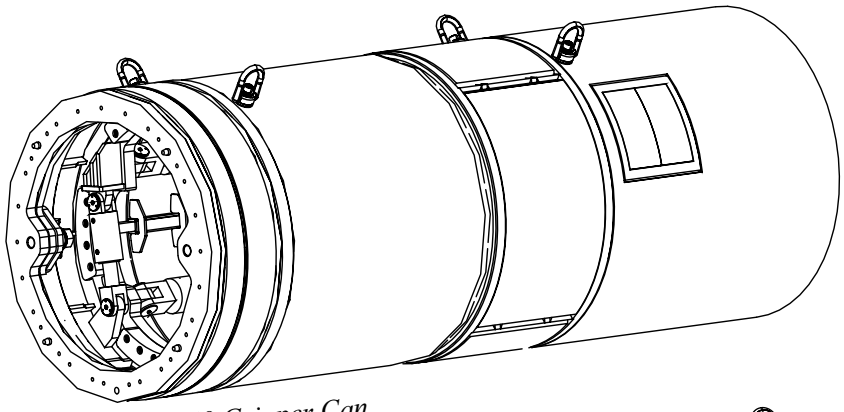
Gripper Can Operation & Maintenance
F62540F, F62876F
Instruction Part No. 050185A

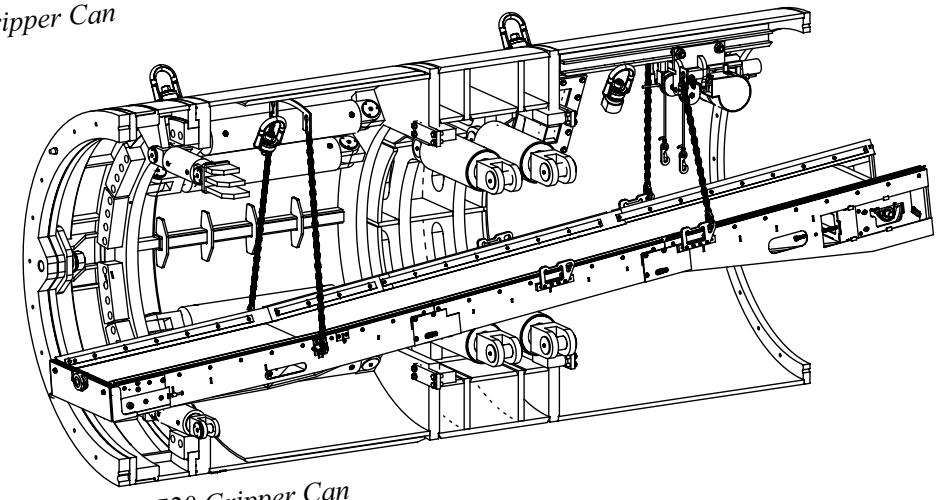
This instruction contains important safety, operation, and maintenance information for your Akkerman Gripper Can. You must read and understand this instruction, your Akkerman Tunnel Boring Machine (TBM) Operator's Manual and any additional equipment instructions or manuals before you operate and maintain this equipment. Keep this instruction with your Akkerman Gripper Can at all times. Additional copies of this instruction can be obtained from Akkerman Aftermarket Support Department, or downloaded from www.akkerman.com.

The Gripper Can is used with the TBM to provide hydraulically actuated jacking and gripping cylinders for the stabilization and propulsion of the TBM during installation of pipe or tunnel lining tunnel building applications. The Gripper Can is launched behind the TBM and houses a second conveyor and the haul unit for spoil removal operations while tunneling. All functions of the Gripper Can are tied to the TBM hydraulic system.

This Gripper Can instruction includes:



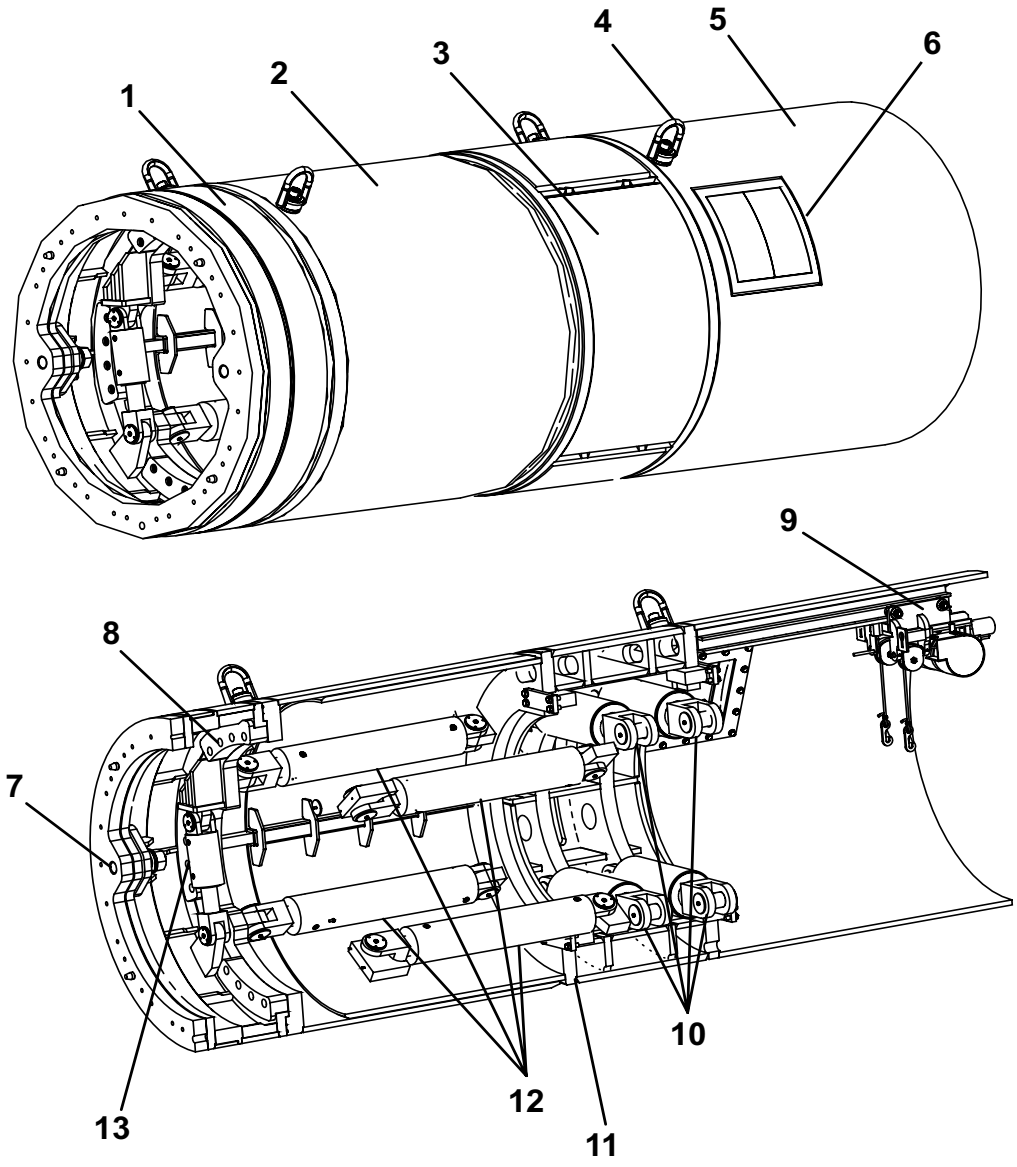
540 Gripper Can



720 Gripper Can

I. Terminology

Gripper Can

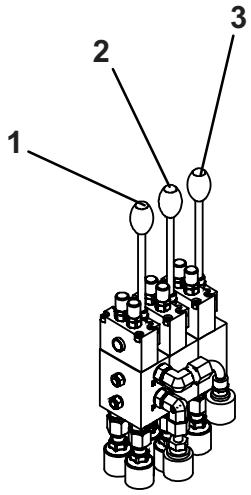


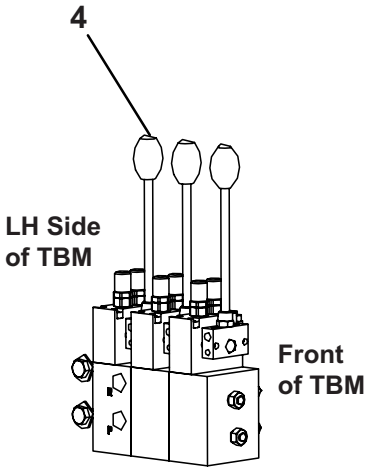
540 Gripper Can shown.

1. Roll Correction Section
2. Jacking Section
3. Gripper Shoe Section, (2) Shoes
4. Lift Eye
5. Tail Shield Section
6. Inspection Windows (2)
7. TBM Alignment Pins
8. Guide Plates, 540 (6) / 720 (10)
9. Rear Conveyor Lift
10. Gripper Shoe Cylinders (4)
11. Gripper Shoe Stops, 540 (4) / 720 (8)
12. Jacking Cylinders, 540 (4) / 720 (8)
13. Roll Correction Cylinders (2)

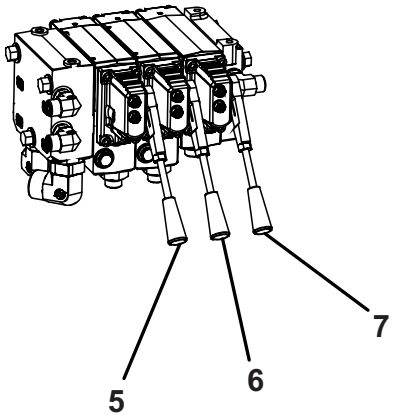
Gripper and Jacking Controls

Gripper Can Pilot Line Connections (in TBM)

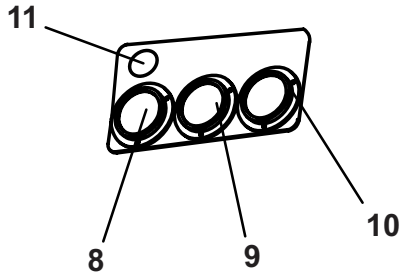




Gripper Can Auxiliary Manual Connections



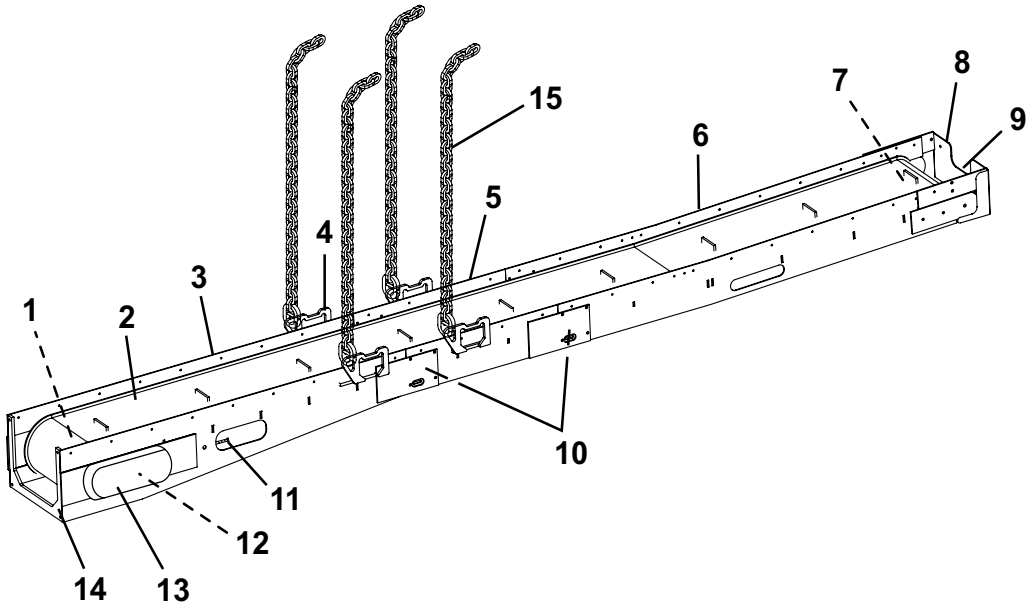
Gripper Can Pressure Gauge Mount Plate



1. Roll Correction Lever
2. Gripper Shoe Cylinder Control Lever
3. Conveyor Lift Control Lever
4. Conveyor Drive Lever
5. Auxiliary Roll Correction Lever
6. Auxiliary Gripper Shoe Cylinder Control Lever
7. Auxiliary Conveyor Lift Lever
8. Gripper Pressure Gauge
9. Jacking Pressure Gauge
10. Roll Correction Pressure Gauge
11. Gripper Shoe Pressure Switch Indicator*

*Gripper Shoe Pressure Switch Indicator location may vary by model.

Belt Conveyor



Shown without hopper extensions.

1. Drive Motor Frame Assembly
2. Belting
3. Drive Frame Assembly
4. Lift Bracket
5. Extension Frame Assembly
6. Feed Frame Assembly
7. Front Roller Assembly
8. Dirt Guard
9. Carrier Bearing
10. Idler Roller
11. Belt Tensioning Screw
12. Drive Motor & Roller Assembly
13. Conveyor Chain Cover
14. Drive Frame Free End Support
15. Safety Chain

II. 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.

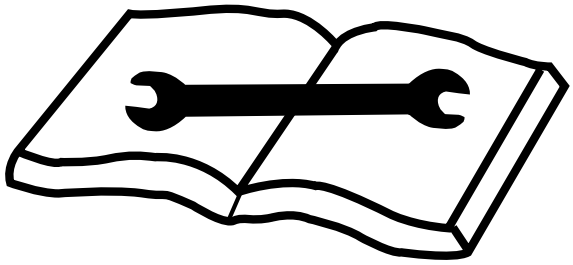
ATTENTION!
BECOME ALERT!
YOUR SAFETY IS INVOLVED!

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.



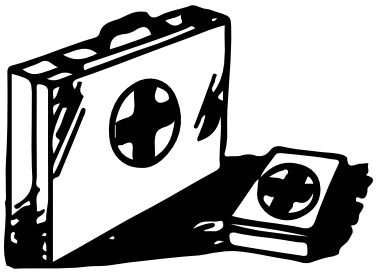
Wear Protective Clothing

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.

Keep First-Aid Kit Accessible

Keep a first-aid kit handy and properly maintained. Call 9-1-1 for emergencies.



Hydraulic Oil/Fluids Under Pressure

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

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.

Beware of Suspended Loads

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

If a hydraulic hose from the boom of a crane or excavator breaks, the boom can fall instantly.

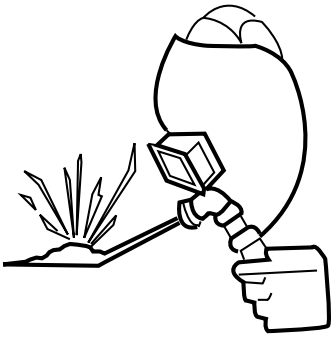
Do not enter area under or around a load.

Keep Personnel Away from Moving Parts

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

Unauthorized Welding

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

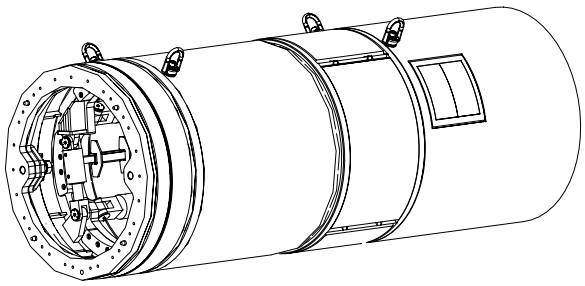


Do not weld on any structural member. Unauthorized welding or repair will void the warranty.

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.



Inspect Electrical Connections

⚠WARNING Regularly inspect electrical connections to be sure they are secure. Failure to do so could cause an explosion if moisture enters an unsecured electrical connection.

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.

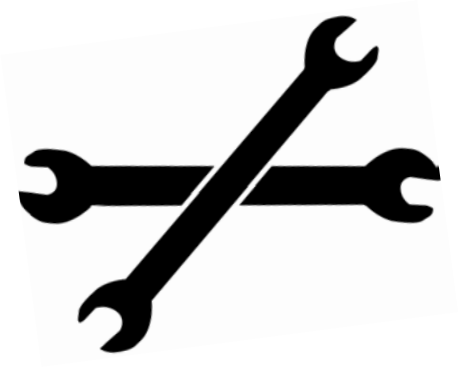
Handle parts carefully to avoid crushing and pinch point hazards.

Using Tunnel Power Cable

⚠DANGER NEVER disconnect tunnel power cables when tunnel power is ON. Doing so WILL cause severe injury or death from electrical shock.

Practice Safe Maintenance

⚠WARNING Unexpected equipment movement may cause serious personal injury.



Lockout/Tagout power before performing any maintenance.

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

Only trained and qualified personnel should perform any maintenance or repairs.

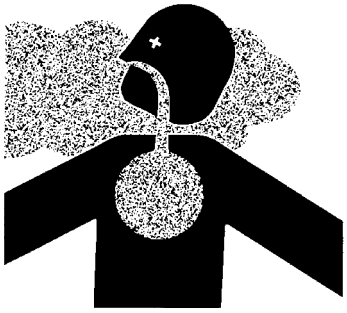
Keep the area around the equipment clean and dry when performing maintenance.

Do not service the machine while it is in motion.

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

Test Tunnel Ventilation

⚠WARNING Keep boring head 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 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.

Do not use haul unit to evacuate the tunnel. The electrical contacts with the unit can cause an explosion.

Keep Away From Belt Conveyor

⚠DANGER Contact with rotating conveyor belt or idler rollers will cause severe injury or death.

Keep hands, body, and objects clear of rotating conveyor.

Do not operate without covers and guards in place.

Lockout/Tagout power before servicing belt conveyor.

Avoid Tunnel Wall Contact

⚠WARNING Contacting tunnel wall and other pipeline obstructions can cause severe personal injury or death.

Keep all body parts on haul unit while unit is moving.

Watch for Conveyor

⚠WARNING Avoid contact with conveyor. Failure to do so could cause severe injury or death.

While moving haul unit into tunnel, avoid hitting the conveyor.

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.

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.

No Smoking in Shaft or Tunnel

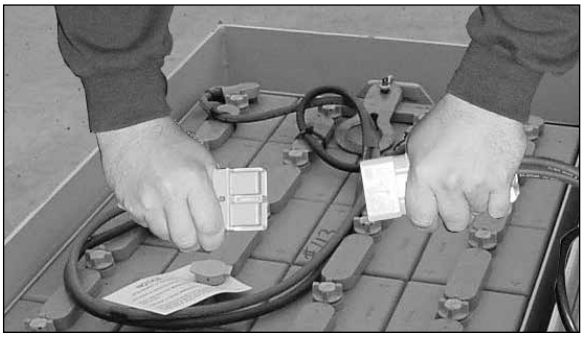
⚠WARNING Smoking in shaft or tunnel could cause an explosion if combustible gases are present.

Do not smoke in shaft or tunnel.

Lockout/Tagout Power Before Servicing Haul Unit

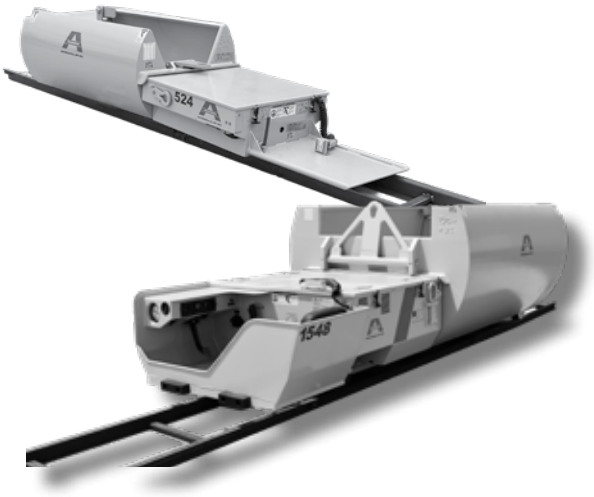
⚠WARNING Failure to lockout tagout power before servicing can cause severe personal injury or death.

Disconnect battery harness from contactor harness and remove battery pack from haul unit to Lockout/ Tagout power before performing any maintenance.



Keep Riders Off Haul Unit

Allow only operator on operating seat when moving haul unit. Keep riders off.



Riders on haul unit can be easily injured by being struck by objects or being thrown off of the equipment. Riders can also obstruct the operator's view resulting in the equipment being operated in an unsafe manner.

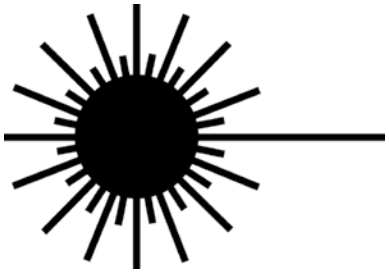
A rider may be allowed in an empty dirt bucket (with contractor approval only), to transport personnel from the tunnel opening to the boring head. If allowed, the rider MUST be fully inside dirt bucket, including head and all other body parts, to avoid contact with obstructions. Also, rider cannot obstruct the operator's view.

Stay Away From Crane

⚠DANGER NEVER disconnect tunnel power cables when tunnel power is ON. Doing so WILL cause severe injury or death from electrical shock.

Avoid Laser Light Exposure

⚠DANGER Staring into laser light will cause severe injury.

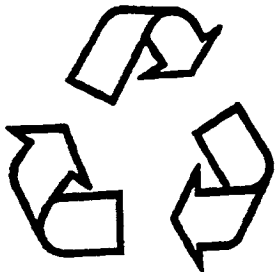


Do not stare into laser guidance system light beam. Avoid direct eye exposure.

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.

Recycle Waste

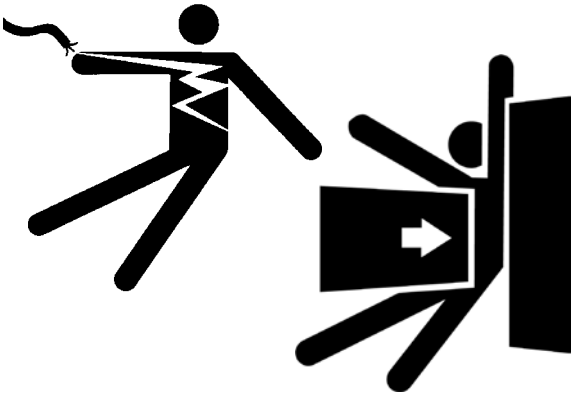
Follow local, state, federal, and international regulations when recycling or disposing of waste. Waste includes fluids/oil, fuel, filters, coolant, and batteries.



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

Lockout/Tagout Procedure Guideline

Lockout/Tagout (LOTO) power before attempting to make repairs, service or adjustments. Proper lockout tagout will prevent accidents and save lives. OSHA requires equipment placed in lockout tagout when the unexpected machine start up or release of stored energy could injure workers during cleaning, adjustments, repairing and servicing.



⚠DANGER Failure to LOTO power before adjustments, repairs or servicing WILL cause severe personal injury or death.

LOTO power before adjustments, repairs or servicing. Electrical repairs must be performed only by a certified electrician.

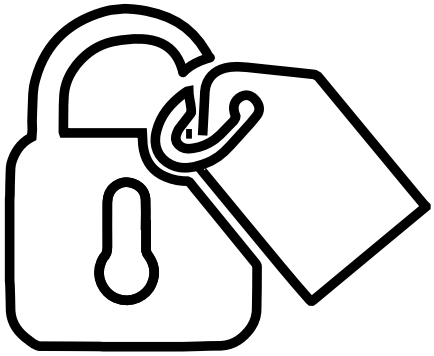
The contractor is fully responsible for the safety of all personnel on the job site. Use the following as a guideline for a LOTO procedure. The contractor must determine the best lockout tagout practices for their employees on the job site.

1. Follow all Federal, State and Local safety regulations and procedures.
2. Be sure OSHA prescribed safety personal protective equipment is worn by all personnel.
3. Be sure the area is safe for operation. Keep work site clean and organized.
4. Set all controls to the OFF or neutral position.
5. Push IN all E-Stop buttons.

6. There are two LOTO options for the Gripper Can:

   • LOTO the power source (generator or other external power source), refer to step 7 for details.

   • LOTO the TBM Control Box **AND** the 5200 Pump Unit Main Breaker on the Main Power Panel - refer to step 8 for details.



7. ***LOTO the Power Source Option***

   LOTO the power source (generator or other external power source). Refer to the power source or generator manufacturer for proper LOTO procedure.

Lockout/Tagout Procedure Guideline (continued)

8. **LOTO the TBM Control Box <u>AND</u> the 5200 Pump Unit Main Breaker on the Main Power Panel Option**

• TBM Control Box LOTO:
Be sure the main power switch (A) on the control box is in the OFF position. The TBM Main Power switch ON/OFF orientation may vary.

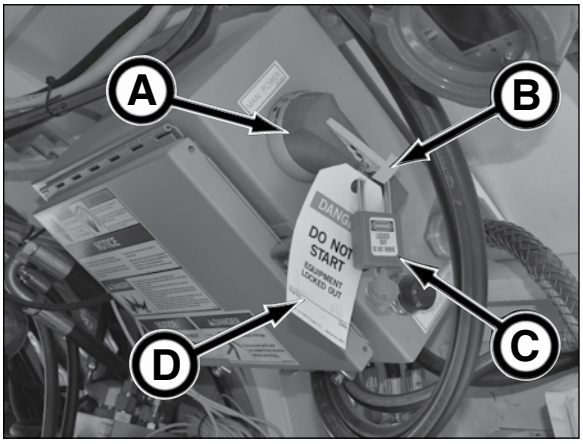
Flip safety latch (B) out on main power switch and install shackle of OSHA approved lock (C) with tag (D) through latch.

Secure lock by pushing shackle into body of the lock until the shackle is locked into the locking mechanism. Turn key to lock shackle in place.

Remove key from lock.

Test to be sure shackle is fully secured into lock.

Sign “Equipment Locked Out” tag or equivalent.



TBM Control Box in LOTO

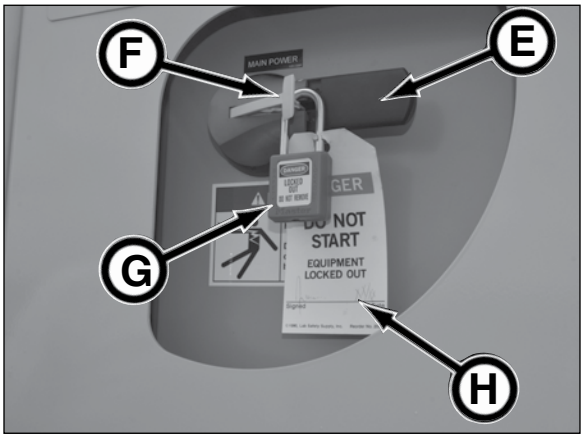
• 5200 Pump Unit Main Breaker LOTO:
Be sure the main power breaker (E) on the main power electrical panel is in the OFF position. Flip safety latch (F) out on main power breaker and install shackle of OSHA approved lock (G) with tag (H) through latch.

Secure lock by pushing shackle into body of the lock until the shackle is locked into the locking mechanism. Turn key to lock shackle in place.

Remove key from lock.

Test to be sure shackle is fully secured into lock.

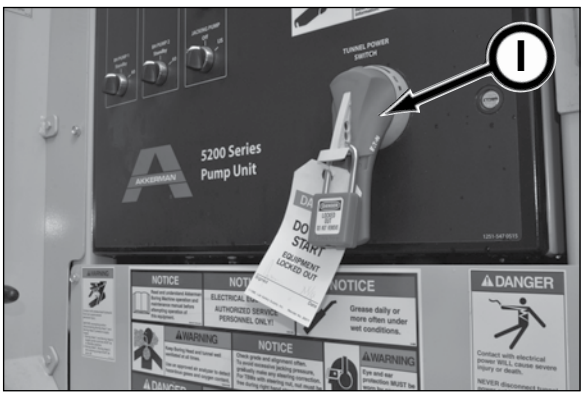
Sign “Equipment Locked Out” tag or equivalent.



Main Power Breaker on 5200 Pump Unit in LOTO

IMPORTANT: By placing LOTO at the Tunnel Power switch (I) on 5200 Pump Unit, ONLY the electrical power (tunnel) from the 5200 to the TBM is locked out. **The hydraulic power from the 5200 to the TBM is still energized and the electrical power on the 5200 is still live.**

To LOTO power to the 5200, the 5200 main power breaker MUST be in LOTO. Refer to 5200 Pump Unit Main Breaker LOTO above.



Tunnel Power Switch on 5200 Pump Unit Control Panel in LOTO

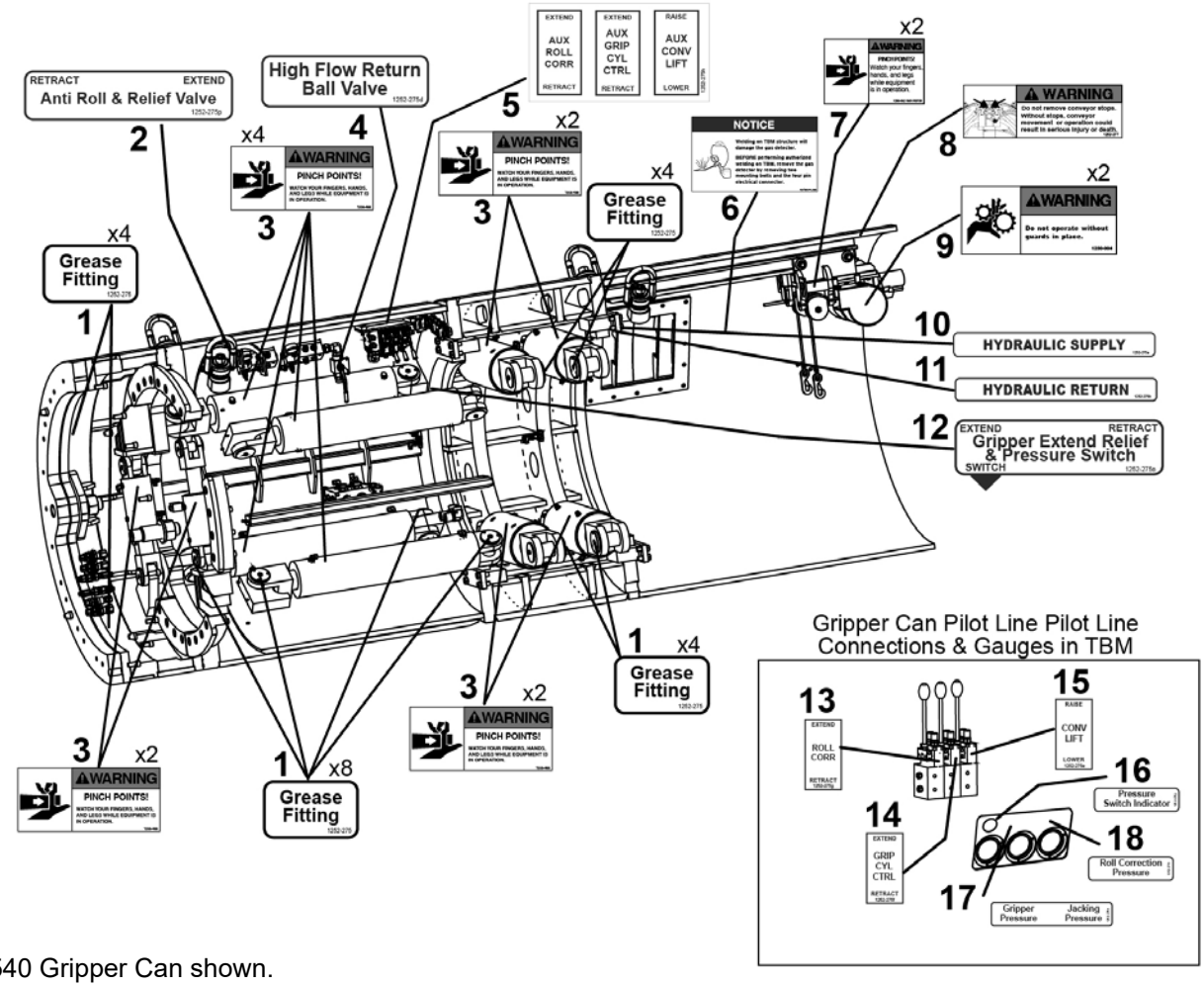
III. Decals

Keep all decals clean and readable. Use soft cloth, water, and a mild soap to clean the decals if they are too dirty to read. DO NOT clean decals with solvent. Solvent can damage them. Replace safety decals immediately if they are damaged, missing, or hard to read.

Serious injury or property damage can occur if safety instructions are not followed. Contact Akkerman Aftermarket Support for free replacement safety decals.

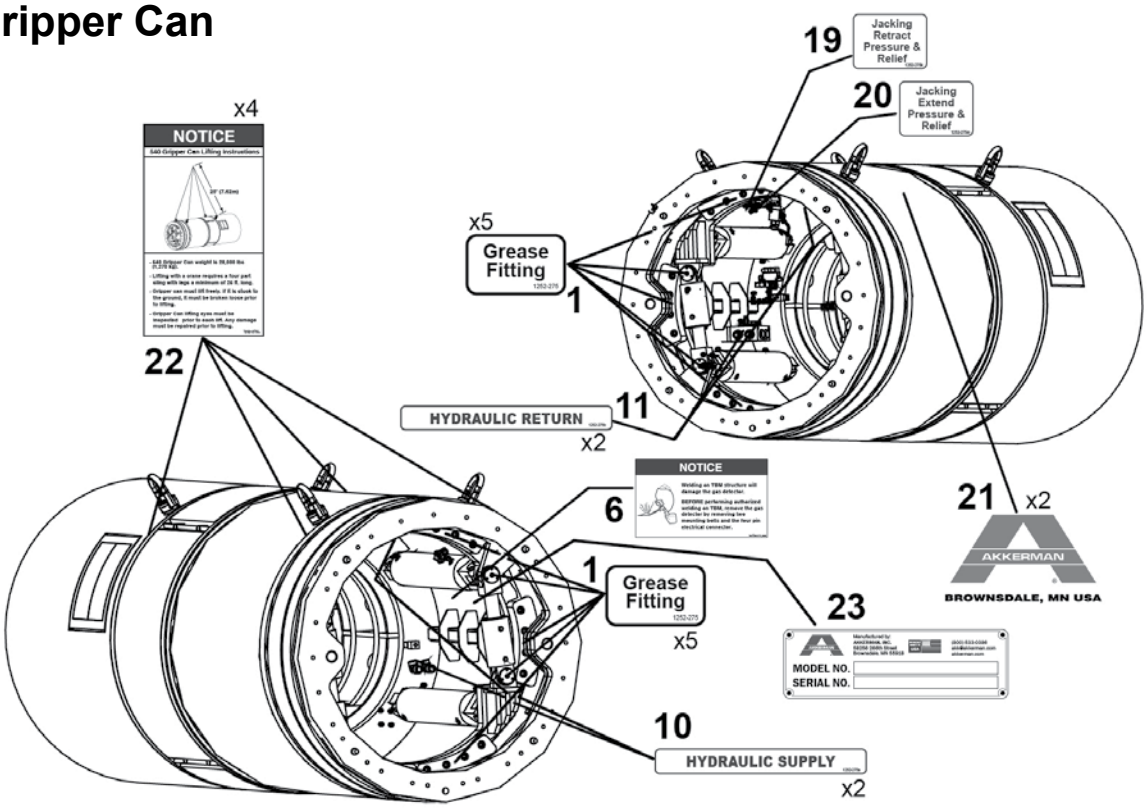
If a part is replaced that has a safety decal on it, apply a new safety decal to the replacement part. Before applying a new decal, be sure the surface is clean and dry.

Gripper Can



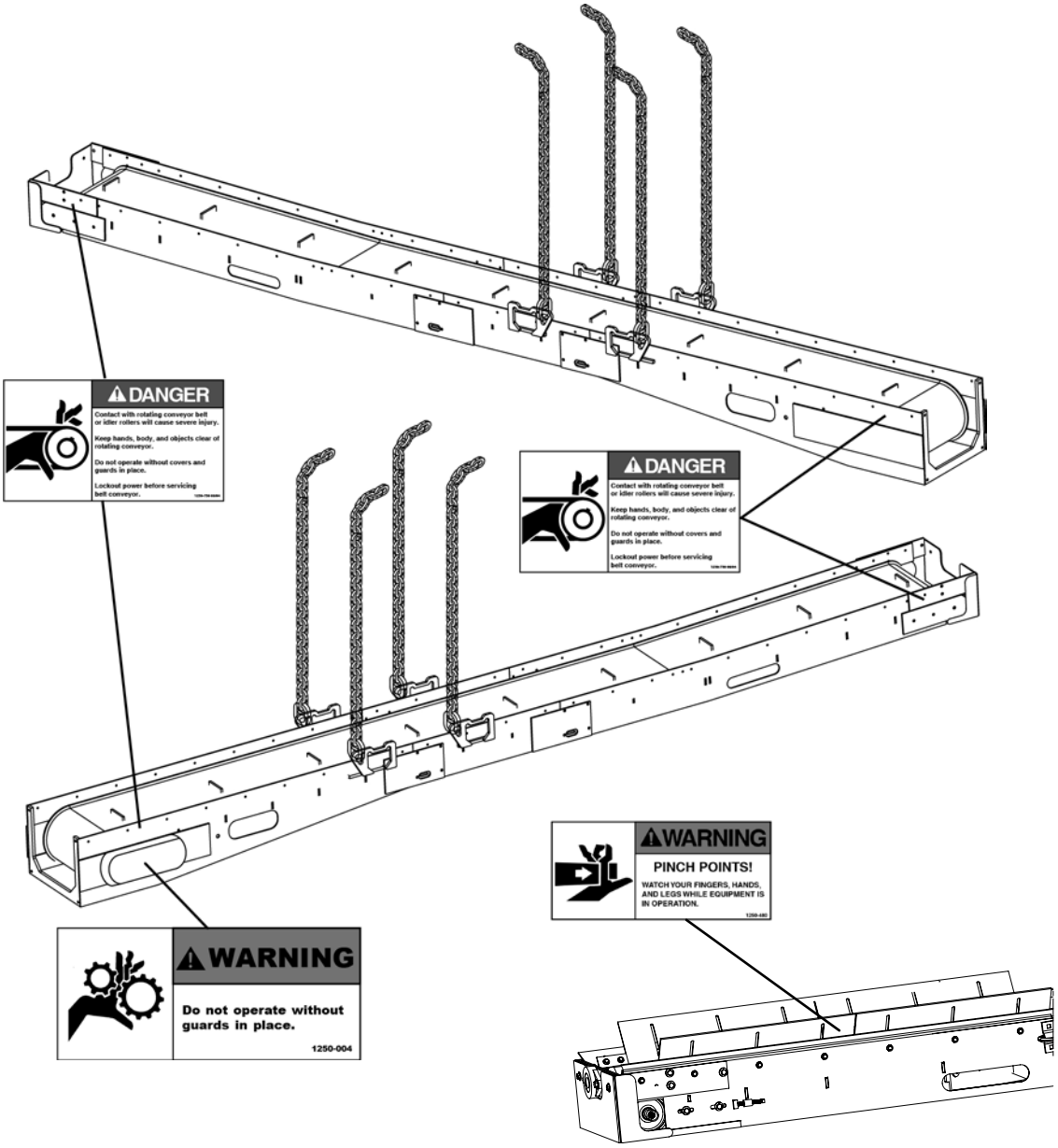
540 Gripper Can shown.

Gripper Can



540 Gripper Can shown.

Belt Conveyor



Belt conveyor with hopper extensions.

IV. Controls & Instruments

Emergency Stop

⚠WARNING ALL TBM Emergency Stop (E-Stop) buttons MUST be tested and operating properly BEFORE operating TBM and Gripper Can. Failure to do so may cause severe injury or death.

The E-Stop button will illuminate when it is pulled OUT.

NOTICE All TBM E-Stop buttons MUST be pulled out to restart operation.

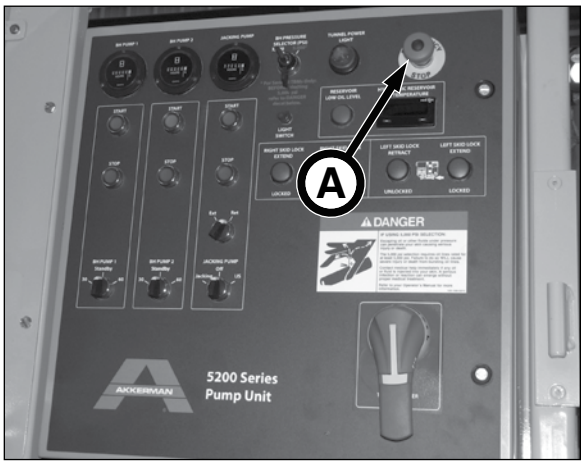
NOTICE All E-Stop buttons (Pump Unit E-Stop (A), Remote Pump Unit E-Stop (B) and TBM E-Stop (C) MUST be pulled out to restart operation.

The operating lights will not be functional when an E-Stop button is pushed IN.

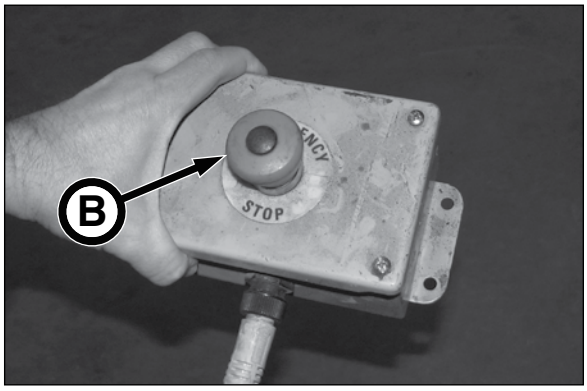
E-Stop on TBM
Push TBM E-Stop button (C) IN to stop all TBM functions.

IMPORTANT: DO NOT operate the TBM without electric power. Below is the result of no electric power in the TBM:

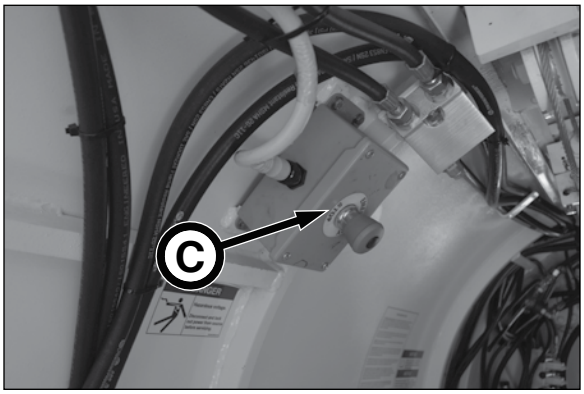
1. The bearing oil pump will not operate therefore the bearing cavity oil will not be recirculated.
2. The gas detector will not function.
3. The scavenging pump will not operate causing the excess oil in the scavenging pump reservoir to flow out of the circuit breather into the TBM.
4. The operating lights will not function.
5. The bearing seal grease pump will not operate, as a result, the bearing seals will not be greased.



E-Stop on 5200 Series Pump Unit



Remote E-Stop on 5200 Series Pump Unit



E-Stop on TBM

Main Power Switch

⚠DANGER Hazardous voltage. Disconnect and Lockout/Tagout (LOTO) power from source before servicing.

⚠DANGER If high voltage cables or cable connections are damaged, contact with cables/ connections may result in electrical shock causing severe injury or death. Disconnect and LOTO power from source before servicing.

⚠WARNING Any electrical work performed on the pump unit or TBM must be completed by a certified electrician.

NOTICE All Emergency Stop (E-Stop) buttons must be pulled out to restart operation.

Use the TBM Control Box Main Power Switch (A) to provide power from the pump unit to the TBM electrical components as follows:

1. With the power cables properly installed on the 5200 Pump Unit and the input power in proper phase, LOTO power on the pump unit and external power source.

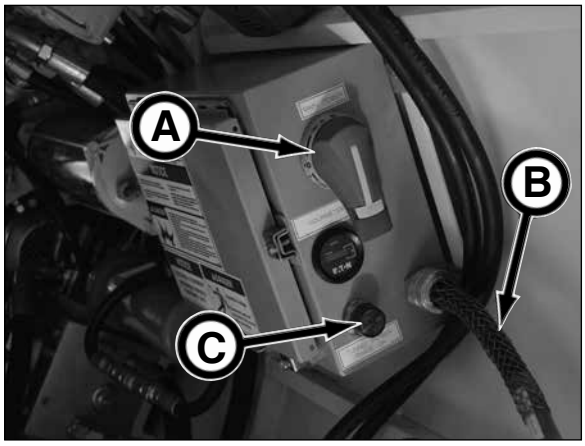
2. Install the 480V power cable from the power unit to the Incoming Power connection (B) on the TBM control box.

3. Pull out all E-Stop buttons.

4. Turn on external power source and pump unit with proper phase.

5. Check the Tunnel Power Phase OK light (C). If the light is illuminated, turn ON main power switch (A). The TBM Main Power Switch ON/OFF orientation many vary.

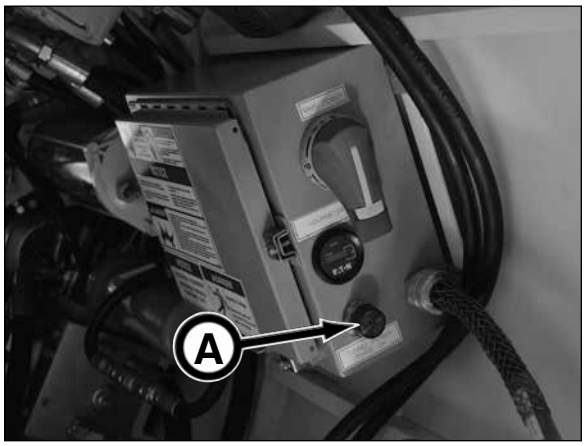
6. Once main power switch is turned to the ON position, the 480V power provides power to the bearing lubrication pump and the scavenging pump and seal grease pump. The 480V circuit also powers a transformer inside the electrical box which converts the 480V power to 24 VDC. The 24 VDC circuit provides power for the lights, gas detector and the conveyor safety valve circuit.



TBM Control Box

Tunnel Power Phase OK Light

⚠WARNING Any electrical work completed on the pump unit or TBM must be performed by a certified electrician.



The input power is monitored for proper three phase electrical power.

If the Tunnel Power Phase OK light (A) is ON, this indicates that the external power source and pump unit phase power is installed correctly and that the main power in the TBM can be turned on.

If the light does not illuminate, check the phase power from the external power source and pump unit. Refer to your 5200 Jacking System Operator's Manual, *Phase Error Light* in section 4, Controls and Instruments to correct the input phase.

IMPORTANT: DO NOT start up electric components if the Tunnel Power Phase OK light is NOT illuminated. Doing so will run components backwards causing damage.

Gripper Inspection Windows

The gripper can has two inspection windows to view the gripper shoes while engaged in the tunnel wall from the interior of the gripper can.

To inspect the tunnel from the gripper can interior, remove the inspection window inserts.

Remove the sixteen (16) 5/8 in. bolts around the window assembly and retain for later.

Grab window insert handles and lift out the insert from window.

Following inspection, return window insert to the inspection window assembly, and replace and tighten hardware.

Remove inspection window bolts

Remove inspection window inserts

Gripper Can Pressure Gauges

The Gripper Can is equipped with three hydraulic pressure gauges to monitor the Gripper Can gripper, jacking, and roll correction pressures.

Pressures may exceed 5,000 psi due to high jacking in hard ground conditions or over advancement by the pump unit operator.

IMPORTANT: During Gripper Can advancement, DO NOT EXCEED the maximum rated cylinder pressure. Doing so will cause hydraulic component, main bearing, and structural damage.

Gripper Cylinder Pressure Gauge

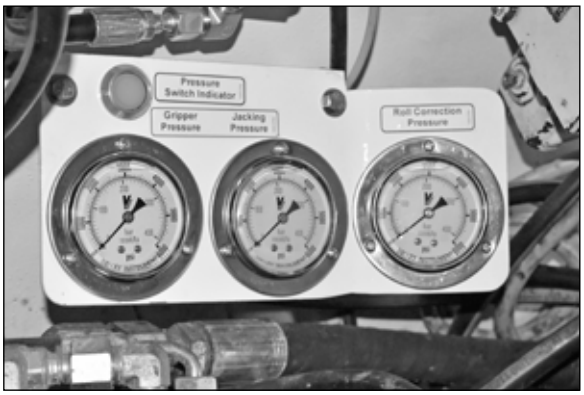
	Models 540 / 720
Extend Maximum	5,000 / 5,000 psi
Relief Setting	3,000 / 3,500 psi
Retract Maximum	5,000 / 5,000 psi
Relief Setting	2,500 / 2,500 psi

Jacking Cylinder Pressure Gauge

	Models 540 / 720
Extend Maximum	5,000 / 5,000 psi
Relief Setting	3,600 / 3,100 psi
Retract Maximum	5,000 / 5,000 psi
Relief Setting	1,600 / 1,000 psi

Roll Correction Cylinder Pressure Gauge

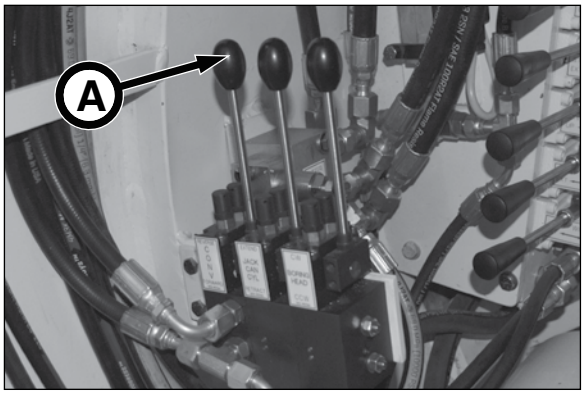
	Models 540 / 720
Extend Maximum	5,000 / 5,000 psi
Relief Setting	2,500 / 3,500 psi
Retract Maximum	5,000 / 5,000 psi
Relief Setting	2,500 / 3,500 psi



L to R: Gripper, Jacking, Roll Correction Cylinder Pressure Gauges
540 Gripper Can Pressure Gauges Shown

Conveyor Controls

Conveyor Drive & Speed Control Lever



The conveyor drive lever (A) controls the forward/ back direction and speed of the belt conveyor.

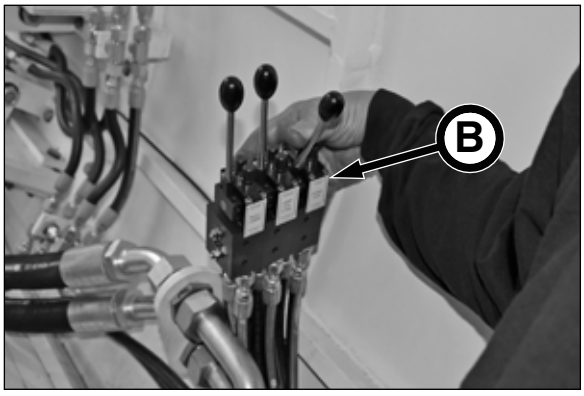
The further the lever is moved from neutral, the faster the conveyor belt will move. This control also is equipped with a friction detent, so the lever will remain in the desired position until you move it back to neutral position. Move the lever as follows:

Forward - towards reception shaft
Back - towards launch shaft

Control the speed of the conveyor so when the spoils drop on the conveyor, they do not pile up on the belt. A change in TBM advancement rate or ground conditions will require an adjustment in the conveyor speed.

⚠WARNING Running the conveyor too fast can cause severe injury from flying debris and cause possible machine damage. Slow the conveyor speed so there is continual controlled movement of the spoils into the dirt bucket.

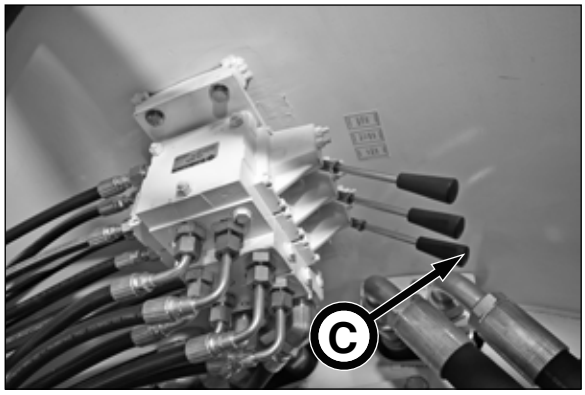
Conveyor Lift Lever



The conveyor lift control lever (B), is remotely located on the Gripper Can Pilot Line Connections in the TBM, and raises or lowers the second conveyor in the gripper can. Move the conveyor lift control lever as follows:

Forward - raises conveyor (operation)
Back - lowers conveyor (maintenance)

Auxiliary Conveyor Lift Lever



The auxiliary conveyor lift control lever (C) located in the gripper can, raises or lowers the second conveyor in the gripper can. Use the auxiliary conveyor control for maintenance or troubleshooting on the gripper can conveyor only. Move the auxiliary conveyor lift control lever as follows:

Up - raises conveyor (operation)
Down - lowers conveyor (maintenance)

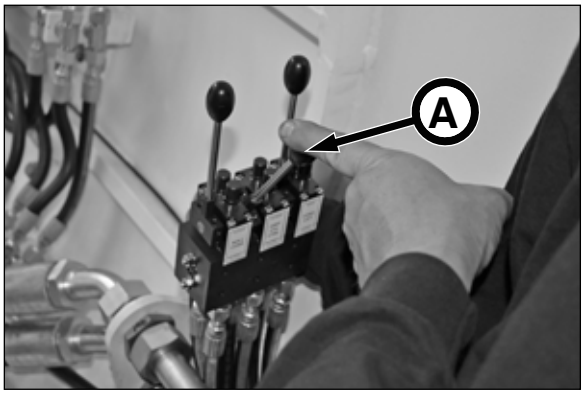
The main power must be ON for the auxiliary conveyor lift to operate.

Gripper Cylinder Controls

Gripper Shoe Cylinder Control Lever

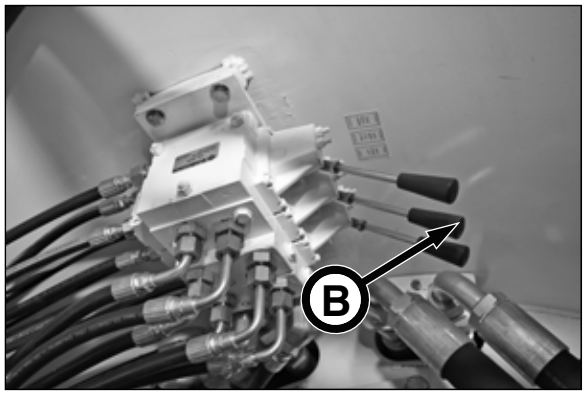
The gripper shoe cylinder control lever (A), is remotely located on the Gripper Can Pilot Line Connections in the TBM, and extends the gripper cylinder shoes up to 5 in. (127 mm) beyond the outside diameter of the gripper can and retracts them to flush with the outside diameter. Move the gripper control lever as follows:

Forward - extends gripper cylinder shoes
Back - retracts gripper cylinder shoes



	Models 540 / 720
No. of Cylinders	4 / 4
Cylinder Stroke	10 / 10 in. (254 mm)

NOTICE The gripper shoe stops in the gripper can ensure consistent and equal retraction of the gripper cylinders.



Auxiliary Gripper Shoe Cylinder Control Lever

The auxiliary gripper shoe cylinder control lever (B) located in the gripper can, extends the gripper cylinder shoes up to 5 in. (127 mm) beyond the outside diameter of the gripper can and retracts them to flush with the outside diameter. Use the auxiliary gripper cylinder control for maintenance or troubleshooting. Move the auxiliary gripper cylinder control lever as follows:

Up - extends gripper cylinder shoes
Down - retracts gripper cylinder shoes

The main power must be ON for the auxiliary gripper cylinder control to operate.

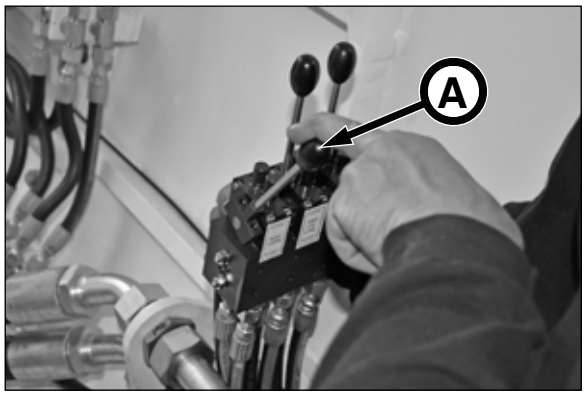
Roll Correction Controls

Roll Correction Control Lever

The roll correction cylinder control lever (A), is located on the Gripper Can Pilot Line Connections in the TBM, and assists the gripper cylinders to re-level the TBM and gripper can. Move the roll correction control lever as follows:

Forward - extends roll correction cylinders
Back - retracts roll correction cylinders

	Models 540 / 720
No. of Cylinders	2 / 2
Cylinder Stroke	4 / 6 in. (102/152 mm)

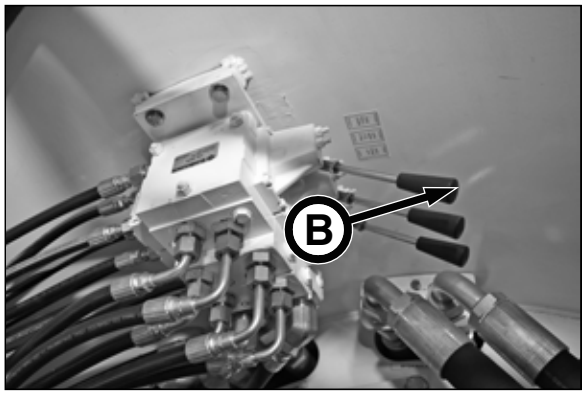


Auxiliary Roll Correction Control Lever

The auxiliary roll correction control lever (B) located in the gripper can, assists the gripper cylinders to re-level the TBM and gripper can. Use the auxiliary roll correction control for maintenance or troubleshooting. Move the auxiliary roll correction control lever as follows:

Up - extends roll correction cylinders
Down - retracts roll correction cylinders

The main power must be ON for the auxiliary roll correction control to operate.



Jacking Can Cylinder Controls

Jacking Can Cylinder Control Lever

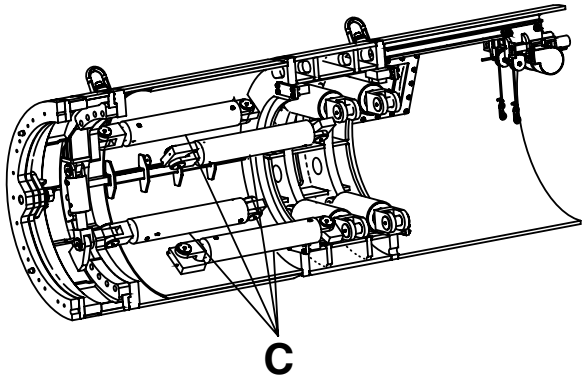
As the TBM and gripper can mine through the ground, the hydraulically actuated jacking cylinders (C) extend, and the pipe or tunnel lining is installed behind them.

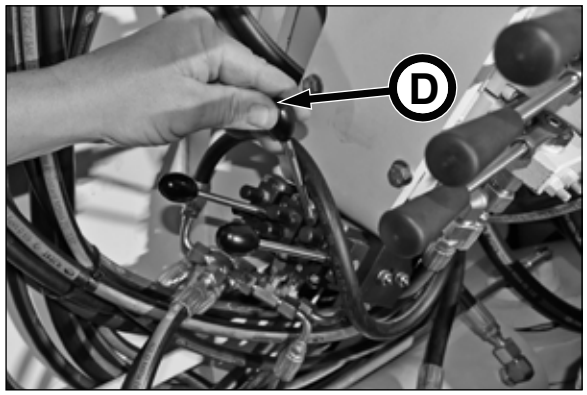
The jacking can cylinder control lever (D) is located in the TBM and will extend and retract the jacking cylinders in the gripper can.

Move the jacking can cylinder control lever as follows:

Forward - extends jacking cylinders
Back - retracts jacking cylinders

	Models 540 / 720
No. of Cylinders	4 / 8
Cylinder Stroke	30 / 30 in. (762 mm)



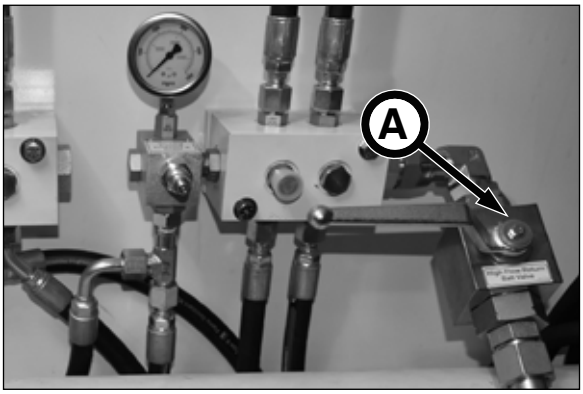


High Flow Return Ball Valve

During normal gripper can jacking operations, the High Flow Return Ball Valve remains closed. In some instances it may be necessary to retract the jacking cylinders only using the 5200 pump unit jacking cylinders, or an IJS. To do this you must open the High Flow Return Ball Valve.

To open High Flow Return Ball Valve lever (A) turn the lever to the open position.

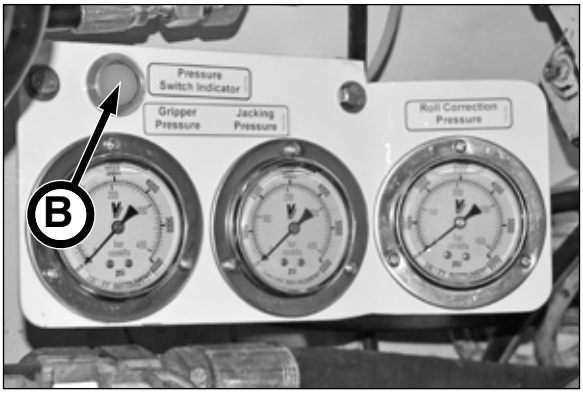
After the jacking cylinders are fully retracted, close the High Flow Return Ball Valve lever (A) to return to normal gripper can jacking operations.



NOTICE The High Flow Return Valve lever must be fully closed or the gripper can extend will not function correctly.

Gripper Shoe Pressure Switch Indicator

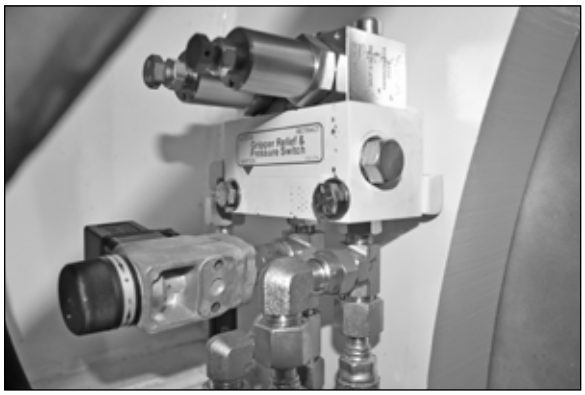
The Gripper Shoe Pressure Switch Indicator (B) is located on the Gripper Can Pressure Gauge Mount Plate. The Gripper Shoe Pressure Switch Indicator lights up green when the gripper shoe cylinder extend pressure has reached the switch setting, or red if pressure is below the switch setting.



Pressure Switch Indicator in 540 Gripper Can

Gripper Shoe Relief Valve and Pressure Switch

The Gripper Shoe Relief Valve limits the gripper can cylinder thrust against the tunnel wall. During normal operation, the factory setting is not adjusted.



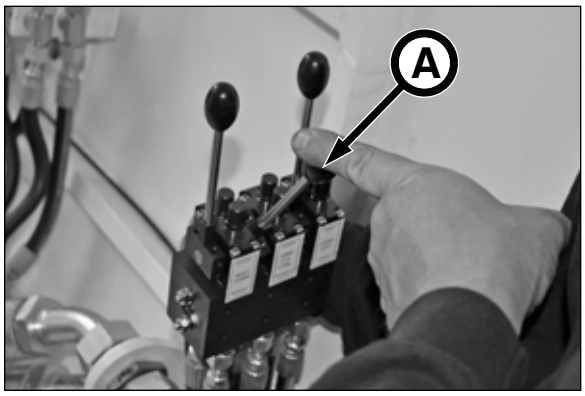
Factory Settings:

	Models 540 / 720
Gripper Shoe Relief Valve	3,000 / 3,500 psi
Pressure Switch	2,900 / 3,400 psi

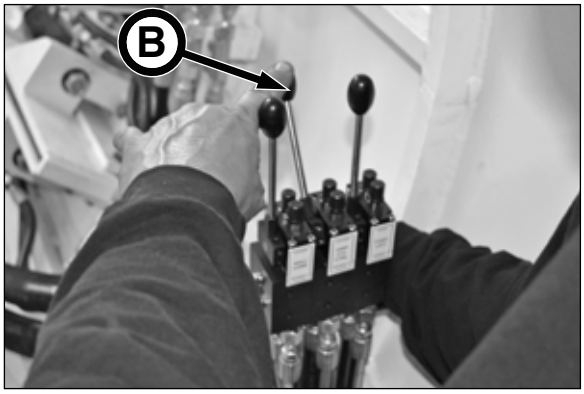
If the ground conditions change so the TBM advancement cannot be achieved, or the gripper can creeps backward or rolls, it is necessary to increase the Gripper Relief Valve force, and adjust the Pressure Switch dial so the jacking cylinders extend reaches the adjusted minimum pressure with a 100 psi differential.

To increase the Gripper Shoe Relief Valve pressure:

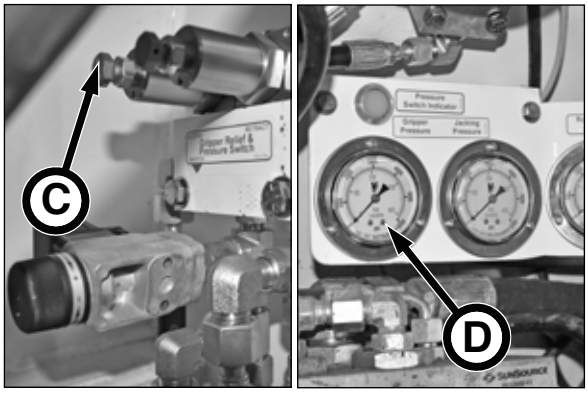
1. Move the Gripper Shoe Control Lever backward (A) to fully retract the gripper cylinders.



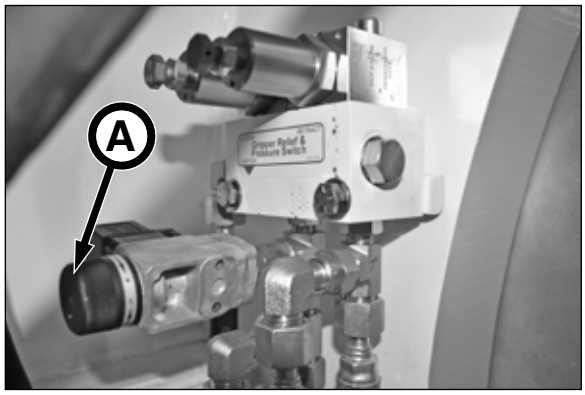
2. Move the Gripper Shoe Control Lever forward (B) to fully extend the gripper cylinders. This resets the cylinders and allows trapped spoil to fall away.



3. With the Gripper Shoe Control lever still extended, adjust the extend Gripper Shoe Relief Valve (C) using a 9/16 in. wrench until the Gripper Pressure Gauge (D) corresponds with the intended setting.

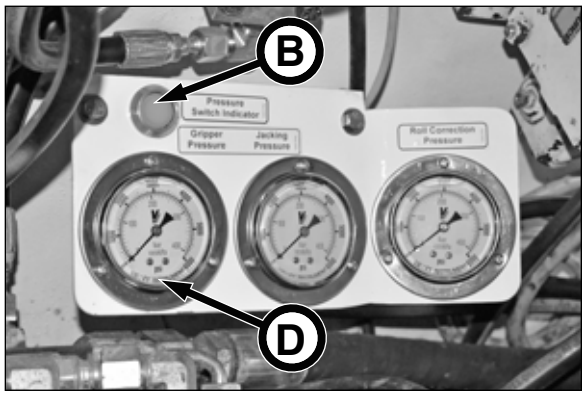


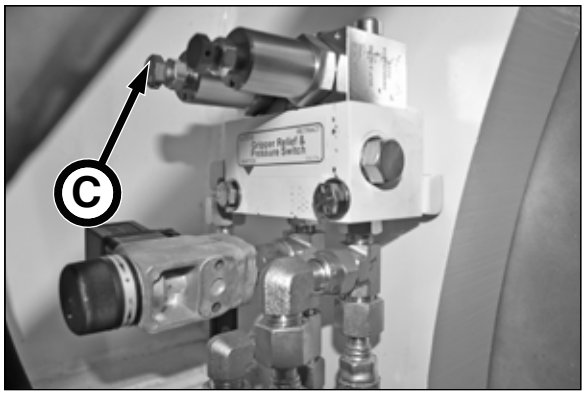
Gripper Relief Valve and Pressure Switch (continued)



4. Adjust the pressure switch dial (A) up until the Pressure Switch Indicator (B) light turns red. Slowly adjust pressure switch down until Pressure Switch Indicator light turns green.

   Pressure switch setting should now match the Gripper Extend Relief Valve setting.

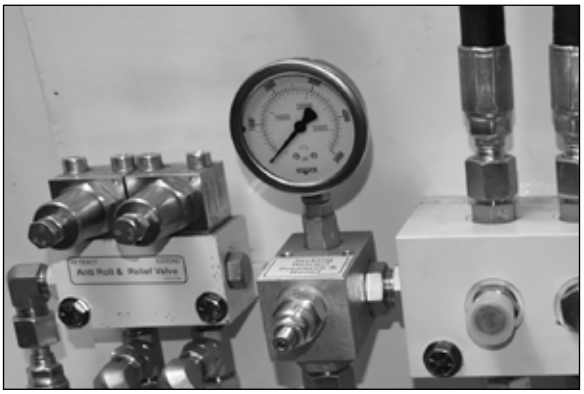




5. Readjust the Gripper Shoe Relief Valve (C) up 100 psi to keep a 100 psi differential between the Gripper Shoe Relief Valve setting and the pressure switch, as shown on the Gripper Pressure Gauge (D).

   The pressure switch setting should always be approximately 100 psi below the Gripper Shoe Relief Valve setting.

Roll Correction Relief Valve

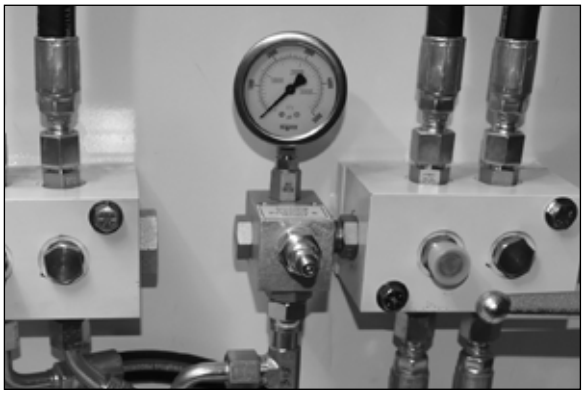


The Roll Correction Relief Valve (A) protects the Roll Correction hydraulic cylinders from overpressure. During standard operation, do not adjust the factory settings of the Roll Correction Relief Valve. Contact Akkerman Aftermarket Support for additional information.

Factory Settings:	Models 540 / 720
Relief Valve - Retract	2,500 / 3,500 psi
Relief Valve - Extend	2,500 / 3,500 psi

IMPORTANT: During Gripper Can roll correction, DO NOT EXCEED the maximum rated cylinder pressures. Doing so will cause hydraulic component, main bearing and structural damage.

Jacking Extend Pressure Gauge and Relief Valve

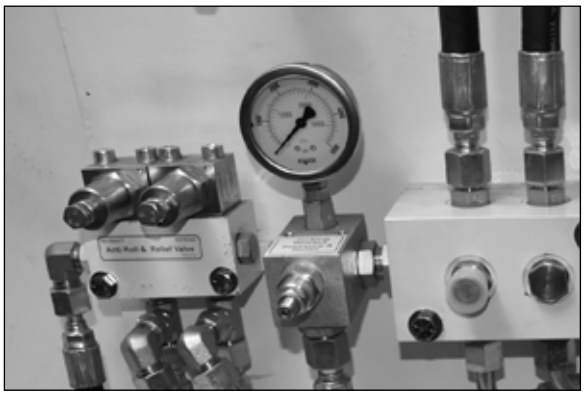


The Jacking Extend Pressure Gauge displays the pressure rating of the jacking cylinders while in the extend position. During standard operation, do not adjust the factory settings of the Jacking Extend Valve. Contact Akkerman Aftermarket Support for additional information.

Factory Settings:	Models 540 / 720
Extend Setting	5,000 / 5,000 psi
Relief Setting	3,600 / 3,100 psi

IMPORTANT: During Gripper Can extension, DO NOT EXCEED the maximum rated cylinder pressure. Doing so will cause hydraulic component, main bearing and structural damage.

Jacking Retract Pressure Gauge and Relief Valve



The Jacking Retract Pressure Gauge displays the pressure rating of the jacking cylinders while in the retract position. During standard operation, do not adjust the factory settings of the Jacking Retract Valve. Contact Akkerman Aftermarket Support for additional information.

Factory Settings:	Models 540 / 720
Retract Setting	5,000 / 5,000 psi
Relief Setting	1,600 / 1,000 psi

IMPORTANT: During Gripper Can retraction, DO NOT EXCEED the maximum rated cylinder pressure. Doing so will cause hydraulic component, main bearing and structural damage.

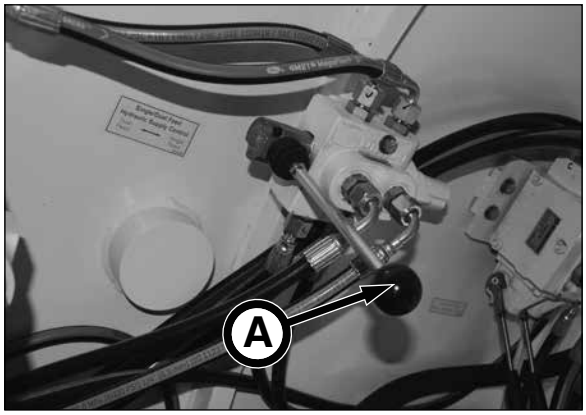
Single/Dual Feed Hydraulic Supply Control

The 5200 Pump Unit provides hydraulic oil supply/return to the TBM and Gripper Can through single and dual feed supply lines. Single feed supplies 60 gpm of low-pressure oil to the boring head, steering, and conveyor. Dual feed supplies up to an additional 60 gpm of low-pressure oil (for a total of 120 gpm) using the Boring Head 2 motor.

When using single feed supply (60 GPM), the single/dual feed hydraulic supply control (B) must be in the Single Feed position.

When using dual feed supply (90/120 GPM), the single/dual feed hydraulic supply control (A) must be in the Dual Feed position.

If the supply control is not switched to the appropriate position, the boring head cutterhead and conveyor will not operate properly.



V. Pre-Start Inspection

⚠WARNING Do not operate this equipment until you read, study, and understand this manual and ALL other equipment manuals that may be used. 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 to ensure 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, monitoring of combustible and toxic gases including the depletion of oxygen; flammable, combustible, and hazardous materials are properly stored; and a lockout/tagout procedure is in place (for more information, refer to section II, Safety - Lockout/Tagout Procedure Guideline).

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 maintenance.

	1. Use “ONE-CALL” notification to check for buried utility lines prior to tunneling.
	2. Check the excavated launch and reception shafts for proper shoring or bracing to prevent slides or cave-ins.
	3. Thoroughly clean equipment of mud and dirt. Keep job site clean and organized.
	4. Check condition of personal protective equipment. Replace equipment if defective.
	5. Contractor is responsible for all personnel to wear proper protective equipment on the job site.
	6. Remove combustible or flammable materials from equipment. Store materials properly.
	7. Test **ALL** Emergency Stop buttons for proper operation at the start of each shift.
	8. Test air monitoring and ventilation detectors for proper operation.
	9. Thoroughly inspect all equipment for damage, including loose or missing hardware. Repair or replace before operating.
	10. Be sure all covers and guards are in place before operation.
	11. Check electrical lines for frayed, damaged, or worn insulation or wires. Replace damaged or worn electrical lines/connections.
	12. Check for fluid leaks. Repair leak or replace components.
	13. Prior to startup, ensure the electrical phase power is correctly installed and verified. Otherwise damage will occur to components.
	14. Perform all lubrication and maintenance procedures. Refer to Section IX, Periodic Maintenance.
	15. Test each function and control to ensure correct operation.
	16. Check hydraulic hoses and lines for leaks, wear and/or damage. Replace any defective hoses and/or lines.
	17. Perform pre-start inspection on your equipment. Refer to your equipment’s operator’s manual.
	18. Conveyor MUST be secured with four safety chains to conveyor bracket in TBM, and chain from conveyor safety valve must be tethered to conveyor.
	19. Test the TBM electrical motors for proper rotation prior to operating the pump unit or power pack.
	20. Decals must be clean and legible.
	21. Before startup, ALL controls must be in the OFF or neutral position.

VI. Operation

Operating Guidelines

⚠WARNING Do not operate this equipment until you read, study, and understand this manual and all other support equipment operation manuals. Failure to do so, could result in severe personal injury or death.

1. Before operating, read, study, and understand this manual and all other support equipment operation manuals.
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 protective equipment is being worn by all personnel.
5. Be sure the area is safe for operation. Keep work site clean and orderly.
6. NEVER operate equipment if it has been engulfed with water. Contact Akkerman Aftermarket Support for proper procedures on how to restore equipment for operation.
7. Have fully charged fire extinguishers on the job site at all times.
8. Be sure the excavated launch and reception shafts are properly shored or braced to prevent slides or cave-ins.
9. Before operation, determine whether the job site has confined spaces. Follow OSHA regulations for proper training required for employees working in and around confined spaces.
10. A fully trained and qualified signal person must direct the crane operator when lifting and lowering equipment into the launch or reception shafts.
11. Never walk or work under any part of the crane or suspended loads.
12. Fresh air must be supplied to all underground work areas in sufficient amounts to prevent any dangerous or harmful accumulation of dusts, fumes, mists, vapor, or gases.
13. Before operating, thoroughly inspect all equipment and repair equipment problems. Check hoses for cuts or bulges. Replace worn or damaged hoses.
14. Before starting equipment, walk completely around all machines and equipment. Let all job site personnel know that you are starting up the equipment. Do not start until all unauthorized personnel are clear of the equipment.
15. Test air monitoring and ventilation detectors for proper operation. Never enter a tunnel without combustible gas detectors and oxygen deficiency detectors.
16. Test all Emergency Stop circuits for proper operation at the start of each shift.
17. Test each control function to make sure they work properly.
18. High pressure hydraulics are used in this Gripper Can. Be sure all covers and guards are in place before operating.
19. Do not make any non-authorized modifications to any Akkerman products. Doing so could cause structural failure and will void the warranty.
20. Check shields and guards. All must be in place and undamaged.

Operating Guidelines (continued)

21. Never leave the TBM operator's control console without first releasing hydraulic pressure, pressing E-Stop, performing daily system shutdown, and disconnecting the main power supply.

22. Conveyors MUST be secured with four safety chains to conveyor brackets in boring shield.

23. Before operating conveyor, all guards and/or safety devices must be in place and operable to prevent any contact with conveyor.

24. Conveyors must not be started until all personnel have been moved away from the conveyors and have been warned that the conveyors are about to start up.

25. The area around conveyor loading and unloading points must be kept clear of obstructions during conveyor operation.

26. Conveyors must be stopped and the power source in lockout/tagout during maintenance, repair, servicing or attempting to remove a jam or overload.

27. While TBM and conveyors are operating, the operator must remain seated in normal operating position.

28. The operator must note and report any slow down of machine operating time that might be an early warning of future problems.

29. When installing ring beam and lagging sections, complete sections must be installed to provide proper thrusting. Failure to do so WILL cause can component damage.

30. When using gripper can jacking cylinders only for pipejacking, or while using an IJS, be sure to open the High Flow Return Ball Valve before using another source to collapse the jacking cylinders.

31. Do not make adjustments or repairs to any of the system components while in operation or until all pressure is released and electrical power is in lockout/tagout.

32. Check line and grade often to avoid misalignment. Keep TBM and gripper can well ventilated to achieve a consistent temperature throughout the pipeline since changes in temperature inside the tunnel can cause the guidance system laser beam to stray off target.

33. After start-up, observe all gauges, controls and warning devices to assure they are functioning properly and their readings are within the operating range.

34. Before performing maintenance, follow the lockout/tagout procedure guideline in section II, Safety.

35. Before servicing electrical components, follow the lockout/tagout procedure guideline in section II, Safety.

36. If this instruction becomes lost, contact Akkerman Aftermarket Support for a new instruction or download it from www.akkerman.com/literature-and-manuals.

Using Emergency Stop

⚠WARNING ALL TBM Emergency Stop (E-Stop) buttons MUST be tested and operating properly BEFORE operating TBM and Gripper Can. Failure to do so may cause severe injury or death.

The E-Stop button will illuminate when it is pulled OUT.

NOTICE All TBM E-Stop buttons MUST be pulled OUT to restart operation.

NOTICE All E-Stop buttons (Pump Unit E-Stop (A), Remote Pump Unit E-Stop (B) and TBM E-Stop (C) MUST be pulled OUT to restart operation.

The operating lights will not be functional when an E-Stop button is pushed IN.

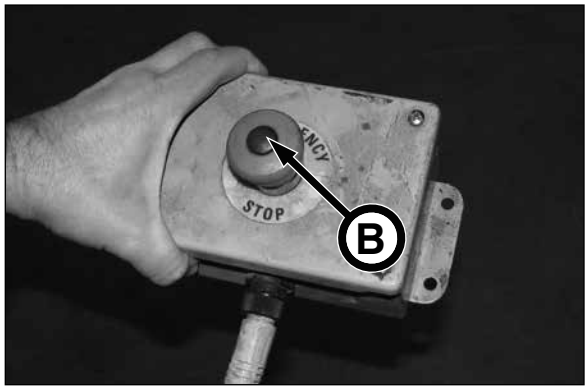
E-Stop on TBMs
Push TBM E-Stop button (C) IN to stop all TBM functions.

IMPORTANT: DO NOT operate the TBM without electric power. Below is the result of no electric power in the TBM:

1. The bearing oil pump will not operate therefore the bearing cavity oil will not be recirculated.
2. The gas detector is no longer functional.
3. The scavenging pump will not operate causing the excess oil in the scavenging pump reservoir to flow out of the circuit breather into the TBM.
4. The TBM operating lights will not function.
5. The bearing seal grease pump will not operate, as a result, the bearing seals will not be greased.

6. Proceed to *Hydraulic Setup - Single/Dual Feed* in this section.

E-Stop on 5200 Series Pump Unit



Remote E-Stop on 5200 Series Pump Unit

E-Stop on TBM

Hydraulic Setup - Single/Dual Feed

The 5200 Pump Unit provides hydraulic oil supply/return to the TBM and Gripper Can through single and dual feed supply lines. Single feed supplies 60 gpm of low-pressure oil to the boring head, steering, and conveyor. Dual feed supplies up to an additional 60 gpm of low-pressure oil (for a total of 120 gpm) using the Boring Head 2 motor.

⚠WARNING Escaping oil or other fluids under pressure can penetrate your skin causing serious injury. Contact medical help immediately if any oil or fluid is injected into your skin. Before hooking up the supply hoses to the pump unit ALWAYS use gloves before connecting or disconnecting hydraulic oil hoses/lines.

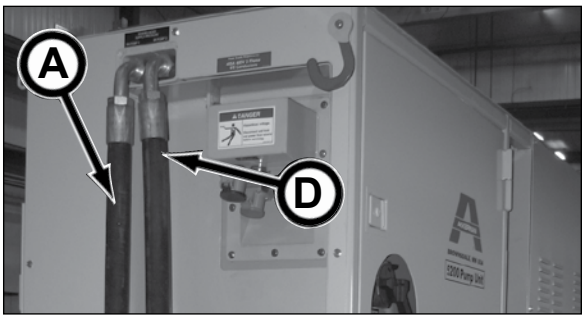
IMPORTANT: If switching from single feed to dual feed during drive, BEFORE connecting/disconnecting hoses, the boring head motors must be shut off.

Single Feed (60 GPM Maximum)

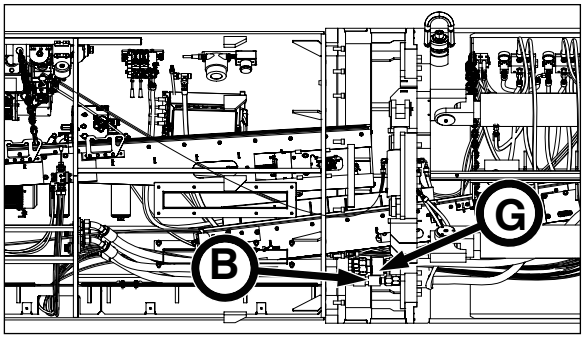
1. Connect boring head 1 supply quick coupler hose (A) to a gripper can supply quick coupler hose (B). Then connect this gripper can supply quick coupler hose (B) to a TBM supply quick coupler hose (C). Cap boring head 2 supply quick coupler hose (D) for single feed option.

2. Connect return line quick coupler hose (E or F) to a gripper can return quick coupler hose (G). Then connect this gripper can return quick coupler hose to a TBM return line quick coupler (H). Cap other return line quick coupler hose. The pump unit return lines are common, thus either return line hose can be used.

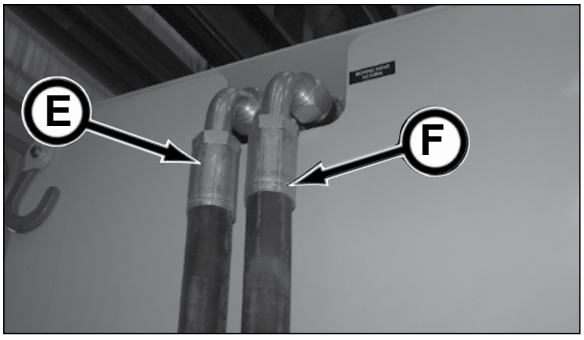
NOTICE Boring Head 2 motor system can be used in place of the Boring Head 1 system. The Boring Head 1 and 2 motor systems are identical 100 HP hydraulic systems. It is critical to use the system that is connected to the TBM pressure and return lines.



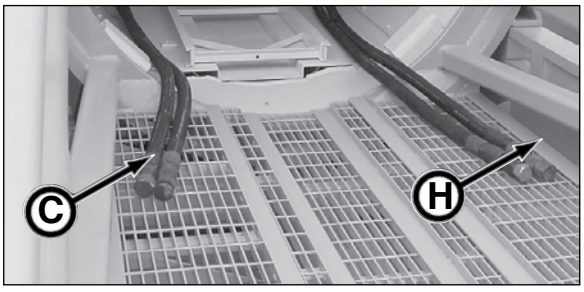
Boring Head 1 Supply



Gripper Can Supply & Return Hoses



Boring Head Return Line



TBM Supply & Return Hoses

(continued on next page)

Hydraulic Setup - Single/Dual Feed (continued)

NOTICE Though it is possible for a 90 GPM flow through the main supply line, it is highly NOT recommended to do so since it will cause additional heat and pressure loss due to back pressure in the system. It is recommended to use a maximum of 60 GPM flow through each of the boring head supply lines for a maximum flow of 120 GPM.

Dual Feed (120 GPM Maximum)

1. Connect boring head 1 supply quick coupler hose (A) to the gripper can supply quick coupler hose (B). Then connect the gripper can supply quick coupler hose (B) to the TBM supply quick coupler hose (C).

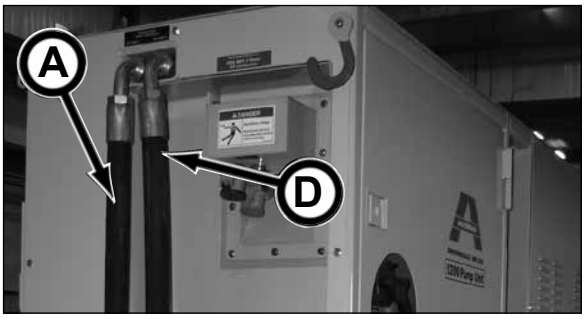
2. Connect boring head 2 supply quick coupler hose (D) to other gripper can supply quick coupler hose (B). Then connect this gripper can supply quick coupler hose (B) to the other TBM supply quick coupler hose (C).

3. Connect return line quick coupler hose (E) to gripper can return quick coupler hose (G). Then connect the gripper can return quick coupler hose (G) to the TBM return line quick coupler hose (H).

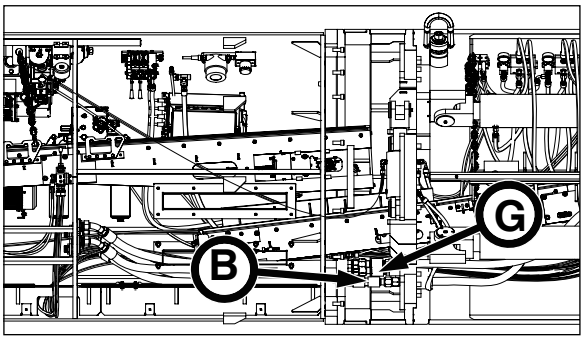
4. Connect the return line quick coupler hose (F) to other gripper can return quick coupler hose (G). Then connect this gripper can quick coupler hose (G) to the TBM return line quick coupler hose (H).

NOTICE The single/dual feed supply control (I) must be positioned to the appropriate location otherwise the boring head cutterhead and conveyor will not operate properly.

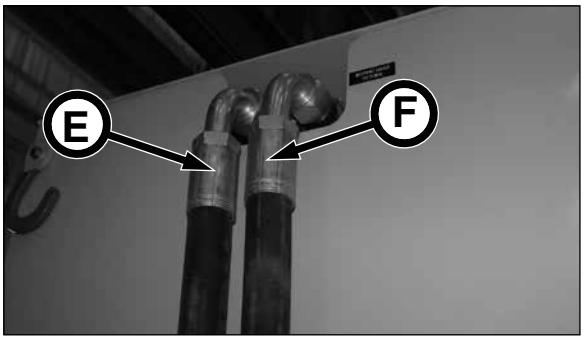
5. Proceed to *Connecting Electrical Connections* in this section.



Boring Head 1 Supply

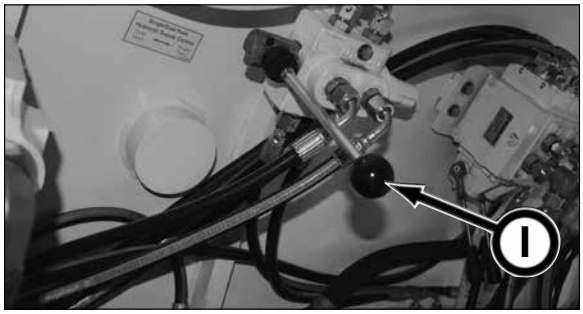


Gripper Can Supply & Return Hoses



Boring Head Return Line

TBM Supply & Return Hoses



Single/Dual Feed Control (Later Models)

Connecting Electrical Connections

⚠DANGER Hazardous voltage.
This system is powered by high voltage electricity.

Failure to lockout/tagout power before connecting power leads will cause severe personal injury or death.

LOTO main power supply before connecting power leads or servicing. ONLY a qualified and trained technician can operate this equipment. Electrical connections or repairs must be performed only by a certified electrician.

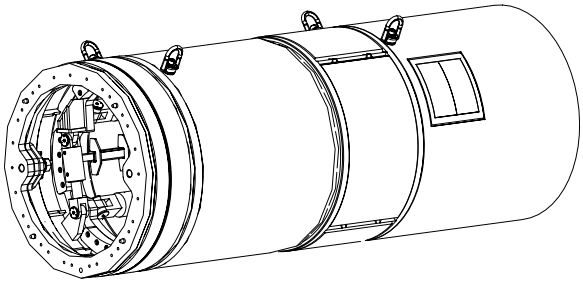
You must carefully perform *Setting Up The 5200 Pump-Unit - Start-Up Check*, and *TBM Start-Up Procedure*, in section 6 of your 5200 Pump Unit and TBM Operator's Manuals before routing TBM electrical through the gripper can to the 5200 Pump Unit.

1. Connect tunnel power lines from the 5200 Pump Unit to the TBM by routing them through the gripper can to connect in TBM.

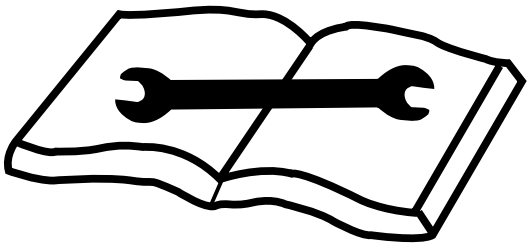
2. Proceed to *Checkout Equipment Prior Startup* in this section.

Checkout Equipment Prior to Startup

1. Perform equipment maintenance as shown in Maintenance section.
2. Check oil level in the pump unit hydraulic reservoir. Add oil if necessary.
3. Inspect all conveyor lift cables daily and replace immediately at the first sign of wear.
4. Inspect all hoses and electrical lines for damage. Replace before operating.
5. Be sure all hydraulic hoses and electrical lines are properly installed.
6. Refer to haul unit, gas detection system, pump unit/jacking frame operation manuals for pre-start checks.
7. Check operation of ALL E-Stop buttons before operation.
8. Proceed to *Power Startup Procedure* in this section.



Power Startup Procedure



1. Perform the 5200 Pump Unit startup procedure. Refer to *Setting Up the 5200 Pump Unit - Startup Check* in section, 6 of your 5200 Jacking System Operator's Manual.

2. Perform the TBM startup procedure. Refer to *TBM Startup* procedure in section 6 of your TBM Operator's Manual.

3. Proceed to *Check Hydraulics After System Startup* in this section.

Check Hydraulics After System Startup

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

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.

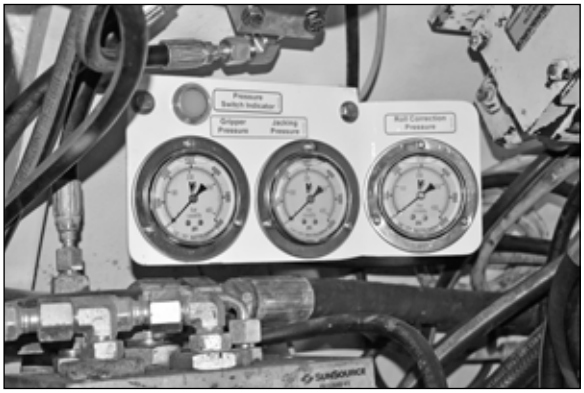
Contact medical help immediately if any oil or fluid is injected into your skin. A serious infection or reaction can emerge without proper medical treatment.

1. If equipped, check all return filter indicators.

2. Check hydraulic components and hoses for leaks. Repair or replace as needed.

3. Check the 5200 Pump Unit hydraulic oil level gauge in hydraulic oil reservoir.

   Fill reservoir with clean, fresh, **FILTERED** hydraulic oil to full mark on gauge. Filling reservoir with unfiltered oil will cause component damage. Do not mix oil manufacturers or grades.



4. Check the gripper can pressure gauges for proper hydraulic operation and system pressure of the gripper, jacking and roll correction pressures. The gripper can is capable of 5,000 psi only if the 5200 Pump Unit Boring Head Pressure Selector is turned to 5,000 psi, otherwise it is limited to 3,000 psi.

5. Proceed to *Setup and Operation Procedure* in this section.

Set Up and Operation Procedure

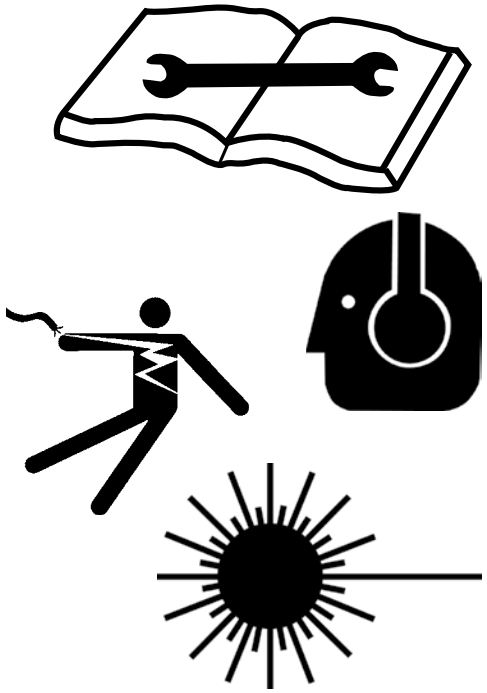
NOTICE Be sure that all TBM operation steps through *Operation - Launching The TBM* have been properly performed PRIOR to performing the *Setup and Operation Procedure*. The instructions below supplement typical operation of the TBM installing pipe or tunneling on a tunneling project using a Gripper Can. Refer to *Launching the TBM* in section 6, Operation of your Operator's Manual before proceeding with gripper can operation.

⚠WARNING Do not operate the gripper can until you read, study, and understand this instruction and all other support equipment operation manuals. Failure to do so, could result in severe personal injury or death.

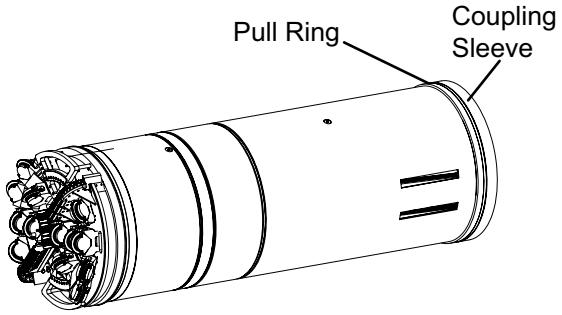
⚠WARNING Hearing protection MUST be worn by operators.

⚠WARNING Any electrical work performed on electrical components must be completed by a certified electrician.

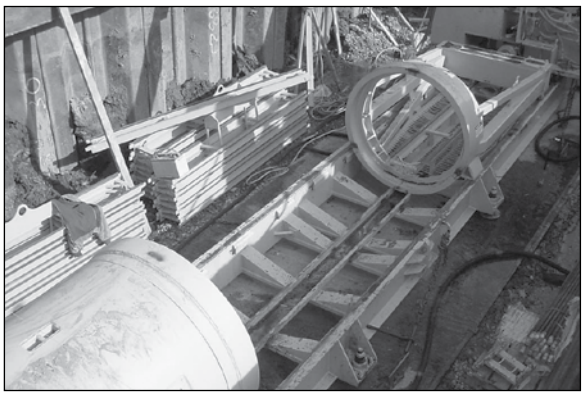
⚠DANGER Staring into laser light will cause severe injury. Do not stare into laser guidance system light beam. Avoid direct eye exposure.



1. Launch the TBM (with the pull ring and coupling sleeve installed) using the 5200 Pump Unit system and only the dirt bucket for spoil removal. Refer to *Launching The TBM* in section 6, Operation of your TBM Operator's Manual.



2. Continue operation until the TBM has been advanced forward enough to allow at least 15 ft. (4.6 m) of skid space to lower the gripper can onto the skid.

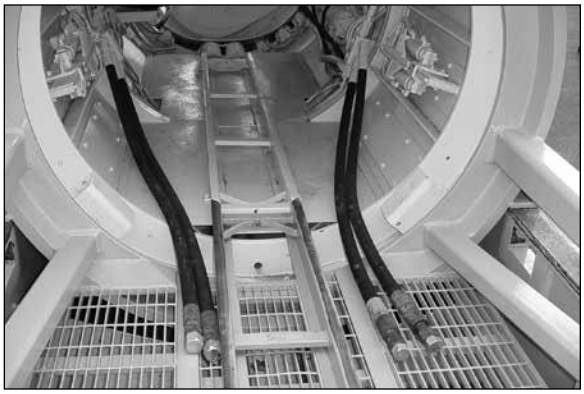


3. Retract the 5200 Pump Unit cylinders and yoke to the back of the skid, allowing at least 15 ft. (4.6 m) of skid space to accommodate the gripper can. On some projects, it may be necessary to also remove the yoke to install the secondary conveyor into the gripper can, (if not lowering the second conveyor with the gripper can).

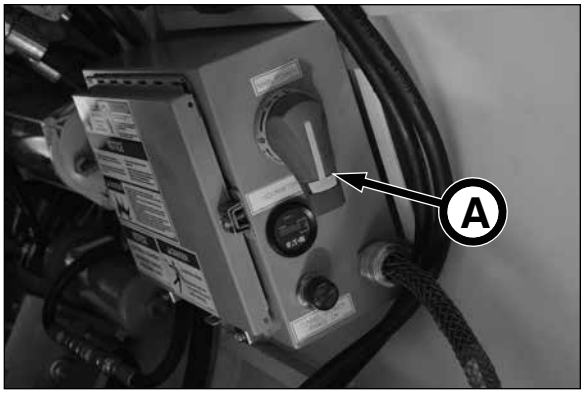
(continued on next page)

Set Up & Operation Procedure (continued)

⚠WARNING Escaping oil or other fluids under pressure can penetrate your skin causing serious injury. Contact medical help immediately if any oil or fluid is injected into your skin. ALWAYS switch power supply switches to the STOP position, move all control valves to the OFF position AND use gloves before connecting or disconnecting hydraulic oil hoses/lines.



4. Disconnect, clean hose ends, and cap the TBM supply and return hoses.

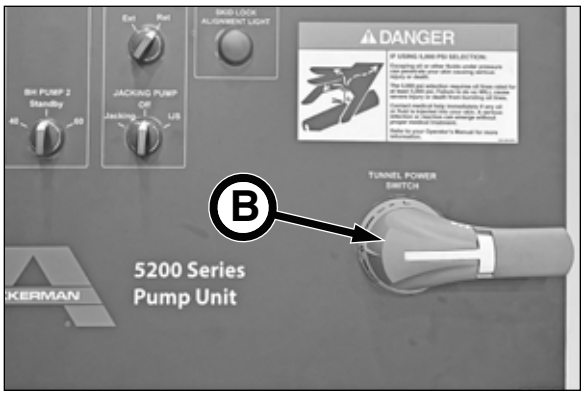


TBM Main Power Switch

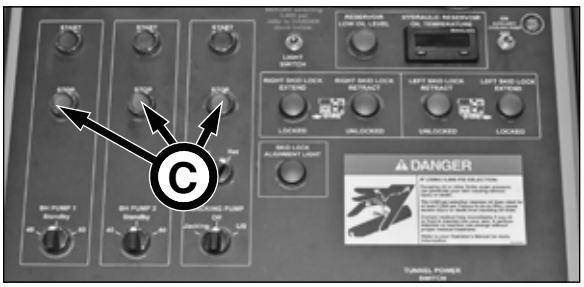
5. Depress Stop buttons (C) for BH Pump 1, BH Pump 2 (if used), and jacking motors on the 5200 Pump Unit.

   Shut down the TBM by moving the TBM Main Power (A) and the 5200 Pump Unit Tunnel Power (B) switches to the OFF position. The TBM Main Power switch ON/OFF orientation may vary.

   Return all hydraulic controls to the OFF or neutral position.



Tunnel Power Switch in OFF Position



Set Up & Operation Procedure (continued)

6. With the TBM Main Power (A) AND the 5200 Pump Unit Tunnel Power (B) switches in the OFF positions, disconnect the ventilation, electrical and communication lines.

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

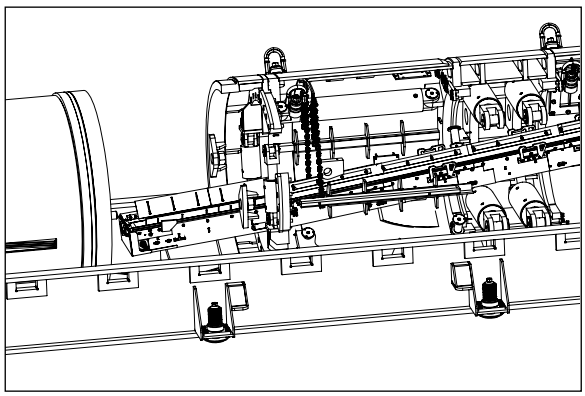
7. With a crane or excavator, check for clearances and carefully lift dirt bucket out of unloading area and move to dumping site.

8. Unload dirt bucket and place off to the side of the launch shaft. The dirt bucket is self-dumping when using a two-line crane or when attaching a stationary line.

NOTICE It is necessary to first bury the gripper can, using the jacking cylinders from the 5200 Pump Unit system, before the gripper can gripper cylinder functions are used.

9. Lower the gripper can onto the jacking system skid base, positioned directly behind the TBM.

   If lowering the second conveyor with the gripper can, make sure there is enough clearance behind the TBM.

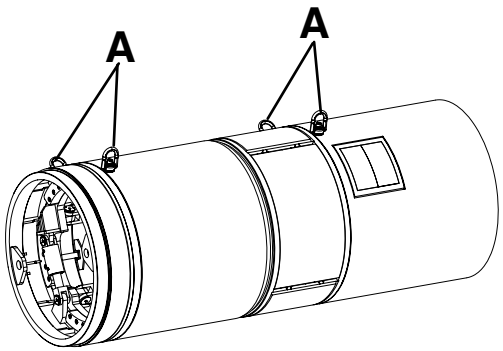


Gripper Can With Conveyor Behind TBM on Skid

(continued on next page)

Set Up & Operation Procedure (continued)

10. After the gripper can is properly position in the launch shaft, remove the gripper can lift eyes (hoist rings) (A, 4 locations) and retain for later use.



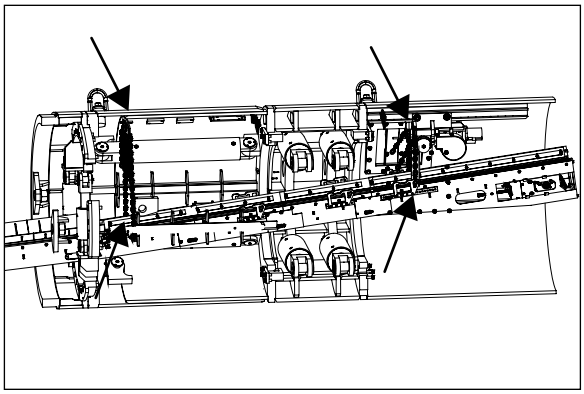
NOTICE Install a 3/4 UNC x 1 bolt to protect hole threads from dirt or debris during tunneling operations.

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

NOTICE When inserting the second conveyor in the gripper can, immediately connect the conveyor cables and safety chains, so the conveyor does not rest on the gripper hydraulic cylinders and potentially cause damage.

11. If the second conveyor was not lowered in the gripper can, carefully lower and install the second conveyor into the gripper can.

    Connect the four conveyor safety chains. Lower the conveyor lift just enough to provide adequate slack in the lift cables to move the lifting hooks to the rear (operating) position on the conveyor lifting eye, and connect the lifting cables to the front lifting position on the conveyor lifting eyes.

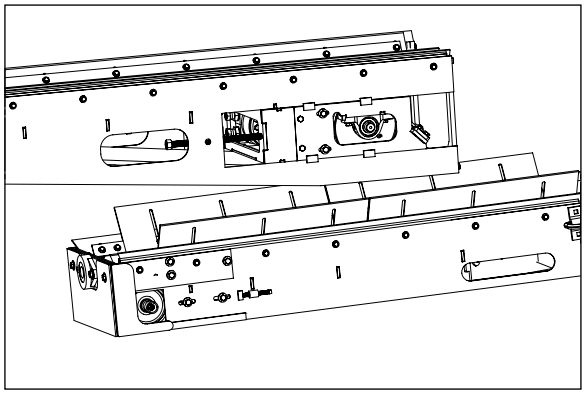


Connect safety chains

IMPORTANT: Your second conveyor safety chains have been modified for length. Be sure to pair the correct conveyor with lengthened safety chains with your gripper can.

Set Up & Operation Procedure (continued)

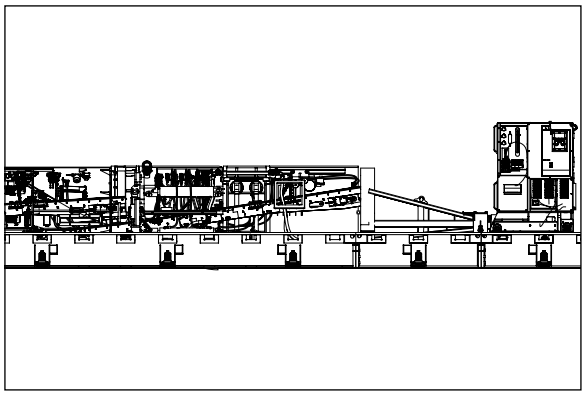
12. Position the second conveyor underneath the TBM (first) conveyor. With the gripper can jacking cylinders extended and steering cylinders collapsed, the overlap is roughly 10-in. (254 mm) and with them retracted, the overlap is roughly 40-in. (1,016 mm).



TBM Conveyor shown over Gripper Can Conveyor with 40-in. overlap

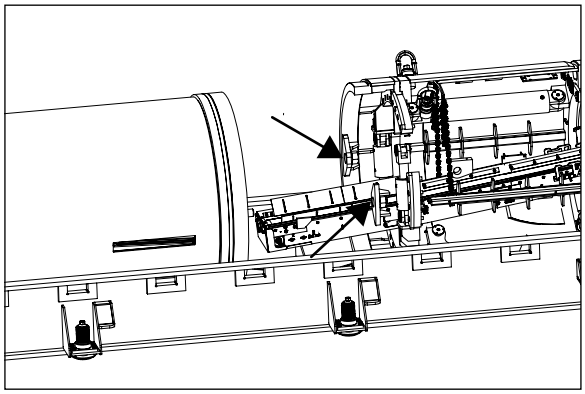
⚠WARNING PINCH POINTS! Watch your fingers, hands, and legs while equipment is in operation.

13. Start the jacking system and apply forward thrust using the 5200 jacking cylinders and yoke to advance the gripper can until it mates with the TBM coupling sleeve.



14. Secure the alignment pins on the gripper can to the TBM alignment pin holes inside the TBM coupling sleeve.

IMPORTANT: Do not fully tighten alignment pins. Allow minimal space for articulation during tunneling steering corrections.



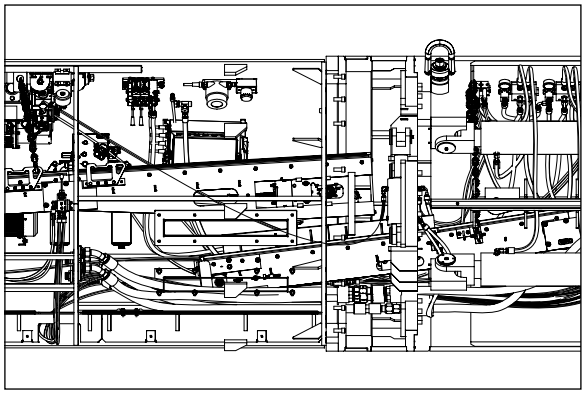
Alignment Pins on Gripper Can

(continued on next page)

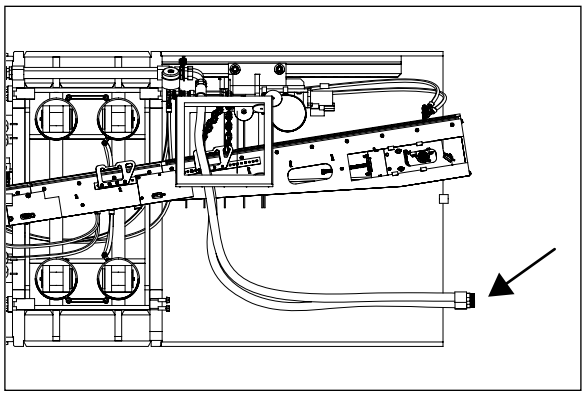
Set Up & Operation Procedure (continued)

15. Connect all hydraulic supply lines between the gripper can and TBM. This includes:

    - Hydraulic Supply and Return
    - Conveyor Supply and Return
    - Tank and Pressure Supply
    - Load Sense
    - Gripper Can Pilot Lines
    - Jacking Extend and Retract
    - T.O. Line
    - Pressure Gauge Lines
    - Pressure Switch to TBM Electrical Box

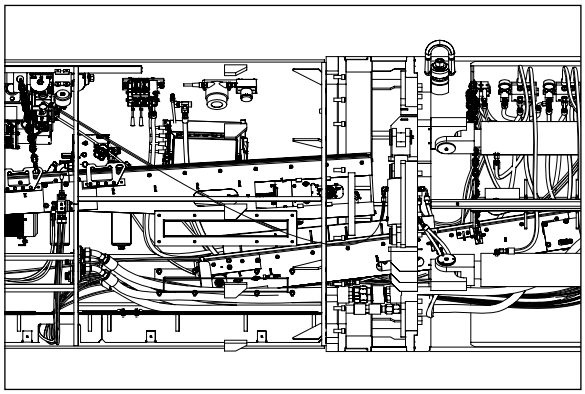


16. Connect hydraulic supply and return hoses from the gripper can to 5200 Pump Unit.



Connect hydraulic hoses to 5200 Pump Unit (not shown)

17. Add power cables and communication lines from TBM to travel through gripper can and connect to the 5200 pump unit connections. Add cables and lines as necessary to extend the lengths.



18. Extend ventilation supply lines from TBM to travel through gripper can to the ventilation system.

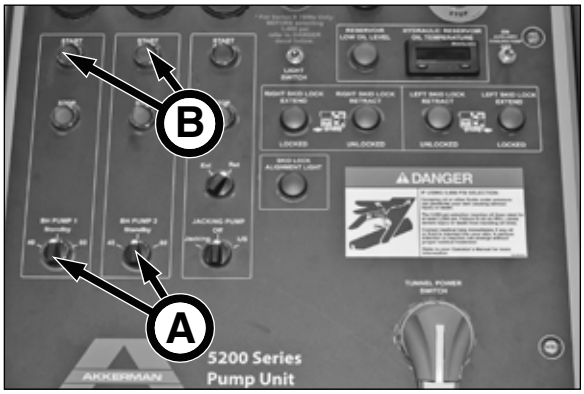
Set Up & Operation Procedure (continued)

19. Move the Tunnel Power (5200 Pump Unit) and Main Power (TBM) switches to the ON position. The TBM Main Power switch ON/OFF orientation may vary.

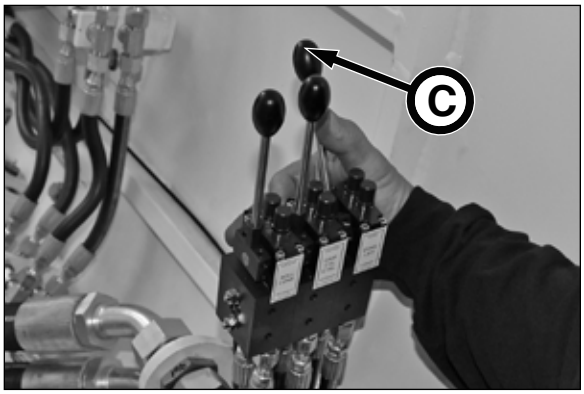
    Alert everyone in tunnel and launch shaft areas that the power will be turned on. Once it is safe, with the BH Pump 1 and BH Pump 2 dials in the standby positions (A), depress the Start buttons for BH Pump 1 and BH Pump 2 (B) (if used) motors.

    Refer to *Operating The Pump Unit - Jacking Operation* in section 6, Operation of your 5200 Pump Unit Operator's Manual.

5200 Pump Unit and TBM Power Switches in ON Position

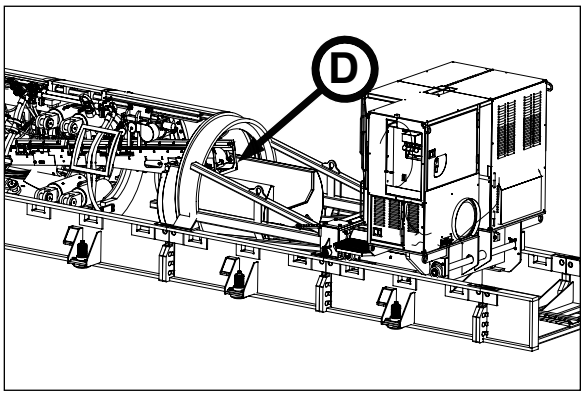


20. Move the Conveyor Lift Control Lever (C) forward (operation) to raise the second conveyor.



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

21. With a crane or excavator, check for clearances and carefully lower and position dirt bucket inside the yoke at the back end of the gripper, under the second conveyor (D).



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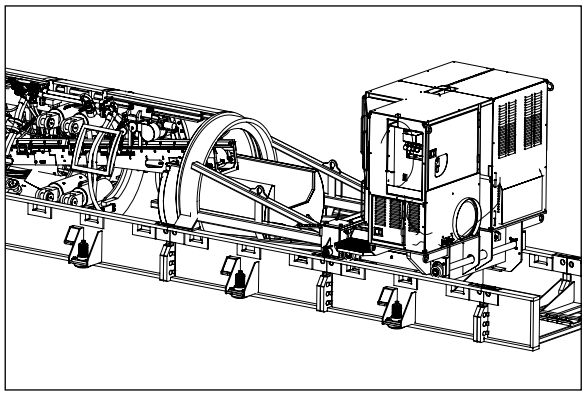
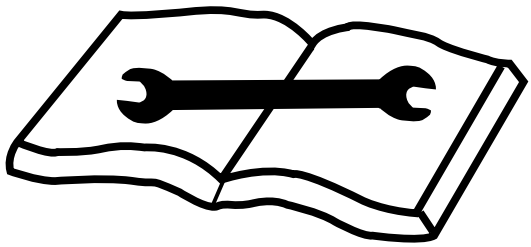
Set Up & Operation Procedure (continued)



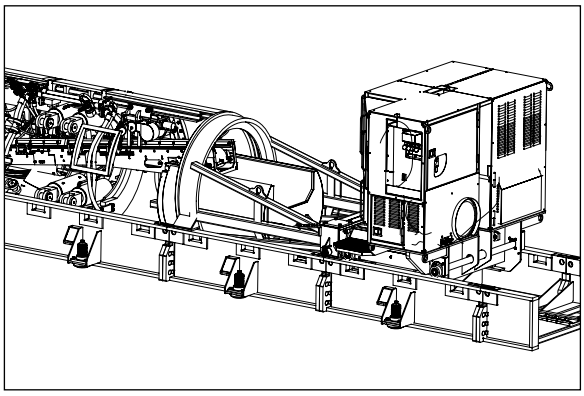
22. Start the jacking system and apply forward thrust using the 5200 pump unit jacking cylinders and yoke to apply forward thrust to mate the yoke with the gripper can.

23. Control the speed of the conveyors so spoils drop on the conveyors, and do not pile up on the belt. A change in TBM advancement rate or ground conditions will require an adjustment in the conveyor speed.

⚠WARNING Running the conveyors too fast can cause severe injury from flying debris and possible machine damage. Slow the conveyors' speed so there is continual controlled movement of the spoils into the dirt bucket.



NOTICE Refer to *Operating The Conveyor* in section 6, Operation of your TBM Operator's Manual.



24. Continue the gripper can launching process until the gripper can is completely buried, using the jacking cylinders from the 5200 pump unit.

    The gripper can is sufficiently buried when the ground provides a stable reaction for the gripper shoes.

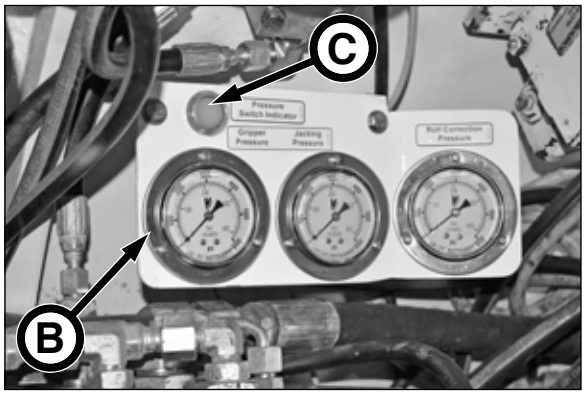
Set Up & Operation Procedure (continued)

25. Extend the gripper shoes by moving the gripper cylinder control lever forward (A) until the gripper shoes firmly engage with the ground.

26. While extending the gripper cylinder shoes, monitor the Gripper Pressure Gauge (B) on the Gripper Can Pressure Gauge Mount Plate.

    When minimum pressure has been met, the Pressure Switch Indicator (C) light turns Green.

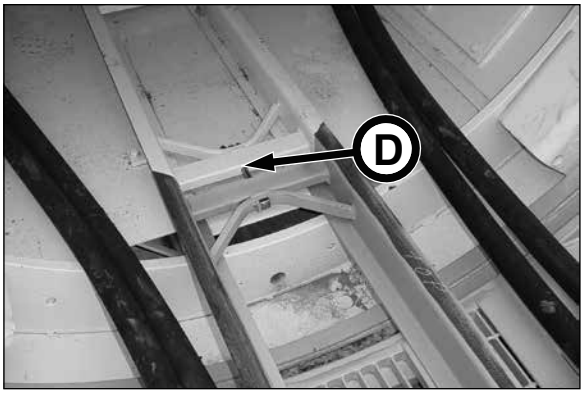
    Refer to *Gripper Relief Valve and Pressure Switch* in section IV, Controls & Instruments for pressure settings.



27. Prepare for the installation of the haul unit. Remove and unload the dirt bucket and place it off to the side of the launch shaft.

28. After the gripper can has been buried Install a haul unit sliding track (not shown) then the first section of track (D) and secure it to the gripper can. The sliding track will extend and retract with the movement of the gripper can jacking cylinders.

    Refer to *Installing Track* in section 6 in the Operation section of your Haul Unit Operator's Manual.



NOTICE Be sure there is always track connecting the pipeline to the rear of the gripper can for the haul unit and loading and unloading of the dirt bucket.

(continued on next page)

Set Up & Operation Procedure (continued)

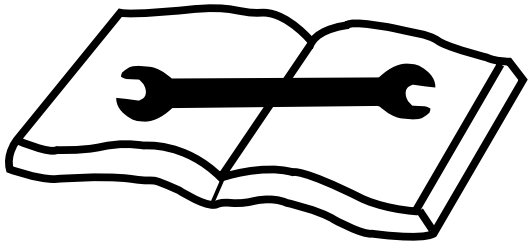
⚠WARNING Suspended loads may fall and cause severe injury or death. Do not allow anyone to enter area under or around a suspended load.

29. Lower haul unit on the track.

    If operating the gripper can for pipejacking, install the operator end of the haul unit towards the TBM/Gripper Can.

    If operating the gripper can in gripper can for gripper mode or tunneling, install the operator end of the haul unit towards the launch shaft.

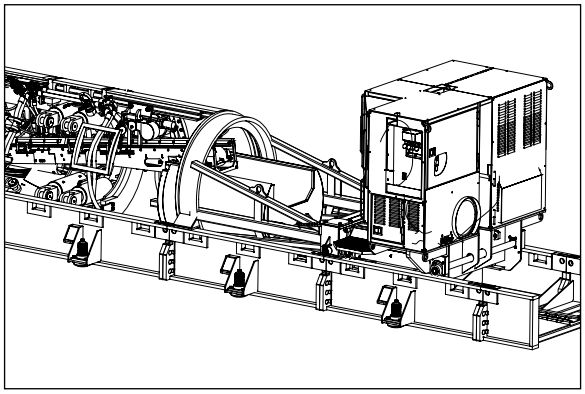
30. Lower and position dirt bucket on the haul unit, inside the yoke at the back end of the gripper, under the second conveyor.



NOTICE For information on operating the haul unit, refer to *Operating The Haul Unit* in section 6, Operation in your Haul Unit Operator's Manual.

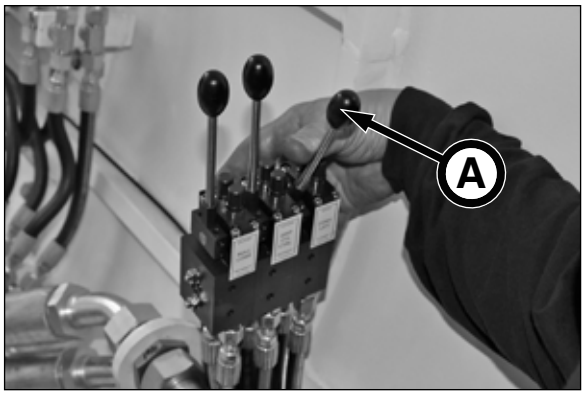
Set Up & Operation Procedure (continued)

31. Adjust the haul unit at the back of the gripper can so the dirt bucket is in position to catch spoils from the second conveyor.

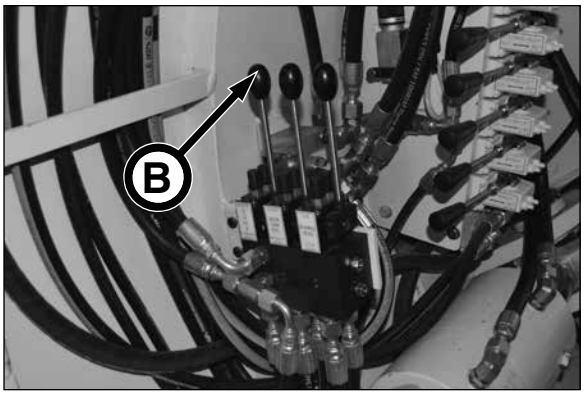


NOTICE Haul Unit track can get slippery. Therefore when operating the haul unit, GO SLOW! Also, remember that the haul unit forward momentum will carry the haul unit past the point where the brake is applied.

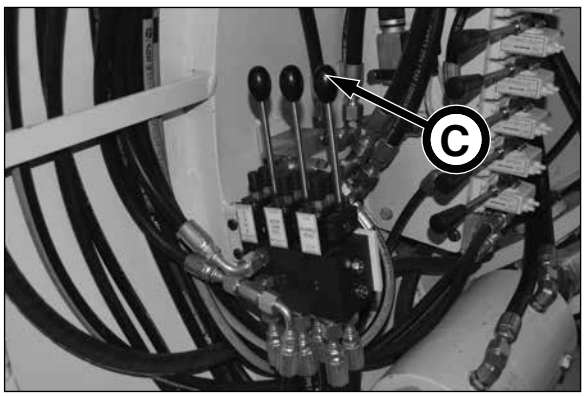
32. Move the conveyor lift control lever backward (A) to lower the second conveyor into operating position (A).



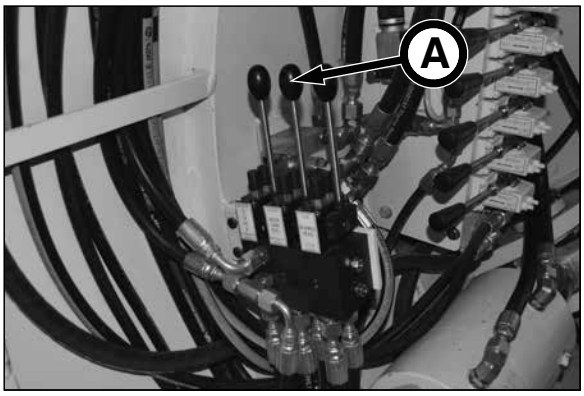
33. Start the conveyors by moving the conveyor drive and speed control forward (B) on the TBM Control Valve bank.



34. Start the Boring Head Control by moving the Boring Head Control Lever (C) in the correct rotation direction on the TBM Control Valve bank.



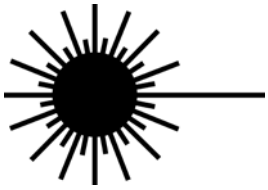
Setup & Operation Procedure (continued)



35. Extend the gripper can jacking cylinders by moving the Jacking Can Cylinder (A) control lever forward to extend the jacking cylinders to engage the TBM cutterhead to the tunnel face.

36. Operate the conveyor to desired speed, and rotate cutterhead with boring head control and apply forward thrust to the TBM from the gripper can jacking cylinders.

⚠DANGER Staring into laser light will cause severe injury. Do not stare into laser guidance system light beam. Avoid direct eye exposure.



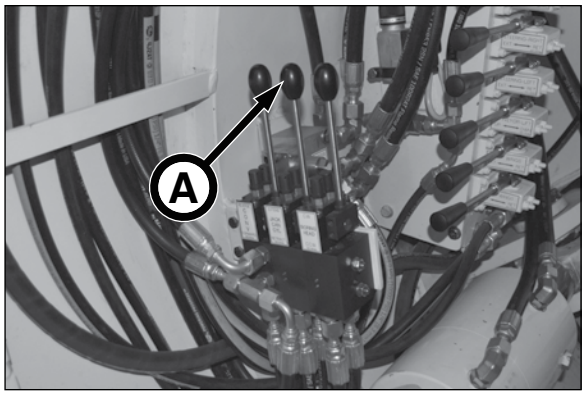
37. Check laser guidance system accuracy often (both with and without forward thrust applied) to avoid making improper steering corrections. TBM conveyors must be lowered to check line and grade target on the TBM cutter face.

    To check laser guidance accuracy, lower both conveyors using the Conveyor Lift controls in TBM Valve Bank and Gripper Can Pilot Line Connections.

38. Unload the dirt bucket when it is full by moving it to the unloading/loading zone in the launch shaft using haul unit operation.

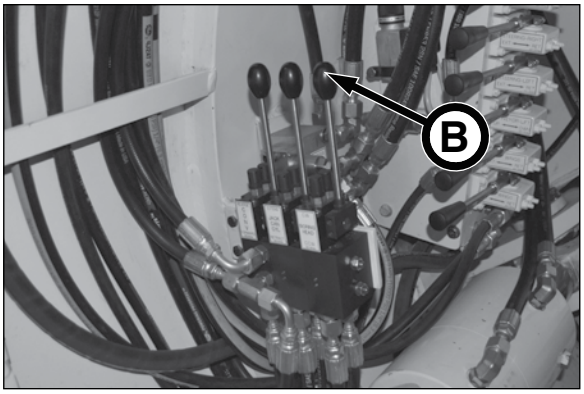
Set Up & Operation Procedure (continued)

39. When the gripper can jacking cylinders are completely extended, move the Jacking Can Cylinder (A) control lever to the neutral position.

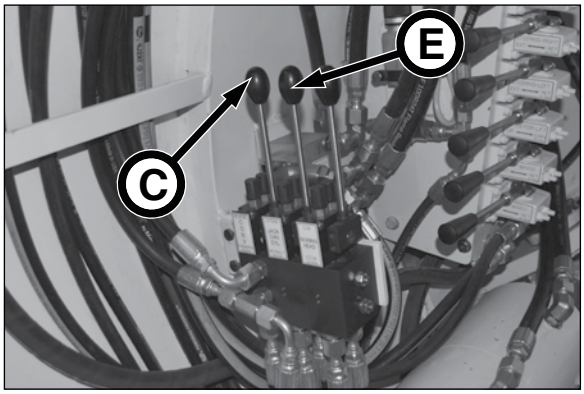


40. Clean spoils from inner drum.

41. Stop the TBM cutterhead by moving the Boring Head Control (B) lever, on the TBM Control Valve bank to the neutral position.

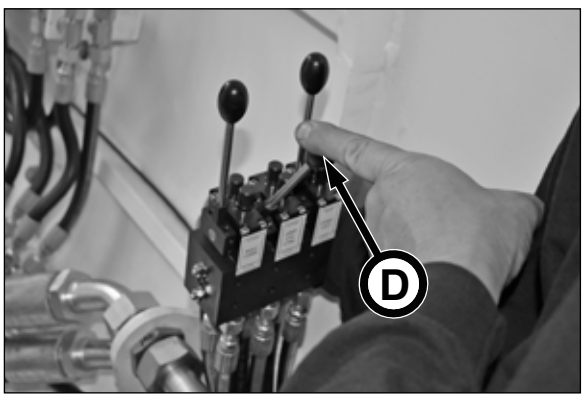


42. Stop the conveyors by moving the Conveyor Drive and Speed Control Lever, on the TBM Control Valve bank backward (C) to the neutral position.



43. Move the Gripper Cylinder Control (D) lever backward to retract the gripper can cylinder shoes.

44. Move the Jacking Cylinder Control (E) lever backward to retract the jacking cylinders.



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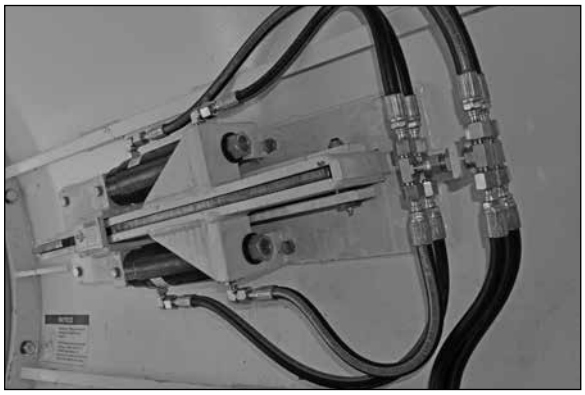
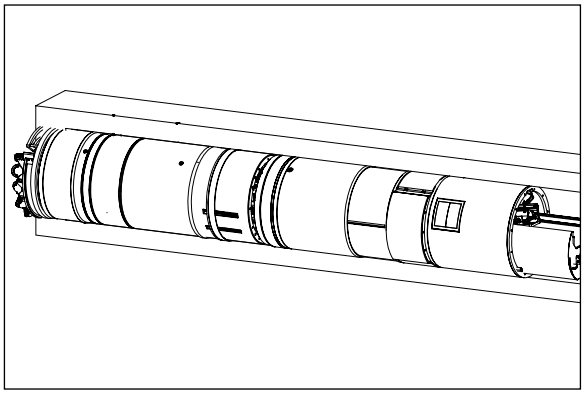
Set Up & Operation Procedure (continued)

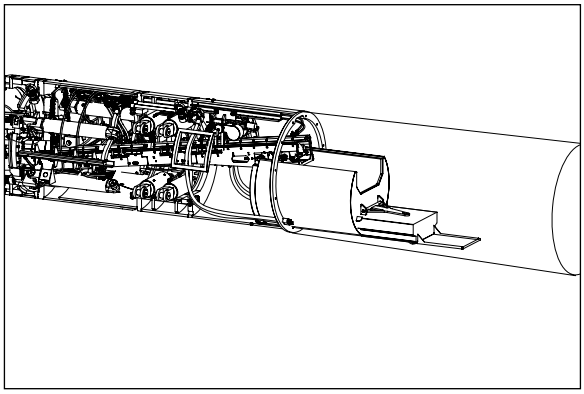


NOTICE It may be necessary to engage the TBM torque/dirt wings, if retracting of gripper can jacking cylinders causes TBM movement.

Refer to *Adjusting TBM Roll* in section 6, Operation of your TBM Operator's Manual for more information. Keep the torque/dirt wings extended until the TBM roll is back to position.



45. Continue operations. Extend the gripper shoe cylinders by moving the Gripper Shoe Cylinder Control lever forwards until the shoes firmly engage with the ground, the minimum pressure has been met (approximately 2,900 psi), and the Pressure Switch Indicator light turns green.



46. Continue to install pipe or build tunnel sections, adding hydraulic hose, power cables, ventilation supply, bentonite hoses, and haul unit track as necessary until the tunnel is complete.

    Refer to *Removing Jacking System* in section 6, Operation, of your TBM Operator's Manual.

Roll Correction Procedure

Roll correction cylinders provide approximately ten (10) degrees of roll correction.

Correct TBM Roll Only

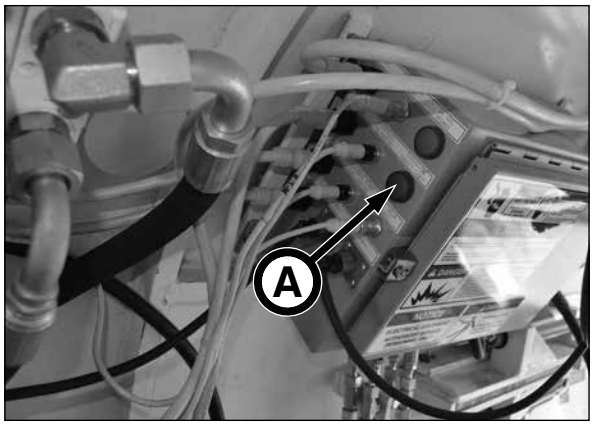
If ONLY the TBM head has rolled (roll correction cylinders have been retracted due to force of TBM roll) and the gripper can has remained in position, correct the TBM roll as follows:

1. Return all hydraulic levers to the neutral positions.

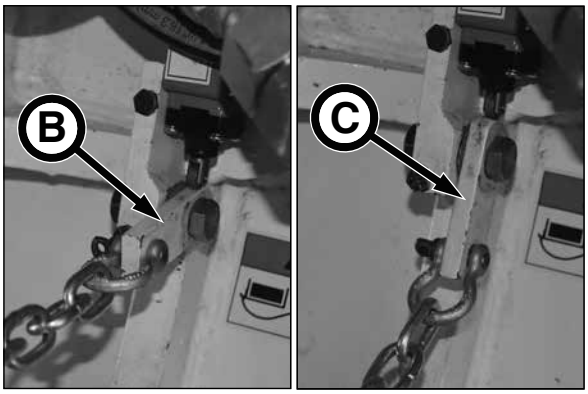
2. If TBM roll has tripped the Conveyor Safety Switch (A) will illuminate on the TBM Control Box, and the tethered chain in the TBM (first) conveyor will be in the tripped position (B), all hydraulic functions in the TBM and Gripper Can will be disabled.

   To reset the Conveyor Safety Switch and enable functions, flip the safety valve lever (C) down to the operation position.

   (Note: There is no safety valve lever on the second conveyor in the gripper can.)

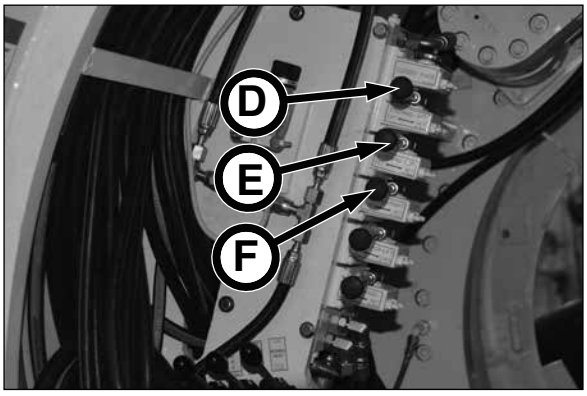


Conveyor Safety Switch on TBM Control Box



Tripped Position *Operation Position*

3. After Conveyor Safety Switch is reset (if necessary), move the Steering Cylinder Control levers (D, E, F) to the retract position to disengage the cutterhead from the tunnel face.



(continued on next page)

Roll Correction Procedure (continued)

4. With the gripper shoe cylinders engaged with the tunnel wall, move the Roll Correction lever to the extend position to bring the TBM back to zero roll.

5. Resume mining operations.

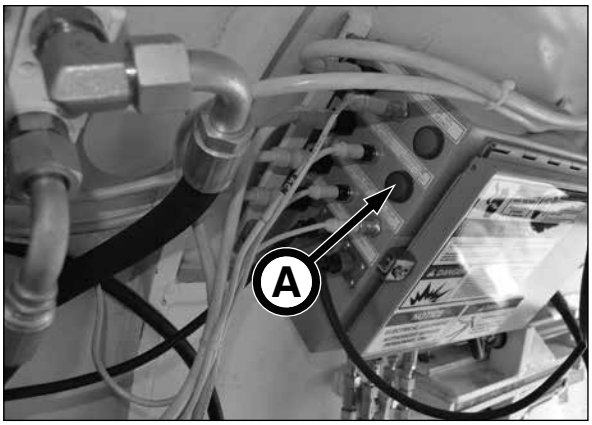
Correct TBM and Gripper Can Roll
If the TBM and Gripper Can have rolled, it is necessary to first correct the Gripper Can roll then TBM roll as follows:

1. Return all hydraulic levers to the neutral positions.

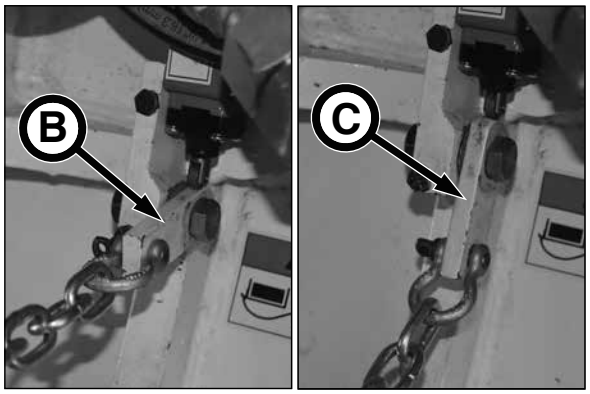
2. If TBM roll has tripped the Conveyor Safety Switch (A) will illuminate on the TBM Control Box, and the tethered chain in the TBM (first) conveyor will be in the tripped position (B), all hydraulic functions in the TBM and Gripper Can will be disabled.

   To reset the Conveyor Safety Switch and enable functions, flip the safety valve lever (C) down to the operation position.

   (Note: There is no safety valve lever on the second conveyor in the gripper can.)



Conveyor Safety Switch on TBM Control Box



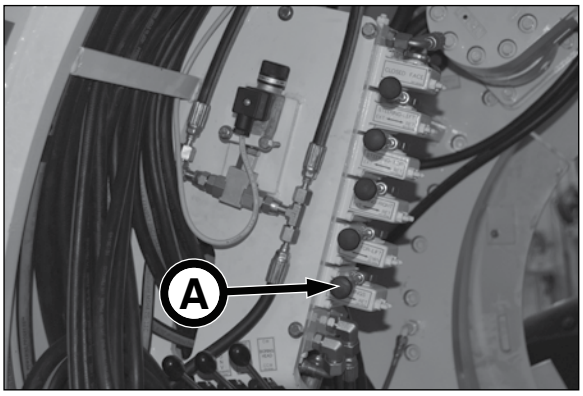
Tripped Position *Operation Position*

Roll Correction Procedure (continued)

3. After Conveyor Safety Switch is reset (if necessary), move the Gripper Shoe Cylinder Control lever to the retract position to disengage the gripper shoes from the tunnel wall.

4. Move the Roll Correction lever to the retract position to bring the gripper can back to zero roll.

   If the TBM cutterhead starts to move, move the Dirt Wing lever (A) to the extend position to engage the dirt wings and hold the TBM in the tunnel wall.

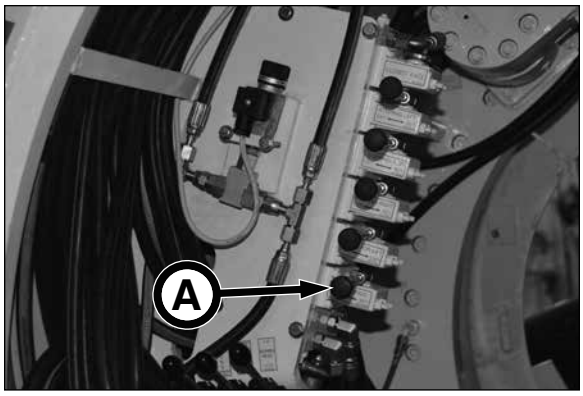


5. When the gripper can has returned to zero roll, move the Gripper Shoe Cylinder Control to the extend position to engage the tunnel wall.

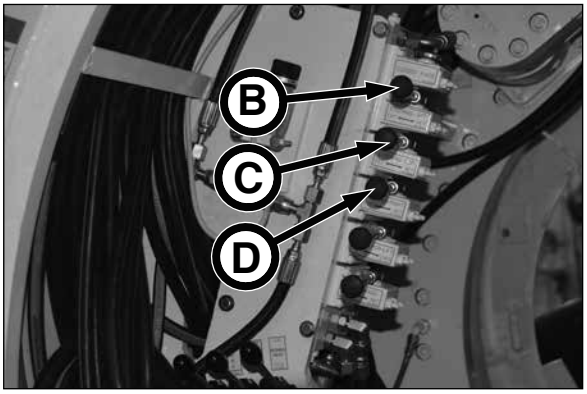
(continued on next page)

Roll Correction Procedure (continued)

6. Move the Dirt Wing lever (A) to the retract position to disengage the dirt wings from the tunnel wall.



7. Move the Steering Cylinder Control levers (B, C, D) to the retract position to disengage the cutterhead from the tunnel face.



8. Move the Roll Correction lever (A) to the extend position to bring the TBM back to zero roll.

9. Resume mining operations.

Cold Weather Operation

Freezing temperatures during the tunneling 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.

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 bentonite pump and/or water cooling 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.
- A spoil (muck) dump needs to be located carefully since the wet loose material will freeze forming a pointed pile instead of a mound.

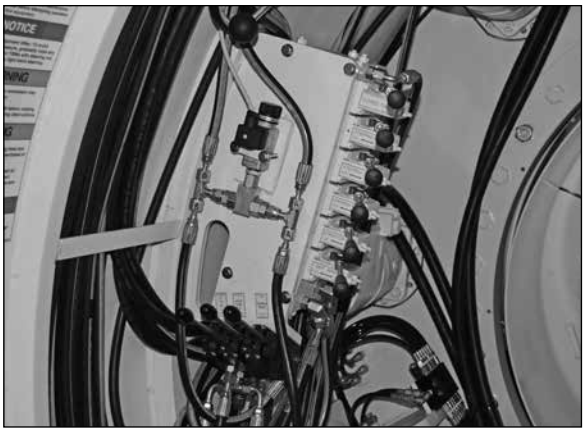
If systems were shut down for freezing weather, be sure to start systems slowly and let them run for at least five minutes to allow for warm up and in the case of a pump, to displace any surface ice that may have accumulated in the fluid before going back to full operation mode.

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.

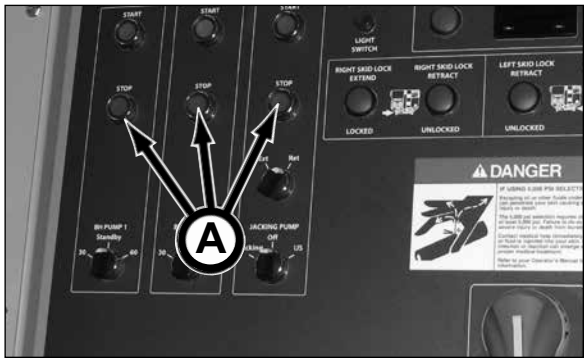
Daily Shutdown

1. Return all controls on the gripper can, TBM, jacking system, haul unit and other support equipment to the OFF or neutral position.

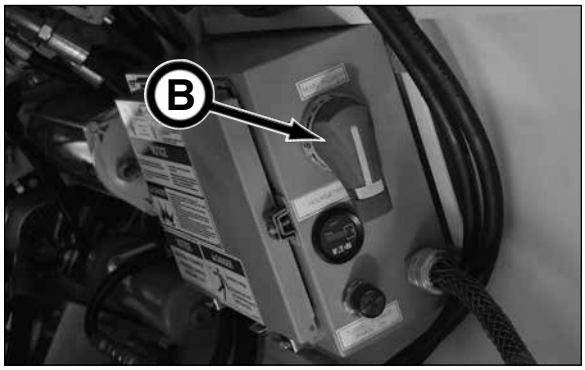
2. Return all hydraulic controls (A) on the pump unit and TBM to the OFF or neutral position.



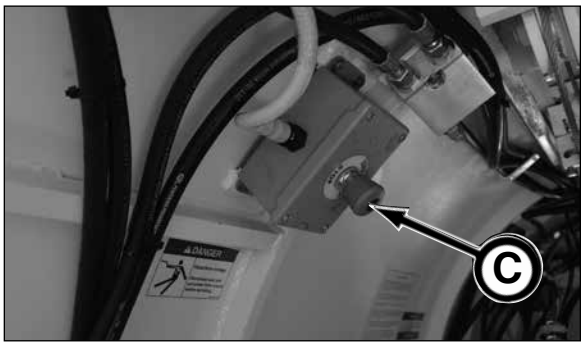
3. Depress Stop buttons (A) for BH Pump 1, BH Pump 2 (if used), and jacking motors on the 5200 Pump Unit.



4. Move the TBM Main Power switch (B) to the OFF position. The TBM Main Power switch ON/OFF orientation may vary.

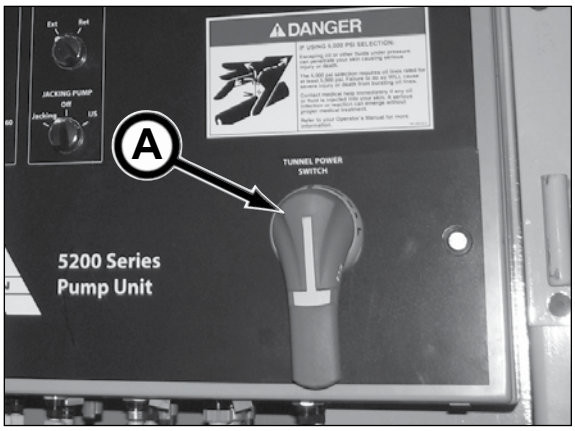


5. Push TBM E-Stop button (C) IN.



Daily Shut Down (continued)

6. Move 5200 Pump Unit Tunnel Power Switch (A) to the OFF position. Place switch in Lockout/ Tagout (LOTO).

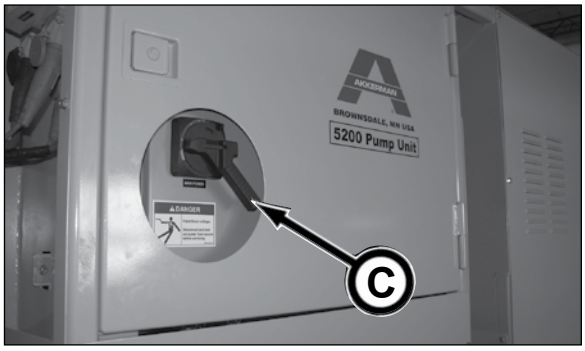


7. Push pump unit E-Stop button (B) IN.

8. Move 5200 Pump Unit Main Power Switch (C) to the OFF position and perform LOTO.

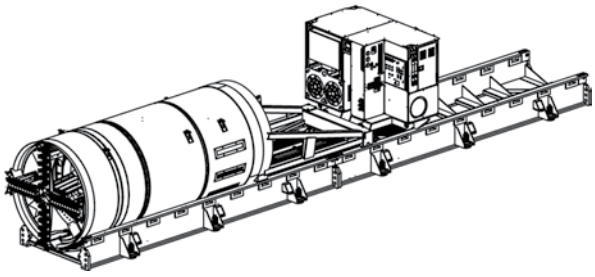
9. Shut off water supply to pump unit heat exchanger. Drain water if freezing temperatures are possible. Purge any remaining water in heat exchanger with compressed air (maximum 25 psi). Refer to your 5200 Pump Unit Operator's Manual for more information.

10. Shut off main power source and perform LOTO.



11. Perform a visual system inspection and check to be sure all electrical and hydraulic connections are properly connected and secured.

NOTICE The pump unit and TBM should not be engulfed with water. Damage will result. If equipment becomes engulfed with water, contact Akkerman Aftermarket Support for proper procedures on how to restore equipment for operation.



VII. Transporting

Transporting Guidelines

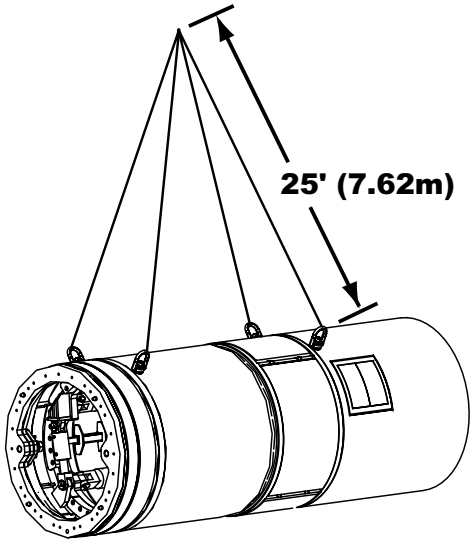
⚠WARNING Suspended load may fall and cause severe personal injury or death.

Do not enter area under or around a load.

1. Know the local, state, and federal transportation regulations.
2. Obtain required permits for transporting.
3. Remove any obstacles from the trailer floor.
4. Clean debris from equipment.
5. Load and unload on level ground.
6. If lifting equipment with a hoist or other lifting device, the equipment lifting eyes and sling must be inspected for damage before lifting. If damaged, replace before lifting.
7. Observe the lifting instructions for other tunneling equipment.
8. Securely fasten equipment to trailer floor.
9. Secure all loose items in gripper can.

Lifting Instructions

- 540 (66.5 in.OD) Gripper Can weight is 31,000 lbs. (14,061 kg).
- 720 (86 in. OD) Gripper Can weight is
- 43,500 lbs (19,731 kg).
- Lifting with a crane requires a four part sling with sling legs a minimum of 25 ft (7.62 m) long.
- Gripper can must lift freely. If it is stuck to the ground it must be broken loose prior to lifting.
- Gripper can lifting eyes must be inspected prior to each lift. Any damage must be repaired prior to lifting.



VIII. Lubricants

NOTICE Use of inferior lubricants can affect the efficient performance of your Gripper Can. Always use high quality lubricants as specified in this section.

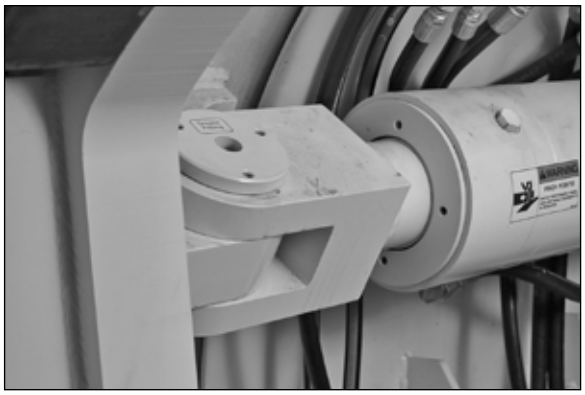
Refer to the Periodic Maintenance section of this instruction and all other support equipment manuals for proper lubrication quantity, maintenance intervals, and procedures.

Grease

The lubrication fittings are greased with Mobilgrease® XHP222 Premium Lubricating Grease.

The XHP222 grease is a multi-purpose, high performance, high temperature, lithium grease.

Use Mobilgrease® XHP222 Premium Lubricating Grease or equivalent when lubricating the lubrication points.



Hydraulic Reservoir Lubricant

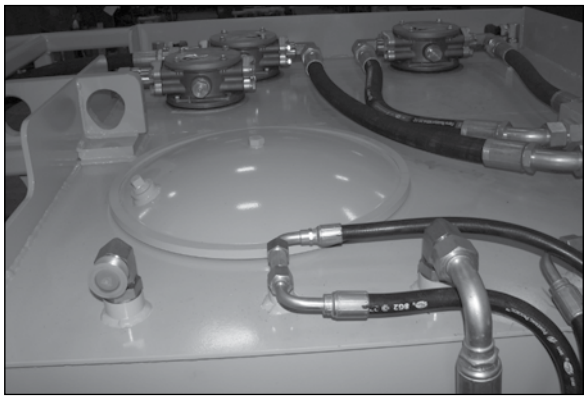
The 5200 Pump Unit provides hydraulic oil for the TBM and gripper can functions. The 5200 Pump Unit hydraulic reservoir is filled with ISO-VG-46 Premium Hydraulic Oil unless otherwise specified on hydraulic reservoir.

Reservoir Capacity: 240 gal (908 L)

NOTICE If using a too heavy of viscosity oil in cold temperatures, hydraulic oil pump damage could result due to pump cavitation. On the contrary, using ISO 32 oils above 150°F operating temperatures (oil temp. in reservoir) will result in reduced hydraulic power to functions.

Recommended hydraulic oil:

Ambient Temp.	**Hydraulic Oil**
-25°F to 60°F (-32°C to 16°C)	ISO 32
0°F to 95°F (-18°C to 35°C)	ISO 46
32°F to 105°F (-0°C to 41°C)	ISO 68



NOTICE If you change to a different oil, use a reputable oil supplier to meet or exceed the ISO-VG-46 or API GL-1/GL-2 oil specification. Do not mix oil manufacturers or grades.

Lubricants (continued)

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.

Store barrels inside whenever possible or at least under cover. Keep barrel bungs tight.

If barrels must be stored outside, lay barrels on their sides. If barrels cannot be laid on their sides, tilt them slightly so water or other contaminates cannot be drawn in around the bung.

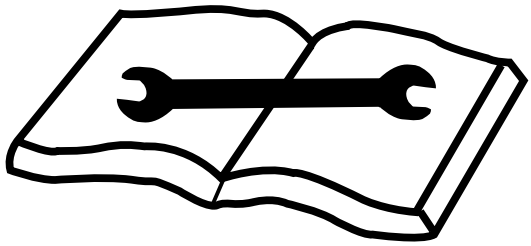
IX. Periodic Maintenance

⚠WARNING Review the Safety section in this manual and read, study, and understand this manual and all other support equipment operation manuals before performing maintenance. Failure to do so, could cause severe injury or death.

Maintenance and repairs must only be performed by a qualified service technician.

Lubrication & Maintenance Intervals

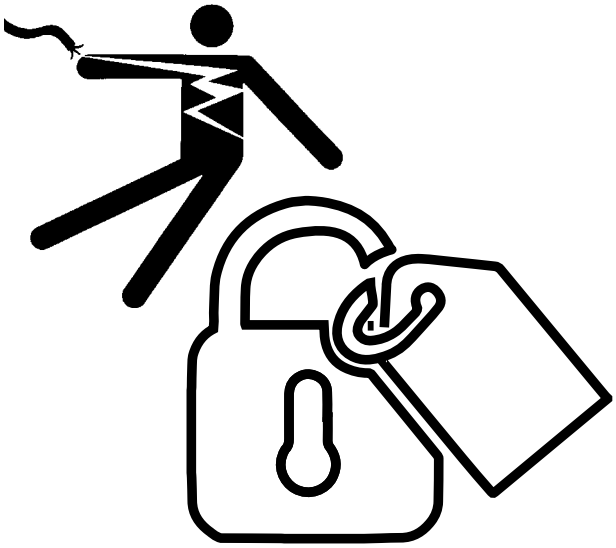
The requirements for lubrication and maintenance are shown on the maintenance charts in this section.



Intervals of maintenance are based on normal operating conditions. If operating under more difficult conditions, use a shorter time interval between maintenance.

Lockout/Tagout Power Before Servicing

⚠WARNING Severe personal injury or death can result from unexpected pump unit start-up or machine movement.



Lockout/Tagout (LOTO) power before attempting to make repairs or adjustments to this equipment, unless otherwise indicated. Proper LOTO will prevent accidents and save lives. Performing the LOTO will also prevent the equipment from moving or operating unexpectedly.

Refer to the Safety Section II, for the Lockout/ Tagout Procedure Guidelines.

Before Performing Maintenance

1. Perform daily shutdown procedure. Refer to Daily Shutdown in the Operation section.

2. Relieve hydraulic pressure.

3. Push in all E-Stop buttons.

4. Do not work on hydraulic system if oil temperature exceeds 150° F (66° C).

5. Lockout/Tagout all power. Refer to the Safety Section II, for the Lockout/Tagout Procedure Guidelines.

Periodic Maintenance (continued)

Hydraulic Oil/Fluids Under Pressure

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

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.

Avoid Pinch Points

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

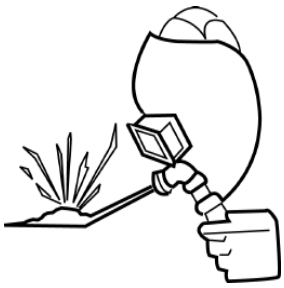
Keep hands away from moving parts.

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

Handle parts carefully to avoid crushing and pinch point hazards.

Unauthorized Welding

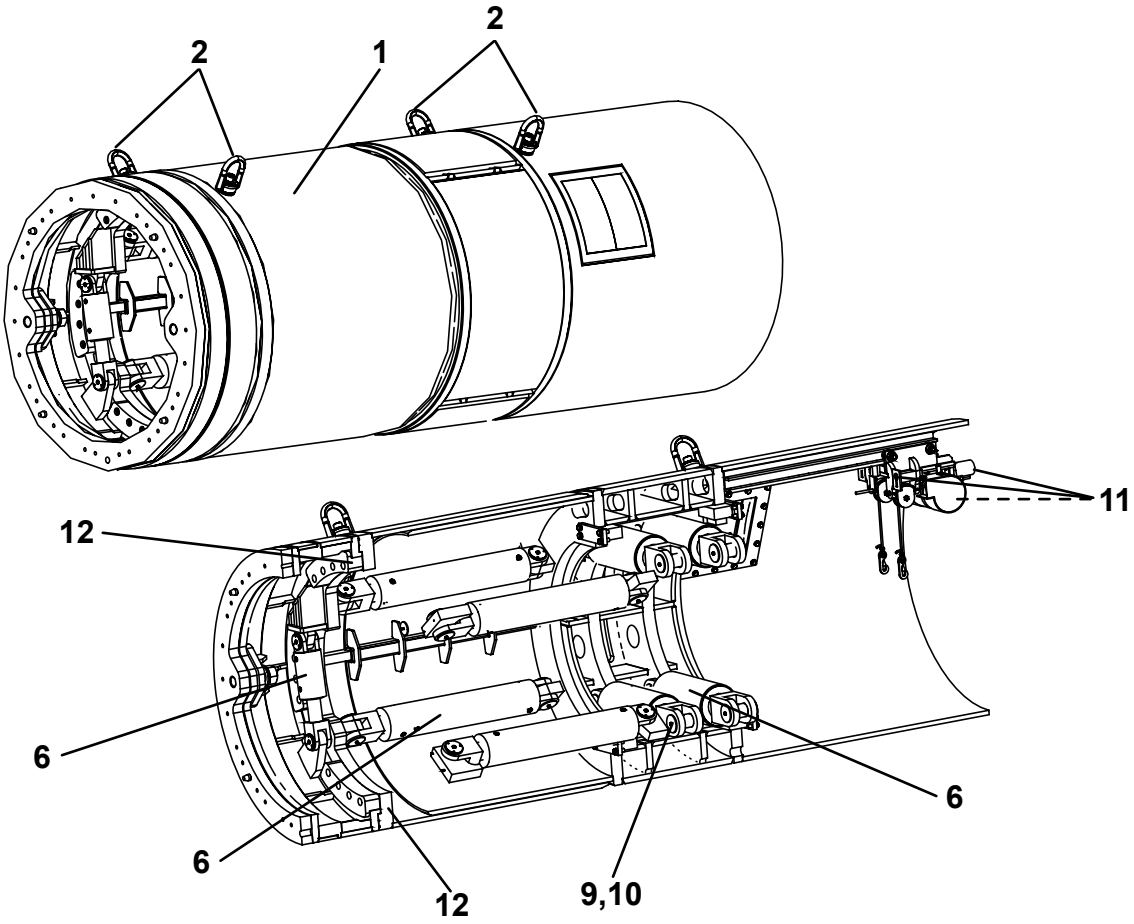
⚠WARNING Unauthorized welding can cause structural failure resulting in possible injury or death.



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

Maintenance Charts

NOTICE The belt conveyor maintenance is located later in this section.

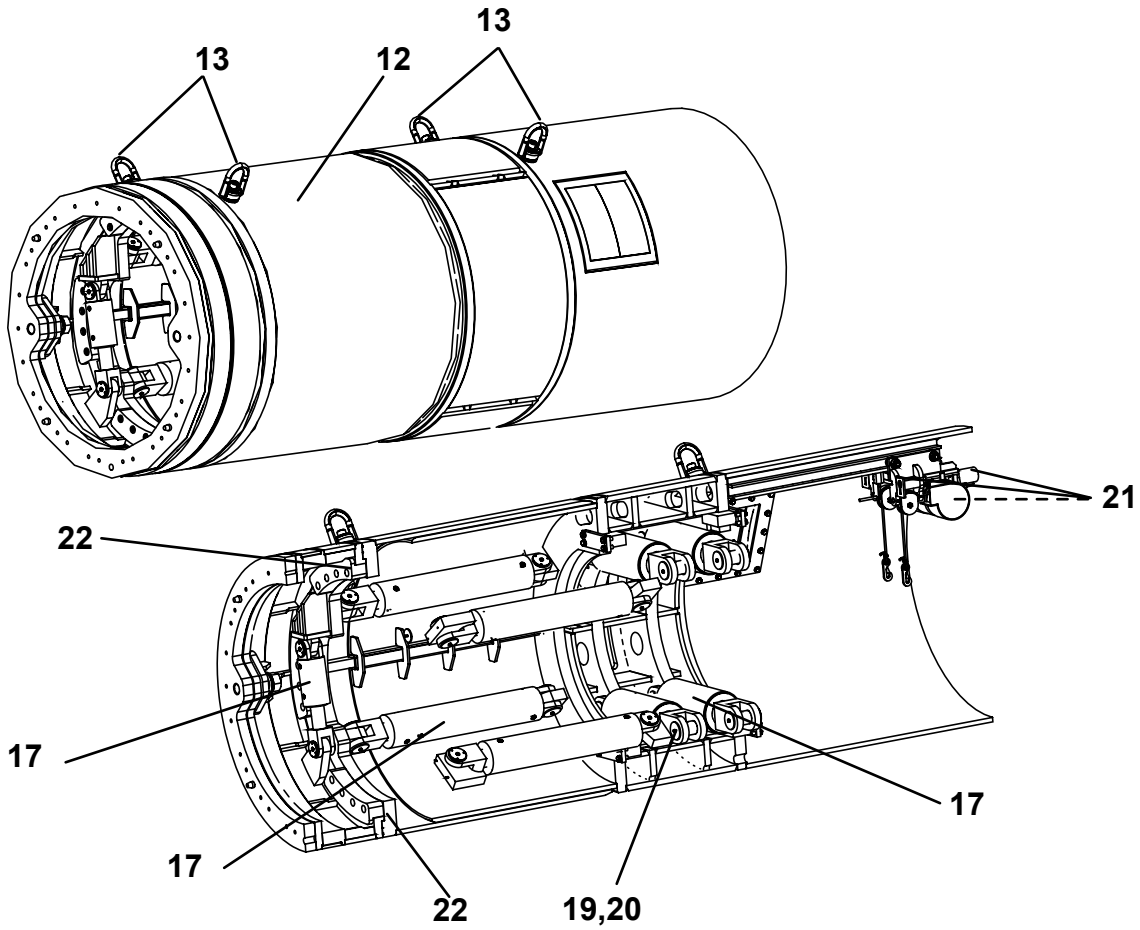


PRIOR TO EACH JOB LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Structure	Inspect for Cracks/Wear	If damaged, repair prior to use.	
2.	Lifting Eyes	Inspect	If damaged, repair or replace prior to use.	
*3.	Hydraulic Hoses	Inspect	If worn or damaged, replace with new.	
*4.	Controls	Check Operation		
*5.	Gauges	Check Operation	Replace if cracks/wear visible.	
6.	Hydraulic Cylinders	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
*7.	Decals	Inspect	Must be legible. Replace as needed.	
*8.	Supporting Equip.	Perform Maintenance	Refer to your machine's maintenance manual.	
9.	Cylinder Mntg. Pins	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
10.	Cylinder Pins	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
11.	Conveyor Lift	Inspect & Lubricate	Inspect cable, replace at first sign of wear or damage.	
			Lubricate conveyor lift and cable pulley bearing (4 places) until grease is forced out.	Mobil XHP222
12.	Roll Correction Joint	Lubricate	Lubricate until grease is forced out.	Mobil XHP222

* Not shown.

Maintenance Charts (continued)

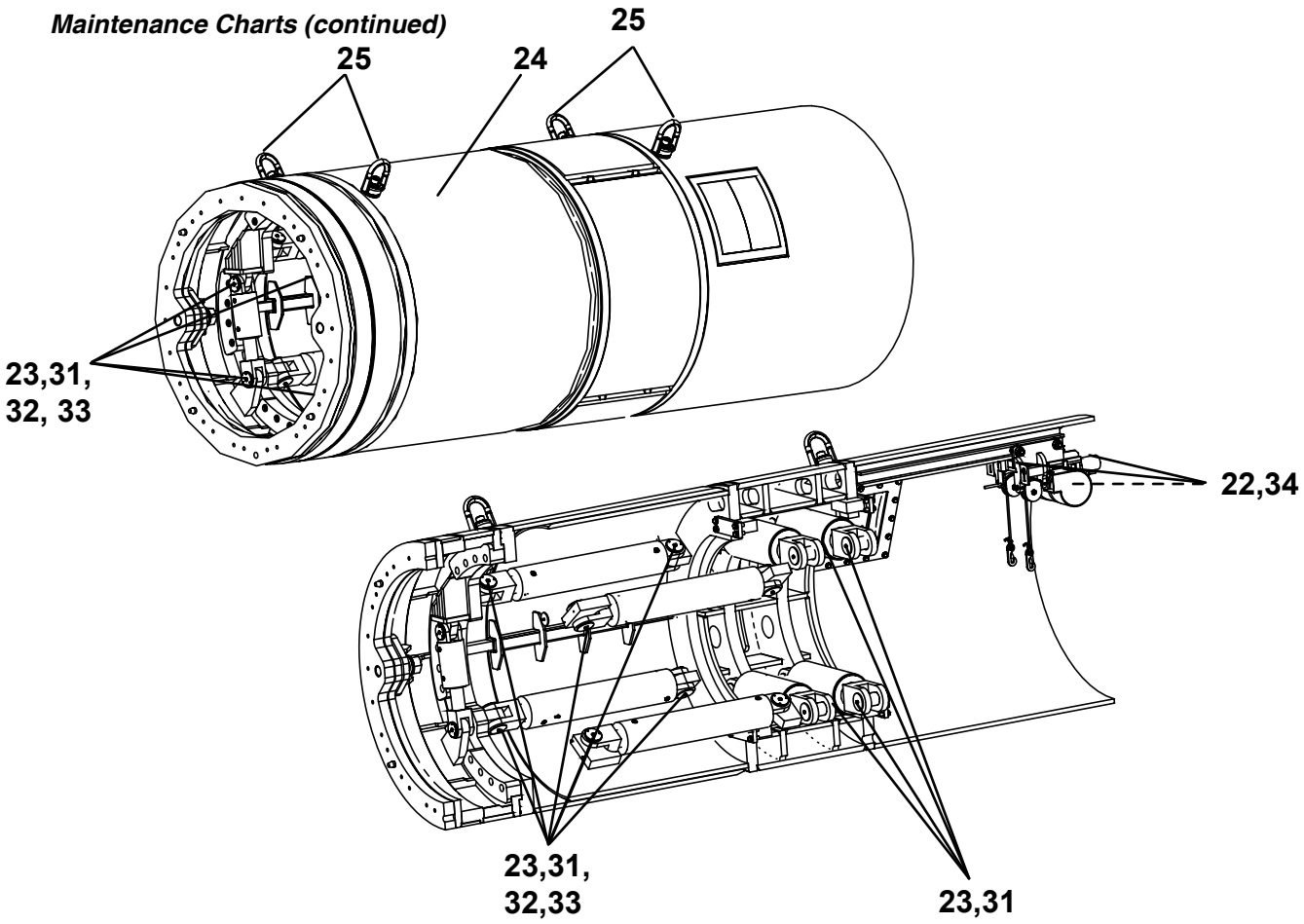


DAILY OR EVERY 10 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
12.	Structure	Inspect for Cracks/Wear	If damaged, repair prior to use.	
13.	Lifting Eyes	Inspect	If damaged, repair or replace prior to use.	
*14.	Hydraulic Hoses	Inspect	If worn or damaged, replace with new.	
*15.	Controls	Check Operation		
*16.	Gauges	Check Operation	Replace if cracks/wear visible.	
17.	Hydraulic Cylinders	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
*18.	Supporting Equip.	Perform Maintenance	Refer to your machine's maintenance manual.	
19.	Cylinder Mntg. Pins	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
20.	Cylinder Pins	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
21.	Conveyor Lift	Inspect & Lubricate	Inspect cable, replace at first sign of wear or damage.	
			Lubricate conveyor lift and cable pulley bearing (4 places) until grease is forced out.	Mobil XHP222
22.	Roll Correction Joint	Lubricate	Lubricate until grease is forced out.	Mobil XHP222

* Not shown.

Maintenance Charts (continued)



WEEKLY

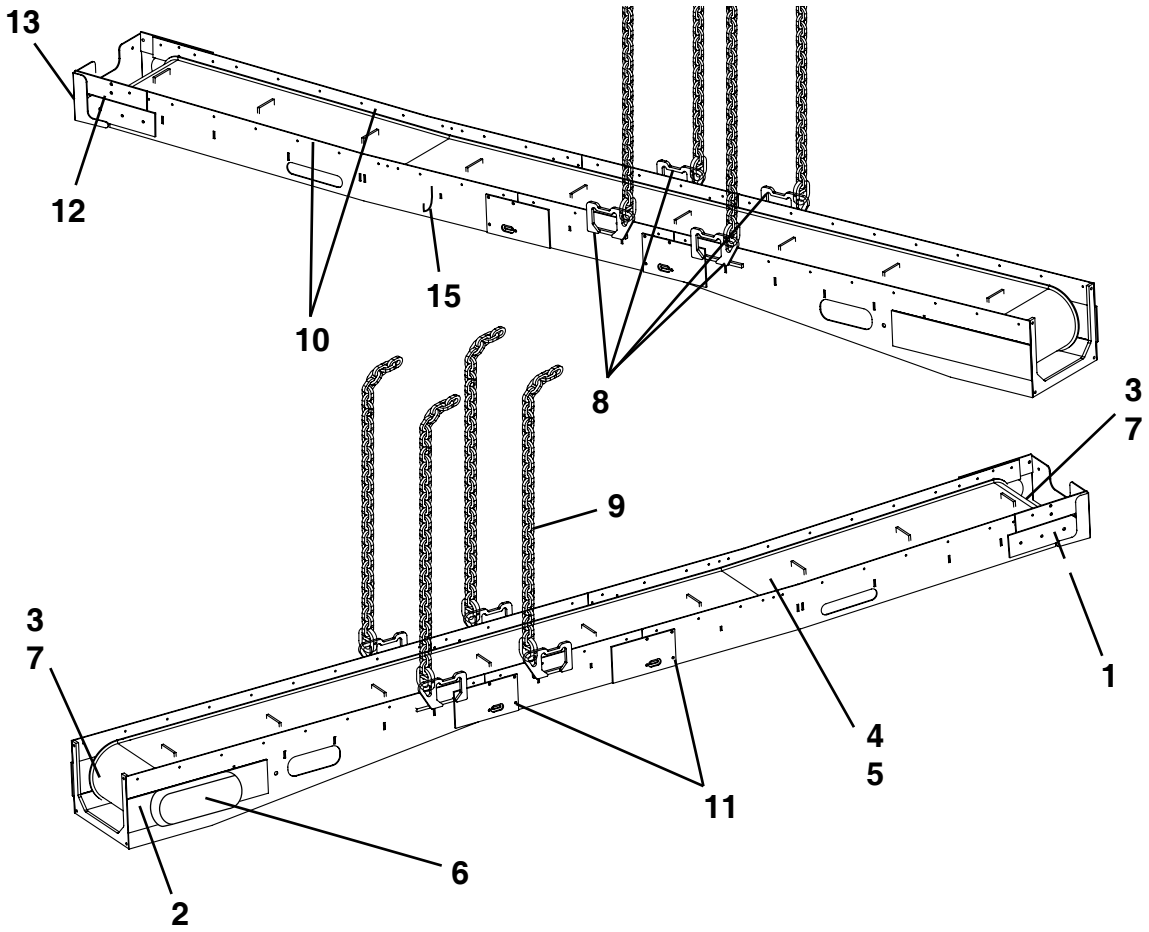
ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
22.	Conveyor Lift	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
23.	Steering Cylinders	Lubricate (2 per cyl.)	Lubricate until grease is forced out.	Mobil XHP222

COMPLETION OF EACH DRIVE

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
24.	Structure	Inspect for Cracks/Wear	If damaged, repair prior to use.	
25.	Lifting Eyes	Inspect	If damaged, repair or replace prior to use.	
*26.	Hydraulic Hoses	Inspect	If worn or damaged, replace with new.	
*27.	Controls	Check Operation		
*28.	Gauges	Check Operation	Replace if cracks/wear visible.	
*29.	Decals	Inspect	Must be legible. Replace as needed.	
*30.	Supporting Equip.	Perform Maintenance	Refer to your machine's maintenance manual.	
31.	Steering Cylinders	Lubricate (2 per cyl.)	Lubricate until grease is forced out.	Mobil XHP222
32.	Cylinder Mntg Pins	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
33.	Cylinder Pins	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
34.	Conveyor Lift	Inspect & Lubricate	Inspect cable, replace at first sign of wear or damage.	
			Lubricate conveyor lift and cable pulley bearing (4 places) until grease is forced out.	Mobil XHP222

* Not shown.

Maintenance Charts - Belt Conveyor



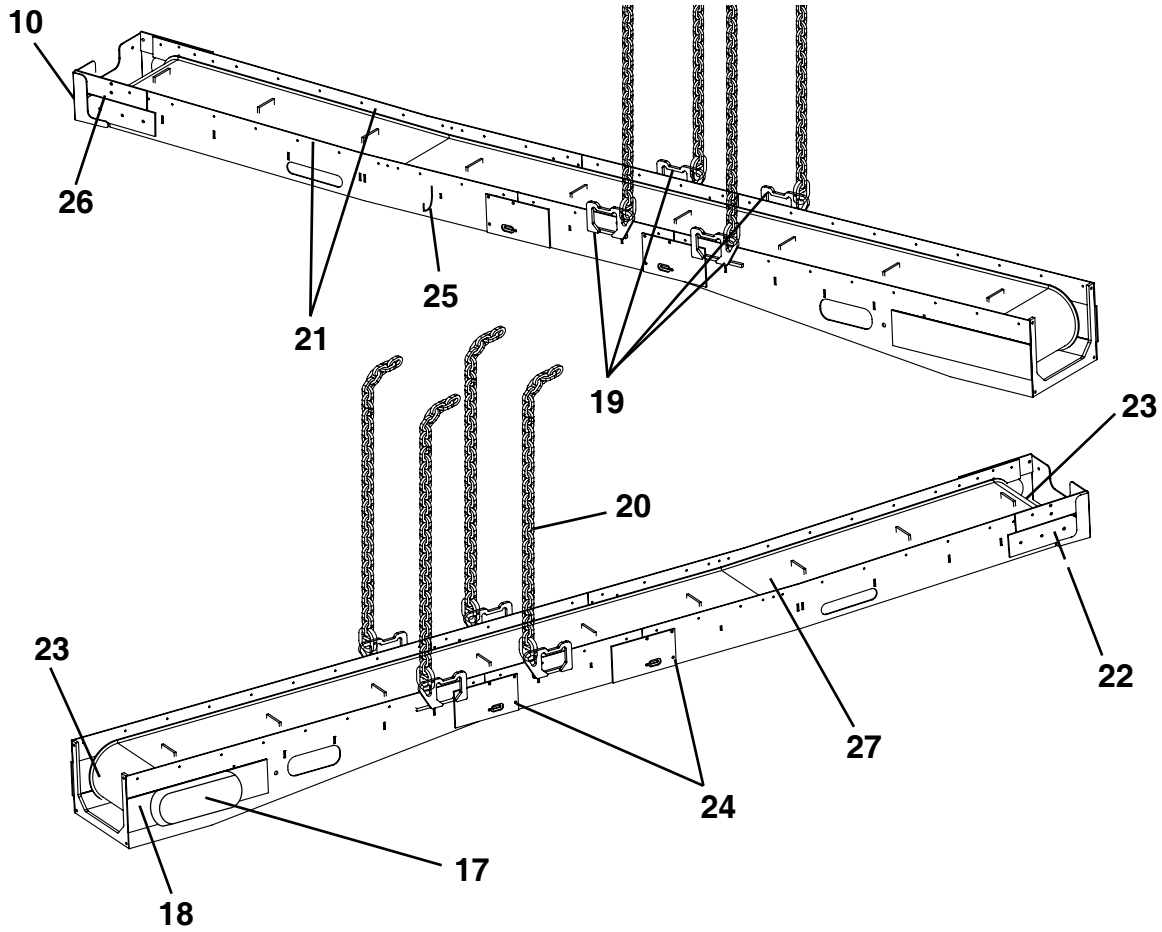
Shown without hopper extensions.

PRIOR TO EACH JOB LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Front Roller	Inspect & Lubricate	If damaged, replace with new.	Mobil XHP222
2.	Drive Roller & Brg.	Inspect & Lubricate	If damaged, replace with new.	Mobil XHP222
3.	Roller Scrapers	Inspect	If damaged, replace with new.	
4.	Belt	Inspect	Replace if worn, cracked or damaged.	
5.	Belt Tension	Check	At center, max. 6” deflection.	
6.	Drive Chain	Inspect & Lubrication	Check for wear and tightness.	Mobil XHP222
7.	Belt Scrapers	Inspect	If damaged, replace with new.	
8.	Lift Eyes	Inspect	If damaged, replace with new.	
9.	Lifting Chain	Inspect	If damaged, replace with new.	
10.	Spoils Guide	Inspect	If damaged, replace with new.	
11.	Idler Rollers	Inspect & Lubricate	If damaged, replace with new.	Mobil XHP222
12.	Nose Bracket & Brg.	Inspect & Lubricate	If damaged, replace with new.	Mobil XHP222
13.	Dirt Guard	Inspect	If damaged, replace with new.	
*14.	Hydraulic Hoses	Inspect	If worn or damaged, replace with new.	
15.	Safety Hook	Inspect	If damaged, replace with new.	
*16.	Decals	Inspect		

* Not shown.

Maintenance Charts (continued)



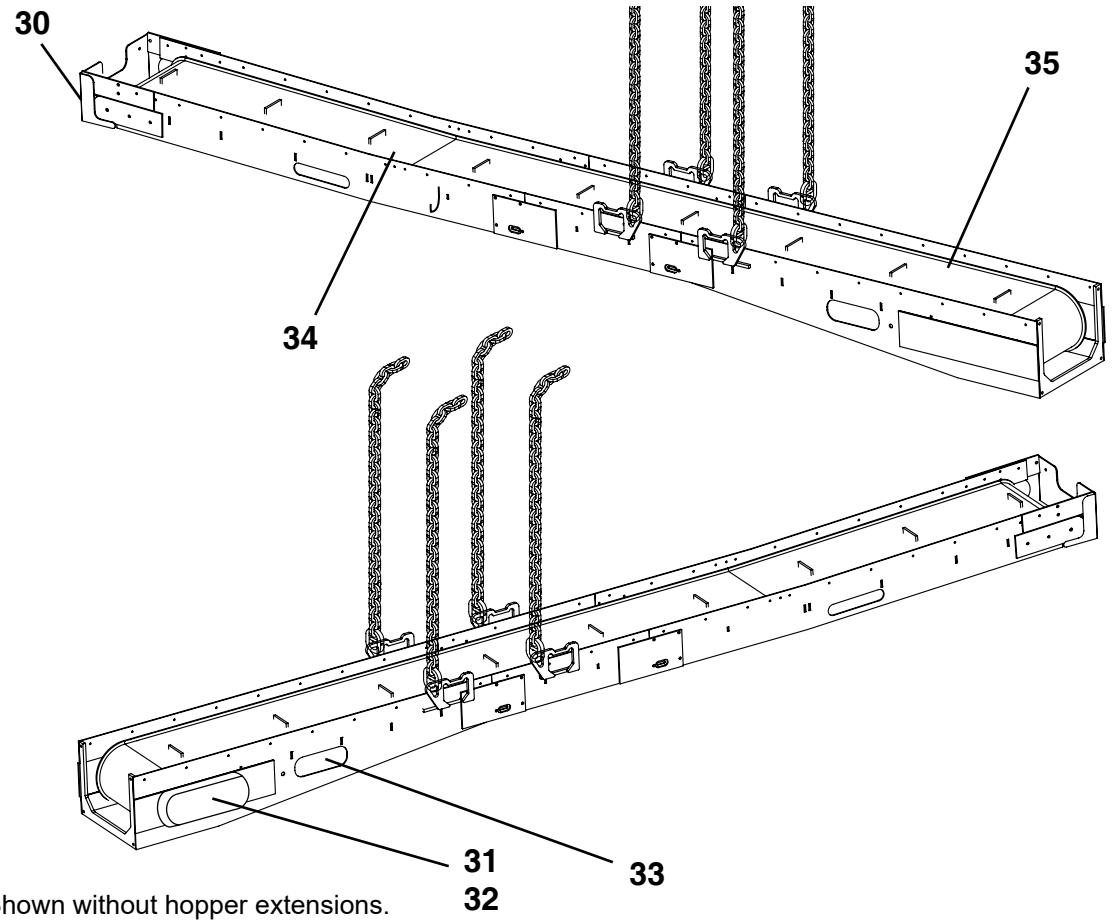
Shown without hopper extensions.

DAILY OR EVERY 10 HOURS OF OPERATION OR EACH SHIFT CHANGE

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
17.	Drive Cover	Inspect	If damaged, replace with new.	
18.	Drive Roller & Brgs.	Inspect & Lubricate	Replace if cracks/wear visible	Mobil XHP222
19.	Lift Eyes	Inspect	If damaged, replace with new.	
20.	Lifting Chain	Inspect	If damaged, replace with new.	
21.	Spoils Guide	Inspect	If damaged, replace with new.	
22.	Front Roller	Inspect	If damaged, replace with new.	
23.	Belt Scrapers	Inspect	If damaged, replace with new.	
24.	Idler Rollers	Inspect & Lubricate	If damaged, replace with new.	Mobil XHP222
25.	Safety Hook			
26.	Nose Bracket & Brg.	Inspect & Lubricate	If damaged, replace with new.	
27.	Belt	Inspect	Replace if worn, cracked or damaged.	
*28.	Decals	Inspect		
*29.	Hydraulic Hoses	Inspect	If worn or damaged, replace with new.	

* Not shown.

Maintenance Charts (continued)



Shown without hopper extensions.

WEEKLY OR EVERY 50 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
30.	Dirt Guard	Inspect	If damaged, replace with new.	
31.	Drive Motor Bolts	Inspect for tightness	If damaged, replace with new.	
32.	Drive Chain	Inspect & Lubrication	Check for wear and tightness.	Mobil XHP222
33.	Belt Adjust Screw	Inspect & Lubricate		
34.	Belt Tension	Check	At center, max. 6” deflection.	

AFTER EACH DRIVE

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
35.	Conveyor	Clean & Empty		

X. Storage

Preparing for Storage

NOTICE Follow the lubrication and maintenance requirements in the Periodic Maintenance section.

1. Repair worn or damaged parts.
2. Wash all equipment thoroughly.
3. Lubricate all grease points. Grease threads on bolts used for adjustments.
4. Retract all hydraulic cylinders if possible. If not, coat exposed cylinder rods with a corrosion preventive.
5. Repaint equipment where necessary.
6. Drain hydraulic oil, flush oil reservoirs, change hydraulic filters, and refill hydraulic reservoirs. Check for leaks.
7. Wipe up lubrication spills. Dispose of rags and trash properly. Store oily rags and other flammable material in protective containers.
8. If possible, store equipment under cover and out of the weather in a ventilated area.
9. Remove laser guidance system and place it in the storage box.
10. Do not smoke in areas where flammable materials are stored.
11. Store fuels and lubricants in properly marked containers.

Removing from Storage

NOTICE Follow the lubrication and maintenance requirements in the Periodic Maintenance section.

1. Clean equipment thoroughly.
2. Check to make sure all decals including safety decals are clean and readable.
3. Check condition of wires and cables. Repair or replace as necessary.
4. Remove the cylinder corrosion preventive from the cylinder rods if it is not compatible with hydraulic oil or seal materials.
5. Check for leaks. Repair or replace as necessary.
6. Check hydraulic oil level in reservoir. If fluid is low, check for leaks and add oil as required. Refer to Lubricants section.
7. Perform a oil analysis on the oil in the hydraulic reservoir. Replace the hydraulic oil and filters if the test reveals contamination.
8. Check the return filter indicators. Replace filter(s) as needed.
9. Check condition of all hoses and connections. Tighten, repair or replace with new as needed.
10. Before operating, cycle hydraulic functions several times to purge air from the hydraulic system.
11. Review this Instruction manual.

XI. Troubleshooting

Gripper Can

Problem	Cause	Solution
Jacking thrust cylinders stall at less than 500 psi.	Cylinder at full extension.	Retract.
	Worn or damaged cylinders seals.	Replace seals.
	Worn or damaged control valve seals.	Replace seals.
	Faulty pendant extension cable.	Remove cable and re-test, repair cable.
	Worn or damaged hydraulic pump.	Test/replace pump.
	High Flow Return Ball Valve open.	Close High Flow Return Ball Valve.
Gripper thrust cylinders stall at less than 500 psi.	Cylinder at full extension.	Retract.
	Worn or damaged cylinders seals.	Replace seals.
	Worn or damaged control valve seals.	Replace seals.
	Faulty pendant extension cable.	Remove cable and re-test, repair cable.
	Worn or damaged hydraulic pump.	Test/replace pump.
Jacking cylinder(s) collapse when forward thrust is stopped.	Worn or damaged cylinder seals.	Replace seals.
Jacking pressure gauge pressure drops when forward thrust is stopped.	Low cylinder load.	Avoid over excavation at tunnel face.
	Worn or damaged cylinder seals.	Replace seals.
Gripper can creeps or rolls.	Gripper extend relief valve is limiting force.	Increase gripper extend relief valve and pressure switch.

Belt Conveyor

Problem	Cause	Solution
Conveyor lift or steering does not operate.	Obstacle in travel area.	Remove obstacle.
	Valve handle stuck in the ON position.	Repair valve.
	Check valve did not release.	Replace check valve.

Conveyor Stalls:

1. Check conveyor operating pressure gauge - Gauge reads 500 - 1000 psi.

TEST: Disconnect conveyor hoses, turn valve on and read pressure gauge, turn valve off.

a. Gauge reads 2800 psi.

Low belt tension.	Tighten belt tension.
Broken drive chain.	Replace drive chain.
Worn or damaged conveyor drive motor.	Replace motor.
Wet conveyor belt.	Tighten under belt scrapers.

b. Gauge reads less than 1500 psi.

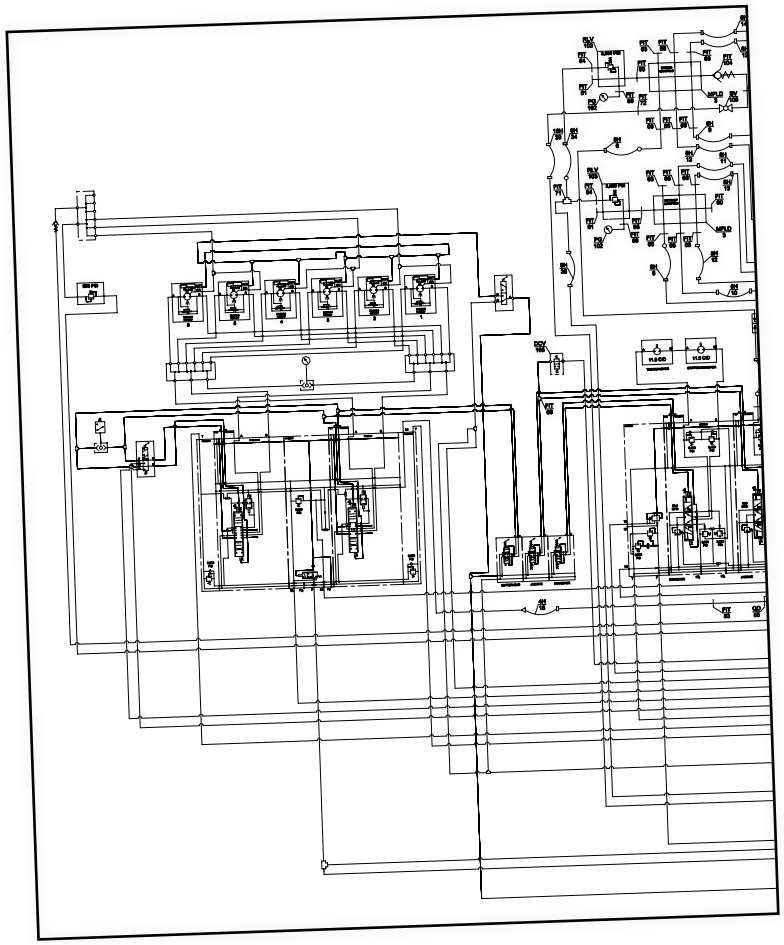
Conveyor valve not in full ON position.	Turn valve to full ON position.
Worn or damaged conveyor valve.	Replace valve.
Safety valve tripped.	Reset.
Power unit supply valves not in full ON position.	Turn valve to full ON position.
Clogged hydraulic filter element.	Replace filter element.

2. Check conveyor operating pressure gauge - Gauge reads 2800 psi.

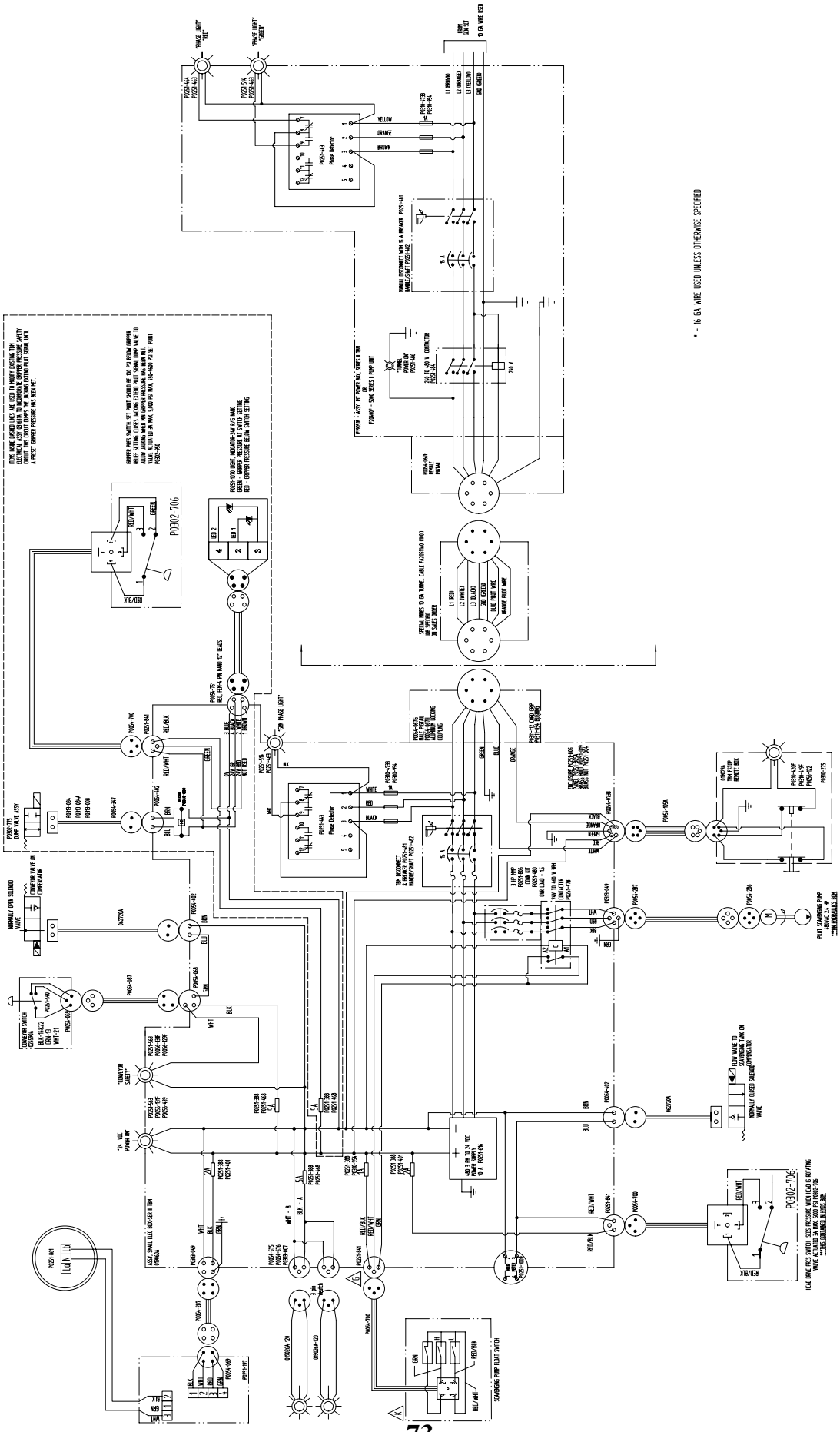
Obstacle lodged in belt or drive chain.	Remove obstacle. Check belt and drive chain for damage.
Conveyor quick coupler faulty or not properly connected.	Properly connect coupler or replace.
Damaged bearing on conveyor.	Replace bearing.

Gripper Can Hydraulic Schematic

Please contact Akkerman Aftermarket Support for hydraulic schematic drawings of the Gripper Cans.

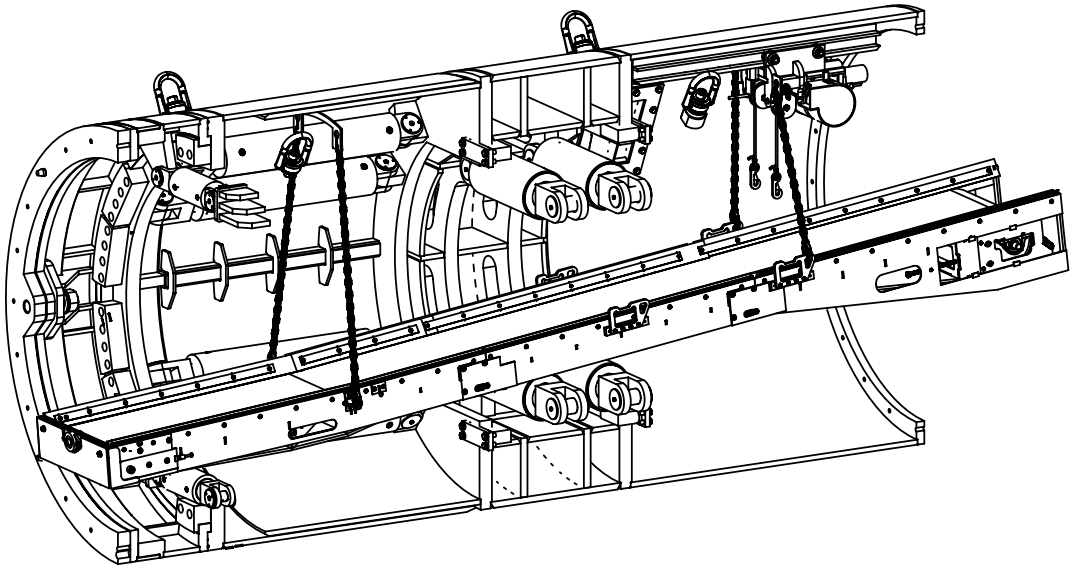


540 / 720 Gripper Can Electrical Schematic



XII. Specifications

Gripper Can



Structure	**Models 540 / 720**
Outside Diameter	66 / 86 in. (1,676 / 2,184 mm)
Overall Length	177.2 in. (4,500 mm)
Weight (without conveyor)	31,000 lbs. / 43,500 (14,061 / 19,731 kg)

Jacking Cylinders	**Models 540 / 720**
Number of Cylinders	4 / 8
Cylinder Stroke	30 / 30 in. (762 mm)
Max. Extend Force Each	71 Ton @ 5,000 psi
Relief Setting 540	51 Ton @ 3,600 psi
Relief Setting 720	44 Ton @ 3,100 psi
Max. Retract Force Each	39 Ton @ 5,000 psi
Relief Setting 540	12.5 Ton @ 1,600 psi
Relief Setting 720	8 Ton @ 1,000 psi

Gripper Cylinders	**Models 540 / 720**
Number of Cylinders	4 / 4
Cylinder Stroke	10 / 10 in. (254 mm)
Max. Extend Force Each	126 Ton @ 5,000 psi
Relief Setting 540	75 Ton @ 3,000 psi
Relief Setting 720	75 Ton @ 3,500 psi
Max. Retract Force Each	66 Ton @ 5,000 psi
Relief Setting 540	40 Ton @ 2,500 psi
Relief Setting 720	40 Ton @ 2,500 psi

Roll Correction Cylinders	**Models 540 / 720**
Number of Cylinders	2 / 2
Cylinder Stroke	4 / 6 in. (101.6/152.4 mm)
Max. Extend Force Each	40 Ton @ 5,000 psi
Relief Setting 540	24 Ton @ 2,500 psi
Relief Setting 720	24 Ton @ 3,500 psi
Max. Retract Force Each	22 Ton @ 5,000 psi
Relief Setting 540	13 Ton @ 2,500 psi
Relief Setting 720	13 Ton @ 3,500 psi

Safety Circuit.....Pressure switch indicator on gripper can extend circuit, dumps jacking extend pilot signal to tank until gripper minimum pressure setting is met

Hydraulic Controls

Gripper Can supply is fed by the 5200 Pump Unit (or other power support equipment) where the oil is dispersed to the main valve bank in the TBM. Gripper can joystick controls are proportionally controlled, and remotely located behind the TBM operator. Functions are forward (extend) / backward (retract).

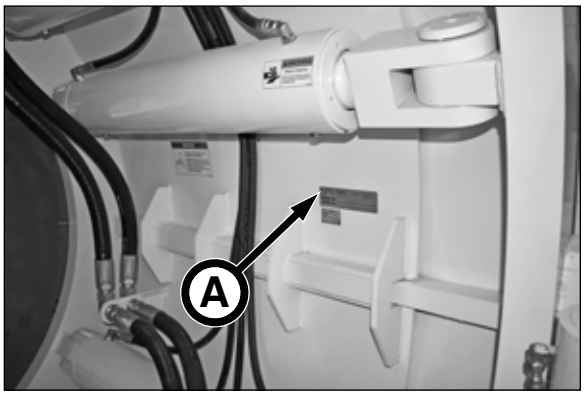
XIII. Identification Numbers

Model and serial numbers are required when ordering parts or requesting service information. Record your model and serial number below.

GRIPPER CAN (A)

Model Number _____

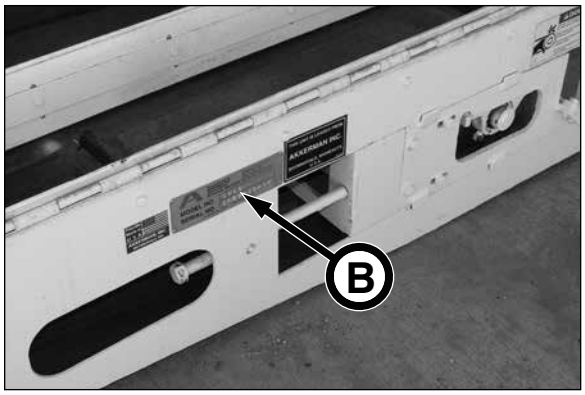
Serial Number _____



CONVEYOR (B)

Model Number _____

Serial Number _____



XIV. 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 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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