

## Loss Control Considerations for the Transportation of fresh fruits and vegetables

The purpose of this leaflet is to inform interested parties about the challenges and risks associated with the refrigerated road transport of fruits and vegetables.

This document was prepared in part following a specific claim where a consignment of fresh plums was transported overland from Chile to Brazil. Upon arrival, the receivers found that the plums had suffered temperature deviations and quality impairment.

A review of the claim file indicated that inappropriate operating standards had been applied both at the outset of the journey and during transit.

The issues observed were not isolated to this single incident but are in fact a recurring problem across many regions of the world. In short, the incidents and scenarios described herein are attributable to poor temperature management during transit.

### The challenge

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Trailer operators have the option of running their refrigeration units in one of two modes:

- "Continuous mode"
- "Start-stop mode"

The "start-stop" mode consumes less fuel and is therefore perceived as a cost-saving measure for hauliers, and is also the more environmentally friendly option in terms of fuel consumption. For these reasons, it is often the preferred choice for carriers.

However, the cooling capacity within the cargo compartment is significantly reduced in start-stop mode, which can damage temperature-sensitive cargo.

The use of "continuous" mode should be a requirement wherever temperature-sensitive perishable cargoes are being transported.

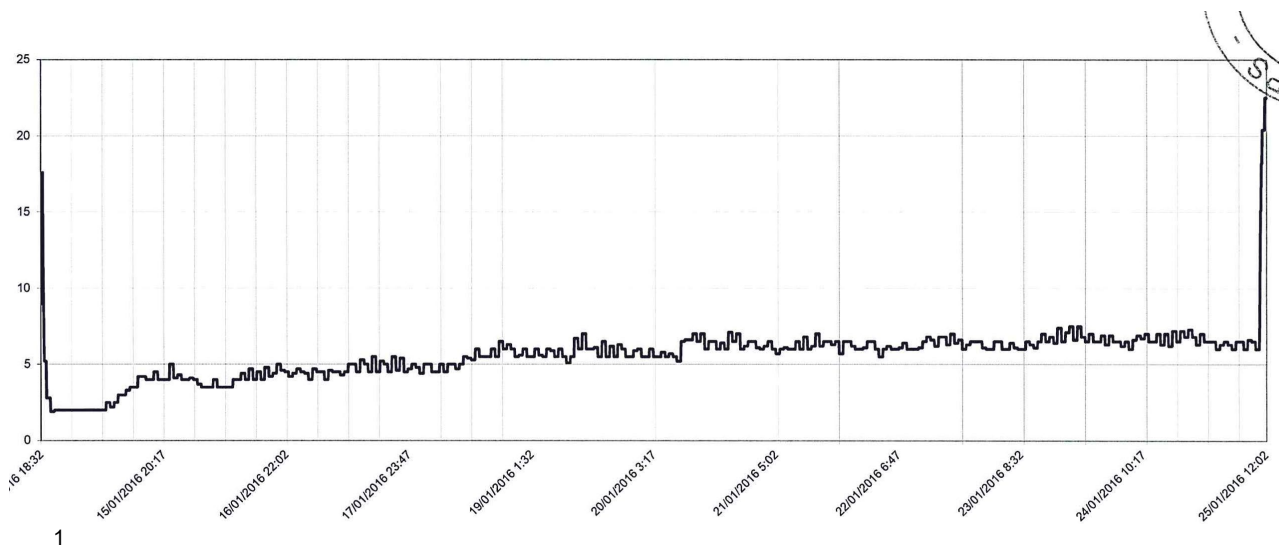
## The challenge explained

Returning to the claim described above, our client reported that upon receipt, the consignment of fresh plums had suffered temperature deviations and quality impairment.

The quality issues manifested as elevated temperatures across part of the consignment, with some plums found to be at an advanced stage of ripening — to the extent that they were eating-ripe immediately upon arrival and could no longer be held in storage for trading purposes. A proportion of the consignment was overripe, and decay had already commenced.

## Temperature records

The consignment was equipped with two temperature recorders placed at different locations within the load. The recordings showed the following:



### Recorder 1 — front of the trailer (adjacent to the refrigeration unit):

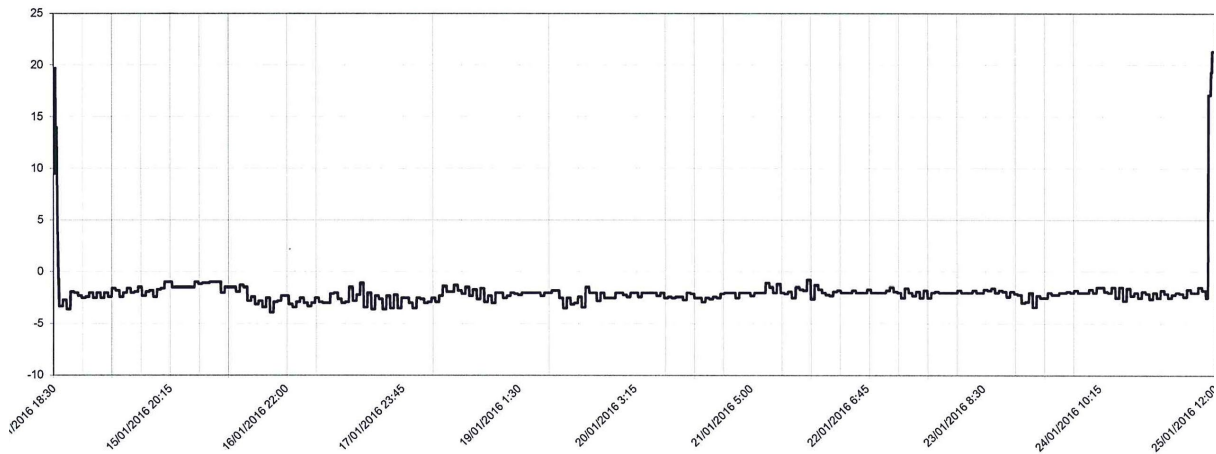
- After the commencement of recording, temperatures fell to approximately +1.9°C.
- Temperatures then began to rise steadily, reaching +6.0°C after several days and remaining between +5.2°C and +7.5°C for the remainder of the transit.

### Recorder 2 — rear of the trailer (near the door end):

- After the commencement of recording, temperatures fell to approximately -3.6°C.
- Throughout the remainder of the transit, temperatures fluctuated between -3.9°C and -0.7°C.

Both recordings display a characteristic irregular pattern: a gradual temperature rise, followed by a period of relatively stable temperature, then a sharp drop. This pattern is diagnostic of a refrigeration unit operating in "start-stop" mode.

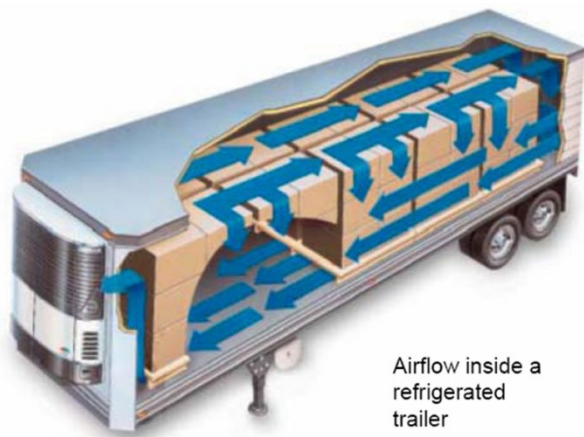
<sup>1</sup> AIG Claims File



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## How a Refrigerated Trailer Works

To understand the significance of these recordings, it is helpful to understand the operating principles of a refrigerated trailer.



Airflow inside a refrigerated trailer

Air is supplied from the refrigeration unit at the front end of the trailer, near the ceiling (the supply air outlet), and returns to the unit via an inlet at the front end near the floor (the return air inlet). This circulation path front-top to front-bottom via the length of the cargo is essential to maintaining uniform temperatures throughout the load.

The refrigeration unit regulates temperature by measuring the return air temperature. When the return air matches the set-point, the unit maintains its current output. In the case of the plum consignment, the set-point was +0.5°C.

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During loading operations in warm ambient conditions, warm air inevitably enters the cargo compartment. When the refrigeration unit starts, the return air temperature will therefore be above the set-point — not because the cargo is warm, but because the warm ambient air is the first to circulate back to the return air sensor.

In response, the unit automatically drives the supply air temperature well below the set-point in order to achieve the required return air temperature. Given that the set-point in this case was only marginally above freezing (+0.5°C), supply air temperatures can readily fall below 0°C during this initial pull-down phase.

The temperature recordings in this case confirm a sustained differential between supply and return air throughout the entire transit. One recorder showed temperatures ranging between -3.9°C and -0.7°C whilst the other simultaneously recorded between +5.2°C and +7.5°C. This sustained differential is indicative that the refrigeration unit was continuously working to reduce an elevated return air temperature — and never achieved equilibrium.

<sup>2</sup> AIG Claims File

<sup>3</sup> <https://www.tis-gdv.de/tis/tagungen/svt/svt10/wild/inhalt-htm/>

Had the refrigeration unit been operating in "continuous" mode throughout the transit, the differential between supply and return air would have equalised relatively quickly — typically within a matter of hours, subject to unit capacity and ambient conditions — and the set-point temperature would have been maintained consistently throughout the transit.

By contrast, when operating in "start-stop" mode, the cargo compartment is subject to heat ingress during each "off" cycle from:

- Heat radiation through the trailer walls from the external environment.
- Residual heat retained within isolated pockets of cargo, arising from poor stowage patterns or inadequate packaging.
- Biological heat generated by the respiration of the fruit itself.

It should be noted that fresh fruits and vegetables are living commodities that continue to respire after harvest, generating heat at a rate that increases as product temperature rises. This biological heat load is a factor unique to fresh produce transport and is effectively managed in continuous mode but becomes a compounding risk in start-stop operation.

Isolated thermal pockets within the load can be created by unfavourable stowage patterns or inadequate packaging. These can be mitigated through the application of proper stowage and packaging standards (see Recommendations below). Heat radiation from outside the trailer and biological heat from the cargo itself are, however, negligible concerns when the unit is operated in "continuous" mode, provided the cargo was in sound condition at the time of loading.

In this case, sub-zero supply air temperatures were circulating through the load, causing freezing damage to the plums at the front of the trailer. This freezing damage in turn accelerated deterioration, generating additional biological heat and compounding the temperature management failure throughout the consignment.

In summary, whilst operating the refrigeration unit in "continuous" mode does carry a higher fuel cost, it substantially reduces and, in most circumstances, eliminates the risk of temperature-related cargo damage to fresh perishables.

## Temperature instructions

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Considering the above, it is of paramount importance that carriers are provided with comprehensive written carrying instructions. A set-point temperature alone is not sufficient. Instructions must also address the required operating mode and include a requirement that temperature records are disclosed to the cargo interest upon arrival or upon request.

Carriers should, in turn, insist on receiving full carrying instructions before accepting a temperature-sensitive consignment and should confirm in writing that they have been received and understood.

## Carriers scope of operating

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Hauliers and drivers must monitor their refrigeration unit's operation routinely throughout the transit to ensure that the cargo is maintained at the required temperature.

Shippers of fresh produce requiring specific carrying temperatures must stipulate that their cargo be transported with the refrigeration unit set to "continuous" mode, so that the cargo is exposed to a consistently circulating air temperature.

Furthermore, hauliers and drivers should be instructed that, where ambient temperatures at the loading address are elevated and the required set-point is close to freezing, the set-point should be managed carefully during the initial stages of transit — reducing it gradually until supply and return air temperatures have equalised, rather than holding a fixed setting that may drive sub-zero supply air into a warm load.

Prior to loading, drivers should also satisfy themselves that the refrigeration unit is functioning correctly, that door seals are intact, and that the unit's temperature data logger is operational. Any defects should be reported to the carrier before the consignment is accepted.

## Recommendations

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In summary, the following recommendations are made:

- Avoid multi-temperature loads unless using a trailer specifically designed and equipped for multi-temperature operation with physical segregation between temperature zones.
- Ensure drivers are properly trained in the operation of the refrigeration unit. They must understand when "continuous run" or "start-stop" mode is appropriate, based on the commodity being carried and the prevailing ambient temperature conditions.
- Be aware of the age and condition of the trailer. The insulating capacity of refrigerated trailers (expressed as an 'R-value') deteriorates over time. Trailers more than five years old may be significantly less effective at resisting heat ingress, and particular care should be taken when using older equipment for sensitive cargoes such as ice cream or stone fruits.
- Use appropriate packaging. Packaging for fresh produce should be vented to allow air circulation through the stow. Solid-sided packaging is appropriate for frozen goods only. All packaging should be sufficiently robust to prevent compression damage during transit.
- Pre-cool the cargo to the required carrying temperature before loading, to remove field heat and minimise the thermal load placed on the refrigeration unit.
- Pre-cool the trailer to the required set-point temperature before loading commences. Note that this is most effective where the trailer rear is docked to a refrigerated loading bay; in open loading conditions the benefit is limited.
- Switch the refrigeration unit off during the loading operation to minimise the ingress of warm, humid ambient air into the cargo compartment.
- Ensure correct airflow within the trailer. This requires: the use of double-faced block pallets to provide adequate airflow beneath the cargo; sufficient clearance between the top of the stow and the trailer ceiling; a clean trailer interior free of obstructions; and confirmation that the evaporator return air inlet at the base of the front wall is unobstructed.
- Where possible, avoid stowing cargo directly against the trailer sidewalls, where insulation is typically thinnest and external heat ingress is greatest.
- Provide the driver with written temperature instructions covering the required set-point, the required operating mode, and the monitoring regime for the transit.
- Instruct the driver to operate the refrigeration unit in "continuous" mode throughout the transit where the cargo is liable to damage from temperature deviation.

- Instruct the driver to monitor supply and return air temperatures at regular intervals, as follows:
  - Continuously for the first 15 minutes prior to departure — confirm that the required temperatures are being achieved and that no adverse conditions are present before the vehicle moves. If temperatures are not within acceptable parameters, adjust the set-point and continue monitoring before departing.
  - 30 minutes after departure — check supply and return air temperatures and adjust the set-point if required.
  - 1 hour after departure — repeat.
  - 3 hours after departure — repeat.
  - 5 hours after departure — repeat.
  - Thereafter, continue checking at intervals of not more than 2 hours until supply and return air temperatures have equalised. Once equilibrium is achieved, monitoring intervals may be extended.

Note: The timings above are recommendations only and should be adapted to the specific circumstances of each transit, including the ambient temperature, cargo type, transit duration, and the age and condition of the refrigeration unit.

Drivers must notify the shipper or their nominated agent immediately upon observing any temperature deviation that cannot be corrected through set-point adjustment and must await instructions before proceeding with delivery.

**For further information, please contact your local Marine Risk Consultant.**

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