Case Study:
JLG® DaVinci Lift Proves Itself in Cold-Temperature Applications



Machine operation and productivity in cold temperatures is a huge concern for users who are considering using electric equipment in refrigerated food processing warehouses, cold storage facilities, vaccine laboratories, or outdoors in winter weather conditions, to name a few. Many remember the challenges they had operating early generations of electric hand drills or other battery-powered tools — the batteries drained quickly, or these tools performed poorly when temps dipped below freezing. These experiences left a lasting impression, and even today, several generations of battery technology later, people are still hesitant to use electric equipment in cold-temperature applications.

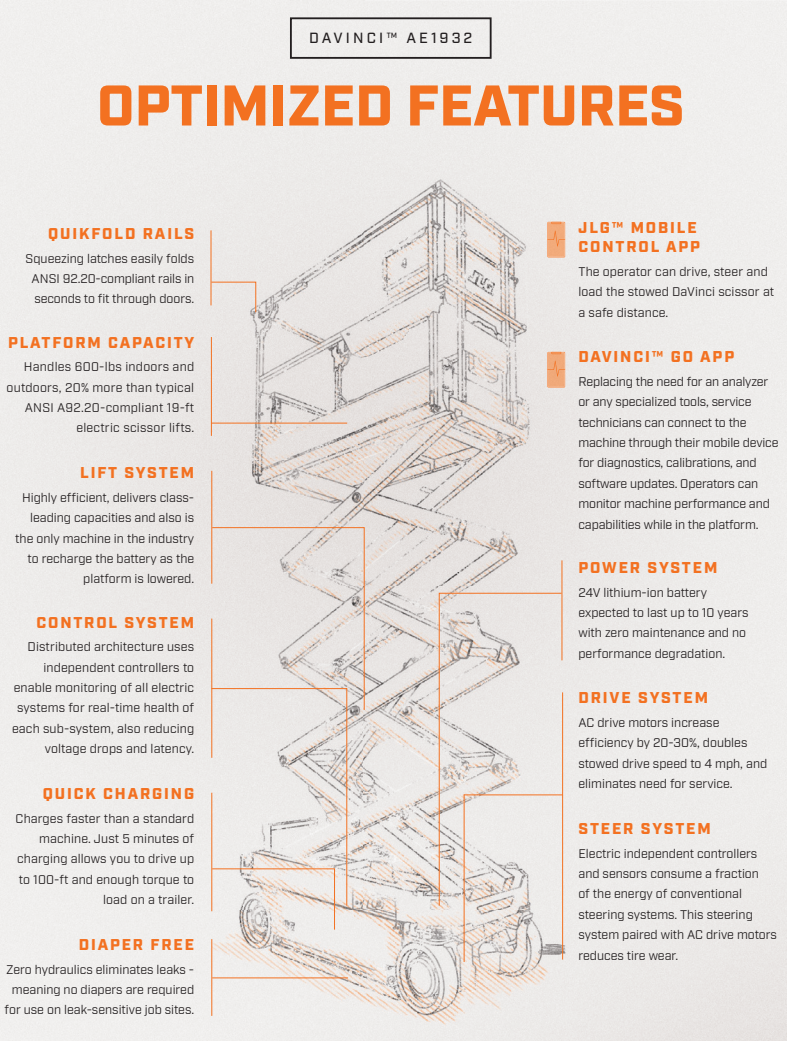
"Working in below-freezing temperatures can impact the performance of equipment, resulting in slow, sluggish functionality, as well as reduced battery runtime by up to 50 percent, in part due to hydraulics and previous battery technology," says Bob Begley, JLG's director of product management for scissor, vertical and low-level access lifts.

Despite cold weather performance concerns, electric MEWPs (mobile elevated work platforms) like scissor lifts are often needed on maintenance projects or construction job sites in colder temperatures because of restrictions in certain work environments, like noise and air pollution requirements, that prevent the use of internal-combustion (diesel, dual fuel or gas) machines.

According to Begley, battery-powered scissor lifts have been around for a long time but have been limited to only having enough power to electrify components, like the drive system. Traditionally, the rest of these machines' systems run on hydraulics, like the lift and steer functions.

But, he says, battery technology has been rapidly advancing in recent years, driving the industry towards more electrified products — including the advent of 100-percent, fully electric machines.

One example of a recent advancement is the JLG® DaVinci® AE1932 lift, introduced in early 2021, the world's first all-electric scissor lift. The DaVinci lift combines state-of-the-art engineering and technology within an elegant design to set new industry benchmarks for performance. With a host of advanced innovations and optimized features, the DaVinci lift was designed to drive productivity higher. For example, equipped with a single, 24V lithium-ion battery, this machine features zero hydraulics to help eliminate job site leaks and zero emissions to help control job site pollution. And, it is purpose-built for applications where stringent environmental regulations must be met while offering consistent, ongoing productivity — even in the coldest conditions.



Let's start by looking at why battery technologies play such a big role in how MEWPs perform in cold conditions...

Battery Technology

There are multiple types of batteries used in MEWPs, each with various tradeoffs related to performance and productivity: FLA (flooded lead acid), AGM (absorbed glass mat), Nickel-metal hydride and Lithium-ion. The most common ones used in MEWPs today are FLA and Lithium-ion.



FLA

FLA batteries have been powering equipment in the access industry for decades. Coupled with onboard chargers, these battery systems are designed to offer peak battery performance and life. That's because they are relatively inexpensive to maintain, can work in a vast temperature range and are durable and forgiving of misuse.

FLA batteries should ideally retain an 80 percent or better charge for optimal performance. Unfortunately, anything lower causes the batteries to sulfate, or self-deteriorate, causing them to lose capacity.

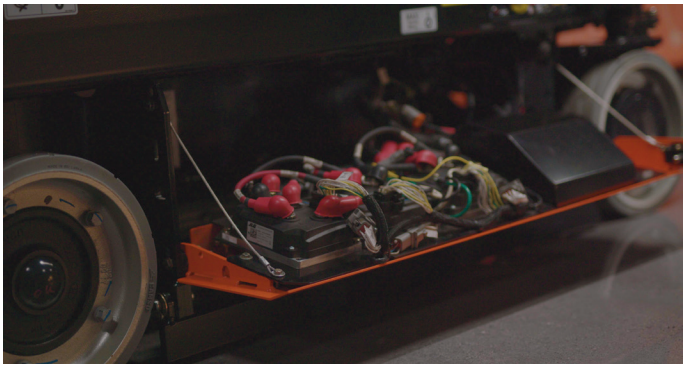
Another known issue of FLA batteries is freezing. If an FLA battery is deeply discharged and the temperature gets low enough, the battery will freeze into an ice cube, impacting the battery's service life. During battery discharge, the sulfuric acid turns into water, making it possible to freeze. A battery with a 0 percent SoC can freeze at 32°F (0°C).

Lithium-Ion

This is not the case with lithium-ion batteries used in JLG's DaVinci lift. These batteries experience zero performance degradation to maintain top-of-the-line productivity, even as the battery is being depleted while working in cold environments.

Also, lithium-ion power offers faster charge times than FLA batteries. Compared to a typical scissor lift that takes nearly nine hours to fully charge, JLG's DaVinci lift takes just 3.5 hours with its standard 650W charger. This type of battery also offers an opportunity charging feature that allows it to be periodically charged throughout the day without damaging the battery. A quick, 30-minute charge leads to hours of productivity.

In addition, lithium-ion batteries offer environmental benefits over FLA batteries by eliminating the risk of acid spills and outgassing concerns. This means that machines equipped with this type of battery, like the DaVinci lift, have an advantage where cleanliness is essential, such as in refrigerated food processing warehouses and cold storage applications.



DaVinci's Battery Solution

While other OEM brands may offer lithium-ion-powered models, these machines require multiple batteries to run the equipment today. To alleviate this, JLG engineers worked while designing the DaVinci lift to optimize every system to reduce energy consumption and recover energy as the machine descends to maximize operational duration on a single charge. This design means that the DaVinci lift can be powered with a single lithium-ion battery without compromising performance.

But it's not just the advances in battery technology that influences a MEWP's performance in below-zero applications. Battery management also significantly affects how these machines work in extremely cold temperatures. Let's dig and find out why...

Battery Management

These types of temperature conditions can cause bigger voltage drops in FLA batteries during operation, resulting in the machine's control system thinking the batteries are nearly out of charge. When this happens, the control system, which is designed to protect the machine's vital components, including the battery, will limit performance to preserve basic machine functionality.



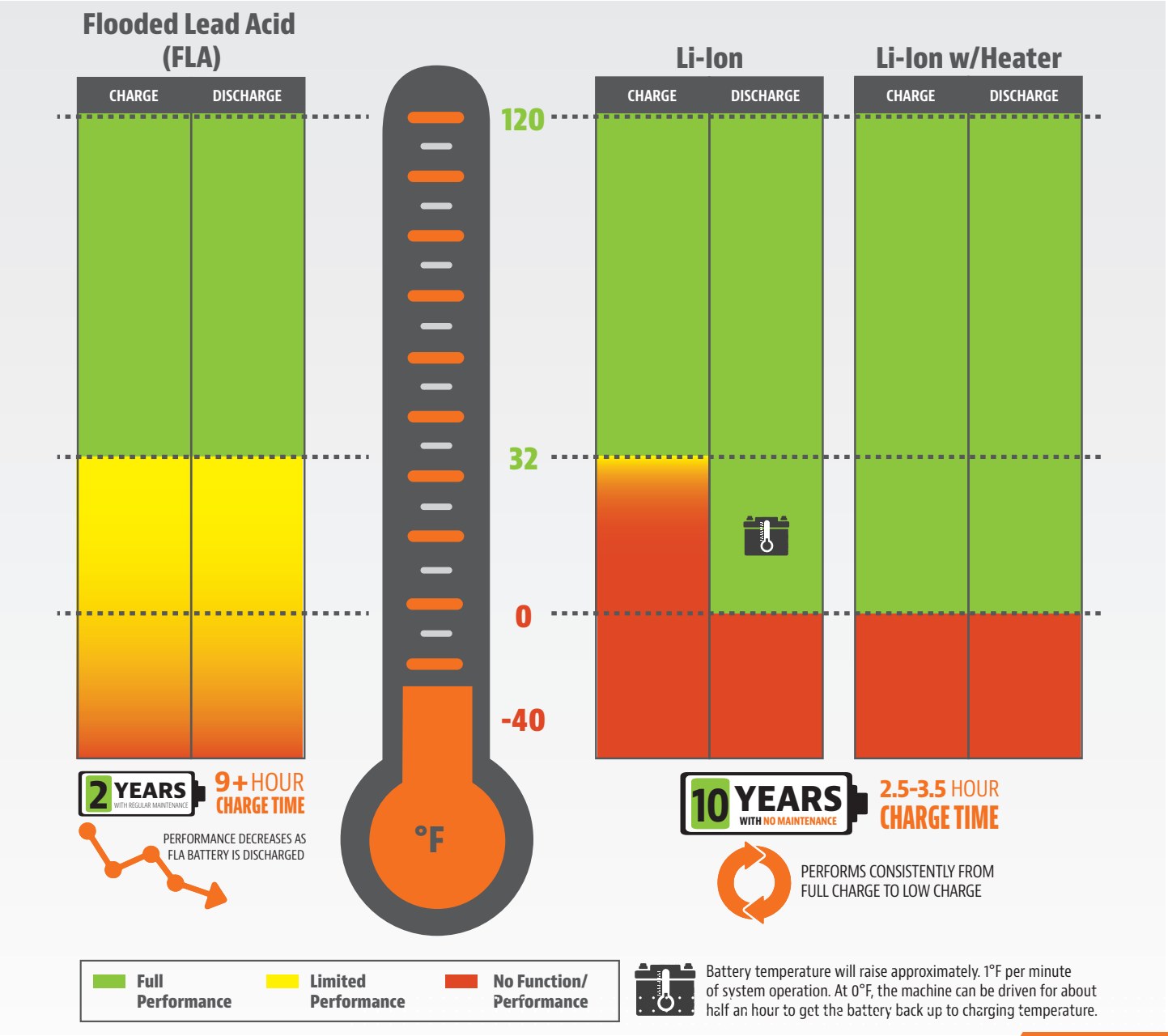
FLA

In this scenario, with FLA batteries, keeping the batteries as highly charged as possible (80-percent State of Charge, SoC, or greater) will keep the batteries' voltage in an optimal operating range, resulting in the least amount of voltage drop.

Lithium-Ion

Machines that are fully electrified, like JLG's DaVinci lift, don't have this issue. They are highly efficient, and the power required to run these machines is cut by more than 40 percent. This opens the door for incorporating a single lithium-ion battery.

And, modern lithium-ion cell chemistries and battery management systems are much more consistent in performance and reliability across a wide range of temperatures compared to FLA batteries. For example, lithium-ion batteries can be working consistently in 32°F (0°C) or below temperatures without needing to maintain a high SoC.





DaVinci's Battery Management Solution

Adding to its other advantages, the DaVinci lift also features an advanced battery management system (ABMS) that monitors the machine's charge and usage while providing detailed diagnostic information about the battery and charge systems via the DaVinciGo app.

Now that you know more about how and why batteries influence machine productivity, let's talk about the way JLG's innovative all-electric machine performs in real-world, below-freezing conditions...

DaVinci's Battery System Put to the Test

"One of the most important considerations when selecting battery-powered MEWPs for working in cold conditions is productivity," says Austin Caskey, a product line manager at Sunbelt Rentals. "Our customers want to rent electric scissor lifts that are dependable and ready to work. But at any given time in a below-freezing work area, due to rapidly declining performance, you may need twice the number of scissor lifts that you'd usually need to get the job done."

Begley says that it's commonplace for a hydraulic scissor lift equipped with FLA batteries to not even get a full shift's worth of work in freezing temperatures. He also notes that it takes at least eight hours to fully charge these machines.

But what about the DaVinci lift? With its all-electric components and quick-charging lithium-ion battery pack, could it be the solution for productively using electric scissor lifts in cold-temperature applications moving forward?

"We had a lot of assumptions about how the DaVinci lift would perform that we needed to put to the test," says Begley.

To find out, JLG partnered with Sunbelt Rentals to put this revolutionary new machine with its innovative energy-efficient design and advanced battery system to find out.

Freezer Application Test

In October 2021, a team from JLG and Sunbelt Rentals set out to test the performance of the DaVinci scissor lift in an industrial freezer that reaches temperatures as low as 0°F (-18°C).

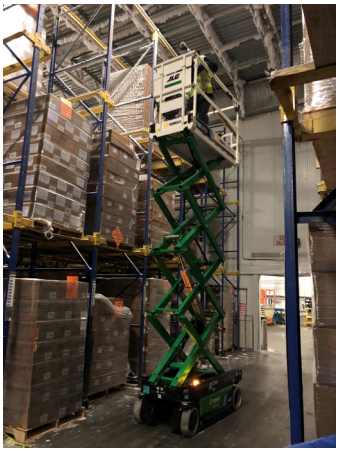
"We chose to run the test in one of the harshest environments we could find — an industrial-sized freezer located at one of our customer's locations in Concord, North Carolina," says Caskey.



The unit was 40-ft wide by almost 150-ft long with close to 28-ft ceilings, split into two rooms. "The first room, the smaller of the two, was a receiving area where pallets of material were unloaded and loaded from tractor-trailers," he says. "According to the gauge in this temporary holding room, which was located by the entrance to the freezer, the temperature in the area was 20°F (-6°C).

"The second room," continues Caskey, "was a long-term storage room with two long hallways formed by floor-to-ceiling racks to store goods." The temperature in this freezer area was 0°F (-18°C).

According to Caskey, the customer shared that employees often use scissor lifts in both freezer areas to complete cleaning and maintenance tasks.



Testing in Cold Temperatures

To start the test, Caskey says that the team placed the DaVinci scissor lift in the warmest area of the freezer (approximately 20°F/-6°C) with a full charge (97% State of Charge, or SoC) and stored it there overnight. "We have a lot of customers in the northern U.S. and in Canada that have to store their equipment outside," he says. "We wanted to simulate the machine being in that kind of environment because they need electric equipment that will work well in lower temperatures."

Begley says that the following day, when the team checked on the machine, its SoC was reduced by less than 10 percent and that the battery's internal temperature was at 12°F (-11°C). The team plugged in the battery charger for about 45 minutes, increasing the battery's internal temperature to 27°F (-2°C).

Once the machine was warmed up and fully charged again, the JLG and Sunbelt Rentals team got to work, beginning a series of duty-cycle tests (which include drive, elevate, descend and return cycles) on the DaVinci machine in one of the rows between the racks in the long-term holding room. "Data was collected using the DaVinciGo mobile application throughout this test," says Begley. "The DaVinci machine performed a series of full test cycles in approximately two hours and showed no signs of performance degradation."

"Based on our experiences with hydraulic machines in colder temperatures," says Caskey, "we expected a loss of performance as we went through the cycles. That's why we typically rent two scissor lifts at a time for freezer applications, so our customers can alternate machines every couple of hours to ensure their project stays on time (one machine works while the other one warms up and charges). With these typical electric scissor lifts, operators notice a slow decline in performance almost instantly, nearly as soon as a machine starts working.

"But," he continues, "in the hours we were cycle testing the DaVinci (lift), it never lost functionality or speed in the freezer. We went up and down a lot with the machine during the tests — doing way more than a normal work cycle, and there was no degradation in performance."

He goes on, "This capability will translate to huge savings for our customers, both in time (swapping out machines) and money (rental rates), because now they will only have to run one machine to complete the work."

At one point during the day, the team took a 45-minute break in testing. Instead of just parking the machine where it was, they drove the DaVinci machine into the coldest section of the freezer, where ambient temperatures were close to 0° F (-18°C), to store it there. During this pause, battery data continued to be collected. "The team wanted to make sure they were measuring everything to accurately assess the machine's capabilities in this type of environment," he says.

When testing resumed, the team was able to complete additional cycles with the DaVinci lift before the machine started intermittently slowing down on its own. "The machine completed one more cycle in this semi-slowed state before machine functions were completely prevented," says Caskey. "That's a very different response than we would have gotten from a traditional electric-drive model."

"Once the machine completely ran out of power, the team concluded the test, achieving a total of 26 cycles," says Begley. After cycling power, the battery went from 0 percent to 2 percent SoC, allowing the team to move the DaVinci lift to an area where it could be charged.

Begley notes that JLG has implemented provisions into the DaVinci lift's proprietary software to protect the battery when the SoC is very low, reducing the risk of damage caused by fully discharging a battery.

After this test, Begley says that the DaVinciGo app recorded that the machine's internal battery temperature was 51°F (10°C), which allowed the battery to be charged immediately.



"The JLG team continued to collect battery data from the DaVinci lift for approximately 30 minutes after the test while the battery was charging," adds Begley. "In that time, the battery managed to make it from 0 percent to 34 percent SoC."

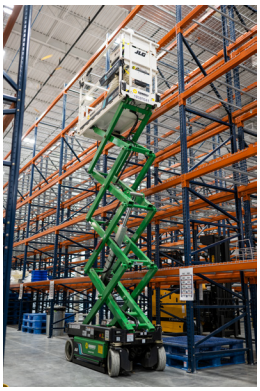
Conclusion from Testing

Based on a detailed review of the JLG and Sunbelt Rentals test report, Begley says that the DaVinci lift performed as anticipated, meeting everyone's expectations for using this all-electric machine in this type of climate condition. "We are confident that this machine is suitable for working in cold-environment applications, similar to those tested in the freezer at our customer's location in North Carolina," he concludes.

"The 19-ft scissor lift is one of the most commoditized rental machines in the world," says Caskey. "But, this one is unlike anything else available in the market, and our customers are taking note. It charges faster and stays charged longer, and the difference is noticeable."

He adds, "Because it's engineered with no hydraulics, there is no risk of leaks or spills — that means that we can rent these machines into clean, sensitive environments without our customers being concerned about how the lifts will impact the job site. This offers a new solution for our customers in certain facilities to rent this machine to use during planned shutdowns. It's a big deal."





Caskey says that the DaVinci lift's attributes appeal to many of its customers. Today, Sunbelt Rentals carries a large fleet of JLG DaVinci scissor lifts nationwide with plans to add additional units as demand increases.

"Our larger customers with sustainability goals request it for the environmental benefits," he continues, "and smaller customers like it for the performance benefits. Many of our customers have started requesting this machine by name when they are ready to rent."



Unlocking New Possibilities and Applications

By solving one of the industry's challenges with electric equipment, the JLG all-electric DaVinci lift will quickly find its place as the go-to choice for working at height in cold-climate conditions, says Begley.

"The DaVinci scissor lift represents a new generation of electrified access equipment," he adds. "While there are already battery-powered, or electric, scissor lifts on the market today, this all-electric machine differentiates itself from other 19-ft models available.

"Thanks to its productivity in cold-temperature applications, the DaVinci lift unlocks new possibilities and applications," he says, "and will serve as the blueprint for future electrification."

Representing a new generation of electrified access equipment...



To learn more about the innovative, all-electric DaVinci scissor lift, visit www.allelectricscissor.com.

About Sunbelt Rental's Sustainability Initiatives

Sunbelt Rentals embraces responsible sustainability by bringing innovation forward to reduce the carbon footprint. Dedicated to our environmental commitments, Sunbelt Rentals operates in a manner that contributes positively to the communities where we work and live. In collaboration with manufacturers, we invest in solutions that help reduce fuel consumption, eliminate emissions, decrease noise pollution and meet or exceed performance. To learn more, visit sunbeltrentals.com/esg.

Sustainability at JLG

JLG has long been a pioneer in producing environmentally friendly lift and access equipment. Sustainability guides our responsibility to the environment and our customers, who demand green solutions. And as an Oshkosh company, we continue to lead the way in making innovative products that meet our customers' needs for energy-efficient solutions and reduce the impact on the environment. To learn more, visit jlg.com/sustainability.

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