

Safe Carriage of Grain

Introduction

The term “Grain” refers to wheat, maize (corn), oats, rye, barley, rice, pulses, seeds, and their processed forms so long as their behaviour is similar to that of grain in its natural state.

When carried in bulk on ships, these cargoes are defined by their "free flowing" nature, which means they can settle and shift during a voyage posing significant risks to ship stability.

To mitigate these stability risks, the International Grain Code (part of SOLAS Chapter VI), mandates strict safety precautions for the vessels to have a Document of Authorisation or an approved equivalent as required by the Grain Code. Furthermore, vessels are subject to stowage requirements designed to minimise the effects of shifting and settling. It is the responsibility of the ship's master to ensure that all filling, trimming (levelling) and securing follow the specific loading conditions including the recent amendment to the Code ([Steamship Mutual - Amendments to the International Code for the Safe Carriage of Grain in Bulk](#))

Grain has inherent biological characteristics that present unique risks during carriage. As an organic, living cargo, grain is vulnerable to damage from wetting, mould growth, water ingress, infestation and contamination. In addition, exposure to external heat sources, such as engine room bulkheads or heated bunker tanks as well as self-heating within the grain itself, can lead to significant deterioration and extensive cargo damage, often resulting in significant claims. Improper fumigation practices also account for a significant proportion of grain related cargo damage and subsequent legal disputes.

This Risk Alert provides general but important guidance on the precautions and operational considerations necessary to mitigate these risks and reduce the likelihood of grain cargo damage claims.

Cargo Hold Cleaning

Before loading, it is essential that all cargo holds are prepared to meet Grain Clean standards, which represent the level of cleanliness required for food grade commodities. This means the holds must be completely free from insects, odours, residues of previous cargoes, lashing materials, dunnage, loose rust scale, paint flakes and any other foreign matter that could contaminate the grain. Particular attention should be given to removing any loose scale or flaking paint, as these can detach during the voyage and mix with the cargo, which is unacceptable under Grain Clean standards. The cleaning process should include thorough sweeping of all surfaces, followed by washing down with fresh water to remove any rust and salt deposits.



Figure 1: Example of flaking rust and paint

After washing, the holds must be completely dried and well ventilated to prevent moisture accumulation between structural members and hold fittings.

Most exporters and local authorities enforce high standards of hold cleanliness for grain shipments and failure to comply can result in delays and rejection of cargo holds. For detailed guidance on achieving and verifying proper hold cleanliness, refer to the Club's publication "[Hold Cleaning – When is Clean, Clean Enough?](#)", which provides comprehensive best practices and inspection criteria.

Hold Structure & Bilge Integrity

The Club recommends conducting thorough inspections of all structural and operational components within the cargo holds prior to loading grain cargoes. Carefully examine the bulkheads, wing tanks, topside tanks, double bottom tank tops, sounding and filling pipes, manholes and the ship's sides for any signs of damage or leakage. Indicators such as rust stains or damp streaks often suggest the presence of cracks or structural weaknesses that require immediate attention.

In addition to structural checks, the bilge pumping system should be tested to confirm that it is functioning properly, including the performance and integrity of each component including pipes, valves, expansion joints and non-return valves in the system. Furthermore, bilge wells should be clear of obstructions and be covered with burlap or another suitable material, securely fastened in place.



Figure 2: Residues from previous cargo in cement loading hole, leading to cargo hold rejection.

Cargo Hold Weathertight Integrity

Conduct a comprehensive inspection of all hatch coamings and hatch seals, ventilation ducts, hatches, drain channels, sounding pipes, temperature ports and other components of the cargo hold to ensure the weather integrity of the cargo spaces. Rubber gaskets must be examined carefully to confirm that they are intact, continuous and free from cracks, cuts or signs of compression set that could compromise their sealing capability.

Hatch cover cleats, wedges and rest pads should be properly adjusted to ensure uniform pressure across the hatch cover seals, ensuring the cargo holds are secure and weather tight.

To confirm the weathertightness of the hatches, an ultrasonic test (UST) should be conducted using approved, certified and calibrated equipment. Deficiencies identified during the UST should be addressed promptly and corrective actions should be documented. The results of the ultrasonic test should be recorded in detail as part of the vessel's pre-loading checks and safety records.

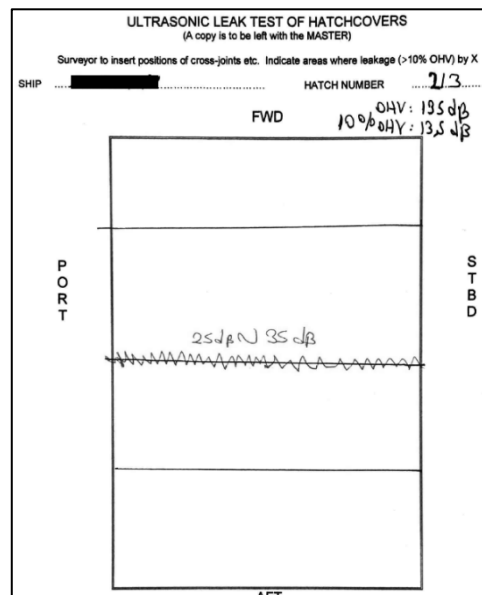


Figure 3: UST reading with unacceptable levels along hatch cover joints.

Non-return valves, pipes and associated drain channels should be checked to verify that they are clear, functional, and free from any obstruction. Attention should be given to hatch coaming drain channels, as blockages in these areas can lead to water accumulation and potential ingress into the cargo hold.

Fuel & Ballast Water Distribution and Management

When planning fuel oil distribution, special attention is be given to tanks that require heating. Avoid heating fuel oil tanks adjacent to cargo holds as heat transfer can raise the temperature within the cargo spaces, potentially causing heat damage to sensitive grain shipments. Proper planning may ensure heated tanks are positioned away from cargo holds, minimising the risk of heat related deterioration and maintaining cargo integrity throughout the voyage.



Figure 4: Hatch coaming, drainpipes and non-return valves

Filling ballast tanks above double bottom level increases the risk of accidental water ingress into the cargo holds through defects in manholes or other structures and may cause severe cargo damage. To prevent accidental cargo damage, avoid filling ballast tanks next to cargo holds above the tank-top level, provided this is safe and practical for the vessel's operations.

Cargo Condition and Sampling

Verify the moisture content of the grains and obtain a formal cargo quality certificate or equivalent from shippers to confirm the cargo specifications. For safe shipment and carriage, most grain commodities are generally expected to be presented in a dry condition. While moisture content levels in the region of approximately 11–14.5% are sometimes referenced, acceptability may vary depending on the type of grain, ambient temperature and applicable local authority, cargo and trade requirements. Masters and operators are advised to seek expert guidance to confirm the acceptable moisture limits for the specific grain being carried.

Lower moisture limits are needed for certain voyages depending on the destinations in relation to the climate, duration of voyage and carriage. Excessive moisture content in the cargo significantly increases the natural respiration rate generating heat within grain, causing self-heating and creating conditions that promote mould growth, rotting and caking.



Figure 5: Monitor and record cargo moisture content.

During loading operations, it is essential to implement a systematic sampling procedure to ensure representative samples are collected and maintained. It is highly recommended to appoint a competent surveyor to oversee this process and assist with general loading operations. Ensuring that all samples are clearly labelled, well-documented and preferably collected jointly with cargo interests can be pivotal in defending the vessel's position should a claim arise. Sampling can be performed manually or through automated systems that continuously collect samples from the conveyor belt during loading. In addition, it is recommended that the moisture content of the cargo is verified by an independent inspector or laboratory. The Club should be notified and formal protests lodged with all cargo interests, should there be deviations from specifications provided by the shipper.



Figure 6: Example of well labelled and documented representative samples taken during loading.

Monitoring the cargo temperature during loading operations is crucial, as it provides a record and early sign of potential damage. An increase in temperature or variation above the ambient level can signal the onset of self-heating, which may lead to cargo deterioration during the voyage.

Additional samples should be collected whenever there is a change in weather conditions or a change in the cargo source, as these factors can significantly affect grain quality. For each sample collected, detailed records must be kept, including the date, time, source location, cargo hold identification and prevailing weather conditions during loading. All reference samples should be sealed and securely stored onboard until discharge.

Loading Precautions

Cargo loading must not be conducted during periods of precipitation. All cargo holds should remain securely closed and adequately protected to prevent introduction of external moisture throughout the loading process. It is important to record the ambient temperature of the cargo at the time of loading, as temperature data is a critical parameter for monitoring cargo condition during transit.



Figure 7: Example of effective monitoring.

Cargo loading operations should be continuously monitored to identify any signs of contamination or deterioration in the cargo quality. Cargo Surveyors and ship's crew should look for foreign materials, evidence of insect or infestation, and discoloration or signs of compromised quality. Detecting substandard cargoes and documenting them along with notifications to cargo interests, allows initiation of corrective measures, replacement of unsound cargo and can aid in any claim defence.

Fumigation Safety and Control

Prior to fumigation, the master must receive comprehensive written instructions from the fumigator in charge detailing the type of fumigant to be used, its associated health hazards and all necessary safety precautions. Given the highly toxic nature of commonly used fumigants, these instructions must be strictly adhered to without exception.

Safe fumigation practices require that the treated space be rendered completely gastight for the entire exposure period.



Figure 8: Fumigator-in-charge must ensure careful dosage, distribution and even placement of fumigant sleeves.

This duration can range from several hours to multiple days, depending on factors such as the fumigant type, its concentration, the nature of the pests being targeted, the commodity under treatment and the prevailing temperature conditions.

Fumigation may be carried out while the vessel is in port and / or continued during transit, provided that all procedures comply with the requirements outlined in the Recommendations on the Safe Use of Pesticides in Ships Applicable to the Fumigation of Cargo Holds - [Recommendations on the Safe Use of Pesticides in Ships Applicable to the Fumigation of Cargo Holds - MSC.1/Circ.1264/Rev.1](#). Strict compliance with these guidelines is vital to ensure both the effectiveness of the fumigation process and the safety of all personnel onboard until completion of discharge of cargo.

The fumigator in charge must ensure controlled distribution of fumigant material to prevent accumulation of fumigants in one location, reducing the likelihood of localised heat generation and excessive gas release. Fumigant tablets must be properly distributed throughout the cargo holds using recommended methods, such as placement in sleeves or other approved dispersal systems.

The gases produced during fumigation are hazardous and can leak outside the cargo holds, posing a serious risk to the ship's crew. Masters are to be provided with sufficient gas detection tubes to ensure the atmosphere outside the cargo holds is checked at regular intervals, to ensure crew safety.

Cargo Hold Sealing

Upon completion of cargo loading, all cargo holds should be securely sealed in the presence of an independent surveyor to ensure compliance and maintain the integrity of the shipment.

Cargo hold seals should remain intact throughout the voyage and must only be broken at the discharge port in the presence of cargo interests and appointed surveyors. An exception may apply where prior agreement has been obtained to allow seals to be broken at sea for operational reasons or for the purpose of fumigation or an emergency.

In such cases, the circumstances must be fully documented, including accurate logbook entries and clear photographic evidence and all relevant cargo interests must be promptly notified.



Figure 9: Cargo hold sealed using tamper proof seals with serial number.

Voyage Fumigation Controls

When fumigation is carried out during voyage, it is imperative that all procedures strictly follow the written instructions provided by the fumigator in charge. These instructions will outline the fumigant type, application method, exposure duration and safety precautions necessary to protect both personnel and cargo.

In cases where fumigation requirements conflict with ventilation management, such as when ventilation is restricted to maintain fumigant concentration, the master must immediately notify the cargo interests and document the situation.

Special attention must be given when using phosphine generating formulations, such as aluminium phosphide or magnesium phosphide tablets. Residues from these fumigants can react with moisture, releasing phosphine gas and generating localised heat, which poses a significant risk of heat-damage to cargo or fire. If a concentrated quantity of fumigants in cargo comes into contact with water condensation or with water that entered a cargo hold due to poor weathertightness, it could result in excessive phosphine gas emission and the formation of a flammable mixture, creating severe risks to cargo integrity and vessel safety.

Ventilation and Moisture Control

Grain is hygroscopic, meaning it naturally absorbs and releases moisture. So, effective ventilation management is key to prevent moisture damage to the grain cargo during the voyage. Improper ventilation can lead to the formation of ship's sweat or cargo sweat, both of which cause serious and extensive cargo damage, including mould growth, caking and self-heating. Grains, like other agricultural products, undergo metabolic respiration during storage and generate heat. While the intensity of this process is influenced by the grain's natural moisture content, any increase in moisture within the cargo hold can accelerate respiration, resulting in elevated temperatures that promote heat damage and mould contamination.



Figure 10: Example of damage due to mould

To prevent these damages and minimise risk, ventilation should be managed in accordance with established best practices, considering temperature gradients, humidity levels and weather conditions during the voyage. The primary hazard is condensation in the form of ship sweat or cargo sweat. Atmospheric parameters in relation to the temperature and relative humidity in cargo holds play a crucial role in assessing the risk of condensation and moisture related damage.

To minimise and prevent condensation, the dew point of the air within the cargo hold must be kept below the temperature of the hold structure and the cargo. This can be achieved through ventilation, by replacing warm, moist air in the hold with cooler, drier air. Two prominent criteria for determining whether to conduct ventilation or not are based on the “Dew Point Rule” and the “Three Degrees Rule.”



Figure 11: Cargo lumps and cake formation indicating wetting damage.

Ventilation must be done if the dew point temperature inside the hold is higher than the dew point temperature of the air outside. Where entry into the cargo hold is not possible, the "Three Degrees Rule" may be used. In this rule, the dry bulb temperature of the outside air is compared with the average cargo temperature at the time of loading, and ventilation is needed if the outside air is three degrees cooler than the average loading temperature of the cargo.

The decision to ventilate should take prevailing weather conditions into account to avoid introduction of moisture into the cargo holds. For detailed guidance on proper ventilation techniques and risk mitigation strategies, refer to Risk Alert - [Steamship Mutual - The Problem of Sweat](#), which provides comprehensive recommendations for avoiding moisture-related damage during transit.

Additionally, proper ventilation management and record keeping of the ventilation process and environmental parameters are essential throughout the voyage. The deck logbook should include detailed entries of weather conditions, atmospheric temperature, and relative humidity for the entire voyage, along with the temperature of the cargo and relative humidity in each hold. The ventilation log should clearly note any reasons for not conducting ventilation.

Safe Hold Access at Discharge

Obtain clear and detailed instructions from the fumigator in charge regarding the ventilation of cargo holds that were fumigated. The agreed procedure must specify both the method and duration of ventilation, ensuring that all fumigant gas is safely dispersed before personnel entry. Strict compliance with Enclosed Space Entry procedures is needed prior to allowing crew members or stevedores or any other personnel into cargo spaces. These procedures should include atmospheric testing, ventilation and the use of proper personal protective equipment to mitigate the risk of exposure to toxic gases or oxygen deficiency.

Enclosed space entry precautions are critical even when fumigation has not been performed. Grains, being organic material, continue to respire during carriage, consuming oxygen and releasing carbon dioxide within the cargo hold creating a hazardous condition. No entry to cargo compartments should occur until the space has been tested and declared safe. For the safe entry into enclosed spaces [Revised Recommendations for Entering Enclosed Spaces Aboard Ships – MSC 581\(110\)](#) should be followed.

Discharging & Monitoring Control

Before opening any cargo hold hatch covers, all relevant stakeholders should be present to jointly witness the breaking of seals (where applicable) and the initial opening of the holds. Immediately upon opening and before discharge begins, record the observed condition of cargo backed by photographic evidence. Any visible damage should be formally acknowledged by all parties and

thoroughly documented, as this evidence is vital for the effective handling of potential cargo damage claims.

Discharge operations should not be conducted during periods of precipitation. All non-working hatches, including access hatches and vents must be kept closed to protect the cargo from external moisture. Monitor the cargo to identify any signs of contamination or deterioration in the cargo and maintain a detailed log with photographic evidence of the cargo's condition throughout the operation.

It is also important for the vessel to document any apparent mishandling of cargo including the condition of shore facilities, such as stained or soiled discharge hoppers and truck loading beds. Collecting evidence of any mishandling at the shore facility helps protect against potentially spurious claims arising from mishandling of cargo after it crosses the ship's railing.

Conclusion

The safe carriage of bulk grain cargo requires proactive vessel preparation, effective cargo monitoring and strict adherence to established industry best practices. Proper hold preparation, effective moisture and ventilation management and professionally managed fumigation play a vital role in reducing the risk of cargo deterioration. Consistent application of these measures safeguards cargo integrity and significantly minimises the financial and legal exposure associated with bulk grain damage claims for members, shipowners and operators.

Supportive Information

For further information on this or other Loss Prevention topics please contact the Loss Prevention Department, Steamship Insurance Management Services Ltd.

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