CROSSING PIPELINES

SUMMARY
Damage to existing pipelines/cables can be hazardous and expensive. The money spent due to damage is much more than the cost of locating existing utilities before construction. The crossing lines must be properly documented, protected, inspected, and supported.

DEFINITIONS
Crossing pipeline/cable – A crossing pipeline or cable is an existing line that crosses over the new pipeline installation.
S.U.E. – Subsurface Utility Engineering – locating, mapping, conflict resolution, permits, notification
811 – A nationwide telephone number to have existing utility locations marked on ground.
D.I.R.T. – Reporting system for damage and near misses to existing utilities.
Competent Person – Trained person who assesses whether a trench is safe to enter or not and has authority to prevent entry. OSHA requires that every excavation project has one.

INTRODUCTION
As shown in figure 1, a new pipeline installation sometimes passes beneath (or over) another pipeline or cable. Some contracts may call for the crossing line to be removed and replaced after the new pipeline has been installed. But typically the line is left in place and the new installation works around it. Installation at the crossing involves the following:

1. Location
2. Proximity to other utilities
3. Documentation
4. Notification
5. The crossing pipeline must be supported during construction.
6. Safety
7. The crossing pipeline must be checked for leaks and damage.
8. A new base for the crossing pipeline must be constructed.

Figure 1  Existing Pipeline Crossing New Installation
If the new pipeline crosses OVER another line, any action necessary depends on how close the lines are. If the existing line is exposed then location, documentation, notification, and inspection necessary. If not exposed, but there is a possibility of damage to the existing line then notification is necessary.

**LOCATION**

There are about 200,000 damage incidents a year and about one billion dollars in repair costs to underground utilities, plus potential harm to workers and area residents. Locating existing lines is crucial to new pipeline installations. In the design process, data collection is essential. There are concerted efforts in some areas to have a coordinated system for mapping all underground facilities. In many cases, the information is available through 811 ONE CALL.

Existing crossings are shown on the plans for pipeline construction. Design engineers can rely on existing maps and information, or use a SUE firm to provide the necessary information, and the contractor can use 811 service. NOTE: Locations do NOT usually provide elevation or depth information. Locations are referred as:

*Approximate Locations:* Locations shown on plans, marked on ground, etc. should be considered as approximate locations.

*Exact Locations:* The exact locations is typically not known until the pipe/cable has been uncovered.

**S.U.E (Subsurface Utility Engineering)**

SUE firms offer utility locating and mapping services for the project owner or designer. The result can be one of several levels, depending on the job requirements:

*Quality Level D (QL-D)* — involves utility records research and interviews with knowledgeable utility personnel.

*Quality Level C (QL-C)* — involves surface survey, identifying and recording aboveground features of subsurface utilities such as manholes, valves and hydrants.

*Quality Level B (QL-B)* — involves application of “surface geophysical methods” such as electromagnetic-based locating instruments, ground penetrating radar, radar tomography, metal detectors and optical instruments to gather and record approximate horizontal (and, in some cases, vertical) positional data.

*Quality Level A (QL-A)* — involves physical exposure via “soft-digging” (vacuum excavation or hand digging) and provides precise horizontal and vertical positional data.

For buried pipeline installation, Quality Level A is usually required. Locating underground obstacles before construction begins can be much less than the cost of damage to existing utilities, danger to workers and residents, and litigation. SUE firms can also resolve conflicts, help arrange for permits, replacement or restoration information, inspections, and final documentation.
811
Calling 811 gets you to your local utility locating service. As described below, 811 may also be used to report unknown crossings, and hazardous and unhazardous damage. Check with local utility locator to see what services are offered.
If 811 does not provide services other than location, then the contact numbers for the utilities and the governmental agencies in the area must be provided the inspector and the contractor’s competent person(s). Contact numbers for both routine notification and for emergencies are necessary.

CGA
The Common Ground Alliance is a non-profit organization devoted to preventing damage to underground utilities. The funding comes from paid membership in the organization. CGA implemented and now promotes the 811 ONE CALL system for locating utilities.
www.commongroundalliance.com

D.I.R.T. (Damage Information Reporting Tool)
DIRT is a program operated by the Common Ground Alliance (CGA) for the collection and reporting of underground damage. DIRT is a voluntary system although some States require it for contractors. Users submit information to the website on damages and near misses. The data is analyzed to help prevent future damage. This effort enables better worker safety and prevents costly damage. In 2009, DIRT estimates that there were 200,000 damage events in the United States (Analysis and Recommendations -2009, CGA-DIRT). At a repair cost of $5000 each (author’s estimate), there is about one billion dollars in damages each year. Not all events are reported and the study is not a random sample.
www.cga-dirt.com

Proximity
Typically, the depths of pipelines conveying potable water, recycled water, and sewage are in descending order of water quality. There is usually a requirement that there be at least one foot vertical separation between parallel or crossing lines (measured between pipe barrels). If not possible, some agencies now allow/require a Styrofoam spacer block between the pipe. There is also usually a requirement that there be a minimum of 10 ft horizontally between parallel water and sewer pipe. Many agencies also require that there should not be a joint in the water pipe that is within 8 to 10 feet of the sewer line. In other cases, there is a one foot minimum separation requirement between any pipe and a structure. Separation distances refer to outer surface of any pipe coating or wrap.
If the pipelines that are exposed in the excavation do not meet these requirements, the owner or design engineer must be notified. This pertains to both existing lines and the new lines.
DOCUMENTATION

To prevent damage to underground utilities during construction, their location should be exactly known. Documentation of known and unknown crossings will help in the mapping of these facilities. Elevation or Depth should be noted.

Known Crossings

During excavation of a trench, there will be existing pipelines and cables that cross over the new line. These have to be carefully uncovered because only an approximate location is shown on the plans. Typically, no elevation or depth is shown for these crossing lines.

The exact location of the lines must be noted and reported to the owner/operator. Location must include the elevation or depth. The governmental agency with jurisdiction for the area may want to be notified so they can update their records. Any change in location should also be noted on as-built drawings.

Unknown Crossings

There may be crossing lines encountered that are not on the plans. The exact location of active lines must be noted and reported to the owner/operator. Note valves, markings on the pipe, manholes, etc. along the alignment of the unexpected pipeline/cable. Take photos. In addition to the owner/operator, the governmental agency with jurisdiction for the area may want to be notified so they can update their records. The work should not proceed until the proper support has been planned.

Abandoned Crossings

Abandoned crossings, known and unknown, can be removed across the width of the excavation. The ends must be permanently plugged, typically by filling with concrete. An old abandoned pipeline may still collect water and any flow into the excavation, or after completion, should be prevented. Unknown lines should be reported to local governmental agency.

NOTIFICATION OF CONSTRUCTION

Most specifications require that the owners/operators of the crossing lines notified when their line is uncovered. Many will want to have a representative there, particularly for electrical, telephone, fiber optic, and gas lines.

CONSTRUCTION SUPPORT

To prevent damage to the crossing pipelines and cables, they should be temporarily supported where they have been uncovered.

Typical Supports

Some of the crossing lines will require some type of temporary support system from the ground surface. As discussed later, in some cases, the engineer or the owner/operator will have designed and issued instructions for the construction of the support system for special cases. For the more routine crossings the contractor devises support systems for the crossing lines. Typically, a beam is laid across the trench and the pipe supported by slings or cables.

Whether or not a crossing pipeline or cable is supported, and amount of support, depends on the width of the trench and the type of pipe or cable. The exposed pipe/cable will be like a beam with fixed
ends. If the pipe/cable will sag, then support should be provided to prevent sag that will damage the pipe/cable. A pipeline that sags across the excavation can open joints, damage coatings and linings, and even cause failure. The effect of damage may not be known until the pipe is covered and reactivated, or even years later. The pipe is typically supported from a beam across the top of the trench, as shown in Figure 1. The supports should be fabric lifting straps, not wire rope or cables. The straps should be easily adjustable in case the pipeline needs to be raised or lowered during construction.

If the crossing pipeline is under pressure and left active, vibrations may increase and the pipe may move due to water hammer. The vibrations and movement may weaken any joints.

If the crossing pipeline is ductile iron with a corrosion sleeve over it, remove the sleeve and then replace it just before backfilling. The existing sleeve is too easily damaged from the new installation activities (such as the support slings). The new sleeve must be well taped to existing sleeve material.

**Warning** - Exposed pipe that has gasketed bell-and-spigot joints (or other unrestrained joint) must be supported before the underlying soil bedding is removed to prevent the joints from opening. Bell restrain harnesses, illustrated in Figure 2, can be used to prevent the joints from opening. The harness effectively makes a restrained joint.

**Warning** – Adding a restrained harness also increases the weight of the exposed pipe in the excavation. This may mean that a support beam must be added or the number of support straps increased.

**Warning** – Do not tighten bolts on a bell restrain harness so that the spigot is forced further into the bell.

Calculating the necessary support system can be found in many excavation handbooks and manuals. A good reference is *Excavation Systems Planning, Design, and Safety* by Joe M. Turner (2008).

For these same reasons, the contractor must identify any unexpected lines and notify the design engineer and the utility. The work should not proceed until the proper support has been planned.

**Warning** – The contractor and the inspector must have information readily available about contacting the engineer and the utilities.
**Warning** – The support system is typically beams laid across the open trench with straps supporting the crossing pipeline. The end bearing of the beam will increase the load at the top of the trench. This load must be spread out as much as possible and be part of the design of the support beam.

In addition to being temporarily supported, any exposed sanitary sewer should have a continuous waterproof trough placed under it.

**Warning** - Exposed black polyethylene pipe will soften from heat and sunlight and should be supported if that possibility exists.

Any cables that cross the excavation that are encased in concrete, typically unreinforced, will need support.

**Special Supports**

In some cases, the engineer or the owner/operator will have designed and issued instructions for the construction of the support system. Many of the crossing pipelines are critical local utilities and maintaining their integrity is not only important for the safety of workers and personnel in the vicinity, but for providing service to the public. Turner (2008) recommends that identifying and planning the level of support and protection for these crossing or parallel lines should be the responsibility of the design engineer, not the contractor.

**Temporary Pipe Removal**

Any pipe that has portions removed for the excavation must be temporarily plugged to keep debris out.

**Unexpected Obstructions**

When the crossing pipe unexpectedly creates a conflict in alignment with the new pipeline, operating agency or owner must be contacted. Change in alignment, relocation, or re-construction of the existing pipe, or the new pipe, must be agreed on and approved. Installation requirements of the existing or new line may need modification. Changes in alignment in the excavated area should have restrained joints. Agency/owner should be contacted to observe the modifications. Take photos.

**Thrust Blocks**

Any thrust blocks that are exposed or known to be close to the excavation should be removed and reconstructed during backfilling of the trench. Do not excavate under existing thrust blocks.

Note soil support conditions and replicate as much as possible when replacing. Or meet replacement requirements of operating agency or owner of line.

Some existing thrust blocks may have been designed with higher assumed soil bearing pressure than the replaced soil. When the thrust block cannot be formed against native soil, standards and manuals recommend compacting soil to 90 percent Proctor between the thrust block and the native soil. The 90 percent compaction may have a lower bearing pressure than the original design. The 90 percent compaction may also be insufficient if the soil becomes wet. The soil can become wet because of surface water infiltration through the new backfill, French drain effect around the new (or existing pipe), or potential leaks. The soil should be compacted to at least 95 or 100 % Proctor, or flowable fill be used.
SAFETY

Existing or new leaks can be dangerous to workers and public. Support systems should be checked.

Support Beams
The support system is typically beams laid across the open trench with straps supporting the crossing pipeline. The end bearing of the beam will increase the load at the top of the trench. The competent person should inspect the support system at the beginning of each day.

Toxic fumes
Immediately after exposing crossing pipes and during the uncovering process, the competent person must monitor the excavation for toxic gases. Natural gas is lighter than air and will dissipate but is explosive when first exposed. Hydrogen sulfide (sewer gas), propane, and most gasoline fumes are heavier than air and will accumulate in the trench. Carbon monoxide is just barely lighter than air but must be a concern.
Checking the air in the bottom of the trench must checked at the beginning of the day.

Cables and Gas Lines
Electrical and telephone cables and any gas lines must be protected from possible damage while exposed. Exposed cables and gas lines must never be left unguarded and they must be protected from possible vandalism.

INSPECT EXISTING PIPE
LEAK AND DAMAGE CHECK

Once the line has been uncovered, it should be inspected for leaks, damage, and potential leaks.

Damage
Inspect crossing pipe for damage from uncovering, or from old damage when installed.
Leaks
Excessive deflection
Excessive cracks
Exposed re-bar
Flexible coating
Cuts or scratches deeper than 1/10 of pipe wall thickness for thermoplastic pipe (PVC and HDPE).

Previous damage to coatings may be obvious because of signs of corrosion. Damage done while uncovering the pipe may not be as apparent and will require closer examination.

Inspect any restrained joints, couplings, old repairs for damage or excessive corrosion.
Inspect condition of any previous repairs
Polyethylene Baggies

Polyethylene corrosion baggie around ductile iron pipe should be replaced and properly sealed to existing baggie.

Leaks

Inspect all pipe and joints for leaks and damage. Look for signs of old leaks (damp pipe, stains, crusty buildups, corrosion at mechanical joints, roots around joint, water in corrosion baggies) and new leaks caused from exposing the pipe (seeps, moisture). Repair as necessary. If the existing pipeline was constructed with joints with angular deflection, measure the angular offset and compare with allowable values.

Existing Leaks

If the newly uncovered line is leaking, the contractor and the project inspector should take immediate action to protect the workers, inhabitants in the area, and the integrity of the line. The dangers include natural gas leaks, electrical shock, sewer gases, high pressure water that could erode the trench supports or fill the excavation with water. There could be impending collapse or failure of the line. The project inspector and the competent person must always observe the uncovering of any crossing pipeline or cable and have the emergency contacts readily available.

If the pipe/cable has failed or could fail, the owner/operator must be notified and agreement reached for remedial action.

The inspector must have the knowledge to recognize the potential problems. Being aware of the pre-installation pipe acceptance criteria will be useful. Accordingly, the inspector must be on site when any crossing pipe/cable is uncovered.

The contractor should also be aware of these issues and assist in the inspection of the pipe, particularly for hazardous conditions.

If the line has been deactivation for the construction, the responsibility is no less. The pipe/cable and particularly the joints should be examined to see if leaking had been occurring. The inspection should look for damp pipe or cracks, water in any sleeves, crusty material at joint or anywhere along pipe, or any gas or sewer odor.

New Damage

If the pipe has been damaged but not leaking, the owner/operator must be notified to see what repairs or remedial action needs to be taken.

Potential Leaks

The potential for any future failures or leaks should be considered by looking for deflected pipe, cracks in the pipe, gouges, cuts, scrapes, high alignment angles, sagging of line, corrosion of pipe particularly at scrapes or dislodged coatings, corroded nuts and bolts on mechanical joints, etc. Thermoplastic pipe should not have any cut or scrape that is deeper than 10 percent of the pipe wall thickness.

Any corrosion sleeves around ductile iron pipe should be removed for inspection of the line. The old sleeve should be discarded and a new sleeve installed, taped to the remaining existing sleeves.
The line should also be inspected for any damage to the pipe or coating from the recent uncovering activities. Any previous damage may be evident due to staining, crusty buildups, corrosion, etc, but recent damage may be harder to determine.

The pipe may have been on the verge of collapsing, failing, or leaking, and the process of uncovering and restoring may accelerate the process. According to Murphy’s law, the failure will occur right after the area has been restored, or as soon as the warranty period is over.

Both the contractor and the inspector must have the knowledge to recognize when a pipe or joint needs remedial action, especially for the safety of the workers and the public.

CONSTRUCTION

The soil support for the crossing line must be properly restored.

Pipe Support

Installing pipe under crossing pipelines is a common occurrence that is generally done successfully despite several potential problems. The biggest problem is providing adequate soil support for the crossing line. The soil support for the crossing line is removed during the excavation of the trench. The pipe on either side of the excavation rests at equilibrium in the trench wall. However, during backfilling most methods of compacting the soil around the pipe do not densify the material directly under the pipe. The result is that the pipe is like an unsupported beam across the excavation. If there are unrestrained joints in the uncovered section, the weight of the pipe sections will make the uncovered portion sag and potentially open the joints. See TECH NOTE “Compaction Under a Pipe.”

When the crossing pipeline has a cohesionless bedding and embedment, the soil around the pipe at the trench wall can ravel into the excavation. This support will have be restored even though it is in the trench wall.

Vertical settlement of the pipe due to lack of firm soil support under the pipe when the backfill around the pipe was compacted may be a significant factor. It is difficult to compact soil directly beneath a pipe and a poorly compacted area results as shown in the following Figure 3:

Figure 3  Poorly Compacted Soil Under Pipe

Two of the best methods to provide adequate soil support under a pipe are (1) internal vibration and (2) flowable fill. Compaction of the area directly beneath the pipe can be accomplished by using cohesionless soils (clean sand or gravel) densified by internal vibrators. This compaction method is described in another TECH NOTE “Saturation and Internal Vibration.” Flowable fill about one to two feet thick under the pipeline could also be used.

NOTE: Compaction using internal vibrators in cohesionless soils is described in Chapter 10 of Pipeline Installation by Howard and in ASTM F 1668 “Practice for Installing Thermoplastic Pipe.” A video of the procedure can be seen on the “links” page of the website AmsterHoward.com.
Backfilling

Compacting the backfill over the pipe can create unsafe impact loads on the pipe. The same requirements as for new backfill should be followed. No compaction of the first one foot over the pipe and no ride-on compaction equipment used until there is at least 3 feet of cover over the pipe. A compaction wheel should not be used until there is two feet of cover over the pipe. No cobbles size rock or larger should be placed within 1 foot of the pipe and nothing larger than 6 inches should be within three feet of the pipe. If these requirements are impractical because the pipe is close to the ground surface or roadway, then the crossing pipe/cable should be encased in flowable fill.

Any corrosion sleeves around ductile iron pipe should be removed for inspection of the line. The old sleeve should be discarded and a new sleeve installed, taped to the remaining existing sleeves.

REFERENCES
