How Does a Locator Know Their Marks are Accurate?

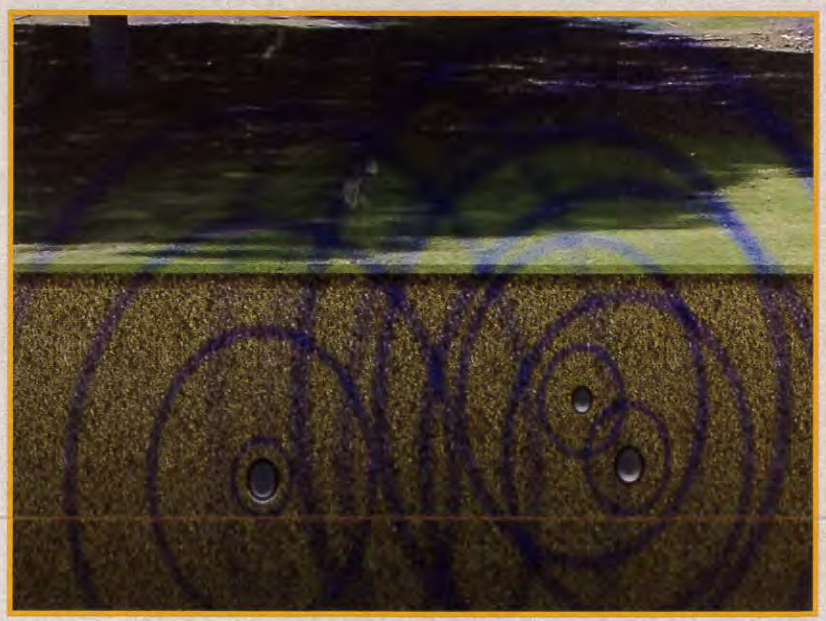
By Thomas Young

We all know the importance of the one call system and how critical it is to have an area checked for buried utilities before the ground is broken. But when someone goes out to locate and mark underground utilities, what are they really looking for? They can't physically see the pipes and cables they are tracing, so they rely on a locating instrument to guide them. Do locators really trace the underground pipes and cables or do they simply look for a positive response from their receiver over the area that they think the pipe or cable runs? "Hey, if the as-built says it's here and I get a solid response from my receiver then it's OK to lay paint, right?" But what if the signal they are tracing is distorted? Distortion affects locating accuracy and most receivers can't show distortion without making the user take extra steps to look for it. Time pressures are constant in the locating world. Do locators really have the time to stop and ALWAYS check for distortion?

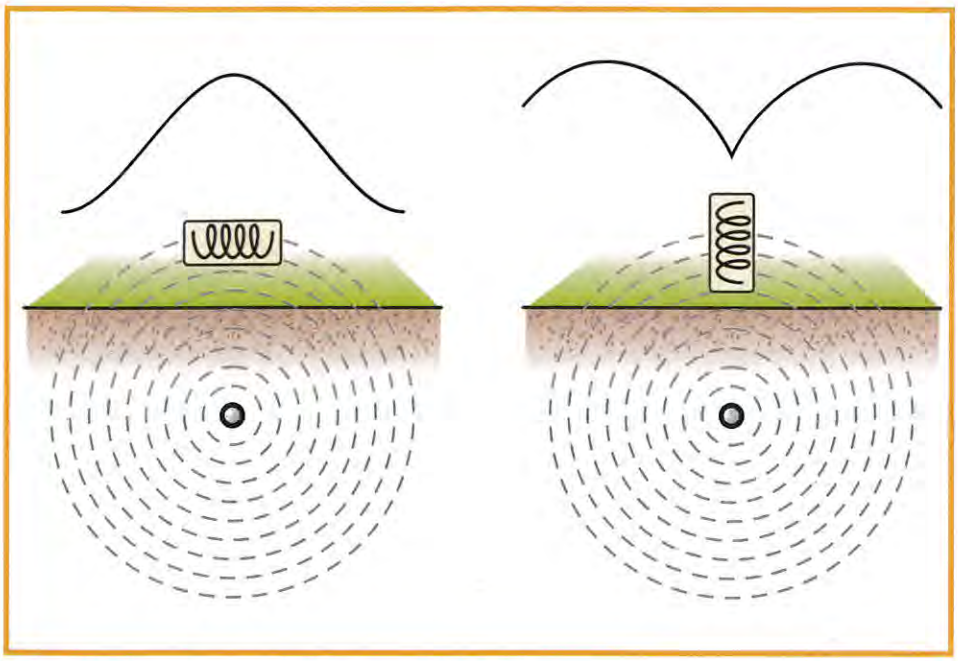
Each day, someone, somewhere is going to want to dig a hole. Under current law a notice is sent out and locators come to perform the important job of locating and marking any underground utilities that may be in the area. A transmitter is set up and then an alternating current is applied to the known conductors underground. An electrical circuit is created where alternating current flows down the conductor and then back through the earth to the transmitter. The result is an electromagnetic field around the conductor that can be visualized as concentric signal shells. (A classic analogy is to look at waves in a still pond after a pebble is dropped into the water.) The locating professional uses a receiving instrument that tells him if he is over the conductor, so he can paint a mark above ground to let others know where the utility is located.

The story is familiar and fairly simple, but there is a catch: What if the signal is not completely round? If the signal from the transmitter encounters some other metal object or other utilities in the area, above or below ground, it can add confusion or lead the locator onto a non-target conductor. This coupling can change the shape of the signal field and distort it, possibly affecting where the receiver pinpoints the line above ground. How does the locator know that the marks he is being paid to place on the ground are accurate?

Concentric shells around the conductor



Coupling between the target conductor on the left and the two unknown conductors on the right can generate multiple fields that may have an impact on the overall shape of the signal.



An antenna coil positioned horizontally PEAKs when more horizontal signal passes through it (left). Positioned vertically, the same antenna cannot sense the signal at the same point (right) until the signal angle is more vertical, as it is on either side of the utility.

Most locators know that a round signal from the target conductor usually equates to more accurate locating above ground. They also know that conventional receivers can work in two different modes, usually known as "PEAK" or "NULL" modes.

Comparing the results in each mode can help determine if the signal is round or not. Many may have also attended a class at Staking University and know that there are four other ways to check the shape of the signal using traditional "paddle" shaped receivers. *(See table below.)*

With constant pressure to locate more and more utilities each day, locators may find it difficult to constantly look at the signal in different ways. In reality, locate professionals do not always stop and take the time to switch modes or use triangulation to check for a distorted signal. The locator usually applies a signal to the target conductor and follows its path by observing where the signal PEAKS over the line. On a single conductor, with a fair amount of current, this can be easy to do until something unknown and unseen changes underground.

Confirmation bias also comes into play when locating. All of us have a tendency to focus on, give priority to and remember the evidence that confirms what we already believe is correct. When we can see the transformer on the street and the box on the side of the building, we can almost envision where the underground conductor runs. If we trace between those two points and mark the PEAK signal strength that should be fine, right? Thinking one knows the path of an underground conductor and then confirming that path ACCURATELY may often require more information than is offered by a receiver in PEAK mode only. (see *http://en.wikipedia.org/wiki/Confirmation_bias* for more information.)

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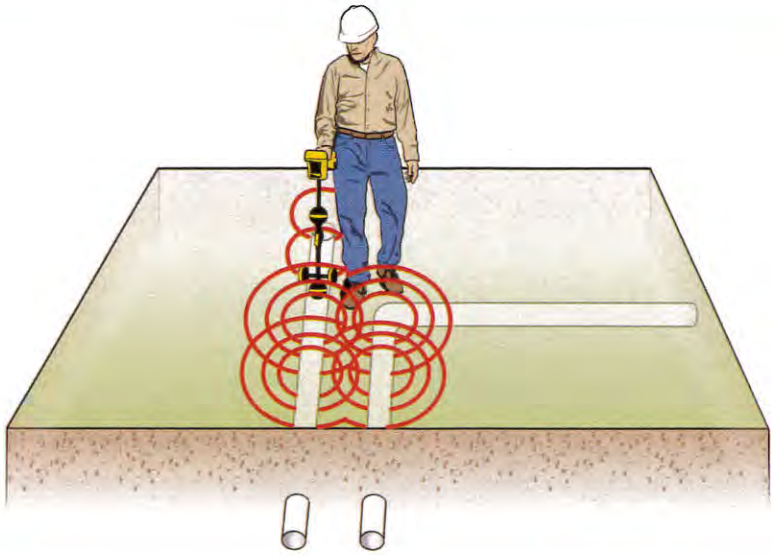
Businesses want to get their locating done quickly, yet they need to do it accurately. How can one check for signal distortion without compromising productivity? One way is to trace most of the pipe or cable in PEAK mode and then occasionally stop to check it in NULL mode as well. The obvious question

TYPE OF TEST	DESCRIPTION
1. **PEAK Versus NULL**	PEAK and NULL readings should agree at the same point on the ground if the signal is round.
2. **Digital Depth**	If the locator is lifted by 1 foot then the digital depth reading should increase by 1 foot when taken again at the lifted position.
3. **Triangulation**	The receiver is held at a 45 degree angle over the conductor and pulled to either side until the receiver shows a balanced reading. The distance on each side is compared and should be equal if the field shape is round.
4. **PEAK Method**	Pull the receiver an equal distance to each side of the original PEAK. The readings on either side should match.
5. **NULL Method**	In NULL mode the receiver is raised straight up. The reading should still indicate a NULL if the signal is round.



The signal is generally round until the target conductor encounters something else that may affect the signal's shape and where the PEAK position is indicated above ground.

is how often does one stop to check? Do they incorporate another one of the five methods listed earlier as well? Should they trace in PEAK mode on the way out, leaving small dots as they go and then mark the line again on the way back while retracing in NULL mode? Though it is relatively new, a more efficient approach may be to use a locator that offers more information.

There Is No Denying That Locators Have A Lot Of Work To Do Each Day

Nowadays, new user interfaces can alert the user of signal distortion. Different manufacturers use different methods, but most still rely on PEAKs and NULLS.

Ridgid SeekTech, however, uses eight antennas to show the general location, direction and signal distortion surrounding an underground conductor. This approach does not use separate PEAK and NULL modes but instead looks at all of the signal angles and knows where the locator is within the signal field. Two omnidirectional antenna arrays, with three antennas each, show the signal in the form of a line on the screen. A set of two balancing "gradient" antennas offers a simple but separate indicator for comparison.

When everything is in balance, the locator only needs to walk in line with the conductor and trace it. If the direction changes, the line on the screen will show the turn. If the signal changes shape, the top and bottom antenna arrays will get different readings and the line on the screen will fade to static depending on the extent of the distortion. More importantly, the left/right guidance arrows may not agree with the line on the screen, alerting the locator of an imbalance in the readings. Easy to read signal strength and continuous depth readings are on screen as well.

Everything in balance. Keep walking!

Distorted signal, caused by the large metal car parked over the conductor's path.

"THE RECEIVER IS SAYING THE SIGNAL IS DISTORTED. NOW WHAT?"

What it really says is DON'T DIG YET! DO NOT PLACE A MARK ON THE GROUND! Go back to the transmitter and see if changing something can improve the situation. Try to better isolate the conductor and get an undistorted signal. Maybe a common ground needs to be disconnected? Look for other sources of information to help decipher the locate. If the locate is uncertain, then the marks left on the ground should be in the form of words such as "Pot hole required" or "Hand dig." Locators in the field should always think through locates carefully and mark the location with the best information they have.

In our daily lives, the popular trend is towards using more information. Smart phones and smaller laptops give us the information we need faster, so we can do things more efficiently. Likewise for locating professionals, tracing underground utilities accurately and efficiently is the primary goal. When using traditional locating receivers, consistently stopping to use different techniques to check for signal distortion helps improve accuracy. Alternatively, using an advanced receiver that can sense all of the signal, and therefore sense the differences in its shape, can help keep locators moving down the line. **UF**

Thomas Young has worked in the utility locating arena for the past 10 years with Ridgid SeekTech, a market leader in new locating technologies.