OPERATOR'S MANUAL

Excavator Boring Shield

960 EBS With On-Board Power Pack SN: F08643F00

EX50 Excavator SN: F11030F00

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SERVICE • RELIABILITY • INNOVATION

Introduction

This operator's manual contains important safety, operation, and maintenance information for your Akkerman Excavator Boring Shield (EBS). You must read and understand this manual, your haul unit operator's manual, gas detection system and jacking frame operation manual before you operate and maintain this equipment. Keep this manual with your EBS at all times. Additional copies of this manual may be purchased from the Akkerman Aftermarket Support Department.

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 Excavator Boring Shield. 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.

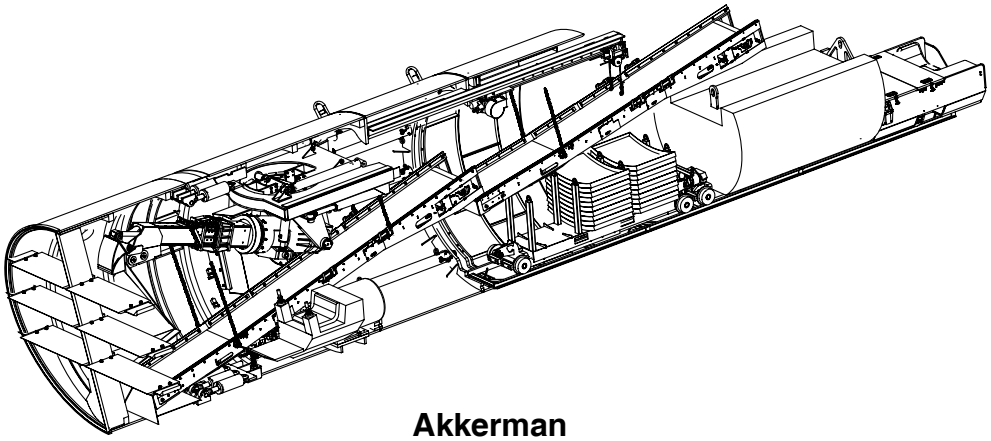
⚠DANGER Indicates an extremely hazardous situation which, if not avoided, WILL result in death or serious injury.

⚠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.



Akkerman
Excavator Boring Shield With Jacking/Liner Can & 1548 Haul Unit

Pipejacking and tunneling is a type of "trenchless technology" that utilize an excavator boring shield (EBS). The EBS is advanced through the ground by hydraulic jacking/liner can cylinders within the EBS liner can. Before launching the EBS, a thrust block or support structure is constructed in the launch shaft. A support ring is placed against the block/support to provide a thrust support against the complete diameter of the liner plate ring. This support ring also provides a dirt bucket loading/unloading area. Liner plates are assembled in the EBS liner can. The EBS is advanced by extending twelve liner can cylinders against the liner plates. Once the cylinders are fully extended, they are retracted and another ring of liner plates are installed. As the EBS is advanced, the EX-50 excavator removes soil and obstacles at the face of the bore between the boring shield shelves into the incline floor area where the conveyor carries the material to the dirt bucket. Once the dirt bucket is full, the dirt bucket is removed from the tunnel via a haul unit to the unloading area in the launch shaft where the dirt bucket is hoisted out of the shaft and unloaded. The EBS can be equipped with closeable hydraulic doors to prevent subsidence from entering the interior of the EBS.

The EBS and pipe can also be advanced through the ground by hydraulic jacking cylinders on a jacking frame or pump unit from the launch shaft as used in typical pipe jacking operations.

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

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

NOTES

Contents

(continued on next page)

Safety

BE ALERT FOR SAFETY INFORMATION

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

Read all safety information.

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

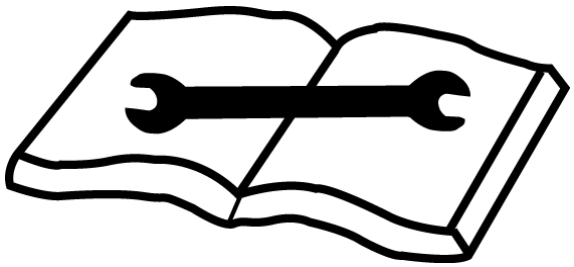
ATTENTION!
BECOME ALERT!
YOUR SAFETY IS INVOLVED!

READ OPERATOR'S MANUAL

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

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

Any unauthorized modifications will void the warranty.



WEAR PROTECTIVE CLOTHING

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

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

LOCKOUT/TAGOUT POWER BEFORE SERVICING

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

This boring shield 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.

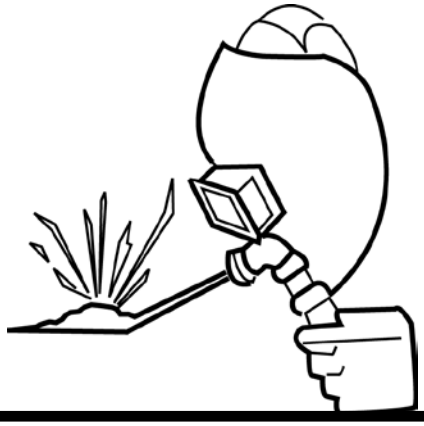
If a hydraulic hose from the boom of a crane or excavator breaks, the boom can fall instantly.

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.

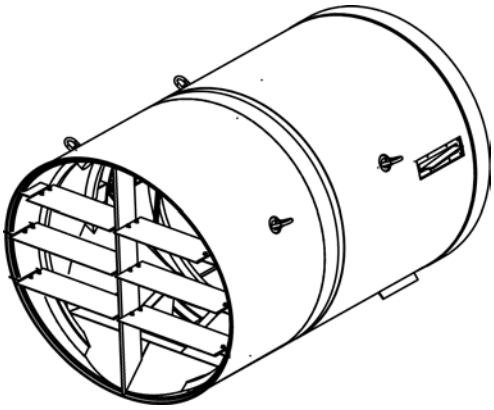
UNAUTHORIZED WELDING



⚠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.

PRACTICE SAFE MAINTENANCE

⚠WARNING Unexpected equipment movement may cause serious personal injury.

LOCKOUT power before performing any maintenance.

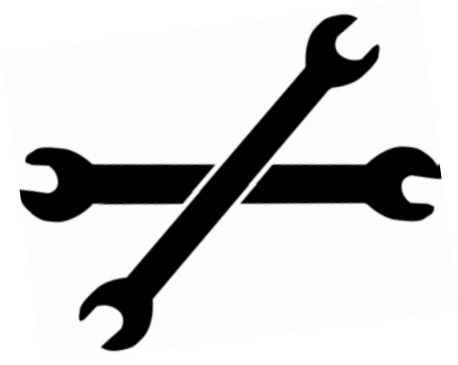
Shut down equipment before making repairs, adjustments, or removing obstructions.

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.



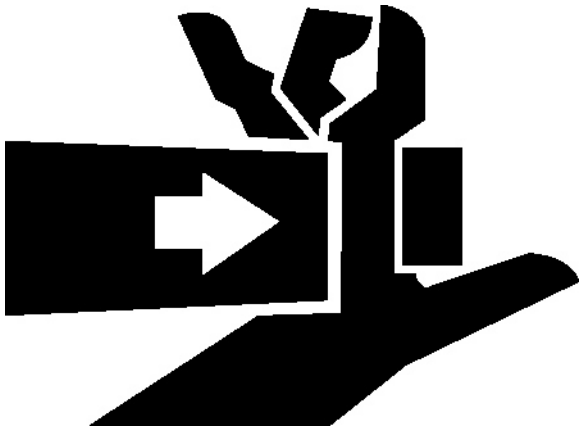
AVOID PINCH POINTS

⚠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.

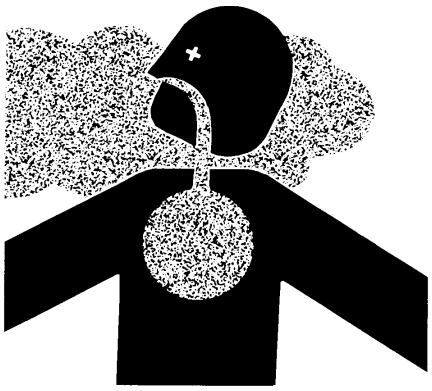
Handle parts carefully to avoid crushing and pinch point hazards.



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.

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.

SLIPPERY WHEN WET

⚠WARNING Slips and falls can cause serious personal injury.

Ensure firm footing in wet or slippery conditions.

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

Remove any buildup of grease, oil, or debris.

FIRE PREVENTION

⚠CAUTION Fires can cause injury or property damage.

Keep equipment clean. Remove all debris from equipment.

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

NO SMOKING IN SHAFT OR TUNNEL

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

Do not smoke in shaft or tunnel.

KEEP JOB SITE CLEAN AND ORGANIZED

⚠WARNING Tripping can cause serious personal injury.

Be sure to keep job site clean and organized.

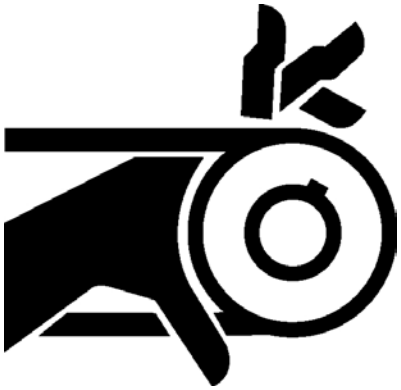
KEEP AWAY FROM BELT CONVEYOR

⚠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 power before servicing belt conveyor.



KEEP AWAY FROM AUGER (IF EQUIPPED)

⚠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.

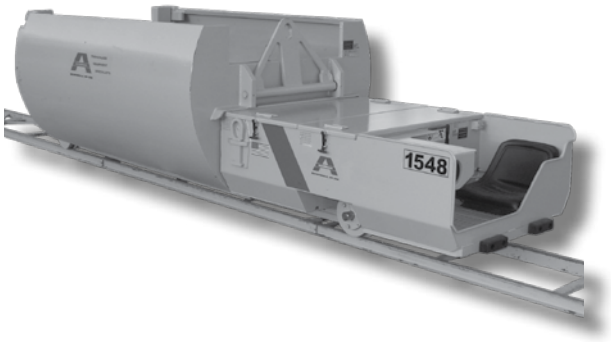
Lockout power before servicing.

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.

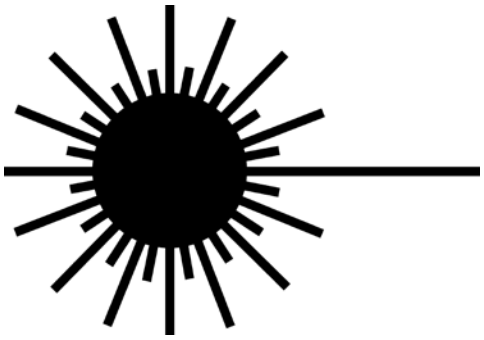
Disconnect battery harness from contactor harness and remove battery pack from haul unit to LOCKOUT, TAGOUT power before performing any maintenance.

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.

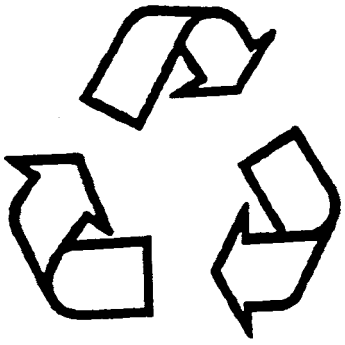
To avoid possible exposure to radiation in excess of acceptable emission limits, all repairs to laser must be performed by the original manufacturer or an authorized service technician.



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.



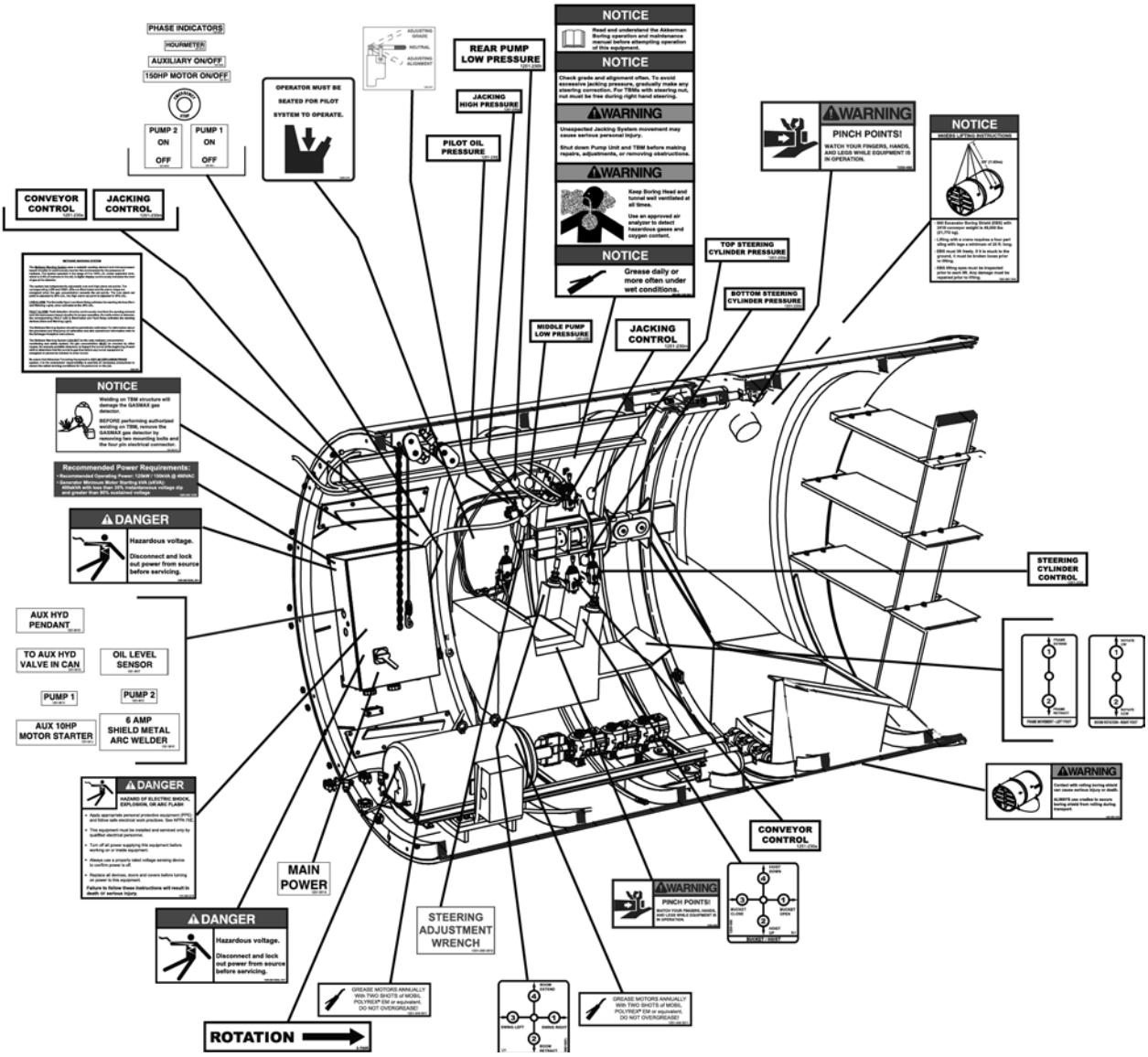
Decals

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.

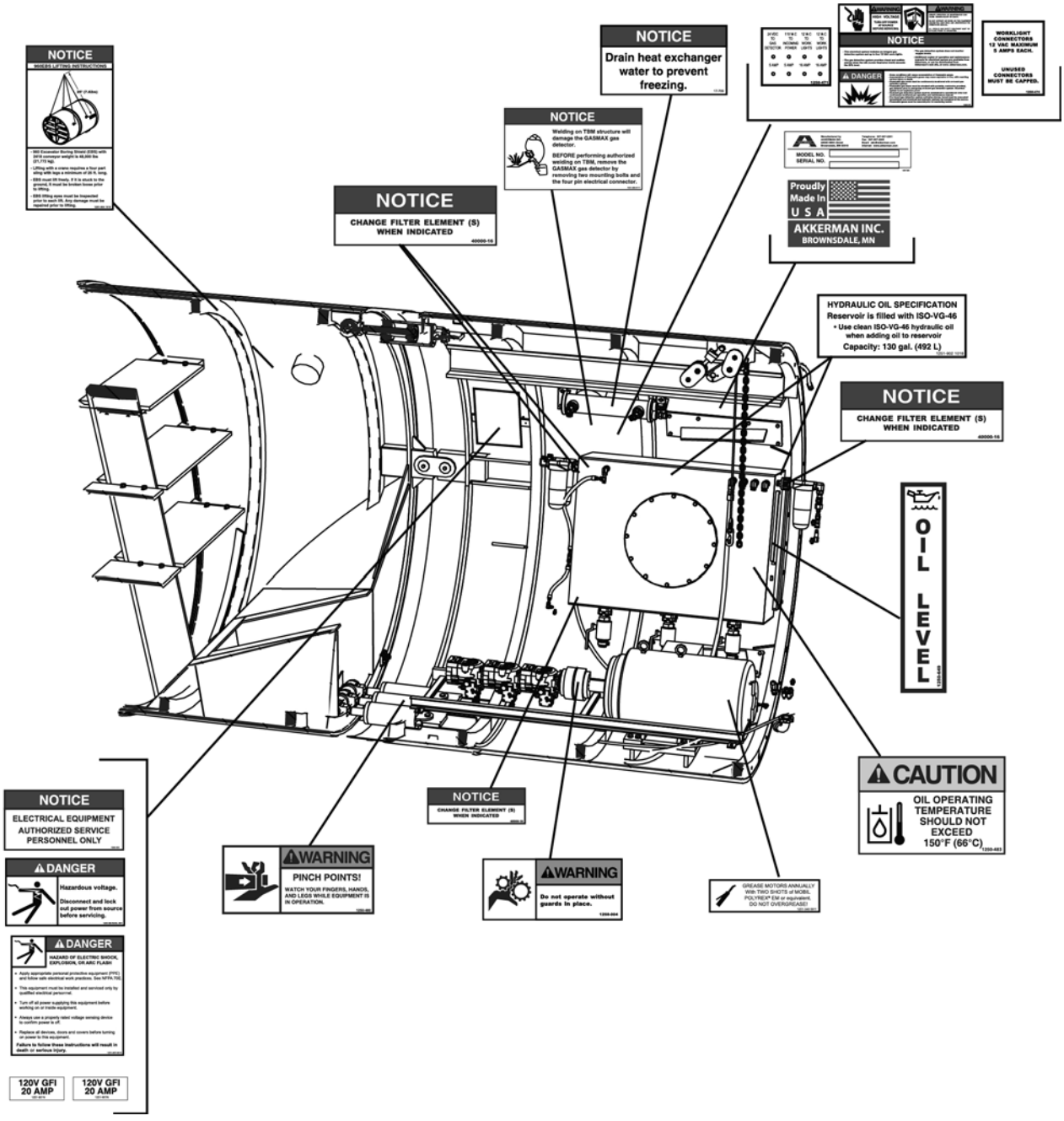
Serious injury or property damage can occur if safety instructions are not followed. Contact your Akkerman Aftermarket Support representative for free replacement safety decals.

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.

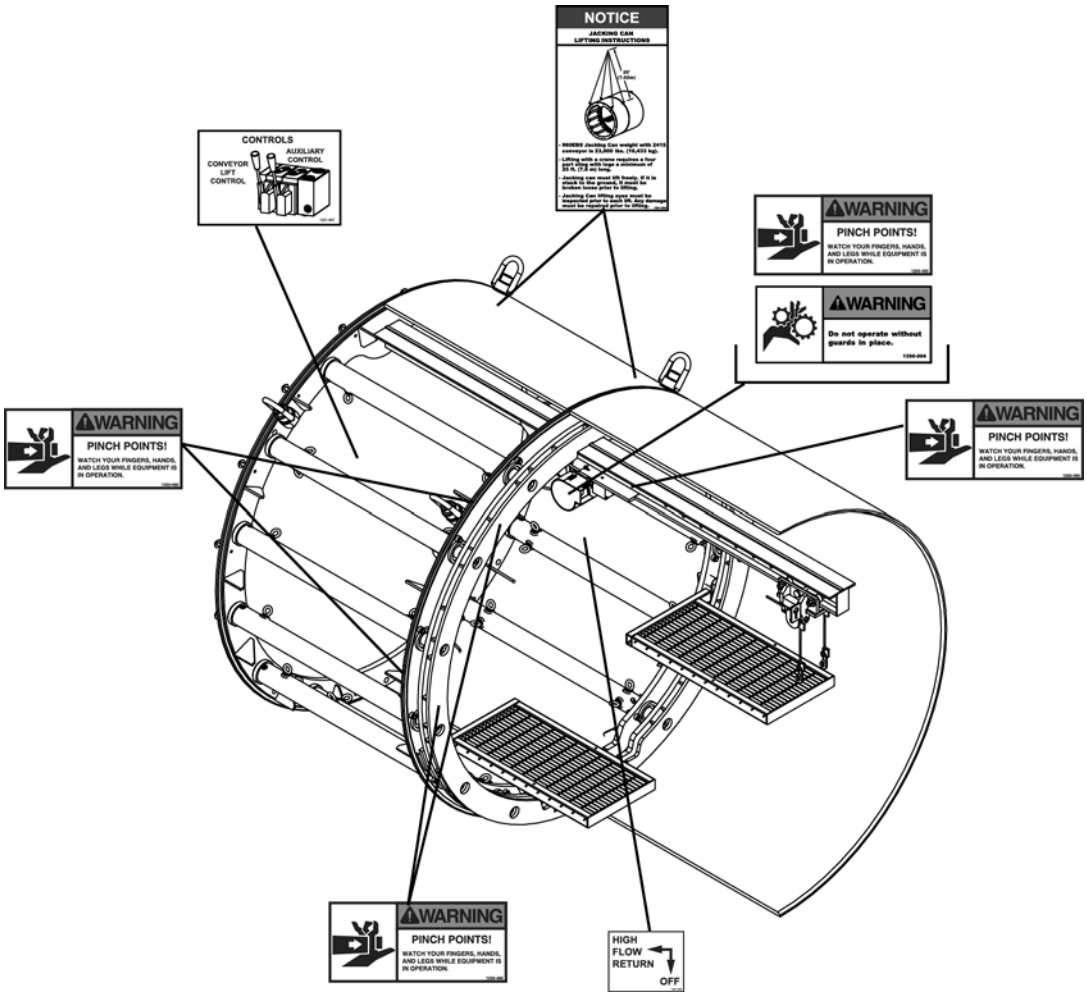
960EBS - LEFT VIEW



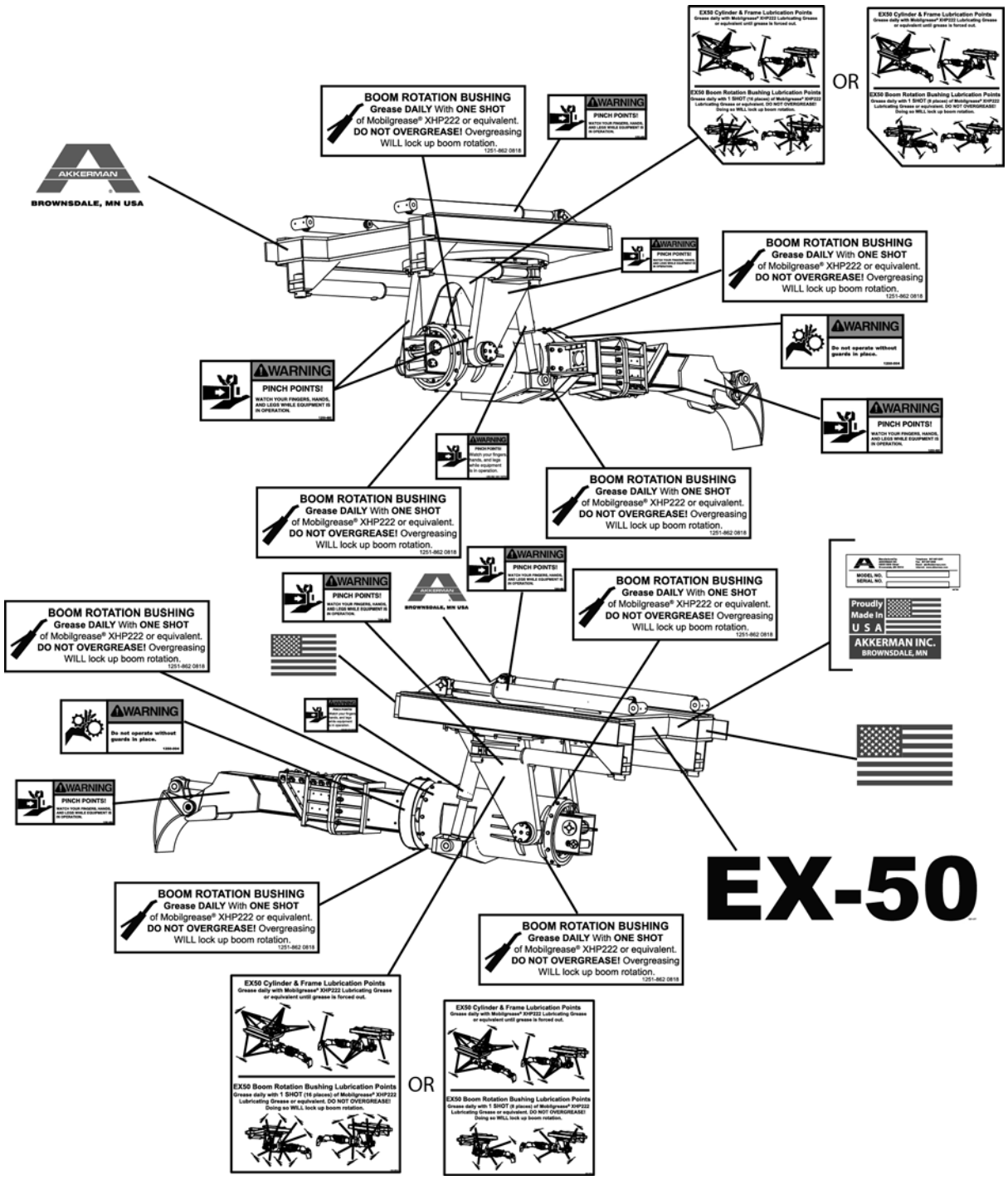
960EBS - RIGHT VIEW



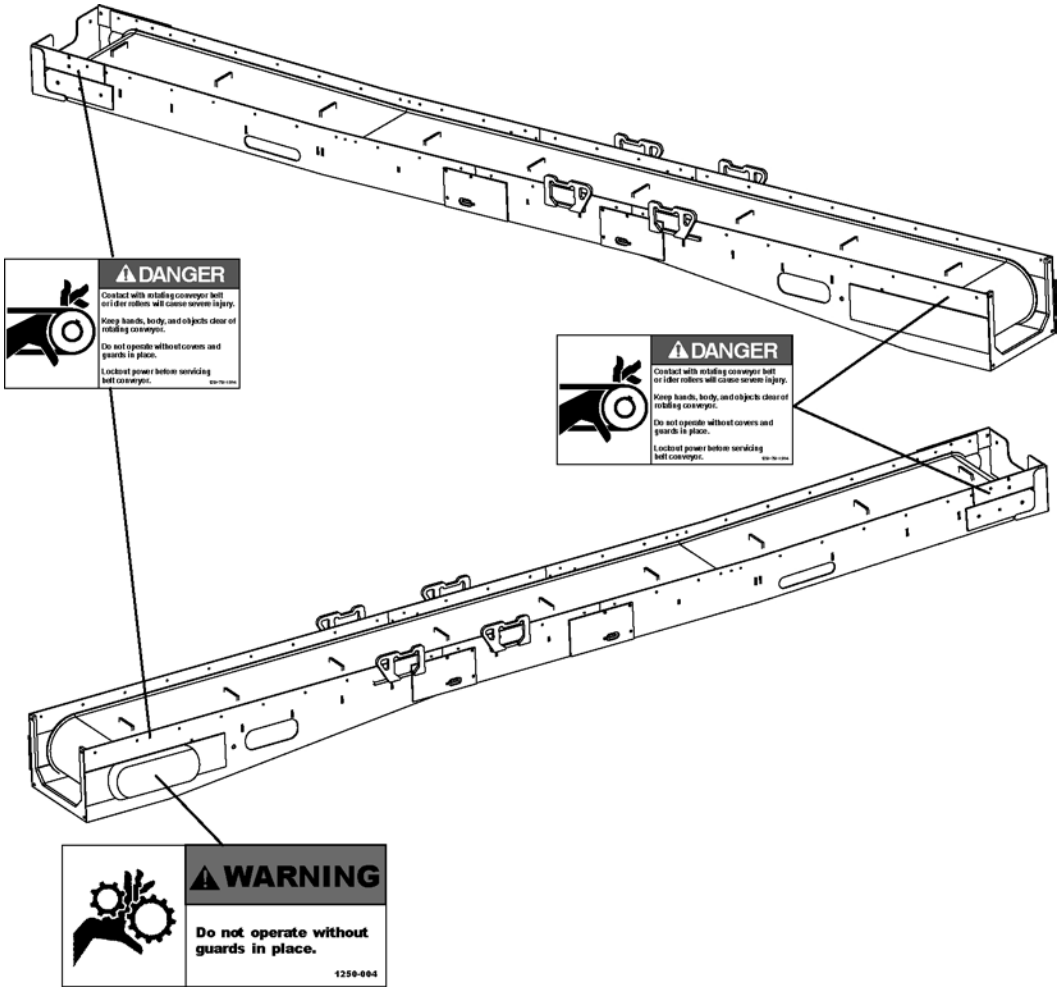
JACKING/LINER CAN



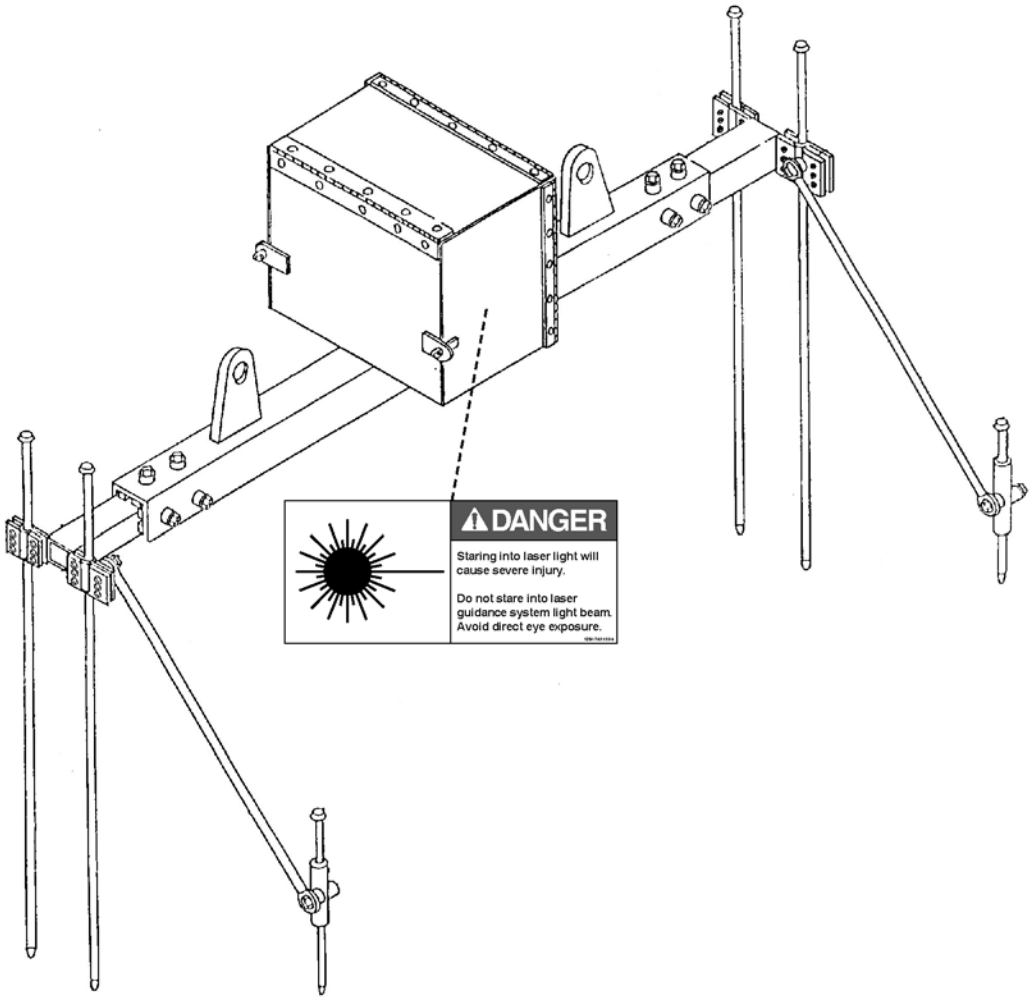
EX50 EXCAVATOR



BELT CONVEYOR

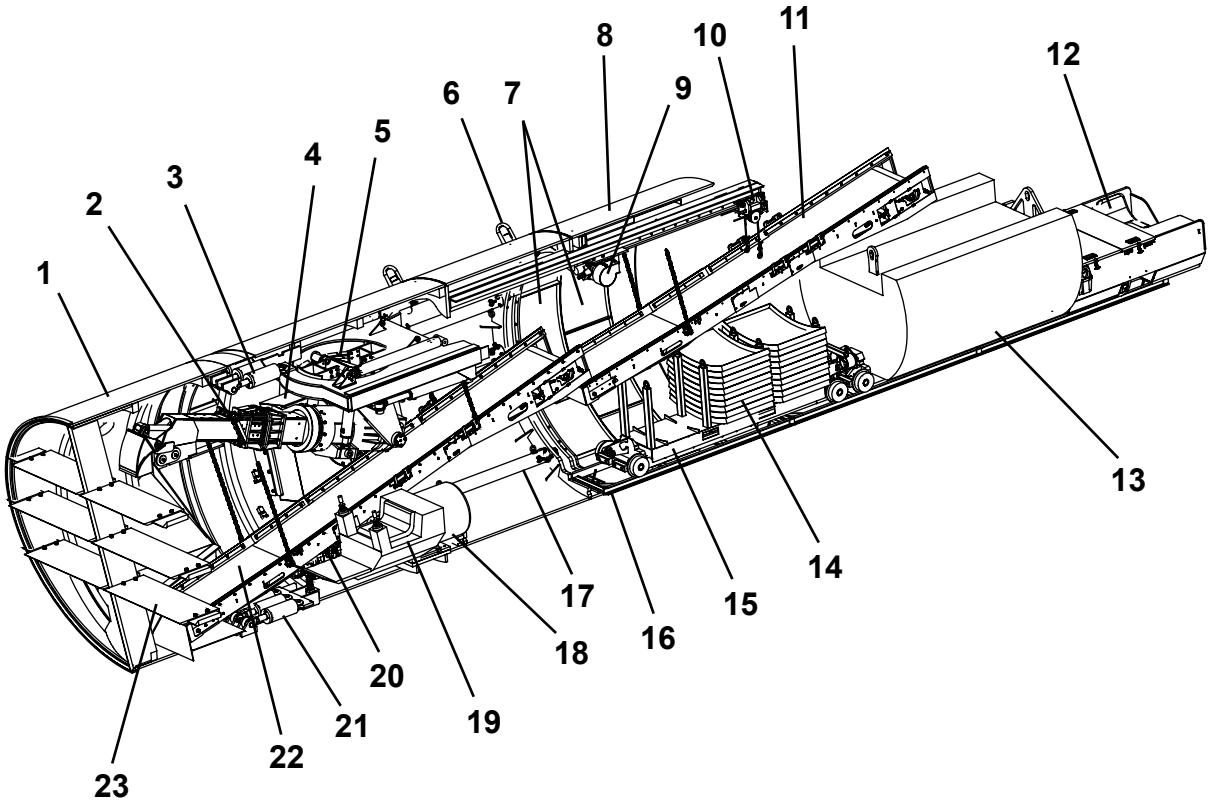


LASER LIGHT STAND



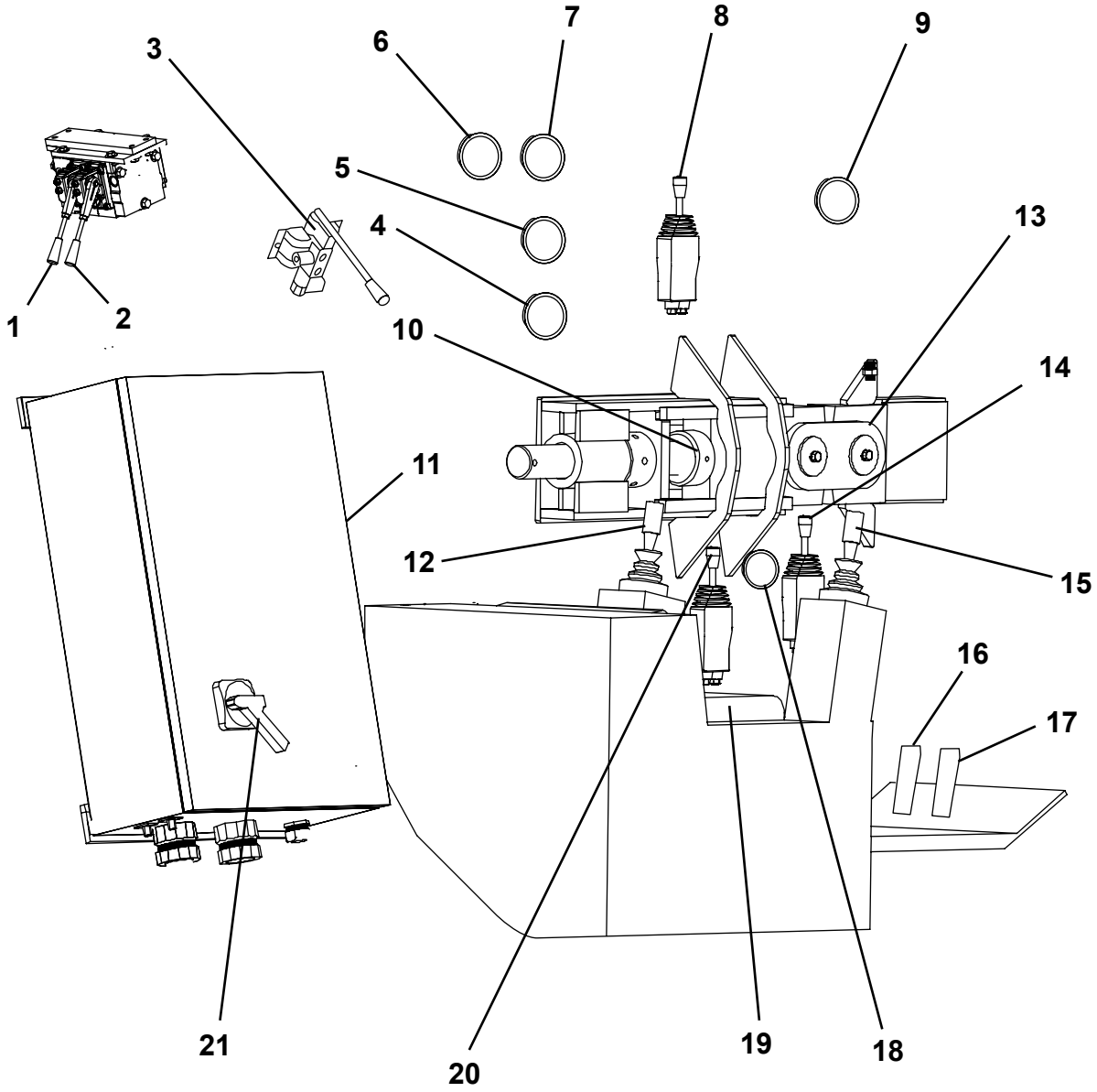
Terminology

960 BORING SHIELD WITH ON-BOARD POWER PACK



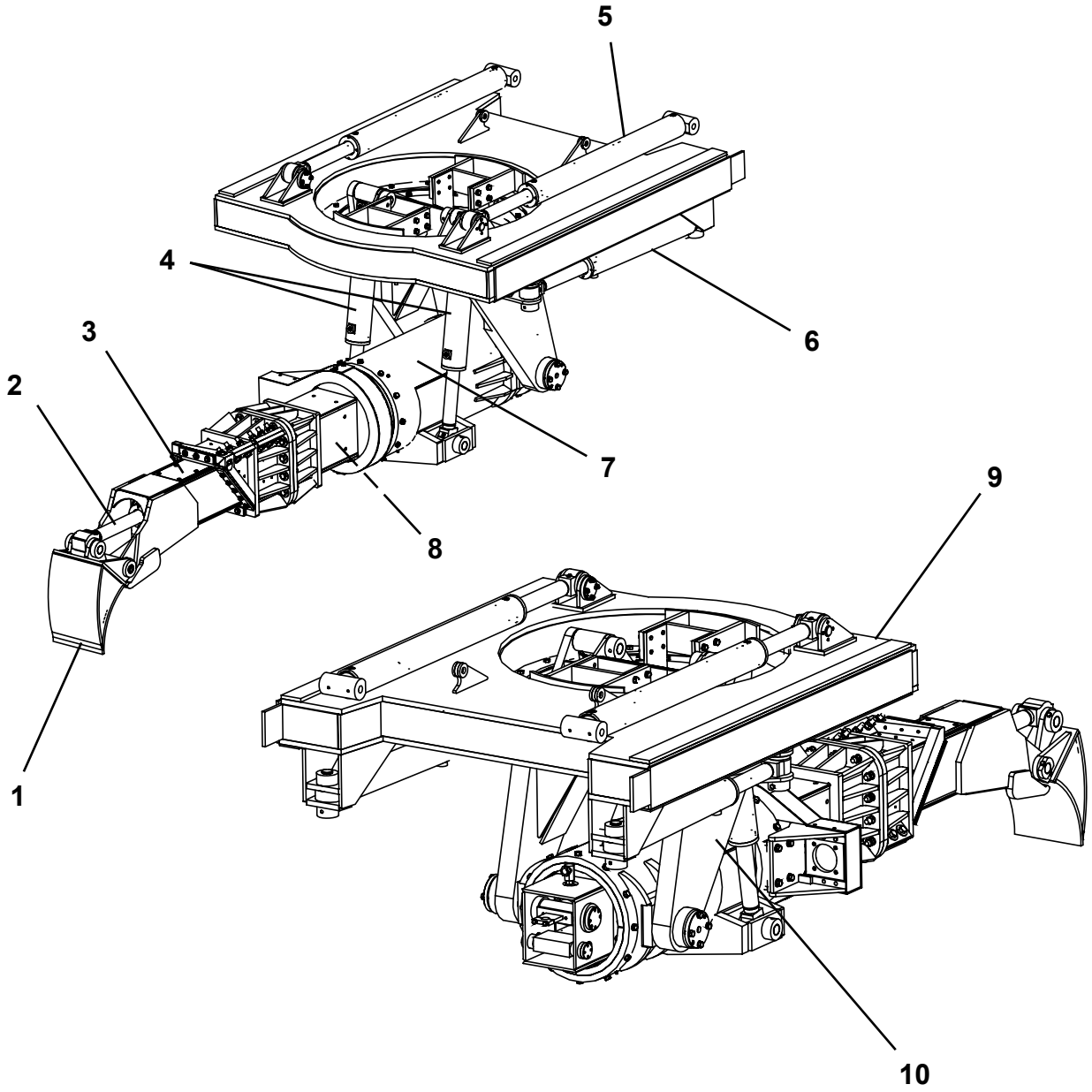
1. 960 Boring Shield
2. EX50 Excavator
3. Top Steering Cylinders
4. Hydraulic Oil Reservoir 130 Gal.
5. Heat Exchanger
6. Lift Eye
7. Assembled Liner Plates
8. Jacking/Liner Can
9. Conveyor Lift
10. Conveyor Gantry
11. 2415 Conveyor
12. 1548 Haul Unit
13. Dirt Bucket
14. Liner Plate Segments
15. Liner Plate/Bucket Cart
16. Haul Unit Track
17. Jacking Cylinder 54 in. (1,3172 mm) Stroke
18. Electric Motor 150 HP
19. Operator Station
20. Pumps
21. Bottom Steering Cylinders
22. 2418 Conveyor
23. Boring Shield Shelf

OPERATOR CONTROLS



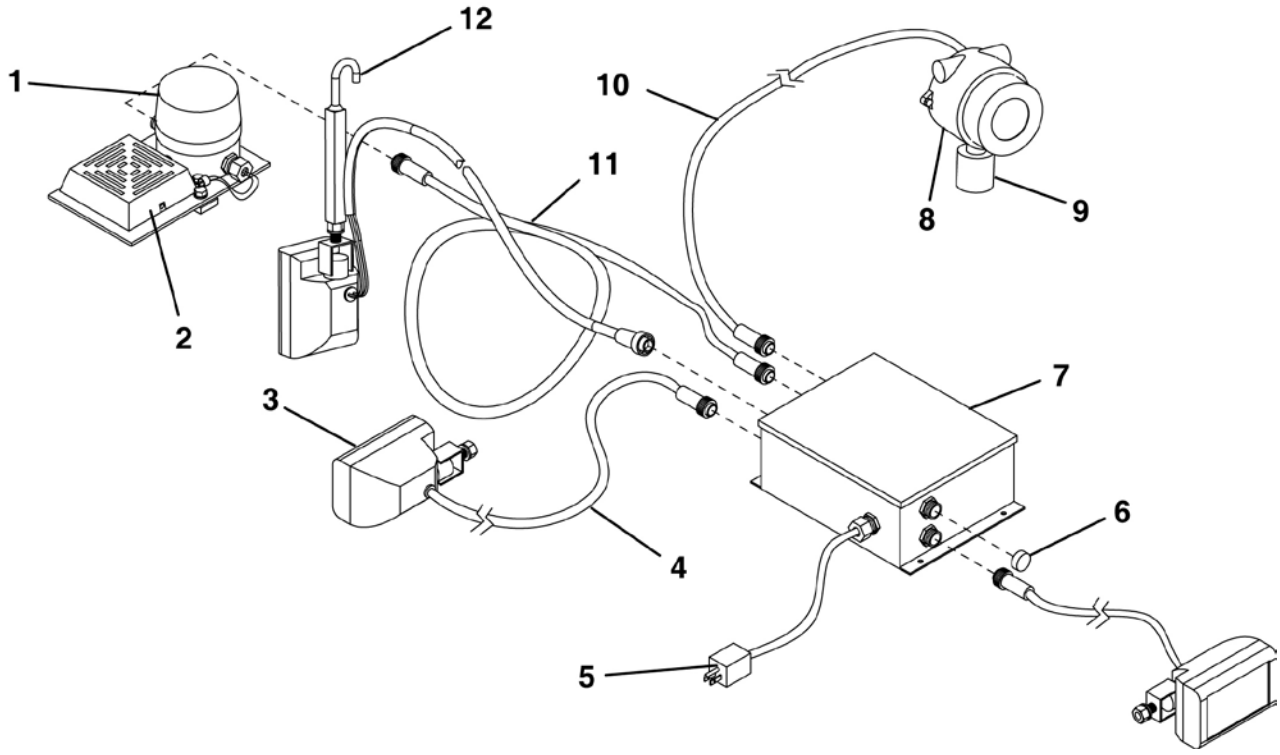
1. Conveyor Control
2. Jacking Control
3. Grade/Alignment Control
4. Pilot Oil Pressure Gauge (300 psi)
5. Jacking Pressure Gauge (5,000 psi)
6. Pump 1 Low Pressure Pump Gauge (2,800 psi)
7. Pump 2 Low Pressure Pump Gauge (2,800 psi)
8. Jacking Control
9. Top Steering Cylinder Pressure Gauge
10. Steering Adjustment (Side to Side)
11. Emergency Stop
12. Excavator Boom Extend / Swing Joystick Control
13. Steering Link
14. Steering Cylinder Joystick Control
15. Bucket / Hoist Joystick Control
16. Excavator Frame Movement Foot Control
17. Boom Rotation Foot Control
18. Bottom Steering Cylinder Pressure Gauge
19. Operator Seat
20. Conveyor Joystick Control
21. Main Power Control

EX50 EXCAVATOR



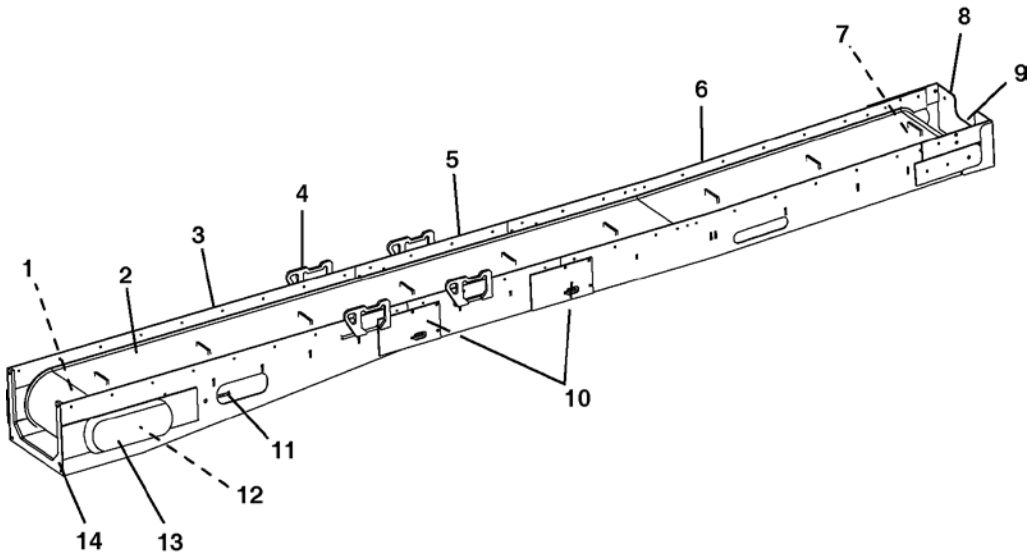
1. Bucket
2. Bucket Cylinder
3. Boom Extension
4. Boom Hoist Cylinder
5. Frame Slide Cylinder
6. Boom Swing Cylinder
7. Boom Rotation Drive
8. Boom Extension Cylinder
9. Slide Frame Assembly
10. Hoist & Swing Frame Assembly

GAS DETECTION SYSTEM (GDS GASMAX II)



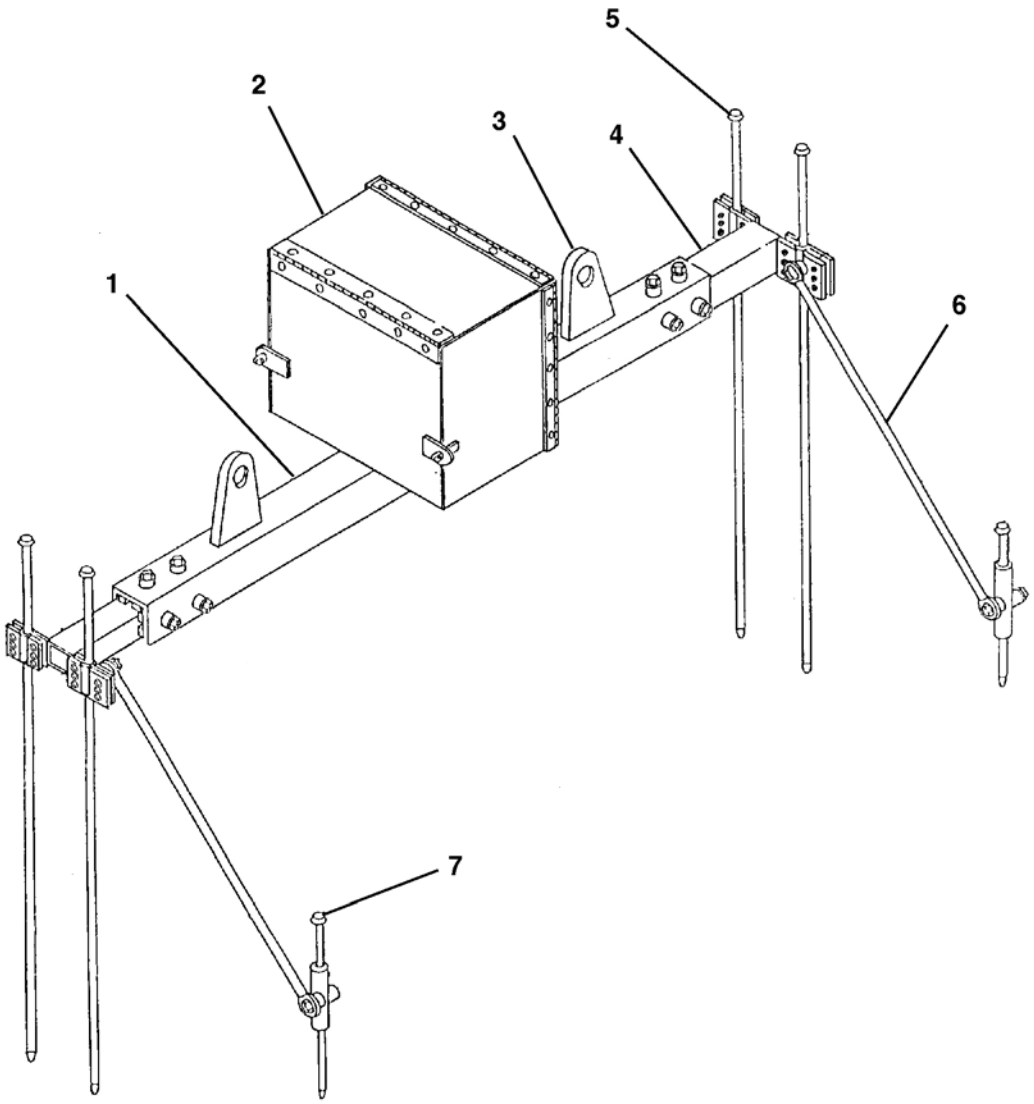
1. Strobe Light
2. Horn
3. Light
4. Cable Assembly
5. 110 VAC Outlet
6. Cap
7. Electrical Box Assembly
8. Transmitter/Relay
9. Combustible Gas Sensor
10. Cable Assembly
11. Cable
12. Extension Light

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)

LASER LIGHT STAND



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

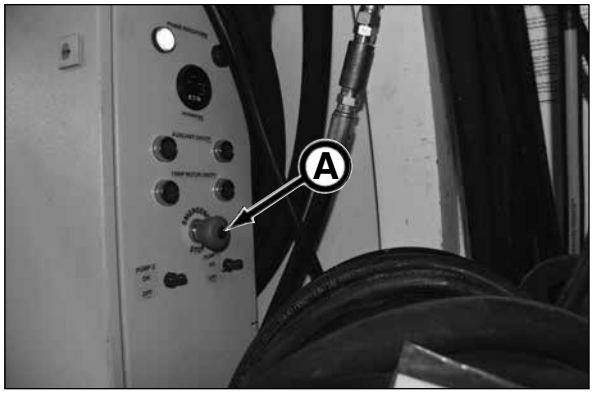
Controls & Instruments

EMERGENCY STOP

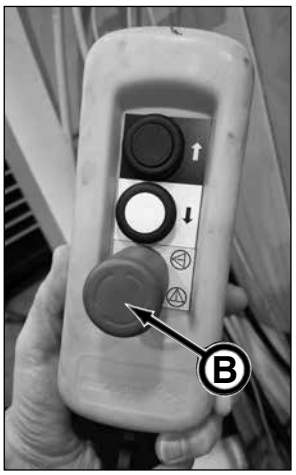
The control panel Emergency Stop button (A) and the auxiliary pendant Emergency Stop button (B) will stop the electrical motor rotation and hydraulic power.

The button functions as follows.

STOP	- Push button IN
Power for Start Circuit	- Pull button OUT

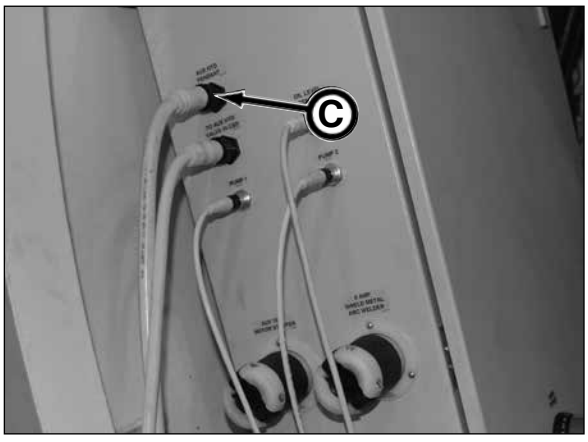


EBS Control Panel Emergency Stop Button (A)



Auxiliary Pendant Emergency Stop Button (B)

NOTICE The auxiliary pendant must be connected to the Aux Hyd Pendant connection (C) on the control panel. Failure to do so will prevent the electrical and hydraulic systems from functioning.



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.

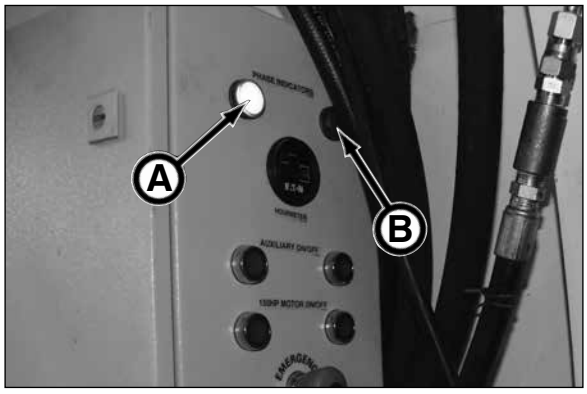
Any electrical work completed on the power pack must be performed by a certified electrician.

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.

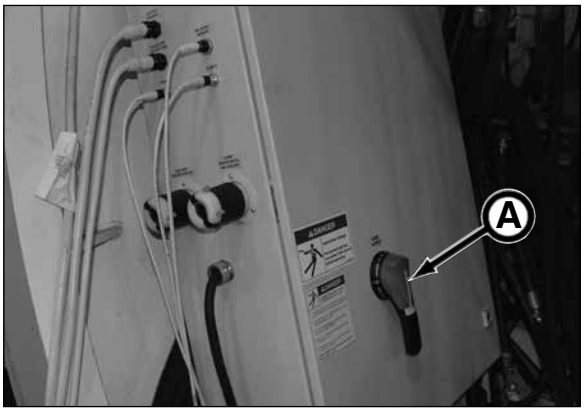


MAIN POWER DISCONNECT SWITCH

⚠DANGER Hazardous voltage. Disconnect and lock out/tag out 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 lock out/tag out 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 EBS control panel. This will supply hydraulic oil to the boring shield, excavator, conveyor and jacking/liner 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).

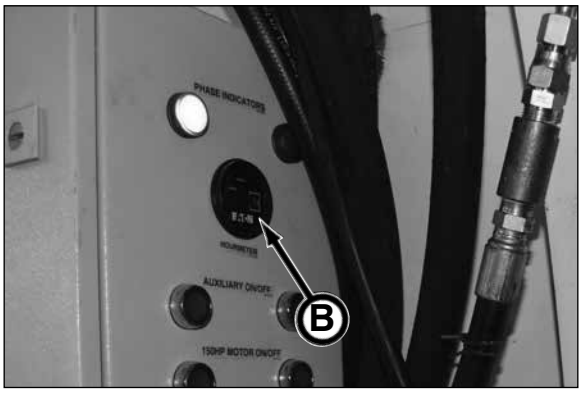
2. With proper phase power, flip desired main power disconnect switch(s) to the ON position.

HOURMETER

A hourmeter (B) is installed on the control panel to help determine proper maintenance intervals.

The hourmeter 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 pump is running.

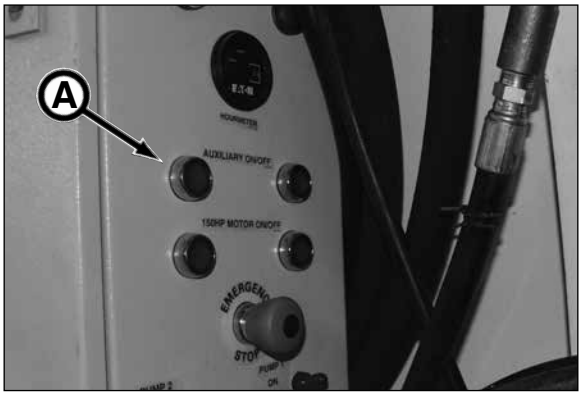


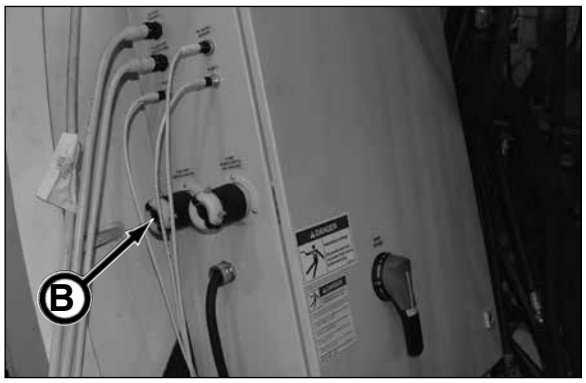
AUXILIARY MOTOR CONTROL

The Auxiliary On/Off controls operate the auxiliary 10HP motor (supplied by customer).

The 10HP motor will be wired to the Aux 10HP Motor Starter connection (B) on the control panel.

⚠WARNING The wiring of the auxiliary 10HP motor must be completed by a certified electrician.





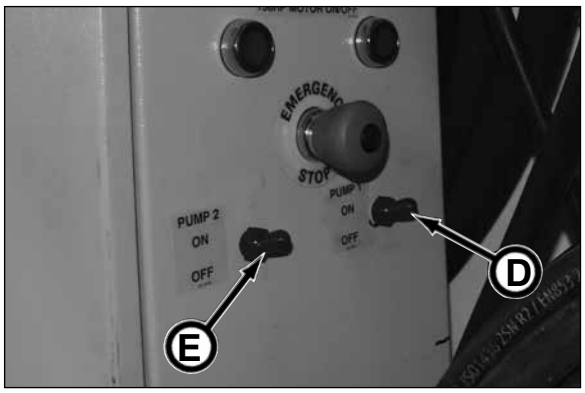
150HP MOTOR ON/OFF CONTROL

The 150HP main motor On/Off controls (C) operate the three hydraulic pumps which provides hydraulic power to the boring shield, excavator, conveyor and jacking/liner can components.

PUMP 1 & PUMP 2 ON/OFF CONTROLS

The Pump 1 (D) and Pump 2 (E) On/Off controls regulate the hydraulic oil for the boring shield, excavator, and conveyor components.

The 150HP motor control must be ON for the pumps to function.



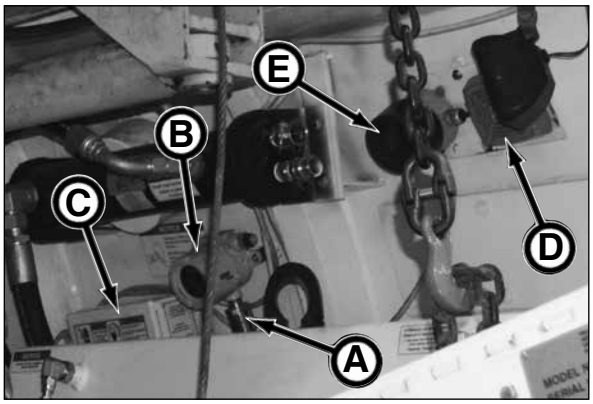
GAS DETECTION SYSTEM

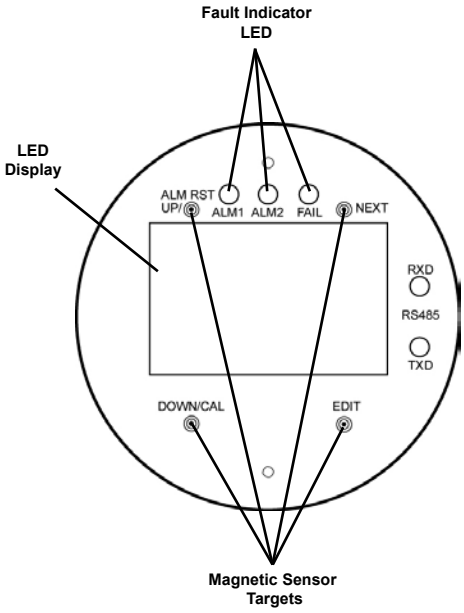
The gas detection system includes the following primary components; the gas sensor (A), transmitter/relay (B). The Akkerman system also provides a power supply (C) for the system, and an audible (D) and visual (E) alarm system.

NOTICE For more information, refer to the Akkerman Gas Detection System Operation & Parts manual.

(GDS GasMaxII) The transmitter LCD display shows calibrated engineering values, bar graph data, 30 minute tread, calibration, sensor fault, and setup information. During normal operation, the current gas concentration is indicated on the display.

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.



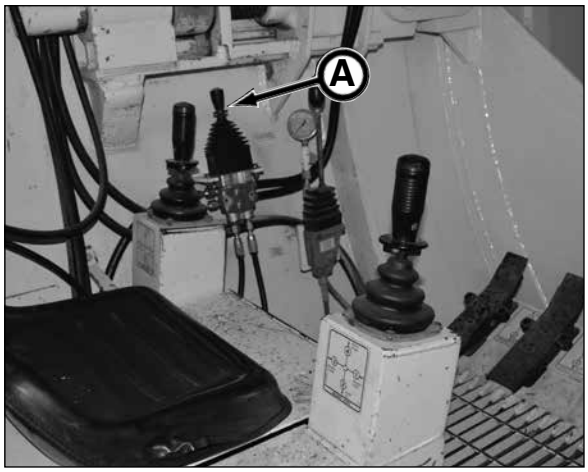


GDS GasMax II Transmitter Display

CONVEYOR CONTROLS

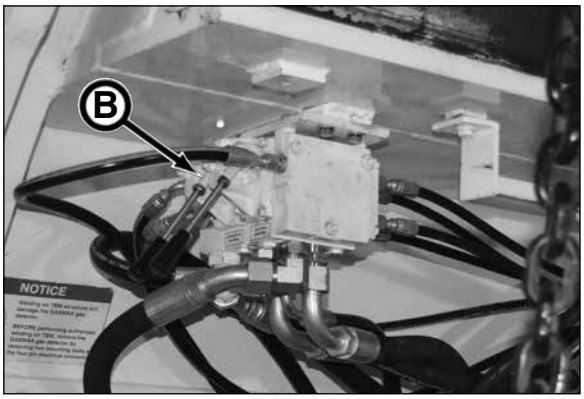
Conveyor Drive

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



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

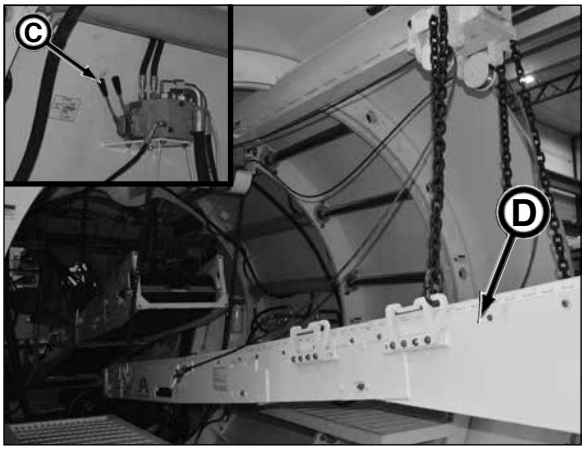
⚠WARNING Running the conveyor too fast can cause severe injury from flying debris and cause possible machine damage. Slow the conveyor speed so there is continual controlled movement of the spoils into the dirt bucket.



The conveyor valve section and manual control (B) is located at the rear of the boring shield.

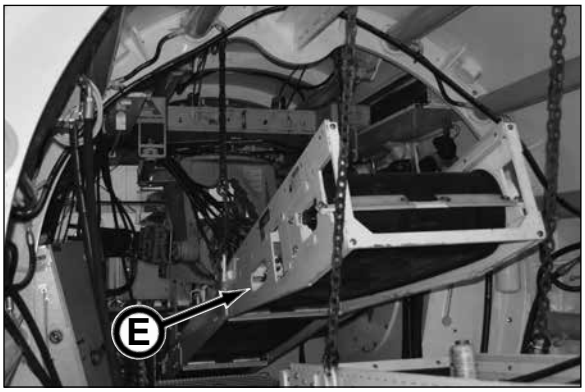
Conveyor Lift

The conveyor lift control (C) raises and lowers the conveyor (D) in the jacking/liner can.

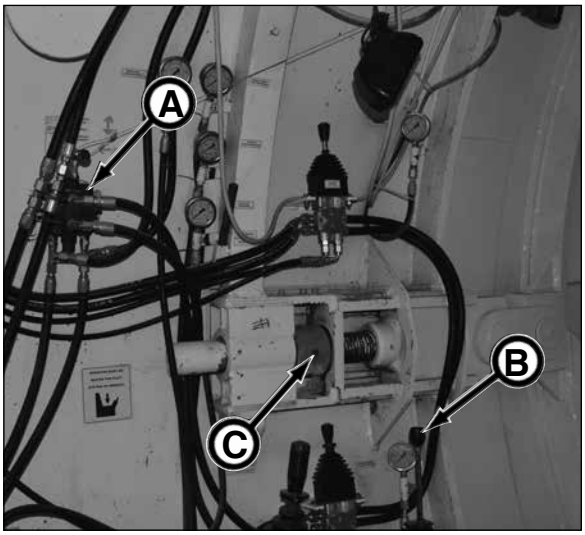


NOTICE Do not over-raise the conveyor. Doing so may cause damage to the conveyor and excavator.

NOTICE The conveyor (E) in the boring shield is raised and lowered by extending and retracting the excavator frame with the left foot control when the conveyor is connected to the excavator conveyor lifting cables.



STEERING CONTROLS

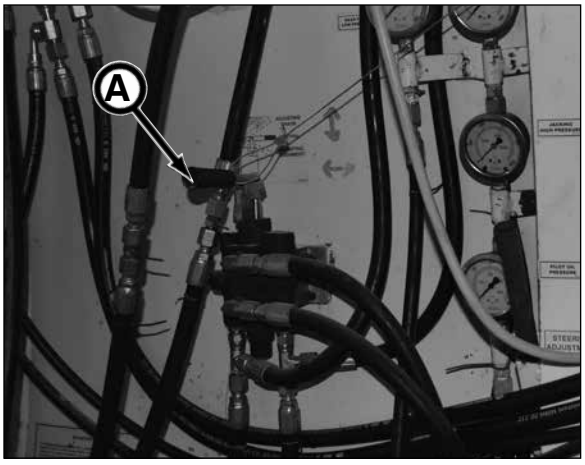


The steering controls include the steering selector (A), steering cylinder joystick control (B), and steering adjustment nut (C).

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

Steering Selector

Use the steering selector (A) to select the grade or alignment adjustment.



GRADE (up/down)

Move steering selector UP to select GRADE, then operate the steering cylinder control to adjust the steering cylinders. Once adjustment is made, move steering selector to Neutral position.

NEUTRAL

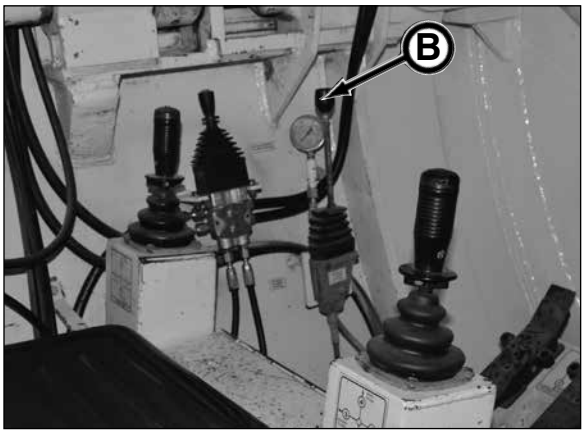
Move selector to middle position or Neutral to prevent accidental engagement of steering cylinders.

ALIGNMENT (left/right)

Move steering selector DOWN to select Alignment. Once adjustment is made, move steering selector to Neutral position.

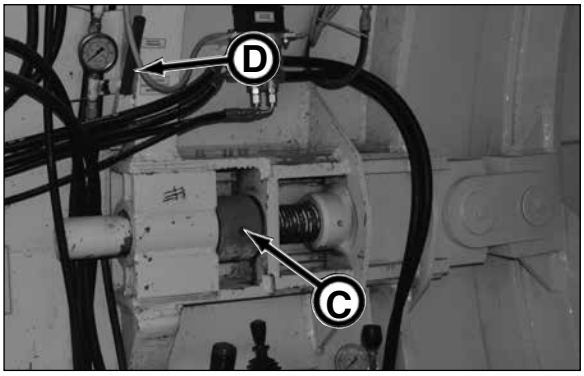
Left turn: operate the steering cylinder control (B) UP while turning steering adjustment nut (C) forward.

Right turn: operate the steering cylinder control (B) DOWN while turning steering adjustment nut back.



Steering Cylinder Control

The steering cylinder control lever (B) on the EBS control valve controls the extend and retract movement of the steering cylinders.

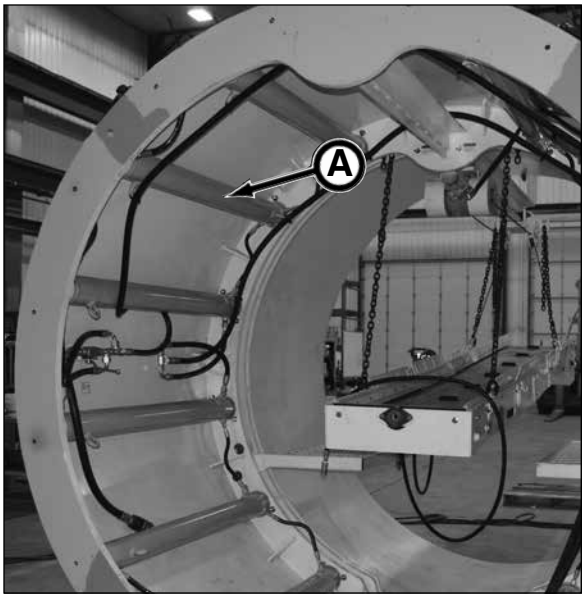


Steering Adjustment Nut Assembly

The steering adjustment nut assembly (C) provides right to left manual steering adjustments by rotating the nut forward or backwards.

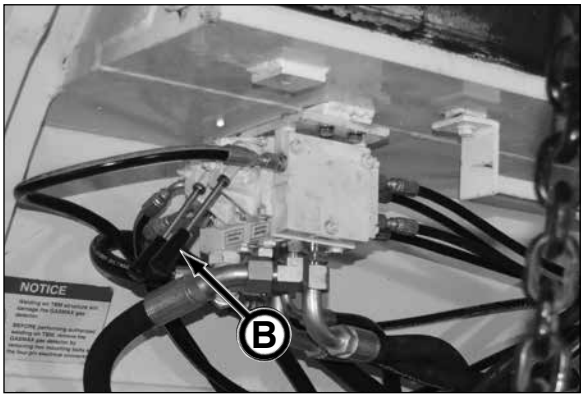
A steering adjustment wrench (D) may be used to rotate nut, otherwise relieve pressure on the nut by slightly moving steering cylinders and rotate nut by hand.

JACKING CYLINDER CONTROLS

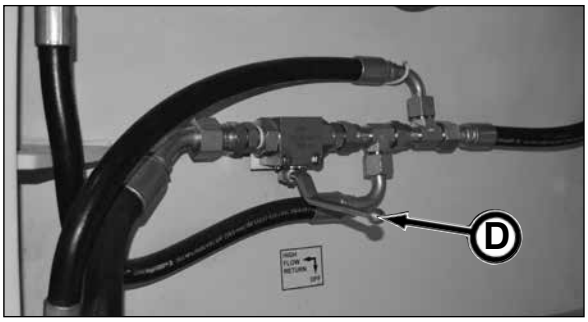


The EBS and tunnel is advanced through the ground by the extending the hydraulic jacking/liner can jacking cylinders (A) against the liner plates that are assembled in the jacking/liner can.

The jacking cylinders in the jacking/liner can are controlled by jacking control lever (B) located at the rear of the boring shield.



The boring shield operator can also operate the jacking cylinders using joystick control (C).



High Flow Return Valve Control (D)
This control will allow the quick retraction of the jacking cylinders. The jacking control lever must be in retract position.

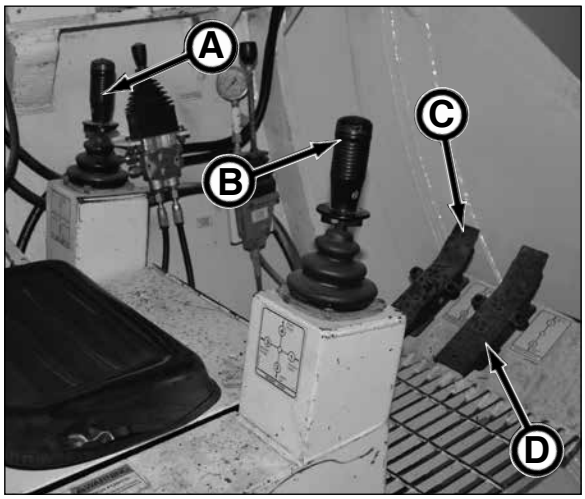
When jacking be sure this control is in the OFF (closed) position.

EXCAVATOR CONTROLS

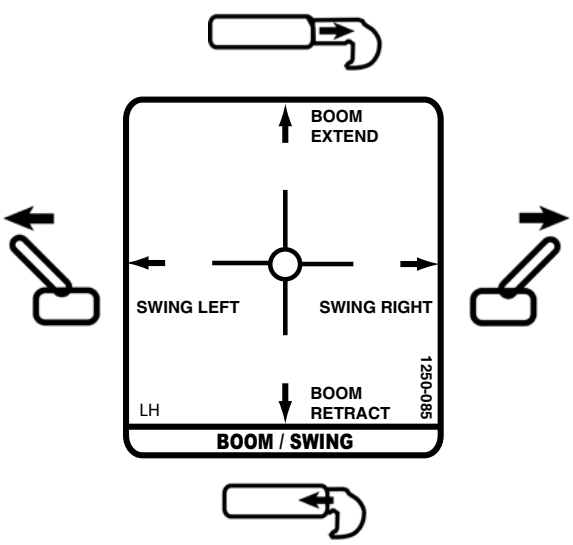
The excavator boom is controlled by joystick and foot controls and removes soil and obstacles at the face of the bore between the boring shield shelves with the boom bucket.

The excavator controls consist of the Boom Extend/Swing Joystick (A), Bucket/Hoist Joystick (B), Frame Movement Foot Control (C) and the Boom Rotation Foot Control (D).

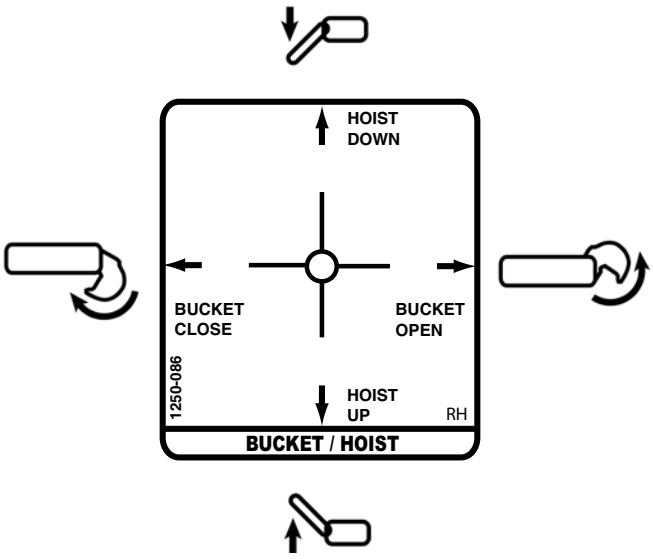
Move the controls as shown below:



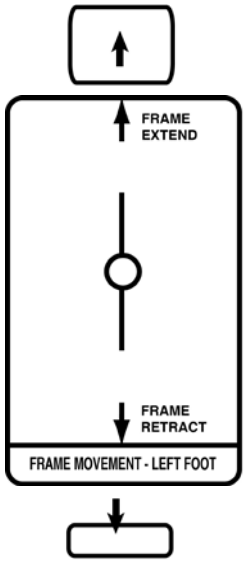
Boom Extend/Swing Joystick (A)



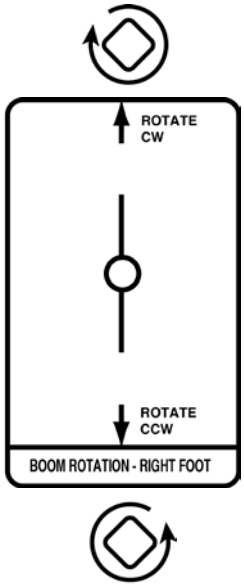
Bucket/Hoist Joystick (B)



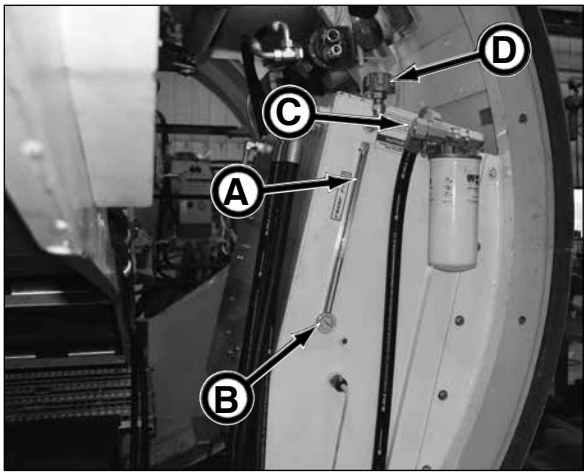
Frame Movement Foot Control (C)



Boom Rotation Foot Control (D)



HYDRAULIC OIL RESERVOIR



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

The reservoir capacity is 130 gal. (492 L).

Filling oil reservoir:

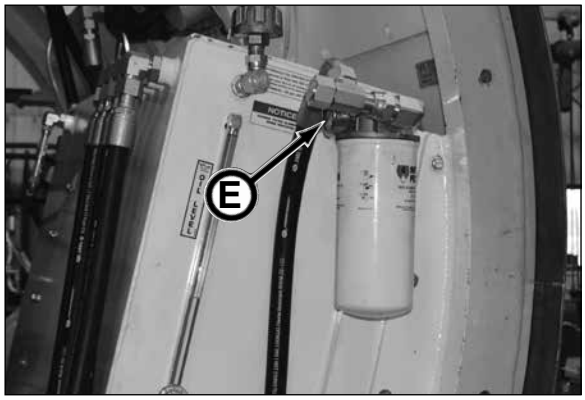
1. Clean area around fitting cap (C). Remove cap.
2. Attach external fill pump (hand or electric pump) with 16MFOR adapter to fitting.
3. Clean area around breather (D). Remove breather while filling for proper venting.
4. Fill reservoir with clean, fresh, **FILTERED** ISO-VG-46 20W Premium Hydraulic/Turbine 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-46 20W or API GL-1/GL-2 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.

RETURN FILTER INDICATORS

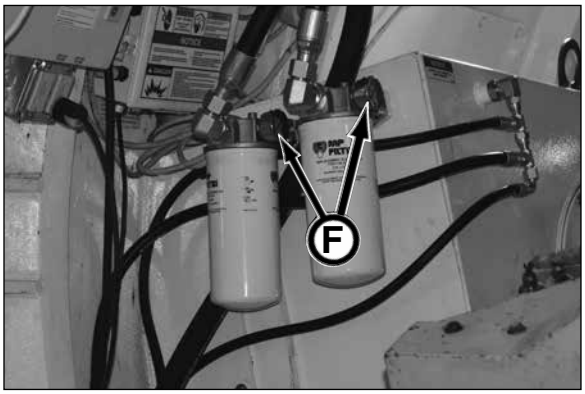


To prevent under or over servicing of the hydraulic filter elements, filter indicators are installed on the hydraulic return circuit.

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

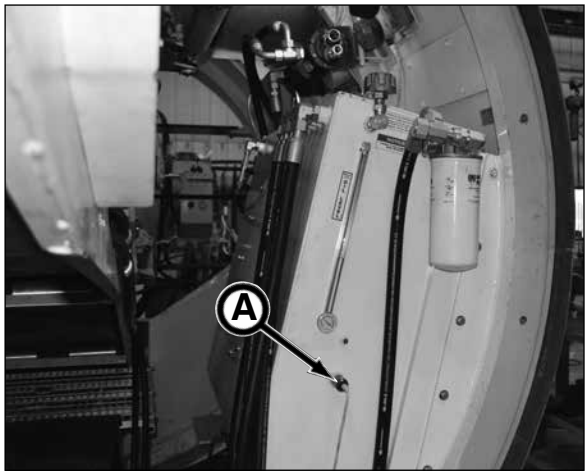
The yellow zone indicates that the filters will soon require replacement.

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.

LOW OIL LEVEL SENSOR

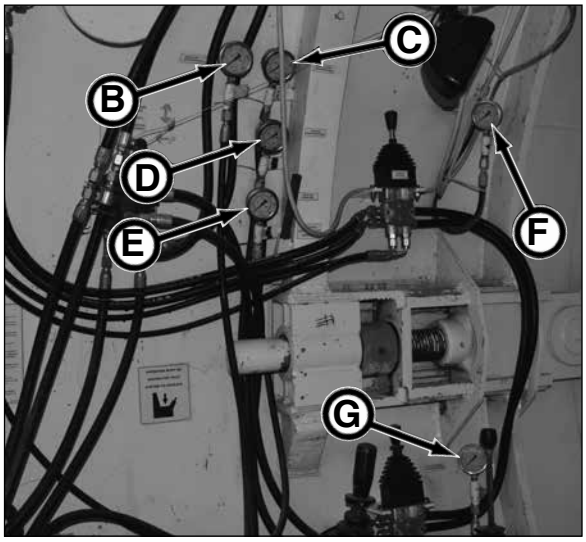


The hydraulic reservoir is equipped with a low oil level sensor (A).

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.

PRESSURE GAUGES

The boring shield is equipped with pressure gauges to monitor the pilot, excavator low pressure pumps, jacking high pressure and top and bottom steering cylinder pressures.



• Pump 1 Low Pressure Gauge (B)
This system is capable of 2,800 psi.

• Pump 2 Low Pressure Gauge (C)
This system is capable of 2,800 psi.

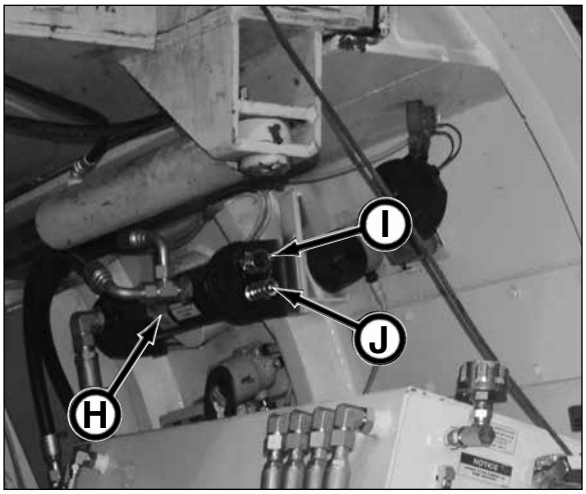
• Jacking Pressure Gauge (D)
This system is capable of 5,000 psi.

• Pilot Pressure Gauge (E)
This system is capable of 300 psi.

• Top Steering Cylinder Pressure Gauge (F)
This system is capable of 2,800 psi.

• Bottom Steering Cylinder Pressure Gauge (G)
This system is capable of 2,800 psi.

HYDRAULIC OIL COOLING SYSTEM



The low pressure Pump 1 and Pump 2 hydraulic oil circulates through the heat exchanger (H) and back to tank to cool the oil.

The heat exchanger water supply must be a minimum of 8 GPM of CLEAN water.

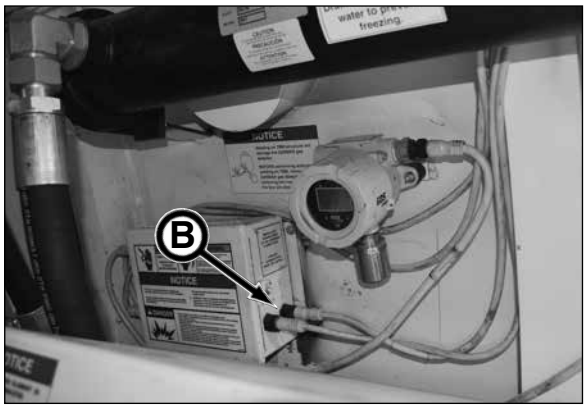
Heat Exchanger Water Supply Connection (I)
Heat Exchanger Water Discharge Connection (J)

LIGHTS

The boring shield is equipped with two operating lights (A) connected to the gas detector electrical box assembly (B).

Once the main power disconnect switch (C) is flipped to the ON position, the lights power on.

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

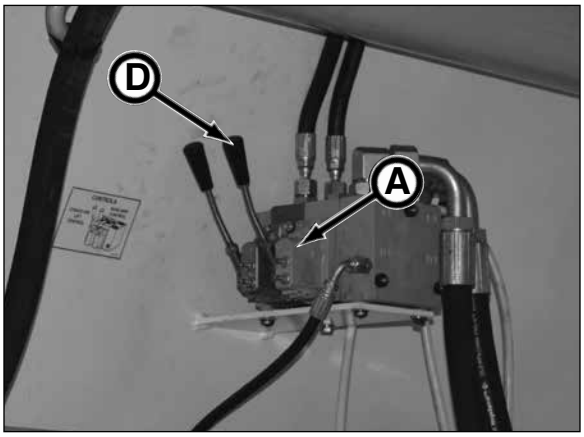


CONTROL PENDANT - AUXILIARY HYDRAULIC VALVE

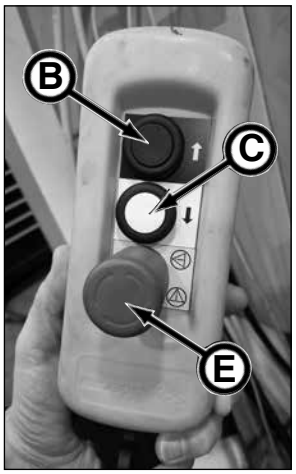
The control pendant allows the operator to control the auxiliary hydraulic valve section (A) with pendant switches (B and C) if a ring expander, winch or other hydraulic component (supplied by customer) is installed.

The auxiliary equipment can also be controlled manually with control lever (D).

The main power must be ON for the control pendant to operate the valve.



The control pendant is also equipped with a Emergency Stop button (E).



NOTES

Pre-Start Inspection

⚠WARNING Do not operate this equipment until you read, study, and understand this manual and ythe Akkerman haul unit, gas detection 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.

	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.
	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. 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 harnesses.
	15. Check for fluid leaks. Repair leak or replace components.
	16. Keep job site clean and organized.
	17. Perform all lubrication and maintenance procedures. Refer to Section 9, Periodic Maintenance.
	18. Test each function and control to ensure correct operation.
	19. Check hydraulic hoses and lines for leaks, wear and/or damage. Replace any defective hoses and/or lines.
	20. Check oil level in hydraulic oil reservoir. Add as needed.
	21. Be sure the green Phase OK Indicator light is illuminated before starting electrical components.
	22. Check cable for continuity and shorting before each use. Constantly check cables for damage.
	23. Perform pre-start inspection on your equipment. Refer to the equipment operator’s manual.
	24. Conveyor MUST be secured with four safety chains to each conveyor.
	25. Test the electrical motor for proper rotation prior to operation.
	26. 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, 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 Product 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. Be sure the excavated launch and reception shafts are properly shored or braced to prevent slides or cave-ins.

9. A fully trained and qualified signal person must direct the crane operator when lifting and lowering equipment into the launch or reception shafts.

10. Never walk or work under any part of the crane and suspended loads.

11. 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.

12. Before operating, thoroughly inspect all equipment and repair equipment problems. Check hoses for cuts or bulges. Replace worn or damaged hoses.

13. 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.

14. Test air monitoring and ventilation detectors for proper operation. Never enter a tunnel without combustible gas detectors and oxygen deficient detectors.

15. Test all Emergency Stop circuits for proper operation at the start of each shift.

16. Test each control function to make sure they work properly.

17. High pressure hydraulics are used in this boring shield. Be sure all covers and guards are in place before operating.

18. Do not make any non-authorized modifications to any Akkerman products. Doing so could cause structural failure and will void the warranty.

19. Check shields and guards. All must be in place and undamaged.

(continued on next page)

Operating Guidelines (continued)

20. Never leave the operator's seat without first releasing hydraulic pressure, performing daily system shutdown, and disconnecting the main power supply.

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

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

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

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

25. Conveyors must be stopped and the power source in lock out, tagout during maintenance, repair, servicing or attempting to remove a jam or overload..

26. While boring shield and conveyors are operating, the operator must remain seated in normal operating position.

27. **The EX50 excavator is designed to move spoils in tunnel to the conveyor. DO NOT use EX50 excavator to aid in the moving of tunneling equipment or other site preparation equipment or parts. Doing so will result in excavator damage.**

28. When operating the EX50 excavator, operate slowly and carefully so the excavator does not hit the operator.

29. In hard ground, use the EX50 to scrape the soil around the perimeter of the cutting area so the center spoils will drop to the conveyor.

30. In sand soils, the EX50 excavator is used more for clean up and guiding spoils to the conveyor.

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

32. 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.

33. 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 lock out, tag out.

34. Check line and grade often to avoid mis-alignment. Keep boring shield 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.

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

36. Before performing maintenance, lock out the main disconnect, shut off generator or other external power source, and attach a DO NOT OPERATE tag or similar warning tag to the main power disconnect.

37. Lock out, tag out electrical power at the source (generator) before servicing electrical components.

38. 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.

1. Safety equipment, first-aid kit, fire extinguishers, and stokes-type stretcher.
2. Any other required safety gear, such as air monitoring and gas detection systems, including personal gas detectors.
3. Ventilation fan(s) and ducting.
4. Communications equipment and good quality flashlights.
5. Generator sized for the project's power requirements including an adequate fuel supply for the generator's minimum period of operation.
6. A crane sized to project requirements.
7. Adequate pumping capacity for launch and reception shaft sump, and process water overflow, potential storm event inflow, trash pump, and hoses.
8. Adequate job site lighting, crew safety vests, and traffic control devices/signage, and barricades.
9. Wash down hose and spray nozzle.
10. Measuring and surveying equipment; including sight level or theodolite, laser levels, plumb-bobs, string lines and 100' tape measure.
11. Secure tool and equipment storage.
12. Rubber-tired front-end loader with bucket and forks.
13. Skid steer loader.
14. Shovels, rakes, and brooms.
15. Bullfloat and trowels.
16. Concrete bucket, tremie hose and hopper.
17. Carpentry tools including circular saw, sawzall, extension cords, and cordless drill w/bits, and basic hand tools.
18. Hammer drill and masonry bits, small "rivet buster" type jackhammer, chisels.
19. Sledgehammer(s), pry and crowbars of all sizes, spud wrenches, and pick-bars.
20. Various sizes hydraulic bottle jack(s), railroad or house type jacks, portapower hydraulic jack cylinder kit.
21. Log chains, shackles and clevis'.
22. Chain or cable-type "come alongs."
23. Arc welder and cutting torch rigs, eye shields and required protective gear.
24. Disc and mini-disc grinders, and extra discs.
25. Mechanic's tools, including but not limited to; wrenches, sockets, allen wrenches, torque wrenches, pliers, screwdrivers, hammers, etc.
26. Grease gun.
27. Electrician's tools, including test meters, voltage indicator, ground fault indicator, and specialty hand tools.
28. Pipe wrenches, water pump pliers, pump packing removal kit.

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 EBS project.

Equipment:

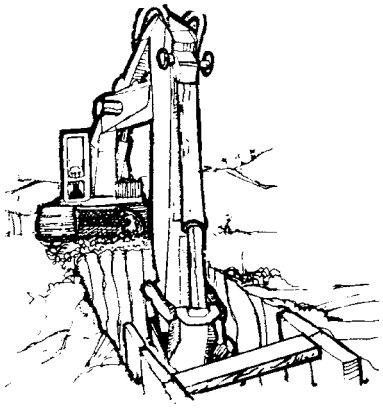
- EBS
- Power Pack if not On-Board
- Skid and Jacking Frame
- Yoke (if needed)
- Crane
- Portable Welders
- Small Generator
- Fork Lift
- Pipe Lubrication Pump
- Spoil Removal Truck
- Portable Toilet
- Generator Or Power Source

Other site considerations:

- Spoil Removal Truck Access
- Launch Shaft Size
- Walkways
- Pipe Unloading area
- Hose Interconnections
- Pipe Staging Area
- Fresh Water Supply
- Electrical Interconnections
- Jacking Shaft Access Area
- Any Traffic or Other Physical Restraints

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.



AEM is the original author and publisher of the above illustration

⚠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.

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.

(continued on next page)

System Set-Up (continued)

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

9. (External Power Pack if used) Lower power pack on a level, solid foundation an appropriate distance from the edge of the shaft to prevent shaft cave-in.

10. 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.

11. Lower the stand for the laser guidance system as close to the rear of the jacking shaft as possible without contacting ski/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.

12. Install the launch shaft seal and casing in the front of the launch shaft, if required.

13. Lower excavator boring shield (with conveyor installed) onto the front of the rail system.

14. Lower jacking/liner can (with conveyor installed) onto rails. Align jacking/liner can to boring shield four alignment pins. Secure boring shield to jacking/liner can with twelve 3/4 UNC x 4 in. bolts and flat washers. The jacking/liner can holes are threaded.

15. Recheck the skid/rail system base frame and alignment. Check machine elevation and make final pipe line calculations.

16. Lower support ring between the EBS and the thrust block/support structure. This support ring provides a thrust support against the complete diameter of the liner plate ring. It is also used to load/unload the dirt bucket.

17. Set up the boring shield to jacking/liner can hydraulic hoses and electrical connections (refer to Connecting Hydraulic Hose Quick Disconnects on next page).

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

18. Connect generator/power source electric cables to the electrical box in the boring shield (refer to Connecting Power Pack Electrical Connections on next page).

19. Ensure the EBS alignment and grade are steered parallel to the rail system base.

20. Be sure the conveyors are properly installed and secured to the lifting cables (four per conveyor). Adjust the conveyor as needed into the operating position.

21. 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.

CONNECTING POWER PACK ELECTRICAL CONNECTIONS

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

Failure to lockout 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 EBS main electrical box power connection (A).

   Recommended Power Requirements
   • Recommended Operating Power:
   ..... 125kW / 150kWA @ 480 VAC

   • Generator Minimum Motor Starting kVA (skVA):
   ..... 400skVA with less than 35% instantaneous voltage dip and greater that 90% sustained voltage

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

CONNECTING HYDRAULIC HOSE QUICK DISCONNECTS

The pressure, return, load sense, conveyor and jacking hydraulic hoses are equipped with quick disconnects. Be sure the connections are properly secured. Connect the hydraulic hose quick disconnects as follows:

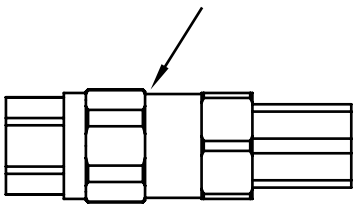
• All Quick Disconnects

CONNECT

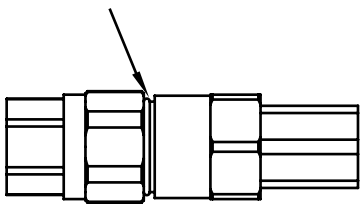
a. Hand tighten coupler by rotating clockwise (CW) until o-ring is no longer visible. If o-ring is visible, the connection is not locked.

DISCONNECT

b. Rotate hose coupler counterclockwise (CCW) until coupler is removed.



Connection Locked
Metal To Metal Contact



Connection Unlocked
O-Ring Partially Exposed

CHECKOUT EQUIPMENT PRIOR TO START-UP

1. Grease components as shown in Periodic Maintenance section.

2. Connect clean water supply hoses with 8 GPM minimum to heat exchanger in EBS.

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

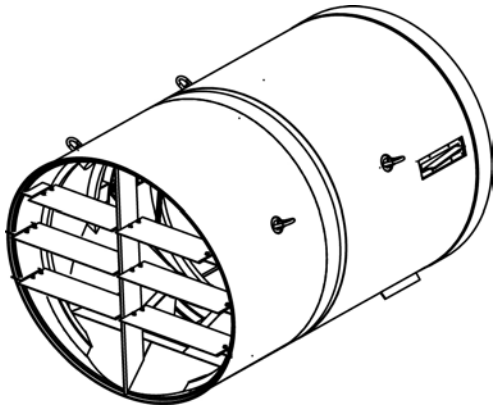
4. Inspect conveyor lift cables daily and replace immediately at the first sign of wear.

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.

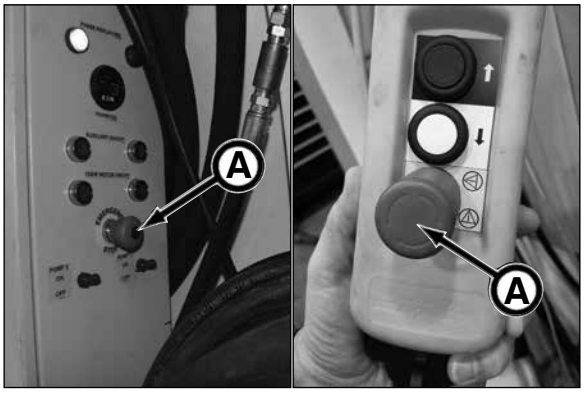
8. Refer to your haul unit, gas detection system, and jacking frame operation manuals for pre-start checks.



POWER START UP PROCEDURE

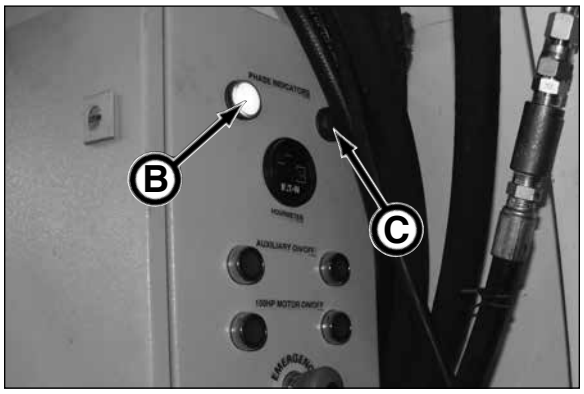
Once generator power, electrical cables and hydraulic hoses are properly connected, the power can be started as follows:

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



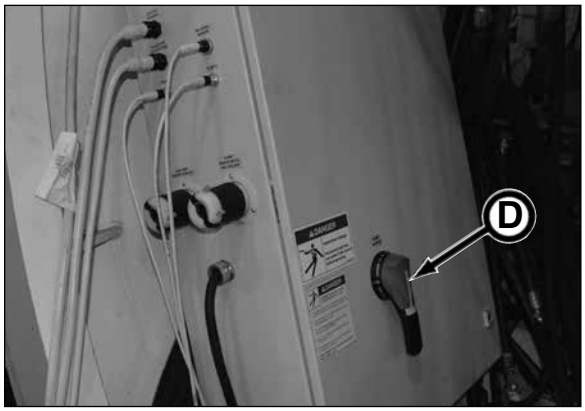
2. Check Phase Power Indicators. If the green Phase OK indicator (B) is illuminated, the external phase power is installed correctly and the power pack main power can be turned on.
   If the red Phase Error indicator (C) is illuminated, the external power source is installed incorrectly. Lockout tagout 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 buttons (A).

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

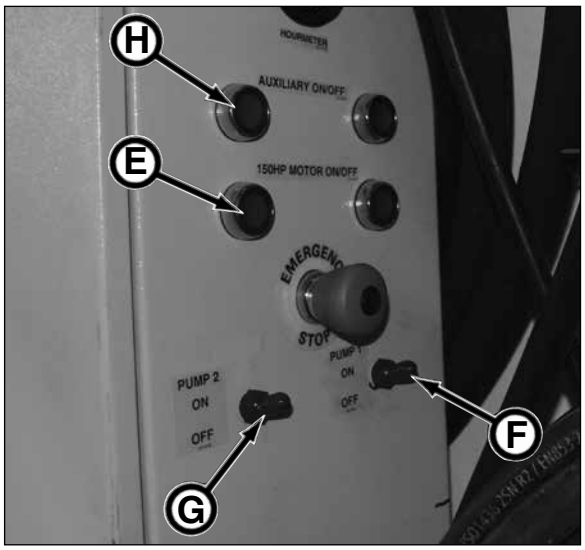


5. Press the 150HP motor control button (E) to the ON position.

6. Flip the Pump 1 (F) and Pump 2 (G) controls to the ON position.

7. (If used) Flip the Auxiliary motor control button (H) to the ON position.

8. Proceed to System Launch & Operation Procedure in this section to start EBS operations.



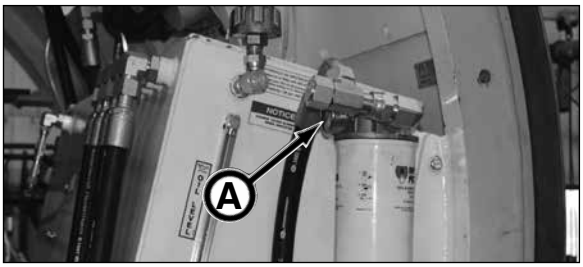
CHECK HYDRAULICS AFTER SYSTEM START-UP

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

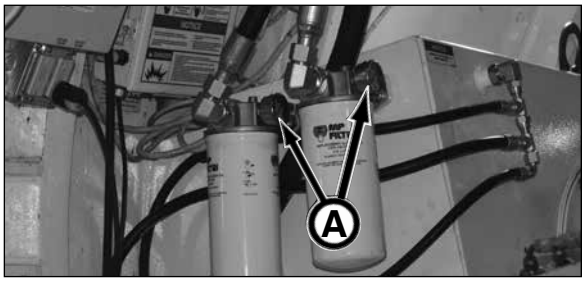
Release all pressure before performing maintenance or repairs, Never weld near pressurized fluid lines.

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

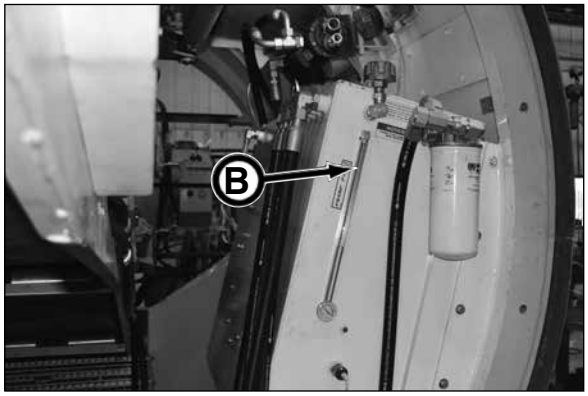
Contact medical help immediately if any oil or fluid is injected into your skin. A serious infection or reaction can emerge without proper medical treatment.



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-46 20W 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.

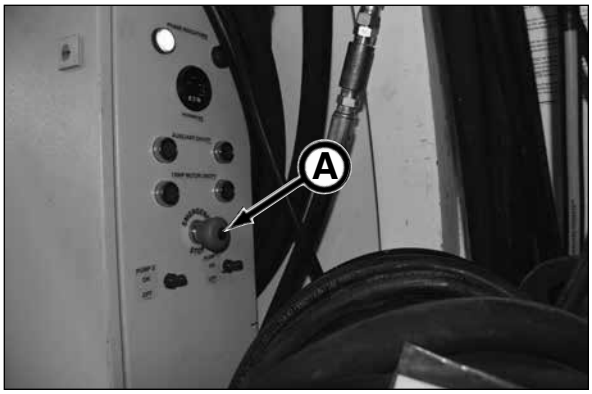
4. Check pressure gauges for proper hydraulic operation.

- Pump 1 Low Pressure Gauge -capable of 2,800 psi.
- Pump 2 Low Pressure Gauge -capable of 2,800 psi.
- Jacking Pressure Gauge -capable of 5,000 psi.
- Pilot Pressure Gauge -capable of 300 psi.
- Top Steering Cylinder Pressure Gauge -capable of 2,800 psi.
- Bottom Steering Cylinder Pressure Gauge -capable of 2,800 psi.

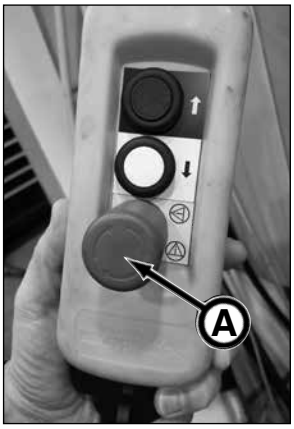
USING EMERGENCY STOP

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

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



EBS Control Panel Emergency Stop Button



Auxiliary Pendant Emergency Stop Button

USING GAS DETECTOR

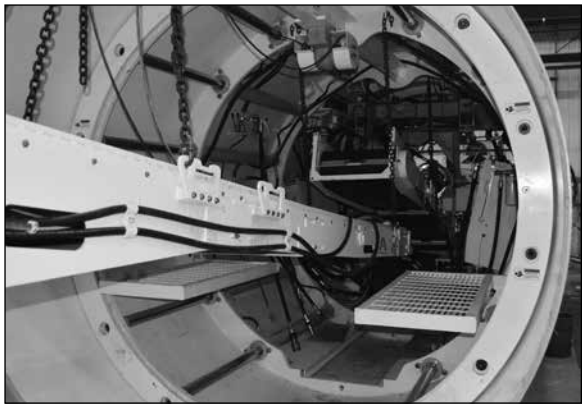
⚠DANGER Be aware that the harmful effects of entering an oxygen-deficient atmosphere can be so immediate that it is impossible to retreat to safety.

The gas detection system installed in the EBS system monitors only combustible gas levels. Monitoring of 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 EBS 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.

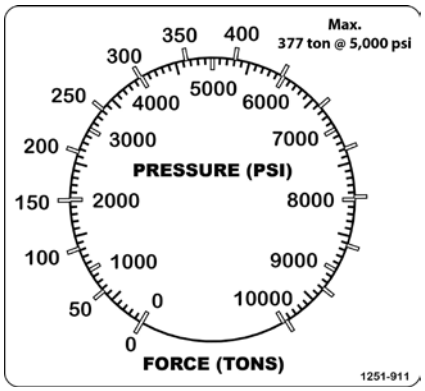
ADJUSTING THRUST PRESSURE

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 boring shield jacking system. The factory setting is 5,000 psi (34.474 mPa). If your pipe or tunnel liner 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 or tunnel liner.



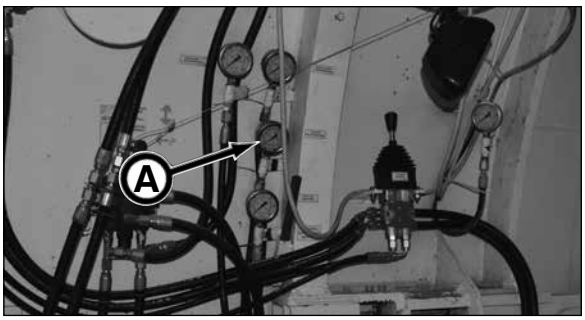
1. Check the thrust pressure rating for your product pipe or tunnel liner.

2. Calculate the pressure limit for your product pipe or tunnel liner based on every 1,000 psi is equal to approximately 75 tons of thrust pressure. Or refer to the thrust pressure diagram (to the right or the decal provided for the boring shield).



3. With the hydraulic hoses connected to the jacking can and power pack operating, fully retract the jacking cylinders.

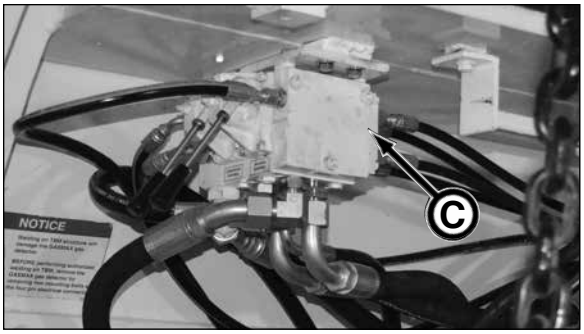
4. Check the thrust (jacking) pressure on the jacking pressure gauge (A).



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

5. There are two methods for adjusting the thrust pressure:

Method 1 Adjustment at the Pump Control (B) or



Method 2 Adjustment at the Jacking Valve (C).

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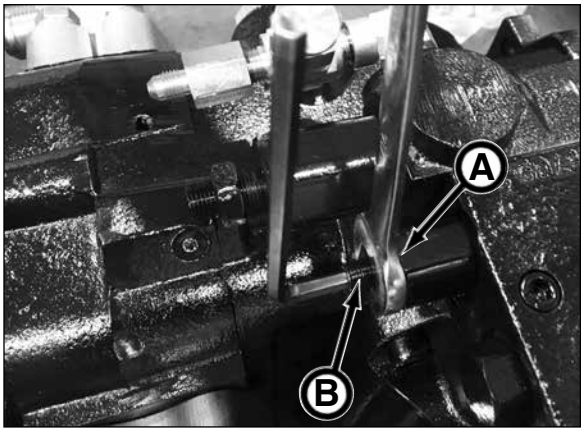
Method 1 Adjustment At the Pump Control

• If the pressure needs to be decreased, loosen jam nut (A) with a 9/16” wrench and turn adjustment screw (B) OUT with a 3/16 in. allen wrench. The pressure will drop approximately 1,000 psi per one complete revolution. Once the pressure is properly adjusted, tighten jam nut.

• If the pressure needs to be increased, loosen jam nut (A) with a 9/16” wrench and turn adjustment screw (B) IN with a 3/16 in. allen wrench. The pressure will increase approximately 1,000 psi per one complete revolution. Once the pressure is properly adjusted, tighten jam nut.



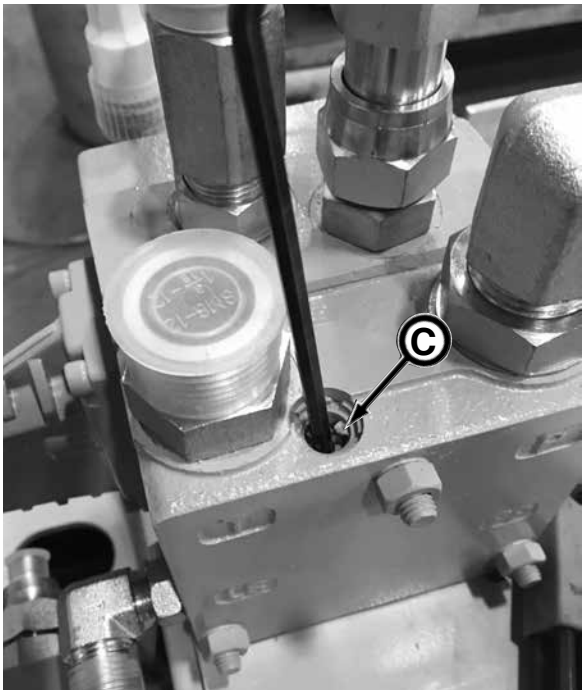
Pressure Adjustment At Pump Control

Method 2 Adjustment At the Jacking Valve

IMPORTANT: With this method the oil flow will go over the relief setting, therefore will generate more heat to the hydraulic system.

Using a 4 mm allen wrench:
• 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.



Pressure Adjustment At Jacking Valve

LAUNCH & OPERATION PROCEDURE

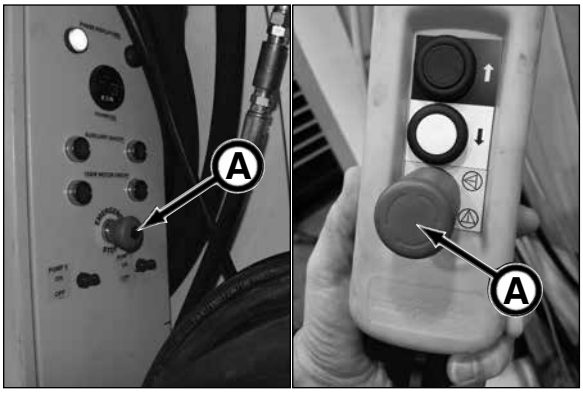
NOTICE The system set-up procedures must be completed prior to performing the launch and operation procedure.

⚠WARNING Hearing protection MUST be worn by operator while EBS is in operation.

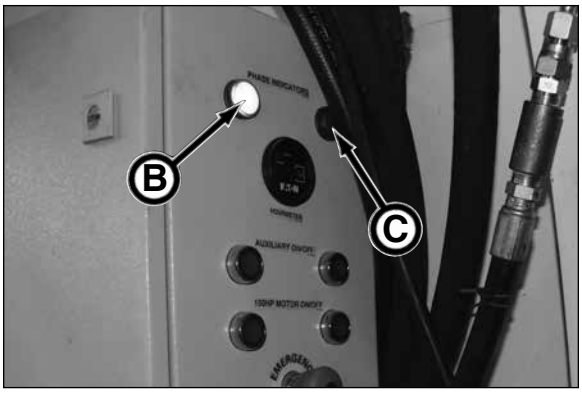
⚠WARNING Any electrical work performed on the electrical components must be completed by a certified electrician.

1.With Emergency Stop button (A) pushed in to stop position and all other controls turned to OFF position, hook up generator or other external power source to electrical connection on main electrical box in EBS (refer to Connecting Power Pack Electrical Connection in this section)

2. Turn generator or other source ON, and check the phase indicator lights. 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. Lock out, tag out all power and reverse two generator power leads, such as the red and black leads on main electrical box in TBM. Disconnect all power BEFORE attempting to rework the generator power.



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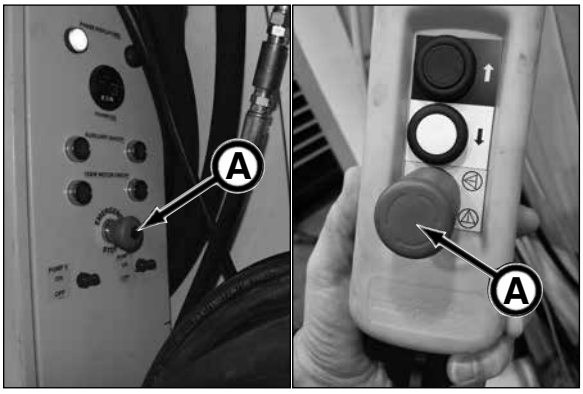
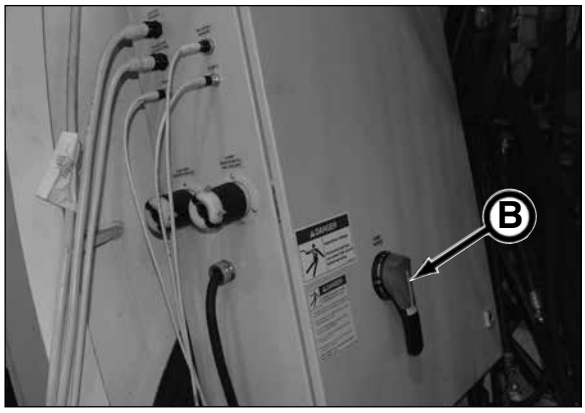
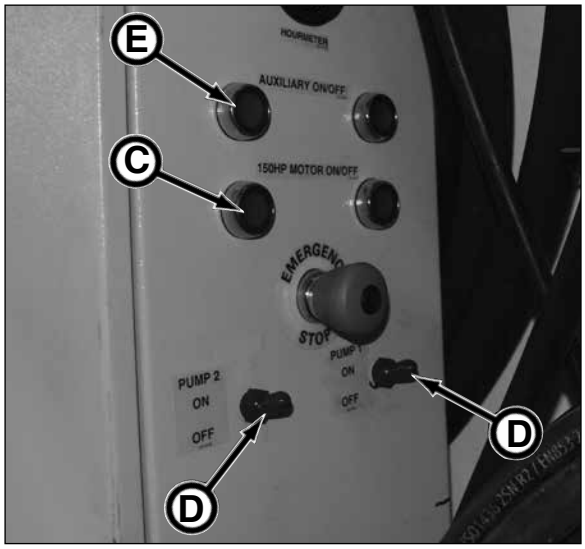
3. Confirm that all EBS controls are in the OFF position.
4. Turn on cooling water supply to heat exchanger.
5. Pull out all E-Stop buttons (A).



6. Flip main power disconnect switch (B) to the ON position.



7. Press the 150HP motor control (C) to the ON position.
8. Flip the Pump 1 and Pump 2 control switches (D) to the ON position.
9. (If used) Press the Auxiliary motor control (E) to the ON position.



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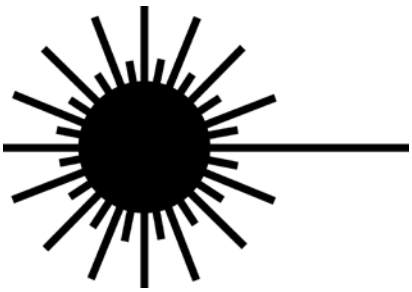
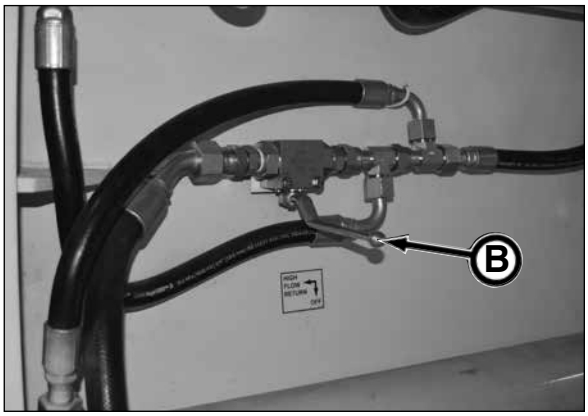


⚠DANGER Staring into laser light will cause severe injury. Do not stare into laser guidance system light beam. Avoid direct eye exposure.

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



11. Retract jacking cylinders using jacking control. Use High Flow Return control valve (B) as needed.

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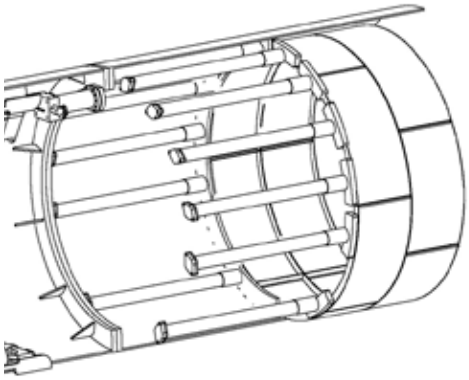
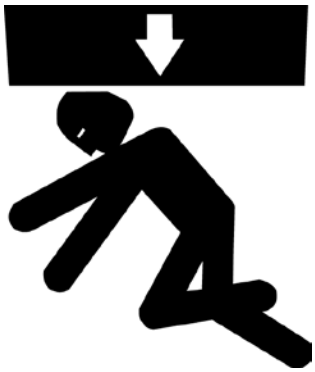
12. Assemble liner plate rings in jacking/liner can.

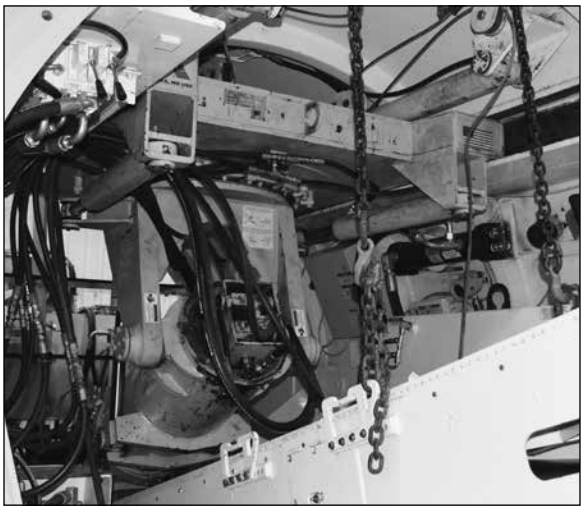


13. Once the liner plate rings (two complete sets) are assembled in the liner can of EBS, extend the jacking cylinders. The cylinders apply pressure to the liner plate which applies pressure to the thrust black or other support structure, pushing the EBS forward. Excavate face of EBS with EX50 as needed.



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

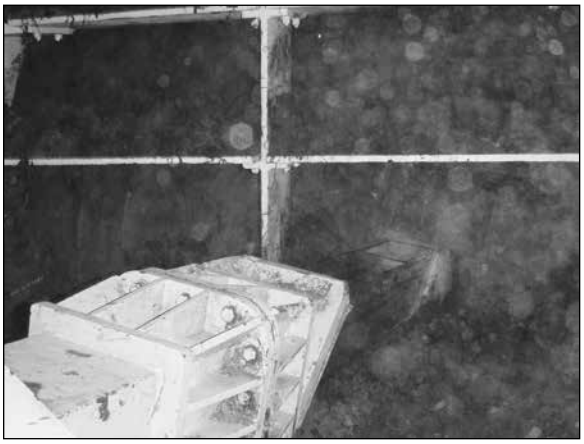
14. Lower the dirt bucket into position behind the conveyor; do not install the haul unit at this time.



15. Operate the conveyor and adjust the conveyor speed as needed.

16. As the jacking cylinders are extended, use the EX50 as needed to load spoils on the conveyor.

    - In hard ground, use the EX50 to excavate around the perimeter of the cutting area so the center spoils will drop to the conveyor.
    - In sand soils, the EX50 excavator is used more for clean up and guiding spoils to the conveyor.

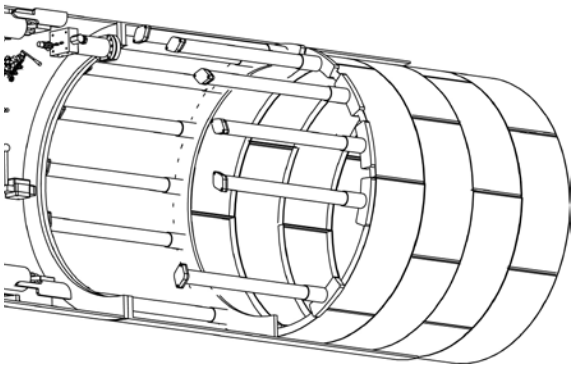


17. When the jacking cylinders are completely extended, retract the cylinders.

(continued on next page)

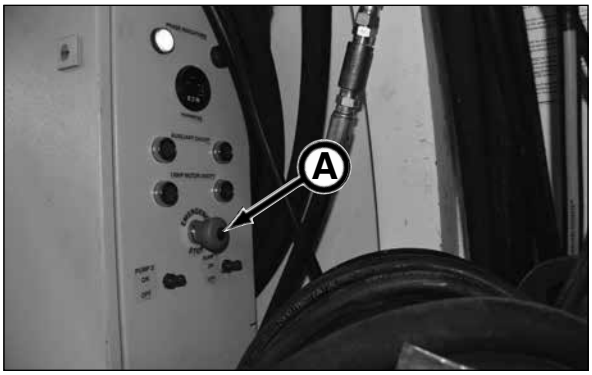
Launch & Operation Procedure (continued)

18. Check and adjust grade and alignment often. Remember to use only minor adjustments.



19. Continue assembling liner plate rings (complete sets) until EBS has been advanced forward enough to lower haul unit into EBS.

20. Remove dirt bucket.



21. Press E-Stop button IN (A) to shut down EBS power.

22. Perform lock out, tag out procedure on generator or other power source.

23. 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.

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

⚠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.

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

26. Perform power start up procedure (refer to Power Start-Up Procedure in this section).

27. Retract jacking/liner can cylinders and assemble liner plate rings in EBS.

28. Once the liner plate rings (two sets) are assembled in the liner can of EBS, extend the jacking cylinders and excavate face as necessary.

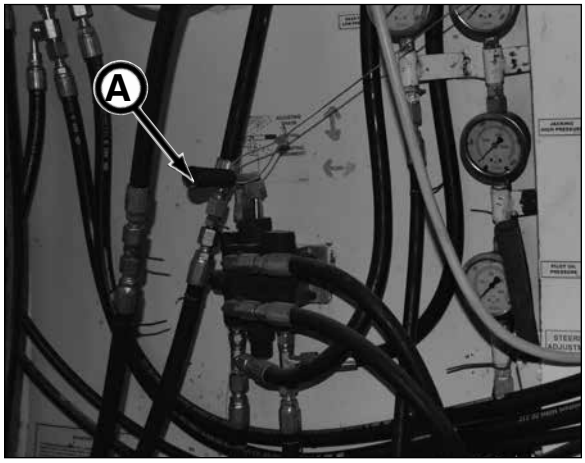
29. When the jacking cylinders are completely extended, retract the cylinders while loading spoils on the conveyors.

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

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

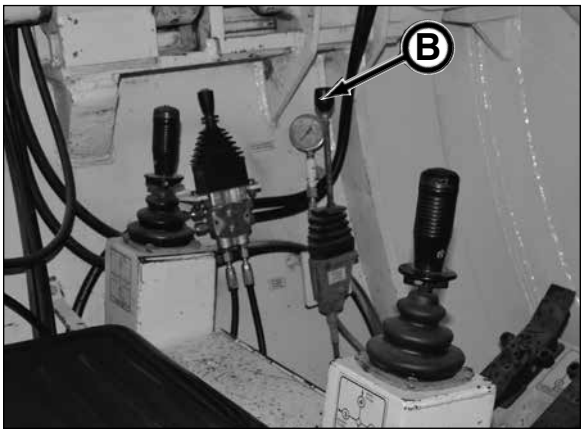
32. Continue to install additional liner plate, power cable and ventilation system as needed until the pipeline is complete.

STEERING ADJUSTMENTS



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

Use the steering selector (A) to select the grade or alignment adjustment.

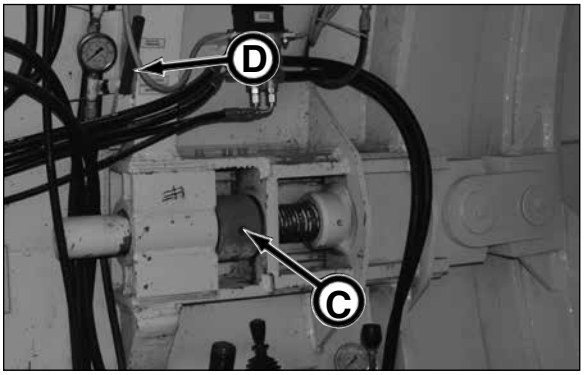


GRADE (up/down)
Move steering selector UP to select GRADE, then operate the steering cylinder control (B) to adjust the steering cylinders. Once adjustment is made, move steering selector to Neutral position.

ALIGNMENT (left/right)
Move steering selector DOWN to select Alignment. Once adjustment is made, move steering selector to Neutral position.

Left turn: operate the steering cylinder control (B) UP while turning steering adjustment nut (C) forward.

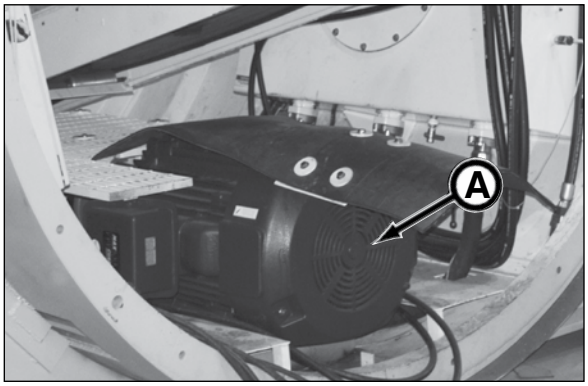
Right turn: operate the steering cylinder control (B) DOWN while turning steering adjustment nut back.



The steering adjustment nut assembly (C) provides right to left manual steering adjustments by rotating the nut forward or backwards.
A steering adjustment wrench (D) may be used to rotate nut, otherwise relieve pressure on the nut by slightly moving steering cylinders and rotate nut by hand.

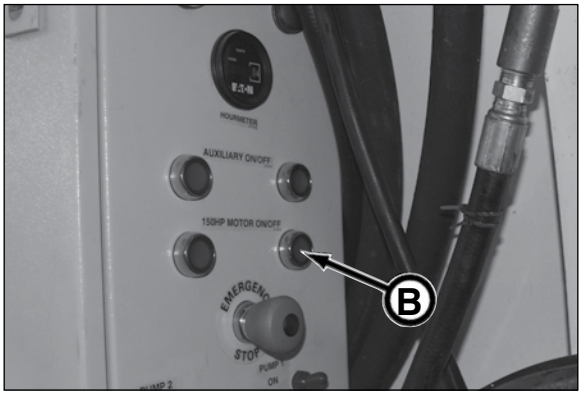
STOPPING THE POWER PACK 150HP MOTOR

The 150HP main motor operates the three hydraulic pumps which provides hydraulic power to the boring shield, excavator, conveyor and jacking/liner can components.



1. To stop the operation of the power pack 150 HP motor (A), simply press the 150HP motor control button (E) to the OFF position.

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

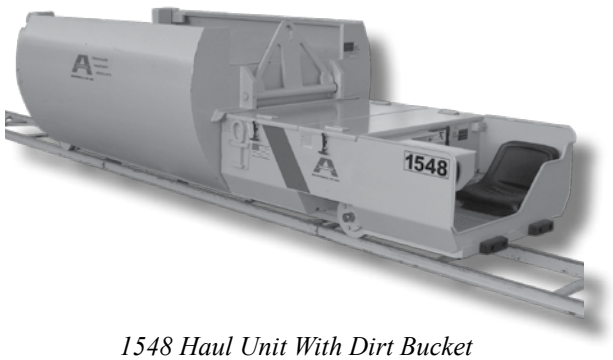


USING HAUL UNIT

⚠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.

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.



1548 Haul Unit With Dirt Bucket

DAILY SHUTDOWN

1. (If used) Flip the Auxiliary motor control button (A) to the OFF position.

2. Flip the Pump 1 (B) and Pump 2 (C) controls to the OFF position.

3. Press the 150HP motor control button (D) to the OFF position.

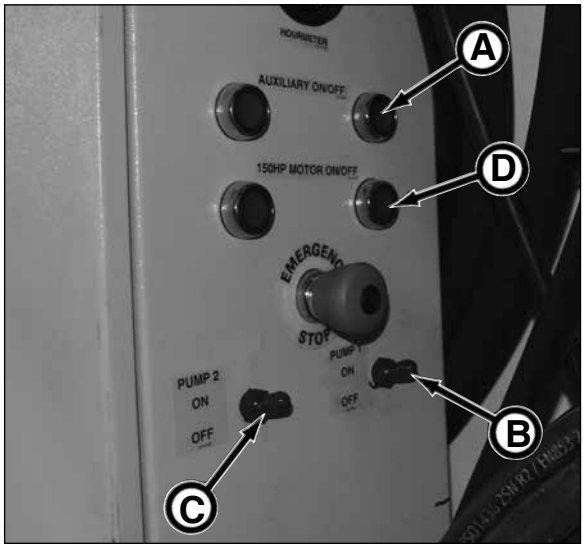
4. Flip main power disconnect switch (E) to the OFF position.

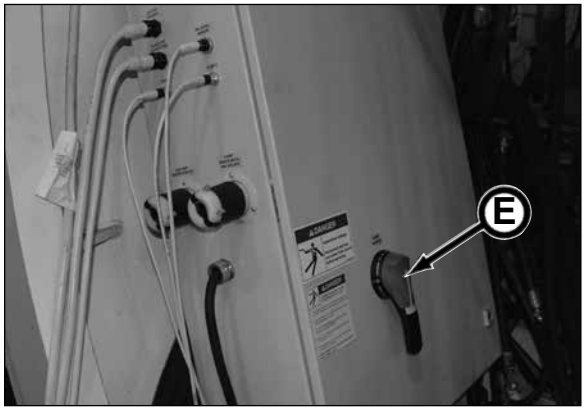
5. Push IN E-Stop buttons (F) to shut down EBS power.

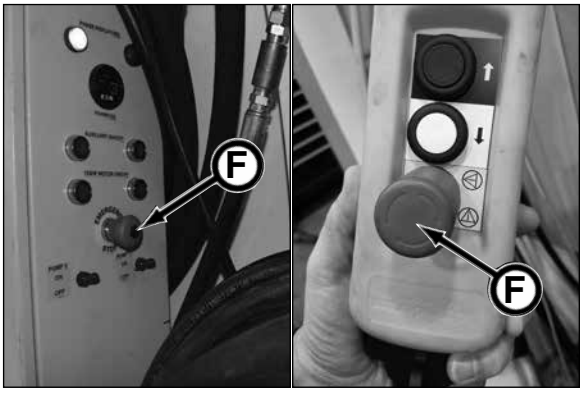
6. Shut off water supply to heat exchanger.

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

8. 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.







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 boring shield and jacking/liner can.
9. When transporting 960B boring shield machine, be sure cradles are in place prior to shipping.
10. Observe the lifting instructions for the Boring Shield and the Jacking/Liner Can on the following page.

LIFTING INSTRUCTIONS

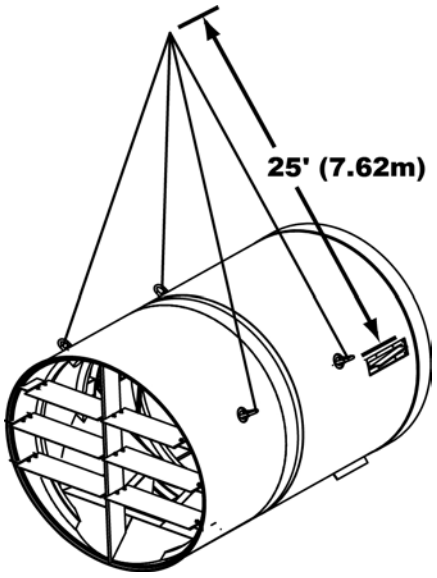
1. Excavator Boring Shield (EBS)

- 960EBS Excavator Boring Shield with 2418 conveyor weight is 48,000 lbs. (21,722 kg).

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

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

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



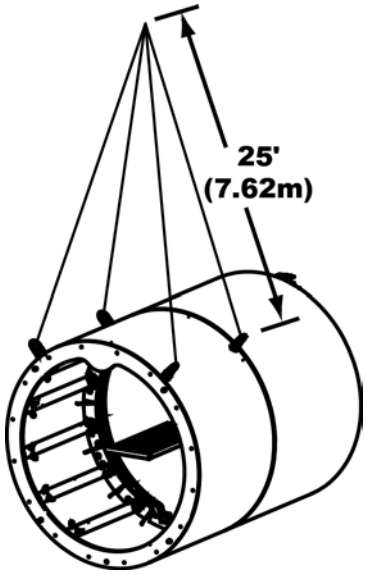
2. Jacking/Liner Can

- 960EBS Jacking/Liner Can with 2415 conveyor weight is 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/Liner Can must lift freely. If it is stuck to the ground, it must be broken loose prior to lifting.

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



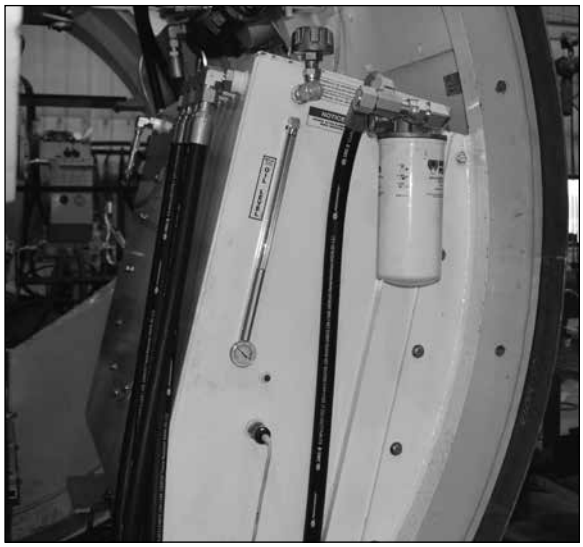
Lubricants

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

POWER PACK HYDRAULIC OIL RESERVOIR LUBRICANT

The power pack oil reservoir is typically filled with ISO-VG-46 Premium Hydraulic/Turbine Oil.

Use an API GL-1/GL-2 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:

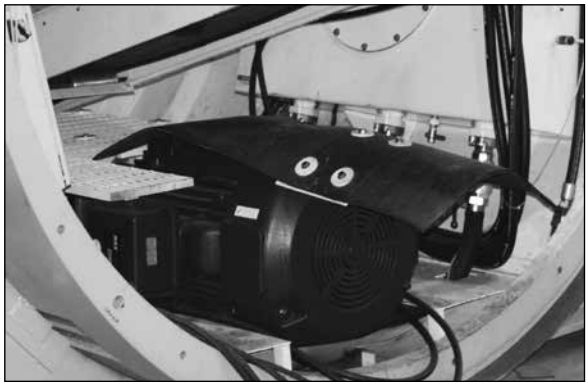
Ambient Temp.	**Hydraulic Oil**
-25°F to 60°F (-32°C to 16°C)	ISO 32
0°F to 95°F (-18°C to 35°C)	ISO 46
32°F to 105°F (-0°C to 41°C)	ISO 68

NOTICE If you change to a different oil, use a reputable oil supplier to meet or exceed the ISO-VG-68 or API GL-1/GL-2 oil specification. **Do not mix oil manufacturers or grades.**

Oil capacity is approximately 130 US gal. (492 L).

ELECTRIC MOTOR GREASE

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

GREASE

The lubrication points are greased (C) with Mobilgrease® XHP222 Premium Lubricating Grease.

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

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

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.

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.

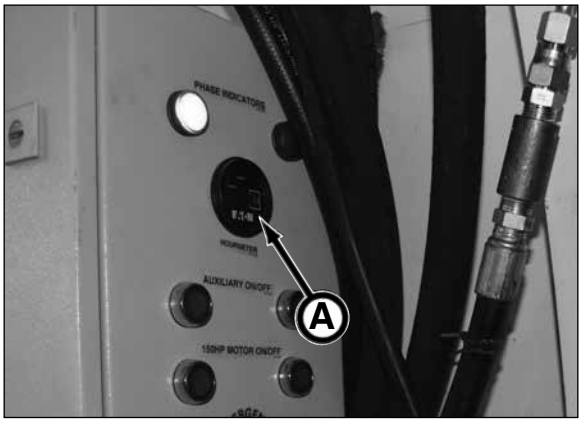
LUBRICATION & MAINTENANCE INTERVALS

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 hourmeters (A) on each module to help determine proper maintenance intervals.

The hourmeters register in full hours and 1/10ths hours.

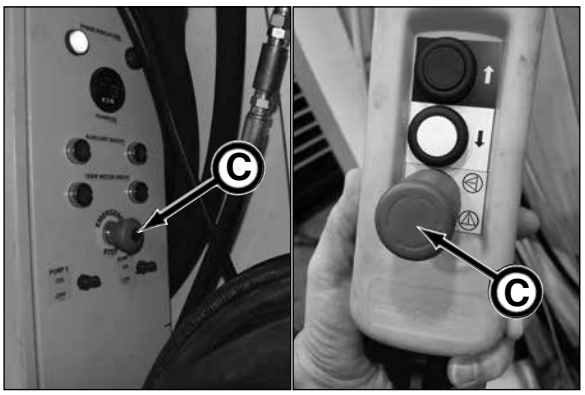


LOCKOUT TAGOUT POWER BEFORE SERVICING

⚠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 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.



BEFORE PERFORMING MAINTENANCE

1. Perform daily shutdown procedure. Refer to Daily Shut Down 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 lock out/tag out 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.

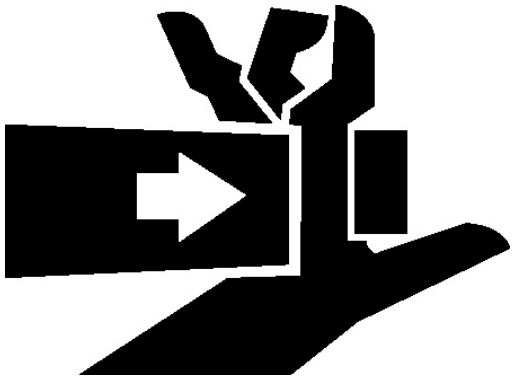
AVOID PINCH POINTS

⚠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.



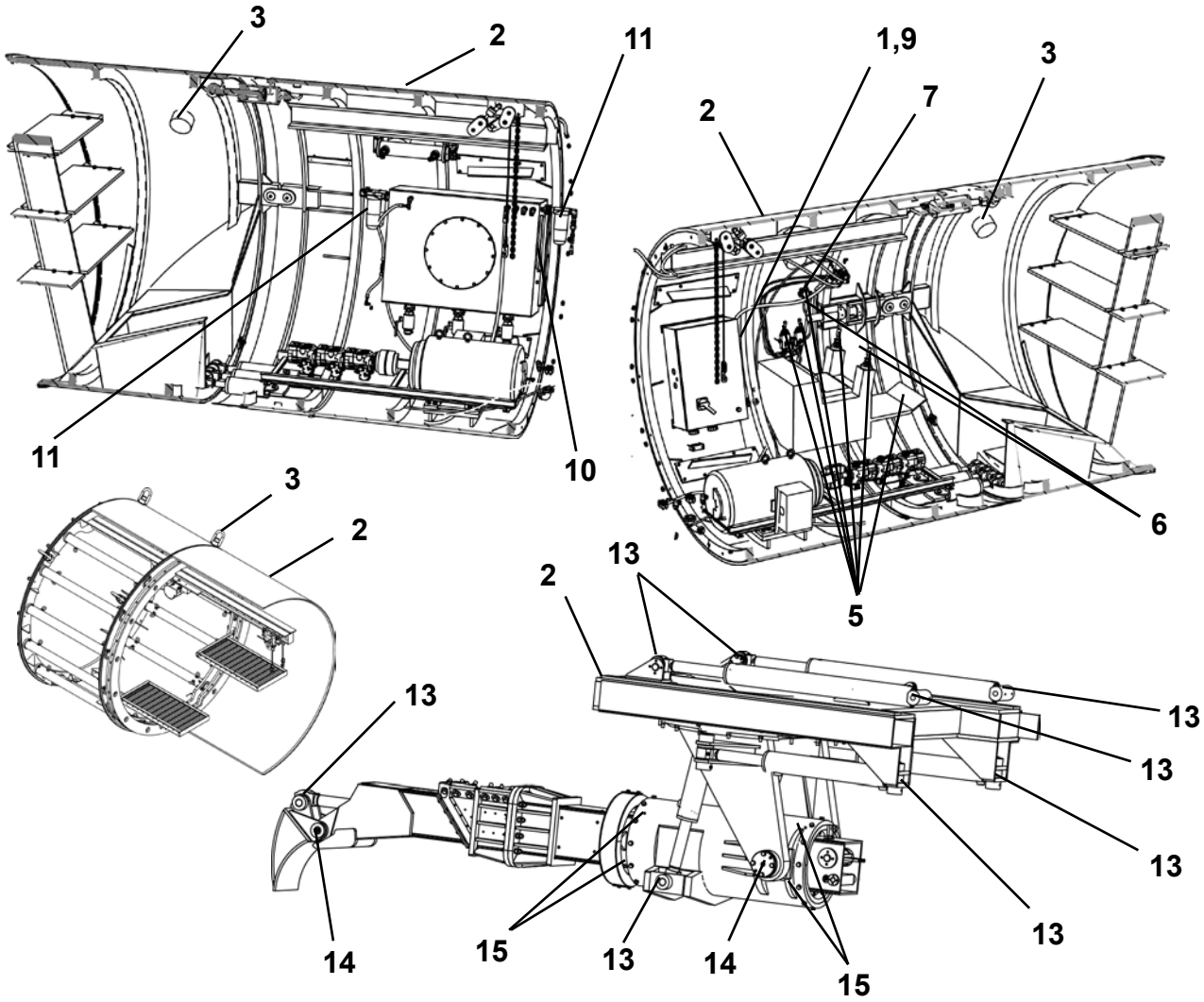
UNAUTHORIZED WELDING

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

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

MAINTENANCE CHARTS

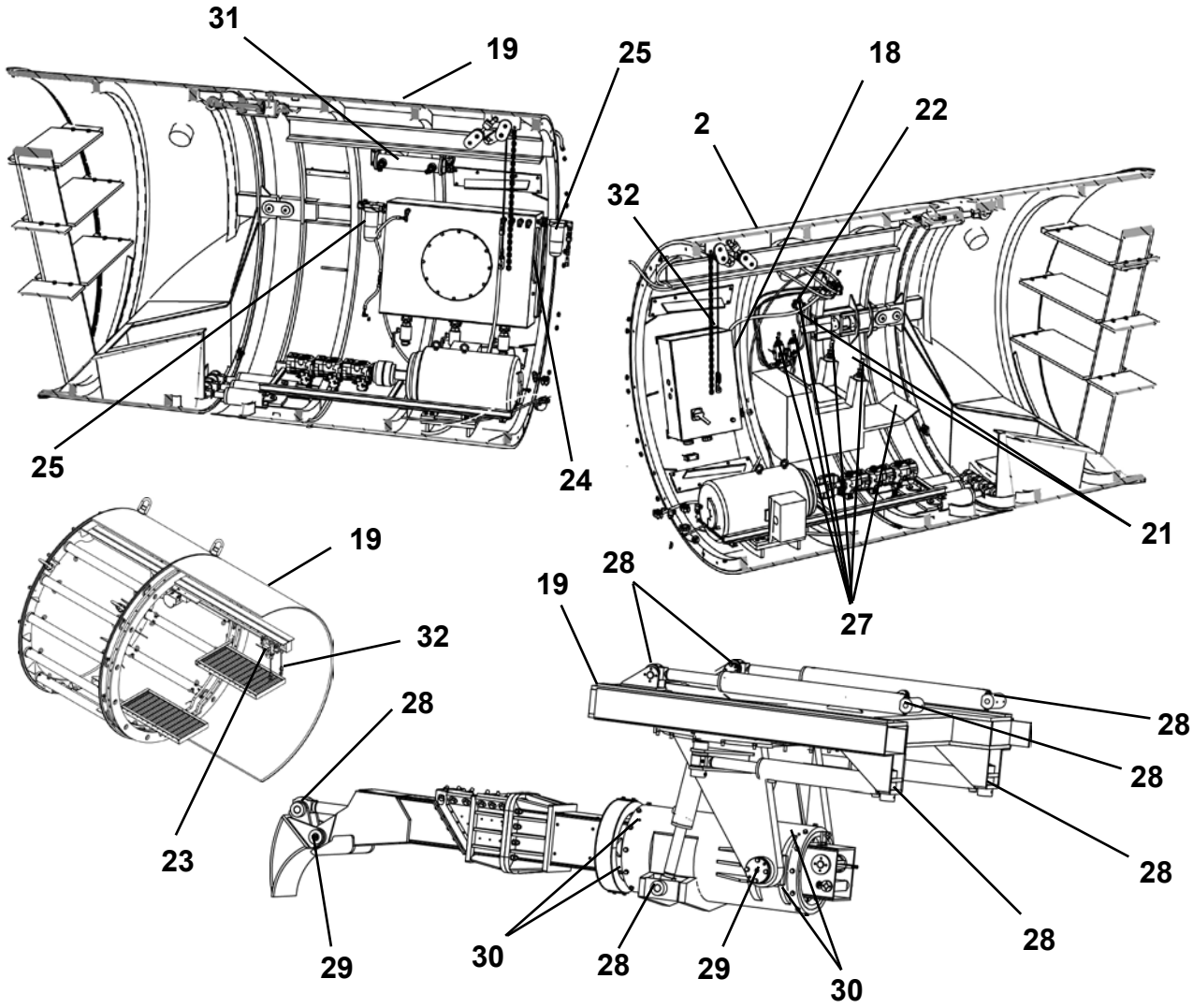
Use the item number in the chart to refer to the detailed maintenance procedures later in this section.



PRIOR TO EACH JOB LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	E-Stop	Check Operation	E-Stop- Power Pack & Controller	
2.	Structure	Inspect for Cracks/Wear	If damaged, repair prior to use.	
3.	Lift Eyes	Inspect	If damaged, repair or replace prior to use.	
*4.	Elect/Hyd Connect.	Check	Connections must be secured.	
5.	Controls	Check Operation		
6.	Gauge	Check Operation		
7.	Steering	Check Line & Grade		
8.	Conveyor Lift	Lubricate (11 places)	Lubricate until grease is forced out.	Mobil XHP222
9.	Phase Power	Check		
10.	Hydraulic Oil	Check Level & Condition	Refill or replace as needed.	ISO-VG-46
11.	Hyd. Return Filters	Check	Replace filters per indicator.	Return Filters
*12.	Rails	Inspect	If damaged, repair or replace.	
13.	EX50 Cylinder Pins	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
14.	EX50 Frame	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
15.	EX50 Boom Rot. Bshg	Lubricate	Lubricate with one shot of grease.	Mobil XHP222
*16.	Decals	Inspect	Must be legible. Replace as needed.	
*17.	Supporting Equip.	Perform Maintenance	Refer to your machine's maintenance manual.	

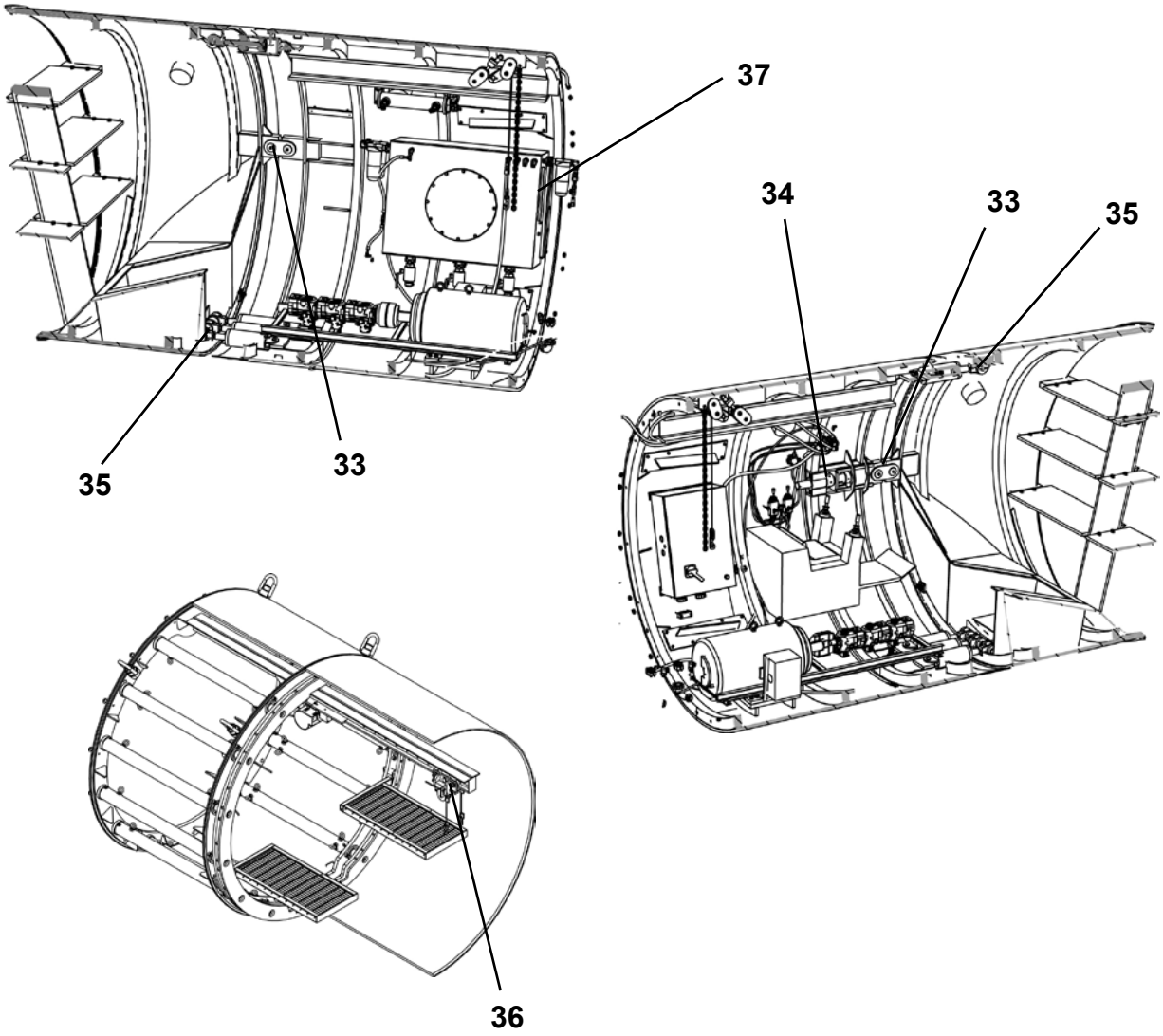
* Not Shown



DAILY OR EVERY 10 HOURS OF OPERATION OR SHIFT CHANGE

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
18.	E-Stop	Check Operation	E-Stop- Power Pack & Controller	
19.	Structure	Inspect	If damaged, repair prior to use.	
*20.	Elect/Hyd Connect.	Check	Connections must be secured.	
21.	Gauge	Check Operation		
22.	Steering	Check Line & Grade		
23.	Conveyor Lift	Lubricate (11 places)	Lubricate until grease is forced out.	Mobil XHP222
24.	Hydraulic Oil	Check Level & Condition	Refill or replace as needed.	ISO-VG-46
25.	Hyd. Return Filters	Check	Replace filters per indicator.	Return Filters
*26.	Rails	Inspect	If damaged, repair or replace.	
27.	Controls	Check Operation		
28.	EX50 Cylinder Pins	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
29.	EX50 Frame	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
30.	EX50 Boom Rot. Bshg	Lubricate	Lubricate with one shot of grease.	Mobil XHP222
31.	Heat Exchanger	Flush & Drain	In freezing weather.	
32.	Conveyor Lift Cable	Inspect	Replace at first sign of wear or damage.	

* Not Shown



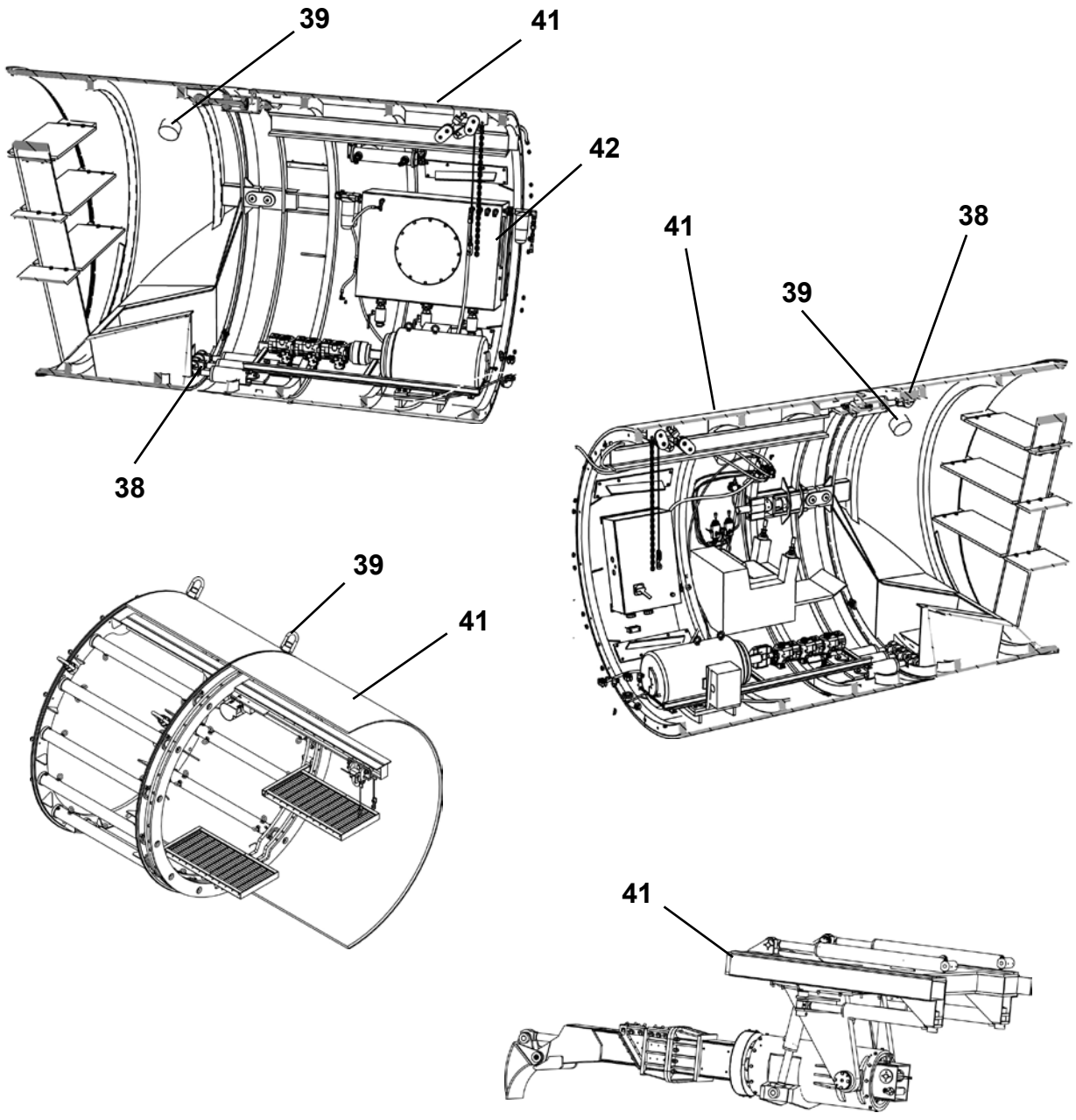
WEEKLY OR EVERY 50 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
33.	Steering Link	Check for elongation.	Replace if > 3/16”.	
34.	Steering Link	Lubricate nut & threads.	Lubricate thoroughly.	Anti seize lube
35.	Steering Cylinder	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
36.	Conveyor Lift	Lubricate	Lubricate until grease is forced out.	Mobil XHP222

MONTHLY OR EVERY 250 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
37.	Pwr Pack Oil Analysis	Perform Analysis	Oil Sample	

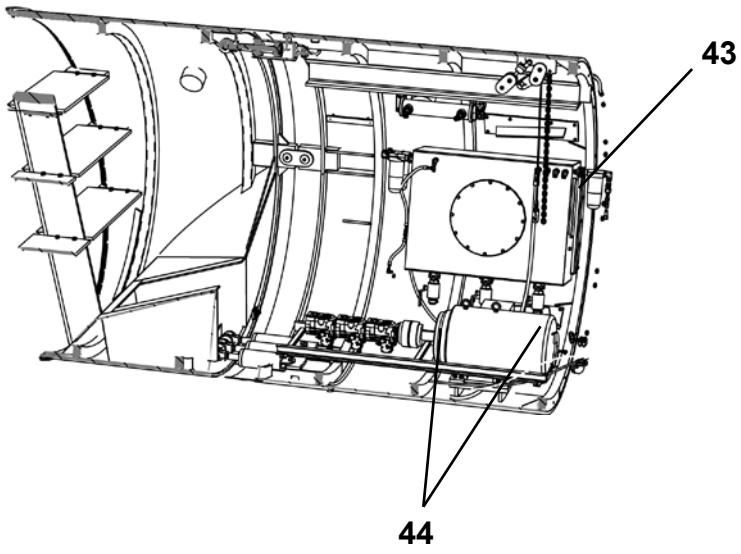
* Not Shown



COMPLETION OF EACH DRIVE

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
38.	Steering Cylinders	Inspect	If damaged, repair or replace.	
39.	Lifting Eye	Inspect	Repair if damaged before lifting.	
*40.	Hoses/Pwr Cables	Inspect	Replace if damaged before operating.	
41.	Structure	Inspect	If damaged, repair or replace	
42.	Hydraulic Reservoir	Drain Water	Drain until water is removed.	

* Not Shown



EVERY 1000 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
43.	Hydraulic Reservoir	Drain & Fill	Drain and fill with new oil.	ISO-VG-46

ANNUALLY

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

PRIOR TO EACH JOB LAUNCH

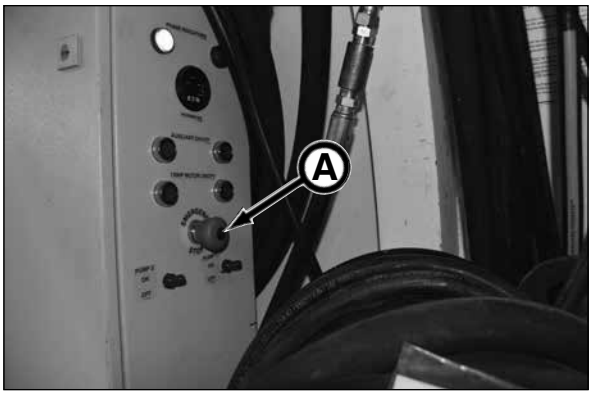
1. CHECK EMERGENCY STOP OPERATION

⚠WARNING Emergency Stop (E-Stop) buttons MUST function properly BEFORE operating the sliplining system. Failure to do so may cause severe injury or death.

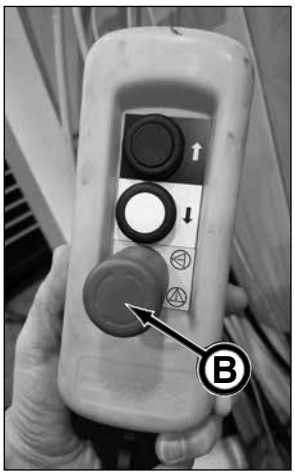
Check E-Stop buttons (A and B) for proper operation. When pushed in, the E-Stop must stop hydraulic and electrical power. Be sure to check the function of both E-Stop buttons; the EBS control panel and the auxiliary pendant.

The button will function as follows:

STOP	- Push button IN
Power for Start Circuit	- Pull button OUT



EBS Control Panel Emergency Stop Button (A)



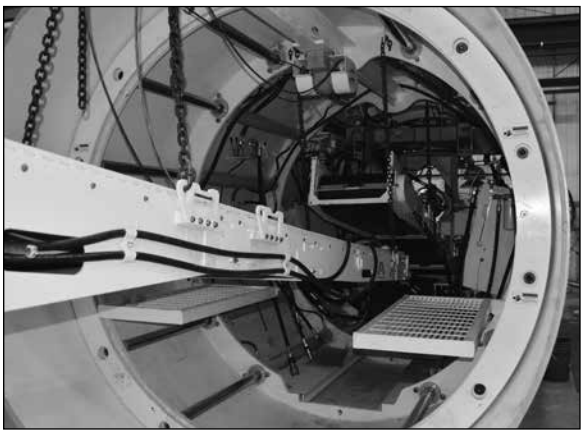
Auxiliary Pendant Emergency Stop Button (B)

2. INSPECT STRUCTURES

Perform a visual inspection of the boring shield, EX50 excavator and jacking/liner can structures for cracks, wear or other damage. Repair or replace BEFORE operation.

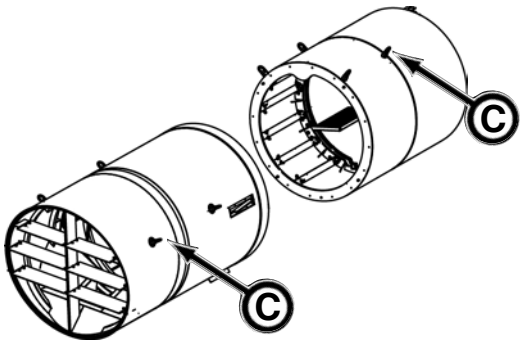
Check for oil leaks and debris buildup. Make repairs as needed and remove debris.

Check for loose, damaged or missing parts. Repair or replace as necessary. Replace any defective parts.



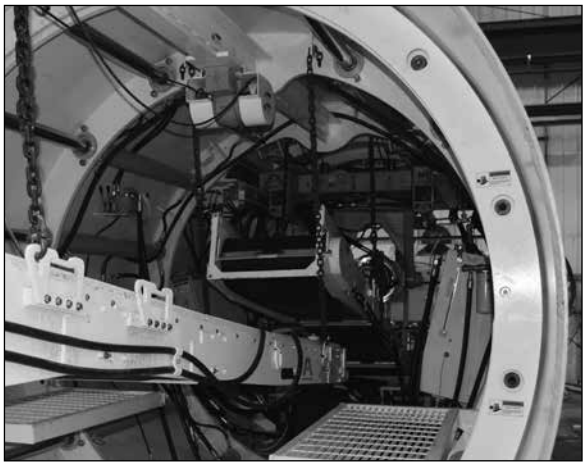
3. INSPECT LIFTING EYES

Inspect lifting eyes (C) for wear or damage. Worn or damaged lifting eyes MUST be replaced before lifting.



4. 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 LOCK OUT, TAG OUT, 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.

5. CHECK CONTROL OPERATION

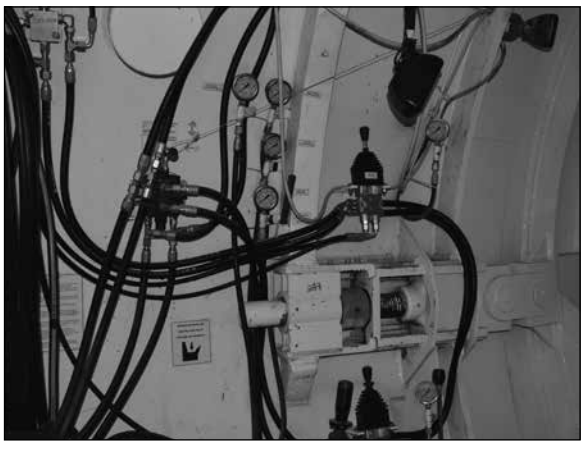
⚠WARNING BEFORE checking control operations, be sure all personnel are away from machine. Unexpected movement may cause severe injury or death.

Check all controls a for proper operation. If controls do not function properly, repair or replace BEFORE operation.

- ALL E-Stop buttons
- On-Board Power Pack controls
- Excavator control functions
- Jacking/Liner Can control functions
- Conveyor functions
- Light operation

6. CHECK GAUGE OPERATION

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



Check pressure gauges for proper hydraulic operation.

- Pump 1 Low Pressure Gauge -capable of 2,800 psi.
- Pump 2 Low Pressure Gauge -capable of 2,800 psi.
- Jacking Pressure Gauge -capable of 5,000 psi.
- Pilot Pressure Gauge -capable of 300 psi.
- Top Steering Cylinder Pressure Gauge -capable of 2,800 psi.
- Bottom Steering Cylinder Pressure Gauge -capable of 2,800 psi.

7. CHECK STEERING LINE & GRADE

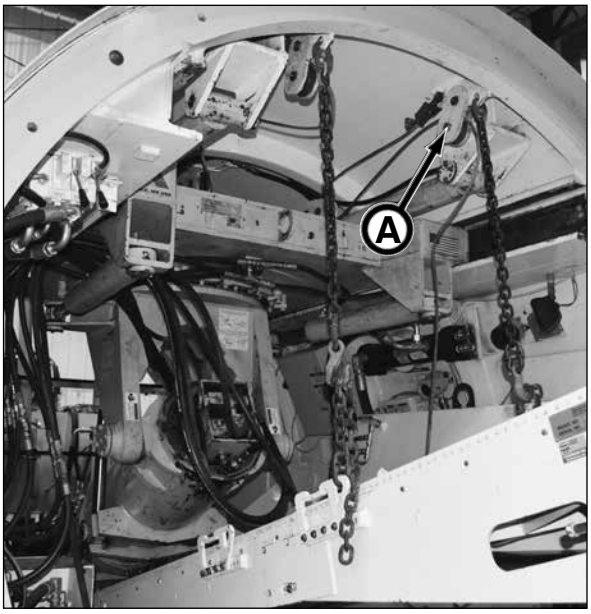
Check line and grade before launching. Adjust as needed using the steering cylinders and steering adjustment assembly.

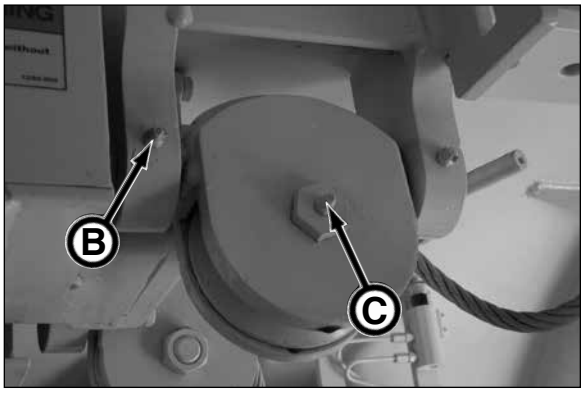
Be sure to check line and grade alignment often, with and without forward thrust applied. Keep in mind if you are off one degree, the bore will be off nearly two feet per one hundred feet.

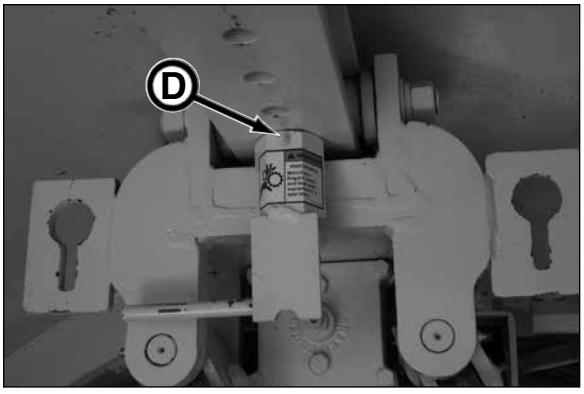
8. LUBRICATE CONVEYOR LIFT

Lubricate conveyor lift (11 places) with Mobilgrease® XHP222 or equivalent until grease is forced out.

Excavator pulley bearing (A) - 4 places
Trolley bracket pins (B) - 4 places
Cable pulley bearing (C) - 2 places
Adjustment pin (D) - 1 place



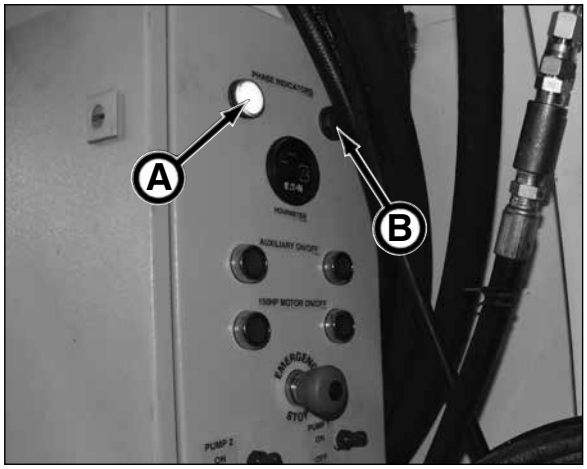




9. CHECK PHASE POWER

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

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



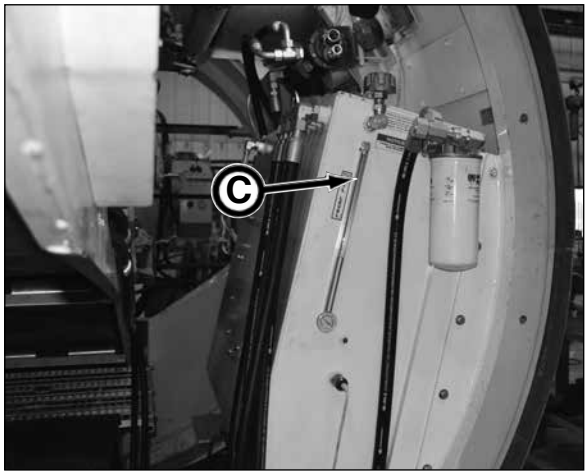
If the green Phase OK indicator (A) is illuminated, this indicates that the external power source phase power is installed correctly and the main power can be turned on.

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.

10. 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.

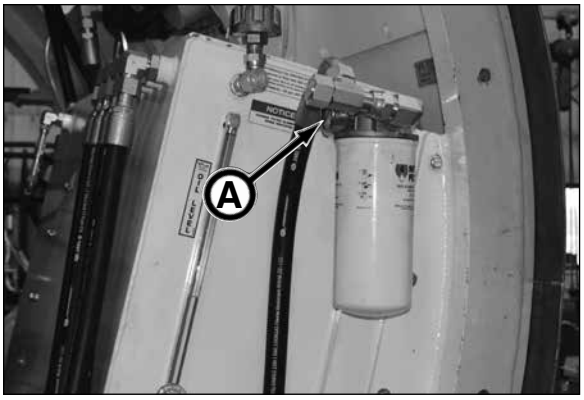


If any of these conditions are found, the reservoir must be drained, cleaned, and refilled with new, clean filtered hydraulic oil. All hydraulic filters also require replacement. Refer to Every 1000 Hours of Operation, “43. Drain & Fill Hydraulic Oil” in this section.

2. Check the hydraulic reservoir sight gauge (C) 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.

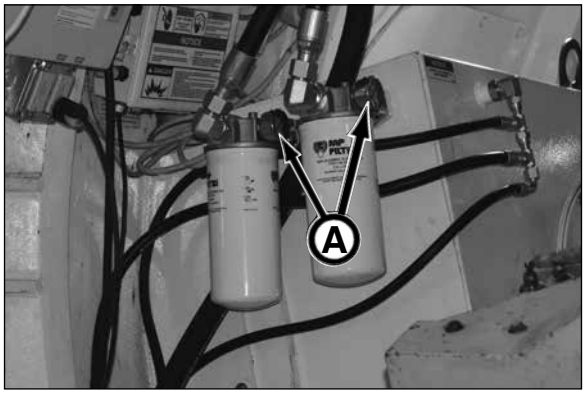
11. CHECK HYDRAULIC RETURN FILTER INDICATORS

To prevent over or under servicing of the hydraulic return filters, filter indicators (A) are installed on the filter head assemblies in the power pack.



Always check gauges when the oil is at normal operating temperature and the system is at normal operating flow. Otherwise, the gauges may indicate a false reading.

All filters and oil 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.



The green OK zone indicates that the filter is functioning properly.

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

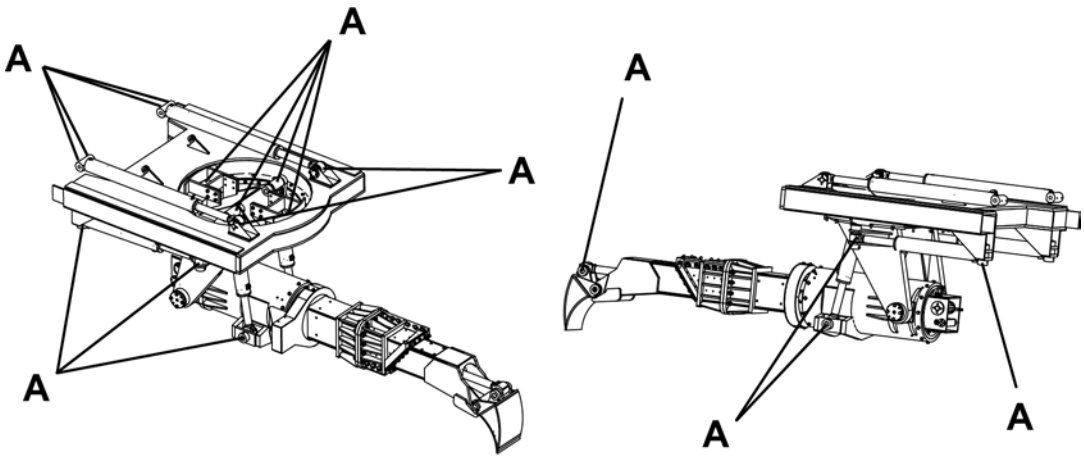
When the needle on the gauge is in the red CHANGE zone, replace filter(s) as soon as possible to prevent hydraulic component damage.

12. INSPECT RAIL SYSTEM

Inspect rail system (C) for wear or damage. Worn or damaged rails MUST be replaced before lifting.

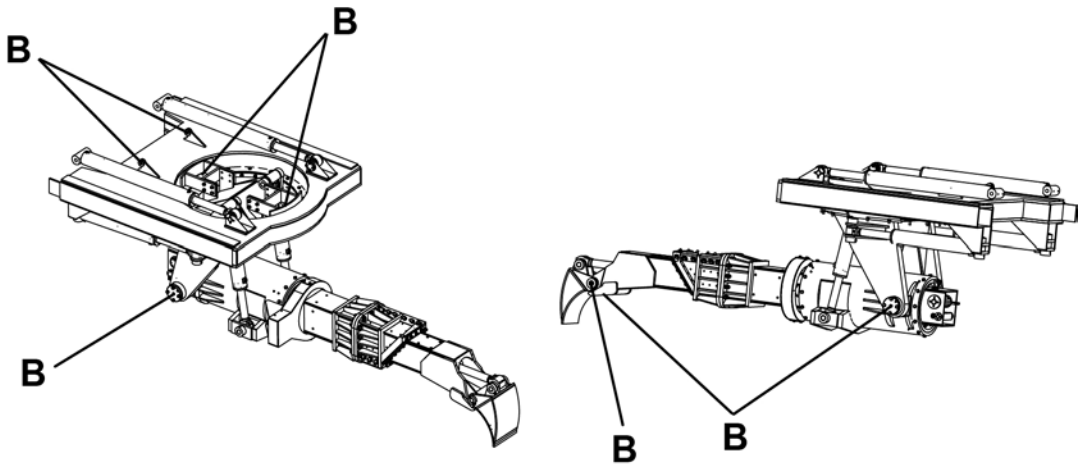
13. LUBRICATE EX50 CYLINDER PINS

Lubricate cylinder pins (A) with Mobilgrease® XHP222 or equivalent until grease is forced out.



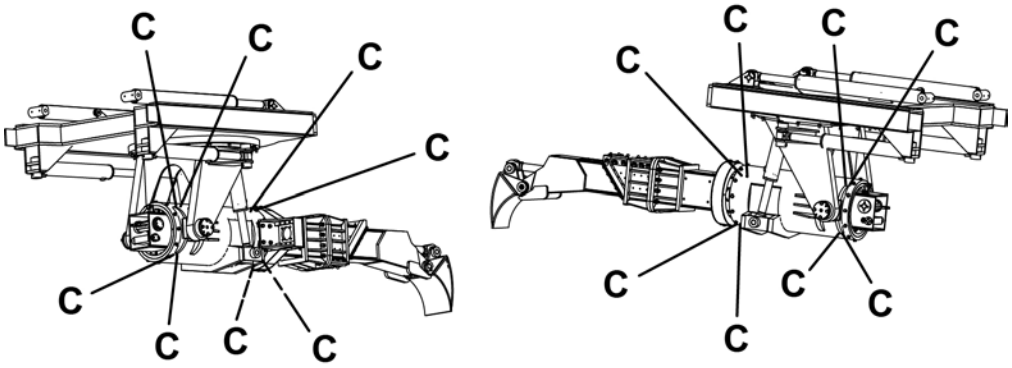
14. LUBRICATE EX50 FRAME LUBRICATION POINTS

Lubricate frame lubrication points (B) with Mobilgrease® XHP222 or equivalent until grease is forced out.



15. LUBRICATE EX50 BOOM ROTATION LUBRICATION POINTS

Lubricate boom rotation bushings (C) with ONE SHOT of Mobilgrease® XHP222 or equivalent. **DO NOT OVERGREASE! Doing so WILL lock up boom rotation.** Later models have 16 places, earlier models have 8 lubrication points.



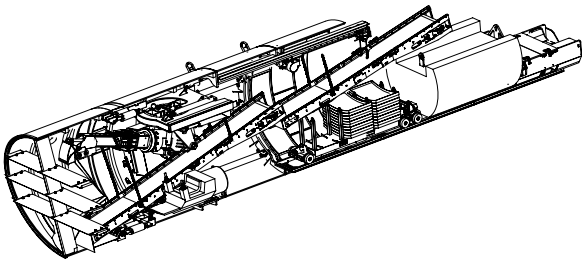
16. INSPECT DECALS

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.

17. 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 EBS. Refer to the operation and maintenance manuals of the equipment.

DAILY OR EVERY 10 HOURS OF OPERATION OR SHIFT CHANGE

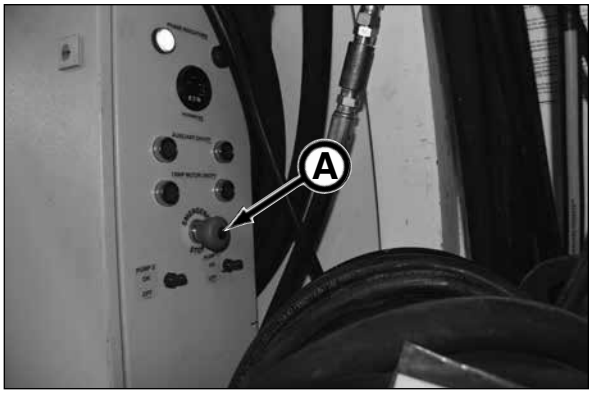
18. CHECK EMERGENCY STOP OPERATION

⚠WARNING Emergency Stop (E-Stop) buttons MUST function properly BEFORE operating the sliplining system. Failure to do so may cause severe injury or death.

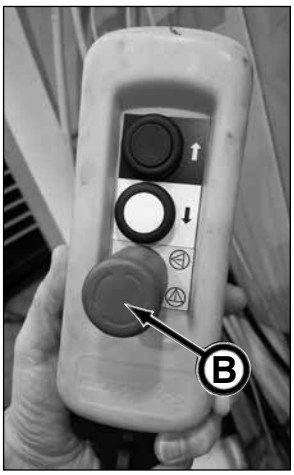
Check E-Stop buttons (A and B) for proper operation. When pushed in, the E-Stop must stop hydraulic and electrical power. Be sure to check the function of both E-Stop buttons; the EBS control panel and the auxiliary pendant.

The button will function as follows:

STOP	- Push button IN
Power for Start Circuit	- Pull button OUT



EBS Control Panel Emergency Stop Button (A)



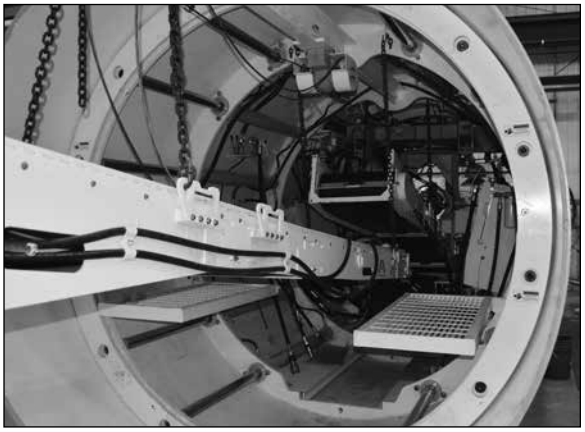
Auxiliary Pendant Emergency Stop Button (B)

19. INSPECT STRUCTURES

Perform a visual inspection of the boring shield, EX50 excavator and jacking/liner can structures for cracks, wear or other damage. Repair or replace BEFORE operation.

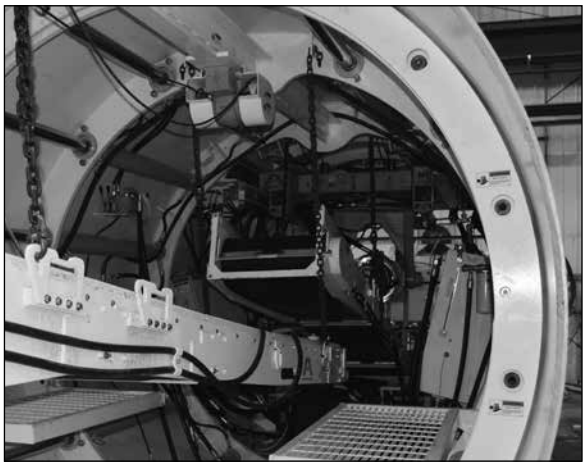
Check for oil leaks and debris buildup. Make repairs as needed and remove debris.

Check for loose, damaged or missing parts. Repair or replace as necessary. Replace any defective parts.



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.

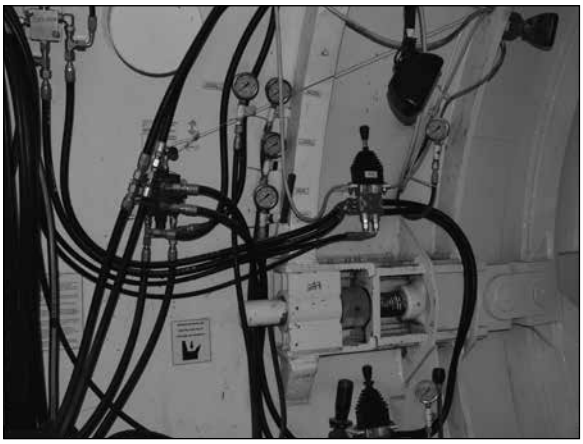


With power in LOCK OUT, TAG OUT, check electrical power cables and connections for fraying, wear or damage. If damaged, the cables must be replaced BEFORE operation. Be sure connections are secured.

Inspect ALL hydraulic hoses for cracks, wear or other damage. Repair or replace BEFORE operation.

21. CHECK GAUGE OPERATION

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



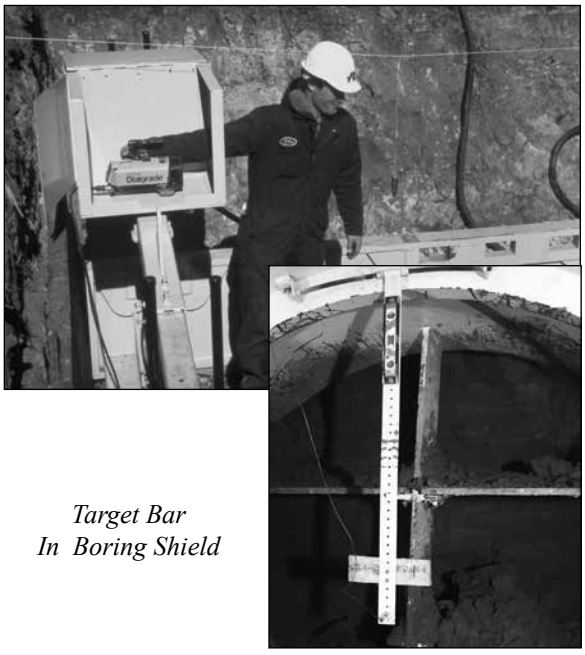
Check pressure gauges for proper hydraulic operation.

- Pump 1 Low Pressure Gauge -capable of 2,800 psi.
- Pump 2 Low Pressure Gauge -capable of 2,800 psi.
- Jacking Pressure Gauge -capable of 5,000 psi.
- Pilot Pressure Gauge -capable of 300 psi.
- Top Steering Cylinder Pressure Gauge -capable of 2,800 psi.
- Bottom Steering Cylinder Pressure Gauge -capable of 2,800 psi.

22. CHECK STEERING LINE & GRADE

Check line and grade often. Adjust as needed using the steering cylinders and steering adjustment assembly.

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.

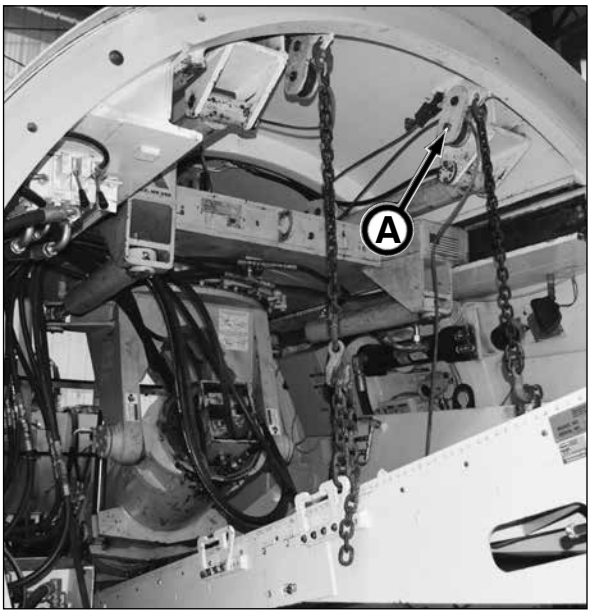


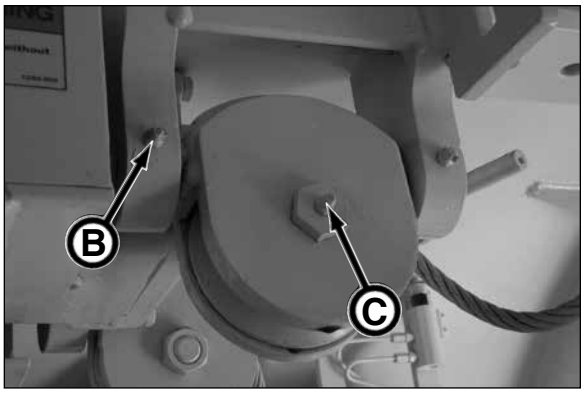
Target Bar In Boring Shield

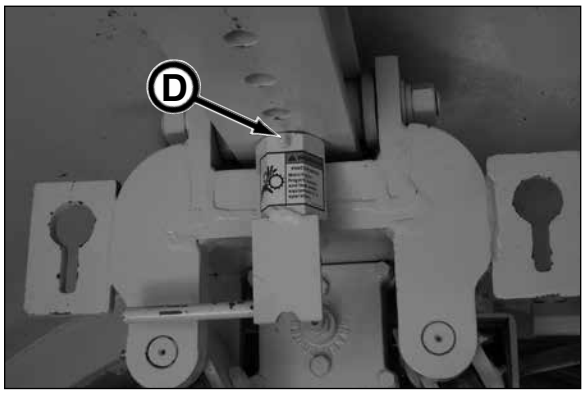
23. LUBRICATE CONVEYOR LIFT

Lubricate conveyor lift (11 places) with Mobilgrease® XHP222 or equivalent until grease is forced out.

Excavator pulley bearing (A) - 4 places
Trolley bracket pins (B) - 4 places
Cable pulley bearing (C) - 2 places
Adjustment pin (D) - 1 place







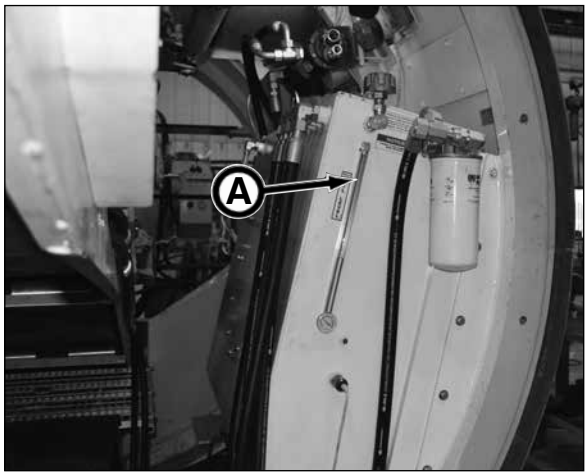
24. CHECK HYDRAULIC OIL RESERVOIR CONDITION & LEVEL OF OIL

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, “43. 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.



25. CHECK HYDRAULIC RETURN FILTER INDICATORS

To prevent over or under servicing of the hydraulic return filters, filter indicators (B) are installed on the filter head assemblies in the power pack.

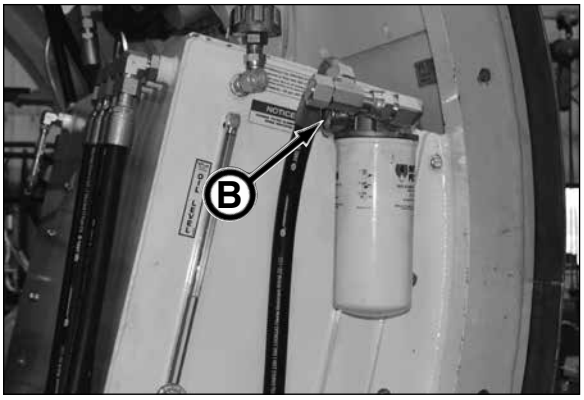
Always check gauges when the oil is at normal operating temperature and the system is at normal operating flow. Otherwise, the gauges may indicate a false reading.

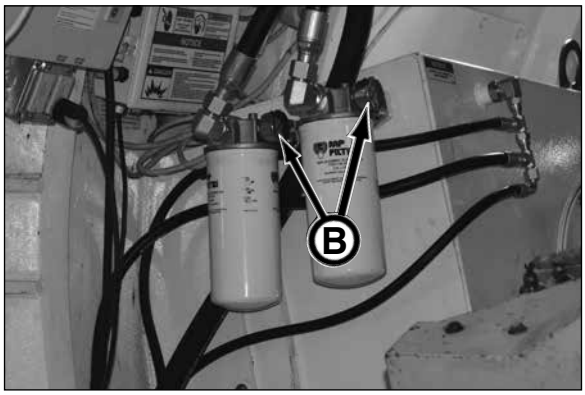
All filters and oil require replacement if any of the following situations occur:
- A major component fails.
- Any sign of water contamination from an oil analysis or if oil is milky or foaming.
- A hydraulic oil sample indicates large particle contamination.

The green OK zone indicates that the filter is functioning properly.

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

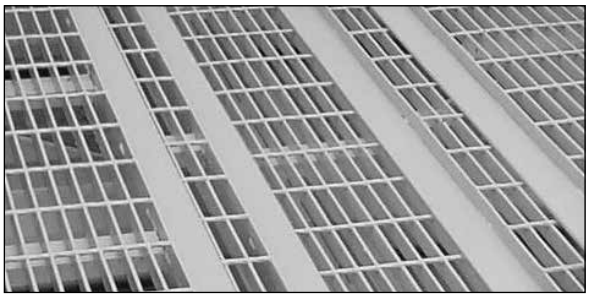
When the needle on the gauge is in the red CHANGE zone, replace filter(s) as soon as possible to prevent hydraulic component damage.





26. INSPECT RAIL SYSTEM

Inspect rail system for cracks, wear or damage. Worn or damaged rails MUST be replaced before lifting.



27. CHECK CONTROL OPERATION

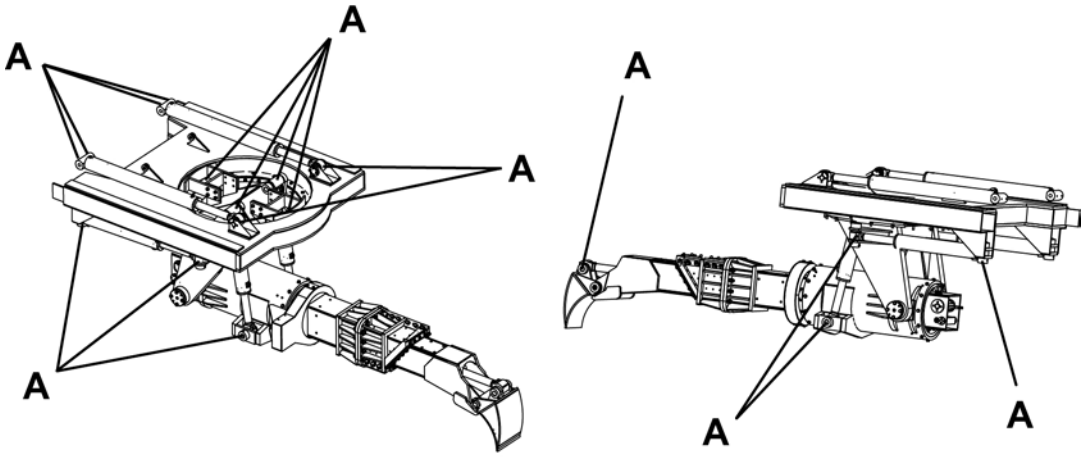
⚠WARNING BEFORE checking control operations, be sure all personnel are away from machine. Unexpected movement may cause severe injury or death.

Check all controls a for proper operation. If controls do not function properly, repair or replace BEFORE operation.

- ALL E-Stop buttons
- On-Board Power Pack controls
- Excavator control functions
- Jacking/Liner Can control functions
- Conveyor functions
- Light operation

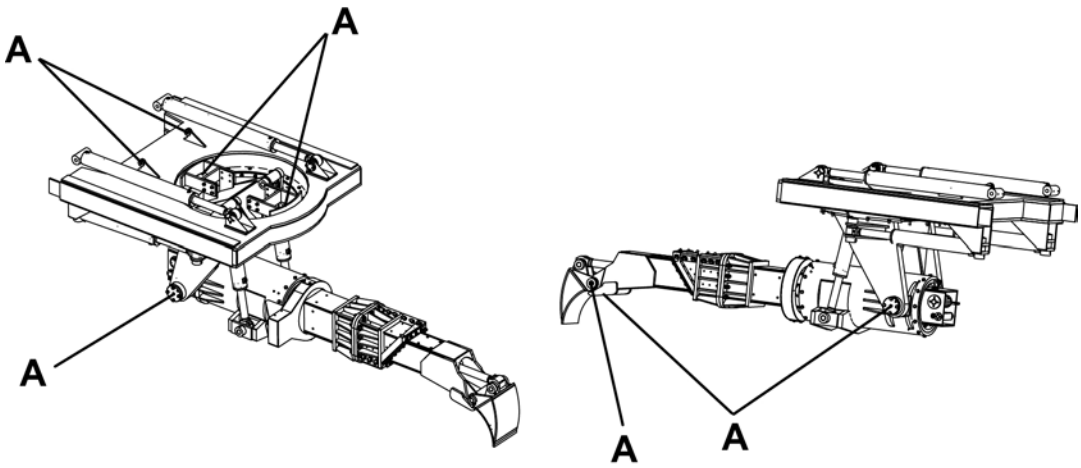
13. LUBRICATE EX50 CYLINDER PINS

Lubricate cylinder pins (A) with Mobilgrease® XHP222 or equivalent until grease is forced out.



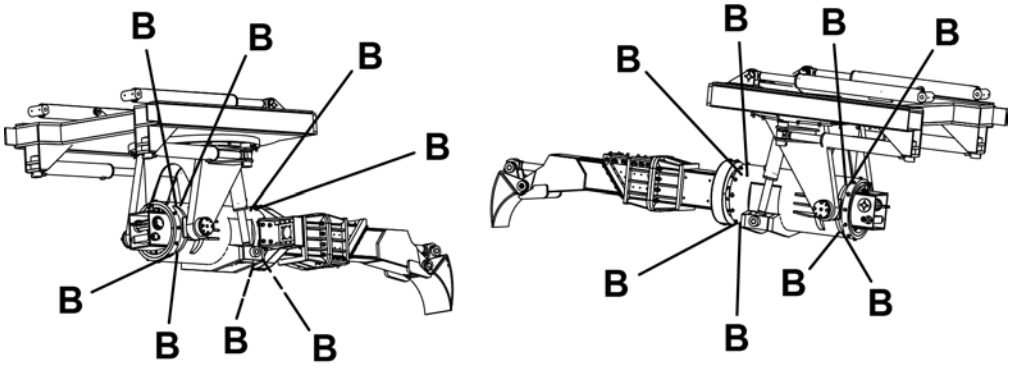
29. LUBRICATE EX50 FRAME LUBRICATION POINTS

Lubricate frame lubrication points (A) with Mobilgrease® XHP222 or equivalent until grease is forced out.



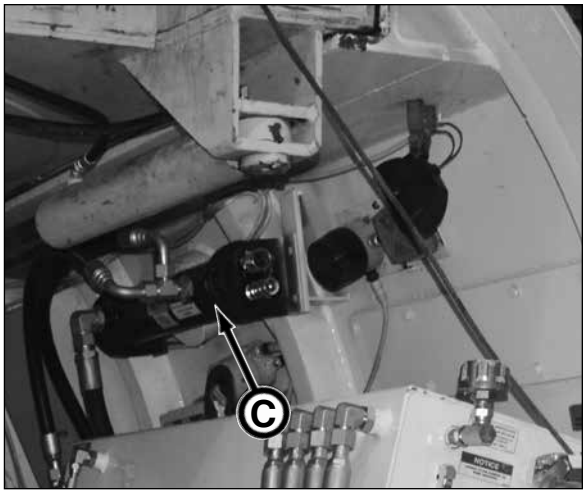
30. LUBRICATE EX50 BOOM ROTATION LUBRICATION POINTS

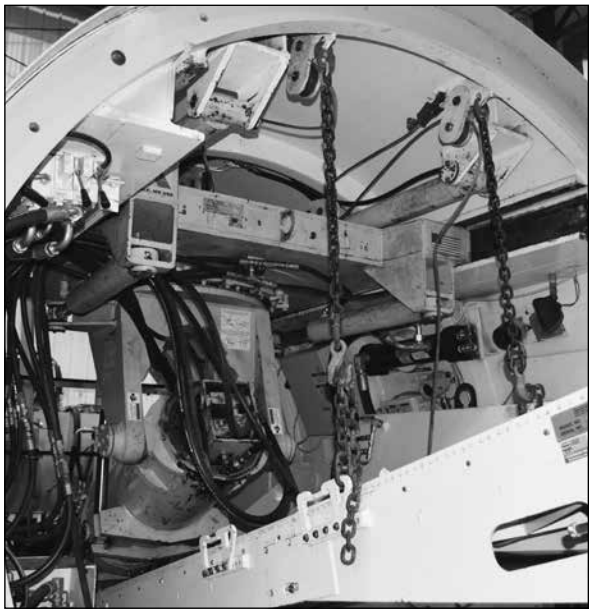
Lubricate boom rotation bushings (B) with ONE SHOT of Mobilgrease® XHP222 or equivalent. **DO NOT OVERGREASE! Doing so WILL lock up boom rotation.** Later models have 16 places, earlier models have 8 lubrication points.



31. FLUSH & DRAIN HEAT EXCHANGER

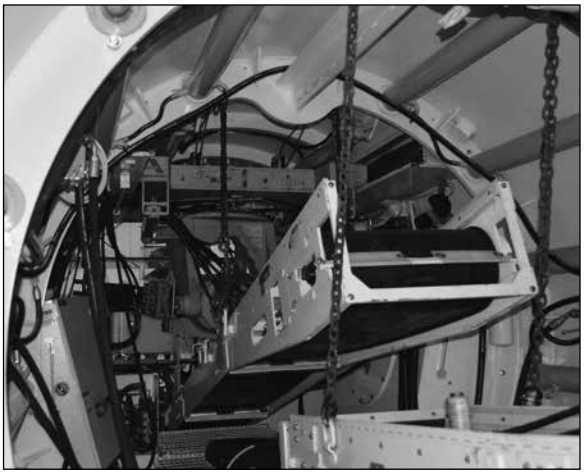
In freezing weather, flush and drain heat exchanger (C) and lines.





32. INSPECT CONVEYOR LIFT CABLES

Inspect all conveyor lift cables for wear or damage. Worn or damaged cables MUST be replaced immediately.



WEEKLY OR EVERY 50 HOURS OF OPERATION

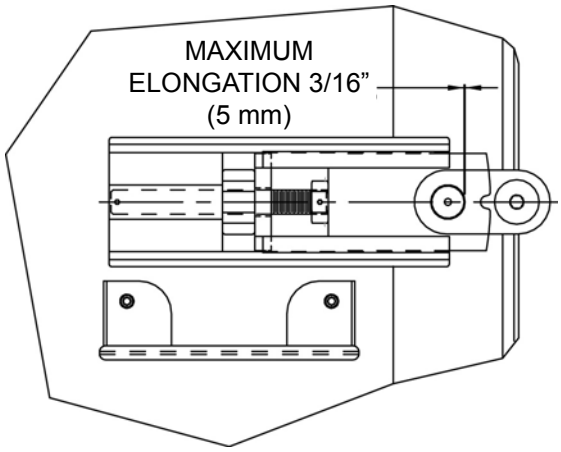
33. CHECK STEERING LINK FOR ELONGATION

Remove bolt and washer from steering link and check for elongation.

The maximum elongation is 3/16” (5 mm). If elongation exceeds 3/16” (5 mm), the steering link and new hardware must be replaced.

If link or hardware is damaged, replace with new.

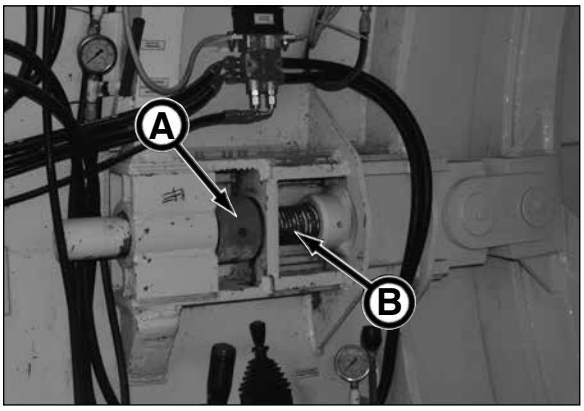
Repeat inspection on other steering link.



34. LUBRICATE STEERING LINK

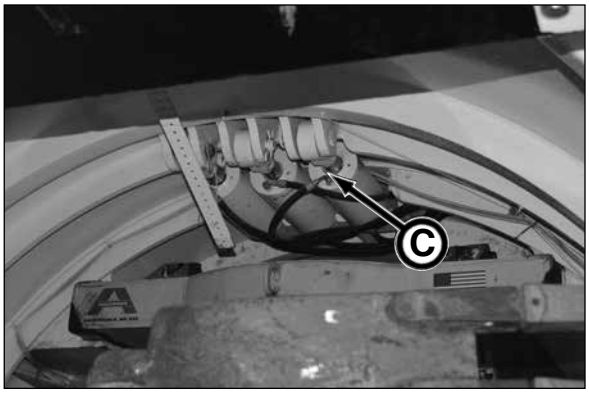
Lubricate steering link nut (A) and threads (B) with an anti-seize lubricant.

Lubricate threads thoroughly.



35. LUBRICATE STEERING CYLINDERS

Lubricate all top and bottom steering cylinders (6 places) (C) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.

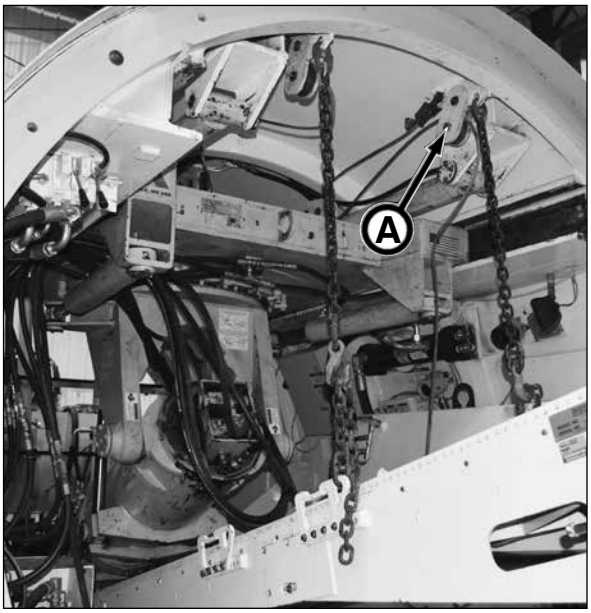


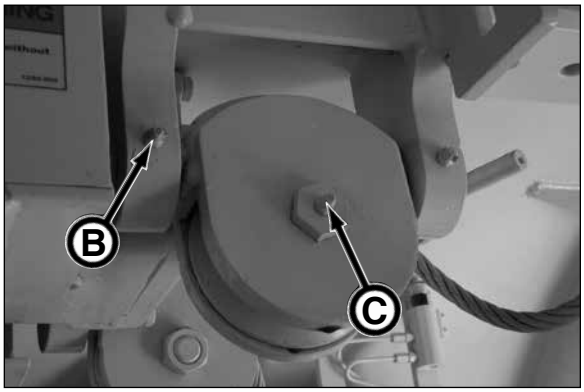
Top Steering Cylinders (C) Shown

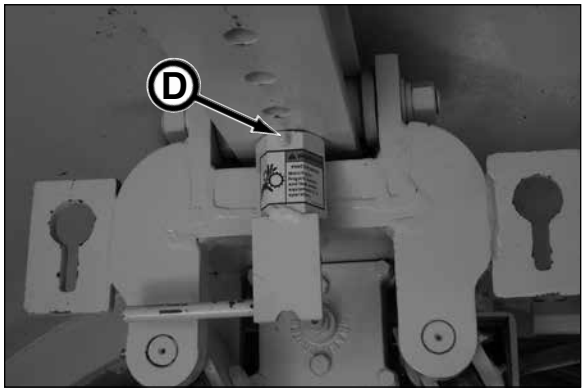
36. LUBRICATE CONVEYOR LIFT

Lubricate conveyor lift (11 places) with Mobilgrease® XHP222 or equivalent until grease is forced out.

Excavator pulley bearing (A) - 4 places
Trolley bracket pins (B) - 4 places
Cable pulley bearing (C) - 2 places
Adjustment pin (D) - 1 place

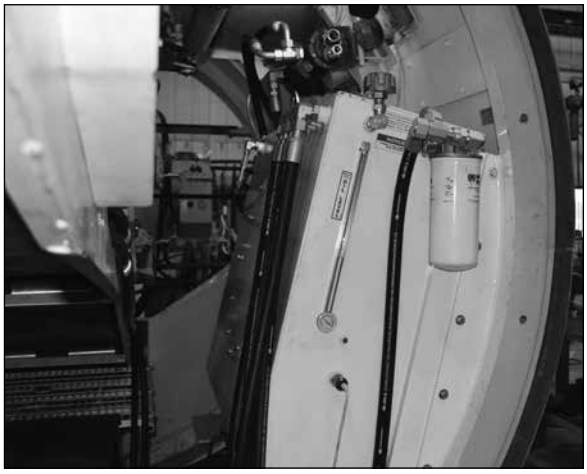






MONTHLY OR EVERY 250 HOURS OF OPERATION

37. PERFORM HYDRAULIC OIL ANALYSIS



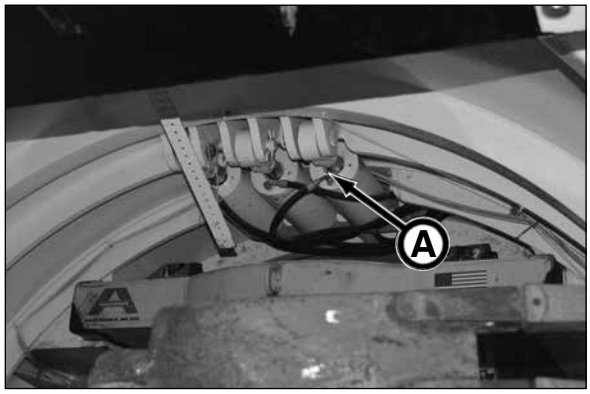
Test the quality of the hydraulic reservoir oil. Perform an oil analysis by sending an oil sample to a qualified testing facility.

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

38. INSPECT STEERING CYLINDERS

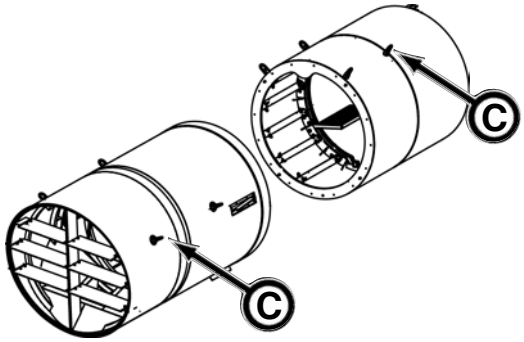
Inspect steering cylinders (A) for wear or damage. Repair or replace before operating.



Top Steering Cylinders (A) Shown

39. INSPECT LIFTING EYES

Inspect lifting eyes (C) for wear or damage. Worn or damaged lifting eyes MUST be replaced before lifting.

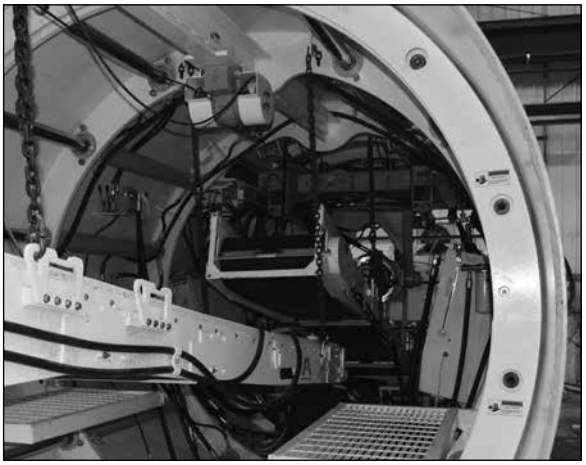


40. INSPECT HYDRAULIC HOSES & POWER CABLES

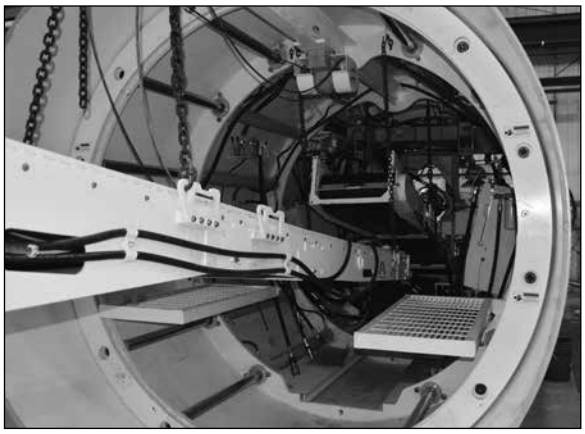
⚠DANGER If high voltage cables or cable connections are frayed, worn or damaged, contact with cables/connections will result in electrical shock causing severe injury or death.

With power in LOCK OUT, TAG OUT, 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.



41. INSPECT STRUCTURES

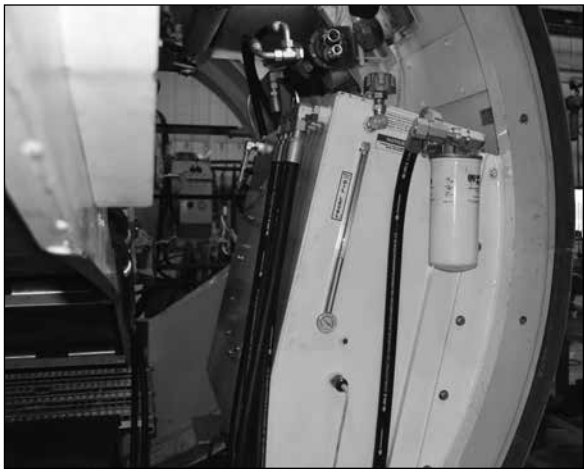


Perform a visual inspection of the boring shield, EX50 excavator and jacking/liner can structures for cracks, wear or other damage. Repair or replace at the completion of each drive and BEFORE operation.

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.

42. 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.

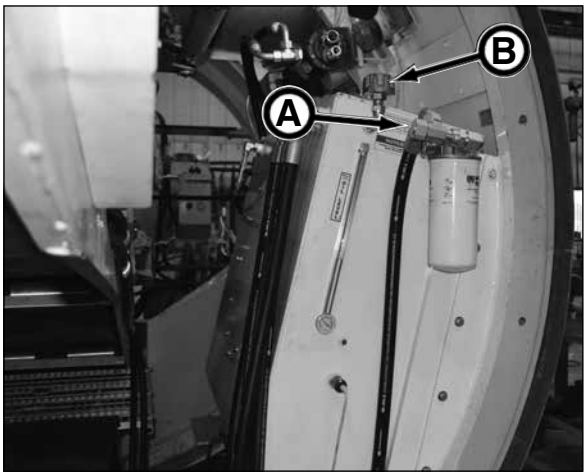
2. Using a catch pan loosen drain plug in reservoir and drain until there is no water in oil.

3. Retighten drain plug.

EVERY 1000 HOURS OF OPERATION

43. DRAIN & FILL HYDRAULIC RESERVOIR

Drain and fill oil in hydraulic reservoir every 1000 hours of operation.



1. Drain oil into an appropriate sized catch pan. Reinstall drain plug.

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

3. Attach external fill pump (hand or electric pump) with 16MFOR adapter to fitting.

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

5. Fill reservoir with clean, fresh, **FILTERED** ISO-VG-46 20W 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-46 20W or API GL-1/GL-2 oil specification. Do not mix oil manufacturers or grades.

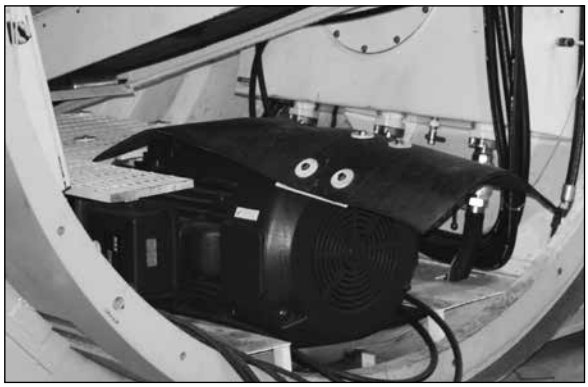
6. Remove external fill pump.

7. Replace breather and fitting cap.

ANNUALLY

62. 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.

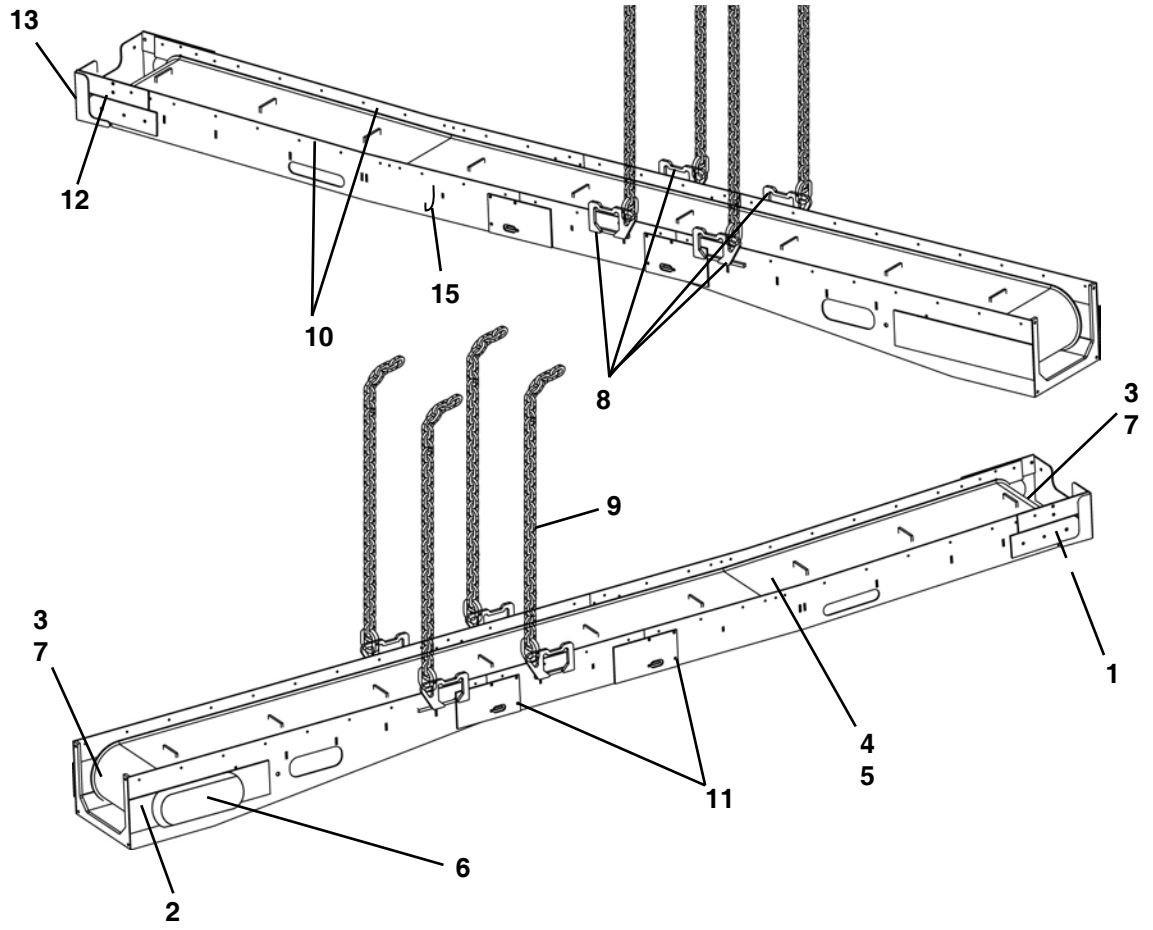
GREASE TYPE (unless nameplate states otherwise:
Nameplate Ambient Temperature between -22°F (-30°C) to 150°F (65°C) inclusive:
Recommended grease for standard service conditions is Mobil Polyrex® EM. Equivalent and compatible greases include: Texaco Polystar RB, Rykon Premium #2, Pennzoil Pen 2 Lube,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

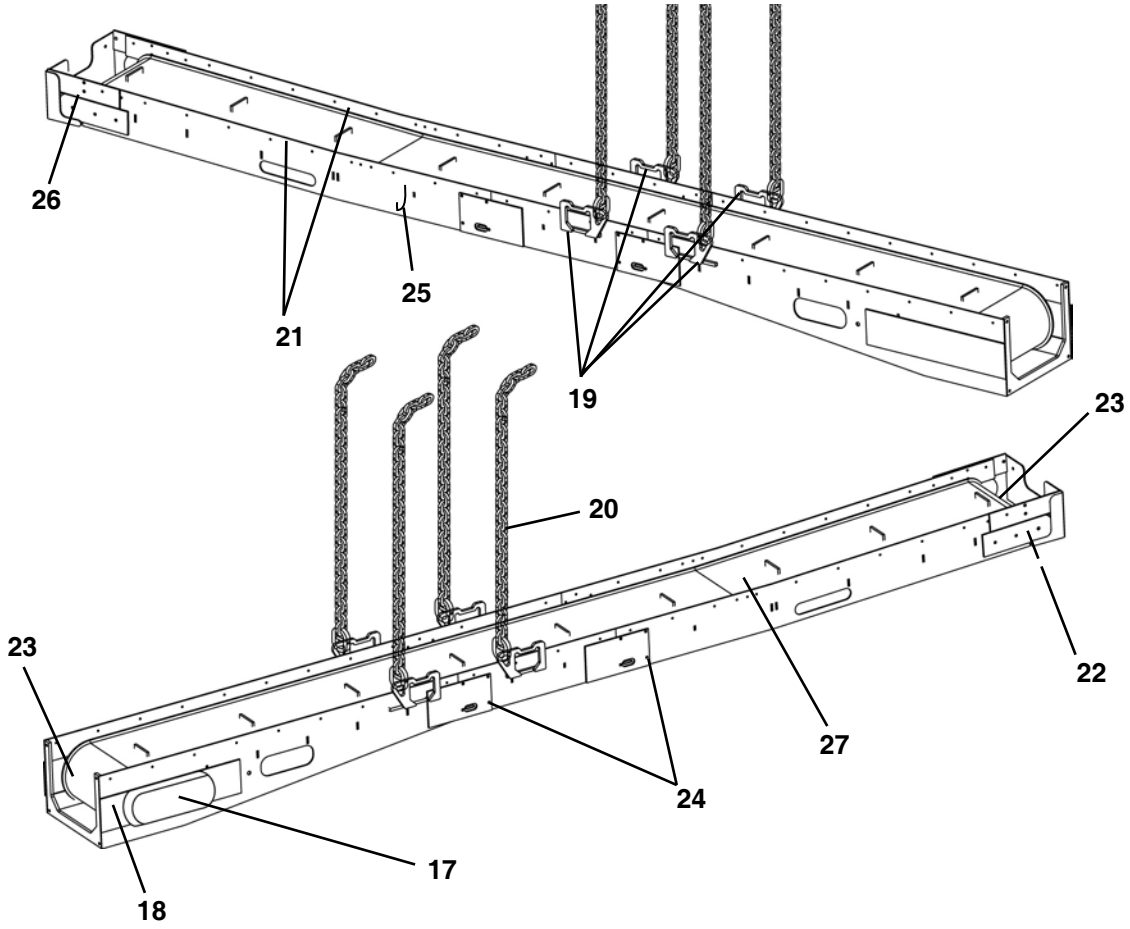
Use the item number in the chart to refer to the detailed maintenance procedures later in this section.



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		

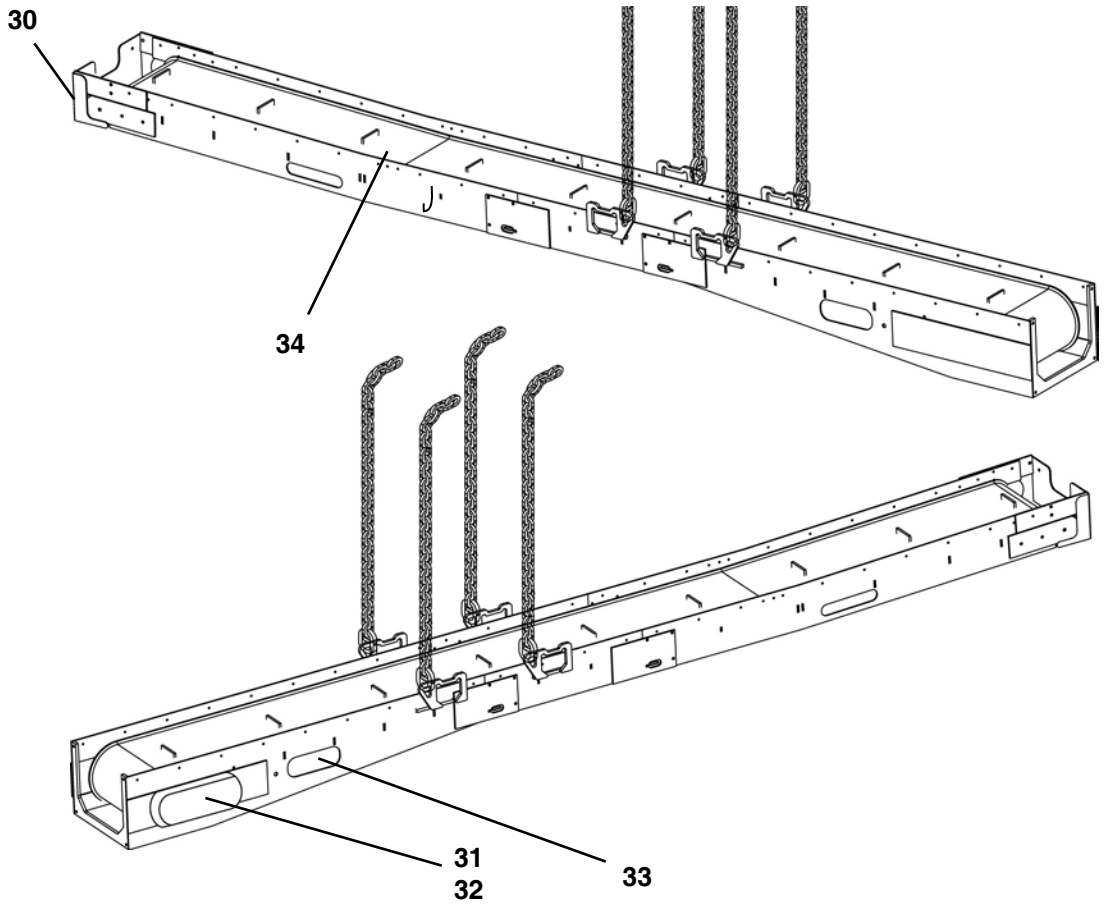
* Not Shown



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			
26.	Nose Bracket	Inspect	If damaged, replace with new.	
27.	Belt	Inspect	Replace if worn, cracked or damaged.	
*28.	Decals	Inspect		
*29.	Hydraulic Hoses	Inspect	If worn or damaged, replace with new.	

* Not Shown



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.	

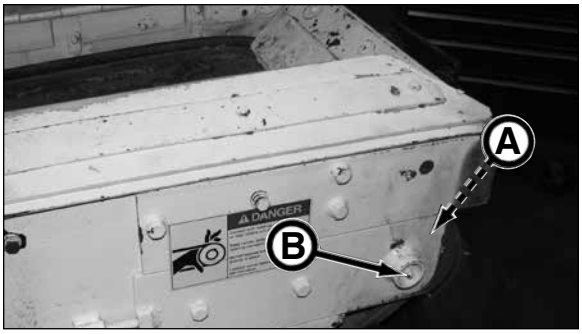
* Not Shown

PRIOR TO EACH JOB LAUNCH

1. INSPECT & LUBRICATE FRONT ROLLER

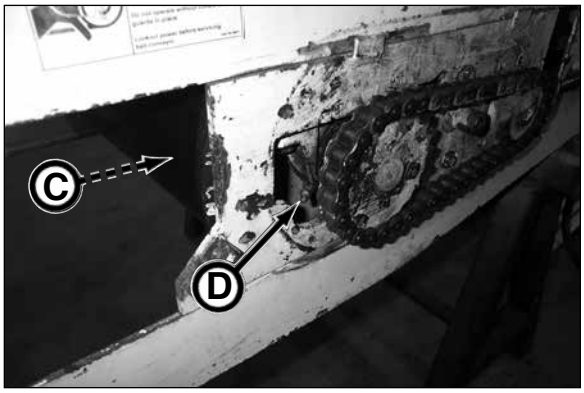
Inspect front roller (A) for wear or damage. If worn or damaged, replace with new.

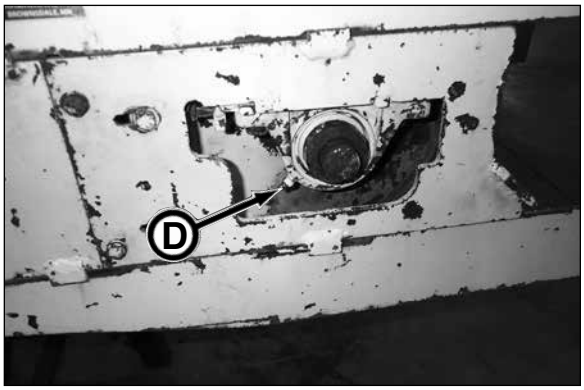
Lubricate front roller bearings (B) (2 places) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.

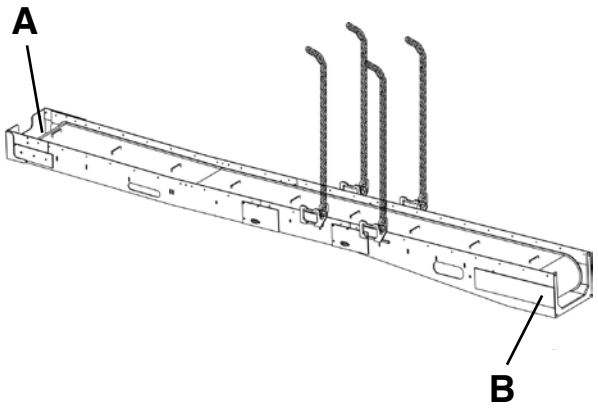


2. INSPECT & LUBRICATE DRIVE ROLLER & BEARING

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.





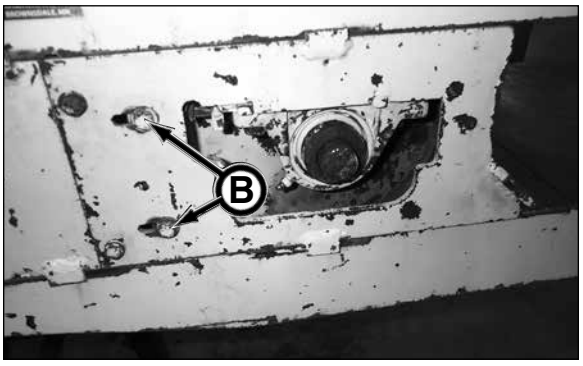


3. INSPECT ROLLER SCRAPERS

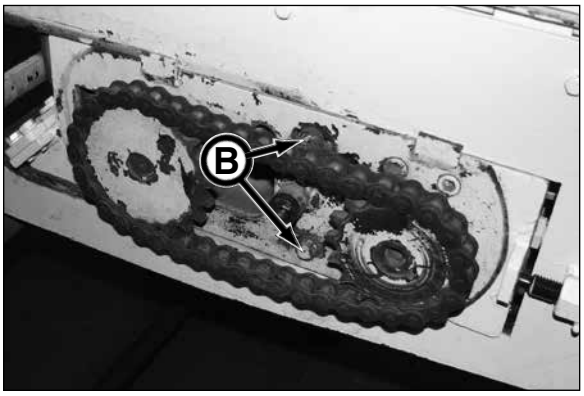
Inspect front roller (A) and the internal drive roller (B) scrapers for wear or damage. If worn or damaged, replace with new.

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 lock out power to conveyor.

Check conveyor belt tension by:

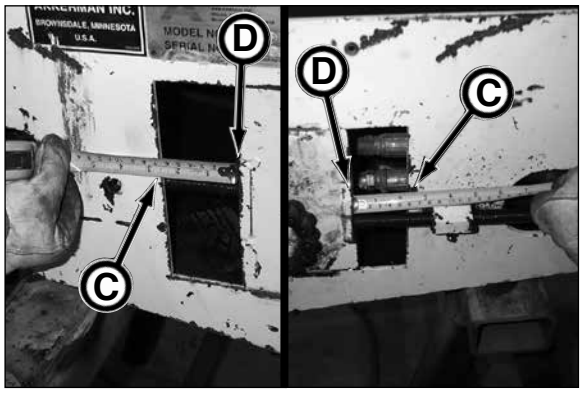
1. Remove or rotate spoil guides up out of the way of belt.

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.

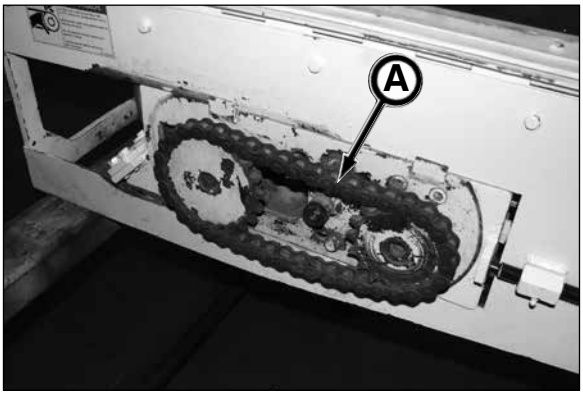
2. Once proper belt tension is achieved, the inner belt scrapers need to be readjusted for a 1/16 in. (1.5 mm) clearance.

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.



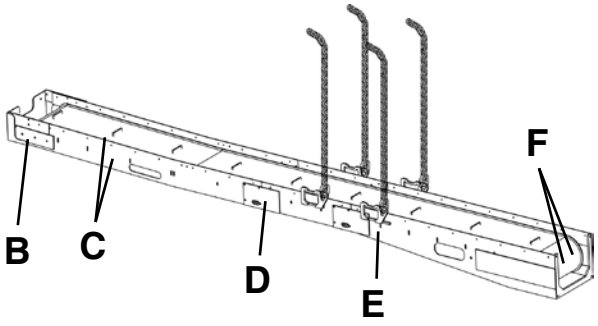
7. INSPECT BELT SCRAPERS

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.

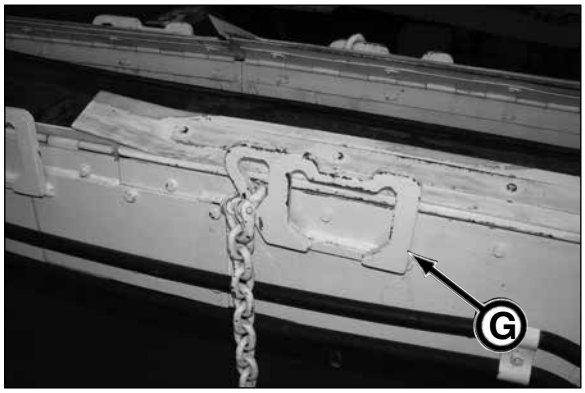
Once scrapers are adjusted, run the conveyor belt and make sure the scrapers do not contact the belt. If so, the scrapers MUST be readjusted. Once adjusted, stop belt rotation and lock out power to conveyor.

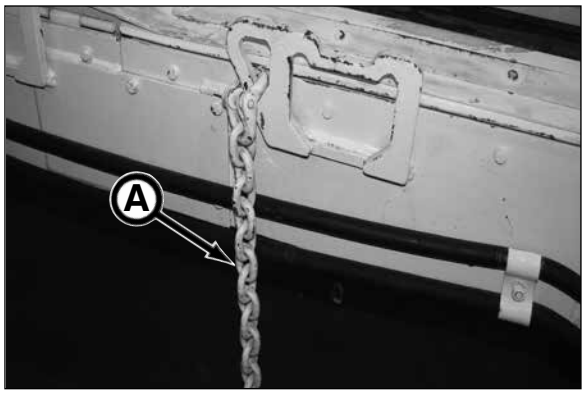


B - Front End External Belt Scraper
C - Inner Belt Scraper (2)
D - Idler Roller Scraper for Extension Frame
E - Idler Roller Scraper for Drive Frame
F - External Belt Scraper (2)

8. INSPECT LIFTING EYES

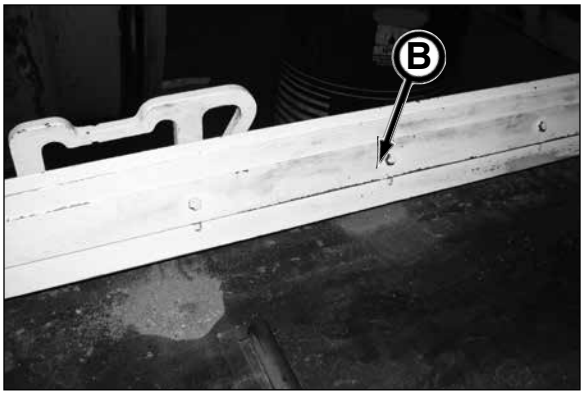
Inspect lifting eyes (G) for wear or damage. If worn or damaged, replace with new.





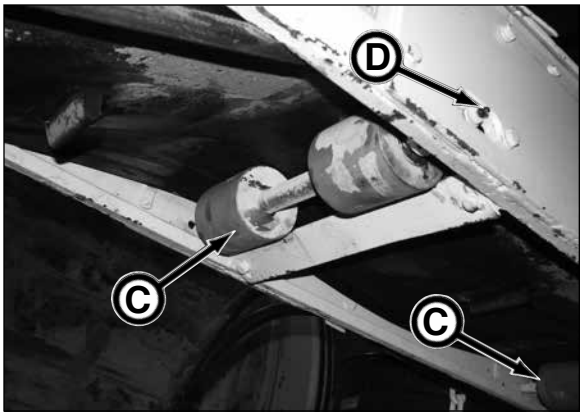
9. INSPECT LIFTING CHAINS

Inspect lifting chains (A) for wear or damage. If worn or damaged, replace with new.



10. INSPECT SPOILS GUIDES

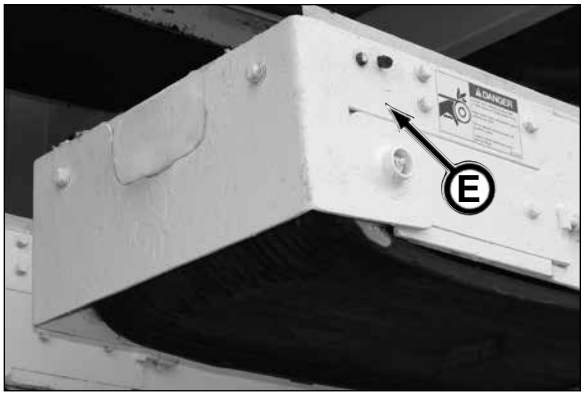
Inspect spoils guides (B) for wear or damage. If guide cannot be adjusted to within 1/4 in. (6.4 mm) of the belt, the guide should be replaced. Otherwise if damaged, replace with new.



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.

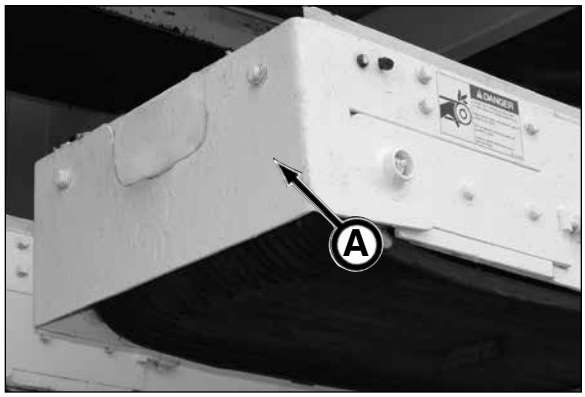


12. INSPECT NOSE BRACKET

Inspect nose bracket (E) for wear or damage. If worn or damaged, replace with new.

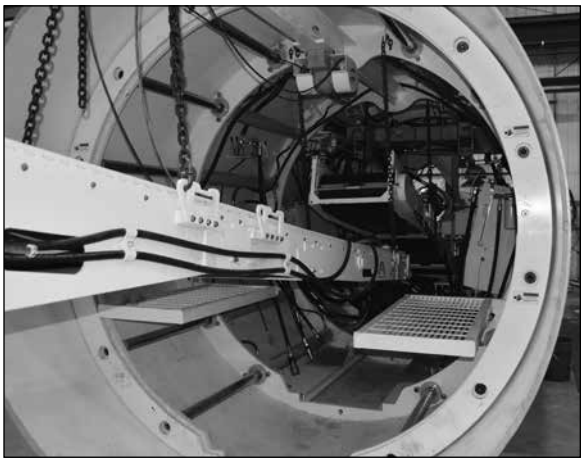
13. INSPECT DIRT GUARD

Inspect dirt guard (A) for wear or damage. If worn or damaged, replace with new.



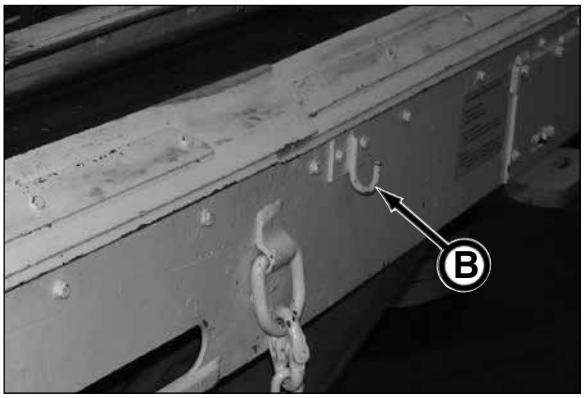
14. INSPECT HYDRAULIC HOSES

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.

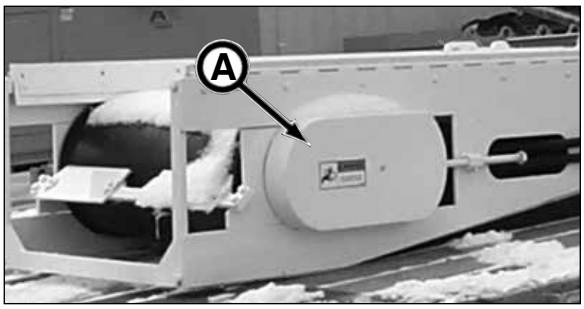
Before applying a new decal, be sure the surface is clean and dry.

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.



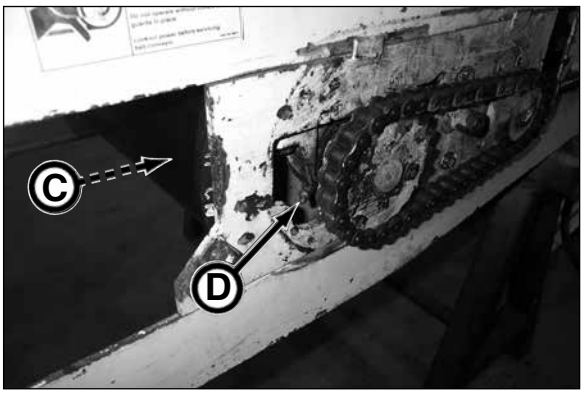
18. INSPECT & LUBRICATE DRIVE ROLLER & BEARING

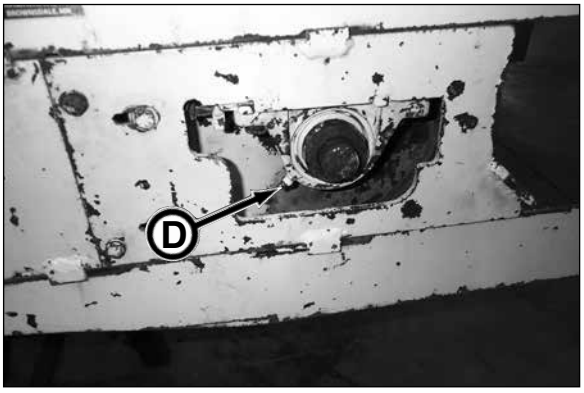
1. Remove guard.

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.

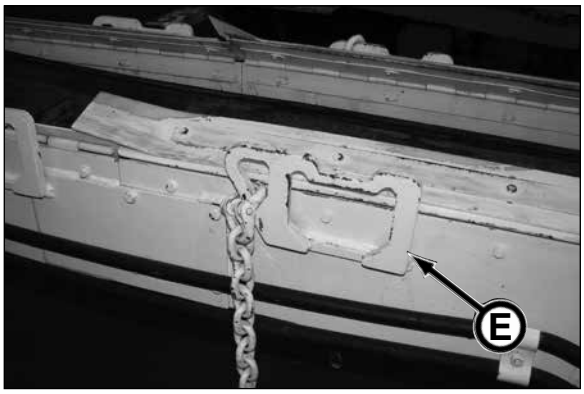
4. Replace guard before operating conveyor.

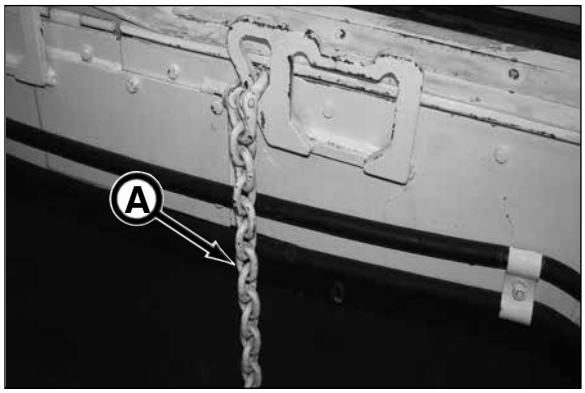




19. INSPECT LIFTING EYES

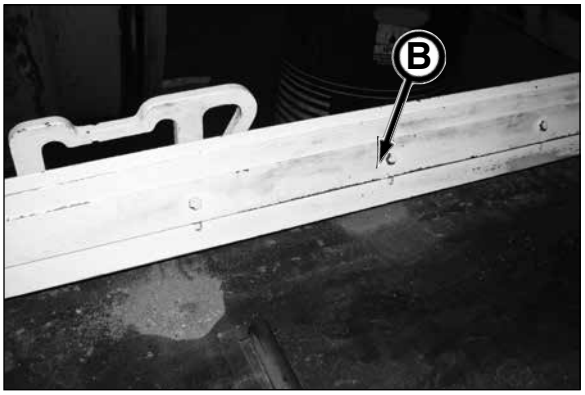
Inspect lifting eyes (E) for wear or damage. If worn or damaged, replace with new.





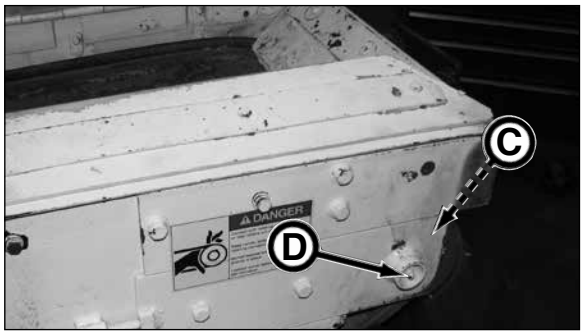
20. INSPECT LIFTING CHAINS

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.

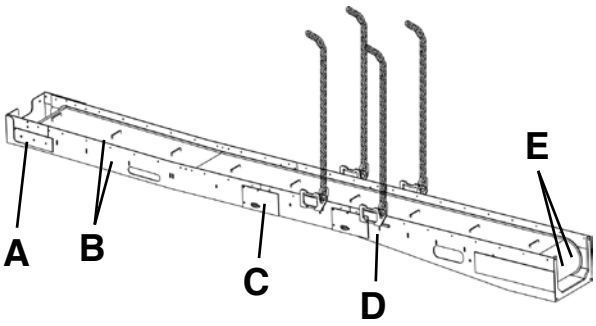
23. INSPECT BELT SCRAPERS

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 lock out power to conveyor.

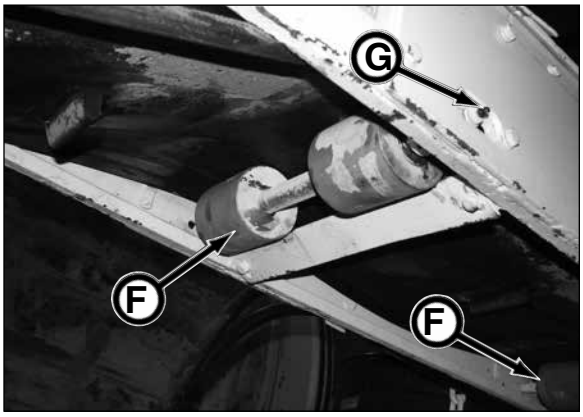


A - Front End External Belt Scraper
B - Inner Belt Scraper (2)
C - Idler Roller Scraper for Extension Frame
D - Idler Roller Scraper for Drive Frame
E - External Belt Scraper (2)

24. INSPECT & LUBRICATE IDLER ROLLERS

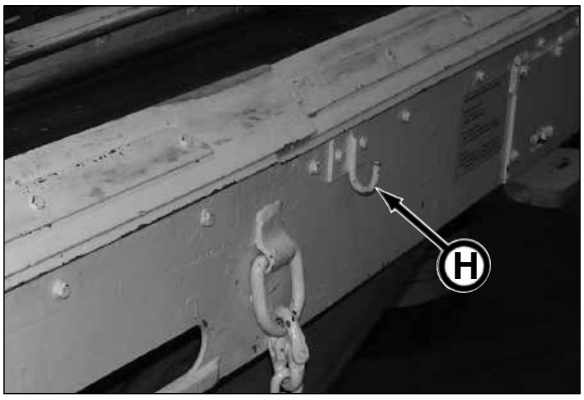
Inspect idler rollers (F) for wear or damage. If worn or damaged, replace with new.

Lubricate idler roller bearings (G) (4 places) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.



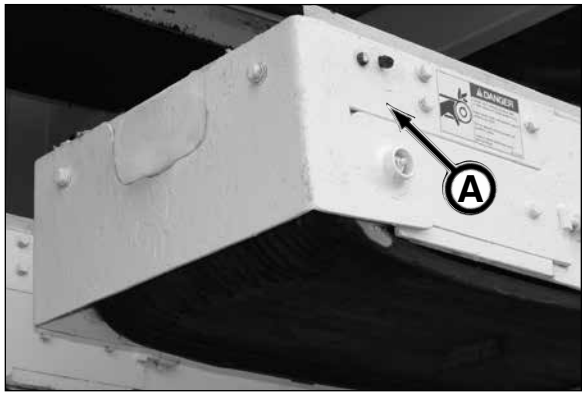
25. INSPECT CONVEYOR SAFETY HOOK

Inspect hook (H) for wear or damage. If worn or damaged, replace with new.



26. INSPECT NOSE BRACKET

Inspect nose bracket (A) for wear or damage. If worn or damaged, replace with new.



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:

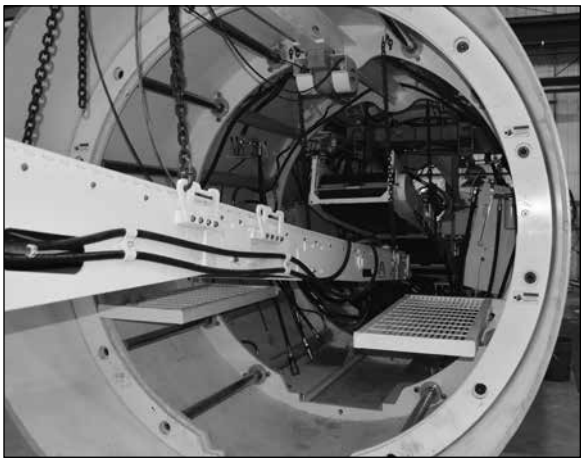
- The side ribs are worn to the point of no longer able to hold material.
- Cracks in the belt.
- Holes in the belt.
- Multiple belt lugs are missing.
- Belt can no longer be adjusted due to stretch in belt.

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.

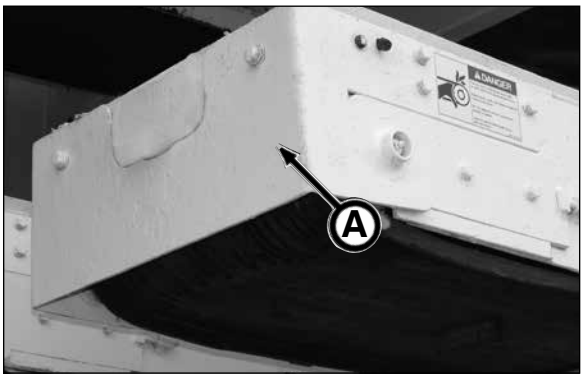
Before applying a new decal, be sure the surface is clean and dry.



29. INSPECT HYDRAULIC HOSES

Inspect hydraulic hoses for wear or damage. Repair or replace BEFORE operation.

WEEKLY OR EVERY 50 HOURS OF OPERATION



30. INSPECT DIRT GUARD

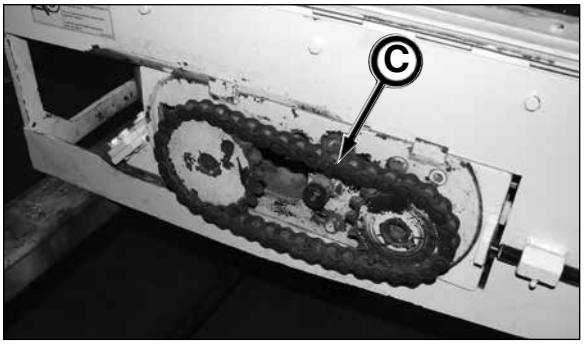
Inspect dirt guard (A) for wear or damage. If worn or damaged, replace with new.

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

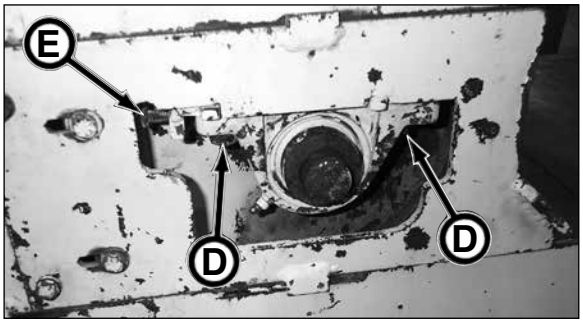
1. Inspect drive chain (C). If worn or damaged, replace with new.

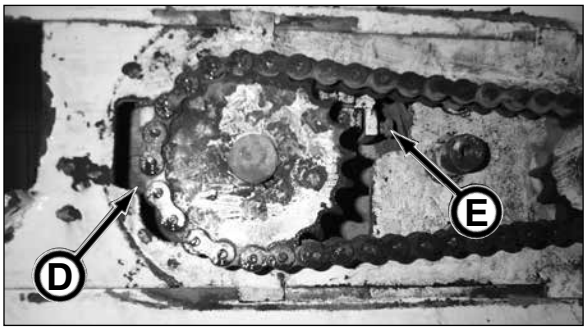
2. Check chain tension. The center of the chain should have a maximum deflection of 3/16 in. (4.8 mm).

   To adjust chain tension, loosen bolts (D) on pillow block bearings and tighten chain adjustment bolt (E) until the 3/16 in. (4.8 mm) deflection is achieved. Then retighten pillow block bearing bolts.

3. Thoroughly lubricate chain with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent.

   Replace cover before operating conveyor.

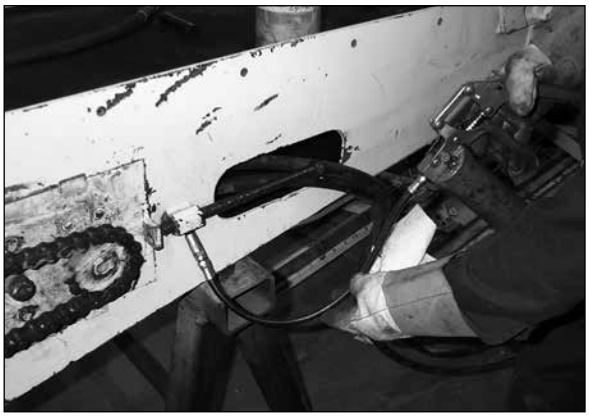




33. INSPECT & LUBRICATE BELT ADJUSTMENT SCREW

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.

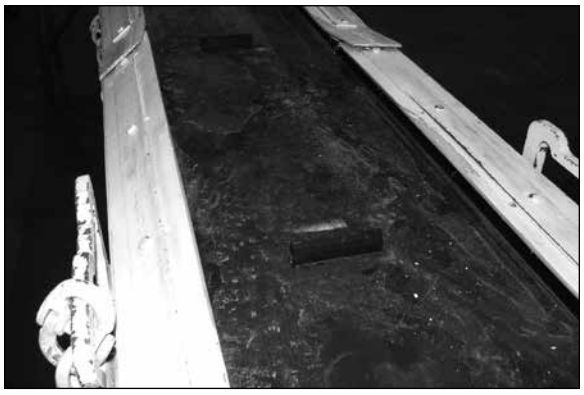
3. Observe the belt tracking the entire length of the conveyor. The gap between the belt and the conveyor must be the same on both sides.

⚠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 lock out 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).

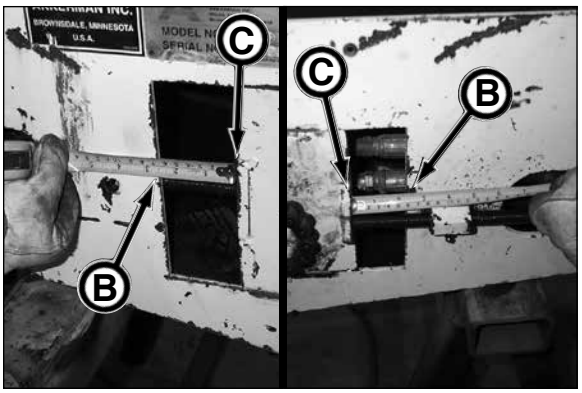
NOTICE Be sure the center rib on the under side of the belt stays in the groove of pulley.

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.



Storage

PREPARING FOR STORAGE

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

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

REMOVING FROM STORAGE

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

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

NOTES

Troubleshooting

960 EXCAVATOR BORING SHIELD

Problem	Cause	Solution
150 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 a minimum of 8 gpm.
	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.
	Flow control valve set too high.	Decrease flow.
	Valve handle stuck in the ON position.	Repair valve.
	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.
	Worn or damaged steering link adjustment screw.	Replace adjustment screw.
	Excessive thrust pressure.	Reduce thrust pressure.
	Faulty check valve.	Replace check valve.
TBM will not steer up/down.	Line/Grade selector valve not in correct position.	Up for grade. Down for line.
	Flow control valve set too low.	Increase flow.
	Worn or damaged cylinder seals.	Replace seals.
	Check valve not releasing.	Replace check valve.
TBM will not steer left/right.	Steering link nut not being rotated to maintain free travel of shield.	Keep nut free while steering left or right.
	Steering links stretched.	Replace steering link.
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.

(continued on next page)

Problem	Cause	Solution
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.

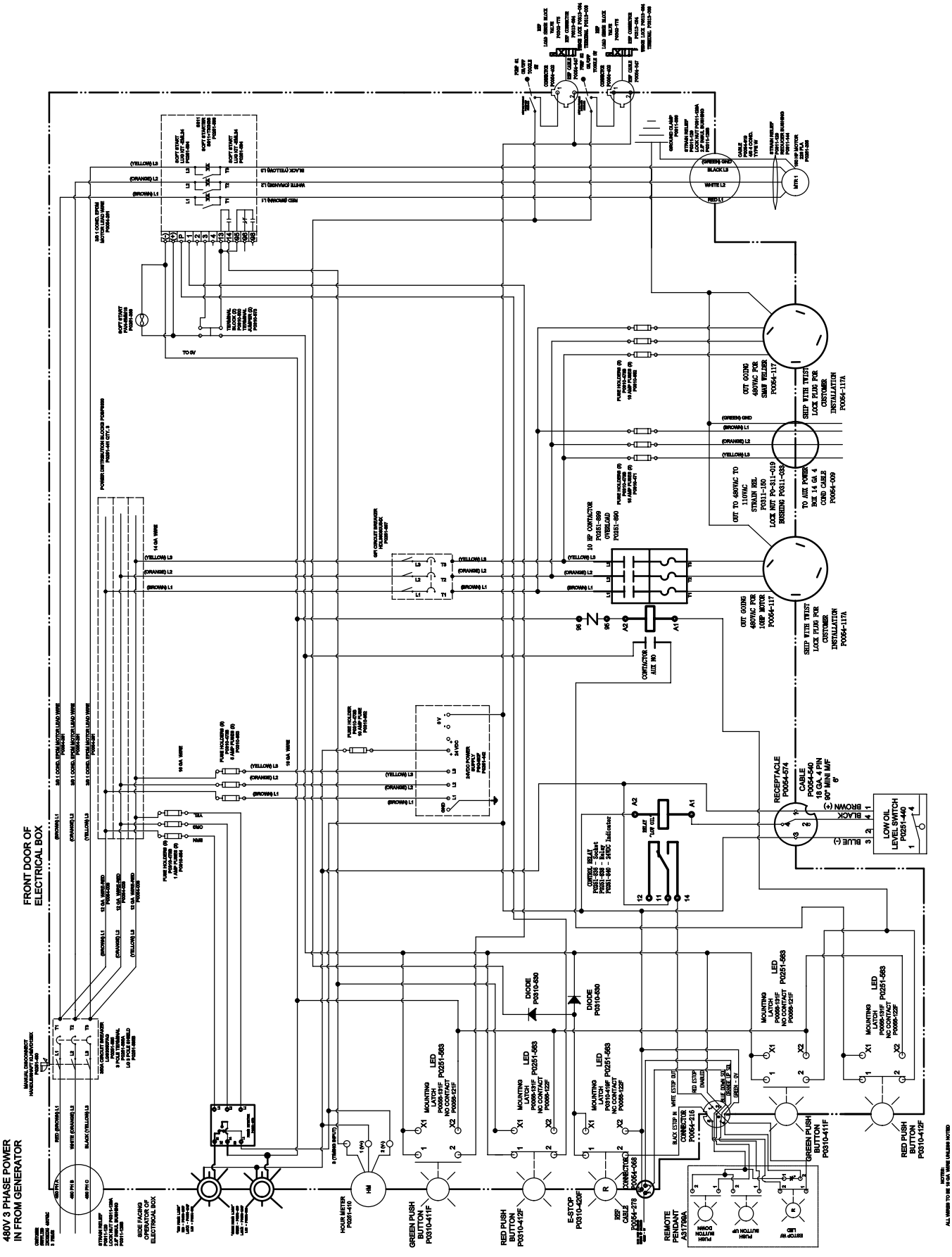
EX50 EXCAVATOR

Problem	Cause	Solution
Excavator does not operate.	Operator is not sitting in operator seat.	Operator must sit in operator seat to activate safety switch.
	Improper phase power.	Contact electrician to correct phase.
	Power source is Off.	Turn on power source.
	150HP motor is OFF.	Turn motor ON.
	Pump(s) are OFF.	Turn both Pump 1 & Pump 2 ON.
	Improper motor rotation.	Electrician must re-wire motor for clockwise motor rotation.
Joysticks are physically hard to move or stiff.	Blockage or obstruction in return line.	Replace return line.
Only half of the joystick functions operate.	**IMPORTANT: DO NOT** operate for extended periods with this condition. Doing so WILL result in pump damage.	
	Pump suction ball valve(s) closed.	Open ball valve(s).

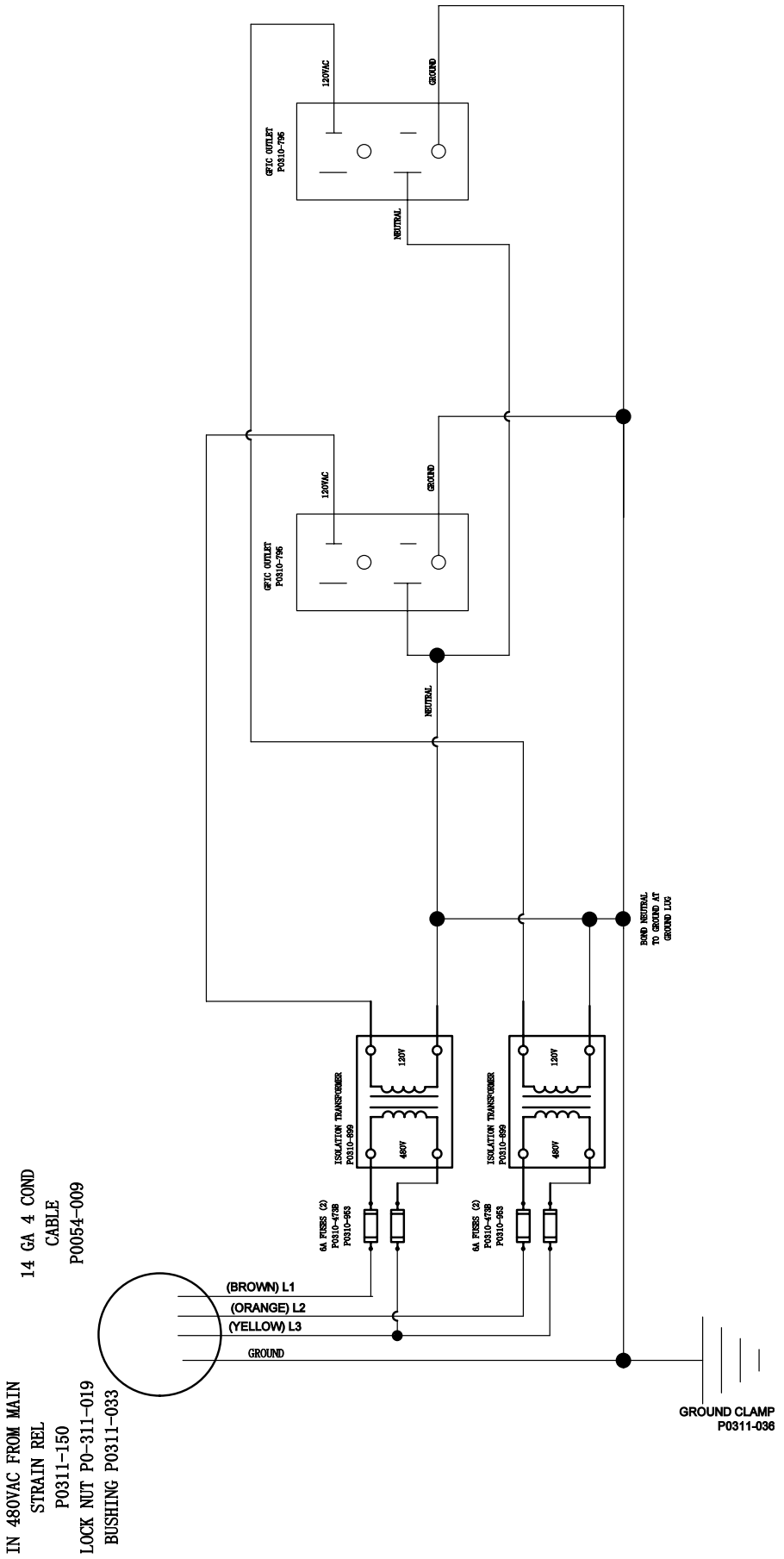
BELT CONVEYOR

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.

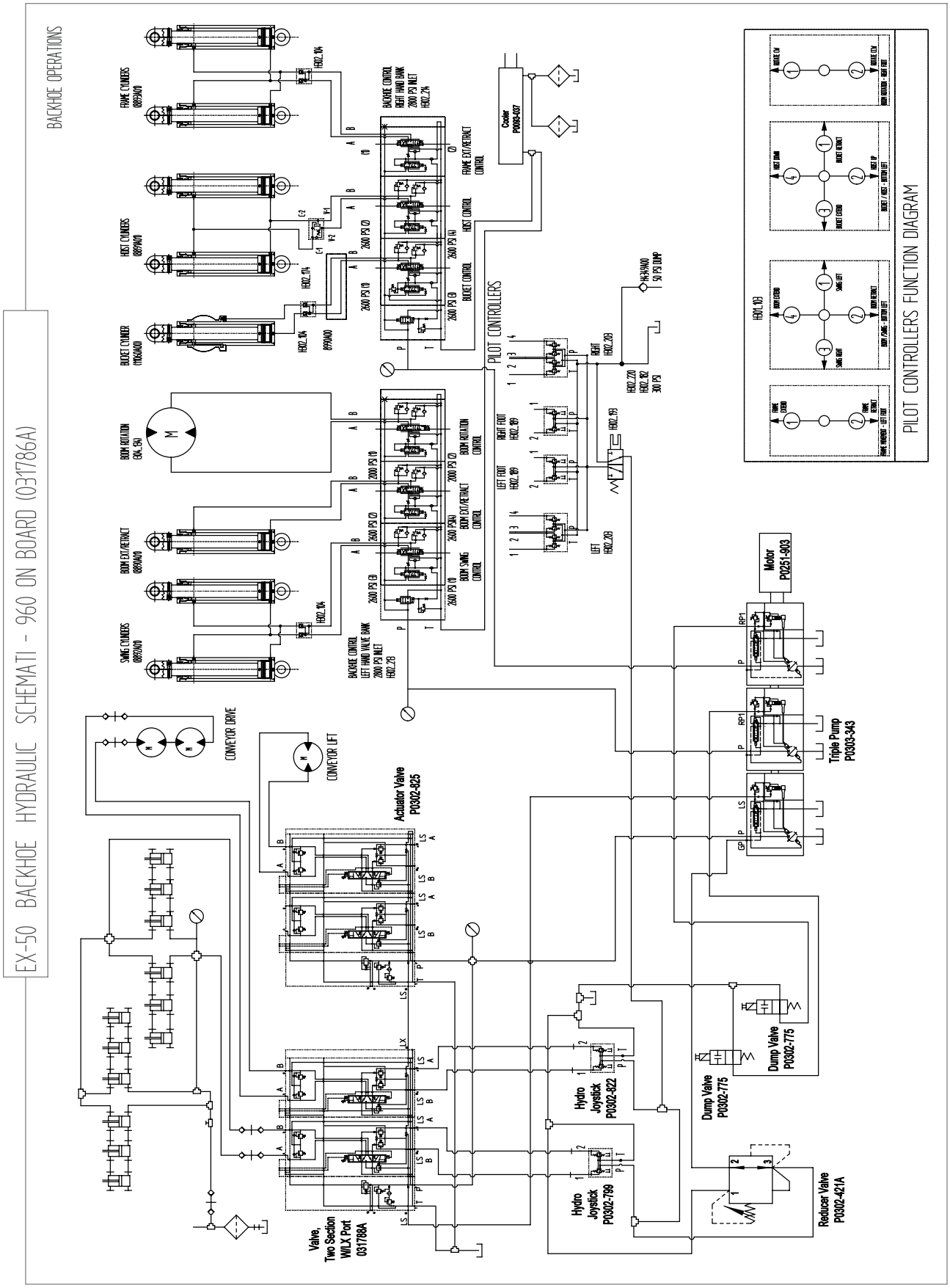
ELECTRICAL SCHEMATIC - ON-BOARD POWER PACK



ELECTRICAL SCHEMATIC - AUXILIARY POWER ELECTRICAL BOX

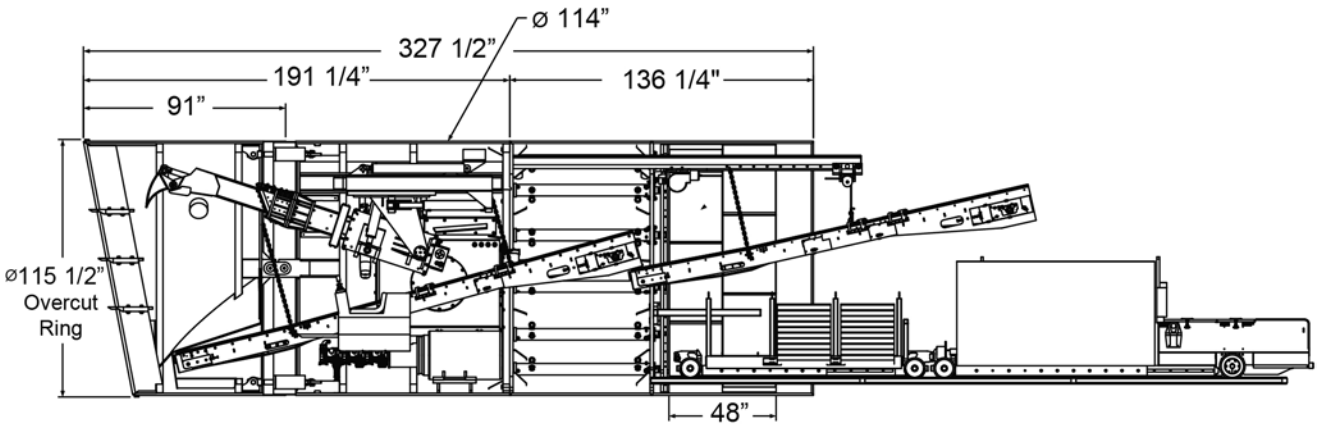


HYDRAULIC SCHEMATIC



Specifications

960 EXCAVATOR BORING SHIELD WITH ON-BOARD POWER PACK



Structure

Outside Diameter. ..... 114 in. (2,896 mm)
Cutting Diameter (Overcut Ring) ..... 115.5 in. (2,934 mm)

Propulsion (Thrust) ..... 377 Tons

Hydraulics

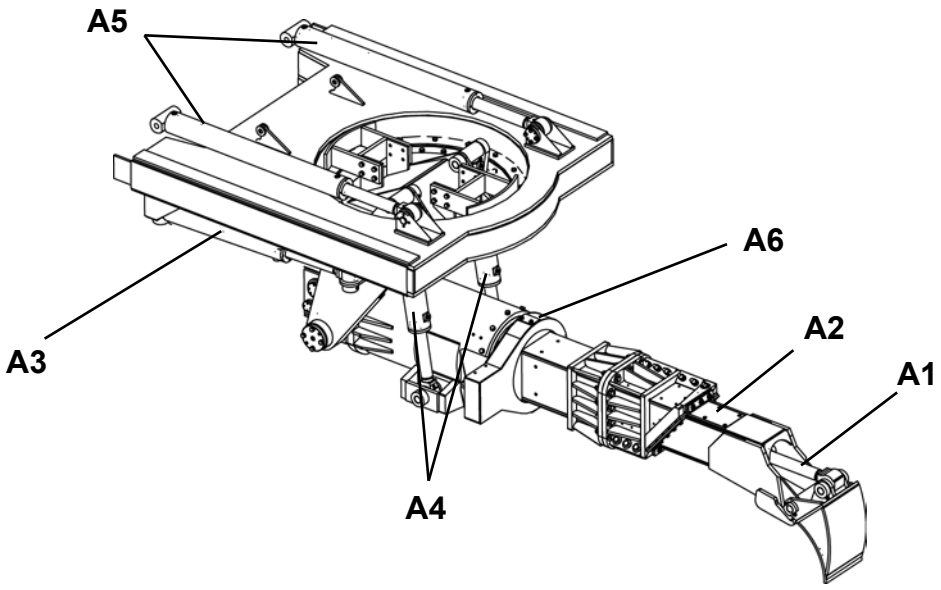
Operating Pressure (Maximum) ..... 60 gpm @ 2,800 psi
Jacking Pressure (Maximum) ..... 30 gpm @ 5,000 psi
Jacking/Liner Can Cylinder ..... Twelve, 54 in. (1,372 mm) Stroke
Hydraulic Reservoir Capacity ..... 130 gal. (492 L)
Heat Exchanger Cooling Water Supply (minimum) ..... Clean, 8 gpm

Electrical

Power ..... 480VAC 3 Phase
Recommended Power Requirements
Recommended Operating Requirements .....125kW / 150kWA @ 480VAC
Generator Minimum Motor Starting kVA (skVA)
.....400skVA with less than 35% instantaneous voltage dip and greater that 90% sustained voltage
Gas Detector 110V
GFI Outlets ..... Two, 20A, 120AC
Welder Supply Electrical Connection ..... One, 6A, 480VAC, 3 Phase
Power Motor Starter 10HP Electrical Connection..... One, 14A, 480VAC, 3 Phase

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

EX50 EXCAVATOR



Excavating Power (Primary Functions) (in Pounds Force)

Paddle Cylinder (**A1**) ..... 11,600 lbf

Boom Extension Cylinder (**A2**) 48 in. (1,219 mm)
- Extension ..... 24,000 lbf
- Retraction ..... 12,000 lbf

Boom Swing Cylinder (**A3**)

Paddle Position	Paddle Ready	Paddle Rolled
Boom Retracted	8,900 lbf	10,700 lbf
Boom Extended	5,800 lbf	6,500 lbf

Boom Hoist Cylinder (**A4**) - Paddle In Ready Position

Hoist Motion	Hoist Up	Hoist Down
Boom Retracted	5,400 lbf.	11,600 lbf
Boom Extended	3,700 lbf	7,900 lbf

Frame Advance Cylinder (**A5**) 36 in. (914 mm)
- Extension ..... 48,000 lbf
- Retraction ..... 24,000 lbf

Boom Rotation (**A6**) ..... Bi-Directional, 225 degrees

Hydraulic Controls

The 60 gpm supply is fed into the on-board power pack (two pumps) where the oil is dispersed to the two main valve banks and the hydraulic pilot circuit.

- A. Valve Bank 1 (Four Section Valve Bank) ..... 29 gpm @ 2,800 psi
  - 1. Boom Swing Control ..... Primary Function
  - 2. Boom Extension Control ..... Primary Function
  - 3. Boom Rotation Control ..... Positioning Function
  - 4. Shield Steering Control ..... Positioning Function
- B. Valve Bank 2 (Three Section Valve Bank) ..... 29 @ 2,800 psi
  - 1. Paddle Control ..... Primary Function
  - 2. Hoist Control ..... Primary Function
  - 3. Frame Extension Control ..... Positioning Function
- C. Pilot Circuit Controls ..... 300 psi

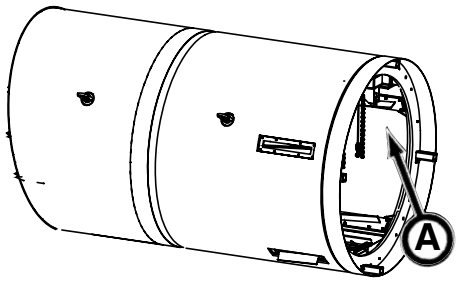
Identification Numbers

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

BORING SHIELD (A)

Model Number _____

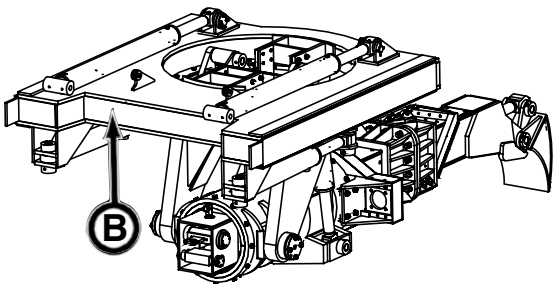
Serial Number _____



EX50 EXCAVATOR (B)

Model Number _____

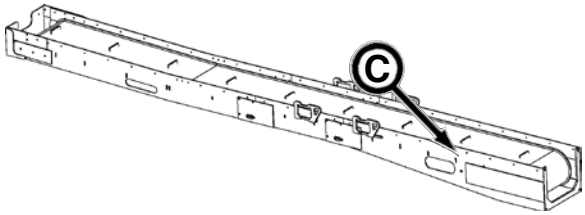
Serial Number _____



CONVEYOR (C)

Model Number _____

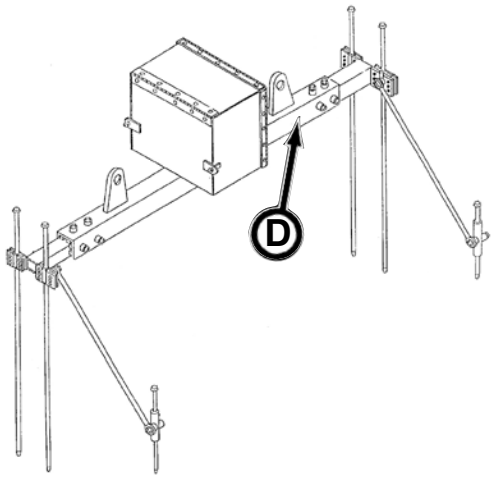
Serial Number _____



LASER LIGHT STAND (D)

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

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