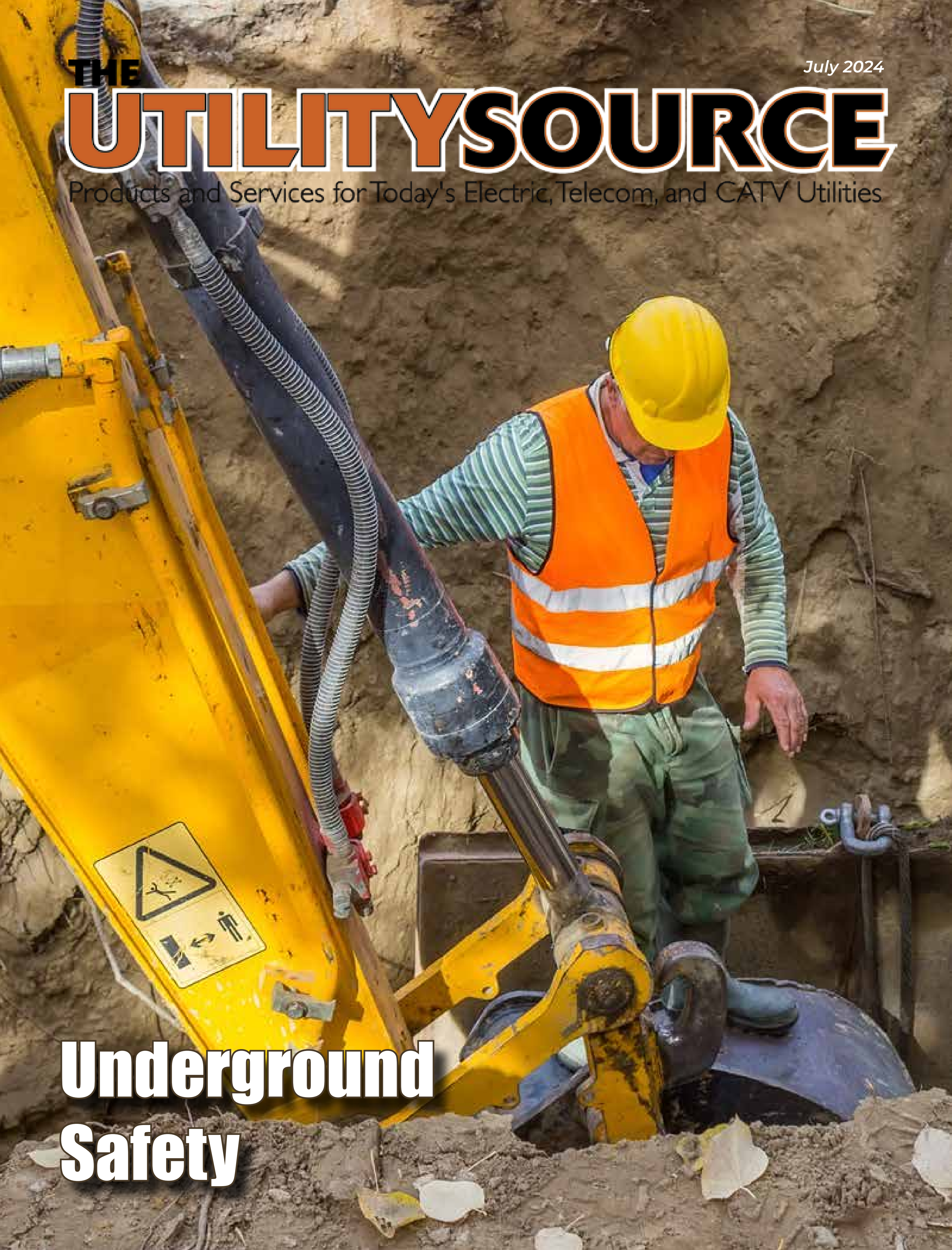
July 2024

THE UTILITY SOURCE

Products and Services for Today's Electric, Telecom, and CATV Utilities



Underground Safety

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THE UTILITY SOURCE

Products and Services for Today's Electric, Telecom, and CATV Utilities

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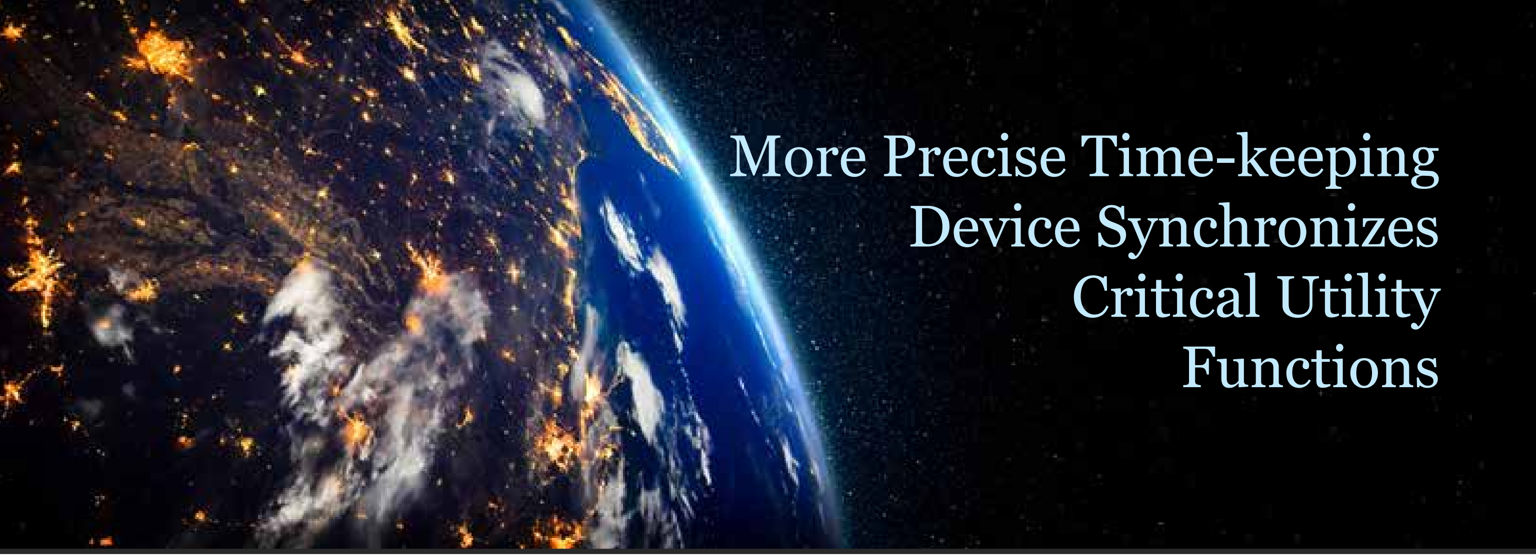

More Precise Time-keeping Device Synchronizes Critical Utility Functions

Utility substations require extremely precise sub-millisecond time synchronization to facilitate improved location of faults, multi-rate billing, power-flow monitoring and event reconstruction.

Precise timekeeping is fundamental to the function of the power grid and is used in many applications to improve reliability, reduce costs, predict and prevent faults, and check operation of devices. As such, the power grid requires precise time synchronization across system-wide devices, often with sub-millisecond accuracy.

To accomplish this, extremely precise satellite clocks serve as the time source for the network time protocol, and the information is distributed to the other devices on the network. In fact, satellite clocks are standard within electric utility substations and at certain distribution line locations.

"If all of your distribution points or substations have access to a satellite clock, they share a common source for correlation," says Nathan Irvin, product manager of networking products at NovaTech Automation, a leading U.S. provider of automation and engineering solutions for power utilities headquartered in Quakertown, PA.

Despite being extremely accurate, utilities are continuously seeking even greater precision in timekeeping. Luckily, advancements in satellite clock design and programming can enhance accuracy. Currently, the accuracy is pushing towards achieving a margin of plus or minus 20 nanoseconds.

Utilities anticipate significant benefits from the improved accuracy, including more precise location of faults, multi-rate billing, power-flow monitoring, and event reconstruction.

Highly accurate satellite clocks
Satellite clocks work by connecting with orbiting satellites that maintain precise time using highly accurate atomic clocks. At the substation, the satellite clock receives time from the satellites in orbit. Utilizing advanced algorithms, it then accounts for external factors to provide an accurate time.

To improve the speed of connection and accuracy, some clocks provide multi-constellation support, which provides the ability to lock into any available satellites orbiting the planet. The satellites include GPS, maintained by the US but used globally; European Union's global navigation satellite system GALILEO; China's BEIDOU satellite navigation system; and Russia's GLONASS global navigation satellite system.

The satellite clock serves network time protocol (NTP) to other devices on the network. These devices are typically "agnostic" and can be used as a time source for any device in the substation, regardless of brand.

Still, companies like NovaTech continue to invest in research and development to achieve even incremental improvements in clock accuracy in the sub-millisecond range.

Novatech has long served the utility industry. The company's flagship product, Orion, is a communication and automation processor that can connect to nearly any substation device in its native protocol, perform advanced math and logic, and securely present the source or calculated data to any number of clients in their own protocol. Orion connects to IED's such as microprocessor-based relays, meters, event recorders, and RTUs before connecting to a preexisting enter-

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prise network or SCADA system.

“While any satellite clock can access satellites as a time source, the hardware and software within the satellite clock can make it more precise and accurate,” says Irvin. “So, in addition to our previous utility solutions, NovaTech offers timekeeping devices.”

The latest release is the Kronos Series 3. Named after Kronos, the God of Time, the satellite clock provides multi-constellation support and includes several upgraded features including antenna-cable delay compensation.

According to Irvin, “By building antenna cable-delay compensation into the algorithms for calculating time, along with multi-constellation support, we’re able to provide best in class accuracy.”

The Series 3 offers increased output flexibility for syncing devices with their optimal mechanisms, supporting both traditional legacy formats and the latest technologies, such as Ethernet over fiber.

The Kronos Series 3 supports PTP, NTP, and SNTP. Common legacy formats also supported include modulated and unmodulated IRIG-B over twisted pair, coax, or fiber; and PPS or PPM signals

The Kronos 3 supports Parallel Redundancy Protocol (PRP) and the High-availability Seamless Redundancy (HSR) within an ethernet network. These protocols are used to implement zero-loss redundancy on wired ethernet.

“Because it is critical to maintain time and communication between the various IEDs, utilities want to build their ethernet networks in a way that if one ethernet network goes down, there is a backup that the same traffic flows across,” says Irvin.

The net results of these upgrades are more precise time with sub-millisecond accuracy.

“In the prior version of Kronos, the master clock was able to achieve 60 nanosecond maximum time deviation while locked with the satellite. For Series 3, that drops to 20 nanoseconds,” says Irvin.

Satellite clocks must also be concerned with “holdover,” which refers to the ability of a clock or timing device to maintain its accuracy and continue functioning reliably even when it temporarily loses its external reference signal due to adverse weather conditions, interference, or other factors.

During holdover, the satellite clock relies on its internal oscillator or timing mechanism to continue providing timekeeping information until it can reestablish a connection with the satellites. For this, Kronos Series 3 offers enhanced accuracy through an optional oven-controlled crystal oscilla-


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tor for better accuracy in longer holdover situations.

An oven-controlled crystal oscillator (OCXO) is a type of crystal oscillator that maintains its frequency stability by controlling the temperature of the crystal within a temperature-controlled oven. This helps to minimize frequency drift caused by temperature variations, resulting in better accuracy over longer holdover periods.

"In holdover, TCXO has typical drift of 9ms/day, whereas OCXO has a typical drift of less than 100μs/day. All clocks also support out-of-bounds alarm when the time drifts more than a specified value," explains Irvin.

Utilities benefit

According to Irvin, there are many applications in the power grid that can benefit from more precise timekeeping.

Multi-rate billing: Typically required accuracy: 0.5 to 1 second.

To get better utilization of the grid, power utilities often charge different prices at different times of the day. The revenue meters of utility and consumer as well as the machines and processes at the user's site need a common time-base.

"Although this application does not require exceptional time accuracy, it can benefit utilities that implement a multi-rate billing structure," says Irvin. "To ensure they are charging the end customer accurately, they need to have a precise time source to know when they should switch the rates."

Event reconstruction, sequence-of-events (SOE): Typically required accuracy: 1 to 5 ms (sub-cycle of the 50/60 Hz sine wave).

Events in the power grid need a spatial-temporal frame of reference (what happened where, what happened when) so that cause and effect can be correctly understood.

In the analysis of the large blackout of August 2003 that lasted almost 48 hours and affected 10 million people in the Northeastern and Midwestern United States and the Canadian province of Ontario, more time was spent ordering and manually time-tagging unsynchronized event recordings than on any other task.

"If some devices have a less accurate time source than others, then manual adjustments are required to properly reconstruct the events," says Irvin. "Synchronizing the devices in the network with a satellite clock eliminates a lot of this type of work."

Power-flow monitoring: Typically required accuracy: 1 to 10 μs.

The phase component of the so-called synchrophasors can be used to estimate the power flow and the stability of a

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Traveling wave-based fault location: Typically required accuracy: better than 1 μs (for a 300 m fault location accuracy).

The location of faults can be accomplished by precisely time tagging wavefronts. Faults on the power transmission system cause transients that propagate along the transmission line as waves. Each wave is a composite of several frequencies, ranging from a few kilohertz to several megahertz, having a fast-rising front and a slower decaying tail.

“Composite waves have a propagation velocity and characteristic impedance and travel near the speed of light away from the fault location toward line ends. The location of faults can be accomplished by precisely time-tagging wave fronts as they cross a known point typically in substations at line ends,” says Irvin.

Integration of Renewable Energy Resources
To connect to the national grid, the electrical energy from solar panels, wind turbines, or batteries is passed through inverters or power electronic converters. These devices convert the DC (direct current) output from the sources into AC (alternating current) suitable for transmission and distribution on the grid. In order to integrate renewable energy into the grid effectively, it must be synchronized with the existing grid frequency.

“With all these distributed renewables, it is important for them to properly tie into the existing line. They need to match the waveform frequency accurately when they are adding power to the line,” says Irvin. “In addition to the synchronization, it’s important to accurately understand how much power is being added and when that power is added, which is where satellite clocks can play a crucial role in renewable integrations.”

For utilities, precision timekeeping plays a critical role in the operation and efficiency of the power grid, emphasizing the necessity for exact time synchronization across devices to enhance reliability, minimize costs, and facilitate fault prediction and prevention.

With the use of highly accurate satellite clocks providing time synchronization with the potential to reach accuracies within plus or minus 20 nanoseconds, utilities are on the verge of achieving even greater operational precision.

For more information on solutions for a continuously evolving power grid from NovaTech Automation, visit www.novatechautomation.com or call (913) 451-1880.

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Underground Safety

1. Follow excavation standards
One of the best ways to ensure utility construction safety is following excavation standards. Official standards designed by organizations like OSHA and the U.S. Department of Labor are required in the workplace for a reason — they work. You can use these standards as a roadmap to ensure minimum safety measures are in place.

For example, OSHA standard 1926.651 outlines all the requirements for the excavation process. This standard includes the basic step-by-step process for a safe excavation as well as some best practices. You can always contact OSHA for more information or guidance on a specific standard.

One helpful feature in OSHA standards is the soil classification index — an appendix of the 1926 set of standards. Soil classification is vital for understanding your job site and preparing for any geological risks that might be present. Additionally, the type of soil you're working with can impact the ground-penetrating detection techniques you need to use to locate any existing buried infrastructure accurately.

2. Always verify the estimated location
Tracking down the estimated location of underground utilities can be frustrating and time consuming, but it's critical for ensuring safety. If you simply start digging with an approximate location in mind, you risk accidentally breaking a pipe or powerline, causing injury or damage.

Always complete the standard process for verifying the exact location of the underground utilities your team is excavating or working on. This usually requires contacting the original installer, identifying the estimated location and confirming it using detection equipment. Try to time location verification with clear, dry weather since soil dampness can interfere with ground-penetrating radar accuracy.

When in doubt, use the standard 811 hotline to contact Call Before You Dig services. Remember to leave plenty of time to verify the dig location since getting the right personnel and equipment on-site can take a day or two.

3. Prioritize safe trenching practices
Trenches are necessary for underground utility work, but they can be a serious hazard without the proper precautions. Observing the necessary trenching best practices is essential for ensuring underground utility construction safety.

For example, shielding and shaving are vital to verifying trenches are stable enough for your team to work in. Shaving may still be necessary even if you have shielding equipment like trench boxes in place. Take concerns about soil stability seriously, even if you must install more supports.

Make sure your team is highly aware of their surroundings at all times, as well. Seemingly simple oversights can lead to severe accidents, such as entering a wet trench or moving a suspended load over a canal with workers inside. Remind workers to keep all their equipment at least two feet away from the edge of the trench to prevent items from accidentally falling in.

4. Ensure safety equipment is easily available
Every industry pro knows the importance of safety equipment. However, you may have team members who aren't experienced yet or cannot afford good safety gear. Likewise, an experienced employee could easily have an accident that leads to a piece of their gear breaking.

It's always a good idea to keep some safety equipment on hand in case anyone needs it in situations like this. Make sure your team knows you have safety equipment available, *"As a safety professional, you always want your workers to have access to leading edge safety tools that improve safety and focus. Working with **COOLSHIRT SYSTEMS** over the past two years allowed me to help design a tool **by lineman for lineman.***

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as well. This will reduce a worker's anxiety about asking to borrow a hard hat or gloves.

Readily available safety gear also makes it more difficult for workers to pass off PPE non-compliance. Remind your team that failing to wear all of their protective equipment can be life threatening. For example, studies show 70% of falling accidents involved a worker lacking PPE.

Encourage your team to invest in their own safety equipment. However, it's always best to have backup gear available so you can always put safety first.

5. Pay attention to weather
Weather is one of the most important factors in underground utility construction safety before and during on-site operations. Rain, snow, sleet, frost and high humidity all impact site safety and soil conditions. You need to pay close attention to weather patterns to make sure everyone can work safely.

For example, if you conduct trench shoring while the soil is frozen, the holes may become unstable and cave in when the ground thaws. On the other hand, if you dig, shield and shave a trench while the dirt is excessively dry, you may need more moisture to maintain stability.

Sudden changes in weather pose a particular hazard. For instance, heavy rain overnight can completely flood a trench or make the soil too damp to dig safely. If wet weather transitions to freezing temperatures, you can end up with icy canals. Both scenarios are too hazardous to approve on-site operations for the day.

Delays may be frustrating, but project leaders must pay attention to weather conditions. It's not worth risking your team's safety to try working through a bit of rain.

6. Use technology to monitor safety
There's been a lot of innovation in the underground utilities and construction industry in recent years. One of the exciting developments to come out of that innovation is IoT safety monitoring equipment. IoT devices can be extremely helpful, particularly at large job sites where visual monitoring is challenging.

There are a wide variety of IoT tools available that you can use to automate safety monitoring. For example, the mining industry is using IoT air quality sensors to detect hazardous fumes and pollutants in tunnels. Similarly, you can use IoT sensors to monitor soil conditions so you can remotely check your job site before calling in workers for the day.

Ensuring underground utility construction safety
Underground utility construction safety is all about awareness, preparation and wise decision making. Implementing the safety measures outlined here can help you ensure your team is always safe on the job. Top priorities in underground utility safety include trench stability, weather, soil conditions, PPE, effective safety monitoring and accurate location estimating. •


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