Underground Utility Detection
& Inspection Services

"It's A Jungle Out There!"

Limitations of Electromagnetic (EM) Locating Technology

As part of our continued commitment to accuracy, safety, and professionalism in the field, this memo outlines the limitations associated with electromagnetic (EM) locating technology. Understanding these limitations is critical for making informed decisions, setting clear expectations with clients, and avoiding liability in cases where conditions prevent reliable results.

Key Limitations of EM Locating

1. EM Locators Do Not Detect Physical Utilities

EM devices detect electromagnetic signals, not the pipes or cables themselves. If there is no current present or induced, the utility cannot be located.

2. Signal Dependency

A detectable signal requires:

- A passive signal (live electrical cable (50Hz-60Hz) or re-radiated signal)
- A signal applied via direct connection, clamp, or induction.

Non-metallic/non-conductive lines cannot be located electromagnetically without a tracer wire unless they are inserted with a traceable component (e.g., flex rod/flexi trace, sonde, push video camera, sewer crawler, fish tape, etc.)

3. Field Distortion Issues

EM fields can be distorted by:

- Nearby conductors or bonded lines
- Adjacent metallic lines (induced signals or coupling)
- Common bonding between utilities
- Poor transmitter grounding or placement
- Congested utility corridors

Result: Distorted fields result in inaccurate utility location and depth readings.

Additionally, variable frequency motors (VFM's) and drives (VFD's) generate complex, fluctuating electromagnetic fields due to their rapidly changing frequencies and harmonics. These signals can interfere with electromagnetic locating equipment in several ways:

- **Signal Distortion:** The irregular EM emissions produced by VFM's/VFD's can distort or mask the locate signal, making it difficult to differentiate between the target utility and electrical noise.
- **False Readings:** Locators may inadvertently pick up stray signals or phantom lines caused by harmonic interference, leading to inaccurate markings or misidentification.
- **Reduced Signal Clarity:** In areas with high electrical noise, particularly in industrial environments, the clarity and precision of active or passive locates may be significantly diminished.

To mitigate these effects, it is important to:

- De-energize or isolate VFM's or VFD's when possible, during locating activities.
- Use additional verification methods, such as Ground Penetrating Radar (GPR), when electromagnetic distortion is suspected.
- Communicate any known presence of VFDs/VFMs to clients, so we can plan accordingly.

4. Peak vs. Null Discrepancy

Distortion can be identified if Peak and Null readings do not align:

- Use both Peak and Null modes.
- If they align, the signal likely has no distortion to minimal distortion.
- If they do not align:

1. Distortion is present 2. Markings should be buffered accordingly. 3. The true location is offset toward the Peak side and away from the Null.

- Always rely on Peak mode for final markings.

5. Unreliable Depth Measurements in Certain Conditions

Depth readings should not be trusted:

- Near bends or "T" connections,
- Close to the transmitter,
- Where utilities change depth,
- In the presence of distorted fields,
- When using Power or Radio modes (Passive modes)

6. Passive Mode Limitations

- Power Mode and Radio Mode cannot trace lines to a reliable source.
- Cannot provide depth measurements
- May produce false positives due to stray currents or re-radiation
- Signals can be picked up by rebar, fences, or other unintended conductors

7. Induction Mode Limitations

- Induction sends signal in a cone shape, often jumping to adjacent lines
- Cannot reliably trace within 30 ft of the transmitter due to airborne signal
- High risk of coupling to unintended lines
- Depths are often unreliable, especially near metal covers or shallow interference
- False positives are common unless verified by:

1. Moving the transmitter and observing signal movement 2. Tilting the transmitter 3. Checking for air signal interference with the receiver

8. Ground Placement Sensitivity

- Incorrect ground stake positioning can cause:

1. Weak signals 2. Unintended signal paths 3. Signal loss or distortion 4. Bleed offs onto other utilities

- Place ground rod at a 90° angle to the target line and as far as practical without crossing other utilities
- Avoid placing grounds:

1. Near other utilities 2. Near metallic objects 3. Across from other conductors

9. Frequency Limitations

- **High frequencies (65–480 kHz):**

1. Better for induction or when continuity is poor 2. More prone to distortion and bleed offs 3. Shorter tracing distance

- **Medium frequencies (8 kHz – 33 kHz):**

1. Good for pipes and cables 2. Medium tracing distance

- **Low frequencies (512 Hz–1 kHz):**

1. More accurate 2. Longer tracing distance 3. Requires good continuity and direct connection

- Use the lowest frequency possible to locate utilities.

10. Connection Quality Requirements

- Direct connection requires:

1. Clean, conductive surface (no rust or paint) 2. Good ground return path 3. Clean metal-to-metal connection

- Poor connections lead to:

1. Low current (mA) readings 2. Inadequate signal transmission 3. Unreliable location and depth data 4. No signal

- Watch for weak or zero mA readings — check connections before proceeding

11. False Signals from Rebar and Metallic Structures

- Rebar, wire mesh, fences, manhole covers, grounding, and other metals can re-radiate signals, resulting in:

1. Ghost lines 2. Inaccurate signal paths 3. Bleed offs 4. Distortion 5. Misleading location and depth data

- Raising the receiver and lowering gain may help isolate true utility signals

12. Environmental Interference

Environmental factors can significantly affect the accuracy and reliability of electromagnetic (EM) locating. Interference may arise from a variety of sources and conditions, including but not limited to:

1. Metal Objects – Fences, grounds, ground rings, manholes, vaults, catch basins, grates, rebar, wire mesh, utility coils, and similar metallic structures. 2. Utility Congestion – Closely spaced or overlapping utilities can produce signal distortion or coupling. 3. Grounding Conditions – Poor or inconsistent grounding can weaken or misdirect EM signals. 4. Poor Soil Conductivity – Dry, sandy, or rocky soils can reduce signal strength and penetration. 5. Overhead Interference – Power lines and other aerial conductors can introduce unwanted EM noise. 6. Common Bonding – Shared or bonded grounding systems can cause signal bleeding between utilities. 7. Overhead Electrical Interference – Electrical transmission lines may create electromagnetic noise that disrupts locating accuracy.

A few important technical notes:

- Some utilities include extra cable coiled near an appurtenance so that the owner can use the spare cable later.
- Coils and closely spaced conductors can cause interference and abnormal readings during electromagnetic locating.
- Signals often become distorted near appurtenances because multiple lines exit the appurtenance, and our EM signal can bleed off on any conductive material.
- For this reason, our marks may be less accurate within a 5-foot radius of any appurtenance.

Note: All the above factors may introduce unintended signal pathways or weaken signal strength.

Limitations Due to Restricted Access to Utility Points

Electromagnetic (EM) locating depends on the ability to apply a signal directly to the target utility or to detect a naturally present electromagnetic field. When access is not provided to key utility infrastructure such as vaults, manholes, panels, utility rooms, meters, or other access points, the accuracy and completeness of a locate are significantly reduced.

Why Access Matters

Direct Connection Requires Contact: The most accurate method of applying a traceable signal is through a direct connection using a transmitter's test leads directly attached to the utility. This requires physical access to:

- Meters
- Wires
- Pipes
- Ground wires
- Service Panels
- Utility vaults or pull boxes
- Transformers and switch gear
- Communication pedestals
- Bonding points or exposed piping
- Cable risers or utility rooms

Clamp Applications Require Space Around Exposed Conduit: Signal clamps can only be used when there is adequate exposed, separated, and accessible conduit. If utilities are bundled, buried, or behind locked access, clamp use is not possible.

No Access = No Circuit = No Signal Path: Without access to both a signal application point and a good ground return path, the signal either cannot be applied at all or may dissipate quickly, resulting in weak or undetectable EM fields.

Blind Induction Is Unreliable in Congested or Unknown Areas: If access is not provided, a technician may be forced to rely on induction, which:

- Re-radiates signals indiscriminately to multiple lines

- Creates false positives through coupling
- Prevents accurate depth readings near the transmitter
- Cannot confirm utility ownership or path without tracing it from a known point
- Does not trace all utilities

Consequences of Limited Access

- **Incomplete Locates:** Portions of the utility path may remain untraced, especially from service panels, transformers, vaults, or where utilities change direction or enter buildings.
- **Misidentification or Misrouting:** Without a known starting point and stopping point, technicians cannot verify if the line being traced is the correct one.
- **Increased Risk of Damage:** Clients who perform excavation without ensuring utilities have been properly located from source to termination may risk hitting buried infrastructure.

Best Practices

- Always Request Access in Advance: Coordinate with the site contact to ensure unlocked access to key utility rooms, vaults, and panels.
- Document Denied or Inaccessible Points: Clearly note all access restrictions in your locate report and communicate them to the client.
- Never Assume a Utility Has Been Fully Traced Without Access: If access is denied, inform the client that a full locate could not be completed and that unmarked utilities may be present.
- Always confirm signal quality before tracing
- Use both Peak and Null to assess distortion
- Clearly communicate any limitations to the client
- Document all site conditions, limitations, and observations
- When in doubt, add buffer zones to markings

If any questions arise in the field or if you encounter uncertain conditions, contact management before proceeding. As always, document all limitations and client communications thoroughly.

Stay safe and stay accurate.