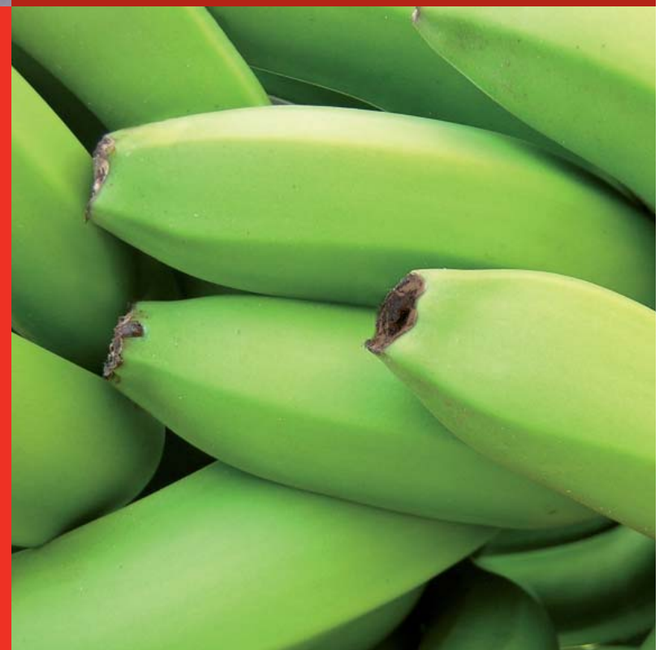
STAY COOL
WE CARE

HAMBURG SÜD



Contents

About us

Hamburg Süd and its reefer services

Since our founding in 1871, Hamburg Süd has evolved into a worldwide logistics and ocean transport organisation dedicated to providing our customers with tailor-made transportation solutions. One of our special areas of expertise is the transportation of temperature-controlled cargoes. It is a field in which we have consistently been at the forefront of new technologies and in which our know-how is unrivalled in the international shipping industry.

Refrigerated cargo (reefer cargo) is one of the most important commodity groups carried on Hamburg Süd vessels. Due to its perishable nature, special procedures are in place to handle this cargo, from packing plant to final destination.

With long experience in the transport of perishable cargo, Hamburg Süd ranks among the top five reefer container carriers worldwide and the largest container carriers in the South American markets. Together with the renowned Aliança brand as a Brazilian flag carrier, the Hamburg Süd Group stands for the highest schedule reliability and the shortest transit times.

Part of Hamburg Süd's mission statement describes the partnership we wish to establish with our customers. Many of our partners are in the business of shipping reefer cargo, and we ensure that it is handled in the best possible manner, using best practices and new technologies as they emerge. With our in-house Global Reefer Competence Team, we are keeping and further developing our expertise in the reefer segment to always provide prime support to our customers for the shipment of their perishable cargo.

We aim to offer our customers the latest reefer equipment technologies in order to guarantee optimal transport conditions for perishable cargo. To achieve this, Hamburg Süd continuously invests in optimising its services and in cutting-edge vessels featuring a high reefer capacity and special state-of-the-art reefer containers capable of meeting the needs of the most varied refrigerated products.

On top of that, we perform comprehensive research into innovations such as ecologically friendly, energy-saving software solutions. An aspect which takes account, above all, of the protection of the environment and of natural resources, and is an integral part of each organisational and financial decision taken at Hamburg Süd.

ISO certification

The Hamburg Süd Group operates an integrated Safety, Environmental and Quality Management System.

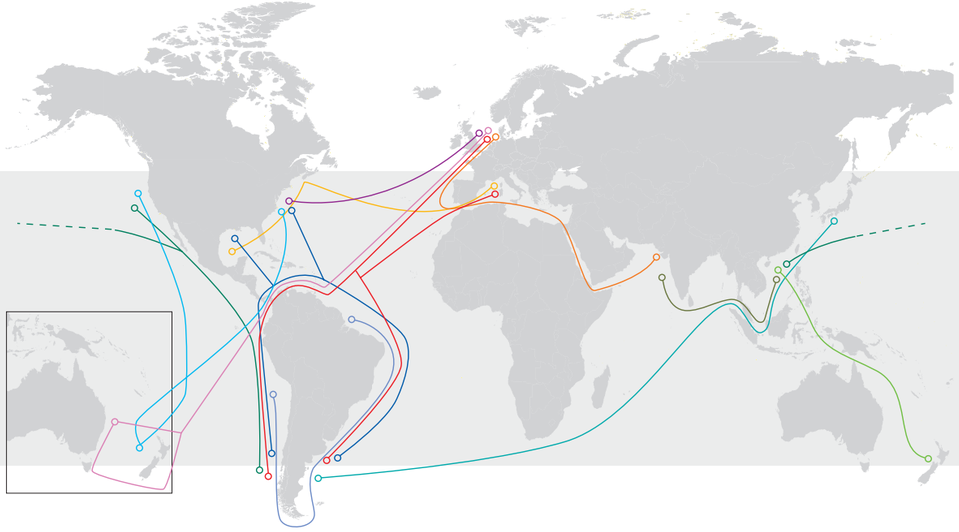
As one of the first internationally leading container shipping companies, the Hamburg Süd Group was certified worldwide in accordance with ISO 9001 as early as 1996. At the same time, the ISM Code was introduced on a voluntary basis. In addition, the existing Quality and Safety Management System was augmented by the ISO 14001 Environmental Management System in 2000.

The aim of the integrated management system is to ensure quality awareness through the continuous improvement of work processes in order to achieve the highest possible customer satisfaction. The integration of the Environmental Management System is an attempt to reconcile environmental protection and economic viability by making sparing use of natural resources. Quality and environmental targets are formulated and reviewed on a regular basis in order to ensure the process of continuous improvement.

Global seaborne reefer trades

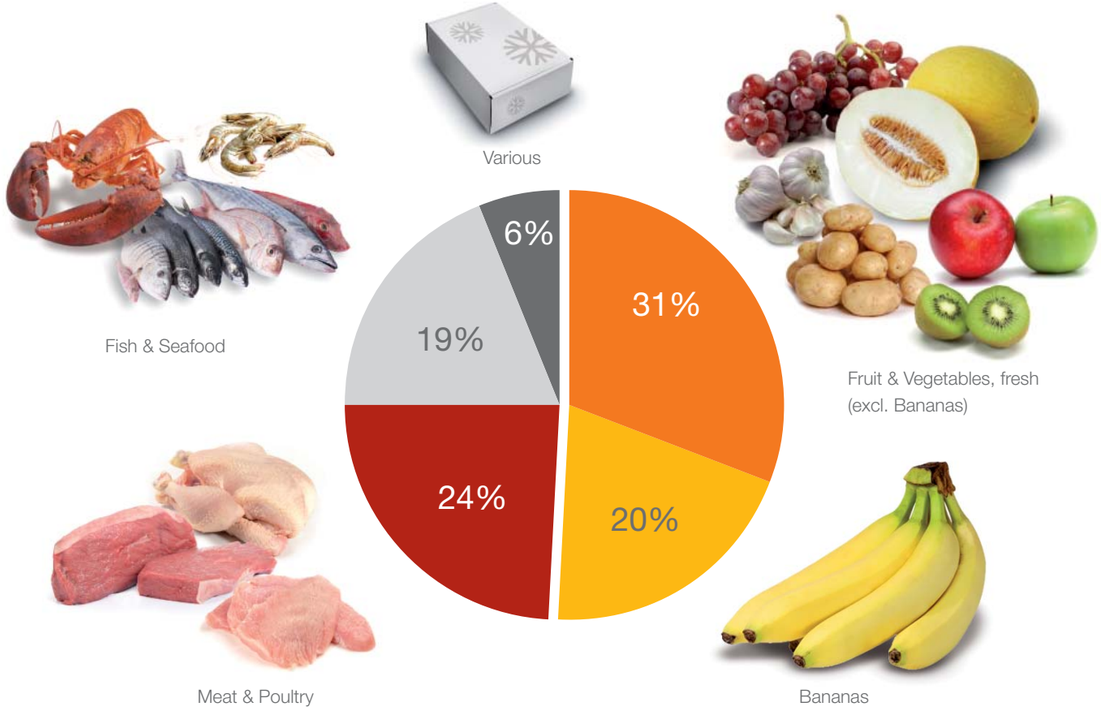
The preferences of consumers across the globe determine the trade patterns for foodstuffs. When people in one part of the world increase their demand for a special kind of fruit, growers on another continent are quick to cater to the demand for their products. A continuous adaptation to changing customer demands is our key to success in the reefer business.

As **reefer cargo** is mainly carried from the production areas in the Southern Hemisphere to the industrialised countries in the Northern Hemisphere, it moves along the main liner services of Hamburg Süd.
Hamburg Süd, as a traditional North-South carrier, offers services along most of the world's key reefer trades.



Main liner services of Hamburg Süd

- Europe / Mediterranean – South America / Central America
- Europe – Mediterranean / Inner Med / Middle East / Pakistan / India
- Mediterranean – Canada / Central America
- Europe – Central America / New Zealand / Australia
- Europe – North America
- North America / Central America / Caribbean – South America
- Intra South America
- North America – New Zealand / Australia / Pacific Islands
- Asia – South Africa / South America
- Asia – Central America / North America / South America
- Asia – India / Pakistan
- Asia – Australia / New Zealand



Global seaborne reefer cargo – commodity split year 2008 (source: Drewry).

The dominant cargo type in temperature-controlled transport is fresh fruit, consisting mainly of bananas – the single most important reefer cargo – apples and oranges. Other commodities are meat, poultry, fish, seafood, vegetables, dairy products, flowers, photographic material and pharmaceuticals.

When it comes to transporting reefer cargo, factors such as temperature control, air exchange, humidity levels, and proper packing and loading become extremely important. Because the characteristics of this cargo type 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 at –1.4°C or frozen at –18°C. Other cargoes, such as fresh fruit, have to be kept at temperatures mainly ranging from 0°C to +13°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!

Integrated reefer containers

Hamburg Süd has 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 our trade routes. The integrated container is especially suitable for door-to-door transport. Only electrical power is required.

Hamburg Süd's reefer containers are built to the highest possible technical standards. As a result, our equipment is regarded by the industry as state-of-the-art. The design reflects a combination of long experience, extensive research and testing programmes. Our Volumax® reefers provide an interior volume of 30 cubic metres in the 20' container and 70 cubic metres in the 40' High Cube container, giving them the highest interior volume available on the market today.

Main technical features:

- Service temperature range –30°C to +30°C
- Magnum® –35°C to +30°C
- Fresh air exchange adjustable (0 to 285 cbm/h)
- Dehumidification range 50% to 95% maximum relative humidity
- Operating voltage 360 to 500 Volt/50 to 60 Hertz
- Unsurpassed internal volume to provide maximum cargo space
- High-tech, CFC-free insulation ensures minimum heat leakage
- Special "T-bar" floors to ensure optimum air circulation
- Temperature control through built-in microprocessor
- High-quality cooling machinery
- The use of environmentally friendly refrigerants

Specifications

Size	20' x 8' x 8'6"	20' x 8' x 8'6"	40' x 8' x 9'6"
ISO Code	22R1	22R1	45R1*
Equipment Type	Integrated Reefer Container	Integrated Reefer Hanging Cargo	Integrated Reefer High Cube Container
Interior Dimensions (Length, Width, Height)	5,470 – 5,560 mm (L) 2,290 – 2,304 mm (W) 2,290 – 2,345 mm (H)	5,458 mm (L) 2,294 mm (W) 2,291 mm (H)	11,582 – 11,651 mm (L) 2,290 – 2,310 mm (W) 2,544 – 2,607 mm (H)
Door Opening (Width, Height)	2,290 – 2,300 mm (W) 2,271 – 2,344 mm (H)	2,296 mm (W) 2,290 mm (H)	2,288 – 2,310 mm (W) 2,490 – 2,576 mm (H)
Weights Gross	30,480 kg	30,480 kg	34,800 kg
Tare	2,500 kg – 3,160 kg	3,920 kg	4,260 kg – 4,900 kg
Payload	27,320 kg – 27,980 kg	26,530 kg	29,900 kg – 30,540 kg
Volume	29.20 – 30.00 cbm	28.70 cbm	67.50 – 70.00 cbm

** Various equipment types are available (AFAM+, EverFresh)*

Pre-Trip Inspection (PTI) and container check

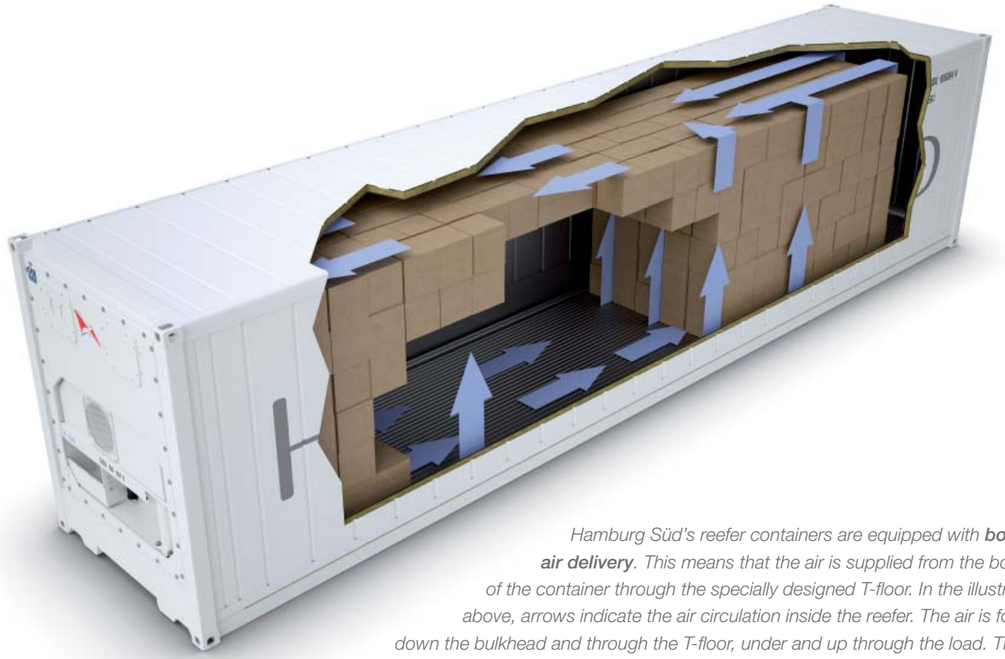
It is one of the highest priorities of Hamburg Süd to provide our customers with the most suitable container equipment for their needs at any time. Before one of our reefer containers is released to a customer, it must always pass through a "Pre-Trip Inspection" (PTI).

The Hamburg Süd PTI is a long and extensive check of the container and the operation of the reefer machinery. This ensures that only clean and undamaged containers with reefer machinery in perfect running order are made available to our customers.

Air circulation

Internal air circulation is essential for maintaining prescribed temperatures in reefer containers. Cold air is constantly circulated through the cargo space to dissipate transmitted heat.

Cold air flows through and around the goods in the container. This air is blown in at the bottom of the refrigeration unit through the gratings in the ducted floor and then drawn off again below the container ceiling. The circulating fans then force the air through the air cooler, which also acts as the evaporator in the cold circuit, and back through the gratings into the cargo. The most common form of ducted floor is known as a T-bar floor (T-floor), taking its name from the T-shaped cross-section of aluminium extrusions that form the floor.



*Hamburg Süd's reefer containers are equipped with **bottom air delivery**. This means that the air is supplied from the bottom of the container through the specially designed T-floor. In the illustration above, arrows indicate the air circulation inside the reefer. The air is forced down the bulkhead and through the T-floor, under and up through the load. The air returns to the evaporator over the top of the load and through the top of the bulkhead.*

Stuffing

Each commodity has different airflow requirements. Inside a reefer container the airflow is influenced by the type of packaging and the method of stuffing used. In the case of pre-cooled **frozen goods**, air only has to flow around the cargo, since no heat has to be dissipated from the goods themselves. Only the heat which penetrates the insulation from outside has to be removed. When transporting **chilled goods** such as fruit and vegetables, however, air also flows through the cargo, as it generates respiration heat internally which has to be dissipated.

There are two standard loading patterns for perishable products in reefer containers:

A block stow of break bulk cargo (e.g. loose cartons), and

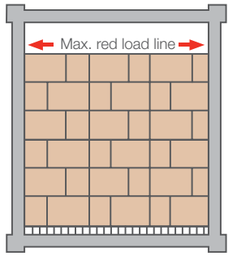
B palletised cargo stowage (e.g. cartons on a pallet).

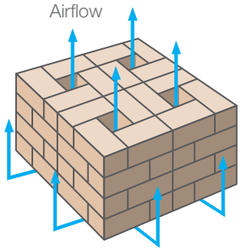
With both stuffing patterns, cargo must cover the entire T-floor to ensure proper distribution of refrigerated air. This is possible to arrange in most cases when, for example, loose cartons are stuffed into the reefer container. However, not all palletised cargo or, say, drums, can be stuffed in this way. In that case, when the cargo does not cover the entire T-floor, heavy cardboard or dunnage must be placed where no cargo is stuffed. This will **avoid short-circuiting** the circulating air and ensure proper refrigerated air distribution in reefer containers with bottom air supply. Improper stuffing, and thus respective by-passing of the circulating air, initiates a larger spread of different temperatures within the cargo and can lead to severe cargo damage.

The height of the cargo must not exceed the **red cargo load line**, which shows maximum allowed cargo height, so that ample free space is left above the stow to ensure proper air circulation around the load.

A Block stow of break bulk cargo

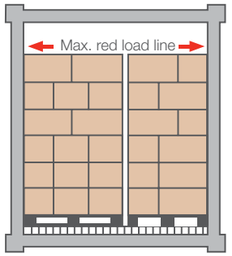
For loose cartons, two stuffing patterns are recommended: a weave block stow or a chimney block stow. Which pattern is chosen depends on the type of cartons and the commodity involved.

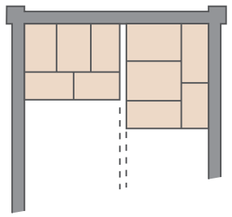




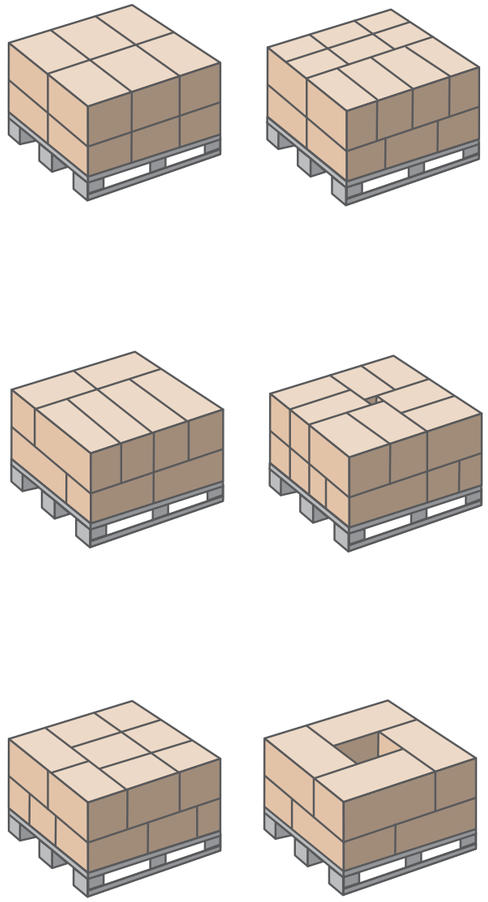
B Palletised cargo stowage

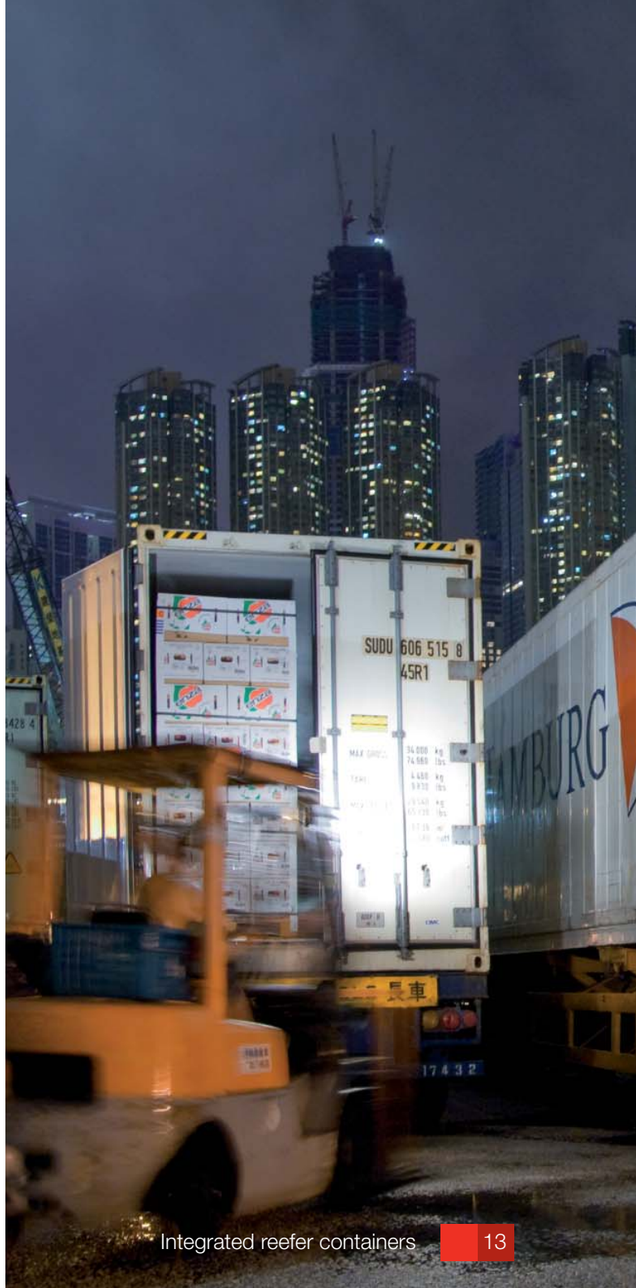
For palletised loads, the stuffing patterns shown below and right are recommended (examples).





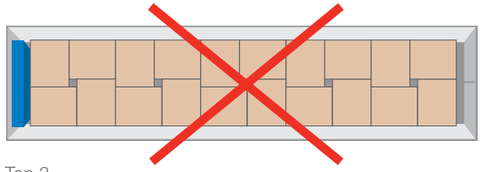
(Top view)



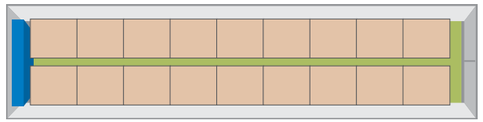


Reefer container stuffing – top view

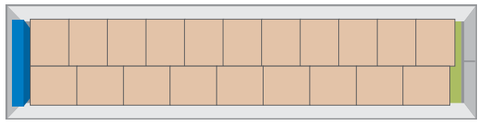
Air always takes the path of least resistance. In order to force air up and through the cargo and to avoid short-circuiting of the circulating air the container T-floor needs to be occupied entirely. Where the cargo does not cover the T-floor, some type of filler (dunnage, cardboard, etc.) should be used. This applies, among other things, to so-called „chimney“ stuffing patterns and free space on the „centre-line“. In case of pallet stuffing the front face of the last pallet(s) at the door should be blocked or covered as this increases the pressure to force air up and through the cargo. At the door end, the container must not be loaded past the end of the T-floor with cargo or filler.



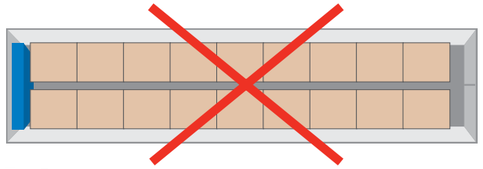
Top 3



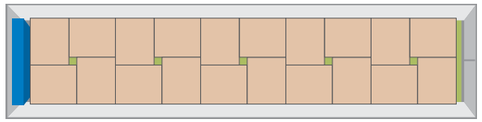
Top 4



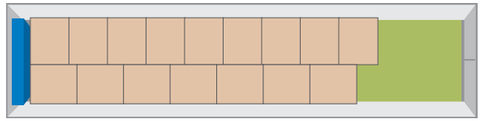
Top 1



Top 5



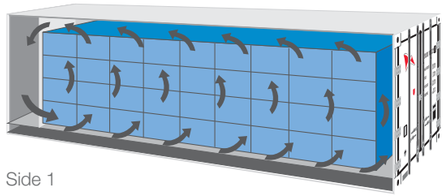
Top 2



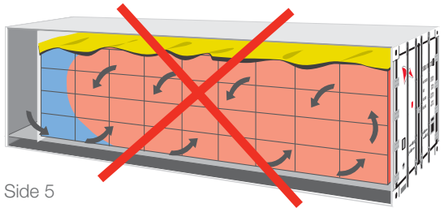
Top 6 (not completely loaded)

Refrigeration unit | Pallet | Filler | Wrong stuffing

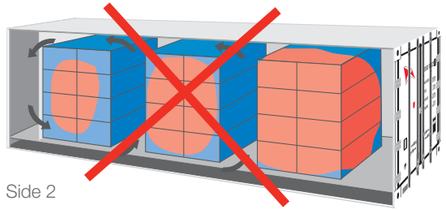
Reefer container stuffing – side view



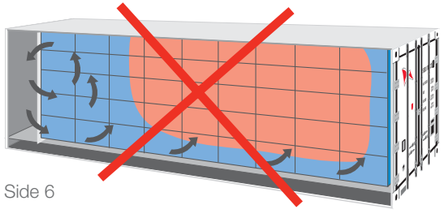
Side 1



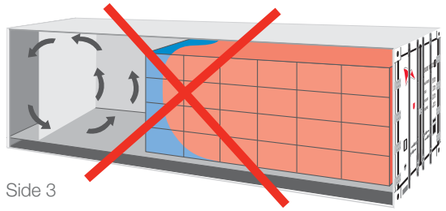
Side 5



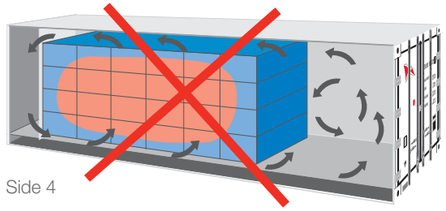
Side 2



Side 6



Side 3



Side 4

Side 1 above shows a correctly stuffed reefer container (refrigeration unit left, doors right). **Sides 2 to 6** illustrate improperly loaded reefer cargo. In three of these cases **(Sides 2 to 4)**, air tends to “short circuit” or flows past the cartons/product rather than through them. 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. So gaps and chimneys can reduce the ability to maintain temperature. Note: Properly pre-cooled (“pre-frozen”) frozen cargo may be transported as illustrated in **Side 4**. However, cargo would require bracing (not shown). **Sides 5 and 6** illustrate restricted airflow scenarios due to plastic covering on top of the load and stuffing above the maximum red load line respectively.

Cold | Hot | Plastic covering | Airflow | Wrong stuffing

Frozen products

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. It is, of course, necessary to ensure that air can circulate under, over and to each side and end of the stow.

Chilled products

The significant difference when stuffing chilled products such as fruit and meat is that refrigerated air must be circulated through the entire load. This is because heat in the reefer container is not generated just from the outside, but may also be produced by the cargo itself. The respiration process of fruit and vegetables, for example, requires air circulation both around the commodity and through the load to remove respiratory heat, water vapour and gases such as carbon dioxide and ethylene.

Correct **cargo packaging** is essential in maintaining product quality during transportation and marketing. In addition to protection, packaging in the form of bins, boxes, crates, etc. serves to enclose the product and provide the means of handling.

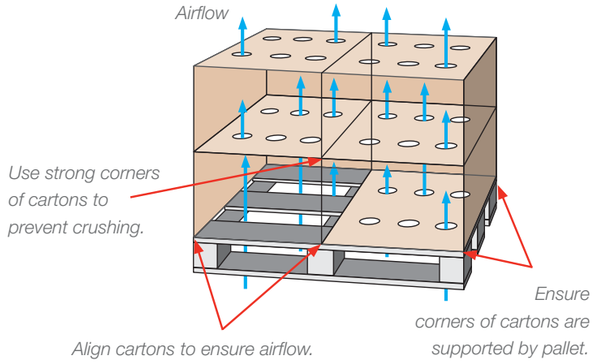
The packaging must withstand:

- 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

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, pre-cooling method, strength and buyer's specification.

Cartons for **fresh fruit and vegetables** require airflow holes in the top and bottom so that when stacked they 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 its corners. Stacking cartons directly on top of each other is recommended to minimise crushing of the cartons below.

If loading cargo on pallets, the cartons on the pallets should be placed so that air flows up into the cartons unrestricted. 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.



Temperature control

Proper temperature control is the most important factor in maintaining the quality of perishable commodities. Continuous, optimal temperature setting – throughout the complete so-called **“cold chain”** – must be maintained to preserve product integrity. The cold chain is critical to the optimisation of product quality at destination. If breaks in the cold chain occur, this integrity will be compromised and products rendered more susceptible to ageing and decay. Once temperature deviations occur, they cannot be reversed. 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

Shipments of perishables are permanently supervised by qualified reefer personnel within Hamburg Süd’s global network. Example: Hamburg Süd is doing the utmost to ensure cold chain maintenance even under difficult local circumstances. That way we have developed a so-called “transfer container” to secure the cold chain during anti-narcotics control in ports lacking reefer warehouses.

Our **integrated reefer containers** are each equipped with their own electrically driven mechanical refrigeration unit, plugged into electric power at depots, terminals and aboard ships. During land transport, the refrigeration units may require the support of a diesel engine-driven generator set **(genset)**.

Hamburg Süd’s 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 warming.

The **Magnum** reefers maintain temperatures down to as low as –35°C and are thus especially suited for the shipment of fatty fish products. But the rule “colder is better” for increased cargo protection throughout the cold chain also applies to some other types of frozen cargo like ice cream.

Reefer containers are designed to maintain cargo temperature in the given range, not to cool it down further! Therefore, products must always be correctly pre-cooled to transport temperature prior to being loaded into the container.

The proper pre-cooling of products will have a positive effect on their shelf life and 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 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!

The life processes of fruit and vegetables can result in the production of appreciable amounts of heat. Respiration 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 fruits are intolerant of excessively low temperatures, which cause a physiological alteration known as **chilling injury**. Tropical and sub-tropical fruit and vegetables such as bananas, melons, avocados, mangoes and papayas are particularly at risk.

Pre-cooling of the reefer container itself should generally not take place. It should only be pre-cooled before loading 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 approx. 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.

When water and heat pass the air cooler (evaporator) of the refrigeration 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 refrigeration machinery. Refrigeration machineries provide different options of **ice removal via defrost** cycles. The usual defrost cycle is Defrost on Demand (Auto Defrost), which minimises defrosting activity and maximises cooling performance.

If a reefer container does not have an Auto Defrost option, following settings apply:

- For frozen cargo, defrost interval must be set at 24 hours
- For chilled cargo with closed ventilation, defrost interval must be set at 12 hours
- For chilled cargo with open ventilation, defrost interval must be set at 6 hours

Temperature control systems

In refrigerated transport equipment, the temperature is maintained by a thermostat controlling the refrigeration 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.

The **set-point** is the temperature at which the controller is set. The main object of reefer transport is to ensure minimum loss of quality during transport, and therefore precise control at the lowest temperature the cargo can tolerate is necessary. When transporting chilled goods (–9.9°C or warmer), our modern refrigeration units are controlled by a sensor located in the delivery air stream, i.e. the air leaving the unit and about to enter the cargo space. This is called delivery air control. The units retain a sensor in the return air for control when transporting frozen goods (return air control at –10°C or colder). It must be emphasised that the set-point temperature should not be confused with the product temperature. 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 delivery air.

Our reefer units are fitted with controllers that have both return and delivery air temperature sensors which feed control signals to an electronic, computer-based controller. The controller adjusts the refrigeration unit, the fans and the overall capacity of the refrigeration unit to give a very precise delivery air temperature. The signals (temperatures) from the sensors are recorded by our electronic temperature monitoring systems and stored in memory, along with other information, for later retrieval for up to two years.

All Hamburg Süd ships built since 1998, and those currently on order, are equipped with the latest **Remote Monitoring System**, providing continuous checking of individual integrated reefer container operations throughout the voyage. Our equipment has **Remote Monitoring Modems (RMM)** installed that allow the vessels' cargo care specialists to monitor the temperatures and alarms of all reefer containers via an online computer system. In addition, the expert electronics engineers on board ensure the smooth functioning of all components.

Special features

Cold treatment

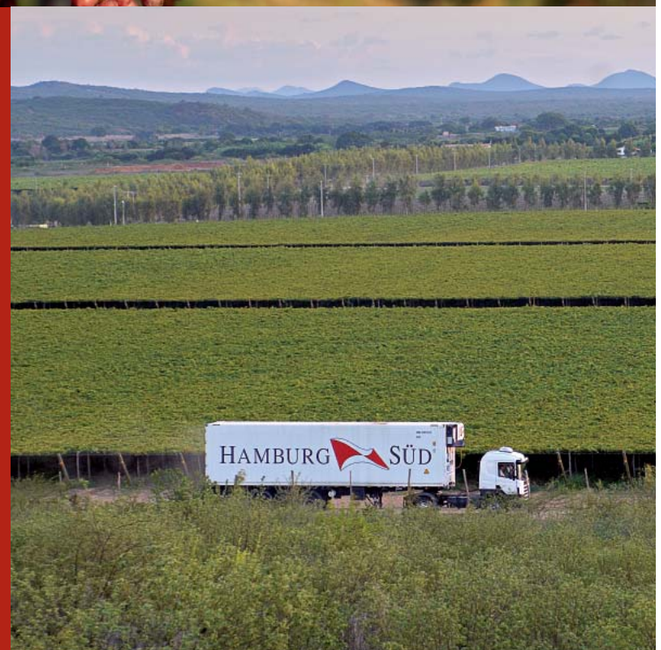
Cold treatment, or cold sterilisation, is commonly practiced in reefer containers. It means that sustained cold temperatures are maintained for lengthy durations, a post-harvest method which is utilised in order to disinfest fruit subject to the fruit fly pest and other potentially damaging insects. Our state-of-the-art reefer equipment can maintain specific temperatures for the proper duration as required by cold treatment specifications and guidelines such as USDA requirements for insect cold treatment.

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.

Bulb mode

Hamburg Süd reefer containers are certified for the transport of flower bulbs. Set in the so-called "bulb mode", our reefer containers follow the standards for flower bulb transportation of the Dutch Agrotechnological Research Institute (ATO).



Atmosphere management

Fresh air ventilation

For commodities that require fresh air circulation, like most fresh fruit and vegetables, our reefer containers can provide air exchange through defined vent openings. Ventilation must be closed when transporting frozen foods or controlled atmosphere loads.

During transport, fresh fruit and vegetables continue to 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-flavour, they have to be removed from the container atmosphere. Depending on the respiration rate of the commodity shipped, ventilation vents of a reefer container are usually opened at defined set-points in cbm/h for most fresh fruit and vegetables. Hamburg Süd's reefer containers can provide vent opening in the range of 0 to 285 cbm/h. The single permitted dimension unit for ventilation is "cbm/h". Due to a lack of standardisation, a vent setting in "%" is not acceptable, as it could lead to severe misinterpretations, depending on the manufacturer of the cooling unit.

Humidity control

Our reefer containers are equipped with automatic drains which open and close automatically as required in order to release any excess water that might accumulate inside the container.

Also, 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.

The relative humidity of the air around fresh produce in a reefer container is dependent on transpiration (and respiration) through the surface of the product, the rate of fresh air ventilation, the relative humidity of the fresh air and the temperature of the refrigerant coil relative to the dew point of the air in the cargo space.

For **fresh fruit and vegetables**, recommended relative humidity levels vary but are generally 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.

Some products like ginger, seed potatoes and photographic material are **susceptible to high humidity** and may require a lowered level of relative humidity during transport. For these products, our reefer containers offer a **dehumidification mode** which keeps the air inside the container at a specific maximum level of humidity. It enables all our reefer containers to control the relative humidity in the range of 50% to 95%, with the refrigeration unit operating in the chill temperature range.

MA and CA containers

Modified Atmosphere (MA) and Controlled Atmosphere (CA) have become effective means of securing and preserving cargo quality. Hamburg Süd is leading the way worldwide with MA and CA shipments. No other shipping company is able to offer such varied MA/CA equipment.

Fresh **fruit and vegetables** are living, metabolising items. The life of this perishable commodity type is ticking away from the moment it is picked from the mother plant. Basically, fruit is on a starvation diet once harvested. The key to delivering better quality produce is to slow down the consumption of the produce's food reserves.

Post-harvest processes on fruit and vegetables

Ambient Air

Oxygen (O_2)	21%	Nitrogen (N_2)	78%
Carbon dioxide (CO_2)	0.03%	Inert gases	1%

Water (H_2O)
Transpiration
➜ Dehydration

Carbon dioxide (CO_2) + Water (H_2O) + Heat
Respiration
➜ Ripening/Ageing

Growth of aerobic microorganisms
➜ Decay

Ethylene (C_2H_4)
Ethylene production
➜ Ripening/Ageing

Decomposition of valuable ingredients
➜ Nutritional value reduced

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

During transport, post-harvest processes on fruit and vegetables are generally minimised through temperature control and fresh air ventilation. In order to reduce them even further, MA and 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. For MA/CA, the O_2 content is generally decreased and the CO_2 content is increased. Both of these changes will tend to slow down the life process of the produce.

MA is a partly controlled change of air composition, while CA means the most advanced technology for constantly measuring and actively maintaining the atmospheric conditions in a reefer container throughout a shipment's entire journey.

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 also ethylene formation can be slowed down dramatically. The same effect occurs when the CO_2 content is increased. Growth of aerobic bacteria, yeast and mould is inhibited in high concentrations of CO_2. In addition, mould requires oxygen to grow, so limiting the amount of O_2 in the environment will limit the capacity of mould 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.

Hamburg Süd offers you the following types of MA and CA containers:

Modified Atmosphere (MA)	Controlled Atmosphere (CA)
■ AFAM+	■ EverFresh™
■ MAXtend™	

The lifespan of perishables can be prolonged by keeping them at their optimal temperature, combined with the supply of the most effective atmospheric blend.

The art of MA and CA for fruit and vegetables is to tailor the atmospheric composition to the requirements of the particular product. Too low an O_2 content of the air may cause a product to suffocate. Similarly, an excessive CO_2 content could cause suffocation of the "living" product, since it will be impeded in its release of the CO_2 it breathes out. Therefore, it is of utmost importance to apply the most suitable technology and atmosphere settings to each individual type of fruit.

The ideal composition of MA and CA transport is commodity specific. Our team of dedicated reefer specialists will support you in developing tailor-made solutions for your MA and CA cargoes!

Equipment Diversity

Cargo Expertise

Tailor-made Solutions

Benefits of MA/CA for fresh produce

- Delayed ripening, ageing, decay and associated changes prolong the shelf life of products, giving the retail food trade 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.
- Fruit can be shipped with a higher degree of ripeness.
- Higher sales for the retail food trade thanks to enhanced quality, taste, nutritional value and appearance, and so 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 emission.

AFAM+ MA

The "Automated Fresh Air Management" method takes advantage of the fact that the **respiration of fruit** converts O_2 into CO_2. If produce is placed in a reefer container with vents closed, the CO_2 content produced by the respiration process is allowed to increase. The O_2 content is reduced to an equal extent. As atmospheric air contains 21% O_2 and approx. 0% CO_2, an increase of, say, 10% in the CO_2 content will reduce the O_2 content to approx. 11%. The combined total percentage of CO_2 and O_2 always remains at 21%. The percentage of N_2 (including inert gases) remains unchanged and is just the same as in ambient air: 79%.

AFAM+ is a type of MA container that utilises a motorised fresh air exchange system. After reaching the required atmosphere conditions, the CO_2/O_2 set-point is maintained throughout the voyage simply by opening the **fresh air ventilation**. The system monitors CO_2 levels and constantly opens and closes the container vent in response to produce respiration. Installation of ethylene scrubbers to take ethylene out of the container atmosphere is recommended for products that produce high amounts of this so-called "ripening gas".

MAXtend MA

The MAXtend system is based on the same principle as AFAM+. However, in order to establish the initial atmosphere more quickly and/or independently of produce respiration, **gases from cylinders can be pre-injected** into the container once, before commencement of ocean transport. A so-called "curtain" (plastic sealing sheet) is used at the container door to improve gas tightness and to ensure that the pre-injected gas mixture cannot escape. Atmosphere maintenance during the trip is similar to AFAM+ and therefore relies solely on using controlled fresh air ventilation to replace O_2 consumed by continuing fruit respiration. Depending on the commodity, scrubbing of ethylene and/or carbon dioxide is recommended.

EverFresh CA

The crucial difference between the above-mentioned MA techniques and CA is that in EverFresh the container atmosphere is not regulated by ventilation but by active **N_2 injection during transport**. An N_2 gas-separating membrane is integrated into the refrigeration unit and allows each container to have a fresh stream of N_2 throughout the journey, whenever the O_2 and CO_2 sensors activate N_2 production. A compressor takes the ambient air, compresses it and forces the compressed air through the hollow fibre membrane, which separates and thereby concentrates N_2. When piped into the refrigerated container, the N_2-enriched atmosphere stream dilutes the O_2 level to reach set-point, in most cases below 5% O_2, and N_2 levels distinctly above 79%. Depending on the carried product, CO_2 can be increased in parallel, the same as described for MA. The controller continuously monitors and controls the O_2 and CO_2 concentrations and adjusts their levels towards the set-points by varying the volume and purity of the nitrogen introduced into the container. EverFresh containers regularly apply a curtain at the door end, and ethylene scrubbing if required.

Pre-treatment of reefer cargo

The condition of products before they are stuffed plays an important role in their condition upon arrival. That is why it is 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. The carrier must fully reject responsibility for cargo damage encountered due to inadequate pre-treatment of reefer cargo. Successful shipping begins at the point of origin of reefer cargo!

There is no technology available to overcome or reverse the process of fruit ripening, only techniques to retard the process. If a cargo is already too mature or of substandard quality when loaded for a particular journey to allow the goods to arrive at the required maturity, then a rejection or claim for damages by the recipient is the logical consequence, despite all the reasonable care and diligence exercised by the carrier .

The basic requirement in the carriage of temperature-controlled cargoes is to deliver the goods, as far as is possible, in the same condition as they were received. 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.

The actual transport temperature required will depend on many factors, and may require expert advice. Our team of dedicated reefer specialists is ready to support you!

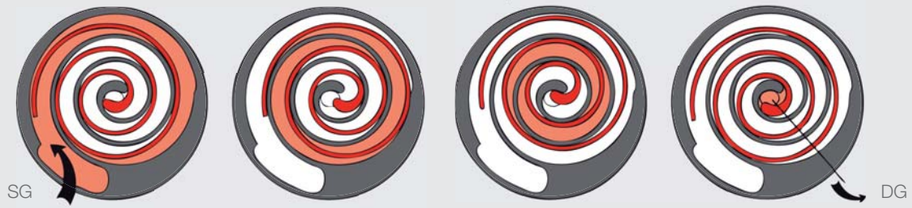
Ice cold and efficient

The number of reefer shipments is continuously growing and with them the number of reefer containers. They only fulfil their purpose when they keep the temperature constant in adverse ambient conditions. To do this, reefer containers require electrical energy – how efficiently they convert this into refrigerating capacity is a quality feature and an important criterion for the environmental compatibility of a reefer shipment.

As one of the first shipping companies worldwide, Hamburg Süd has championed compression-efficient **scroll compressors** since 1997. Thus, a very large proportion of our fleet sails with these units. They work up to 40% more efficiently than traditional piston compressors. The economical operation of our reefer containers with scroll technology benefits our customers as well as the environment.

Efficient refrigeration: in long test series, Hamburg Süd identifies the ideal technology for its reefer containers.

What is a SCROLL COMPRESSOR? A scroll compressor in a refrigerated container compresses the gaseous coolant. It consists of two interleaved scrolls, or spirals – one rigid and one flexible. The coolant flows in through the suction tube (SG) and compression begins. The flexible scroll orbits the fixed scroll eccentrically without rotating. Since the scrolls touch on two opposite sides, pockets are produced which become ever smaller from the outside inwards, thereby compressing the coolant. It then escapes at the centre, highly compressed (DG). Compared with traditional piston compressors, in which a piston moves up and down as in a combustion engine, scroll technology has higher energy efficiency.



The coolant enters the compressor (SG), is forced inwards by the rotary movements of the two metal scrolls and compressed. The compressed medium then escapes at the centre (DG).

Environmentally friendly refrigerants

We use only environmentally friendly refrigerants in our refrigeration units.

Energy-saving software solutions

To improve our reefer shipments still further, we reproduce the operating conditions of a reefer container in elaborate laboratory tests and measure the energy consumption. Only with these practical test series is it possible to optimise reefer container operation and so relieve the environment of unnecessary energy expenditure. As a result of the tests, Hamburg Süd has developed software in cooperation with a reefer manufacturer that saves approx. 30% energy. This is achieved through a more efficient use of the refrigeration components. Energy-saving software used by other shipping lines might allow a higher bandwidth of air temperatures. In contrast to these approaches, Hamburg Süd will continue to provide tight air temperature control.

Volumax® reefers

Hamburg Süd has the reefer containers with the largest interior volume worldwide. This raises transport performance per container and enhances the CO_2 balance of container shipments.

Good atmosphere for fresh produce

MA/CA shipments are a significant gain for the environment, because they mean a move away from transport by air for sensitive fruit and vegetables such as exotics. In a MA or CA container, fruits carried by ship reach their destination just as fresh and flavourful as by plane. The difference: carriage by ship causes just a fraction of the climate-malign gases produced by air transport per tonne moved.

Helpful facts

Recommended transport conditions and approx. shelf life of reefer cargo

The following tables provide recommended settings (temperature, ventilation, dehumidification) and shelf life information for selected products in standard reefer containers.

Fresh fruit and vegetables

(Relevant data for reefer container settings are shown in **red**.)

Commodity	Temperature °C	Ventilation (air exchange) cbm/h	Humidity relative %	Dehumidification (max. relative humidity setting)	Approximate shelf life (in ambient air)
Apples	–1 to +4	10 to 60	90 to 95	OFF	2 to 7 months
Apricots	–0.5 to 0	15 to 60	90 to 95	OFF	1 to 4 weeks
Asparagus	0 to +2	20 to 25	90 to 98	OFF	2 to 3 weeks
Avocados	+4 to +13	40 to 60	85 to 90	OFF	2 to 3 weeks
Bananas	+13 to +13.5	25 to 60	85 to 95	OFF	18 to 22 days
Beans (green, snap)	+4 to +7.5	20 to 30	95 to 98	OFF	7 to 10 days
Blueberries	–0.5 to 0	0 to 10	90 to 95	OFF	10 to 14 days
Broccoli	0	20 to 60	90 to 98	OFF	10 to 14 days
Cabbage (early)	0	20 to 60	90 to 98	OFF	3 to 6 weeks
Cabbage (late)	0	20 to 60	90 to 98	OFF	5 to 6 months
Cabbage (Chinese)	0	20 to 60	90 to 98	OFF	2 to 3 months
Carrots (topped)	0	10 to 20	90 to 98	OFF	1 to 9 months
Cassava (yucca, manioc)	0 to +5	10 to 20	85 to 90	OFF	1 to 2 months
Cauliflower	0	20 to 60	90 to 98	OFF	2 to 4 weeks
Cherries (sweet)	–1 to 0	0 to 10	90 to 95	OFF	2 to 3 weeks
Coconuts (dehusked)	0 to +2	0 to 25	75 to 85	ON or OFF	1 to 2 months
Corn (sweet, baby)	0	10 to 15	90 to 98	OFF	5 to 8 days
Cucumbers	+10 to +13	15 to 25	90 to 95	OFF	10 to 14 days
Eggplants (aubergine)	+8 to +12	10 to 15	90 to 95	OFF	1 to 2 weeks
Figs (fresh)	–0.5 to 0	0 to 5	85 to 90	OFF	7 to 10 days
Garlic	–3 to +1	0 to 15	60 to 70	ON	6 to 7 months
Ginger	+12 to +14	10 to 15	65 to 75	ON	2 to 3 months
Grapefruit	+10 to +15	15 to 50	85 to 90	OFF	1 to 2 months
Grapes (table, with sulphur dioxide pads)	–1 to 0	10 to 15	85 to 95	OFF	1 to 5 months
Kiwifruit	0	20 to 60	90 to 95	OFF	2 to 3 months
Lemons	+10 to +14	15 to 25	85 to 95	OFF	1 to 3 months
Lettuce (iceberg)	0	20 to 50	90 to 98	OFF	2 to 3 weeks
Limes	+8 to +12	15 to 25	85 to 90	OFF	2 to 5 weeks
Lychees	+2 to +6	10 to 15	90 to 95	OFF	3 to 5 weeks
Mandarins (easy peelers)	+4 to +8	15 to 25	90 to 95	OFF	3 to 8 weeks
Mangoes	+9 to +14	25 to 30	85 to 95	OFF	2 to 3 weeks
Melons (cantaloupe, charentais)	+2 to +5	25 to 30	90 to 95	OFF	1 to 2 weeks
Melons (galia, orange flesh)	+7 to +8	25 to 30	90 to 95	OFF	2 to 3 weeks
Melons (water, honeydew, piel de sapo)	+9 to +12	25 to 30	85 to 95	OFF	2 to 3 weeks
Onions (dry)	0 to +2	10 to 15	65 to 75	ON	6 to 9 months
Oranges	+2 to +10	15 to 25	85 to 90	OFF	1 to 3 months
Papayas	+7 to +13	25 to 30	85 to 90	OFF	1 to 3 weeks
Peaches/Nectarines	–0.5 to 0	15 to 25	90 to 95	OFF	2 to 5 weeks
Pears	–1.5 to 0	15 to 25	90 to 95	OFF	1 to 8 months
Peas (snow, sugar snap)	0 to +1	15 to 25	90 to 98	OFF	1 to 2 weeks
Peppers (bell/sweet and chili)	+7 to +10	10 to 15	90 to 95	OFF	2 to 3 weeks
Persimmon (kaki)	0	15 to 25	85 to 95	OFF	1 to 3 months
Physalis (cape gooseberries)	+10 to +16	0 to 15	65 to 80	ON or OFF	3 to 6 weeks
Pineapples	+7 to +13	15 to 25	85 to 90	OFF	2 to 3 weeks
Plantains	+9 to +15.5	20 to 25	85 to 95	OFF	1 to 4 weeks
Plums	–0.5 to 0	15 to 25	90 to 95	OFF	2 to 5 weeks
Potatoes (seed)	+4 to +8	10 to 25	80 to 90	ON or OFF	2 to 6 months
Potatoes (table)	+5 to +10	10 to 50	85 to 95	OFF	2 to 12 months
Potatoes (for processing)	+10 to +15	10 to 50	85 to 95	OFF	2 to 12 months
Potatoes (sweet)	+12 to +16	0 to 10	80 to 95	OFF	4 to 6 months
Squash (summer, soft rind)	+5 to +10	0 to 10	90 to 95	OFF	10 to 14 days
Squash (winter, hard rind, pumpkins)	+10 to +13	0 to 60	60 to 80	ON or OFF	5 to 8 weeks
Strawberries	–0.5 to 0	10 to 15	90 to 95	OFF	3 to 8 days
Tomatoes	+7 to +15	15 to 30	65 to 90	ON or OFF	1 to 4 weeks
Turnips	0 to +4	0 to 10	90 to 95	OFF	4 to 5 months
Yams	+16 to +20	0 to 10	65 to 80	ON or OFF	2 to 5 months

Meat, poultry, fish, seafood, dairy products and other commodities

(Relevant data for reefer container settings are shown in **red**. Frozen and non-respiring cargoes do not require ventilation.)

Commodity	Temperature °C	Approximate shelf life (in ambient air)
Bakery products	+10 to +18	depending on commodity
Butter	0	2 to 4 weeks
Butter (frozen)	–23	10 to 12 months
Cheese	0 to +4	depending on variety
Chocolate	+10 to +18	10 to 15 months
Codfish (dried, salted)	+2 to +4	12 months
Eggs (with shell)	–1 to +3	5 to 6 months
Eggs (dried, whole solids)	+4 to +10	1 to 2 years
Fish (frozen)	–18 or colder	4 to 12 months
Honey (strained)	+10 to +20	1 to 2 years
Ice cream (frozen dairy desserts)	–26 or colder	4 to 6 months
IQF (individually quick frozen products)	–18 or colder	depending on commodity
Juice (fruit) and concentrate (frozen)	–18 or colder	1 year
Margarine	–12 to –8	6 months
Meat (chilled)	–1.4	1 to 8 weeks
Meat (frozen)	–18 or colder	6 to 18 months
Milk (pasteurised)	0 to +1	2 to 4 months
Milk (dried)	+7 to +21	6 to 9 months
Poultry (frozen)	–18 or colder	6 to 16 months
Shrimps (frozen)	–18 or colder	10 to 12 months

If your product is not mentioned or additional information is required, please ask your local Hamburg Süd representative.

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		

Formulae: C = 5/9 (F – 32), F = 9/5 C + 32

Disclaimer

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 at February 2010

Reference and acknowledgement

Hamburg Süd especially wishes to thank Mr Harm de Haan for allowing us to use content and informational graphics from the two books cited below for this brochure and whose advice as a reefer expert of long standing we greatly appreciate.

De Beer'S Consolidated Manual On The Transportation Of Perishable Cargo In Reefer Containers
by Harm de Haan. ISBN: 978-90-8620-001-6. Pub date: 2005. Pages: 112. Publisher: NPN Drukkers b.v., Breda, The Netherlands

De Beer'S Consolidated Manual On Postharvest Handling, Cooling And Storage Of Fruit And Vegetables
by Harm de Haan. ISBN: 978-90-8620-002-3. Pub date: 2008. Pages: 216. Publisher: NPN Drukkers b.v., Breda, The Netherlands

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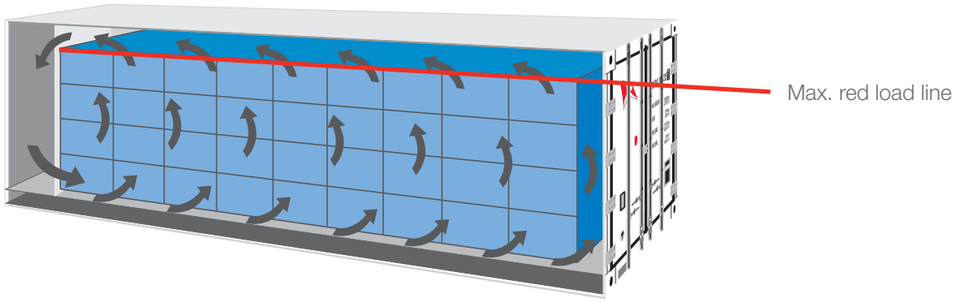
Notes

Recommended checklist – Part II

Before and during stuffing

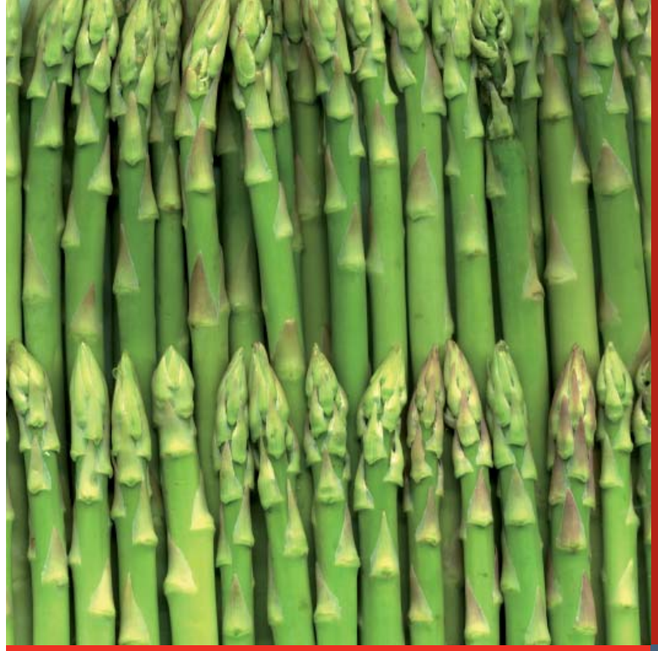
- ☐ Cargo was correctly pre-treated, packed and is pre-cooled to transport set-point
- ☐ Container is in sound and clean condition and set at the required set-points (temperature, ventilation, etc.)
- ☐ Container unit is not run with rear doors open
- ☐ Container floor and drains stay free of debris
- ☐ 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)
- ☐ Cargo is blocked and braced as necessary to avoid shifting
- ☐ Entire T-floor is covered with cargo (or filler material)
- ☐ T-floor space is not left open between cargo and the front/end bulkhead or side walls
- ☐ Cargo (or filler) is not loaded beyond the end of the T-floor
- ☐ 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

Recommended checklist – Part I



Preparing for shipment

- ☐ Optimal temperature requirement (in °C or °F)
- ☐ Fresh air ventilation if required (in cbm/h)
- ☐ For dehumidification: max. relative humidity setting (in %)
- ☐ For MA/CA: gas composition (O_2 and/or CO_2 in %), and type of scrubber if required
- ☐ Transport time versus practical storage/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



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