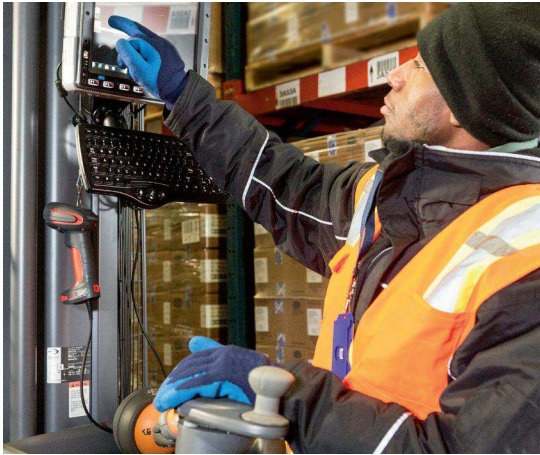


THE COLD HARD FACTS:

Using Rugged Mobile Computers in Cold Environments



Executive Summary



Coats, hats, proper ear protection, footwear, and gloves are essential for warehouse workers to function more than a few minutes in cold storage areas. In much the same way, mobile data-collection computers must be built to perform under these demanding conditions. Unless mobile computers, associated barcode readers, and wireless networking equipment have been designed with features required specifically for use in cold environments, the level of their reliability will fall right along with the temperatures.

Standard computer models deliver less-than-substandard performance if they are consistently used inside freezers or exposed to frequent temperature changes. In fact, moving the computer between normal and cold areas is extraordinarily hard on just about every part of the device, even if it's ruggedized. In the short term, LCD screens fog up, batteries won't release enough energy and processors may not perform as intended. This all equates to reduced user productivity. Long-term use of non-optimized equipment in cold conditions causes screens and housings to become brittle, and repeated condensation can cause internal components to corrode, short-circuit, and fail.

Workers shouldn't have to work hard to keep their mobile computers functioning. Fortunately, low temperatures don't have to mean reduced reliability and productivity. There are mobile computers, wireless networking gear, and data-collection peripherals available that are specifically made for prolonged use in cold, moist, and freezing conditions. This white paper describes the conditions where cold environment computers are necessary, the warning signs that indicate when devices aren't up to their environmental requirements, and explains the key differences between standard and cold environment rugged data-collection computers.

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The Solution: Rugged Mobile Computers Built to Thrive in and out of the Cold



Companies no longer have to compromise on functionality and information access just because of the environment. Next-generation cold storage mobile computers are built not only to withstand prolonged use in the cold, but more importantly transitioning between cold and warm locations.

What Changes in the Cold?

Cold air, frost, and condensation. Each of these elements creates a specific challenge for rugged mobile computing equipment. The insulation used to keep refrigerated and frozen storage areas cold also poses problems when it comes to wireless connectivity. Here's a brief overview of how these conditions impact mobile computer performance.

Frost

Frost obscures LCD screens, so users can't see prompts or verify the data they enter. Productivity and accuracy both suffer.

Barcode readers and image capture devices will not function if frost covers their optical ports. In these cases, workers must resort to manual data entry, which severely reduces productivity and increases error rates.

Frost can also cause keys to stick if the device is improperly constructed or insufficiently sealed. Error rates grow exponentially.

Condensation

Condensation causes the same problems as frost by making screens and scanners unusable.

Condensation presents more of a problem because it can occur inside the screen or scan window, and thus can't easily be cleared away. It's a very serious problem because it can cause internal components to corrode, short-circuit, and fail, making the device unusable until it is repaired or replaced.

Cold

Battery-powered mobile devices are challenged by cold temperatures because batteries can't release their energy when temperatures drop below certain levels. The result is reliability and

productivity problems that threaten on-time performance and reduce overall efficiency.

Insulation

Insulation used to keep cold air from escaping can also restrict the movement of radio waves. Insulation absorbs RF signals, and commonly creates what is known as the “multi-path effect,” which occurs when signals bounce off obstacles and arrive at the access point at slightly different times.

Most rugged mobile computers won’t stop working if they’re occasionally taken into a freezer for very short periods of time, or used longer-term in lightly refrigerated areas. The amount of exposure to extreme cold conditions, and the frequency of transition from cold to normal temperatures, are the key considerations for determining if specialized cold-environment equipment is needed.

Standard computers will generally perform normally at temperatures down to approximately -20°C (-10°F), which is appropriate for common refrigerated environments. Computers that are used consistently at those temperatures, or in freezers (which are often kept at -30°C/-22°F) should be made specifically for those conditions.

Temperature changes are especially hard on computers because condensation often results and can cause complete failure in relatively short order. Rugged cold environment models should be used if the equipment will experience travel through normal, refrigerated, and frozen areas throughout the day as part of normal picking and putaway operations. Extreme temperature swings are the most dangerous, as in the summer when a forklift may be moving from a -30°C (-22°F) freezer to a 38°C (100°F) dock door.

Evaluating a Device for Use in Cold Storage



Any handheld computer can be carried in a case or holster, but that superficial protection doesn't render the device suitable for prolonged use in cold temperatures. True rugged cold-temperature computers use parts, materials, and manufacturing processes specifically designed for the environment. Practically every component of a mobile computer – from the casing to the internal circuitry – can be optimized for use in cold conditions. This section explains how true cold-temperature computers are different from standard models and identifies key features and specifications to look for.

Heaters

Integrated heaters are the components that truly set cold-environment computers apart. Heaters are factory-installed options that ensure reliable computer performance in several key ways. Most importantly, heaters can prevent condensation, the most detrimental result of cold storage environments in both the short-term and long-term. Condensation typically forms on unheated displays and the scan windows of barcode readers, causing them to fog over. Productivity plummets. Accuracy suffers if workers attempt to use the unreadable terminal by continuing to enter data if they can't verify what they are entering. In addition, manual entry on keypads with heavy gloves can lead to additional data entry errors in itself.

Barcode reading accuracy is also compromised if there is condensation on the scan window, but

it is more likely that the barcode reader won't function at all for as long as the condensation is present. Condensation forces workers to enter data manually and prevents them from taking advantage of on-screen prompts. Heaters are therefore essential for cold-environment use. Internal heaters are recommended if computers will be consistently used at temperatures of -10°C (14°F) and below, or will frequently move in and out of cold areas.

Housing

Mobile computers should be made from durable material suitable for industrial applications and be well constructed to limit the effects of exposure. A strong seal is essential for preventing moisture and condensation from damaging the inside of the computer. The Ingress Protection (IP) rating

is an independently certified measurement of how well a device is protected against various environmental conditions. The first digit in the two-digit IP rating indicates how well the device is sealed against particles, the second against water. Particle ratings range from 0 (no protection) to 6 (dust tight). The second digit is more important for cold environment use. It ranges from 0 (no protection) to 8 (sealed against full immersion in water).

Ruggedized mobile computers for warehouse and other industrial environments typically have an IP54 rating, which means they are protected against dust and splashing water. IP54 may not be resistant enough for cold environments, particularly where frequent entry and exit from the cold environment will cause condensation. IP65 or higher is appropriate for most cold environments. These devices are sealed against dust and can withstand jets of water, which is sufficient protection to prevent internal moisture.

Batteries

Mobile computers typically use Li-Ion batteries. Cold temperatures prevent common Li-Ion batteries from releasing their charge, making the powered device unusable until the battery is warmed. Li-Ion batteries also tend to fail completely when temperatures reach -30°C (-22°F), which is common in frozen storage areas.

Low-impedance lithium-ion batteries specially formulated for cold-temperature

use are available. These batteries will release their charge at colder temperatures than will standard models, and have lower failure points.

Connectors

Connectors that link the computer to peripherals or power sources (e.g., the battery on a vehicle-mounted computer) are another important variable to reliability. Most connectors clip into place. Screw-in connectors are less common, but are a superior choice for cold environments. Not only does the screw threading provide a stronger connection that is less likely to detach, it provides more compression force for a better seal against moisture.

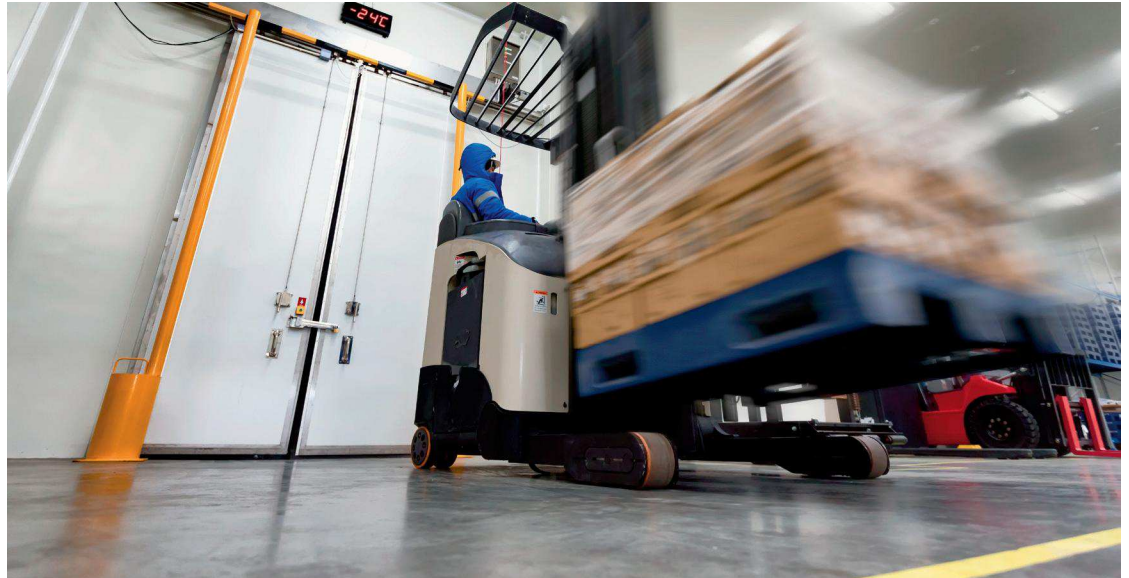
Ergonomics

Just as you can't judge a book by its cover, you can't judge a cold-environment computer by its outward appearance. Manufacturers typically make cold-environment computers with large, well-spaced keys to facilitate easy use by gloved operators. A glove-friendly keypad layout is useful, but ergonomics won't overcome inferior housing, components, or environmental protection, which are often the true differentiators between standard and purpose-built cold environment computers. Users report that overall size and weight are more important than keypad configuration for overall satisfaction and ease of use.

Feature Comparison

FEATURE	STD MOBILE COMPUTER	COLD ENVIRONMENT COMPUTER	COMMENTS
Internal Heater	No	Yes	
Heated Display	No	Yes	Computers can have heated displays even if they do not have internal heaters
Housing	Standard	Formulated to resist cracking when dropped in cold temperatures	Standard computers may not perform up to their specified drop rating when used in cold environments because the housing may become brittle.
Connectors	Clip-in or plug-in	Screw-in	Screw comments generally apply to vehicle-mounted computers, which have multiple cables to power and peripherals.
IP Rating	Typically IP54 or less	IP65 or higher	
Battery	Standard lithium-ion	High-grade lithium-ion formulated for cold conditions	Battery comments apply to handheld computers only. Vehicle-mounted units are powered by the vehicle's battery.

Wireless Infrastructures in the Cold



Popular industrial wireless communication technologies, including Bluetooth® and IEEE 802.11-standard wireless networks, can be used in cold storage and freezer environments. Some adjustments may be required to wireless LANs to ensure consistent, quality performance.

Access points (APs) often need to be installed directly in refrigerated or frozen storage areas to provide coverage there, because thick walls and insulation can block signals from APs outside the cold zone. When access points are installed in refrigerated or freezer zones, they should be put into a heated enclosure to protect against condensation and cold.

The multipath effect is a real concern for any insulated, cold, or damp environment, and is especially so for cold storage facilities, where all these conditions are present. There are specialized antennas that can be used with common access points to correct for the multipath effect. Such antennas are highly advantageous for providing wireless LAN connectivity to mobile computers used in cold storage environments.

Barcode Readers



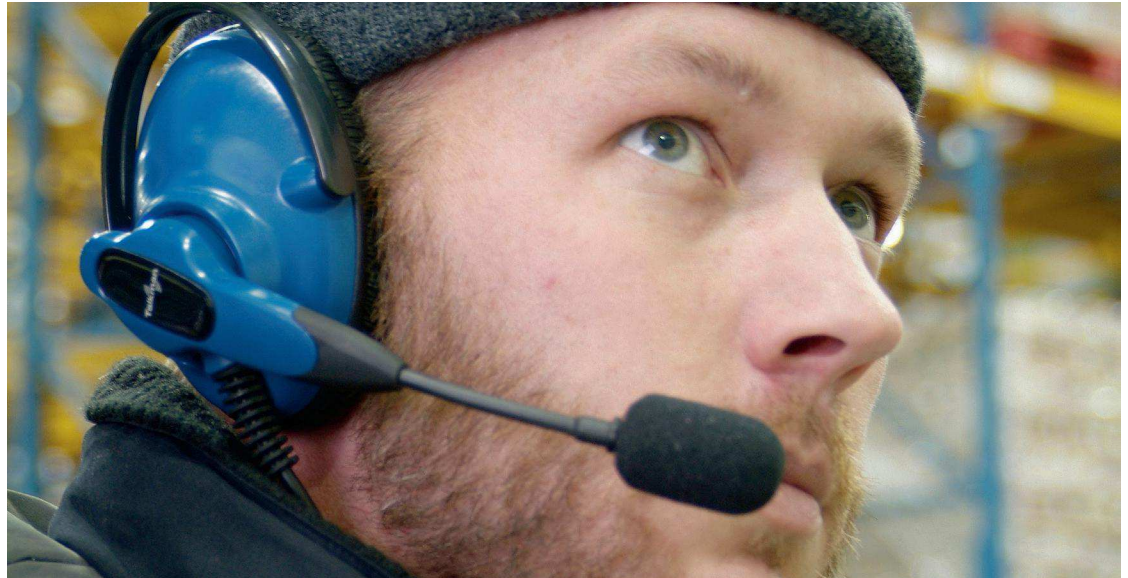
Barcode scanners need a direct line of sight to the label for accurate reading and decoding, so fogging or condensation on the scanner optics can present a problem. The best solution is to have the barcode reader integrated as a component of the handheld computer, to take advantage of the computer's internal heater to function properly.

Handheld computers are available with near/far scanners, and can be used with powered vehicle-mount cradles. This makes them an intriguing option for forklifts in cold storage areas. However, handheld devices may not always be a viable option on forklifts, and the wireless or tethered handheld scanners that are typically used in conjunction with true vehicle-mount devices are not available with internal

heaters. In these cases, heated holsters can be used to mitigate problems with condensation.

Bluetooth is a popular option for interfacing barcode scanners and other peripherals to mobile computers. Bluetooth is especially valuable in cold environments, because the wireless interface eliminates worries about connector failures from condensation.

Alternative Data-Collection Options



Speech recognition and RFID are alternatives to barcodes for accurate data entry, and have several advantages for cold environments. Speech recognition terminals are worn on a belt or shoulder holster, rather than carried, and can be worn under a coat. Terminals worn under coats aren't exposed to the temperatures cold enough to cause problems.

RFID is advantageous because it requires no line of sight for data entry. Therefore, the condensation that can plague barcode readers is not a factor. Condensation frequently occurs after pallets are shrink-wrapped, which makes it difficult for some laser barcode devices to read labels under the wrapping. RFID is a good option for identifying cases and pallets after the shrink-wrap process.

Conclusion

Thriving in cold conditions requires the ability to adapt to the environment. Mobile computers can be adapted for cold-environment use with heaters, housings, components, and peripherals that set them apart from standard models. Without these adaptations, mobile computers are at significantly elevated risk for failure, putting organizations at risk for lost productivity as well as unnecessary repair and replacement costs. Seemingly minor problems such as frequent battery changes and devices periodically being unusable because of condensation problems drive up operating costs by reducing productivity and threatening on-time performance.

About Honeywell

Honeywell Safety and Productivity Solutions offers a full range of mobile computers, smartphones, and accessories with different ruggedness levels, features, and configuration options so enterprises don't need to compromise to get a mobile device that meets their specific needs.

Honeywell Safety and Productivity Solutions is a leading manufacturer of high-performance image- and laser-based data collection hardware, including rugged mobile computers and barcode scanners, radio frequency identification solutions, voice-enabled workflow, and printing solutions. With the broadest product portfolio in the automatic identification and data collection industry, Honeywell Safety and Productivity Solutions provides data collection solutions for retail, healthcare, distribution centers, direct store delivery, field service, manufacturing, and transportation

and logistics companies seeking to improve operations and enhance customer service. Additionally, Honeywell Safety and Productivity Solutions provides advanced software, service, and professional solutions that help customers better manage data and assets. Honeywell Safety and Productivity Solutions products are sold worldwide through a network of distributor and reseller partners. For more information on Honeywell Safety and Productivity Solutions, please visit www.honeywellaidc.com.

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