What's Your Location?

Keep Your Directional Drilling Operations on Target with the Proper Locating System

By Siggi Finnsson and Eileen Robinson

It's often said that locating systems put the "directional" in horizontal directional drilling (HDD) operations. Since it's the locating equipment that provides the drilling crew with the information necessary to steer the drilling tool to its destination, these systems are essential components in keeping HDD crews accurate and on target.

There are two main categories of locating systems currently available: walk-over locating systems and wireline guidance systems. The majority of HDD work done today uses walk-over locating systems, since these are less expensive and easier to use — so these walk-over systems will be the focus of this write-up.

HDD

Horizontal directional drilling is an evasive method for installing utility lines — gas pipes, water pipes or fiber-optic conduit below the ground, without the need to cut a trench. Directional drilling offers minimal surface disruption compared to trenching. Horizontal directional drills "bore" a tunnel using fixed-length drill rods that are threaded together to create what's called a drill string. This drill string is advanced (drilled) through the ground from an entrance to an exit location. This is called drilling a pilot hole.

The pilot hole can be drilled to precise locations because of the drilling tool's slanted steering plate. The orientation of the tool and its slanted steering plate is what determines the direction the tool will move when pushed into the ground without rotation. The steering plate reacts off the soil and a deviation in the tool's direction is achieved. The steering orientation of the tool is analogous to a 12-hour clock face looking in the direction of the bore: 12 o'clock relates to an upward movement; 6 o'clock relates to a downward movement; 9 o'clock is left; and 3 o'clock is right.

Once the pilot hole has been completed (the drill tool arrives at the exit location), the drilling tool is removed and a hole opening device, called a reamer, is attached. The reamer is then attached to a conduit, referred to as the product pipe. This assembly is pulled back through the pilot hole to the drill, resulting in a completed installation with minimal surface disruption.

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The function of the locating system on an HDD operation is to provide the driller with information on the tool's position and heading to guide the pilot hole process. This information includes the clock or roll position (as described above), inclination (pitch), depth, heading (direction), temperature and battery status.

HDD Locating Systems

Below are some commonly used terms and definitions often used when discussing a directional drilling and location system operation:

1. **Receiver** — the locating or tracking device.
2. **Locator** — the person operating the receiver.
3. **Operator** — the person operating or controlling the drilling machine.

The components comprising a typical walk-over locating system usually include:

1. **Receiver or locating device:** This is carried by the locator to track the drilling tool.
2. **Remote display:** This is placed at the drill rig to provide the operator with the transmitter's information that is sent from the receiver.
3. **Transmitter:** This is placed in the drilling tool, measures approximately 15 in. in length by 1.25 in. in diameter

Transmitter

The transmitter is commonly referred to as a sonde, beacon or probe. It is most often battery powered and transmits a magnetic signal from inside the drill tool. This magnetic signal field has distinct characteristics and a well-defined shape that can be accurately located.

A secondary signal, the data signal, is also emitted from the transmitter. This signal includes roll (clock), pitch, temperature and battery status. The roll readout is typically in 12 to 24 distinct clock positions for precise steering. The pitch readouts are displayed in whole percents or degrees, or in some cases 1/10 of degrees or percents. Reading pitch in the 1/10 degree or percent increments is becoming increasingly popular as directional drilling is more frequently being used for gravity sewer installations, which have precise slope requirements.

The temperature information from the transmitter acts as a warning indicator against incurring damage to the sensitive electronic components from frictional heat generated during the drilling process. The battery status indicates the amount of available battery life of the transmitter.

Receiver and Remote Display

The receiver picks up the transmitter's information and processes it into useful information for the locator. The receiver then transmits this information via a telemetry signal back to the remote display at the drill. This allows the operator to view in real-time the same information that the locator sees.

The format of the information available to the locator and operator will differ depending upon the locating manufacturer, but generally consists of the following:

1. Drill tool depth
2. Drill tool direction (heading)
3. Drill tool clock orientation
4. Drill tool pitch
5. Transmitter temperature and battery status

Based on the above information, the locator is able to make educated decisions about how to steer the tool to the desired location. Besides the depth information, the pitch and roll orientation help determine the correct steering command. As an example, assume that the direction of the tool is correct but the pitch needs to be changed from negative 5 percent (-5 percent) to level (0 percent). Let's say that the drill head is stopped and is oriented at 4 o'clock. The first step is to rotate the drill string until the clock reads 12 (because you want to drill upwards from a negative pitch). The drill string is pushed through the ground and the operator monitors the pitch readings on the remote display until they reach 0 percent. Now the drill string can be rotated and the tool should proceed straight and level.

Interference — Things that Can Make Locating Difficult

Since most drilling takes place in urban areas, a common problem encountered in HDD locating is interference. Interference is often referred to as being either active or passive. Active interference is defined as "anything that emits a signal or generates its own magnetic field." Some examples of active interference include power lines, traffic loops, fiber trace lines, TV cables, phone cables, fiber-optic lines and invisible dog fences. Some of the possible effects of active interference include erratic depth readings, loss of pitch and roll data and inaccurate calibration that may lead to depth errors.

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Passive interference, as the name implies, does not generate a signal. It can be defined as "anything that blocks, absorbs or distorts a magnetic field." Examples include metal structures such as chain link fences, rebar, salt water, ferrite in the soil and other unknown sources. Anything that is conductive has the potential to act as a passive interference source. Possible effects of passive interference include depths greater than actual depth, incorrect tool location and heading, no signal or weak signal and incorrect calibration that may lead to depth errors.

It is therefore important to be familiar with the operation of the locating equipment so that when anomalies occur, they are immediately obvious to the locator.

Selecting a Locating System

A locating system can represent a substantial investment, anywhere from $10,000 to $20,000. There is a wide variation in the design approach taken by the various locating equipment manufacturers with their equipment. Following are some factors a prospective HDD contractor ought to consider prior to investing in a locating system:

• **Ease of use:** A locating system that is easy to use and allows for quick training means a shortened learning curve and ultimately more competent locators.

An HDD locator system (from the left): the remote display, a battery charger with a rechargable Ni-Cad battery, Eclipse receiver, followed by a stack of batteries. In the foreground are two transmitters, a battery powered one (closest to the system) and then a cable transmitter (longer with a wire attached).

• **Size of Drilling Machine:** Rig size can potentially dictate the scopes of work undertaken. A smaller machine is better suited to work in urban environments where setup space is at a premium, drilling depths are typically shallow and the interference potential can be high.

• **Types of projects:** Installing utilities such as water, fiber, TV cable or power lines are typically shallower installations and may not require deep range transmitters or sensitive pitch transmitters that would be required on deep bores (highway or river crossings) or sewer installations.

• **Flexibility:** Once a locating system has been selected and purchased, it can become difficult and expensive to change the system later. As a company's business grows, so too can the projects become more involved and complex. Good examples are large river and highway crossings. It is therefore important to plan for the future by selecting a system with a variety of capabilities or the option of upgrading or expanding the capabilities of the existing system to meet the company's new work needs.

• **Support:** The availability of technical support can be critical, particularly for the operators who are new to the equipment. Support may also be needed in the form of loaner equipment. Another consideration may be the location of the repair facility. If the equipment cannot be repaired in the United States, it may take a considerable amount of time for repairs.

Some questions to consider if you are purchasing a locating system:

1. How well does the locating system handle interference?
2. Does the system operate at more than one frequency?
3. What is/are the locating frequency(ies) of the system?
4. Is the system capable of generating an electronic as-built?
5. How accurate is the system?
6. Does the system offer smaller sized transmitters for smaller tools or housings?
7. Does the system offer long-range cable transmitters for deep bores?
8. How widely is the system used?
9. Is there a dealership network that supports these systems?
10. Is loaner equipment available?
11. What kind of instruction materials are available?
12. Is there on-site field training available?

Summary

The locating system is an integral part of the drilling operation and consists of sensitive electronic equipment and should be treated as such. There are a number of locating equipment manufacturers, each with differing design and operational approaches. A carefully considered choice, along with recommendations from contractors within the industry, should result in successful and profitable HDD operations.

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