EM Equipment Operations

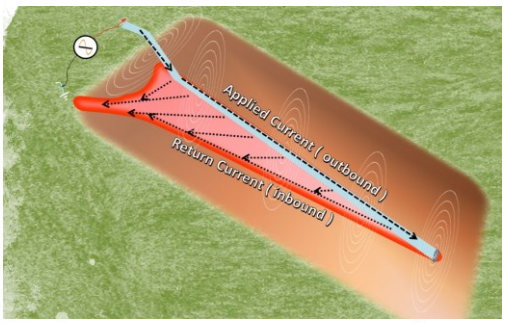
Signal Transmitter

Signal Receiver

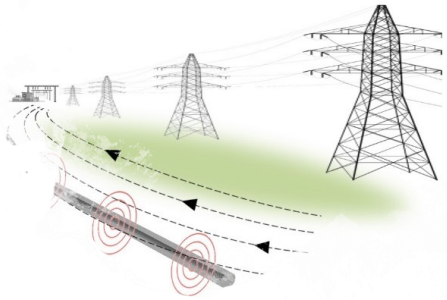
Sweep, Pinpoint, Tracing Techniques

1

2 Types of Detectable EM Signals



- Active Signals are applied by transmitter to an underground line at a set frequency



- Passive Signals are already present on many buried conductors and are detectable by a signal receiver programed to detect their specific frequencies.

2

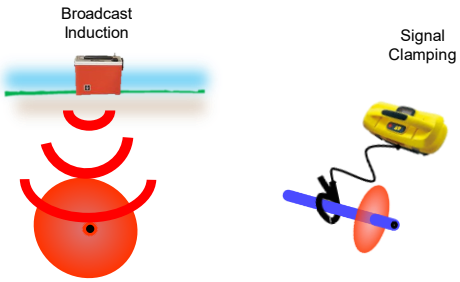
Applying a Signal with EM Transmitter

Active Signal Application Methods

- Direct Connection: (metal to metal contact) is made between the transmitter's wire leads attached to the conductor and the ground stake
- Utilizes the signal wave as the force that creates the current. Signal induced by ring clamp or using the transmitter to broadcast signal to buried conductor.

Direct Connection

Signal Induction



3

Direct Connection Method (metal to metal contact)

"Locating Best Practice" should be first choice for applying an active signal is to directly connect to your target line

Applied current will flow along the path of least resistance within a conductive circuit

- When attaching transmitter clips, insure good metal to metal connection between clip and conductor.
- Place ground stake at 90-degree angle from the expected path of the line
- Better grounding = better signal

(add water to temporary ground stake, if necessary, to increase signal current)

4

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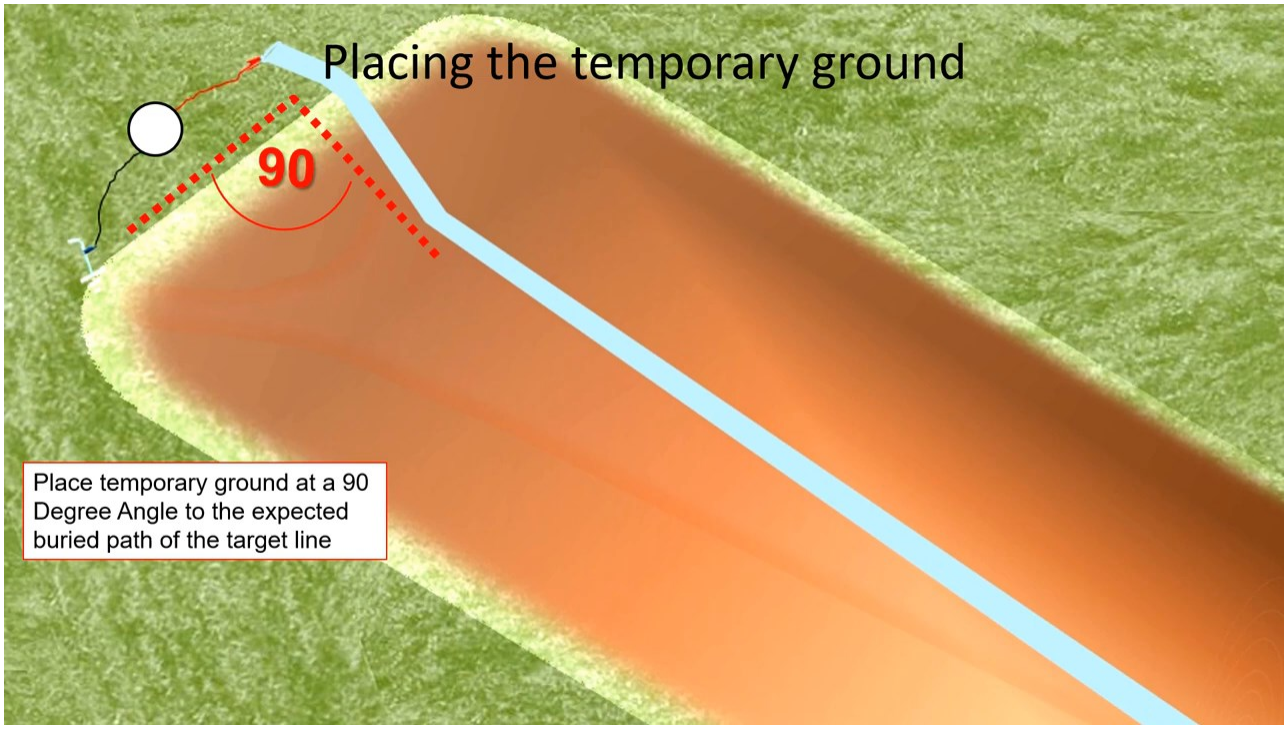

Placing the temporary ground
90
Place temporary ground at a 90 Degree Angle to the expected buried path of the target line

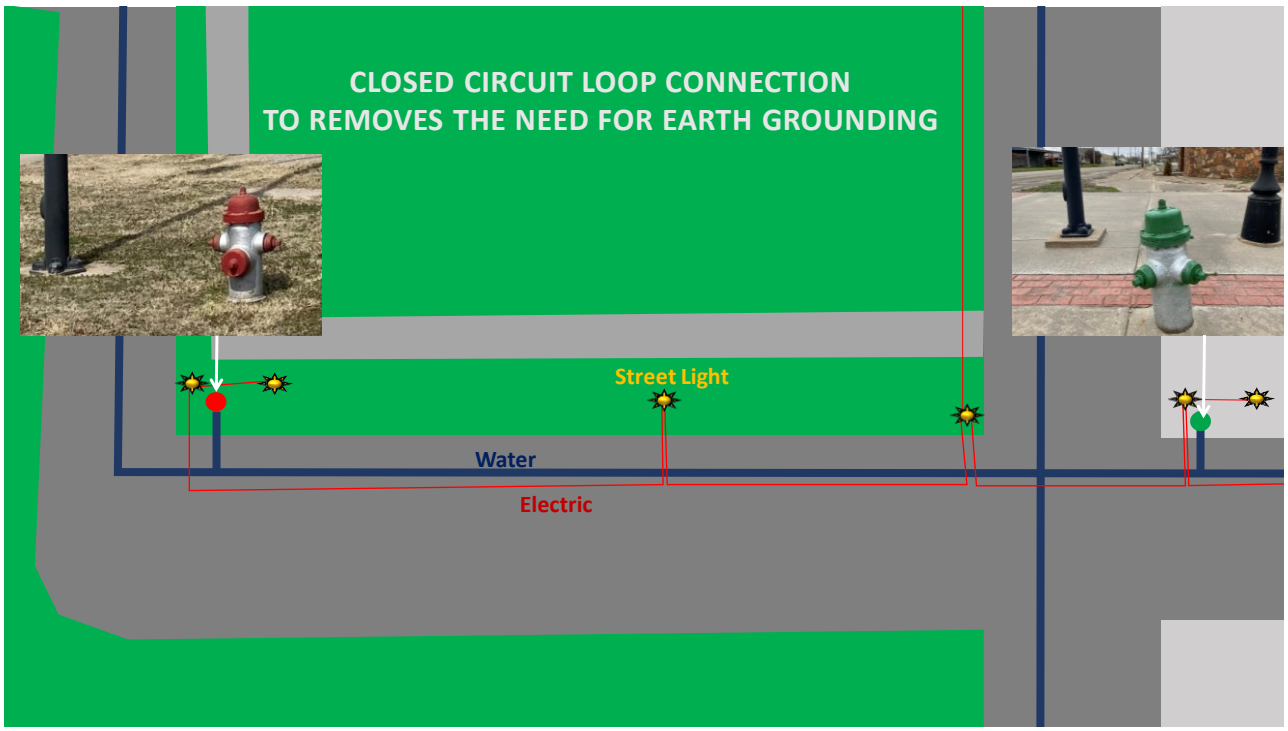
9

10

A few more tips on grounding

- Do not place ground over or towards adjacent buried lines
- Do not place ground on the other side of adjacent lines
- Do not place ground close to metallic fences that run parallel with target line
- A shovel or probe usually provides a better grounding results due to a larger surface to earth contact.
- Add water to temporary ground stake to improve grounding conditions.

11



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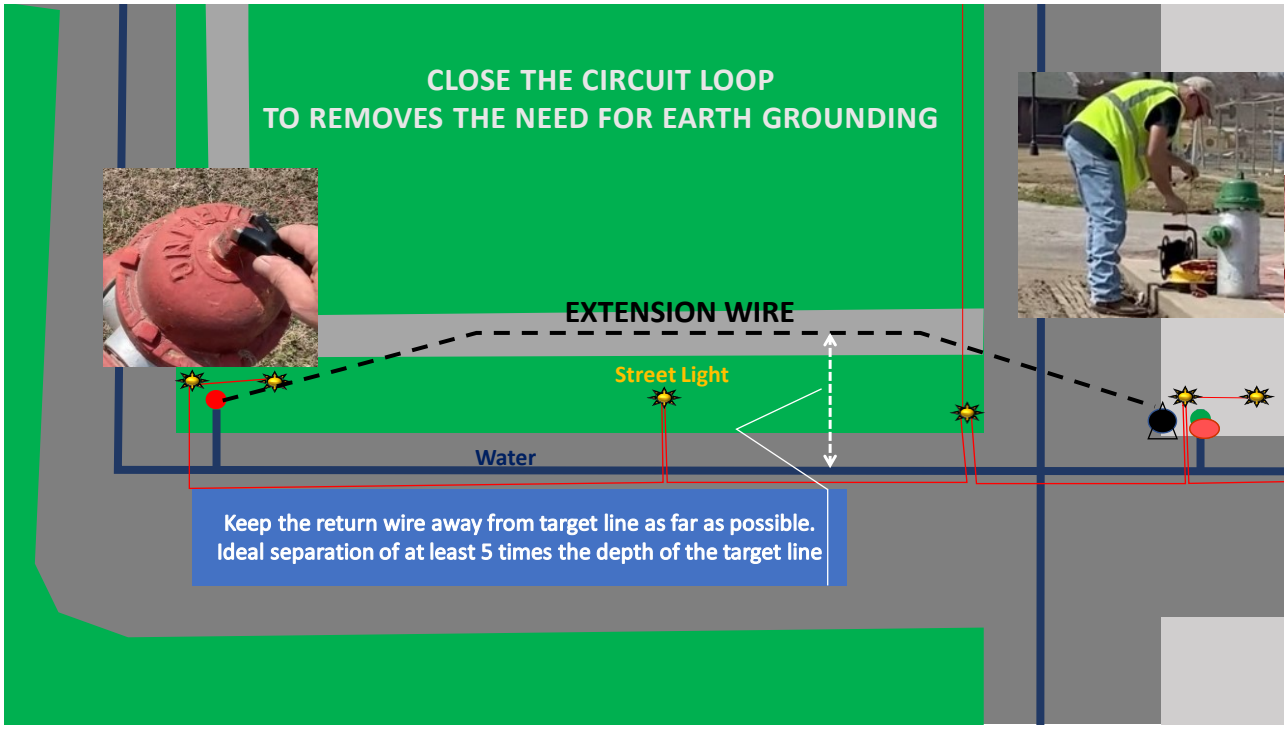

CLOSE THE CIRCUIT LOOP
TO REMOVES THE NEED FOR EARTH GROUNDING
EXTENSION WIRE
Street Light
Water
Keep the return wire away from target line as far as possible.
Ideal separation of at least 5 times the depth of the target line

13


N Depot Ave
N Seay Ave
W Broadway St
W Broadway St

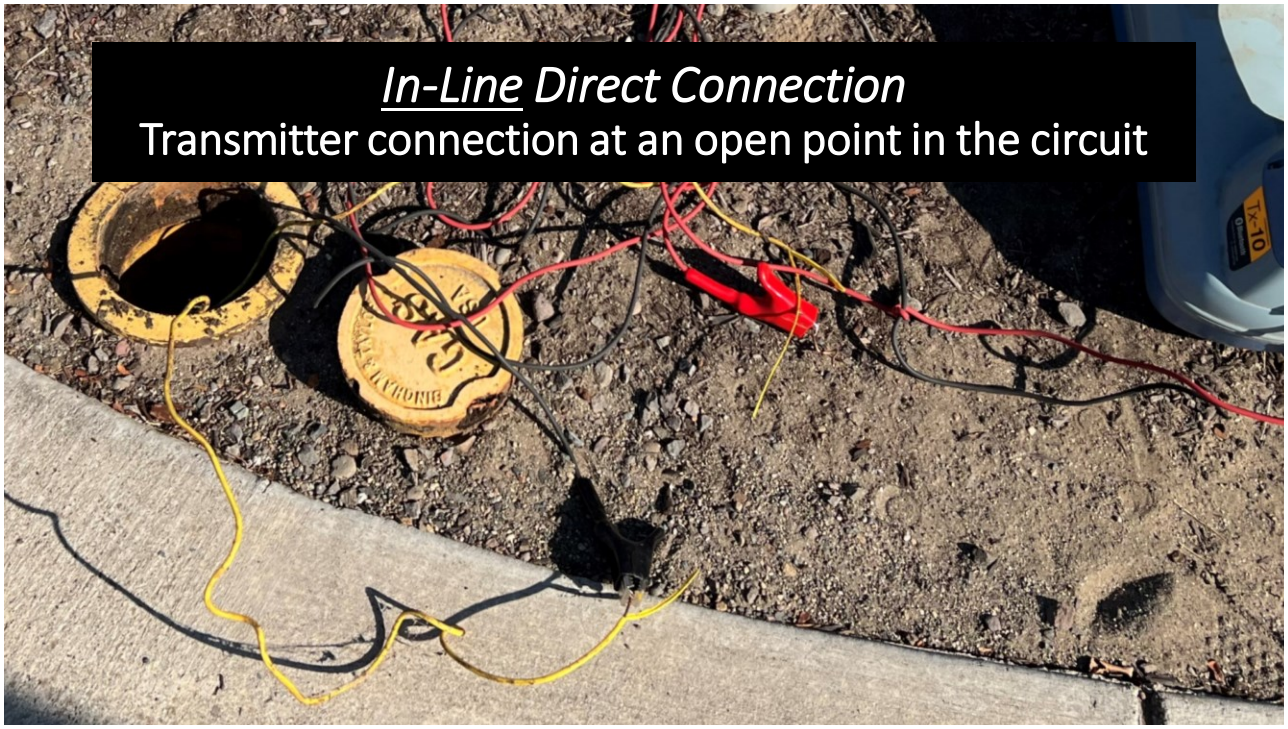
14


VIVAX METROTECH
vLoc3-Pro
42.5
124dB 145mA
32.8kHz
The end of a tracer wire represents an open in the circuit loop
Connect the tracer wire to the ground to complete the circuit loop
15

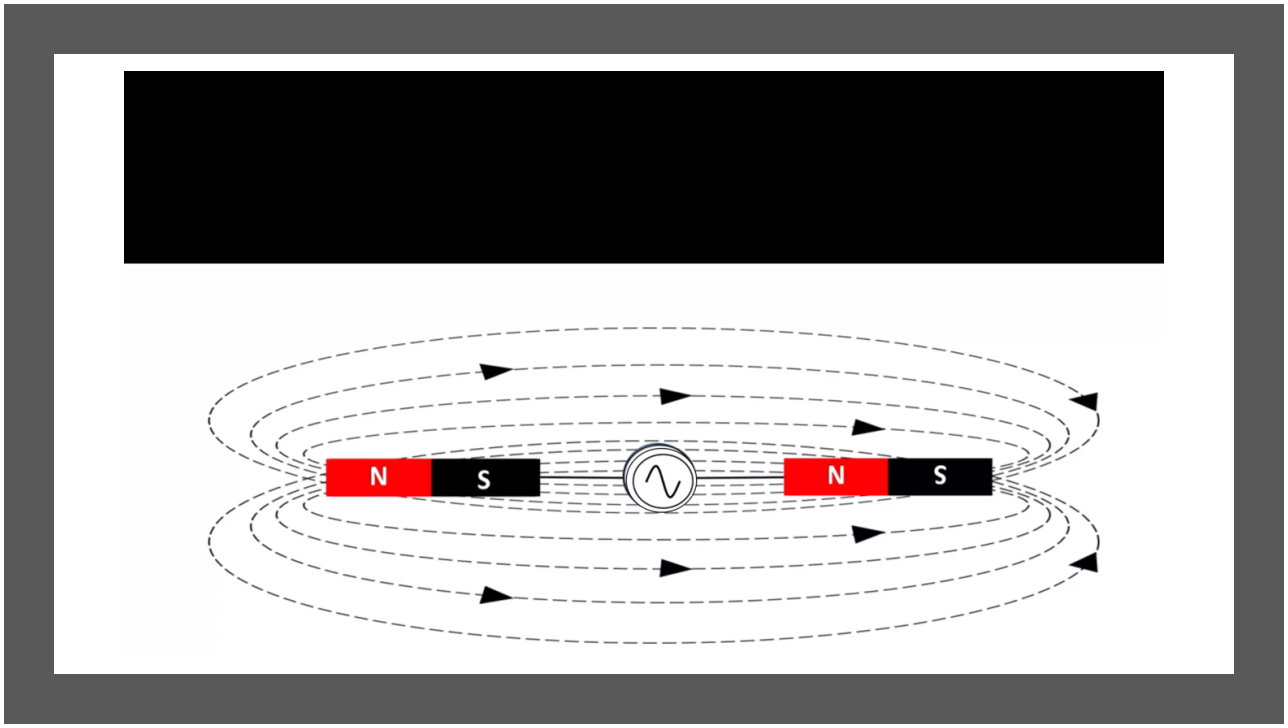
15


Placing a far end ground improves circuit conditions.
This provides a direct pathway for signal currents to return to earth.

16


In-Line Direct Connection
Transmitter connection at an open point in the circuit

17


N
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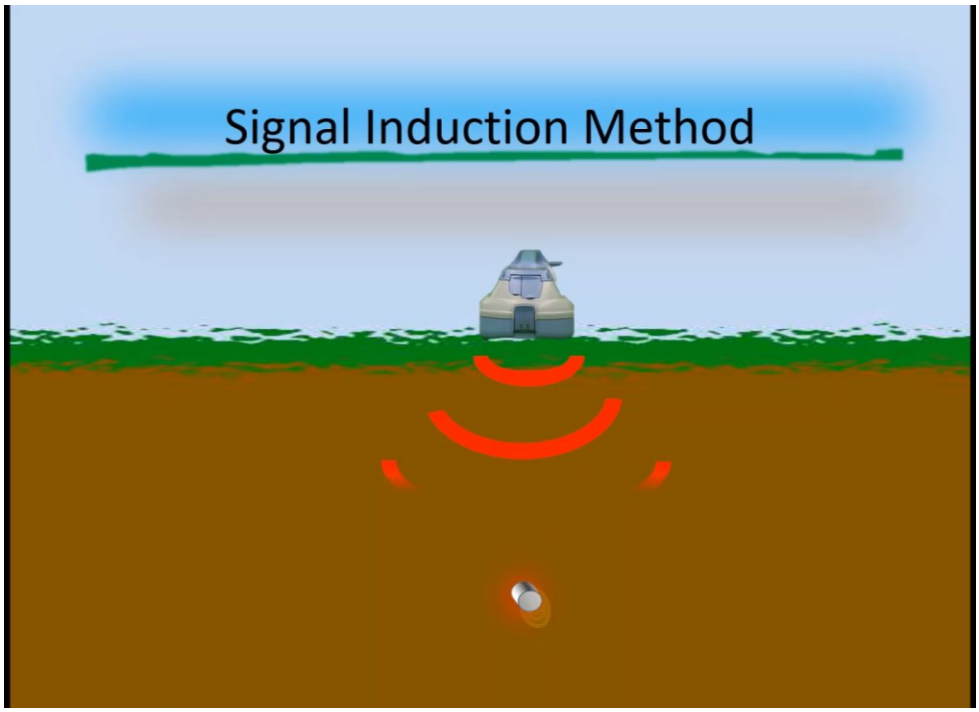
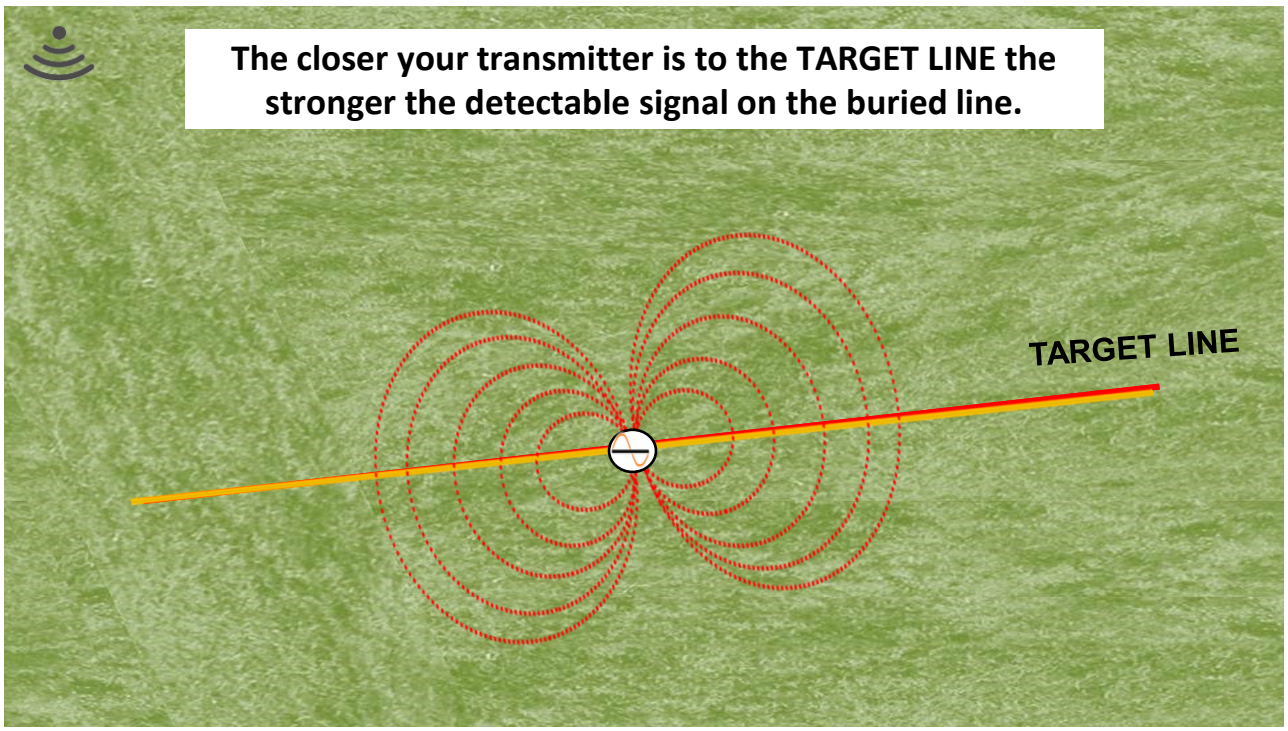
18


Signal Induction Method

19


The closer your transmitter is to the TARGET LINE the stronger the detectable signal on the buried line.
TARGET LINE

20

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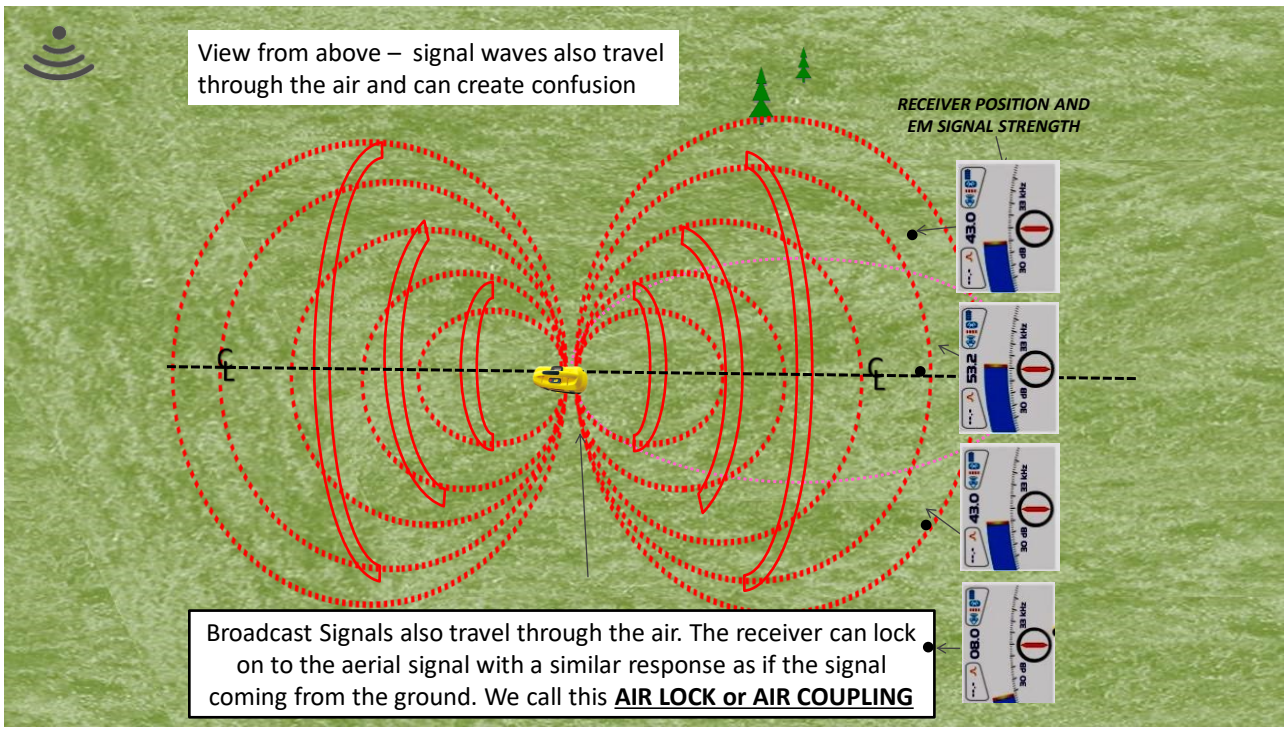
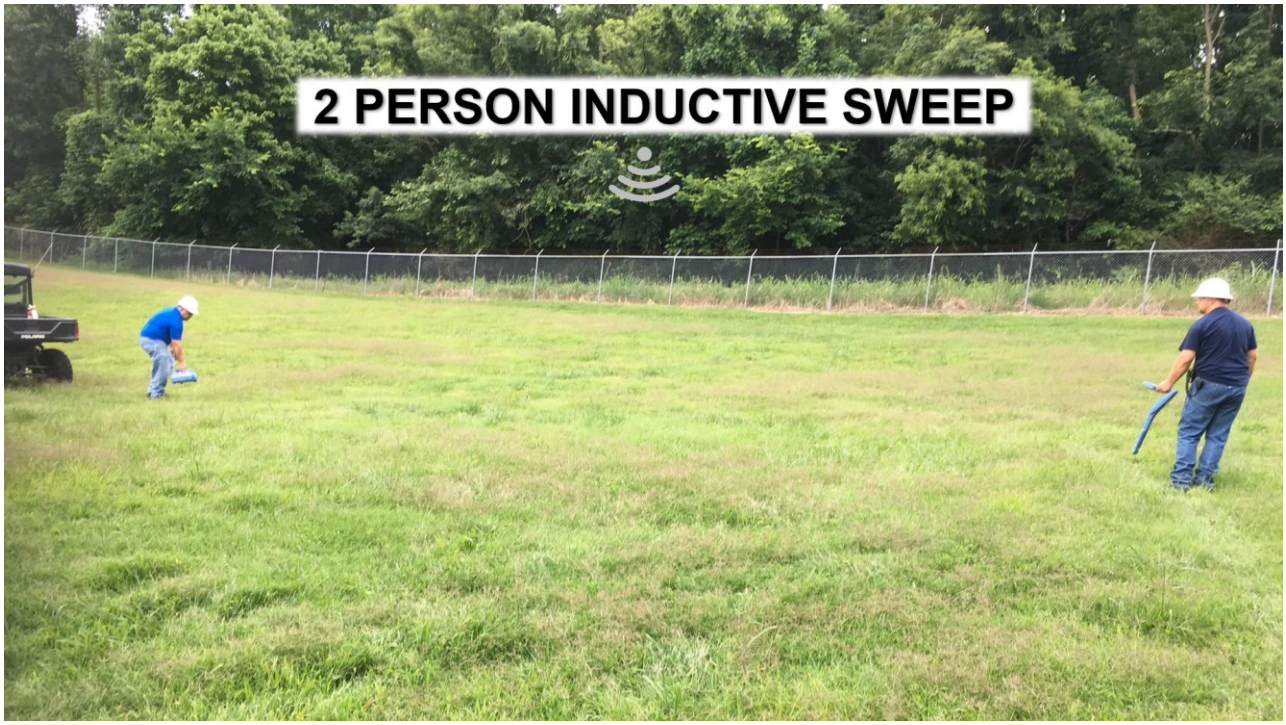

View from above – signal waves also travel through the air and can create confusion
RECEIVER POSITION AND EM SIGNAL STRENGTH
Broadcast Signals also travel through the air. The receiver can lock on to the aerial signal with a similar response as if the signal coming from the ground. We call this AIR LOCK or AIR COUPLING

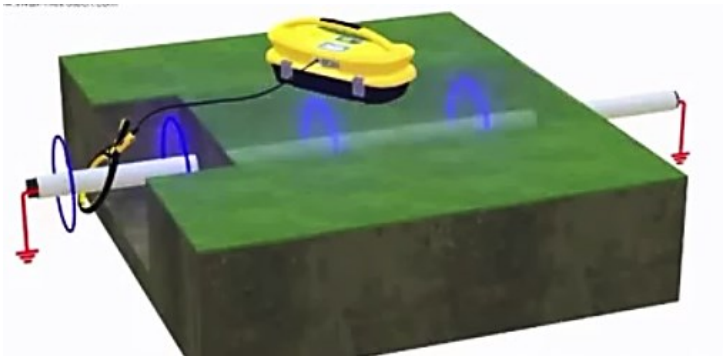
22



23

Active Signal Ring Clamp Accessory

- Primarily used for cable locating
- Ring clamp should be placed between two grounding points of the cable



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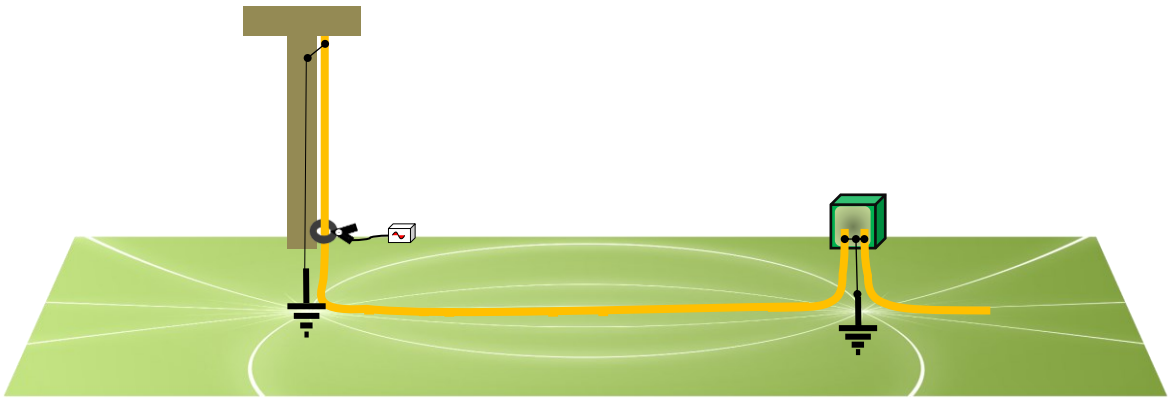
⏚ The conductors physical ground connection points to earth complete the locatable circuit loop



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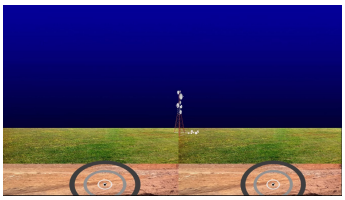
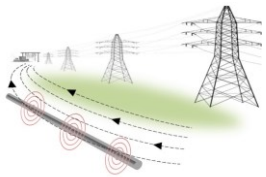
Passive Signals

- Occur “naturally” on underground lines as the result of signal broadcast or radiation from outside sources
- Created by various sources
  - CPS /CP120 (cathodic protection signal)
  - 60Hz Power
  - Radio (radio signal radiation)
- Underground facilities provide paths of least resistance for passive currents to flow along
- Almost always present to some level on most metallic underground facilities including steel gas lines, telephone cables and power cables and abandon lines.





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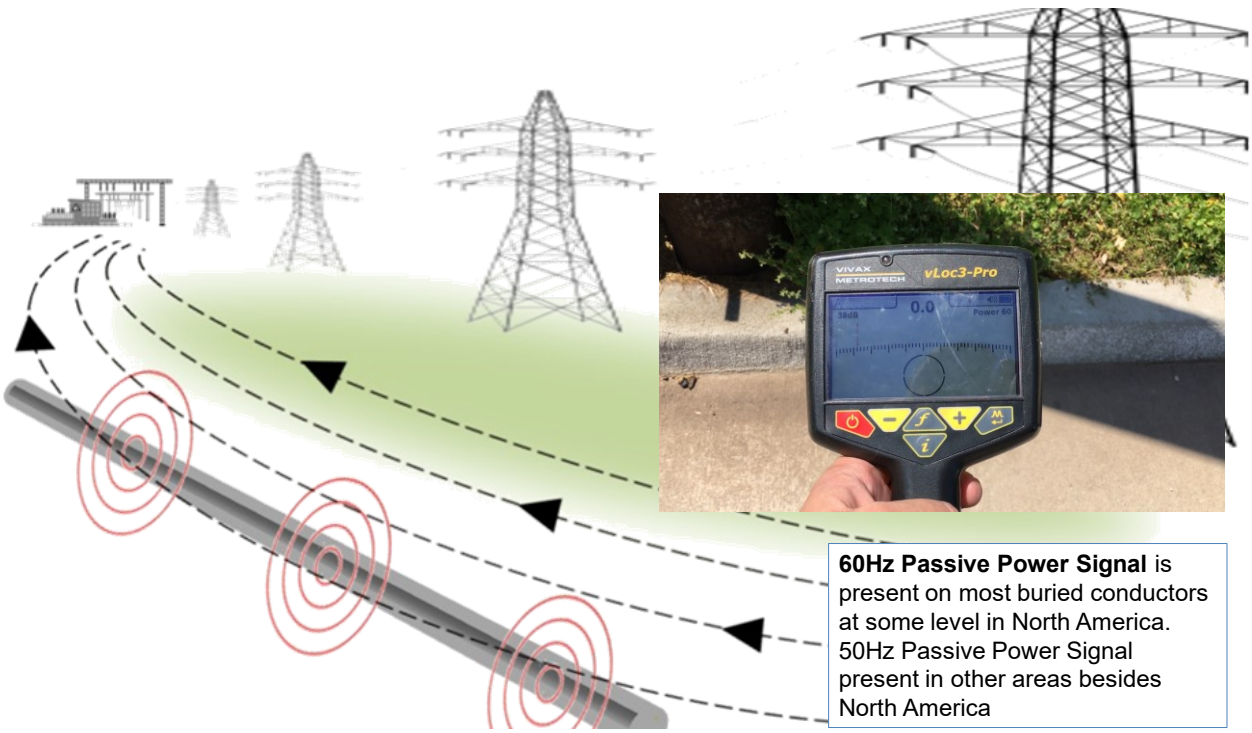

60Hz Passive Power Signal is present on most buried conductors at some level in North America. 50Hz Passive Power Signal present in other areas besides North America

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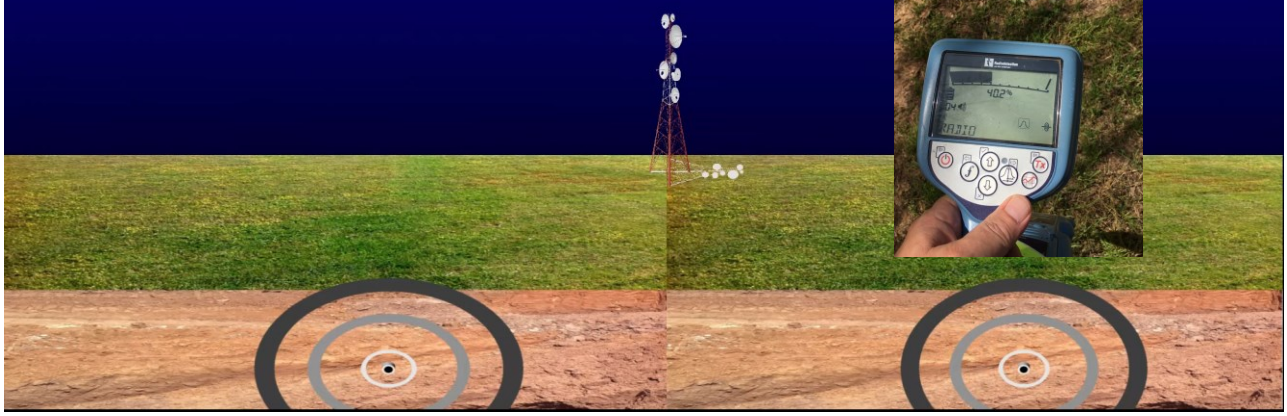
Cathodic Protection Signal
Created by Corrosion Prevention System
Channel CPS, CP120, 120Hz

29

29

Radio Signal Detection



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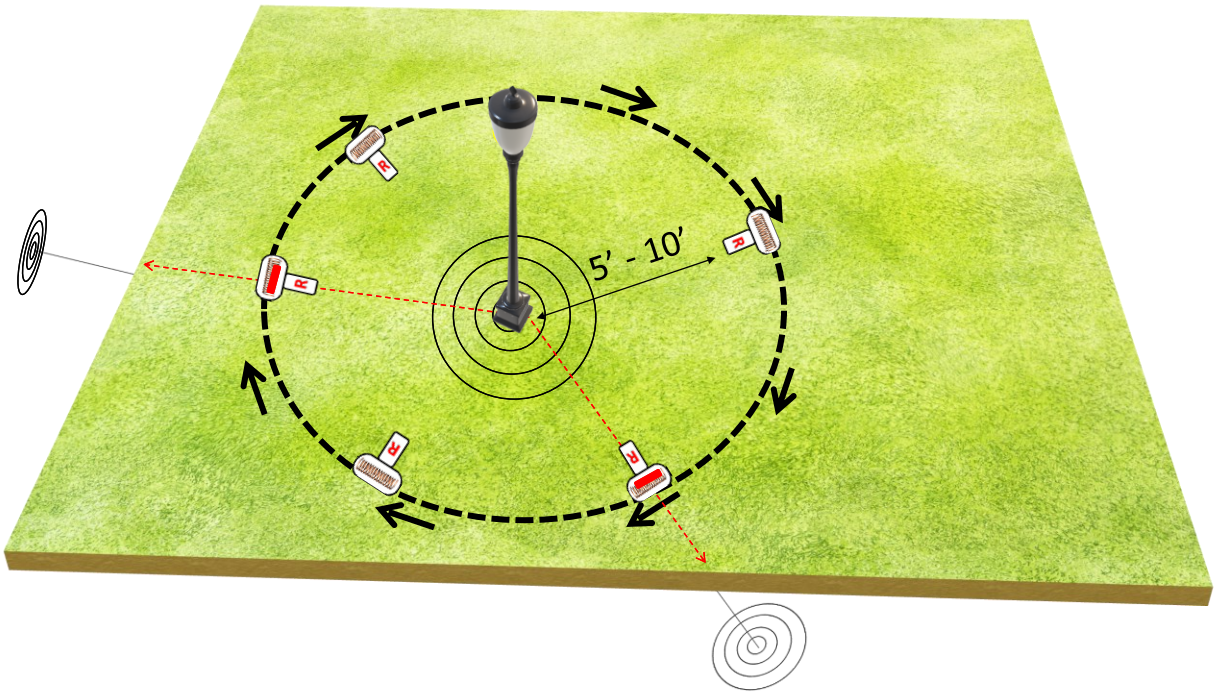

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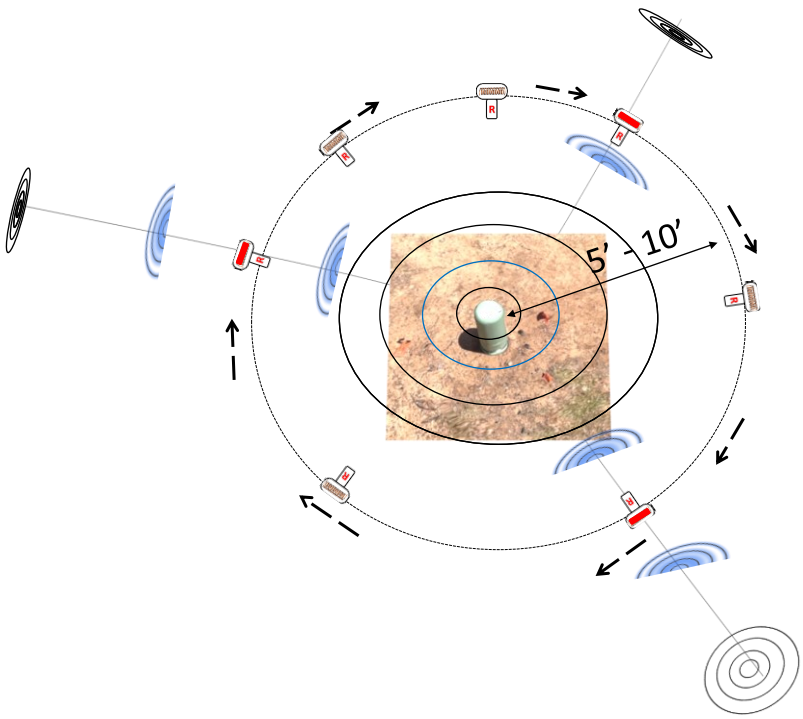

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EM Signal Receivers

- Detect signal fields broadcasting at a known frequency
- Designed to find (TDC) Top-Dead-Center of a perfectly round signal field
- Can estimate the location, orientation and depth of line along with current level of signal.
- Have auto or manual gain to adjust sensitivity

33

Signal Strength Reading

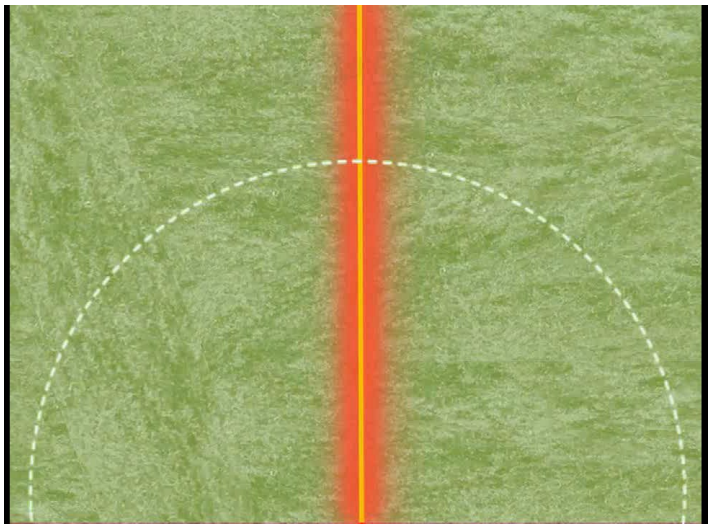
- Is a measurement of overall signal strength being detected by the signal receiver
- Signal strength level depends on the orientation of the receiver's antennas detecting the signal, the distance between the signal receiver and target/source
- The overall signal strength or intensity level of the signal at ground level and the sensitivity/gain setting of the signal receiver

PAINT ON PEAK !!!

34

Sweep Pinpoint and Trace

** PAINT ON THE PEAK OF THE SIGNAL*



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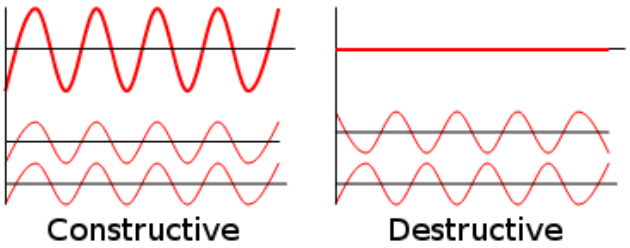

Signal Distortion or destructive waves

(Expected at Turns, Tees, Splices, Crossing Utilities, Above Ground Metal Objects)

Occurs when Electromagnetic signals of the same frequency and phase collide with each other. This causes distortion or in some cases signal cancellation

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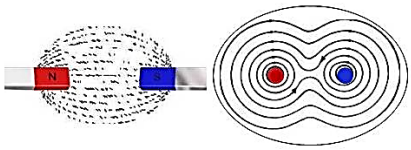
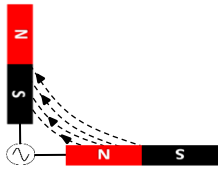
Understanding Signal Distortion and Signal Interference

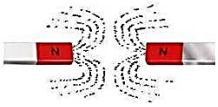
EM Signal fields are moving magnetic fields created by current and able to create electrical current on adjacent conductors.
Two EM Signal fields side by side will react the same as two stationary magnets place end to end, side to side or at and related angle

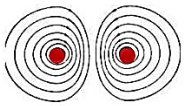
– Opposite fields attract

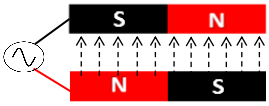




– Similar fields repel







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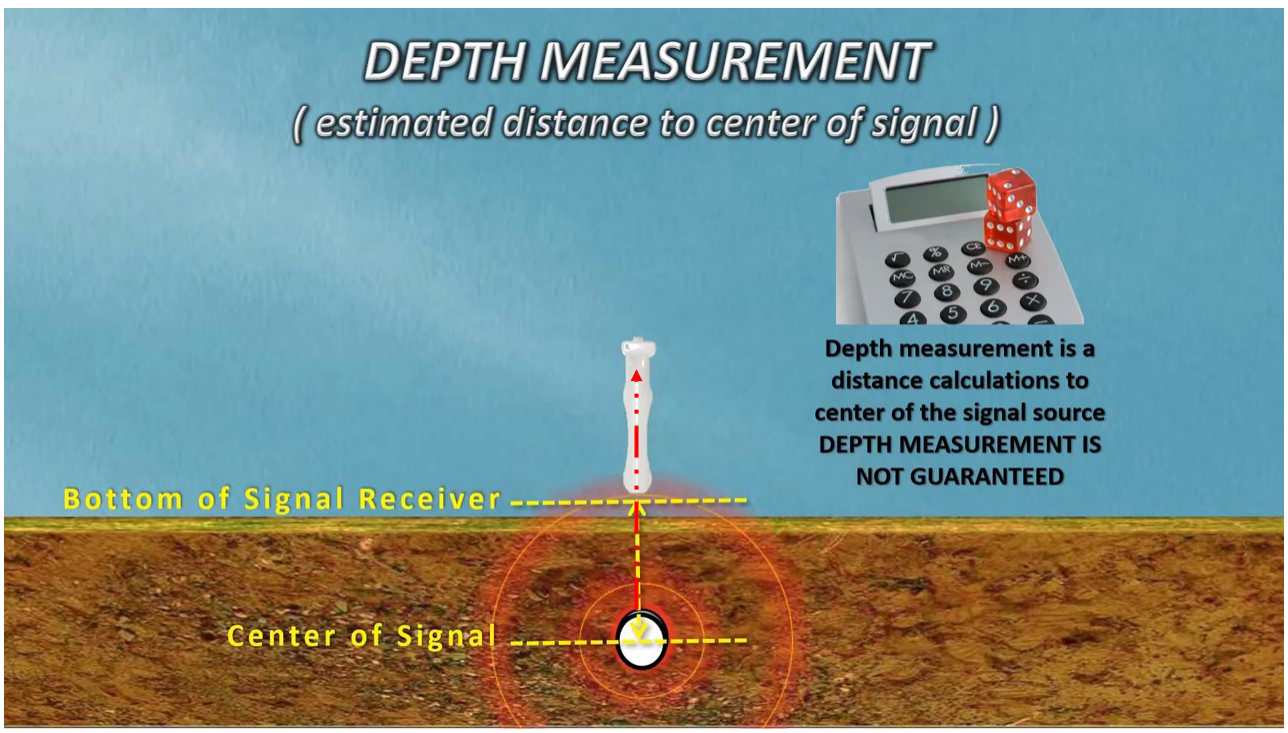

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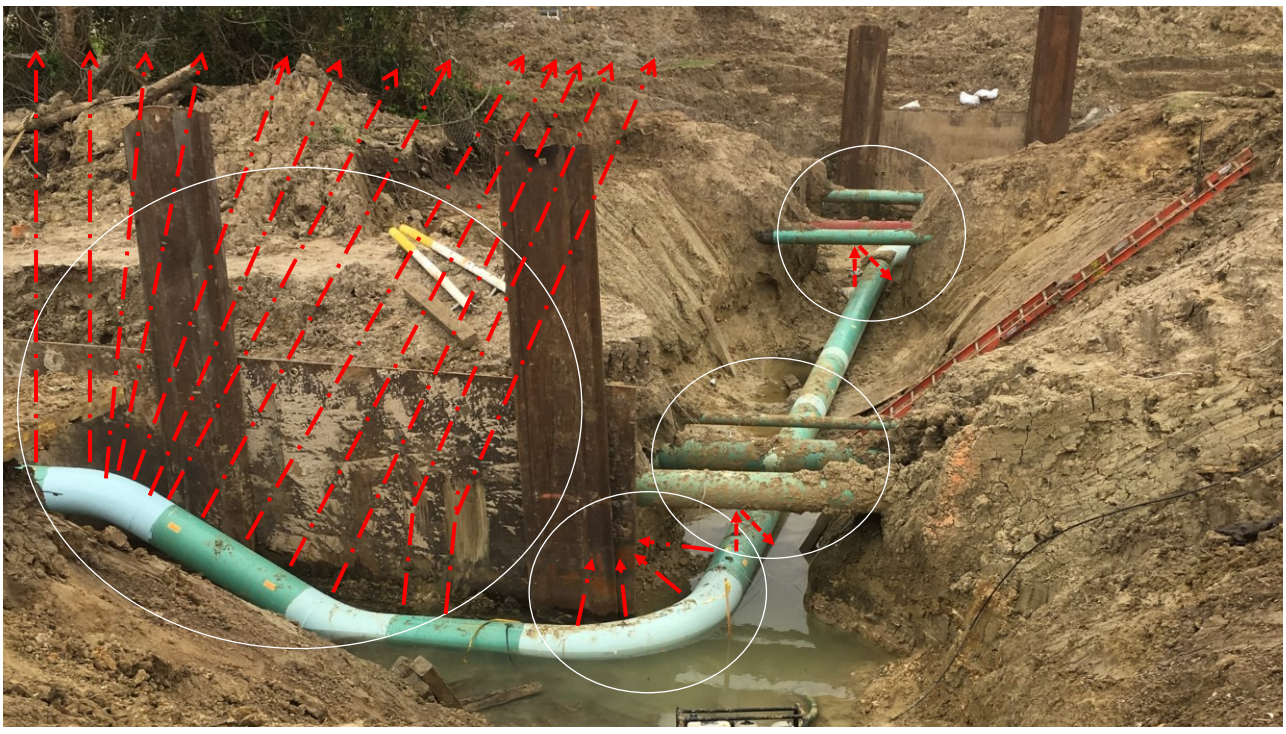
Steel toed boots and other metal objects can influence the depth measurement

39



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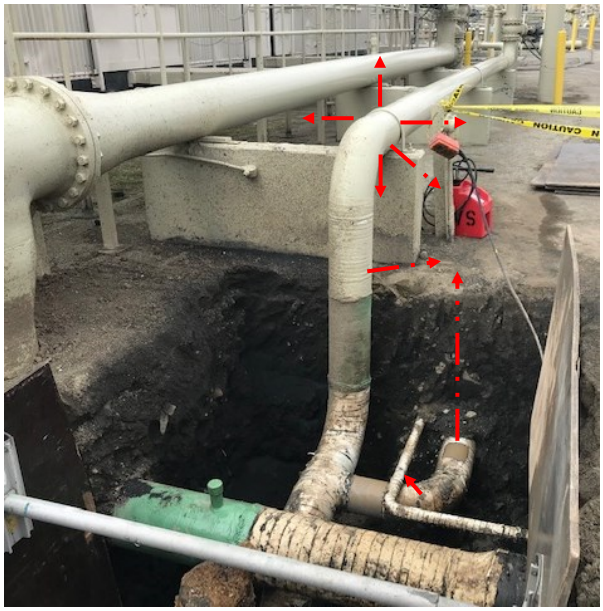

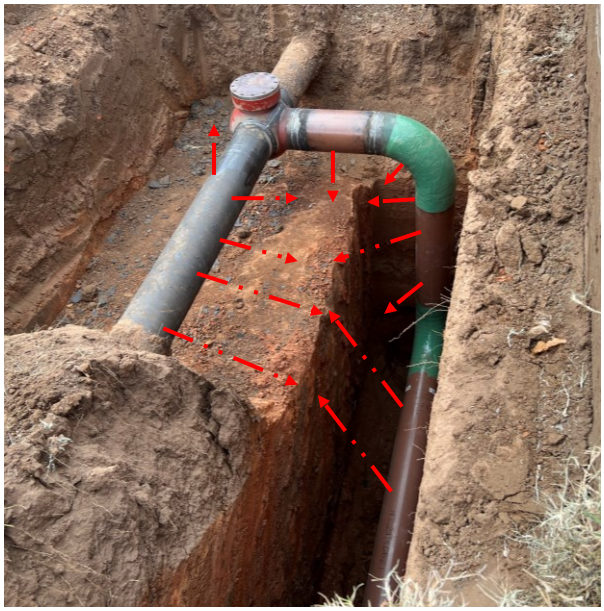

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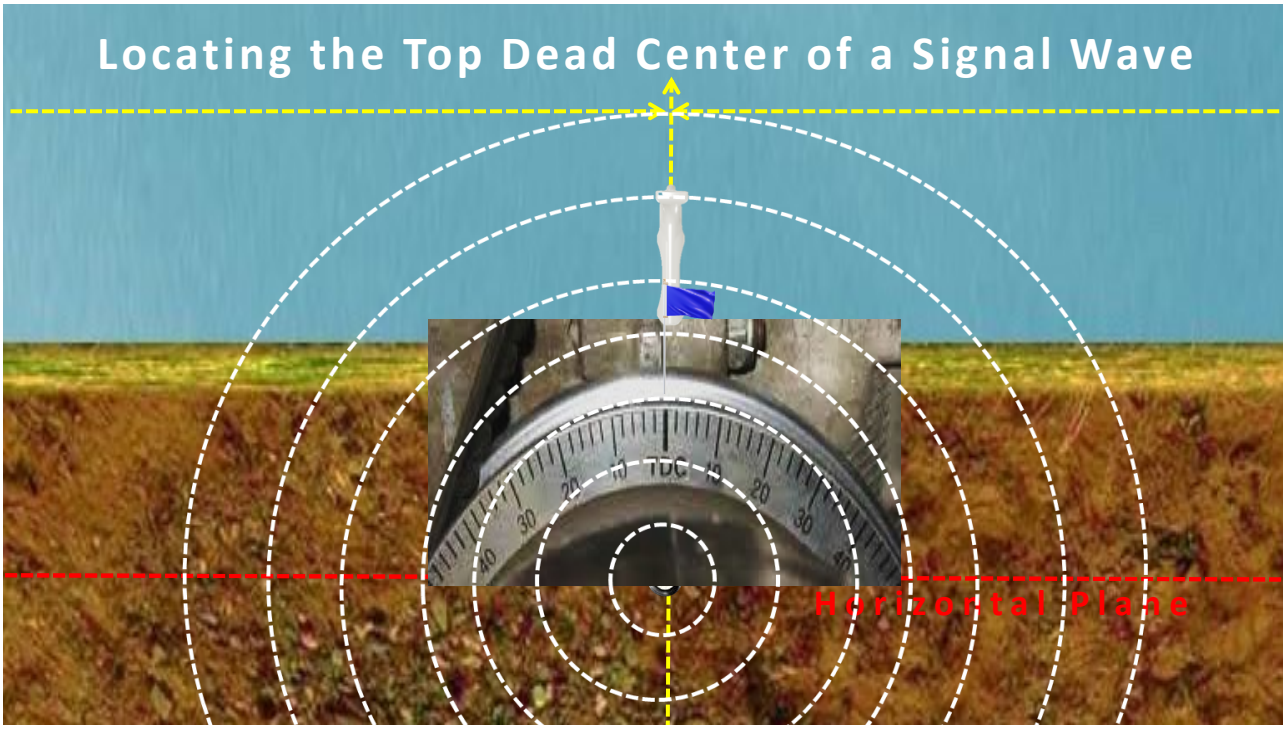
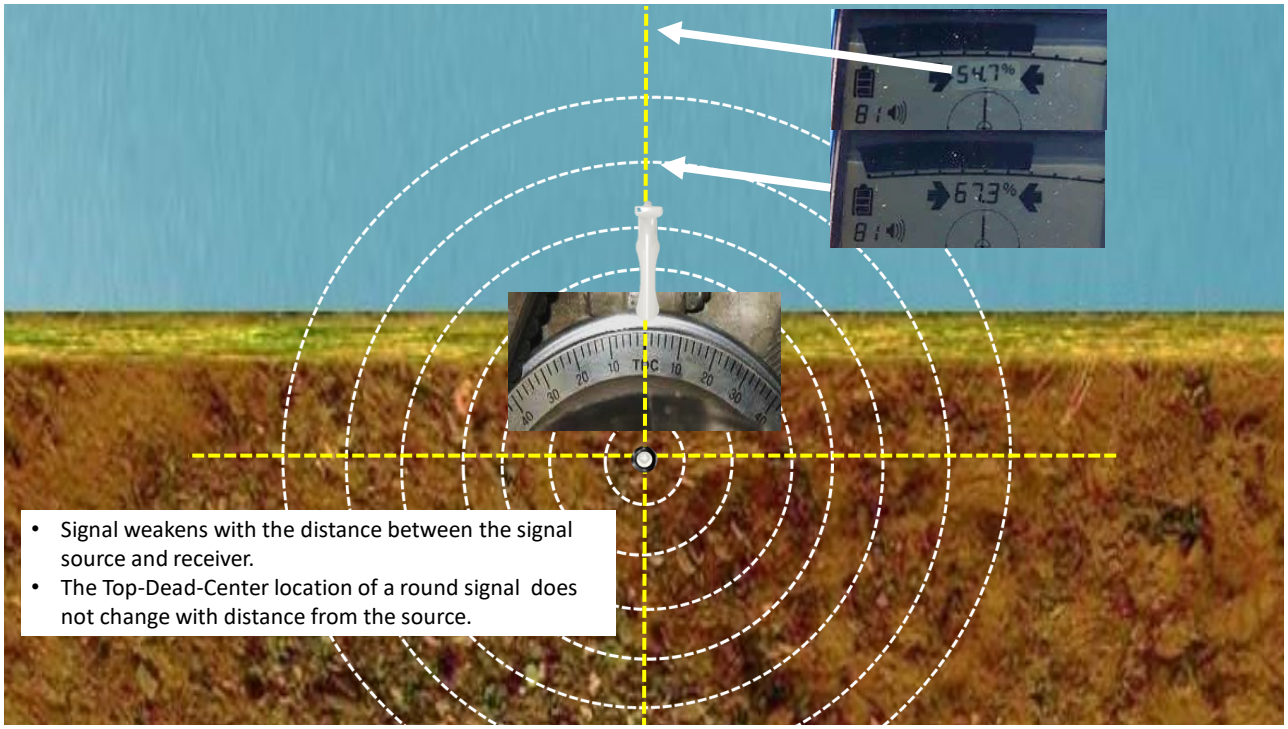
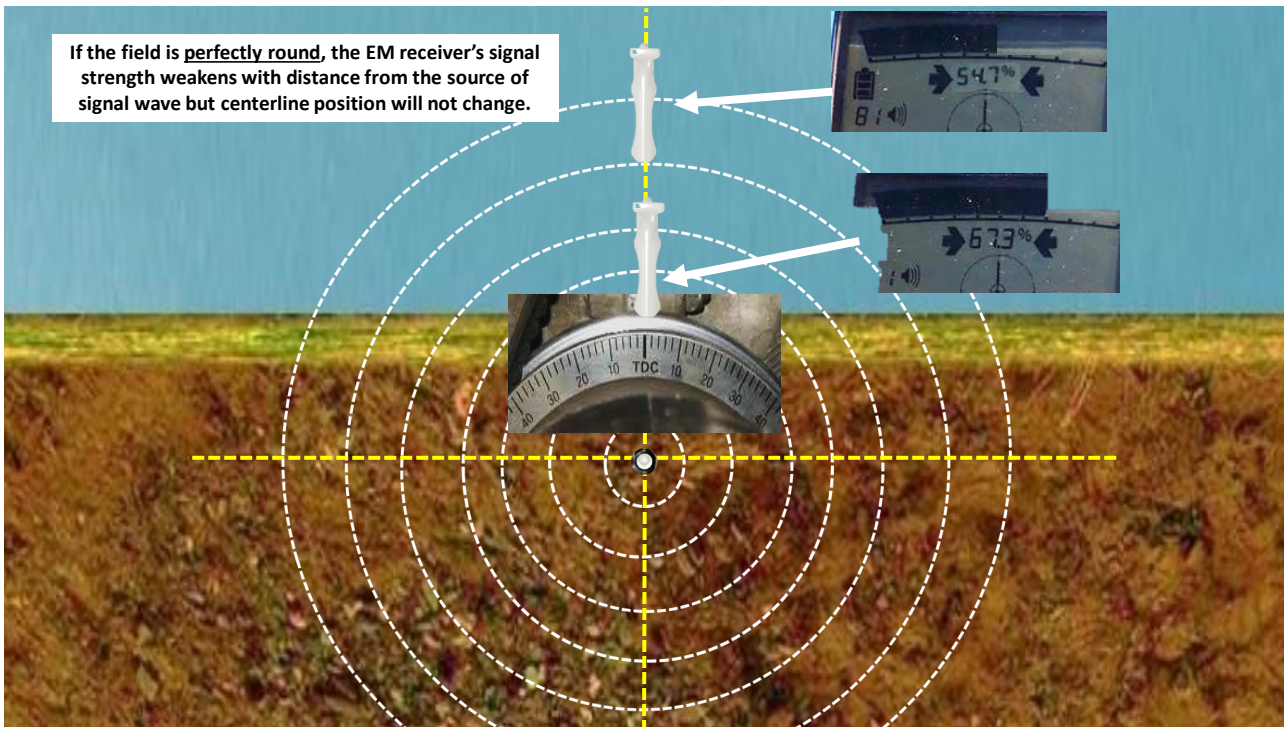

Locating the Top Dead Center of a Signal Wave
TDC
Horizontal Plane

42


54.7%
67.3%
TDC
• Signal weakens with the distance between the signal source and receiver.
• The Top-Dead-Center location of a round signal does not change with distance from the source.

43


If the field is perfectly round, the EM receiver's signal strength weakens with distance from the source of signal wave but centerline position will not change.
54.7%
67.3%
TDC

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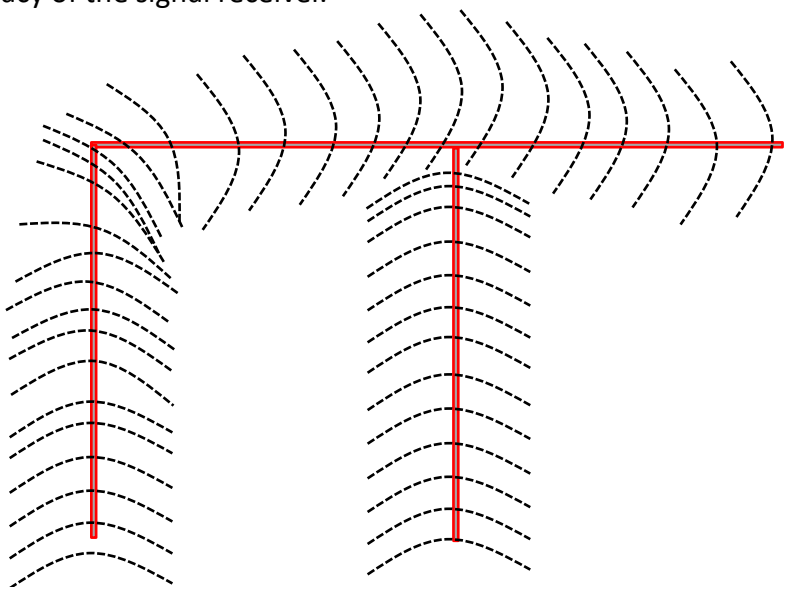
Signal Fields Collide but do not overlap. like a turn or a splice. The shape of the signal field can be impacted within 5’-10’ from the point of intersect. This can impact the accuracy of the signal receiver.



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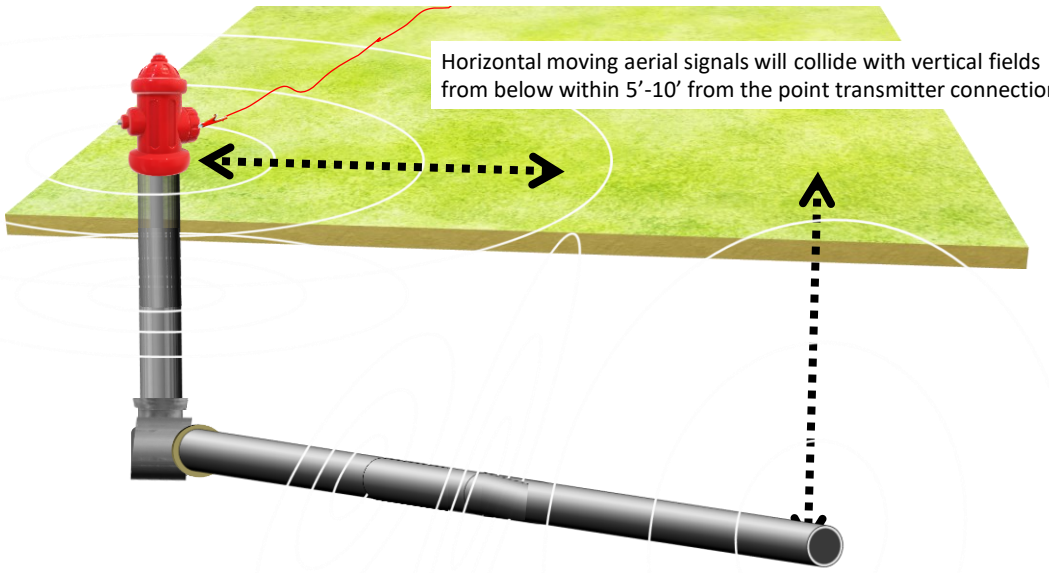

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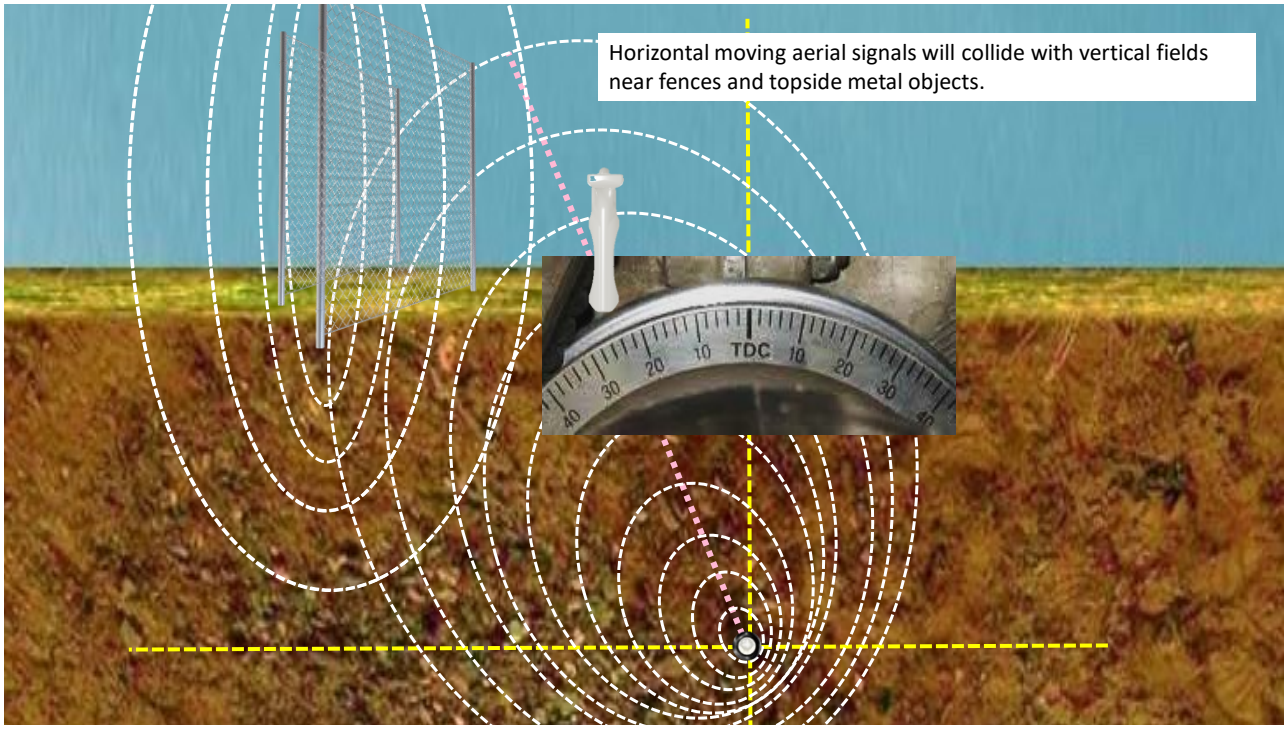
Horizontal moving aerial signals will collide with vertical fields near fences and topside metal objects.
TDC

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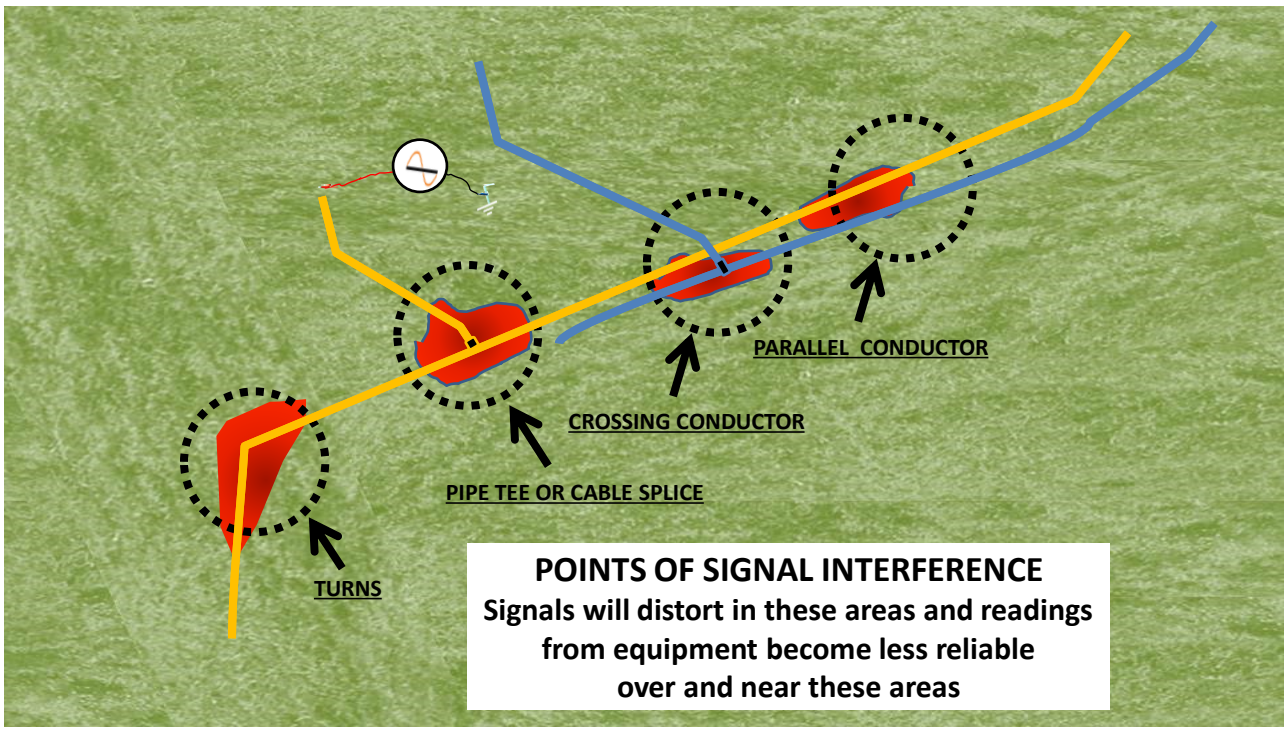
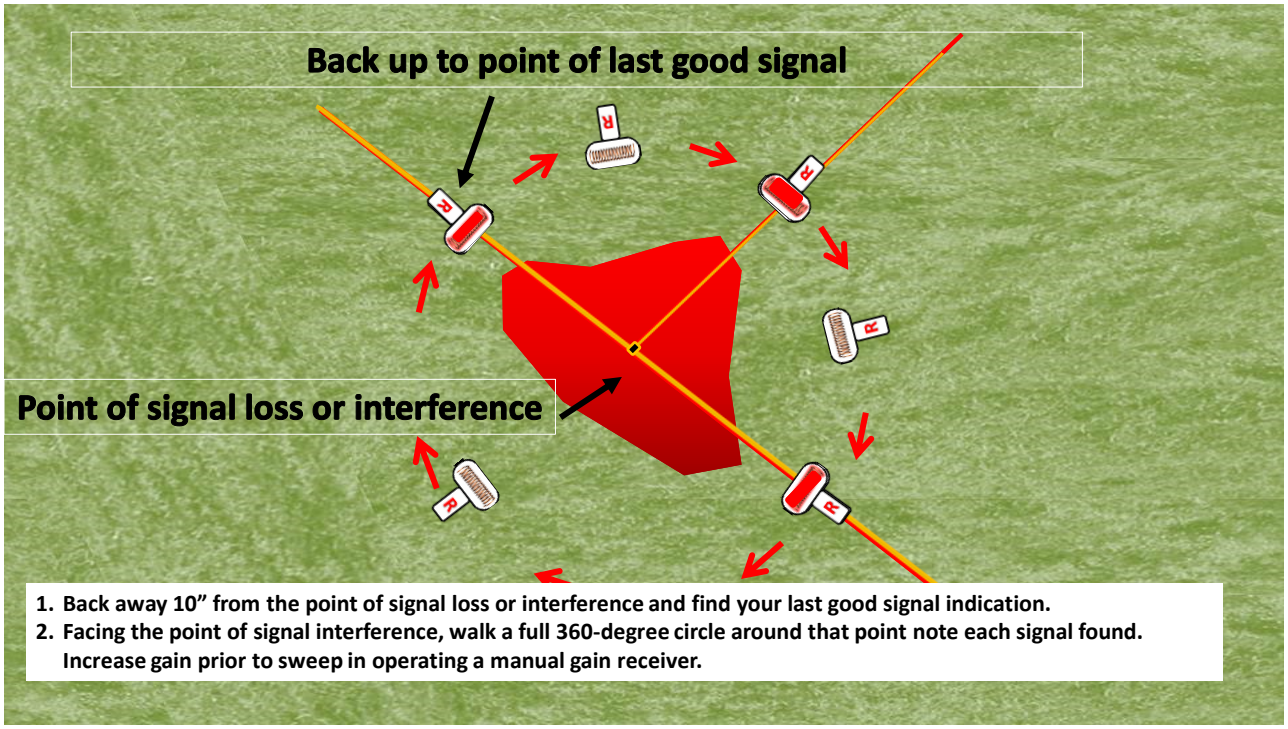
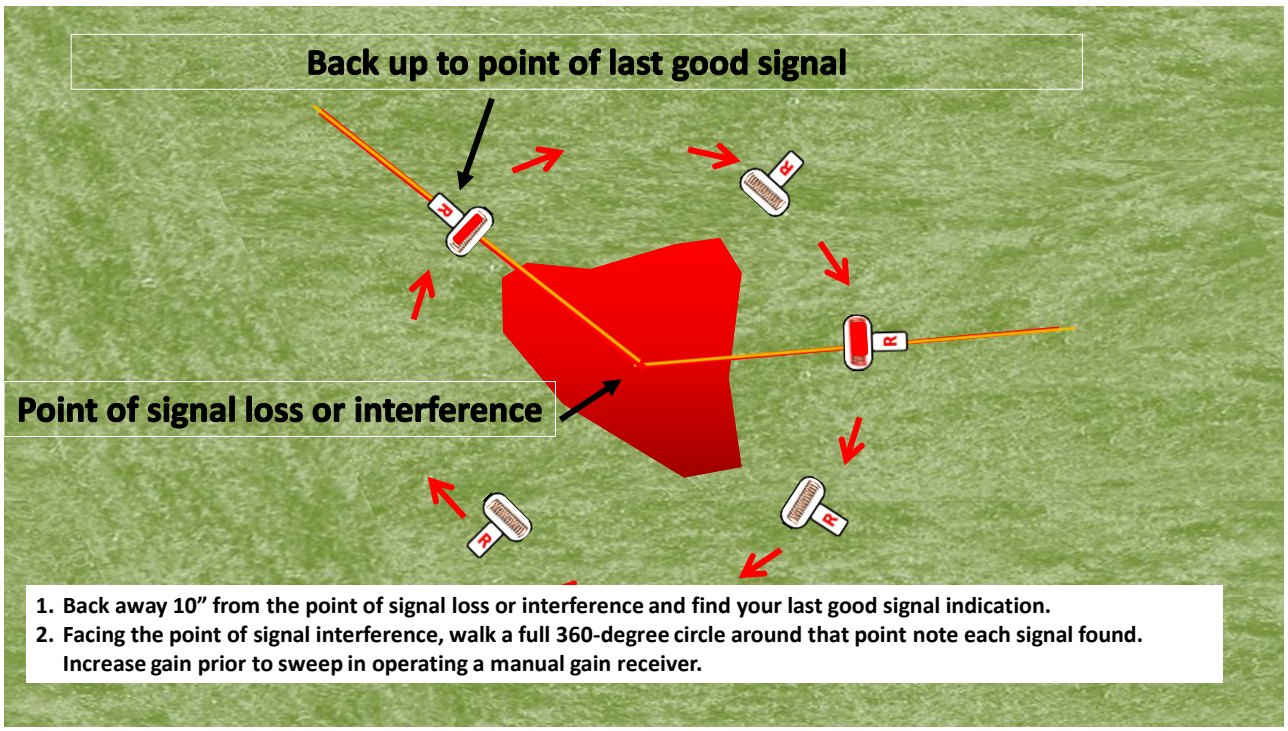

PARALLEL CONDUCTOR
CROSSING CONDUCTOR
PIPE TEE OR CABLE SPLICE
TURNS
POINTS OF SIGNAL INTERFERENCE
Signals will distort in these areas and readings from equipment become less reliable over and near these areas

48


Back up to point of last good signal
Point of signal loss or interference
1. Back away 10” from the point of signal loss or interference and find your last good signal indication.
2. Facing the point of signal interference, walk a full 360-degree circle around that point note each signal found. Increase gain prior to sweep in operating a manual gain receiver.

49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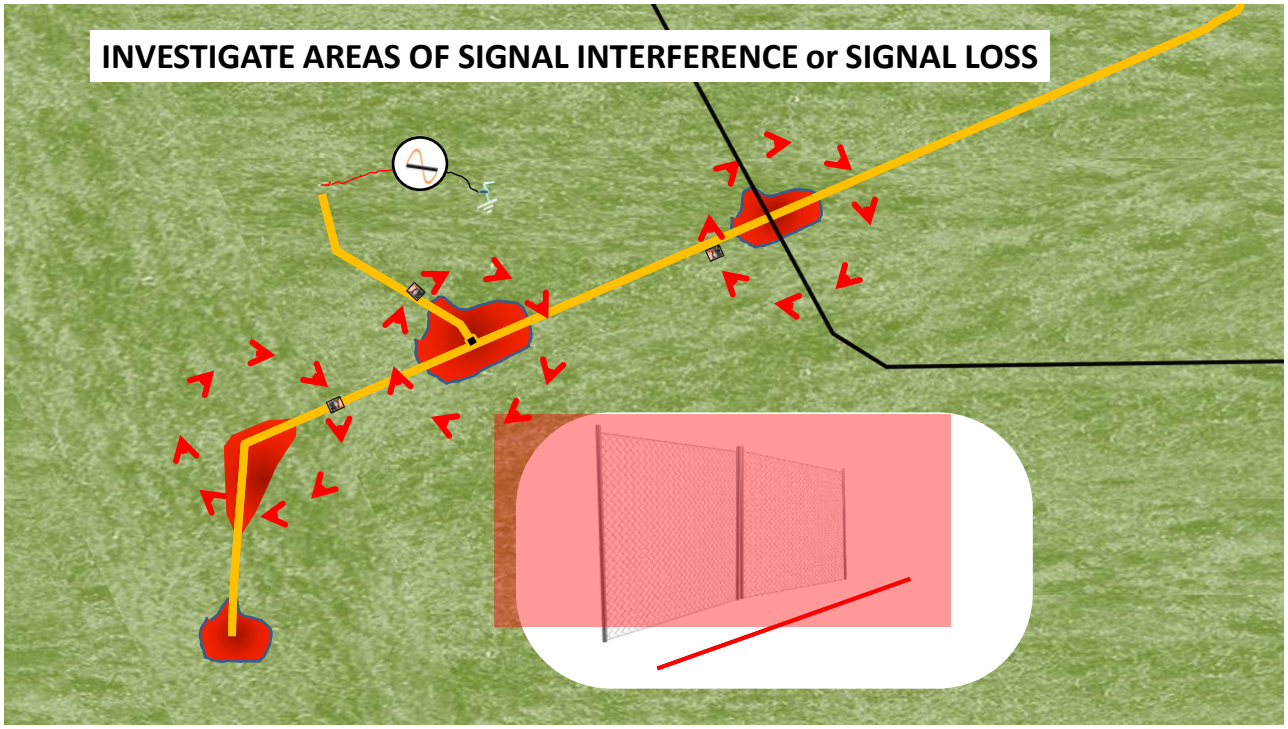
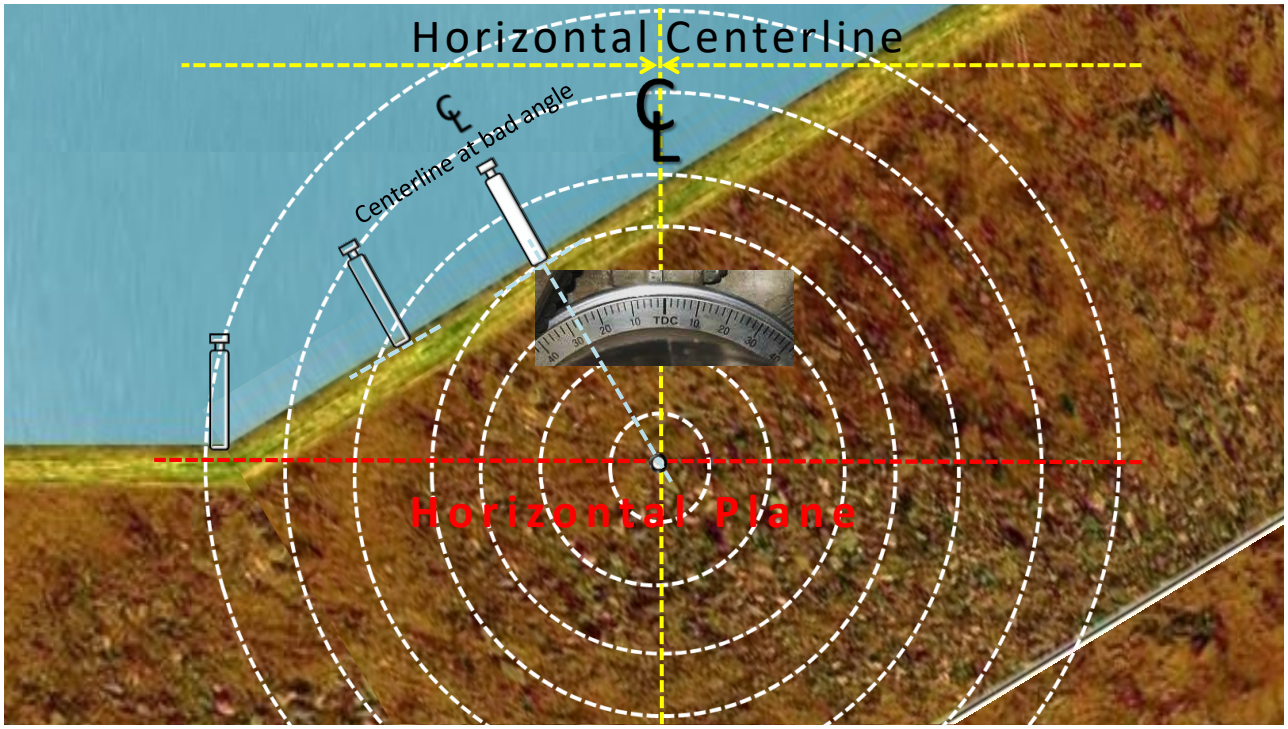
50


INVESTIGATE AREAS OF SIGNAL INTERFERENCE or SIGNAL LOSS

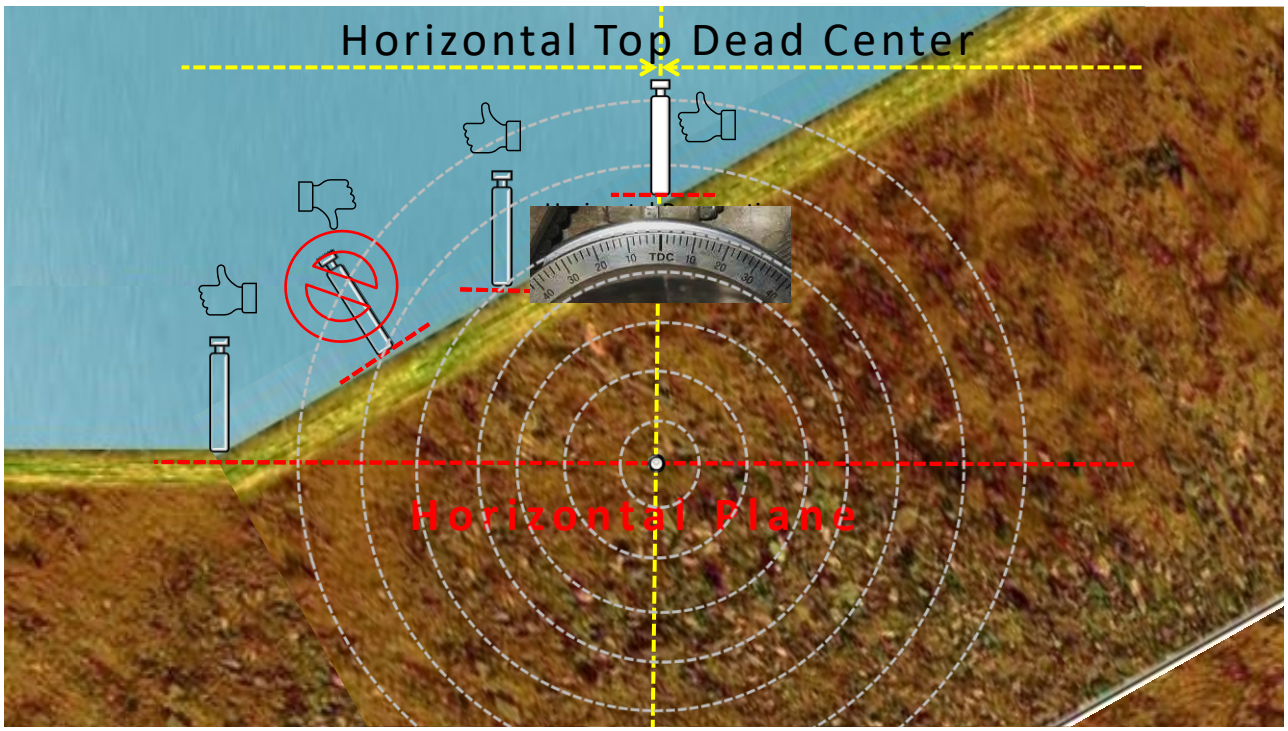
51


Locating Along A Slope

52


Horizontal Centerline
Centerline at bad angle
Horizontal Plane

53


Horizontal Top Dead Center
Horizontal Plane

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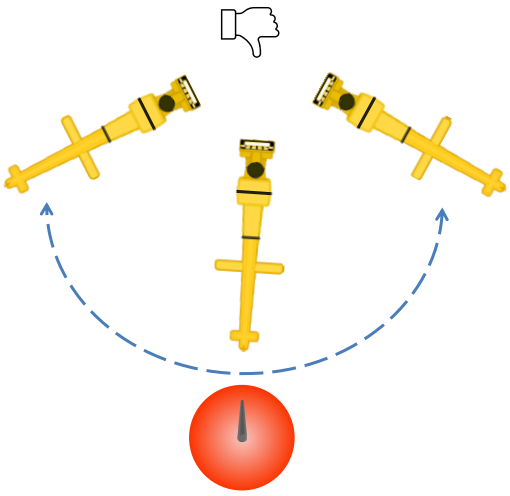
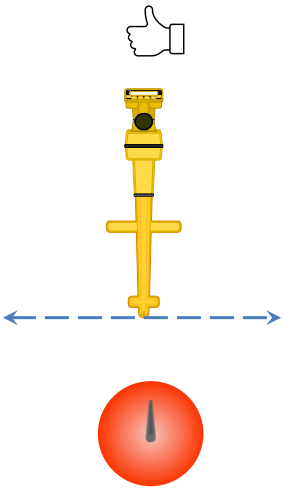
Tech Tip!
Keep Receiver Level when pinpointing and tracing

Avoid swinging your receiver



Move it evenly through the signal field



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