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THE CARRIAGE OF REEFER CONTAINERS

The purpose of this bulletin is to provide Members with a set of guidelines on the carriage of temperature controlled cargo in reefer containers to ensure maximum protection during transit. It was originally written in response to a claims analysis finding that the numbers of reefer container claims were increasing, and evidence that the casual transportation of reefer containers by non-specialised operators was a growing practice.

The complex nature of the subject precludes advice for every eventuality, and consequently these guidelines are outlined in broad and general 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 transit is carried out in a safe and efficient manner with minimum loss of product quality.

To achieve this it is vital that all concerned appreciate the importance of maintaining the specified cargo temperature throughout the journey. It is also essential to understand that the primary purpose of transport equipment is to maintain temperature. Such equipment is not designed to cool warm cargo other than extremely slowly.

Members operating vessels on which reefer containers are carried on an occasional basis are therefore asked to heed the following recommendations and to note the subsequent advice concerning the operation, stowage and transportation of refrigeration units in general.

Guidelines

- a. Vessels should always carry basic reefer spares, suitable tools and repair manuals specifically relating to the type(s) of refrigeration units carried, for use by the reefer technician in case it is necessary to effect emergency repairs during the voyage. There are many different types of reefer unit in general use, each having individual repair and maintenance characteristics. The provision of a working platform is essential if containers are to be stowed more than one tier high.
- b. If insulated containers powered by clip-on refrigeration units or reefer containers powered by clip-on generator sets are to be carried, similar precautions regarding spares and repair manuals should be taken.
- c. The ship's crew should make certain that the spares provided are of the correct type and quantity before loading commences.
- d. Prior to shipment it is essential that written confirmation is obtained from the shippers addressing all cargo conditions of carriage including temperature, ventilation and humidity requirements. International Cold Chain Technology (ICCT) recommendations regarding the specification of carriage conditions are available from the Loss Prevention department on request.
- e. Members should give precise instructions to their vessels, listing details of all parties to be contacted in the event of a malfunctioning reefer container.
- f. Members are urged to provide their vessels with a reefer operations manual specifying the carriage particulars of various commodities shipped in refrigerated containers, possible problems and a summary of trouble shooting procedures. If there is any doubt, the advice of cargo care experts should be obtained.
- g. Before loading commences, crews should reconfirm that the vessel's reefer plugs are compatible with all reefer containers planned for shipment.
- h. A number of reefer extension leads should be carried as a precaution against the failure of individual plugs.
- i. Members should ensure that where chart recorders are fitted, the recording charts are removed before the container is released to the consignee and are retained for a period of at least twelve months. If electronic logging is incorporated, procedures for downloading records should be established and observed.

- j. If stuffing is to be carried out at the loadport terminal itself, a surveyor should be appointed to monitor the arrival temperature of the cargo and to note details of any departure from specification.
- k. Many reefer container losses have arisen from confusion between Fahrenheit and Celsius temperature scales, and also between plus and minus temperatures. Great care should be exercised to ensure that carriage temperatures are correctly set as soon as containers are placed on board. Any discrepancy between container settings as received and bill of lading instructions should be reported immediately.
- l. At sea, reefer units should be inspected at intervals of not more than six hours, recording the times of such inspections and noting details of any problems 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.
- m. Basic instruction in customary reefer container practices such as on-board monitoring and recording procedures, the checking of seals and the shifting of containers at intermediate ports would clearly benefit inexperienced crews. Members are asked to consider implementing such training schemes where applicable.
- n. If circumstances permit, Members are requested to keep their crews informed of the values of the commodities shipped so that the significance of a potential loss can be fully appreciated.

Reefer Containers

A reefer container is designed to maintain cargo at the pulp temperature prevailing at the time of stuffing. Although the container machinery over a period of time can bring cargo delivered at too high a temperature down to (or closer to) the designated temperature, this is not the primary function of a reefer container.

If a container is loaded with a cargo where the pulp temperature exceeds the carriage temperature stipulated by the shippers, the "warm" cargo will cause the temperature of the delivery air to rise very rapidly when passing up and through the cargo. Eventually, the return air may reach a temperature level whereby the refrigeration machinery cannot cool it down sufficiently prior to re-circulating it as delivery air. In this event, the tracking pattern on the chart or logger will show a 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 arrested as the refrigeration unit begins to run in standard operational mode.

In cases where the stuffing temperature is higher than the stipulated carriage temperature, the refrigeration unit will cool down the surface layer of the cargo relatively quickly (within days). However, the centre of the stow will not reach the desired temperature for a considerable period of time. The temperature of a cargo stuffed into a refrigerated container should not, in general, deviate by more than 3°C (5°F) from the specified carriage temperature. Chilled cargo (excluding bananas) should not deviate by more than 0.4°C (1°F). This does not mean that even these deviations should be encouraged; the objective is to receive and deliver the cargo at the carriage temperature.

Defrosting

During the operation of a refrigeration unit, a layer of ice will form on the evaporator coils depending on the temperature set, the temperature of the cargo, the amount of fresh air ventilation and the cargo humidity. The unit periodically enters a phase where heat is produced by a series of electrical bars, allowing defrosting to take place. At such times, all fans are turned off automatically in order to prevent heat from entering the cargo compartment.

However, the return air temperature sensor is so closely located to the refrigeration machinery that the temperature record will inevitably register some of this rise. The record will therefore display periodic temperature increases in keeping with the defrost periods. It must be stressed that these increases, which are conspicuous on paper chart recorders, have no immediate effect on the actual temperature of the cargo and are not an indication of an unstable refrigeration unit. Electronic loggers usually indicate the timing and duration of defrost periods in addition to temperatures.

If, as described in the previous section, a cargo is loaded into a container in a "warm" condition exceeding the specified temperature, the refrigeration unit will automatically work to bring the cargo temperature down towards the correct level. This unintentional strain on the unit may result in a heavier accretion of ice on the evaporator coils, leading to an increase in the defrost patterns recorded.

Recorder charts do not identify refrigeration unit defects, but do give useful indications of correct operation. Data logger records may give detailed information about system faults in addition to set point, delivery and return air temperatures. Container temperature recording systems do not usually record actual cargo temperature, only air temperatures, but cargo temperature may be recorded by shippers' loggers within the stow.

Malfunction of a reefer unit

Should a refrigeration unit cease to operate, the chart or logger will register a gradual but steady rise in temperature to the point where eventually the ambient temperature is recorded. Again, the sensor will record an air temperature and the record will not accurately reflect the true position regarding the cargo itself. 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 record may not be a precise representation of the temperature or condition of the cargo within. These examples are given merely to warn that conclusions should not be drawn automatically from the temperature tracking pattern alone.

Equipment

The standard terms of measurement for refrigerated containers are the "20 foot equivalent unit" (TEU) and the "40 foot equivalent unit" (FEU). These terms do not distinguish between containers of differing heights. Two principal types of reefer container are in use today:

- i. Insulated containers requiring an external refrigeration source. These units are often referred to as being of "port hole" or "Con-air" design. It is expected that they will be gradually phased out.
- ii. The second, and by far the largest group, consists of insulated containers each fitted with an integral reefer machinery unit, often known as "integrals" or "reefers".

Prior to delivery to a shipper, an integral unit container must be subjected to a Pre-Trip Inspection (PTI) arranged by the carrier or his local agent, which involves the refrigeration machinery being run and tested by a specialist engineer, usually within the port area. During a PTI the machinery is checked, faulty parts are repaired or replaced, and thermostatic temperature recorders (if fitted) are wound up and calibrated (normally at 0°C). In such cases a copy of the test programme results is left inside the temperature chart recording box for the benefit of the vessel's crew, declaring the outcome of the tests and any repairs carried out.

Modern electronic controllers usually incorporate a self-checking PTI procedure which may be carried out quite simply. Attention by a fully trained refrigeration engineer may be required only if the automatic system indicates a fault. These systems retain a record of the previous PTI.

The PTI should be repeated if stuffing is to take place after more than a 31 day delay.

In some cases, generating 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 moment the container is loaded aboard the ship. Generators consist of three types:

- i. Permanent fixed units
- ii. Top clip-on units
- iii. Under-slung clip-on units

Generator units must undergo similar tests before the accompanying containers are released from the depot, and serial numbers must be recorded. The inspection also verifies that a generator unit has adequate fuel supplies for the return journey. It is important that the container temperature settings are checked prior to a container being shipped out, and that the correct temperature scale (°C/°F) is selected, particularly in the case of digital displays.

The external temperature recording equipment of a refrigerated container may consist of a Partlow chart fitted to a circular recording disc. Discs must be checked to ensure they are fully wound. A check should also be made to ascertain that the Partlow chart and the thermostat setting correspond to the same temperature scale as specified by shippers. All relevant shipping details must be entered on the Partlow chart by the carrier's representative or agent, and commencement of tracking must correspond with the date and time of the hook-up to the external power source.

If electronic logging is used rather than a chart recorder, an appropriate "start of journey" code may need to be keyed in.

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

to ensure they are suitably calibrated and are correctly monitoring the appropriate importation carriage temperature.

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

In tropical or sub-tropical regions, it is preferable that containers are loaded in a temperature controlled environment (eg chilled warehouse). However, if loading in ambient conditions, containers should not be pre-cooled before stuffing 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, the only exception being loading or devanning using a cold store tunnel.

Container shipment/On-carriage

When a reefer container is awaiting shipment or on-carriage from the place of receipt or terminal, it must always be hooked up to a static power jack point or independent generating unit so that the reefer machinery can continue to operate.

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

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

Temperature recording

A Partlow recorder registers temperature on a pressure sensitive circular chart over a 31 day period. If the voyage transit is expected to exceed 31 days, care must be taken to ensure charts are replaced by a ship's engineer before expiry. It is imperative the device is rewound with the fixed key attachment whenever a new chart is affixed. Replacement charts must always be used when a transfer from vessel to vessel takes place. The first chart should be placed underneath the new chart in order to build up a complete temperature record for the entire voyage up until arrival at the final destination.

These charts should always carry the following endorsements:

Name of Vessel
Voyage Number
Container Number
Temperature Setting
Load Port
Discharge Port
Date of Stuffing/Change
Ventilators: Closed/Open (degrees)
Humidity Controls (HMC) (percentage)

Data logger recorders may monitor both air and cargo pulp temperatures within a reefer unit, and the data is stored in an electronic memory. The memory also logs PTI results, alarms and transit details (eg shifting of the container in port), together with serial data communication to both the controller and the power unit. The data can be transmitted directly to an IBM compatible PC, from where information can be either printed out or transferred to disk. The information is generally more comprehensive and accurate than indicated by a Partlow chart alone.

Where electronic recording systems are incorporated, the "start of trip" information should include details of origin and destination. Date and time should also be checked for accuracy. The use of any portable recorders within the cargo space should be noted on all cargo documents. These portable recorders may be disposable or

returnable units using bimetallic strip sensors, or may be electronic memory recorders. The latter type may have cargo probes attached by leads, or may incorporate an internal sensor.

When installed at a Container Freight Station (CFS) to accompany prepared shipments, it is vital the portable recorder charts are filled in correctly by the carrier's representative or agent. The location of a recorder should be noted on all documents together with the time and date of its activation.

Seals and security

In 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 container yard for shipping out. On receipt, a seal should be affixed without delay and the details again noted on all documents.

It is particularly important where veterinary seals are attached to containers that all details are noted and the seals checked for signs of interference on arrival at the container yard. Imports to the EU, USA and Japan will only be permitted if veterinary seals are intact on arrival, thus confirming the cargo has not been tampered with in any way during the transit. At intermediate ports, the vessel or her agents must reconfirm the security of all such seals and this fact must 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, which may be prior to receipt by the carrier. In such cases, the carrier needs to have evidence of previous temperature maintenance.

Commodities

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

- i. Chilled
- ii. Frozen

Many chilled cargoes (e.g. fruit) are regarded as a "live" cargo since they continue to respire post harvest and as such are susceptible to desiccation (wilting and shrivelling). This is not the case with commodities such as chilled meat or cheese. The minimum fruit carriage temperature is usually no lower than -1.1°C (30°F). Frozen cargo is regarded as "inert" and is normally carried at or below -18°C (0°F).

However, both categories are highly perishable and require care in handling to ensure arrival in optimum condition. In chilled commodity transportation, the ventilators are normally left in an open position, with a limited number of exceptions (eg meat, chocolate, film, chemicals, dairy products, and controlled atmosphere shipments). Some cargoes may require controlled humidity (eg flower bulbs). It should be remembered in such cases that many refrigeration units are only capable of reducing humidity within the cargo space and the settings should be applied accordingly. Those units which can increase humidity may incorporate water tanks with special cleaning and hygiene requirements to avoid contaminating the cargo. Controlled atmosphere carriage 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.

Stowage

Correct stowage is extremely important to the carriage of containerised 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 cargo, the objective is to provide a circulation of cold air around the cargo to reduce the possibility of temperature variations at the boundaries (eg walls, floor and roof). With chilled live cargoes (eg fruit and vegetables), the air flow must 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.

Cargo must never be loaded above the red line marked inside the container. This space must always be left to allow an uninterrupted flow to the front air intake. The ideal stowage pattern should permit free movement of

delivery air whilst restraining any movement of the cargo. Adequate space must be left above and below the stow to allow free air circulation (see Figures "A" & "B").

Fig A

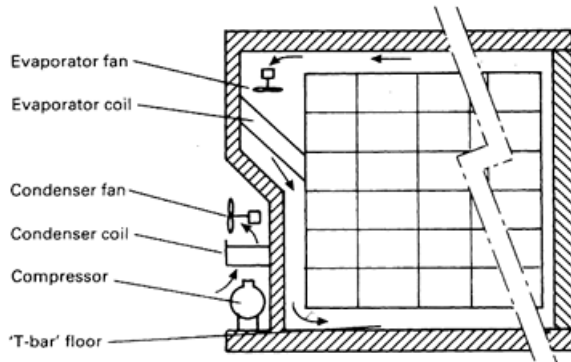
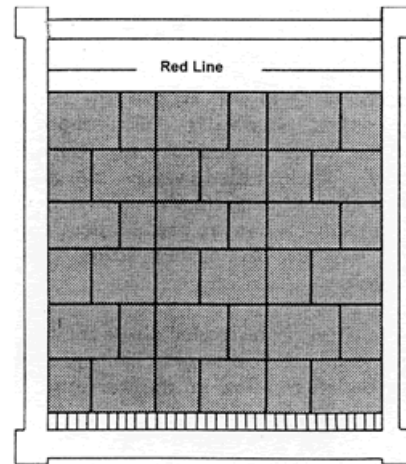


Fig B



Frozen products require a very simple stowage arrangement provided they are loaded at the specified carriage temperature. This can be achieved by a solid block stow, with no space between the stow and the container walls. When carrying frozen cargo, the fresh air ventilation hatches must always be closed.

It is important to ensure that the cargo stow covers the entire floor area, projecting beyond the rear floor restrictions of the "T" bars in order to prevent the air short circuiting, and to facilitate an effective flow of return air. In larger containers, if the cargo volume is less than the space in the container, the stow should be of uniform height. As stowage plays an important part in maintaining the quality and security of the cargo during transit, it is essential that specialist advice is sought should there be any doubts when a cargo is booked.

Inspection of cargo

Many bills of lading will allow a carrier to open a sealed container in order to mitigate a potential loss. The method of inspection will depend on the type of cargo and, in most cases, will require the assistance of a specialist.

The pulp temperatures of chilled fruit and vegetable cargoes and core temperatures of frozen cargo must always be measured, where possible, before a reefer unit is stuffed. Fruit and vegetables should also be checked for pre-cooling damage, 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, odours, black spot, colour and flavour changes, and should also be examined for signs of any upward temperature deviation and subsequent re-freezing. Cartons, trays and other packaging should be scrutinised in respect of their suitability to protect the cargo during a long sea transit.

In the event of a reefer machinery unit appearing to function erratically, the vessel should advise its owners and the agents at the next port prior to arrival so that arrangements can be made to rectify the problem ashore if nothing can be done during the sea transit. In such circumstances, a surveyor should be appointed to attend the vessel on arrival in order to inspect and report on the condition of the cargo and the container.

If a container sustains physical damage, the agent and/or the surveyor must ensure that action is taken to rectify the problem without delay so that a potential cargo loss can be minimised.