

標題

UK 籍船における IMSBC コードに規定される試験基準
について

ClassNK

テクニカル インフォメーション

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各位

UK 籍船における国際海上固体ばら積み貨物(IMSBC)コードに規定される試験基準等に関しまして、
今般、UK 政府より、Marine Guidance Note の通知がありましたのでお知らせ致します。

IMSBC コードの第 4 節及び第 8 節の改正の適用(MSC.1/Circ.1452)に関するサーキュラーは、実行
可能な限り早く適用することが要求されます。また、IMSBC コードに記載されていない貨物情報の提
出のためのガイドライン(MSC.1/Circ.1453)、液状化貨物の承認手順のためのガイドライン
(MSC.1/Circ.1454)及び鉄鉱粉運送及び試験基準の改正案の適用(DSC.1/Circ.71)に関わるサーキ
ュラーは、可能な限り早急に適用することが要求されます。

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SOLID BULK CARGOES (IMSBC) CODE AND THEIR CONDITIONS
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NOTES:

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1. MGN 511 (M)
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**Maritime &
Coastguard
Agency**

MARINE GUIDANCE NOTE

MGN 511 (M)

SOLID BULK CARGOES - Adoption of Amendment 02-13 to the International Maritime Solid Bulk Cargoes (IMSBC) Code - MSC.1/Circ.1452

Notice to all ship owners, ship operators, terminal operators, port authorities, classification societies, agents, charterers, shippers, consignors, masters and all other parties involved in the transport of solid bulk cargoes by sea.

Summary

The purpose of this Marine Guidance Note is to advise industry of an amendment (02-13) to the International Maritime Solid Bulk Cargoes (IMSBC) Code. This amendment also adds products which previously have not been included in Appendix 1 of the IMSBC Code.

Users of the Code are advised to implement the amendments as soon as possible, in particular, Section 4 – Assessment of acceptability of consignments for safe shipment and Section 8 – Test procedures for cargoes which may liquefy.

1. Introduction/ Background

- 1.1 The International Maritime Solid Bulk Cargoes (IMSBC) Code establishes international provisions for the safe loading, trimming, carriage and discharge of solid bulk cargoes when transported by sea, ensuring compliance with the provisions of the SOLAS Convention and identifies the risks associated with such cargoes with the aim of taking measures to minimize and to control them.
- 1.2 In a dry, granular, cargo the individual particles are in contact with each other such that frictional forces prevent them sliding over one another. However, if there is enough moisture present then there is the potential for the cargo to behave like a liquid. This is because settling of the cargo occurs under the influences of vibration, over stowage and the motion of the ship. As such, the spaces between the particles reduce in size with an accompanying increase in water pressure between the particles. This results in a reduction in friction between the particles and can allow the cargo to shift suddenly.
- 1.3 This cargo movement can result in a loss of stability and over recent years, has been associated with the loss of life in numerous marine casualties. Such cargoes are identified



as Group A cargoes in the IMSBC Code. Group A consists of cargoes which may liquefy if shipped at a moisture content in excess of their transportable moisture limit.

2. Amendment 02 – 13 to the International Maritime Solid Bulk Cargoes (IMSBC) Code.

2.1 The International Maritime Organization (IMO) has recently adopted an amendment to the International Maritime Solid Bulk Cargoes (IMSBC) Code. IMO has invited users of the Code to implement it as soon as possible after 1 January 2014 with a final entry into force date of 1 January 2015.

2.2 In particular, operators are strongly advised, in light of recent incidents on vessels carrying cargo which may liquefy, to implement amendments to Sections 4 and 8 as soon as practical. These are:

- Section 4 – Assessment of acceptability of consignments for safe shipment now requires the shipper to provide the ship's master or his representative with a signed certificate of the Transportable Moisture Limit and a signed certificate of declaration of the moisture content each issued by an entity recognised by the Competent Authority of the port of loading.
- Section 8 – Test procedures for cargoes which may liquefy: This now has an additional paragraph which states that if samples remain dry following a can test, the moisture content of the material may still exceed the Transportable Moisture Limit (TML).

See MSC.1/Circ.1452 attached.

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MSC.1/Circ.1452
9 July 2013

EARLY IMPLEMENTATION OF AMENDMENT 02-13 TO THE INTERNATIONAL MARITIME SOLID BULK CARGOES (IMSBC) CODE

1 The Maritime Safety Committee, at its ninety-second session (12 to 21 June 2013), in adopting resolution MSC.354(92) on *Amendments to the International Maritime Solid Bulk Cargoes (IMSBC) Code* and considering the proposal by the Sub-Committee on Dangerous Goods, Solid Cargoes and Containers, at its seventeenth session, invited SOLAS Contracting Governments to implement the aforementioned amendment as soon as practicable, in particular sections 4 and 8, taking into account that the entry-into-force date of the amendment is expected to be 1 January 2015.

2 The relevant paragraphs of sections 4 and 8 of the amendment to the IMSBC Code are as follows:

"Section 4 – Assessment of acceptability of consignments for safe shipment

4.3.2 When a concentrate or other cargo which may liquefy is carried, the shipper shall provide the ship's master or his representative with a signed certificate of the TML, and a signed certificate or declaration of the moisture content, each issued by an entity recognized by the Competent Authority of the port of loading. The certificate of TML shall contain, or be accompanied by, the result of the test for determining the TML. The declaration of moisture content shall contain, or be accompanied by, a statement by the shipper that the moisture content is, to the best of his knowledge and belief, the average moisture content of the cargo at the time the declaration is presented to the master.

4.3.3 When a concentrate or other cargo which may liquefy is carried, procedures for sampling, testing and controlling moisture content to ensure the moisture content is less than the TML when it is on board the ship, shall be established by the shipper, taking account of the provisions of this Code. Such procedures shall be approved and their implementation checked by the competent authority of the port of loading*. The document issued by the competent authority stating that the procedures have been approved shall be provided to the master or his representative.

4.3.4 If the cargo is loaded on to the ship from barges, in developing the procedures under 4.3.3, the shipper shall include procedures to protect the cargo on the barges from any precipitation and water ingress.

* Refer to MSC.1/Circ.1454, *Guidelines for developing and approving procedures for sampling, testing and controlling the moisture content for solid bulk cargoes which may liquefy*.



4.4.3 For a concentrate or other cargo which may liquefy, the shipper shall facilitate access to stockpiles for the purpose of inspection, sampling and subsequent testing by the ship's nominated representative.

Section 8 – Test procedures for cargoes which may liquefy

8.4.2 If samples remain dry following a can test, the moisture content of the material may still exceed the Transportable Moisture Limit (TML)."

3 Member Governments are invited to bring this circular to the attention of all concerned, taking into account the voluntary application date of 1 January 2014, of the amendment to the IMSBC Code, pending its envisaged mandatory entry-into-force date of 1 January 2015.



Maritime &
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Agency

MARINE GUIDANCE NOTE

MGN 512 (M)

SOLID BULK CARGOES - Guidelines for the submission of information and completion of the format for the properties of cargoes not listed in the International Maritime Solid Bulk Cargoes (IMSBC) Code and their conditions of carriage - MSC.1/Circ.1453

Notice to all ship owners, ship operators, terminal operators, port authorities, classification societies, agents, charterers, shippers, consignors, masters and all other parties involved in the transport of solid bulk cargoes by sea.

Summary

The purpose of this Marine Guidance Note is to advise industry of Guidelines by the International Maritime Organization on the details required by Competent Authorities in order for them to apply to IMO for cargoes not listed in the International Maritime Solid Bulk Cargoes (IMSBC) Code to be incorporated into appendix 1 of the IMSBC Code.

1. Introduction/ Background

- 1.1 Shippers of solid bulk cargoes intended for carriage and which are not listed in appendix 1 of the International Maritime Solid Bulk Cargoes (IMSBC) Code, are required, prior to loading, to provide the Competent Authority of the port of loading with the characteristics and properties of the cargo in accordance with Section 4 of the Code. Based on the information provided, the Competent Authority of the port of loading will assess the acceptability of the cargo for safe shipment and provide to the master a certificate stating the characteristics of the cargo and the required conditions for carriage and handling of that shipment.
- 1.2 On receipt of the information, the Competent Authority of the State of the port of loading will submit an application to the International Maritime Organization (IMO) within one year of the certificate being issued, for the cargo to be included in appendix 1 of the IMSBC Code. This application will be based upon the information provided and taking into account the IMO Guidelines and the format for submission.



2 Implementation

- 2.1 Mandatory entry into force date of these guidelines is 1 January 2015. Operators are advised to implement these guidelines as soon as possible after 1 January 2014 on a voluntary basis.

3 Contact

- 3.1 The contact details for the United Kingdom competent authority are:
Environmental Policy Branch
Bay 2/08
Spring Place
105 Commercial Road
Southampton, SO15 1EG

See MSC.1/Circ.1453 attached.

More Information

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MSC.1/Circ.1453
9 July 2013

**GUIDELINES FOR THE SUBMISSION OF INFORMATION AND COMPLETION
OF THE FORMAT FOR THE PROPERTIES OF CARGOES NOT LISTED IN THE
INTERNATIONAL MARITIME SOLID BULK CARGOES (IMSBC) CODE AND
THEIR CONDITIONS OF CARRIAGE**

1 The Maritime Safety Committee, at its ninety-second session (12 to 21 June 2013), in adopting resolution MSC.354(92) on *Amendments to the International Maritime Solid Bulk Cargoes (IMSBC) Code* and considering the proposal by the Sub-Committee on Dangerous Goods, Solid Cargoes and Containers, at its seventeenth session, with regard to implementation of subsection 1.3.3 of the IMSBC Code, approved *Guidelines for the submission of information and completion of the format for the properties of cargoes not listed in the IMSBC Code and their conditions of carriage*, set out in the annex.

2 Member Governments are invited to bring the annexed Guidelines to the attention of all concerned, taking into account the voluntary application date of 1 January 2014 of amendment 02-13 of the IMSBC Code pending its envisaged mandatory entry-into-force date of 1 January 2015.

ANNEX

GUIDELINES FOR THE SUBMISSION OF INFORMATION AND COMPLETION OF THE FORMAT FOR THE PROPERTIES OF CARGOES NOT LISTED IN THE INTERNATIONAL MARITIME SOLID BULK CARGOES (IMSBC) CODE AND THEIR CONDITIONS OF CARRIAGE

Foreword

When a cargo which is not listed in the International Maritime Solid Bulk Cargoes (IMSBC) Code is intended to be carried in bulk, the competent authority of the port of loading should provide to the master a certificate stating the characteristics of the cargo and the required conditions for carriage and handling of that shipment. The competent authority of the port of loading should also submit an application to the Organization to incorporate this solid bulk cargo into appendix 1 of the IMSBC Code. The format of this application should be as outlined in subsection 1.3.3 of the IMSBC Code. These Guidelines provide guidance on the type and structure of information which is required in the application.

General

The application should be supported as a minimum by relevant data such as may be contained in Material Safety Data Sheet (MSDS), Safety Data Sheet (SDS) or other relevant documentation. Applicants should therefore complete and submit the questionnaire in the appendix. Where applications indicate use of equipment or systems, references to relevant internationally agreed standards for such equipment or systems should be indicated.

1 Section "TENTATIVE BULK CARGO SHIPPING NAME"

This is the proposed Bulk Cargo Shipping Name (BCSN) to be identified in capital letters. When the cargo constitutes dangerous goods, the BCSN is to be supplemented with the United Nations (UN) number. Secondary names which are proposed to be indicated in appendix 4 "Index" of the IMSBC Code may also be listed in this section.

2 Section "Description"

This section should be used to specify the type of material, the manufacturing process, the raw material, the particle size and form, the colour, the composition of the material and its variability, the moisture content, properties of the cargo such as in/soluble in water, dusty, hygroscopic, and other specific characteristics.

3 Section "Characteristics"

3.1 The table specifying the characteristics of the cargo should be completed as follows:

3.2 **Angle of repose:** This box should be used to indicate the angle of repose for non-cohesive granular materials. If the evaluation of the properties of the material proved that the cargo is cohesive, the entry should be "Not applicable".

3.3 **Bulk density:** This box should be used to indicate the bulk density or the range of bulk density, as applicable, in kg/m³.

3.4 **Stowage factor:** This box should be used to indicate the stowage factor or range of stowage factor, as applicable, in m³/t.

3.5 Size: This box should be used to indicate the form and size or size-range of particles, pellets, lumps, etc., in mm and its variability, as applicable.

3.6 Class: This box should be used to indicate the hazard classification in accordance with section 9.2 of the IMSBC Code. If the cargo does not fall under Group B, the entry should be "Not applicable". In addition, if the cargo constitutes dangerous goods and has subsidiary risks, the subsidiary risks should be indicated.

3.7 Group: This box should be used to indicate the cargo group in accordance with subsection 1.7 of the IMSBC Code (possible entries are "A and B", "A", "B" or "C").

4 Section "Hazard"

4.1 This section should be used to specify the hazard(s) of the material relevant for sea transport, such as combustibility, toxicity, corrosivity, radiotoxicity, hygroscopy, liability to oxygen depletion, decomposition, self-heating, spontaneous ignition, liquefaction, emission of flammable and/or toxic gases or vapours, reactivity with water, fuel oil or other organic materials.

4.2 In case of non-hazardous cargo, write "No special hazards". If the cargo is non-combustible or constitutes a low fire-risk, write "This cargo is non-combustible or has a low fire-risk".

5 Section "Stowage and segregation"

5.1 This section should be used to specify the requirements for stowage and segregation of the cargo, such as separation from foodstuff, from wooden boundaries or from other cargoes, stowage away from sources of heat or ignition, away from fuel oil tanks, away from machinery space boundaries.

5.2 Furthermore this section should be used to stipulate requirements for fire/heat insulation for fuel oil tanks and machinery space bulkheads arranged adjacent to the cargo spaces, for resistance of cargo hold boundaries to fire and/or passage of liquids, for gas-tight machinery space bulkheads, for escaping gases away from accommodation spaces.

5.3 If no stowage and/or segregation requirements are appropriate, write "No special requirements".

6 Section "Hold cleanliness"

6.1 This section should give advice on the preparation of cargo spaces prior to loading, such as cleanliness and dryness of cargo spaces and bilge wells, washing with fresh or sea water, free from salt, provision of protective coating or lime-wash, removal of wooden dunnage.

6.2 If no requirement is necessary, write "No special requirements".

7 Section "Weather precautions"

7.1 This section should provide requirements relating to weather conditions and protective measures to be applied prior to and during loading and/or during unloading, such as moisture content of the cargo, prohibition of cargo handling during precipitation, closing of hatch covers.

7.2 If no requirement is necessary, write "No special requirements".

8 Section "Loading"

8.1 This section should be used to specify requirements and precautions during loading, such as trimming procedure, prevention of overstressing of the tank top, prevention of dust, dust control equipment, inerting of cargo spaces, gas and temperature measurement.

8.2 If no requirement is necessary, write "No special requirements".

9 Section "Precautions"

9.1 This section should be used to specify precautions to be taken prior to loading, such as protection of the ship and the crew from dust of the cargo, posting of "NO SMOKING" signs on deck, electrical equipment to be of certified safe type (explosion protection), removal of electrical links, spark arresting screens for ventilation openings, safety locking device for cargo space bilge lines, protection of bilge wells, gas-tightness of machinery space bulkheads, pressure test of fuel tanks adjacent to the cargo hold.

9.2 Furthermore this section should be used to describe specific conditions of the cargo prior to loading, such as permissible limits of temperature in stockpile, other conditions of stockpile and test certificates to be provided prior to loading, e.g. certificate of moisture content and transportable moisture limit, weathering certificate, exemption certificate.

9.3 If no requirement is necessary, write "No special requirements".

10 Section "Ventilation"

10.1 This section should be used to specify requirements for ventilation of cargo spaces (refer to section 3.5 of the IMSBC Code) with regard to the ventilation system and the operation of ventilation during the voyage.

10.2 If no requirement is necessary, write "No special requirements".

11 Section "Carriage"

11.1 This section should be used to specify requirements and instructions to be observed during the voyage, such as procedures and equipment for gas and temperature measurement, sealing of hatches, ventilators and other openings of cargo holds in order to prevent ingress of water or leaking of inert gas, maintaining an inert atmosphere, checking the cargo surface for liquefaction and decomposition, checking of cargo spaces for condensation, testing of the acidity of bilge water and instructions for bilge pumping, ventilating of cargo holds and adjacent spaces.

11.2 If no requirement is necessary, write "No special requirements".

12 Section "Discharge"

12.1 This section should be used to specify requirements to be observed prior to and during unloading, such as precaution for entry of personnel into cargo spaces, use of personnel protection, gas measurement, restrictions for bunkering or pumping of fuel oil, trimming of hardened cargo, prevention of dust, protection of the ship.

12.2 If no requirement is necessary, write "No special requirements".

13 Section "Clean-up"

13.1 This section should be used to specify requirements for cleaning up of cargo spaces and bilge wells, such as removal of cargo residues and spillages, decontamination, use of fresh water or seawater, use of personnel protection, precautions for the use of the shipborne bilge system.

13.2 If no requirement is necessary, write "No special requirements".

14 Section "Emergency Procedures"

14.1 The table specifying the emergency procedures should be completed for materials of Group B as follows.

14.2 Special emergency equipment to be carried: This box should be used to specify the special emergency equipment to be carried, such as protective clothing, self-contained breathing apparatuses, fire-fighting equipment. Otherwise, write "Nil".

14.3 Emergency Procedures: This box should be used to specify protective measures for entering the cargo spaces. Otherwise, write "Nil".

14.4 Emergency action in the event of fire: This box should be used to specify emergency action in the event of fire, such as supply or exclusion of air, use of water, CO₂ or whether a fixed gas fire-extinguishing system may be exempted, etc. Otherwise, write "Nil".

14.5 Medical First Aid: Reference should be made to the *Medical First Aid Guide (MFAG)*, as applicable.

* * *

Appendix

IMO SOLID BULK CARGO INFORMATION REPORTING QUESTIONNAIRE

It is recommended to provide the following information, in addition to the information described in subsection 1.3.3 of the IMSBC Code.

Basic background information

- Are there other synonyms or trade names in use?
- How is it manufactured, how is it made, or where does it originate?
- What is it used for?
- Where is it produced? In what countries? In what volumes?
- What experience do you have with the cargo?

Basic cargo properties

The following information may be included in the Description section of the draft individual schedule.

- What colour is it?
- Does it have an odour?
- What form is the cargo in? What particle sizes?
- How much moisture is in the cargo? How much oil is in the cargo?
- How is it stored? Outside? Under cover?
- Does the cargo cake when wet?
- Is it a cohesive cargo or a free-flowing cargo?

Hazardous properties

For this section of the questionnaire, each answer should be supported by test data on multiple samples from difference sources. If a question is not applicable, a detailed explanation of why it is not applicable should be made.

- Does it meet the definition of dangerous goods (Hazard Classes 1-9)? Which hazard classes?
- Is the cargo easily ignitable, combustible or flammable?
- Can the cargo contribute to fire or accelerate a fire?
- Does the cargo self-heat? What causes the self-heating? Fungal or bacterial growth? Oxidation?
- Does the cargo react with water causing toxic or flammable gases to be released? Which gases? How toxic or flammable are the gases? What is the rate of evolution?
- Is the cargo toxic? Toxic by inhalation? Toxic by skin contact or ingestion? How toxic? Acute or chronic toxicity?

- Does the cargo exhibit any long-term health effects, such as carcinogenic, mutagenic or reprotoxic properties?
- Is the cargo a respiratory sensitizer?
- Does the cargo contain known pathogens?
- Does the cargo react with water reaction causing corrosion? Corrosion to eyes, skin, or metal? What is the rate of corrosion?
- Is the cargo corrosive without water? Corrosion to eyes, skin, or metal? What is the rate of corrosion?
- Is the cargo hazardous to the environment?
- Is the dust flammable or explosive?
- Can the cargo deplete oxygen in cargo spaces and adjacent spaces? By how much?
- Is the cargo incompatible with other cargoes or chemicals? Which cargoes or chemicals?
- Can the cargo liquefy during a voyage? What is the Transportable Moisture Limit (TML) of the cargo?

Operational questions

- How is the cargo loaded? Conveyor? Clam shell?
- Does the cargo need to be trimmed?
- What type of ship will be used? Bulk carrier? OBO? Self-unloading vessel? General cargo ship? Barge?
- What experience do you have carrying the cargo in bulk by vessel? By road and rail?
- Have there been any incidents when transporting the cargo as a result of the cargo properties or hazards?
- Are there any recommendations for tank or hold cleaning?

Emergency response questions

- In the event of a fire can the cargo be extinguished with water? CO₂?
- In the event of personal exposure what procedures should be followed?
- What happens in the event of an accidental release to water during transport?

Testing questions

- Which hazards have been assessed?
- Which tests were conducted?
- What were the results of these tests?
- What was the actual data from the tests?
- How many tests were conducted?
- What samples were tested? Are the samples representative of the cargo to be shipped?



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MARINE GUIDANCE NOTE

MGN 513 (M)

SOLID BULK CARGOES - Guidelines for developing and approving procedures for sampling, testing and controlling the moisture content for solid bulk cargoes which may liquefy - MSC.1/Circ.1454

Notice to all ship owners, ship operators, terminal operators, port authorities, classification societies, agents, charterers, shippers, consignors, masters and all other parties involved in the transport of solid bulk cargoes by sea.

Summary

Liquefaction of fine particle cargoes, resulting in cargo movement and loss of stability has been associated with the loss of life in numerous, recent marine casualties. The purpose of this Marine Guidance Note is to advise of guidelines prepared by the International Maritime Organization (IMO) on the preparation, approval and implementation of procedures for sampling, testing and controlling moisture content for solid bulk cargoes which may liquefy.

The main objective of the Guidelines is to ensure safe transport of such cargoes and to complement the provisions of the International Maritime Solid Bulk Cargoes (IMSBC) Code by:

- assisting shippers in preparing procedures for sampling, testing and controlling moisture content as required by paragraph 4.3.3 of the IMSBC Code; and
- assisting competent authorities of ports of loading when approving and checking the implementation of such procedures in accordance with paragraph 4.3.3 of the IMSBC Code.

1. Introduction/ Background

- 1.1 The International Maritime Solid Bulk Cargoes (IMSBC) Code establishes international provisions for the safe loading, trimming, carriage and discharge of solid bulk cargoes when transported by sea, ensuring compliance with the provisions of the SOLAS Convention and identifies the risks associated with such cargoes with the aim of taking measures to minimize and to control them.



- 1.2 In a dry, granular, cargo the individual particles are in contact with each other such that frictional forces prevent them sliding over one another. However, if there is enough moisture present then there is the potential for the cargo to behave like a liquid. This is because settling of the cargo occurs under the influences of vibration, over stowage and the motion of the ship. As such, the spaces between the particles reduce in size with an accompanying increase in water pressure between the particles. This results in a reduction in friction between the particles and can allow the cargo to shift suddenly.
- 1.3 This cargo movement can result in a loss of stability and over recent years, has been associated with the loss of life in numerous marine casualties. Such cargoes are identified as Group A cargoes in the IMSBC Code.

2. International Maritime Organization Guidelines

- 2.1 The International Maritime Organization (IMO) has published guidelines on the preparation, approval and implementation of procedures for sampling, testing and controlling moisture content for solid bulk cargoes which may liquefy – See MSC.1/Circ.1454, attached.
- 2.2 The main objectives of the Guidelines are to ensure safe transport of such cargoes and to complement the provisions of the IMSBC Code by:
- assisting shippers in preparing procedures for sampling, testing and controlling moisture content as required by paragraph 4.3.3 of the IMSBC Code; and
 - assisting competent authorities of ports of loading when approving and checking the implementation of such procedures in accordance with paragraph 4.3.3 of the IMSBC Code.
- 2.3 Liquefaction may occur when the moisture content of the cargo exceeds the Transportable Moisture Limit (TML). Therefore, except for specially constructed or fitted cargo ships as described in subsection 7.3.2 of the IMSBC Code, it is particularly important to ensure that the moisture content is less than the TML of the cargo and to control its moisture content until it is on board the ship.
- 2.4 For this purpose, it is required by the IMSBC Code to determine by a test the acceptability of consignments for safe shipment. Considering that the determination of the acceptability is fundamental to avoid liquefaction during transport, the shipper should establish procedures for sampling, testing and controlling moisture content. These procedures should be approved and their implementation checked by the competent authority of the port of loading.
- 2.5 Sections 2, 3 and 4 of the Circular contain guidance to develop such procedures for sampling, testing and the control of moisture content respectively.

3 Implementation

- 3.1 Mandatory entry into force date of these guidelines is 1 January 2015. Operators are advised to implement these guidelines as soon as possible after 1 January 2014 on a voluntary basis.



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MSC.1/Circ.1454
9 July 2013

**GUIDELINES FOR DEVELOPING AND APPROVING PROCEDURES FOR
SAMPLING, TESTING AND CONTROLLING THE MOISTURE CONTENT
FOR SOLID BULK CARGOES WHICH MAY LIQUEFY**

1 The Maritime Safety Committee, at its ninety-second session (12 to 21 June 2013), in adopting resolution MSC.354(92) on *Amendments to the International Maritime Solid Bulk Cargoes (IMSBC) Code* and considering the proposal by the Sub-Committee on Dangerous Goods, Solid Cargoes and Containers, at its seventeenth session, approved *Guidelines for developing and approving procedures for sampling, testing and controlling the moisture content for solid bulk cargoes which may liquefy*, as set out in the annex.

2 Member Governments are invited to bring the annexed Guidelines to the attention of all concerned, taking into account the voluntary application date of 1 January 2014 of amendment 02-13 of the IMSBC Code pending its envisaged mandatory entry-into-force date of 1 January 2015.

ANNEX

GUIDELINES FOR DEVELOPING AND APPROVING PROCEDURES FOR SAMPLING, TESTING AND CONTROLLING THE MOISTURE CONTENT FOR SOLID BULK CARGOES WHICH MAY LIQUEFY

Foreword

These Guidelines, prepared by the Maritime Safety Committee of the International Maritime Organization (IMO) contain guidance on the preparation, approval and implementation of procedures for sampling, testing and controlling moisture content for solid bulk cargoes which may liquefy. These guidelines were developed as part of the work to ensure safe transport of such cargoes and to complement the provisions of the International Maritime Solid Bulk Cargoes (IMSBC) Code related to the assessment of acceptability of consignments (see section 4 of the IMSBC Code).

The main objectives of the Guidelines are:

- to assist shippers in preparing procedures for sampling, testing and controlling moisture content as required by paragraph 4.3.3 of the IMSBC Code; and
- to assist competent authorities of ports of loading when approving and checking the implementation of such procedures in accordance with paragraph 4.3.3 of the IMSBC Code.

1 Introduction

1.1 The IMSBC Code establishes international provisions for the safe loading, trimming, carriage and discharge of solid bulk cargoes when transported by sea, ensuring compliance with the provisions of the SOLAS Convention and identifies the risks associated with such cargoes with the aim of taking measures to minimize and to control them.

1.2 One of the risks identified is the risk associated with liquefaction of certain cargoes which may contain sufficient moisture to become fluid under the stimulus of compaction and the vibration which occurs during a voyage. Such cargoes are identified as Group A cargoes in the IMSBC Code.

1.3 Liquefaction may occur when the moisture content of the cargo exceeds the Transportable Moisture Limit (TML). Therefore, except for specially constructed or fitted cargo ships as described in subsection 7.3.2 of the IMSBC Code, it is particularly important to ensure that the moisture content is less than the TML of the cargo and to control its moisture content until it is on board the ship.

1.4 For this purpose, it is required by the IMSBC Code to determine by a test the acceptability of consignments for safe shipment. Considering that the determination of the acceptability is fundamental to avoid liquefaction during transport, the shipper should establish procedures for sampling, testing and controlling moisture content. These procedures should be approved and their implementation checked by the competent authority of the port of loading.

1.5 Sections 2, 3 and 4 of these guidelines contain guidance to develop such procedures for sampling, testing and the control of moisture content respectively.

2 Development of sampling procedures

2.1 The shipper should establish a sampling procedure to ensure that test samples used to determine the acceptability of consignments for safe shipment are representative of the consignments to be transported. Methods of sampling may vary since the character of the cargo and the form in which it is available will affect the method to be used. It is, therefore, of the utmost importance to describe accurately the sampling procedures.

2.2 The procedures should take into account the appropriate provisions of subsections 4.4 to 4.7 of the IMSBC Code.

2.3 The procedure should, at least, include provisions:

- to identify the consignment to be sampled;
- to identify the material (type, particle size distribution, composition) and to ensure that the consignment corresponds to the description of the material;
- to identify the appropriate time, frequency and place to take samples;
- to describe the method of sampling, including:
 - the number of subsamples or increments which are required;
 - the quantity of material to be taken (subsample or increment size);
 - the location where the subsamples or increments have to be taken in the consignment;
 - the method of combining the subsamples or increments to arrive at a representative sample;
 - the method to ensure that the moisture content of the representative sample will not be subject to variation; and
 - the method to ensure the traceability of the subsamples or increments and of the representative samples;
- on the equipment used for sampling and procedures for its maintenance, when necessary;
- to identify persons responsible for sampling and the description of their training to fulfil their responsibilities; and
- to identify a technical supervisor responsible for the implementation of the sampling procedures and the description of its training commensurate with its role and responsibilities.

2.4 Records of the following activities addressed in the procedure for testing should be kept and made available to the competent authority of the port of loading upon request:

- training;
- internal review to ensure that the procedure is applied correctly;

- forms where the traceability of the subsample and representative sample is ensured;
- maintenance of equipment for sampling, when necessary; and
- any modification to the procedure for testing.

Records should be kept for a period of time established by the competent authority of the port of loading in the working language of the shipper. If the language or languages used are not English, French or Spanish, a translation into one of these languages should be included.

3 Development of testing procedures

3.1 The shipper should establish a test procedure to determine the acceptability of its consignments for safe shipment.

3.2 The procedure should, at least, include:

- the description of the test method for determining the moisture content.

Recognized international and national methods for determining moisture content for various materials are referred to in paragraph 1.1.4.4 of appendix 2 of the IMSBC Code;

- the description of the test method for determining the acceptability of consignments.

Recommended methods for determining transportable moisture limit (TML) are given in appendix 2 of the IMSBC Code. However, it is recognized that, in some instances and taking into account the scope of each of the methods, they may not be suitable for the cargo to be transported.

If the recommended methods are not suitable for the material in question, any alternative method for this material should be approved by the competent authority of the port of loading. When approving such method, the competent authority should make sure that this method gives reliable results data in order to characterize the risk of liquefaction of the cargo on board the ship. It should also be established that:

- the method can easily be carried out and is reproducible;
- the method gives compatible results at the ship level;
- the method is consistent with feedback;
- the method is capable of providing a safety margin with respect to the risk of liquefaction;
- the method and its related transportability criteria to ensure that the moisture content of the consignment is less than the TML;

- the protocol to implement the test method:

The protocol should be written in the working language of the persons responsible for testing. If the language or languages used is not English, French or Spanish, a translation into one of these languages should be included.

The protocol should also include a periodic internal control procedure to ensure that the protocol is applied correctly:

- an example of the form where the consignment has to be identified and where the results to the test have to be reported;
- the list of the equipment to conduct the tests, the procedure to ensure the accurate calibration and maintenance of the equipment and the location(s) where the test is conducted;
- the list of persons responsible for testing and the description of their training to fulfil their responsibilities; and
- the name of the technical supervisor designated to be responsible for the implementation of the test procedure and the description of its training commensurate with its role and responsibilities.

3.3 Records of the following activities addressed in the procedure for testing should be kept and made available to the competent authority of the port of loading upon request:

- training;
- internal review to ensure that the protocol is applied correctly;
- forms where the consignments and results are reported;
- maintenance, calibration and testing of any testing equipment; and
- any modification of the procedure for testing.

Records should be kept for a period of time established by the competent authority of the port of loading in the working language of the shipper. If the language or languages used are not English, French or Spanish, a translation into one of these languages should be included.

4 Development of procedures for controlling moisture content

4.1 The shipper should establish a procedure for controlling moisture content to ensure that the moisture content is less than the TML when it is on board the ship. Once the moisture content has been measured, it is important to ensure that the moisture content remains below the TML. This procedure should be based on an analysis of all factors that may influence the moisture content between the production/extraction area and the ship.

4.2 The procedure should, at least, include:

- a description of the geographic configuration of the production/extraction area;
- a description of the location of the stockpiling/storage area, when applicable;

- a description of the method(s) to transport the consignment from the production/extraction area to the stockpiling/storage area or to the ship and, when applicable, from the stockpiling area to the ship and a description of the precautions taken during these transport operations to control moisture content of the consignment (such as: use of closed vehicles, suspension of certain operations and conveyor belts sloped and covered during rainfall);
- a description of the stockpiling/storage method(s), when applicable and of the precautions taken during stockpiling/storage (such as configuration of the pile to allow rain to run off) to control moisture content of the consignment;
- a description of the method(s) to load the cargo from shore to ship and precautions to protect the cargo from precipitation and water ingress (see paragraph 4.3.4 when loaded from barges);
- a description of the sampling operations between the production/extraction area and the ship to measure and report moisture content at different stages before being on board the ship (such as during stockpiling, conveyor transport, loading);
- a description of the conditions when the cargo is not authorized to be loaded and when the loading should be suspended on board the ship (moisture content greater than the TML, weather conditions);
- a description of the periodic internal control procedures to ensure that the procedure for controlling moisture content is applied; and
- a description of the human and material resources and of the awareness and training activities of the personnel involved to implement the procedure.

4.3 Records of the following activities addressed in the procedure for controlling moisture content should be kept and made available to the competent authority of the port of loading upon request:

- training;
- internal review to ensure that the procedure for controlling moisture content is applied correctly;
- weather conditions during which the procedure is applied; and
- any modification of the procedure for testing.

Records should be kept for a period of time established by the competent authority of the port of loading in the working language of the shipper. If the language or languages used are not English, French or Spanish, a translation into one of these languages should be included.

5 Approval of the procedures by the competent authority

5.1 According to paragraph 4.3.3 of the IMSBC Code, the procedures for sampling, testing and controlling moisture content should be approved and their implementation checked by the competent authority of the port of loading.

5.2 Before any transport of Group A cargoes, the shipper should establish the required procedures as described in sections 2 to 4 of these guidelines and should provide them well in advance to the competent authority of the port of loading for approval.

5.3 As defined in section 1.7 of the IMSBC Code, the competent authority means any national regulatory body or authority designated or otherwise recognized as such for any purpose in connection with the IMSBC Code. Contracting Governments are invited to inform the organization of the name and address of competent authorities in their country authorized to approve the procedures for dissemination through the GISIS database.

5.4 The procedures are subject to:

- .1 an initial verification by the competent authority of the port of loading before the document required in paragraph 4.3.3 of the IMSBC Code is issued. This verification should ensure that the procedures comply with the provisions of the IMSBC Code and of these guidelines, the personnel involved have received appropriate training and the required equipment is available and in conformity with the description in the procedures;
- .2 a renewal verification at intervals specified by the competent authority of the port of loading, but not exceeding five years. This verification should ensure that the approved procedures still comply with the applicable provisions of the IMSBC Code in force at the time of the renewal verification and are implemented by the shipper; and
- .3 at least one intermediate verification. If only one intermediate verification is carried out, it should take place before the first anniversary date of the document required in paragraph 4.3.3 of the IMSBC Code. The intermediate verification should ensure that the procedures are implemented by the shipper.

5.5 The competent authority of the port of loading should determine which changes to approved procedures should not be implemented unless the relevant changes are approved.

5.6 A document should be issued after the initial and renewal verification in accordance with the provisions of paragraph 4.3.3 of the IMSBC Code by the competent authority of the port of loading. It should be issued for a period specified by the competent authority of the port of loading, which should not exceed five years.

5.7 The document should clearly identify the procedures involved and should include a statement to the effect that the competent authority has approved the procedures. It should be drawn up in a form corresponding to the model given in the appendix to these guidelines.

5.8 A copy of the document should be provided to the master or his representative in accordance with paragraph 4.3.3 of the IMSBC Code.

* * *

Appendix

(Identification of the competent authority)

(State)

Approval Number:

Approval issued under the provisions of paragraph 4.3.3 of the
International Maritime Solid Bulk Cargoes (IMSBC) Code

Name and address of the shipper:

Port of loading:

Bulk cargo shipping name:

Reference of the procedure for sampling:

Reference of the procedure for testing:

Reference of the procedure for controlling moisture content:

Date of initial/renewal verification on which this approval is based:

This is to approve the procedures mentioned above and that they have been verified in accordance with MSC.1/Circ.1454 on Guidelines for developing and approving procedures for sampling, testing and controlling the moisture content for solid bulk cargoes which may liquefy

Specific remarks:

This approval is valid until subject to verifications in accordance with MSC.1/Circ.1454 on Guidelines for developing and approving procedures for sampling, testing and controlling the moisture content for solid bulk cargoes which may liquefy

Issued at:

Date of issue:

(Signature of the competent authority issuing the approval)



Maritime &
Coastguard
Agency

MARINE GUIDANCE NOTE

MGN 514 (M)

SOLID BULK CARGOES - Early implementation of draft amendments 03-15 to the International Maritime Solid Bulk Cargoes (IMSBC) Code related to the carriage and testing of Iron Ore Fines - DSC.1/Circ.71

Notice to all ship owners, ship operators, terminal operators, port authorities, classification societies, agents, charterers, shippers, consignors, masters and all other parties involved in the transport of solid bulk cargoes by sea.

Summary

Liquefaction of mineral ores, including iron ore fines, may result in cargo shift and loss of stability and this has been the cause of a number of serious casualties in recent years. Iron ore fines are particularly prone to liquefaction and the Master should refer to section 7 of the International Maritime Solid Bulk Cargoes (IMSBC) Code, which warns about cargoes that may liquefy.

The purpose of this Marine Guidance Note is to advise industry of the draft individual schedule for IRON ORE FINES and the draft revised individual schedule for IRON ORE and the draft new test procedure for determining the Transportable Moisture Limit (TML) of iron ore fines contained in the DSC.1/Circular.71

In considering the above, users of the IMSBC Code are advised to implement the draft schedules and test procedures as soon as possible.

1. Introduction

- 1.1 Liquefaction of mineral ores, resulting in cargo shift and loss of stability, has been a major cause of marine casualties for many decades. Recent incidents, which appear to have lead to several total losses, have primarily involved the carriage of unprocessed natural ores such as iron ore fines. Associated with some of these casualties and near misses has been poor compliance with the testing and certification requirements that are designed to ensure that cargoes are loaded only if the moisture content is sufficiently low to avoid liquefaction occurring during the voyage.



2. New draft schedule for Iron Ore Fines, revised schedule for Iron Ore and new test procedure for determining the TML of Iron Ore Fines

- 2.1 In light of these incidents, the International Maritime Organization (IMO) has prepared a new draft schedule for Iron Ore Fines, a draft amendment to the individual schedule for Iron Ore and a draft amendment to appendix 2 to the IMSBC Code for the inclusion of "Modified Proctor/Fagerberg test procedure for iron ore fines.
- 2.2 A new schedule for Iron Ore Fines was adopted and as a consequence of this the existing schedule for Iron Ore should be amended.
- 2.3 The new schedule for Iron Ore Fines, a Group A Cargo, is valid for iron ore cargoes containing both 10% or more of fine particles less than 1 mm in diameter and 50% or more of particles less than 10 mm in diameter. The content of goethite shall be less than 35%.
- 2.4 The existing schedule for Iron Ore, a Group C Cargo, is amended to be valid for iron ore cargoes containing either less than 10% of fine particles less than 1 mm in diameter, or less than 50% of fine particles less than 10 mm in diameter, or both, or iron ore fines containing 35% or more goethite.
- 2.5 The shipper is required to provide to the master well in advance the declaration of the goethite content of the cargo as part of the cargo information.
- 2.6 Appendix 2 in the IMSBC Code should be amended to include the Modified Proctor/Fagerberg Test Procedure for Iron Ore Fines.
- 2.7 Taking into account that the mandatory entry into force date of these amendments would be 1 January 2017, operators are strongly advised, in light of these recent incidents on vessels carrying cargo which may liquefy, to implement the relevant sections of amendment 03-15, as described in the DSC.1/Circular.71, as soon as possible.

DSC.1/Circ.71 is attached which sets out the full details.



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DSC.1/Circ.71
15 November 2013
Original: ENGLISH

**EARLY IMPLEMENTATION OF DRAFT AMENDMENTS TO THE IMSBC CODE
RELATED TO THE CARRIAGE AND TESTING OF IRON ORE FINES**

1 The Maritime Safety Committee, at its ninety-first session (26 to 30 November 2012), noted that the Sub-Committee on Dangerous Goods, Solid Cargoes and Containers (DSC), at its seventeenth session (17 to 21 September 2011), had decided not to finalize a draft schedule for iron ore fines in order to await the outcome of related research, with a view to finalizing the draft schedule(s) and appropriate test methods at DSC 18; and had issued DSC.1/Circ.66/Rev.1 on Carriage of iron ore fines that may liquefy so that it would continue to be applied until the finalization of the schedule(s).

2 In this regard, the Maritime Safety Committee, at its ninety-first session, authorized DSC 18 to issue a DSC circular on early implementation of the draft schedule(s) for iron ore fines, after the Sub-Committee finalizes the draft schedule(s).

3 As instructed, DSC 18 (16 to 20 September 2013) prepared a draft individual schedule for IRON ORE FINES, a draft amendment to the individual schedule for IRON ORE and a draft amendment to appendix 2 to the IMSBC Code for the inclusion of "Modified Proctor/Fagerberg test procedure for iron ore fines", which are expected to be adopted as part of amendment 03-15 to the IMSBC Code by the Maritime Safety Committee, at its ninety-fifth session, in 2015. Therefore, taking into account that the mandatory entry into force date of these amendments would be 1 January 2017, DSC 18 agreed to invite SOLAS Contracting Governments to voluntarily implement the aforementioned draft schedules and test procedure as soon as possible.

4 The draft individual schedule for IRON ORE FINES and the draft revised individual schedule for IRON ORE are set out in annexes 1 and 2 to this circular. The draft new test procedure for determining TML of iron ore fines is set out in annex 3 to this circular.

5 Member Governments are invited to bring this circular to the attention of all concerned.

6 This circular supersedes DSC.1/Circ.66/Rev.1.



ANNEX 1

DRAFT INDIVIDUAL SCHEDULE FOR IRON ORE FINES

IRON ORE FINES

The provisions of this schedule shall apply to iron ore cargoes containing both:

- .1 10% or more of fine particles less than 1 mm ($D_{10} \leq 1$ mm); and
- .2 50% or more of particles less than 10 mm ($D_{50} \leq 10$ mm).

Notwithstanding the above provision, iron ore fines where the total goethite content is 35% or more by mass may be carried in accordance with the individual schedule for "IRON ORE", provided the master receives from the shipper a declaration of the goethite content of the cargo which has been determined according to internationally or nationally accepted standard procedures.

Description

Iron ore fines vary in colour from dark grey, rusty red to yellow and contain hematite, goethite and magnetite with varying iron content.

IRON CONCENTRATE is a different cargo (See individual schedule for "Mineral Concentrates")

Characteristics

Angle of repose	Bulk density (kg/m ³)	Stowage factor (m ³ /t)
Not applicable	1,500 to 3,500	0.29 to 0.67
Size	Class	Group
10% or more of fine particles less than 1 mm and 50% or more of particles less than 10 mm	Not applicable	A

Hazard

This cargo may liquefy if shipped at moisture content in excess of its transportable moisture limit (TML). See section 7 of this Code.

This cargo may affect magnetic compasses.

This cargo is non-combustible or has a low fire risk.

Stowage and segregation

No special requirements

Hold cleanliness

No special requirements

Weather precautions

When a cargo is carried in a ship other than a specially constructed or fitted cargo ship complying with the requirements in subsection 7.3.2 of this Code, during loading and unloading operations, the following provisions shall be complied with:

- .1 the moisture content of the cargo shall be kept less than its TML during loading operations and the voyage;
- .2 unless expressly provided otherwise in this individual schedule, the cargo shall not be handled during precipitation;
- .3 unless expressly provided otherwise in this individual schedule, during handling of the cargo, all non-working hatches of the cargo spaces into which the cargo is loaded or to be loaded shall be closed;
- .4 the cargo may be handled during precipitation under the conditions stated in the procedures required in subsection 4.3.3 of this Code; and
- .5 the cargo in a cargo space may be discharged during precipitation provided that the total amount of the cargo in the cargo space is to be discharged in the port.

Loading

Trim in accordance with the relevant provisions required under sections 4 and 5 of the Code. As the density of the cargo is high, due consideration shall be given to ensure that tanktop is not overstressed during voyage and during loading by a pile of the cargo.

Precautions

Loading rates of this cargo are normally very high. Due consideration shall be given to the ballasting operation in developing the loading plan required by SOLAS regulation VI/7.3. Bilge wells shall be clean, dry and protected as appropriate to prevent ingress of the cargo.

Ventilation

No special requirements

Carriage

Cargo hold bilges shall be sounded at regular intervals and pumped out, as necessary. The appearance of the surface of this cargo shall be checked regularly during voyage, as far as practicable. If free water above the cargo or fluid state of the cargo is observed during voyage, the master shall take appropriate actions to prevent cargo shifting and potential capsize of the ship, and give consideration to seeking emergency entry into a place of refuge.

Discharge

No special requirements

Clean-up

No special requirements

ANNEX 2

DRAFT REVISED INDIVIDUAL SCHEDULE FOR IRON ORE

IRON ORE

The provisions of this schedule shall apply to iron ore cargoes:

- .1 containing either:
 - .1 less than 10% of fine particles less than 1 mm ($D_{10} > 1$ mm); or
 - .2 less than 50% of particles less than 10 mm ($D_{50} > 10$ mm); or
 - .3 both; or
- .2 iron ore fines where the total goethite content is 35% or more by mass, provided the master receives from the shipper a declaration of the goethite content of the cargo which has been determined according to internationally or nationally accepted standard procedures.

Description

Iron ore varies in colour from dark grey to rusty red. It varies in iron content from haematite, (high grade ore) to ironstone of the lower commercial ranges. Mineral Concentrates are different cargoes (see IRON CONCENTRATE).

Characteristics

Angle of repose	Bulk density (kg/m ³)	Stowage factor (m ³ /t)
Not applicable	1,250 to 3,500	0.29 to 0.80
Size	Class	Group
Up to 250 mm	Not applicable	C

Hazard

No special hazards.

This cargo is non-combustible or has a low fire risk.

Iron ore cargoes may affect magnetic compasses.

Stowage and segregation

No special requirements.

Hold cleanliness

No special requirements.

Weather precautions

No special requirement.

Loading

Trim in accordance with the relevant provisions required under sections 4 and 5 of the Code. As the density of the cargo is extremely high, the tanktop may be overstressed unless the cargo is evenly spread across the tanktop to equalize the weight distribution. Due consideration shall be paid to ensure that tanktop is not overstressed during voyage and during loading by a pile of the cargo.

Precautions

Loading rates of this cargo are normally very high. Due consideration shall be given to the ballasting operation to develop the loading plan required by SOLAS regulation VI/7.3. Bilge wells shall be clean, dry and protected as appropriate to prevent ingress of the cargo.

Ventilation

No special requirements.

Carriage

No special requirements.

Discharge

No special requirements.

Clean-up

No special requirements.

ANNEX 3

DRAFT NEW TEST PROCEDURE FOR DETERMINING TML OF IRON ORE FINES

Appendix 2

*Laboratory test procedures,
associated apparatus and standards*

1 Test procedures for materials which may liquefy and associated apparatus

"1.4 Modified Proctor/Fagerberg test procedure for Iron Ore Fines

1.4.1 Scope

- .1 The test procedure specified in this section (this test) should only be used for determining transportable moisture limit (TML) of Iron Ore Fines. See individual schedule for Iron Ore Fines.
- .2 Iron Ore Fines is iron ore containing both:
 - .1 10% or more of fine particles less than 1 mm, and
 - .2 50% or more of particles less than 10 mm.
 - .3 The TML of Iron Ore Fines is taken as equal to the critical moisture content at 80% degree of saturation according to the modified Proctor/Fagerberg method test.
 - .4 The test procedure is applicable when the degree of saturation corresponding to Optimum Moisture Content (OMC) is 90% or higher.

1.4.2 Modified Proctor/Fagerberg test equipment

- .1 The Proctor apparatus (see figure 1.4.1) consists of a cylindrical iron mould with a removable extension piece (the compaction cylinder) and a compaction tool guided by a pipe open at its lower end (the compaction hammer).
- .2 Scales and weights (see 3.2) and suitable sample containers.
- .3 A drying oven with a controlled temperature interval from 100°C to maximum 105°C.
- .4 A container for hand mixing. Care should be taken to ensure that the mixing process does not reduce the particle size by breakage or increase the particle size by agglomeration or consistency of the test material.
- .5 A gas or water pycnometry equipment to determine the density of the solid material as per a recognized standard (e.g. ASTM D5550, AS1289, etc.)

1.4.3 Temperature and humidity (see 1.1.3)

1.4.4 Procedure

.1 Establishment of a complete compaction curve

A representative sample according to a relevant standard (see section 4.7 of the IMSBC Code) of the test material is partially dried at a temperature of approximately 60°C or less to reduce the samples moisture to suitable starting moisture, if needed. The representative sample for this test should not be fully dried, except in case of moisture content measurement.

The total quantity of the test material should be at least three times as big as required for the complete test sequence. Compaction tests are executed for five to ten different moisture contents (five to ten separate tests). The samples are adjusted in order that partially dry to almost saturated samples are obtained. The required quantity per compaction test is about 2,000 cm³.

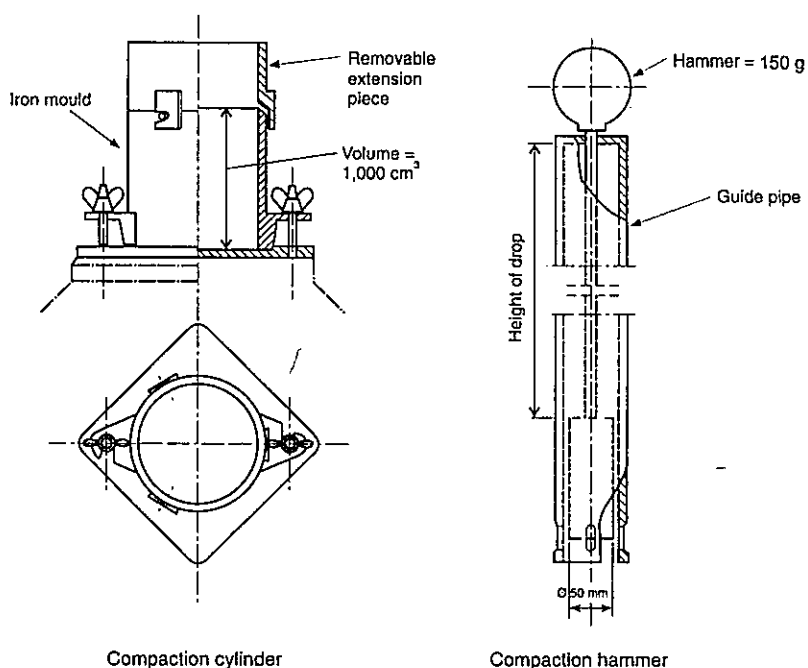


Figure 1.4.1

At each compaction test a suitable amount of water is added to the sample of the test material. The sample material is gently mixed before being allowed to rest and equilibrate. Approximately one fifth of the mixed sample is filled into the mould and levelled and then the increment is tamped uniformly over the surface of the increment. Tamping is executed by dropping a 150 g hammer 25 times through the guide pipe, 0.15 m each time. The performance is repeated for all five layers. When the last layer has been tamped, the extension piece is removed and the sample is levelled off along the brim of the mould with care, ensuring to

remove any large particles that may hinder levelling of the sample, replacing them with material contained in the extension piece and re-levelling.

When the weight of the cylinder with the tamped sample has been determined, the cylinder is emptied, the sample is dried at 105°C and the weight is determined. Reference is made to ISO 3087:2011 "Iron ores -- Determination of the moisture content of a lot". The test then is repeated for the other samples with different moisture contents.

Density of solid material should be measured using a gas or water pycnometry equipment according to internationally or nationally accepted standard, e.g. ASTM D5550 and AS 1289 (see subsection 1.4.2.5).

.2 Definitions and data for calculations (see figure 1.4.2)

- empty cylinder, mass in grams: A
 - cylinder with tamped sample, mass in grams: B
 - wet sample, mass in grams: C
- $$C = B - A$$
- dry sample, mass in grams: D
 - water, mass in grams (equivalent to volume in cm³): E

$$E = C - D$$

Volume of cylinder: 1000 cm³

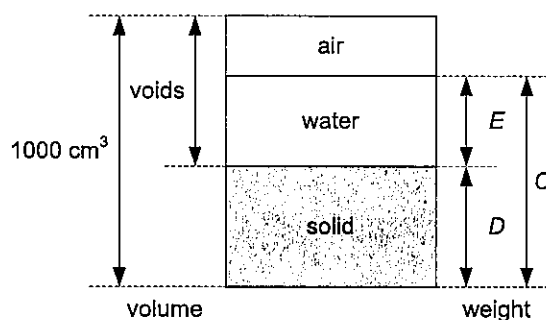


Figure 1.4.2

.3 Calculation of main characteristics

- density of solid material, g/cm³ (t/m³): d
- dry bulk density, g/cm³ (t/m³): γ

$$\gamma = \frac{D}{1000}$$

- net water content, volume %: e_v

$$e_v = \frac{E}{D} \times 100 \times d$$

- void ratio: e (volume of voids divided by volume of solids)

$$e = \frac{d}{\gamma} - 1$$

- degree of saturation, percentage by volume: S

$$S = \frac{e_v}{e}$$

- gross water content, percentage by mass: W^1

$$W^1 = \frac{E}{C} \times 100$$

- net water content, percentage by mass: W

$$W = \frac{E}{D} \times 100$$

.4 Presentation of the compaction tests

For each compaction test the calculated void ratio (e) value is plotted as the ordinate in a diagram with net water content (e_v) and degree of saturation (S) as the respective abscissa parameters.

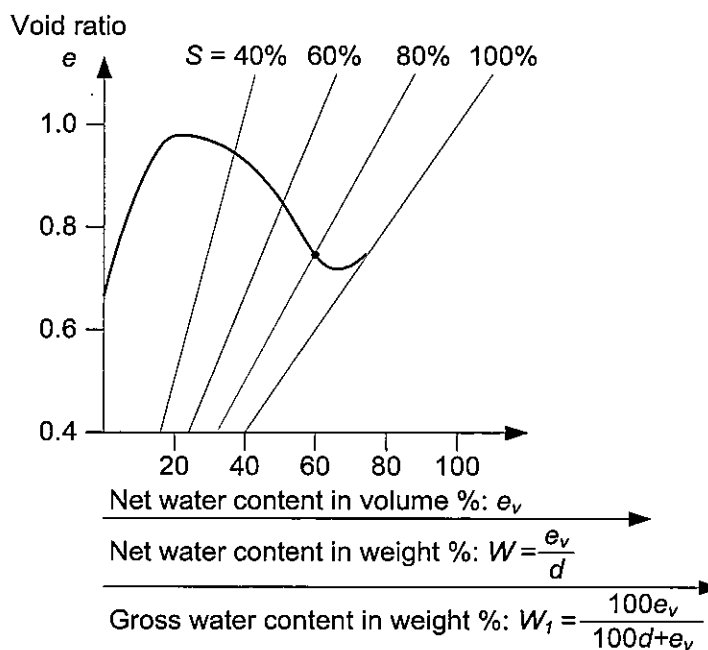


Figure 1.4.3

.5 Compaction curve

The test sequence results in a specific compaction curve (see figure 1.4.3).

The critical moisture content is indicated by the intersection of the compaction curve and the line $S = 80\%$ degree of saturation. The transportable moisture limit (TML) is the critical moisture content.

Optimum Moisture Content (OMC) is the moisture content corresponding to the maximum compaction (maximum dry density) under the specified compaction condition. To check the applicability of this test, the relationship between moisture content and dry density should be evaluated, during this test. Then the OMC and the corresponding degree of saturation should be determined. This test procedure was developed based on the finding that the degree of saturation corresponding to OMC of iron ore fines was 90 to 95%, while such degree of saturation of mineral concentrates was 70 to 75%. In the case that the degree of saturation corresponding to OMC is less than 90%, the shipper should consult with an appropriate authority, for the reason that this test may not be applicable for the material and the TML determined by this test may be too high."
