OPERATOR'S MANUAL

Tunnel Boring Machine

Series II

840

S/N: F31100F

Publication No. 050162A

Rev. No. 210930, R250331

Akkerman Inc. 58256 266th Street Brownsdale, MN 55918
Phone: 507-567-2261 Fax: 507-567-2605 email: akk@akkerman.com

SERVICE • RELIABILITY • INNOVATION

⚠ DANGER

This machine is powered by high voltage electricity.

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

LOCKOUT/TAGOUT main power supply before servicing. ONLY a qualified and trained technician can operate this equipment. Electrical repairs must be performed only by a certified electrician.

NOTES

Introduction

This operator's manual contains important safety, operation, and maintenance information for your Akkerman Tunnel Boring Machine (TBM). You must read and understand this manual, your haul unit operator's manual, pump unit operator's manual, the gas detection system operation manual and any other supporting equipment manuals before you operate and maintain this equipment. Keep this manual with your TBM at all times. Directions in this manual are referenced from the launch shaft going forward to the reception shaft, unless otherwise noted. You may purchase additional copies of this manual from the Akkerman Aftermarket Support Department, or download it from the Akkerman web site at www.akkerman.com.

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

The use of second rate parts could affect the efficient performance of the Tunnel Boring Machine. ALWAYS use genuine Akkerman parts.

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

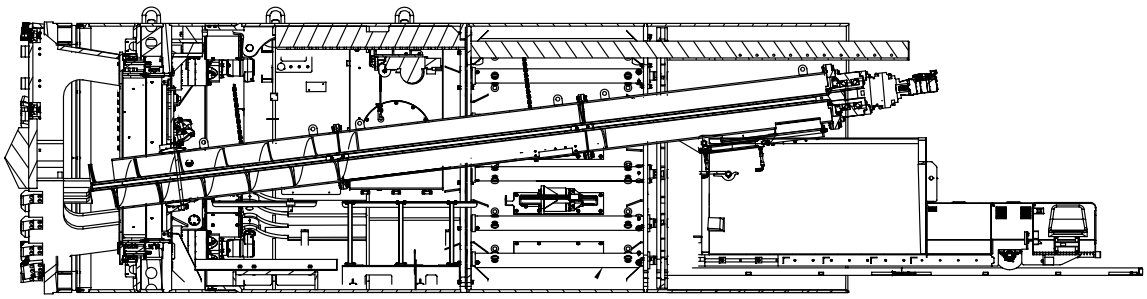
⚠DANGER Indicates an extremely hazardous situation which, if not avoided, WILL result in death or serious injury.

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

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

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

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



TBM 840 Series II With Screw Conveyor & 1548 Haul Unit

Earth pressure balance (EPB), pipejacking and tunneling is a type of "trenchless technology" that utilizes a tunnel boring machine (TBM). The TBM is advanced through the ground by hydraulic jacking cylinders on a jacking can, jacking frame, or pump unit/yoke from the launch shaft. As the TBM advances, powerful hydraulic motors rotate a bearing/inner drum. In EPB mode, the operator manually adjusts the advance rate or spoil removal as necessary to keep the earth pressure in the acceptable range.
Connected to the drum is a cutterhead or closed face attachment. As it rotates, the attachment teeth or disc cutters excavate the face, and the spoils fall into the drum/chamber. Scoops and paddles in the drum/chamber dump/direct the spoils onto a conveyor (belt/screw), which carries the material to the dirt bucket. Once the dirt bucket is full, the dirt bucket is removed from the pipeline via a haul unit to the unloading area in the launch shaft, where the dirt bucket is hoisted out of the shaft and unloaded, and returned to the haul unit.

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

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

NOTES

Contents

(continued on next page)

(continued on next page)

Troubleshooting (continued)

NOTES

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.

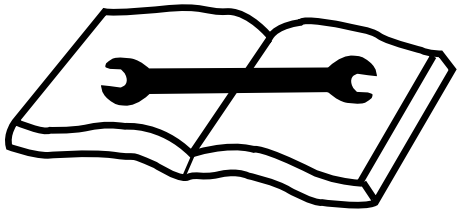
ATTENTION!
BECOME ALERT!
YOUR SAFETY IS INVOLVED!

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.



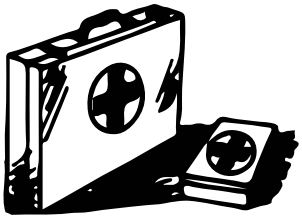
WEAR PROTECTIVE CLOTHING

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.



ELECTRIC SHOCK, EXPLOSION OR ARC FLASH HAZARD

⚠DANGER Failure to follow the instructions below will result in serious injury or death.

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E.
- This equipment must be installed and serviced only by qualified electrical personnel.
- Turn off all power supplying this equipment before working on or inside equipment.
- Always use a properly rated voltage sensing device to confirm power is off.
- Replace all devices, doors and covers before turning on power to this equipment.

LOCKOUT/TAGOUT POWER BEFORE SERVICING

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

This tunnel boring machine contains high voltage electricity.

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

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.

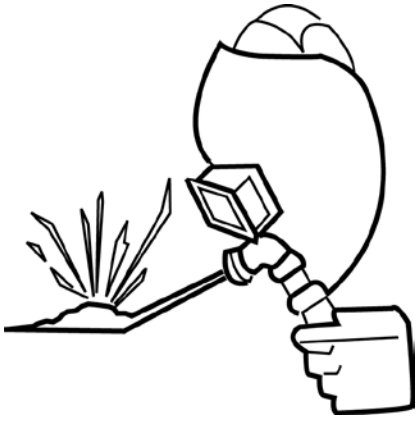
KEEP PERSONNEL AWAY FROM MOVING PARTS

⚠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.

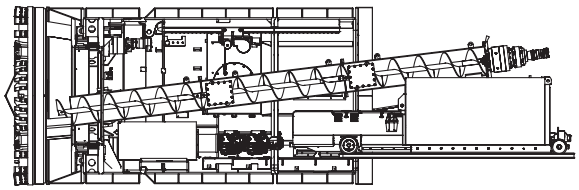
Do not weld on any structural member. Unauthorized welding or repair will void the warranty.



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.

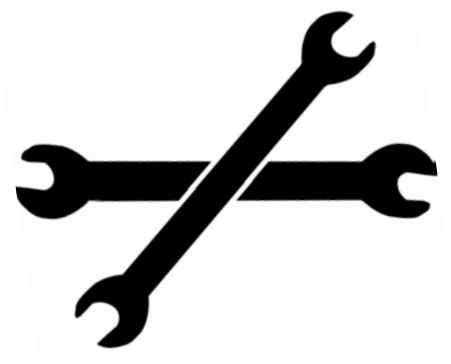
USING TUNNEL POWER CABLE

⚠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.

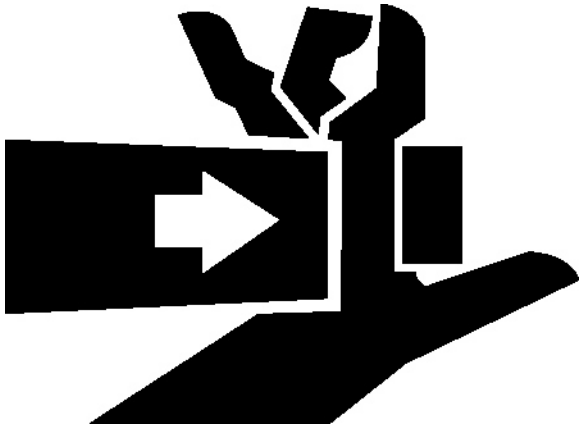
Only trained and qualified personnel should perform any maintenance or repairs.

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.

AVOID PINCH POINTS



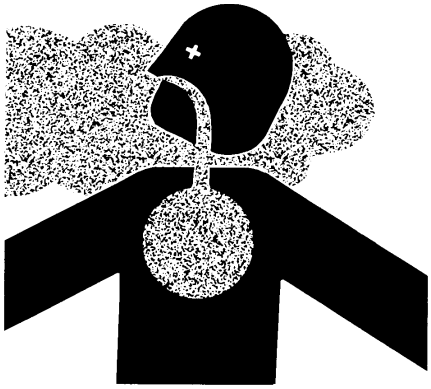
⚠WARNING Moving parts or the mishandling of parts can cause severe personal injury.

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.

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.

STAY AWAY FROM CRANE

⚠DANGER Stay away from operating crane. If close to power lines, the crane, load, and ground may become electrified resulting in serious injury or death.

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.

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.

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.

KEEP JOB SITE CLEAN AND ORGANIZED

⚠WARNING Tripping can cause serious personal injury.

Be sure to keep job site clean and organized.

CONVEYOR OPERATION

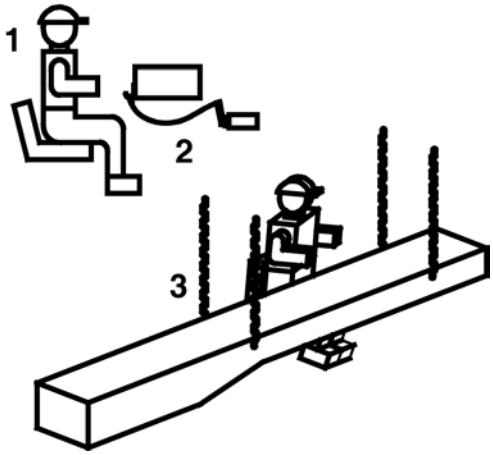
⚠WARNING Conveyor can jam in rotating cutterhead causing conveyor to swing into operator, resulting in severe personal injury.

While cutterhead is rotating:

1. Operator MUST remain seated in normal operating position.

2. Cutterhead drive dump valve (conveyor safety valve) MUST be tethered to conveyor.

3. ALL FOUR safety chains MUST be secured to conveyor.



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.

KEEP AWAY FROM SCREW CONVEYOR AUGER

⚠DANGER Contact with rotating auger will cause severe injury or death.

Keep hands, body, and objects clear of operating auger.

Do not operate without covers and guards in place.

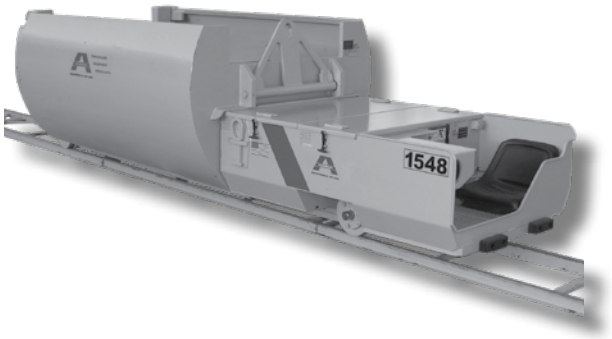
Lockout tagout power before servicing.

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.

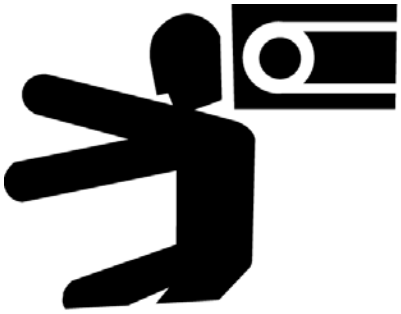


AVOID TUNNEL WALL CONTACT

⚠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.

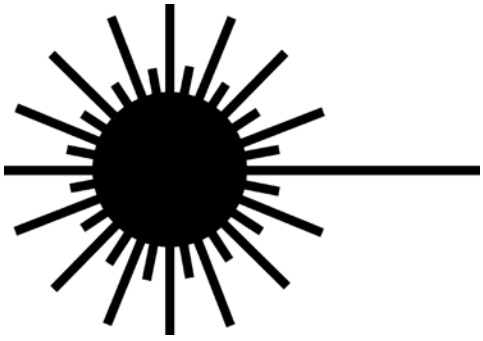
While moving haul unit into tunnel, avoid hitting the conveyor.

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.

AVOID LASER LIGHT EXPOSURE

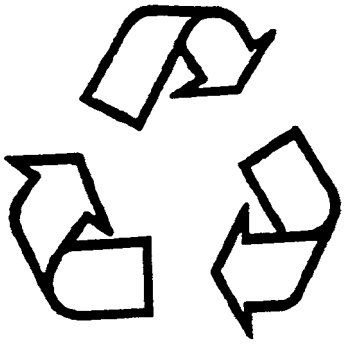


⚠DANGER Staring into laser light will cause severe injury.

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

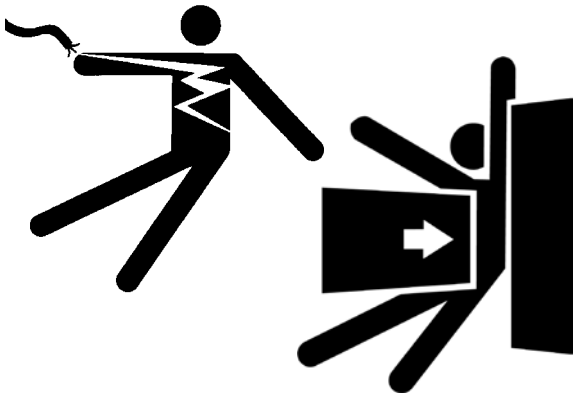


Follow local, state, federal, and international regulations when recycling or disposing of waste. Waste includes fluids/oil, fuel, filters, coolant, and batteries.

Use leakproof 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 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 lockout tagout power before adjustments, repairs or servicing WILL cause severe personal injury or death.

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

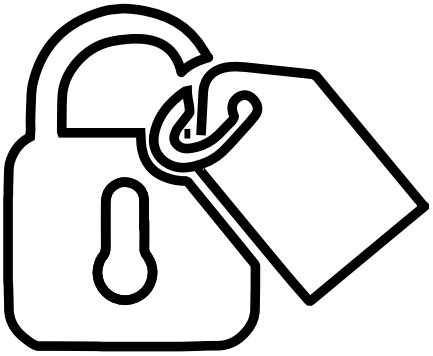
The contractor is fully responsible for the safety of all personnel on the job site. Use the following as a guideline for a lockout tagout procedure. The contractor must determine the best lockout tagout practices for his/her employees on the job site.

1. Follow all Federal, State and Local safety regulations and procedures.
2. Be sure OSHA prescribed safety personal protective equipment is being 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 lockout tagout options for the 840 TBM Series II:

   • Lockout Tagout the Power Source - refer to step 7 for details.

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

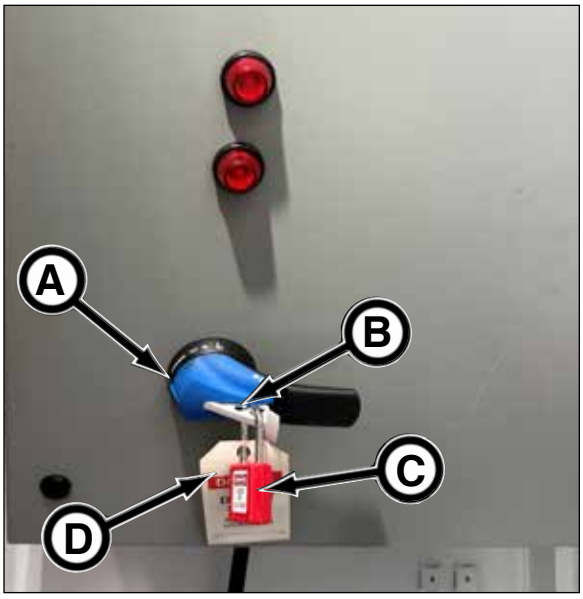


7. ***Lockout Tagout the Power Source Option***

   Lockout Tagout power source or generator. Refer to the power source or generator manufacturer for proper lockout tagout procedure.

(continued on next page)

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



• TBM Control Box Lockout Tagout:
Be sure the main power switch (A) on the control box is in the OFF position. Flip safety latch (B) out on main power switch and install shackle of OSHA approved lock (C) with tag (D) through latch.

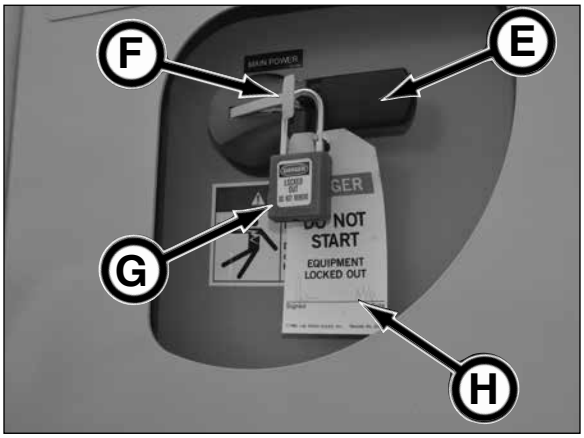
Secure lock by pushing shackle into body of the lock until the shackle is locked into the locking mechanism. Turn key to lock shackle in place.

Remove key from lock.

Test to be sure shackle is fully secured into lock.

Sign “Equipment Locked Out” tag or equivalent.

• 5200 Pump Unit Main Breaker Lockout Tagout:
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.

IMPORTANT: By placing lockout tagout 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 lockout power to the 5200, the 5200 main power breaker MUST be in lockout tagout. Refer to 5200 Pump Unit Main Breaker Lockout Tagout above.

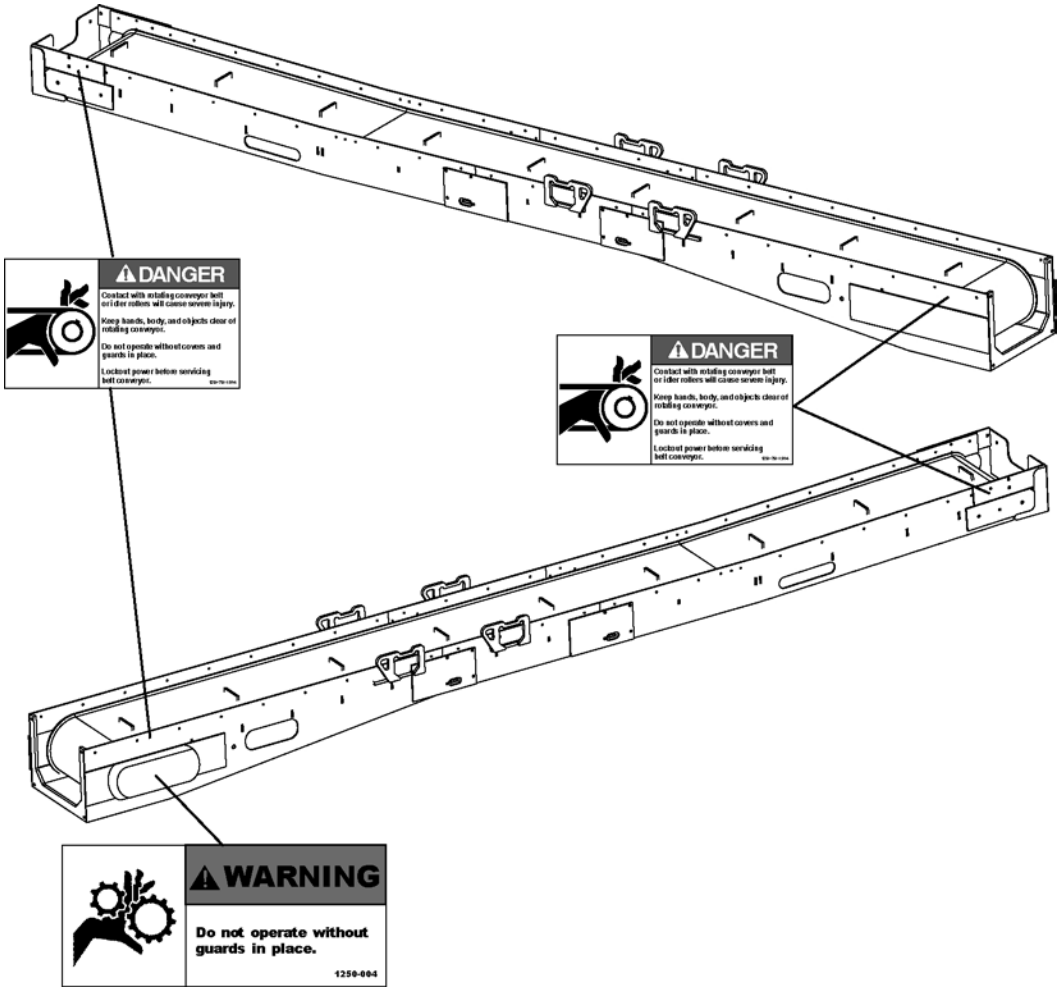
Safety Decals

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 will damage the surface of the decal. Replace safety decals immediately if they are damaged, missing, or hard to read.

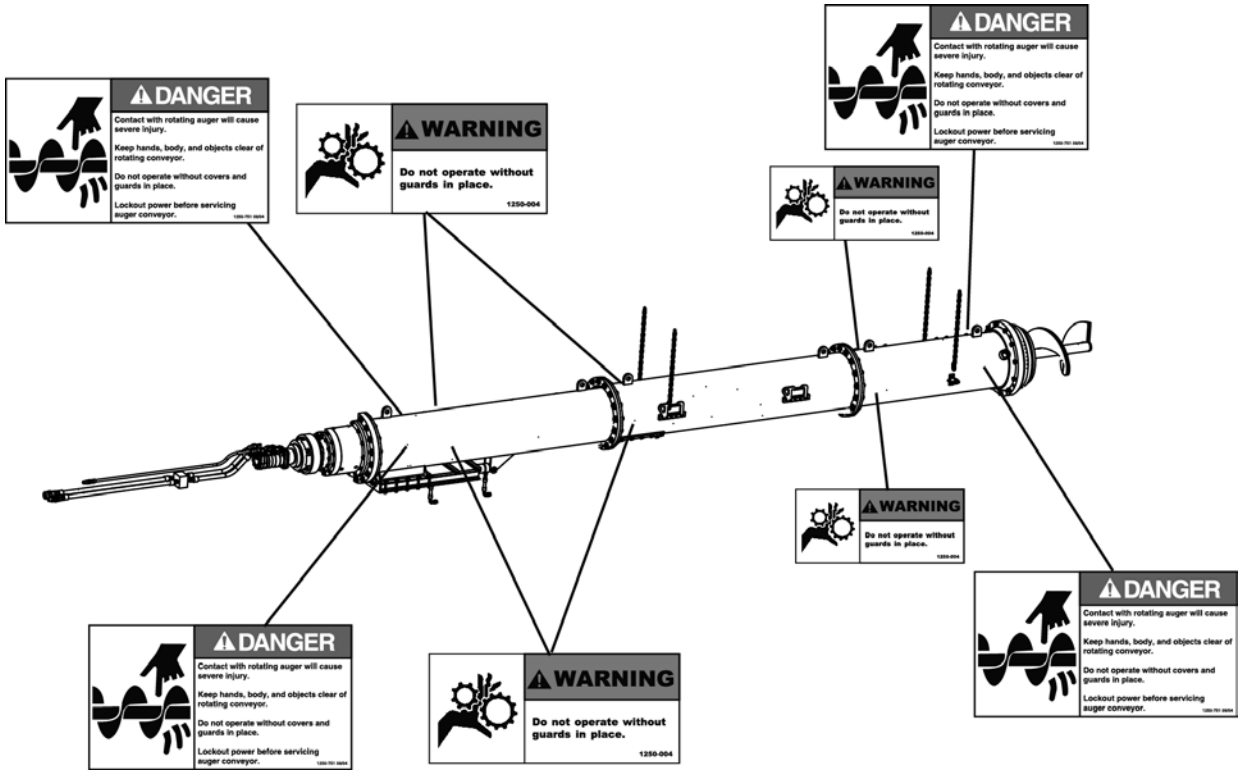
Serious injury or property damage can occur if safety instructions are not followed. Contact your Akkerman Aftermarket Support representative for free replacement safety decals.

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.

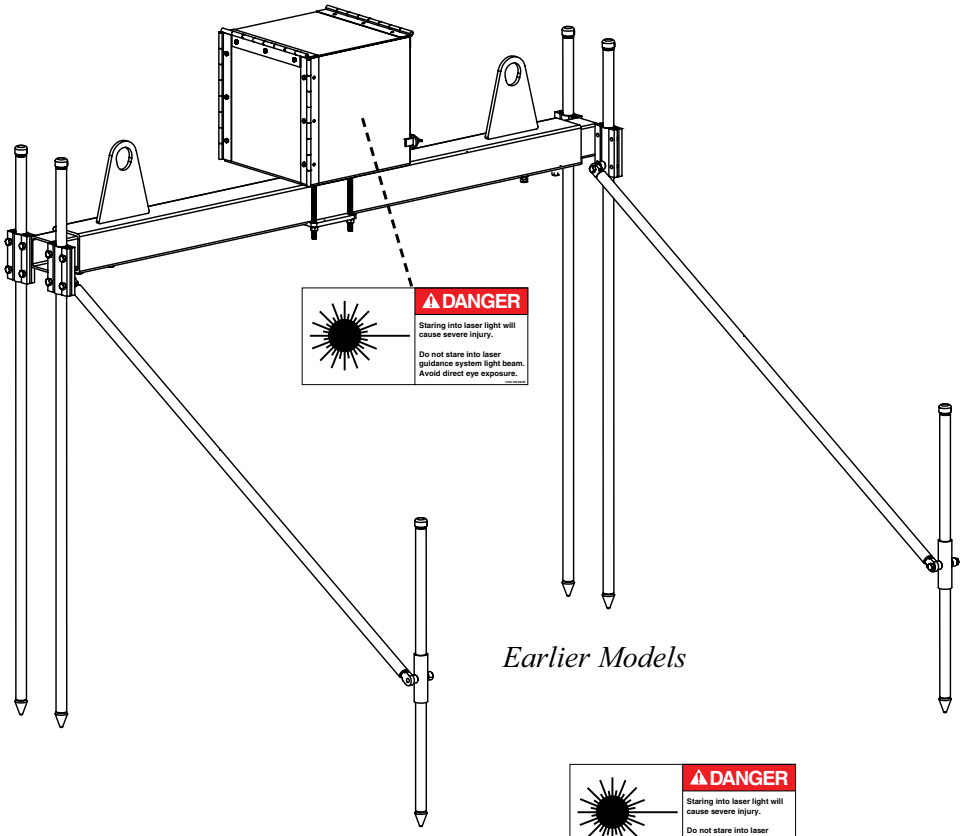
BELT CONVEYOR



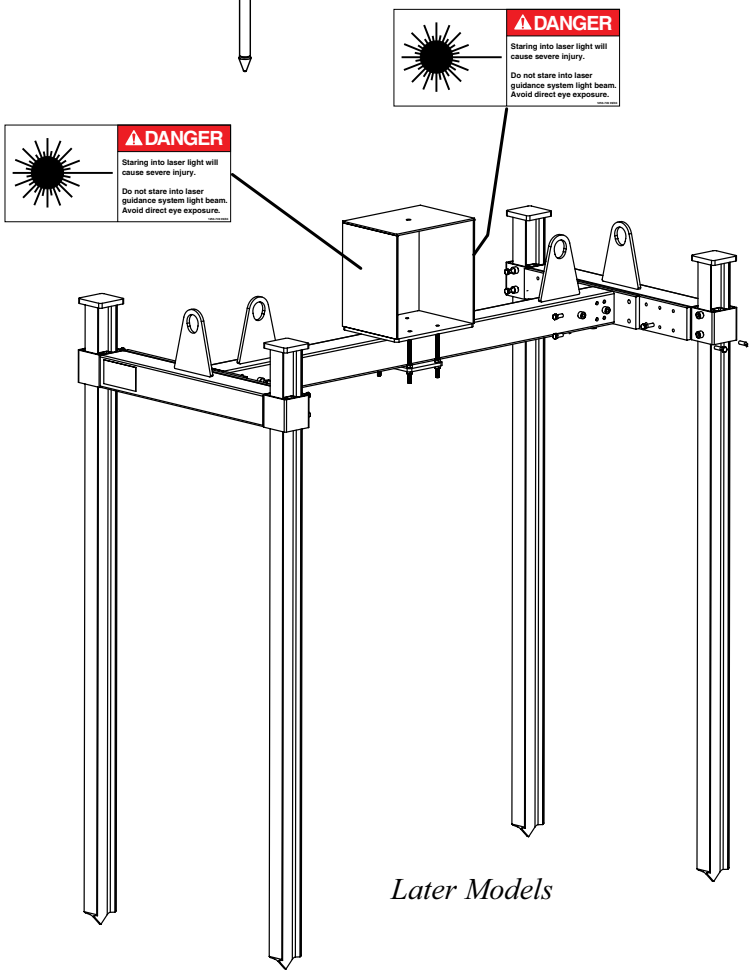
SCREW CONVEYOR



LASER LIGHT STAND



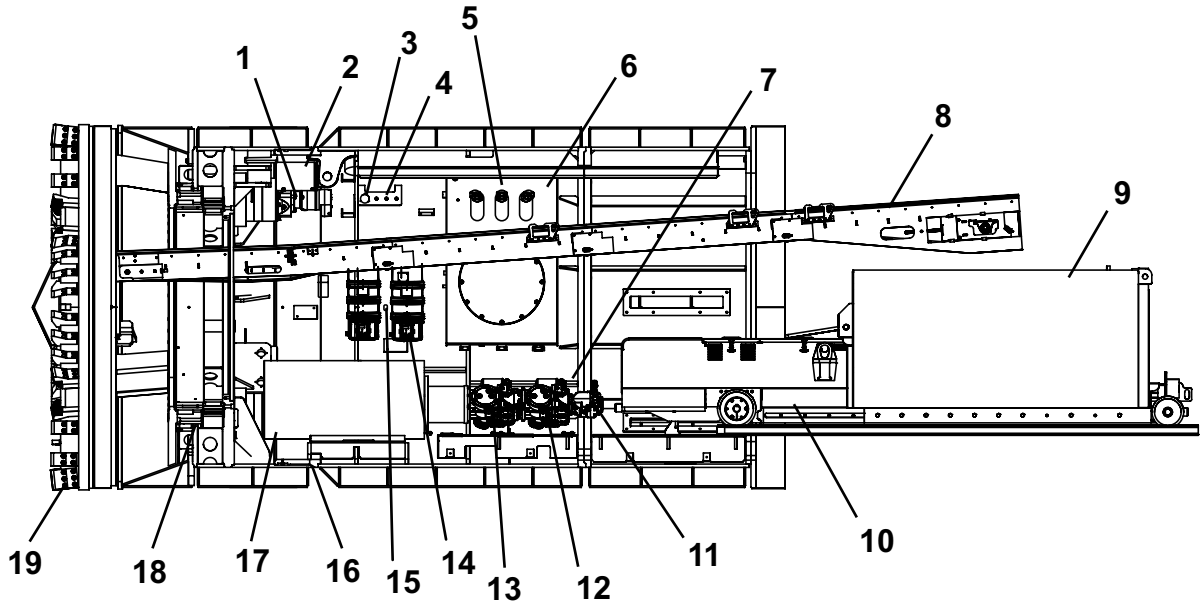
Earlier Models



Later Models

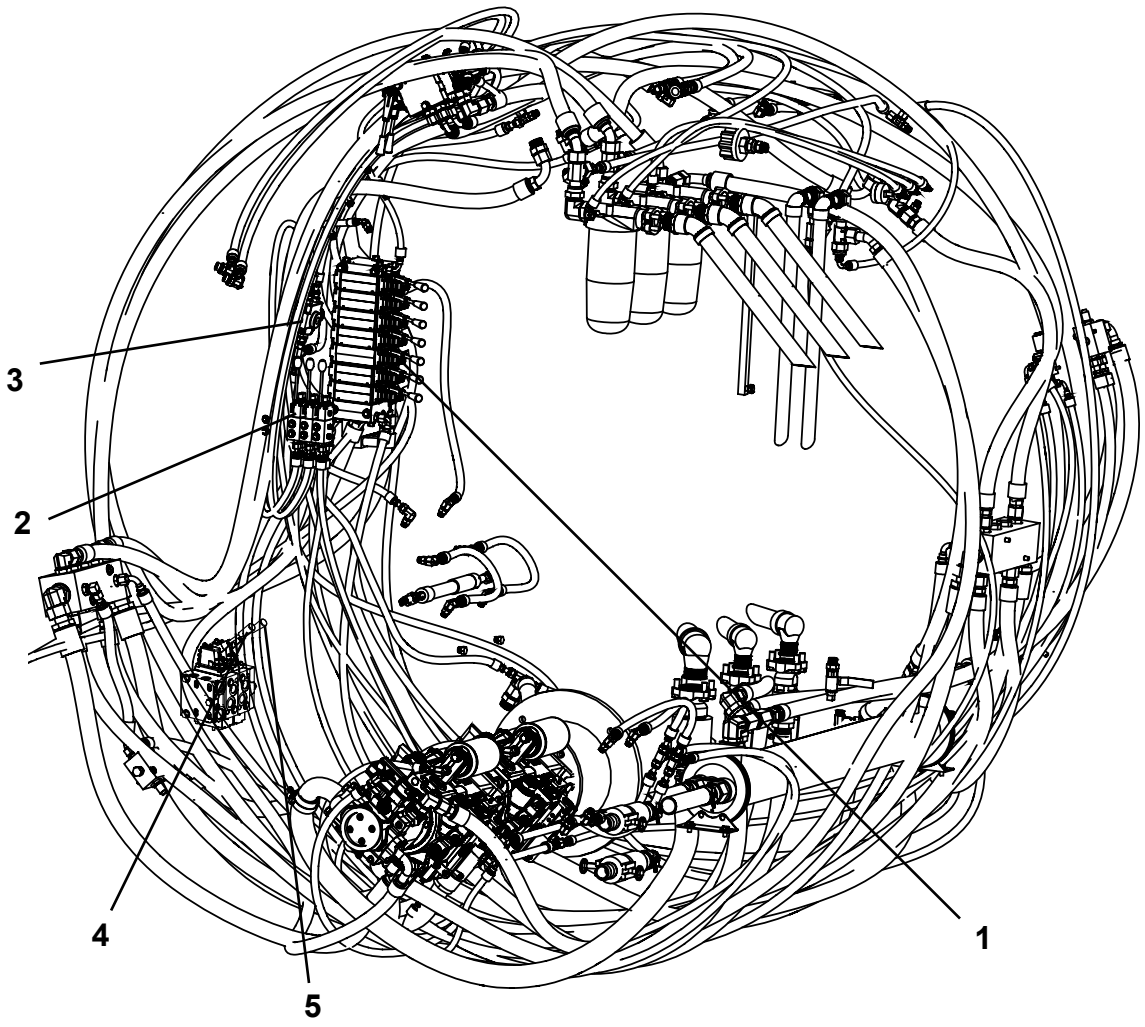
Terminology

840 TBM WITH ON-BOARD POWER PACK



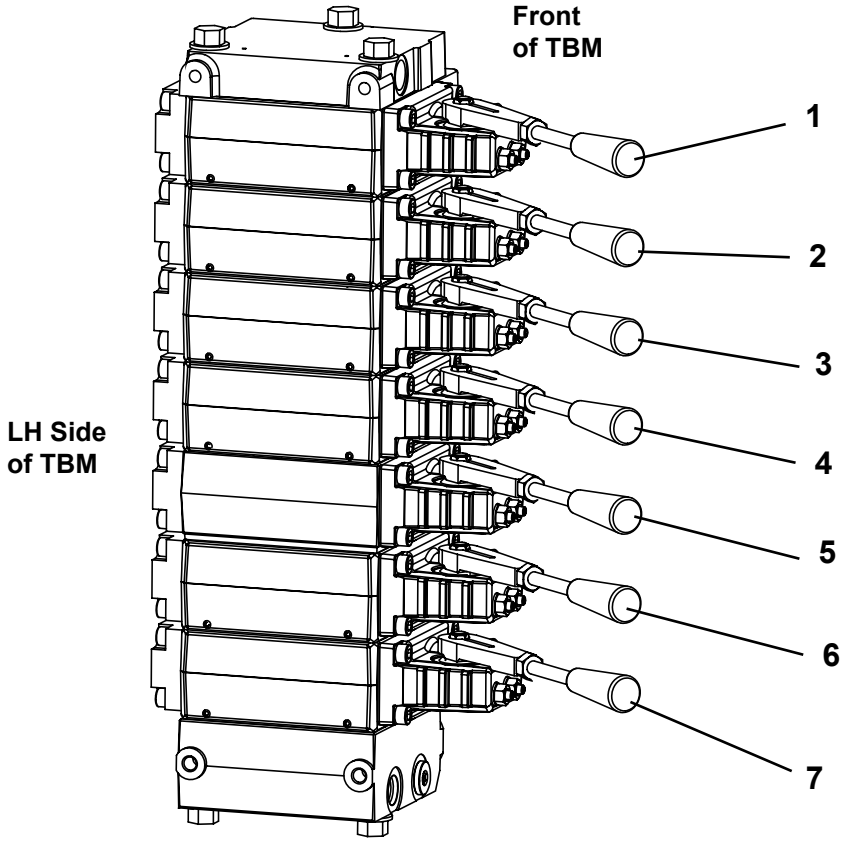
1. Drive Motors
2. Steering Cylinder
3. Bearing Lube Pressure Gauge
4. Return Filter Indicators
5. Return Filters
6. Power Pack Hydraulic Reservoir
7. Oil Cooler
8. Belt Conveyor
9. Dirt Bucket
10. 1548 Haul Unit
11. Load Sense Pump (Steering, Dirt Wings, Closed Face, Screw Conveyor Gate)
12. Main Drive Hydrostatic Pump #2 (Cutterhead)
13. Main Drive Hydrostatic Pump #1 (Cutterhead)
14. Grease System Containers
15. Grease Filter
16. Steering Joint
17. Electric Motor 300 HP
18. Cutterhead Bearing/Seals
19. Cutterhead

OPERATOR CONTROLS

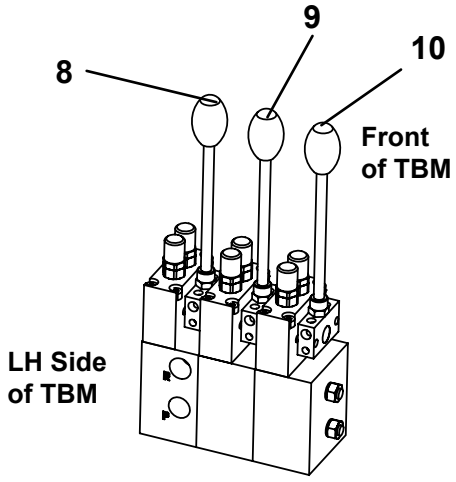


1. TBM Control Valve
2. Conveyor/Jacking Can/Boring Head Controls
3. Boring Head Speed Control
4. Conveyor Control
5. Jacking Control

TBM CONTROL VALVES

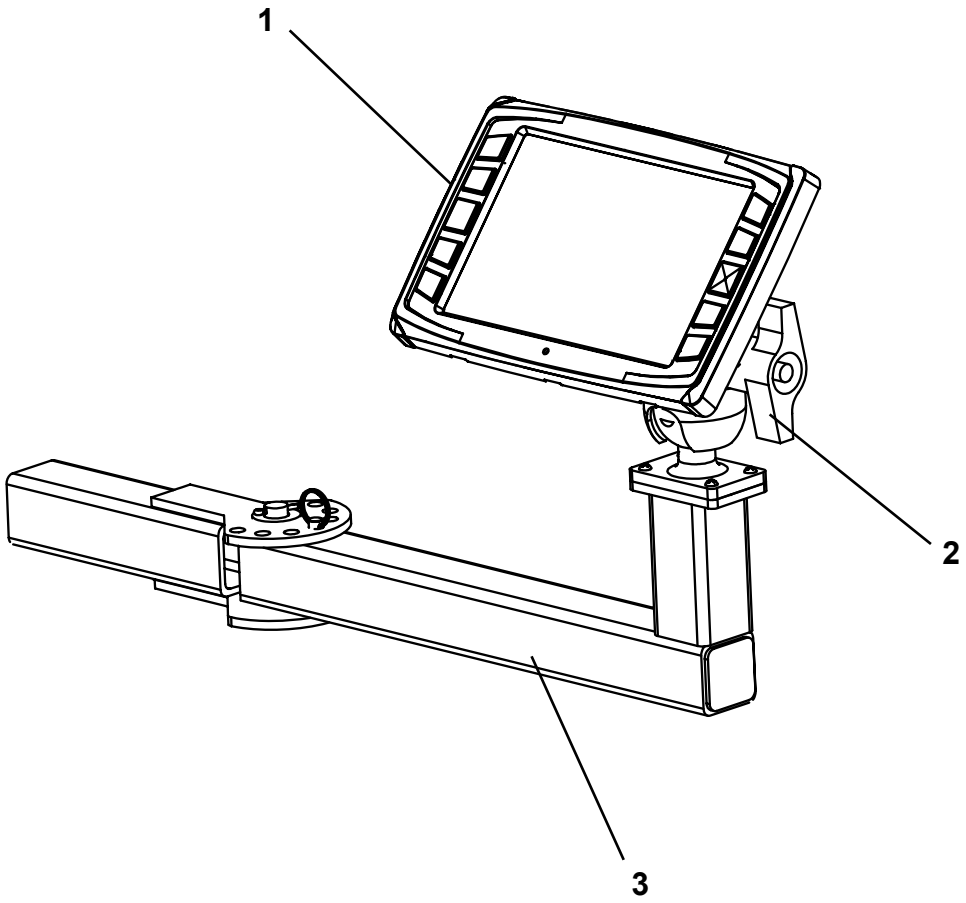


1. Closed Face or Screw Gate
2. Steering - Left
3. Steering - Top
4. Steering - Right
5. Conveyor Lift
6. Dirt Wing
7. Dirt Wing (840 TBM SN1 only) /Auxiliary (840 TBM SN2 only)



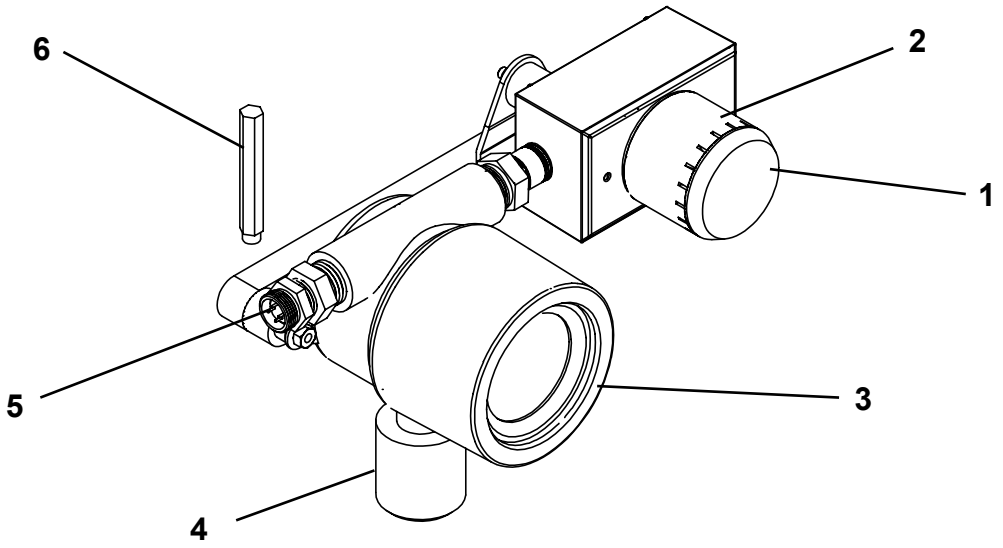
8. Conveyor Drive
9. Jacking Can Cylinders
10. Boring Head Control

CONTROL MONITOR



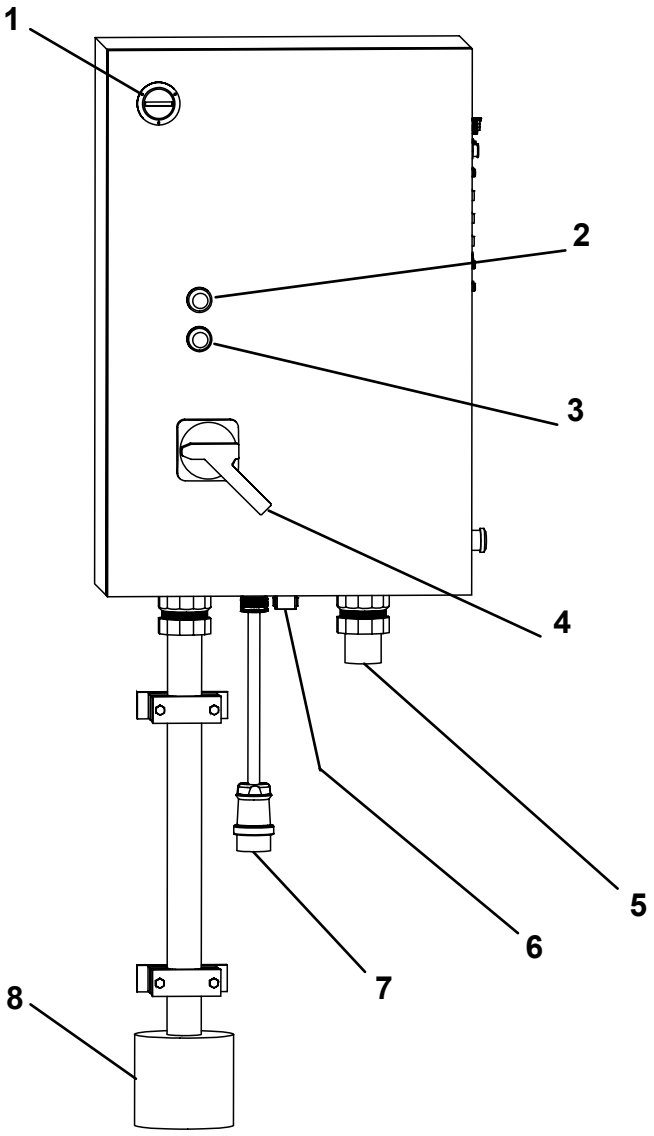
1. Monitor
2. Monitor Mount
3. Adjustable Monitor Stand

GAS DETECTION SYSTEM (GDS GASMAX II OR BUCKEYE BFT-44)



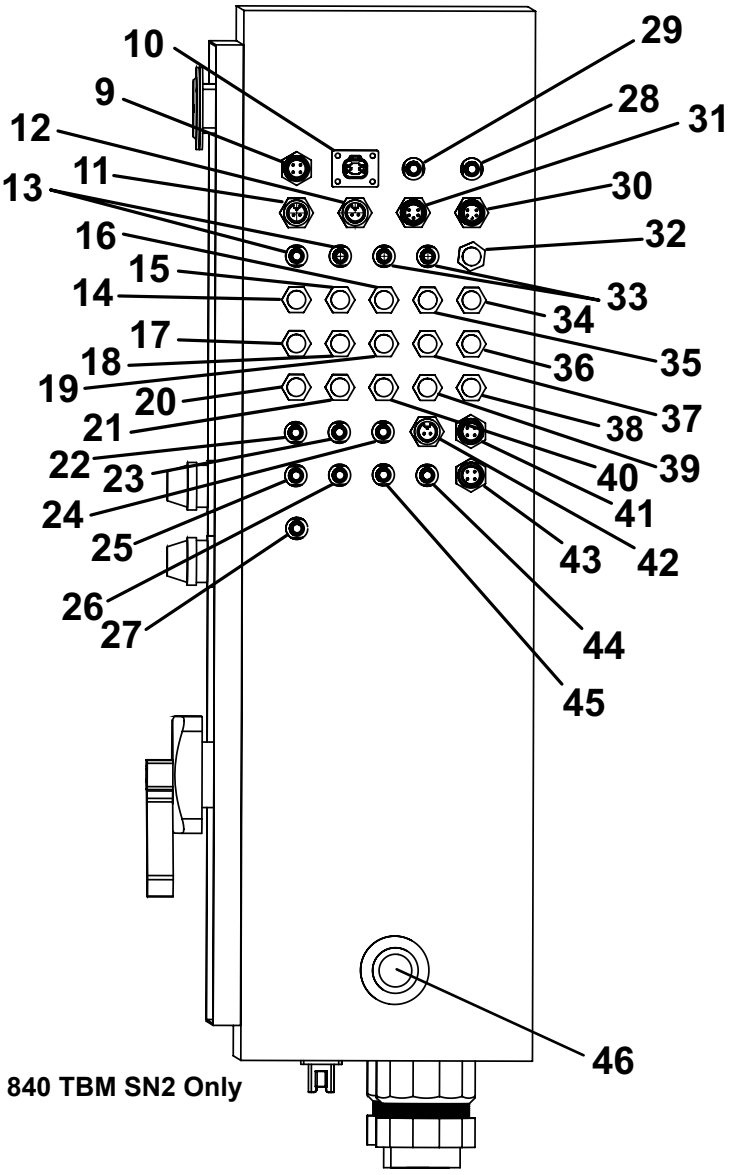
1. Strobe Light
2. Horn
3. Transmitter/Relay
4. Sensor Element
5. Cable Connection From TBM Electrical Box
6. Magnetic Wand

TBM ELECTRICAL BOX



1. Hour meter
2. Head Power ON Indicator
3. Boring Head Power ON Indicator
4. Main Power Disconnect
5. Power To 300 HP Motor
6. Display Monitor Harness (840 TBM SN2 only)
7. Head Power 30 AMP From Pit Box
8. TBM Power In From Pit Box

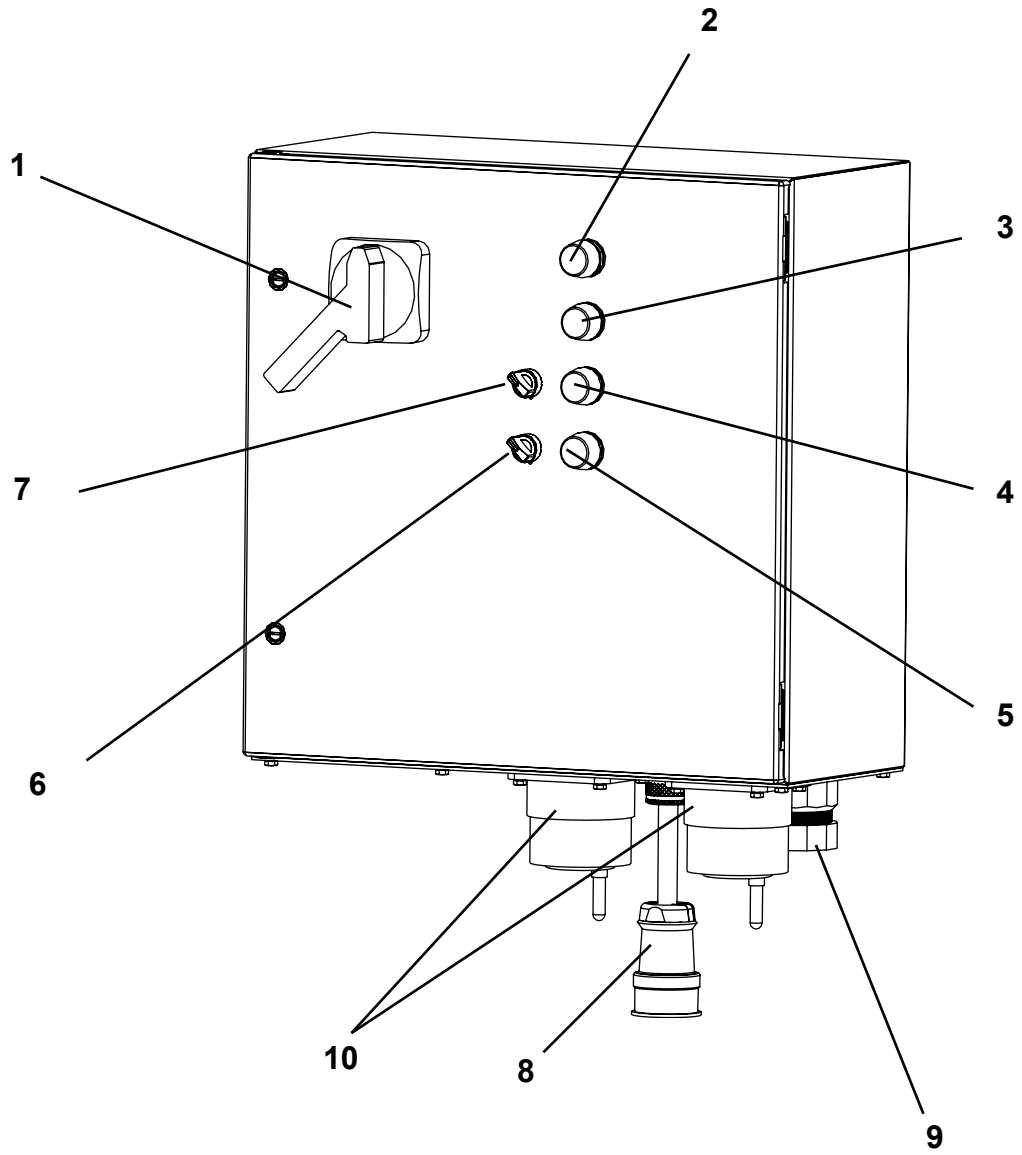
(continued on next page)



840 TBM SN2 Only

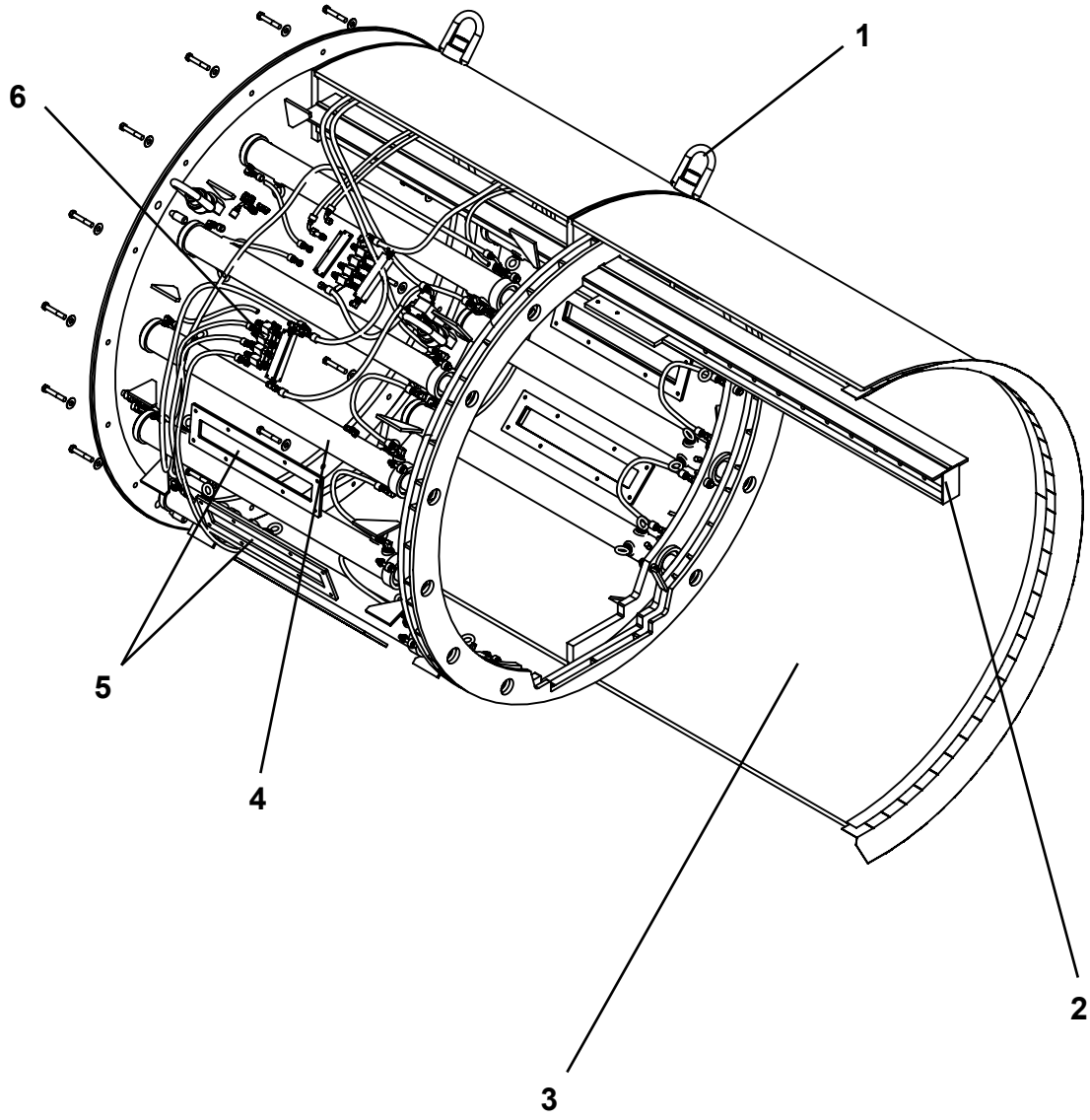
9. Bearing Oil Pump
10. Screw Speed
11. Grease Pump #1
12. Grease Pump #2
13. Front Lights
14. Top Steer Pressure
15. Right Steer Pressure
16. Left Steer Pressure
17. Screw Gate/Cut Face Pressure/ Screw Conveyor Speed Sensor
18. Dirt Wing #2 Pressure
19. Dirt Wing #1 Pressure
20. Cutter Head Speed
21. Hydraulic Oil Low
22. Right Steer Position
23. Top Steer Position
24. Left Steer Position
25. Earth Pressure Screw
26. Earth Pressure #2
27. Roll Inclinometer
28. Dump Valve #2 PSI Switch
29. Dump Valve #1 PSI Switch
30. Dump Valve #2
31. Dump Valve #1
32. Jacking Pressure
33. Rear Lights
34. Cutter CW Pressure
35. Cutter CCW Pressure
36. Conveyor Reverse Pressure
37. Conveyor Forward Pressure
38. Load Sense Pressure
39. Grease Pressure
40. Hydraulic Temperature
41. Gas Detector Sensor
42. Conveyor Safety Switch
43. Transformer Box
44. Load Sense Dump Valve
45. Earth Pressure #1
46. E-Stop Switch

PIT BOX



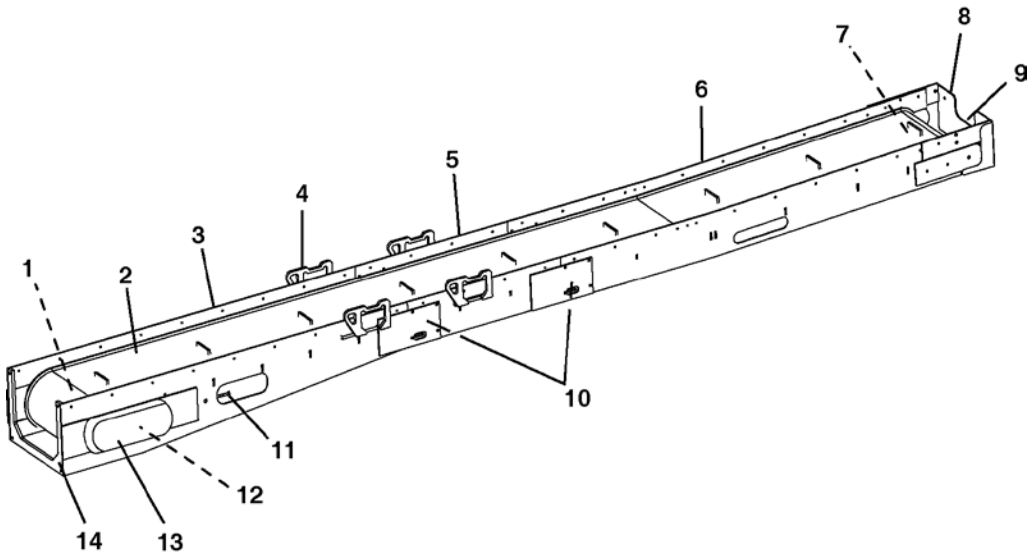
1. Main Power Disconnect
2. Phase Power OK (Green)
3. Phase Power Error (Red)
4. Boring Head Power ON Indicator
5. Head Power ON Indicator
6. Head Power ON/OFF Switch
7. Boring Head ON/OFF Switch
8. Power To TBM Electrical Box
9. Power From Power Source (Generator)
10. To TBM Power

JACKING CAN



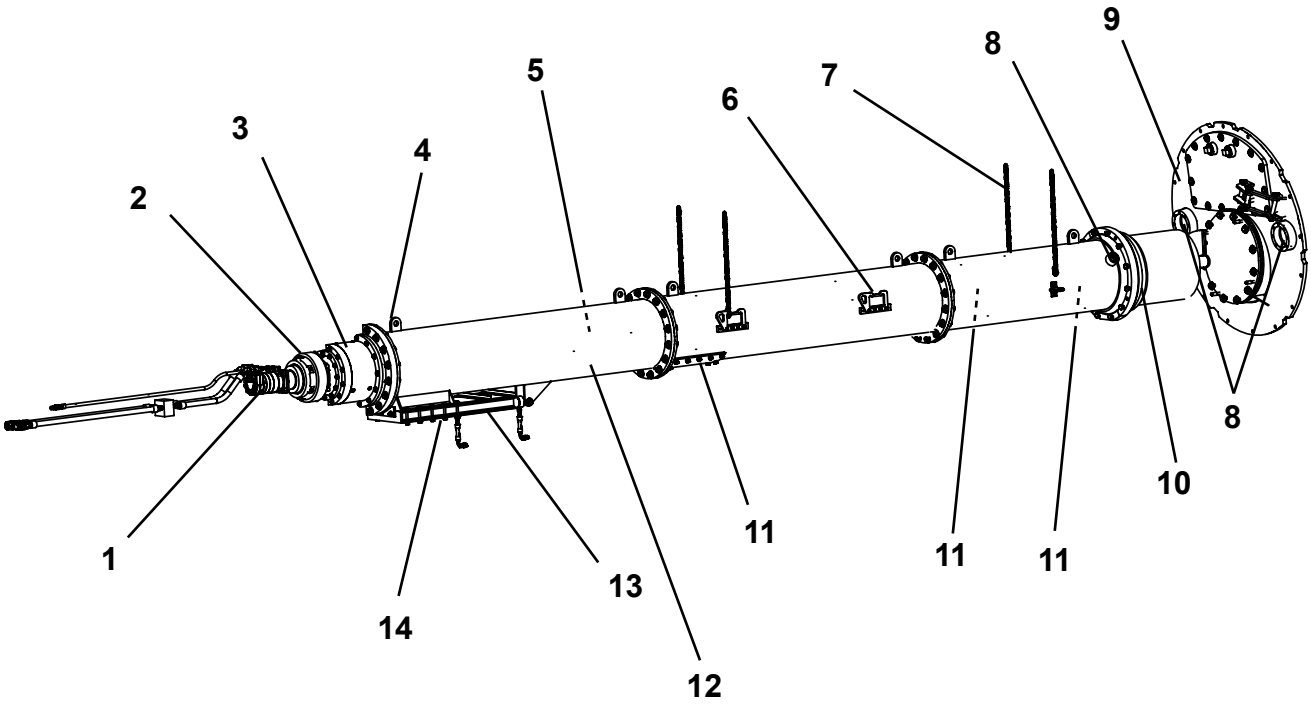
1. Lift Eye
2. Conveyor Support
3. Liner Plate / Ring, Beam & Lagging Building Area
4. Jacking Thrust Cylinders
5. Dirt Wings
6. Jacking Can Hydraulics

CONVEYOR - BELT



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 (not shown)

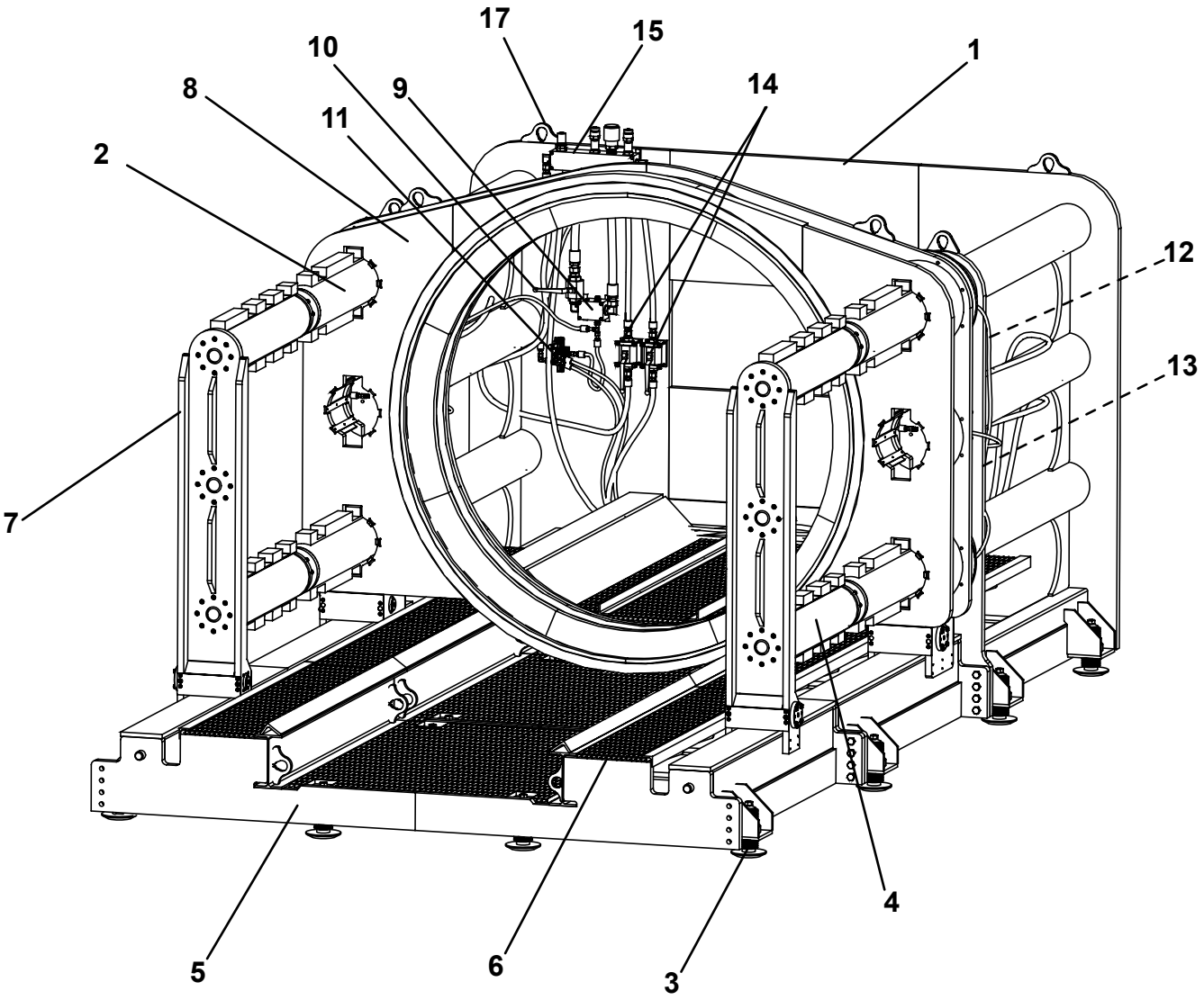
CONVEYOR - SCREW



1. Hydraulic Motor
2. Gear Box
3. Bearing
4. Lift Eye
5. Auger
6. Lift D Ring
7. Lifting Chain
8. EPB Sensor
9. Bulkhead
10. Swivel Collar
11. Access Doors
12. Auger Casing
13. Gate Cylinder
14. Gate Rail

KEYHOLE JACKING FRAMES

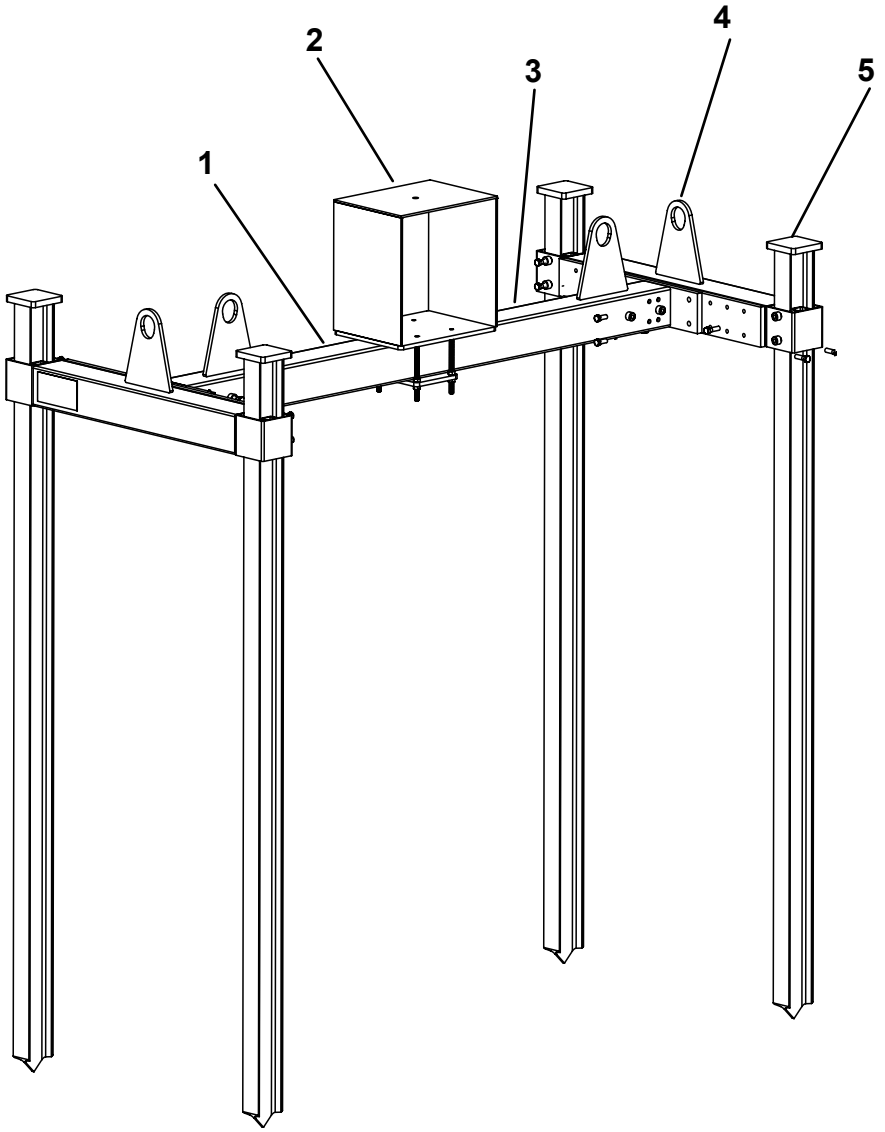
Model 960JF Shown



1. Reaction Wall
2. Keyhole Cylinder
3. Leveling Screw
4. Cylinder Extension
5. Skid Assembly
6. Skid Riser
7. Cylinder Support
8. Thrust Block
9. Hi Flow Return Manifold
10. Hi Flow Return Control Valve
11. Winch and Auxilliary Control Valve
12. Extend Pressure Manifold (2)
13. Retract Pressure Manifold (2)
14. Cylinder Syncing Valves
15. Hydraulic Manifold
16. Hydraulic Winch*
17. Lift Eye

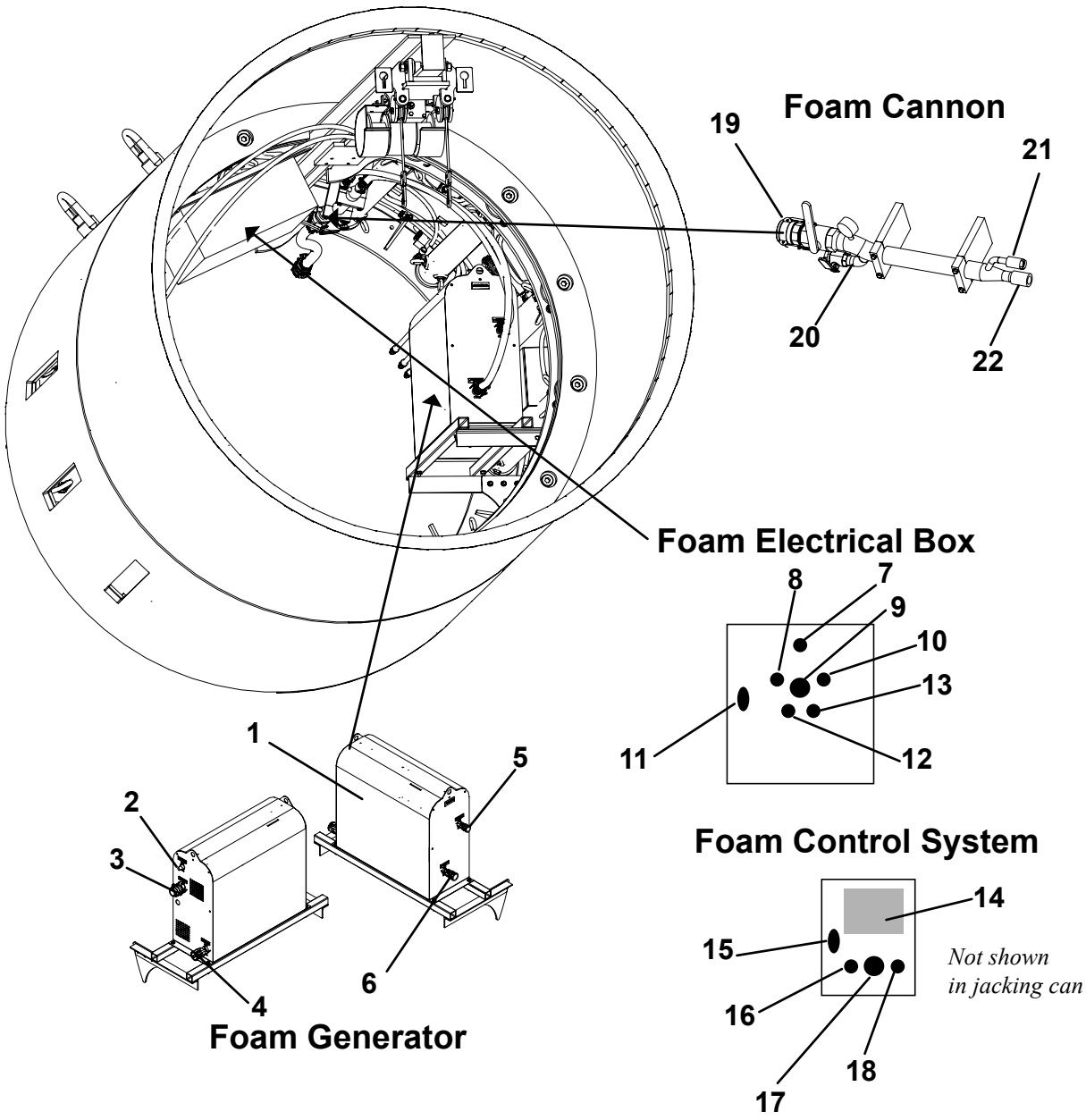
* Not shown

LASER LIGHT STAND



1. Adjustable Frame
2. Laser Box Assembly
3. Sliding Tube
4. Lift Bracket
5. Long Stake

FOAM GENERATION SYSTEM

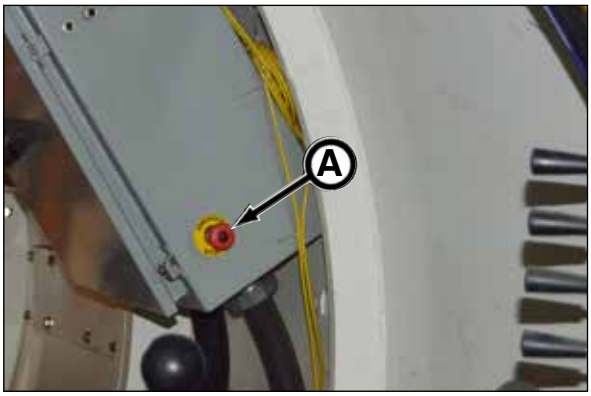


1. Foam Generator - PVC Protective Panels
2. Foam Generator - Foam Inlet
3. Foam Generator - Air Inlet
4. Foam Generator - Water Inlet
5. Foam Generator - Air Outlet
6. Foam Generator - Foam Solution Outlet
7. Foam Electrical Box - Power On
8. Foam Electrical Box - General Stop
9. Foam Electrical Box - E-Stop
10. Foam Electrical Box - Safety Reset
11. Foam Electrical Box - Lock
12. Foam Electrical Box - Flow Off
13. Foam Electrical Box - Flow On
14. Foam Control System - Monitor
15. Foam Control System - Lock
16. Foam Control System - General Stop
17. Foam Control System - E-Stop
18. Foam Control System - Safety Reset
19. Foam Cannon - Outlet to Manifold
20. Foam Cannon - Sample Port
21. Foam Cannon - Air Inlet
22. Foam Cannon - Liquid Inlet

Controls & Instruments

EMERGENCY STOP

E-Stop on TBM Control Panel
The control panel Emergency Stop button (A) will stop the electrical motor rotation and hydraulic power.

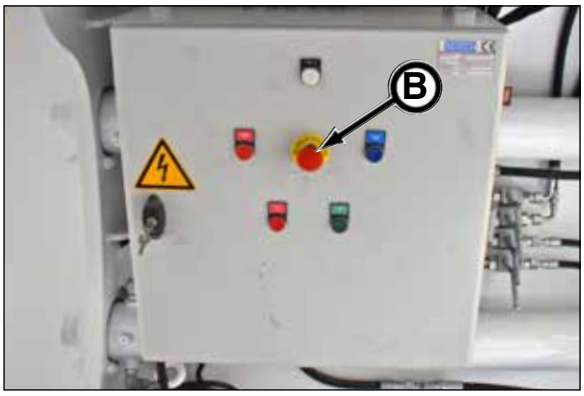


Push the Emergency Stop button IN to stop all TBM power circuts.

Pull the button OUT to start TBM power circuits. The button will illuminiate when it is pulled OUT.

NOTICE This Emergency Stop button will not stop the power from the power source (generator). The power source (generator) must be equipped with an E-Stop.

E-Stop on Foam Electrical Box
The Foam Electrical Box Emergency Stop button (B) will stop electrical power to the foam generation system.



Push the Emergency Stop button IN to stop all Foam Generation System functions.

Pull the button OUT to start the foam generation system functions.

NOTICE This Emergency Stop button will shut down the Foam Generation System power only. It DOES NOT shut down tunnel power circuits.

E-Stop on Foam Control Box
The Foam Control Box Emergency Stop button (C) will stop electrical power to the foam generation system.

Push the Emergency Stop button IN to stop all Foam Generation System functions.

Pull the button OUT to start the foam generation system functions.

NOTICE This Emergency Stop button will shut down the Foam Generation System power only. It DOES NOT shut down tunnel power circuits.

POWER PHASE INDICATORS

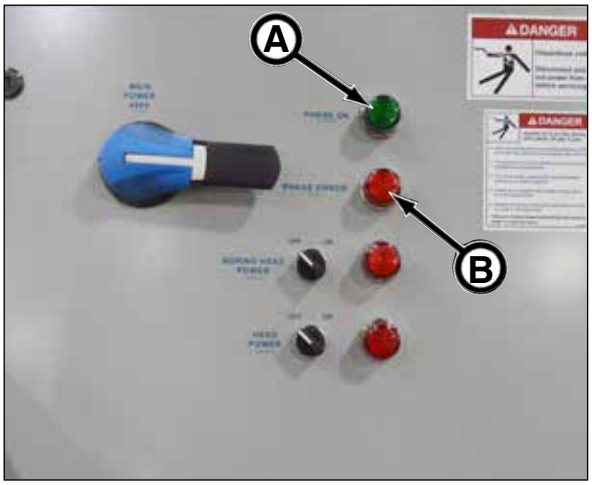
The input power on the power pack is monitored for proper three phase electrical power. The green Phase OK indicator must be illuminated before operating equipment.

⚠DANGER Failure to lockout power before servicing will cause severe personal injury or death.

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

Any electrical work completed on the power pack must be performed by a certified electrician.

IMPORTANT: If the red Phase Error indicator is illuminated, the power pack starting is disabled. This starting interlock will prevent the components from running backwards which would result in damage.



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

If the green Phase OK indicator (A) is illuminated, this indicates that the external power source phase power is installed correctly and the main power can be turned on.

If the red Phase Error indicator (B) is illuminated, this indicates that the external power source is installed incorrectly. Lockout tagout all power before disconnecting power lead cables. Have a certified electrician reverse the two generator electrical phase conductors on the power circuit and recheck phase power.

MAIN POWER DISCONNECT SWITCH

⚠DANGER Hazardous voltage. Disconnect and lockout tagout power from source before servicing.

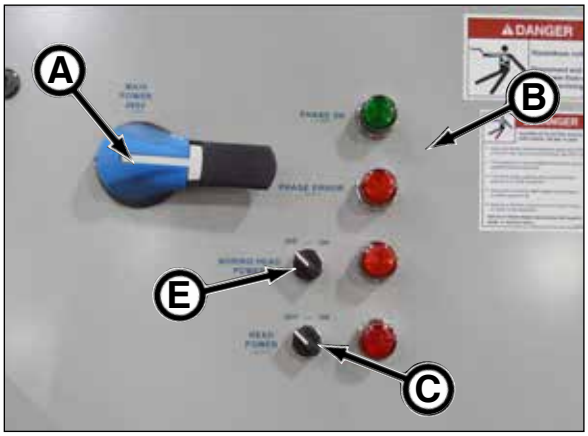
⚠DANGER If high voltage cables or cable connections are damaged, contact with cables/ connections will result in electrical shock causing severe injury or death. Disconnect and lockout/ tagout power from source before servicing.

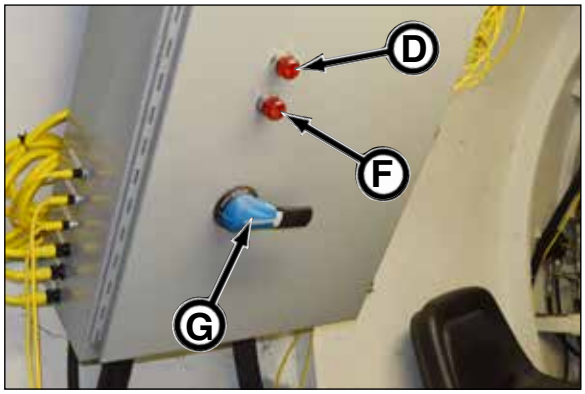
⚠WARNING Any electrical work performed on the electrical components must be completed by a certified electrician.

NOTICE All Emergency Stop buttons must be pulled out to restart operation.

Use the main power disconnect switch (A) to allow electrical power from an external power source to the TBM electrical components (lights, gas detector, monitor, conveyor safety valve circuit). This will also supply hydraulic oil to the cutterhead, conveyor, bearing lubrication pump, steering, seal grease pump and jacking can components.

1. Turn on external power source and check Power Phase Indicators (B) for proper phase (refer to Power Phase Indicators in this section).
2. With proper phase power, flip main power disconnect switch (A) to the ON position.
3. Turn Head Power switch (C) to the ON position. The Head power ON indicator (D) will illuminate on the TBM electrical box when power is energized from the pit box.
4. Turn Boring Head Power switch (E) to the ON position to provide power to the TBM cutterhead circuit. The Boring Head power ON indicator (F) will illuminate on the TBM electrical box when power is energized from the pit box.
5. Turn Boring Head Power main disconnect (G) in the TBM to the ON position to power the cutterhead.





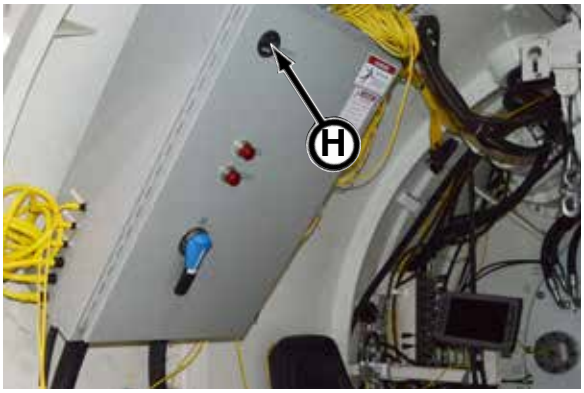
TBM 840 SN1 Shown

HOUR METER

A hour meter (H) is installed on the control panel to help determine proper maintenance intervals.

The hour meter displays the operating hours in full hours and 1/10ths hours of the motor and should be used as a guide for scheduling periodic maintenance.

Time accumulates when electrical motor is running.

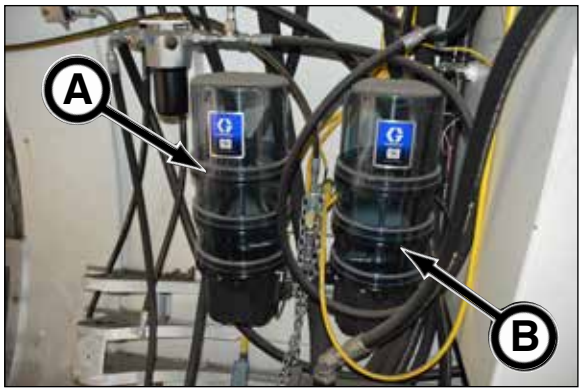


TBM 840 SN1 Shown

GREASE PUMP SYSTEM

The grease pumps lubricate the bearing cavity dirt/lip seals to prevent dirt from entering the bearing cavity. The grease pumps will automatically cycle when the cutterhead is rotating.

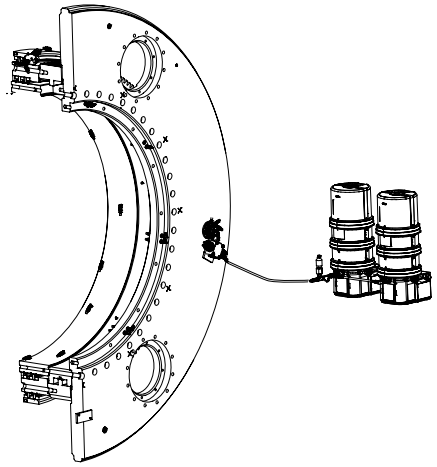
IMPORTANT: NEVER operate TBM without pumping grease to the bearing cavity dirt/lip seals. Doing so will introduce contamination in the bearing cavity resulting in seal, seal surface and bearing damage.



There are two grease pumps installed in the TBM; Grease System 1 (A) and Grease System 2 (B). They are equipped with translucent containers to easily inspect the grease level.

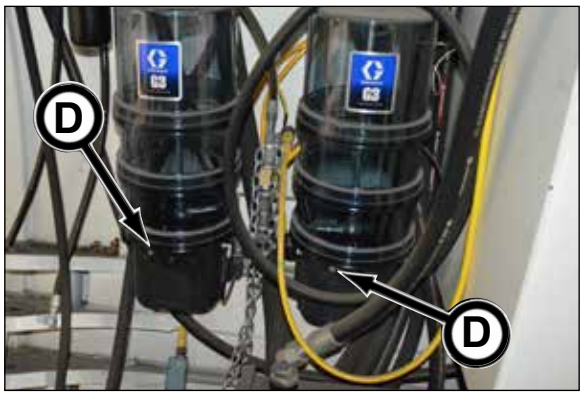
The two grease pumps are indicated on the control screen Pump 1+2 (C) and cycle as follows:

- **Cutterhead operation > 4.5 rpm**
  Both grease pumps operate continuously
- **Cutterhead operation = 3.5 - 4.5 rpm**
  One grease pump in continuous operation every 15 minutes, one cycles on and off every one minute, then they alternate functions
- **Cutterhead operation < 3.5 rpm**
  One grease pump operates continuously, then alternates with the other grease pump every 15 minutes



IMPORTANT: Check the grease containers daily to be sure there is ample amount of grease in the grease containers for the day.

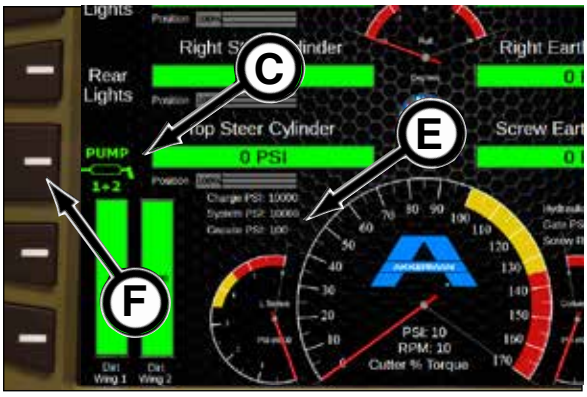
Fill the grease containers with Mobil® SHC 101 EAL Grease or equivalent through the grease pump fill ports (D) until the grease container is full.



Check the boring grease pressure gauge (E) for any indication that the pump is either not working properly, the in-line filter is plugged, or a grease line is clogged. If there is no or low pressure on the gauge, the reservoir is out of grease or the pump is not operating. The operator MUST press the grease pump button (F) to switch the operation to the other grease pump/container. **NEVER operate TBM without pumping grease to the bearing cavity dirt/lip seals.**

Boring Grease Pressure (E)
If the cutterhead is rotating, the boring grease pressure gauge displays minimal pressure (for example, 150 psi).

- If the grease in-line filter is plugged or a grease line is clogged, the pressure will display a much higher pressure. The High Grease Pressure alarm message will appear on the control screen.
- If there is no pressure on the gauge, the reservoir is out of grease or the pump is not operating. The Low Grease Pressure alarm message will appear on the control screen.
- The operator MUST press the grease pump button (F) to switch the operation to the other grease pump/container.



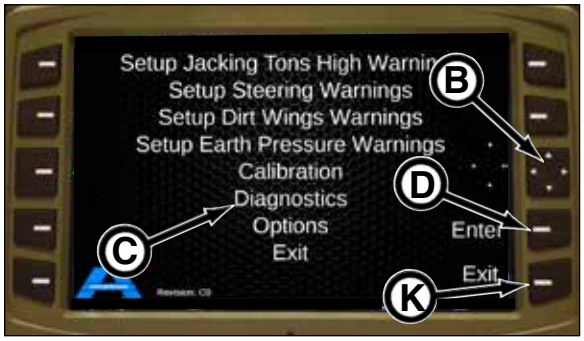
(continued on next page)

For testing grease pump operation or purging grease from bearing seals at the end of each drive, a momentary switch is provided for each grease pump to temporarily turn the pump on and off.

1. With the TBM energized with full power, press Menu button (A) on the main screen.

2. Using the up or down arrow on four-way directional button (B), select Diagnostics (C).

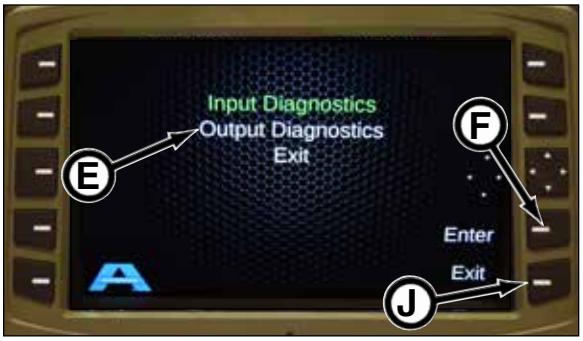
3. Press Enter button (D).



4. The diagnostic window appears.

5. Use the up or down arrow on four-way directional button to select the Output Diagnostics (E) option. The selected will be highlighted in green.

6. Press Enter button (F) to view output diagnostics screen.



7. To operate grease pump 1, press Run Grease Pump 1 button (G). This is a momentary switch, therefore as soon as you release the button the pump will stop.

8. To operate grease pump 2, press Run Grease Pump 2 button (H). This is a momentary switch therefore as soon as you release the button the pump will stop.

9. Press Exit button (I) to return to the diagnostics screen.

10. Press Exit button (J) to return to the menu screen.

11. Press Exit button (K) to return to the control screen.

BEARING CAVITY LUBE SYSTEM

The bearing cavity lube pump (A) circulates the oil through the bearing cavity circuit.

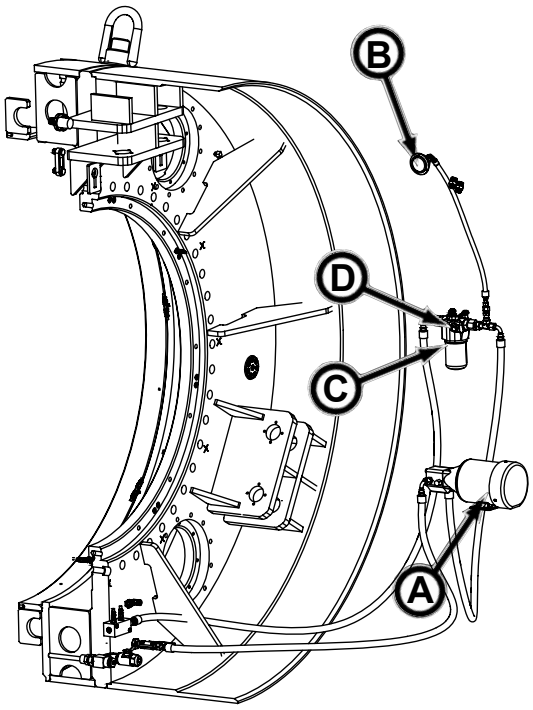
The bearing lube pump automatically recirculates (when the cutterhead rotates) oil through the bearing, the bearing cavity, the pump, filter, bearing oil manifold and then back through the bearing etc.

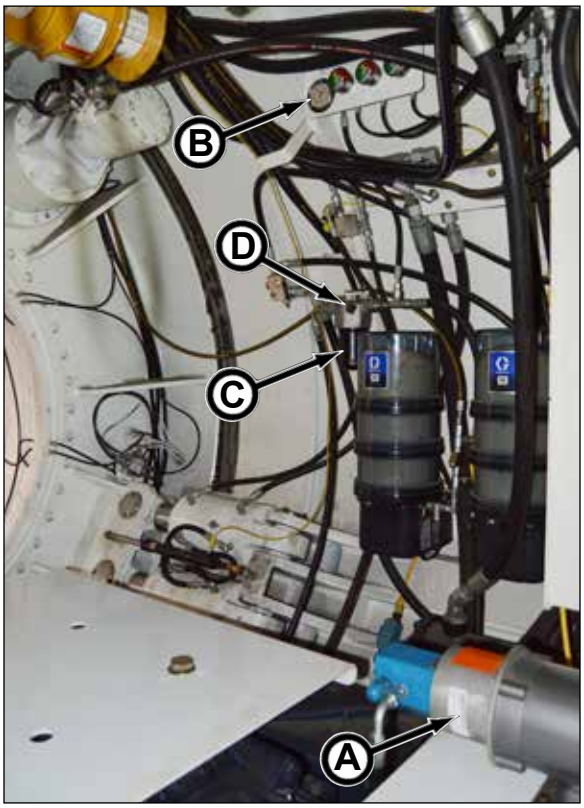
NOTICE Check the bearing lube pressure gauge (B) to be sure the pump is operating properly. If there is no pressure, the lubrication system must be checked for proper operation before continuing to operate.

If the cutterhead is rotating, the bearing lube pressure gauge will display a maximum pressure of 500 psi. A reading of 500 psi indicates that the oil is cold or the bearing lube filter is dirty.

To prevent under or over servicing of the bearing cavity oil lube filter (C) and a filter indicator (D) is installed on the filter head assembly. A red band will appear on the filter indicator when the filter requires replacement. (refer to 12. Check Bearing Cavity Oil Filter in section 9, Periodic Maintenance, Prior To Each Drive Launch).

(continued on next page)





For testing lube pump operation or circulating lubricant through the bearing cavity circuit without rotating the cutterhead, a momentary switch is provided for the bearing lube pump to temporarily turn the pump on and off.

1. With the TBM energized with full power, press Menu button (A) on the main screen.

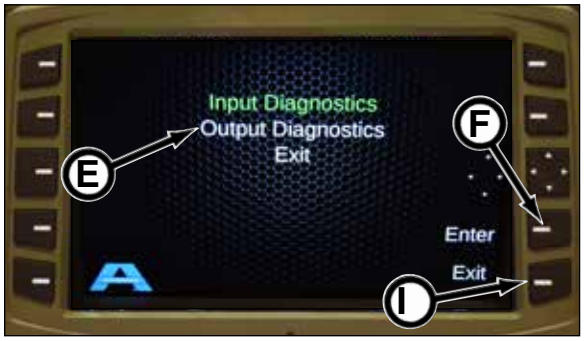
2. Using the up or down arrow on four-way directional button (B), select Diagnostics (C).

3. Press Enter button (D).

4. The diagnostic window appears.

5. Use the up or down arrow on four-way directional button to select the Output Diagnostics (E). The selected will be highlighted in green.

6. Press Enter button (F) to view output diagnostics screen.



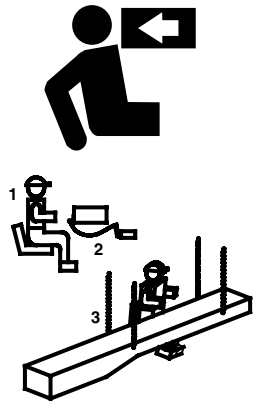
7. To operate bearing lube pump, press Run Bearing Lube Pump button (G). This is a momentary switch, therefore as soon as you release the button the pump will stop.

8. Press Exit button (H) to return to the diagnostics screen.

9. Press Exit button (I) to return to the menu screen.

10. Press Exit button (J) to return to the control screen.

CONVEYOR SAFETY SWITCH (VALVE)



⚠WARNING Conveyor can jam in rotating cutterhead causing conveyor to swing into operator, resulting in severe personal injury.

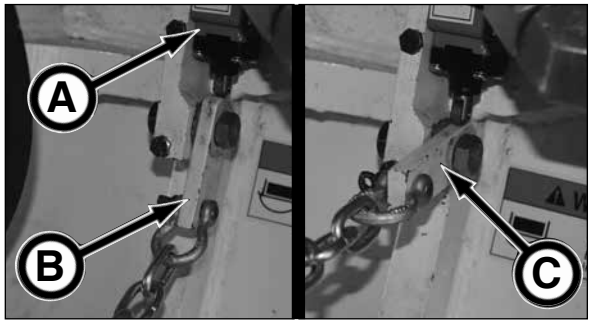
1. The conveyor safety valve (cutterhead drive dump valve) MUST be tethered to conveyor and the operation MUST be tested before starting the conveyor to insure proper operation.
2. ALL FOUR safety chains MUST be secured to conveyor.
3. Operator MUST remain seated in normal operating position.

The conveyor safety switch will trip when the conveyor is pulled by excessive conveyor movement. When the conveyor safety switch trips, the cutterhead stops rotating.

A tethered chain is connected to the conveyor safety switch and to the conveyor.

To reset the conveyor safety switch and to resume cutterhead rotation, flip the valve lever down to the operation position (B).

Location (C) indicates the valve lever in the tripped position.



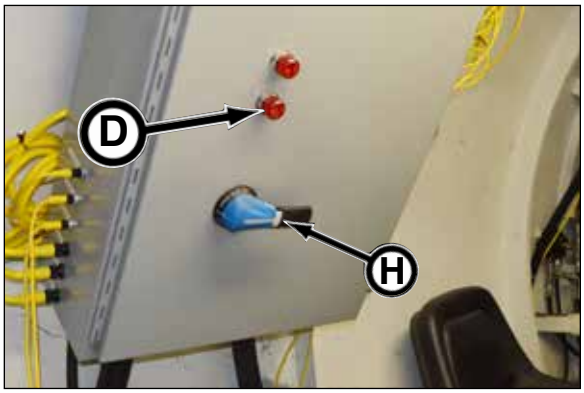
Operation Position *Tripped Position*

BORING HEAD POWER ON LIGHT

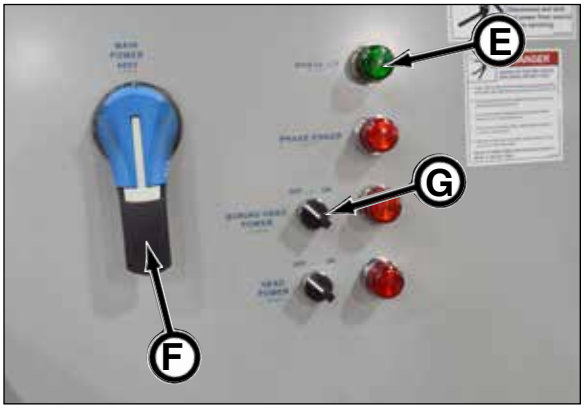
⚠WARNING Any electrical work performed on TBM or other equipment must be performed by a certified electrician.

The input power is monitored for proper three phase electrical power on the TBM pit box

If the Boring Head Power On light (D) is illuminated, this indicates that the external power source phase power is installed correctly (E), the pit box main power disconnect switch (F) is ON and the Boring Head Power switch (G) is ON providing cutterhead power to the TBM electrical box. The main disconnect switch (H) in the TBM can be flipped to the ON position provided it is verified with all tunneling personnel that it is safe to start the cutterhead.



TBM 840 SN1 Shown

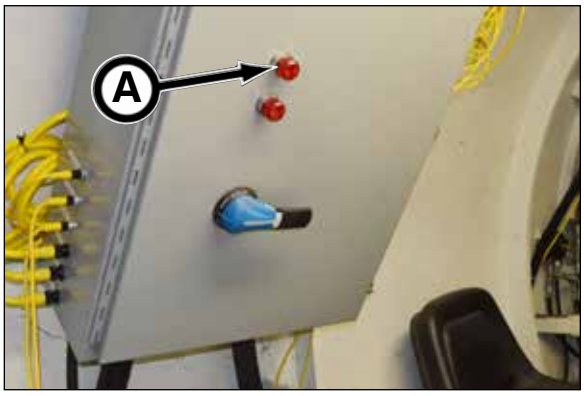


HEAD POWER ON LIGHT

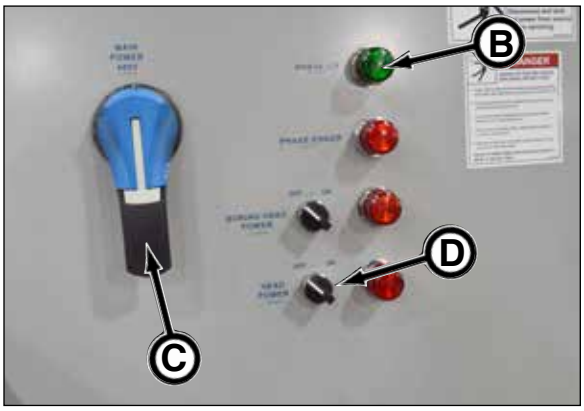
⚠WARNING Any electrical work performed on TBM or other equipment must be performed by a certified electrician.

The input power is monitored for proper three phase electrical power on the TBM pit box

If the Head Power On light (A) is illuminated, this indicates that the external power source phase power is installed correctly (B), the pit box main power disconnect switch (C) is ON and the Head Power switch (D) is ON providing power to the TBM components (lights, steering, dirt wings, auxiliary and conveyor functions)



TBM 840 SN1 Shown



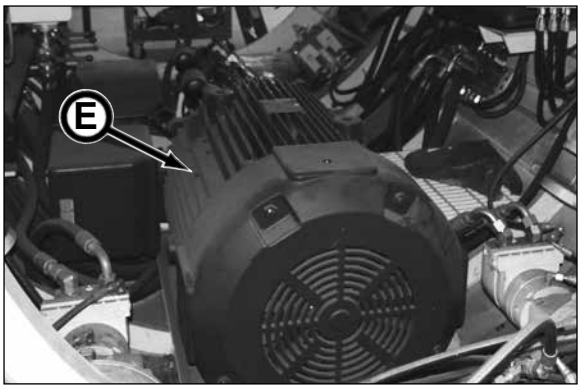
300 HP MOTOR ON/OFF CONTROL

The 300 HP main motor (E) operates the three hydraulic pumps which provides hydraulic power to the TBM cutterhead and head power components.

Control the motor as follows:

To start the motor:
Press button (F). The Start Pump wording (G) will turn green.

To stop the motor:
Press button (F) again. The Start Pump wording (G) will turn white.



GAS DETECTION SYSTEM

The gas detection system includes the following primary components; the gas sensor, and transmitter/ relay. The Akkerman system also provides a power supply for the system, and an audible and visual alarm system.

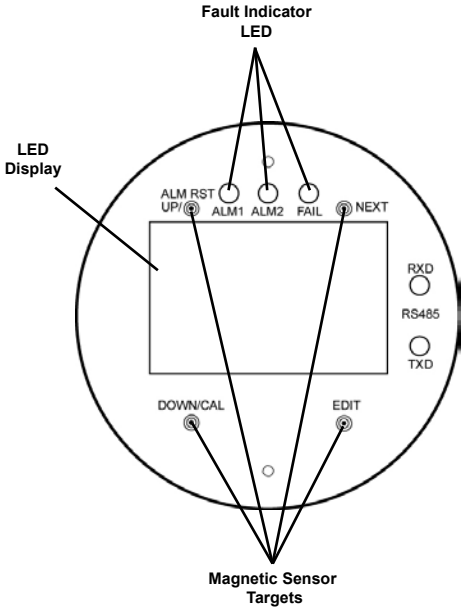
NOTICE Refer to your Gas Detector User manual or the Akkerman Gas Detection System Operation & Parts Manual for operation and maintenance procedures.

⚠DANGER The gas detection system installed in the TBM, monitors only methane gas levels. **Monitoring of all gas levels is the responsibility of the contractor.** This includes the accumulation of combustible and toxic gases, and depletion of oxygen. The contractor must keep the tunnel ventilated with fresh air.

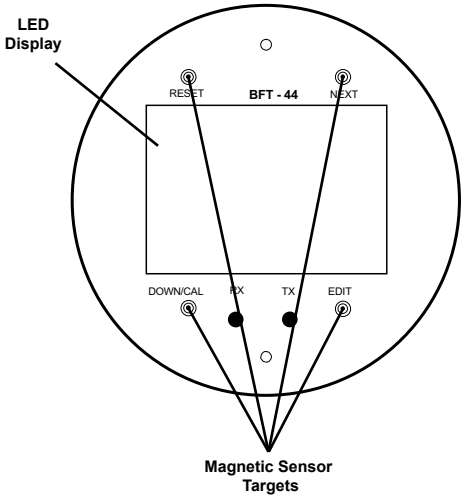
The gas detection system includes the following primary components; the gas sensor, and transmitter/relay. The Akkerman system also provides a power supply for the system, and an audible and visual alarm system.

The transmitter has a LED/LCD display, depending upon the model of your gas detector. During normal operation, the current gas concentration is displayed. It is also used to display/scroll messages when in calibration mode or when a sensor fault is detected.

The four magnetic sensor controls are activated by a magnetic wand. Holding the magnetic wand over one of the magnetic sensor targets will activate that sensor. It may take several seconds for the magnetic sensor to activate. If the transmitter does not respond, remove the magnetic wand for several seconds and try again.



Earlier Models - GDS GasMax II Transmitter Display



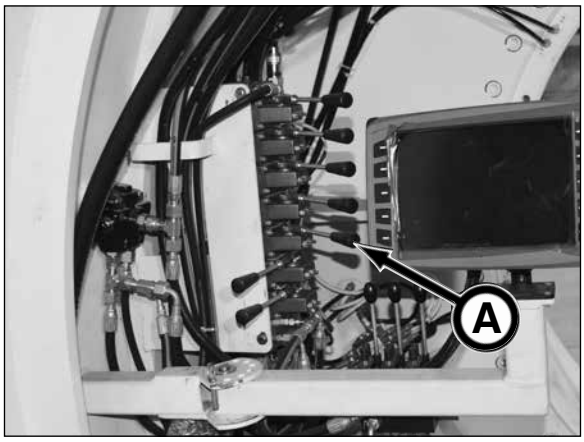
Later Models - Buckeye Gas Detector Transmitter Display

CONVEYOR CONTROLS

Conveyor Lift

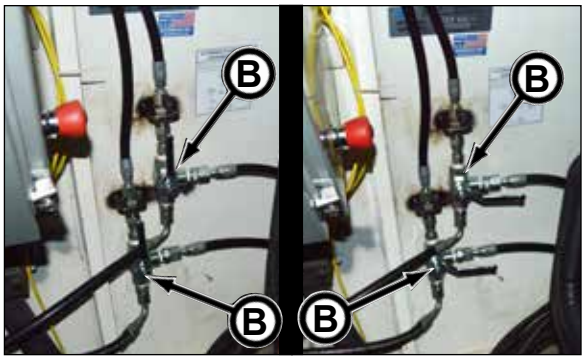
The conveyor lift control (A) on the TBM control valve raises or lowers the conveyor. Move the control lever as follows:

LEFT - raises conveyor
RIGHT - lowers conveyor



NOTICE Do not over-raise the conveyor. If conveyor is completely raised when the steering cylinders are retracted, damage will result to conveyor and/or conveyor cables.

When using the conveyor lift control, both ball valves (B) MUST be in the same position for the conveyor lift to operate.



Ball Valves Positioned For Front Conveyor Lift Operation

Ball Valves Positioned For Rear Conveyor Lift Operation

Conveyor Drive & Speed Control

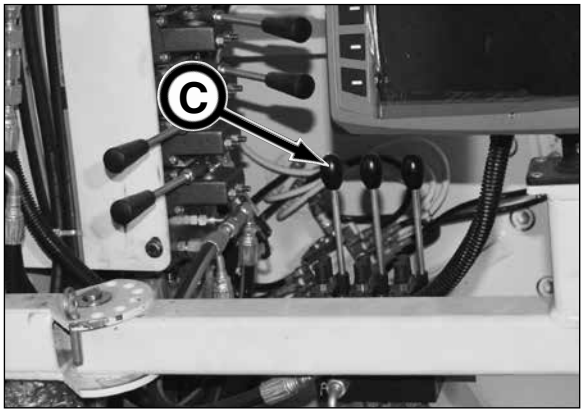
The conveyor drive lever (C) controls the forward/ reverse direction and speed of the belt or screw conveyor.

The further the lever is moved from neutral, the faster the conveyor belt or screw 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:

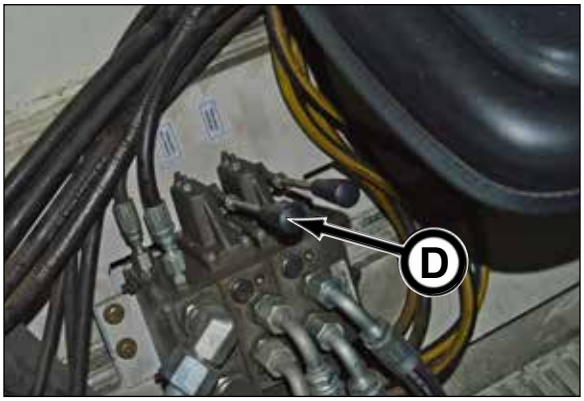
PUSH - towards reception shaft (CW)*
PULL - towards launch shaft (CCW)*

** as viewed from the operator seat.*



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

An additional manual conveyor drive lever (D) control is located by the operator seat.



⚠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.

BORING HEAD CONTROL

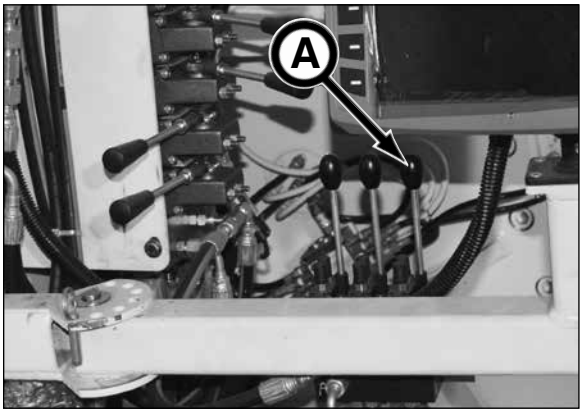
The Boring Head Control lever (A) controls the cutterhead rotation. Move the lever as follows:

Push - forward (CW rotation*) direction
Pull - reverse (CCW rotation*) direction

* as viewed from operator seat, inside TBM

NOTICE Verify the control direction before mining.

The further the lever is moved from neutral, the faster the cutterhead will rotate. The lever is a spring centered control, therefore when control is released the control will move to neutral.



BORING MOTOR SPEED CONTROL

The Boring Motor Speed Control lever (B) controls the speed and torque of the boring head two speed drive motors. Operating pressure is 5,000 psi. Move the lever as follows:

Forward (IN) - Low speed, high torque (LSHT)
Back (OUT) - High speed, low torque (HSLT)

Speed @ 120 GPM

LSHT.....3.3 rpm
HSLT.....5.0 rpm

Torque - Continuous

LSHT ..... 270,000 ft-lb
HSLT ..... 180,000 ft-lb

Torque - Peak

LSHT ..... 450,000 ft-lb
HSLT ..... 300,000 ft-lb

STEERING CONTROLS

The steering cylinder control levers (A, B, C) on the TBM control valve regulate the movement of the steering cylinders.

When steering corrections are necessary, be sure to **make ONLY minor adjustments over several feet**. Making more extreme steering adjustments will increase the jacking forces due to the front and trailing sections are not in parallel.

At initial start up, the steering cylinders should all be set at the 50% cylinder extension position:

- **840: 6 in. (152 mm)**

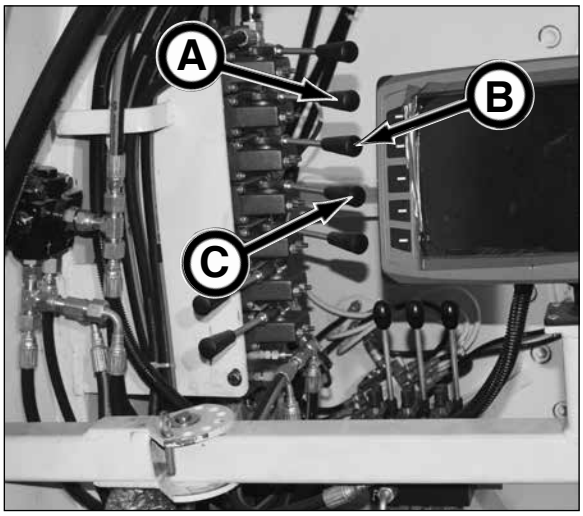
Move steering cylinders as follows:

Steer UP
Extend the left (A) and right (C) cylinders the same amount or retract the top (B) cylinder(s).

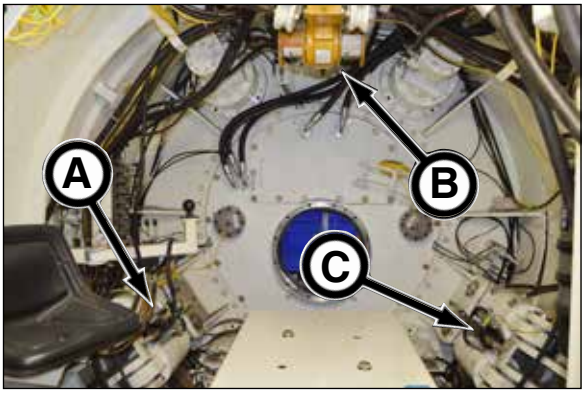
Steer DOWN
Extend the top (B) cylinders or retract the left (A) and right (C) cylinders the same amount.

Steer LEFT
Extend the right (C) and retract the left (A) cylinders the same amount or;
Extend the right (C) cylinder(s) and then extend the top (B) cylinder(s) half the amount of the right cylinder(s).

Steer RIGHT
Extend the left (A) and retract the right (C) cylinders the same amount or;
Extend the left (A) cylinder(s) and then extend the top cylinder(s) (B) half the amount of the left cylinder(s).



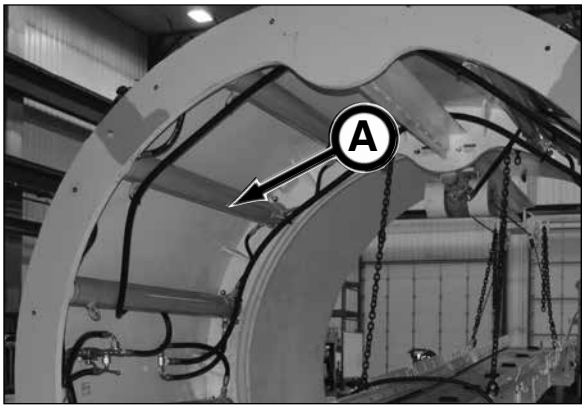
Steering Cylinder/Control - Left (A)
Steering Cylinder/Control - Top (B)
Steering Cylinder/Control - Right (C)



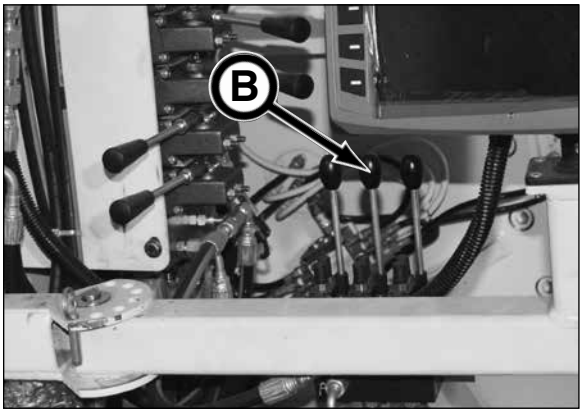
PRESSURE METERS
The Steering PSI meters show the active pressure in the cylinders.

System Pressure (Load Sense) (D)
Steering Cylinder Pressure - Left (E)
Steering Cylinder Pressure - Top (F)
Steering Cylinder Pressure - Right (G)

JACKING CAN CYLINDER CONTROL



The TBM and tunnel can be advanced through the ground by extending the hydraulic jacking/liner can jacking cylinders (A) against the liner plates or other tunnel liner that are assembled in the jacking/liner can or shaft.



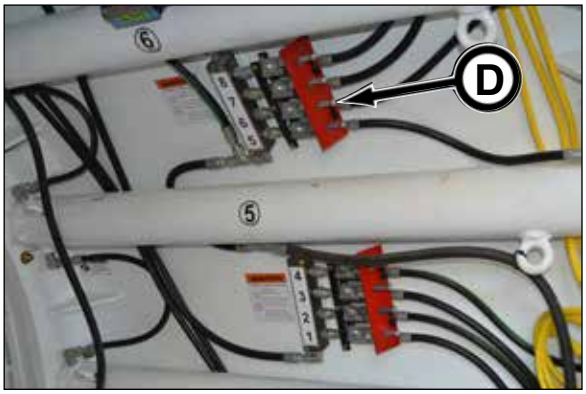
The jacking cylinders in the jacking/liner are controlled by jacking can cylinder control lever (B). This control is equipped with a friction detent, so the lever will remain in the desired position until the control is moved back to neutral position.

Move the control lever as follows:

FORWARD - extends jacking can cylinders

BACK - retracts jacking can cylinders

An additional manual jacking can cylinder lever (C) control is located by the operator seat.



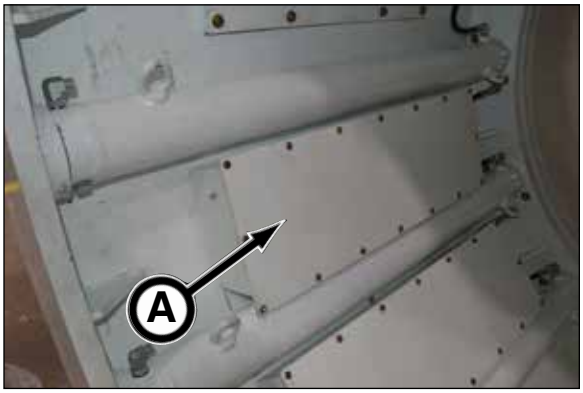
⚠WARNING If using segment lining controls (D), use ONLY with segmented rings.

DO NOT use the segment lining controls with the one piece thrust ring.

Doing so may cause severe injury or death and component damage.

TORQUE/DIRT WING CONTROL

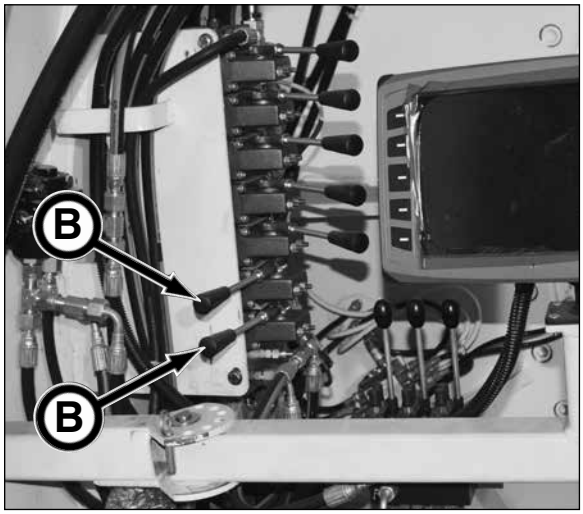
The torque/dirt wings (A) are used to control the TBM roll. If the TBM rolls 1/4 to 1/2 in. (6.35 to 12.7 mm) from level, the torque wings or dirt wings need to be extended.



There are various dirt wing configurations available for installation on the TBM. Contact your Akkerman Aftermarket Support representative for more information.

Torque wings are straight (non-directional) fins that help stabilize the TBM roll by holding the position of the TBM. If the TBM roll is excessive, extend the torque wings and if necessary, change the direction of the cutterhead rotation as needed to control the roll.

Dirt wings are directional (CW or CCW) fins to help control the roll without the need to change the cutterhead rotation.



Extend Torque/Dirt Wings (B)
Move control lever (B) LEFT until the torque/dirt wings are fully extended. The torque/dirt wings are fully extended when the system pressure reads 5,000 psi.

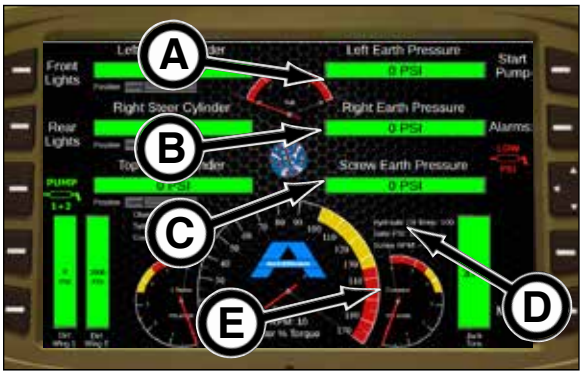
Retract Torque/Dirt Wings (B)
Move control lever (B) RIGHT until torque/dirt wings are fully retracted.

Use the torque wings/dirt wings as needed until the TBM roll is back to level position.

The dirt wing pressure (C) is displayed on the monitor. This system is capable of 2,800 to 3,000 psi.

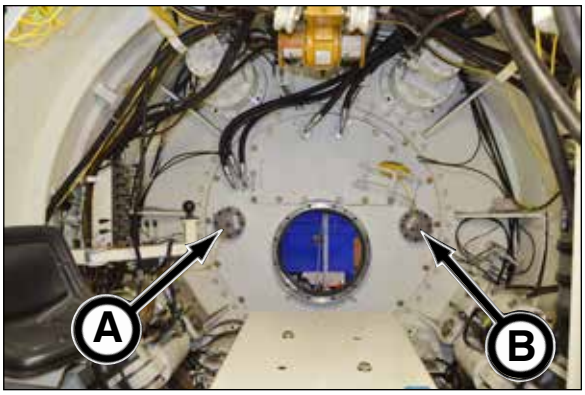
EARTH PRESSURE SENSORS

To retain the earth pressure as recorded on the Geotechnical report while mining, the operator manually adjusts the machine advance rate or the spoil removal rate (screw conveyor) to keep the earth pressure in the acceptable range. The face pressure must be maintained to prevent over and under mining.



IMPORTANT: While retaining earth pressure, **DO NOT exceed 15 psi.** Doing so will cause damage to the TBM seals.

The control monitor displays the earth pressure at the front bulkhead and at the front of the screw conveyor.

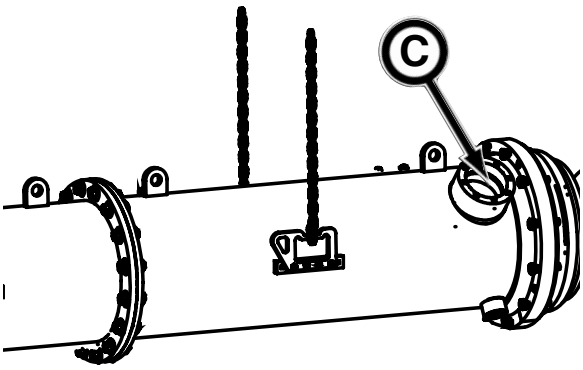


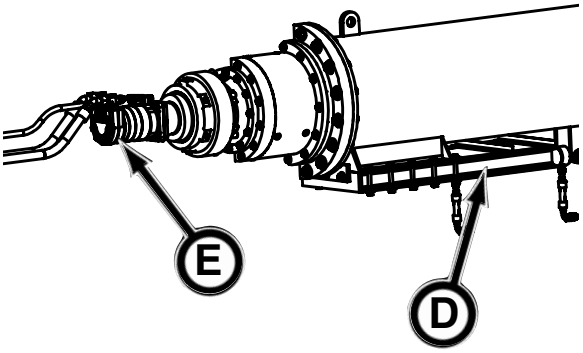
TBM
The Left Earth Pressure (A) and Right Earth Pressure (B) displays the left and right bulkhead earth pressure sensor readings of the pressure transducers.

Screw Conveyor
The Screw Earth Pressure (C) and Gate PSI (cylinder) (D) and screw drive pressure gauge (E) display the readings of the screw conveyor pressure transducers.Screw conveyor rpm is indicated on the control monitor.

The three EPB sensors are rated at 14.5 psi (1 bar).

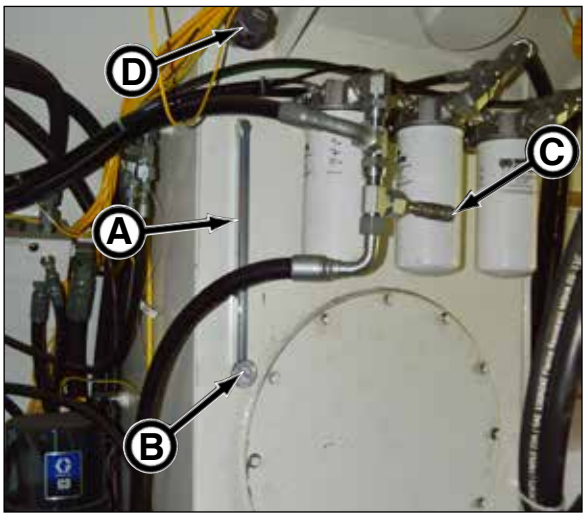
A - Left Earth Pressure Sensor/Gauge
B - Right Earth Pressure Sensor/Gauge
C - Screw Earth Pressure Sensor/Gauge
D - Screw Conveyor Gate (Cyl) Pressure
E - Screw Conveyor Drive Pressure





HYDRAULIC OIL RESERVOIR

The hydraulic reservoir includes an oil level sight gauge (A) and temperature gauge (B).



The reservoir capacity is 120 gal. (454 L).

Filling oil reservoir:

1. Clean area around fitting cap (C). Remove cap.
2. Attach external fill pump (hand or electric pump) with male end quick coupler P0100-089.
3. Clean area around breather (D). Remove breather while filling for proper venting.
4. Fill reservoir with clean, fresh, **FILTERED** ISO-VG-68 Premium Hydraulic/Turbine Oil or equivalent to full mark on gauge. Filling reservoir with unfiltered oil will cause component damage.

NOTICE If you change to a different oil, use a reputable oil supplier to meet or exceed the ISO-VG-68 or DIN 51524-3 (HVLP) or ISO 11158-HV oil specification. Do not mix oil manufacturers or grades.

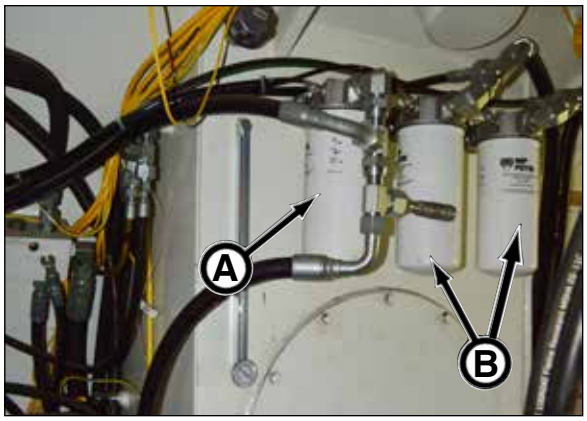
5. Remove external fill pump.
6. Replace breather and fitting cap.

The hydraulic oil reservoir is equipped with a low oil level sensor. When the oil level in the hydraulic oil reservoir reaches the low oil level sensor, the hydraulic power will shut down to prevent damage to components.

The oil reservoir temperature is also displayed at the control monitor on the Hyd Temp F gauge (E).

The hydraulic oil reservoir is also equipped with a high temperature sensor. When the oil temperature in the hydraulic oil reservoir reaches 150°F (66°C), the hydraulic power will shut down.

RETURN FILTER INDICATORS

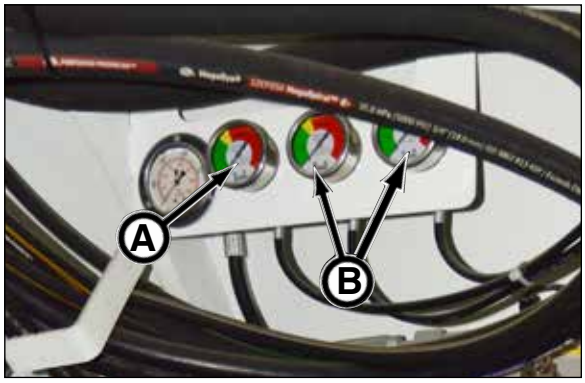


To prevent under or over servicing of the hydraulic filter elements, filter indicators are installed on the hydraulic return circuit.

Return Filter Assemblies Filter Indicators: High Flow Return (A) & Pump 1 / Pump 2 (B)
The green OK zone indicates that the filters are functioning properly.

The yellow zone indicates that the filters will soon require replacement.

Replace filters when the needle on the gauge is in the red CHANGE zone.



NOTICE The red indicator may display at initial start-up until the oil reaches normal operating temperature. If the needle continues to be in the red zone after reaching normal operating temperature, replace filters to prevent contamination.

CONTROL MONITOR

The control monitor displays critical tunneling data: steering cylinder pressure and position; earth pressure; jacking tons; dirt wing pressure; load sense pressure; grease pressure; screw gate/closed face pressure; hydraulic oil reservoir temperature; conveyor pressure; cutterhead pressure, rpm and percent of torque; TBM roll indicator; grease pump indicator, cutterhead rotation indicator; and active alarm messages.

In addition the control monitor is used to control the 300 HP motor and front and rear lights.
The control monitor allows the operator to:

- ***set visual alarm warnings on meters*** (Jacking Tons, Steering Cylinders, Dirt Wings and Earth Pressure Sensors) if certain conditions are met or exceeded.

- ***set calibration*** for steering cylinder positions and earth pressure sensors.

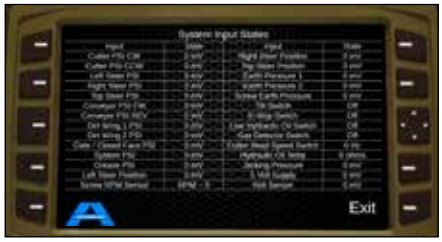
- ***view input and output diagnostics*** for troubleshooting.

- ***change screen options***:
  - control mode between TBM (open) and EPB (closed)
  - adjust the back-light level of the monitor screen
  - change background theme: gray, black, carbon or diamond plate

Steering Meter Alarm Setting Screen

Steering Calibration Setting Screen

Input Diagnostic Screen



Screen Options

(continued on next page)

I. ***Setting visual alarm warnings on meters***

Each meter warning (Jacking Tons, Steering Cylinders [pressure and extension], Dirt Wings [pressure] and Earth Pressure Sensors [minimum and maximum pressures) can be set with a colored visual alarm (A) if certain specifications are met or exceeded. This is helpful for the operator to be visually alerted to a operator set condition such as high jacking tons or high steering or earth pressures. Change the meter limits on the visual alarm as follows:

1. On the main screen, press Menu button (B).

2. Using the up or down arrow on four-way directional button (C), select one of the four alarm warning options. The selected warning will be highlighted in green.
   a. Setup Jacking Tons High Warnings
   b. Setup Steering Warnings
      - Steering PSI
      - Steering Extension
   c. Setup Dirt Wings Warnings
   d. Setup Earth Pressure Warnings

3. Press Enter button (D).

3. The alarm option window appears. Press Adjust button (E).

4. The selection will flash. Use the up or down arrow on four-way directional button to change the numeric value to the desired alarm setting.

5. Press Save (F) button to confirm new setting.

6. Press Exit button (G) to return to alarm option window.

7. If setting other alarms, repeat steps 2 through 6.

8. Press Exit button again to return to the main screen.

II. ***Setting calibration for steering cylinder positioning and earth pressure sensors***

IMPORTANT: Steering cylinder sensor calibration should ONLY be performed by an experienced tunneling technician under a controlled environment.

A. Calibrating Steering Cylinder Sensors

Linear transducer sensors should be calibrated before each drive. If the steering cylinders are repaired or replaced, calibration is required so the steering cylinder positions will be accurately monitored on the control monitor.

Calibrate the steering cylinder sensors as follows:

1. With the TBM energized with full power, press Menu button (A) on the main screen.

2. Using the up or down arrow on four-way directional button (B), select Calibration (C).

3. Press Enter button (D).

4. The calibration window appears.

IMPORTANT: Calibration should ONLY be performed by an experienced tunneling technician under a controlled environment.

Press Enter Steering button (E).

5. The steering cylinder calibration window appears.

6. Using the up or down arrow on four-way directional button, select the Left Steering 0% (F) option. The Left Steering % option will be highlighted in green.

7. Press Adjust button (G).

8. The selection will flash.

9. Calibrate the 0% position: fully retract the left steering cylinders. You will notice the steering cylinder pressure rise. Visually verify that both left steering cylinders are fully retracted. Once verified, press Set to Current Input button (H).

10. Press Save button (I) to confirm new setting.

(continued on next page)

11. Using the up or down arrow on four-way directional button, select the Left Steering 100% (A) option. The Left Steering 100% option will be highlighted in green.

12. Press Adjust button (B).

13. The selection will flash.

14. Calibrate the 100% position: fully extend the left steering cylinders. You will notice the steering cylinder pressure rise. Visually verify that both left steering cylinders are fully extended. Once verified, press Set to Current Input button (C).

15. Press Save button (D) to confirm new setting.

16. Repeat steps 4 through 15 for the right steering 0% (E) and 100% (F) calibration, and the top steering 0% (G) and 100% (H) calibration.

17. Press Exit button (I) to return to the calibration screen.

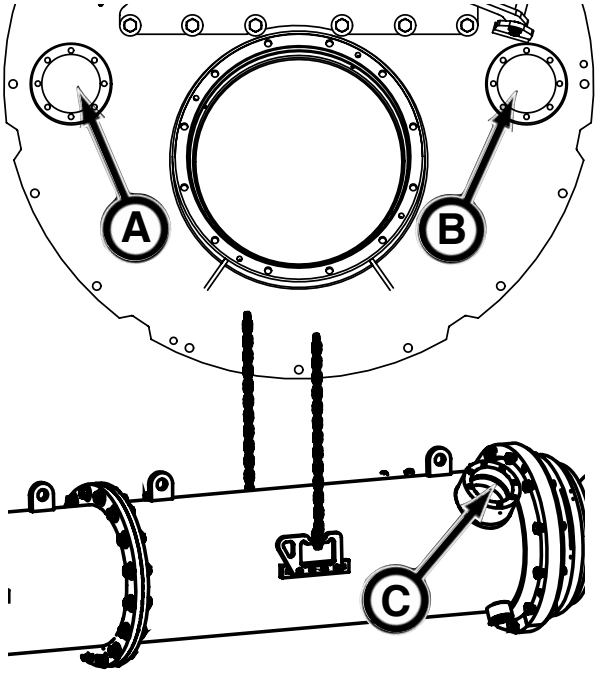
18. Press Exit button (J) to return to the main screen.

IMPORTANT: Earth pressure sensor calibration should ONLY be performed by a certified electrician and an experienced tunneling technician under a controlled environment.

B. Calibrating Earth Pressure Sensors

Earth pressure sensors: left (A), right (B) and screw (C) must be calibrated before each drive to ensure pressure accuracy. The earth pressure sensor calibration requires a special calibration fixture.

Do not attempt to calibrate the earth pressure sensors without an Akkerman technician.



SETTING STRAIN GAGE AMPLIFIER DIP SWITCHES

⚠WARNING Failure to lockout tagout power before resetting strain gage amplifier DIP switches can cause severe personal injury or death.

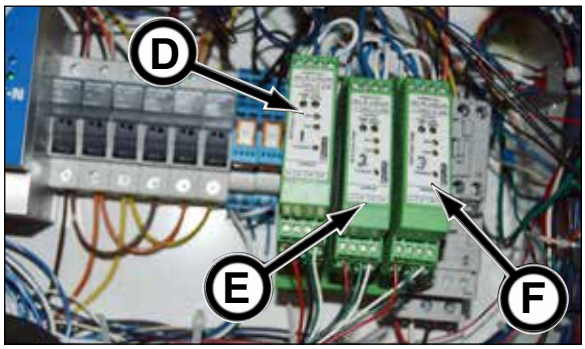
1. Gain access to the three strain gage amplifiers in the 840 control box and remove them from the DIN rail.
   Amplifier 1 (D): Left Earth Pressure Sensor (A)
   Amplifier 2 (E): Right Earth Pressure Sensor (B)
   Amplifier 3 (F): Screw Earth Pressure Sensor (C)

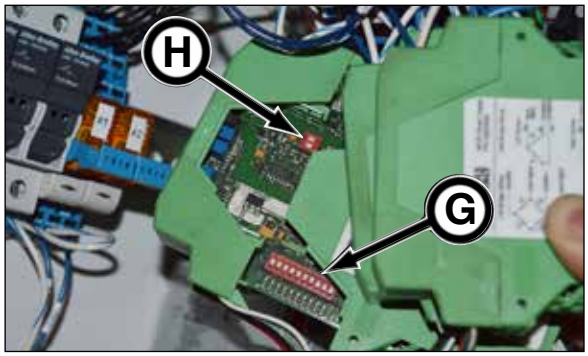
2. Set the DIP switch settings as follows:
   • slide the unit partially out of the case to access the DIP switches.

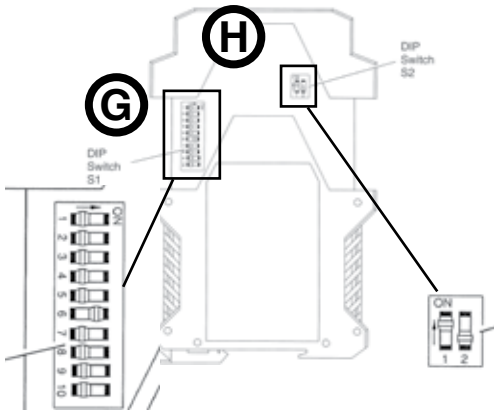
   • on DIP switch S1 (G):
   Switch 1 thru 5, 7 thru 10: OFF
   Switch 6: ON

   • on DIP switch S2 (H):
   Switch 1: ON
   Switch 2: OFF

3. Repeat step 2 on the other two strain gage amplifiers. Once all amplifier DIP switches are set properly, replace amplifiers on DIN rail.





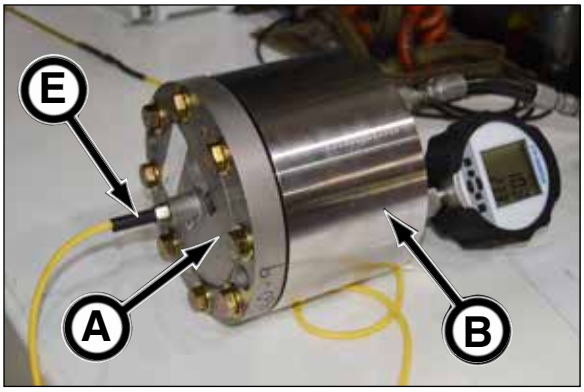


(continued on next page)

EARTH PRESSURE SENSOR CALIBRATION PROCEDURE

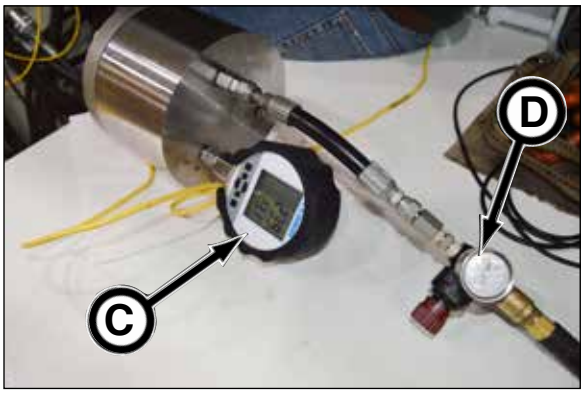
4. Set up the left earth pressure sensor for calibration.

5. Mount the earth pressure sensor (A) to the Akkerman sensor fixture (B).



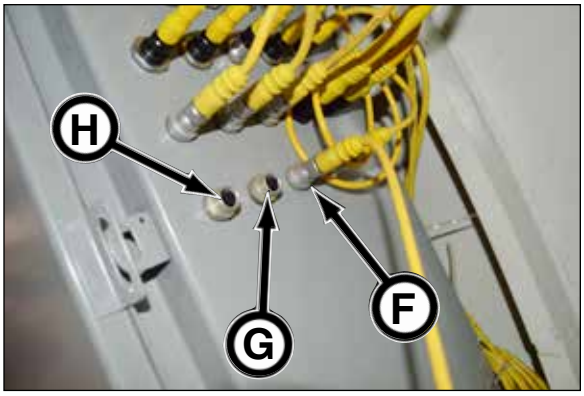
6. Install pressure gauge (C) to sensor fixture.

7. Install pressure regulator (D) to sensor fixture.



8. Connect cable (E) from earth pressure sensor to the left earth pressure connection (F) on the 840 control box.

   • Right Earth Pressure connection (G)
   • Screw Pressure connection (H)

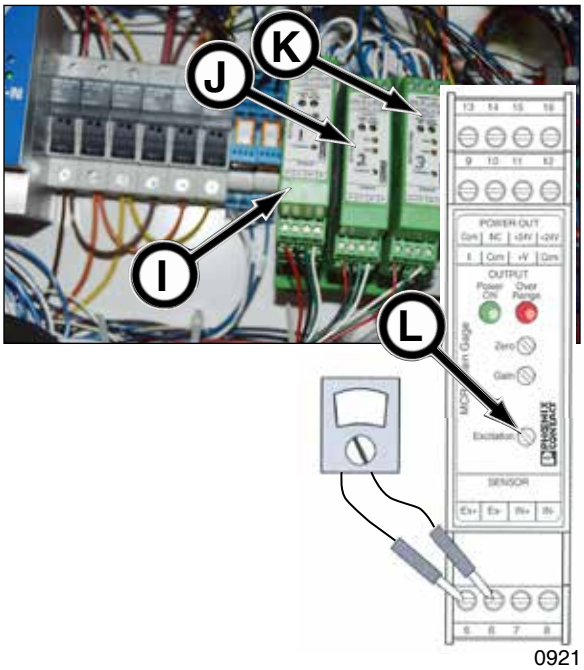


TBM 840 SN1 Shown

9. Set strain gage amplifier 1 (I) (Left Earth Pressure Sensor) trimpot Excitation.

   • Strain Gage Amplifier 2 (J) (Right Earth Pressure Sensor)
   • Strain Gage Amplifier 3 (K) (Screw Earth Pressure Sensor)

   Connect a voltmeter to terminals 5 and 6 and adjust the Excitation trimpot (L) to 10 volts.



(continued on next page)

⚠WARNING Calibrating the earth pressure sensors require a certified electrician to make adjustments in the TBM control box with live electrical current. The certified electrician must wear proper PPE before making adjustments. Failure to do so can cause severe personal injury or death.

Electrical adjustments/repairs must be performed only by a certified electrician.

10. With the TBM control box energized, press Menu button (A) on the main screen.

11. Using the up or down arrow on four-way directional button (B), select Calibration (C).

12. Press Enter button (D).

13. The calibration window appears.

IMPORTANT: Calibration should ONLY be performed by a certified electrician and an experienced tunneling technician under a controlled environment.

Press Enter Pressures button (E).

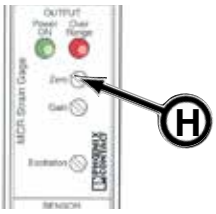
14. The earth pressure calibration window appears.

15. Using the up or down arrow on four-way directional button, select the Left Earth 0 PSI (F) option. The Left Earth 0 PSI option will be highlighted in green.

16. Press Adjust button (G).

17. The selection will flash.

18. Calibrating Zero PSI:
    Connect compressed air to pressure regulator. Set regulator to zero psi. Adjust Zero trimpot (H) to approximately 50 mV as shown on Current Sensor Values (I).
    Once at approximately 50 mV, press Set to Current Input button (J).



19. Press Save button (K) to confirm new setting.

20. Disconnect air supply to regulator.

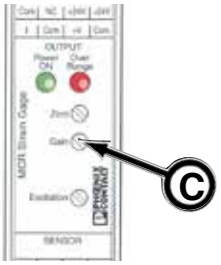
(continued on next page)

21. Using the up or down arrow on four-way directional button, select the Left Earth 100 PSI (A) option. The Left Earth 100 PSI option will be highlighted in green.

22. Press Adjust button (B).

23. The selection will flash.

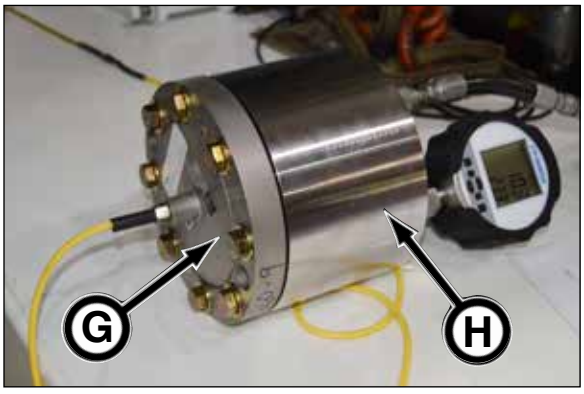
24. Calibrating 100 PSI:
    Connect compressed air to pressure regulator. Set regulator to 100 psi. Adjust Gain trimpot (C) to approximately 450 mV as shown on Current Sensor Values (D). Once at approximately 450 mV, press Set to Current Input button (E).



25. Press Save button (F) to confirm new setting.

26. Disconnect air supply to regulator.

27. Disconnect sensor (G) from fixture (H). Mount the sensor in the proper location on the bulkhead or screw conveyor. Route cable from sensor to control panel away from moving parts.



28. Repeat steps 4 through 27 to calibrate the right earth pressure sensor and the screw pressure sensor.

29. Once calibration is complete, press Exit button (I) to return to the calibration screen.

30. Press Exit button (J) to return to the main screen.

(continued on next page)

IMPORTANT: Once the earth pressure sensors have been calibrated and the sensors are mounted securely in place, a pressure correction MUST be performed. Failure to do so WILL result in inaccurate pressure readings.

Proceed to step 31 for the pressure correction procedure.

31. Press Menu button (A) on the main screen.

32. Using the up or down arrow on four-way directional button (B), select Calibration (C).

33. Press Enter button (D).

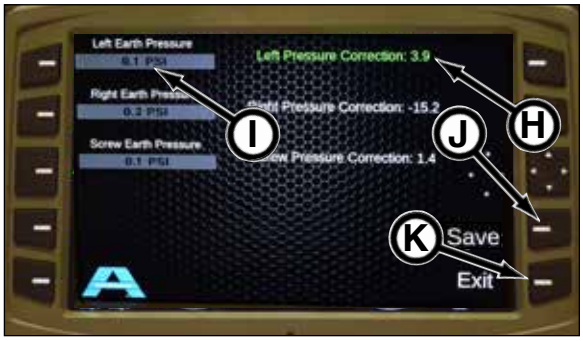
34. The calibration window appears.

35. Press Pressure Correction button (E).

36. The pressure correction window appears.

37. Using the up or down arrow on the four-way directional button, select the Left Pressure Correction (F) option. It will be highlighted in green.

38. Press Adjust button (G).



39. Using the up or down arrow on the four-way directional button, change the correction factor (H) as needed until the Left Earth Pressure meter reading (I) is between 0.1 and 0.4 psi.

NOTICE The correction factor is a variable number. It is critical that the Earth Pressure meter readings are between 0.1 and 0.4 psi.

40. Once the Left Earth Pressure meter reading is between 0.1 and 0.4 psi, press Save button (J) to confirm correction.

41. Repeat steps 37 through 40 to perform the pressure correction procedure on the Right Earth Pressure and Screw Earth Pressure sensors.

42. Press Exit button (K) to return to calibration window. Press Exit button (L) to return to the main screen.

III. ***Viewing Input and Output Diagnostic States***

The system input and output states are shown in the Diagnostics screen and will be helpful if troubleshooting becomes necessary.

1. With the TBM energized with full power, press Menu button (A) on the main screen.

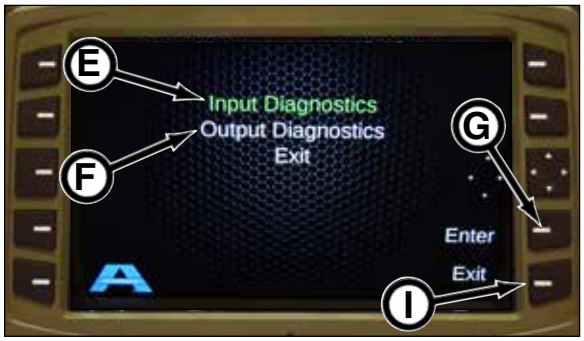
2. Using the up or down arrow on four-way directional button (B), select Diagnostics (C).

3. Press Enter button (D).

4. The diagnostic window appears.

5. To view the Diagnostics, use the up or down arrow on four-way directional button to select either the Input Diagnostics (E) or Output Diagnostics (F) option. The selected will be highlighted in green.

6. Press Enter button (G) to view selected diagnostics.



7. Press Exit button (H) to return to the diagnostics screen.

8. Press Exit button (I) to return to the main screen.

System Input states are shown in Millivolt, Hz, Ohms and On or Off depending on the feed back signal.

System output states are shown as 0 or 1000.
A 0 (zero) indicates the output is OFF.
A 1000 indicates the output is ON.

IV. Change Screen Options

The operator can change the main screen from EPB (closed) to TBM (open) model control screen. In addition the backlight illumination level and background theme can be changed.

A. Control Mode

1. On the main screen, press Menu button (A).

2. Using the up or down arrow on four-way directional button (B), select Options (C).

3. Press Enter button (D).

3. The options window appears. The mode option (E) will be highlighted in green. Press Adjust button (F).

4. The selection will flash. Use the up or down arrow on four-way directional button to change the mode from EPB to TBM.

• The EPB (closed) mode shows the complete control screen including the earth pressure meters.

• The TBM (open) mode shows the control screen without the earth pressure meters.

(continued on next page)

5. Press Save button (A) to confirm new setting.

6. The option selection window appears.

7. Use the up or down arrow on four-way directional button (B) to select and change backlight level or background theme.

8. Press Exit button (C) to return to the alarm/ calibration/diagnostics/option window.

9. Press Exit (D) again to return to the main screen.

III. ***Change Screen Options (continued)***

B. Backlight Level

Changes the back lighting on the control monitor screens.

1. On the main screen, press Menu button (A).

2. Using the up or down arrow on four-way directional button (B), select Options (C).

3. Press Enter button (D).

4. The option window appears. Use the up or down arrow on four-way directional button to Backlight Level (E).

5. The backlight level option will be highlighted in green. Press Adjust button (F).

6. The selection will flash. Use the up or down arrow on four-way directional button to change the numeric value to the desired backlight level setting.

7. Press Save button (G) to confirm new setting.

8. The option selection window appears.

9. If needed, use the up or down arrow on four-way directional button to select and change the background theme or screen control mode.

10. Press Exit button (H) to return to the alarm/ calibration/diagnostics/option window.

11. Press Exit button (I) again to return to the main screen.

III. ***Change Screen Options (continued)***

C. Background Theme

Changes the background themes on the control monitor screens.

Background theme options:

- Gray
- Black
- Carbon
- Diamond Plate

1. On the main screen, press Menu (A).

2. Using the up or down arrow on four-way directional button (B), select Options (C).

3. Press Enter button (D).

4. The option window appears. Use the up or down arrow on four-way directional button to Background theme (E).

5. The background theme option will be highlighted in green. Press Adjust button (F).

6. The selection will flash. Use the up or down arrow on four-way directional button to change to the desired background theme.

7. Press Save button (G) to confirm new setting.

8. The options selection window appears.

9. If needed, use the up or down arrow on four-way directional button to select and change the backlight level or screen control mode.

10. Press Exit button (H) to return to the alarm/calibration/diagnostics/option window.

11. Press Exit (I) again to return to the main screen.

PRESSURE GAUGES

The TBM is equipped with pressure gauges and meters to monitor the TBM functions.

Steering Pressure Meters (A) - Left-Top-Right
The steering pressure meters show the active pressure in the cylinders. This system is capable of 5,000 psi (extend and retract).

Earth Pressure Meters (B) - Left-Right-Screw
The earth pressure meters show the pressure at the earth pressure sensors. This system is capable of 14.5 psi (1 bar).

Cutter % Torque Gauge (C) & Digital RPM & PSI Readout (D)
The cutter gauge shows the percent of torque. This system pressure is capable of 5,000 psi. The RPM is capable of 4.8 or 7.3 rpm.

Jacking Pressure Gauge (E)
The jacking pressure gauge shows the active pressure in the jacking can cylinders. This system is capable of 5,000 psi.

Dirt Wing Pressure Meters (F)
The dirt wing pressure meters show the active pressure in the dirt wing cylinders. This system is capable of 3,000 psi.

Load Sense Pressure Meter (G) & Digital Readout (H)
The load sense pressure meters/readout monitor the inlet pressure to the seven bank control valve. It displays the pressure for the conveyor, conveyor lift, dirt wings, steering cylinders, closed face and jacking can cylinders.

The maximum system pressure for the belt conveyor, conveyor lift, dirt wings and closed face is 3,000 psi. The maximum system pressure for the screw conveyor, steering cylinders and jacking can is 5,000 psi

This system is capable of 3,000/5,000 psi depending on the function being used.
Standby pressure is 200 - 400 psi.

Conveyor Pressure Gauge (I)
The conveyor pressure gauge shows the inlet pressure at the conveyor valve.
This system is capable of 3,000 psi for belt conveyor / 5,000 psi for screw conveyor.

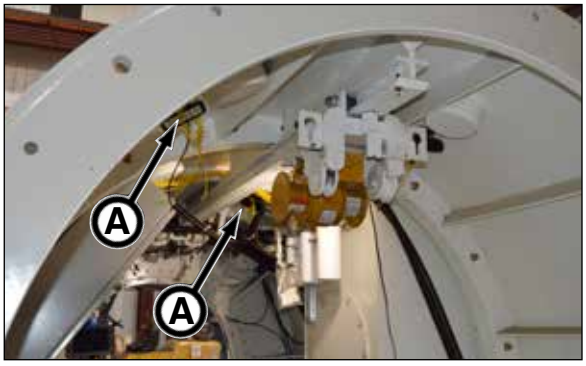
Screw Gate / Closed Face Pressure Digital Readout /Screw Conveyor Speed Sensor (J)
The screw gate pressure or closed face pressure readout shows the active pressure in the gate or closed face cylinder. This system is capable of 3,000 psi. The screw conveyor speed sensor displays in EPB mode only, in negative rpms going CCW and positive rpms while turning the screw conveyor CW during normal mining operations.

Grease Pressure Digital Readout (K)
If the cutterhead is rotating, the boring grease pressure gauge will display minimal pressure (for example, 150 psi). If the grease in-line filter is plugged or a grease line is clogged, the pressure will display a much higher pressure. If there is no pressure on the gauge, the reservoir is out of grease or the pump is not operating. The minimum system pressure is 150 psi.

NOTICE NEVER operate TBM if a filter or grease line is plugged. Doing so will introduce contamination in the bearing cavity resulting in seal, seal surface and bearing damage.

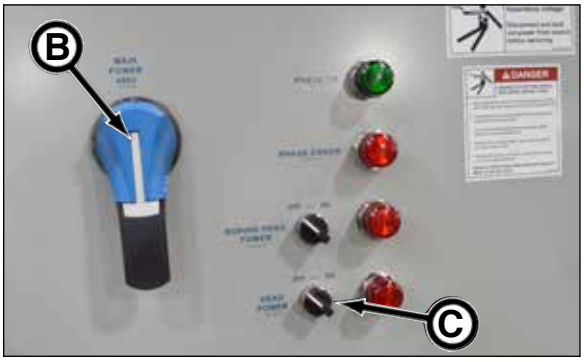
Lube Pressure Gauge (L)
The lube pressure gauge shows the pressure in the bearing cavity lube circuit. The maximum system pressure is 500 psi.

LIGHTS



The TBM is equipped with operating lights (A). The TBM 840 SN1 has two lights and those thereafter have four lights.

Once the pit box main power disconnect switch (B) and the head power switch (C) are flipped to the ON position then there is power to the lights.



Turn the lights on and off by pressing the front lights (D) and rear lights (E) buttons on the control monitor.

The light assemblies are magnetically mounted therefore they can be moved to desired location.

HYDRAULIC OIL COOLING SYSTEM

The hydraulic oil circulates through the heat exchanger (A) and back to tank to cool the oil.

The heat exchanger water supply must be CLEAN water with the GPM requirements per water temperature as shown in the following water table:

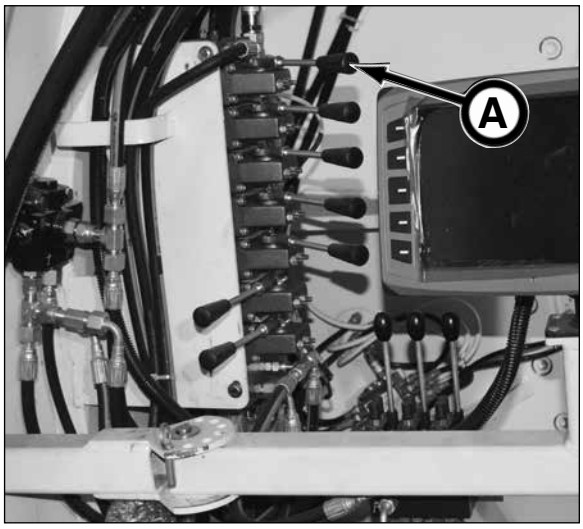
40°F	6.9 GPM	55°F	9.9 GPM	70°F	13.1 GPM	85°F	16.9 GPM
45°F	7.9 GPM	60°F	10.9 GPM	75°F	14.4 GPM	90°F	18.2 GPM
50°F	8.8 GPM	65°F	11.8 GPM	80°F	15.7 GPM		

NOTICE This water table shows typical GPM requirements per water temperature. The actual GPM requirements may be more or less depending on ground conditions.

Heat Exchanger Water Supply Connection (B)
Heat Exchanger Water Discharge Connection (C)

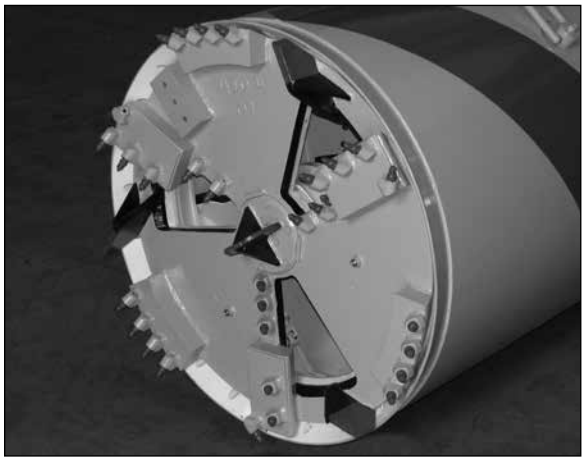
CLOSED FACE / SCREW GATE CONTROL

The Closed Face control lever (A) controls the opening and closing of the doors on the optional closed face cutterhead attachment. Used in unstable ground conditions, the hydraulically operated doors control subsidence of loose soil while excavating the ground.



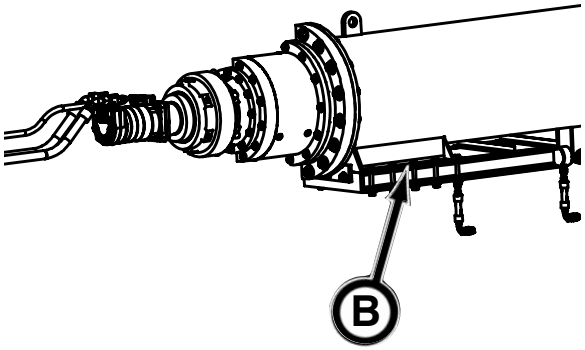
A lubrication system (two water/lubrication ports on cutterhead) is equipped on the closed face attachment to provide a method to lubricate the face if needed.

NOTICE For more information and operating guidelines, refer to Using Closed Face or Auxiliary Control in section 6, Operation of this manual.



In TBM mode, the closed face pressure is shown at the Closed Face PSI digital readout (C). When the pressure increases rapidly, the closed face doors are closed indicating the cylinders are fully extended.

This control lever (A) also controls the screw conveyor gate (B) when hydraulics are connected to the screw conveyor.



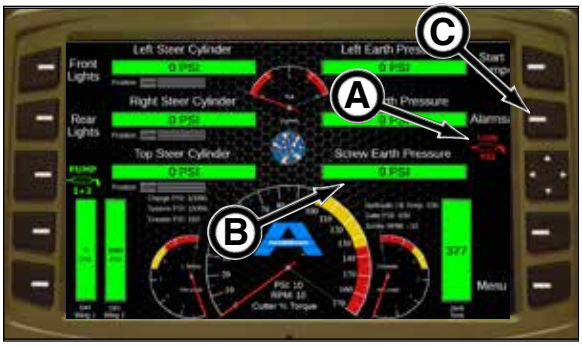
In EPB mode, the gate cylinder pressure is shown at the Gate PSI digital readout (C). When the pressure increases rapidly, the gate door is closed indicating the cylinder is fully extended.

ALARM MESSAGES

The control monitor screen will display alarm fault and warning messages to alert the operator of potential operational issues. In some cases the alarm messages are simply warnings of a potential issue that will need attention, and other alarm messages that are an immediate issue where the machine components will be automatically shutdown to prevent damage to the operation of the machine.

The alarm messages are shown on the main control monitor screen:

- alarm icon indicators (A)
- alarm information area (B)



Main Control Screen

The active alarm messages and icon indicators can also be viewed on the Active Alarm screen by pressing the Alarms button (C).

To clear messages and icons from the Active Alarm screen and the main screen, press Clear button (D).

An override fault function is available when the following faults are encountered since these faults result in an automatic shut down. Press the corresponding Override fault button as follows:

- Roll Limit Fault
pressing the Override Roll button (E) allows the operator to operate the pump and rotate the cutterhead in opposite direction of roll

- Hot Hydraulic Oil Temp Fault
pressing the Override Temp button (F) allows the operator to operate the pump to circulate oil for cooling to lower the hydraulic oil temperature; no TBM functions will work

To return to the main screen press Exit button (G).

Active Alarm Screen With Roll Limit Fault

Active Alarm Screen With High Oil Temp Fault

Alarm Messages

1. Alarm Message: ***Low Hydraulic Oil Level***
Machine Component: Hydraulic System
Affect To Machine: This fault message is displayed when the hydraulic oil level in the oil reservoir reaches the low level sensor. Pumps and cutterhead rotation will automatically shut down. Fill the reservoir with fresh, clean ISO-VG-68 Premium Hydraulic/Turbine Oil or equivalent.

2. Alarm Message: ***Warm Hydraulic Oil Temp***
Machine Component: Hydraulic System
Affect To Machine: Warning message is displayed when the hydraulic oil temperature in the oil reservoir reaches 130°F (54° C). Reduce load to reduce oil temperature. Check to be sure water supplied for oil cooling is at the proper temperature and flow (refer to Hydraulic Oil Cooling System in this section).

3. Alarm Message: ***Hot Hydraulic Oil Temp***
Machine Component: Hydraulic System
Affect To Machine: This fault message is displayed when the hydraulic oil temperature in the oil reservoir reaches 150°F (66° C). Pumps and cutterhead rotation will automatically shut down. Press the Override Temp button and once enabled, press Start Pump button on control screen to operate the pump for cooling the hydraulic oil.

(continued on next page)

Main Control Screen

Active Alarm Screen

Alarm Messages (continued)

4. Alarm Message: ***Low Grease Pressure***
Machine Component: Grease System
Affect To Machine: This warning message is displayed when the grease pressure lowers to 150 psi indicating the grease pump is not operating or the reservoir is out of grease. The operator must switch the grease operation to the other grease pump.

5. Alarm Message: ***High Grease Pressure***
Machine Component: Grease System
Affect To Machine: This warning message is displayed when the grease pressure reaches 2,500 psi indicating the grease in-line filter is plugged or a grease line is clogged. The operator must switch the grease operation to the other grease pump.

6. Alarm Message: ***E-Stop Switch Pressed***
Machine Component: Emergency Stop System
Affect To Machine: This fault message is displayed when the E-Stop button in the TBM is pressed. This will deactivate electrical and hydraulic power in the TBM. This E-Stop will not stop the power from the power source (generator).

7. Alarm Message: ***Steer Pressure High***
Machine Component: Steering Cylinders
Affect To Machine: This warning message is displayed when the steering cylinder pressure has exceeded the user set point (refer to Control Monitor, I. Setting Visual Alarm Warnings On Meters in this section).

8. Alarm Message: ***Steer Over Extension***
Machine Component: Steering Cylinders
Affect To Machine: This warning message is displayed when the steering cylinder extension has exceeded the user set point (refer to Control Monitor, I. Setting Visual Alarm Warnings On Meters in this section).

9. Alarm Message: ***Gas Detected***
Machine Component: Gas Detector
Affect To Machine: This warning message is displayed when the gas detector detects a gas level reading of 10% (default) or higher. The horn on the gas detector will sound intermittently until the system detects a gas level reading of 25% LEL (default) or higher at which time the horn will sound constantly and the pumps and cutterhead rotation will stop.

10. Alarm Message: ***Roll Limit***
Machine Component: Inclinometer
Affect To Machine: This fault message is displayed when the TBM roll angle rolls to ± 4°. Pumps and cutterhead rotation will automatically shut down. Press the Override Roll button and once enabled, press Start Pump to rotate the cutterhead in the opposite direction of the TBM roll.

11. Alarm Message: ***Jacking Limit***
Machine Component: Jacking System
Affect To Machine: This warning message is displayed when the jacking tons has exceeded the user set point (refer to Control Monitor, I. Setting Visual Alarm Warnings On Meters in this section).

FOAM GENERATOR SYSTEM CONTROLS

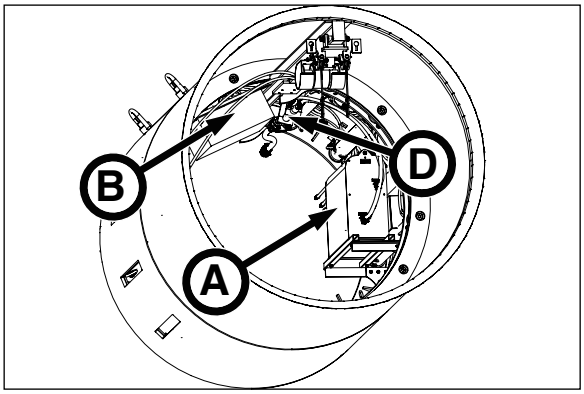
The Foam Generator System (if equipped) is integrated into the 840 TBM to condition the excavated ground with foam to help increase cutting efficiency and reduce cutting torque.

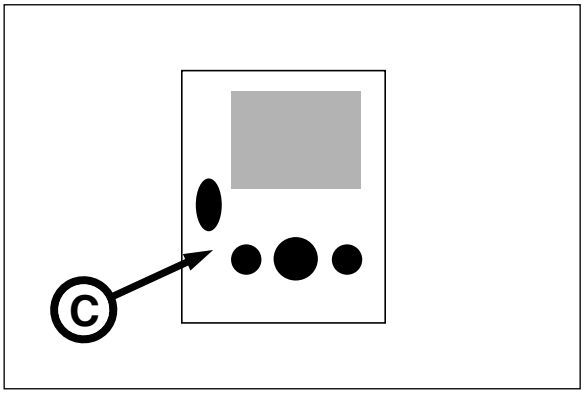
The Foam Generator System comprises a foam generator (A), foam electrical box (B), foam control box (C), and foam cannon (D).

The foam injection ports (6) on the TBM bulkhead pump foam into the cutterhead chamber, screw conveyor and the cutterhead face to mix with spoils and create a “toothpaste consistency” for spoil removal through the screw conveyor.

Refer to the Foam Injection Rate (FIR) table in Operation, Controlling Foam Generation System, section 6 for FIR and Foam Expansion Ratio (FER) guidelines.

IMPORTANT: Before starting and start up of the Foam Generator System controls, be sure the power start up and check hydraulics after systems start up procedures are performed. Be sure that the cutterhead and screw conveyors are rotating AND the jacking cylinders are extending.





FOAM GENERATOR CONTROLS

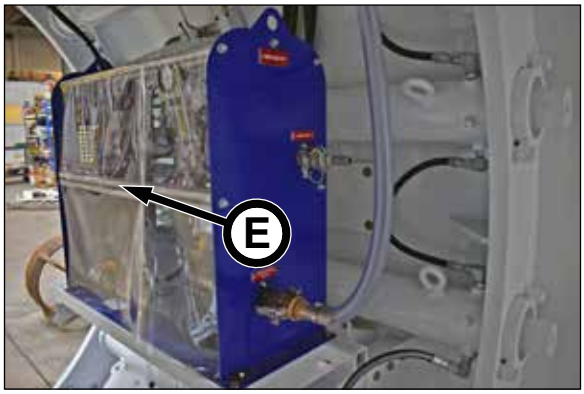
⚠WARNING Be sure the Foam Generator PVC panels (E) are in place before operating to prevent contact with dangerous parts. Failure to do so could cause severe injury or death.

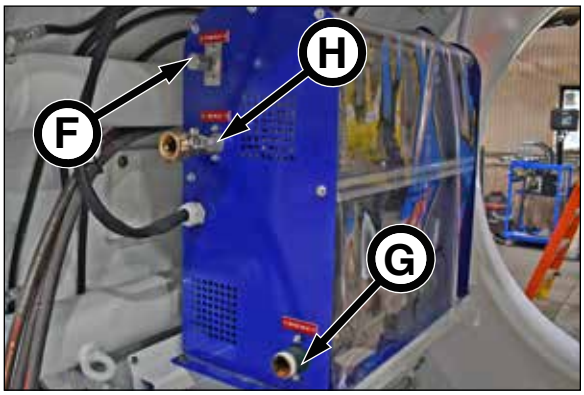
The Foam Generator contains hydraulic and pneumatic components to dose, mix and propel air and water with a foaming agent concentrate to the foam cannon, which travels to the injection ports on the TBM bulkhead.

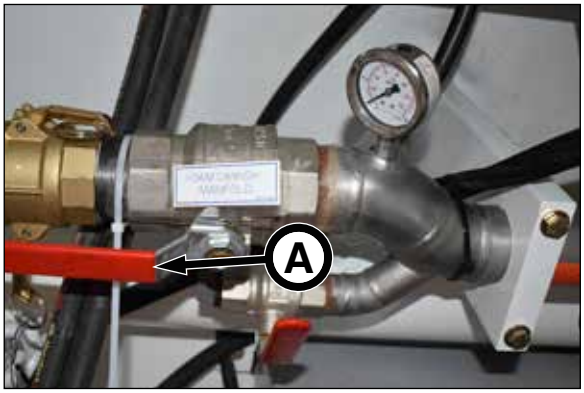
To activate the Foam Generator to generate foam:

1. Connect the Foam Generation System electrical, compressed air, and water circuits.

2. Connect the foaming agent concentrate tank to the foam inlet (F), compressed air to the air inlet (G), and water supply to the water inlet (H).



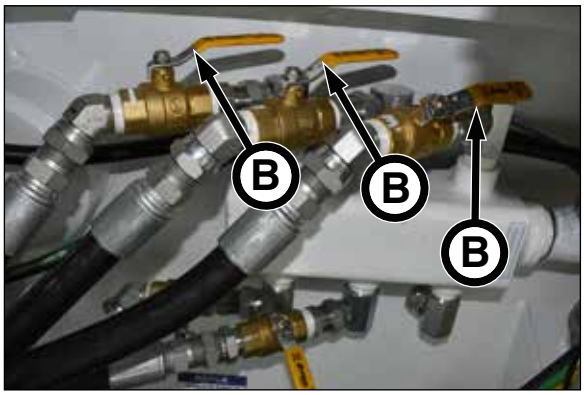




3. Check that the manual foam shutoff valves are open on the foam cannon (A) and foam manifold (B) (6).

⚠WARNING High pressure foam can cause severe injuiry. Be sure all shut off valves are in the open position before use.

4. Refer to Foam Control Box for operation controls.



FOAM ELECTRICAL BOX CONTROLS

⚠DANGER Hazardous voltage. Disconnect and lockout tagout power from source before servicing.

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

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

NOTICE All Foam System Emergency Stop buttons must be pulled out to restart operation. Refer to the Lockout Tagout Procedure Guideline in section 1, Safety.

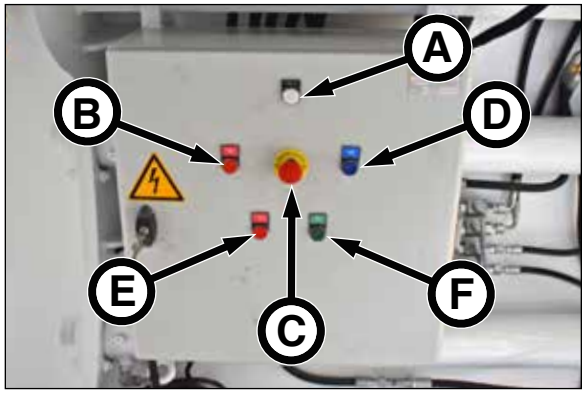
The Foam Electrical Box ensures distribution and management of the Foam Generator System electrical power.

FOAM MAIN POWER DISCONNECT: Use the main power disconnect switch to allow electrical power from the connected power source to power the Foam Generator System Electrical Box.

Turn the Foam Main Power Disconnect switch (C) CW to the ON position. This will cause the Power On button to illuminate in white.

(continued on next page)

Foam Electrical Box Controls (continued)



***POWER ON* (A):** After the Foam Main Power Disconnect switch is turned to the ON position, this light will illuminate.

***GENERAL STOP* (B):** Push IN to stop power to Foam Generator System.

***EMERGENCY STOP* (C):** In an emergency, push IN to stop Foam Generation System. Pull OUT to restart power to Foam Generator System. Be sure the Foam Control Box E-Stop is also pulled OUT to restart.

IMPORTANT: This emergency stop shuts down Foam Generator System power ONLY. This emergency stop DOES NOT shut down tunnel power.

***SAFETY RESET* (D):** Press this button to reset the Foam Generator System after pressing the Emergency Stop.

***FLOW OFF* (E):** Press this button to turn the foam flow OFF.

***FLOW ON* (F):** Press this button to turn the foam flow ON.

Electrical power must first be turned on for the Foam Electrical box to power up. Be sure to first:

- Turn on the external power source (check Power Phase Indicators for proper phase)
- Flip Foam Main Power Disconnect Switch to the ON position
- Turn the Head Power Switch to the ON position
- Turn the Boring Head Power Switch to the ON position
- Turn the Boring Head Power main disconnect in the TBM to the ON position

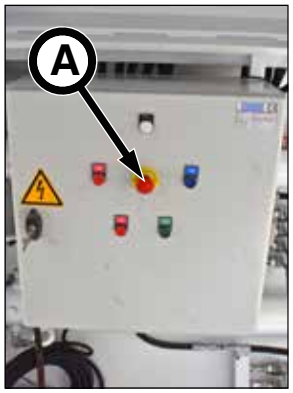
(Refer to the Power Phase Indicators, Main Power Disconnect Switch, Boring Head Power On Light, Head Power On Light in this section.)

To power the Foam Electrical Box:

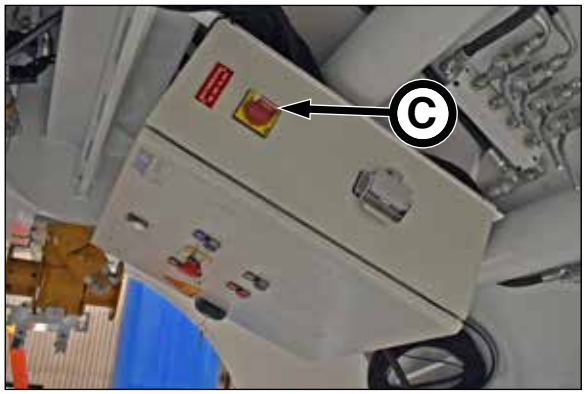
NOTICE Before using the Foam Generator System, be sure that the Foam Electrical Box is properly locked. Remove key and retain for later.

NOTICE Before starting the Foam Electrical Box, be sure the manual foam shutoff valves are open on the foam cannon and foam manifold (6).

1. Pull out Emergency Stop (A, B) on Emergency Stop buttons on the Electrical and Control Boxes. **IMPORTANT: This emergency stop shuts down Foam Generator System power ONLY. This emergency stop DOES NOT shut down tunnel power.**



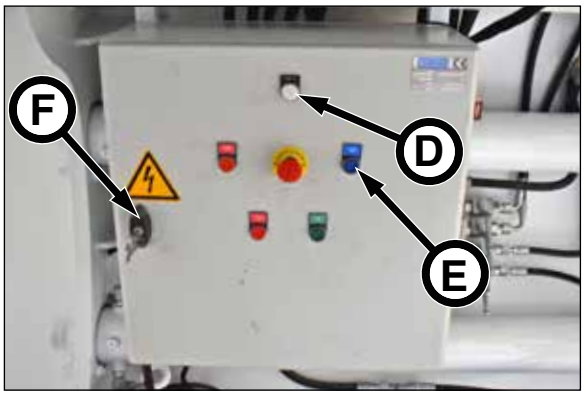
2. Turn the Foam Main Power Disconnect switch (C) CW to the ON position.



3. The Power On indicator light (D) will illuminate in white.

4. Press the Safety Reset push button (E). The Foam Generator System is now ready to operate.

5. Lock (F) the Foam Generator Electrical Box and retain the key.



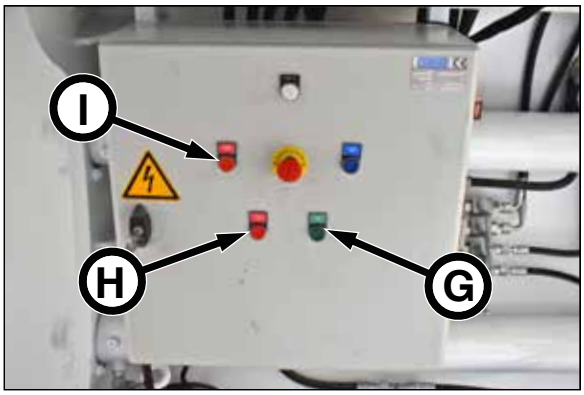
To start Foam Electrical Box operations:

1. Press the Flow On (G) button.

To stop Foam Electrical Box operations:

1. Press the Flow Off (H) button.

2. Press the General Stop (I) button.



FOAM CONTROL BOX

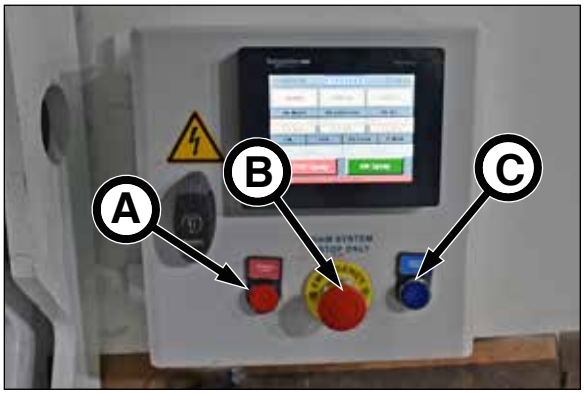
The Foam Control Box is the main interface for the operator. It allows the operator to control and monitor all functions of the Foam Generation System.

IMPORTANT: Before starting and start up of the Foam Generator System controls, be sure the power start up and check hydraulics after systems start up procedures are performed. Be sure that the cutterhead and screw conveyors are rotating AND the jacking cylinders are extending.

The Foam Control Box houses the following controls buttons:

***GENERAL STOP* (A):** Push IN to stop power to Foam Generator System Monitor.

***EMERGENCY STOP* (B):** In an emergency, push IN to stop Foam Generator System Monitor power. Pull OUT to restart power to Foam Generator System Monitor power.
IMPORTANT: This emergency stop shuts down Foam Generator System power ONLY. This emergency stop DOES NOT shut down tunnel power.



***SAFETY RESET* (C):** Press this button to reset the Foam Generator System Control Box power after pressing the Emergency Stop.

The Foam Control Box monitor contains the following control functions:

1. The Home Page tab (D) displays the flow rates, pressures, concentrations and other essential parameters.

2. Press the Settings tab (E) to enter and adjust all foam control operating parameters. Press each button and set the percentages and flow rates per the foam plant and foam agent concentrate manufacturers' recommendations for the project.

Refer to the Foam Injection Rate (FIR) table in Operation, Controlling Foam Generation System, section 6 for FIR and Foam Expansion Ratio (FER) guidelines.

NOTICE Make sure to set the pressure regulator so the water pressure does not exceed 58 psi (4 bar).

3. Press the Alarms tab (A) to view system alarms and faults.

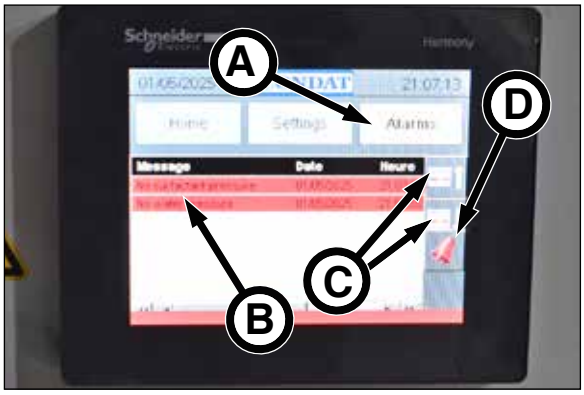
   Acknowledged Alarms, Active Unacknowledged, and Acknowledged messages display in a list (B).

   Scroll through the list of messages using the Scroll Up and Down buttons (C).

   To change the state of an Active Unacknowledged Alarm to an Acknowledged Alarm, highlight the message by pressing the Scroll Up or Scroll Down (C) button, and when highlighted, press the Alarm Acknowledgment (bell) (D) button.

   The Active Unacknowledged Alarm message(s) will now change to Acknowledged Alarm messages (E).

   Refer to yout Foam Generation System User Manual for more information.



NOTES

Pre-Start Inspection

⚠WARNING Do not operate this equipment until you read, study, and understand this manual and the Akkerman haul unit, gas detection system, foam generation system, and jacking frame operation manuals. A daily inspection of the equipment must be performed to prevent severe personal injury or death and equipment damage.

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

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. Tunnel must be ventilated with fresh air.
	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 for loose or missing hardware. Replace damaged or missing hardware.
	12. Check for worn, loose, or damaged wire connections. Repair or replace wiring.
	13. Tighten loose clamps or fittings.
	14. Check electrical cables for frayed or worn insulation or wiring. Replace damaged or worn electrical lines/ connections/harnesses.
	15. Check for fluid leaks. Repair leak or replace components.
	16. Check grease level in seal grease container. Add grease as needed.
	17. Check hydraulic hoses and lines for leaks, wear and/or damage. Replace any defective hoses and/or lines.
	18. Conveyor MUST be secured with four safety chains to each conveyor.
	19. Check oil level in hydraulic oil reservoir. Add as needed.
	20. Steering joint must be fully lubricated prior to startup.
	21. Conveyor MUST be secured with four safety chains to conveyor bracket in TBM, and chain from conveyor safety valve must be tethered to conveyor.
	22. The gas detector sensor must be installed with the sensor facing down to ensure proper operation and to prevent the buildup of moisture or contaminants, such as oil and dirt.
	23. Be sure the green Phase OK Indicator light is illuminated before starting electrical components.
	24. Test the electrical motor for proper rotation prior to operation.
	25. Test each function and control to ensure correct operation.
	26. Perform all lubrication and maintenance procedures. Refer to Section 9, Periodic Maintenance.
	27. Check cable for continuity and shorting before each use. Constantly check cables for damage.
	28. Perform pre-start inspection on your equipment. Refer to the equipment operator’s manual.
	29. Be sure bearing oil lube pump and seal grease pump are functioning properly.
	30. Decals must be clean and legible.

NOTES

Operation

OPERATING GUIDELINES

⚠WARNING Do not operate this equipment until you read, study, and understand this manual and your haul unit, gas detection system, foam generation system, and jacking frame operation manuals. Failure to do so, could result in severe personal injury or death.

1. Before operating, read and understand the Safety, Pre-Start Inspection, Operation and Maintenance sections.
2. Do not operate this equipment while under the influence of alcohol, drugs, or medication.
3. Follow all Federal, State, and Local safety regulations and procedures.
4. Be sure OSHA prescribed safety 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 your Akkerman Aftermarket Support representative for proper procedures on how to restore equipment for operation.
7. Have fully charged fire extinguishers on the job site at all times.
8. Once survey is complete, perform a general visual inspection of the survey line to make sure it is in the same direction as the project bore. If not, the survey must be remarked. A good survey is critical for proper line and grade.
9. Be sure the excavated launch and reception shafts are properly shored or braced to prevent slides or cave-ins.
10. 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.
11. A fully trained and qualified signal person must direct the crane operator when lifting and lowering equipment into the launch or reception shafts.
12. Never walk or work under any part of the crane and suspended loads.
13. 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.
14. Before operating, thoroughly inspect all equipment and repair equipment problems. Check hoses for cuts or bulges. Replace worn or damaged hoses.
15. 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.
16. Test air monitoring and ventilation detectors for proper operation. Never enter a tunnel without combustible gas detectors and oxygen deficiency detectors.
17. Test all Emergency Stop circuits for proper operation at the start of each shift.
18. Test each control function to make sure they work properly.
19. High pressure hydraulics are used in this TBM. Be sure all covers and guards are in place before operating.
20. Do not make any non-authorized modifications to any Akkerman products. Doing so could cause structural failure and will void the warranty.
21. Check shields and guards. All must be in place and undamaged.
22. Before starting equipment, thoroughly inspect all equipment. Inform all job site personnel that the equipment will be starting up. Do not start until all unauthorized personnel are clear of the equipment.
23. BEFORE operating conveyor, the chain from the conveyor safety valve MUST be tethered to conveyor AND ALL FOUR safety chains MUST be secured to conveyor.

(continued on next page)

Operating Guidelines (continued)

24. Before operating conveyor, all guards and/or safety devices must be in place and operable to prevent any contact with conveyor.
25. Conveyors must not be started until all personnel have been moved away from the conveyor and have been warned that the conveyors are about to start up.
26. Keep hands, body, and objects clear of rotating conveyor or operating auger. Do not operate without covers and guards in place. Lockout tagout power before servicing.
27. The area around conveyor loading and unloading points must be kept clear of obstructions during conveyor operation.
28. Conveyors must be stopped and the power source in lockout, tagout during maintenance, repair, servicing or attempting to remove a jam or overload.
29. Pressure peaks cause hoses to jump without notice. Keep all personnel away from hoses during operation of equipment.
30. Check to be sure the bearing and lubrication pump and seal grease pumps are operating during the drive.
31. While retaining earth pressure, **DO NOT EXCEED 15 psi.** Doing so will cause damage to the TBM seals.
32. During TBM advancement, do not allow steering cylinder pressures to exceed the maximum rated steering pressure. Doing so will cause hydraulic component & structural damage.
33. The operator must note and report any slow down of machine operating time that might be an early warning of future problems.
34. When installing liner plates, complete sets must be installed to provide proper thrusting of unit. Failure to do so WILL cause jacking/liner can component damage.
35. 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.
36. Check line and grade often to avoid mis-alignment. Keep TBM well ventilated to achieve a consistent temperature throughout the pipeline since changes in temperature inside the pipe can cause laser beam to stray off target. Keep in mind if you are off one degree, the bore will be off nearly two feet per one hundred feet.
37. After start-up, observe all gauges, controls and warning devices to assure they are functioning properly and their readings are within the operating range.
38. Before performing maintenance, lockout tagout the generator or other external power source, and the main power disconnect.
39. Lockout tagout electrical power at the source (generator) before servicing electrical components.
40. If this manual becomes lost, contact your Akkerman Aftermarket Support representative for a new manual.

RECOMMENDED TOOLS & EQUIPMENT

Below is a list of tools and equipment for most complex technical construction operations. Financial resources and equipment availability are as much of a deciding factor as immediate job site requirements in determining what items should be on hand. This list contains many items, some of which may only be needed in special situations, and may not be exhaustive. Please contact the Akkerman Aftermarket Support department for Akkerman supplied spare parts.

SAFETY EQUIPMENT

- Safety equipment, first-aid kit, fire extinguishers, and stokes-type stretcher
- Air monitoring system
- Gas detection system
- Personal gas detectors
- Any other required safety PPE or gear

CONSUMABLES

- Anchors to holdup tunnel utilities
- Grease
    - TBM lip seal grease, low viscosity Type 1 - Mobil SHC™ 101 grease or equivalent, biodegradable is recommended but not required (Note: expect to use 1 gal. of grease per day, grease tubes or 5-gal. pail of grease with air powered pump can be used)
    - Multiple tubes of type 2 general purpose, multi-purpose grease for maintaining equipment, if biodegradable, use Mobil SHC™ 102 or equivalent
- Hydraulic Oil - AW46 hydraulic oil to fill tunnel supply/return lines (Note: 5200 pump unit comes with 230-gal. of oil and dual feeding TBM will require approximately 25-gal. of additional oil per 100-ft. of tunnel)
- Pads - oil absorbent
- Propylene Glycol (RV Antifreeze) for winterizing equipment during freezing temperatures
- Rope
- Rubber gloves
- TBM cutterhead tooling spares (bullet bits, spade tooling, and disc cutters)
- Wire - tie or mechanics

TOOLS

- Carpentry tools - circular saw, Sawzall®, cordless drill with bits, and basic hand tools
- Chains - log, shackles, and clevises
- Concrete bucket, tremie hose and hopper
- Electrician tools - test meters, multimeter, voltage indicator, ground fault indicator, and specialty hand tools
- Extension cords
- Extension ladder
- Flashlights - good quality
- Grease gun - battery-operated, or 5 gal. pail of grease for the TBM lip seal
- Grinders - disc and mini-disc, and extra discs
- Hose - to wash down with spray nozzle

(continued on next page)

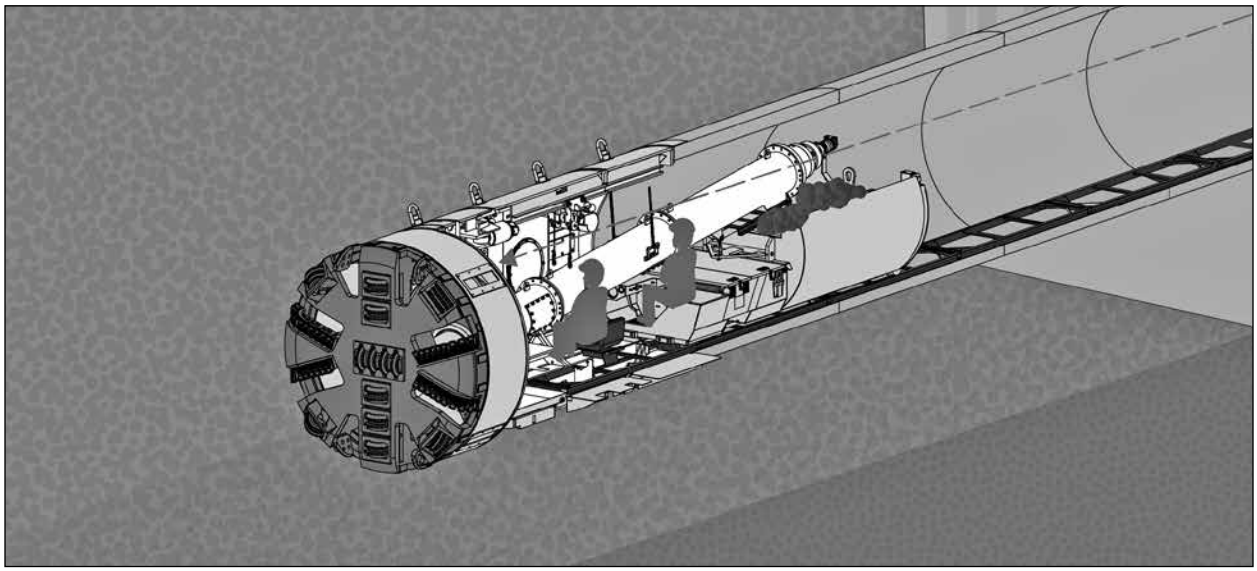
Recommended Tools & Equipment, Tools (continued)

- Hydraulic tools - various size bottle jack(s), railroad or house type jacks, portapower hydraulic jack cylinder kit
- Levels (6-in., 4-ft., and 8-ft.)
- Measuring and surveying equipment/tools - sight level or theodolite, laser levels, plumb-bobs, string lines and 100 ft. tape measure, transit level, grade rod, string line, and plumb-bobs
- Mechanic tools including but not limited to wrenches (1/4 to 2 in.), allen wrench set (1/16 to 3/4 in.), torque wrenches, pipe wrenches, crescent wrenches, pliers, screwdrivers, hammers (1, 3, and 5 lb.), full drive socket/ratchet sets (3/8, 1/2 and 3/4 in.)
- Pipe tools - pipe wrenches, water pump pliers, pump packing removal kit
- Shovels, rakes, and brooms
- Sledgehammer(s), pry bar set (large railroad style bar), crowbars of all sizes, and a variety of spud wrenches, and pickbars
- Storage - to secure tools and equipment
- Welder (Arc), and cutting torch rigs, eye shields and required protective gear

SUPPORT EQUIPMENT

- Crane/excavator and rigging - appropriately sized for tunneling equipment and pipe segments
- Front-end loader - rubber-tired with bucket and forks or skid steer loader
- Generator - minimum motor starting kVA (skVA): 830skVA with less than 35% instantaneous voltage dip and greater than 90% sustained voltage
- Laser for TBM guidance system
- Lighting
    - Adequate job site lighting, crew safety vests, and traffic control devices/signage, and barricades
    - Tunnel lights
- Power requirements (see support equipment recommendations and generator minumum motor starting requirements)
- Pumps
    - Bentonite Pump with bentonite/pipe lubricant (polymer), available hydrant (preferred) or clean water supply, bentonite supply hose for tunnel and pipe ports, and bentonite tunnel valves
    - Cooling water pump 8 to 15 gpm for pump unit, available hydrant (preferred) or clean water supply, and 1-in. camlock connection
    - Shaft pump - adequate pumping capacity for launch and reception shafts, and process water overflow, potential storm event inflow, trash pump, and hoses
- Tunnel communication headsets and communication equipment
- Ventilation fan(s) and ducting to supply fresh air to TBM

SITE PLANNING



It is important to carefully review the site and make sure that it is arranged in the most effective manner possible. Here is a list of equipment and site considerations that are typically needed for a TBM project.

EQUIPMENT

- TBM
- Crane
- Pipe lubrication pump
- Skid and jacking frame (if used)
- Portable welders
- Spoil removal truck
- Yoke (if needed)
- Small generator
- Portable toilet
- Fork lift
- Generator or power source

OTHER SITE CONSIDERATIONS

- Spoil removal truck access
- Pipe unloading area
- Fresh water supply
- Launch shaft size
- Hose interconnections
- Electrical interconnections
- Walkways
- Pipe staging area
- Jacking shaft access area
- Any traffic or other physical restraints

SYSTEM OVERVIEW

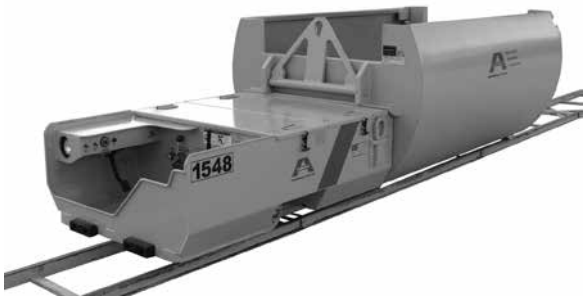
Tunnel Boring Machine (TBM)
The purpose of the TBM is to excavate material at the cutter face and guide (steer) the pipe through the ground. As the TBM is advanced by the pipe jacking system, powerful hydraulic motors in the TBM rotate an inner drum. A cutterhead or closed face attachment is connected to the drum. As it rotates, the attachment teeth excavate the face and the spoils fall into the drum. Dirt scoops and paddles in the drum dump the spoils onto a conveyor for removal from the pipe line.

Akkerman TBMs are articulated and hydraulically steerable in any direction. With the proper use of a laser, the strictest line and grade requirements can be maintained throughout the pipeline installation. An operator is positioned near the front of the machine to observe soil conditions and to monitor line and grade. A methane detection system is also standard equipment in Akkerman TBMs.

Jacking System
The jacking system for the 840 is typically a jacking can to build liner plate or ring beam and lagging tunnels. The 840 can also utilize a jacking frame or a 5200 Pump Unit with a thrust yoke which provides the horizontal thrust, using hydraulic cylinders, to push the TBM and pipe through the ground.

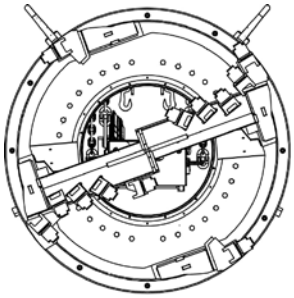
Conveyor
(Belt - Open Mode, Screw - Closed Mode)
As the spoils are dropped onto the conveyor from the TBM inner drum, the conveyor carries the spoils to the dirt bucket on the haul unit. The conveyor transports the spoil from the front of the boring head to the dirt bucket on the haul unit. Conveyors are offered in several sizes to maximize the performance for each size boring head.
A screw conveyor is used in a closed earth pressure balance mode using the rear gate and performs better in certain sticky or sloppy ground conditions.

Haul Unit System
The haul unit transports the spoils from the TBM back to the launch shaft. A crane is then used to hoist the dirt bucket out of the shaft for unloading. The typical haul unit system comprises haul unit, track, and dirt bucket.

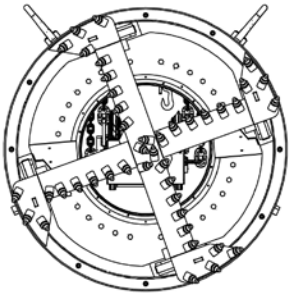


Foam Generation System (not shown)
The Foam Generator System (if equipped) is intergrated into the 840 TBM to condition the excavated ground with foam to help increase cutting efficiency and reduce cutting torque.
The Foam Generator System comprises a foam generator, foam electrical box, foam control system monitor, and foam cannon. The foam injection ports on the TBM bulkhead pump foam into the cutterhead chamber to mix with spoils and create a “toothpaste consistency” for removal through the screw conveyor.

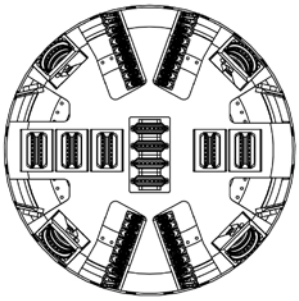
CUTTERHEADS



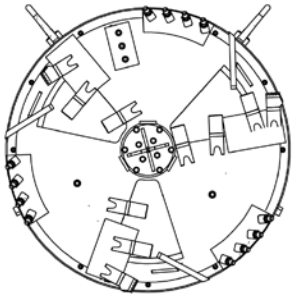
Dirt Bar Head



Carbide Quad Bar Head



Mixed Ground Disc Head



Closed Face Head

TBMs are equipped with two cutterheads and may be interchanged underground.

- Dirt Bar Cutterhead for dry, dewatered ground (clay, silty sand)
- Carbide Cutterhead for stiff, dry, dewatered ground (soft to medium hard rock)

Two optional cutterheads are available:

- Mixed Ground Disc Cutterhead is used for high compressive strength geology.
- Closed Face Cutterhead is used for boring in unstable ground conditions. The hydraulically operated doors control subsidence of loose soil while excavating the ground.

SYSTEM SET-UP

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

⚠WARNING Gases may be present during excavation and could cause severe personal injury or death. Use an approved air analyzer to detect hazardous gases on the job site and in the tunnel at all times.

2. After the soil analysis, shaft layout design, and survey are complete, excavate the launch and reception shafts. Be sure the shafts will be well drained and use proper shoring or bracing in accordance with your local, state, and federal regulations.

3. Construct a shaft floor with a solid base suitable for the weight of the tunneling equipment. Consult your civil and structural engineers for your shaft floor requirements.

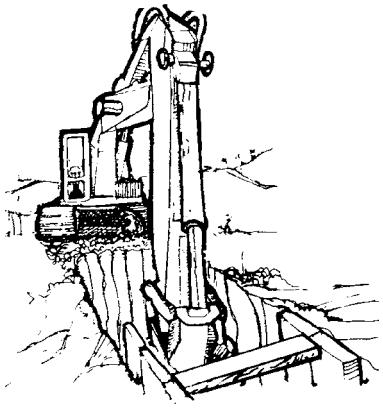
4. Place steel plates on the launch shaft floor for supporting the base of the tunneling equipment and pipe.

5. Construct a concrete thrust block designed to withstand the applied load. A structural engineer must be consulted on the design of this block. This block must be square with the line of the tunnel axis and skid/rail assembly.

NOTICE If using a jacking frame, space must be provided for the mounting of the laser behind the jacking frame.

⚠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 Be sure the crane and all lifting equipment is rated to lift load. Remember, you may be able to lift the load in close at ground level, but as the load radius and elevation change, the lifting capacity of the crane or excavator or other lifting equipment decreases.



AEM is the original author and publisher of the above illustration

6. Lower skid or rail system into launch shaft place against the thrust block. Adjust skid or rail system to line and grade. Be sure there is at least 6 inches between the front of the jacking rails and where the launch seal will be located.

7. Check to be sure skid/rail system is making full contact against thrust block structure.

8. Lower jacking system (if used) onto skid/rail system and make sure the frame is properly centered on the rails.

NOTICE Both the left and right ends of the skid frame (if used) MUST be against thrust block, otherwise damage will occur to the skid frame during jacking operation.

(continued on next page)

System Set-Up (continued)

9. Place the generator or main power source as far away from the launch shaft as possible. This will reduce the noise to the operator and make it easier to communicate with the launch and reception shaft personnel.
10. Install the launch shaft seal and casing in the front of the launch shaft, if required.
11. Lower tunnel boring machine (TBM) (with conveyor installed) onto the front of the skid/rail system, making sure the cutter teeth/discs on the TBM will not strike the skid/rail assembly when the cutterhead is rotated.
12. Check TBM side to side level by placing level on the cylinder lift trolley rail. If not level, have crane operator move the TBM until TBM side to side is level.
13. Place level on inner drum level bar and rotate the inner drum as needed until level. This will position the target bolt on the cutter bar in the proper location for setting the guidance system.
14. Check to be sure front drum is parallel with mid drum/dirt wing drum. Place a 4 ft. level or other long straight edge between the front drum and mid drum sections. If mid section lines up with level or straight edge, then the front and back sections of the TBM are running parallel.

    If there is a gap between the two sections, the sections are not parallel. Move steering cylinders as needed until there is no longer a gap.

NOTICE The TBM line and grade MUST be steered parallel to the jacking system base.

15. Lower jacking can onto skid/rails. Align jacking can to TBM. Secure TBM to jacking can with required hardware.
16. Recheck the skid/rail system base frame and alignment. Check machine elevation and make final pipe line calculations allowing for the cutter bit “over cut”.
17. Lower the stand (if used) for the laser guidance system as close to the rear of the jacking shaft as possible without contacting skid/rail system, jacking system (if used), or thrust block. Be sure the guidance system will not be affected by thrust applied to jacking system.

NOTICE For proper guidance system installation, refer to your laser manufacturer’s installation requirements. Be sure laser beam has a clear path to target.

18. Set up the TBM to jacking can hydraulic hoses and electrical connections.

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

19. Connect the Foam Generation System electrical, compressed air, and foaming agent concentrate circuits (if equipped).
20. Connect generator/power source electric cables (refer to Connecting Power Pack Electrical Connections on next page).
21. Be sure the conveyor is properly installed and secured to the slip bearing or bulkhead and lifting cables (four per conveyor). Adjust the conveyor as needed into the operating position. Fasten chain from conveyor safety switch valve to conveyor hook.
22. A proper ventilation system must be installed throughout the tunnel. 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.
23. Connect water supply hoses to heat exchanger and foam generator inlet (if equipped).
24. Check that the cutter bar or closed face mounting bolts are securely fastened.
25. Verify that the TBM operator is able to quickly evacuate the TBM in the event of an emergency.
26. Proceed to Connecting Power Pack Electrical Connections in this section.

CONNECTING POWER PACK 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.

LOCKOUT TAGOUT 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.

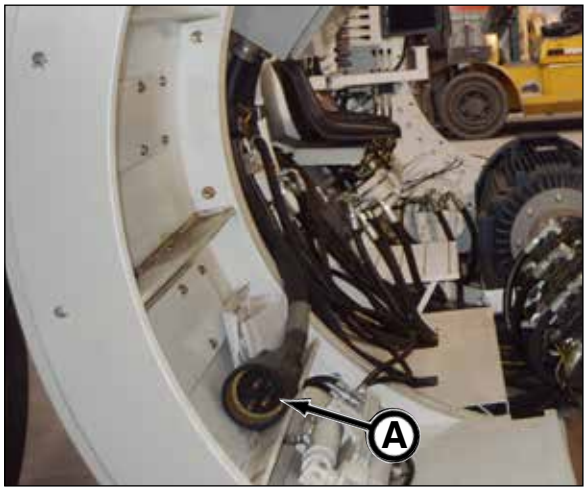
MAIN POWER FROM GENERATOR

1. With generator or power source properly ground, connect generator power cable to the pit box (not shown), and from the pit box to the TBM main electrical box power connection (A).

   Recommended Power Requirements
   • Recommended Operating Power:
   ..... 300kW / 330kVA @ 480 VAC

   • Generator Minimum Motor Starting kVA (skVA):
   ..... 830skVA with less than 35% instantaneous voltage dip and greater that 90% sustained voltage

2. Proceed to Checkout Equipment Prior Start-Up in this section.



CHECKOUT EQUIPMENT PRIOR TO START-UP

1. Perform equipment maintenance as shown in Periodic Maintenance section.

2. Connect clean water supply hoses to heat exchanger in TBM per the GPM water requirements shown in the water table below:

40°F	6.9 GPM	55°F	9.9 GPM	70°F	13.1 GPM	85°F	16.9 GPM
45°F	7.9 GPM	60°F	10.9 GPM	75°F	14.4 GPM	90°F	18.2 GPM
50°F	8.8 GPM	65°F	11.8 GPM	80°F	15.7 GPM		

NOTICE This water table shows typical GPM requirements per water temperature. The actual GPM requirements may be more or less depending on ground conditions.

3. Check the oil level in on-board hydraulic reservoir. Add oil if necessary.

4. Inspect conveyor lift cables daily and replace immediately at the first sign of wear.

5. Check to be sure all suction valves are open and tie strapped to prevent accidental closing of valve.

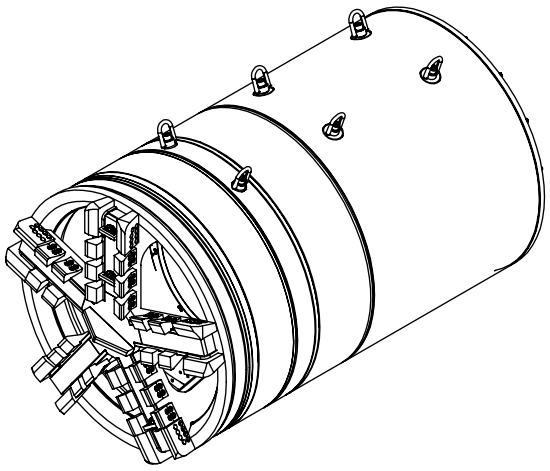
6. Inspect all hoses and electrical lines for damage. Replace before operating.

7. Be sure all hydraulic hoses and electrical lines are properly installed.

8. Refer to your haul unit, gas detection system, and jacking frame operation manuals for pre-start checks.

9. Be sure to check the operation of ALL E-Stop buttons before operating TBM.

10. Proceed to Power Start Up Procedure in this section.



POWER START UP PROCEDURE

Once generator power, electrical cables and hydraulic hoses are properly connected, the power can be started as follows:

1. With E-Stop button(s) (A) pushed in, turn on generator/power source main power to the power pack.

2. Check Phase Power Indicators. If the green Phase OK indicator (B) is illuminated, the external phase power is installed correctly and the power pack main power can be turned on. If the red Phase Error indicator (C) is illuminated, the external power source is installed incorrectly. Lockout tagout all power before disconnecting power lead cables. Have a certified electrician reverse the two generator electrical phase conductors on the power circuit and recheck phase power.

   IMPORTANT: If the red Phase Error indicator is illuminated, the starting is disabled. This starting interlock will prevent the components from running backwards which would result in damage.

3. With proper phase power, pull out ALL E-Stop button(s) (A).

4. Flip main power disconnect switch (D) on the pit box to the ON position.

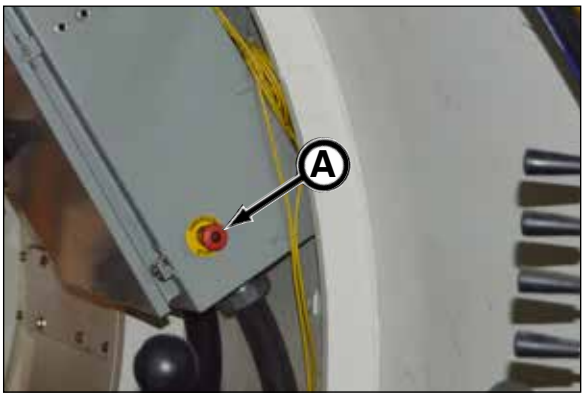
5. Turn Boring Head switch (E) to the ON position.

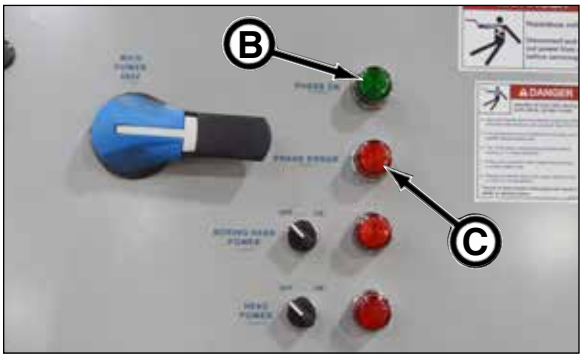
6. Turn Head Power switch (F) to the ON position.

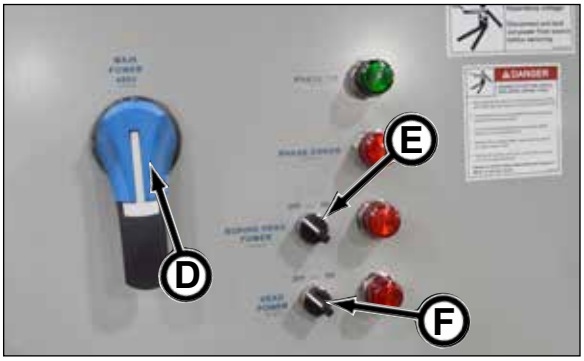
7. Flip main power disconnect switch (G) on the TBM electrical box to the ON position.

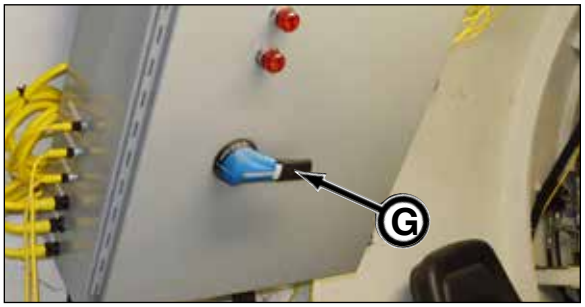
8. To start the 300 HP motor, simply press the 300 HP motor control button (H) so the Start Pump indicator (I) turns green indicating the motor is ON. Verify that the motor rotation is correct.

9. Proceed to Check Hydraulics After System Start-Up in this section.









CHECK HYDRAULICS AFTER SYSTEM START-UP

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

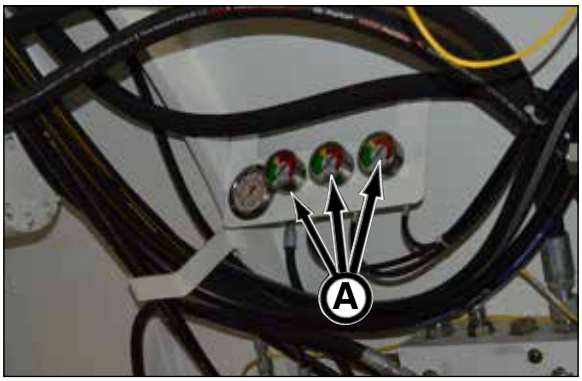
Release all pressure before performing maintenance or repairs, Never weld near pressurized fluid lines.

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. Check all return filter indicators (A). Once operating temperature reaches at least 100°F (38°C), if the filter indicator needle is in the red CHANGE zone, replace filter(s).

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



3. Check hydraulic oil level gauge (B) in hydraulic oil reservoir.

   Fill reservoir with clean, fresh, **FILTERED** ISO-VG-68 Premium Hydraulic/Turbine Oil or equivalent to full mark on gauge. Filling reservoir with unfiltered oil will cause component damage. Do not mix oil manufacturers or grades.

4. Check pressure gauges for proper hydraulic operation.

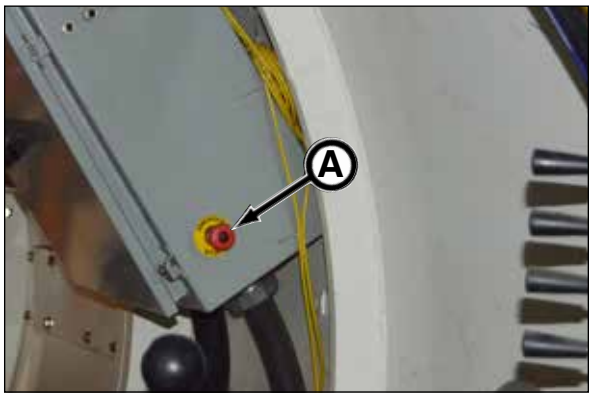
5. Proceed to System Launch & Operation Procedure in this section to start TBM operations.

USING EMERGENCY STOP

Push IN Emergency Stop button (A) to stop ALL power.

Push IN Emergency Stop buttons (B or C) on the foam generation system to stop foam generation functions.

All Emergency Stop buttons must be pulled out to restart operation.



USING GAS DETECTOR

⚠DANGER Be aware that the harmful effects of entering an oxygen-deficient atmosphere can be so immediate that it is impossible to retreat to safety.

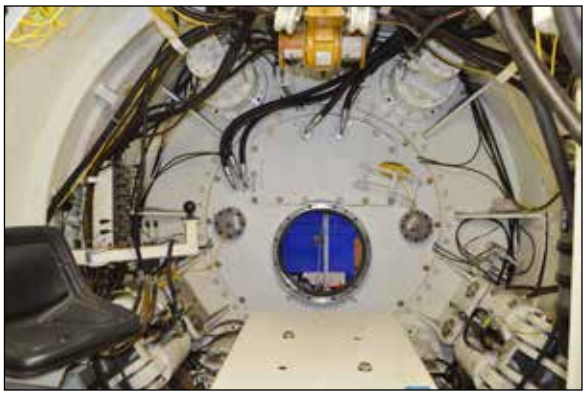
Refer to your Gas Detection System Operation & Parts Manual for properly operating the gas detector.

The gas detection system installed in the TBM system monitors only methane gas levels. **Monitoring of all gas levels is the responsibility of the contractor.** This includes the accumulation of combustible and toxic gases, and depletion of oxygen. The contractor must keep the tunnel ventilated with fresh air.

The gas detection system installed in the TBM CANNOT be the only methane or other combustible monitoring system. The gas concentration must be checked by other portable detectors to inspect the tunnel at the beginning of each shift to determine that the tunnel is gas free before any tunnel equipment is energized or personnel are allowed to enter the tunnel. The contractor is responsible for providing air analyzers to detect hazardous gases or oxygen deficiency on the job and in the tunnel at all times.

ADJUSTING THRUST PRESSURE

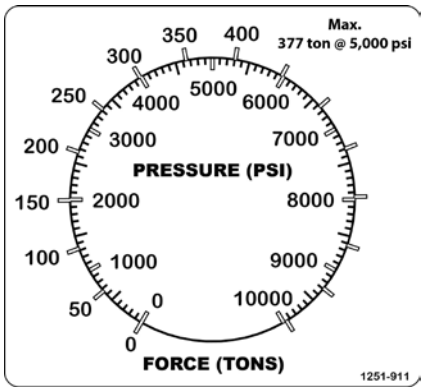
To protect your product pipe and tunnel liner (such as liner plate or ring beam and lagging), you must be sure the pipe or tunnel liner can withstand the thrust pressure of the TBM system. The factory setting is 5,000 psi (34.474 mPa). If your pipe, liner plate or ring beam and lagging is rated lower than 5,000 psi (34.474 mPa), the jacking system thrust pressure must be adjusted. Failure to do so WILL damage your pipe, liner plate or ring beam.



IMPORTANT: Only a qualified service technician is allowed to perform pressure adjustments.

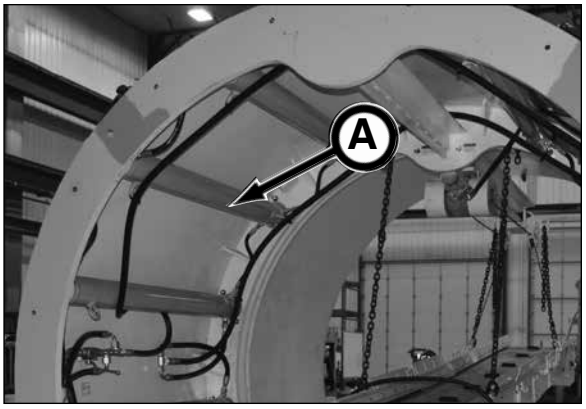
1. Check the thrust pressure rating for your product pipe, liner plate, or ring beam and lagging.

2. Calculate the pressure limit for your product pipe, liner plate, or ring beam and lagging. based on every 1,000 psi is equal to approximately 75 tons of thrust pressure. Or refer to the thrust pressure diagram shown.

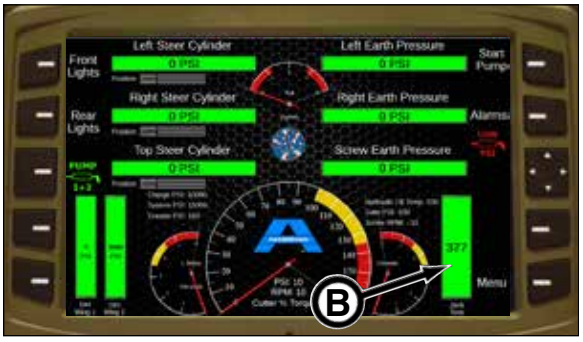


Thrust Pressure Diagram

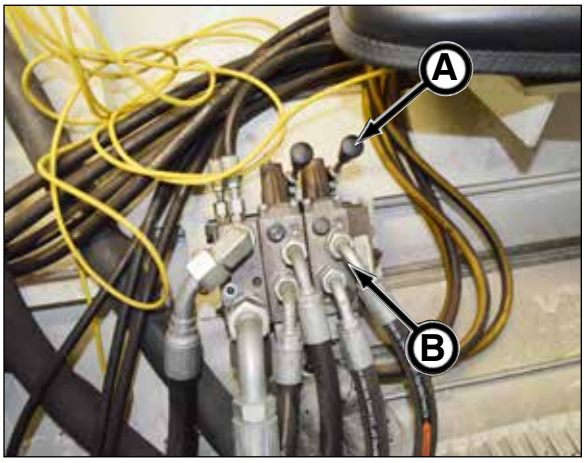
3. Fully extend and fully retract the jacking can cylinders (A) to view the extend pressure and retract pressure for setting pressure adjustments.



4. Check the thrust (jacking) tons on the Jack Tons gauge (B).



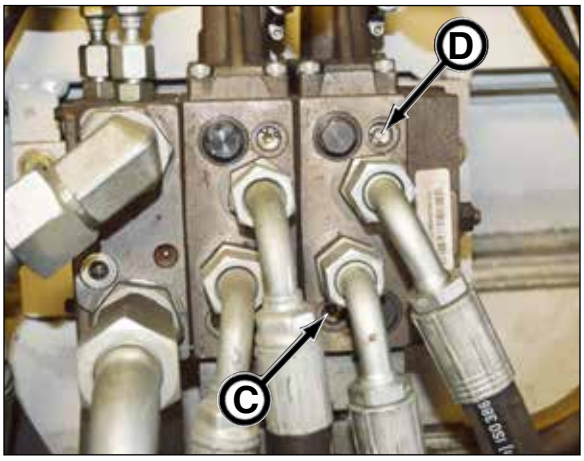
(continued on next page)



IMPORTANT: Only a qualified service technician is allowed to perform pressure adjustments.

5. With the jacking cylinder control (A), adjust the thrust pressures at the jacking valve (B) as follows:

Using a 4 mm allen wrench:



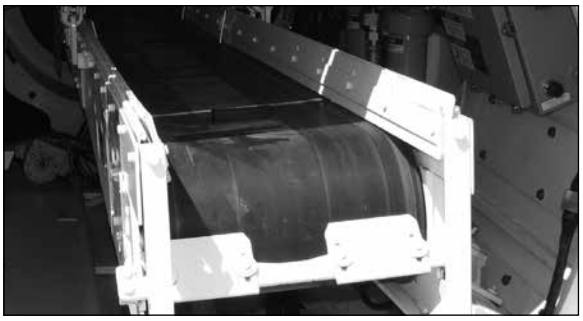
Extend Pressure Adjustment Screw (C)
Fully extend jacking cylinders:
• If the pressure needs to be decreased, turn adjustment screw (C) OUT. The pressure will drop approximately 1,000 psi per one complete revolution.

• If the pressure needs to be increased, turn adjustment screw (C) IN. The pressure will increase approximately 1,000 psi per one complete revolution.

Retract Pressure Adjustment Screw (D)
Fully retract jacking cylinders:
• If the pressure needs to be decreased, turn adjustment screw (D) OUT. The pressure will drop approximately 1,000 psi per one complete revolution.

• If the pressure needs to be increased, turn adjustment screw (D) IN. The pressure will increase approximately 1,000 psi per one complete revolution.

ADJUSTING CONVEYOR (BELT/SCREW) PRESSURE



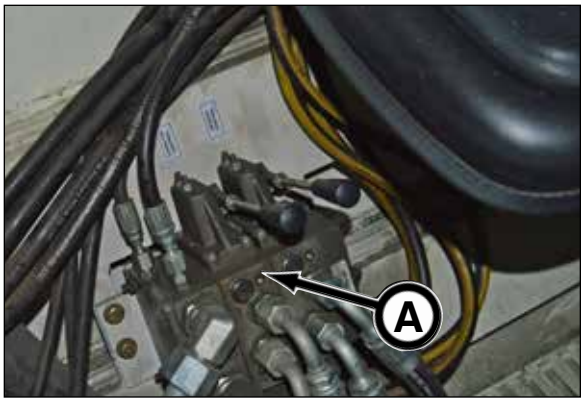
If switching conveyors, it is critical that the conveyor pressure relief settings are changed on the conveyor valve.
The belt conveyor is rated at 3,000 psi (20.684 mPa) and the screw conveyor is rated at 5,000 psi (34.474 mPa).

Belt Conveyor

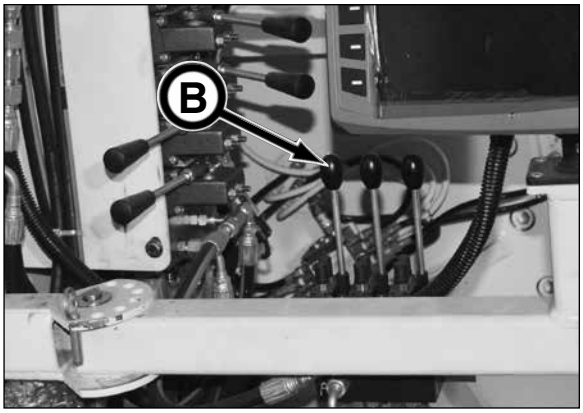
Failure to adjust the conveyor pressure from 5,000 psi to 3,000 psi, WILL result in damage to the conveyor components and hoses.

Screw Conveyor
Failure to adjust the conveyor pressure from 3,000 psi to 5,000 psi, will result in poor conveyor performance.

IMPORTANT: Only a qualified service technician is allowed to perform pressure adjustments.



1. Uncouple the conveyor hydraulic hose QDs to perform the pressure adjustments at the conveyor valve (A).

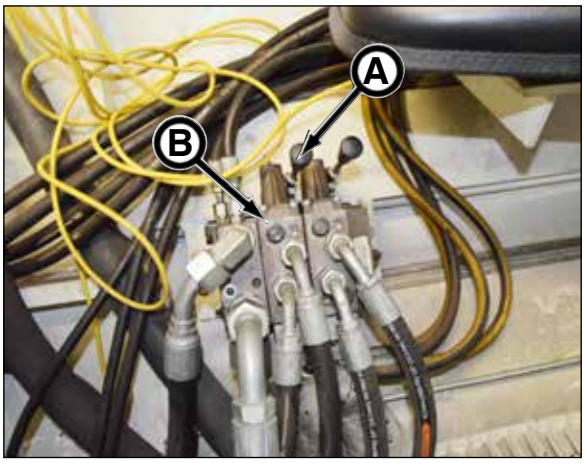


2. Fully move the conveyor lever (B) forward. Check pressure on Conveyor gauge (C).

3. Fully move the conveyor lever (B) back. Check pressure on Conveyor gauge (C).

4. If the pressures noted in steps 2 and 3 are not the proper settings per conveyor used (belt - 3,000 psi, screw - 5,000 psi), proceed to step 5 to reset conveyor relief pressure.

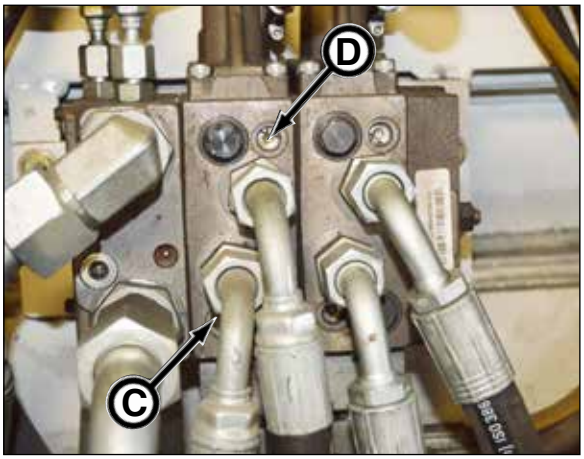
(continued on next page)



5. With the conveyor control (A), adjust the conveyor pressure at the conveyor valve (B) as follows:

Using a 4 mm allen wrench:

Belt Conveyor Pressure: 3,000 psi
Screw Conveyor Pressure: 5,000 psi



** Clockwise Drive Adjustment Screw (C)*
Fully move the conveyor lever in the forward direction:
• If the pressure needs to be decreased, turn adjustment screw (C) OUT. The pressure will drop approximately 1,000 psi per one complete revolution.

• If the pressure needs to be increased, turn adjustment screw (C) IN. The pressure will increase approximately 1,000 psi per one complete revolution.

** Counterclockwise Pressure Adjustment Screw (D)*
Fully move the conveyor lever in the back direction:
• If the pressure needs to be decreased, turn adjustment screw (D) OUT. The pressure will drop approximately 1,000 psi per one complete revolution.

• If the pressure needs to be increased, turn adjustment screw (D) IN. The pressure will increase approximately 1,000 psi per one complete revolution.

NOTICE If hoses have been switched, the adjustment screws will be opposite of the above procedures.

** viewed from the operator seat.*

CONTROLLING FOAM GENERATION SYSTEM

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

⚠WARNING Be sure the Foam Generator PVC panels are in place before operating to prevent contact with dangerous parts. Failure to do so could cause severe injury or death.

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

NOTICE All Emergency Stop buttons must be pulled out to restart operation.

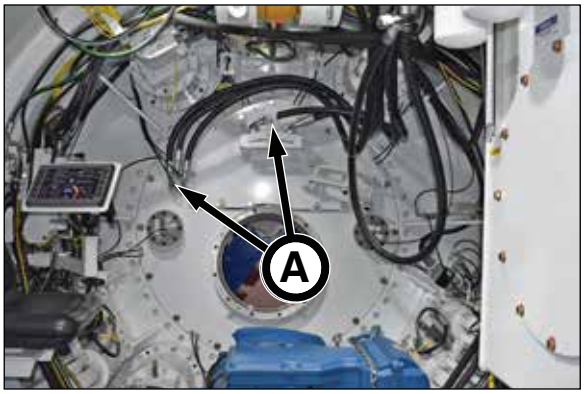
NOTICE Before using the Foam Generator System, be sure that the Foam Electrical Box is properly locked.

NOTICE Before starting the Foam Electrical Box, be sure all the Foam Cannon valves are in the open position.

The Foam Generator System comprises a foam generator, foam electrical box, foam control box, and foam cannon.

The foam injection ports (A) (6) on the TBM bulkhead pump foam into the cutterhead chamber, screw conveyor and the cutterhead face to mix with spoils and create a “toothpaste consistency” for spoil removal through the screw conveyor.

IMPORTANT: Before starting and start up of the Foam Generator System controls, be sure the power start up and check hydraulics after systems start up procedures are performed. Be sure that the cutterhead and screw conveyors are rotating AND the jacking cylinders are extending.



TBM 840 SN2 foam injection port locations shown (the sixth location is into the screw conveyor)

(continued on next page)

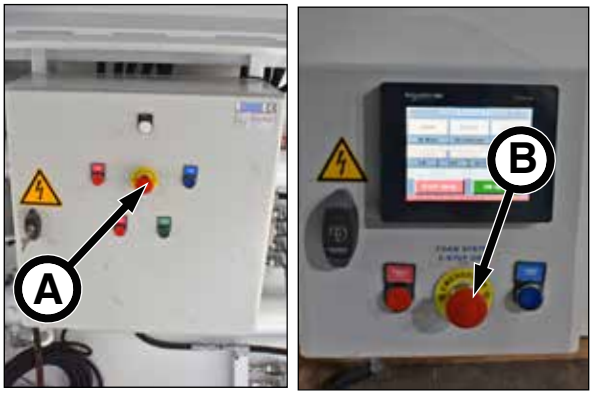
Controlling Foam Generation System (continued)

1. Connect the Foam Generation System electrical, compressed air, and water circuits.

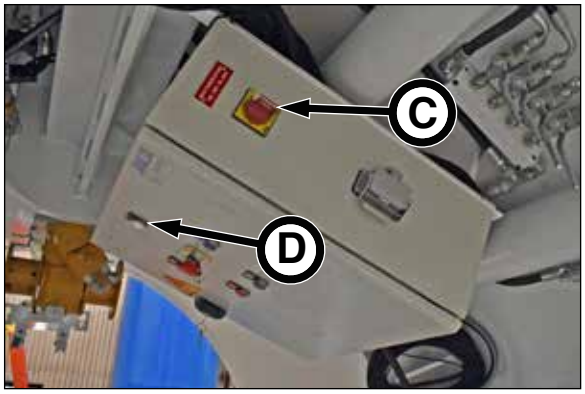
2. Connect the foaming agent concentrate tank to the foam inlet.

3. Check that the manual water and air shutoff valves are open.

4. Pull out Emergency Stop (A, B) on Emergency Stop buttons on the Electrical and Control **IMPORTANT: This emergency stop shuts down Foam Generator System power ONLY. This emergency stop DOES NOT shut down tunnel power.**

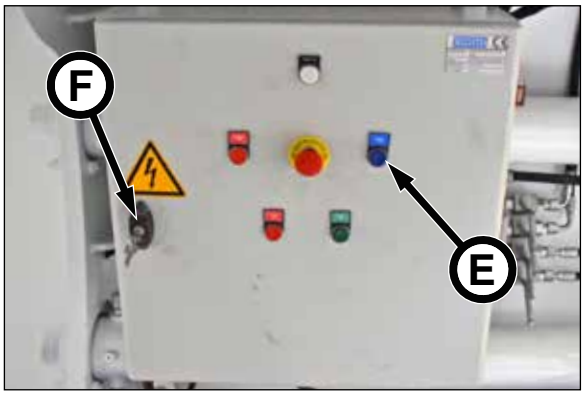


5. Turn the Foam Main Power Disconnect switch (C) CW to the ON position. The Power On indicator light (D) will illuminate in white.



7. Press the Safety Reset push button (E). The Foam Generator System is now ready to operate.

8. Lock (F) the Foam Generator Electrical Box and retain the key. Move to the Foam Control Box.



The operator uses Foam Control Box monitor to control foam distribution.

9. The Home Page tab (A) displays the system flow rates, pressures, concentrations and other essential parameters.

10. Press the Settings tab (B) to enter and adjust all foam control operating parameters. Press each button and set the percentages and flow rates per the foam plant and foam agent concentrate manufacturers' recommendations for the project.

    Refer to the Foam Injection Rate (FIR) table on the next page for FIR and Foam Expansion Ratio (FER) guidelines.

    a. To enter the setting, press an empty field alongside the surfactant concentration (C), FER, Foam flow or Working pressure parameters.

    b. In the next window, enter the appropriate numerical setting on the keypad (D) and press enter to return to the Settings window.

NOTICE Make sure to set the pressure regulator so the water pressure does not exceed 58 psi (4 bar).

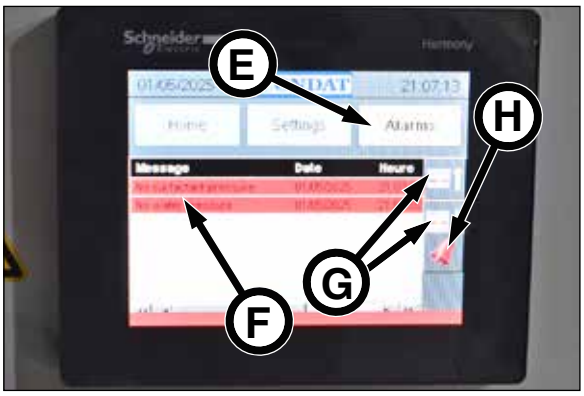
11. As needed, press the Alarms tab (E) to view system alarms and faults.

    Acknowledged Alarms, Active Unacknowledged, and Acknowledged messages display in a list (F).

    Scroll through the list of messages using the Scroll Up and Down buttons (G).

    To change the state of an Active Unacknowledged Alarm to an Acknowledged Alarm, highlight the message by pressing the Scroll Up or Scroll Down (G) button, and when highlighted, press the Alarm Acknowledgment (bell) (H) button.

    The Active Unacknowledged Alarm message(s) will now change to Acknowledged Alarm messages (F).



Foam Injection Rate (Liter/Min) - 98" Gage Cut

Advancement Rate (inches/min)	Foam to Soil Ratio (%)																														
	20.0	22.5	25.0	27.5	30.0	32.5	35.0	37.5	40.0	42.5	45.0	47.5	50.0	52.5	55.0	57.5	60.0	62.5	65.0	67.5	70.0	72.5	75.0	77.5	80.0
1.00																			100	104	108	112	116	120	124
1.25															102	107	111	116	120	125	130	134	139	144	148
1.50												103	108	114	119	124	130	135	141	146	151	157	162	168	173
1.75										105	111	117	124	130	136	142	148	154	161	167	173	179	185	191	198
2.00								104	111	118	125	132	139	146	153	160	167	174	181	188	195	202	208	215	222
2.25						100	108	116	124	131	139	147	154	162	170	178	185	193	201	208	216	224	232	239	247
2.50					102	110	119	127	136	144	153	161	170	178	187	195	204	212	221	229	238	246	255	263	272
2.75				102	111	120	130	139	148	158	167	176	185	195	204	213	222	232	241	250	259	269	278	287	297
3.00			100	110	120	130	141	151	161	171	181	191	201	211	221	231	241	251	261	271	281	291	301	311	321
3.25			108	119	130	141	151	162	173	184	195	205	216	227	238	249	259	270	281	292	303	313	324	335	346
3.50		104	116	127	139	151	162	174	185	197	208	220	227	243	255	266	278	290	301	313	324	336	347	359	371
3.75		111	124	136	148	161	173	185	198	210	222	235	247	259	272	284	297	309	321	334	346	358	371	383	395
4.00	105	118	131	144	158	171	184	197	210	223	236	249	263	276	289	302	315	328	341	354	368	381	394	407	420
4.25	111	125	139	153	167	181	195	208	222	236	250	264	278	292	306	320	334	347	361	375	389	403	417	431	445
4.50	117	132	147	161	176	191	205	220	235	249	264	279	293	308	323	337	352	367	381	396	411	425	440	455	469
4.75	124	139	154	170	185	201	216	232	247	263	278	293	309	324	340	355	371	386	402	417	432	448	463	479	494
5.00	130	146	162	178	195	211	227	243	259	276	292	308	324	341	357	373	389	405	422	438	454	470	486	503	519
5.25	136	153	170	187	204	221	238	255	272	289	306	323	340	357	374	391	408	425	442	459	476	493	510	527	544
5.50	142	160	178	195	213	231	249	266	284	302	320	337	355	373	391	408	426	444	462	480	497	515	533	551	568
5.75	148	167	185	204	222	241	259	278	297	315	334	352	371	389	408	426	445	463	482	500	519	537	556	574	593
6.00	154	174	193	212	232	251	270	290	309	328	347	367	386	405	425	444	463	483	502	521	541	560	579	598	618
6.25	161	181	201	221	241	261	281	301	321	341	361	381	402	422	442	462	482	502	522	542	562	582	602	622	642
6.50	167	188	208	229	250	271	292	313	334	354	375	396	417	438	459	480	500	521	542	563	584	605	625	646	667
6.75	173	195	216	238	259	281	303	324	346	368	389	411	432	454	476	497	519	541	562	584	605	627	649	670	692
7.00	179	202	224	246	269	291	313	336	358	381	403	425	448	470	493	515	537	560	582	605	627	649	672	694	717
7.25	185	208	232	255	278	301	324	347	371	394	417	440	463	486	510	533	556	579	602	625	649	672	695	718	741
7.50																									

FIR
FIR = Foam injection ratio
Start at 40% Foam to Soil ratio or 100 l/m
Target a 4"-8" Slump with concrete cone

FER
FER = Foam Expansion Ratio (5%-30%)
Low FER is Wet Foam, used in dry soils
High FER is Dry Foam, used in wet soils

Foam Agent
Foaming agent concetration varies depending on agent and geology (1-5%). See foaming agent manufaturer for dosage recommendations.

M5B Foam Injection System has a minimum pumping rate of 100 l/min

NOTICE This foam injection rate table advancement rate and foam to soil ratio are specific to the TBM 840 diameter only.

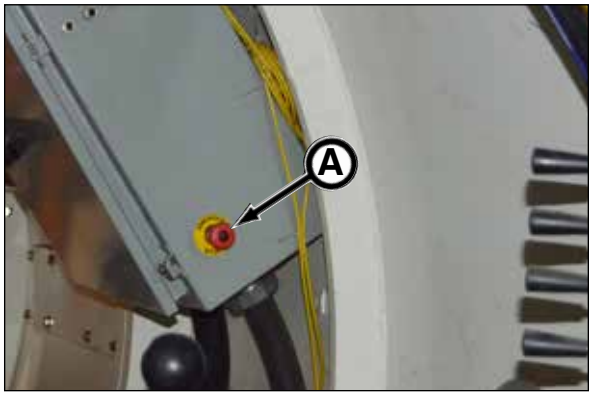
LAUNCH & OPERATION PROCEDURE

Use the following as a general launch and operation procedure for installing liner plate/ring beam and lagging using the jacking can. The 840 TBM can also be used to install pipe using a jacking system.

NOTICE The system set-up, equipment checkout, power start up and checking hydraulics after system start-up procedures must be completed prior to performing the launch and operation procedure.

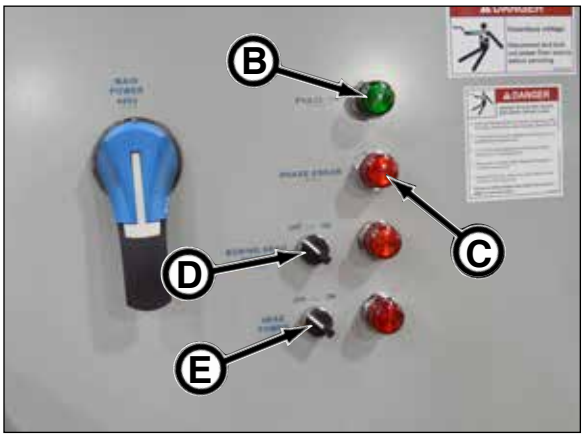
⚠WARNING Any electrical work performed on the electrical components must be completed by a certified electrician.

1. With Emergency Stop button (A) pushed IN and all other controls turned to OFF position, hook up generator or other external power source to pit box (refer to Connecting Power Pack Electrical Connections in this section).
2. Turn generator or other source ON, and check the phase indicator lights (refer to Power Start Up Procedure in this section). If the green Phase OK light (B) is ON, the power leads are connected correctly and you can now proceed to running the TBM.



NOTICE If the red Phase Error light (C) is ON, the generator phase power is installed incorrectly (refer to Power Start Up Procedure in this section).

3. Confirm that all TBM controls are in the OFF position.
4. Connect clean water supply hoses to heat exchanger in TBM per the GPM water requirements shown in the water table below:



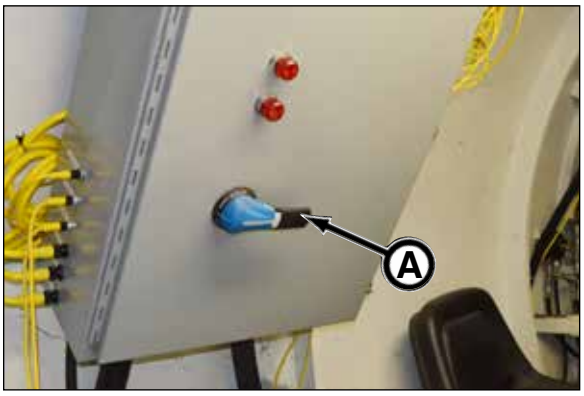
40°F	6.9 GPM	55°F	9.9 GPM	70°F	13.1 GPM	85°F	16.9 GPM
45°F	7.9 GPM	60°F	10.9 GPM	75°F	14.4 GPM	90°F	18.2 GPM
50°F	8.8 GPM	65°F	11.8 GPM	80°F	15.7 GPM		

NOTICE This water table shows typical GPM requirements per water temperature. The actual GPM requirements may be more or less depending on ground conditions.

5. Turn on cooling water supply to heat exchanger.
6. Pull out all E-Stop button(s) (A).
7. Flip main disconnect switch on pit box to the ON position.
8. Turn Boring Head switch (D) to the ON position. This provides power to the 300 HP electric motor.
9. Turn Head Power switch (E) to the ON position. This provides power to the TBM components, lights, steering, auxiliary and conveyor functions.

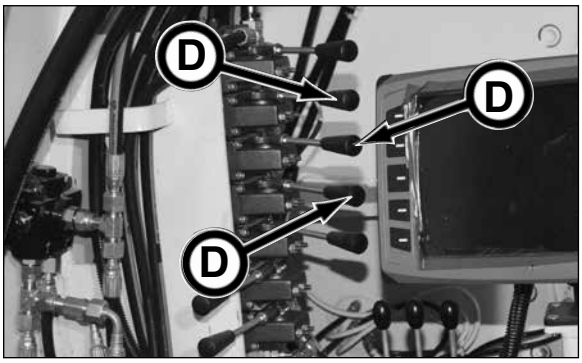
(continued on next page)

10. Flip main power disconnect switch (A) to the ON position. This switch provides power to the 300 HP motor.

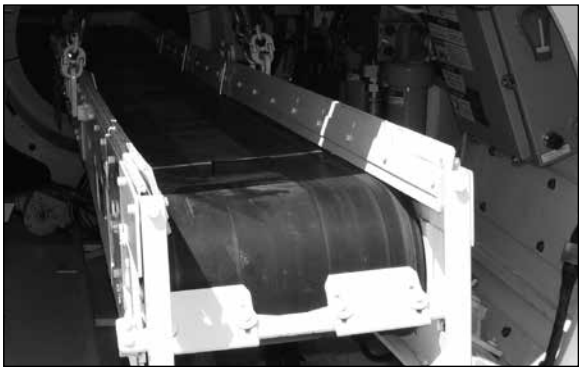


11. To start the 300 HP motor, simply press the 300 HP motor control button (B) so the Start Pump indicator (C) turns green indicating the motor is ON.

12. Fully extend steering cylinders with the Steering Cylinder controls (D) and then retract approximately 6 inches (152 mm).



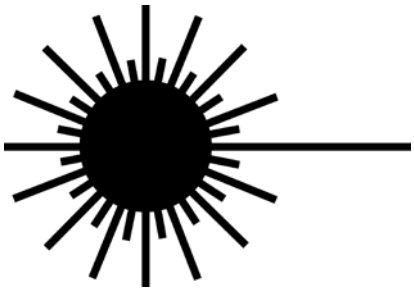
⚠WARNING Be sure that forward pull exists on the conveyor lifting cables and safety chains throughout the full advance travel. Failure to do so may cause severe injury from conveyor slipping out of the cutter bar center pin.



13. Return the conveyor to the maintenance position.

(continued on next page)

Launch & Operation Procedure (continued)

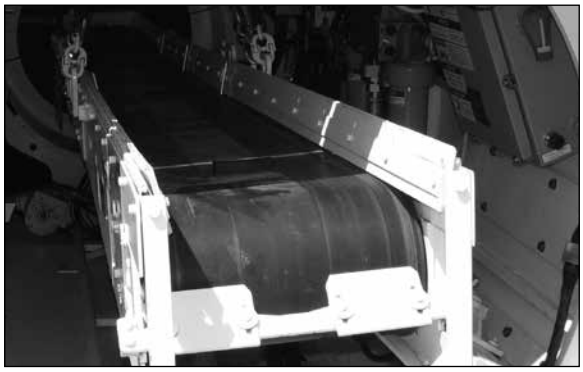


⚠DANGER Staring into laser light will cause severe injury. Do not stare into laser guidance system light beam. Avoid direct eye exposure.

14. Set laser guidance system to grade and alignment. Be sure the laser beam can be easily seen on the target bar (on the cutter attachment) from the operator seat. Adjust conveyor as needed.

NOTICE For proper guidance system installation, refer to your laser manufacturer's installation requirements.

NOTICE If using Akkerman AZ100 Total Guidance System or other guidance system, refer to the guidance system operation manual for proper setup.

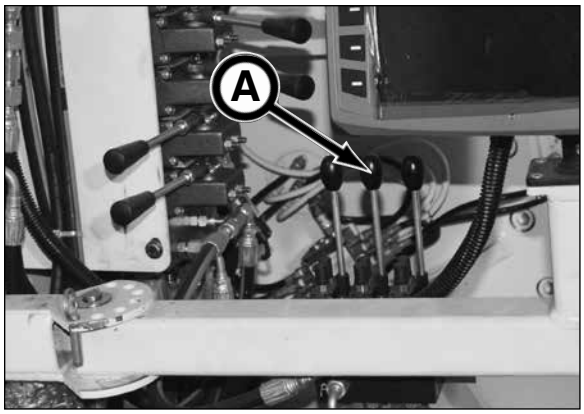


NOTICE Typically after TBM is leveled and prior to launching the TBM, some operators steer 1/2 to 3/4 in. (13 to 19 mm) up to compensate for the ground conditions at start up. The TBM has a tendency to dip once launched into the ground. This steering adjustment is dependent upon ground conditions.

15. Move the conveyor into the operating position.

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

16. Place the dirt bucket into position behind the conveyor; do not install the haul unit at this time.

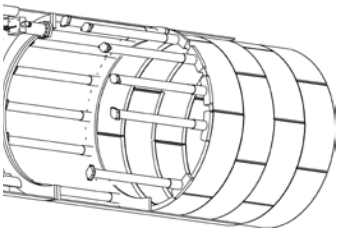


17. Retract jacking can cylinders with Jack Can Cylinder Control (A).

(continued on next page)

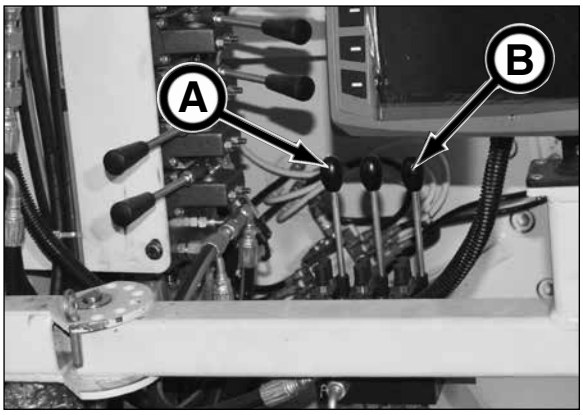
Launch & Operation Procedure (continued)

18. Assemble liner plate rings/ring beam and lagging in jack can.



⚠WARNING If using segment lining controls, use only with segmented rings. Do not use the segment lining controls with the one piece thrust ring. Doing so may cause severe injury or death and component damage.

19. Once the liner plate rings/ring beam and lagging are assembled in liner can of TBM, extend the jacking can cylinders while rotating the cutterhead. The cylinders apply pressure to the liner plate which applies pressure to the thrust block or other support structure, pushing the TBM forward.



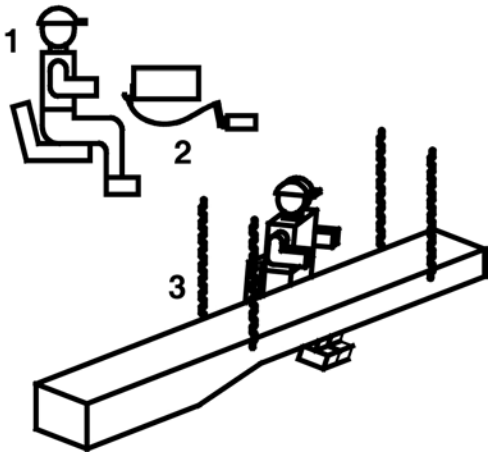
NOTICE Before rotating the cutterhead, be sure the cutter teeth will not interfere with jacking system frame.

NOTICE If operating in EPB mode, refer to Advancing 840 TBM In EPB (Closed) Mode in this section.

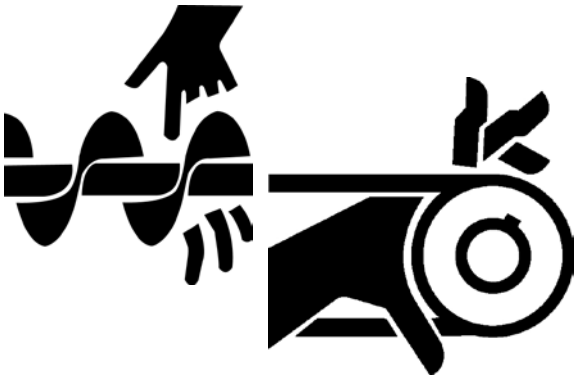
20. Operate the conveyor with control (A) to desired speed to empty spoils into dirt bucket, rotate cutterhead with boring head control (B) and apply forward thrust to the TBM from jacking can/jacking system.

NOTICE Refer to Operating The Conveyor in this section for more information.

⚠WARNING Conveyor can jam in rotating cutterhead causing conveyor to swing into operator, resulting in severe personal injury. While cutterhead is rotating:



1. Operator MUST remain seated in normal operating position.
2. The conveyor safety valve (cutterhead drive dump valve) MUST be tethered to conveyor and the operation MUST be tested before starting the conveyor to ensure proper operation.
3. ALL FOUR safety chains MUST be secured to conveyor before operating inner drum.



⚠DANGER Contact with rotating auger conveyor or belt conveyor rollers will cause severe injury or death.
Keep hands, body, and objects clear of operating auger and conveyor. Do not operate without covers and guards in place. Lockout tagout power before servicing.

(continued on next page)

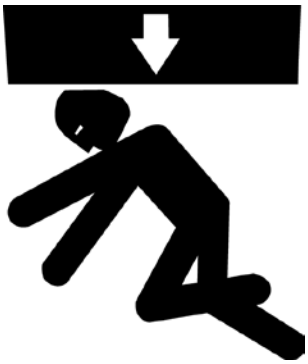
Launch & Operation Procedure (continued)

21. When the jacking can cylinders are completely extended, retract the cylinders.

22. Check and adjust grade and alignment after each dirt bucket removal to avoid excessive jacking pressure, and more often if necessary.

23. Continue assembling liner plate rings/ring beam and lagging until TBM has been advanced forward enough to lower haul unit into TBM.

24. Check if TBM over cut is sufficient to allow steering corrections, but does not exceed job specifications.



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

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

26. Unload dirt bucket. The dirt bucket is self-dumping when using a two-line crane or when attaching a stationary line.

27. Check and adjust grade and alignment often (after each dirt bucket at a minimum) to avoid misalignment and excessive jacking pressure. Refer to Making Steering Adjustments and Adjusting TBM Roll in this section.

IMPORTANT: While operating TBM, periodically check to be sure the bearing oil lubrication pump and grease pumps and are functioning properly.

(continued on next page)

Launch & Operation Procedure (continued)

28. Before installing first track section, turn pump off with control button (A). On the pit box, turn Head power and Boring Head switches to OFF position. Also turn main disconnect switch to OFF position.

29. Install the first track section. Refer to your Haul Unit Operator's Manual for track installation. Sections of track will need to be added as new liner plate sections are assembled. Also, be sure there is always track connecting the pipeline and the skid/rail assembly for the haul unit loading and unloading of the dirt bucket.

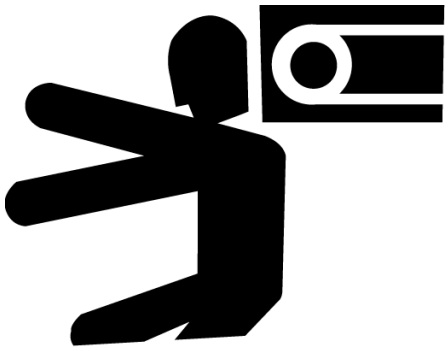
⚠WARNING Suspended loads may fall and cause severe injury or death. Do not allow anyone to enter area under or around a suspended load.

30. Lower haul unit onto track. Refer to your Haul Unit Operator's Manual for haul unit installation.

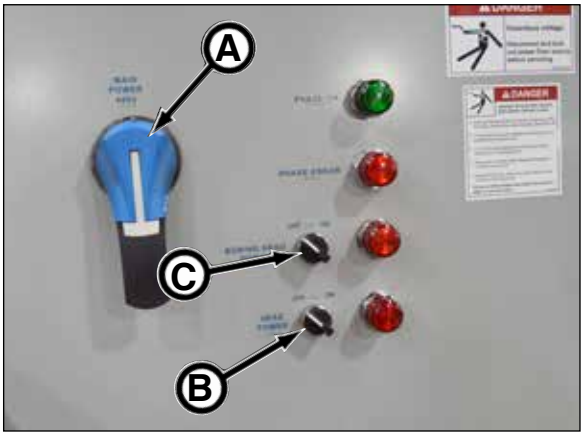
(continued on next page)

Launch & Operation Procedure (continued)

31. Lower dirt bucket into place on haul unit. Move the haul unit into the pipeline until the dirt bucket is underneath the 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.



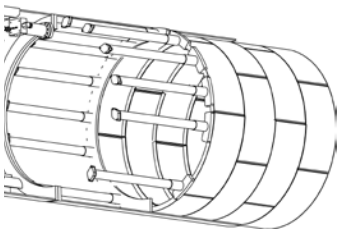
32. On pit box, turn main disconnect switch (A) to ON position. Turn Head power (B) and Boring Head (C) switches to ON position.

33. Start 300 HP motor with control button (D).

(continued on next page)

Launch & Operation Procedure (continued)

34. Retract jacking can cylinders.



35. Assemble liner plate rings/ring beam and lagging in TBM.

36. Once the liner plate rings/ring beam and lagging are assembled in jacking can of TBM, simultaneously extend the jacking can cylinders, rotate the cutterhead and operate the conveyor as needed.

37. When the jacking can cylinders are completely extended, retract the cylinders.

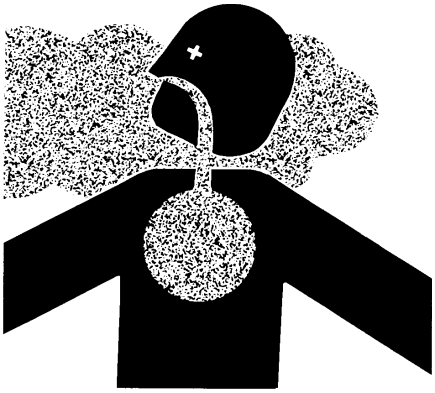
38. Unload the dirt bucket once it is full by moving it to the unloading/loading zone in the launch shaft with the haul unit.

39. Recheck laser guidance system accuracy often, with and without forward thrust applied to avoid making improper steering corrections.

40. Periodically it will be necessary to stop the TBM operation to add power cables, ventilation, communication lines, water lines, foam system lines (if equipped), and track in the tunnel.
    a. On control monitor, turn off pump.
    b. On pit box, turn Head Power and Boring Head switches to the OFF position.
    c. Turn main disconnect switch on the foam electrical box to OFF position, and turn the foam cannon valves and foam manifold valves to the OFF position.
    d. Turn main disconnect switch on pit box to OFF position.

41. Disconnect the ventilation, electrical, compressed air, water and communication lines.

⚠ DANGER The Akkerman gas detection system only monitors methane gas levels. Monitoring of gas levels is the responsibility of the contractor. This includes accumulation of combustible and toxic gases, and depletion of oxygen. The contractor must keep the tunnel ventilated with fresh air AT ALL TIMES.

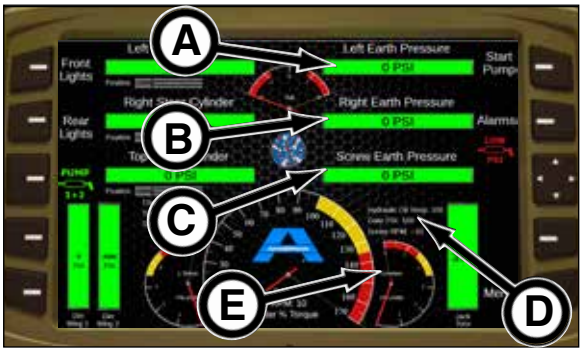


42. Add utilities in TBM and pipeline. Once it is verified by all tunnel personnel that is it safe to restart operations, restart power to TBM.

43. Continue to install additional liner plate/ring beam and lagging in jacking can and add utilities as needed until pipeline is complete.

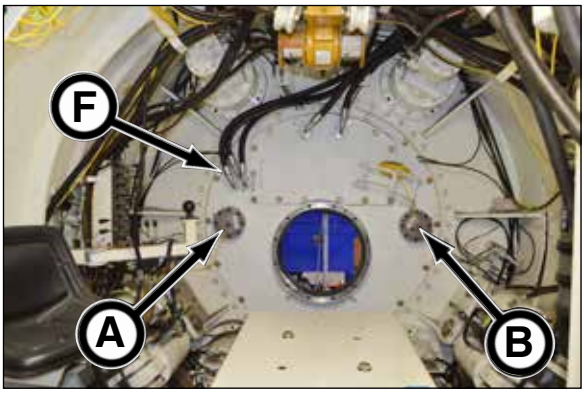
ADVANCING 840 TBM IN EPB (CLOSED) MODE

To retain the earth pressure as recorded on the geotechnical report while mining, the operator manually adjusts the machine advance rate or the spoil removal rate using the screw conveyor speed/ rear gate opening to keep the earth pressure in the acceptable range. ***The face pressure must be maintained to prevent over and under mining.***



The control monitor displays the earth pressure at the front bulkhead and at the front of the screw conveyor.

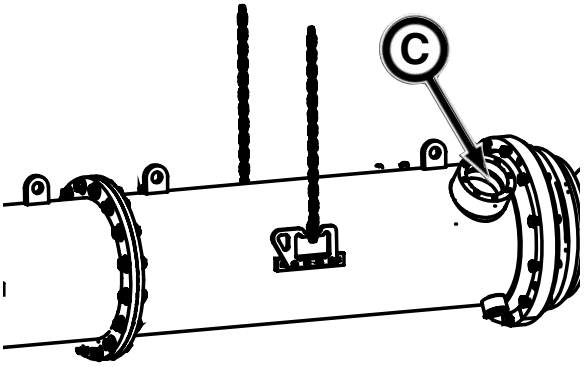
TBM
The Left Earth Pressure (A) and Right Earth Pressure (B) displays the left and right bulkhead earth pressure sensor readings of the pressure transducers.



Screw Conveyor
The Screw Earth Pressure (C), Gate PSI (cylinder) and screw conveyor rpm (D) and screw drive pressure gauge (E) display the readings of the screw conveyor pressure transducers.

The three EPB sensors are rated at 14.5 psi (1 bar).

A - Left Earth Pressure Sensor/Gauge
B - Right Earth Pressure Sensor/Gauge
C - Screw Earth Pressure Sensor/Gauge
D - Screw Conveyor Gate (Cyl) Pressure
E - Screw Conveyor Drive Pressure



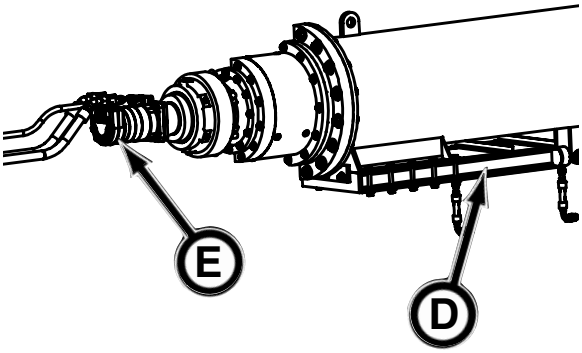
Guidelines

1. While retaining earth pressure, **DO NOT EXCEED 15 psi.** Doing so will cause damage to the TBM seals.

2. Use a maximum of 80% cutterhead rotation when jacking. If an obstruction is encountered, there is an additional 20% torque available. Reduce jacking speed to reduce torque.

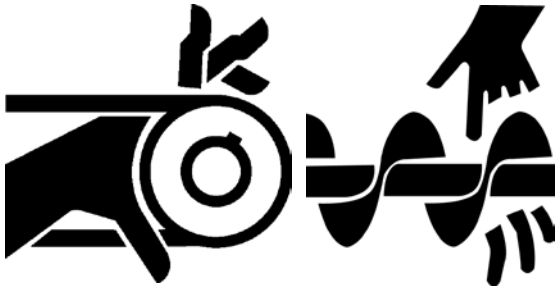
3. The cutterhead works equally well in both directions.
   - Watch for machine roll. If it exceeds 1.5 to 2 degrees, reverse the cutting head rotation.
   - Operate cutterhead rotation at high speeds in stable ground, lower speeds in unstable ground.

4. The screw conveyor speed must be adjusted as needed to retain the earth pressure balance. Screw conveyor rpm is indicated on the control monitor. Adjusting the screw conveyor rear gate opening can also be used to control spoil flow.
   - Reduce screw conveyor speed to increase soil pressure.
   - Increase screw conveyor speed to reduce soil pressure.



5. Ports (F) are provided on the bulkhead for pumping foam or slurry into the cutterhead chamber to mix with the spoils to create a “toothpaste consistency” for removal through the screw conveyor.

OPERATING THE CONVEYOR



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

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

Do not operate without covers and guards in place.

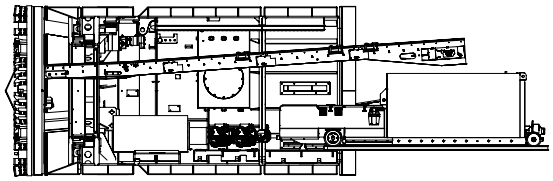
Lockout/tagout power before servicing belt or screw conveyor.

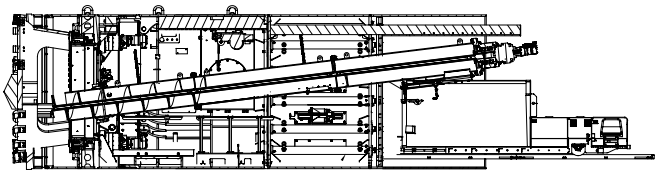
Conveyor Operation Guidelines:

1. Check conveyor for damage before operating. Repair or replace damage or wear before operating.
2. Operator MUST remain seated in normal operating position.
3. ALL FOUR safety chains MUST be secured to conveyor before operating.
4. Avoid contact with conveyor.
5. Keep hands, body, and objects clear of operating conveyor.
6. Do not operate without covers and guards in place.
7. Lockout tagout power before performing maintenance or repairs on conveyor.
8. NEVER perform maintenance to conveyor while the conveyor is running.
9. While conveyor is running, DO NOT try to dislodge material from pulleys.
10. NEVER use a shovel, or other hand tool to clean material buildup while the conveyor is running.
11. Before operating conveyor, check to be sure the belt is properly tensioned.

NOTICE Refer to Conveyor Controls in section 4, Controls & Instruments for proper control operation.

1. With conveyor properly installed and all guards in place, inform all personnel in tunnel that the conveyor is going to start up and to stay clear of the conveyor.





2. Move conveyor into operating position with conveyor lift control using controls to adjust lift speed.

⚠WARNING Adjusting the lift speed too quickly for the operator to handle could cause severe injury or machine damage.

NOTICE Do not over-raise the conveyor. Doing so may cause damage to the conveyor and TBM.

3. Move dirt bucket into position to catch spoils from conveyor.

⚠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.

4. Operate conveyor control to control the direction and speed of the belt or screw conveyor.

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

NOTICE Control the speed of the conveyor so when the spoils drop on the conveyor, they do not pile up on the belt or in the auger. A change in ground conditions will require periodic adjustments to the conveyor speed.

MAKING STEERING ADJUSTMENTS

NOTICE Steering adjustments are typically made when the dirt bucket is removed from the launch shaft, then the conveyor is lowered to expose the laser beam on the target bolt area.

NOTICE The more often the target position is checked, the less steering adjustments will be required.

When steering corrections are necessary, be sure to **make ONLY minor adjustments over several feet**. Making more extreme steering adjustments will increase the jacking forces due to the front and trailing sections are not in parallel.

At initial start up, the steering cylinders should all be set at the 50% cylinder position cylinder extension:

- **840: 6 in. (152 mm)**

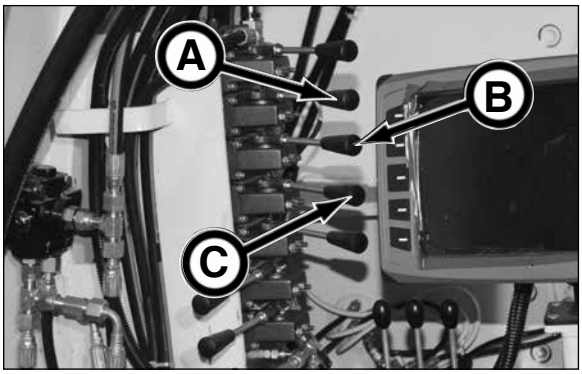
Move steering cylinders as follows:

Steer UP
Extend the left (A) and right (C) cylinders the same amount or retract the top (B) cylinders.

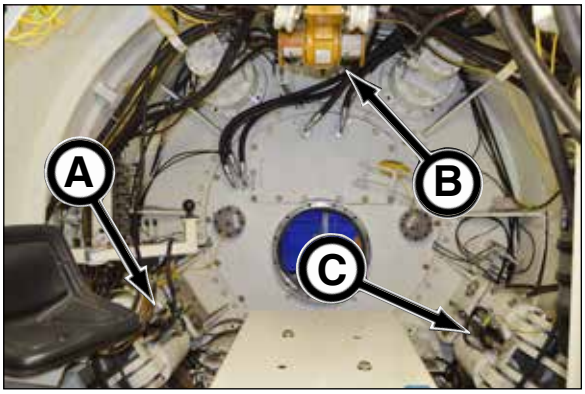
Steer DOWN
Extend the top (B) cylinders or retract the left (A) and right (C) cylinders the same amount.

Steer LEFT
Extend the right (C) and retract the left (A) cylinders the same amount or;
Extend the right (C) cylinders and then the top (B) cylinders half the amount of the right cylinders.

Steer RIGHT
Extend the left (A) and retract the right (C) cylinders the same amount or;
Extend the left (A) cylinders and then the top cylinders (B) half the amount of the left cylinders.

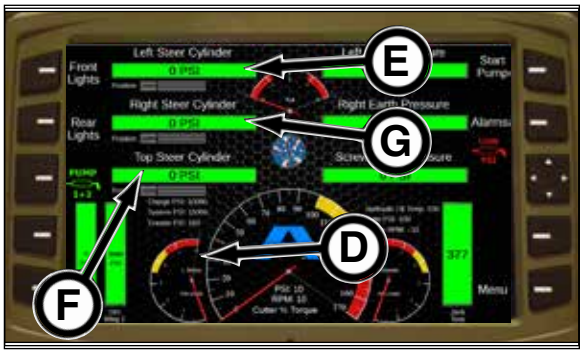


Steering Cylinder/Control - Left (A)
Steering Cylinder/Control - Top (B)
Steering Cylinder/Control - Right (C)



PRESSURE GAUGES
The Steering PSI gauges show the active pressure in the cylinders.

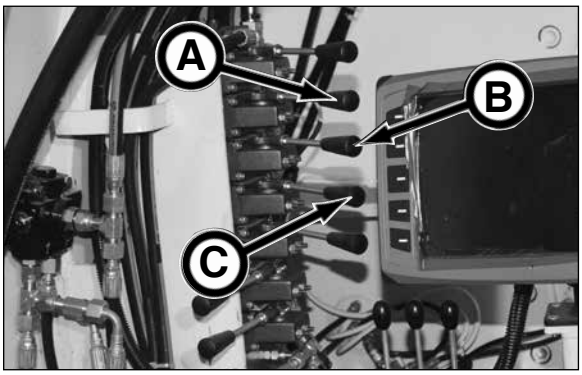
System (Load Sense) Pressure (D)
Steering Cylinder Pressure - Left (E)
Steering Cylinder Pressure - Top (F)
Steering Cylinder Pressure - Right (G)

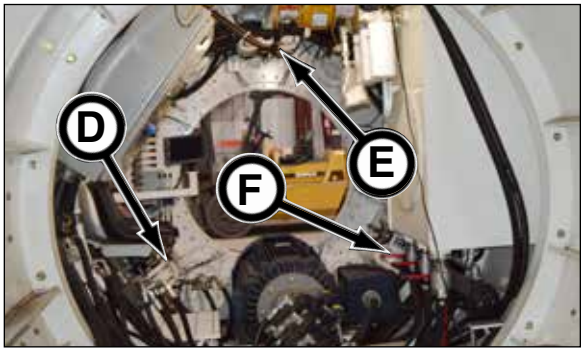


ACCESSING FRONT OF TBM / ENCOUNTERING AN OBSTRUCTION

To access the front of the machine and the face of the bore, retract the steering cylinders with control levers (A, B, & C). Be sure to perform the lockout tagout procedure before accessing the front of the TBM to prevent accidental startup.

This method allows for the removal of large obstructions, whether planned or unexpected and makes it easy to perform routine maintenance and repairs.





Steering Cylinders:
Left (D)
Top (E)
Right (F)

ADJUSTING TBM ROLL

If the TBM rolls 1/4 to 1/2 in. (6 to 13 mm) from level, the dirt wings need to be extended. The torque wings/dirt wings (G) are fully extended when the dirt wing pressure gauges (H) read 2,800 - 3,000 psi.

Control the TBM roll with torque wing lever or dirt wing control lever (I) as follows:

TORQUE WINGS (Straight Non-directional Fins)
- typically used in EPB mode with bi-directional cutterhead.

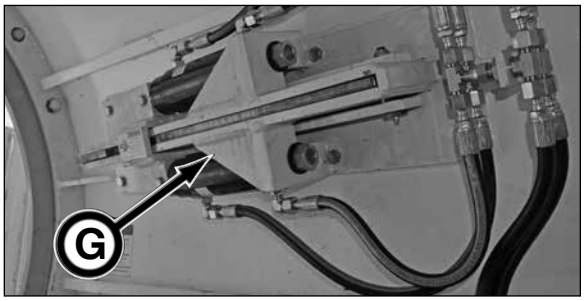
Extend torque wings to help stabilize the roll by holding the position of the TBM. Change the cutterhead rotation as needed to control the roll.

DIRT WINGS (Directional CW-CCW Fins)
- typically used with cutter bar or closed face cutterhead

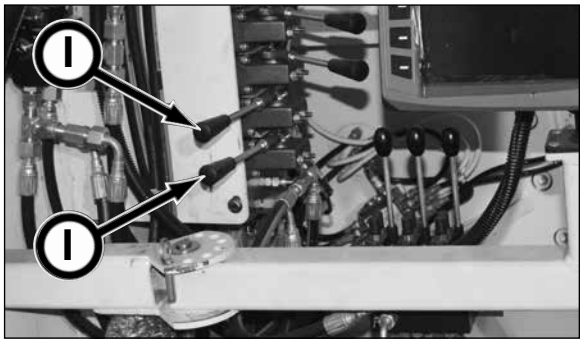
Extend the dirt wings to control the roll without the need to change the cutterhead rotation.
Example when using CW dirt wings:
Operator side is low: extend dirt wings
Operator side is high: retract dirt wings

Keep the torque/dirt wings extended until the TBM roll is back to level position.

The 840 TBM is equipped with a roll indicator (J).
A negative reading indicates that the machine has rolled counterclockwise as viewed from the rear of the TBM.
A positive reading indicates that the machine has rolled clockwise as viewed from the rear of the TBM.

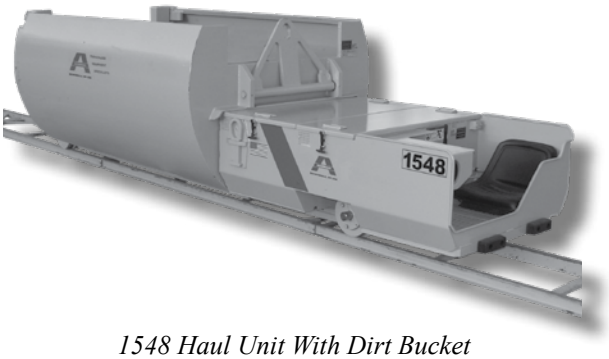


Shown without enclosure



USING HAUL UNIT

⚠WARNING Contacting tunnel wall and boring head components can cause severe injury or death. Keep all body parts on Haul Unit while unit is moving.

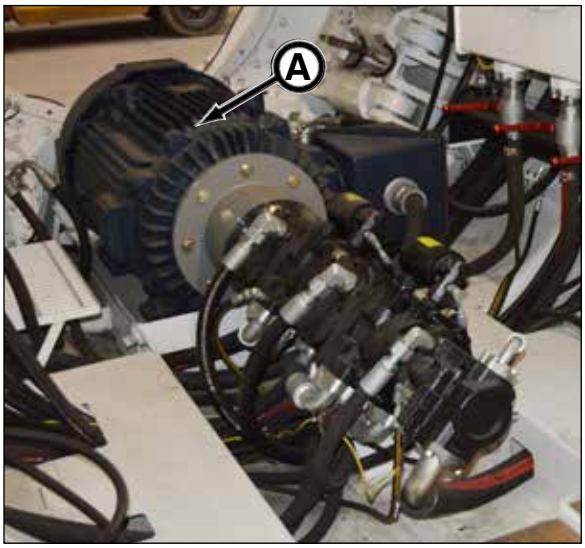


1548 Haul Unit With Dirt Bucket

Refer to your Haul Unit Operator's Manual for the proper safety, operation, and maintenance information.

Keep all tooling or other support equipment off of the haul unit.

STOPPING THE POWER PACK 300 HP MOTOR



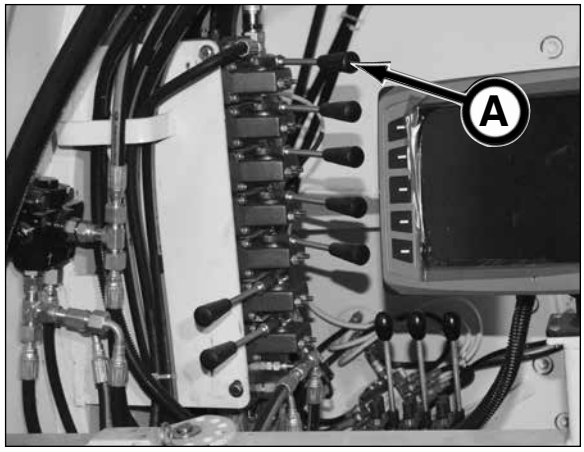
The 300 HP main motor (A) operates the three hydraulic pumps (two hydrostatic pumps, one load sense pump) which provides hydraulic power to the cutterhead, TBM, conveyor and jacking can components.

1. To stop the operation of the power pack 300 HP motor, simply press the 300 HP motor control button (B) so the Start Pump indicator (C) turns white indicating the motor is OFF

2. If shutting down for the day, perform daily shutdown (refer to Daily Shutdown in this section).

USING CLOSED FACE OR AUXILIARY CONTROL

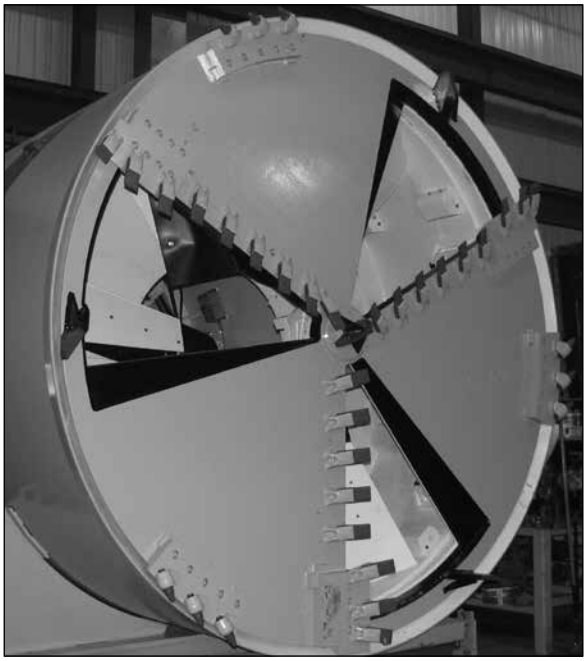
The Closed Face lever (A) controls the opening and closing of the doors on the optional closed face cutterhead attachment. Used in unstable ground conditions, the hydraulically operated doors control subsidence of loose soil while excavating the ground.



Move the lever as follows:

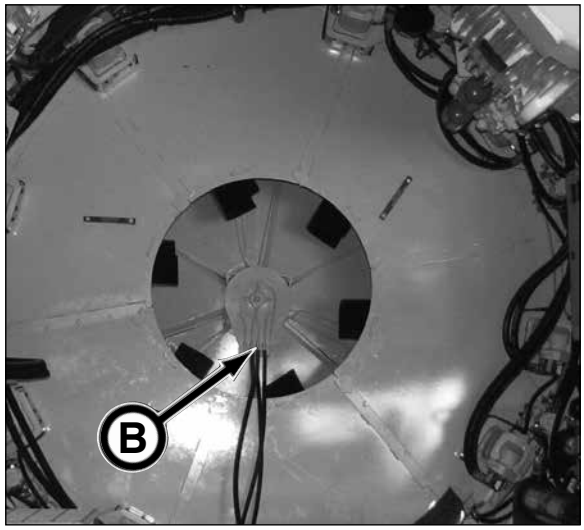
PUSH - close doors (extends cylinders)
PULL - open doors (retracts cylinders)

A lubrication system (B) (two water/lubrication ports on cutterhead) is equipped on the closed face attachment to provide a method to lubricate the face if needed. If the water ports are not used, be sure the lines are purged with grease by removing plugs on front of closed face attachment, then fill lines with grease through grease fitting on manifold block. Replace plugs on front of closed face.



Operating Guidelines:

1. Open doors only as needed while advancing to prevent over excavating.
2. Connect water/lubrication hose to 1/2” fitting on closed face attachment to lubricate clay or abrasive materials.
3. At each shift change, or at the end of the day, close doors to prevent material flow into the TBM.
4. If it becomes necessary to enclose the inner drum to control subsidence of loose soil from entering the TBM, such as at the end of the day, add dirt scoop covers and outside scraper covers. ***IMPORTANT: Do not operate with covers in place. Doing so will cause premature failure to the TBM seals and/or bearing.***



CUTTERHEAD OPERATION GUIDELINES

1. Use a maximum cutterhead drive torque of 80%. If an obstruction is encountered, there is an additional 20% torque available to break through the obstruction. Reduce jacking speed to reduce torque.

2. Abrupt operation may cause machine to roll.

3. Watch for machine roll. If it exceeds 1.5 to 2 degrees, reverse the cutting head rotation.

4. Operate cutterhead at high speeds in stable ground, lower speeds in unstable ground.

5. If cutterhead torque is too high, reduce jacking speed.

JACKING OPERATION GUIDELINES

1. Never exceed maximum jacking thrust rating of the liner plate, ring beam lagging or pipe. Consult liner plate, ring beam lagging or pipe manufacturer to obtain this rating.

2. Use lower jacking pressures and lowest cutting head torque possible (below 80%), while maintaining high production rates.

3. Maintain proper grade and alignment of the tunnel to ensure low jacking pressure.

4. Using lubrication (bentonite/polymer) may in certain ground conditions, lower jacking pressure.

5. Do not allow steering pressures to rise above the cutterhead rating (specific to cutter design; contact your Akkerman Aftermarket Support representative for more information) for soft ground. Reduce advancement rate or increase cutterhead rotation speed to reduce pressure.

6. Jacking speed is too fast if the conveyor cannot reduce the soil pressure at full speed.

7. If cutterhead torque is too high, reduce jacking speed.

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.

OPERATING KEYHOLE JACKING FRAMES

⚠WARNING **Pinch Points!** Contact with moving 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.

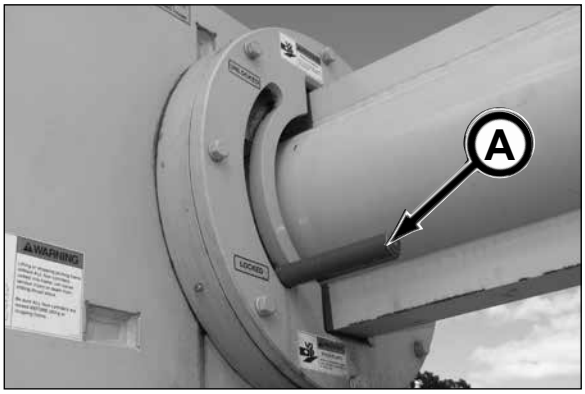
1. Start jacking frame hydraulic pump.

2. Select RETRACT on pendant.

3. When jacking cylinders are fully retracted, press Stop button on pendant.

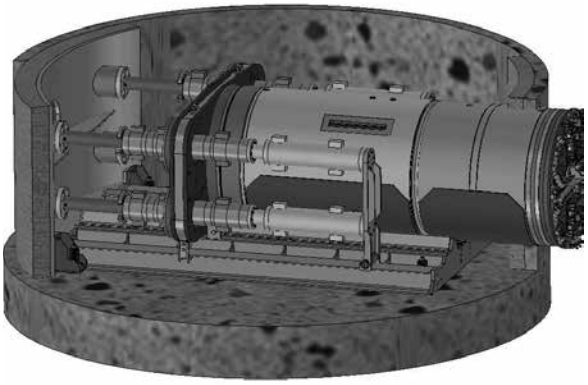
NOTICE The jacking frame hydraulic circuit contains a flow divider which synchronizes the left cylinders and the right cylinders during unrestricted extending and retracting. The flow divider eliminates the need for an operator to manually adjust the speed of the cylinders via ball valves.

If the cylinders get out of sync and it is not possible to lock the frame in the same keyed position, simply fully retract or fully extend the cylinders and allow the pressure in the circuit to build momentarily. This will allow the cylinders to equalize.



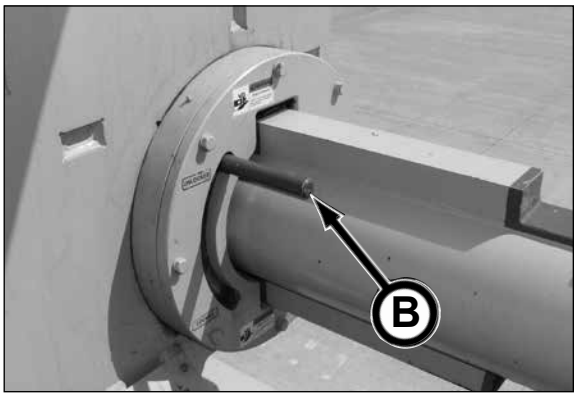
4. By communicating with jacking shaft operators, ensure that all cam locks are aligned and locked with the keyhole slots of the all the cylinders on the frame using cam lock levers (A).

NOTICE Be sure the cam locks are locked onto the same keyhole slot on all cylinders. If not, the frame will twist when the cylinders reach a fully extended or fully retracted position.



5. Start cutterhead rotation and press EXTEND on pendant to start forward thrust.

- Refer to Jacking Operation Guidelines to help determine a proper hydraulic flow rate.
- Monitor jacking pressures. If pressures approach 50% of the system capacity, intermediate jacking stations may be required. Contact your Akkerman Aftermarket Support representative for more information on using Intermediate Jacking Stations (IJS).



6. Once the jacking cylinders have reached full extension, stop cutterhead rotation.

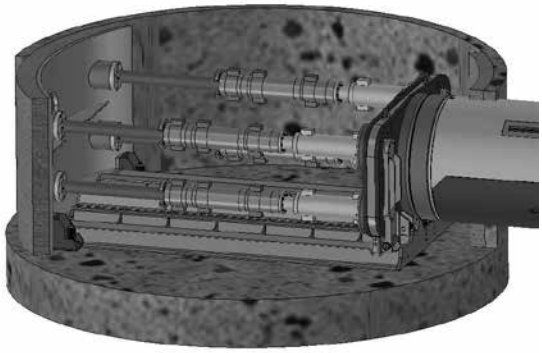
7. Unlock cam locks (with lever [B]), retract cylinders until they align with the next keyhole slot positions.

(continued on next page)

8. Lock cam locks and select EXTEND position on pendant.

9. Start cutterhead rotation, and start forward thrust until jacking cylinders have reached full extension.

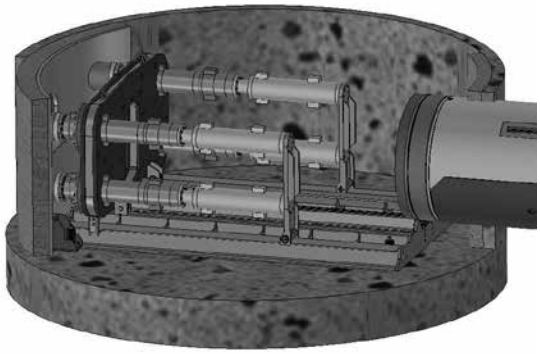
10. Repeat steps 2 through 9 until the entire length of the TBM/pipe is at the end of the jacking frame or until there is enough room to set another pipe.



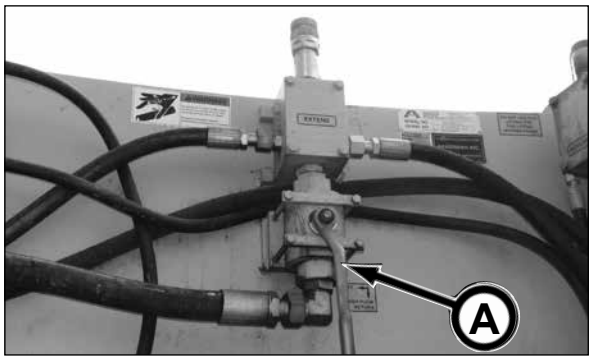
11. Once the jacking cylinders have reached full extension:
    a. Stop cutterhead rotation.

12. Move thrust frame to the back of the jacking frame using the winch as follows to allow enough room to lower the next pipe onto the jacking frame:

    Fully retract cylinders with frame locked to cylinders using the High Return Flow valve (A) on the jacking frame. Then, unlock frame from cylinders. Hook winch cable to frame and retract winch cable until it aligns to desired keyhole slot.



NOTICE If winch is not available, use the jacking frame cylinders as follows: retract frame, unlock cam locks, extend cylinders, lock cam locks, retract cylinders, etc until frame is at back of jacking frame.



13. Stop jacking frame hydraulics.

14. Lower the next pipe and repeat until the tunnel is complete.

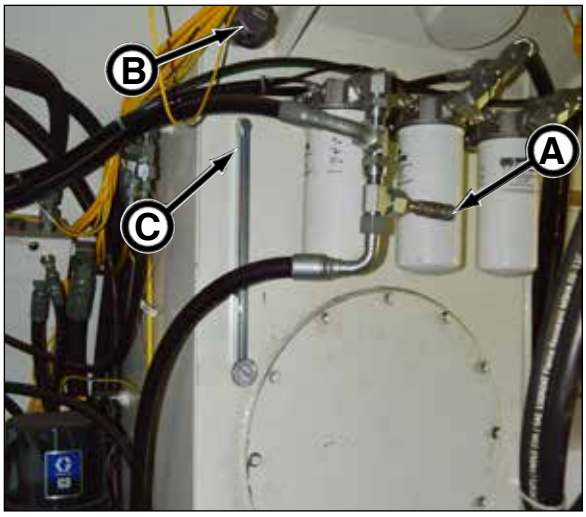
FILLING TBM HYDRAULIC RESERVOIR

1. Clean area around fitting cap (A). Remove cap.

2. Attach external fill pump (hand or electric pump) with male end quick coupler P0100-089.

3. Clean area around breather (B). Remove breather while filling for proper venting.

4. Fill reservoir with clean, fresh, **FILTERED** ISO-VG-68 Premium Hydraulic/Turbine Oil or equivalent to full mark on gauge (C). Filling reservoir with unfiltered oil will cause component damage.



The reservoir capacity is 120 gal. (454 L).

NOTICE If you change to a different oil, use a reputable oil supplier to meet or exceed the ISO-VG-68 or DIN 51524-3 (HVLP) or ISO 11158-HV oil specification. Do not mix oil manufacturers or grades.

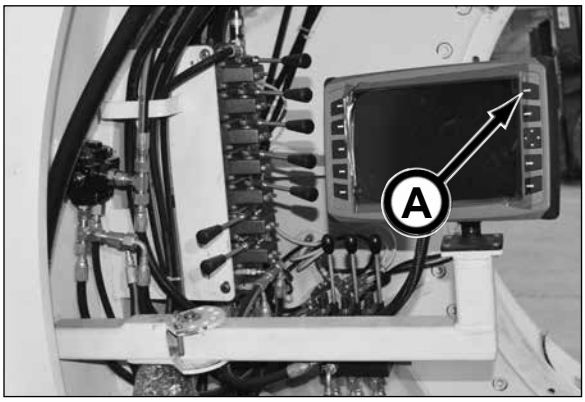
5. Remove external fill pump.

6. Replace breather and fitting cap.

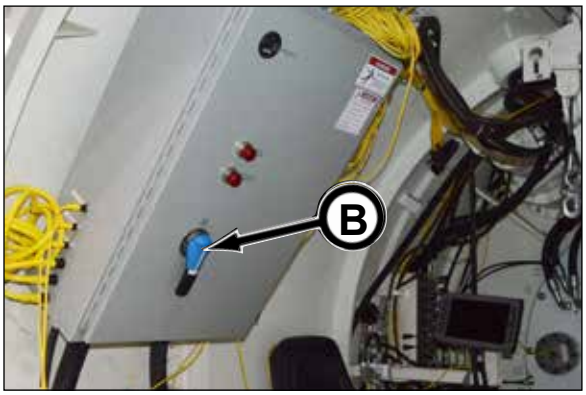
DAILY SHUTDOWN

1. Return all controls on the TBM, jacking can, jacking frame or other equipment to the OFF or neutral position.

2. On the monitor, turn the motor OFF by pressing Start Pump button (A). The Start Pump indicator will turn from green to white to indicate the motor is OFF.

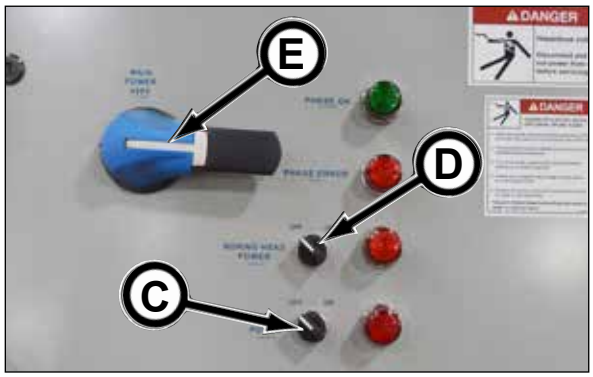


3. Flip the TBM main disconnect switch (B) on the electrical box to the OFF position.

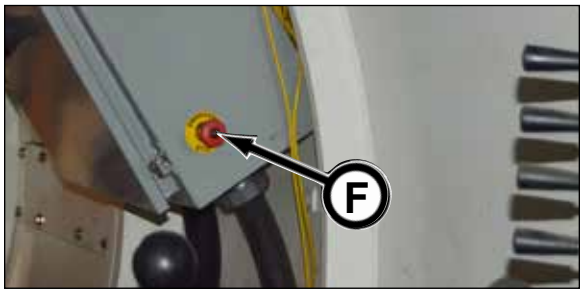


4. On the pit box, turn the Head Power (C) and Boring Head Power (D) switches to the OFF position.

5. Flip the main power disconnect switch (E) on the pit box to the OFF position.



6. Push IN E-Stop button (F) on TBM electrical box and any other support equipment to prevent any accidental powering of equipment.



7. Shut off water supply to heat exchanger (G).

8. Shut down generator or other power source and perform lockout tagout procedure.

9. Perform a visual machine inspection by checking the fluid levels, hydraulic hose and power cable wear or damage and any machine damage. Make repairs before operating. Also check to be sure all connections are properly connected and secured.

REMOVING TBM

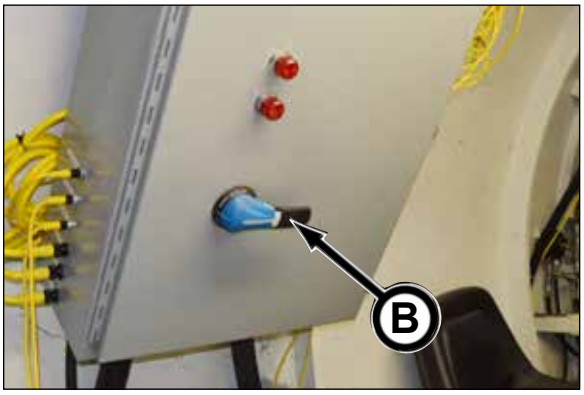
⚠WARNING Any electrical work completed on the TBM and jacking system **MUST** be performed by a certified electrician.

When pipe line or tunnel lining is complete and TBM is in reception shaft, remove the TBM as follows. For pump unit or jacking system removal, refer to your operation manual.

1. Return all controls on the TBM, jacking can, jacking frame or other equipment to the OFF or neutral position. Release pressure on hydraulic hoses.

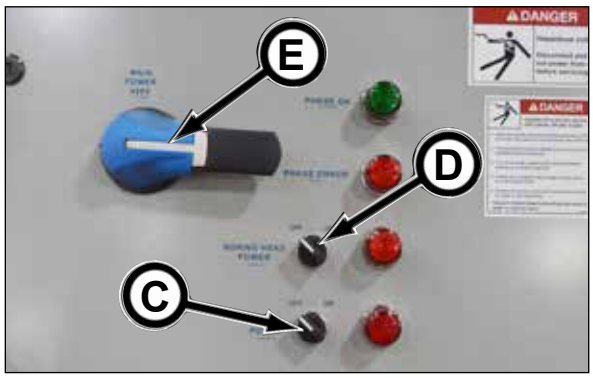
2. Stop the 300 HP motor by pressing Start Pump button (A).

3. Flip the TBM main disconnect switch (B) on the electrical box to the OFF position.



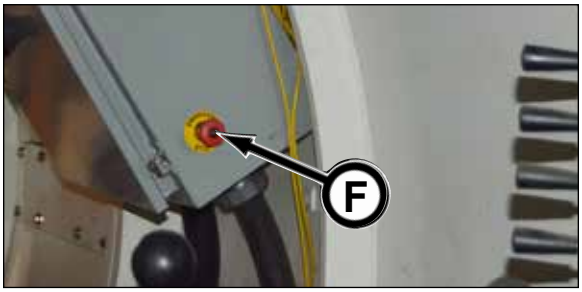
4. On the pit box, turn the Head Power (C) and Boring Head Power (D) switches to the OFF position.

5. Flip the main power disconnect switch (E) on the pit box to the OFF position.



6. Push IN E-Stop button (F) on TBM electrical box and any other equipment to prevent any accidental powering of equipment.

7. Shut down generator or other power source and perform lockout tagout procedure.

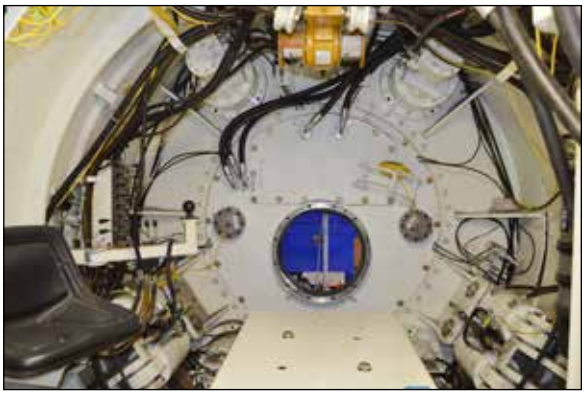


⚠WARNING Failure to lockout tagout power before servicing can cause severe personal injury or death.

This TBM contains high voltage electricity.

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

8. Disconnect electrical power cables and store them in a clean, dry location.



⚠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.

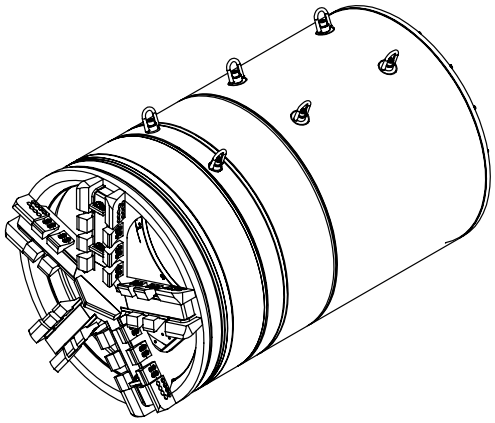
DO NOT use your hands to check for leaks. When searching for leaks, use a piece of wood or cardboard.

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.

9. Release pressure on hydraulic hoses. Disconnect IJS hydraulic hoses (if used); reclaim hydraulic oil in hoses. Store hoses in a clean, dry location.

10. Disconnect communication lines, ventilation supply, water supply lines, bentonite hoses (if used), foam generation system lines (if used), and IJS hydraulic hoses and cable (if used). Store water lines, hoses and cable in a clean, dry location.

(continued on next page)

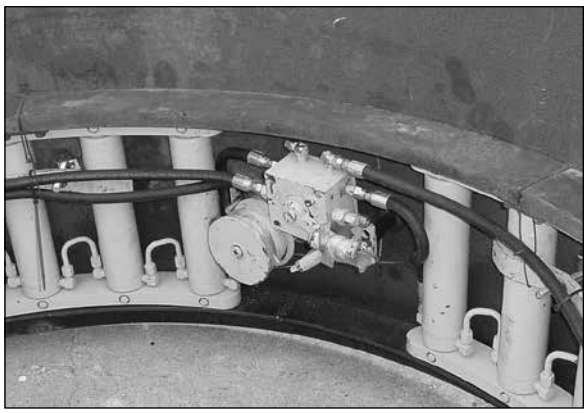


NOTICE If using Intermediate Jacking Stations (IJS), the outer shell will remain in pipe line.

11. If IJS are used:
    a. Remove IJS #1 valve, cylinder segments, and cap hoses, lines, valve and cylinder ports. Cut off valve and cylinder segment bolts. Close IJS #1 gap by operating IJS #2.

    b. Remove IJS #2 valve, cylinder segments, and cap hoses, lines, valve and cylinder ports. Cut off valve and cylinder segment bolts. Close IJS #2 gap by operating IJS #3.

    c. Remove IJS #3 valve, cylinder segments, and cap hoses, lines, valve and cylinder ports. Cut off valve and cylinder segment bolts. Close IJS #3 gap by operating jacking cylinders (if IJS #3 is the last IJS).



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

12. Remove TBM, haul unit and track.

13. Remove pump unit/jacking frame, yoke and skid(s) if used.

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. Securely fasten equipment to trailer floor.
8. Secure all loose items in TBM and jacking can.
9. Observe the lifting instructions for the TBM and the jacking can on the following page.

LIFTING INSTRUCTIONS

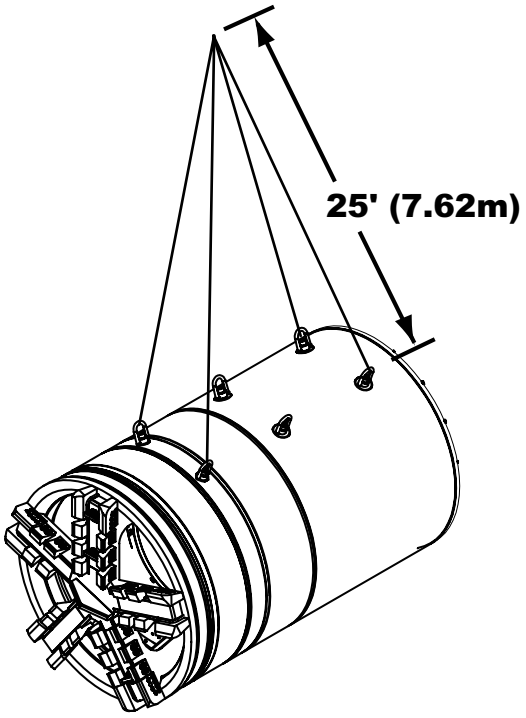
1. 840 TBM

- 840 TBM weight is approximately 58,000 lbs. (26,308 kg).

- Lifting with a crane requires a four part sling with the outer legs a minimum of 25 ft. (7.62 m) long.

- TBM must lift freely. If it is stuck to the ground, it must be broken loose prior to lifting.

- TBM lifting eyes must be inspected prior to each lift. Any damage must be repaired prior to lifting.



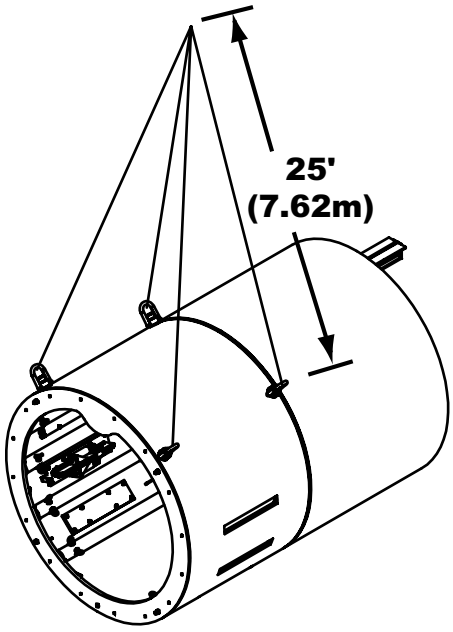
2. Jacking Can

- 840 TBM Jacking Can weight is approximately 23,000 lbs. (10,433 kg).

- Lifting with a crane requires a four part sling with the four outer legs a minimum of 25 ft. (7.62 m) long.

- Jacking Can must lift freely. If it is stuck to the ground, it must be broken loose prior to lifting.

- Jacking Can lifting eyes must be inspected prior to each lift. Any damage must be repaired prior to lifting.



Lubricants

NOTICE Use of inferior lubricants can affect the efficient performance of your tunnel boring machine. Always use high quality lubricants as specified in this section.
Refer to the Periodic Maintenance section for proper lubrication quantity, maintenance intervals, and procedures.

Refer to your Haul Unit, Foam Generation System and Jacking System Operator's Manuals for proper lubricants.

BEARING CAVITY LUBRICANT

The bearing cavity is filled with Mobilgear™ 600XP 460 gear oil. This oil is formulated to provide extra protection for gears, bearings and seals.

Use Mobilgear™ 600XP 460 gear oil or equivalent when adding or changing lubricant. Oil must be visible in bearing cavity oil sight gauge (B).

NOTICE If you change to a different oil, use a reputable oil supplier to meet or exceed the Mobilgear® 600XP 460 oil specification. Do not mix oil manufacturers or grades.

Bearing Cavity Fill Port (A)
Bearing Cavity Oil Sight Gauge (B)

Oil capacity is approximately 80 gal. (303 L)

ELECTRIC MOTOR GREASE

The electric motor bearings with are lubricated with Mobil Polyrex® EM grease or equivalent (refer to Grease Type below). The Mobil Polyrex® EM grease is a specially formulated grease for electric motor bearings.

GREASE TYPE (unless nameplate states otherwise:
Nameplate Ambient Temperature between -22°F (-30°C) to 150°F (65°C) inclusive:
Recommended grease for standard service conditions is Mobil Polyrex® EM. Equivalent and compatible greases include: Texaco Polystar RB, Rykon Premium #2, Pennzoil Pen 2 Lube, Chevron SRI & Mobil SHC 100.

Nameplate Ambient Temperature below -22°F(-30°C):
Special low temperature grease is recommended such as Aeroshell 7 or Beacon 325 for ball bearings and Mobil SHC 100 for roller bearings.

Use Mobil Polyrex® EM grease or equivalent when lubricating the motor bearings. Refer to section 9, Periodic Maintenance for more information.

POWER PACK HYDRAULIC OIL RESERVOIR LUBRICANT

The power pack oil reservoir is typically filled with ISO-VG-68 Premium Hydraulic/Turbine Oil.

Use an ISO-VG-68 or equivalent when adding or changing lubricant.

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 oil above 150°F operating temperatures (oil temp. in reservoir) will result in reduced hydraulic power to functions.

Recommended hydraulic oil:

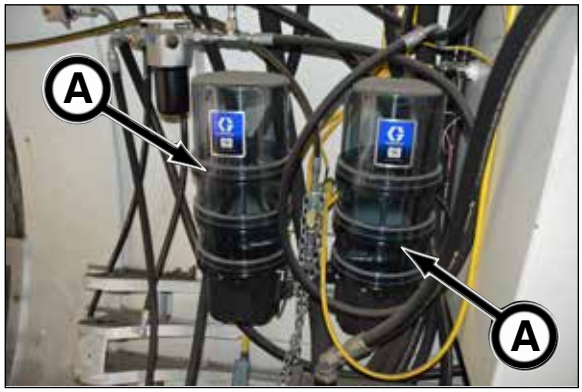
Ambient Temp.	**Hydraulic Oil**
-25°F to 60°F (-32°C to 16°C)	ISO 32
0°F to 95°F (-18°C to 35°C)	ISO 46
32°F to 105°F (-0°C to 41°C)	ISO 68

NOTICE If you change to a different oil, use a reputable oil supplier to meet or exceed the ISO-VG-68 or DIN 51524-3 (HVLP) or ISO 11158-HV oil specification. **Do not mix oil manufacturers or grades.**

Oil capacity is approximately 120 US gal. (454 L).

GREASE PUMP LUBRICANT

The grease pump containers (A) are filled with Mobil SHC™ 101 EAL Grease. This environmental awareness lubricant (EAL) is a multipurpose grease formulated for the lubrication of equipment in environmentally sensitive areas.



Use Mobil SHC™ 101 EAL grease or equivalent when refilling grease pump containers.

DO NOT operate TBM when the grease pump containers are out of grease.

Oil capacity is approximately 3 US gal. (12 L) per grease container.

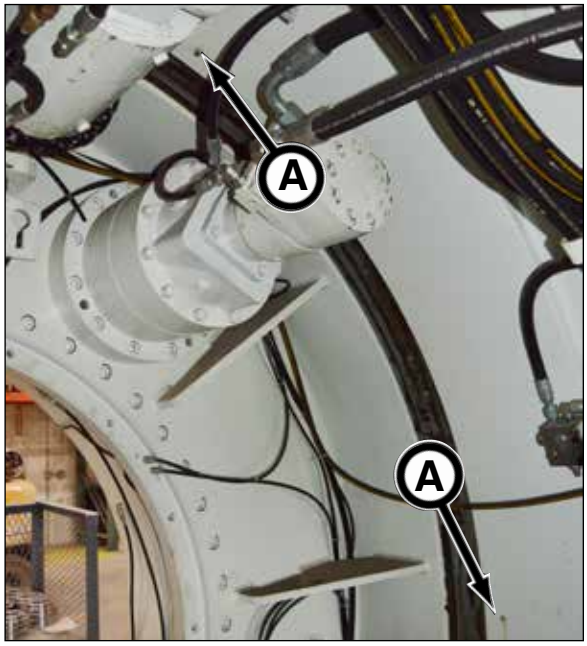
STEERING JOINT GREASE

The steering joint is lubricated 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 steering joint.

There are three steering joint grease fittings (A). One each at the following locations:
1 o'clock, 4 o'clock and 8 o'clock (not shown).

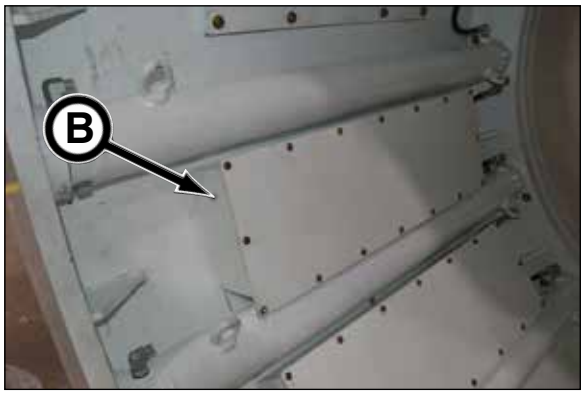


DIRT WING GREASE

The lubrication fittings (B) (one per dirt wing) are greased with Mobilgrease® XHP222 Premium Lubricating Grease unless otherwise specified.

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.



Enclosed Dirt Wing

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.

NOTES

Periodic Maintenance

⚠WARNING Review the Safety section in this manual 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.

Use the hour meter (A) to help determine proper maintenance intervals.

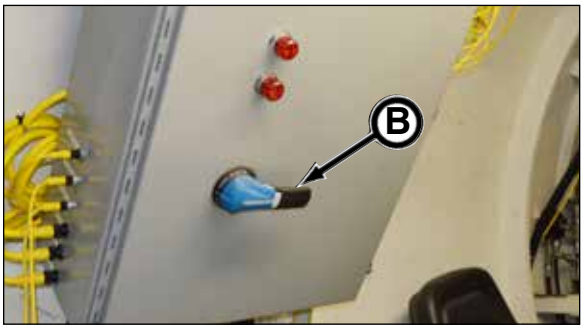
The hour meter registers in full hours and 1/10ths hours.

LOCKOUT TAGOUT POWER BEFORE SERVICING

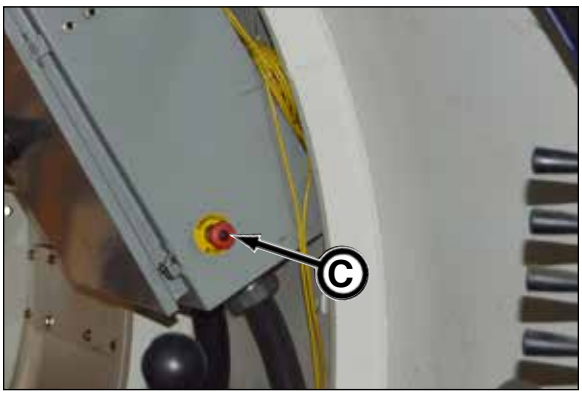
⚠WARNING Severe personal injury or death can result from unexpected pump unit start-up or machine movement.

LOCKOUT TAGOUT power before attempting to make repairs or adjustments to this equipment, unless otherwise indicated. Proper lockout will prevent accidents and save lives. Performing the lockout tagout will also prevent the equipment from moving or operating unexpectedly.

1. Flip main power disconnect switch (B) to the OFF position.
2. Push all E-STOP buttons (C) IN including any remote E-STOP buttons.
3. Shutdown power from the power source.
4. Lockout tagout all power sources.



TBM 840 SN1 Shown



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 button(s).

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

5. **Lockout tagout all power. Perform lockout tagout procedure.**

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.

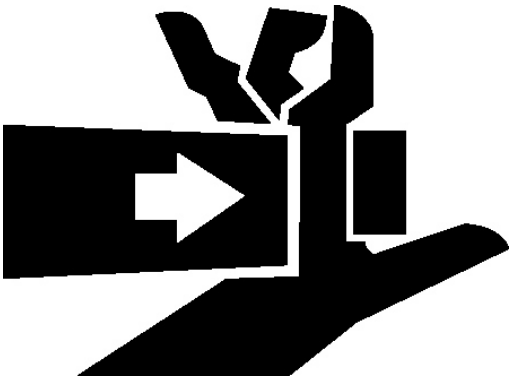
AVOID PINCH POINTS

⚠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.



WELDING

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.

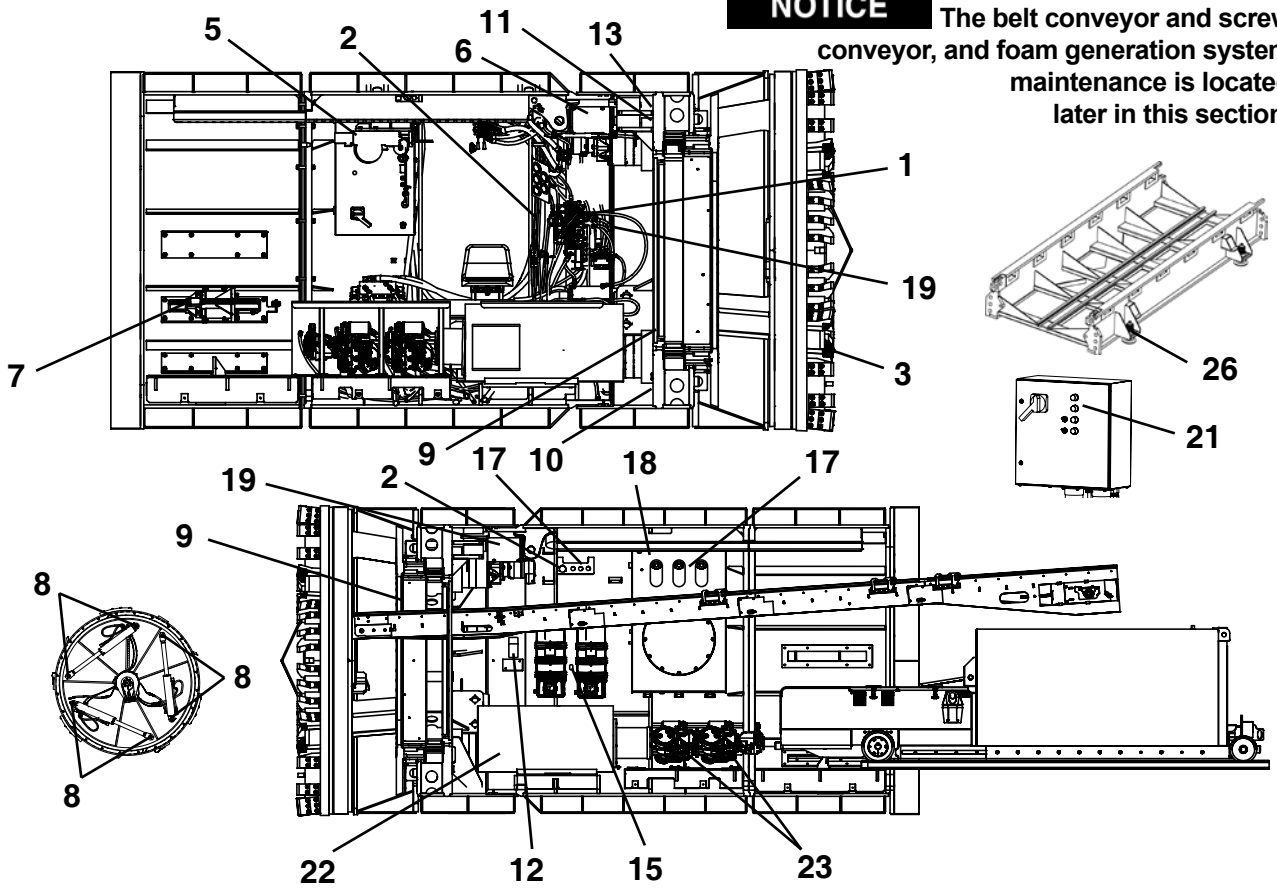
WELDING ON TBM STRUCTURE

NOTICE Welding on TBM structure will damage the gas detector.

BEFORE performing authorized welding on TBM, remove the gas detector by removing two mounting bolts and the four pin electrical connector.

MAINTENANCE CHARTS

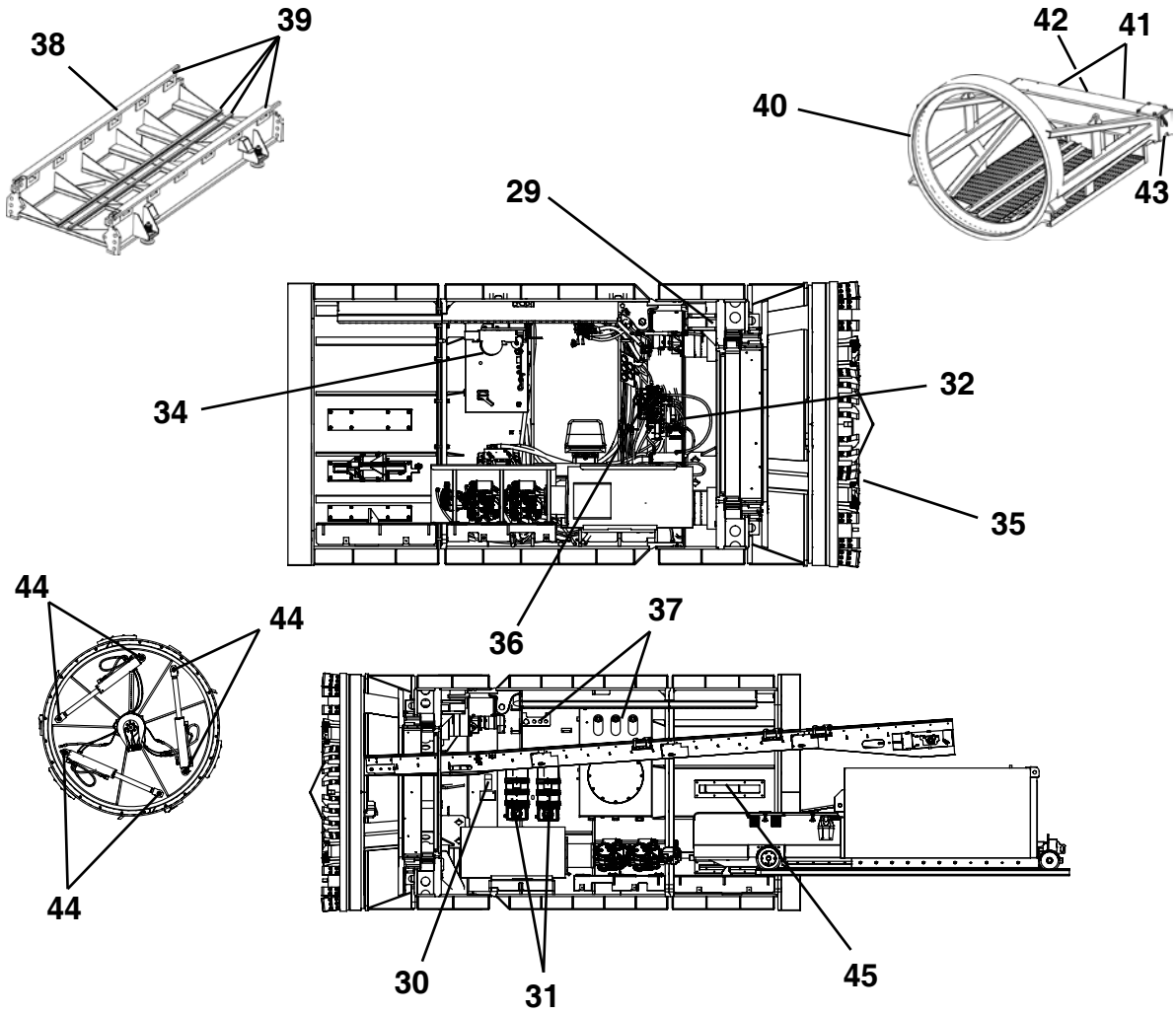
NOTICE **The belt conveyor and screw conveyor, and foam generation system maintenance is located later in this section.**



PRIOR TO EACH JOB LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Controls	Check Operation		
2.	Gauge	Check Operation		
3.	Cutters/Scrapers	Check	Replace if damaged.	
*4.	Steering	Check Line & Grade		
5.	Conveyor Lift	Lubricate (7 places)	Lubricate until grease is forced out.	Mobil XHP222
6.	Steering Cylinder	Lubricate (2 per cyl)	Lubricate until grease is forced out.	Mobil XHP222
7.	Dirt/Torque Wing	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
8.	Closed Face Cyl/Door	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
9.	Inner Drum/Brg Bolts	Check	Visually check for loose/damaged bolts.	
10.	Bearing Cavity	Inspect Oil Quality If contaminated, drain & fill.	If contamination is present, drain oil, inspect seals/bearing & fill with new oil.	Mobilgear® 600XP 460
11.	Bearing Cavity Oil	Check Oil Level	Oil must be visible on sight gauge.	Mobil 600 XP 460
12.	Bearing Lube Filter	Check Filter	Replace as needed.	
13.	Bearing Cavity Vent	Check	Clean if necessary.	
14.	Grease Pump	Fill (2) Containers	3 gal. (11 L) per container	SHC 101 EAL**
15.	Grease Pump Filter	Replace Grease Filter		
16.	Grease Pumps	Check Operation	Operation with Head Rotation	
17.	Return Filter	Check (3 Filters)	Replace filter(s) per indicator.	Filter Element
18.	Hydraulic Oil	Check Condition & Level	Refill or replace as needed	ISO-VG-68
19.	Steering Joint	Lubricate (3 places)	Lubricate until grease is forced out.	Mobil XHP222
*20.	Hoses/Pwr Cables	Inspect	Replace if cracks/wear visible.	
21.	Phase Power	Check		
22.	Electric Motor	Verify Motor Rotation		
23.	Hydrostatic Pump	Check Filters (2)	Replace as needed.	
24.	Gas Detector	Test Operation	See Gas Detection Manual	
*25.	Lift Eyes	Inspect	If damaged, replace with new.	
26.	Leveling Screws	Lubricate	Lubricate generously.	Mobil XHP222
*27.	Decals	Inspect	Must be legible. Replace as needed.	
*28.	Supporting Equipment	Perform Maintenance	Refer to your machine's maintenance manual.	

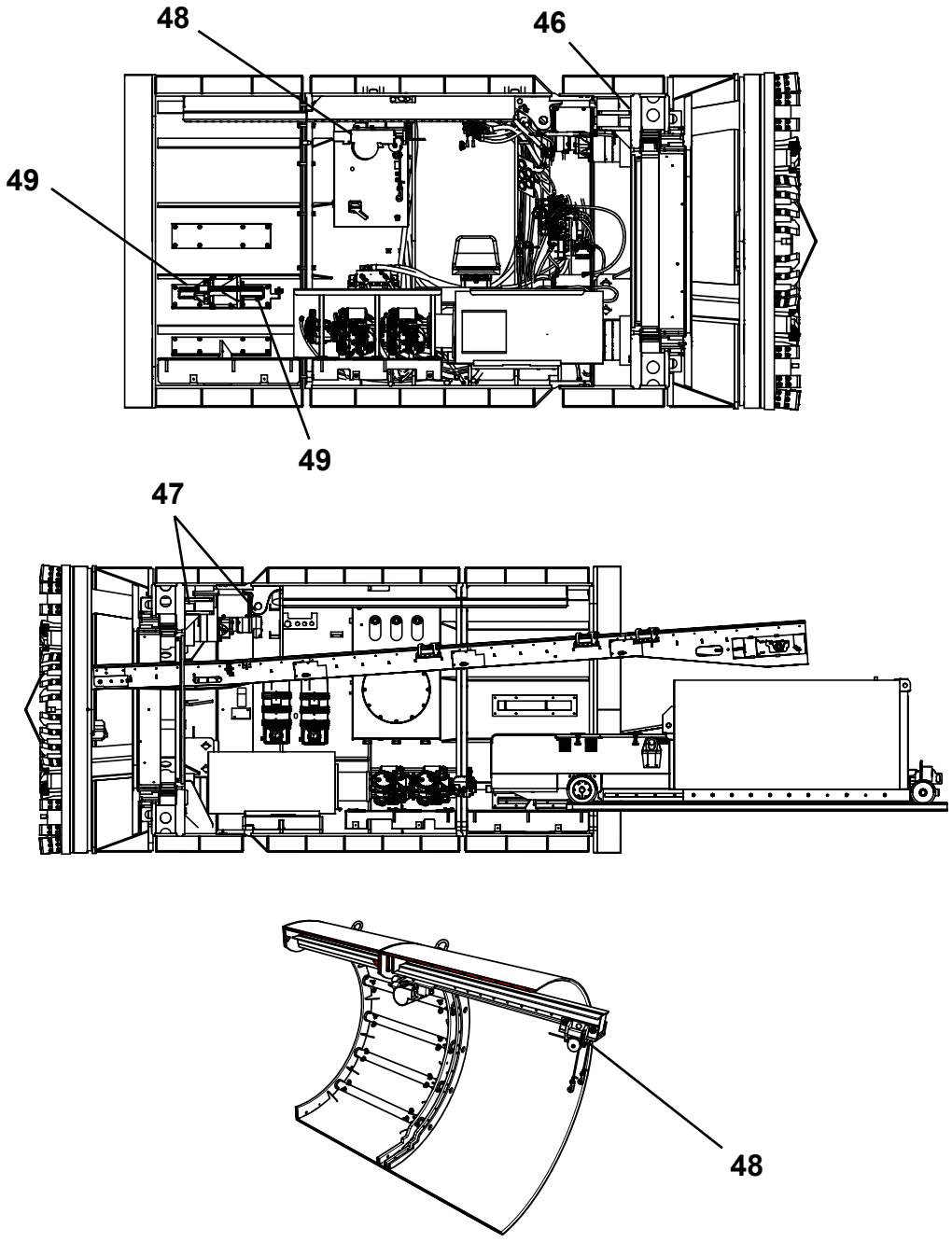
* Not Shown ** Mobil® SHC 101 EAL Grease



DAILY OR EVERY 10 HOURS OF OPERATION OR SHIFT CHANGE

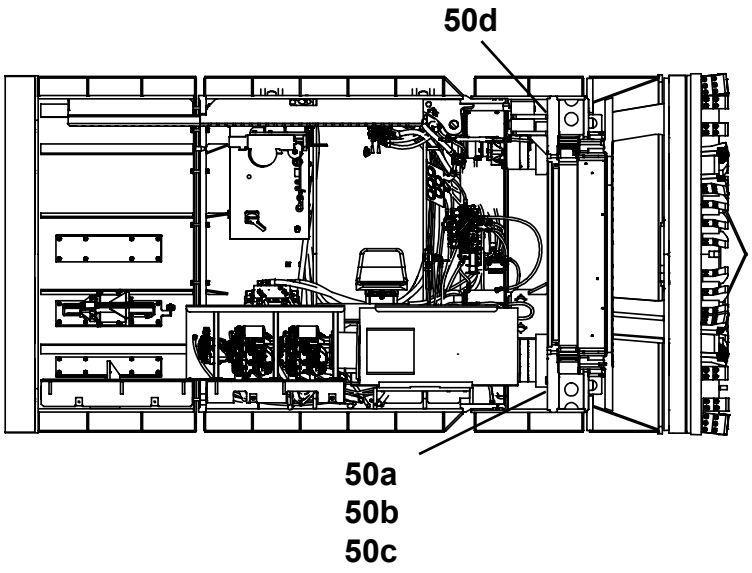
ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
29.	Bearing Cavity Oil	Check Oil Level	Oil must be visible at sight gauge.	Mobil 600 XP 460
30.	Bearing Lube Filter	Check Filter	Replace filter per indicator.	
31.	Grease Pump Containers	Check Grease Container Level	Fill as needed.	Mobil SHC Grse 101 EAL
32.	Steering Joint	Lubricate (3 places)	Lubricate until grease is forced out.	Mobil XHP222
*33.	Hoses/Pwr Cables	Inspect	Check connection, replace if damaged.	
34.	Conveyor Lift Cable	Inspect	Replace at first sign of wear or damage.	
35.	Cutters/Scrapers	Inspect & Adjust	Adjust over cut and replace worn or damaged teeth.	
36.	Controls	Check For Proper Operation		
37.	Return Filter	Check (3 Filters)	Replace filter(s) per indicator.	Filter Element
38.	Skid Base	Inspect	If damaged, repair or replace.	
39.	Rails	Inspect	If damaged, repair or replace.	
40.	Yoke Frame	Inspect	If damaged, repair or replace.	
41.	Ram Retaining Pins	Inspect	If damaged, repair or replace.	
42.	Retaining Pin Stop	Inspect	If damaged, repair or replace.	
43.	Yoke Wheels	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
44.	Closed Face Cyl.	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
45.	Dirt/Torque Wing Pins	Lubricate	Lubricate	Mobil XHP222

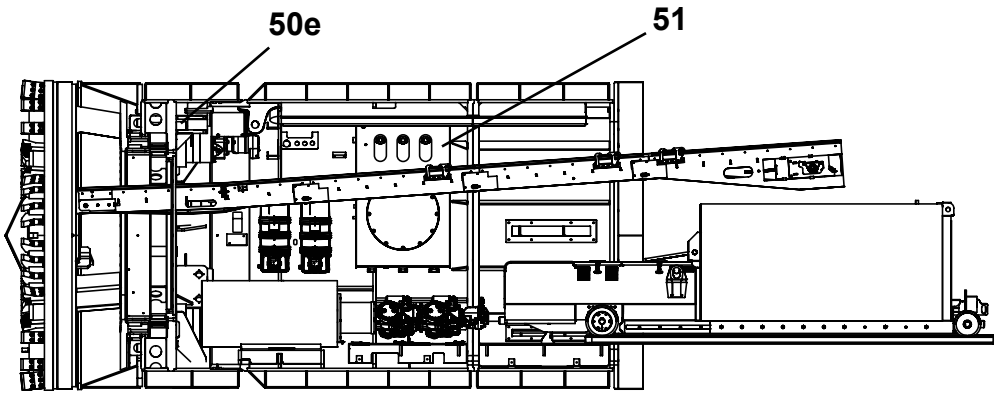
* Not Shown



WEEKLY OR EVERY 50 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
46.	Bearing Cavity Vent	Check	Clean if necessary.	
47.	Steering Cylinder	Lubricate (2 per cyl)	Lubricate until grease is forced out.	Mobil XHP222
48.	Conveyor Lift	Lubricate (7 places)	Lubricate until grease is forced out.	Mobil XHP222
49.	Dirt/Torque Wing Pins	Lubricate	Lubricate until grease is forced out.	Mobil XHP222



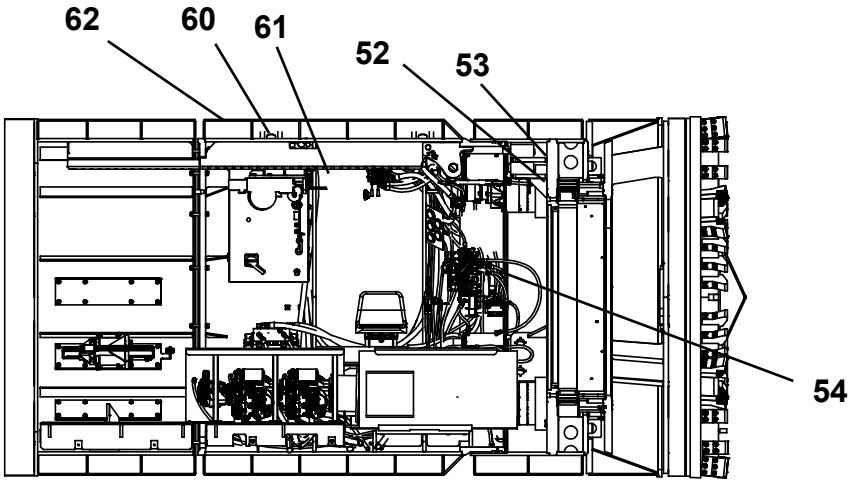


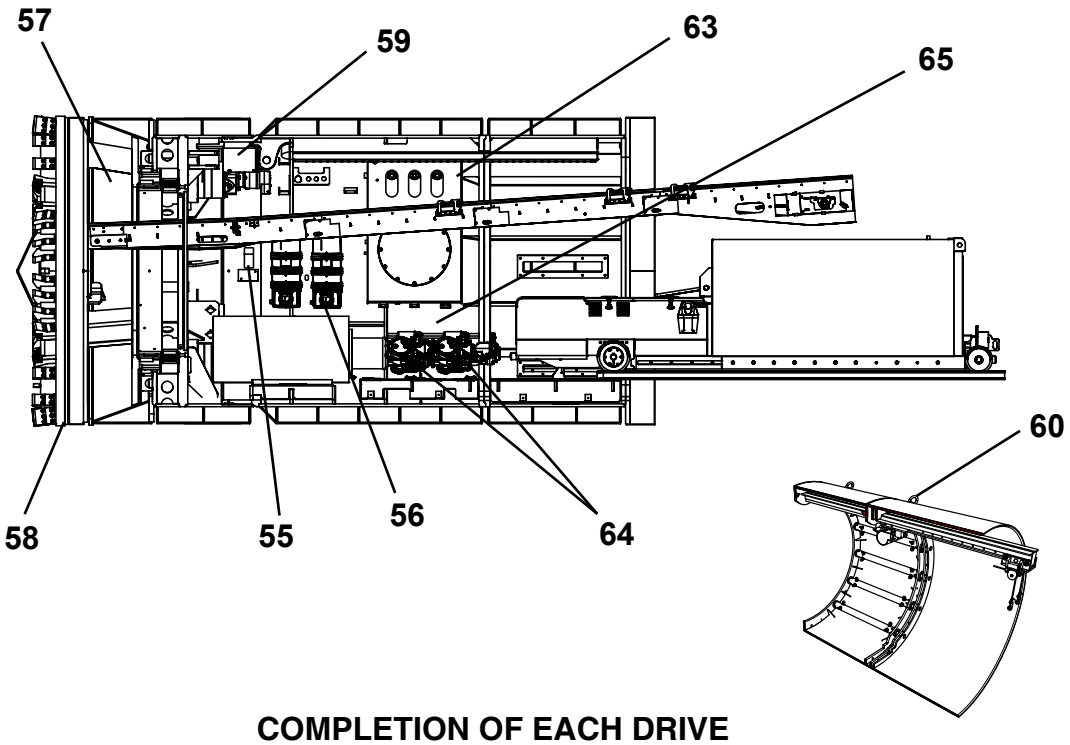
AFTER FIRST DRIVE OR FIRST 100 HOURS OF OPERATION*, THEN MONTHLY OR EVERY 250 HOURS OF OPERATION THEREAFTER

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
50.	Bearing Cavity	a. Drain Cavity		
		b. Check Suction Screen	Clean	
		c. Inspect Magnet	If excessive fragments on magnet contact Akkerman representative.	
		d. Bearing Cavity Vent	Clean	
		e. Fill Cavity**	Oil must be visible in sight gauge. Approx. 80 gal. (303 L)	Mobilgear 600 XP 460
51.	Pwr Pack Oil Analysis	Perform Analysis	Oil Sample	

* Whichever occurs first

** Oil change intervals may be increased with periodic examination of oil samples. Any sign of contamination requires the immediate replacement of the bearing cavity oil with new, clean oil.

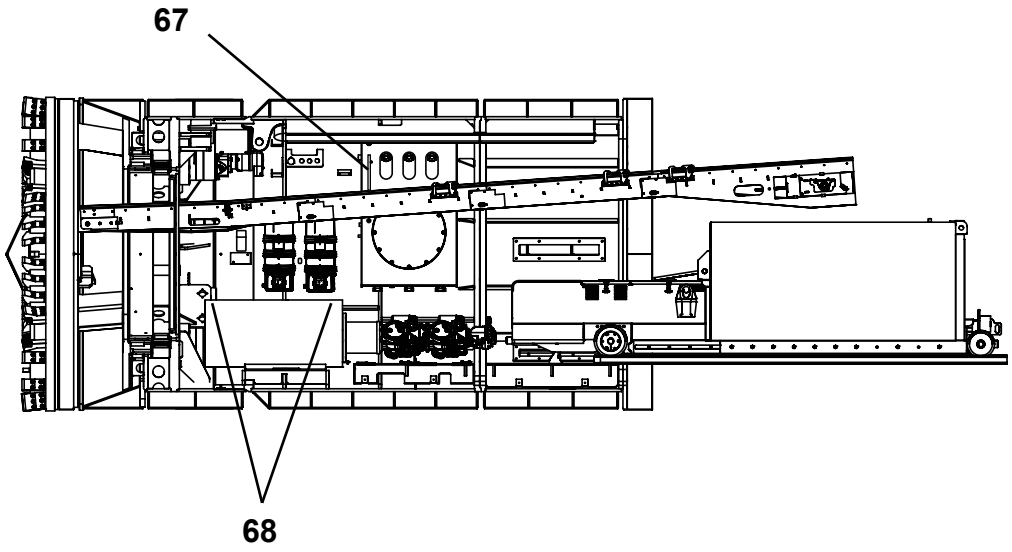




COMPLETION OF EACH DRIVE

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
52.	Bearing Cavity Oil	Check Oil Level	Oil must be visible on sight gauge.	Mobil Gear 600 XP 460
53.	Bearing Cavity Vent	Check	Clean if necessary.	
54.	Steering Joint	Lubricate (3 places)	Lubricate until grease is forced out.	Mobil XHP222
55.	Bearing Oil Filter	Check Filter	Replace filter per indicator.	
56.	Bearing Seal	Purge Grease	Purge until grease is forced out.	Mobil 101 EAL
57.	Dirt Paddles	Inspect	Replace if damaged.	
58.	Cutter Ring	Inspect For Damage		
59.	Steering Cylinders	Inspect	If damaged, repair or replace.	
60.	Lifting Eye	Inspect	Repair if damaged before lifting.	
61.	Gas Detector	Remove from TBM	Clean and place in storage box.	
62.	Structure	Inspect	If damaged, repair or replace	
63.	Hydraulic Reservoir	Drain Water	Drain until water is removed.	
64.	Hydrostatic Pump	Check Filters	Replace as needed.	
65.	Heat Exchanger	Drain		
*66.	Hoses/Pwr Cables	Inspect	Replace if cracks/wear visible.	

* Not Shown



EVERY 1000 HOURS OF OPERATION

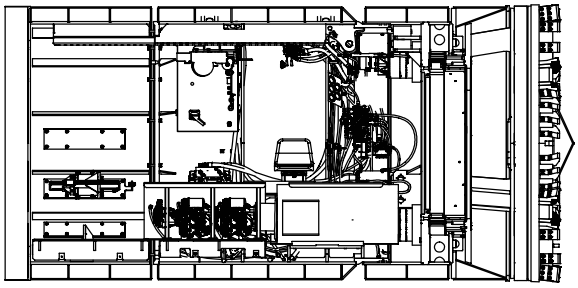
ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
67.	Hydraulic Reservoir	Drain & Fill	Drain and fill with new oil.	ISO-VG-68

ANNUALLY

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
68.	Electric Motor Brgs.	Lubricate (2 places)	2 Shots	Mobil Polyrex EM

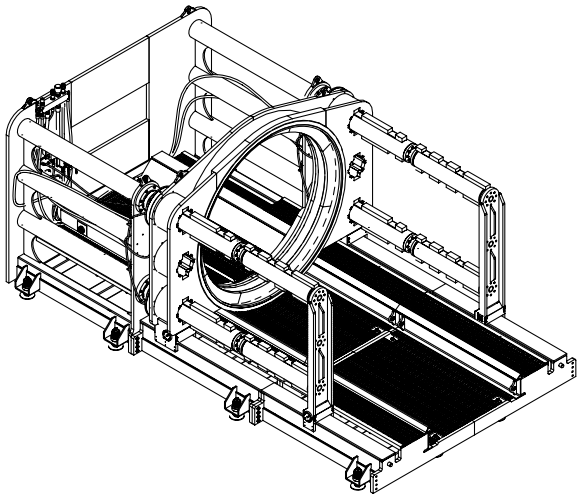
PRIOR TO EACH JOB LAUNCH

1. CHECK CONTROL OPERATION



Before launching TBM, be sure to check all TBM, jacking frame, pump unit, haul unit controls and other supporting equipment for proper operation. If controls do not function properly, repair or replace BEFORE operation.

CHECK THE FOLLOWING CONTROLS FOR PROPER OPERATION:

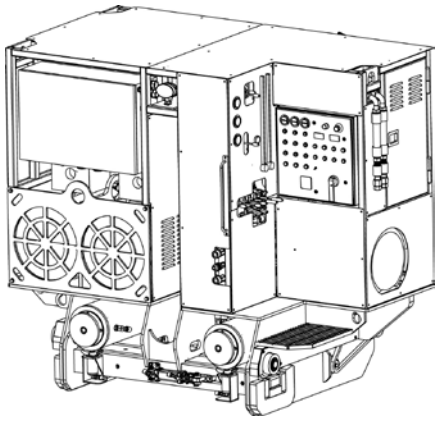


- ALL E-Stops, and gas detectors*:
  check for proper operation
  * refer to your GasMax Instruction Manual for operation and maintenance procedures.

- Conveyor Controls:
  conveyor lift - up and down
  conveyor drive - forward and reverse
  conveyor safety valve switch - MUST stop cutterhead rotation

- Boring Head Controls:
  cutterhead rotation - CW and CCW rotation

- Steering Controls:
  steering cylinder - extend and retract



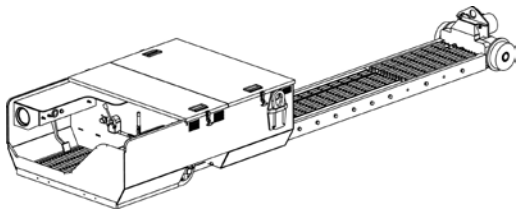
- Dirt Wing Controls
  cylinder control - extend and retract

- Closed Face / Screw Gate Controls
  check control operation

- Pump Unit Controls (if used)

- Haul Unit Controls

- Jacking Frame/IJS Controls (if used)



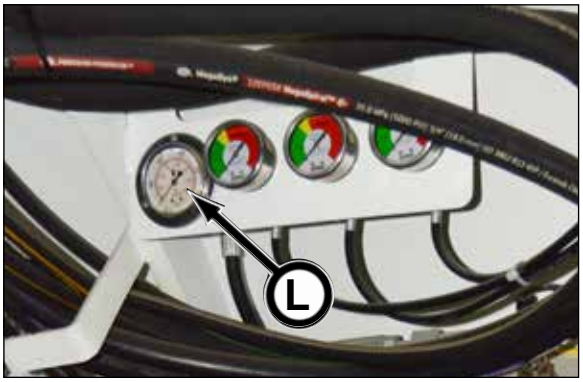
- Lights

2. CHECK GAUGE OPERATION

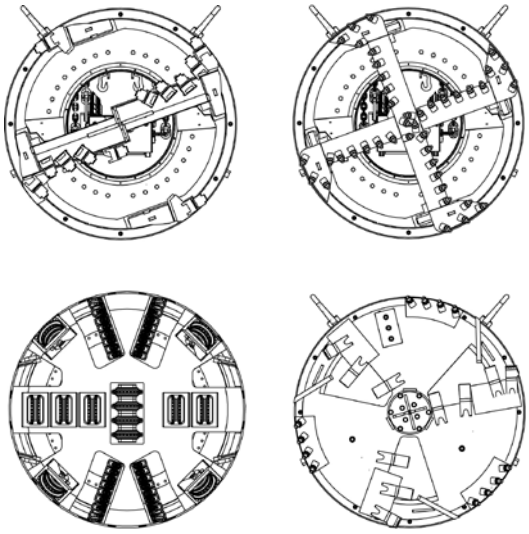
Check system pressures for proper operation.
If systems are not functioning properly, repair or replace system components BEFORE operation.

TBM (Max.)
Steering pressure (A) ..... 5,000 psi
Earth pressure (B) ..... 14.5 psi (1 bar)
Cutterhead torque/pressure (C/D)..... ..5,000 psi
Cutterhead RPM (D)..... ..4.8 or 7.3 rpm
Jacking pressure (E) ..... 5,000 psi
Dirt Wing pressure (F) ..... 3,000 psi
Load Sense/System pressure*(G/H) 3,000/5,000 psi
Conveyor pressure (I).....2,800 - 3,000 psi
Closed Face/Screw Gate pressure (J) ... 3,000 psi
Boring Grease pressure (K)
..... minimal (approx 150 psi)
Lube Pressure (L) .....maximum 500 psi

***** Based on function.



A - Steering Pressure
B - Earth Pressure
C - Cutter % Torque
D - Cutterhead Pressure / RPM
E - Jacking Pressure
F - Dirt Wing Pressure
G - Load Sense/System Pressure
H - Load Sense/System Pressure
I - Conveyor Pressure
J - Closed Face/Screw Gate Pressure
K - Boring Grease Pressure
L - Lube Pressure



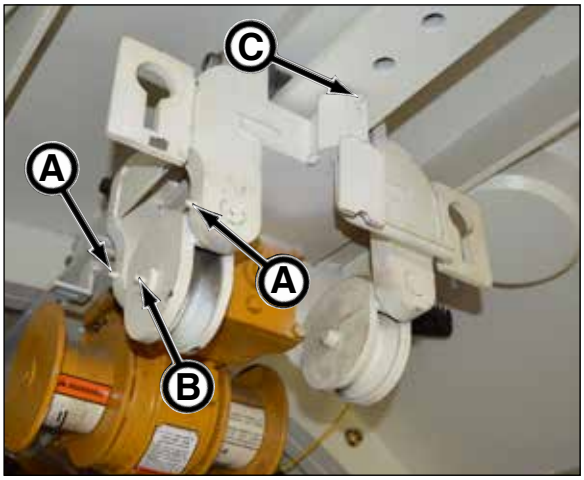
3. CHECK CUTTER TEETH/SCRAPERS/DISC CUTTERS

Check all cutter teeth, scrapers and disc cutters. Repair or replace as necessary.

4. CHECK LINE & GRADE

Check line and grade before launching. Adjust as needed using the steering cylinder controls.

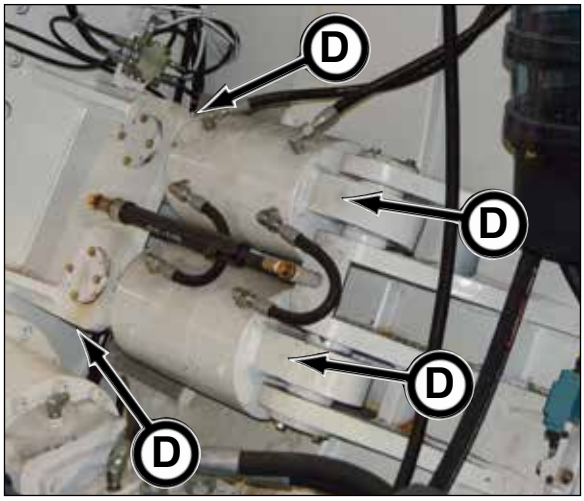
Be sure to check line and grade alignment often, with and without forward thrust applied. Keep in mind if you are off one degree, the bore will be off nearly two feet per one hundred feet.



5. LUBRICATE CONVEYOR LIFT

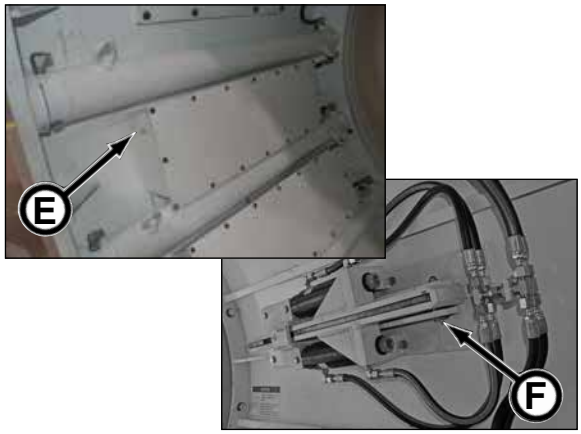
Lubricate conveyor lift (7 places) with Mobilgrease® XHP222 or equivalent until grease is forced out.

Trolley bracket pins (A) - 4 places
Cable pulley bearing (B) - 2 places
Adjustment pin (C) - 1 place



6. LUBRICATE STEERING CYLINDERS

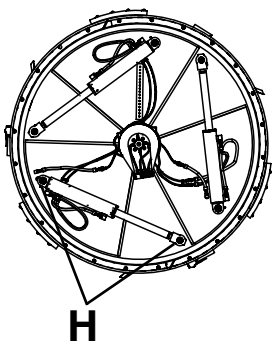
Lubricate all steering cylinders (D) (2 places per cylinder) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.

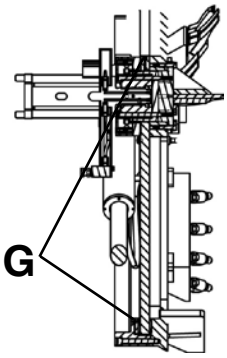


7. LUBRICATE DIRT WING/TORQUE WING

Lubricate all dirt wing/torque wings with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent:

- enclosed (E) (1 place): lubricate until resistance is felt while pumping grease.
- non-enclosed (F) (2 places): lubricate until grease is forced out.



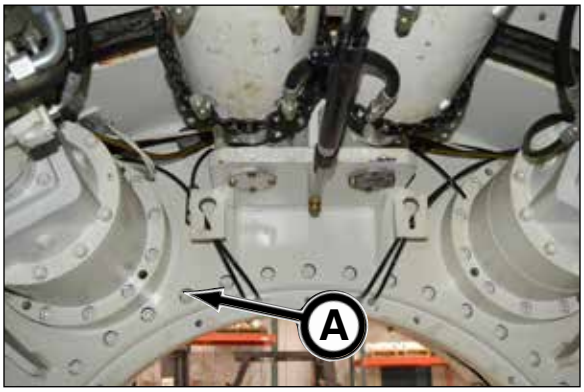


8. LUBRICATE CLOSED FACE CYLINDERS & DOORS (IF EQUIPPED)

Lubricate closed face doors (G) with Mobilgrease® XHP222 or equivalent until grease is forced out.

Lubricate closed face cylinders (H) with Mobilgrease® XHP222 or equivalent until grease is forced out.

9. CHECK INNER DRUM & BEARING BOLTS



Visually check bearing to drive housing (A) and inner drum to bearing (B) for loose or damaged bolts. If bolt(s) are loose or damaged, contact your Akkerman Aftermarket Support representative BEFORE replacing any bolts to the bearing or inner drum.

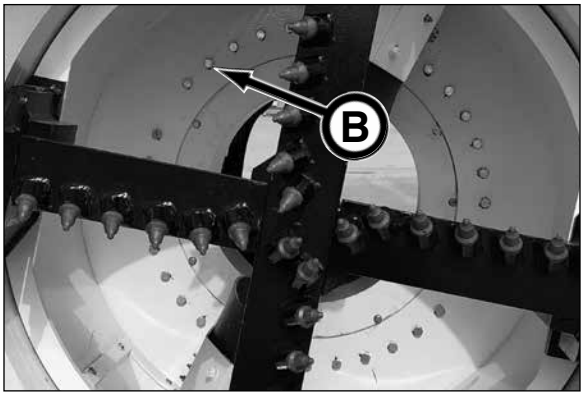
IMPORTANT: Visually check for loose or damaged bolts only. Checking each bolt torque with a torque wrench may damage the clamp load established from the original torquing of the bolt.

Once approved for replacement, tighten the new hardware to the following torque:

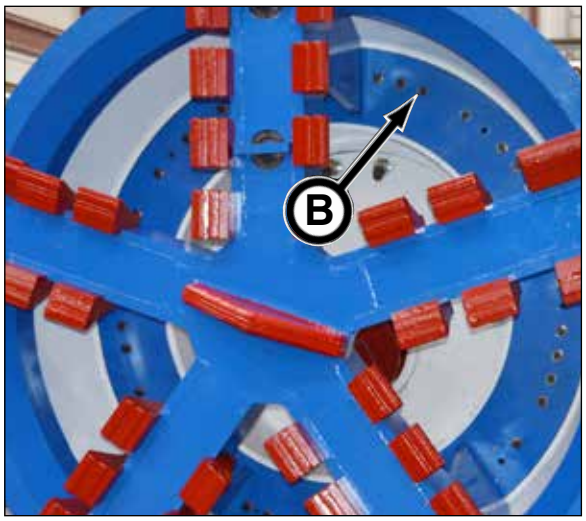
Bearing To Drive Housing SHSC Screws (A)
PM20B x 2.5 Class 12.9 to 394 ft-lb (534 N·m) (lubricated) torque with a properly calibrated torque wrench.

Inner Drum/Cutter Bit To Bearing Hardware (B)
• *PM20A x 2.5 Class 10.9 Hex Bolts* with flat washers to 337 ft-lb (457 N·m) (lubricated) torque with a properly calibrated torque wrench.

• *PM20B x 2.5 Class 12.9 SHSC Screws* to 394 ft-lb (534 N·m) (lubricated) torque with a properly calibrated torque wrench.



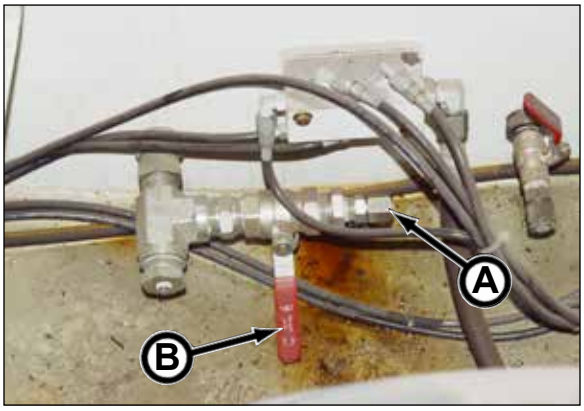
Dirt Bar Head



Mixed Ground Disc Cutterhead

10. CHECK BEARING CAVITY OIL CONDITION

Check the oil condition of the bearing cavity by draining a measured sampling of the oil.



1. Be sure to the clean the area around the bearing cavity oil shutoff drain plug (A) before removing to prevent contamination from entering bearing cavity.

2. Remove drain plug and install a hose to shutoff valve. Route hose to a clean container.

3. Open shutoff valve (B) to dispense an appropriate oil sample.

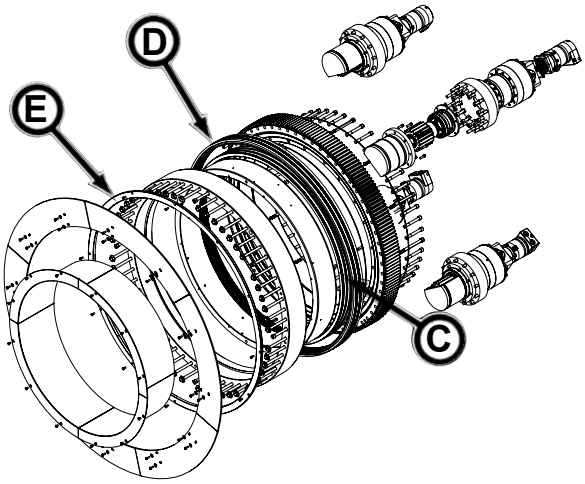
4. Close bearing cavity oil shutoff valve.

5. Inspect the drained oil for contaminants.

   • If water and/or grease is visible in the oil, the inner lips seals (C) and outer lip seals (D) are damaged and must be replaced. Contact your Akkerman Aftermarket Support representative for details on replacing the seals.

   • With any contamination, the bearing cavity must be completely drained and refilled with fresh, clean Mobilgear® 600XP 460 oil, once the lip seals are replaced.

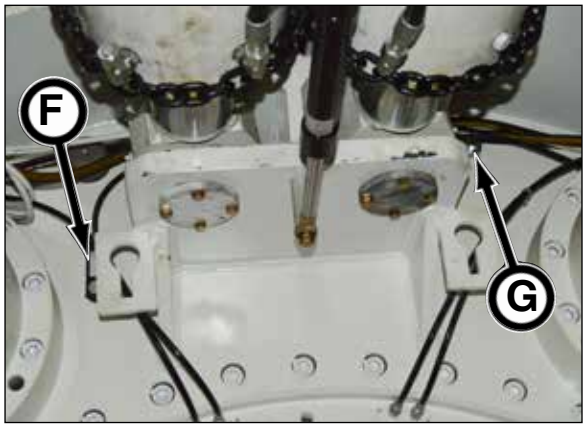
   • Check the lip seal retaining ring (E) for damage. If ring has excessive damage, replace with new.



6. Replenish bearing cavity of the volume of oil drained from step 3. Use fresh, clean Mobilgear® 600XP 460 oil. Replace fill port plug.

7. Remove hose from shutoff valve and replace drain plug.

11. CHECK BEARING CAVITY OIL LEVEL

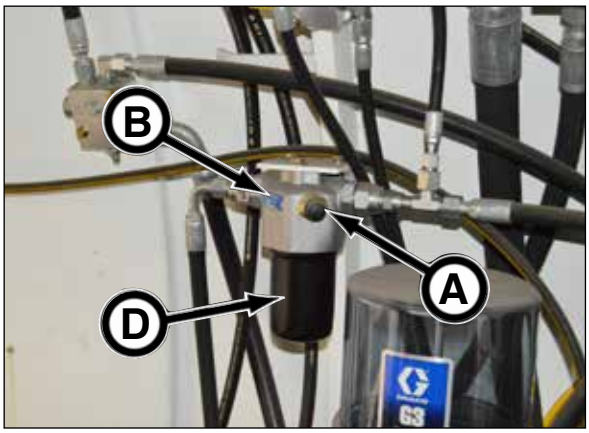


1. Check bearing cavity sight gauge oil level (F). If oil level is not at sight gauge level, add oil in bearing cavity fill port (G) until oil level is at proper level on sight gauge.

2. Replace fill plug.

12. CHECK BEARING CAVITY OIL FILTER

To prevent under or over servicing of the bearing cavity oil lube filter, a filter indicator (A) is installed on the filter head assembly (B).



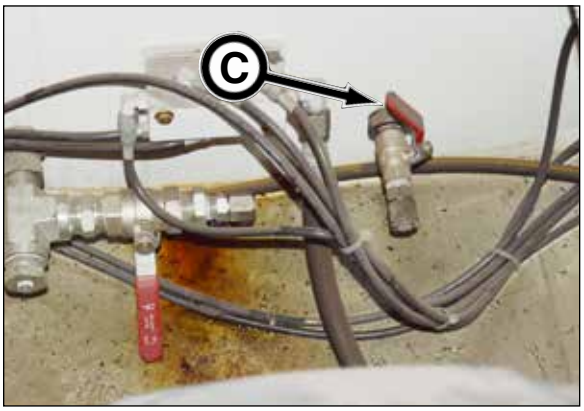
A red band will appear on the filter indicator when the filter requires replacement.

NOTICE The red band may display at initial start-up until the oil reaches normal operating temperature. If the red band continues to display after reaching normal operating temperature, replace filter to prevent contamination.

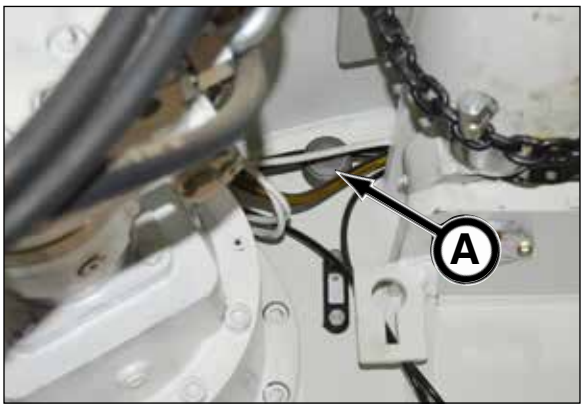
If filter requires replacement, use the following procedure:

1. With power LOCKED OUT, clean and dry area around filter assembly.
2. Close bearing oil cavity shutoff valve (C). This will prevent cavity from draining an excessive amount of lubricant.
3. Remove filter housing (D) from filter head using an oil filter wrench.
4. Remove filter from housing and dispose of filter properly.
5. Remove filter o-ring if stuck in filter housing.
6. Install new o-ring with a light coat of clean oil. Check to be sure the o-ring is not twisted and that it is correctly in place.
7. Install new filter until gasket makes contact with filter head.
8. Replace and secure filter housing to filter head assembly using an oil filter wrench.
9. **Open bearing oil cavity shutoff valve (C).**

   IMPORTANT: Failure to open bearing oil cavity shutoff valve before operating TBM WILL cause bearing and bearing lube circuit component damage since the bearing oil will not be recirculating.



10. Check for leaks.

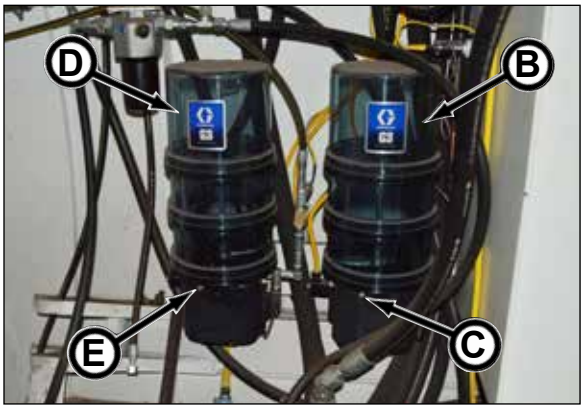


13. CHECK BEARING CAVITY VENT

Check bearing cavity vent (A) for dirt or debris build-up. Clean vent or replace if it shows signs of wear or damage.

14. FILL GREASE PUMP CONTAINERS

The grease pumps lubricate the bearing cavity dirt/lip seals to prevent dirt from entering the bearing cavity. Be sure the grease pump containers are filled before operation and during drive to prevent contamination from entering bearing cavity.



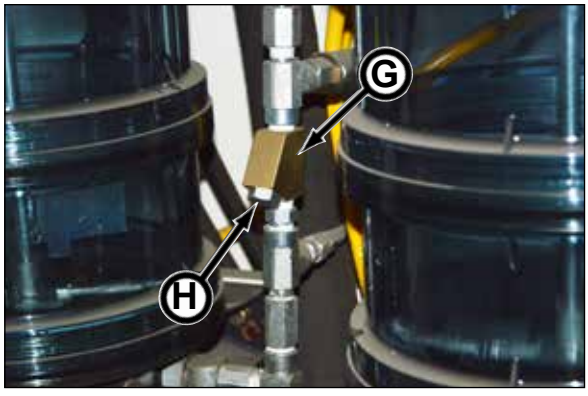
1. Fill the grease system #1 (B) with Mobil® SHC 101 EAL grease or equivalent through the grease pump fill port (C) until the grease pump container is filled.

2. Fill the grease system #2 (D) with Mobil® SHC 101 EAL grease or equivalent through the grease pump fill port (E) until the grease pump container is filled.

NOTICE If there is no pressure on the Grease PSI readout (F), the reservoir is out of grease or the pump is not operating.

NOTICE **NEVER** operate TBM if a filter, grease line or oil line is plugged, or if grease containers are empty. Doing so will introduce contamination in the bearing cavity resulting in seal, seal surface and bearing damage.

15. REPLACE GREASE PUMP FILTER ELEMENT



1. Gain access to the grease pump filter (G).

2. Remove plug (H).

3. Remove element and replace with new element.

4. Replace plug.

16. CHECK GREASE SYSTEM OPERATION

1. Inform all personnel that the TBM will be started shortly and the cutterhead will be rotating.

2. Once personnel are safely away from moving parts, start the TBM and rotate the cutterhead.

3. Check to be sure the grease system is automatically operating.

4. Observe the Grease PSI reading (A) to check if the Grease PSI is too low (less than 150 psi) or too high (2,500 psi). Keep in mind, if the grease is cold, the pressure will be higher.

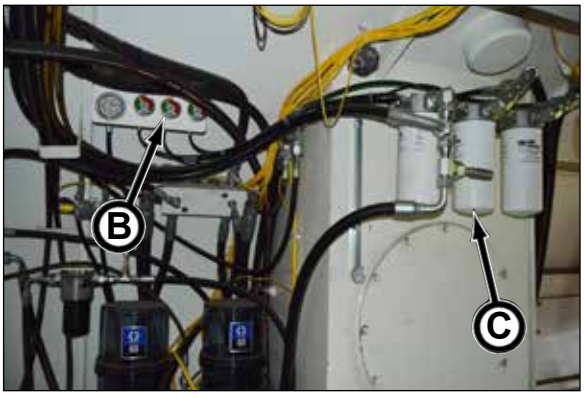
5. Troubleshoot any grease pump issues before launching TBM.

   • If the grease in-line filter is plugged or a grease line is clogged, the pressure will display a much higher pressure.

   • If there is no pressure on the gauge, the reservoir is out of grease or the pump is not operating.

17. CHECK RETURN FILTER INDICATORS

To prevent under or over servicing of the return filter elements, filter indicators (B) are remotely mounted for each filter assembly. There are **three** return filter assemblies (C) installed on your TBM.



The green OK zone indicates that the filter is functioning properly.

The yellow zone indicates that the filter will soon require replacement.

When the needle on the gauge is in the red CHANGE zone, replace filter as soon as possible to prevent hydraulic component damage using the following procedure:

(continued on next page)

NOTICE The filter indicator may display a red band at initial start-up until the oil reaches normal operating temperature. If the indicator continues to display the red band after reaching normal operating temperature, replace filter to prevent contamination. All filters require replacement if any of the following situations occur:

- A major component fails.
- Any sign of water contamination from an oil analysis or if oil is milky or foaming.
- A hydraulic oil sample indicates large particle contamination.

1. Clean and dry area around the return filter (A).

2. Remove filter. Dispose of oil and filter properly.

NOTICE Remove filter gasket if stuck in filter housing.

3. Lubricate new filter gasket with a light coating of clean hydraulic oil and install into filter housing. Be sure gasket is not twisted and that it is properly seated into housing groove.

4. Fill new filter with clean hydraulic oil.

5. Install new filter. Hand tighten only. Follow tightening instructions on filter.

6. Check for leaks.

7. If needed, repeat steps 1 through 6 for other filters.

8. Check hydraulic oil reservoir oil level (B). Add hydraulic oil if necessary.

18. CHECK HYDRAULIC OIL RESERVOIR CONDITION & LEVEL OF OIL

1. Check reservoir hydraulic oil for the following:

   a. Check for oil bubbles or foaming oil. This may indicate an air leak in the system.
   b. Check for milky oil. This indicates that there is water in the system. Be sure your oil is being properly stored.
   c. Large particle contamination from oil sample.

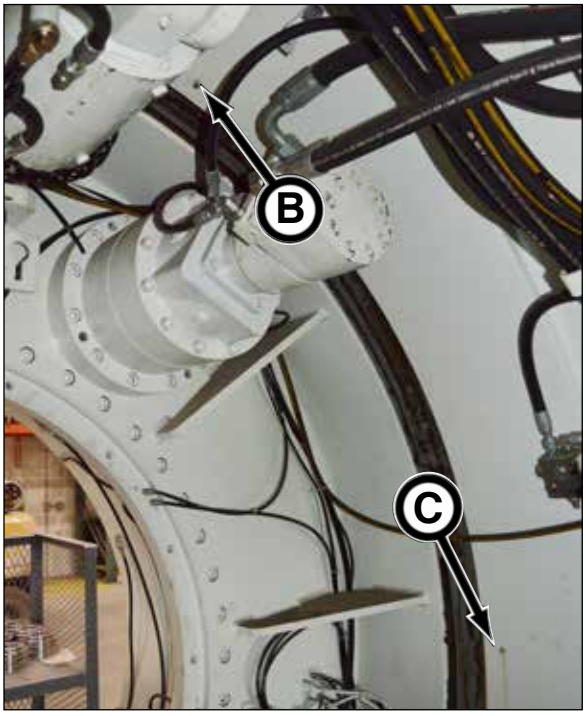
If any of these conditions are found, the reservoir must be drained, cleaned, and refilled with new, clean filtered hydraulic oil. All hydraulic filters also require replacement. Refer to Every 1000 Hours of Operation, “67. Drain & Fill Hydraulic Oil” in this section.

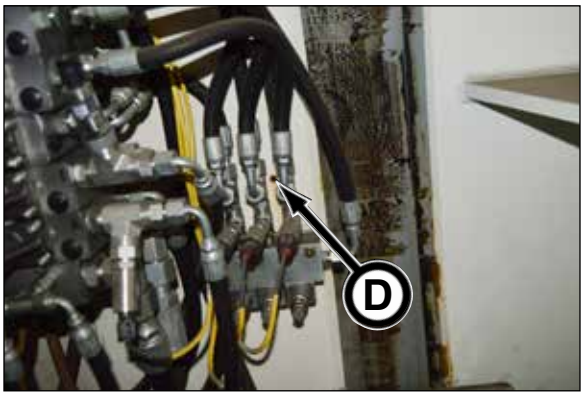
2. Check the hydraulic reservoir sight gauge (A) for the proper oil level. Keep oil maintained between the low and high marks on the gauge. If needed, add clean, filtered oil to the reservoir.

19. LUBRICATE STEERING JOINT

Lubricate steering joint lubrication fittings (3 places) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.

The steering joint lubrication fittings are located at the following positions:
1 o’clock (B), 3 o’clock (C) and 8 o’clock (D).





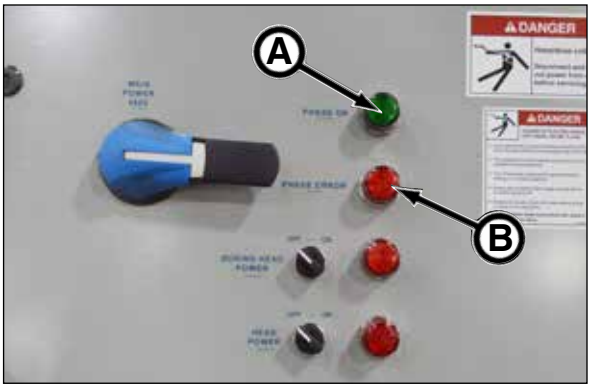
20. INSPECT HYDRAULIC HOSES & POWER CABLES

⚠DANGER If high voltage cables or cable connections are frayed, worn or damaged, contact with cables/connections will result in electrical shock causing severe injury or death.

With power in LOCKOUT TAGOUT, check electrical power cables and connections for fraying, wear or damage. If damaged, the cables must be replaced BEFORE operation. Be sure connections are secured.

Inspect ALL hydraulic hoses for cracks, wear or other damage. Repair or replace BEFORE operation.

21. CHECK PHASE POWER



The input power on the power pack is monitored for proper three phase electrical power. The green Phase OK indicator must be illuminated before operating equipment.

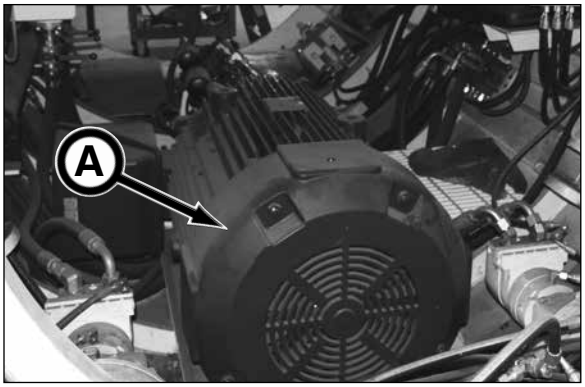
IMPORTANT: If the red Phase Error indicator is illuminated, the power pack starting is disabled. This starting interlock will prevent the components from running backwards which would result in damage.

If the green Phase OK indicator (A) is illuminated, this indicates that the external power source phase power is installed correctly and the main power can be turned on.

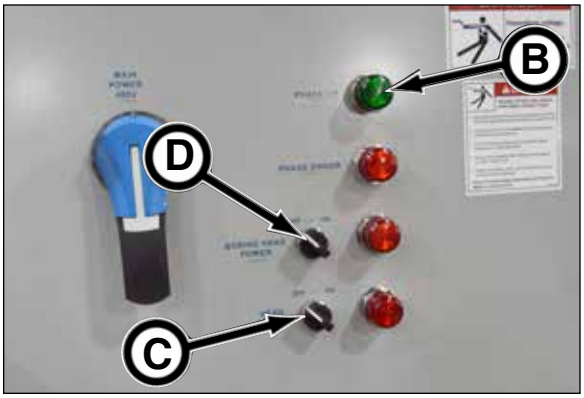
If the red Phase Error indicator (B) is illuminated, this indicates that the external power source is installed incorrectly. Lockout tagout all power before disconnecting power lead cables. Have a certified electrician reverse the two generator electrical phase conductors on the power circuit and recheck phase power.

22. CHECK DRIVE MOTOR ROTATION

Check drive motor (A) rotation. Improper motor rotation will cause component damage.

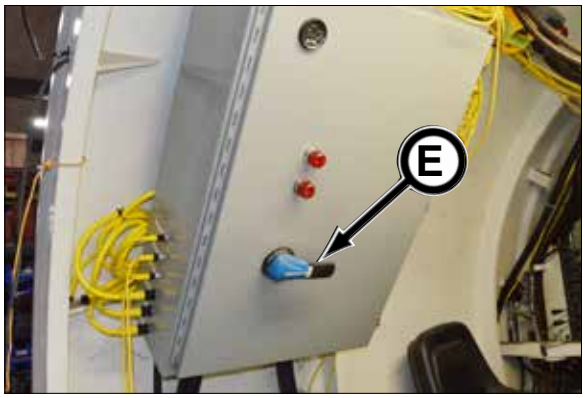


1. With power on and the pit box indicates that power is in proper phase (B), turn on head power (C) and boring head power (D).



2. In TBM, turn main disconnect switch (E) to the ON position.

3. Bump* Start Pump button (F) to start and then quickly stop motor to check rotation.
   *"bump start" is an intermittent push of the button, then turned off immediately.



4. If rotation is incorrect, have your certified electrician perform the following procedure.

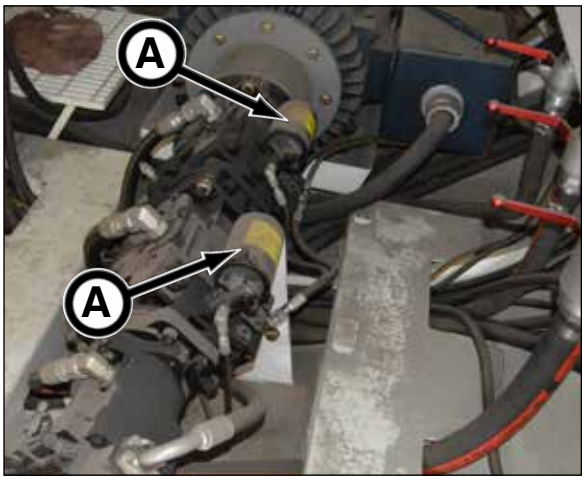
   a. Push E-Stop button IN and turn main power switch to OFF.
   b. Perform lockout, tagout procedure on main power source.
   c. Test to ensure no voltage is present, then rewire for proper motor rotation.
   d. Turn on main power source, pull E-Stop button out and turn head power and boring head power on.
   e. Repeat steps 2 and 3 to verify power motor rotation.

5. Once motor rotation is correct, turn main power disconnect in TBM to OFF position. Turn head power and boring head power off.

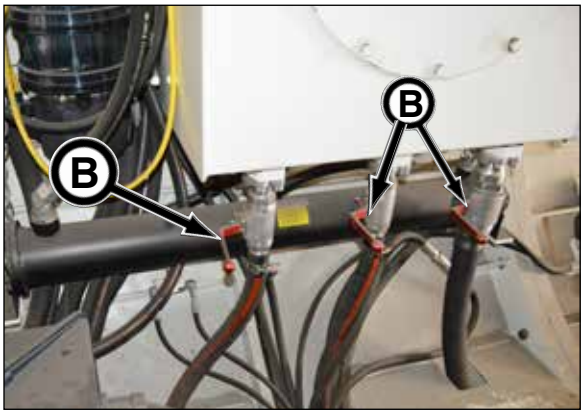
6. Push E-stop IN to prevent any accidental starting. Perform lockout, tagout procedure.

23. REPLACE HYDROSTATIC PUMP FILTERS

Replace hydrostatic pump filters (A) before each drive.

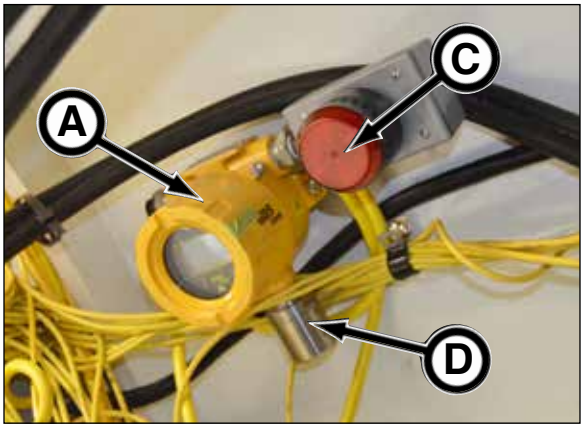


1. Turn main hydraulic shutoff valves (B) to the closed position.
2. Place a catch pan below filter being removed.
3. Remove filter.
4. Install new spin-on filter (hand tighten only).
5. Dispose of oil properly.
6. Replace other filter using steps 2 through 5.
7. Turn main hydraulic shutoff valves to the open position. Tie strap valve handle in the open position to prevent accidental closure while operating.



IMPORTANT: Failure to open shutoff valves (B) WILL cause damage to pumps. Be sure to tie strap valve handles in the open position to prevent accidental closure while operating.

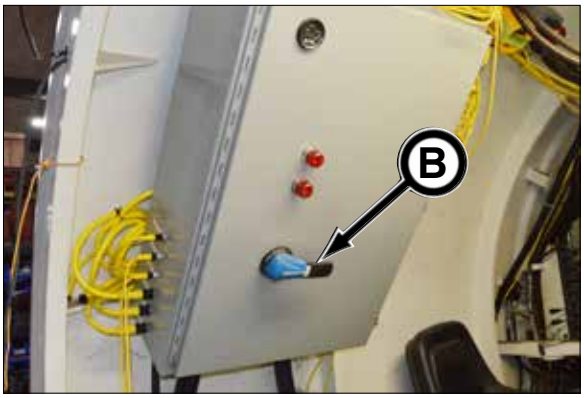
24. TEST GAS DETECTOR OPERATION



Test the gas detector (A) operation as follows:

1. Prior to energizing the system, the tunnel must be checked for concentrations of combustible gases and oxygen deficiency. This must be done with a separate contractor supplied gas detector. Once acceptable combustible gas and oxygen levels are confirmed, the system can be energized.

NOTICE At the start of every new drive, and every forty hours of operation, or after significant service, a “gas challenge” procedure MUST be completed on the Akkerman gas detection system. For details, refer to the Akkerman Gas Detection System Operation & Parts Manual.

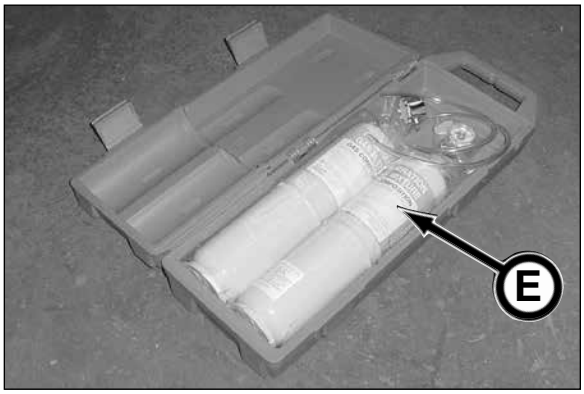


2. With the Pit Box head power on and the TBM main power disconnect switch (B) to the ON position the horn will sound for a few seconds.

   If the horn and strobe (C) come on immediately, typically the sensor (D) must be replaced. To test the operation of the horn and strobe, simply apply a gas concentration (Akkerman calibration kit (E) PN P0310-266) to sensor or check the horn and strobe operation by using the magnetic wand and touch the following sensor points on the LCD display (refer to the Akkerman Gas Detection System Operation & Parts Manual):

   Edit/Alarm Settings/Edit/Down Cal to Relay Config/ Edit/Edit (changes FailSafe from No to Yes to activate the horn and strobe). Press Edit again to stop horn and strobe.

   If horn and strobe do not come on or any error is shown on the LCD display, the problem(s) must be corrected prior to allowing people in the tunnel and before the boring head operation.

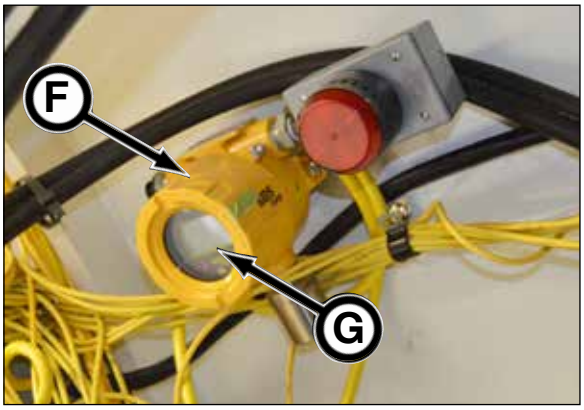


3. The gas detection system transmitter (F) includes a LCD/LED display (G). Once the system has completed its start up sequence, this display will stabilize and indicate the methane gas level.

If there is no response from the alarms and the display is blank, have a certified electrician determine if power is available to the unit.

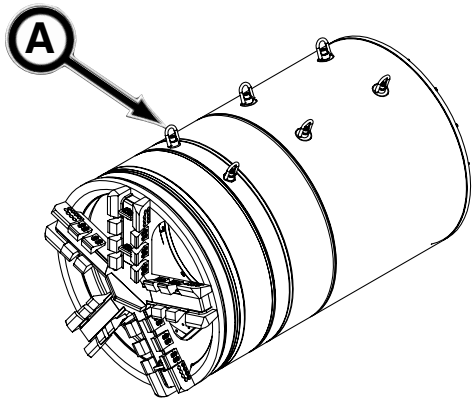
If the display has an error message, refer to the transmitter manual in the Akkerman Gas Detection System Operation & Parts Manual.

Contact the Akkerman Aftermarket Support Department for assistance.



25. INSPECT LIFTING EYES

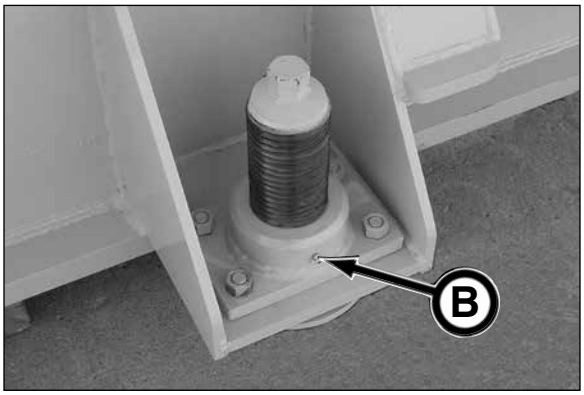
Inspect lifting eyes (A) for wear or damage. Worn or damaged lifting eyes MUST be replaced before lifting.



26. LUBRICATE LEVELING SCREWS

Lubricate leveling screws (B) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent.

Lubricate threads thoroughly.



27. INSPECT DECALS

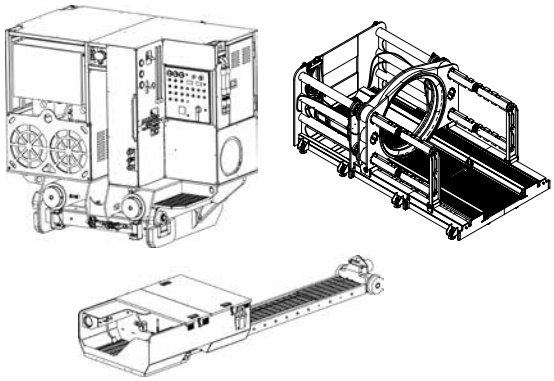
Inspect ALL decals, operational and safety decals to be sure they are clean and readable.

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

Before applying a new decal, be sure the surface is clean and dry.

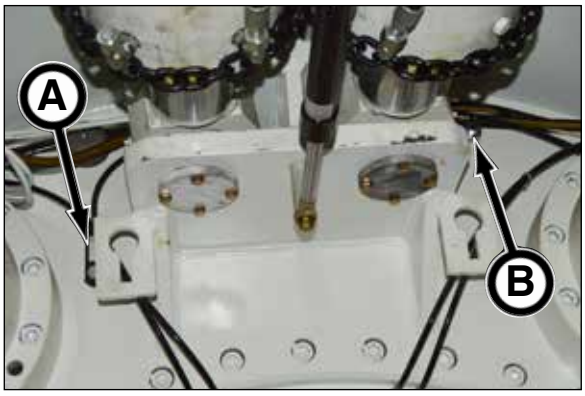
28. PERFORM MAINTENANCE ON ALL SUPPORTING EQUIPMENT

Be sure all supporting equipment such as the haul unit, jacking frame, and generator are properly maintained and are operating properly. Be sure to repair or replace equipment before operating TBM. Refer to the operation and maintenance manuals of the equipment.



DAILY OR EVERY 10 HOURS OF OPERATION OR SHIFT CHANGE

29. CHECK BEARING CAVITY OIL LEVEL



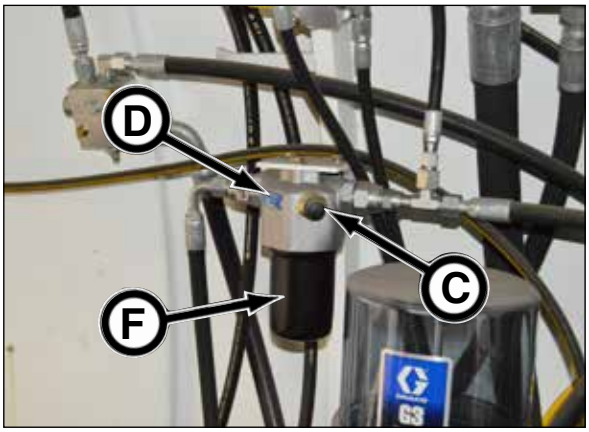
1. Check bearing cavity sight gauge oil level (A). If oil level is not at sight gauge level, add oil in bearing cavity fill port (B) until oil level is at proper level on sight gauge.

2. Replace fill plug.

30. CHECK BEARING CAVITY OIL FILTER

To prevent under or over servicing of the bearing cavity oil lube filter, a filter indicator (C) is installed on the filter head assembly (D).

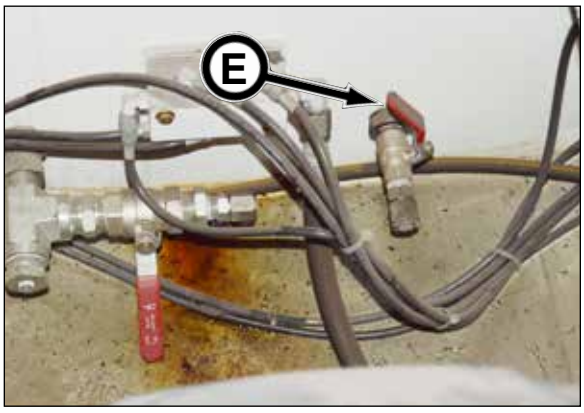
A red band will appear on the filter indicator when the filter requires replacement.



NOTICE The red band may display at initial start-up until the oil reaches normal operating temperature. If the red band continues to display after reaching normal operating temperature, replace filter to prevent contamination.

If filter requires replacement, use the following procedure:

1. With power LOCKED OUT, clean and dry area around filter assembly.
2. Close bearing oil cavity shutoff valve (E). This will prevent cavity from draining an excessive amount of lubricant.
3. Remove filter housing (F) from filter head using an oil filter wrench.
4. Remove filter from housing and dispose of filter properly.
5. Remove filter o-ring if stuck in filter housing.
6. Install new o-ring with a light coat of clean oil. Check to be sure the o-ring is not twisted and that it is correctly in place.
7. Install new filter until gasket makes contact with filter head.
8. Replace and secure filter housing to filter head assembly using an oil filter wrench.
9. **Open bearing oil cavity shutoff valve (C).**

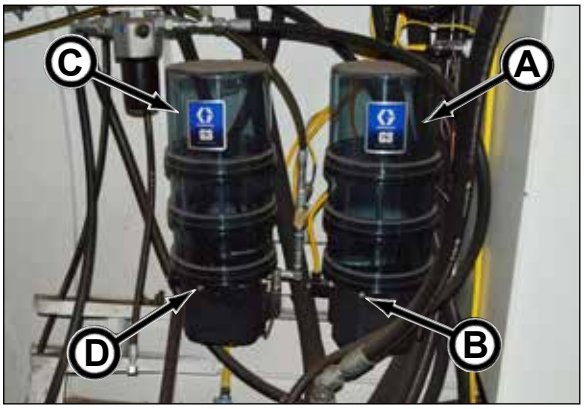


IMPORTANT: Failure to open bearing oil cavity shutoff valve before operating TBM WILL cause bearing and bearing lube circuit component damage since the bearing oil will not be recirculating.

10. Check for leaks.

31. FILL GREASE PUMP CONTAINERS

The grease pumps lubricate the bearing cavity dirt/lip seals to prevent dirt from entering the bearing cavity. Be sure the grease pump containers are filled before operation and during drive to prevent contamination from entering bearing cavity.



1. Fill the grease system #1 (A) with Mobil® SHC 101 EAL grease or equivalent through the grease pump fill port (B) until the grease pump container is filled.

2. Fill the grease system #2 (C) with Mobil® SHC 101 EAL grease or equivalent through the grease pump fill port (D) until the grease pump container is filled.

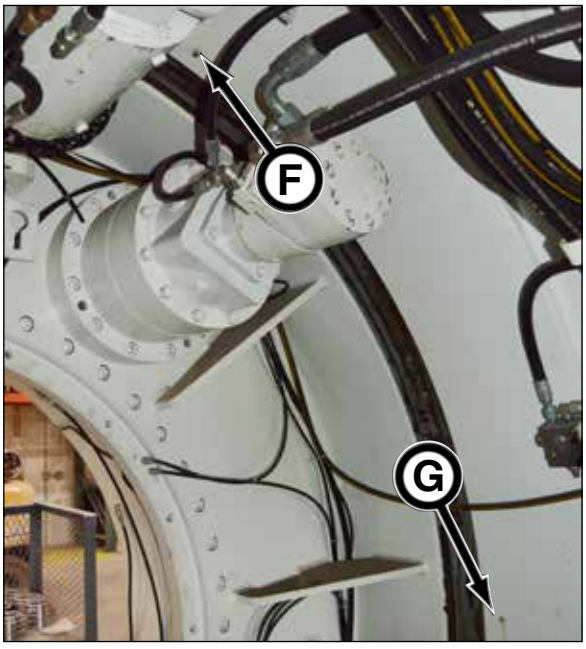
NOTICE If there is no pressure on the grease PSI readout (E), the reservoir is out of grease or the pump is not operating.

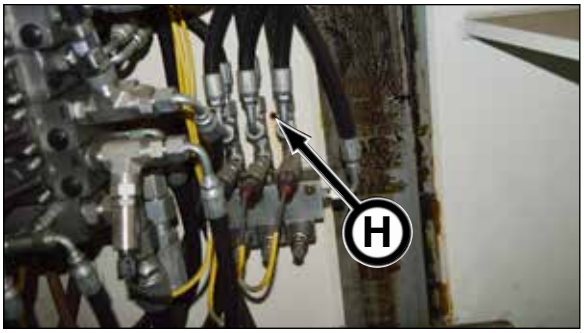
NOTICE **NEVER** operate TBM if a filter, grease line or oil line is plugged, or if grease containers are empty. Doing so will introduce contamination in the bearing cavity resulting in seal, seal surface and bearing damage.

32. LUBRICATE STEERING JOINT

Lubricate steering joint lubrication fittings (3 places) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.

The steering joint lubrication fittings are located at the following positions:
1 o'clock (F), 4 o'clock (G) and 8 o'clock (H).





33. INSPECT HYDRAULIC HOSES & POWER CABLES

⚠DANGER If high voltage cables or cable connections are frayed, worn or damaged, contact with cables/connections will result in electrical shock causing severe injury or death.

With power in LOCKOUT TAGOUT, check electrical power cables and connections for fraying, wear or damage. If damaged, the cables must be replaced BEFORE operation. Be sure connections are secured.

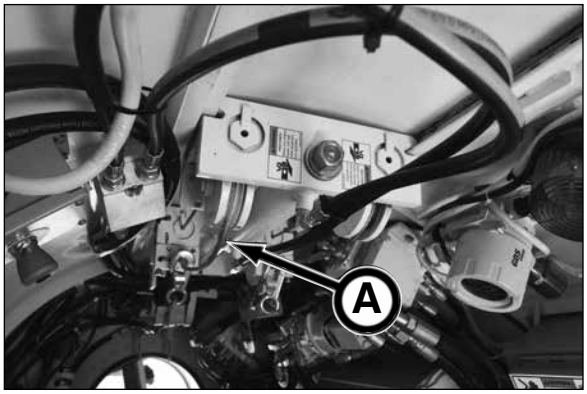
Inspect ALL hydraulic hoses for cracks, wear or other damage. Repair or replace BEFORE operation.

TBM 840 SN1 Shown

34. INSPECT CONVEYOR LIFT CABLES

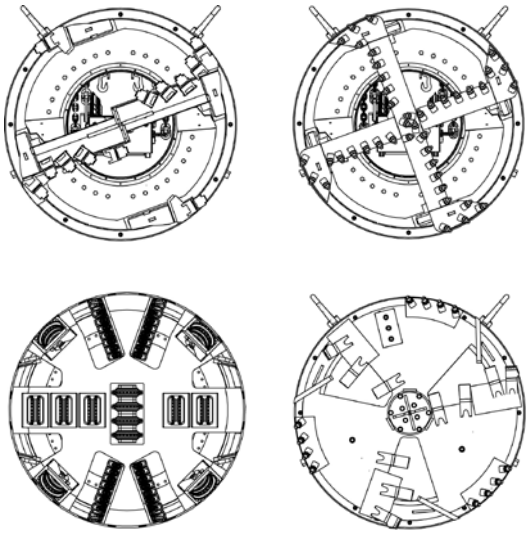
Inspect conveyor lift cables (A), hooks, protective sleeves and cable clamps for wear or damage.

Replace cables, hooks, protective sleeves and cable connectors as a set at the first sign of wear or damage.



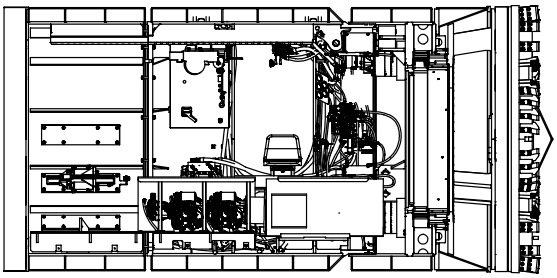
35. INSPECT CUTTER BAR/TEETH/SCRAPERS/ DISC CUTTERS

Inspect cutter bar, cutter teeth, scrapers and disc cutters. Repair or replace as necessary.



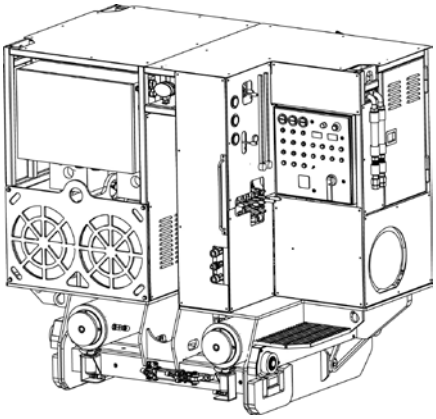
36. CHECK CONTROL OPERATION

Before operating TBM or at each shift change, be sure to check all TBM, Pump Unit, haul unit controls and other supporting equipment for proper operation. If controls do not function properly, repair or replace BEFORE operation.



CHECK THE FOLLOWING CONTROLS FOR PROPER OPERATION:

- ALL E-Stops, and gas detectors*:
  check for proper operation
  * refer to your GasMax Instruction Manual for operation and maintenance procedures.



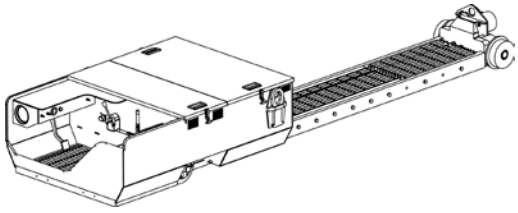
- Conveyor Controls:
  conveyor lift - up and down
  conveyor drive - forward and reverse
  conveyor safety valve switch - MUST stop cutterhead rotation

- Boring Head Controls:
  cutterhead rotation - CW and CCW rotation

- Steering Controls:
  steering cylinder - extend and retract

- Dirt Wing Controls
  cylinder control - extend and retract

- Auxiliary or Closed Face Controls
  check control operation



- Pump Unit Controls

- Haul Unit Controls

- Jacking Frame/IJS Controls

- Foam Generation System Controls (if equipped)

- Lights

37. CHECK RETURN FILTER INDICATORS

To prevent under or over servicing of the return filter elements, filter indicators (A) are remotely mounted for each filter assembly. There are **three** return filter assemblies (B) installed on your TBM.

The green OK zone indicates that the filter is functioning properly.

The yellow zone indicates that the filter will soon require replacement.

When the needle on the gauge is in the red CHANGE zone, replace filter as soon as possible to prevent hydraulic component damage using the following procedure:

NOTICE The filter indicator may display a red band at initial start-up until the oil reaches normal operating temperature. If the indicator continues to display the red band after reaching normal operating temperature, replace filter to prevent contamination. All filters require replacement if any of the following situations occur:

- A major component fails.
- Any sign of water contamination from an oil analysis or if oil is milky or foaming.
- A hydraulic oil sample indicates large particle contamination.

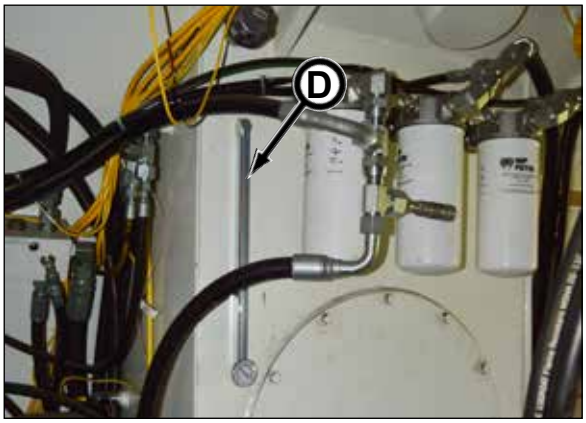
1. Clean and dry area around the return filter (C).

2. Remove filter. Dispose of oil and filter properly.

NOTICE Remove filter gasket if stuck in filter housing.

3. Lubricate new filter gasket with a light coating of clean hydraulic oil and install into filter housing. Be sure gasket is not twisted and that it is properly seated into housing groove.

4. Fill new filter with clean hydraulic oil.



5. Install new filter. Hand tighten only. Follow tightening instructions on filter.

6. Check for leaks.

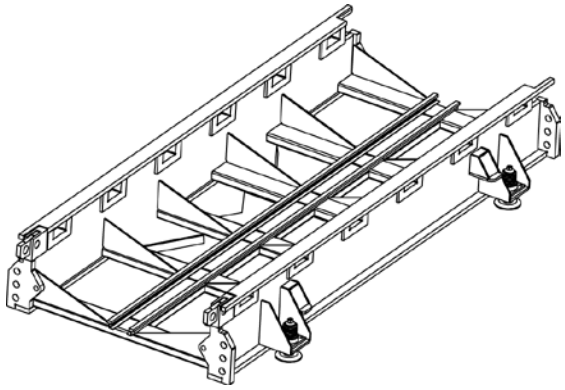
7. If needed, repeat steps 1 through 6 for other filters.

8. Check hydraulic oil reservoir oil level (D). Add hydraulic oil if necessary.

38. INSPECT SKID BASE (IF USED)

Visually inspect skid base for cracks or other damage. Also check for damaged, loose, or missing hardware. Replace with new.

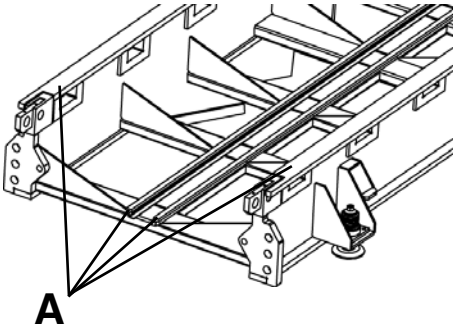
If cracks or damage are present, contact your Akkerman Aftermarket Support representative for authorized repair or replacement procedures.



39. INSPECT RAILS (IF USED)

Clean and inspect rails (A) for cracks or other damage.

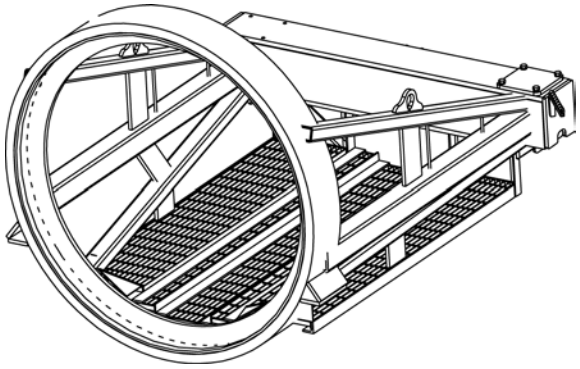
If cracks or damage are present, contact your Akkerman Aftermarket Support representative for authorized repair or replacement procedures.



40. INSPECT YOKE FRAME (IF USED)

Visually inspect yoke for cracks or other damage. Also check for damaged, loose, or missing hardware. Replace with new.

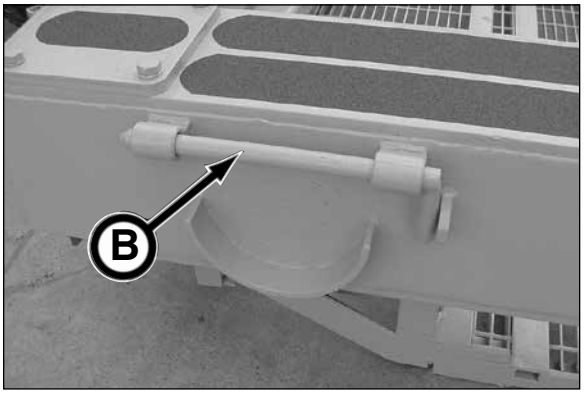
If cracks or damage are present, contact your Akkerman Aftermarket Support representative for authorized repair or replacement procedures.



41. INSPECT YOKE RAM RETAINING PINS (IF USED)

Visually inspect retaining pins (B) (2 places) for damage.

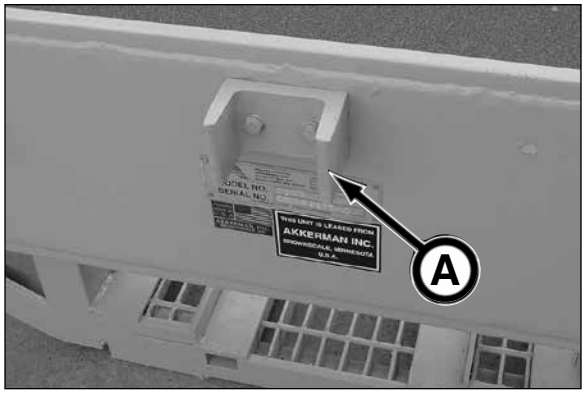
If damage is present, replace with new.



42. INSPECT YOKE RAM RETAINING PIN STOP (IF USED)

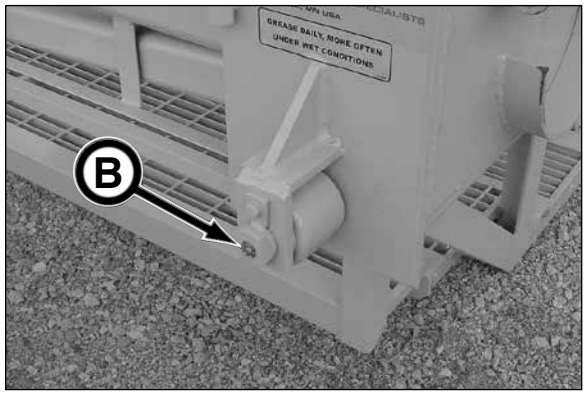
Visually inspect stop (A) or hardware for damage.

If damaged or missing, replace with new.



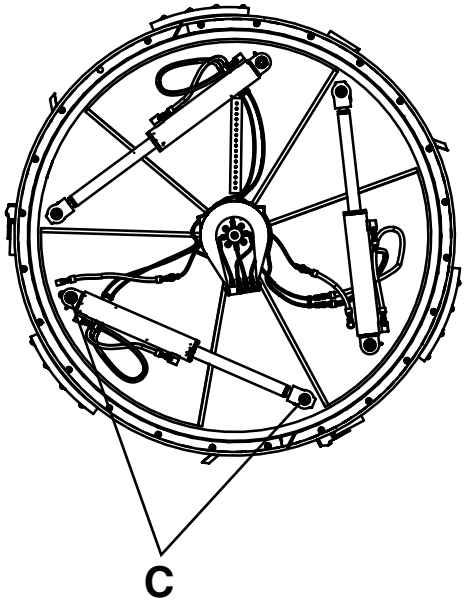
43. LUBRICATE YOKE WHEELS (IF USED)

Lubricate yoke wheels (B) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent.



44. LUBRICATE CLOSED FACE CYLINDERS (IF EQUIPPED)

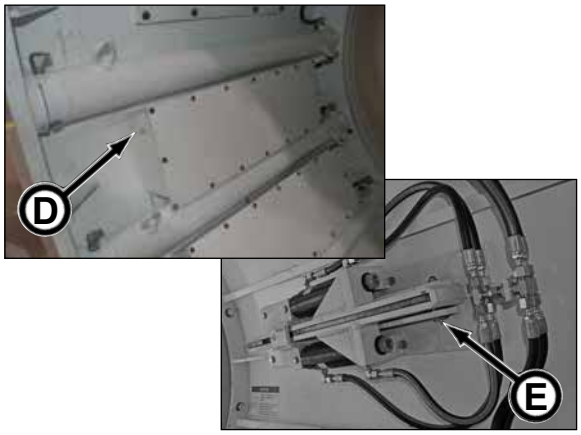
Lubricate closed face cylinders (C) with Mobilgrease® XHP222 or equivalent until grease is forced out.



45. LUBRICATE DIRT WING/TORQUE WING

Lubricate all dirt wing/torque wings with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent:

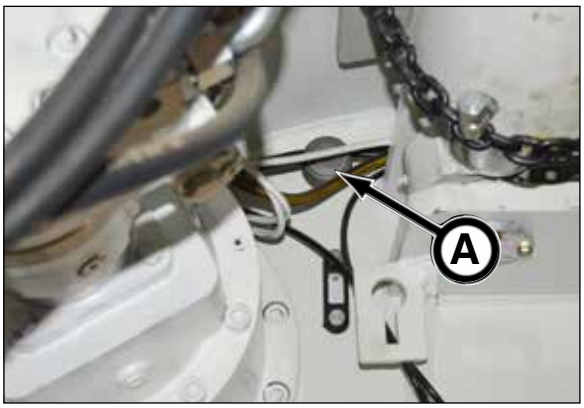
- enclosed (D) (1 place): lubricate until resistance is felt while pumping grease.
- non-enclosed (E) (2 places): lubricate until grease is forced out.



WEEKLY OR EVERY 50 HOURS OF OPERATION

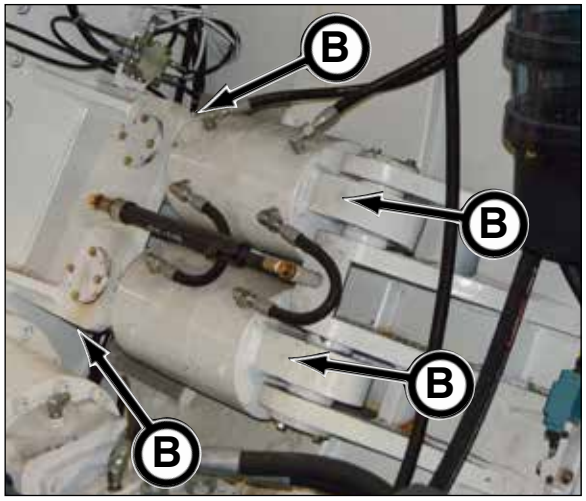
46. CHECK BEARING CAVITY VENT

Check bearing cavity vent (A) for dirt or debris build-up. Clean vent or replace if it shows signs of wear or damage.



47. LUBRICATE STEERING CYLINDERS

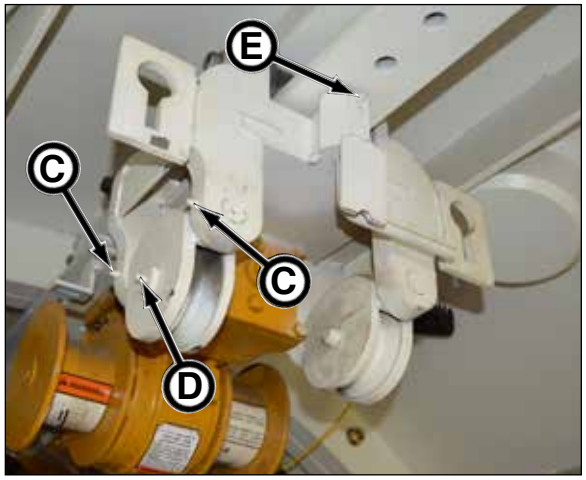
Lubricate all steering cylinders (B) (2 places per cylinder) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.



48. LUBRICATE CONVEYOR LIFT

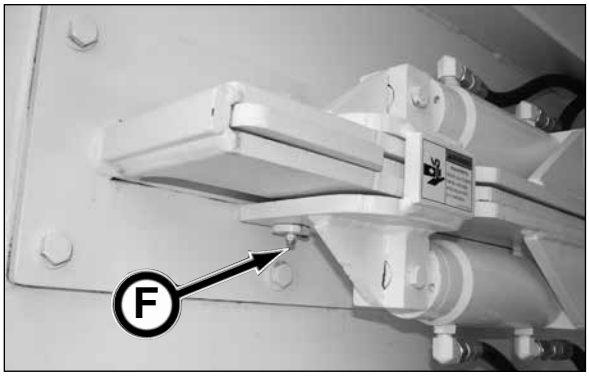
Lubricate conveyor lift (7 places) with Mobilgrease® XHP222 or equivalent until grease is forced out.

Trolley bracket pins (C) - 4 places
Cable pulley bearing (D) - 2 places
Adjustment pin (E) - 1 place



49. LUBRICATE DIRT WING/TORQUE WING PINS

Lubricate all dirt wing/torque wing pins (F) (2 places per dirt wing) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.



AFTER FIRST DRIVE OR FIRST 100 HOURS OF OPERATION*, THEN MONTHLY OR EVERY 250 HOURS OF OPERATION THEREAFTER

50. PERFORM BEARING CAVITY MAINTENANCE

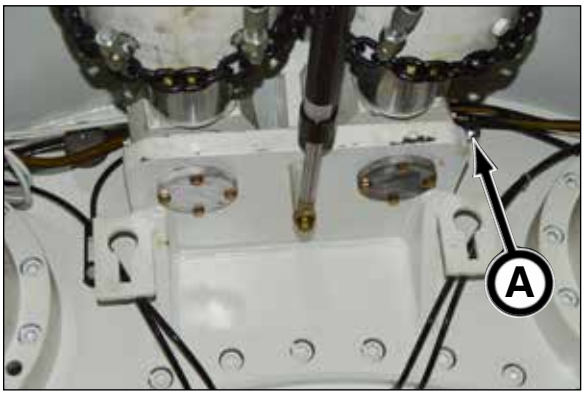
NOTICE Oil change interval may be increased with periodic examination of oil samples. Any sign of contamination requires the immediate replacement of the bearing cavity oil with new, clean oil.

The bearing cavity maintenance consists of:

- draining bearing cavity
- check and clean suction screen
- inspect bearing cavity magnetic rod for fragments
- clean bearing cavity vent
- fill bearing cavity with new, fresh oil.

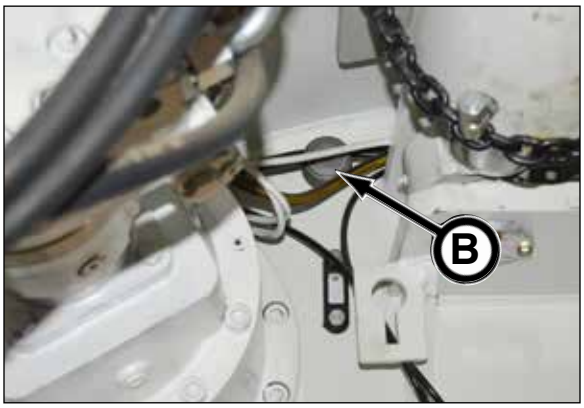
* Whichever occurs first.

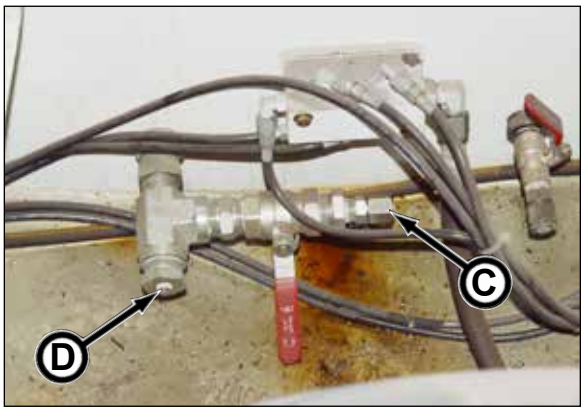
Perform bearing cavity maintenance as follows:



1. Clean area around bearing cavity oil fill port (A) and bearing cavity oil vent (B) to prevent dirt/debris from accidentally entering bearing cavity.

2. Remove fill plug and retain for later reinstallation.



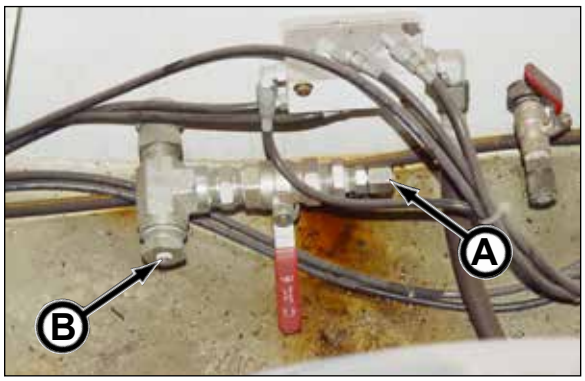


3. Clean area around bearing oil drain shutoff valve port (C) and magnetic rod valve (D).

(continued on next page)

4. Remove drain plug (A) and install a hose to shutoff valve. Route hose to a properly sized container for draining the oil from the bearing cavity.

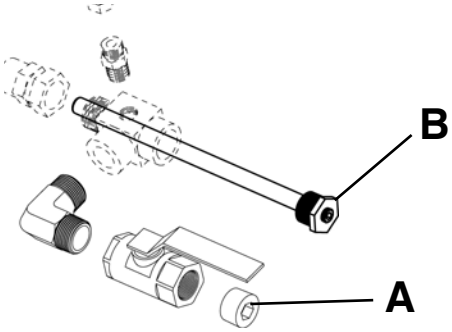
5. Open bearing oil drain shutoff valve and drain oil into container until bearing cavity is drained.



NOTICE If possible, carefully rotate TBM to drain additional oil from bearing cavity.

6. Remove magnetic rod/plug (B). Inspect rod for metal fragments. If fragments appear to be excessive, contact your Akkerman Aftermarket Support representative for information on how to resolve this issue.

7. Clean rod and replace magnetic rod valve plug.

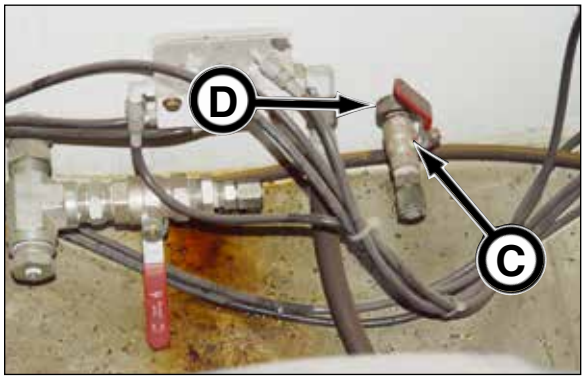


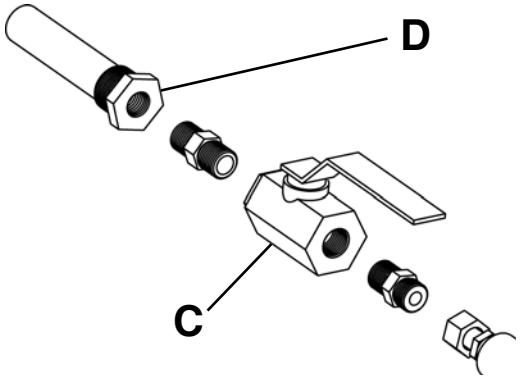
8. Clean area around bearing cavity oil shutoff valve (C) and suction strainer (D). Close valve.

9. Remove suction strainer/shutoff valve and clean strainer.

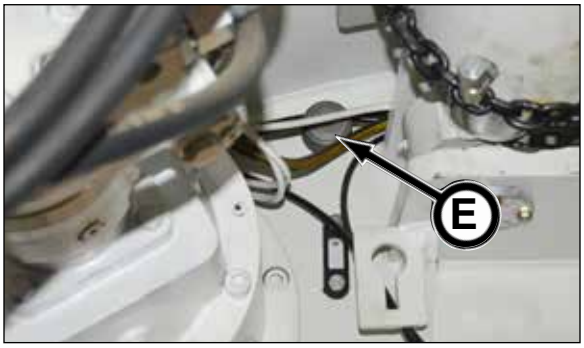
10. Replace suction strainer/shutoff valve.

11. Open bearing cavity oil shutoff valve.





12. Check bearing cavity vent (E) for dirt or debris build-up. Clean vent or replace if it shows signs of wear or damage.

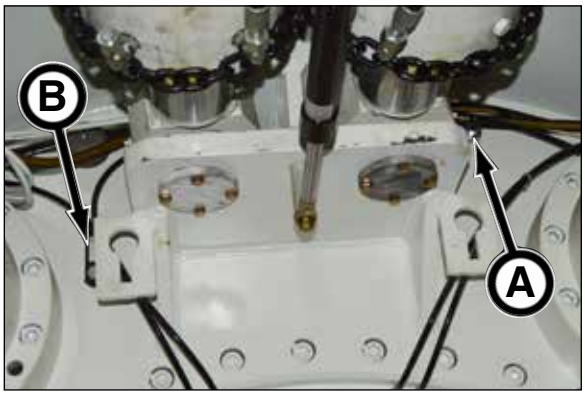


(continued on next page)

13. Fill the bearing cavity with Mobilgear® 600XP 460 gear oil or equivalent through fill port (A) until the oil level is visible on the sight gauge (B).

    Bearing Cavity Oil Capacity (Approximately) ..... 80 gal. (303 L)

14. Replace fill port fitting.



51. PERFORM HYDRAULIC OIL ANALYSIS

Test the quality of the hydraulic reservoir oil. Perform an oil analysis by sending an oil sample to a qualified testing facility.

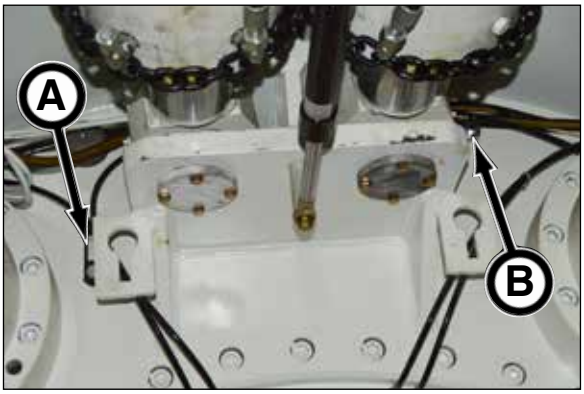
If the test reveals higher contamination levels than allowed by your oil manufacturer, or if your oil is milky or discolored, drain and replace the hydraulic reservoir oil. If draining and replacing the hydraulic oil reservoir is required, all hydraulic filters should also be replaced.

COMPLETION OF EACH DRIVE

52. CHECK BEARING CAVITY OIL LEVEL

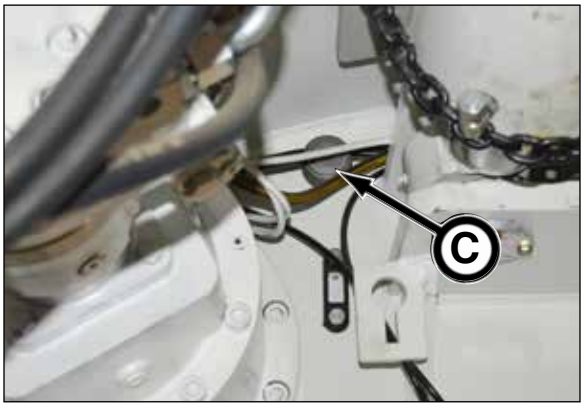
1. Check bearing cavity sight gauge oil level (A). If oil level is not at sight gauge level, add oil in bearing cavity fill port (B) until oil level is at proper level on sight gauge.

2. Replace fill port fitting.



53. CHECK BEARING CAVITY VENT

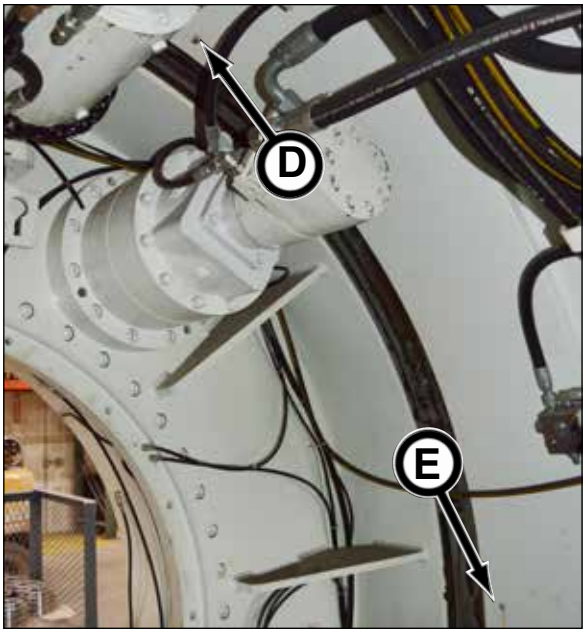
Check bearing cavity vent (C) for dirt or debris build-up. Clean vent or replace if it shows signs of wear or damage.

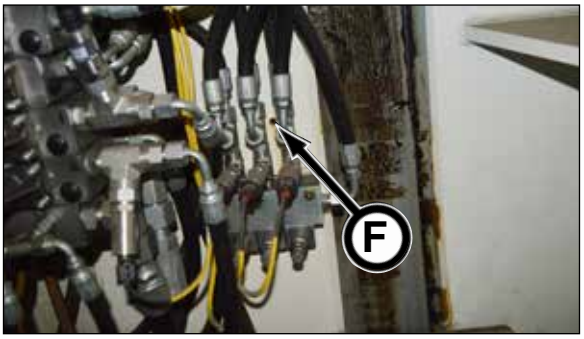


54. LUBRICATE STEERING JOINT

Lubricate steering joint lubrication fittings (3 places) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.

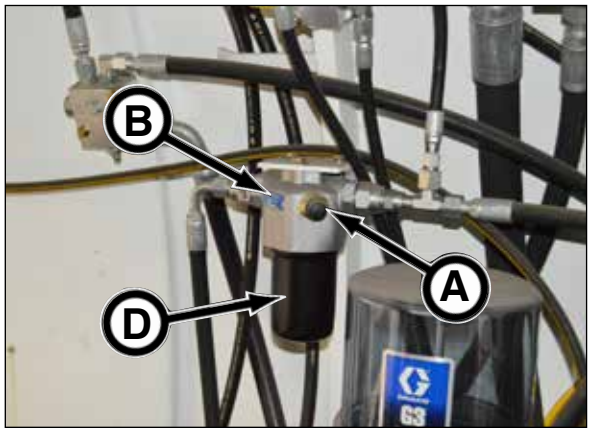
The steering joint lubrication fittings are located at the following positions:
1 o'clock (D), 4 o'clock (E) and 8 o'clock (F).





55. CHECK BEARING CAVITY OIL FILTER

To prevent under or over servicing of the bearing cavity oil lube filter, a filter indicator (A) is installed on the filter head assembly (B).

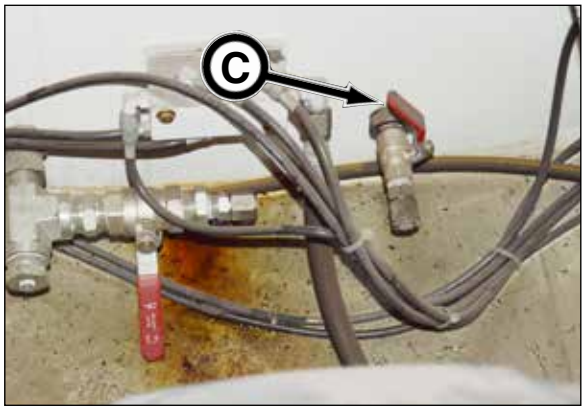


A red band will appear on the filter indicator when the filter requires replacement.

NOTICE The red band may display at initial start-up until the oil reaches normal operating temperature. If the red band continues to display after reaching normal operating temperature, replace filter to prevent contamination.

If filter requires replacement, use the following procedure:

1. With power in LOCKOUT TAGOUT, clean and dry area around filter assembly.
2. Close bearing oil cavity shutoff valve (C). This will prevent cavity from draining an excessive amount of lubricant.

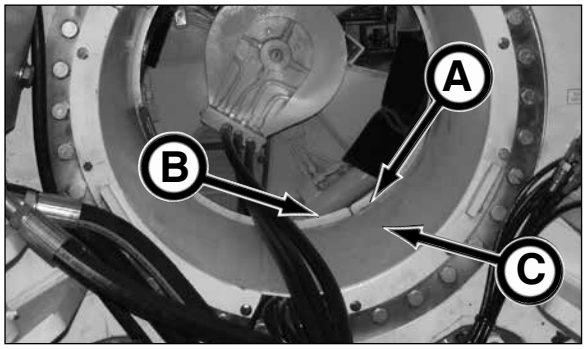


3. Remove filter housing (D) from filter head using an oil filter wrench.
4. Remove filter from housing and dispose of filter properly.
5. Remove filter o-ring if stuck in filter housing.
6. Install new o-ring with a light coat of clean oil. Check to be sure the o-ring is not twisted and that it is correctly in place.
7. Install new filter until gasket makes contact with filter head.
8. Replace and secure filter housing to filter head assembly using an oil filter wrench.
9. **Open bearing oil cavity shutoff valve (C).**

   IMPORTANT: Failure to open bearing oil cavity shutoff valve before operating TBM WILL cause bearing and bearing lube circuit component damage since the bearing oil will not be recirculating.

10. Check for leaks.

56. PURGE BEARING SEAL GREASE



It is necessary to purge the bearing seals of grease to remove dirt that may have entered the seal area during the drive.

Purge the bearing seal grease until fresh, clean grease is visible in the area (A) between the bulkhead adapter plate (B) and bearing guard (C) as follows:

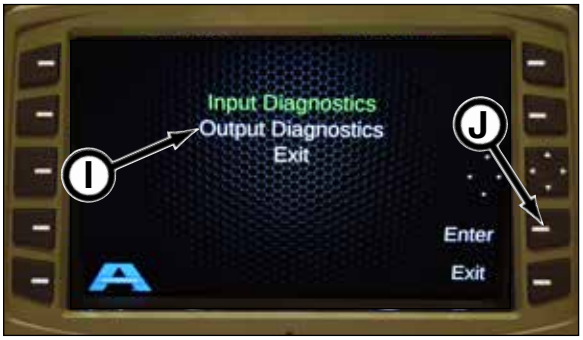
NOTICE The bearing seals can also be purged with grease by rotating the cutterhead.

1. Check the grease containers (D) to be sure there is an ample amount of grease in the reservoir to purge the bearing seals.

2. With the TBM energized with full power, press Menu button (E) on the main screen.

3. Using the up or down arrow on four-way directional button (F), select Diagnostics (G).

4. Press Enter button (H).



5. The diagnostic window appears.

6. Use the up or down arrow on four-way directional button to select the Output Diagnostics (I) option. The selected will be highlighted in green.

7. Press Enter button (J) to view output diagnostics screen.

(continued on next page)

8. To operate grease pump 1, press Run Grease Pump 1 button (A). This is a momentary switch, therefore as soon as you release the button the pump will stop.

9. To operate grease pump 2, press Run Grease Pump 2 button (B). This is a momentary switch therefore as soon as you release the button the pump will stop.

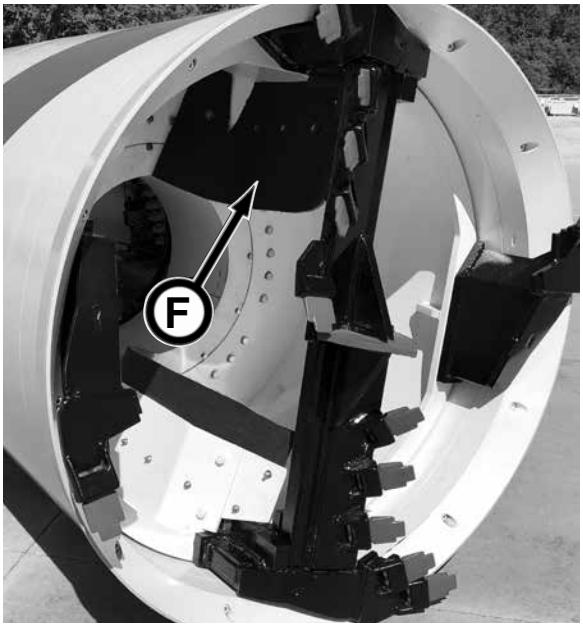
10. Press Exit button (C) to return to the diagnostics screen.

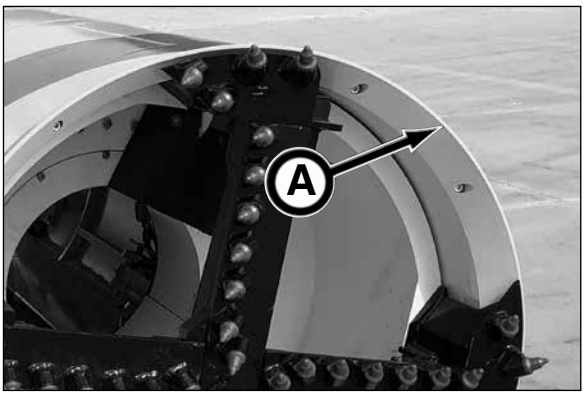
11. Press Exit button (D) to return to the menu screen.

12. Press Exit button (E) to return to the control screen.

57. INSPECT DIRT PADDLES

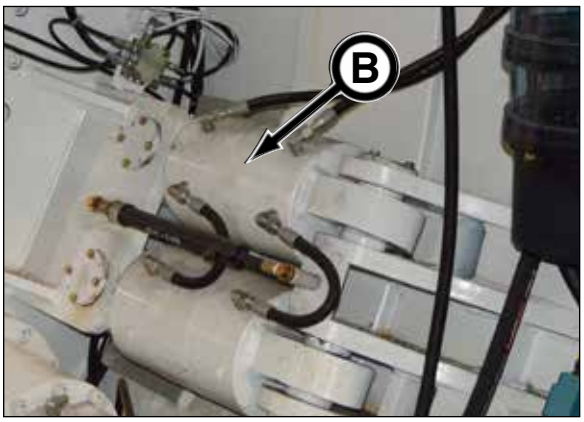
Inspect dirt paddles (F) for wear or damage. Replace dirt paddles as needed.





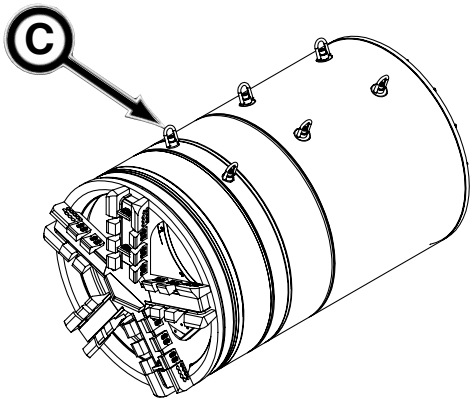
58. INSPECT CUTTER RING

Inspect cutter ring edge (A) for wear or damage. Cutter ring should not be dented, bent or flat. Repair as needed.



59. INSPECT STEERING CYLINDERS

Inspect all steering cylinders (B) for wear or damage. Repair or replace before operating.



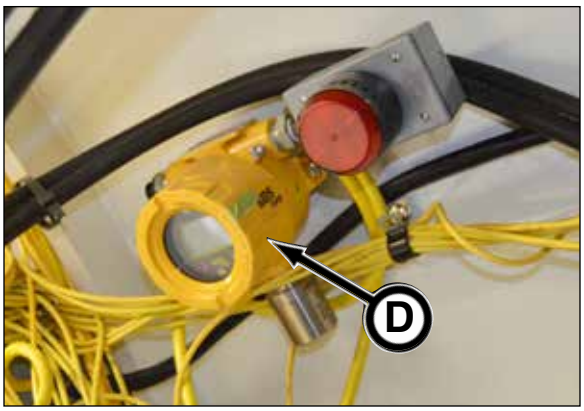
60. INSPECT LIFTING EYES

Inspect lifting eyes (C) for wear or damage. Worn or damaged lifting eyes MUST be replaced before lifting.

61. CLEAN & STORE GAS DETECTOR

NOTICE For more information, refer to your GasMax Instruction Manual.

Once the contractor determines the TBM gas detector is no longer needed in the TBM after the end of the drive:

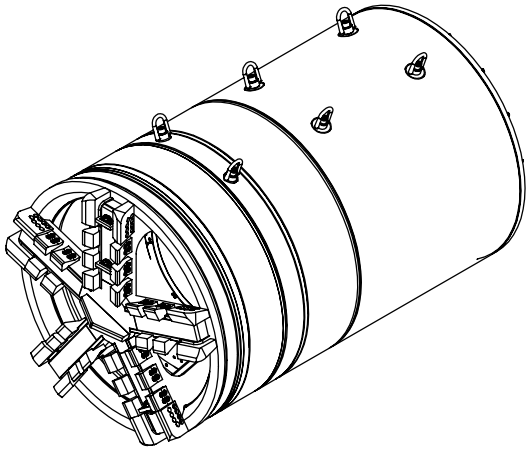


1. Remove gas detector (D) from TBM.

IMPORTANT: Be careful to not subject sensor to any water or cleaning solution, otherwise sensor will be damaged. Refer to gas detector manual for more maintenance information.

2. Clean display with a mild, abrasive-free cleaning solution and scratch free cloth.
3. Clean housing with a mild cleaning solution and place in a storage box.
4. Place box in a ventilated, preferably climate controlled area.

62. INSPECT STRUCTURES

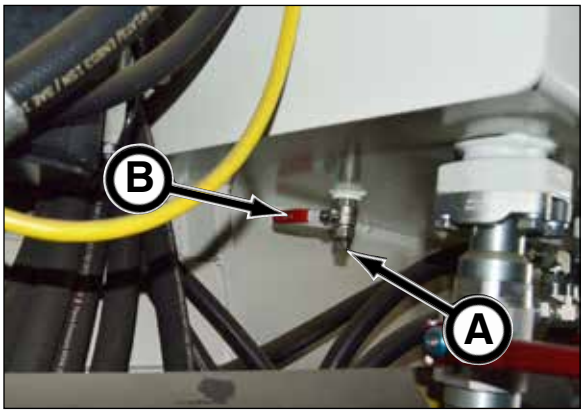


Perform a visual inspection of the TBM and jacking/ liner can structures for cracks, wear or other damage. Repair or replace at the completion of each drive and BEFORE operation.

Check for oil leaks and debris buildup. Make repairs as needed and remove debris.

Check for loose, damaged or missing parts. Repair or replace as necessary. Replace any defective parts.

63. DRAIN WATER FROM HYDRAULIC RESERVOIR

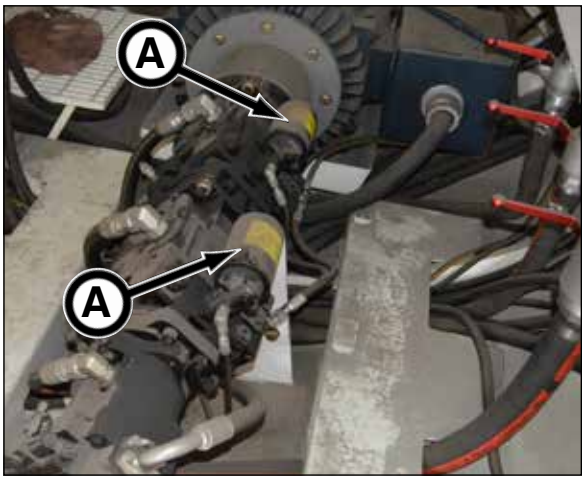


Remove water contamination from the hydraulic reservoir by draining water from the reservoir at the completion of each drive.

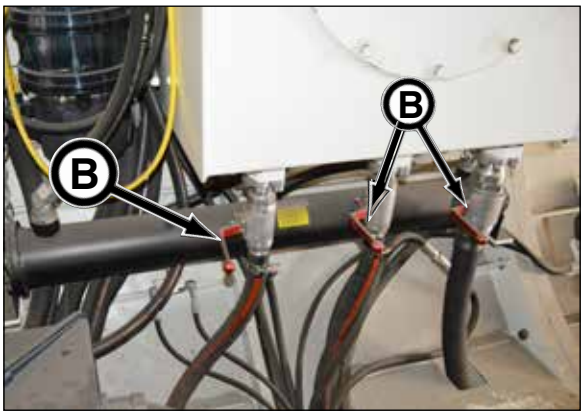
1. Allow oil in hydraulic reservoir to settle overnight.
2. Remove drain plug (A) from shutoff valve (B).
3. Install hose to shutoff valve and route hose to a catch pan.
4. Open shutoff valve to drain oil until there is no water in oil.
5. Close shutoff valve and remove hose.
6. Reinstall drain plug.

64. CHECK HYDROSTATIC PUMP FILTERS

Inspect hydrostatic pump filters (A). Replace as needed.



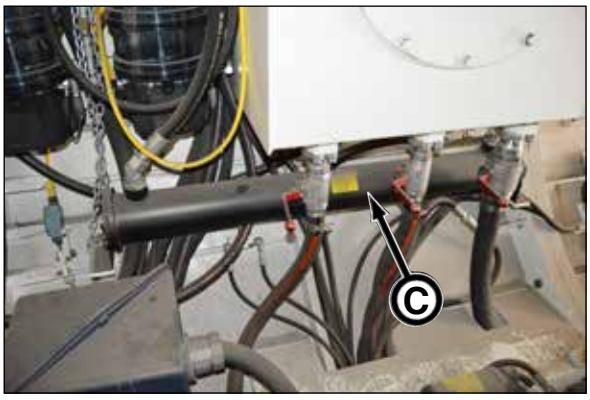
1. Turn main hydraulic shutoff valves (B) to the closed position.
2. Place a catch pan below filter being removed.
3. Remove filter.
4. Install new spin-on filter (hand tighten only).
5. Dispose of oil properly.
6. Replace other filter using steps 2 through 5.
7. Turn main hydraulic shutoff valve to the open position. Tie strap valve handle in the open position to prevent accidental closure while operating.



IMPORTANT: Failure to open shutoff valve (B) WILL cause damage to pumps. Be sure to tie strap valve handle in the open position to prevent accidental closure while operating.

65. FLUSH & DRAIN HEAT EXCHANGER

In freezing weather, flush and drain heat exchanger (C) and lines.



66. INSPECT HYDRAULIC HOSES & POWER CABLES

⚠DANGER If high voltage cables or cable connections are frayed, worn or damaged, contact with cables/connections will result in electrical shock causing severe injury or death.

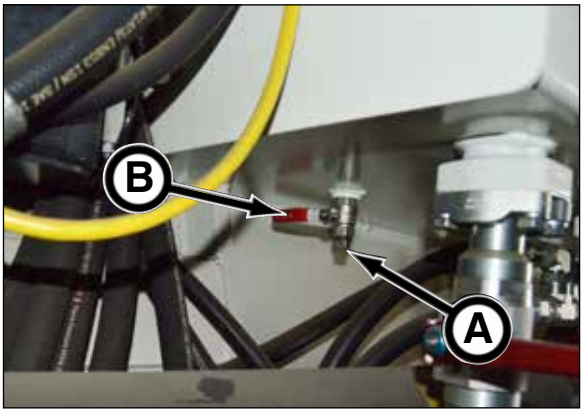
With power in LOCKOUT TAGOUT check electrical power cables and connections for fraying, wear or damage. If damaged, the cables must be replaced BEFORE operation. Be sure connections are secured.

Inspect ALL hydraulic hoses for cracks, wear or other damage. Repair or replace BEFORE operation.

TBM 840 SN1 Shown

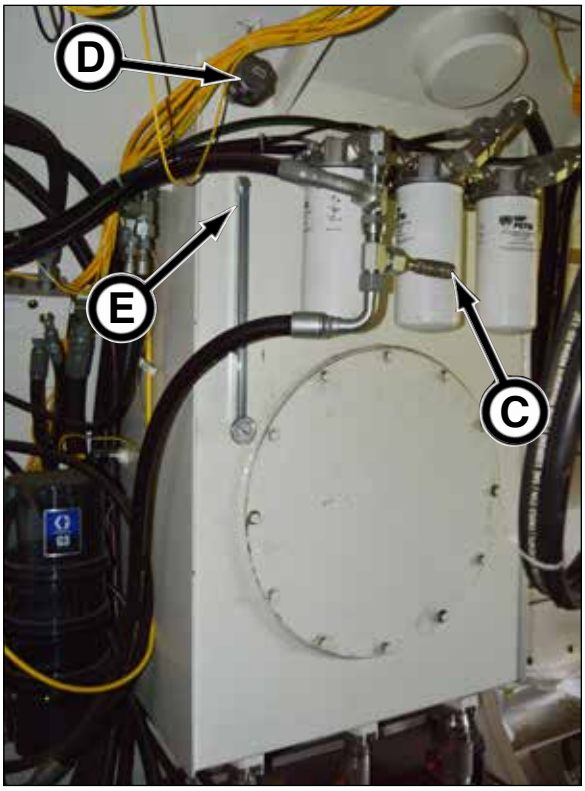
EVERY 1000 HOURS OF OPERATION

67. DRAIN & FILL HYDRAULIC RESERVOIR



Drain and fill oil in hydraulic reservoir every 1000 hours of operation.

1. Remove drain plug (A) from shutoff valve (B).
2. Install hose to shutoff valve and route hose to an appropriate sized catch pan.
3. Open shutoff valve to fully drain oil from the reservoir into catch pan.
4. Close shutoff valve and remove hose.
5. Reinstall drain plug.
6. Clean area around fitting cap (C). Remove cap.
7. Attach external fill pump (hand or electric pump) with 16MFOR adapter to fitting.
8. Clean area around breather (D). Remove breather while filling for proper venting.
9. Fill reservoir with clean, fresh, **FILTERED** ISO-VG-68 Premium Hydraulic/Turbine Oil or equivalent to full mark on gauge (E). Filling reservoir with unfiltered oil will cause component damage.



NOTICE If you change to a different oil, use a reputable oil supplier to meet or exceed the ISO-VG-68 or DIN 51524-3 (HVLP) or ISO 11158-HV oil specification. Do not mix oil manufacturers or grades.

10. Remove external fill pump.
11. Replace breather and fitting cap.

ANNUALLY

68. LUBRICATE MOTOR BEARINGS

NOTICE Refer to the electric motor manufacturer for additional electric motor maintenance information.

Lubricate the electric motor bearings with two shots of Mobil Polyrex® EM grease or equivalent (refer to Grease Type below). There are two lubrication fittings on each electric motor.

When adding lubricant, keep dirt out of the lubrication area. Wipe the fitting completely clean and use clean greasing equipment.

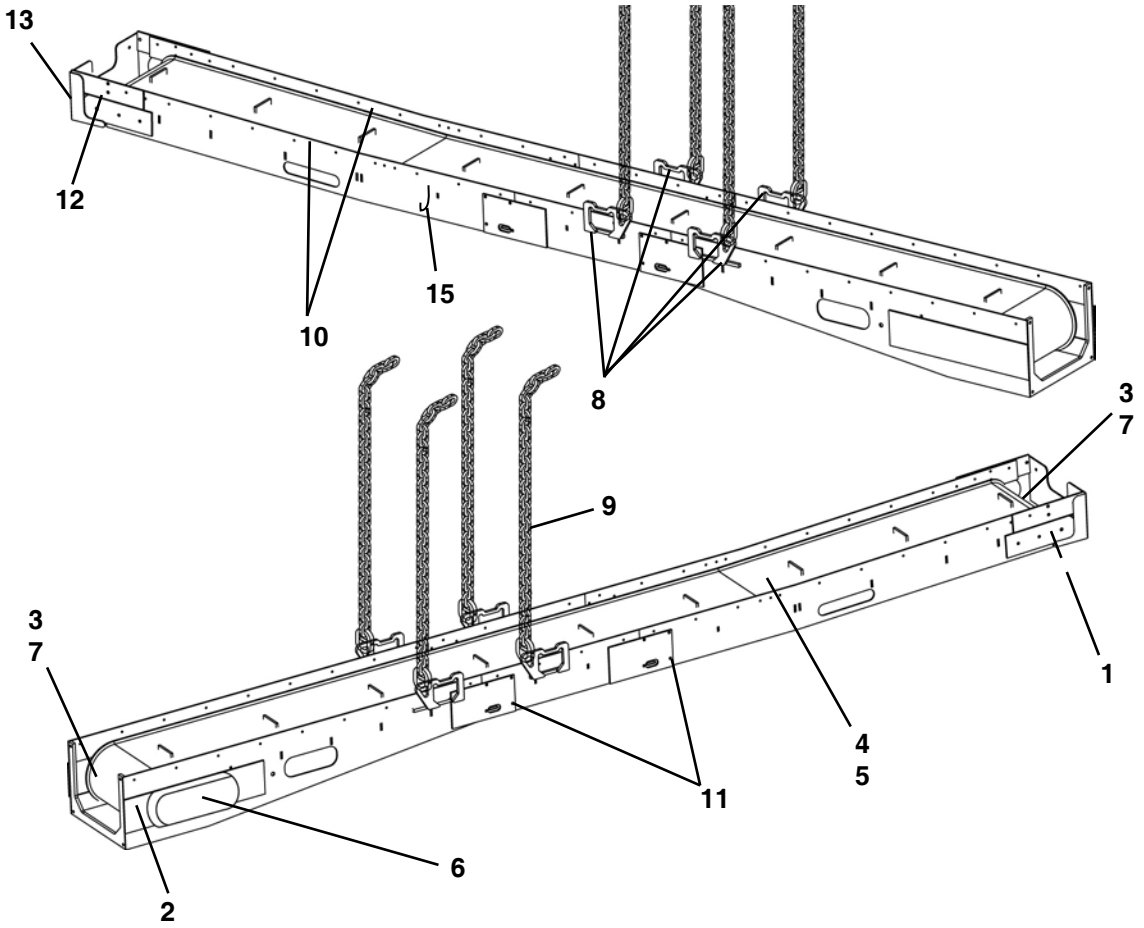
GREASE TYPE (unless nameplate states otherwise):
Nameplate Ambient Temperature between -22°F (-30°C) to 150°F (65°C) inclusive:
Recommended grease for standard service conditions is Mobil Polyrex® EM. Equivalent and compatible greases include: Texaco Polystar RB, Rykon Premium #2, Pennzoil Pen 2 Lube, Chevron SRI & Mobil SHC 100.

Nameplate Ambient Temperature below -22°F (-30°C): Special low temperature grease is recommended such as Aeroshell 7 or Beacon 325 for ball bearings and Mobil SHC 100 for roller bearings.

NOTES

MAINTENANCE CHARTS - BELT CONVEYOR

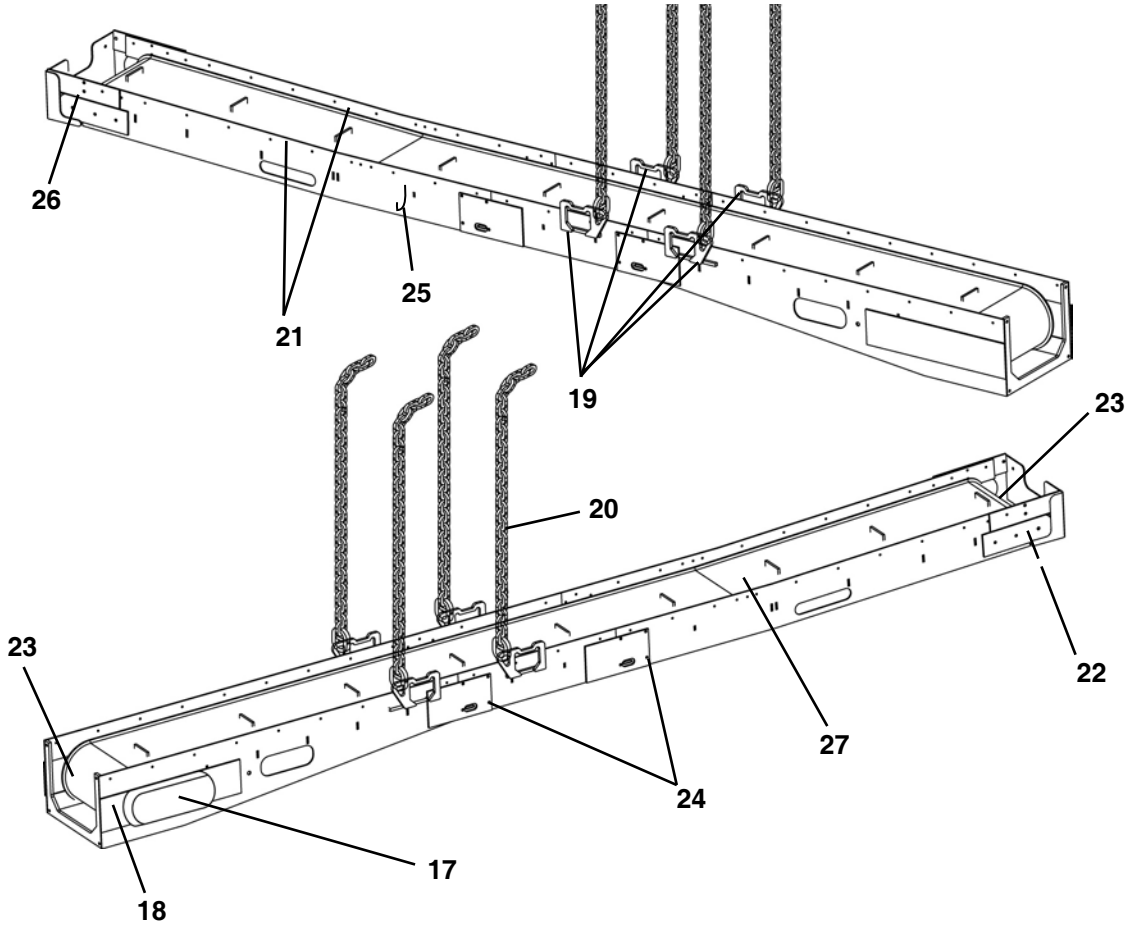
Use the item number in the chart to refer to the detailed maintenance procedures later in this section.



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	Inspect	If damaged, replace with new.	
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	If worn, replace.	

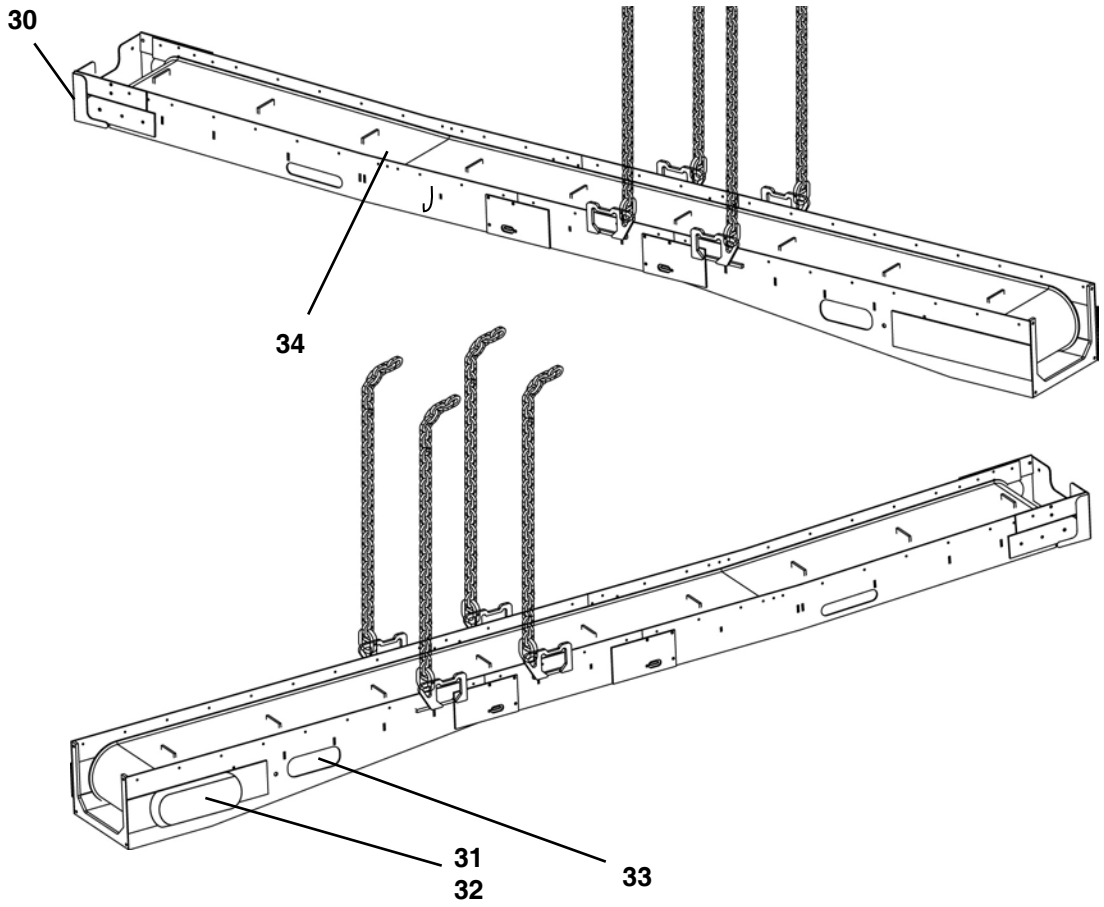
* Not Shown



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	Inspect	If damaged, replace with new.	
26.	Nose Bracket & Brg	Inspect & Lubricate	If damaged, replace with new.	
27.	Belt	Inspect	Replace if worn, cracked or damaged.	
*28.	Decals	Inspect	If worn, replace.	
*29.	Hydraulic Hoses	Inspect	If worn or damaged, replace with new.	

* Not Shown



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.	

COMPLETION OF EACH DRIVE

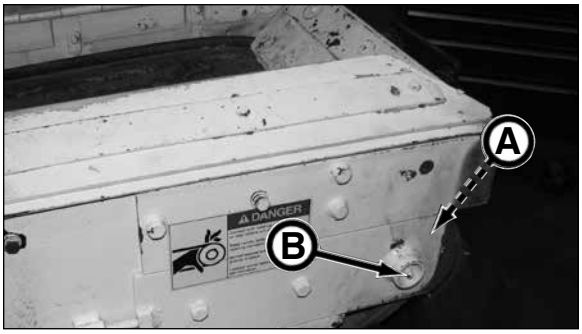
ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
35.	Conveyor	Clean		

PRIOR TO EACH JOB LAUNCH

1. INSPECT & LUBRICATE FRONT ROLLER

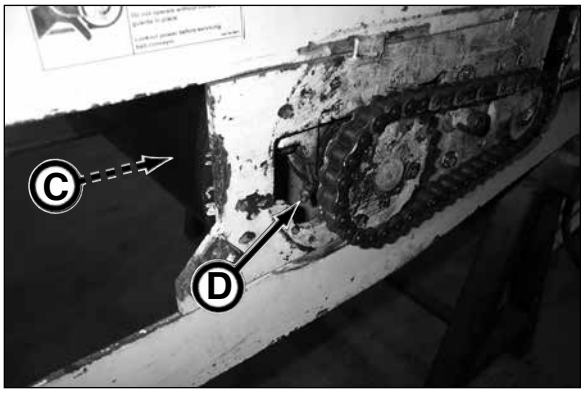
Inspect front roller (A) for wear or damage. If worn or damaged, replace with new.

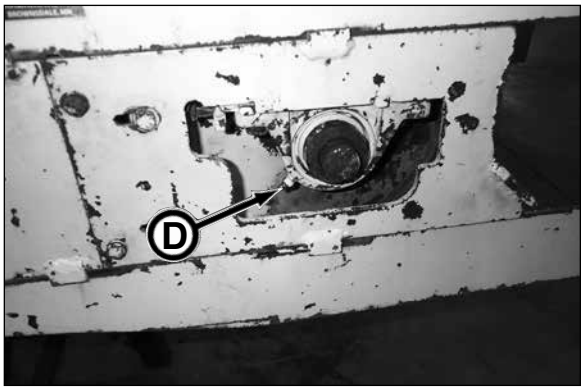
Lubricate front roller bearings (B) (2 places) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.



2. INSPECT & LUBRICATE DRIVE ROLLER & BEARING

1. Remove guard.
2. Inspect drive roller (C) for wear or damage. If worn or damaged, replace with new.
3. Lubricate drive roller pillow block bearings (D) (2 places) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.
4. Replace guard before operating conveyor.



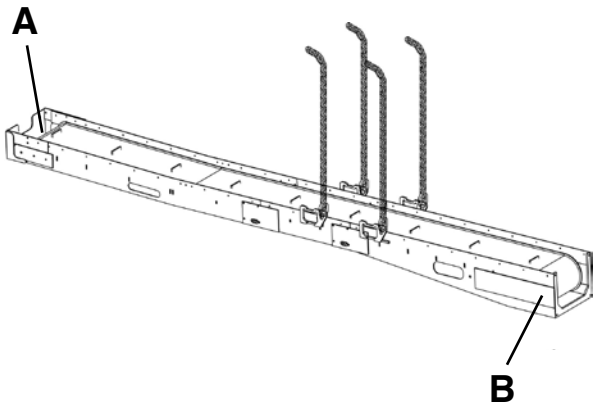


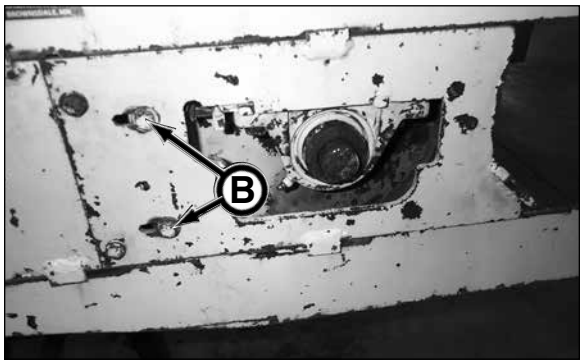
3. INSPECT ROLLER SCRAPERS

Inspect front roller (A) and the internal drive roller (B) scrapers for wear or damage. If worn or damaged, replace with new.

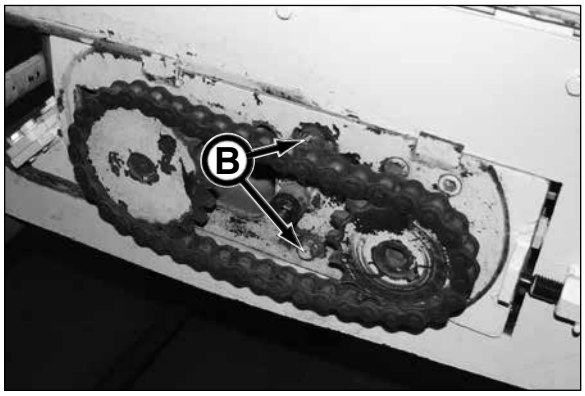
Check to be sure scrapers are adjusted so they are approximately 1/16 in. (1.5 mm) from the rollers.

Before operating conveyor, replace any cover/ guards that were removed for this inspection.





Internal Drive Roller Scraper Adjustment



Internal Drive Roller Scraper Adjustment

4. INSPECT BELT

Inspect belt for cracks, wear, or damage. At the first sign of cracks, wear, or damage, replace conveyor belt.

Conveyor belt should be replaced if:

- The side ribs are worn to the point of no longer able to hold material.
- Cracks in the belt.
- Holes in the belt.
- Multiple belt lugs are missing.
- Belt can no longer be adjusted due to stretch in the belt.

5. CHECK BELT TRACKING & TENSION

Check the belt tracking as follows:

⚠WARNING Contact with rotating conveyor belt or rollers will cause severe injury or death. Keep hands, body, and objects clear or rotating conveyor.

1. Remove or rotate spoil guides up out of the way of belt.

2. With personnel away from conveyor, start the conveyor belt rotation.

3. Observe the belt tracking the entire length of the conveyor. The gap between the belt and the conveyor must be the same on both sides.

⚠WARNING NEVER adjust tracking while belt is rotating. Doing so can result in serious injury.

4. If the tracking requires adjustment, stop belt rotation and make small adjustments by using BOTH tracking adjustment bolts (A).

5. Start belt rotation and observe belt tracking. If further adjustment is needed, repeat steps 4 and 5 until the belt tracks straight on conveyor.

6. Once belt is tracking properly, stop belt rotation and lockout power to conveyor.

Check conveyor belt tension by:

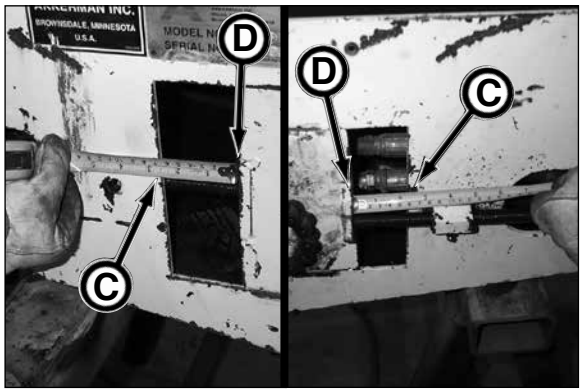
1. Remove or rotate spoil guides up out of the way of belt.

2. In the center of the conveyor, lift the belt (B) and measure the deflection. The deflection should be a maximum of 6 in. (152 mm).

NOTICE Be sure the center rib on the under side of the belt stays in the groove of pulley.

Adjusting conveyor belt tension:

1. Use BOTH adjustment screws to tighten belt to a 6 in. (152 mm) deflection in the center of the conveyor. Use a tape measure to measure the distance from the conveyor frame (C) to the drive motor frame (D). This distance must be the same on both sides of the conveyor.



NOTICE Be sure to tighten BOTH adjustment screws the same rate or distance. Failure to do so will cause premature wear in the belt due to the tension being different on each side of the belt.

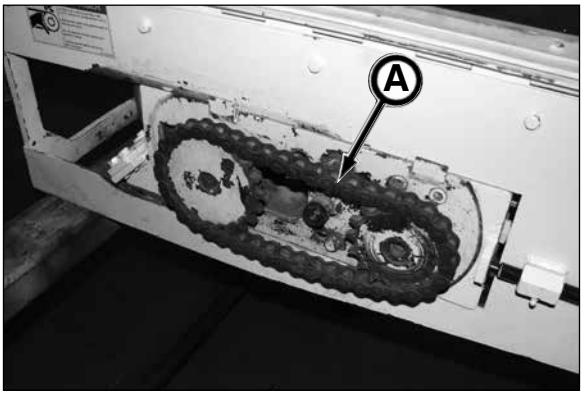
2. Once proper belt tension is achieved, the inner belt scrapers need to be readjusted for a 1/16 in. (1.5 mm) clearance.

6. INSPECT & LUBRICATE DRIVE CHAIN

Inspect drive chain (A). If worn or damaged, replace with new.

Thoroughly lubricate chain with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent.

Replace cover before operating conveyor.



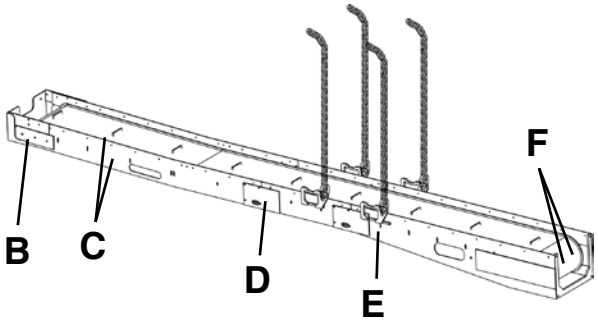
7. INSPECT BELT SCRAPERS

Inspect belt scrapers for wear or damage. If worn or damaged, replace with new.

Check to be sure scrapers are adjusted so they are approximately 1/16 in. (1.6 mm) from the belt.

⚠WARNING Contact with rotating conveyor belt or idler rollers will cause severe injury or death. Keep hands, body, and objects clear or rotating conveyor.

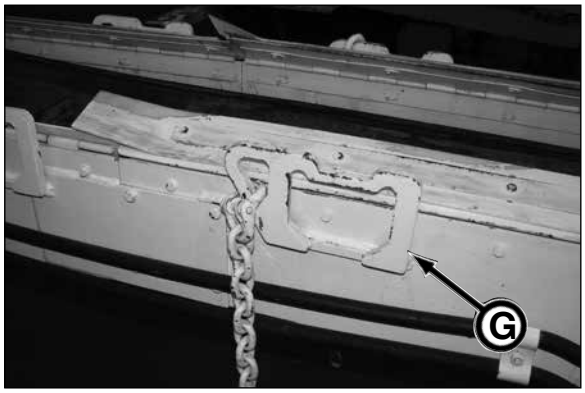
Once scrapers are adjusted, run the conveyor belt and make sure the scrapers do not contact the belt. If so, the scrapers MUST be readjusted. Once adjusted, stop belt rotation and lockout power to conveyor.



B - Front End External Belt Scraper
C - Inner Belt Scraper (2)
D - Idler Roller Scraper for Extension Frame
E - Idler Roller Scraper for Drive Frame
F - External Belt Scraper (2)

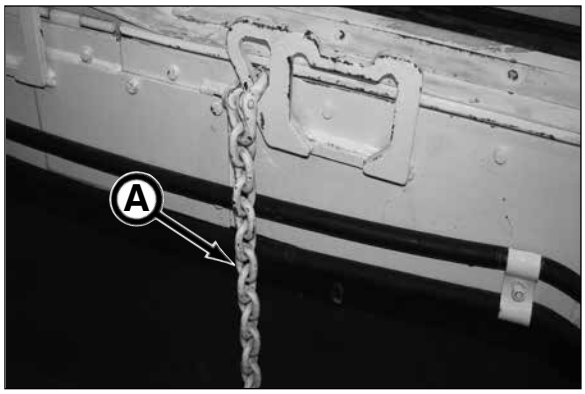
8. INSPECT LIFTING EYES

Inspect lifting eyes (G) for wear or damage. If worn or damaged, replace with new.



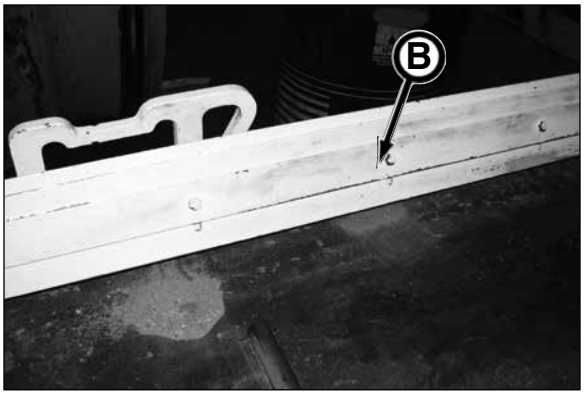
9. INSPECT LIFTING CHAINS

Inspect lifting chains (A) for wear or damage. If worn or damaged, replace with new.



10. INSPECT SPOILS GUIDES

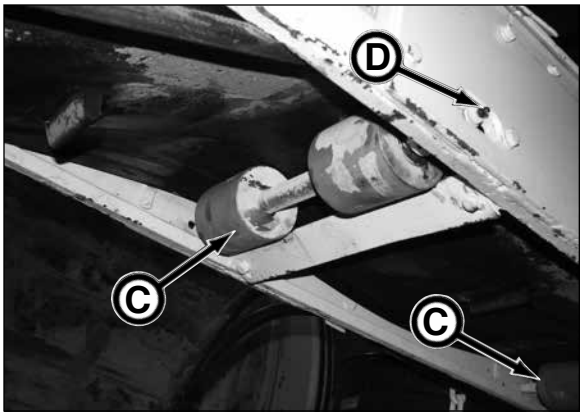
Inspect spoils guides (B) for wear or damage. If guide cannot be adjusted to within 1/4 in. (6.4 mm) of the belt, the guide should be replaced. Otherwise if damaged, replace with new.



11. INSPECT & LUBRICATE IDLER ROLLERS

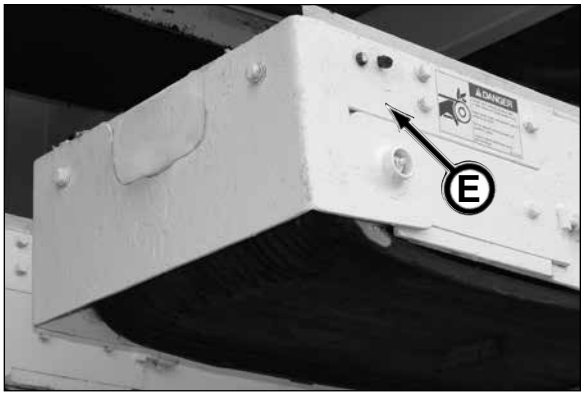
Inspect idler rollers (C) for wear or damage. If worn or damaged, replace with new.

Lubricate idler roller bearings (D) (4 places) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.



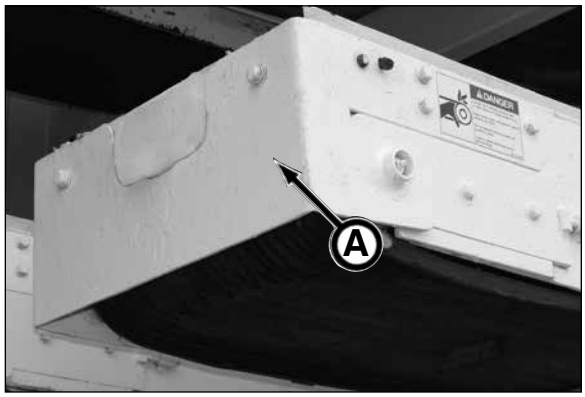
12. INSPECT NOSE BRACKET

Inspect nose bracket (E) for wear or damage. If worn or damaged, replace with new.



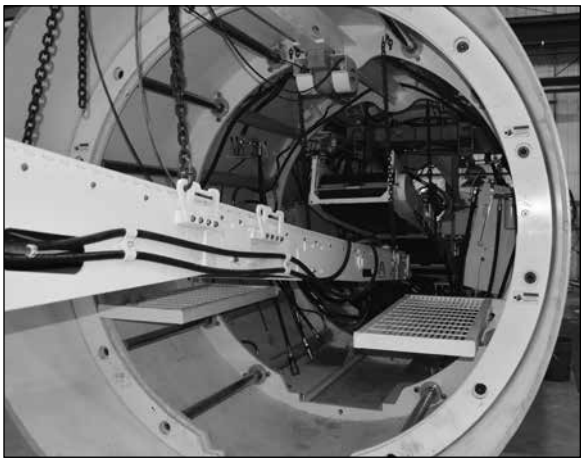
13. INSPECT DIRT GUARD

Inspect dirt guard (A) for wear or damage. If worn or damaged, replace with new.



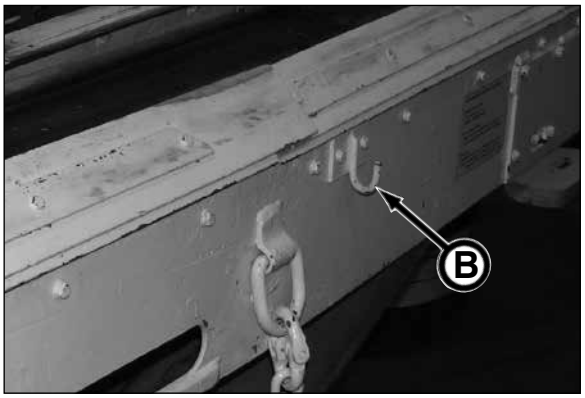
14. INSPECT HYDRAULIC HOSES

Inspect hydraulic hoses for wear or damage. Repair or replace BEFORE operation.



15. INSPECT CONVEYOR SAFETY HOOK

Inspect hook (B) for wear or damage. If worn or damaged, replace with new.



16. INSPECT DECALS

Inspect ALL decals, operational and safety decals to be sure they are 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 safety decals with solvent. Solvent will damage decals. Replace decals immediately if they are damaged, missing, or hard to read.

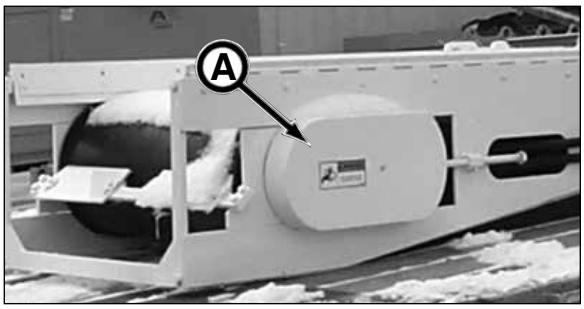
Before applying a new decal, be sure the surface is clean and dry.

DAILY OR EVERY 10 HOURS OF OPERATION OR EACH SHIFT CHANGE

17. INSPECT DRIVE CHAIN COVER

Inspect drive chain (A) for wear or damage. If worn or damaged, replace with new.

NEVER operate conveyor without cover in place.



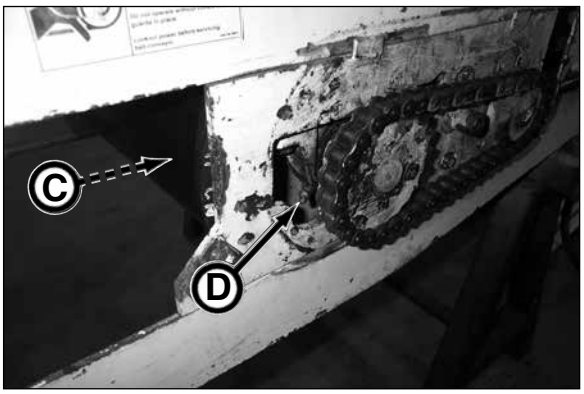
18. INSPECT & LUBRICATE DRIVE ROLLER & BEARING

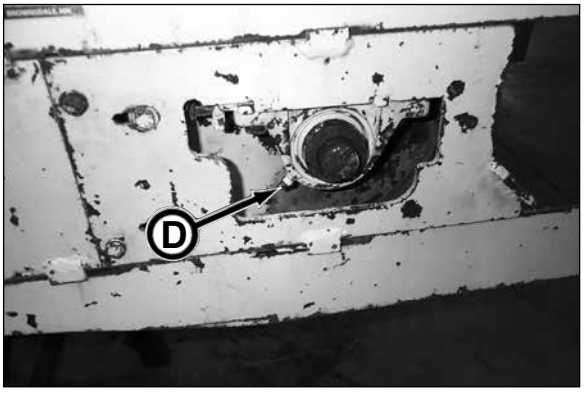
1. Remove guard.

2. Inspect drive roller (C) for wear or damage. If worn or damaged, replace with new.

3. Lubricate drive roller pillow block bearings (D) (2 places) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.

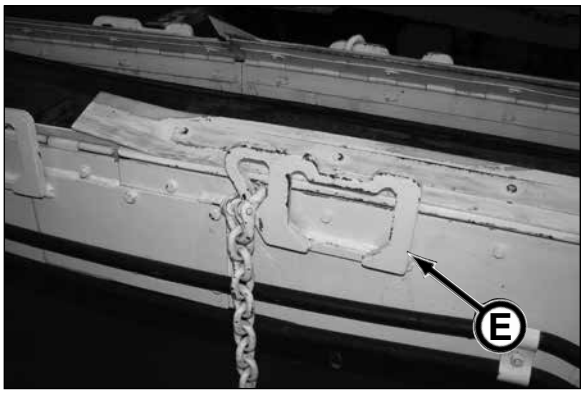
4. Replace guard before operating conveyor.

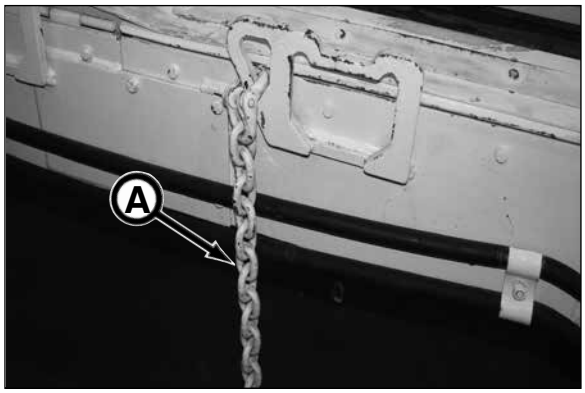




19. INSPECT LIFTING EYES

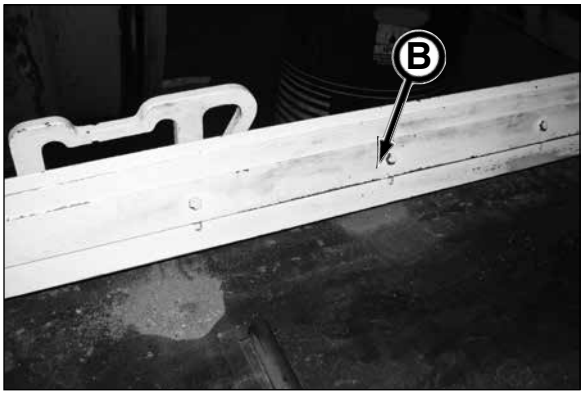
Inspect lifting eyes (E) for wear or damage. If worn or damaged, replace with new.





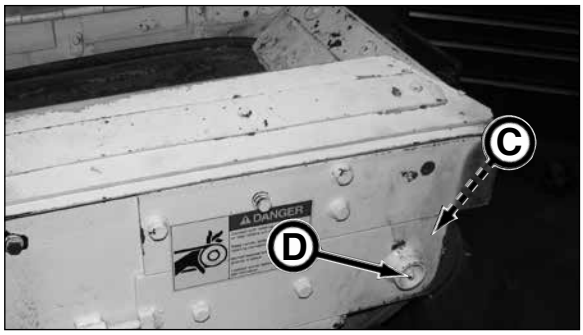
20. INSPECT LIFTING CHAINS

Inspect lifting chains (A) for wear or damage. If worn or damaged, replace with new.



21. INSPECT SPOILS GUIDES

Inspect spoils guides (B) for wear or damage. If guide cannot be adjusted to within 1/4 in. (6.4 mm) of the belt, the guide should be replaced. Otherwise if damaged, replace with new.



22. INSPECT & LUBRICATE FRONT ROLLER

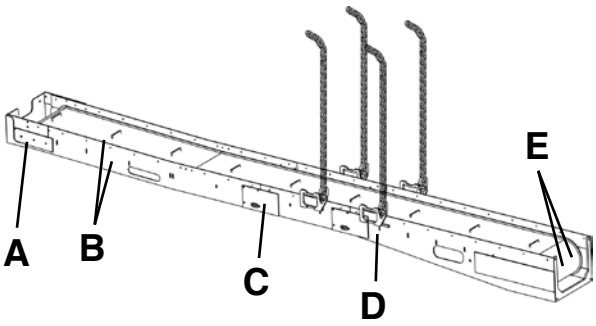
Inspect front roller (C) for wear or damage. If worn or damaged, replace with new.

Lubricate front roller bearings (D) (2 places) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.

23. INSPECT BELT SCRAPERS

Inspect belt scrapers for wear or damage. If worn or damaged, replace with new.

Check to be sure scrapers are adjusted so they are approximately 1/16 in. (1.5 mm) from the belt.



⚠WARNING Contact with rotating conveyor belt or idler rollers will cause severe injury or death. Keep hands, body, and objects clear or rotating conveyor.

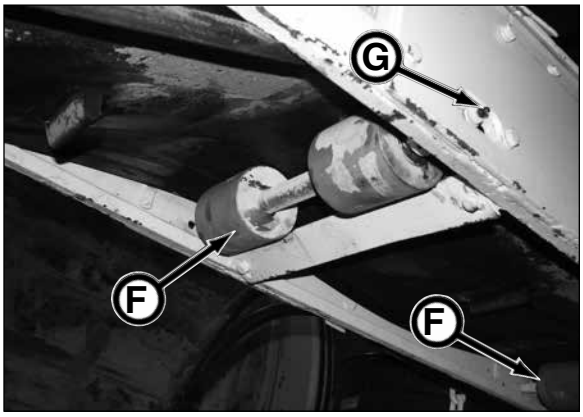
Once scrapers are adjusted, run the conveyor belt and make sure the scrapers do not contact the belt. If so, the scrapers MUST be readjusted. Once adjusted, stop belt rotation and lockout power to conveyor.

A - Front End External Belt Scraper
B - Inner Belt Scraper (2)
C - Idler Roller Scraper for Extension Frame
D - Idler Roller Scraper for Drive Frame
E - External Belt Scraper (2)

24. INSPECT & LUBRICATE IDLER ROLLERS

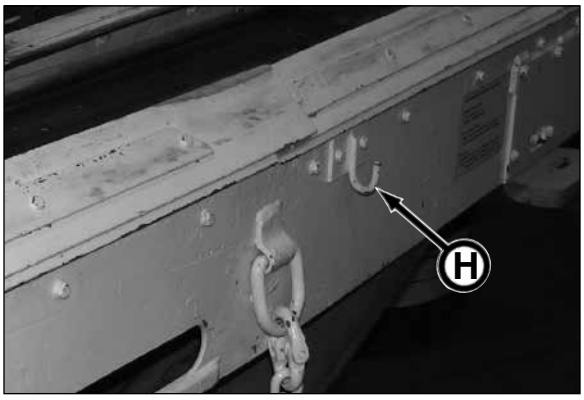
Inspect idler rollers (F) for wear or damage. If worn or damaged, replace with new.

Lubricate idler roller bearings (G) (4 places) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.



25. INSPECT CONVEYOR SAFETY HOOK

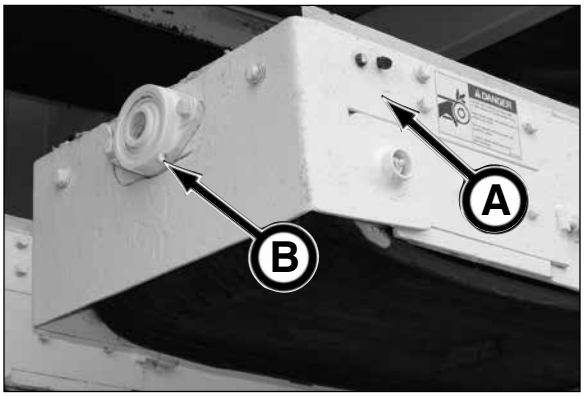
Inspect hook (H) for wear or damage. If worn or damaged, replace with new.



26. INSPECT & LUBRICATE NOSE BRACKET & BEARING

Inspect nose bracket (A) for wear or damage. If worn or damaged, replace with new.

Lubricate nose bearing (B) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.



27. INSPECT BELT

Inspect belt for cracks, wear, or damage. At the first sign of cracks, wear, or damage, replace conveyor belt.

Conveyor belt should be replaced if:

- The side ribs are worn to the point of no longer able to hold material.
- Cracks in the belt.
- Holes in the belt.
- Multiple belt lugs are missing.
- Belt can no longer be adjusted due to stretch in belt.

28. INSPECT DECALS

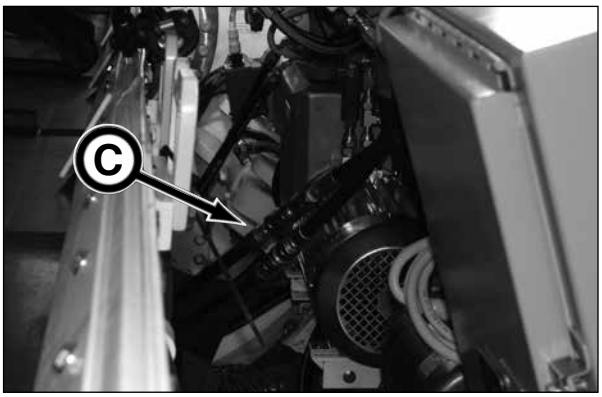
Inspect ALL decals, operational and safety decals to be sure they are clean and readable.

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

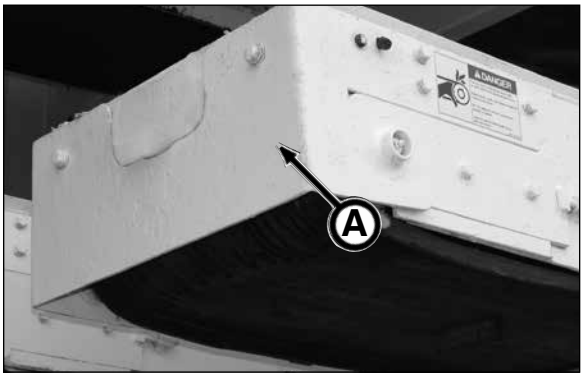
Before applying a new decal, be sure the surface is clean and dry.

29. INSPECT HYDRAULIC HOSES

Inspect hydraulic hoses (C) for wear or damage. Repair or replace BEFORE operation.



WEEKLY OR EVERY 50 HOURS OF OPERATION



30. INSPECT DIRT GUARD

Inspect dirt guard (A) for wear or damage. If worn or damaged, replace with new.

31. CHECK DRIVE MOTOR BOLT TIGHTNESS

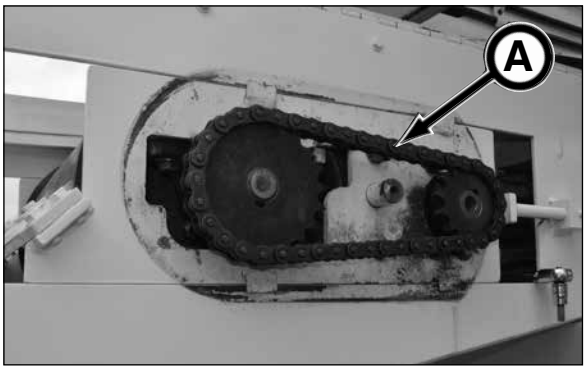
Check drive motor bolt (B) tightness. Tighten bolts to the following torque:

3/8 in. - 40 ft-lb. (54 N·m)
1/2 in. - 90 ft-lb. (122 N·m)

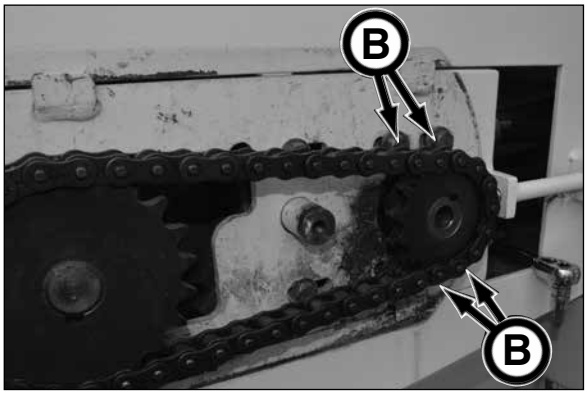
If bolt(s) do not hold torque, the bolts must be replaced with new.

32. INSPECT & LUBRICATE DRIVE CHAIN

1. Remove cover.

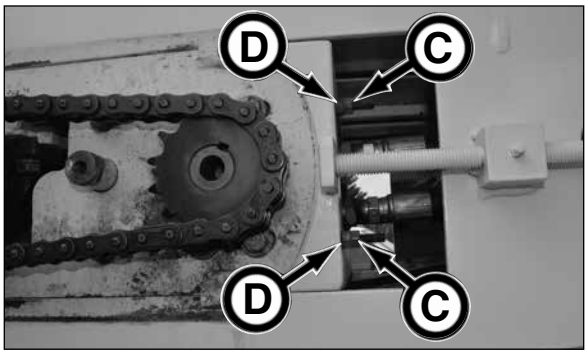


2. Inspect drive chain (A). If worn or damaged, replace with new.



3. Check chain tension. The center of the chain should have a maximum deflection of 3/16 in. (4.8 mm).

   To adjust chain tension:
   a. loosen four motor mount bolts (B).



   b. loosen jam nuts (C).
   c. evenly adjust both nuts (D) as needed until the 3/16 in. (4.8 mm) deflection is achieved.
   d. retighten motor mount bolts.
   e. tighten jam nuts.
   f. cover must be replaced before operating conveyor.

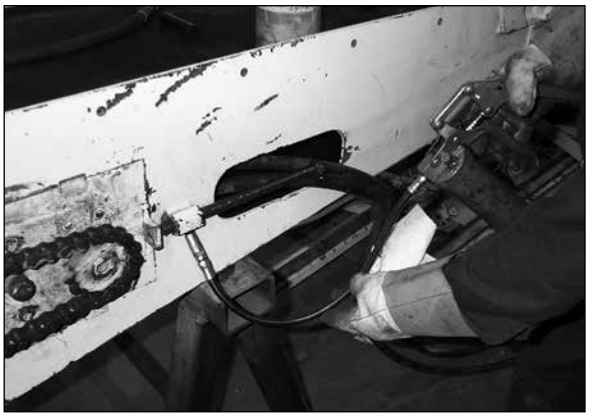
4. Thoroughly lubricate chain with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent.

5. Replace cover before operating conveyor.

33. INSPECT & LUBRICATE BELT ADJUSTMENT SCREW

Inspect belt adjustment screw for wear or damage. If worn or damaged, replace with new.

Lubricate belt adjustment screw (2 places) with one shot of Mobilgrease® XHP222 Premium Lubricating Grease or equivalent.



34. CHECK BELT TRACKING & TENSION

Check the belt tracking as follows:

⚠WARNING Contact with rotating conveyor belt or rollers will cause severe injury or death. Keep hands, body, and objects clear or rotating conveyor.

1. Remove or rotate spoil guides up out of the way of belt.

2. With personnel away from conveyor, start the conveyor belt rotation.

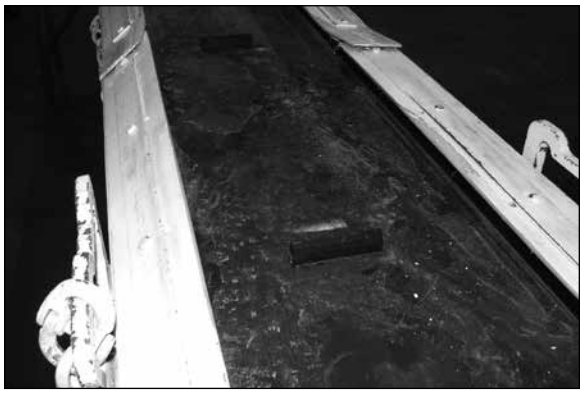
3. Observe the belt tracking the entire length of the conveyor. The gap between the belt and the conveyor must be the same on both sides.

⚠WARNING NEVER adjust tracking while belt is rotating. Doing so can result in serious injury.

4. If the tracking requires adjustment, stop belt rotation and make small adjustments by using BOTH tracking adjustment bolts (A).

5. Start belt rotation and observe belt tracking. If further adjustment is needed, repeat steps 4 and 5 until the belt tracks straight on conveyor.

6. Once belt is tracking properly, stop belt rotation and lockout power to conveyor.



(continued on next page)

Check conveyor belt tension by:

1. Remove or rotate spoil guides up out of the way of belt.

2. In the center of the conveyor, lift the belt (A) and measure the deflection. The deflection should be a maximum of 6 in. (152 mm).

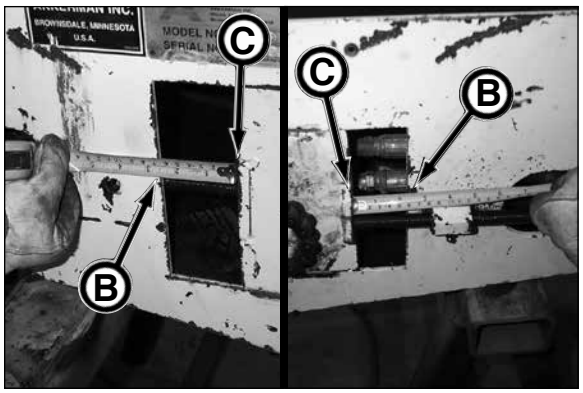
NOTICE Be sure the center rib on the under side of the belt stays in the groove of pulley.

Adjusting conveyor belt tension:

1. Use adjustment screws (2 places) to tighten belt to a 6 in. (152 mm) deflection in the center of the conveyor. Use a tape measure to measure the distance from the conveyor frame (B) to the drive motor frame (C). This distance must be the same on both sides of the conveyor.

NOTICE Be sure to tighten BOTH adjustment screws the same rate or distance. Failure to do so will cause premature wear in the belt due to the tension being different on each side of the belt.

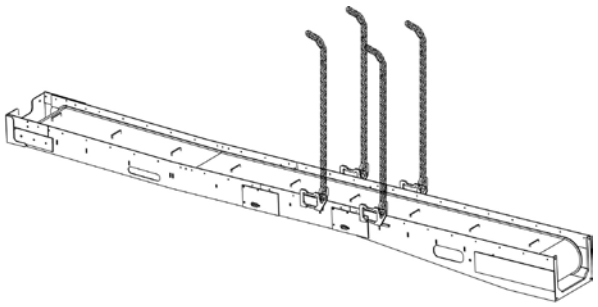
2. Once proper belt tension is achieved, the inner belt scrapers need to be readjusted for a 1/16 in. (1.5 mm) belt clearance.



COMPLETION OF EACH DRIVE

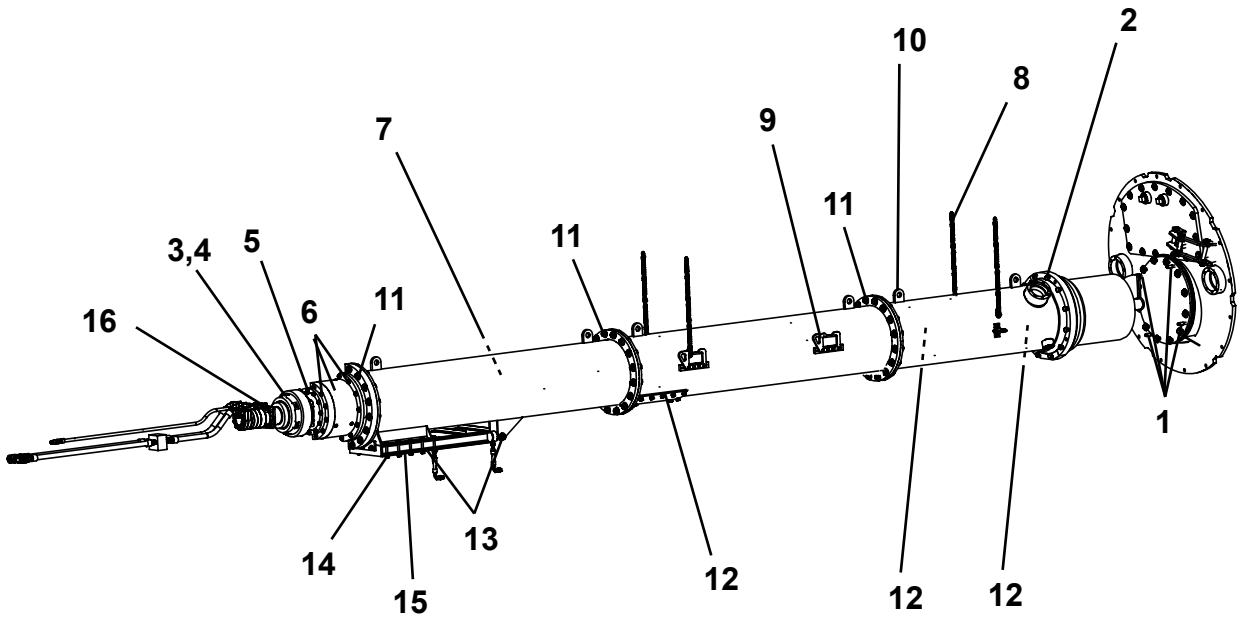
35. CLEAN CONVEYOR

Spray the belt conveyor with water to clean the conveyor of dirt and debris while it is soft and flexible, and before the dirt hardens.



MAINTENANCE CHARTS - SCREW CONVEYOR

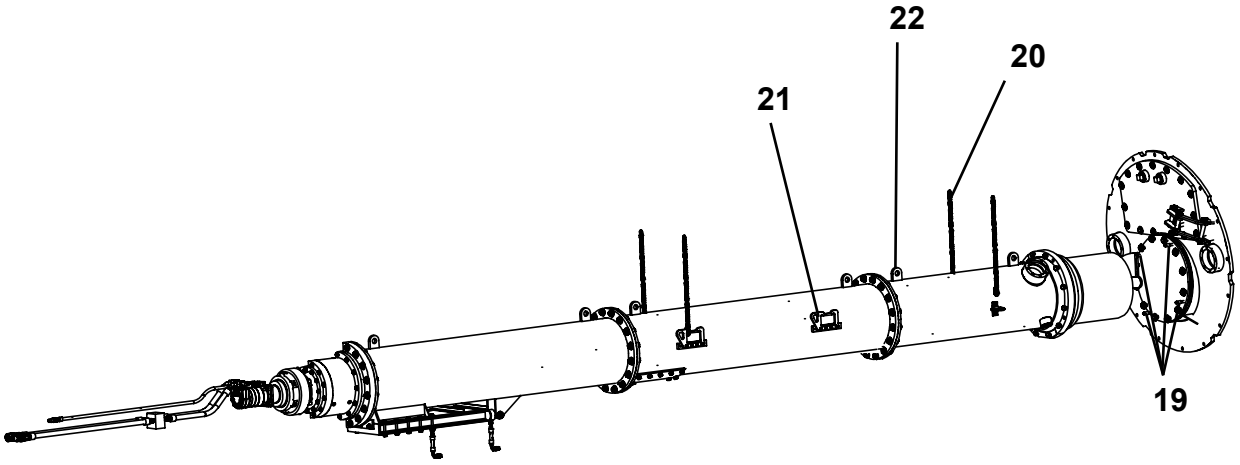
Use the item number in the chart to refer to the detailed maintenance procedures later in this section.



PRIOR TO EACH JOB LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Bulkhead	Lubricate (4 places)	Lubricate with 3 shots each	Mobil XHP222
2.	Swivel Collar	Inspect	If damaged, repair or replace.	
3.	Gear Box	Check For Water	If water is visible, gear box must be drained, flushed, seals replaced & add new oil	Mobil SHC 630
4.	Gear Box	Check Oil Level	Oil must be visible at check port.	Mobil SHC 630
5.	Gear Box	Inspect	If damaged, repair or replace.	
6.	Bearing Housing	Inspect & Check Oil Level	If damaged, repair or replace. Oil must be visible at check port.	Mobil SHC 630
7.	Auger	Inspect	If damaged, repair or replace.	
8.	Lifting Chain	Inspect	If damaged, replace with new.	
9.	Lift D-Ring	Inspect	If damaged, replace with new.	
10.	Lift Eyes	Inspect	If damaged, replace with new.	
11.	Auger Casing	Inspect (3 mounts)	If damaged, repair or replace.	
12.	Access Door Cover	Inspect (3 covers)	If damaged, repair or replace.	
13.	Gate Cylinder Pins	Lubricate (2 places)	Lubricate until grease is force out.	Mobil XHP222
14.	Gate Rail Bolts	Inspect	If damaged, replace with new.	
15.	Gate Rails	Inspect & Lubricate	If damaged, repair or replace.	Mobil XHP222
16.	Motor Mount Bolts	Inspect	If damaged, repair or replace.	
*17.	Hydraulic Hoses	Inspect	If worn or damaged, replace with new.	
*18.	Decals	Inspect	If damaged, replace with new.	

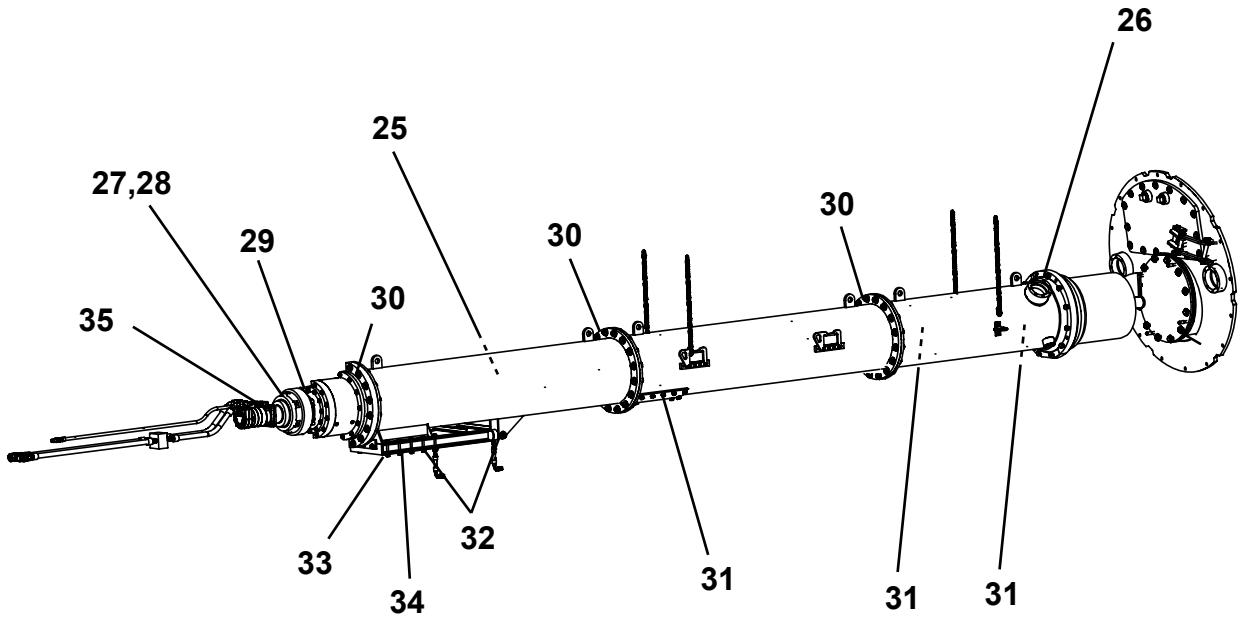
* Not Shown



DAILY OR EVERY 10 HOURS OF OPERATION OR EACH SHIFT CHANGE

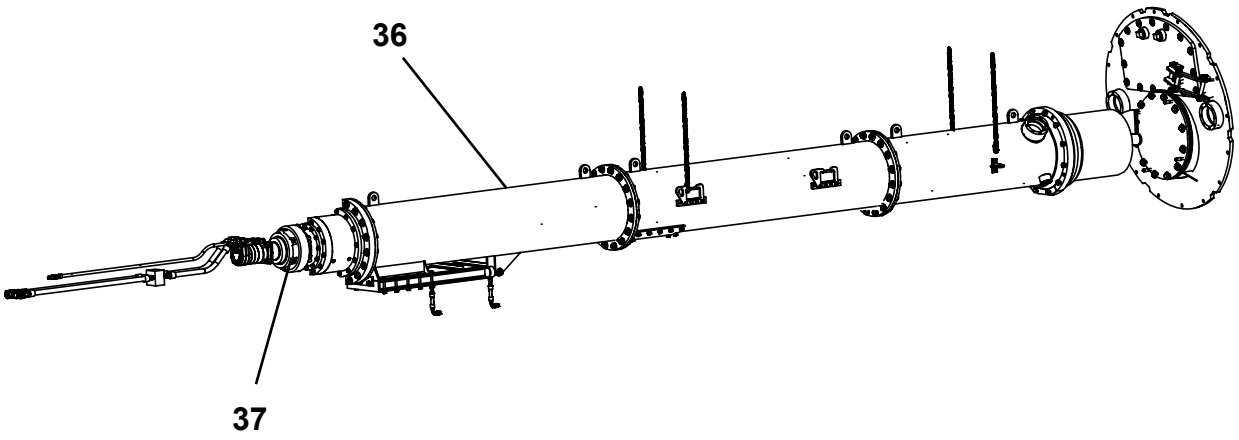
ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
19.	Bulkhead	Lubricate (4 places)	Lubricate with 3 shots each, twice daily	Mobil XHP222
20.	Lifting Chain	Inspect	If damaged, replace with new.	
21.	Lift D-Ring	Inspect	If damaged, replace with new.	
22.	Lift Eyes	Inspect	If damaged, replace with new.	
*23.	Hydraulic Hoses	Inspect	If worn or damaged, replace with new.	
*24.	Decals	Inspect	If damaged, replace with new.	

* Not Shown



WEEKLY OR EVERY 50 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
25.	Auger	Inspect	If damaged, repair or replace.	
26.	Swivel Collar	Inspect	If damaged, repair or replace.	
27.	Gear Box	Check Oil Level	Oil must be visible at check port.	Mobil SHC 630
28.	Gear Box	Inspect	If damaged, repair or replace.	
29.	Bearing Housing	Inspect & Check Oil Level	If damaged, repair or replace.	
			Oil must be visible at check port.	Mobil SHC 630
30.	Auger Casing	Inspect	If damaged, repair or replace.	
31.	Access Door Cover	Inspect	If damaged, repair or replace.	
32.	Gate Cylinder Pins	Lubricate (2 places)	Lubricate until grease is force out.	Mobil XHP222
33.	Gate Rail Bolts	Inspect		
34.	Gate Rails	Inspect & Lubricate	If damaged, repair or replace.	Mobil XHP222
35.	Motor Mount	Inspect	If damaged, repair or replace.	



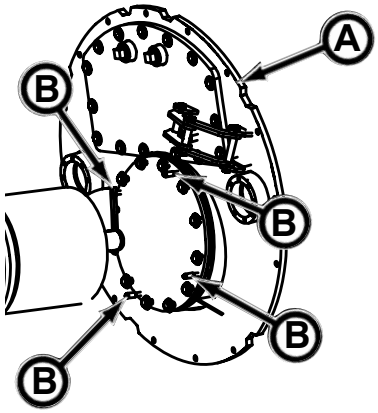
COMPLETION OF EACH DRIVE

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
36.	Conveyor	Clean & Empty		

EVERY 1000 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
37.	Gear Box	Drain & Fill	Oil must be visible at check port.	Mobil SHC 630

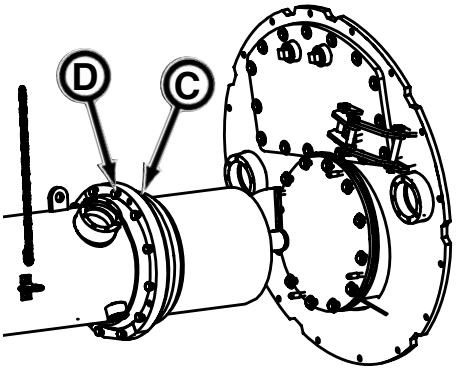
PRIOR TO EACH JOB LAUNCH



1. INSPECT & LUBRICATE BULKHEAD

Inspect bulkhead (A) for wear or damage. If worn or damaged, repair or replace with new.

Lubricate bulkhead (4 places [B]) with Mobilgrease® XHP222 Premium Lubricating Grease.



2. INSPECT SWIVEL COLLAR

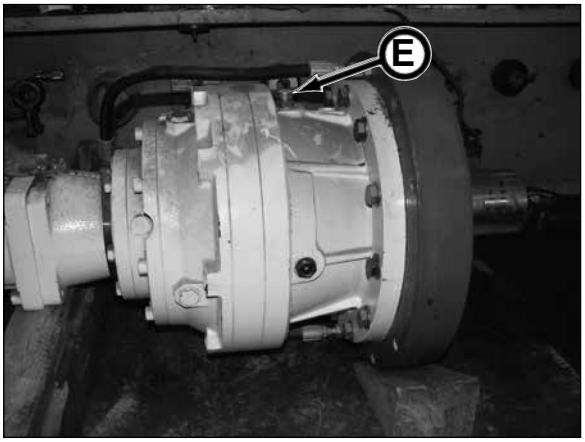
Inspect collar (C) for wear or damage. If worn or damaged, replace with new.

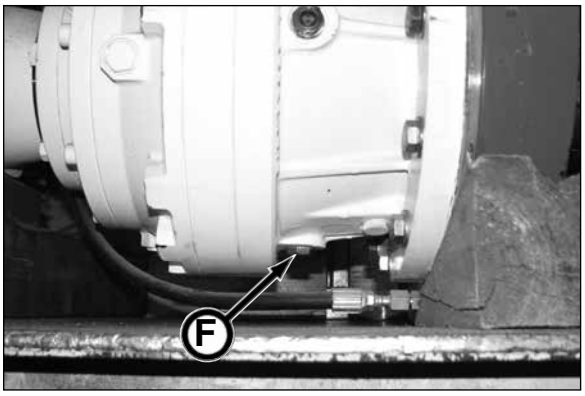
Visually check swivel collar for loose or damaged bolts (D). If bolt(s) are loose or damaged, they must be replaced with new.

Tighten bolts to the following torque:

3/4 in. - 282 ft-lb. lubed (382 N·m)

If bolt(s) do not hold torque, the bolts must be replaced with new.



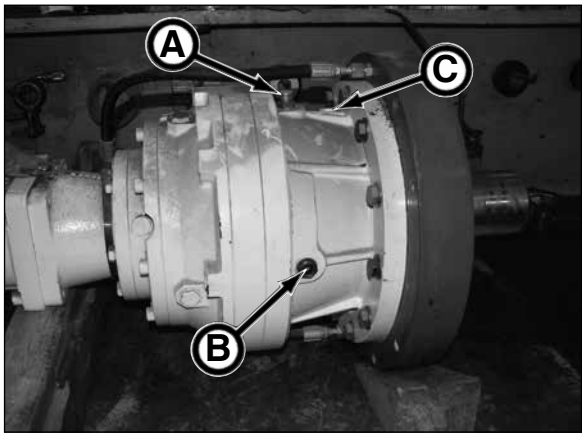


3. CHECK GEAR BOX OIL QUALITY

1. With the breather (E) in the 12 o'clock position, clean area around drain plug (F). Using a catch pan, loosen drain plug and drain a sampling of oil to check for water in the oil. Retighten drain plug. Be sure to recycle the drained oil properly.

2. If water is visible, the gear box seals have failed. In this case the gear box must be drained and flushed, seals replaced and the gear box filled with fresh, clean Mobil SHC™630 Synthetic Bearing and Gear oil. Contact your Akkerman Aftermarket Support representative for more information.

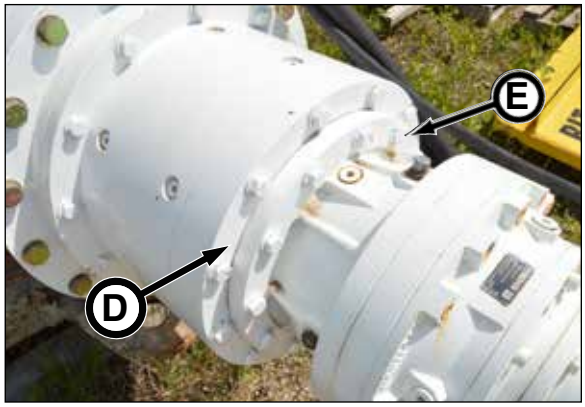
4. CHECK GEAR BOX OIL LEVEL



1. With the breather (A) in the 12 o'clock position, check that the gear box oil level is visible on sight gauges (B) (located in 3 o'clock and 9 o'clock positions). Be sure to allow a few minutes for the oil to settle before checking oil level.

2. If oil is not visible in sight gauge, clean area around fill plug (C). Remove fill plug and add Mobil SHC™ 630 Synthetic Bearing and Gear oil or equivalent until oil is visible in sight gauge. Replace fill plug.

5. INSPECT GEAR BOX



Inspect mount (D) for wear or damage. If worn or damaged, repair or replace with new.

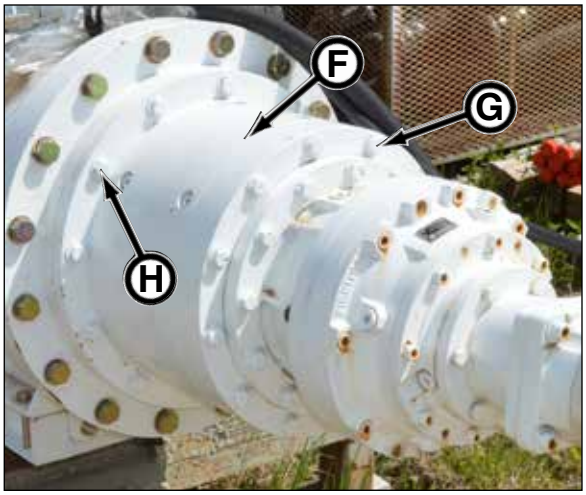
Visually check gear box mount for loose or damaged bolts (E). If bolt(s) are loose or damaged, they must be replaced with new.

Tighten bolts to the following torque:

1/2 in. - 80 ft-lb. lubed (108 N·m)

If bolt(s) do not hold torque, the bolts must be replaced with new.

6. INSPECT BEARING HOUSING & CHECK OIL LEVEL



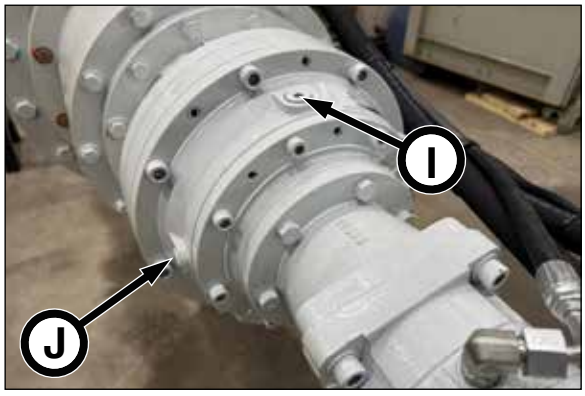
Inspect bearing housing (F) for wear or damage. If worn or damaged, repair or replace with new.

Visually check bearing housing mount for loose or damaged bolts (G, H). If bolt(s) are loose or damaged, they must be replaced with new.

Tighten bolts to the following torque:

1/2 in. - 80 ft-lb. lubed (108 N·m)

If bolt(s) do not hold torque, the bolts must be replaced with new.



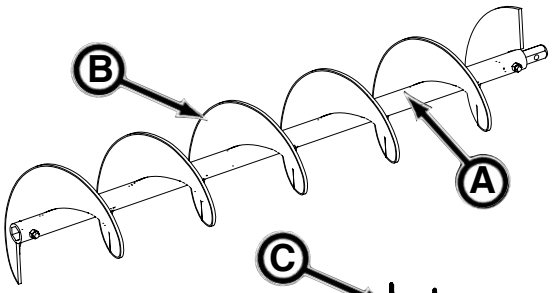
Check the bearing housing oil level:

1. Position the bearing housing with the fill port (I) in the 12 o'clock position and the check port in the 9 o'clock or 3 o'clock position.

2. Remove the check plug (J). If the oil is not visible at the check port level, add fresh, clean Mobil SHC™ 630 Synthetic Bearing and Gear oil in the fill port until the oil is level with the check port.

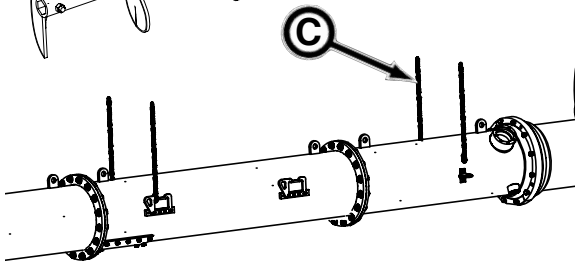
7. INSPECT AUGER

Inspect auger shaft (A) and flighting (B). If damaged, repair or replace with new.



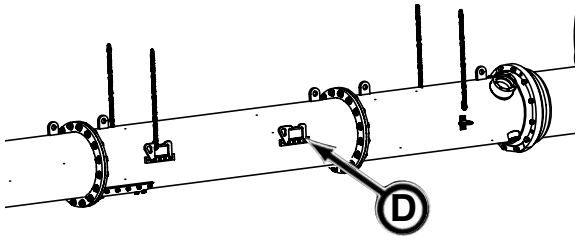
8. INSPECT LIFTING CHAINS

Inspect lifting chains (C) for wear or damage. If worn or damaged, replace with new.



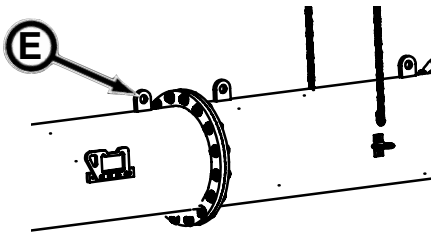
9. INSPECT LIFT D-RINGS

Inspect lift D-rings (D) for wear or damage. If worn or damaged, replace with new.



10. INSPECT LIFTING EYES

Inspect lifting eyes (E) for wear or damage. If worn or damaged, replace with new.



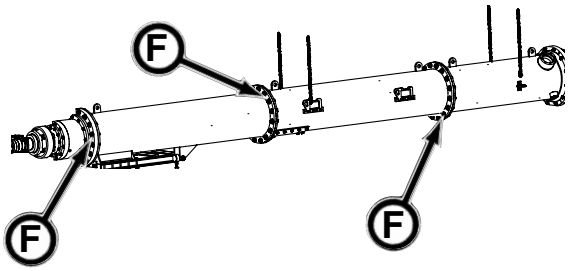
11. INSPECT AUGER CASING

Visually check auger casing mounts (F) for loose or damaged bolts. If bolt(s) are loose or damaged, they must be replaced with new.

Tighten bolts to the following torque:

3/4 in. - 282 ft-lb. lubed (382 N·m)

If bolt (s) do not hold torque, the bolts must be replaced with new.



12. CHECK ACCESS DOOR COVERS

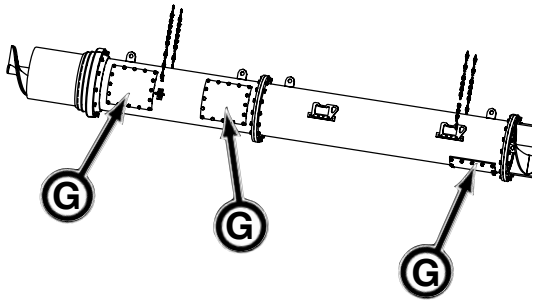
Inspect access door covers (G) for wear or damage. If worn or damaged, repair or replace with new.

Visually check auger casing covers for loose or damaged bolts. If bolt(s) are loose or damaged, they must be replaced with new.

Tighten bolts to the following torque:

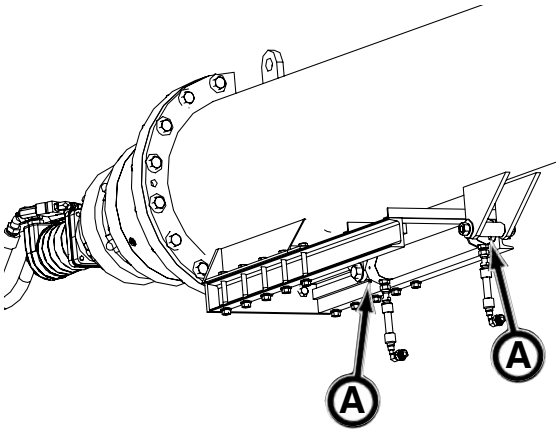
3/4 in. - 282 ft-lb. lubed (382 N·m)

If bolt (s) do not hold torque, the bolts must be replaced with new.



13. LUBRICATE GATE CYLINDER PINS

Lubricate gate cylinder pins (A) (2 places per cylinder) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.



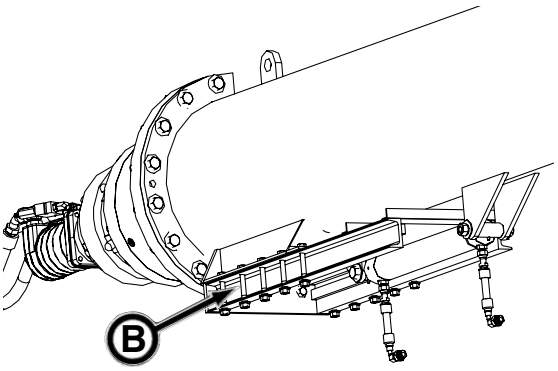
14. INSPECT GATE RAIL BOLTS

Visually check gate rail for loose or damaged bolts (B). If bolt(s) are loose or damaged, they must be replaced with new.

Tighten bolts to the following torque:

1/2 in. - 80 ft-lb. lubed 108 N·m)

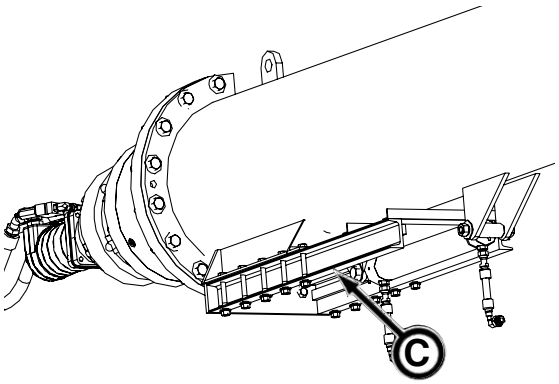
If bolt (s) do not hold torque, the bolts must be replaced with new.



15. INSPECT & LUBRICATE GATE RAILS

Inspect gate rails (C) for damage. If damaged, repair or replace as needed.

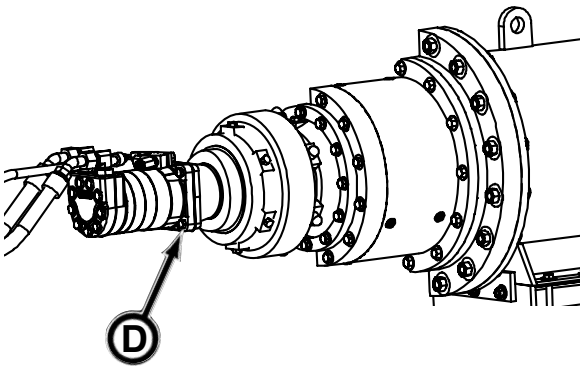
Lubricate gate rails with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent.



16. INSPECT MOTOR MOUNT BOLTS

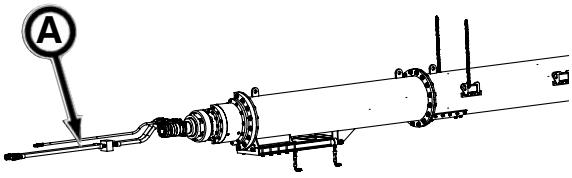
Check drive motor bolt (D) tightness. Tighten bolts to the 110 ft-lb (149 N·m) torque.

If bolts do not hold torque, replace bolts with new.



17. INSPECT HYDRAULIC HOSES

Inspect hydraulic hoses (A) for wear or damage. Repair or replace BEFORE operation.

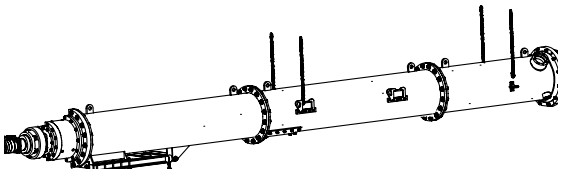


18. INSPECT DECALS

Inspect ALL decals, operational and safety decals to be sure they are 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 safety decals with solvent. Solvent will damage decals. Replace decals immediately if they are damaged, missing, or hard to read.

Before applying a new decal, be sure the surface is clean and dry.

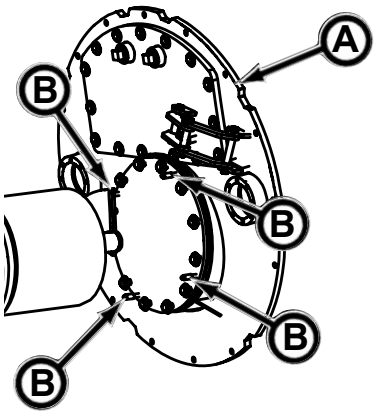


DAILY OR EVERY 10 HOURS OF OPERATION OR EACH SHIFT CHANGE

19. INSPECT & LUBRICATE BULKHEAD

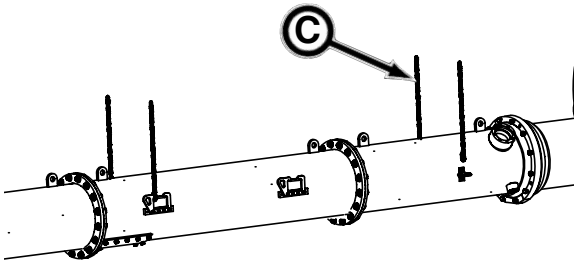
Inspect bulkhead (A) for wear or damage. If worn or damaged, replace with new.

Lubricate bulkhead (B) (4 places) with Mobilgrease® XHP222 Premium Lubricating Grease twice daily.



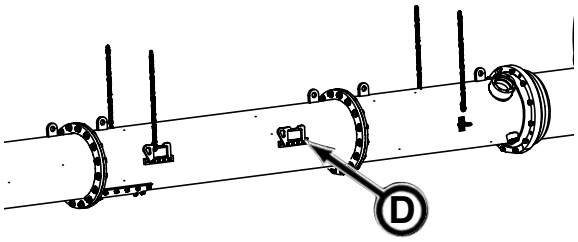
20. INSPECT LIFTING CHAINS

Inspect lifting chains (C) for wear or damage. If worn or damaged, replace with new.



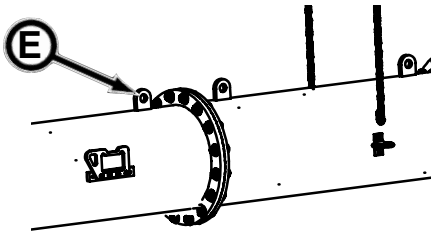
21. INSPECT LIFT D-RINGS

Inspect lift D-rings (D) for wear or damage. If worn or damaged, replace with new.



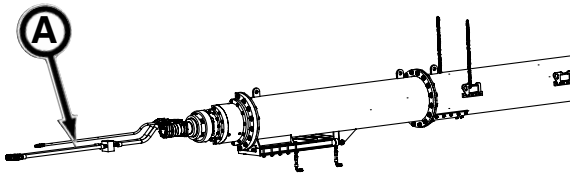
22. INSPECT LIFTING EYES

Inspect lifting eyes (E) for wear or damage. If worn or damaged, replace with new.



23. INSPECT HYDRAULIC HOSES

Inspect hydraulic hoses (A) for wear or damage. Repair or replace BEFORE operation.

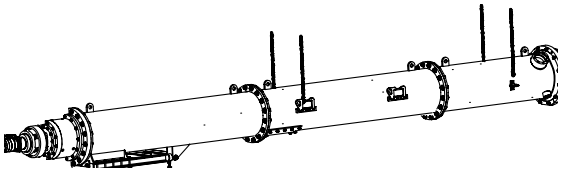


24. INSPECT DECALS

Inspect ALL decals, operational and safety decals to be sure they are 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 safety decals with solvent. Solvent will damage decals. Replace decals immediately if they are damaged, missing, or hard to read.

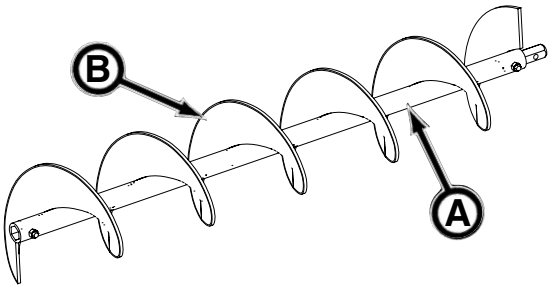
Before applying a new decal, be sure the surface is clean and dry.



WEEKLY OR EVERY 50 HOURS OF OPERATION

25. INSPECT AUGER

Inspect auger shaft (A) and flighting (B). If damaged, repair or replace with new.



26. INSPECT SWIVEL COLLAR

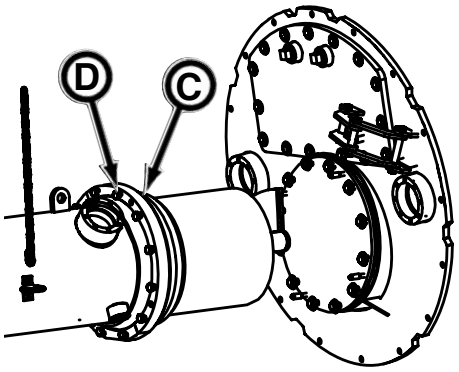
Inspect collar (C) for wear or damage. If worn or damaged, replace with new.

Visually check swivel collar for loose or damaged bolts (D). If bolt(s) are loose or damaged, they must be replaced with new.

Tighten bolts to the following torque:

3/4 in. - 282 ft-lb. lubed (382 N·m)

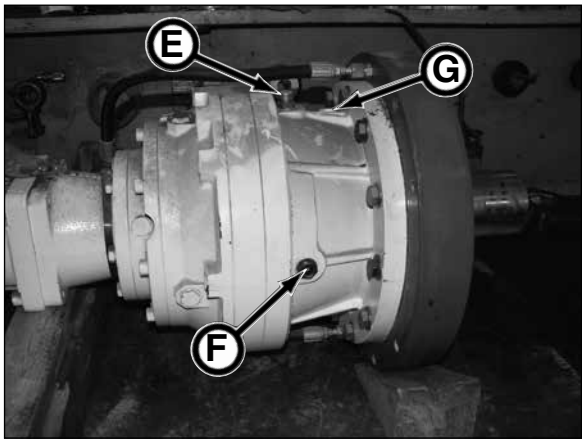
If bolt (s) do not hold torque, the bolts must be replaced with new.



27. CHECK GEAR BOX OIL LEVEL

1. With the breather (E) in the 12 o'clock position, check that the gear box oil level is visible on sight gauges (F) (located in 3 o'clock and 9 o'clock positions). Be sure to allow a few minutes for the oil to settle before checking oil level.

2. If oil is not visible in sight gauge, clean area around fill plug (G). Remove fill plug and add Mobil SHC™ 630 Synthetic Bearing and Gear oil or equivalent until oil is visible in sight gauge. Replace fill plug



28. INSPECT GEAR BOX

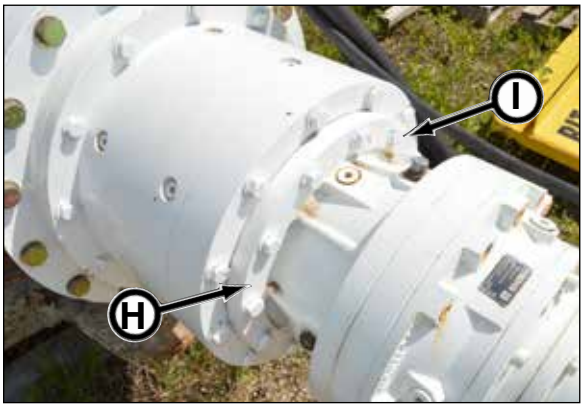
Inspect mount (H) for wear or damage. If worn or damaged, repair or replace with new.

Visually check gear box mount for loose or damaged bolts (I). If bolt(s) are loose or damaged, they must be replaced with new.

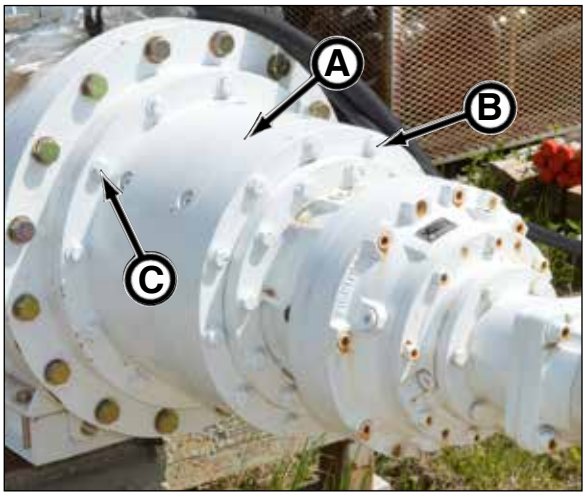
Tighten bolts to the following torque:

1/2 in. - 80 ft-lb. lubed (108 N·m)

If bolt (s) do not hold torque, the bolts must be replaced with new.



29. INSPECT BEARING HOUSING & CHECK OIL LEVEL



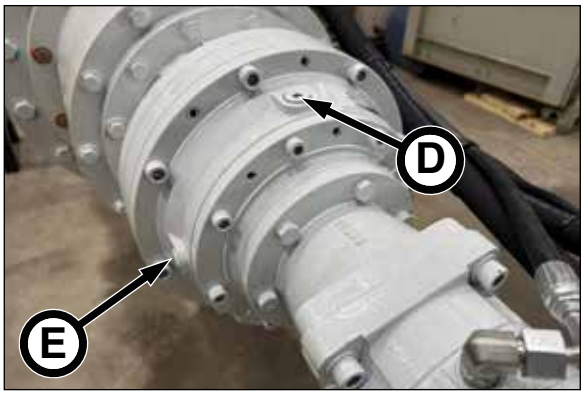
Inspect bearing housing (A) for wear or damage. If worn or damaged, repair or replace with new.

Visually check bearing housing mount for loose or damaged bolts (B, C). If bolt(s) are loose or damaged, they must be replaced with new.

Tighten bolts to the following torque:

1/2 in. - 80 ft-lb. lubed (108 N·m)

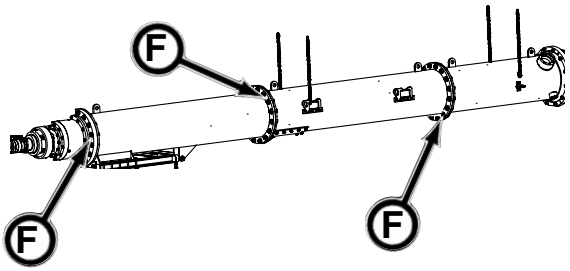
If bolt (s) do not hold torque, the bolts must be replaced with new.



Check the bearing housing oil level:

1. Position the bearing housing with the fill port (D) in the 12 o'clock position and the check port in the 9 o'clock or 3 o'clock position.
2. Remove the check plug (E). If the oil is not visible at the check port level, add fresh, clean Mobil SHC™ 630 Synthetic Bearing and Gear oil in the fill port until the oil is level with the check port.

30. INSPECT AUGER CASING



Inspect auger casing for wear or damage. If worn or damaged, repair or replace with new.

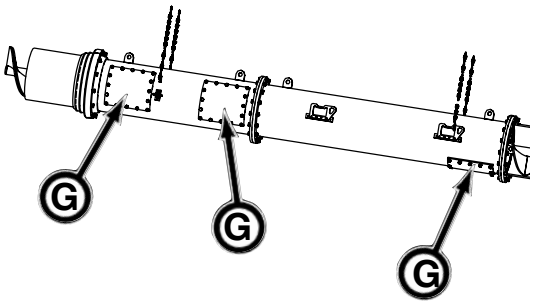
Visually check auger casing mounts (F) for loose or damaged bolts. If bolt(s) are loose or damaged, they must be replaced with new.

Tighten bolts to the following torque:

3/4 in. - 282 ft-lb. lubed (382 N·m)

If bolt (s) do not hold torque, the bolts must be replaced with new.

31. CHECK ACCESS DOOR COVERS



Inspect access door covers (G) for wear or damage. If worn or damaged, repair or replace with new.

Visually check auger casing covers for loose or damaged bolts. If bolt(s) are loose or damaged, they must be replaced with new.

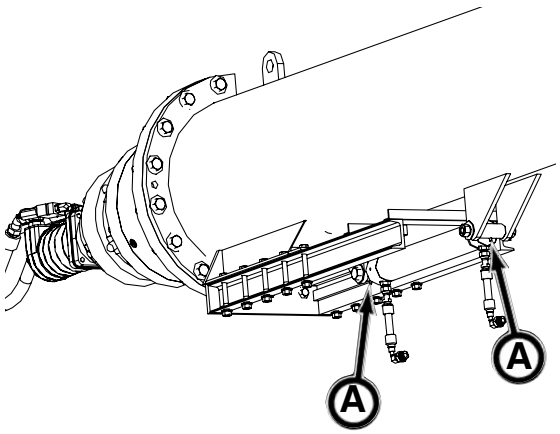
Tighten bolts to the following torque:

3/4 in. - 282 ft-lb. lubed (382 N·m)

If bolt (s) do not hold torque, the bolts must be replaced with new.

32. LUBRICATE GATE CYLINDER PINS

Lubricate gate cylinder pins (A) (2 places per cylinder) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.



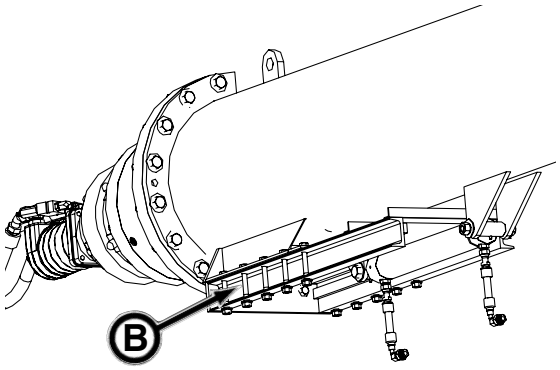
33. INSPECT GATE RAIL BOLTS

Visually check gate rail for loose or damaged bolts (B). If bolt(s) are loose or damaged, they must be replaced with new.

Tighten bolts to the following torque:

1/2 in. - 80 ft-lb. lubed (108 N·m)

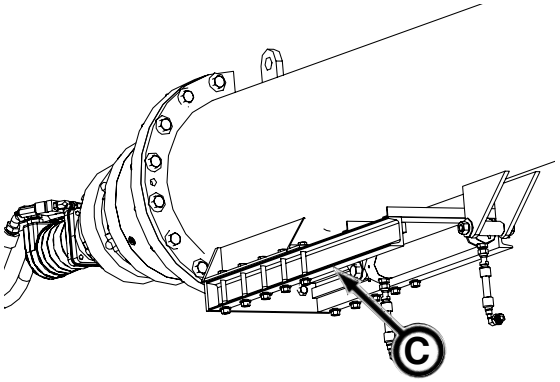
If bolt (s) do not hold torque, the bolts must be replaced with new.



34. INSPECT & LUBRICATE GATE RAILS

Inspect gate rails (C) for damage. If damaged, repair or replace as needed.

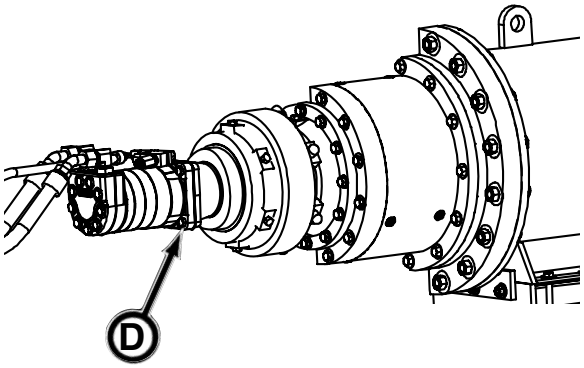
Lubricate gate rails with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent.



35. INSPECT MOTOR MOUNT BOLTS

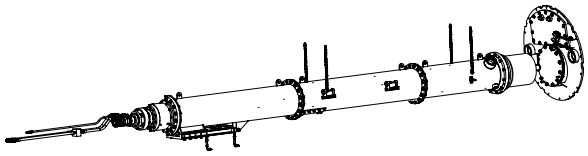
Check drive motor bolt (D) tightness. Tighten bolts to the 110 ft-lb (149 N·m) torque.

If bolts do not hold torque, replace bolts with new.



COMPLETION OF EACH DRIVE

36. CLEAN & EMPTY CONVEYOR



Flush the screw conveyor with water to clean the conveyor of dirt and debris while it is soft and flexible, and before the dirt hardens to conveyor and auger.

Fully empty the contents of the conveyor.

EVERY 1000 HOURS OF OPERATION

37. DRAIN & FILL GEAR BOX

1. Orient gear box so the breather (A) is in the 12 o'clock position (the two sight gauges (B) will be located in 3 o'clock and 9 o'clock positions).

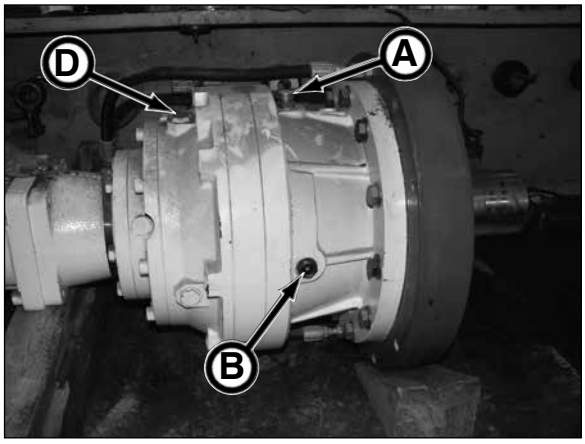
2. Clean area around the drain (C) and fill (D) ports.

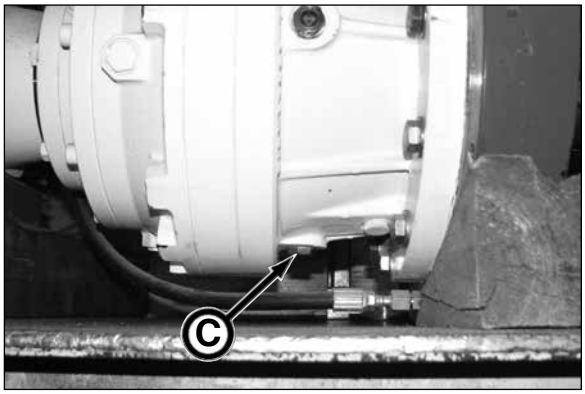
3. Drain oil from gear box by removing drain plug (B) into a properly sized catch pan. Be sure to recycle the drained oil properly.

4. Replace drain plug.

5. Add fresh, clean Mobil SHC™ 630 Synthetic Bearing and Gear oil through the fill port until the oil level is visible on the sight gauges (C).

6. Replace fill plug.

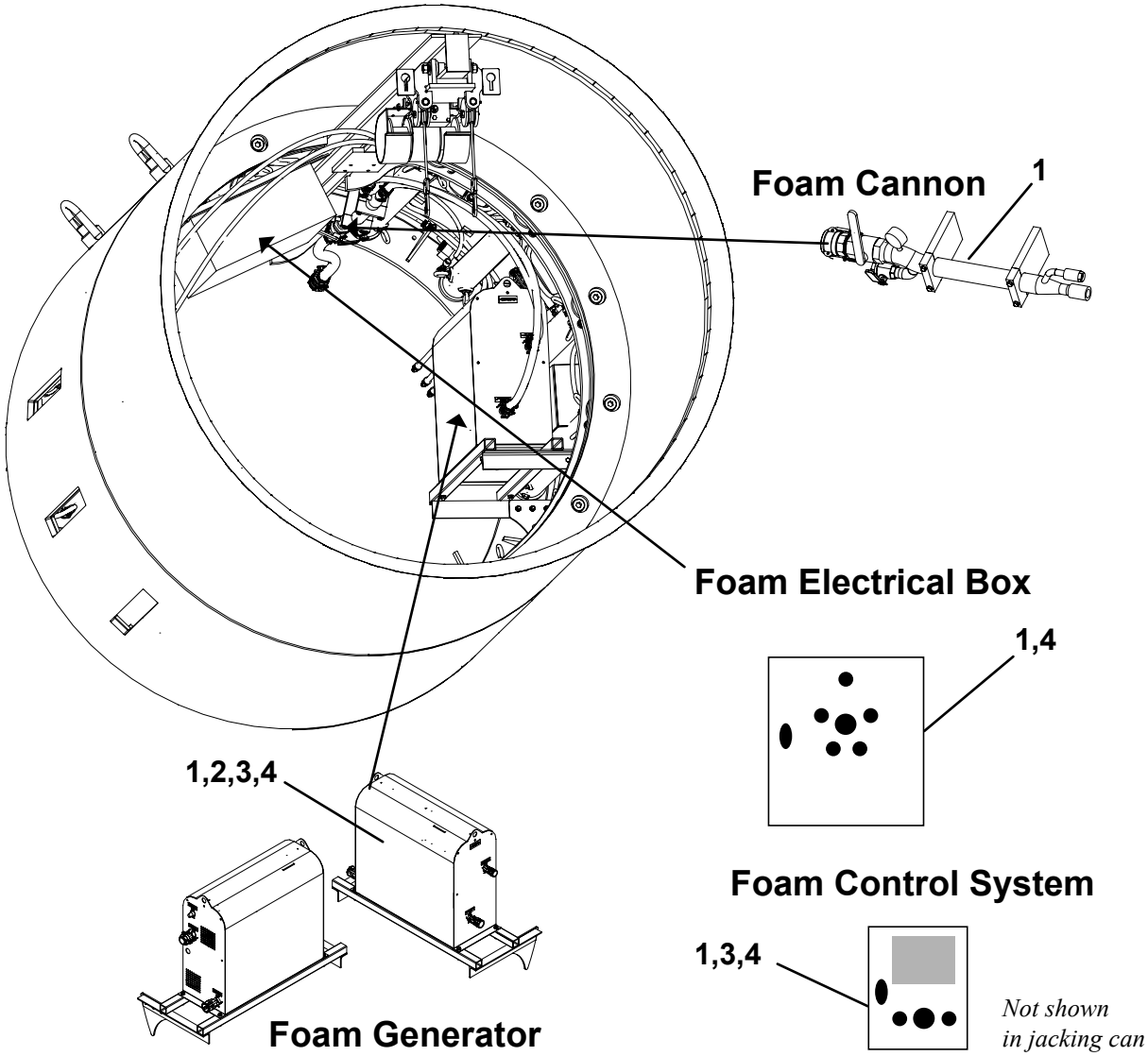




MAINTENANCE CHARTS - FOAM GENERATION SYSTEM

Use the item number in the chart to refer to the detailed maintenance procedures later in this section.

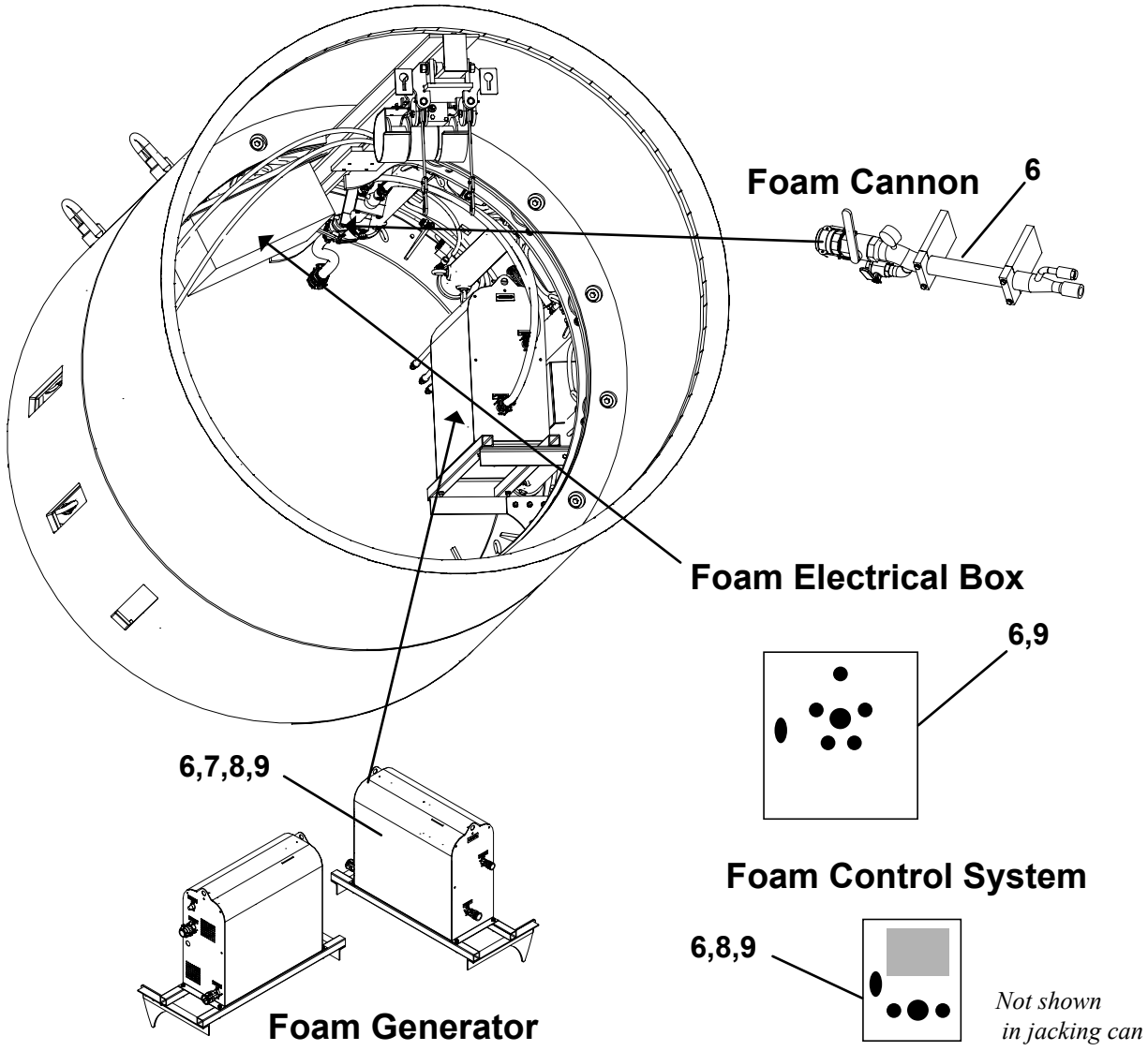
IMPORTANT: The Foam Generator System maintenance in this section covers only general maintenance. You must refer to your Foam Generation User Manual for specific intervals and procedures.



PRIOR TO EACH JOB LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Structures	Clean & Inspect	Remove dirt and debris. If damaged, repair or replace.	
2.	Foam Generator	Lubricate	Apply appropriate lubricant to moving parts.	
3.	Foam Generator & Control Box	Check Levels	Check foaming agent levels.	
4.	Controls	Check Operation		
5.	Decals (not shown)	Inspect	Must be legible. Replace as needed.	

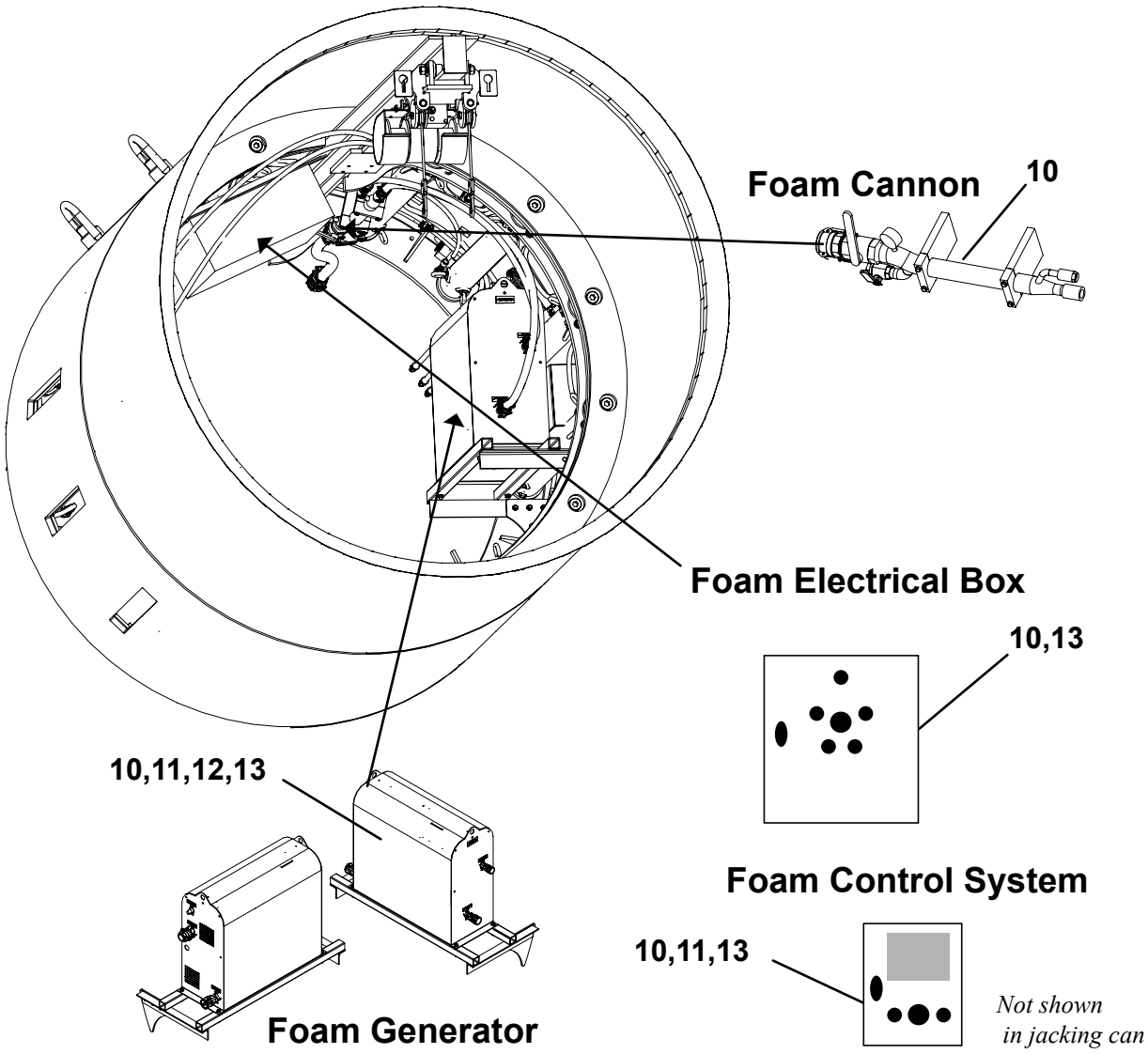
IMPORTANT: The Foam Generator System maintenance in this section covers only general maintenance. You must refer to your Foam Generation User Manual for specific intervals and procedures.



DAILY OR EVERY 10 HOURS OF OPERATION OR SHIFT CHANGE

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
6.	Structures	Clean & Inspect	Remove dirt and debris. If damaged, repair or replace.	
7.	Foam Generator	Lubricate	Apply appropriate lubricant to moving parts.	
8.	Foam Generator & Control Box	Check Levels	Check foaming agent levels.	
9.	Controls	Check Operation		

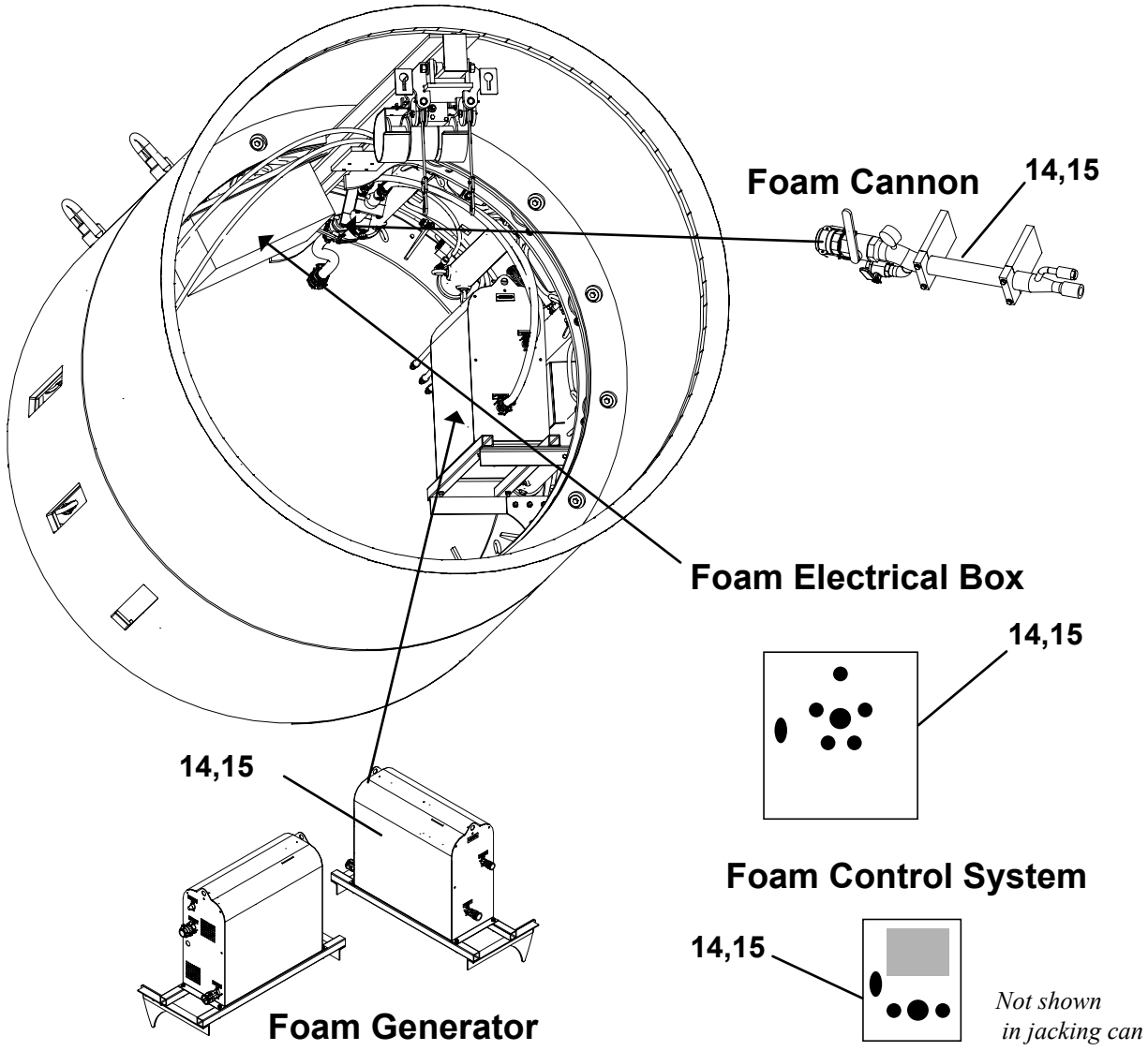
IMPORTANT: The Foam Generator System maintenance in this section covers only general maintenance. You must refer to your Foam Generation User Manual for specific intervals and procedures.



WEEKLY OR EVERY 50 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
10.	Structures	Clean & Inspect	Remove dirt and debris. If damaged, repair or replace.	
11.	Foam Generator	Lubricate	Apply appropriate lubricant to moving parts.	
12.	Foam Generator & Control Box	Check Levels	Check foaming agent levels.	
13.	Controls	Check Operation		

IMPORTANT: The Foam Generator System maintenance in this section covers only general maintenance. You must refer to your Foam Generation User Manual for specific intervals and procedures.



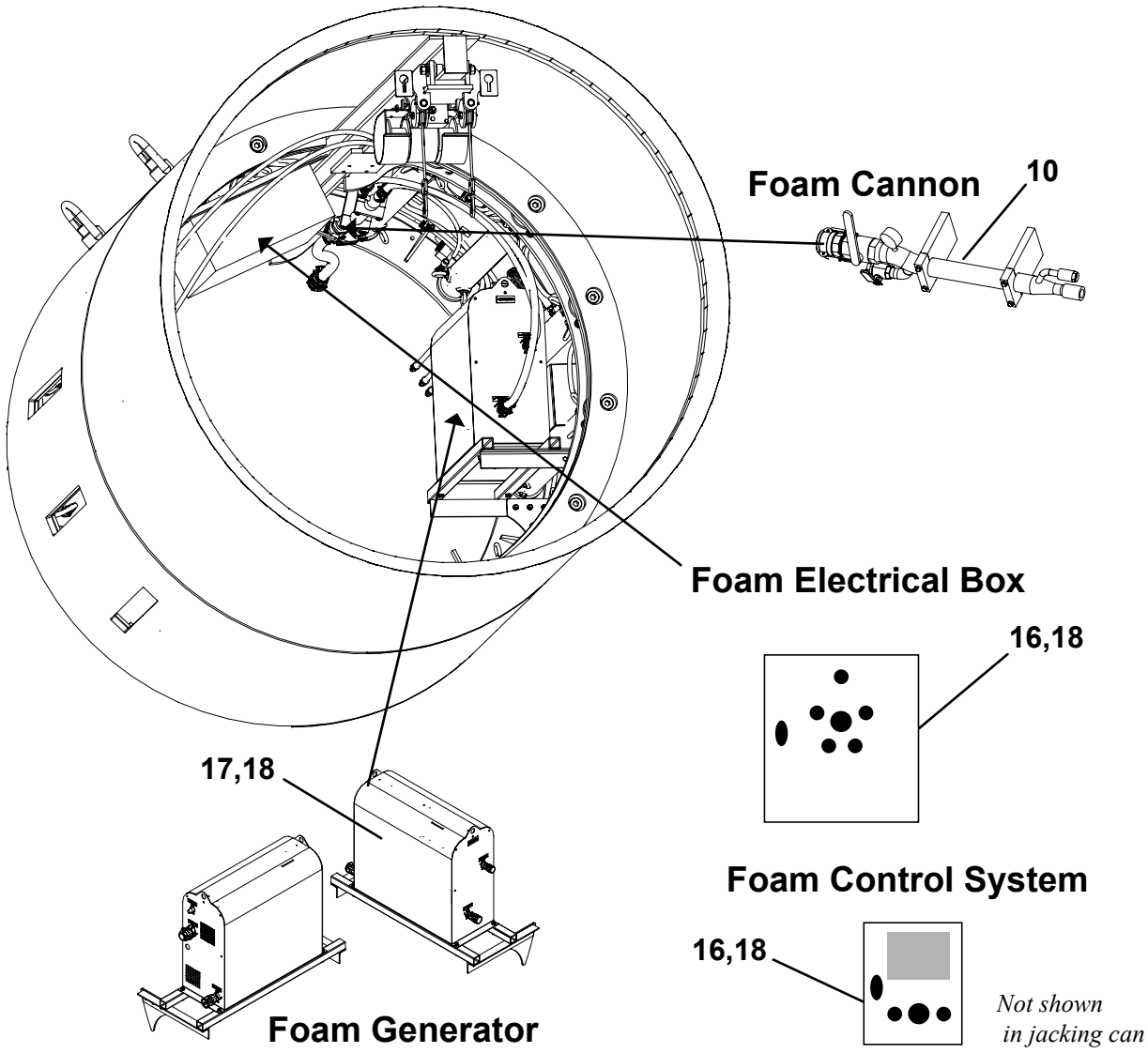
MONTHLY OR EVERY 250 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
14.	Structures	Inspect	If damaged, repair or replace.	

EVERY 750 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
15.	System	Clean & Lubricate	Perform extensive cleaning and maintenance. Apply appropriate lubricant to moving parts. See manufacturer's user manual for reference.	

IMPORTANT: The Foam Generator System maintenance in this section covers only general maintenance. You must refer to your Foam Generation User Manual for specific intervals and procedures.



EVERY 1500 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
16.	Electrical Box & Control Box Terminal Blocks	Inspect & Check	If damaged, repair or replace. Check tightness. See manufacturer's user manual for reference.	
17.	Water Filter	Clean	Disassemble, clean, reassemble.	

ANNUALLY

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
18.	System	Perform Maintenance & Inspection	Performed by qualified technician. See manufacturer's user manual for reference.	

PRIOR TO EACH JOB LAUNCH

1. CLEAN & INSPECT STRUCTURES

Regularly clean foam generator components and electrical and control box cabinet exteriors to prevent dirt and debris buildup. Check for leaks and debris buildup.

Visually inspect the foam generator, electrical, and control boxes for cracks, wear, or other damage. Inspect structures and mountings. Inspect pipes, fittings, and electrical components for damage. Check for leaks, damaged fitting threads, deformities, abnormal noise, etc. Check for missing parts. Tighten hardware as needed. Do not overtighten hardware. If damaged, defective, or missing repair or replace BEFORE operation.

Check electrical and control box cabinet locking mechanisms for correct locking and unlocking functions.

2. LUBRICATE FOAM GENERATOR

NOTICE Refer to foam generator manufacturer User Manual for additional foam generator maintenance information.

Lubricate moving parts with recommended lubricant or equivalent to reduce wear.

3. CHECK FOAM GENERATOR & CONTROL BOX LEVELS

Check control box monitor for water and foam agent levels. Be sure levels are within the acceptable operation range BEFORE operation.

4. CHECK CONTROL OPERATION

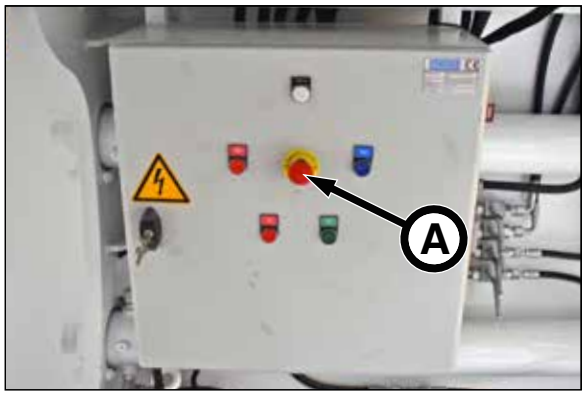
⚠WARNING Emergency Stop (E-Stop) buttons MUST function properly BEFORE operating the foam generation system. Failure to do so may cause severe injury or death.

Be sure to check all foam generation system controls for proper operation. If controls do not function properly, repair or replace BEFORE operation.

Check both E-Stop buttons (A, B) for proper operation. When pushed in, the E-Stop button must stop all foam generation system functions.

Ensure buttons and lights in the electrical and control boxes illuminate when activated and function properly.

Check buttons and cables for wear or damage. If cables show signs of wear or damage, repair or replace.



5. INSPECT DECALS

Inspect ALL operational and safety decals to be sure they are clean and readable.

Use soft cloth, water, and mild soap to clean the decals if they are too dirty to read. DO NOT clean decals with solvent. Solvent will damage decals. Replace decals immediately if they are damaged, missing, or hard to read. Contact manufacturer for replacement decals.

Before applying new decal, be sure the surface is clean and dry.

DAILY OR EVERY 10 HOURS OF OPERATION OR SHIFT CHANGE

6. CLEAN & INSPECT STRUCTURES

Regularly clean foam generator components and electrical and control box cabinet exteriors to prevent dirt and debris buildup. Check for leaks and debris buildup.

Visually inspect the foam generator, electrical, and control boxes for cracks, wear, or other damage. Inspect structures and mountings. Inspect pipes, fittings, and electrical components for damage. Check for leaks, damaged fitting threads, deformities, abnormal noise, etc. Check for missing parts. Tighten hardware as needed. Do not overtighten hardware. If damaged, defective, or missing repair or replace BEFORE operation.

Check electrical and control box cabinet locking mechanisms for correct locking and unlocking functions.

7. LUBRICATE FOAM GENERATOR

NOTICE Refer to foam generator manufacturer User Manual for additional foam generator maintenance information.

Lubricate moving parts with recommended lubricant or equivalent to reduce wear.

8. CHECK FOAM GENERATOR & CONTROL BOX LEVELS

Check control box monitor for water and foam agent levels. Be sure levels are within the acceptable operation range BEFORE operation.

9. CHECK CONTROL OPERATION

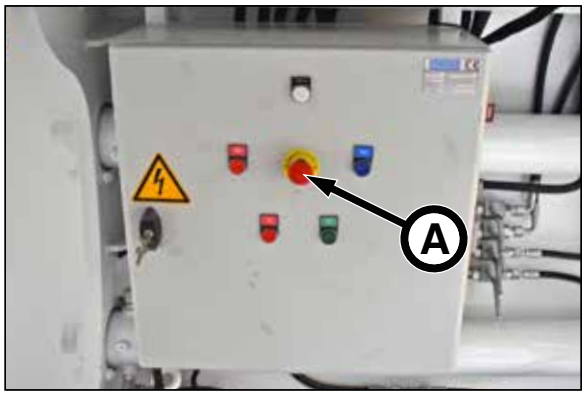
⚠WARNING Emergency Stop (E-Stop) buttons MUST function properly BEFORE operating the foam generation system. Failure to do so may cause severe injury or death.

Be sure to check all foam generation system controls for proper operation. If controls do not function properly, repair or replace BEFORE operation.

Check both E-Stop buttons (A, B) for proper operation. When pushed in, the E-Stop button must stop all foam generation system functions.

Ensure buttons and lights in the electrical and control boxes illuminate when activated and function properly.

Check buttons and cables for wear or damage. If cables show signs of wear or damage, repair or replace.



WEEKLY OR EVERY 50 HOURS OF OPERATION

10. CLEAN & INSPECT STRUCTURES

Regularly clean foam generator components and electrical and control box cabinet exteriors to prevent dirt and debris buildup. Check for leaks and debris buildup.

Visually inspect the foam generator, electrical, and control boxes for cracks, wear, or other damage. Inspect structures and mountings. Inspect pipes, fittings, and electrical components for damage. Check for leaks, damaged fitting threads, deformities, abnormal noise, etc. Check for missing parts. Tighten hardware as needed. Do not overtighten hardware. If damaged, defective, or missing repair or replace BEFORE operation.

Check electrical and control box cabinet locking mechanisms for correct locking and unlocking functions.

11. LUBRICATE FOAM GENERATOR

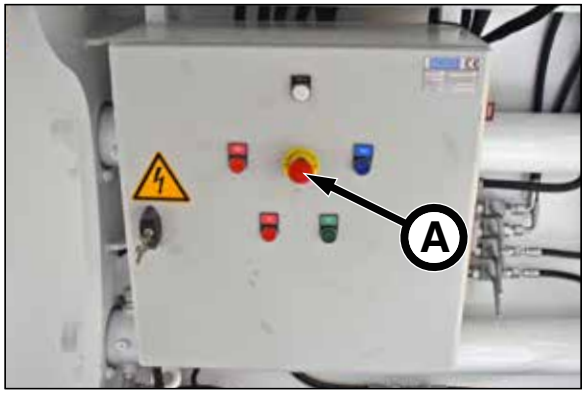
NOTICE Refer to foam generator manufacturer User Manual for additional foam generator maintenance information.

Lubricate moving parts with recommended lubricant or equivalent to reduce wear.

12. CHECK FOAM GENERATOR & CONTROL BOX LEVELS

Check control box monitor for water and foam agent levels. Be sure levels are within the acceptable operation range BEFORE operation.

13. CHECK CONTROL OPERATION



⚠WARNING Emergency Stop (E-Stop) buttons MUST function properly BEFORE operating the foam generation system. Failure to do so may cause severe injury or death.

Be sure to check all foam generation system controls for proper operation. If controls do not function properly, repair or replace BEFORE operation.

Check both E-Stop buttons (A, B) for proper operation. When pushed in, the E-Stop button must stop all foam generation system functions.

Ensure buttons and lights in the electrical and control boxes illuminate when activated and function properly.

Check buttons and cables for wear or damage. If cables show signs of wear or damage, repair or replace.

MONTHLY OR EVERY 250 HOURS OF OPERATION

14. INSPECT STRUCTURES

Visually inspect the foam generator, electrical, and control boxes for cracks, wear, or other damage. Inspect structures and mountings. Inspect pipes, fittings, and electrical components for damage. Check for leaks, damaged fitting threads, deformities, abnormal noise, etc. Check for missing parts. Tighten hardware as needed. Do not overtighten hardware. If damaged, defective, or missing repair or replace BEFORE operation.

Check foam electrical and control box cabinet locking mechanisms for correct locking and unlocking functions.

EVERY 750 HOURS OF OPERATION

15. CLEAN & LUBRICATE SYSTEM

Perform extensive cleaning and maintenance.

Apply appropriate lubricant to moving parts.

See manufacturer’s user manual for reference.

EVERY 1500 HOURS OF OPERATION

16. INSPECT & CHECK ELECTRICAL BOX & CONTROL BOX TERMINAL BLOCKS

Visually inspect electrical and control box. Repair or replace damaged components.

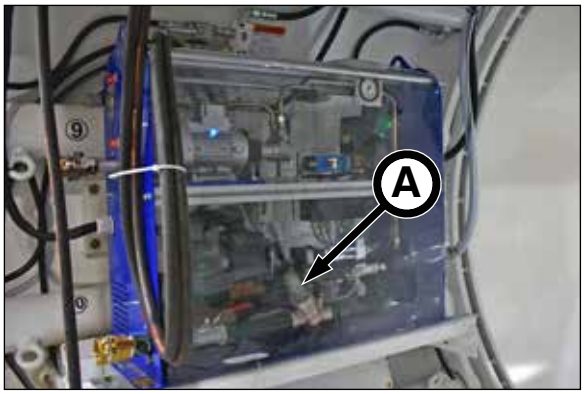
Check foam electrical and control box terminal blocks. Tighten as needed. See manufacturer's User Manual for reference.

Foam electrical box terminal blocks shown

17. CLEAN WATER FILTER

Disassemble, clean, and reassemble water filter in foam generator (A).

See manufacturer's user manual for reference.



ANNUALLY

18. PERFORM SYSTEM MAINTENANCE & INSPECTION

Contact manufacturer for qualified technician maintenance. See manufacturer's user manual for more information.

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.
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. Drain heat exchanger.
8. Wipe up lube spills. Dispose of rags and trash properly. Store oily rags and other flammable material in protective containers.
9. If possible, store equipment under cover and out of the weather in a ventilated area.
10. Remove laser guidance system and place it in the storage box.
11. Do not smoke in areas where flammable materials are stored.
12. Store fuels and lubricants in properly marked containers.
13. Loosen belt on belt conveyor.
14. If equipped, remove and store foam agent concentrate.

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. Tighten belt tension on belt conveyor.
12. Review this Operator's Manual and your supporting equipment manuals.

NOTES

Troubleshooting

840 TBM

Problem	Cause	Solution
300 HP motor will not start.	Emergency stop button pushed IN.	Pull E-STOP button out.
	Improper phase power.	Contact electrician to correct phase.
	Power source is OFF.	Turn on power source.
	Main disconnect switch is OFF	Turn disconnect ON.
	Generator or power supply faulty.	Repair or replace.
	Low oil level.	Fill reservoir with oil.
	Faulty low oil level switch or relay.	Replace switch or relay.
	Faulty E-stop cable, switch or relay.	Replace switch, cable or relay.
Power pack motor starts but no oil pressure available.	**IMPORTANT: DO NOT** operate for extended periods with this condition. Doing so WILL result in pump damage.	
	Incorrect motor rotation.	Rewire motor for proper rotation.
	Low oil level.	Add hydraulic oil as needed.
	Closed pump suction valve.	Open valve.
	Control valve not turned ON.	Turn control valve ON.
	Faulty control valve switch.	Repair or replace switch.
	Flow rate turned too low.	Readjust flow rate.
	Worn or damaged hydraulic pump.	Repair or replace pump.
Temperature gauge exceeds 150 degrees.	Heat exchanger water supply not adequate.	Water supply must be at minimum: see water table on page 4-34.
	Oil supply to heat exchanger turned off.	Turn on oil supply.
	Excessive hydraulic circuit pressure to boring machine.	Reduce steering flow control. Replace boring head filters.
	Hydraulic circuit disconnected causing a safety relief to be activated.	Connect hoses.
	Excessive ambient temperature.	Provide fresh, clean, cold water source.
	Excessive horsepower required by TBM or jacking operation.	Reduce advancement rate or install IJS.
	Heat exchanger water passages plugged.	Clean heat exchanger.

(continued on next page)

Problem	Cause	Solution
Conveyor lift or steering does not operate.	Obstacle in travel area.	Remove obstacle.
	Check valve did not release.	Replace check valve.
Steering cylinder(s) collapse when forward thrust applied.	Worn or damaged check valve.	Replace check valve.
	Faulty cylinder seals.	Replace seals.
	Obstruction against cutter ring.	Remove obstruction.
	Insufficient over-cut clearance.	Readjust over-cut.
	Excessive thrust pressure.	Reduce thrust pressure.
	Faulty check valve.	Replace check valve.
TBM will not steer up/down.	Worn or damaged cylinder seals.	Replace seals.
	Check valve not releasing.	Replace check valve.
TBM will not steer left/right.	Worn or damaged cylinder seals.	Replace seals.
	Check valve not releasing.	Replace check valve.
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.
	Cylinder piston relief leaking.	Replace relief.
	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.	Pilot operated check valve leaking.	Replace valve.
	Worn or damaged cylinder seals.	Replace seals.
	Cylinder piston relief leaking.	Replace relief.
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.
	Pilot operated check leaking.	Replace valve.

BELT CONVEYOR

Problem	Cause	Solution
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.

SCREW CONVEYOR

Problem	Cause	Solution
No spoils at discharge.	Check auger for rotation.	Correct operation.
	Auger stalled.	Check for rocks or obstructions.
	Operating pressure too low.	Adjust to proper setting.
	Cutterhead not advancing.	Advance cutterhead.
	Pump not on.	Turn on pump.
Auger in low speed operation.	Speed set too low.	Adjust to higher speed.
	Rotational pressure too high.	Empty auger until pressure is reduced.
		Open screw gate until pressure is reduced.
	Low standby pressure.	Adjust to 200-400 psi.
Screw gate will not open or will not close.	Obstruction at gate rail.	Remove obstruction.
	Operating pressure too low.	Adjust to proper setting.

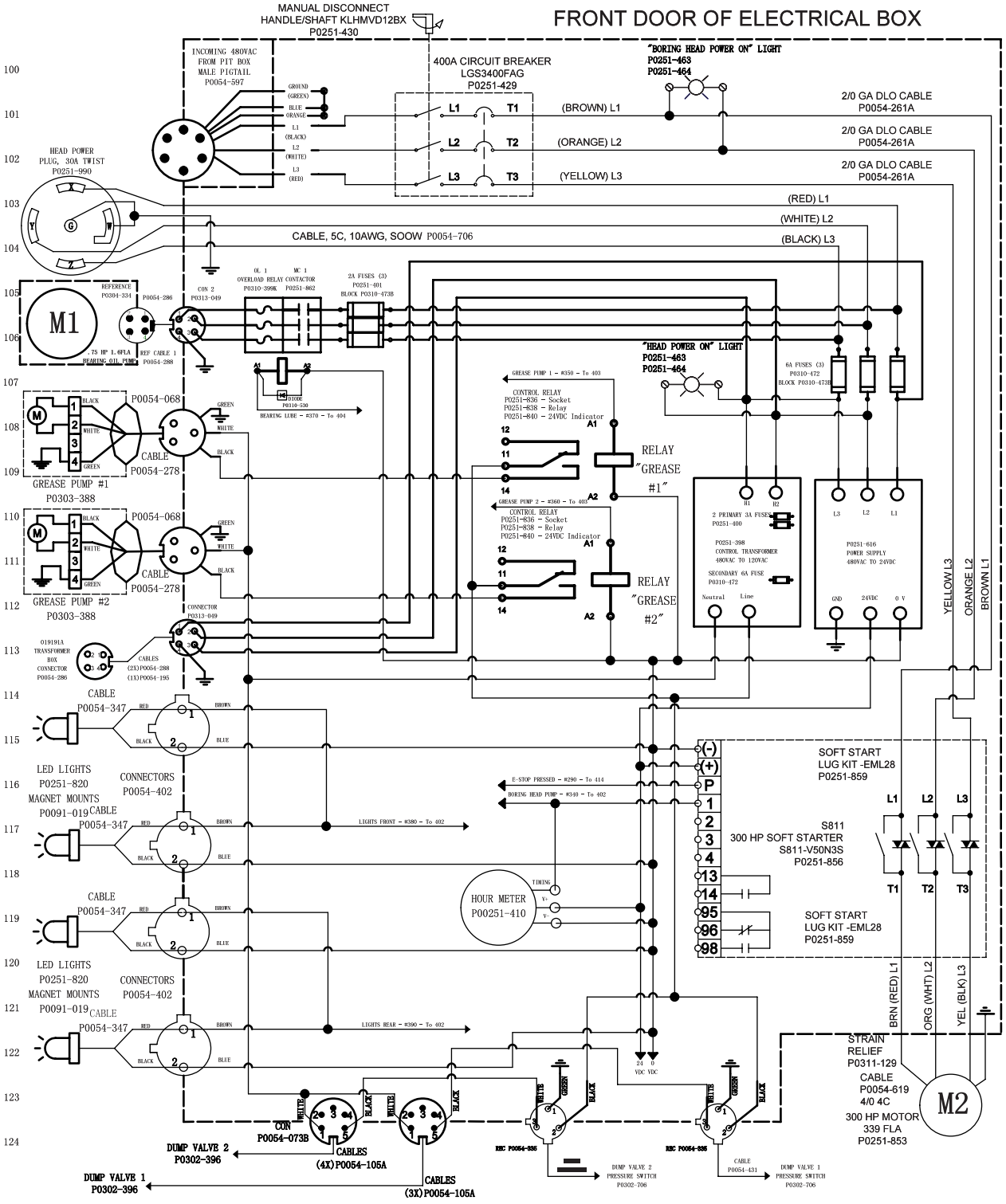
FOAM GENERATION SYSTEM

IMPORTANT: Refer to your Foam Generation System User Manual for additional troubleshooting problems, causes and solutions.

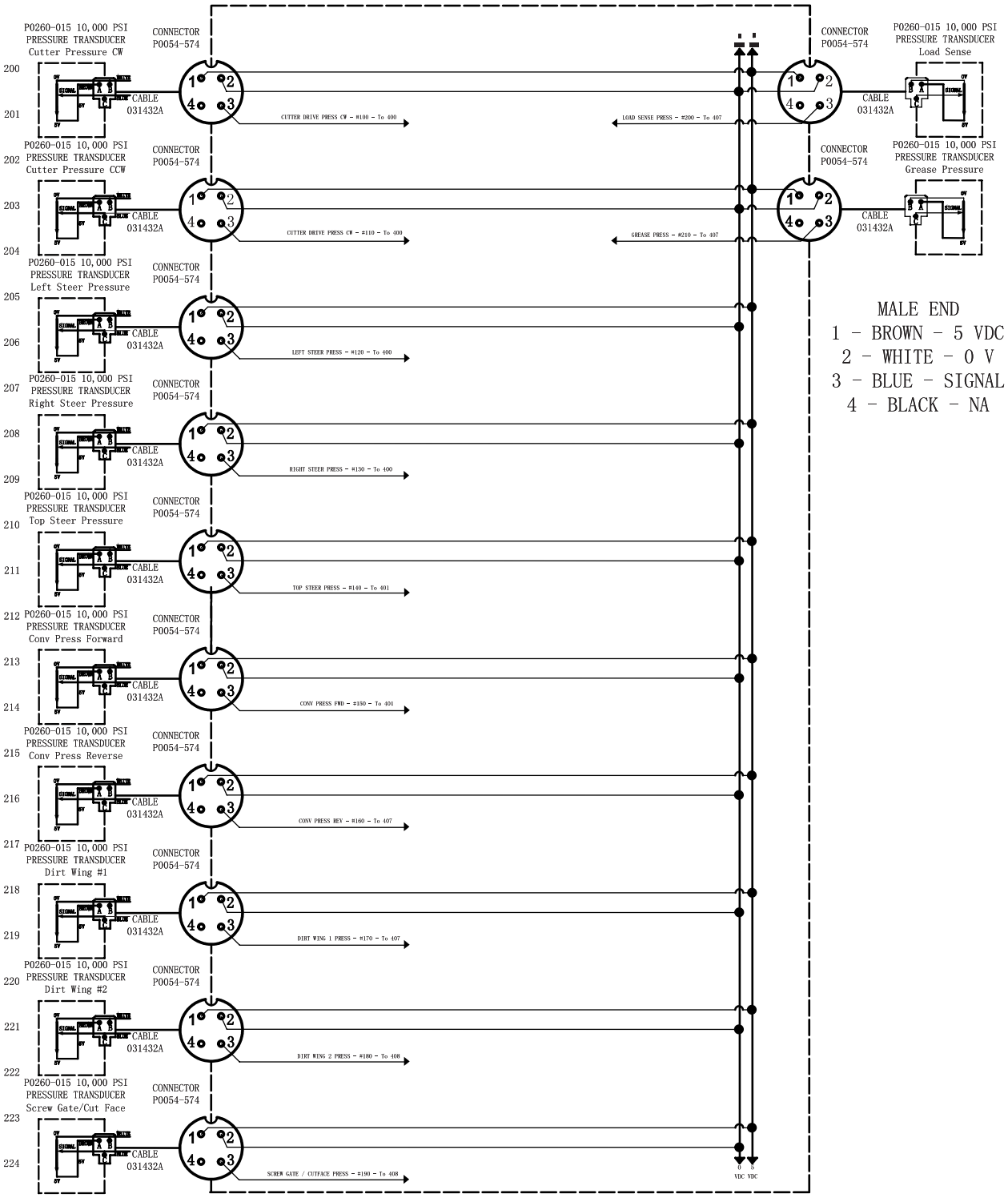
Problem	Cause	Solution
Foam Generation System does not start.	E-Stops are not pulled OUT.	Pull OUT all E-Stops.
	Main power disconnect is not turned to the ON position.	Turn main power disconnect to the ON position.
	Did not press the Safety Reset button.	Press the Safety Reset button.
	Foam cannon valves are closed.	Open the foam cannon valves.
	Communication cables are not connected.	Connect communication cables to foam electrical box.
No foam is generated.	Water not connected to water inlet.	Connect water to inlet.
Water pressure is too high.	Water pressure is set incorrectly.	Set water pressure not to exceed 58 psi (4 bar).
Foam mixture is incorrect.	Incorrect foam mixture settings.	Adjust foam settings on foam control box control system.

ELECTRICAL SCHEMATIC - 840 ELECTRICAL BOX SN1

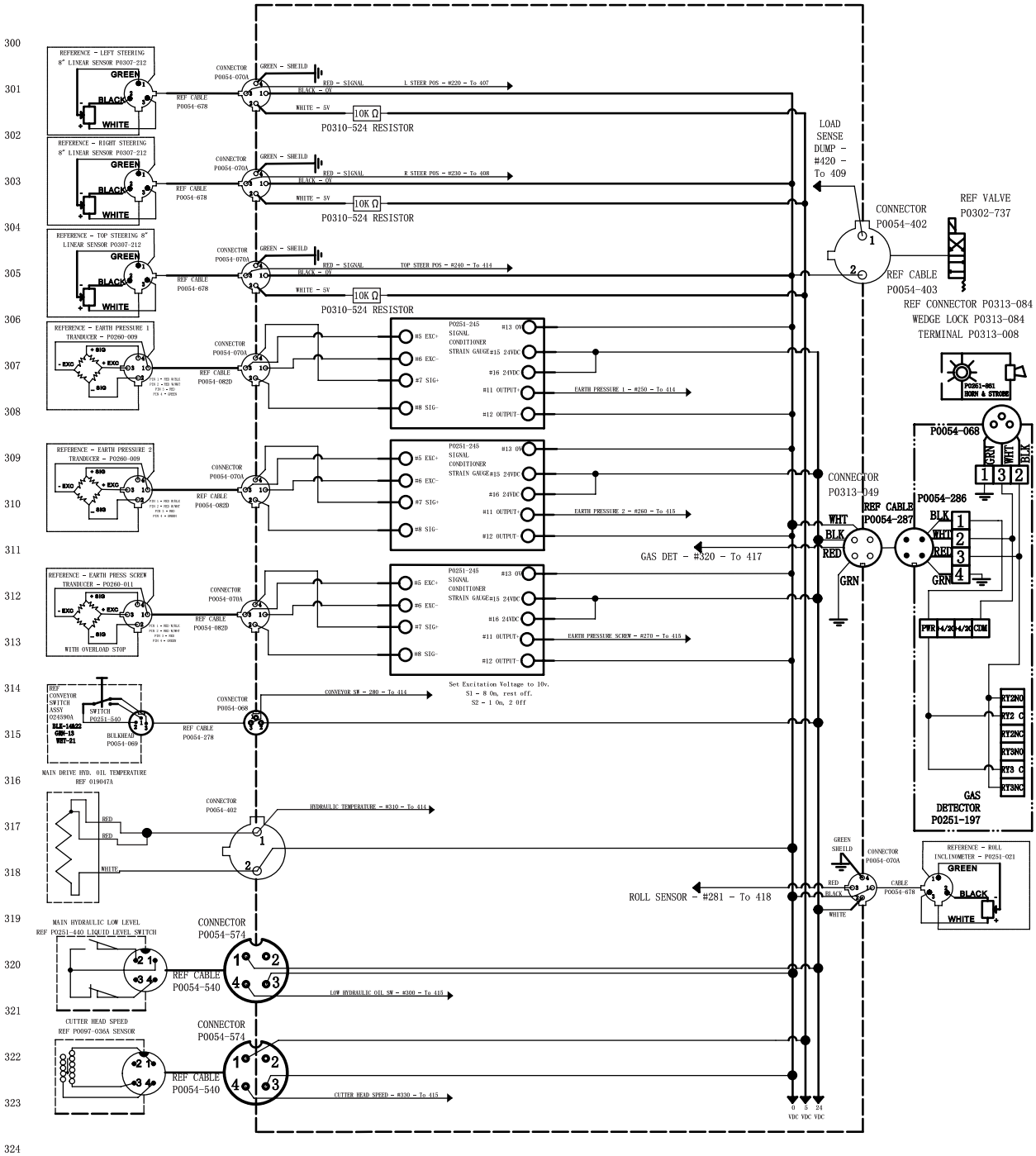
840 Electrical Box - Part 1 Of 6



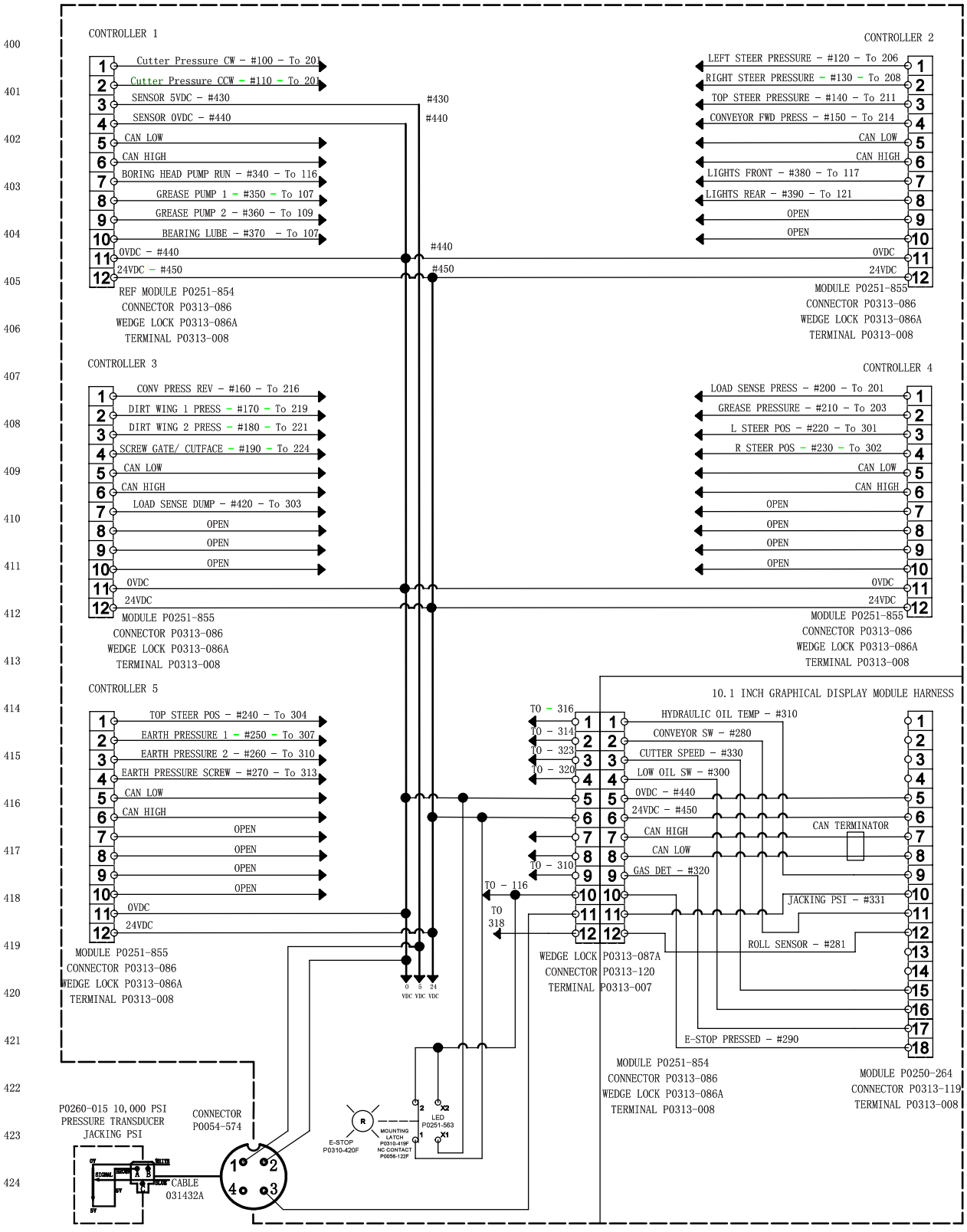
840 Electrical Box - Part 2 Of 6



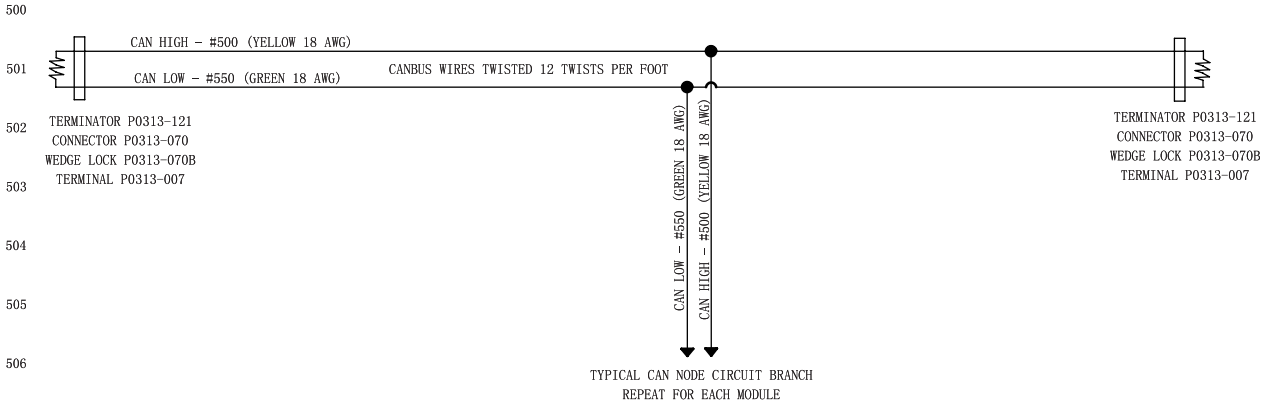
840 Electrical Box - Part 3 Of 6



840 Electrical Box - Part 4 Of 6



840 Electrical Box - Part 5 Of 6

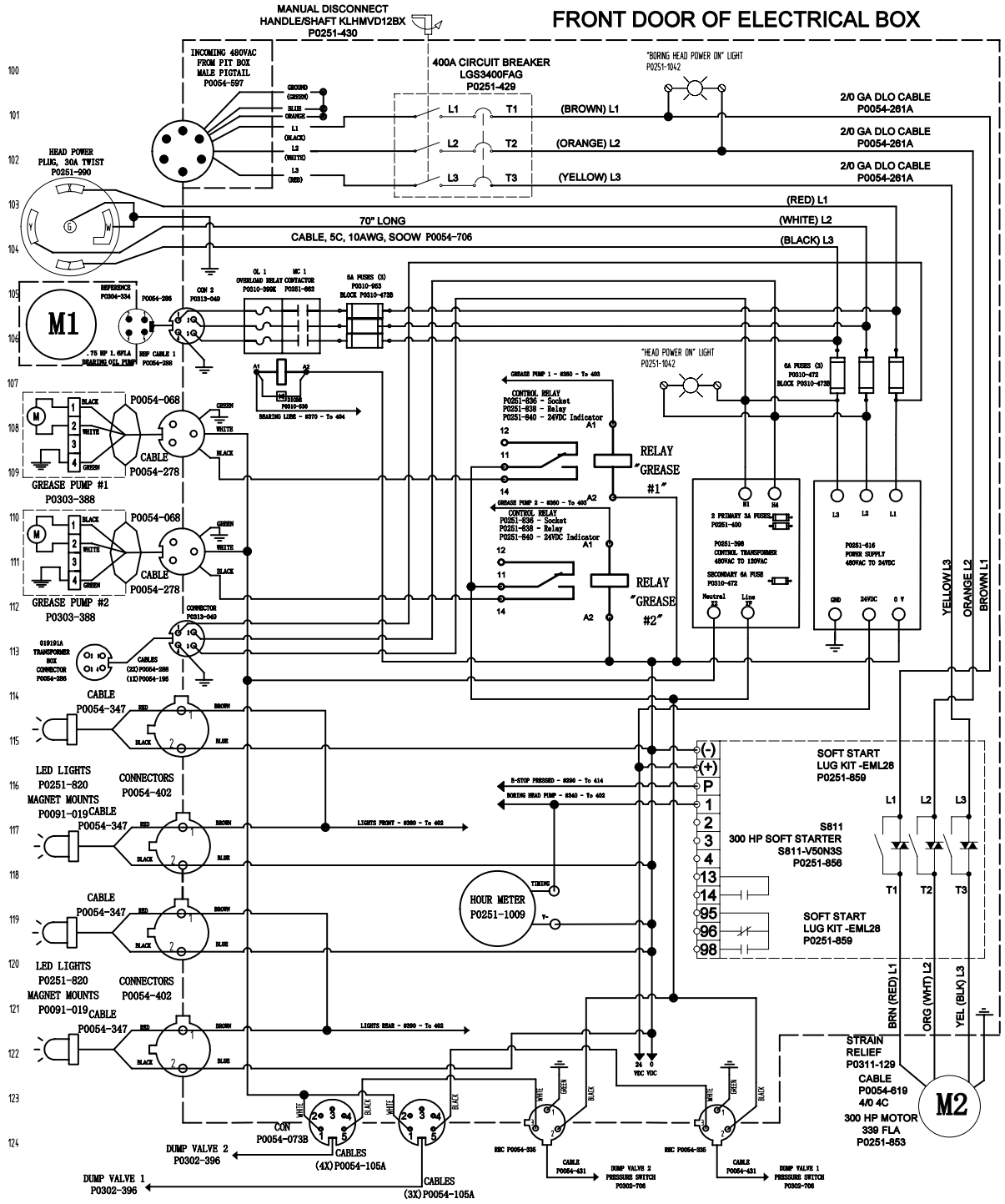


840 Electrical Box - Part 6 Of 6

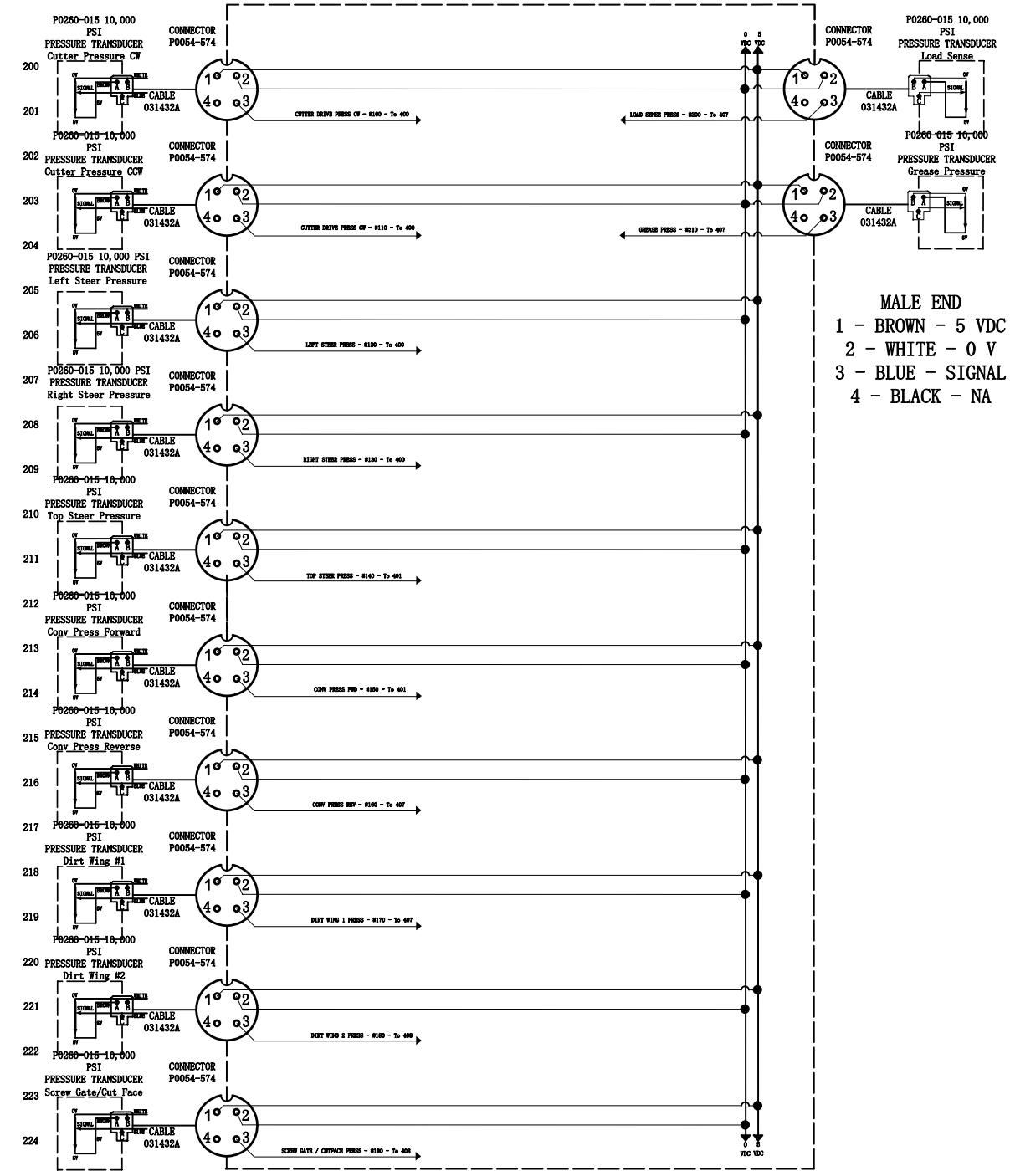
Description	Wire Number	Module Location
Cutter Head Pressure CW	100	M1 Pin #1
Cutter Head Pressure CCW	110	M1 Pin #2
Left Steering Pressure	120	M2 Pin #1
Right Steering Pressure	130	M2 Pin #2
Top Steering Pressure	140	M2 Pin #3
Screw Conveyor Pressure Forward	150	M2 Pin #4
Screw Conveyor Pressure Reverse	160	M3 Pin #1
Dirt Wing #1	170	M3 Pin #2
Dirt Wing #2	180	M3 Pin #3
Screw Gate or Cutter Face	190	M3 Pin #4
Load Sense Pressure	200	M4 Pin #1
Grease Pressure	210	M4 Pin #2
Left Steering Postition	220	M4 Pin #3
Right Steering Position	230	M4 Pin #4
Top Steering Position	240	M5 Pin #1
Earth Pressure 1	250	M5 Pin #2
Earth Pressure 2	260	M5 Pin #3
Earth Pressure Screw	270	M5 Pin #4
Roll Sensor	281	Display Pin #11
Conveyor Switch	280	Display Pin #12
E-Stop Switch	290	Display Pin #18
Low Hyd Switch	300	Display Pin #16
Hyd Oil Temp	310	Display Pin #9
Gas Detector	320	Display Pin #17
Speed Sensor	330	Display Pin #15
Jacking Pressure	331	Display Pin #10
BORING HEAD PUMP Run	340	M1 Pin#7
Grease Pump #1	350	M1 Pin#8
Grease Pump #2	360	M1 Pin#9
Bearing Lube	370	M1 Pin#10
2 Lights Front	380	M2 Pin#7
2 Lights Rear	390	M2 Pin#8
NOT USED - 2 Speed Valve 1	400	M2 Pin#9
NOT USED - 2 Speed Valve 2	410	M2 Pin#10
Load Sense Dump	420	M3 Pin#7
5 VDC	430	M1 Pin #3
0 VDC	440	M1 Pin #2
24 VDC	450	

ELECTRICAL SCHEMATIC - 840 ELECTRICAL BOX SN2

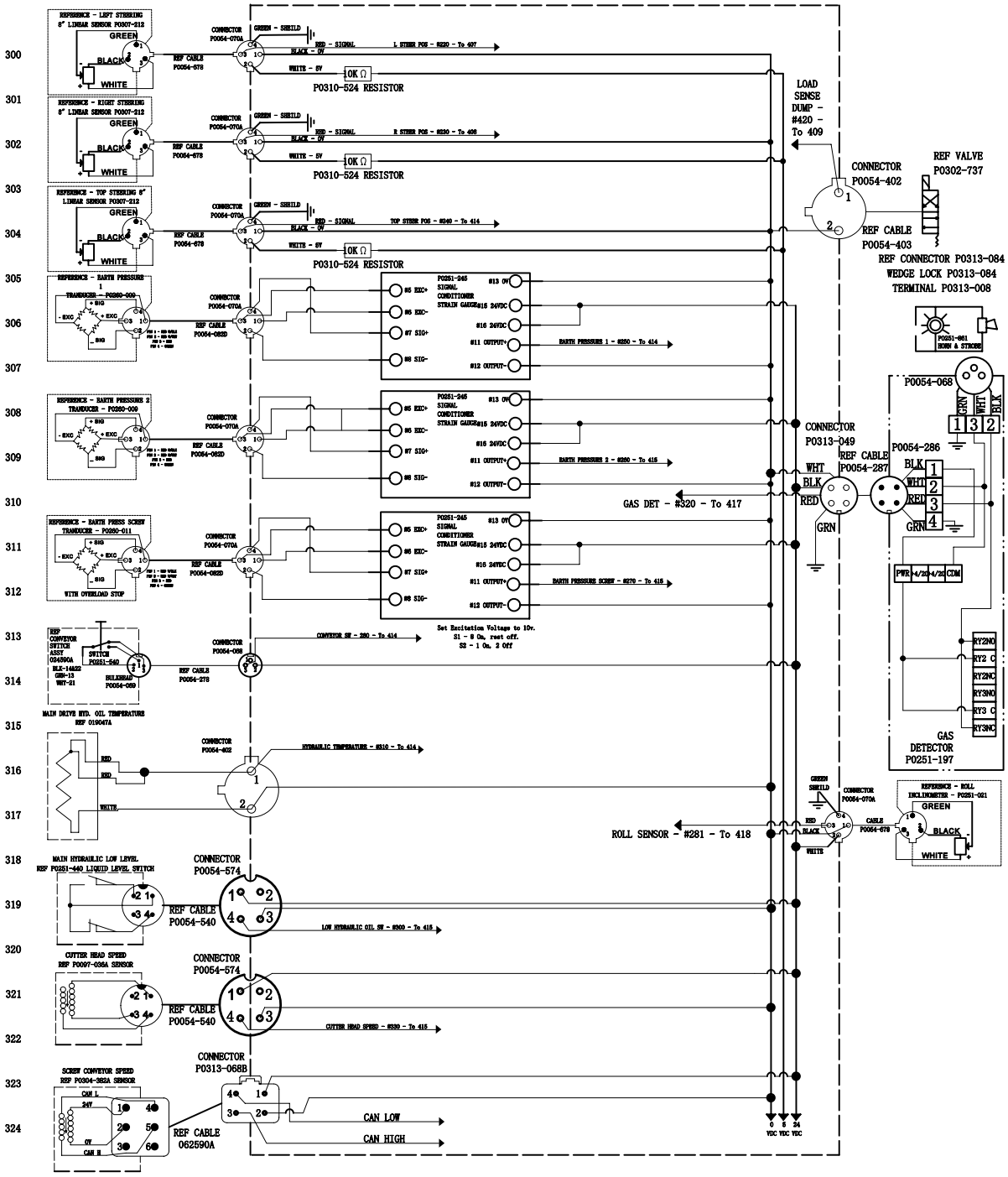
840 Electrical Box SN2 - Part 1 Of 7



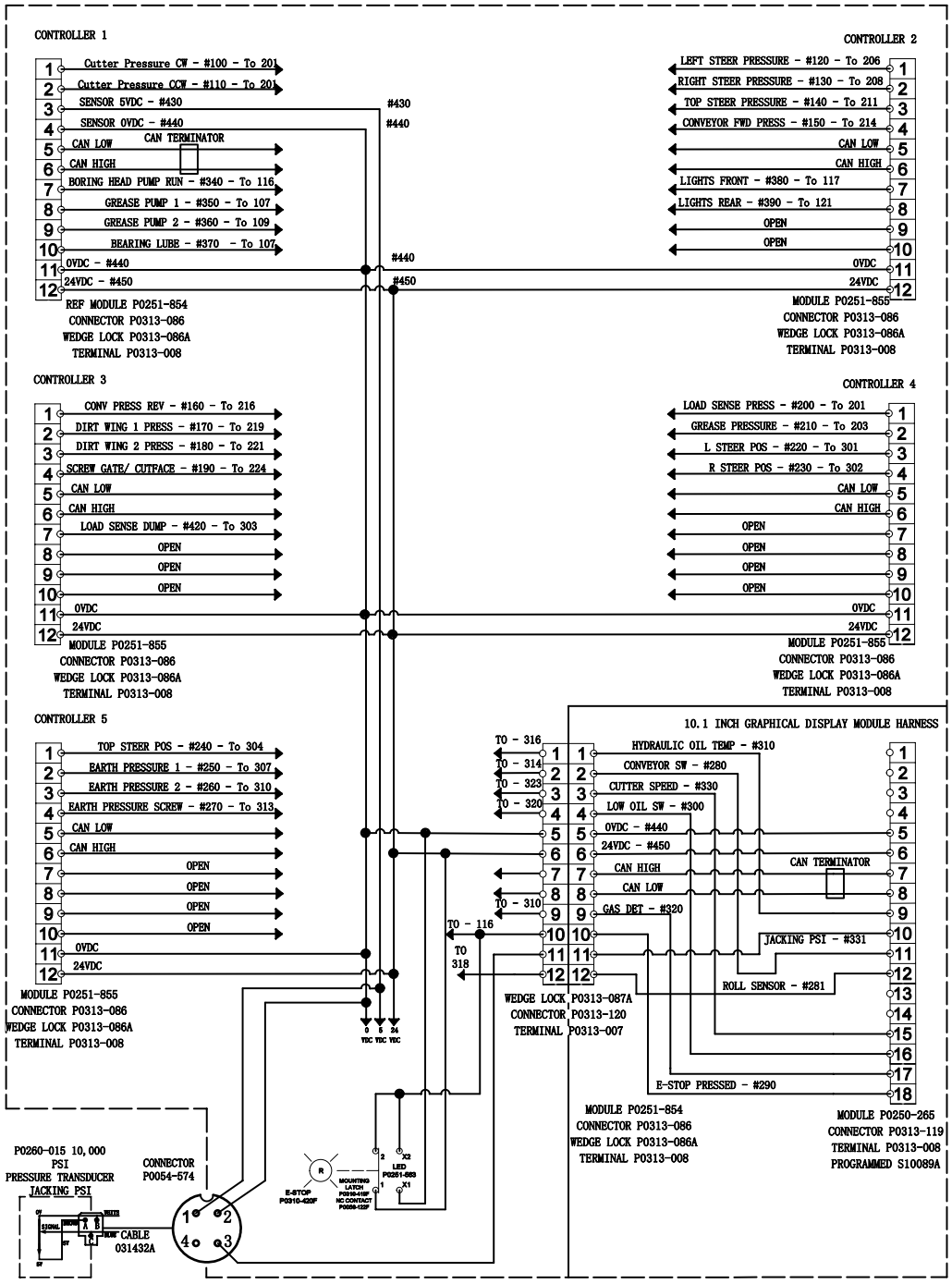
840 Electrical Box SN2 - Part 2 Of 7



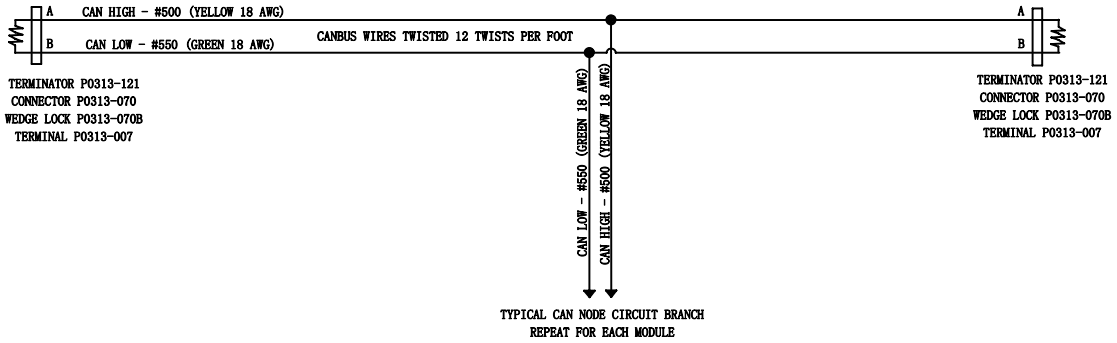
840 Electrical Box SN2 - Part 3 Of 7



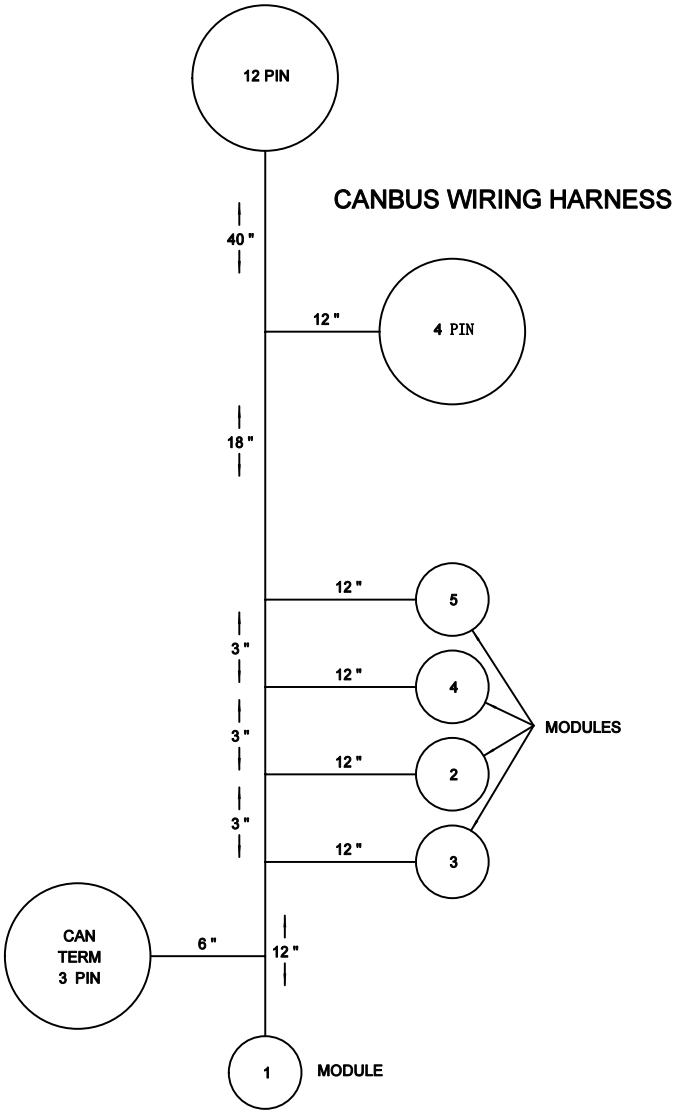
840 Electrical Box SN2 - Part 4 Of 7



840 Electrical Box SN2 - Part 5 Of 7



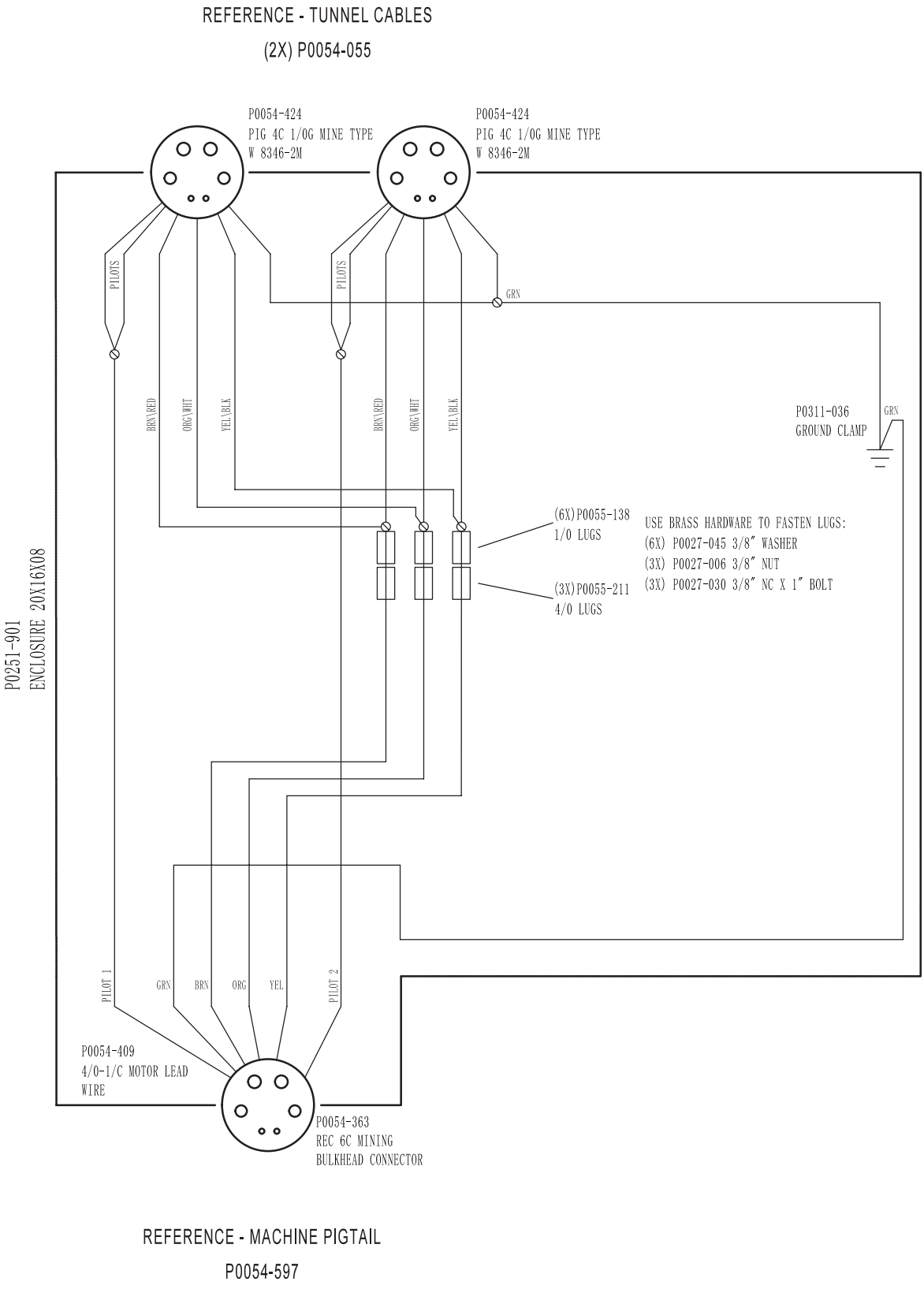
840 Electrical Box SN2 - Part 6 Of 7



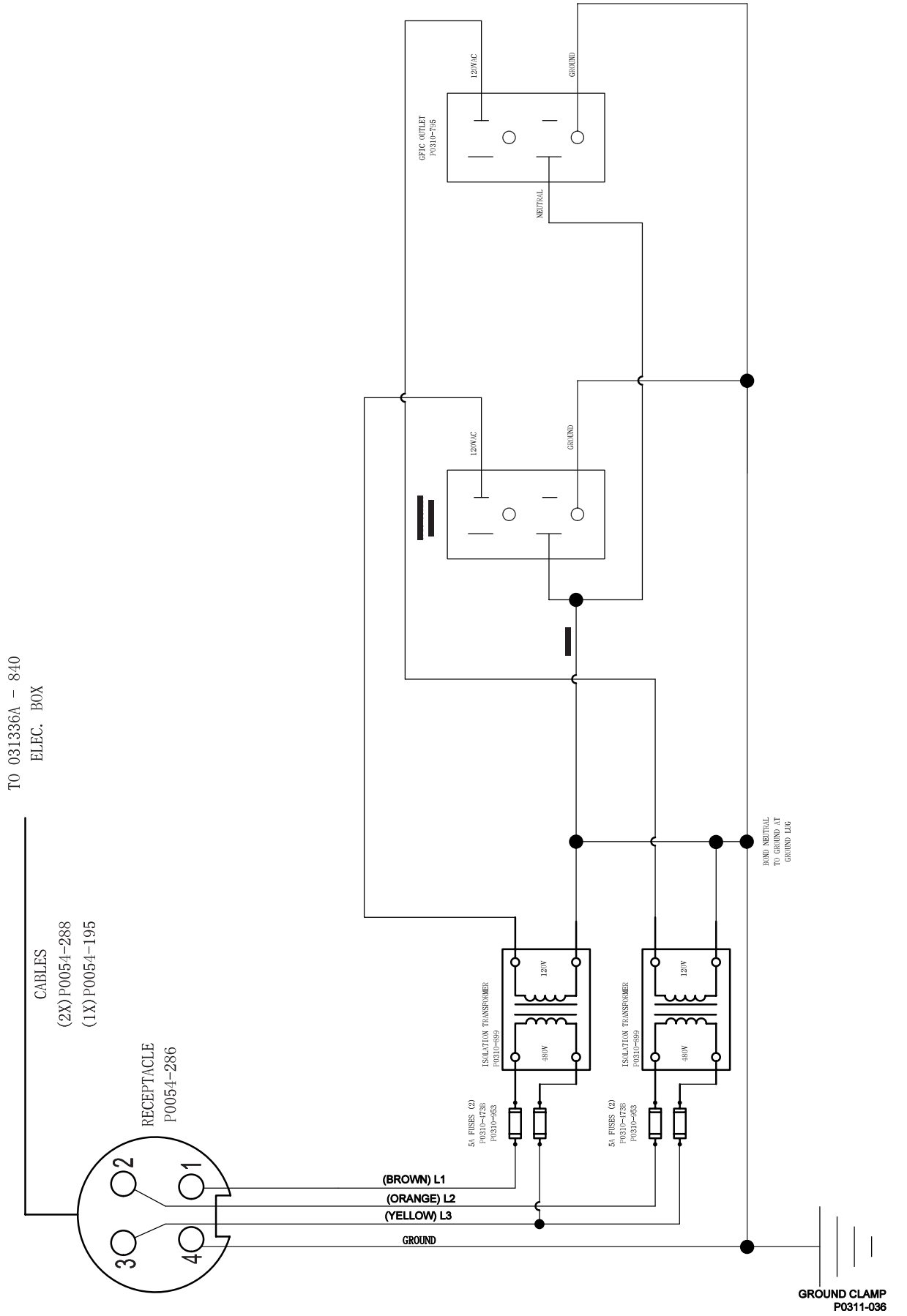
840 Electrical Box SN2 - Part 7 Of 7

Description	Wire Number	Module Location
Cutter Head Pressure CW	100	M1 Pin #1
Cutter Head Pressure CCW	110	M1 Pin #2
Left Steering Pressure	120	M2 Pin #1
Right Steering Pressure	130	M2 Pin #2
Top Steering Pressure	140	M2 Pin #3
Screw Conveyor Pressure Forward	150	M2 Pin #4
Screw Conveyor Pressure Reverse	160	M3 Pin #1
Dirt Wing #1	170	M3 Pin #2
Dirt Wing #2	180	M3 Pin #3
Screw Gate or Cutter Face	190	M3 Pin #4
Load Sense Pressure	200	M4 Pin #1
Grease Pressure	210	M4 Pin #2
Left Steering Postition	220	M4 Pin #3
Right Steering Position	230	M4 Pin #4
Top Steering Position	240	M5 Pin #1
Earth Pressure 1	250	M5 Pin #2
Earth Pressure 2	260	M5 Pin #3
Earth Pressure Screw	270	M5 Pin #4
Roll Sensor	281	Display Pin #11
Conveyor Switch	280	Display Pin #12
E-Stop Switch	290	Display Pin #18
Low Hyd Switch	300	Display Pin #16
Hyd Oil Temp	310	Display Pin #9
Gas Detector	320	Display Pin #17
Screw Speed Sensor	325	
Speed Sensor	330	Display Pin #15
Jacking Pressure	331	Display Pin #10
BORING HEAD PUMP Run	340	M1 Pin#7
Grease Pump #1	350	M1 Pin#8
Grease Pump #2	360	M1 Pin#9
Bearing Lube	370	M1 Pin#10
2 Lights Front	380	M2 Pin#7
2 Lights Rear	390	M2 Pin#8
NOT USED - 2 Speed Valve 1	400	M2 Pin#9
NOT USED - 2 Speed Valve 2	410	M2 Pin#10
Load Sense Dump	420	M3 Pin#7
5 VDC	430	M1 Pin #3
0 VDC	440	M1 Pin #2
24 VDC	450	

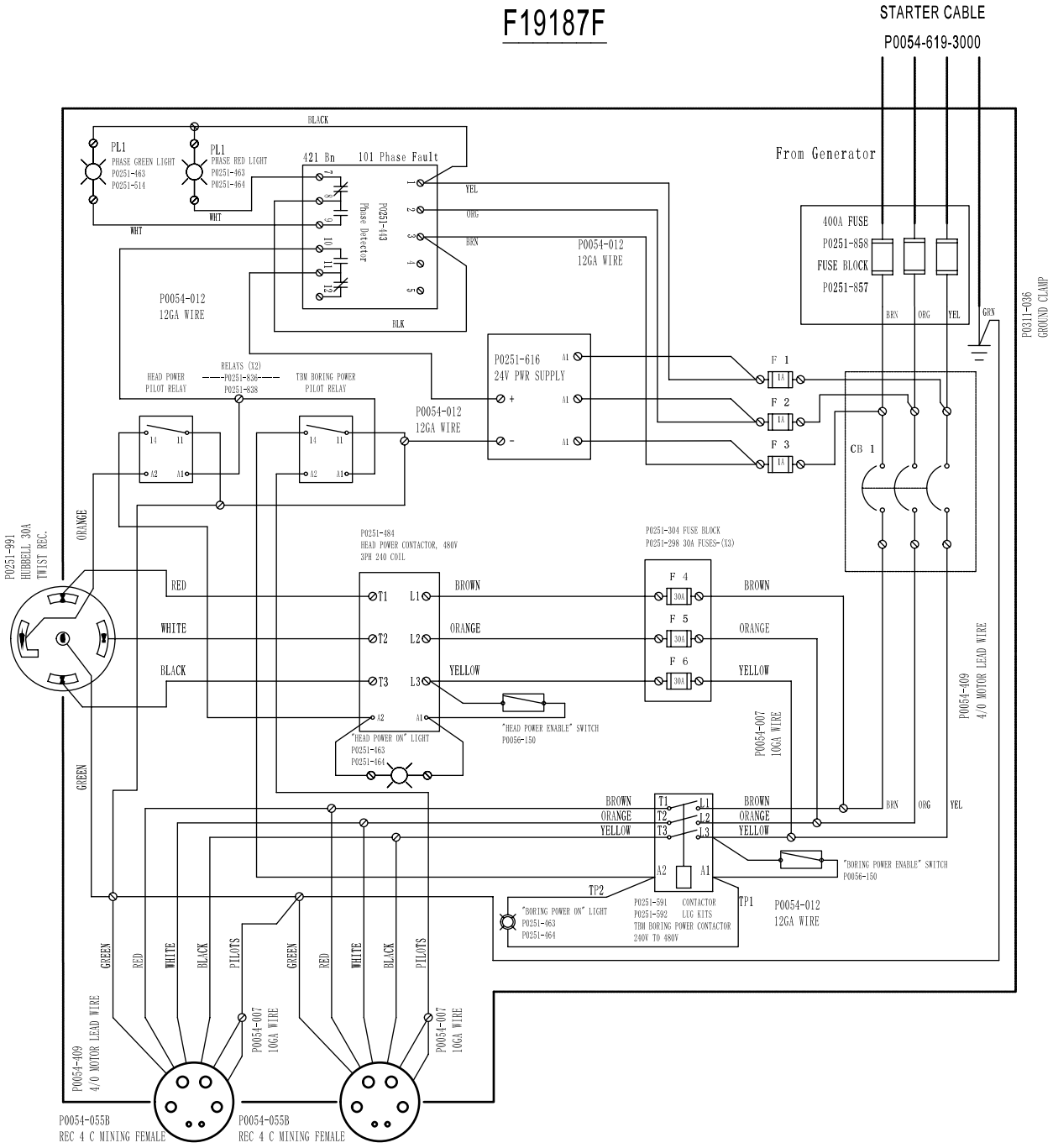
ELECTRICAL SCHEMATIC - MACHINE POWER BOX



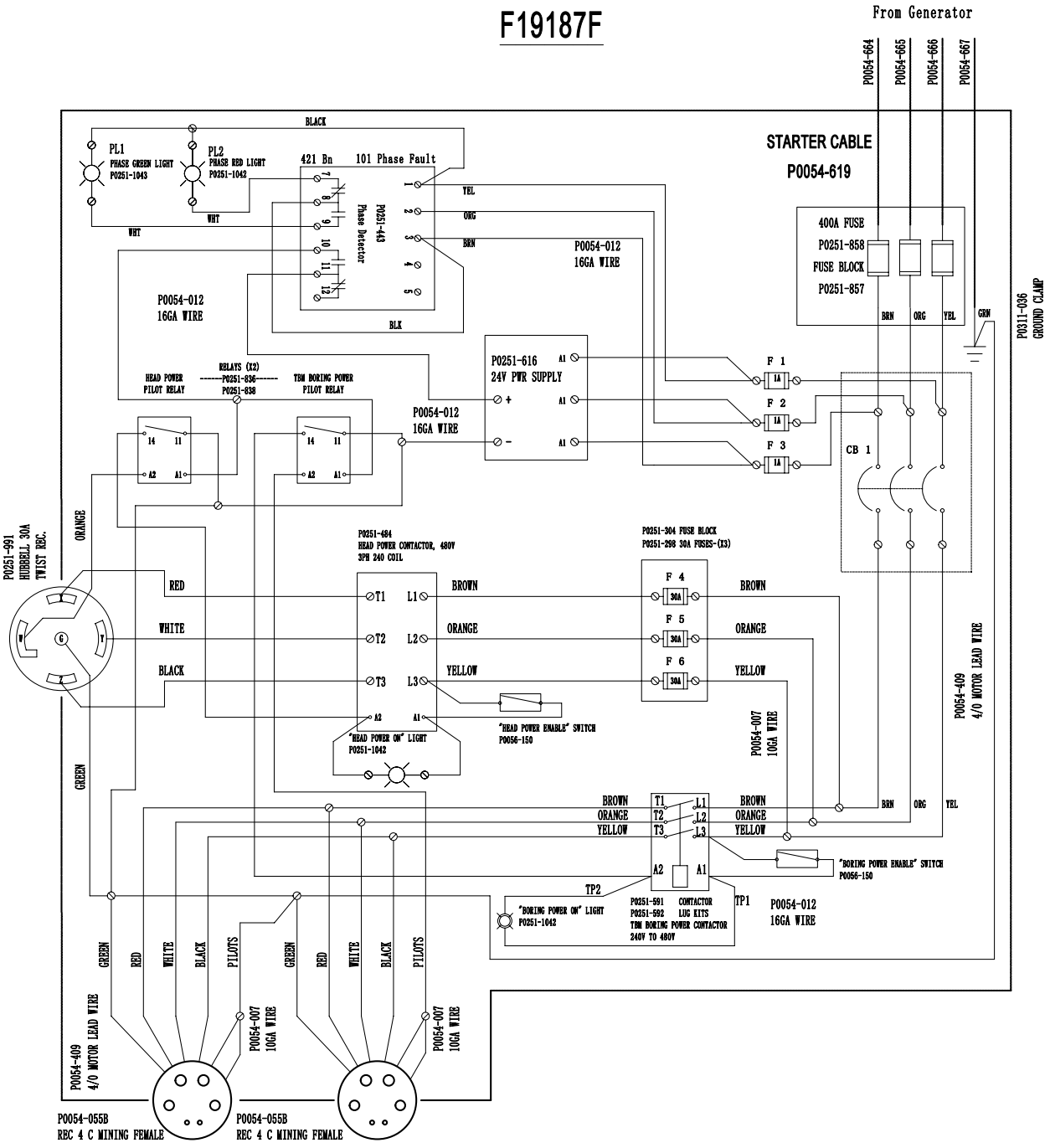
ELECTRICAL SCHEMATIC - MACHINE TRANSFORMER BOX



ELECTRICAL SCHEMATIC - 840 SN1 PIT BOX



ELECTRICAL SCHEMATIC - 840 SN2 PIT BOX

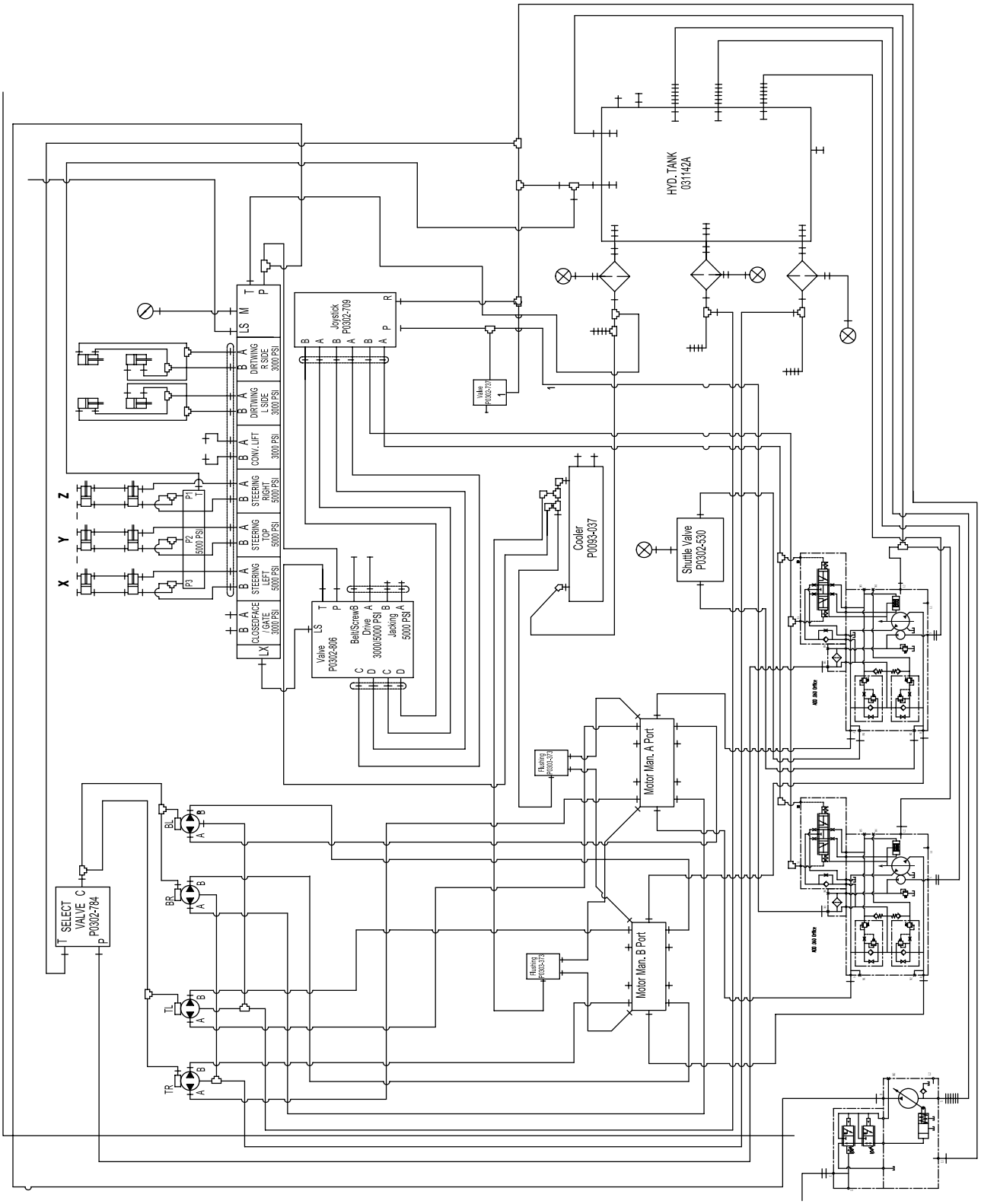


REFERENCE - TUNNEL CABLES

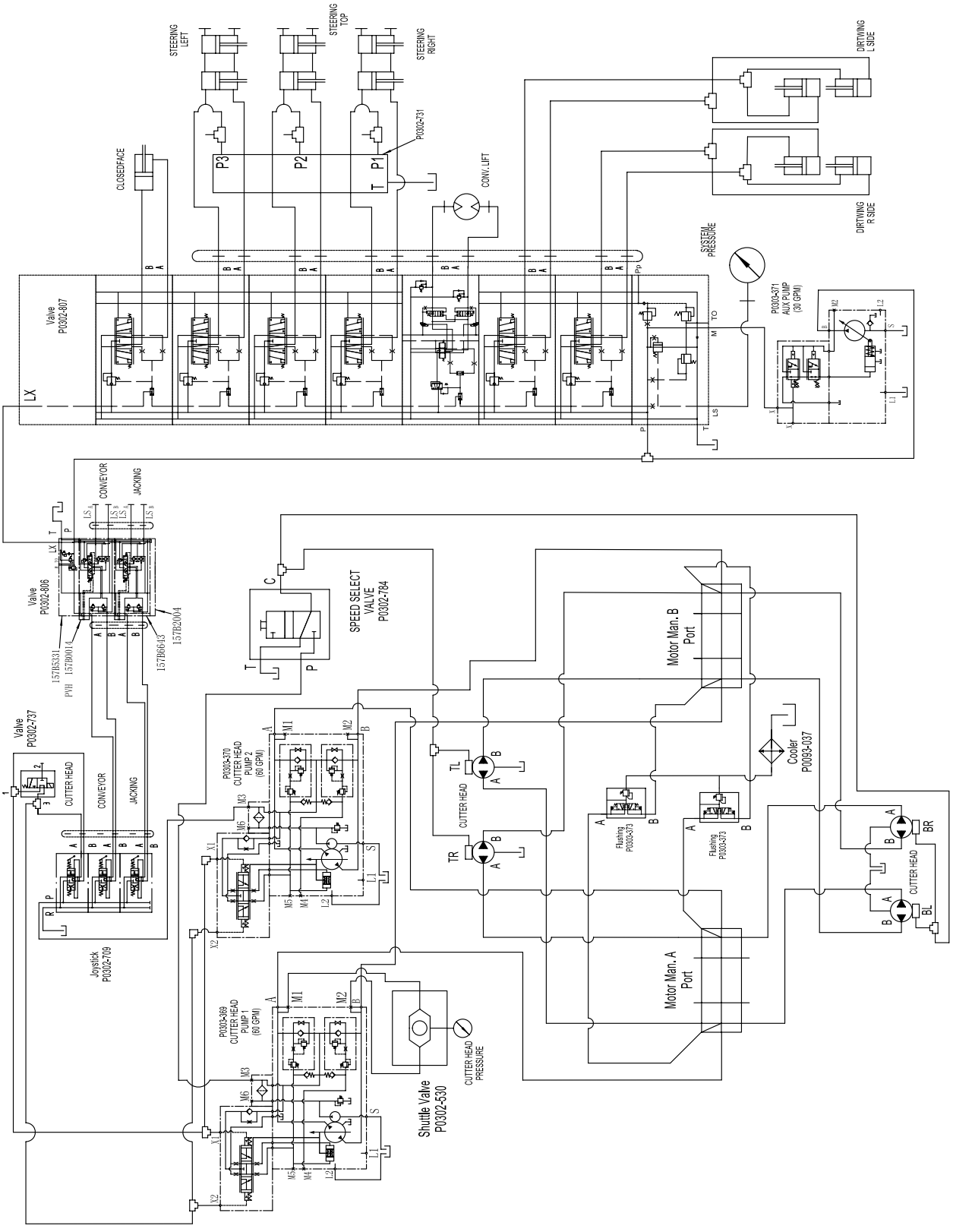
(2X) P0054-055

HYDRAULIC SCHEMATIC - 840 SN1

840 Hydraulic Schematic - Part 1 Of 2

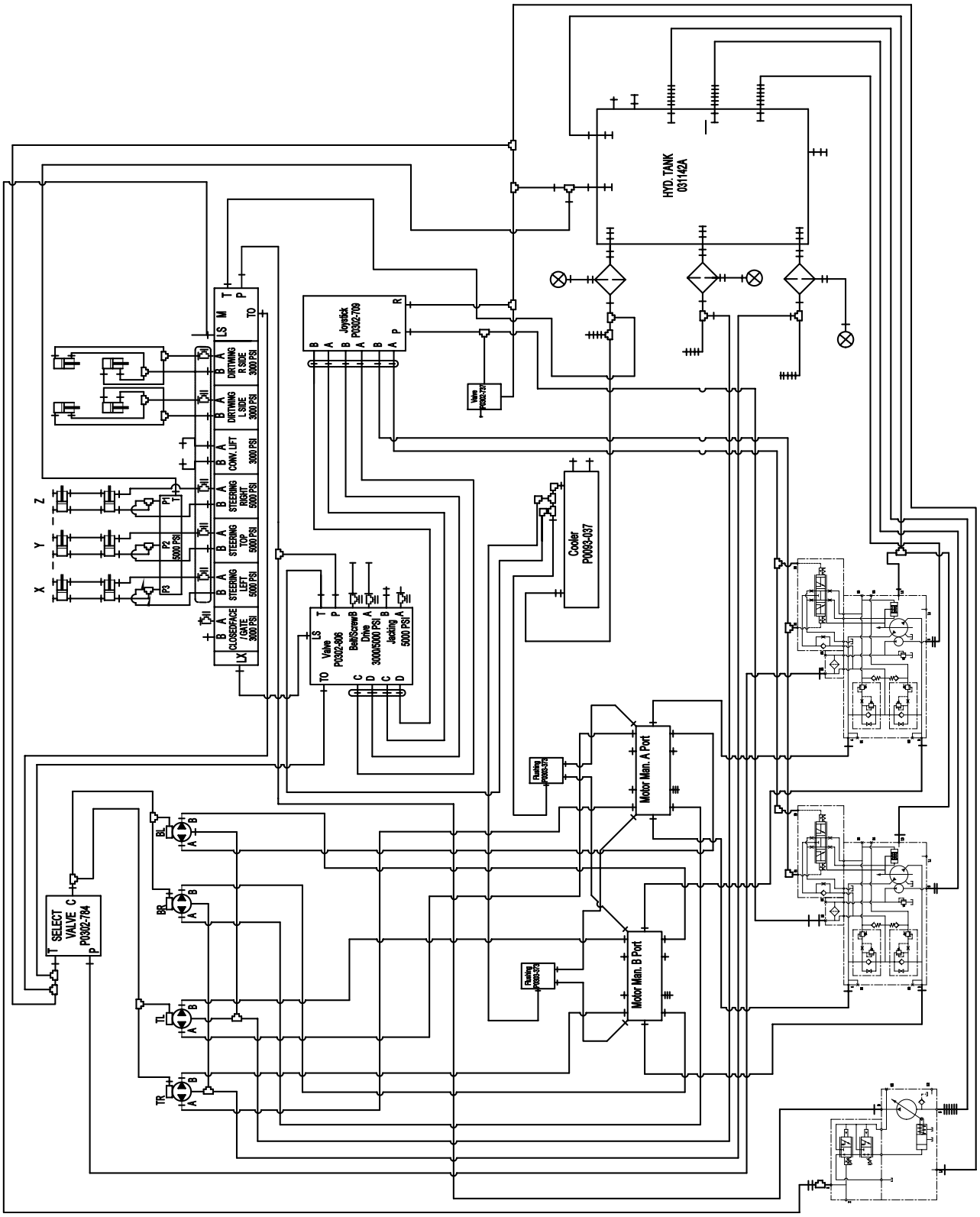


840 SN1 Hydraulic Schematic - Part 2 Of 2

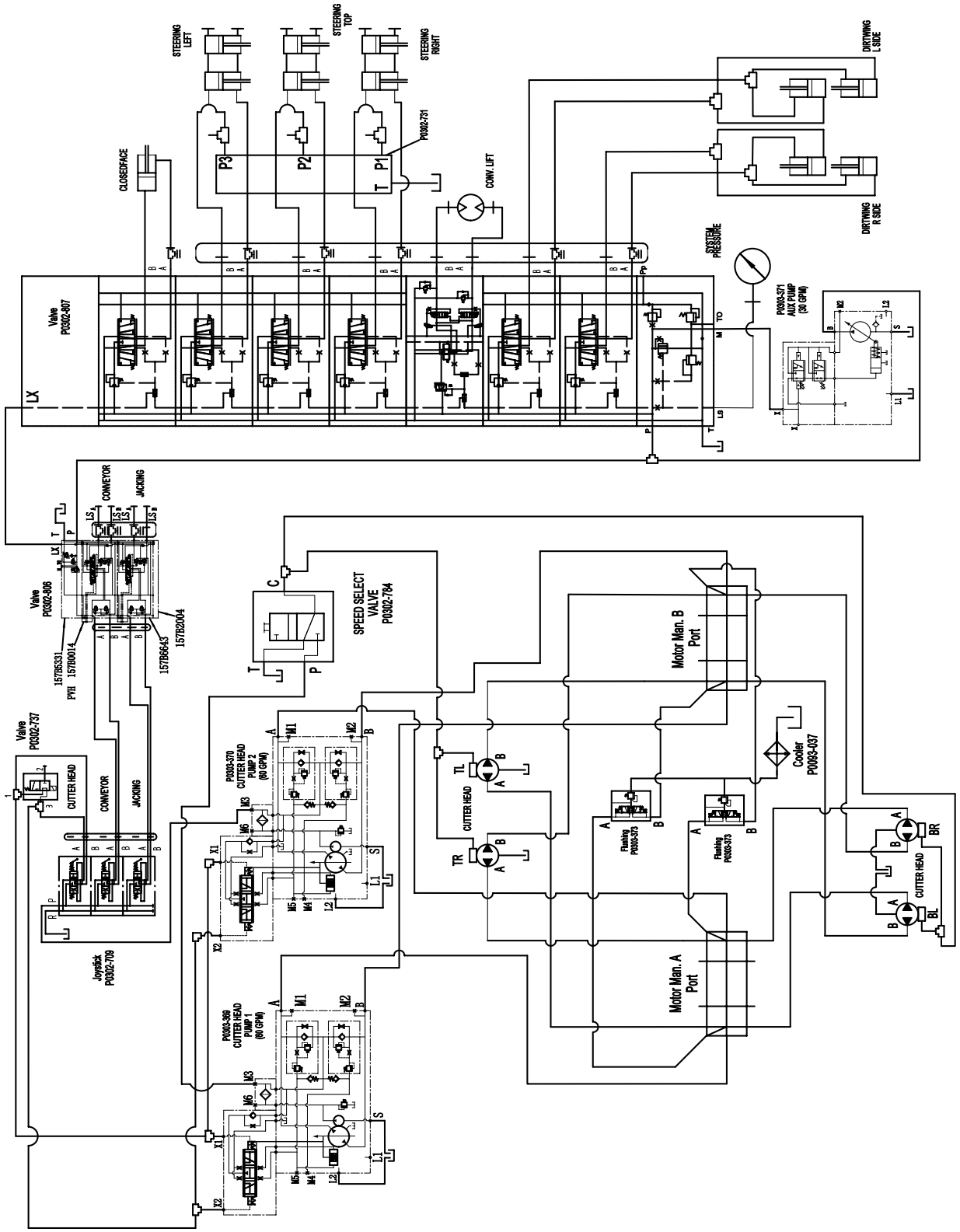


HYDRAULIC SCHEMATIC - 840 SN2

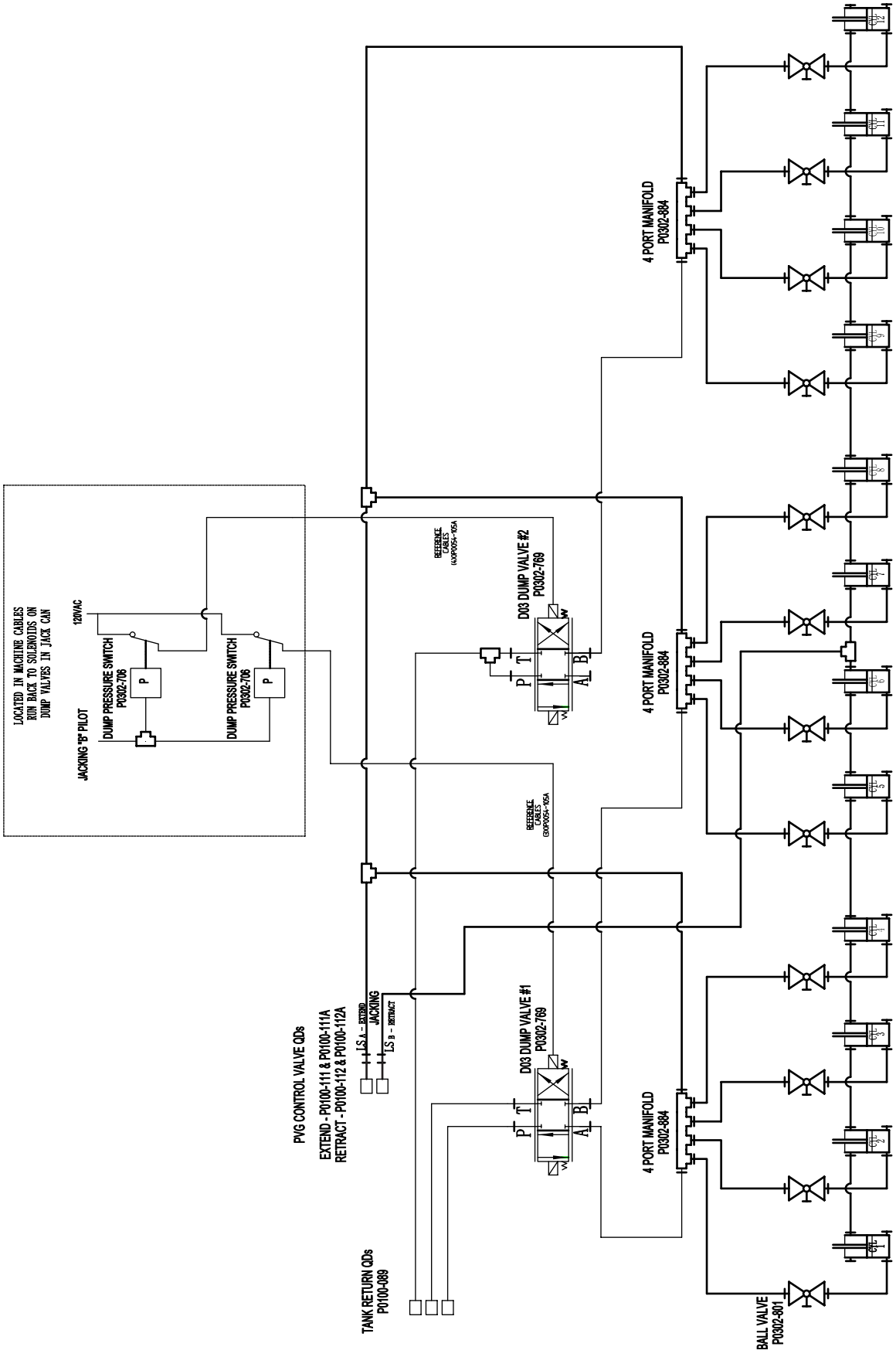
840 SN2 Hydraulic Schematic - Part 1 Of 2



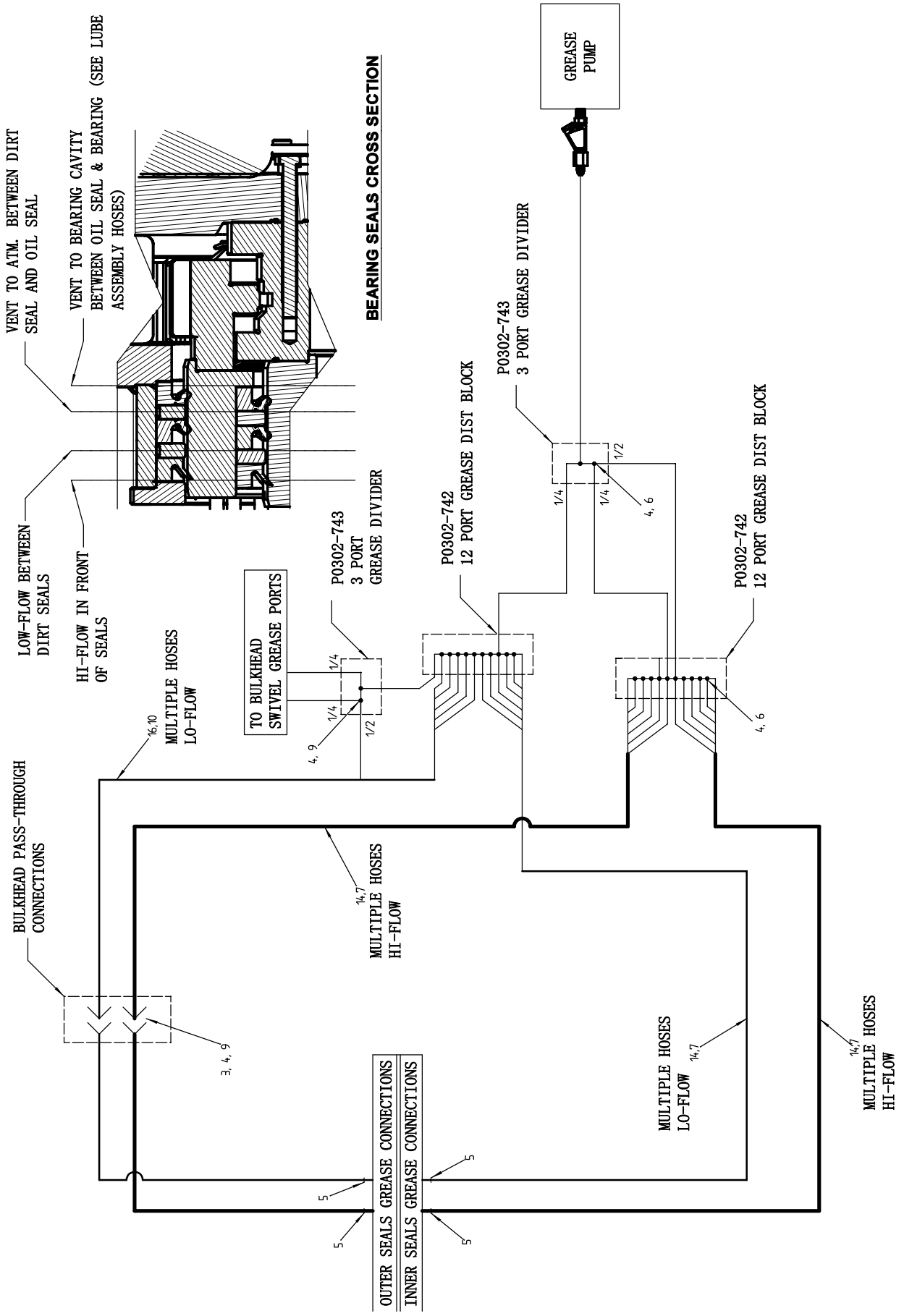
840 SN2 Hydraulic Schematic - Part 2 Of 2



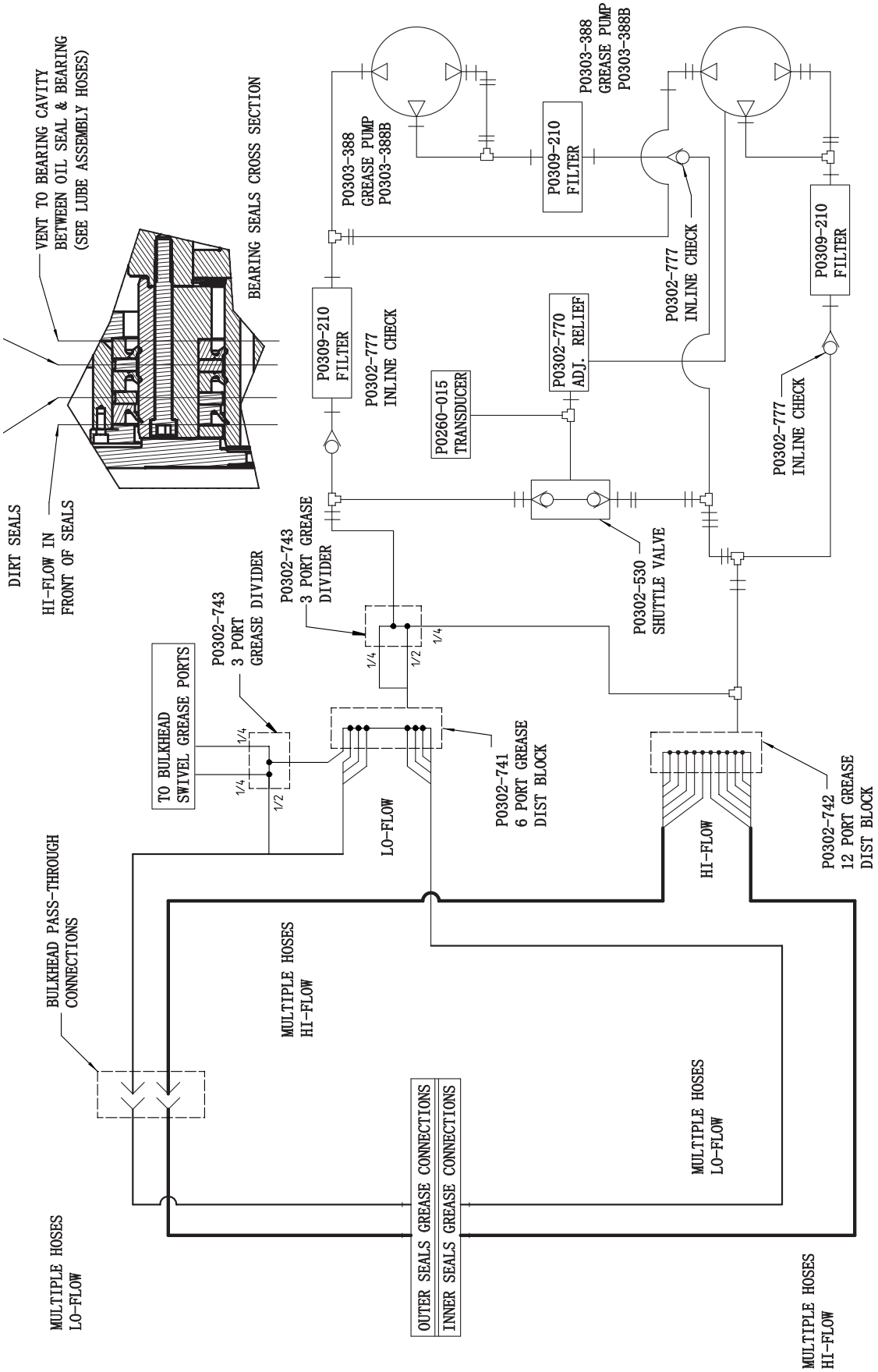
HYDRAULIC SCHEMATIC - JACKING CAN



GREASE SCHEMATIC - 840 SN1



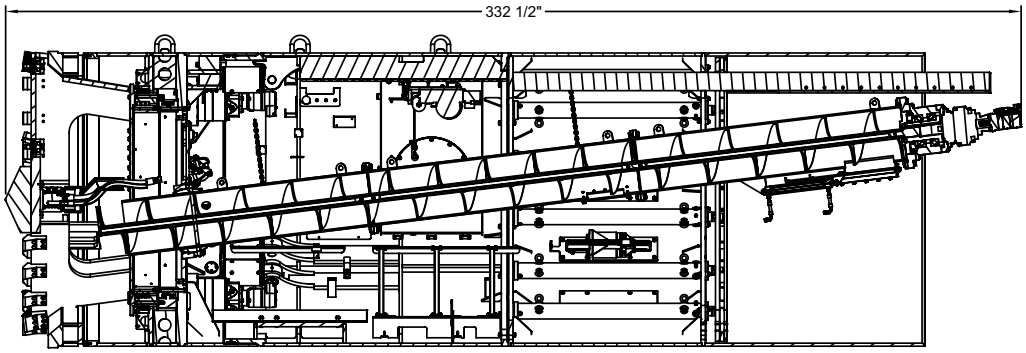
GREASE SCHEMATIC - 840 SN2

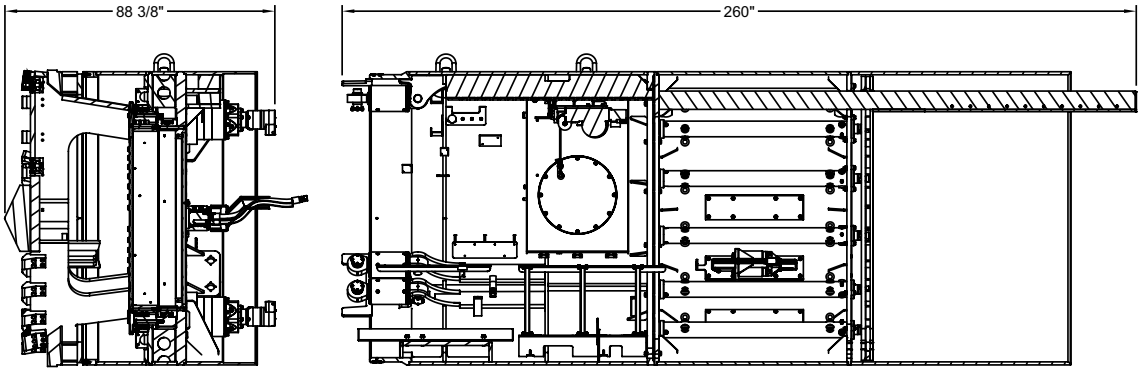


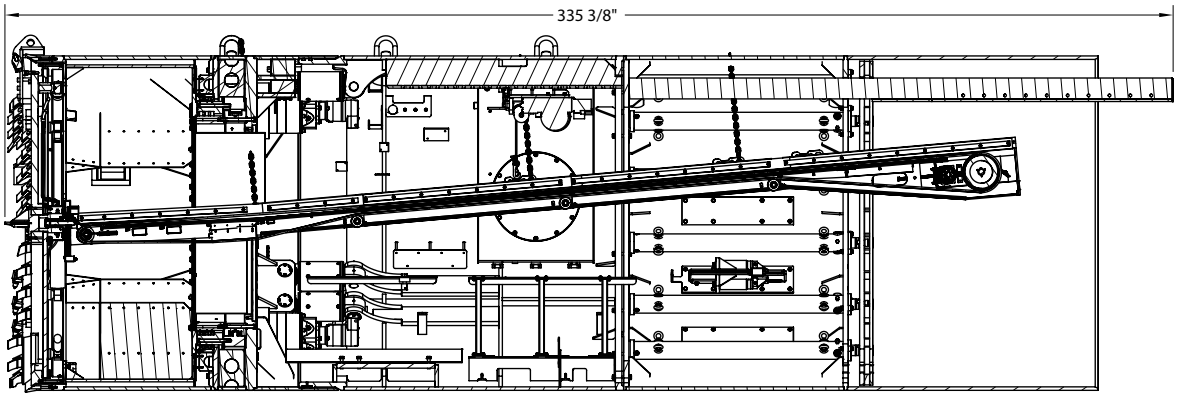
NOTES

Specifications

840 TBM SERIES II WITH ON-BOARD POWER PACK







Structure

Outside Diameter ..... 96 in. (2.4 m)
Cutting Diameter (Overcut Ring) ..... 98 in. (2.5 m)
Overall Length TBM ..... 332.5 in. (8.45 mm)
  Front Length ..... 88.375 in. (2.2 m)
  Rear Length ..... 260 in. (6.6 m)
Overall Length Jacking Can ..... 136.25 in. (3.5 m)
Weight
  TBM with Screw Conveyor (approximately) ..... 58,000 lbs. (26,308 kg)
  Jacking Can (approximately) ..... 23,000 lbs. (10,433 kg)

Propulsion (Thrust) ..... 377 Tons

(continued on next page)

Cutterhead

Rotational Speed
- Soft Ground ..... Unidirectional
- Hard Ground ..... Unidirectional
- Closed Face ..... Unidirectional
- Mixed Ground Disc Cutterhead ..... Bi-directional
- Rock Disc Cutterhead ..... Bi-directional
- EPB Soft Ground ..... Bi-directional

Drive Motors ..... Four, Two Speed (29.3 CID/19.5 CID), Periphery - Drive Electric/Hydraulic

Speed
- Low Speed High Torque (LSHT) ..... 3.3 RPM @ 120 GPM
- High Speed Low Torque (HSLT) ..... 5.0 RPM @ 120 GPM

Torque - Continuous
- LSHT/HSLT ..... 270,000/180,000 ft-lb

Torque - Peak
- LSHT/HSLT ..... 450,000/300,000 ft-lb

Bearing Type ..... Three-row roller slewing bearing with integral drive gear

Sealing System ..... TBM lip seals with automated, pressurized grease flushing
- Seal Grease Container (2) ..... 6 gal (22.7 L)
- Grease Consumption ..... 0.065 gal/hr (0.25 L/hr)
- Filtration ..... 10 Micron

Steering System

Articulation ..... 3 Point, 3 Degrees

Number of Cylinders ..... Six

Cylinder Stroke .....6 in. (152 mm)

Rated Pressure..... 5,000 psi

Tons Total 575

Hydraulics

Hydraulic Reservoir ..... 120 gal. (454 L)

Hydraulic Cooling ..... Heat Exchanger (Oil/Water)

TBM Control Valve - 7 Section
- Closed Face/Auxiliary ..... 6.6 GPM @ 3,000 psi
- Steering (Left, Top, Right) ..... 6.6 GPM @ 5,000 psi
- Conveyor Lift ..... 6.6 GPM @ 3,500 psi
- Dirt Wings (2) ..... 6.6 GPM @ 3,000 psi

Cutterhead Valve ..... Two Pumps, 55.4 GPM @ 5,000 psi

Jacking ..... 10.2 GPM @ 5,000 psi

Belt Conveyor ..... 26.4 GPM @ 3,000 psi

Screw Conveyor ..... 26.4 GPM @ 5,000 psi

Jacking Can Cylinder ..... Twelve, 54 in. (1,372 mm) Stroke, 37 tons @ 5,000 psi

Pumps
- Hydrostatic pump (two) ..... 130 cc (7.9 CID), 120 GPM
- Load Sense pump .....65 cc (4 CID), 65 GPM

CID - Cubic Inch Displacement

(continued on next page)

Electrical

Power ..... 480VAC 3 Phase

Recommended Power Requirements

Recommended Operating Requirements ..... 300kW / 330kVA @ 480VAC

Generator Minimum Motor Starting kVA (skVA)

..... 830skVA with less than 35% instantaneous voltage dip and greater that 90% sustained voltage

Head Power ..... 30 amp @ 480VAC

Single 4 conductor1/0 gauge cables with pilot circuit through the tunnel. Supplies power to machine . controls, lights and on-board 120 VAC outlets (four 120 VAC GFI 20 amp outlets)

Boring Power ..... 400 amp @ 480VAC

Parallel 4 conductor 1/0 gauge cables with pilot circuit through the tunnel. Supplies power to 300 HP boring head and auxiliary hydraulic pump drive motor. Motor starting controlled by soft starter.

Pit Power Box ..... Single 4/0 four conductor in generator. Cable length 250 ft. Equipped with E-Stop. Three phase power and rotation indicator. Boring head and head power control selector switch.

Earth Pressure Sensors

Rated ..... 14.5 psi (1 bar)

Quantity of Sensors ..... Three

Locations: ..... Two in plenum chamber bulkhead, one in screw conveyor

Safety Circuit

E-Stop Button Control (On Pit Box) ..... System Shut Down

Conveyor Safety Valve Switch ..... Rotation Shut Down

Gas Detector ..... Methane Gas

Bearing Lube ..... 0.048 in^3/rev

Speed ..... 1,775 rpm

Conveyors

Open Mode ..... Belt Conveyor, 24 in. Wide, 0-650 ft/min

Closed Mode ..... Screw Conveyor, 16 in. Diameter, 16 in. Pitch, 0-34 RPM

..... Includes one conditioning port and one EPB port

Foam Generation System

Dimensions ..... 35 x 13 x 30 in. (880 x 340 x 753 mm) (l x w x h)

Power Voltage 480VAC

Water Supply Flow Rate ..... up to 211 gpm (800 l/min)

Water Supply Pressure ..... 29 - 145 psi (2-10 bar)

Compressed Air Supply Pressure ..... 87- 145 psi (6-10 bar)

Compressed Air Supply Flow Rate ..... 100 - 2000 NL/min

Foam Generator Weight (Empty) ..... 176 lb (80 kg)

Protection Index ..... IP 65

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

NOTES

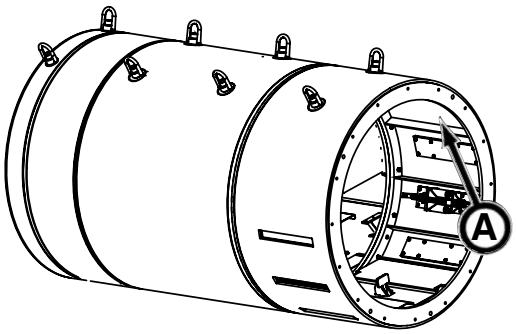
Identification Numbers

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

TUNNEL BORING MACHINE (A)

Model Number _____

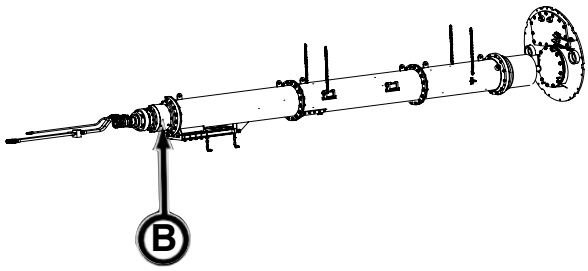
Serial Number _____



SCREW CONVEYOR (B)

Model Number _____

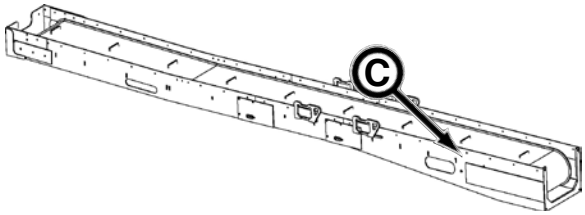
Serial Number _____



BELT CONVEYOR (C)

Model Number _____

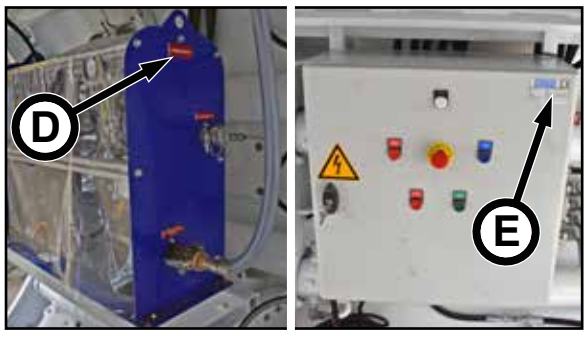
Serial Number _____



FOAM GENERATOR SYSTEM (D, E)

Model Number _____

Serial Number _____



NOTES

Safety Data Sheets

The Federal Occupational, Safety, and Health Administration (OSHA) Standard 29 CFR 1910.1200, require that specific safety data sheets (SDS) be available to employees before operating this equipment. This may include information on substances contained in this equipment such as hydraulic fluid and gear lubricant.

Akkerman Inc. will provide, at no cost, SDS which apply to its product line. Simply contact your Akkerman Product Support representative for a copy.

To ensure a prompt response to your SDS request, include your return address (including zip or postal code) and the equipment's model numbers and serial numbers with your request.

NOTES

Warranty

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

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

NOTES

Index

B (continued)

C

C (continued)

C (continued)

D

D (continued)

E

E (continued)

F

F (continued)

G

G (continued)

G (continued)

H

H (continued)

I

J

K

L

L (continued)

M

M (continued)

M (continued)

N

O

P

P (continued)

P (continued)

R

S

S (continued)

S (continued)

S (continued)

T

T (continued)

U

V

V (continued)

W

Y

Z