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WHITE PAPER

Addressing Problems with Power in the Oil and Gas Industry

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Suppose you work in an air-conditioned office on mundane tasks where a power supply failure may result in little more than minor frustration. In that case, many cheap-and-cheerful UPS systems are available from vendors like Amazon, Best Buy, and Walmart. However, suppose you are employed in the oil and gas industry out in the field—operating in hostile environments involving high humidity, shock and vibration, and extreme temperatures—and working on mission-critical and safety-critical applications where a power failure may cost millions of dollars and potentially involve injury and loss of life. In that case, only the best UPS systems on the market will do.

Although climate change is driving the adoption of renewable energy sources (solar, wind, and hydro),[1] the combination of global geopolitical tensions and the need for affordable energy—coupled with ever-increasing requirements for products like plastics that are derived from fossil fuels—is maintaining the demand for oil and gas.[2] For example, the US Energy Information Administration (EIA) expects US crude oil production to surpass 12.9 million barrels per day for the first time in late 2023 and to exceed 13 million barrels per day in early 2024.[3] As another example the recent acquisition of Pioneer Natural Resources by Exxon Mobil Corporation means that Exxon's production volume in the Permian Basin will more than double to 1.3 million barrels of oil equivalent per day (MOEBD), and is expected to increase to approximately 2 MOEBD by 2027.[4]

Common trends seen in every segment of the oil and gas industry include the increasing use of the Internet of Things (IoT). This is coupled with artificial intelligence (AI) and machine learning (ML), big data and analytics, robotics and automation, cloud computing, and predictive maintenance.[5]

The oil and gas industry is typically divided into three segments: upstream, midstream, and downstream. The upstream segment includes exploring and producing crude oil and natural gas. The midstream segment embraces transportation and storage, including pipelines, pumping stations, tank trucks, rail tank cars, transcontinental tankers, and other infrastructure. And the downstream segment involves everything associated with refining crude oil into fuels such as gasoline, kerosene, heating oils, jet fuels, etc. The downstream segment also includes transforming crude oil and natural gas into end products like plastics, synthetic rubbers, fertilizers, and preservatives.

The need for reliable power—as provided by Uninterruptible Power Supply (UPS) systems—applies to every segment of the oil and gas industry.

Problems with Power

A common factor for many UPS deployments in the oil and gas industry is harsh environments, including shock and vibration, high humidity, extreme temperatures (both hot and cold), particulate matter like dust and sand, and harsh climatic conditions like rain, sleet, and snow. Salt spray may also be a factor in the case of offshore oil platforms and transcontinental tankers.

Another common issue is "dirty power" coming from the primary supply. This dirty power can manifest in spikes, dips, surges, transients, and unwanted harmonics. If left untreated, dirty power can damage sensitive equipment and electronic systems. As was previously noted, for example, the oil and gas industry is currently seeing increasing use of artificial intelligence and machine learning across the board. In the context of DrillOps, for instance, these technologies can continuously monitor drilling systems and adapt to changes, thereby maximizing the rate of drill penetration while protecting drill string integrity. These systems can detect anomalies to facilitate predictive maintenance but demand clean power to perform their magic.

Even in the case of air-conditioned environments where environmental stresses are non-existent and clean power is the norm, off-the-shelf commercial UPS systems are less than ideal when damage to equipment due to loss of power can result in hundreds of thousands of dollars in lost production. When it comes to mission-critical and safety-critical applications in hostile environments like oil rigs, where problems with power can easily result in millions of dollars in lost production and may potentially involve injury and loss of life, failure is simply not an option. Commercial and so-called "ruggedized" UPS systems cannot satisfy the demands of these applications. Truly rugged UPS systems are the only option.

Critical Requirements for Oil and Gas UPS Systems

The first requirement for a UPS system to be deployed in the oil and gas industry—especially in upstream and midstream applications—is that it must be rugged, which means it is suitable for use in hostile environments. Unfortunately, it's common for UPS manufacturers to describe their systems as being "ruggedized." Still, all this typically means is that they've taken a standard commercial UPS base and reinforced various aspects of the system.

By comparison, a genuinely rugged UPS is designed, developed, and manufactured from the ground up to be rugged. The "gold standards" for ruggedness in the form of shock, vibration, EMI/EMC, and environmental conditions (low pressure (altitude), temperature, humidity, sand/dust, etc.) are standards like **MIL-STD-461, MIL-STD-810, and MIL-STD-901**. Truly rugged UPS systems conform to these standards, while so-called "ruggedized" UPS systems… don't.

The second requirement is that the UPS system employs the most appropriate topology (architecture). There are three main UPS topologies: offline (a.k.a. standby or battery backup), line-interactive, and online double conversion. The crème de la crème in UPS topologies is online double conversion in which incoming AC power is converted to DC and then regenerated back to AC. This AC-DC-AC design ensures increased load isolation from any irregularities in the main supply. The battery provides a redundant input source during the regeneration process, thereby ensuring uninterrupted power to the load during fluctuations in the AC supply or complete loss of the AC supply.

The third requirement is that the supplier of the UPS systems can offer customization services. Every oil and gas deployment has its own unique set of requirements. In some cases, for example, the systems must meet the IP65 international standard to be dust-tight and watertight. In other cases, the systems must be presented in specially created enclosures and mounted in unusual ways. Trying to "make do" with standard off-the-shelf offerings inevitably leads to problems.

Additional Functions and Features

Many additional functions and features associated with UPS systems are of interest to oil and gas customers. These are briefly summarized as follows:

Battery Chemistries

The two most common types of UPS battery chemistry are valve-regulated lead acid (VRLA) and lithium iron phosphate ($LiFePO_4$). While lead acid batteries have historically been the battery of choice for UPS applications, the newer lithium iron phosphate batteries provide double the life and storage capacity due to their exceptional long-term thermal and chemical stability. The UPS supplier should offer both these chemistries.

Battery Presentation

Batteries may be presented to the UPS chassis in three ways: external, fixed, and removable. In the case of an external battery module (EBM), the battery pack is presented in its chassis, which is connected to the UPS chassis using a cable. A fixed battery implementation means the battery is located inside the UPS chassis. In many oil and gas deployment scenarios, the preferred alternative is to present the battery pack in a removable, hot-swappable drawer. The UPS supplier should offer EBM and hot-swappable drawer options.

Connectors, Enclosures, Voltages, and Frequencies

- To cater for the wide variety of oil and gas deployment scenarios, USP systems must be available in various enclosure types (e.g., rackmount, wall/bulkhead-mount, vertical freestanding)
- They must offer a variety of international connector options (NEMA, IEC, Circular MIL, Terminal Block, Pigtail)
- They must support multiple input and output frequencies and voltages

Global Support

Since many oil and gas companies have international operations, it's essential that the manufacturer of their UPS systems also has a worldwide presence. This includes having a global network of partners and distributors who can provide local support in key countries worldwide. It also includes having service centers on multiple continents, such as North America, Europe, and Asia.

How AMETEK IntelliPower Exceeds Oil and Gas Industry Expectations

IntelliPower has decades of experience creating UPS systems in the oil and gas industry. Our UPS offerings apply to every industry segment, from upstream to midstream to downstream.

Three key features apply to every UPS product in the IntelliPower portfolio:

1. **Each unit is rugged**
2. **Each unit is custom-designed**
3. **Each unit features an online double conversion topology**

Many suppliers of UPS systems offer only a limited range of off-the-shelf "vanilla" solutions. By comparison, every member of the IntelliPower UPS portfolio was first developed as a custom solution to address a unique customer requirement that couldn't be satisfied by existing off-the-shelf solutions.

Over the past 25 years, IntelliPower has developed a modular "building block" approach for its electronics hardware, firmware, embedded software, and enclosure technologies, all designed in-house. This provides us with a unique capability to create custom solutions to meet virtually any application requirements quickly.

At the heart of every UPS is its battery. This is the most vulnerable element, accounting for over 50% of all UPS failures. Maintaining batteries correctly increases UPS reliability and reduces the chance of unplanned downtimes that can translate into millions of dollars of lost revenue. However, even when well maintained, batteries inevitably experience a decrease in capacity from the day they are manufactured. To address these issues, IntelliPower offers an innovative, cost-saving program in which replacement batteries are offered at a significant discount.

There is a tremendous difference between the initial cost of a UPS system and the total cost of ownership (TCO). An IntelliPower rugged UPS system typically lasts 10 to 15 years in the field. By comparison, a "ruggedized" UPS typically survives only 3 to 5 years in the field. So, while it is true that an IntelliPower rugged UPS may cost a little more than a "ruggedized" offering, the fact that it will typically last three times longer means its total cost of ownership is lower!

Example IntelliPower Oil and Gas UPS Deployments

IntelliPower UPS systems can be found around the globe serving on offshore oil platforms, land-based drilling rigs, heavy construction equipment, and oil refineries, protecting everything from blowout preventer (BOP) control systems to data center servers. Three example deployments are as follows:

Offshore Oil Platform

A customer came to us with two problems associated with the UPS systems required to support their blowout preventer (BOP) control systems. The first problem was that their existing UPS systems, which they had purchased from another supplier, were not as rugged as they were claimed to be. As a result, these units were—in the customer's own words—"failing right, left, and center." The second problem was that their existing supplier was unwilling (or unable) to change their offerings.

When this customer came to us, we created a custom solution to sustain the desired output voltage for over 2 hours. Unlike their cumbersome dual-cabinet incumbent system, our replacement combined all the components—UPS, batteries, and charger—mounted inside one rugged, self-cooling cabinet. The enclosures for these 3,000-point systems were equipped with eye hooks to facilitate transportation via helicopter. Due to this success, the customer came back to us requesting a custom UPS system.

Land-Based Drilling Rigs

The customer was operating land-based oil rigs in areas that experienced extreme temperatures and other environmental issues like dust and sand. This deployment exhibits two main similarities with the previous example. First, the customer's existing UPS systems, which they had purchased from another supplier, were failing in the field at an unacceptable rate. Second, their current supplier was unwilling (or unable) to modify their existing offerings.

These rigs were in states like Kansas, Oklahoma, and New Mexico, where temperatures can range from as low as –57°F (as recorded in Ciniza, New Mexico, on 13 January 1963) and as high as +121°F (as recorded at Fredonia, Kansas, on 18 July 1936). The existing UPS systems were presented in an enclosure with a single fan attached to the rig. The big problem was that the UPS batteries were mounted outside the enclosure to facilitate ease of exchange. This was a "Catch 22" situation because the batteries outside the enclosure exposed them to extreme temperatures, thereby increasing their failure rate.

We created a system in which the UPS, battery, and charger were all packaged in a single enclosure equipped with multiple fans. Furthermore, the battery was presented as a hot-swappable, field-replaceable, removable drawer.

Heavy Construction Equipment

This third example involved a customer fracking in the Dakotas to unlock natural gas and crude oil reserves. In this case, mining equipment in super-low-profile bulldozers was experiencing problems. These vehicles had been augmented with sophisticated electronics and computer systems. However, whenever one of these bulldozers reversed direction, a huge surge would wipe out some of the electronics and/or computers.

The solution was to mount a UPS system on the outside of the bulldozer (there was no room inside the cabin). In addition to problems with dust, sand, grit, and other particulate matter, these UPS systems were guaranteed to experience extreme vibration and shock. Once again, we developed a custom solution that met the customer's needs and exceeded their expectations.

Conclusion

Rugged UPS systems from IntelliPower are used worldwide in mission-critical and safety-critical oil and gas applications. Every product in IntelliPower's UPS portfolio started life as a custom creation, is designed to be rugged from the ground up, and features an online double conversion topology in which incoming AC power is first converted to DC and then regenerated back to AC, thereby ensuring uninterrupted power to the load during fluctuations in the AC supply or complete loss of the AC supply.

The many additional functions and features that are of interest to IntelliPower's Oil and Gas customers include:

- Multiple battery chemistry options (VRLA and $LiFePO_4$).
- Multiple battery presentation styles (external and removable).
- Multiple enclosure styles (rackmount, wall/bulkhead-mount, vertical freestanding).
- A variety of international connector options (NEMA, IEC, Circular MIL, Terminal Block, Pigtail).
- Multiple input and output frequencies and voltages.

Also of interest to our international customers is our global support, our battery replacement program, and our UPS systems, which provide a lower TCO (total cost of ownership).

References

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