UK P&I CLUB

Carefully to Carry

Coal cargoes

Since the publication of this article in Carefully to Carry No.13, issued in April 1989, there have been major changes in the recommendations for the safe carriage of coal cargoes.

Following a spate of coal cargo fires and explosions, a research project was sponsored by the UK Department of Trade and Industry. A working group comprised of:

British Coal
P&O Bulk Carriers
Souter Shipping
Minton, Treharne & Davies Ltd, instructed by the International Group of P&I Clubs and the Salvage Association

The main aim of the project was to validate the use of gas measurement to detect spontaneous heating of coal cargo at an early stage. Data was collected from a large number of voyages, some of which involved heated coal cargoes. Recommendations following this research were included in the revised entry for coal in the IMO *Code of Safe Practice for Solid Bulk Cargoes* (the IMO BC Code).

Properties and characteristics

The Categories A, B, C and D have now been excluded from the IMO BC Code and the properties and characteristics are shown under BC 010, at Appendix B, pages 61-66 of the Code 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, 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.

- Coals may be subject to oxidation, leading to depletion of oxygen and an increase in carbon dioxide in the cargo space.

- Some coals may be liable to self-heating that could lead to spontaneous combustion in the cargo space. 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.

- 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% by 75% by volume.

"The carrier shall properly and carefully load, handle, stow, carry, keep, care for and discharge the goods carried."

Hague Rules, Articles iii, Rule 2

Carefully to Carry Advisory Committee

This report was produced by the Carefully to Carry Committee – the UK P&I Club's advisory committee on cargo matters. The aim of the Carefully to Carry Committee is to reduce claims through contemporaneous advice to the Club's Members through the most efficient means available.

The committee was established in 1961 and has produced many articles on cargoes that cause claims and other cargo related issues such as hold washing, cargo securing, and ventilation.

The quality of advice given has established Carefully to Carry as a key source of guidance for shipowners and ships' officers. In addition, the articles have frequently been the source of expertise in negotiations over the settlement of claims and have also been relied on in court hearings.

In 2002 all articles were revised and published in book form as well as on disk. All articles are also available to Members on the Club website. Visit the Carefully to Carry section in the Loss Prevention area of the Club website www.ukpandi.com for more information, or contact the Loss Prevention Department.

General requirement for all coals

The Code states that prior to loading, the shipper or his appointed agent should provide in writing to the master, 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 he has received this information prior to accepting the cargo.

In our opinion this is an essential requirement for the safe shipment of the cargo, this information will decide 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 precautions intended to be taken and the procedures intended 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, then the following additional precautions should be taken:
  - The hatches should be closed immediately after completion of loading in each cargo space. The hatch-covers can also be additionally sealed with a suitable sealing tape. Surface ventilation should be limited to the absolute minimum time necessary to remove methane which may have accumulated. Forced ventilation should not be used. On no account should air be directed into the body of the coal as air could promote self-heating.
  - Personnel should not be allowed to enter the cargo space, unless they are wearing self-contained breathing apparatus and access is critical to the safety of the ship or safety of life. The self-contained breathing apparatus should be worn only by personnel trained in its use.
  - When required by the competent authority, 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 55oC, expert advice should be obtained.
  - If the carbon monoxide level is increasing steadily, a potential 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 fighting coal cargo fires at sea, but may be used for cooling the boundaries of the cargo space.

In our opinion, 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, twice daily if rapid changes are detected.

Gas monitoring of coal cargoes

All vessels engaged in the carriage of coal cargoes should have on board an instrument for measuring methane, carbon monoxide and oxygen. The SOLAS Regulations Chapter 11 – Carriage of Cargoes gives strength to this statement:

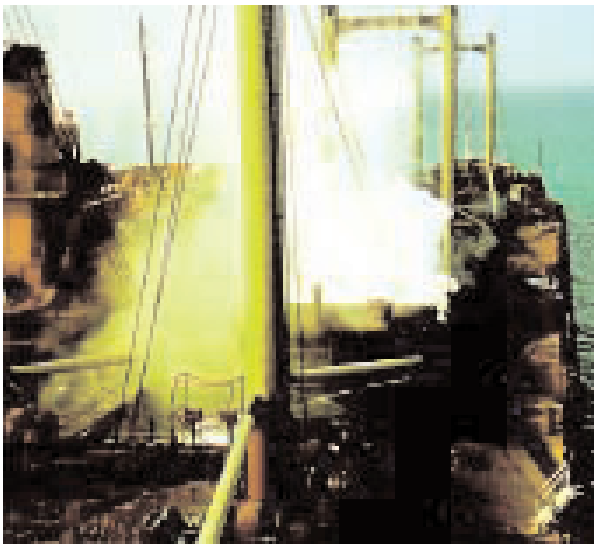
Regulation 3
Oxygen analyses and gas detection equipment

- When transporting a bulk cargo which is liable to emit a toxic or flammable gas, or cause 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.
- The Administration shall take steps to ensure that crews on ships are trained in the use of such instruments.

Appendix G of the IMO BC Code provides detailed procedures for gas monitoring of coal cargoes, equipment to be used, design and siting of sample points and measurement.

The Code details the requirements including the following:

- The ship should be suitably fitted and carry onboard 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;
  - pH value of cargo hold bilge samples.
- These instruments should be regularly serviced and calibrated. Ship personnel should be trained in the use of such instruments. Details of gas measurement procedures are given in Appendix G of the IMO BC Code.
- The atmosphere in the space above the cargo in each cargo space should be regularly monitored for the presence of methane, oxygen and carbon monoxide. Details of gas monitoring procedures are given in Appendix G. Records of these readings should be maintained. The frequency of the testing should depend upon the information provided by the shipper and the information obtained through the analysis of the atmosphere in the cargo space.
- Unless expressly directed otherwise, all holds should be surface ventilated for the first 24 hours after departure from the loading port. During this period, one measurement should be taken from one sample point per hold.
- If after 24 hours the methane concentrations are at an acceptably low level, the ventilators should be closed. If not, they should remain open until acceptably low levels are obtained. In either event, measurements should be continued on a daily basis.
- Other requirements relate to trimming the cargo, smoking, and use of naked lights etc.



Special precautions

The special precautions relate to coals emitting methane and self-heating coals.

Coals emitting methane

Methane is a flammable gas, and within the range of 5% to 16% in air can form a flammable mixture which can be readily ignited by a spark or naked light. The Code advises that if the shipper has advised 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 flammable limit then suitable precautions should be observed including

- Maintain adequate surface ventilation without directing air into the body of the coal.
- Venting any gases prior to opening the hatchcovers or other openings.
- Enclosed working spaces should be adequately ventilated with equipment safe for use in a flammable atmosphere.

Self-heating coals

Low rank coal types are more prone to oxidation than the high rank anthracites and are thus 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 recommendations of the IMO BC Code are as follows:

- There are many robust instruments suitable for shipboard use. Methane, oxygen and carbon monoxide can be detected by the same instrument. It is essential that the instruments are used and maintained strictly in accordance with manufacturers' instructions.
- The research leading to the amendment of the Coal entry in the BC Code, indicated that meaningful results of the gas concentrations in a hold could be made from one sample point per hold. For convenience in case of adverse weather conditions the sample points could be fitted one on either side of the hatchcover. Measurement from either of these locations would be satisfactory. Use of these sampling positions provide:
- An accurate picture of the gas concentrations in the hold;
- Prevent the admission of air (oxygen) into the hold, which could assist spontaneous heating.

Acid conditions

Many coals contain sulphur. If the sulphur is in a soluble form it may react with moisture in the coal to form sulphurous and sulphuric acids. These acids will of course attack steel, corroding bilge systems, tank top areas and in some cases bulkheads. It is thus 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. Without acid conditions it is still advisable to regularly pump the bilges to prevent the accumulation of water drained from the cargo collecting at lower hold levels and thus creating problems at discharge.

Entry to cargo spaces

As previously stated, coal will oxidize, and this oxidation process removes oxygen from the surrounding atmosphere. The oxygen content of a normal atmosphere is 20.8%. Tests of the atmosphere in a sealed hold carrying a coal cargo have indicated an oxygen content less than 4%. It is thus essential that prior to entry into a cargo space or a neighbouring confined space that suitable test procedures are followed. Appropriate recommendations are detailed in Appendix F of the IMO BC Code.

The importance of this test procedure cannot be over emphasised. We still learn of loss of life through entry into cargo spaces and confined spaces without prior testing of the atmosphere. However, it is encouraging to note that at least one major exporting terminal will not commence loading a coal cargo until they are satisfied that the vessel is equipped with the relevant test apparatus and persons trained in the use of the apparatus.

2001 Supplement to 1998 Edition IMO BC Code

An amendment to the 1998 edition of the BC Code includes 'Brown Coal (Lignite) Briquettes'. Brown coal (lignite) briquettes are manufactured by pressing dried coal particles into compressed blocks; they are subject to oxidation leading to oxygen depletion and carbon dioxide increase within the cargo space. They are liable to self-heating and may lead to 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. For details of particular stowage requirements, the IMDG Code should be carefully consulted. For full details of preloading, loading and post-loading operations and recommendations, the IMO BC Code supplement should be consulted.

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