



Chapter 6 – Coal Cargoes

This chapter, and all of the chapters in Part 2, should be read in conjunction with the booklet *Carrying Solid Bulk Cargoes Safely* (Reference 16), published by Lloyd's Register/UK P&I Club/INTERCARGO, which can be found on the UK P&I website.

6.1 Properties and Characteristics

The *International Maritime Solid Bulk Cargoes Code* (IMSBC Code) (Reference 17) categorises coal as Group B (cargoes with a chemical hazard) and Group A (cargoes which may liquefy). The general properties and hazards are as follows:

- 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, eg electrical or frictional sparks, a match or lighted cigarette. Methane is lighter than air and so may 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
- 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 ie, within this range of concentration it may burn.

It is toxic by inhalation with an affinity for blood haemoglobin over 200 times that of oxygen

- some coals may heat spontaneously and this may lead to spontaneous combustion in the cargo space. Flammable and toxic gases, including carbon monoxide, may be produced
- 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
- coal cargoes may liquefy when their moisture content exceeds their transportable moisture limit (TML).

6.2 General Requirement for All Coals

The IMSBC Code states that, prior to loading, the shipper or their appointed agent should provide, in writing to the Master, a cargo declaration containing the characteristics of the cargo and the recommended safe handling procedures. These details should include whether the cargo may be liable to emit methane or self-heat.

The Master should be satisfied that they have received this information prior to accepting the cargo. This is an essential requirement for safe shipment of the cargo as it determines the method of safe carriage.

- If the shipper has advised that the cargo is liable to self-heat, the Master should seek confirmation that the intended precautions and the intended procedures for monitoring the cargo during the voyage are adequate
- if the cargo is liable to self-heat, or an analysis of the atmosphere in the cargo space indicates an increasing concentration of carbon monoxide, the following additional precautions should be taken:
 - the hatches should be closed immediately after completion of loading in each cargo space. The hatch covers may also be additionally sealed with a suitable sealing tape. Surface ventilation should be limited to the absolute minimum time necessary to remove methane that may have accumulated. Forced ventilation should not be used. On no account should air be directed into the body of the coal as this could promote self-heating
 - personnel should not be allowed to enter the cargo space unless they are wearing self-contained breathing apparatus (SCBA) and access is critical to the safety of the ship or safety of life. The SCBA should be worn only by personnel trained in its use
 - when required by the competent authority (CA), the carbon monoxide concentration in each cargo space should be measured at regular time intervals to detect self-heating
 - if, at the time of loading, when the hatches are open, the temperature of the coal exceeds 55°C, expert advice should be obtained.

If the carbon monoxide level is increasing steadily, self-heating may be developing. The cargo space should be completely closed down and all ventilation ceased. The

Master should seek expert advice immediately. Water should not be used for cooling the material or for fighting coal cargo fires at sea, but may be used for cooling the boundaries of the cargo space.

Even if the shipper considers that the cargo is not liable to self-heat, the recommendations stated above should be closely followed. Monitoring the atmosphere of the cargo space is essential at least once daily, and twice daily if rapid changes are detected.

During loading, all cargo should be properly trimmed as level as possible to the boundaries of the cargo spaces.

During and after loading, it is important to regularly monitor the temperature of cargo. While measuring temperature by lowering thermometers into sounding pipes may be useful generally, it should not be relied upon to reflect any changes occurring in the bulk of the cargo. This is because temperature monitoring via sounding pipes will only detect heating coal in the immediate vicinity and will not provide information on the bulk of the cargo.

During the voyage, the bilge of the hold should be tested to monitor the pH. If the pH level indicates a corrosion risk, the bilges can be pumped out to avoid the accumulation of acid on the tank tops and throughout the bilge system.

6.3 Gas Monitoring and Ventilation Coal Cargoes

All vessels engaged in the carriage of coal cargoes should have on board an instrument for measuring methane, carbon monoxide and oxygen, as per Section 3.2.5 of the IMSBC Code (Reference 17). SOLAS Chapter VI – Carriage of cargoes and oil fuels (Reference 18) confirms this requirement:

Regulation 3

“Oxygen analysis and gas detection equipment

1. *When transporting a solid bulk cargo which is liable to emit a toxic or flammable gas, or cause oxygen depletion in the cargo space, an appropriate instrument for measuring the concentration of gas or oxygen in the air shall be provided together with detailed instructions for its use. Such an instrument shall be to the satisfaction of the Administration.*
2. *The Administration shall take steps to ensure that crews of ships are trained in the use of such instruments.”*

Appendix 1 of the IMSBC Code provides the individual schedules of solid bulk cargoes (Reference 17). This includes the schedule for coal that also contains, as a separate appendix, the procedures for gas monitoring of coal cargoes, the equipment to be used, the design and siting of sample points, and procedures for measurement.

- “3 The ship shall be suitably fitted and carry on board appropriate instruments for measuring the following without requiring entry in the cargo space:*
- .1 Concentration of methane in the atmosphere;*
 - .2 Concentration of oxygen in the atmosphere;*

- .3 Concentration of carbon monoxide in the atmosphere; and
- .4 pH value of cargo space bilge samples.”

The appendix goes on to state:

“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.”

The appendix continues:

- “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 any event, the atmosphere in the cargo spaces shall be monitored on a daily basis.”*

Other requirements set out in the schedule relate to trimming the cargo, smoking and the use of naked lights etc.

6.4 Special Precautions

Special precautions apply to coals emitting methane and self-heating coals.

Coals emitting methane

Methane is a flammable gas that, within the range of 5 to 16% in air, can form a flammable mixture that can be readily ignited by a spark or naked light. The IMSBC Code, in the Appendix to the schedule relating to coal, requires the following special precautions:

“1. Coals emitting methane

“When the shipper has informed that the cargo is liable to emit methane or analysis of the atmosphere in the cargo space indicates the presence of methane in excess of 20% of the Lower Explosion Limit (LEL), the following additional precautions shall be taken:

- .1 Adequate surface ventilation shall be maintained, except for an appropriate period for the purpose of gas monitoring.
- .2 Care shall be taken to remove any accumulated gases prior to operation of the hatch covers or other openings for any reason, including discharging. Care shall be taken to operate hatch covers of the cargo spaces and other openings to avoid creating sparks. Smoking and the use of naked flame shall be prohibited.
- .3 Personnel shall not be permitted to enter the cargo space or enclosed adjacent spaces unless the space has been ventilated and the atmosphere tested and found to be gas-free and to have sufficient oxygen to support life. Notwithstanding these provisions, emergency entry into the cargo space may be permitted without ventilation, testing the atmosphere or both, provided that the entry into the cargo space is undertaken only by trained personnel wearing self-contained breathing apparatus under the supervision of a responsible officer and special precautions are observed to ensure that no source of ignition is carried into the space.
- .4 The master shall ensure that enclosed working spaces such as storerooms, carpenter's shops, passageways, tunnels, etc., are regularly monitored for the presence of methane. Such spaces shall be adequately ventilated and, in the case of mechanical ventilation, only equipment safe for use in an explosive atmosphere shall be used." (Reference 17)

Self-heating coals

Low-rank coal types are more prone to oxidation than the high-rank anthracites and are therefore more liable to spontaneous heating. High inherent moisture contents, which can evaporate to create large internal surface areas susceptible to oxidation, will assist this heating process. Frequently, cargoes may consist of coals of different ages and from different mines, which can also lead to spontaneous heating problems.

The Appendix to the coal schedule of the IMSBC Code goes on to state further special precautions as follows:

- "2.1 The cargo spaces shall be closed immediately after completion of loading in each cargo space. The hatch covers may also be additionally sealed with a suitable sealing tape. Only natural surface ventilation shall be permitted and ventilation shall be limited to the absolute minimum time necessary to remove methane which may have accumulated.
- .2 Personnel shall not enter the cargo space during the voyage, unless they are wearing self-contained breathing apparatus and access is critical to safety of life and the safety of the ship.
- .3 Prior to loading, temperature of this cargo shall be monitored. This cargo shall only be accepted for loading when the temperature of the cargo is not higher than 55°C.
- .4 When the carbon monoxide level is increasing steadily, a potential self-heating may be developing. In such a case, the cargo space shall be completely closed and all ventilation ceased, and the master shall seek expert advice immediately. Water shall not be used for cooling material or fighting coal fires at sea, but may be used for cooling the boundaries of the cargo space.
- .5 When the carbon monoxide level in any cargo space reaches 50 ppm or exhibits a steady rise over three consecutive days, a self-heating condition may be developing and the master shall inform the shipper and the company of, at least,

the following information if an accurate assessment of the situation is to be achieved:

- .1 identity of the cargo spaces involved; monitoring results covering carbon monoxide, methane and oxygen concentrations;*
- .2 if available, temperature of the cargo, location and method used to obtain results;*
- .3 time gas sample taken (monitoring routine);*
- .4 time ventilators opened/closed;*
- .5 quantity of coal in hold(s) involved;*
- .6 type of coal as per cargo information, and any special precautions indicated on information;*
- .7 date loaded, and ETA at intended discharge port (which shall be specified); and*
- .8 comments or observations from the ship's master."*

6.5 Acid Conditions

Many coals contain sulphur and if this is in soluble form it may react with moisture in the coal to form sulphurous and sulphuric acids. These acids will attack steel, corroding bilge systems, tank top areas and, in some cases, bulkheads. For this reason, it is recommended that regular hold bilge testing should be conducted. If acid conditions are indicated, the bilges should be pumped regularly to minimise contact between the acids and the hold structure. This will also prevent the accumulation of water drained from the cargo collecting at lower hold levels and creating problems at discharge.

6.6 Entry to Cargo Spaces

Coal will oxidise, which is a process that removes oxygen from the surrounding atmosphere. The oxygen content of a normal atmosphere should be approximately 20.9% for safe entry. However, tests of the atmosphere in sealed holds carrying coal cargoes have indicated an oxygen content of less than 4%. It is essential that suitable test procedures are followed to confirm sufficient oxygen prior to entry into a cargo space or a neighbouring confined space. Requirements for the safety of personnel are detailed in Section 3 of the IMSBC Code. In addition, Appendix 1 contains the specific risks associated with each cargo type (Reference 17).

The importance of this test procedure cannot be overemphasised. Preventable loss of life continues to occur as a result of entry into cargo spaces and confined spaces without prior testing of the atmosphere. Ships must be equipped with the relevant test apparatus and personnel trained in its use.

6.7 Brown Coal (Lignite) Briquettes

Amendment 03-15 of the IMSBC Code that entered into force on 1st January 2017 and the Supplement (the *Code of Practice for the Safe Loading and Unloading of Bulk Carriers* (BLU Code)) (Reference 17) include 'brown coal (lignite) briquettes', which are manufactured by pressing dried coal particles into compressed blocks. The briquettes are subject to oxidation, which leads to both oxygen depletion and carbon dioxide

increase within the cargo space. They are also liable to self-heating and spontaneous combustion, which in turn may produce flammable and toxic gases.

Boundaries of cargo spaces in which briquettes are stowed should be fire and liquid resistant. The *International Maritime Dangerous Goods Code* (IMDG Code) should be consulted for particular stowage requirements (Reference 19). For full details of pre-loading, loading and post-loading operations and recommendations, the BLU Code (Supplement to the IMSBC Code) (Reference 17) should be consulted.

6.8 The Risk of Liquefaction

Amendment 04-17 of the IMSBC Code that entered into force on 1st January 2019 set out new requirements to manage the risk of liquefaction of coal cargoes. The IMSBC Code (Coal schedule in the Appendix) now classifies all coal cargoes as both Group A (risk of liquefaction) and Group B, unless a test confirms otherwise. The shipper is required to demonstrate that the coal does not belong to Group A, specifically:

“Coal shall be classified as Group A and B unless classified as Group B only by a test determined by the appropriate authority or where it has the following particle size distribution:

- .1 not more than 10% by weight of particles less than 1 mm ($D_{10} > 1 \text{ mm}$); and*
- .2 not more than 50% by weight of particles less than 10 mm ($D_{50} > 10 \text{ mm}$).*

Notwithstanding the above, a blend of two or more coals shall be classified as Group A and B unless all original coals in the blend are Group B only.”



Figure 6.1: Where coal cargoes are subject to rainfall in the load port, they should be covered where possible but always reinspected and retested to confirm their moisture level.

Before loading, the Master should request evidence of the correct coal classification. Shippers should clearly demonstrate whether the cargo falls under Group A and B or Group B only. If no information is available from the shipper, the Master should assume

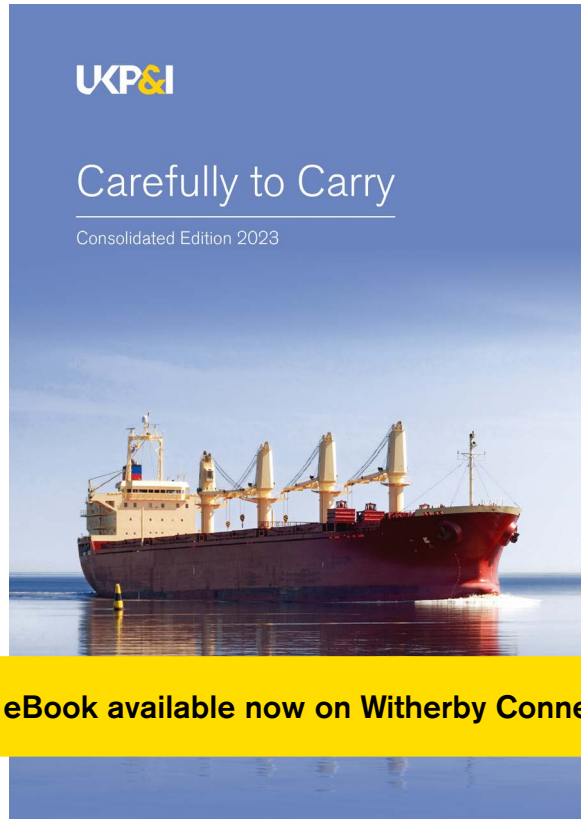
that the coal is both Group A and B and therefore is at risk of liquefaction. However, as required by the IMSBC Code, the Master should insist that the cargo transportable moisture limit (TML) test documentation and its moisture certificate is presented prior to loading.

Where cargo is ashore for a long period and subject to moisture increase by rain, it is essential that the cargo moisture level is reinspected prior to loading.

For further details of the general risk of cargoes that may liquefy, see Chapter 8.



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