Comparison of MACS Forced-Air Cooler vs. Conventional Cooling Tunnels

MACS COOLER™

MODULAR AUTOMATED COOLING SYSTEM

www.macscooler.com

Precooling

Definition: Removal of field heat from produce prior to shipping and distribution

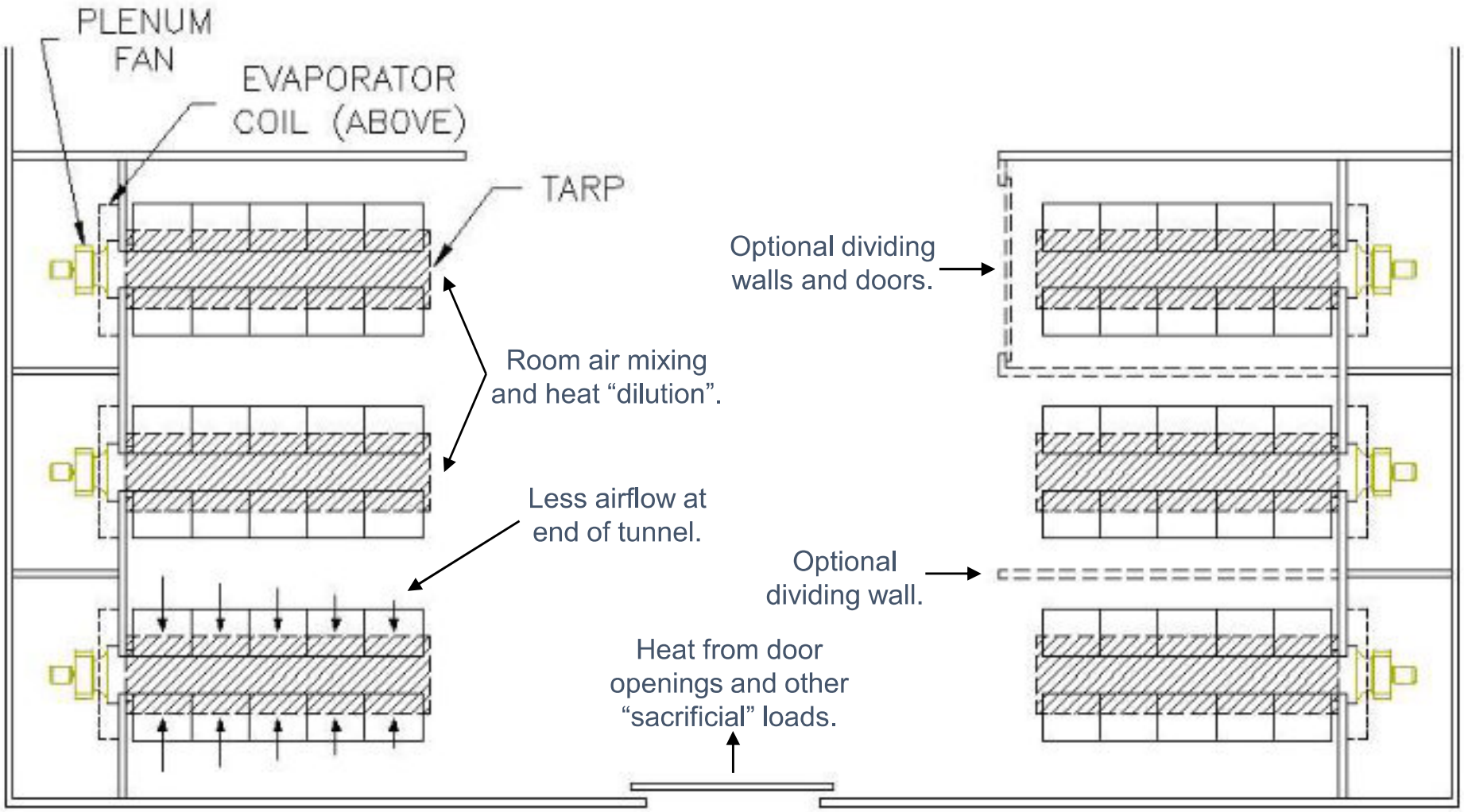
Purpose: To slow down post-harvest degradation thereby increasing shelf life and making nationwide and worldwide distribution of fresh produce possible.

Using conventional cooling methods, the field-packed produce is unloaded…

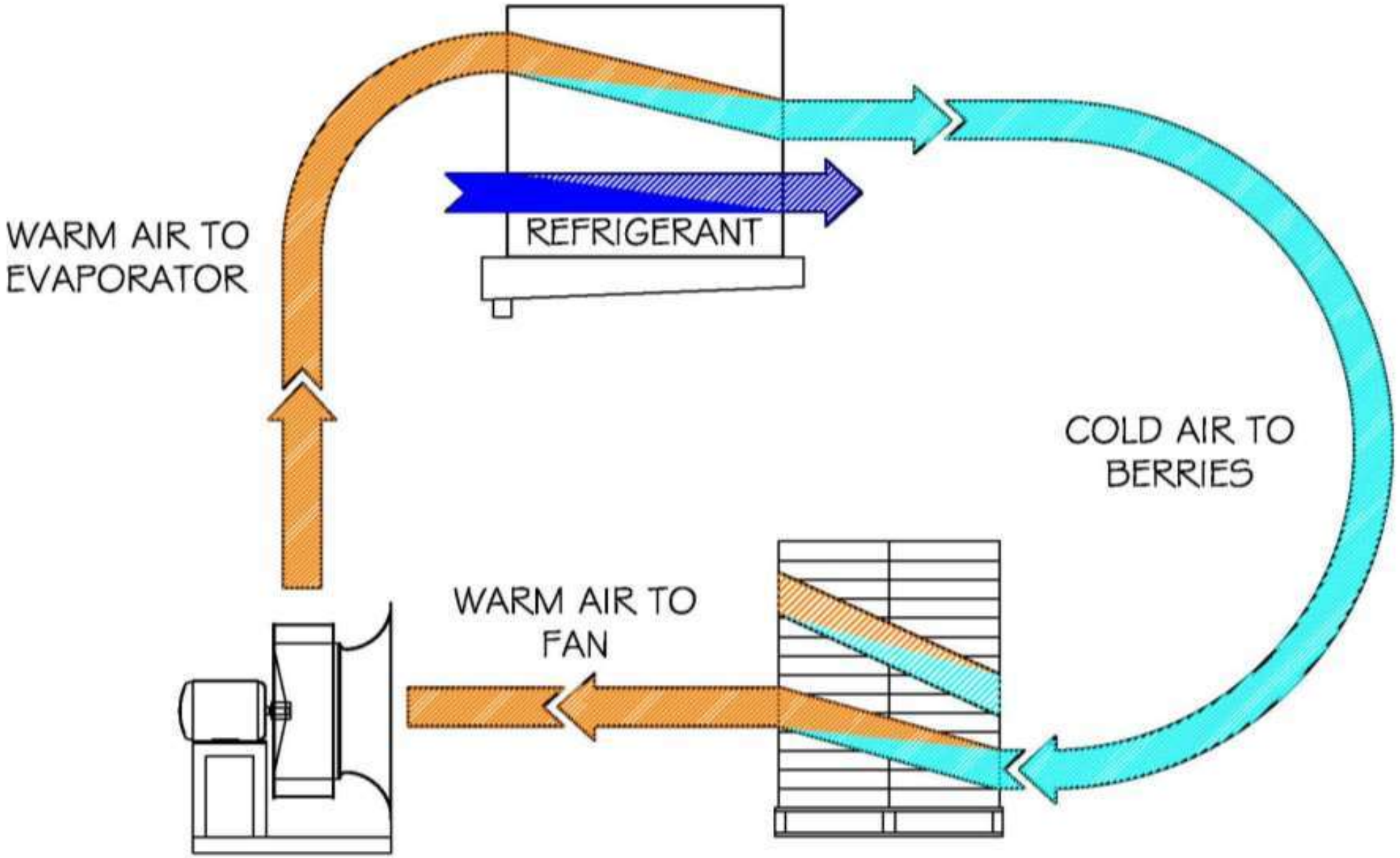
stacked in front of a fan forming a tunnel…

then tarped and cooled.

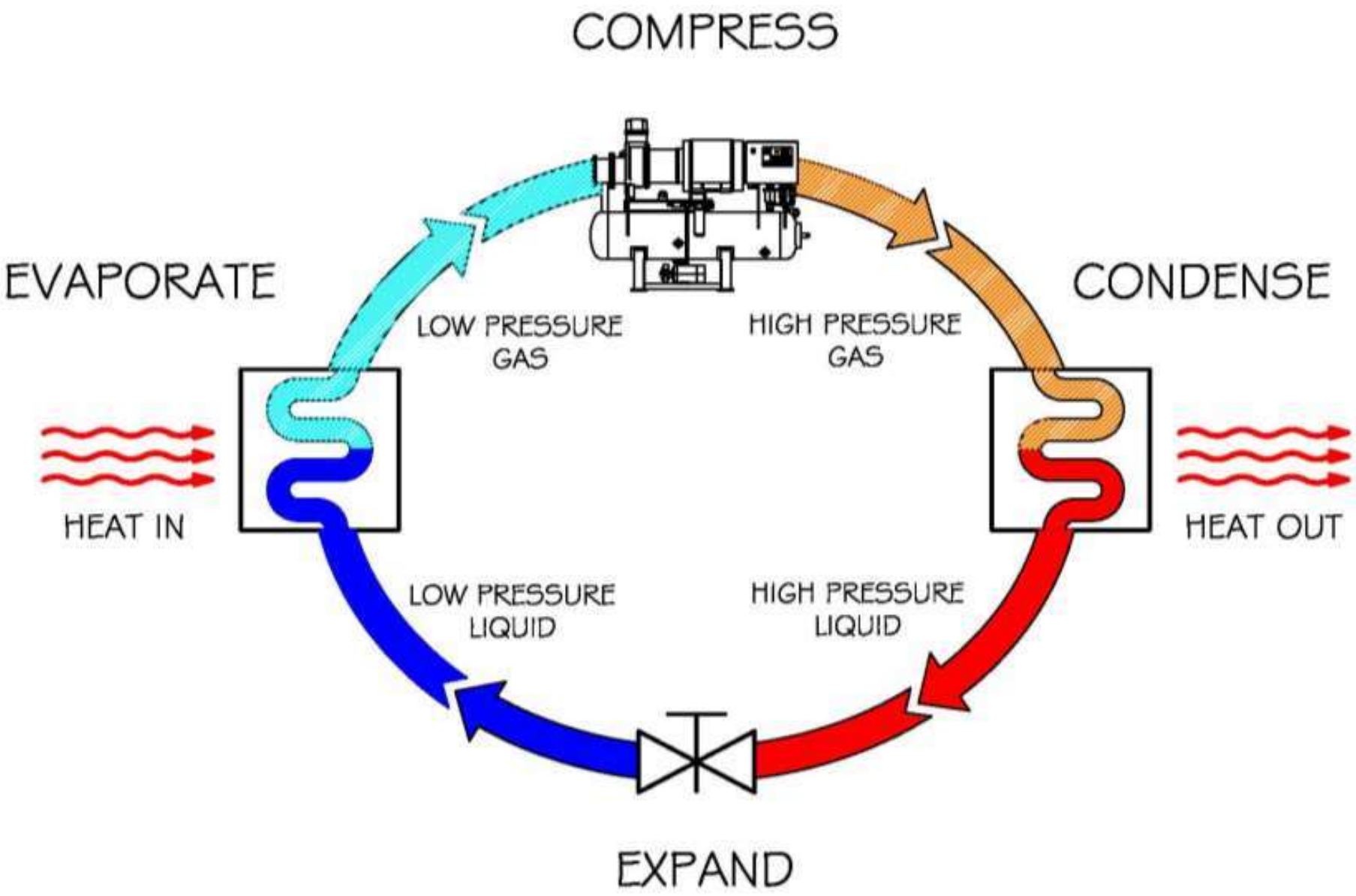
Conventional Tarped Tunnels



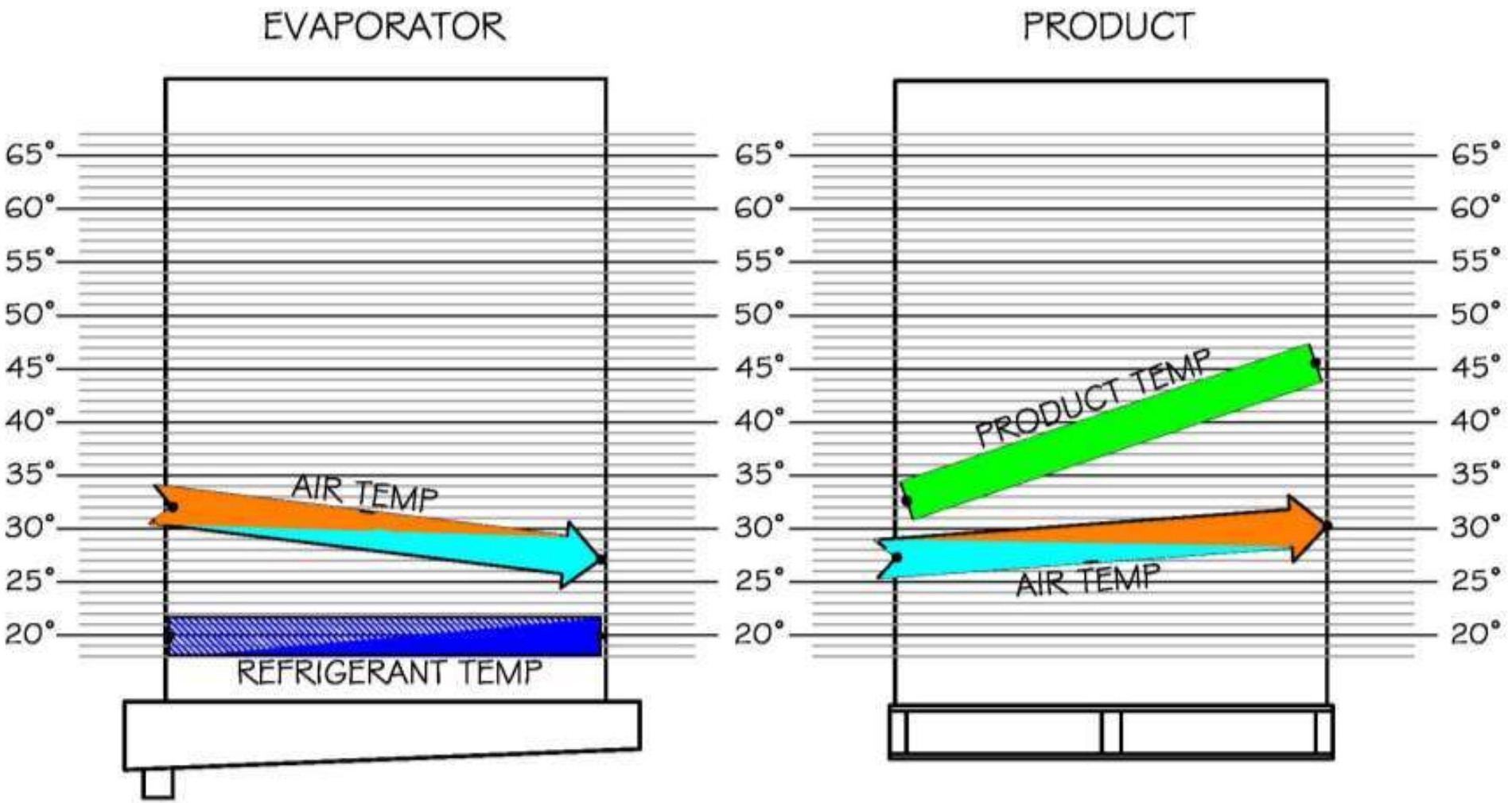
The Forced-Air Cooling Cycle



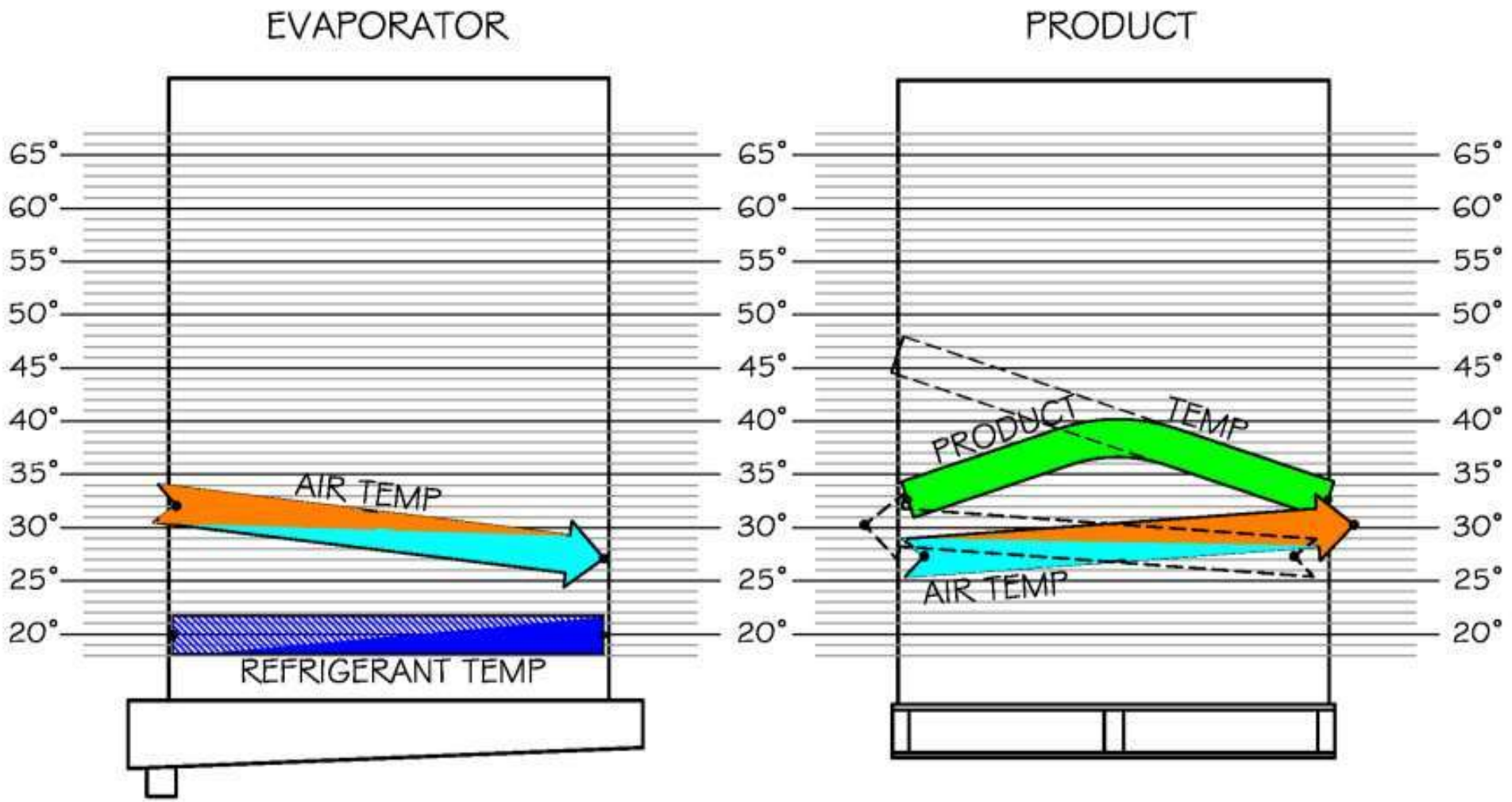
The Refrigeration Cycle



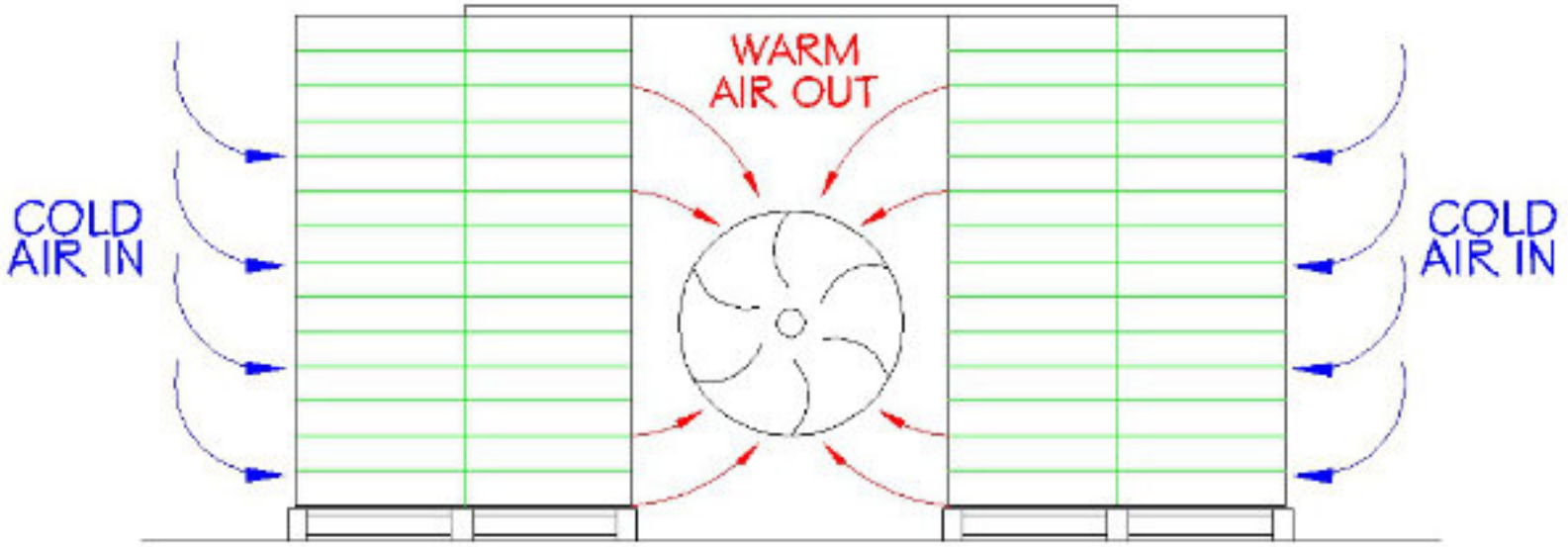
Temp Gradients, One-Way Air



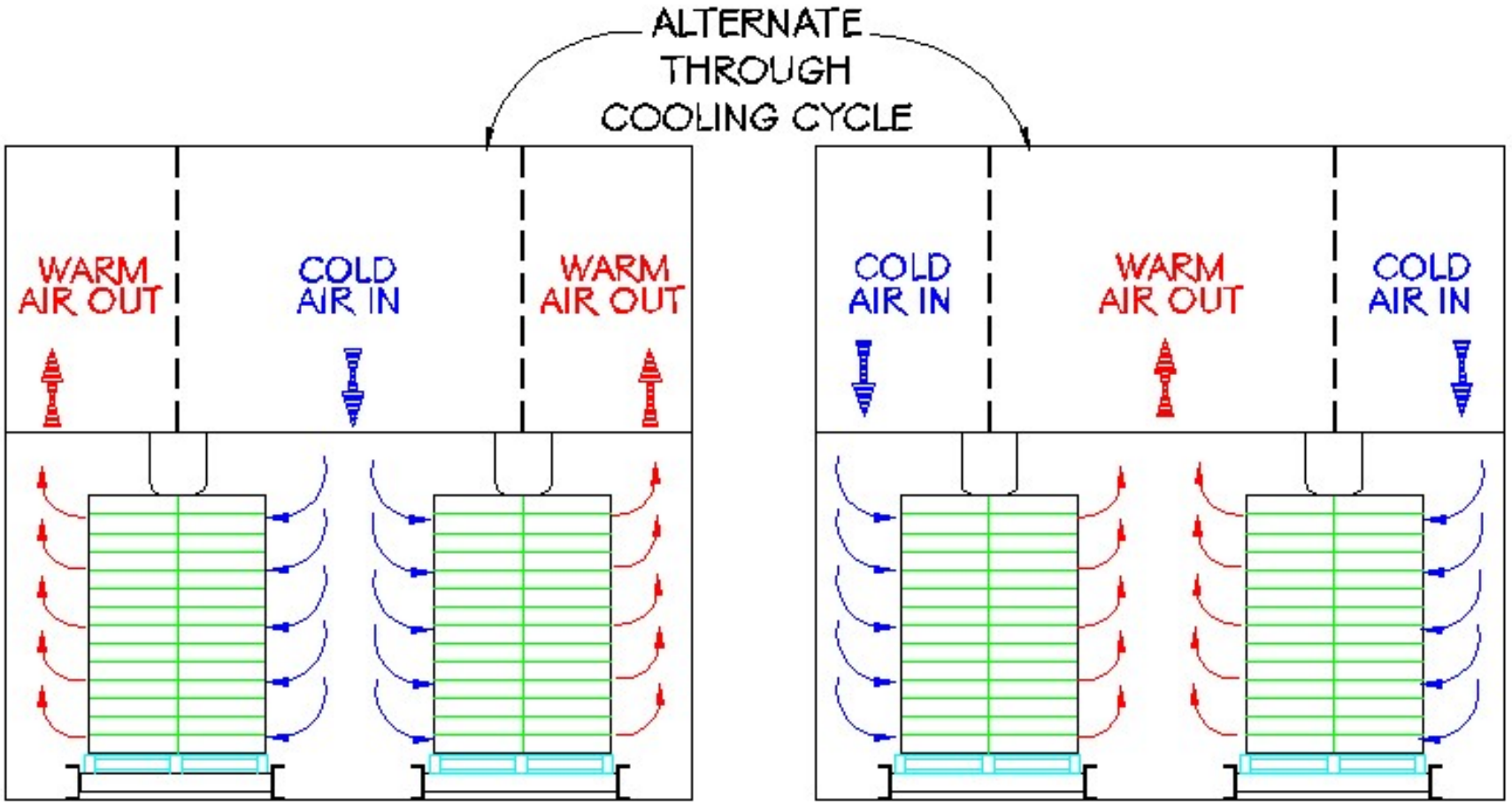
Temp Gradients, Two-Way Air



Conventional Tunnel
One-Way Cooling



Automated Cooler
Two-Way Cooling



Automated Forced-Air PreCooler History

1988 – Bob Ohling's portable reverse-air cooler, Santa Maria / Mexico

- 10 pallets, manual load and unload
- Airflow reversing mechanical dampers

1993 – Autocoolers installed at Driscoll's in Santa Maria, CA

- Conveyorized, 10 pallets each zone, batch loading
- Conveyed into the cold room
- Airflow reversing mechanical dampers

1997 – Autocoolers installed at Driscoll's in Watsonville, CA

- Conveyorized, 8 pallets each zone, semi-continuous loading
- Airflow reversing mechanical dampers

Autocoolers, Watsonville, CA

Automated Forced-Air PreCooler History

2000 - 2004 – MACS Cooler design conceived and developed

- Configured into shippable module
- Airflow change by zone (no dampers)
- Inflatable air seals (hang-ups, pallet sizes)
- 6 pallets each zone

2005 – 1st MACS Cooler operational at Watsonville Berry Cooler

- 4 modules long
- Improved cooling quality
- Good uptime record
- Reduced cooling costs

MACS Cooler, Pajaro, CA

2005 - 2007 – Design modifications and enhancements

- Improved cleanability and serviceability
- Galvanized frame
- Improved air filtration for seals
- Vacuum doors
- Controls and instrumentation
- Seal changes
- Pallet side shift option

2008 – Redesigned MACS Coolers installed in Santa Maria, CA

- 2 – Two module units at Frontier Cooling
- 1 – Single module unit at MJA Cooling

Automated Forced-Air PreCooler History

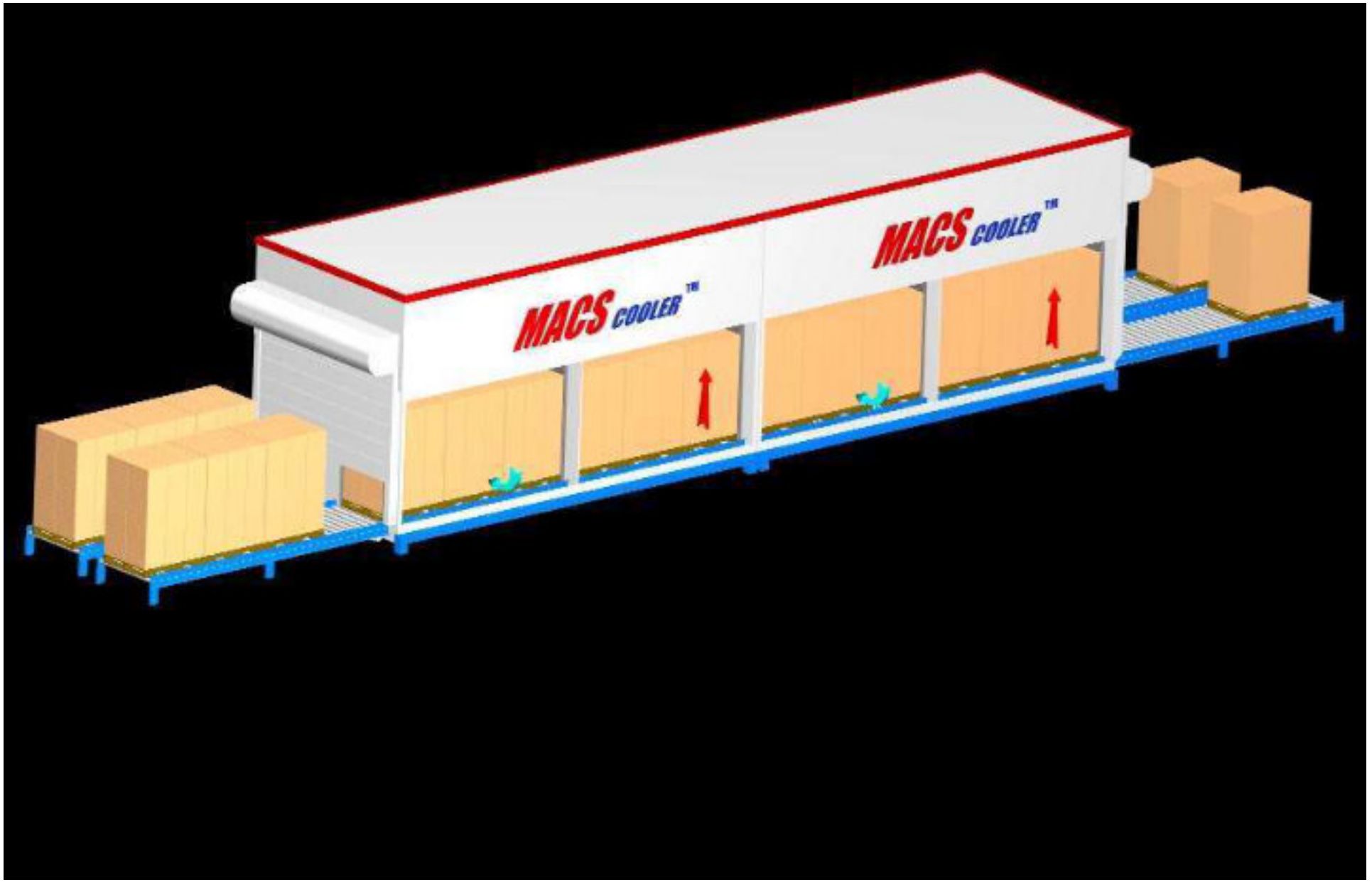
2000 - 2004 – MACS Cooler design conceived and developed

- Configured into shippable module
- Inflatable air seals (hang-ups, pallet sizes)
- Airflow change by zone (no dampers)
- 6 pallets each zone

2015 - 2016 – New generation MACS Cooler

- Improved PLC and Display
- Many new automatic features
- Real-time notifications
- Cooling improvements
- Efficiency improvements
- Emailed reports

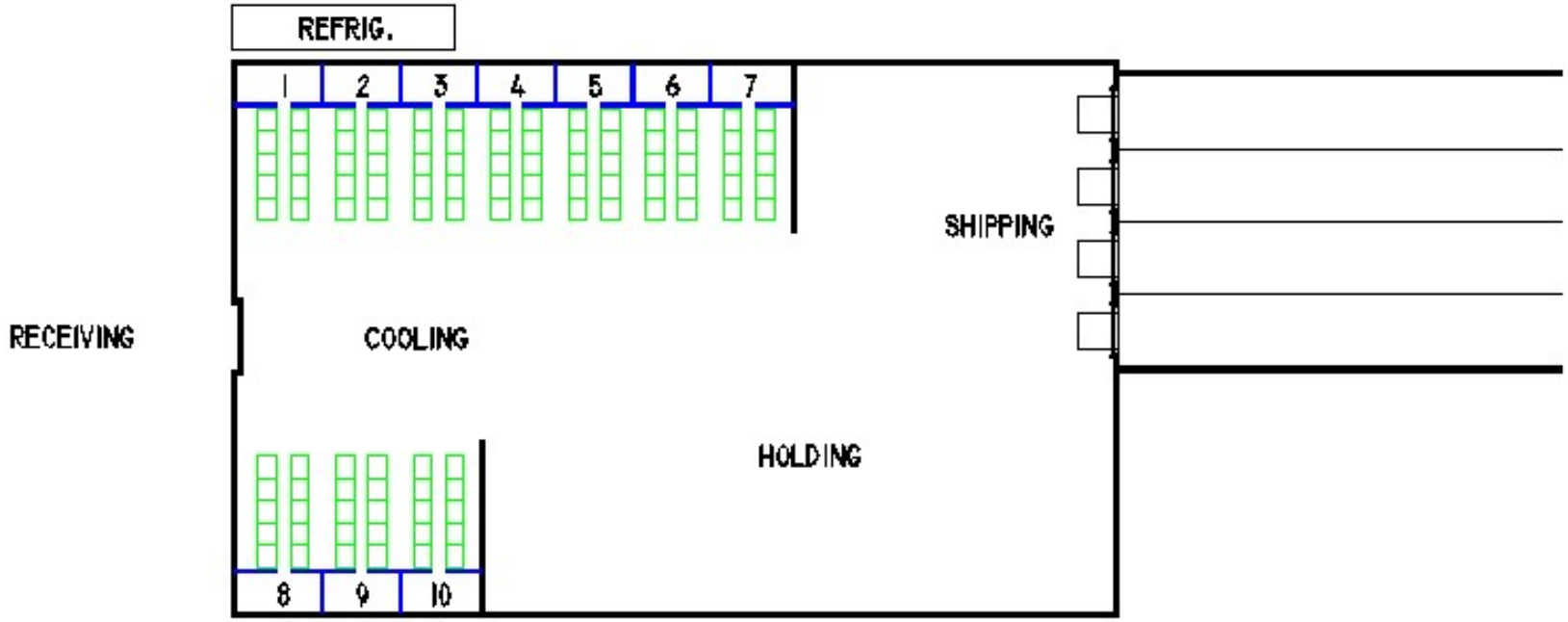
MACS Coolers, Castroville, CA



Section view of MACS Cooler with Product loaded on Infeeds, Zones 1-4, and Outfeeds. Rendered in AutoCAD 3D.

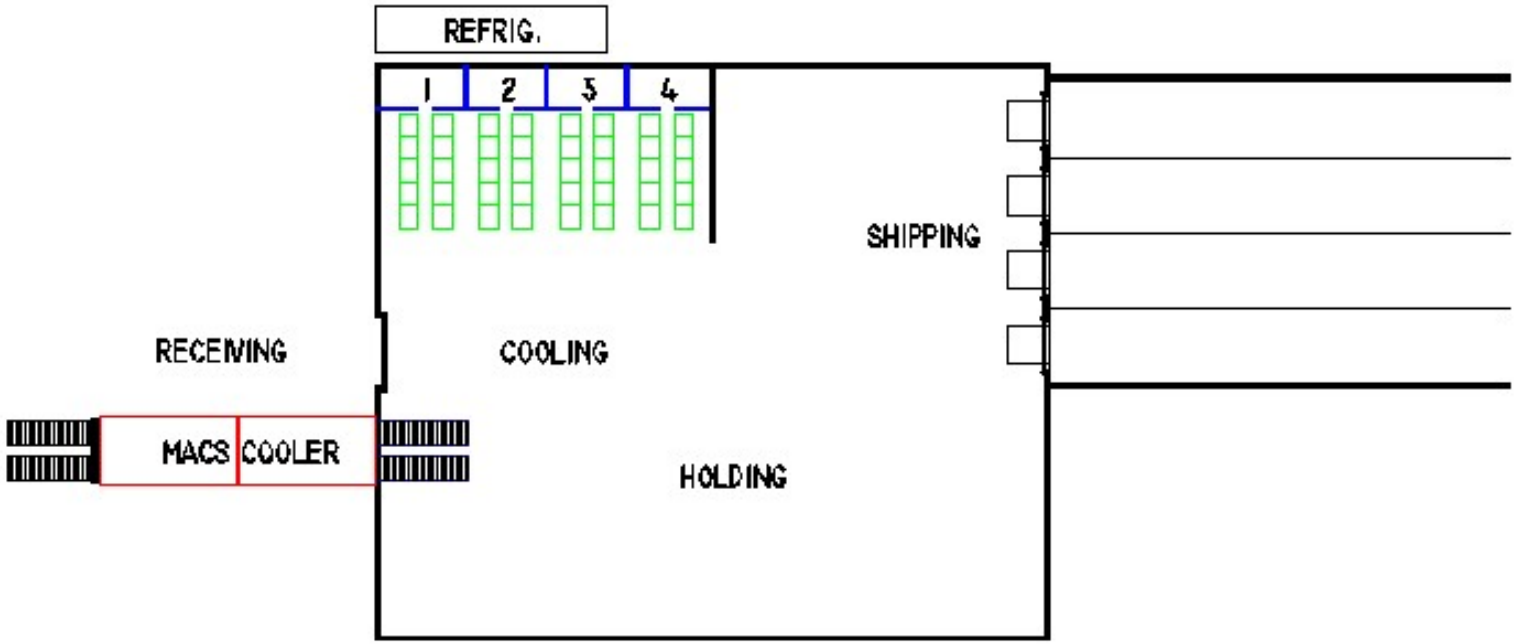
500 Pallet/Day Cooler

10 Conventional Tunnels



500 Pallet/Day Cooler

4 Conventional Tunnels + One Automated Cooler
4500 S.F. Smaller Building



Tunnel Design Comparisons

The following is based on 108 cartons/pallet, 8 lbs strawberries/carton, 65° start, 33° finish

Tunnel Design	Fan Data				Pallets Cooled	Cooling Time (min.)	Fan Hp-Hr per Pallet
	Type	Qty.	Hp ea.	Hp Tot.			
A	Prop. Prop.	2 1	7.5 10	25	8	120	6.25
B	Prop. Prop.	2 1	15 20	50	10	70	5.83
C	Prop.	5	15	75	32	120	4.69
D	Cent.	1	30	30	10	110	5.50
E	40" AF	1	15	15	8	110	3.44
F	44" AF	1	20	20	10	100	3.33
						Average Conventional Tunnel	4.84
MACS Cooler	40" AF	4	15	60	24	44	1.83

Electrical Usage Comparison

The following is based on 108 cartons/pallet, 8 lbs strawberries/carton, 65° start, 33° finish

	Typical Conventional Tunnel	MACS Cooler Zone (1 Zone)
Fan Horsepower	25	15
Pallets per Turn	9	6
Cooling Time, minutes	105	44
Transition Time, minutes	30	3
Pallets Cooled per 10 hr day	40	77
Product Heat, Refrigeration Ton-Hrs/Pallet	2.8	2.8
Fan Run Time, hrs/day	8.9	9.8
Fan Heat, Refrigeration Ton-Hrs/Pallet	1.6	0.6
Bldg. Space for Cooling, s.f./tunnel	726	144
Space Cooling Load, Tons-hrs/Pallet	0.9	0.1
Refrigeration Tons-hrs/pallet, Total	5.3	3.4
Fan kWh/Pallet	5.6	1.9
Refrigeration kWh/Pallet	8.5	5.5
Total kWh/Pallet	14.1	7.4
	Electrical Savings	**48%**

Cooling Expense Comparison

The following is based on per pallet costs (cooling only) for a typical strawberry cooler running 8 lb/carton, 108 cartons/pallet, 300 pallets/day, 30,000 pallets/year

Cooling Expense Item	6 Conventional Tunnels	1 Two Module MACS Cooler	$ Saved per Pallet	$ Saved per Year
1) Electrical Energy	$ 2.12	$ 1.11	$ 1.01	$ 30,150
2) Cooler Forklift Driver Labor	$ 6.25	$ 2.50	$ 3.75	$ 112,500
3) Cleaning and Maintenance	$ 0.15	$ 0.33	$ (0.18)	$ (5,484)
4) Forklift Expense	$ 1.09	$ 0.65	$ 0.44	$ 13,088
Totals	$ 9.61	$ 4.60	$ 5.01	$ 150,254
			52%	Savings

<u>Economic Considerations</u>:

This savings is about 5¢/carton, less than 1% of selling price.

Cooling quality is also improved which maintains or increases product value.

Capital Cost Comparison

The following is based on expanding the cooling capacity of an existing facility by 300 pallets of strawberries per day

Capital Cost Item	6 Conventional Tunnels	1 Two Module MACS Cooler
1) Pre-Cooling Equipment	$ 300,000	$ 690,000
2) Evaporator Valve Groups	$ 30,000	$ 20,000
3) Electrical Connections and Controls	$ 36,000	$ 6,000
4) Refrigeration High-Side Addition	$ 250,000	$ 250,000
5) Refrigerated Building Cost (new and/or retrofit)	$ 495,000	$ 30,800
	$ 1,111,000	$ 996,800
	10% Savings	

Additional Saving and Advantages

- Reduce cooling expenses (see "Cooling Expense Comparison" sheet)
- Steadier refrigeration load
- Accelerated asset depreciation
- Lower property taxes
- Lower permitting cost
- Faster project implementation

California Produce that can be Force-Air Cooled

Apples
Apricots
Artichokes
Avocados
Bell peppers
Blueberries
Boysenberries
Broccoli
Cantaloupe
Cauliflower
Chili peppers
Corn, sweet
Cucumbers
Dates
Figs
Grapes, table
Honeydew
Kiwifruit
Leaf lettuce
Lemons
Mushrooms
Nectarines
Olives
Oranges
Peaches
Pears
Plums
Raspberries
Romaine lettuce
Spinach
Squash
Strawberries
Sweet cherries
Tomatoes
Watermelon

MACS COOLER™

MODULAR AUTOMATED COOLING SYSTEM

www.macscooler.com

Engineered for MACS Cool, Inc. by Hawkins Engineering, Moss Landing, CA

Manufactured and Installed for MACS Cool, Inc. by C.I.M., Santa Maria, CA