



MAINTAINING THE COLD CHAIN

Harvest, Packing and Dispatch

Establishing and maintaining
the Cold Chain during the
harvest, packing and dispatch
of fresh produce for export.

Write in this table details of the products to be handled by the person(s) using this pocket guide. This will ensure they have the information required to use the tables in this guide. The relevant

Product	Perishability Rating (see back page)



VICTORIAN AIRFREIGHT COUNCIL



Food Victoria



information for many products is available from the “Produce Handling Guidelines” wall chart.

Storage Temperature ° (C)	Relative Humidity (%)

DISCLAIMER

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For further information contact the Victorian Airfreight Council, phone (03) 9651 9154 or the Victorian Sea Freight Council, phone (03) 9655 6457.

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THE IMPORTANCE OF THE COLD CHAIN

The Cold Chain is the management of produce temperature, from harvesting through to consumer, to maintain the quality of the product. Maintenance of the Cold Chain is the best way to minimise all forms of deterioration after harvesting, including -

- Weight loss resulting in wilting and limpness

- Softening

- Unwanted ripening

- Bruising

- Colour changes

- Texture degradation

- Development of rots and moulds.

Good Cold Chain management results in the consumer receiving a product of “fresh” quality, leading to greater satisfaction and increased demand.

The export of fresh produce often involves long journey times and frequent handling. This makes effective Cold Chain management more difficult but even more essential to ensure the product offered for final sale retains maximum freshness.

It's Everyone's Responsibility

Maintaining the Cold Chain is the responsibility of everyone who handles fresh produce from production to retail sale. A breakdown in temperature control at any stage will impact on the final quality of the product, although the effect may not be visible until several days later.

Without the cooperation of everyone involved in handling fresh produce, the consumer will not be able to enjoy the produce in the best possible condition.

Plan the Cold Chain

For the Cold Chain to be achieved, the chain needs to be established and ready before harvesting starts. Organise staff, equipment, supplies and transport to assist in an efficient operation from harvest to dispatch. This will make management of the Cold Chain easier and reduce the risk of damage to produce.

START THE COLD CHAIN AT HARVEST

- Harvest produce early, in the cooler hours of the day.
- Irrigation can be used to minimise field heat in some products, but only if it does not hinder harvest access or reduce the quality of the produce.
- Protect the harvested produce from the sun by placing in the shade and covering with reflective foil blankets.
- Construct a shade cover on picking platforms to keep produce in the shade.
- Transport produce to the packing shed regularly so that it can be cooled within the times given in the table below. Cover produce during transport to reduce air flow over the produce.

How soon do I need to start cooling?

This table provides a guide to the maximum hours from harvest to start of cooling. It is based on the perishability rating of the produce and the difference between produce harvest temperature and recommended storage temperature.

Temperature Difference	Product Perishability Rating			
	Very High	High	Moderate	Low
0 - 5°C	4 hrs	8 hrs	18 hrs	36 hrs
5 - 12°C	3 hrs	5 hrs	12 hrs	24 hrs
12 - 25°C	2 hrs	3 hrs	8 hrs	18 hrs
> 25°C	1 hr	2 hrs	4 hrs	12 hrs

COOL FACTS

- ④ Produce on the top of bins or boxes can rapidly exceed 40°C when standing in the sun.
- ④ Produce temperatures change rapidly with increased air movement from either natural breeze or during open transportation.

RAPID COOLING

Rapid Cooling systems maximise postharvest quality by quickly reducing produce temperature. Systems available include vacuum, hydro or forced-air cooling. The “Produce Handling Guidelines” wall chart provides a guide to suitable cooling methods for many products. The most suitable cooling method to use depends on:

- Product perishability
- Sensitivity to immersion in water
- Susceptibility to water loss
- Optimum storage temperature to be reached
- Volume and value of product
- Type of packaging used
- Range of products to be cooled
- Length of the harvest season.

- Ensure that the cooling system is well maintained and working efficiently before use.
- Load produce into the cooling system as rapidly as possible after receipt.
- Measure initial produce pulp temperature to determine the amount of cooling required.
- Remove produce from rapid cooling system when the required pulp temperature is reached.
- If the amount of product exceeds the capacity of the cooling system, use the cooling priority table on the next page to determine which produce to cool first.

COOL FACTS

- 4 Economic consideration will affect the type of cooling system to be used – high capital investments and operational costs have to be recouped. An expensive system may not give the necessary returns in the markets you are supplying.

Which product should I cool first?

This table provides a guide to cooling priorities when more than one product requires Rapid Cooling. It is based on product perishability and the difference between product temperature and desired storage temperature. Cool the lowest number first.

Temperature Difference	Product Perishability Rating			
	Very High	High	Moderate	Low
0 - 5°C	7	10	13	16
5 - 12°C	4	8	11	15
12 - 25°C	2	5	9	14
> 25°C	1	3	6	12

What if the product will not be packed immediately?

When produce is not packed immediately after harvest, it should be kept at near optimum storage temperature while waiting for packing. During this time product temperature should not exceed optimum storage temperature by more than the °C indicated.

Time to Packing	Product Perishability Rating			
	Very High	High	Moderate	Low
Same day	2°C	5°C	10°C	20°C
Next day	0°C	2°C	5°C	10°C
More than 1 day	0°C	0°C	2°C	5°C

KEEP PRODUCE COOL DURING HANDLING

- Keep the packing shed as cool as possible. Depending on conditions, consider installing –
 - A refrigerated packing area
 - Air conditioning
 - Evaporative cooling
 - Shed insulation
 - Sprinklers on the roof
 - Shade trees and grass
- Minimise the time the product spends out of the coolroom during grading and packing.
- Measure produce pulp temperature after handling procedures to determine whether rapid re-cooling is necessary (see table on next page). If not, produce should be placed directly in the cool room.
- Set a maximum “on packing shed floor” time for the produce being handled, taking into account product perishability and packing shed conditions.
- For some products (especially slow accumulating sizes and smaller volume packing operations) consider moving packed produce from the packing line directly to the cool room and palletising to common sizes inside the cool room.

COOL FACTS

- ④ Produce warms rapidly on packing lines, with smaller sized products warming faster than larger products.
- ④ The greater the difference in temperature between the product and the packing shed air, the faster the product will warm.
- ④ Handling systems which involve immersion of produce in water can rapidly change produce temperature.

Do I need to use Rapid Cooling after packing?

The need for Rapid Cooling after packing is dependent on the perishability of the produce and the difference between the produce pulp temperature and the recommended storage temperature. Use the table to decide whether Rapid Cooling is required.

Temperature Difference	Product Perishability Rating			
	Very High	High	Moderate	Low
< 5°C	Yes	No	No	No
5 - 10°C	Yes	Yes	No	No
10 - 15°C	Yes	Yes	No	No
> 15°C	Yes	Yes	Yes	No

Note: Rapid Cooling may be necessary for some of the “No” ratings if time from packing to shipping is short, as produce should be at the required storage temperature before shipment.

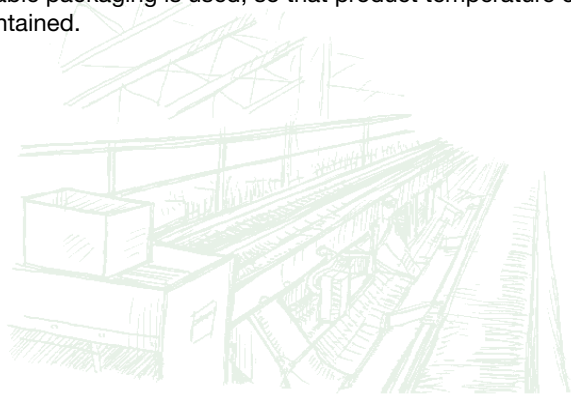
CHOOSE THE BEST PACKAGING

To effectively cool and maintain the temperature of the product, the cooling system and packaging type used need to be coordinated. This includes all packaging used - bags, trays, boxes, box liners, pallets, pallet wraps etc.

Factors that need to be considered include:

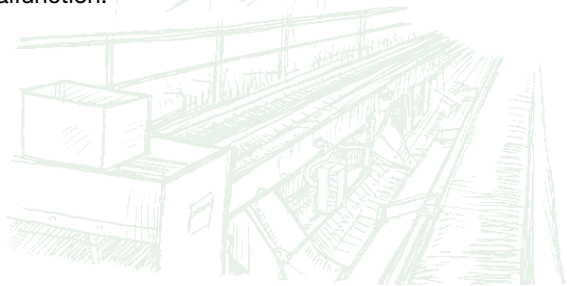
- Ventilation – vital for most forms of cooling
- Product protection – to minimise bruising and crushing
- Strength – to cope with humidity levels, potential water contact through hydro-cooling or icing, weight of product, handling consolidation and transportation
- Insulation – may be required during air transport or for iced products
- Modified atmosphere – requires specialised packaging
- Presentation at point of sale
- Labelling.

If product consolidation is to occur at a separate facility, ensure suitable packaging is used, so that product temperature can be maintained.



STORE AT OPTIMUM TEMPERATURE

- Set coolroom to the optimum temperature for the product, then measure product pulp temperature and adjust thermostats to ensure optimum storage temperature is achieved.
- If the product is susceptible to chilling injury, the anticipated time in storage needs to be considered.
- When storing produce at temperatures near 0°C, be careful not to freeze produce. Watch for cold pockets due to irregular air movement patterns, and cover tops of bins or pallets directly under or exposed to the cold air from forced draft coils.
- Before storing multiple products in a single coolroom, determine the compatibility of the products, based on -
 - optimum storage temperatures
 - ethylene producers or sensitive to ethylene
 - ability to induce off odours or flavours in other products.
- Where possible use separate cool rooms for the rapid removal of field heat and the storage of cooled produce.
- Fit clear plastic curtains to the cool room door to help maintain room temperature when the door is open.
- Install automatic or mechanised door openers so that doors can be opened and closed from forklifts.
- Install an alarm to provide early warning of coolroom malfunction.



KEEP IT COOL DURING DISPATCH

- **DO NOT** load warm produce. Refrigerated containers and trucks do not cool produce, only maintain its temperature.
- Establish an efficient loading operation at the packing shed. Loading docks that allow direct access to the cool room should be installed and used whenever possible. If loading docks are not available, load truck or container in the packing shed or a shaded loading area as quickly as possible.
- Minimise the time that the product is out of the coolroom by palletising and preparing the product for loading in the coolroom and leaving produce in the coolroom until truck or container is ready for loading.
- Measure produce pulp temperature at time of loading and record on consignment note.

COOL FACTS

- 4 Curtain sided (tautliner) trailers are not suitable for long distance and/or low temperature transport as most manufacturers will only guarantee temperature control to 15°C less than ambient.
- 4 Unless using refrigerated loading docks, pre-cooling of the van or container is of limited value. Pre-cooling can result in excess condensation leading to ice on the evaporator coils and less efficient operation once loading is completed.

ENSURE THE COLD CHAIN CONTINUES

- Use transport with suitable cooling and insulation to carry the product at the optimum temperature for the entire length of the journey.
- Select the best carrier for the job, taking into account reliability, vehicles, service and experience in handling fresh produce.
- Prepare contingency plans in conjunction with carriers in case of equipment breakdown or other problems during transit.
- When consolidation, trans-shipment or similar is necessary, ensure the handlers have both the facilities and well developed handling practices to ensure the Cold Chain is maintained.
- Coordinate all forms of transport used through to the final destination to ensure Cold Chain best practices are followed.
- Data loggers can be used to monitor the effectiveness of the Cold Chain beyond the packing shed to the final destination.

Having produced and packaged a top-quality product, ensure this quality is maintained through careful continuation of the Cold Chain right through to the end consumer.

Fruit and Vegetable Perishability Ratings

VEGETABLES

Product	Rating
Asparagus	Very high
Beans	Very high
Beetroot	Moderate
Broccoli	Very high
Brussels sprouts	High
Cabbage	Moderate
Capsicum	High
Carrots	High
Cauliflower	High
Celery	High
Chinese cabbage	High
Cucumber	High
Eggplant	High
Garlic	Low
Leeks	High
Lettuce	Very high
Mushrooms	Very high
Onion	Low
Parsnip	Moderate
Peas	Very high
Potato, Sweet Potato	Low
Pumpkin	Low
Radish	Very high
Rhubarb	High
Shallots/spring onion	High
Snow peas	Very high
Spinach	Very high
Squash (hard shell)	Low
Sweet corn	Very high
Tomato, mature green	Moderate
Tomato, coloured	High
Turnip	Moderate
Zucchini	Very high

FRUIT

Product	Rating
Apple	Moderate
Apricot	High
Avocado, green	Moderate
Avocado, ripe	High
Banana, green	Moderate
Banana, ripe	High
Berries	Very high
Cherry	Very high
Fig	High
Grape	Moderate
Grapefruit	Moderate
Honeydew	Moderate
Kiwi fruit	Moderate
Lemon	Moderate
Loquat	High
Lychee	High
Mandarin	Moderate
Mango	High
Nashi	Moderate
Nectarine	High
Olive	High
Orange	Moderate
Papaya	High
Passionfruit	High
Peach	High
Pear	Moderate
Persimmon	Moderate
Pineapple	Moderate
Plum	Moderate
Quince	Moderate
Rockmelon	Moderate
Strawberries	Very High
Watermelon	Moderate