

Chapter 36 – Carriage Instructions for Refrigerated Cargoes

Refrigerated cargoes are usually perishable and their safe carriage depends on maintaining suitable storage conditions during transportation.

Refrigerated cargoes include frozen products such as meat, fish and seafood, and chilled products such as fresh fruits and vegetables. Chilled products are also known as perishable products. Generally, frozen goods do not suffer if overcooled, but chilled goods can be damaged by temperatures that are too low. Much tropical and sub-tropical produce is liable to chilling injury if subjected to temperatures below those usually experienced in the growing area. Chilled products need to be maintained at temperatures very close to the required set point temperatures. Because they are living and respiring, these products generate heat of respiration, which unless extracted at a sufficient rate will cause an overall increase in temperature and result in damage. This is why the evaporator fans work at high speed for chilled cargoes while for frozen cargoes, since there is no respiration or heat generation, evaporator fans run at slower speed.



Figure 36.1: Transportation of refrigerated cargo.

Successful transportation depends 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, 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 seem prepared to accept inadequate instructions, either through ignorance or because of what has been accepted previously by themselves or others. Instructions may be based on goods of different origin, which may have different requirements. For example, there are a few hundred varieties of bananas, each variety requiring its own carriage conditions. It is not acceptable to assume what the carriage requirements are, even if the carrier has carried similar cargo in the past.

36.1 General Requirements

The responsibility for specifying carriage instructions lies with the shipper of the goods and only they know 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.

It should be explicitly understood that the responsibility of specifying carriage instructions lies solely with the shipper and not with the carrier.

The exact nature of the cargo needs to be known and, in the case of fruit, for example, carriage requirements may vary depending on type, variety, maturity, origin and growing season conditions. The following general requirements typically apply to refrigerated cargoes:

- If mixed loads of different commodities are to be carried in a single cargo space, it is necessary to consider compatibility of temperature, atmosphere (particularly ethylene levels) and liability to taint. It is possible that gases liberated from one cargo may be detrimental to another. 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, because an international journey may use different carriers at the start and end of the journey
- it is important to pass on the necessary carriage instructions to all carriers in the supply chain, particularly if multimodal transportation is involved
- factors such as relative humidity and maximum time without refrigeration should not be overspecified, but should meet the necessary requirements of the goods
- overspecification of requirements is to be avoided as it tends to lead to more, and sometimes spurious, claims regarding technicalities that have not actually affected cargo quality.

36.2 Requirements for Containerised Cargoes

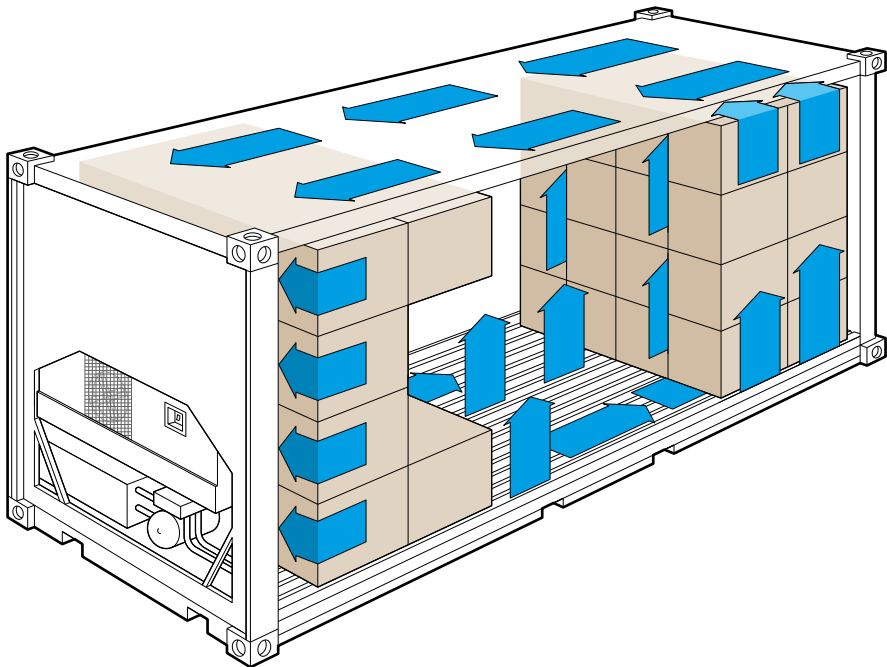


Figure 36.2: Cargo in refrigerated container.

The parameters that may be included in carriage instructions for containerised refrigerated cargo are:

- Pre-trip inspection of containers
Before stuffing the cargo, all refrigerated containers should be subject to pre-trip inspection in which the physical condition of the container is ascertained along with the proper running of the refrigeration equipment.
- pre-stuffing sanitation
Containers to be used for refrigerated goods should be clean and odour free, and 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.
- pre-cooling of the cargo
Before loading the cargo into the container, the cargo should be pre-cooled to the required carriage temperature. It should be noted that the machinery of a reefer container is not designed to cool the cargo, but only to maintain the cargo temperature. It is not to be used as a cold storage where the temperature of the cargo is brought down rapidly using powerful heavy-duty refrigeration machinery.
- cooling during part-loaded conditions
Part-loaded containers should be closed and the temperature maintained if there is a delay before complete loading.
- prohibition of loading of hot cargo
Hot cargo should not be loaded into the container. Many insurance claims have been reported at the consignee's end due to insufficient cooling of the cargo before loading into the container.
- 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 under deck stow, should be stated.
- ventilation
The rate of fresh air ventilation for fresh produce should be specified as an absolute figure in cubic metres per hour. The specification of a percentage rate of ventilation has meaning only 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 the air and the goods, and within the bulk of the goods. The only temperature that can be controlled is the set point, which corresponds to the air delivery temperature for chilled goods and the 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.

For the United States Department of Agriculture (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.

Although degrees Celsius (°C) are the international standard, degrees Fahrenheit (°F) are still commonly used in the USA. As zero degrees C (0°C) is a common chilled goods temperature and zero degrees F (0°F) is a common frozen goods temperature, great care is needed to avoid possible confusion of units. In case of doubt, clarification should be obtained from the shipper.

- maximum time with 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 rate
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 (90%) or low (50%) humidity. Without such equipment, relative humidity is not controllable and should not be specified.
- defrosting intervals
The time interval between each consecutive defrost should be specified. Chilled cargoes generally need more frequent defrosting (6 to 8-hour interval) due to respiration and liberation of moisture, and frozen cargoes need less frequent defrosting (24-hour interval). When set as a parameter, the equipment automatically defrosts at the specified intervals.
- 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 the 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, 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 and whom to notify if limits are 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 equipment failures, for example. Standard procedures and safe limits should be available. The party to be contacted if parameters go beyond the set limits should be clearly specified, with contact details provided for second and third back-up options.

36.3 Specific Requirements for Reefer Ships

The parameters for reefer ship carriage instructions may include:

- Pre-loading sanitation
Compartments to be used for refrigerated goods should be clean and odour free and 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. 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 pre-cooling 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 minus 7°C (–7°C), or 18°F, of the requested air delivery temperature. This is a parameter that may usefully be measured and reported but should not be specified.

After cooling, or throughout in the absence of cooling, the rate of fresh air ventilation for fresh produce should be specified. This may be given as an absolute figure in cubic metres per hour, or as a rate stating the number of 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 the air and the 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 necessary 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, the International Council on Clean Transportation (ICCT) note:

“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.” (Reference 61)

Although degrees Celsius ($^{\circ}\text{C}$) are the international standard, degrees Fahrenheit ($^{\circ}\text{F}$) are still commonly used in the USA. As zero degrees Celsius (0°C) is a common chilled goods temperature and zero degrees F (0°F) is a common frozen goods temperature, great care is needed to avoid possible confusion of units. In case of doubt, clarification should be obtained from the shipper.

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.”

Overspecification 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 2 to 3%, so an acceptable range of at least $\pm 5\%$ must be specified, albeit with a tighter target.

- carbon dioxide limits or target
For many fruits, a maximum level of CO_2 may be specified as the overriding parameter for the 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 requires 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 the temperature of the air in ships’ holds. Any specific shipper requirement should be stated, particularly 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, 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.
- USDA requirements, if any
The USDA requires that all refrigerated cargoes entering the US should comply with special requirements of cold treatment and maintenance of cargo temperature during the voyage. This is to prevent entry of insects along with the goods into the US territory. The USDA requires special temperature probes to be inserted into the cargo at various locations within the cargo hold and continuous recording of the temperature. On arrival at US ports, cargo will be allowed to land only if the temperature of the cargo has been maintained continuously within the specified limits.

36.4 Documentation

The importance of documents

Documents are fundamentally important in the investigation of any claim involving damage to cargo. They will be examined by the technical surveyors and may be used as evidence in any subsequent legal proceedings. The following documents are likely to be important in the event of a claim:

- Ship's log
- B/L
- mate's receipts and attached record of the inspection of the cargo prior to and during loading
- stowage plan
- deck log of loading and unloading
- engine room log
- any documentation arising from disputes during unloading and/or receipt of cargo.

In addition, photographs and video recordings can provide important evidence in support of statements in the logs and inspection reports.

Mate's receipts

The mate's receipts should include the record of the pre-shipment inspection. This record should detail all observations on the cargo's condition at the time of receipt,

including results of at least a visual inspection of each part of the consignment. Records should also include temperature measurements, taken at sufficiently frequent intervals to provide a fair indication of the average temperature of the cargo.

Any observations that indicate that the cargo temperature is high or that cargo was delivered in a damaged or deteriorated condition should be supported as far as possible by further evidence. This evidence might include photographs taken during pre-shipment inspection or results of reports by cargo surveyors.

The mate's receipt should include any information on the nature of the consignment supplementary to the B/L as well as details of any labels.

Stowage plan

A stowage plan should be drawn up for all cargoes – an accurate plan is a central piece of evidence in any damage claims arising against the vessel. The stowage plan should indicate the location of each consignment and part of consignment and should include the following information:

- Number of units (pallets, cartons or blocks) in each location
- gross and net weight
- origin of each part
- the corresponding B/L.

Deck log for loading

Loading

Many charterparty agreements specify a minimum rate of transshipment or loading. To demonstrate compliance with this, and to provide evidence in case of claims concerning damage to the cargo during loading, the timing and sequence of events during loading should be noted in the deck log. As a minimum, the log record should include the following:

- Time alongside
- where cargo was loaded from
- times of opening and closing of hatches
- arrival and departure times of stevedores on board
- times when the refrigeration system was turned on and off
- start and finish times of cargo stowage
- any breaks in loading
- weather conditions (sun, wind, rain, ambient temperature)
- any unusual or irregular events that might affect the condition of the cargo during stowage or subsequent carriage.

Deck log for unloading

Unloading

Normally, unloading is the responsibility of the receiver, and the Master of the vessel could consider that their responsibility for the cargo is over. However, the deck log

should continue to record conditions during discharge, logging similar information as listed above for loading.

Engine room log

The engine room log is important since it contributes evidence about the temperature of the ship's cargo during stowage and carriage. The log should document at least the following:

- The locations of temperature sensors in the holds
- temperatures at the sensors in the holds
- times when compressors were turned on and off
- in air-cooled systems, the temperatures in the air streams entering and leaving the holds and compartments
- in pipe-cooled systems, the temperatures of refrigerant to and from the cooling pipes.

36.5 Actions in Case of Dispute

Action by the Master of the ship

The Master must load the cargo in apparent good order and condition and act to maintain it in this state. This section describes actions to be taken when a potential problem is identified.

In the event of any concern or dispute over the condition of the cargo while loading or unloading, the Master should contact their shipowners or charterers or their P&I correspondent. Best practice would indicate that loading or unloading should cease until instructions have been received, although this may not always be possible.

As soon as any question is raised over the condition of the cargo, the Master should begin to document the events surrounding the discovery of defective material, and the nature and possible extent of the alleged defects.

If possible, loading or unloading of the vessel should be halted and the hatches closed until a cargo surveyor is present. Ideally, cargo should be inspected and sampled while still in the hold, or even during discharge, allowing the surveyor to determine whether the nature and extent of the damage is in any way related to the position in the hold.

Once the cargo has been discharged into store it may be more difficult, or impossible, to relate damage to location in the hold unless the cargo is adequately labelled. Therefore, if loading or unloading must continue, the Master should ensure that each cargo unit is labelled, as it leaves the hold, with the hatch number and deck as well as the location within the hatch and deck. The deck log should also record the destination of the material and the agent responsible for handling it.

Records

The Master should ensure that all records and documents relevant to the dispute are secure and that they are only made available to parties representing the ship's interests.

Services of surveyors

When a problem is identified during loading or unloading, for example if the temperature of the material is too high, loading or unloading should cease until the cargo has been inspected by a specialist surveyor.

If the dispute concerns the quality of the product, it will probably be necessary to call in at least one specialist surveyor to examine the cargo, establish its current quality and determine the nature and cause of any defects.

If it is suspected that defects result from maritime causes, for example physical damage from movement of cargo, or from contamination with seawater, fuel oil or bilge water, an expert in ship operations should be called in. However, if the defects could be attributed to the initial quality of the material when loaded, or to the way the product was stowed and carried on the ship, a specialist surveyor would be more appropriate.

Many of the surveyors appointed by local shipping agents are general marine surveyors, often with a seagoing background; they are not necessarily skilled in the evaluation of the quality of refrigerated cargoes. Masters and agents are, therefore, advised to check the expertise and qualifications of surveyors carefully to ensure that their technical background and experience are appropriate for the particular job.

As a general rule, a single surveyor should not be commissioned for both a cargo survey and a survey of ship condition. Since the skills required for each type of assessment are very different, it is unlikely that one person would have experience in both areas at the levels of expertise required. For example, a fish cargo surveyor should have a background in food science and the inspection of food products and, ideally, some experience in assessing the quality of frozen fishery products.

Official inspectors and sampling procedures

Where official inspectors are involved, the Master should document the authority under which the officials visited the ship and the name and status of each official.

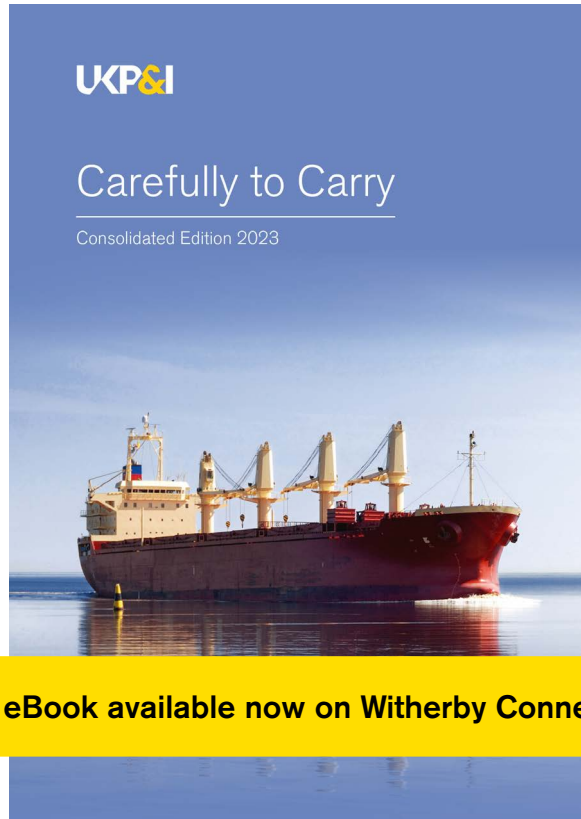
The Master is also advised to record the nature and amounts of any samples taken by representatives of the owners or by officials. Such records should include the location of the samples within the hatch or deck, the authority under which the samples were taken and the destination of the samples.

If part of the sample is given to the Master, they should ensure that it is fully labelled and, if possible, that it is sealed in a container and marked as such by the person taking the sample. The Master should store the sample in a secure place, under conditions such that the quality of the sample will not change.

If the cargo is in store, the surveyor should take into account the manner of discharge and delivery to the store, in case these operations could have affected the quality of the product or could in themselves be responsible for any damage.



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