

Carsten Simms | MICON-Drilling GmbH

DIRECTIONAL DRILLING WITH RAISE BORE MACHINES IN THE MINING INDUSTRY

We recently experienced more requests for the need of directional drilling in the mining industry using raise bore machines. As raise bore machines are normally used to drill vertical pilot holes using automated vertical drilling tools like MICON RVDS which is globally used with all existing raise bore contractors.

Especially the current hydro power plant projects were requesting slanted, inclined or even nearly horizontal shafts or tunnels. The standard directional drilling technology would normally request the use of MWD (Measurement While Drilling) Tools in combination with downhole mud motors with installed bent. These tools were developed beginning of the 1970s and are still standard for use with standard land rigs.

A raise bore machine has of course a different setup. Especially the travelling height is limited by the length of the hydraulic cylinders which is standard for the use of raise bore rods in length of 1,5m. The use of a downhole motor for directional drilling though is a standard which was used for directional drilling already before MWD systems were invented with either so called steering tools or mechanical photographic measurement tools like single shot for example. Using a downhole motor with a raise bore machine is though possible but of course needs special preparations in means of safety and special installations especially inside galleries like overhead cranes and the possibility to flap back to top of the raise bore machine while inserting the downhole motor.

When a downhole motor is installed with a raise bore machine the following bottom hole assembly consists more or less of a setup which was used in the 1960s like just an orienting sub followed by the needed stabilization of the hole. The directional drilling then without non magnetic environment like nonmagnetic drill collars normally used with MWD tools then needs the use of downhole north seeking gyroscopic measurement systems which are ran into the hole by wireline either slickline in memory mode or with single conductor cable in online mode.

We in MICON have several examples how to conduct this kind of work in a periodic time of the last 20 years in several countries. As always pictures are the best way to see how this works and we have positive results to show.

77. BHT - FREIBERGER UNIVERSITÄTSFORUM

2026

KOLLOQUIUM 4

„ADVANCED DRILLING TECHNOLOGIES AND SUBSURFACE ENGINEERING
INNOVATIVE BOHRTECHNOLOGIEN UND UNTERGRUNDNUTZUNG“



Directional Drilling with Raise Bore Machines in the Mining Industry

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MICON Directional Drilling Services

Raise Bore Machines compared to standard drilling rigs:

Raise Bore Machine examples:



Standard Drilling Rig

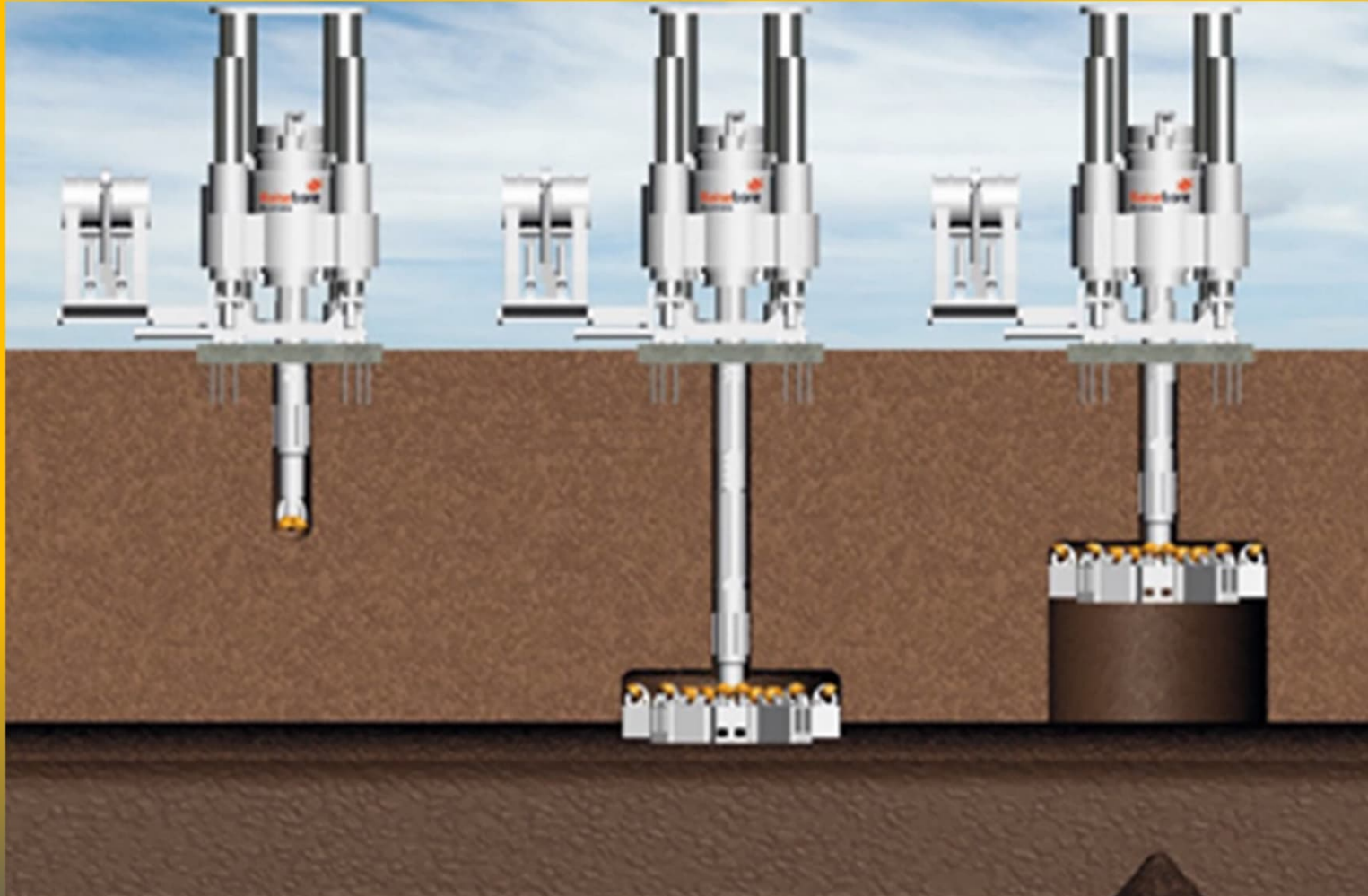


MICON Directional Drilling Services

Raise Bore Machine standard application:

Step 1 = Pilot Hole drilling

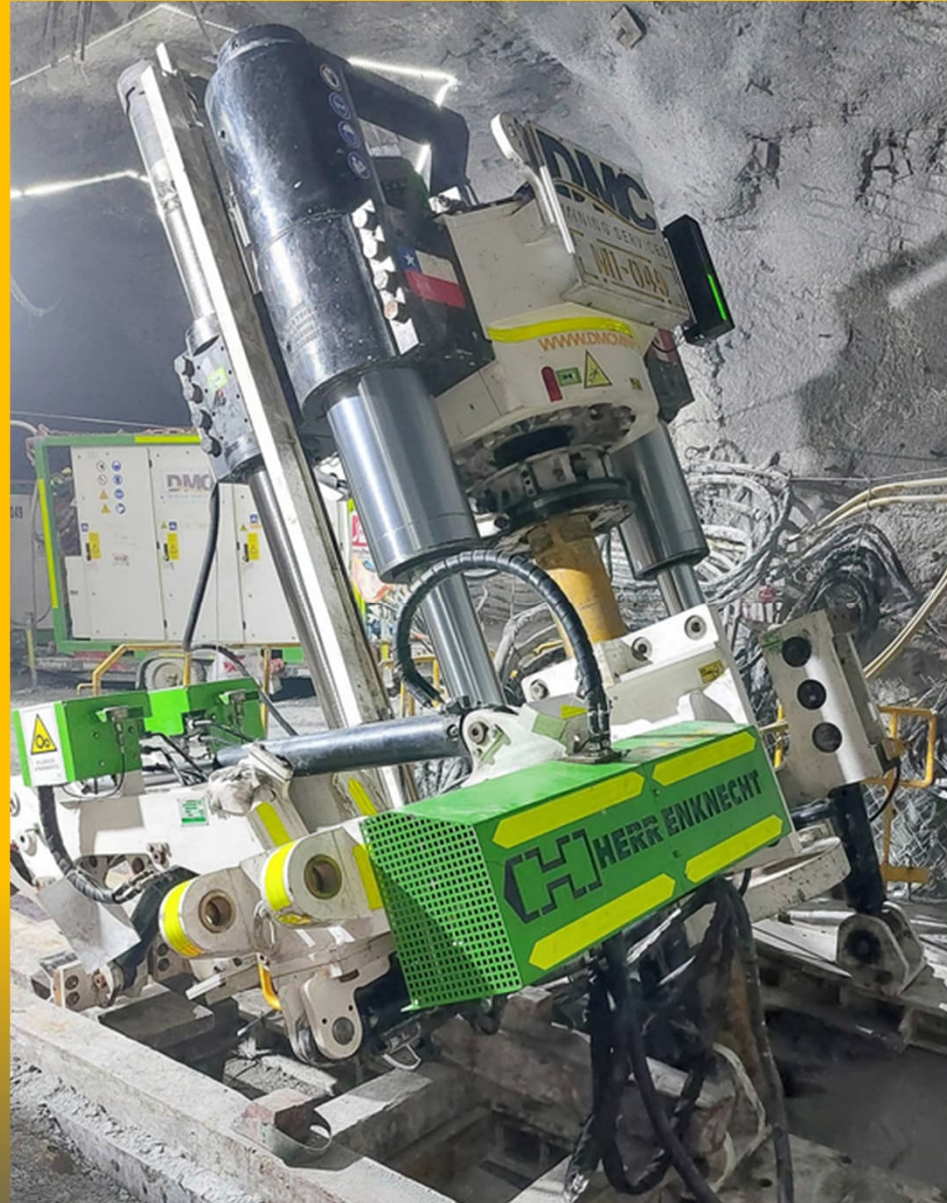
Step 2 = Hole opening („Raising“ up a shaft)



MICON Directional Drilling Services

Raise Bore Machine tilting option:

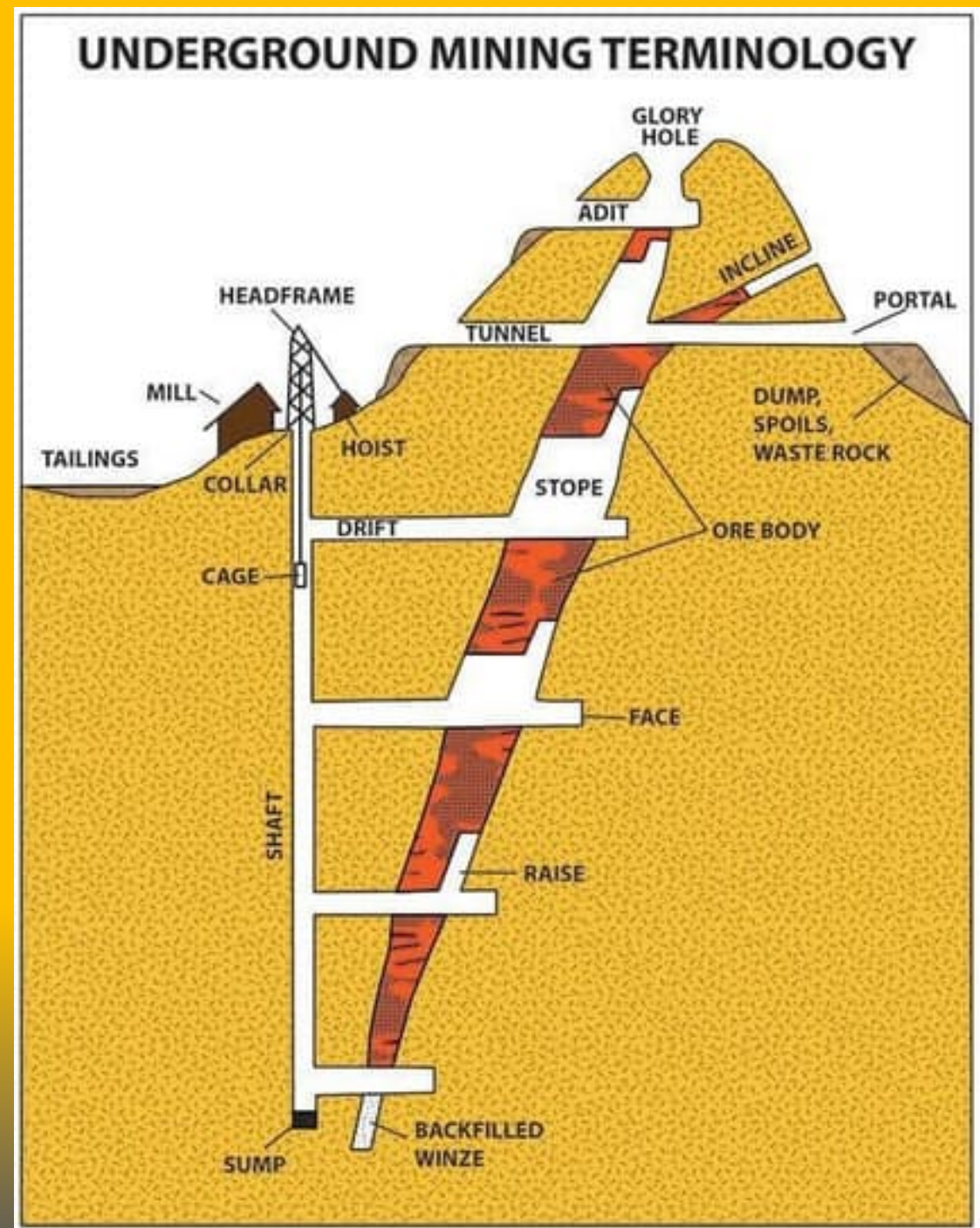
So nearly every project where a raise bore machine is not setup vertical there is directional drilling needed!



Tilted by ~20° here

Available Service potentials in the mining environment:

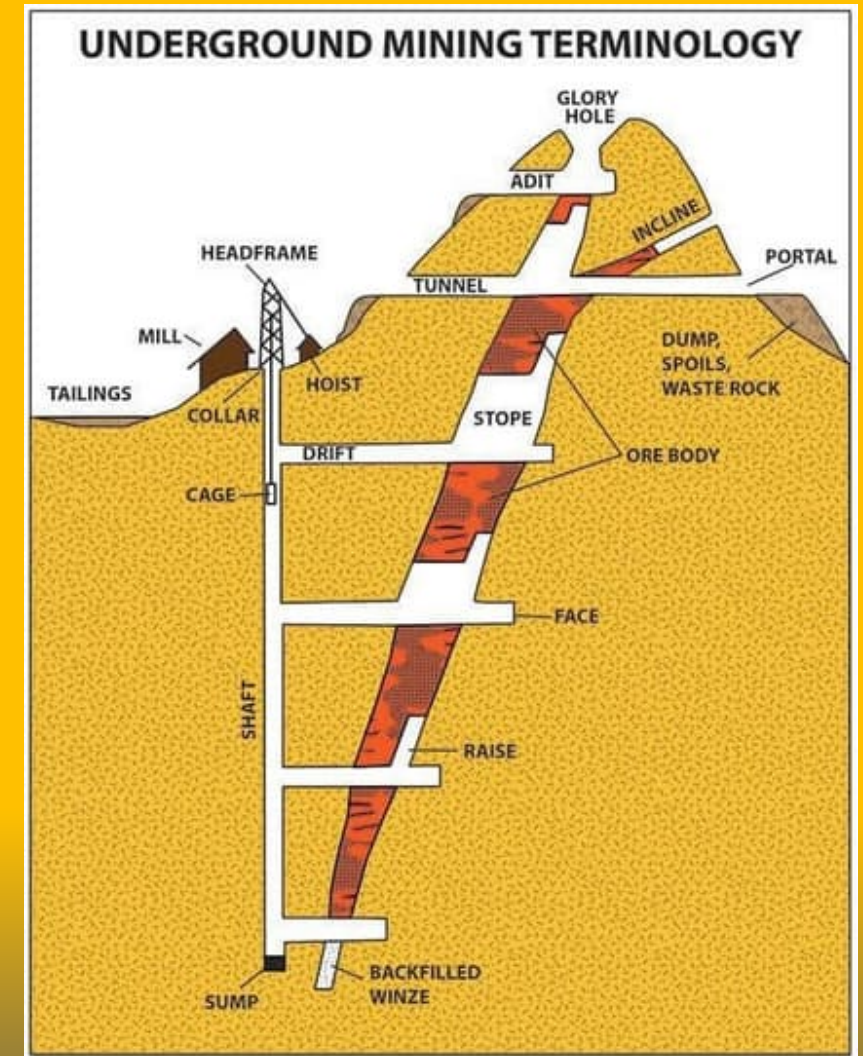
- Vertical Shafts
- Inclined Shafts
- Horizontals
- Raises



For all before mentioned applications directional drilling might be needed

As of:

- Controlled vertical drilling >>>
 - Automated vertical drilling services with MICON RVDS tools
- Directional drilling for inclined or horizontal wells
 - Conventional directional drilling service >>> **Focus on this presentation**



Main applicable services:

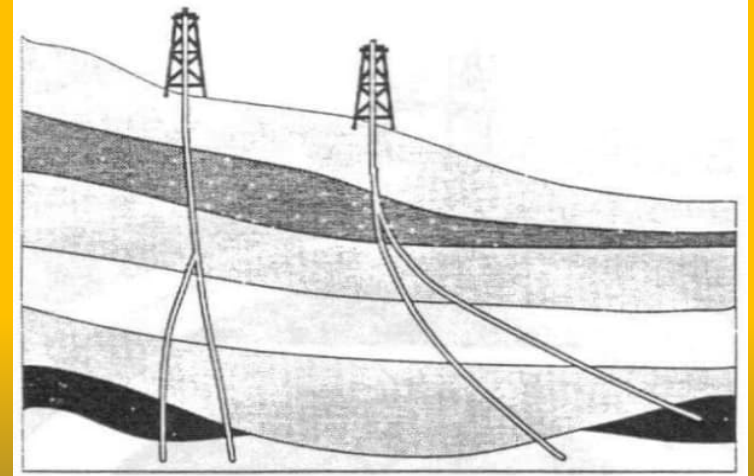
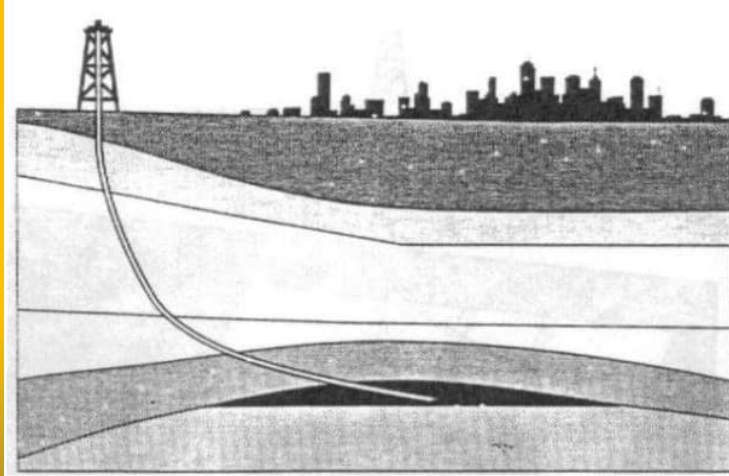
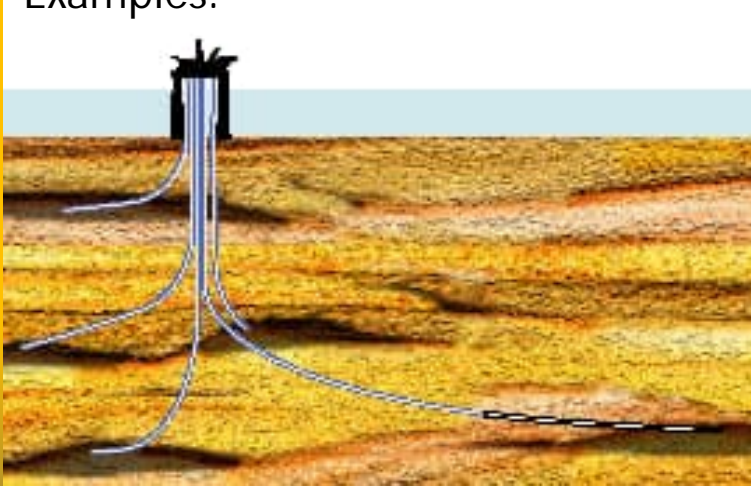
- a) Directional Target Drilling
(Surface and Underground)
- b) Borehole Survey
(Surface and Underground)
- c) Both services above combined! (a+b)

MICON Directional Drilling

Official Definition of Directional Drilling:

Directional drilling is defined as the practice of controlling the direction and deviation of a borehole to a predetermined underground target or location.

Examples:



Conventional Drilling Services toolings:

- MWD – Measuring While Drilling
- PDM – Positive Displacement Downhole Motors
- Survey Tools – Digital Multi Shot and Steering Tool Systems
- Gyro Tools – North Seeking Gyro Multi Shot System

MICON Directional Drilling

Main uses and advantages for directional drilling:

- Continuous control of well path
- Multiple targets can be reached from one start point
 - Intersect crucial targets, measure well path while drilling, control well path, define actual hole position accurately and reduce mining cost
- Reduces uncertainty (mostly important for hitting defined underground shafts)
- Reduce costs of drill programs
 - Reduce number of drill sites, roads and pad construction
 - Reduce number of holes due to more information per hole
 - Reduce drilling time
 - Avoid downtimes for survey

On following slides please see some examples of

MICON directional drilling in mining projects:

MICON Directional Drilling – Selected Projects



Cable Railway Stoos
Switzerland



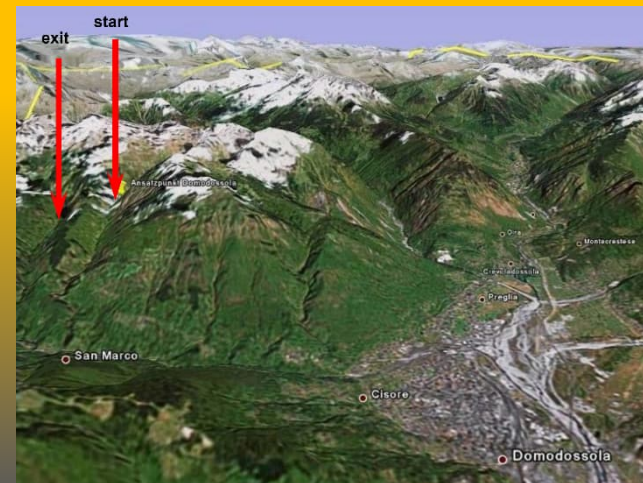
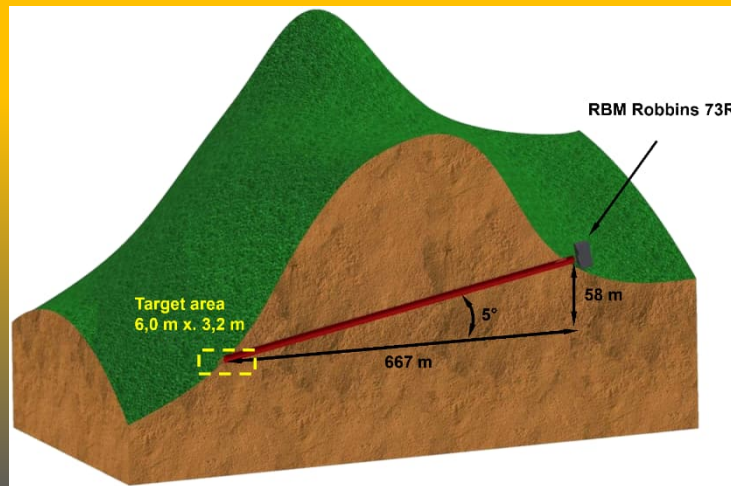
Pilot and Guiding Hole for Tunnel Excavation



MICON Directional Drilling – Selected Projects



Simplon Pass – Italy – Pilot Holes for Hydropower Dam Connections



MICON Directional Drilling – Selected Projects

Hydro Power Project Ebensee – Austria – 2 Sections Directional Pilot Holes (04/2025)



Equipment in use on this project:

- 9-5/8" MICON downhole motors
- Orienting sub, custom made for rasebore string equipment
- Electronic Multishot as steering tool application for directional drilling
- North seeking Gyro tool to survey the well trajectory
- Monoconductor wireline unit to run above measurement tools

MICON Directional Drilling – Selected Projects

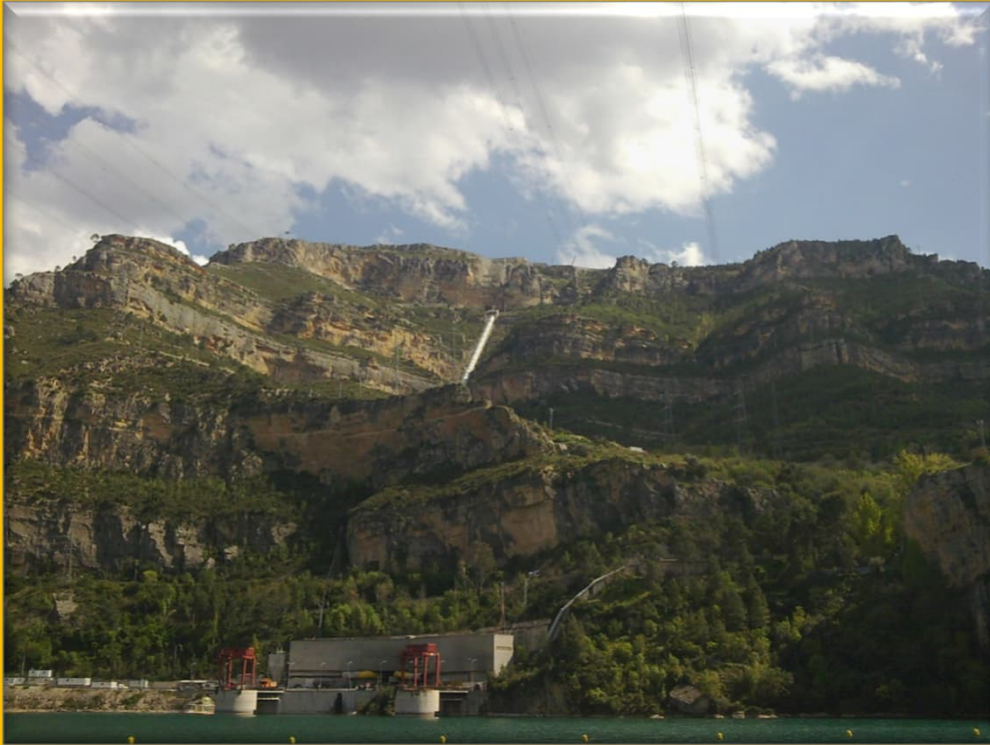
Vegsund Connection Hole for residual wastewater
Norway – 430m x 12 ¼" Directional Pilot Hole (05/2026)



Equipment in use on this project:

- 9-5/8" MICON PDM & MICON MWD System
- North seeking Gyro tool to survey the well trajectory
- Monoconductor wireline unit to run above measurement tool

MICON Directional Drilling – Selected Projects



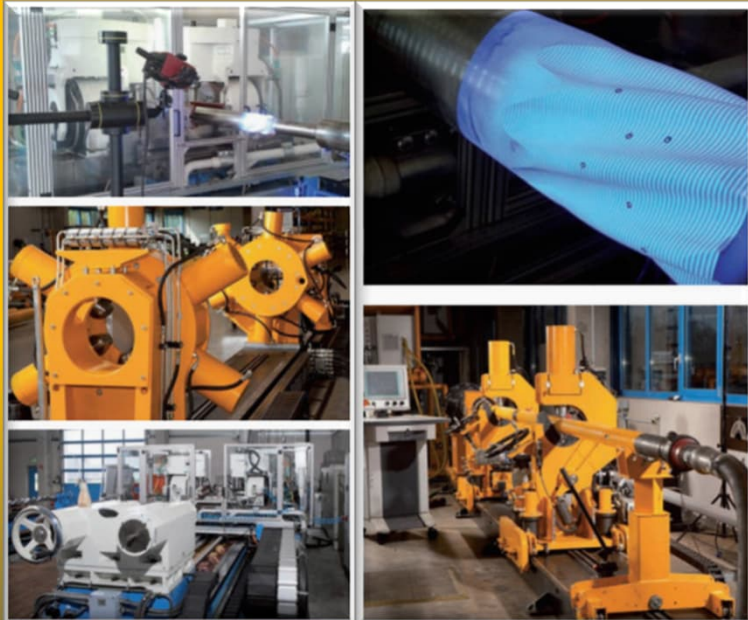
La Muela – Spain – Directional Pilot Holes for Hydropower Projects



MICON Directional Drilling Equipment

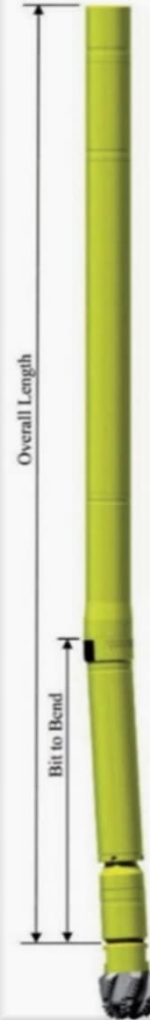
MICON Mud Motors

- Proven performance
- Development, engineering and manufacturing in Germany
- 2.7/8" to 9.5/8" (3.1/2" to 24" drilling diameter)
- Various combinations of powersections available



- Latest manufacturing, assembling, QC and testing standards
- Latest CAD/CAM software for production, 3-D simulation software for design
- Reliable motor data sheets for each motor and each size
- Professional and efficient maintenance

4.3/4" MICON Drill 300



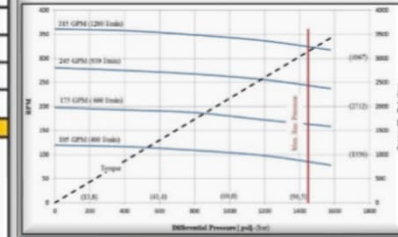
General		
	US Units	SI Units
Overall Length	22.8 ft	6.95 m
Bit to Bend	4.33 ft	1.32 m
Weight	941.4 lbs	427 kg
Bit Size Range	5.5/8" - 7.3/8"	
Top Connection	NC 38	
Bit Connection	3.1/2" Reg. Box	
Max. Slick OD at Wear Ring	5.3"	134.5 mm
Power Section and Performance		
lobe Configuration	5/6	
Number of Stages	5.0	
Flow Rate	105 - 315 GPM	400 - 1,200 l/min
Speed	120 - 360 RPM	
Speed to Flow Ratio	1.14 rev/gal	0.3 rev/l
Rotor Nozzles	No	
Standard Elastomer		
Max. Operational		
Differential Pressure	1,450 psi	100 bar
Torque	3,150 ft-lbs	4,250 Nm
Power Output	195 hp	145 kW
Bearing Section		
Operational Limits		
WOB	13.5 klbs	60 kN
Maximum Operational		
WOB	19 klbs	85 kN
Backreaming Weight	10 klbs	45 kN
Maximum Static Loads		
Bit Overpull*	56 klbs	250 kN
Body Overpull*	157 klbs	700 kN
Set Down Weight*	49 klbs	220 kN
Ultimate Loads		
Bit Overpull*	157 klbs	700 kN
Body Overpull*	292 klbs	1,300 kN
Set Down Weight*	78 klbs	350 kN

* While Motor is not operating

Dogleg severity capabilities

Dogleg Severity (°/100 ft)	Flow Rate (GPM)									
	0.50	0.60	0.80	1.00	1.20	1.50	2.00	2.50	3.00	3.50
4"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.5"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.0"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.5"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.0"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.5"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7.0"	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

PDM performance diagram



MICON Directional Drilling Equipment

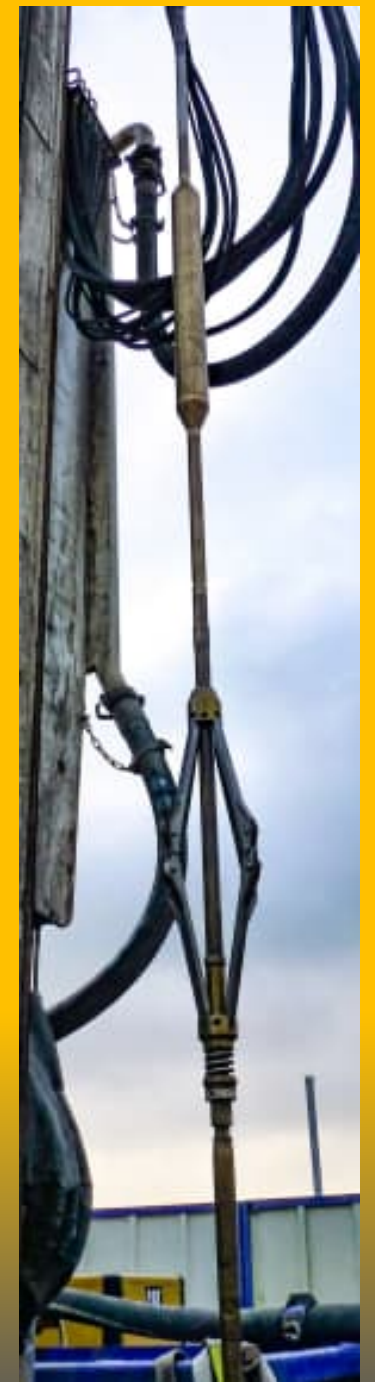
MICON EMS = Electronic Multishot Tool

MICON NSG = North Seeking Gyro Tool

Mobile Wireline Unit with monoconductor cable

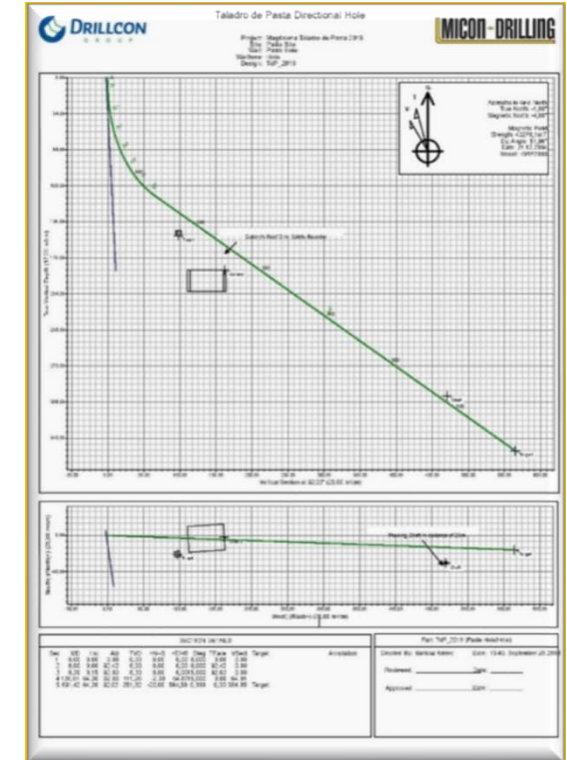
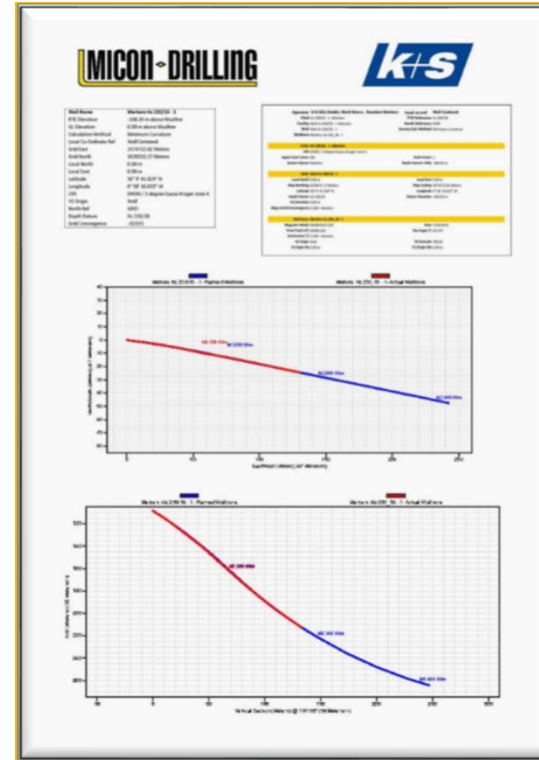


- MICON manufactures fit for purpose running gear according to the proposed drill string in any size
- For horizontal drilling, 3m plastic push rods can be used



MICON Well Planning and Directional Drilling Operation

- Latest Innova Well Seeker Pro™ and Innova Engineering™ software
- Good mix of very well educated and trained engineers with long time experienced operator
- Directional well path simulation, torque and drag simulation, hydraulic modelling and magnetic interference analysis
- Standalone or cloud based planning and monitoring during the project execution
- Tight reporting procedures
- End of Well reporting with all relevant aquired data



MICON-DRILLING **K+S**

Well Name	Well Type	Well Status	Well Depth	Well Diameter	Well Orientation
MICRO-001-001	Oil Well	Planned	2000 m	120 mm	Vertical
MICRO-001-002	Oil Well	Planned	2000 m	120 mm	Vertical
MICRO-001-003	Oil Well	Planned	2000 m	120 mm	Vertical
MICRO-001-004	Oil Well	Planned	2000 m	120 mm	Vertical
MICRO-001-005	Oil Well	Planned	2000 m	120 mm	Vertical

Drillcon Iberia

Regeneración Sistema de Pesca 2019
 Pesca 2019
 Pesca 2019

Plan: TAP_2019

Standard Planning

16 September, 2019

Well Name	Well Type	Well Status	Well Depth	Well Diameter	Well Orientation
MICRO-001-001	Oil Well	Planned	2000 m	120 mm	Vertical
MICRO-001-002	Oil Well	Planned	2000 m	120 mm	Vertical
MICRO-001-003	Oil Well	Planned	2000 m	120 mm	Vertical
MICRO-001-004	Oil Well	Planned	2000 m	120 mm	Vertical
MICRO-001-005	Oil Well	Planned	2000 m	120 mm	Vertical



THANK YOU FOR YOUR ATTENTION!

ANY QUESTIONS

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