Transport of Perishables

### Cherry Life

<table>
<thead>
<tr>
<th>Temperature (°F)</th>
<th>Respiration Rate</th>
<th>Life (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>40</td>
<td>15</td>
<td>8</td>
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<tr>
<td>60</td>
<td>35</td>
<td>3</td>
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<tr>
<td>70</td>
<td>35</td>
<td>3</td>
</tr>
</tbody>
</table>
Before Loading Trailer

- Equipment is in good condition

Clean floor & walls

Chute attached, Seals intact
Before Loading Trailer

- Equipment is in good condition
- Cooled to transport temperature
Before Loading Trailer

- Equipment is in good condition
- Cooled to transport temperature
- Reefer off when doors are open

Loading Product

- Product is well cooled
- Pallet loads are unitized
- Keep an air space around load
Trailer Heat Gain

Stone Fruit & Table Grapes

Product warming in 3.5 days transport, average of 7 loads

- Solid bulkhead, full air chute, loaded on palettes, staggered or centerline loaded.
- Average air temp = 31° F
Frozen Products

Product warming in 3 - 4 days transport

-3°C (-5°F)  3°C (5°F)  7°C (13°F)

No chute

Solid bulkhead, floor loaded.
Set point temp = -18°C (0°F)

LeBlanc, et al., 1994

Airflow in Trailers

wall channel
Centerline vs Staggered Loading

- In 7 loads - no significant difference in average load temperature.
- Other tests show about 1°F increase in product temp loaded next to wall vs away from wall.

Centerline vs Staggered Loading
Centerline Air Bags

Staggered Load Offsets
Airflow in Trailers

Rear Brace
Airflow in Trailers

Loading

- Fruit is well cooled.
- Pallet loads are unitized.
- Keep an air space around load.
- **Meet highway weight limits.**
Single Pallet Problems

Single pallet in front

air bag

Single Pallet

Single pallet allows air to bypass load
Set Thermostat

- For stone fruit and grapes ≤ 34° F

Temperature Recorders
Mixed Load Problems

- Blocked air flow
- Warm produce

Blocked air flow

- Crushed ice on floor
- Hand loaded boxes
- Load dividers
Mixed Load Problems

- Blocked air flow
- Warm produce
- Temperature, ethylene, odor compatibility

Produce Compatibility
Horizontal Air Supply

Carrier: Smart-Air system

wall plenum

FDA Food Safety Modernization Act

- **Vehicles and transportation equipment:** The design and maintenance of vehicles and transportation equipment to ensure that it does not cause the food that it transports to become contaminated.
- **Transportation operations:** The measures taken during transportation to ensure food is not contaminated, such as adequate temperature controls and separation of food from non-food items in the same load.
- **Information exchange:** Procedures for exchange of information about prior cargos, cleaning of transportation equipment, and temperature control between the shipper, carrier, and receiver, as appropriate to the situation. For example, a carrier transporting bulk liquid non-dairy foods would want to ensure that vehicles that have previously hauled milk will not introduce allergens into non-dairy foods through cross contact.
- **Training:** Training of carrier personnel in sanitary transportation practices and documentation of the training.
- **Records:** Maintenance of written procedures and records by carriers and shippers related to transportation equipment cleaning, prior cargos, and temperature control.

http://www.fda.gov/Food/GuidanceRegulation/FSMA/default.htm
Marine Containers

Airflow In Containers

- high capacity fan
- product
- evaporator
- deep channel floor
Break-Bulk Ships

Package

- strength for 3 weeks at high humidity
- vertical venting
Pallet

- deck boards must support box corners
- no box overhang
- stabilize with netting or corner boards & straps
- 4-way pallet

Package & Pallet Design

- Vents for vertical airflow.
- Pallet is secured.
- Box vents align.
- Boxes extend to edge of pallet.
- Deck boards allow vertical airflow.
Precooling

• cool stone fruit and grapes to 32° F

Before Loading

• prec cool container.
• turn off refrigeration when doors are open.
• do not load with trash in floor or damaged walls or door seals.
Air Flow In Containers

- High capacity fan
- Evaporator
- Deep channel floor

Uncovered Floor

- Air bypasses product

- Product
Do not load above limit line

Block exposed pallet openings and cover floor to deflectors

Loading

Loading Patterns

18 Pallets

20 Pallets

Problem Load

19 Pallets
**Single Pallet in Front**

Air bypasses load

![Diagram of Single Pallet in Front]

**Loading Patterns**

*Horizontal airflow*

- Blocks extend full length of container to direct airflow and stabilize pallets.
- Tight stack pallets to prevent air from bypassing around the pallets.
- Boxes must have box vents on the long sides of the pallet load. Pallets are loaded with the long dimension parallel to the length of the container.
- Hand load boxes on the floor behind the last pallets to cover the floor and pallet openings. Place an air bag at the rear to seal the vertical air supply plenum.
After Loading

• set supply-air temperature control
• set thermostat to $\leq 34^\circ$ F

• adjust air exchange to:
  45 cfm for stone fruit
  15 cfm for grapes
Automatic vent control

- $\text{CO}_2$ & $\text{O}_2$ measurement
- lower ventilation rates
- faster cool down

Thermoking: AFAM+

Air Freight
Pre & Post Flight Handling

Often more than 50% of trip

Product Temperature

Cool product to lowest possible temperature.
**Strawberry Quality**

<table>
<thead>
<tr>
<th>Temperature Pattern</th>
<th>°C</th>
<th>Sound Fruit (%)</th>
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<tbody>
<tr>
<td></td>
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<td>51</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

**Air Freight**

Protect from heating

- Temperature Gain in 8 hr (°F)
  - No wrap
  - Wrap
  - Wrap + coolant
Refrigerated Containers