OPERATOR'S MANUAL

TriHawk® Tooling Installation

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Introduction

This operation manual contains important safety and operation information for installing the TriHawk® tooling. You must read and understand this manual, your GBM 240A Operator's Manual, Akkerman Bentonite & Lubrication Pump Operation & Parts Manual and other equipment manuals before you operate and maintain this equipment. Keep this manual with your GBM system at all times. Additional copies of this manual may be purchased from the Akkerman Aftermarket Support Department, or downloaded from the Akkerman web site at www.akkerman.com.

The contractor is responsible for the overall safety program on the job site. Use this manual as a part of the safety program.

The use of second rate parts could affect the efficient performance of this system. ALWAYS use genuine Akkerman parts.

Understand safety signal words, DANGER, WARNING, CAUTION, SAFETY INSTRUCTIONS, and NOTICE. When you see these words in this manual or on safety decals mounted on your equipment, follow the safety message to avoid personal injury and/or property damage.

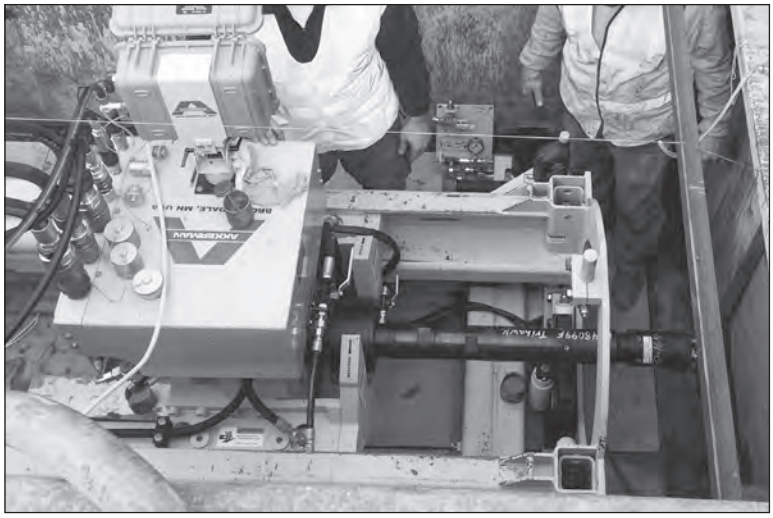
⚠DANGER Indicates an extremely hazardous situation which, if not avoided, WILL result in death or serious injury.

⚠WARNING Indicates a potentially hazardous situation which, if not avoided, COULD result in death or serious injury.

⚠CAUTION Indicates a potentially hazardous situation, which, if not avoided, MAY result in minor or moderate injury. It may also be used to alert against unsafe practices.

SAFETY INSTRUCTIONS Usually consists of individual messages stating procedures or actions that must be followed for the safe operation of a product.

NOTICE Identifies potential property damage and important installation, operator, or maintenance information.



GBM 240A Jacking Frame With TriHawk® Tooling

The Akkerman GBM pilot tube system with the Rock Drill Adapter and the TriHawk® or other soft rock steering tooling provides the ability to accurately drill through rock formations on line and grade using the Akkerman standard GBM guidance system or contractor supplied sonde/beacon housing. Using the Akkerman GBM 240A stand alone frame or GBM frame/auger boring machine with the Akkerman pilot tubes, depending on the bit, drills a 4.8 - 5.5" OD pilot bore on line and grade. The Akkerman Bentonite and Lubrication pump provides the polymer fluid needed to cool the drill bit and suspend the cuttings during transport from the drilling bit to the launch shaft. The polymer fluid is pumped into the pilot tube annular space, through the rock drill adapter, out through the tooling bit port and then through the outside of the pilot tubes to the launch shaft.

If you find any errors with this manual or know of ways to improve procedures, please let us know. Mail your suggestions to: Akkerman Inc, ATTN: Technical Publications, 58256 266th Street, Brownsdale, MN 55918.

Akkerman Inc. reserves the right to improve its product without notice or obligation.

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Safety

BE ALERT FOR SAFETY INFORMATION

When you see this safety alert symbol on your equipment or in this manual, be alert to the possibility of personal injury or property damage.

Read all safety information.

Keep safety decals clean and in good condition. Replace missing or damaged safety decals.

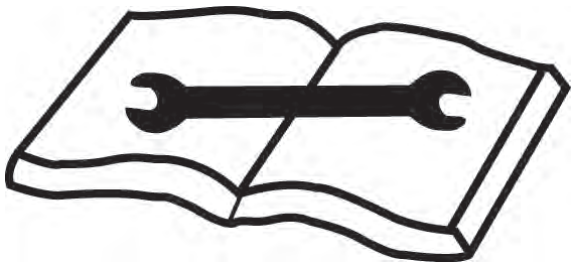
ATTENTION!
BECOME ALERT!
YOUR SAFETY IS INVOLVED!

READ OPERATOR'S MANUAL

⚠WARNING Unsafe operation or maintenance can cause severe injury or death.

Read and understand the Operator's Manual before operating or servicing this equipment.

Any unauthorized modifications will void the warranty.



WEAR PROTECTIVE CLOTHING

Wear OSHA approved protective clothing, such as hard hat, gloves, safety goggles, earmuffs or ear plugs, face shield, and steel-toed boots, when operating and servicing this equipment.

Wear reasonably close fitting clothing and remove jewelry before working on or near this equipment. This will help prevent the danger of catching them in moving parts or controls.

LOCKOUT/TAGOUT POWER BEFORE SERVICING

⚠WARNING Failure to lockout/tagout power before servicing can cause severe personal injury or death.

LOCKOUT/TAGOUT main power supply before servicing. Electrical repairs must be performed only by a certified electrician.

MAINTAIN BATTERY SAFELY

⚠WARNING Batteries produce explosive gases.

Wear eye protection and protective clothing during battery service.

Keep sparks, flames, and cigarettes away from batteries.

Contact with battery acid can cause severe burns. Flush immediately and thoroughly with clean water. Get medical attention immediately.

Charge a battery only in a well-ventilated area.

Never charge a frozen battery.

HYDRAULIC OIL/FLUIDS UNDER PRESSURE

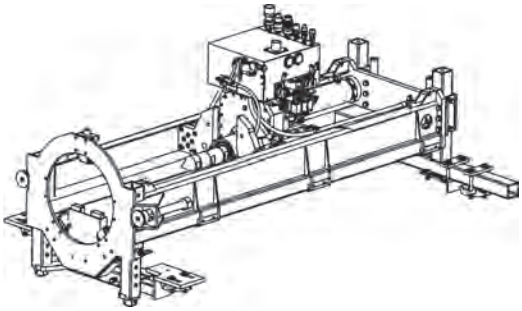
⚠WARNING Escaping oil or other fluids under pressure can penetrate your skin causing serious injury.

Release all pressure before performing maintenance or repairs. Never weld near pressurized fluid lines.

DO NOT use your hands to check for leaks. When searching for leaks, use a piece of wood or cardboard.

Contact medical help immediately if any oil or fluid is injected into your skin. A serious infection or reaction can emerge without proper medical treatment.

HIGH PRESSURE HYDRAULICS



⚠WARNING The GBM contains high pressure hydraulics.

Keep all guards in place.

BEWARE OF SUSPENDED LOADS

⚠WARNING Suspended loads may fall and cause severe personal injury or death.

If a hydraulic hose breaks from the boom of a crane/excavator, or the lifting support fails, the boom and/or load can fall instantly.

Do not enter area under or around a suspended load.

KEEP PERSONNEL AWAY FROM MOVING PARTS

⚠WARNING Crushing hazard.
Keep personnel away from inside of GBM when jacking or moving GBM. Failure to do so could result in serious personal injury or death.

USING PLUMB BOB

⚠WARNING Falling plumb bob can cause serious personal injury or death, and/or equipment damage.

NEVER hang or secure the plumb bob overhead when not in use.

ALWAYS remove the plumb bob from the string lines and place in storage container after use.

AVOID PINCH POINTS

⚠WARNING Moving parts or the mishandling of parts can cause severe personal injury.

Keep hands away from moving parts.

Watch your fingers, hands, and legs while equipment is in operation.

Handle parts carefully to avoid crushing and pinch point hazards.

PRACTICE SAFE MAINTENANCE

⚠WARNING Unexpected Jacking System movement may cause serious personal injury.

LOCKOUT/TAGOUT power before performing any maintenance.

Shut down GBM before making repairs, adjustments, or removing obstructions.

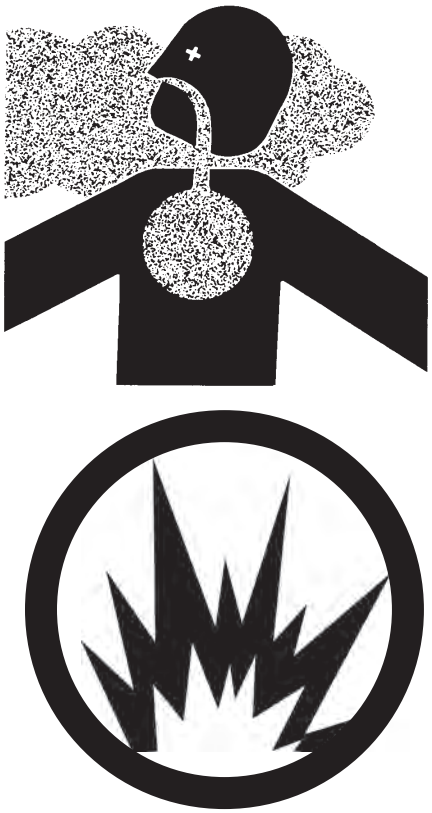
Only trained and qualified personnel should perform maintenance or repairs.

Keep the area around the equipment clean and dry when performing maintenance.

Do not service the machine while it is in motion.

Replace worn or damaged parts. Remove grease, oil, or debris buildup.

TEST SHAFT & TUNNEL VENTILATION



⚠WARNING Keep shafts and tunnel well ventilated at all times.

Use an approved air analyzer to detect hazardous gases and oxygen content.

Before and during the shaft operation, test for combustible and toxic gases and oxygen deficiency.

If the levels exceed MSHA/OSHA prescribed levels, leave tunnel and shaft immediately! Do not activate or deactivate any electrical or hydraulic devices, since any sparks could cause an explosion.

Once ALL personnel are out of tunnel/shaft, cut power from power source.

Gases must be removed before reentering tunnel/shaft.

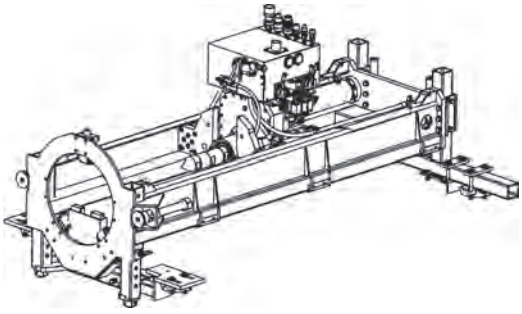
FIRE PREVENTION

⚠CAUTION Fires can cause injury or property damage.

Keep equipment clean. Remove all debris from equipment.

Have a fire extinguisher available at all times. Keep the fire extinguisher fully charged.

REGULARLY CLEAN AND INSPECT EQUIPMENT



Remove any grease, oil, or debris buildup to avoid potential injury or equipment damage.

Inspect equipment for damage. If damaged, repair or replace immediately.

KEEP JOB SITE CLEAN AND ORGANIZED

⚠WARNING Tripping can cause serious personal injury.

Be sure to keep job site clean and organized.

SLIPPERY WHEN WET

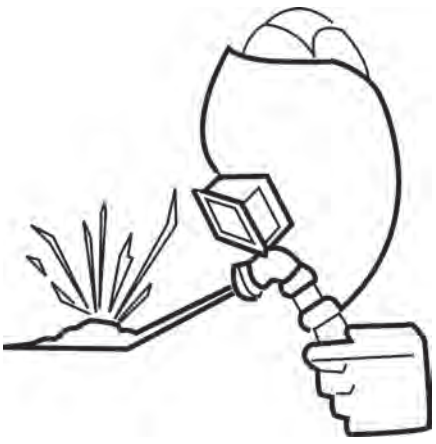
⚠WARNING Slips and falls can cause serious personal injury.

Ensure firm footing in wet or slippery conditions.

Replace skid-resistant material if it is damaged or missing to prevent slips and falls.

Remove any buildup of grease, oil, or debris.

UNAUTHORIZED WELDING



⚠WARNING Unauthorized welding can cause structural failure resulting in possible injury or death.

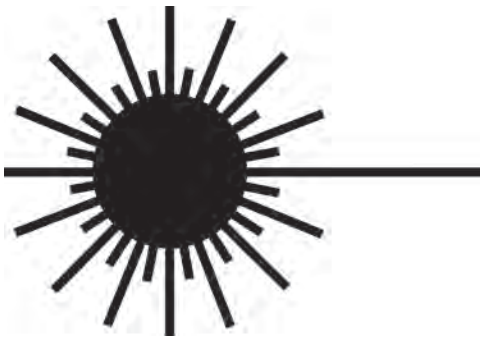
Do not weld on any structural member. Unauthorized welding or repair will void the warranty.

AVOID LASER LIGHT EXPOSURE

⚠DANGER Staring into laser light will cause severe injury.

Do not stare into laser guidance system light beam. Avoid direct eye exposure.

To avoid possible exposure to radiation in excess of acceptable emission limits, all repairs to laser must be performed by the original manufacturer or an authorized service technician.



NO SMOKING IN TUNNEL

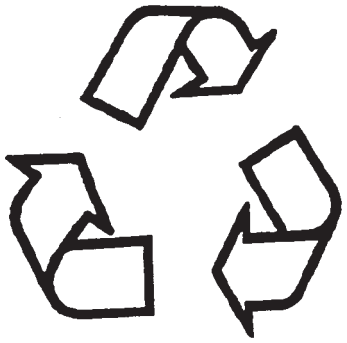
⚠WARNING Smoking in tunnel could cause an explosion if combustible gases are present.

Do not smoke in tunnel.

RECYCLE WASTE

Follow local, state, federal, and international regulations when recycling or disposing of waste. Waste includes fluids/oil, fuel, filters, coolant, and batteries.

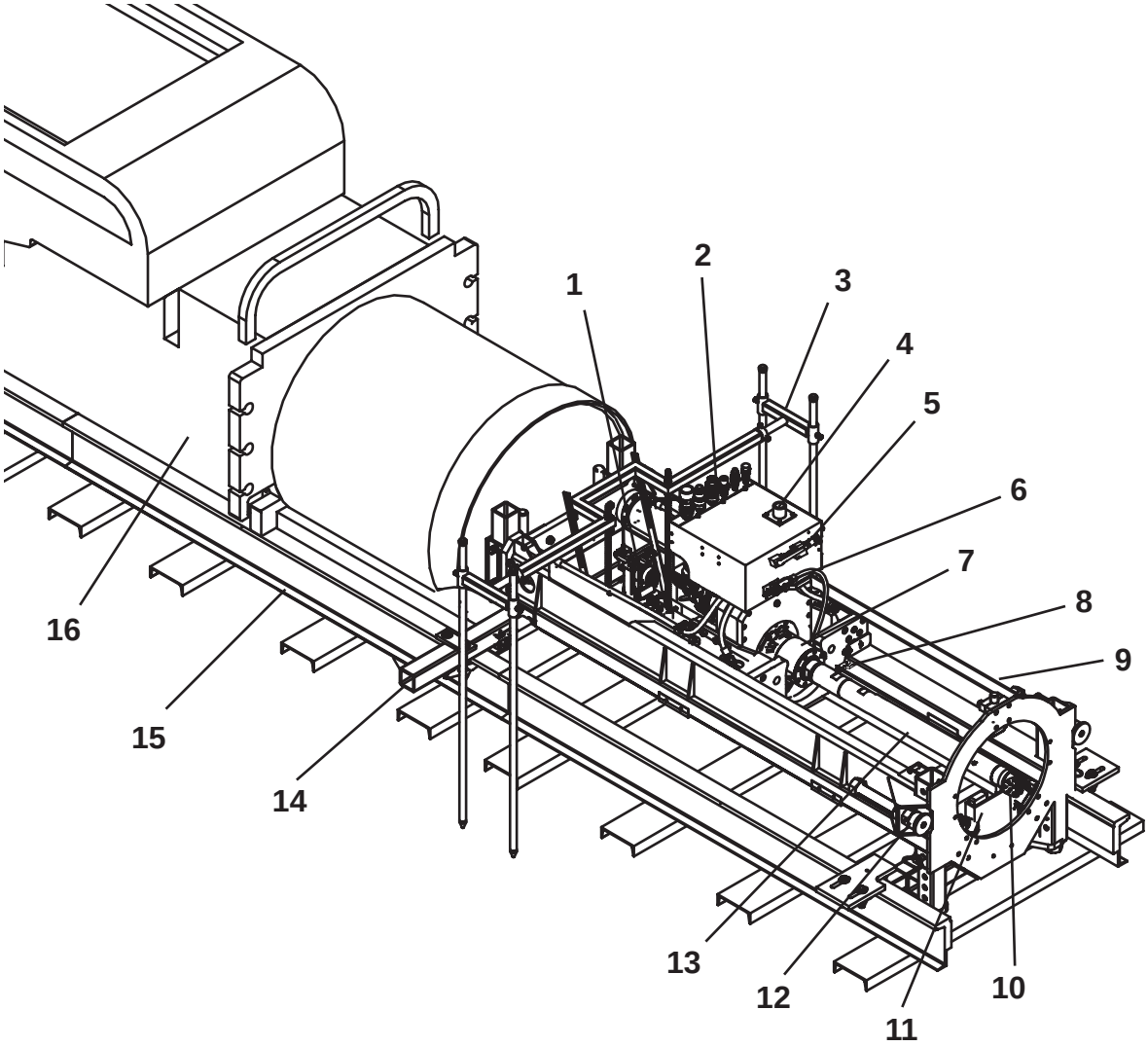
Use leakproof containers when draining fluids/oil. Do not pour waste on the ground, down a drain, or into any water source.

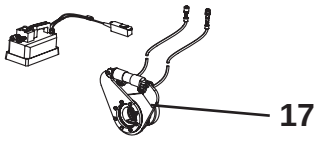


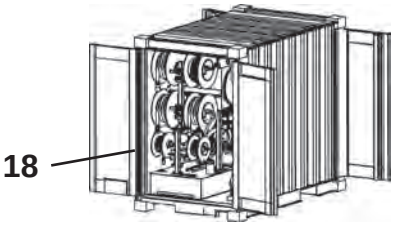
NOTES

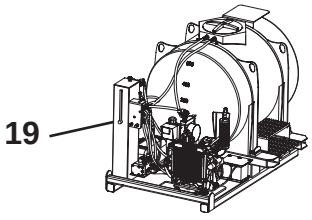
Terminology

GBM ROCK DRILL SYSTEM



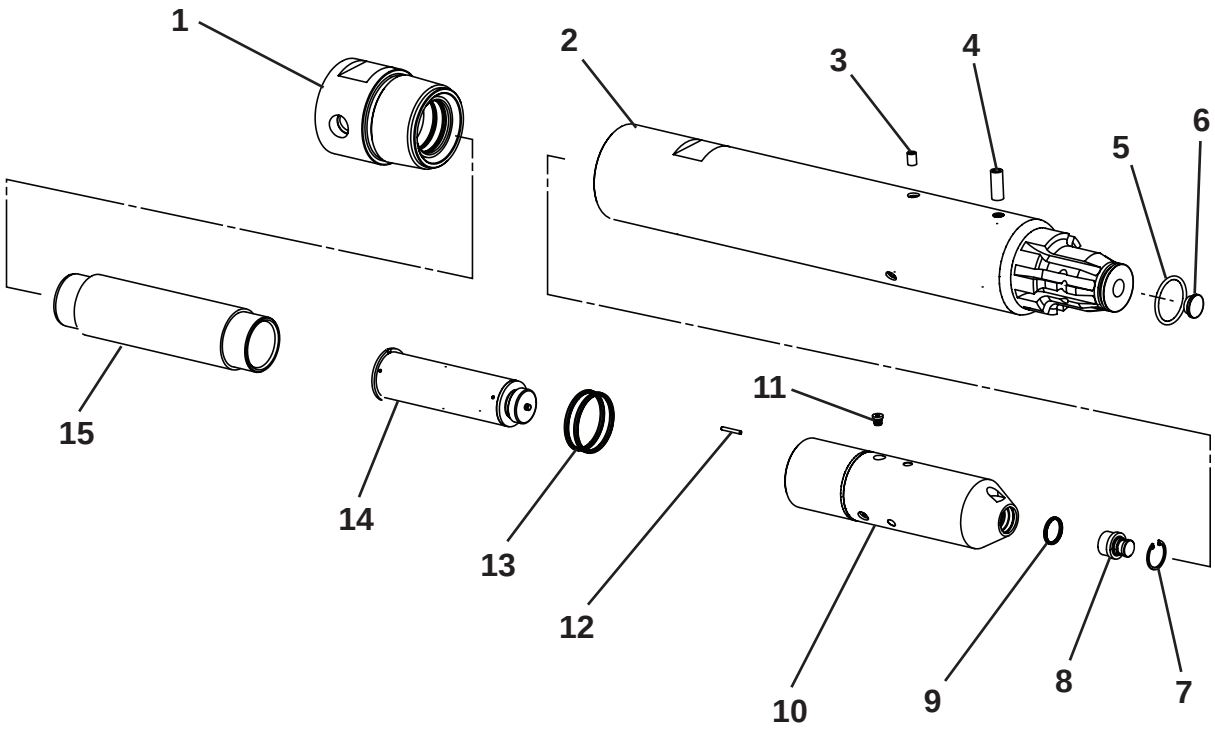






1. Theodolite
2. Hydraulic Connections
3. Guidance System Mounting Stand
4. Guidance System Monitor Mount
5. TriHawk Jacking PSI Control
6. Fluid Lube Control
7. Drive Swivel
8. Lube Dump Control
9. GBM 240A Jacking Frame
10. TriHawk Cutter BIt
11. Hydraulic Make Up Tool
12. Shaft Tensioner
13. Rock Drill Adapter (RDA)
14. Universal Auger Rig Adapter
15. ABM Track
16. Auger Boring Machine
17. Reception Breakout Tool
18. GBM Power Pack
19. Bentonite & Lubrication Pump (1525B/D Shown)

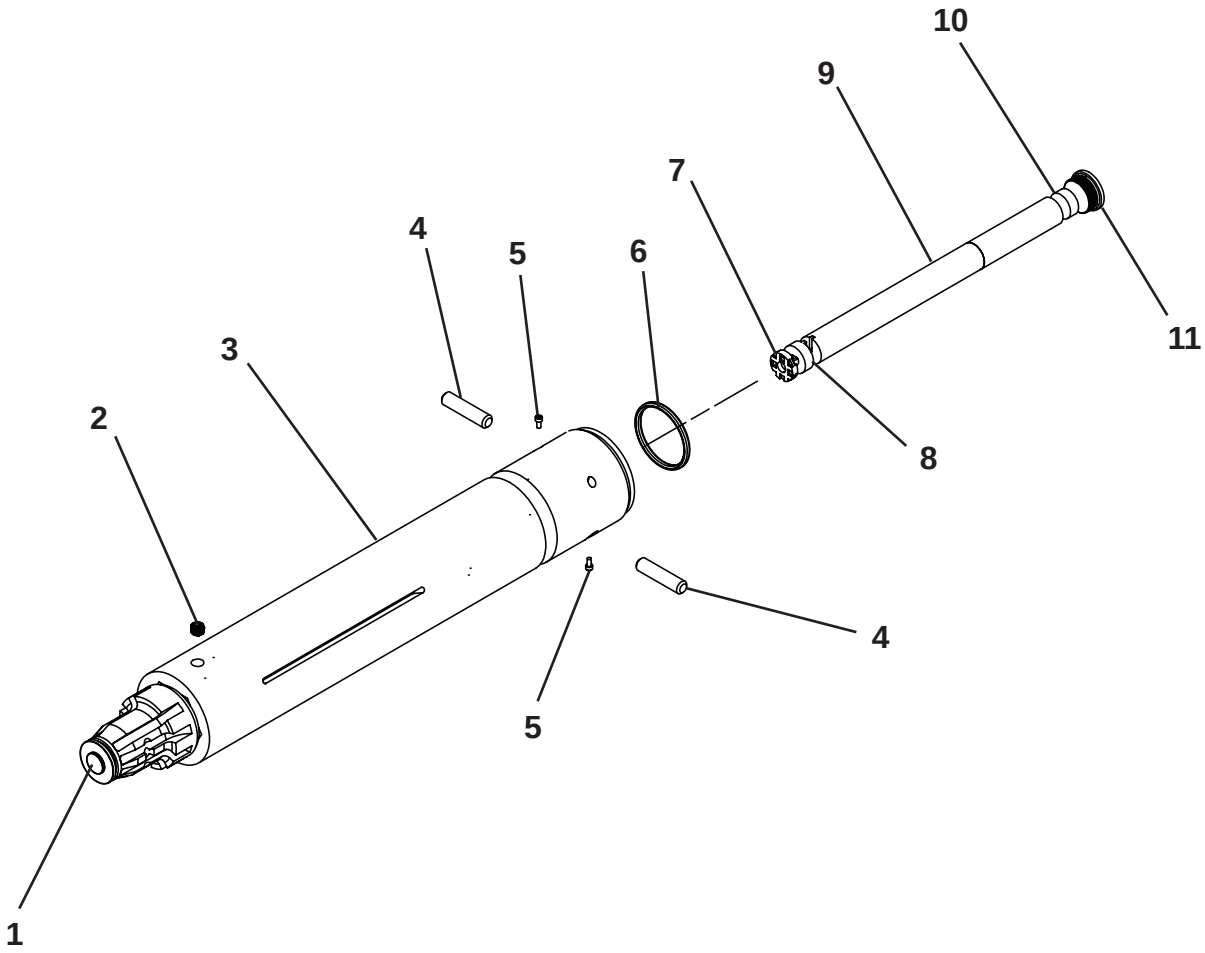
ROCK DRILL ADAPTER (RDA)



1. Air/Fluid Connector
2. Pilot Tube To TriHawk Adapter
3. Socket Head Cap Screw 3/8 UNC x .5
4. Socket Head Cap Screw 1/2 UNC x 1.25
5. Oring*
6. Check Valve*
7. Snap Ring
8. Check Valve
9. Oring
10. Target Holder
11. Plug
12. Roll Pin 1/8 x 1
13. Orings
14. Target Assembly**
15. Inner Tube

* Oring & check valve included with TriHawk spud part.
** Not part of Rock Drill Adapter

SONDE HOUSING ASSEMBLY



1. Check Valve*
2. Plug
3. Sonde Housing Adapter
4. Connection Pin
5. Socket Head Cap Screw 10-24 x .375
6. Oring
7. Cushion**
8. Alignment Key**
9. Sonde/Beacon Assembly***
10. Foam Cushion
11. Plug

* Check valve included with TriHawk slined adapter.
** It may be helpful to secure items 7 and 8 to customer supplied Sonde/Beacon assembly item 9 before inserting parts into housing.
*** Customer supplied Sonde/Beacon (Max length 15 In. (381 mm)

TRIHAWK® CUTTER BITS

TriHawk I
P0050-164

- ***TriHawk I drill bit*** is an aggressive cutting tool for boring in soft rock conditions up to 8,000 psi.

  Ground: Compacted soils, cobble, soft rock

  Bit Type: Embedded carbide and replaceable bullet teeth

  Cut Diameter: 5.12 in. (130 mm)

TriHawk III
P0050-162

- ***TriHawk III drill bit*** is the cutting tool for soft to medium rock up to 12,000 psi and cobble bores.

  Ground: Hard soils, soft rock

  Bit Type: Replaceable bullet teeth w/ hard facing

  Cut Diameter: 5.5 in. (140 mm)

TriHawk IV
P0050-161

- ***TriHawk IV drill bit*** is designed for glacial till, and heavy, overburden cobble or fractured rock.

  Ground: Tilt, cobble, soft rock

  Bit Type: Embedded carbide

  Cut Diameter: 5.5 in. (140 mm)

TriHawk V
P0050-160

- ***TriHawk V drill bit*** provides unbeatable performance in round rock cobble, flat river stone, hardpan and loose fill.

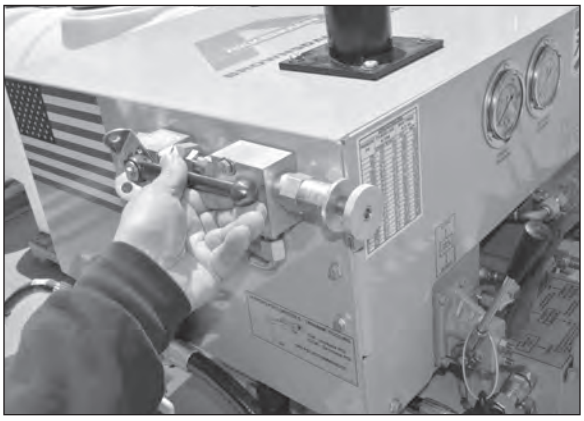
  Ground: Gravel, loose fill, dense soil

  Bit Type: Embedded carbide

  Cut Diameter: 4.8 in. (122 mm)

Controls & Instruments

TRIHAWK® JACKING PSI CONTROL



The Jacking PSI controls are used to regulate the thrust pressure (500 psi maximum) when operating the TriHawk tooling.

This control limits the thrust pressure so the cutter bit teeth are not overloaded (may result in breakage) and will also help prevent stalling.

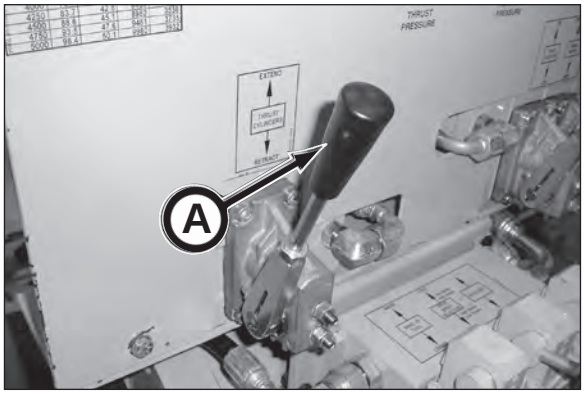
BEFORE operating the TriHawk tooling, flip the pressure control to the ON position.

THRUST CYLINDER CONTROL

Use the thrust cylinder control (A) to extend and retract the frame thrust cylinders.

Extend Cylinders - Push lever Up
Retract Cylinders - Pull lever Down

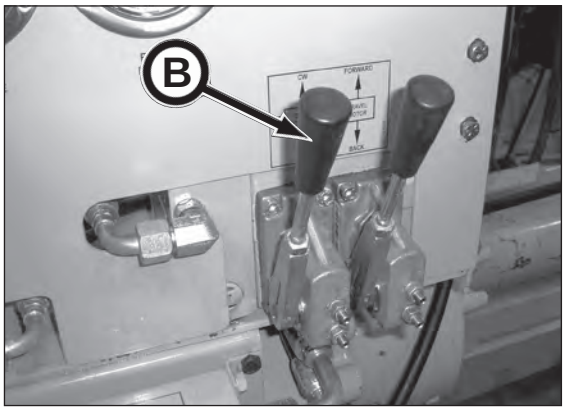
This control is also used for advancing and retracting the TriHawk tooling and pilot tubes. The Jacking PSI Control must be in the ON position for the proper operation of the TriHawk tooling (refer to TriHawk Jacking PSI Control in this section). Faster advance rate will cause larger chips which could result in plugging of the chips in the bored hole.



GBM Frame

DRIVE ROTATION CONTROL

The drive rotation control (B) is used to rotate the TriHawk/RDA and pilot tubes.



NOTICE Typically rotate the pilot tube string CW. Rotating the pilot tubes CCW may be necessary for steering corrections.

IMPORTANT: If rotating tubes CCW for a steering correction, the target image MUST ROTATE, otherwise the tubes are unthreading resulting in unrecoverable TriHawk/RDA and pilot tubes. Do not engage cutter bit into rock while rotating tubes CCW.

Use CCW rotation when the TriHawk/RDA or pilot tube is locked into the make up tool for removal from the gear box drive adapter.

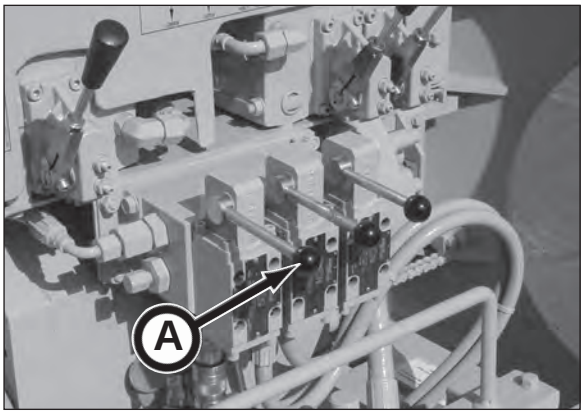
Clockwise (CW) Rotation - Push lever Up
Counter-Clockwise (CCW) Rotation - Pull lever Down

MAKE UP TOOL CONTROL

The hydraulic make up tool control (A) is used to tighten each section of the pilot tubes as they are being installed in the launch shaft.

In pull back operation, the make up tool is used to separate the pilot tubes in the launch shaft.

Lock - Push lever Up
Unlock - Pull lever Down



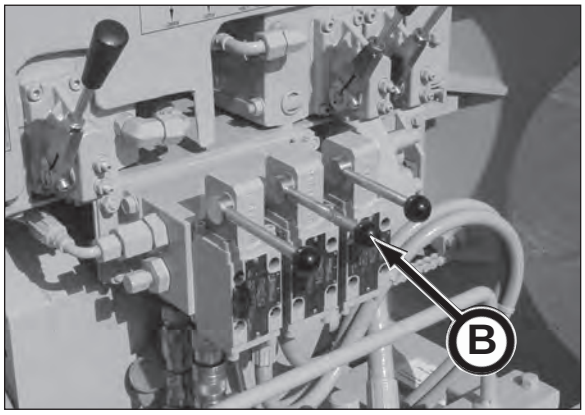
DRIVE SPEED SELECTOR

The drive speed selector (B) controls the rotational drive motor speed and torque.

When torquing tube joints, use the LSHT or Low Speed High Torque position.

When operating TriHawk cutter, use the HSLT or High Speed Low Torque position.

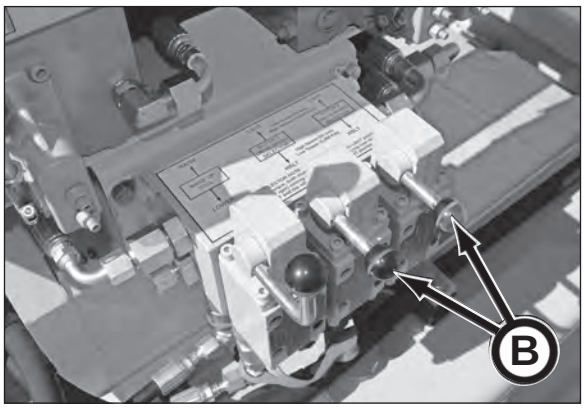
LSHT - Push lever Up
HSLT - Pull lever Down



240A SN FA40027F-55 & Before (2 Speed Drive Motor)

Three Speed Drive Motor Selector Notes:

1. For maximum torque, both drive speed selector levers must be in the LSHT position.
2. For maximum speed, both drive speed selector levers must be in the HSLT position.
3. A mid speed (37 rpm) setting can be achieved by placing one drive speed motor selector in HSLT position and the other drive speed motor selector in LSHT position.

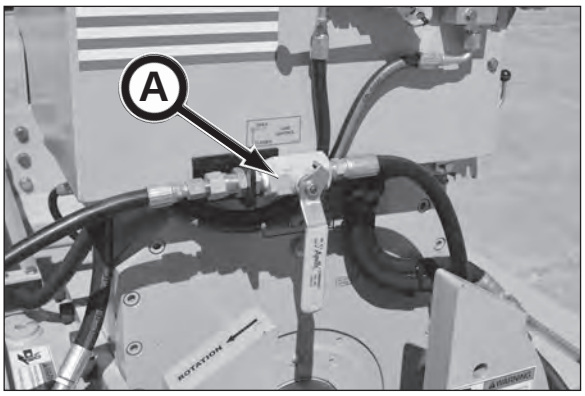


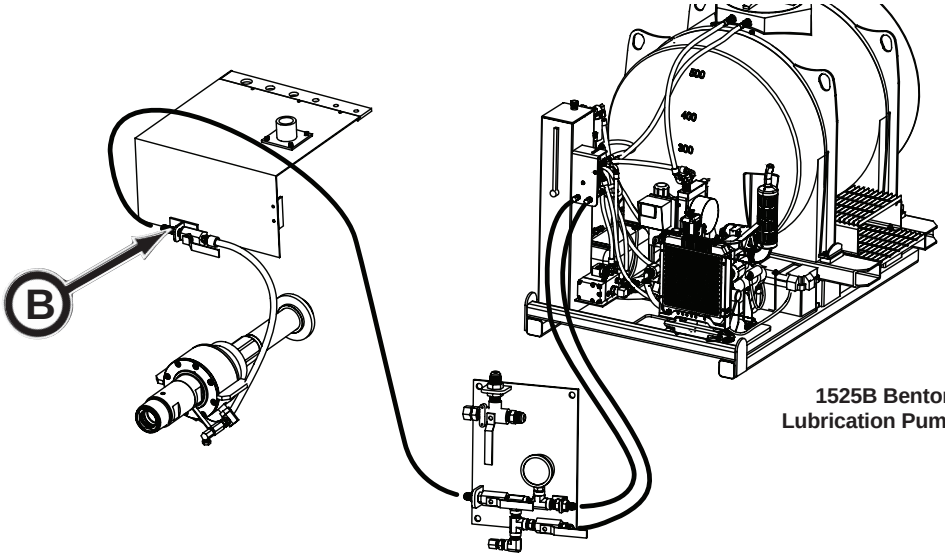
240A SN FA40027F-56 & After (3 Speed Drive Motor)

LUBE CONTROL

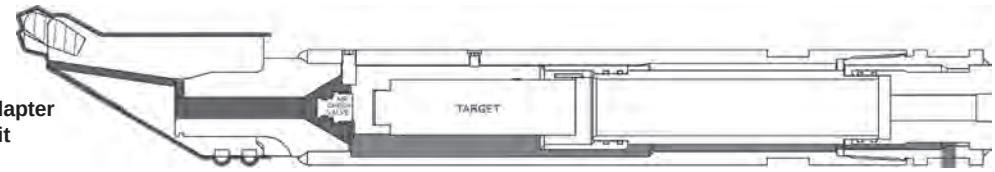
The lube control (A) regulates the lubricant flow to the drive swivel which allows the lubricant to flow through the dual walled pilot tube annular space and then out the TriHawk cutter bit port.

• Lubricant flowing through the RDA and out of the TriHawk drill bit port cools the drill bit and flushes the cuttings to the launch shaft. Control lubrication flow so there is lubricant/cuttings flowing out of the bored hole into the launch shaft.





1525B Bentonite & Lubrication Pump Shown

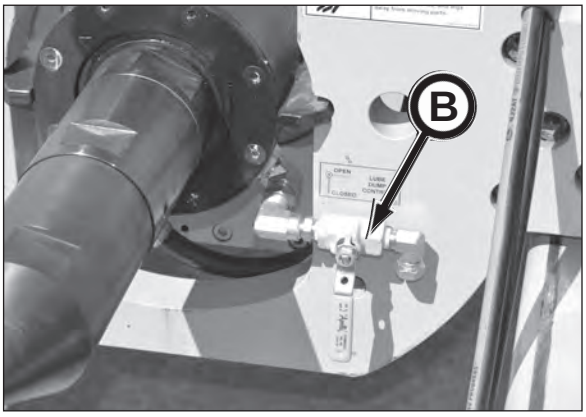


Pilot Tube To TriHawk Adapter With TriHawk Drill Bit Fluid Path

LUBE DUMP CONTROL

Using the lube dump control (B), vents the lubricant fluid into a catch pan or other suitable container **BEFORE LOOSENING PILOT TUBE JOINTS**.

This will relieve fluid pressure and prevent the fluid from entering the inner tube of the pilot tube.



NOTES

Pre-Start Inspection

⚠WARNING Do not operate this equipment until you read, study, and understand this manual, your GBM 240A Operator's Manual, Bentonite & Lubrication Pump Operation & Parts Manual and other equipment manuals. A daily inspection of the equipment must be performed to prevent severe personal injury or death and equipment damage.

The contractor is fully responsible for the safety of all personnel on the job site. Check with the contractor that all site preparation requirements are in place. Be sure to comply with all OSHA regulations, such as: an active safety program is in practice, a confined space permit (if needed) is issued, personal protective equipment is being worn; flammable, combustible, and hazardous materials are properly stored; and a lockout/tagout procedure is in place.

Use the following checklist ✓ as a guide for your daily pre-start inspection. Make a copy of this Pre-Start Inspection checklist. Once it is complete, check off, initial and date each item and file the copy as a record of Inspection.

	1. Refer to GBM 240A, Bentonite & Lubrication Pump manuals for pre-start inspection information.
	2. A qualified electrician must check that all electrical connections are properly secured and grounded prior to operation.
	3. Check condition of personal protective equipment. Replace equipment if defective.
	4. Contractor is responsible for all personnel to wear proper protective equipment on the job site.
	5. Test air monitoring and ventilation detectors for proper operation.
	6. Inspect all equipment for damage. Repair or replace as needed.
	7. Be sure all covers and guards are in place before operation.
	8. Periodically check that all fittings are tight and hoses are in proper working condition.
	9. Check for fluid leaks. Repair leak or replace components.
	10. Keep job site clean and organized.
	11. Check all equipment for proper lubrication.
	12. Check that all pumps are working properly.
	13. Before TriHawk operation, check to be sure fluid is flowing out of all the cutter bit ports.
	14. Inspect cutter bit for wear or damage. Replace replaceable bullet teeth as needed. Check embedded carbide and hard facing for wear or damage. Replace bit as needed.
	15. Before operating, be aware of all pinch point areas on the equipment by conducting a visual inspection.

NOTES

Operation

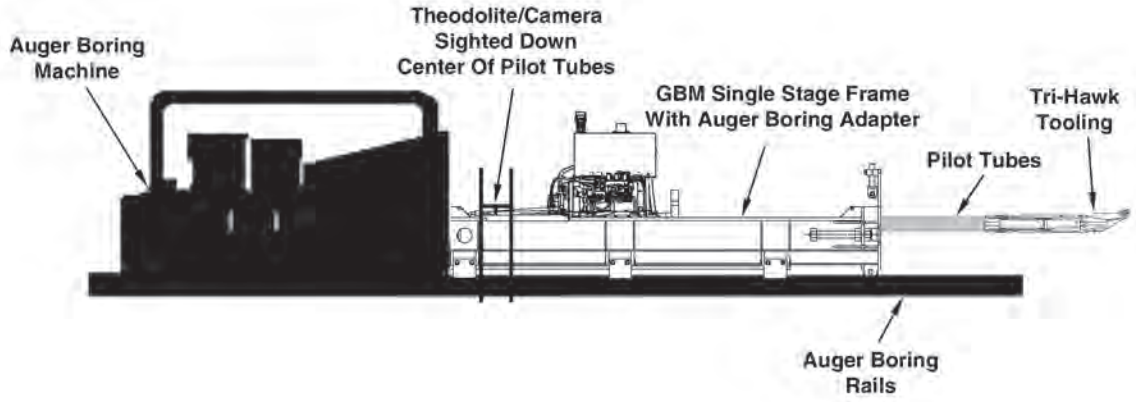
OPERATING GUIDELINES

IMPORTANT: *Use this manual along with your GBM 240A Operator's Manual, Bentonite & Lubrication Pump Operation & Parts Manual and other equipment manuals. You must read and understand the manuals before you operate and maintain this equipment. These manuals include important safety, operation and maintenance information.*

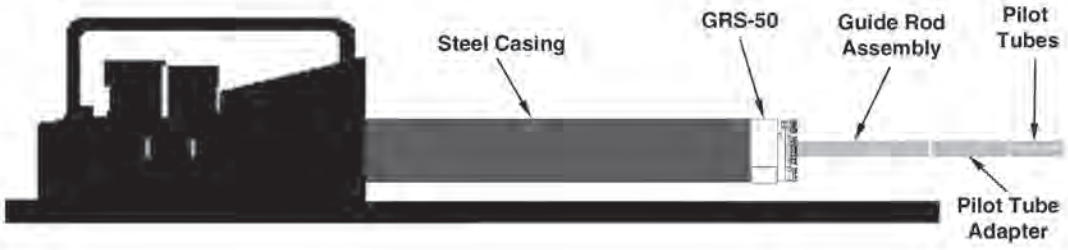
1. Before operating, read and understand the Safety, Pre-Start Inspection, and Operation sections.
2. Do not operate this equipment while under the influence of alcohol, drugs, or medication.
3. Follow all Federal, State, and Local safety regulations and procedures.
4. Be sure OSHA prescribed safety personal protective equipment is being worn by all personnel.
5. Be sure the area is safe for operation. Keep work site clean and organized.
6. NEVER operate equipment if it has been engulfed with water. Contact your Akkerman Aftermarket Support representative for proper procedures on how to restore equipment for operation.
7. Have a fully charged fire extinguisher on the job site at all times.
8. Before operating, repair all equipment issues.
9. Be sure the excavated launch and reception pits or shafts are properly shored or braced to prevent slides or cave-ins.
10. Test air monitoring and ventilation detectors for proper operation. Never enter a tunnel without gas detectors.
11. A fully trained and qualified signal person must direct the excavator or crane operator when lifting and lowering equipment into the launch or reception pits.
12. Never walk or work under any part of the excavator or crane and suspended loads.
13. Remove plumb bobs from string lines and place in storage container after use. Never hang or secure plumb bobs over shaft. Doing so may cause severe injury or death from a falling plumb bob.
14. Operate jacking system at lowest pressure possible to prevent excessive heat build up.
15. Test all controls to make sure they work properly.
16. Pressure peaks cause hoses to jump without notice. Keep all personnel away from hoses during operation of equipment.
17. Lock out/tag out electrical power at the source (generator) before servicing electrical components.
18. ALWAYS rotate the pilot tubes CW (clockwise). Rotating the pilot tubes CCW (counterclockwise) will unthread the pilot tubes in the pipeline resulting in unrecoverable pilot tubes. If using the carve cutting method, pilot tubes can be rotated CCW provided it is for positioning the cutter bit and no drilling.
19. Adding more thrust pressure does not increase penetration rate. Drilling with excessive weight on cutter bit can only decrease bit life and increase the torque loading on the pilot tube string.
20. High pressure hydraulics are used on the GBM. Be sure all covers and guards are in place before operating.
21. The harder the rock the slower the advancement rate.
22. Check line and grade alignment on target monitor often to avoid misalignment.
23. Do not make any modifications to any Akkerman products. Doing so could cause structural failure and will void the warranty.
24. Do not make adjustments or repairs to the hydraulic system components while in operation or until all pressure is released and power pack is in lock out/tag out.
25. If this manual is lost, contact your Akkerman Aftermarket Support Representative to order a replacement manual or download this manual from the Akkerman web site at www.akkerman.com.

GBM INSTALLATION WITH TRIHAWK TOOLING

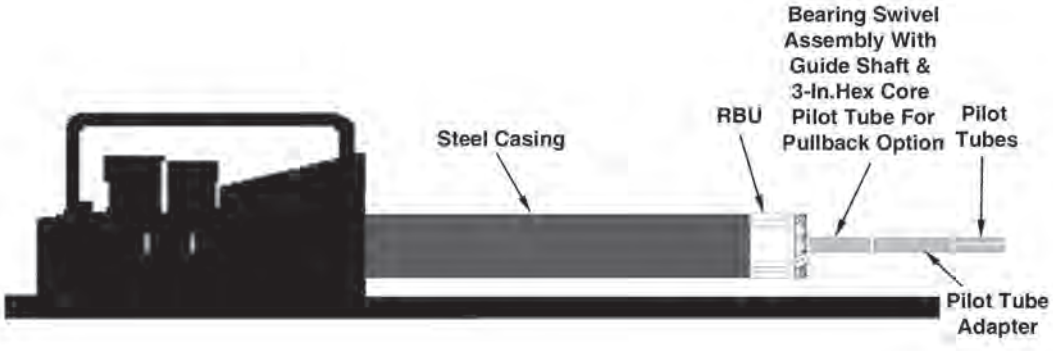
STEP 1: PRECISE INSTALLATION OF PILOT TUBES WITH GBM USING TRIHAWK TOOLING



STEP 2: INSTALLATION OF STEEL CASING WITH AUGER BORING MACHINE USING GRS-50



STEP 2: INSTALLATION OF STEEL CASING WITH AUGER BORING MACHINE USING RBU



TRIHAWK SYSTEM INSTALLATION SET UP

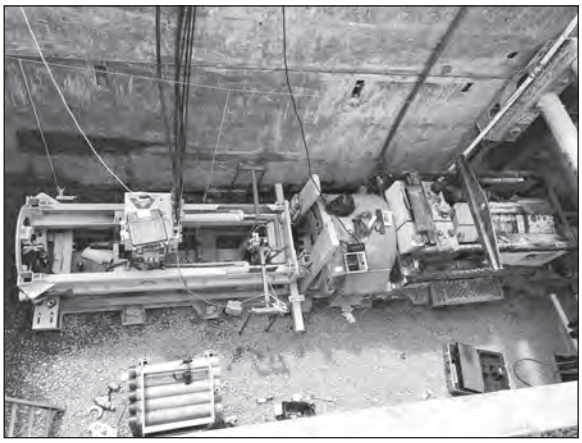
IMPORTANT: *Use this manual along with your GBM 240A Operator's Manual, Bentonite & Lubrication Pump Operation & Parts Manual and other equipment manuals. You must read and understand the manuals before you operate and maintain this equipment. These manuals include important safety, operation and maintenance information.*

⚠WARNING Suspended loads may fall and cause severe personal injury or death. Do not enter area under or around a suspended load.

1. The contractor is fully responsible for the design and construction of the OSHA required launch and reception shafts. For setup and installation drawings specific to the project, contact the Akkerman Sales Department.

2. On the GBM jacking frame, position and secure the gearbox assembly in the middle of the frame. This will balance the frame during the installation process.

3. Lower the GBM 240A frame into the launch shaft onto the auger boring track. With the GBM jacking frame positioned on the auger track rails, tighten the hardware to secure the position of the jacking frame to the track rails. The jacking frame and track must be anchored securely to prevent shifting during operation. It is recommended to secure the GBM frame as close to the wall as possible so the TriHawk/RDA assembly will be easier to keep the straight during the boring process.



IMPORTANT: The GBM frame MUST be in the same center line as the center line of the auger boring machine.

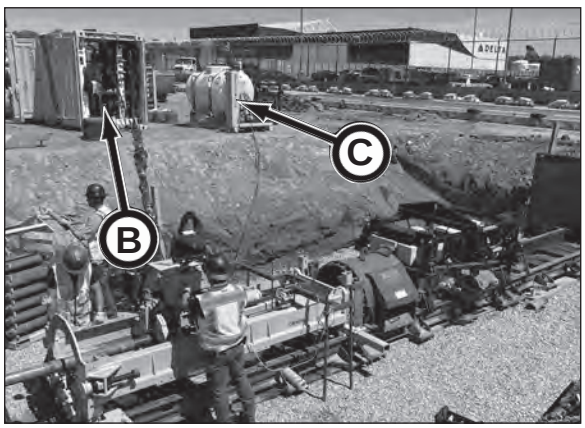
4. After the GBM jacking frame is secured to the auger frame rails, the auger boring unit is lowered and advanced forward to the back of the GBM jacking frame, which is used as a backstop.

   A stand alone backstop (A) can also be used in place of the auger boring unit, though the jacking frame and the backstop must be anchored securely to prevent shifting during operation.

NOTICE Drill uphill if possible to help flush cuttings to the launch shaft.

5. Position the power pack (B) on firm, level ground. Refer to 240A Operator's manual for setup and operation.

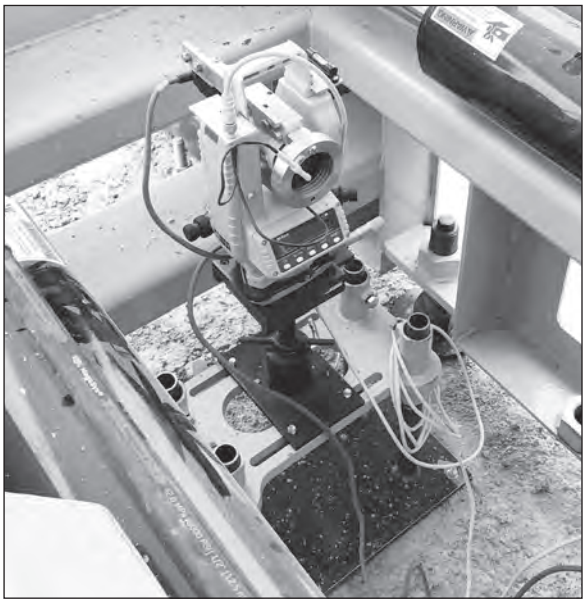
⚠WARNING Do not position the GBM power pack near the edge of the shaft where the ground may be unstable and cause a slide or cave-in. Doing so could cause severe injury or death.



6. Position the Bentonite & Lubrication Pump (C) on firm, level ground. Refer to Bentonite & Lubrication Pump Operation manual for setup and operation.

(continued on next page)

7. Install the guidance system using the mounting base (as shown) or the guidance system mounting stand. The guidance system must be secured in solid material and cannot contact any moving parts. **Refer to and perform section 6, Operation, Guidance System Setup in the 240A Operator's Manual for complete guidance system setup.**

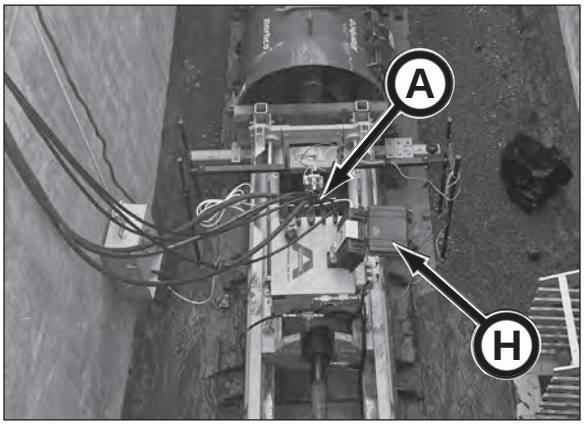


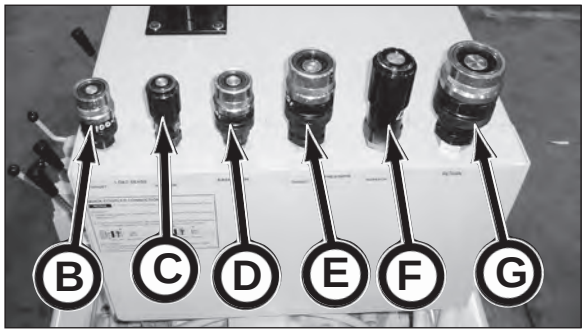
IMPORTANT: It is critical to check the zero point calibration of the theodolite before using in launch shaft. If the theodolite gets bumped, jarred or dropped, the calibration must be checked. Failure to check this calibration could cause misalignment in your line and grade. Keep in mind if the theodolite is misaligned one degree, you will be off nearly two ft (0.6 m) per 100 ft (30.5 m) in the drive (refer to Checking Theodolite Zero Point Calibration in section 6, Operation, Guidance System Setup, Checking Theodolite Zero Point Calibration in your 240A Operator's Manual.

8. With the power pack engine shut down, roll out the hydraulic hoses and connect the hoses to the GBM jacking frame hydraulic connections (A) as shown:

   - rotation load sense (B)
   - thrust load sense (C)
   - case drain (D)
   - rotation pressure (E)
   - thrust pressure (F)
   - return (G)

   Refer to Quick Coupler Installation in section 6, Operation, GBM Frame Set Up In Shaft of the 240A Operator's Manual.



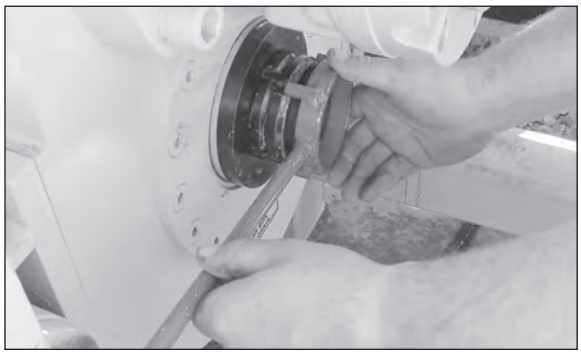


9. Setup the guidance system monitor (H):

   a. Connect cable from camera to Camera connection on guidance system.
   b. Connect LED cable from theodolite to LED/ Focus connection on guidance system.
   c. Connect power cable from pendant to Power IN connection on guidance system.

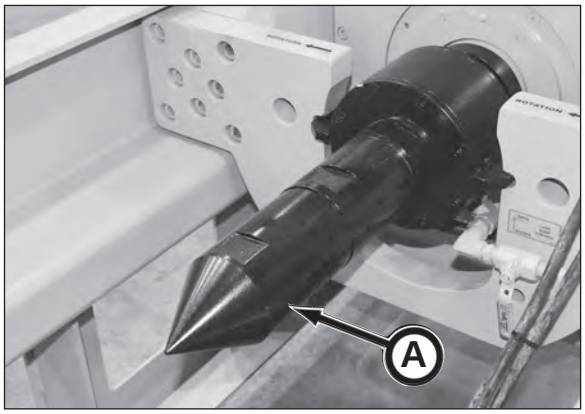
(continued on next page)

10. Secure one locknut so the locknut is flush with the back of the drive swivel on the back of the gear box. This allows the swivel to be attached to the gear box during pull back and allows some travel when tightening tube connections.



NOTICE If two locknuts are installed, remove one locknut.

11. To check center line of bore, use the alignment guide adapter (A).



12. Once alignment is confirmed, remove alignment guide adapter.

(continued on next page)

13. Preparing Bentonite & Lubrication Pump (use any Akkerman Bentonite & Lubrication Series Pump).

Refer to Bentonite & Lubrication Pump Operation manual for setup, mixing and operation.

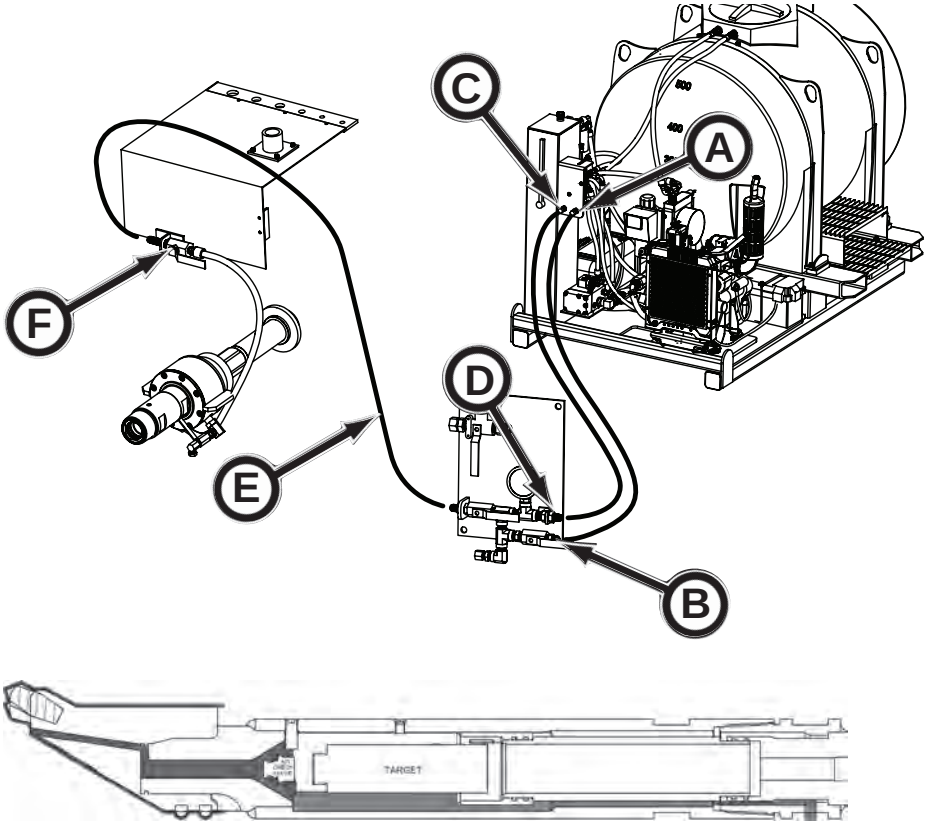
⚠WARNING Do not position the lubrication pump near the edge of shaft where the ground may be unstable and cause a slide or cave-in. Doing so could cause severe injury or death.

I. With the Bentonite & Lubrication Pump on firm, level ground, connect the lubrication hose to pump return connection (A) and lubrication return connection (B) on shaft control.

II. Connect the lubrication hose to pump pressure connection (C) and lubrication Pressure IN connection (D) on shaft control.

III. Connect the lubrication hose (E) from the shaft control to the lube control valve (F) on the GBM. The lube control on the GBM is connected to the drive swivel which allows the lubricant to flow through the dual walled pilot tube annular space and out the TriHawk® cutter bit ports.

Guidelines:
• (Soft Rock With TriHawk® cutter bit) control the lubrication flow so there is fluid flowing (flush cuttings) from the outside of the pilot tubes into the launch shaft.
• before loosening pilot tube joints, vent the fluid to relieve pressure and prevent the fluid from entering the inner tube of the pilot tube.
• use of polymers and bentonite with fluid mixtures up to 100 seconds (Marshall Funnel) viscosity can be used in any of the Akkerman Bentonite & Lubrication Pumps.



Pilot Tube To TriHawk Adapter (RDA)
With TriHawk Drill Bit
Fluid Path

(continued on next page)

IV. Prepare the Bentonite & Lubrication Pump

a. Fill Bentonite & Lubrication Pump tank with clean water.

b. Contact a drilling fluid supplier. Follow instructions from your supplier with the specific drilling fluid for the geology of the job.

c. Check the pH balance of the water. Your fluid supplier will provide information on how to achieve the proper water pH balance (typically using soda ash). Proper pH balance is critical to ensure the fluid can be fully hydrated.
- Obtain a pH test kit. There are various kinds of kits. Some test kits use litmus paper and others use drops to compare the color results to a color chart provided in the test kit.

d. Refer to the Bentonite & Lubrication Pump Operation Manual for mixing of products in tank.
- Additives should be gradually poured into the mixing tank per package instructions, though it is never recommended to exceed a rate of 50 lbs of additive in a 3 to 5 minute period. Adding lubricant too quickly will cause granules to settle at the bottom of the tank resulting in an improper mixture.

IMPORTANT: Fluid lubrication MUST be used anytime the TriHawk cutter bit is being advanced as follows:
As a guideline, use up to 4 gpm of lubricant to flush cuttings to launch shaft and for cooling of tool. Typically a mix of bentonite and polymer is used to keep the cuttings floating until they are removed in the launch shaft. Contact your polymer supplier for help with the proper lubrication mixture for your project.

e. At completion of drive, the Bentonite & Lubrication Pump must be thoroughly flushed and cleaned. Refer to Bentonite & Lubrication Pump Operation manual.

14. Proceed to Installing TriHawk Cutter To Rock Drill Adapter in this section.

INSTALLING TRIHAWK CUTTER TO ROCK DRILL ADAPTER

1. Check o-rings (A) in target holder for damage. If damaged, replace with new.

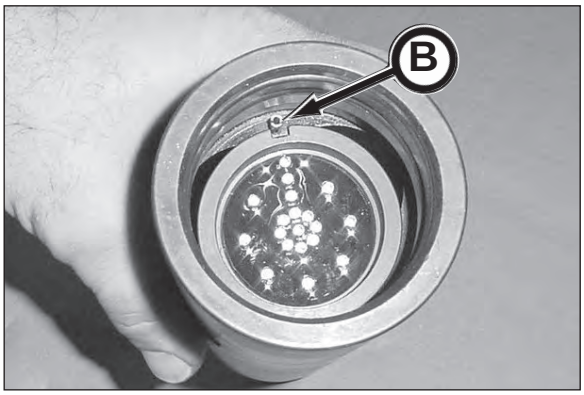
   Check to be sure that both o-rings are properly seated into target holder.

2. (Replaceable battery target) Remove cap on target. Place two new 1.5 volt, D size, alkaline batteries with the positive polarity going into target tube. Replace cap and turn completely in to illuminate the LED lights and to prevent moisture from entering target tube.


GBM
Smart Target
Instructions

NOTICE If using smart target, for smart target modes and operation refer to GBM Smart Target Instructions, 050144A provided with your smart target, or refer to page 8-2.

3. Slide target into target holder. Be sure the notch on the target aligns with pin (B) on holder.



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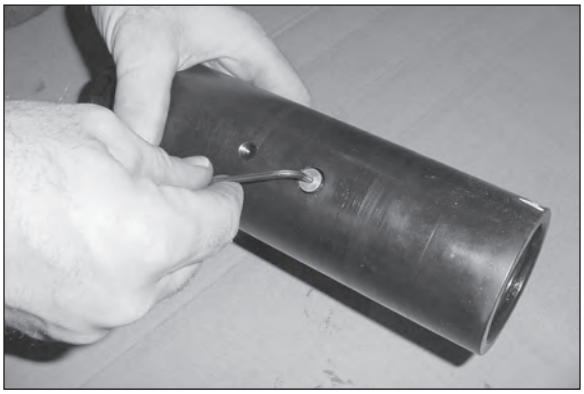
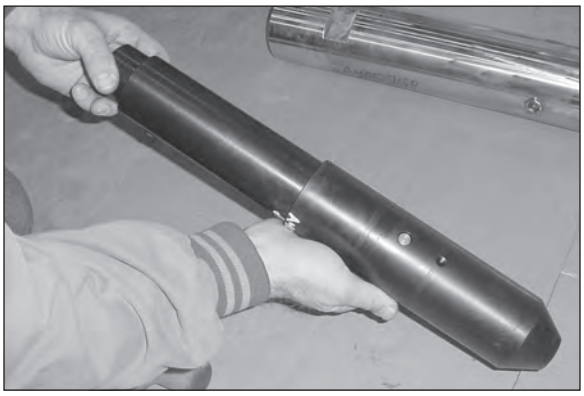
4. Secure target to target holder by tightening three set screws with a 1/8” allen wrench.



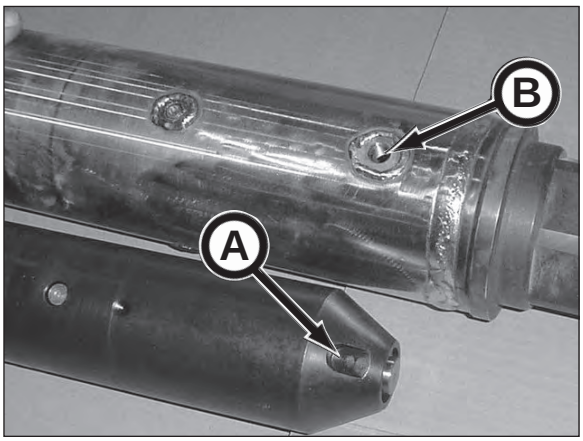
5. Fully insert inner tube into target holder.



6. Loosen three set screws on rock drill adapter with a 3/16” allen wrench, so the target assembly can be slid into adapter.

7. Remove the front 1/2 x 1-1/4 set screw for alignment purposes.

8. Before installing the target assembly, note that the target holder cavity (A) must align with the adapter set screw hole (B) on the rock drill adapter.



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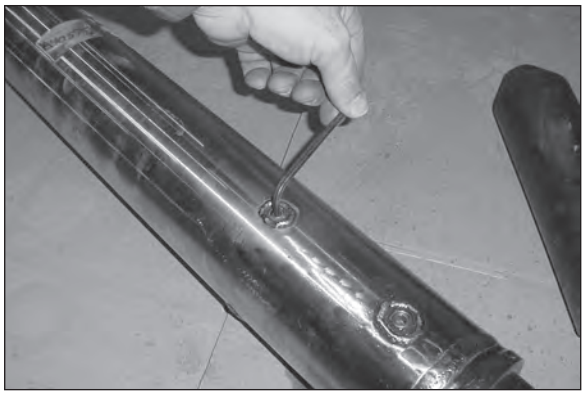
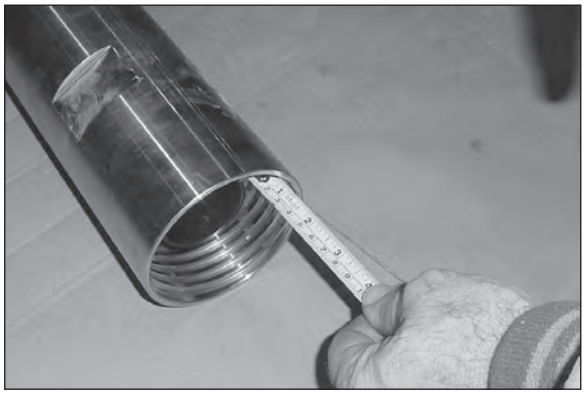
9. Slide target assembly into adapter. Be sure the target holder cavity aligns with the adapter set screw hole.

10. Reinstall the 1/2 x 1-1/4 in. set screw (removed in step 7) with a 1/4” allen wrench.

11. Tighten the other three set screws with a 3/16” allen wrench.



12. Check to be sure that the inner tube end of the target assembly is 1 in. (25.4 mm) from the end of the rock drill adapter. If not, the target must be remounted until the 1 in. clearance is achieved.



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13. Choose the TriHawk cutter bit per rock conditions.

TriHawk I
P0050-164

- ***TriHawk I drill bit*** is an aggressive cutting tool for boring in soft rock conditions up to 8,000 psi.

TriHawk III
P0050-162

- ***TriHawk III drill bit*** is the cutting tool for soft to medium rock up to 12,000 psi and cobble bores.

TriHawk IV
P0050-161

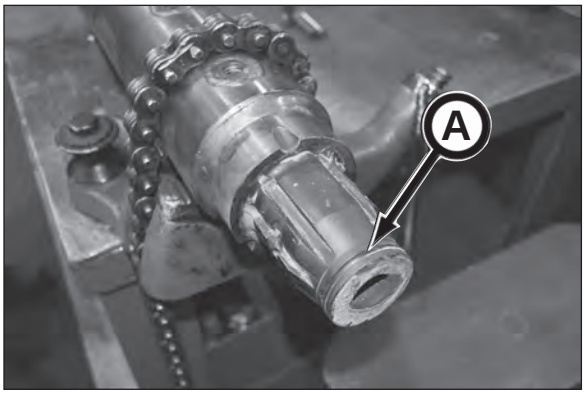
- ***TriHawk IV drill bit*** is designed for glacial till, and heavy, overburden cobble or fractured rock.

TriHawk V
P0050-160

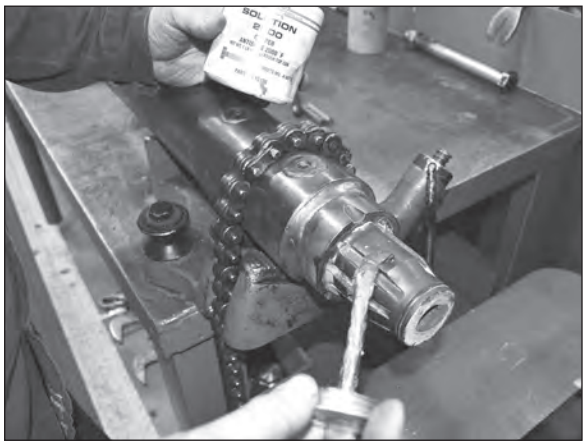
- ***TriHawk V drill bit*** provides unbeatable performance in round rock cobble, flat river stone, hardpan and loose fill.

14. Check o-ring (A) for damage. If o-ring is damaged, replace with new.

    Check that the o-ring is properly seated into steering head.



15. Apply anti-sieze compound to adapter stem.



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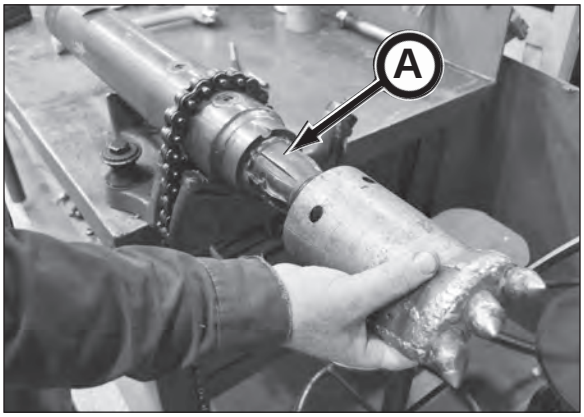
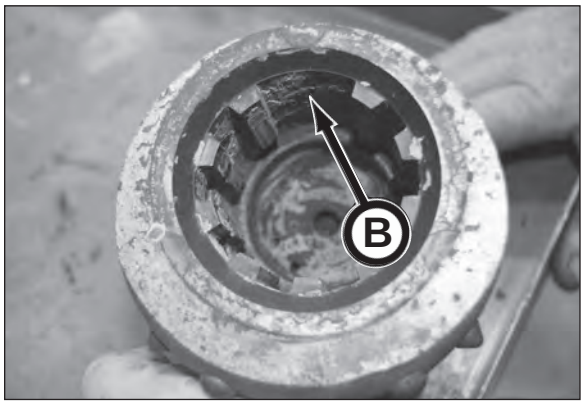
16. Inspect the cutter bit. If equipped with bullet teeth, the teeth should rotate in the mount. The embedded carbide or hard facing should not be missing or damaged. If so, the cutter bit must be replaced.

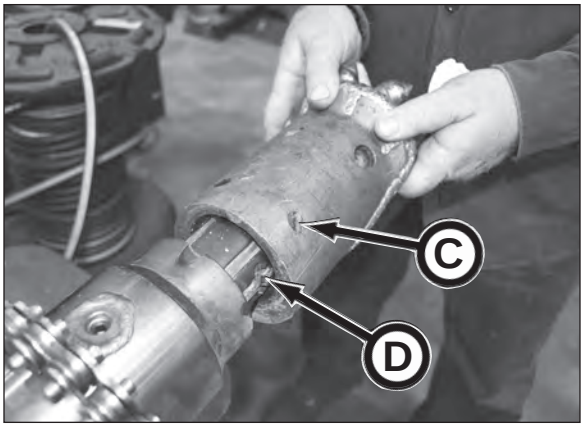


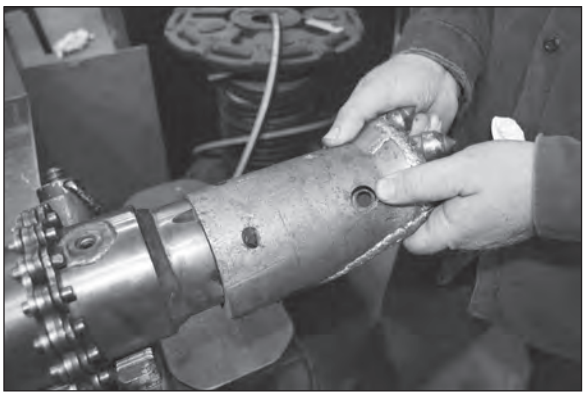
NOTICE TriHawk I is shipped with two sets of bullet teeth; a short 3 in. (76 mm) set and a long 3.5 in. (89 mm) set. Be sure the short teeth are installed in the bit on initial bore. If needed, the long bullet teeth can be installed to oversize the hole after pull back.

The wide notch (A) on the adapter will align with the groove (B) in the cutter bit. If there is excessive groove damage, replace with new bit.



17. Install the cutter bit on the adapter stem until the pin holes (C) on the bit align with the countersink holes (D) in the adapter. There will be no gap between the adapter and the cutter bit surfaces.





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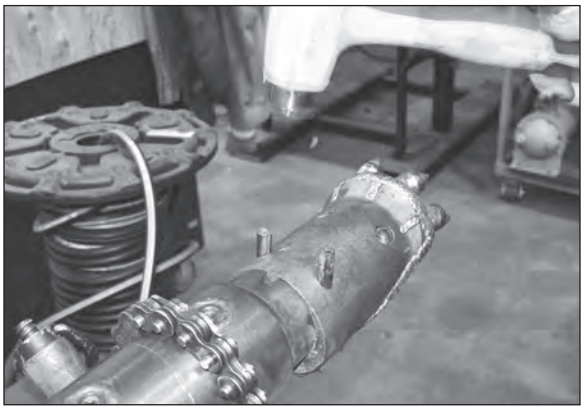
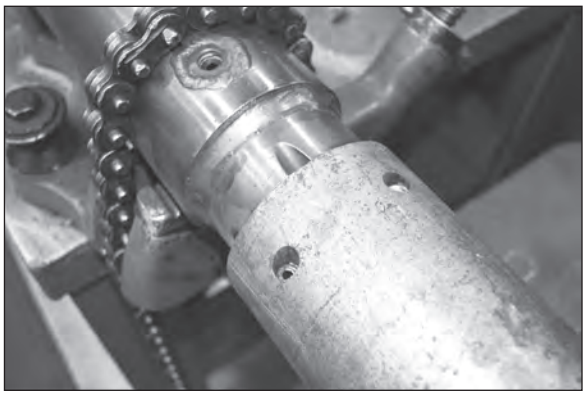
18. Apply anti-sieze compound to spring pins.

19. Install two spring pins to secure the cutter bit to the adapter.



20. Using a punch, center the spring pins in the cutter bit.

21. Proceed to TriHawk System Operation.



TRIHAWK® SYSTEM OPERATION

General Guidelines:

1. Bore uphill if possible to help flush cuttings to launch shaft.

2. Be sure fluid is flowing out of all ports of the cutter bit before starting bore.

3. Fluid must be used constantly while boring, otherwise the head will plug up.

4. As a guideline, use up to 4 gpm of lubricant to flush cuttings to launch shaft and for cooling of tool. Typically a mix of bentonite and polymer is used to keep the cuttings floating until they are removed in the launch shaft. Contact your polymer supplier for help with the proper lubrication mixture for your project.

5. Set jacking advancement so rotation pressure is below 3,000 psi. Excessive pressure will stall cutter bit and shorten cutter bit life. DO NOT exceed 500 psi thrust pressure.

6. Bore past make-up tool, then pull back one to three inches (25.4 mm to 76.2 mm) to connect to make-up tool.

7. Before breaking pilot tube joints, turn off fluid and drain fluid with lube dump control to prevent fluid from entering the pilot tube.

8. It is a good idea to flush cuttings at end of each stroke to prevent the loss of steering due to chip buildup.

9. At the end of the day, run the last pilot tube with fluid until there are no longer any chips being removed in the launch shaft.

10. For faster GBM gear box retract, turn the TriHawk Jacking PSI control to the OFF position. After retract, be sure to turn the TriHawk Jacking PSI control ON before advancing, otherwise the high pressure will break the cutter bit.

11. Torque the pilot tube connections to:
    Drive Speed Selector Position: LSHT - 3,000 psi (6,300 ft-lb) or HSLT - 4,500 psi (6,360 ft-lb)

12. Use only Akkerman pilot tubes.

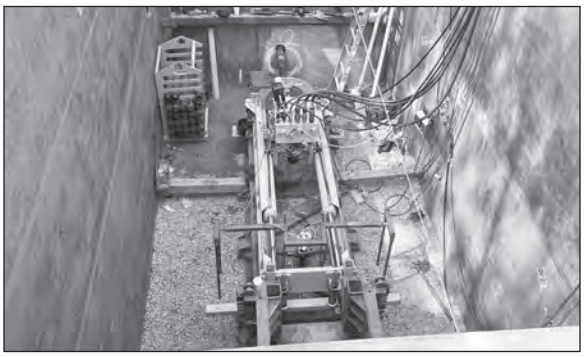
13. If rotating tubes CCW for a steering correction, the target image MUST ROTATE, otherwise the tubes are unthreading resulting in unrecoverable pilot tubes. Do not engage cutter bit into rock while rotating tubes CCW.

14. The harder the rock, the slower the advancement rate.

Operation:

1. With frame and alignment properly setup on line and grade, prepare to install TriHawk/RDA in the GBM frame.

   The surface must be flat and perpendicular to the GBM frame. The key to installing the TriHawk/RDA cutter bit is start it straight, otherwise it is very difficult to overcome a steer at the beginning of the bore.



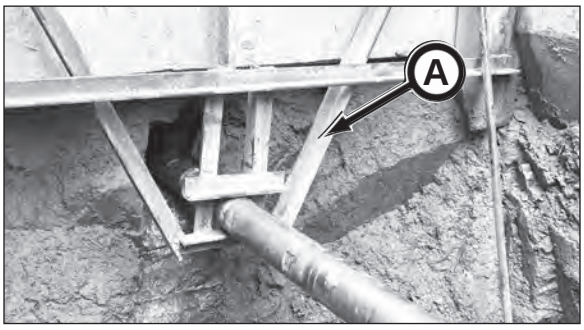
IMPORTANT: To keep the TriHawk/RDA boring a straight path, you may need to utilize one of the following ***options***:

Option a:

- pour a concrete block to create the flat surface.

Option b.

- create a stabilizer structure (A) to contain the pilot tubes in line.



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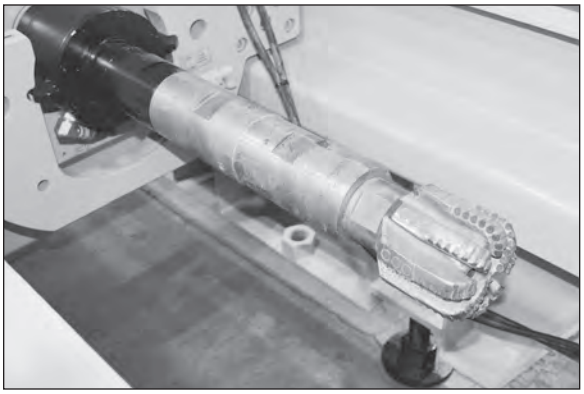
Option c:

- it may be necessary to use a reamer. Contact your Akkerman Aftermarket Sales representative for more information. The PDC reamer is used for the first 10 ft. (3 m) or until the heads starts to go off line. Then pull back reamer equipment and proceed to install the TriHawk tooling.

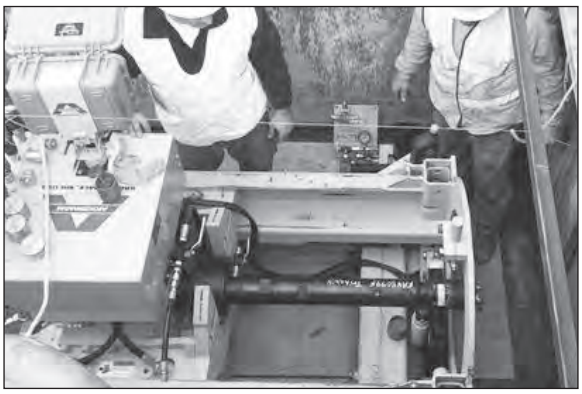
  Using the reamer requires special tooling: API Adapter (PN A49571A), special target (PN A49689A) and PDC reamer (PN P0050-185).



2. Operate power pack at 1,500 to 1,700 rpm.

⚠WARNING Suspended loads may fall and cause severe personal injury or death. Do not enter area under or around a suspended load.

3. Lower TriHawk/RDA into launch shaft and install TriHawk/RDA to drive swivel assembly on gear box using the drive rotation control to CW position, to thread the assembly to the drive swivel on gear box.



(continued on next page)

4. Move the Drive Speed Selector to the LSHT (Low Speed High Torque) position.

NOTICE Drive Speed Selector Positions:
LSHT - Torquing Tube Connections (3,000 psi)
HSLT - Torquing Tube Connections (4,500 psi)
HSLT - Drilling

5. Push TriHawk/RDA forward until the notches in the TriHawk/RDA line up with the tube support in the make-up tool (A).

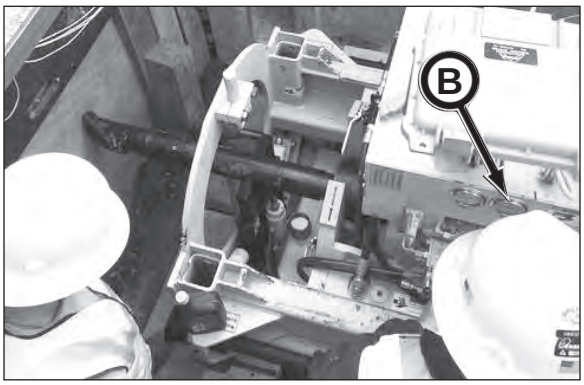
6. Engage the make-up tool tube support to the notches on the TriHawk/RDA.

7. Torque the connection to 3,000 psi (6,300 ft-lb) on rotation pressure gauge (B) .

8. Release make-up tool to disengage tube support from TriHawk/RDA .

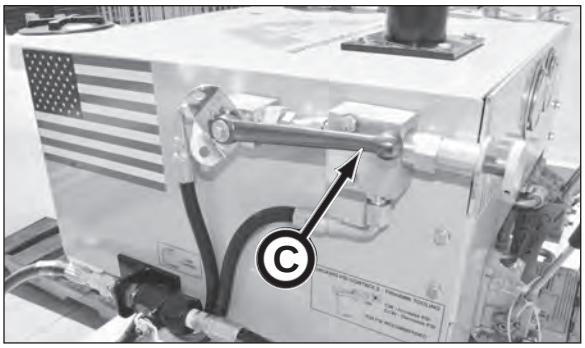
9. Advance TriHawk/RDA to the shaft wall with the tip UP, by extending thrust cylinders.

10. Position the Drive Speed Selector to HSLT (High Speed Low Torque).



11. Turn the TriHawk Jacking PSI control (C) to the ON position. This should typically be set at 500 psi. The harder the rock the greater the jacking psi maybe needed (contact your Akkerman Aftermarket Support representative for more information on setting the jacking psi). Never exceed 3,000 - 4000 psi rotation pressure while thrusting.

12. Use fluid anytime you are advancing the TriHawk cutter bit otherwise the unit will plug up requiring pull back.



13. Be sure fluid is flowing out of all ports of the TriHawk cutter bit before starting bore.

    IMPORTANT: Fluid lubrication MUST be used anytime the TriHawk cutter bit is being advanced as follows:
    As a guideline, use up to 4 gpm of lubricant to flush cuttings to launch shaft and for cooling of tool. Typically a mix of bentonite and polymer is used to keep the cuttings floating until they are removed in the launch shaft. Contact your polymer supplier for help with the proper lubrication mixture for your project.

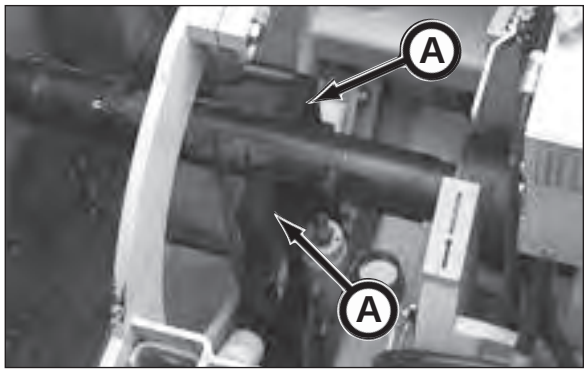
(continued on next page)

14. At the start of bore, advance and rotate slowly to keep the bore straight. Steering will not be necessary until the TriHawk/RDA is buried.

NOTICE A pilot tube may need to be installed before the TriHawk/RDA is completely buried. Be sure to always tighten the connections to 3,000 psi (6,300 ft-lb) in LSHT. In HSLT, tighten connections to 4,500 psi (6,360 ft-lb).

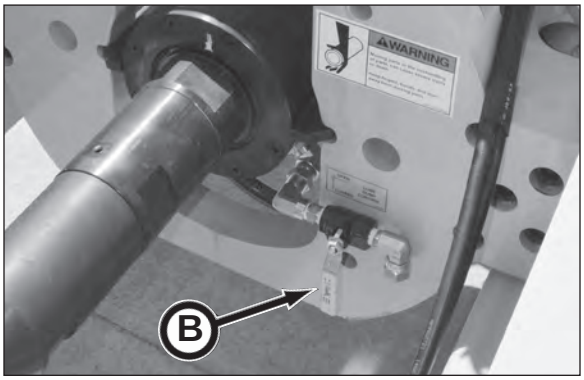
15. Bore TriHawk/RDA until the notches in the TriHawk/RDA go past the tube support (A) on the make-up tool one to three inches (25.4 mm to 76.2 mm) and then pull back until the notches line up with the tube support.

16. Engage the make-up tool tube support to the notches on TriHawk/RDA.



17. BEFORE breaking connection, shut off fluid and drain fluid with lube dump valve (B). Otherwise fluid will enter the sight path to the target. Once completely drained close dump valve.

18. Disengage the drive adapter from the TriHawk/RDA by rotating the drive CCW with the drive rotation control and using the thrust cylinder control to retract the thrust cylinders.



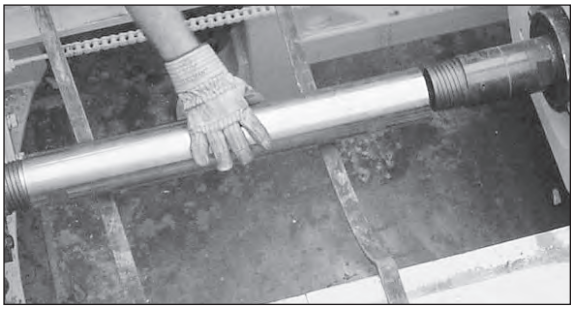
19. Move the gear box assembly towards the back of the GBM frame using the thrust cylinder control until there is enough room to lower a pilot tube.

NOTICE For faster retract speed, turn the TriHawk Jacking PSI control to the OFF position. Once frame is retracted, you MUST move the Jacking PSI control to the ON position. Failure to so will break the teeth on the TriHawk cutter bit due to too much pressure during advancement.

(continued on next page)

20. Place support bars on frame rails.
21. Remove cap and plug from pilot tube and secure them together for storage.

NOTICE If there is dust or dirt in the pilot tube threads, or poor thread lubrication, a high breakout torque and thread damage will occur. This will cause damage to the reception shaft breakout tool and/or other tooling and accessories. Be sure to ALWAYS store pilot tubes with clean caps and plugs attached with threads well lubricated. Use Copper Guard-4 lubricant, part number P0310-778 or equivalent.

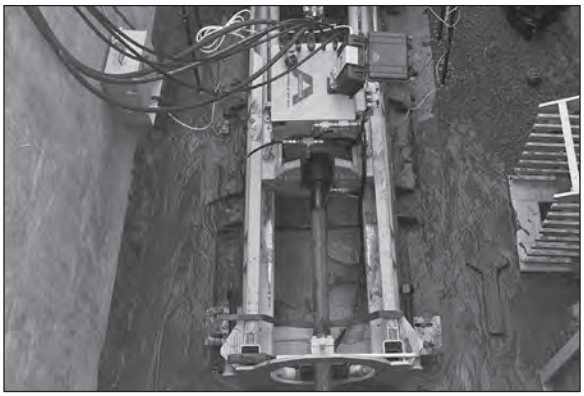


22. Place the pilot tube on the pilot tube support bars.

NOTICE BEFORE you install each pilot tube, inspect o-rings for damage. Replace if damaged. Also, wipe o-rings with a lubricant. DO NOT spray a lubricant on the o-rings. Doing so will make it difficult to identify the target on the monitor due to the reflection of the lubricant in the pilot tube.

23. Advance gear box assembly with thrust cylinder control while rotating the drive CW (using the drive rotation control) to thread the pilot tube to the drive assembly and TriHawk/RDA.
24. Torque the connection to 3,000 psi (6,300 ft-lb) on rotation pressure gauge (A) mounted on gear box.
25. Release make-up tool to disengage tube support from TriHawk/RDA.
26. Start fluid.

    IMPORTANT: Fluid lubrication MUST be used anytime the cutter bit is being advanced.



(continued on next page)

27. Advance and rotate slowly to keep the bore straight.

28. While the pilot string is advancing, check the target position often. Use the drive rotation and thrust cylinder controls to align the target on line and grade. Refer to Steering The TriHawk Cutter Bit in this section.

    Typically rotate the pilot tube CW. Rotating the pilot tubes CCW may be necessary for steering correction placement. ***Do not engage cutter bit into rock while rotating tubes CCW.***

    IMPORTANT: If rotating tubes CCW for a steering correction, the target image MUST ROTATE, otherwise the tubes are unthreading resulting in unrecoverable pilot tubes.

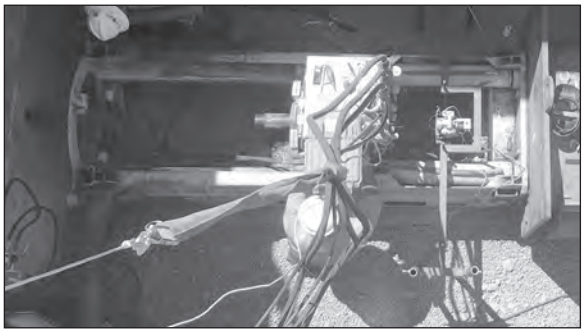
    NOTICE The harder the rock the slower the advancement rate.

29. Continue boring until it is necessary to add a pilot tube. When adding a pilot tube:

    • Bore until the notches of the last tube is one to three inches (25.4 mm to 76.2 mm) past the make-up tool tube support and then pull back until the notches line up with the tube support.

    • Engage the make-up tool tube support to the notches of the last tube.

    • BEFORE breaking connection, shut off fluid and drain fluid with lube dump valve. Otherwise fluid will enter the sight path to the target. Once drained close dump valve.
    IMPORTANT: NEVER break pilot tube joints before removing fluid from bored hole. Doing so will cause fluid to enter the sight path to the target.



    • Disengage the drive adapter from the pilot tube by rotating the drive CCW with the drive rotation control and using the thrust cylinder control to retract the thrust cylinders.

    • Move the gear box assembly towards the back of the GBM frame using the thrust cylinder control until there is enough room to lower a pilot tube.

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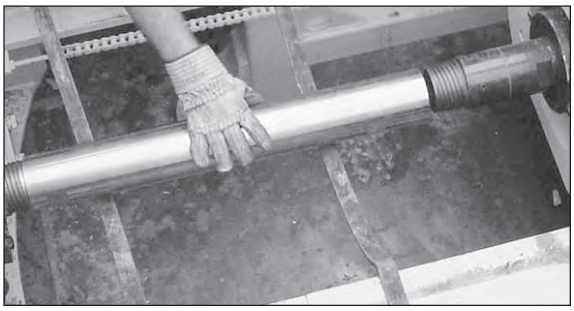
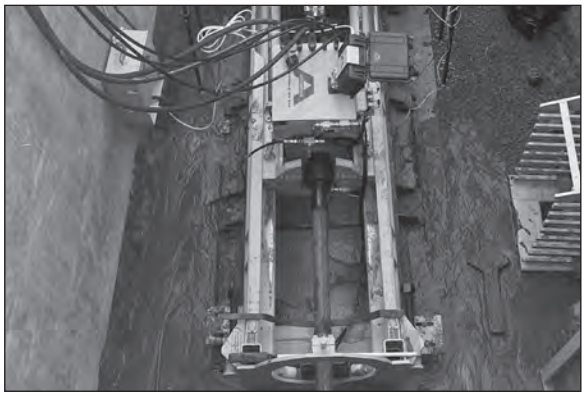


• Place pilot tube on support bars.



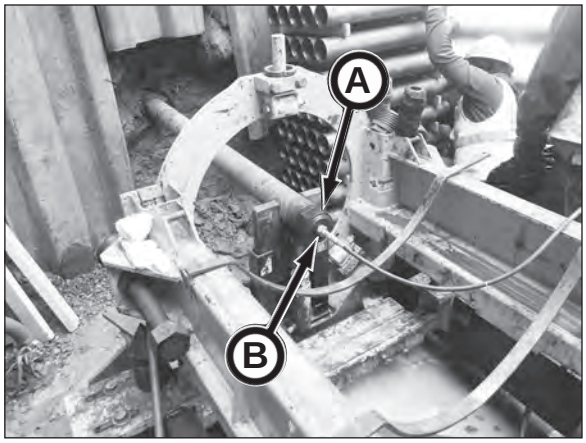
• Advance gear box assembly with thrust cylinder control while rotating the drive CW to thread the pilot tube to the drive assembly and the pilot tube string.

• Torque the connection to 3,000 psi (6,300 ft-lb).

• Release make-up tool to disengage tube support from pilot tube.

• Start fluid.

• Advance and rotate slowly to keep the bore straight.



30. Moisture or condensation may build up in the pilot tube string resulting in poor target visibility. If this occurs, install the air/fluid connector (A) to the end of the pilot tube and add air through port (B) to purge the moisture or condensation and increase visibility to the target. Use nitrogen, not oxygen, and as a guideline, maintain 50 psi (345 kPa) for 5 minutes per 100 ft (30.5 m), and adjust accordingly.

IMPORTANT: At the end of the day, run the last pilot tube with fluid until there are no longer any chips being removed into the launch shaft.
Also, before breaking through to the reception shaft, run the last pilot tube with fluid until there are no longer any chips being removed into the launch shaft.

31. Continue to add pilot tubes until the TriHawk/RDA reaches the reception shaft.
32. With the cutter bit in the reception shaft, empty the lubrication tank and fill it with fresh clean water. Run clean water through the pilot tube string until there is only clean water flowing into the reception shaft.

NOTICE Be sure water is flowing out of all ports on the cutter bit. This will insure that the ports are open when using for next bore. Otherwise, the polymer will harden resulting in the plugging of the ports.

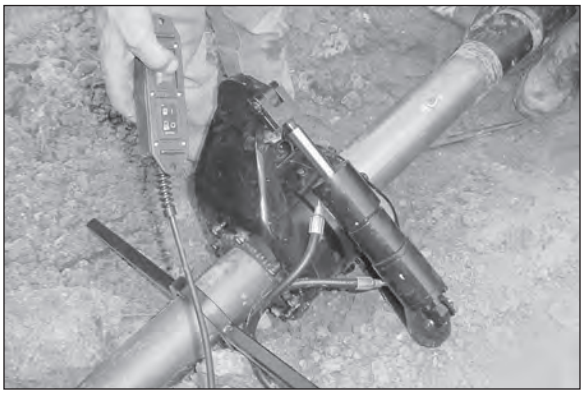
(continued on next page)

33. Remove guidance system and theodolite.

34. Remove the TriHawk/RDA from the pilot tube string using the reception shaft breakout tool. Refer to your GBM Operator's Manual for information on how to use the breakout tool.

35. With the TriHawk/RDA removed, remove the target and the battery. Store in a clean, dry area.

36. Complete bored hole as stated in job project requirements. Remove pilot tubes in the reception shaft with the breakout tool as they are advanced into the reception shaft.



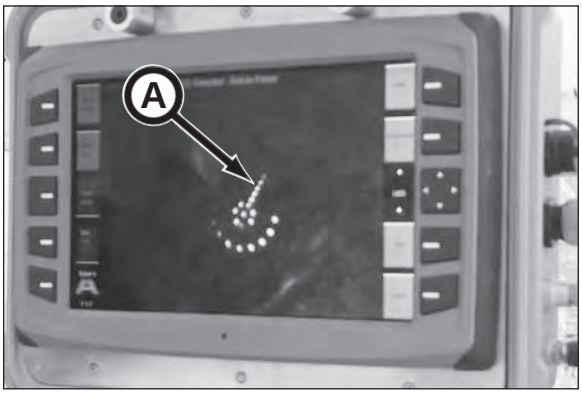
NOTICE If the job site includes the vertical pilot tube racks, be sure when placing the pilot tubes in the rack, that the end with the cap is on top and the plug is at the bottom. If the plug is on top rain water will enter the pilot tubes. Moisture in the tubes may create rust and must be cleaned prior to use, otherwise the humidity will affect the line of sight, In addition, the moisture will break the inner tubes in freezing weather.

NOTICE If there is dust or dirt in the pilot tube threads, or poor thread lubrication, a high breakout torque and thread damage will occur. This will cause damage to the reception shaft breakout tool and/or other tooling and accessories. Be sure to ALWAYS store pilot tubes with clean caps and plugs attached with threads well lubricated. Use Copper Guard-4 lubricant, part number P0310-778 or equivalent.

STEERING TRIHAWK CUTTER BIT

With the constant monitoring of the target position on the guidance system cross hairs, the operator will be able to make steering adjustments to keep the TriHawk bit on line and grade.

When making steering corrections, there will be a series of minor feathering adjustments to get the cutter bit back on line and grade (see Steering Corrections on page 5-24). There are various steering methods to address the different rock conditions (soft rock, solid rock, fractured rock and voids in rock). Two methods are outlined below:



NOTICE The steering line (A) shown on the monitor indicates the position of the tip of the cutter bit.

1. **Continuous CW Rotation Cutting Method** (less aggressive method used in softer rock): Drilling remains relatively straight and makes small chips.

   a. Rotate CW at approximately half speed (do not exceed 3,000 psi to 4,000 psi rotation)

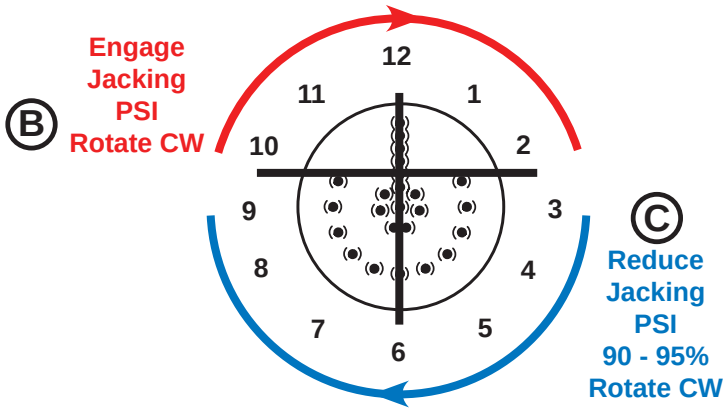
   b. Fully engage jacking cylinders in red quadrant (B).

   c. Release 90 - 95% of jacking psi in blue quadrant (C).

   d. Fully engage jacking cylinders in red quadrant (B).

   e. Release 90 - 95% of jacking psi in blue quadrant (C).

   f. Repeat sequence until the steering correction has been made.



Steering Adjustment Required: UP

(continued on next page)

2. Carve Cutting Method (more aggressive method typically used in harder rock). Used when alignment is more off line and makes larger chips. Drilling only in red quadrant.

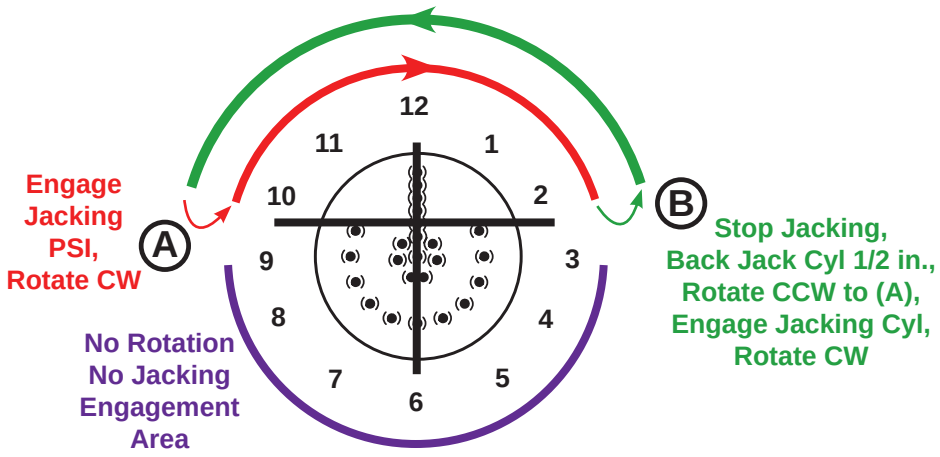
a. Rotate CW at approximately half speed or less (do not exceed 3,000 psi to 4,000 psi rotation) and fully engage jacking cylinders in red quadrant (A).

b. At beginning of green quadrant (B), stop rotation and jacking, then back off the jacking cylinders approximately 1/2 in. (12.7 mm), rotate CCW to start of red quadrant (A), then rotate CW.

c. Fully engage jacking cylinders in red quadrant (A).

d. At beginning of green quadrant (B), stop rotation and jacking, then back off the jacking cylinders approximately 1/2 in. (12.7 mm), rotate CCW to start of red quadrant, then rotate CW.

e. Repeat sequence until the steering correction has been made.



Steering Adjustment Required: UP

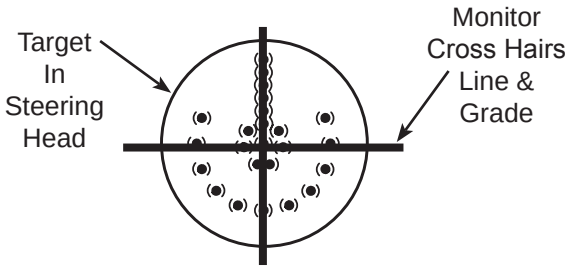
Proceed to next page for steering correction instructions by cutting method.

Steering Corrections:

While drilling with the TriHawk cutter bit, it is typical that the center of the target dots will wander as it is rotating but if the center dots are staying outside the cross hairs, a steering correction is required. With steering corrections, use a feathering sequence to fully engage the jacking PSI in the quadrant(s) you need to steer to.

1. Perfect target position:

On line and grade. No steering adjustments needed. Continue rotation while maintaining the jacking at 500 psi.



Perfect Target Position

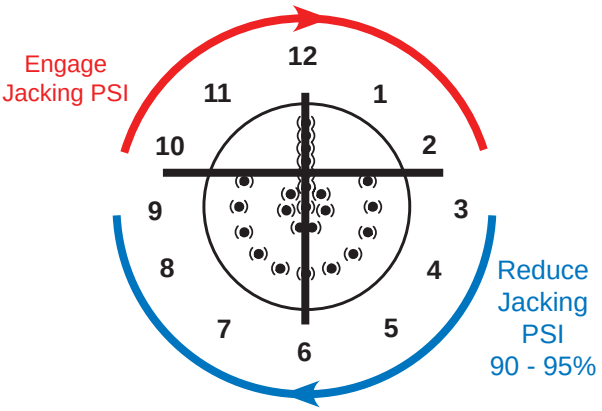
2. Steering adjustment: UP

A. Continuous CW Rotation Cutting Method

- Rotate CW at half speed, fully engage jack cylinders from 10 o'clock to 2 o'clock positions.

Continue CW rotation at half speed and reduce jacking PSI to 90 - 95% from 3 o'clock to 9 o'clock positions, then fully engage jack cylinders from 10 o'clock to 2 o'clock positions.

- Repeat this sequence until this feathering procedure gets the target back to line and grade.



Steering Adjustment Required: UP
Continuous CW Rotation Cutting Method

B. Carve Cutting Method

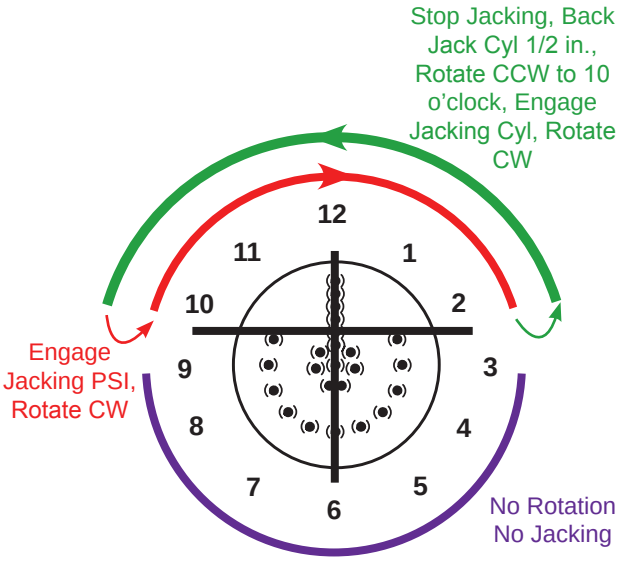
- Rotate CW at half speed or less and fully engage jack cylinders from 10 o'clock to 2 o'clock positions.

- Stop rotation and jacking, then back off the jacking cylinders 1/2 in. (12.7 mm).

- Rotate CCW (no cutting) from 2 o'clock back to 10 o'clock position.

- Repeat this sequence until this feathering procedure gets the target back to line and grade.

- There is no rotation or jacking from 3 o'clock to 9 o'clock positions.



Steering Adjustment Required: UP
Carve Cutting Method

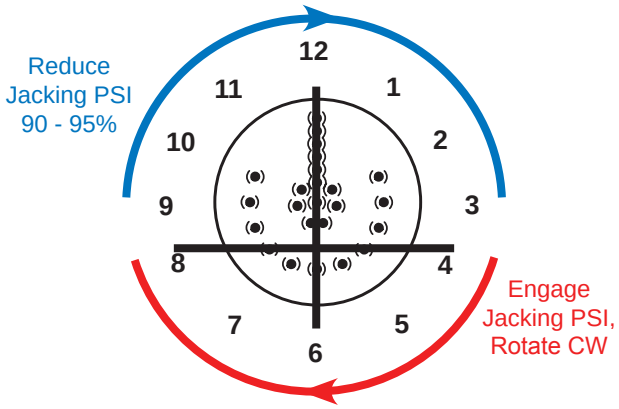
3. Steering adjustment: DOWN

A. Continuous CW Rotation Cutting Method

- Rotate CW at half speed, fully engage jack cylinders from 4 o'clock to 8 o'clock positions

Continue CW rotation at half speed and reduce jacking PSI to 90 - 95% from 9 o'clock to 3 o'clock positions, then fully engage jack cylinders from 4 o'clock to 8 o'clock positions.

- Repeat this sequence until this feathering procedure gets the target back to line and grade.



Steering Adjustment Required: DOWN
Continuous CW Rotation Cutting Method

B. Carve Cutting Method

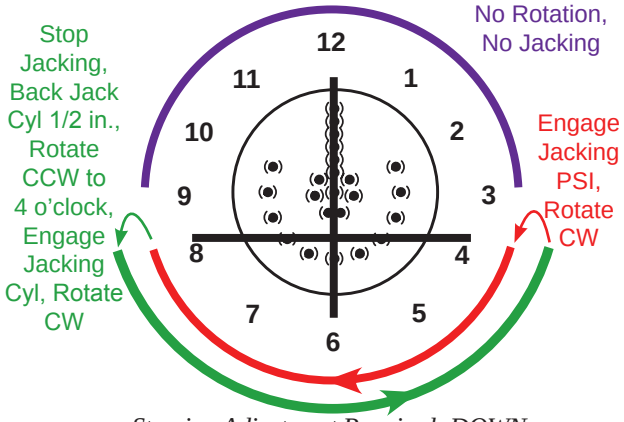
- Rotate CW at half speed or less and fully engage jack cylinders from 4 o'clock to 8 o'clock positions.

- Stop rotation and jacking, then back off the jacking cylinders 1/2 in. (12.7 mm).

- Rotate CCW (no cutting) from 8 o'clock back to 4 o'clock positions.

- Repeat this sequence until this feathering procedure gets the target back to line and grade.

- There is no rotation or jacking from 9 o'clock to 3 o'clock positions.



Steering Adjustment Required: DOWN
Carve Cutting Method

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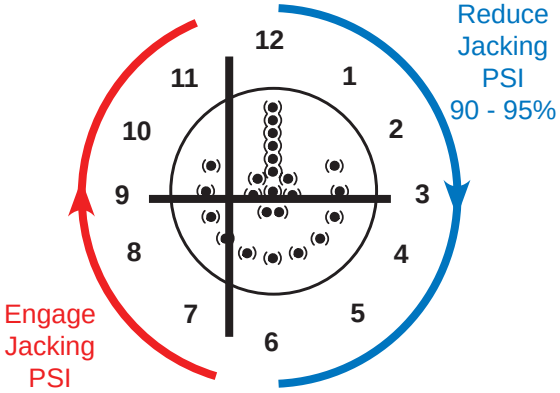
4. Steering adjustment: LEFT

A. Continuous CW Rotation Cutting Method

- Rotate CW at half speed, fully engage jack cylinders from 7 o'clock to 11 o'clock positions

Continue CW rotation at half speed and reduce jacking PSI to 90 - 95% from 12 o'clock to 6 o'clock positions, then fully engage jack cylinders from 7 o'clock to 11 o'clock positions.

- Repeat this sequence until this feathering procedure gets the target back to line and grade.



Steering Adjustment Required: LEFT
Continuous CW Rotation Cutting Method

B. Carve Cutting Method

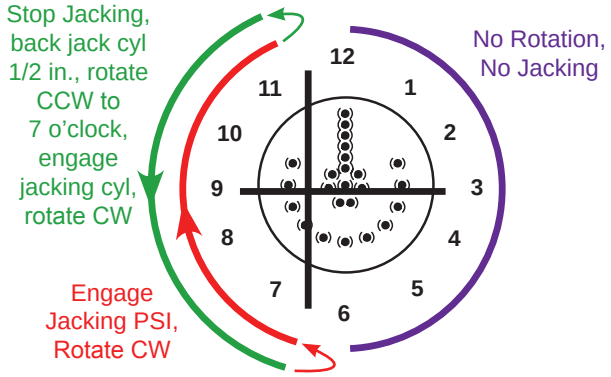
- Rotate CW at half speed or less and fully engage jack cylinders from 7 o'clock to 11 o'clock positions.

- Stop rotation and jacking, then back off the jacking cylinders 1/2 in. (12.7 mm).

- Rotate CCW (no cutting) from 11 o'clock back to 7 o'clock positions.

- Repeat this sequence until this feathering procedure gets the target back to line and grade.

- There is no rotation or jacking from 12 o'clock to 6 o'clock positions.



Steering Adjustment Required: LEFT
Carve Cutting Method

(continued on next page)

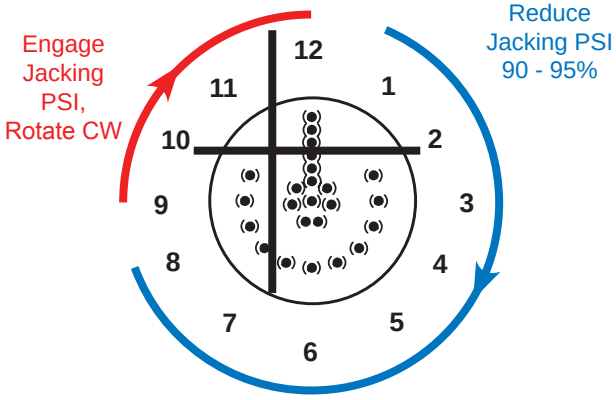
5. Steering adjustment: UPPER LEFT

A. Continuous CW Rotation Cutting Method

- Rotate CW at half speed, fully engage jack cylinders from 9 o'clock to 12 o'clock positions

Continue CW rotation at half speed and reduce jacking PSI to 90 - 95% from 1 o'clock to 8 o'clock positions, then fully engage jack cylinders from 9 o'clock to 12 o'clock positions.

- Repeat this sequence until this feathering procedure gets the target back to line and grade.



Steering Adjustment Required: UPPER LEFT
Continuous CW Rotation Cutting Method

B. Carve Cutting Method

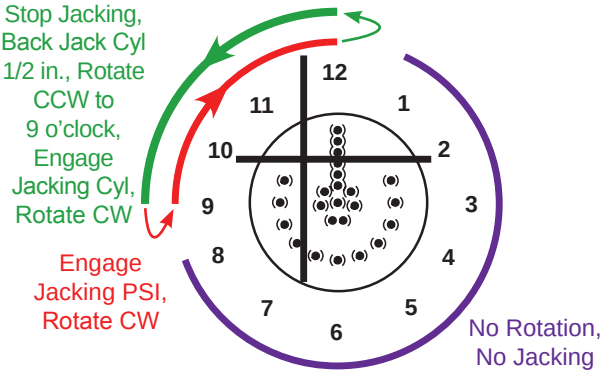
- Rotate CW at half speed or less and fully engage jack cylinders from 9 o'clock to 12 o'clock positions.

- Stop rotation and jacking, then back off the jacking cylinders 1/2 in. (12.7 mm).

- Rotate CCW (no cutting) from 12 o'clock back to 9 o'clock positions.

- Repeat this sequence until this feathering procedure gets the target back to line and grade.

- There is no rotation or jacking from 1 o'clock to 8 o'clock positions.



Steering Adjustment Required: UPPER LEFT
Carve Cutting Method

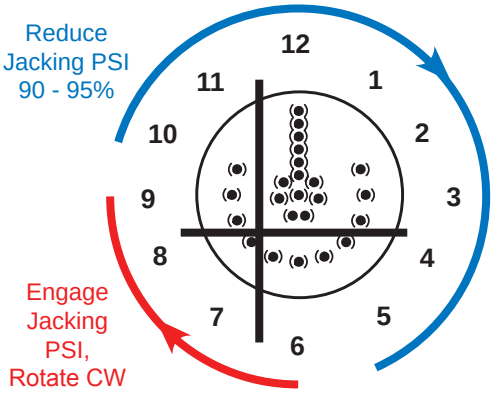
6. Steering adjustment: LOWER LEFT

A. Continuous CW Rotation Cutting Method

- Rotate CW at half speed, fully engage jack cylinders from 6 o'clock to 9 o'clock positions

Continue CW rotation at half speed and reduce jacking PSI to 90 - 95% from 10 o'clock to 5 o'clock positions, then fully engage jack cylinders from 6 o'clock to 9 o'clock positions.

- Repeat this sequence until this feathering procedure gets the target back to line and grade.



Steering Adjustment Required: LOWER LEFT
Continuous CW Rotation Cutting Method

B. Carve Cutting Method

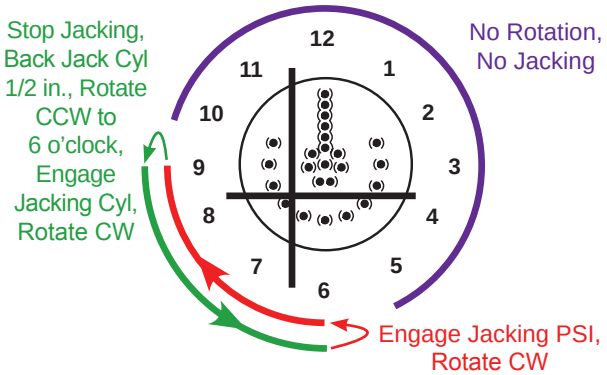
- Rotate CW at half speed or less and fully engage jack cylinders from 6 o'clock to 9 o'clock positions.

- Stop rotation and jacking, then back off the jacking cylinders 1/2 in. (12.7 mm).

- Rotate CCW (no cutting) from 9 o'clock back to 6 o'clock positions.

- Repeat this sequence until this feathering procedure gets the target back to line and grade.

- There is no rotation or jacking from 10 o'clock to 5 o'clock positions.



Steering Adjustment Required: LOWER LEFT
Carve Cutting Method

(continued on next page)

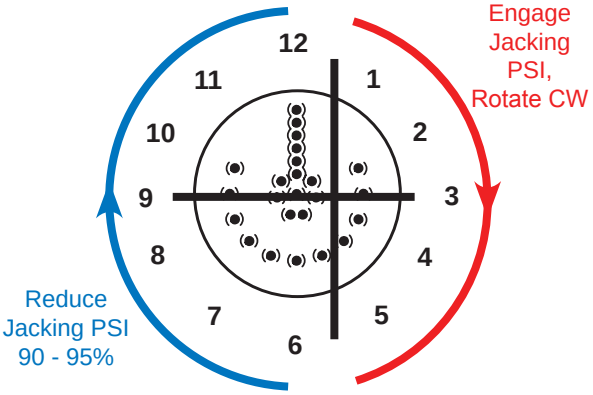
7. Steering adjustment: RIGHT

A. Continuous CW Rotation Cutting Method

- Rotate CW at half speed, fully engage jack cylinders from 1 o'clock to 5 o'clock positions.

Continue CW rotation at half speed and reduce jacking PSI to 90 - 95% from 6 o'clock to 12 o'clock positions, then fully engage jack cylinders from 1 o'clock to 5 o'clock positions.

- Repeat this sequence until this feathering procedure gets the target back to line and grade.



Steering Adjustment Required: RIGHT
Continuous CW Rotation Cutting Method

B. Carve Cutting Method

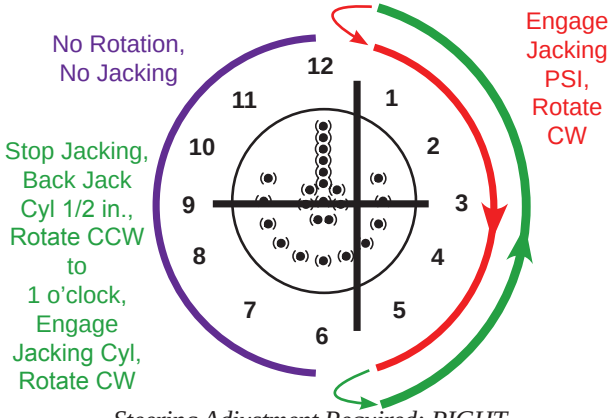
- Rotate CW at half speed or less and fully engage jack cylinders from 1 o'clock to 5 o'clock positions.

- Stop rotation and jacking, then back off the jacking cylinders 1/2 in. (12.7 mm).

- Rotate CCW (no cutting) from 5 o'clock back to 1 o'clock positions.

- Repeat this sequence until this feathering procedure gets the target back to line and grade.

- There is no rotation or jacking from 6 o'clock to 12 o'clock positions.



Steering Adjustment Required: RIGHT
Carve Cutting Method

---

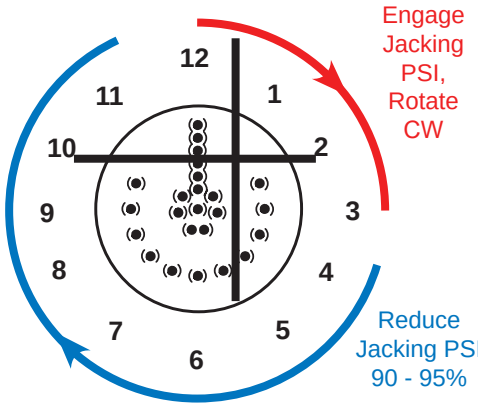
8. Steering adjustment: UPPER RIGHT

A. Continuous CW Rotation Cutting Method

- Rotate CW at half speed, fully engage jack cylinders from 12 o'clock to 3 o'clock positions.

Continue CW rotation at half speed and reduce jacking PSI to 90 - 95% from 4 o'clock to 11 o'clock positions, then fully engage jack cylinders from 12 o'clock to 3 o'clock positions.

- Repeat this sequence until this feathering procedure gets the target back to line and grade.



Steering Adjustment Required: UPPER RIGHT
Continuous CW Rotation Cutting Method

B. Carve Cutting Method

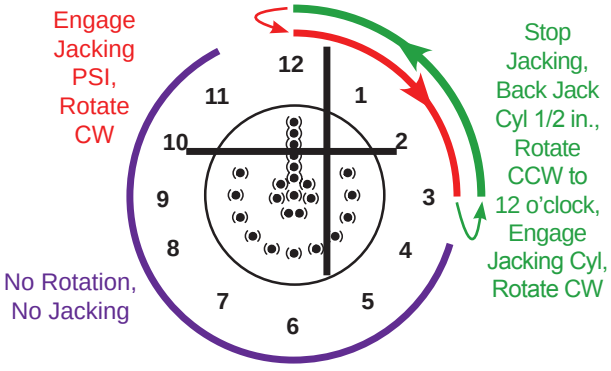
- Rotate CW at half speed or less and fully engage jack cylinders from 12 o'clock to 3 o'clock positions.

- Stop rotation and jacking, then back off the jacking cylinders 1/2 in. (12.7 mm).

- Rotate CCW (no cutting) from 3 o'clock back to 12 o'clock positions.

- Repeat this sequence until this feathering procedure gets the target back to line and grade.

- There is no rotation or jacking from 4 o'clock to 11 o'clock positions.



Steering Adjustment Required: UPPER RIGHT
Carve Cutting Method

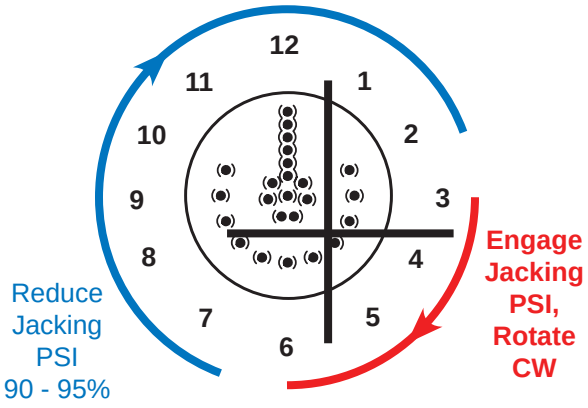
9. Steering adjustment: LOWER RIGHT

A. Continuous CW Rotation Cutting Method

- Rotate CW at half speed, fully engage jack cylinders from 3 o'clock to 6 o'clock positions.

Continue CW rotation at half speed and reduce jacking PSI to 90 - 95% from 7 o'clock to 2 o'clock positions, then fully engage jack cylinders from 3 o'clock to 6 o'clock positions.

- Repeat this sequence until this feathering procedure gets the target back to line and grade.



Steering Adjustment Required: LOWER RIGHT
Continuous CW Rotation Cutting Method

B. Carve Cutting Method

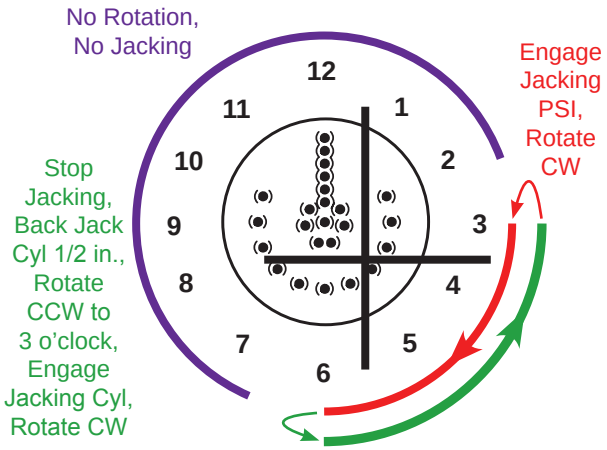
- Rotate CW at half speed or less and fully engage jack cylinders from 3 o'clock to 6 o'clock positions.

- Stop rotation and jacking, then back off the jacking cylinders 1/2 in. (12.7 mm).

- Rotate CCW (no cutting) from 6 o'clock back to 3 o'clock positions.

- Repeat this sequence until this feathering procedure gets the target back to line and grade.

- There is no rotation or jacking from 7 o'clock to 2 o'clock positions.



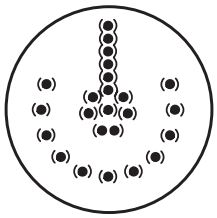
Steering Adjustment Required: LOWER RIGHT
Carve Cutting Method

---

10. Steering adjustment: VOIDS IN ROCK

- Pockets (voids) in rock formation will not be visible on the target screen until it is too late; the bit followed the void. In this case, the success rate for a bore on line and grade is low since the steering head is no longer contacting rock which provides the ability to steer the head.

- If this occurs, attempt to advance with slow rotation on the rock that it is engaging then full rotation at area of void. Repeat this process until the steering head is back to full engagement on the rock. If successful, continue to steer the head as needed to achieve line and grade.



Voids In Rock Formation Not Visible On Target Screen

LOSS OF STEERING

In the event steering is lost:

Causes

- There may be a build up of chips around the cutter bit.
- If cuttings are sticking behind the cutter bit, there is no way to steer away or to have the cutter bit react to steering.
- There appears to be little to no cuttings coming back to the launch shaft.

Solution

- Flush the cutter bit.
  Pull back the pilot string and fill the hole with fluid, then push back into hole as fast as possible. Repeat this method a few times and then continue with steering corrections (continuous rotation cutting or carve cutting) to determine if that technique will correct the steering.

  It is a good idea to flush cuttings at end of each stroke to help prevent the chips from building up.

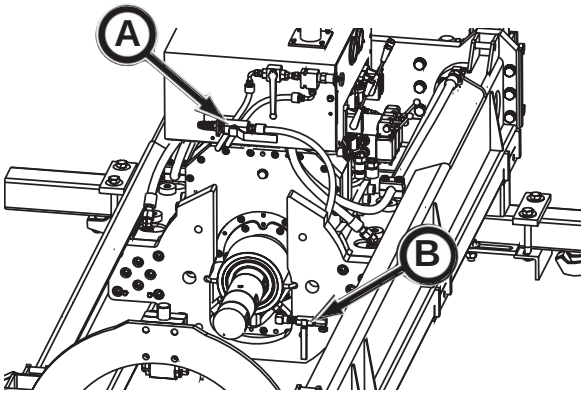
REGULATING FLUID

It is important to properly regulate the bentonite and lubrication pump fluid in the while operating the TriHawk/RDA and when adding pilot tubes.

- ***TriHawk/RDA Operation***
  - fluid flowing into pilot tube annular space

  240A Frame Lube Controls
  - Open lube control (A)
  - Close lube dump control (B)

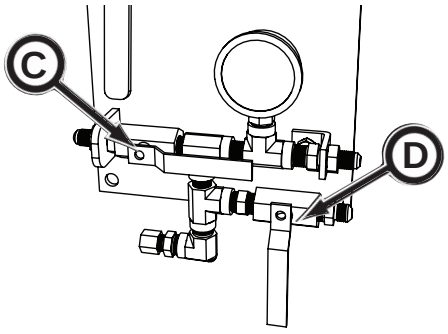
  Pump Shaft Controls
  - Open pressure control (C)
  - Close return control (D)



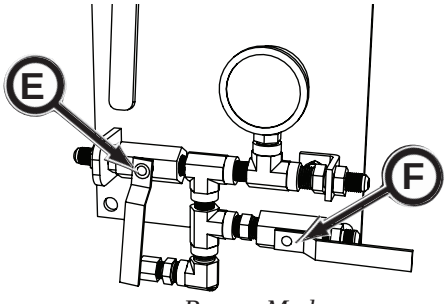
- ***Setting New Pilot Tubes***
  - fluid bypassing to pump

  240A Frame Lube Controls
  - Close lube control (A)
  - Open lube dump control (B)
    BEFORE loosening tube joints, fully drain the fluid to prevent the fluid from entering the inner tube of the pilot tube.

  Pump Shaft Controls
  - Close pressure control (E)
  - Open return control (F)



Jetting Mode



Bypass Mode

REPLACING BULLET TEETH

Periodically it will become necessary to replace the bullet teeth on your TriHawk cutter bit.

NOTICE The photos show the TriHawk I cutter bit. The installation procedure is the same for all TriHawk cutter bits equipped with bullet teeth.

1. Place the punch in the pocket at the back of the tooth. Carefully use a hammer to strike the punch for tooth removal.

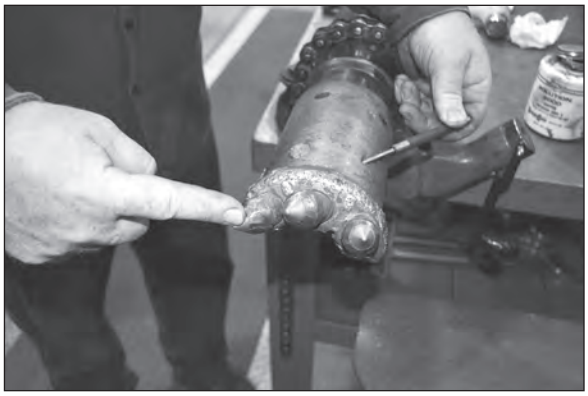
2. Clean tooth pocket. Be sure no debris or dirt is in the pocket. If there is damage, in the pocket or tooth mounting area, the cutter bit should be replaced with new.

3. Apply anti seize to the tooth shank.

4. With the new bullet tooth square over the mount hole, place a piece of wood over the tooth and carefully hammer the bit into place.

NOTICE Never use a hammer to directly strike a bullet tooth, otherwise damage to the tooth will occur.

5. Once properly installed, the tooth must freely rotate.



Right Bullet Tooth

Middle Bullet Tooth

Left Bullet Tooth

COLD WEATHER OPERATION

Freezing temperatures during the boring process creates the necessity to prepare the site and equipment for the cold weather. Failure to do so will cause damage to components and supporting equipment.

Refer to your equipment manuals for specific information when operating in cold weather.

There are various methods of keeping equipment from freezing:

- Tent working areas with a heating system when possible.
- When working with water, it needs to be constantly circulated to prevent freezing. Otherwise the equipment must be drained and/or treated with a RV anti-freeze solution to prevent freezing.
- If any water/fluid pumps will be shut off for a considerable length of time and the temperature is at or below freezing, the fluids must be drained or treated with RV anti-freeze. Refer to pump manufacturer for more information.
- Water tanks must be drained or treated with RV anti-freeze.
- Drain hoses to prevent freezing and keep low areas properly drained to prevent freezing damage.
- For diesel engines, use a diesel conditioner as well as a non-gelling winter fuel.
- For all equipment, use proper lubricant based on ambient temperature to prevent damage.
- Use compressed air to purge a system of water. Be sure the discharge valve is open before doing so.
- Install heaters for hydraulic systems.

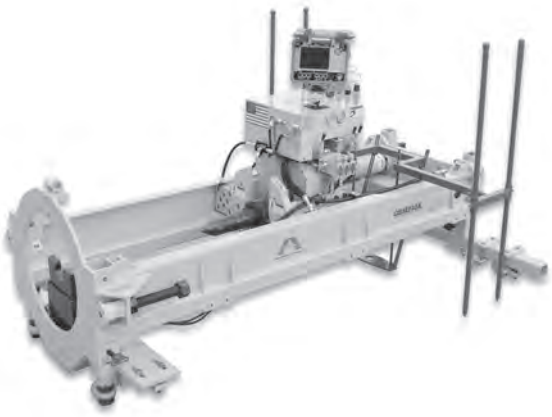
If systems were shut down for freezing weather, be sure to start systems slowly and let them run for at least five minutes to allow for warm up and in the case of a pump, to displace any surface ice that may have accumulated in the fluid before going back to full operation mode.

Remember it is also critical to keep the work site safe and employees comfortable during the freezing weather. Good training, supervision, proper clothing and limiting personal exposure to the weather is essential for keeping personnel and equipment safe on the job site.

NOTES

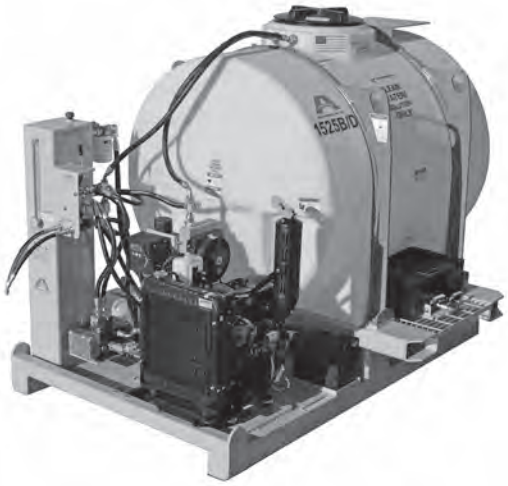
Lubricants

Use of inferior lubricants and polymers can affect the efficient performance of your Akkerman equipment. Always use high quality lubricants. Refer to your Akkerman manuals or maintenance instructions for maintaining your equipment with the proper lubricants.



Jacking Frame

Power Pack



Bentonite & Lubrication Pump

Reception Shaft Breakout Tool

RBU

STORING LUBRICANTS

Your equipment can operate at maximum performance only if clean lubricants are used. Use clean containers to handle all lubricants.

Lubricants should be stored in an area protected from dust, moisture, and other contaminates.

Storage

NOTICE Refer to your equipment manuals for specific storage information.

1. Wash all parts thoroughly.
2. Flush the cutter bit and rock drill adapter with clear water. Dry the cutter bit and rock drill adapter with compressed air (50 psi maximum).
3. Disassemble the cutter bit from the the rock drill adapter.
4. Be sure to remove the target and batteries from the RDA. Store in a clean, dry area.
5. Inspect the cutter bit for damage. If damaged, repair or replace as needed.
6. Inspect bullet teeth (if equipped). Replace if damaged.
7. Store in a dry environment.

NOTES

Specifications

- Assembly includes Akkerman Pilot Tube to TriHawk Adapter to work with TriHawk® drill bits I, III, IV, and V.
- Dual wall pilot tubes provide a means to lubricate the head and remove cuttings from head back to launch shaft.
- Standard Akkerman GBM target positioned in the target housing of the pilot tube to TriHawk adapter.
- A polymer fluid must be added to cool the drill bit and suspend cuttings during transport from the drilling bit to the launch shaft. The polymer fluid is pumped into the pilot tube annular space, through the pilot tube adapter then out through the TriHawk tooling bit port.
- Boltless modular design of the square-drive spline makes it easy to interchange drill bits.

TriHawk I
P0050-164

- ***TriHawk I drill bit*** is an aggressive cutting tool for boring in soft rock conditions up to 8,000 psi.

  Ground: Compacted soils, cobble, soft rock

  Bit Type: Embedded carbide and replaceable bullet teeth

  Cut Diameter: 5.12 in. (130 mm)

TriHawk III
P0050-162

- ***TriHawk III drill bit*** is the cutting tool for soft to medium rock up to 12,000 psi and cobble bores.

  Ground: Hard soils, soft rock

  Bit Type: Replaceable bullet teeth w/ hard facing

  Cut Diameter: 5.5 in. (140 mm)

TriHawk IV
P0050-161

- ***TriHawk IV drill bit*** is designed for glacial till, and heavy, overburden cobble or fractured rock.

  Ground: Tilt, cobble, soft rock

  Bit Type: Embedded carbide

  Cut Diameter: 5.5 in. (140 mm)

TriHawk V
P0050-160

- ***TriHawk V drill bit*** provides unbeatable performance in round rock cobble, flat river stone, hardpan and loose fill.

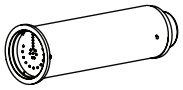
  Ground: Gravel, loose fill, dense soil

  Bit Type: Embedded carbide

  Cut Diameter: 4.8 in. (122 mm)

Akkerman Inc.
58256 266th Street • Brownsdale, MN USA 55918

GBM Smart Target Instructions

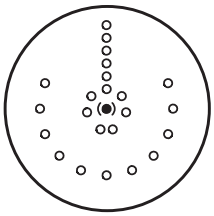


Instruction Part No. 050144A

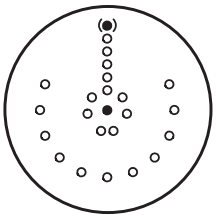
The Akkerman GBM Smart Target is a multi-functional programmable target.

- ***Normal mode:*** all LEDs are on (depending on programming mode) with the steering line LEDs flashing every second.
- ***Battery Voltage Indicator*** is visible at power up for one second. The outer ring LEDs are used as the gauge. One LED is on, then one LED for every 1/10th volt above 2.3 v.
- **Sleep mode*** (only center LED flashes) will conserve battery power when the target has not been rotated more than ± 20° for ten minutes. Wake from sleep mode by simply rotating the target.
- ***Low Battery mode**** (center LED on, outer mots LED on steering line flashing) will activate when the battery level reaches <2.1V. Sleep mode will activate in one minute to conserve battery power.
- ***High Temperature mode**** (all LEDs flash) activates when the target temperature is >131°F (55°C). High temperature mode deactivates when target temperature is <127°F (53°C).

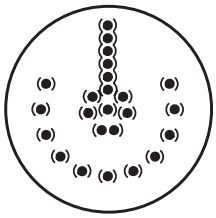
* Refer to illustrations below



Sleep Mode
- only center LED flashes



Low Battery Mode
- center LED on, outer most LED on steering line flashing



High Temperature Mode
- all above LEDs flash

• Programming mode:

This mode allows the operator to increase/decrease the LED brightness and/or allow the inner LED ring display to be turned on/off. To enter programming mode, a series of target rotations are required within various time constraints.

Enter Programming Mode:

1. Rotate target and stop with the steering line pointing up to 12 o'clock position.
2. Wait 10 seconds for a single flash to appear, and within 10 seconds rotate target CW one complete rotation and stop in the up (12 o'clock) position.
3. Wait 10 seconds for a double flash to appear, and within 10 seconds rotate target two complete CW rotations and stop in the up (12 o'clock) position.
4. Wait 10 seconds for a triple flash to appear, and within 10 seconds rotate target three complete CW rotations and stop in the up (12 o'clock) position.
5. Wait 10 seconds. You are now in programming mode and only the steering line LEDs should be illuminated with outer most LED flashing rapidly.
6. Within 10 seconds rotate the target to desired command (see below):

Programming Command Modes:

- **Increase LED Brightness:** rotate target CW one full rotation with the steering line at the 12 o'clock position. Once brightness level is achieved, rotate target to store the setting.
- **Decrease LED Brightness:** rotate target CW 1/2 rotation with steering line at 6 o'clock position. Once brightness level is achieved, rotate target to store the setting.
- **Inner Ring On/Off:** rotate target CW 1/4 rotation with steering line at 3 o'clock position. The inner ring will toggle On/Off. Wait for inner ring to set the on/off position before rotating.
- **Steering Line Animation On/Off:** rotate target CW 3/4 rotation with steering line at 9 o'clock position. The steering line animation will toggle.

Reset to factory default mode: Using a solid, level surface, place target cap on surface. The outer ring LEDs will go off one by one until the complete target LEDs are off. Then all LEDS will blink twice. The target is now reset to the factory default settings.

Warranty

Akkerman warrants that all equipment manufactured by it be free from defects due to workmanship or material when normally used and serviced for a period of 90 days from the date of shipment by Akkerman. Normal wear and tear to the equipment, including, but not limited to, wear on the cutter face tooling, hydraulic filters, augers, casings, slurry line and seals is not covered by this warranty. Akkerman does not warrant that the equipment meets the requirements of any particular safety code or rule governing equipment classification. If the Customer has questions about local safety codes, rules or ordinances, authorities local to the project should be consulted.

In order to be considered as a potential warranty claim, the component in question must be returned to Akkerman (freight prepaid) for factory inspection and analysis, and determination of warranty applicability. No warranty is provided for electronics or electrical components of any kind. The validity of all warranty claims are subject to the discretion and determination of the Akkerman Aftermarket Support Department. All such determinations are final.

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