Specification No: SIM2018Utility

Title: Nondestructive location and marking of underground utilities.

Purpose:
The purpose of this specification is to provide engineers and specifiers a suggested framework for detailing the minimum requirements for a nondestructive location of underground utilities prior to excavation/ground disturbance.

Accompanying Documents:
- Practice SNT-TC-1A, *Personnel Qualification and Certification in Nondestructive Testing, Ground Penetrating RADAR.*
- Subsurface Investigation Methodology (*SIM*), White Paper

1. Codes, Standards & Definitions

1.1 Occupational Safety and Health Administration - Safety and Health Standards Digest Construction Industry (OSHA) - 3149/1996)

1.2 American Society for Nondestructive Testing, (ASNT). The ASNT is the world's largest technical society for nondestructive testing (NDT) professionals. The society provides a forum for exchange of NDT technical information; NDT educational materials and programs; as well as standards and services for the qualification and certification of NDT personnel.

1.3 ASNT Recommended Practice No. SNT-TC-1A Personnel Qualification and Certification in Nondestructive Testing. This Recommended Practice establishes the general framework for a qualification and certification program. In addition, the document provides the educational experience and training recommendations for different test methods including use and application of ground penetrating RADAR. This recommended practice is not intended to be used as a strict specification. It is recognized, however, that contracts require programs which meet the intent of this document. For such contracts, purchaser and supplier must agree upon acceptability of an employer's program.

1.4 Federal Communications Division, (FCC). The Federal Communications Commission (FCC) is an independent United States government agency. The FCC was established by the Communications Act of 1934 and is charged with regulating interstate and international communications by radio, television, wire, satellite and cable.

1.5 Common Ground Alliance, (CGA). The CGA is a member-driven association of 1,700 individuals, organizations and sponsors in every facet of the underground utility industry. Established in 2000, CGA is committed to saving lives and preventing damage to underground infrastructure by promoting effective damage prevention practices. CGA has established itself as the leading organization in an effort to reduce damages to underground facilities in North America through shared responsibility among all stakeholders. The underground utility location contractor shall adhere to all applicable safety guidelines in accordance with federal, state, and local ordinances.

1.6 Definitions

1.6.1 **Subsurface Investigation Methodology, (SIM).** Set of methods, training, field mentoring, and necessary equipment required for a complete subsurface investigation of underground utilities resulting in mark out of critical targets. Examples: power , communication, water and sewer, gas line and other commercial/industrial buried service lines.

1.6.2 **Utility location.** The process of identifying and labeling public and private utility lines that are underground. These lines may include telecommunication,

electricity distribution, natural gas, cable television, fiber optics, traffic lights, street lights, storm drains, water mains, and wastewater pipes.

1.6.3 **Owner** – Legal owner of the structure or property to be investigated.

1.6.4 **Contracting agency** – The contractor hired directly or indirectly by the owner who is sub-letting the scanning requirements to a scanning contractor.

1.6.5 **Scanning contractor** – The contractor hired to perform the scanning operation resulting in location of underground utilities.

1.6.6 **Ground Penetrating Radar (GPR)** – A geophysical method that uses pulses of electromagnetic wave energy to image the subsurface. Ground penetrating radar transmits energy in the microwave band of the of the electromagnetic spectrum

1.6.7 **Frequency** - The frequency describes the number of waveforms transmitted from a GPR antenna per second. Frequency is measured in cycles per second, or Hertz (Hz).

1.6.8 **Line Scan** - Collection of one straight line of GPR data resulting in the display of a cross-sectional depth representation of the RADAR signal moving through the material scanned.

1.6.9 **Electromagnetic locator (EM)**– Also known as a pipe and cable locator, is used for tracing utility lines and metallic pipes, and clearing excavation and drilling locations. These utility locators consist of two main parts, a transmitter and a receiver.

2. SIM Prerequisite Qualifications

2.1 Scanning contractor shall submit certification of experienced-based training that meets or exceeds the guidelines detailed in ASNT document 'Recommended Practice SNT-TC-1A, *Personnel Qualification and Certification in Nondestructive Testing Level I'*. The ASNT document recommends 8 hours as a minimum for training and a minimum of 60 hours practicing GPR in order to be a certified NDT Level I in Ground Penetrating Radar.

2.2 Scanning contractor shall utilize detailed methods, Subsurface Investigation Methodology, SIM requirement for competent field personnel:

2.2.1.1 Field mentoring, 4 weeks of application training from mentor.

2.2.1.2 80 hours of classroom curriculum, GPR theory, underground utility location training, SIM investigative method training.

2.2.1.3 Post classroom training mentoring, 4 week practical application of testing equipment and investigative methods.

2.3 Field technicians shall maintain minimum OSHA 10 safety training certificate.

2.4 Scan contractor insurance requirements, commercial liability insurance $1,000,000 limit with $5,000,000 umbrella (includes auto and worker comp), professional liability $2,000,000 limit.

2.5 GPR equipment provided by scanning contractor:

2.5.1.1 Ground penetrating radar system, to include:

2.5.1.2 Radar Data Acquisition System/Controller with integrated display.

2.5.1.3 Various applicable RADAR antennas, Utility and Concrete.

2.5.1.4 Miscellaneous hardware, cables, hand cart, marking tape, and power supply.

2.6 Electromagnetic Locating Equipment, "Pipe Locator":

2.6.1.1 Capable of receiving electromagnetic and communication line frequencies passively or induced.

3. Investigation Scope

3.0 Scanning contractor will utilize job site information, available as-builts and prints/plans and previously detailed equipment to locate and mark out underground facilities and unknown anomalies.

3.1 This mark out may include depth estimates of targets.

3.2 If the scan area includes a slab on grade and the post scan work requires trenching a lower frequency antenna may be used to locate targets in the backfill material under the slab.

3.3 Review of equipment capabilities and potential job-site performance impedances.

4. SIM Pre-scan Investigation

4.0 SIM Pre-investigation Steps :

4.1 Job Hazard Analysis, form review, or equal site safety review documentation. Review and sign site safety plan if applicable.

4.2 Site walk and project scope meeting, review scan locations. Note: look for visible clues such as electrical rooms, service access ports like manholes and other utility boxes, visible conduits, etc.

4.3 Site contact interview, review known utilities, discuss possible unknowns, and anticipated critical targets. Review site post scan scope of work. Suggest scan area options.

4.4 Will GPR data samples be required for reporting.

4.5 Type of markings (paint, flags, other)

4.6 Client deliverable requirements, report format/documentation. GPS Mapping of site findings.

5. SIM Scanning Procedures

5.0 Quality of scan data

5.1 It is recommended that the scanning contractor calibrate the GPR system to the conditions at each site. This calibration may be estimated or a test performed to determine the correct dielectric of the soil using hyperbola matching or calibrating to an object at a known depth.

5.2 Perform several test scans through the scan area to determine the approximate maximum depth penetration and to gauge the probability of success in finding the desired targets.

5.3 Review the clarity of the scan data. Adjustments in gain, depth range, filters, and other settings may be necessary.

6. SIM Methods for Complete Investigation

6.0 Follow and document the SIM methods applied.

6.1 Confirm information collected from section 4.2 and 4.3.
- 6.1.1 As-built site plans, original design plans.
- 6.1.2 Site walk aboveground utility indicators.

6.2 Scan and mark with electromagnetic locator.
- 6.2.1 Trace all known utilities. Typical known utility list includes five primary utilities to any building, water, electric, gas, sanitary sewer, and communication lines. Additionally, all utilities identified on a drawing not on list, any that have been communicated verbally, and any utility for which a feature can be observed.
- 6.2.2 Use EM Locator at visible features valve, manhole, riser, etc.
- 6.2.3 Use direct connection method when possible (note: do not connect directly to any potentially live electrical wires)
- 6.2.4 Use induction clamp if directi connection is not possible
- 6.2.5 Use induction method if induction clamp is not possible
- 6.2.6 After connecting or inducing with the transmitter, use the receiver to complete a full 360° sweep around the connection point.
- 6.2.7 Mark and trace all potential fields that are detected.
- 6.2.8 During this sweep, measure mA levels on the receiver in order to assist in correctly identifying the target line.
- 6.2.9 Identify the target line by tracing it to the connection point and at least to the next feature.
- 6.2.10 After tracing and marking any utility, sweep parallel to the utility on both sides in order to check for laterals/T's.
- 6.2.11 Insert traceable rodder or sonde into known sewer, storm, and drain lines.
- 6.2.12 Trace the rodder or sonde using the receiver.
- 6.2.13 Use EM receiver to attempt to locate any unidentified, known utilities from features using passive modes (Power/Radio).
- 6.2.14 Sweep using passive modes parallel to the utility on both sides in order to check for laterals/T's.

6.3 Scan with GPR standard utility antenna, typical frequency 400 MHz or 350 Hyper stacking antenna.
- 6.3.1 Calibrate GPR settings to current site conditions.
- 6.3.2 Use GPR to attempt to locate any unidentified, known utilities.
- 6.3.3 Collect scans with GPR parallel to any marked utility in order to check for laterals/T's.
- 6.3.4 Document any known utilities that could not be located.
- 6.3.5 Perform passive sweeps with electromagnetic locator to locate unknown utilities.
- 6.3.6 Sweep all areas in a grid with spacing determined by site conditions.
- 6.3.7 Sweep separately with Power mode and Radio mode (and Cathodic Protection mode when applicable)
- 6.3.8 Collect GPR scans to locate unknown utilities.
- 6.3.9 Scan all areas in a grid with spacing determined by site conditions.
- 6.3.10 Collect GPR scans across all previously located utilities to confirm locations and approximate depths.
- 6.3.11 Document findings with photos and additional reporting/mapping if required.

7. SIM Post investigation hand off

7.0 If possible, a recap and review of findings with site contact
- 7.1 Explain scan findings, where did the technologies work well and where results were inconclusive due to interference and or soil conditions.
- 7.2 Explain markings and depth estimates.
- 7.3 Review original scope to confirm expectations were met/exceeded.

Conclusion:

This specification details steps and methods that ensure the best nondestructive scan results. There is an emphasis on the value of training and mentorship because of the many potential scenarios a field technician may encounter and the many ways the equipment can be applied. The SIM approach, (experienced-based training combined with technology) has proven to be consistently accurate and efficient in accounting for site variability.

Please visit www.simspec.org for more information and detailed SIM specification.