

Carefully to Carry

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Carriage instructions for refrigerated cargoes

Many shippers and carriers are prepared to accept inadequate instructions either through ignorance or through unquestioning acceptance of what has been accepted previously

Introduction

Refrigerated cargoes are invariably perishable to a greater or lesser degree, and their safe carriage depends on maintaining suitable storage conditions during transportation. This is true for all modes of transport and all cargoes, though conditions are more critical for longer journey times and for more perishable commodities.

Refrigerated cargoes include both frozen and chilled goods, the latter including fresh fruits and vegetables. Generally, frozen goods do not suffer if over-cooled, whereas chilled goods can be damaged by low temperatures, either by freezing or by chilling injury to fresh produce. Much tropical and sub-tropical produce is liable to chilling injury if subjected to temperatures below those usually experienced in the growing area.

Successful transportation is dependent on the carriage instructions, which define the conditions in which the goods are to be carried. If these instructions are incomplete, inadequate, contradictory, or wrong, then problems can be expected. For the shipper, there is the risk of loss of cargo. For the carrier, there is the risk of a claim even if the goods are undamaged. Many shippers and carriers are prepared to accept inadequate instructions either through ignorance or through unquestioning acceptance of what has been accepted previously by themselves or others. Instructions may be based on goods of different origin, which may have different requirements.

The way in which cargo is stowed into holds or stuffed in containers is important for successful carriage, and is dealt with later.

These recommendations have been drawn up to assist both shippers and carriers to re-assess their carriage instructions in order to improve the operation of refrigerated transport chains. Any suggestions for improving these recommendations would be welcome.



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

Hague Rules,
Articles iii, Rule 2

Carefully to Carry Advisory Committee

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

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

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

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

First, general requirements are considered. Thereafter, separate sections relate to containerised cargoes and to shipments in reefer vessels. For ease of reference, points that are the same for both types of transport are repeated in the appropriate sections.

General requirements

The responsibility for specifying carriage instructions is that of the shipper, the owner of the goods. Only the shipper knows the full nature of the goods, their prior history and their requirements. Frequently this responsibility is passed to the carrier, but in this case the shipper should agree the acceptability of the specified conditions prior to shipment. In either case, the exact nature of the cargo needs to be known – in the case of fruit, for example, carriage requirements may vary dependent on type, variety, maturity, origin and growing season conditions.

- If mixed loads of differing commodities are to be carried in a single cargo space, it is necessary to consider compatibility of temperature, atmosphere (especially ethylene levels) and liability to taint. This will usually require specialist cargo care advice.
- It may be necessary to ensure that carriage conditions are specified to all carriers in the transport chain, as on occasions an international journey may use different carriers at the start and end of the journey.
- Items such as relative humidity and maximum time without refrigeration should not be over-specified but should meet the necessary requirements of the goods.
- Over-specification of requirements is to be avoided as it tends to lead to more, and sometimes spurious, claims regarding technicalities which have not actually affected cargo quality.

Many of the items listed here may be taken for granted in the case of regular shipments, but may need to be specified if a new carrier is used.

Specific requirements for containerised cargoes
The parameters that may be included in carriage instructions for containerised refrigerated cargo are listed below:

- Pre-stuffing sanitation.
- Pre-cooling of containers.
- Cooling during part-loaded conditions.
- Prohibition of stuffing cargo at mixed temperatures.
- Stowage requirements.

- Ventilation.
- Carriage temperature.
- Maximum time with refrigeration.
- Air circulation rate.
- Relative humidity.
- Measurement and reporting requirements.
- Special conditions for cold weather.
- Need to pass instructions to subsequent carrier.
- Need to notify if limits exceeded.

For controlled atmosphere shipments, additionally:

- Levels (ranges) for O₂, CO₂, humidity, ethylene.
- Permitted time to reach specified levels.
- Procedure in event of CA system failure.
- Safety requirements.
- Discharge atmosphere requirements.

Each of these is considered below:

Pre-stuffing sanitation

The proper cleanliness and lack of odour in containers to be used for refrigerated goods should be a matter of normal good practice, but any special or particular needs should be identified.

Pre-cooling of containers

Pre-cooling is only useful when loading from temperature-controlled loading bays; in other conditions, it can result in excessive moisture ingress from the atmosphere and is not recommended.

Cooling during part-loaded conditions

Part-loaded containers should be closed and temperature maintained if there is a delay before complete loading.

Prohibition of stuffing cargo at mixed temperatures

Properly pre-cooled cargo and substantially warmer cargo should not be mixed.

Stowage requirements

Any special stowage requirements, such as a protected or underdeck stow, should be stated.

Ventilation

The rate of fresh air ventilation for fresh produce should be specified. This should be as an absolute figure in

cubic metres per hour. The specification of a percentage rate of ventilation only has meaning if related to a specific container size and a specific model of refrigeration unit.

Carriage temperature

It is not physically possible to provide refrigeration in the absence of temperature differences, both between air and goods and within the bulk of the goods. The only temperature which can be controlled is the set point, which corresponds to air delivery temperature for chilled goods and to air return temperature for frozen goods. The term 'carriage temperature' therefore has little meaning, and 'set point temperature' should be specified. If appropriate, this may be augmented by a maximum allowable temperature during periods without refrigeration.

Although degrees Celsius (°C) are the international standard, in the USA degrees Fahrenheit (°F) are still commonly used. As zero degrees C is a common chilled goods temperature and zero degrees F is a common frozen goods temperature, great care is needed to avoid possible confusion of units.

For USDA and other cold treatment quarantine requirements, maximum pulp temperature may have to be maintained below a specified temperature throughout a continuous period of days or weeks, and only approved equipment may be used.

Maximum time without refrigeration

Sometimes it may be necessary for statutory or other reasons to specify a maximum duration of time without refrigeration, either per event or in total for the journey. This should not be necessary if temperature limits are well defined.

Air circulation

Some containers have a high air circulation rate for chilled goods and a lower rate for frozen goods. If a speed change switch is fitted, low speed operation for chilled goods may be possible, but as this inevitably results in a wider range of cargo temperature, it is not recommended.

Relative humidity

When equipment with humidity control is used, a range must be specified. It is difficult to measure humidity regularly to better than the nearest 2 to 3%, so an acceptable range of at least $\pm 5\%$ should be specified, albeit with a tighter target. Special equipment is available to maintain either high (e.g. 90%) or low (e.g. 50%) humidity. Without such equipment, relative humidity is not controllable and should not be specified.

Measurement and reporting requirements

It is normal to record air temperature in refrigerated containers, and some equipment also records delivery air temperature. Any specific shipper requirement for reporting temperatures should be stated. When the refrigeration unit is not running, the recorded temperatures do not reflect cargo temperatures. Shippers may choose to put their own recording equipment within cargo, in which case they should inform both carriers and receivers.

Special conditions for cold weather

Sometimes special requirements exist for exceptionally cold conditions. However, it should be noted that most transport refrigeration equipment will control temperature using either cooling or heating as necessary to maintain specified conditions.

Need to pass instructions to subsequent carrier

If there is uncertainty at the start of a voyage as to who will be the final carrier, it may be necessary to request the initial carrier to pass on carriage instructions.

Need to notify if limits exceeded

Procedures for notification of out of specification conditions should be established prior to acceptance of cargo for shipment. This could apply to warm loading, or to equipment failures, for example. Standard procedures and safe limits should be available.

Additional requirements for controlled atmosphere shipments

Controlled atmosphere (CA) systems are designed to maintain an atmosphere different from normal, usually with low oxygen and increased carbon dioxide. They enhance the storage life of some produce when used in conjunction with refrigeration. There are additional requirements for such shipments, as follows:

Levels (ranges) for O₂, CO₂, humidity, ethylene

For each of the atmospheric gases to be controlled, upper and lower concentration limits should be specified.

Permitted time to reach specified levels

The maximum time allowed to reach the specified levels may be laid down.

Procedure in event of CA system failure

The failure of a CA system will not necessarily have a drastic effect on the produce if the refrigeration continues to run. In these circumstances it will be necessary to introduce fresh air ventilation to fruit and vegetable cargoes. This should be specified.

Safety requirements

CA produces an atmosphere which is deadly to humans – breathing an oxygen-depleted atmosphere induces rapid unconsciousness and may result in death. Adequate safety systems must be in place, and these may need to allow for the possibility of stowaways in the cargo.

Discharge atmosphere requirements

The safety requirements extend to those unloading cargoes. Proper ventilation prior to entering containers and training of workers are both necessary.

Containerised transport of perishables without refrigeration

Some perishable commodities are carried without refrigeration, possibly for very short-duration journeys, or in ventilated equipment. In these cases it is wise to consider which of the previous requirements may still apply.

Products with limited temperature sensitivity may be carried under refrigeration for certain journeys only. The following guidelines suggest when this may be appropriate:

- For any goods requiring close temperature control, refrigeration is essential. If temperatures need to be maintained within a band of 2°C or less, refrigeration should be virtually continuous.
- At the other extreme, for less sensitive goods with a maximum temperature tolerance of 30°C or above, refrigeration is only necessary for storage on land at high ambient temperatures. For containerised shipments at sea, a protected stow may be requested.
- If the maximum permitted temperature is 25°C or lower, refrigeration should be used for any journeys through the tropics and for any journeys anywhere in a summer season.
- If cargo requirements are marginal, either in terms of temperature tolerance or in terms of possible delays at high ambient temperatures, then the only safe option is to use refrigeration.
- Frozen foods may sometimes be carried without refrigeration for short journeys as long as the cargo is not subjected to more than the specified maximum temperature. This should only be done with the consent of the owner of the goods.

Specific requirements for reefer ships

The parameters that may be included in carriage

instructions for refrigerated cargo are listed below:

- Pre-loading sanitation.
- Pre-cooling of cargo space.
- Cooling during part-loaded conditions.
- Prohibition of loading cargo at mixed temperatures.
- Stowage requirements.
- Ventilation (or lack of) during cooling.
- Ventilation thereafter.
- Carriage temperature.
- Air circulation rate.
- Relative humidity limits or targets.
- Carbon dioxide limits or targets.
- Ethylene limits.
- Measurement and reporting requirements.
- Special conditions for cold weather.
- Need to pass instructions to subsequent carrier.
- Need to notify if limits exceeded.

For controlled atmosphere shipments, additionally:

- Levels (ranges) for O₂, and CO₂, humidity, ethylene.
- Permitted time to reach specified levels.
- Procedure in event of CA system failure.
- Safety requirements.
- Discharge atmosphere requirements.

Each of these is considered below.

Pre-loading sanitation

The proper cleanliness and lack of odour in compartments to be used for refrigerated goods should be a matter of normal good practice, but any special or particular needs should be identified.

Pre-cooling of cargo space

The pre-cooling of cargo spaces removes heat from steelwork and provides a check on the operation of the refrigeration system. However, an excessive pre-cooling time only wastes energy and time. Duration of 24 hours after the required temperature has been reached is sufficient. The required pre-cooling temperature may be a few degrees lower than required transport temperature.

Cooling during part-loaded conditions

Part-loaded spaces should be closed and temperature maintained if there is a delay before completing loading. Care should be taken to ensure that under these conditions the temperature is not held at a precooling temperature below the required transport temperature for long enough to damage the cargo.

Prohibition of loading cargo at mixed temperatures

Properly pre-cooled cargo and substantially warmer cargo should not be mixed at loading.

Stowage requirements

Any special stowage requirements should be stated.

Ventilation (or lack of) during cooling

For most refrigerated cargoes, the cargo should be loaded at the required carriage temperature. For some cargoes, notably bananas and the less sensitive citrus varieties, cooling in transit is normal. In these cases a period of 48 hours should be specified, during which fresh air ventilation is stopped to allow maximum refrigeration.

Reference is sometimes made to the 'reduction period' which is the time from hatch closure to the air return temperature reaching within 18°F of the requested air delivery temperature. This is a parameter which may usefully be measured and reported but should not be specified.

Ventilation thereafter

After cooling, or throughout in the absence of cooling, the rate of fresh air ventilation for fresh produce should be specified. This may be as an absolute figure in cubic metres per hour, or as a rate in air changes per hour of the empty volume of cargo space. Alternatively it may be linked to measured values of humidity, ethylene or carbon dioxide. Care is necessary to avoid requirements that conflict.

Carriage temperature

It is not physically possible to provide refrigeration in the absence of temperature differences both between air and goods and within the bulk of the goods. Carriage temperature for chilled goods must therefore be specified as the air delivery temperature. Pulp temperatures may usefully be measured and reported.

It may be required to specify a lower temperature for a limited period to ensure rapid cooling of warm cargo, known as 'shock treatment'. Dual-temperature regimes, in which the delivery air temperature is changed after a specified period of days, may also be stipulated.

For frozen cargo, it is usually sufficient to specify a maximum temperature that should not be exceeded.

This may be subject to qualification for short periods. For example:

Cargo temperature shall not exceed -18°C, except for short periods during power disconnection or defrosting, when temperatures shall not exceed -15°C. A single specified 'carriage temperature' is a meaningless specification that should never be accepted.

Although degrees Celsius (°C) are the international standard, in the USA degrees Fahrenheit (°F) are still commonly used. As 0°C is a common chilled goods temperature and 0°F is a common frozen goods temperature, great care is needed to avoid possible confusion of units.

For USDA and other cold treatment quarantine requirements, maximum pulp temperature may have to be maintained below a specified temperature throughout a continuous period of days or weeks, and only approved equipment may be used.

Air circulation rate

The rate of circulation of air around and through the cargo controls the range of temperature within the cargo, and also the rate of cargo cooling. Minimum rates may be specified, usually as multiples of the empty volume of the hold per hour. Often these multiples are misleadingly referred to as 'air changes per hour', or 'ACH', a term best used for ventilation rather than circulation rates.

Relative humidity limits or target

Relative humidity may not be specifically controllable in shipments; if there are critical requirements, either special equipment or special packaging or both will be required. A sensible specification is as follows:

Relative humidity should be maintained at the maximum possible, after the delivery air temperature and fresh air ventilation requirements have been met.

Over-specification of humidity requirements is likely to lead to conflicting instructions. When special equipment with humidity control is used, a range must be specified. It is difficult to measure humidity regularly to better than the nearest two to three percent, so that an acceptable range of at least plus or minus five percent must be specified, albeit with a tighter target.

Carbon dioxide limits or target

For many fruits, a maximum level of carbon dioxide may be specified, this to be the overriding parameter for ventilation rate control. Care is necessary to avoid conflicting ventilation requirements.

Ethylene limits

The measurement or specification of ethylene levels is

rare, as accurate measurement at very low concentrations needs specialised equipment. If limits are to be specified, the measurement and control regime must also be specified.

Measuring and reporting requirements

It is normal for carriers to measure temperatures of the air in ships' holds. Any specific shipper requirement should be stated, especially if it involves cargo rather than air temperature. Shippers frequently choose to put their own recording equipment within the container/cargo in which case they should inform both carriers and receivers.

Special conditions for cold weather

Sometimes special requirements exist for exceptionally cold conditions. However, it should be noted that most transport refrigeration equipment will control temperature using either cooling or heating as necessary to maintain specified conditions.

Need to pass instructions to subsequent carrier

If there is uncertainty at the start of a voyage as to who will be the final carrier, it may be necessary to request the initial carrier to pass on carriage instructions.

Need to notify if limits exceeded

Procedures for notification of out of specification conditions should be established prior to acceptance of cargo for shipment. For example, this could apply to warm loading, or to equipment failures. Standard procedures and safe limits should be made available.

Additional requirements for controlled atmosphere shipments

Controlled atmosphere (CA) systems are designed to maintain an atmosphere different from normal, usually with low oxygen and increased carbon dioxide. They enhance the storage life of some produce when used in conjunction with refrigeration. There are additional requirements for such shipments as follows:

Levels (ranges) for oxygen, carbon dioxide, humidity and ethylene

For each of the atmospheric gases to be controlled, upper and lower limits should be specified.

Permitted time to reach specified levels

The maximum time allowed to reach the specified levels may be stipulated.

Procedure in the event of CA system failure

The failure of a CA system will not necessarily have a drastic effect on the produce if the refrigeration continues to run. In these circumstances it will be necessary to introduce fresh air ventilation, which should be stated.

Safety requirements

CA produces an atmosphere that is fatal to humans – breathing an oxygen-depleted atmosphere induces rapid unconsciousness and may result in death. Adequate safety systems must be in place, and these should always admit the possibility of stowaways in the cargo.

Discharge atmosphere requirements

The safety requirements extend to those unloading cargoes. Proper ventilation prior to opening cargo spaces and training of workers are both essential.