

Risk Evaluation of Potential Coating Damage From HDD

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ABSTRACT

Pipe installed by the Horizontal Directional Drilling (HDD) method is typically unreachable for repair. Thus, the pipe coating needs to survive the initial installation to provide the longest potential for protection. There isn't currently a standard which guides coating selection industry wide, but this paper will provide guidance on potential ways to evaluate and can serve as a backbone for developing a standard.

Key words: Horizontal Directional Drilling, HDD, Abrasion Resistant Overcoat, ARO, Pipeline Design, Pipeline Coatings

INTRODUCTION

This paper will identify the potential causes of pipe coating failure, from the design angles to the soil types, to the fracture methods of rocks, and pull forces. It will present a logical method for evaluating the condition of an HDD pull prior to its installation so that the right level of coating protection may be applied. The pipelines that carry our world's energy and industrial networks are a vital lifeblood of our society. HDD's play such an integral part in keeping all aspects of the pipeline and its construction running smoothly, the aim here it to ensure there are no hiccups along the way.

HDD pipeline installation is a valuable method, but there are limitations both in installations and in long-term maintenance. Often HDDs can be more expensive and complex because the pipelines have to go deeper than they would in shallow trenches which presents challenges with physical realities such as accessibility for troubleshooting if something goes wrong and almost no chance for repair or even visual inspection once the line is in place.

HDDs carry their own set of risks particularly when compared against other methods of pipeline installation. HDDs are nearly always installed in High Consequence Areas (HCA) and at the same time they are inserted into the ground by one of the harshest means possible. Hazards associated with horizontal directional drilling include environmental concerns from drilling mud releases, or dangerous outcomes from contacting other pipelines during the drilling process. HDDs are likely to encounter

difficulty in providing uniform Cathodic Protection (CP) to the length of the pipe section due to variations in soil resistivity, drilling mud, and the presence of rock formations, nearby powerlines, or bodies of water. In addition to these hazards, the installation itself can result in significant damage to the anti-corrosion coatings which creates vulnerable points on the pipe where corrosion and pitting can begin. There is a lack of understanding and communication across the industry on how to handle these certain issues that arise during drilling and installation. For operators to avoid these risks it's important that they understand what the problems are so they can take action before it becomes an emergency situation in an HCA.

The issues mentioned can be mitigated by utilizing some the industry best practices in terms of drilling, design layout, soil evaluations, and the application of proper Abrasion Resistant Overcoats (ARO's) to protect the coating. Some simple changes in design can aid in avoiding over straining the pipe by reducing the size of a turn, flattening out the design by extending the length, and ensuring that the pipe is drilled through and installed in the most stable soils available along the drilling path. Those steps in conjunction with selecting a protective coating designed for the stresses evaluated in the particular HDD can result in a pipeline that can last the entire design life with little to no need for repair.

DOES THE PROBLEM MERIT A RESPONSE?

While the initial intention of this white paper was to provide guidance on how to ensure a pipeline coating remains intact after being installed by HDD, the research into the types of damage and their root causes, had less to do with the coatings themselves and more to do with the conditions surrounding the pipe and its installation. The data has been gathered by onsite evaluation of coatings and the damage found, the remediation steps taken to install the pipeline without damage, interviews with drilling companies, inspectors, and contractors. Additional supporting documents were used from industry best practices and other publications focusing on HDD pipe installation methods.

One of the primary causes of coating damage is the lack of adherence to coating standards by trenchless installation methods. This has been a problem that is slowly gaining attention, but it still hasn't been acknowledged as a widespread issue. The reason for the lack of adherence is due to the lack of an international standard geared specifically for this type of installation. AMPP is close to releasing a standard to address coating types for HDD, but that standard does not include selection criteria, or some of the newest forms of ARO, and as such will continue to have pitfalls for the users.

Horizontal directional drilling is an extremely fast and economical option for running pipeline through difficult terrain such as wetlands, mountain passes, and other challenging terrains. Trenchless drilling methods also frequently take place under high-consequence areas such as buildings, neighborhoods, roads or railways and every type of water formation. It is now more common place, and as a result there are many HDD installers in the market. However good prices may lead to bad quality with some suppliers sacrificing thorough hole cleaning process for lower cost of production. Construction design problems arise when the installer fails to account for certain challenges that might be faced during construction. Problems can arise because typically there are few regulations in place which mandate how HDD drills should occur or the condition the pipe or coating should be in at the completion. They simply get "around it" using whatever method is most convenient at the time of installation. So, the pipe getting installed as part of large transmission or distribution pipeline, was wisely installed along the best possible route, but is now prone to increased stress fractures and higher corrosion rates due to poor installation design or practices, and increased coating damage caused by the installation.

Do these items of concern add up to an issue which requires an immediate response? Of course, they do. The net result is a critical component of the pipeline now lies beneath an HCA with coating damage and residual strain on the pipe. This is on a pipe that was installed in this manner due to the inaccessibility of trenching, meaning that this section of pipe is likely unreachable for repair should future inspections

deem it necessary. Ultimately HDD sections specifically, need to be installed with all the pipe and protection mechanisms intact in order to survive the full design life of the pipeline.

TYPE AND CAUSE OF COATING PROBLEMS

The potential causes of pipe coating failure generally stem from the following issues: the design angles in the HDD, to the types of soil the pipe passes through, the hardness and fracture methods of the rock in or around the hole, and pull forces exerted on the pipe during installation. The pipe and/or coatings can also be damaged because of improper handling of the pipe during installation. Contractors develop lift plans prior to pullback to define how the pipe will be supported and what equipment will be necessary to facilitate installation.

The result of damage from each cause can be numerous. For example, the overall design path of the HDD can cause abrasion damage, shearing of the coating, gouges in conjunction with the soil conditions, impacts to the elevated profiles, and cracking from excessive bending of the coatings. How does the design of a pipeline potentially cause abrasion damage? Even this one question has several potential sources of abrasion. First is the diameter of the bore hole, if it isn't sufficiently oversized, the pipe will travel along the surface of the hole as it is being pulled into place, this is clearly an abrasive issue. The second way that the design can abrade the pipe is by pulling it through sandy or loose soils that can mix with the drilling fluid. Having a sandy drilling fluid is similar to pulling the pipe through high grit sand paper. Another impact of the design that may lead to abrasion damage is from the angles within the drill. The angle of entry into the hole, or turning points within the hole can force the pipe to drag across the surface depending on the slope and length of the angle. In Fig 1 the curvature of the hole forces the pipe to slide along the sides at the points labelled F and N

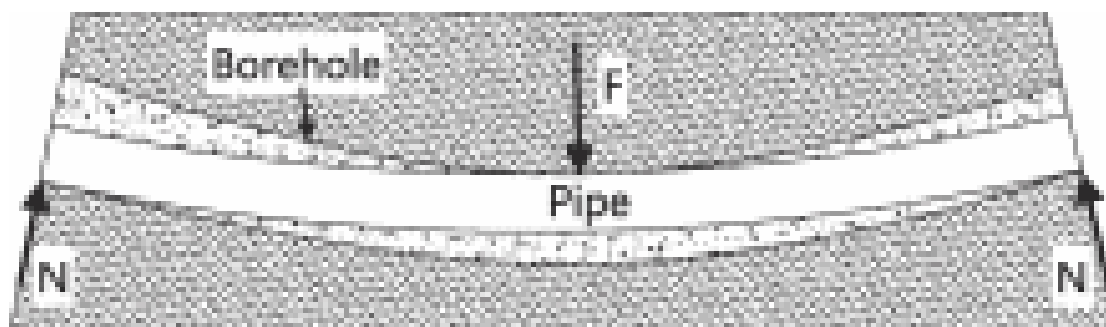


Fig 1. Pipe in contact with bore hole surfaces

The results of abrasion in the hole look like Figure 2 where the coating has been smoothly sanded down. While there are multiple causes of abrasion from the HDD installation method, the good news is that industry wide, the generally accepted coating systems are well rated for abrasion specifically and in testing HDD coatings, a report from Hair¹ states:

“Coating loss due to abrasion from soil and very soft rock (i.e., shale and mudstone) is not a critical problem in HDD installations unless large, abundant inclusions of significantly harder material are likely to be encountered (i.e., cobbles and boulders). Coating loss occurs during HDD installations through hard abrasive rock (i.e., granite, quartzite, and hard sandstone). In general, bedrock with high unconfined compressive strength and Mohs hardness can be expected to be abrasive and cause coating wear. Point loads from sharp rock fragments and gravel may also gouge coating.”



Fig 2. Pipe with ARO showing abrasion wear

As mentioned in the Hair¹ report, The types of soil the HDD passes through makes a big difference in the coating's survivability as well. This is also a part of the design process, but the HDD is limited to the soils that are native in the area that the pipe must pass through. This is one area that makes every single HDD installation unique, because regardless of the length, diameter, or chosen pathway, each HDD will encounter differing soil types based on location, geology, and depth of the installation. The stability of the hole during HDD operations also typically depends on the type and composition of the formation, hole diameter, drilling fluid properties, groundwater conditions, and the HDD geometry. Holes drilled or reamed through loose soil formations, soil formations with significant gravel content, and rock formations with poor rock mass quality are prone to instability. Unstable holes lead to frac outs and can create immense issues for the pipe and its coating. When the hole collapses on the pipe it is similar to dragging the pipe through a dry whole. The coating now must contend with rocks and gravel dragging along the surface along with added strain on the pipe which can cause sheering. In a study done by Williamson et al². In 2000, 4 coatings were tested to determine how they would fair in a buried test against soils with various size and shapes of rocks. They tested FBE coatings and dual layer powders and evaluated the amount of damage based on the number of holidays in the coating. As is visible from their findings in Figure 3, the increase in quantity and size of rocks caused an increase in failures, and as one may expect, an increase in coating thickness also showed a decrease coating damage.