Staking University

Locating Certification Seminar (LCS) Class Outline

I. How Locating Instruments Work:

A. There are two ways to energize the target line:
   1. Metal-to-metal
   2. Nonmetal-to-metal

B. There are two ways to receive the transmitter's energy:
   1. Peak
   2. Null

C. The transmitter's energy wants to leave the pipe or cable equally in all directions.

D. The transmitter's energy always follows path of least resistance.

E. Different transmitter frequencies can and sometimes will do different things.

F. The line tracing results cannot be changed with the receiver.

II. How to Use Locating Instruments: Current

A. Whatever leaves the transmitter must come back to the transmitter.

B. There are 4 major factors that influence current flow:
   1. Far end grounds
   2. Insulation
   3. Earth
   4. Frequency

C. Assessing the current level anywhere along the pipe or cable with the receiver:
   1. Good
   2. OK
   3. Poor

III. How to Use Locating Instruments: Receiver and Transmitter

A. Receiver: There are five ways to determine the shape of the transmitter's energy after it leaves the pipe or cable:
   1. Peak versus null
   2. Digital depth validation
   3. Null method
   4. Triangulation
   5. Peak method

B. Transmitter: There are four ways to change tracing results:
   1. Change the grounding system
   2. Change from conductive to inductive (or vice-versa)
3. Move the transmitter
4. Change the frequency

IV. Conclusion: Current—Shape—Endpoint

A. Voltage is placed on a metallic utility by a transmitter. Voltage produces alternating current as the metal utility and earth form a circuit. Current travels in two directions on both the utility and through the earth.

B. A product of this current flow is a field detectable at the earth's surface.

C. A coiled receiving antenna detects the field.

D. Alternating current can be applied using a variety of frequencies. Without current, no field exists.

E. A coiled-antenna can be positioned in one of two optimized-response positions: peak and null.

F. The simultaneous use of multiple coiled-antennas within the field provides information beyond lateral location, such as utility depth estimation.

G. A field generated by transmitters other than our own—such as a power plant—is referred to as a passive signal.

H. The type of utility being located may only be determined by following the field to a logical or visual endpoint.

WICT: Staking University's Written Instrument Certification Test

Staking University's WICT assesses the student's knowledge of two areas of concentration:

I. How a locating instrument works

II. How to use a locating instrument

A score of 93% or above is needed to pass.

The written test consists of 18 questions designed to determine the student's retention of knowledge in two areas:

I. **Current** level: an assessment of the amount of the transmitter's energy at any point along the pipe or cable.

II. Signal **shape**: determining the shape of the magnetic fields as either round or not round.

HICT: Staking University's Hands-on Instrument Certification Test

Staking University's HICT assesses the individual locator's competency, regardless of instrument or utility located. To pass, a Staking University student must demonstrate that they have a command of the locating instrument by performing in three areas of concentration as listed below:

I. **Current** level - an assessment of the amount of the transmitter's energy at any point along the pipe or cable.

A. Properly identify the level of current.

B. If current is not detected, demonstrate methods of producing current.

II. Signal **Shape** – a magnetic field that is either a round field or a not-round field.

A. Demonstrate at least three methods to determine whether the signal shape is round or not round.

B. Demonstrate methods that may produce a round signal when a not-round signal is detected.

III. **Endpoint** – trace a signal to a visual or logical endpoint.

Staking University's HICT Scorecard

I. Demonstrate methods that will indicate amount of current flow on the utility:

A. Good – steady peak response

B. Okay – peak response with slight fluctuation

C. Poor – wildly fluctuating peak response

II. Demonstrate at least three of the five methods to determine signal shape:

A. Peak vs. null

B. Digital depth validation

C. Peak method

D. Null method

E. Triangulation

III. Assess the current flow and signal shape:

A. Change frequency

B. Change ground connections to earth

C. Change application method (inductive or conductive)

D. Move the transmitter

IV. Demonstrate methods to determine utility being located.

Follow the trace to a visual or logical endpoint and/ or direct a two-man sweep.

Glossary of Terms

60-cycle: alternating current whose frequency is 60 hertz.
Access point: a bare metal spot on a pipe or cable whereby one end of the conductive transmitting antenna is attached.
Active: a receiver response to a magnetic field generated by the transmitter.
Air lock: any receiver reading created by the transmitter's energy leaving the transmitting antenna and not the pipe or cable.
Alternating current: the type of energy produced both by an electric power plant and the transmitter; energy that flows in two directions.
Apex: the topmost part of a signal circle.
Attracting field: a magnetic field whose energy moves toward another field; this field is not circular.
Audio frequency: another name for low frequency.
Bad current: with the receiver held stationary, a peak response that fluctuates considerably.
Bond: the physical attachment of one line leg to other line legs or a ground.
Bottom receiving antenna: the lower half of stacked peak antennas.
Circuit: when discussing electromagnetic theory, the name for current flowing on a conductor and through earth.
Close-end ground: a metal making contact with earth at the end of a line leg where the transmitter is deployed.
Close-end: the end of a line leg where the transmitter is located.
Coil orientation: the positioning of coil windings within a magnetic field.
Coil: wire, usually copper, wrapped around a core in a spool-of-thread-type fashion.
Common ground: a shared metallic grounding connection amongst cable systems.
Concentric signal circles: the transmitter's energy that orbits the pipe or cable at all distances from the pipe or cable.
Conductive transmitting antenna: a wire with two ends which connects the transmitter to 1) the pipe or cable and, 2) the earth.
Conductive: transferring the transmitter's energy onto a pipe or cable by employing a metal-to-metal connection between the transmitter and the pipe or cable.
Conductor: a name for a metallic pipe or cable when discussing electromagnetic theory.
Cross: a potential signal split on a piping system where the transmitter's energy encounters three new line legs.
Current flow reading: a measurement on the transmitter of the amount of energy leaving the transmitter.
Current level: an assessment of the amount of the transmitter's energy at any point along the pipe or cable.
Current measurement: a receiver reading, usually displayed in milliamps, that is produced by stacked-peak antennas and estimates how much of the transmitter's energy is located at the point of the reading.
Current: the flow of the transmitter's energy on a pipe or cable.
Depth validation: the raising of the receiver a known amount to see if a new digital depth reading has increased by that known amount.
Digital depth: a pipe or cable depth estimation utilizing at least two stacked peak antennas situated a fixed distance apart.
Direct current: the type of energy produced by batteries; energy that flows in one direction.
Earth: soil.
Electromagnetic pipe and cable locating: the detection of magnetic fields produced by current flow on metallic pipes and cables.
Electronic null: a receiver response whereby two symmetrically and horizontally positioned peak antennas record identical signal strengths.
Energize: to transfer the transmitter's energy to a pipe or cable.
Far-end ground: a pipe or cable's metal component making contact with earth at the opposite end of a line leg from where the transmitter is deployed.
Far-end: the end of a line leg opposite of the transmitter location.
Frequency: the transmitter's energy as measured in hertz or kilohertz.
Good current: with the receiver held stationary, a peak response that does not fluctuate.
Ground rod: a copper or aluminum rod ranging in length up to 16' that serves to ground a cable system.
Ground: where an insulated metallic utility makes contact with earth.
Grounding device: a piece of metal driven into earth so that the conductive transmitting antenna may be attached.
Hertz: the number of times current on a pipe or cable changes directions in one second.
High frequency: any transmitting frequency 10 kilohertz and above up to 480 kilohertz.
High-high frequency: any transmitting frequency from 200 kilohertz or greater.
High-low frequency: any transmitting frequency greater than 1 kilohertz up to 10 kilohertz.
Horizontal inspection of field: receiver readings that are obtained perpendicular to the pipe or cable location.
Horizontally positioned peak antennas: on a multiple antenna receiver, a pair of tire coils used to produce an electronic null response.
Inductive coupler: a type of inductive transmitting antenna that is not located in the transmitter but rather in clamp that encompasses a cable.
Inductive transmitting antenna: a coil located in the transmitter whose purpose is to energize the pipe or cable without using a metal-to-metal connection.
Inductive: transferring the transmitter's energy onto a pipe or cable without employing a metal-to-metal connection between the transmitter and the pipe or cable.
Insulation: coating on a pipe or cable that separates the metal from earth.
Insulator: a break in a pipe's metallic continuity.
Isolate: the ability to keep the transmitter's energy away from non-target lines.
Kilohertz: 1000 hertz.

Line leg: a single-direction section of a pipe or cable that has metallic continuity.
Logical or visual termination point: a trace that leads to an above-ground, utility-related structure.
Low frequency: any transmitting frequency below 10 kilohertz.
Low-high frequency: any transmitting frequency less than 200 kilohertz but greater than 10 kilohertz.
Low-low frequency: any transmitting frequency one kilohertz or below.
Magnetic field: the product of alternating current flowing on a pipe or cable.
Metallic continuity: a line leg that has no insulators or unarmored slices.
Metallic path: the route on a pipe or cable that the transmitter's energy follows.
Metallic utility: a pipe or cable with metallic content.
Metal-to-metal: another term for the use of a conductive transmitting antenna.
Multiple antenna receivers: a receiver that employs two or more receiving antennas.
Multiple frequency transmitters: a transmitter that generates two or more frequencies.
Neutral: a cable that provides metallic continuity between ground rods.
Non-metallic utility: a pipe or cable with no metallic content.
Nonmetal-to-metal: another term for the use of an inductive transmitting antenna.
Non-target line: any pipe or cable not intended to be detected.
Not-round field: a magnetic field that is either an attracting or repelling field.
Null: a receiver response taken at the apex whereby the coil orientation is horizontal, like a tornado.
OK current: with the receiver held stationary, a peak response that fluctuates slightly.
Open end: a pipe or cable's metal component not making contact with earth where a line leg terminates.
Parallel conductor: a conductor that has an optimum chance of being induced.
Passive: a receiver response to a magnetic field generated by something other than the transmitter.
Path of least resistance: the route the transmitter's energy follows in order to return to the transmitter.
Peak: a receiver response taken at the apex whereby the coil orientation is vertical, like a tire.
Perpendicular conductor: a conductor that has no chance of being induced.
Pumpkin-shaped field: the field that is produced by an inductive transmitting antenna.
Radio frequency: another name for high frequency.
Receiver reading: signal strength, a peak or a null response, a digital depth reading, or a current measurement.
Receiver: a handheld antenna or series of antennas used to determine the strength and location of a magnetic field.
Receiving antenna: a symmetric metallic winding induced upon by a magnetic field.
Repelling field: a magnetic field whose energy moves away from another field; this field is not circular.
Resistance: anything that reduces current flow.
Round field: a magnetic field that is not an attracting or repelling field.
Signal circle: the transmitter's energy that orbits the pipe or cable at a particular distance from the pipe or cable.
Signal decay rate: the diminishing strength of the magnetic field as the field travels away from the pipe or cable.
Signal shape: a magnetic field that is either a round field or a not-round field.
Signal splits: a location along the pipe or cable where the transmitter's energy can begin to travel on two or more new line legs.
Signal strength: measurement of the magnetic field with a tire coil orientation.
Signal: the part of a magnetic field that intersects a receiving antenna.
Single antenna receiver: a receiver that only employs one antenna.
Single frequency transmitter: a transmitter that generates only a single frequency.
Splice: a potential signal split on a cable system where the transmitter's energy encounters multiple new line legs and the potential of going to earth.
Stacked-peak antennas: two coils—a bottom receiving antenna and a top receiving antenna—which are both situated at the apex of two concentric signal circles.
Target line: the pipe or cable intended to be detected.
Tee: a potential signal split on a piping system where the transmitter's energy encounters two new line legs.
Tire: a vertical coil winding that provides a peak response; windings that are oriented to the pipe or cable like a "tire to the road."
Top receiving antenna: the upper half of stacked-peak antennas.
Tornado: a horizontal coil winding that provides a null response; windings that are oriented to the pipe or cable like a "tornado traveling down the road."
Trace: the entire section of a pipe or cable being located.
Transmitter: a generator of alternating current, or energy; a miniature power plant.
Transmitting antenna: a metallic device used to transfer the transmitter's energy from the transmitter to the pipe or cable.
Triangulation: a method for depth determination utilizing a single null antenna or a pair of horizontally positioned peak antennas held at a 45-degree angle.
Unarmored splice: a break in a cable's metallic continuity.
Un-bond: the physical detachment of one line leg from other line legs or a ground.
Vertical inspection of field: receiver readings that are obtained on top of the pipe or cable location.
Voltage: the amount of pressure behind the transmitter's energy.
Windings: the wire in a coil that is wrapped around the core.