Underground Facility Locator

Field Task Competency Manual

Version 4.0


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UNDERGROUND FACILITY LOCATOR FIELD TASK COMPETENCY MANUAL

A manual developed for Underground Facility Locators (UFL) and endorsed by the Canadian Association of Pipeline and Utility Locating Contractors (CAPULC).

Version 4.0 – 2022

DISCLAIMER

The information provided in this field task manual is for general application only and is not for use as a complete reference. Terms in this manual vary between facility owners and jurisdictions. It is not a definitive guide to government regulations nor is it a guide to the practices and procedures applicable to every locate circumstance nor a guide to safety hazards and mitigation. Appropriate regulations, company-specific work practices and manufacturers' equipment instructions must be considered and applied with due diligence. Canadian Association of Pipeline and Utility Locating Contractors (CAPULC), Locate Management Institute and advertisers assume no responsibility whatsoever, for any injury, loss or damage arising from its use. Locate Management Institute and CAPULC do **not** endorse or recommend any company or commercial product depicted in this manual.

ACKNOWLEDGEMENTS

This manual was developed by Locate Management Institute with the assistance from the Canadian Association of Pipeline and Utility Locating Contractors (CAPULC) members, industry, facility owners, and equipment manufacturers. Their collective input and dedication to the development of the UFL Field Task Competency Manual are greatly appreciated by the Association and Locate Management Institute.

LOCATE MANAGEMENT INSTITUTE

INTRODUCTION

This fourth edition of the Underground Facility Locator Field Task Manual (Manual) specifies Locator training standards and competency requirements in an effort to increase the accuracy and reliability of locates. By the nature of their role as critical stakeholders in the damage prevention process, Locators have a significant influence on the success of a ground disturbance. The UFL is responsible for locating underground facilities within urban and rural settings, and for creating and updating records (drawings) indicating the approximate horizontal alignment of underground facilities. Locators have an obligation to provide sufficient information to anyone undertaking a ground disturbance to allow the ground disturber to complete their work safely and in compliance with governing regulations and industry best practices. The Manual contains task descriptions developed by experienced Locators with input from industry stakeholders.

Note: *For the purposes of this manual, the term Locator is used to identify an individual who performs locating activities regardless of their employer.*

Competencies are identified as every day work tasks that make up the knowledge, skills, attitudes, and technology used by Locators in accomplishing their day-to-day employment. The Manual developed for UFL's is endorsed by Canadian Association of Pipeline and Utility Locating Contractors – CAPULC (refer to Section 6.2). The tasks in the Manual are derived from an extensive base of 3200+ competencies assembled by Locate Management Institute. Use Section 6.3: UFL Competency Assessment Observations and Recommendation to document a Locator's competencies and skills assessment.

Field task competency training, work performance, experience, and successful completion of industry-specific locating course(s) or program(s) are requirements for Underground Facility Locators.

The **UFL Competency Cycle** consists of three stages:

1. Knowledge development (preferably industry specific) course(s),
2. Industry specific field training (hands-on or OJT), and
3. Industry specific final assessment (verification of knowledge and skills).

The Manual represents the third and final stage in the UFL Competency Cycle. When this is completed, the UFL will have the necessary knowledge and skills to work within an industry specific sector(s).

Topics such as safety, personal protective equipment (PPE) and environmental considerations relating to underground facility locating are not addressed in this manual. UFL's must be aware of applicable safety and environmental requirements within their industry specific sector and/or the jurisdiction.

The manual is periodically revised with advances in technology, education and training, industry feedback and regulatory changes.

TO EMPLOYERS OF UNDERGROUND FACILITY LOCATORS

An Employer is responsible to ensure that the UFL Competency Cycle is completed. From an Employer's point of view, the Manual verifies that the Employer has assessed the UFL in the applicable task descriptions relating to their industry sector. The Manual is the Employer's and UFL's record that the UFL has demonstrated competencies within industry specific sector(s).

TO UNDERGROUND FACILITY LOCATORS

The Manual is the property [illegible] to validate the UFL's competencies through consistent evaluation and assessment. The Manual contains task descriptions which were assembled by experienced Locators with input from industry stakeholders. We wish to reaffirm our commitment to the competencies of UFL's and the safe working environment in which they work.

The challenge will be to make sure that new procedures and changing technologies are incorporated into the Manual. In order for the Manual to continue to provide the necessary and relevant assessment now and into the future, we need your input. As an experienced UFL, your feedback is vital, and we appreciate your help with the ongoing enhancement of the Manual.

As per industry best practices, certificates are valid for three years.

UFL Manuals are assigned to a specific individual to track their specific task assessment(s).

TO FACILITY OWNERS

Facility owners (operators) must request to see that the UFL has completed (or is working toward completing) the Manual or possesses a Certificate of Achievement.

Facility owners are encouraged to participate and support in the ongoing enhancement of the Manual.

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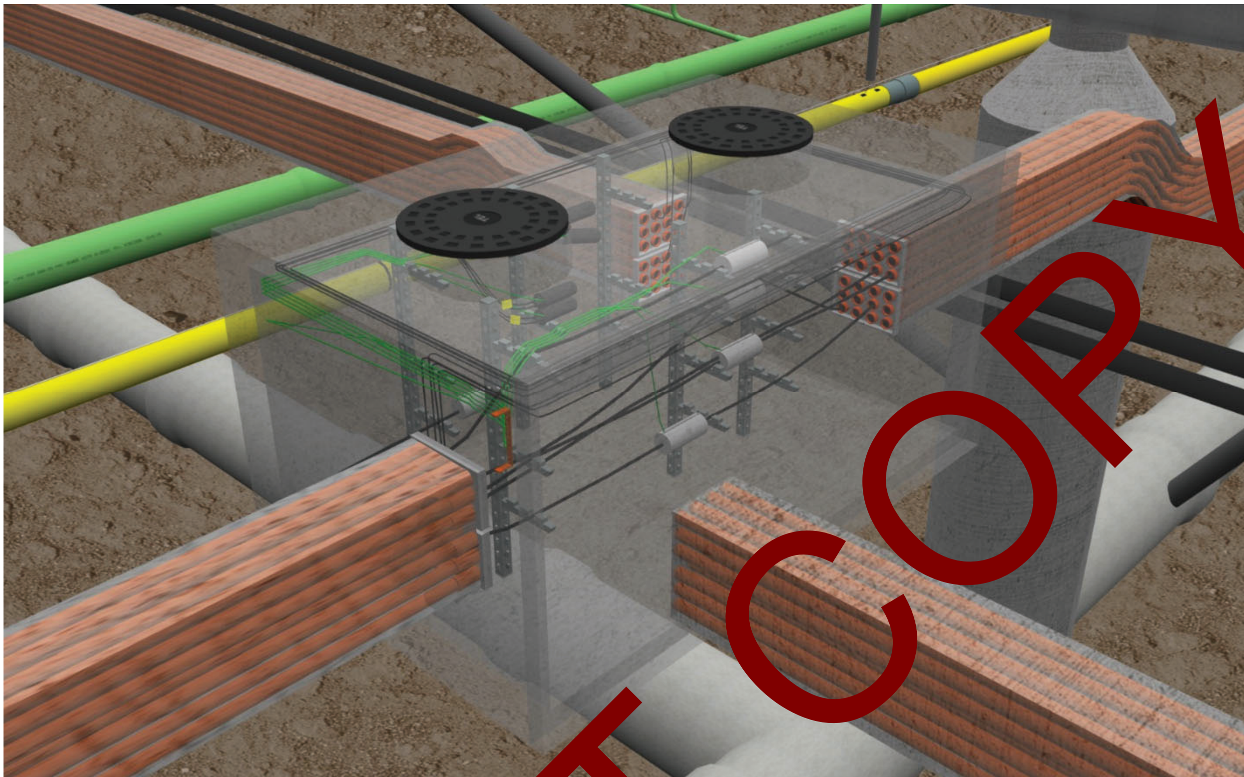
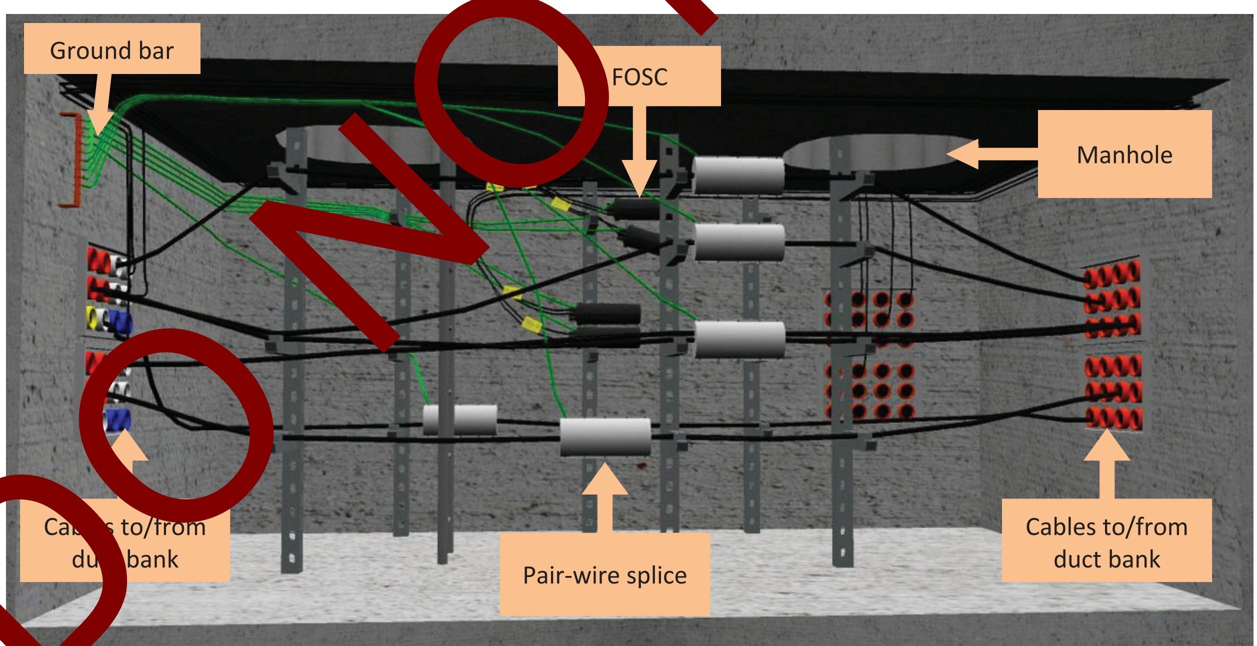
Telephone network cables originate from a central office (CO) and run through a series of vaults/manholes, housings, and local distribution terminals. Fibre-optic cables are sliced together in fibre-optic spice closures (FOSC).



Teleco cables entering and exiting a vault through conduits via duct banks



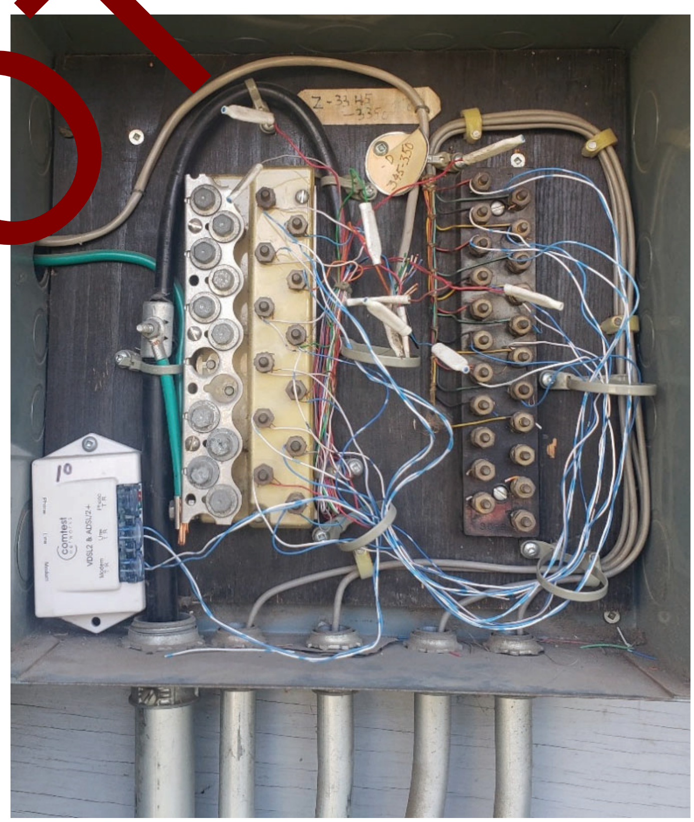
Interior of telecommunication vault

Customer optical network terminal (ONT)

Customer network interface device (NID)

Generally, privately-owned facilities are for the sole use of the property owner. Privately-owned or customer-owned lines will not be registered with a notification service (one-call centre).

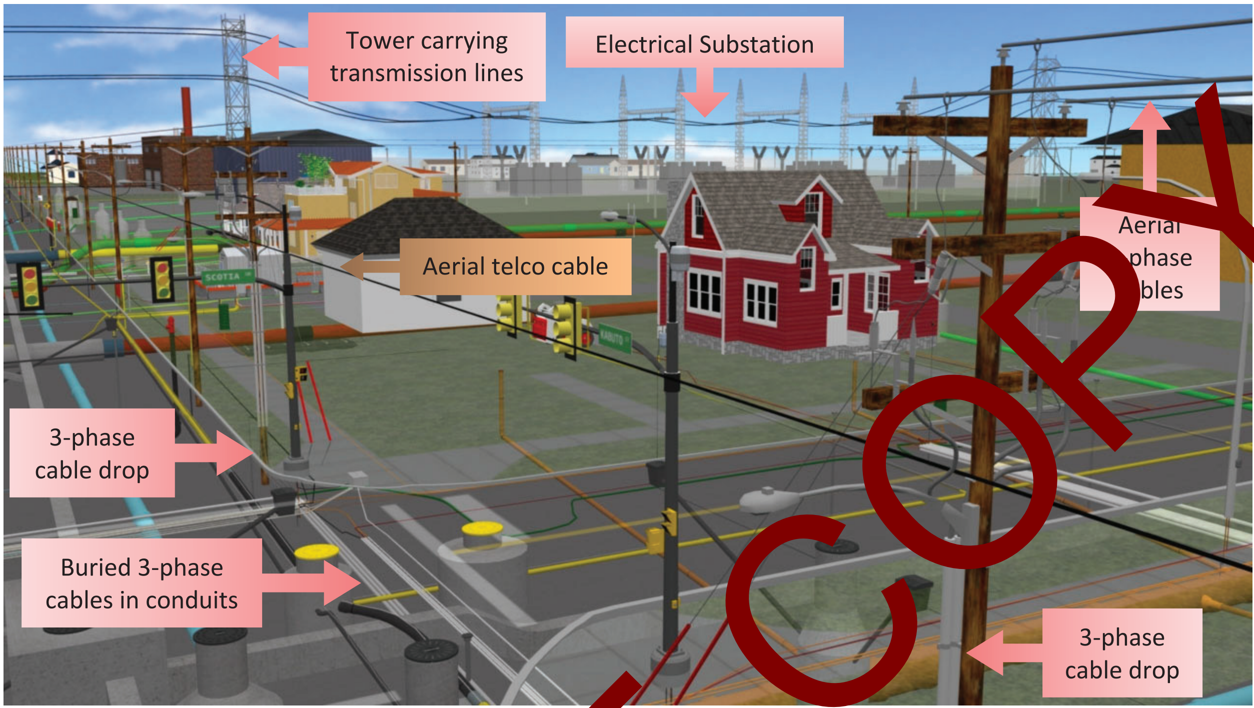
Privately owned fibre



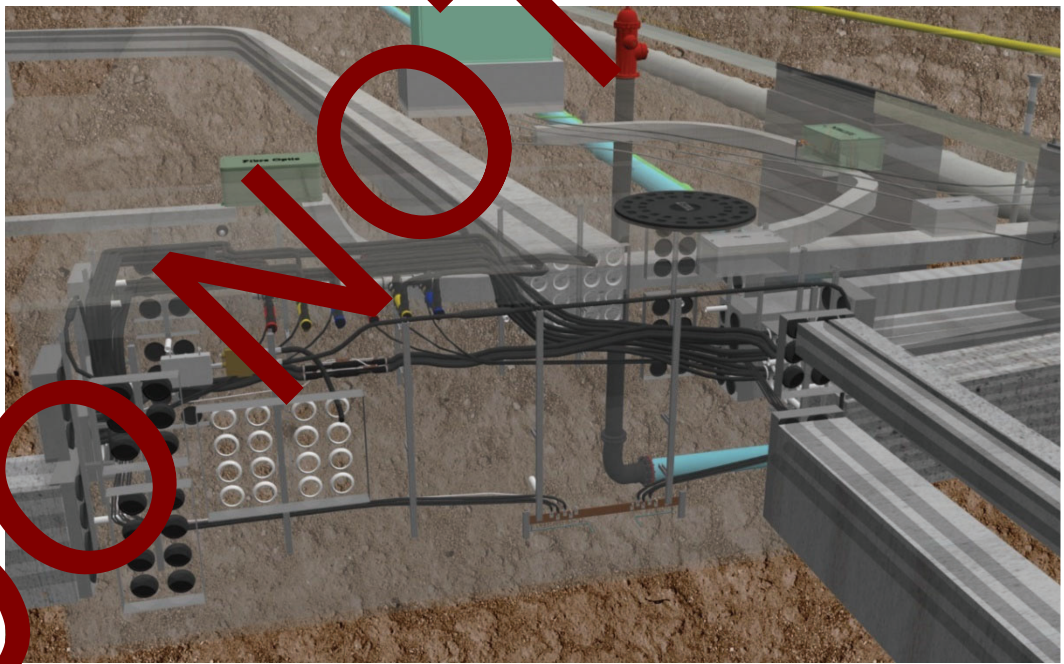
Service pair cable in and four private cables out

1.3 Electrical Distribution Infrastructure

The electrical power grid begins at the generation sites, stretching out to substations and eventually to the end users.



Electrical substation (background) servicing urban area via overhead power lines



Power cables entering and exiting a vault through conduits via duct banks

Three-phase transmission lines carry electricity from generation sites to substations.

High-voltage cables may be installed for short distances within tunnels/duct banks or enclosed in pressurized steel pipes in high-density urban areas or buried in environmentally sensitive areas.

Power below 150 kV (after the substation transformers) is typically considered to be distribution electricity.

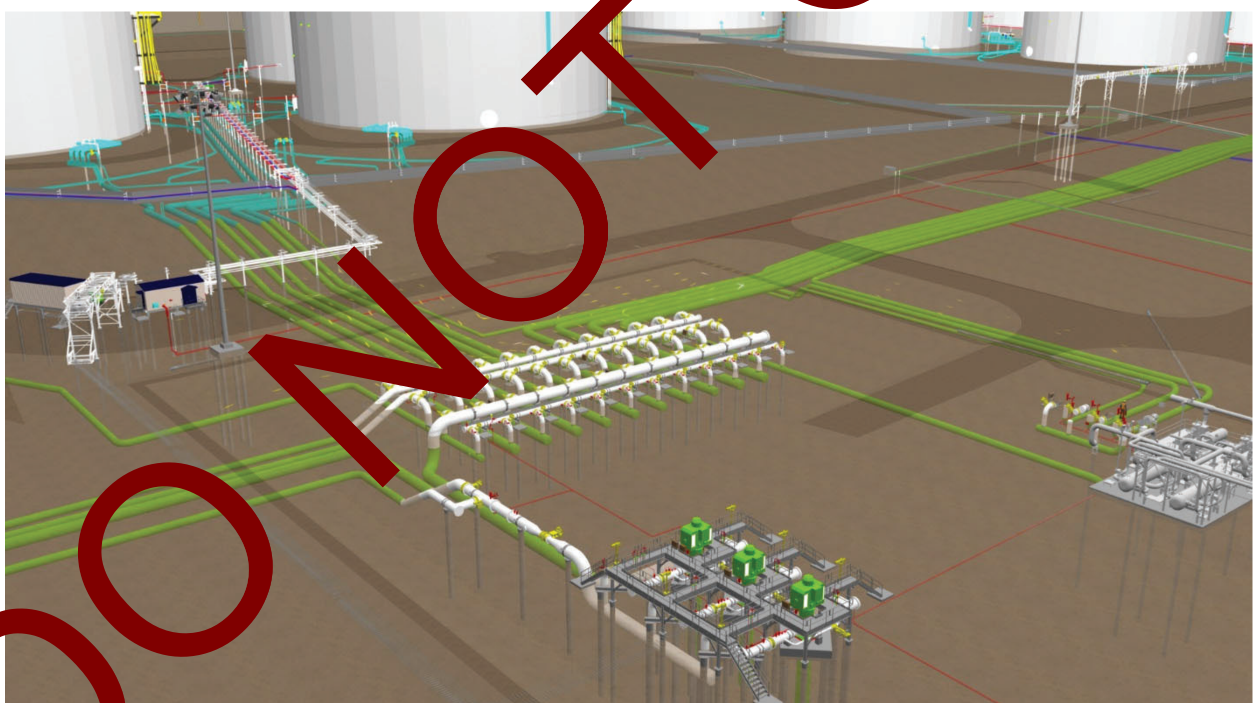
1.4 Transmission Pipeline Infrastructure

Transmission pipelines transport oil and natural gas products within a province and across provincial or international boundaries. These pipelines range in diameter from approximately 100-1200 mm (~4 - 48 in.) and are almost exclusively constructed of steel. Transmission pipelines generally operate at very high pressures.

Pipeline risers within a compressor station

Crude oil transmission pipelines carry several types of liquids including crude oil, refined petroleum products, and natural gas liquids (NGLs). Natural gas transmission pipelines typically only transport natural gas and NGLs.

These products are metered into the transmission pipeline system, from upstream oil & gas producers' facilities, and pumped or compressed for transport to refineries, storage sites, and shipping terminals. Products, such as natural gas, may be transported to distribution centres near population areas where it is metered from the transmission line and into local distribution systems.



Transmission pipelines within a storage facility pumping station

1.8 Storm Sewer Infrastructure

Storm sewer lines (drains) carry large amounts of water that accumulate (sometimes very quickly) from rainstorms or melting snow. These lines are generally the deepest and largest buried pipes. Many old storm drains were constructed of brick, however new storm drains are usually built of concrete.

Water flows into storm drains through inlets (grate-covered hole at the surface) and/or catch basins (rectangular storage tank).

Storm water infrastructure

Storm sewer lines less than 760 mm (~30 in) in diameter may be constructed of clay, iron, PVC, plastic, or occasionally steel. Larger trunk lines are typically built of reinforced concrete.

Normally, storm main lines are installed below water lines to prevent cross contamination in the event of a leak.

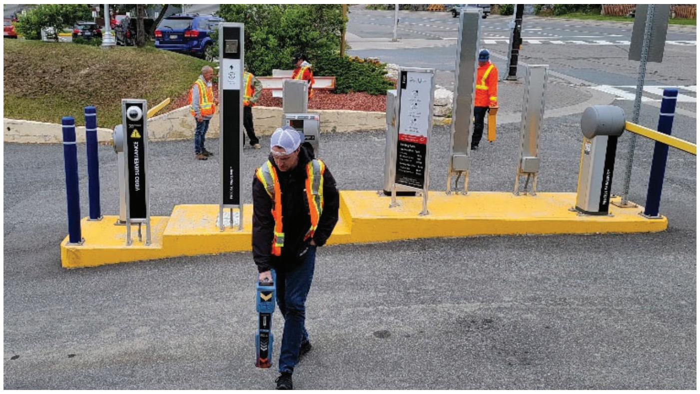
Storm systems rely almost entirely on gravity flow. At every major change in direction or grade of a gravity-flow line, a manhole is constructed to provide a cleanout and inspection point. At some point in the system, a lift station may either pump the storm water to another gravity-flow pipe at a higher elevation or force the storm water into a pipeline.

Storm lines are often the most difficult to locate due to pipe material and depths. Fish tapes, conductive rodding tools or sondes may be required to locate with EM equipment. GPR may be another alternative. Records and visual inspection may be a feasible way to determine the alignment and depth of storm line.

Looking inside a storm manhole

Catch basin tying into a main line manhole

Utility-owned facilities such as telephone, power, and gas end at a customer's network device or meter, also known as a demarcation point. Ownership transfers from the utility company to the property owner at the demarcation point (typically attached to a house or building but may also be attached to power poles, placed along property boundaries, and sometimes hidden amongst vegetation).

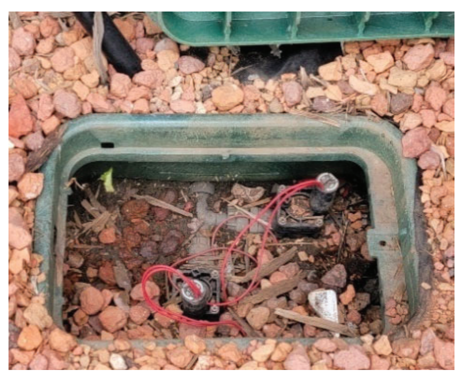


Locating electrical facilities at an auto-pay station

Direct hook-up on a private gas line

Locating privately owned facilities on a hotel property

Irrigation main valves



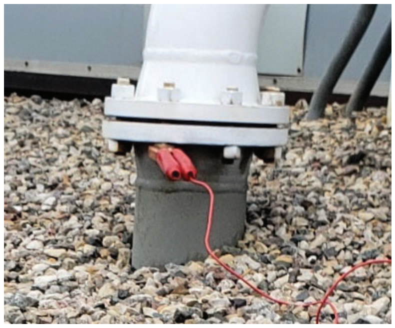
Sprinkler control valves

2.3 Active Signals

Active signals are deliberately applied to a facility from the transmitter.

There are three ways (methods) to apply an active signal:

1. Direct Hook-Up – the positive clamp is connected to a suitable access point and the negative clamp is connected to a ground rod.



Direct Hook-Up to a steel pipe

2. Inductive Clamp – the inductive clamp is placed around the facility.

Inductive clamp around a fibre-optics cable

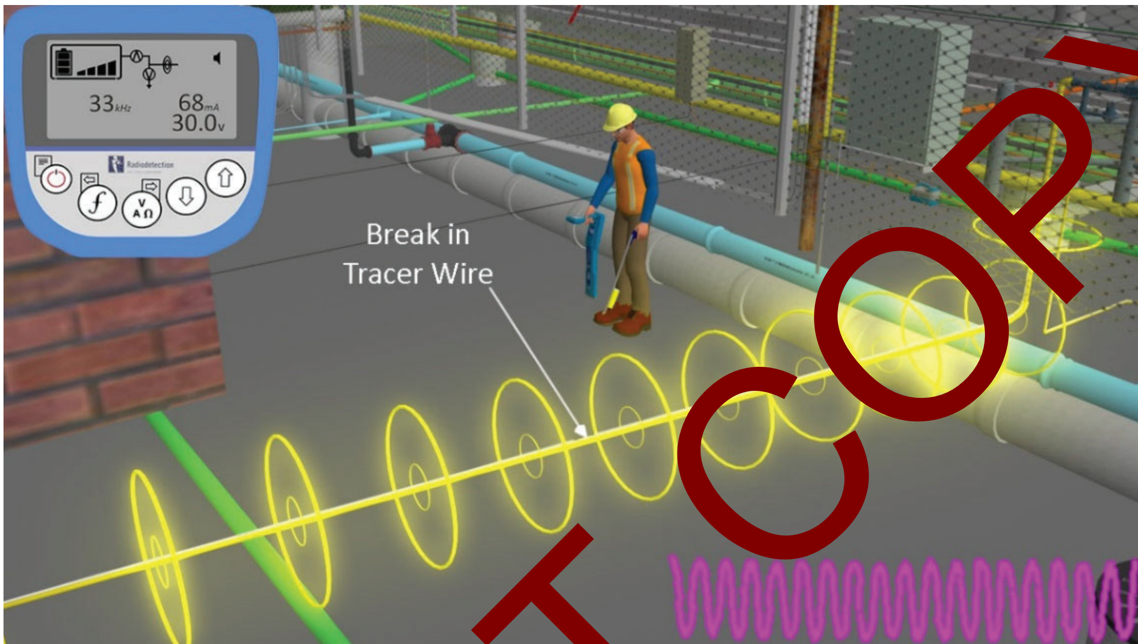
3. Inductive (Induction) – the transmitter is positioned above and in line with the suspected path of the facility.

Inductive (various transmitters)

Higher frequencies are more likely to bleed onto other conductors and therefore decay faster than lower frequencies. High frequencies are best used for:

- large diameter, deep or well insulated facilities, and
- jumping breaks in tracer wire
- Induction methods

It may be necessary to utilize a high frequency in direct hook-up mode on a highly resistant facility.



Using a high frequency to jump a break in tracer wire

Using a high frequency on a cathodic test lead attached to a large diameter pipe

2.8 Capacitance

Capacitance is the rate at which signal bleeds off a facility and into the ground. Higher frequencies and large diameter facilities contribute to greater capacitance which cause signals to travel less distance than lower frequencies and those on smaller facilities.

High frequencies and output power have a greater chance to cause unwanted coupling; however, they may be required to detect a signal on highly resistant facilities.

Larger diameter facilities provide more surface area for signals to bleed off into the ground compared to smaller diameter facilities.

Illustrating the rate of capacitance (signal loss) with different frequencies and facility diameters

High frequency and output power may be required for resistance factors including:

- facility diameter
- facility depth
- facility material, coating, sheathing, insulation, and condition
- whether or not the facility is grounded at both ends
- broken tracer wire
- facility housing if directly connected (electrical or telecommunication)
- the method (mode) being used
- soil conditions
  - damp soil carries the best signal
  - in dry soil a signal dissipates (weakens) faster

2.11 Antenna Configurations

There are several receiver antenna configurations including:

- Peak
- Null
- Dual Null
- Peak & Null Arrows
- Peak, Null Arrows & Bar Graph Needle
- Broad Peak
- Omni/360º Peak
- Compass antenna

Regardless of the antenna configuration, receiver faceplates commonly display the following indicators:

- Antenna configuration
- Signal strength (bar graph & numeric value)
- Gain (dB)
- Null arrows
- Compass
- Current
- Depth

The most accurate readings are determined (displayed) when the receiver is:

- perpendicular to the ground, and
- parallel to and directly over the centre of the target facility

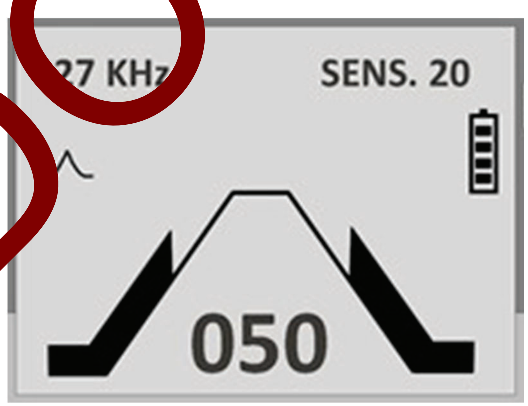
It is good practice to utilize more than one Peak and Null antenna configuration to pinpoint and mark the location of a target facility, especially if there is signal distortion.

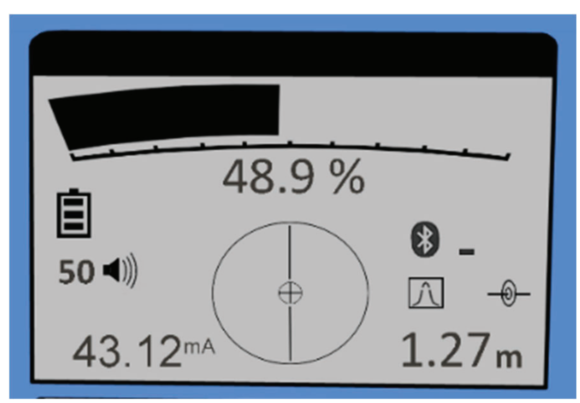
The following antenna symbols (icons) are general representations and may not precisely correlate to a specific manufacturer.

Peak

Peak (Horizontal) antennae are less prone to the effects of signal distortion and provide the most accurate signal, current, and depth readings.

Maximum peak response (highest signal level) is indicated as the highest signal (tone) and displayed as the highest numeric value and/or bar graph. The signal level will decrease as the receiver is moved further away from the centre of a target facility.





2.12 Depth Measurements

WARNING! — Depth measurement relies on a number of factors which can result in inaccurate readings; therefore, it should be used as a guide only. Exposing a facility is the best method to determine its actual depth.

Facilities are buried at depths of less than 30 cm (1 ft.) to more than 50 m (163 ft.). Increasingly, facilities are being installed with directional drilling resulting in facility profile changes along the length of a directionally drilled facility.

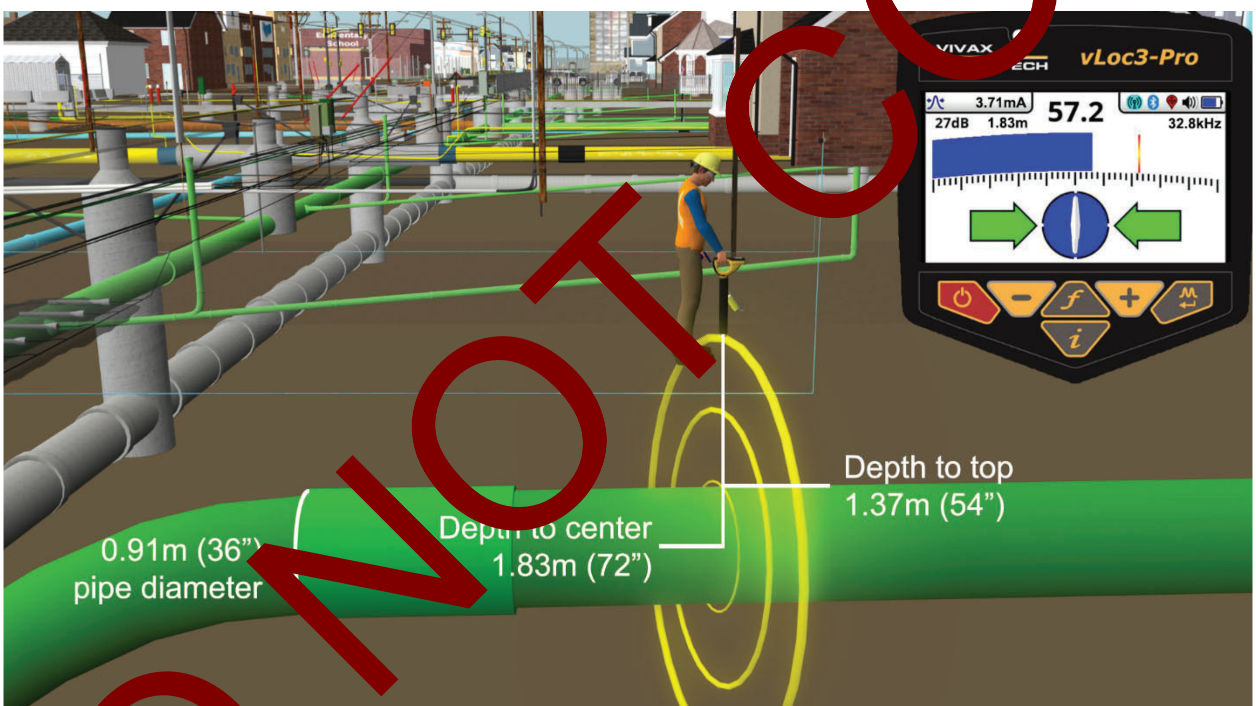
Varying depths can cause distortion, unwanted coupling and/or a complete loss of signal, which can lead to mis-locates.

Most receivers are designed with depth measurement functionality; some can provide continuous depth measurements. Generally a signal will generally begin to deteriorate at depths of 2-3 metres and will continue to degrade as the facility goes deeper until it is no longer detectable. The deeper the facility the more unreliable the depth readings.

The most accurate depth measurements are when all antenna configurations point to the same location. Active methods, with the direct hook-up generally being best, provide more accurate depth measurements as compared to passive methods.

Depth is measured to the centre of a signal, not to the top of a facility. For example, a large diameter pipe is much closer to the surface than the depth reading. To determine the top of a facility, subtract the facility's radius (half the diameter) from the depth display.

In the image below, the receiver depth reading is 1.83m (72 inches) and the diameter of the pipe is 0.91m (36 inches) therefore, the top of the pipe is 1.83m – 0.91m = 1.37m (54 inches) below the surface.



Measuring the depth of a facility

Do not provide depth measurements unless the readings indicate that the facility is dangerously shallow or deeper than normal. Do not rely on depth measurements:

- near the transmitter
- where the facility is changing in depth
- close to tees or y-lats
- in congested areas
- whenever the signal is distorted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Pre-Locate Procedures - Field

1. Consult with ground disturber/excavator and/or field personnel to validate locate request and any safety or access (landowner) requirements, including receiving hot work permits and the use of gas detectors/monitors. Acquire permission (written preferred) from facility owners to take photographs of work area. Ensure the photos include work area and points of reference.
2. Create safe work plan.
3. Conduct a job briefing.
4. Implement safe work plan.
5. Utilize available facility owner-supplied records and any other available information sources. Perform a visual inspection to ensure that facilities at the site match those shown on the records. Check facility/housing identification and safety [illegible]/tag[illegible]. Records must never be used as a stand-alone locating procedure. Records are guidelines that must be proven through visual inspection and locate signals.
6. Use appropriate locating methods to locate facilities under the scope of the locate request.
7. Mark located facilities using the APWA color code best practices.


Reviewing information sources

Utilizng facility records

NOTES:

Original Date	Review Date		Review Date
Assessor	Assessor		Assessor
Signature UFL		Signature Employer	

3.2 Locate Marking Procedures

Underground Facility Locators should use the *APWA Uniform Colour Code* to mark buried facilities. To avoid confusion in congested areas, a Locator may need to use a site-specific color code.

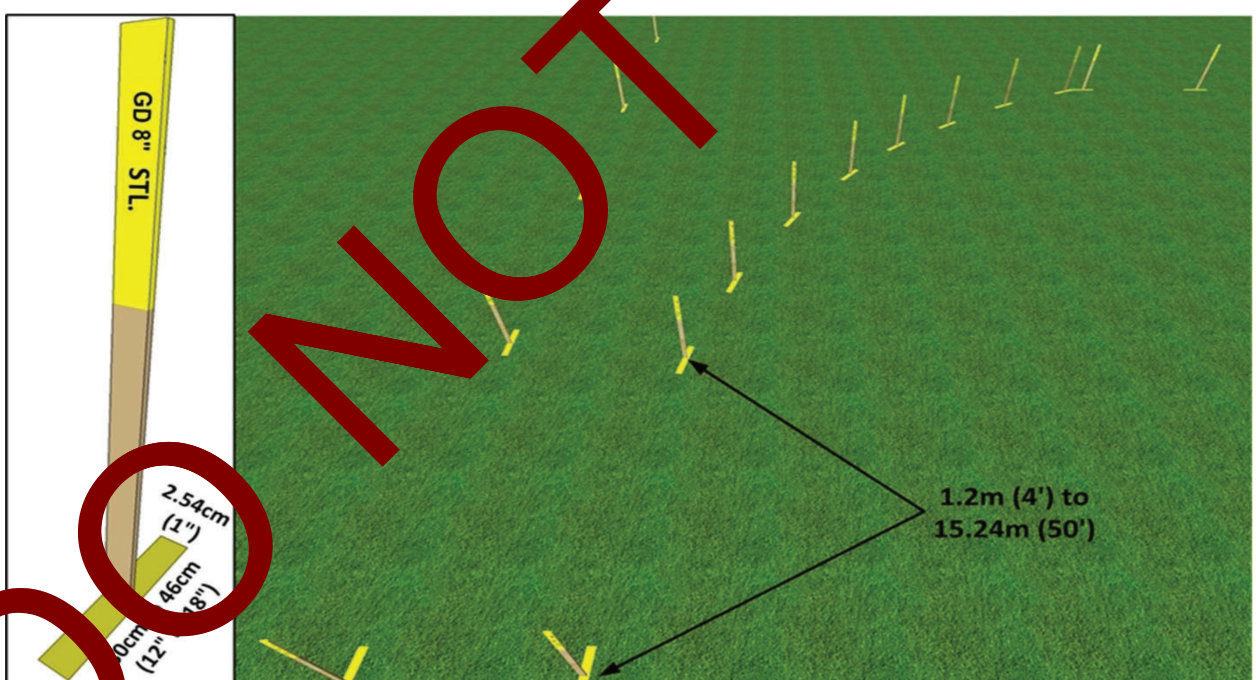
WHITE	Limits of proposed excavation
PINK	Temporary survey marks
RED	Electric power lines, cables, conduits and ducts or lighting wire and cables
YELLOW	Gas, oil, petroleum, steam or gaseous materials
ORANGE	Telephone, cable, TV, communications, alarm/signal lines, wires, cables, conduits or ducts
BLUE	Potable water lines or pipes
PURPLE	Irrigation, reclaimed water or slurry lines or pipes
GREEN	Sanitary sewer, storm water, culvert or drain lines

APWA Uniform Colour Code

The following are general marking guidelines derived from the CGA Best Practices. Refer to the CGA Best Practices "Guidelines for Operator Facility Field Delineation" for a complete description and examples. Site specific or facility owner marking procedures may vary from the CGA Best Practices.

1. Use paint, flags, stakes, whiskers or a combination in the appropriate colour for the facility located and include company identifier (name, initials, or abbreviation) and a description of the facility (size and material type).
2. Paint marks in the appropriate colour are to be approximately 30 to 46 cm (12 to 18 in.) in length and 2.54 cm (1 in.) in width.
3. Separate paint marks, stakes, flags, or whiskers by approximately 1.2 to 15.24 m (~4 to 50 ft.) in distance. Use more markers in areas where the line bends, deflects or tees.

Note: *Ensure the pipeline right-of-way is marked with pink stakes and paint. Proposed excavation areas should be marked with white stakes and paint.*



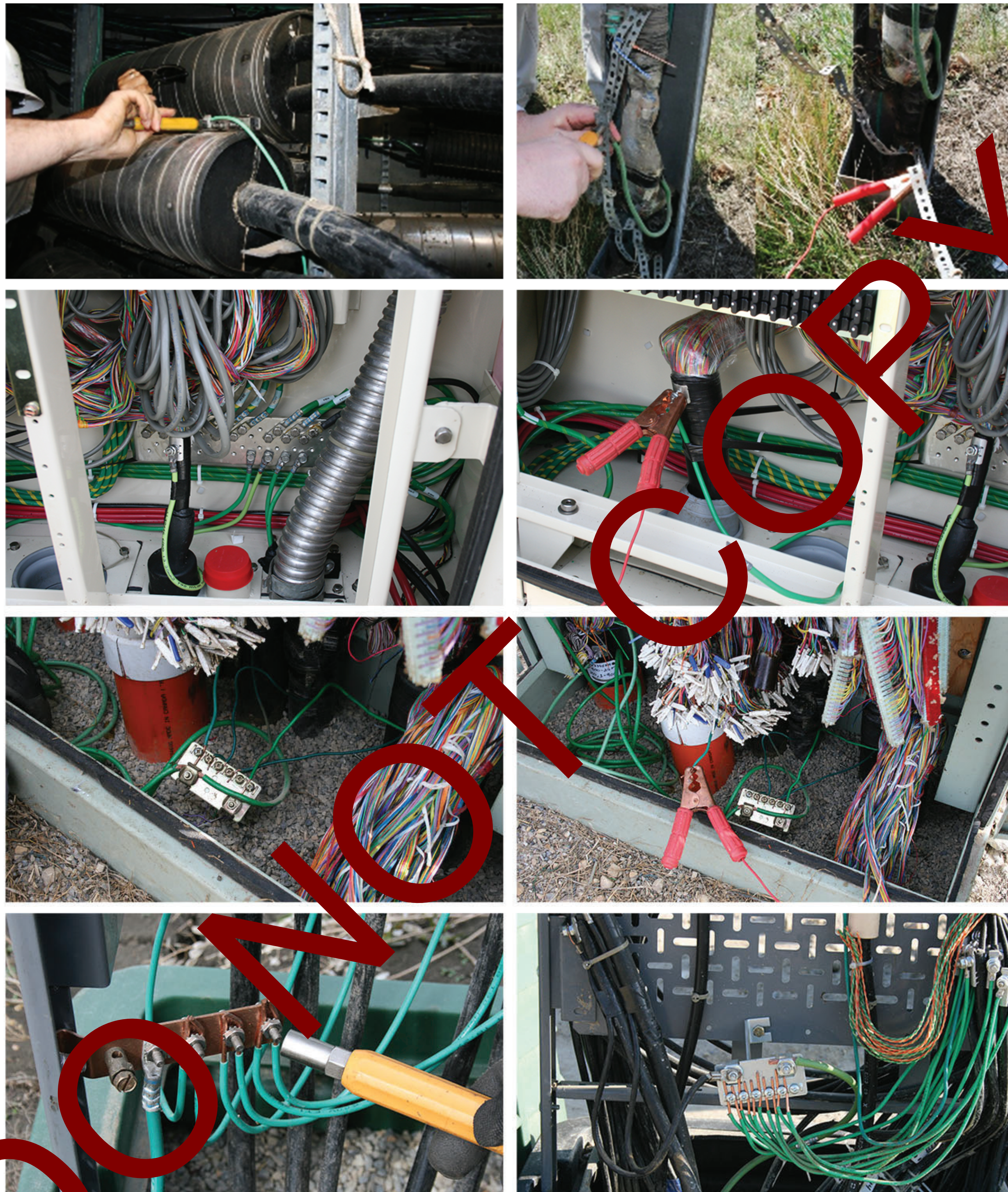
Example of stake and paint marks for gas distribution pipelines

Safe and suitable transmission pipeline access points

Directly connected to a transmission pipeline

NOTES:

Original Date	Review Date	Review Date
Assessor	Assessor	Assessor
Signature UFL	Signature Employer	



Direct hook-up connection points for telecommunication cable

Cross sections of electric power cables with varying resistance factors

Direct hook-up to electrical housing

Flexible Clamp

Flexible clamps (strap clamps or wrap-around clamps) are generally 12” to 18” long. These clamps are limited to a few frequencies, such as 33kHz and 83kHz, which must be manually selected on both the clamp and transmitter.

Flexible Clamp being utilized around a light standard

Clamp Extension Rod

An inductive clamp can be threaded to an extension rod to reach cables in deep and/or difficult access points. Use the clamp’s cable to open and close the clamp around a target.

Using a Clamp Extension Rod to reach a target cable

Current/Signal Direction Clamps

To assist in determining a target cable, some manufacturers have designed clamps capable of providing current/signal direction on receiver display. These clamps use lower frequencies and are useful when there are adjacent facilities in close proximity. To use these types of clamps, the transmitter and receiver may require upgrades from the manufacturer. Refer to the manufacturer’s instructions for using these clamps.

NOTES

Original Date	Review Date	Review Date
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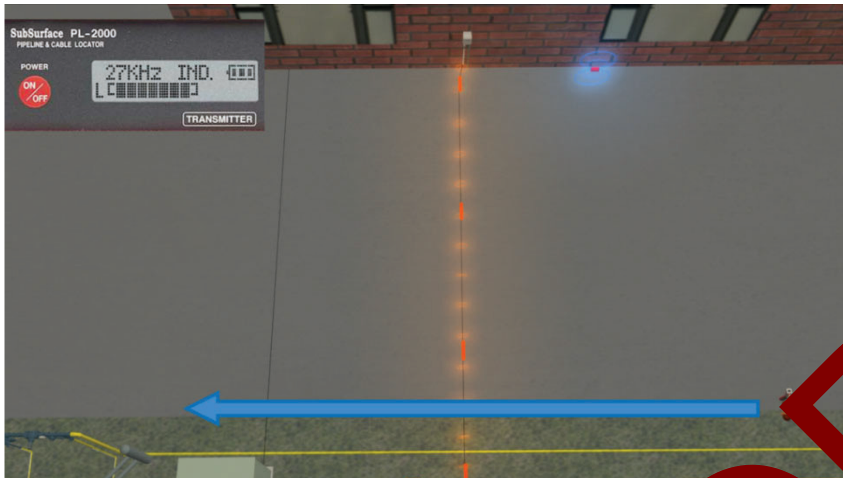
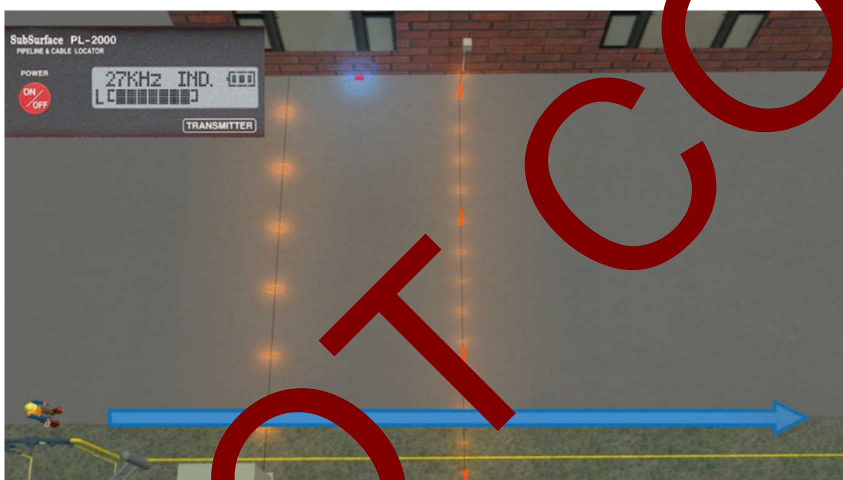


Performing a Parallel Line Check (tranmsitter right of known line) – No Parallel Line Detected



Performing a Parallel Line Check (tranmsitter left of known line) –Parallel Line Detected

Parallel Line Check (tranmsitter left of known line) – Crossing Line Detected

NOTES:

Original Date	Review Date	Review Date
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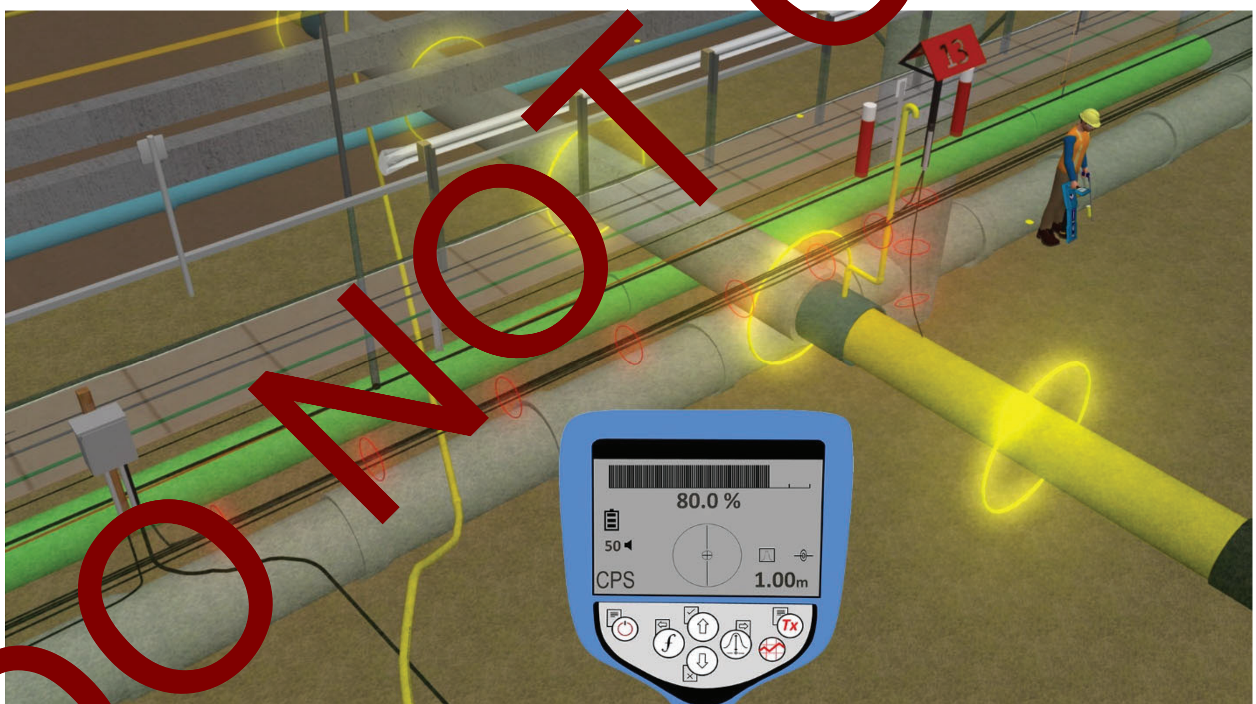
3.14 CPS Mode

Cathodic Protection System (CPS) Mode does not require a transmitter. Some receivers have a passive CPS Mode tuned to the same frequency (120 Hz) as the cathodic protection system. This method can be used to locate cathodically protected pipelines. If searching for unknowns perform circle and grid patterns.

When cathodic protection is applied to a pipeline with a cathodic rectifier, an electromagnetic field radiates from the pipe which can be detected by a CPS Mode-equipped receiver. If there is sufficient signal and separation between pipes (e.g., 3 m [~10 ft.] or more) the CPS Mode can efficiently establish the approximate pipeline position. In areas where there is not sufficient separation the CPS signal will become distorted. Due to limitations and inconsistencies with the CPS Mode, it should be used in conjunction with and verified by other locating methods.

Note: *CPS Mode is a great starting point for locating a cathodically protected pipe when the approximate alignment is known and no access points are readily available.*

1. Power on the receiver.
2. Set the receiver to *CPS* Mode.
3. Adjust the receiver gain as high as possible keeping the meter on scale.
4. Orientate the receiver as per the equipment manufacturer's specifications and walk towards the approximate alignment of the target facility.
5. Stop when the signal peaks.
6. Orientate the receiver parallel with the highest signal. Slowly move the receiver left and right to pinpoint the signal.
7. Confirm that Peak and Null signals correlate.
8. Trace and mark target line.
9. Use an active locating method to verify any CPS locate.



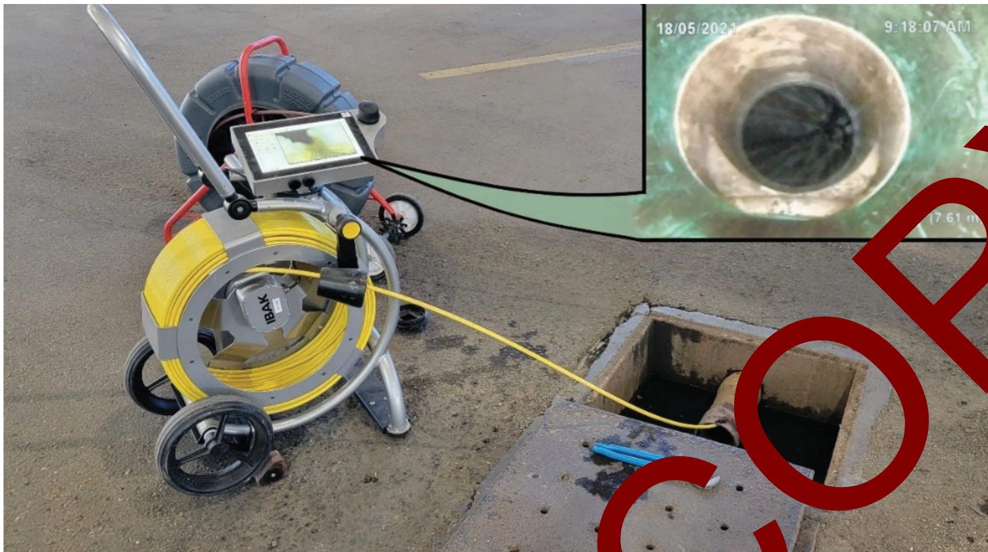
CPS Mode

NOTE

Original Date	Review Date	Review Date
Assessor	Assessor	Assessor
Signature UFL	Signature Employer	

Sondes are designed in different shapes and sizes, and have various signal ranges and frequencies (e.g., 512HZ, 640HZ, 8kHZ, 9.8kHZ, 33kHZ, 83kHZ).

A sonde may also be a fundamental component of an inspection camera to identify damage or obstructions within a facility. Some rodding tools have a system monitor to display and record the camera footage.



A camera sonde inside a drainage line

Preparation

Before inserting a sonde into an access point:

1. Check the sonde's batteries and ensure the sonde is properly attached to the rodding spool.
2. If applicable, check the camera monitor's batteries or plug in the AC adapter.
3. If applicable, connect the rodding spool to the camera monitor.
4. Power on the sonde and check the signal and depth reading.
5. If applicable, check the camera monitor to ensure there is free disc space.
6. Determine the general direction of the facility.

Testing a sonde prior to feeding into an access point

4 Obstacles and Tracing Problems

Locating obstacles cause signal problems which can negatively affect the accuracy of the locate. Tracing problems can be both frustrating and time consuming. Understanding the effects of locating obstacles may assist in solving tracing problems. Locating obstacles and tracing problems include:

- technology limitations
- pipe materials range from steel, concrete, cast iron, ductile iron, clay, polyethylene, polyvinyl chloride, fiberglass, fibre spar, and fiber reinforced plastic
- cable may be copper, fiber optic, aluminum, coax, or concentric neutral
- varying resistance (OHMs) between facilities
- facilities have different shapes, compositions, densities and diameters
- facilities are buried as shallow as 0.0 to 0.5 m (~0 to 6 in.) to depths greater than 50 m (~164 ft.)
- in congested areas, some facilities may be stacked vertically in a common/joint trench
- multiple lines may be grouped in a conduit, duct bank, common/joint trench, or utilidor
- un-cleared terrain and various weather conditions
- inaccurate or incomplete map sources
- unwanted coupling, signal distortion, sharp drop in signal, and complete loss of signal
- facilities are buried near conductive surface structures or near concrete reinforced with rebar
- facilities are common-bonded, parallel, short, non-grounded, and closer than normal
- breaks in tracer wire
- tees and y-laterals

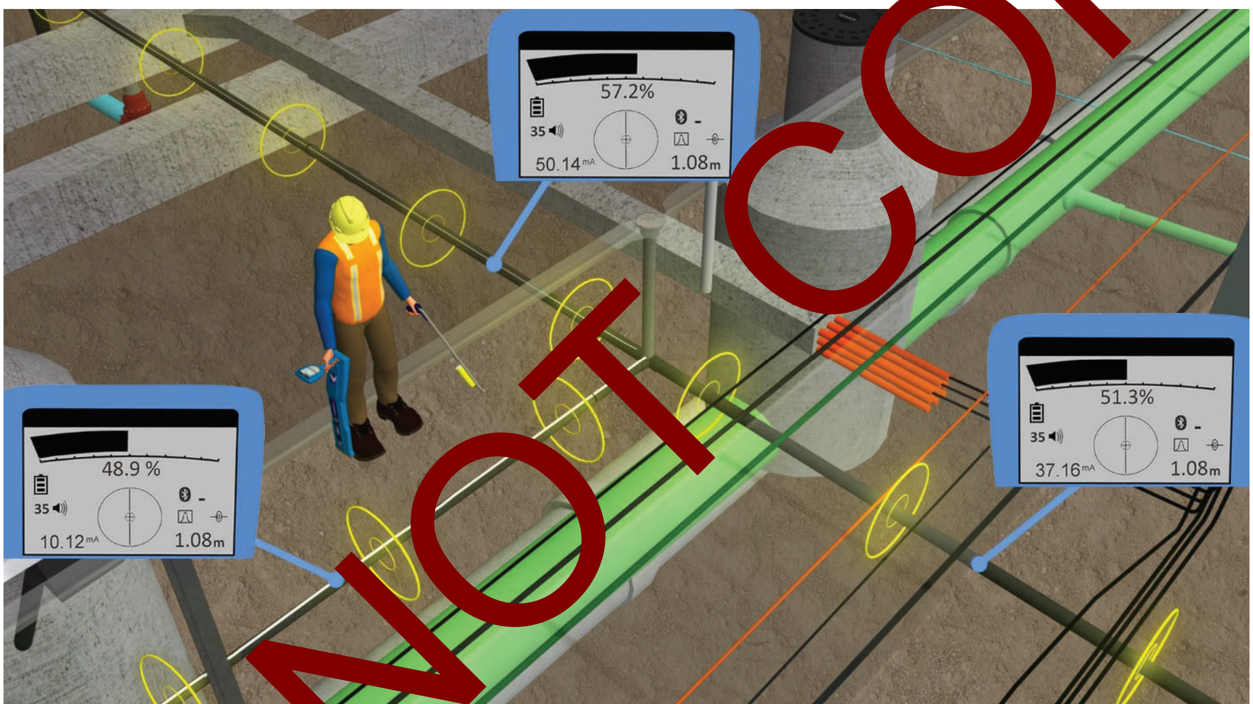
Locating obstacles

4.15 Locating Tees and Y-Laterals

Tees and y-laterals (y-lats) are common pipeline industry terminology for the intersection or joining of two pipes. At tees and y-lats, electromagnetic signals can jump or bleed over on to other nearby facilities, which can lead to mis-locates.

1. Trace and mark the main line. Do not move the transmitter.
2. Walk parallel to the main line with the receiver perpendicular to the main line.
3. If a signal is detected, trace and mark it away from the main line. Ensure the sum of the milliamps on all the facility branches correlate to the value on the transmitter.
4. If using direct hook-up or inductive clamp, power off, disconnect the transmitter. Reposition the transmitter to the furthest marked position and perform the Inductive Method.
5. Trace the signal back to the tee or y-lat.
6. Perform the ALL Method.

Note: *It may be impossible to detect all the signals for short tees and y-lats. Using the record(s) may be the only viable option to mark the approximate alignment of short tees and y-laterals.*



Locating a tee

NOTES:

Original Date	Review Date	Review Date
Assessor	Assessor	Assessor
Signature UFL	Signature Employer	

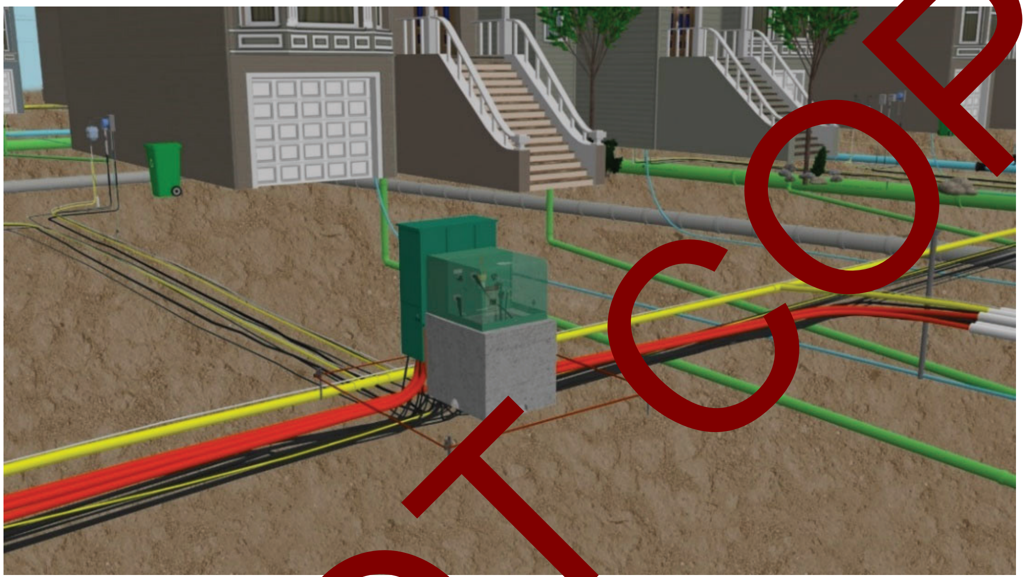
4.16 Common-Bonded Facilities

Common-bonded facilities are connected by either conductive materials, or cathodic protection, or they share a common ground. For common-bonded telecommunication cables see Task 3.4.

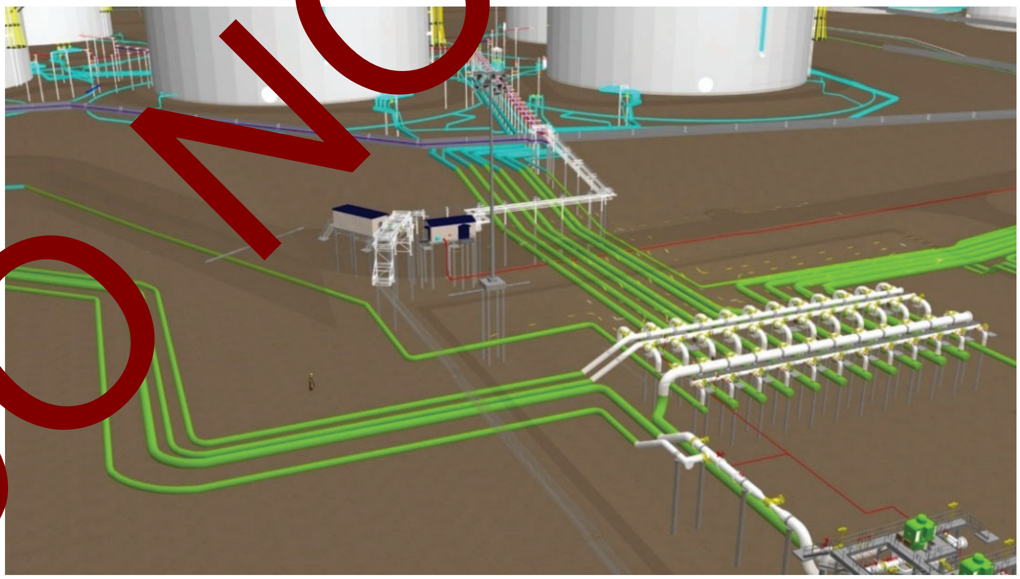
Note: *To minimize signal distortion when locating common-bonded steel pipes, de-energize the cathodic protection system and/or disconnect the cathodic cable(s). (De-energizing or disconnecting must be performed by trained and authorized personnel).*

1. Locate the signals towards the common-bonded area. If using direct hook-up, ensure the milliamp readings correlate to the value on the transmitter.
2. Perform Parallel Line Checks and the ALL Method.

Note: *Re-connect the cathodic cable(s) and re-energize the cathodic protection. Re-connecting or re-energizing must be performed by trained and authorized personnel.*



3-party pedestal common bonded area



Common bonded tank manifold

NOTES:

Original Date	Review Date		Review Date
Assessor	Assessor		Assessor
Signature UFL		Signature Employer	

5 Other Technologies

There are other technologies that are capable of detecting buried facilities including magnetic locators (pin finder) ground penetrating radar (GPR) and electronic marker systems (EMS).

5.1 Magnetic Locators (Pin Finder)

Magnetic locators detect the presence and location of ferrous (iron) objects.

Using a magnetic locator (pin finder) to locate a water curbstop valve

Surveyors commonly use them to detect buried survey pins; however, they can also be used to detect other buried ferrous objects such as storage tanks, pipe valves and fittings, well casings and manhole covers.

Survey pin (left); well casing (top right); water valve (bottom right)

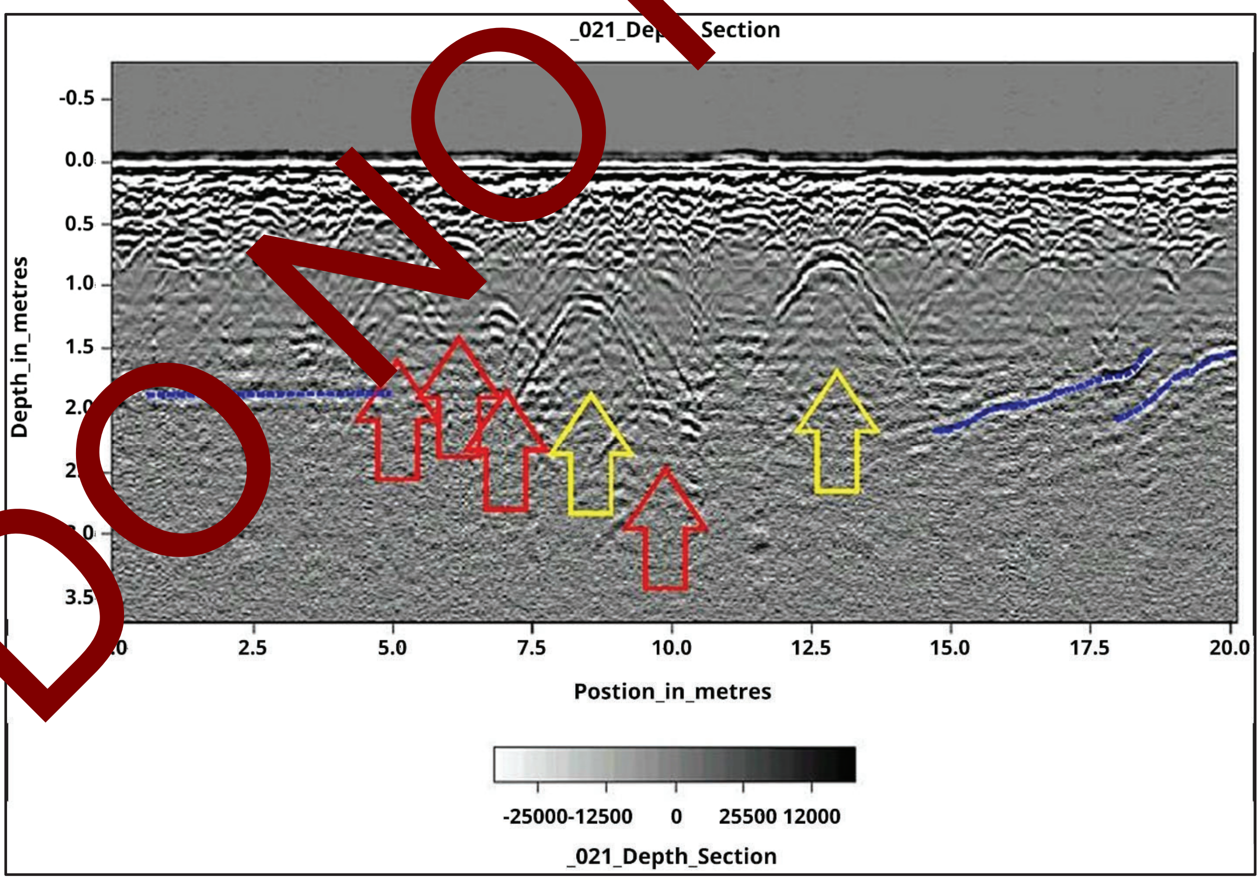
All ferrous objects exhibit some quantity of a magnetic field. These magnetic fields have “north” and “south” poles with corresponding positive and negative fields.

5.2 Ground Penetrating Radar

Ground Penetrating Radar (GPR) can be used to locate buried facilities or objects. GPR devices emit radio waves (signals measured in Megahertz (MHz)) down through the ground, which then reflect back to the receiver (in varying degrees) off the matter that the signal encounters. This matter may include concrete, grass, snow, ice, dirt, rebar, facilities, and rocks.

Locating facilities with Ground Penetrating Radar

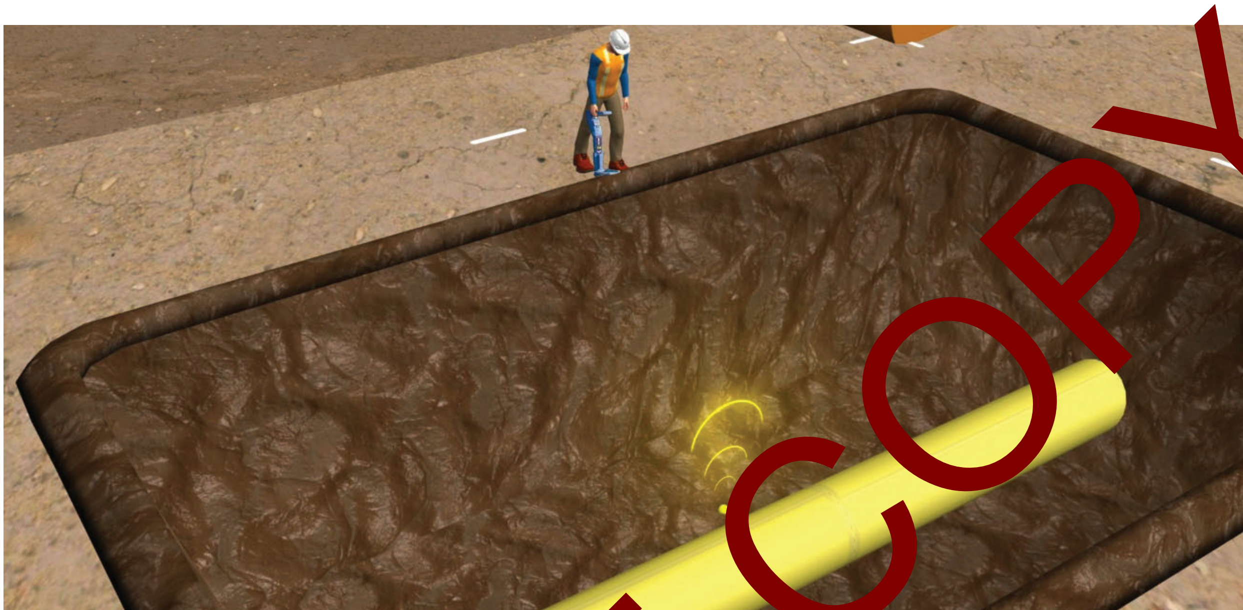
A GPR device is comprised of a control panel, antennae, battery, digital drive and encoder. The antennae transmit and receive the signals, the encoder then interprets the signals by measuring the time and strength of each returning pulse. The encoder stores this information on the digital drive and displays the data on the control panel for the user to interpret.



GPR scanning data

RFID Capabilities

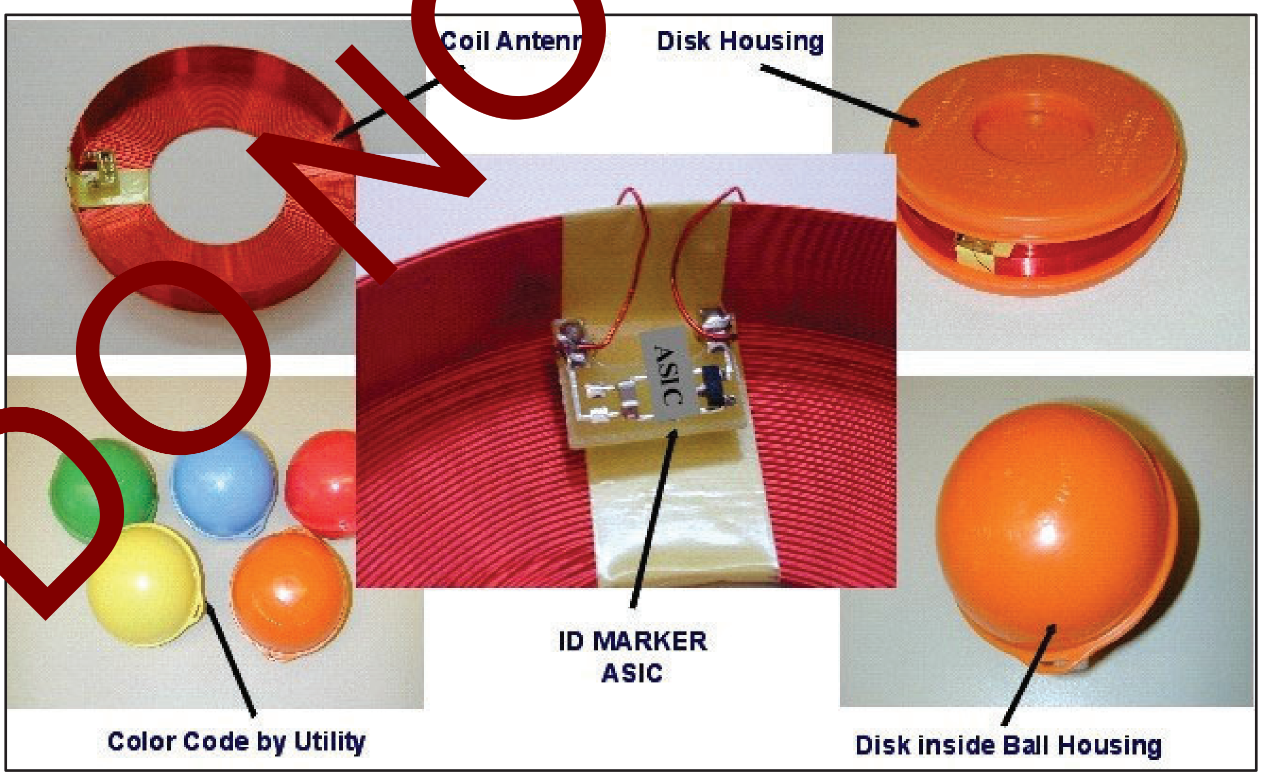
Some EMS markers have Radio Frequency Identification (RFID) functionality and are sometimes referred to as RFID markers. RFID markers have data chips (storage devices) that, when energized by the receiver signal, relay stored facility information to the receiver. RFID markers can be programed with a unique identifier and facility details such as diameter, material, and purpose of the target facility (e.g., 6”, Plastic, Water Line). Some markers are not programmable and only offer the capability of detecting the marker location.



Marker ball placed at pipe weld

Types and Limitations

All EMS markers contain a round metal coil with a capacitor. Some ball markers are encased in liquid to maintain an internal vertical configuration. This allows a ball to be dropped into holes without worry for orientation. Other marker types must be correctly orientated when put in place. Markers are activated by the receiver signals and can last for multiple decades.



Components of various EMS markers