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Paper 2

UNGUIDED AND GUIDED AUGER BORING METHOD - DIGITALIZATION FOR JACKING CONTROL AND DATA RECORDING

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ABSTRACT:

Nowadays the demand for environmentally friendly and advanced trenchless pipe installation methods is growing. New markets like environmental energy of wind, sun and water and the requirement to have stabile grids requires smart technologies with reliable history and the possibility of digitalization and automatization of the whole construction process.

The history of drilling started 600 years BC with the first vertical bores. 300 years BC the Archimedean screw was developed, during the 14th century Leonardo da Vinci developed one of the first horizontal drilling machines. It took centuries up to the 1930´s to develop the first unguided Auger Boring Machines for mining and civil engineering applications. In the 60´s the first optical guiding systems came up. Digital optical systems, laser and gyro based systems are state of art today.
Enhancements never stops! Today the digitalization enables new technologies and marriage of proven data recording standards. Normative regulations presuppose automatic and nonmanipulable recording of jacking parameters and data recording.
The presentation gives an overview of the unguided and guided Auger Boring Methods and current developments of the digitalization in the recording process during piloting and the upsizing bore. Digital documentation of the pilot bore, drilling length, thrust force, torque and bentonite flow rate are state of art. GPS location of jobsite position and wireless data transfer are not science fiction anymore. Smartphone apps, remote access and automatization of all processes will be the future challenges to endure the lack of qualified staff.

1. Auger boring Methods

1.1. Unguided auger boring

In the unguided auger drilling process, a steel pipe (drill pipe or casing pipe) is pushed forward with the aid of a auger boring rig. The direction and tilt are taken into account when aligning the drilling rig. The drilled material is extracted using a drill head and a auger. The steel casing pipe remains in the ground, while recoverable drill pipes are pressed out with the carrier pipe in a further work step. The method is used for both unconsolidated rock and solid rock. The choice of drill head depends on the subsoil conditions. In the case of solid rock and non-cohesive unconsolidated rock, down-the-hole hammers are also used.

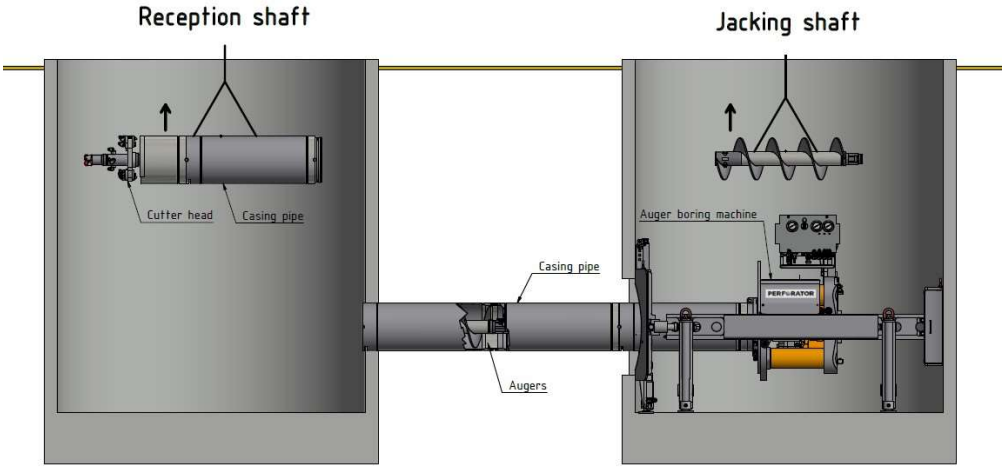

Figure 1. Step 1-Casing pipe installation

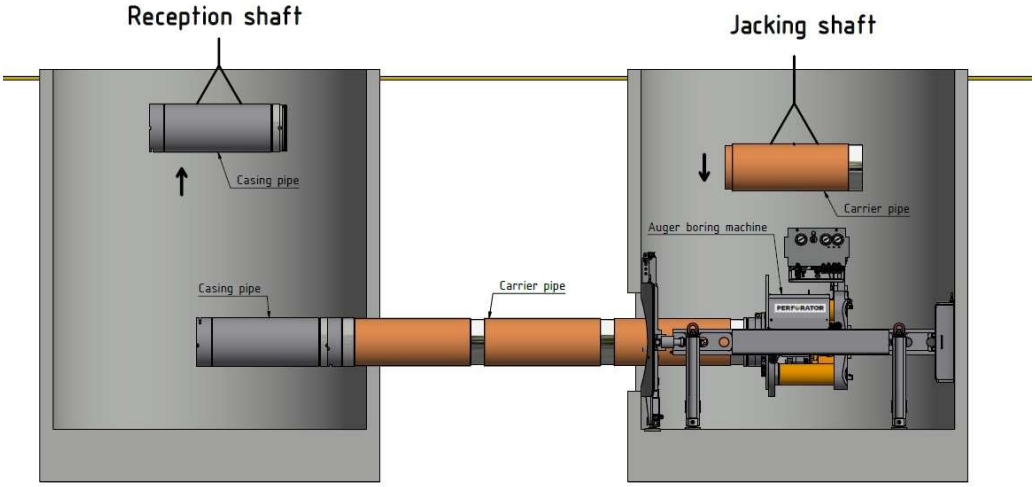

Figure 2. Step 2-Carrier pipe installation

1.2. Guided auger boring – pilot tube method with soil displacement

In this process a string of pilot tubes is installed by displacing the ground with a steering head complete with target. The surveying and control is carried out using an optical-electronic navigation system The system consists of the optical aiming device, a digital camera unit and a monitor. Directional changes are carried out by control surfaces of the control head using the reaction force of the foundation soil. Subsequently, casing or product pipes of the same or larger outer diameter are driven while simultaneously pressing out the pilot tubes. Larger outer diameters require widening by soil removal in one or more operations.

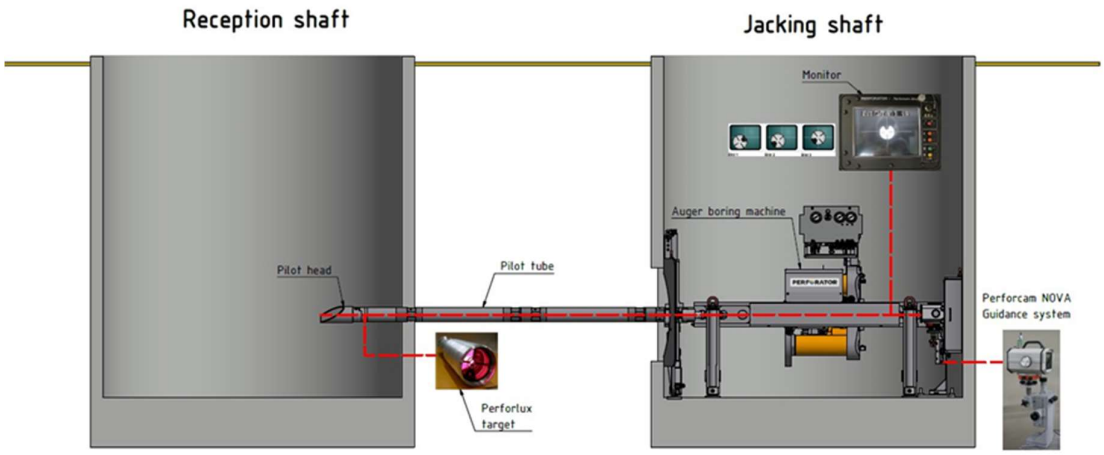

Figure 3. Step 1-Pilot tube installation

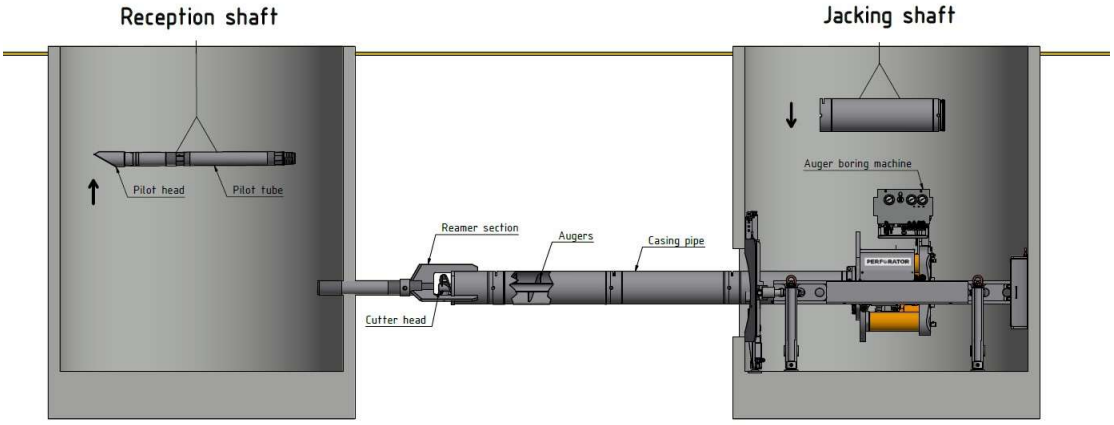

Figure 4. Step 2- Casing pipe installation

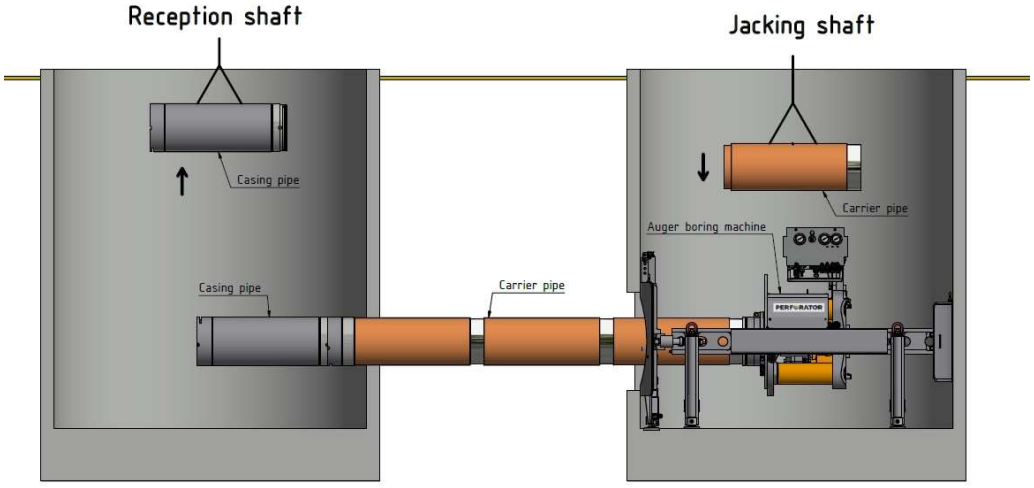

Figure 5. Step 3-Carrier pipe installation

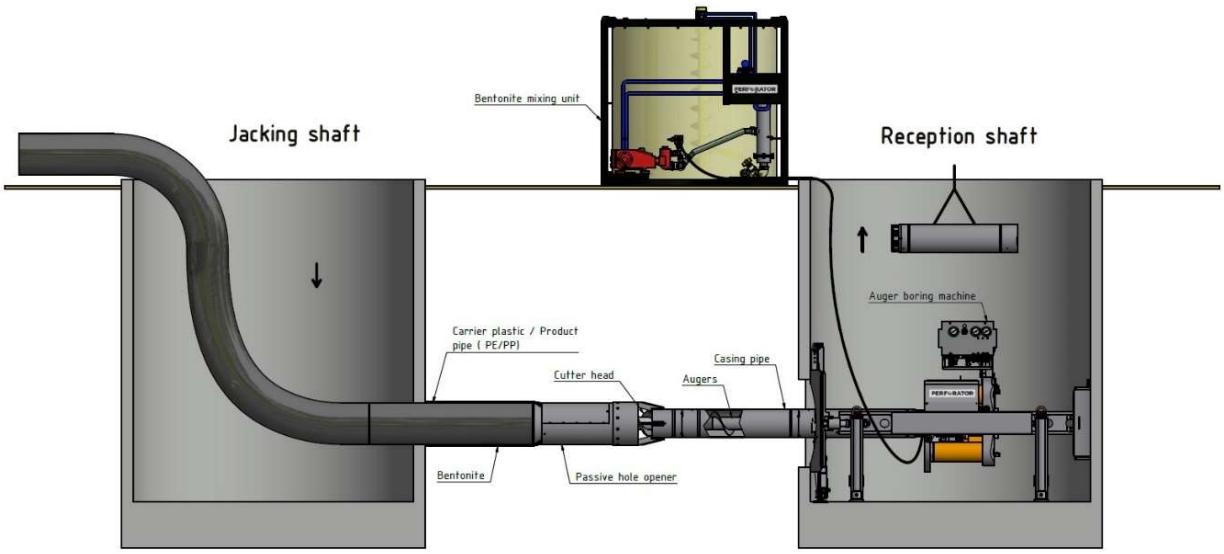

Figure 6. Step 3-Carrier pipe installation PE pipes with passive hole opener

1.3. Guided auger boring – pilot tube method with soil removal

In this method, the pilot tube string (casing pipe) is driven by removing the soil. As with pilot tube jacking with soil displacement, surveying and control is carried out with an optical-electronic navigation system. Directional changes are carried out by a steerable drill head (pipe control). Pipe control systems make it possible to lay casing pipes with diameters of 406–1.420 mm in unconsolidated and solid rock, controlled in just one work step. Product pipes of the same outer diameter are driven while the casing pipes are pressed out at the same time.

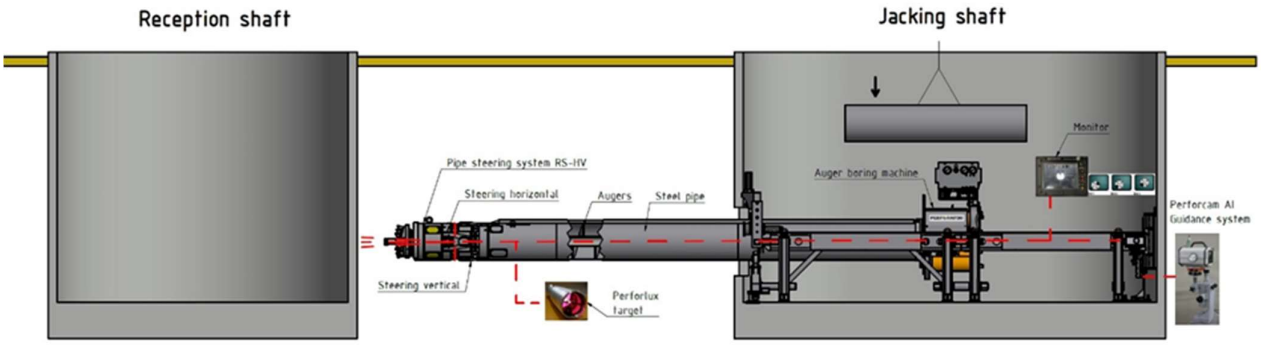

Figure 7. Step 1-Casing pipe installation

Figure 8. Pipe steering system RS-HV

1.4. Pilot tube jacking with microtunnelling

The process variant combines the classic pilot tube jacking methods with directly driven powered reaming heads (PUD) or powered cutting heads (PPS). The driven reaming heads or cutting heads are connected to casing pipes that are already laid (steel pipes or temporary casing pipes) with internal auger. The product pipes are then connected to the PUD or PPS and pressed in. At the same time, the drilling material is transported into the target pit by means of augers. PUDs are used for unconsolidated rock (easily displaceable soils) up to a product pipe diameter of 1.200 mm, PPS can be used up to solid rock and a product pipe diameter of 1.520 mm.

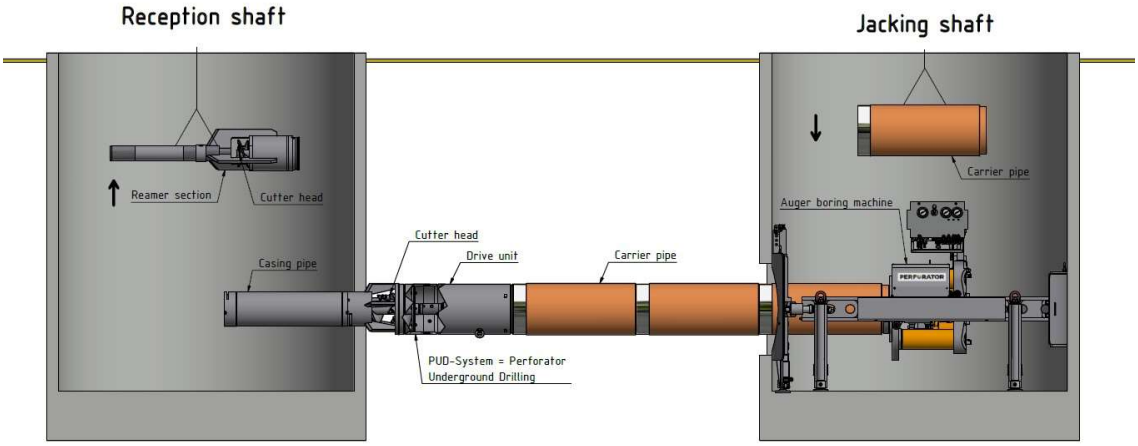

Figure 9. Step 3-Carrier pipe installation with PUD

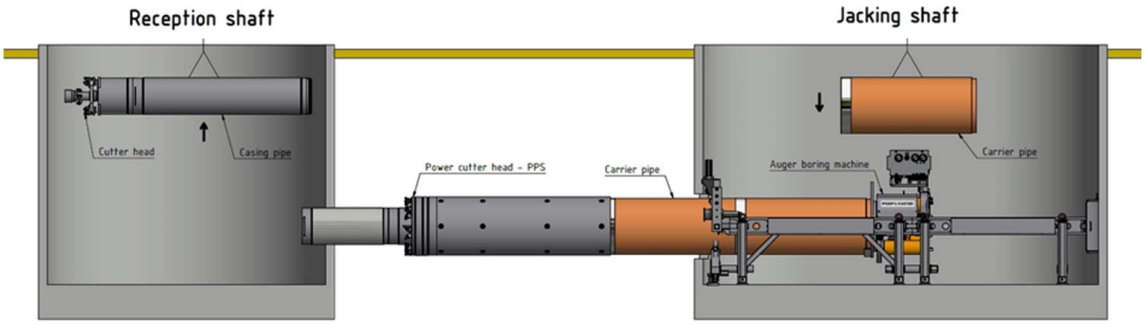

Figure 10. Step 3-Carrier pipe installation with PPS

Figure 11. PPS Powered cutting head OD 1.520 mm

1.5. HDD (Horizontal Directional Drilling) method as pilot tube jacking with soil displacement

HDD (Horizontal Directional Drilling) method as pilot pipe tube jacking with soil displacement. In this process a string of pilot tubes is installed by displacing the ground with a steering head complete with target. In the case of unconsolidated rock drilling, the soil is extracted hydromechanically with high-pressure nozzles on the drill head and, at the same time, mechanically with cutting elements on the drill head (control head). Surveying and control is carried out with an optical-electronic navigation system, which guarantees the highest degree of positional accuracy. In the HDD process variant, gravity pipes made of polyethylene (PE) can therefore also be laid. The product pipe is laid using the pull-back method with backreamer and bentonite.

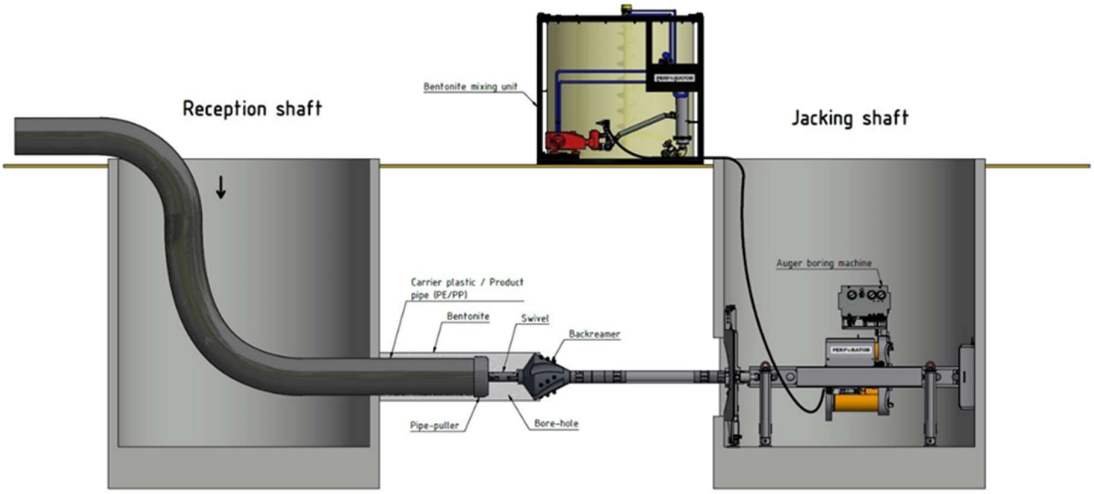

Figure 12. PTM HDD

2. Navigation system and data recording

The optical-electronic navigation systems are used for pilot tube jacking with and without soil removal (RS-HV pipe control). The system consists of a optical aiming device, a digital camera unit with GPS receiver, a TFT monitor with data logger and a length measuring unit.

Figure 13. PERFORCAM optical-electronic navigation system

The latest versions optical-electronic navigation systems offer an artificial intelligence for automated processes, digital recording and navigation of the pilot tube jacking.

First, the direction and tilt of the camera unit and the auger drilling rig are adjusted as required. This is controlled via the target optics inserted in the control head or initial auger of the pipe control system, which is optically detected by the camera and displayed on the monitor. The control movement or position change takes place with the pilot bore via a control bevel on the control head and, on the pipe control system, via the deflection of the front pipe, which is also called the cutting ring. The control data stored with the data logger includes all relevant drilling parameters and is continuously recorded.

Figure 14. PERFORDAT measuring and data recording unit

The measuring and data recording unit records and log the jacking length and force exerted on the pipeline being laid. All relevant jacking data during the pipe-laying process is displayed and stored in real time. The internal display can be mirrored to your smartphone or desktop device via Wi-Fi. The press force is determined via the pressure transmitters connected to the machine's press cylinders. The length measurement during the installation of the pipes is mapped via a measuring wheel with rotary encoder. If the permissible jacking forces are exceeded, a visual and acoustic signal is triggered. A water or bentonite pressure and flow measurement is also part of the system. The recorded measured values can be documented after the work is completed.

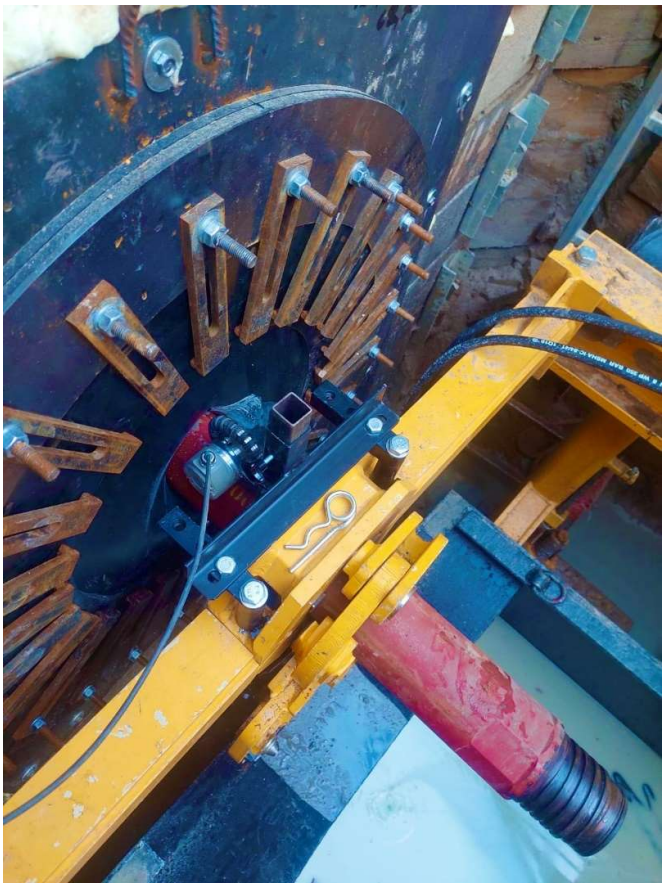

Figure 15. Unit for measurement jacking length

3. Foresight into the future of auger boring

Obligatory for a digital future of auger boring will be a combined data recorder for pilot bore and pipe jacking with automatic and non-manipulable logging function. The gathered data will be managed in cloud-based data management systems. This will enable all involved parties to get a 100% live overview of the jobsite and ensures a building information modeling (BIM) for the whole project.

Wireless sensor networks provide the basis for novel communication and measurement systems for future developments to minimize the effects of non-existing human recourses.

Topics like remote maintenance, machine management and remote access and support are steps to come to a fully automated drilling process. Artificial intelligence (AI) will be a integral part for future developments.

Energy savings, green power supply with fuel cells or H2-powered are not phrases anymore, they are getting real!

Challenging times speeding up developments! We can be excited what is coming next!

4. Contact

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