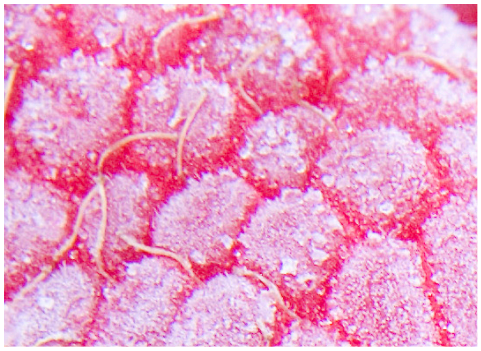
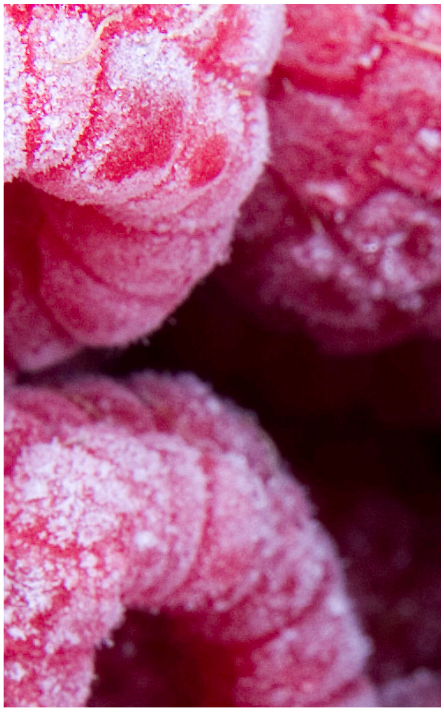
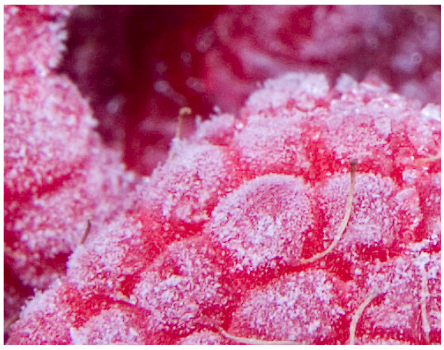


WHITE PAPER, MAY 2011

DEEP-FREEZE

Optimizing Efficiency in Deep-Freeze Warehouses





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DEEP-FREEZE

OPTIMIZING EFFICIENCY IN DEEP-FREEZE WAREHOUSES

For decades, the vast majority of deep-freeze warehouses have been manually-operated facilities with workers operating lift trucks to move pallets of frozen products. Because of increased consumer demand for frozen food products and a highly competitive market with low margins, the deep-freeze supply chain is continually looking for ways to improve its lead time, accuracy of orders and to ensure a higher level of product quality for the retailers that it serves. As a solution, food processors, distributors and retailers are shifting away from manually-operated sub-zero facilities and turning to high-bay deep-freeze warehouses, equipped with streamlined logistics processes.

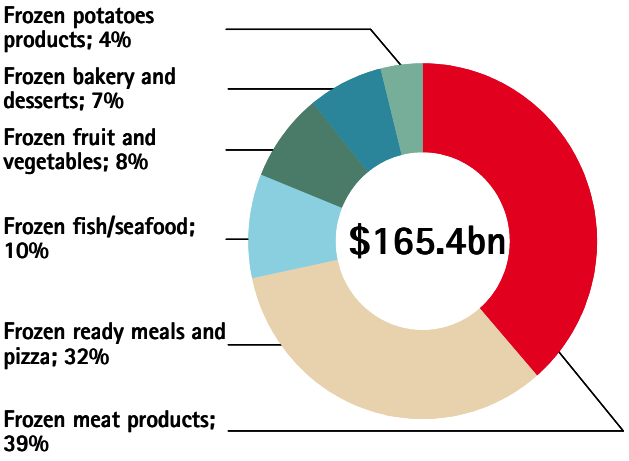
This white paper examines deep-freeze supply chain issues that the frozen food industry is facing, with a focus on the technology that can provide solutions to these issues. Such solutions include maximizing deep-freeze warehouse space utilization; improving energy efficiency in the sub-zero warehouse; faster receiving and retrieval of deep-freeze products; monitoring and controlling time per temperature zone; improved inventory and order fulfillment accuracy; and the requirement to access immediate tracking information and the identification of products in the deep-freeze warehouse. This paper reviews some of the latest, key technology used in the deep-freeze environment, such as automated storage and retrieval systems (ASRS), unit modular conveyor systems, automated case picking, controls systems, and load tracking and verification.

Demand for Frozen Food

The global demand for frozen food continues to grow, as it has for the past decade. It will continue to expand at a rate of 4 percent annually for at least the next five years according to the industry profile report, Global Frozen Food, released and published in October 2010 by Datamonitor.

Convenience is driving frozen food market sales globally. Consumers are looking for healthy, but less time-consuming meals, according to the report. The meat segment accounts for the highest share (39 percent) followed by frozen ready meals and pizza (33 percent) in the overall frozen food segment. But frozen fish/seafood, fruit and vegetables, bakery and desserts, and potato products also continue to fuel the growth.

The global frozen foods market was estimated to be $165.4 billion in 2009 and is expected to grow by 21 percent to $199.5 billion by 2014.



Global frozen food market segments: % share, by value, 2009(e) Source: Datamonitor 2010

In the face of this continually rising worldwide demand for frozen food products, the need for a more reliable and efficient deep-freeze supply chain has become a challenge to overcome. An unbroken deep-freeze supply chain is an uninterrupted series of storage and distribution activities which maintain frozen product at a consistent sub-zero temperature range. Consequently, deep-freeze warehousing has become a focal point for food processors, distribution centers and retailers to streamline throughput and improve cost efficiencies.

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Deep-Freeze Challenges

Cold storage, deep-freeze warehouses pose definite challenges for food processors, distribution centers and retailers who endeavor to have facilities operating at a high level of efficiency. Maintaining a high throughput rate along with inventory and fulfillment accuracy at -28° C (-18.4° F) is a much more difficult task than in an ambient temperature or even a chilled warehouse.

Compared to non-deep-freeze facilities, most manually-operated sub-zero warehouses have a higher incidence of product damage, missed product rotation and wrong item fulfillment which have negative impacts on production. These warehouses also have heightened facility, equipment and product damage, primarily caused by manually-operated fork lifts impacting racks and doors, significantly higher than that found in ambient temperature and chilled warehouses. Not surprisingly, personnel turnover in sub-zero storage facilities is also higher than in non-deep-freeze warehouses. Whilst the temperature in these facilities is cold enough to store food products safely, it creates an extreme environment with difficult working conditions for personnel, increased safety issues, and staff recruitment and retention problems.

Automation of deep-freeze warehousing has been embraced as an ideal solution to these difficulties. The most streamlined frozen food warehouses today are highly automated sites, with maximized high-bay, high-density storage utilizing ASRS. These deep-freeze warehouses maintain precision product identification and rotation, provide rapid throughput at over 99.9 percent accuracy levels, and are considerably more energy efficient than their manually-operated predecessors.

Need for Speed

Every aspect of sub-zero warehousing is moving faster. The consumption of frozen products has increased dramatically and rapid replenishment of retailers' shelves is more than ever important in order to not lose any sales in the stores. Turnover of stock is faster, with an increasing number of products – more stock-keeping units (SKUs) in the -20° C to -28° C (-4° F to -18.4° F) range, and there is a need to respond quickly to market demands. This puts warehouses that are operating manually at a disadvantage with regards to maintaining cost efficiency and order accuracy.

To stay competitive, food producers, distribution centers and retailers need to implement systems for deep-freeze that will have the flexibility to adjust to market conditions such as increases in SKU range and shortened lead times very quickly and accurately. Deep-freeze facilities need to acquire the same standards of storage and picking methods used successfully in the chilled and dry grocery product sectors. They require systems that will respond to retailer needs and get products out of the deep-freeze warehouse to retail outlets quickly and with minimal order errors.

Today, a producer, distributor and retailer of frozen food products needs to track and identify where each pallet came from, where it was stored, what the temperature was in storage, and other critical data to keep track of its perishable inventory and ensure its product integrity. Manual handling leaves open the possibility of human error, but streamlined programmable logic controller (PLC)-controlled automation, integrated with a warehouse management system (WMS), provides this data quickly with reliable and verifiable documentation.

Manual picking at -28° C (-18.4° F)

High-Bays Optimize Space and Energy Efficiency

There is a major benefit for a warehouse switching from a manual to an automated deep-freeze facility, and that is maximized building volume utilization and increased cost efficiency through high-bay accessibility.

In a typical manually-operated sub-zero warehouse, forklift trucks are limited to a maximum reach of around 7 meters (23 feet),

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allowing for pallets to be placed into four vertical positions on the rack system. If a deep-freeze needs to store more pallets, the only way it can go is horizontally by expanding the footprint of the warehouse or building another deep-freeze to accommodate the additional pallet locations. It is not unusual for food manufacturers to have multiple manual deep-freeze locations, continuing to add storage footprint as the company expands.

Within a high-bay warehouse system, it is possible to have as many as 25 vertical pallet positions on racks 50 meters (165 feet) high. For the deep-freeze warehouse environment this is an important efficiency factor in footprint consolidation. It can handle the same number of pallets, but on a smaller footprint. But of equal importance, the footprint reduction becomes an increasingly important factor in energy savings since much of the cold loss in a sub-zero warehouse occurs through the roof.

In effect, deep-freeze warehouses are giant insulated freezers which extract heat to produce a cold environment. The removal of heat comes at a hefty energy cost. Having a smaller roof footprint in a sub-zero warehouse presents a considerably better energy solution. Typically, 43 percent of the refrigeration load in a deep-freeze is due to losses through the roof and walls. And, high-bay deep-freezes, on average, have 40 percent less surface area than warehouses using lift trucks. A 2 000 square meter (21 500 square foot) high-bay deep-freeze facility with 10 000 pallet locations could reduce energy costs by up to one-third of that needed for a manual facility handling the same number of pallet locations.

Those high-bay, deep-freeze warehouses that are the most energy and cost efficient have achieved a high density of space utilization. This means they have a space configuration that allows for the maximum number of pallet positions to fit into the facility.

High-bay systems optimize cubic space usage in deep-freeze, not only by their vertical stacking capability, but also by minimizing aisle cubic footage. By eliminating the need for forklift trucks, aisles can be made significantly more narrow – allowing 3.7-meter (12-foot) wide aisles to become just 1.5-meter (5-foot) wide. This space can then be used for more pallet positions.

Automation Designed for Deep-Freeze

Aside from maximizing the cubic space utilization of the physical deep-freeze structure itself, it is the automated equipment inside that defines the warehouse's throughput speed and efficiency.

But designing systems that will function optimally under these extreme conditions requires careful engineering.

Not all automated warehouse equipment performs well at -28°C. The most high-speed and durable material handling equipment capable of a high level performance at ambient temperatures would in short time be incapacitated in a deep-freeze environment.

Specially blended steels, oils, greases and other lubricants for gearboxes, bearings and drives are specified for extreme low temperatures. Wiring and electrical cables are designed to flex in these temperatures. PLCs, PCs and other electronic controls components are kept in heated cabinets. Photo-electronic sensors that feed computer information and detect pallets are maintained to be free from frost by being equipped with heating devices.

Automated systems for deep-freeze need to be designed to include these features, not only so that they can be highly streamlined but also for system longevity. Such equipment encompasses a range of fully-automatic and semi-automatic options, including ASRS for mini-loads, robotic picking systems for cases, and modular conveying systems for pallets and unit loads.

ASRS Optimizes Throughput and Energy Efficiency – ASRS are computer-controlled systems for automatically depositing, storing and retrieving unit loads from defined storage locations. They allow inventory to be moved quickly, safely and precisely in a warehouse environment. When applied to a sub-zero warehouse, ASRS produce dramatic results, effectively making a deep-freeze facility as efficient as an automated ambient or chilled warehouse.

The latest generation of ASRS provides a uniquely flexible and modular design that is equipped with a multi-load remote pallet handling capability, ideal for deep-freeze warehouse automation at its coldest (-28° C). These ASRS allow rapid configuration to the right storage and retrieval need for almost any application. From floor level to up to 50 meters (165 feet) tall, they provide single-deep, double-deep, triple-deep and multi-deep stacking, with the flexibility to handle one load at a time or multi-loads.

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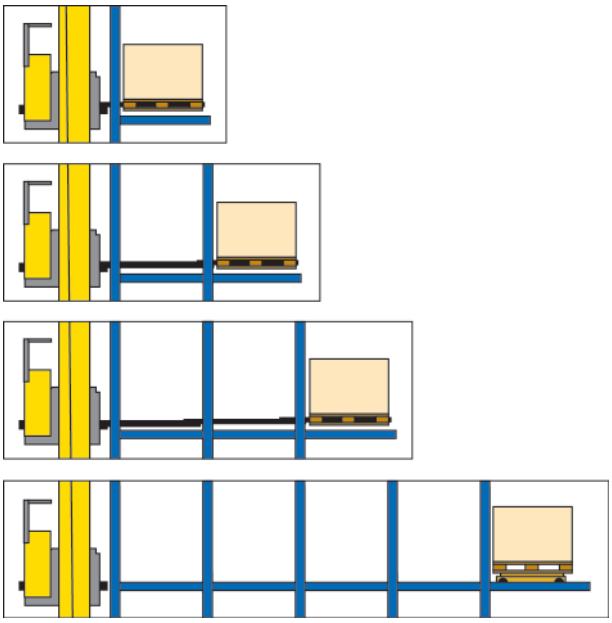

Single-, double-, triple- and multiple-deep storage

When a pallet is on the load-handling device it is carried off the ASRS machine into the rack. It can then perform a function called deep-lane storage. Conventional ASRS machines only go one- or two-pallets deep, using a fork attached to the machine. The latest systems can go three pallets deep with a telescope fork, and then with a satellite remote unit it can run a pallet 12 meters (40 feet) into the racking – as much as 10 pallets deep, and then return back to the ASRS machine.

Infrared or wireless is used to communicate between ASRS units and the conveyor system, which instructs the ASRS where to place incoming pallets and where to retrieve pallets for shipping.

When pallets are retrieved from the racking, the ASRS places them on a conveyor system where they exit the deep-freeze through insulated, air-locked pallet doors bound for picking or shipping. These doors are only large enough to allow a pallet to pass, and only open when product needs to go in and out, and only as long as necessary. This reduces excess air exchange in and out of the freezer, making it more efficient and reducing energy costs. In manual deep-freeze warehouses, opening and closing pallet entry doors can reach 9 percent of the total refrigeration load. High-bay warehouses equipped with automated doors for entry and exit greatly reduce this load factor.

Because of the precision of the ASRS controls and its integration with the warehouse management system, the ASRS always selects the correct inventory, item numbers, and it always rotates the product properly.

The most advanced models of ASRS use an integrated controls architecture for material flow control. These systems integrate the ASRS with other automated equipment in the deep-freeze warehouse creating one single, efficient transport system that provides optimum throughput under any system capacity. The ASRS' wireless Ethernet and drives are located in a heated cabinet on the unit, while the PLC and remote touch panel human machine interface (HMI) are stationed outside the deep-freeze in ambient temperature. The controls system enables optimized speed and precision with ASRS positioning.

ASRS cranes can be designed to deliver energy efficiency in deep-freeze storage because of their flexibility. Warehouse cranes are typically optimized for peak throughput, performing many moves in and out of the racking. These modern systems reduce energy consumption by operating at variable speeds depending on the demand load in the warehouse.

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Stacker crane in deep-freeze warehouse

Pallet at receiving station in front of pallet entry door

These systems also generate electricity from lowering their lift carriages, using their motors as a generator. Electricity is then put back into the main power supply. The energy regeneration can account for up to 40 percent of the ASRS' total power usage.

Automated Case Picking Speeds Product Handling – Manual case picking in deep-freeze facilities poses significant challenges, both to maintaining product integrity and to the safety and retention of workers.

Some pick solutions automatically remove the pallet from the deep-freeze allowing picking of cases in an area that is just below or above freezing, then automatically return the pallet into the deep-freeze for storage. There are limits to fulfill with cold chain compliance, however. For example, pallets may only be allowed out of the deep-freeze for possibly 20 – 30 minutes in the picking temperature-controlled environment, before returning to deep-freeze.

The same cautions apply when receiving products. In many sub-zero warehouses receiving is located in a chilled environment, kept just below freezing point. When pallets are unloaded, they are conveyed directly into the deep-freeze through pallet entry doors. A maximum of 30 minutes may be allowed in this chilled temperature zone for unloading.

Some modern pick solutions allow automated case picking to take place inside the deep-freeze, without the need for workers to operate in the sub-zero environment, thus maintaining a constant deep-freeze temperature for products.

One version utilizes a versatile gripper head mounted into an automatic stacker crane. The crane, instructed by controls software, travels automatically to the correct picking location. The gripper head then extends to support the load, which is placed onto a conveyor. The equipment is designed for temperature exposure down to -28° C. This crane delivers high pick rates per hour and consistent, reliable picking with a low product defect rate.

Other versions provide agile compact ASRS machines (mini-loads) with direct case handling capability. Inbound product loads are automatically depalletized and stored directly in high bay shelves. Cases are automatically retrieved in any sequence to build customized loads, optimizing outbound truck loads and downstream handling.

Modular Conveyors Enhance Flexibility – Transporting unit loads in and out of the deep-freeze requires a conveyor system capable of continuous operation in this extremely cold, harsh environment.

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To meet this challenge, modular conveyor systems have been developed that can adapt to the needs of receiving and input into the deep-freeze, integration with ASRS, and delivery of unit loads to pick stations outside of the deep-freeze.

The conveying systems provide a unique flexibility for handling product in deep-freeze down to -28° C. Their modular set-up integrates chain conveyors, roller conveyors, transfer units, turntables, vertical conveyors, and pallet carriers and dispensers.

These systems can integrate shuttle cars in a variety of functions, such as feeding multiple order-picking stations and for use in staging areas. They integrate a profile gauge to measure pallet dimensions and weight without stopping the load, and are used at system entry points to prevent incorrect load units from entering into the system. Some systems are frequency controlled for high-speed operation and gentle load handling, with controls located in heated cabinets.

Load Tracking and Validation Improve Product Reliability – High-bay deep-freeze warehouses are ideal candidates for the precise and efficient tracking of frozen products because of their highly automated and computer controlled systems. The warehouses' WMS, along with PLCs in the ASRS and modular conveying system, are capable of monitoring batch numbers, production dates and weight as the unit loads and cases are moved through and stored in the facility.

Incoming products are tracked with pallet labels. As soon as each pallet is received and scanned it associates with a prior electronic-received purchase order in the WMS. It can then be put straight into the conveyor system where it is automatically booked in and moved into the automated high-bay deep-freeze warehouse. The warehouse knows precisely what that product is and how many cases are on the pallet.

Temperature data loggers and/or radio frequency identification (RFID) tags help monitor the temperature history of the incoming trucks, warehouse and the temperature history of the product being shipped outbound.

This level of supply chain analytics allows sub-zero warehouses to maintain precise control on their products through every stage of their handling – from receiving, to storage, through picking and shipping.

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SUMMARY

The demand for highly-automated, high-bay deep-freeze warehouses is growing based upon the ability to ensure supply line product integrity, and more cost efficient and energy efficient sub-zero warehouse operation. This growth is influenced by a number of factors unique to high-bay deep-freeze systems, including:

a) A seamless link on the supply chain for the storage of products at sub-zero temperatures;
b) Faster receiving and retrieval of deep-freeze products;
c) Immediate tracking and identification of products in the facility;
d) Improved inventory and order fulfillment accuracy;
e) Reduced staff recruitment and retention problems in deep-freeze areas;

High-bays maximize warehouse volume utilization and optimize energy efficiency. Those high-bay, deep-freeze warehouses that are the most energy and cost efficient have achieved a high density of space utilization coupled with streamlined automation. Some of the latest automation designed for deep-freeze includes:

ASRS Optimizes Throughput and Energy Efficiency

ASRS are computer-controlled systems for automatically depositing, storing and retrieving unit loads from defined storage locations. The Swisslog Vectura™ ASRS provides a uniquely flexible and modular design that is equipped with a multi-load remote pallet handling capability, ideal for deep-freeze warehouse automation at its coldest (-28° C). The system allows configuration to the right storage and retrieval need for almost any application and provides single-, double-, triple- and multi-deep storage.

When a pallet is on the load-handling device it is carried off the ASRS machine into the rack. It can then perform a function called deep-lane storage. Conventional ASRS machines go single-, double- or triple-deep, using a telescope fork attached to the machine. The Swisslog MaxiPacker™ can run a pallet 12 meters (40 feet) into the racking with its satellite remote unit – as much as 10 pallets deep, and then return back to the ASRS machine.

Automated Case Picking Speeds Product Handling

Manual case picking in deep-freeze facilities poses significant challenges, both to maintaining product integrity and the safety and retaining of workers. A solution developed by Swisslog, called RoboPick™, allows automated case picking to take place inside the deep-freeze, without the need for workers to operate in the sub-zero environment, thus maintaining a constant deep-freeze temperature for products.

Modular Conveyors Enhance Flexibility

Transporting unit loads in and out of the deep-freeze requires a conveyor system capable of continuous operation in this extremely cold, harsh environment. To meet this challenge, Swisslog has developed a modular conveyor system called ProMove™. ProMove™ can adapt to the needs of receiving and input into the deep-freeze, integration with ASRS, and delivery of unit loads to pick stations outside of the deep-freeze.

Load Tracking and Validation Improve Product Reliability

High-bay deep-freeze warehouses are ideal candidates for the precise and efficient trakking of frozen food products because of their highly-automated and computer-controlled systems. The warehouses' WMS, along with PLCs in the ASRS and modular conveying system, are capable of monitoring pallet moving, production dates and weight as the unit loads and cases are moved through and stored in the facility.

ABOUT SWISSLOG

Swisslog is a global provider of integrated logistics solutions for warehouses, distribution centers and hospitals. The company has considerable know-how and special expertise within the temperature-controlled logistics sector, having pioneered the design and development of automated systems for deep-freeze. In fact, no other material handling or logistics manufacturer has installed as many automated systems in deep-freeze warehouses. The comprehensive services portfolio ranges from building complex warehouses and distribution centers for food manufacturers, wholesale distributors and retailers, to implementing Swisslog's own software and technology for intra-company logistics solutions with more than 50 deep-freeze projects realized.

Swisslog's solutions optimize customers' production, logistics and distribution processes to increase flexibility, responsiveness and quality of service while minimizing logistics costs. With years of experience in the development and implementation of integrated logistics solutions, Swisslog provides the expertise that customers in more than 50 countries around the world rely on.

With Global Headquarters in Buchs/Aarau, Switzerland, Swisslog currently employs over 2 000 staff in 20 countries worldwide.

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