Don't work up a sweat!

In the period between 1996 and 2000 condensation claims accounted for in excess of USD 2 million of Gard Services' major cargo claims.1 Gard Services is concerned that these claims will increase in the future, partly due to the increased time pressure on ships' crews and partly because crews may not be getting proper education in the basics of seamanship.

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Sweat is the term commonly used to describe condensation that forms in a vessel's cargo spaces. This formation of moisture can cause damage to and/or deterioration of the cargo. The vessel has a very important role to play in avoiding this damage. Sweat can result from the vessel's improper ventilation of the cargo space, or lack thereof, and damage can be minimised or even avoided by proper cargo stowage arrangements. Gard Services' experience is that a claimant will invariably allege a failure of the vessel to follow proper ventilation practice or to properly stow the cargo. Under the Hague/Hague-Visby Rules this would be an alleged breach of Article III Rule 2.2 Unfortunately, in too many cases, the carrier is unable to sustain a defence to these allegations, not only because evidence suggests that the vessel has been at fault, but also because the vessel does not have sufficient evidence (e.g., proper ventilation records).

1. Claims on Gard in excess of USD 150,000 and net of deductible. 2. Subject to the provisions of Article IV, the carrier shall properly and carefully load, handle, stow, carry, keep, care for, and discharge the goods carried.

TYPES OF SWEAT AND HOW THEY FORM

The two main types are cargo sweat and ship's sweat. Before we go on to discuss these it is important to understand what is meant by "dew point". All air contains water vapour of varying quantities. The dew point indicates the amount of moisture in the air. The higher the dew point, the higher the moisture content of the air at a given temperature. Conversely, the dew point of humid air will be higher than the dew point of dry air. Dew point temperature is defined as the temperature to which the air would have to cool (at constant pressure and constant water vapour content) in order to reach saturation. A state of saturation exists when the air is holding the maximum amount of water vapour possible at the existing temperature and pressure. Condensation of water vapour begins when the temperature of air is lowered to its dew point and beyond.

Cargo sweat – Cargo sweat is condensation which forms on the cargo. It occurs when the temperature of the cargo is less than the dew point of the air in the hold. The cargo cools the air in contact with it and condensation forms on the cargo. The cargo may therefore be damaged by direct contact with moisture. Cargo sweat is most associated with the incorrect ventilation of warm moist air into a hold with cold cargo. It is akin to the condensation forming on a cold drinks can when taking it out of the fridge on a summer's day.

Case example: A full cargo of refined sugar in bags was rejected due to serious caking. The cargo was sold for salvage, but at a significant loss. The claim against the vessel owner was settled for in excess of USD 1 million. The caking was largely attributed to cargo sweat, which had resulted from improper ventilation. The voyage was from Europe (a cool climate) to the Middle East (a hot climate) in May and ventilation was not necessary. Ventilation during humid conditions in the Red Sea, with the aid of mechanical fans, and with the stow arranged in channels is thought to have greatly exacerbated the damage.

Ship's sweat – Ship's sweat is condensation which forms on the internal ship's steelwork. It occurs when the temperature of the ship's steelwork is lower than the dew point of the air in the hold. Condensation will form on the deckhead and/or on the inside of the shell plating. This moisture can then drop down from the deckhead on to the surface of the stow or come into contact with the cargo stowed directly against the sides of the hold. Ship's sweat is most associated with a voyage to a colder climate and the failure to ventilate the hold, replacing moist air from the load port or air made moist by the cargo, with drier air. It is akin to the condensation forming on the window when taking a warm shower on a cold winter's day.

Case example: A bagged cargo of parboiled rice was discharged in West Africa severely caked and stained resulting in a depreciation in value. The loss claimed against the vessel owner necessitated a settlement of tens of thousands of US dollars. The caking and staining was largely attributed to ship's sweat – direct contact of the bags with the internal steel of the vessel. The ship's sweat had largely resulted from a failure of the vessel to ventilate the cargo on the early part of the voyage – from India to the Cape of Good Hope in October.

PROPER VENTILATION PRACTICE TO AVOID SWEAT

The decision to ventilate and, equally important, when not to ventilate, so as to avoid sweat, should largely be based on the following considerations:

The nature of the cargo and its packing – There are two basic groups of cargo, which pose significantly different risks of sweat: hygroscopic and non-hygroscopic.

Hygroscopic cargoes contain moisture, mostly in natural form; for instance, agricultural, fish and forest cargoes. For example rice has a moisture content of around 14 per cent. It is important to note that these cargoes can absorb and release moisture. It is more likely that damage is caused when moisture is absorbed. A hygroscopic cargo with a moisture content and temperature such that water vapour will leave the cargo and enter the hold air will result in the build up of moist air and increase the risk of sweat.

Non-hygroscopic cargoes contain no moisture; for example, steel. Whilst non-hygroscopic cargoes may be wet before shipment, e.g., because they have been affected by rain before loading, it is better to avoid shipment of wet cargo rather than face the difficult task of deciding whether or not to ventilate. Non-hygroscopic cargoes do not give off moisture, but may absorb or be damaged by it.

Packing – Packing is an important factor and, for the purposes of ventilation, it can essentially make a non-hygroscopic cargo a hygroscopic cargo and vice-versa. For example, wood is hygroscopic and is often used as packing. Again however, the emphasis should be on avoiding shipment of wetted cargo. A starker example is sugar. Raw sugar is usually shipped in bulk and has a moisture content of around 0.25-1.1 per cent. However, refined sugar usually has a very low moisture content (0.03-0.05 per cent) and is commonly bagged within inner polythene plastic bags and outer woven polypropylene bags. The low permeability of the liner to moisture in vapour form essentially means therefore that refined sugar, bagged in this way, can be considered non-hygroscopic in nature.

Climatic changes on the voyage – Consideration needs to be given to the temperature and humidity conditions expected from the place of loading through the voyage to the place of discharge, as is relevant to the time of year. The term climate includes here the sea temperature, as that has particular relevance insofar as ship's sweat is concerned. The sea temperature will have the greatest effect on the temperature of the steelwork in the hold which is adjacent to or in contact with the sea.

Putting together all of these factors, the risk of sweat can be predicted and therefore, broadly speaking, it can be decided whether ventilation is necessary, unnecessary or to be prevented. Some examples:

Hygroscopic cargo from warm to cold climate – There is a danger of heavy ship's sweat and vigorous ventilation will therefore be necessary to replace moist air with drier air. The air in the hold may already be moist from ambient air at the place of loading, but is also likely to receive large volumes of moisture from the cargo itself. The aim is to lower the dew point temperature, thus making it unlikely that the steel structure of the vessel can cool air in contact with it sufficiently to reach that temperature.

Hygroscopic cargo from cold to warm climate – The risk of sweat is generally low and ventilation is therefore largely unnecessary. There is a risk of cargo sweat if warm moist air is introduced into the hold.

Non-hygroscopic cargo from warm to cold climate – There may be a risk of ship's sweat if the hold air is moist from the load port. Ventilation to improve the dew point of the hold air is therefore advantageous.

Non-hygroscopic cargo from cold to warm climate – Cargo sweat is likely if warm moist air is introduced into the hold. Ventilation is not therefore necessary and the holds should be sealed.

As an aide mémoire, mariners have often relied on the following very general rule:

"Warm to cold: ventilate hold Cold to hot: ventilate not"

It is important to remember, however, that the vessel will often pass through different climatic regions. In the example given for ship's sweat above, whilst ventilation was necessary in the first part of the voyage, it was not necessary in the second part from the Cape of Good Hope to West Africa. It may also be very dangerous to ventilate, as has been shown in the example given above for cargo sweat. In that case the vessel ventilated whilst transiting humid conditions in the Red Sea, with the result that moister air was introduced into the holds. With all this in mind, a rule is required to ensure that, when the vessel does ventilate, it improves the air conditions in the hold, and thereby reduces the risk of sweat developing.

The Dew Point Rule – The Dew Point Rule is probably the most common rule followed to ensure best ventilation practice.[3] It is simply: – Do not ventilate if the dew point of the ambient air is higher than the dew point of the air inside the cargo space. – Ventilate only if the dew point of the ambient air is lower than or equal to the dew point of air inside the cargo space. – Remember, a higher dew point is bad and a

lower dew point is good. – Clearly, when it is raining, snowing, etc., or it is foggy, misty, etc., it will not be safe to ventilate.

- Another rule, which depends on the cargo temperature, can be used but is probably not as easy to follow and is probably less recognised.

The sea conditions – If, in adverse sea conditions, there is a risk of sea spray entering the ventilation openings to the cargo spaces, no ventilation should take place and the ventilator openings should be closed and sealed.

Inspections of the cargo spaces – The cargo spaces should be inspected regularly to check for signs of sweat (providing it is safe to enter).

Hours of darkness – Providing ventilation can and should be carried out, based on the above considerations, ventilation should continue to take place night and day. A failure to ventilate at night will probably be viewed unfavourably by a court or arbitration tribunal, unless of course there was a valid reason not to ventilate.

Shippers' instructions – Shippers may have special instructions for ventilation. If these are at odds with what the vessel would expect, it would be prudent to obtain the views of an expert.

Expert advice – If there is any doubt about ventilation, expert advice ought to be sought.

VENTILATION SYSTEMS

Vessels are normally fitted with one of two systems: natural or mechanical.

Natural ventilation simply describes a system whereby ambient air is allowed to enter and leave the hold naturally, via trunking connecting the hold to and above deck level.

Mechanical ventilation describes a system whereby air movement is forced, usually by electrical fans that are fitted in the ventilation trunking. These can usually be operated so as to either draw air into or eject air out of the hold.

System features – In the hold there is usually two or more ventilation openings in the deckhead, one set forward, one set aft. This arrangement therefore only provides for surface ventilation of the cargo. It is less common for the trunking to extend down the bulkheads, so as to provide through ventilation (not normally required for bulk cargoes). Above deck the trunking may stand alone or may be built into part of a deck structure, e.g., the hatch coaming. Whatever the system, every ventilator should be provided with a means of closing, e.g., a screw-down mushroom cover, a flap or door. If the on-deck trunking is on a swivel arrangement, the vent opening can be turned to face forward when safe to ventilate (so as to maximise air intake), or aft when there is a risk of sea spray. The trunking arrangement may serve holds on an individual or common basis. Where cargoes with different ventilation requirements are stowed in different holds, care will need to be taken to arrange stowage and ventilators correctly.

Ventilation in practice – With natural ventilation, the air will usually move from forward to aft, with the movement of the vessel. Mechanical ventilation can aid this movement by setting fans to draw in forward and eject aft. It is important to avoid short-circuiting the air movement, e.g., via a hold opening between the ventilators. Fans can usually be operated at various speeds, so for example when vigorous ventilation is necessary high speeds can be used. If, despite ventilation, ship's sweat is still occurring, the hatch covers can always be opened. Opening the hatch covers may also be necessary where there is an air pocket in the hatch square, caused for example by a high cargo stow.

System checks – Some points to check with ventilation systems: – Closing appliances are often exposed on deck and easily become rusty. They need to be kept in good condition so that they can be opened and closed with ease. The ventilators will often need to be operated numerous times during the voyage, and often at short notice, e.g., sudden heavy sea spray. Surveyors for cargo interests often suggest that the vessel can not have ventilated properly when they find ventilators in poor condition and difficult to operate. – The closing mechanism should always be checked to ensure an effective seal. – Ventilators should be clearly marked to show when they are in the open or closed position (unless obvious), and also show which hold they serve. – Fans for mechanical ventilation should be checked for operation before loading.

De-humidifiers – On some ships fixed or portable de-humidifying units may be fitted in the holds. These act to remove moisture from the hold air and therefore control the dew point.

Charterparty – The ventilation system should be properly described in the charterparty and care should be taken to avoid accepting ventilation requirements, which may be difficult or even impossible to comply with. It is also a good idea to obtain written acknowledgment from the shipper where the vessel is only fitted with natural ventilation, particularly on voyages where ship's sweat is expected. The shippers are then on notice of the vessel's ventilation limitations.

TEMPERATURE MEASUREMENTS AND VENTILATION RECORDS

Determining the dew point – Compliance with the Dew Point Rule requires determination of the dew point. If cargoes requiring ventilation are to be carried it is very important that the vessel has on board the necessary instruments, with spares, to determine the dew points, and that the crew is properly trained to use the instruments. If the vessel is not properly equipped it risks being uncargoworthy and in breach of Article III Rule 1 (b) of the Hague/Hague-Visby Rules.[4] Most vessels have a basic psychrometer[5] on each bridge wing housed within a Stephenson screen. The psychrometer consists of two thermometers which are identical, save for one which has its bulb covered with a jacket of tight muslin cloth, and which must be saturated with distilled water. The dew point is determined from careful reading of the temperature on the two thermometers and by reference to dedicated dew point tables, such as those found in the Mariner's Handbook.[6] Using the psychrometer on the windward bridge wing will give the dew point of the ambient air. For the holds, a psychrometer[7] can also be used, preferably within the hold (providing it is safe to enter). Temperatures should be taken at various places and sufficient time needs to be allowed for thermometers to acclimatise (the psychrometer should be waved in the air). If the holds can not be entered, the psychrometer may be placed down the outlet ventilation trunk or hold access.

1. The carrier shall be bound before and at the beginning of the voyage to exercise due diligence to properly man, equip and supply the ship.

2. A type of hygrometer, i.e., a means by which the water content/humidity of the air can be measured.

3. Using this table requires the temperature from the dry bulb thermometer and the depression of the wet bulb temperature as compared to the dry bulb temperature. The wet bulb temperature should always be lower because of cooling due to evaporation of water from the muslin cloth.

4. Other instruments include the whirling hygrometer (manufacturer's instructions need to be consulted).

Records – As mentioned in the introduction, records are essential to the carrier's defence of cargo claims. It may be that, on some voyages, sweat can not be prevented. For example, ship's sweat resulting from ventilation being restricted due to say fog or heavy seas on deck. In those circumstances it may be necessary to evidence that the vessel did ventilate as much as it reasonably could, when it could. On the other hand, moisture damage to the cargo may be due to the inherent nature of the cargo itself, e.g., pre-shipment moisture content, and the carrier may need to evidence that when the cargo was ventilated it was ventilated correctly. It is important to bear in mind that, even if poor ventilation practice has only contributed to cargo damage, with the predominant cause being, for example, inherent vice of the cargo, the carrier faces the difficult, if not impossible, task of having to prove the extent of damage caused by the vessel's wrong doing so as to avoid liability in full.

It is strongly recommended that a separate ventilation log be drawn up where the observations for each hold are recorded. A suggested proforma is set out below.

In addition to the ventilation record, it is also important to take and record the bilge soundings, as these too will be evidence of moisture within the hold. Obviously, the bilges should be dry before loading.

VENTILATION LOG – HOLD 1 ONLY VENTILATE IF THE OUTSIDE AIR DEW POINT IS LESS THAN OR EQUAL TO THE HOLD AIR DEWPOINT

DATE	TIME	OUTSIDE AIR DRY BULB TEMP.	OUTSIDE AIR WET	HOLD AIR	HOLD AIR DRY	HOLD AIR WET	HOLD AIR DEW POINT	VENTILATION YES/NO	SEA TEMP.	COMMENT*

	BULB TEMP.	DEW POINT	BULB TEMP.	BULB TEMP.
0000				
0400				
0800				
1200				
1600				
2000				

STOWAGE

As the reader will have gathered by now, stowage is an important issue, not just in terms of avoiding sweat but also in terms of trying to prevent it from damaging the cargo.

Increasing the risk of sweat – Improper stowage can increase the risk of sweat. For example, stowage of a wet cargo in the same hold as dry cargo. Careful stowage planning is therefore important, but so too is the inspection of cargo before and during loading. A normally dry cargo may be wetted ashore, e.g., due to rain or snow, and it is therefore important to stop such cargoes from being loaded, either to be replaced or satisfactorily dried. Materials used in the stow, e.g., dunnage and shoring, should also be dry.

Moisture migration – Moisture migration, which is the movement of moisture within the cargo stow, is also worthy of mention. For example, moisture will migrate within a bulk cargo of grain to the outer parts of stow when these parts are cooled, e.g., because the ship's steelwork is cooled by falling air and sea temperatures. The physics at work in this phenomenon are beyond the scope of this article, and it is considered sufficient to appreciate the importance of good stowage to remove excess moisture at the extremities of the stow.

Aiding ventilation – Stowage can go a long way to aid ventilation so as to avoid sweat. A very good example is when ventilation channels are employed in the stow. These can be very effective in preventing ship's sweat where hygroscopic cargoes are carried from warm to cold climate. Ventilation is necessary to replace air in the hold made moist by the cargo, with drier air from outside. For this reason, stowage channels are often employed with bagged rice cargoes, but the effectiveness of these channels very much depends on the actual arrangement. Some arrangements are better than others and expert advice should be sought.

Protecting the cargo from sweat/moisture – As already discussed, some sweat (notably ship's sweat) may be unavoidable, particularly at the sides and bottom of the hold where ventilating air can not reach or reach in sufficient quantity. Whilst this is not relevant for bulk cargoes, it is highly relevant for bagged and other packaged/unitised cargoes. In terms of trying to prevent cargo being damaged by sweat, dunnage is key. As already mentioned, it is important that the dunnage is dry, otherwise it defeats one of the very objects for which it is used. Probably the most common dunnage is kraft paper, but this has its limitations. For example, it provides only a thin barrier between the cargo and any moisture and can also easily be torn. A good example is when paper is used to cover the sides of a hold with internal frames (or a hold with corrugated bulkheads). The weight of the cargo often pushes through the paper spanning the frames, with the result that cargo comes into direct contact with the side of the hold between the frames. This also adversely affects the productiveness of the ventilation channels provided between the frames. In view of these problems it is recommended that kraft paper be used with other (sturdier) dunnage material or cargo battens.

Bamboo sticks and mats have commonly been used for shipments of bagged rice from places such as Thailand. The experience of some operators is that this material is less effective than kraft paper, used with, for example, plastic. This may be because the bamboo already contains some moisture and/or because, compared to paper, it more readily gives off moisture that is absorbed from sweat. It may also be that bamboo provides less of a barrier to cold air contacting the extremities of the stow, and which can be relevant to moisture migration.

On the tank top, dunnage should be aligned so that moisture can flow easily to the bilges. The dunnage should also be strong enough to withstand compression forces. For example, the weight of a steel cargo is often so great that the timber floor is compressed. As a result, the barrier between the cargo and any moisture on the tank top is greatly reduced.

Charterparty terms – It is fair to say that, in today's world, shippers generally make it more difficult for the ship in terms of preventing damage caused by sweat. The cheaper stowage option is often chosen and from time to time cargoes with excessive moisture contents are hipped. Owners should therefore be alive to the risks of sweat when arranging fixtures and try to ensure that the charterers are made responsible for stowage. As already mentioned, onerous ventilation requirements should also be avoided.

CONTAINERS

Sweat can occur in a container just as it can in a cargo hold. A good example of ship's sweat can be found in the article "How do you like your coffee?", which appeared in Gard News issue No. 148. The article also provides some useful commentary on handling claims for damage caused by condensation.

VENTILATION FOR OTHER PURPOSES

Ventilation may be required for other purposes. For example, the removal of unwanted gases from the cargo space (e.g., ethylene which ripens fruit cargoes), the removal of heat from cargoes prone to heating. The ventilation of dangerous goods should always be in accordance with the relevant industry regulations and codes, e.g., the BC and IMDG Codes.

CONCLUSION

Shipowners and carriers need to be fully aware of the risks of sweat, which are no less today than they were many years ago. The risks and the control measures need to be understood, not just by those on board, but also by those fixing the vessel's employment, and by those arranging stowage on the vessel. If proper precautions are not taken and/or proper ventilation practice is not adhered to, either to reduce the risk of sweat and/or protect the cargo from damage by sweat, claims for damage can be considerable. Whilst it can be most frustrating when damage of this nature occurs through a lack of basic seamanship, there is equally nothing more frustrating than when good grounds for defending claims can not be sustained through a failure of the vessel to properly record its ventilation practice. The message is simple – don't work up a sweat – work out what is needed to control it!

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Any comments to this article can be e-mailed to the Gard News Editor.

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