PACKING HOUSE - CALIFORNIA

01 A GUIDE TO BEST PRACTICES

PACKING HOUSE CALIFORNIA

HARVESTING AND TRANSPORT TO THE PACKING HOUSE

Although the harvesting of fruit is not a direct packing house operation, it is sometimes controlled by the packing house. In some instances, picking teams are operated by the packing house, and in most instances the decision to pick as well as what fruit to pick (complete crop or only certain sizes), and how much to pick per day is dictated by the packing house which needs to plan packing on the basis of incoming fruit, capacity and customer demands. The packing house therefore does have a role to pay in harvesting.

In addition to playing a role in overall delivery of fruit for packing, which affects the through-put of the packing operation, the eventual fruit quality can be considerably affected by fruit attributes at the time of harvest, as well as the harvest process.

Although fruit from Californian packing houses is mostly for internal USA consumption, and even the longest shipping distances to the East Coast are not longer than a few days, storage potential for marketing purposes and ripening physiology are nevertheless important. Certain quality aspects can be determined prior to harvest which may indicate potential for storage, the risk of chilling damage, shelf life and ripening physiology.

It has been shown that an analysis of fruit mineral constituents, especially nitrogen and calcium, is a useful tool to predict post-harvest shelf life, as well as possible development of internal disorders such as grey pulp, and resistance to chilling injury. It would be a good idea to have analysis from early in the season to the time of picking, to see the trends in changes as well as actual levels. However, an analysis for each orchard at least one month before minimum maturity is advised. Levels of nitrogen at less than 1% and showing a decreasing trend, plus calcium at 0.05% or higher, would indicate good quality fruit. Using this information, packing houses are able to determine risk for internal or external disorders,

as well as shelf life and ripening behavior. Lower calcium will cause faster ripening, higher ethylene evolution, higher fruit respiration and therefore higher risks for quality defects. These factors can be included in the packing house marketing and distribution plans, with higher risk fruit going to closer markets, short storage periods or food service where fruit are to be ripened and used within a short time.

At certain times of the year, and in certain orchards, especially in cool coastal areas, fog or rain may be present at the time of picking. This leads to fruit having a high turgidity, and the lenticels may be very easily damaged during picking and transport to the packing house. This leads to lenticel damage resulting in black spots on the fruit surface after packing. If fruit are to be stored for some time, the areas of damage may appear similar to chilling damage. These areas of the fruit surface appear to become more sensitive to low temperatures. Wherever possible, do not pick wet fruit. It is also advisable to cease irrigation at least one day prior to harvesting.

There is also the probability that weather conditions can be very hot and dry at the time of harvesting. While it is not practical to stop picking on such days, the high temperatures and low relative humidity will affect fruit quality and shelf life by increasing post-harvest water loss and maintaining high fruit respiration. The Q10 principle implies that for every 10 degrees increase in temperature fruit shelf life halves. If it can be arranged, picking during cooler times of day or even at night, can substantially help decrease the effects of hot and dry conditions. Fruit should also be kept as cool as possible, and transported to the packing house as soon as possible.

The picking operation is very important, and the first point in the supply chain where fruit damage can occur. Packing houses should check the protocols of picking companies to ensure that fruit will incur as little damage as possible. If packing houses are responsible for picking, it is essential that good protocols and supervision of the picking operations is undertaken.

Pickers need to be trained to handle the fruit very carefully, and understand the consequences if fruit is damaged. Finger nails of all pickers need to be cut very short, as finger nails can easily damage fruit. When placing fruit in picking bags, it must not be rubbed against the side of the bag and must be placed carefully in the bag. No fruit should be allowed to fall on the ground, and any fruit that does must not be included.

When emptying the fruit from the picking bag into the bulk bin, fruit must be placed carefully so that as little damage as possible is done. The supervisor needs to keep a check of this.

In order to decrease the potential of stem end rot, the picking clippers should be cleaned with a sterilizing compound at regular intervals. When a picker empties the picking bag is a good time to do this.

On arrival in the orchard, the bulk bins must be checked that they are clean and free of sand, leaves or any branches. There should be a soft, sponge base in the bins. The bins must be placed on a wooden pallet when delivered to the field. This is to stop sand accumulating on the base, which will fall into other bins and damage fruit when the bins are loaded for transport to the packing house. Sand in the bins will also fall onto the pack line when the fruit is dumped, and will cause damage to the fruit. The same arrangement will be needed at areas where the bins may be accumulated before transport to the packing house. While bins are being filled, as well as when waiting for transport to the packing house, they should be placed in the shade or under a shade structure if large numbers are to be accumulated before transport to the packing house. When full, the bins can also be covered to keep fruit out of direct sun. For convenience, the cover can be the same as used in the bottom of the bin.

Full bins should be transported to the packing house as soon as possible, especially if conditions are hot and dry. For good fruit quality the fruit should lose as little water as possible after harvest. Only if conditions are cold and wet, should bins be left in the orchard for more than a few hours. In the latter case, if it is necessary to pick, fruit can stand in the orchard to lose some turgidity before transporting them, to decrease the chance of lenticel damage.

It is expected that once harvested, fruit will be transported to the packing house, graded and packed in accordance with the individual packing house protocols and market requirements. Thereafter, pallets need to be cooled or pre-cooled prior to transport. This is a critical component of the supply chain, and is therefore included in the manual.

The temperature for the cooling protocol is chosen based on fruit maturity and market intentions.

MATURITY DETERMINATION

Fruit maturity is based on dry matter of the fruit. The dry matter is determined using the method outlined in the California Food and Agriculture Code of Regulations Article 11 Avocados section 1408.3. The minimum dry matter is taken as 20.8%, and in addition fruit size, fruit weight and date of release is imposed.

However, although the Agricultural Code of Regulations forms the legal basis for measuring the dry matter of avocados, and helps to define the minimum starting date for harvest, it alone does not necessarily provide the information needed for best practices leading to ideal fruit quality in all markets.

LOGISTICS PLANNING AS RELATED TO DRY MATTER

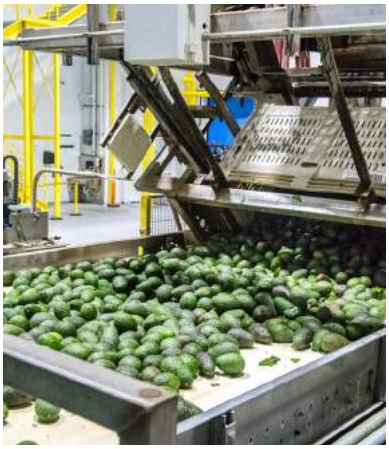
Packing houses need to be aware of the maturity of fruit on a fruit size basis as well as the variability, especially near the start of the season, for each consignment of fruit arriving from the field. This is especially important where packing houses are packing fruit from a number of producers with variable tree age and condition. This is particularly important for making decisions concerning fruit cooling and for marketing to determine the optimal shipping destination. Therefore, it is recommended that on arrival at the packing house, if the dry matter of the consignment is not already known, samples should be taken and tested. These results will help to determine the correct temperature for cooling the fruit as well as shipping.

When planning packing for the following week, it is helpful if the packing house makes arrangements to receive fruit in batches of similar dry matter to enable as much consistency as possible within pallets for cooling in each cooling chamber. It is very important to try as best possible, not to have mixed maturity fruit within a box, pallet or consignment. The ripening characteristics will be different, and mixed maturities will result in checker board ripening if within a box, and create great difficulties for correct choice of cooling, as well as downstream for fruit ripeners, re-packers and within the retail sector. The objective of pre-planning as described, is to decrease errors in choosing suitable cooling regimes, as well as ensuring as uniform a pack as possible. If the fruit packed is very variable in maturity, a higher incidence of mixed ripening will occur, which creates considerable problems at retail level and if fruit is to be pre-ripened before sale.

THE PACK LINE

There are many different combinations of equipment on the pack line, with variations in washing, brushing, drying, grading and packing. There is no single best practice. However, it is essential to ensure that minimal fruit damage occurs on the pack line. Because of the generally rough nature of Hass fruit (compared to most other avocado cultivars) the potential for damage, and in particular, lenticel damage, is high. Damaged lenticels cause increased water loss, as well as result in notable blemish at destination. In addition, it is possible that damaged lenticels will increase the possibility of chilling damage.

It is suggested that the pack line be regularly checked for the potential to damage fruit. Each section of the line should be checked separately, to isolate any areas causing damage. Fruit can be removed from the line and carefully checked for damage. Another very simple technique, is to wrap a number of fruit in thin aluminum foil, and place them on the pack line amongst other fruit. At the end of each section (for example brushes) remove the fruit from the line and inspect for any damage of the aluminum foil. Damage is a good indication of a problem within that section. See also section on packing house cleaning.



Dump

Wash

Grade

Sticker

Pack

Stack

FRUIT COOLING

Fruit cooling is probably the most important operation within the logistics chain, as this sets the parameters for fruit quality, by being the major controller of fruit physiological changes from harvest to sale. This will dictate the rate of ripening, as well as shelf life, and influence the potential for post-harvest defects. The cooling parameters set at packing, as well as the degree to which these have been effectively implemented, are critical to the success of the entire cold chain.

The temperature to which fruit is to be cooled depends on:

- Dry matter
- Distance to destination
- Potential storage requirement
- Picking season, early or late for the particular fruit origin

Based on dry matter, approximate temperatures are:

- Dry matter < 23% use 45°F
- Dry matter 23-26% use 42°F
- Dry matter >26% use 40°F but as dry matter approaches 30% this can be decreased to 39°F. Late season high dry matter fruit with a short supply chain including fruit from Mexico may be shipped at a temperature as low as 38°F

Do not adjust low dry matter fruit (<23%) or early season fruit to a lower temperature than stated above, as chilling damage may occur in fruit stored for longer than 2 weeks. At low dry matter the temperature indicated will not result in premature ripening provided there are no significant cold chain breaks. The closer the market or shorter the intended storage period, the more flexibility there is for cooling fruit to a slightly higher temperature than those shown.

There are three potential cooling points in the packing house cooling operations.

REMOVAL OF FIELD HEAT ON ARRIVAL AT PACKING HOUSE

The first point is on arrival of fruit from the field. Packing houses have different operations at this point. However, it is necessary to ensure that the time between arrival and final cooling is as short as possible. The faster that field heat can be removed the better the potential for extended shelf life and the slower the subsequent quality deterioration. Packing houses have a number of options for temperature control of fruit on arrival.

- Picking bins or boxes are off loaded into a holding area before moving into the packing house. The holding area is simply a shaded area. This is the least satisfactory situation, as field heat is not substantially removed before final cooling, and a cooling delay of up to 24 hours is often recorded, especially during peak packing periods. For best practice, fruit should be moved into the packing house as soon as possible, and not longer than 24 hours.
- A cooled area. The temperature of this area is best at approximately 56°F to 59°F.
- Some packing houses use hydro cooling of fruit as soon after arrival as possible. Fruit are best hydro cooled to a temperature of 56°F to 59°F. Fruit should be packed as soon as possible after hydro cooling or held in a temperature controlled area at approximately the same temperature as stated above. If fruit are hydro cooled, precautions are needed to ensure the water which is re- circulated is clean and free of potential pathogens. This would constitute a Hazard Analysis and Critical Control Point (HACCP). Fruit should be moved into the packing house for packing or stored at the same temperature as target fruit temperature after hydro cooling.

The most effective packing house entry point cooling system is hydro cooling.

Fruit should not be held for more than 24 hours in any system before final cooling.

FORCED AIR COOLING AFTER PACKING

The second point of cooling is after packing and palletization. The purpose of this cooling point is to cool fruit to the temperature of shipping.

When loading pallets into forced air cooling chambers, ensure that as far as possible, only the same box type are loaded, because the air flow characteristics may otherwise differ, and cooling will not be even. Also ensure that there are no gaps between pallets within each pallet row (normally two rows of pallets with a tunnel or plenum between them approximately the width of a pallet), and have an even number and height of pallets as far as possible. If there are incomplete pallets due to a lack of boxes of a size at the end of the packing day, it is probably preferable to cool these rather than leaving them for another 24 hrs. before cooling. However, these pallets should be almost complete, and placed at the back (cold tunnel door side) of the line of pallets, so as to disrupt air flow as little as possible. To ensure that air is pulled through the pallets, ensure that the top and back (door end) of the pallets is adequately covered by a tarpaulin, so that air is pulled by the fan only horizontally through the sides of the pallets.

Do not attempt to cool too rapidly, as wind chill damage may occur on the surface of the fruit. As a guide, it is likely that cooling will take approximately 7 or more hours for 20 pallets, although the starting temperature of the fruit will greatly influence this. Sufficient temperature sensors should be placed in the fruit pulp both inside the rows of pallets and outside, at the front, center and back of the row of pallets to monitor the cooling, so as to ensure that pulp temperature reaches the desired point within all pallets. An approximate guide to the air flow rate required is 1 l sec^{-1} kg^{-1}. However, this is only a guide and the actual air flow rate will depend on both the design of the cooling equipment and the type of packing material used for the fruit, with some boxes having greater air flow through them than others. The change in pulp temperature of the fruit should be monitored. The rate of cooling between the back and front of the pallet rows will differ slightly, so the sensors will not reach the objective temperature at exactly the same time, but the cooling rate is correct when all sensors reach the set objective temperature at approximately the same time. It is particularly important that some sensors do not show a temperature considerably below the set temperature, as chilling damage may then occur to some of the fruit. This would be an indication that the rate of cooling is too rapid. It is also particularly useful to check the differential as well as rate of temperature change between fruit on the outside and inside of pallets. If fruit temperature on one side of a pallet is considerably different to the other, and one side is decreasing much more rapidly than the other, it is a good sign that air flow is too rapid. This could lead to chilling damage on one side of the pallets or inadequate cooling on the other. Air flow rate should then be decreased. When setting the air delivery temperature, do not set the temperature lower than 1°F (0.5°C) below the intended target fruit pulp temperature. It is particularly useful to also monitor external fruit temperature.

This can be done using an infrared thermometer, and fruit at positions similar to the pulp temperature measurements should be used. Again, the external temperatures should not decrease substantially below set temperature, otherwise chilling damage can occur. To ensure that cooling throughout the pallets has been adequate, both external (outside of the pallet) and internal (the side of the pallet facing into the plenum) should show similar fruit pulp temperatures, and that both are close to the set temperature. A variation of 1°F (0.5°C) is acceptable. Further, fruit pulp temperature will tend to be 0.5°F to 1°F (0.28°C to 0.5°C) above the set temperature.

When running the forced air cooling unit, it is preferable to always maintain the air flow in the same direction. If air flow is reversed after a number of hours to obtain the same fruit temperature on the inside and outside of the pallets, there is the possibility that fruit in the center of the pallets is not adequately cooled, without the operator realizing it.

In order to decrease the potential for fruit dehydration during cooling, which in turn will affect the rate of ripening, shelf life and external appearance, the cooling chambers should be humidified. This can be done by applying water through humidifiers attached to the heat exchanger unit, or by ensuring the floor of the cooling chamber is wet before starting the cooling cycle. It is not sufficient to just monitor cooling chamber humidity and assume that an ideal relative humidity reading of 85-95% is correct. The air loses water when it passes over the cooling coils, and this may then be replaced by water loss from the fruit, providing a false reading. The fruit contained in 20 pallets can lose as much as 20 gallons of water during a cooling cycle. Therefore, this needs to be added to the room to prevent excessive water loss from the fruit.

STORAGE AFTER COOLING

Fruit will need to be stored after cooling until shipment. The cold rooms used for storage should be set at the intended shipping temperature, and fruit stored for the shortest time possible before shipping, taking into account logistics and marketing considerations. This holding room cold area is not suitable as a fruit cooling zone, and fruit needs to be adequately cooled in forced air cooling tunnels before being placed in the cold storage chambers. The cooling in this area is static cooling, and there is a possibility that fruit on the inside of pallets will not be adequately cooled if not already cooled when placed in the holding room.

The ideal holding room will have a pre-installed stacking system where pallets may be stacked and are separated sufficiently to allow air flow between them. If not, pallets should be placed in the cold room in such a way that sufficient air flow surrounds them. A minimum of 4 inches should be maintained between pallets. The cooling system fans should be placed such that there is an even air flow throughout the room.

Air delivery in the holding room should not be set at more than 2°F (1°C) below the target fruit pulp temperature. This is particularly important when the cold room contains fruit awaiting shipment which is less mature and was pre-cooled to a temperature higher than new fruit coming into the room. For a short overlap period, the higher temperature should be used. Air temperature should be checked on a daily basis, and fruit temperatures checked on a random basis to ensure target temperatures are being maintained.

As in the cooling tunnels, the holding room should be humidified. The same specifications and procedures as outlined for cooling tunnels can be used.

Before dispatch, pallets should be marked, or suitable documentation provided with the consignment, to indicate the desired temperature at which to transport and store the fruit. This will be especially useful in ensuring the fruit is handled downstream in the manner desired.

VENTILATION OF COLD ROOM AND COOLING TUNNELS

With constant usage over a number of months, there is a possibility that the carbon dioxide and possibly ethylene levels within cold rooms and cooling tunnels could increase. It is also a common practice for packing houses to hold quality control samples. These also become a source of ethylene. Ethylene build up in particular is problematic as it affects the shelf life and quality of avocado fruit. All cooling tunnels, as well as cold room storage areas and fruit transfer zones should be regularly checked (at least once per week) for buildup of gasses. Ethylene levels should not be detected. This becomes more critical later in the season when fruit is more mature and at peak times during the season when cold stores tend to be storing more fruit before dispatch.

In the case of ethylene, ethylene scrubbers are available, and are used in some packing houses to aid in ensuring there is no ethylene build-up. Regular venting of free air should also be undertaken to prevent a buildup of gasses, especially ethylene. If ethylene scrubbers are installed, it does not remove the need to vent the area with fresh air. Venting with fresh air should be done for 15 to 20 minutes with fans running. Depending on volumes of fruit moving through the cooling and holding areas, this may be needed at intervals between 2 and 6 days. Approximately 3 to 4 air volume changes may be needed to ensure gas build-up is eliminated.

To prevent rapid build-up of gasses as described, no internal combustion engine equipment should be operated in or near cold rooms. Trucks delivering fruit or at the loading docks to be loaded with cooled fruit should not be running when the loading dock doors are opened, and sufficient time after truck engines are stopped should be allowed for gas emissions to disperse.

PACKING HOUSE CLEANING

It is essential that the entire packing house, cooling tunnels, cold rooms and all packing house machinery and equipment be maintained in good condition and cleaned on a regular basis. In particular, two issues are of importance.

The first relates particularly to aspects which could damage the fruit surface, often causing lenticel damage, such as sand, leaves and deposits which form on rollers and belts in the pack line. While every effort should be made to limit the introduction of such components, it is inevitable that some field originating matter will be introduced to the packing house with the fruit. General cleaning should take place after every operational shift. Constant moving of fruit over brushes, rollers and belts, results in wax build-up (from fruit surfaces) on pack line equipment. It is particularly important that brushes be cleaned regularly, as they can become important sources of abrasion and fruit damage. The pack line should be inspected for such deposits and any defects such as broken padding on drop plates or corners, which can damage fruit, on a regular basis. A general inspection should be done daily, with a more careful inspection and cleaning if required, at least once per week.

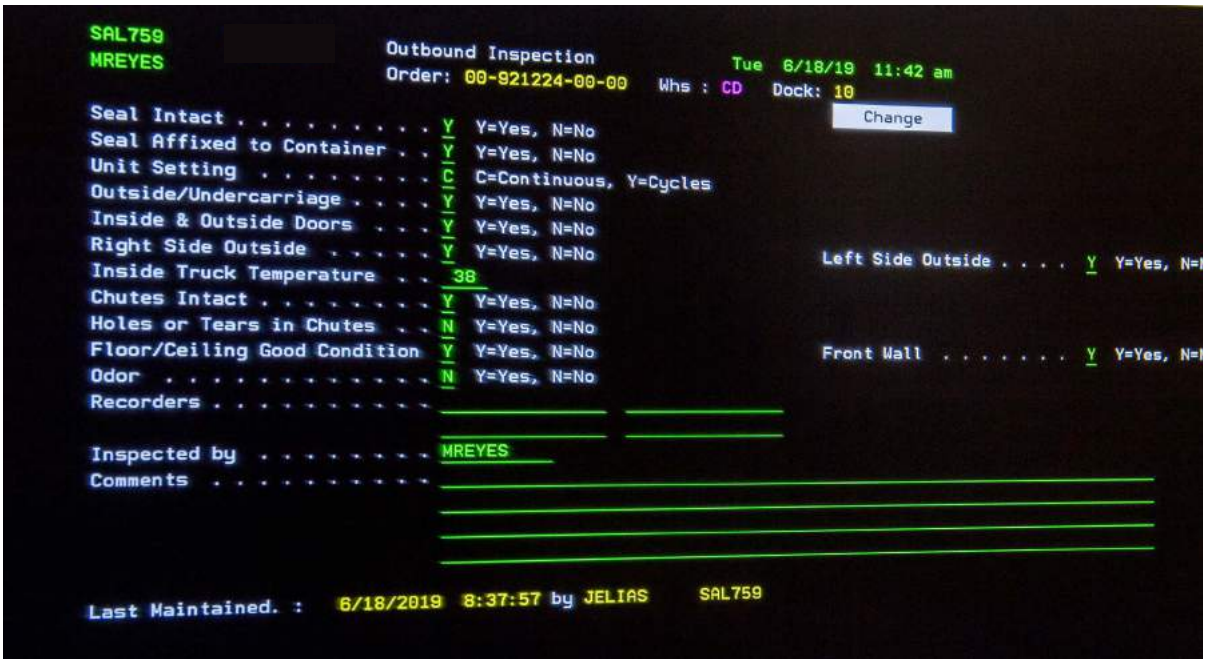
The second issue of importance relates to sanitation, and is particularly important where high humidity conditions (such as cooling tunnels and cold rooms) are present, or water is applied such as hydro cooling (if used) or fruit washing. Suitable sanitizing products should be added to any applied water for cooling or washing, and re-cycled water should be filtered to ensure not only good sanitation, but the removal of potentially abrasive particulate matter. High humidity areas such as cooling tunnels and cold rooms must be regularly cleaned with a suitable sanitizing compound.

TRANSPORT TRUCK LOADING

Correct loading of transport trucks is essential to ensure the cold chain is not broken, both at initial loading of the fruit and at the time of unloading, especially if fruit is to be unloaded at more than one destination. This aspect is discussed under the packing house section, because the operation sets the parameters for the entire transport operation.

Transport trucks should be positioned at the loading dock such that there is a good seal between the open truck and the loading dock, to minimize loss of cold air from the cold room or pallet warming during loading.

Before loading, the truck must be checked for cleanliness and operational correctness (readiness for operation) in accordance with product safety regulations. It is also essential that the truck is already cooled to the correct shipping temperature. Incorrect temperature at loading will be difficult to rectify without compromising fruit temperature.



Before loading, pallets should be checked for correct fruit pulp shipping temperature. A single fruit half way up a pallet can be used for this purpose. A hand held digital thermometer can be used, with a fruit probe inserted into the pulp of the fruit. Ideally, the position should be marked, so that the same fruit can be used for future temperature checks. The probe should be sterilized with a sterilizing agent after each reading. A temperature record needs to be kept. Fruit should not be loaded if temperature is not within the target temperature (+1°F or 0.5°C) unless approval is obtained. The temperature devices must have the calibrations checked at regular intervals to ensure correctness. Such measurements and records are essential to ensure temperature management is correct at the time of loading, and ensures correct responsibility for product care during all sectors of the logistics chain.

Pallets should be loaded such that the last pallets scheduled to be delivered at destination are the first to be loaded, to ensure as little cold chain break as possible at destination. Pallets should also be loaded such that there are no gaps between them, to ensure adequate air movement of cold air through the pallets.

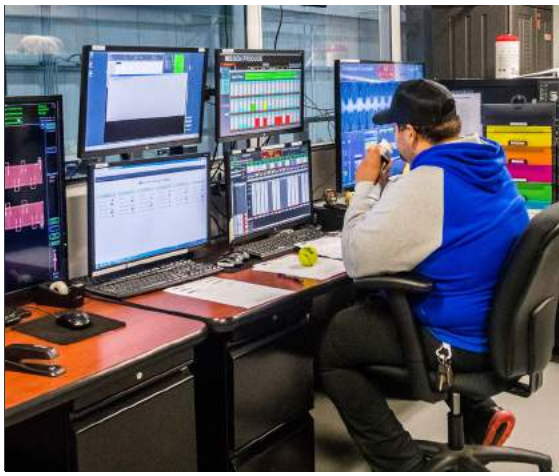
At loading, temperature tracking devices need to be inserted into boxes of pallets at the front and rear at least, of the truck. Ideally, if there is more than one consignment of fruit to be delivered (more than one destination), temperature tracking devices should be included in each consignment. The reason for this is that failure in the cold chain may occur at various points down stream, and if only one destination point is tracked, failures may occur at other points in pallets going to a different destination, without being tracked.

The type of temperature recorder used is of importance with regards to the reliability and usefulness of information collected. While a minimum requirement could be considered to be a recorder which requires removal at some point and downloading of data, with subsequent reporting of any out of protocol information, the usefulness relies on the timely actions of downstream operators, essentially at the final delivery point of the fruit. Fruit may be destined for an intermediate point, such as a regional distribution center, before further delivery. The net result of this, is that any deviations from protocol which may occur may only be found long after the event, making timely remedial action difficult or impossible. The alternative, is the use of a real-time tracking device, which can be checked by the packing house until final delivery point is reached. This allows for timely remedial action to be taken should a deviation from protocol be noted. It also allows timely checking of transport progress. At least one such device should be included in each consignment. In terms of fruit quality management, such devices allow for active temperature management and cost effectiveness.

ADMINISTRATION OF QUALITY MANAGEMENT AT PACKING HOUSE LEVEL

The packing house, as initial handler of the fruit and the entity that packs and prepares fruit with knowledge of fruit initial quality and final intended destination, should be responsible for setting protocol parameters, and tracking progress through the supply chain. Suitable check points and documentation where appropriate need to be implemented by packing house management. It is necessary for a successful quality management program that the entire distribution chain be coordinated, and the packing house is the ideal place for this, as they have contact with all components of the chain, including producers and marketers. Appropriate instructions for all parts of the logistics chain should be generated, and a copy should accompany each fruit consignment. These instructions could be linked to or attached to the bill of lading, which would make them part of the carrier contract.

It is therefore suggested that the entire quality management operation for each consignment of fruit from a packing house be controlled and monitored by a quality management specialist at the packing house.



ROLE OF CALIFORNIAN PACKING HOUSES AND IMPORTER RECEIVING FACILITIES IN RELATION TO IMPORTED FRUIT

There are some instances where packing houses in California as well as receiving facilities belonging to importers act as a distribution hub for imported fruit. The quality protocols for distribution hubs as well as those for packing houses (where appropriate) should be used.

ROLE OF CALIFORNIAN PACKING HOUSES AND IMPORTER RECEIVING FACILITIES AS RE-PACKERS

Some Californian packing houses as well as receiving facilities belonging to importers may act as re-packers for fruit from other origins than the normal fruit packed by them on the pack line in the case of packing houses, or from multiple origins in the case of importers. The quality protocols relating to re-packers as well as the packing houses themselves should be used.

ACTION ITEMS

PACKING HOUSE CALIFORNIA

- ☐ Ensure all staff members are sufficiently trained for the task as well as overall packing house objectives
- ☐ Determine dry matter and maturity level for all consignments and size categories
- ☐ Take into account field origin of fruit and fruit quality aspects e.g. fruit nitrogen and calcium concentrations
- ☐ Plan the logistics
- ☐ Determine cooling, holding and shipping temperatures
- ☐ Ensure cooling rates are appropriate
- ☐ Load cooling tunnel to ensure even cooling at appropriate rate
- ☐ Store fruit until shipment at appropriate temperature
- ☐ Check that transport conforms to requirements and temperature is correct
- ☐ Load transport to ensure temperatures are maintained
- ☐ Add temperature tracing device to fruit
- ☐ Regularly check cooling tunnels and holding rooms are ventilated and that there is no build-up of gases especially ethylene
- ☐ Check packing house equipment for cleanliness, areas of potential fruit damage and sanitize where necessary
- ☐ Track progress of each consignment, including fruit temperature
- ☐ Take appropriate actions for any items out of protocol