CARGO AND CARGO HOLD VENTILATION

INTERCARGO
International Association of Dry Cargo Shipowners

Standard Club

DNV·GL

CONTENTS

1 INTRODUCTION

THE PURPOSE OF THIS GUIDE

This guide has been produced to provide vessel Masters and crew with a clear and concise understanding of the ventilation requirements for various dry bulk and bagged cargoes. Such awareness will assist in preventing claims for cargo damage, contamination, additional survey costs, delays to ships, avoiding disputes over off-hire and charter party issues, and most importantly averting accidents and injury to crew and other personnel.

Further understanding is gained through the inclusion of the applicable regulatory requirements that are included throughout this guide.

WHAT IS VENTILATION

Ventilation, in its most basic form, is the supply of fresh air into a space. On bulk carriers, this generally means the provision of fresh air into the cargo holds, which is achieved through either natural or mechanical means. In broader terms, ventilation is understood to be all the steps taken to prevent damage to cargoes from condensed moisture within the cargo holds. One such option for preventing condensation within a cargo hold is the method of air conditioning of the cargo hold atmosphere by the use of a dehumidifier in an internal circulation mode, which does not fit in the narrow definition of ventilation.

REASONS FOR VENTILATION

The primary purposes of ventilation are to minimize damage to the cargo and to ensure the safety of the crew and vessel. This is achieved by

- minimizing the formation of sweat by dew point control,
- removing hazardous gases which may be emitted by the cargo,
- preventing excessive heating of the cargo, and
- removing taint.

GENERAL REGULATORY REQUIREMENTS

The requirements on ventilation for dry bulk cargoes are governed by **Regulation II-2/19** of the **International Convention for the Safety of Life at Sea (SOLAS)** as well as the relevant IMO circulars and the **International Maritime Solid Bulk Cargoes Code (IMSBC Code)**.

The requirements of **SOLAS Regulation II-2/19** (formerly Regulation 54) entered into force with the 1981 SOLAS amendments and are applicable to all ships with a keel-laying date on or after 1 September 1984 (1 July 1992 for ships less than 500 GT).

The IMSBC Code came into force on 1 January 2011 and is applicable to all ships engaged in the carriage of dry bulk cargoes, irrespective of the keel-laying date. Some of the provisions continue to be for information and recommendation purposes only. However, the provisions on ventilation in section 3.5 and in the individual schedules of solid bulk cargoes in Appendix 1 of the IMSBC Code are treated as mandatory.

From a regulatory perspective, the reasons for ventilating are purely safety based, with the following objectives:

- The occurrence of an explosive atmosphere in cargo holds shall be avoided.
- Toxic gases and vapours shall be removed from the cargo holds as far as possible.
- Toxic gases, vapour and dust shall be kept away from accommodation spaces.
- Special attention shall be paid to oxygen-depleting cargoes.
- Self-heating properties of cargoes shall be considered when applying ventilation.

2 TYPES OF VENTILATION

The cargo holds of most dry cargo ships have either natural or mechanical ventilation systems.

All ventilation trunks should be made of steel according to the requirements of the classification societies. The interconnection of ventilation systems for cargo holds with other spaces is not permitted. Ventilator openings on deck shall have a height of at least 900 mm in Position 1 and at least 760 mm above the deck in Position 2 (see Figure 10).

NATURAL VENTILATION SYSTEM

A natural ventilation system, as the name suggests, is based on nature's law of air circulation. Air can enter and leave the hold through the vents located above the deck level. This allows cool, heavier air from the outside atmosphere to replace the lighter, rising warm air inside the cargo hold.

Some older designs of dry cargo ships were fitted with ventilator shafts leading to the lower parts of the cargo hold. In these cases, air circulation in the cargo hold was achieved by trimming the ventilators (cowl direction) with respect to the wind direction. This was more effective on general cargo ships carrying bagged or breakbulk cargoes requiring through ventilation.

Through ventilation is when the air is forced into the body of the cargo. It is generally not required for solid bulk cargoes and is difficult to achieve. When a hold is loaded with a solid bulk cargo, the ventilation provided is usually surface ventilation, with air flowing over the surface of the cargo from ventilators.

On newer designs of dry cargo ships (particularly bulk carriers), the hinged-door type ventilators are often fitted on the sides of the hatch cover. These can then be opened depending on the relative wind direction to provide adequate surface ventilation within the cargo hold.

Figure 1: External view of hinged-door ventilator on cargo hold hatch cover side (photo courtesy of Optimum Marine Management Ltd.)

Figure 2: Internal view of hinged-door ventilator on cargo hold hatch cover side (photo courtesy of Optimum Marine Management Ltd.)

Hinged-door type ventilators can also be found in casings attached to the main deck, and gooseneck vents can also be attached to the hatch covers.

Figure 3: Hinged-door natural ventilator in casing on main deck (photo courtesy of OLDENDORFF CARRIERS GmbH & Co. KG.)

Figure 4: Gooseneck ventilation pipe fitted to hatch cover (photo courtesy of Navios ShipManagement Inc)

For cargoes liable to emit toxic gases, natural ventilation is required (**IMSBC Code subsection 3.5.1**) as a minimum. The ventilation shall be arranged such that toxic gases, vapours or dust cannot enter accommodation spaces (**IMSBC Code subsection 3.5.5**). A proper distance[1] between ventilation outlets and accommodation spaces should be kept.

Figure 5: Gooseneck ventilator at cargo hold entrance (photo courtesy of OLDENDORFF CARRIERS GmbH & Co. KG.)

According to **SOLAS Regulation II-2/19.3.4.3**, natural ventilation shall also be provided if there is no provision for mechanical ventilation. However, for some cargoes this is in contradiction to the requirements of the IMSBC Code. The IMSBC Code stipulates some cargoes shall not be ventilated during the voyage. In this case, the operational requirement of the IMSBC Code should be applied irrespective of SOLAS regulations.

In addition, ventilation may be required if the cargoes are liable to deplete oxygen (**IMSBC Code Appendix 1**). Prior to the entry of cargo holds and enclosed spaces adjacent to cargo holds, the atmosphere must be measured and spaces must be ventilated, as necessary. The means of ventilation are not described in the IMSBC Code. For cargo holds, natural ventilation can be sufficient, whereas the ventilation of adjacent spaces is usually supported by mobile ventilation fans. Recommendations for entering enclosed spaces can be found in **IMO Resolution A.1050(27)** "Revised recommendations for entering enclosed spaces aboard ships".

[1] Neither SOLAS nor the IMSBC Code specify what a proper or appropriate distance should be, however, for toxic gases. DNV GL specifies 10 m (DNV-GL-RU-SHIP Pt.6 Ch.5 Sec.10 [3.9.3]).

MECHANICAL VENTILATION SYSTEM

Figure 6: Hinged-door mechanical ventilation – exhaust vent (photo courtesy of OLDENDORFF CARRIERS GmbH & Co. KG.)

Mechanical ventilation, in contrast, is a system where the movement of air is forced using electrical fans within the ventilator shafts. All type of fans can be present in cargo holds (exhaust, supply or reversible). With some systems, it is possible to vary the speed of the fans to further control the ventilation.

An open-circuit system draws atmospheric air into the hold by fan induction and exhausts it from the hold by fan extraction.

The capacity of a ship's hold ventilation fans is normally expressed in the number of air changes that can be achieved in an empty hold per hour. When cargo is carried, the number of air changes per hour increases, as there is less air in the hold.

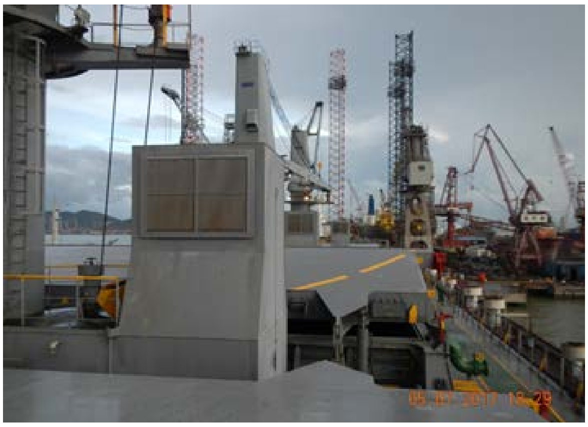


Figure 7: External view of mechanical ventilation casing with louvre on the main deck (photo courtesy of Ionic Shipping (Mgt) Inc.)

Figure 8: View of cargo hold mechanical ventilation impeller from inside the cargo hold – cross-deck (photo courtesy of Ionic Shipping (Mgt) Inc.)

Mechanical ventilation is to be provided for cargoes liable to emit flammable gases or vapours in an amount which can form an explosive atmosphere with air (**IMSBC Code subsections 3.5.1 and 9.3.2.1.3**).

For some cargoes like FERROSILICON 1408[2] or ALUMINIUM SILICON POWDER, UNCOATED 1398, the mechanical ventilation system must have a capacity of at least six air changes per hour based on an empty cargo space for removal of gases and vapours from cargo holds (SOLAS Regulation II-2/19.3.4.1 and the IMSBC Code Appendix 1). For the removal of gases and vapours, exhaust ventilation is recommended.

For other cargoes, a specific capacity is not clearly defined. In this case, the ventilation should be adequate to avoid the build-up of a flammable atmosphere.[3]

For cargoes with self-heating properties, mechanical ventilation should only be applied in special circumstances. In no case shall the ventilation be directed into the body of the cargo (**IMSBC Code subsection 3.5.6 and Appendix 1**).

[2] This requirement is applicable to both ferrosilicon schedules in IMSBC Code: FERROSILICON UN 1408 with 30% or more but less than 90% silicon (including briquettes) and FERROSILICON with at least 25% but less than 30% silicon, or 90% or more silicon.
[3] Clarification from the shipper should be sought on a case-by-case basis to determine the correct amount to ventilate.

Figure 9: Mechanical mushroom-type ventilator (photo courtesy of Liberty Maritime Corporation)

Continuous ventilation is required for cargoes that fall under IMDG Class 4.3 and are substances which, in contact with water, emit flammable gases, such as hydrogen gas, falling within the UN N.5 test as Dangerous Goods. In addition to Class 4.3 cargoes, there are cargoes assigned MHB (WF) such as 'FERROPHOSPHORUS (including briquettes)' and 'FERROSILICON with at least 25% but less than 30% silicon, or 90% or more silicon' that also require continuous ventilation.

IMSBC references to continuous ventilation requirements can be found within **IMSBC Code subsections 3.5.3 and 3.5.4**.

However, cargoes with a low gas evolution rate, such as DIRECT REDUCED IRON (A), or cargoes where ventilation would support the self-heating process, such as COAL, shall only occasionally be ventilated.

If continuous ventilation is required, the cargo holds shall be ventilated by a mechanical ventilation system during the entire voyage. The ventilation should not be interrupted even in adverse weather conditions. In addition, for some cargoes, two separate fans are to be provided per cargo hold to maintain forced ventilation if one fan fails (**IMSBC Code Appendix 1**). For continuous ventilation, the ventilation openings shall comply with the requirements of the **International Convention on Load Lines (ICLL) Regulation 19(3)** for openings not fitted with weathertight closures. In this case, the openings shall be arranged at least 4,500 mm above the deck in Position 1 and at least 2,300 mm above the deck in Position 2 (see Figure 10).

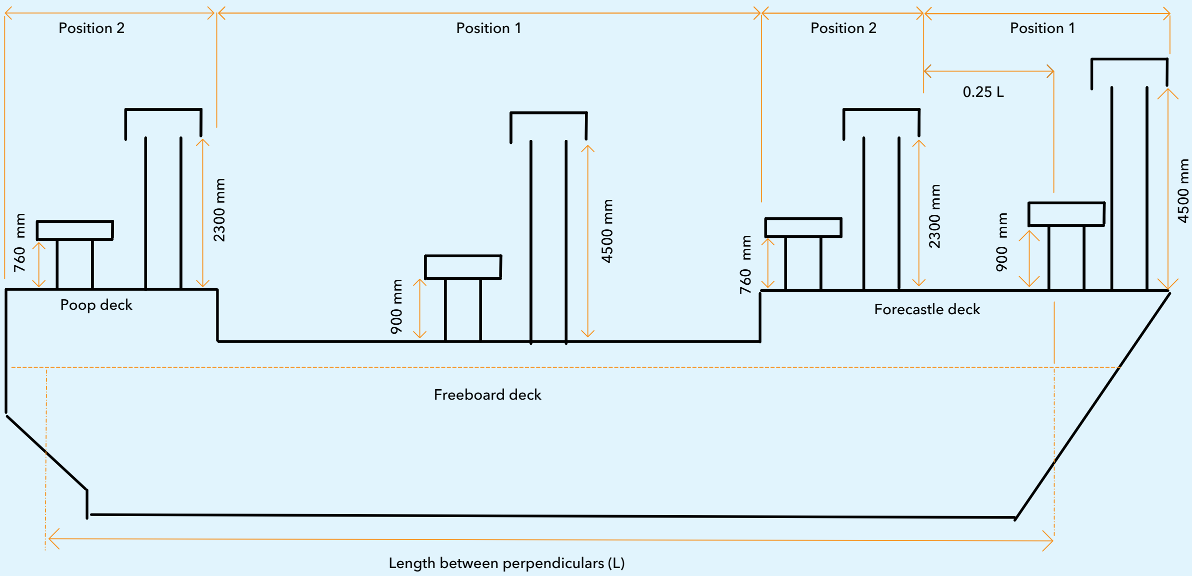


Figure 10: Sill heights of ventilation openings

It is important to note that if a wrong decision has been made to ventilate cargo on ships with means for mechanical ventilation, when in fact the cargo should not have been ventilated, the resulting damage to the cargo would be much greater than the cargo damage caused by improper ventilation on a ship provided with natural ventilation only, due to mechanical ventilation having much greater air exchange capacity than natural ventilation.

MECHANICAL DEHUMIDIFYING OF CARGO HOLDS

It is important to be aware that on some voyages the only way of removing moisture from the cargo hold atmosphere, thereby eliminating the possibility of condensation, is through air-conditioning of the hold.

Figure 11: Portable Dehumidifiers (photo courtesy of Neda Maritime Agency Co. Ltd).

A closed-circuit system uses a dehumidifier and temperature control system so that each hold can be supplied or recirculated with dry air. The air is dried by drawing it through a conditioning plant with a moisture absorbing solution before it is passed into the cargo hold ventilation system.

Alternatively, portable dehumidifiers can be fitted in the cargo holds to remove moisture from the hold air and control the dew point. These dehumidifiers utilize a desiccant material to reduce moisture content in the air. Typical systems may include a fluted or corrugated media configured in a rotating mass. As the air passes through the flutes of the material, it contacts the desiccant and gives off its moisture.

VENTILATOR MAINTENANCE

To satisfy SOLAS requirements, every ventilator should have a positive means of closing. The closing mechanism could be in the form of a weathertight door or a ventilator flap (or damper) set within the vent trunk and operated by an external lever, or it may consist of a cowl which can be screwed down into a closed position by the operation of a valve wheel. It is essential that the closing devices are maintained and in a good condition, which includes being greased as needed and inspecting the gaskets to ensure an effective seal, especially in the case of a fire or shipping spray in the vicinity of ventilator intakes.

Figure 12: Mechanical ventilation with integrated closing damper (photo courtesy of OLDENDORFF CARRIERS GmbH & Co. KG.)

Ventilation ports and fan spaces must be checked for possible loose rust or paint chips that might fall onto the cargo, causing contamination. Prior to any loading operation, the fans for mechanical ventilation should be checked to ensure they are in operation.

It is recommended that the ventilators are prominently and permanently marked with the space (that is being serviced by the vent) and that it is indicated whether the shut-off is open or closed with the direction of the damper mechanism.

3 CARGO SWEAT AND SHIP SWEAT

Cargo damage caused by moisture, or "moisture damage", is one of the most significant reasons for cargo claims and, in many instances, is the direct result of cargo or ship sweat. Sweat is condensation that occurs when the dew point has been reached. When this condensation materializes on the cargo, this is known as cargo sweat, and when on the ship's structure, it is called ship sweat.

WHAT IS CARGO SWEAT?

Cargo sweat occurs when warm moist air is introduced into cargo holds and comes into contact with cold cargo. This usually happens when cargo is loaded in a cold climate, and the vessel then sails to a warmer climate. The cargo holds are ventilated, and warm air is introduced into the holds. A typical example would be steel products loaded in winter in China and bound for Southeast Asia.

Figure 13: Surface corrosion or rust due to cargo sweat (photo courtesy of The Standard Club)

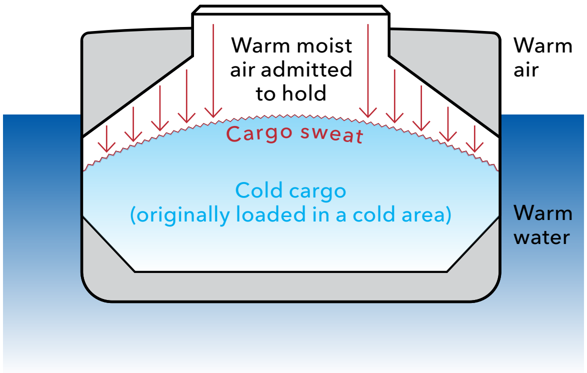


Figure 14: Cargo sweat

WHAT IS SHIP SWEAT?

Figure 15: Ship sweat on the underside of the cargo hold hatch cover (photo courtesy of CWA International Ltd)

Figure 16: Ship sweat on the shell and side frames of the cargo hold (photo courtesy of Fleet Management Limited)

Ship sweat is the condensation on the ship's structure that occurs when warm air in the cargo hold comes into contact with the cold steel structure in the hold. This typically occurs when cargo is loaded in a warm climate and the vessel then sails on a voyage to a colder climate.

In such cases, cargo may get damaged by overhead drips or by contact with sweat which has formed on the ship's sides or by condensed water which may accumulate at the bottom of the hold.

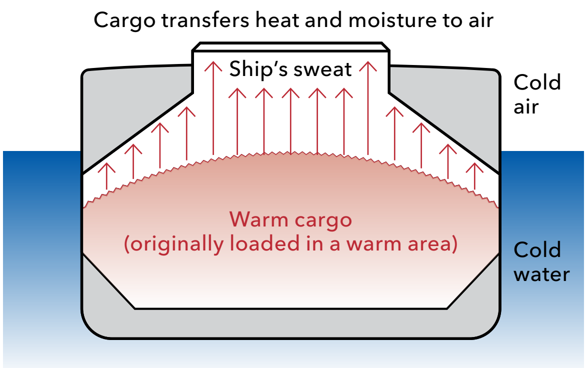


Figure 17: Ship sweat

UNDERSTANDING RELATIVE HUMIDITY, DEW POINT AND GUIDE TO ITS MEASUREMENT

To fully understand cargo sweat and ship sweat, the following terms need to be considered and understood: Relative humidity, in simple terms, is the amount of water vapour in the air. It is expressed as a percentage of the maximum amount of water vapour that can be held in the air. When there is 100% relative humidity, the air is saturated with water vapour and cannot hold any more moisture.

With that said, however, the amount of vapour that can be held in a gas varies with the temperature of that gas. The higher the temperature, the higher the amount of vapour that can be held. Equally, the lower the temperature of that gas, the lower the amount of vapour that can be held in the gas. Thus, relative humidity is the ratio of water vapour in the air to the maximum amount of water vapour that can be held in the air at a given temperature.

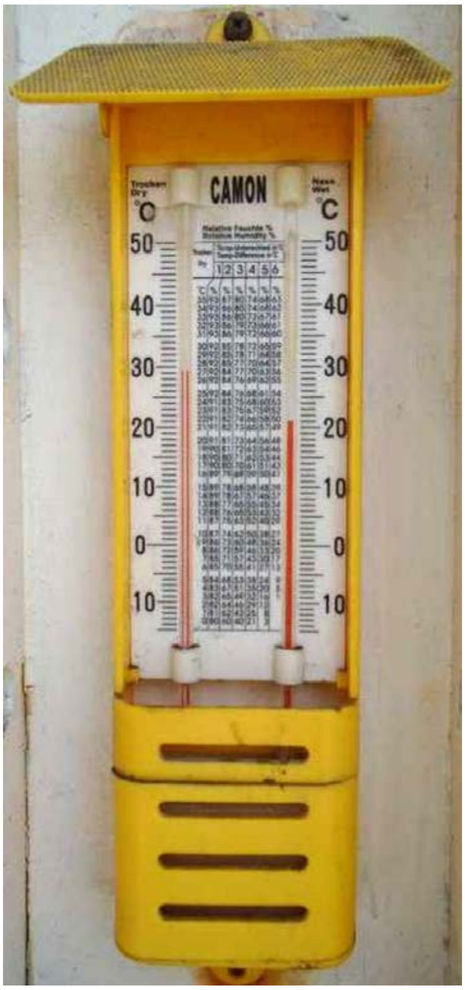


Figure 18: Traditional wet-bulb/dry-bulb thermometer (photo courtesy of Emarat Maritime LLC)

As warm air can hold more water vapour, the relative humidity as a percentage will decrease as the temperature increases, and vice versa, even though the actual or absolute amount of moisture remains the same.

Dew point is the temperature at which the air becomes saturated and will condense. As discussed above, for a given air, the relative humidity will increase as the temperature cools. If the air cools enough, it will become saturated and have a relative humidity of 100%. At this point, it will start to condense. This is the dew point.

Dew point can be measured by a number of methods and instruments. The traditional method is to use a wet-bulb/dry-bulb thermometer combined with a dew point table.[4]

A wet-bulb/dry-bulb thermometer, as the name suggests, contains two thermometers:

A wet-bulb thermometer indirectly measures the moisture content of the air. It is a standard thermometer that has a piece of cloth or sock wrapped around its bulb, which is kept moist by distilled water. As water evaporates from the sock, it cools the bulb, which in turn lowers the temperature. The higher the moisture content in the air, the lesser the amount of water that evaporates from the sock, and thus the less the wet-bulb temperature will drop.

A dry-bulb thermometer is a standard ordinary thermometer that measures the ambient air temperature.

The readings of the two thermometers are then compared and the dew point can then be obtained by using a dew point table.

It was once standard practice that a wet-bulb/dry-bulb thermometer was kept on each bridge wing in a Stevenson Screen. However, this has become less common today. The wet-bulb/dry-bulb thermometer on the bridge wing would obviously not provide the temperature and dew point in the cargo holds or on the deck and thus a whirling psychrometer (a hand-held device containing a wet-bulb/dry-bulb thermometer) was traditionally used. For time efficiency, it is now common practice to instead use electronic psychrometers and hygrometers.

[4] See Appendix 2 for an example of a dew point table.

Figure 19: Whirling psychrometer with case, instructions and dew table (photo courtesy of OLDENDORFF CARRIERS GmbH & Co. KG.)

Figure 20: Whirling psychrometer in use (photo courtesy of Fleet Management Limited)

For steel cargoes only, some operators, for reasons of efficiency and general convenience, use "multi-channel wireless hygro-thermometers". The transmitters are fixed to magnets and then placed on the bulkhead low in the cargo hold. Using these thermometers is simple: crew members simply walk up the deck with a remote sensor, wait for the right channel to be received (remote sensors send a signal every one to two minutes) and take a reading. The whole recording process of temperature and relative humidity for five cargo holds can be performed in around 20 minutes rather than the two to three hours needed when using a hand-held psychrometer. The dew point can then be calculated using dew point tables. Good practice would be to label the hygro-thermometers "non-intrinsic meter – use with steel cargoes".

Figure 21: Wireless hygro-thermometer – transmitter and reader/sensor

4 WHEN TO VENTILATE

Ventilating the cargo is not merely allowing the outside air into the cargo hold; it is a precise process where a number of factors need to be considered. Failing to adhere to correct requirements may cause cargo damage and result in substantial claims. The decision to ventilate should be taken after considering the following factors:

- Instructions contained in the charter party or voyage order
- Temperature, nature and requirements of the cargo
- Temperature, relative humidity and dew point of air inside and outside the hold
- Sea temperature, as it may lower the temperature of the hold steel adjacent to or in contact with the sea, resulting in condensation forming on the shell plating (ship sweat)
- Vent opening should not be exposed to sea spray

A review of all of these factors can predict the risk of sweat, and therefore, broadly speaking, it can be decided whether ventilation is necessary or to be prevented.
In general, there are two ventilation rules which the Master should check and confirm when voyage orders are received. If these instructions are at odds with what he would expect for his vessel, he is advised to be prudent and clarify instructions before execution.

DEW POINT RULE

- **Ventilate** if the dew point of the air inside the hold is higher than the dew point of the air outside the hold.
- **Do not ventilate** if the dew point of the air inside the hold is lower than the dew point of the air outside the hold.

Prior to entering the cargo hold, due regard needs to be given to cargoes that are liable to oxidize (causing oxygen depletion inside the hold) or to emit toxic gases. In such a case, any entry (if necessary) should be done in accordance with enclosed space guidelines (after proper ventilation, gas checks and with proper PPE).

THREE DEGREE RULE

In many instances, it is impractical to measure hold dew point temperatures accurately, or at all. In such cases, ventilation requirements may be estimated by comparing the average cargo temperature at the time of loading with the outside air temperature. This should be done several times a day.

- **Ventilate** if the dry bulb temperature of the outside air is at least 3°C cooler than the average cargo temperature at the time of loading.
- **Do not ventilate** if the dry bulb temperature of the outside air is less than 3°C cooler than the average cargo temperature at the time of loading, or warmer.

This rule avoids the need to take readings in the holds after the voyage has commenced and relies on the fact that the temperature of the cargo mass, except at the boundaries, only slowly changes during a voyage. In order to apply the rule, it is necessary for the ship's crew to take a number of cargo temperature readings during loading. Hand-held infrared thermometers are ideal for this task.

Based on the above considerations, if ventilation can and has to be carried out, it should continue to take place not only in daytime but, importantly, also at night.

Generally, on a voyage from cold to warm regions, no ventilation is required; but from warm to cold regions, surface ventilation is required.

Figure 22: Drip lines from ship sweat on cargo surface (photo courtesy of CWA International Ltd)

RECORDKEEPING

It is the carrier's responsibility to ensure that ventilation is conducted in accordance with voyage instructions and that entries are made accurately in the relevant logbook concerning items which could affect the condition of cargo, as this will later assist the shipowners in documenting their case in the event of a cargo claim.
The following should be recorded from the time of arrival at the port of loading, throughout the voyage, and up to completion of discharge:

- Outside air temperature and dew point
- Hold air temperature and dew point
- Sea temperature
- Hold bilge soundings
- Weather conditions (wind speed and direction, sea conditions, precipitation)
- Times when hold ventilation started and stopped
- Times when hatches are opened and closed
- Any incidence of rain during cargo operations
- Times when barge hatch covers are opened and closed
- Moisture levels of cargo during loading
- Photographs taken during loading
- Times when hold bilges are pumped out
- Results of hatch cover weathertightness tests (preferably ultrasonic leak test) before loading

Provided it is safe to enter, the cargo spaces should be inspected regularly to check for signs of sweat. Results of the inspection should be documented.

If ventilation is impossible due to inclement weather or adverse sea conditions, it is of utmost importance that the times of interruption of ventilation, together with all relevant aspects of weather and sea conditions, are logged.

A number of cargoes have special ventilation requirements. Broadly, there are two groups of cargo prone to significant risk due to condensation/sweat and these are:

- Hygroscopic cargoes
- Hazardous cargoes

HYGROSCOPIC CARGOES

Hygroscopic cargoes are cargoes that contain natural moisture content, such as **agricultural products (grains or animal feed), FERTILIZER, SALT, SUGAR, TIMBER and WOOD PULP**. They have a tendency to absorb, retain or release moisture depending on the surrounding atmosphere. This may lead to a build-up of moist air inside the hold, causing self-heating or spreading of moisture in the cargo and results in caking or cargo damage. Maintaining the quality of cargoes that are hygroscopic in nature depends on monitoring and controlling moisture content within a safe range.

The risk of sweat on a voyage from a cold to warm climate is low, but on a voyage from a warm to cold climate, there is a high danger of ship sweat occurring during carriage. Ventilation may be necessary to replace the moist air inside the cargo hold with drier outside atmospheric air.

Some hygroscopic cargoes, particularly **FERTILIZER and SALT**, when carried in bulk, should not be ventilated during the voyage if they are in a sound state at the time of shipment, as ventilation could increase the risk of moist sea air entering the cargo hold, increasing the moisture content of the cargo.

HAZARDOUS CARGOES

Ventilation is equally important for solid bulk cargoes that are susceptible to oxidation (e.g. seed cake), which can cause oxygen depletion inside the holds or produce carbon dioxide and carbon monoxide. Entry of personnel into cargo spaces for such cargoes shall not be permitted until tests have been carried out and it has been established that the oxygen content has been restored to a normal level and hazardous gases are absent.

For hazardous cargoes, the IMSBC Code states: "… unless expressly provided otherwise, when cargoes which may emit toxic gases are carried, the cargo spaces shall be provided with mechanical or natural ventilation; and, when cargoes which may emit flammable gases are carried, the cargo spaces shall be provided with mechanical ventilation."

SEED CAKE UN 1386 (a) stipulates that cargoes should not be mechanically ventilated (except in an emergency) and caution is required when mechanically ventilating other hazardous seed cake cargo, as it may enhance the oxidation process, causing self-heating or spontaneous combustion.

WOOD PELLETS can decompose and ferment over time, producing carbon monoxide and carbon dioxide. Thus, confined space entry requirements should be followed when carrying this cargo.

Some cargoes, like SILICOMANGANESE or FERROSILICON, are not liable to oxidize but may emit toxic gases or fumes and hydrogen gas, particularly when wet. Masters are recommended to follow specific instructions from the IMSBC Code and cross-check against the charter party or voyage instructions. In case of any doubt as to the exact nature of the cargo or the carriage requirements, it would be prudent to clarify the instructions and comply with the stringent regime.

For cargoes like COAL and DIRECT REDUCED IRON (A), only surface ventilation should be conducted when necessary to dissipate gases. Air should not be directed into the body of the cargo, as it is likely to cause the cargo to self-heat. When mechanical ventilation is used, the fans should be certified as explosion-proof and must prevent spark generation. Wire mesh guards must be fitted over inlet and outlet ventilation openings, and the escaping gases must not be able to enter living quarters.

For coal cargoes, the IMSBC Code requires that, unless expressly provided otherwise, surface ventilation of the cargo holds carrying this cargo should be done for the first 24 hours after departure from the load port. During this period, the atmosphere in the cargo spaces shall be monitored once from one sample point per cargo space. In order to obtain meaningful measurement of the gases, the ventilation needs to be stopped for a suitable period (the IMSBC code recommends that this period is not less than four hours) before readings are taken. When the methane concentrations are at an acceptably low level, the holds should be sealed and gas monitoring should continue. In any event, the atmosphere in the cargo spaces shall be monitored on a daily basis.

Certain cargoes, including direct reduced iron, are known to be particularly reactive with moisture; and in contact with water, these cargoes have the propensity to release hydrogen, which is a flammable gas forming an explosive mixture in air. Care needs to be taken, particularly during inclement weather conditions, as using mechanical ventilation may deliver moist air (salt water) to the cargo holds and accelerate the release of hydrogen.

Some direct reduced iron requires an inert gas (nitrogen is preferred) to be introduced into the cargo hold prior to loading in order to purge the air from the cargo and form a blanket over the top of the cargo. In these instances, suitable gas meters will be required on board.

Self-heating coals liberate higher quantities of methane as the coal temperature rises due to oxidation. This becomes especially noticeable after coal reaches 40°C. The methane release continues exponentially as the coal oxidizes up to the upper threshold of the oxidation processes, typically 65°C to 70°C. Above this threshold, exothermic release of heat continues at a more accelerated pace as pure oxidation processes gives way to the start of what is more of a pure chemical reaction process. Coal temperatures reaching 55°C require special awareness. While still not critical, the coal requires careful handling procedures so as to not exacerbate the heating curve.

It is important to ventilate holds to lower methane levels to acceptable levels 25% to 35% LEL, all the while limiting and avoiding the over-ventilation of the cargo hold that will cause a fresh supply of oxygen which worsens the self-heating properties.

Generally speaking, the ventilation of methane (natural ventilation) occurs faster than the increase of oxygen into the cargo hold, as methane is a lighter-than-air flammable gas. In most cases, only the air vent on the down-wind side of the hatch should be used. It helps to allow the venting of methane gases and the slow increase of oxygen content in the holds.

Oxygen content for self-heating coals will frequently see oxygen levels in the 4% to 8% range. For this reason, only non-catalytic sensors should be used in gas-monitoring equipment (the most common type). The use of infrared sensors for LEL determination will provide reliable results, avoiding issues with false readings and casting aside doubts about meter accuracy and the over-ventilation (frequency) of cargo holds.

Ideally, through trial and error, holds after the third day of transit should be only "partially ventilated" (natural ventilation) based upon the trends for methane and oxygen. Trial and error and knowledge of the methane-oxygen trend will help optimize the ventilation period where LEL methane levels are dropped to 25% to 35% LEL and oxygen allowed to rise to no more than 13% to 15%.

Self-heating coals emit carbon monoxide during the oxidation and chemical processes. Methane is often released as a result of self-heating, and ventilation often requires a careful balance between keeping the coal starved of oxygen with just enough ventilation to reduce risk associated with the methane.

As a generalized statement, higher rank coals tend to have a greater propensity to evolve methane, compared to the lower rank coals which are more prone to self-heating. Additionally, particle size, moisture content, ash yield and other factors serve to influence methane properties of coal as well. Smaller particle sized coals also have a larger influence on both self-heating and methane emitting properties. The pH values of the water draining from coal may provide a tell-tale to a coals propensity for self-heating, as both sulphur and moisture content are indicative of coals with a greater propensity to self-heat.

It is just as important after ventilation to re-take gas and temperature readings (after 20 to 30 minutes) to establish a new "starting point" for gas and temperature. This practice will help establish the duration of natural ventilation needed to optimize gas reduction whilst maintaining the cargo under a low-oxygen environment. It is important that all the relevant temperature and gas monitoring logs and ventilation timings are carefully maintained for the following reasons:

- To indicate whether there is a build-up of dangerous gases
- To indicate whether the cargo is beginning to self-heat
- To establish "trends" for liberated gas and temperature changes from the cargo / cargo hold; for cargoes that do not require "constant ventilation", establishing the trend will provide added confidence and good seafarer-like practices, and help establish suitable intervals in which to ventilate the cargo holds
- To serve as evidence in defence of the carrier in the event of a cargo claim

For the carriage of cargoes which are liable to create an explosive atmosphere, the electrical equipment located in the hazardous area (zone 1) and extended hazardous area (zone 2) needs to comply with the requirements of IEC 60092-506 and IACS Unified Interpretation SC79.

Electrical equipment in hazardous areas must be certified by a notified body for use in dangerous environments. Explosion-proof-type electrical equipment is identified by the so-called apparatus group (protection against gas penetration) and the temperature class (maximum surface temperature to prevent ignition source). An overview is provided in Tables 1 and 2.

Non-essential electrical equipment not required during the voyage may be isolated from the electrical supply from a place outside of the hazardous area and secured against unintentional re-connection.

Apparatus group	Typical gas/vapour
IIA	Propane, methane
IIB	Ethylene, hexane
IIC	Acetylene, hydrogen
(Equipment certified for group IIC is also suitable for IIB and IIA. Equipment certified for group IIB is also suitable for IIA but not for IIC.)	

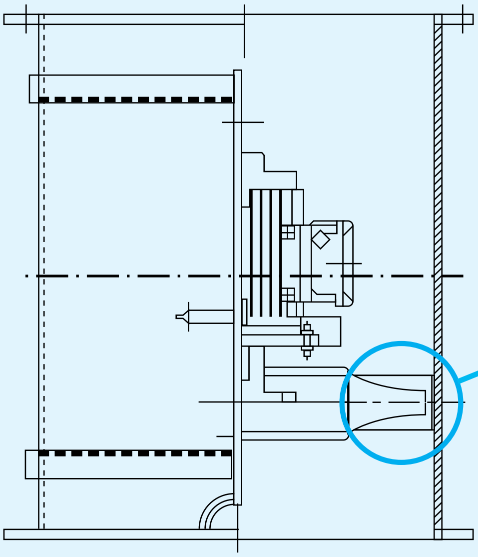
Temperature class	Max. surface temperature
T1	Less than 450°C
T2	Less than 300°C
T3	Less than 200°C
T4	Less than 135°C
T5	Less than 100°C
T6	Less than 85°C

Tables 1 and 2: Apparatus groups and temperature classes according to IEC 60079-0

In addition, protection against the ignition of dust must be considered. Depending on the properties of the cargo, a temperature class of T3 or more and degree of protection of IP5X (protection against dust penetration) for electrical equipment installed in hazardous areas can be required (IEC 60092-506).

The requirements for individual cargoes are governed in the publication of the International Electrotechnical Commission IEC 60092-506, Annex A.

In addition to the requirements for explosion-proof electrical equipment, the mechanical part of the fans shall feature a non-sparking design according to IACS Unified Requirement F29. The impeller and the trunk shall have a sufficient distance and be made of materials that cannot produce sparks even in abnormal conditions (i.e. damage to the bearing). This is typically realized with a brass, bronze or copper ring fitted in the fan casing in way of the impeller. Other possible solutions are described in the above-mentioned IACS publication. The distance between the casing and the impeller shall be not less than 10% of the shaft diameter in way of the impeller bearing, but not less than 2 mm and not more than 13 mm.



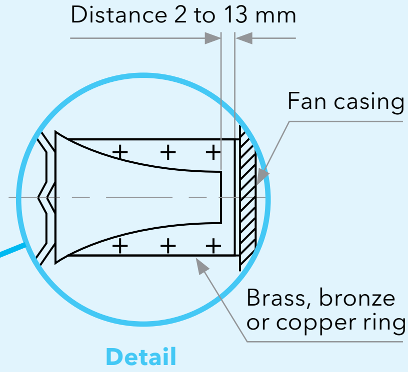


Figure 23: Example of non-sparking design

Figure 24: Example of non-sparking design

For various cargoes, wire mesh guards shall be fitted over the fan openings on deck. The wire mesh guards shall have a mesh size not exceeding 13 x 13 mm and shall prevent foreign objects entering the fan casing which could produce sparks with the rotating impeller (**SOLAS Regulation II-2/19.3.4.2 and MSC/Circ.1120**).

Figure 25: Fixed mechanical ventilator with wire mesh (photo courtesy of Fleet Management Ltd)

In addition, for the carriage of SEED CAKE UN 1386 (b), SEED CAKE UN 2217 and SULPHUR UN 1350, all ventilation openings on the deck shall be fitted with spark-arresting screens (**IMSBC Code Appendix 1**). These screens have a much finer mesh size than wire mesh guards. A definition of the term is not included in the IMSBC Code. However, the U.S. Coast Guard (**46 CFR §151.03-25**), for example, defines the mesh size as follows: single screen with at least 30 x 30 threads per square inch or two screens with 20 x 20 threads per square inch fitted in series not less than half an inch or more than one and a half inches apart.

5 CARGO STOWAGE

Generally speaking, for the majority of bulk cargoes, there are no specific stowage requirements; however, for some cargoes, such as steel products which are susceptible to rusting and especially hygroscopic cargoes, it is important that they do not come into contact with moisture. For those hygroscopic cargoes carried in bulk, as with most bulk cargoes, there is little that can be done in stowage terms to avoid contact with moisture, with sweat being controlled by ventilation.

BAGGED HYGROSCOPIC CARGOES

For bagged hygroscopic cargoes, it is recommended to use dunnage to maintain a clear air gap between the cargo and the ship's side. Sometimes vertical tunnels are created by shoring and dunnaging to ensure natural ventilation is possible to the bottom section of the stow.

Dunnage should be laid in a criss-cross fashion and effective drainage channels should be formed over the sloping hopper sides down to the tank-top. Bags on the lower layer, near the tank-top and in the vicinity of the lower hopper, should be palletized to effectively lift the cargo above the tank-top and to allow free drainage to bilge wells.

Plastic sheets should be laid between the cargo and the pallets/dunnage. If there are different grades of bagged cargo, then separation cloth (plastic sheet) should be placed between them in order to protect against moisture migration between the parcels. An overlap of at least 300 mm should be maintained between the plastic sheeting, and all joints should be taped together.

Styrofoam insulation sheets are suggested to be placed on the shell plating with a minimum overlap of around 100 mm, and the joints between sheets should be taped.

After completion of loading, the top surface of the bagged cargo should be covered with kraft paper to protect it against the possibility of condensation dripping from the underside of the hatch cover.

Other methods of dunnage include layers of kraft paper, Styrofoam, and plastic sheeting for hygroscopic cargoes intended for human consumption such as rice.

Figure 26: Uppermost layer of bagged cargo topped with craft paper (photo courtesy of OLDENDORFF CARRIERS GmbH & Co. KG.)

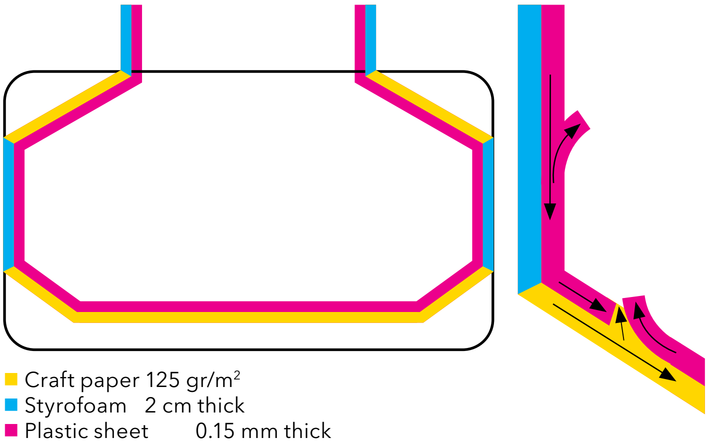


Figure 27: Correct layout and placement of layers of vital importance to protect the cargo (illustration courtesy of OLDENDORFF CARRIERS GmbH & Co. KG.)

Careful consideration of the layout and placement is needed of the various layers to ensure the cargo does not come into contact with water. Typically, this would mean the bottom of the upper plastic sheets being placed beneath the top of the lower plastic sheets; thus, any water or sweat dripping down the cargo would stay behind the plastic and not come into contact with the cargo.

It is prudent to consider mechanically ventilated vessels for such trade involving bagged cargoes. If the ship is not fitted with mechanical ventilators, then portable blowers can be considered to create thorough ventilation.

Figure 28: Layers of Styrofoam, kraft paper and plastic sheeting (photo courtesy of OLDENDORFF CARRIERS GmbH & Co. KG.)

Figure 29: Portable blower for mechanical ventilation (photo courtesy of NYK Line)

Bagged cargoes are considered "packaged goods" and do not fall under the regime of the IMSBC Code. For packaged goods classed as dangerous goods, the International Maritime Dangerous Goods Code (IMDG Code) is to be consulted instead.

NON-HYGROSCOPIC CARGOES

Non-hygroscopic cargoes like steel have no inherent moisture content; however, they may become damaged (rusty) in the presence of moisture.

When carrying such cargoes from a cold to warm climate, cargo sweat is likely if warm and moist outside air is introduced inside the cargo hold; hence, ventilation is not necessary, and the hold should be kept sealed. However, when loading in a warm climate, there may be a risk of ship sweat, making ventilation necessary. The only way to eliminate condensation in such cases is by using dehumidifiers in the cargo holds. However, it is recommended to ensure that the dehumidifier cabling does not compromise the integrity of the hold or pose a fire hazard. Dehumidifiers should drain directly to hold bilges, which should be pumped dry regularly, and records of bilge pumping operations should be maintained.

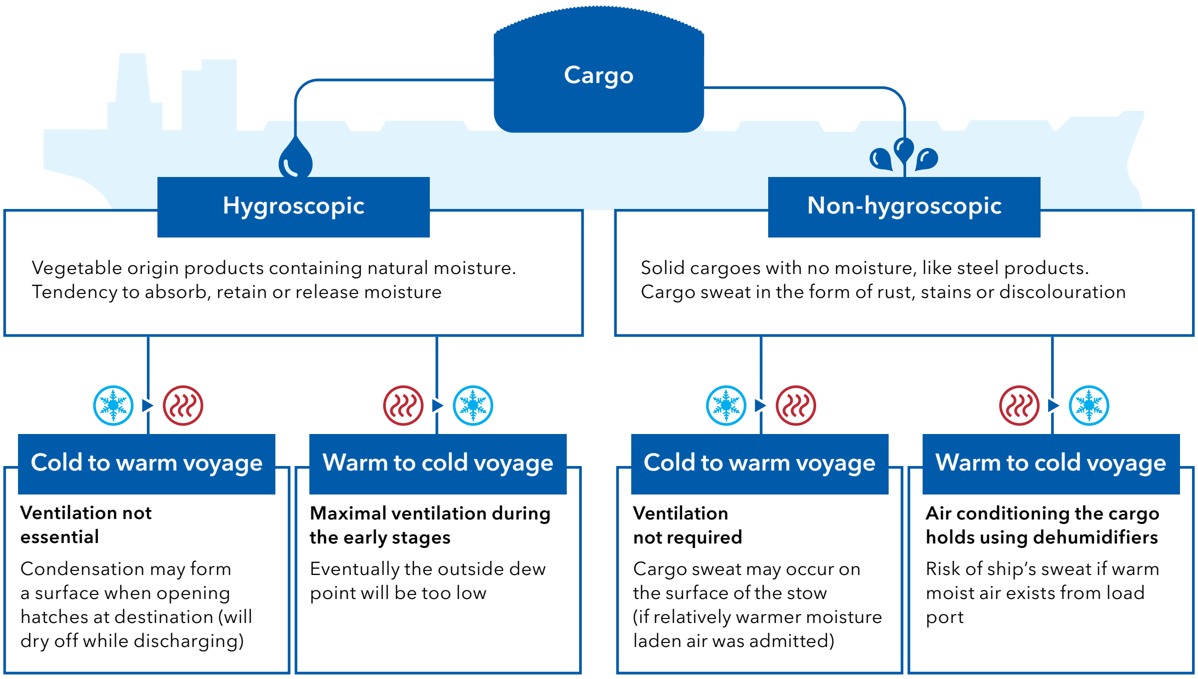


Figure 30: Hygroscopic vs. Non-hygroscopic cargo

Packing, stowing and dunnaging of such cargoes need careful consideration. Effective drain channels and clear air gaps are recommended to be maintained between the ship side and the cargo to allow any ship sweat to drain freely without coming into contact with the cargo.

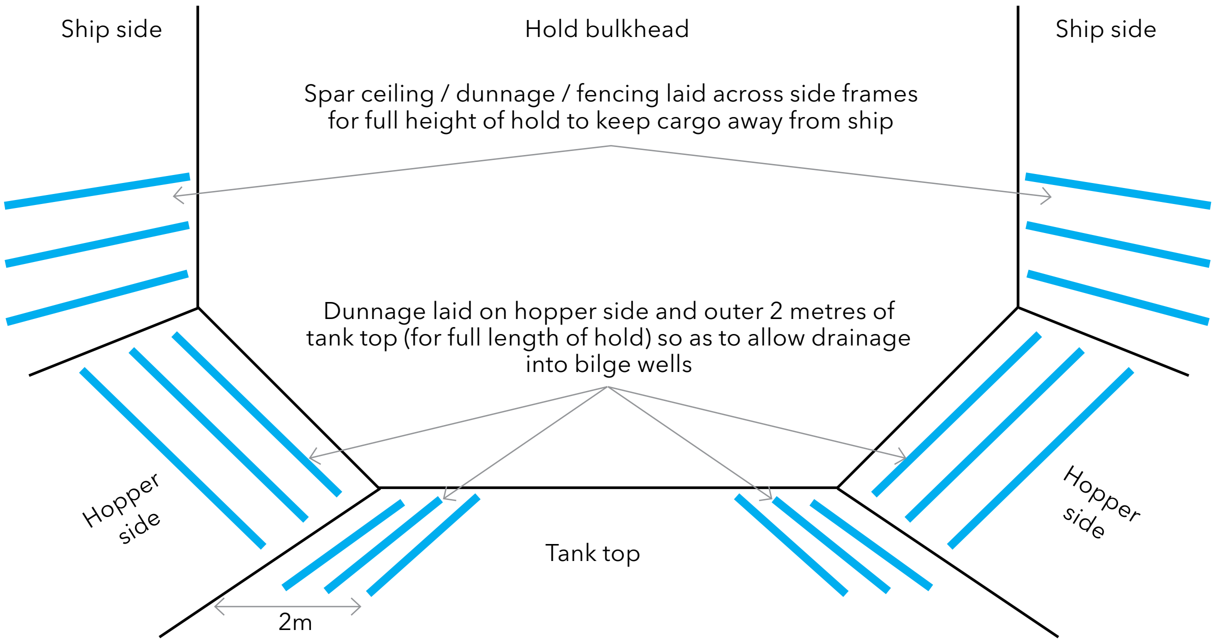


Figure 31: Typical dunnage arrangements for avoiding cargo contact with moisture

MIXED CARGOES

Problems may arise if hygroscopic and non-hygroscopic cargoes with different inherent temperatures are loaded into the same compartment. Their ventilation requirements may differ, resulting in damage to one or other of the products despite normal routines being followed. As far as possible, hygroscopic and non-hygroscopic cargoes should not be stowed together.

It is also important that these water-sensitive cargoes are not handled during precipitation. The Standard Club receives several queries from its members on whether to continue cargo operations during rainy conditions in exchange for a letter of indemnity (LOI) or rain letter from the shippers, receivers or charterers.

This raises the question of whether such LOIs or rain letters from the shipper can be completely relied upon, as in an event of a cargo claim it may be difficult for the ship to prove if the wet damage was attributed to the rain or due to inadequate cargo care (ventilation) during the voyage.

From a P&I Club's perspective, it is recommended that the cargo documents (bills of lading and mate's receipt) are properly claused to reflect the state of the cargo loaded. If the Master is worried about the state of the cargo, an expert or surveyor should be appointed and additional analysis of the cargo should be carried out.

6 FUMIGATION

Fumigation is the deliberate release of toxic gases into the cargo hold with the intention to prevent insect infestation within the cargo. Fumigation is common practice for ships engaged in the carriage of agricultural cargoes such as grains, seed cake and logs. It can be carried out in port (before or after the loading of the cargo) or during the voyage.

SOLAS Reg.VI/Reg. 4 on the use of pesticides in ships, state that appropriate precautions shall be taken in the use of pesticides in ships, in particular for the purposes of fumigation. IMDG and IMSBC codes provide similar recommendations to ensure safe and effective fumigation. Further guidance related to the fumigation of cargo are laid down in the following IMO circulars -

- Revised Recommendations on the safe use of pesticides in ships (**MSC.1/Circ.1358**);
- Recommendations on the safe use of pesticides in ships applicable to the fumigation of cargo holds (**MSC.1/Circ.1264**, as amended by **MSC.1/Circ.1396**); and
- Revised Recommendations on the safe use of pesticides in ships applicable to the fumigation of cargo transport units (**MSC.1/Circ.1361**).

FUMIGANT APPLICATION

The most commonly used fumigants are aluminium or magnesium phosphides, which come in the form of pellets. These pellets are spread uniformly on top of the bulk stow or inserted just beneath the layers of the cargo using sleeves that are readily retrievable once fumigation is completed and leave little physical residue. The pellets react with atmospheric moisture and dissolve over time, creating hazardous phosphine gas. All that is left after the pellets are converted into gas is a greyish-white powder. It is recommended that the crew keep a watchful eye on the cargo holds which are being fumigated to make sure that the gas pellets are distributed or scattered evenly across the top of the stow and that the pellets are not simply dumped in large piles, which could result in explosions during the voyage.

The most common cause of such fumigant explosions inside the holds is the uneven distribution of the phosphide pellets on top of the bulk stow, with small heaps concentrated in a particular position.

Unless the shipboard team has received special training and are certified and equipped with all necessary fumigation equipment, it is recommended to engage a qualified fumigator to ensure their safety. The holds

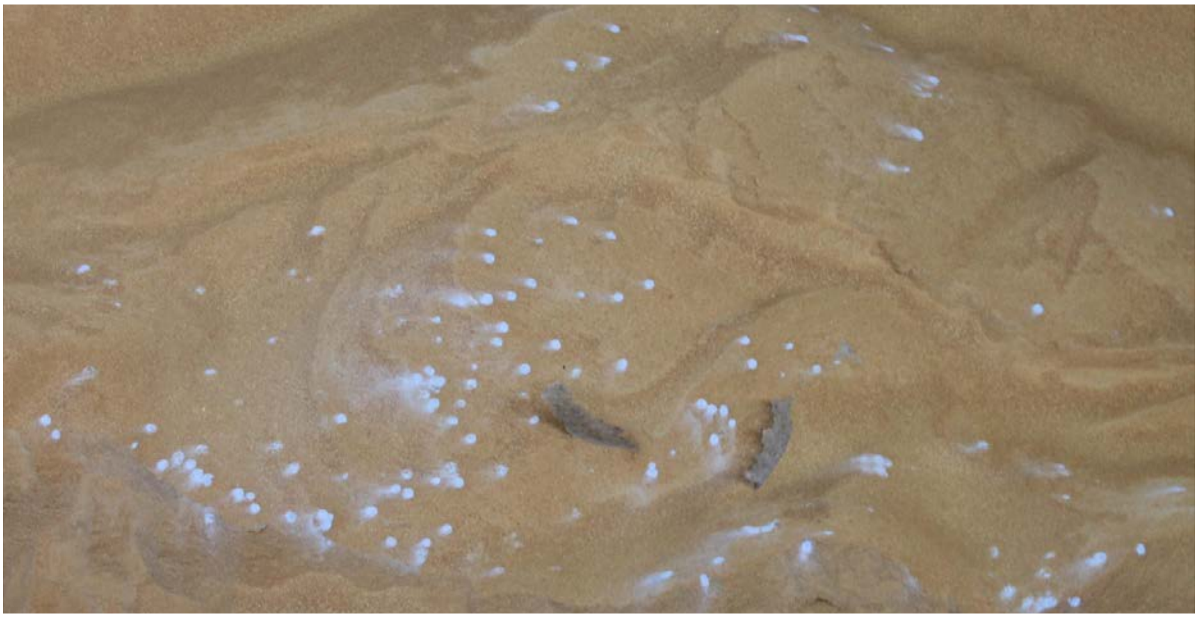


Figure 32: Fumigant residue on cargo surface - photo courtesy of CWA International Ltd

must not be ventilated until the minimum fumigation period has expired, and care must be taken to ensure that subsequent ventilation does not endanger the crew.

MSC.1/Circ.1358, under para. 3.1.3.2 states that *"since fumigant gases are poisonous to humans and require special equipment and skills in application, they should only be used by specialists and not by the ship's crew".* **MSC.1/Circ.1264, under paragraph 5.1.1** states that *"ship's personnel should not handle fumigants and such operations should be carried out only by qualified operators"*. The International Maritime Fumigation Organisation (IMFO) also provides guidance for ships carrying out fumigation during transit.

As fumigation requirements may prevent the Master from ventilating the cargo during the voyage, full and clear instructions need to be received from the charterers and shippers. These instructions should refer to product sheets (MSDS), correct procedures and safety advice, application dangers, the method of handling/ disposal, and requirements for personal protective equipment and monitoring equipment. It should be agreed that ventilation may not take place during such time, with the vessel not being responsible for any possible damage to the cargo as a direct result.

HAZARDS

Phosphide fumigants can be extremely hazardous, as they are both poisonous to humans and have the capability to produce toxic and explosive gases.

While the surface application of pellets may be useful in its purpose, a flammable phosphine and air mixture is likely to form and accumulate on top of the cargo inside the hold. When it comes into contact with moisture, heat is generated, and at concentrations above its lower flammable limit, it may ignite spontaneously. Ignition of a high concentration of phosphine gas may result in an explosion, causing the displacement of hatch covers, damage to the vessel and cargo, and serious injury to the people nearby. Fumigation placards should be placed at hold entrances and on hatch covers. In keeping with the best confined entry practices, cargo hold access should be locked to prevent accidental entry until advised otherwise. There should be careful consideration when accessing deck houses where phosphine gas may seep. In good weather, it is good practice for the deck house doors to be kept open as a precautionary measure.

Water bypassing hatch seals can greatly increase the natural slow release of phosphine to explosive levels. Hatch gaskets, compression bars, drainage channels and one-way drainage valves should be inspected prior to loading cargoes that will be fumigated. Good seafarer-like practice may consider use of hatch tape on hatch joints as an added level of precaution, especially if rough weather might be encountered after departure.

The crew should avoid hosing the hatch and coamings until after the minimum fumigation period has passed and should not carry out hot-works on deck during this period. After which, restrictions for hot-works while carrying combustible cargoes should be in accordance with company procedures and good seafarer-like practices.

Particular attention must be given to the disposal of the fumigant residues. **MSC Circular 1264** mentions specifically that "clear written instructions must be given to the Master of the ship, to the receiver of the cargo and to the authorities at the discharging port as to how any powdery residues are to be disposed of".

MSC Circular 1396 further highlights that "when Phosphine generating formulations are used to fumigate, any collected residue may ignite". In any case, the disposal of the fumigant waste must be done in accordance with manufacturer's instructions or with instructions provided by the fumigation company at the port of loading.

Another form of fumigant used is methyl bromide, which is applied in gaseous form and hence not approved for in-transit fumigation. The IMO's recommendations on the safe use of pesticides on ships (as listed in **MSC Circular 1358**) mentions specifically that fumigation with methyl bromide is permitted only when the ship is within a port, either at anchor or alongside, and the crew has disembarked. Before personnel are permitted to enter, the treated spaces need to be well ventilated and issued with a gas-free certificate.

There have been a number of crew fatalities on bulk carriers in recent past caused by enclosed space entry procedures not being followed. In a few cases, one of the contributory causes was inadequate ventilation after the holds were fumigated. Even though the hatch covers were opened for aeration, the toxic fumigant gases were trapped between the layers of cargo and released during discharge. The cargo had to be discharged on the quay by grabs and spread into a thin layer by bulldozers to disseminate the fumigant gas that was trapped between the lower layers.

The Standard Club recommends that shipowners and operators obtain specific instructions from the charterers and the fumigation company on the required procedure and time for making the holds gas-free, so that they can be rendered safe for crew entry. Adequate precautions and notices should be in place when dealing with fumigants on board the ships in accordance with IMO guidelines.

A "fumigator-in-charge" should be designated by the fumigation company. He should be able to provide documentation to the Master proving his competence and authorization.

The Master should be provided with written instructions by the fumigator-in-charge on the type of fumigant used, the hazards to human health, the precautions to be taken and the ventilation process to make the cargo holds gas-free. Such instructions should be written in a language readily understood by the Master or his representative. The ship, when carrying fumigated cargo, should be provided with suitable gas-detection equipment to verify the concentration of the fumigant gases.

CHARTER PARTY CLAUSE

BIMCO published the Cargo Fumigation clause in 2015, with the aim to provide clear allocation of the responsibilities, risks and costs arising from cargo fumigation operations on board ships. The Standard Club has provided further guidance with respect to this clause. It is recommended to incorporate this clause into charter parties where possible.

Finally, the atmosphere inside the accommodation should be monitored for hazardous gases and the records maintained on board.

7 CONFINED SPACE ENTRY

Despite the well-known risks, confined space entry continues to account for a significant proportion of deaths on board dry cargo vessels. The exact reasons for this are unknown, however not following the relevant safety management procedures is most likely the single major contributing factor.

WHAT IS A CONFINED SPACE?

A confined space is a space that has one of the following three characteristics:

- Limited ventilation
- Limited access
- Not designed for continuous occupancy

Typical confined spaces found on board bulk carriers include cargo holds, enclosed Australian ladder spaces, ballast tanks, fuel oil tanks, void spaces, duct keels and other spaces that are usually kept closed and unoccupied. It is important to note that this is not an exhaustive list and any space that fits the definition of a confined space should be treated as one.

HAZARDS

Many cargoes have the potential to:

- Reduce the amount of oxygen in the cargo hold
- Produce toxic gases
- Produce flammable gases
- Produce airborne dust
- Produce excessive heat

The above can cause one or more of the following: asphyxiation, poisoning, explosion and burns. Thus, suitable safety measures should be taken before entering cargo holds. The spaces adjacent to the cargo holds, such as ballast tanks, have the potential to have the same atmosphere as the cargo holds and thus entry into these spaces should be treated in the same way.

SAFE PRACTICE

In an ideal world, it would not be necessary to enter a confined space. However, there are a number of reasons why crew and other personnel may need to do so, for example cargo hold cleaning and ballast tank surveys.

The first question that should be asked is: Is it necessary to enter the confined space? If it is, then there are several actions and/or precautions that need to be taken in order to remove the risk of injury, such as:

- All personnel involved in confined space entry should be suitably trained and authorized to do so.
- A competent person (usually the Master or Chief Officer) should carry out a risk assessment.
- The atmosphere of the space to be entered should be tested.
- An Entry Permit System should be in place.
- The established on-board procedures for entering confined spaces should be implemented.

The International Safety Management Code Part A, Section 7 “Shipboard Operations”, requires that appropriate confined space entry procedures are in place:

"The Company should establish procedures, plans and instructions, including checklists as appropriate, for key shipboard operations concerning the safety of the personnel, ship and protection of the environment. The various tasks should be defined and assigned to qualified personnel."

The IMSBC Code also refers to the "Revised Recommendations for Entering Enclosed Spaces aboard Ships".

Relevant requirements

- **SOLAS III/19** amendments, applicable from 1 January 2015, require that crew members with enclosed space entry or rescue responsibilities shall participate in an enclosed space entry and rescue drill on board the ship at least once every two months. A part of the drill is checking and the use of instruments for measuring the atmosphere in enclosed spaces.
- **SOLAS XI-1/7** amendments, applicable from 1 July 2016, require that every ship to which Chapter I applies shall carry an appropriate portable atmosphere testing instrument or instruments*. As a minimum, these shall be capable of measuring concentrations of oxygen, flammable gases or vapours, hydrogen sulphide and carbon monoxide prior to entry into enclosed spaces**. Instruments carried under other requirements may satisfy this regulation. Suitable means shall be provided for the calibration of all such instruments.
- The Standard Club published "Master's Guide to Enclosed Space Entry" which focuses on making seafarers aware of the risks associated with entering an enclosed space and the applicable on-board procedures, using case studies to highlight the common errors which make a seafarer put himself and others in danger.

*Refer to the "Guidelines to facilitate the selection of portable atmosphere testing instruments for enclosed spaces" as required by SOLAS Regulation XI-1/7 (MSC.1/Circ.1477).
**Refer to the "Revised Recommendations for Entering Enclosed Spaces aboard Ships" (Resolution A.1050(27)).

8 CASE STUDIES

The Standard Club continues to witness high numbers of wet cargo damage claims, caused either by fresh water or seawater, but the most sinister damage is due to condensation. Inadequate or improper ventilation and poor stowage may result in caked and mouldy bulk, bagged dry cargoes or rusty steel cargoes.

CASE STUDY 1

The case involves a dry-cargo ship with a cargo of steel coils and pipes loaded in Taiwan and South Korea for discharge in multiple ports in the USA. The voyage involved great circle sailing through the relatively cooler Bering Sea region. Charter party and voyage instructions identified the Dew Point Rule to be applicable for the voyage.

Figure 33: Rust visible on outer surfaces and banding (photo courtesy of The Standard Club)

An on-hire survey was conducted prior to commencement of loading. The survey included a hatch cover ultrasonic test to confirm its weathertightness. A pre-loading steel survey was conducted to reflect the cargo condition accurately in the bill of lading.

At the port of discharge, some steel coils showed rust on their outer surfaces and banding. Rust streaks were also noted on steel pipes. Condensation (ship sweat) was reportedly the cause of damage to the cargo, for which the receiver sought to recover damages. The shipowner sought to deny liability on the basis that inclement weather conditions were experienced during the voyage, even though a weather routing service was utilized.

The ship was able to carry out hold ventilation only on fair weather days. However, the ventilation logs indicated that this rule may have been broken at several points during the voyage, as the ventilation was only done for daytime periods and restricted during the night hours.

In order to protect the shipowner against cargo deterioration claims, it is necessary for the vessel to produce records showing that customary ventilation routines were followed.

It is imperative that when fixing the vessel for a particular voyage where condensation (ship or cargo sweat) is expected, the ship's ventilation limitation is considered, especially in cases where the vessel is only fitted with natural ventilation and thorough ventilation may not be possible.

It could be possible that on some voyages, sweat cannot be prevented, especially in cases where hold ventilation is restricted due to fog or shipping seas on deck. In such circumstances, it is necessary to maintain documented records to prove that the ship complied whenever the situation permitted.

There was also a dispute as to how the moisture entered inside the packaging around the coils. For steel cargoes (especially coils or finished/coated pipes), it is important that the quality of packing, adequacy of wrapping and suitability of stowage is checked and verified to withstand the foreseeable risks of carriage on the anticipated voyage. In this case, both parties relied on the surveyor's opinion that the packaging was inadequate to prevent the entry of loose water from external wetting. Eventually, a claim of around 70,000 US dollars was brought forward against the shipowner.

CASE STUDY 2

This case involves moisture damage of wheat in bulk loaded on a handy-size bulk carrier on a voyage from Gdynia, Poland to Damietta, Egypt.

At the port of loading, cargo hold cleanliness was checked and a hatch covers hose test was carried out. Ventilation was not conducted, as the ship was on a voyage from a cold to a warm climate.

At the port of discharge, variously caked and mouldy cargo was observed in all the five cargo holds. The claimants alleged that failure by the ship to ventilate correctly resulted in the development of condensation, causing the cargo to deteriorate.

The ship argued that no ventilation was carried out in accordance with the general principle of "cold to hot, ventilate not" in order to avoid cargo sweat. However, the ship's crew failed to maintain documented logs of air and ocean water temperatures, humidity and dew point during the passage from Poland to Egypt, leading the claimants to maintain that the ship was at fault. The case was later settled amicably between the parties. The ventilation rule should be properly described in the charter party or voyage instructions, and care should be taken to avoid accepting ventilation requirements which may be difficult or even impossible to comply with. For example, avoiding cargo sweat at the discharging port could be difficult when the holds are opened for discharging and the cold cargo comes into contact with warm moist air.

It is also important to recognize that some agricultural products may have inherent moisture levels which exceed acceptable limits at the time of loading, making them biologically unstable. When grain is shipped with moisture content in excess of 14%, moisture migration may well occur in any event. Spoilage may then be increased by uninformed ventilation; lack of ventilation may assist in limiting the damage.

Such details may not be known to the ship, and prudent ventilation measures may be insufficient to prevent the cargo from deteriorating during passage.

Documented logs are essential for the ship's defence against cargo claims. This is particularly important for regions with significant variance between the air and ocean water temperature or at places where day and night air temperatures differ substantially. Should the necessary evidence be missing or incomplete, it is difficult for the P&I Clubs to counter such claims.

This kind of damage is also very common in cases of bagged agricultural products, caused by poor stowage and lack of protection of the bags from the ship's bulkheads. It is imperative that the ship's crew closely monitor the cargo loading operations especially in regard to the stowage/dunnage of the bags and ensure effective air channels are provided for adequate ventilation between the layers.

Figure 34: Cargo sweat on rice bags (photo courtesy of CWA International).

9 GLOSSARY

Ship sweat is condensation that occurs on the ship's internal structure.

Cargo sweat is condensation that occurs on the cargo.

Confined space is a space that has one of the following three characteristics:

1. Limited ventilation
2. Limited access
3. Not designed for continuous occupancy

Dew point is the temperature at which the air becomes saturated and will condense.

Fumigation is the deliberate release of toxic gases into the cargo hold with the intention to prevent insect infestation within the cargo.

Hygroscopic cargoes are cargoes that have a natural moisture content and can absorb.

IMFO stands for International Maritime Fumigation Organisation, "an international group of independent companies that would enable its members to provide the option of guaranteed fumigation to their customers, by controlling the fumigation at both load and discharge port".[5]

IMO stands for International Maritime Organization, "the United Nations specialized agency with responsibility for the safety and security of shipping and the prevention of marine and atmospheric pollution by ships".[6]

IMDG Code stands for International Maritime Dangerous Goods Code.

IMSBC Code stands for International Maritime Solid Bulk Cargoes Code.

Mechanical ventilation A mechanical ventilation system is a system where the movement of air is forced using electrical fans within the ventilator shafts.

Natural ventilation A natural ventilation system, as the name suggests, is based on nature's law of air circulation, where vents located above the deck level allow cool heavier air from outside atmosphere to replace the lighter rising warm air inside the cargo hold.

Position 1 Upon exposed freeboard and raised quarter decks, and upon exposed superstructure decks situated forward of a point located a quarter of the ship's length from the forward perpendicular.

Position 2 Upon exposed superstructure decks situated abaft a quarter of the ship's length from the forward perpendicular and located at least one standard height of superstructure above the freeboard deck.

Relative humidity is the amount of water vapour in the air and is expressed as a percentage of the amount of the maximum amount of water vapour that can be held in the air.

SOLAS stands for International Convention for the Safety of Life at Sea and is the primary set of regulations that dictate the minimum standards for the construction, equipment and operation of ships from a safety point of view.

Zone 1 An area in which an explosive gas atmosphere is likely to occur in normal operation.

Zone 2 An area in which an explosive gas atmosphere is not likely to occur in normal operation.

[5] IMFO website – Home page
[6] IMO website – About IMO – Introduction to IMO

CARGO TEMPERATURE / VENTILATION LOG

M/V:

Average cargo temperature at loading:

Date/Time		Outside air temp.			Hold No. 1			Hold No. 2			Hold No. 3			Hold No. 4			Hold No. 5			Venti-lation Y/N	Sea temp.
		Dry Bulb	Wet Bulb	Dew point	Dry Bulb	Wet Bulb	Dew point	Dry Bulb	Wet Bulb	Dew point	Dry Bulb	Wet Bulb	Dew point	Dry Bulb	Wet Bulb	Dew point	Dry Bulb	Wet Bulb	Dew point		
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DEWPOINT TABLE (FOR USE WITH MARINE SCREEN)

Dry Bulb	Depression of wet bulb																								
°C	0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0
40	40	40	40	39	39	39	39	38	38	38	38	37	36	36	35	34	34	33	32	32	31	30	29	29	28
39	39	39	39	38	38	38	38	37	37	37	37	36	35	35	34	33	33	32	31	31	30	29	28	28	27
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-16	-18	-19																							
-17	-19																								

In the table, lines are ruled to draw allenlion to the fact that above the line evaporalion is going on from a water surface, while below the line it is going on from an ice surface. Owing to this, interpolation must not be made between figures on different sides of the lines.

For dry bulb temperatures below 0°C it will be noted that, when the depression of the wet bulb is zero, i.e. when the temperature of the wet bulb is equal to that of the dry bulb, the dew-point is still below the dry bulb, and the relative humidity is less than 100 per cent. These apparent anomalies are a consequence or the method or computing dew-points and relative humidities now adopted by the Meteorological Office, in which the standard saturation pressure [or temperature below 0°C is taken as that over water, and not as that over ice.

INTERCARGO
International Association of Dry Cargo Shipowners

The International Association of Dry Cargo Shipowners (INTERCARGO) is representing the interests of quality dry cargo shipowners, with 2,400 registered ships out of more than 11,000 ships in the global dry bulk fleet, corresponding to over 25% of the global dry bulk fleet basis deadweight. The dry bulk sector is the largest shipping sector in terms of number of ships and deadweight. INTERCARGO convened for the first time in 1980 in London and has been participating with consultative status at the International Maritime Organization (IMO) since 1993. INTERCARGO provides the forum where dry bulk shipowners, managers and operators are informed about, discuss and share concerns on key topics and regulatory challenges, especially in relation to safety, the environment and operational excellence. The Association takes forward its Members' positions to the IMO, as well as to other shipping and international industry fora, having free and fair competition as a principle.

Standard Club

Standard Club is a specialist marine and energy insurer known for its diverse membership, pioneering loss prevention expertise and attractive pricing. Solutions oriented underwriters work alongside proactive technical and legal experts who advise members on how to prepare for new regulations and implement best practice.

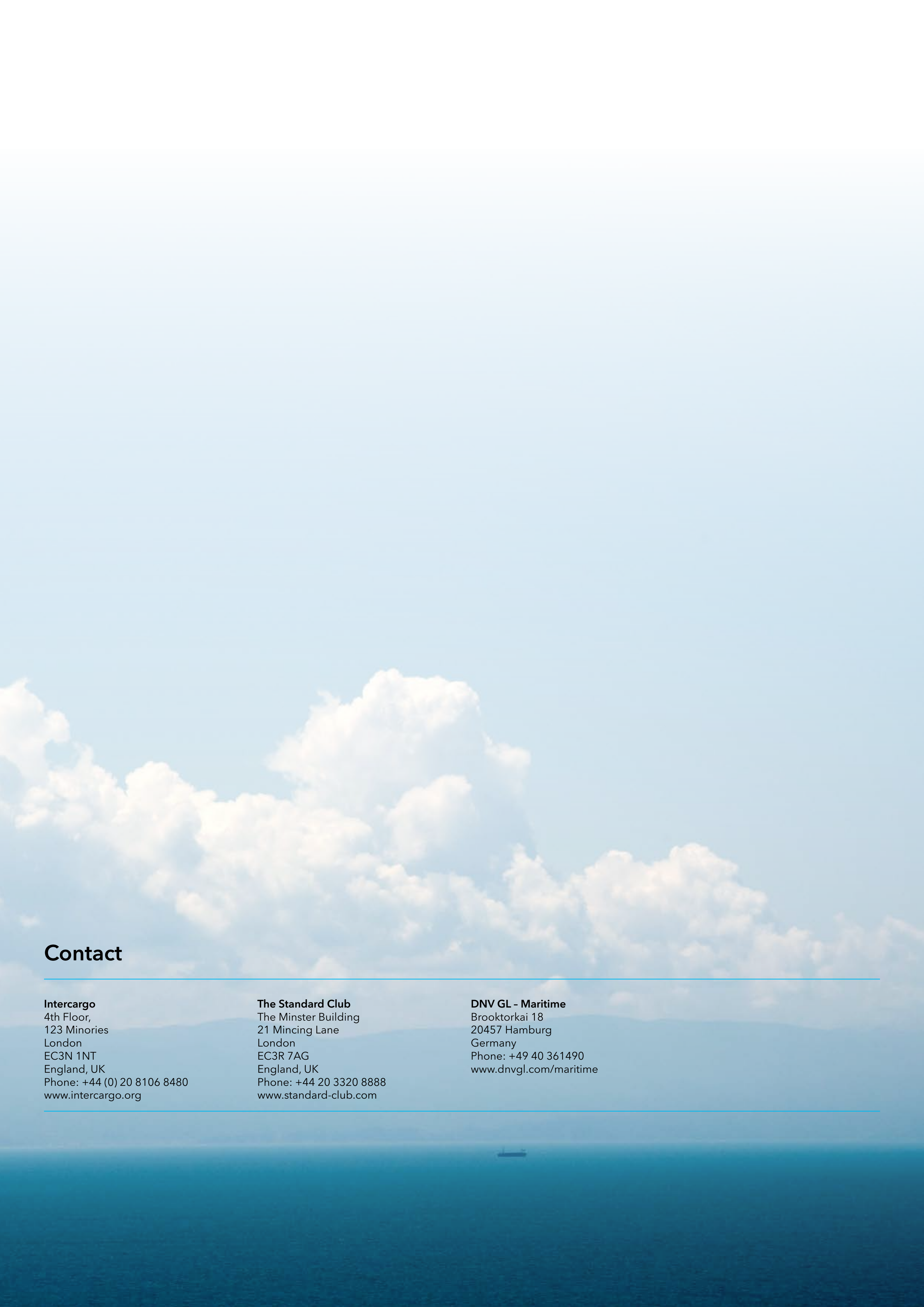
At Standard Club, we build relationships by really getting to know our customers, including gaining a detailed knowledge of their operations, a full understanding of their priorities and a complete picture of the potential risks and challenges they face. This helps to guarantee our members get immediate, appropriate and comprehensive support wherever, whenever.

We are always by your side.

DNV·GL

We are the independent expert in risk management and quality assurance. Driven by our purpose, to safeguard life, property and the environment, we empower our customers and their stakeholders with facts and reliable insights so that critical decisions can be made with confidence. As a trusted voice for many of the world's most successful organizations, we use our knowledge to advance safety and performance, set industry benchmarks, and inspire and invent solutions to tackle global transformations.

DNV GL is the world's leading classification society and a recognized advisor for the maritime industry. We enhance safety, quality, energy efficiency and environmental performance of the global shipping industry – across all vessel types and offshore structures. We invest heavily in research and development to find solutions, together with the industry, that address strategic, operational or regulatory challenges.



Contact

Intercargo
4th Floor,
123 Minories
London
EC3N 1NT
England, UK
Phone: +44 (0) 20 8106 8480
www.intercargo.org

The Standard Club
The Minster Building
21 Mincing Lane
London
EC3R 7AG
England, UK
Phone: +44 20 3320 8888
www.standard-club.com

DNV GL – Maritime
Brooktorkai 18
20457 Hamburg
Germany
Phone: +49 40 361490
www.dnvgl.com/maritime