




STAY COOL – WE CARE

HAMBURG SÜD

A Maersk Company

CONTENTS

Passionate experts in reefer transports

Hamburg Süd ranks among the ten largest container shipping brands worldwide and is a commercially independent member of the Maersk Group. Each and every one of our approximately 5,000 employees is an expert in their field. We listen to our customers, know how important a well-functioning transport chain is for them, and feel personally responsible for it – especially when it comes to reefer container transports, an area in which Hamburg Süd and its Aliança subsidiary are some of the leading providers.

Whether fruit, meat, fish, vegetables, dairy or other perishable products – temperature-sensitive cargo is in good hands with us. Our Global Reefer Competence Team experts provide our customers with in-person and customized advice around the world.

With over 100 years of experience in reefer transports, it goes without saying that we always offer our customers innovative solutions utilizing state-of-the-art technology, such as Controlled Atmosphere (CA) and Remote Container Management (RCM). In fact, Hamburg Süd offers access to the largest reefer and CA container pool in the world. CA is an effective and sustainable means of safeguarding and preserving the quality of fresh fruit and vegetables by creating an atmosphere inside the container that perfectly meets the requirements of the particular product under transport. In addition to ensuring that the sensitive cargo reaches its destination just as fresh and flavorful as it would by plane, carriage by ship also gener-

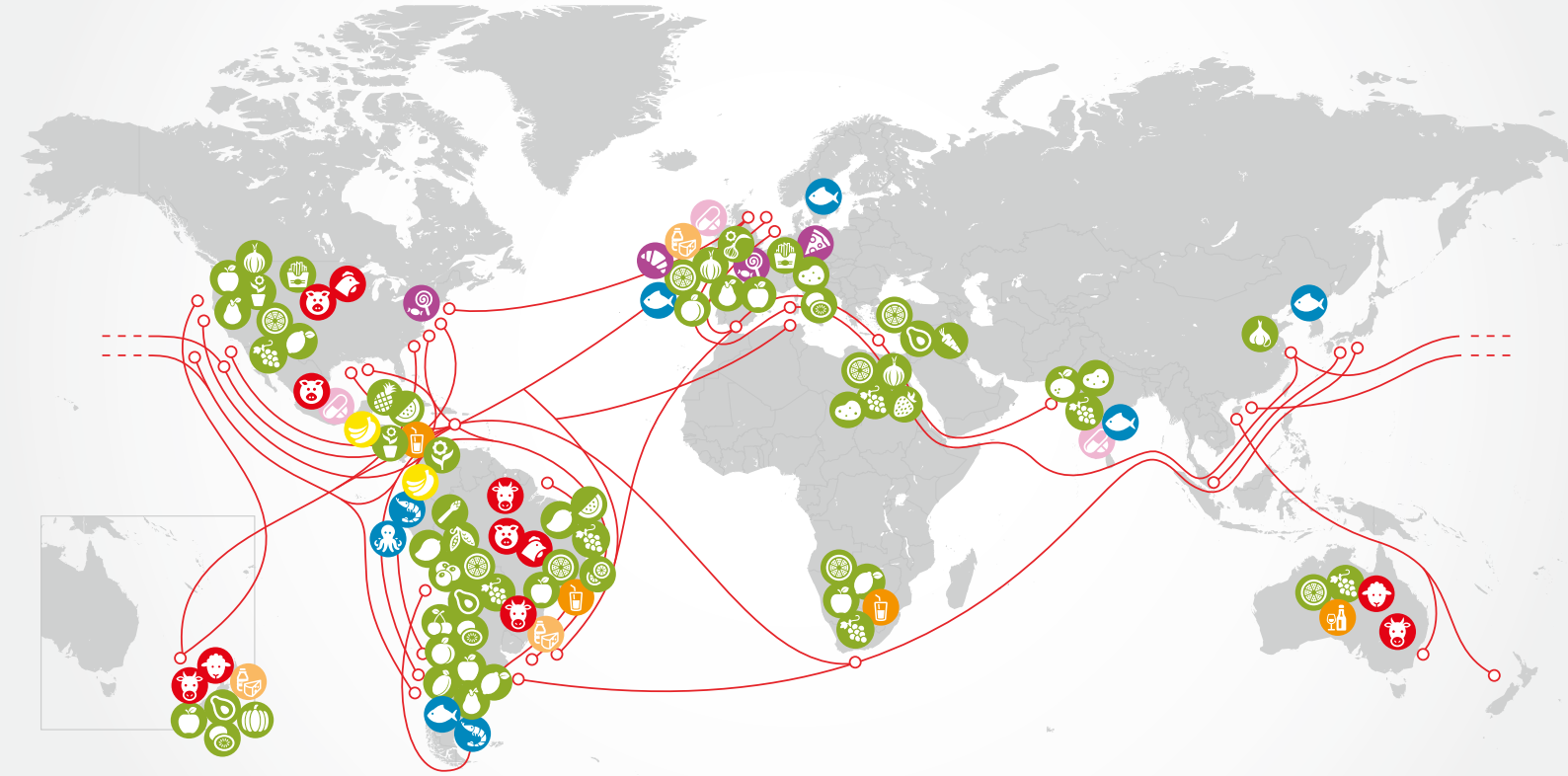
ates just a fraction of the climate-harming gases produced by air transport per ton moved.

Furthermore, all reefer containers in our equipment pool are fitted with devices for Remote Container Management (RCM). This brings unrivalled transparency to the shipping of perishable products as it enables live monitoring of the reefer container around the clock. While offering real-time GPS tracking, RCM also monitors and records the power status of the refrigeration unit. On top of that, sensors gather real-time data on a range of factors – including temperature, relative humidity, O_2 and CO_2 levels in the container atmosphere – to know exactly what is happening inside the box. With this data, we help our customers make their supply chain more efficient than ever. Simply put, customers who choose Hamburg Süd reefers benefit from cutting-edge technology, the cargo expertise of our passionate workforce, and the personal touch in container shipping.

Integrated Management System

Hamburg Süd's Integrated Management System encompasses the issues of environmental protection and quality. The quality standard ISO 9001 was implemented as early as 1996, with the environmental norm ISO 14001 being added in 2000. It is the overriding goal of the Hamburg Süd Group to ensure and constantly improve the quality and environmental compatibility of the services offered, and to avoid errors and risks. Customer satisfaction is a fundamental concern and is ensured by meeting to the greatest degree possible all requirements relating to quality and environmental protection. It is further verified by regular measurements and analyses. Service quality is fostered by working with selected and regularly vetted partners and specialist companies who also have the appropriate qualifications. Environmental impact is continuously reduced by environmental activities.

Hamburg Süd offers services along most of the world's key reefer trades.



Our vessels transport a variety of reefer cargo that requires temperature control and, in some cases, atmosphere management to maintain quality.

Commodity split

- Fruit and vegetables, flowers and plants (excl. bananas and plantains)
- Bananas and plantains
- Meat
- Fish and seafood
- Foodstuff (other)
- Pharmaceuticals
- Beverages and juice
- Dairy

GLOBAL SEABORNE REEFER TRADES

The preferences of consumers across the globe determine the trade patterns for foodstuffs. When one part of the world increases its demand for a special kind of fruit, growers on another continent are quick to cater to this demand. A continuous adaptation to changing customer demands is Hamburg Süd's key to success in the reefer business.

Reefer cargo is mainly carried from the production areas in the Southern Hemisphere to the industrialized countries in the Northern Hemisphere. Hamburg Süd is traditionally strong in the north–south services that typically transport many reefer cargoes and, as such, has long-standing experience in shipping perishable goods.

The dominant cargoes that are transported globally in temperature-controlled containers are fruit and vegetables, with bananas representing the single most important reefer cargo. Other commodities are meat, fish and seafood, dairy products, flowers, and pharmaceuticals.

When it comes to transporting reefer cargo, factors such as temperature control, air exchange, humidity levels, and proper packing and stuffing become extremely important. Because the characteristics of reefer cargo vary from commodity to commodity, handling procedures and transit environments will vary as well. Some cargoes, such as meat, have to be kept either chilled between –1 °C and –2 °C or frozen at –18 °C or colder. Other cargoes, such as fresh fruit, have to be kept at temperatures ranging from –3 °C to +16 °C to ensure that they arrive in the best possible condition.

We have the perfect solution for your reefer cargo: ask your local Hamburg Süd representative for more information.

Our equipment pool is comprised of a large fleet of modern integrated reefer containers (reefers) with cooling facilities built into the container. They come in 20′ and 40′ sizes and are available on all of our trade routes. The integrated container is especially suitable for door-to-door transport; only electrical power is required. Our reefer containers are built to the highest possible technical standards, a result of which is that our equipment is regarded by the industry as state-of-the-art. The design reflects a combination of long experience, extensive research and testing programs.

Main technical features and Pre-Trip Inspection (PTI)

One of Hamburg Süd's highest priorities is to provide its customers with the most suitable container equipment for their needs at any time. Before one of our reefer containers is released to a customer, it must always pass through a "Pre-Trip Inspection" (PTI). The Hamburg Süd PTI ensures that only clean and undamaged containers with reefer machinery in perfect running order are made available to our customers.

- Temperature ranges:
  Regular reefer: –30 °C to +30 °C PrimeLINE®/MAGNUM®/MAGNUM PLUS®: –35 °C to +30 °C
  Super Freezer: –60 °C to –10 °C MAGNUM PLUS® for 20′ reefer: –40 °C to +30 °C
- Ventilation (fresh-air exchange) range: 0 to 240 cbm/h
- Dehumidification range: 60% to 95% maximum relative humidity
- Operating voltage: 360 to 480 Volt/50 to 60 Hertz
- Fan speed (internal air circulation): max. 3,000 cbm/h (low speed), max. 6,000 cbm/h (high speed)
- High-tech insulation ensures minimum heat leakage
- Special "T-bar" floors ensure optimum air circulation
- Temperature-controlled using built-in microprocessors
- High-quality reefer machinery

Air circulation

Internal air circulation is essential for maintaining prescribed temperatures in reefer containers, from the refrigeration unit down to the door end; therefore, temperature-controlled air is constantly circulated throughout the cargo space. The reefer machinery is built to deliver high levels of air circulation with two fan motors positioned above the air cooler or "evaporator". The fan speed and thus the amount of air circulation will be adjusted by the machinery to the level to maintain the required temperatures.

Our reefer containers are equipped with "bottom air supply": temperature-controlled air is forced down the bulkhead and blown in at the bottom of the refrigeration unit through the gratings in the ducted floor, or T-floor. After circulating inside the container, the air is forced through the evaporator and guided into the T-floor again.

Each commodity has different airflow requirements. The airflow inside a reefer container is affected by the type of packaging and the method of stuffing that is being used. Depending on the type of commodity, different stuffing patterns need to be considered. The perishable industry has developed successful solutions in this regard, some examples of which are illustrated on the following pages.

Chilled and frozen products

When transporting chilled products such as fruit and meat, the temperature-controlled air must be circulated throughout the entire load. This is because heat within the container is not only generated from the outside, but may also be produced by the cargo itself. The respiration process of fresh fruit and vegetables, for example, requires air circulation both around the commodity and throughout the load to remove respiratory heat, water vapor, and gases such as carbon dioxide and ethylene.

Example 1 – chilled products

Fresh fruit and vegetables in palletized stowage (cartons on pallets) with door bottom blocking.

Air always takes the path of least resistance. If air gaps or chimneys are left in a stow, they provide an easier route for airflow than that through the cargo. Air that does not go through the cargo cannot remove respiratory heat, and air moving through chimneys near the air distribution area cannot reach further parts of the cargo. Gaps and chimneys therefore reduce the capability to maintain temperature; ergo, the cargo must cover the entire T-floor to ensure proper distribution of temperature-controlled air.

When the cargo does not cover the entire T-floor, some type of filler material (heavy cardboard, dunnage, etc.) must be placed wherever there is no cargo. This prevents a short-circuiting of the circulating air and forces air up and through the cargo to ensure proper air distribution in reefer containers with bottom air supply. Improper stuffing, and consequently the bypassing of circulating air, initiates a larger spread of temperatures within the cargo and can lead to severe cargo damage. It is important to ensure that air can circulate under, over and to each side and end of the stow and, in the case of respiring cargo, throughout the load.

As air provides an additional insulation against the ambience, the load should not be squeezed into the container – a space of a few millimeters to the side walls of the container should be left in order to allow air circulation between the cargo and the inner surface of the container.

Please note: In a reefer container, both the cargo and any filler material must be blocked and braced to stop the load from shifting. The graphs in this guide are general schematic illustrations depicting air circulation in reefers only and do not show any required cargo-securing material.

1 REFRIGERATION UNIT

2 MAX. RED LOAD LINE

The height of the cargo must not exceed the red cargo load line, which indicates the maximum allowed cargo height and ensures sufficient space is left above the stow to facilitate proper air circulation around the load.

3 T-FLOOR

The most common form of ducted floor is known as a T-floor (T-bar floor), which takes its name from the T-shaped cross-section of aluminum extrusions that form the floor.

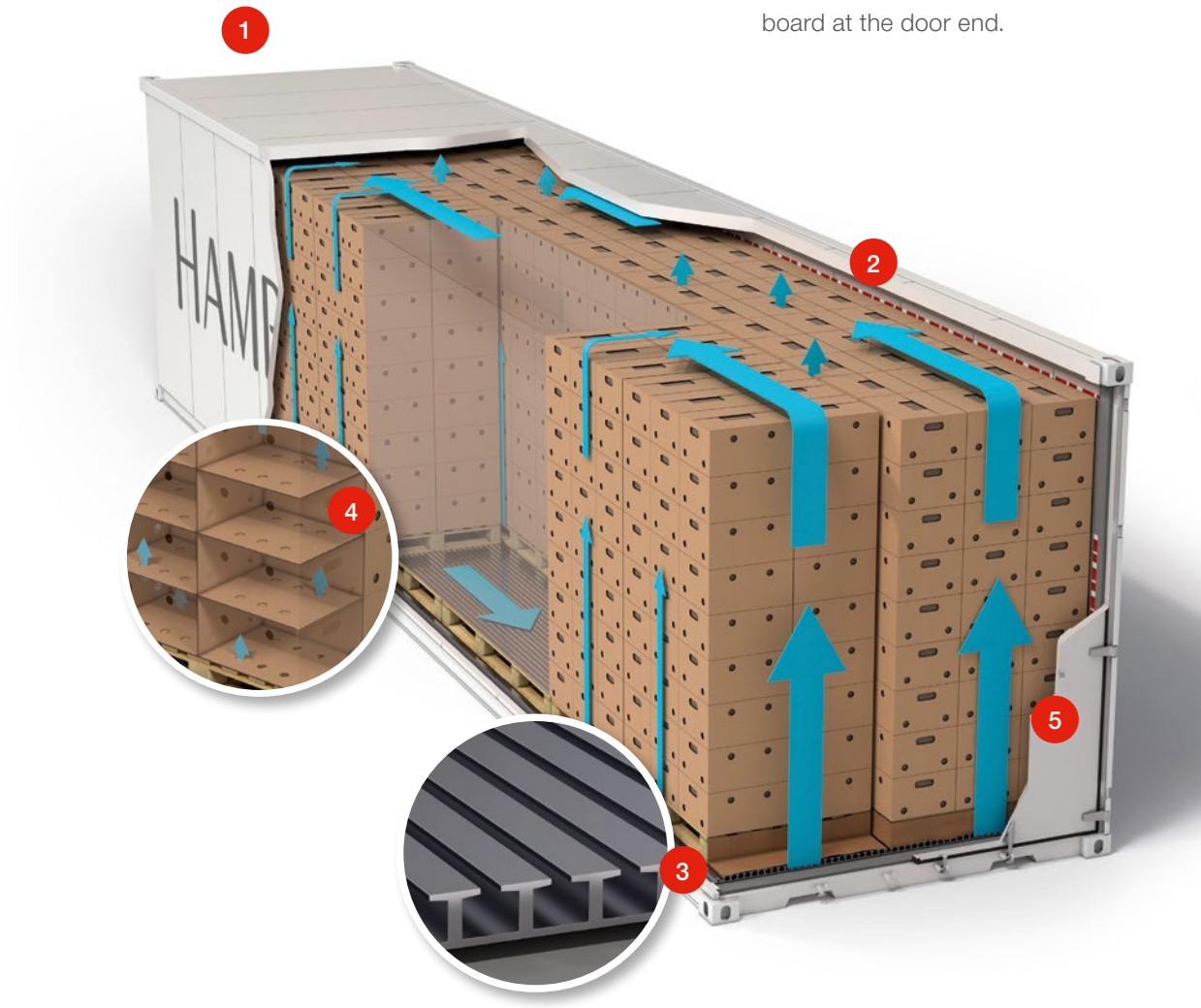
4 AIRFLOW

The arrows indicate the air circulation inside a reefer container.

5 DOORS

With regard to pallet stuffing, the front face of the last pallet(s) at the door should be covered with filler material in the same way the open T-floor should, as this increases the pressure to force air up and through the cargo.

The container must not be loaded with cargo or filler material beyond the T-floor at the door end. The below example shows a so-called "bottom blocking" with cardboard at the door end.



Airflow

Correct cargo packaging is essential to maintain product quality during transportation and marketing. The most commonly used types of packaging are cartons, crated boxes and bags. The material used for this packaging depends on the product, packing method and strength, pre-cooling method and buyer's specifications.

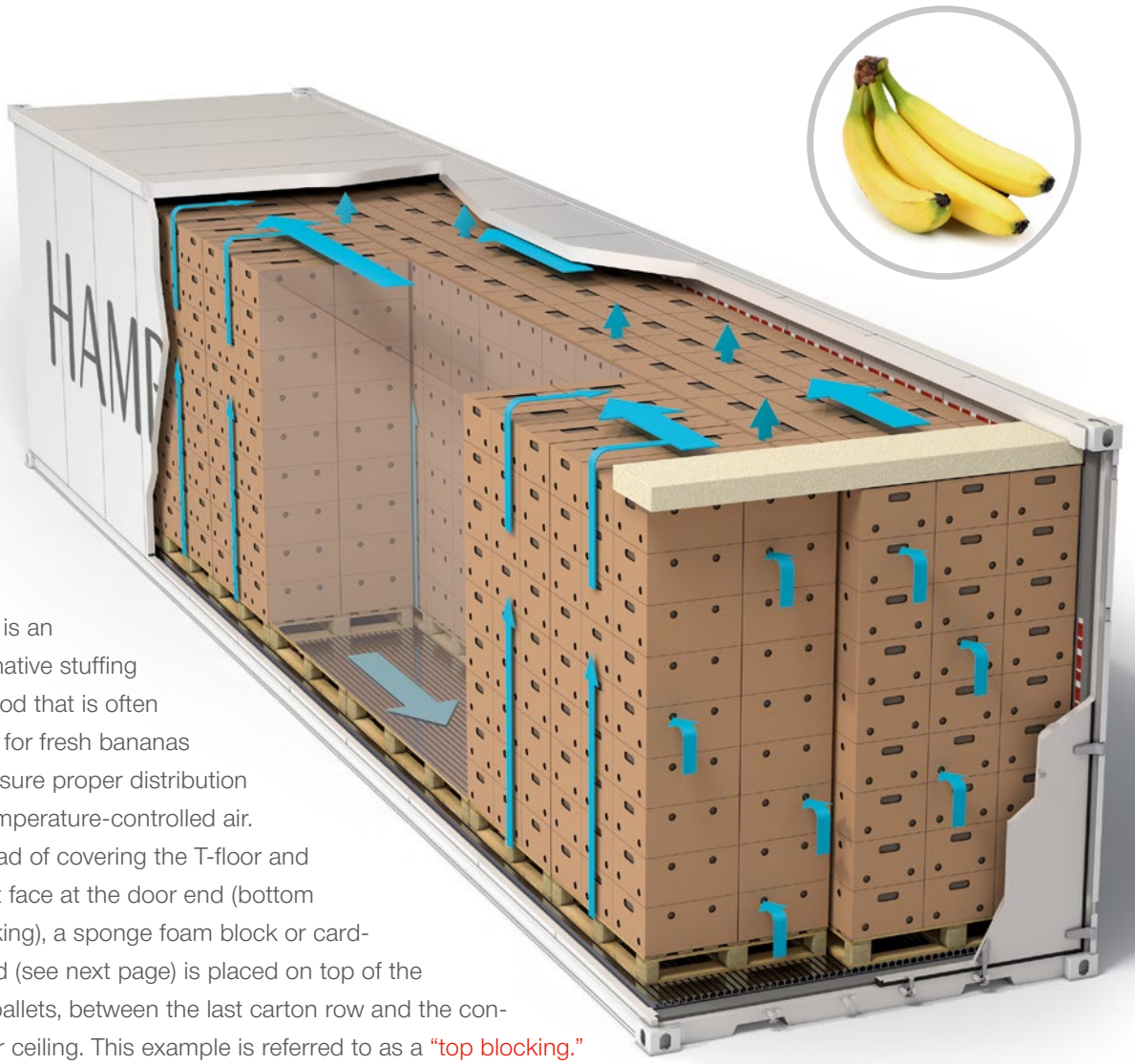
The packaging must withstand:

- rough handling (stuffing and unstuffing)
- compression from the accumulated weight of stacked packages
- impact and vibration during transport
- high humidity during pre-cooling, transit and storage

Cartons for fresh fruit and vegetables require airflow holes in the top and bottom that, when stacked, align with adjacent cartons. The number, placement, size and shape of the air holes are determined by the product being packaged. Wax-impregnated cardboard or other materials that will not lose strength in high-humidity environments are to be applied. The strength of a carton is in its corners. Stacking cartons directly on top of each other is recommended to minimize crushing cartons below. If loading cargo on pallets, the cartons on the pallets should be placed so that air flows up into the cartons unrestrictedly. The corners of each carton should be supported directly by the pallet and if pallets are wrapped in plastic to provide stability, the bottom and top of the pallet/cartons must not be covered.

Example 2 – chilled products

Fresh fruit and vegetables in palletized stowage (cartons on pallets) with door top blocking.



Here is an alternative stuffing method that is often used for fresh bananas to ensure proper distribution of temperature-controlled air. Instead of covering the T-floor and pallet face at the door end (bottom blocking), a sponge foam block or cardboard (see next page) is placed on top of the last pallets, between the last carton row and the container ceiling. This example is referred to as a "top blocking."

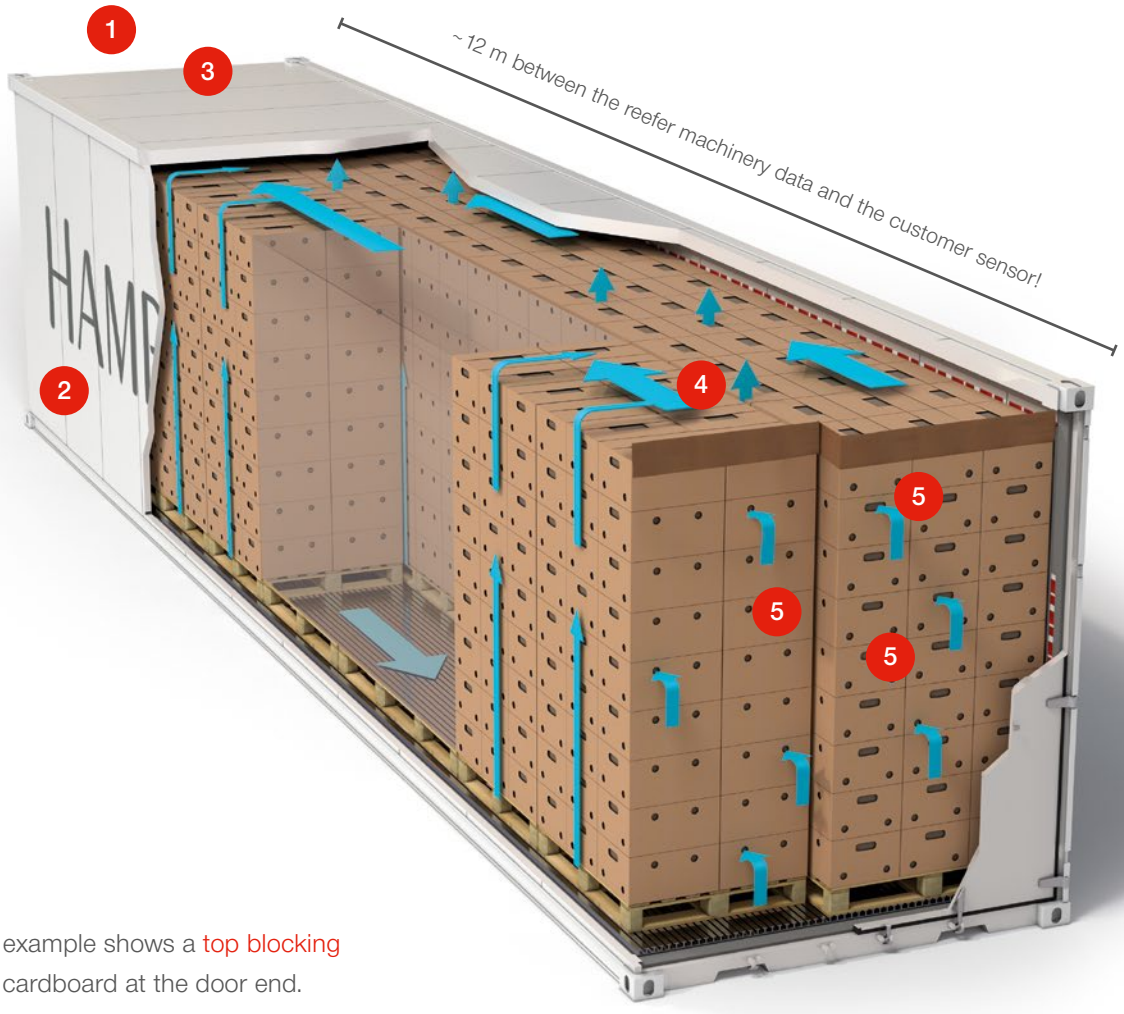
1 REFRIGERATION UNIT

2 SUPPLY AIR SENSOR

3 RETURN AIR SENSOR

4 RECOMMENDED CUSTOMER SENSOR LOCATION

5 TRADITIONAL CUSTOMER SENSOR LOCATIONS



This example shows a top blocking with cardboard at the door end.

A warrantable concern of reefer customers is the proper maintenance of the “cold chain” for their perishable cargo. In this respect the following questions regularly apply:

A) Does the reefer machinery work properly?

B) Is power supply provided along the trip?

C) Does enough air move through the full cargo load (from the reefer unit to the door end)?

Air temperature measurement in a reefer

In all our reefer containers, the machinery of the refrigeration unit is equipped with supply and return air sensors. With the temperature data measured by these sensors, questions A) and B) can easily be answered.

To get a reply for question C), our customers often use and install their own separate and independent sensors.

As air circulates through the cargo, from bottom to top, the recommended location for the customer sensor is on top of the inner corner carton of the last pallet stowed lengthways as indicated in the graph on the left. This way, a representative measuring of the air temperature at the door end can be achieved (proper packaging and stuffing provided). Traditionally, customer sensors are often positioned at the rear of the last pallets as shown in the graph. Due to the specific airflow conditions at the door end, this often leads to unrepresentative temperature measuring and a high mismatch with the reefer machinery data measured approximately 12 m further away.

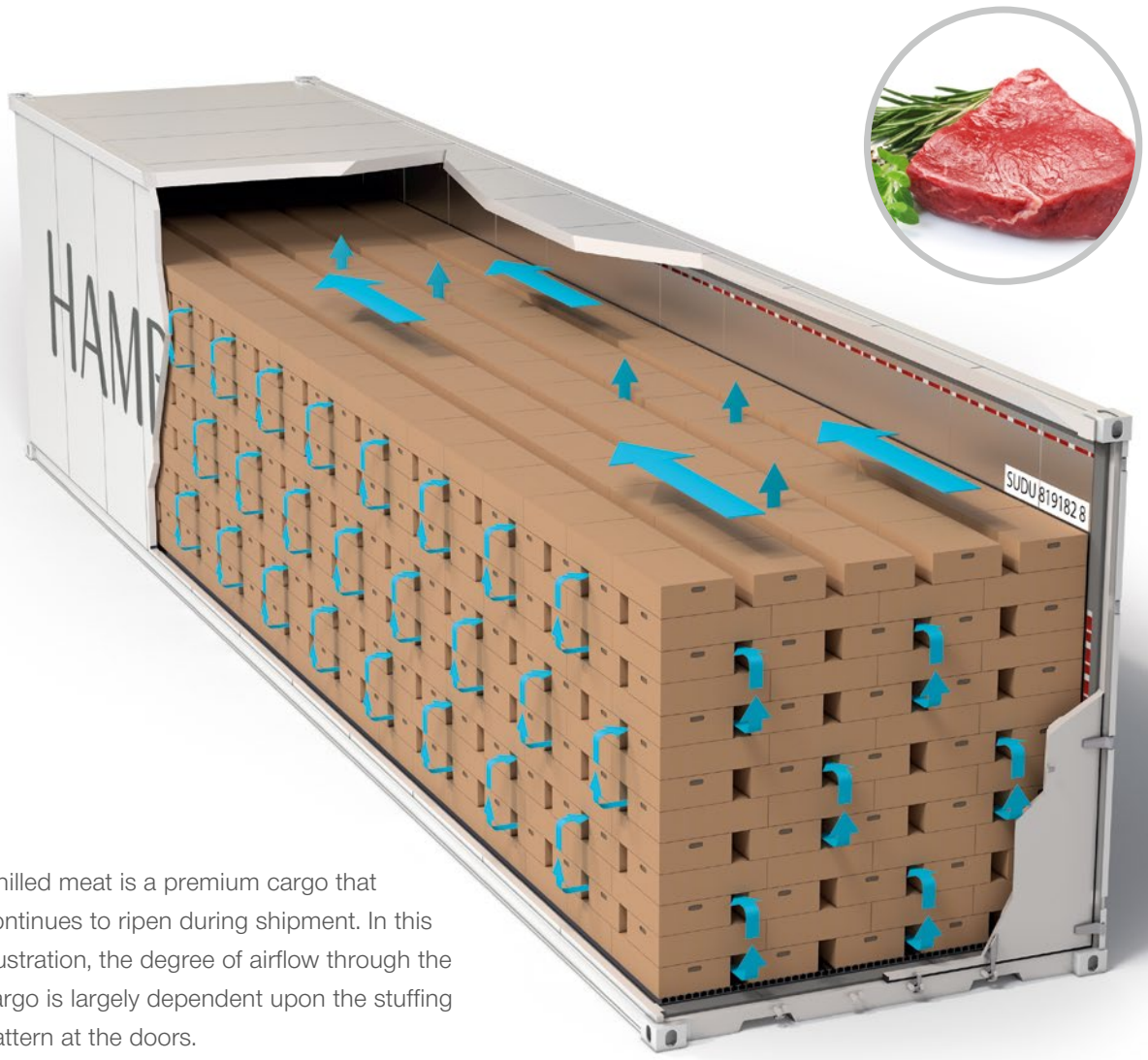
When blocking the air flow at the bottom, do not use an additional top blocking.

Nor vice versa: do not block the air flow at the bottom when using a top blocking.

Bottom or top blocking at the door end is possible to ensure the required airflow through and around the cargo. If properly secured, a top blocking should be preferred as it provides increased airflow between the cargo and the doors and can therewith further reduce the exposure to hot or cold ambient temperatures. Please ensure using either one method of blocking at the door end – bottom or top blocking – and do not mix them.

Example 3 – chilled products

A pigeonhole stow is common for chilled meat in break bulk cargo (loose cartons).

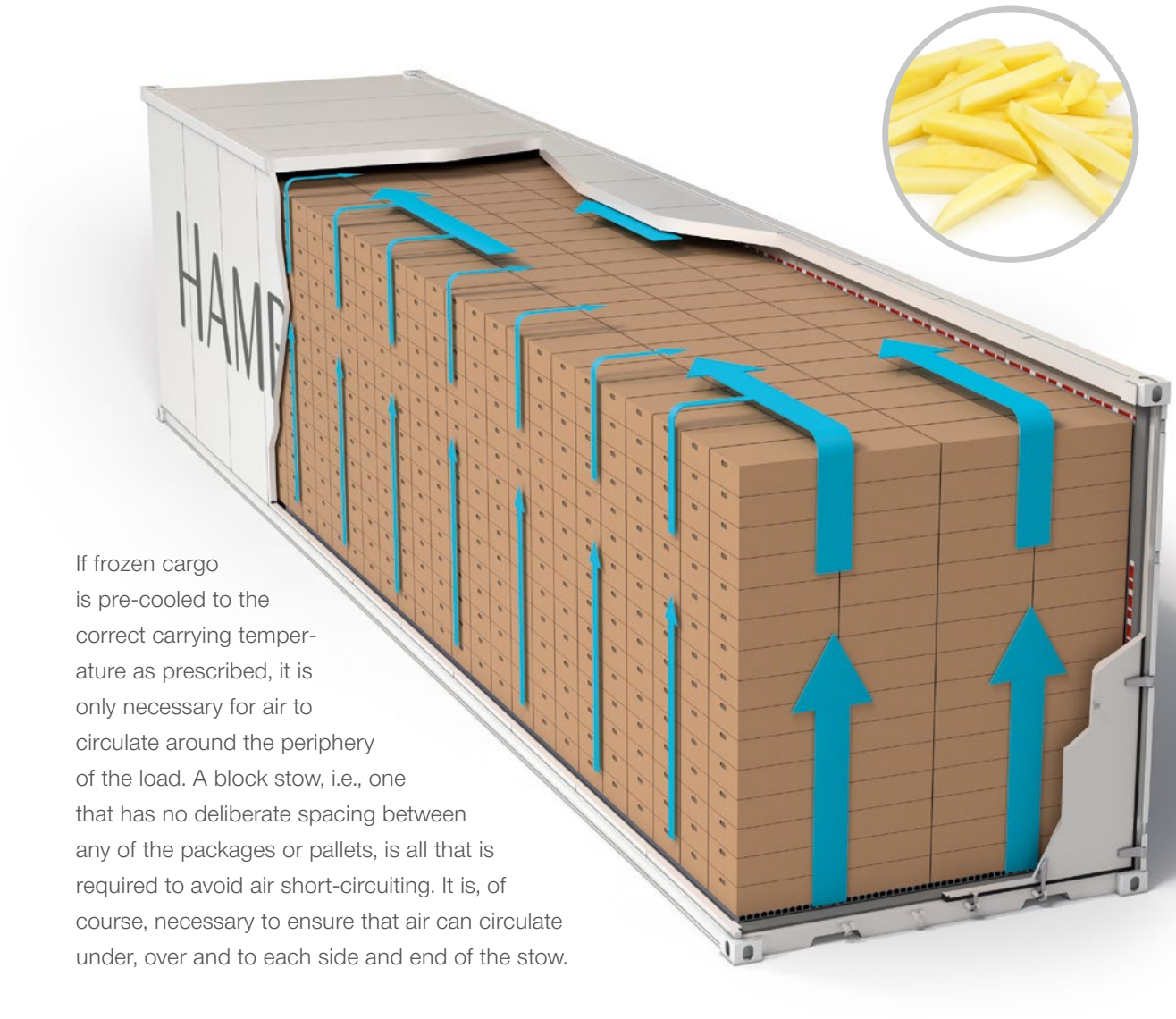


Chilled meat is a premium cargo that continues to ripen during shipment. In this illustration, the degree of airflow through the cargo is largely dependent upon the stuffing pattern at the doors.

Example 4 – frozen products

Block stow of frozen break bulk cargo (loose cartons).

In the case of pre-cooled frozen goods, temperature-controlled air only has to flow around the cargo, since no heat has to be dissipated from the cargo itself. Only the heat that penetrates the insulation from outside (and the heat of the fan motors) has to be removed. The same applies for such pre-cooled chilled products that do not produce any heat or respiratory gases, like butter for example.



If frozen cargo is pre-cooled to the correct carrying temperature as prescribed, it is only necessary for air to circulate around the periphery of the load. A block stow, i.e., one that has no deliberate spacing between any of the packages or pallets, is all that is required to avoid air short-circuiting. It is, of course, necessary to ensure that air can circulate under, over and to each side and end of the stow.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Proper temperature control is the most important factor in maintaining the quality of perishable commodities; ergo, a continuous optimal temperature setting throughout the complete “cold chain” must be maintained. If breaks in the cold chain occur, product integrity will be compromised and products will be more susceptible to ageing and decay.

For optimal quality, it is therefore critical to maintain proper temperatures from origin all the way to the end consumer.

Unbroken perishable supply cold chain and cool solutions

Shipments of perishables are permanently supervised by qualified reefer personnel within Hamburg Süd’s global network. Hamburg Süd is doing its utmost to ensure cold chain maintenance even under difficult local circumstances. For this reason, we have developed the so-called Stuffie containers or Sortie containers.

Example 1

To secure the cold chain and avoid condensation of humidity on the refrigerated cargo during anti-narcotics control, e.g., of loads of fresh fruit in ports with tropical climate and lacking reefer warehouses. The Sortie container in this case has two openings on the side, one for a truck and the other for the reefer container. The cargo from the refrigerated truck is transferred to the reefer container, with a cold environment within the Sortie container. Usually workers for the devanning of the truck and stuffing of the containers are present, as well as authorities, customs and anti-narcotics control staff.

Example 2

To protect sensitive fish catches by containerizing directly from a fishing vessel at the port. Here the fish is loaded through hatches in the top of the Stuffie container, immediately cooled and transferred into a reefer container, therewith optimizing the cold chain. A Sortie container for fish has the same function as the Stuffie container, but up to five reefer containers can be connected, enabling on-site sorting by size and variety.

All of our integrated reefer containers are equipped with their own refrigeration unit, which can be plugged into electric power supplies at depots, terminals and aboard ships. During land transport, the refrigeration units may require the support of a genset, i.e., a diesel engine-driven generator set.

Reefer containers are typically designed to keep temperature at set points in the range of –30 °C to +30 °C in ambient temperatures from –30 °C to +50 °C, i.e., they can maintain temperature by cooling AND heating. The PrimeLINE and MAGNUM reefers maintain temperatures down to as low as –35 °C, the MAGNUM PLUS in the 20′ reefer size down to –40 °C and the Superfreezer even down to –60 °C. These container types are therewith particularly suited to achieve effective enzyme inhibition and a longer shelf life for (fatty) fish products. But the rule “colder is better” for increased cargo protection throughout the cold chain also applies to other types of frozen cargo, such as seafood and ice cream. Moreover, the higher cooling capacity and faster temperature pull-down of PrimeLINE/MAGNUM/MAGNUM PLUS containers can provide a higher extent of tolerance for premium products such as pizza already at –30 °C.

Pre-cooling

Products should always be correctly pre-cooled to transport temperature prior to being loaded into the container, unless otherwise agreed with Hamburg Süd. The proper pre-cooling of products has a positive effect on their shelf life and results in an enhanced output compared to products that have not been pre-cooled. When the products are packed at temperatures above the carriage temperature, this might have a negative effect on cargo quality.

The post-harvest processes of fruit and vegetables can produce appreciable amounts of heat. Respiratory heat is typically between two and seven times higher at +10 °C than at 0 °C. Although it might therefore appear to make sense to store fruit and vegetables at as low a temperature as can be achieved, some kinds of fruit are intolerant to excessively low temperatures, resulting in a physiological alteration known as the "chilling injury." Tropical and sub-tropical fruit and vegetables such as bananas, melons, avocados, mangoes and papayas are particularly at risk.

The following example perfectly describes the importance of temperature effects on perishable cargo and the necessity of a fast pre-cooling of the cargo at origin:

Table grapes deteriorate more in 1 hour at +32 °C than in 1 week at 0 °C!

Pre-cooling of the reefer container itself is not required and should generally not take place. In exceptional cases and with specific agreements with Hamburg Süd in place, it could be arranged only if the container is loaded at an airlock ("cold tunnel"), for instance in a cold store, so that the temperature outside the opened doors is approximately the same as the temperature inside the container. Otherwise, when the doors of a pre-cooled container are opened in warm ambient air, water will condense on the cold container walls, which may cause subsequent damage to the cargo.

Defrost intervals

When water and heat pass the evaporator (air cooler) of the reefer machinery, ice is formed. This effect needs to be kept to a minimum, as it has a negative impact on the cooling performance of the reefer machinery. Refrigeration machineries provide different options of ice removal via defrost cycles. Our reefer's defrost cycle is Defrost on Demand (Auto Defrost), which minimizes defrosting activity and maximizes cooling performance.

The set point temperature is the temperature at which the controller is set.

In reefer containers, the temperature is maintained by a thermostat controlling the reefer machinery. The temperature sensor measures the air temperature and sends a signal to the controller, which adjusts the refrigeration system. Modern refrigeration systems control the temperature by generally applying three different modes: full capacity, modulation control and on–off control. Frequency modulation is the most technologically advanced way to adjust the power output of the compressor, enabling it to speed up or slow down according to the requirement of the loaded reefer cargo.

The main object of reefer transport is to ensure minimum loss of quality during transport; therefore, precise control at the lowest temperature the cargo can tolerate is crucial. When transporting chilled goods (–4.9 °C or warmer), our modern refrigeration units are controlled by a sensor located in the supply air-stream (supply air sensor), i.e., the air leaving the unit and about to enter the cargo space. This is called supply air control. The units retain a sensor in the return air (return air sensor) for control when transporting frozen goods (return air control at –5.0 °C or colder).

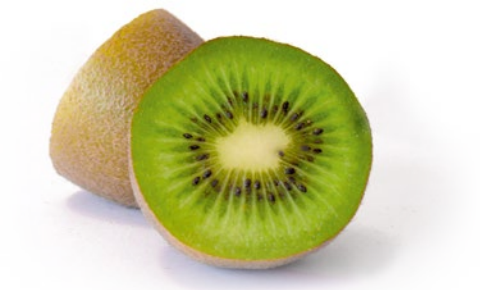
It must be emphasized that the set point temperature should not be confused with the product temperature. When shipping fresh fruit for example, the air warms up as it moves through the cargo space, and the temperature of the return air will be higher than the temperature of the supply air.

Special features

Cold treatment

Cold treatment (CT), or cold sterilization, is commonly practiced in reefer containers. It means that sustained cold temperatures are maintained for lengthy durations: a postharvest method that is utilized to disinfest fruit subject to the fruit fly pest and other potentially damaging insects. Our state-of-the-art reefer equipment can maintain specific temperatures for the proper duration as required by CT specifications. Hamburg Süd offers manual as well as Automatic CT (ACT) services from various origins to CT-requesting destinations in accordance with import authority guidelines. In the case of ACT, the reefer machinery will automatically raise the set point to the recommended transport temperature of the specific fruit once the CT protocol requirements have been fulfilled.

Multi-temperature mode



Instead of maintaining just one set point temperature throughout the trip, our reefer containers can also be set to run a defined temperature program as per the needs of our customers and their individual cargo. The multi-temperature mode (MTS) is also known as automatic set point change (ASC).

ATO certificate

Our reefer containers are certified for the transport of flower bulbs as they follow the standards for flower bulb transportation of the Dutch Agrotechnological Research Institute (ATO).

Pharmaceuticals

The transportation of pharmaceutical products in reefer equipment is subject to the particularly strict guidelines of the Good Distribution Practice (GDP) scheme, specified by the World Health Organization as well as the European Commission.

Hamburg Süd complies with the GDP requirements by having an Integrated Management System (please see Integrated Management System on page 4). For pharmaceuticals it is specifically important to maintain quality and integrity along the entire supply chain from the manufacturer to the customer. To guarantee that pharmaceuticals are consistently transported under suitable conditions the characteristics of both, the products as well as the container equipment, need to be considered. In order to ensure all this, Hamburg Süd's Pharma Team was set up as a risk management division.

The Hamburg Süd process

The conditions like the packaging, the stuffing as well as the nature of the products itself have to be suitable for technical and physical requirements allowing for proper air circulation inside the reefer container and therewith a stable cooling. For shipments where a proper air circulation within the container cannot be guaranteed and consequently the temperature cannot be kept stable, damages to the cargo are very likely. In order to avoid this, the pharma checklist was implemented and plays a major role in the process of accepting temperature controlled pharmaceuticals. Important parameters like cargo volume and weight, temperature setting and packaging are asked for on the pharma checklist.

As a rough guide it can be said that cargo volume should make up at least one third of the total container volume (for container volumes please see Container details on page 44).

At the time of booking, the customer always needs to fill out the checklist. Based on given information, the Pharma Team carries out a risk analysis with regards to operational feasibility of the shipment. Depending on the individual risk, the shipment will be accepted or recommendations will be given in order to minimize the risk.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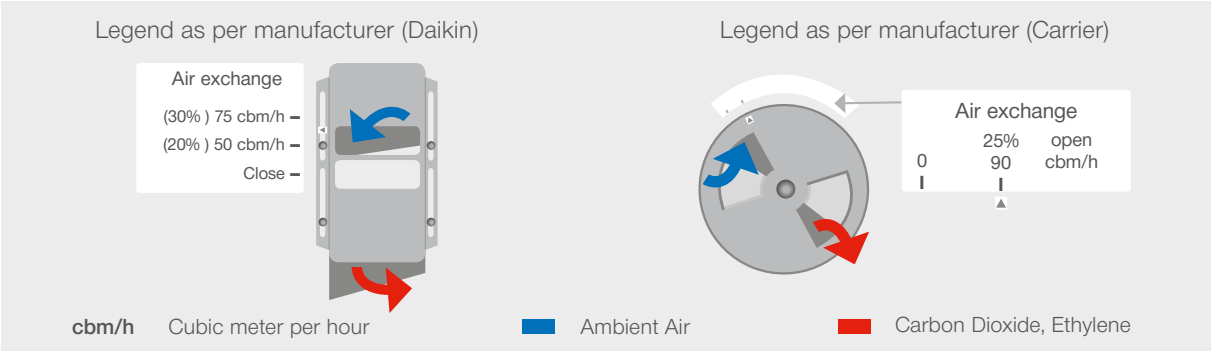
Fresh-air ventilation

For commodities that require fresh air, like most fresh fruit and vegetables, our reefer containers can provide air exchange through ventilation. During transport, fresh fruit and vegetables continually respire and, thus, produce gases such as carbon dioxide and ethylene. As these respiratory gases can lead to cargo damage such as uncontrolled ripening, ageing and off-flavor, they have to be removed from the container atmosphere. Depending on the respiration rate of the commodity that is being shipped, fresh-air vents of a reefer container are usually opened at defined set points in cbm/h for most fresh fruit and vegetables. Our reefer containers can provide vent openings in the set point range of 0 to 240 cbm/h.

Precision equals freshness: the single permitted dimension unit for ventilation settings is “cbm/h.” Due to a lack of standardization, ventilation measured in percentages (“%”) is not acceptable, as it could lead to severe misinterpretations depending on the manufacturer of the refrigeration unit. Vent openings must be closed when transporting frozen goods or Controlled Atmosphere (CA) loads.

Examples of different designs of fresh-air openings of reefer machinery manufacturers



Working principles and sizes of fresh air vent openings heavily differ depending on the reefer machinery type, model, and size used. Due to this fact, a ventilation setting like 1/4 open (25%), which is commonly used for, e.g., grapes, oranges, or apples, does not result in the same fresh-air ventilation ratio but varies for example between 65 and 90 cbm/h, taking a unit of the container manufacturers Daikin and Carrier as examples.

Examples of ventilation settings and the impact of conversions from % into cbm/h

Commodity	Vague ventilation setting	Setting for manufacturer 1 (Daikin)	Setting for manufacturer 2 (Carrier)	Hamburg Süd recommendation
Grapes, table (fresh)	1/4 open = 25%	65 cbm/h	90 cbm/h	10 to 15 cbm/h
Oranges (fresh)	1/4 open = 25%	65 cbm/h	90 cbm/h	15 to 25 cbm/h
Apples (fresh)	1/4 open = 25%	65 cbm/h	90 cbm/h	10 to 50 cbm/h

Humidity control

Our reefer containers are equipped with drains to release any excess water that might accumulate inside the container. Simultaneously, drains prevent outside water from entering the container. For loads of fresh fruit and vegetables, for example, the drains are usually opened, whilst for chilled and frozen cargo the drains are closed. Alternatively automatic drains are applied that open and close automatically as required, except for Controlled Atmosphere (CA) loads where the drains must always be manually closed.

The relative humidity of the air inside a reefer container can be of particular importance in the transport and storage of chilled reefer cargo. Dry air may cause desiccation of fresh fruit and vegetables, which can affect the appearance and will certainly reduce the weight at the point of sale. Very damp air, with high relative humidity, will encourage the development of various fungal disorders on many fruits and vegetables. Recommended relative humidity levels for fresh fruit and vegetables vary, but generally fall between 85% and 95%, depending on the fruit and variety. In most cases, these high humidity levels are formed automatically in a reefer container due to the concurrence of the above-mentioned factors, and no further humidity control is required by the reefer container.

Dehumidification

Some products, like fresh garlic and onions, ginger or seed potatoes, are susceptible to high humidity and may require a reduced level of relative humidity during transport to prevent germination or decay. For these products, our reefer containers can offer dehumidification that keeps the air inside the container at a specific maximum level of humidity. The controller of a reefer container cannot be set to humidify the air, but only to dehumidify to a set point level between 60% to 95% relative humidity in the chilled temperature range.

The relative humidity of the air around fresh fruit and vegetables in a reefer container is dependent on the following factors:

- When humid air is cooled down at the start of the transport, the relative humidity increases (+).
- Transpiration and respiration through the surface of the product provide additional humidity to the air (+).
- Fresh-air ventilation with humid air can raise the relative humidity level further (+).
- The cooling process itself usually removes humidity from the container air through condensation at the evaporator fins (–).

As a result, a natural balance of 85% to 95% relative humidity is usually formed automatically.

Make your cargo feel good

Did you know that too much fresh air can actually harm fresh produce, like pumpkins, onions and seed potatoes during transportation?

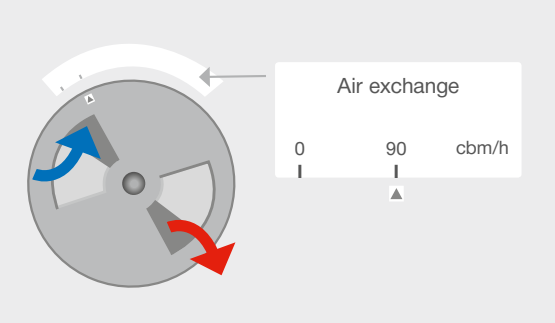
Ventilation is often confused with air circulation. But while ventilation means exchange of ambient air into the container via vents (please see Fresh-air ventilation on page 26), circulation is the airflow within the container and through and/or around the cargo (please see Air circulation on page 9). The main purpose of air circulation is to achieve the proper temperature distribution within the container. It is enabled by the reefer machinery, especially the fan motors and fans and can be influenced by the air permeability of the packaging materials and stuffing methods.

Consequently, high ventilation does not result in high air circulation around the cargo. On the contrary, too much fresh air puts a burden on the reefer machinery as additional energy is necessary to bring the temperature and relative humidity of the fresh air to the set point level. This effect is even more negative with activated dehumidification. Furthermore, additional fresh air leads to faster icing of the evaporator coils resulting into more defrosts as a consequence.

Advantages of using the right ventilation

- tailoring transport conditions to the needs of your cargo
- quickly reaching the temperature and relative humidity set points
- less ice formation on the evaporator coils resulting into less defrosts
- preventing excessive energy consumption, thereby lowering environmental footprint

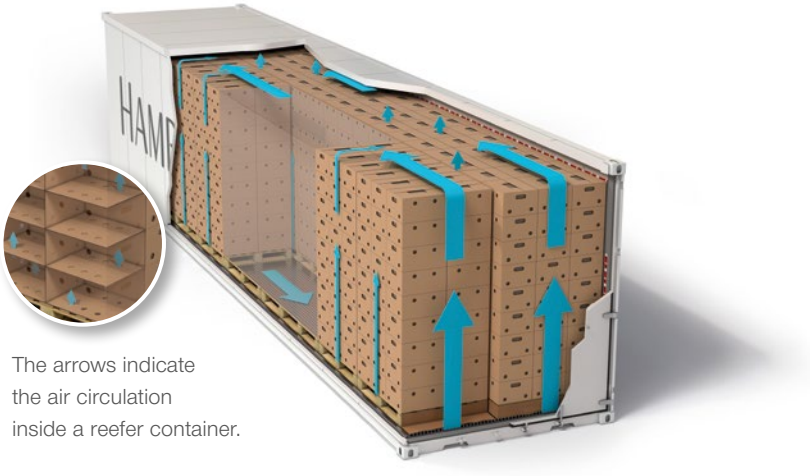
Fresh-air ventilation (exchange)



Ambient air

Carbon dioxide, ethylene

Internal air circulation



The arrows indicate the air circulation inside a reefer container.

Our recommendation

With regard to cargo quality maintenance and reduction of CO_2 emissions, the target should be to carry the fresh produce at the lowest tolerated temperature and lowest required level of fresh-air exchange. The ventilation rate depends on the respiration rate of the individual commodity.

At Hamburg Süd, we recommend the following ventilation and dehumidification settings for the following commodities, for example

Commodity	Ventilation (air exchange) cbm/h	Humidity (relative) %	Dehumidification (max. relative humidity setting) ON/OFF
Onions, bulbs (fresh)	10 to 40	65 to 75	ON
Potatoes, seed (fresh)	10 to 25	65 to 90	ON or OFF
Squash, winter, hard rind, pumpkins (fresh)	10 to 60	65 to 85	ON or OFF

Relevant data for reefer container settings are shown in red. For temperature and shelf life see Helpful facts as from page 44.

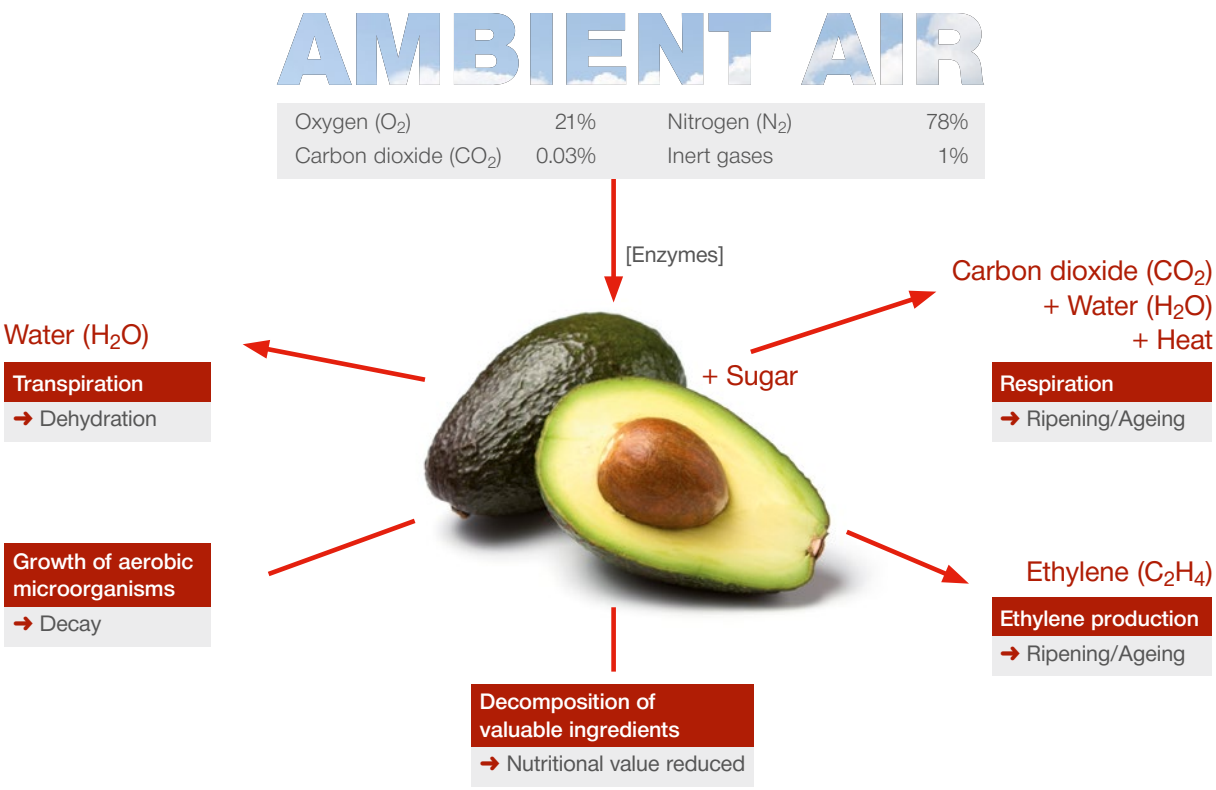
CA containers

Controlled Atmosphere (CA) is an effective and sustainable means of safeguarding and preserving the quality of fresh fruit and vegetables.

Hamburg Süd has always been on the forefront of new technologies for CA shipments and we offer our customers access to the largest CA container pool in the world.

Fresh fruit and vegetables are living metabolizing items: the lifespan of this perishable commodity ticks away the moment it is harvested. Fruit is inherently on a starvation diet once it is picked from the mother plant. The key to delivering better quality produce is to slow down the enzyme-driven consumption of the fruit and vegetables' food reserves. During transport in reefer containers, post-harvest processes on fresh produce are generally minimized through temperature control combined with fresh-air ventilation. In order to re-

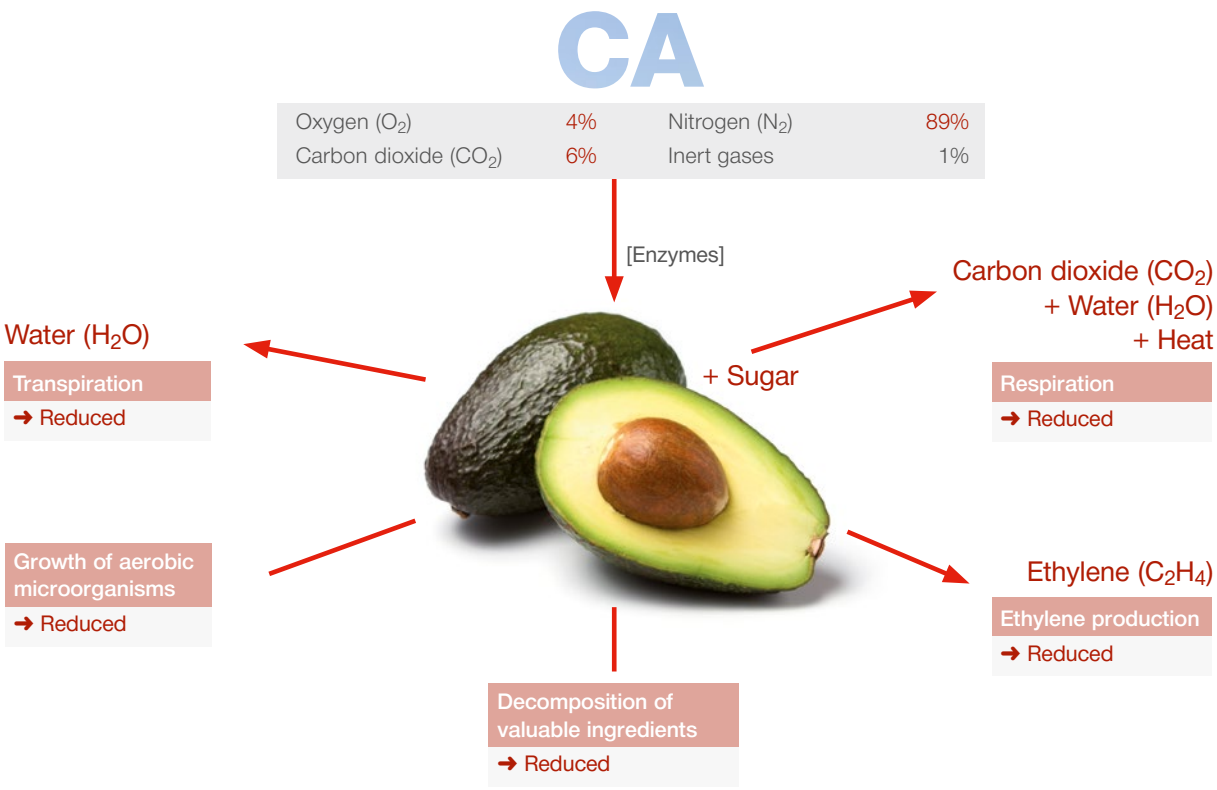
Post-harvest processes on fruit and vegetables



Fruit and vegetables are still alive during transport and undergo the normal processes associated with life (i.e., respiration and ageing). Respiration results in the conversion of oxygen into carbon dioxide.

duce them even further, CA containers have been developed. This special type of reefer equipment can specifically change the gas composition of the container atmosphere in order to enhance the effect of refrigeration and thereby prolong product shelf life. Roughly speaking, atmospheric air consists of 21% oxygen (O_2) and 0.03% carbon dioxide (CO_2), with the remainder consisting chiefly of nitrogen (N_2) and inert gases. The most important gases in the atmosphere are O_2 and CO_2. O_2 is required for the respiration process; if the availability of O_2 is reduced, the respiration rate (and, thus, ethylene formation) can be slowed down dramatically. The same effect occurs when the CO_2 content is increased. Growth of aerobic bacteria, yeast and mold is inhibited in high concentrations of CO_2. In addition, mold requires oxygen to grow, so limiting the amount of O_2 in the environment will limit the capacity of mold to cause spoilage. The decomposition of valuable ingredients is inhibited as well, due to the fact that (pro)vitamins are more stable in an O_2-reduced environment.

Post-harvest processes on fruit and vegetables



In CA conditions the post-harvest processes on fruit and vegetables in a reefer container are further reduced and shelf life is therewith prolonged.

Equipment Diversity

Cargo Expertise

TAILOR-MADE SOLUTIONS

The lifespan of perishables can be prolonged if they are kept at their optimal temperature and in the most effective atmosphere. The ideal composition of CA transport is commodity-specific. Our team of dedicated reefer specialists will support you in developing tailor-made solutions for your CA cargoes.

For CA, the O_2 content of the container atmosphere is generally decreased while the CO_2 content is increased. Both of these changes will tend to slow down the life process of the produce. The same working principle goes for the quite old-fashioned Modified Atmosphere (MA) containers. MA is a rather passive, partly controlled change of air composition, while CA provides the most technologically advanced way of constantly measuring and actively maintaining the atmospheric conditions in a reefer container throughout a shipment's entire journey.

To the benefit of the cargo, Hamburg Süd decided to terminate offering the meanwhile outdated MA containers and to focus solely on state-of-the-art CA container shipments. The art of CA for fruit and vegetables is to tailor the atmospheric composition to the requirements of the particular product. Too little O_2 content in the atmosphere may cause a product to suffocate. Similarly, an excessive CO_2 content could cause suffocation of the "living" product, as it will be unable to release the CO_2 it breathes out. It is therefore essential to apply the most suitable technology and atmospheric settings to each individual type of fruit.

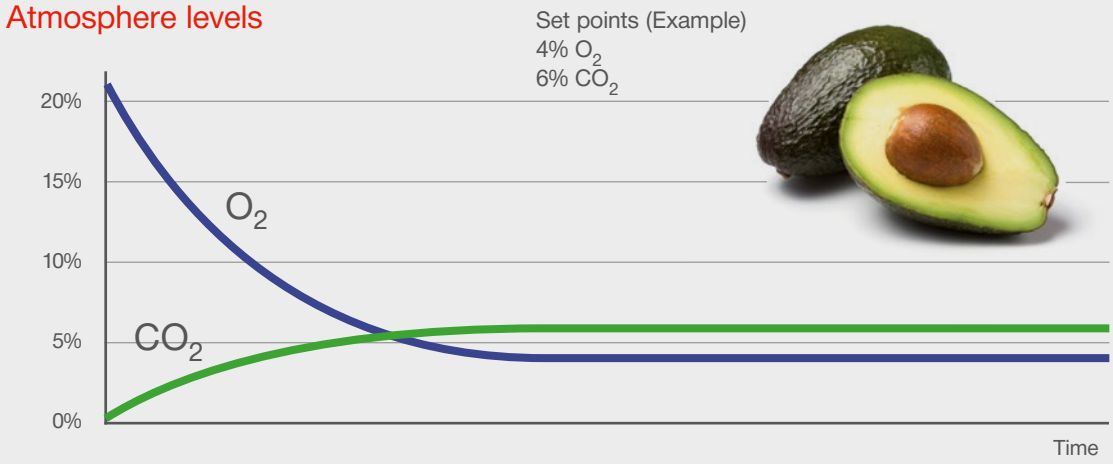
Working principle

The respiration of fruit and vegetables converts O_2 into CO_2. In the former, meanwhile outdated MA container types that we consequently do not offer

our customers any more, the following principle applied: if produce was placed in a reefer container with vents closed, the CO_2 content produced by the respiration process was allowed to increase. The O_2 content was reduced to an equal extent. As atmospheric air contains 21% O_2 and approximately 0% CO_2, an increase of, say, 10% in the CO_2 content resulted with a reduced O_2 content of approximately 11%. The combined total percentage of CO_2 and O_2 always remained at 21%. At the same time the percentage of N_2 (including inert gases) remained unchanged at 79%, just the same as in ambient air. This atmospheric composition was used for avocado MA shipments, for example.

Our state-of-the-art CA containers are initially based on the above described principle of produce respiration. However, while the described MA system was limited to set points where the combined total percentage of CO_2 and O_2 remained at 21% as per respiration balance, our latest CA systems, StarCare™ and XtendFRESH™, offer an innovative key solution:

Excessive CO_2 is taken out of the container atmosphere (either by a membrane or a scrubber) to finally reach the ideal CA conditions for the respiring fruit, for avocadoes 4% O_2 and 6% CO_2, for example (please see pages 30 and 31).



For commodities that have a relatively low respiration rate and require high CO_2 concentrations, such as blueberries, we offer gas injection from cylinders before commencement of ocean transport in order to establish the desired atmosphere more quickly and independently of produce respiration. This service we call StarCare+.

Other fruit types, such as apples, respire relatively little and benefit from both low O_2 and CO_2 concentrations. For this application we have EverFRESH®, also called StarFresh, CA containers in our pool that offer active N_2 injection during transport. An N_2 gas-separating membrane is integrated into the refrigeration unit and allows the container to have a fresh stream of N_2 throughout the journey whenever the O_2 and CO_2 sensors activate N_2 production. When piped into the reefer container, the N_2-enriched atmosphere stream dilutes the O_2 level to reach the set point: in most cases below 5% O_2, with N_2 levels (including inert gases) distinctly above 79%.

After reaching the required set points, the CO_2 and O_2 levels are actively maintained throughout the voyage by a combination of CO_2 removal and fresh-air injection, or in the latter case by varying the volume and purity of the N_2 introduced into the container. For fruit and vegetables that produce ethylene and/or are susceptible to this so-called "ripening gas," either separate or integrated ethylene scrubbers that systematically take ethylene out of the container atmosphere are applied for the CA shipment. A so-called "curtain" (plastic sealing sheet) is regularly used at the container door to ensure airtightness at the door end.

Benefits of CA containers for fresh produce

- Prolonged shelf life of products through delayed ripening, ageing and decay, therewith providing the retail food trade with extended selling periods.
- Reduced water loss and weight shrinkage.
- Longer transit times become possible; so, cargo can be shipped to more distant destinations and/or to new markets.
- CA containers represent an alternative to handling- and waste-intensive MA packaging.
- Fruit can be shipped with a higher degree of ripeness.
- Enhanced quality, taste, nutritional value and appearance result in more sales for the retail food trade and less spoilage.
- Post-harvest treatment of fruit can be reduced.
- More attractive prices due to lower transport costs compared to air freight.
- The move away from transport-by-air means a significant gain for the environment due to reduced CO_2 emissions.

Please note: MA packaging (such as Banavac bags for bananas) must never be applied in CA containers. Any packaging used in CA containers must be perforated/with holes to allow contact between the cargo and container atmosphere (such as Polypac®/polybag does for bananas).

Hamburg Süd has always been a pioneer in the development of new CA technologies for reefer containers.

The basic requirement in the carriage of reefer cargoes is to deliver the goods, insofar as possible, in the same condition as they were received; in other words, to maintain quality.

To achieve this, it is imperative that the total transit time of perishables must never get too close to, reach or exceed their approximate overall shelf life. In addition to shelf life, the condition of the product before it is stuffed plays an important role in its condition upon arrival: it is therefore essential that all products are treated correctly prior to stuffing.

Even though temperature control and atmosphere management are optimal during the entire voyage, products will only arrive in perfect condition if the pre-treatment has been performed correctly. Cargo quality can never be improved during the trip – even the very best CA container is not a hospital. Successful shipping begins at the point of origin of reefer cargo, and the carrier must fully reject responsibility for cargo damage encountered due to inadequate pre-treatment.

There is no technology available to overcome or reverse the process of fruit ripening; only technologies that slow the process exist. If, at loading time, a cargo is already too mature or is of too substandard a quality to arrive at the required level of maturity, a rejection or claim for damages by the recipient is the logical consequence, notwithstanding the reasonable care and diligence exercised by the carrier.

As temperature-sensitive goods deteriorate at a rate that is temperature dependent, temperature maintenance is paramount. For frozen goods, this requires the maintenance of a temperature low enough to effectively stop deterioration. For chilled goods, temperature must be maintained at the lowest possible temperature that will not damage the cargo, and atmosphere management may be necessary as well.

The optimal transport conditions will depend on many factors and may require expert advice. Our team of dedicated reefer specialists is ready to support you.


HAMBURG SÜD

All reefer containers in our equipment pool are fitted with devices for Remote Container Management (RCM), which brings unrivalled transparency to the shipping of perishable products as it enables live monitoring of the reefer container.

In addition to offering real-time GPS tracking, RCM monitors and records the power status of the refrigeration unit. On top of that, sensors gather real-time data on a range of factors – including temperature, relative humidity, O_2 and CO_2 levels in the container atmosphere – to know exactly what is happening inside the box around the clock.

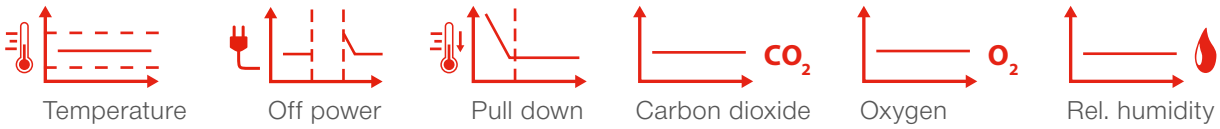
Thanks to this advanced technology, our RCM operations team can permanently monitor the correct functioning of each reefer container throughout the entire voyage – from pick-up to delivery – using an outstanding RCM alarm system. If potential issues arise, they are quickly identified and resolved so as to ensure perfect maintenance of the cold chain for our customers' perishable cargoes.

What's more, after identifying reoccurring errors or faulty components, we can carry out preventive maintenance on the equipment and, if required, make in-transit adjustments so as to maintain the perfect environment for the cargo.

We also offer the benefits of RCM directly to our customers through an Internet platform. This leads to detailed and transparent information 24/7, including location tracking of the reefer container, supply and cold chain visibility, cargo flexibility, and other value added. Based on smart, data-driven decisions, a shipper can divert a shipment to another market to meet his receiver's requirements, to name just one example.

In other words, the RCM dashboard offers a clear overview of the state of the cargo. This means peace of mind and no surprises when opening the container upon its arrival.

Parameter



RCM gives a real-time view inside the container. Simply log in and check your cargo's conditions – whether with your computer, your smartphone or any other device.

The RCM solution consists of

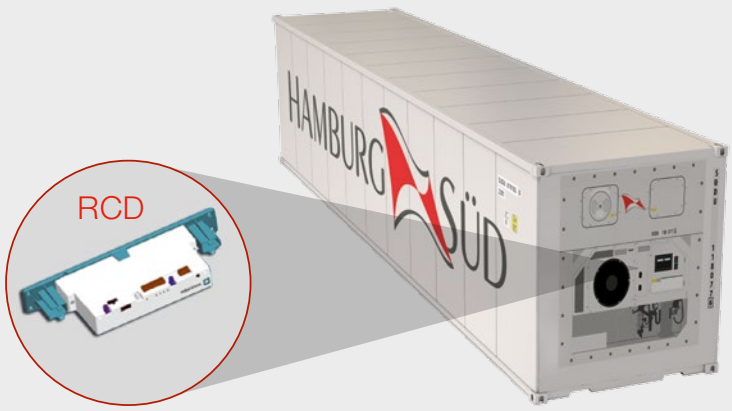
GPS unit
tracks container position on land/at sea.

3G high-temperature SIM card
communicates reefer stats and data through Global System for Mobile Communications (GSM) to and from central IT system.

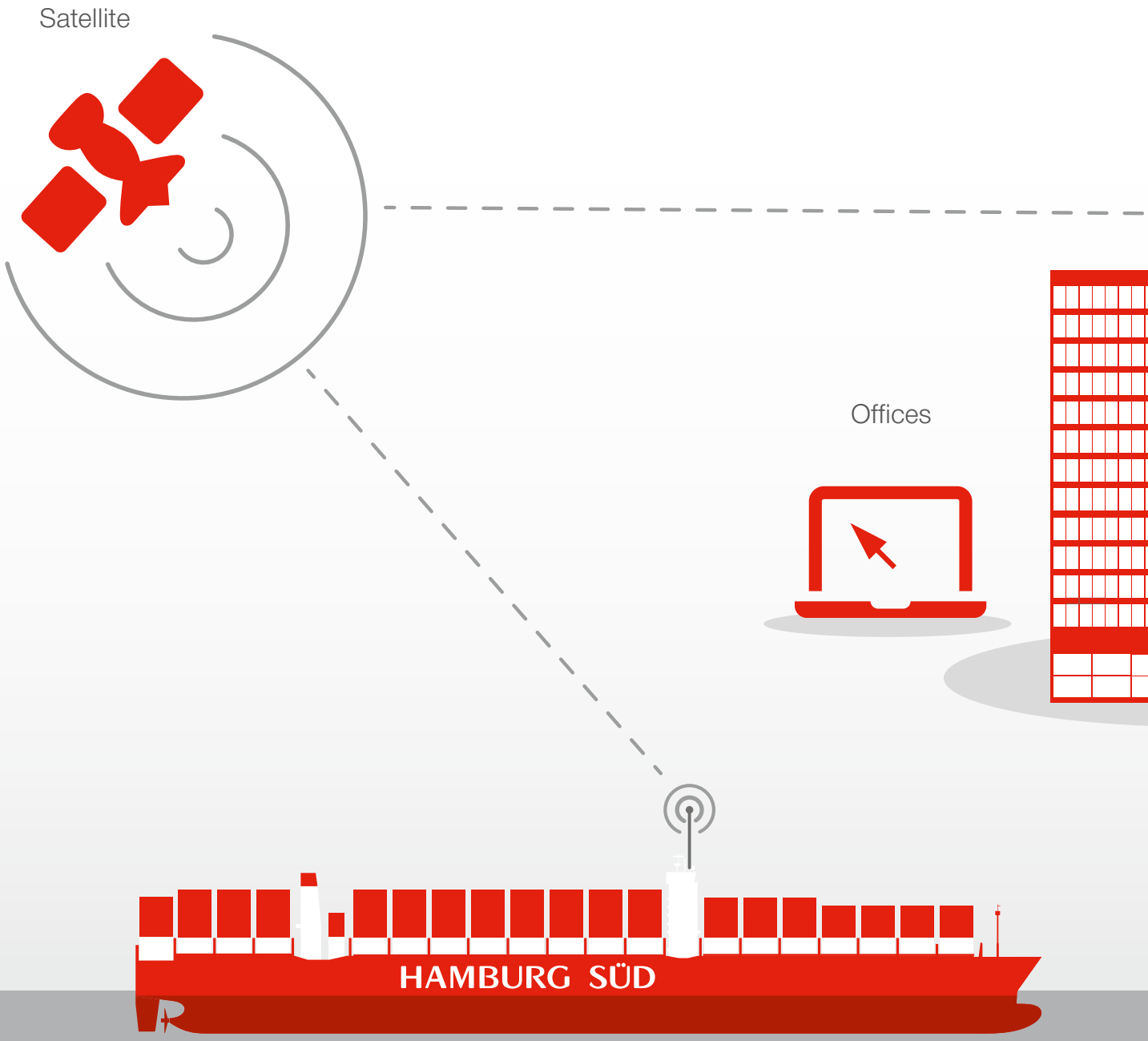
GSM antennae
communicate with the Remote Container Device (RCD) and the satellite. The RCD is a device located inside the control panel that transmits the data via two antennae.

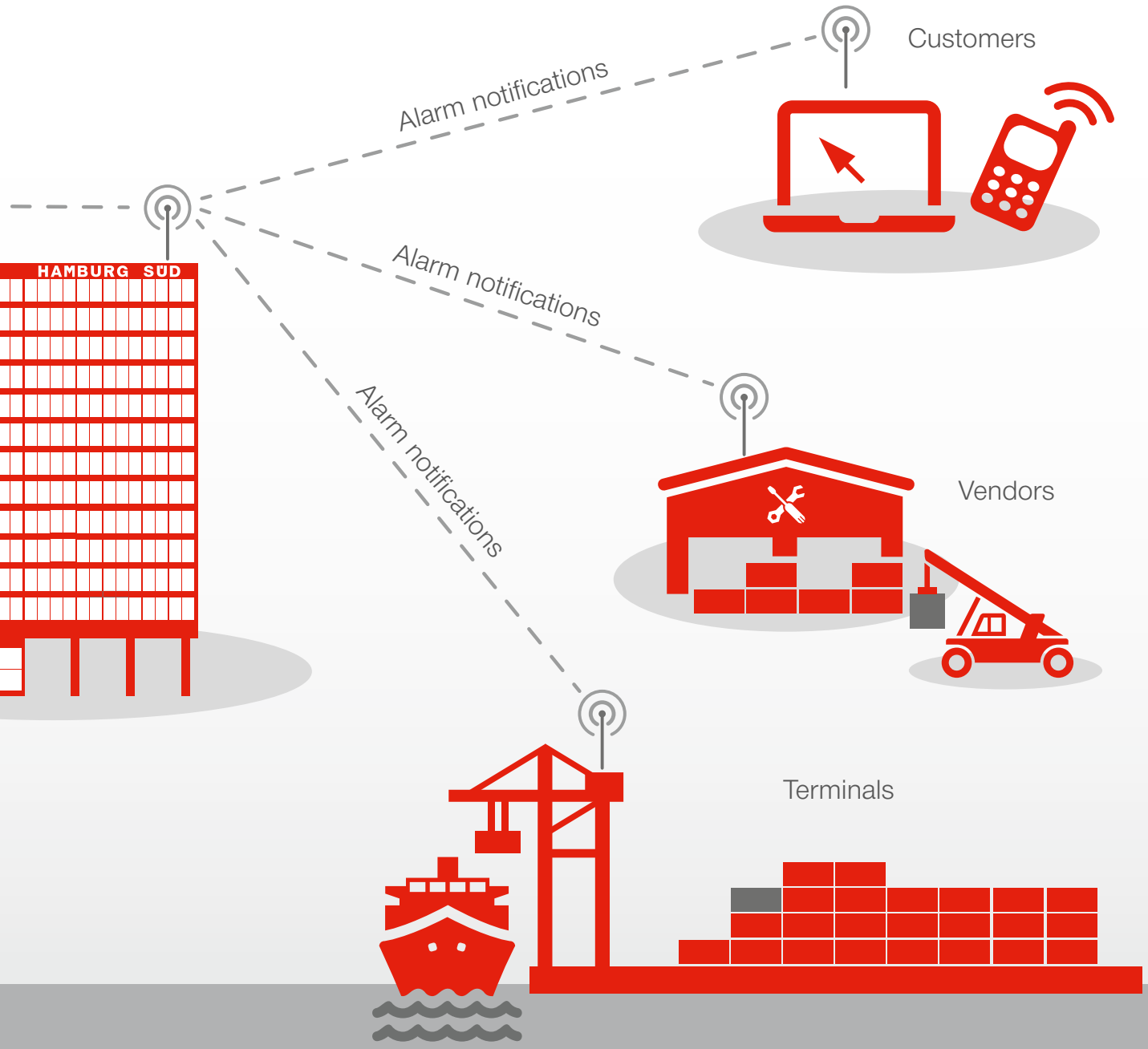
Antenna 1:
Container readings of, e.g., temperature, relative humidity, levels of O_2/CO_2, fan speed; sends alarm signals

Antenna 2:
GPS position



Flow of information




Customers
Alarm notifications
Alarm notifications
Alarm notifications
HAMBURG SÜD
Vendors
Terminals

Benefits of RCM for our customers

Peace of mind by having a clear overview of the state of the shipment and the cargo 24/7. And by knowing that our RCM operations team is permanently monitoring the reefer to ensure correct functioning and will act quickly to resolve any issues that arise.

See the details on the status of the reefer settings, and check that the cargo was kept at the requested set points throughout the entire journey.

Track & Trace the location of the container to follow up on the transport plan (please see Transport plan and pre-treatment of reefer cargo on page 36) and also for security reasons.

Set point change is possible during transit, if needed.

Supply chain visibility to ensure that all partners in the transport chain of the reefer container are held accountable to their promises.

Graphs for temperature and, where applicable, for humidity, CO_2 and O_2 levels are available.

Off-power periods can be identified; thereby corrective and preventive actions can accordingly be implemented.

Notification service in case any inconsistencies occur with the reefer container and its correct functioning.

Flexibility to take data driven decisions during the journey and divert the cargo to another destination if preferred.

Initial pulldown of temperature can be closely monitored, if required, such as when it has been agreed to load cargo at ambient temperature, i.e., without pre-cooling.

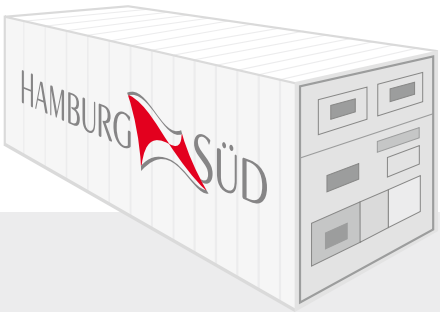
Value added in cooperation with the receivers, as RCM data allows for improved cargo outcome prediction.

Quality standards and regulatory requirements that have to be met for specific products can be proven with RCM data.

Data download can be arranged remotely whenever required during the trip, including before container arrival to speed up processes such as the quick release of cold treatment cargo.

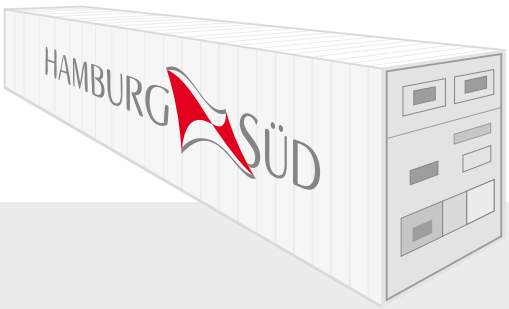
Extra application of separate customer sensors can be reduced.

Container details



20′ Standard Reefer Container

Description	Imperial	Metric
Maximum payload	61,220 lb	27,770 kg
Dimensions	20′ x 8′ x 8′6″	20′ x 8′ x 8′6″
Volume	999	28 cbm
Door openings width	7′ 6 1/8″	2,290 mm
Door openings height	7′ 4 11/16″	2,252 mm
Internal length	17′ 10 51/64″	5,456 mm
Internal width	7′ 6 1/8″	2,290 mm
Internal height to load line	7′ 2 9/64″	2,188 mm
Weight gross	67,200 lb	30,480 kg
Weight tare	5,980 lb	2,710 kg

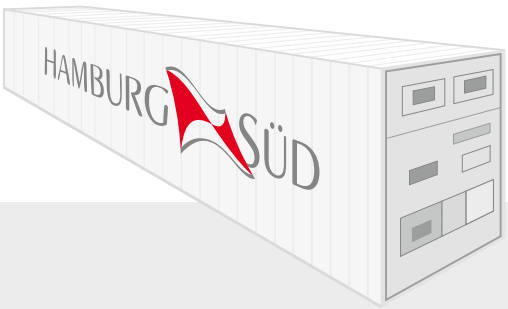


40′ High Cube Reefer Container/ PrimeLINE®/XtendFRESH™

Description	Imperial	Metric
Maximum payload	65,680 lb	29,790 kg
Dimensions	40′ x 8′ x 9′6″	40′ x 8′ x 9′6″
Volume	2,376	67 cbm
Door openings width	7′ 6 3/16″	2,290 mm
Door openings height	8′ 4 11/16″	2,557 mm
Internal length	38′ 5/8″	11,599 mm
Internal width	7′ 6 3/16″	2,290 mm
Internal height to load line	8′ 1 3/64″	2,465 mm
Weight gross	74,960 lb	34,000 kg
Weight tare	9,280 lb	4,210 kg

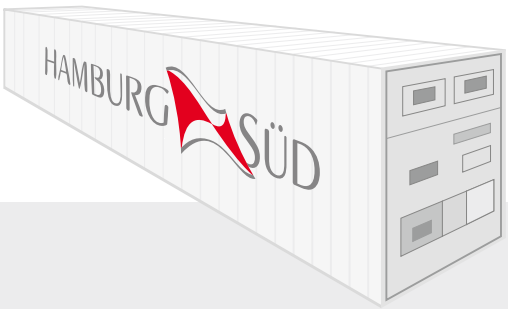
40′ High Cube MAGNUM®

Description	Imperial	Metric
Maximum payload	64,772 lb	29,380 kg
Dimensions	40′ x 8′ x 9′6″	40′ x 8′ x 9′6″
Volume	2,261	64 cbm
Door openings width	7′ 5 9/16″	2,276 mm
Door openings height	8′ 1 1/4″	2,471 mm
Internal length	37′ 11 13/16″	11,578 mm
Internal width	7′ 5 3/4″	2,280 mm
Internal height to load line	8′ 10 7/16″	2,450 mm
Weight gross	74,957 lb	34,000 kg
Weight tare	10,185 lb	4,620 kg



40′ High Cube StarCare™

Description	Imperial	Metric
Maximum payload	65,587 lb	29,750 kg
Dimensions	40′ x 8′ x 9′6″	40′ x 8′ x 9′6″
Volume	2,384	67 cbm
Door openings width	7′ 6 3/16″	2,290 mm
Door openings height	8′ 4 11/16″	2,557 mm
Internal length	38′ 5/8″	11,599 mm
Internal width	7′ 6 3/16″	2,290 mm
Internal height to load line	8′ 1 3/64″	2,465 mm
Weight gross	74,960 lb	34,000 kg
Weight tare	9,370 lb	4,250 kg



40′ High Cube Super Freezer

Description	Imperial	Metric
Maximum payload	64,573 lb	29,290 kg
Dimensions	40′ x 8′ x 9′6″	40′ x 8′ x 9′6″
Volume	2,129	60 cbm
Door openings width	7′ 5 11/16″	2,278 mm
Door openings height	8′ 1 5/16″	2,473 mm
Internal length	37′ 11 13/16″	11,578 mm
Internal width	7′ 2 1/8″	2,188 mm
Internal height to load line	7′ 9 11/16″	2,380 mm
Weight gross	74,957 lb	34,000 kg
Weight tare	10,384 lb	4,710 kg


HAMBURG SÜD










Recommended transport conditions and approximate shelf life of reefer cargo

The following table provides recommended settings (temperature, ventilation, and dehumidification) and shelf life information for selected products in reefer containers. Relevant data for reefer container settings are shown in red.

If your product is not mentioned or additional information is required, please ask your local Hamburg Süd representative. Our dedicated reefer specialists can support you for other reefer commodities not mentioned here, including pharmaceuticals or flower bulbs, where special requirements apply, and for further information on the use of CA containers.

Commodity	Temperature °C	Ventilation (air exchange) cbm/h	Humidity relative %	Dehumidification (max. relative humidity setting) ON/OFF	Approximate shelf life after harvest (in ambient air)	Further methods for shelf life extension
A						
Apples (fresh)	–1 to +4	10 to 50	90 to 95	OFF	1 to 7 months	CA containers sometimes used
Apricots (fresh)	–0.5 to 0	10 to 30	90 to 95	OFF	1 to 4 weeks	CA containers often used
Artichokes, globe (fresh)	0 to +2	0 to 15	90 to 95	OFF	2 to 3 weeks	
Asparagus (fresh)	0 to +2	10 to 25	90 to 98	OFF	2 to 3 weeks	MA packaging or CA containers often used
Avocados (fresh)	+4 to +13	10 to 60	85 to 95	OFF	2 to 3 weeks	CA containers usually used
B						
Bakery products (chilled)	+10 to +18	0 (=closed)	60 to 95	ON or OFF	depends on commodity	
Bakery products (frozen)	–18 or colder	0 (=closed)	–	OFF	3 to 18 months	
Bananas (fresh)	+13 to +14.4	10 to 60	90 to 95	OFF	18 to 22 days	MA packaging (Banavac) or CA containers often used
Beans, green, snap (fresh)	+4 to +7.5	10 to 20	95 to 98	OFF	7 to 10 days	
Blueberries (fresh)	–1 to 0	0 to 10	90 to 95	OFF	10 to 14 days	MA packaging or CA containers often used
Broccoli (fresh)	0 to +1	10 to 50	90 to 98	OFF	10 to 14 days	
Butter (chilled)	0 to +8	0 (=closed)	–	OFF	2 to 6 weeks	
Butter (frozen)	–18 or colder	0 (=closed)	–	OFF	8 to 12 months	
C						
Cabbage, Chinese (fresh)	0 to +2	10 to 40	90 to 98	OFF	2 to 3 months	

Commodity	Temperature °C	Ventilation (air exchange) cbm/h	Humidity relative %	Dehumidification (max. relative humidity setting) ON/OFF	Approximate shelf life after harvest (in ambient air)	Further methods for shelf life extension
Cabbage, early (fresh)	0 to +2	10 to 40	90 to 98	OFF	3 to 6 weeks	
Cabbage, late (fresh)	0 to +2	10 to 40	90 to 98	OFF	5 to 6 months	
Carrots, topped (fresh)	0 to +2	10 to 20	90 to 98	OFF	1 to 9 months	
Cassava, yuca, manioc (fresh)	0 to +5	10 to 20	85 to 90	OFF	1 to 2 months	
Cauliflower (fresh)	0 to +1	20 to 60	90 to 98	OFF	2 to 4 weeks	
Cheese (chilled)	0 to +10	0 (=closed)	–	OFF	depends on variety	
Cherries, sweet (fresh)	−1 to 0	10 to 15	90 to 95	OFF	2 to 3 weeks	MA packaging often used
Chocolate (chilled)	+8 to +18	0 (=closed)	65 to 70	ON or OFF	5 to 15 months	
Cocoa butter (chilled)	+15 to +25	0 (=closed)	–	OFF	12 to 24 months	
Coconuts, dehusked (fresh)	0 to +2	0 to 25	85 to 90	OFF	1 to 2 months	
Codfish, dried, salted (chilled)	+1 to +3	0 (=closed)	65 to 70	ON	12 months	
Corn, sweet, baby (fresh)	−0.5 to +1	10 to 15	90 to 98	OFF	5 to 8 days	
Cucumbers (fresh)	+10 to +13	10 to 25	90 to 95	OFF	10 to 14 days	
D						
Dates (fresh)	0 to +2	0 (=closed)	65 to 85	ON or OFF	6 to 12 months	
E						
Eggplants, aubergine (fresh)	+8 to +12	10 to 15	90 to 95	OFF	1 to 2 weeks	
Eggs, dried, whole solids (chilled)	+4 to +10	0 (=closed)	–	OFF	1 to 2 years	
Eggs, with shell (chilled)	−1 to +3	0 (=closed)	–	OFF	5 to 6 months	
F						
Figs (fresh)	0 to +1	0 to 10	85 to 90	OFF	7 to 10 days	
Fish (frozen)	−18 or colder	0 (=closed)	–	OFF	4 to 12 months	
French fries, potato wedges (frozen)	−18 or colder	0 (=closed)	–	OFF	12 to 24 months	
Fruit (frozen)	−18 or colder	0 (=closed)	–	OFF	depends on commodity	

Commodity	Temperature °C	Ventilation (air exchange) cbm/h	Humidity relative % 	Dehumidification (max. relative humidity setting) ON/OFF	Approximate shelf life after harvest (in ambient air)	Further methods for shelf life extension
G						
Garlic (fresh)	–3 to +1	0 to 15	60 to 70	ON	6 to 7 months	
Ginger (fresh)	+12 to +14	10 to 15	65 to 85	ON	2 to 3 months	
Grapefruit (fresh)	+10 to +15	10 to 30	85 to 90	OFF	1 to 2 months	sometimes carried at +8 °C though subject to chilling injury below +10 °C
Grapes, table (fresh)	–1 to 0	10 to 15	85 to 95	OFF	1 to 5 months with sulphur dioxide pads	CA containers can be used as alternative to sulphur dioxide pads
H						
Honey, strained (chilled)	+10 to +20	0 (=closed)	–	OFF	1 to 2 years	
I						
Ice cream, dairy desserts (frozen)	–22 or colder	0 (=closed)	–	OFF	4 to 6 months	
IQF, individually quick-frozen products (frozen)	–18 or colder	0 (=closed)	–	OFF	depends on commodity	
J						
Juice, concentrate, fruit (frozen)	–18 or colder	0 (=closed)	–	OFF	1 year	
K						
Kiwifruit, green, golden (fresh)	–0.5 to +5	15 to 40	90 to 95	OFF	2 to 3 months	
L						
Lemons (fresh)	+10 to +14	15 to 25	85 to 95	OFF	1 to 3 months	up to 4 weeks at +5 to +9 °C is tolerated by most varieties, though chilling-sensitive
Lettuce, iceberg (fresh)	0 to +1	10 to 30	90 to 98	OFF	2 to 3 weeks	
Limes (fresh)	+8 to +12	15 to 25	85 to 90	OFF	2 to 5 weeks	often carried at +7 °C though subject to chilling injury below +8 °C; dehumidification sometimes applied to reduce mold growth
Lychees (fresh)	+2 to +6	10 to 15	90 to 95	OFF	3 to 5 weeks	MA packaging or CA containers often used

Commodity	Temperature °C	Ventilation (air exchange) cbm/h	Humidity relative % –	Dehumidification (max. relative humidity setting) ON/OFF	Approximate shelf life after harvest (in ambient air)	Further methods for shelf life extension
M						
Mandarins, clementines, tangelos, tangerines, easy peelers (fresh)	+4 to +8	15 to 25	90 to 95	OFF	3 to 8 weeks	
Mangoes (fresh)	+8 to +14	25 to 30	85 to 95	OFF	2 to 4 weeks	CA containers sometimes used
Margarine (chilled)	0 to +18	0 (=closed)	–	OFF	2 to 5 months	
Meat (chilled)	–2 to –1	0 (=closed)	–	OFF	1 to 8 weeks	vacuum packaging often used
Meat (frozen)	–18 or colder	0 (=closed)	–	OFF	6 to 18 months	
Melons, cantaloupe, charentais (fresh)	+2 to +5	25 to 30	90 to 95	OFF	1 to 2 weeks	MA packaging often used
Melons, galia, orange flesh (fresh)	+7 to +8	25 to 30	90 to 95	OFF	2 to 3 weeks	MA packaging often used
Melons, water, honeydew, piel de sapo (fresh)	+9 to +12	0 to 30	85 to 95	OFF	2 to 3 weeks	
Milk, dried (chilled)	+7 to +20	0 (=closed)	–	OFF	6 to 9 months	
Milk, pasteurized (chilled)	0 to +1	0 (=closed)	–	OFF	2 to 4 months	
Mushrooms (fresh)	0 to +1	10 to 30	90 to 98	OFF	5 to 7 days	
O						
Onions, bulbs (fresh)	0 to +8	10 to 40	65 to 75	ON	2 to 9 months	
Oranges (fresh)	+2 to +10	15 to 25	85 to 90	OFF	1 to 3 months	
P						
Papayas (fresh)	+7 to +13	10 to 30	85 to 90	OFF	1 to 3 weeks	
Peaches, nectarines (fresh)	–0.5 to 0	10 to 25	90 to 95	OFF	2 to 5 weeks	CA containers often used
Pears (fresh)	–1.5 to 0	10 to 25	90 to 95	OFF	1 to 8 months	
Peas, snow, sugar snap (fresh)	0 to +1	10 to 25	90 to 98	OFF	1 to 2 weeks	MA packaging or CA containers often used
Peppers, bell, sweet, chili (fresh)	+7 to +10	10 to 15	90 to 95	OFF	2 to 3 weeks	
Persimmon, kaki (fresh)	–1 to +1	10 to 25	85 to 95	OFF	1 to 3 months	
Physalis, cape gooseberries (fresh)	+9 to +16	10 to 15	65 to 85	ON or OFF	3 to 6 weeks	max. 3 weeks at +5 °C possible without chilling injury

Commodity	Temperature °C	Ventilation (air exchange) cbm/h	Humidity relative %	Dehumidification (max. relative humidity setting) ON/OFF	Approximate shelf life after harvest (in ambient air)	Further methods for shelf life extension
Pineapples (fresh)	+7 to +13	10 to 25	85 to 90	OFF	2 to 3 weeks	often carried at +6.5 °C though subject to chilling injury below +7 °C
Plantains (fresh)	+9 to +12	10 to 50	85 to 95	OFF	1 to 4 weeks	sometimes carried at +7.2 °C though subject to chilling injury below +9 °C
Plums (fresh)	–0.5 to 0	10 to 25	90 to 95	OFF	2 to 5 weeks	CA containers often used
Pomegranates (fresh)	+5 to +9	10 to 25	90 to 95	OFF	2 to 3 months	
Potatoes, for processing (fresh)	+10 to +15	10 to 50	85 to 95	OFF	2 to 12 months	
Potatoes, seed (fresh)	+4 to +8	10 to 25	65 to 90	ON or OFF	2 to 6 months	
Potatoes, sweet (fresh)	+12 to +16	0 to 25	65 to 85	ON or OFF	4 to 6 months	
Potatoes, table (fresh)	+5 to +10	10 to 50	85 to 95	OFF	2 to 12 months	
Poultry (frozen)	–18 or colder	0 (=closed)	–	OFF	6 to 16 months	
R						
Radish (fresh)	0 to +5	0 to 15	90 to 95	OFF	1 to 4 weeks	
S						
Seafood, shrimps, mussels, octopus, squid (frozen)	–18 or colder	0 (=closed)	–	OFF	6 to 12 months	
Squash, summer, soft rind (fresh)	+5 to +10	0 to 10	90 to 95	OFF	10 to 14 days	
Squash, winter, hard rind, pumpkins (fresh)	+10 to +13	10 to 60	65 to 85	ON or OFF	5 to 8 weeks	
Strawberries (fresh)	–0.5 to 0	10 to 15	90 to 95	OFF	3 to 8 days	
T						
Taro, malanga (fresh)	+7 to +13	10 to 15	85 to 90	OFF	2 to 5 months	
Tomatoes (fresh)	+7 to +15	10 to 30	65 to 85	ON or OFF	1 to 4 weeks	
Turnips (fresh)	0 to +4	0 to 10	90 to 95	OFF	4 to 5 months	
V						
Vegetables (frozen)	–18 or colder	0 (=closed)	–	OFF	depends on commodity	
W						
Wine (chilled)	+12 to +15	0 (=closed)	–	OFF	1 to several years	
Y						
Yams (fresh)	+16 to +20	10 to 20	65 to 85	ON or OFF	2 to 5 months	

Temperature conversion chart – Celsius and Fahrenheit

°F	°C	°F	°C	°F	°C	°F	°C
–31.0	–35.0	–1.0	–18.3	29.0	–1.7	59.0	15.0
–30.0	–34.4	0.0	–17.8	30.0	–1.1	60.0	15.6
–29.0	–33.9	1.0	–17.2	31.0	–0.6	61.0	16.1
–28.0	–33.3	2.0	–16.7	32.0	0.0	62.0	16.7
–27.0	–32.8	3.0	–16.1	33.0	0.6	63.0	17.2
–26.0	–32.2	4.0	–15.6	34.0	1.1	64.0	17.8
–25.0	–31.7	5.0	–15.0	35.0	1.7	65.0	18.3
–24.0	–31.1	6.0	–14.4	36.0	2.2	66.0	18.9
–23.0	–30.6	7.0	–13.9	37.0	2.8	67.0	19.4
–22.0	–30.0	8.0	–13.3	38.0	3.3	68.0	20.0
–21.0	–29.4	9.0	–12.8	39.0	3.9	69.0	20.6
–20.0	–28.9	10.0	–12.2	40.0	4.4	70.0	21.1
–19.0	–28.3	11.0	–11.7	41.0	5.0	71.0	21.7
–18.0	–27.8	12.0	–11.1	42.0	5.6	72.0	22.2
–17.0	–27.2	13.0	–10.6	43.0	6.1	73.0	22.8
–16.0	–26.7	14.0	–10.0	44.0	6.7	74.0	23.3
–15.0	–26.1	15.0	–9.4	45.0	7.2	75.0	23.9
–14.0	–25.6	16.0	–8.9	46.0	7.8	76.0	24.4
–13.0	–25.0	17.0	–8.3	47.0	8.3	77.0	25.0
–12.0	–24.4	18.0	–7.8	48.0	8.9	78.0	25.6
–11.0	–23.9	19.0	–7.2	49.0	9.4	79.0	26.1
–10.0	–23.3	20.0	–6.7	50.0	10.0	80.0	26.7
–9.0	–22.8	21.0	–6.1	51.0	10.6	81.0	27.2
–8.0	–22.2	22.0	–5.6	52.0	11.1	82.0	27.8
–7.0	–21.7	23.0	–5.0	53.0	11.7	83.0	28.3
–6.0	–21.1	24.0	–4.4	54.0	12.2	84.0	28.9
–5.0	–20.6	25.0	–3.9	55.0	12.8	85.0	29.4
–4.0	–20.0	26.0	–3.3	56.0	13.3	86.0	30.0
–3.0	–19.4	27.0	–2.8	57.0	13.9		
–2.0	–18.9	28.0	–2.2	58.0	14.4		

Formulas: °C = 5/9 (°F – 32); °F = 9/5 °C + 32

All information contained in this brochure corresponds to the information available at the time of going to press, is for preliminary information only and is not legally binding.

The prerequisites are: top-quality cargo, correct customary pre- and post-harvest treatments, suitable packaging, correct stacking on pallets and stuffing of container, etc. Subject to the varieties, their maturities and ripeness stages, their origin (growing regions), their growth conditions (i.e., seasons), previous storage history and many more factors, there can be variations in the data for shipments of natural products.

Our liability for any and all damages in connection with the use of and/or the reliance on inaccurate and/or incomplete information, whether in contract or in tort, is limited only to instances in which we have acted with gross negligence or intent.

All information contained in this brochure is subject to change.

As of September 2019

Photos

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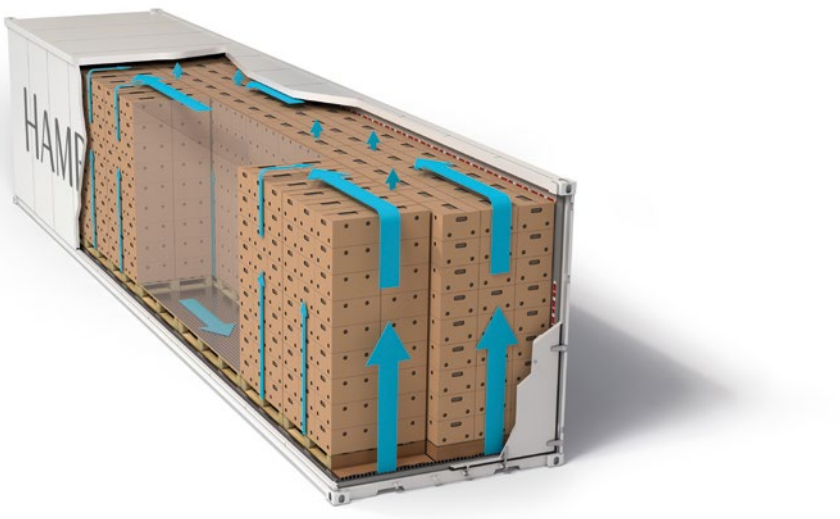
Preparing for a reefer container shipment

- ☐ Optimal temperature requirement (in °C or °F)
- ☐ Fresh-air ventilation, if required (in cbm/h)
- ☐ For dehumidification: max. relative humidity setting (in %)
- ☐ For CA: gas composition (O_2 and/or CO_2 in %)
- ☐ Transport time versus practical shelf life of the product
- ☐ Volume and weight of cargo
- ☐ Stuffing pattern and packaging material
- ☐ Required documentation, including legislative requirements
- ☐ Genset requirement for pre- and on-carriage



Before and during stuffing of a reefer container

- [ ] Cargo was correctly pre-treated, packed and is pre-cooled to transport set point
- [ ] Container is in a sound and clean condition, and is set at the required set points (temperature, ventilation, etc.)
- [ ] Container unit is not run with doors open
- [ ] Container floor and drains stay free of debris
- [ ] Cargo is never stuffed above the maximum red load line
- [ ] Cargo is stable and evenly stuffed according to stuffing guidelines (weight should be distributed for maximum stability and the entire T-floor should be covered)
- [ ] Entire T-floor is covered with cargo (or filler material)
- [ ] Cargo (as well as any filler material) is blocked and braced as necessary to avoid shifting
- [ ] T-floor space is not left open between cargo and the front/end bulkhead or side walls (for fresh fruit see Stuffing Example 1 and 2 on pages 10 and 13 respectively: instead of covering the T-floor at the door end, a rubber foam wedge or cardboard can be placed on top of the last pallets)
- [ ] Cargo (or filler material) is usually not loaded beyond the end of the T-floor (check air flow requirements)
- [ ] Total cargo weight does not exceed the maximum payload of the container
- [ ] Total weight of the container (container, cargo, chassis and genset) does not exceed the road limitations in any country crossed during transport

Contacts

If you have any further questions, simply contact the appropriate regional office, which will be pleased to supply you with the contact details of our local representatives.

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Reefer Guide, 01/2021