Avoiding Underground Utilities during Horizontal Directional Drilling Operations

Safety and Health Information Bulletin

SHIB 03-13-2018

BEFORE ANY DRILLING OCCURS A CONTRACTOR MUST USE THE STATE'S UTILITY LOCATION SYSTEM

Introduction

Installing underground utility lines safely using horizontal directional drilling (HDD) equipment prevents the drill from hitting and breaking existing underground utility lines (i.e., electrical, water, sewage, gas, steam, chemical). If the drill contacts underground electrical wires, the operator may be electrocuted. Striking natural gas lines with the drill may cause gas leaks at the worksite or down the line in surrounding areas, potentially causing an explosion. This Bulletin addresses safe HDD operations and specific methods to avoid underground lines because visibility is more limited than in vertical drilling.

Although HDD is considered trenchless, there are occasions when trenches are dug to accommodate the machine or reception pit. Trench/excavation controls must be implemented in accordance with (29 CFR Part 1926 Subpart P) to ensure adequate cave-in protection.

Ensure workers are not between a machine and trench wall when bringing a drilling machine down a ramp to place it in a hole. This will prevent them from getting crushed if the machine moves or lurches unexpectedly.

In 2013, an HDD operation installing underground cable in Kansas City, Mo., damaged a natural gas line, which resulted in an explosion and fire. The hand-dug "potholes" along the planned drill path revealed two utility lines two feet underground. The work crew presumed that one of these two lines was the gas line that they were looking to avoid striking, even though it was at a shallower level than they expected; in fact, both lines were electrical. Without verifying their assumption, the crew proceeded to drill deeper to lay a path for the new cable, and struck the

HDD Terminology Used in This Document

Back reamer: tool used for enlarging the pilot bore, and for pulling the utility line (e.g., fiber optic cable) into the bore.

Bore: the extended underground cavity or hole created by the HDD process.

Casing: a pipe installed to stabilize a wider-diameter bore after drilling.

Conduit: plastic piping installed in a bore to protect fiber optic cable or low voltage power lines.

Drill stem and head: metal rod and drill bit that convey rotational force, transmit drilling fluid into the bore, and excavate soil and rock while cutting the bore.

Potholing: method used to excavate small test holes from the surface to a buried utility line to expose its location. Techniques range from hand digging to using mechanical digging tools.

Reception Pit: excavation into which trenchless technology equipment is driven and recovered following the installation of the product pipe, conduit, or cable.

Tracking device: a device used to track the boring progress along the drilling path using an electromagnetic field to detect the drill head.

Vacuum excavator: a system used to dig potholes by high-pressure air or water to break up and vacuum soil and expose buried utility lines.

actual gas line further below. The resulting explosion and fire severely injured three HDD workers, destroyed a restaurant, and damaged other nearby buildings. Several bystanders were injured and a restaurant worker was killed.

What is Horizontal Directional Drilling?

HDD is a trenchless technology that uses surface-launched equipment to drill underground horizontally and install pipes, conduits, and cables. HDD is used in several industries, such as utilities and telecommunications, at sites with limited space (e.g., dense, urban areas) or where traditional vertical excavations are too hazardous (e.g., under lakes and rivers). Although HDD technology is thought to take less time, require fewer workers, and cause less surface damage compared to traditional open trench excavations, it is more difficult to avoid utility lines when using HDD because of the limited visibility inherent to the process.

How HDD Equipment Operates

HDD equipment operations vary depending on the bore's diameter, the installation length, and individual worksite complexities such as physical features, weather, and industry type. The following briefly describes the HDD process, which is important for understanding why it is critical to determine where utility lines are before drilling.

- **Drill the Pilot Bore**: The HDD machine operator, makes a pilot bore by running the drill stem and head through the entire drill path, from the entry point to the exit point in the reception pit. The "tracker," uses a hand-held tracking device and the potholes to ensure that the operator is drilling along the predetermined path and avoiding underground utility lines. Drilling fluid is pumped through the drill head to reduce friction, make the bore stable, and remove cuttings. Workers may change or add drill rods to extend the drill stem, as needed. (See Figure 1.)
- **Enlarge the Bore:** Once the pilot bore reaches the reception pit, the drill head is removed and a back reamer is attached to the drill stem. HDD machine operators pull the back reamer from the exit point through the pilot bore to the entry point, making the bore hole larger. The back reamer is designed with cutters and has nozzles to eject drilling fluid. (See Figure 2.)
- **Install Conduit/Casing**. Concurrent with the bore-enlarging operation, conduit or casing (i.e., product pipe) is attached to the back reamer and pulled into the bore until it is pulled to the entry point, where the drill stem and back reamer are removed. During the entire operation, the tracker continues to monitor with the handheld device and the potholes to ensure that no utilities or obstacles are hit. (See Figure 2.)

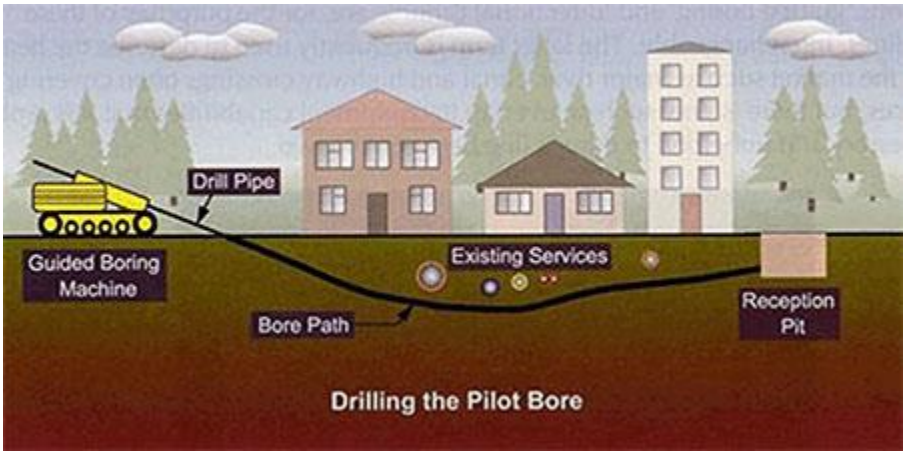

Figure 1: Drilling the pilot bore.

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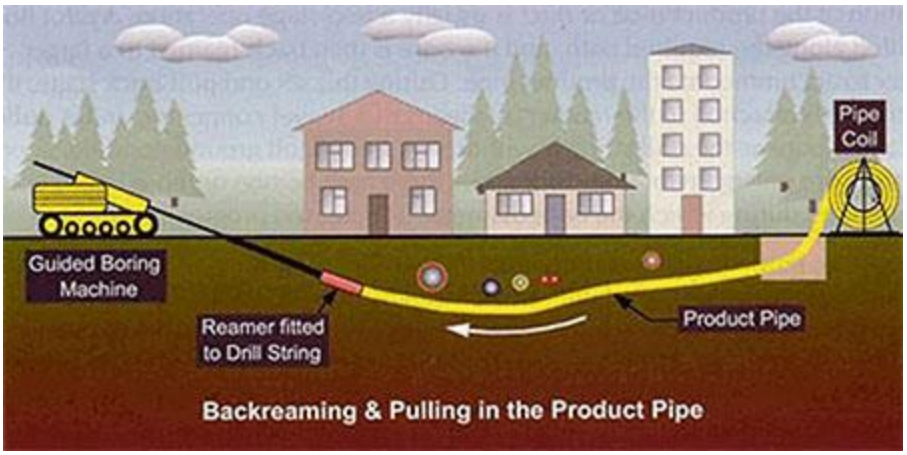

Figure 2: Backreaming and pulling the product.

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Avoiding Underground Utility Lines

Always verify underground lines, using surface markings, before drilling vertically or horizontally to avoid hitting them. Since underground lines can be difficult to identify if they are covered by other lines, are undocumented, are buried at depths different from code requirements, or are in a different position from initial installation due to ground settling, it is important to use multiple identification and verification methods before drilling.

The risk of striking underground natural gas or electric utility lines increases when HDD is used in urban areas.

To verify and avoid underground utility lines when using HDD:

- Visually inspect the entire planned digging path for structures that indicate potential underground utilities (e.g., gas meters and manhole covers).
- Review drawings and contact utility companies directly, whenever possible, to verify underground utility locations.
- Compare findings with surface markings (discussed below) to identify any missed utility.
- Employ potholing and other safety precautions described below to further identify and avoid lines in the drill path.

Underground service locators typically cannot provide depth information for utility lines. Employers must implement safe work practices that always verify the depth of utility lines near the planned drill path to prevent hitting them.

One common industry practice is to call 811, the "Call Before You Dig" number, to establish the location of any underground utility installations in the work area.

Use Potholing to Verify Utility Lines before Drilling

If possible, physically verify underground utility line locations by potholing along the planned drill path. Potholes are vertical holes dug by hand or with a vacuum excavator. It is important that potholes go to the planned drill path's depth—*even if this is beyond the deepest known utility line*—to identify any hidden lines. Potholing also allows the tracker to visually observe the drill stem and drill head during drilling to ensure that the HDD machine operator avoids striking utility lines along the drill path. The tracker typically uses a tracking device to determine whether the drill stem and head are following the planned drill path. The tracker is there to warn the HDD machine operator about utility lines with enough time to change direction if needed.

Safety Precautions to Avoid Underground Utilities

Conduct site-specific safety assessments, develop and implement site-specific work plans, train workers, and provide and ensure the use of the right equipment to workers, including personal protective equipment (29 CFR Part 1926 Subpart E). Ensure the use of safe work practices from the planning phase to completion. Potential hazards associated with HDD operations include mechanical rotating parts (e.g., struck-by, caught-in), high-pressure drilling fluid, and damaging electric and gas lines and other underground utilities (e.g., electrocution, fires, explosions). Take the following safety precautions:

Verify underground utility lines visually by potholing. This allows the tracker to guide the HDD machine operator to maneuver the drill stem to avoid striking utility lines and prevent an incident that could result in worker injuries or fatalities.

- Use site-specific safety assessments to determine appropriate drilling techniques and safety practices (e.g., when potholing, drilling the bore, or using a back reamer).
- Contact the local utility location service to mark lines and assist with determining utility locations. Compare drawings with surface markings, as some utility lines may miss detection or may be missing from utilities maps.
- Review drawings and contact utility companies directly, whenever possible, to verify underground utility locations.
- Ensure that the HDD machine operator and tracker walk through the planned drill path during planning and site preparation. Check for structures (e.g., gas meters and manhole covers) that may indicate an underground utility line, obstructions along the drill path, and potential sources of interference that could affect tracking device readings.
- Use safe and appropriate potholing techniques to the planned drill path's depth to expose any hidden underground utilities.
- Train HDD machine operators and trackers *before starting the operation* to communicate effectively with hand signals and radios.
- Ensure trackers check the tracking device readings frequently during HDD operations and compare them with the pre-operational walkthrough readings. If any changes in readings occur (e.g., depth), the tracker should immediately signal the HDD machine operator to *stop drilling*, *investigate*, and *take appropriate safety precautions before continuing to drill*.
- Instruct trackers to look into the potholes to observe the:
  - drill stem as it passes near underground utility lines during drilling, and guide the HDD machine operator along the bore path to avoid striking a line;
  - back reamer to verify that it follows the bore path and avoids utility lines.
- Drill at a pace that is slow enough to permit the tracking device to sense any drill line deflections caused by large obstructions.

Comply with all applicable local, state, and federal regulations, including those issued by OSHA, Department of Transportation (DOT) (e.g., Pipeline and Hazardous Materials Safety Administration), Federal Aviation Administration (FAA), Federal Highway Administration (FHWA), Federal Railroad Administration (FRA), and others.

How Striking a Natural Gas Line Can Result in an Explosion and Fire

Striking underground natural gas lines may present explosion and fire hazards in the workplace and surrounding areas. If the drill stem, drill head, or back reamer strikes a natural gas line, gas may leak into the workspace, or build up where air can get trapped in the area (e.g., buildings, vaults, pits), and result in an explosion and fire. Natural gas is easily ignited by an open flame, static electricity, glow plugs from diesel engines, or sparks from the HDD machine or nearby equipment. As natural gas accumulates in a space, higher concentrations increase the risk for an explosion and fire.

How Employers Can Prevent or Minimize the Impact of Natural Gas Explosions and Fires

Employers must develop a fire protection program and follow it throughout all construction phases, including HDD operations (29 CFR Part 1926 Subpart F). Employers must prohibit open flames and smoking at a worksite when conducting HDD operations (29 CFR 1926.151(a)(3)).

Develop and implement an adequate site-specific Emergency Action Plan (EAP) for workers to follow for different emergencies that could occur—such as gas, electric, or sewer line strikes—and communicate the plan to all workers (see 29 CFR 1926.35(e)(2) for OSHA requirements related to EAPs in construction). Include steps in the EAP to take if a natural gas leak is suspected, including immediately evacuating the area and, from a safe location, calling 911, and the utility company. *If using a cell phone, move away from the area where there might be gas before calling*. Employers need to train all workers on appropriate precautions to take during different emergencies, immediately alert all workers in an emergency, and evacuate workers from unsafe areas to a safe, predesignated assembly location.

How to Identify a Natural Gas Leak

Employers must ensure that workers can identify a potential natural gas leak. Handheld natural gas detectors are most effective, but other indicators include:

- Dirt, water, or debris blowing from the ground into the air.
- An unusual sound, such as hissing, whistling, or roaring, near a natural gas line.
- Smelling a distinctive sulfur-like odor, which is typically added to natural gas, although some people cannot smell the odor. Note that *not all gas is odorized*, especially at large industrial sites, and may be impossible to smell.

Immediately contact local emergency responders (e.g., call 911) if excavation damage results in a natural gas release. See OSHA SHIB Hazards Associated with Striking Underground Gas Lines.

Training

Design and provide training specific to the work location and job tasks. Train workers, in a language and vocabulary they understand to recognize unsafe conditions and methods to control or eliminate hazards *before* they start working (29 CFR 1926.21).

Train all workers to:

- Identify utility lines (e.g., "Call 811 Before You Dig" training) and how to clarify erroneous or unclear information from surface markings or drawings.
- Use potholing to verify underground utility lines (e.g., gas, electric, cable, water, sewer).
- **Identify, evacuate, and report** a natural gas leak.

Permit only workers qualified by training or experience to operate machinery and equipment (29 CFR 1926.20(b)(4)).

- HDD machine operation requires technically skilled workers who understand the machine's complexities and safe work practices. HDD manufacturers may detail in their manuals specific training requirements for machine operators. Train workers to identify potential technical difficulties that require adjustments for safe operation (e.g., to the HDD machine, tracking device, work plan, or drill path) and the correct methods for making necessary adjustments.
- Train trackers in the proper use of the tracking device to guide the HDD machine operator along the drill path.

In addition to training on hazards posed by underground utility lines, train workers on avoidance of and protection from other hazards to which they might be exposed, such as noise (29 CFR 1926.52, 29 CFR 1926.101) and communication about hazardous chemicals (e.g., drilling fluid, 29 CFR 1926.59, 29 CFR 1910.1200).

Have supervisors perform and document field safety audits to evaluate worker performance and confirm the training program's effectiveness.

Resources

ASTM F1962-11, Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings. ASTM International, West Conshohocken, PA, 2011.

Horizontal Directional Drilling Best Practices for Operators. OSHA and the American Pipeline Contractors Association (APCA) Alliance, February 2008. A Spanish version is also available.

Horizontal Directional Drilling Best Practices for Supervisory Personnel . OSHA and APCA Alliance, February 2008. A Spanish version is also available.

Horizontal Directional Drilling Good Practices Guidelines – 2017 (4th Edition). North American Society for Trenchless Technology (NASTT). NASTT is a member of the HDD Consortium, which first published these HDD guidelines in 2001.

Pavement Utility Cuts 4. Reducing Pavement Cuts by Integrating Technology. U.S. Department of Transportation, Federal Highway Administration website updated June 2017.

Additional Information

OSHA can provide compliance assistance through a variety of programs, including technical assistance about effective safety and health programs, workplace consultations, and training and education. OSHA's On-Site Consultation Program offers free, confidential occupational safety and health services to small and medium-sized businesses in all states and several territories across the country, with priority given to high-hazard worksites. On-Site consultation services are separate from enforcement and do not result in penalties or citations. To locate the OSHA On-Site Consultation Program nearest you, visit www.osha.gov/consultation.

Workers' Rights

Workers have the right to:

- Working conditions that do not pose a risk of serious harm.
- Receive information and training (in a language and vocabulary the worker understands) about workplace hazards, methods to prevent them, and the OSHA standards that apply to their workplace.
- Review records of work-related injuries and illnesses.
- File a complaint asking OSHA to inspect their workplace if they believe there is a serious hazard or that their employer is not following OSHA's rules. OSHA will keep all identities confidential.
- Exercise their rights under the law without retaliation, including reporting an injury or raising health and safety concerns with their employer or OSHA. If a worker has been retaliated against for using their rights, they must file a complaint with OSHA as soon as possible, but no later than 30 days.

For additional information, see OSHA's Workers page.

Contact OSHA

Under the Act, employers are responsible for providing safe and healthful workplaces for their employees. OSHA's role is to ensure these conditions for America's working men and women by setting and enforcing standards, and providing training, education and assistance. For more information, visit www.osha.gov or call OSHA at 1-800-321- OSHA (6742), TTY 1-877-889-5627.

This Safety and Health Information Bulletin is not a standard or regulation, and it creates no new legal obligations. The Bulletin is advisory in nature, informational in content, and is intended to assist employers in providing a safe and healthful workplace. Pursuant to the *Occupational Safety and Health Act (OSH Act)*, employers must comply with hazard-specific safety and health standards and regulations promulgated by OSHA or by a state with an OSHA-approved state plan. In addition, pursuant to Section 5(a)(1), the General Duty Clause of the Act, employers must provide their employees with a workplace free from recognized hazards likely to cause death or serious physical harm. Employers can be cited for violating the General Duty Clause if there is a recognized hazard and they do not take reasonable steps to prevent or abate the hazard. However, failure to implement any recommendations in this Safety and Health Information Bulletin is not, in itself, a violation of the General Duty Clause. Citations can only be based on standards, regulations, and the General Duty Clause.