An innovative approach to varied locating challenges, the DigiTrak Eclipse Locating system.

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Introduction

John Mercer and Peter Hambling founded Digital Control Incorporated (DCI) in 1988 to develop an advanced Horizontal Directional Drilling (HDD) drill head locating system. They shared a strong commitment to technical excellence and placed a top priority on research and development. In 1991, the first DigiTrak® locating system was introduced by DCI. This system effectively doubled the capacity of any other locator at the time with an operating depth of 20 feet and was the first walk-over system to display both roll and pitch orientation of the tool head. Subsequent and continuous advancements have made the DigiTrak® product line of HDD locators the most widely recognized and used in this country and around the world.

Locating System Technology

It is worthwhile to start by defining some of the terminology used later on in this article.

- Transmitter: A transmitting device placed inside a housing at the front of the drill string
- Receiver: A handheld locating device used to locate the position of the transmitter
- Remote Display: A remote readout on the drilling machine
- Locator: The person tasked with locating the transmitter by using the receiver
- Operator: The person sitting at the controls of the drilling machine

An HDD transmitter emits a di-pole magnetic field as well as data which is picked up by a receiver and turned into usable locating information. This information is then used to make steering decisions allowing the drilling team to direct the drill head along a predetermined path. Not only is it important to locate the transmitter, but its direction (called locate point) and a host of other data such as drill head orientation (clock) and inclination (pitch) needs to be efficiently transmitted to the receiver. From the locator's standpoint, all this needs to be achieved in a simple and effective manner in order to insure as an efficient operation as possible.

Digitrak® Eclipse® Locating System

The Eclipse locating system consists of a receicer, seen on the right hand side in figure 1, a remote display on the left, a battery charger sitting in between the two and an assortment of transmittters.

This system is most commonly used as a walk over system which means that the locator is required to walk over the bore path and track the drill head as the pilot bore advances. Later in this article its use as a magnetic guidance system will be described.

When used as a walk over locating system there are four different transmitters that can be used with the

Eclipse locating system. Each one of these is sewer grade, that is, the pitch or inclination is measured in 0.1% or 0.1 degree increments. These are a standard transmitter, with a depth range of 50 ft, a dual frequency transmitter with a depth range of 60 ft in high frequency mode and 40 ft in low frequency mode. The third is a smaller transmitter, depth range 16 ft, intended for smaller machines employing smaller drill heads. The fourth transmitter is a wire line transmitter which as the name implies is powered by an above ground power source, most often the drill machine battery, through a wire that runs on the inside of the drill pipe. Its depth range is 80 ft.

Short case histories

Following are three short project stories describing the various features of the Eclipse locating system.

Sanitary Sewer Project in Berea, Ohio

In November 2003, Precision Directional Boring (PDB) was hired as a subcontractor to directionally drill a sanitary sewer project in Berea, Ohio using a DitchWitch® JT 2720 directional drilling machine. The project consisted of installing 400 ft of 12" Certainteed-Certa-Lok C-900 PVC pipe with a fall of 0.75%. Ground conditions consisted of fairly uniform hard clay. One of the most challenging aspects of this project was that at the first manhole the invert depth of the pipe was planned at 38 ft while the last manhole the invert depth was 41 ft. Based on the demanding specifications, PDB decided to use their Eclipse locating system with the dual frequency transmitter. Along with the Eclipse system a process called Arrow Bore was used, which calls for placing relief tubes every 30 ft which allows for checking of the line and grade on a regular basis. In order to reach the first manhole depth, the machine had to be set back 200 ft requiring PDB to rely solely on the locating system to keep the bore on line and to reach the desired depth before verification at the first relief tube. According to Willard Roth, President of PDB, the front and rear locate feature and depth accuracy of the Eclipse system enabled them to hit the first target precisely on line and depth. The same was true for all thirteen of the relief tubes. In every case the pilot bore was dead on target. Due to the exacting nature of this installation the pilot bore took about 4 days to complete. After installation, the pipe was inspected and the invert was found to be only 0.5" off of the planned depth at the first manhole and about 2" at the final manhole. This was more than acceptable to the project engineer.

Figure 3. The drill ready to launch the pilot bore

Verizon FTTP Project in South Lake, Texas

Dakota Directional out of Ennis, Texas is a contractor working on a large FTTP (Fiber To The Premise) project for the Verizon telephone company. On January 18, 2005 they set up to do a fairly typical bore on this project using their Vermeer® D16x20 drilling machine. This run was to

install 290 ft of 2” HDPE conduit at a depth of 3 ft for a fiber optic line in a residential area. The bore was drilled at an upward slope generally following the surface where the elevation at the end of the bore was about 6.2 ft higher than at the entry point. Ground conditions consisted of loam, some clay and a rocky section at the beginning of the bore. The Eclipse DataLog feature was used to document the bore. Figure 4 shows the bore profile after downloading from the Eclipse receiver on the computer using the Eclipse DataLog software.

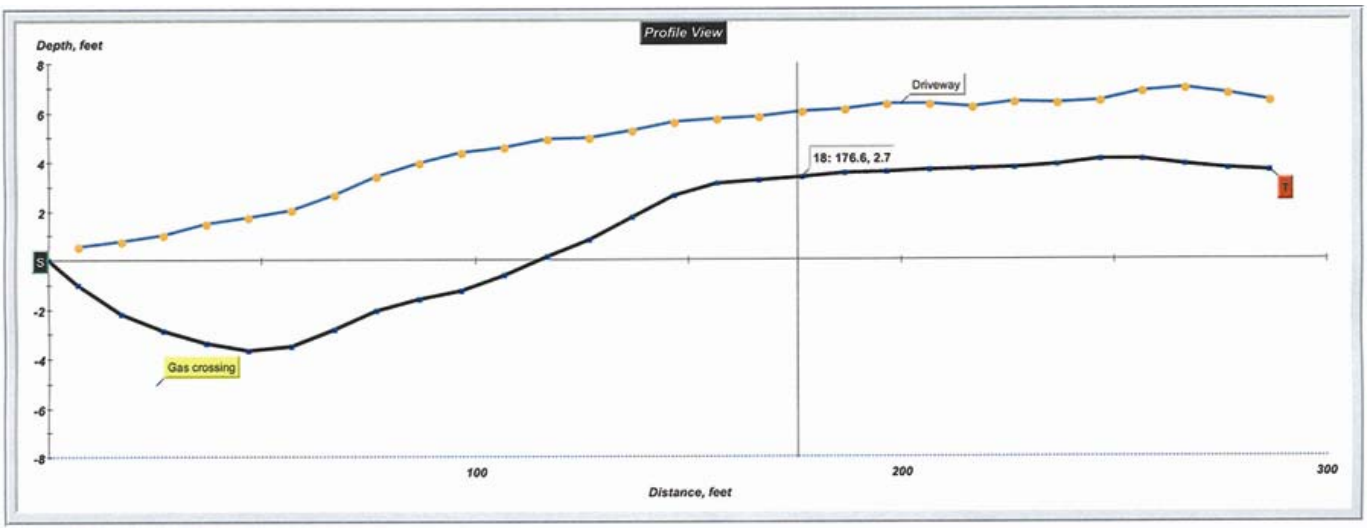

Figure 4. Drill profile report using the Eclipse DataLog Software.

Drilling started in the morning and about 27 ft from the starting pit a gas line at a depth of 6 ft had to be crossed. Due to rocky conditions at the beginning of the bore, the bore path was changed to get beneath the rocky section. As a result the bore path ended up being about 2 ft deeper than planned for the first 10 rods or so. This brought the bore closer to the gas pipe than originally anticipated but the changed path was nonetheless deemed acceptable and the bore continued. Once out of the rocky section, the progress and steering continued without any problems. The 290 ft pilot bore was finished in about 90 minutes including some delays due to the steering problems at the outset. The pullback was completed just before noon allowing the crew to set up and complete a second very similar bore in the afternoon.

A-12 Highway crossing near Driebergen, Netherlands

The DigiTrak Eclipse Short Steering Tool (SST™) is a magnetic guidance wire line system designed to work with the Eclipse walk over locating system. The SST transmitter provides the industry standard guidance tool information, namely roll in 360 distinct increments, inclination in either 0.1 percent or degree increments and compass heading, often referred to as yaw angle, in 0.1 degree increments. This information is sent back the same wire that powers the transmitter.

Van de Beek BV is an accomplished HDD contracting firm located in Neerinjen in the Netherlands. Following is the account of a bore completed in February 2005 using their Vermeer® D50x100 machine and the Eclipse SST system. The project called for installing 2 x 6.3 in and 3 x 4.9 in conduits underneath the A-12 highway for the Enecon utility company. Total length of the bore was planned at 590 ft at a maximum depth of 21 ft. Ground conditions consisted of fairly uniform, sandy clay. Figure 5. shows the SST software screen with the completed bore. The bore plan called for an approximately 130 ft straight section and a gentle

turn to the left and then straight again for the remainder. While excavating the entry pit an unmarked power line was discovered on the left side of the pit, and with trees on the right side of the pit the machine could not be repositioned.

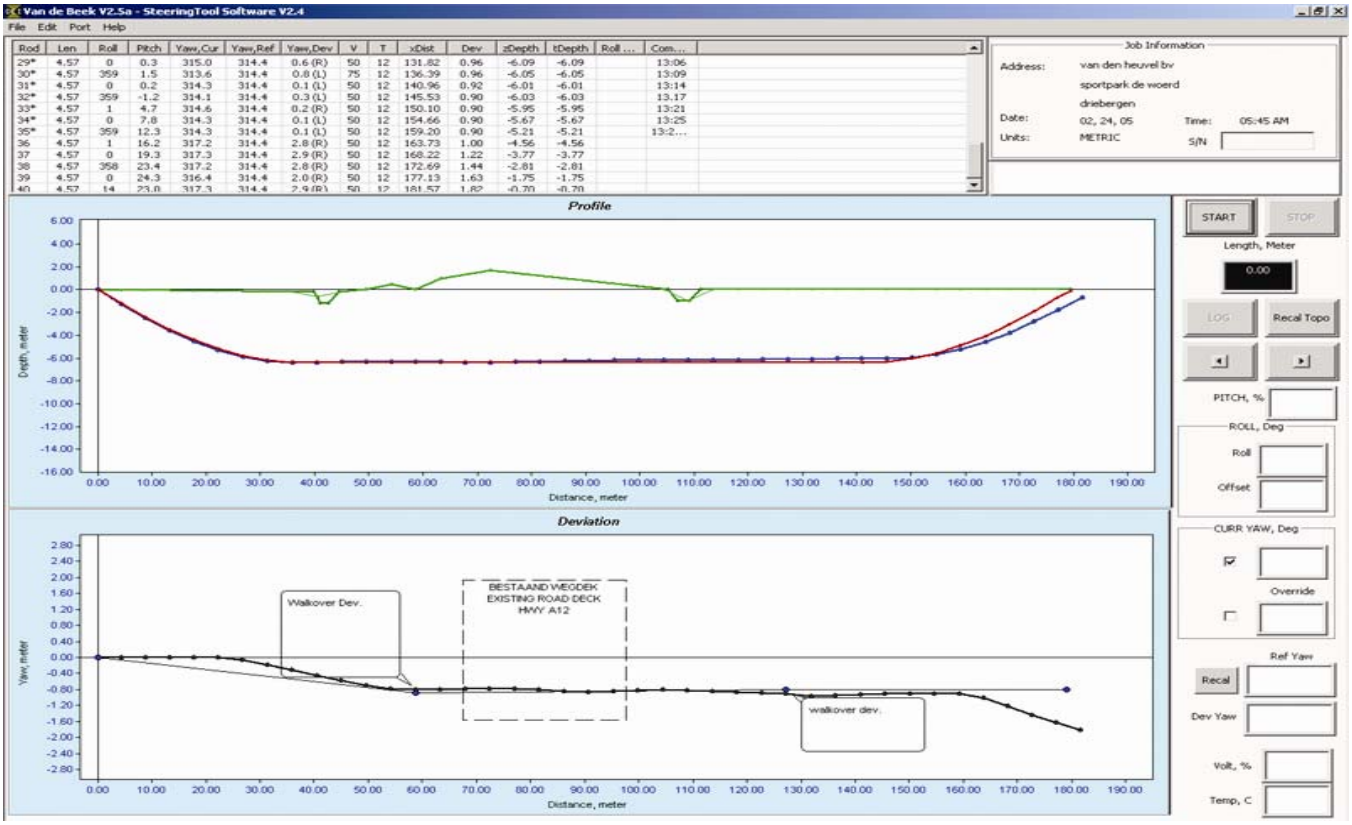

Figure 5. Eclipse SST main screen showing the A-12 highway crossing.

A new reference yaw heading to the left of the power line was established and using the walkover capability, the bore started. After about 65 ft a right hand turn was started and again using the Eclipse receiver the tool housing was guided on to the original heading. The new bore path reached the originally planned path at about the 180 ft mark. While crossing under the 6 lane highway, the magnetic heading information was used to maintain course. Once across the highway, the magnetic heading was verified with the Eclipse receiver. Another power line was discovered at the exit end which diverted the bore path about 3.3 ft to the right of the planned exit point. The final feet were drilled and tracked using the walkover method. The pilot bore was completed in 6 hours and all 5 conduits bundled together were installed in 2 hours which included pre reaming.

Summary

The DigiTrak Eclipse locating system has been designed to be very user friendly and simple to use. At the same time it is very accurate and fast. This leads to a short learning curve allowing locators quick proficiency in its use. A second and very important consideration is the flexibility which allows the same locating system to be used on a multitude of differing projects. By using the same locating system for most if not all of their diverse work, an HDD contractor can have greater confidence when tackling more complex projects that they will invariably encounter.