



LATEST ON DIRECT PIPE® AND E-POWER PIPE®

Case studies and outlook





AGENDA

- I. Introduction - History
- II. E-Power Pipe® - Technology
- III. E-Power Pipe® – References
- IV. Direct Pipe® – Technology
- V. Direct Pipe® – References
- VI. Conclusion / Outlook



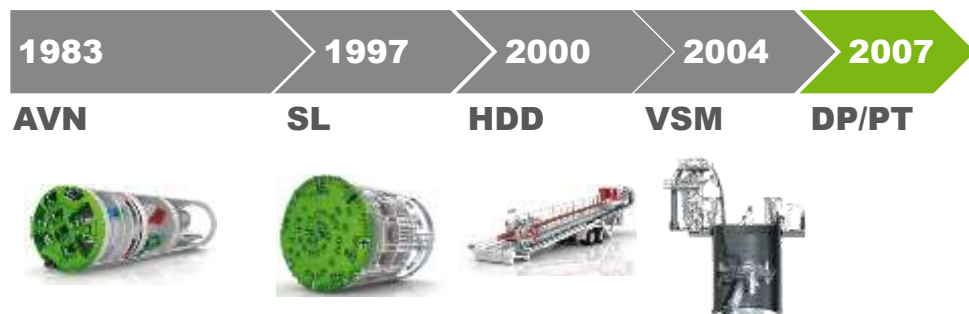
HISTORY

Milestones of the Product Development

2007

Start of Direct Pipe® and Pipe Thruster Technology

- › Alternative to HDD in critical soil conditions.
- › MT application for the pipeline market.



HISTORY

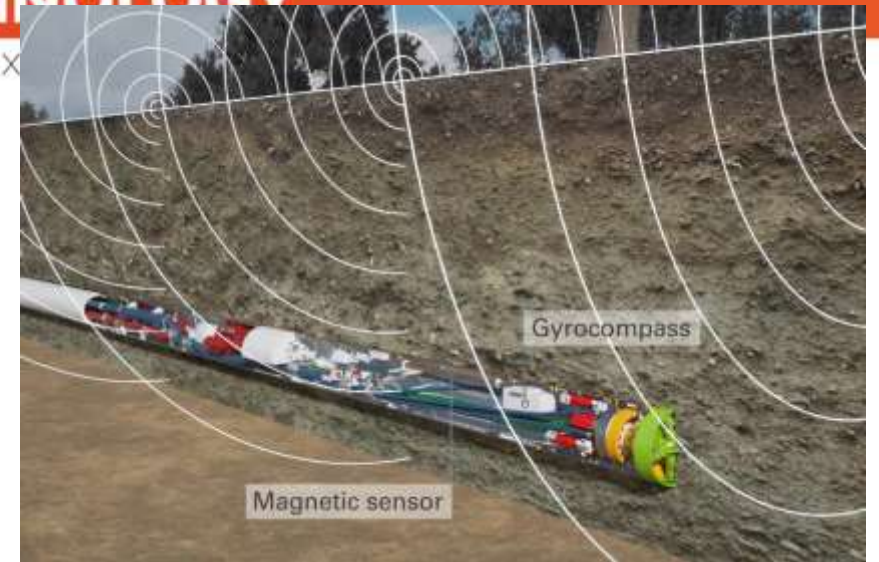
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Milestones of the Product Development

2017

Start of the E-Power Pipe® Technology

- › Trenchless method for shallow cable installation method.
- › Pilot Project Borken, Germany, AVNS 350 XB, l = 300m





PIPELINE INSTALLATION

Construction methods and their application range

	Semi-trenchless	Trenchless					
	Pipe Express®	Auger Boring	HDD	Direct Pipe®	E-Power Pipe®	Casing / tunnel	
						Pipe Jacking	Segment Lining
Installation	One-step	One-step/ Multi-step	Multi-step	One-step	Multi-step	One-pass/ two-pass	One-pass/ two-pass
Material pipe, liner	Steel	All (stiff)	Steel/HDPE/ PVC...	Steel	Steel/HDPE/ PVC...	All (stiff)	Reinforced concrete
Diameter (ID/OD)	OD 30" – 60"	OD 4" - 56"	OD 10" – 60"	OD 24" – 60"	OD 10" – 28"	250-4000mm Tunnel ID	>2300mm Tunnel ID
Max. installation length	~2,000 m	~100 m	~5,000 m	~2,000 m	~1,000 m	~2,500 m	~10,000 m
Min. installation depth	1 m	1.5 x Ø Pipe (OD)	10-15 x Ø Pipe (OD)	3 x Ø Pipe (OD)	1.5 m	2-3 x Ø Tunnel (OD)	2-3 x Ø Tunnel (OD)
Geology	All rock < 15 MPa	All rock < 30 Mpa	cohesive soil	All rock <150 MPa	All rock <30 MPa (temp. 150 MPa)	All rock <400 MPA	All rock <400MPa

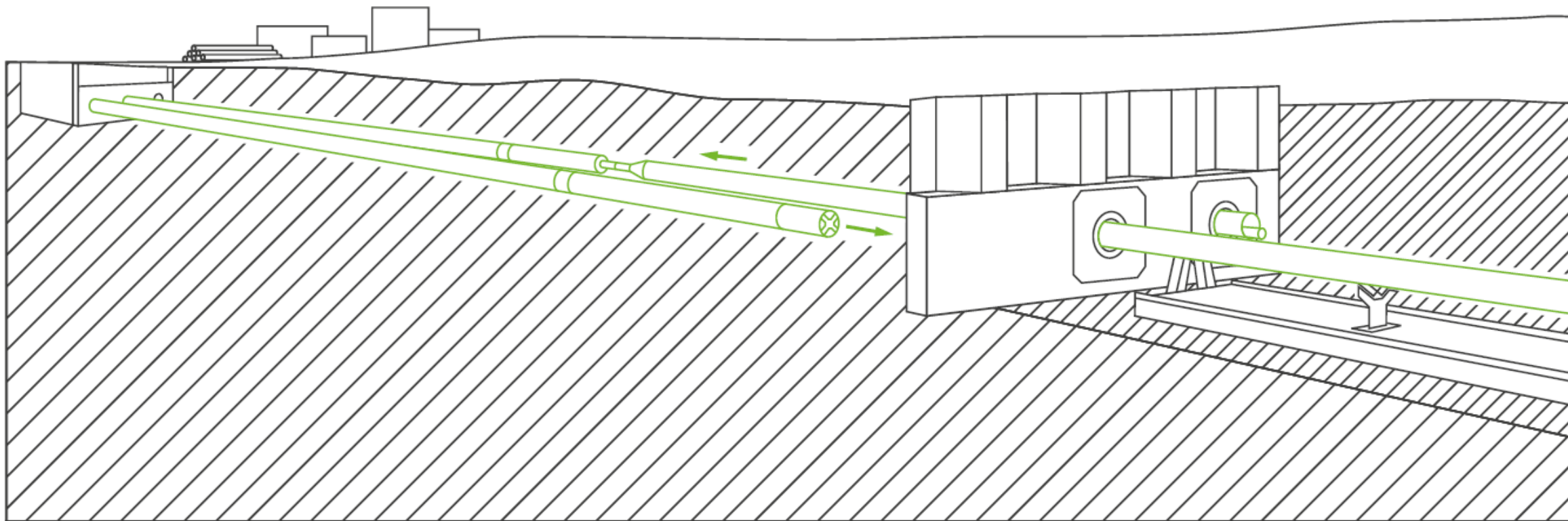
The information in this table is intended as an initial guideline; the parameters may vary depending on the project.



E-POWER PIPE® TECHNOLOGY

Technology and process overview

EPOWER PIPE



Two-step installation, e.g. cable casing pipe (HDPE)



E-POWER PIPE® TECHNOLOGY

Technology and process overview using AVNS 350 XB

EPOWER PIPE



Animation



E-POWER PIPE® TECHNOLOGY

Two-step installation of pipes and pipelines

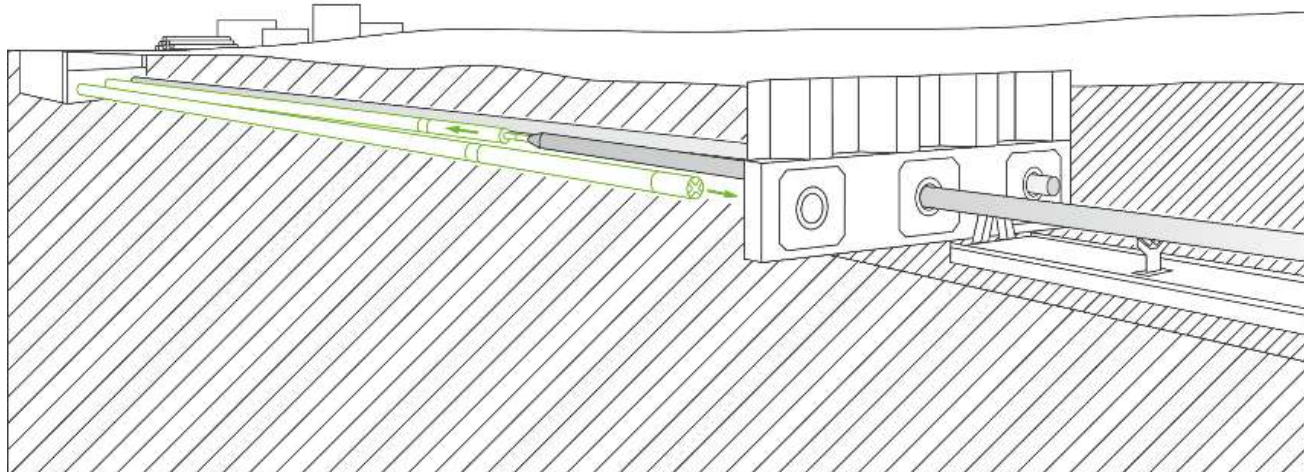
EPOWER PIPE



- › AVNS MTBM with slurry jet pump
- › diameters $\geq 28"$
- › long drives $> 1,000$ m
- › little overburden (min. 1.5 m)
- › constant distance between lines < 1 m
- › special jacking pipes for installation
- › Grouting of annulus during pullback of product pipe

Installation steps

1. **Pilot bore** with temporary jacking pipes
2. **Pullin of product pipe** or casing

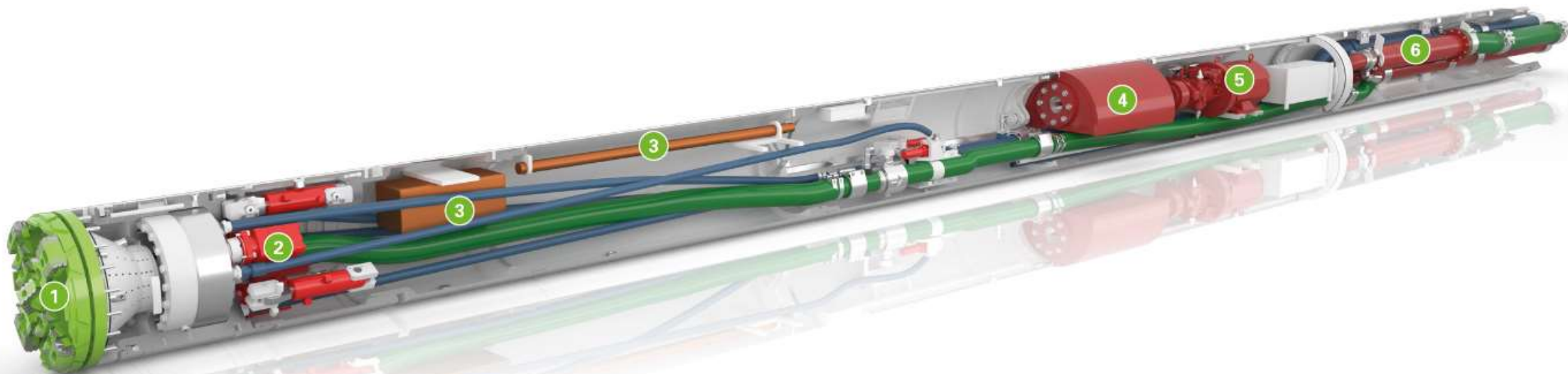




E-POWER PIPE® TECHNOLOGY

Core Component: AVNS slurry microtunnelling machine with jet pump

EPOWER PIPE



- | | |
|---------------------|------------------|
| 1 Cutterhead | 4 Hydraulic tank |
| 2 Peripheral drive | 5 Hydraulic pump |
| 3 Navigation system | 6 Jet pump |



JET PUMP TECHNOLOGY IN AVNS

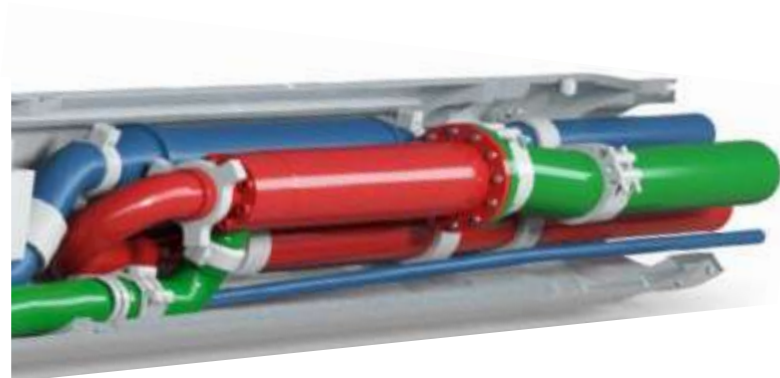
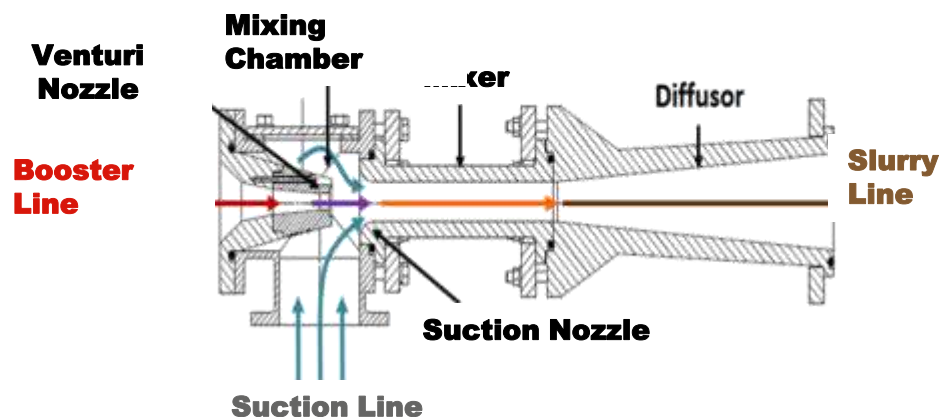
For slurry MTBMs smaller than 30" - capable of distances > 1,000m.





JET PUMP TECHNOLOGY IN AVNS

For slurry MTBMs smaller than 30" - capable of distances > 1,000m.



Booster Line – High Pressure

Booster Line – High Flow Speed

Suction Side – Low Pressure

Mixing of Boost Flow & Suction Stream

Build-Up of Slurry Pressure

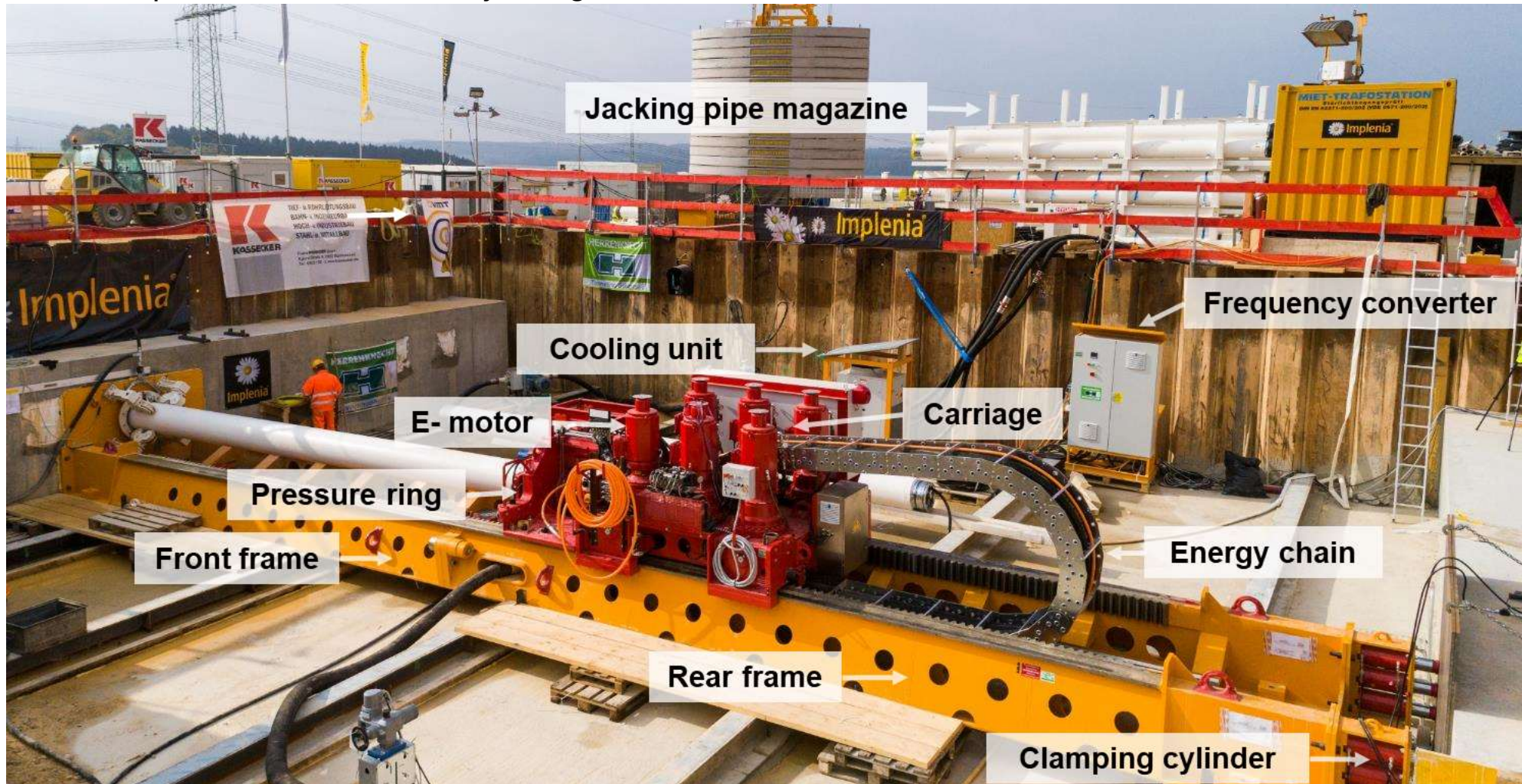




E-POWER PIPE® TECHNOLOGY

Core Component: Rack & Pinion jacking frame

EPOWER PIPE



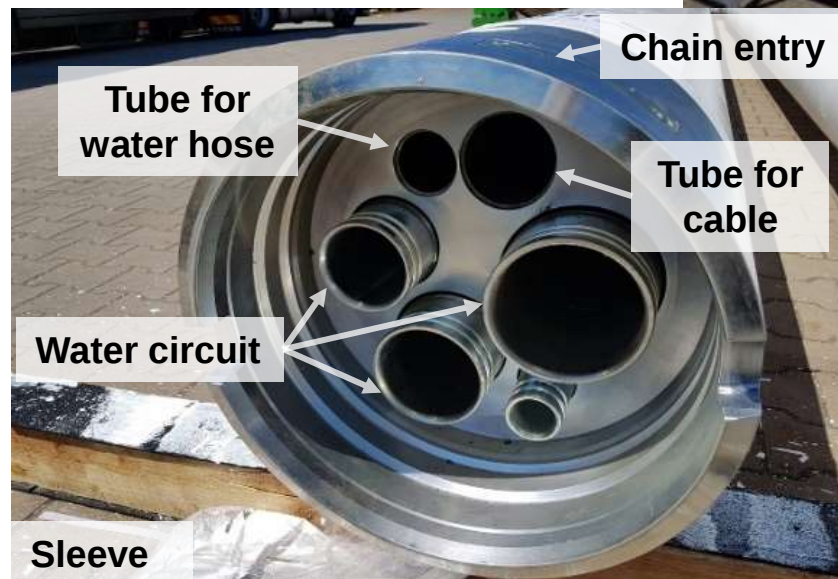


E-POWER PIPE® TECHNOLOGY

Core Component: Steel jacking pipes & coupling system

- › Tight sleeve connection system (ZSM)
- › 350 t of transferable pull and pushing force
- › Dimensions: 9 m long; 457 mm outer diameter
- › 2.5 t weight per jacking pipe

E-POWER PIPE



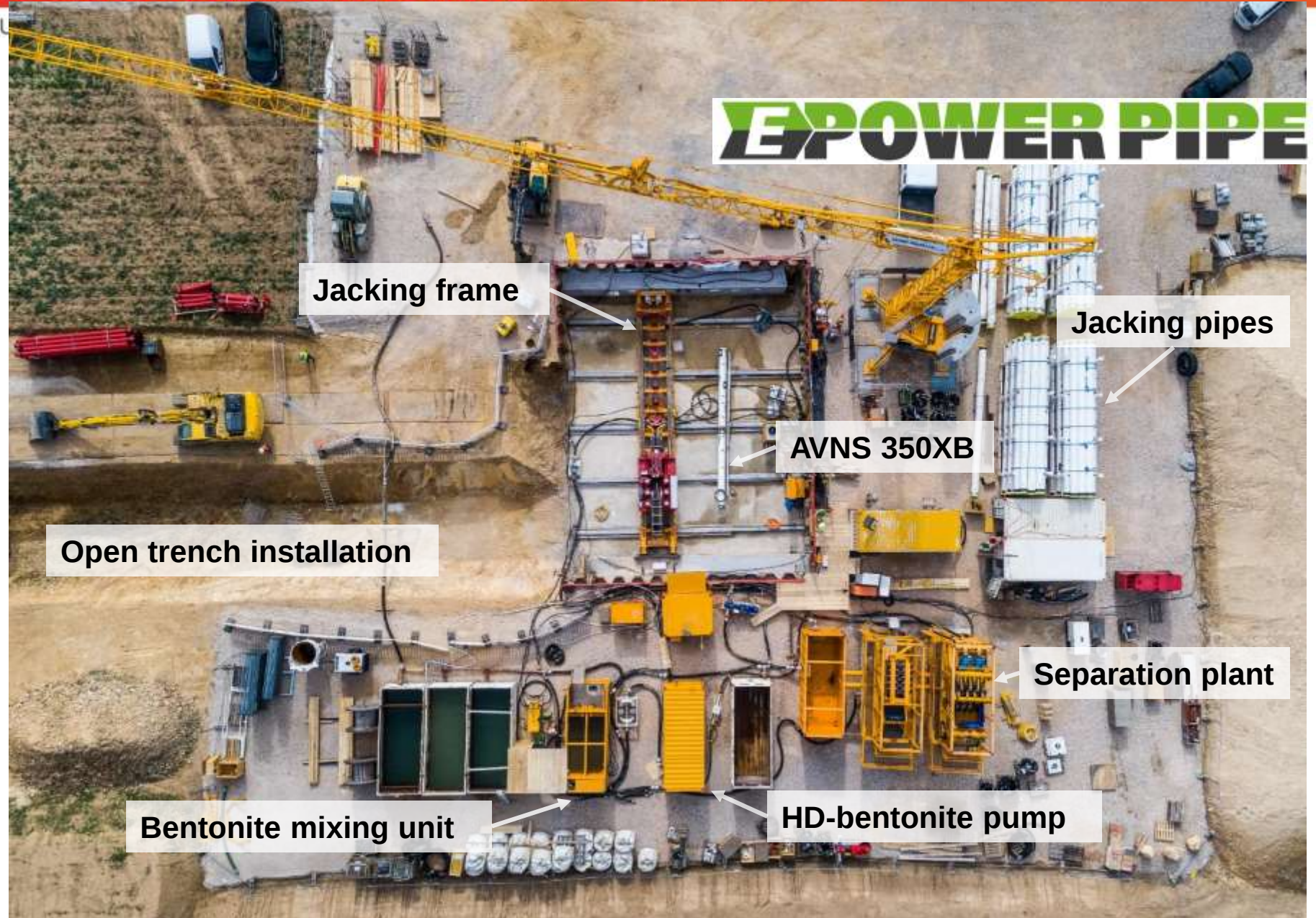


UNDERGROUND CONSTRUCTION TECHNOLOGY

THE UNDERGROUND U

E-POWER PIPE® TECHNOLOGY

Jobsite installation





E-POWER PIPE® TECHNOLOGY

Project references in Germany: protective pipes for underground cables

EPOWER PIPE

1 Borken, TSO Amprion

- ▶ Sections 3 x 300 m, constant depth
- ▶ Geology: silt, sand, clay
- ▶ Feb-Mar 2017

2 Conneforde, TSO Tennet

- ▶ Sections 6 x 300 m, S-curves $r=500\text{m}$
- ▶ Geology: silt, sand, clay, till, boulders
- ▶ Nov 2017 – Jan 2018

3 Bacharach, TSO Amprion

- ▶ Sections 6 x ~ 700 m, curves $r=500\text{m}$
- ▶ Geology: silt, sand, sticky clay, schist, quartzite boulders, iron ore
- ▶ Nov 2018 – Mar 2019

4 Grossgartach, TSO TransnetBW

- ▶ Sections 3 x 455 m, curves $r_v=500\text{m}$, $r_H=788\text{m}$
- ▶ Geology: clay
- ▶ Feb-Mar 2021



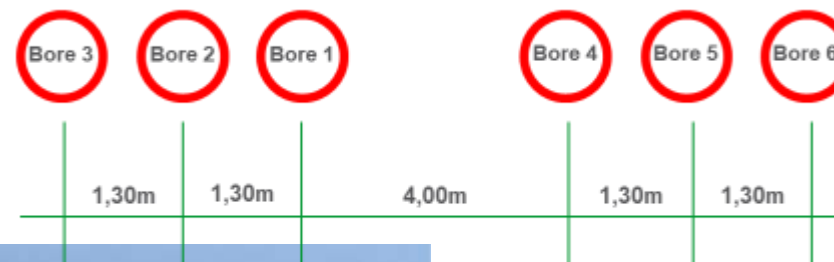


E-POWER PIPE® TECHNOLOGY

Project no. 3 in Bacharach, Germany

- › Sections 6 x ~ 700 m, curves $r=500\text{m}$
- › Average overburden: 2 m

E-POWER PIPE





E-POWER PIPE® TECHNOLOGY

Latest cable project in the Netherlands

- › Location: Eindhoven, NL
- › High-voltage cable line (150 kV)
- › Installation length:
 - › 2 x 400m (done)
 - › 2 x 2,000m (to start January 2022)
- › Cutting diameter: 505mm
- › Geology: sand, silt, clay, peat
- › Contractor: Denys
- › Client: Tennet NL

EPOWER PIPE

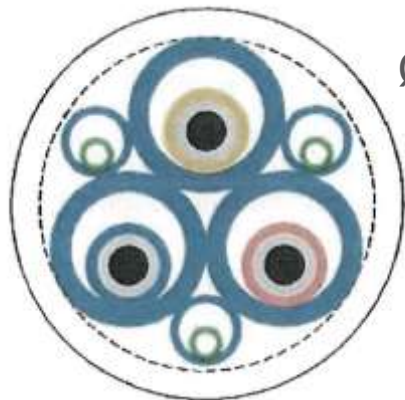
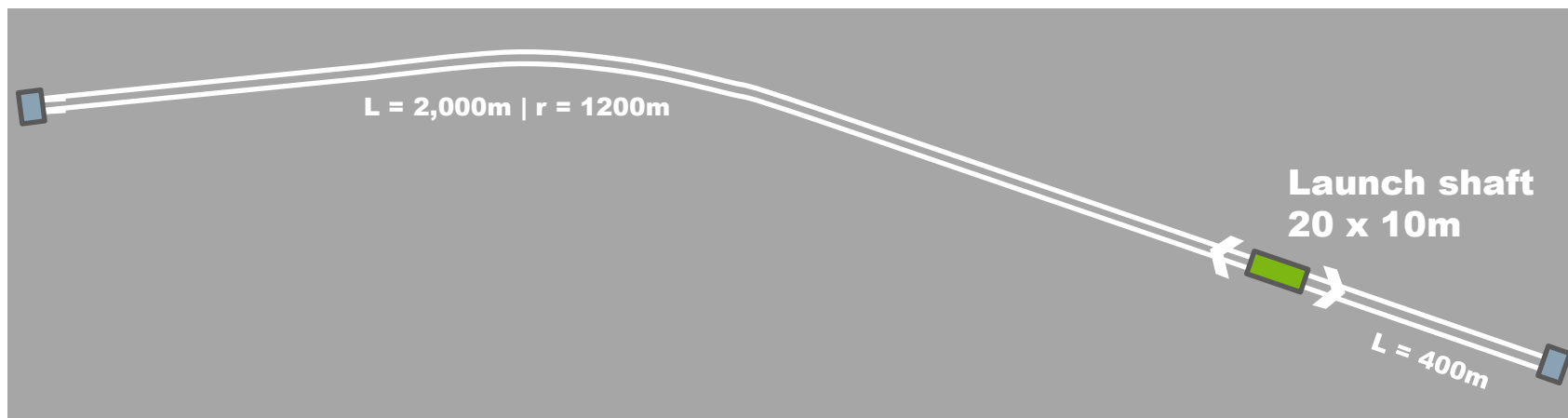




E-POWER PIPE® TECHNOLOGY

Latest cable project in the Netherlands

EPOWER PIPE



Ø protective pipe / **Bundle**
OD 431 mm



UNDERGROUND CONSTRUCTION TECHNOLOGY

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DIRECT PIPE® TECHNOLOGY





DIRECT PIPE® TECHNOLOGY

Benefits of the one-step pipeline installation method



- ▶ one pass installation
- ▶ min. frac out risk
- ▶ borehole supported
- ▶ highly accurate
- ▶ less soil excavation
- ▶ shorter crossing distance



DIRECT PIPE® TECHNOLOGY

High flexibility

- ▶ Step 1: Pipeline installation



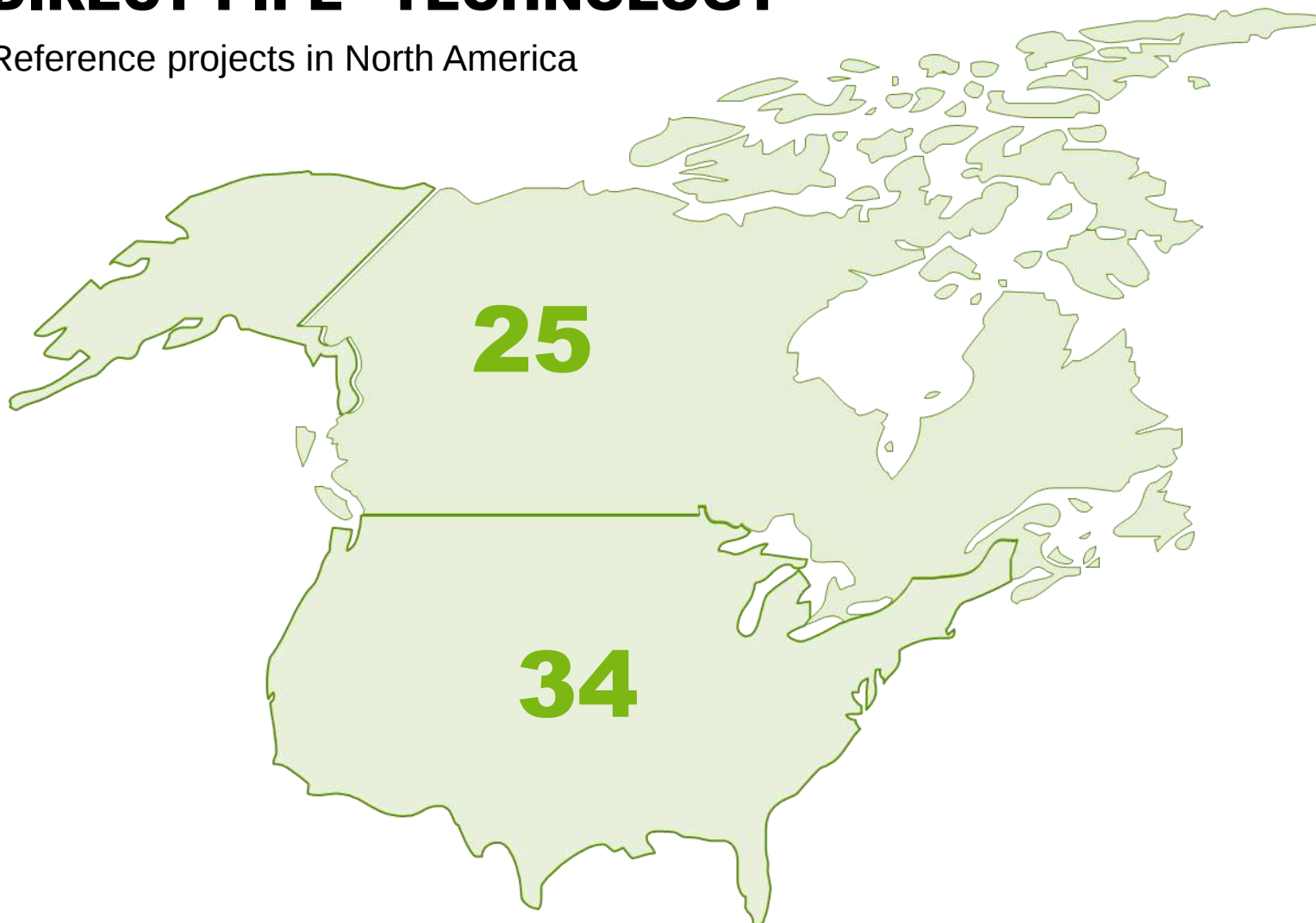
- ▶ Step 2: Pipeline Retraction for e.g. tool change – Borehole is stabilized with Bentonite





DIRECT PIPE® TECHNOLOGY

Reference projects in North America



1 Highway 70 Crossing,
Florida, 30", 705ft gas pipeline
(2010)



26 Sur de Texas Tuxpan
Pipeline, Texas, 42", 4,900ft gas
pipeline landfall (2017)



DIRECT PIPE® TECHNOLOGY

Longest reference project: World Record in New Zealand

- › M-2170M, AVN1000 + Pipe Thruster HK750PT
- › Location: Algies Bay, New Zealand
- › Use of Pipeline: 48" Casing Snells Algies Wastewater Pipe and Outfall Replacement, Shore approach with offshore recovery
- › Drilling length: 2,021m
- › Geology: mudstone, sandstone,
- › Client: Watercare, Auckland
- › Contractor: McConnell Dowell
- › Performance:
 - › Best daily performance: 42.5m
 - › Best weekly performance: 211m
 - › End position reached: July 28th, 2020

**WORLD
RECORD
2,021 M**





DIRECT PIPE® TECHNOLOGY

Smallest reference project: 28" Direct Pipe with AVNS 600, with jet pump system

- › M-2596M, AVNS600 + H-144, HK500PT
- › Project: GIPL-Gas Interconnector Poland-Lithuania
- › 2 river crossings executed:
 - › # 1 River Czarna Hancza: 320 m
 - › # 2 River Narew: 884 m
- › Geology: sand, gravel, boulders
- › Client: Gaz-System
- › Contractor: GGT Solutions





DIRECT PIPE® TECHNOLOGY

Smallest reference project: 28" Direct Pipe with AVNS 600, with jet pump system

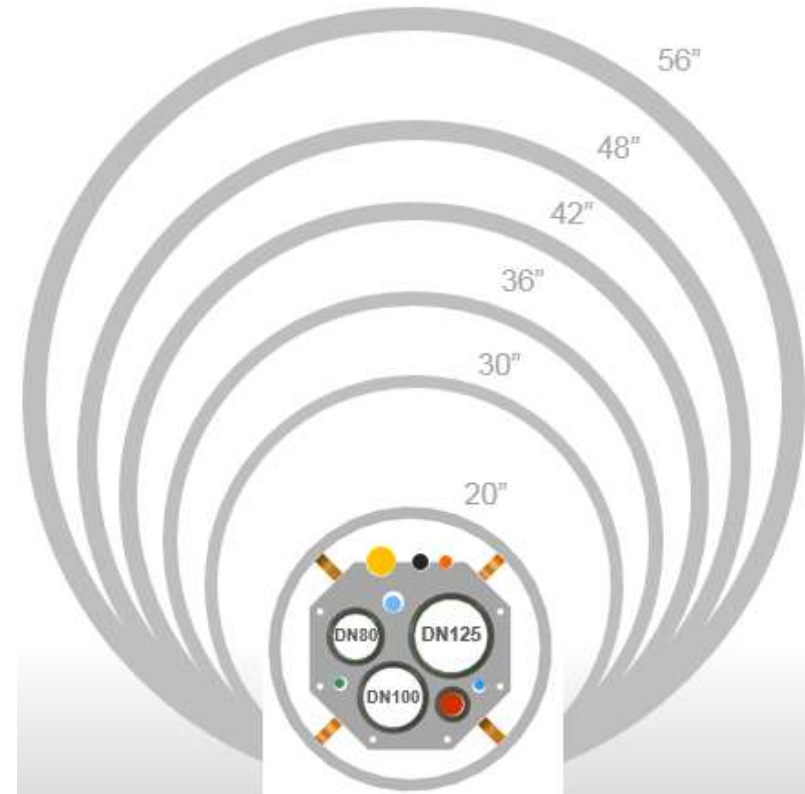


VIDEO



OUTLOOK & TRENDS

- › Longer drives
- › More complex geologies
- › New tooling approaches
- › Faster installations - modular systems
- › Hybrid guidance systems
- › Operator assist systems
- › Low CO2 footprint



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