Reefer units guide for flowerbulb shipment

Auteur: Leo Lukasse (ATO certification)
Date: June 21, 2007
Reefer units guide for flowerbulb shipment

With thanks to

NIEBERDING VERZEKERINGEN BV
Postbus 37, 2180 AA Hillegom

VELDEBOER AGREX B.V.
Agrarische Expertise

K-SERVICES
Presentation outline

- Reefer containers, general issues
- Reefer unit settings
- Project outputs
- Issues for further investigations
Reefer units guide for flowerbulb shipment

- In 2006:
  - 750,000 reefer containers
  - 3,000,000 reefer container shipments (7.5% annual growth)
  - 6500 flowerbulb shipments in reefer containers (= 0.2% of total, ± 0% growth)
  - 80% of flowerbulb shipments come from NL, 60% to US, 35% to Far East
Reefer units guide for flowerbulb shipment

- Reefer container
  - Head space
  - T-bar floor
  - Supply air
  - Refrigeration unit with fan
  - Return air
Factors affecting bulb quality at delivery

**Settings:**
- temperature setpoint
- fresh air vents
- defrost interval
- relative humidity setpoint
- fan speed
- defrost termination temperature

**Climate:**
- temperature
- humidity
- ethylene

**Other aspects:**
- duration of trip
- container U-value
- 20 ft / 40 ft HC
- stowage & packaging
- open space above cargo
- container precooling
- cargo precooling
- open drainholes
- unit's heating, refrigeration, and fan capacity
- moisture, heat and ethylene production of the bulbs
- sorting fusarium prior to trip

**Bulb quality at departure**

**Bulb quality at delivery**
Presentation outline

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### Overview of possible reefer unit settings

<table>
<thead>
<tr>
<th>issue no.</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>temperature</td>
</tr>
<tr>
<td>2</td>
<td>fresh air vents</td>
</tr>
<tr>
<td>3</td>
<td>defrost interval</td>
</tr>
<tr>
<td>4</td>
<td>RH (dehumidification)</td>
</tr>
<tr>
<td>5</td>
<td>bulb mode</td>
</tr>
</tbody>
</table>
Reefer unit setting 1 of 5: temperature

- Supply air temperature (SAT) control
- Usually return air temperature = SAT + {0.5 ~ 1.0 °C}
- Usually cargo temperatures < SAT + 1.5 °C (fans at high speed)
- Cargo temperatures deviate due to:
  - Autonomous heat production
  - Heat / cold ingress from outside
Reefer unit setting 2 of 5: fresh air vents

- Max. capacities (manufacturer specs!):
  - 190 CMH (Daikin)
  - 285 CMH (TK)
  - 225 CMH (Carrier)
Reefer unit setting 2 of 5: fresh air vents

- Fan speed is affected by:
  - 50 / 60 Hz
  - economy mode
  - Dehumidification (hi, lo, alt)
  - ice formation (defrosting)
Reefer unit setting 2 of 5: fresh air vents

- Why ventilate?
  - Refresh gases (oxygen, CO$_2$, ethylene)
  - Dehumidification
Reefer unit setting 2 of 5: fresh air vents

- Adverse effects of ventilation
  - Moisture ingress -> ice, relative humidity
  - Ethylene prod. 5 ml/h
  - Amb. hum. 20 g/kg
Reefer unit setting 2 of 5: fresh air vents

- Ethylene sensing at AFSG:
  - from 10 ppb on
  - Accuracy ± 1.5%
Reefer unit setting 3 of 5: defrost interval

- Why defrost?
  - refrigeration capacity
  - air flow
Reefer unit setting 3 of 5: defrost interval

- Manually set at 3, 6, 9, 12 or 24 h, or AUTO or OFF
- AUTO is coming on
- TK’s Magnum solely relies on AUTO
- One defrost takes at least 30 min. (fans off)
- 6h defrost interval pretty common, but frequent!
- Don’t defrost when set temperature > 10 °C
- Use ‘reefer settings support tool’ for advice
Reefer unit setting 4 of 5: RH (dehumidification)

- supply air
  - evap. coil
  - heater
  - refr. unit
- return air
- cargo hold

Mollier-h/x-diagram
for humid air
P = 1013.25 mbar
Reefer unit setting 4 of 5: RH (dehumidification)

- Many, but not all, reefers have dehumidification
- How to reduce RH:
  - Less ventilation
  - Lower fan speed
- By default dehumidification yields alt fan speed (25% less fresh air!) with Carrier and Daikin
- Use ‘reefer settings support tool’ for advice
Reefer unit setting 5 of 5: bulb mode

- Only software issue
- Why use bulb mode?
  - Extra dehumidification capacity
  - Less defrost heat reaching the bulbs
- ‘bulb mode on’ is a meaningless spec.
- If bulb mode ‘on’ then:
  - RH setpoint range extended (Carrier only) to 60%
  - Fan speed may be set at lo, hi or alt (RH, ΔT, fresh air)
  - Defrost termination temp. adjustable from ± 30 to 4 °C
- ‘reefer settings support tool’ advises on fan speed
Reefer unit setting 5 of 5: bulb mode

- Defrost termination temperature (DTT)
  - How to use?
  - 8 °C commonly accepted. Who knows why?
  - Optimal usage strongly related to specific reefer unit type?
- Chilled meat, blood plasm?
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Shipper’s check list

Shipper’s (vendor’s, exporter’s) check list for flowerbulb shipment in reefer containers

<table>
<thead>
<tr>
<th>Shipper’s container no. (e.g. MWCU 675342[9])</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>YTO certified</td>
<td>□ yes, □ no</td>
</tr>
</tbody>
</table>

**CONTAINER INSPECTION**

| Drain holes clean and open | □ yes, □ no |
| Visible defects in container inner or outer walls | □ yes, □ no |
| Visible defects at T-bars or bulkhead bottom plate | □ yes, □ no |
| Visible defects of rubber door gasket | □ yes, □ no |
| Container clean internally | □ yes |
| Container precooling okay | □ yes, □ no, □ not applicable |

**REEFER UNIT SETTINGS**

| Temperature setpoint | □ °C, □ °F |
| Unit of temperature setting |  |
| Fresh air vent setting | m³/h |
| Relative humidity setpoint | □ off, □ % |
| Fan speed | □ hi(gh), □ air(ernating), □ lo(w) |
| Bulb mode | □ on, □ off |
| Defrost termination temp. (N.A. if bulb mode off) | □ °C, □ N.A. (not applicable) |

**CARGO ISSUES**

| Cargo stowed below load line | □ yes |
| Filler/dunnage in center channel or chimneys | □ yes, □ no |
| Cargo stowed beyond T-section floor | □ no |
| T-bars occupied entirely | □ yes |
| No. of mobile temp. recorders placed |  |
| Mobile temp. recorders started | □ yes |
| Sealing number of door seal applied |  |

**ACCOUNT**

| Checked by (person’s name) |  |
| Date |  |
| Place |  |
**Reefer settings support tool for flowerbulbs**

**Reefer Settings Support Tool for Flowerbulbs (Version 1.0)**

- **Author:** Leo Lukaasse (leo.lukaasse@wur.nl)
- **Date:** May, 2007
- **Affiliation:** Wageningen UR, The Netherlands
- **Website:** [www.reefersettingsupport.nl](http://www.reefersettingsupport.nl)

**Purpose:** Get advised unit settings based on desired climate, destination and main Reefer unit capacities.

**How to use?** Fill out the blank fields and check the orange fields for suggestions, advice and expected climate.

**Suggestions for Improvement:** The author encourages users to send him suggestions for improvement or questions about related issues.

**Disclaimer:** Wageningen UR, AFSG and the authors do not accept any liability for damages or losses of whatever nature, that may be caused by the use of these calculations.

### Input Information:

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature setpoint [°C]</td>
<td>17</td>
</tr>
<tr>
<td>RH setpoint [%]</td>
<td>25</td>
</tr>
<tr>
<td>Acceptable temperature spread [°C]</td>
<td>2</td>
</tr>
<tr>
<td>Fresh air required [m³/h]</td>
<td>50</td>
</tr>
<tr>
<td>Fan speed</td>
<td>Low</td>
</tr>
<tr>
<td>Destination</td>
<td>Far East</td>
</tr>
<tr>
<td>Heating capacity [kW] [60Hz]</td>
<td>4.08</td>
</tr>
<tr>
<td>Refrigeration capacity [kW]</td>
<td>2/2, 38 degC, 60 Hz</td>
</tr>
<tr>
<td>Fan capacity [m³/h] @ high speed, 50 Hz</td>
<td>5500</td>
</tr>
</tbody>
</table>

### Comments/Suggestions on Dehumidification and Defrosting:

- Heating capacity [kW] insufficient, consider 1. reduction of fan speed, 2. increase of acceptable temp. spread, 3. reduction of defrost interval [hours]
- Refrigeration capacity [kW] sufficient
- Heating + refrigeration insufficient heating capacity alternating: no defrost necessary
- Min. Fan speed required to meet ΔT required defrost interval [hours]:
- Advised unit settings:
  - Temperature setpoint [°C]: 17
  - RH setpoint [%]: 65
  - Container precooling: none
  - Fan speed: Low
  - Fan setting [m³/h]: 180
  - Defrost interval [hours]: no defrosts necessary
  - Defrost termination temp. [°C]: unit's default
  - Drain holes: Open

### Expected Climate in Container:

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature spread [°C]</td>
<td>Max: 3.5 above setpoint</td>
</tr>
<tr>
<td>RH [%]</td>
<td>75</td>
</tr>
</tbody>
</table>

### Summary of Fan Speeds

<table>
<thead>
<tr>
<th>Fan Setting</th>
<th>Airflow [% of high speed]</th>
</tr>
</thead>
<tbody>
<tr>
<td>high</td>
<td>100</td>
</tr>
<tr>
<td>alternating</td>
<td>75</td>
</tr>
<tr>
<td>low</td>
<td>50</td>
</tr>
</tbody>
</table>

### Summary of Ocean Climates Per Destination

<table>
<thead>
<tr>
<th>Destination</th>
<th>Ambient Temp. [°C]</th>
<th>Amb. Humidity [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>US East Coast</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>US West Coast</td>
<td>27</td>
<td>20</td>
</tr>
<tr>
<td>Far East</td>
<td>27</td>
<td>20</td>
</tr>
</tbody>
</table>
Reefer units guide for flowerbulb shipment

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Reefer units guide for flowerbulbs</td>
<td>Manual, document</td>
</tr>
<tr>
<td>Shipper’s checklist</td>
<td>Checklist</td>
</tr>
<tr>
<td>Reefer settings support tool for flowerbulbs</td>
<td>Excel program</td>
</tr>
</tbody>
</table>

- Download via [www.nieberding.nl](http://www.nieberding.nl)
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Issues for further investigations

- Vents, fan speed, defrosting -> $\Delta T$?
- AFAM/Autofresh
- Autonomous heat production of bulbs
- Measurements during transport:
  - Relative humidity in cargo
  - Ethylene levels in containers
- Defrosting heat load on cargo (hot gas/electric)
- Defrost termination temperature

Innovatievouchers:
- www.senternovem.nl/innovatievouchers
- www.minlnv.nl
Questions, remarks, discussion

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www.reefertransport.nl