

国 际 海 事 组 织

固体散装货物安全操作规则

CODE OF SAFE PRACTICE FOR
SOLID BULK CARGOES

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INTERNATIONAL MARITIME ORGANIZATION

**CODE OF SAFE PRACTICE FOR
SOLID BULK CARGOES**

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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 by sea every year. While the vast majority of these shipments are made without incident, there have 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 recognized 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 International Maritime Organization (IMO). This work was undertaken by the Organization's Sub-Committee on Containers and Cargoes and several editions of the Code of Safe Practice for Solid Bulk Cargoes (BC Code) have been published, the first appearing in 1965.

The carriage of dangerous goods is principally governed by Chapter VII of the International Convention for the Safety of Life at Sea, 1974, which entered into force on 25 May 1980, superseding the 1960 Convention. A revised chapter VII was adopted by IMO's Maritime Safety Committee in 1983, which amendment entered into force on 1 July 1986. Part A of the revised chapter VII governs the carriage of dangerous goods in both packaged form and in solid form in bulk.

The latest amendments to chapter VII entered into force on 1 February 1992 and 1 January 1994, respectively. The latter amendment also includes a complete revision of chapter VI, which governs solid bulk cargoes in general.

The BC Code itself provides guidance 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. It includes general advice on the procedures to be followed whenever bulk cargoes are to be shipped, a description of the hazards associated with certain materials, lists of typical materials currently shipped in bulk and details of recommended test procedures to determine various characteristics of solid bulk cargo materials.

The current edition includes completely new descriptions of two test procedures (appendix D) and amendments to appendix B and appendix C.

It should be carefully noted that the list of materials 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 characteristics and chemical properties of the material.

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 materials.

The BC Code is recommended to Governments for adoption or for use as the basis for national regulations in pursuance of their obligations under chapters VI and VII of the 1974 SOLAS Convention, as amended. Those Member States that adopt the Code as a basis for national regulations are invited to advise the Organization accordingly.

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① Flammable has the same meaning as inflammable. In common with the usage in other IMO codes and in recent conventions adopted under the auspices of IMO, 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.

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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 materials 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 this Code are given in section 1.
- 3 In general, the hazards associated with the shipment of materials 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 appendices B and 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 2.5 and 6 and in appendices B, 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 contain at least a proportion of finely grained material and some moisture (usually water);**

(Advice on this subject will be found in sections 7 and 8 and in 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 3 and 9 and in appendices B, D. 4, D. 5, D. 6 and E)

4 Unless the physical or chemical properties of the materials 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 material to be shipped. Advice on this subject will be found in section 4.

5 The need for all personnel involved to exercise great care in preparation for and during loading or unloading materials and in particular when entering spaces which may be deficient in oxygen, or which may contain toxic gases, is given special mention in section 3 and appendix F.

6 Lists of typical materials 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 materials are given only for guidance. Consequently, before loading it is essential to obtain currently valid information on the physical and chemical properties of the materials presented for shipment.

7 Details of test procedures, together with advice on methods of sampling to obtain representative samples for test purposes, are given in sections 7 and 8 and appendix D.

8 The 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);
- .4 resistance to detonation; and
- .5 self-heating of charcoal.

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 ships personnel are described. These tests should only be used in circumstances where the master doubts whether the condition of the material is such as to ensure safe shipment.

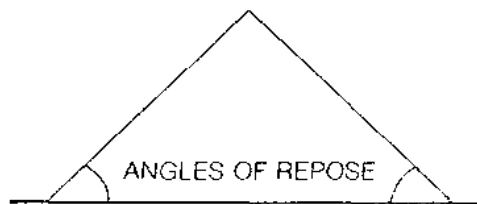
10 An index listing all the materials mentioned in this Code and indicating the appropriate appendix in

which further information will be found is given in the Index of Materials at the end of this Code. Again it is emphasized that this list of materials 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 maximum slope angle of non-cohesive (i. e. free-flowing) granular material. It is the angle between a horizontal plane and the cone slope of such material.



- 1.2 Cargoes which may liquefy — are materials which contain at least some fine particles and some moisture, usually water, although they need not be visibly wet in appearance. They may liquefy if shipped with a moisture content in excess of their 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 — is any space in the ship appropriated for the carriage of cargo.
- 1.5 Flow moisture point — is the percentage moisture content (wet mass 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 Incompatible materials — are those materials that may react dangerously when mixed. They are subject to the segregation requirements of 9.3 and the individual entries in appendix B.
- 1.8 Moisture content — is that portion of a representative sample consisting of water, ice or other liquid^① expressed as a percentage of the total wet mass of that sample.
- 1.9 Moisture migration — is the movement of moisture contained in materials by settling and consolidation of the material due to vibration and ship's motion. Water is progressively displaced, which may result in some portions or all of the materials developing a flow state.
- 1.10 Representative test sample — is a sample of sufficient quantity for the purpose of testing physical and chemical properties of the consignment to meet specified requirements. It should be collected by means of an appropriate systematic sampling procedure (see 4.3).
- 1.11 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.
- 1.12 Solid bulk cargo — is any material, other than liquid or gas, consisting of a combination of particles, granules or any larger pieces of material, generally uniform in composition, which is loaded directly into the cargo spaces of a ship without any intermediate form of containment.
- 1.13 Stowage factor — is the figure which expresses the number of cubic metres which one tonne of material will occupy.
- 1.14 Transportable moisture limit — of a cargo which may liquefy represents the maximum moisture content of the material which is considered safe for carriage in ships not complying with the special provisions of 7.2.2 and 7.2.3. 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 Procedures given in this Code apply only to the usual cases wherein the moisture consists almost entirely of water or ice.

- 1.15 Trimming — for the purposes of this Code, trimming means any levelling of the material within a cargo space, either partial or total, by means of loading spouts or chutes, portable machinery, equipment or manual labour.

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 material 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 $0.56\text{m}^3/\text{t}$ 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 materials of about 1.39 to $1.67\text{m}^3/\text{t}$ when loaded to full bale cubic and deadweight capacity. Because of the high density of some materials, 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 materials, then the following precautions are recommended:

- 1 the general fore and aft distribution of materials by mass should not differ appreciably from that found satisfactory for general cargoes;

- .2 the maximum number of tonnes of material loaded in any cargo space should not exceed
 $0.9 LBD$ tonnes (2.1.2.2.2)

where:

L = length of the hold in metres

B = average breadth of the hold in metres

D = summer load draught in metres;

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

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

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

- .4 if the material is trimmed entirely level, the maximum number of tonnes of material loaded in any lower hold cargo space may be increased by 20 % over the amount calculated by formula (2.1.2.2.2), subject, however, to full compliance with 2.1.2.2.1; and
- .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 % 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 II-1/22.1 of the International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended, a stability information booklet should be provided aboard all ships which are subject to that Convention. Where materials 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 should 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 materials should normally be loaded in the lower hold cargo spaces rather than in 'tween-deck cargo spaces.

2.1.3.3 When, however, it is necessary to carry high-density materials in 'tween-decks or higher cargo spaces, care should 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 material, 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 materials which are suspected of readily shifting are carried in 'tween-deck 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 material 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 materials 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 materials 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 Safety of personnel and ship

3.1 General requirements

3.1.1 Prior to and during loading, transport and discharge of bulk materials, all necessary safety precautions, including any appropriate national regulations or requirements, should be observed.

3.1.2 Advice on medical matters is given in the IMO/WHO/ILO Medical First Aid Guide for Use in Accidents Involving Dangerous Goods (MFAG). A copy of the MFAG should be on board each ship.

3.2 Poisoning, corrosive and asphyxiation hazards

3.2.1 Certain bulk materials are liable to oxidation, which in turn may result in oxygen reduction, emission of toxic fumes and self-heating. Others may not oxidize but may emit toxic fumes, particularly when wet. There are also materials which, when wetted, are corrosive to skin, eyes and mucous membranes or to the ship's structure. In these cases, particular attention should be paid to personal protection and the need for special precautions and measures to be taken prior to loading and after unloading.

3.2.2 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.

3.2.3 Shipmasters are warned that cargo spaces and adjacent spaces may be depleted in oxygen or may contain toxic or asphyxiating gases. An empty cargo space or tank which has remained closed for some time may have insufficient oxygen to support life.

3.2.4 Many materials frequently carried in bulk are liable to cause oxygen depletion in a cargo space or tank; these include most vegetable products, grains, timber logs and forest products, ferrous metals, metal sulphide concentrates and coal cargoes.

3.2.5 It is, therefore, essential that entry of personnel into enclosed spaces should not be permitted until tests have been carried out and it has been established that the oxygen content has been restored to a normal level throughout the space and that no toxic gas is present, unless adequate ventilation and air circulation throughout the free space above the material has been effected. It should be remembered that, after a cargo space or tank has been tested and generally found to be safe for entry, small areas may exist where oxygen is deficient or toxic fumes are still present. **General precautions and procedures for entering enclosed spaces appear in appendix F and on the Maritime Safety Card. As much publicity as possible should be given to the hazards associated with entry into enclosed spaces. A poster on the subject should be produced. A specimen (reduced format) for such a poster for display on board ships in accommodation or other places, as appropriate, has been included in appendix F.** ①

3.2.6 When transporting a bulk cargo which is liable to emit a toxic or flammable gas, or cause oxygen depletion in the cargo space, an appropriate instrument for measuring the concentration of gas or oxygen in the cargo space should be provided.

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

① Refer also to MSC/Circ. 487 of 6 June 1988 and MSC/Circ. 556 of 20 June 1991.

gas mixtures.

3.2.8 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.

3.3 Health hazards due to dust

3.3.1 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 this Code.

3.4 Flammable atmosphere

3.4.1 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.

3.4.2 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 (see also 9.3.2.1.3 for requirements for mechanical ventilation). 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.

3.5 Ventilation systems

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

3.6 Grain under in-transit fumigation

3.6.1 Fumigation should be performed in accordance with the latest version of the Recommendations on

the Safe Use of Pesticides in Ships.

3.6.2 A copy of these Recommendations should be on board each ship undergoing in-transit fumigation, for use by ship's personnel.

Section 4 Assessment of acceptability of consignments for safe shipment

4.1 Provision of information

4.1.1 Prior to shipment, the shipper should provide details regarding the nature of the material.

4.1.2 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 such as toxicity, corrosivity, etc., flow moisture point, stowage factor, moisture content, angle of repose, drainage to form a wet base, etc., of any material constituting bulk cargo in order that any safety precautions which may be necessary can be put into effect.

4.1.3 To do this the shipper will need to arrange, possibly in consultation with the producers, for the material 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 material.

4.2 Certificates of test

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

4.2.2 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 material 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.

4.2.3 Where certification is required by appendix B for materials possessing chemical hazards, the