



# CARGO ADVICE

## Coal cargoes

### Introduction

The IMSBC code defines three types of cargo:

- Group A cargoes – cargoes which may liquefy
- Group B cargoes – cargoes which possess chemical hazards
- Group C cargoes – cargoes which are neither liable to liquefy nor possess chemical hazards

Coal cargoes are classified as either both Groups A and B, i.e. they can liquefy and they may emit chemicals, or as Group B only, if they do not have a tendency to liquefy.

#### **Methane emission**

Typically, coal emits methane to varying degrees. This is a natural property of coal and starts as soon as the coal is exposed to air when being mined.

- In some coal, particularly low rank coal, the tendency to emit methane is low. Low rank coal is geologically younger coal i.e. it has lower carbon & higher volatile matter content.
- For higher rank bituminous coals, which are geologically older coal i.e. higher carbon and lower volatile matter content, the tendency to emit methane is increased.
- For anthracite (non bituminous coal), which is a very high rank coal, methane emissions are again low.

- The bulk of coal traded internationally is bituminous (i.e. black thermal coal and coking coal – generally medium geological age) with some tendency to emit methane. Usually, the Master is only given the cargo declaration, probably with little or no supporting information, to assist in understanding how liable the coal is to emit methane. One indicator is that the cargo declaration and/or the bill of lading may mention 'coking coal'. Coking coals are liable to emit methane, even if it is not stated on the cargo declaration.
- Typically, Indonesian as well as Colombian coal is low rank and its tendency to emit methane is lower. Indonesian coal is mainly sub-bituminous (brown coal) or high volatile bituminous in rank. Sub-bituminous coals are young and are highly likely to self-heat.

***It is advisable to treat Indonesian thermal coals as self-heating, regardless of what is indicated on the cargo declaration.***

#### **Absorption of oxygen**

Coal will absorb oxygen from the air, generate heat and emit carbon monoxide and carbon dioxide. It may also emit hydrogen sulphide if pyrite (iron sulphide) is present in the coal. The absorption of oxygen is an exothermic reaction which will generate heat and can, given the right conditions, turn into a fire.

Any fire requires fuel, oxygen and heat. In the case of coal, the coal itself is the fuel. Oxygen is present in air, and as the coal reacts with oxygen at any temperature, heat is generated, which, if not controlled, will rise to the point where a fire can start.

# Guidelines for the shipment of coal cargoes

*Whilst not exhaustive, these guidelines should assist in the shipment of coal cargoes. The Appendix to the coal schedule in the IMSBC Code provides detailed guidance, which should be followed.*

## 1. Pre-loading

- Ensure that ship's holds are clean to the level required.
- Ensure that temperature and gas measuring equipment as well as the portable breathing apparatus sets meet the requirements of the IMSBC Code. The thermometer should be in the range 0°C to 100°C and capable of measuring the temperature without requiring entry into the cargo space.
- The ship should have at least two gas meters on board (in case one should fail) with certificates of calibration that will cover the period of the voyage. At a minimum the meters should measure methane (usually in % of Lower Explosive Limit or LEL), carbon monoxide and oxygen. The LEL is the lower limit, below which a mixture of methane and air will not explode. For normal air (21% oxygen) the LEL is 5% methane. Meters usually measure the percentage of LEL with 100% representing 5% methane in air.
- The ship should also carry on board an instrument to measure the pH value of cargo space bilge samples.
- Obtain a Cargo Declaration for Solid Bulk Cargoes from the Shipper, which should state the cargo's liability to emit methane and/or to self-heat. If the cargo is also Group A, certificates of testing showing the transportable moisture limit (TML) and the actual moisture content of the cargo as loaded should be provided. The TML is the maximum moisture content of the cargo, which is considered safe for carriage. The actual moisture of the cargo should, of course, be less than the declared TML.

## 2. During loading

- Care should be taken to ensure that no source of ignition is taken into the hold.
- The cargo should not be loaded at a temperature in excess of 55°C. The Master should be vigilant during loading and if there is any sign of smoke or steam coming from the coal, loading should be stopped to investigate.
- Group A cargoes should not be handled during precipitation and all non-working hatches should be closed. Ports of loading in tropical areas are subject

to heavy rain fall and if the coal is transported in the open, a significant amount of water can be added to the cargo. In this case, the Master should be aware that the moisture content of the coal may exceed its TML.

- Trim cargo as reasonably level as possible. This reduces the likelihood of the cargo shifting and minimises the air entering the cargo, which could lead to spontaneous combustion. Using a bulldozer on the surface of the coal in the hold, compacts the surface of the coal and reduces the access of oxygen to the cargo.
- Once the hold is trimmed, hatches should be closed as soon as possible.

## 3. During voyage

- Crew should not be permitted to enter a hold unless the atmosphere has been tested and shown to be gas-free and to have sufficient oxygen to support life.
- Emergency entry into a hold may be permitted without ventilation, testing the atmosphere or both, provided that the entry is undertaken by trained personnel wearing self-contained breathing apparatus.
- Free space gas testing should be carried out and recorded on a daily basis.
- The IMSBC Code states that "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". It is recommended in the IMSBC Code that the ventilation should be interrupted for not less than four hours prior to the gas readings being taken.
- The IMSBC Code states that cargoes with methane levels above 20% LEL should be ventilated. This will leave a comfortable margin to prevent 100% LEL being reached. Note that methane is lighter than air and thus tends to congregate at the top of the free space in holds.
- An indication that self-heating may be occurring in a coal cargo is the level of carbon monoxide in the hold. The IMSBC Code recommends that the Master informs the owner if the carbon monoxide readings exceed 50 ppm.
- Self-heating is associated with the release of steam, followed by smoke and then flames when sufficient oxygen is present.
- Coal temperatures have a tendency to rise steadily to 50°C/55°C, then more rapidly to 70°C/75°C and then rise at an increasing rate to a point where ignition takes place.

- In the event of fire being observed in a hold, water should not be used to extinguish the flames. The hold should be sealed tight. Expert advice should be obtained and consideration should be made to divert to the nearest suitable port.
- Cargoes that are emitting methane and exhibiting self-heating require careful monitoring. If the methane content in the hold exceeds the LEL, the gases in the hold constitute an explosive mixture. It is therefore important to deal with methane in preference to any self-heating that may be taking place.
- Measure pH value of cargo space bilge samples regularly. If the pH monitoring indicates that a corrosion risk exists, bilges should be frequently pumped out in order to avoid possible accumulation of acids on tank tops and in the bilge system.
- Keep a record of the amount of water pumped out of the hold bilges. This will assist in case of a claim for cargo short weight as the total volume of water pumped should be added to the weight determined by draught survey, belt scale etc at the discharge port.

#### 4. During discharge

- In the event of self-heating being suspected, or fire being apparent, the discharge port authorities should be notified.
- Precautions should be taken when opening the hatches. Fire hoses should be positioned so that any hot coal can be cooled in the grab after removal from the hold. Water should not be added to the cargo hold.
- Discharge should not be made onto rubber conveyor belts, unless fire resistant, and with the knowledge and go ahead of the port authorities.
- Opening holds and the "first grab" can result in fire or hot spots being observed. The discharge should stop and the port authorities informed.

#### 5. Risks associated with carriage

##### *Methane emission*

- If the methane content in the hold exceeds the LEL, the gases in the hold constitute an explosive mixture. Even a small spark can cause an explosion. An additional danger from a methane explosion is that coal dust that has settled may be agitated into a dust cloud and the methane explosion can ignite the coal in the air. This could lead to a stronger explosion and potentially more damage to the vessel.
- There is a risk to the cargo from an explosion since there is likely to be a resulting fire with total or partial loss of cargo.

##### *Self-combustion*

- The presence of carbon monoxide indicates that the coal is oxidising and if the level of CO continues to rise, the coal might ignite. Depending on where the coal is combusting (it is often a localised phenomenon), there may be a rise in temperature detected, but this is not always the case. If some part of the coal is burning, it may only be detected during unloading, when smoke will become apparent emanating from the cargo. There may be flames arising from the coal during unloading with potential damage to grabs and other unloading equipment such as belt conveyors. Smoke inhalation is a risk for the crew and anyone within the vicinity. Breathing apparatus will be required in the event of a fire.
- The risk to the cargo is that the coal has burned. Loss of cargo will occur and heat from the fire may damage the coal, causing loss of value.

##### *Sea water contamination*

- Sea water ingress into the cargo introduces chlorides into the coal. Excessive chloride is damaging to equipment used for burning and coking of coal.
- Chloride content in the cargo can be reduced by stockpiling the coal in the open and allowing rain water to wash away the sea water and the chloride.
- Sea water also adds sodium to the coal which can reduce the value of both thermal and coking coal. Sodium reduces the melting point of ash which affects coal fired boiler efficiency and also adversely affects the reactivity of coke made from coal.

##### *Acidic water formation*

- Coals with high pyritic sulphur content can react with water in the coal and oxygen in the air to form sulphuric acid. The acid formed can cause corrosion within the hold.

##### *Liquefaction*

- Coal cargoes which are classified as Group A may liquefy if shipped at a moisture content exceeding the TML.

## Conclusion

Most voyages with coal cargoes will be uneventful, but sometimes things go wrong. The coal may have been mishandled during storage, loading or may contain hot spots. Coal cargoes require constant monitoring to identify any problems at an early stage. Left untreated, hazards can cause serious damage to vessel and crew. If in doubt seek the advice of an expert.



## Loss prevention essentials

- Make sure that the vessel's temperature and gas measuring equipment are working and ready to be used.
- If there is any sign of smoke or steam coming from the coal during loading, stop and investigate.
- Cargoes with methane levels above 20% LEL should be ventilated to avoid the creation of an explosive atmosphere in the hold.
- Monitor the carbon monoxide levels in the hold during the voyage. Increasing levels may indicate ongoing self-heating.