

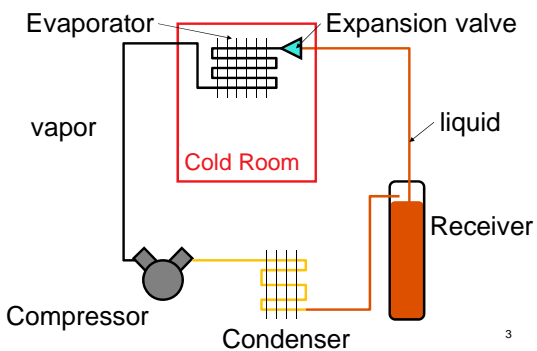
Cold Storage

Jim Thompson
Biological & Agricultural
Engineering, UC Davis



2

Mechanical Refrigeration



3

Cold Storage

- Temperature variation $< 2^{\circ}$ F (1° C).

4

Maintaining Temperature

- Refrigeration capacity.

5

Reciprocating Compressor



6

Maintaining Temperature

- Refrigeration capacity.
- Evaporator coils.

7

Finned-Tube Evaporators



8

Maintaining Temperature

- Refrigeration capacity
- Evaporator coils
- Insulation

9

Insulation

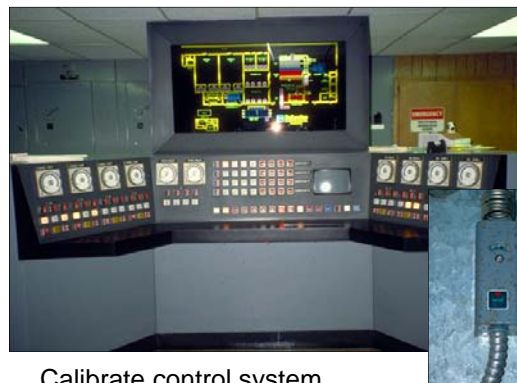


10

Maintaining Temperature

- Refrigeration capacity.
- Evaporator coils.
- Insulation.
- Controls/thermostat.

11



Calibrate control system

12

Maintaining Temperature

- Refrigeration capacity.
- Evaporator coils.
- Insulation.
- Controls/thermostat.
- Air mixing volume (usually above fruit).

13

Cold Storage

- Temperature variation < 2° F.
- Relative Humidity > 90% - 95%.

14

Maintaining High Humidity

- Large evaporator surface.
- High evaporator temperature.

15



Higher capital cost but
1. lower energy use.
2. more uniform temperature.
3. higher humidity.

16

Maintaining High Humidity

- Large evaporator surface.
- High evaporator temperature.
- Reduce refrigeration load.

17

Maintaining High Humidity

- Large evaporator surface.
- High evaporator temperature.
- Reduce refrigeration load.
- Humidifier.

18

Humidifiers



Adds water to
packing materials



19

Maintain High Humidity

High humidity requires uniform
air temperature.

20

Reduce Moisture Loss

- Minimize paper & wood packaging.

A 2lb fiberboard
box can absorb
water equal to 1%
of fruit weight.



21

Reduce Moisture Loss

- Minimize paper & wood packaging.
- Reduce time between picking and cooling.

22

Reduce Moisture Loss

- Minimize paper & wood packaging.
- Reduce time between picking and cooling.
- Harvest during the cool hours of the day & protect fruit from heating.



23

Cold Storage

- Temperature variation < 2° F.
- Relative Humidity > 90% - 95%.
- Adequate airflow & good uniformity.

24

Airflow Capacity

- 100 cfm per ton of product for initial cooling ($0.05 \text{ m}^3/\text{mt}$).
- 20 - 40 cfm per ton for long term storage ($0.01 - 0.02 \text{ m}^3/\text{mt}$).

Use only as much air as is needed to maintain uniform temperature.

25

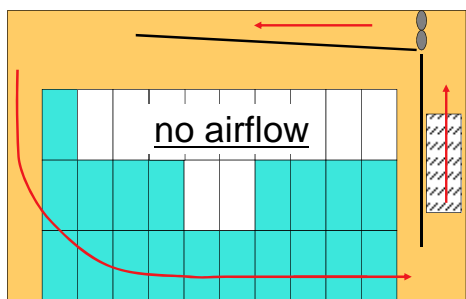
Airflow Uniformity

Solid ceiling plenum or duct



Airflow Uniformity

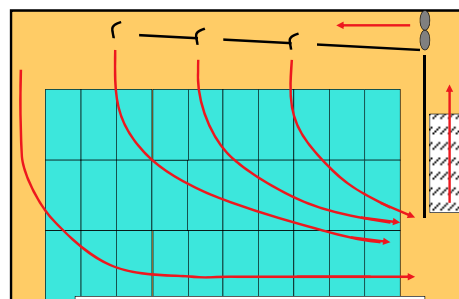
Solid ceiling plenum



27

Airflow Uniformity

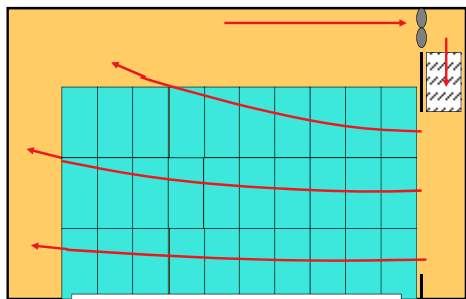
Slotted ceiling plenum



28

Airflow Uniformity

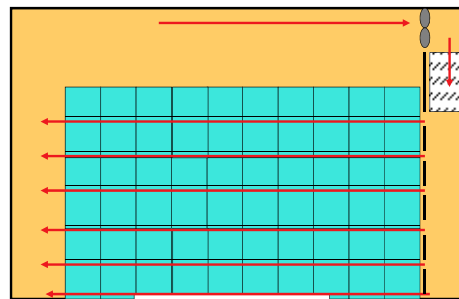
Vertical Slots in Plenum Wall



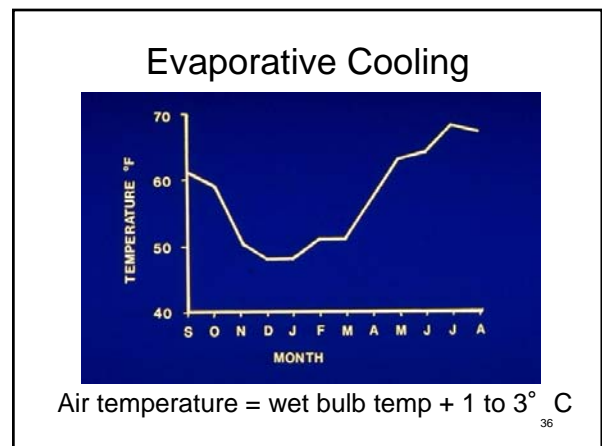
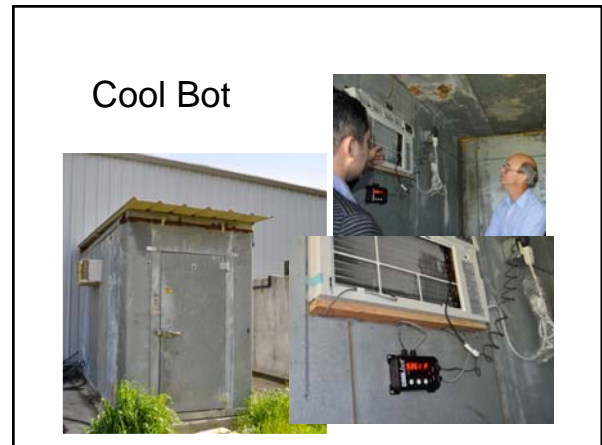
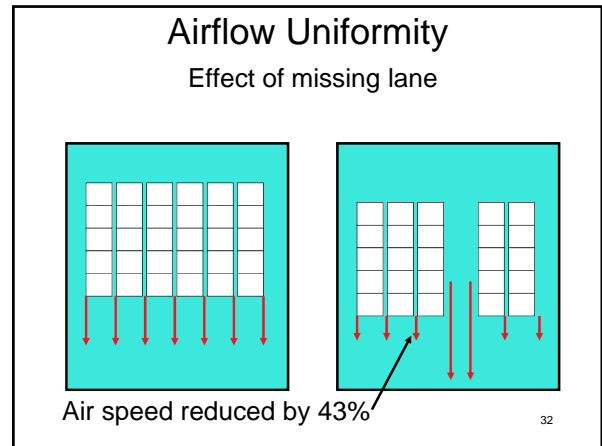
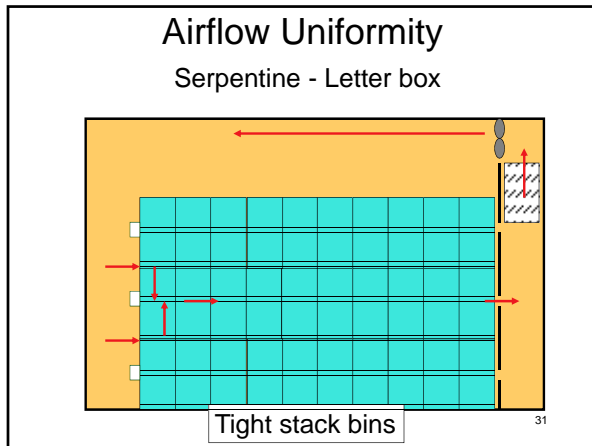
29

Airflow Uniformity

Horizontal Slots in Plenum Wall



30



Evaporatively Cooled Storage



37

Underground Storage



38

Well Water Temperature



39

Construction Steel Frame



40

Insulation



41

Construction - Wood Frame



42

