AKKERMAN®

PRACTICAL APPROACH TO

CONVENTIONAL PIPE JACKING

An equipment and methodology guide for one of the most popular trenchless installations in North America.

Provided By:
Akkerman Inc.
Brownsdale, MN

Rev 260507

Thank you

Thank you for your interest in Akkerman equipment. If you are interested in further information, please do not hesitate to reach out to one of our sales managers. We would be more than happy to assist you.

Kind regards,

The Akkerman Team

Committed to **Excellence** since 1973

AKKERMAN®

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About **Akkerman**

Who We Are

For over five decades, Akkerman Inc. has been at the forefront of trenchless technology, delivering reliable, high-performance equipment designed to tackle the most demanding underground construction challenges.

As a leading North American manufacturer in our industry, we have built a reputation for excellence, pioneering cutting-edge solutions that support infrastructure projects across the globe.

Driven by innovation and customer-centric values, Akkerman has continuously evolved to meet the increasing complexities of trenchless construction. Our portfolio encompasses advanced manned pipe jacking, microtunneling, guided boring, earth pressure balance, and sliplining systems, each engineered for versatility across diverse soil conditions. In addition to our standard equipment line, we offer custom manufacturing to accommodate specialized project requirements, including systems up to 14ft (4.26 meters) in diameter.

Justin Akkerman, P.E.
President

Justin earned a bachelor's degree in civil engineering from the University of Minnesota and later obtained his Professional Engineer licensure in the State of Minnesota. As a third generation Akkerman, he has been immersed in the family business all of his life.

Jason Holden
V.P. - Chief Revenue Officer

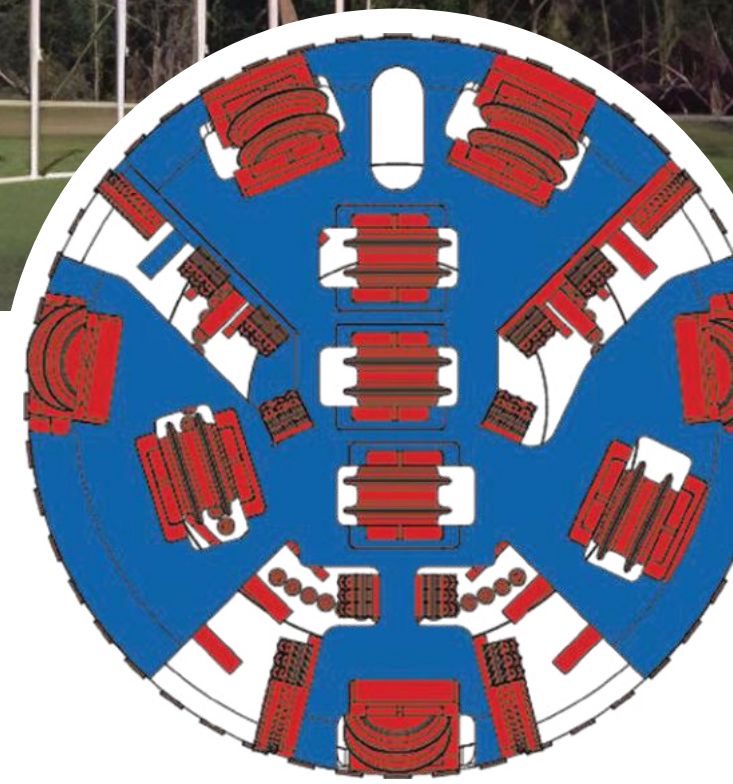
Jason earned a bachelor's degree in mechanical engineering from Minnesota State University along with an extensive technical history in mobile hydraulics. Since 2004, Jason has advanced multiple departments throughout Akkerman with his diverse skill set. He has received the coveted NUCA Associate of the Year Award along with other industry accolades throughout his tenure with Akkerman.

Jay Zimmerman
V.P. - Chief Financial Officer

Jay plays an integral role in the company's stability with his financial strategy, planning, and related analysis. He joined Akkerman in 1998 after serving 11-years with a Fortune 500 company. Jay is a graduate of University of Wisconsin - Green Bay and holds CMA & CPA certificates. He is proud to be one of only a small number of Green Bay Packer fans working within the ranks of Akkerman.

Brad Wheeler, P.E.
Director of Engineering

Brad earned a bachelor's degree in mechanical engineering from North Dakota State University, a master's degree in business, and later obtained his Professional Engineer licensure in the State of Minnesota. His engineering design and business acumen has been proven throughout Akkerman product lines.



Made in America

Akkerman takes pride on our ability to manufacture high-quality trenchless products using American made materials with dedicated employees.

At the heart of our success is an unwavering commitment to partnership. Our clients rely on us for expert collaboration, precision-engineered products, and comprehensive support throughout the project lifecycle. Backed by a team of skilled engineers, seasoned field technicians, and a responsive aftermarket service department, we ensure seamless integration, on-site training, and rapid parts availability to minimize downtime.

Akkerman's legacy is built on reliability, adaptability, and technical excellence. With every project, we reaffirm our dedication to empowering our partners with industry-leading solutions that drive efficiency and long-term success.

CERTIFIED BY SCB ISO 9001™

MINNESOTA MADE IN USA

Core Values

- **Teamwork**
- **Integrity**
- **Quality**
- **Innovation**
- **Safety**

MANAGEMENT TEAM

PRESIDENT

Justin Akkerman, P.E.

(507) 539-0028 (direct) | jakkerman@akkerman.com

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V.P. - CHIEF REVENUE OFFICER

Jason Holden

(507) 539-0022(direct) | jholden@akkerman.com

Jason earned a bachelor's degree in mechanical engineering from Minnesota State University along with an extensive technical history in mobile hydraulics. Since 2004, Jason has advanced multiple departments throughout Akkerman with his diverse skill set. He has received the coveted NUCA Associate of the Year Award along with other industry accolades throughout his tenure with Akkerman.

V.P. - CHIEF FINANCIAL OFFICER

Jay Zimmerman

(507) 539-0024 (direct) | jzimmerman@akkerman.com

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DIRECTOR OF ENGINEERING

Brad Wheeler, P.E.

(507) 539-0012 (direct) | bwheeler@akkerman.com

Brad earned a bachelor's degree in mechanical engineering from North Dakota State University, a master's degree in business, and later obtained his Professional Engineer licensure in the State of Minnesota. His engineering design and business acumen has been proven throughout Akkerman product lines.

SALES TEAM

SALES MANAGER
- FLORIDA

Troy Stokes

(507) 539-0055 (direct) | tstokes@akkerman.com

Troy's experience in the underground industry has spanned nearly four-decades and involved all trenchless technologies. He is a contributing author for several trenchless resource publications including the ASCE 36-15: Standard Design and Construction Guidelines for Microtunneling. **Territories: Southern & Southeastern US, Mexico, South America, Australia, New Zealand.**

SALES MANAGER
- MINNESOTA

Robin Lorenzen

(507) 539-0046 (direct) | rlorenzen@akkerman.com

Robin's decades of trenchless experience makes him an integral resource in the conceptualization and design of many Akkerman products. Since 1989, he has been helping contractors install thousands of feet of pipeline all over North America and Europe. **Territories: Midwestern US & Central Canada.**

SALES MANAGER
-WASHINGTON STATE

Chris Sivesind

(507) 539-0016 (direct) | csivesind@akkerman.com

Chris began his career at a young age while working at his father's pipejacking and auger boring business. After receiving a bachelor's degree in Business Administration from Washington State University, he continued in the trenchless industry as a specialty shoring installation consultant, and in sales for another trenchless manufacturer. Sivesind is an active participant in many industry associations. **Territories: West Coast, Western Canada, Europe, & Asia Pacific.**

SALES MANAGER
- WISCONSIN

Jon Valin

(507) 539-0047 (direct) | jvalin@akkerman.com

Jon has served the heavy civil, construction, and repair industry for over 20-years and has developed the attention to detail required in the trenchless industry. His knowledge and expertise allow him to understand the challenges of contractors, while his position at Akkerman allows him to provide solutions they require. **Territories: Great Lakes Region, East & Northeastern US, Eastern Canada, Middle East, and India.**

TECHNICAL SUPPORT

Daryl Anderson

AFTERMARKET PARTS MANAGER

(507) 539-0017 (direct)
(507) 993-3649 (mobile)
danderson@akkerman.com

Paul Krebsbach

AFTERMARKET SUPPORT SPECIALIST

(507) 539-0043 (direct)
pkrebsbach@akkerman.com

Cameron Landherr

TECH. SUPPORT & SERVICE MANAGER

(507) 539-0013 (direct)
(507) 440-7044 (mobile)
clandherr@akkerman.com

LOCATION

CORPORATE

58256 266th Street Brownsdale, MN 55918

(800) 533-0386
akk@akkerman.com
www.akkerman.com

Introduction to Pipe Jacking

Pipe Jacking (PJ) is a trenchless construction technique by which jacking pipe is thrust through the ground from a launch shaft to a reception shaft with advancement provided by a hydraulic jacking frame located in the launch shaft. Several variations of pipe jacking exist today. Each variation is uniquely different and offer distinct advantages when applied on the appropriate projects.

It is important to understand the advantages, limitations, and costs associated with each pipe jacking technique before selecting a preferred trenchless method on a particular project. While the responsibility of executing the means and methods for a particular project typically fall on the contractor, owners and engineers are finding benefits to specify the intended trenchless methods in early stages of design to provide better clarity and ensure equal opportunity and fairness with respect to pricing from the prospective bidders.

Various pipe jacking methods are shown in Figure 1 below. As innovation and technology increases in the trenchless industry, new trenchless methods as well as increased capabilities of existing technology will be realized.

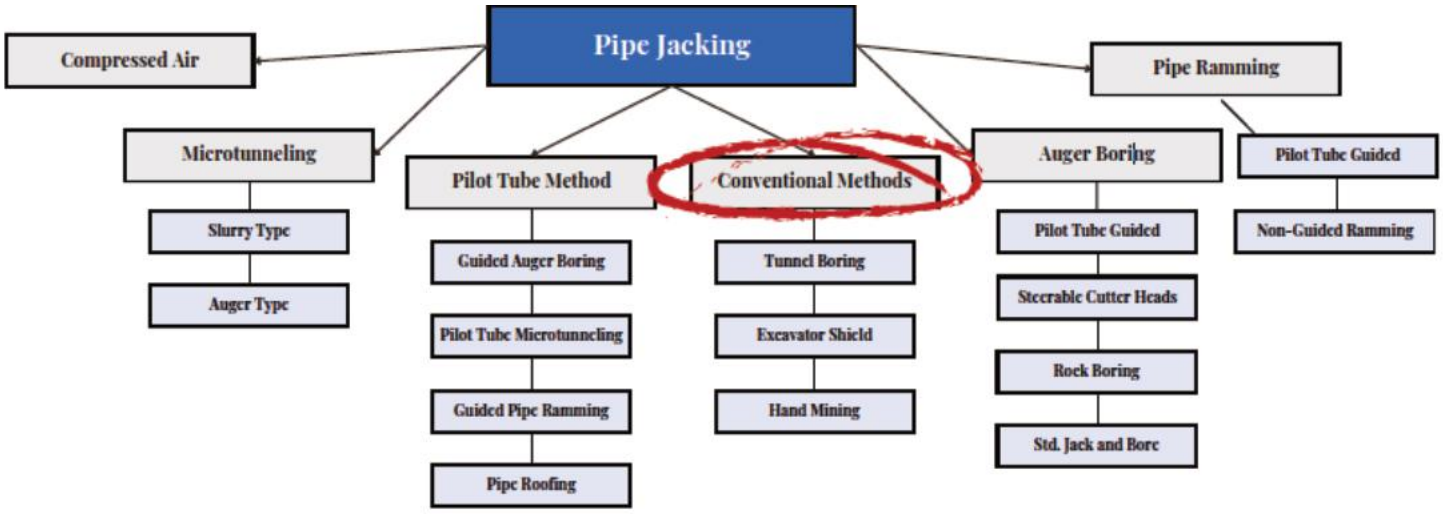


Figure 1: Typical trenchless pipe jacking methods used in North America.

The focus of this document will be to help the reader understand both the advantages and limitations of **Conventional TBM Pipe Jacking** since it is one of the most popular and cost-effective trenchless methods to accurately install trenchless utilities over 48-in (OD). As one of the earliest forms of pipe jacking, the Conventional TBM pipe jacking method has been adapted with increased capabilities to bridge the gap that traditionally existed between other more costly trenchless methods.

CONVENTIONAL PIPE JACKING

Conventional Pipe Jacking is an accurate trenchless construction method of thrusting approved jacking pipe through the ground, while advancing a steerable tunnel shield with mechanical excavation for the installation of new service lines, sewer tunnels and utilities while personnel entry is permitted. Differing from the microtunneling method, pipe jacking requires personnel entry into the tunnel to operate equipment which limits typical installations to 48-inch (OD) and larger.

Akkerman pipe jacking systems are often selected due to the capacity to meet the performance requirements specified in the contract documents while maintaining productivity and minimizing production costs. Below are the general minimum requirements often associated with Akkerman pipe jacking systems.

KEY BENEFITS:

Laser-Guided Technology

Akkerman TBMs are fully guided and include an articulated steering joint to control both vertical and horizontal deviation to a tolerance of +/- 3% of the TBM diameter or 1-in (25mm) on grade, whichever is greater, or +/- 6% of the TBM diameter or 2-in (50mm) on line, whichever is greater from designed line and grade.

Minimal Surface Disruption

Pipe jacking is a proven trenchless method, meaning it reduces traffic disruptions, environmental impact, and the need for large excavations commonly found with open-cut and cover installations.

Versatility in Soil Conditions

Akkerman pipe jacking TBMs can handle various ground conditions, including clays, sand, gravel, and rock.

Diverse Jacking Pipe Options

Akkerman pipe jacking systems allows the use of the underground industries most common jacking pipes. These include but are not limited to reinforced concrete (RCP), steel casing (SC), Polymer Concrete (PC), Fiber Reinforced (FRP), and Vitrified Clay Pipe (VCP).

Cost-Effective

Trenchless projects reduce restoration costs, minimize delays, and improve project longevity over traditional open-cut methods.

Proven Industry Reputation

Akkerman has been a trusted name in trenchless technology for over 50 years, with a track record of successful projects worldwide. The equipment is manufactured in the U.S. and supported by extensive customer support and training programs.

Akkerman pipe jacking system. Circa 1960's

INTERESTING PIPE JACKING FACTS:

- The first pipe jacking project was in the United States of America, and has been identified as a concrete culvert installation under the Northern Pacific Railroad in 1896.
- Pipe jacking became popularized for the installation of gravity flow sewer installations between the 1950-1960's. The first Akkerman pipe jacking system was built in 1963 to install 36-in RCP under a road in Minnesota, USA.
- Many internet broadband cables are networked within sewer systems installed by pipe jacking to avoid unnecessary digging and disruption.

Trenchless Method - Conventional Pipe Jacking

Pipe jacking is done from a launch shaft to a reception shaft with advancement provided by a jacking frame located in the launch shaft. The Operator controls the excavation at the face as the TBM is advanced by thrust forces transmitted from the jacking unit through the product pipe. Excavated material is transferred into specially designed haul unit that carries the soil back to the launch shaft for removal at the surface. At the end of each prefabricated pipe segment, a new section of pipe is lowered into the launch shaft which contains the necessary tunnel connections and connected for continued advancement.

Typical components of an Akkerman conventional pipe jacking system are shown in Figure 2. Additional equipment is required above ground such as a generator, ventilation system, bentonite system, crane, support equipment, etc.

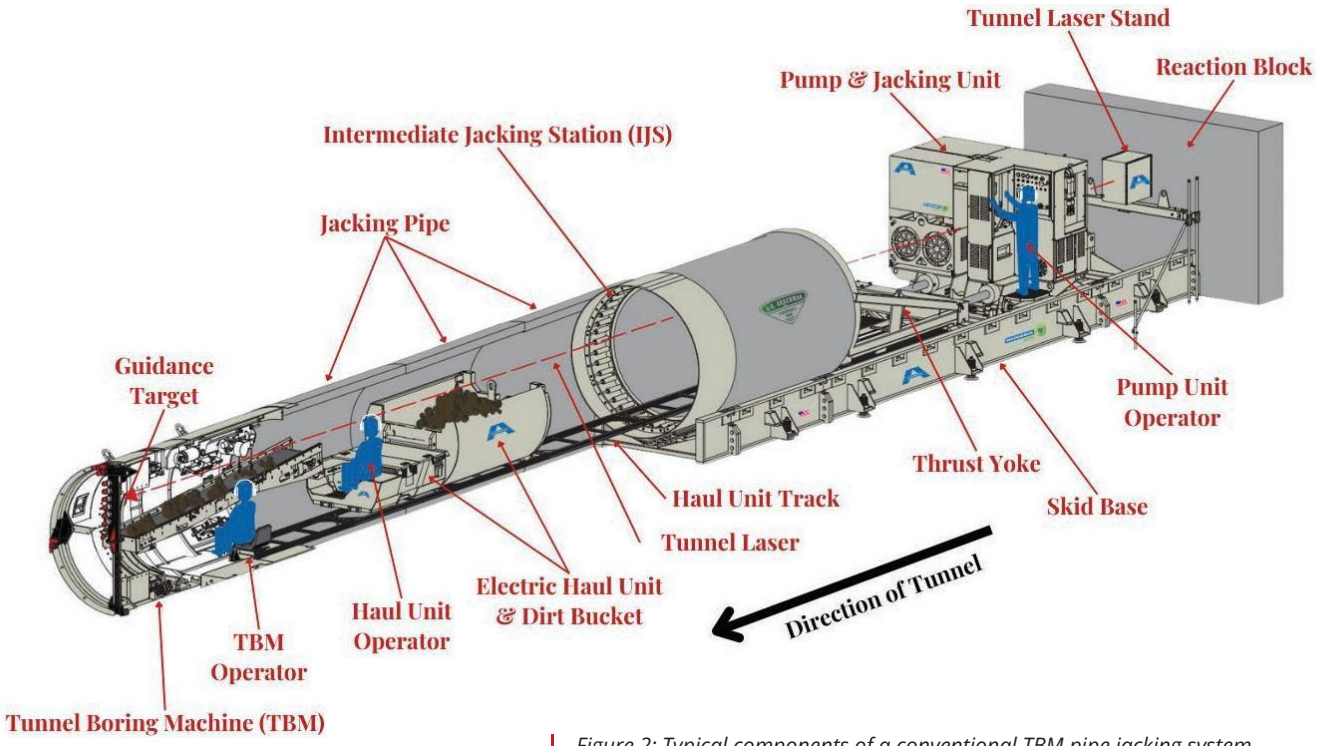


Figure 2: Typical components of a conventional TBM pipe jacking system.

Jobsite Preparation & Planning

It is important to carefully review the project site to ensure it is arranged in the most effective manner possible. During the planning stage, allowable working space on the surface to accommodate the support equipment must be considered. While some support equipment can be located in close proximity to the project site, other equipment must be operated in unison with the pipe jacking equipment and located directly adjacent to the jacking shaft.

Figure 3: Overhead view of efficient pipejacking jobsite. Photo courtesy of Capitol Tunneling Inc. - Columbus, OH

Figure 4: Example of an aerial hazard that could influence jobsite safety and efficiency.

Below is a list of equipment and site considerations that are common on pipe jacking projects:

- Crane
- Generator
- Ventilation System
- Bentonite System
- Cooling Water System
- Jobsite Lighting
- Pipe Storage
- Muck Storage
- Spare Parts
- Truck Entrance-Deliveries & Muck Removal
- Parking
- Dewatering Pumps
- Fencing & Safety Railing
- Tool Storage

ADDITIONAL CONSIDERATIONS

All shafts need access for cranes, excavators, and/or material handlers for their construction, setting equipment, loading pipe, and removing excavated material. It is critical to look up and survey for aerial safety hazards or obstructions such as overhead wires, power lines, or nearby buildings that may be inside the work zone. The location of a site should minimize social and economic impacts to the community by selecting launch and retrieval locations with the least amount of disturbance.

Shaft Construction

A variety of shaft construction types have been successfully used for conventional pipe jacking. The shaft construction method should be selected based upon variables such as the ground conditions, invert depth, tunnel diameter, thrust requirements, and final structure design. In North America, it is common for contractors to use proper sloping, trench boxes, soldier piles with wood lagging (or steel), liner plates, or interlocking sheeting. Since a TBM can be jacked into an embankment, as is often the case with a rail crossing, an adequate sub-floor and reaction block constructed at the correct elevation may be adequate.

Highly engineered launch and reception shafts often required for slurry microtunneling, such as secant piles or caissons, will typically not be required for conventional pipe jacking unless the project design is using the shaft as part of a permanent structure.

The contractor is responsible for the design and construction of the trenchless shafts in accordance with Federal OSHA Code, Construction Standards for Excavations, 29 CFR, Part 1926, Subpart P.

Figure 5: Akkerman pipe jacking system launching from driven sheet pile shaft construction.

JACKING PIT	CONSIDERATIONS
LENGTH	Determined by overall length of product pipe. Must be able to accommodate the TBM during launch. Typical working lengths are between 32.5’ - 40’.
WIDTH	Determined by pipe diameter and shaft construction method. Must provide adequate workspace for spoil removal from pipe jacking system. Working widths are typically 10' or larger.
DEPTH	Excavation must be deep enough to allow construction of adequate sub floor to support the weight of the trenchless equipment. Typically 12-in of crushed rock or 6-in of concrete in certain conditions may be required to stabilize jacking skid frame.
DEWATERING	Install pit sump pump(s). Position pump(s) in corner location(s) that allow grade to induce flow towards pump location.

Table 1: Conventional Pipe jacking (TBM) shaft considerations.

Equipment Setup - Launch Shaft

Properly setting, adjusting, and securing the equipment in the launch shaft is the primary step to achieving accurate results. This phase of the project requires extreme care to ensure that the equipment is set to the correct line and grade of the designed bore path. Prior to excavating the shaft, confirm the floor-to-invert dimension with the product pipe on the launch skid and understand the equipment's adjustability. An example of a floor-to-invert layout for 60-in RCP is shown in Figure 6 below. Akkerman skids are designed to accommodate finite elevation adjustments. The overall length of skid needs to accommodate the TBM to be launched and also provides clearance for one or multiple jacking pipes to be set during normal operation. It is common for 40-ft of skid to be used. If launch conditions allow, this configuration allows crews to install pipe more efficiently by decreasing downtime during pipe changes.

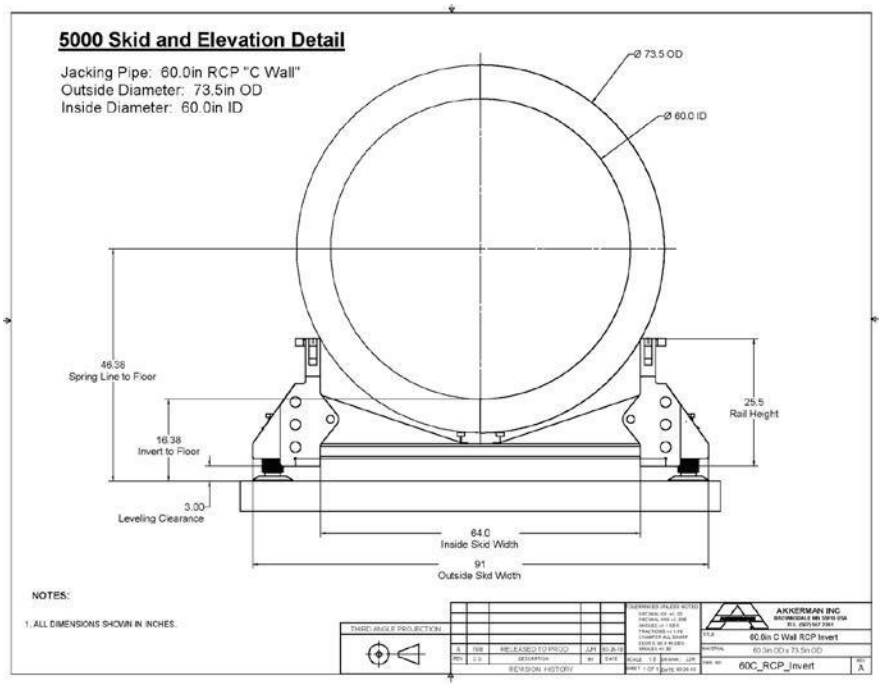


Figure 6: General Invert Layout of 60-in RCP set on 5000-series skid.

Equipment Setup and Survey Tech Tips

- Utilize accurate survey techniques to set pins for the alignment of the equipment.
- Ensure site survey and equipment setup is double checked by a competent person to minimize error.
- Resurvey shaft alignment pins as necessary to ensure thrust forces have not cause shaft misalignment.
- Properly anchor and secure equipment.
- Document your work!

Pipe Jacking Guidance

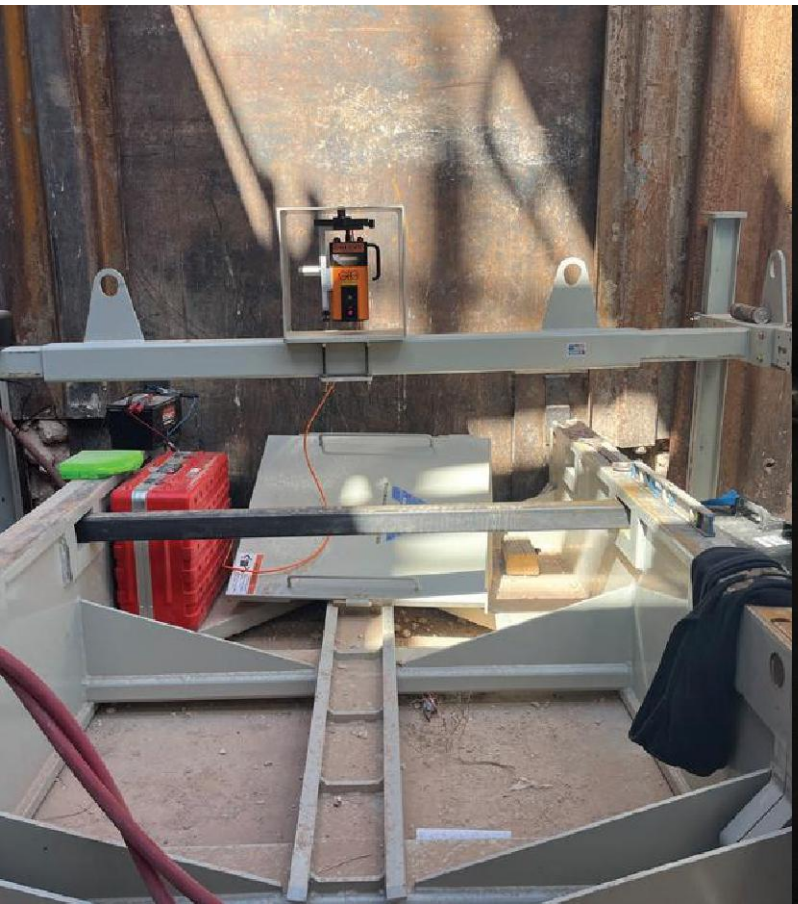
An Akkerman pipe jacking system uses a simplified laser-to-target tunnel guidance system to locate the actual position of the TBM relative to a shaft-mounted tunnel laser that is calibrated to the designed line and grade. Laser-to-target tunnel guidance systems are the most widely used type of guidance system in the industry and have the ability to produce extremely accurate results when setup and used effectively.

After the initial setup of the launch shaft, the tunnel laser is installed on an adjustable stand that minimizes the movement and vibration from nearby equipment. The laser stand is designed to be isolated from any thrust or reaction forces required to advance the pipe string to minimize deviation errors. Alignment of the guidance system is done using survey pins (marks) to run a stringline with two plumb bobs that transfer the surveyed points from the shaft wall to the shaft floor. To minimize line movement and achieve accurate results, the plumb bobs should be captured in an oil bath. Once the alignment and height of the laser has been adjusted properly to the TBM, the designed tunnel grade can be locked onto the laser.

LASER-TO-TARGET GUIDANCE LIMITATIONS

As described by Snell's Law, tunnel lasers will have effective limits based on pipe diameter, tunnel length and air quality conditions. Tunnel conditions are often highly variable, and laser beams will refract as it passes through changes in humidity, dust, or variations in ambient temperature. It is recommended to use proven tunnel lasers, such as the GeoLaser VL-80 or similar, that is designed specifically for tunnel environments. It is also highly recommended to ensure proper ventilation exists for both tunnel personnel as well as guidance system air quality.

Drives lengths exceeding 1000-LF have been successfully achieved on numerous occasions using a laser-to-target guidance system, however any project requiring drive lengths over 600-LF need to take special precautions. Additional survey checks, monitoring and documentation should be implemented. Laser refraction checks should be performed after pipe changes or shift breaks.



Geotechnical Considerations for Pipe Jacking

The selection of a trenchless method and the proper configuration of the trenchless equipment rely heavily on the anticipated ground conditions within the zone of influence along the alignment. Trenchless professionals must develop a clear understanding of the geological conditions to properly plan, design, and install underground infrastructure. Geotechnical data required for the structural design may differ from what is required for the tunnel construction. In order to properly configure the equipment prior to launch, it is important for the owner to communicate the anticipated behavior of the ground within the zone of influence along the alignment.

The **Tunnelman's Ground Classification System (TGCS)** is used to classify soil and rock conditions based on their behavior during tunneling operations. These characteristics may dictate or exclude certain trenchless methods based on ground behavior, stability, and required support.

Ground Type	Description	Stand-up Time	Typical Support Needed	Conventional Pipe Jacking Suitability
Firm Ground	Cohesive soil, soft rock, or dry sand with cohesion.	Several hours to days	Minimal to no support needed at the tunnel heading. Ground is considered stable when disturbed by cutterhead. Jacking pipes can be advanced through excavation before the ground starts to move.	**Yes** – TBM can be setup in open-mode configuration. Soft ground conditions suitable for either legacy series-I TBMs or Series-II TBMs with standard cutterhead configurations. Rock conditions will require 2017 or newer Series-II type TBMs fitted with appropriate mixed-face or rock cutterheads selected based on GBR.
Raveling Ground	Loose, dry, granular soil that slowly falls into the tunnel	Minutes to hours	Mechanical face support may be required depending on the degree of overstress in the ground. Overstress determines the rate (slow/fast) at which the ground may shift.	**Slow Raveling: Yes** – Small chunks or flakes of ground may separate when disturbed by cutterhead. Heading is predominately stable when undisturbed. Trenchless contractors should consider additional shifts to avoid periods of exposed face if operating without a close-faced attachment or mechanical support. **Fast Raveling: Marginal** – TBM will require face support based on type of raveling ground such as hooded shield, closed-face attachment, or sand shelves.
Running Ground	Dry, loose, non-cohesive soil like dry sand	Immediate collapse	Non-consolidated, granular materials without cohesion that are unstable at a slope greater than their angle of repose. (Typ. 30-35 degrees) When exposed to steep slopes, material will run like granulated sugar sand until material flattens to the angle of repose.	**Marginal –** TBM will require face support at the heading. Legacy Series-I TBMs will require sand shelves. Series-II TBMs with closed-face attachments or sand shelves. Shields will require a hood and sand shelves to maintain the angle of repose. Anticipate high thrust loading conditions. Proper tunnel lubrication is advised.
Flowing Ground	Saturated sand, silts, or clays that behave like a fluid	Immediate ground flow	Saturated sand, silts, or clays that behave like a fluid. May be pressurized from the water column.	**No –** Conventional open-face TBMs are not recommended for pressurized, flowing ground conditions. **Marginal exception –** Flowing ground conditions with < 1 bar may be possible with the installation of an EPB bulkhead and screw conveyor system on Series-II TBMs.
Squeezing Ground	Highly plastic soil, or clay that deforms under pressure	Deforms over time	Ground squeezes and extrudes into tunnel heading without visible fracturing or breaking. The ground is typically water-saturated but is not considered as running.	**Yes –** Face support is required on the TBM to control intrusion of material. Installation of close-face attachment in addition to a screw conveyor for muck removal is recommended.
Swelling Ground	Expansive clays that absorb water and increase in volume	Deformation over days	Highly consolidated clays. Swelling clays will typically have a Liquid Limit (LL) > 50% and Plasticity Index (PL) > 25%	**Yes –** Conventional pipe jacking. It is important to consult a mud engineer before injecting a standard water/bentonite lube mixture around the annulus of the pipe to prevent premature or accelerated swelling. The introduction of anti-swelling agents and clay inhibitors may be recommended.

Figure 7: Generalized Tunnelman's Ground Classification System (TGCS) and TBM Suitability.

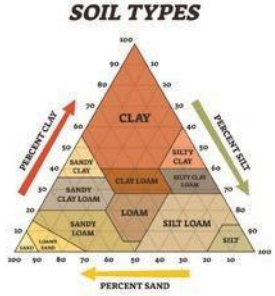


Figure 8: Soil Texture Triangle

Understanding soil behavior is an important part of underground construction. The soil texture triangle shown in Figure 8 is a useful tool to help classify and understand soil behavior, which directly affects tunnel stability, excavation method, and support requirements.

Each soil type and ratio present unique challenges with tunnel construction and may require alternative methods based on anticipated conditions.

Pipe Jacking Equipment - Model 5200 Pump Unit & Accessories

Akkerman 5200 Series Pump Units are one of the most important tools a contractor can have in their trenchless toolbox. This versatile system provides hydraulic power to the tunnel boring machine while simultaneously advancing the pipe string in one unit. With enough installed power to accommodate all major utility jacking pipe diameters, the 5200 Pump Unit will be used on all pipe jacking projects.

The 5200 Pump Unit mounts on Akkerman's robust 5000 series skid that is extendable for any pipe length and is paired with a thrust yoke to match the pipe diameter of the installation. The yoke transfers the thrust from the hydraulic cylinders inside the 5200 Pump Unit while providing a service bay to accommodate spoil removal.

BENEFITS:

- The 5200 Pump Unit is designed to work with all Akkerman pipe jacking TBM diameters.
- Powerful boring head hydraulic supply with multiple flow and pressure range settings to accommodate both new and legacy Akkerman pipe jacking TBMs.
- Simple operator controls. Easy to train, understand and retain operator functions to assist contractors dealing with workforce and labor issues.
- Advanced hydraulic filtration, hydraulic oil cooling, system monitoring, and operator feedback.
- Great for pipe jacking, hand mining, slip jacking, final pipe installations, stand-alone hydraulic power pack requirements, or with other pipe jacking methods such as guided boring or slurry microtunneling.

TECHNICAL SPECIFICATIONS:

Generator requirements:	275kW / 340kVA @ 480 Vac, 60hz, 3-PH • Minimum starting kVA: 385 skVA	**Additional Features:**	• Phase detection indicators • Skid locking proximity indicators • Low tank level alarm • Digital oil temp display • In-Tank filtration • Wheel travel function (25ft/min)
Electrical Input:	400A main power disconnect		
Installed Power:	265 hp (197kW) - Multiple TEFC motors		
TBM Boring Head Supply:	(2) – 100hp (75kW) TEFC • 0-40 GPM @ 5000psi • 0-80 GPM @ 5000psi • 0-100 GPM @ 2800psi • 0-120 GPM @ 2800psi	**Thrust Capacity:**	Extension Data • 400 tons @ 8000psi • 0-31 in/min Retraction Data • 94 tons @ 2500psi • 0-42 in/min
Jacking & IJS Supply:	(1) – 60hp (45kW) TEFC	**IJS Supply**	0-13.5 GPM @ 8000 psi (max)
Reservoir Capacity:	260 gallons	**Cooling Water Req'd:**	5-20 GPM (Variable on temp)
Weight:	18,000 lbs. with Hyd. Oil 16,300 lbs. without Hyd. Oil	**Dimensions:**	Height – 90in (2.29m) Width – 105in (2.67m) Length – 64in (1.63m)
Skid Options:	2.5 ft – Qty (1) typ. 7.5 ft – Qty (2) typ. 22.5 ft – Qty (1) typ.	**Thrust Yoke Options:**	360, 48SC, 420, 420X, 480, 480X, 540, 540X, 600, 600X, 660, 660X, 720, 720X, 780X. 840X, 960X, and Custom

Figure 9: Akkerman Model 5200 Pump Unit technical specifications.

MODEL 5200 PUMP UNIT GENERAL ARRANGEMENT

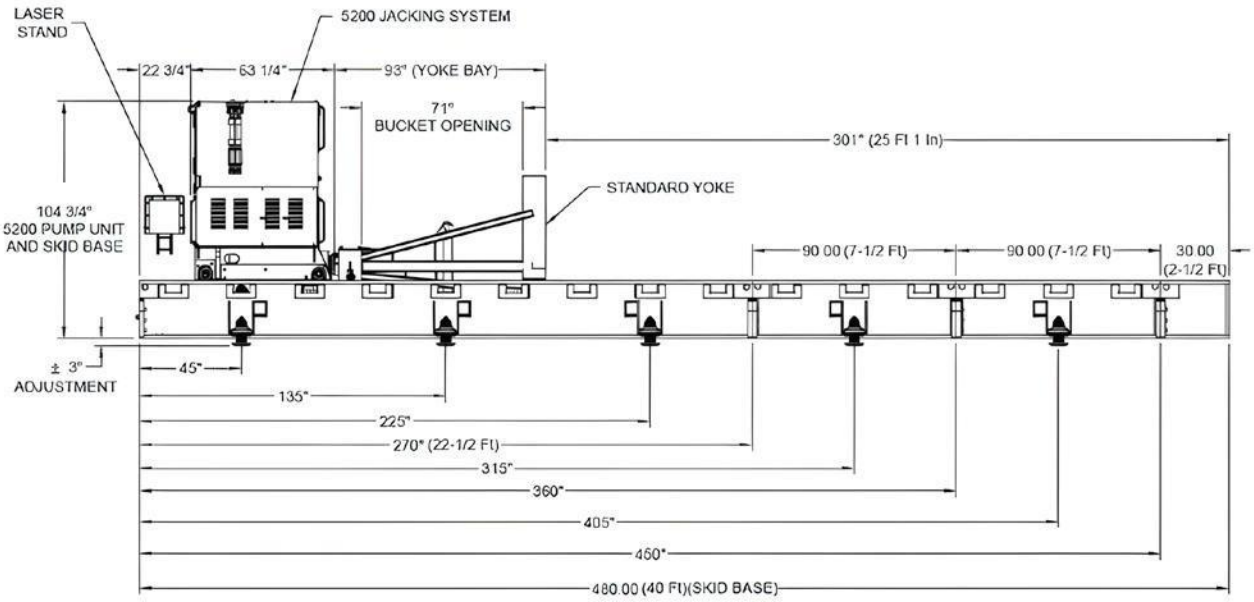


Figure 10: Akkerman Model 5200 Pump General Arrangement Drawing.

COMMON PUMP UNIT ACCESSORIES:

Model 5000-Series skids are designed to work with all Akkerman pump units and can be combined together to create a multitude of lengths. Skids come in standard lengths of 2.5-, 7.5-, and 22.5-ft long. Most pipe jacking projects use a combination of (1)-22.5ft, (2)-7.5ft, and (1)-2.5ft skids for a total length of 40-ft.

Akkerman **thrust yokes** are specifically designed to evenly distribute the thrust forces from the pump unit to the jacking pipe. Thrust yokes are built in common diameters ranging from 44-in to 114-in OD and may be customize to fit a particular jacking pipe or application.

The **laser stand** is a critical tool to position the tunnel guidance laser in the launch shaft. The stand isolates the tunnel laser from reaction forces that are typically transferred to the thrust block or shaft walls during pipe jacking. These reaction forces can cause laser movement if not isolated properly causing tunnel misalignment.

A **200-hp Auxiliary Pump** is an add-on option to any Akkerman 5200 Pump Unit. This auxiliary pump boosts performance on 72-in and larger TBMs when tackling difficult ground conditions and/or extended tunnel alignments.

Akkerman Tunnel Boring Machines & Accessories

Akkerman TBMs have been the gold standard in pipe jacking since 1973. The original Akkerman Series-I TBM revolutionized the pipe jacking industry and is still successful today in soft, non-pressurized ground conditions.

In 2017, Akkerman launched the Series-II TBM lineup featuring a redesigned cutterhead drive system that delivers high output torque with the ability to maintain thrust loads required to cut hard rock.

Today, Akkerman offers both Series-D and Series-II TBM configurations in the most common pipe jacking diameters. While both configurations include the heavy-duty, two-speed, periphery cutterhead drive system to support ranging ground conditions from soft ground to hard rock, both have distinct advantages that may appeal to specific trenchless contractors.

The Akkerman Series-D or "D-Mode" TBMs use a larger internal diameter main drive bearing allowing Akkerman engineers to maximize the face access portal. Maximizing the access area is often critical on smaller TBMs for obstruction removal or cutter tooling changes.

The Akkerman Series-II TBM's main drive bearing configuration include additional sealing capacity that allows these systems to be converted to true EPB-mode with the installation of a bulkhead with fluid swivel, screw conveyor, and EPB sensors.

Cutterheads are designed to work unidirectionally for increased material conveyance and tooling placement, however Akkerman Series-D and Series-II TBMs can operate bi-directionally, perform in soft soil or rock conditions, and are fully articulated to ensure accurate line and grade tolerances. The most common TBM diameters are listed in Figure 11 below. Custom diameters and cutterheads can be designed and manufactured to customer specifications.

TBM Model	Shield Dia.	Cut Dia. (Typ.)	Max Skin Dia.	Drive System	HSLT	LSHT	Articulation	Open Mode	Closed Mode	EPB Mode	Rock Mode
WM48SC-D	48 in	50 in	55 in	(4) – Hyd. Motor Periphery	41,600 ft-lb / 23.6 RPM	62,500 ft-lb / 15.7 rpm	3-Position / 3º Degrees	Yes	Yes	No	Yes
WM420-D	51 in	52.5 in	58 in	(4) – Hyd. Motor Periphery	45,100 ft-lb / 21.8 RPM	67,600 ft-lb / 14.5 rpm	3-Position / 3º Degrees	Yes	Yes	No	Yes
WM420-II	51 in	52.5 in	58 in	(5) – Hyd. Motor Periphery	44,000 ft-lb / 22.2 RPM	66,000 ft-lb / 14.8 rpm	3-Position / 3º Degrees	Yes	Yes	Yes	Yes
WM480-D	58 in	59.5 in	65 in	(5) – Hyd. Motor Periphery	66,300 ft-lb / 21.2 RPM	99,500 ft-lb / 14.1 RPM	3-Position / 3º Degrees	Yes	Yes	No	Yes
WM480-II	58 in	59.5 in	65 in	(6) – Hyd. Motor Periphery	64,000 ft-lb / 22.1 RPM	96,000 ft-lb / 14.7 RPM	3-Position / 3º Degrees	Yes	Yes	Yes	Yes
WM540-D	65 in	66.5 in	72 in	(6) – Hyd. Motor Periphery	74,000 ft-lb / 19.0 RPM	111,000 ft-lb / 12.6 RPM	3-Position / 3º Degrees	Yes	Yes	No	Yes
WM540-II	65 in	66.5 in	72 in	(6) – Hyd. Motor Periphery	74,000 ft-lb / 19.0 RPM	111,000 ft-lb / 12.6 RPM	3-Position / 3º Degrees	Yes	Yes	Yes	Yes
WM600-II	72 in	73.5 in	79 in	(6) – Hyd. Motor Periphery	85,000 ft-lb / 16.5 RPM	128,000 ft-lb / 11.0 RPM	3-Position / 3º Degrees	Yes	Yes	Yes	Yes
WM720-II	86 in	88 in	93 in	(9) – Hyd. Motor Periphery	159,000 ft-lb / 8.9 RPM	239,000 ft-lb / 5.9 RPM	3-Position / 3º Degrees	Yes	Yes	Yes	Yes
WM780-II	93 in	94.5 in	108 in	(9) – Hyd. Motor Periphery	175,000 ft-lb / 8.1 RPM	263,000 ft-lb / 5.4 RPM	3-Position / 3º Degrees	Yes	Yes	Yes	Yes
WM96SC-II	96 in	98 in	114 in	(4) – Hyd. Motor Periphery	270,000 ft-lb Cont. / 450,000 ft-lb max. 0-5 rpm		3-Position / 3º Degrees	Yes	Yes	Yes	Yes
WM840-II	102 in	103.5 in	114 in	(4) – Hyd. Motor Periphery	270,000 ft-lb Cont. / 450,000 ft-lb max. 0-5 rpm		3-Position / 3º Degrees	Yes	Yes	Yes	Yes
WM960-II	114 in	115.5 in	128 in	(5) – Hyd. Motor Periphery	320,000 ft-lb Cont. / 550,000 ft-lb max. 0-3.5 rpm		3-Position / 3º Degrees	Yes	Yes	Yes	Yes

Figure 11: General Akkerman Pipe Jacking TBM Specification. Subject to Change.

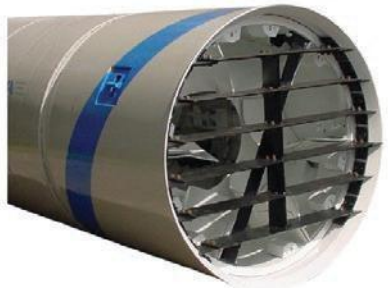
TBM Cutterhead Options

Dirt Bar Cutterhead

The **Dirt Bar** cutterhead is the most efficient cutterhead for soft, stable soil conditions above the water table. The dirt bar excels in clay ground conditions and maximizes ribbon cutting and material flow. The dirt bar is accessible underground for obstruction removal, tooling changes, or a cutterhead change to the more aggressive carbide quad bar cutterhead.

Carbide Quad Bar Cutterhead

The **Carbide Quad Bar** cutterhead is most efficient in firm ground to highly weathered rock, such as shale that has UCS less than 4000-psi. Tooling wear will increase rapidly at strengths exceeding 4000-psi. The carbide quad bar cutterhead is accessible underground for tooling changes, obstruction removal, or cutterhead configuration change to the standard dirt bar.

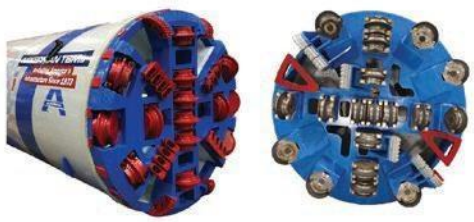


TBM Sand Shelves

Sand Shelves are standard options on legacy Akkerman Series-I TBMs only. Sand shelves can be added to Series-D or Series-II TBMs as an option. Sand shelves help maintain the angle of repose when the face is exposed to running ground conditions. Sand shelves are mounted at fixed positions within the shield. The operator can elect to remove sections of shelving to adjust material flow.

Closed-Face Attachment

The **Closed-Face Attachment** is specifically designed to work with Akkerman TBM pipejacking systems to provide immediate face support when operating in loose or unstable soils. The TBM operator has full control of the hydraulically actuated doors, while the fluid swivel allows lubricant to be pumped to the face to ensure material flow. Trenchless contractors often pair a screw conveyor for material removal when using a closed-face attachment to help control highly plastic and saturated clay loam soils.



Disc Cutter Heads (DCH)

Various **Rock and Mixed-Face Disc Cutterheads (DCH)** are available for Akkerman TBMs and are selected based on the anticipated geotechnical conditions, tunnel diameter, and length of the drive. Various tooling options are available. DCH heads designed for Series-D and Series-II TBMs only. Not suitable for legacy Series-I TBM systems.

Akkerman Haul Units & Accessories

Material is conveyed from the TBM to the launch shaft by specially designed haul units. Akkerman produces two classes of haul units with a variety of muck boxes to maximize mucking efficiency.

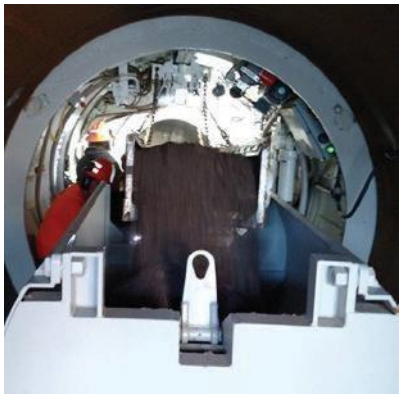
The operator-controlled haul units are electrically driven and include regenerative braking, removeable battery packs, inching control, and tunnel safety lighting.

Akkerman's **Model 524 Haul Unit** is a tunnel labor's best friend. Compact enough to fit inside of a 36-in I.D. tunnel, the 524 haul unit is widely used by trenchless contractors for pipejacking and hand mining projects.

The larger **Model 1548 Haul Unit** offers trenchless contractors an option for more power, speed, and mucking capacity when installing tunnels at 60-in I.D. and larger. Featuring an adjustable length frame, the 1548 can accommodate both standard length and extended length dirt buckets.

Haul Unit Track

Unloading Dirt Box



Loading Dirt Box

Model	Pipe Dia.	Power	Voltage	Speed	Braking	Max Grade	Width	Length	Track Gage	Weight
524 Haul Unit	> 36 in ID	5hp (3.7kW)	24Vdc	0-4 mph (0-500 ft/min)	Electric / Caliper Disc	5% Empty / 2.5% Full	31 in	128.5 in	11.13 in	950 lbs.
524X Haul Unit	> 36 in ID	5hp (3.7kW)	24Vdc	0-4 mph (0-500 ft/min)	Electric / Caliper Disc	5% Empty / 2.5% Full	31 in	158.8 in	11.13 in	1150 lbs.
1548 Haul Unit	> 60 in ID	15hp (11.2 kW)	48Vdc	0-8.5 mph (0-750 ft/min)	Regenerative / Caliper Disc / Mechanical	5% Empty / 2.5% Full	47.63 in	143in / 173in	20in (Standard) / 24in (Optional)	4500 lbs.

Figure 12: General Akkerman Haul Unit Specifications. Subject to Change.

DID YOU KNOW...

Tunnellers in the 1800's often used wheelbarrows, hand carts, baskets, or buckets on small-scale tunnels to transport excavated material from the heading to the outside world.

Large-scale projects, such as the one illustrated, would use horse-drawn wagons. The horses, ponies, or mules used by the tunnellers and miners alike were often referred to as "Pit Ponies."

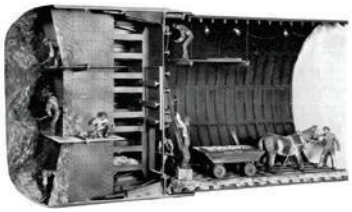


Photo courtesy of The Project Gutenberg. Museum of History and Technology,

Akkerman Dirt Buckets

Akkerman dirt buckets are designed to maximize the removal of excavated material from the heading during every muck cycle. Each dirt bucket is designed with a rounded profile that aligns with the inside diameter of the anticipated tunnel to increase capacity.

Dirt boxes can be dumped quickly and efficiently. A hinged gate allows the crane operator to safely lift the dirt box from the shaft while containing the spoils.

Dirt buckets are available in standard and extended length. It is important the dirt bucket selected is sized for the haul unit, sized for the I.D. of the tunnel, and is the correct length for the thrust yoke.

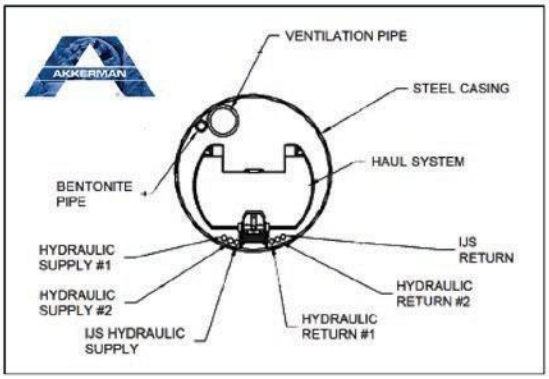


Figure 13: Fitment of Tunnel Provisions

Figure 13 is a reference drawing illustrating the fitment of the haul unit, track, and additional tunnel accessories necessary for pipe jacking installations.

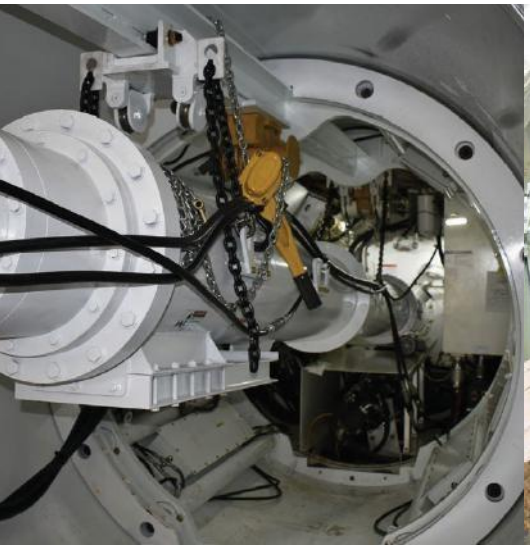
During the pipe jacking process, the mucking system must pass through additional components such as intermediate jacking stations, lubrication control valves, gas monitoring stations, tunnel lighting, and any other provisions.

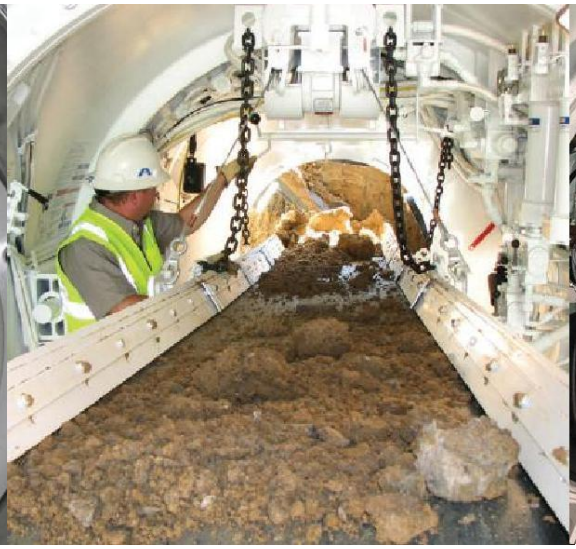
Model	Tunnel Dia.	Bucket Length	Spoils Volume	Gross Capacity	Dry Weight	Haul Unit
360	> 36 in	61 in	0.9 yd^3	8,000 lbs.	440 lbs.	524 Haul Unit
360X	> 36 in	90 in	1.3 yd^3	8,000 lbs.	530 lbs.	524X Haul Unit
48SC	> 40 in	61 in	1.0 yd^3	8,000 lbs.	475 lbs.	524 Haul Unit
420	> 42 in	61 in	1.1 yd^3	8,000 lbs.	480 lbs.	524 Haul Unit
420X	> 42 in	90 in	1.7 yd^3	8,000 lbs.	630 lbs.	524X Haul Unit
480	> 48 in	61 in	1.5 yd^3	8,000 lbs.	670 lbs.	524 Haul Unit
480X	> 48 in	90 in	2.3 yd^3	8,000 lbs.	810 lbs.	524X Haul Unit
540	> 54 in	61 in	1.9 yd^3	8,000 lbs.	1,000 lbs.	524 or 1548 Haul Unit
540X	> 54 in	90 in	2.9 yd^3	8,000 lbs.	1,180 lbs.	524X or 1548 Haul Unit (Extended)
600	> 60 in	61 in	2.3 yd^3	16,000 lbs.	1,280 lbs.	1548 Haul Unit
600X	> 60 in	90 in	3.5 yd^3	16,000 lbs.	1,470 lbs.	1548 Haul Unit (Extended)
720	> 72 in	61 in	2.9 yd^3	20,000 lbs.	1,570 lbs.	1548 Haul Unit
720X	> 72 in	90 in	4.4 yd^3	20,000 lbs.	1,820 lbs.	1548 Haul Unit (Extended)
780X	> 78 in	90 in	5.4 yd^3	20,000 lbs.	2,100 lbs.	1548 Haul Unit (Extended)

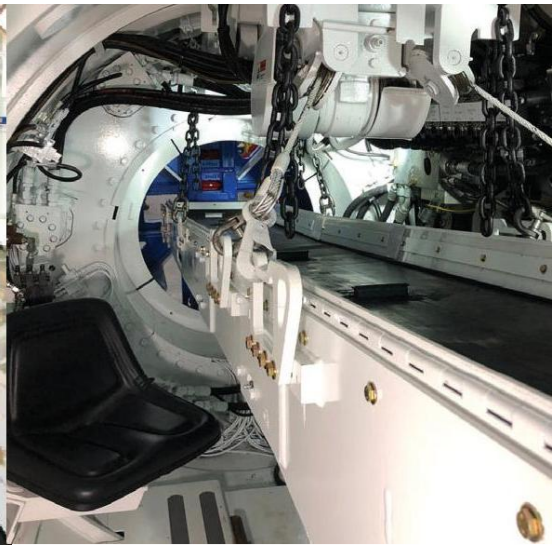
Figure 14: General Akkerman Dirt Bucket Specifications. Subject to Change.

TBM Belt & Screw Conveyors

Akkerman offers a variety of belt and screw conveyors to fit inside your TBM. Standard conveyors can easily be removed from the tunnel heading to allow more access to the face for tooling changes or obstruction removal. In the event of a ground condition change, belt and screw conveyors can also be changed underground.







Model	Conveyor Type	Conveyor Width	Conveyor Length	TBM Compatibility
1015	Belt	10 in	15 ft	WM360
1215	Belt	12 in	15 ft	WM48SC, WM420
1615	Belt	16 in	15 ft	WM480, WM540
2015	Belt	20 in	15 ft	WM540, WM600
2415	Belt	24 in	15 ft	WM600, WM660, WM720, WM780
2418	Belt	24 in	18 ft	WM720, WM780, WM96SC, WM840
2423	Belt	24 in	23 ft	WM720, WM780, WM96SC, WM840, WM960
120	Screw	12 in	15 ft	WM360, WM48SC, WM420, WM480, WM540
120 EPB	Screw	12 in	16 ft	Series-II TBMs with EPB Bulkhead Kits
140	Screw	14 in	15 ft	WM540, WM600, WM660
160	Screw	16 in	15 ft	WM720, WM780, WM96SC, WM840, WM960
160 EPB	Screw	16 in	22 ft	Series II TBMs > 86in with EPB Bulkhead Kits

Figure 15: General Akkerman Conveyor Specifications and Compatibility Chart. Subject to Change.

Jobsite Support

The following list is to be used as a general guideline when preparing for your TBM project. Some of the items may not be used on your project, however the following list is a general representation of the most-common items to have available for efficient and productive operation. For additional information, please refer to the TBM Operator's Manual or contact the Aftermarket Support department for further assistance.

CONSUMABLE ITEMS

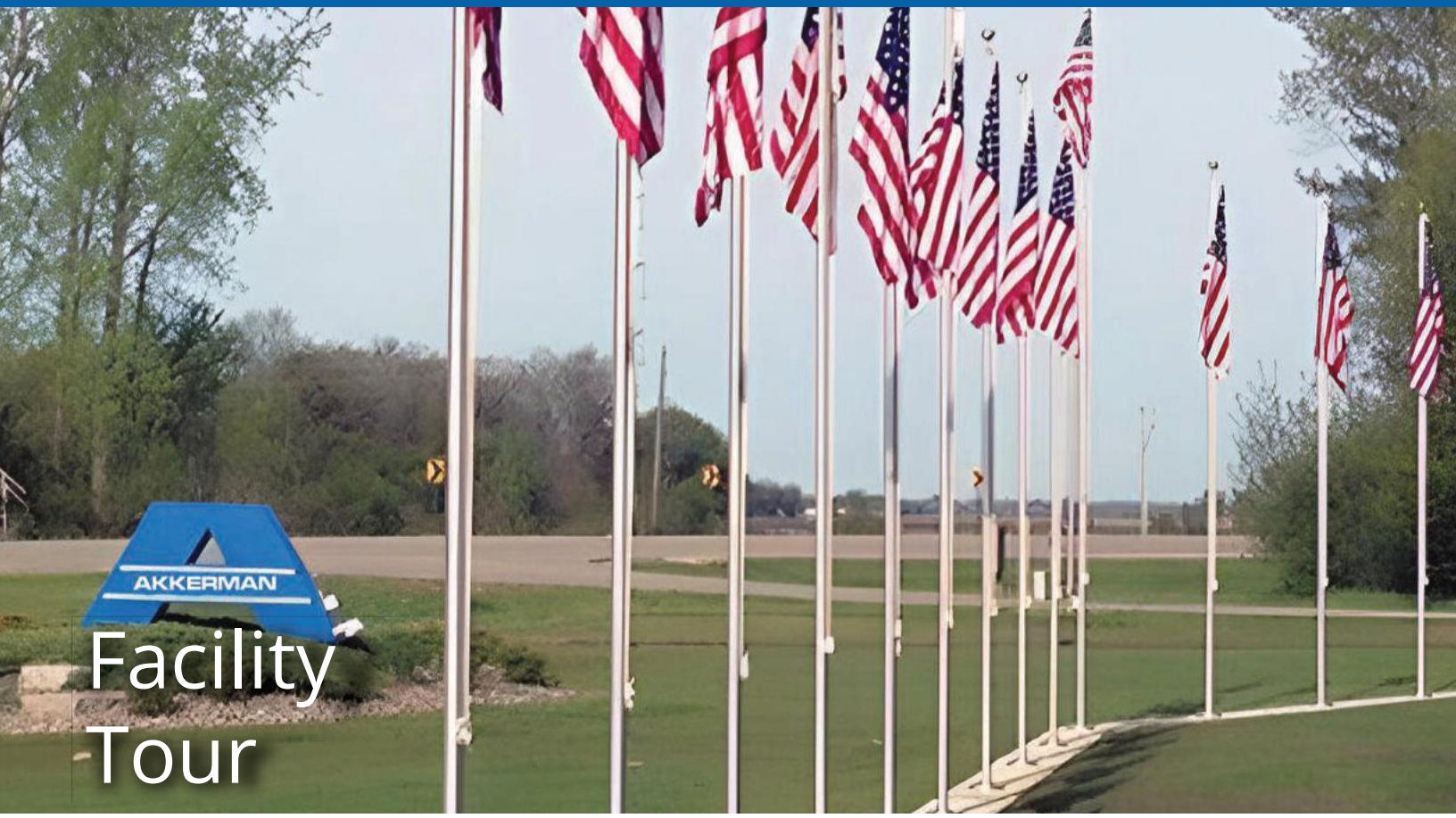
- TBM lip seal grease:
  - Low viscosity Type 1 - Mobil SHC 101 or equivalent.
  - Biodegradable is recommended but not required for machine performance.
  - Anticipate 1-2 gallons of grease per shift. Air powered or electric grease transfer gun recommended for filling reservoir underground.
- AW46 Hydraulic Oil to fill tunnel lines:
  - 5200 Pump unit is pre-filled with 230 gallons of hydraulic oil.
  - Dual feeding the TBM will require approximately 25 gallons per 100 LF of tunnel to replenish oil lines.
- General purpose grease (Type 2) for equipment maintenance. If project requires biodegradable grease, use Mobil SHC 102 or equivalent.
- Wire ties and/or mechanic's wire.
- Rope.
- If temperatures are going to drop below freezing, have 55 gallons of Propylene Glycol (RV Antifreeze) available for winterizing equipment during shutdowns or before return shipment. **Always winterize before returning equipment to Akkerman, Inc from September to April.**
- Spare cutterhead tooling (bullet bits, spade tooling, and/or disc cutters).
- General spare parts. Akkerman offers consignment parts packages for TBM rental systems.
- Anchors to hold tunnel utilities such as lighting, cables, or ventilation.
- Oil absorbent pads and spill kits.
- Rubber gloves.
- Inspection reports / daily reports / job logs.

JOBSITE TOOLS

- Basic Mechanical Hand Tools - Standard & Metric:
  - Wrenches to 2-in.
  - Adjustable wrenches - 12, 15, 18-in.
  - Allen wrench set - standard & metric.
  - 1-lb, 2-lb, 3-lb hammer.
  - Pry bar set.
  - Punches and chisels.
  - Large maul.
  - Shovels, brooms, rakes.
- 4-ft level for assisting setting equipment.
- Welder, welding rods, and safety equipment.
- Grinding equipment.
- Torch Set with extension leads and safety equipment.
- Tarp or pop-up tent for rain.
- Surveying Equipment - transit level, grade rod, string line, plumb bobs, plumb bob oil, etc..
- Flashlights.
- Hydraulic bottle jacks.
- Bullet level.
- Electrical diagnostic tools.

SUPPORT EQUIPMENT

- Generator - 275kW / 340kVA@480Vac-60hz min:
  - 385 skVA gen minimum motor starting with less than 35% instantaneous voltage dip and greater than 90% sustained voltage.
- Bentonite & Lubrication testing & consumables:
  - Bentonite / Polymer / Additives.
  - Marsh Funnel test kit.
  - Clean water - ph test kit.
- Cooling water supply - 8 to 15 gpm:
  - Hydrant preferred. Clean water required.
- TBM Guidance Laser.
- Communication Set.
- Air Compressor - Hand Tools.
- Air Hammer - Temp. Augers and Casings.
- Nitrogen Tank - Purge pilot tubes (moisture).



Facility Tour

SALES

Akkerman sales team has decades of industry experience and is ready to help. Whether you have an inquiry about one of our products or would simply like to learn about a particular trenchless method, or sales team has the knowledge and experience to guide you in the right direction.

ENGINEERING

Our engineering team is dedicated to providing our customers with innovative trenchless solutions using proven design concepts. The experienced team uses state-of-the-art modeling, finite element analysis, and design process tracking software to ensure Akkerman products are built to the highest quality standards.

PRODUCTION CONTROL

Short lead times, on-time deliveries, and quality of every piece is critical. Akkerman uses customized ERP systems to streamline inventory levels, track work orders, and customize process sheets to capture historical knowledge.

RAW MATERIAL INITIAL PROCESSING

Akkerman sources the best materials from the most trusted suppliers in the United States. We dedicate temperature controlled indoor storage for steel to ensure CNC cut quality. Every piece of steel on an Akkerman TBM passes through initial process before it takes shape.

WELD SHOP

Akkerman recently expanded our weld shop to include additional bays, new equipment, new overhead cranes, and a generous staging area for equipment builds. Experienced welders are trained on the latest techniques and methods to ensure strong, safe, and smooth welds are laid. Akkerman welders take pride in their craft, and their craftsmanship is on display with every piece of Akkerman equipment.

MACHINE SHOP

Akkerman has a state-of-the-art machine shop with some of the largest vertical turning lathe CNC machines in the Midwest. We have a mix of both large and small CNC mills and lathes to produce most of our parts in-house, which allows Akkerman to quickly produce components when needed. Our skilled machinists are trained, knowledgeable, and meet high quality standards.

PAINT SHOP

Even though the paint wears off trenchless equipment rather quickly, every TBM that leaves the Akkerman factory will always have the infamous blue stripe, Akkerman logo, and American flag proudly displayed.

EQUIPMENT ASSEMBLY & TESTING

Quality is a critical part of everything we do. We diligently adhere to the highest quality standards and are in complete control of the manufacturing process from start to finish.

TECHNICAL SERVICES & REFURBISHMENT

Customer support is a top priority for Akkerman and our customers. Akkerman technicians are available for operational training or equipment repair. In-house technical services include equipment refurbishment, warranty, rebuilding, repurposing, and updating.

AFTERMARKET PARTS

Akkerman aftermarket support is available to assist any of your parts needs with well over 1,000,000 + in-stock parts. Customized parts kits can be arranged specifically for your specific needs.

SHIPPING & LOGISTICS

The quality of Akkerman extends to shipping. Whether it is a part or an entire TBM system, we can help you get it there. Our logistics team can help customize your load if you do not have a preferred carrier.

D.H. AKKERMAN TRAINING AND DEVELOPMENT GROUNDS

Development of the current and future workforce is critical to Akkerman. Completed in 2023, the D.H. Akkerman Training and Development Grounds was developed specifically for the enhancement of guided boring operational training. Interested clients can sign-up to attend a customized training course at: akkerman.com/training-center

NEW INVENTORY.

Akkerman carries an extensive stock of equipment inventory in the most common pipe jacking diameters. Our customers appreciate quick lead times and the ability to respond to emergency infrastructure projects.

USED INVENTORY

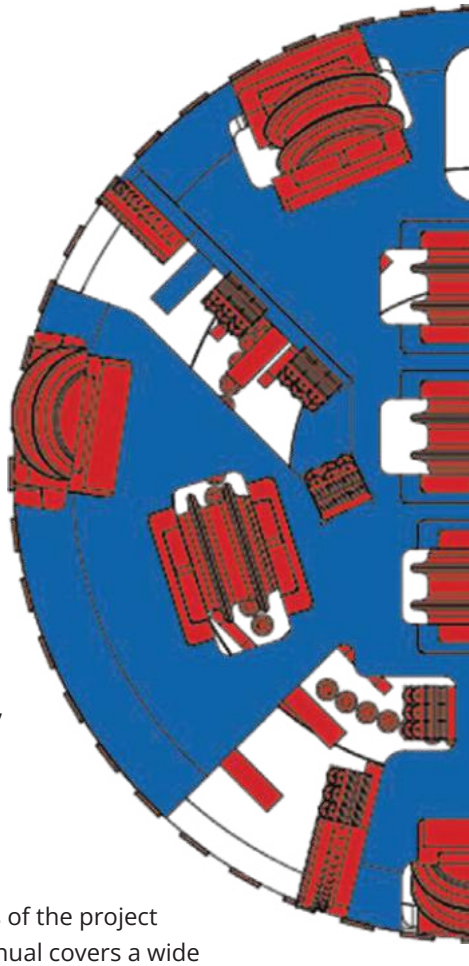
Akkerman used inventory is inspected, refurbished, and tested to new standards. Akkerman used equipment is often rental equipment that has only been used on one or two projects. Once the equipment has been factory certified, it is sold with a factory warranty as if it were NEW.

EMPLOYEES

We believe that our greatest strength is our employees. We are proud of our employee's commitment to excellence. Our skilled professionals are dedicated to advancing trenchless technology, equipment reliability, and responsive service. **We are Driven for Customer Success!**

TRENCHLESS INDUSTRY

RESOURCES



Standards & Best Practices

Akkerman has been invested in advancement of the trenchless industry for over 50-years. We recommend the following resources that are available to further your trenchless knowledge and assets of the industry. These resources were referenced in the creation of this document.

ASCE Manual and Reports on Engineering Practice No. 133. Pilot Tube and Other Guided Boring Methods. 2017

- This abstract was prepared by a professional task commitee and covers the design and installation of utility pipelines of various types of pilot tube applications under roads, railroads, constructed and natural structures, and other surface obstacles.

The National Utility Contractor's Association. Trenchless Construction and New Installation Methods - 5th Edition. 2022

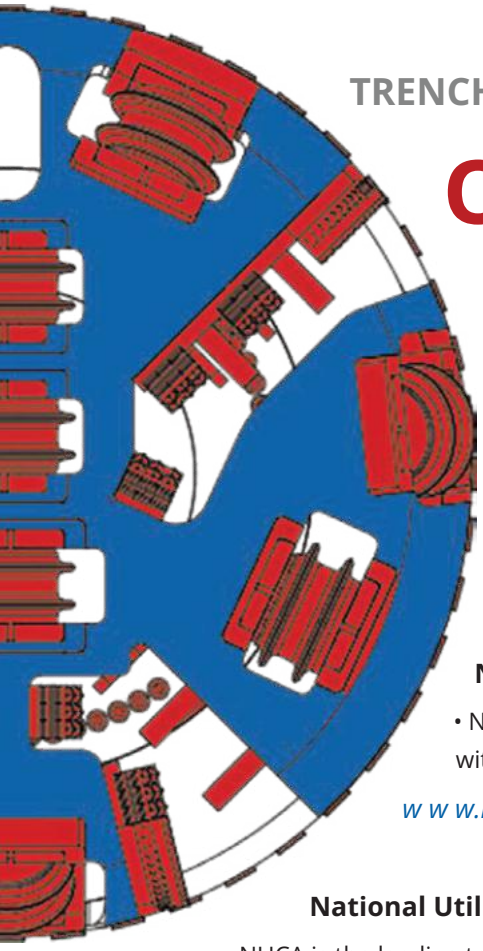
- This manual was prepared by a commitee of trenchless professionals selected from all aspects of the project phase including owners, engineers, contractors, manufacturers, attorneys, and more. This manual covers a wide variety of new construction trenchless installations.

American Society of Civil Engineers (ASCE/CI 36-15). Standard Design and Construction Guidelines for Microtunneling. 2015

- This standard guideline covers planning, design, pipe materials, and construction of microtunneling.

Pipe Jacking Association. An Introduction to pipe jacking and microtunnelling. 2017

- This document is produced by the Pipe Jacking Association and provides valuable information regarding various pipe jacking techniques.



TRENCHLESS INDUSTRY

ORGANIZATIONS

Dedicated to Trenchless Construction

Akkerman supports the advancement of the trenchless industry through education, membership, and advocacy to several industry organizations that are dedicated to furthering the growth of utility construction. These organizations can offer several benefits to owners, engineers, and contractors in the trenchless construction industry. Listed below are a few examples. Several opportunities exist on a local region or state level.

North American Society For Trenchless Technology - NASTT

• NASTT is an engineering society of individuals, public organizations and private companies with strong beliefs in the practical, social and environmental benefits of trenchless technology.

w w w.nas t t.org

National Utility Contractors Association - NUCA

• NUCA is the leading trade association working solely for the utility construction and excavation industry in the United States. NUCA's core purpose is to improve the operational proficiency and financial performance of its members.

w w w.nuca.com

International Society of Trenchless Technology - ISTT

• ISTT seeks to advance the science and practice of trenchless technology for the public benefit and to promote education, training, study and research in the said science and practice for the public benefit, and to publish the useful results of the same

w w w.ist t.com

Underground Construction Association - UCA

• UCA provides technical resources, professional development, and networking opportunities to engineers and related professionals in the tunneling and underground construction industries.

w w w.smenet.org

CASE STUDY

PIPEJACKING&UTILITY TUNNELING | TUNNEL BORING

Project Name:
Mainline Segment 9, I-20/ Railroad Crossing

General/Subcontractor:
Culberson Construction, LLC/ J & J Boring, Inc

Location:
Midland, TX

Ground Conditions:
Varying UCS caliche and limestone rock

Akkerman Equipment:
TBM 48SCII, 50-in. OD Disc Cutter Head, Tunnel Boring System with 5200 Pump Unit, 524 Haul Unit

Pipe:
48-in. OD Steel Casing

Total Length/Hard Rock Section:
550-lf./250-lf. (DCH used for 250)

PROJECT OVERVIEW

The project involved the construction of a 36-in. diameter HDPE water line inside of a 48-in. diameter casing, that ran under highway I-20 and a Union Pacific Railroad near Stanton, TX.

While using their 48SCII TBM with standard carbide cutter head, J & J Boring, Inc. encountered rock conditions midway across the bore which were not stated in the pre-bid GDR. The unanticipated ground proved challenging to mine with the initial TBM cutter head setup. After a few worn tooling changes, the contractor decided to develop a better solution to mine the rock.

THE CHALLENGES

- Installation in hard caliche/limestone rock
- Crossing under active rail line and I-20 Highway
- Actual project rock rating was 40% harder than pre-project GDR indicated
- Hardest rock encountered within sensitive rail road Zone A, requiring 24-hour non-stop construction and no surface access

THE SOLUTION

Key benefits of owning an Akkerman TBM is the interchangeable cutter heads feature and the ability to access the face for obstruction removal. J & J Boring, Inc. contacted Akkerman for a Disc Cutter Head attachment for their 48SCII TBM to fracture the hard caliche and limestone rock into pieces while maintaining alignment despite geological variations.

The 48SCII TBM Cutter Head features:

- (16) 6.5-in. disc cutters, capable of 5 tons of thrust each
- Cutter head rock scrapers assist in transferring cuttings away from the face, to the conveyor, then to the haul unit for removal from the tunnel
- Heavy-duty bearing to handle disc thrust loads
- Recommended Uni-directional operation for effective mining

The lead 48-in. casing was welded to the TBM to counteract the rotational torque necessary to mine the rock with the uni-directional cutter head. The operators monitored the thrust loads on the cutters to ensure they did not become overloaded.

OUTCOME

- J & J Boring, Inc. completed the drive in challenging rock that would have been otherwise improbable
- No cutter head tooling replacements required
- Mid-project rock testing indicated project rock samples of 13,000 PSI UCS.

Corporate Headquarters
58256 266th Street
Brownsdale, MN 55918 | USA
Ph.: +1 (800) 533.0386 | akk@akkerman.com

CASE STUDY

PIPEJACKING&UTILITY TUNNELING | TUNNEL BORING

Project Name:
East Side Interceptor Sewer

Minger Construction, Inc.

Location:
Mequon, WI

Owner:
City of Mequon

Ground Conditions:
Clay with Trace Sand and Gravel

Akkerman Equipment:
TBM 420B, 5200 Pump Unit, 524 Haul Unit

Pipe:
48-in. ID Hobas® **Total Length/Longest:**
7,985-lf./1,288-lf.

PROJECT OVERVIEW

In response to significant flooding events that caused basement backups for City of Mequon residents, the City's Sewer Utility District commissioned a study for a wet weather relief sewer.

The study and design lead to the construction of the two-phase East Trunk Sewer Construction project, designed by R.A. Smith Inc., and awarded to prime contractor Minger Construction Co., Inc. for $14.8 million.

Construction included 7,985-feet of 48-inch ID and 2,365-feet of 24-inch ID Hobas® pipe by trenchless methods, 316-feet of open cut installations, connections and restorative measures.

THE CHALLENGES

- Construction near waterways, wetlands, alongside and under railroads, freeways and streets, the Katherine Kearney Carpenter Park, and residential communities
- Permitting was required for the WDNR, Union Pacific Railroad, the Wisconsin Department of Transportation, Ozaukee County, and the MMSD, and easements were acquired on 15 private properties
- Longest drive of 1,288-feet ran parallel to the Union Pacific Railroad, along three medians on North Port Washington Road under live traffic along a very busy thoroughfare
- Squeezing clay around the TBM
- Existing utilities within close proximity to many of the tunnel drives

THE SOLUTION

Minger subcontracted J&J Boring, Inc. to assist, using two Tunnel Boring Machine (TBM) systems to accelerate installation efforts and take advantage of the milder temperatures.

Eleven drives were completed with Akkerman TBMs and tunnel boring systems at 26-32-foot depths. On the drives presenting squeezing clay, crews utilized a bentonite and lubrication pump to inject lubrication at the cutter face.

The TBM work started in July and was completed in December. After the TBM work, Minger crews installed 2,365 feet of 24-ID pipe with their GBM 4800 system with equal success.

OUTCOME

- Successful concurrent installations, completed within the required timeline
- Verification of the tunnel was completed via CCTV, indicating that no settlement occurred
- When boulders were encountered, the technology allowed for face access so even unanticipated boulders could be overcome

Corporate Headquarters
58256 266th Street
Brownsdale, MN 55918 | USA
Ph.: +1 (800) 533.0386 | akk@akkerman.com

For more information please visit:
www.akkerman.com

CASE STUDY

PIPEJACKING&UTILITY TUNNELING | TUNNEL BORING

Project Name:
Hwy. 400 & Tiffin Street Overpass & Barrie Collingwood Railway Overhead

Subcontractor:
CRS Tunnelling

Location:
Barrie, Ontario, Canada

Owner:
Ministry of Transportation

Ground Conditions:
Compacted Sand and Dirt

5200 Pump Unit and 1548 Haul Unit

Pipe:
72-in. ID RCP

Total Length/Longest:
200-lf./200-lf.

PROJECT OVERVIEW

CRS Tunnelling was selected subcontractor to work with Dufferin Construction on a Ministry of Transportation Project in the City of Barrie, Ontario, Canada.

The project involved the construction of a tunnel under Hwy. 400 installed by pipe jacking methods to install the RCP product pipe.

THE CHALLENGES

- Construction adjacent to a watercourse
- containing protected aquatic species
- Protective soil erosion and sedimentation control
- measures to prevent impact
- Tunnelling occurred beneath a major expressway
- Limited cover over the crown of the tunnel
  Complex traffic control and staging plans
  Experienced tunneling expertise required to ensure correct levels of face support

THE SOLUTION

- 720 Series II TBM and Tunnel Boring System
- Closed face cutter head to prevent subsidence

OUTCOME

- Successful installation with no settlement of the roadway surfaces or impeded traffic

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CASE STUDY

PIPEJACKING&UTILITY TUNNELING | TUNNEL BORING

Project Name:
Blacks Run Interceptor Division 1B Replacement

General/Subcontractor:
Garney Construction/Aaron Enterprises Inc.

Location:
Harrisonburg, VA

Owner:
Harrisonburg-Rockingham Regional Sewer Authority

Ground Conditions: Lean Clay, Weathered Rock, Limestone, and Dolomite

Akkerman Equipment:
TBM 600, 74-in. OD Mixed Disc Cutter Head, Tunnel Boring System with 5200 Pump Unit, 524 Haul Unit

Pipe:
72-in. ID Steel Casing

Total Length/Longest:
200-lf.

PROJECT OVERVIEW

The Blacks Run Interceptor – Division 1B – Replacement project scope included 3,700-lf. of 48-in. sanitary sewer installed by open-cut and trenchless methods.

A 200-lf. section that crossed under Stone Spring Road requiring a tunnel boring machine to maintain traffic on a busy arterial roadway.

THE CHALLENGES

- 72-in. steel casing to house a 48-in. sanitary
- sewer interceptor
- Critical line and 1.02% downhill grade
- Limited geotechnical information available
  The test bore showed the presence of lean clay, soft weathered rock, limestone, dolomite at launch and exit shafts Strict timeline was in place
- for the tunnel to keep
  pace with the open-cut operations going on elsewhere on the project site
- Groundwater encountered at the half-way mark during the downhill run

THE SOLUTION

Akkerman supplied a powerful TBM with a mixed-face disc cutter head mixed-face disc cutter head capable of 24,000 UCS psi to tackle the varied ground conditions.

OUTCOME

- Full-face of rock was encountered at various sections of the tunnel, but the mixed-ground cutter head and TBM system tackled it without issue
- The tunnel was completed on line & grade and on time for crews to go home for Christmas.

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CASE STUDY

PIPEJACKING&UTILITY TUNNELING | TUNNEL BORING

ProjectName:
Michigan Ditch Tunnel

BTrenchless, A Division of BT Construction, Inc.

Location:
Never Summer Mountain, Jackson, CO

Owner:
City of Fort Collins

Ground Conditions:
Highly Fractured Pegmatite & Gneiss Rock

Akkerman Equipment: 720 Series II TBM, 98-in. Mixed-Ground Disc Cutter Head, 5200 Pump Unit and Dual Bucket 1548 Haul Unit

Pipe:
98-in. OD Ring Beam & Lagging, 60-in. Hobas®

Total Length/Longest:
766-lf./766-lf.

PROJECT OVERVIEW

The 5.2-mile Michigan Ditch conveys transmountain fresh drinking water for City of Fort Collins residents. A slow-moving landslide imparted damage to various portions of its above-ground piping network, and its continuous restoration had been a burden on the City. The damage reached critical mass when a landslide moved a large section of the delivery system a significant distance.

The City of Fort Collins recognized the water source as one of their communities' most valuable commodities and put together a team of experts using an Alternative Product Delivery System model.

The team decided to re-route and permanently protect the most vulnerable portion of the aqueduct by constructing a 98-in. OD ring-beam and lagging through Never Summer Mountain. The 766-ft. tunnel featured a 630-ft. radius curve, to be completed with 60-in. OD carrier pipe.

THE CHALLENGES

- High-risk tunnel in highly fractured pegmatite
- and gneiss ground conditions
- Required construction between the snowfall end
- in the spring and when it began again in late fall
- Remote project site more than 30-miles from the
- closest city

Considerable site preparation before tunneling equipment was mobilized

Careful scheduling and staging to safely transport equipment without exceeding access road weight limits

THE SOLUTION

BTrenchless ordered a customized TBM system package:

- 720 Series II TBM with TBM stabilizers and the maximum number of TBM drive motors
- 98-in. mixed-ground disc cutter head, designed to excavate up to 15,000 psi rock with back-
- loaded tooling mounts Propulsion can for the
- TBM to advance off of the
- constructed tunnel
  Dual extended belt conveyors to extend through the TBM and propulsion can for maximum tunneling efficiency to excavate one ring set within two haul unit cycles
- A standard 5200 Pump Unit with a 200 HP Auxiliary Pump

OUTCOME

- A challenging project exceeded all of its goals
- The collaborative approach of the ADPS model resulted in nearly $1 million in project savings
- The project will provide reliable drinking water for City of Fort Collins residents for many years

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ROCKING IN PHOENIX – DROUGHT PIPELINE PROJECT

As we look ahead into 2023, Akkerman will be celebrating its 50th anniversary as one of North America's premier manufacturers of trenchless equipment. The first Akkerman TBM was developed in 1963 by Don (D.H.) Akkerman out of necessity to install road crossings safely and efficiently. For the next decade, D.H. continued to refine the pipe jacking process through his own contracting efforts. Industry demand for the equipment rose, and Akkerman Inc. was established as a trenchless equipment manufacturer in 1973 with Maynard Akkerman at the helm. Today, Akkerman offers multiple product lines for new trenchless installations including pipe jacking, slurry microtunneling, tunnel boring, guided boring, auger boring, and earth pressure balance equipment.

Akkerman TBMs were popularized by trenchless contractors for their

ability to direct install product pipe on line and grade in non-pressurized soil conditions. The new series of Akkerman TBMs can accommodate rock, while maximizing clearance through the bearing for removal of obstructions in soft ground like their predecessors. This TBM design was recently selected by Horizontal Boring LLC and outfitted with a rock disc cutterhead for the City of Phoenix's Drought Pipeline Project.

HWY SR-51 TRENCHLESS CROSSING

Horizontal Boring LLC recently completed the Hwy SR-51 crossing

SR-51 Launch shaft setup.

with an Akkerman WM720-II TBM. This crossing was part of the City of Phoenix's Drought Pipeline Project that will convey 60-MGD of treated water from the 24th Street Water Treatment Plant to the north Phoenix area. Serving more than 400,000 north Phoenix residents, the new pipelines will be used to alleviate the effects of drought by ensuring that water supplies from the Salt and Verde Rivers are available during future shortage on the Colorado River. The successful completion of the Hwy SR-51 crossing is an example of the versatility and cost savings this trenchless method offers municipalities seeking new installation solutions.

The 330-lf crossing of 86-in steel casing was originally designed to be constructed by either hand-mine operations or slurry microtunneling, due to the geotechnical report anticipating 15,000-psi rock including clasts up to 35,000-psi. Since no ground water was present in the formation, Horizontal Boring LLC selected an Akkerman TBM with a disc cutterhead designed for the alignment. This method would prove to be safer and more efficient than hand-mining, while more cost-effective than slurry microtunneling.

Pipe jacking is done from a launch shaft to a reception shaft with advancement provided by a hydraulic jacking frame located in the launch shaft. Excavation is controlled at the face by the operator as the TBM is advanced by thrust forces transmitted from the jacking frame through the product pipe. Excavated material is transferred into an electrically powered haul system that carries the material back to the launch shaft for removal. At the end of each section of pipe, a new section of pipe along with tunnel provisions are connected for continued advancement.

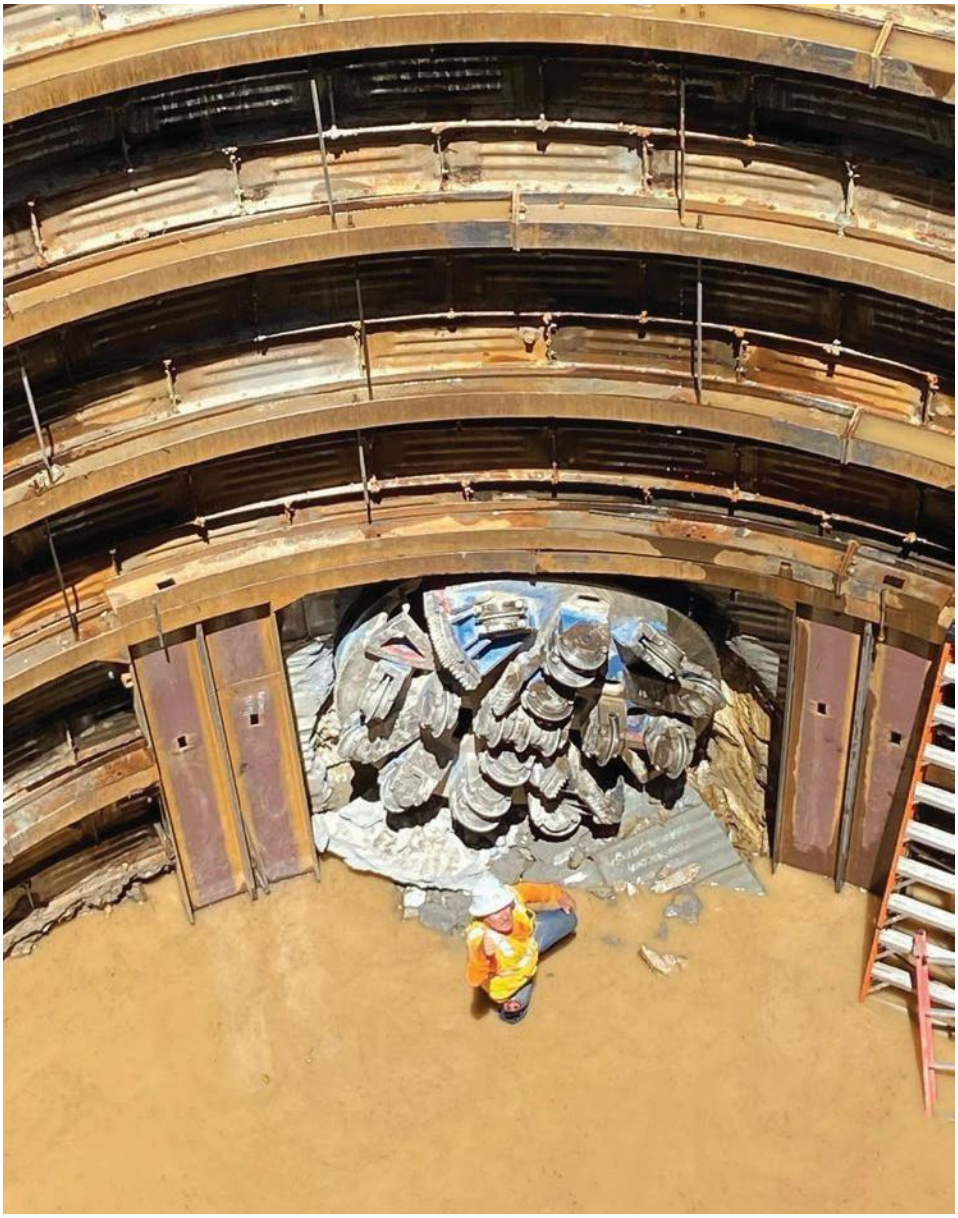
An Akkerman 5200 pipe jacking system was used in the launch shaft with 37.5-ft of rail. This configuration allowed Horizontal Boring LLC to setup and launch the TBM in one section and accommodate the 20-ft long pipe. The pump unit serves as the jacking frame and hydraulic power supply for the pipe jacking sequence and can accommodate TBMs ranging from 48-in. to over 100-in. OD with proper setup.

Each Akkerman TBM is shipped with a standard dirt bar and carbide bar cutterhead to suit ground conditions ranging from soft ground to weathered rock (UCS < 4000-psi). These standard cutterheads can be changed underground if necessary. Closed face cutterhead attachments that can mechanically control unstable ground conditions with hydraulically closeable doors require installation prior to the tunnel construction. Due to the rock conditions on the SR-51 crossing, a disc cutterhead was required to complete the alignment, and installed at the factory prior to shipping.

WM720-II Cutterhead – SR-51 Crossing

To efficiently fracture the breccia and schist rock formation, the cutterhead was designed with 11.5-in. single disc cutters as well as bolt-on carbide tipped scrapers to remove soil and other debris. For maximize disc cutter life, the overall thrust applied was monitored and regulated through the load applied to the articulation joint of the TBM. Removable grizzly bars enabled the operator to adjust the cutterhead opening ratio (COR) or allowed access the face for potential obstruction removal. Since no pressurized ground conditions were exhibited in the geotechnical report, closed mode tunneling or costly compressed air interventions, would not be required on the SR-51 crossing.

Tunnel guidance is provided by a simplified laser-to-target system. The TBM operator assesses the position of the tunnel laser at the cutterhead every 10-14 inches of advancement. Based on the position of the laser, the operator makes steering adjustments with the three-point steering system to maintain the desired line and grade. While enhanced guidance systems can be added to Akkerman TBMs to meet engineering specifications such as electronic data logging or remote monitor-

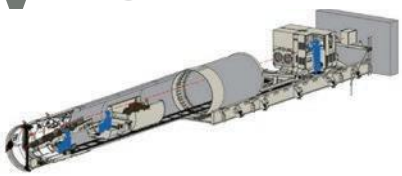


Akkerman TBM at the reception shaft. Hwy SR-51 Crossing.

ing, the conventional laser-to-target guidance system has been proven for decades, and effective at distances exceeding 1,000 ft.

In order to maintain efficient pipe jacking operations in the hard ground conditions displayed on the SR-51 crossing, the overcut was designed to 1-in. (per radius). This design provides clearance on the annulus of the pipe to maintain low thrust forces while allowing steering corrections along the alignment in hard ground conditions. If the overcut diameter is too small in hard ground, the tolerances of steel casing will stack-up, causing high jacking loads along the pipe string where steering corrections are required to maintain line and grade. This can potentially lead to sudden spikes in jacking forces, pipe failure, or a seized tunnel.

General Layout – TBM Pipe Jacking



Bentonite injection was used to fill the annulus between the steel casing and rock to support the pipe jacking process. Lubrication is critical in all trenchless pipe jacking methods, as the proper engineered mix maintains the annulus, reduces risk of settlement, and lowers overall thrust requirement of the installation. The proper lubrication mix should always be engineered based on the actual ground conditions and adjusted accordingly if ground conditions change along the alignment. A distinct advantage to conventional pipe jacking is that the operator can monitor the interaction of the cutterhead, so changes in ground conditions are evident in real time.

The overcut and bentonite proved to be an important factor as Horizontal Boring LLC was required to stop tunneling for approximately 60-days, awaiting the completion of the settlement monitoring system along the crossing's right-of-way. With the TBM advanced nearly 50-ft into the alignment, crews monitored the shafts for the risk of flooding as Arizona was inundated by early season rain events. Once green lighted to commence operating again, Horizontal Boring LLC experienced a break-out jacking force of around 350-ton but dropped to around 100-ton after pipe advancement and additional bentonite injection.

Horizontal Boring LLC achieved around 15 to 20 ft of 86-in. OD steel casing per shift. A second shift was deployed to set and weld the 20-ft sections of steel casing in the launch shaft which can often require 8 hours to complete.

Akkerman Inc. is proud to have been a part of the infrastructure solution that is essential to the economic health and vitality of Phoenix and wants to congratulate Horizontal Boring LLC, The City of Phoenix, and all others involved in the Phoenix Drought Pipeline Project.

Jason Holden is the vice president, chief revenue officer for trenchless equipment manufacturer Akkerman in Brownsdale, Minnesota.

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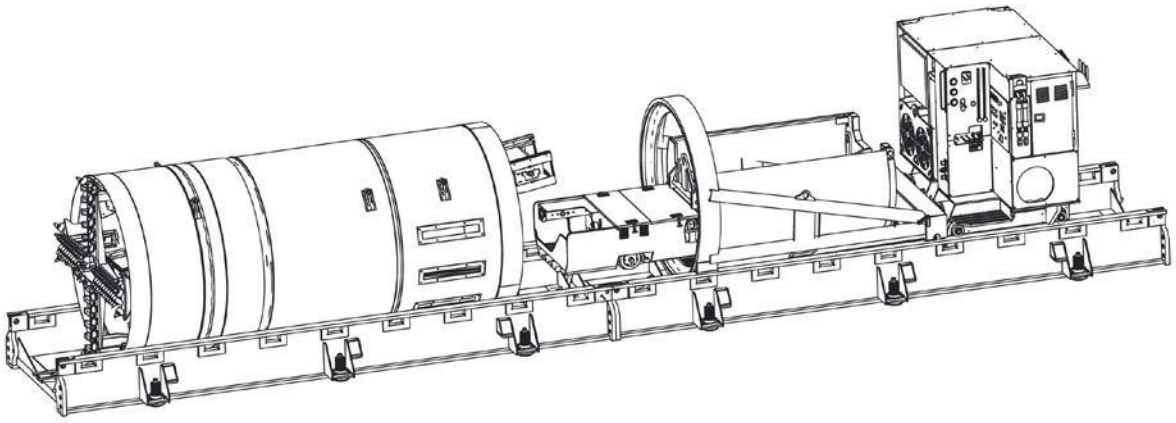

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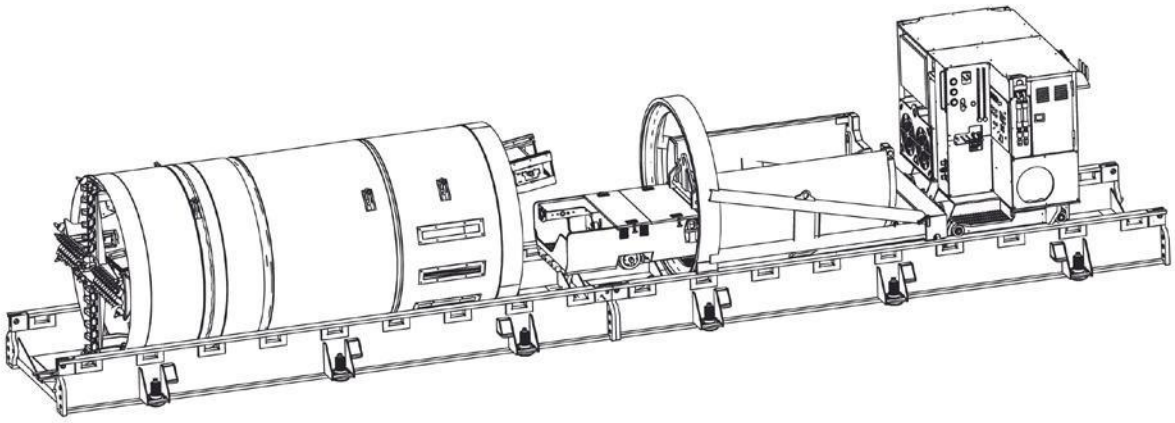

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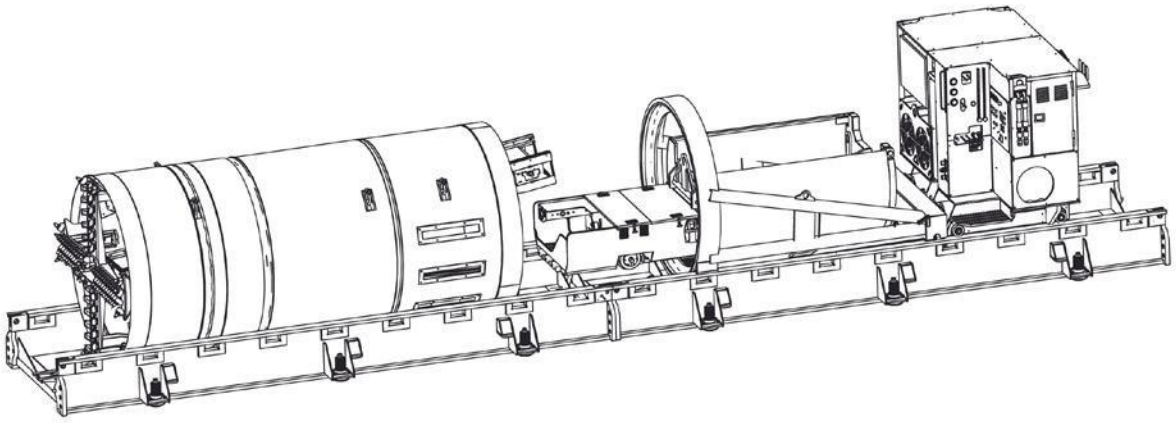

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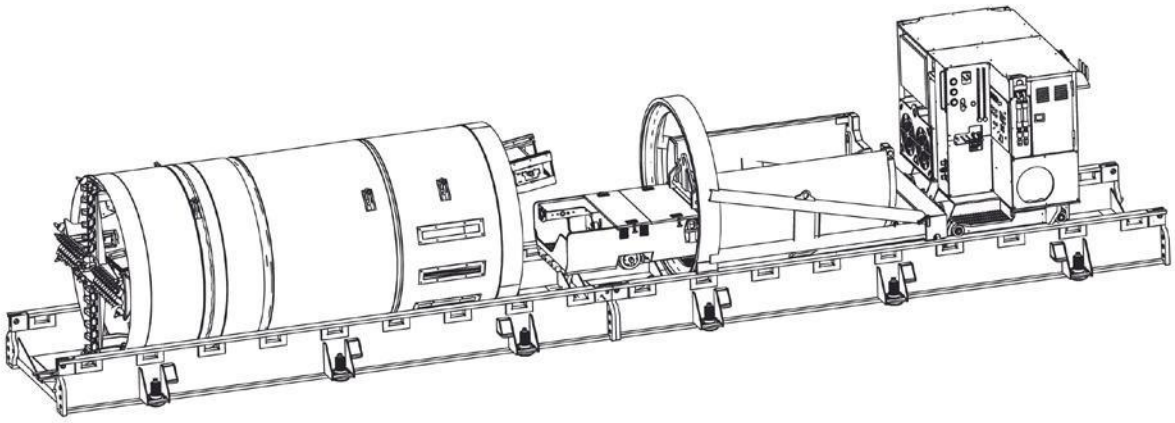

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