SPECIAL ISSUE:
Locating &
Damage Prevention

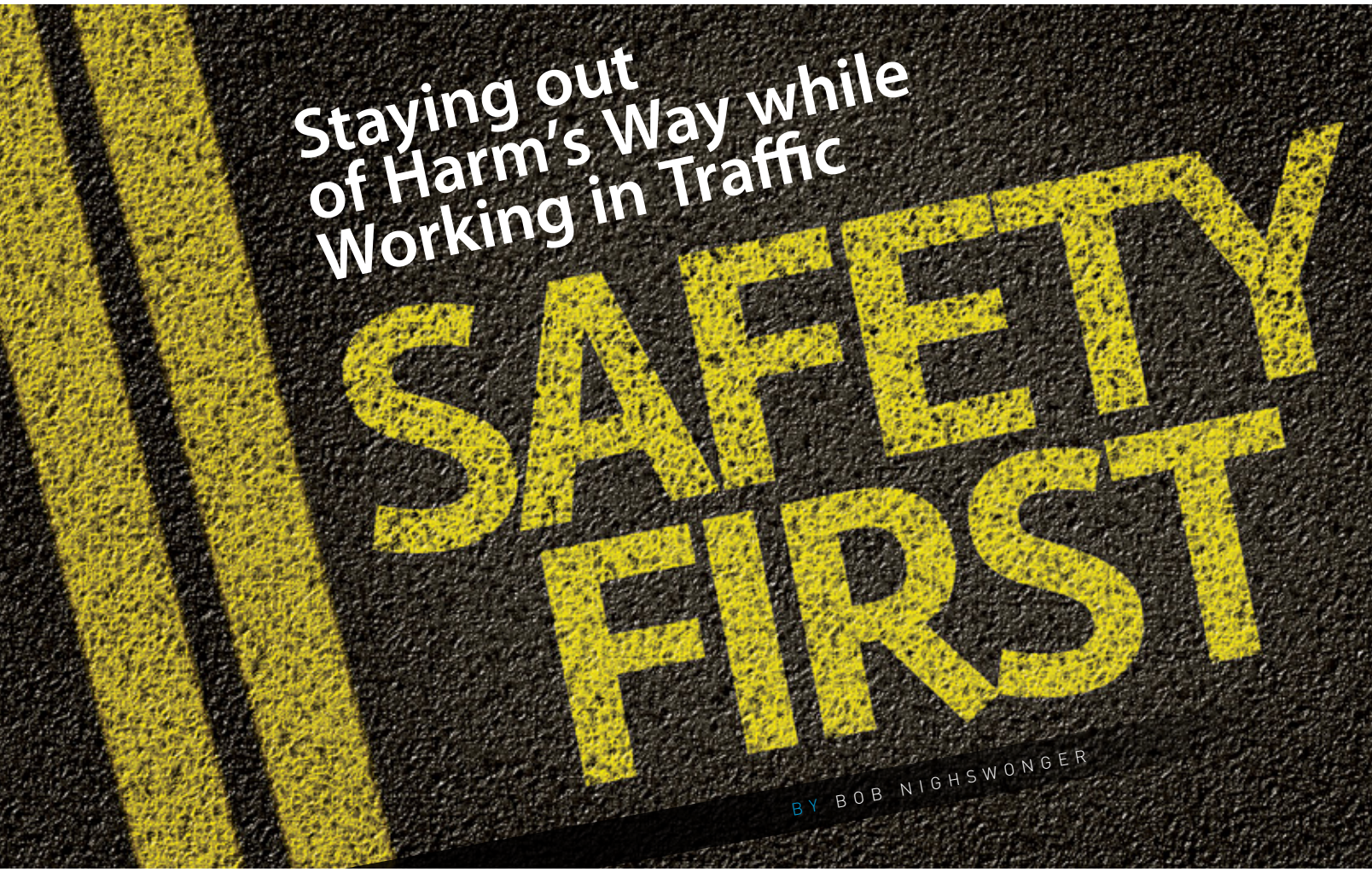
BY BOB NIGHSWONGER

EXCAVATION SAFETY GUIDE & DIRECTORY

811 DAMAGE PREVENTION PROFESSIONAL

Protect What Matters

Staying out of Harm's Way while Working in Traffic



BY BOB NIGHSWONGER

Many jobs requires a person to work in the roadway or on the road side. According to OSHA statistics, nearly half, 40% of road workers who are killed on the job are hit by moving vehicles and almost 50% are hit by construction equipment and construction vehicles. During my years of line locating, I have painted many miles of line buried beneath the road. Unlike the movie character Austin Powers, "Danger" should not be your middle name when working next to or in the middle of the road. I speak from personal experience when I say there is literally danger around every corner when marking lines buried beneath busy roadways.

I was once hit in the neck with a rock that was propelled by a tire when a car passed me by. In that instance, I was in the wrong place at the wrong time. I have also been hit in the side of my face by a cup of soda thrown by a passenger of a random car driving by. I'm sure that guy though it was funny but I came to realize a new level of stupid that day. I have never been hit by a car but have had several close calls. Luck has played a big part of my survival but I like to give credit to the skills I developed playing dodge ball, which is a long lost sport. In dodgeball, you keep your eye on the ball and dodge, dip, dash when you need to avoid getting hit by the ball.

A few of my near misses were my own fault. My closest was when focusing on the task at hand, I was distracted by the readings of my line locating equipment and stepped into a lane of traffic. Luckily the driver saw me and swerved to miss. I was so close that the side mirror of the car passed between the screen on my locating equipment and my eyes. In this case, I took my eye off the dodgeball. I had several other close calls where drivers where distracted or in a hurry.

During a training event a few years ago, a water line locator in the class told us all a bone-chilling survival story. He had been hit in the back by a small SUV and became wedged beneath the vehicle. In a moment of

panic, the driver drug him for a little over 150 feet while slowing down and speeding up twice in attempts to shake him from beneath her vehicle before finally coming to a stop. He survived and recovered; and returned to line locating with a new perspective on safety in traffic.

In the survival story above, the locator told us he made the mistake of using only three cones placed beside and behind his truck to merge traffic to the middle lane so he could mark his water line in the outside lane. He was ahead of the cones marking the lines. After the SUV passed his truck and cones,

"...After the SUV passed his truck and cones, the driver merged back into the outside line and hit the locator"

the driver merged back into the outside line and hit the locator.

Make yourself as visible as possible. Use your PPE to make yourself visible. Use your traffic cones, flashers, beacon lights and whatever else you have available to safely merge traffic around your work area when locating along the road.

Plan Ahead. Pick the best time of day to mark lines in a traffic way. When you read your tickets in the morning, determine which jobs will require road marking and routed those jobs for a good time of day. It has been my experience that during a normal workday, traffic is considerably lighter between the hours of 9am to 11am and from 1:30 to 2:30pm. If you have a jobs that involves marking on a busy road, try to schedule it between those hours. Don't take unnecessary risk. In heavy traffic it may be best to call for assistance to get a person onsite as your traffic spotter to cover your back.

Safety Scan. During your visual site inspection, view your work area like a playing field. Look sideline to sideline and goal line to goal line to determine your traffic control needs. Consider any special access to manholes and valves that may need to be opened for access to connection points to the utility.

Keep your eye on the ball. Years ago, when marking the road we mainly worried about drivers just not seeing us. In today's world we have so many drivers distracted by their cell phones. Drivers not only talking on the phones but those who also post selfies, send or read texts and emails or even watch a movie while cruising down the road. Plan your locate so you can walk towards traffic when marking lines in the road, keeping you facing the oncoming traffic. Just like the game, you want to keep your eyes on the oncoming dodgeball. You may also want to consider using a paint stick that will allow you to remain upright when tracing and marking lines in the road. If you're forced to bend over with a can of paint in your hand to mark the line, you are taking your eyes off the traffic. Some locators call this spraying and praying. If you must bend over to paint and turn away from traffic, this is a good time to have a fellow employee onsite to be your traffic spotter and watch your back.

With repetition can come complacency and it takes great self-discipline to make safety your first priority. Don't wait until you have an accident or a close call occurs before you to think safety first. Be safety minded and good luck. Your best safety tools are your eyes and your brain when working in the roadway. Always keep an eye out for crazy drivers and never underestimate the level of stupid that could be behind the wheel. ESG

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Introduction to Locating Technologies & Techniques

BY BOB NIGHSWONGER

There is not a single-source technological solution available on the market for locating any and all types of underground facilities in any circumstance without limitations. There are, however, several different types of technologies available today for locating buried facilities. Many of these were designed for other tasks in other industries but are often applied for finding underground facilities. I've listed a few of these technologies, how they are applied for locating, and a brief description of their advantages and limitations.

1. ELECTROMAGNETIC (EM) PIPE AND CABLE LOCATOR

This is the most common of locating equipment and consists of a portable signal transmitter, which applies a signal to the line, and also a hand-held signal receiver used for detecting and tracing the signal being applied. The transmitter creates a detectable electromagnetic field also called a signal. An EM signal receiving unit detects the signal and provides information about the signal field, including horizontal centerline of the field, intensity of the field and estimated distance to the center of the signal.

An EM "signal transmitter" applies an alternating current to underground cables and pipes by means of direct connection or electromagnetic induction, also called inductive broadcasting. The signal current constantly reverses in direction as it travels back and forth along the underground line. The back and forth movement of the current produces a moving magnetic field "signal" that rotates back and forth around the conductor.

An EM "signal receiver" ,which is tuned-in to the transmitters frequency, can detect the signal. Once the signal is detected, the receiver can provide information about the signal, including signal strength, direction, estimated horizontal centerline of the signal and vertical distance to the center of the signal.

UTA Locator Training Malaysia - GPR Demo

UTA Locator Training, Orlando, FL, GPR and EM Locator

Advantages: It is the most common piece of equipment used to estimate the location of pipe and cables; a signal receiving unit can provide the operator with a variety of information about the signal being detected. This information includes horizontal centerline of the signal, the intensity of the signal and the estimated distance to the center of the signal source; most signal receivers are programed to also detect "Passive Signals" which are created from outside sources other than the signal transmitter. These signals are already present on many conductive lines in the ground and only require a signal receiver for detection; many advancements of this technology in the past have been focused on making it easier to use, lighter in weight, or providing more information about an EM signal that includes line direction and GPS ordinance.

Limitations: To be located, the pipe or cable must be metallic and have electrical continuity; the accuracy of information provided is dependent on the shape of the magnetic field. Much of the information provided by the receiver is formulated under the assumption that the magnetic signal field is perfectly round.

Related EM Technologies and Accessories

• ***EM Sonde Beacon:*** a miniature signal transmitter that can be pushed along a pipe and located at the surface of the ground by a signal re-

ceiver tuned in to the same broadcast frequency.

• ***EM Markers:*** small electronic markers that can be buried over the top of a non-conductive utility or at specific points within a network, including underground splices or connections. These markers can be detected by a receiver programmed to find the specific frequency of the EM markers.

2. GROUND-PENETRATING RADAR (GPR)

Ground-penetrating radar, commonly called a GPR, is a non-invasive, near-surface geological investigation tool. In the locating industry, we use it to find buried pipes, cables, vaults, tanks, barrels and other buried objects.

The GPR antenna is both a radar signal broadcast source and a radar signal receiver unit. Radar waves, which are broadcast into the soil, are reflected back by underground objects. The GPR antenna can be mounted to a portable cart along with a laptop computer. The cart is pushed along by a technician who reads real time data. The signals that reflect back from the underground objects are displayed on the screen as the cart moves across the surface of the earth. This technology is similar to a fish-finder. The GPR broadcasts high-range radar waves and simultaneously receives radar waves that are reflected back from underground objects.

Advantages: In ideal conditions, the GPR can locate non-conductive pipes, tunnels, tanks and barrels at depths up to 30 ft. or greater; quickly deployed and provides operator with real time display of radar signal reflections received back from objects as the cart is moved along the pavement or earth; multi GPR antennas are often combined and pulled behind a golf cart or small pickup; very effective for concrete investigations for rebar and post tension cables, cracks and voids.

UTA Line Locator Training, Assorted Locating Equipment, Oakland, CA

Limitations: The "detectability" of underground pipes, cables and other objects and structures in the ground depends upon their size, shape, depth and the difference in electrical properties of the soil and the object below, as well as operator skills and ability to interpret readings.

3. FERROMAGNETIC LOCATOR

Unlike ordinary metal detectors, which detect all metal, the ferromagnetic detectors only responds to items with ferromagnetic content, specifically iron and steel. This is often used to find below-surface manhole lids, valve covers, property pins, iron or steel plates, tanks, barrels, and unexploded ordinances, to name a few.

Advantages: Ferromagnetic detectors are capable of locating ferrous metals at greater depths than a conventional metal detector can; advanced Ferromagnetic technology provides magnetic polarity information which allows the operator to locate pipe joints in cast and ductile iron pipes. Each joint reverses polarity. This is more effective when the location on the pipe is already known.

Limitations: Effectiveness and overall accuracy depends on size and depth of object, the sensitivity setting of the receiver, and the skill of operator.

4. ACOUSTIC "SOUND" TRANSMITTER & RECEIVER

This technology combines acoustic water leak detection equipment with a noise transmitter designed to place noise on a pipe. It is often used to locate non-conductive water pipes. A sound transmitter creates noise along the pipe, which causes the surrounding soil to vibrate. This sound, or vibration, is transmitted by the pipe and can be heard and measured by highly sensitive microphones. The intensity of the sound wave is greatest when the microphone is positioned directly over the line.

Advantages: Acoustic technology is often effective in locating non-metallic pipes for up to 300 ft. or more in ideal conditions.

Limitations: The effectiveness depends on the strength of the noise generator, the type of pipe material, and the density of the surrounding soils; some noise transmitters which create vibrations in the water have been known to create leaks in some old piping systems.

There are several other technologies used to investigate the underground, but these are a few of the more common ones. To date, we still do not have a single source machine that is capable of locating all underground facilities without limitations. DP

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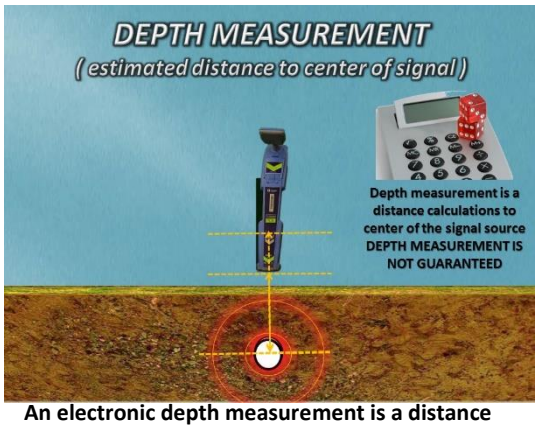
How Deep Is It?

How deep is the line buried? During my years of line locating, this is a question that I've probably been asked about a thousand times. I was not allowed by my employer to provide depth readings to excavators for liability reasons. My normal response was "I can't see it so I don't know how deep is" There are several reasons why an electronic depth reading provided by line locating equipment can be wrong. This fact makes it impossible for the equipment manufacture or the operator of the line locating equipment to guarantee an accurate depth reading is being provided by the machine. The only sure way to know the depth of any buried line is to safely expose the line and see it with your own eyes.

Electronic Depth Estimation and Signal Fields



An electronic depth measurement is a distance calculation from the bottom of the locator's signal receiver to the center of the signal field being detected. This reading is not a depth of cover over a buried pipe. Since the receiver is estimating distance to the center of a perfectly round signal, if you're locating a large diameter pipe the depth calculation is to the center of the pipe. It has been claimed in many equipment manuals that in suitable conditions the accuracy of the depth reading provided by the signal receiver should +/- 5% for lines up to 10 to 15 feet in ideal conditions. The likelihood of error increases with the depth of the line because signals created on deeper lines provide weaker and less reliable when detected a calculated at surface level.

Suitable conditions for depth measurement are when the signal transmitter is directly connected to a buried line that is buried in a straight line without any adjacent lines in the ground. The locatable signal would be a strong signal that is perfectly round in shape as it radiates or broadcast out from the underground line. It would be similar to a water ripple created by a golf ball in the middle of a pond of calm water. In areas of signal wave distortion, the signal is not perfectly round which causes the mathematical calculation of distance to line to be incorrect. In an area of signal distortion caused by target signal coupling with a nearby line, the depth reading can be in error up to 50% off the actual depth. That means a line buried 10 feet deep can produce a depth reading of either 5 feet or 15 feet.

Tips for Electronic Depth Estimating

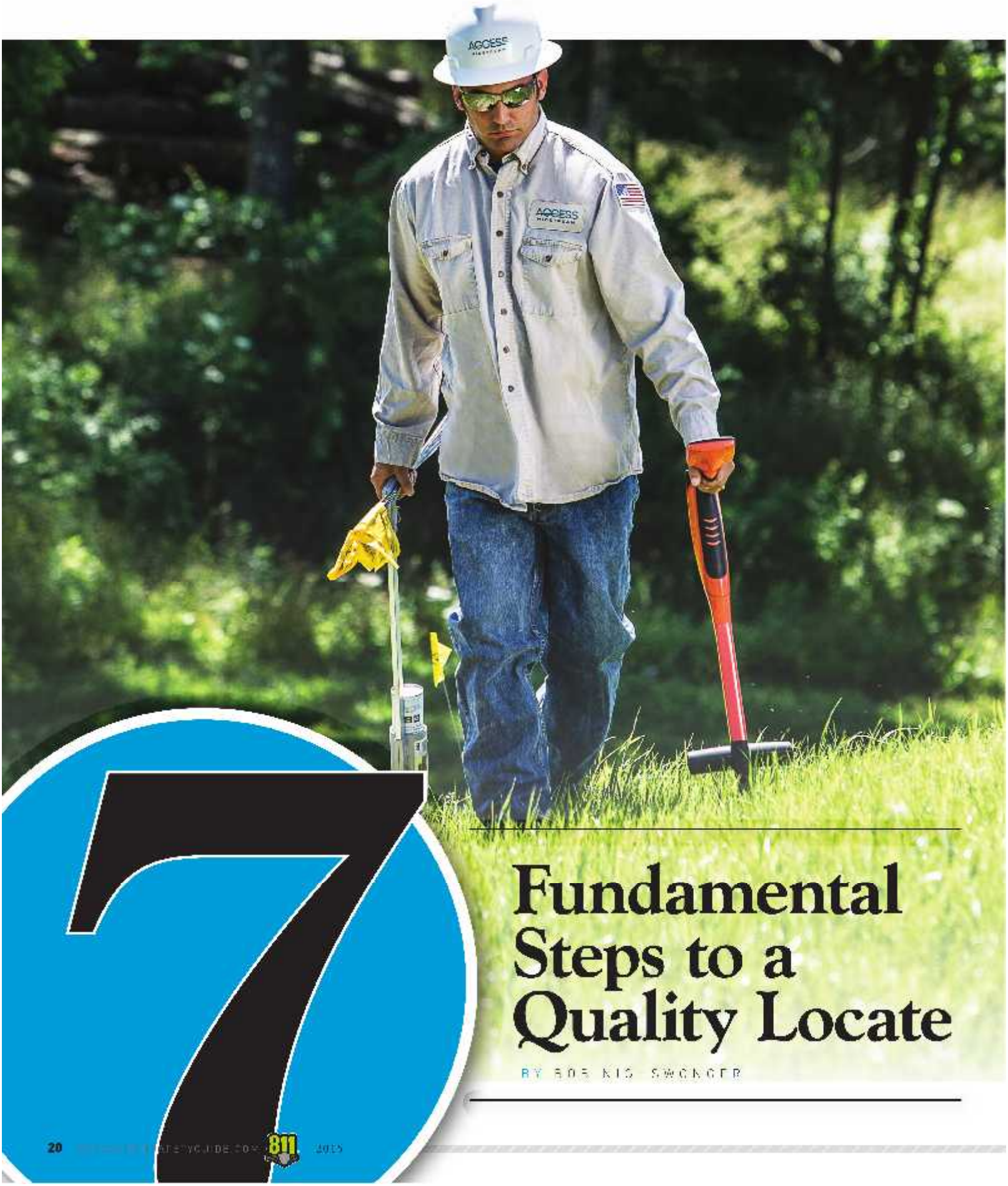
Choose point along the target line where it runs in a straight line for at least 10 feet in both directions from that point. Avoid taking a depth measurement within 15 feet of the transmitter due to interfering fields being broadcast for the temporary ground stake and wire connection leads.

The most accurate depth estimates are normally obtained from a buried line is when measurement is taken from a signal created by a signal transmitter that is directly connected to the targeted line. The depth assumptions are that the receiver is directly over the top of the line. Another assumption is that the receivers handle is aligned with the direction of the line or orientation of the signal field.

Use the guidance indicators and signal strength readout to pinpoint the exact location directly over the line. This will be the top dead center of the round signal field. Then establish the exact line direction of the line. Some receivers align the handle of the receiver to the direction of the buried line. Set the bottom of the receiver on the ground while maintaining alignment and obtain an electronic depth reading by either the push of a button or full time display. Note the depth at ground level and then raise the receiver directly up about a 12 to 18 inches above surface. Check the depth reading again and do the math. The reading should equal the sum of the depth at ground level plus the distance you lifted the receiver from the surface.

There are many areas along a buried line where depth measurements are not favorable. A few of these areas include any point along the line that is within 8 to 10 feet of an abrupt turn or change of direction in the target line. This includes the area where the line could be at a downward or upward pitch from the surface of the ground. Other areas to avoid taking a depth reading would be near a tee in a pipe or splice in a cable or tracer wire. In these areas, the signal splits in multiple directions and will collide and distort. Any point along the path of a target line where signal may bleed over to another nearby line or metallic object like a fence or heavy equipment. This also includes joint trench scenarios where your targeted line is buried with several other lines.

With countless variables which cause an electronic depth reading to be in error, it will never be as reliable as safely exposing a buried line prior to digging across, above or beneath a buried line. If the depth of the line is important, **the only way to guarantee it… is to see it.**



7 Fundamental Steps to a Quality Locate

BY BOB NICSWONGER

As an underground line locator and buried utility traffic controller, it has been my experience that when I followed the same steps during each line locate I was much more productive during my day and made far fewer mistakes. Although many locators may approach the task differently, I'd like to present seven fundamental steps for every locator to consider.

Follow Safety Procedures and Use Your Safety Equipment and Knowledge

Try to make the right choices and take a personal approach to your safety and the safety of others around you. You are ultimately responsible for your safety during the day while driving to, and performing, line locates. The choices you make on the jobsite will often not only affect your own safety but also have an impact on the safety of others. Start by identifying the hazards that exist, or may exist, on the jobsite and then choose the appropriate personal protective gear and equipment you will need to perform the task safely.

Read the ticket and check all prints before and after performing the locate

During the planning stages of the job, you should thoroughly read the excavation notice to gain a clear understanding of the dig area. If you are unclear of the exact location of the digsite, contact the caller of the ticket for additional details. Access area maps, prints and records for the dig area and identify your dig area on the prints. Determine the number, type and size of buried lines you have in the area along with the location of the topside access point best suited for applying the transmitter to each buried metallic line or tracer wire. Prints should be considered a guide and not a fact. If your print shows that you have a line buried near the dig area but not in the dig area, it's always a good idea to hook up and verify the line is actually clear.

Visually Survey the entire scope of work

A visual inspection of the jobsite is a very important step to ensuring that all of the lines in the requested area are marked. Start by visually confirming the entire scope of work on the locate ticket by doing a jobsite walkthrough. While on your walkthrough, confirm the location of the access points that you identified on your prints. Take a close look at the landscape to search for topographical clues to utility construction like trench lines, cracks, patches or cuts in the pavement. A good visual inspection can also help you identify other buried facilities that may not have been documented on your prints. Be on the lookout for any conditions that might affect the accuracy of your locate like chain link fences, guard rails, guy wires and overhead lines that may interfere with your locatable signal. And as always, watch for safety hazards or abnormal conditions that may impact your safety.

Make a locate plan and work your plan

When making a locate plan for multiple utilities, consider the big picture first. Locate one type of network at a time. On the majority of my jobs, I would normally be responsible for several types of buried networks and would locate one type of utility or pipeline network at a time and one target line at a time. Often times when faced with locating right-of-ways or easements that are very congested with underground pipes and cables, I have been forced to locate the shallowest and most conductive lines first and then locate the deeper and harder to find buried lines.

Trace, Pinpoint and Mark

The temporary markings placed on a site is a form of nonverbal communication between the line locator and the person requesting the buried facility markings. The color of the markings identify the type of product flowing through the particular pipe or cable being identified and the path of the buried line. As a line locator, your temporary markings should clearly identify the estimated horizontal location and pathway of buried line and more if known. Other valuable information you could provide with your location markings could include size of line, type of line or pipe material as well as the number of lines in a single trench or conduit package. It's also important to indicate the operator of that particular line if known.

Double check and restore the site

Carpenters live by the golden rule to measure twice and cut once. As a line locator, it's important to take another look at your locate ticket and prints to make sure you've accounted for all the lines buried on or near the jobsite to prevent a damage. When you're satisfied that everything is accounted for, you should make sure that you've closed all lids, boxes or covers you may have opened during the job and have retrieved all of your tools and equipment.

Document your work and communicate any high profile facility

I was once told by a supervisor that if it wasn't documented it never happened. It is important to document any and everything related to the excavation notice. Many locating technicians take several pictures of their markings as well as written documentation of any changes relative to the excavation area shown on the locate request, any conversations with the excavator either onsite or over the phone and any other clarifications that relate to information shown on the dig notification. Many pipeline operators and utility operators require a representative be onsite when excavation is taking place near the critical line. If your situation warrants, notify the excavator that there is a critical line buried on their jobsite and arrange a high-profile meet. After arrangements are made, document the conversation to include the date and time the meeting will take place.

The task of line locating involves much more than simply knowing how to operate an electronic line detector. Following the same routine on each job can reduce the chances of error. ESG

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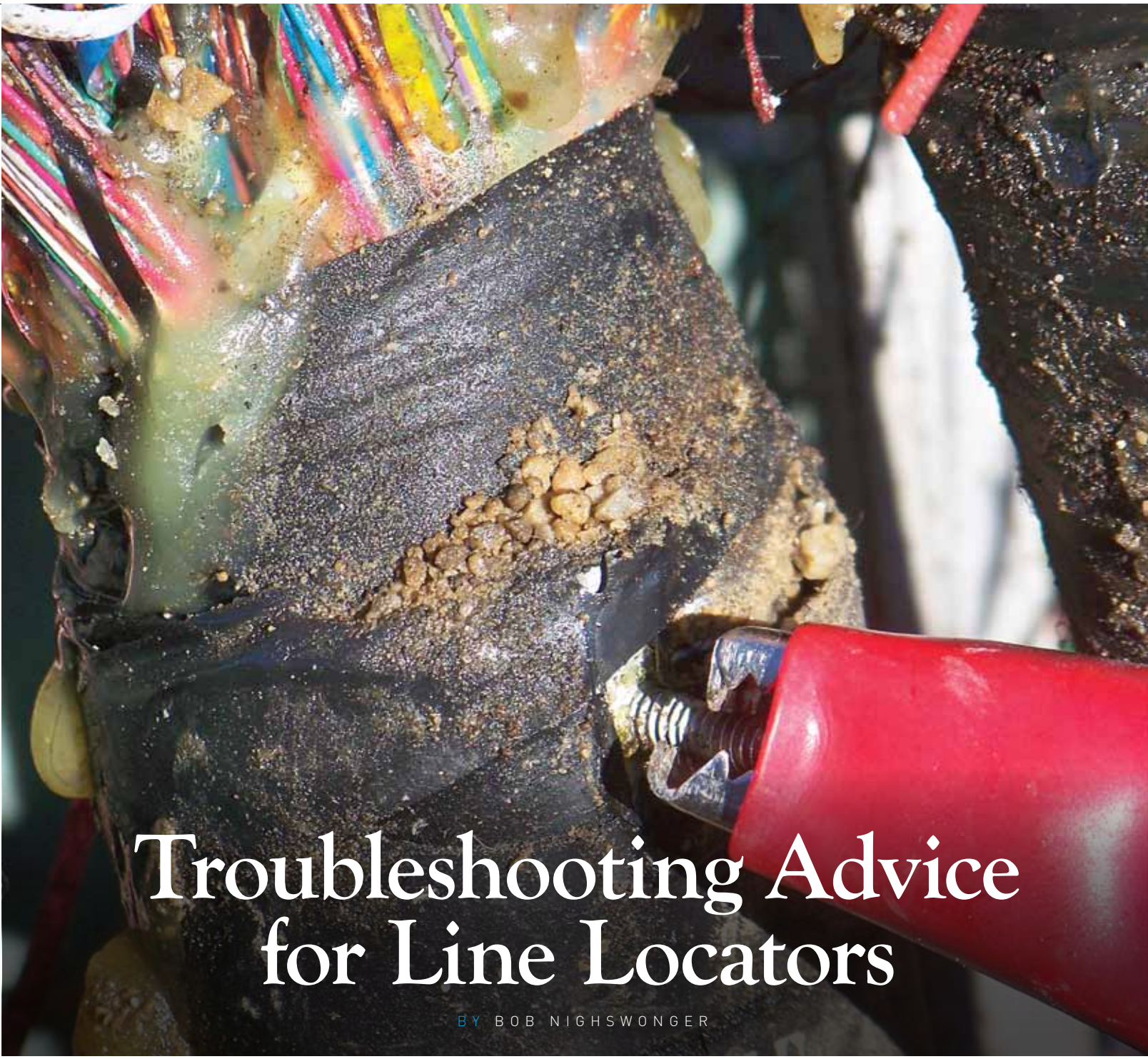

Troubleshooting Advice for Line Locators

BY BOB NIGHSWONGER

If you are responsible for line locating and have encountered problem locates you are not alone. Throughout my locating years it's been my opinion (and I think other locators would agree) that in ideal conditions the task of line locating is pretty cut and dry. You apply signaling current to a buried target line which creates a signal field which is broadcast out from your targeted line. Once a good signal field is created, finding the signal field and tracing the field becomes easier and easier with practice.

Technically we locate the top dead center of the circular field which should be located directly above the buried target line. Locating problems are created by site conditions that are not ideal. Solving line locating problems takes reasoning to determine the cause of the problem and taking action to solve the problem. You have to use your eyes and your brain. The first step to solving a line locating problem is to step back and think about it. Start gathering all the information known to you at this point.

A good understanding of the theory of how locating equipment works and the limitations of the technology is critical for solving line locating problems. The more you understand about how locating equipment works the greater your chances of success when troubleshooting. This information is needed to help determine the possible conditions that exist which may be creating the problem at hand.

Troubleshooting Advice for Line Locators
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Troubleshooting Advice for Line Locators
continued from p.17

For example, in ideal conditions you would choose a low range frequency applied by direct connection to an aboveground access point for the underground facility. This is considered target shooting the line. Higher range frequency settings are great for solving problems when ideal conditions do not exist. Higher frequencies can also create problems by bleeding off to other pipes or cables in the area and creating multiple signals which confuse both the equipment readings and the user. So high frequencies can be viewed as a form of target shooting with a shot gun - if you're not careful, you may hit more than one target with your blast.

Gather Information at Hand and Apply Reason

Gather the information available to you. *(Note: The settings and readings available from your transmitter and receiver will vary depending on the brand and model of locate instrument you are using.)*

✓ Transmitter:
- output current reading
- applied power level/volts
- circuit/loop resistance/ohms
- frequency setting
- method of signal application
- placement of ground stake

✓ Receiver:
- The number and location of all signals detected onsite while performing a signal sweep and search of the site
- detection mode setting: peak, null, directional, single peak
- signal strength level at top dead center (TDC) of signal
- directional indication of TDC, left/right arrows or directional needle
- sensitivity/gain setting
- signal current level
- orientation indication

✓ Target Line Characteristics:
- size of target line
- conductivity of target line
- electrical continuity of locatable circuit
- depth of the target line
- type of backfill around the line

✓ Site Conditions:
- soil conditions
- presence of other buried lines in the area
- visible common bonding with other lines
- topside metallic objects

✓ System Mapping:
- general area of line (normally not drawn to scale)
- offset measurements to line from a known point
- number of lines in the area
- physical makeup of the line
- proximity of splices, tees or turns depending on system
- location of topside access point(s) to underground target line

Reason - Use your deductive and inductive reasoning skills.

Every line locate is different. Always consider site condition variables in advance when setting up and performing a line locate or when troubleshooting. Each target line has its own level of impedance to the flow of signaling currents produced by the transmitter. Impedance is the overall resistance of the electrical medium or pathway in which current flows and factors in signal loss to ground and other lines in the area through capacitance and inductance.

Consider site conditions such as conductivity of your line and the soil, visual indications or clues of other buried lines that may or may not be sharing a common bond with other lines in the area, the size and depth of the target line, and the presence of topside metallic structures. These site factors may interfere with the strength and/or shape of your locatable signal field on your target line.

Take Action

Keep in mind that there might be several different causes for the problem you are experiencing and several possible solutions for each possible cause. Take action by using the process of elimination beginning with the most logical corrective action or adjustment to overcome the most logical cause of the problem. After taking corrective actions, compare your results to see if you fixed the problem. Don't overthink it! Start with the simplest checks and equipment

Unable to transmit or detect a locatable signal (no signal or weak signal produced)	
Probable Causes:	**Corrective Actions:**
Poor Transmitter Connection	✓ Check direct connection point to ensure metal-to-metal contact is made between metal clip and target line. Rotate connection clip on connection point until good metal-to-metal contact is made. ✓ Remove rust or paint from connection point if necessary. ✓ Choose a different point of connection to the target line. ✓ For tracer wire, strip coating to expose clean and corrosion-free wire and reconnect the clip.
Poor Grounding Conditions	✓ Improve grounding conditions. ✓ Ensure a good ground connection between transmitter lead and temporary ground stake. ✓ Pour water in the hole made by ground stake and reset ground stake in hole, deeper if possible. ✓ Try using a better grounding source like a shovel, probe bar, nearby metal sign post or multiple ground stakes attached by a jumper lead. The more metal-to-earth contact made by a ground source, the better the chances of generating good signal.
Transmitter Settings and Application	✓ Increase power output level ✓ Set transmitter and receiver to a higher frequency and try again. Caution! Higher frequencies increase chances of signal bleed off which creates multiple signals which can interfere with the locate. A more conductive line buried near target line can steal the high frequency signal. ✓ Change method of signal application. If direct connection is not working try inductive ring clamp or inductive broadcast.
Broken direct connection leads	✓ Connect leads and check the output meter to verify high current levels are achieved. ✓ For transmitters without an audio or visual indication of current level, connect leads together and lay them in a circle on the ground. Hold receiver over wires to determine if signal is present. If leads are broken, replace or repair. A break in the connection leads normally occur at the connection point between wire and metal clip.
Non-Conductive Line	✓ Check available records or local resources to determine if line is non-conductive. If so, try a different technology and/or process to locate non-conductive target line. Example: Radar, sonar, or exploratory excavation using safe methods such as hand tools, vacuum excavation or safe probing. ✓ If records or research indicate a non-conductive line buried with tracer wire, safely hand excavate around the point where pipe enters the ground. Sometimes tracer wires are cut at ground level during landscape activities. ✓ If records or research indicates target line is conductive, change location of signal transmitter or method of signal deployment.

Good signal produced by transmitter but no clear signal detected by signal receiver.	
Probable Causes:	**Corrective Actions:**
Transmitter or Receiver Settings	✓ Confirm frequency selected on receiver is same as frequency on transmitter. ✓ Increase sensitivity gain and sweep again. ✓ Try a different frequency. ✓ Change signal reception mode and try again.
Interfering signals	✓ Broaden Search Area. Move further away from the transmitter and perform a larger 360° sweep. Don't assume the path of line. Ensure all possible pathways of target line are covered during signal search.
Target line buried at excessive depth	✓ Use direct connection method of signal application. Find or apply the best grounding possible onsite and pour water to the ground stake. ✓ Select a low frequency (<33 kHz). ✓ Set transmitter on high power output. Most 10 watt transmitters are only allowed to broadcast 10 watts on frequencies < 33kHz. The goal is to generate the highest current possible from transmitter. The higher the current level produced, the deeper it can be detected and the further the signal will travel.
Open Circuit: Target line has a break in electrical continuity	✓ Go to far end of cable or wire and apply a far end ground to give current a direct path to ground. ✓ Move transmitter to new location beyond locate area to transmit a signal back towards the open point.

Signal Interference from overhead lines or aboveground metallic structures	
Probable Causes:	**Corrective Actions:**
Equipment settings	✓ Set receiver to twin peak reception mode if possible. Two reception coils or aerials are activated. The upper aerial is placed at a known point above lower sensor located near ground and acts as a filter when detecting stronger signals coming from lines above the receiver. The receiver will only acknowledge signals that come in stronger at the bottom aerial and filters signals it detects from above. ✓ Check ground (Do not ground to the wire on side of utility pole or ground wire with other wires attached to it). ✓ Change frequency and try again. Choose an odd number frequency if available. Ambient background noise created by electrical activity in the area causes interference with certain signal frequencies. There is an optimum frequency choice for any given locate scenario.
Interference caused by fence / guardrail	✓ If near a fence or guardrail, set receiver to peak mode and lift receiver to a height where the bottom of the receiver is about half the height of the fence or guardrail. This shields the signal coming from the fence or guardrail.

Multiple signals detected on-site/ more than one target to choose from	
Probable Causes:	**Corrective Actions:**
Suggestions for identifying target line when multiple signals are present	✓ Utilize receiver's current reading option to take a current measurement over each signal. The signal with the greatest current level (measured in milliAmps) should be target line. ✓ Change transmitter and receiver frequency to available current direction frequency. The signal with the arrow pointing away from transmitter should be target line. ✓ Trace signals out to see where they go.
Temporary ground stake over adjacent line	✓ Ensure you are using an independent ground stake. ✓ Move independent ground stake. Placing over an adjacent line can create unwanted signal on the adjacent line.
Signal frequency setting	✓ Change frequency and compare results. Higher frequency signals will bleed off to nearby lines which rebroadcast a weaker signal with lower current levels. In areas of common bonded lines, unwanted signals are produced on conductors that are directly attached to target line. Sometimes the signal strength of these unwanted signals can be reduced by increasing the signal frequency. Try both and compare results.
Other utilities lines share a common ground/bond	✓ Isolate target line from any common bond if you can do it safely and have permission from the utility owner and your employer (for safety reasons never disconnect the ground wire on any electric line).

adjustments and go from there, eliminating one possible cause at a time until a solution is found.

Common Problem Locates

Unable to transmit or detect a locatable signal (no signal or weak signal produced)

Symptom: Transmitter meter shows that no signal current or very low level of current is being produced by the transmitter. For signal transmitters without meters or current indicators, the amount of signal being received will indicate if sufficient current is being produced.

Good signal produced by transmitter but no clear signal detected by signal receiver

Symptoms: Meter readings or audio tone indicates that a good signal is being produced by your transmitter but you are unable to detect the transmitted signal with your receiver.

Signal Interference from overhead lines or aboveground metallic structures

Symptoms: This often happens in areas with high electrical activity. Signal interference is identified by one or more of these systems: ghost signals beneath overhead power lines, signal strength reading is jumpy, pulsing signal and or an erroneous depth measurement.

Multiple signals detected on-site/ more than one target to choose from

Symptoms: Multiple signals were detected onsite during the 360° signal sweep. Multiple signals can cause the locate technician to choose the wrong signal as the target line. Never assume the line you are directly connected to will be the only line carrying signal.

With more and more pipes and cables being placed on private property and in already congested right-of-ways, the task of line locating is becoming increasingly more challenging. Solving locating puzzles takes patience and perseverance. It is important to remember to first gather available information to help determine the possible causes of the problem and then take action one step at a time. After each step or action, try again and see if the problem is solved. ESG

Bob Nighswonger is President/CEO of Utility Training Academy Inc. Bob has 28 years of line locating and damage prevention experience and has been a long time professional instructor of line locating technicians. Bob can be reached for questions and feedback emailing bob@utasearch.com.

Aboveground Clues to Belowground Facilities

BY BOB NIGHSWONGER

Taking the time to perform a visual inspection of your excavation site is a key step in preventing unexpected encounters with unmarked underground facilities. "Look before you dig".

Prior to each departure, commercial airline pilots and their crew perform a detailed visual inspection of the aircraft inside and out. The pilot takes a walk around the outside of the aircraft as well, looking for any visual signs of damage, leaks or problems. The pilot and crew also check the operational controls and gauge settings. Flight attendants perform visual safety checks to ensure doors are closed and secure, all passenger seatbelts are fastened and all seats are in upright positions. The crew performs a safety briefing with passengers. The "all systems check" that is performed by the pilot and crew members reduce the chances of an unexpected surprise during the flight.

It is a good idea to take the same type of care before you break ground on any excavation project. A close visual inspection of the planned dig site, by an excavator or excavation crew, can greatly reduce the chances of an unexpected surprise during excavation.

A few visual signs of ownership transfer points would be any visible utility meter (Gas, Electric and Water Meters), and any communication demarcation point normally located at the house protector or the entrance point of a building. The lines that feed these metering or transfer points belong to the service provider and should be marked up to this point by member utilities responding to your 811 notification. Any lines buried beyond the ownership transfer points will most often belong to the property owner and go unmarked by the utility owner.

"Visually identify or otherwise determine the points of ownership transfer within each utility system on your planned dig site."

Your eyes and brain are very valuable damage prevention tools when both are applied before and during your excavation job. You can use them both to perform a topside visual survey to look for signs of buried utilities that are not identified by markings. Since the temporary markings are estimations of the path of buried lines, a visual confirmation is needed if digging near or across the marked line. This is done by safely exposing the marked lines and seeing them with your own eyes. In most states you are required to do this type of visual verification by using hand tools to expose the marked lines.

A good topside visual inspection of your dig site prior to breaking ground is key to preventing damage to public and private buried utilities.

Visually identify or otherwise determine the points of ownership transfer within each utility system on your planned dig site. A few visual signs of ownership transfer points would be any visible utility meter (Gas, Electric and

A. Meter on Transformer

The high voltage primary electric cable feeding this commercial should be marked up to the transformer. The high voltage secondary cables leaving the transformer normally will not be marked by the electric company's technician

B. Metered Electrical Panel

This specific electrical panel is located on the property line and is fed by a single underground power service line. From this point, six private electric lines are exiting and are buried throughout the property.

C. Commercial Business Sign

Fed by electric wire.

D. Parking Lot Light

Fed by electric wire.

E. Private Electric Splicing Box

Above ground and lid to underground splicing vault. All of these lines are private and buried beyond the meter.

Here are a few signs of underground electric lines and a few points to consider when spotting these signs.

Water Meters), and any communication demarcation point normally located at the house protector or the entrance point of a building. These underground lines feeding the water, electric, natural gas and telecommunication networks belong to the service provider. The utility service providers mark the lines feeding these points in response to your call to 811. Any lines buried beyond the ownership transfer points will most often belong to the property owner and go unmarked by the utility owner.

Private Electric Cables and Wires

Keep an eye out for electric meters and any structures fed by underground electric wires. Look for electric meters near property lines, within the property, on the outside wall of a house or building or inside the building. The buried line feeding electricity to the meter points should be marked in response to your 811 call but the private electric lines buried "after the meter" will normally not be marked in response to your call to 811 notification.

Private Gas or Liquid Fuel Lines and Underground Fuel Tanks

Private underground fuel lines and fuel tanks are often located on residential and commercial properties that have a need for the product. The fuel line and fuel tank to the building, house or structure will most likely not be marked in response to your 811 call. The propane tanks and other fuel tanks may also be buried on your dig site and require extreme care when digging near the tank and the location of the fuel line should be identified. Look for signs of line entry to the house, basement or structure.

Propane Tanks are most often fed by delivery trucks and not a pipe. The tank itself being the source, the underground pipe placed from the tank to the house, building or structure is a service supply line. This line will most likely not be marked by the 811 locators. The tanks themselves are often buried so be on the lookout for metal lids or caps. These tanks are similar to underground fuel tanks at commercial gas stations that have buried pipes running from the tanks to the pumps.

Private Gas Service Lines

This particular set of gas meters is considered a multi-meter manifold. This metering point is fed by a single pipe from the gas company and has two separate private gas lines leaving this point to two different houses. Look for the round gas regulator. It will be placed on the supply side of the meter. Natural gas meters are located in the basements of buildings or houses, or on the outside wall, at the property line or at a master metering point of a multi-structure property.

Private Fire Protection Systems

The basic private fire water systems consist of water pipes buried from the municipal water tap or inlet point to the fire hydrants or other fire department connection points (FDC's) placed throughout the property. If your job is on commercial property, keep an eye out for fire hydrants and FDC points during your site inspection. The customer connection point will normally be located near the property line. The water pipe feeding this point will normally be marked by the 811 locator. Pipes that leave that point will not get marked.

Private Water Lines, Fire Protection and Irrigation Systems, Chilled Water and Steam Systems

Private water systems are most commonly buried from the water metering to the building

Private underground fuel lines and fuel tanks are often located on residential and commercial properties that have a need for the product.

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or house, from an irrigation tap to locations throughout a property. Private chilled water and steam systems are most often located on commercial properties, schools and universities.

Pipeline Markers

Keep an eye out for high-profile pipeline markers. There are approximately 2 million miles of hazardous material pipelines in the US which provide bulk transportation of gasses and liquid fuels across our country. Many state and federal regulations require that pipeline operators must have a company representative on-site during excavation over or near their pipelines. The operators of these specific high-profile pipelines will normally contact you to make arrangements to be onsite during your excavation. After calling 811, make sure to monitor your email, fax, phone or voicemails for a meet request notification from the pipeline owner.

Excavating Near Pipelines

A minimum clearance will normally be required between the pipeline and whatever is being installed. If heavy equipment or dump trucks will be crossing over the pipeline during your excavation, the pipeline operator may require the placement of large metal plates or the addition of soil cover over the pipeline to prevent a potential hazardous damage caused by the extreme weight of the equipment.

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If your job is on commercial property, keep an eye out for fire hydrants and FDC points during your site inspection.

Reading The Landscape

On this page is a good example of how to read the landscape prior to planned excavation. In this scenario I'm planning my work prior to

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There are approximately 2 million miles of hazardous material pipelines in the US which provide bulk transportation of gasses and liquid fuels across our country.

calling 811. I've identified several notable signs of underground utilities belonging to public and private property owner at this location as well as a pipeline buried on or near this dig.

A. **THREE LARGE WATER VALVES** placed in a tee configuration which often indicates a tee in the water main which also means the water company probably poured concrete support or thrush blocker in the area the mains are connected.

B. **ONE TELEPHONE PEDESTAL** Telephone and CATV lines will normally be marked along the public easement and on private property to the building or house demarcation point. Look for the phone protector in the house, conduit on the wall of a building or inside equipment room of a building for signs of telephone cables.

C. **SEWER CLEAN OUT PIPE** located near roadside. This is a large diameter cleanout pipe and may possibly be part of a public system. Sewer cleanouts are most often placed on sewer laterals for access to clear drainage problems. The clean out pipe curves towards the flow of the sewer just before it connects to the top of the sewer lateral pipe. Look for sewer laterals to be located near buildings or houses as well as near property lines and other meter points.

D. **GAS METER** Note: The service line from meter to building will not be marked by 811 locator.

E. **EXPOSED PIPE ON SITE** may be an active line or may be an abandoned section of pipe. Further investigation will probably be necessary after the 811 call.

F. **TWO WATER METERS** Note**:** The two service lines buried from water meter to building or house will not be marked by 811 locator.

G. **SEWER MANHOLE** This particular manhole is placed over a public sewer main.

H. **PETROLEUM PIPELINE MARKER** This specific post indicates the presence of a petroleum transmission line and is considered a high-profile line. (Refer to page 22) Not pictured are nearby large petroleum storage tanks. Other obvious signs of high-profile lines may be an electrical substation or water towers.

Look before you dig! A visual site inspection is a key part of any damage prevention plan. For safety's sake, take the time to inspect your dig site prior to excavation and daily during excavation activities. Once the temporary markings are placed on the ground, it will be up to you to protect the integrity of the marks or call for a remark if your marks have been destroyed or are no longer reasonably visible for safe excavation. ESG

How to read the landscape prior to planned excavation.

About the Author BOB NIGHSWONGER is the President of the Utility Training Academy and a long-time line locating and damage prevention instructor. Mr. Nighswonger can be reached at bob@utasearch.com

Where the Shovel Meets the Dirt: Tips for Safely Exposing Utility Lines

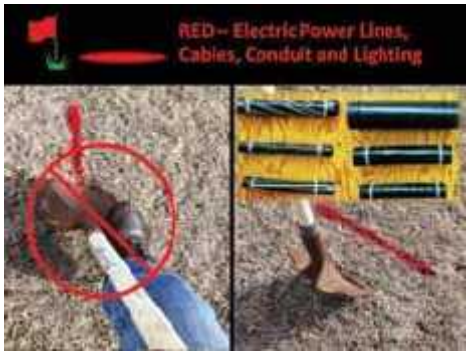
By Bob Nighswonger, Damage Prevention Instructor

When challenged with safely exposing all the underground pipes and cables in conflict with your excavation project it is important to have a good understanding of the meaning behind the colored markings. It's also important to have a general knowledge of the type line you are about to expose. Let's take a closer look at the systems associated with the markings and a few tips for safely exposing the line.

White and Pink are the only two colors in the APWA color code that do not designate the approximate location of underground lines on a job site. White is used by excavators to designate a proposed path or area of excavation and pink is used to identify survey points and property boundaries.

Red markings identify electric systems including high voltage, medium voltage and low voltage power lines and wires. If you need to expose a marked power line you should respect the dangers posed by electrical shock and consider taking a little extra care and a little extra time if needed to do it safety.

A large portion of power lines are buried directly in the ground without protective conduit. Avoid digging at a perpendicular angle directly over the mark. Begin slightly offset and dig at an angle towards the expected location of the cable. If exposing with hydro-excavation machine low pressure is recommended. Some direct buried power lines are very old and may not have an outer coating or jacket around the cable. Unjacketed cables are very easily damage by tools and pressurized water jets. The cables on the right side of the illustration below are considered jacketed cables. The coating is placed for electrical insulation as well as added protection for the cable. WARNING: Even jacketed power cables are still very susceptible to damage by sharp hand digging tools!



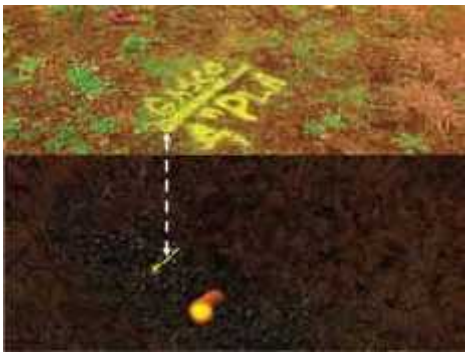
Yellow is used to designate the approximate location of pipe systems which carry natural gas, oil, steam and petroleum products. Some of the pipe materials used within these systems include steel, cast iron, plastic and concrete. There are several things you should consider when digging near or hand exposing pipes marked in yellow.

First, the metallic pipes associated with these systems are normally covered with a special pipe coating designed to prevent corrosion. These protective coatings range from a special paint fused to the pipe, called fusion bond to a special tar based coating wrap which encircles the pipe and often has a thin layer of paper covering the tar itself. If at any time during excavation the pipe's coating is scraped, gouged or even grooved by a shovel, the excavator should stop and immediately report the damage to the utility owner so the coating can be repaired before covering it back up. Unreported damage to pipe coatings can lead to disastrous results down the road. Many gas explosions have been linked back to coating damage during previous excavation, in some cases occurring years before the explosion.

Secondly, when digging on or near yellow marks watch for lines labeled as plastic. The locator's marks show the path of the tracer wire buried in the same trench as the pipe, not the actual pipe. If exposing a mark labeled as plastic, dig very gently since you're actually exposing a thin tracer wire with a pipe buried nearby. A damaged tracer wire that is not repaired correctly can make it very hard, if not impossible, to locate the next time. Report any tracer wire damage to the utility owner so it can

"…it's important to have a good understanding of the meaning behind the colored markings. It's also important to have a general knowledge of the type line you are about to expose."

be repaired correctly with a water tight splice.



Orange marks identify the approximate location of communication type cabling networks. Beneath the marks you will find both direct buried cables and cables placed in conduits or packages of pipes often referred to as duct runs. Many small communication service wires can be buried quite shallowly and are often damaged with the first scoop of a shovel. Extra care should be taken to safely expose these lines.

Blue marks identify the approximate location of pipes carrying drinking water. In response to an 811 notification, the public water line locator will mark the water system along the public easements or right of way and up to the water meter. At this point, the water system ownership changes from public provider to property owner. The privately owned lines from the meter to the customer's house or building in most cases will not be marked in response to an 811 notification.

Purple is used to mark reclaimed water, irrigation and slurry lines. Although irrigation systems are found on both public and private properties and range from a small pipe buried to water a flower bed to vast networks of large underground pipes buried throughout rural areas to provide irrigation water to large fields and orchards, most irrigation systems are located on private property and go unmarked in response to an 811 notification because it's normally owned by the property owners. Look for signs of irrigation systems like sprinkler heads and irrigation control boxes.

Green marks identify the approximate location of sewer and storm sewer pipes as well as other drain lines. Be aware that there are some pressurized pipes that force raw sewer to flow at a bulk rate. These sewer lines are considered forced mains and pose a high risk of a wide area sewer spill if accidently damaged. Most sewer lines are non-pressurized and are installed at a constant downhill pitch to allow the sewer to flow using gravity to do all the work. These lines are considered gravity systems and also cause quite a mess on a job site when damaged. Most private sewer or drain lines go unmarked in response to an 811 notification. Some states exempt sewer lines from being marked by the wastewater operator.

DIGGING DEEPER!

About the Author

BOB NIGHSWONGER is the President of the Utility Training Academy and a long time line locating and damage prevention instructor. He has served 25 years in the damage prevention industry and is a frequent speaker at the annual CGA Excavation Conference & Expo and other industry related events. Bob also conducts frequent locator training webinars for Excavation Safety University. He can be reached at ***bob@utasearch.com***