



Subsurface Solutions

Ground Graffiti Artist Supplies



Line Locating 101

Outline & Objectives



- How does a locator work?
- Why doesn't a locator work?
- How do I work a locator properly?
- How do I confirm my locate accuracy?
- What accessories do I need?
- What locator do I need?



Witching Sticks (dowsing rods)

Signal Circles – Magnetic Field



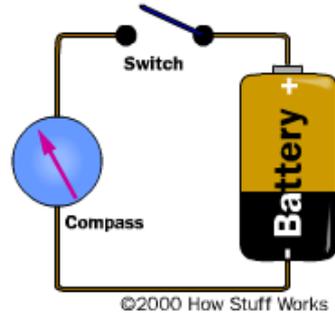


Electromagnetic Locators

Part 1: How does a locator work?



Electro-Magnetism



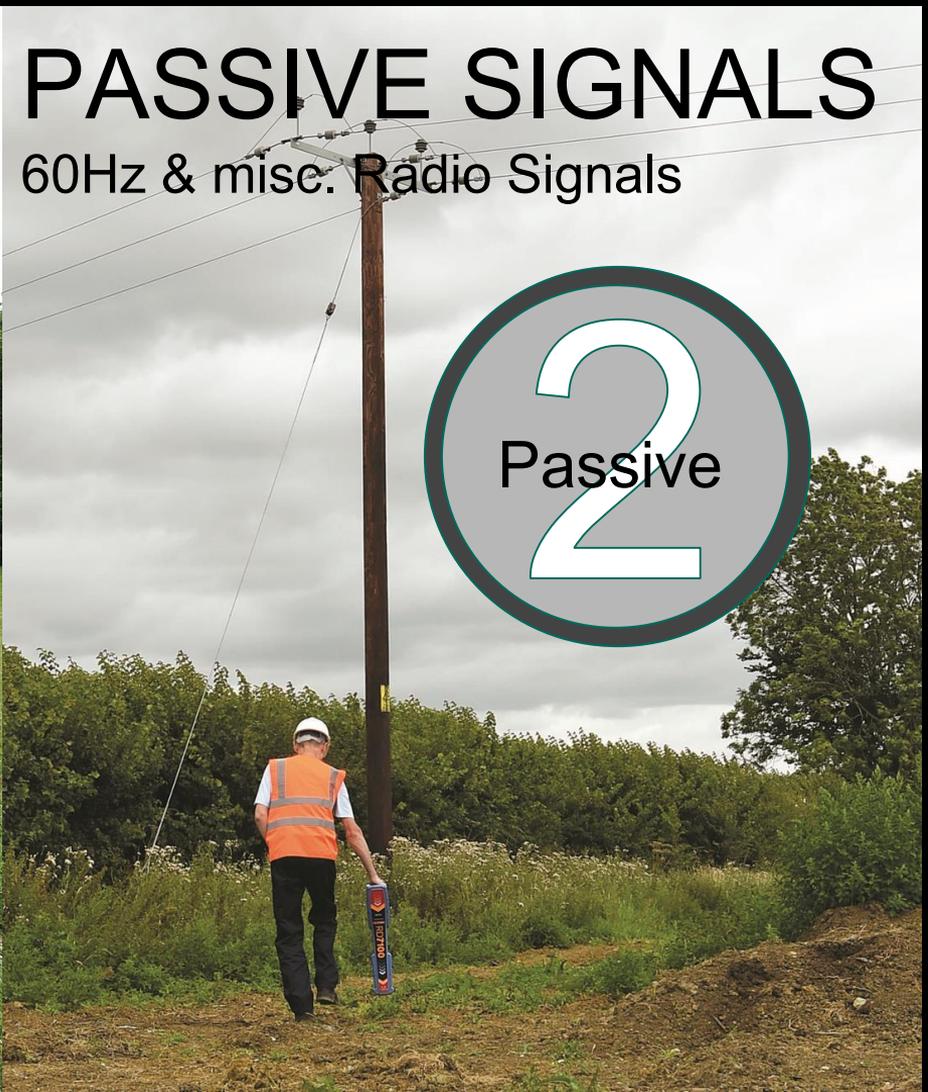
An oscillating electric field or alternating current (AC) produces a magnetic field. The moving electrons create a magnetic field surrounding the wire, and that field is strong enough to affect a compass.

Part 1: How does a locator work?

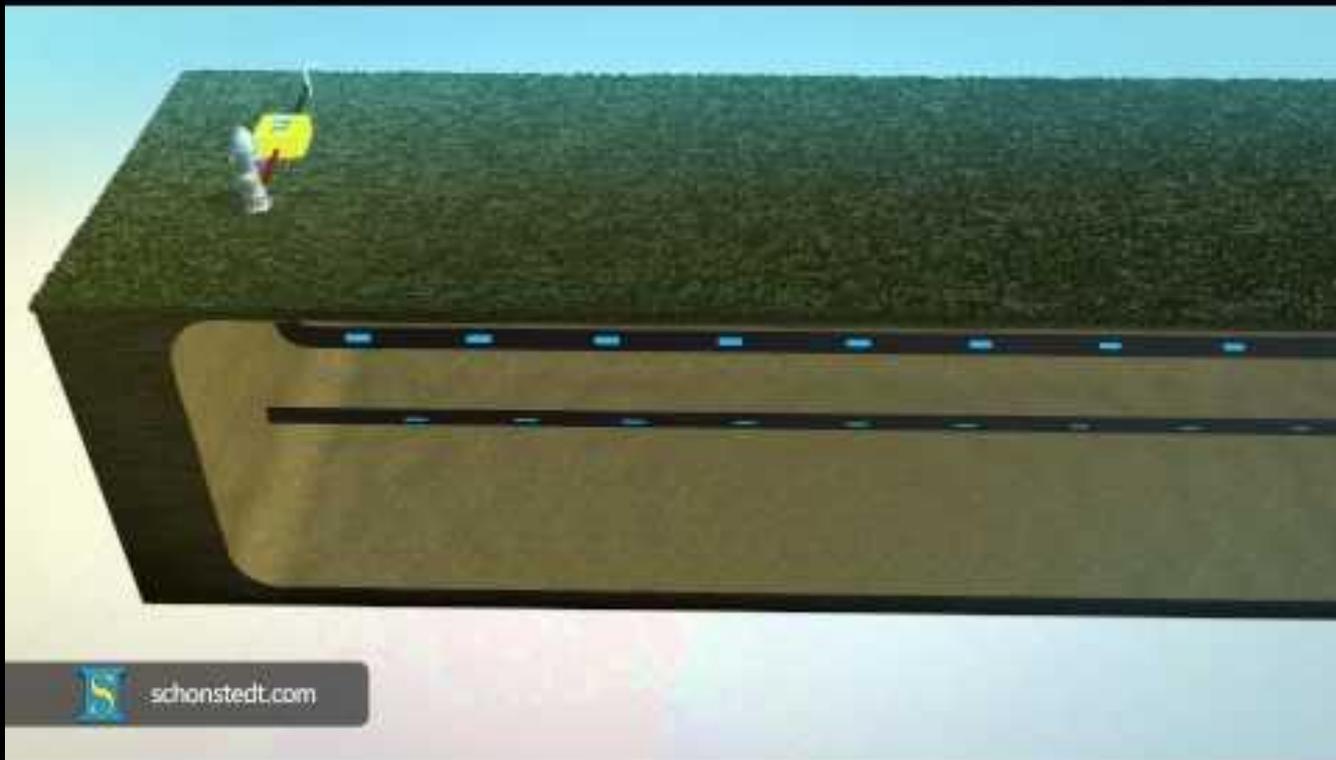


Advantages of Electro-magnetism

- Can locate through all soil types, asphalt and cement
- Measure depth much deeper, but less accurate at deeper depths
(accuracy is <5% under 10ft and >5% after 10ft)
- Measure current
- Measure current direction
- Isolate your target line



Active & Passive Locating

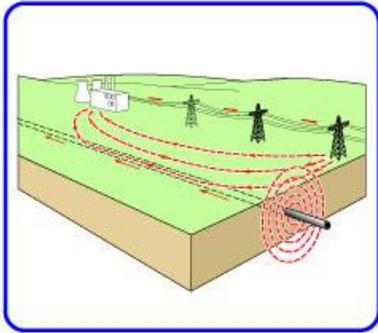




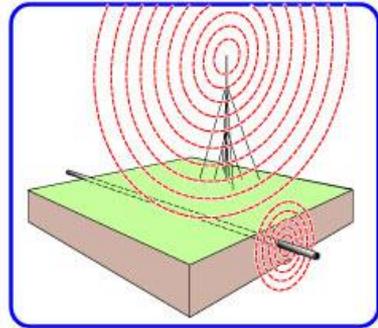
Part 1: How does a locator work?

Passive Signals

Passive signals are naturally present in many conductors and buried metal utilities. There are two types of passive signals:

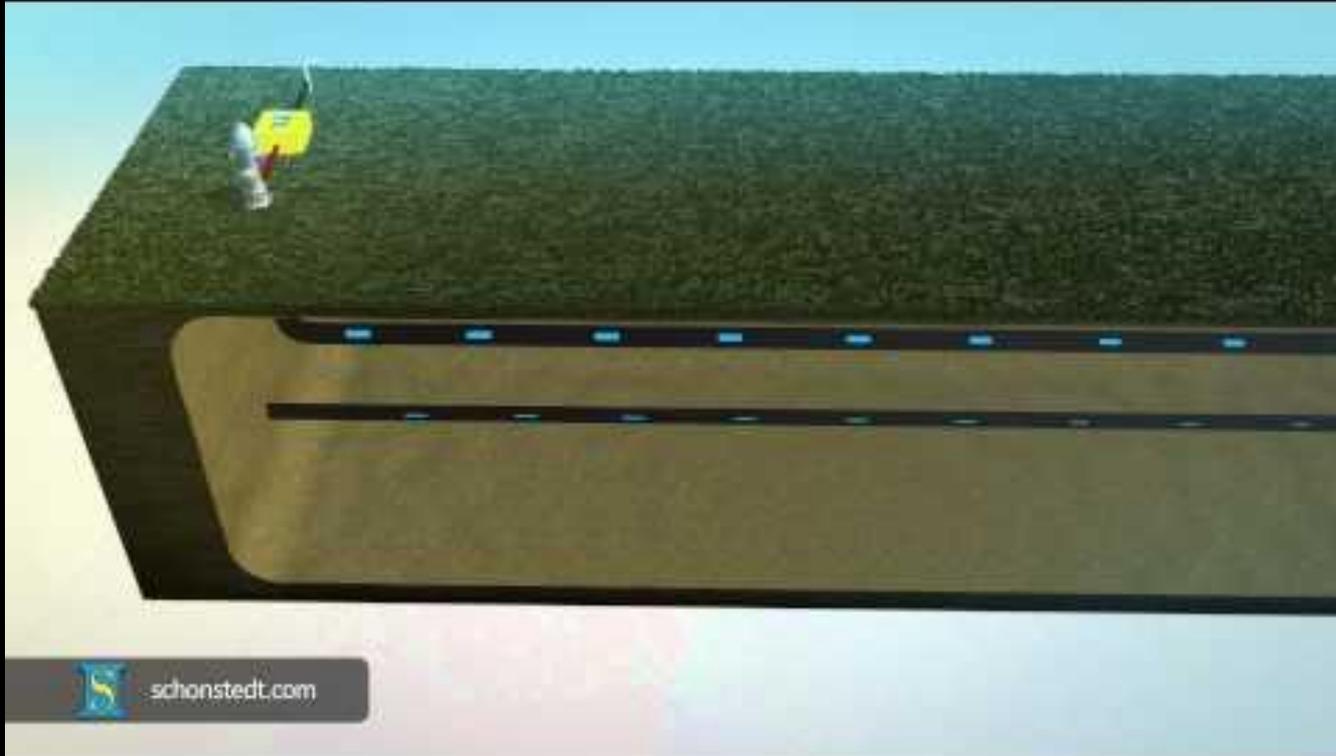


POWER: Current-carrying power cables radiate a signal at 50/60Hz, is a passive locate frequency that doesn't require a transmitter.



RADIO: Long wave radio transmissions penetrate the ground and flow as radio frequency currents along buried pipes and cables.

Passive Locating

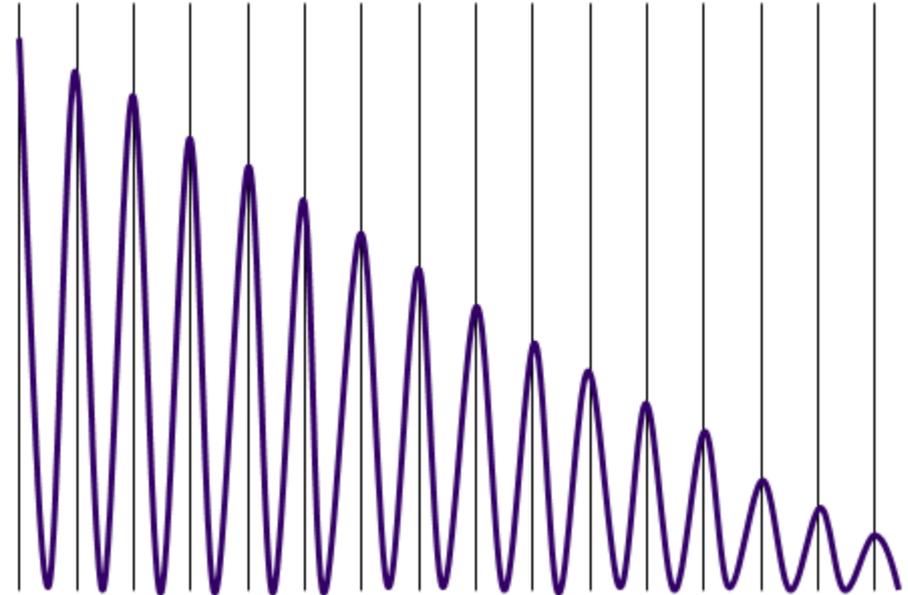


Passive Signals – Power Mode

- Broadband ‘comb’ filter detects every mains harmonic up to 1 kHz
- More energy into the antennas = more sensitivity than single harmonic locates for a given signal

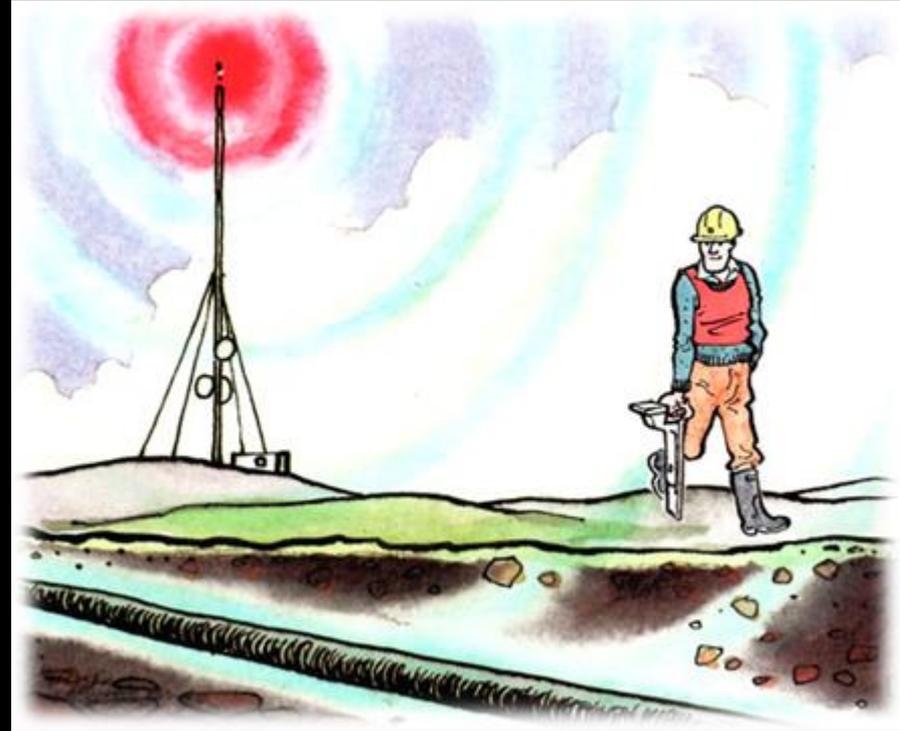


60 120 180 240 300 360 420 480 540 600 660 720 780 840 900 960 Hz



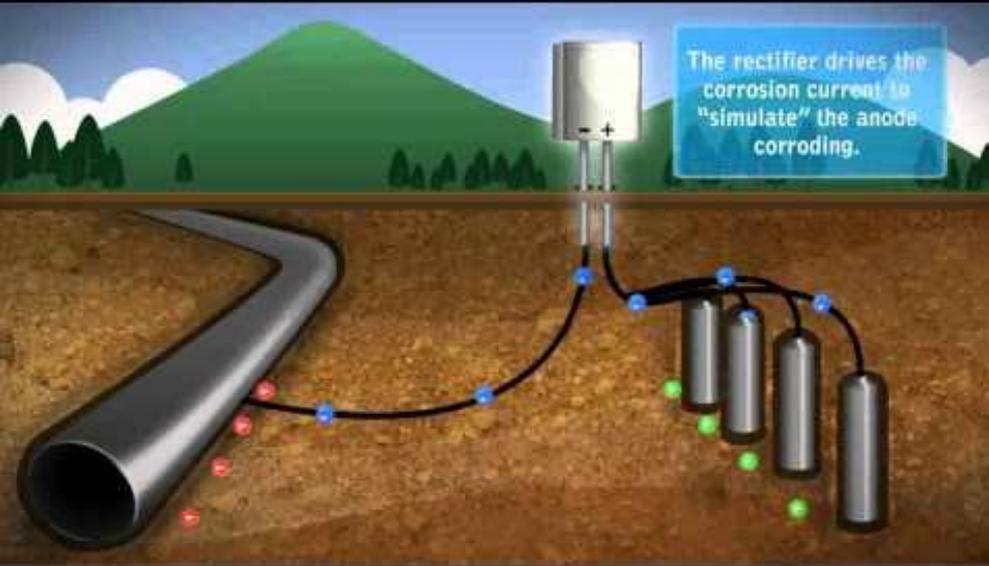
Passive Signals – Radio Mode

- Radio frequencies traveling around the earth couple onto existing cable, pipes or anything conductive.
- Locates a wide band of frequencies - 15kHz to 29kHz

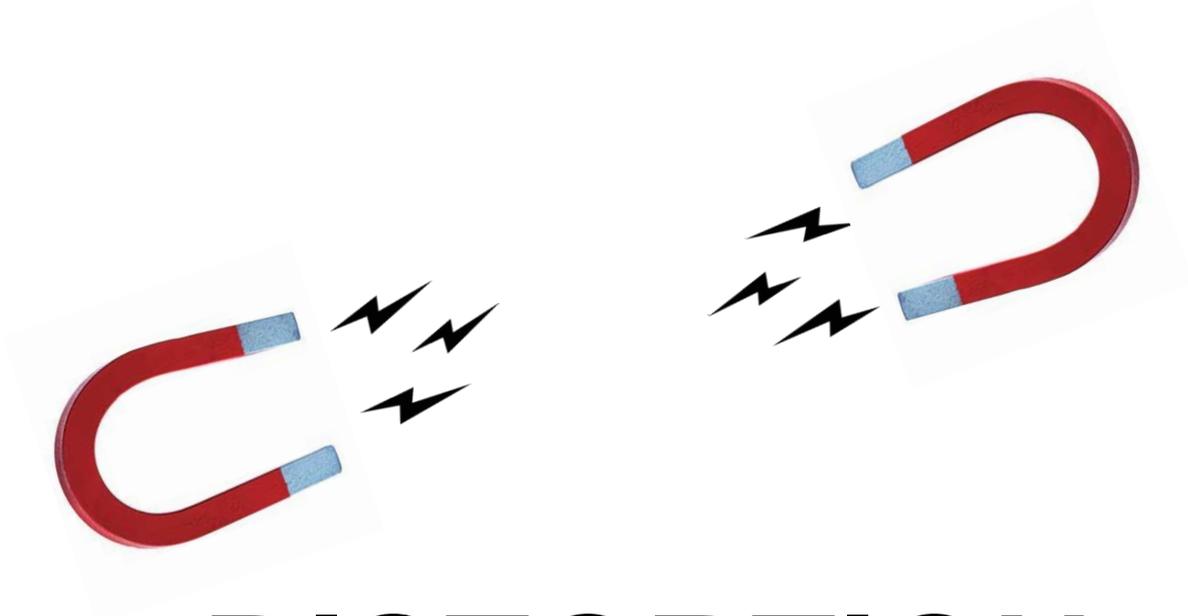


Passive Signals – CPS Mode

Rectifiers impress DC current that simulates 120Hz on the pipe.



Part 2: Why doesn't a locator work?

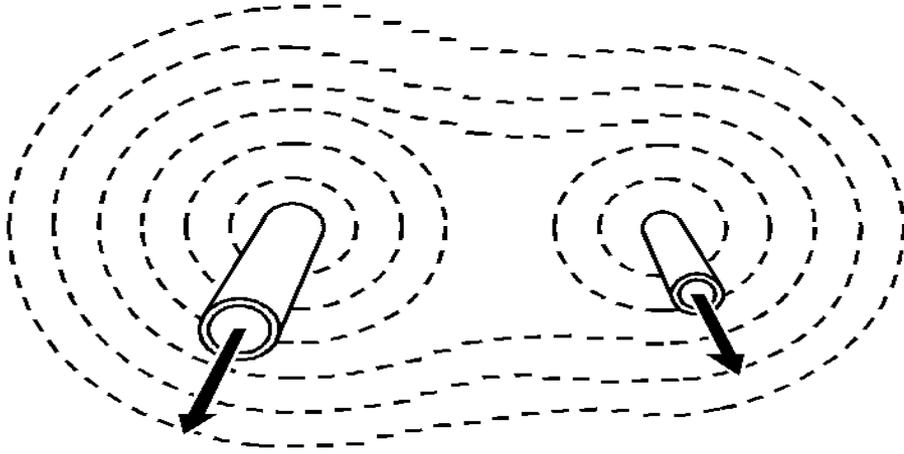


DISTORTION



Part 2: Why doesn't a locator work?

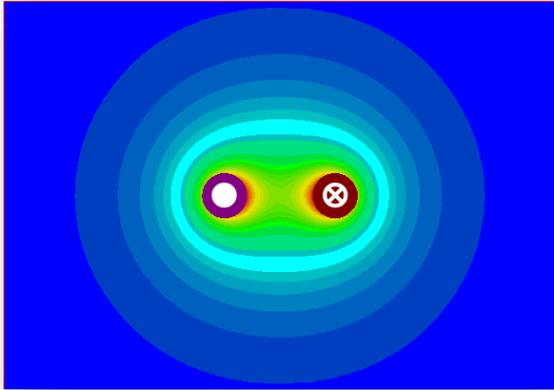
Congestion



When the conductors are close together, the magnetic fields can interfere with each other, causing a distorted field which is no longer cylindrical. This can lead to poor locate results and inaccurate measurements.

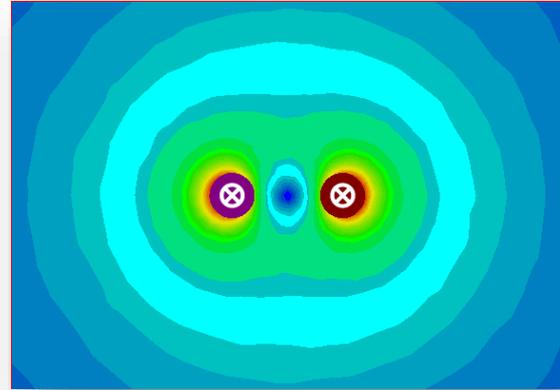
Part 2: Why doesn't a locator work?

Congestion – Constructive Interference



Part 2: Why doesn't a locator work?

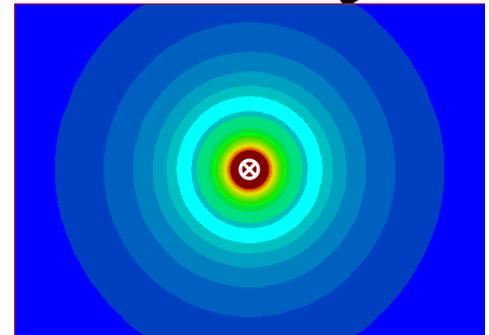
Congestion – Destructive Interference





Part 2: Why doesn't a locator work?

How do I keep the locate signal cylindrical?



Part 3: Why doesn't a locator work?



LOCATE SIGNALS ARE AFFECTED BY:

- 1. METHOD OF SIGNAL APPLICATION**
- 2. GROUNDING**
- 3. PEAK OR NULL**
- 4. CONGESTION**
- 5. FREQUENCY APPLIED**

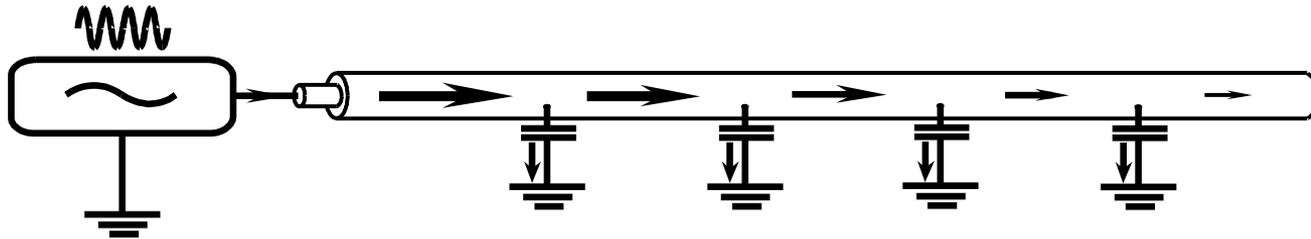
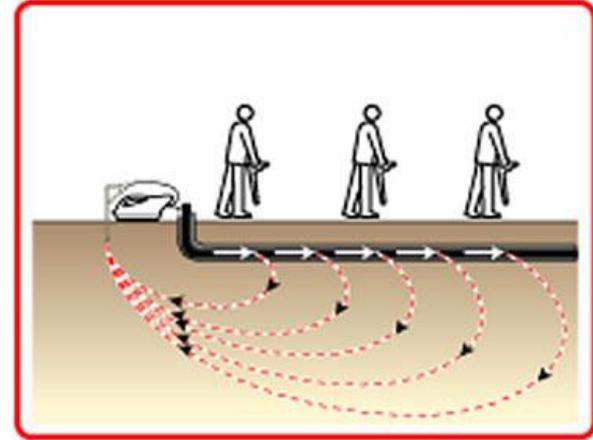


Part 3: How do I work a locator properly?

Active Locating

Direct Connect Locating requires three components;

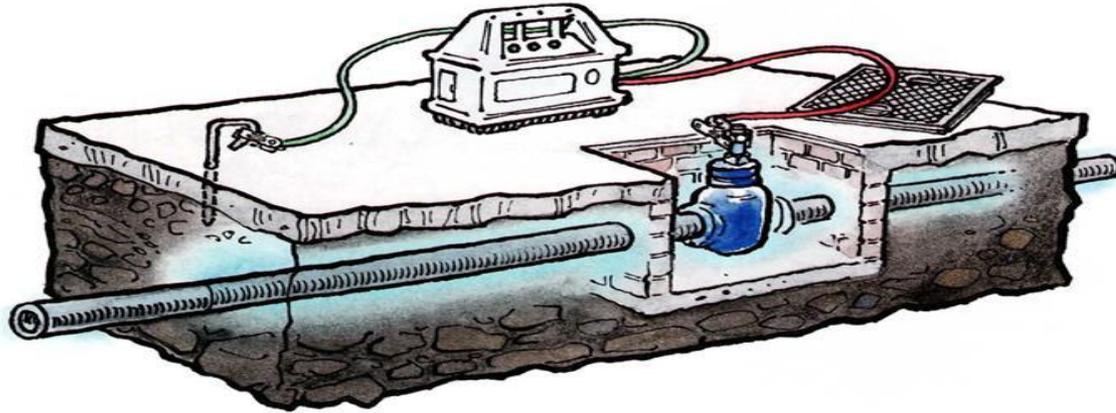
1. A transmitter or signal source
1. A metallic conductor
1. A return path. Ideally, the earth.





Part 3: How do I work a locator properly?

Active Locating - Grounding & Hookup Points

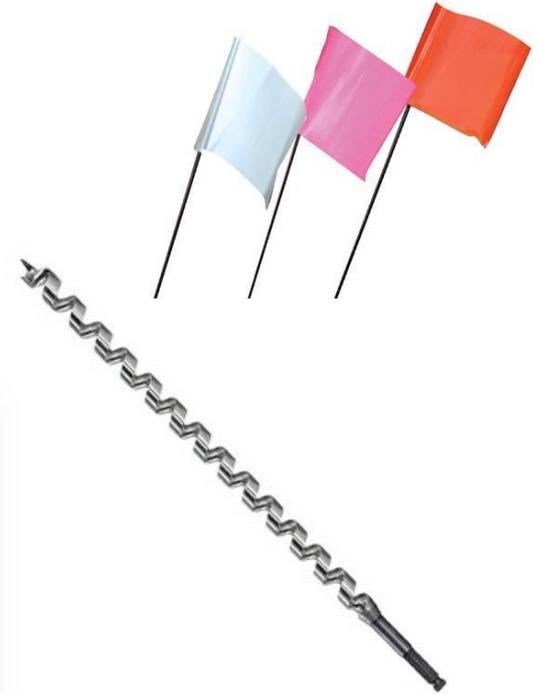


What you ground to and where you place the ground can significantly affect your results. **Ground rods should be placed at 90 degrees from the target line. The cables and transmitter should also be placed away from the target line.**



Part 3: How do I work a locator properly?

Active Locating - Grounding & Hookup Points





Part 3: How do I work a locator properly?

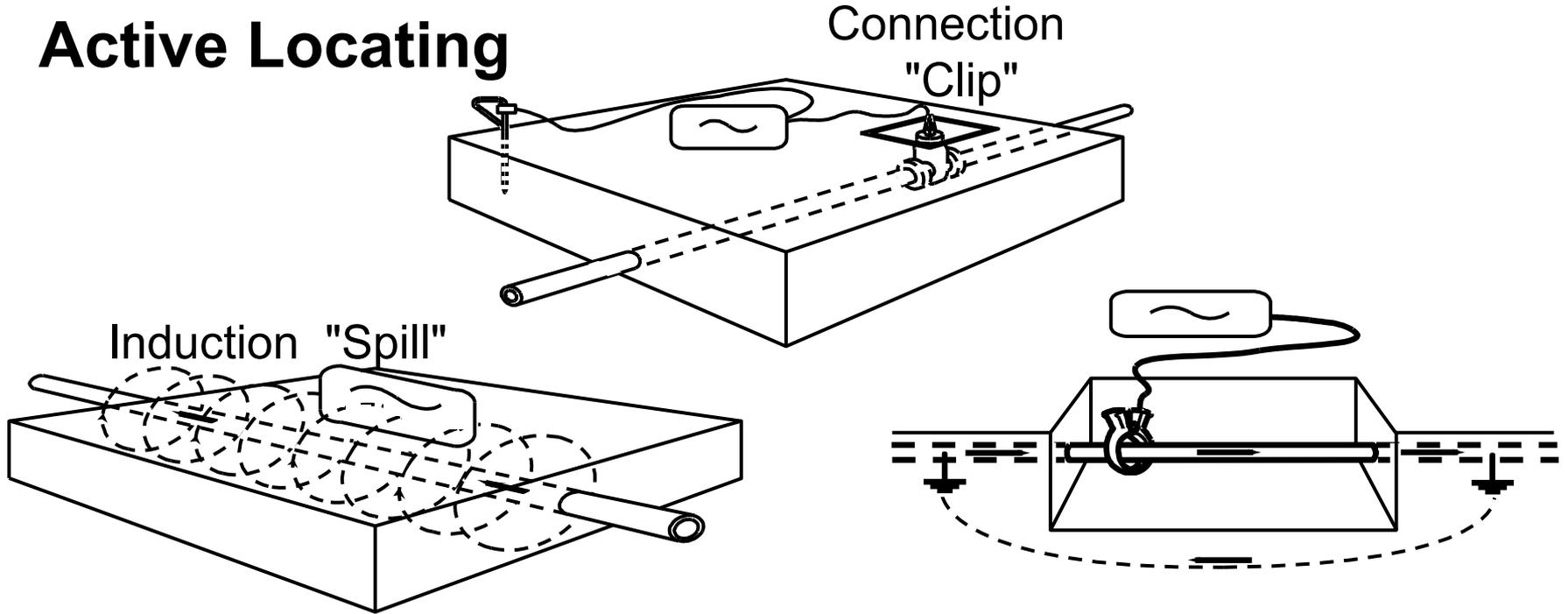
Hook up points





Part 3: How do I work a locator properly?

Active Locating



There are three main methods of Active Signal Application.

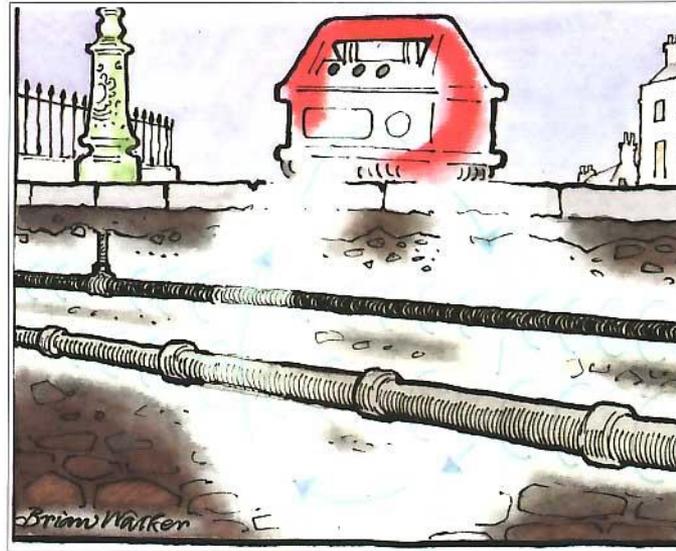


Induction allows the user to quickly and easily apply a locate signal, by placing the transmitter in the vicinity of a known conductor or conductors.



Part 3: How do I work a locator properly?

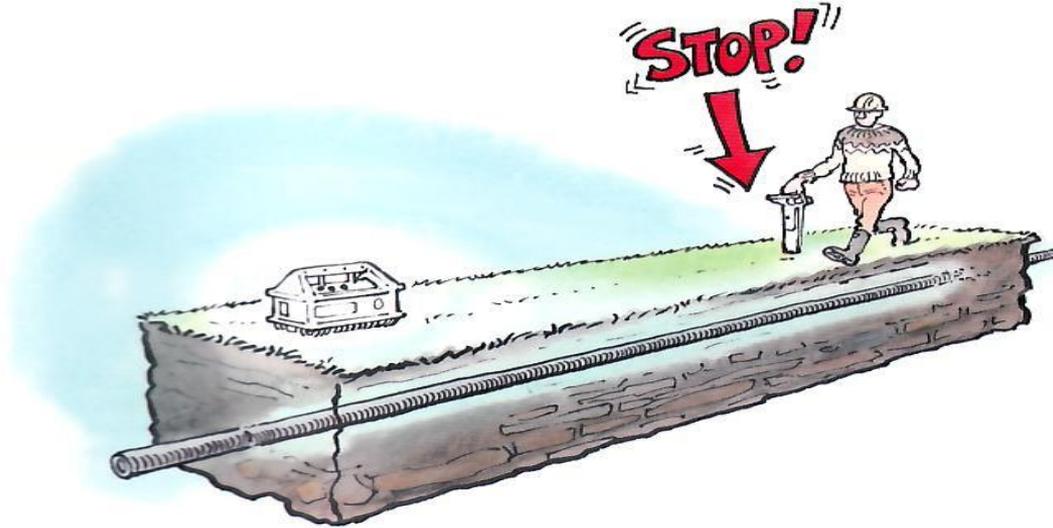
Induction



Induction may apply signal into more than one pipe or cable. **It should only be used if connecting or clamping isn't possible!**



Part 3: How do I work a locator properly? Induction



Always use the receiver 30 feet away from the transmitter so it doesn't pick up airborne signals directly from the transmitter.

Part 3: How do I work a locator properly?

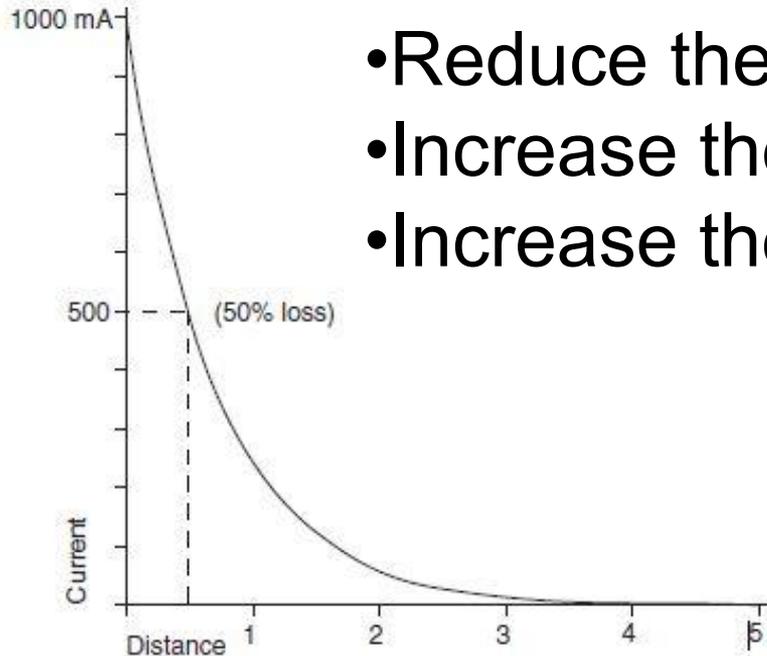


How far can a transmitter signal be traced?



Part 3: How do I work a locator properly?

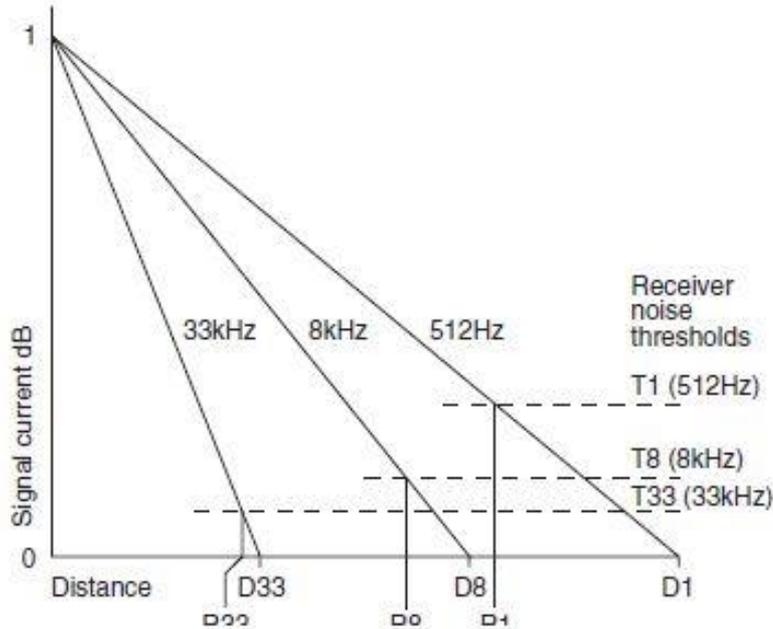
How far can a transmitter signal be traced?



- Reduce the rate of signal loss
- Increase the signal current
- Increase the receiver sensitivity



Part 3: How do I work a locator properly?



Signal current level usually becomes undetectable by the receiver because its indistinguishable from background noise and interference.

512Hz has a greater noise threshold because it falls within the harmonic frequencies associated with 50 and 60Hz power systems.



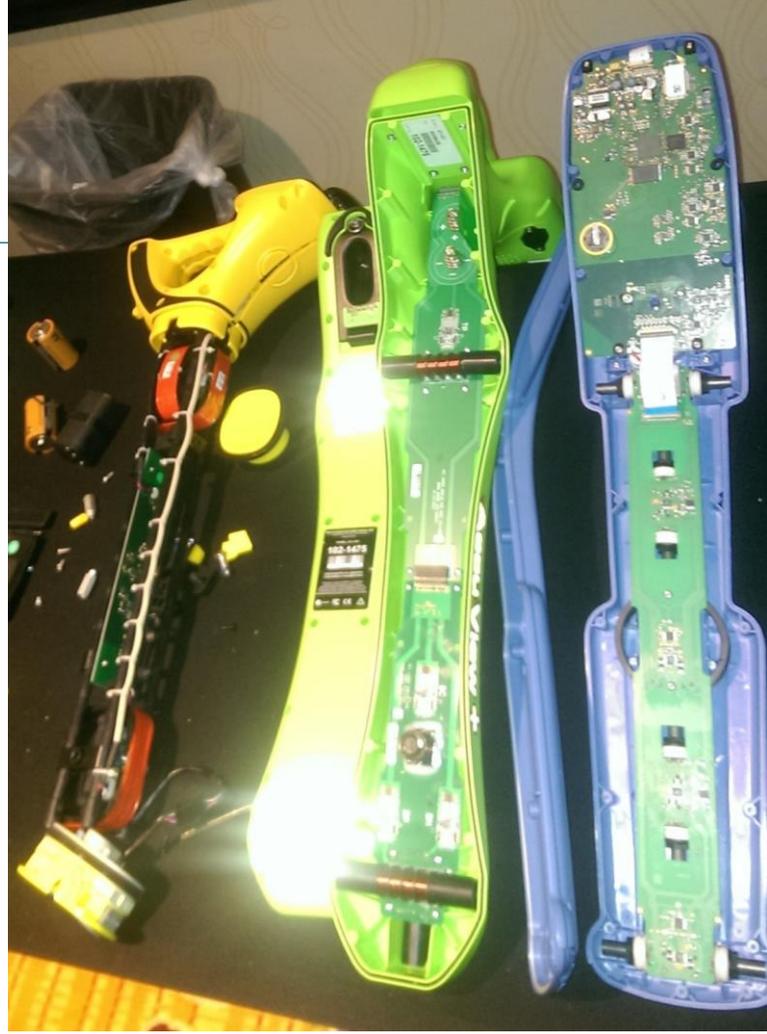
Part 3: How do I work a locator properly?

Peak or Null?



Different aerial orientations can be used for different responses.
Peak uses multiple horizontal antenna's and is most accurate.

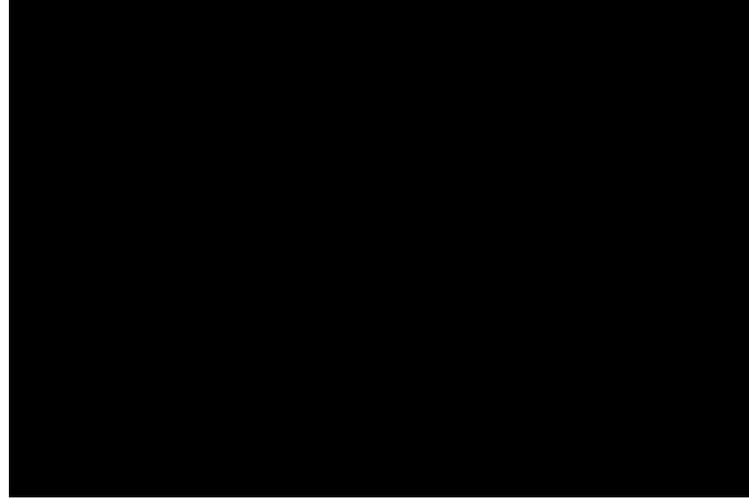
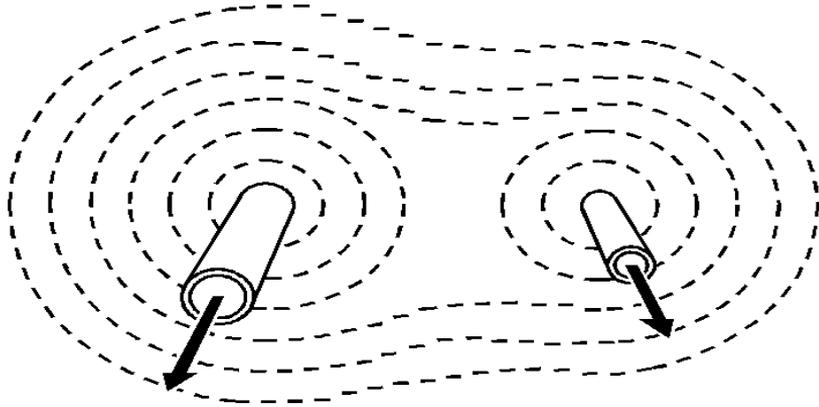
Peak or Null?





Part 3: How do I work a locator properly?

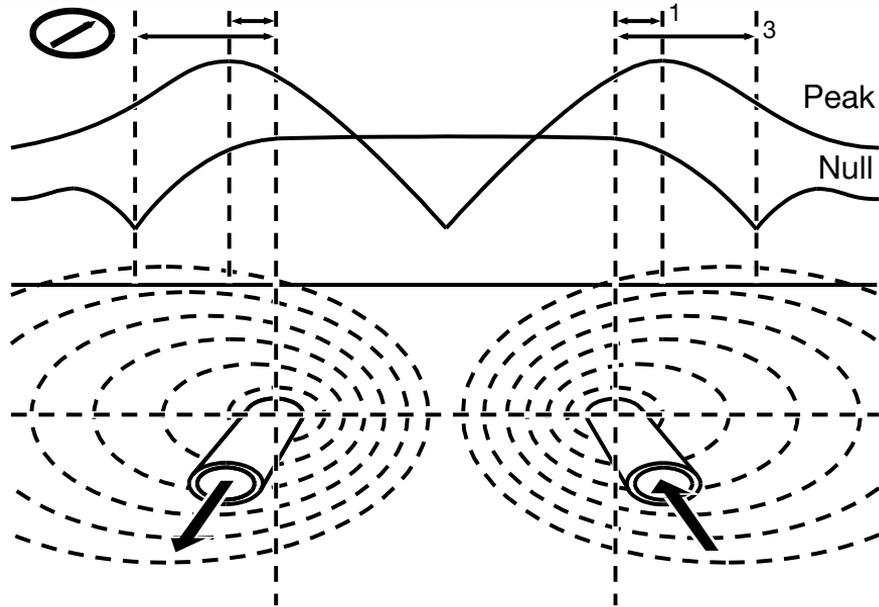
Congestion



When the conductors are close together, the magnetic fields can interfere with each other, causing a distorted field which is no longer cylindrical. This can lead to poor locate results and inaccurate measurements.



Part 3: How do I work a locator properly?



This distortion varies depending upon the direction and magnitude of the current flow, causing a discrepancy between the peak and null aerial responses.



Part 3: How do I work a locator properly?

Depth is to Center of Target Line





Why?





Part 3: How do I work a locator properly?

Very Low

Less than 1 kHz

Very Long Range
No Induction
Little "Spillage"
Better Identification

Low

1-10 kHz

Long Range
Poor Induction
Less "Spillage"



Frequency Applied

High

10-50 kHz.

Easy Induction
Shorter Range
More "bleed off"

Very High

50kHz+

Short Range
Excellent Induction
Severe "Spillage"

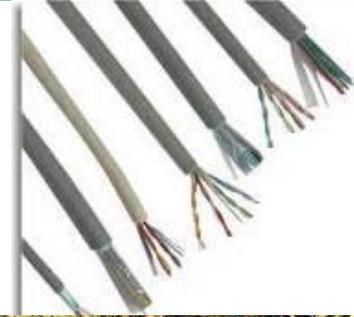


What is the most effective frequency?

Very Low

Less than 1 kHz

Fiber Optic Cable
Copper Telephone
Tracer Wire
(Low resistance lines)



Low

1-10 kHz

Cable TV
Electric
Coated Gas Pipe
Copper Pipe



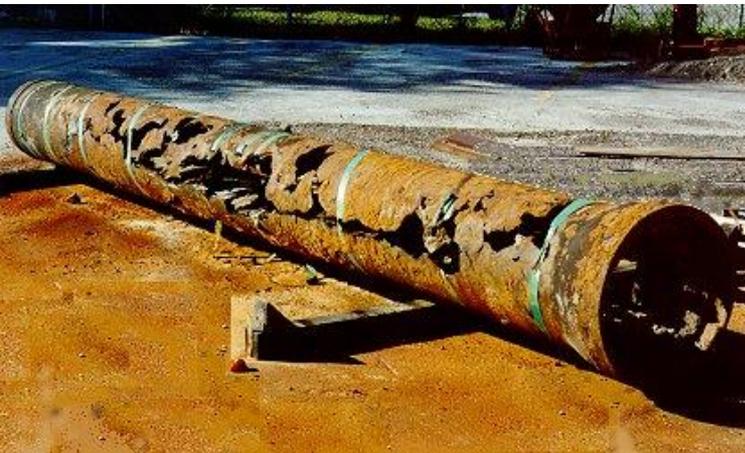


What is the most effective frequency?



High
10-50 kHz.

Cast Iron Pipe
Ductile Iron
(High resistant lines)



Very High
50kHz+

Use for induction
Cable breaks
(Severe resistant lines)

Part 3: How do I confirm my locate accuracy?

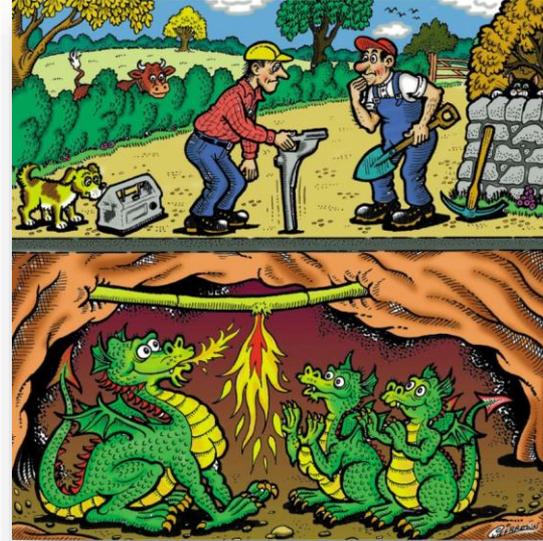


- Probing
- Pot-hole
- Backhoe
- Ground Penetrating Radar

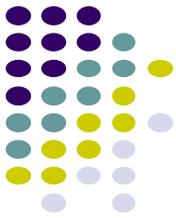
Part 3: How do I confirm my locate accuracy?



- Levels of confirmation
 - Depth
 - Current Measurement
 - Current Direction
 - Peak / Null
 - Other



LEVELS of CONFIRMATION



A.C.I.D.	Not Confirmed	Confirmed ✓	Not Confirmed
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Current Direction



Current measurement

13 mA

27 mA

19 mA

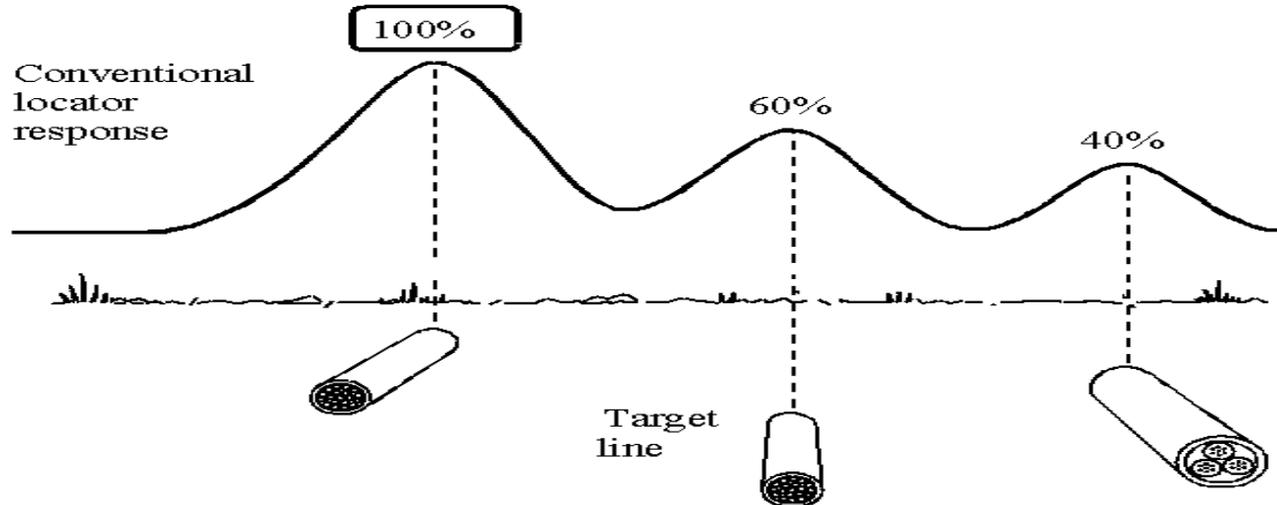
Depth Measurement

8 "

3' 11"

29"

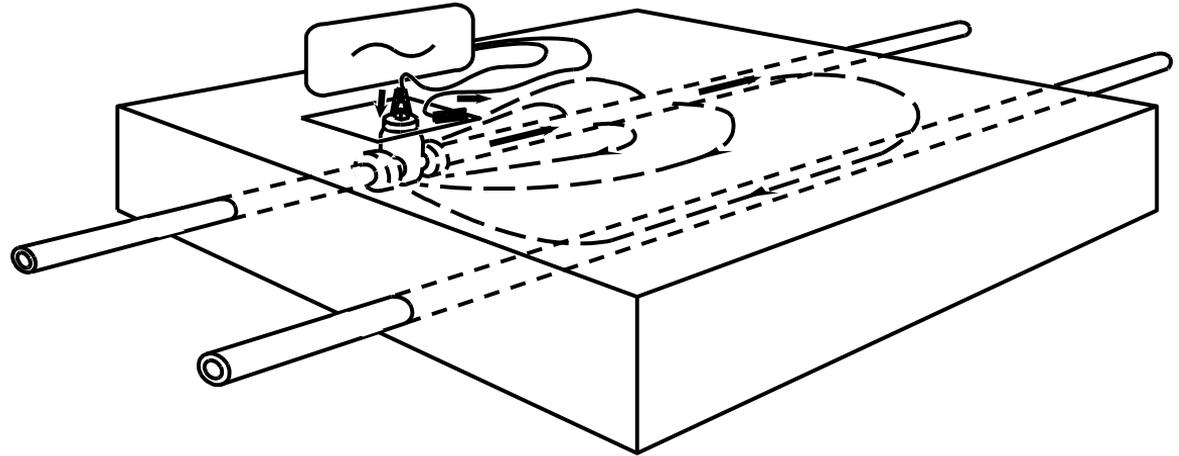
Conventional locator response



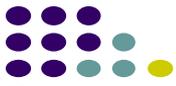
Current Measurement



Current direction & compass



Locator Comparison



LOCATOR	FREQUENCIES (Hz)	PEAK / NULL	CURRENT MEASUREMENT	OUTPUT
810 Metrotech	83000	Peak & Null	No / AGC	1/4 Watt
480 Split Box	83000	Peak & Null	No	1 Watt
Radiodetection CAT & Genny	33000	Peak	No	1/4 Watt
8869 Rycom	815, 8000, 82000	Peak & Null	No	1 Watt
8876 Rycom	815, 82000	Peak & Null	Yes	2.6 Watts
9860 Metrotech	9800, 82000	Peak & Null	Yes	3 Watts
505 Go-Fer Tinker & Rasor	83000	Peak & Null	No	3 Watts
Radiodetection RD400	CD, 12 Frequencies 256 to 200000	Peak & Null	Yes & CD	5 Watts / 300mA
Radiodetection RD8000	CD, 30 Frequencies 98 to 200000	3 Peak, 1 Null	Yes , CD, Compass	10 Watts / 1A
Radiodetection Pipeline Current Mapper (PCM)	CD, 4, 8, 98, 512	Peak & Null	Yes & CD	150 Watts / 3A

I see colored flags and/or paint marks on the ground and in the yard. What do they mean?



American Public Works Association

The American Public Works Association (APWA) is probably best known from its recommendations on locate color standards. Actually, the APWA adopted the Uniform Color Code from the American National Standards Institute (ANSI) standard Z53.1 Safety Colors.



Color Code



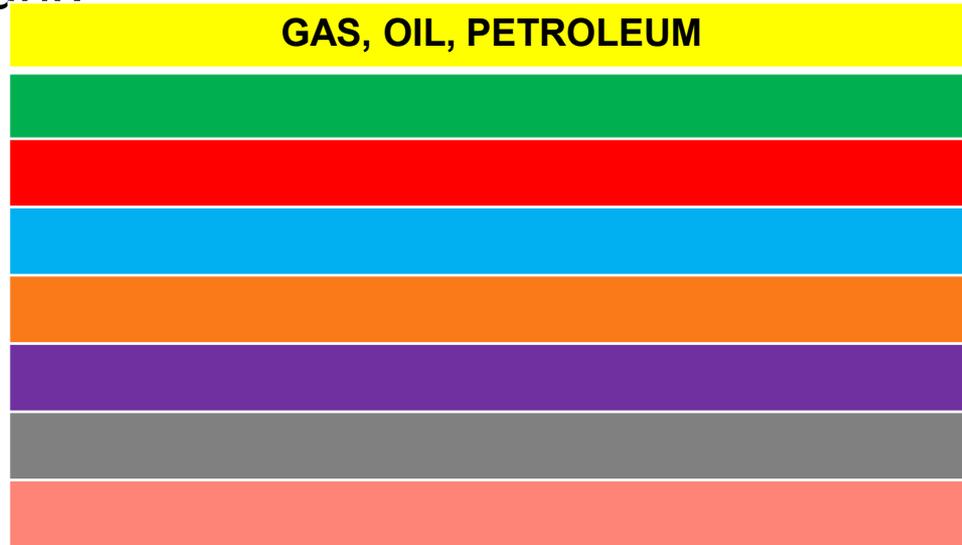
uniform color codes are used to represent the utility underground





Color Code

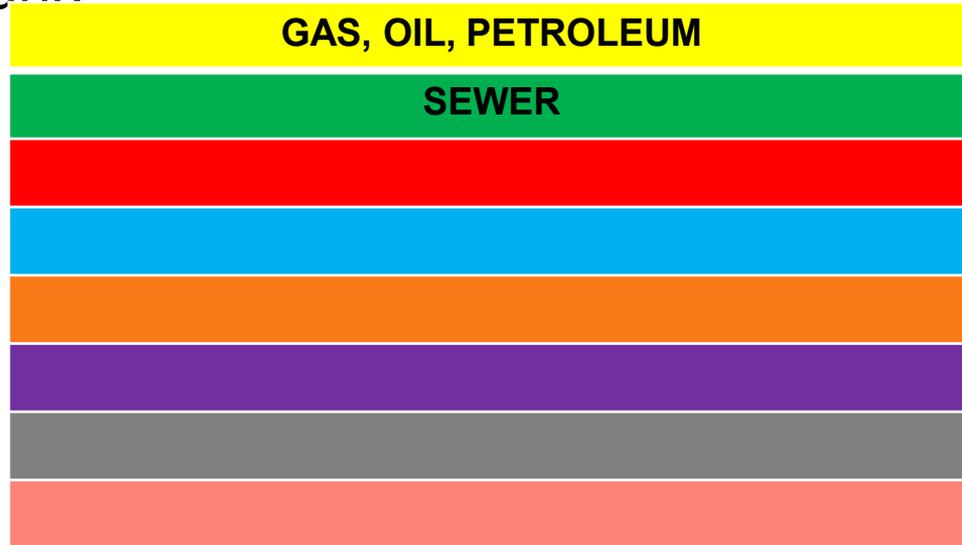
uniform color codes are used to represent the utility underground





Color Code

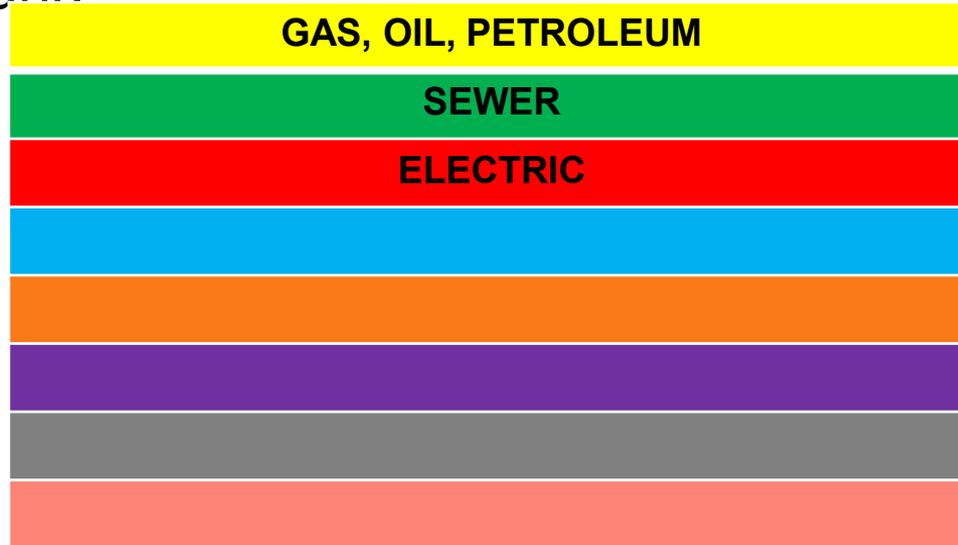
uniform color codes are used to represent the utility underground



Color Code



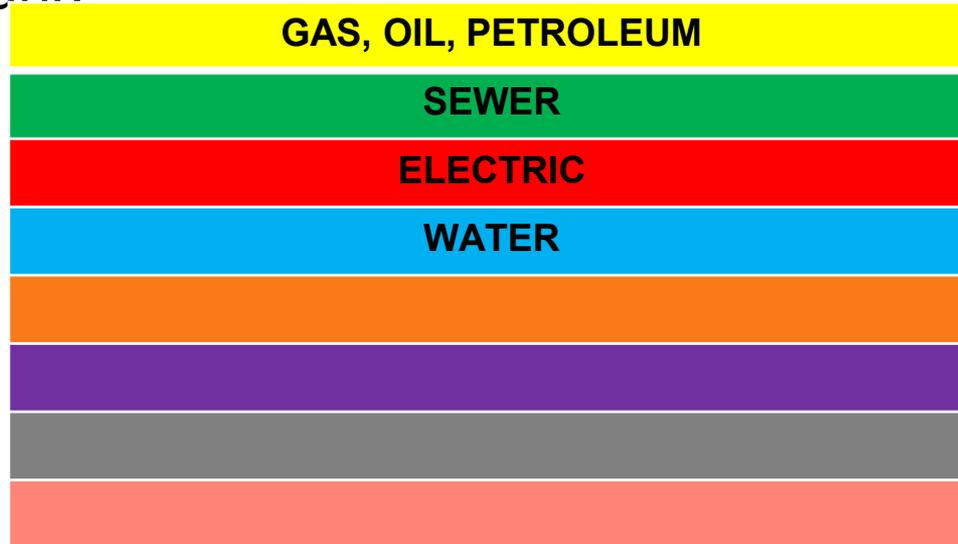
uniform color codes are used to represent the utility underground



Color Code



uniform color codes are used to represent the utility underground



Color Code



uniform color codes are used to represent the utility underground

GAS, OIL, PETROLEUM
SEWER
ELECTRIC
WATER
COMMUNICATION, TELEPHONE, TV

Color Code



uniform color codes are used to represent the utility underground

GAS, OIL, PETROLEUM
SEWER
ELECTRIC
WATER
COMMUNICATION, TELEPHONE, TV
RECLAIMED WATER

Color Code



uniform color codes are used to represent the utility underground

GAS, OIL, PETROLEUM
SEWER
ELECTRIC
WATER
COMMUNICATION, TELEPHONE, TV
RECLAIMED WATER
PROPOSED EXCAVATION (Black when snow)



Color Code

uniform color codes are used to represent the utility underground

GAS, OIL, PETROLEUM
SEWER
ELECTRIC
WATER
COMMUNICATION, TELEPHONE, TV
RECLAIMED WATER
PROPOSED EXCAVATION (Black when snow)
TEMPORARY SURVEY

Summary of Training



- Locators read to the _____ of the pipe or cable?
- Can locators read through pavement?
- What frequencies bleed off more?
- Where should a ground rod be placed?
- What color is used to mark gas?
- How far apart should you keep the TX & RX during induction?
- Are peak antenna's vertical or horizontal?
- Does passive locating require a transmitter?



Subsurface Solutions

Damage Prevention Experts

www.SubsurfaceSolutions.com



Subsurface Solutions

Damage Prevention Experts

www.SubsurfaceSolutions.com

JEOPARDY BOARD

Locator Smart	Utilities	811
\$100	\$100	\$100
\$200	\$200	\$200
\$300	\$300	\$300
\$400	\$400	\$400
\$500	\$500	\$500

Topic 1 - \$100 Question

This is the color used to
mark power lines

Click to see answer



Topic 1 - \$100 Answer

What is Red?

Click to return to Jeopardy Board 

Topic 1 - \$200 Question

This is the color used to
mark gas lines

Click to see answer 

Topic 1 - \$200 Answer

What is Yellow?

Click to return to Jeopardy Board 

Topic 1 - \$300 Question

The direction a peak
response antenna sits inside
a locator

Click to see answer



Topic 1 - \$300 Answer

What is horizontal?

Click to return to Jeopardy Board 

Topic 1 - \$400 Question

Depth readings are measured from the bottom of the locator to this

Click to see answer



Topic 1 - \$400 Answer

What is the center of the
pipe or cable?

Click to return to Jeopardy Board 

Topic 1 - \$500 Question

The opposite of active
locating using a transmitter

Click to see answer



Topic 1 - \$500 Answer

What is passive locating?
(No transmitter)

Click to return to Jeopardy Board 

Topic 2 - \$100 Question

The amount of time utilities
have to respond to a normal
locate request

Click to see answer



Topic 2 - \$100 Answer

What is 2 business days?

Click to return to Jeopardy Board 

Topic 2 - \$200 Question

The minimal distance the transmitter and receiver should be separated when inducing a signal

Click to see answer



Topic 2 - \$200 Answer

What is 30 feet?

Click to return to Jeopardy Board 

Topic 2 - \$300 Question

Locators can read through
these types of surfaces

Click to see answer



Topic 2 - \$300 Answer

Dirt, rocks, asphalt, cement,
sand, clay, water

[Click to return to Jeopardy Board](#)



Topic 2 - \$400 Question

An odorant added to natural
gas

Click to see answer



Topic 2 - \$400 Answer

What is mercaptan?
(rotten egg smell)

Click to return to Jeopardy Board 

Topic 2 - \$500 Question

Signal 'Bleed Off' is created
by these frequencies

Click to see answer



Topic 2 - \$500 Answer

What are high frequencies

(higher than 8kHz)

Click to return to Jeopardy Board



Topic 3 - \$100 Question

This is the angle ground rods should be placed

Click to see answer



Topic 3 - \$100 Answer

What 90 degrees

(away from the located line)

Click to return to Jeopardy Board



Topic 3 - \$200 Question

The depth a person must dig in order to be required by law to place a locate request

Click to see answer



Topic 3 - \$200 Answer

What is any depth; anytime
the soil/ground is disturbed?

Topic 3 - \$300 Question

Type of locating using two
metal rods

Click to see answer



Topic 3 - \$300 Answer

What is witching sticks?
(dowsing rods)

Click to return to Jeopardy Board 

Topic 3 - \$400 Question

Most accurate antenna
orientation to use

Click to see answer



Topic 3 - \$400 Answer

What is peak or horizontal
antennas?

Click to return to Jeopardy Board 

Topic 3 - \$500 Question

The most accurate locate
method

Click to see answer



Topic 3 - \$500 Answer

What is hand dig or hydrovac?

Click to return to Jeopardy Board 