm, with clinkers up to 50 mm. 75% copper with lead, tin, zinc, traces of others. Moisture: 1.5% approximately. Odourless. Dry: light grey. Wet: dark green.
COPPER MATTE	45°	0.25 to 0.35	Crude black copper ore. Small metallic round stones or pellets. Size: 3 mm to 25 mm. 75% copper; 25% impurities. Moisture: none. Odourless. Metallic black.
CRYOLITE	45°	0.70	A fluoride of sodium and aluminium used in production of aluminium and for ceramic glazes. Pellets: 6.4 mm to 12.7 mm long. Slightly pungent odour. Grey. Prolonged contact may cause serious damage to the skin and nervous system.
DIAMMONIUM PHOSPHATE	30°	1.20	Fertilizer. Diameter: 2.45 mm. Grey. Slightly pungent odour.
DOLOMITE	36° to 42°	0.56 to 0.65	A carbonate of calcium and magnesium. Used for refractory purposes, road construction and as a fertilizer compound. Size: 0.1 mm to 19.00 mm. Moisture: none. Odourless. Off-white, brown tones.
FELSPAR LUMP	35° to 45°	0.60	Crystalline minerals consisting of silicates of aluminium with potassium, sodium, calcium and barium. Used in ceramics and enamelling. Shipment in different sizes between 0.1 mm and 300 mm. White or reddish colour.

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Material	Approximate angle of repose	Approximate stowage factor m^3/t	Properties, observations and special requirements*
FERROCHROME	45°	0.18 to 0.26	Raw material of iron mixed with chrome. Shipment in different sizes between 0 mm and 300 mm. Moisture: none.
FERROCHROME, exothermic	45°	0.18 to 0.26	An alloy of iron and chromium. Warning: no welding or hot work should be permitted in vicinity.
FERROMANGANESE	42° to 45°	0.18 to 0.28	Raw material of iron mixed with manganese. Shipment in different sizes between fines and 300 mm.
FERROMANGANESE, exothermic	42° to 45°	0.18 to 0.28	
FERTILIZERS WITHOUT NITRATES, non-hazardous	26° to 50°	0.90 to 1.40	Powder and granular. Size: 1 mm to 3 mm. Moisture: 0% to less than 1%. Odourless. Greyish/brown/beige.
FLY ASH	40°	1.26	Light finely divided powder. Used in commercial products. Diameter: 2–3 microns. Residual ash from coal-fired power stations.
GRANULATED SLAG	40°	0.90	Residue of blast furnaces in granulated form. Used by industry. Detrimental if loaded too hot. Size: 0 mm to 5 mm. Iron: 0.5%.
GYPSUM	40° to 50°	0.67 to 0.78	A natural hydrated calcium sulphate. Insoluble in water. Used in cement, tiles, plaster, plate glass, etc. Fine powder to 100 mm. Average moisture: 1% to 2%.
ILMENITE SAND	30° to 38°	0.31 to 0.42	Black sand: average grain size: 0.15 mm†. Abrasive. From ilmenite sand monazite, zircon and titanium are obtained. Cargo should be kept dry. Moisture: 1% to 2%.
IRON ORE	30° to 75°	0.29 to 0.80	Ore. Fines and lumps. Size: fines to 250 mm. Dusty. Moisture: 0% to 16%.

* For comprehensive information on transport of any cargo listed, refer to Sections 1–11 of this Code.

† 0.15 mm is nearest IS screen size.

Material	Approximate angle of repose	Approximate stowage factor m^3/t	Properties, observations and special requirements*
IRON ORE PELLETS	27° to 45°	0.24 to 2.53	Ore. Round pellets. Up to 20 mm. Moisture: 0% to 2%.
IRON PYRITES	37° to 40°	0.40	Iron sulphide. Used in the manufacture of sulphuric acid. 20% fines; 80% lumps. Size: 30 mm to 150 mm.
IRONSTONE	36°	0.39	Ore. Maximum size: 75 mm. Moisture: 1% to 2%.
LABRADORITE	greater than 35°	0.60	A lime-soda rock form of felspar. Lumps between 50 mm and 300 mm.
LEAD ORE	30° to 60°	0.24 to 0.67	Powdery. Toxic, with acids evolves highly toxic vapour.
LIMESTONE	34° to 55°	0.67 to 0.84	A sedimentary rock containing calcium carbonate. Lumps: size 25 mm to 75 mm. Moisture: up to 4%.
MAGNESITE	34° to 45°	0.39 to 0.84	Crystalline carbonate of magnesium. Used for refractory purposes. Powder/fines to lumps. Size: 3 mm to 20 mm. Odourless. Yellowish. Moisture: none.
MANGANESE ORE	28° to 60°	0.32 to 0.70	Ore. Fine dust to lumps. Size: below 5 mm to 250 mm. Moisture: variable, up to 15%.
MILORGANITE	40° to 45°	1.53	Heat-dried activated sludge. Very fine granular product. Moisture: 3% to 5%. Black speckled colour.
MONOAMMONIUM PHOSPHATE	36°	1.21	Can be highly corrosive in presence of moisture. Acidity and impurity such as chloride ions in the absence of calcium ions may increase corrosion. Ammonium phosphates with pH greater than 4.5 are essentially non-corrosive. Continuous carriage may have detrimental structural effects over a long period of time.

* For comprehensive information on transport of any cargo listed, refer to Sections 1–11 of this Code.

Material	Approximate angle of repose	Approximate stowage factor m^3/t	Properties, observations and special requirements*
MURIATE OF POTASH	30° to 47°	0.81 to 1.12	Fertilizer. White crystals. In granular and powder form. Moisture: variable. Iodine odour.
PEANUTS (in shell)	50°	3.29	Extremely dusty. Moisture: variable. Tan colour.
PEBBLES (sea)	30°	0.59	Round pebbles: 30 mm to 110 mm. Roll very easily; should be overstowed with a layer of sacks.
PELLETS (concentrates)	44° to 46°	0.47	Concentrate ore which has been pelletized. Approximately 10 mm. Moisture: up to 6%.
PERLITE ROCK	45°	0.98 to 1.06	Clay-like and dusty. Moisture: 0.5% to 1%. Light grey. Odourless.
PHOSPHATE, defluorinated	30° to 35°	1.12	Granular, similar to fine sand. Moisture: none. Dark grey.
PHOSPHATE ROCK, calcined	28° to 50°	0.64 to 1.26	Mineral, fertilizer. Usually in the form of fine ground rock or prills. Extremely dusty. Is gyroscopic and will cake and harden if wet. Keep dry.
PHOSPHATE ROCK, uncalcined	15° to 34°	0.70	An ore in which phosphorus and oxygen are chemically united. Lumps and powder. Low angle of repose after loading, but once settled not liable to shift. Dusty. Moisture: 0% to 2%.
PIG IRON	36°	0.30	High-carbon iron. Size: 80 mm x 90 mm x 550 mm.
POTASH	32° to 35°	0.77 to 1.03	A carbonate of potassium. Used in fertilizers and soaps. Granular. Moisture: variable to 2%. Brown, pink, white.
POTASSIUM SULPHATE	31°	0.90	Hard crystals or powder. Used in aluminium, glass, etc. Colourless or white.
PUMICE	45°	1.90 to 3.25	Highly porous rock of volcanic origin. Used as an abrasive. Powder or lumps. Greyish-white.

* For comprehensive information on transport of any cargo listed, refer to Sections 1–11 of this Code.

Material	Approximate angle of repose	Approximate stowage factor m^3/t	Properties, observations and special requirements*
PYRITE (containing copper and iron)	32° to 60°	0.33 to 0.50	Iron disulphide containing copper and iron. Used in the manufacture of sulphuric acid. Fines and lumps. Various sizes from fines to 300 mm. Moisture: 0% to 7%.
PYROPHYLLITE	40°	0.50	A natural hydrous aluminium silicate. Used in ceramics, slate, pencils, etc. 75% lumps; 20% rubble; 5% fines. Chalk white.
QUARTZ	35°	0.60	Crystalline lumps between 50 mm and 300 mm.
QUARTZITE	35° to 40°	0.64	Lumps of 10 mm to 130 mm. Moisture: under 1%. White, red, brown.
RUTILE SAND	33° to 38°	0.39	Fine particled cargo 60% less than 0.15 mm†. Abrasive. Material is used for hardening steel. Shipped dry.
SALT	30° to 45°	0.81 to 1.12	Sizes: grain fines to 12 mm. Moisture: variable to 5.5%. White.
SALT CAKE	30°	0.89 to 0.95	Impure sodium sulphate. Used in ceramic glazes. Granular. Moisture: none. White.
SALT ROCK	30°	0.98 to 1.06	Small granules. Moisture: 0.02%. White.
SAND (FOUNDRY, QUARTZ, SILICA, POTASSIUM FELSPAR, SODA FELSPAR)	30° to 52°	0.50 to 0.98	Usually fine particled. Abrasive. Used for a variety of purposes including glass and steel making.
SCRAP METAL (see also IRON SWARF, Appendix B)	45°	varies	Various types of scrap metal, engine blocks, etc.
SILICAMANGANESE	45°	0.18 to 0.26	Sizes from fines to 300 mm.
SODA ASH (dense and light)	25° to 45°	1.03 to 1.67	Sodium carbonate. Powdery. Moisture: 0% to 20%. White.

* For comprehensive information on transport of any cargo listed, refer to Sections 1–11 of this Code.
† 0.15 mm is nearest ISO screen size.

Material	Approximate angle of repose	Approximate stowage factor m^3/t	Properties, observations and special requirements*
STAINLESS STEEL GRINDING DUST	45°	0.42	Caked, 75 mm to 380 mm lumps. Moisture: 1% to 3%. Brown.
STONE CHIPPINGS	55°	0.71	Fines to 25 mm.
SUGAR (raw, raw brown, refined white)	30° to 39°	1.00 to 1.60	Powdery. Moisture: 0% to 0.05%.
SUPERPHOSPHATE	30° to 40°	0.84 to 1.00	A fertilizer composed of phosphate treated with sulphuric acid. Granular, fines and powdery, up to 0.15 mm† diameter in size. Moisture: 0% to 7%. Greyish-white.
SUPERPHOSPHATE, triple granular	29° to 30°	1.17 to 1.23	Fine, free flowing prills; very dusty. Hygroscopic and will cake and harden if wet. Contains acid and will decompose burlap or canvas cloth.
TACONITE PELLETS	30°	1.53 to 1.67	Ore. Round steel pellets; approximately 15 mm diameter. Moisture: 2%. Grey.
TALC	20° to 45°	0.64 to 0.73	A natural hydrous magnesium silicate. Used in ceramics, electrical insulation, etc. Powdery to lumps 100 mm. Grey colour.
UREA	28° to 45°	1.17 to 1.56	Fertilizer. Form: granules, beads and prills. Dusty. Diameter: 1 mm to 3 mm. Moisture: less than 1%.
VERMICULITE	36°	1.37	A mineral of the mica group. Used in insulation and fire-proofing. Size: approximately 3 mm sq. Average moisture: 6% to 10%. Grey.
WHITE QUARTZ	42° to 45°	0.61	99.6% silica content. Lumps varying in size up to 150 mm.
ZIRCON SAND	33° to 38°	0.36	Fine particled cargo 60% less than 0.15 mm†. Abrasive. Material is used for hardening steel. Shipped dry.

* For comprehensive information on transport of any cargo listed, refer to Sections 1–11 of this Code.
† 0.15 mm is nearest ISO screen size.

APPENDIX D

LABORATORY TEST PROCEDURES, ASSOCIATED APPARATUS AND STANDARDS

D.1 **Test procedures for cargoes which may liquefy and associated apparatus**

Section D.1 is divided into two sub-sections: D.1.1 applies to concentrates and similar materials; D.1.2 applies to coal.

D.1.1 *Recommended test procedure for concentrates and similar material*

D.1.1.1 *Scope*

The test described below provides for determination of:

.1 The moisture content of a sample which may be a mineral concentrate or other similar fine grained material. These will hereinafter be referred to as the test material.

.2 The flow moisture point of the test material under impact or cyclic forces of the flow table apparatus.

.3 The transportable moisture limit of the test material.

D.1.1.2 *Apparatus* (see figure D.1.1.2)

.1 Standard flow table and frame (ASTM Designation (C230-68) see D.3).

.2 Flow table mounting (ASTM Designation (C230-68) see D.3).

.3 Mould (ASTM Designation (C230-68) see D.3).

.4 Tamper (see figure D.1.1.2.4).

.5 Scales and weights (ASTM Designation (C109-73) see D.3) and suitable sample containers.

.6 Glass graduated measuring cylinder and burette having capacities of 100-200 ml and 10 ml respectively.

.7 A hemispherical mixing bowl approximately 30 cm diameter, rubber gloves and drying dishes or pans. Alternatively an automatic mixer of similar capacity can be used for the mixing operations. In this case care should be exercised to ensure that the use of such a mechanical mixer does not reduce the particle size or consistency of the test material.

.8 A drying oven with controlled temperature up to approximately 110°C. This oven should be without air circulation.

Fig. D.1.1.2 *Flow table and accessory apparatus*

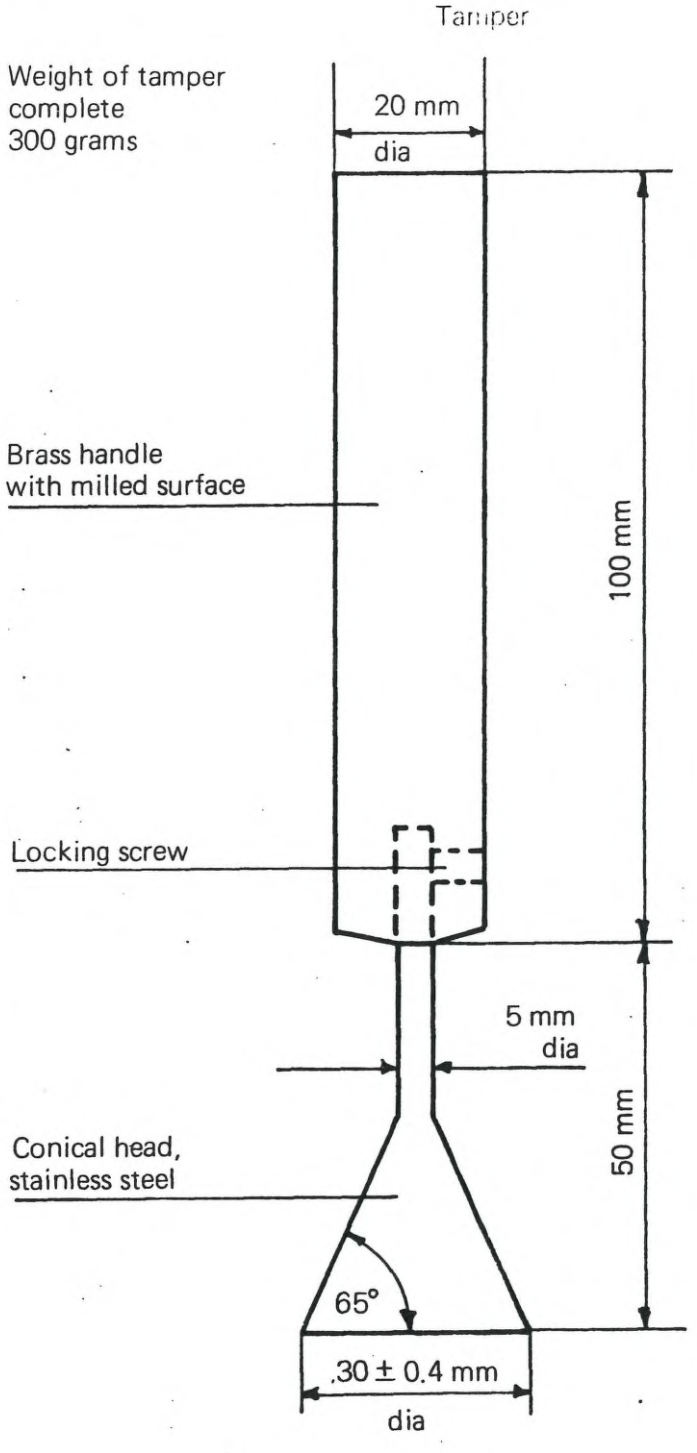


Fig. D.1.1.2.4 *Descriptive drawing of tamper*

D.1.1.3 *Temperature and humidity*

It is preferable to work in a room where the samples will be protected from excessive temperatures, air currents and humidity variations. All phases of the material preparation and testing procedure should be accomplished in a reasonable space of time to minimize moisture losses and, in any event, within the day of commencement. Where possible, sample containers should be covered with plastic film or other suitable cover.

D.1.1.4 *Procedure*

The quantity of material required for a flow moisture test will vary according to the specific gravity of the material to be tested. This will range from approximately 2 kg for coal to 3 kg for mineral concentrates. It should be collected as a representative sample of the cargo being shipped. Experience has shown that more accurate test results will be obtained by ensuring that the moisture content of the test sample is increased rather than decreased towards the flow moisture point. Consequently it is recommended that a preliminary flow moisture test should be conducted, generally in accordance with the following, to indicate the condition of the test sample, i.e. the quantity of water and the rate at which it has to be added or whether the sample should be air dried to reduce its moisture content before commencing the main flow moisture test.

D.1.1.4.1 Preparation of the test sample

The representative sample of test material is placed in the mixing bowl and thoroughly mixed. Three sub-samples (A, B and C) are removed from the mixing bowl as follows: About one fifth of the sample (A) shall be immediately weighed and placed in the drying oven to determine the moisture content of the sample "as received". Two further sub-samples, each of about two fifths of the gross weight shall then be taken, one (B) for the preliminary flow moisture point test and the other (C) for the main flow moisture point determination.

Having completed the preliminary flow moisture point test, the sample for the main test is adjusted to the required level of moisture content below the flow point.

.1 Filling the mould. The mould is placed on the centre of the flow table and filled in three stages with the material from the mixing bowl. The first charge, after tamping, should aim to fill the mould to approximately one third of its depth. The quantity of sample required to achieve this will vary from one material to another, but can readily be established after some experience has been gained on the packing characteristics of the material being tested.

The second charge, after tamping, should fill the mould to about two thirds of its depth and the third and final charge, after tamping, should reach to just below the top of the mould (see fig. D.1.1.4-2).

.2 Tamping procedure. A tamper of a type illustrated in fig. D.1.1.2-4 should be used. Since the tamping operation is performed manually, it is difficult to define clearly an exact and reproducible procedure. However, the aim should be to attain a degree of compaction similar to that prevailing at the bottom of a shipboard cargo of the material being tested. To this end, it is recommended that firm pressure of the tamper (not distinct blows) should be applied successively over the whole area of the sample until a uniformly flat surface is obtained over the entire area, particularly at the outer edges of each successive layer.

.3 Removal of the mould. The mould is tapped on its side until it becomes loose, leaving the sample in the shape of a truncated cone on the table.

D.1.1.4.2 The preliminary flow moisture test

.1 Immediately after removing the mould, the flow table is raised and dropped up to 50 times through a height of 12.5 mm at a rate of 25 times per minute. If the material is below the flow moisture point, it usually crumbles and bumps off in fragments with successive drops of the table (see fig. D.1.1.4-3).

.2 At this stage, the flow table is stopped and the material returned to the mixing bowl where 5-10 ml of water, or possibly more, is sprinkled over the surface and thoroughly mixed into the material, either with rubber gloved fingers or an automatic mixer.

The mould is again filled and the flow table is operated as described in D.1.1.4.2.1 for up to 50 drops. If a flow state is not developed, the process is repeated with further additions of water until a flow state has been reached.

.3 Identification of a flow state. The impacting action of the flow table causes the grains to rearrange themselves to produce compaction of the mass. As a result, the fixed volume of moisture contained in the material at any given level increases as a percentage of the total volume. A flow state is considered to have been reached when the moisture content and compaction of the sample produce a level of saturation such that plastic deformation occurs.* At this stage, the moulded sides of the sample may deform, giving a convex or concave profile (see fig. D.1.1.4-4).

With repeated action of the flow table, the sample continues to slump and to flow outwards. In certain materials cracks may also develop on the top surface. Cracking without the appearance of free moisture is not however an indication of development of a flow state. In most cases, measurement of the deformation is helpful in deciding whether or not plastic flow has occurred. A template which, for example, will indicate an increase in diameter of up to 3 mm in any part of the cone is a useful guide for this purpose. Some additional observations may be useful. For example: When the (increasing) moisture content is approaching the flow moisture point the sample cone begins to show a tendency to stick to the mould. Further, when the sample is pushed off the table, the sample may leave tracks (stripes) of moisture on the table. If such stripes are seen the moisture content may be above the flow moisture point. Deformation of the cone may appear at moisture contents lower than the flow moisture point, but in that case the sample will leave no moisture tracks when removed.

Measuring the diameter of the cone, at the base or at half height, will always be useful. By addition of water in increments of 0.4 to 0.5 per cent and applying 25 drops of the flow table, the first diameter increase will generally be between 1 and 5 mm and after a further increment of water the base diameter would have expanded to between 5 and 10 mm.

*Note: In certain conditions, the diameter of the cone may increase before the flow moisture point is reached, due to low friction between the grains, rather than to plastic flow. This must not be mistaken for a flow state.

.4 As an alternative to the procedure descibed above, for many concentrates a fast way of finding the approximate flow moisture point is as follows:

When the moisture content is definitely beyond the flow moisture point, measure the diameter after 25 knocks, repeat the test after adding a further increment of water, measure the diameter and draw a diagram as illustrated in fig. D.1.1.4-1 showing increase in diameter plotted against moisture content. A straight line drawn through the two points will cross the moisture content axis close to the flow moisture point.

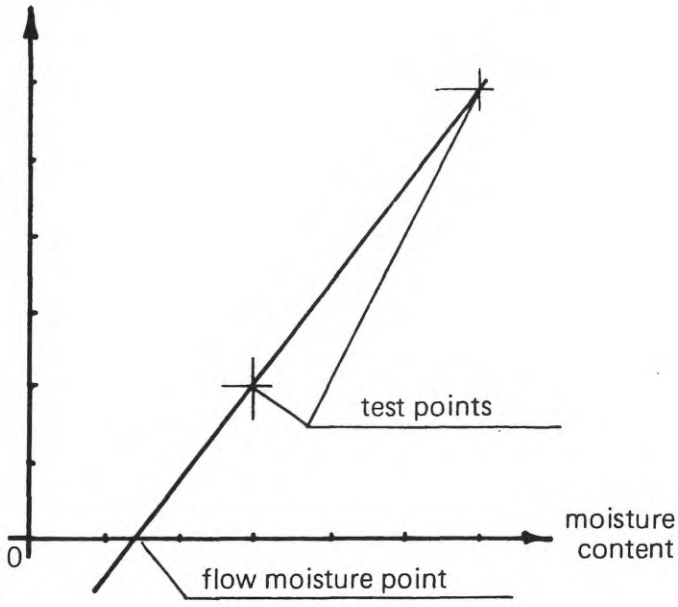


Fig. D.1.1.4-1

D.1.1.4.3 The main flow moisture test

When a flow state has been reached in the preliminary test, the moisture content of sub-sample (C) is adjusted to approximately the last value which did not cause flow in the preliminary test. The final test is then carried out on this adjusted sample in the same manner as for the preliminary test, but in this case with the addition of water in increments of only 0.4 to 0.5 per cent of the weight of the test material. At each stage a representative sample of 100-200 grams is taken from the mixing bowl, placed in a closed weighing glass and retained for moisture determination if required.

When a flow state has been reached, the moisture content should be determined on two samples, one with a moisture content just above the flow moisture point and the other with a moisture content just below the flow moisture point. The difference between the two values should then be 0.5 per cent or less and the flow moisture point is taken as the mean of these two values.

D.1.1.4.4 Determination of moisture content

Introduction

It should be noted that for many materials, there are recognized international and national methods for determining moisture content. These methods, or ones that have been established to give equivalent results, shall be followed.

Samples to be dried at 105°C

It is clearly important that the samples should be dried to constant weight. In practice, this is ascertained after a suitable drying period, by weighing the sample successively with an interval of several hours elapsing. If the weight remains constant, drying has been completed; whereas if the weight is still decreasing, drying is continued.

The length of the drying period depends upon many variables such as the disposition of the material in the oven, the type of container used, the particle size, the rate of heat transfer, etc. It may be that a period of five hours is ample for one concentrate sample whereas it is not sufficient for another.

Sulphide concentrates tend to oxidize and therefore the use of drying ovens with air circulation systems is not recommended for these materials, nor should the test sample be left in the drying oven for more than four hours.

Examples of calculation

Taking w_1 as the exact weight of the sub-sample as received of approximately 1/5 of the gross sample (see D.1.1.4.2);

Taking w_2 as the exact weight of the first sub-sample after drying of approximately 1/5 of the gross sample (see D.1.1.4.2);

Taking w_3 as the exact weight of the sample just above flow state of approximately 100-200 g (see D.1.1.4.2);

Taking w_4 as the exact weight of the sample just above flow state after drying of approximately 100-200 g (see D.1.1.4.3);

Taking w_5 as the exact weight of the sample just below flow state (see D.1.1.4.3);

Taking w_6 as the exact weight of the sample just below flow state after drying (see D.1.1.4.3);

Then

.1 The moisture content of the concentrate as received is

$$\frac{(w_1 - w_2)}{w_1} \times 100 \qquad \text{(D.1.1.4.4.1)}$$

.2 The flow moisture point of the concentrate is

$$\frac{\frac{(w_3 - w_4)}{w_3} + \frac{(w_5 - w_6)}{w_5}}{2} \times 100 \qquad \text{(D.1.1.4.4.2)}$$

.3 The transportable moisture limit of the concentrate is

90% of formula (D.1.1.4.4.2)

Fig. D.1.1.4-2

Fig. D.1.1.4-3

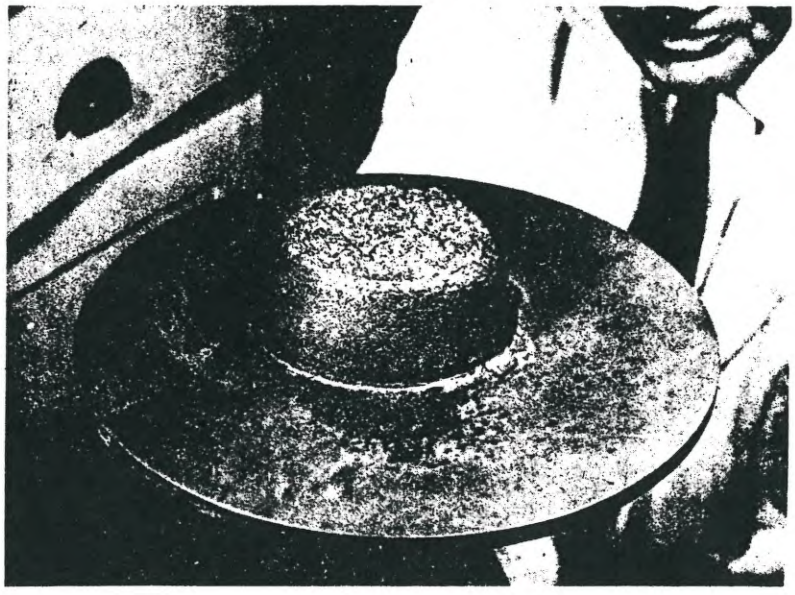


Fig. D.1.1.4-4

D.1.2 *Test procedures for coals*

D.1.2.1 *Coals with maximum grain size below 1 mm*

The procedures described in D.1.1.2 to D.1.1.4.3 inclusive apply.

D.1.2.1.1 Determination of moisture content

The recommended methods for determinations of the moisture content are those described in ISO 589-1974 "Hard coal – Determination of total moisture". This method or ones that have been established to give equivalent results should be followed.

D.1.2.2 *Coals with maximum grain size in the range of 1 to 7 mm*

The procedures described in D.1.1.2 to D.1.1.4.3 may not be applicable because the coarser grains can cause the flow moisture point on the flow table to be indeterminate. For such coals the procedures to be adopted should be those approved by authority of the port State.

D.1.2.3 *Coals with maximum grain size in excess of 7 mm*

The procedures described in D.1.1.2 to D.1.1.4.3 inclusive are not applicable. Experience has shown that the flow table method is unsuitable for these coals. The procedures to be adopted should be those approved by the authority of the port State.

D.1.2.2 and D.1.2.3 also apply to other coarse materials on which a satisfactory result cannot be obtained by the flow table method.

D.2 Test procedures to determine angle of repose and associated apparatus

D.2.1 *Determination of angle of repose of fine grained materials (size less than 10 mm) "tilting box test". For use in laboratory or Port of Loading*

D.2.1.1 *Scope*

The test provides for the determination of the angle of repose of the fine grained non-cohesive materials (size less than 10 mm). The results so obtained may be used when interpreting Sections 3 and 4 of this Code for the materials in question.

D.2.1.2 *Definition*

The angle of repose obtained by this test is the angle formed between the horizontal and the top of the testbox when the material in the box just begins to slide in bulk.

D.2.1.3 *Principle of test*

When measuring the angle of repose by this method the material surface must initially be level and parallel to the testbox base. The box is tilted without vibration and tilting is stopped with the product just begins to slide in bulk.

D.2.1.4 *Apparatus* (see figure D.2.1.4)

Apparatus is as follows:

.1 A framework on top of which is attached an open box. Attachment of the box to the frame is by means of a shaft passing through bearings affixed to both the frame and the end of the box, enabling the box to be subjected to a controlled tilt.

.2 The dimensions of the box are 600 mm long, 400 mm wide and 200 mm high.

.3 To prevent sliding of the material along the bottom of the box during tilting, a tightly fitting grating (openings 30 x 30 x 25 mm) is placed to the bottom of the box before filling.

.4 Tilting of the box is effected by a hydraulic cylinder fitted between the frame and the bottom of the box. Other means may be used to obtain the required tilting but in all cases vibration must be eliminated.

.5 To pressurize the hydraulic cylinder, a hydropneumatic accumulator may be used, pressurized by air or gas at a pressure of about 5 kp/cm^2.

.6 The rate of tilting should be approximately 0.3 degrees/sec.

.7 Range of tilt should be at least 50 degrees.

.8 A protractor is fitted to the end of the shaft. One lever of the protractor is fitted so that it may be screw-adjusted to the horizontal.

.9 The protractor should measure the angle of the top of the box to the horizontal to within an accuracy of 0.5 degrees.

.10 A spirit level or some other levelling device must be available to zero the protractor.

D.2.1.5 *Procedure*

The box is filled with the material to be tested by pouring it slowly and carefully from the lowest practical height into the box in order to obtain uniformity of loading.

The excess material is scraped off by the aid of a straight edge, inclined at about 45 degrees towards the direction of scraping.

The tilting system is then activated and stopped when the material just begins to slide in bulk.

The angle of the top of the box to the horizontal is measured by the protractor and recorded.

D.2.1.6 *Evaluation*

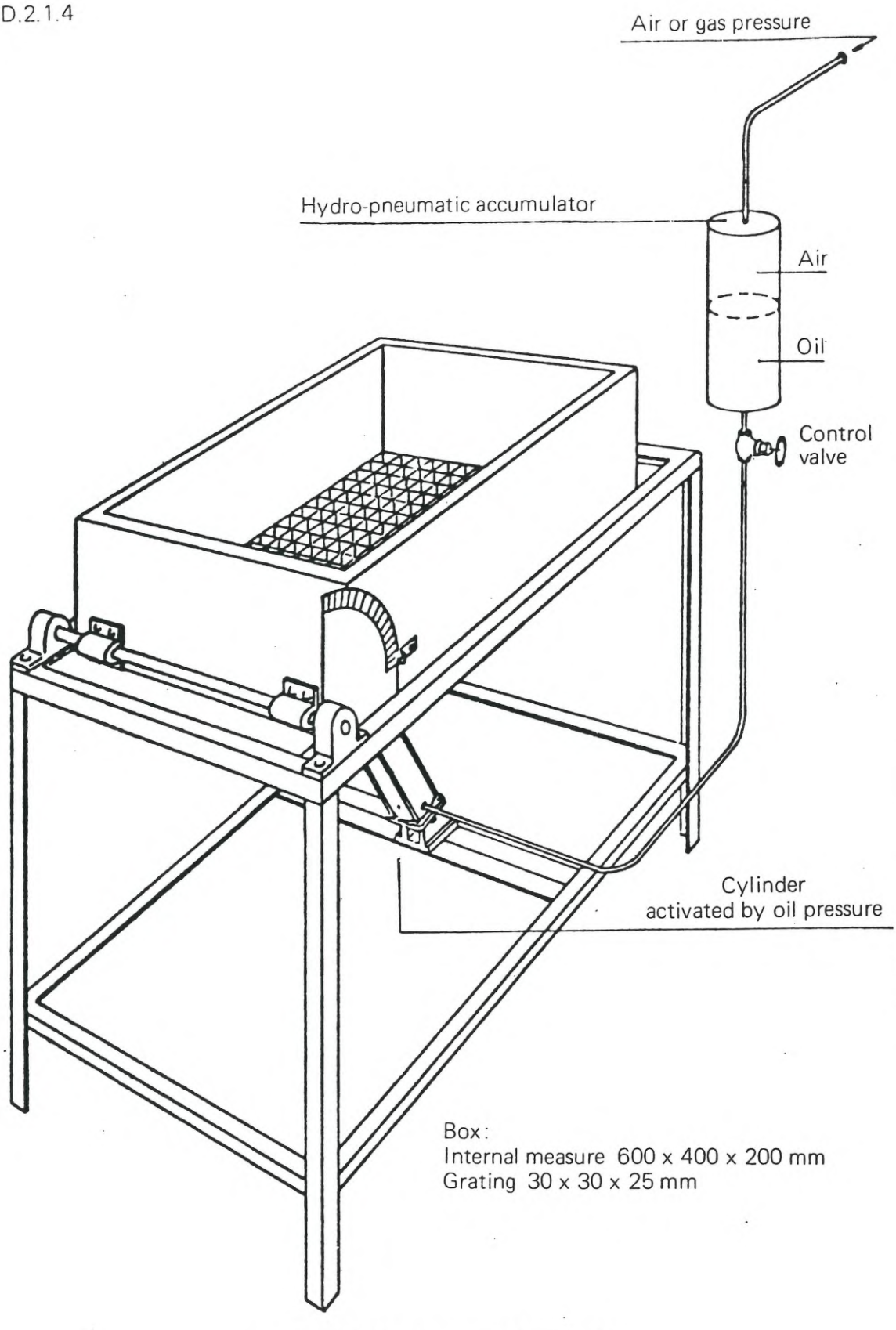
The angle of repose is calculated as the mean of three measurements and is reported to within half a degree.

Notes

Preferably the test should be carried out with three independent samples.

Care should be taken to ensure that the shaft is adjusted to be horizontal before testing.

Fig. D.2.1.4



BASIC SKETCH OF TILTING BOX

D.2.2 *Alternative or shipboard test method to be used for the determination of the angle of repose when the tilting box is not available*

D.2.2.1 *Definition*

According to this method the angle of repose is the angle between the cone slope and the horizontal measured at half height.

D.2.2.2 *Principle of test*

To determine the angle of repose, a quantity of the material to be tested is poured very carefully out of a flask onto a sheet of rough-textured paper, in such a way that a symmetrical cone is formed.

D.2.2.3 *Equipment*

The necessary equipment to carry out this test is as follows:

- a horizontal table free from vibrations;
- a sheet of rough-textured paper onto which the material should be poured;
- a protractor;
- a 3 litre conical flask.

D.2.2.4 *Procedure*

Put the sheet of paper on the table. Split 10 dm^3 of the material to be tested into three sub-samples and test each in the following way:

Pour two thirds of the sub-sample (i.e. 2 dm^3) onto the sheet producing a starting cone. The remainder of this sub-sample is then poured very carefully from a height of a few millimetres above on top of the cone. Care should be taken that the cone will be built up symmetrically. This may be achieved by revolving the flask slowly close around the top of the cone when pouring.

When measuring, care should be taken that the protractor does not touch the cone, otherwise this may result in sliding of the material and spoil the test.

The angle has to be measured at 4 places around the cone, about 90 degrees apart.

This test should be repeated on the other two sub-samples.

D.2.2.5 *Calculations*

The angle of repose is taken as the mean of the 12 measurements and is reported to half a degree. This figure can be converted to the tilting box value as follows:

$$a_t = a_s + 3 \text{ degrees} \qquad \text{(D.2.2.5)}$$

where a_t = angle of repose according to the tilting box test,

a_s = angle of repose according to the survey test.

D.3 Standards used in test procedures

D.3.1 *Standard flow table and frame* *

D.3.1.1 *Flow table and frame*

D.3.1.1.1 The flow table apparatus shall be constructed in accordance with fig. D.3. The apparatus shall consist of an integrally cast rigid iron frame and a circular rigid table top 10 ± 0.1 inches (254 ± 2.5 mm) in diameter, with a shaft attached perpendicular to the table top by means of a screw thread. The table top to which the shaft with its integral contact shoulder is attached, shall be mounted on a frame in such a manner that it can be raised and dropped vertically through the specified height with a tolerance in height of ± 0.005 inches (0.13 mm) for new tables and ± 0.015 inches (0.39 mm) for tables in use, by means of a rotated cam. The table top shall have a fine machined plane surface, free of blowholes and surface defects, and shall be scribed as shown in fig. D.3. The table top shall be of cast brass or bronze having a Rockwell hardness number not less than HRB 25 with an edge thickness of 0.3 inches (8 mm), and shall have six integral radial stiffening ribs. The table top and attached shaft shall weigh 9 ± 0.1 lb (4 ± 0.05 kg) and the weight shall be symmetrical around the centre of the shaft.

D.3.1.1.2 The cam and vertical shaft shall be of medium carbon machinery steel, hardened where indicated in fig. D.3. The shaft shall be straight and the difference between the diameter of the shaft and the diameter of the bore of the frame shall be not less than 0.002 inches (0.05 mm) and not more than 0.003 inches (0.08 mm) for new tables and shall be maintained at from 0.002 to 0.010 inches (0.26 mm) for tables in use. The end of the shaft shall not fall upon the cam at the end of the drop, but shall make contact with the cam not less than 120 degrees from the point of drop. The face of the cam shall be a smooth spiralled curve of uniformly increasing radius from ½ to 1¼ inches (13 to 32 mm) in 360 degrees and there shall be no appreciable jar as the shaft comes into contact with the cam. The cam shall be so located and the contact faces of the cam and shaft shall be such that the table does not rotate more than one revolution in 25 drops. The surfaces of the frame and of the table which come into contact at the end of the drop shall be maintained smooth, plane, and horizontal and parallel with the upper surface of the table and shall make continuous contact over a full 360 degrees.

D.3.1.1.3 The supporting frame of the flow table shall be integrally cast of fine-grained, high-grade cast iron. The frame casting shall have three integral stiffening ribs extending the full height of the frame and located 120 degrees apart. The top of the frame shall be chilled to a depth of approximately ¼ inch (6.4 mm) and the face shall be ground and lapped square with the bore to give 360 degrees contact with the shaft shoulder. The underside of the base of the frame shall be ground to secure a complete contact with the steel plate beneath.

D.3.1.1.4 The flow table may be driven by a motor[1], connected to the cam shaft through an enclosed worm gear speed reducer and flexible coupling. The speed of the cam shaft shall be approximately 100 rpm. The motor drive mechanism shall not be fastened or mounted on the table base plate or frame.

The performance of a flow table shall be considered satisfactory if, in calibration tests, the table gives a flow value that does not differ by more than 5 percentage points from flow values obtained with a suitable calibration material.[2]

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* Source: "Standard Specification for Flow Table for Use in Tests of Hydraulic Cement", Designation C230-68. Reprinted by permission of American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, Penna., USA, copyright 1977.

1 A $\frac{1}{20}$ hp (0.3 W) motor has been found adequate. The flow table may be driven by a hand-operated cam shaft as shown in the illustration.

2 Such a material may be obtained from the Cement and Concrete Reference Laboratory at the National Bureau of Standards, Washington, D.C. 20234, USA.

D.3.1.2 *Flow table mounting*

D.3.1.2.1 The flow table frame shall be tightly bolted to a cast iron or steel plate at least 1 inch (25 (25 mm) thick and 10 inches (250 mm) square. The top surface of this plate shall be machined to a smooth plane surface. The plate shall be anchored to the top of a concrete pedestal by four ½ inch (13-mm) bolts that pass through the plate and are embedded at least 6 inches (150 mm) in the pedestal. The pedestal shall be cast inverted on the base plate. A positive contact between the base plate and the pedestal shall be obtained at all points. No nuts or other such levelling devices shall be used between the plate and the pedestal. Levelling shall be effected by suitable means under the base of the pedestal.

D.3.1.2.2 The pedestal shall be 10 to 11 inches (250 to 275 mm) square at the top, and 15 to 16 inches (375 to 400 mm) square at the bottom, 25 to 30 inches (625 to 750 mm) in height, and shall be of monolithic construction, cast from concrete weighing at least 140 lb/ft^3 (2240 kg/m^3). A stable gasket cork pad, ½ inch (13 mm) thick and approximately 4 inches (102 mm) square, shall be inserted under each corner of the pedestal. The flow table shall be checked frequently for levelness of the table top, stability of the pedestal, and tightness of the bolts and nuts in the table base and the pedestal plate. (A torque of 20 lb ft (27 N m) is recommended when tightening those fastenings.)

D.3.1.2.3 The table top, after the frame has been mounted on the pedestal, shall be level along two diameters at right angles to each other, in both the raised and lowered positions.

D.3.1.3 *Flow table lubrication*

D.3.1.3.1 The vertical shaft of the table shall be kept clean and shall be lightly lubricated with a light oil (SAE-10). Oil shall not be present between the contact faces of the table top and the supporting frame. Oil on the cam face will lessen wear and promote smoothness of operation. The table should be raised and permitted to drop a dozen or more times just prior to use if it has not been operated for some time.

D.3.1.4 *Mould*

D.3.1.4.1 The mould for casting the flow specimen shall be of cast bronze or brass, constructed as shown in fig. D.3. The Rockwell hardness number of the metal shall be not less than HRB 25. The diameter of the top opening shall be 2.75 ± 0.02 inches (69.8 ± 0.5 mm) for new moulds and 2.75 + 0.05 inches (+ 1.3 mm) and –0.02 inches for moulds in use. The surfaces of the base and top shall be parallel and at right angles to the vertical axis of the cone. The mould shall have a minimum wall thickness of 0.2 inches (5 mm). The outside of the top edge of the mould shall be shaped so as to provide an integral collar for convenient lifting of the mould. All surfaces shall be machined to a smooth finish. A circular shield approximately 10 inches (254 mm) in diameter, with a centre opening approximately 4 inches (102 mm) in diameter, made of non-absorbing material not attacked by the cement, shall be used with the flow mould to prevent mortar from spilling on the table top.

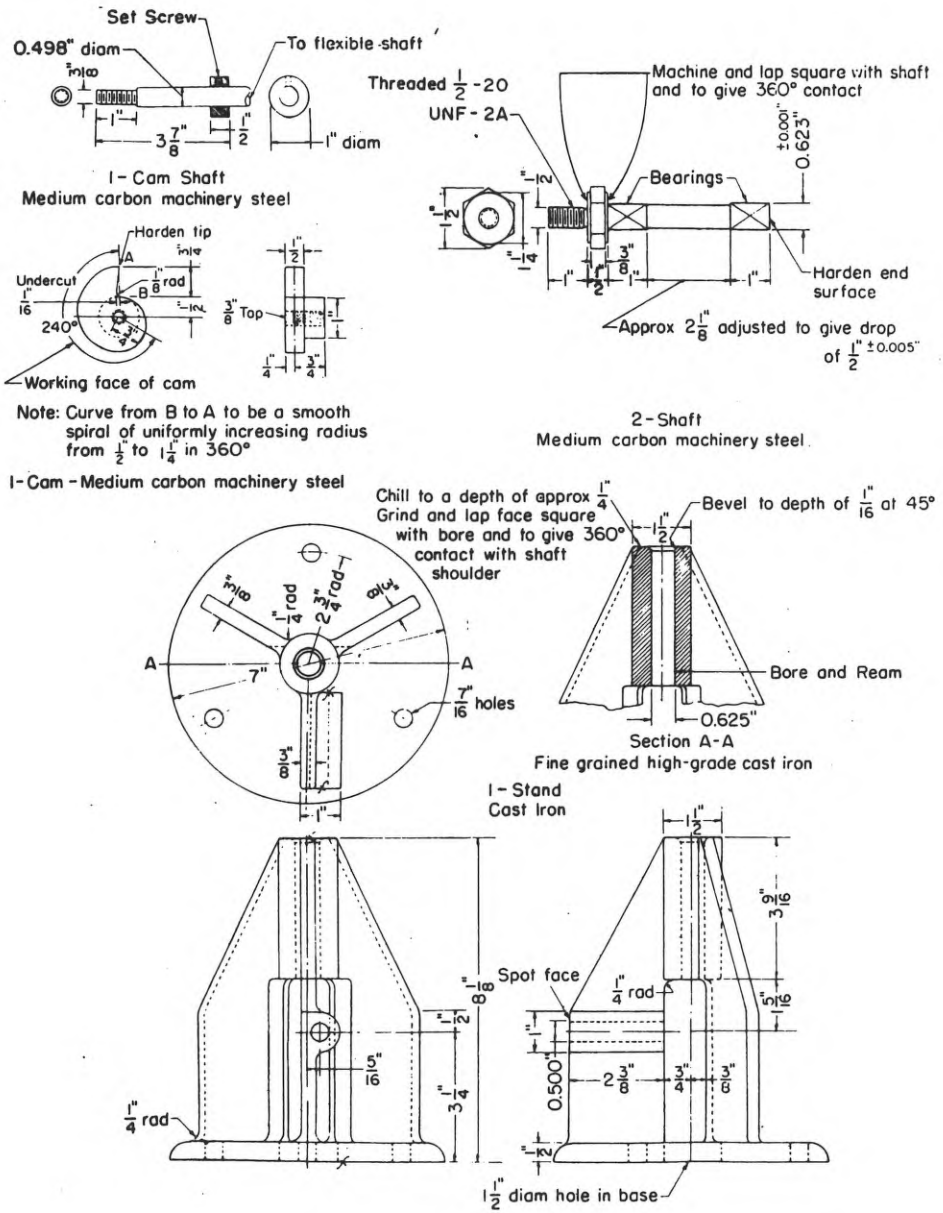
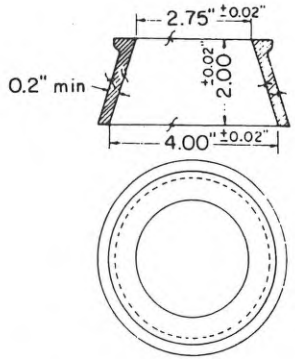

Set Screw
0.498" diam
To flexible shaft
1" diam
1 - Cam Shaft
Medium carbon machinery steel
Harden tip
Undercut
240°
Working face of cam
Top
Note: Curve from B to A to be a smooth spiral of uniformly increasing radius from 1/2" to 1 1/4" in 360°
1 - Cam - Medium carbon machinery steel
Threaded 1/2 - 20 UNF - 2A
Machine and lap square with shaft and to give 360° contact
Bearings
Harden end surface
Approx 2 1/8" adjusted to give drop of 1/2" ±0.005"
2 - Shaft
Medium carbon machinery steel
Chill to a depth of approx 1/4"
Grind and lap face square with bore and to give 360° contact with shaft shoulder
Bevel to depth of 1/16" at 45°
Bore and Ream
0.625"
Section A-A
Fine grained high-grade cast iron
1 - Stand
Cast Iron
Spot face
1 1/2" diam hole in base

Fig. 1


2.75" ±0.02"
0.2" min
2.00" ±0.02"
4.00" ±0.02"
1 - Mold
Bronze (Rockwell B-25)

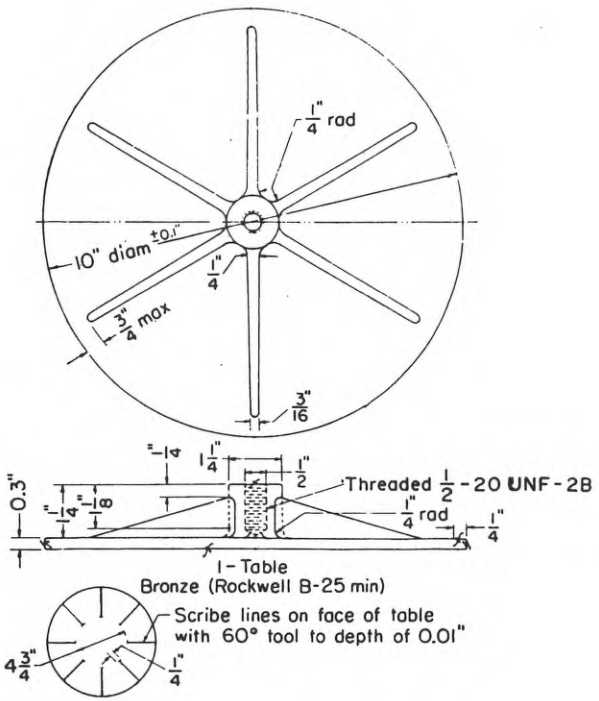

10" diam ±0.1"
3/4" max
Threaded 1/2 - 20 UNF - 2B
1 - Table
Bronze (Rockwell B-25 min)
Scribe lines on face of table with 60° tool to depth of 0.01"

Fig. D.3

D.3.2 *Scales and weights* *

D.3.2.1 *Scales*

D.3.2.1.1 The scales used shall conform to the following requirements. On scales in use the permissible variation at a load of 2000 g shall be ± 2.0 g. The permissible variation on new scales shall be one half of this value. The sensibility reciprocal[1] shall be not greater than twice the permissible variation.

D.3.2.2 *Weights*

D.3.2.2.1 The permissible variations on weights shall be as prescribed in the table below. The permissible variations on new weights shall be one half of the values in the table below.

PERMISSIBLE VARIATIONS ON WEIGHTS

Weight, g	Permissible variations on weights in use, plus or minus, g
1000	0.50
900	0.45
750	0.40
500	0.35
300	0.30
250	0.25
200	0.20
100	0.15
50	0.10
20	0.05
10	0.04
5	0.03
2	0.02
1	0.01

* Source: "Standard Method of Test for Compressive Strength of Hydraulic Cement Mortars", Designation C109-58. Reprinted by permission of American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, Penna., USA, copyright 1977.

1 Generally defined, the sensibility reciprocal is the change in load required to change the position of rest of the indicating element or elements of a non-automatic-indicating scale a definite amount at any load. For more complete definition, see "Specifications, Tolerances, and Regulations for Commercial Weighing and Measuring Devices" ***Handbook H44***, National Bureau of Standards, Washington, DC., USA. September, 1949, pp. 92 and 93.

D.4 Trough test for determination of the self-sustaining exothermic decomposition of fertilizers containing nitrates*

D.4.1 *Definition*

A fertilizer capable of self-sustaining decomposition is defined as one in which decomposition initiated in a localized area will spread throughout the mass. The tendency of a fertilizer to undergo this type of decomposition can be determined by means of the trough test. In this test localized decomposition is initiated in a bed of the fertilizer to be offered for shipment contained in a horizontally mounted trough, and the rate at which the decomposition propagates through it is measured after removal of the initiating heat source.

D.4.2 *Apparatus*

The apparatus (fig. D.4-1) consists of a trough of internal dimensions 150 x 150 x 500 mm, open at the top. The trough is constructed of square meshed gauze (preferably stainless steel) with a mesh width of about 2.5 mm and a wire thickness of 1.5 mm. The bars have a diameter of 10 mm. Fertilizers with a particle size distribution such that a significant amount falls through the mesh of the trough should be tested in a trough of smaller mesh gauze, or alternatively in a trough lined with gauze of a smaller mesh. During initiation sufficient heat should be provided and maintained to establish a uniform decomposition front. Two alternative methods are recommended, viz:

D.4.2.1 *Electrical heating*

An electrical heating element (capacity 250 watts) enclosed in a stainless steel box is placed inside and at one end of the trough (fig. D.4-2). The dimensions of the stainless steel box are 150 x 150 x 10 mm, and the wall thickness 3 mm. The side of the box which is not in contact with the fertilizer should be insulated with an asbestos plate (5 mm thick). The heating side of the box may be protected with aluminium foil or a stainless steel plate.

D.4.2.2 *Gas burners*

A steel plate (thickness 1-3 mm) is placed inside one end of the trough and in contact with the wire mesh (fig. D.4-1). The plate is heated by means of two Teclu burners which are fixed to the trough support and are capable of maintaining the plate at temperatures between 400 - 800°C, i.e. dull red heat. For example, this may be achieved by a burner capacity of about 200 dm^3/h of town gas at a pressure of 6 cm water assuming a specification of town gas as follows:

higher calorific value 4200 $kcal/m^3$,
lower calorific value 3750 $kcal/m^3$,
s = 0°C, 760 mm Hg.

D.4.2.3 To prevent heat transport along the outside of the trough a heat shield consisting of a steel plate (2 mm thick) should be installed at about 5 cm from the end of the trough where the heating takes place.

D.4.2.4 The life of the apparatus may be prolonged if it is constructed of stainless steel throughout. This is particularly important in the case of the gauze trough.

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* Source: IMDG CODE, pages 9005–9008.

D.4.3 *Procedure*

D.4.3.1 The apparatus should be set up under a fume hood to remove toxic decomposition gases. Although there is no explosion risk, when performing the test it is advisable to have a protective shield, e.g. of suitable transparent plastics, between the observer and the apparatus.

D.4.3.2 The trough is filled with a fertilizer in the form to be offered for shipment and decomposition is initiated at one end, either electrically or by means of gas burners as described above. Heating should be continued until decomposition of the fertilizer is well established and propagation of the front (over approximately 3-5 cm) has been observed. In the case of products with high thermal stability it may be necessary to continue heating for one hour. In the case of fertilizers which show a tendency to melt, the heating should be done carefully, i.e. with a small flame.

D.4.3.3 About 20 minutes after the heating has been discontinued, the position of the decomposition front is noted. The front can be observed by difference in colour, e.g. brown (undecomposed fertilizer) to white (decomposed fertilizer). A graph of the progression of the decomposition front along the trough against time is then prepared, and the propagation rate (cm/h) is obtained from the graph, using the portion where the rate is constant.

D.4.4 *Results*

D.4.4.1 If propagation of the decomposition continues throughout the entire trough, the fertilizer is capable of showing self-sustaining decomposition. The propagation rate (cm/h) is noted.

D.4.4.2 If propagation does not continue throughout the entire trough, the fertilizer is regarded as free from the hazard of self-sustaining decomposition.

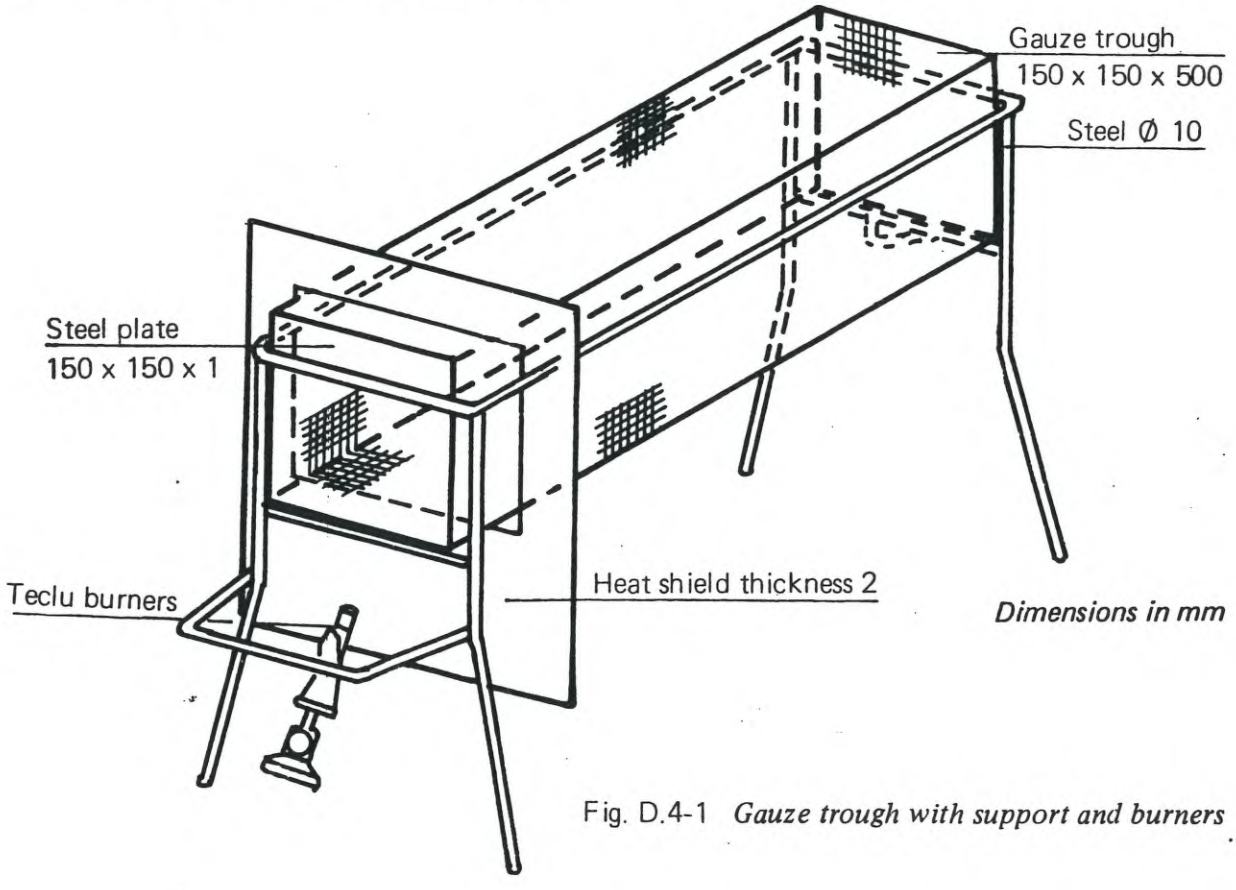
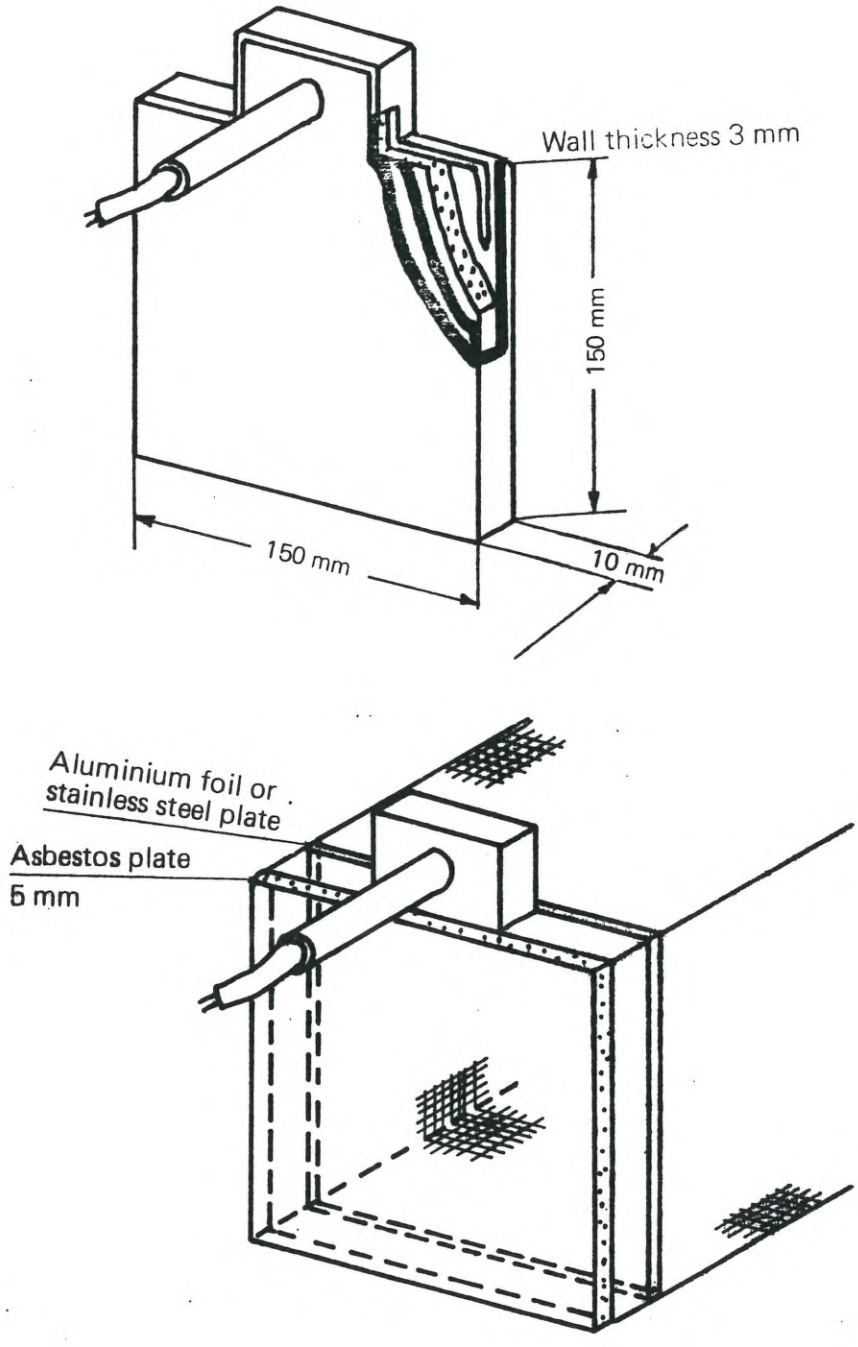


Fig. D.4-1 *Gauze trough with support and burners*



Trough to be placed on support as shown in Fig. D.4-1

Fig. D.4-2 *Electrical heating device (capacity 250 watts)*

APPENDIX E

INDEX OF MATERIALS

Materials	Appendix	Materials	Appendix
CORN GLUTEN (MEAL) (PELLETS) (see SEED CAKE)	B	GYPSUM	C
COTTON SEED, MEAL, CAKE EXPELLERS or PELLETS (see SEED CAKE)	B	HIGH IRON BRIQUETTES (see DIRECT REDUCED IRON)	B
CRYOLITE	C	HOMINY CHOP (see SEED CAKE)	B
CUTTINGS (metal) (see IRON SWARF)	B	ILMENITE ("dry" and "moist")	A
DIAMMONIUM PHOSPHATE	C	ILMENITE SAND	C
DIRECT REDUCED IRON	B	IRON ORE	C
DOLOMITE	C	IRON ORE CONCENTRATE	A
EXPELLERS (see SEED CAKE)	B	IRON ORE (MAGNETITE)	A
FELSPAR LUMP	C	IRON ORE (PELLET FEED)	A
FERROCHROME	C	IRON ORE (SINTER FEED)	A
FERROCHROME, exothermic	C	IRON ORE PELLETS	C
FERROMANGANESE	C	IRON ORE PELLETS, metallized (see DIRECT REDUCED IRON)	B
FERROMANGANESE, exothermic	C	IRON OXIDE, spent	B
FERROPHOSPHORUS	B	IRON PYRITE	A
FERROSILICON	B	IRON PYRITES	C
FERTILIZERS (see under chemical names)		IRON SPONGE, pre-crushed	B*
FERTILIZERS WITHOUT NITRATES	C	IRON SPONGE, spent (see IRON OXIDE, spent)	B
FILINGS, metal (see IRON SWARF)	B	IRON SPONGE PELLETS (see DIRECT REDUCED IRON)	B
FISHMEAL, FISHSCRAP	B	IRONSTONE	C
FLUORSPAR	B	IRON SWARF	B
FLY ASH	C	LABRADORITE	C
FOUNDRY SAND (see SAND)	C	LEAD NITRATE	B
GALENA (lead)	A	LEAD ORE	C
GARBAGE TANKAGE (see TANKAGE)	B	LEAD ORE CONCENTRATE	A
GLUTEN PELLETS (see CEREALS)	B	LEAD ORE RESIDUE	A
GRANULATED SLAG	C	LEAD SILVER ORE	A
GROUND NUTS, MEAL, CAKE, EXPELLERS or PELLETS (see SEED CAKE)	B	LEAD SULPHIDE	A
		LEAD SULPHIDE (galena)	A
		LEAD AND ZINC CALCINES, mixed	A
		LEAD AND ZINC MIDDLINGS	A
		LIMESTONE	C

* Entry to be developed later.

Materials	Appendix
LINSEED, MEAL, CAKE, EXPELLERS or PELLETS (see SEED CAKE)	B
LOW SPECIFIC ACTIVITY SUBSTANCE (LSA) (radioactive)	B
MAGNESITE	C
MAGNESIUM NITRATE	B
MAGNETITE	A
MAGNETITE-TACONITE	A
MAIZE, MEAL, CAKE, EXPELLERS or PELLETS (see SEED CAKE)	B
MANGANESE ORE	C
MANGANIC CONCENTRATE (manganese)	A
MEAL, oily (see SEED CAKE)	B
MILFEED PELLETS (see CEREALS)	B
MILORGANITE	C
MONOAMMONIUM PHOSPHATE	C
MURIATE OF POTASH	C
NEFELIN SYENITE (mineral)	A
NICKEL ORE CONCENTRATE	A
NIGER SEED, MEAL, CAKE or EXPELLERS (see SEED CAKE)	B
OIL CAKE (see SEED CAKE)	B
PALM KERNEL, MEAL, CAKE, EXPELLERS or PELLETS (see SEED CAKE)	B
PEANUTS (in shell)	C
PEANUTS, MEAL, CAKE or EXPELLERS (see SEED CAKE)	B
PEBBLES (sea)	C
PELLETS (concentrates)	C
PELLETS, CEREAL (see SEED CAKE)	B
PELLETS WOOD PULP (see WOOD PULP PELLETS)	B
PENCIL PITCH	B
PENTAHYDRATE CRUDE (see also BORAX)	A C
PERLITE ROCK	C
PETROLEUM COKE, calcined	B
PETROLEUM COKE, uncalcined	B
PHOSPHATE, defluorinated	C
PHOSPHATE ROCK, calcined	B
PHOSPHATE ROCK, uncalcined	C
PIG IRON	C
PITCH PRILL	B
POLLARD PELLETS (see CEREALS)	B
POTASH	C
POTASH MURIATE (see MURIATE OF POTASH)	C
POTASSIUM FELSPAR SAND (see SAND)	C
POTASSIUM NITRATE	B
POTASSIUM SULPHATE	C
PRILLED COAL TAR (see PITCH PRILL)	B
PUMICE	C
PYRITE (containing copper and iron)	C
PYRITES	A
PYRITES (cupreous)	A
PYRITES (fine)	A
PYRITES (flotation)	A
PYRITES (sulphur)	A
PYRITIC ASHES (iron)	A
PYRITIC CINDERS	A
PYROPHYLLITE	C
QUARTZ	C
QUARTZ SAND (see SAND)	C
QUARTZITE	C
RAPE SEED, MEAL, CAKE, EXPELLERS or PELLETS (see SEED CAKE)	B

Materials	Appendix	Materials	Appendix
RASORITE 46 (see BORAX)	C	SLAG GRANULATED (see GRANULATED SLAG)	C
RICE BRAN, MEAL, CAKE, EXPELLERS or PELLETS (see SEED CAKE)	B	"SLIG" (IRON ORE CONCENTRATE)	A
		SODA ASH (dense and light)	C
RICE BROKEN (see CEREALS)	B	SODA FELSPAR SAND (see SAND)	C
ROUGH AMMONIA TANKAGE (see TANKAGE)	B	SODIUM NITRATE	B
		SODIUM NITRATE/POTASSIUM NITRATE (mixture)	B
RUTILE SAND	C		
SAFFLOWER SEED, MEAL, CAKE EXPELLERS or PELLETS (see SEED CAKE)	B	SOYABEAN, MEAL, CAKE EXPELLERS or PELLETS (see SEED CAKE)	B
SALT	C	SPONGE IRON PELLETS (see DIRECT REDUCED IRON)	B
SALT CAKE	C	SPONGE IRON, pre-crushed	B*
SALTPETRE (see POTASSIUM NITRATE)	B	STAINLESS STEEL GRINDING DUST	C
SALT ROCK	C	STEEL SWARF (see IRON SWARF)	B
SAND (FOUNDRY, QUARTZ, SILICA, POTASSIUM, FELSPAR, SODA FELSPAR)	C	STONE CHIPPINGS	C
		STRUSSA PELLETS (see CEREALS)	B
		SUGAR (raw, raw brown, refined white)	C
SAND ILMENITE (see ILMENITE SAND)	C	SULPHUR (lump or coarse grained powder)	B
SAND RUTILE (see RUTILE SAND)	C	SUNFLOWER SEED, MEAL, CAKE, EXPELLERS or PELLETS (see SEED CAKE)	B
SAND ZIRCON (see ZIRCON SAND)	C	SUPERPHOSPHATE	C
SAWDUST	B	SUPERPHOSPHATE, triple granular	C
SCRAP METAL	C	SWARF (see IRON SWARF)	B
SEED CAKE (see also CEREALS)	B B	TACONITE PELLETS	C
SEED EXPELLERS, oily (see SEED CAKE)	B	TALC	C
		TANKAGE	B
SHAVINGS, metal (see IRON SWARF)	B	TANKAGE FERTILIZER (see TANKAGE)	B
SILICAMANGANESE	B and C	TOASTED MEALS (see CEREALS)	B
SILICA SAND (see SAND)	C	TURNINGS, metal (see IRON SWARF)	B
SILVER LEAD ORE CONCENTRATE	A		

* Entry to be developed later.

Materials	Appendix	Materials	Appendix
UREA	C	ZINC ORE (burnt ore)	A
VANADIUM ORE	B	ZINC ORE (calamine)	A
VERMICULITE	C	ZINC ORE (crude)	A
WHITE QUARTZ	C	ZINC-LEAD MIDDLINGS	A
WOODCHIPS	B	ZINC SINTER	A
WOOD PULP PELLETS	B	ZINC SLUDGE	A
ZINC AND LEAD CALCINES	A	ZINC SULPHIDE (concentrates)	A
ZINC ASHES	B	ZINC SULPHIDE (blende)	A
ZINC ORE CONCENTRATE	A	ZIRCON SAND	C