

Achieving \$225 million savings through **CO₂ refrigeration innovation**



Outdoor Parallel Rack - Long Island, NY



"We didn't have the power distribution for electric defrost at many sites, so the willingness of Zero Zone to innovate with hot gas defrost saved us a ton of money, about \$1.5 million per site."

Refrigeration Design Engineer

Business Overview

Locations: 185 Fulfillment Centers & 500 Stores

Employees: 1.5 million

2024 Revenue: \$620.1 billion

Partners: Since 2024

This global digital commerce enterprise faced significant challenges in modernizing its refrigeration systems across its extensive network of facilities. The company's objectives included improving energy efficiency, reducing operational costs, ensuring compliance with stringent regulations, and aligning with its carbon-neutral pledge by 2040. There were four main challenges to achieving these goals:



Cold Storage Warehouse

Four Challenges



High Electrical
Upgrade Cost



Operational
Risk During
Commissioning



Safety, Compliance,
and Refrigerant
Selection



Reliability and
Long Term System
Performance

Challenge 1: High Electrical Upgrade Costs

Many of the client's facilities were aging and required substantial electrical upgrades to support traditional electric defrost systems. The estimated cost of these upgrades ranged from \$1.5-\$1.8 million per site. Across the client's 125 planned sites, the total cost would exceed \$200 million, posing a significant financial hurdle.

\$200M
cost avoidance

Solution

The client implemented hot gas defrost systems in collaboration with Zero Zone. Hot gas defrost eliminates the need for electric defrost systems, reducing the electrical load and avoiding costly infrastructure upgrades such as new transformers, conduits, and municipal approvals.

"We didn't have the power distribution for electric defrost at many sites, so the willingness of Zero Zone to innovate with hot gas defrost saved us a ton of money, about \$1.5 million per site."

"The payback on this design is incredible, about 35% savings on electrical costs across the board, with a six-year ROI. This was huge for us."

Refrigeration Design Engineer

Result

- **Per Site Savings:** \$1.5-\$1.8 million
- **Cumulative Savings Across 125 Sites:** \$187.5-\$225 million in avoided upgrade costs
- **Energy Efficiency:** Hot gas defrost systems also delivered a 35% reduction in electricity usage, with a six-year return on investment

35%
less electricity

Challenge 2: Operational Risks During Commissioning

Startup delays during system commissioning significantly impacted operations. At large hubs, delays in refrigeration readiness were costing the client \$156,000–\$250,000 in sales per day, while even smaller sites faced daily losses of \$130,000–\$140,000. Additionally, inconsistent startup processes created inefficiencies that required frequent interventions.

\$250k
sales per day

Solution

The client streamlined its commissioning process by collaborating closely with Zero Zone to:

- Improve communication between refrigeration contractors and system manufacturers.
- Ensure on-site support during key startup phases.
- Develop robust commissioning protocols, including early identification of potential blockers.

“When everything is aligned; controls, contractors, and the equipment, we avoid huge headaches and meet our deadlines. It’s about execution all the way to the finish line.”

Result

- **Minimized Delays:** Commissioning processes became more efficient, reducing costly delays.
- **Daily Savings:** Up to \$250,000 per day in lost sales avoided at large hubs.
- **Improved Efficiency:** A consistent two-to-three-week commissioning timeline with a 14-day burn-in period ensured systems were operational within optimal timelines.



Piping - Outdoor Parallel Rack

“Every day we aren’t pushing product costs us between \$156,000 and \$250,000 at a hub. Zero Zone helped minimize these delays by collaborating on the startup process.”

Refrigeration Design Engineer

Challenge 3: Safety, Compliance, and Refrigerant Selection

The client sought to align its operations with sustainability goals, including achieving carbon neutrality by 2040. However, the choice of refrigerants posed challenges:

- **Ammonia:** While cost-effective for large systems, ammonia systems require expensive compliance with Process Safety Management (PSM) protocols, increased zoning restrictions, and 24/7 supervision by RETA-certified technicians (costing \$100K–\$125K per technician annually).
- **Propane:** Systems hold tons of pressurized propane which pose challenges in densely populated areas and require on-site support during key startup phases.

Solution

This client standardized on CO₂ refrigerant systems due to their safety, regulatory advantages, and alignment with sustainability goals:

- CO₂ is non-flammable and non-toxic, eliminating fire hazards and zoning restrictions.
- Systems are designed for easy maintenance, avoiding the need for highly specialized technicians.

“With ammonia, the costs of compliance and zoning are a nightmare. CO₂ eliminates those hurdles and is better aligned with our long-term vision for sustainability.”

Refrigeration Design Engineer

“CO₂ is here to stay. It’s non-toxic, non-flammable, and aligns perfectly with our sustainability goals. We’ve been designing with CO₂ for 13 years, and it’s the right fit for the future.”

Result

- **Labor Savings:** Eliminated the need for 24/7 RETA-certified ammonia technicians, reducing labor costs by \$625K–\$875K annually per large hub.
- **Regulatory Compliance:** Avoided zoning restrictions and PSM compliance costs of up to \$350K annually per site.
- **Sustainability Leadership:** CO₂ systems support the client’s carbon-neutral pledge by reducing greenhouse gas emissions and eliminating reliance on HFC or flammable refrigerants.

Challenge 4: Reliability and Long-Term System Performance

This client needed refrigeration systems that could withstand its demanding, high-volume operations. Previous systems had faced design and quality issues, leading to costly failures such as heater replacements and compressor breakdowns.

Solution

This client partnered with Zero Zone to design refrigeration cases with:

- 90-bar internal robustness for durability under high pressure.
- Simplified piping layouts to minimize maintenance needs.
- Enhanced quality control during manufacturing to prevent failures.

“The first [hot] gas defrost system we piloted saved us a ton of money and worked incredibly well. We’re seeing the same robustness in the new systems—everything is done right, down to the last nut and bolt.”

Result

- **System Longevity:** CO₂ systems are designed to last 12–15 years, with capital improvements at the mid-life point to optimize performance.
- **Reduced Maintenance Costs:** Robust designs minimized failures, avoiding costly repairs such as the \$150,000 heater replacement at a previous site.
- **Operational Resilience:** Systems maintained a $\pm 2^{\circ}\text{F}$ variance, critical for food safety and product longevity. The client’s carbon-neutral pledge by reducing greenhouse gas emissions and eliminating reliance on Freon or flammable refrigerants.



90-bar case coils



3RHMC30TBB

“Zero Zones cases are the most robust I’ve worked with. In five to seven years, parts and pieces aren’t falling off. That reliability is crucial for a 24/7 operation like ours.”

Refrigeration Design Engineer

Holistic Results and Outlook

The strategic shift to CO₂ refrigeration systems with hot gas defrost technology has proven transformative, addressing critical challenges and delivering measurable results:

- ✓ **Revenue Impact:** \$250,000/day of revenue during commissioning (\$22,500/day profit).
- ✓ **Total Cost Avoidance:** \$187.5-\$225 million across 125 sites avoiding electrical upgrades.
- ✓ **Energy Efficiency:** 35% reduction in electricity usage, achieving a six-year ROI.
- ✓ **Sustainability Impact:** CO₂ systems aligned with the client's carbon-neutral pledge, setting a new standard for environmentally responsible refrigeration.

System Components

- The **Compressors** are a semi-hermetic reciprocating type. These compressors have a variable frequency drive for capacity control on the lead compressor of each suction group.
- 8 **Cooler Evaporator Coils** cycle 80 tons of refrigerant designed as two redundant 40 ton systems to quickly cool the warehouse space.
- **Dual High Pressure Expansion Valves** and **Dual Flash Gas Bypass Valves** create redundancy in the system to ensure an accurate temperature can be maintained if a fault occurs. They are controlled by E3 controls.
- **Stainless Steel Piping** is able to handle the high pressures of CO₂. In the event of a shutdown, the stainless steel piping will prevent the need to blow a charge when the pressure increases, saving refrigerant.
- **Oversized Suction Accumulators** for system protection during startup and rack failure.

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