



Energy Savings Deep Freeze Logistics

Strategies and Solutions to Future-Proof
Deep-Freeze Warehouses

ssi-schaefer.com

SSI SCHÄFER

Table of Contents

Introduction	Page 04
New Construction vs. Retrofit	Page 06
Future-Proof Planning	Page 08
Manual Deep-Freeze Warehouses	Page 10
Semi-Automatic Deep-Freeze Warehouses	Page 12
Fully Automatic Deep-Freeze Warehouses	Page 14
Temperature-Controlled Fulfillment Solutions	Page 16
Manual Rack Systems	Page 18
Semi-Automatic Rack Systems	Page 22
Fully Automatic Rack Systems	Page 24
Energy-Efficient High-Bay Warehouses	Page 26
Storage-Retrieval Machines and Shuttles	Page 28
Containers, Bins, and Trays	Page 31
Picking Solutions	Page 32
Additional Picking Solutions	Page 34
Transport	Page 36
Software Solutions	Page 37
Safety	Page 38
Fire Protection Measures	Page 39
What You Should Look for in a Vendor	Page 40
Planning and Project Start	Page 42
Conclusion	Page 43
Contacts	Page 45



Introduction

To say that the frozen product market is competitive would be an understatement. Growth has been explosive: Total revenue is projected to increase nearly 42% by 2028, according to Brand Essence Market Research. From \$258 billion in 2021 to a projected \$366 billion in 2028 at an annual growth rate of over 5%. Several factors drive this growth. The main driver is global change in consumer behavior. Everywhere you look, you find companies building additional storage capacity and putting semi- or fully-automatic intralogistics systems into operation to help offset staff shortages.



Supply Chains Under Strain

The pandemic forced yet another fundamental change to the industry's strategies for temperature-controlled storage, though demand was already high before the lockdowns. A few years ago, just-in-time warehousing methods were considered the key to a profitable supply chain. Now everyone wants to quickly ensure ample availability of storage capacity to meet skyrocketing product demand; against a backdrop of global supply chain disruptions, stockpiling of imported goods is increasing.

However, cold storage facilities are almost out of space. Demand for cold storage from food producers and processors will not decline in the foreseeable future.

Implementing a Strategy for Cold Chain and Deep-Freeze Logistics

With greater demand for cold storage capacity, all the players are rethinking their strategy. As stock turnover speed increases, operating profitably requires efficient processes and cost-effective use of warehouse and handling technology. Although safety is a key concern throughout the food industry, distributors, producers, and retailers all along the cold chain need to consider many other factors that play a role in temperature-controlled logistics: are not expected to, occupational safety, traceability requirements, staff shortages, growing consumer demand in the e-commerce sector, and future expansions for growing businesses. For investments in intralogistics, weighing the benefits of new construction versus retrofits along with the current and future demographic conditions at the location are strategic elements that are especially relevant.

Cutting Costs and Saving Energy

The current pace of energy price increases represents a major challenge for logistics companies in the deep-freeze sector. Energy costs in the U.S. are rising to over \$30 billion. And it's not just North America, energy estimates for Europe are still concerning as unprecedented hikes continue with the political turmoil in Ukraine. These types of issues have always played a crucial role in new

planning, upgrades, and expansions – but it has now become the leading business-critical factor and often triggers a decision in favor of new construction. Although the rising costs of frozen foods can be passed on to some degree, every facility faces declining net profits if the deep-freeze systems are not updated. Most cold storage operators are now making capital investments to reduce energy costs. In so doing, it is important to understand which upgrades can have the greatest impact.

While newer refrigeration technologies are more energy-efficient, a high-density storage facility can help reduce overall expenses – including labor costs. Higher storage rooms and greater storage densities reduce energy consumption and require less real estate. Compact automated warehouses require up to 60% less space than manual facilities, based on a height difference of 9 m to 12 m as opposed to 27 m to 37 m. Furthermore, modern storage-retrieval machine manufacturers offer the latest energy-saving technologies that optimize movement of

equipment to reduce energy consumption by as much as 25%.

Meeting Sustainability Targets

Many cold storage operators are already working to reduce energy costs; they now also face the increasingly common challenge of achieving end-to-end sustainability. Some background: many packaged consumer goods manufacturers have been taking steps toward a more sustainable future, which is good for more than just their brand image. Integrating sustainable processes into workflows can meet some of these demands, but on the path to more cost-effective business operations, all the facets need to be considered – including the choice of location and solution provider. While many companies have already achieved energy savings, others can realize additional savings through technology, software, and design.

„The demand for frozen storage has grown tremendously and continues to grow.“

Challenges

New Construction vs. Retrofitting Existing Facilities



“Location, location, location” – this key factor is just as crucial for commercial real estate. But other business factors also play a role. When it comes to deep-freeze logistics, the market is changing, and the importance of proximity to urban centers is increasing. Therefore, the question is sometimes whether the better choice is to retrofit an existing facility or to invest in a nice new building on a greenfield site just outside the city. The COVID-19 pandemic changed consumer preferences, and e-commerce is also altering food and beverage shopping patterns. This could be an argument for a business strategy with smaller locations close to consumers, making last-mile delivery or replenishment much easier and cost-effective for brick-and-mortar retailers. But other costs also need to be considered when weighing the

benefits of retrofits versus new construction projects. Each option has advantages and disadvantages, which must be considered individually when planning a facility and incorporated into the further strategy. As mentioned above, location is the key to any strategy.

But there are other factors to consider, such as the required storage capacity, the turnover performance, the energy costs, transportation issues, and the availability of skilled labor.



New Contruction

Carrying out an automation project precisely according to the specific requirements is easier in a new construction project, where there is often more room for effective planning and an

opportunity to consider future growth and scalability. Buildings can also be constructed without regard to what buildings currently exist and what other buildings are needed.

Advantages:

- Greater energy efficiency
- The design takes current and future business requirements into account thoroughly
- Space for future expansions
- Leasing or ownership as options
- The best possible integration of automation technology

Disadvantages:

- Greater distance from urban centers and longer transport times
- Difficulty finding qualified staff
- New commercial development has a negative environmental impact

Retrofit

If an existing site needs to be expanded, upgrades are usually necessary. When expanding existing sites, low building heights often limit the selection of suitable technologies

since certain options often require greater room heights, which are frequently unavailable in older buildings. But there are also advantages.

Advantages:

- Less impact on the environmental
- Revitalization of urban areas
- Subsidies for upgrades
- Easier staff recruitment in urban areas

Disadvantages:

- Longer construction and installation times
- Higher staffing demands for operation
- Grandfather policies no longer apply, requiring safety equipment to be retrofitted
- Limited technical performance due to space constraints

Future-Proof Planning

As with all distribution or storage projects, ideally, potential business growth should be considered and planned at an early stage.

While most business models only specify a certain time frame and/or storage space requirements, the technical planning phase is better suited to considering future order intake. Such advance planning can reduce the cost of subsequent expansions and retrofits as business volumes grow. For this reason, selecting the system also requires careful consideration. It is always best to choose a solution that is easy to upgrade or expand from the initial planning or design phase. Scalable hardware and software are usually the keys to a well-managed system for long-term use. They make it easy to transition to more storage space and higher technical performance in the future.

- Consideration of business growth in the planning phase
- Ease of retrofit/expansion
- Scalable hardware/software

Small Deep-Freeze Warehouses – Location and Early Automation Are Crucial

Even before COVID-19, frozen goods consumption was increasing steadily. This rise in demand has led to a review of strategies in logistics networks for refrigerated and frozen products.

Thanks to automation, smaller sites can make a positive contribution to the logistics chain because they make it possible to increase

turnover performance and quickly replenish supplies at brick-and-mortar stores.

With proper planning, such facilities can be designed to scale up in response to future growth.

Medium-Sized Deep-Freeze Warehouses – Safeguarding the Food Supply

As the global population grows, medium-sized sites can import and export food to guarantee the population a secure supply of temperature-sensitive goods.

Medium-sized deep-freeze warehouses are considered large enough to handle complex fulfillment challenges or meet the requirements of specific workflows or processes.

In this context, one classic example is the requirements of the food industry's track-and-trace protocols. A majority of the facilities are designed as typical deep-freeze warehouses to maintain food quality. The best way to implement the associated processes efficiently is with medium-sized to large facilities with automated processes for future growth and/or planning for possible changes with food safety regulation.

Large Deep-Freeze Warehouses – Cost Savings Through Automation

Capacity constraints, food processing, and more extensive regulatory requirements are sometimes crucial factors in choosing larger intralogistics systems.

In terms of automation, the advantage of these is that they can save energy and implement more complex workflows.

Besides additional storage space, the extra floor space also allows for a safer work environment since it provides enough room for every employee. For the sake of employees' long-term health and motivation, work areas need to be ergonomic and provide enough space for every staff member to work within an optimized area.





Manual Deep-Freeze Warehouse

Although lower investment costs might make manual warehouses seem more economical, this is often not the case. In particular, the following challenges impact food safety and the cost structure and need to be considered carefully.

Condensation

When employees enter or leave an area, condensation enters the facility. This is especially true of warehouses that maintain both deep-freeze areas and other temperature ranges. Liquid gets in and collects on surfaces, which then become slippery – creating a risk of accidents, not to mention potential product damage.

Product Damage in Cold Storage

Errors caused by employees are common in manually controlled facilities. The more frequent

the interaction between the staff and the product, the greater the risk of product damage. For example, products can be damaged by a forklift or during manual picking. Therefore, automated processes often help minimize the damage.

Staff Costs

Staff is an essential factor in manual facilities. For example, labor costs are quite high in the cold chain and represent a bigger budget item than in a warehouse for a dry goods line. According to the Global Cold Chain Alliance, labor costs account for

46% of operating costs in temperature-controlled warehouses. Another factor that exacerbates the challenge of recruiting qualified employees for refrigerated and deep-freeze storage is that additional warehouses are currently under construction, increasing the demand for labor. In the current labor market, qualified professionals are hard to find and retain. Deep-freeze facilities with conventional management are less attractive to skilled workers: the work environment is challenging and physically demanding, so they typically experience higher turnover. Furthermore, workers are subject to greater risk due to cold exposure. Given this factor occupational safety programs are a high priority, but healthcare costs can still be significantly elevated.

Frequent Contact with Products

With manual solutions, often there are no strict workflows implemented. As a result, products sometimes move between temperature zones, and the First In First Out (FIFO) method is not always used when retrieving them. This method is usually mandatory due to expiration dates for food products. In addition to the higher reject rate, the failure to follow the retrieval sequence leads to more manual product handling, which entails a higher risk of damage.

Advantages of Manual Deep-Freeze Warehouses

Flexibility and Low Investment Costs

However manual intralogistics systems also offer advantages. As a general rule, processes in manual facilities are easy to modify. Logistics service providers that operate on the basis of temporary customer orders often cite this advantage. Although operating a manual facility is more costly in the long run, construction may be less expensive initially, depending on the location. In addition, software systems exist for warehouse

management that are optimized for manual facilities to ensure end-to-end traceability based on identification systems such as barcodes. Nevertheless, this approach still involves a manual element that can be easily manipulated and thus poses a risk for food handling.

Semi-Automatic Deep-Freeze Warehouse



Deep-freeze warehouses with a partially automated configuration typically include individual automated elements. Good planning provides opportunities for savings and effective processes.

Increasing Cost-Effectiveness

When first getting started with automation, moving from a manual to a semi-automatic process is often a logical step, especially if an existing building is retrofitted. However, subsequent conversion from a semi-automatic system to a fully automatic one is often not cost-effective.

The switch from manual to full automation is not only a strategic decision but also one that needs to be justified as an investment. As a result, many cold storage operators are switching from a manual solution to a semi-automatic one **to reduce labor costs, increase food safety and turnover, etc.**

Logistics service providers often choose this strategy on the basis of short-term contracts with their customers. This allows them to further increase the cost-effectiveness of an existing site before opting to build a new one. One important variable in determining what level of automation will be cost-effective is the future availability of labor at the location. The most cost-effective solution can then be selected within these limits.

Suitable Semi-Automatic Systems

Most retrofitted semi-automatic solutions use high-density channel storage with pallet shuttle systems or mobile racks. Although channel storage is most often found in new buildings, it can also be implemented at existing sites. Most systems are relatively easy to install if the temperature is raised to just below freezing. Raising the temperature for the duration of the installation saves time and money.

High-density channel storage works very well with a fairly small number of SKUs (Stock Keeping Units), especially where storage requirements are stricter. **Mobile racks** can also be implemented to free up additional storage space by reducing the traffic area. As customers grow or the range of SKUs change this is an attractive option for logistics service providers too.

Automated guided vehicles (AGVs) can integrate with mobile storage solutions to create a very efficient cold storage system. If only some of the processes need to be automated, AGVs may be sufficient. However, under deep-freeze conditions, using AGVs still presents some challenges since many sensors, batteries, and other components do not function reliably at temperatures in the freezing range. Therefore, it is advisable to select a vendor carefully.

Successfully moving to a semi-automatic process requires good planning, as well as an expert review of existing processes and workflows by an experienced IT team.



Fully Automatic Deep-Freeze Warehouse

Where long-term capacity utilization is guaranteed, and the necessary investment capital is available, a fully automatic warehouse is the optimal solution.

Enormous Potential Savings

A fully automatic cold storage facility can cost half as much as a conventional building for storing the same number of pallets since it requires much less space. Extremely high labor and energy costs in manual facilities are the main arguments in favor of fully automatic deep-freeze warehouse solutions, but there are other advantages as well.

Energy Savings

Constructing warehouses with a vertical extension and using less surface area not only reduces energy costs thanks to the smaller warehouse footprint – it also requires less land, and the volume that needs to be cooled is smaller. In addition to lower taxes and fees, this also means a smaller environmental impact. Furthermore, fully automatic systems are equipped with perfectly insulated airlocks for pallet transport. In such a configuration, the cold air stays inside, and warm air and moisture stay outside. This reduces energy costs and also improves product quality. A fully automatic system only opens the gates to the locks during transport. That reduces energy consumption and minimizes costs. A fully automatic system also makes it possible to free up more storage space within a fixed area.

Labor Cost Savings

Fully automatic systems require less labor, resulting in significant cost savings. And they also offer other advantages for staffing: for example, for fully automatic systems, it is usually easier to find employees, and the required skills are different. Staff retention is usually higher, too. In a fully automatic cold storage warehouse, staff's cold exposure is lower, so employees are happier.

High-Density Space Utilization

A fully automatic refrigerated warehouse offers more storage space per cubic meter, which improves the return on investment per square meter compared to manual or semi-automatic facilities. Highly automated systems require narrow aisles, but no forklifts or AGVs. That means less equipment to maintain and more space for products. Fully automatic solutions require reliable logistics software. That in turn can increase order processing efficiency, helping increase overall technical performance. It also yields a better return on investment, because more products can be distributed within a given time frame.

Safety

Fully automatic intralogistics systems have high safety standards and require regular inspections, especially if SRMs are used. To meet these, safety components exist that function reliably even in deep-freeze warehouses, ensuring the safety of people and products. That maintains product quality and reduces liability in connection with food safety. Preventing access to safety hazards or immediately stopping hazardous machinery when people pass by openings also helps keep employees away from potential dangers.

Staging

With a storage-retrieval machine or other fully automatic system, sequential staging can be done faster and with less labor. This is especially advantageous when the products are prepared for loading outside the deep-freeze area, reducing the dwell time of all products. A well-planned and highly automated solution should include a staging area with temperature control. Orders that mix refrigerated and frozen stored products not only need to be loaded correctly for transport but also require route sequencing. Fully automatic facilities typically use warehouse management software to handle this step of the process.

Greater Storage Capacity

In automated facilities, it is easy to create greater storage capacity, resulting in higher production efficiency as a result of greater production batch sizes (less production line downtime for process changeovers). This has a significant impact since the variety of product is increasing – in terms of package size, ingredients for special diets, and special food categories such as kosher meals or organic foods. The savings from greater production efficiency for meeting market demands can easily justify automation if you consider all the aspects of dealing with the complexity increase associated with greater product variety. And let us not forget the growing demand for order-picking processes.

Fully automatic systems offer the best return on investment. Many companies lack the capital to invest in a bigger solution, but if they can raise it, they can expect to see a return within three to five years.



Deep-Freeze Fulfillment Solution: the Optimal Solution for Your Supply Chain

As with all distribution centers, the various areas can be associated with the corresponding key functions. Some of these key functions vary from system to system, but almost all systems share the following functional areas: storage, picking, transportation and software.

Storage

A variety of different products and services are associated with distribution centers for refrigerated and frozen products, each with different storage requirements:

- Number of SKUs
- Product types
- Temperature targets
- Technical performance requirements
- Commercial feasibility

As a general rule, different warehouse solutions are optimally suited for manual, semi-automatic, or fully automatic systems. Below you will learn about different solutions for each type of distribution center.



Sustainability in the warehouse is achievable by using the latest intralogistics technology to maximize storage capacity and minimize the refrigerated area.



Single-Deep Longitudinal Beam Racks

Although selective pallet racks are the most common type of rack system in cold storage, they do not offer the same capacity or density as other rack system types. However, they are the most cost-effective option, so if you really need a quick solution for pallet storage with a limited number of pallets, they can be a good solution for you.



Manual Rack Systems

Most manual facilities use a very limited number of storage components. A forklift and some kind of rack storage system are the most common. The rack system can differ according to application and the number of SKUs.

While a variety of different rack system types exist for manual applications, specific requirements need to be considered for deep-freeze warehouses.

Structural Frames vs. Rolled Frames

Rack systems with rolled frames and structural frames have different advantages and disadvantages. When evaluating them for a particular application, all these individual factors need to be taken into account. Structural frames provide the best resistance in the event of forklift impact, especially in applications with frequent high stock turnover, like the food industry. However, because they use welded shelf connectors, structural frames may not be the best choice for sites with a high degree of seismic activity. In these locations, the flexibility that bolted connections offer may strengthen the structure and help lower costs. A rolled frame can also be provided with welded or bolted rack connectors. Bolted structures allow significantly lower transportation costs because the frame can be delivered disassembled; however, this increases the duration and cost of installation. Bolted connections

also make it much easier to replace damaged components. Finally, welded frames present a significant challenge during annual inspection: if a weld joint appears to be compromised, the only way to check the quality of the weld is with a cross-section of the area. In contrast, it is easy to check and verify the torque of a bolted connection. Ideally, you should discuss your application and requirements in detail with your rack supplier so they can review the advantages and disadvantages of the various solutions and show you the best design for your needs.

Drive-in and Transit Racks

While a drive-in pallet rack is not as cost-effective as a longitudinal beam rack, it can be just as economical in manual applications. Drive-in racks are designed for horizontal storage of two to 10 pallets per pallet position in the depth dimension. These systems can be closed at one end of an aisle; hence the name "drive-in". This increases the storage capacity. But for cold chain applications, drive-in pallet storage is not optimal. Although it supports the First In First Out (FIFO) method, when more than two pallets are stored in the depth dimension, it makes it more difficult to manage stock turnover with expiration dates. Drive-in racks also pose safety and financial risks since forklifts can easily damage the rack when they drive into it.



Stock Method

FIFO (First In - First Out)

Advantages:

- Efficiency
- Perfect product rotation with fast turnaround
- Fast installation

Disadvantages:

- Lowest storage density, so high energy costs
- High storage costs when business grows
- Limited storage height

Stock Method

FILO (First In - Last Out) and FIFO (First In - First Out)

Advantages:

- Almost unlimited depth
- Efficiency
- Integration with other pallet rack systems possible
- Higher pallet storage density within manual pallet rack systems

Disadvantages:

- Limited stock applications
- Poor access to pallets in the second row or behind them
- Difficulty maneuvering and higher maintenance expenses

Pallet Flow Rack

In pallet flow racks, a gravity system is used for flow, and a FIFO rotation manages food and beverages. Aisles are located between the racks, so forklifts can insert stored goods on one side while goods are removed from the other aisle. This concept guarantees stock rotation. In addition, the roller function of the racks allows fast replenishment after a unit is removed.



Stock Method

FIFO (First In - First Out)

Advantages:

- Greater capacity than conventional pallet rack storage
- Reduced travel times between aisles

Disadvantages:

- Installation must be compact in cold storage
- Lubricants can jam at low temperatures
- Plastic and/or rubber wheels can tear at low temperatures
- Pallets can get stuck in the channel

Double-deep

Double-deep rack systems work exactly as the name implies: pallets are stored two deep, not one. Such racks are also called deep-reach pallet racks. This design is intended to consolidate the aisle space, achieving more storage capacity in the same warehouse space. However, such racks require forklifts with a particularly long reach. These systems can also be designed for a depth of three pallets, depending on your requirements.



Stock Method

LIFO (Last In - First Out)

Advantages:

- Allow high-density storage in manual applications
- Good for fast-moving SKUs
- Very good for a small number of SKUs

Disadvantages:

- Not ideal for items with expiration dates
- Special forklift required
- Whether pallets can be positioned three deep depends on weight

Pushback Rack

A pushback rack is a pallet storage system with a carousel carrier on slanted rails. Depending on the installation, one rack can store two to six pallets. When pallets are loaded, the second pallet pushes the first backward. This continues until all pallet positions are occupied. When a pallet is removed, the remaining pallets move forward on the rail. This type of racking system uses the Last In - First Out (LIFO) method, allowing high-density storage.



Stock Method

LIFO (Last In - First Out)

Advantages:

- Allows high-density storage
- Good for fast-moving SKUs
- Very good for a small number of SKUs

Disadvantages:

- Not ideal for items with expiration dates
- Product damage is possible



Semi-Automatic Rack Systems

Ideal for manually operated facilities whose technical performance needs to be increased or where additional space needs to be freed up.

Solutions of this type are often seen in deep-freeze warehouses with a very small number of SKUs requiring the FIFO method.

These systems use warehouse management systems to achieve higher technical performance and nearly error-free picking. Semi-automatic solutions also reduce the risks for employees, thus reducing liability.

We distinguish two main types of warehouse solutions: channel storage systems and mobile racks.

Channel Storage Systems

Channel storage systems offer a warehouse solution within a specified area. Multiple storage bins are inserted one after another in so-called channels. The channel shuttles or pallet shuttles move up and down the channel, storing and retrieving goods. For occupational health and safety reasons, only the loading unit at the very front of a given channel is accessible at all times. **The design of a channel storage system is especially compact.** This type of warehouse is suitable for large volumes with a minimal number of SKUs. It can also be used for staging stock in front of the loading dock to make truck loading efficient.

Another advantage of a channel storage system is the option of using **both the First In - First Out and the First In - Last Out storage method in the same warehouse.** The channel shuttles can also be controlled remotely. This is a huge advantage in a cold storage facility since it reduces **employees' exposure to cold.** Access to the channel for cleaning and maintenance work as needed must be possible without jeopardizing continuous availability of the facility.



Stock Method

FIFO (First In - First Out)

FILO (First In - Last Out)

FIFO & FILO Combined

(possible if there is an aisle for manual access on the lower level)

Advantages:

- Allows high-density storage
- Very good for a small number of SKUs
- Good option for upgrading manual processes
- Can be installed as part of a retrofit
- Allows integration of other automation components
- Efficient truck loading and dock management

Disadvantages:

- More expensive than manual solutions
- Special training required
- Not suitable for higher SKU quantities

Mobile Racks

Cold storage always requires quick, easy, smooth picking processes. Mobile racks for deep-freeze rooms offer **rapid visibility and a high storage capacity.** Since space in deep-freeze warehouses is more expensive, it makes sense to use technology that frees up additional room for storage with minimal aisle area. Rails installed on the floor guide the rack, which is equipped with wheels. The rack moves when access is needed.

Employees have easy access via a warehouse management system. When an item needs to be removed, the system locates it, and the corresponding aisle opens. Safety sensors detect movements, people, and obstacles to allow safe item retrieval. And in addition to easy stock access, there are other reasons to choose mobile racks. They can easily accommodate loading units of different sizes.

Technical performance increases when warehouse management software is used. Items can be easily grouped for picking within specific areas and time periods. Mobile racks are also a good choice for facilities handling products with a low number of SKUs and a low-to-medium level of stock turnover. Such applications are often suited for small to medium-sized facilities.

Stock Method

FIFO (First in - First Out)

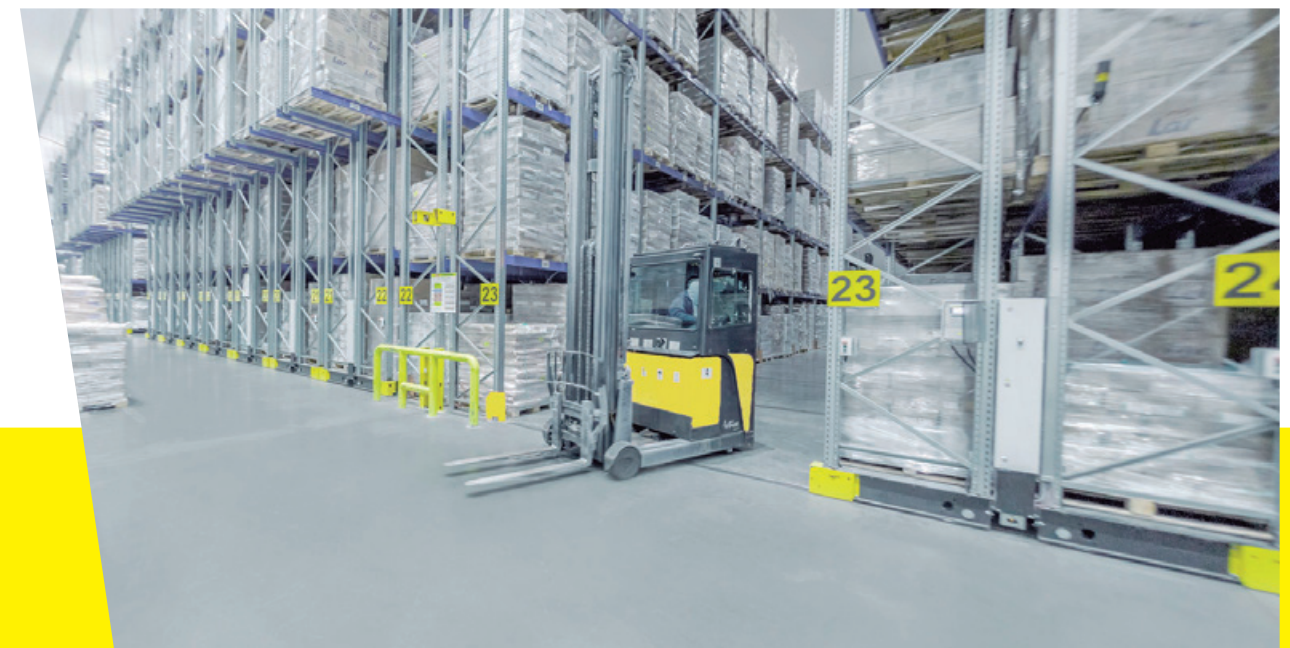
FILO (First in - Last Out)

Advantages:

- Suitable for small to medium-sized areas
- Can be used in conjunction with a warehouse management system
- Allows manual access
- High-density storage
- Allows remote control
- Integration with lighting solutions for additional energy savings

Disadvantages:

- Most suitable for new construction projects since the floor needs to be very flat
- Typically used for comparatively low technical performance demands



Fully Automatic Rack Systems

Alongside a large number of advantages over manual and semi-automatic solutions, fully automatic rack systems also have the highest investment costs.

A fully automatic system is generally the best solution for the following parameters and objectives in particular:

- High technical performance required
- High number of SKUs
- High-density storage
- Limiting labor costs
- Reducing product rejects
- Reducing operational costs
- Complete product visibility and traceability

Tracking and traceability are mandatory for certain products like foods and are required by regulatory authorities in various countries. A fully automatic system records batch numbers, expiration dates, and storage and retrieval dates, allowing easier access for items to be removed and destroyed in the event of a product recall.

Stock Method

Advantages:

- High storage density and fast access
- Lower labor costs
- Complete product visibility and traceability

Disadvantages:

- High investment costs



Energy-Efficient High-Bay Warehouses

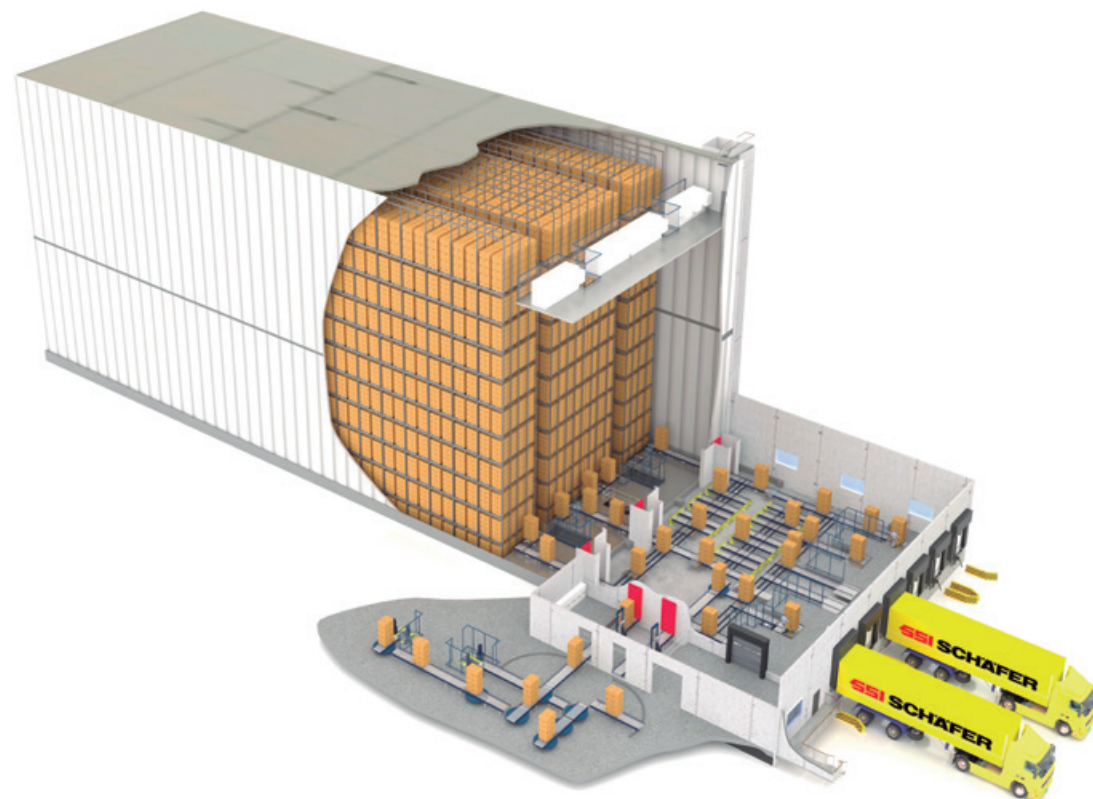
Designed for maximum energy efficiency, high-bay warehouses (HBWs) offer a fully automatic rack system that, when combined with storage-retrieval machines (SRMs), provides the highest storage density of any automated pallet solution and often forms the cornerstone of a cold storage solution.

An HBW, in combination with an SRM, allows maximum storage density in a relatively small area. This is particularly important in the cold chain since every cubic meter of the warehouse needs to be climate controlled, whether or not it is occupied by a product.

These towering structures measure 12 to 45 meters (40' to 148') high and, depending on the requirements, can hold thousands or even hundreds of thousands of pallets.

In particular, two designs are distinguished:

- A freestanding structure where the racks are built inside a finished, self-supporting building.
- A rack-supported structure in which the rack is built on a finished foundation slab. These then support the roof and walls that enclose the rack system, creating a building. Such a design is typically chosen for heights of 18 meters (60') and above since constructing a conventional building with the corresponding height is comparatively expensive.



The rack systems used for a high bay are customized for each application and can store loads in three ways:

1. Single-deep

Single-deep storage has one pallet position on each side of the aisle. This storage approach is chosen for applications with a high number of SKUs combined with high availability.

2. Double-deep

Double-deep storage has two pallet positions on each side of the aisle. It is chosen for most applications because it offers a good compromise between storage density, technical performance, and relatively low cost per storage location and is suitable for a medium number of SKUs.

3. Multiple-deep

Multiple-deep storage (also called channel storage) uses a pallet shuttle to access pallets stored on both sides of the aisle 10 to 15 pallets deep. This storage approach requires greater investment. However, due to the higher number of storage locations compared to conventional single- and double-deep storage, the costs per storage location are lower. Nonetheless, multiple-deep storage works very well in applications with a small number of SKUs and medium technical performance requirements.



Storage-Retrieval Machines and Shuttles for Deep-Freeze Warehouses



With temperatures as low as -28 degrees Celsius, fully automatic cold chain systems require the use of storage equipment designed for such demanding conditions.

Characteristics

Advantages:

- Can be used with a high number of SKUs
- Extremely high storage density through use of vertical space
- Can be used in conjunction with a warehouse management system
- Limits employees' exposure to cold
- Can be operated in a completely dark scenario for additional energy savings
- Ease of maintenance with access on the ground
- Long-term energy savings for deep-freeze chain applications

Disadvantages:

- Requires an IT system
- Best suited for new construction projects; retrofit projects are possible if load requirements are met and the floor is level
- Possibly longer amortization period depending on application
- Higher investment costs

Storage-Retrieval Machines for Heavy Loads

An SRM (storage-retrieval machine) is an automatic pallet storage device. These storage systems automatically remove and place pallets within the rack system on the basis of the specifications of software algorithms. The robust machines can be equipped with one or two load-handling devices and can be used for single-, double- or multiple-deep storage and retrieval.

In existing buildings, especially short SRMs specifically designed for low heights – less than 12 meters – can be used. These systems can also be equipped with energy-saving devices that limit power consumption and heat generation.

Shuttle Systems for Heavy Loads

Like any application, these have limitations. Height restrictions may limit the option of installing a fully automatic solution. This may also be an issue if a facility is located in an urban area where zoning requirements include height restrictions. When this type of constraint is in play, it is necessary to find a solution that can work within the limits of the building site.

Pallet storage solutions are an option for facilities up to 8 meters (26') high and can serve two to four rack levels per aisle. They include a load-handling device that runs on a lower track because the loads on the floor are not as high as when standard storage-retrieval machines are used. For applications requiring high technical performance without height restrictions, these devices can be designed to work with multiple units, one on top of the other. That allows higher technical performance without a high bay warehouse. This type of application works particularly well for frozen products. The high density and rapid demand for products is a perfect combination with these device types.

Characteristics

Advantages:

- Can be used with a low to medium number of SKUs
- Extremely dense storage
- High turnover performance
- Limits employees' exposure to cold
- Potentially lower costs than standard facilities with automatic storage-retrieval machines
- Can be used for projects on sites that have already been built on
- Can be operated in a completely dark scenario for additional energy savings

Disadvantages:

- Higher investment costs

Highly Dynamic Storage With Pallet Shuttles

For applications requiring high technical performance, pallet shuttles also offer a way to combine a highly dynamic solution with dense storage. This is achieved by additional load-handling devices (LHDs) within an aisle, which are usually connected to the ground-level conveying system via front lifts. Some pallet shuttles are designed to serve a single level; others can serve multiple levels (between two and four, depending on pallet height), but all are used in multiple-deep storage approaches. This type of device is also especially useful in existing buildings due to its low profile.





Containers, Bins, and Trays for Deep-Freeze Warehouses

Since most automated deep-freeze warehouse applications are pallet systems, reusable containers, bins, and trays represent a small proportion. However, it is still important to understand what to look for when selecting a vendor to supply these essential storage components.

but commercial PP's behavioral characteristics at low temperatures are rather unfavorable. A supplier should be chosen that can use a copolymer PP blend for applications that include deep-freeze environments. A copolymer blend is usually suitable for -23 degrees Celsius and above.

First of all, plastic can become brittle at low temperatures. That reduces its impact strength, which increases the risk of cracking under pressure. Polypropylene (PP) containers are recommended for automated systems because of the lower noise level,

Shuttle Systems for Small Load Carriers

For applications where cases, bins, or cartons need to be stored, special shuttles for more compact loads exist. This is an especially significant bonus for cold storage facilities where mixed cases are stored and picked for different retailers or other businesses. For case picking and automation planning, ideally you should choose a solution that grows with your business.

As a general rule, when reviewing the options, two differences need to be considered. First, shuttle types exist that are designed for higher technical performance. A shuttle that moves on one level can often travel at higher speeds even when loaded. Secondly, certain shuttle types are able to handle mixed

cases with different widths and lengths. This feature, along with their ability to handle multiple-deep storage units, makes these shuttles an excellent choice for deep-freeze environments.

One such unit is a flexible shuttle for one level, which can handle load units up to 50 kg (100 Lbs). The adjustable storage location size allows flexible storage density up to the maximum, making this a great choice for businesses that are still in growth mode and need to scale up later.

Characteristics

Advantages:

- Scalable shuttle system
- Allows handling of loads with different dimensions
- High speed when loaded, even in deep-freeze environments
- Suitable for multiple-deep storage to maximize storage density

Disadvantages:

- The maximum case load is usually lower (50 kg / 100 Lbs))



Picking Solutions for Deep-Freeze Environments

With the global shift in consumer behavior towards frozen convenience foods, the technical performance demands have increased significantly. However, for picking in deep-freeze environments, employees' needs must always be a priority.

Therefore, as much automation should be used as possible. That reduces labor costs and the risk of liability in conjunction with human exposure to cold. Frozen products are also typically products that require extreme caution when handling during picking – error-free picking is a must.

Tracking expiration dates and batch numbers within the automated system ensures correct picking for all orders. This is essential for frozen products. The key is to harmonize the relationship between the picking technology and the order processing.

Case Picking

In case picking, either an employee or a stand-alone/automated robotic solution picks cases on a pallet for shipment to a retailer or processing plant. There are also applications where cases are picked and shipped as individual deliveries. Such systems still tend to be the exception, but they are becoming more and more popular.

When planning an automated solution, there are two options for process design:

1. Move the pallet to a different area for picking. This allows employees to pick over a longer period of time. However, this option depends on the product type.
2. Picking directly within the deep-freeze area. Such a setup is more expensive – the process takes longer because employees can only be in the refrigerated or frozen area for a limited amount of time.

software support, with feedback to a person via voice instructions (Pick by Voice or Voice Picking). The software application optimizes picking and limits the time an employee spends in the facility.

In most manual or semi-automatic applications, picking within the deep-freeze warehouse uses a Pick by Voice approach. Employees can pick cases with their hands, and they receive audio feedback to confirm the correctness of the item and quantity picked. A wireless Bluetooth headset is used for the order-picking process.

There are two primary methods to choose from for case picking:

In both applications, picking is primarily done with



Picking Methods

Person-to-Goods

The person-to-goods principle is self-explanatory: The picker moves through picking aisles or areas to pick items on the case level for order processing. An employee can pick the cases directly onto a pallet (pick-to-pallet) or place them on a conveying system (pick-to-belt) for transport to a downstream pallet storage or truck loading area. Replenishment can be done either manually or via an automatic storage-retrieval machine, provided that the reserve stock is stored in an automated system. The picking surface for this type of picking is usually either a pallet rack (static or pallet flow) or container flow rack.

This solution offers very flexible picking performance since additional staff can be deployed to handle peak loads. A typical picking rate is **150 to 250 cases per hour**.

Goods-to-Person

The goods-to-person method is also self-explanatory: the product that is to be picked is removed from an automatic storage system and fed to an employee or robot for picking. This form of picking increases employee productivity by eliminating unnecessary travel time. However, it obviously requires a higher investment because of the automation solution for transporting the product to the picker. This is a great option for adding additional case picking functionality to an automated storage system; however, the capacity is limited by the number of picking stations in the design.

With a higher level of investment, using robots for picking is an option. This achieves the highest degree of automation and reduces employees' workload. A typical picking speed is **350 to 650 cases per hour**.

Other Picking Solutions



Automated picking systems offer fast incoming order processing with consistently high quality, regardless of the workload.

Layer-Picking

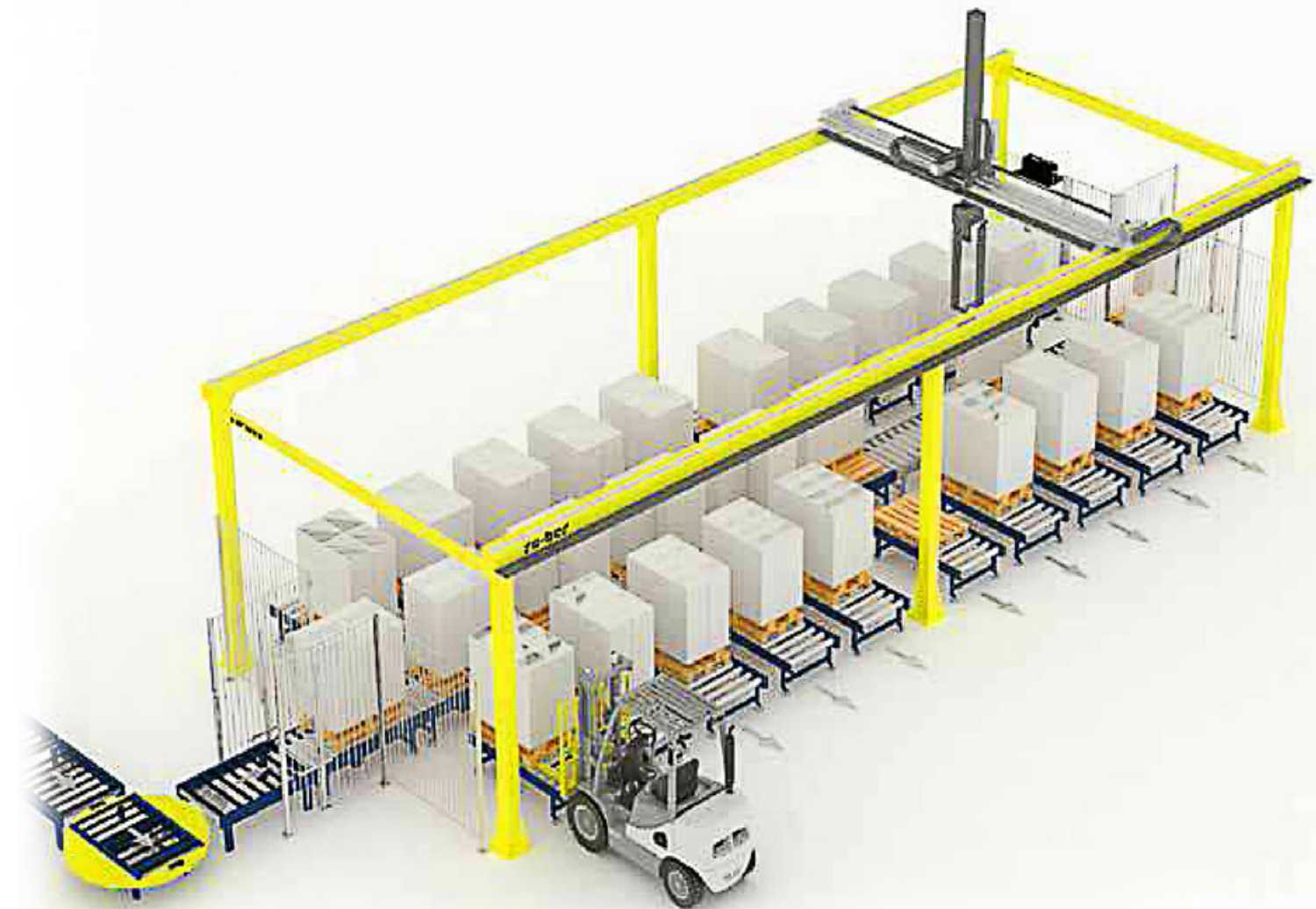
The layer-picking method is ideal for high-volume deep-freeze warehouses. With layer-picking, mixed-SKU pallets are assembled quickly from one or more layers at once. The result is a pallet with mixed layers, often called a rainbow pallet. The individual layers are removed with a robot or a forklift attachment. An SRM can be easily integrated with automated layer-picking and used for staging replenishment and storage until shipment. This can dramatically reduce labor costs in the warehouse picking area.

Pallet Picking

In pallet picking, a complete pallet is removed from an SRM system or conventional pallet rack and taken directly to the staging area. That way, route sequencing can be performed for shipping, or it can be loaded directly onto a truck.

Robotic Picking

Robotic picking is the most efficient solution for a deep-freeze facility. For both layer and case picking, a robotic solution makes it possible to achieve 24-hour operation in a cold environment. With this technology, picking can be done in layers or cases to assemble or depalletize a pallet.



Software Solutions for the Cold Chain

Cold chain automation has very specific requirements, so you should look for a warehouse management system (WMS) or warehouse control system (WCS) programmed to meet exactly these challenges.

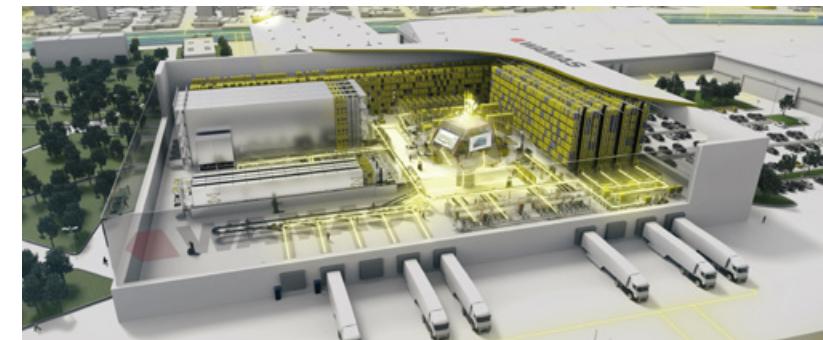
Warehouse optimization for frozen products has various aspects. First of all, logistics software should allow optimization for different **storage strategies**. This typically starts before a delivery is even accepted. Look for logistics software that **can be integrated** into an **ERP** system and tracks the logic of the incoming goods on any given day. This allows the system to **reallocate stock and optimize it based on incoming goods**.

When a delivery arrives, the goods are scanned and checked. Expiration dates, batch numbers, and GTIN data can be recorded. This is especially useful for producers and logistics service providers in the deep-freeze sector since these fields can be used for order processing, as well as for the **tracking and tracing functions specified by legal or procedural requirements**.

For fast-moving SKUs, the first SKU stored is also taken out first, but these items should be stored as close to the picking area as possible. Intelligent logistics software handles this for you and **positions the stock according to the turnover rate**. This method increases the output speed and saves valuable time when picking in cold environments. Slow movers may be stored in a different area.

The facility configuration determines the **optimal placement** according to the current stock and historical profiles. Good logistics software also makes it easier to **meet the safety requirements** that are mandatory for deep-freeze storage. One indicator is the maximum picking time when an employee picks in a frozen or refrigerated area.

The system can also track each employee's maximum daily exposure to cold. The same applies to monitoring the time items spend outside the designated temperature zone so food does not spoil. Logistics software can also **coordinate the route sequence for truck loading**. Since freezer systems have some of the highest operating costs, good logistics software can provide clues about when a sensor needs to be replaced or repaired.



Such features keep **operating costs as low as possible** and reduce **maintenance and repair requirements** to the essential **minimum**. **Real-time data** is another key element for WMS reporting within the cold chain. If there are multiple facilities, choose a WMS that is multi-tenant and provides real-time, up-to-date information on key performance indicators. Also make sure the software solution runs well on **mobile devices**.

Software provides the leverage for reducing complexity in your supply chain and optimizing warehouse performance.

Transport

In the planning for a deep-freeze facility, the required transport operations should be kept to a minimum. Experience matters here and designers need to consider the operating costs incurred as a result of energy consumption. Ideally, every square centimeter or foot within the refrigerated area should be used for storage.

However, it is advisable to provide a conveying system for all routes that are kept at ambient temperature. As already described, this reduces costs because it allows higher turnover and lower risk of liability.

Conveying System Features

Advantages:

- Lower space demand
- Less damage
- No persons in deep-freeze areas
- No problems with batteries for forklifts

Disadvantages:

- Less flexibility

Safety is Top Priority

Safety is the most important requirement for both staff and products and should be taken into account when deciding on a retrofit or major new construction too.

The more automation is used in facility operations, the fewer problems there are with damaged products or staff liability. Training is helpful, but human error is inevitable. Automation technology can reduce the risks.

Planning individual processes precisely makes it possible to compensate for even the smallest risks, which is extremely beneficial for the safety of people and technical performance.

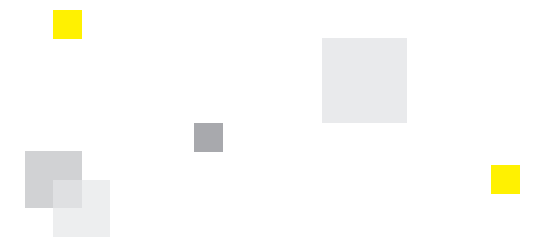


Fire Protection Measures

Fires in industrial facilities are rare, but cannot be completely ruled out. Prevention is always best, and there are several alternatives. Since deep-freeze facilities are large, densely packed buildings with little space, sprinkler systems do not work well. In the event of a fire, sprinklers can also damage products and cause costly downtime. Most facilities operate around the clock and cannot afford interruptions. Installing a sprinkler system can also be expensive, even if it is a retrofit. The continuous movement of air between racks can be a hazard to firefighters in a dark and icy environment - neither producers nor external logistics service providers want such a scenario to arise.

Newer facilities are now being designed to reduce oxygen

levels, sometimes even to zero, to prevent fires from starting in the first place. Such systems keep damage to a minimum and protect employees, firefighters, and products. A well-designed facility should use adequate oxygen levels to essentially prevent fires from starting. According to global industrial fire protection service provider Wagner, oxygen levels are typically lowered from the normal 20.9% to 13.8% or 17.0%, depending on the products in stock and environmental conditions.



Service Life & Customer Service

The service life of a deep-freeze facility is typically around 34 years, but this is related more to the facility itself than to the technical solution. Most intralogistics solutions last longer and can be upgraded as a business grows. Preventive maintenance service may not be needed immediately in a new facility, but planning ahead is always better. Find a preventive maintenance team with a good reputation that can be stationed on-site or be available on-call for maintenance and that has experience in automation.

A reputable preventive maintenance team can provide long-term service contracts and maintenance hotlines for when you need them. Downtime is not an option in deep-freeze facilities, and condensation can occur at any time on sensors or near doors. It is always best to have a team of professionals on hand to make adjustments, run diagnostics and make repairs as needed.



What You Should Look for in a Vendor

To select the right automation and technology partner, your key criteria should be finding one with experience that you can rely on, and that will be around for a long time. After all, cost savings are not the only factor. Look for a vendor that has implemented multiple systems with similar applications and offers long-term customer service. The following points should also be considered:



Integrity

Most companies advertise the integrity of their work. Find a vendor with experts you can trust – for example, engineers who take the time to address your specific needs and business challenges. A successful corporate culture promotes innovation and transparency. Ask about processes for installation and operation. These processes and procedures should be well documented and available for review.

Flexibility – Now and in the Future

Distribution centers are typically built so that as the business grows, they can be scaled up or retrofitted, or additional locations can be added. Applications change, and this should also be true of software and systems engineering. Choose a vendor that will work with you to implement processes to achieve strategic business goals. Processes will change – choose a vendor that is able to keep your software and all systems up to date.

History and Experience

Some of the best technology comes from startups. However, for distribution, it is better to stick with the experts. Industry experts agree: that getting started within the software industry is not difficult, but making automation technology and understanding distribution and warehouse operations requires specialized skills. Look for a provider with decades of experience to meet your needs. Large, complex projects obviously require a high level of expertise. But even the simplest applications benefit from decades of experience with installations and proven approaches.

Long-Term Prospects

Choose an economically stable provider whose company will be around on the market for a long time. Technology companies come and go. Therefore, it is best to choose a company with a long track record and a sustainable business model that continues to evolve. Ask for references and look into employee numbers and locations to assess a partner’s future success. Look at the customers list too. If you see that large companies rely on a specific vendor, chances are good that this company will be around for the long term.

Comparable Quotes

Getting multiple quotes is always better. However, make sure the quotes are comparable. System manufacturers and software vendors may differ in terms of additional equipment and technologies. Knowing the differences between vendors can help you find the best deal. So make sure you are really comparing apples to apples. Note that a final desperate attempt to include a technological feature in the quote is not exactly the best advertisement for a company. Proven technology always follows precise plans and undergoes beta testing before a new release.

Adaptability

Every application is different, so every system will have differences too. Software and automation technology should meet all requirements when it comes to facility design and installation. Smaller manual applications can be implemented with a “one-size-fits-all” approach, but future scalability is essential. Availability also needs to be taken into account. Does the vendor have an on-site location? How easy is it to reach the vendor?

References and Reviews

As with any large purchase, check references. Since this is a large investment, ask for two or three references. Check whether the references are of similar size and involve similar processes. Checking references gives you peace of mind and can alleviate concerns that the vendor could be incapable of handling certain functions. A reputable vendor will not hesitate to show you some examples of previous contracts or to arrange for you to view a facility. Be wary of review websites. Many automation and/or warehouse technology ranking sites are based on a “pay-to-play” model. These sites work through search engine optimization and then sell placements on their website. Often they are owned by the same organization. In addition, a large WMS software solution does not warrant the same type of reviews that a personal software program would have. Users usually do not review the individual software solutions they use for work, so asking for references is a better idea than looking at reviews.



Planning and Project Start



Every company has its own specific logistics requirements. So, any successful planning initially requires an in-depth analysis of the current situation.

Whether you are planning a completely new construction, an expansion or a retrofit, it is always advisable to consult professionals. Expert consultants for deep-freeze systems can look at the specific requirements and tailor a solution precisely to your needs. This will save you time and money.

A well-designed solution with proven cold chain processes reduces energy and labor costs. Before contacting a vendor, you should have the following data at hand to expedite the process:

Checklist for Your Request

Your expert consultant will need the following information:

- Number of SKUs
- Required technical performance (throughput, input, output ...)
- Types of items
- Type of picking (whole pallets, layers, cases etc.) for forklifts
- Data acquisition requirements
- Current software solution (if any) and need for integration
- Current number of employees and shifts (for retrofits and expansion projects)



Conclusion

The return an investment will yield depends heavily on an application’s individual requirements and on the systems selected. Since energy consumption is a huge cost driver in the deep-freeze industry, it is essential to maximize building efficiency and minimize the total space as much as possible.

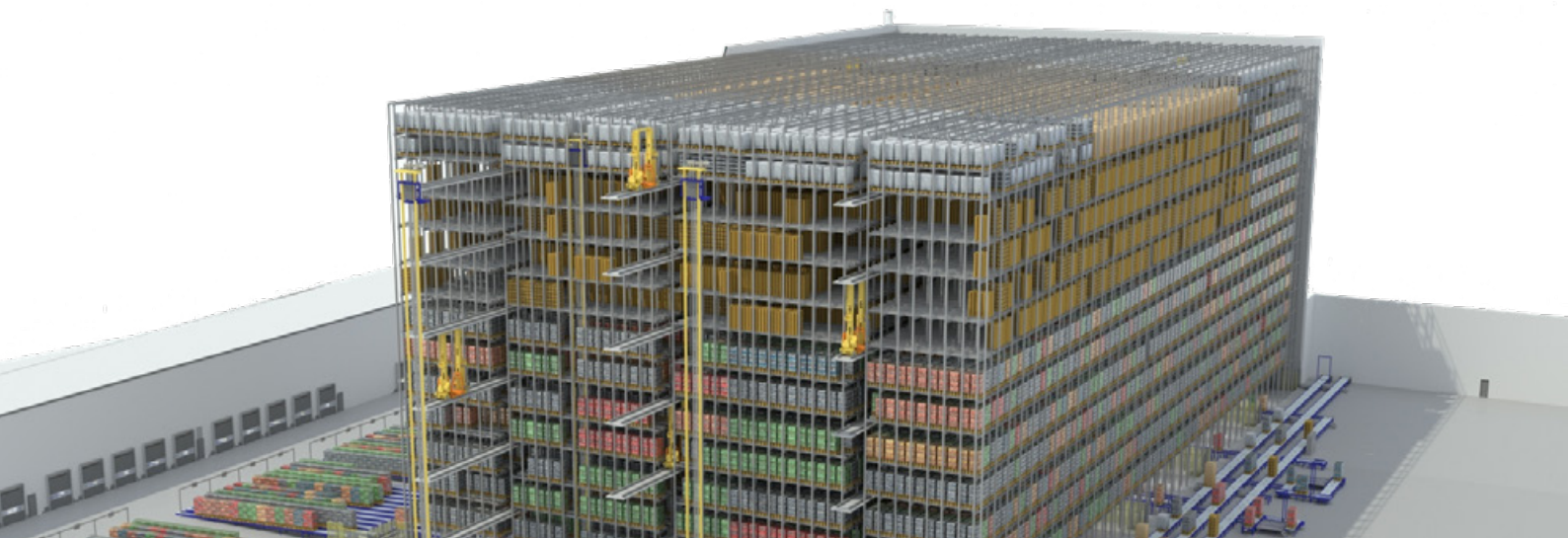
All movements within the facility should be as efficient as possible. This not only reduces energy costs but also generates less heat, so your air conditioning system will operate more cost-effectively.

Different systems offer very different returns on investment. With a new construction project, you can expect significant reductions in labor costs and space, as long as the building is highly automated. However, before you calculate savings, you should first determine the current labor costs as a baseline.

Typically, a new deep-freeze facility can yield a positive return on investment within three years. This is also true of a highly automated solution. For retrofitting an existing facility, the amortization period can be somewhat longer – typically four to five years. When all aspects of the project are considered – including buildings, systems, and the reduction in production costs due to the increase in batch size – the result is a higher return on investment

than with manual systems. This is due to less frequent product damage and a lower reject rate, higher production volumes, lower labor costs, higher technical performance in order execution, etc. Labor and energy costs are the most important deciding factors.

Skilled labor shortages and the expense of manual labor for picking play a big role. Energy consumption must be considered for all seasons. During the holiday season, higher demand subjects the facilities to more intensive use; the same is true for the summer months, electricity consumption for air conditioning can be higher.





Contacts

Let's talk about the future of your deep-freeze warehouse! Do you need more information? Or do you have questions about a specific project?

We are here for you:

ssi-schaefer.com

Your experts for deep-freeze logistics!

Literature Cited

- **Brand Essence Market Research** (June 2023): <https://brandessenceresearch.com/food-and-beverage/frozen-food-market-size>
- **Global Cold Chain Alliance** (July 2020): <https://www.gcca.org/resources/2020-covid-19-cold-chain-business-impact-survey-summary>
- **Utility Dive** (April 2018): <https://www.utilitydive.com/spons/alternative-energy-now-hasalternative-storage/520802/>

Six Reasons to Choose SSI SCHAEFER

■ **Stability**

As a financially independent family business, SSI SCHAEFER is committed to long-term solutions. You can trust that our team of experts will be there for you today, tomorrow and in years to come.

■ **Efficiency**

SSI SCHAEFER solutions are scalable and able to grow with your business. You can always upgrade or retrofit.

■ **Quality**

As a systems specialist and original equipment manufacturer, SSI SCHAEFER provides tailor-made and high-quality solutions from a single source, specifically designed to meet your challenges.

■ **Reliability**

Thanks to our worldwide Customer Service & Support network, SSI SCHAEFER ensures smooth operation of your system, both during and after installation.

■ **Know-how**

SSI SCHAEFER solutions are always up-to-date with the latest technological standards and can be easily integrated into an existing (IT) landscape.

■ **Internationality**

As a global organization, SSI SCHAEFER has local offices worldwide. With over 70 operative subsidiaries, our team of experts speak your language.

ssi-schaefer.com

2023/07 DE © SSI SCHÄFER
Printed in Germany.
No liability for printing errors.

SSI SCHÄFER