



Chapter 8 – Mineral Ore Concentrates and Other Materials that May Liquefy

Section 7 of the *International Maritime Solid Bulk Cargoes Code* (IMSBC Code, Reference 17) contains general procedures for cargo that may liquefy. The recommended procedures for testing materials that may be subject to liquefaction are covered in Appendix 2 and Section 8. Masters should be aware of Amendment 03-15 of the IMSBC Code that entered into force on 1st January 2017. It included an individual and revised schedule for iron ore fines to address the dangers related to liquefaction.

The following points should be borne in mind by shipowners and Masters when contemplating the carriage of concentrates.

Many minerals that are insoluble in water and that contain mainly finely divided material may liquefy on ocean voyages if they contain an excessive amount of water when loaded or if they subsequently become wetted. This applies even though they may appear to be in the form of dry powders or granular materials.

Liquefaction occurs as a result of energy being applied to the cargo in the form of vibration from the ship's engine or due to motion in heavy seas. Liquefaction may become apparent at almost any stage of a voyage. Any cargo of finely divided material that starts to flatten and develop a putty-like surface during a voyage has begun to liquefy.

The presence of water on the surface of the cargo is also indicative of liquefaction. It must be stressed, however, that liquefaction can occur without liquid water being observed on the surface of the cargo. If flattening or a putty-like surface is observed, the ship should take urgent action and should proceed to the nearest port of refuge. It may be prudent to adjust course and speed to reduce the motion of the ship, even if this means having to steam further before reaching a suitable port.

Liquefaction is unlikely to occur if, when loaded, the cargo complies with the IMO requirement that the moisture content is relatively uniform and below the transportable moisture limit (TML) in each hold. There has been no case of liquefaction involving a cargo that in every respect complied with the IMO requirements.

Before loading any cargo with a potential to liquefy, Masters should carefully check all the documentation provided by the shippers or charterers. All cargoes known to liquefy are identified as such under the heading *Hazards* in Appendix 1 of the IMSBC Code, although total reliance on such information alone is not advised.

It is therefore recommended that, where a Master is concerned about possible liquefaction of a cargo of mineral in a finely divided form, they should insist on a written statement from the shippers or charterers confirming that the product will not liquefy if it contains an excess of moisture.

Alternatively, the Master should obtain the required documentation to satisfy their own suspicions. If the Master is not satisfied with the response obtained, it is recommended that they consult the P&I Club, either through the owners or ship managers.

8.1 Documentation

Before loading commences, the Master should receive a letter from the shippers indicating that the Master will be supplied with certificates stating the average moisture content of the cargo loaded into each separate hold. It will be appreciated that sampling before shipment, except in climates where there is no rainfall, is not satisfactory. Many of the larger shippers use an automatic sampling procedure during loading to obtain satisfactory samples for moisture content measurement. Under these circumstances, actual figures for the average moisture content of cargo loaded into each hold can only be given at the end of the loading period.

After completion of loading of materials known to liquefy, and before starting a voyage, the Master should be supplied with a certificate stating the TML for the cargo. It is stipulated by the IMSBC Code that the testing necessary for the provision of such certificates should be carried out not more than six months prior to loading (see Section 4.5 of the Code). Masters should ensure that this certificate is dated within six months of loading and that it is issued by a reliable laboratory. It is reasonable to

assume that certificates issued by major shippers of mineral ore concentrates, as listed in the IMSBC Code, are reliable. However, where there are shipments of less common materials, or where shipments are from newly developed sources, the certificates should be issued by a laboratory reliably known to have the necessary equipment and expertise to conduct the test. If there is any doubt about this matter, the Master should notify the shipowners. They should then contact the Association to obtain expert advice on how to check that the laboratory has the necessary equipment and expertise.

Sampling and testing of this cargo for moisture content should be conducted as near as possible to the time of loading.

The IMSBC Code stipulates as follows:

“The shipper shall be responsible for ensuring that a test to determine the TML of a solid bulk cargo is conducted within six months to the date of loading the cargo. Notwithstanding this provision, where the composition or characteristics of the cargo are variable for any reason, the shipper shall be responsible for ensuring that a test to determine the TML is conducted again after it is reasonably assumed that such variation has taken place.”

8.2 Careful Examination

Regardless of any evidence provided by the various certificates discussed above, Masters are strongly advised to examine the stockpiles of cargoes before loading. Water draining from stockpiles must be considered to indicate the probability that a part of the material in the stockpile has a moisture content above the TML. A watch should be kept on the condition of the cargo being loaded. Any obviously wet material should be rejected as such cargo might form a shear plane on which a basically sound cargo loaded subsequently might slide.

Masters should be aware of the risk of loading cargo at sub-zero temperatures, when it may contain ice crystals but not appear to be damp. It is recommended that, when cargo is loaded under such conditions, samples are drawn from various levels, including the bottoms of piles, and that these are warmed and then checked by the can test, as described in Section 8.4 of the IMSBC Code.

Under no circumstances should Masters agree to the erection of shifting boards or other temporary arrangements to carry cargoes loaded at moisture contents above the TML. If bulkheads are to be erected to facilitate the carriage of this type of cargo, they must be constructed strictly as required in Section 7.3.2 of the IMSBC Code (Reference 17).

It cannot be too strongly stressed that when carrying cargoes of this nature, failure to ensure that they are accompanied by the correct reliable documentation and to ensure that they are in generally uniform condition at the time of loading can result in the loss of both a ship and its crew.



Figure 8.1: Liquefied ore concentrate in ship's hold.

8.3 Dangerous Reactions

There are two other dangers associated with concentrate cargoes. The first is that some concentrates may heat. Shippers should always be asked specifically about this possibility. Stows of such concentrates should be trimmed roughly flat using a tracked bulldozer or similar machine that also compacts the cargo. It is sometimes helpful to sheet such materials with heavy gauge polythene film, which further restricts the rate of air penetration into the cargo.

The second danger arises from the fact that, even if concentrate cargoes do not heat, they absorb oxygen such that the atmosphere above the cargo, in a hold that is inadequately or not at all ventilated, may become deficient in oxygen and enriched with nitrogen. Air contains roughly 76% nitrogen and 20.8% oxygen and, as the oxygen is absorbed by the cargo, the oxygen content may fall to as low as 4%.

The minimum concentration of oxygen required in the atmosphere to support life is 19.5%. It is vital to gauge the atmosphere before entering the hold. Fatal accidents have occurred where persons have entered fully closed holds loaded with concentrates where the oxygen content was too low.

8.4 Nickel Ore which May Liquefy

Nickel ore cargoes carry a risk of liquefaction during carriage and liquefaction incidents have resulted in several ship losses, such as the *'Emerald Star'* in 2017. In recent years, the majority of liquefaction incidents relate to nickel ore cargoes being exported from Indonesia and the Philippines, although the risk of liquefaction is common to all nickel ore cargoes. The risk is increased at these ports during the rainy season, which is increasingly variable due to changing weather patterns.

Amendment 02-13 of the IMSBC Code, which entered into force on 1st January 2015, includes the addition of nickel ore as a Group A cargo (with a risk of liquefaction). If the moisture content of nickel ore exceeds its transportable moisture limit (TML), it may liquefy. This has the potential to cause instability and capsizing of the ship.

While the can test is a conventional method used by Masters and surveyors for cargo, the actual moisture content (MC) and TML can only be verified during laboratory analysis, as confirmed on the cargo certificates and declaration. The Master should not load the cargo without confirmation of the MC and TML. Additionally, the Master should pay close attention to the weather, particularly rainy weather, and monitor the cargo ashore to ensure it is not loaded wet.

8.5 Carriage of Bauxite which May Liquefy

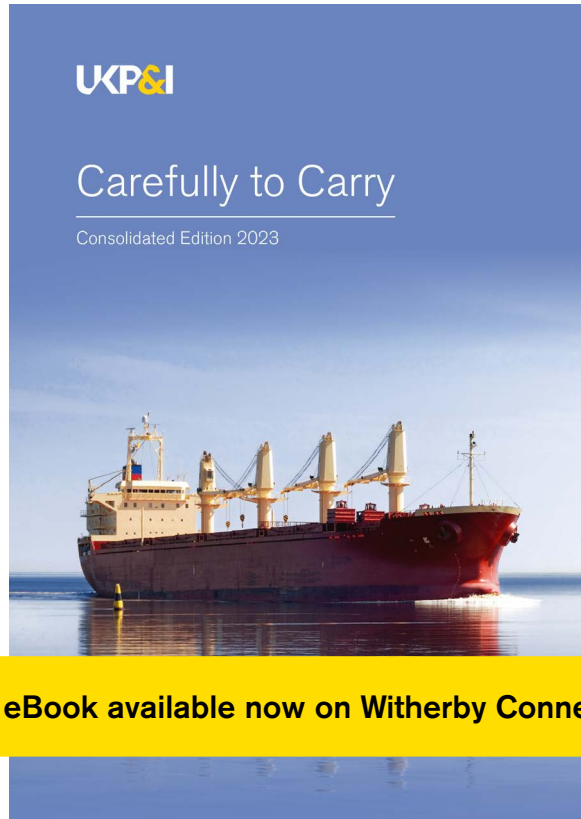
Following the loss of the Supramax bulk carrier '*Bulk Jupiter*' in January 2015, with the tragic loss of 18 lives, the IMO Sub-Committee on the Carriage of Cargoes and Containers (CCC), at its second session in September 2015, noted that the loss of the ship may have been caused by liquefaction of the cargo. Circular CCC.1/Circ.2 'Carriage of Bauxite which may Liquefy' was issued at that time to raise awareness of the potential risks posed by moisture in the carriage of bauxite. Bauxite was described in the IMSBC Code at that time as a Group C cargo, and the potential for this cargo to liquefy was not specifically addressed. Subsequent work undertaken by the industry Global Bauxite Working Group (GBWG) in conjunction with competent authorities indicated that there was a need to draw a distinction between the types of bauxite cargoes that can liquefy and those that do not. As a result of this work, the IMSBC Code was amended under Amendment 05-19 to include a new Group A cargo BAUXITE FINES and the existing schedule for BAUXITE, classified as Group C, was revised. The two schedules are distinguished primarily on the basis of a particle size distribution (PSD) criterion that, in simple terms, permits BAUXITE FINES to be loaded with a larger percentage of fine particles compared to BAUXITE, although drainage properties also come into consideration. The amended IMSBC Code entered into force on 1st January 2021.

The revised IMSBC Code includes the following amendments:

- A test procedure for determining the transportable moisture limit (TML) for bauxite
- addition of a new schedule for BAUXITE Group A, with the shipping name BAUXITE FINES
- amendments to the schedule for BAUXITE Group C.



Price: £95



This comprehensive publication, compiled by the UK P&I Club, details best practice for the carriage, loading and storage requirements of a wide range of cargoes. It also contains essential information on draught surveys and preparing cargo plans.

Outlining and expanding on all major international cargo regulations and guidelines, it also includes detailed checklists, information on draught surveys and guides to preparing cargo plans. Cargoes covered include timber, gas, grain, steel and other metals, bulk goods and refrigerated goods.