

AUTOMATED

FORCED-AIR

PRE-COOLING

AUTOMATED

FORCED-AIR

→ PRE-COOLING

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FORCED-AIR

→ PRE-COOLING

(vs. "In-Transit")

AUTOMATED

→ FORCED-AIR

PRE-COOLING

→ **AUTOMATED**

FORCED-AIR

PRE-COOLING

→ **AUTOMATED**

(vs. “Conventional”)

FORCED-AIR

PRE-COOLING

The field-packed produce is unloaded...



stacked in front of a fan...



forming a tunnel...



then tarped and cooled.



Driscoll's[®]

Strawberries

8-16 oz. Baskets



Driscoll's[®]

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8-16 oz. Baskets



Driscoll's[®]

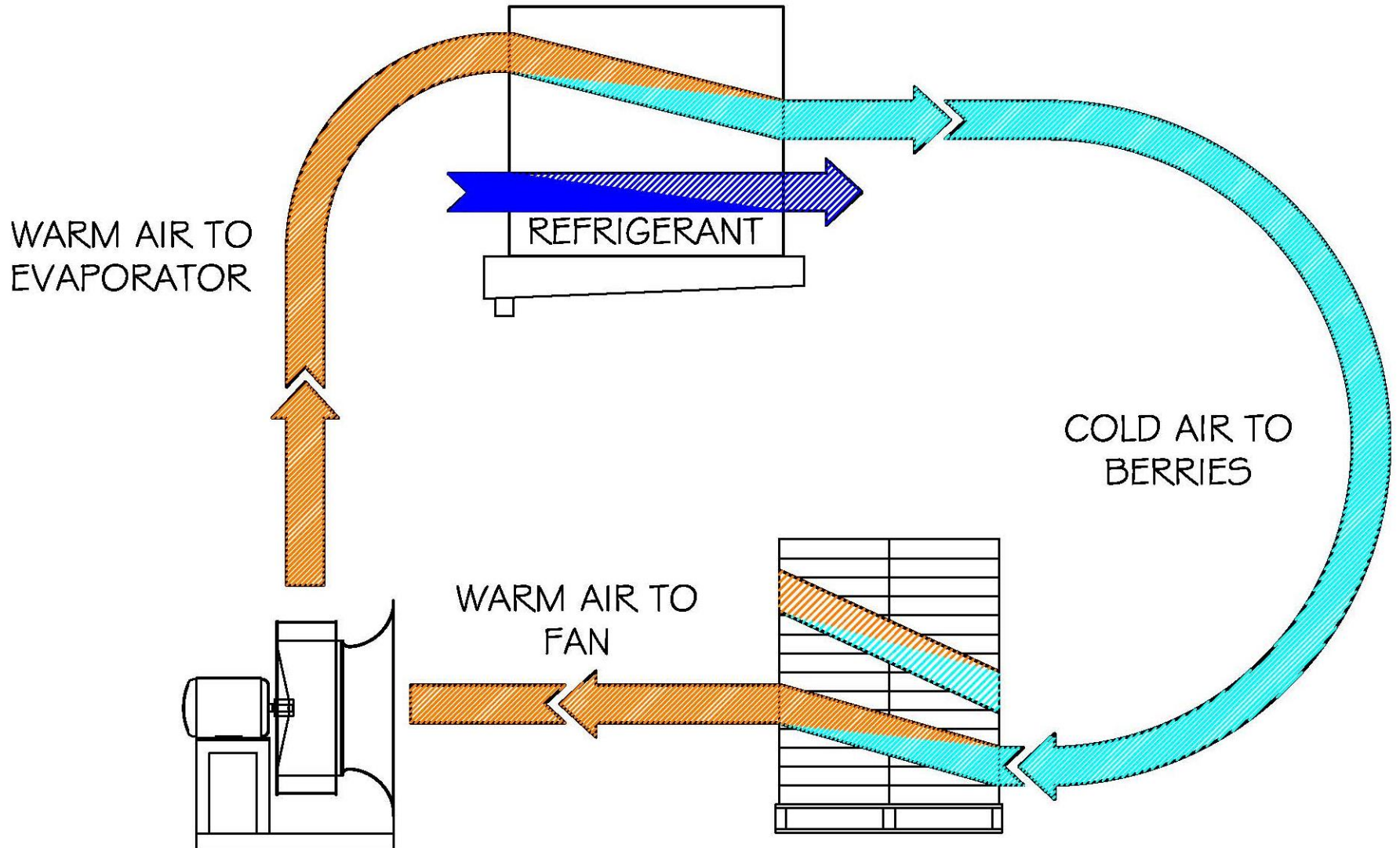
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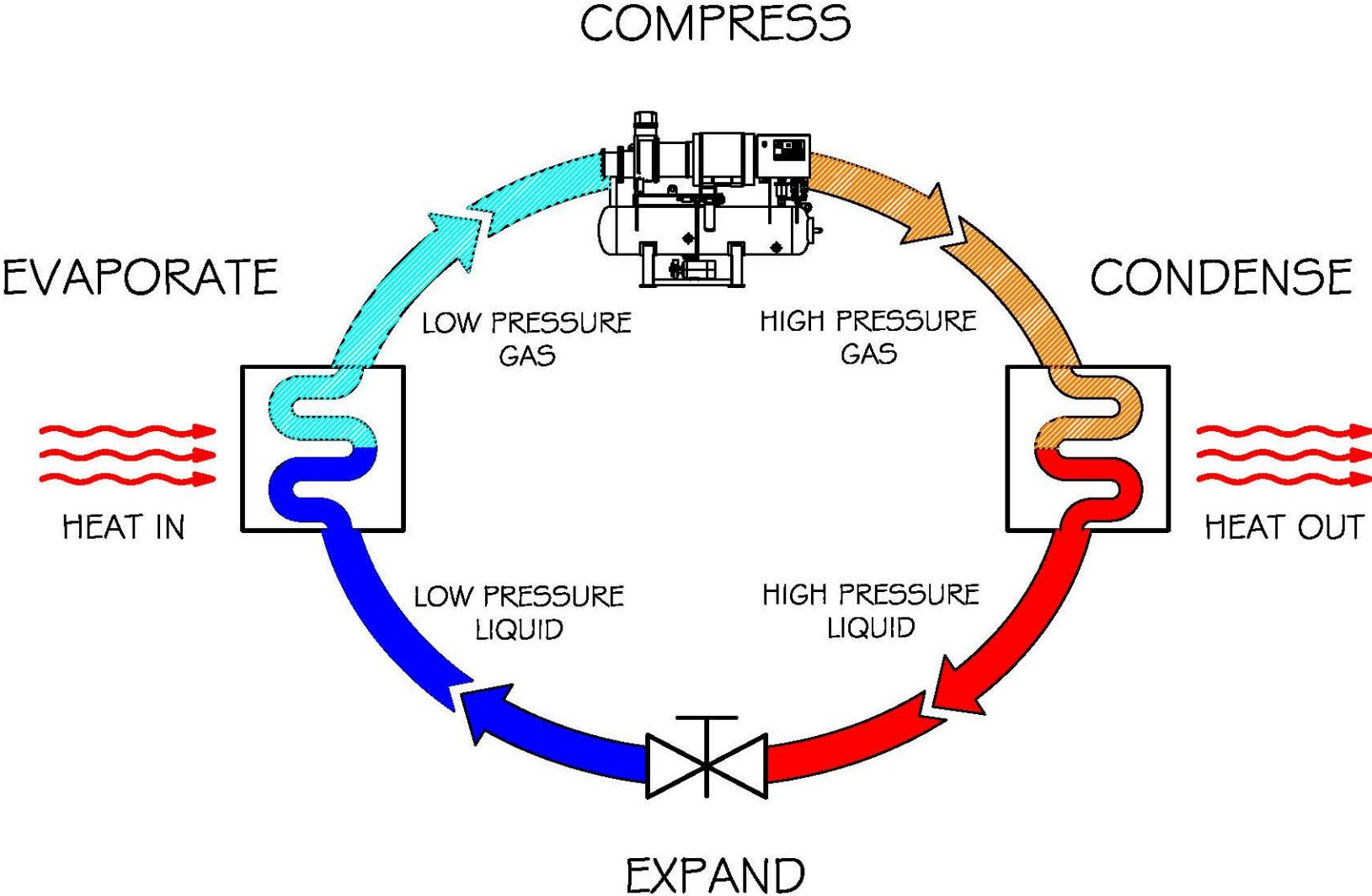




The Forced-Air Cooling Cycle



The Refrigeration Cycle



The heat leaves the facility here...



1 DAY = 2,000,000 LBS. BERRIES

70,000,000 BTU OF HEAT REMOVED

15,000 KW-HOURS USED (39% USEFUL)

Typical Cooling Tunnels



Other Examples of Cooling Tunnels



Other Examples of Cooling Tunnels



Other Examples of Cooling Tunnels



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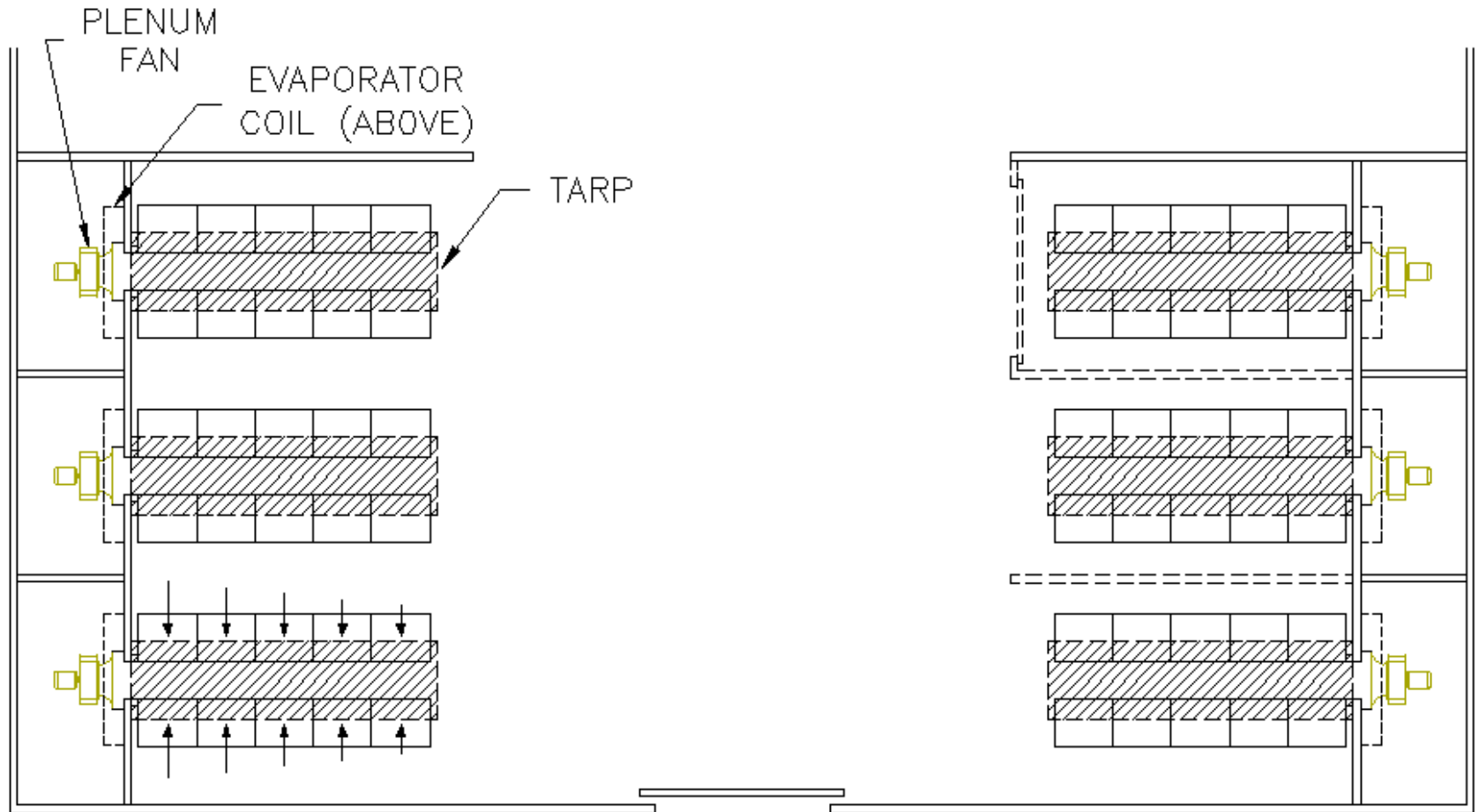
Other Examples of Cooling Tunnels



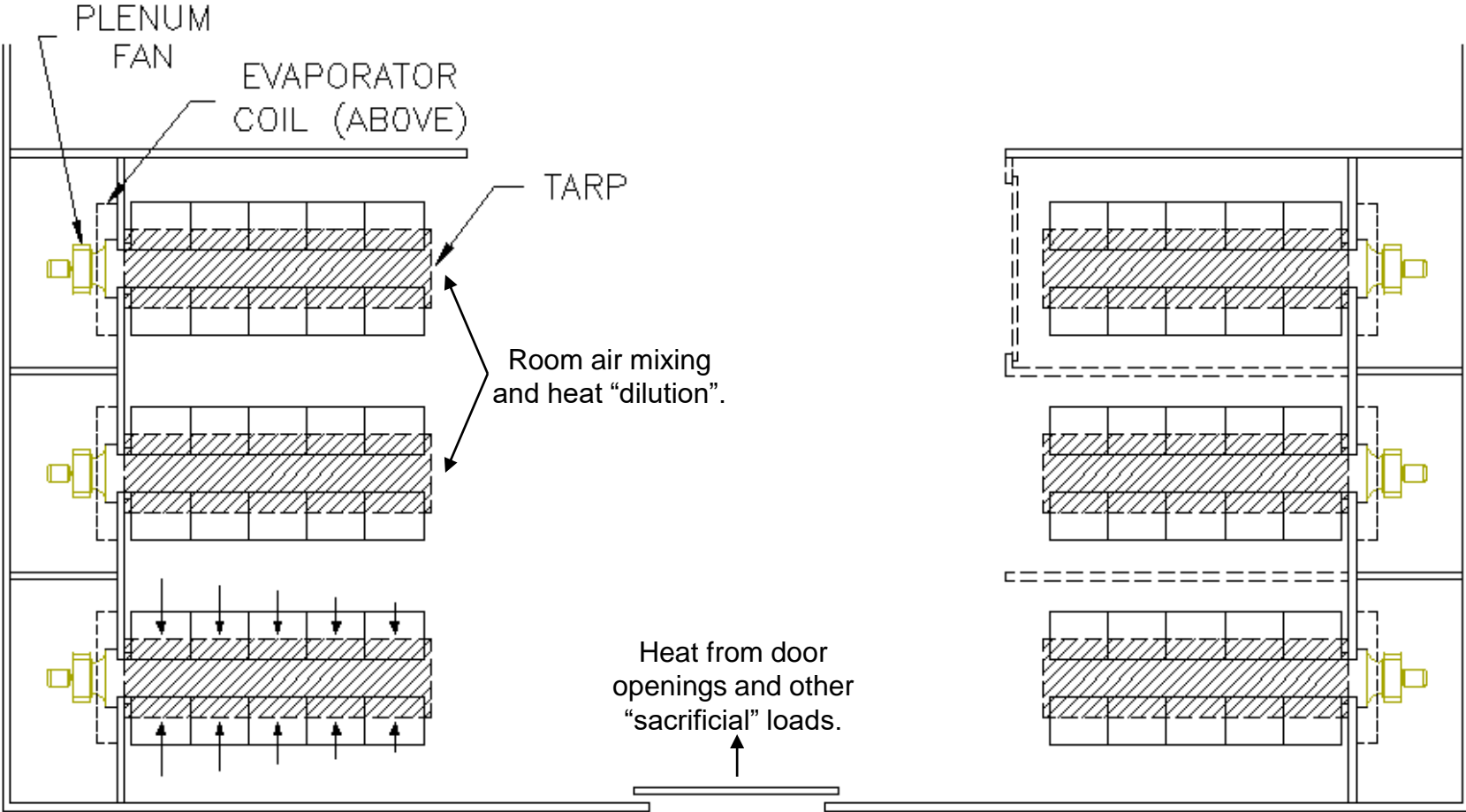
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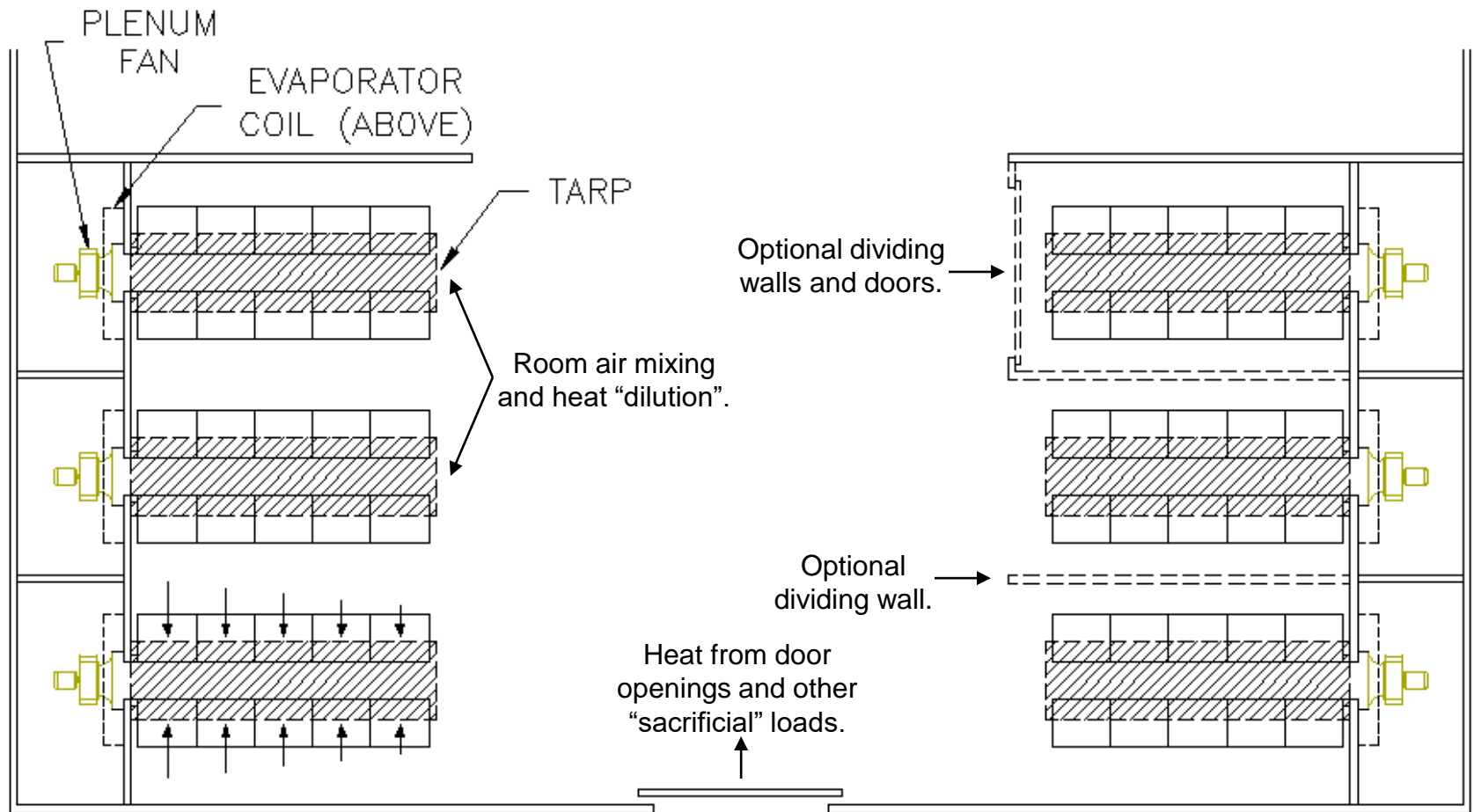
Conventional Tarped Tunnels



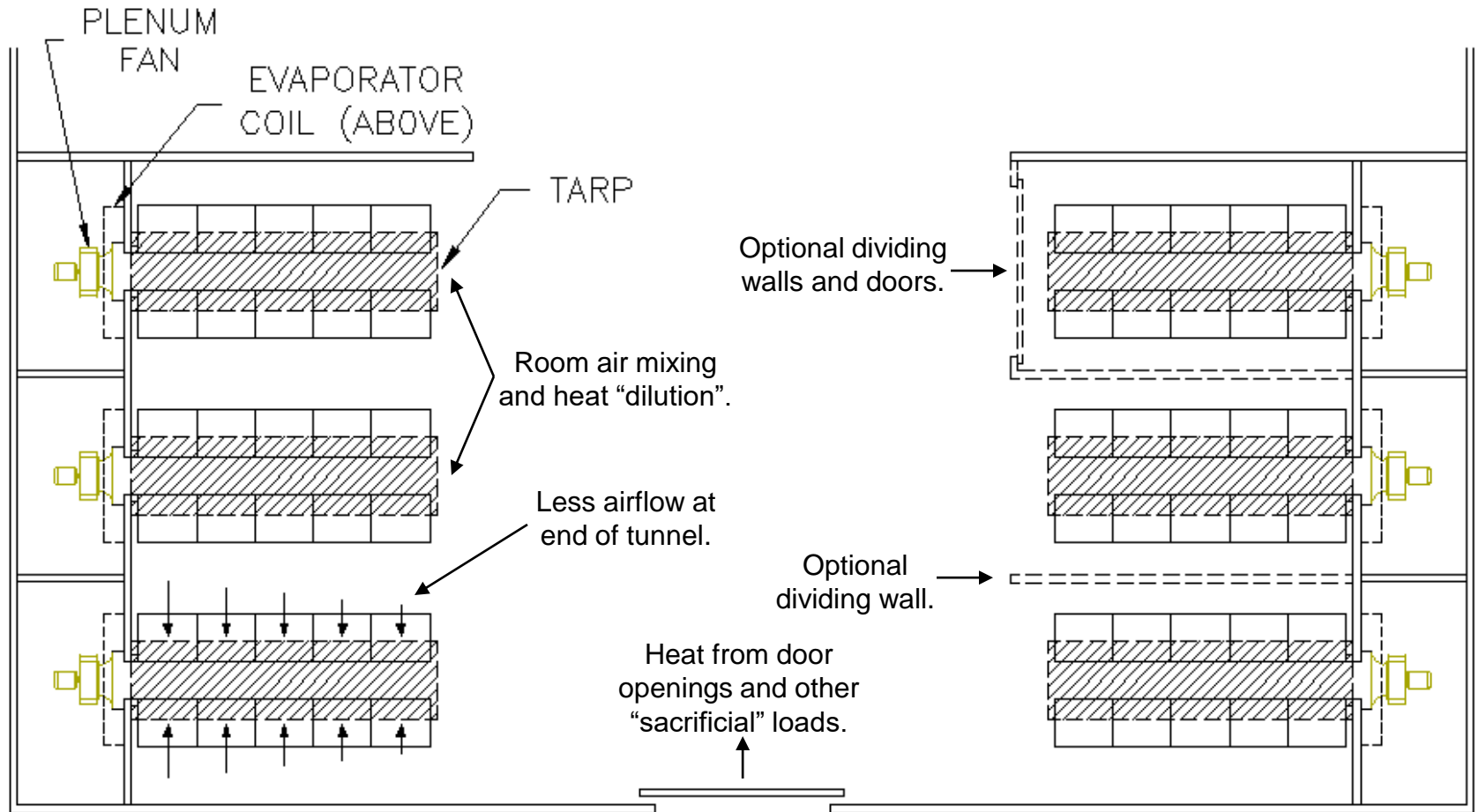
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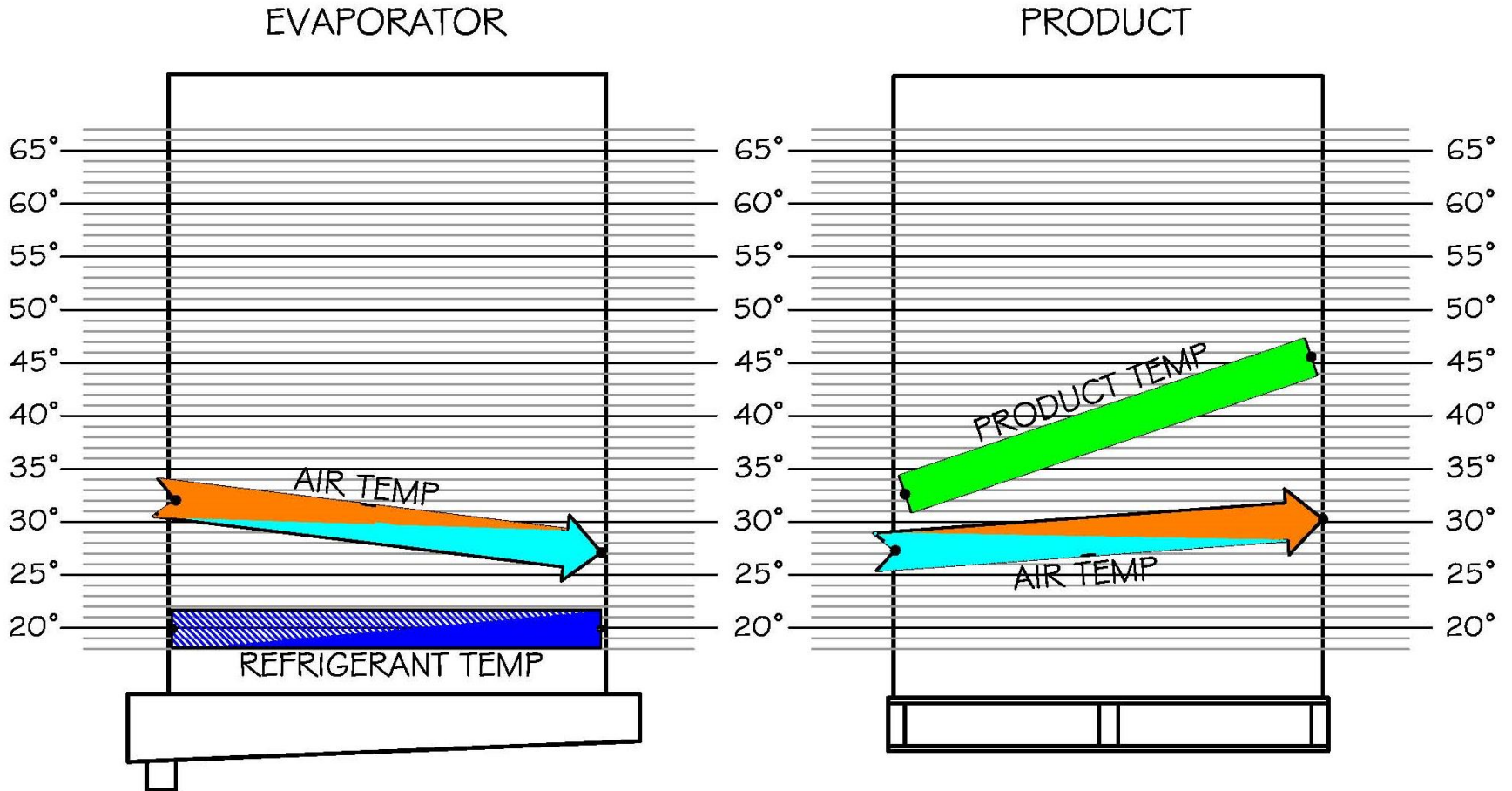
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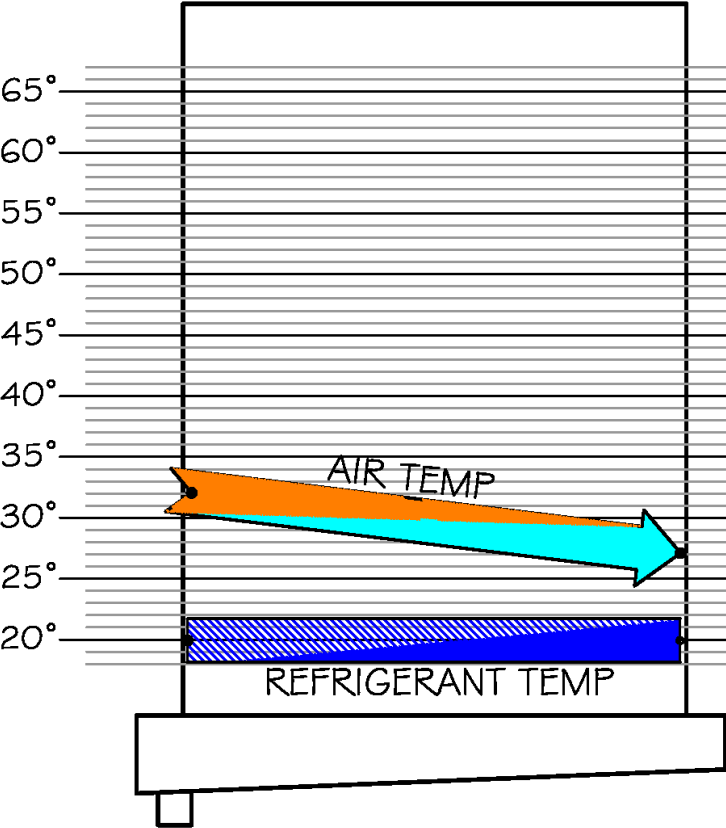


Temp Gradients, One-Way Air

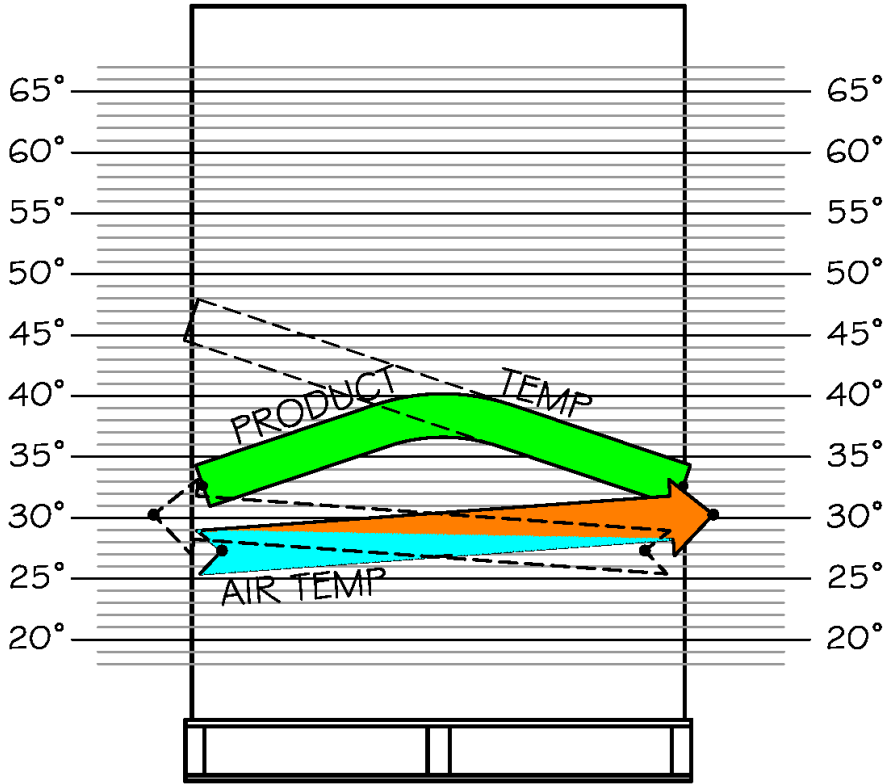


Temp Gradients, Two-Way Air

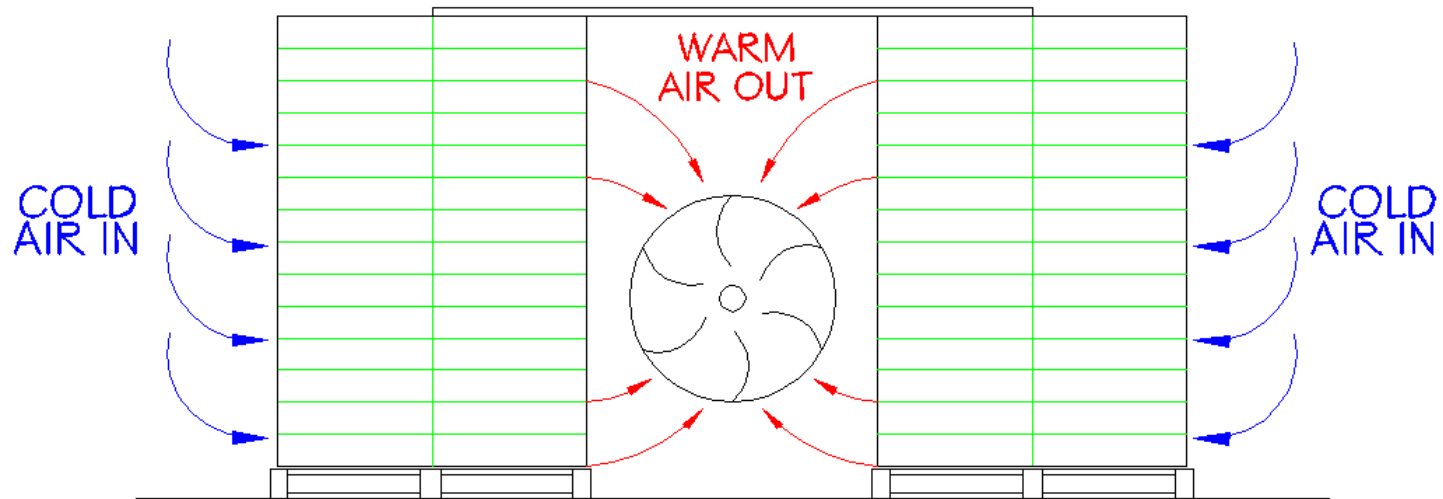
EVAPORATOR



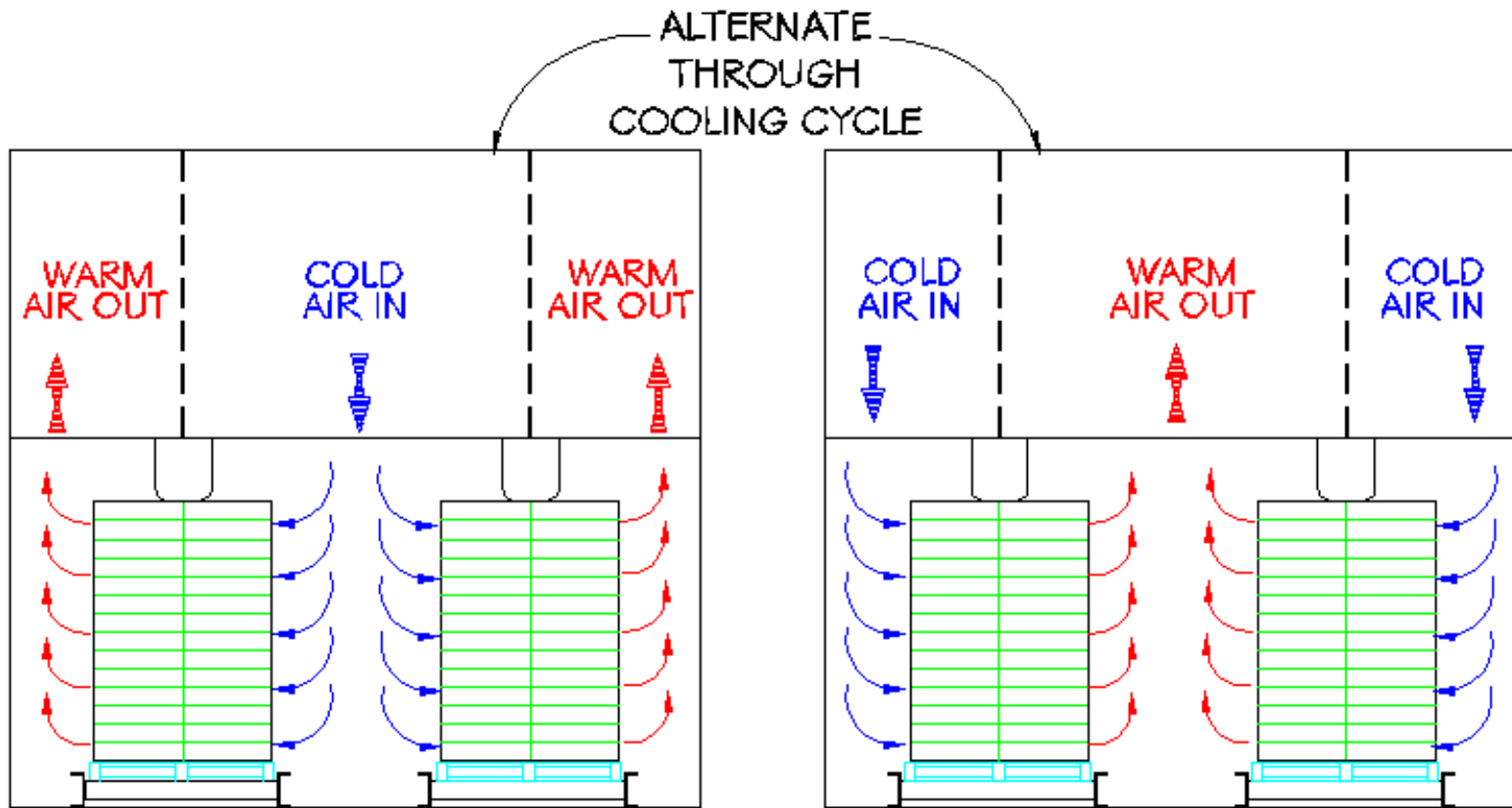
PRODUCT



Conventional Tunnel One-Way Cooling



Automated Cooler Two-Way Cooling



Automated F.A. PreCooler History

Automated F.A. PreCooler History

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

- 10 pallets, manual load and unload

- Airflow reversing mechanical dampers

FIG. 1

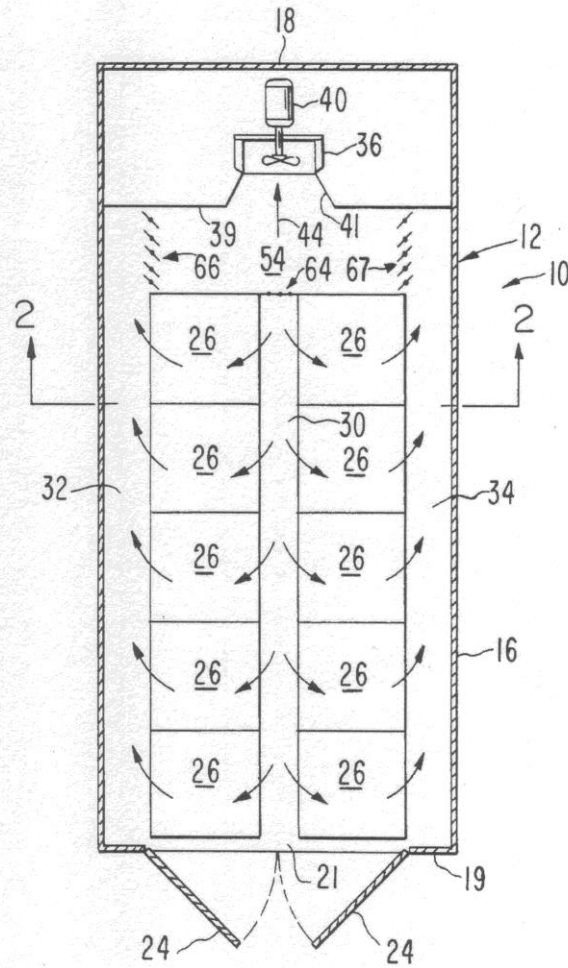


FIG. 5

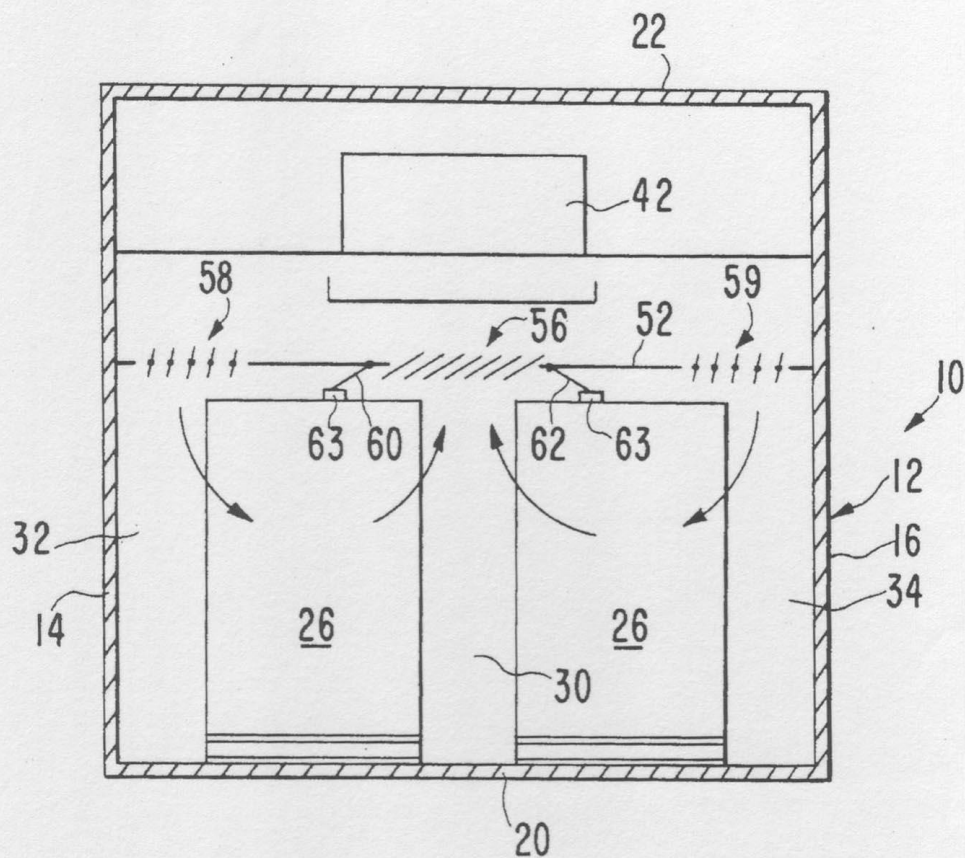
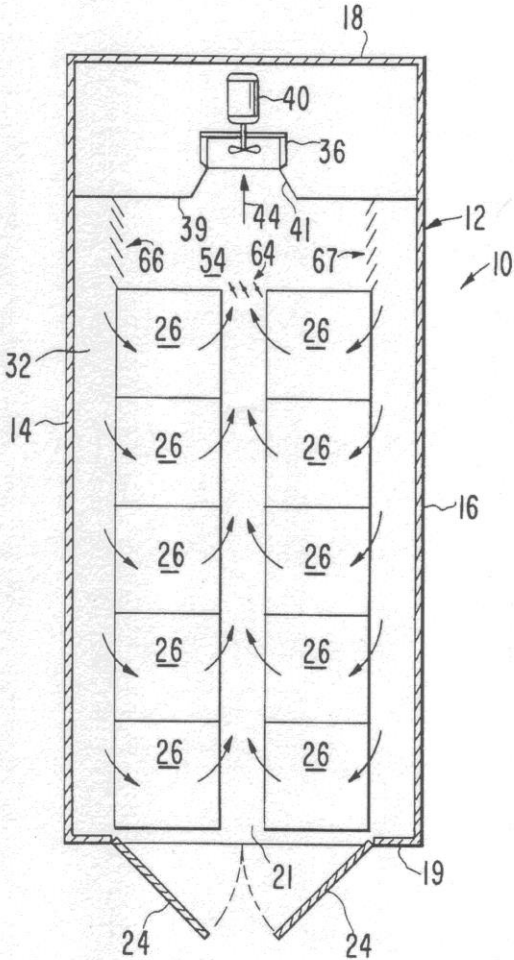
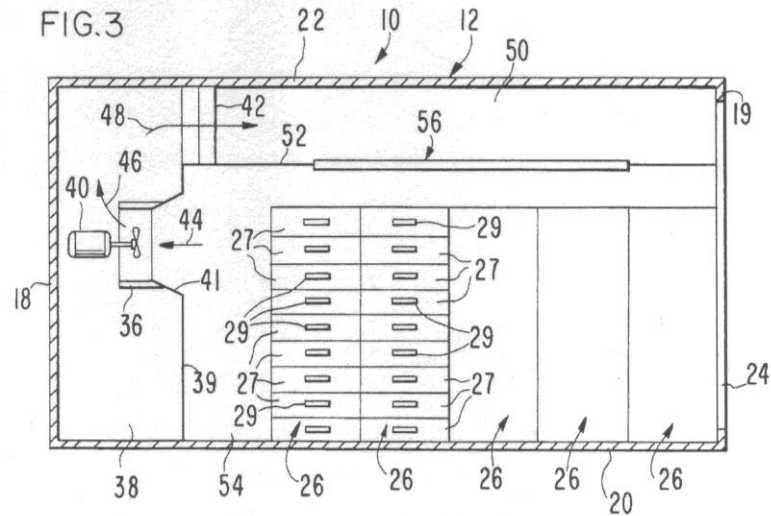
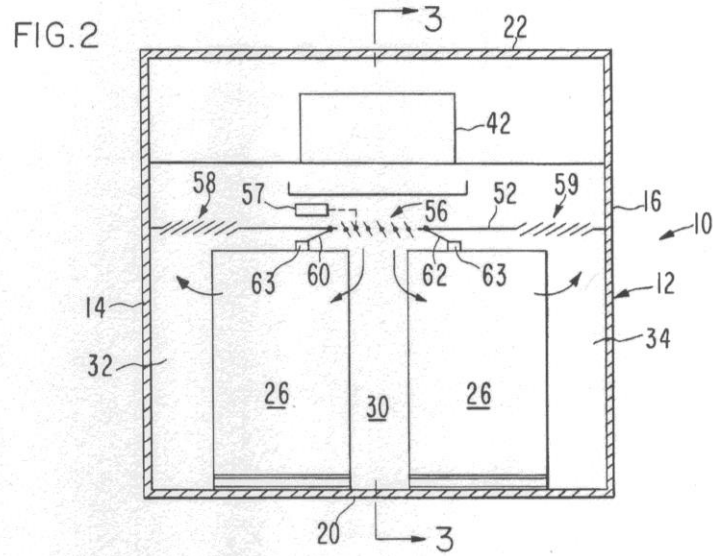


FIG. 4





Automated F.A. PreCooler History

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- Conveyorized, 10 pallets each zone, batch loading
- Conveyed into the cold room
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Driscoll's Watsonville Autocooler



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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

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2005 – 1st MACS Cooler operational at Watsonville Berry Cooler

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

Watsonville Berry Cooler 4-Module, 2005



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

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2008 – Redesigned MACS Coolers installed in Santa Maria, CA

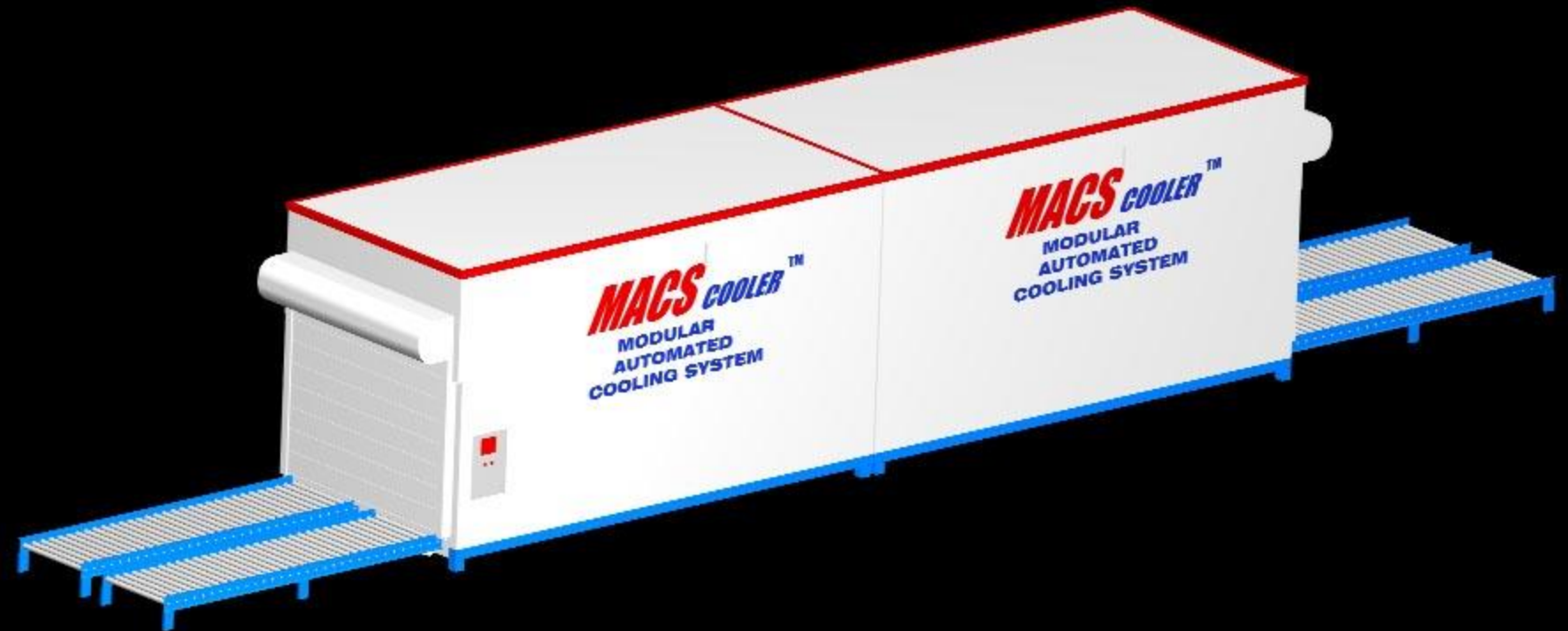
- 2 – Two module units at Frontier Cooling
- 1 – Single module unit at MJA Cooling

Frontier Cooling 2-Module (x2), 2008



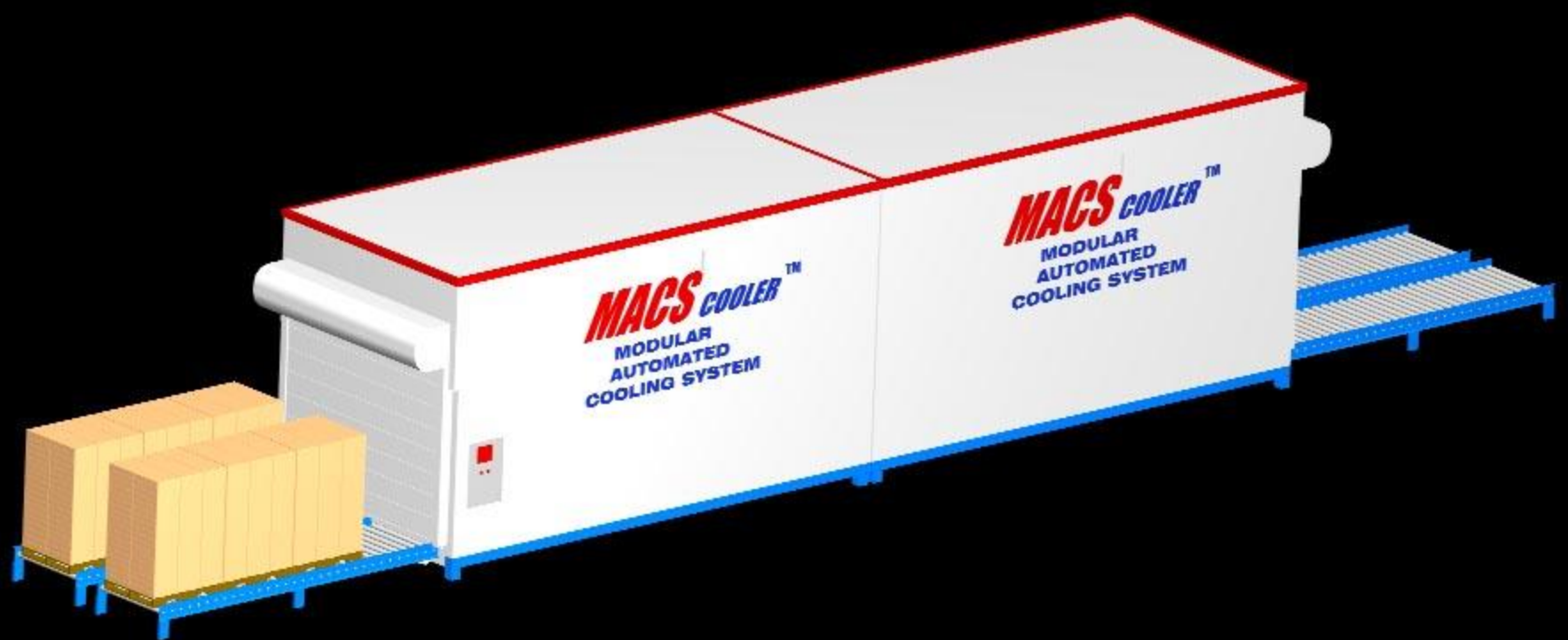
MJA Cooling 1-Module, 2008

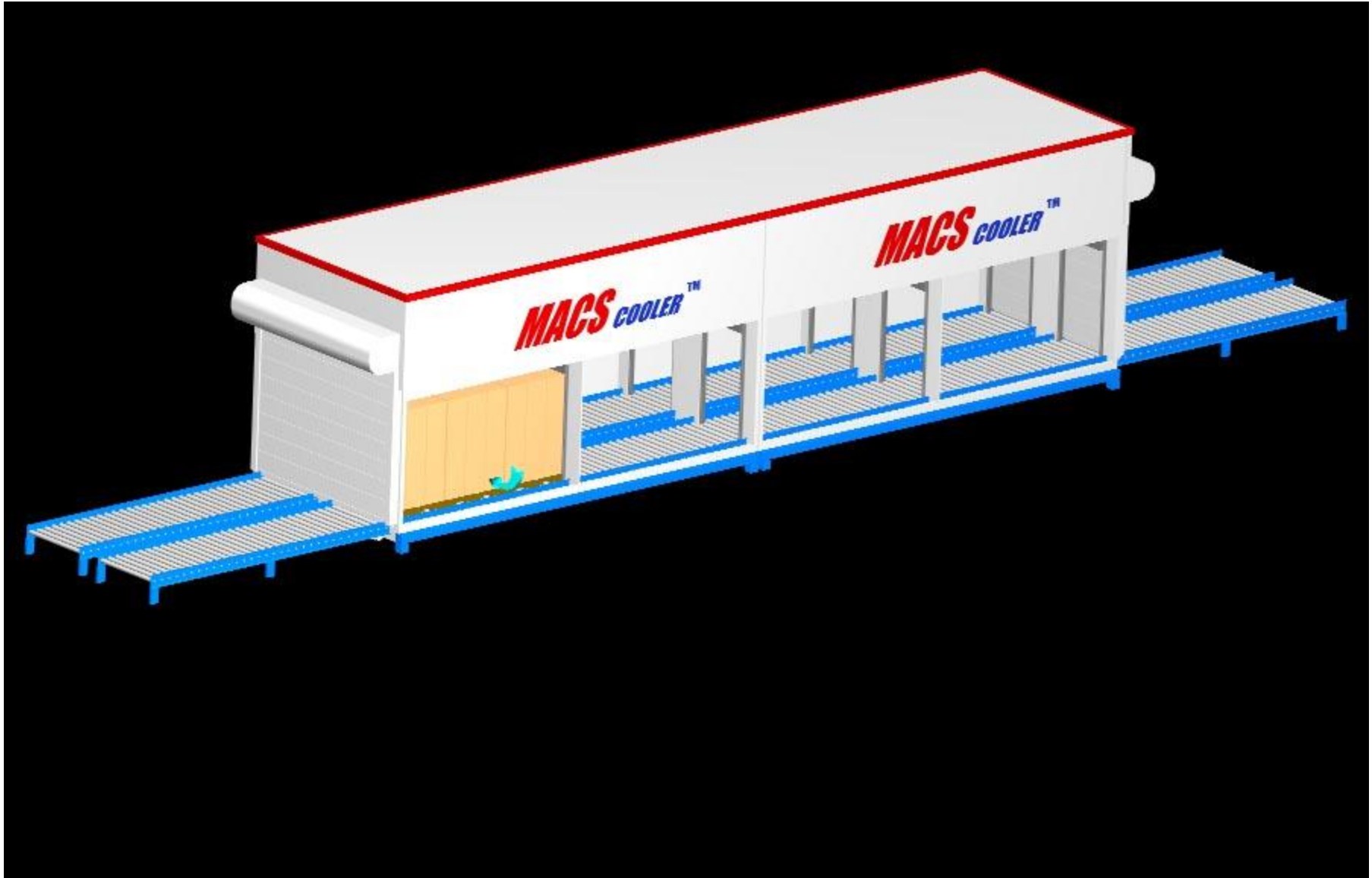


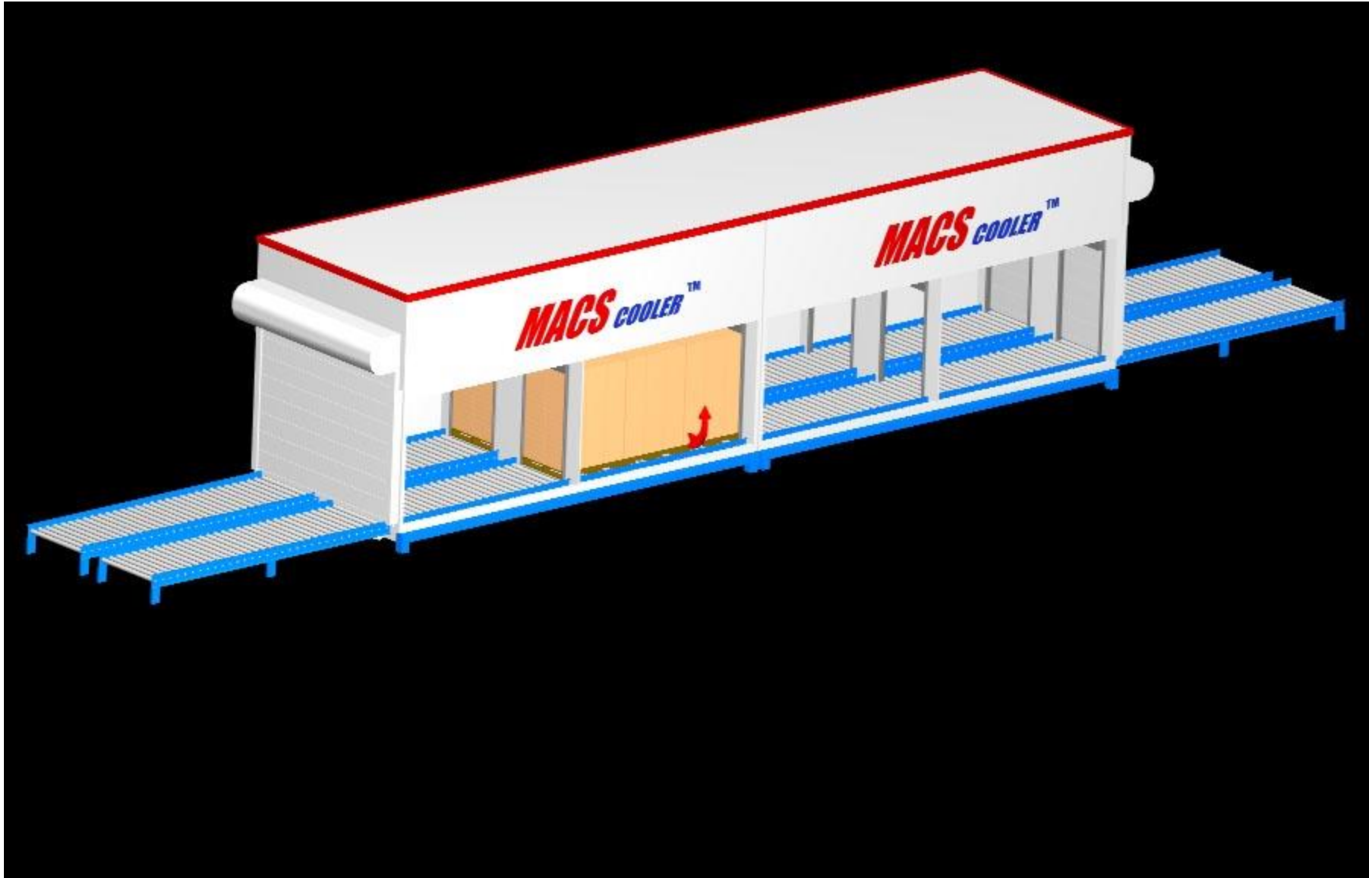


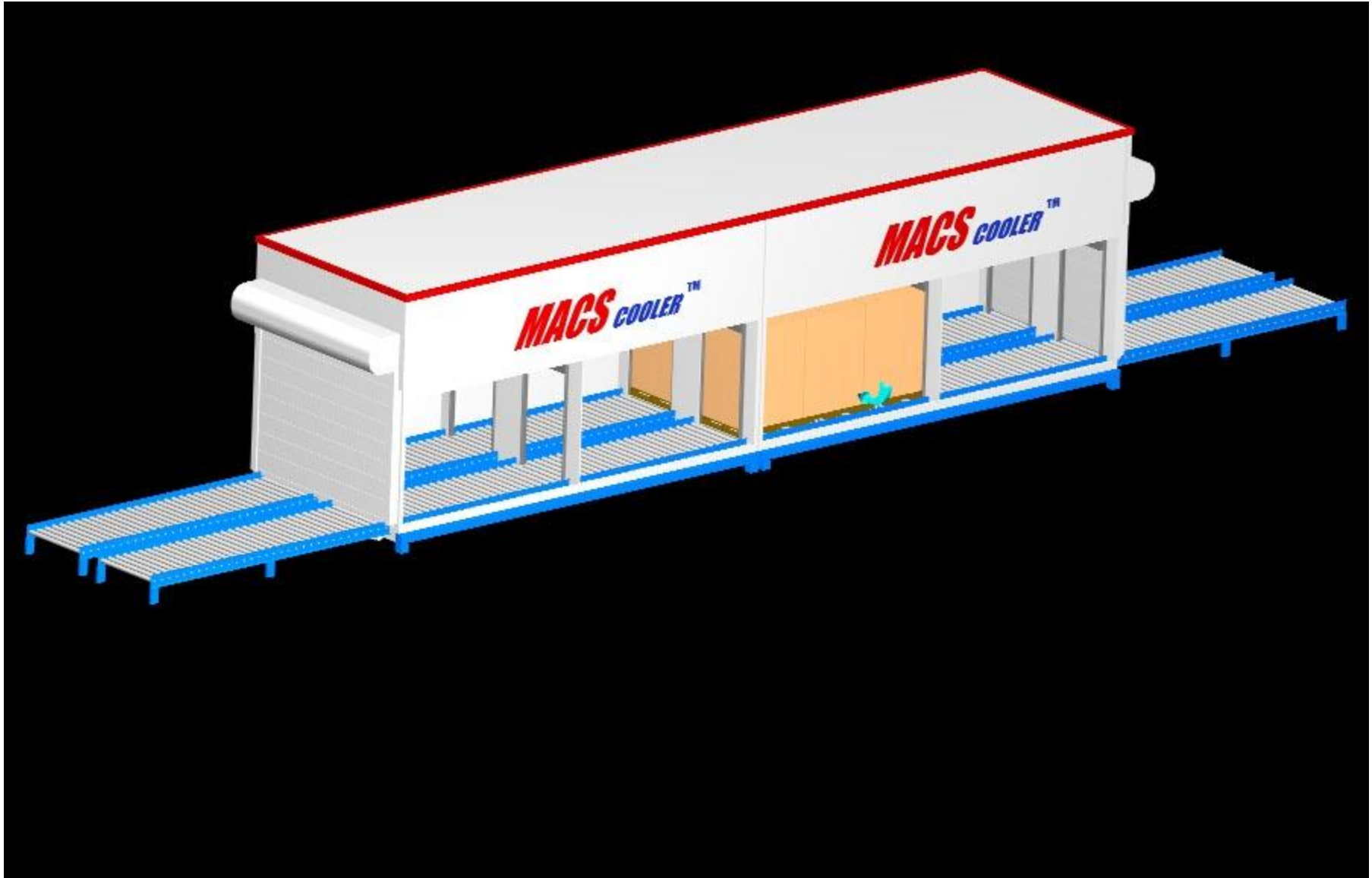
MACS COOLER™
MODULAR
AUTOMATED
COOLING SYSTEM

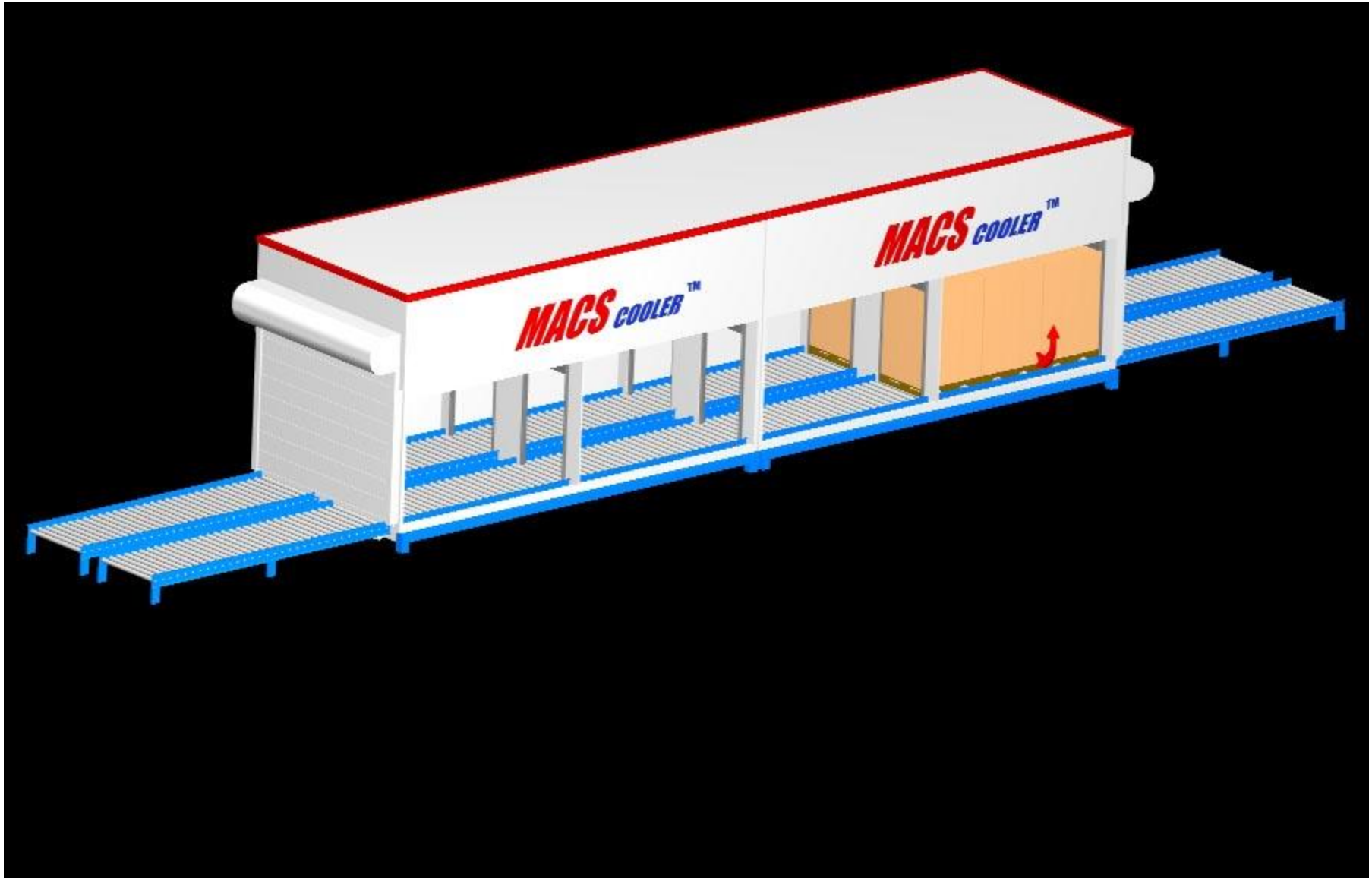
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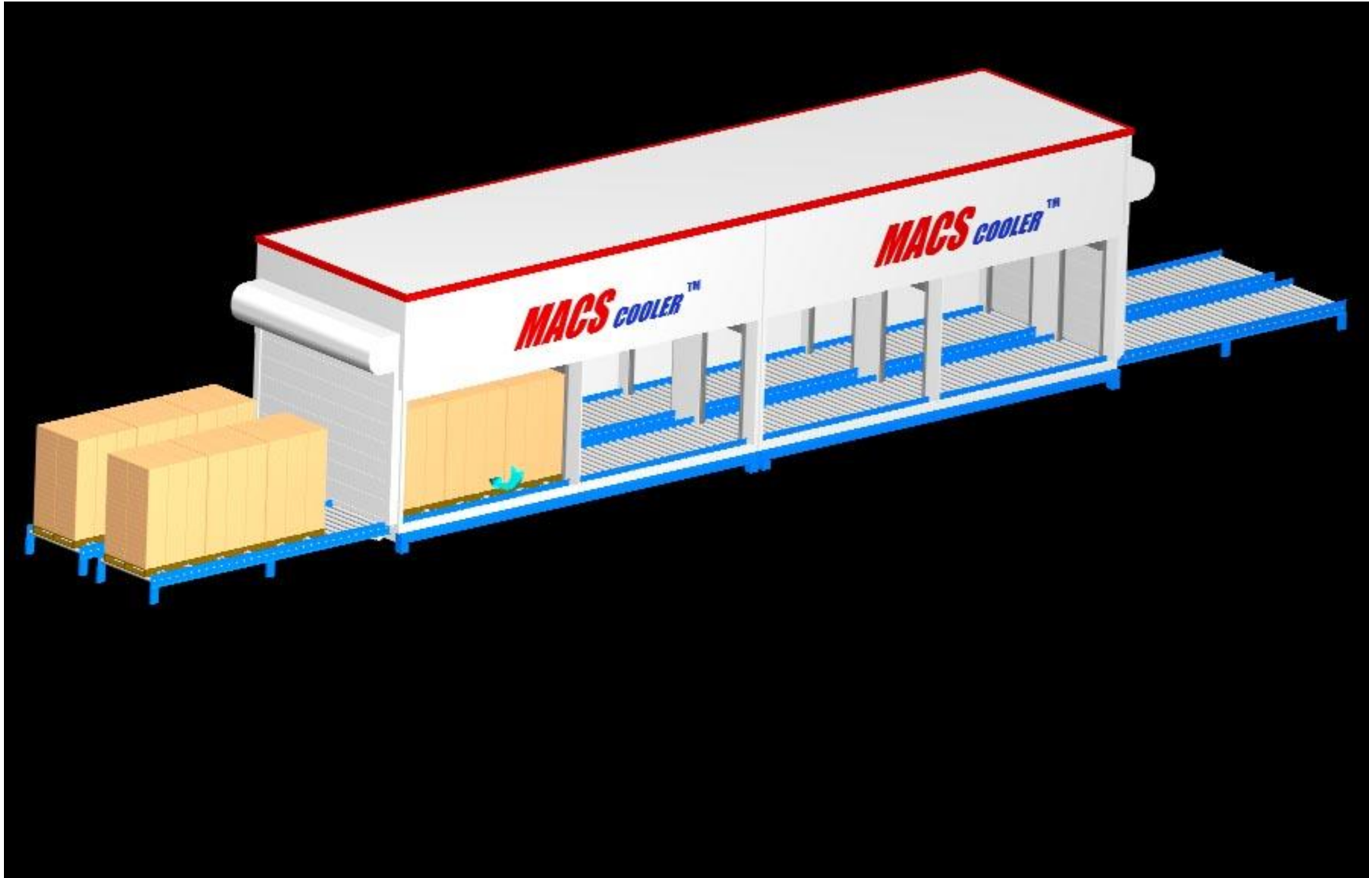




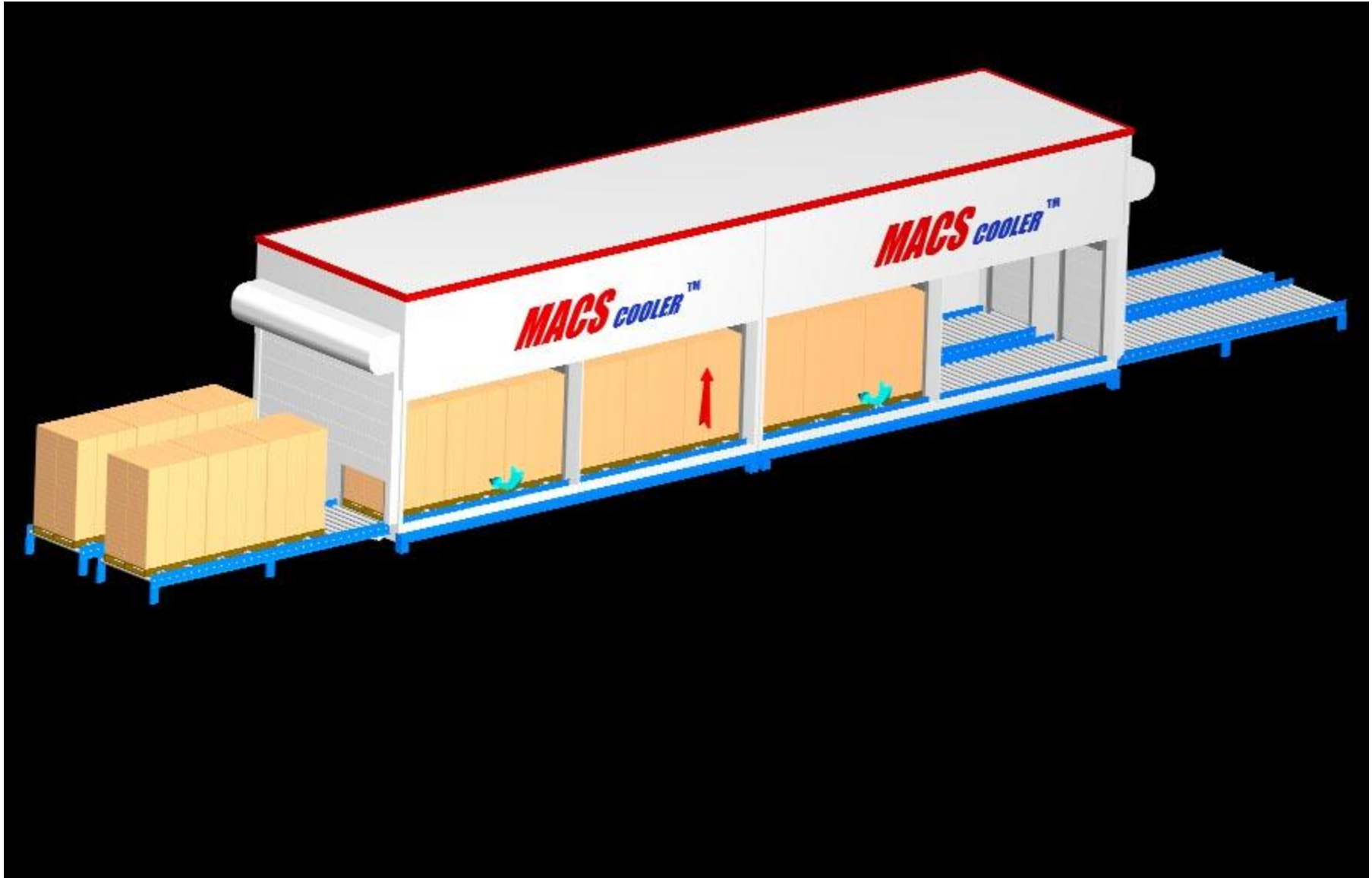
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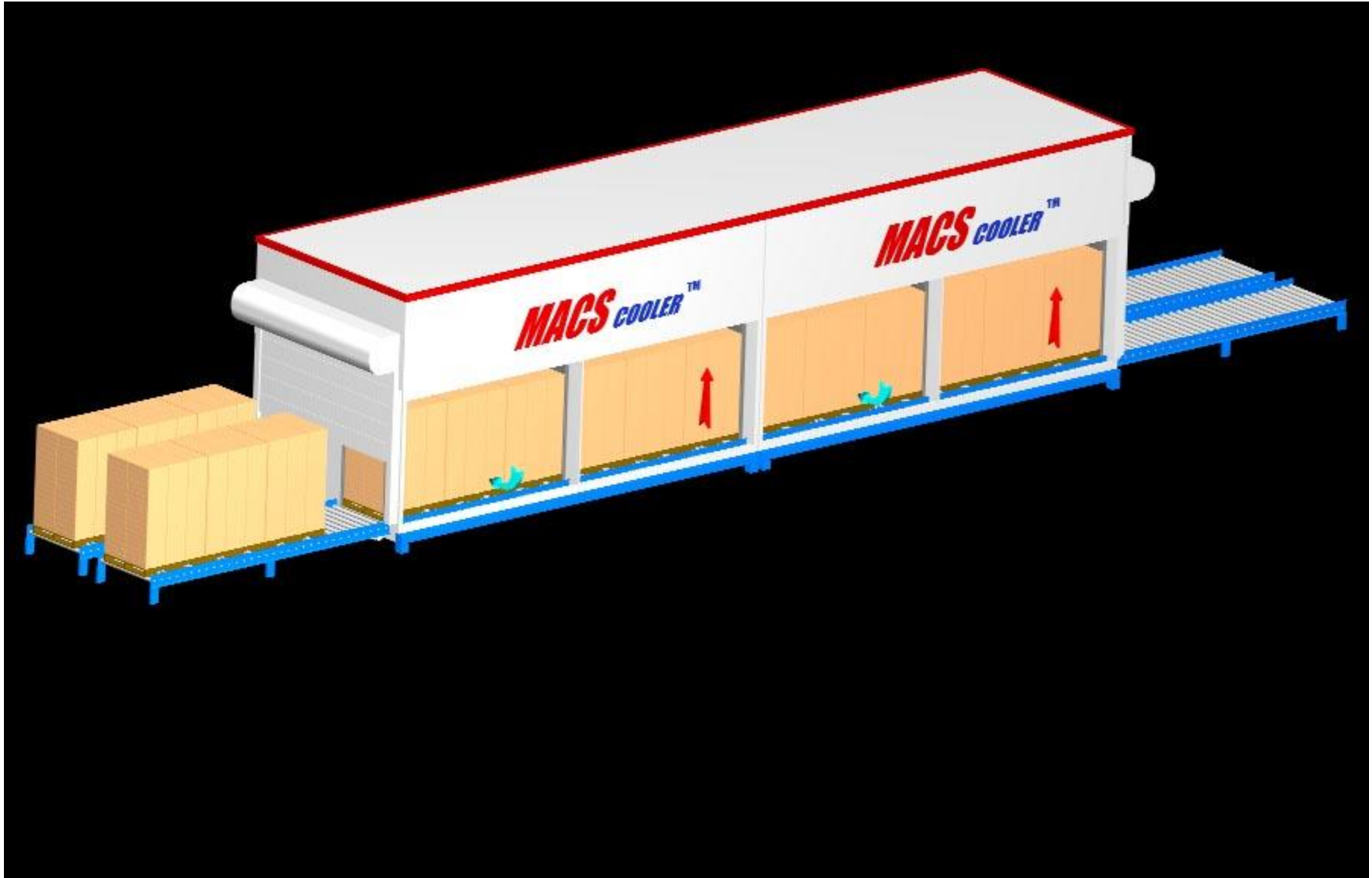
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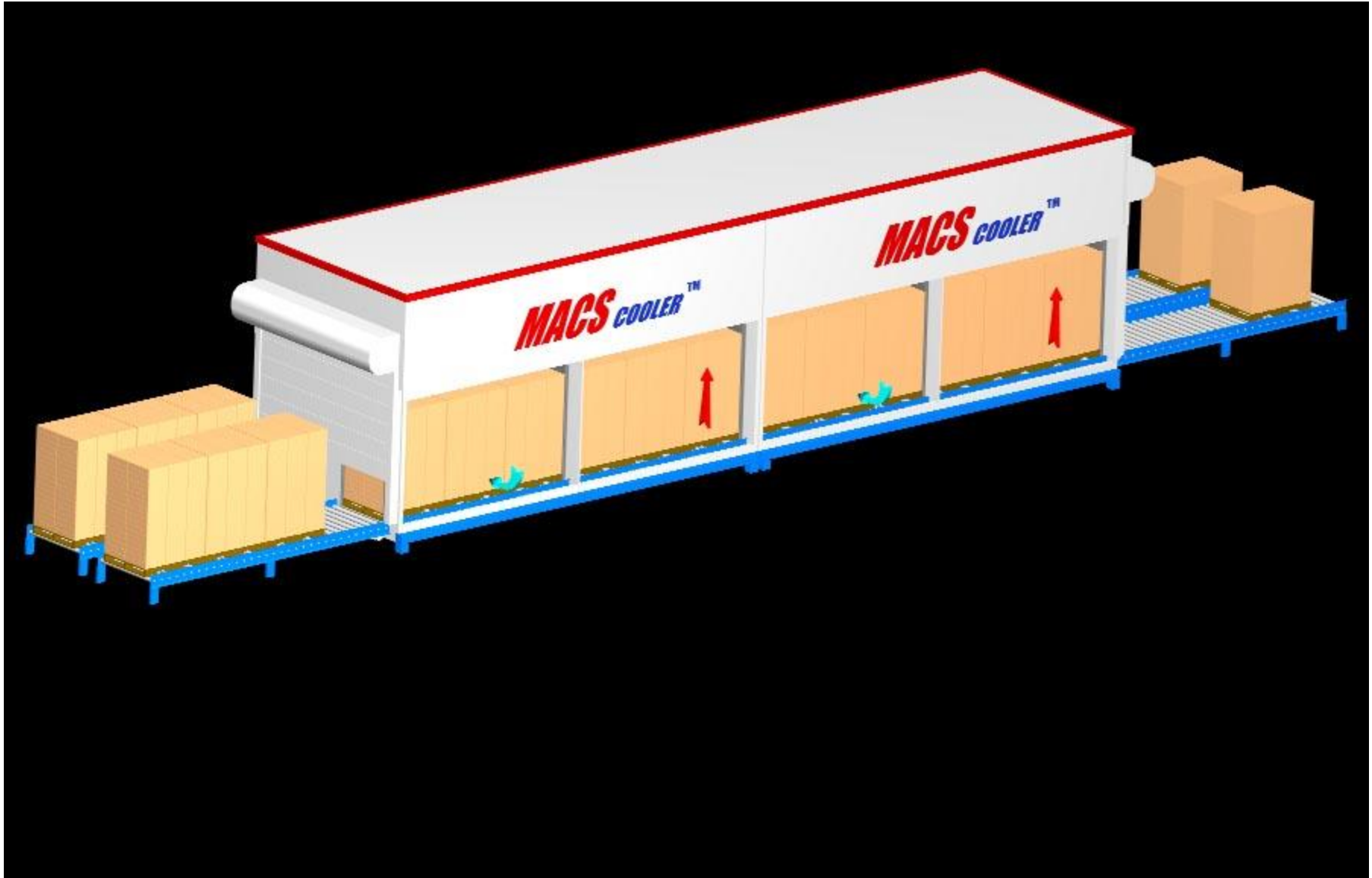






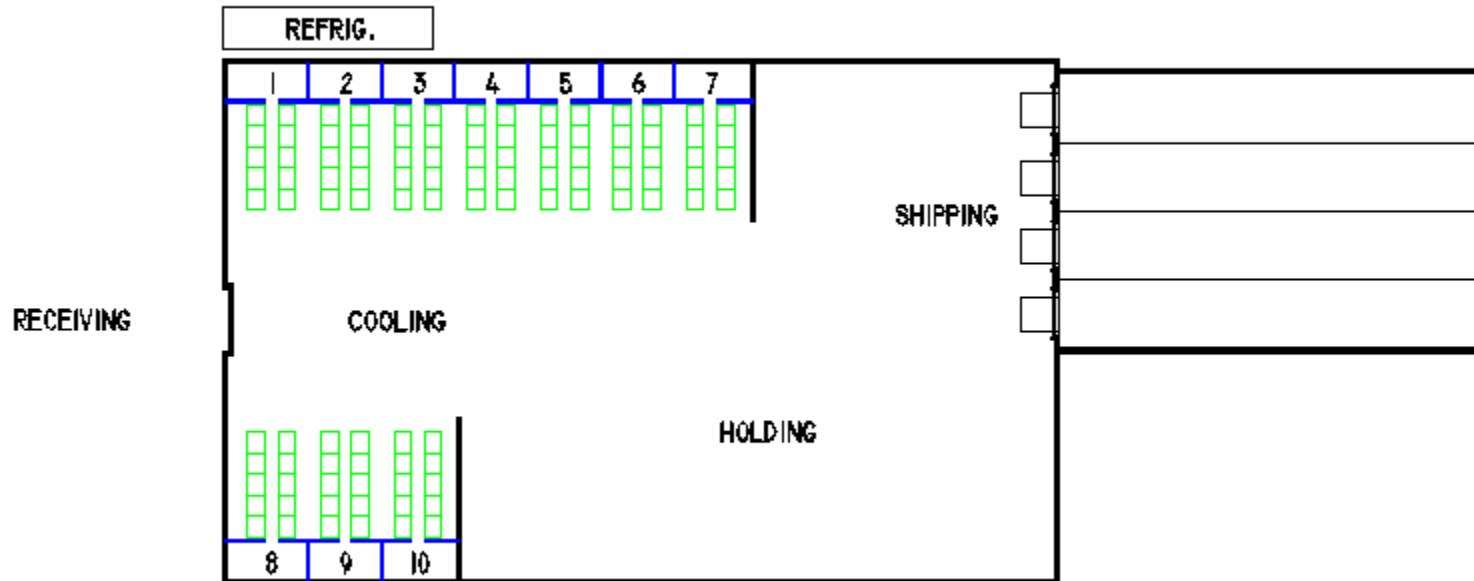






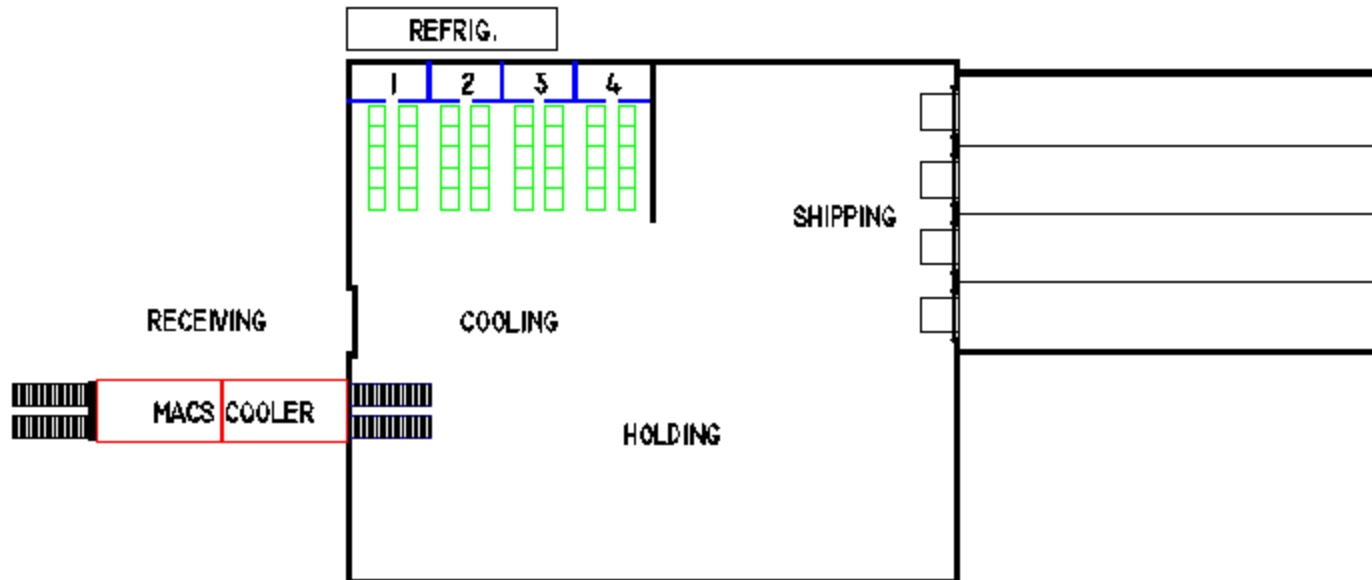
500 Pallet/Day Cooler

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.	2	7.5	25	8	120	6.25
	Prop.	1	10				
B	Prop.	2	15	50	10	70	5.83
	Prop.	1	20				
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
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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
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	

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Economic Considerations:

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Economic Considerations:

- 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 by PreCooling Type

Commodity	Cooling Method	k -Tons /year
Aparagus	Hydro	30
Apples	Room or Forced-air	77
Apricots	Room or Forced-air	9
Artichokes	Hydro	37
Avocados	Forced-air	135
Beans, snap	Hydro	30
Bell peppers	Room or Forced-air	462
Blueberries	Forced air	5
Boysenberries	Forced air	1
Broccoli	Liquid ice or Forced-air	920
Cabbage	Vacuum	303
Cantaloupe	Hydro or Forced-air	551
Carrots	Hydro	1052
Cauliflower	Forced-air	322
Celery	Hydro	850
Chili peppers	Room or Forced-air	82
Corn, sweet	Hydro	228
Cucumbers	Room or Forced-air	58
Dates	Room	19
Figs	Forced-air	7
Garlic	Room	215
Grapefruit	Room	201
Grapes, table	Forced-air	614

Commodity	Cooling Method	k -Tons /year
Head lettuce	Vacuum	2125
Honeydew	Forced-air	175
Kiwifruit	Forced-air	23
Leaf lettuce	Vacuum or Forced-air	740
Lemons	Room	798
Mushrooms	Forced-air	57
Nectarines	Forced-air	218
Olives	Forced-air	23
Onions	Room	1102
Oranges	Room	2268
Peaches	Room or Forced-air	601
Pears	Room or Forced-air	229
Plums	Room or Forced-air	158
Pumpkins	Room	57
Raspberries	Forced-air	58
Romaine lettuce	Vacuum or Forced-air	672
Spinach	Vacuum or Forced-air	231
Squash	Room or Forced-air	82
Strawberries	Forced-air	827
Sweet cherries	Hydro	32
Tangerines	Room	135
Tomatoes	Room or Forced-air	574
Watermelon	Forced-air	320

TOTAL 17,713

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Up to 46% can be forced-air cooled.

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