draft

Code of Practice for handling fresh fruit and vegetables in refrigerated shipping containers for Australian exports

Shipping Australia Ltd
Food Science Australia
Australian Quarantine and Inspection Service
Department of Agriculture and Fisheries and Forestry

2007 Edition

Code of Practice for handling fresh fruit and vegetables in refrigerated shipping containers

The original Code of Practice was prepared by Mr A R Irving, Principal Experimental Scientist of the CSIRO Division of Food Science & Technology, with the assistance of members of a Department of Primary Industries and Energy Working Party on 'The Shipping Conditions for Horticultural Commodities.'

Because of the advances in technology and horticultural practices since the previous editions was written a further rewrite was deemed necessary and was undertaken by the Container (Technical) Committee, of the Shipping Australia Limited (SAL).

SAL acknowledges the assistance of Dr Alister Sharp, Dr Nevin Amos and Dr David Tanner from Food Science Australia (FSA) (a joint of CSIRO and the Victorian Government) for their part in editing this and previous editions of this Code of Practice.

SAL also acknowledges and thanks the South Australian Freight Council Inc (SAFC) and its Cold Chain and Quality Working Group as well as the South Australian Research and Development Institute (SARDI) for the industry based input they have provided to this publication.

13 March 2007

Published by the Shipping Australia Limited
Level 6 131 York Street SYDNEY NSW 2000
ABN. 61 096 012 574

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Abbreviations and useful acronyms

%	Percentage
AAPC	Australian Apple and Pear Council
AAPGA	Australian Apple and Pear Growers Association
AAPMA	Australian Association of Ports and Marine Authorities
ABARE	Australian Bureau of Agricultural and Research Economics
ACG	Australian Citrus Growers Inc.
ACGF	Australian Citrus Growers Federation
ACIAR	Australian Centre for International Agricultural Research
ACS	Australian Customs Service
AFAM	Automated Fresh Air Management
AFFA	Department of Agriculture, Fisheries and Forestry Australia
AFSC	Australian Food Standards Committee
AFSEC	Australian Food Standards Executive Committee
AHEA	Australian Horticultural Exporters Association
AHEC	Australian Horticultural Export Council
AHECC	Australian Harmonised Export Commodity Classification
AHGC	Australian Horticultural Growers Council
AHPC	Australian Horticultural Policy Council
AHQCS	Australian Horticultural Quality Certification Scheme
AICCC	AQIS/Industry Cargo Consultative Committee
AIDC	Australian Industry Development Corporation
AIFST	Australian Institute of Food Science and Technology
ANGA	Australian Nashi Growers' Association
APHC	Australian Plant Health Council
APHIS	Animal and Plant Health Inspection Service (USA)
APIC	Australian Potato Industry Council
APNI	Australian Plant Name Index
AQIS	Australian Quarantine and Inspection Service
ARS	Agricultural Research Service (USDA)
AS	Australian Standard
CA	Controlled Atmosphere
CAN	Customs Authority Number
CFIA	Canadian Food Inspection Agency
CFM	Cubic Feet per Minute
CFR	Code of Federal Register (USA)
CMDG	Citrus Market Development Group
CMF	Citrus Marketing Forum

CO	Carbon Monoxide
CO_2	Carbon dioxide
CODEX	Codex Alimentarius
COMPILE	Customs On Line Method of Preparing from Invoices Lodgeable Entries
COU	Clip on Unit
CQO(A)	Chief Quarantine Officer (Animals)
CQO(P)	Chief Quarantine Officer (Plants)
CRN	Customs Reference Number
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DETYA	Department of Education Training & Youth Affairs
DEWRSB	Department of Employment, Workplace Relations and Small Business
DFAT	Department of Foreign Affairs and Trade
DIMA	Department of Immigration and Multicultural Affairs
DISR	Department of Industry, Science and Resources
DISR	Department of Industrial and Scientific Research (New Zealand)
DOTRS	Department of Transport and Regional Services
DPI	Department of Primary Industries & Energy
EC(O)R	Export Control (Orders) Regulations
ECA	Export Control Act 1982
ECD	Export Condition Database
ECN	Export Clearance Number
ECO	Export Control (Processed Food) Orders
ECS	Automatic Export Certification
EDI	Electronic Data Interchange
EICON	Export/Import Conditions System (Now ICON)
EIS	Export Inspection Service (now AQIS)
EP	Export Permit
EPA	Environmental Protection Agency
EQIP	Essential Quarantine Introductory Program
ERA	Export Receival Advice (now superseded by the electronic Pre-Receival Advice (PRA)
EXDOC	AQIS Electronic Export Documentation System
EXIT	Export Integrated System
FAE	Fresh Air Exchange
FAK	Freight All Kinds
FC	Fumigation Certificate
FCL	Full Container Load
FOI	Freedom of Information
FSA	Food Science Australia
FSIS	Food Safety and Inspection Service (USDA)

GPPPO	Grains, Plant and Plant Products Orders
HAL	Horticulture Australia Limited
HC	High Cube
HICC	Horticultural Industry Consultative Committee
HMAC	Horticultural Market Access Committee
HPC	Horticultural Policy Council
HRDC	Horticultural Research and Development Corporation
ICON	Import Conditions Database
ICPM	Interim Commission on Phytosanitary Matters
IMAP	International Market Access Program
IMO	International Maritime Organisation
IMO Class	International Maritime Organisation Classification for dangerous goods
IP	Import Permit
IPHRWG	Interstate Plant Health Regulatory Working Group
IPPC	International Plant Protection Convention
ISO	International Organisation for Standardisation
ISPM	International Standards for Phytosanitary Measures
LCL	Less than Container Load
MA	Modified Atmosphere
MAF	Ministry of Agriculture and Fisheries (NZ)
MAFF	Ministry of Agriculture, Forestry & Fisheries (Japan)
MAFF	Ministry of Agriculture, Fisheries and Food (UK)
NACMA	National Agricultural Commodities Marketing Association
NATA	National Association of Testing Authorities
NFF	National Farmers' Federation
O_2	Oxygen
OCPPO	Office of the Chief Plant Protection Officer
OECD	Organisation for Economic Co-operation and Development
P.O.D	Port of Discharge
P.O.L.	Port of Loading
PACC	Pesticides and Agricultural Chemicals Committee
PC	Phytosanitary Certificate
PFF	Papaya Fruit Fly
PGGO's	Prescribed Goods (General) Orders
PMS	Plant/Product Monitoring Scheme
PPQ	Plant Protection and Quarantine (US PPQ Treatment Manual)
PRA	Pre-Receival Advice (electronic)
PTI	Pre Trip Inspection
QA	Quality Assurance

QC	Quality Control
QEAC	Quarantine and Exports Advisory Council
QFVGA	Queensland Fruit and Vegetable Growers' Association
RFP	Request for Permit (to export)
RWTA	Refrigerated Warehouse and Transport Association of Australia
SA	Standards Australia
SAFC	South Australian Freight Council
SAL	Shipping Australia Limited
SARDI	South Australian Research & Development Institute
SCA	Sea Cargo Automation
STA	Supermarket to Asia
Temp.	Temperature
TQC	Total Quality Control
TQM	Total Quality Management
UN No	United Nations Number
USDA	United States Department of Agriculture
VBS	Vehicle Booking System
VFD	Variable Frequency Drive
W/C	Watt per degree Celsius

Glossary of terms

Absolute Humidity	Actual weight of water vapour in a parcel of air and is expressed in grams per cubic metre. The greater the air temperature the more water vapour that it can absorb before becoming saturated
Anti - Chamber	This is a chamber or facility, which ensures that cool-room conditions exist in the transfer area when cargo is loaded from storage into the container.
Air-bagging	Bags filled with air are used in containers that are not full of cargo to fill large gaps to prevent cargo movement without restricting airflow.
Broken Stowage	Unfilled spaces throughout the container.
Controlled Atmosphere	The gas mixture surrounding the cargo is controlled so that its composition is as desired
Dew Point Temperature	Temperature at which the air has to be cooled for the water vapour to condense out into water droplets. It is also known as the saturation temperature, and is dependent on the absolute humidity
Chock	Block or wedge used to prevent movement of cargo within the container
Dunnage	Timber utilised to provide space within the stow of cargo to permit ventilation.
Hydro-cooling	A process in which the produce is rapidly cooled after harvesting by spraying, drenching or immersion with cold water
Kazoo	The nozzle on the container drain plug.
Modified Atmosphere	Gases are removed or added to create an atmospheric composition, which is different from that of air around the commodity.
Partlow Chart	This is a clock-based analogue temperature recording circular chart. It traces and records the delivery or return air temperature within the container
Relative Humidity	Ratio between the amount of water vapour in the air and the amount it can contain at that temperature. It is usually expressed as a percentage
Senescence	Ageing of the commodity
Set Point	Temperature setting on the controller of the refrigeration unit
Shrink Wrapping	Application of a protective synthetic plastic wrapping material to unitise slip sheeted and/or palletised loads, improving handling and protecting the goods from shifting during transit
Slip Sheets	A thin corrugated fibreboard or plastic sheets used in place of a pallet to maximise space utilisation. Slip sheeting requires special forklift attachments.
Stowage Factor	Volume occupied by unit weight of cargo. Usually expressed as cubic metres per tonne. It does not take into account any space, which may be lost due to broken stowage
Sweat or Condensation	Is formed when the water vapour in the air condenses out into water droplets when the air is cooled below the dewpoint. The water droplets may be deposited onto the container structure or onto the cargo and packages.
Vacuum-cooling	This is a post harvest/pre-shipment process, which relies on the cooling effect of water evaporation on or within the product to reduce temperature. It requires a vacuum chamber to lower the boiling point of the moisture in the product
Ventilate	To allow fresh air to circulate throughout the cargo in the container

1 Introduction

Growers, packers, exporters and shipping companies have a common interest in providing the best possible quality produce to export markets. Quality cannot be improved during handling and transport, but the rate at which it is lost can be reduced by following the recommendations in this Code of Practice.

Each particular overseas market and/or customer has product specifications, for example, the size, colour and maturity of produce. Thus produce should be grown with the intention of supplying a particular customer, and the harvesting, grading and packing should be carried out in accordance with those specifications.

Shippers and consignees should be aware of the maturity indices for chilled horticultural produce. Whilst there are procedures for retarding the ripening process, it is not possible to reverse it.

Exporters need to be committed to supplying high quality produce on a regular basis.

There are various models, makes and ages of refrigerated containers in use. When exporting temperature and time sensitive commodities, exporters should liaise accordingly with the shipping company to ensure a container fit for purpose is supplied that is capable of operating to desired and mutually agreed requirements.

Maintaining proper conditions during shipment from the packing shed to the overseas market is an important factor in minimising quality loss.

Trial shipments of a new fruit or vegetable will require substantial co-operation between all parties to ensure satisfactory outturn of cargo at destination.

Shippers, exporters, carriers and agents should be aware that where an in transit cold sterilization or quarantine process is required the temperatures and other related procedures in this manual should be disregarded. The carriage of ITCS cargoes is a complex process which must be performed in accordance with the protocols agreed between the Governments and Quarantine bodies of the exporting and importing countries. There is no attempt in this manual to explain these protocols because they vary from country to country, from cargo to cargo and transit time to transit time. The policies and protocols as agreed and nominated by the carrier/and or its agents in conjunction with the respective government bodies must apply throughout the total post harvest to final consignee supply chain.

Problems could occur in the carriage of containerised reefer cargo due to the lack of adequate and accurate carriage instructions issued by shippers. It is extremely important that rational procedural precautions are routinely adopted and instructions are always given in writing to all parties in the transport chain. Shippers must ensure that all documentation shows the Set Point temperature. It is recommended that the information contained in the electronic Pre-Receival Advice should be made available to all parties in the transport chain.

The Shipper is in the best position to know the optimum temperature and container vent settings (or Fresh Air Exchange rates) for the carriage of his product and his reefer instructions should be followed unless they are obviously wrong or raise a natural uncertainty. Carriage instructions given to a shipping company must be complete, adequate and accurate to avoid the risk of damage to the cargo. It must be noted that the same produce from different origins may require different carriage requirements.

Temperature is considered to be measured and stated in Degrees Celsius [°C], while Fresh Air Exchange rates should be stated in cubic metres per hour (CMH) for the purpose of this Code. Any variance from this practice must be highlighted to all parties in the chain to ensure that there is no misunderstanding.

Each link/carrier in the transport chain must pass on the carriage requirements to subsequent links/ carriers.

It must be stressed that the only temperature, which can be controlled is the *'Set Point'*. The Set Point corresponds to air delivery temperature for chilled cargo. The term *'carriage temperature'* therefore, cannot be used in carriage instructions.

The successful delivery of horticultural produce from origin to destination in refrigerated containers is also dependent on the maintenance of suitable storage and packing conditions during transport.

The quality of the produce can be maintained only if each link in the chain continuously maintains the integrity of the chain.

1.1 Marine insurance

Shippers and Consignees should be aware that the Contract of Carriage in the Bill of Lading, whilst placing certain responsibilities on the Carrier also places liability on Shippers/Consignees for certain events.

It is strongly recommended that shippers/consignees acquaint themselves with these liabilities and make provision for them in their insurance arrangements.

In particular shippers/consignees should look at their liability under the following:

- General Average
- Damage/loss to container whilst in their care
- Damage or injury caused due to improper packing
- Failure to disclose hazardous or dangerous cargo.

It is suggested that shippers/consignees seek further clarification from their insurance brokers or the marine underwriting members of the Insurance Council of Australia Limited.

2 Produce quality factors

2.1 Respiration of fruit and vegetables

2.1.1 Fresh fruit and vegetables are alive. They respire (breathe) by taking up oxygen (O_2) and giving off carbon dioxide (CO_2) and heat. The carbon dioxide released during respiration may induce storage disorders in some produce if the concentration is allowed to build up in the surrounding air. The maximum concentration of CO_2 for some fruits is given in Appendix 1, Table 1 under ventilation. Fresh fruit and vegetables also transpire i.e. they lose water. After harvest, losses caused by respiration and transpiration cannot be replenished. Thus fruit and vegetables are perishable and the higher the rate of respiration or transpiration the higher the rate of senescence.

The rate of deterioration depends on the environmental conditions following harvest. Respiration and transpiration rates fall as the temperature is lowered. For most produce, the respiration rate also falls if the O_2 level in the surrounding air is lowered and the CO_2 level is raised. Using changed atmosphere conditions is called Controlled Atmosphere (CA) or Modified Atmosphere (MA) storage. The respiration rate of fruit and vegetables can be reduced (to extend the shelf life) by altering the composition of the air in the surrounding atmosphere. This can be achieved by reducing the oxygen content, increasing the nitrogen content or a combination of both.

Modified atmosphere packaging (semi-permeable packaging), allows the fruit to breathe, but as the carbon dioxide level increases, respiration is slowed; the production of ethylene falls and the ripening process is slowed down. The difficulty with modifying or controlling the atmosphere is that prolonged exposure to high levels of carbon dioxide may affect the colour and/or flavour of the fruit. It is important that the set limits for oxygen and carbon dioxide are not exceeded. A very low level of oxygen or a high level of carbon dioxide would cause suffocation of the fruit (refer to Table 1&2 in Appendix 1).

Alteration of temperature and atmosphere provide the main ways of reducing deterioration rates and prolonging storage life of produce. CA systems are designed to maintain an atmosphere different from normal, usually with low oxygen and increased carbon dioxide contents. This enhances the storage life of some produce, when used in conjunction with refrigeration.

CAUTION: CA could be fatal to humans due to the low oxygen content. CA compartments must be appropriately marked and must be adequately ventilated prior to entry.

2.1.2 Fruit and vegetables vary in their rate of respiration and transpiration and in their response to low temperatures and changed gas compositions; this variation depends on a number of factors including growing conditions, variety and maturity. There is no single, ideal condition that is suitable for storage of all varieties of produce.

2.1.3 The heat released by respiring produce depends upon the type of produce, its maturity, and its temperature. Respiration heat varies over a large range and must be removed throughout storage and transport.

2.2 Ethylene

2.2.1 All fruits release small amounts of ethylene during growth and some release much larger amounts during ripening. Excess ethylene emissions can accelerate the ripening process of produce. CA storage reduces the rate of ethylene production and sensitivity to ethylene of some produce. Ripening can be induced in some fruit (eg. bananas) by introducing ethylene into the surrounding air. Ethylene can increase the rate of deterioration of some produce and may cause off-flavours. Thus produce that is sensitive to ethylene, (eg. bananas, avocados and kiwi fruit) must not be stored or transported with produce that release ethylene (refer to Section: 9 Stowage). Leafy vegetables are particularly sensitive to ethylene, with the leaves turning yellow in colour, russet spotting and abscission occurring with prolonged exposure. Cucumbers also turn yellow in colour and become soft. Ethylene in the atmosphere can also be removed by absorption with activated carbon, potassium permanganate, or catalytic oxidisation. Ethylene must be removed from storage and transport enclosures by venting or

scrubbing. Exhaust gases from internal combustion engines may contain levels of ethylene that can cause damage to produce. Therefore the vents (air freshening devices) fitted to integral containers should be left closed during inland transport periods.

A matter of considerable importance, which affects the ripening process of fruit, is the time delay between harvesting and transfer to an environment where this process can be controlled. The atmospheres in which fruits are kept or carried have a significant effect on the ripening process. The atmosphere must be regulated to control this process, as per the client's requirements allowing the fruit to arrive un-ripened at its destination. The presence of O_2 allows the production of ethylene, which in turn activates the ripening process. Ventilation to remove the ethylene from the atmosphere or controlling the atmosphere by replacing O_2 with CO_2 is the methods used to control this process.

2.3 Temperature

The amount of deterioration of quality of produce is a function of both time and temperature. A small drop in temperature at high temperatures gives only a small reduction in the rate of deterioration, but a small drop in temperature (even a drop of 1°C) at low temperatures can give a large reduction in the rate of deterioration. For example, 5 days storage of cabbage at 5°C gives the same amount of deterioration due to respiration as 9 days storage at 0°C.

2.4 Chilling injury

Chilling Injury: A physiological disorder caused by low temperature stress, causing sensitive produce to discolour or reduce their physical appearance.

2.4.1 Produce exposed to temperatures below a critical level (dependent on the commodity, but above the freezing temperature) could suffer from 'Chilling Injury'. The degree of damage is dependent on the sensitivity of the produce, the duration of exposure and temperature. Some produce suffers 'chilling injury' if stored at temperatures below about 12°C. The tolerance of such sensitive produce to low temperatures varies widely between different species and varieties, eg. bananas will develop chilling injury below 12°C. This can limit the extent to which reduction in temperature can be used to extend storage life.

For some of this produce, the reduced deterioration as a result of low temperature storage must be balanced against the risk of damage due to chilling injury. For example, with oranges, an increased deterioration rate at higher temperatures may be due to fungal or bacterial decay as well as that caused by a higher respiration rate, and it may be preferable to risk chilling injury and transport at a lower temperature.

The transport of some chilling sensitive produce below their (minimum long term) chilling temperature is possible provided the combination of transport temperature and supply chain duration means that all the produce will be sold and consumed before the chilling injury is noticeable. This strategy involves some risks and requires a very good understanding of the produce being shipped, the duration of the supply chain and the rate of development of chilling injury symptoms that will impact on marketability of the product.

3 Container description

3.1 Power supply & plug

All refrigerated containers utilised in the Australian trade operate on 440 volt/ 60hz and onboard vessels they operate on 415 volt/ 50hz within Australian ports.

The power cable is fitted with an ISO standard CEE-17 plug. Care must be taken to ensure that plug is not damaged (cable length – 18 metres).

If the safety plug is damaged or tampered with there is a possibility of electrocution or fire if used incorrectly; if a damaged plug is encountered, do not plug into power & advise the Shipping Company of the situation immediately.

3.1.1 A container used for the refrigerated shipping of produce is essentially an insulated box to which a supply of refrigerated air is attached. Most containers used from Australia have external dimensions of; 6.06 (L) x 2.438 (W) x 2.438 or 2.591 (H) m.
12.192 (L) x 2.438 (W) x 2.591 or 2.895 (H) m.

40' Refrigerated container

View from door end

3.1.2 An integral container has a refrigeration unit built into the end of the container. The unit has its own temperature control system and fans to circulate the refrigerated air.

The refrigeration unit is fitted with some form of visible temperature indicating devices and all containers have Temperature Recording device (s). Although there are still many containers in existence with "Partlow" or similar circular 31 day chart recording equipment these are now being phased out and replaced by electronic data recorders which generally need to be electronically downloaded to provide voyage carriage temperature and unit operational, alarm and performance history. Some containers are fitted with both a chart and electronic recorders but this is because some owners elect to have both, to allow for industry transition from chart recorders to more modern technology. Those packers, shippers' freight depots and carriers who have chart operations included in their procedures or practices should be aware of this technology change and progression.

3.1.3 In integral containers, depending on the design of the unit, the refrigerated air is supplied either at floor level or at ceiling level; the containers are said to have either bottom air delivery or top air delivery, respectively. The greater percentage of integral containers currently in service has bottom air delivery.

Examples of different machinery types with common function but differently arranged venting mechanisms, operating devices, reefer machinery and evaporator access arrangements




Typical internal view showing Airflow floor and front bulkhead with bottom air delivery and top air return panels. Also shows position of maximum cargo height line when container is used for refrigerated or temp controlled cargo (usually 100 mm from top in 6M container and 150/200mm for 12M container).

3.1.4 The unit attached to a container is designed only to maintain produce temperature and cannot reduce produce temperature quickly. Thus, ideally packers should ensure that produce is within 1°C of the desired carriage temperature before loading into the container and the unit should be placed and kept on power as soon as possible after stowing of the produce is complete (Refer to Table 1 & 2 in Appendix 1).

NOTE: The refrigeration units should never be run with the container doors open, except where the container is sealed into an anti-chamber loading dock. If left open, condensation and moisture will be drawn into the container and across the evaporator coils. This will cause the evaporator coil to ice up and possibly cause the reefer container to malfunction and damage to the cargo. Condensation may also form on the cargo and packaging, resulting in 'cargo sweat', which could weaken any fibreboard packaging.

3.1.5 Except in cold climates, the temperature of the circulating refrigerated air rises as the heat leaking into the container or generated by the produce is absorbed by the air. Thus, the temperature of the return air is warmer than the delivery air; the difference is normally 1 to 2°C for chilled cargo (lower for hard frozen cargo), but can be as high as 3°C and higher during initial temperature pull down of loads. (This excludes the temperature rise of the air due to heat from the circulating fans, as this temperature rise is external to the cargo space).

3.1.6 Containers (6 m long) have nominal heat leakage rates of 20 to 30 W/C (Watts per degree Celsius temperature difference across the container walls). At ambient temperatures above about 20°C the major heat load on the refrigeration unit is heat leakage through the container walls and consequently the major portion of the circulating air should flow over the internal surfaces of the container rather than through the stow.

3.1.7 Produce is not at a uniform temperature throughout a refrigerated container. The coldest produce is near the point where the refrigerated air enters the container. The position of the warmest produce depends on the type of container, but is commonly near the doors (at the top of the reefer around 700 mm from the door). The spread in temperature depends on the ambient temperature, the total air circulation rate and its distribution, the temperature uniformity of the air delivered to the container, and the respiration heat of the produce; the distribution is determined by the basic design of the circulating system and by the stowage of the produce.

3.1.8 The temperature controller on the integral or clip-on unit may be controlled from a sensor placed either in the air entering or the air leaving the container cargo space; the unit is said to operate under delivery air or return air control respectively.

3.1.9 With modern integral containers fitted with electronic/programmable controllers, it is normal for equipment to control delivery air for chilled cargoes, eg. horticultural produce, (and control return air for frozen commodities, eg. hard frozen meat).

3.1.10 Electronically controlled refrigeration units have 3, 6, 12 or 24 hourly defrost cycles (that can be set on the control setting), which last for approximately 30 to 40 minutes. An example of a regular 6-hour defrost recording on a Partlow chart can be observed in Figure 2. The periodic defrost cycles prevent ice build up on the surface of the evaporator coils, which can restrict the airflow through the coils and therefore reduce the refrigeration capacity of the container (see Figure 2).

NOTE: A normal defrost cycle does not heat the cargo, only the evaporator coil and the immediate air chamber is heated. During this time there is no airflow to interior of the container and therefore no measurable effect to the cargo.

Views of typical control, operating and monitoring panel and temperature displays

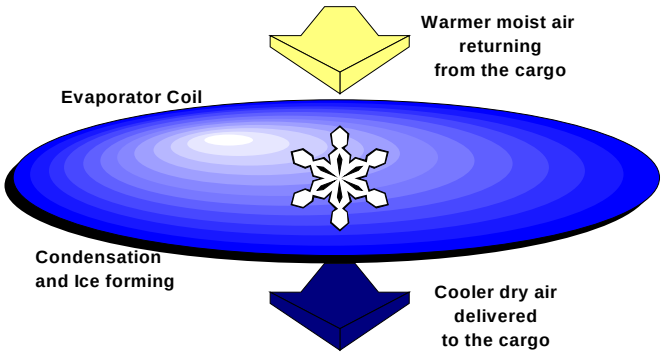


Figure 1: *Airflow through evaporator coil*

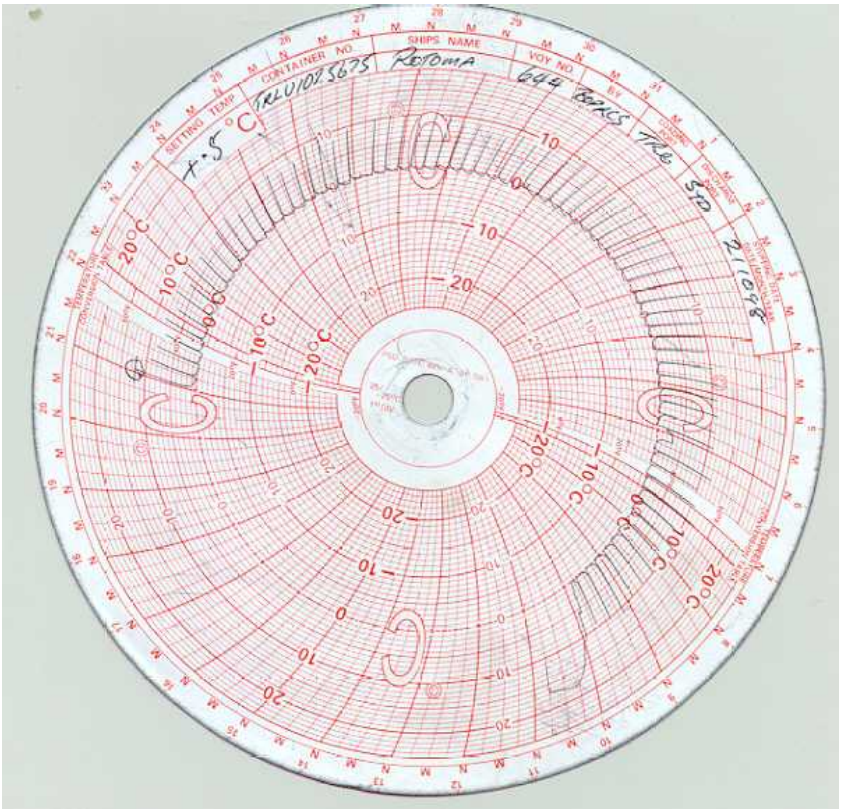


Figure 2: *Partlow chart recording return air of a chilled commodity with normal 6 hourly defrost cycle.*

Typical chart recording devices (now being replaced with electronic data recorders)

3.2 Pre Trip Inspection (PTI)

All refrigerated containers are inspected prior to being released to the shipper/packer or his trucker. The refrigeration units integral to containers or in clip-on units, as well as the associated temperature controllers, are checked for proper operation before being despatched for cargo packing - this is referred to as a 'pre-trip'. This procedure is an extensive technical check of the reefer machinery and the container. Technicians use pre-determined comprehensive checklists to ensure that the container is clean, undamaged and that the reefer machinery is in ideal running condition. Technicians conduct PTI in accordance with shipping company requirements and procedures. The Pre-Trip Inspection (PTI) of refrigeration equipment also includes a check of the temperature control/recording instrumentation using an electronic digital thermometer that has been calibrated at 0°C in an ice/water slurry. It is important to ensure the drains, collection pan and evaporator coil are cleaned and free of debris during the pre-trip inspection (PTI) of the reefer machinery. At least one defrost cycle should be completed in accordance with the machinery manufacturers instructions at the time of PTI. On completion of the pre-trip service a decal is attached to the machinery end of the container clearly indicating the date of checking. The validity of a pre-trip service is commonly regarded as current for one month from the date entered on the pre-trip decal (different shipping companies may have differing validity periods).

As the intended use of the container is not usually known when the PTI is carried out, the Set Point may be left on a temperature to suit the carriage of Hard Frozen or Chilled cargo (eg. -18° C or 0°C). The Set Point Temperature must be checked before the container unit is placed on power.

On mechanical temperature controllers (Partlow Controller or separate dial setter) the setting can be verified before placing the machinery on power. Electronic temperature controllers may require the machinery to be placed on power, unless the temperature controller is fitted with its own power source. The majority of containers have simple clear starting instructions.

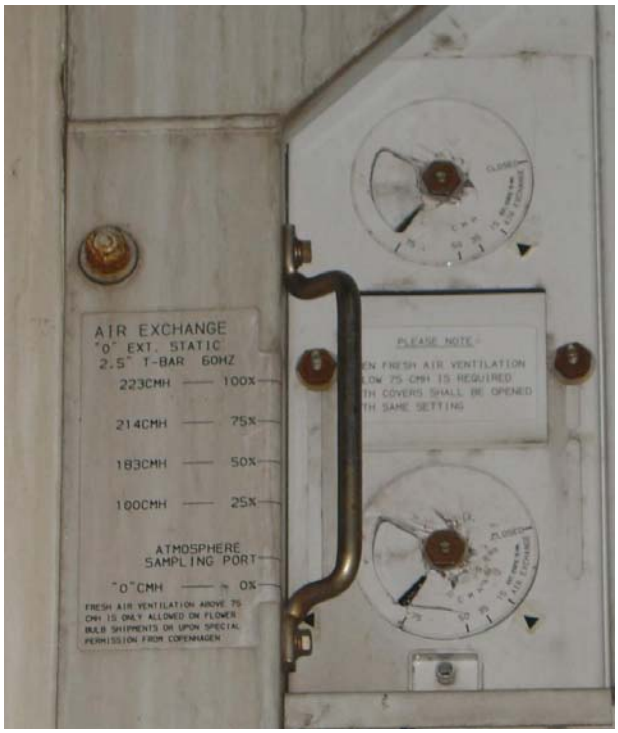
3.3 Set Point

The Set Point is the temperature setting on the controller of the refrigeration unit. For units with delivery air control, the supply temperature will be 0.5 to 1.5°C below the desired carriage temperature. For units with return air control, the set-point temperature will be approximately +2°C the desired carriage temperature, providing the cargo has been pre-cooled to the desired carrying temperature. For produce with a recommended storage temperature at or below 0°C, the set point may need to be set at a higher value than the storage temperature to avoid possible chilling injury or freezing of the produce; the need to do this depends on the type of container and control unit that is used**.** It is essential that container operators know what kind of equipment is under their control, as it is their responsibility to provide a container suitable for the produce to be packed.

(See also paragraph 8.1.3; shippers responsibility to give all relevant details of product to be carried in order that the shipping company can make available a container suited for the carriage of that product)

3.4 Fresh Air Exchange

Ethylene and CO_2 levels in containers are regulated by ventilating with vents (air freshening) – it is essential that the outside air is free of ethylene (**Note: Vents should be closed during road travel to prevent ethylene contamination from vehicle exhausts).** Ventilation is achieved by opening vents that are fitted across the fan; the fan pressure causes fresh air to flow in one vent and air containing the evolved gases to flow out the other vent. **All containers used for fresh produce must be fitted with a means of ventilation. Loading cargo above the maximum 'red line' height can affect fresh air exchange). Note that CA containers operate with these vents closed at all times. Some MA containers (such as AFAMI) operate with electronically controlled vents to regulate gas conditions around the cargo. Loading cargo above the maximum 'red line' height can affect fresh air exchange).** Ventilation should be undertaken to keep the CO_2 level below the maximum specified in Tables 1 & 2, in Appendix 1. **Excess ventilation is of no value** to the produce and can cause excessive amounts of water to condense on the evaporator coils. If this water turns into ice it may restrict the airflow, thereby increasing the temperature spread in the stow. (See Section 3.1.10).



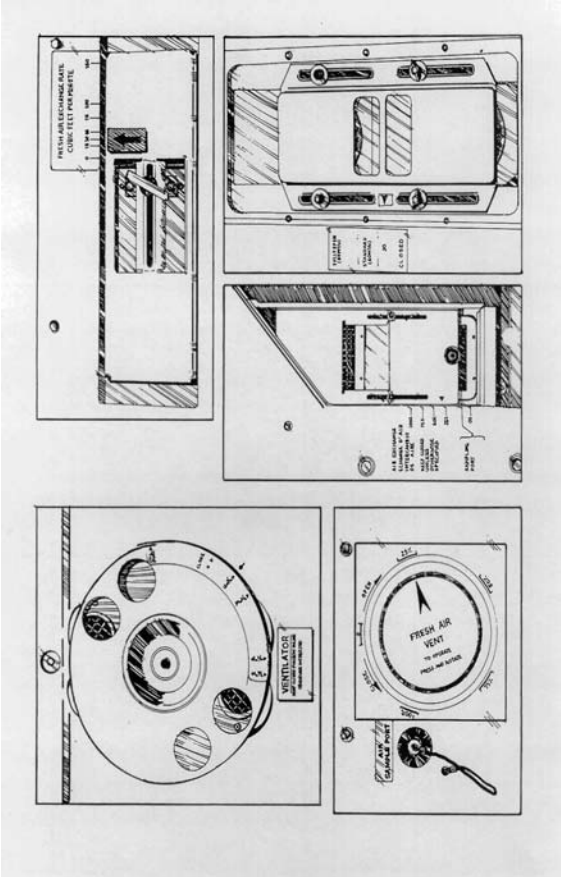


Figure 3: *diagrams of the various vent-setting controls.*

Care must be taken to ensure that the units for settings Fresh Air Exchange are not misread. Containers may be calibrated for Cubic Metres per Hour (CMH), Cubic Feet per Minute (CFM) or as a percentage (%) refer to Figure 3. All units are rated at 60hz for onboard vessels but while on shore the units run at 50hz, which may reduce the set amount of fresh air exchange by up to 23%.

3.5 Controlled Atmosphere (CA) and Modified Atmosphere (MA or AFAM+)

Controlled or modified atmospheres normally are not provided in general refrigerated containers. In suitable containers, it is possible to provide CA or MA conditions (at additional cost) on a one-trip basis. For almost all CA/MA systems now in use the containers must meet a stringent gas-tightness specification and are usually fitted with a plastic sheet inside the doors to avoid the possible problems of leaking door seals. There are some containers especially designed for CA transport. CA containers allow the controlling of the container environment more precisely. Harvested fruit and vegetables continue to breathe until they are consumed or destroyed by decay or desiccation. Under normal circumstances these factors determine the lifespan of the product. The ripening process may be decelerated and the lifespan of a commodity may be prolonged by keeping the produce at optimal temperature coupled with the most effective blend of oxygen, carbon dioxide and nitrogen. Unlike CA and MA units, Automated Fresh Air Management (AFAM)+ uses fresh air exchanges controlled by sensors, which regularly read the O_2 and CO_2 levels inside the container. If the atmosphere is not at the pre-set AFAM+ level, the vent is adjusted mechanically to achieve the required levels.

3.6 Relative humidity

The quality of horticultural produce is directly affected by the relative humidity of the surrounding air. If the humidity is too low, the produce may wilt and shrivel, whilst if it is too high the produce may develop mould. There have been technical advances made in recent years to build refrigerated containers with advanced humidity control systems. Most require a relative humidity of around 90% to be maintained and this is maintained by the transpiration of the produce, when the ventilation and temperature controls of the container are set at an optimal level. Modern containers with advanced humidity control systems are equipped with a water source, a pump and a water atomiser that introduces moisture into the container's air stream. Some reefer containers are fitted with de-humidification equipment, which can reduce the relative humidity of the container to a level of between 50 and 80%.

3.7 Container damage

Every precaution must be taken to ensure that the container and its machinery is not damaged during transport or packing. While the use of freight containers substantially reduces the physical hazards to which cargo is exposed to, improper or careless packing of cargoes may result in serious and costly damage to the container.

The front end of the container houses the machinery, its evaporator and the air circulation system. This machinery is protected by grilles and reasonably robust panels, which can withstand normal wear and tear associated with acceptable methods of loading. However, the impact from careless stowing (improper handling - such as throwing of cargo) could damage and distort the panels and machinery. Damage to the insulating envelope will result in loss of thermal efficiency leading to a reduction in insulating properties.

NOTE: Great care must be taken if forklifts are utilised to stow a refrigerated container. Adequate protection must be provided, in way of plywood or steel sheet flooring of appropriate strength, prior to utilising forklifts or other heavy equipment within the reefer container, to ensure that the ribs on the floor are not damaged.

4 Measurement of produce temperature

Temperature is considered to be measured and stated in Degrees Celsius (°C) for the purpose of this Code. Any variance from this practice must be highlighted to all parties in the chain to ensure that there is no misunderstanding.

It is most important to bear in mind that chilled fresh produce can be extensively damaged by low temperatures, either by freezing or by chilling injury, if subjected to temperatures below those usually experienced in the growing area.

4.1 Thermometer requirements

4.1.1. All cool store and packing shed operators should possess thermometers suitable for measuring produce temperatures. Note that not all electronic thermometers are suitable.

4.1.2. Electronic thermometers should have a resolution of 0.1°C and be capable of measuring temperatures in the range -5°C to +45°C with an accuracy of ±0.5°C; when measuring a temperature of 0°C, the calibrated accuracy should be ±0.2°C.

4.1.3. Electronic thermometers should be protected from condensation when taken out of cool rooms. If the thermometer case is not sealed, the thermometer may be placed in a plastic bag.

4.1.4. Electronic thermometers should maintain their calibrated accuracy to ±0.3°C when taken in and out of cool stores.

4.2 Thermometer calibration

4.2.1. All thermometers should be checked when purchased. All readings should be noted in a logbook. If the reading suddenly changes, return the thermometer to the supplier for checking.

Rechecking/recalibration of electronic thermometers should be carried out monthly using an ice water slurry, which has a temperature of 0.0°C. A sample method for undertaking this calibration is:

Pack chipped or flaked ice into a wide-mouthed vacuum flask and then fill the voids with iced water. Let it stand for 10 minutes and then insert the thermometer probe into the centre of the flask and record readings every minute until steady. Take at least 4 readings (Ideally distilled water should be used, however tap water is suitable provided it is of drinking quality).

4.3 Produce temperature

4.3.1. The indicating thermometer on a cool store measures air temperature at the location of the sensor. It cannot indicate produce temperature, especially whilst produce is cooling.

4.3.2. To obtain reliable produce temperatures, the sensing probe must be inserted into the flesh of the produce; pre-cool the probe before use by inserting into another sample of the same piece of fruit.

4.3.3. Produce temperature will vary in packages within the one pallet, and from pallet to pallet, depending on the air circulation in the cool store and the stacking density of the pallets. Produce must be chosen from a number of pallets and at varying packing height locations to obtain temperature variability information.

4.3.3. Temperature records of produce should be kept, covering the whole period from the time of harvest to the time of export.

4.3.4. Records should be kept of the cooling rate achieved in each cool room.

5 Temperature monitoring during transit

Temperature is considered to be measured and stated in Degrees Celsius (°C) for the purpose of this Code. Any variance from this practice must be highlighted to all parties in the chain to ensure that there is no misunderstanding.

(See also "The use of thermocouples to monitor cargo temperatures in refrigerated freight containers and vehicles" in the Further Information section)

5.1. The recorder on the refrigeration unit on older units records the temperature of the return air, but on some, particularly newer units record the temperature of the delivery air. The accuracy of the recording depends on the care taken during the pre-trip calibration and on any consequential rough handling (eg. container roughly handled). In a container with adequate air circulation, the temperature of the bulk of the produce is close to the return air temperature, providing the product has been pre-cooled to the desired carrying temperature. If the air circulation is inadequate or restricted, the bulk produce temperature may be at a higher temperature than the return air. As units now in service operate with delivery air control, then the recording of the return air temperature will show an increase of approximately +2°C higher then the delivery air temperature; if the unit operates under return air control, then the recording of the return air should be fairly constant. If the delivery air temperature is recorded, then the recorded temperature should be constant and is about 0.5 to 1.5°C below the bulk produce temperature.

5.2. To obtain an independent record of temperature throughout transport, a self-contained, single-point temperature recorder may be placed in the container. The preferred location for the recorder is in the second package down, at the door end near the centre of the stow, and clearly marked with some form of highly visible marking to ensure retrieval on discharge. If the recorder is placed on top of the stow or attached to the ceiling, then the recording will not represent produce temperature but will give information on the performance of the refrigeration unit. Alternatively, a multi-point recorder may be used with temperature sensors placed in the produce as well as in the air. Some of these recorders allow interrogation of the recorded data from outside the container.

5.3 Please also refer to 3.1.2. Some Containers are fitted with mechanical 31 day chart recorders but technology is rapidly moving towards controller and computer linked electronic data storage and recording and charts will become the exception rather than the rule. Modern integral containers are fitted with microprocessors capable of storing electronically, voyage information for up to 1 year, which in turn can be down loaded via a portable computer and reproduced in hard copy if required. Information that can be gathered in this manner includes supply and return air temperatures, set-point changes, alarm conditions, pre-trip condition, defrost frequencies etc. The units also have the capability of recording up to three remote sensors, with most having USDA approval for the recording of fruit temperatures in transit. For USDA and other quarantine cold treatment requirements, maximum pulp temperatures may have to be maintained below a specified temperature throughout a continuous period of days and only approved equipment may be used.

5.4 To allow external monitoring, a thermocouple may be placed in a carton of produce within the stow. The monitored carton should be located in the top layer in the centre line of the container in the tier adjacent to the doors. For integral containers the leads should be taken out through the door seals with the loose material coiled and securely taped to a door handle on the right hand side door.

CAUTION: The thermocouple lead must be laid into a floor channel along the length of the container leaving sufficient length to reach the selected carton prior to commencing container packing.

More detailed information may be obtained by using several thermocouples. The use of external

monitoring allows corrective action to be taken if a fault is found, in contrast to internal monitoring where a fault is discovered only at the end of the journey. However, care needs to be taken in interpreting measured temperatures and in any corrective action taken. eg. If the measured temperature of a carton in the top layer at the doors indicates that the carton is too warm, the set-point of the unit must not be reduced if there is no measurement of the coolest carton.

5.5 Shippers should inform both the shipping company and the receivers, if they choose to install their own recording devices within the cargo.

6 Post harvest requirements for export produce

6.1. Produce should be harvested at a maturity suitable for the intended market and pre-cooled rapidly without delay. The main pre-cooling techniques are forced-air, hydro-cooling and vacuum-cooling. A matter of considerable importance, which affects the ripening process of fruit & Vegetables, is the time delay between harvesting and transfer to an environment where this process can be controlled. The atmospheres in which fruits/Vegetables are kept or carried have a significant effect on the ripening process. Produce should be stored at the ideal temperature to avoid unnecessary water loss. Maintaining the produce at the correct temperature and humidity in storage can reduce dehydration of the produce. Dehydration of the commodity will be increased at higher temperatures.

6.2. To avoid mechanical damage, handling procedures should be suited to the produce. Mechanical damage from compression, impacts and vibration can be reduced by correct handling methods and appropriate machinery.

6.3. **Exporters should select produce which meets market requirements.**

6.4. Where applicable, produce must be treated with recommended dips (e.g. chlorination) or other treatments at the appropriate temperature and concentration, and for the prescribed time and country of destination regulations.

6.5. Ideally all produce should be packed in a temperature-controlled packing area. **After packing, produce should be re-cooled rapidly, using rapid cooling methods and stored at the temperature recommended for long term storage** and where appropriate, under correct CA conditions. However it must be noted that some fruit/vegetables suffer from cooling too rapidly.

6.6. Core or produce temperature records should be kept on all produce, not just the indicated air temperature of the cold room. Thermometers and temperature recording equipment should be calibrated regularly.

NOTE: Exporters are required to comply with Trade Description aspects of the Export Control (Fresh Fruit and Vegetables) Orders, 1987. Where fruit is being exported as Class 1, all produce is required to meet relevant standards contained in the Schedules to the above Orders. All Quality Assurance and Quality Management Systems are required to comply with government legislative requirements, although many businesses are now referring to specifications set in conjunction with their customers. These specifications may be similar to those detailed in the Schedules to the Export Control (Fresh Fruit and Vegetable) Orders.

7 Packaging

For more information see 'Container and Pallet Stowage Recommendations for Export Horticultural Produce', Section 11: Further Information.

7.1 Packages

7.1.1. Carton material should be of sufficient strength to withstand rough export handling conditions. The packaging must be able to support a stacking height of up to 2.5 metres (for 8’ 6” high containers) and 2.85 metres (for 9’ 6” high containers) and withstand humidity without collapsing. Carton blanks and erected cartons must be stored in accordance with manufacturer's instructions. Chilled produce unloaded in South East Asia (and other areas with similar weather conditions) inevitably becomes wet from condensation due to the high humidity in these countries.

7.1.2. A carton should be formed carefully from the fibreboard blanks, according to manufacturer's instructions. Ensure the vent blanks are removed otherwise they may become dislodged and clog up the drain outlet. Clogged drain outlets can result in quality and out-turn problems.

7.1 3. All packages must be clearly labelled with the appropriate trade description and bear the manufacturer’s statement, and in line with labelling requirements as laid down by the regulatory bodies of the importing countries. If local language is required on the label, ensure that the translation is accurate.

7.1.4. Packages should not be over packed beyond the recommended weight. Any overfill of cartons should be kept to a minimum, and should be consistent between cartons, and should be such to ensure produce does not incur “pressure” damage during transit. Any bulging of cartons should be kept within acceptable limits.

7.1.5. Where appropriate, pallet loads of cartons should be allowed to settle before loading.

7.1.6. Polystyrene boxes (eg. the 5 or 10 kg grape or broccoli box) must have integral lids, and be approved by the manufacturer for export under refrigeration.

7.1.7 The selection of packaging usually depends on product type and it may be advisable to ascertain whether there are existing designs, trialled and proven by other exporters that would suit the commodity.

7.1.8 Consideration should be given to the size of the packaging to improve utilisation of the container, without overfilling or restricting the airflow.

7.1.9 Although ventilation holes are usually made on the sides of the cartons, it must be borne in mind that air circulation is usually from beneath, so for optimal circulation, ventilation holes must be located at the top and bottom of the carton. Excessive ventilation may however lead to excessive weight loss, if additional wrapping or packaging is used within the cartons consideration must be given to the effect it will have on the ventilation process.

Note: Packaging vents need to be aligned for adequate airflow.

7.1.10 Dehydration of the produce can be reduced by utilising the appropriate packaging.

7.1.11 Packaging material should be chosen not only for its durability during transport but also its ability to permit the removal of respiratory heat and other gases emitted by the produce (if required).

7.2 Bulk bins

7.2.1 These bins are suitable only for produce able to be bulk stacked, e.g. apples.

7.2.2 Custom size bins make better use of the available space.
Bin sizes 1100 mm x 1100 mm and 1065 mm x 1065 mm and 1085 mm x 1117 mm (WA).

7.3 Palletising

7.3.1. Packages should remain within the pallet dimensions (i.e. no overhang) to maintain stacking strength and stability as well as ease of stowing into the container.

7.3.2 Euro-pallet 1200 mm x 1000 mm requires specifically designed cartons to maximise efficiency of use of the container volume (eg. 395 mm x 295 mm for the grape carton and 595 mm x 395 mm for the potted plant carton).

7.3.3. Custom size pallets will make more efficient use of the container volume (eg. NZ pallet 1080 mm x 980 mm for integral containers). Be aware pallet boards/slip sheets etc may cause airflow restriction.

7.3.4. Handling procedures at the point of import must be arranged.

7.4 Slip sheets

These are technically feasible but no use has been made of them for horticultural produce. Some use has been made of them in the meat industry.

If Slip Sheets are utilised, shippers should ensure that the airflow through the bottom channelling is not obstructed. Also slip sheets must end at the completion of the T-bar.

7.5 Stabilising

7.5.1. Any stabilising method used must keep the pallet firmly together to ensure ease of stowing into the container. Stabilising may be achieved by using pallet adhesive, adhesive tape, stretch wrap, shrink-wrap, stretch netting, or strapping. Right angle corner supports, of metal, fibreboard or plastic, may be used in conjunction with any of the above methods. **Stabilising methods must not restrict air circulation throughout the cargo stow.**

8 Container selection

8.1 Exporter action

8.1.1. **The produce to be carried should be specified when a container is ordered**.

8.1.2. **A container ordered for one commodity should not be used for another commodity without prior approval from the Shipping Company.**

As the intended use of the container is not usually known when the PTI is carried out, the Set Point may be left on a temperature to suit the carriage of Hard Frozen or Chiller cargo (eg. -18°C or 0°C). The Shipper must check the Set Point Temperature before the container unit is placed on power. As the operation of the reefer machinery is checked at the time of PTI, there is therefore no necessity for the shipper/packer to pre-cool the container to check its functionality or to run the equipment during the loading operation (see 9.2.5 and 9.2.6).

It is important to note that refrigerated containers are designed to maintain delivery air temperatures and not to reduce the temperature of the cargo.

8.1.3. The desired produce temperature during transport, vent setting and any other special requirements should be specified at the time of booking to enable the shipping company to select a suitable container. It is suggested that the desired temperature be chosen from the recommendations in Tables 1 & 2 in Appendix 1. Whilst all reasonable care has been taken in preparing these recommendations Shipping Australia accepts no liability resulting from the interpretation or use of the information set out in Tables 1 & 2 in Appendix 1. **The Shipper is in the best position to know the optimum temperature for the carriage of his product.**

It may sometimes be necessary for statutory or other reasons to specify a maximum duration of time without refrigeration, either per event or in total for the journey.

The rate of Fresh Air Exchange (FAE) should be specified by the shipper in Cubic Meters per Hour (CMH). Specification of a percentage rate FAE is not acceptable as it only has a meaning if it relates to a specific model of refrigeration unit and size. For further information on Fresh Air Exchange conversions visit this website: http://www.coldchaincentre.com.au/VentSettingsGuide3.php

8.1.5. The carton size and package configuration used should be appropriate to suit the associated minimum container dimensions, to ensure optimum payload conditions can be achieved.

8.1.6. Verify that the correct set point temperature has been chosen (See Tables 1 & 2 in Appendix 1), especially if the unit is to be operated at the packing shed or in transit from the packing shed to the marine terminal (See 9.2.3).

Set point temperature and Fresh Air Exchange rate and any other specific information must be shown in the electronic Pre-Receival Advice (PRA). The Shipper who arranges the movement of the container from the packing warehouse to the marine terminal, should ensure that that all those involved in the transport chain (including the transport contractor) are made aware of the Set Point Temperature, in the event a unit has to be placed on power during transit, prior to delivery to the marine terminal.

8.2 Shipping company action

Whilst these procedures are covered by the PTI (section 3.2), shipping companies should ensure these processes have occurred.

8.2.1. **All containers must be supplied clean, dry and free from persistent odours from previous cargoes, contaminants, residues, pests and fit for the purpose**. The interior and exterior panelling must be free from any damage that would affect the cargo-worthiness of the container.

For information on relevant standards please refer to booklet entitled *"Standards for Food Quality Shipping Containers"* endorsed by AQIS.

This publication has been developed by Shipping Australia Limited as a general guide and reference for all those involved in the supply, preparation and inspection of shipping containers for the carriage of export food commodities. It is not intended to supersede or override any existing regulations but only to offer simple descriptions and explanations of current AQIS requirements and inspection practices. It covers the most common areas of concern, providing information about rules, conditions and circumstances, as well as giving reference points for further information. The updated PDF version, and not the Pink Book should now be used as the general guide and reference for standards for food quality shipping containers. Companies that are operating Co-regulation Arrangements for empty (dry box) container inspections should ensure that their accredited inspectors have access to and are using the updated PDF version (printed in colour) by the time of the next AQIS audit of their arrangement.

This document is available and may be downloaded from the following websites:

Shipping Australia Limited:
www.shippingaustralia.com.au

AQIS Industry Cargo Consultative Committee (AICCC):
www.aiccc.com/Food_Container_Standards.html

Department of Agriculture Fisheries and Forestry Australia (DAFF):
www.daff.gov.au/corporate_docs/publications/pdf/quarantine/plprog/standardfoodqualityshippingcontainers.pdf

Refer to AQIS - Industry Advice Notice No. 2004 -15:
www.daff.gov.au/content/output.cfm?ObjectID=6CA52947-1AC8-4C18-840638868017EACD

8.2.2. The container should be free of internal bowing that could prevent optimum payload conditions being achieved.

8.2.3. Integral containers must be fitted with ventilation ports to allow venting during the ocean passage of the container. It is suggested that Ventilation Settings with marked positions, should be set as per shipper's requirements who would be guided by the recommendations in Tables 1 & 2 in Appendix 1 (Refer 8.1.3 & 8.1.4).

A container with an air circulation rate appropriate to the produce should be selected. Produce with high rates of respiration requires high air circulation. Produce sensitive to moisture loss requires low air circulation. Produce that has a short storage life at or below 0°C requires high air circulation. There should be no obstructions in the floor ribs that would affect efficient air circulation. Ventilation can be internal with cold air being circulated to maintain the pre-set produce temperature or external, with fresh air being introduced from outside to remove carbon dioxide and other gases released by the produce.

8.2.5 Door gaskets and weather strips must be in good condition to form an effective seal (weather tight) when doors are closed.

8.2.6 Doors and ventilators are in sound condition and in good operational order.

8.2.7. The temperature control unit should be appropriate to the desired produce temperature during transport. If produce is to be carried at or below 0°C then a unit with accurate control of the delivery air temperature must be chosen. If the unit operates with a return air controller, then the unit must be fitted with a correctly set delivery air safety thermostat.

The refrigeration unit on integral containers or clip-ons should be pre-tripped with particular attention to the accuracy of the temperature controller and recorder and a sticker showing the date of service should be attached to the unit. (Refer to section 3.2 Pre-Trip Inspection).

8.2.9 The set point on the temperature control unit should be adjusted to the value appropriate to the type of control unit and the desired temperature of the produce during transport. Recommended values are shown in Tables 1 & 2 in Appendix 1 (refer to sections 8.1.3 & 8.1.4).

On mechanical temperature controllers (Partlow Controller or separate dial setter) the setting can be verified before placing the machinery on power. Electronic temperature controllers may require the machinery to be placed on power, unless the temperature controller is fitted with its own power source.

8.2.10 Simple operating instructions should accompany integral containers to enable the packing shed to connect the units to power if required.

Containers fitted with Partlow Recorders are normally released to the shippers with a clean blank Partlow chart. The shipper/packer should fill in the appropriate details on the chart (i.e. date, container number, vessel/voyage, cargo temperature set point, load port and destination). The chart should be placed on the recorder at the correct time and set to record. Note, in some cases the chart is marked and set by the releasing depot but the shipper/packer should verify the details are correct and match the ERA details. Partlow charts are of prime importance because they give a continuos record, including time off power. As a matter of routine, new charts should be placed in a recorder during a voyage, if the 31-day period expires. The chart/charts should be removed and forwarded to the shipping line's agent at the discharge terminal prior to release of the container to the custody of the consignee. Some shipping companies have adopted procedures to change the 'Partlow Chart' at every interchange between links in the transport chain (receival at Container terminal, loaded on the vessel, discharged at terminal, when given delivery to trucker at discharge port). In such an instance, whoever places the chart on the recorder is responsible for filling out the relevant details on the chart.

Note: Partlow Charts in most containers record return air temperatures.

8.3 Data recorders

If the container is fitted with an electronic temperature recorder that has provision to store & retrieve temperature information the recording of relevant temperature information shall automatically occur whilst the container is operating on power or in many cases also whilst the container is off power if the datacorder has a power back up system. Any other relevant paperwork required should be completed in a timely and accurate manner as is the standard requirement with any export movements.

8.3.1 It is recommended that empty containers released for food quality cargo have seals fitted to the door locking handle to ensure that shippers receive containers in the same condition at the packing shed.

9 Stowage

(See Recommended Reading - 'Container and Pallet Stowage Recommendations for Export Horticultural Produce' in the Further Information section)

There are substantial design differences between refrigerated containers and refrigerated trucks used for domestic transport of refrigerated cargo, which results in significant differences in airflows. It is very important that refrigerated cargo is packed in reefer containers, giving consideration to these differences. The increase in transit times should also be borne in mind.

Consideration must be given prior to vanning of the container to the manufacturer's mass rating (maximum payload) and the legislatively specified mass limitations. These must not be exceeded. The person consigning a container for transport must make an accurate complying weight declaration according to Australian (State) Road legislation.

Packing and securing of cargo in the container must be carried out giving due consideration to sea voyage, which may be undertaken in a variety of weather conditions, which is likely to exert a combination of forces upon the ship and its cargo over a prolonged period of time. Such forces may arise from pitching, rolling, heaving, surging, yawing or a combination of two or more. It must not be assumed that securing methods used for land transport will always be adequate at sea. At the same time, the method of securing must not itself cause any damage or deterioration either to the cargo or the container.

9.1 Mixed cargo

Mixing of cargo in the same container is not recommended

Care should be taken when considering the stowage of more than one commodity in a container or in the same storage area as they may have different ideal demands of temperature and humidity. Emission of odour from one product may have an effect on the other. Furthermore, produce that is very sensitive to ethylene (eg. eggplant, brussel sprout, celery, cucumber, bananas, avocados, peach, pear and kiwi fruit) must not be stored or transported with produce that releases ethylene. Some of the produce that are very susceptible to ethylene also produce and emit ethylene.

Commodities that require varying humidity requirements must not be stowed in the same container. Produce that require high humidity would dehydrate if a high RH is not maintained in a container, similarly products that are adversely effected by high RH (potato, onion, yams etc) would deteriorate in a container maintained at high humidity.

Shipping companies may be able to provide advice to shippers if a mixed commodity load is being considered.

9.2 Before stowage

9.2.1 The container must be inspected for cleanliness, contaminants, residues, pests, odours and bowing, and rejected if it is unfit. If the container ceiling is bowed to such an extent that the necessary roof clearance cannot be attained with properly packed cartons, then the shipping line should be advised before stowing is commenced. If practical the container should be replaced. If the container is being held for more than 24 hours at the packing facility or transport yard, ensure that the machinery is not facing a westerly direction, during hot days the heat on the compressor could cause a malfunction.

9.2.2 The refrigeration unit on integral containers fitted with Partlow charts should be checked for a current pre-trip sticker with current validity and for a chart in the temperature recorder. If the validity date is more than 30 days old, please refer to the shipping line. Details entered on the temperature chart should be checked as correct eg. Container number, commodity, set temperature, intended vessel, Port of Discharge (P.O.D) etc.

9.2.3 The set-point on the unit should be checked to ensure it is near the desired produce temperature. If the

set-point is below -2°C or more than 2°C above the desired produce temperature, then a message to check the setting should be sent with the documentation accompanying the container. If the refrigeration unit is to be operated at the packing shed or during transit from the packing shed to the marine terminal, then the setting should be adjusted after consultation with the shipping company.

9.2.4 Ideally, the loading of a container should take place in a temperature-controlled storage area or docked to an anti-chamber. Otherwise, the container should be placed so that stowing can take place under cover in the shade. **Handling of produce in a non-temperature controlled environment would likely result in moisture being formed on the surface of the commodity, resulting in 'cargo sweat', which could accelerate its deterioration. Condensation may also form on the packaging, which could weaken any fiberboard packaging.**

9.2.5 **The refrigeration units should never be run with the containers doors open, except where the container is to be sealed to an anti-chamber.** Pre-cooling the container before loading is of no benefit as the condensation produced will deposit as ice on the evaporator coils after the unit has been re-started, resulting in additional defrosts, thereby delaying adequate cooling of the cargo.

9.2.6 Where possible, the container should be placed so that the door end is slightly higher than the unit end. This will result in easier stowing with less likelihood of the tiers of produce leaning out towards the doors.

9.2.7 Determine the stowage pattern before stowing is commenced. If necessary, lay a row of cartons across and lengthways down the container floor.

9.2.8 The best stowage pattern should permit air to move freely through the packing and the cargo, whilst preventing any shifting/movement of the cargo. The 'respiratory' heat, carbon dioxide, water vapour and other gases generated by the produce is expelled by air circulation. Any 'broken stowage' should be packed with some material, to reduce the possibility of the air 'short –circuiting'.

9.2.9 **The produce should be within 1°C of the desired carriage temperature before loading into the container.** In Australia local or federal AQIS DPI offices can provide advice on export requirements and other relevant matters in regard to shipping temperatures and acceptance conditions at overseas destinations

9.3 Drain plugs

For cargo's that requires Fresh Air Exchange, ensure that the drain plugs (2 or 4) of the container are unplugged and free from obstruction. This allows moisture to drain from the container.

Note: This is not applicable for AFAM containers.

For cargo's that do not require Fresh Air Exchange (frozen cargo) the drain plugs kazoo should be closed.

9.4 During stowage

9.4.1. The temperature of produce inside cartons selected at random should be measured prior to removal from the cool store**. Only produce cooled to within 1°C of desired transport temperature should be loaded into the container**.

9.4.2. Pallets of produce should be brought out of the cool room only as required. Produce should not be left unnecessarily in ambient conditions while waiting to be stowed.

9.4.3. Stowing should be completed without delays and within one hour. If a break in stowing of more than 20 minutes is to occur, then the container doors should be closed and any unstowed produce returned to the cool room.

9.4.4. **Cargo must not be loaded higher than the 'red loadline' marked inside the container or exceed the end of the floor grills at the door, otherwise correct airflow will be impeded. The load also**

should not exceed the declared cargo weight as shown on the container door. In addition ensure that the cargo weight is acceptable at the port of discharge, for example some East Malaysian destinations have weight restrictions.

9.4.5. Except to meet the importing country's quarantine requirements, dunnage battens are no longer required to be placed between cartons in containers. Instead, cartons should be block stowed with vertical dunnage placed in the door gap to prevent gaps opening up through the stow; this dunnage must not prevent airflow up the door gap. If dunnage battens are used, they should be placed between every second tier of cartons and vertical dunnage should also be placed in any remaining gap at the doors. The stow should finish as close as possible to the end of the floor grills, but not so that the door battens indent into the cartons when the doors are closed. If timber chockings are used to secure the movement of the cargo within the container, it must be ensured that all wood utilised complies with the prevailing wood treatment quarantine regulations of the country of destination.

9.4.6. To meet the importing country's quarantine requirements for produce undergoing in-transit disinfestation, dunnage battens must be placed and taped between every second tier of cartons with an additional set of battens between the last and second last tiers. (This is a requirement under the Export Orders).

9.4.7. The lids of cartons in the top layer must be taped to the base to prevent the lids lifting and restricting the ceiling gap (there should not be any dunnage or plastic on the top of the stow, which could become loose and impede or block the flow of air or the return air vent).

9.4.8 For non-palletised stows, cartons should be block stowed, square on top of each other (without space between the load and the walls of the containers), to facilitate the passage of air through them. If they are interlocked (like bricks in a wall), the airflow is impaired unless the cartons are specifically designed with ventilation holes to achieve vertical airflow. Effective carriage of chilled cargo depends on a full container load with minimum air-bagging, where the stow itself requires the cool air to pass through the cartons, thereby avoiding the possibility of air short-circuiting. Space between the cartons could result in air short-circuiting through the gaps, which would result in some of the cargo not being maintained at the carriage temperature.

Shippers should ensure that the cargo stow enables optimum airflow.

9.4.9 Loading of pallets – Cartons must be stacked squarely and evenly on top of each other so that the weight is taken by the side walls of the carton. The ventilation holes on the top and bottom of the cartons must be aligned to enable air to flow freely through the stow. Any space between the pallets and the door must be covered by a heavy fibreboard to ensure efficient air circulation.

9.4.10 There should be no obstructions in the floor grill that would affect efficient air circulation.

9.4.11 Other common problems that occur are:

- Absence of airflow vents running bottom and top through the cartons
- Trays inside the cartons having no ventilating slots or apertures, blocking the airflow
- Top pads placed in the carton above the fruit and vegetables to prevent bruising, which may also restrict vertical airflow.
- The building of 'chimneys' where four oblong cartons are arranged to form a square, causes short-circuiting of the chilled air away from the product.
- Using shrink-wrapped pallets or slip-sheets may impede or block the airflow through the load, especially at the door.

9.5 After stowage

9.5.1. The container doors should be closed immediately stowage is completed.

9.5.2. All receival terminal documentation should be completed for dispatch with the container.

9.5.3. If the container is not being transported immediately, the unit should be connected to power and

switched on to expel the ambient air that has accumulated during loading. Where it is not possible to keep the unit on power, the unit should be off power no longer than 1 hour (for chilled cargo), kept as cool as possible and definitely away from direct sunlight.

9.5.4 Should a shipper or packer place a reefer container on power the following must be checked: -

a. Check Set point temperature setting and place to correct setting.
b. Fresh air exchange vents are set at the required setting. (The Fresh air exchange vents must remain closed when transporting by rail or truck).

9.5.5 Each link/carrier in the transport chain must notify the exporter and shipping company immediately, if any out of specification conditions of the cargo is noticed/ascertained (for example hot-packed containers, equipment malfunction etc).

10 Transport terminal and ship operation

10.1. The container should travel directly to the container terminal without delays and in conformance with the times off power (a maximum of 1 hour for chilled cargo). Ideally, refrigeration should be applied during transport (also refer 9.2.3).

10.2 As vehicle exhaust gases contain ethylene it is vital to check that the ventilation openings (vents) on integral containers are closed prior to vehicles/prime movers coming anywhere near the container.

Note: Air freshening ports (vents) are reset open on arrival at export terminals when containers are placed on refrigeration power.

10.3 Containers carrying fresh fruit and vegetables (and chilled meat) should be given priority receival by the Export Terminals.

10.4 When the container is received at the terminal, the documentation should be checked to ensure that the produce is as expected. Containers with incomplete documentation should not be received until all specifications have been verified. Electronic transfer of documentation to terminals may alleviate potential delays.

10.5 The temperature of the container should be crosschecked with the Temperature indicated in the electronic Pre-Receival Advice (PRA) and/or with the temperature declared by the shipping line (or their refrigerated contractor). The Shipping Line should be informed immediately of any temperature fluctuations (ideally must be within 1ºC supply air of the exporter required setting) for immediate action. If repairs cannot be achieved the exporter must be advised so a decision can be made on whether the shipment is to proceed or not.

10.6 Refrigeration should be applied as soon as possible, but in any event no more than 30 minutes after receival, and the unit checked to ensure proper operation. All unit monitoring should not exceed 12 hour intervals and should be rechecked before they are transferred to a ship.

10.7 The ventilation (air freshening) openings should be checked to ensure they are in the correct position, i.e. normally open for horticultural produce**. It is suggested that Ventilation Openings with marked positions, should be set as per the electronic Pre-Receival Advice (PRA) instructions.**

11 Brief checklist for shippers when planning a refrigerated cargo shipment:

- ☐ Optimal temperature requirements (in °C)
- ☐ Optimal air ventilation requirements (in m^3/hour)
- ☐ Humidity requirement
- ☐ Transport time
- ☐ Volume of cargo
- ☐ Recommended stowage pattern
- ☐ Actual stowage pattern
- ☐ Documentation requirements
- ☐ Maximum duration without refrigeration
- ☐ Gross load (container, cargo, packaging and dunnage, generator set, semi trailer and prime mover) does not exceed legal weight limitations of constraints or state government regulations (including regulations in destination country).

12 Brief checklist for shippers before and during loading refrigerated cargo:

- ☐ Check PTI decal and validity date
- ☐ Cleanliness of Reefer container
- ☐ Condition of the Reefer container
- ☐ Temperature setting
- ☐ Ventilation setting
- ☐ Humidity setting
- ☐ Cargo stowed under the ‘red line’
- ☐ Cargo evenly stowed
- ☐ Load is stable

Appendix 1: Recommended settings for fruit and vegetables during transport

The contents in the following guide are general recommendations. Such general recommendations on commodities can be affected by cultivar type, growing area, time of year, routing, post harvest conditions and packing, which can all impact on shelf life and commodity outturn. A large number of variations are possible, therefore these general recommendations are offered without the detailed knowledge. The shipper should have intimate knowledge of these conditions and thus the final responsibility rests with the shipper on the acceptance of these guidelines. Shipping companies reserve the right to refuse cargo if it is clearly being carried outside safe or acceptable carriage parameters or if the commodity being shipped is of a quality that may result in a poor cargo outturn at destination. Shipping companies may be able to assist with the temperatures and settings of commodities.

Whilst all reasonable care has been taken in preparing the recommended settings for fruit during transport, Shipping Australia accepts no liability resulting from the interpretation or use of the information set out in the Code.

It is also assumed that all produce is presented at a matured unripened stage (except when it is specifically mentioned). Shippers would be required to use their familiarity with the product to give consideration to the ripening process and the optimum conditions, giving due consideration to the length of voyage and the nature of the product.

It must be noted that optimum storage conditions would vary between different varieties and are largely dependent on pre-harvest conditions.

It is assumed that shippers, with previous experience of carriage of their produce are best suited to advise shipping companies on their requirements with respect to settings on the reefer container.

Table 1: Recommended Settings for Fruit during Transport

FRUIT	Maximum Storage & Transit Time (Days)	Desired Produce Carriage Temp °C [1]	Highest Freezing Temp °C[2]	Ventilation m^3 per hour for 20' (6m) [3,4]	Ventilation m^3 per hour for 40' & 40' HC (12 m) [3,4]	Relative Humidity Percentage %	Ethylene Production Rate	Sensitivity to Ethylene Action	Recommended Modified/ Controlled Atmosphere	
									% O_2	% CO_2
POME FRUIT										
Apple, General	30-365	-1.0-4.0	-1.5	2	4	90-95	VH	H	2-3	1-2
Apple, Jonathon	120-210	2.0-4.0	-1.5	2	5	90-95	Y	Y	1-3	1-3
Apple, Cox	120-150	3.0-4.0	-1.1			90-95			3-4	0-2
Apple, Fuji	150-210	0.0-2.0				90-95			1-2	1-2
Apple, Gala	120-150	0.0				90-95			1.5-2.5	1-5
Apple, Granny Smith	150-270	-1.0-1.0	-1.5	1	3	90-95	Y	Y	1-2.5	1-5
Pear – General	60-210	-1.5--0.5	-1.5	2	4	90-95	H	H	2-3	0-1
Pear – WBC	60-150	-1.0-0.0	-1.6	3	5	90-95	H	H	1-3	0-3
Pear – Nashi	150-180	1-2	-1.6			90-95	H	H	1-3	0-3
Quince	60-90	-0.5-0.0	-2.0			90	L	H		
CITRUS [6]										
Grapefruit	28-70	10-15	-1.5	6	12	85-90	VL	M	3-10	5-10
Lemon	30-180	10-14	-1.4	5	10	85-90	VL	M	5-10	0-10
Lime	42-56	8-10	-1.5	2	4	85-90	VL	M	5-10	0-10
Mandarin	14-28	5-7	-1.0			85-90	VL	M		
Ellendale		7-10				90-98				
Satsuma	56-84	4-5				85-90	L	No		
Clementine	14-28	3-5		6	11	90-95	L	No		
Orange	35-84	5-7	-0.8	3	6	85-90	VL		5-10	5
Valencia	70-98	5-7	-0.8	5	10	90				
Navel	42-56	5-7	-0.8	4	8	90		Yes		
Tangerine	14-28	0-4	-1.0			85-90	VL	M		

Footnotes

1. Produce should be loaded within 1°C of the desired temperature during transport.
2. Produce may suffer chilling injury before freezing occurs.
3. Ventilation rates for 20' (6m) containers are calculated with 10 tonnes of produce at its correct carriage temperature. Those calculated for 40' (12m) containers assume 20 tonnes of product at its correct carriage temperature. Rates have been calculated to keep carbon dioxide levels below 1%.
4. Clarification by the shipping company on ventilation settings is recommended, if the loaded container remains on power at a holding area for an extended period.
5. Containers carrying fresh fruit and vegetables should be given priority receival by Export Terminals.
6. Citrus is chilling injury sensitive. Different temperatures may be required at different periods of the picking season to account for variation in susceptibility to chilling injury.

FRUIT	Maximum Storage & Transit Time (Days)	Desired Produce Carriage Temp °C [1]	Highest Freezing Temp °C[2]	Ventilation M^3 per Hour for 20' (6m) [3,4]	Ventilation M^3 per Hour for 40' & 40' HC (12 m) [3,4]	Relative Humidity Percentage %	Ethylene Production Rate	Sensitivity to Ethylene Action	Recommended Modified/ Controlled Atmosphere	
									% O_2	% CO_2
STONE FRUIT										
Apricot	14-21	-0.5-0.0	-1.1	3	6	90-95	H	H	2-3	2-3
Cherry	14-21	-1.0-0.0	-1.8	4	8	90-95	VL	L	3-10	10-15
Nectarine	14-28	-0.5-0.0	-0.9			90-95	M	H	1-3	3-5
Peach	14-28	-0.5-0.0	-1.0	3	5	90-95	H	H	1-3	3-5
Plum	14-35	-0.5-0.0	-0.8	3	6	90-95	M	H	1-2	0-5
OTHER FRUIT										
Avocado	14-42	5-12	-0.3	22	44	85-90	H	H	2-5	3-10
Banana	14-28	13-16	-0.8	21	43	85-90	M	H	2-5	2-5
Banana (Green)	14-21	12-15		16	32	90-95				
Blackberry	7-14	-0.5-0.0	-0.8	10	20	90-95	L	L	5-10	15-20
Blueberry	10-18	-0.5-0.0	-1.3	3	7	90-95	L	L	3-5	12-20
Boysenberry	2-3	-0.5-0.0	-1.3			90-100	L	L		
Cantaloupe (Rockmelon)	14-21	2.0-5.0	-1.2	4	8	85-90	H	M	3-5	10-20
Carambolas (Star Fruit)	21-28	9.0-10.0	-1.2	13	26	85-90	L	L		
Chestnuts	120-180	0.0				85-95				
Cranberry	60-120	2.0-4.0	-0.9	2	4	90-95	L	L	1-2	0-5
Currants	7-21	-0.5-0.0	-1.0	5	9	90-95	L	L		
Custard Apples	28-42	5-7				85-90	H	H	3-5	5-10
Dewberry	2-3	-0.5-0.0	-1.3			90-95	L	L		
Durian	42-56	4.0-6.0				85-90	M	M	8-10	5-15
Elderberry	7-14	-0.5-0.0	-1.1			90-95	L	L		
Feijoas (Pineapple Guavas)	14-21	5.0-10.0		39	78	90	M	L		
Figs	7-10	0.0-1.0	-2.4	4	7	85-90	M	L	5-10	15-20

Footnotes

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FRUIT	Maximum Storage & Transit Time (Days)	Desired Produce Carriage Temp °C [1]	Highest Freezing Temp °C[2]	Ventilation M^3 per Hour for 20' (6m) [3,4]	Ventilation M^3 per Hour for 40' & 40' HC (12 m) [3,4]	Relative Humidity Percentage %	Ethylene Production Rate	Sensitivity to Ethylene Action	Recommended Modified/ Controlled Atmosphere	
									% O_2	% CO_2
Gooseberry	14-28	-0.5-0.0	-1.1	3	6	90-95	L	L		
Grape	50-150	-1.0-0.0	-2.1	1	2	90-95	VL	L	2-5	1-3
Guavas	14-21	7.0-10.0		23	46	90	L	M		
Kaki (Fuji Fruits)	60-90	-1.0-0.0	-2.0	2	4	90-95	L	H	3-5	5-8
Kiwi Fruit	90-150	-0.5-0.0	-0.9	1	3	90-95	H	H	1-2	3-5
Kumquats	14-28	7.0-10		8	15	90-95	L	No		
Loganberry	2-3	-0.5-0.0	-1.3			90-100	L	L		
Longan	21-35	1.0-2.0	-2.4	4	8	90-95				
Loquat	14-21	0.0	-1.9	7	14	90-95		M		
Lychee	28-42	2.0-6.0		8	16	90-95	M	M	4-6	3-5
Melon, Honeydew	21-28	7.0-10.0	-1.0	3	7	85-90	M	H	3-5	5-10
Mango	14-21	10-13	-0.9	19	37	85-90	M	H	3-5	5-8
Mangosteens	14-28	12-13				85-90	M	H		
Olive	28-42	5.0-10.0	-1.4	16	31	85-90	L	M	2-3	0-1
Papaya	7-21	7-13	-0.9	5	10	85-90	H	H	3-5	5-8
Passion Fruit	21-35	7-10		11	21	85-95	VH	H		
Pineapple	14-28	7.0-10	-1.1	3	5	85-90	L	L	3-5	5-8
Persimmon (Hachiya)	50-90	0.0-1.0	-2.2	2	4	90-95	L	H	3-5	5-8
Pomegranates	60-120	4.0-5.0	-3.0	3	6	90-95	L	L	3-5	5-10
Prickly Pear	21-28	4.0-7.0		5	10	90-95	VL	M		
Rambutan	7-21	10.0-12.0				90-95	H	H	3-5	7-10
Raspberry	2-7	-0.5-0.0	-0.9	12	24	90-95	L	L	5-10	15-20
Strawberry	5-10	0.0	-0.8	8	15	90-95	L	L	5-10	15-20
Water Chestnut	30-60	0.0-2.0				95-100				
Watermelon	14-21	7.0-10.0	-0.6	3	6	85-90	L	H		

Footnotes

1. Produce should be loaded within 1°C of the desired temperature during transport.
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4. Clarification by the shipping company on ventilation settings is recommended, if the loaded container remains on power at a holding area for an extended period.
5. Containers carrying fresh fruit and vegetables should be given priority receival by Export Terminals.

Table 2: Recommended Settings for vegetables during transport

VEGETABLES	Maximum Storage & Transit Time (Days)	Desired Produce Carriage Temp °C [1]	Highest Freezing Temp °C[2]	Ventilation M^3 per Hour for 20' (6m) [3,4]	Ventilation M^3 per Hour for 40' & 40' HC (12 m) [3,4]	Relative Humidity Percentage %	Ethylene Production Rate	Sensitivity to Ethylene Action	Recommended Modified/ Controlled Atmosphere	
									% O_2	% CO_2
Artichokes (Globe)	21-28	0.0-1.0	-1.2	16	32	95-100	VL	L	2-3	2-3
Asparagus	14-21	0.0-2.0	-0.6	31	62	95-100	VL	M	21	10-14
Aubergine(Egg Plant)	7-14	10.0-12.0	-0.8	25	51	90-95	L	L	3-5	0
Baby Corn	4-8	0.0-1.0	-0.6	26	51	90-95	L	L	2-4	5-10
Bean Sprouts	7-9	0.0	-0.4	12	23	95-100				
Beans (Lima)	7-10	0.0-1.0	-0.6	10	21	90-95	L	M		
Beans (Green, Snap or Snake)	7-14	4.0-7.0	-0.7	21	42	90-95	L	M	2-3	3-7
Beets (Bunch)	7-14	0.0-1.0	-0.4	6	11	95-100	VL	L		
Beet (Roots)	120-180	0.0-1.0	-0.9	3	6	95-100	VL	L		
Bitter Gourds, Bitter Melon	14-21	10.0-12.0		18	36	85-90	VL	H	2-3	5
Bok choy	21-40	0.0		6	12	95-100	VL	H		
Breadfruit	14-42	13-14				85-90	M	M	2-5	5
Broccoli	35-50	0.0-1.0	-0.6	13	25	95-100	VL	H	1-3	5-15
Brussels Sprout	21-35	0.0-1.0	-0.8	11	22	90-95	VL	H	1-2	5-7
Cabbage (General)	30-120	0.0-1.0	-0.9	3	6	98-100	VL	H	2-3	3-10
Cabbage (White)	180-210	0.0-1.0	-1.4	4	8	95-100	VL	H		
Cabbage (Chinese)	60-90	0.0	-0.9	7	15	95-100	VL	H	1-2	0-5
Cabbage (Savoy)	28-56	0.0	-0.5	9	19	90-95	VL	H		
Cabbage (Red)	90-180	0.0	-0.9	3	6	90-95	VL	H		
Capsicum	14-21	7.0-10.0	-0.7	6	13	90-95	L	L	3-5	2-5
Carrots	120-180	0.0	-1.4	8	15	95-100	VL	H	21	0

Footnotes

1. Produce should be loaded within 1°C of the desired temperature during transport.
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4. Clarification by the shipping company on ventilation settings is recommended, if the loaded container remains on power at a holding area for an extended period.
5. Containers carrying fresh fruit and vegetables should be given priority receival by Export Terminals.

VEGETABLES	Maximum Storage & Transit Time (Days)	Desired Produce Carriage Temp °C [1]	Highest Freezing Temp °C[2]	Ventilation M^3 per Hour for 20' (6m) [3,4]	Ventilation M^3 per Hour for 40' & 40' HC (12 m) [3,4]	Relative Humidity Percentage %	Ethylene Production Rate	Sensitivity to Ethylene Action	Recommended Modified/ Controlled Atmosphere	
									% O_2	% CO_2
Cauliflower	14-28	0.0-1.0	-0.8	9	18	95-98	VL	H	2-3	3-5
Celery	30-90	0.0-1.0	-0.5	3	7	90-100	VL	H	1-4	3-5
Chicory	14-28	0.0-1.0		22	45	95-100	VL	H	3-4	4-5
Chilli (Pepper)	14-21	7.0-10.0	-0.7	20	40	90-95	L	M	3-5	5-10
Coconuts	30-60	0.0-2.0	-0.9			80-85	L	L		
Corn, Sweet	4-8	0.0	-0.6	20	41	95-98	VL	L	2-4	5-10
Courgette (Zucchini)	7-14	6.0-10.0	-0.5	14	28	90-95	L	M	3-5	5-10
Cucumber	10-14	10-13	-0.5	12	24	90-95	L	H	3-5	0-5
Endive (Escarole)	14-21	0.0	-0.1	7	13	90-100	VL	M		
Fennel	14-28	0.0-2.0		10	19	90-95	No	No		
Garlic	180-210	0.0	-0.8	3	7	65-70	VL	L	1-2	0-10
Ginger	150-180	11-13				65	VL	L		
Horseradish	300-360	-1.0-0.0	-0.8	4	8	95-100	VL	L		
Jackfruit	14-21	12.0-13.0				90-95	M	M		
Leeks	60-90	0.0	-0.7	8	15	95-100	VL	M	1-2	2-5
Lettuce, Butterhead	8-12	0.0-2.0		5	11	90-95	L	M	2-5	0
Lettuce, Iceberg	14-21	0.0-1.0	-0.2	7	14	95-100	VL	H	2-5	0
Manioc	150-180	0.0-2.0		4	8	85-90	VL	L		
Mushrooms	7-14	0.0	-0.9	20	41	90-95	VL	M	3-21	5-15
Okra	7-14	7.0-10.0	-1.8	41	81	90-95	L	M	3-5	0
Olive	28-42	5.0-10.0	-1.4	15	30	85-90	L	M	2-3	0-1
Onions (dry)	30-240	0.0	-0.8	2	3	65-75	VL	L	1-2	0-10
Peas	7-21	0.0	-0.6	20	39	90-95	VL	M	2-3	2-3

Footnotes

1. Produce should be loaded within 1°C of the desired temperature during transport.
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3. Ventilation rates for 20' (6m) containers are calculated with 10 tonnes of produce at its correct carriage temperature. Those calculated for 40' (12m) containers assume 20 tonnes of product at its correct carriage temperature. Rates have been calculated to keep carbon dioxide levels below 1%.
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5. Containers carrying fresh fruit and vegetables should be given priority receival by Export Terminals.

VEGETABLES	Maximum Storage & Transit Time (Days)	Desired Produce Carriage Temp °C	Highest Freezing Temp °C[(2)]	Ventilation M^3 per Hour for 20'	Ventilation M^3 per Hour for 40' & 40' HC	Relative Humidity Percentage %	Ethylene Production Rate	Sensitivity to Ethylene Action	Recommended Modified/ Controlled Atmosphere	
									% O_2	% CO_2
Parsley	30-60	0.0-1.0	-1.1	19	38	95-100	VL	H	8-10	8-10
Parsnip	120-180	0.0-1.0	-0.9	7	14	95-100	VL	H		
Potatoes	56-140	4.0-7.0	-0.8	3	6	90-95	VL	M	19-21	0
Potatoes (Seed)	85-175	4.0-5.0	-0.5			90-95	VL	M		
Pumpkin	60-150	10.0-13.0	-0.8			50-70	L	M		
Radishes	21-28	0.0-1.0	-0.7	3	6	90-95	VL	L	1-2	2-3
Rhubarb	14-28	0.0	-0.9	6	13	95-100	VL	L		
Shallots/Spring Onions	14-28	0.0	-0.9	7	15	95-100	VL	M	2-4	4-20
Shallot bulbs		0.0-2.5	-0.7			65-70	L	L		
Snow Peas	7-14	0.0-1.0	-0.6	37	74	90-95	VL	M	2-3	5-7
Spinach	10-14	0.0	-0.3	12	25	95-100	VL	H	5-10	5-10
Sweet Potato	90-180	13-16	-1.3	14	29	85-90	VL	L		
Taro	120-150	7.0-10.0	-0.9	12	25	85-90	VL	L		
Tomato (Green)	14-28	12-14	-0.6	10	19	85-95	VL	H	3-5	0
Tomato (Firm ripe)	7	7.0-10.0	-0.5	6	13	90-95	H	H	3-5	3-5
Turnip, Roots	120-150	0.0	-1.0	4	9	90-95	VL	L		
Watercress	14-21	0.0	-0.3	8	15	95-100	VL	H		
Yams	90-180	14.0-16.0	-1.1	4	9	70-80	VL	L		

Footnotes

1. Produce should be loaded within 1°C of the desired temperature during transport.
2. Produce may suffer chilling injury before freezing occurs.
3. Ventilation rates for 20' (6m) containers are calculated with 10 tonnes of produce at its correct carriage temperature. Those calculated for 40' (12m) containers assume 20 tonnes of product at its correct carriage temperature. Rates have been calculated to keep carbon dioxide levels below 1%.
4. Clarification by the shipping company on ventilation settings is recommended, if the loaded container remains on power at a holding area for an extended period.
5. Containers carrying fresh fruit and vegetables should be given priority receival by Export Terminals.

Data source:
All information in Tables 1 and 2 was sourced from the Optimal Fresh database, version 1.2.0.13, CSIRO Publishing, www.publish.csiro.au

Appendix 2: Electronic Pre-Receival Advice

The following outlines the steps for facilitating a fully electronic cargo receival process: -

Shipping lines will provide an electronic booking message to the Container Terminal Operators (CTO). The booking message would include the fields:

- Booking Reference number
- Vessel Name
- Lloyd's Number
- Voyage Number
- Shipping Line
- Port of Discharge / Transhipment Port
- Final Destination
- Number of containers in the booking
- Type of containers
- Commodity
- DG, OOG, Reefer data

The Electronic Export Pre-Receival Advice is sent to stevedore by the Exporter (or agent) using any of the available Pre-Receival Advice methods. The following list of data items is the minimum required for validation against the booking list or to meet the stevedore's system requirements. Refer to the IFTERA (5.4 or 5.2) message implementation guidelines for a full list of data items:

- Customs Authority Number (CAN) (C)
- Booking Reference Number (M)
- Shippers Reference Number (M)
- Origin (O)
- Vessel Name (O)
- Lloyd's Number (M)
- Voyage Number (M)
- Shipping Line (M)
- Loading Terminal (M)
- Port of Loading (M)
- Port of Discharge (Next port of discharge) (M)
- Final Discharge Port (O)
- Container Number (M)
- Seal Number (C)
- Seal Identifier (C)
- Commodity (M)
- DG - UN Number (C)
- DG - Class (C)
- Packaging Group (C)
- DG – Net Weight (C)
- OOG – Length, Width and Height (C)
- Reefer Data – Control Temperature (C)
- Reefer Data - Vent Setting. (O)
- Gross Weight (M)
- Container ISO code (M)
- Full / Empty Status (M)
- Arrival Mode of Transport (M)

Data elements indicated with:
(M) – these fields are mandatory
(O) – these fields are optional
(C) – these fields are conditional on other elements and specific cargo and must be supplied where necessary. e.g. if cargo is hazardous, the DG class and UN number is mandatory.

The preferred delivery methods for the PRA should be EDI message in an EDIFACT (IFTERA v5.4) format or

any current existing Web-based forms from various parties, including the stevedore web sites.

However, for any party who is not capable of producing an EDIFACT PRA message, by arrangement, the CTO's are capable of receiving any file format (e.g. CSV or flat file) over any transfer protocol.

CTO receives a Pre-Receival Advice from Exporter (or agent) and validates this information against the Shipping Line booking list and the Vessel Schedule receival window.
CTO checks Algorithm for the Customs Authority Number (CAN) and also sends a message to ACS checking the status of the CAN.

If the information is

a. **correct**, including the CAN status, the stevedore sends back an acceptance message, which will grant entry into the terminal within the standard receival window for the vessel specified.

b. **incorrect**, any anomalies are highlighted to the Exporter (or agent) for rectification and re-submission of the PRA. Some of these anomalies may have been data entry errors that will be rectified at the time of re-submission. However, an anomaly may require the exporter (or agent) to contact the Shipping Line to update booking data.

The Exporter dispatches the container to the wharf only after receiving an acceptance message from the Terminal

NB: The 'industry standard' for acceptance/rejection response message to an EDIFACT IFTERA is the EDIFACT APERAK message. Anything else (like e-mail or human readable APERAK) may be used 'by mutual agreement'.

The stevedore receives the cargo.

Further information

Recommended reading

Cumming, B.A. (1988). Container and pallet stowage recommendations for export horticultural produce. Department of Primary Industries and Energy: Canberra.

Irving, A.R. (1984) Transport of fresh horticultural produce under modified atmospheres. CSIRO Food Research Quarterly 44 (2), 25-33.

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SARDI Cool Chain website: http://www.sardi.sa.gov.au/coolchai/index.htm

Sharp, A.K. (1986). Humidity measurement and control during the storage and transport of fruits and vegetables. CSIRO Food Research Quarterly 46 (4), 79-85.

Sharp, A.K. (1989). The use of thermocouples to monitor cargo temperatures in refrigerated freight containers and vehicles. CSIRO Food Research Quarterly 49 (1/2), 10-18.

Export Control (Fresh Fruits and Vegetables) Orders 1987.

Anon (1989). Guide to Food Transport. Fruit and Vegetables. Mercantila Publishers, Denmark.

Story, A - Simons, D.H. (Eds) (1989) Fresh Produce Manual. Australian United Fresh Fruit & Vegetable Association.

Anon (1995) Guide to Refrigerated Transport. International Institute of Refrigeration, Paris, France.

Guidelines to Department of Primary Industries and Energy inspection and requirements - Standards for Food Quality Shipping Containers.

Tanner, D.J. and Amos, N.D. (2003). Temperature variability during shipment of fresh produce. *Acta Hortic.* **599**: 193 - 203.

Recommended viewing

'A Fresh Start.' (VHS video) How to improve the handling and export of fresh fruit and vegetables in refrigerated shipping containers. Department of Primary Industries and Energy: Canberra.

Cool “A Cold Chain Story” (CDROM). Available through the Cold Chain Centre website: http://www.coldchaincentre.com.au/

List of useful contacts

The AQIS Horticultural Export Consultative Committee is the principal advisory forum for AQIS to consult with the horticultural industry on all issues relevant to exports, including export certification, export market and export quarantine issues.

Australian Quarantine and Inspection Service (all States)

Regional offices

City	International phone	International fax
Adelaide	+61 8 8305 9700	+61 8 8305 9825
Brisbane	+61 7 3246 8755	+61 7 3246 8639
Canberra	+61 2 6272 5131	+61 2 6239 7351
Cairns	+61 7 4030 7800	+61 7 4035 9578
Darwin	+61 8 8999 2075	+61 8 8999 2108
Hobart	+61 3 6233 3626	+61 3 6234 6785
Melbourne	+61 3 9246 6777	+61 3 9246 6800
Perth	+61 8 9311 5333	+61 8 9455 3052
Sydney	+61 2 9364 7222	+61 2 9364 7340

Northern Australia Quarantine Strategy

State	International phone	International fax
Australian Capital Territory	+61 2 6272 3933	+61 2 6272 3399
Northern Territory	+61 8 8999 2045	+61 8 8941 0223
Queensland	+61 7 4030 7800	+61 7 4030 9578
Torres Strait	+61 7 4069 1185	+61 7 4069 1737
Western Australia	+61 8 9192 1579	+61 8 9193 5236

Export Facilitation Officers

State	International phone	International fax
Queensland	+61 7 3246 8709	+61 7 3246 8798
Victoria/Tasmania	+61 3 9246 6702	+61 3 9246 6778
South Australia	+61 8 8305 9713	+61 8 8305 9824
Northern Territory	+61 8 8999 2063	+61 88999 2108
New South Wales	+61 2 8838 3103	+61 2 9630 4650
Western Australia	+61 8 9311 5437	+61 8 9455 3052

State AQIS offices - Seaports	Email addresses
North Queensland – seaports	nqldsea@aqis.gov.au
Queensland - seaports	qldsea@aqis.gov.au
New South Wales – seaports	nswsea@aqis.gov.au
Victoria - seaports	vicsea@aqis.gov.au
South Australia - seaports	sasea@aqis.gov.au
Western Australia - seaports	wasea@aqis.gov.au
Tasmania - seaports	tassea@aqis.gov.au
Northern Territory – seaports	ntsea@aqis.gov.au

State AQIS offices - Quarantine	Email addresses
North Queensland	qnqld@aqis.gov.au
Queensland	qqld@aqis.gov.au
New South Wales	qnsw@aqis.gov.au
Victoria	qvic@aqis.gov.au
South Australia	qsa@aqis.gov.au
Western Australia	qwa@aqis.gov.au
Australian Capital Territory	qact@aqis.gov.au
Tasmania	qtas@aqis.gov.au
Northern Territory	qnt@aqis.gov.au

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