



Ground Disturbance Safety

AMEC Earth & Environmental
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Underground Facilities

- The underground infrastructure in Canada and the United States comprises about 27 million miles (43.2 million kilometers) of pipe, cable, and wire. The term “underground facilities” generally refers to the buried pipelines and cables that transport:
 - petroleum,
 - natural gas,
 - electricity,
 - communications,
 - cable television,
 - steam,
 - water, and
 - sewer.

Danger is There in a Big Way!

- Ground disturbance is one of the riskiest things we are involved in as a company.
- A single underground utility line accident has the potential to cause a catastrophe that can kill or injure hundreds of people, affect thousands more, and cost millions of dollars in terms of property damage, loss of work opportunity, community disruption, ecological damage, insurance and legal liability.

Worldwide Problem

- In 1994, a tragic pipeline accident occurred in Caracas, Venezuela. A 22-ton trenching device, working on a road construction project, struck a 10-inch gas transmission line. An occupied bus and cars stopped by the road construction were engulfed in flames. Fifty-one persons were killed and 34 injured.
- The next year, in April 1995, construction work on a subway system in Taegu, Korea, ruptured a gas line, killing 103 persons.
- These accidents occurred in systems that do not operate under U.S. or Canadian regulations, but they illustrate the catastrophic consequences that can result from excavation or drilling damage to underground facilities.

North American Accidents

- In March 1994, a pipeline accident in Edison, New Jersey, injured 112 persons, destroyed 8 buildings, and resulted in the evacuation of 1,500 apartment residents.
- Accident damage exceeded \$25 million. The U.S. National Transportation Safety Board's (NTSB) investigation determined that the cause of the accident was excavation damage to a 36-inch gas pipe.

North American Accidents

- On June 9, 1994, a **2-inch-diameter** steel gas service line that had been exposed during excavation separated at a compression coupling about 5 feet from the wall of a retirement home in Allentown, Pennsylvania. The escaping gas flowed underground, passed through openings in the building foundation, migrated to other floors, and exploded. The accident resulted in 1 fatality, 66 injuries, and more than \$5 million in property damage.
- In its investigation of this accident, the National Transportation Safety Board (NTSB) identified safety issues relating to pipeline excavation damage prevention and rapid shutdown of failed gas service lines.

North American Accidents

About 10:50 a.m. on December 11, 1998, while attempting to install a utility pole support anchor in a city sidewalk in St. Cloud, Minnesota, a communications network installation crew struck and ruptured an underground, **1-inch-diameter**, high-pressure plastic gas service pipeline, thereby precipitating a natural gas leak. About 39 minutes later, while utility workers and emergency response personnel were taking preliminary precautions and assessing the situation, an explosion occurred. As a result of the explosion, 4 persons were fatally injured; 1 person was seriously injured; and 10 persons, including 2 firefighters and 1 police officer, received minor injuries. Six buildings were destroyed.

The National Transportation Safety Board determined that the probable cause of this accident was the lack of adequate procedures by Cable Contractors, Inc., to prevent damage to nearby utilities when its anchor installation crews encountered unusual conditions such as striking an underground obstacle. Contributing to the severity of the accident was the delay by Cable Contractors, Inc., in notifying the proper authorities.

Burning Road Grader



This accident killed a 41-year-old operator who struck a 10-inch propane pipeline while doing ditch maintenance



Water Main Rupture

Crew repairing water line damaged the main



Burning Bulldozer

Contact with high pressure gas main with the ripper on the dozer



Explosion: Gas line explosion and fire killed three and injured eleven



Gas Main Rupture: Firefighters provide water shield to prevent explosion

Phone Cable Cut



Workers on a highway construction project severed a 900-pair and a 100-pair telephone cable, cutting off service to 600 local homes and businesses



Water Main Rupture

Power company crews replacing a pole augered through a 70 psi water main

Where we are...

- As a company we have had a relatively large number of strikes and close calls.
- Luckily no one was seriously injured, and no explosions or fires occurred.
- Based on probability, our next strike of an underground facility could become a major accident.
- Please help the company to prevent it!

AEE Strikes and Near Misses

- **Main gas service to WeyCo mill in Drayton Valley in 1996 – no injuries but plant shut down for a day**
- **Just missed a big gas line in 1997 - risked business relationship with Suncor**
- **Damaged saltwater disposal line in Redwater in 2000 – costly spill with remediation**
- **Water main in Edmonton in 2001 – client did not pay our fees**
- **Several recent (2003 – 2007) incidents in New Mexico, Alberta, Colorado, Florida, and Ontario involving drill rigs and construction equipment damaging gas, electric and water utility lines**

Causes

- Wrong information – One-call and locators failed to identify the line or made a significant error
- Insufficient due diligence (One-call is NOT enough!), private locators were not used
- Wrong decision based on correct information – failure to properly interpret the clearance requirements
- Failure to properly secure the exposed underground facility
- Failure to secure markings, markings covered with snow
- Poor communication, lack of coordination, disregard of a permit system - subcontractor acts “on its own” (mostly during excavation on construction projects)
- Other causes?

Parties involved

- **Facility owners**
 - design, install, and maintain the underground network
- **Construction crews**
 - engage in excavation activities for a variety of reasons, and they use an assortment of government permits
- **States and provinces**
 - regulate actions to protect safety
- **Insurance companies**
 - insure the underground facilities, property, and construction business activities
- **Fire, police and emergency management agencies**
- **Private Locators**
 - work at excavation sites to identify and mark underground facilities
- **One-call communication centers**
 - coordinate notifications about digging activities. These centers may be an operating unit of a facility owner or they may be independent entities that provide notification service to several facility owners
- **Construction managers/Consultants (AMEC)**

This is a time to “Stop and Think”!

- ... and to conduct a company-wide refresher on ground disturbance

What is Ground Disturbance?

- An excavation is defined as any operation for the purpose of movement or removal of earth, rock or other materials in or on the ground by use of mechanized equipment or by blasting...
- Excavations include, but are not limited to:

- | | |
|------------------------------------|-------------------------|
| ■ Demolition of Structures | ■ Driving Survey Pins |
| ■ Drilling | ■ Digging |
| ■ Cable or Pipe Plowing or Driving | ■ Installing Sign Poles |
| ■ Grading | ■ Scraping |
| ■ Setting Poles | ■ Boring Holes |
| ■ Trenching | ■ Ditching |
| ■ Moving Earth | ■ Dredging |
| ■ Wrecking | ■ Augering |
| | ■ Tunneling |

What is the Regulated Depth?

- Please check your local jurisdiction? Do you know the answer?
- in the majority jurisdictions you should call each time you are planning to scrape the soil or move the earth by use of mechanized equipment

Who is responsible?

- AEE works in multiple jurisdictions. Some of these jurisdictions put automatic responsibility on a prime contractor, others assign joint liability; in all scenarios, prime contractor can be held legally liable.
- In case of an accident, AEE may be found a “controlling employer” (“prime contractor”, “constructor”).
- AEE be cited by the regulators and may be found liable

Legal

- AEE due diligence actions should be in place and documented.
- Contract should include the buried utilities indemnification clause:
 - Seller (Driller, Excavator) agrees to indemnify and defend Buyer (AMEC) and Buyer's Client from and against all damages of any kind associated with the accidental or intentional damage or injury to any buried utilities which occurs incident to the services provided by Seller. The term, "utilities" includes, but is not limited to, telephone, gas, fuel, water, electricity and related media. Seller accepts as a condition of this subcontract award full and complete responsibility for location and determination of such utilities during the performance of the work hereunder.

Competent Person

- North American H&S jurisdictions require a “competent person” to be present at the work site during the ground disturbance/excavations.
- In a broad sense, a competent person is an individual who, by way of training and/or experience, is knowledgeable of applicable standards, is capable of identifying workplace hazards relating to the specific operation, is designated by the employer, and has authority to take appropriate actions. Some standards add additional specific requirements which must be met by the competent person.
- Every contractor should provide a competent person for the tasks they conduct.

Competent Person

- Some jurisdictions require a competent person to have specific training.
- For example, Alberta Pipeline Regulation requires an excavation/drilling competent person (“ground disturbance supervisor”) to complete Level II Ground Disturbance Training
 - This training is required for AEE staff by some of our major Canadian clients (i.e., Imperial Oil and Syncrude)
- In all instances when specific training is required by the regulations or by AEE clients, we need to check if our subcontractors have it.

Finding Underground Facilities

- Published and private information sources – **One-call alone is not enough!**
- Locators (private companies)
- Interview owner
- Visual observations
- Line locating by electronics or exposure
- Work closely with the drilling/construction companies, facility owners, locators, regulators, and all other parties involved

Locators

- An entire industry of underground utility locating businesses have developed in the last two decades. Primarily, these businesses serve utility companies by performing the marking services associated with One-call notification.
- Referred to as locators, these technicians visit construction sites and mark the location of underground facilities using both mapping technology and electronic tools.
- Practices for marking the underground facilities can have an impact on the risk of excavation damage. Good practices include the excavator's pre-marking the intended excavation site to clearly identify to the facility locator the area of digging; positive response by the utility owner to confirm that underground facilities have been marked or to verify that no marking was necessary; the use of industry-accepted marking standards to unambiguously communicate the type of facility and its location; marking facility locations within the specified notification time; and responding to requests for emergency markings, when necessary.

One-Call Notification Systems

- A cornerstone of current damage prevention programs, in both Canada and the US, involves the use of One-call notification centers.
- One-call notification centers function as communication systems established by two or more utilities, government agencies, or other operators of underground facilities to provide one telephone number for notification of excavating, tunneling, demolition, or any other similar work.
- The system is designed so that excavation contractors, facility owners, or the general public can notify the One-call center of the location of intended digging or construction activity.
- US recently implemented country-wide 811 One-call system
 - <http://www.call811.com/about-us/general-info.aspx>
 - <http://www.call811.com/state-specific.aspx>

One-Call Notification Systems

- In some situations, One-Call operators might insist on being contacted only by the contractor who will perform the drilling or the excavation.
- In these situations, AEE retains a high degree of responsibility and should work with the contractor and continue the due diligence.
- AEE also retains a high degree of responsibility in cases where our client says that they will look after the locales. AEE needs to ensure that diligent ground disturbance and risk minimization procedures are completed.

One-Call – Typical Requirements (check your jurisdiction!)

1. You must call for a location request at least 2 working days but not more than 10 working days before any excavation starts. (Excluding holidays & weekends).
2. You must call regardless of where the excavation is located. Even if it is on private property, out in the middle of a field, or on a street that has no name...you must call.
3. You must call even if you are only excavating a few inches or just surface grading. If you move material... you must call.
4. You must call even if the property owner tells you the site has no buried facilities, or they know where buried facilities are located.
5. Make sure you have a proper location request, don't rely on old marks, or another excavator's marks or stake out request.

One-Call – Typical Requirements (check your jurisdiction!)

6. Mark out the area you plan to excavate with White Paint, Flags, or Stakes.
7. When Investigators inspect an excavation/drilling site or investigate damage, they will check to see if you have a proper location request.
8. Review the Location Request Information Sheet so you will know what you need when you call.
9. Emergency is any abnormal condition which presents immediate danger to life or property including discontinuance of a vital utility service necessary for the maintenance of public health, safety and welfare.
10. For emergency excavations notify your one call center with the location of the emergency excavation as soon as possible!

Confirm The Utility Response

- Each facility operator identified on your Location Request Ticket is required to contact you prior to your start date and inform you either their facilities in your excavation area have been marked or they have no facilities in the proposed excavation area.
- Remember, facility operators will only mark out facilities for which they are responsible.
- Facility operators owe you a positive response, and you are responsible for making sure each operator on your ticket has responded.
- Typically, by law, a facility operator can delay marking out your excavation site a maximum of two (2) working days. However, any delay of more than two (2) working days will require your consent (please check your local jurisdiction).
- If you do not hear from a facility operator identified on your location request before your stated commencement date, call the facility operator's contact number. If you do not have the contact number, please call your One-Call Center.
- It is important you provide accurate field contact numbers when you call the One- Call Center for a Location Request; because this is the number facility operators will call if they need to contact you regarding your location request.

Limitations of One Call Systems

- Unless the private facility owner participates in One Call System, privately or customer owned facilities will not be notified and may not be marked.
- Therefore, it is imperative that special precautions be taken by excavators as part of every excavation project.
- AMEC requires a detailed inquiry for private facilities as part of every excavation project.
 - This should include hiring private locators in addition to One Call. Remember: One Call is NOT ENOUGH!
 - This inquiry can include physically inspecting the entire construction site and the surrounding area. Interviewing owners or occupants (or former owners or operators). Ask questions! If a building has heat, what is the source of supply? If there are lights, there is electricity.

Be on the Lookout for Private Facilities

- Ground disturbance projects require great detective skills.
- The excavator knows that private facilities will be part of almost every job.
- They physically inspect the jobsite prior to entering a ticket (or even bidding the job), they query the property owner, see what equipment or power may serve buildings they will excavate around, and look for warning signs.
- They find out who installed the original underground facilities and contact them to determine if any records or maps exist.
- They also prepare maps of any new facilities they install, so that this problem doesn't exist in the future.

Guide To Marks

- The following is only a guideline. Refer to the current Common Ground Alliance (CGA) Best Practices for complete details. www.commongroundalliance.com
- Utility lines should be indicated by markings using current APWA color codes.
- Markings should be 18"-24" in length and 2" in width.
- The owner of a facility should be indicated by initials or by name in letters 6" high at the beginning and end of the locate. On long locates, the facility owner should be indicated every 100'.
- For operators with multiple facilities within an excavation area, for example bundled or stacked facilities, the total number of lines within the ground should be indicated when known.
- If a facility is known to be present but the total number of lines for a facility cannot be determined a corridor marker may be used indicating the approximate width of the facility.
- When known, the size of the line being located should be indicated. Line size should indicate the outside diameter of the pipe or structure.
- Conduit or duct structures, whether single or multiple conduits or ducts, should be indicated by the conduit symbol indicating the approximate depth of the structure.
- When known, the pressure of a gas facility should be indicated.
- When known, termination points, dead ends and stub outs should be indicated.
- Offset markings should be used when there is a strong likelihood that marks may be destroyed, (if placed directly over the facility).

Marking Standards

- Local One-call centers often distribute pocket-size flash cards with these color codes to excavators. The use of standard marking colors informs the excavator about the type of underground facility whose location has been marked:

Marking Standards

APWA Uniform Color Codes
For Marking Underground Utility Lines

White	Proposed Excavation
Pink	Temporary Survey Markings
Red	Electric Power Lines, Cables, Conduit & Lighting Cables
Yellow	Gas , Oil, Steam, Petroleum & Gaseous Material
Orange	Communications , Alarm, Signal Lines, Cables or Conduit
Blue	Potable Water
Purple	Reclaimed Water, Irrigation & Slurry Lines
Green	Sewers & Drain Lines

Respecting the Marks (by the Dig Safely NY)

1. You are responsible for maintaining the marks set down by facility operators at your site.
2. Before you begin your excavation, walk-through the site to familiarize yourself with the markings and the locations of buried utilities. It is a good practice to photograph, videotape or make a sketch of the marks.
3. Pay special attention to any changes in the direction of the underground facilities.
4. If your excavation will cause the removal or disturbance of markings, establish offset marks in order to maintain a reference point for those underground facilities.
5. Make sure everyone involved in your excavation is aware of any established offsets, any compromised marks, or any other information regarding facility locations.

Respecting the Marks (by the Dig Safely NY)

6. Don't put spoil piles over markings. Avoid driving machinery over stakes and flags. Paved areas should be swept periodically so painted marks remain visible.
7. If marks have faded or been compromised to the point where proper and safe excavation is no longer possible, call your One-Call Center and make a request for a re-mark.
8. It is recommended you request re-marking if your project is interrupted for more than 10 working days.
9. If you refresh the markings at your site, make sure you use the uniform color code and identification letters to avoid any confusion. Make a note of the date and actions taken to refresh the marks.
10. Once the project is complete, it is recommended you remove any marks as best you can. This will reduce the likelihood future excavators will mistake them for marks provided in response to their own excavation notice, or assume they do not need to provide notice of intent to excavate.

Tolerance Zone (NY State – local regs may vary)

Tolerance Zone

The tolerance zone is defined as:

- 2 feet on either side of the designated center line of the facility if the diameter is not provided.
- Or, 2 feet from each outside edge if the diameter is provided.

For example:

Measuring The Tolerance Zone

The facility at left is marked as being 20- inches wide. So, 24" on each side, plus the width of the facility, gives us a Tolerance Zone of 68".

The facility at right is marked with its location, but shows no width. So, 24" on each side, gives us a Tolerance Zone of 48".

(Example of the tolerance zone)

Hand Exposure Zone/Clearance Zone

- Please always check local regulations and read clearance distances required by locators!
- For example, in Alberta, “hand expose zone” is 5 m of any Alberta Energy & Utility Board (EUB) regulated pipeline or fiber optic cable; 3 m of federally regulated lines; and 1 m of all other types of underground facilities.
- US SOP “Drilling Safety” requires the following:
 - To avoid contacting underground utilities, a minimum distance of 5 feet will be maintained between all equipment and detected underground lines.
 - Reducing this distances would require a consultation with and consent from the Corporate SHE Department and local management.

Training and Educating Excavation Personnel

- Excavators need to be trained and educated about safe work conditions, good excavation practices, relevant State or Provincial laws, and One-call procedures.
- In this context, the excavator is not only the backhoe or drill rig operator at the construction site, but also AMEC project manager, field engineers and technicians - anyone connected to excavation work.
- Select only qualified and trained subcontractors.

AEE Tools

- Training
- Standard Operating Procedures for drilling and excavation
- Contractor pre-qualification
- Job Hazard Analysis
- Regional regulatory-specific ground disturbance safety systems and checklists

Emergency Planning - Gas Line Rupture

- **Immediate Explosion Alert!**
- Call 911 or local emergency number, make other notifications.
- Evacuate everyone upwind. Isolate spill or leak area immediately in all directions. Prevent entry into sewers, basements or confined low-lying areas. Isolation distance and evacuation area size are site-specific and should be considered during the health and safety planning. Do not allow unauthorized personnel to enter the area.
- Eliminate all possible sources of ignition, including those which do not normally pose a risk, as propane may travel long distances along the ground and flashback to the source (this includes running vehicles and sparks from turning on light switches).
- Keep unauthorized personnel away.
- Stop leak if you can do so without risk (special emergency response training and proper PPE is required).
- Make sure leak area is well ventilated to prevent air concentrations from reaching explosive levels.
- Keep out of low areas as propane gas is heavier than air and will spread along ground and collect in low or confined areas (sewers, basements, tanks).
- Do not touch or walk through spilled material.

Emergency Planning - Gas Line Rupture

- Exercise extreme caution when working in residential areas or in proximity to any buildings, basements, trenches, manholes, etc.
- Please review a case study at <http://www.nts.gov/Publictn/2000/PAB0001.pdf>

Emergency Planning - Gas Fire

- Call 911 or local emergency number; make other notifications.
- Evacuate everyone a safe distance.
- Keep unauthorized personnel away.
- Do not attempt to stop gas flow (unless you can do that with no risk, special emergency response training and proper PPE is required).
- Do not attempt to put out even a small gas-fed fire.
- Do not attempt to enter the area.

Dig with Care!

- 1. Before you use powered equipment within the tolerance zone you must:
 - Verify the location, type, size, direction-of-run and depth of the facility.
 - For gas and liquid petroleum lines, verification must be by means of hand-dug test holes.
 - The location of other utilities must also be verified by means of hand-dug test holes unless otherwise agreed upon with the facility operator.
- 2. Do not assume that buried facilities will be at a certain depth.
 - Facilities may have been originally installed at a prescribed depth, but later erosion or grade changes cause them to now have shallow or deep cover.
- 3. Verification by a hand-dug test hole requires the facility to be exposed to view.
 - If after a diligent search the facility cannot be verified in this manner, notify the facility operator, or your one call center.

Dig with Care!

- 4. Vacuum excavation is an accepted means of verifying the location of marked facilities.
- 5. Powered equipment may be used for removing pavement, but only to the depth of the pavement.
 - Care and good judgment should be used when removing pavement.
 - Avoid starting the pavement break directly over the marked facility.
 - Wherever possible, start a few feet away from the marks and attempt to 'peel' off the pavement or break it into small chunks for removal.
- 6. Verify the location of utilities before you excavate up to the edge of the tolerance zone.
 - It is a good practice to assign workers to do the utility verifications ahead of the excavating crew. You'll be providing a greater margin of safety and any problems can be resolved in time to minimize interference with the excavation.

Dig with Care!

- 7. If the excavation is going to cross a tolerance zone, dig a test hole to expose the facility at the point of crossing.
- 8. If your excavation is going to parallel a utility, you should dig test holes at any marked change of direction, elevation and at branch connection.
- 9. For relatively straight excavations parallel to a utility, a test-hole should be dug approximately every 20 to 25 feet.
- 10. If you find an unmarked or unknown facility, and you can tell who the facility owner is, notify them. Otherwise, notify the One-Call Center.

Suggestions and Reminders

- **Do** report immediately (to 911 and facility operator) any damage to underground facilities resulting in escaping flammable, corrosive, explosive, or toxic liquids or gas.
- **Do** follow the special instructions from facility owners regarding their lines.
- **Do** keep a minimum clearances between any underground facility and the cutting edge of any powered equipment. Know your clearances!
- **Do** protect and preserve the color-coded markings until those markings are no longer needed for a proper and safe excavation.
- **Do** call for a re-mark if the markings are destroyed, or removed before excavation is complete, and allow two working days to re-mark the site.
- **Do** be sure that someone other than the equipment operator, (i.e. the spotter), is there to look for any sign of an underground facility.
- **Do** conduct the excavation near the underground facility carefully. Excavate by hand to be able to tell the exact location of the line and to prevent damage.
- **Do** report any damage to the facility operator. For example, cracked conduit, gouges, dents or breaks to the coatings, cable sheathes and cathodic protection anodes or wiring that may pose problems now or in the future.
- Allow the underground facility operators time to make repairs.

Suggestions and Reminders

- **Don't** call in a location request unless you are prepared to start on the stated commencement date.
- **Don't** assume a pipeline or cable runs straight, or is centered between permanent marker posts.
- **Don't** assume the depth of a utility. Never assume an underground facility is at the same depth throughout the entire route of an excavation.
- **Don't** excavate within the tolerance zone with mechanized equipment prior to verification.
- **Don't** phone in emergency locates that are not really emergencies.
- **Don't** work under anyone else's location request.

Know your regulations!



References

- Case study <http://www.nts.gov/Publictn/2000/PAB0001.pdf>
- Pipeline accident reports by NTSB <http://www.saveballona.org/log.html>
- NTSB Report: Protecting Public Safety Through Excavation Damage Prevention <http://www.nts.gov/publictn/1997/SS9701.pdf>
- NY State Dig Safely, Excavation Manual
- [US Drilling Safety SOP](#)
- [US Excavation Safety SOP](#)