West of England

Loss Prevention Bulletin

The Carriage of Reefer Containers

The Managers are notified of claims involving refrigerated containers on a regular basis, often due to set point temperatures not being maintained while on board. The purpose of this Bulletin is to provide Members with a set of guidelines on the carriage of temperature controlled cargo in refrigerated (reefer) containers to ensure maximum protection during transit.

The complex nature of the subject precludes advice for every eventuality. Consequently these guidelines are outlined in fairly broad terms. It should be understood that exceptions can and will arise, and in such circumstances specialist advice should be sought. The common goal however is the prevention of claims, and to ensure that the cargo is carried in a safe and efficient manner without loss of product quality.

To achieve this aim it is vital that all concerned appreciate the importance of ensuring that the prescribed temperature set point is maintained throughout the voyage. It should also be understood that reefer containers are not designed to lower the temperature of warm cargo other than extremely slowly.

Members operating vessels which may carry reefer containers are advised to consider the following recommendations and note the additional advice concerning the operation, stowage and transportation of such equipment.

Loading and Carriage Guidelines

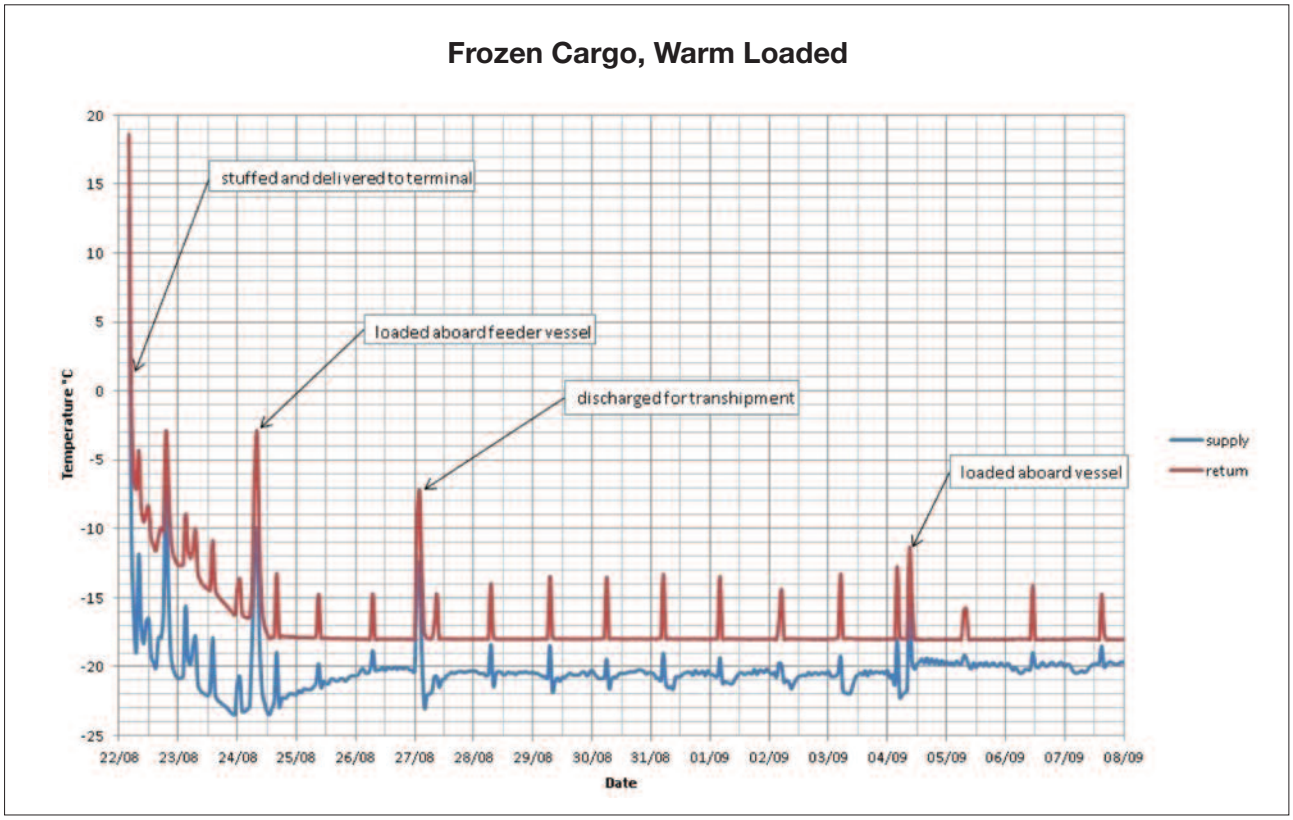
- Vessels should always carry manufacturers' kits of reefer spares, suitable tools and repair manuals specifically relating to the makes and models of the refrigeration units carried. These should be used by the vessel's reefer engineer if it becomes necessary to effect emergency repairs during the voyage. There are several different types of reefer unit in general use, each having individual repair and maintenance characteristics.
- The provision of a safely rigged working platform is essential when repairing a container stowed more than one tier high on deck.
- A supply of refrigerant gas should be carried in accordance with the type and number of refrigerated containers on board.
- Prior to shipment it is essential that written confirmation is obtained from the shippers detailing all conditions of carriage including temperature, ventilation and humidity requirements. International Cold Chain Technology (ICCT) recommendations regarding the specification of carriage conditions are available on the ICCT website.
- If a container is to be stuffed at the load port terminal, a surveyor should be appointed to monitor the arrival temperature of the cargo and to note details of any departure from specification.
- Any particular requirements in the charter party addressing the carriage of reefer containers, for example, monitoring routines, repairs to be attempted, parties to be notified in the event of a malfunction etc., should be complied with, and appropriate instructions provided to the vessel in writing.
- A reefer operations manual should be available on board specifying the carriage conditions for a range of commodities shipped in refrigerated containers, possible problems and a summary of trouble shooting procedures. Should a situation arise which is not addressed in the manual, advice from a specialist should be obtained.
- Before loading commences, the crew should reconfirm that the vessel's power sockets are compatible with the reefer plugs and are sufficient in number for all reefer containers to be carried. If necessary, a suitable quantity of plug adaptors should be obtained.
- Spare reefer extension leads should be carried as a precaution against the failure of individual power sockets.
- Once a reefer container has been plugged in, the locking collar should be placed over the plug and socket. Checks should also be made to ensure that the reefer socket box is completely closed to prevent water ingress during the voyage.

- After a reefer container has been loaded, plugged in and the power has been switched on, a suitably experienced crewmember should confirm that the unit is running and that the temperature is proceeding towards the set point. If a container will not run, some basic checks should be carried out. For example, the power switches on the control panel or the main breakers inside the control panel may have been switched off. If the container still refuses to start after it has been checked by the vessel's reefer engineer, shore assistance should be obtained. If this is also unsuccessful, the container should be sent back to the terminal.
- Many reefer container cargo claims have arisen due to confusion between the Fahrenheit and Celsius temperature scales, and also between positive (+) and negative (-) temperatures. Great care should be exercised to ensure that the set point temperature has been adjusted correctly as soon as the container has been placed on board. Any discrepancy between the actual temperature settings and cargo carriage instructions should be reported immediately.
- At sea, reefer containers should be inspected at intervals not exceeding six hours. The time of such inspections together with the delivery and return air temperatures should be recorded on each occasion. Details of any problems should be documented in an appropriate logbook. Alternatively, automatic logging systems may transmit signals via power cables to a central point. Such systems should be checked for error messages on a regular basis.

Reefer Containers

A reefer container is designed to maintain the pulp temperature of the cargo as at the time of stuffing. Although the container machinery may, over a period of time, reduce the temperature of warm cargo delivered above its prescribed temperature, this is not the primary function of a reefer container.

If the pulp temperature of the cargo exceeds the set point temperature specified by the shippers, the warm goods will



Container supply and return air temperatures for a frozen product loaded when warm

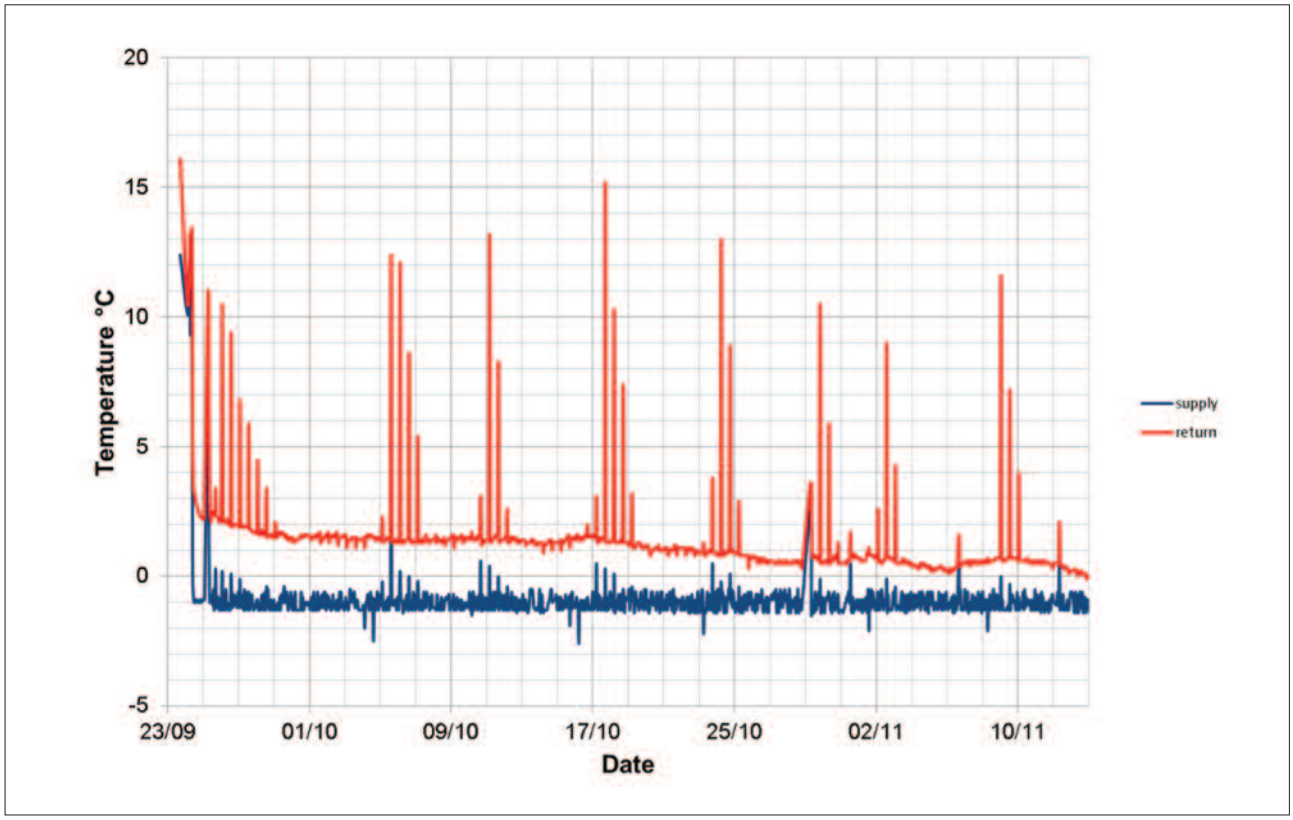
cause the temperature of the delivery air to rise very rapidly when passing up and through the cargo. The return air may eventually reach a temperature level whereby the refrigeration machinery cannot cool it down sufficiently prior to re-circulating it as delivery air. In such an event, the control panel may show a delivery temperature higher than that of the temperature control setting. The delivery/return air differential will in most cases narrow as the continuous circulation of air, being cooler than the cargo, brings the cargo temperature down towards the desired level. Any rise in return air temperature will be halted as the refrigeration unit begins to run in standard operational mode.

The example on the previous page shows a frozen product loaded when warm. The cargo temperature at the time of loading was around -5°C. The exterior of the cargo reached the set point of -18°C shortly after it was loaded, but the core of the stow did not reach the set point until over 3 days later.

In cases where the stuffing temperature is higher than the prescribed set point temperature, the refrigeration unit will cool down the surface layer of the cargo relatively quickly, often within days, but the centre of the stow will not reach the desired temperature for a considerable period of time. The temperature of frozen goods stuffed into a refrigerated container should not, in general, deviate by more than 3°C (5°F) from the specified set point temperature. Chilled cargo (excluding bananas) should not deviate by more than 0.4°C (1°F). However, this does not mean that such deviations are acceptable given that the objective is to receive and deliver the cargo at the carriage set point temperature.

Temperature and Defrosting

During the operation of a refrigeration unit, a layer of ice will form on the evaporator coils depending on the set point temperature, the temperature of the cargo, the amount of fresh air ventilation and the cargo humidity. Periodically the unit will enter a phase where heat is produced by a series of electrical



Evaporator coil defrost cycles recorded on the return air temperature log

heater elements or by the injection of hot gas into the evaporator coil, allowing defrosting to take place. All fans turn off automatically at such times to prevent heat from entering the cargo compartment.

However, since the return air temperature sensor is located close to the refrigeration machinery, some of this temperature rise will be recorded. Therefore, unless suppressed by the data recorder software, the temperature record will display periodic temperature increases coinciding with the defrost periods. Sometimes, if the defrost period is short, the hourly temperature readings and the defrost periods may go in and out of phase. This is illustrated on the previous page.

It is important to note that these increases have no immediate effect on the actual temperature of the cargo and are not an indication of an unstable refrigeration unit. Electronic data loggers usually indicate the timing and duration of defrost periods in addition to temperatures.

If, as described in the previous section, a warm cargo exceeding the specified set point temperature is loaded into a container, the refrigeration unit will start to lower the cargo temperature towards the correct level automatically. If the cargo has defrosted, the refrigeration unit will try to cool the cargo but will continually defrost.

In addition to the cargo set point and the delivery and return air temperatures, the temperature control system provides detailed information about system problems in the form of fault codes. Container temperature recording systems do not usually record the temperature of the cargo, only air temperature, but cargo temperature may be recorded by United States Department of Agriculture (USDA) probes fitted in order to comply with the USDA Cold Treatment Programme for the carriage of fruit. Cargo temperature may also be approximated by data loggers placed within the stow by the shippers.

Should a refrigeration unit fail, the temperature display and the data logger will show a gradual but steady rise in temperature to the point where the ambient temperature is eventually reached. Again, the sensor will only register the air temperature, not the temperature of the cargo. However, the cargo will be reasonably well protected from the influences of the external air temperature by the surrounding insulation.

There are many other situations where the air temperature records may not necessarily represent the actual temperature or condition of the cargo. These examples simply illustrate that firm conclusions cannot be drawn from the air temperature tracking pattern alone.

Equipment

The most common type of refrigerated container is 40 ft long by 9 ft 6 ins high “high cube” fitted with a picture frame integral reefer machinery unit bolted to the front. Such containers are often known as "integrals". 20 ft integrals are also in use but tend to be 8 ft 6 ins high. Reefers containers without a picture frame have been introduced where the reefer machinery has been incorporated into the front of the unit. Reefers of this type are known as “integrated” containers.

The insulation fitted to reefer containers is made from polyurethane foam. The insulation ages and becomes more thermally conductive over time, meaning that older containers tend to warm up more quickly when the power is turned off and consume slightly more power when operating.

Pre-Trip Inspection (PTI)

Prior to delivery to a shipper, a reefer container should undergo a Pre-Trip Inspection (PTI) arranged by the carrier or his local agent. This involves the refrigeration machinery being run and tested by a specialist engineer, usually within the port area. A PTI usually consists of two parts; a visual inspection regarding the structural integrity of the container and refrigeration machinery, and a series of electronic checks triggered by pressing the reefer machinery PTI button which results in a pass or fail. A fail may indicate that the unit is malfunctioning or that parts need to be replaced, requiring the attendance of a qualified refrigeration engineer. A record of the PTI is stored in the memory of the data logger.

A separate PTI may be carried out once the container has been loaded. This type of test is known as a “short PTI” or “function check” and can be performed without risk to the cargo.

If stuffing is delayed it may be necessary to repeat the PTI. Depending on the operator’s procedures this might take place after 30 to 90 days.

In some cases, generator sets capable of providing independent power may be used to facilitate the completion of "cold chain" operations from the premises of the shipper until the container has been loaded. Three types of generator sets are in use:

- Permanent fixed units
- Top clip-on units
- Under-slung clip-on units

Generator units should undergo similar checks before the containers to which they are attached are released from the depot. Their serial numbers should be recorded. The inspection also incorporates a fuel check to confirm that the generator has sufficient fuel for the journey. Before leaving the depot the temperature settings of the container should be verified and the correct temperature scale (°C/°F) selected, particularly in the case of digital displays.

Most refrigerated containers use an electronic logging device to record the temperature. In some cases an optional "start of journey" code (a “trip-start”) may be keyed in.

Older refrigerated containers may be sometimes encountered which record temperatures on a circular card known as a Partlow chart. The chart is rotated by a clockwork mechanism and the temperature is marked on the chart by a stylus. It is essential that the clockwork mechanism is fully wound and that a new card is inserted from the outset, rotating it to a position where the stylus records the temperature against the correct time and date. The chart and the thermostat settings should also match the temperature scale specified by shippers. All relevant shipping details should be noted on the chart by the carrier's representative or agent.

Checks should also be carried out to ensure that ventilation and humidity controls are set to the levels specified. If data logger probes are being used in order to comply with the USDA Cold Treatment Programme, they should be inspected by the carrier's representative or agent before and after fitting and on completion of the PTI to confirm that they are suitably calibrated and are monitoring the set point temperature correctly.

If the cargo is to be carried under controlled atmosphere (CA) conditions, the gas controllers should be correctly set and fresh air vents should be closed. Instructions should be issued regarding the steps to be taken in the event of gas control failure which may include opening the fresh air vents when switching off the CA system.

In tropical and sub-tropical regions it is preferable for containers to be stuffed in a temperature controlled environment such as a chilled warehouse. However, if stuffed in ambient conditions, the containers should not be pre-cooled beforehand except in exceptional circumstances as this may lead to the development of excessive condensation on the inner surfaces of the container.

Refrigeration machinery should always be switched off when the container doors are open to minimise the accumulation of moisture on the evaporator coil.

Container Shipment/On-Carriage

If a reefer container is awaiting shipment or on-carriage, it should always be connected to a static power point or independent generator unit ashore so that the reefer machinery can continue to operate and provide temperature control.

The reefer unit should be checked by the carrier's representative or terminal operator at least 4 times every 24 hours and monitoring reports should be completed throughout. These should be handed to the agent just prior to the container being dispatched. Temperature settings and temperature records should always be cross-checked. Each time a reefer container is monitored, the entire unit should be checked externally.

During such an examination it is essential that all seals, including veterinary seals, are thoroughly inspected by pulling and twisting. Seal numbers should also be checked against the monitoring records. In the event of any irregularities, owners and/or agents should be informed immediately as remedial action may be required in order to mitigate a potential cargo loss.

Temperature Recording

Container data loggers monitor the delivery and return air temperatures within a reefer unit, and the data is stored in an

electronic memory. The memory also records PTI results and alarms, and serial data communication with both the controller and the power unit. The data may be downloaded directly to a computer from where the information may be printed out, saved or forwarded as an email attachment.

If the data logger is capable of recording "start of trip" information, such details should include the origin of the container and its destination. The date and time should also be checked for accuracy. The use of any portable recorders within the container should be noted on all cargo documents. Portable recorders may be disposable or returnable units using bimetallic strip sensors, or may be electronic memory recorders. The latter type may be equipped with cargo probes attached by leads, or may incorporate an internal sensor.

Portable recorders may be installed at a Container Freight Station (CFS) to accompany prepared shipments. In such cases it is vital that the portable recorder charts are completed correctly by the carrier's representative or agent. The location of the recorder should be noted on all documents together with the time and date of its activation. Although it is customary for portable recorders to be placed inside the top carton at the door end of the stow, a better location is close to the delivery air entering the container at the machinery end given that, for the most part, the carrier can only guarantee the temperature of the delivery air.

Seals and security

During CFS operations the carrier's seal should be attached immediately stuffing has been completed, recording the serial number on all shipping documents. In shipper-stuffed units it is not normally possible for the container to be sealed by the carrier or his representative until the container has been returned to the terminal for shipping out. On receipt, a seal should be applied to the container without delay and the details again noted on all documents.

If a veterinary seal is attached to a container, it is important that all details are noted and the seals checked for signs of interference on arrival at the terminal. Imports to the EU, USA and Japan will only be permitted if the veterinary seal is intact when the container is discharged, thus confirming that the cargo was not tampered with while in transit. At intermediate ports the vessel or the local agents should reconfirm the security of all veterinary seals and such details should be noted on the accompanying documentation.

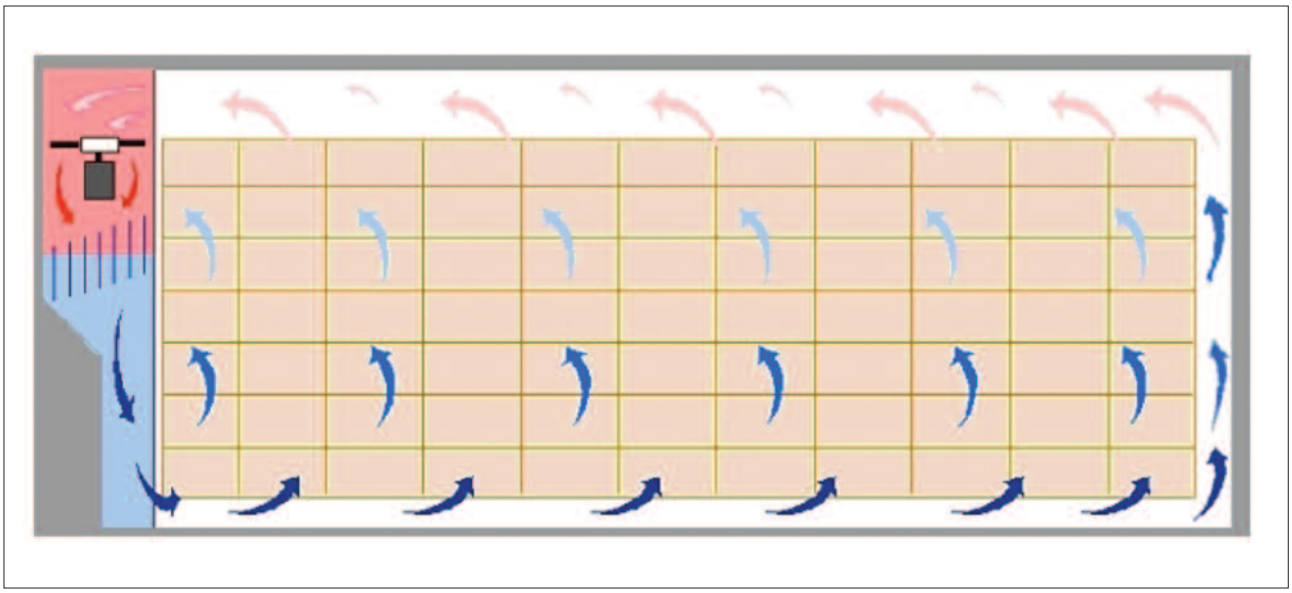
For cargoes classified and labelled as "Quick Frozen" there are special EU importation requirements which demand correct temperature maintenance from the point of production, prior to receipt by the carrier. In such cases the carrier should ensure that the accompanying documentation includes all previous temperature records.

Commodities

In general, refrigerated commodities may be divided into two distinct categories:

- Chilled
- Frozen

Many chilled cargoes (eg fruit) are regarded as a "live" cargo since they continue to respire post harvest and are susceptible to damage due to self-heating, premature ripening, desiccation (wilting and shrivelling) and other conditions. However, this is not the case with commodities such as chilled meat or cheese. The minimum set point temperature for fruit is usually no lower than -1.1°C (30°F). Conversely, frozen cargo is regarded as "inert" and is normally carried at or below -18°C (0°F). Since chilled and frozen goods are both perishable, care must be taken to ensure that the cargo is delivered in optimum condition. For chilled goods the ventilators are generally left in the open position apart from a limited number of exceptions (eg meat, chocolate, film, chemicals, dairy products, controlled atmosphere shipments). Some cargoes may require controlled humidity or high volumes of fresh air (eg flower bulbs). It should also be remembered that most refrigeration units are only capable of reducing humidity and this depends on the quantity of fresh air applied. Controlled atmosphere transportation involves the use of specialised containers capable of substituting the oxygen levels with nitrogen and carbon dioxide in order to extend the post harvest shelf life of the product. This method is suited to many soft and stone fruits but requires specialist knowledge to determine the most appropriate gas concentration levels.



Adequate space must be left around the stow to allow free air circulation

Stowage

Correct stowage within a container is extremely important to the carriage of reefer cargo. However, this is seldom under the control of the carrier who often receives a sealed container "said to contain" a specific cargo.

With frozen goods, the aim is to circulate cold air around the edges of the cargo to reduce the possibility of temperature variations at the boundaries (eg walls, floor and roof). With chilled live cargoes (eg fruit, vegetables) the air flow should be allowed to permeate up and through the cargo stow, removing product heat, carbon dioxide, ethylene (if present), moisture and other residual gases in the process.

Goods should never be loaded above the red line marked inside the container. This space should always be kept clear to allow air to flow uninterrupted towards the front intake. The ideal stowage pattern should permit free movement of delivery air whilst restraining any movement of the cargo. Adequate space should also be left around the stow to allow free air circulation.

Frozen products require a very simple stowage arrangement and should be loaded at the specified set point temperature. This can be achieved by a block stow. However, the cartons should not be packed together too tightly and there should be space between the cargo and the walls to allow heat passing through the sides of the container to be removed by circulating air. This is particularly important if the internal plating of the container is smooth. When carrying frozen cargo, the fresh air ventilation ducts should always be closed.

The cargo stow should cover the entire floor area but should not project beyond the floor "T" bars in order to allow cooling of the door area and to facilitate an effective flow of return air. In larger containers the height of the stow should be uniform if the volume of the cargo is less than the remaining free space.

Since stowage within the container plays an important part in maintaining the quality and security of the cargo during transit, specialist advice should always be sought if any questions or doubts arise at the time of booking.

Cargo Inspections

As far as practicable the pulp temperatures of chilled fruit and vegetables and the core temperatures of frozen goods should always be measured before stuffing. Fruit and vegetables should also be checked for pre-cooling damage such as mould, wilt, dehydration, shrivel, discolouration, soft spots, skin break and slip, bruising, chill damage and odour. Frozen cargoes should be checked for dehydration, desiccation, fluid migration, odour, black spot and colour changes, and for signs of any upward temperature deviation and subsequent

re-freezing. Cartons, trays and other packaging should be examined to determine their suitability for protecting the cargo during a sea passage.

If a reefer machinery unit breaks down or becomes unstable at sea and the fault cannot be repaired on board, the vessel should notify the office and the agents at the next port so that arrangements can be made to rectify the problem on arrival. In such circumstances a surveyor should be appointed to provide details of the fault and assess the condition of the cargo inside the container.

If a reefer container sustains physical damage, a surveyor should again be appointed to investigate the extent of the problem and ensure that action is taken to minimise any potential cargo loss.

Subject to the terms of the contract of carriage as reflected in the bill of lading, the carrier may be permitted to open a sealed container in order to mitigate a potential loss. The method of inspection will depend on the type of cargo. On such occasions a surveyor or a specialist should always be appointed to oversee the operation.

Members requiring further guidance should contact the Loss Prevention department.