WORLD COAL ASSOCIATION

Coal Classification

Industry approach to hazard classification under the revised MARPOL Convention and the IMSBC Code

REPORT 1. NEW COMPLIANCE REQUIREMENTS OF THE MARPOL CONVENTION AND THE IMSBC CODE

World Coal Association

The World Coal Association (WCA) is a global industry association formed of major international coal producers and stakeholders. The WCA works to demonstrate and gain acceptance for the fundamental role coal plays in achieving a sustainable and lower carbon energy future.

Membership is open to companies and not-for-profit organisations with a stake in the future of coal from anywhere in the world, with member companies represented at Chief Executive level.

The publication "Coal Classification - Industry approach to hazard classification under the revised MARPOL Convention and the IMSBC Code" was written by ARCHE, a Belgium-based consultancy specialising in environmental toxicology, under the oversight of the WCA Technical Working Group on Coal Classification and chaired by Dr. Sue Hubbard, Principal Adviser, HSEC Product Regulation & Information Support at Rio Tinto.

ARCHE

ARCHE is a Belgium-based consultancy founded in 2009 by experts with more than 15 years of experience in the field of environmental toxicology, exposure modelling and the preparation of risk assessment dossiers. The company is also recognised as a spin-off of Ghent University.

The experts working at ARCHE have built up in-depth knowledge on the preparation of Chemical Safety Assessments in the framework of the REACH regulation and chemical risk assessments under the predecessor of the REACH regulations (EU regulation 67/1488 on new and existing substances).

One of the key areas of expertise is the preparation of risk assessments for inorganic substances such as metals, alloys, slags etc. ARCHE experts have been involved in the preparation of many guidance documents on these topics - for example Metal Risk Assessment Guidance (MERAG) and a widely used tool for metals classification - MECLAS. The scientific services of ARCHE have also been frequently consulted in the framework of the risk assessment of flame retardants and other organic chemicals.

Any queries related to the publications which are part of this package should be addressed to the WCA Team at classification@worldcoal.org

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Coal Classification – Industry Approach to Hazard Classification under the Revised MARPOL Convention and the IMSBC

Report 1. New Compliance Requirements of the MARPOL Convention and the IMSBC Code

BACKGROUND

This report forms part of a package of reports - "Coal Classification - Industry approach to hazard classification under the revised MARPOL Convention and the IMSBC Code".

The aim of this publication is to help coal producers comply with the new coal classification requirements introduced by the International Maritime Organisation (IMO) under the International Convention for the Prevention of Pollution from Ships (MARPOL) and the International Maritime Solid Bulk Cargoes Code (IMSBC).

The other two reports appearing in this series are:

- Report 2: Analysis of Coal Composition, Ecotoxicity and Human Health Hazards
- Report 3: Coal Classification Guidance

The reports were written by ARCHE, a specialist environmental toxicology consultancy, under the oversight of the World Coal Association Technical Working Group on Coal Classification, chaired by Dr. Sue Hubbard, Principal Adviser, HSEC Product Regulation & Information Support at Rio Tinto.

This publication is available free of charge for all WCA Members.

WORLD COAL ASSOCIATION

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1. INTRODUCTION

Over the past two years, there have been several activities taking place within the International Maritime Organization (IMO) to develop a more systematic consideration of hazard assessment for solid bulk cargoes in the context of existing maritime transport codes.

There are two relevant regulations that suppliers/shippers of solid bulk materials need to comply with:

- International Convention for the Prevention of Pollution from Ships (MARPOL), which has the objective of preventing pollution of the marine environment.
- International Maritime Solid Bulk Cargoes (IMSBC) Code, which has the objective of ensuring safe transport of solid bulk cargoes.

Under MARPOL Annex V on the Prevention of Pollution by Garbage from Ships, the IMO introduced new classification criteria to enable identification of substances harmful to the marine environment (HME). Since 1 January 2013, shippers are responsible for assessing and declaring whether cargoes are harmful to the marine environment using specific environmental classification criteria. In addition, specific health criteria must be assessed by 1 January 2015.

As a result of the above changes, the discharge of residues of certain cargoes into the sea will no longer be allowed when the cargo is classified as a substance harmful to the marine environment. For such cargoes the dry residues and/or the wash water that contains residues from an HME must be discharged at adequate port reception facilities.

Under the IMSBC Code, the IMO also introduced new classification criteria to identify materials hazardous only in bulk (MHB). The new criteria used to define HME under MARPOL Annex V and MHB under the IMSBC Code are taken from the UN Globally Harmonized System of Classification and Labelling (GHS). Further to requirements impacting on the shipping of bulk cargoes, the UN GHS is progressively being adopted by countries where it is replacing existing classification systems.

It was recommended by the International Council on Metals and Mining (ICMM) that all shippers, including shippers of coal, should assess whether their cargoes meet any of the new criteria and, if

necessary, update the shipping documents specifying the identified hazards. Given the above regulatory developments and the recommendation that all cargoes should be assessed according to the new criteria, the World Coal Association (WCA) was tasked with assisting its members in complying with the new IMO rules by providing the following three deliverables:

- summary of compliance requirements of MARPOL and the IMSBC Code with respect to coal cargoes
- comprehensive review of the chemical properties of coal, including the identification of organic and inorganic compounds in coal, elements, minerals, as well as physical properties of relevance to GHS classification criteria
- guidance for coal producers for achieving compliance under MARPOL and IMSBC Code.

The deliverables are produced by ARCHE, a consultancy specializing in environmental toxicology.

Approach

A data inquiry document was distributed among the members of the WCA requesting available information in the following areas:

- Chemical composition of different types of coal (brown coal, (sub-)bituminous coal, anthracite, etc.), their geographic origins and percentages of the different constituents. It was specified that the physical-chemical characterization of different coals should be as detailed as possible.
- Information on the solubility of specific elements/compounds (Transformation/Dissolution Protocol (T/DP) test data for metals, Water Accommodated Fraction (WAF) of organic compounds). It was noted that the above data were only useful when provided in conjunction with the composition of the coals used in these solubility experiments.
- Results of ecotoxicological experiments with coal samples. Ideally, the observed (no-) effects can be related to the known composition of the coal sample that was used in these experiments. Where coal samples are used in water-only exposures (i.e. acute tests with fish, algae, invertebrates), chemical analysis of the testing media can provide useful information to link observed effects with concentration levels of specific compounds.

- Available publications (industry papers, publications in the public domain) on the following topics:
    - composition of coal, properties of coal
    - solubility and (bio-)availability of coal and coal compounds
    - mammalian toxicity data for coal
    - ecotoxicology of coal to aquatic organisms.

Literature in the public domain was identified through the Web of Science database. This database provides web-based access to an extensive collection of ISI citation databases. The Science Citation Index, covering several thousands of journals, provides complete bibliographic data plus citations to worldwide literature across a wide range of scientific and technological disciplines.

2. REGULATORY COMPLIANCE REQUIREMENTS WITH RESPECT TO MARITIME TRANSPORT OF SOLID BULK CARGOES

This section covers recent changes introduced under MARPOL Annex V and the IMSBC Code, as well as the GHS criteria for a cargo to be classified as HME (MARPOL) or MHB (IMSBC Code).

2.1. THE GLOBALLY HARMONIZED SYSTEM OF CLASSIFICATION AND LABELLING OF CHEMICALS (GHS)

The UN Globally Harmonized System of Classification and Labelling of Chemicals (GHS) is a United Nations system to identify hazardous chemicals and to inform users about these hazards[1] through standard symbols and phrases on the packaging labels and through safety data sheets (SDS).

The hazard assessment of a substance (or mixture of substances) entails the determination of predefined adverse effects levels (e.g. concentration that causes 50% effect) for a set of environmental and human health end points. Although the UN GHS is not legally binding, it has already been translated into country-specific legislation in the European Union, (CLP Regulation: classification, labelling and packaging of substances), Australia, Brazil, Japan, China, Korea, Canada and the United States.[2]

[1] It should be noted that the terms 'hazard' and 'risk' are often used interchangeably in chemical assessments, but are inherently different. The hazard of a chemical or substance represents the potential of a substance/mixture to the environment or human health. The risk assessment, on the other hand, evaluates the likelihood that a person or the environment may be harmed or otherwise adversely affected when exposed to a hazardous substance. In summary, it can be stated that the hazard assessment focuses on the toxicological and ecotoxicological properties of a substance, whereas the risk assessment derives safe concentration levels that cause no significant adverse effects to man and environment.

[2] www.unece.org/trans/danger/publi/ghs/implementation_e.html

The end points of the hazard classification in the UN GHS are summarized below:

- physical hazards: explosives, flammable gases/aerosols/liquid/solids, oxidizing gases/liquids/solids, gases under pressure, self-reactive substances, pyrophoric liquids/solids, self-heating substances, substances that on contact with water emit flammable gases, organic peroxides, substances corrosive to metal
- health hazards: acute toxicity (oral, dermal, inhalation), skin corrosion/irritation, serious eye damage, eye irritation, respiratory sensitizer, germ cell mutagenicity, carcinogenicity, reproductive toxicity, specific target organ toxicity (STOT), aspiration hazard
- environmental hazards: acute aquatic toxicity, chronic aquatic toxicity.

A substance can be classified for each of these end points, depending on the outcome of test data that were generated according to internationally accepted test standards (e.g. OECD test Guidance documents). For each end point there are one or more classification categories, and the severity of observed adverse effects will determine the category that is assigned to the substance for a given end point. For each of these end points there are also so-called mixture rules that allow the derivation of a classification for a mixture. This calculation method is based on the individual classifications of each ingredient of the mixture; there is therefore no need to conduct tests on the actual mixture.

It should be noted that there is no testing requirement under GHS: the environmental and human health hazard assessment does not require a prescribed set of testing nor does it require data to be available for all hazard classes: classification is based on all available reliable data, and where needed, expert judgment is needed in the absence of experimental evidence.

Recommended classification strategies for coal

For a complex material such as coal, there are several classification strategies that can be followed for assessing the different relevant end points:

- Based on experimental (eco-)toxicological data that are generated with coal.
- Based on the classification of a comparable coal sample (read-across, bridging principles).

- Calculation method based on the composition of the mixture; this method requires the percentage of each classified compound in coal (i.e. summation method). It should be noted that the summation method is only applicable for human health and environmental end points, and that the concentration limits of a classified substance in coal that will result in a classification for that mixture is end-point dependent. The summation method is not applicable when it comes to the assessment of physical-chemical properties. For coal, however, the majority of physical-chemical end points are not considered relevant. It should also be noted that the Group B (and the Group A) classification of coal under the IMSBC Code is already based on its physical-chemical properties, and therefore no further evaluation is considered relevant (see Annex).

2.2. REGULATIONS FOR MARINE TRANSPORT

This section covers the two following international marine legislations:

- International Maritime Solid Bulk Cargoes Code (IMSBC Code)
- International Convention for the Prevention of Pollution from Ships (MARPOL).

2.2.1. THE INTERNATIONAL MARITIME SOLID BULK CARGOES CODE (IMSBC CODE)

The primary aim of the IMSBC Code is to facilitate the safe stowage and shipment of solid bulk cargoes by providing information on the dangers associated with the shipment of certain types of solid bulk cargoes (e.g. structural damage due to improper cargo distribution, loss or reduction of stability during a voyage, chemical reactions of cargoes like spontaneous combustion, emission of toxic or explosive gases, corrosion, etc.), and instructions on the procedures to be adopted when the shipment of solid bulk cargoes is contemplated.

The IMSBC Code classifies solid cargoes into three categories:

- Group A – bulk materials that may liquefy
- Group B – bulk materials possessing chemical hazards

- Group C – bulk materials that are neither liable to liquefy nor possess chemical hazards.

The code addresses the hazards that are associated with the shipment of solid bulk cargoes. The so-called 'materials hazardous only in bulk' (MHB) are materials that possess chemical hazards when transported in bulk other than materials classified as packaged dangerous goods (i.e. the International Maritime Dangerous Goods (IMDG) Code). These materials present a significant risk when carried in bulk and require special precautions.

Coal and anthracite are already subject to a schedule under the IMSBC Code and are already shipped in Cargo B since they may create flammable atmospheres, may heat spontaneously, may deplete the oxygen concentration and may corrode metal structures.

A summary of the bulk cargo shipping requirements is given in the annex of this guidance document.

In 2013, amendments were introduced to the IMSBC Code with regard to the criteria that define a toxic substance. A substance should be classified as an MHB if the hazard assessment results in one (or more) of the following classifications:

- cargoes developing cargo dust with an acute inhalation toxicity (LC50) of 1-5 mg/l by 4 hours testing (GHS Acute Toxicity Dusts Category 4)
- cargoes developing cargo dust exhibiting an inhalation toxicity of equal to or less than 1 mg/litre/4h (GHS Specific Target Organ Toxicity Single Exposure Inhalation Dust Category 1) or below 0.02 mg/litre/6h/d (GHS Specific Target Organ Toxicity Repeated Dose Inhalation Dust Category 1)
- cargoes exhibiting an acute dermal toxicity (LD50) of 1000-2000 mg/kg (GHS Acute Toxicity Dermal Category 4)
- cargoes exhibiting a dermal toxicity of or below 1000 mg (GHS Specific Target Organ Toxicity Single Exposure Dermal Category 1) or below 20 mg/kg bw/d by 90 days testing (GHS Specific Target Organ Toxicity Repeated Dose Dermal Category 1)
- cargoes exhibiting carcinogenicity (GHS Category 1A and 1B), mutagenicity (GHS Category 1A and 1B) or reproductive toxicity (GHS Category 1A and 1B)
- cargoes that are corrosive to metals

- cargoes that are known to be a respiratory sensitizer (GHS Respiratory Sensitization Category 1)
- cargoes exhibiting skin irritation with a mean value of or higher than 2.3 for erythema/eschar or oedema (GHS Skin Corrosion/Irritation Category 2)
- cargoes exhibiting eye irritation with a mean value of or higher than 1 for corneal opacity/irititis or 2 for conjunctival redness/oedema (GHS Serious Eye Damage Category 1 or Eye Irritation Category 2A).

It should be noted that environmental classification end points, Acute Aquatic Toxicity, Category 1; or Chronic Aquatic Toxicity, Category 1 or 2 are currently a criteria under the IMSBC Code.

2.2.2. MARPOL ANNEX V

The International Convention for the Prevention of Pollution from Ships (MARPOL) is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. The MARPOL Convention was adopted in 1973, whereas the actual protocol was adopted in 1978 (and absorbed the original 1973 Convention); this combined instrument entered into force in October 1983, and has been updated by amendments through the years.

The main objective of MARPOL 73/78 was the preservation of the marine environment through the complete elimination of pollution by oil and other harmful substances and the minimization of accidental discharge of such substances. It was specifically designed to minimize pollution of marine waters, including dumping, oil and exhaust pollution. The protocol includes six technical annexes:

- Annex I: Regulations for the Prevention of Pollution by Oil (entered into force 2 October 1983)
- Annex II: Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk (entered into force 2 October 1983)
- Annex III: Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form (entered into force 1 July 1992)

- Annex IV: Prevention of Pollution by Sewage from Ships (entered into force 27 September 2003)
- Annex V: Prevention of Pollution by Garbage from Ships (entered into force 31 December 1988)
- Annex VI: Prevention of Air Pollution from Ships (entered into force 19 May 2005).

Amendments to MARPOL Annex V (1988) were adopted in July 2011, and came into force in January 2013. The newly adopted amendments to Annex V prohibit the discharge of all garbage into the sea unless explicitly permitted under the annex. Annex V now also includes provisions that prohibit any discharge of dry cargo residues or wash water containing residues that are classified as substances harmful to the marine environment. The new legislation obliges that HME-containing residues and wash waters will have to be discharged at adequate port reception facilities. Absence of adequate port reception facilities at the port of unloading (or next port of loading) could result in refusal of the shipment of such cargo by the shipmaster.

The identification of HME is based on a number of environmental and human health toxicity end points that were taken from the United Nations Globally Harmonized System of Classification and Labelling of Chemicals (UN GHS, 2011).

Criteria for identifying substances harmful to the marine environment

- Environmental classification end points that define a substance as HME:
    - Acute Aquatic Toxicity, Category 1; and/or
    - Chronic Aquatic Toxicity, Category 1 or 2; and/or
- Human health classification end points that define a substance as HME (applicable for oral and dermal hazards or without specification of the exposure route in the hazard statement. It is essential to note that the inhalation route for human health end points is not considered under MARPOL):
    - Carcinogenicity Category 1A/1B *and* high bioaccumulation *and* not rapidly degradable; and/or
    - Mutagenicity Category 1A/1B *and* high bioaccumulation *and* not rapidly degradable; and/or

- Reproductive Toxicity Category 1A/1B *and* high bioaccumulation *and* not rapidly degradable; and/or
- Specific Target Organ Toxicity – Repeated Exposure (STOT-RE) Category 1 *and* high bioaccumulation *and* not rapidly degradable.

- Solid bulk cargoes containing or consisting of synthetic polymers, rubbers, plastics or plastic feedstock pellets (including materials that are shredded, milled, chopped or macerated, or similar materials) are also considered as HME. Naturally occurring substances, however, do not fall under this type of product description.

2.2.3. SUMMARY OF RELEVANT END POINTS FOR ASSESSING COAL UNDER THE IMO REGULATION

Table 1 provides an overview of the different human health and environmental end points that currently have to be addressed under the different legislations: GHS/CLP, MARPOL, IMSBC Code.

Table 1 Overview of relevant hazard end points and classification categories in different legislations

	GHS	MARPOL	IMDG Code[3]	IMSBC Code
Human health				
Acute – oral	Cat.1,2,3,4		Class 6.1	Class 6.1
Acute – dermal	Cat.1,2,3,4		Class 6.1	Class 6.1 (2)
Acute – inhalation	Cat.1,2,3,4		Class 6.1	Class 6.1 (2)
Skin corrosion/irritation	Cat.1,2		Class 8	Class 8
Serious eye damage/irritation	Cat.1,2			Class 8, cfr GHS Cat.1, 2A
Respiratory or skin sensitization	Cat.1			Class 8, cfr GHS Cat.1
Germ cell mutagenicity	Cat.1(A&B),2	Cat.1A/1B (1)		Cat.1A/1B
Carcinogenicity	Cat.1(A&B),2	Cat.1A/1B (1)		Cat.1A/1B
Reproductive toxicity	Cat.1(A&B),2	Cat.1A/1B (1)		Cat.1A/1B
STOT – single exposure	Cat.1,2,3			Cat.1 (inhalation, dermal)

[3] Added to Table 1 for comparison purposes with MARPOL and IMSBC Code

STOT – repeated exposure	Cat.1,2	Cat.1 [1]		Cat.1 (inhalation, dermal)
Aspiration hazard	Cat.1			
Environment				
Aquatic acute	Cat.1,2,3	Cat.1	Class 9	Class 9
Aquatic chronic	Cat.1,2,3,4	Cat.1,2	Class 9	Class 9

[1] And high bioaccumulation and not rapidly degradable, and exposure via oral or dermal route.

[2] Revised classification criteria, in line with GHS Cat.4 – different from IMDG Code Class 6.1 criteria.

2.2.4. SPECIFIC CONSIDERATIONS FOR COAL

The classification of coal for the environment has to be conducted in a similar way for GHS, MARPOL, or IMSBC Code. It should be noted that the current hazard classification procedures for environmental-related end points are based on Ecotoxicity Reference Values (ERVs) that are derived from (predominantly) freshwater effects data. In general, both freshwater and marine species toxicity data are considered suitable for use in classification, provided the test methods used are equivalent. Currently, there is no standard methodology for the derivation of specific ERVs for the marine environment, and as long as there is no evidence for marine species being more sensitive than freshwater species, there is no need to generate marine data and/or ERVs for assessing environmental end points under IMO regulations.

For human health end points, MARPOL exclusively focuses on so-called long-term effects (carcinogenicity, mutagenicity and/or reproductive toxicity; specific target organ toxicity (STOT)) that are the result of either oral or dermal exposure; inhalation is not considered as a relevant exposure route for an HME.

In addition, classification of a material as HME based on human health end points is only relevant for substances that are highly bioaccumulative and not degradable (i.e. persistent). The concept of degradability, as it has been considered and used for organic substances, however, has limited or no meaning for inorganics/metals. These substances may be transformed by normal environmental processes to either increase or decrease the bioavailability and presence of the element in a specific environmental compartment. Equally, the octanol-water partition coefficient (log Kow), which gives an indication on the affinity of a substance to accumulate in biological tissue, cannot

be considered as a measure of the potential to accumulate. The uptake and elimination of many (essential) trace elements and metals is actively regulated, and therefore the bioaccumulation factor is not a constant value but depends on the exposure concentration and the biological need of the organism to take up specific elements/inorganics.

These concepts need to be taken into account when evaluating potential human health effects related to the presence of organics or inorganics in coal; classification of coal as HME is not required when there is sufficient evidence that the criteria for bioaccumulation or persistence are not met for critical compounds that could trigger a human health classification under MARPOL.

3. ANNEX: INFORMATION INCLUDED IN THE IMSBC CODE SCHEDULES FOR DIFFERENT COAL CARGOES

SCHEDULE FOR BROWN COAL BRIQUETTES

Description

Brown Coal (Lignite) Briquettes are manufactured by pressing dried brown coal particles into compressed blocks.

Characterization

ANGLE OF REPOSE	BULK DENSITY (kg/m^3)	STOWAGE FACTOR (m^3/t)
Not applicable	750	1.34
SIZE	**CLASS**	**GROUP**
Mainly up to 50 mm	Material Hazardous only in Bulk	B

Hazard

Briquettes are easily ignited, liable to spontaneous combustion and will deplete oxygen in cargo space.

Appendix information

1. This cargo is easily ignited, liable to heat spontaneously and deplete oxygen in the cargo space.
2. This cargo is subject to oxidation, leading to depletion of oxygen and an increase in carbon dioxide in the cargo space (see also section 3).
3. This cargo is liable to heat spontaneously and may ignite spontaneously in the cargo space. When spontaneous heating occurs, flammable and toxic gases, including carbon monoxide, may be produced. Carbon monoxide is an odourless gas, slightly lighter than air, and has flammable limits in air of 12% to 75% by volume. It is toxic by inhalation, with an affinity for blood haemoglobin over 200 times that of oxygen. The recommended Threshold Limit Value (TLV) for carbon monoxide exposure is 50 ppm.

Stowage and segregation

Appendix information

1. Boundaries of cargo spaces where these cargoes are carried shall be resistant to fire and liquids.

2. This cargo shall be "separated from" goods of classes 1 (Division 1.4), 2, 3, 4 and 5 in packaged form (see IMDG Code) and "separated from" solid bulk material of classes 4 and 5.1.
3. Stowage of goods of class 5.1 in packaged form or solid bulk materials of class 5.1 above or below this cargo shall be prohibited.
4. This cargo shall be "separated longitudinally by an intervening complete compartment or hold from" goods of class 1 other than Division 1.4.
5. This cargo shall not be stowed adjacent to sources of heat.

Hold cleanliness

Clean and dry as relevant to the hazards of the cargo. Previous cargo battens shall be removed from the cargo spaces.

Weather precautions

No special requirements.

Loading

Appendix information

1. Prior to loading, the shipper, or their appointed agent, shall provide in writing to the master, the characteristics of the cargo and the recommended safe handling procedures for loading and transport of the cargo. As a minimum, the cargo's contract specifications for moisture content, sulphur content and size shall be stated.
2. This cargo shall be stored for 7 days prior to loading. This substantially reduces the risk of spontaneous combustion in subsequent transport, storage and handling.
3. Before loading this cargo, the master shall ensure the following:
    - weather deck enclosures to the cargo space have been inspected to ensure their integrity. Such closures are closed and sealed;
    - all electrical cables and components situated in cargo spaces and adjacent spaces are free from defects. Such cables and electrical components are safe to be used in a flammable and/or dusty atmosphere or positively isolated
4. Smoking and the use of naked flames shall not be permitted in the cargo areas and adjacent spaces and appropriate warning notices shall be posted in conspicuous places. Burning, cutting, chipping, welding or other sources of ignition shall not be permitted in the vicinity of cargo spaces or in other adjacent spaces.
5. This cargo shall not be dropped more than one metre during loading to minimize the production of dust and fines.
6. Individual cargo spaces shall be loaded without interruption, where possible. Hot spots may develop in a cargo space that has been kept open for more than six days (or less in weather over 30°C).
7. Prior to departure, the master shall be satisfied that the surface of the material has been trimmed reasonably level to the boundaries of the cargo space to avoid the formation of gas pockets and to prevent air from permeating the body of the briquettes. Casing leading

into the cargo space shall be adequately sealed. The shipper shall ensure that the master receives the necessary cooperation from the loading terminal.

8. Individual cargo spaces shall be closed and sealed as soon as practicable after the cargo has been loaded into each cargo space.

Precautions

Appropriate precautions shall be taken to protect machinery and accommodation spaces from the dust of the cargo. Bilge wells of the cargo spaces shall be protected from ingress of the cargo. Due consideration shall be paid to protect equipment from the dust of the cargo. Persons, who may be exposed to the dust of the cargo, shall wear protective clothing, goggles or other equivalent dust eye-protection and dust filter masks, as necessary.

Appendix information

1. The ship shall be suitably fitted and carry on board appropriate instruments for measuring the following without requiring entry into the cargo space:
2. It is recommended that means be provided for monitoring the temperature of the cargo in the range of 0°C to 100°C to enable the measurement of temperature of the cargo during the voyage without requiring entry into the cargo space.

Ventilation

The cargo spaces carrying this cargo shall not be ventilated during voyage. Refer to the appendix to this schedule.

Carriage

Appendix information

1. As far as practicable, any gases which may be emitted from the cargo shall not be allowed to accumulate in adjacent enclosed spaces, such as store-rooms, carpenter's shop, passage ways, tunnels, etc. Such spaces shall be adequately ventilated and regularly monitored for methane, oxygen and carbon monoxide.
2. Under no circumstances, except in emergency, shall the hatches be opened or the cargo space be ventilated or entered during the voyage.
3. The atmosphere in the space above the cargo in each cargo space shall be regularly monitored for the concentrations of methane, oxygen and carbon monoxide.
4. The frequency of the monitoring shall be determined based upon the information provided by the shipper and the information obtained through the analysis of the atmosphere in the cargo space. The monitoring shall be conducted at least daily and as close as practical to the same time of day. The results of monitoring shall be recorded. The shipper may request more frequent monitoring, particularly if there is evidence of significant self-heating during the voyage.
5. The following issues shall be taken into account:
    - The oxygen level in the sealed cargo space will fall from an initial 21% over a period of days to stabilize at levels of the order of 6 to 15%. If the oxygen level does not fall below 20%, or rapidly increases after an initial fall, it is possible

that the cargo space is inadequately sealed and is at risk of spontaneous combustion.
    - Carbon monoxide levels will build up to concentrations which fluctuate in the 200 to 2000 parts per million (ppm) range in a safe, well sealed cargo space. A rapid increase of approximately 1000 ppm in carbon monoxide levels in this cargo over a 24-hour period is a possible indicator of spontaneous combustion, particularly if accompanied by an increase in methane levels.
    - The methane composition in briquette cargo is normally low, less than 5 ppm and does not constitute a hazard. However, a sudden and continuing rise in methane levels, to concentrations above 10 ppm, is an indicator of the occurrence of spontaneous combustion in the hold.
    - The temperature in this cargo in a well sealed cargo space normally remains at 5 to 10°C above sea water temperature, the increase being due to normal diurnal breathing of small quantities of air into the cargo space. Checking of the cargo space seals to minimize air leakage is essential. A rapid increase in temperature of approximately 20°C over 24 hours is evidence of spontaneous combustion.
6. Regular hold bilge testing shall be systematically carried out. If the pH monitoring indicates that a corrosion risk exists, the master shall ensure that all bilges are kept dry during the voyage in order to avoid possible accumulation of acids on tank tops and in the bilge system.
7. When the behaviour of the cargo during the voyage differs from that specified in the cargo information, the master shall report such differences to the shipper. Such reports will enable the shipper to maintain records on the behaviour of this cargo, so that the information being provided to the master can be reviewed in the light of the transport experience.
8. When the master is concerned that the cargo is showing any signs of self-heating or spontaneous combustion, such as an increase in the concentration of methane or carbon monoxide or an increase in temperature, as described above, the following actions shall be taken:
    - Consult with the ship's agent at the loading port. The Company's designated person ashore shall be advised immediately.
    - Check the seal of the cargo space and re-seal the cargo space, as necessary.
    - Do not enter the cargo space and do not open the hatches, unless the master considers access is necessary for the safety of the ship or safety of life. When any ship's personnel has entered into a cargo space, re-seal the cargo space immediately after the personnel vacate the cargo space. Increase the frequency of monitoring the gas composition, and temperature when practicable, of the cargo.
    - Send the following information, as soon as possible, to the ship's owner or agent at the loading port to obtain expert advice:
        1. the number of cargo spaces involved;
        2. monitoring results of the carbon monoxide, methane and oxygen concentrations;
        3. if available, temperature of the cargo, location and method used to obtain results;
        4. the time the gas analyses were taken (monitoring routine);

5. the quantity of the cargo in the cargo space(s) involved;
6. the description of the cargo as per the shipper's declaration, and any special precautions indicated on the declaration;
7. the date of loading, and Estimated Time of Arrival (ETA) at the intended discharge port (which shall be specified); and
8. any other comments or observations the master may consider relevant.

Discharge

Appendix information

Prior to, and during, discharge:

1. The cargo space shall be kept closed until just before the commencement of discharge of that space. The cargo may be sprayed with a fine water spray to reduce dust.
2. Personnel shall not enter the cargo space without having tested the atmosphere above the cargo. The personnel entering into a cargo space in which the atmosphere contains oxygen levels below 21% shall wear self-contained breathing apparatus. Carbon dioxide and carbon monoxide gas levels shall also be tested prior to entry into the cargo spaces. The recommended Threshold Limit Value (TLV) for carbon monoxide is 50 ppm.
3. During discharge, attention shall be paid to the cargo for signs of hot spots (i.e., steaming). If a hot spot is detected, the area shall be sprayed with fine water spray and the hot spot shall be removed immediately to prevent spreading. The hot spot cargo shall be spread out on the wharf away from the remainder of the cargo.
4. Prior to suspending the discharge of this cargo for more than eight hours, the hatch covers and all other ventilation for the cargo space shall be closed.

Clean-up

After discharge of this cargo, the bilge wells and the scuppers of the cargo spaces shall be checked and any blockage in the bilge wells and the scuppers shall be removed.

Emergency procedures (*Metal Sulphide Concentrates)*

- ***Special emergency equipment to be carried:*** Nil
- ***Emergency procedures:*** Nil
- ***Emergency action in the event of fire***: Batten down. Exclusion of air may be sufficient to control fire. Do not use water. Seek expert advice and consider heading for the nearest suitable port.
- ***Medical first aid***: Refer to Medical First Aid Guide (MFAG), as amended.

Remark

The use of CO_2 or inert gas, if available, should be withheld until fire is apparent.

COAL

Description

Coal (bituminous and anthracite) is a natural, solid, combustible material consisting of amorphous carbon and hydrocarbons.

Characterization

ANGLE OF REPOSE	BULK DENSITY (kg/m^3)	STOWAGE FACTOR (m^3/t)
Not applicable	654 to 1266	0.79 to 1.53
SIZE	**CLASS**	**GROUP**
Up to 50 mm	Material Hazardous only in Bulk	B (and A)

Appendix information

1. Coals may emit methane, a flammable gas. A methane/air mixture containing between 5% and 16% methane constitutes an explosive atmosphere which can be ignited by sparks or naked flame, e.g., electrical or frictional sparks, a match or lighted cigarette. Methane is lighter than air and may, therefore, accumulate in the upper region of the cargo space or other enclosed spaces. If the cargo space boundaries are not tight, methane can seep through into spaces adjacent to the cargo space.
2. Coals may be subject to oxidation, leading to depletion of oxygen and an increase in carbon dioxide or carbon monoxide concentrations in the cargo space. Carbon monoxide is an odourless gas, slightly lighter than air, and has flammable limits in air of 12% to 75% by volume. It is toxic by inhalation with an affinity for blood haemoglobin over 200 times that of oxygen.
3. Some coals may heat spontaneously and the spontaneous heating may lead to spontaneous combustion in the cargo space. Flammable and toxic gases, including carbon monoxide, may be produced.
4. Some coals may be liable to react with water and produce acids which may cause corrosion. Flammable and toxic gases, including hydrogen, may be produced. Hydrogen is an odourless gas, much lighter than air, and has flammable limits in air of 4% to 75% by volume.

Hazard

Coal may create flammable atmospheres, may heat spontaneously, may deplete the oxygen concentration, may corrode metal structures. Can liquefy if predominantly fine 75% less than 5 mm coal.

Stowage and segregation

Appendix information

1. Boundaries of cargo spaces where this cargo is carried shall be resistant to fire and liquids.
2. This cargo shall be "separated from" goods of classes 1 (Division 1.4), 2, 3, 4 and 5 in packaged form (see IMDG Code) and "separated from" solid bulk materials of classes 4 and 5.1.
3. Stowage of goods of class 5.1 in packaged form or solid bulk materials of class 5.1 above or below this cargo shall be prohibited.
4. The master shall ensure that this cargo is not stowed adjacent to hot areas.
5. This cargo shall be "separated longitudinally by an intervening complete compartment or hold from" goods of class 1 other than Division 1.4.

General requirements for all types of these cargoes

Appendix information

1. Prior to loading, the shipper or his appointed agent shall provide in writing to the master the characteristics of the cargo and the recommended safe handling procedures for loading and transport of the cargo. As a minimum, the cargo's contract specifications for moisture content, sulphur content and size shall be stated, and especially whether the cargo may be liable to emit methane or self-heat.
2. Before loading, the master shall ensure the following:
    - All cargo spaces and bilge wells are clean and dry. Any residue of waste material or previous cargo is removed, including removable cargo battens; and
    - All electrical cables and components situated in cargo spaces and adjacent spaces are free from defects. Such cables and electrical components are safe for use in an explosive atmosphere or positively isolated.
3. The ship shall be suitably fitted and carry on board appropriate instruments for measuring the following without requiring entry in the cargo space:
    - concentration of methane in the atmosphere;
    - concentration of oxygen in the atmosphere;
    - concentration of carbon monoxide in the atmosphere; and
    - pH value of cargo space bilge samples.
4. These instruments shall be regularly serviced and calibrated. Ship personnel shall be trained in the use of such instruments. Details of gas measurement procedures are given at the end of this appendix.
5. It is recommended that means be provided for measuring the temperature of the cargo in the range 0°C to 100°C to enable the measurement of temperature of the cargo while being loaded and during voyage without requiring entry into the cargo space.
6. Smoking and the use of naked flames shall not be permitted in the cargo areas and adjacent spaces and appropriate warning notices shall be posted in conspicuous places. Burning, cutting, chipping, welding or other sources of ignition shall not be permitted in the vicinity of cargo spaces or in other adjacent spaces, unless the space has been properly ventilated and the methane gas measurements indicate it is safe to do so.
7. Prior to departure, the master shall be satisfied that the surface of the material has been trimmed reasonably level to the boundaries of the cargo space to avoid the formation of gas pockets and to prevent air from permeating the body of the briquettes. Casings leading into the cargo space shall be adequately sealed. The shipper shall ensure that the master receives the necessary co-operation from the loading terminal.
8. The atmosphere in the space above the cargo in each space shall be regularly monitored for the concentration of methane, oxygen and carbon monoxide. Details of gas monitoring procedures are given at the end of this appendix. The results of monitoring shall be recorded. The frequency of the monitoring shall be determined based upon the information provided by the shipper and the information obtained through the analysis of the atmosphere in the cargo space.
9. Unless expressly provided otherwise, surface ventilation shall be conducted in all cargo spaces carrying this cargo for the first 24 hours after departure from the loading port. During this period, the atmosphere in the cargo spaces shall be monitored once from one sample point per cargo space and for the purpose of the gas monitoring, the ventilation shall be stopped for an appropriate period prior to the gas monitoring.

10. When the methane concentrations monitored within 24 hours after departure are at an acceptably low level, the ventilation openings shall be closed and the atmosphere in the cargo spaces shall be monitored. When the methane concentrations monitored within 24 hours after departure are not at an acceptably low level, surface ventilation shall be maintained, except for an appropriate period for gas monitoring, and the atmosphere in the cargo spaces shall be monitored. This procedure shall be followed until the methane concentrations become acceptably low level. In either event, the atmosphere in the cargo spaces shall be monitored on a daily basis.
11. When significant concentrations of methane is subsequently observed in unventilated cargo spaces, the appropriate special precautions for coals emitting methane shall apply.
12. The master shall ensure, as far as practicable, that any gases which may be emitted from this cargo do not accumulate in adjacent enclosed spaces.
13. The master shall ensure that enclosed working spaces such as storerooms, carpenter's shop, passageways, tunnels, etc. are regularly monitored for the presence of methane, oxygen and carbon monoxide. Such spaces shall be adequately ventilated.
14. Regular hold bilge testing shall be systematically carried out during voyage carrying this cargo. If the pH monitoring indicates that a corrosion risk exists, bilges shall be frequently pumped out during the voyage in order to avoid possible accumulation of acids on tank tops and in the bilge system.
15. If the behaviour of the cargo during the voyage differs from that specified in the cargo declaration, the master shall report such differences to the shipper. Such reports will enable the shipper to maintain records on the behaviour of the coal cargoes, so that the information provided to the master can be reviewed in the light of transport experience.

Hold cleanliness

Clean and dry as relevant to the hazards of the cargo.

Weather precautions

When a cargo may liquefy during voyage in case that the moisture content of the cargo is in excess of its TML and the cargo is carried in a ship other than specially constructed or fitted cargo ship complying with the requirements in subsection 7.3.2 of this Code, the following provisions shall be complied with:

1. the moisture content of the cargo shall be kept less than its TML during 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 provided that the actual moisture content of the cargo is sufficiently less than its TML so that the actual moisture content is not liable to be increased beyond the TML by the precipitation; 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 IMSBC Code.

Without reasonable trimming, vertical cracks into the body of the coal may form permitting oxygen circulation and possible self-heating.

Precautions

Bilge wells shall be clean, dry and covered as appropriate, to prevent ingress of the cargo.

Special precautions

Appendix information

Observations

- Carbon monoxide monitoring, when conducted in accordance with the following procedures, will provide a reliable early indication of self-heating within this cargo. This allows preventive action to be considered without delay. A steady rise in the level of carbon monoxide detected within a cargo space is a conclusive indication that self-heating is taking place.
- All vessels engaged in the carriage of this cargo shall carry on board an instrument for measuring methane, oxygen and carbon monoxide gas concentrations, to enable the monitoring of the atmosphere within the cargo space. This instrument shall be regularly serviced and calibrated in accordance with the manufacturer's instructions. Care shall be exercised in interpreting methane measurements carried out in the low oxygen concentrations often found in unventilated cargo holds. The catalytic sensors normally used for the detection of methane rely on the presence of sufficient oxygen for accurate measurement. This phenomenon does not affect the measurement of carbon monoxide, or measurement of methane by infrared sensor. Further guidance may be obtained from the instrument manufacturer.

Sampling and measurement procedure

- Equipment:
  1. An instrument which is capable of measuring methane, oxygen and carbon monoxide concentrations shall be provided on board a ship carrying this cargo. The instrument shall be fitted with an aspirator, flexible connection and a length of spark-proof metal tubing to enable a representative sample to be obtained from within the square of the hatch.
  2. When recommended by the manufacturer, a suitable filter shall be used to protect the instrument against the ingress of moisture. The presence of even a small amount of moisture will compromise the accuracy of the measurement.
- Siting of sampling points:
  1. In order to obtain meaningful information about the behaviour of this cargo in a cargo space, gas measurements shall be made via one sample point per cargo space. To ensure flexibility of measurement in adverse weather two sample points shall be

provided per cargo space, one on the port side and one on the starboard side of the hatch cover or hatch coaming. (See the diagram of gas sampling point in IMSBC Code.) Measurement from either of these locations is satisfactory.

2. Each sample point shall comprise a hole of diameter approximately 12 mm positioned as near to the top of the hatch coaming as possible. It shall be sealed with a sealing cap to prevent ingress of water and air. It is essential that this cap is securely replaced after each measurement to maintain a tight seal.
3. The provisions of any sample point shall not compromise the seaworthiness of the vessel.

- Measurement:
  The explanation on procedures for measurement is as follows:
  1. remove the sealing cap, insert the spark-proof metal tube into the sampling point and tighten the collar to ensure an adequate seal;
  2. connect the instrument to the sampling tube;
  3. draw a sample of the atmosphere through the tube, using the aspirator, until steady readings are obtained;
  4. log the results on a form which records cargo space, date and time for each measurement; and
  5. put back the sealing cap.
- Measurement strategy:
  The identification of incipient self-heating from measurement of gas concentrations is more readily achieved under unventilated conditions. This is not always desirable because of the possibility of the accumulation of methane to dangerous concentrations. This is primarily, but not exclusively, a problem in the early stages of a voyage. Therefore it is recommended that cargo spaces are initially ventilated until measured methane concentrations are at an acceptably low level.
- Measurement in unventilated holds:
  Under normal conditions one measurement per day is sufficient as a precautionary measure. However, if carbon monoxide levels are higher than 30 ppm then the frequency shall be increased to at least twice a day at suitably spaced intervals. Any additional results shall be logged.
- Measurement in ventilated holds:
  1. If the presence of methane is such that the ventilators are required to remain open, then a different procedure shall be applied to enable the onset of any incipient self-heating to be detected.
  2. To obtain meaningful data the ventilators shall be closed for a period before the measurements are taken. This period may be chosen to suit the operational requirements of the vessel, but it is recommended that it is not less than four hours. It is vital in the interests of data interpretation that the shutdown time is constant whichever time period is selected. These measurements shall be taken on a daily basis.

Ventilation

See special precautions section.

Carriage
See other sections in this Schedule.

Discharge
No special requirements.

Clean-up
No special requirements.

Emergency procedures (*Metal Sulphide Concentrates)*
- *Special emergency equipment to be carried:* Nil
- *Emergency procedures:* Nil
- *Emergency action in the event of fire*: Batten down. Exclusion of air may be sufficient to control fire. Do not use water. Seek expert advice and consider heading for the nearest port.
- *Medical first aid*: Refer to Medical First Aid Guide (MFAG), as amended.

Remark
The use of CO_2 or inert gas, if available, should be withheld until fire is apparent.

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