



HERRENKNECHT AG. THE WORLD LEADER IN MECHANIZED TUNNELLING.

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SRL

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SRL

Buenos Aires | 6th November 2012



HERRENKNECHT AG SCHWANAU HEADQUARTERS.



3,900 Empleados mundial
2,000 Empleados Alemania
227 Practicantes / Trainees

Herrenknecht en cifras (por año):
60 TBM gran diámetro
90 TBM Micro (< 4m de diametro)

GRUPO HERRENKNECHT EN CIFRAS (2011)

Facturación 1.000 millones € - 3.900 empleados – más de 50% de participación en el mercado



Tipo de Maquinas:

- TBM EPB Suelo Blando
- TBM Escudo Mixto
- TBM Gripper Roca
- TBM Escudo Simple Roca
- TBM Escudo Doble Roca
- TBM Convertibles
- TBM para microtuneles – Pipe Jacking
- Perforación horizontal dirigida (HDD)
- Máquinas para perforación vertical de Piques

Geologías:

- Arcilla (Clay)
- Limo (Silt)
- Arena (Sand)
- Grava (Gravel)
- Roca (Rock)
- Agua subterránea (Ground water)

Tipos de Túneles:

- Agua Potable
- Aguas Residuales
- Electricidad
- Petróleo / Gas
- Viales
- Ferrovios
- Metro
- Hidráulicos
- Minería
- Minería Subterránea

Proveedor integral:

- **MSD:** Equipos de transporte
- **H+E:** Bandas transportadoras
- **GTE:** Personal especializado y servicios de consultoría
- **Formwork, Euroform:** moldes dovelas, encofrados
- **Herrenknecht Vertical:** Equipos de perforación vertical hasta 6000m de profundidad
- **VMT:** Sistema de guía para TBM

FACTORS FOR A SUCCESSFUL PROJECT.

FULL SERVICE TUNNELLING WITH HERRENKNECHT AG



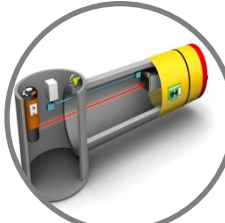
Geotechnical expertise
based on valid field research
in the planning stage



Separation & Material transportation
to achieve maximum performance
rates



Machine concept
according to geology, hydrology and
project conditions



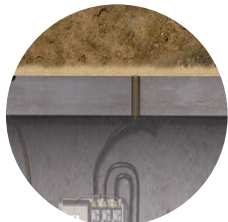
Navigation
to keep the machine on the right track



Pipe & Segment design and quality
Supervision of jacking forces (OLC)
and development of most suitable
segment design



Control and steering
all data of tunnelling components are
integrated in one control unit, visualized on
the operator panel



Bentonite Lubrication System
to minimize friction along the
tunnel alignment



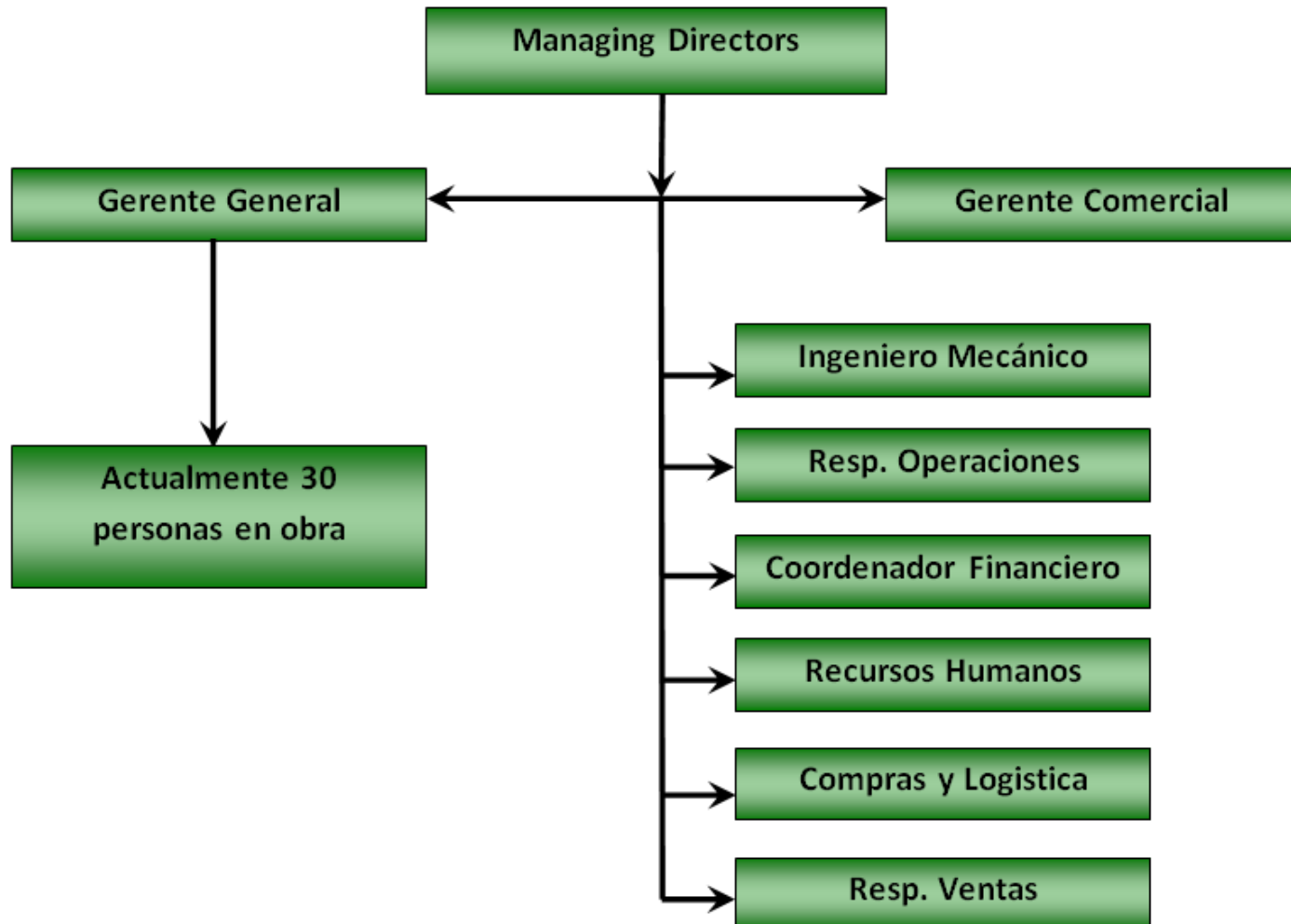
Service
Operators, spare parts and
technical advice



Herrenknecht Argentina SRL

- HK presente en Argentina con un branch desde el 2008
- SRL desde el 2011
- Primera máquina trabajando en Argentina en el 1995
- Prestaciones de servicios post venta:
 - Montaje y desmontaje maquinas
 - Servicios de operación/mantenimiento maquinas y entrenamiento personal
 - Asistencia técnica en obra y mejoría del ciclo de producción
 - Entrega piezas de repuesto y de desgaste
 - Entrega herramienta de corte
 - Puente con la casa Matriz
 - Asesoramiento soluciones técnicas y tecnológicas
 - Reacondicionamiento de Maquinas usadas (Sarmiento)

HAR Organization chart



Obras actuales HAR

- Tunjuelo Canoas (COL): 8,8 km túnel por una planta purificadora (rio), operación y mantenimiento TBM EPB 5m diámetro, 17 personas en obra
- Aguas del Paraná (Escobar): 14km túnel por planta una potabilizadora, operación y mantenimiento de 2 TBM EPB 4,5m diámetro, 8 personas en obra
- Sarmiento (Haedo): túnel ferroviario de 16 km (primera etapa), reacondicionamiento y montaje TBM EPB 11,5m diámetro, hasta 8 personas en obra
- Colector Oeste (Tigre): 4,6 km pipe jacking, asistencia técnica puntual TBM EPB 1500mm

Herrenknecht como partner

- Leader mundial
- Presencia en Argentina y otros 5 países del LA
- Compañía en expansión a pesar de la difícil situación económica Europea
- Posibilidad de financiación de proyectos:
 - prestatario HK y no el Banco
 - tasas intereses nivel europeo 7-8% x año
 - 1ro año de gracia (max 5,5 años)
 - no necesaria garantía del Banco
 - sujeto a aprobación y revisión últimos 3 años de balance



Excavación subterránea con máquinas tuneladoras:
aplicaciones en el ámbito civil y minero.

HERRENKNECHT OFFERS THE ENTIRE SPECTRUM.

VARYING FROM SMALL TO LARGE DIAMETER.



Geologies:

- Clay.
- Silt.
- Sand.
- Gravel.
- Rock.
- Ground water.

Utility Tunnelling:

- Drinking Water.
- Sewage.
- Data.
- Electro.
- Oil/Gas.
- Vertical Drilling.

Traffic Tunnelling:

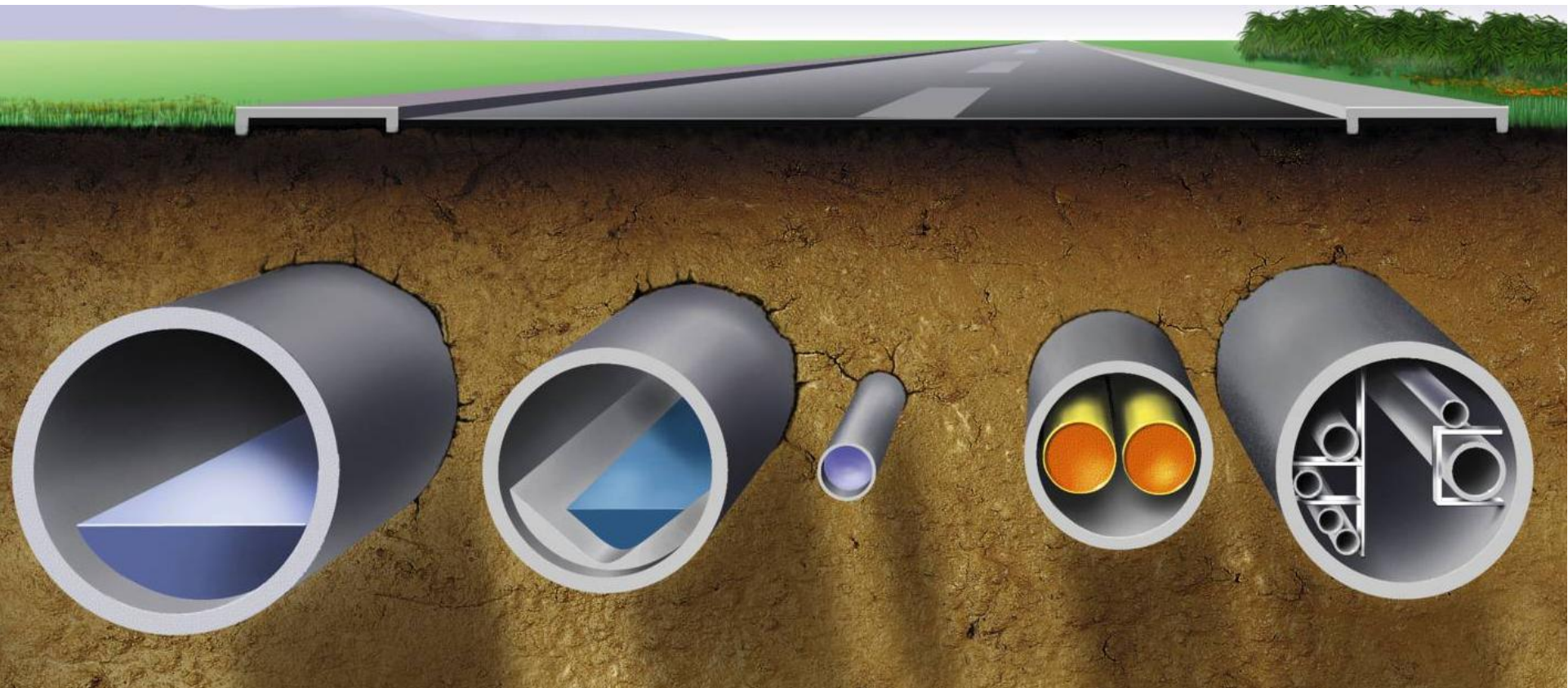
- Road.
- Railway.
- Metro.
- Multi-function tunnel.

Deep Vertical Drilling:

- Oil.
- Gas.
- Geothermal energy.

HERRENKNECHT UTILITY TUNNELLING.

FOR ALL KIND OF PIPELINE SYSTEMS.



UTILITY TUNNELLING MACHINE TYPES.

SOLUTIONS FOR ALL GEOLOGIES.



AVN/AVND



EPB



TBM



HDD



Direct Pipe



PRODUCT FAMILIES IN THE BUSINESS UNIT UTILITY TUNNELLING.

■ Pipe Jacking



■ Segmental Lining



■ HDD



■ Direct Pipe



■ Vertical Shaft Sinking

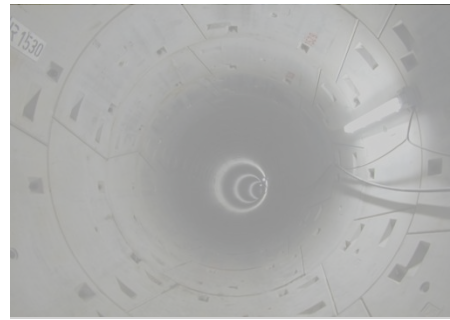


PRODUCT FAMILIES IN THE BUSINESS UNIT UTILITY TUNNELLING.

■ Pipe Jacking



■ Segmental Lining



■ HDD



■ Direct Pipe

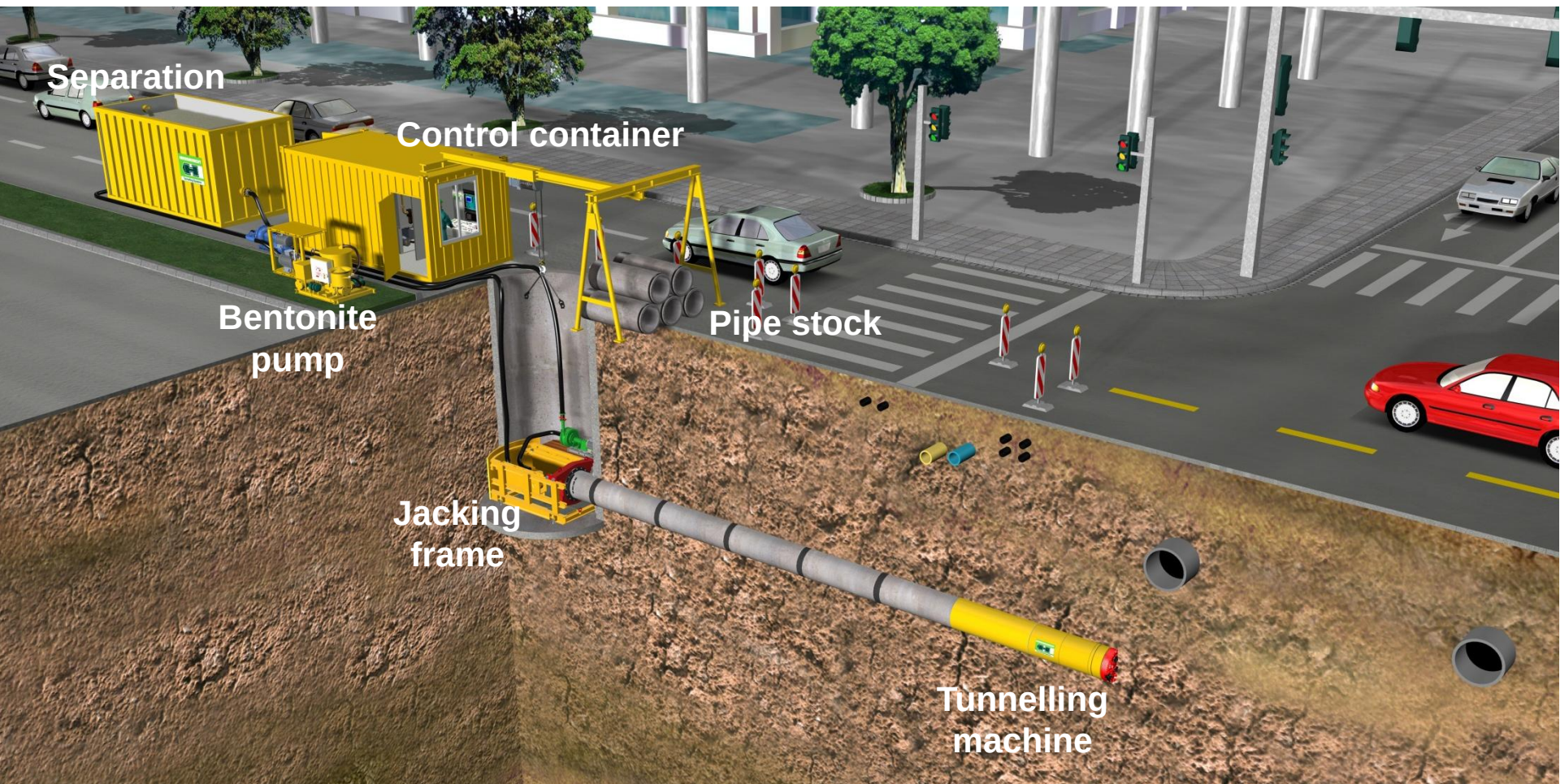


■ Vertical Shaft Sinking



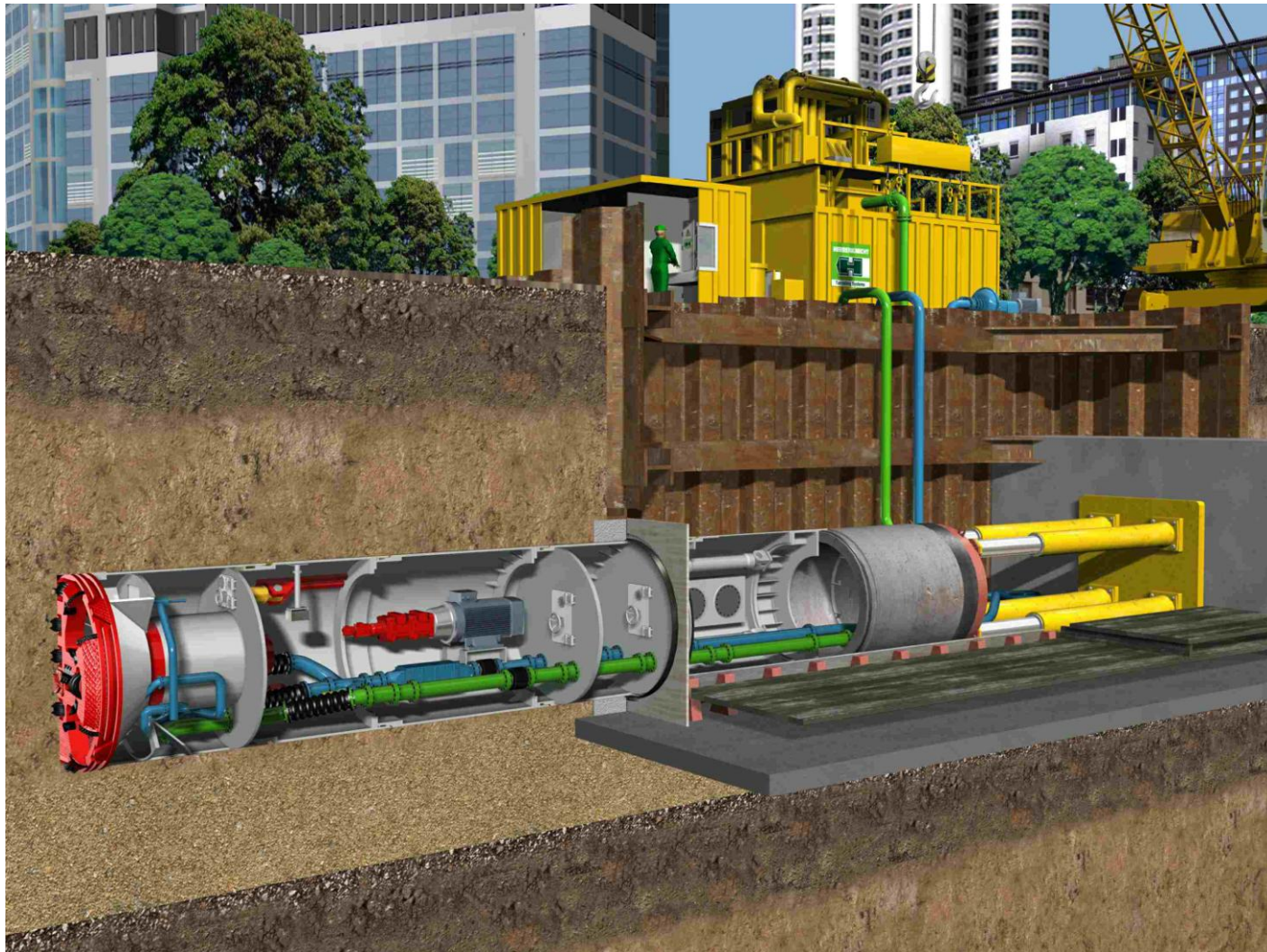
PIPE JACKING.

AVN 600 JOBSITE IN INNER CITY.



PIPE JACKING.

AVN 2000 JOBSITE.



PIPE JACKING.

JOBSITE OF UTILITY EARTH PRESSURE BALANCE SHIELD.

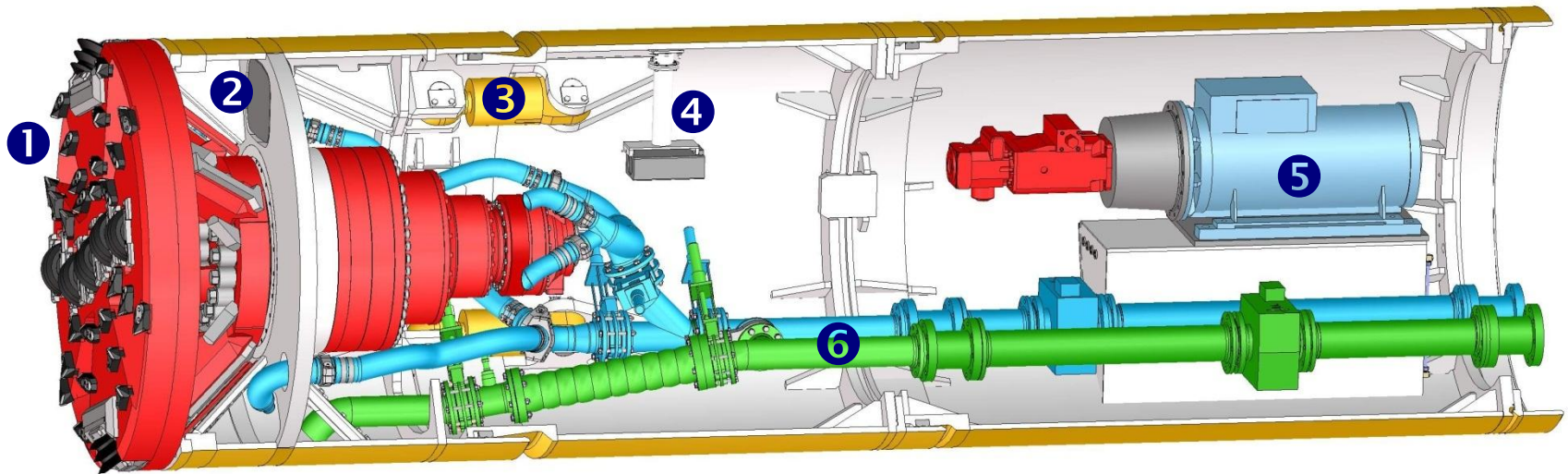


PIPE JACKING.

JOBSITE OF UTILITY EARTH PRESSURE BALANCE SHIELD.



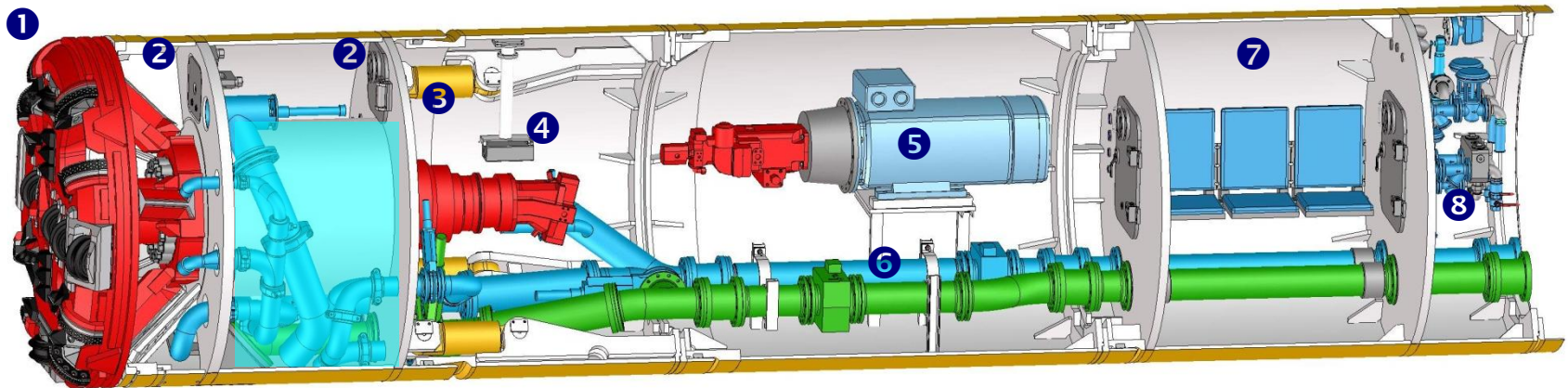
MICROTUNNELLING EQUIPMENT AVN (SLURRY MODE).



- | | |
|-------------------------------|-------------------------|
| ① Cutting Wheel | ④ Laser Target |
| ② Access to the cutting wheel | ⑤ Power Pack |
| ③ Steering Cylinders | ⑥ Feed and Slurry lines |

AVND-SERIES FOR MIXED GROUND CONDITIONS.

COMPRESSED AIR REGULATION UNDER GROUNDWATER.



① Cutting wheel

② Access to cutting wheel

③ Steering cylinder

④ Laser-target

⑤ Powerpack

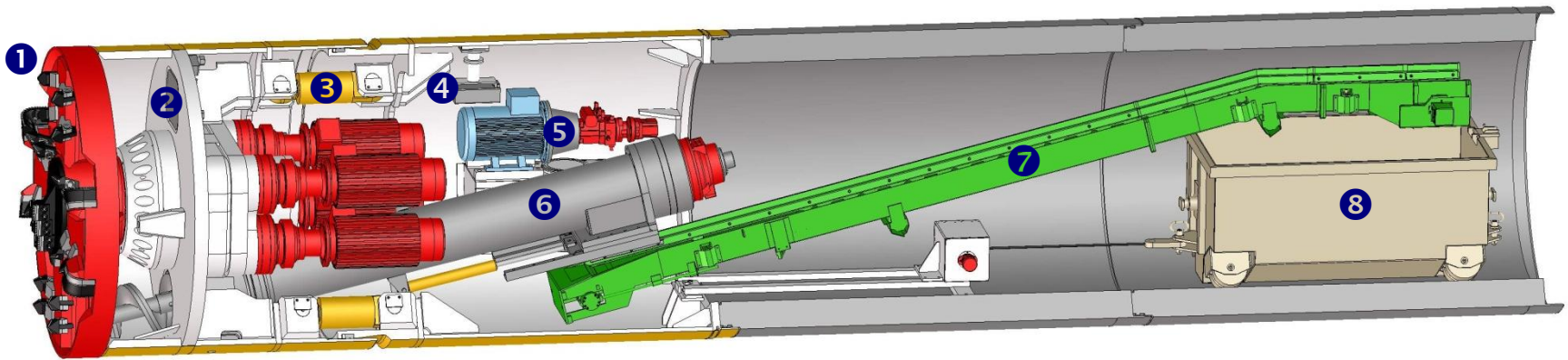
⑥ Feeding and slurry line

⑦ Compressed airlock

⑧ Compressed air regulation unit

MICROTUNNELLING EQUIPMENT EPB.

PIPE JACKING MACHINE.



① Cutting wheel

② Access hatch to cutting wheel

③ Steering cylinder

④ Laser target

⑤ Power pack

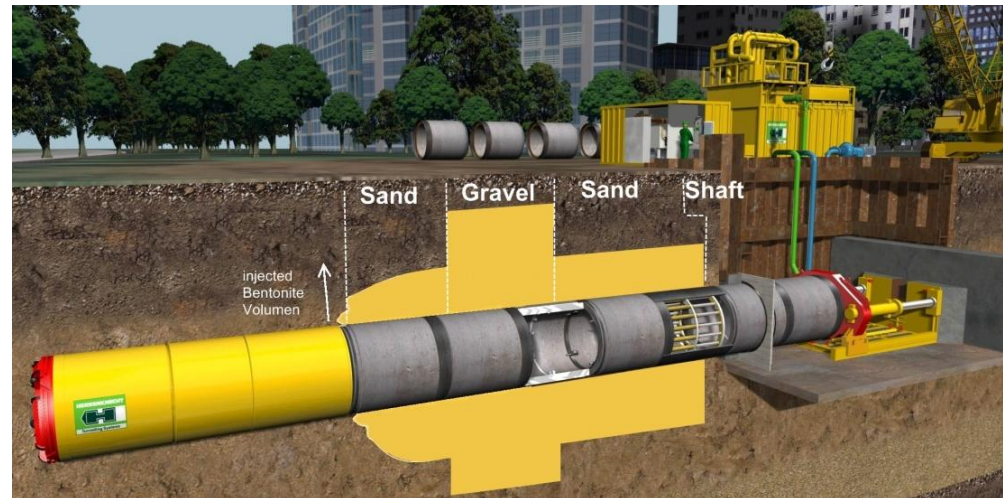
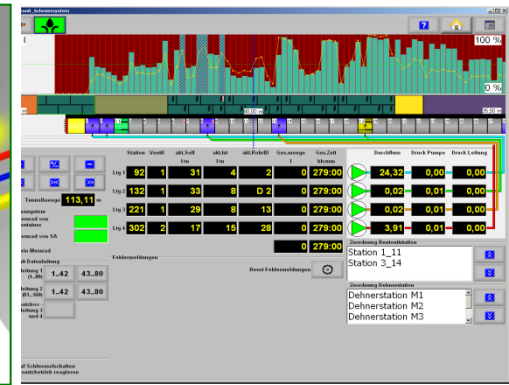
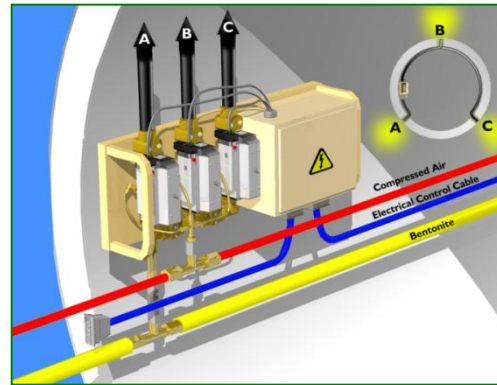
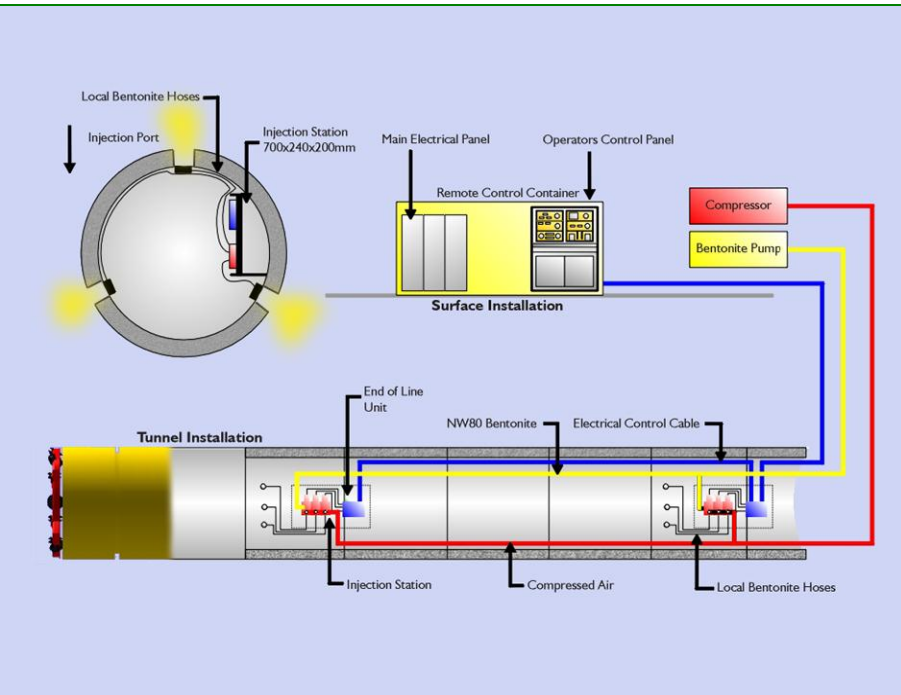
⑥ Screw conveyor

⑦ Conveyor belt

⑧ Waggon

BENTONITE LUBRICATION SYSTEM WITH VOLUME CONTROL.

ADJUSTABLE BENTONITE VOLUME.

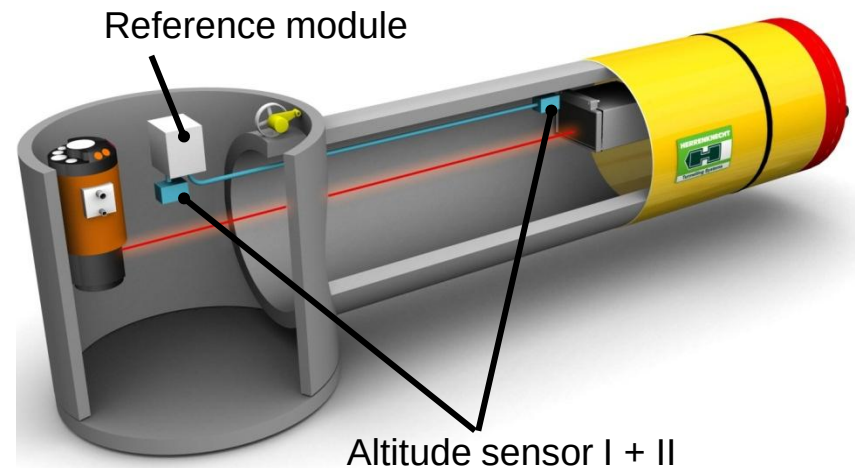
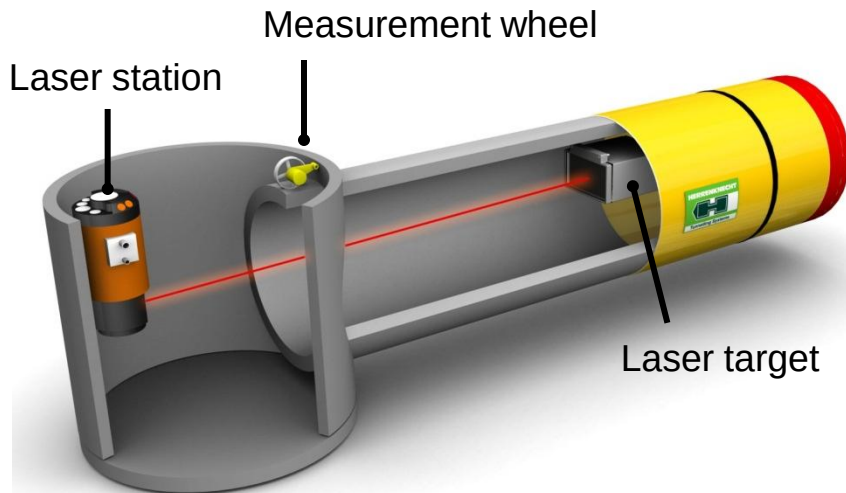


Continuous recording of bentonite volume, pressure, modifications

Overview of friction forces

HERRENKNECHT NAVIGATION SYSTEM.

FOR STRAIGHT DRIVES. ELS – ELECTRONIC LASER SYSTEM.



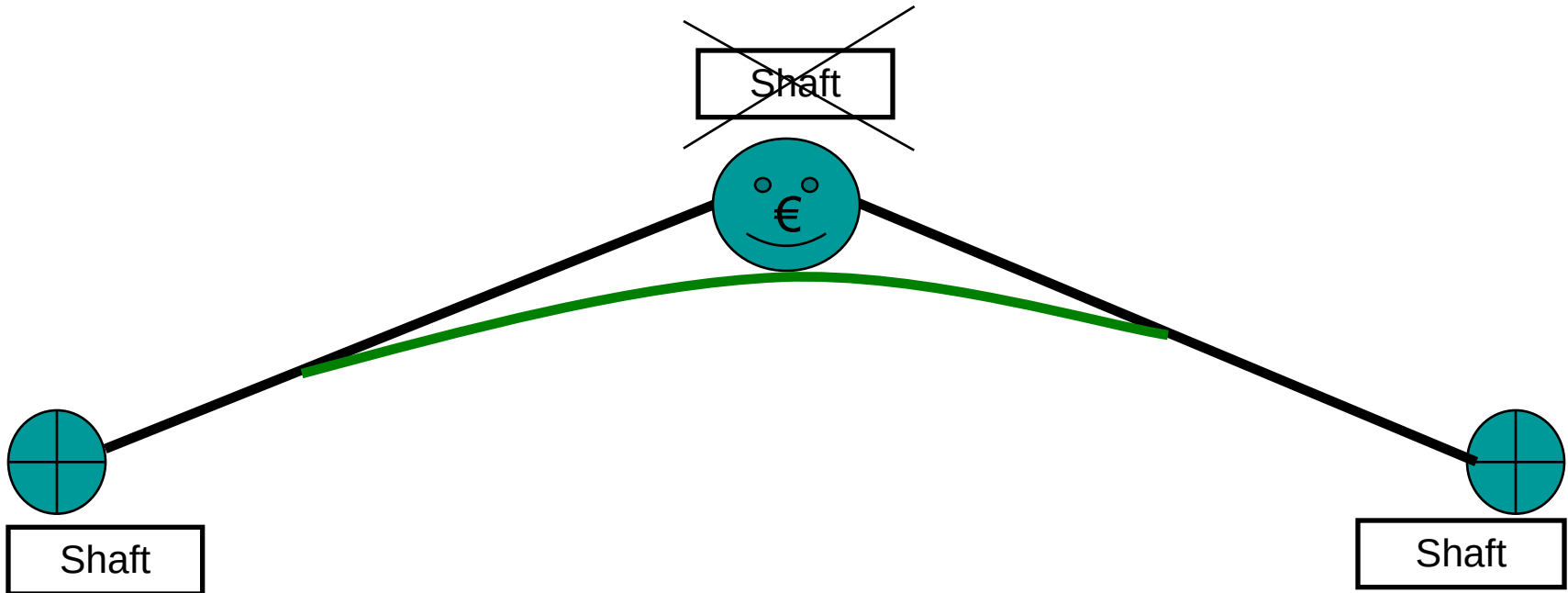
■ straight drives: up to 200m

■ straight drives: up to 400m

■ with hydrostatic water leveling

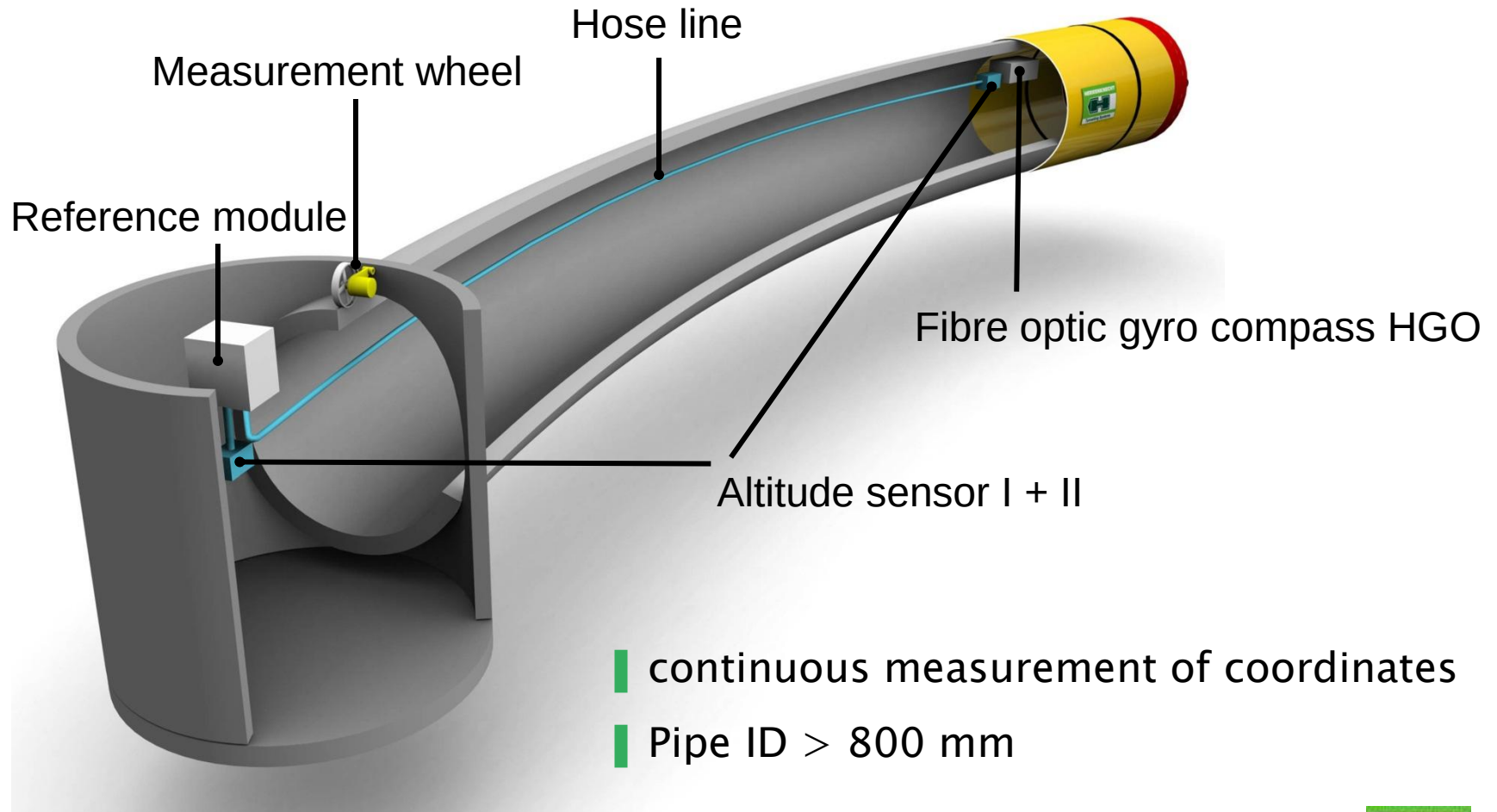
FOR CURVED PIPE JACKS.

GYRO NAVIGATION SYSTEM.



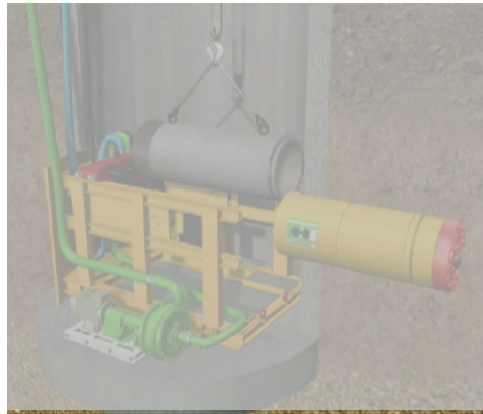
FOR CURVED PIPE JACKS.

GYRO NAVIGATION SYSTEM.



PRODUCT FAMILIES IN THE BUSINESS UNIT UTILITY TUNNELLING.

■ Pipe Jacking



■ Segmental Lining



■ HDD



■ Direct Pipe

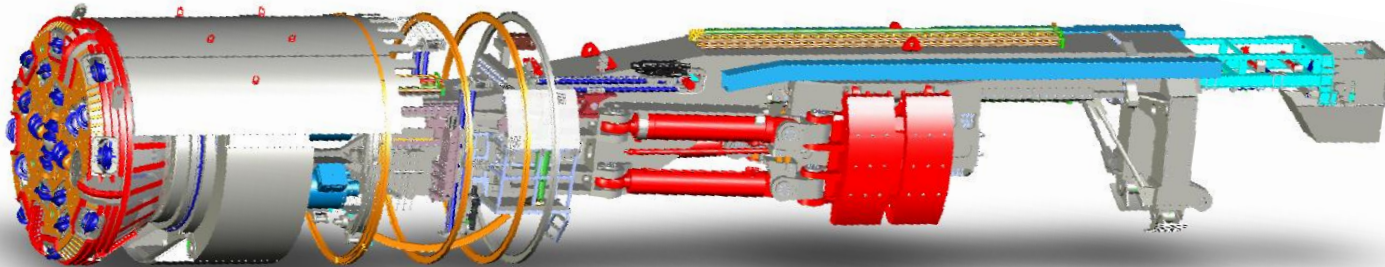


■ Vertical Shaft Sinking

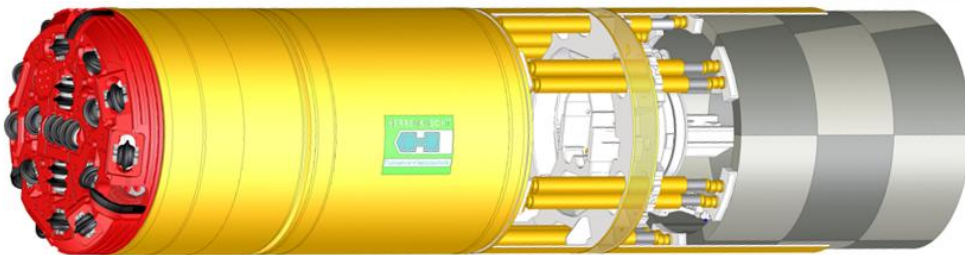


UTILITY TUNNELLING MACHINE TYPES.

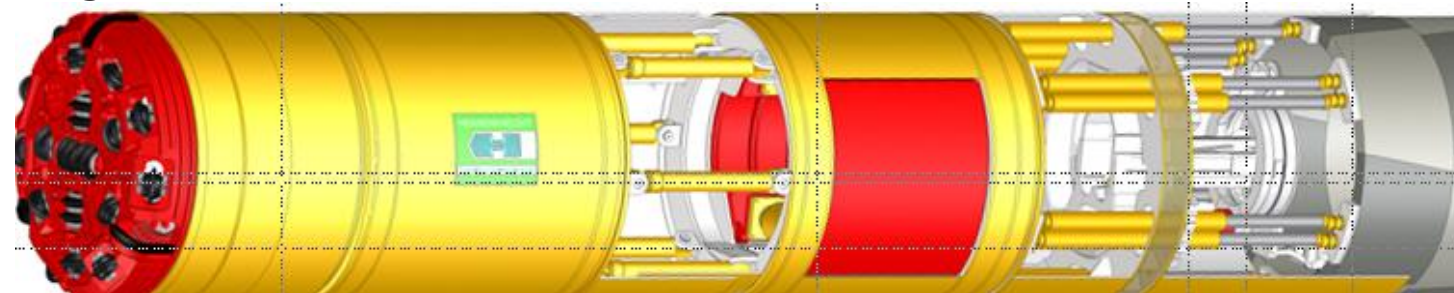
HARD ROCK TBMS.



Gripper TBM



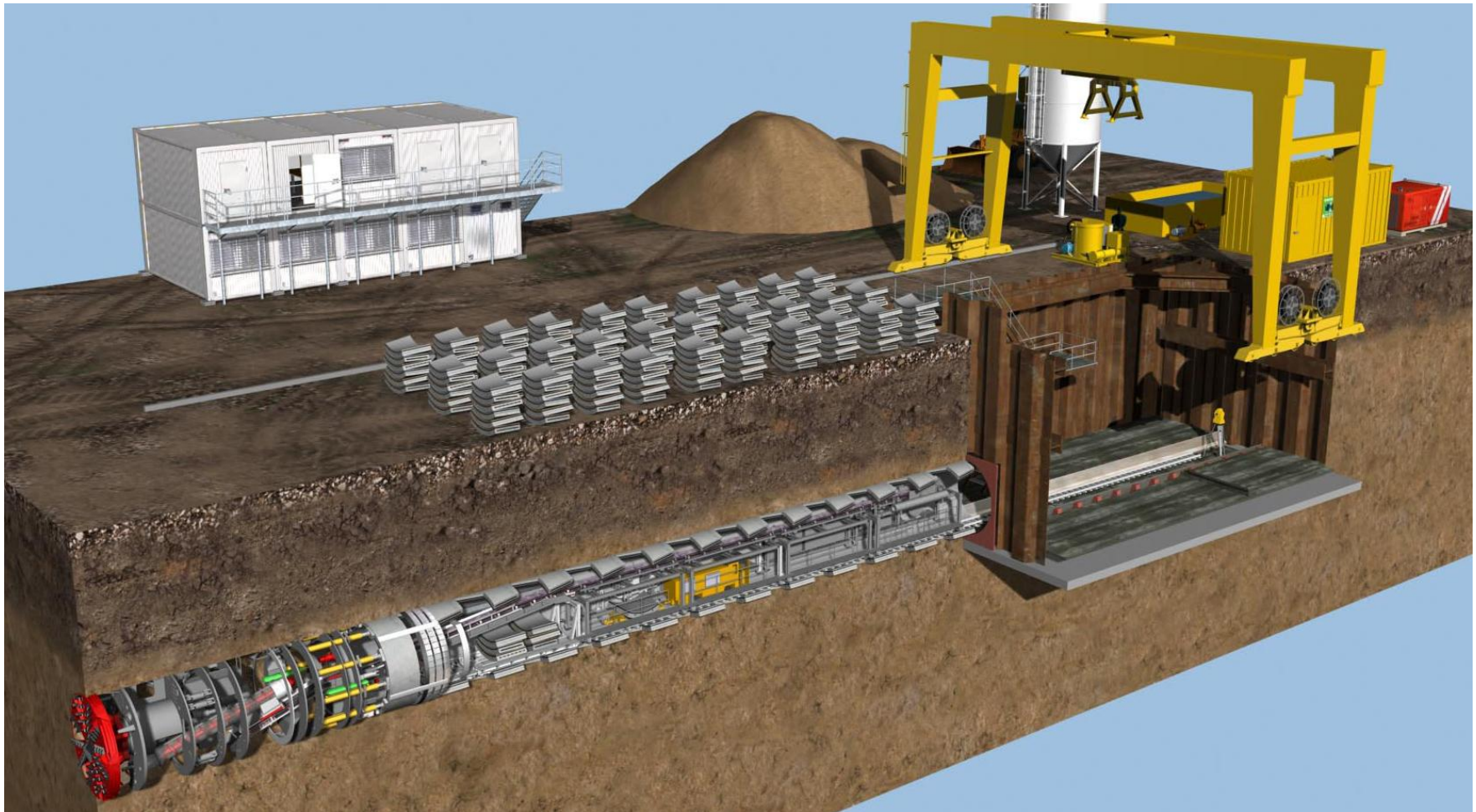
Single Shield



Double Shield

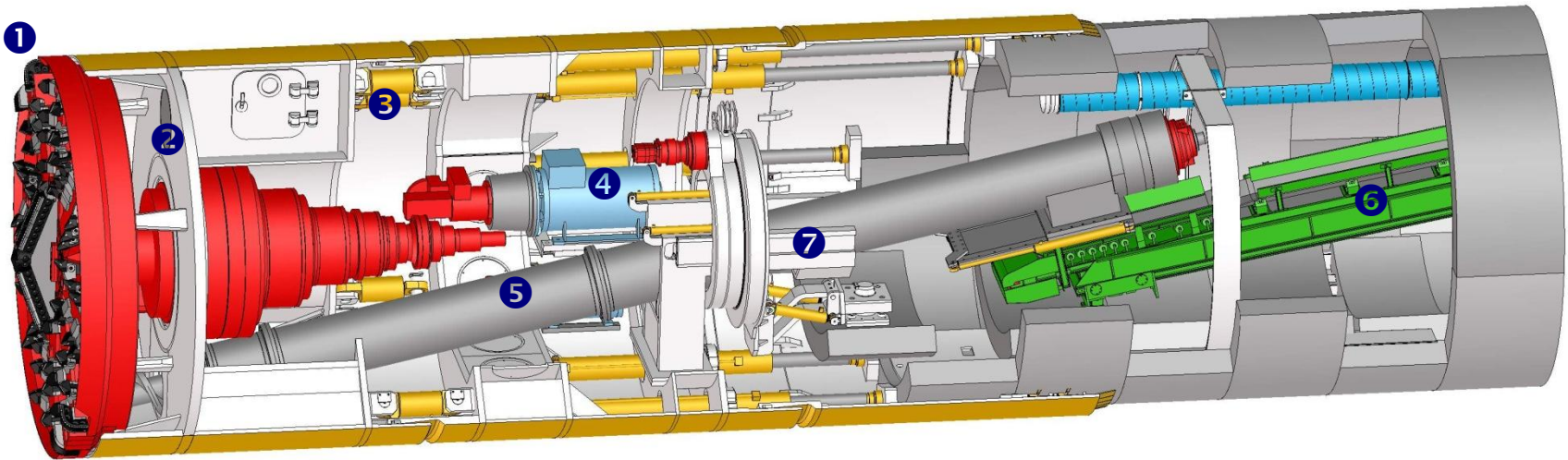
SEGMENT LINING.

JOBSITE OF UTILITY EARTH PRESSURE BALANCE SHIELD.



MICROTUNNELLING EQUIPMENT EPB.

SEGMENT LINING MACHINE.



① Cutting wheel

② Access hatch to cutting wheel

③ Steering cylinder

④ Power pack

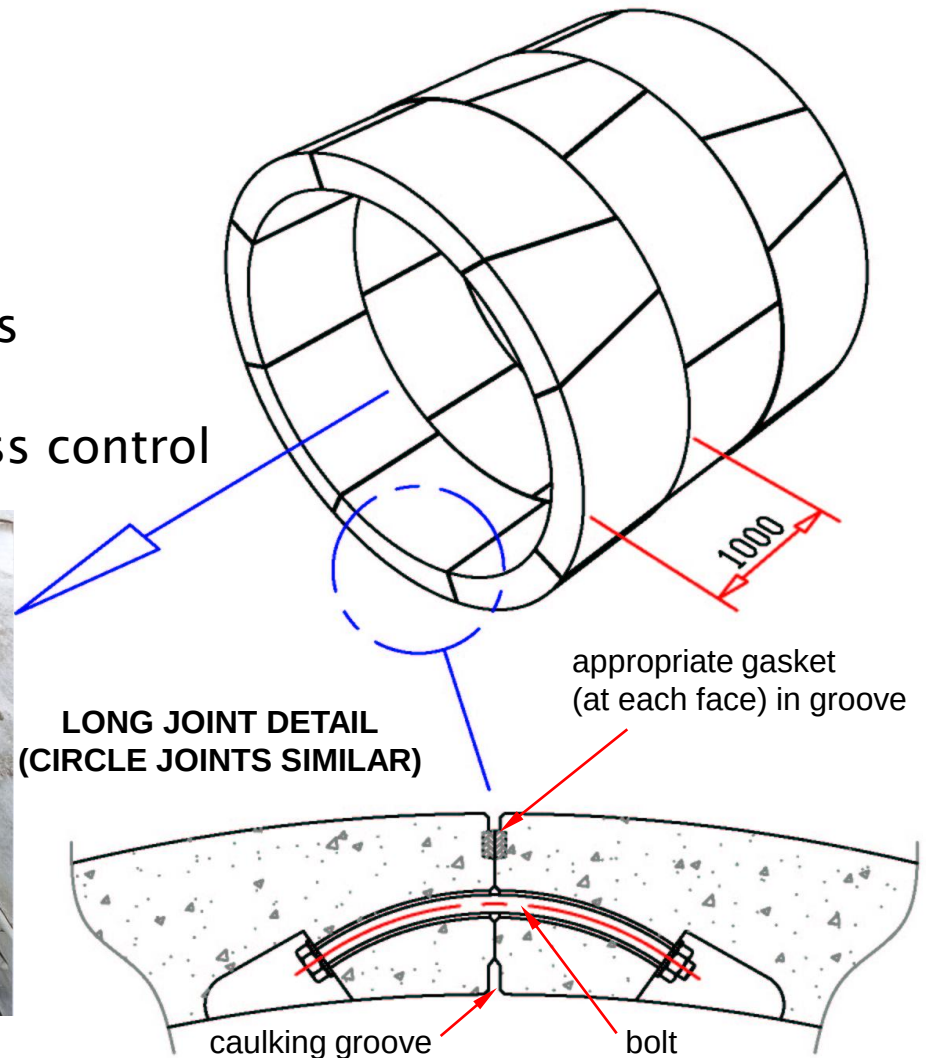
⑤ Screw conveyor

⑥ Conveyor belt

⑦ Waggon

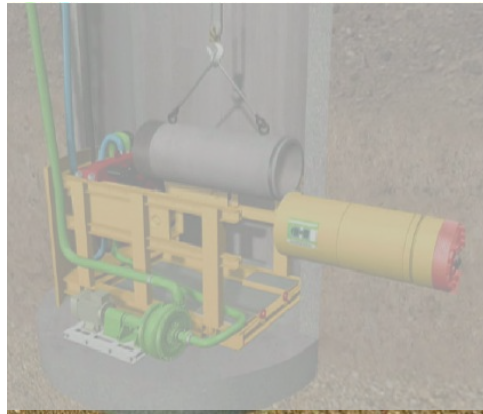
SEGMENT LINING. DESIGN PRINCIPLES.

- rather long tunnels: $>1000\text{m}$.
- larger diameters: $>3\text{m}$).
- multi curves: various directions
- non-remote controlled: process control

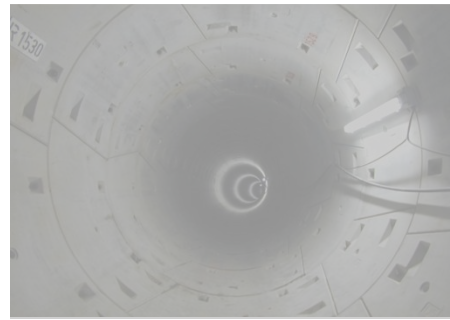


PRODUCT FAMILIES IN THE BUSINESS UNIT UTILITY TUNNELLING.

■ Pipe Jacking



■ Segmental Lining



■ HDD



■ Direct Pipe

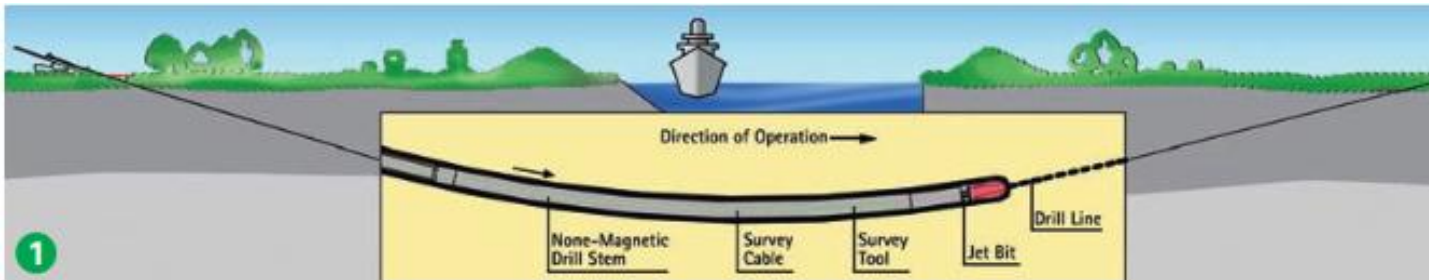


■ Vertical Shaft Sinking

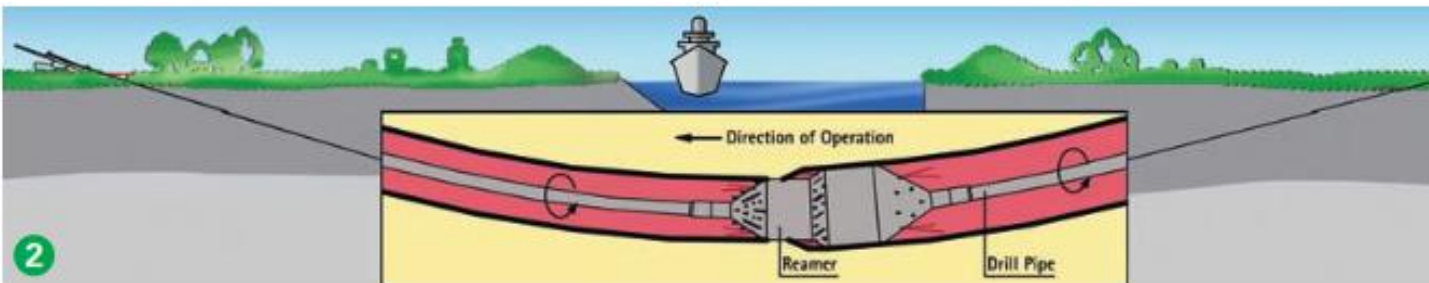


HORIZONTAL DIRECTIONAL DRILLING.

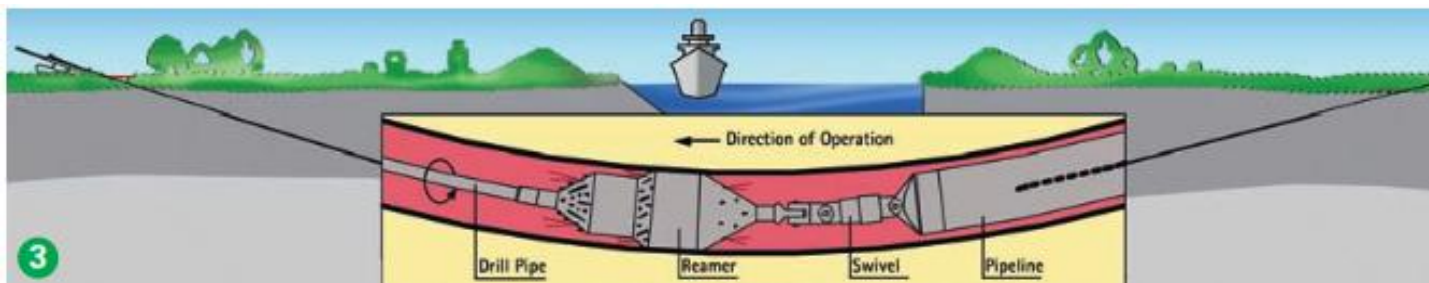
THE METHOD.



Pilot Drill



Reaming



Pipeline Pullback



HORIZONTAL DIRECTIONAL DRILLING.

XXL PIPELINE 56" IN TURKMENISTAN.



Karabekaul | Turkmenistan



HK250T, HK400M,

Pipe Thruster HK750 PT

Geology: Sand, clay,

Sandstone

Pipeline Ø: 56"

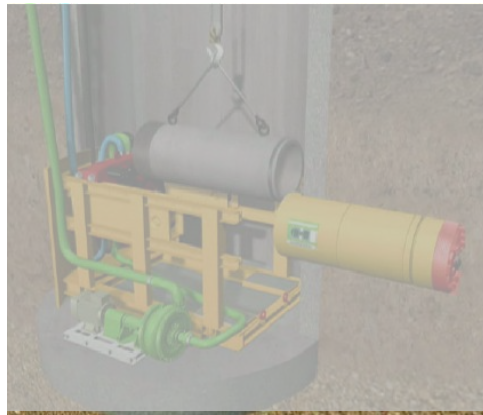
Pipeline Length: 1.750 m

Client: Turkmengas

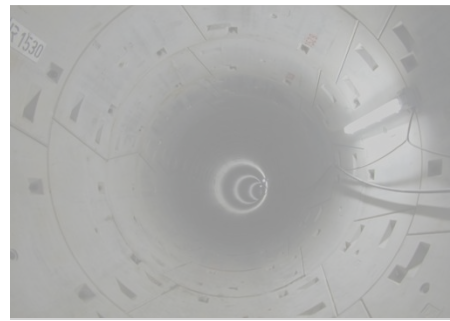


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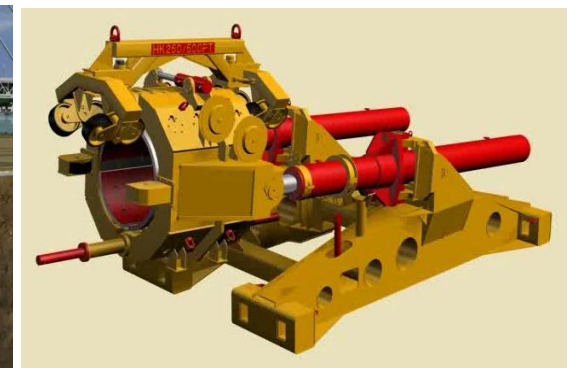
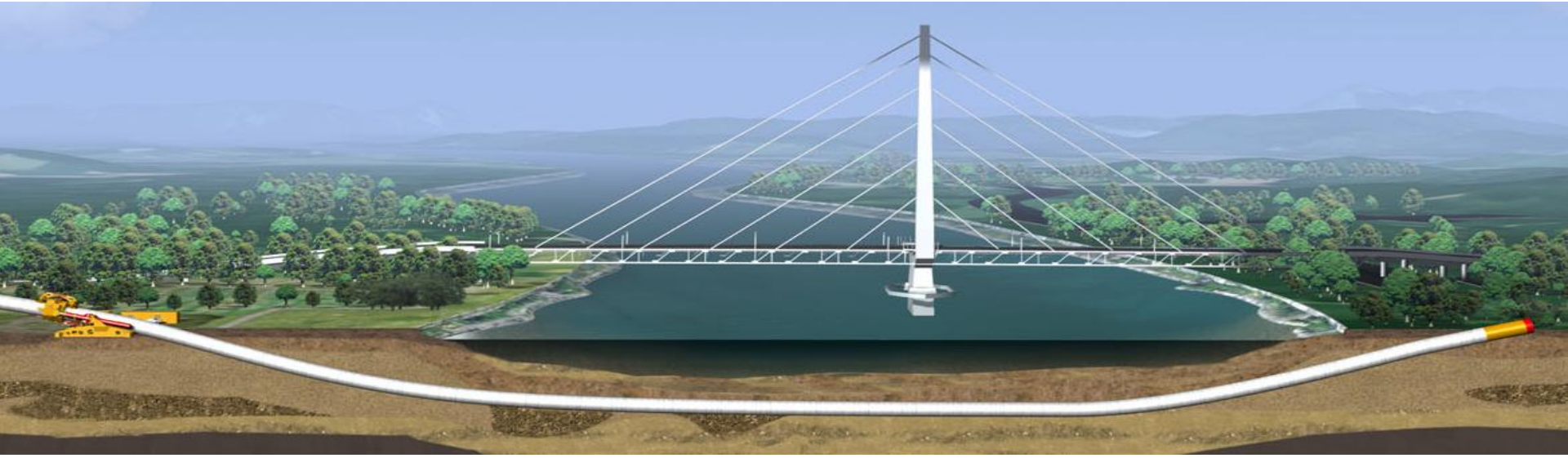


■ Vertical Shaft Sinking



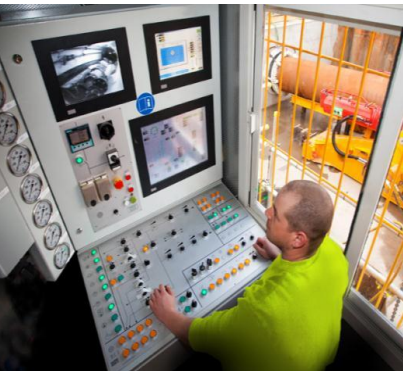
HERRENKNECHT DIRECT PIPE®.

ONE - PASS PIPELINE INSTALLATION IN ALL GEOLOGIES.



2 X 56" RIVER RIBBLE CROSSING (850M) IN GREAT BRITAIN.

SET UP OF THE MACHINE AVN1200 & PIPE THRUSTER.



56" (ID 1400mm) casing for 36" water pipe

2 X 56" RIVER RIBBLE CROSSING (850M) IN GREAT BRITAIN.

SET UP OF THE MACHINE AVN1200 & PIPE THRUSTER.



DIRECT PIPE OPERATION IN THE NETHERLANDS.

LONGEST CROSSING: 1400m.



Direct Pipe Crossing no. 11 |
48" gas pipeline | Netherlands



Diameter: 48"

Length: 1400m (3 sections)

Coating: Polypropylen PP

Geology: sand, little gravel,
clay

Contractor: A. Hak Drillcon

Client: Gasunie NL

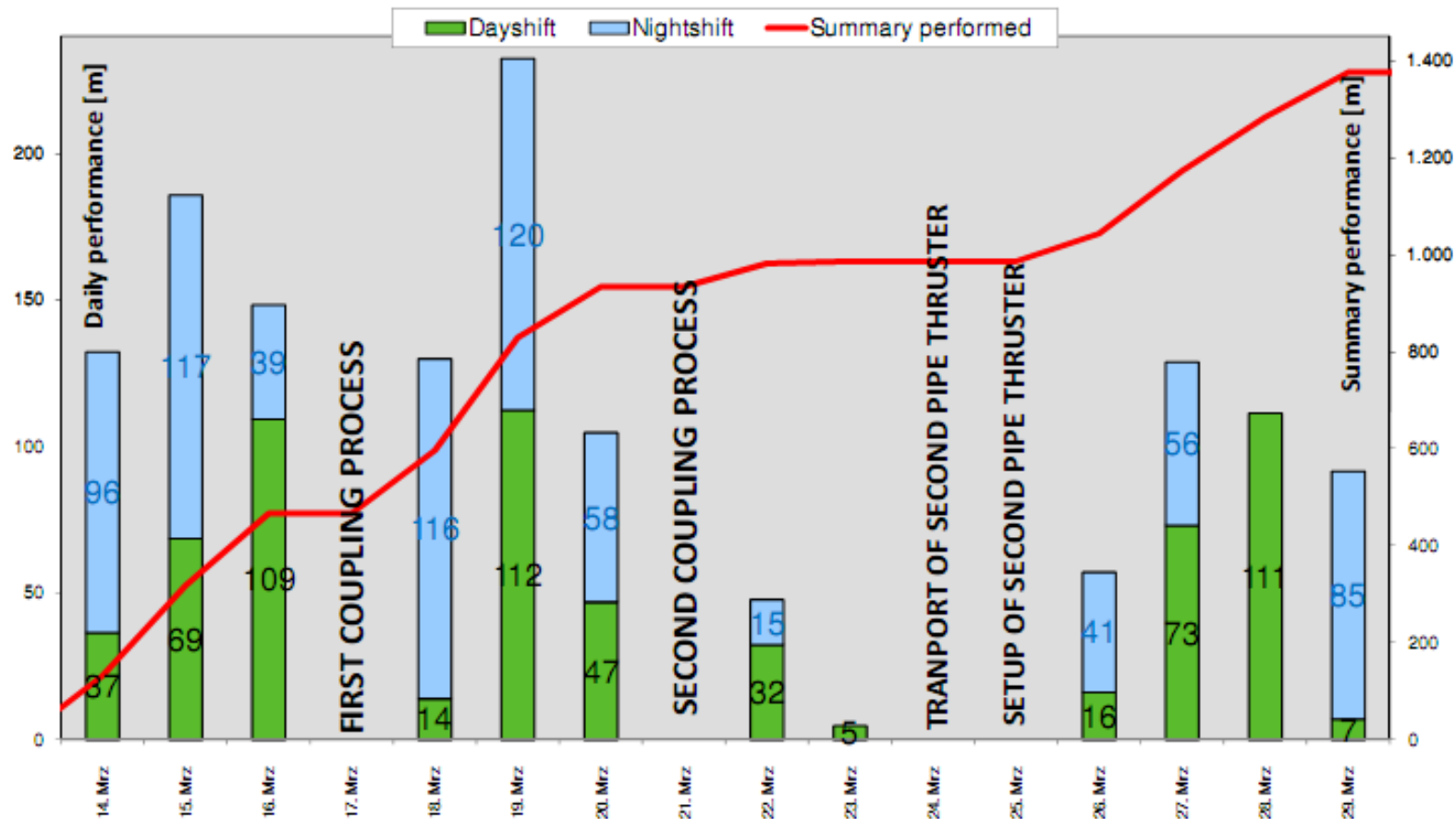
DIRECT PIPE OPERATION IN THE NETHERLANDS.

ADDITIONAL PUSH FORCE BY 2 PIPE THRUSTERS.



PERFORMANCE CHART OF THE 1.400 METER LONG PROJECT.

BEST DAILY PERFORMANCE: 232M.



ADVANTAGES OF THE DIRECT PIPE® - METHOD.

COMPARED TO HDD	COMPARED TO MICROTUNNELLING
1. One-step pipe installation (no reaming steps necessary)	1. One-step pipe installation (no bigger casing pipe necessary) → high speed
2. Smaller borehole diameter (overcut not 1/3 of pipe-Ø but only approx. 10 cm in diameter)	2. Smaller borehole diameter (due to 1.) → less ground to move and dump
3. Permanent borehole support → reduced geological risk	3. Pullback option in case of obstacles → reduced geological risk
4. Access from only one side needed → ideal for Sea Outfalls & narrow cond.	4. Drilling from surface to surface → Simple pit construction on both sides
5. Laying off in pipe sections not risky	
6. Lower mud pressure and mud volume → reduced environmental risk	
7. Less overburden needed → advantage for client for later accessibility	
8. Discontinuous working schedule possible → in event of foreseen or unforeseen stops no risk of loss of borehole	

BOUNDARY CONDITIONS – ASSESSMENT CRITERIA.

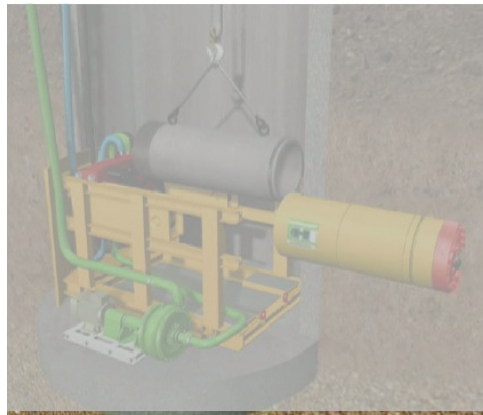
Values noted are typical and can vary from project to project !

- Pipeline diameters: 30"- 60" (28" also feasible)
- Conservative estimated length limitations: depending on diameter, geology & other factors
 - 30" = max. 300 m (with AVN600 Direct Pipe®)
 - 36" = max. 300 m (with AVN800B Direct Pipe®)
 - 42" = max. 700 m (with AVN800A Direct Pipe®)
 - 48" = max. 1.000 m (with AVN1000 Direct Pipe®) – Yet realized: 1.400m !!
 - 56" = max. 1.400 m (with AVN1200 Direct Pipe®)
- Geology: Clay, Silt, Sand, Gravel, Cobbles and Boulders, Rock (with up to 150 MPa)
- Necessary overburden: comparable to Microtunnelling (recommended minimum 2,5 x OD machine)
- Recommended radius – like for HDD-crossings: (depending on Ø & wall thickness) driven radius should be minimum natural bending radius of the pipeline
- Water pressure:
up to 3 bar (3 bar is standard – more is feasible but special design)

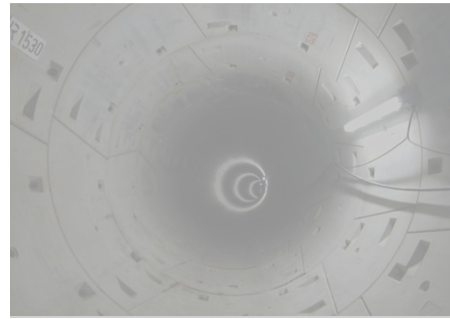
Crossing number	Contractor	Client	Country	Name of project	Pipe - Ø	Purpose	Coating	Drilling Length [m]	Geology	Year of completion
1.	Sonntag	EWB	Germany	Rhine Crossing	48"	Casing	none	464	sand, gravel, clay	2007
2.	Meyer & John	EWE	Germany	Brine Outlet	48"	Casing	PE	283	sand, clay, stones, wood	2009
3.	A.Hak Drillcon	Gasunie	Netherlands	Pipeline Angerlo-Beuningen - Crossing "Mermsestraat"	48"	Gas	PP	362	sand, gravel	2010
4.	A.Hak Drillcon	Gasunie	Netherlands	Pipeline Angerlo-Beuningen - Crossing "Valburg M & R"	48"	Gas	PP	435	sand, gravel, wood	2010
5.	REM Directional Inc.	Florida Gas Transmission	USA	Expans.Project Phase VIII - "Higway 70 Southeast" Crossing	30"	Gas	FBE	224	sand, clay, coral, shell	2010
6.	A.Hak Drillcon	Gasunie	Netherlands	Hartelkanaal Crossing in the harbour of Rotterdam	48"	Gas	PP	545	sand, clay, wood	2010
7.	A.Hak Drillcon	Gasunie	Netherlands	Pipeline Ommen-Angerlo - 1st Crossing of railway line "Zwolle-Almelo"	48"	Gas	PP	516	sand, gravel, loam	2010
8.	A.Hak Drillcon	Gasunie	Netherlands	Pipeline Ommen-Angerlo - 2nd Crossing of railway line	48"	Gas	PP	540	sand, gravel, loam	2011
9.	REM Directional Inc.	Florida Gas Transmission	USA	Highway 39 / Keysville Road	36"	Gas	FBE	119	sand, clay, coral, shell	2011
10.	REM Directional Inc.	Florida Gas Transmission	USA	Collier Parkway Crossing	36"	Gas	FBE	226	sand, clay	2011
11.	A.Hak Drillcon	Gasunie	Netherlands	Pipeline Ommen - Esveld, Crossing in Lochem	48"	Gas	PP	1400	sand, gravel, loam	2011
12.	ICOP spa.	Snam Rete Gas	Italy	Pipeline Poggio Renatico - Cremona; "Scolo Riolo" Crossing	48"	Gas	PE	394	clay, little sand	2011
13.	ICOP spa.	Snam Rete Gas	Italy	Pipeline Poggio Renatico - Cremona; "Desolo" Crossing	48"	Gas	PE	600	clay	2011
14.	ICOP spa.	Snam Rete Gas	Italy	Pipeline Poggio Renatico - Cremona; "Fiumazzo" Crossing	48"	Gas	PE	372	clay	2011
15.	Michels Directional Inc.	Empire Pipeline	USA	Tioga County Extension: "State Highway 382" Crossing	42"	Casing	none	130	gravel, cobbles	2011
16.	ICOP spa.	Snam Rete Gas	Italy	Pipeline Poggio Renatico - Cremona; "Fiume Reno 2" Crossing	48"	Gas	PE	707	clay	2012
17.	KMI	United Utilities	Great Britain	River Ribble Crossing No. 1	56"	Casing	none	860	Clay, gravel, sand, cobbles	2012
18.	KMI	United Utilities	Great Britain	River Ribble Crossing No. 2	56"	Casing	none	860	Clay, gravel, sand, cobbles	2012

PRODUCT FAMILIES IN THE BUSINESS UNIT UTILITY TUNNELLING.

■ Pipe Jacking



■ Segmental Lining



■ HDD



■ Direct Pipe

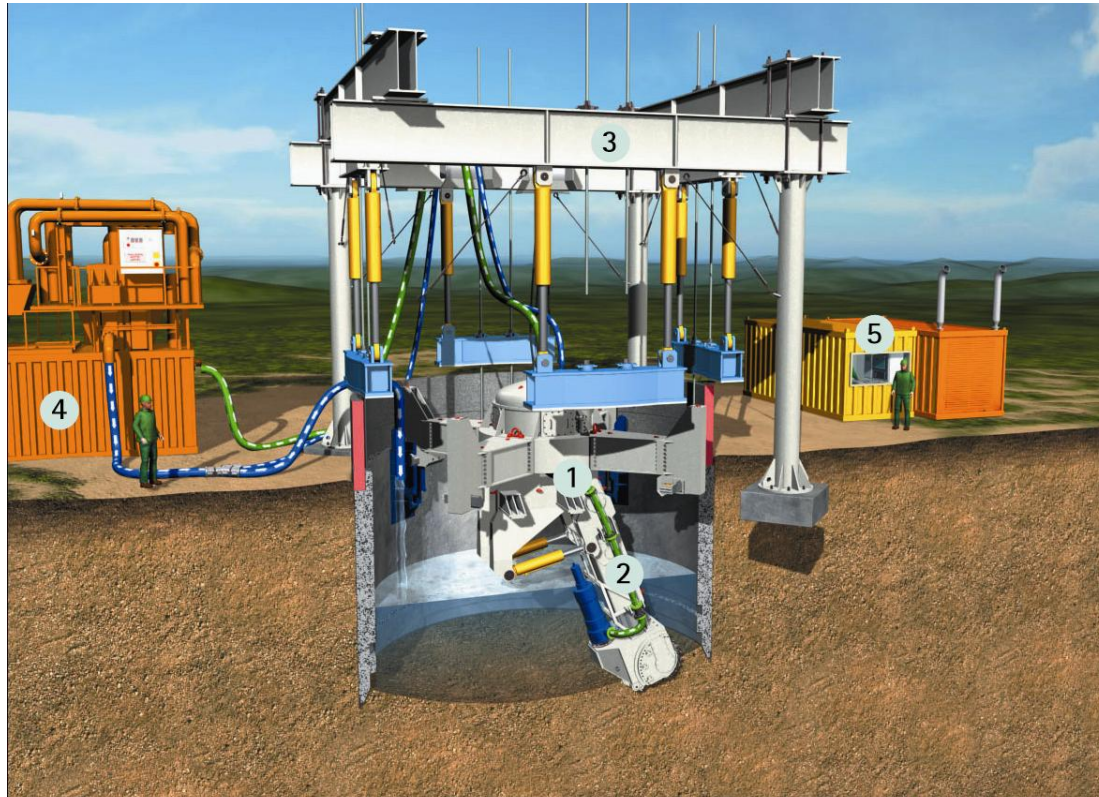


■ Vertical Shaft Sinking



HERRENKNECHT VSM MACHINES.

GENERAL SETUP WITH SLURRY TRANSPORT.



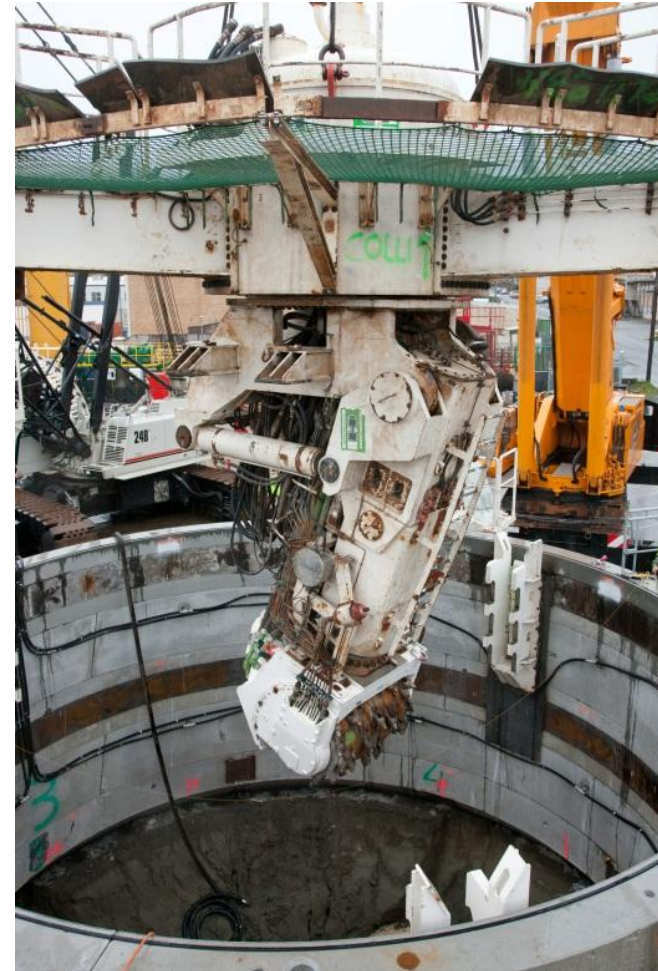
- | | |
|--|---------------------|
| 1 Shaft Sinking equipment | 3 Lowering unit |
| 2 Cutting boom with rotating cutter drum | 4 Separation plant |
| | 5 Control container |

VSM PROJECT IN SEATTLE, USA.

BALLARD SIPHON PROJECT.



- Launch Shaft for EPB TBM | Depth: 45m
- Excavation: up to 2.6m / shift
- First VSM operation in the USA
- VSM chosen due to more safety, less time and less noise than conventional shaft sinking.

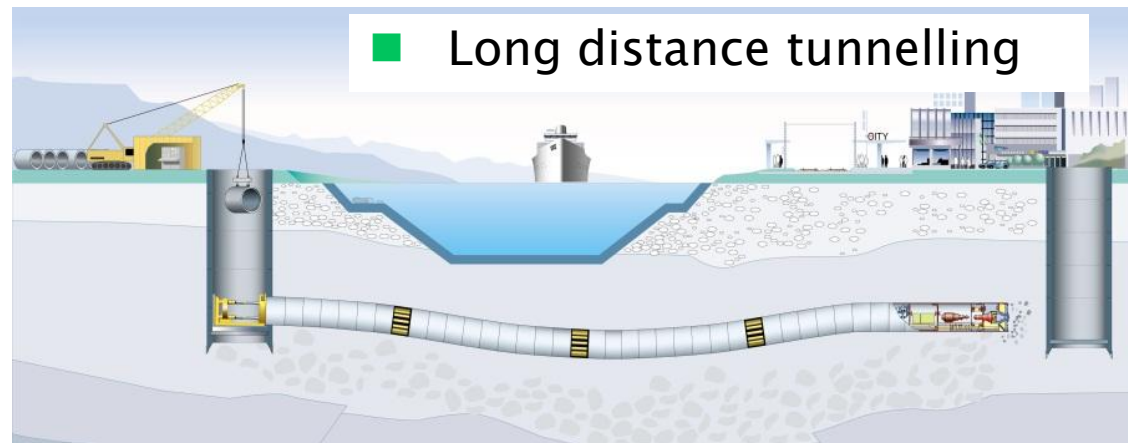


FUTURE VSM APPLICATIONS: HERRENKNECHT U-PARK.

AUTOMATIC UNDERGROUND PARKING SHAFTS.

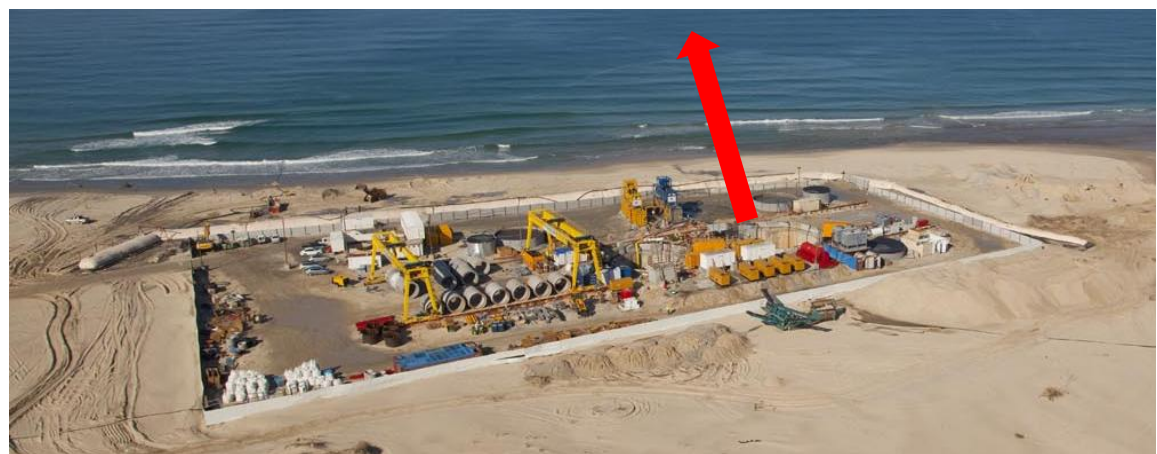
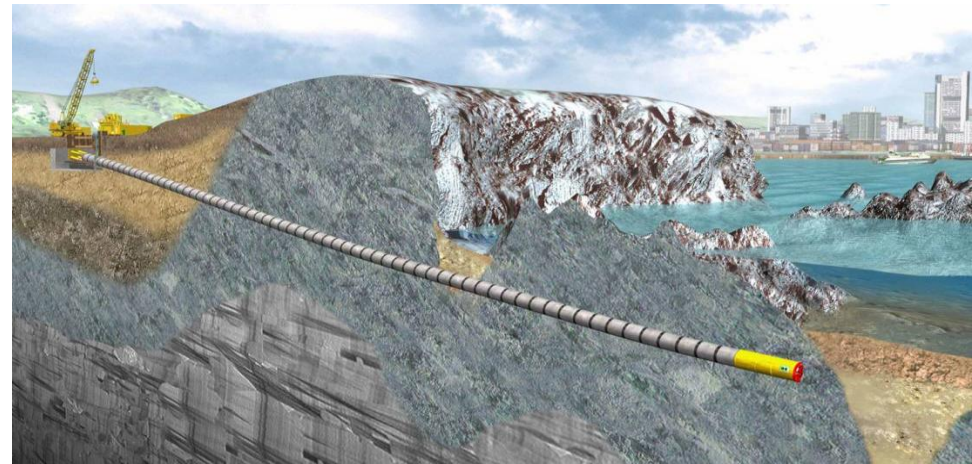


SPECIAL APPLICATIONS IN THE BUSINESS UNIT UTILITY TUNNELLING.



SPECIAL APPLICATIONS UTILITY TUNNELLING.

SEA OUTFALLS AND INTAKES.



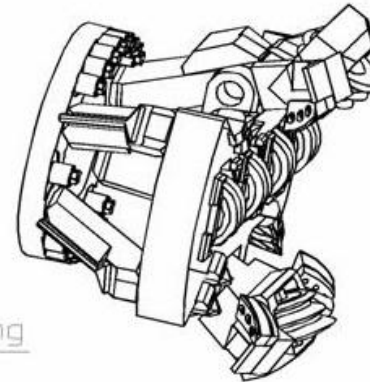
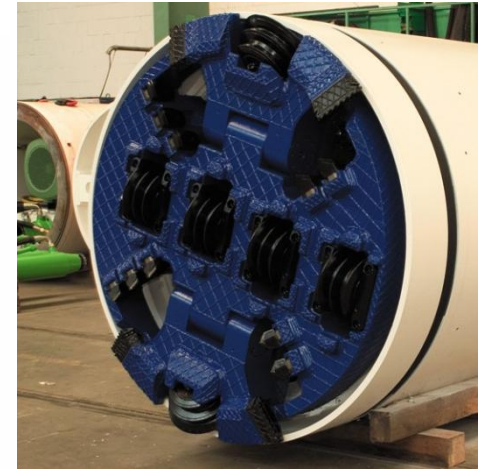
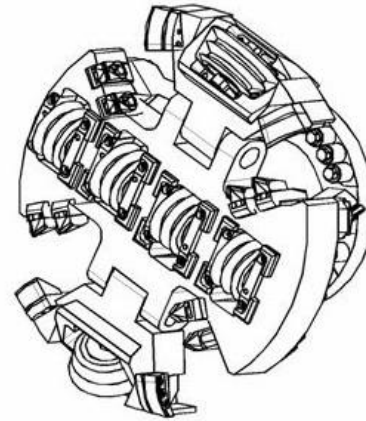
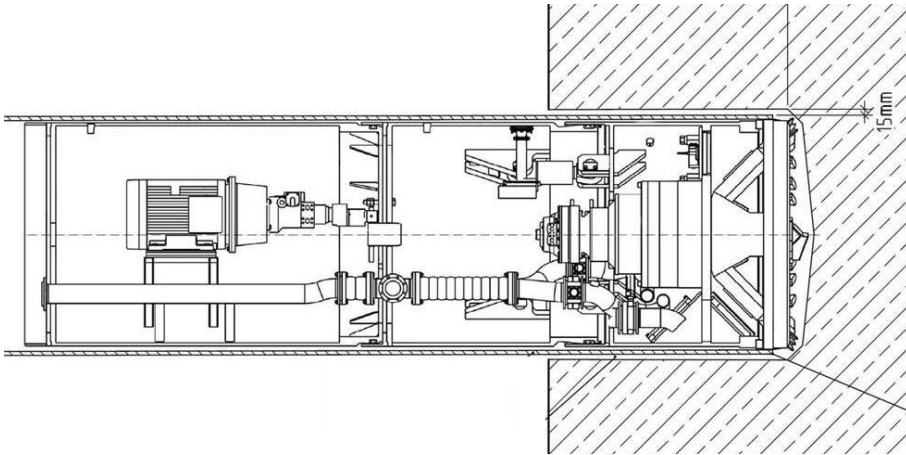
THE SEA OUTFALL CONCEPT.

THE ADVANTAGES.

- Minimized impact on environment
- Sea water quality remains untouched
- Vibrations by construction are reduced
- Construction independent from weather and sea water level
- Tunnel is protected against erosion, settlement
- No impact on existing infrastructure
- Independent from coast line's topography

SPECIAL APPLICATIONS UTILITY TUNNELLING.

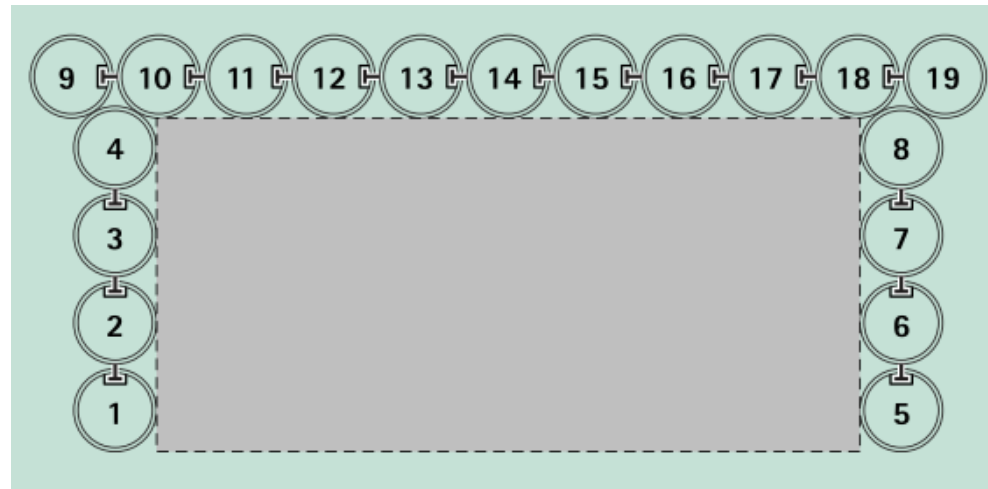
BLIND HOLE RECOVERY. RETRACTABLE MACHINES.



Machines with foldable cutterhead

SPECIAL APPLICATIONS UTILITY TUNNELLING.

PIPE ARCH TECHNOLOGY MADE BY AVN.



THANK YOU VERY MUCH FOR YOUR ATTENTION.

