Today, cold storage operators have more options to manage the risk of fire – conventional sprinkler systems, linear heat detection and newer oxygen reduction systems. (Photo courtesy of Fisher Construction.)

FIGHTING FIRE

Automated warehouses have unique fire risks. Experts weigh in on options to manage exposure.

By Gina Veazey

Few threats pose a greater risk than fire. Beyond costly property damage, fire can disrupt business operations and imperil employees and others. Only cyber incidents and natural catastrophes were greater concerns for the global respondents to the 2024 Allianz Risk Barometer.

Recovery from fire can take longer than from many other threats. Rebuilding a damaged facility and restoring operations to full capacity can take years. In fact, Allianz says fire is the most frequent driver of costly business interruption insurance claims, accounting for more than a third of claims by value.

New Risks From New Tools

Electrification and widespread use of lithium-ion batteries have driven an increased risk of fire in recent years, Allianz reports. Cold storage industry fire experts agree, noting that operators are leaning into technology and automation with stacker cranes and automated storage retrieval systems (ASRS). Many also use lithium-ion battery-driven shuttle systems.

These automated systems may also expose cold storage operators to greater threat of fire. Both stacker cranes and ASRS use sensors to automate storage and retrieval and are connected through a vast and complex network of wires and cables to the warehouse management system (WMS). Shuttle systems also integrate with the WMS and leverage a degree of automation.

"Think of a warehouse that is just a dark room. If you walk in, manually put in a pallet without any ignition threat or source, there's no fire risk," says Frank Siedler, Global Account Director, Fire Protection for Cold Chain Logistics at WAGNER Fire Safety Consulting based in Germany. "But now, with all this new technology, there is a threat of fire in ASRS high bay cold storage. Think about lithium-ion battery-driven shuttle systems. People forget the cold storage atmosphere is very dry, which has an additional catalyst effect."

Approaches to Manage Fire Risk

Although fire risk cannot be fully eliminated, it is well understood and can be closely managed.

Today, cold storage operators have more options to manage the risk of fire – conventional sprinkler systems, linear heat detection and newer oxygen reduction systems (ORS or low-O).

The use of water to fight fire is not a new concept. Neither is the idea of an early warning system to detect temperature spikes. But the emergence of high-stack cold storage warehouses and ORS, as well as ongoing

innovations by sprinkler and fire detection providers, have expanded the conversation about fire protection.

"The key to mitigating risk is to understand the nature of the hazard and to utilize the correct detection and suppression system for the hazard," says Brooke Fishback, Director of International Sales at Protectowire FireSystems. "Cold chain operators should consult with fire industry professionals – fire protection engineers and manufacturers – in order to understand the options and to ensure the best systems are selected."

Owners should make informed decisions about the type of protection used in their facilities. "There is a balancing act between cost and efficacy of the selected system," says Glenn Warga, National Sales/Project Management at Ahern in Wisconsin, United States. "If the facility is an unoccupied 'dark ASRS,' then low-O is an alternative that can offer benefits of eliminating water-based systems that are susceptible to false discharges in freezers, which is never a good thing. However, owners should also consider soft costs of the selected systems, such as maintenance and energy costs."

In a manually operated facility, the risk of a false sprinkler discharge is mitigated with a double interlock preaction system. This prevents false discharges in the event an operator inadvertently hits a sprinkler or the wire since two devices are required to discharge water to the systems.

In addition to the risk of a false sprinkler discharge, densely packed ASRS warehouses limit the space available for sprinkler protection, piping, and other protection devices. Warga says the combination of height and the densely packed storage arrays present a challenge for operators and their CEBA partners.

Sprinkler systems often require more space between tiers and an elevation gain over multiple tiers. When sprinklers are the chosen protection method, flue spaces are necessary to allow fire to move up to the ceiling and water to discharge down into the flue. The flue space requirements will add space to the overall design. This is a required space between pallet loads and can result in the need for several additional feet of vertical and horizontal space.

Sprinkler systems are continually advancing to minimize these limitations, says Warga. Ceiling-only sprinkler systems, which do not require in-rack sprinklers, are currently capable of providing protection up to 55 feet. Above that, Warga says the standards have been evolving to stretch the distance between sprinkler levels.

This is where ORS fills a gap. "I don't see low-ox fighting sprinklers," says Siedler. "I think where sprinklers get to a limit, we can bring in oxygen reduction to have our customers get sufficient fire protection. So, it's not a battle. Oxygen reduction has a few requirements, which are easy to fulfill in a cold storage, but it's still a niche."

Indeed, the constraints of sprinkler systems often lead cold storage operators and their CEBA contractors to look at an ORS as an option, or to augment a fire protection system. But these systems require space, too, and incur ongoing costs.

Entertaining the low-O conversation requires answering tough questions about the amount of space required for equipment and its cost, as well as the ongoing costs of energy to operate the equipment.

An ORS works by adjusting the composition of ambient air. Typically, the air we breathe is about 21% oxygen (O_2) by volume, a level that exceeds the ignition threshold of many materials. Cardboard boxes, for example, are combustible at ambient temperature in an atmosphere of 15% O_2 by volume or greater. In this use case, an oxygen reduction system could be set up according to ISO standard to generate and pump nitrogen into the air as needed to reduce and maintain the proportion of O_2 at a level below the ignition threshold, plus a safety margin, such as 13.9% by volume.

These systems require a machine room with nitrogen generators, control units and electrical cabinets. Piping to disperse nitrogen throughout the facility and sensors to continually detect O_2 levels are also needed. The system is paired with fire detection equipment and an organizational hazard management program.

Another option is linear heat detection. It uses a unique cable that detects a specific temperature anywhere along its length, and it activates when that temperature is reached. Fishback says, "In cold storage warehouses and freezer applications, linear heat detection is typically used as the pre-action on single- and double-interlock sprinkler systems."

Fire detection systems have historically been required to mitigate fire risk, and these technologies are evolving too. For example, environmental monitoring sensors, thermal cameras and fiber optic systems are available to identify overheat conditions and other anomalies, and to prevent failures and fires before they occur.

"This is especially important as cold storage facilities update their existing technologies," says Fishback. "For example, automated warehouses are increasingly turning to rooftop solar panels to supply power to their facility. He notes these are a new and distinct fire hazard and must be monitored.

"Selecting and installing a system designed to detect over-heating and fire conditions in

The Fire Triangle

"People think fires are not possible because of the cold, which is unfortunately not true," notes Siedler.

Although heat does play a role in fire, cold does not. The so-called "fire triangle," which illustrates the elements needed to ignite a fire, includes:

- Fuel, or a combustible material, to feed the fire
- A source of combustion, like an electrical spark, capable of raising the heat of combustible material beyond its ignition temperature
- Oxygen (O_2), readily available in ambient air, to sustain combustion

rooftop solar panels needs to be a part of the discussion at the outset when solar panels are being considered," Fishback advises.

Combination Approach

Demonstrating how these partners often work together, Ahern and Wagner are currently working with Fisher Construction to complete a NewCold warehouse in the U.S. state of Indiana. When complete, the cold storage facility will be the largest in North America, and according to NewCold, it will have a total of 200,000 pallet positions.

"We believe this facility sets a new benchmark for our industry," says Bram Hage, NewCold Founder and CEO. "We are building a more resilient, reliable and sustainable food supply chain to better serve our customers."

In the project's first phase, a 43-meter-high facility with 100,700 pallet positions and nine automated stacker cranes, Fisher and NewCold chose to leverage the Wagner ORS. This phase has been complete and in operation since 2023.

"It's a fully automated system," says Chris Wright of Fisher Construction Group. "You don't have any individuals working in the high rise, it's all cranes running back and forth 24 hours a day."

Construction of the second phase of the facility has just begun and will also use an oxygen reduction system.

"There are different applications for different environments, and it doesn't mean either one of them is right or wrong in those respective areas," Wright says, "but the combination and the approach to use both of these teams has allowed us to construct larger buildings faster, for a lower cost to the owner and to continue to provide the fire protection that keeps everybody safe."

"There's a 'we need to do this right' attitude," says Warga. "Everybody is as transparent as possible and, quite honestly, you need to be when you're embarking on something that is newer and innovative."

Fisher's role is not only significant from a building construction point of view, but also from a design perspective. "They're a design-build general contractor, so they have processes to bring in design partners early on to make sure that everything is constructed appropriately," says Warga. "When Fisher brings in a team, they're very orchestrated. They bring everything together and lead the charge, especially from a design perspective, and then move into a construction sequence."

Ceiling-only sprinkler systems, which do not require in-rack sprinklers, are currently capable of providing protection up to 55 feet. (Photo courtesy of Fisher Construction.)

"We are all under the umbrella of the Global Cold Chain Alliance, and it's good to work with people who share the same spirit," Siedler says. "I'm happy that we are on board with a customer that is a GCCA member, NewCold, and with Fisher Construction, a big player in general contracting with a clear mindset on how to execute that kind of project to make it easy for the customer. Add Ahern, a rock-solid U.S. fire protection company in the United States, and it is just the perfect match."

The project fell under the permitting authority of the U.S. Department of Homeland Security.

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Oxygen Reduction Systems Acceptance

ORS suffers from its own success. Burning buildings make headlines. Buildings that are not burning just don't.

Nonetheless, ORS has gained significant traction with standards for its use in many countries. In some parts of the world, like Germany and its neighboring countries, ORS is fully embraced by authorities and insurers.

In other countries, like in the United States, acceptance is evolving quickly. Siedler says the U.S.-based National Fire Protection Association (NFPA) is currently exploring ORS and the need for a standard in the United States.

Insurers have also begun to embrace low-O systems. Siedler says FM Global, for example, has its own design standard and refers to low-O systems as a "viable alternative" to sprinklers.

Other insurers continue to view ORS as a useful addition to conventional sprinkler systems, rather than as a viable option to them. A 2020 Allianz technical bulletin, for example, says it "does not typically consider a standalone [oxygen reduction system] as an alternative solution to active or passive fire protection systems." However, Allianz recognizes the value of ORS in spaces, such as cold storage specifically, that are normally unoccupied. Its technical bulletin outlines key design and technical requirements.