



OPERATOR'S MANUAL

5200 Series Jacking System

**Pump Unit S/N: F27700F
200 HP Auxiliary S/N: F27573F**

Publication No. 050096A

Rev. No. 150812 R220114

© Akkerman 2015, 2022
All Rights Reserved

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

SERVICE • RELIABILITY • INNOVATION

DANGER

This pump unit is capable of supplying 5,000 psi hydraulic oil to the TBM Series II.



THE 5,000 PSI SELECTION REQUIRES OIL LINES RATED FOR AT LEAST 5,000 PSI. FAILURE TO DO SO WILL CAUSE SEVERE INJURY OR DEATH FROM BURSTING OIL LINES.

NEVER USE OIL LINES RATED LESS THAN 5,000 PSI WHEN USING 5,000 PSI SUPPLY OIL.

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

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

NOTES

Introduction

This operator's manual contains important safety, operation, and maintenance information for your Akkerman 5200 Jacking System. This system includes the 5200 Pump Unit, Skid, Yoke and 200 HP Auxiliary. You must read and understand this manual before you operate and maintain this equipment. Keep this manual with your Pump Unit system at all times. Directions in this manual are referenced from the launch shaft going forward to the reception shaft, unless otherwise noted. Additional copies of this manual may be purchased from the Akkerman Aftermarket Support Department, or downloaded from the Akkerman web site at www.akkerman.com.

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

The use of second rate parts could affect the efficient performance of the Jacking System. ALWAYS use genuine Akkerman parts.

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

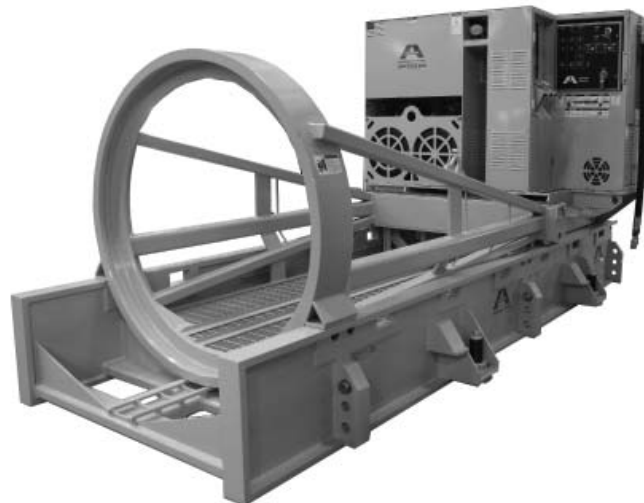
▲ DANGER Indicates an extremely hazardous situation which, if not avoided, WILL result in death or serious injury.

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

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

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

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



5200 Pump Unit with Yoke and Skid

The 5200 Pump Unit has two distinct hydraulic systems powered by electric motors. The high pressure system supplies oil for the two main jacking cylinders and all intermediate jacking stations. The low pressure system supplies oil, via hydraulic lines for the boring head and conveyor.

The Yoke is the frame that the main cylinders push against to advance the boring head and pipe. The Yoke also acts as a dirt bucket unloading area. The Skid base is the foundation of the pump unit and yoke. It also acts as a guide for launching the boring head and pipe into the ground.

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

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

NOTES

Contents

Safety	1	Pre-Start Inspection	5
Be Alert For Safety Information	1-1	Operation	6
Read Operator's Manual	1-1	Operating Guidelines	6-1
Wear Protective Clothing	1-1	Typical 5200 Pipe Jacking System Layout	6-2
Fire Prevention	1-2	Setting Up Jacking System	6-3
Hydraulic Oil/Fluids Under Pressure	1-2	Preparing Pump Unit For Operation	6-6
Unauthorized Welding	1-2	Setting Up 5200 Pump Unit - Start-Up Check .	6-7
Keep Personnel Away From Moving Parts	1-3	Testing Boring Head 1 Motor Rotation	6-9
Regularly Clean/Inspect Equipment	1-3	Testing Boring Head 2 Motor Rotation	6-11
Practice Safe Maintenance	1-3	Testing Jacking Motor Rotation	6-12
Recycle Waste	1-3	Testing Cooling Motor Rotation	6-13
Beware of Suspended Loads	1-4	Setting Up The Pump Unit &	
No Riders On Jacking System	1-4	TBM Supply/Return Hydraulics	6-14
Test Tunnel Ventilation	1-4	200 HP Auxiliary Hookup To Pump Unit	6-15
Lockout/Tagout Power Before Servicing	1-5	Testing 200 HP Motor Rotation	6-18
Slippery When Wet	1-5	Testing Cooling Motor Rotation	6-19
Keep Job Site Clean & Organized	1-5	Operating The Pump Unit	6-20
Keep Away From Conveyors	1-6	Attach Main Jacking Rams To Yoke	6-20
High Pressure Hydraulics	1-6	Positioning Pump Unit/Yoke With TBM	6-22
No Smoking In Tunnel	1-6	Installing Conveyor & Dirt Bucket	6-23
Avoid Laser Light Exposure	1-6	Positioning TBM For Jacking Operation ...	6-24
Using Tunnel Power Cable	1-7	Jacking Operation	6-25
Inspect Electrical Connections	1-7	Using Intermediate Jacking Stations (IJS) ...	6-35
Avoid Pinch Points	1-7	Installing IJS	6-35
Stay Away From Crane	1-7	Operating IJS	6-36
Safety Decals	2	IJS Schematic	6-38
5200 Pump Unit	2-1	Filling Hydraulic Reservoir	6-39
200 HP Auxiliary	2-2	Cold Weather Operation	6-40
Yoke	2-3	Purging Fluid From Tunnel Lines	
Terminology	3	With Non Series II TBM	6-42
5200 Pump Unit		With Series II TBM	6-44
Front Components	3-1	Daily Shut Down	6-46
Rear Components	3-2	Removing Jacking System	6-48
Control Panel.....	3-3	Transporting	7
Operator Control Panel	3-4	Transporting Guidelines	7-1
Main Power Electrical Panel	3-5	Lifting Instructions	7-2
Electrical Connections	3-6	Lubricants	8
200 HP Auxiliary	3-7	Hydraulic Reservoir Lubricant	8-1
Skid & Yoke	3-8	Electric Motor Bearing Grease	8-1
Controls & Instruments	4	Skid Lock Block Grease	8-2
Emergency Stop	4-1	Grease	8-2
Phase Indicator Lights	4-2	Storing Lubricants	8-2
Main Power Switch	4-3		
Tunnel Power	4-4		
System Pressure Gauges	4-5		
Light	4-5		
Motor Controls	4-6		
Boring Head Supply Controls	4-7		
Hydraulic Oil Cooling System	4-8		
Jacking Cylinder Control	4-9		
IJS Cylinder Control	4-10		
Ram Lift Cylinder Control	4-11		
Travel Control	4-12		
Skid Lock Control	4-13		
Filter Indicator Gauges	4-14		
Hydraulic Reservoir	4-15		

(Continued on next page)

Periodic Maintenance.....	9	Storage	10
Lubrication & Maintenance Intervals	9-1	Preparing For Storage	10-1
Before Performing Maintenance	9-1	Removing From Storage	10-1
Hydraulic Oil/Fluids Under Pressure	9-2	Troubleshooting	11
Lockout Power Before Servicing	9-2	General Troubleshooting	11-1
Avoid Pinch Points	9-3	Schematics.....	11-4
Unauthorized Welding	9-3	5200 Pump Unit Hydraulics	11-4 - 11-5
Maintenance Charts	9-4	5200 Pump Unit Electrical	
Prior To Each Job Launch	9-4	SN F27700F-11 & Before	11-6 - 11-10
Daily or Every 10 Hours or Shift Change ...	9-5	SN F27700F-12 & After	11-11 - 11-16
Weekly or Every 50 Hours	9-6	Wire List	11-17-11-19
Monthly or Every 250 Hours	9-7	Specifications	12
Completion Of Each Drive	9-8	General Specifications	12-1
Every 1000 Hours Of Operation	9-8	Relay Settings	12-2
Annually	9-9	Torque Chart	12-3
Maintenance Procedures	9-10	Identification Numbers	13
Prior To Each Job Launch	9-10	Safety Data Sheets	14
Daily or Every 10 Hours or Shift Change .	9-24	Warranty	15
Weekly or Every 50 Hours	9-31	Index	16
Monthly or Every 250 Hours	9-33		
Completion Of Each Drive	9-34		
Every 1000 Hours of Operation	9-35		
Annually	9-37		

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.



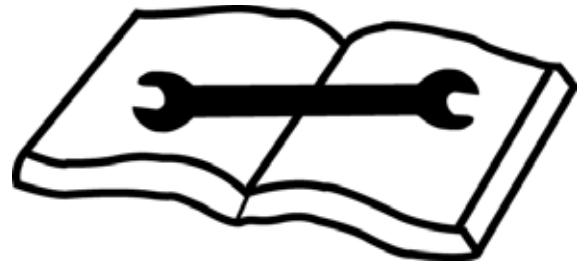
**ATTENTION!
BECOME ALERT!
YOUR SAFETY IS INVOLVED!**

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.



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.



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.

BEFORE disconnecting Boring Head and Auxiliary supply and return lines, all control levers must be in the OFF or neutral position. If using a TBM Series II with the 5200 Pump Unit, the tunnel power MUST be shut off.

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.

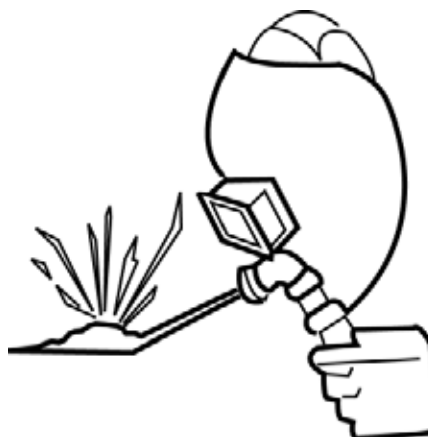


UNAUTHORIZED WELDING

⚠ 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.

Before performing authorized welding on TBM, remove gas detector to prevent damage.



KEEP PERSONNEL AWAY FROM MOVING PARTS

⚠ WARNING

Crushing hazard.

Keep personnel away from inside of yoke, on skid, or behind pump unit when jacking or moving pump unit or yoke. Failure to do so could result in serious personal injury or death.



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.



PRACTICE SAFE MAINTENANCE

⚠ WARNING

Unexpected Jacking System movement may cause serious personal injury.

LOCKOUT power before performing any maintenance.

Shut down Pump Unit 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.

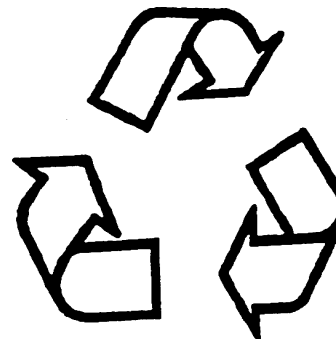
Replace worn or damaged parts. Remove grease, oil, or debris buildup.



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.



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 immediately.

Do not enter area under or around a load.



NO RIDERS ON JACKING SYSTEM

⚠ WARNING Unexpected Jacking System movement may cause riders to slip or fall resulting in serious personal injury.

Do not allow riders on the Pump Unit or the Yoke when they are moving.



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.

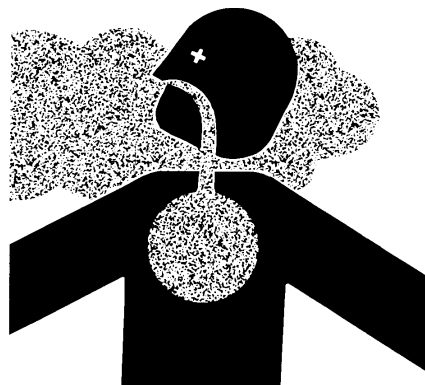
Before and during the tunnel operation, test for combustible and toxic gases and oxygen deficiency.

If the levels exceed MSHA/OSHA prescribed levels, leave tunnel 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, cut power from power source.

Gases must be removed before reentering tunnel.

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



LOCKOUT/TAGOUT POWER BEFORE SERVICING

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

This machine is powered by high-voltage electricity. LOCKOUT/TAGOUT main power supply before servicing. Electrical repairs must be performed only by a certified electrician.



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.



KEEP JOB SITE CLEAN AND ORGANIZED

⚠ WARNING Tripping can cause serious personal injury.

Be sure to keep job site clean and organized.



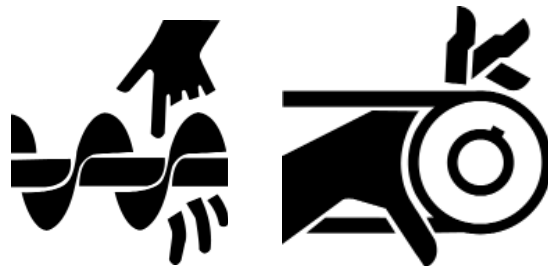
KEEP AWAY FROM CONVEYORS

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

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

Do not operate without covers and guards in place.

Lockout power before servicing.



HIGH PRESSURE HYDRAULICS

⚠ WARNING The 5200 Pump Unit is equipped with high pressure hydraulic components.

Keep all guards in place.



NO SMOKING IN TUNNEL

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

Do not smoke in tunnel.

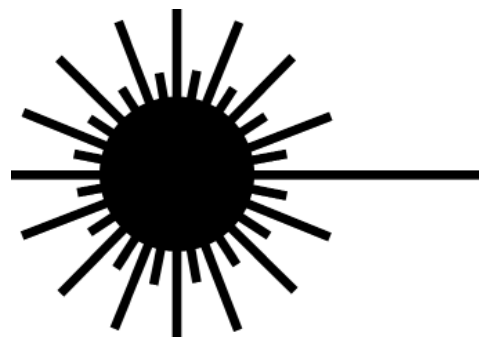


AVOID LASER LIGHT EXPOSURE

⚠ 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.



USING TUNNEL POWER CABLE

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



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 a unsecured electrical connection.



AVOID PINCH POINTS

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

Keep hands away from moving parts.

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

Handle parts carefully to avoid crushing and pinch point hazards.



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.



NOTES

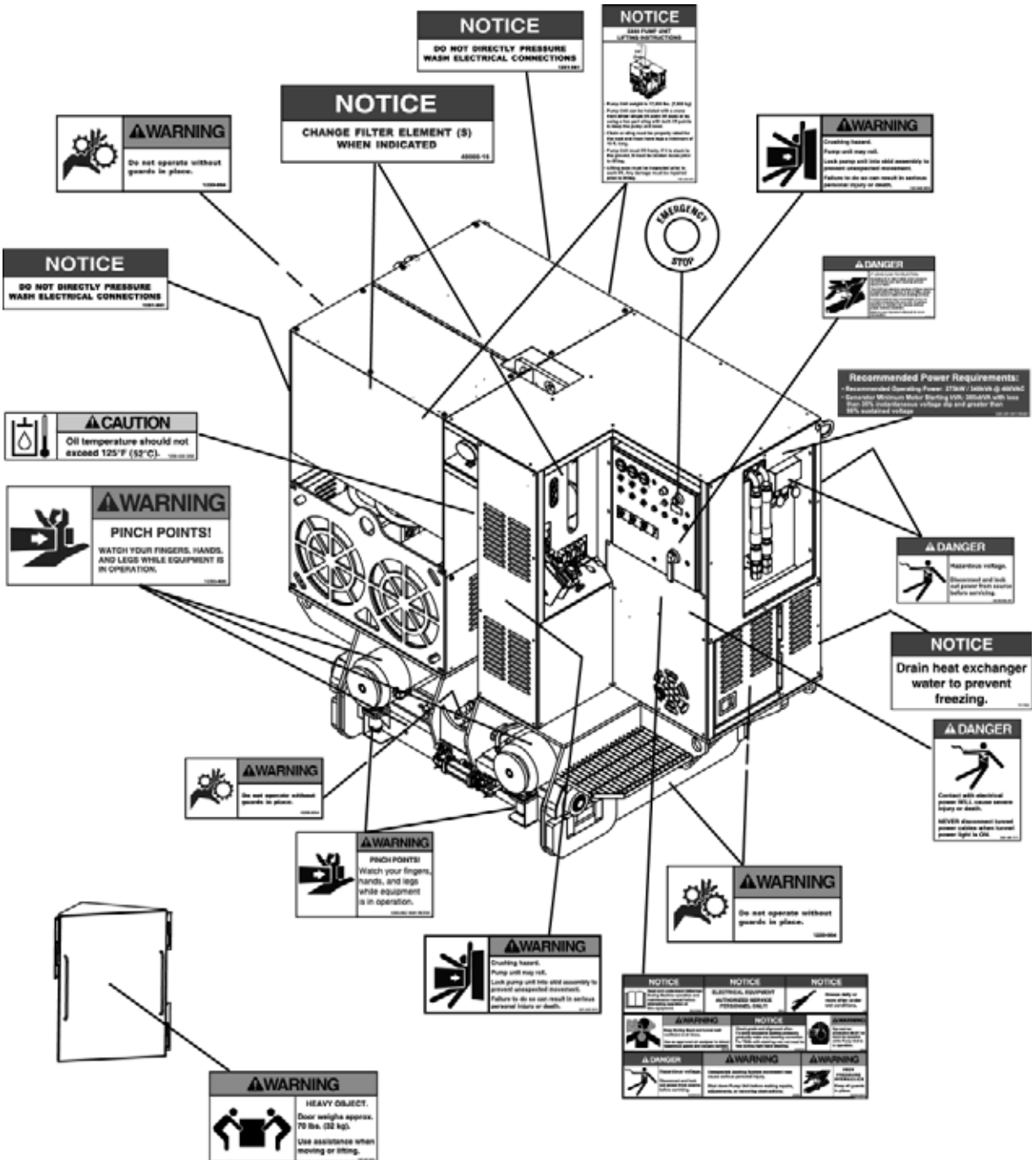
Safety Decals

Keep all safety 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 safety decals with solvent. Solvent can damage them. Replace safety decals immediately if they are damaged, missing, or hard to read.

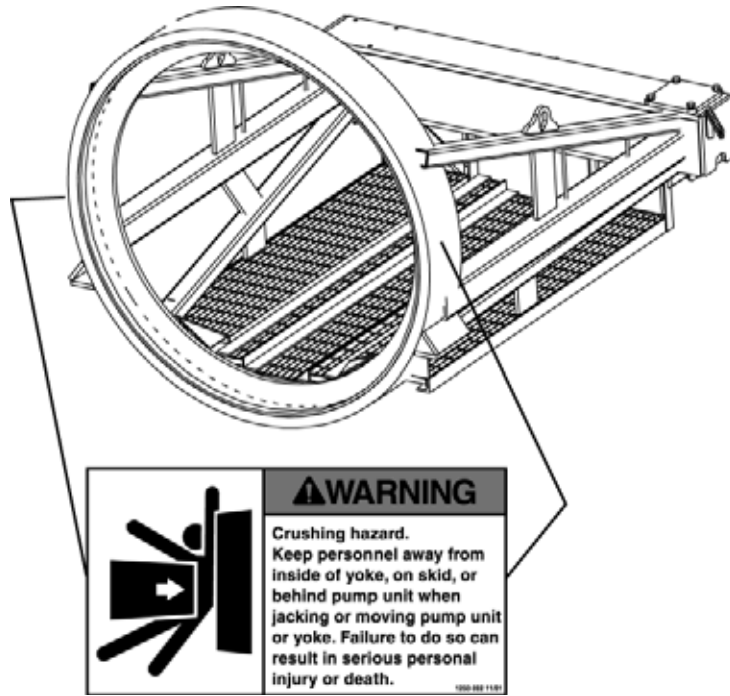
Serious injury or property damage can occur if safety instructions are not followed. Contact your Akkerman Aftermarket Support representative for free replacement safety decals.

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.

5200 PUMP UNIT



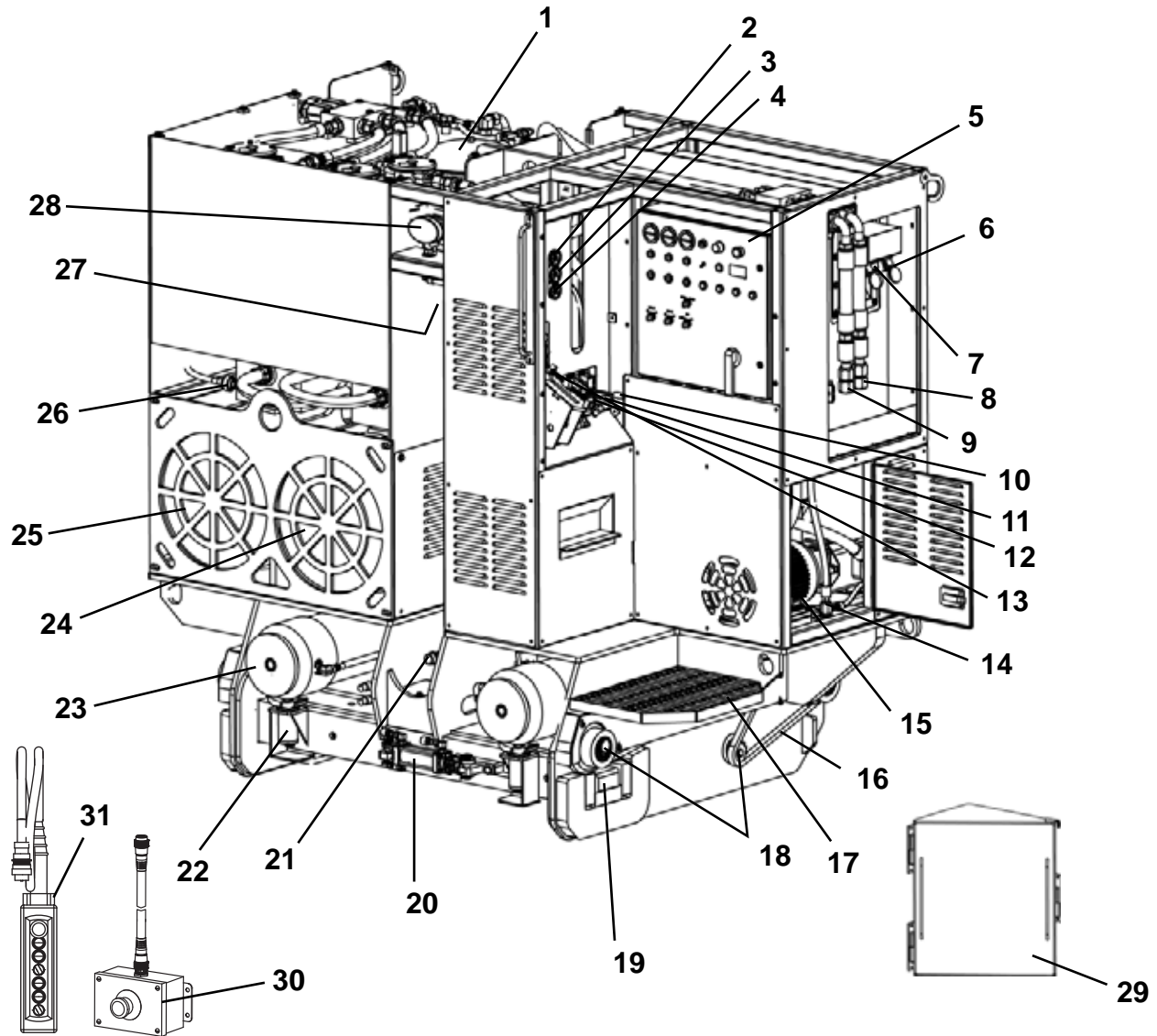
YOKE



NOTES

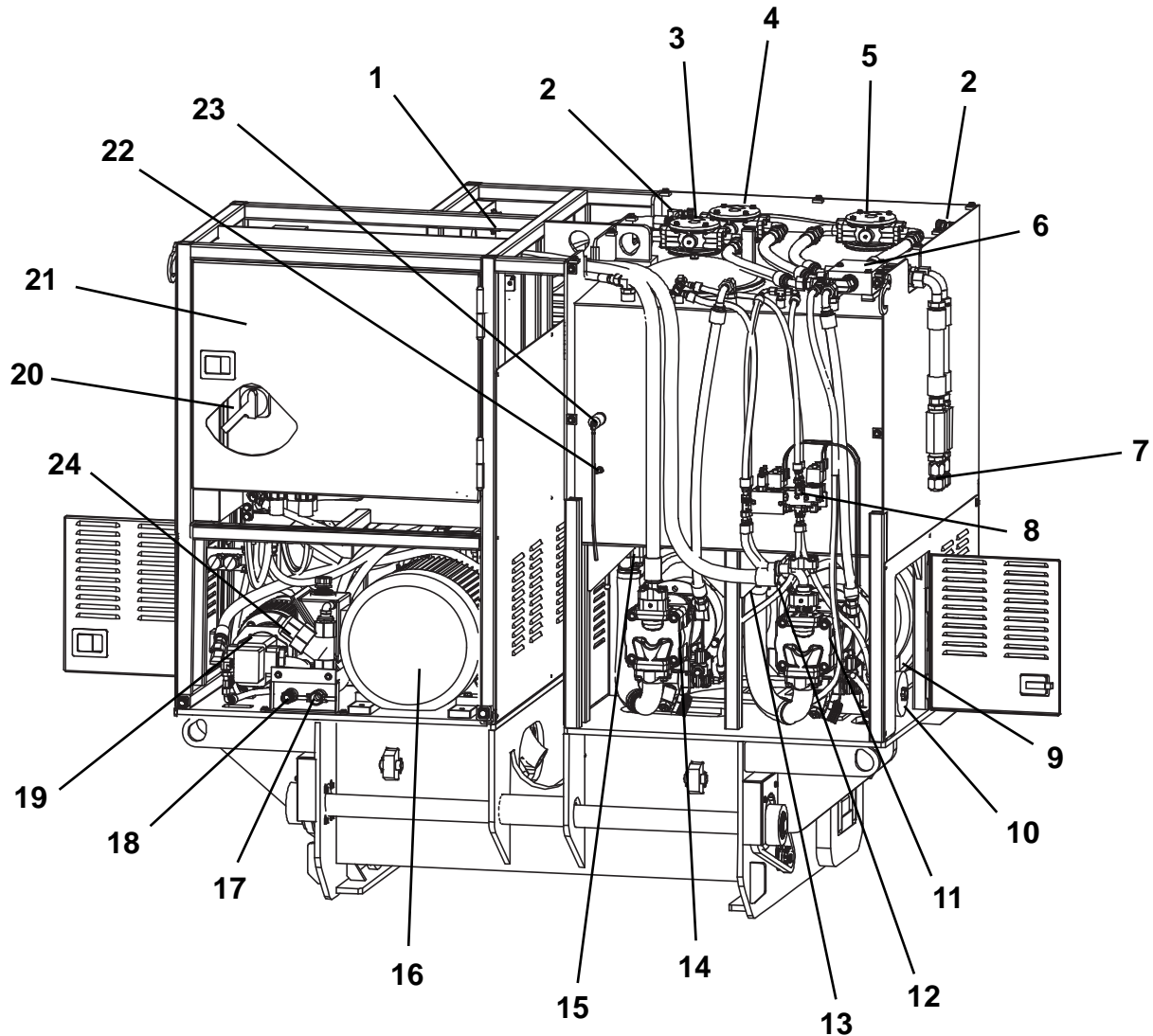
Terminology

5200 PUMP UNIT - FRONT COMPONENTS



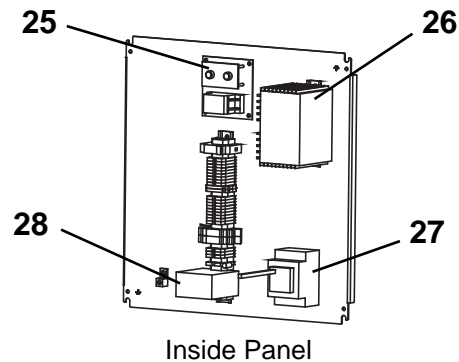
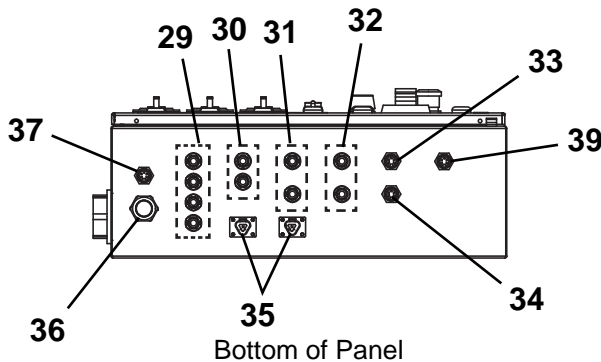
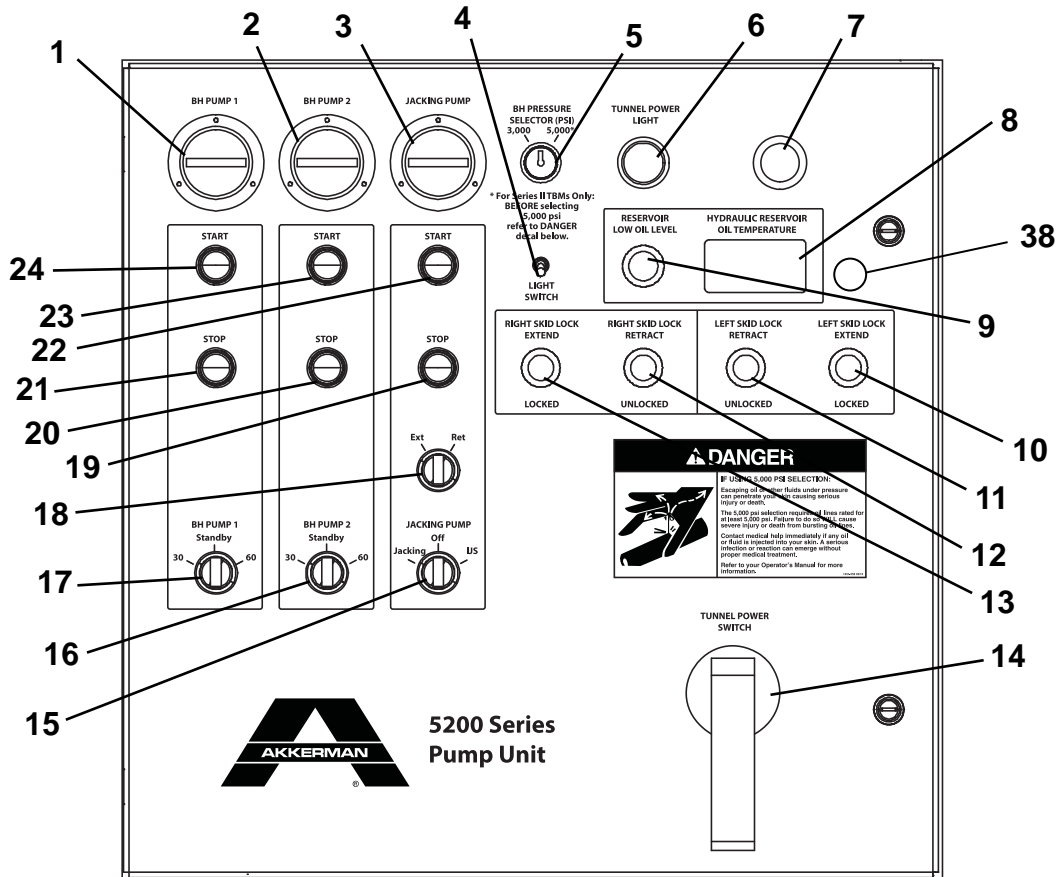
- | | |
|--|---|
| 1. Hydraulic Reservoir - 240 Gallons | 17. Operator Platform |
| 2. Return Filter 1 Indicator | 18. Drive Assembly |
| 3. Return Filter 2 Indicator | 19. Skid Lock |
| 4. Return Filter 3 Indicator | 20. Skid Lock Cylinder |
| 5. Control Panel | 21. Tank Oil Fill Hose |
| 6. Electrical Power Cable Cam Lock Connections | 22. Ram Lift Cylinder |
| 7. Phase Error Light | 23. Jacking Cylinder, 200 Ton Ram |
| 8. Boring Head Supply Pressure Hose - BH Pump 2 | 24. Boring Head 2 Supply 100 HP Motor |
| 9. Boring Head Supply Pressure Hose - BH Pump 1 | 25. Boring Head 1 Supply 100 HP Motor |
| 10. Travel (Pump Unit Drive) Control | 26. Tunnel Power Cable Connection |
| 11. Skid Lock Cylinder Control | 27. Hydraulic Level/Temperature Gauge |
| 12. Ram Lift Cylinder/High Speed Cyl Retract Control | 28. Light |
| 13. Jacking Cylinder Variable Speed Control | 29. Control Panel Vandal Resistant Door |
| 14. IJS Supply Hose Connection | 30. Remote E-Stop (Option) |
| 15. Cooling 5 HP Motor | 31. Control Pendant (Option) |
| 16. Drive Chain | |

5200 PUMP UNIT - REAR COMPONENTS



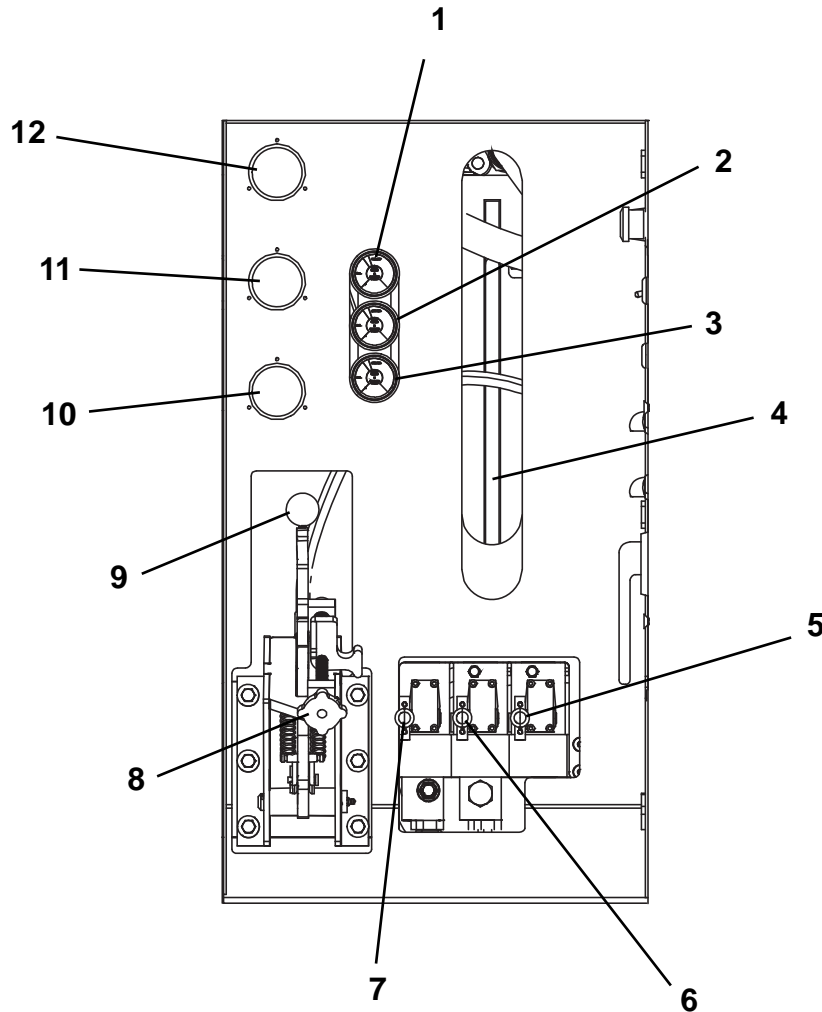
- | | |
|--|--|
| 1. Heat Exchanger | 13. Jacking Supply Shutoff Valve |
| 2. Tank Breather | 14. Boring Head 2 Supply Pump |
| 3. Return Filter 1 | 15. Boring Head 2 Supply Shutoff Valve |
| 4. Return Filter 2 | 16. Jacking System 60 HP Motor |
| 5. Return Filter 3 | 17. Heat Exchanger Water Supply Fitting |
| 6. Return Manifold | 18. Heat Exchanger Water Discharge Fitting |
| 7. Boring Head Return Hoses | 19. Cooling Pump |
| 8. Pressure Control Valves | 20. Main Power |
| 9. IJS Return Hose Connection | 21. Main Power Electrical Panel |
| 10. Tank Fill Pump | 22. Hydraulic Oil Temperature Sensor |
| 11. Boring Head 1 Supply Pump | 23. Low Oil Level Switch |
| 12. Boring Head 1 Supply Shutoff Valve | 24. Water Inlet Strainer |

5200 PUMP UNIT - CONTROL PANEL



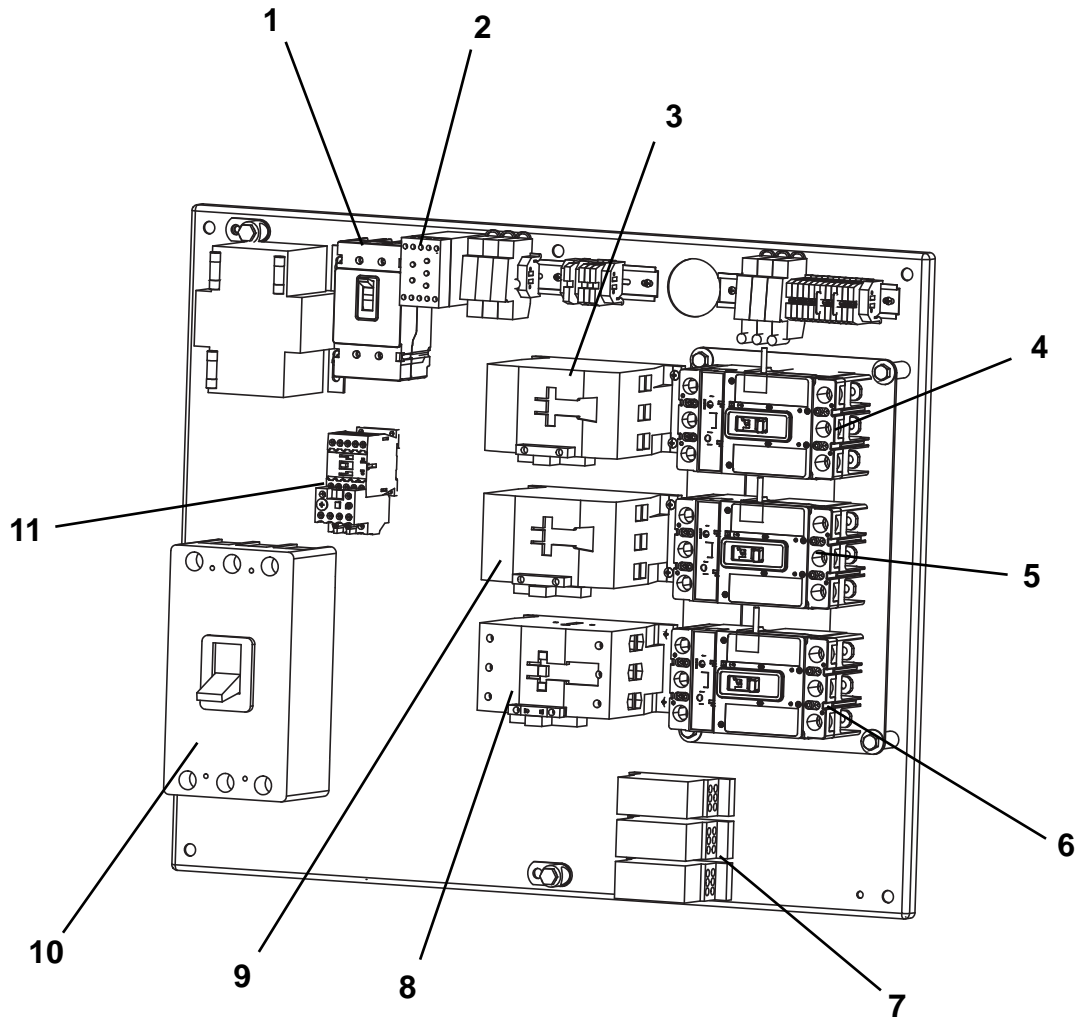
- | | |
|--|--|
| <ul style="list-style-type: none"> 1. Boring Head Pump 1 Hourmeter 2. Boring Head Pump 2 Hourmeter 3. Jacking Pump Hourmeter 4. Light Switch 5. Boring Head Pressure Selector 6. Tunnel Power Light 7. Emergency Stop (E-Stop) 8. Hydraulic Reservoir Oil Temperature 9. Reservoir Low Oil Level 10. Left Skid Lock Extend (Locked) Indicator 11. Left Skid Lock Retract (Unlocked) Indicator 12. Right Skid Lock Retract (Unlocked) Indicator 13. Right Skid Lock Extend (Locked) Indicator 14. Tunnel Power Switch 15. Jacking Pump Selector Switch 16. Boring Head Pump 2 Control 17. Boring Head Pump 1 Control 18. Jacking Cylinder Selector Switch 19. Jacking Pump Stop Control 20. Boring Head Pump 2 Stop Control | <ul style="list-style-type: none"> 21. Boring Head Pump 1 Stop Control 22. Jacking Pump Start Control 23. Boring Head Pump 2 Start Control 24. Boring Head Pump 1 Start Control 25. Pump Controller Board 26. 24V Power Supply 27. Tunnel Power Breaker 15 Amp 28. 480V Tunnel Power Contactor 29. Skid Lock Cable Receptacle 30. Tank Level & Temp. Cable Receptacle 31. Boring Head 1 Cable Receptacle 32. Boring Head 2 Cable Receptacle 33. Jacking Cable Receptacle 34. IJS/Auxiliary Cable Receptacle 35. Lights Cable Receptacle 36. Tunnel Power Cable Receptacle 37. Remote E-Stop Cable Receptacle 38. Auxiliary/Cooling Pump ON/OFF Switch 39. 200 HP Auxiliary - 24V Connection |
|--|--|

5200 PUMP UNIT - OPERATOR CONTROL PANEL



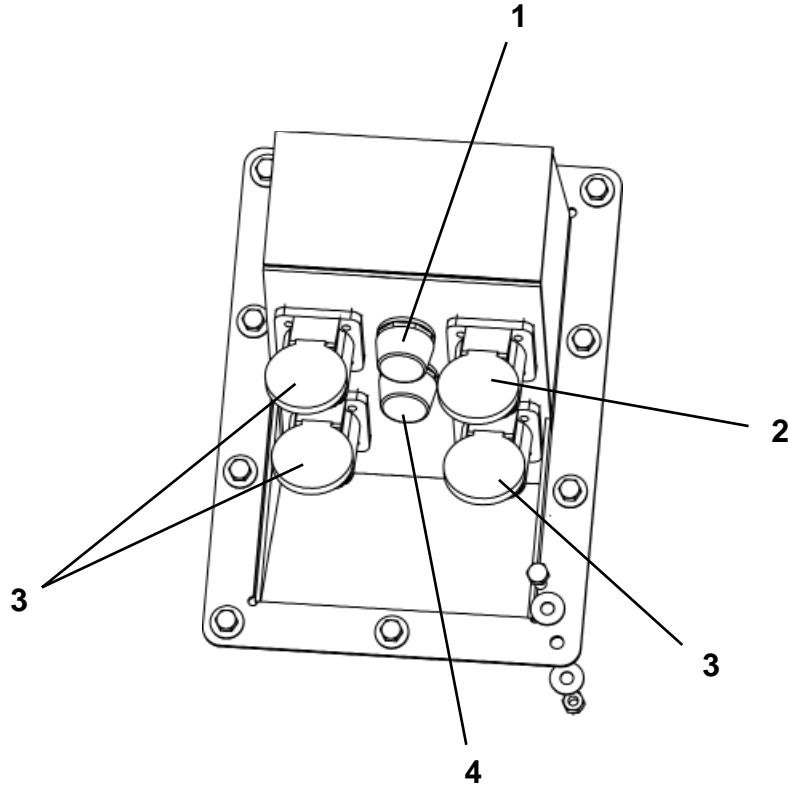
- | | |
|--|---|
| 1. Return Filter 1 Indicator | 7. Ram Lift Cylinder Control / High Speed Jacking
Cylinder Retract Control |
| 2. Return Filter 2 Indicator | 8. Speed Control Stop Adjustment |
| 3. Return Filter 3 Indicator | 9. Jacking Cylinder Variable Speed Control |
| 4. View to Hydraulic Reservoir Level & Temperature | 10. Jacking Pressure Gauge |
| 5. Travel Control | 11. Boring Head 2 Pressure Gauge |
| 6. Skid Lock Cylinder Control | 12. Boring Head 1 Pressure Gauge |

5200 PUMP UNIT - MAIN POWER ELECTRICAL PANEL



1. 480V Breaker
2. Phase Detector
3. Boring Head Motor 1 Contactor
4. Boring Head Motor 1 Breaker With Overload Relay
5. Boring Head Motor 2 Breaker With Overload Relay
6. Jacking Motor Breaker With Overload Relay
7. Power Distribution Block
8. Jacking Motor Contactor
9. Boring Head Motor 2 Motor Contactor
10. Main 400A Breaker
11. Cooling Motor Contactor & Overload Relay

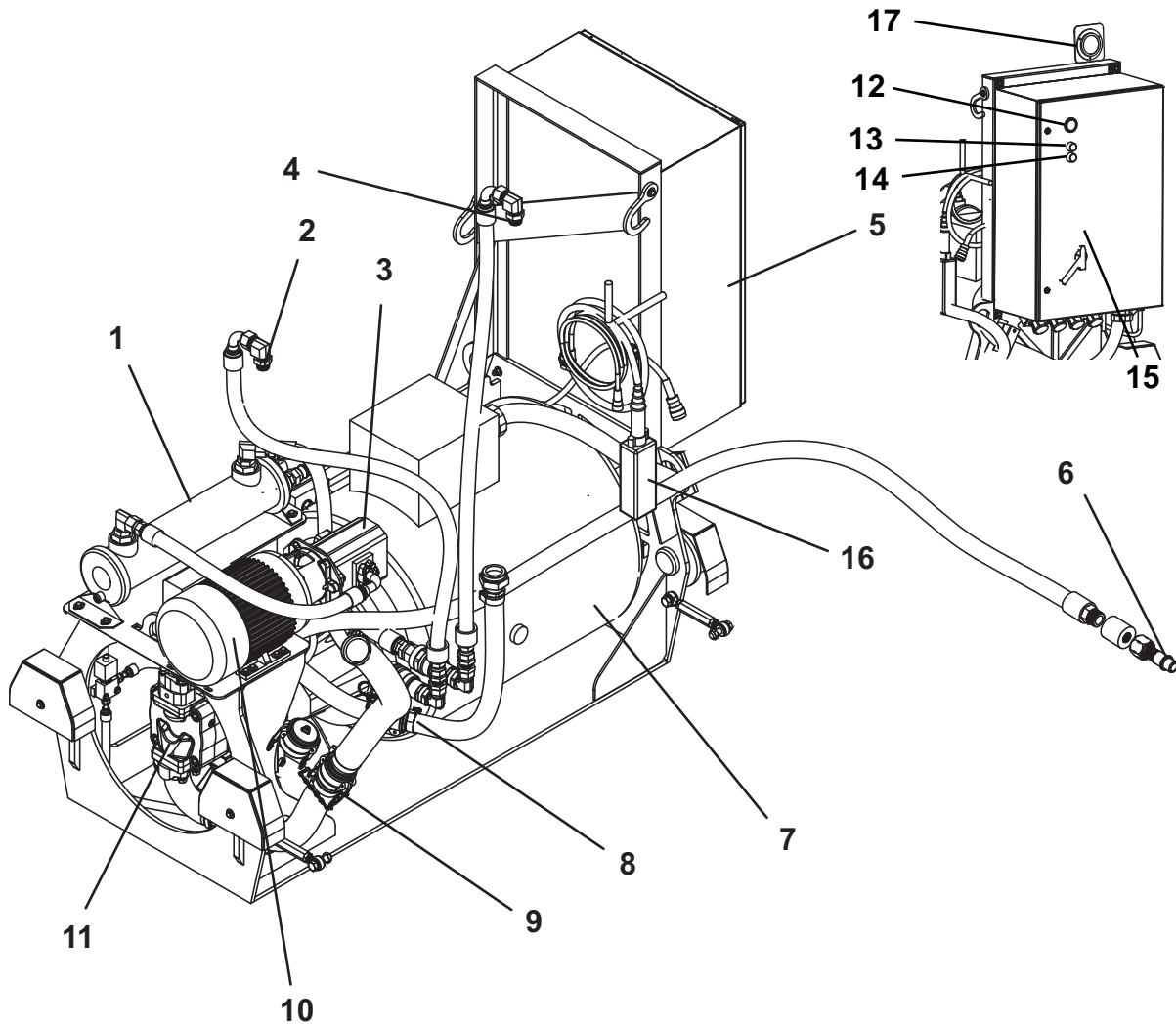
5200 PUMP UNIT - ELECTRICAL CONNECTIONS



1. Phase OK (Green) Light
2. Ground Cable Cam Lock Connection
3. Electrical Power Cable Cam Lock Connections
4. Phase Error (Red) Light

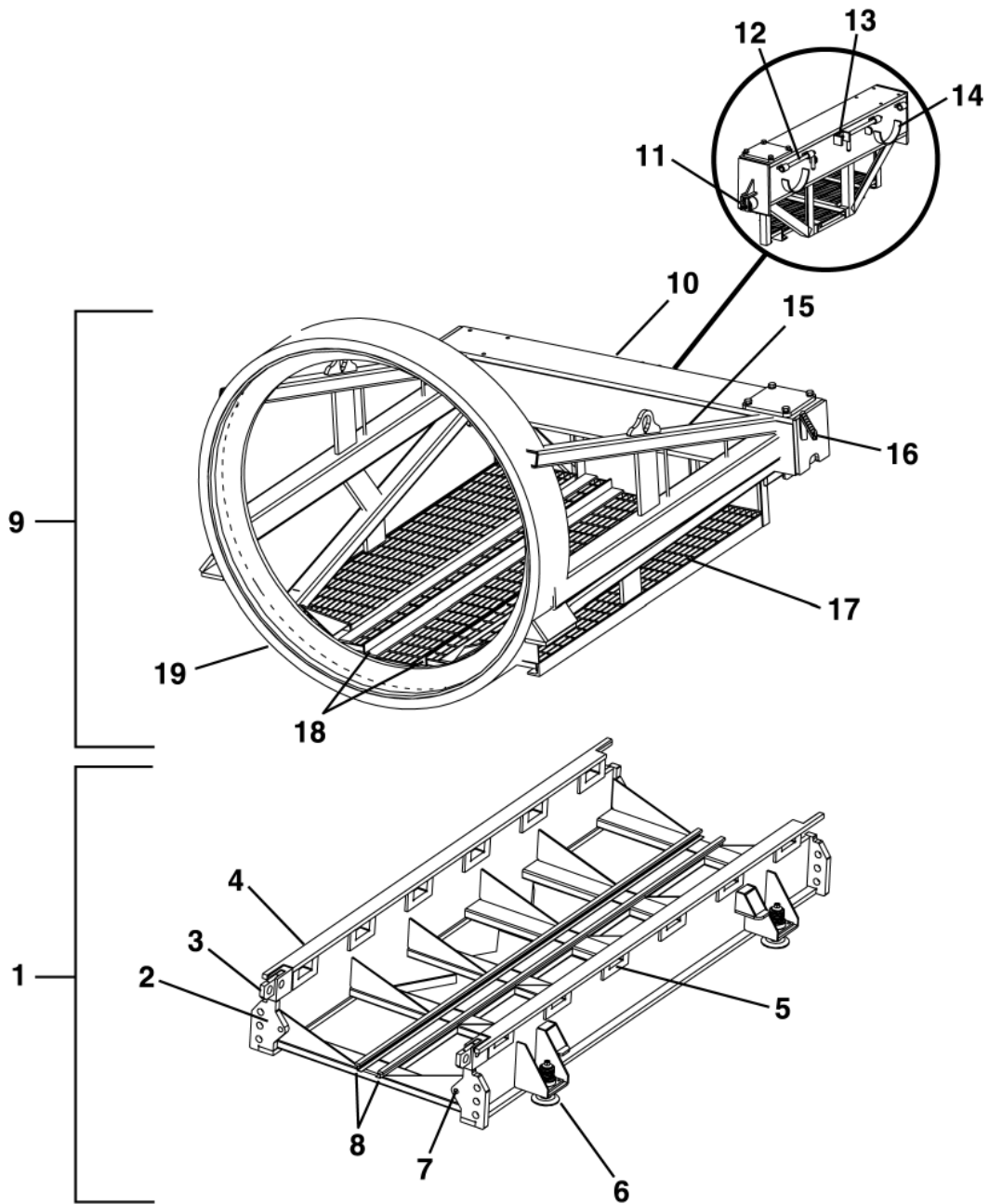
200 HP AUXILIARY

When using the 5200 Pump Unit with the single feed assembly (F27624F) and the 200 HP Auxiliary, each system will provide 60 gpm @ 5,000 psi for a total of 120 gpm @ 5,000 psi.



- | | |
|--|---------------------------------------|
| 1. Heat Exchanger | 10. Cooling Motor 5 HP |
| 2. Cooling Return To 5200 Tank | 11. Pump 200 HP Auxiliary |
| 3. Gear Pump | 12. Hourmeter |
| 4. Case Drain For 200 HP Pump | 13. Phase OK Indicator |
| 5. Electrical Assembly | 14. Phase Error Indicator |
| 6. Auxiliary Supply To Tunnel Hydraulics | 15. Main Power Switch |
| 7. 200 HP Motor | 16. Control Pendant |
| 8. Supply To Cooling Pump From 5200 | 17. Pressure Gauge - Hydraulic Supply |
| 9. Supply To Auxiliary Pump From 5200 | |

SKID & YOKE



- | | |
|----------------------------|----------------------------|
| 1. Skid | 11. Yoke Wheel |
| 2. Skid Base | 12. Yoke Retaining Pin |
| 3. Skid Split Bar | 13. Ram Retaining Pin Stop |
| 4. Side Skid Base Assembly | 14. Ram Cradle |
| 5. Skid Pocket | 15. Yoke Ring Support |
| 6. Leveling Assembly | 16. IJS Line Holder |
| 7. Skid Locator Pin | 17. Floor |
| 8. Rail | 18. Rail (for Haul Unit) |
| 9. Yoke | 19. Yoke Ring |
| 10. Dual Ram Yoke, Rear | |

Controls & Instruments

EMERGENCY STOP

⚠ WARNING ALL Emergency Stop buttons MUST be operating properly BEFORE operating Pump Unit and TBM. Failure to do so may cause severe injury or death.

Push Emergency Stop button (A) IN to stop all electrical and hydraulic functions on the 5200 Pump Unit and the tunnel boring machine.

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

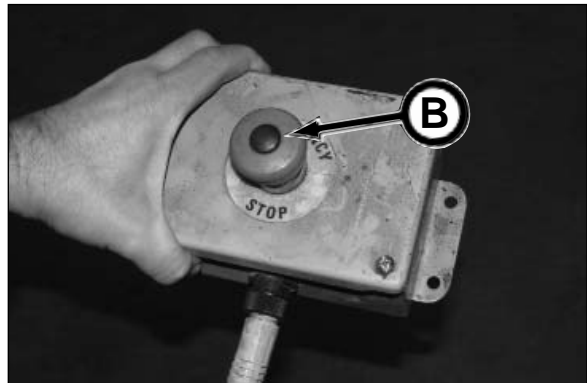
The E-Stop button must be pulled out to restart operation.



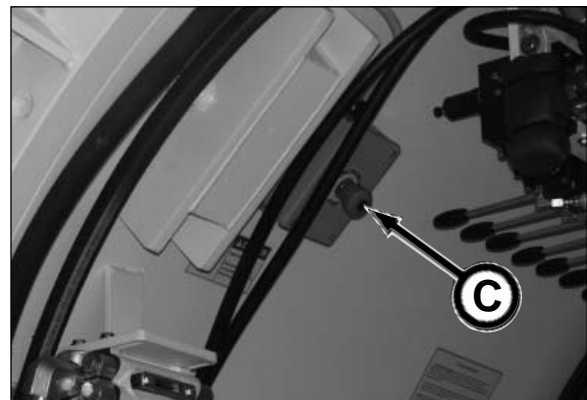
E-Stop on 5200 Pump Unit

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

The operating lights will not be functional.



Remote E-Stop on 5200 Pump Unit



E-Stop on Series II TBM

PHASE INDICATOR LIGHTS

⚠ WARNING Any electrical work completed on the Pump Unit and 200 HP Auxiliary must be performed by a certified electrician.

The input power on both the Pump Unit and the 200 HP Auxiliary is monitored for proper three phase electrical power.

If the green Phase OK Light (A) is ON, this indicates that the input power is in proper phase.

If the red Phase Error Light (B) is ON, this indicates that the external power source phase power is installed incorrectly. Disconnect and lock out ALL power before attempting to reverse the two generator power leads.

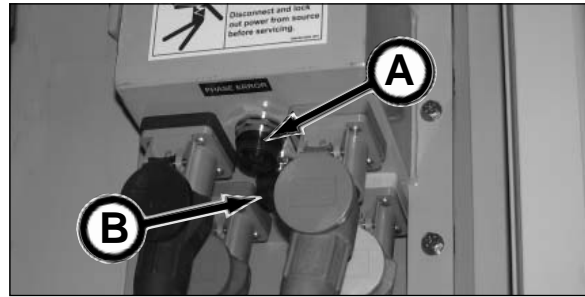
The red Phase Error light will also illuminate in the following conditions:

- Undervoltage (Less than 95%)
- Overvoltage (greater than 110%)
- Phase imbalance
- Phase loss

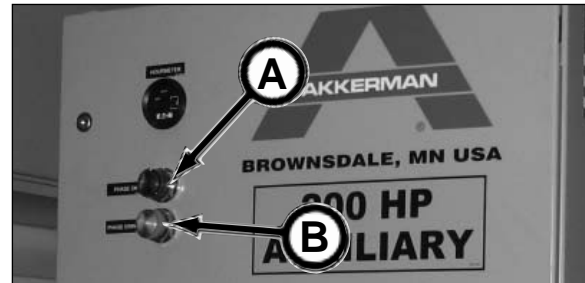
If it becomes necessary to troubleshoot the electrical fault, the 5200 Pump Unit and the 200 HP Auxiliary are equipped with a Phase Detector (C) (includes fault indicators). Gain access to the Phase Detector ONLY if it is required to help diagnose electrical issues. Lockout, tagout power, then open the 5200 main power electrical panel cover (D) and/or the 200 HP Auxiliary electrical panel cover (E) to gain access to the Phase Detector.

Refer to the table to the right for the Phase Error LED status indicator codes. The LED status light is located on the inside of the main disconnect electrical box.

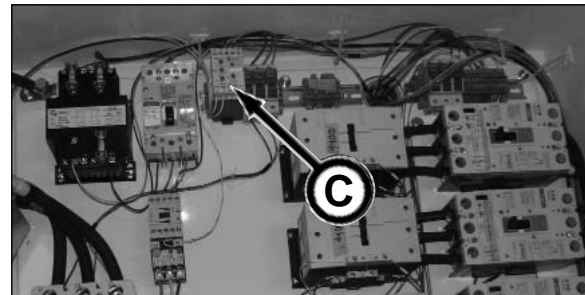
IMPORTANT: DO NOT start up electric motors if the red Phase Error light (B) is illuminated. Doing so will run motors backwards causing component damage.



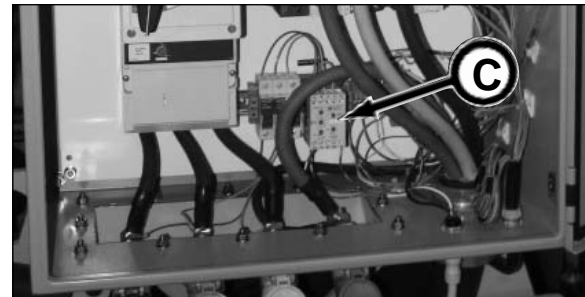
5200 Pump Unit



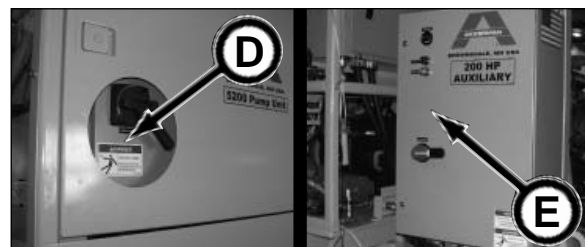
200 HP Auxiliary



5200 Pump Unit



200 HP Auxiliary



FAULT INDICATION CODE TABLE	
Led Status	Indicator
Green Steady	Normal / Relay ON
Green Flashing	Power Up / Restart Delay
Red Steady	Unbalance
Red Flashing	Under Voltage / Overvoltage
Amber Steady	Reversal
Amber Flashing	Loss
Green/Red Alternating	Under / Overvoltage Trip Pending
Red/Amber Alternating	Nominal Voltage Set Error

MAIN POWER 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 may result in electrical shock causing severe injury or death. Disconnect and lock out/tag out power from source before servicing.

Recommended Power Requirements:

- 5200 Pump Unit

- Recommended Operating Power: 275kW / 340kVA @ 480VAC
- Generator Minimum Motor Starting kVA: 385skVA with less than 35% instantaneous voltage dip and greater than 90% sustained voltage

- 200 HP Auxiliary Unit

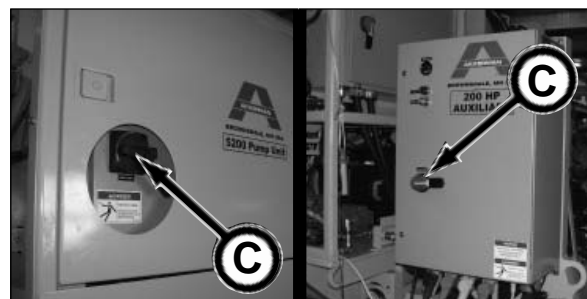
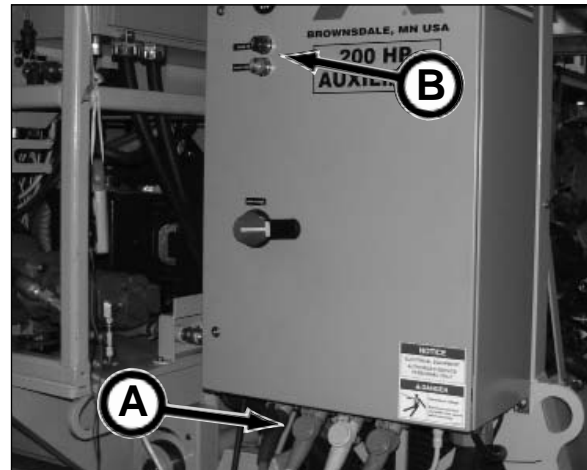
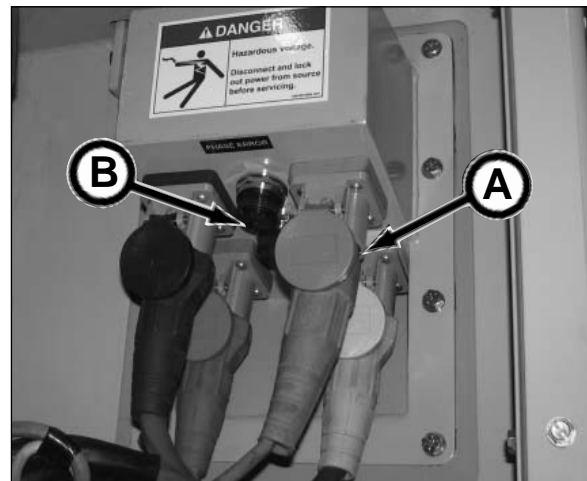
- Recommended Operating Power: 225kW / 280kVA @ 480VAC
- Generator Minimum Motor Starting kVA: 770skVA with less than 35% instantaneous voltage dip and greater than 90% sustained voltage

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

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

Use the main power switch (C) to allow power from an external power source to the pump unit and TBM electrical components as follows:

1. Hook up power cables to the electrical power cable cam lock connections (A) from external power source(s).
2. Turn on external power source(s) and check Phase indicator lights (B) for proper phase (refer to Phase Indicator Lights in this section).
3. With proper phase, turn on main power switch (C).



5200 Pump Unit

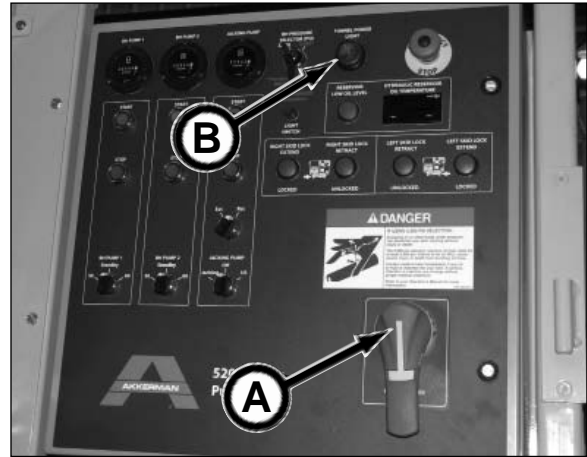
200 HP Auxiliary

TUNNEL POWER

NOTICE If using a TBM Series I machine with the 5200 Pump Unit, the Tunnel Power switch (A) MUST be OFF to operate. If Tunnel Power switch is ON, Pump 1 and Pump 2 will not operate.

The Akkerman 5200 Pump Unit is equipped with a Tunnel Power switch (A) and a Tunnel Power ON light (B) for the Akkerman Series II TBMs with 480V power.

Once the pump unit main power switch is on and all Emergency Stop buttons are pulled out, the Tunnel Power switch can be turned on which will illuminate the Tunnel Power On light. The tunnel power light provides the operator a quick visual indicator that power is ON in the tunnel and to take all necessary precautions with high voltage electricity.



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



Connect a 10GA tunnel cable (Akkerman PN FA20511F0) to the 5200 Pump Unit tunnel power cable connection (C) and the other end to the incoming power connection in the Series II TBM.



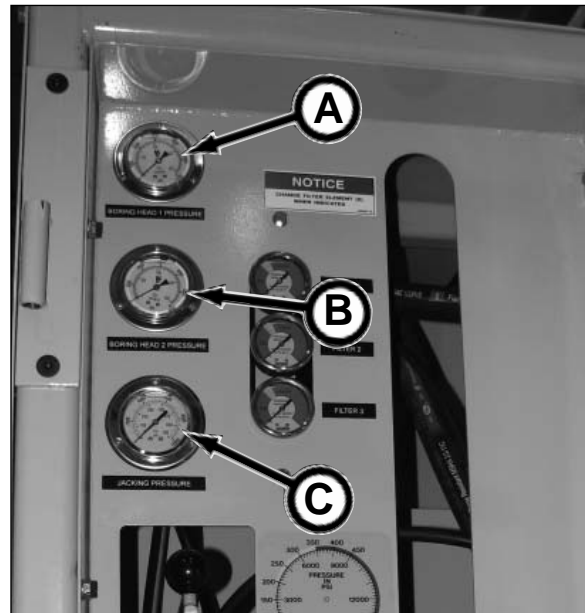
SYSTEM PRESSURE GAUGES

The 5200 Pump Unit is equipped with pressure gauges to monitor the pressures of the hydraulic systems; boring head 1, boring head 2 and jacking systems.

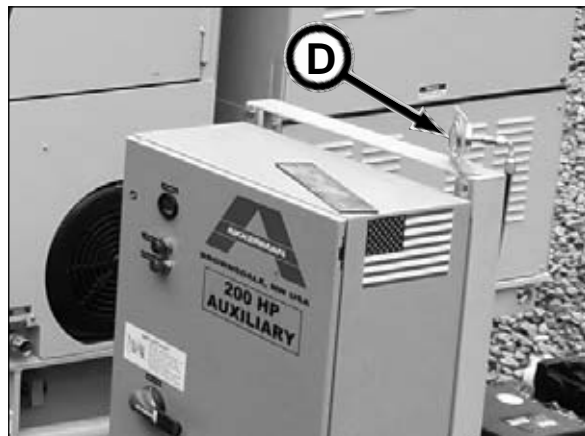
The Boring Head 1 (A) and Boring Head 2 (B) systems are low pressure systems used for the boring head components and conveyor. These systems are capable of 3,000 psi.

NOTICE If using a Series II TBM with boring head lines rated to at least 5,000 psi, a 5,000 psi selection is available.

The jacking system (C) is a high pressure system used to control the dual ram jacking cylinders and the intermediate jacking station cylinders (IJS). The jacking and IJS systems are capable of 8,000 psi.



The 200 HP Auxiliary is equipped with a pressure gauge to monitor the hydraulic supply pressure for the TBM hydraulics (60 gpm @ 5,000 psi).



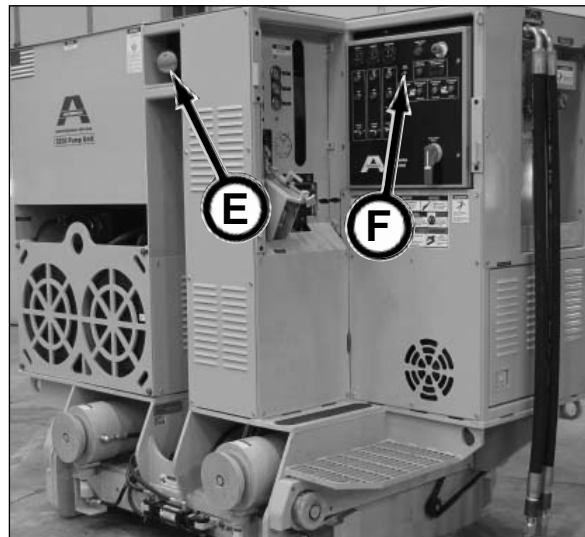
LIGHT

The pump unit is equipped with an operating light (E).

Flip light switch (F) as follows:

Light ON - Up

Light OFF - Down



MOTOR CONTROLS

The motor controls regulate the two 100 HP boring head motors and the 60 HP jacking system motor as follows:

NOTICE All E-Stop buttons must be pulled out for the motor controls to be operational.

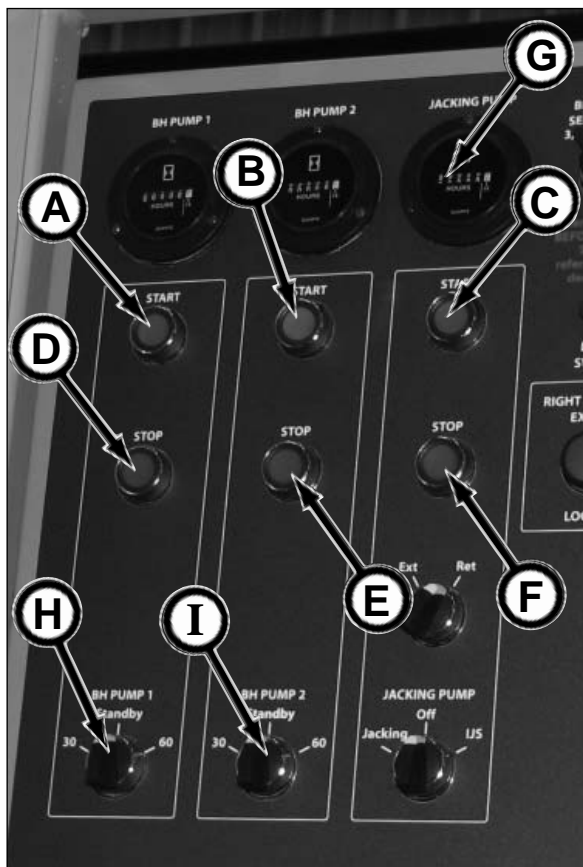
NOTICE The BH Pump 1 (H) and BH Pump 2 (I) controls must be in the Standby position before starting, otherwise the motor(s) will not start.

To power ON the electrical and hydraulic systems, depress START button:

Boring Head 1 System	A
Boring Head 2 System	B
Jacking System	C

To power OFF the electrical and hydraulic systems, depress STOP button:

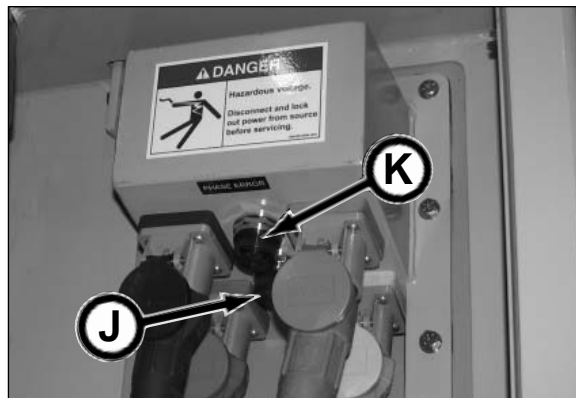
Boring Head 1 System	D
Boring Head 2 System	E
Jacking System	F



The pump unit is also equipped with an individual hourmeter (G) for each motor system. The hourmeter registers in full hours and 1/10th hours.

IMPORTANT: DO NOT start up electric motors if the red Phase Error light (J) is illuminated. Doing so will run motors backwards causing component damage.

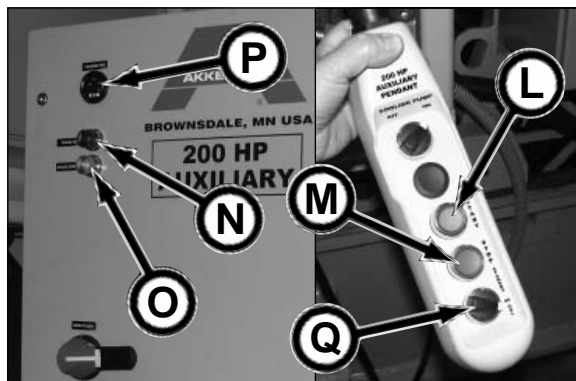
NOTICE The green Phase OK light (K) indicates the power is in proper phase.



The 200 HP Auxiliary is equipped with a control pendant to Start (L) and Stop (M) the 200 HP motor.

The auxiliary unit also includes the Phase OK (N) and Phase Error (O) indicators and hourmeter (P) on the control panel.

NOTICE The 200 HP Auxiliary motor control (Q) must be in the Standby position before starting, otherwise the motor will not start.



BORING HEAD SUPPLY CONTROLS

The boring head supply controls; BH Pump 1 (A) and BH Pump 2 (B); regulate the hydraulic oil flow to the boring head components and conveyor.

The 5200 Pump Unit maximum flow is 120 GPM. The maximum pressure is 3,000/5,000 psi. **(5,000 psi requires TBM Series II and supply lines rated at a minimum of 5,000 psi).**

Use the key switch to change the the pressure mode. Remove the key and store in a safe place to prevent accidental pressure setting change.

• **Move the controls as follows for 3,000 psi:**

Single Feed (60 gal) for all TBMs:

Rotate BH Pump 1 control to 60 gallon position.

Dual Feed (90 gal) for TBM 360, 48SC, 420, 480 & Series II TBMs:

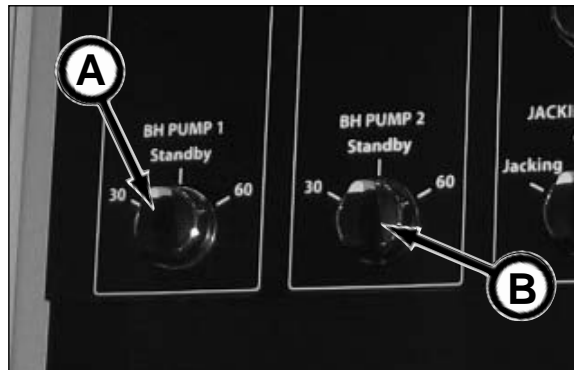
Rotate BH Pump 1 control to 60 gallon position.
Rotate BH Pump 2 control to 30 gallon position.

Dual Feed (120 gal) for TBM 540 (SN 4 & After), 600, 660, 720, 780:

Rotate BH Pump 1 control to 60 gallon position.
Rotate BH Pump 2 control to 60 gallon position.

Dual Feed (120 gal) for Series II TBMs:

Rotate BH Pump 1 control to 60 gallon position.
Rotate BH Pump 2 control to 60 gallon position.



• **Move the controls as follows for 5,000 psi:**

NOTICE The 5,000 psi mode (C) can only be used with a Series II TBM in the 30 gal position. Selecting 60 gal position in the 5,000 psi mode will automatically reduce the supply to the 3,000 psi mode.

Single Feed (34 gal) for Series II TBMs:

Rotate BH Pump 1 control to 30 gallon position.

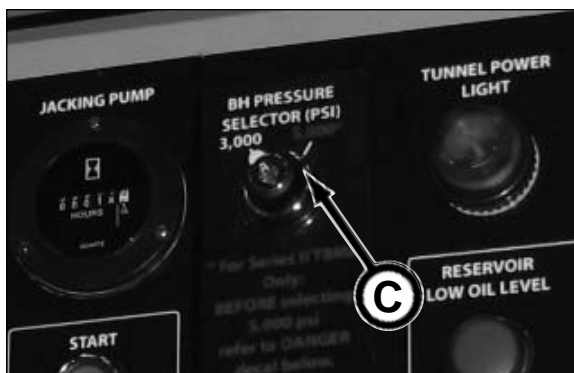
Single Feed* (68 gal) for Series II TBMs: (Check Valve Assembly F27624F Required)

Rotate BH Pump 1 control to 30 gallon position.
Rotate BH Pump 2 control to 30 gallon position.

* Using the optional 200 HP Auxiliary provides an additional 60 gpm @ 5,000 psi.

Dual Feed (68 gal) for Series II TBMs:

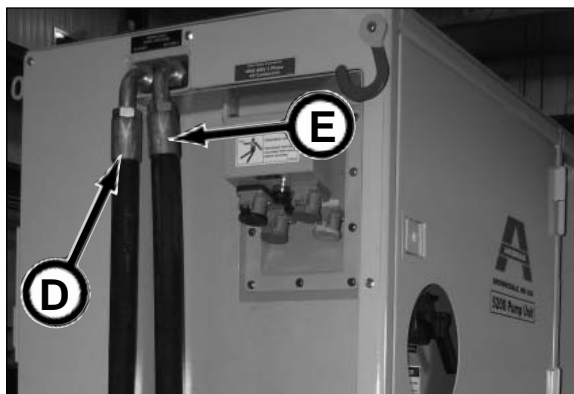
Rotate BH Pump 1 control to 30 gallon position.
Rotate BH Pump 2 control to 30 gallon position.



NOTICE Selecting BH Pump 1 will cause hydraulic oil to flow out the boring head supply pressure hose (D) to the TBM components. Selecting BH Pump 2 will cause hydraulic oil to flow out the boring head supply pressure hose (E) to the TBM components.

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

NOTICE (3,000/5,000 psi mode) When pressure exceeds 2,800/4,800 psi, the boring head component performance will start to diminish until it reaches the relief setting of 3,000/5,000 psi. This will suspend operation, while retaining 3,000/5,000 psi within the pressure lines.



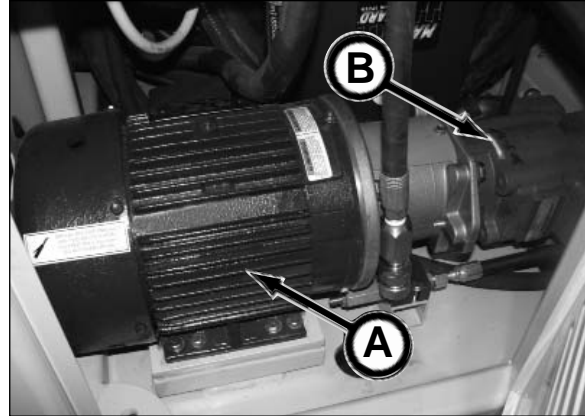
- A - Boring Head Pump 1 Selector
- B - Boring Head Pump 2 Selector
- C - Boring Head Pressure Selector
- D - Boring Head Pump 1 Supply Hose
- E - Boring Head Pump 2 Supply Hose

HYDRAULIC OIL COOLING SYSTEM

The cooling pump circulates hydraulic oil through the heat exchanger and back to tank to cool the oil.

(Early units) Once the Main Power is turned on, the cooling motor (A) and cooling pump (B) start up and continuously run.

(Later units) Once the Main Power is turned on, the cooling motor (A) and cooling pump (B) can be turned on and off with the Auxiliary/Cooling Pump ON/OFF switch (C).

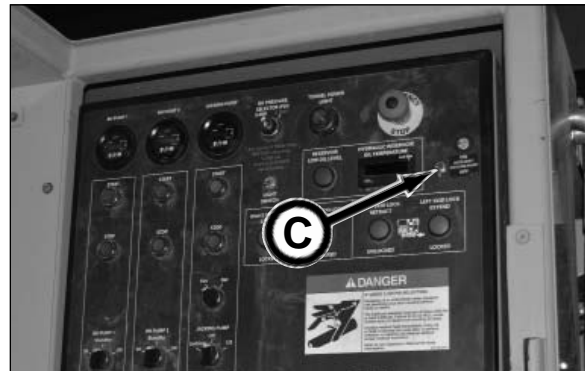


5200 Pump Unit

NOTICE

The Auxiliary/Cooling Pump ON/OFF switch (C) must be ON for the travel, skid lock and ram lift controls to function.

In cold weather the Auxiliary/Cooling Pump ON/OFF switch is turned OFF to heat up the hydraulic oil quicker.



NOTICE

The heat exchanger water supply requirement is 8 GPM minimum of CLEAN water.

The hydraulic oil temperature should not exceed 125°F (52°C).



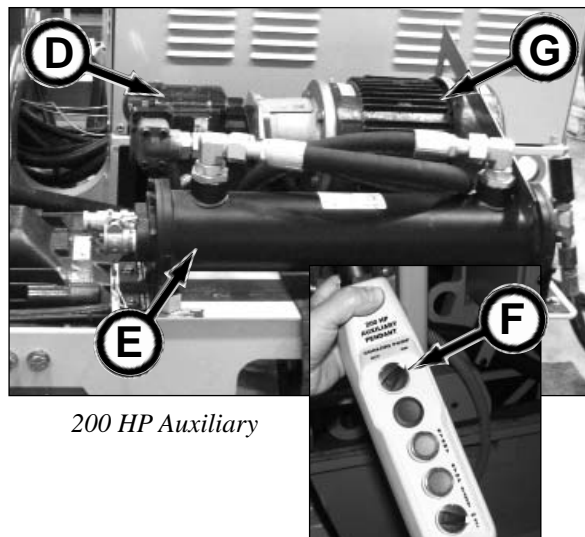
5200 Pump Unit

The 200 HP Auxiliary is also equipped with a cooling pump (D) to circulate the hydraulic oil through the auxiliary heat exchanger (E) and back to the pump unit tank to cool the oil.

The Cooling Pump switch (F) on the control pendant is used to turn the cooling motor (G) ON/OFF.

NOTICE

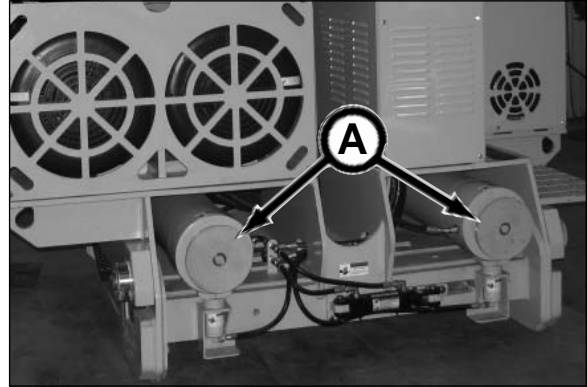
The heat exchanger water supply requirement is 8 GPM minimum of CLEAN water.



200 HP Auxiliary

JACKING CYLINDER CONTROLS

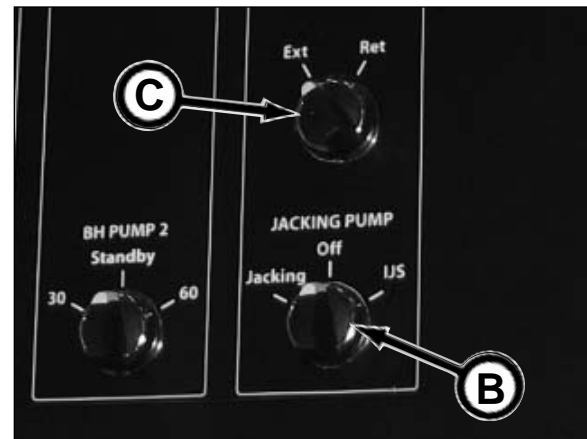
There are four controls that regulate the jacking cylinders; the Jacking Pump Selector, Jacking Cylinder Selector, Jacking/IJS Variable Speed Control, and the High Speed Jacking Cylinder Retract Control.



JACKING PUMP SELECTOR (B)

Turn the selector knob to the desired pump position.

- JACKING - main ram jacking cylinders
- OFF - Off
- IJS - Intermediate Jacking Station Cyl.



JACKING CYLINDER SELECTOR (C)

Turn the selector knob to the desired cylinder position.

- Ext - extends Jacking cylinder
- Ret - retracts Jacking cylinder

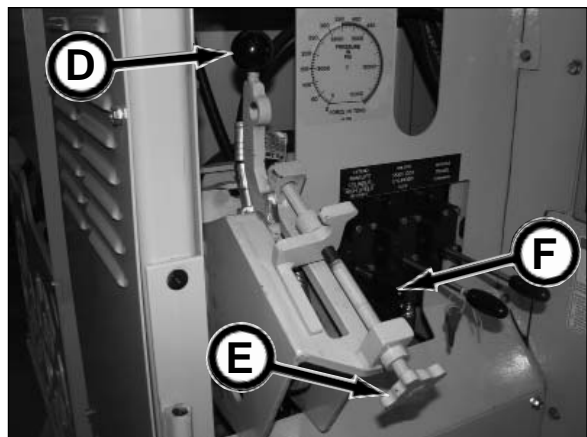
JACKING/IJS VARIABLE SPEED CONTROL (D)

The speed control is a spring loaded, variable main ram and IJS cylinder speed control.

Pull lever down to increase the jacking cylinder extend/retract speed.

Release lever to stop ram movement.

The hand wheel (E) is used to position handle stop for ease of maintaining jacking speed at a desired rate.



HIGH SPEED JACKING CYLINDER RETRACT (F)

This control will allow the quick retraction of the main jacking cylinders. The Jacking Cylinder selector must be in retract position.

IJS CYLINDER CONTROL

There are three controls that regulate the intermediate jacking station cylinders (A); the Jacking Pump Selector, Jacking Cylinder Selector, and the Jacking/IJS Variable Speed Control.



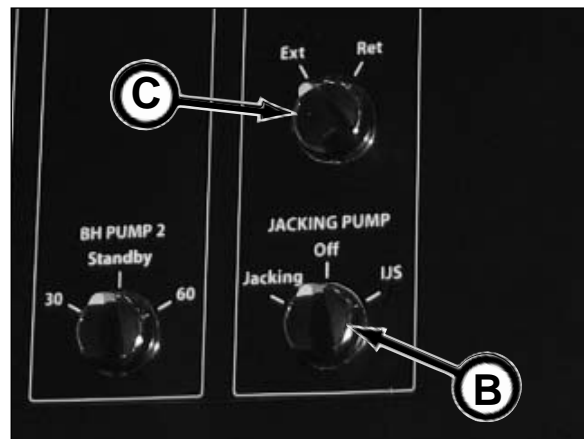
JACKING PUMP SELECTOR (B)

Turn the selector knob to the IJS position.

JACKING	- not used with IJS
OFF	- Off
IJS	- Intermediate Jacking Station Cyl.

JACKING CYLINDER SELECTOR (C)

When the Jacking Pump Selector is at the IJS position, the Jacking Cylinder Selector is inactive.



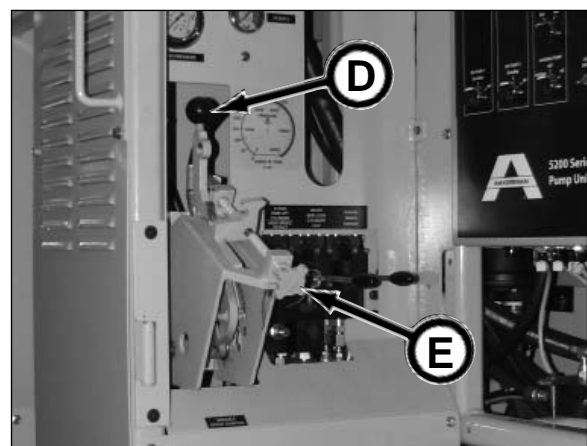
JACKING/IJS VARIABLE SPEED CONTROL (D)

The speed control is a spring loaded, variable main ram and IJS cylinder speed control.

Pull lever down to increase the IJS cylinder extend speed.

Release lever to stop ram movement.

The hand wheel (E) is used to position handle stop for ease of maintaining jacking speed at a desired rate.



RAM LIFT CYLINDER CONTROL

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



The ram lift cylinder control (A) regulates the two ram lift cylinders (B) to align the pump unit main ram cylinders (C) to the yoke ram cradles (D).

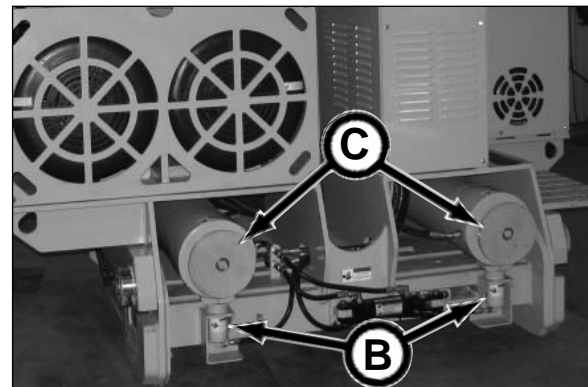
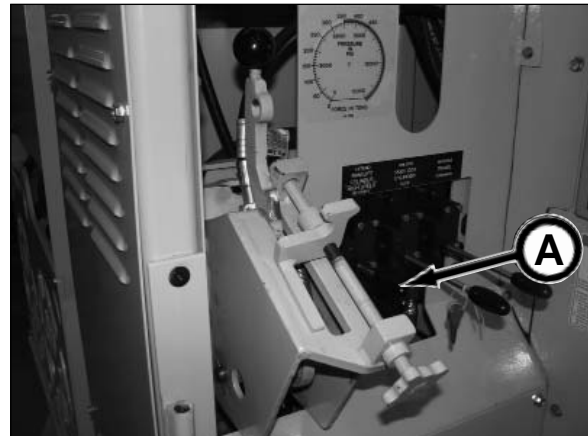
Move control as follows:

UP - Raises main ram cylinders

NOTICE To hold the cylinders in the raised position, move the control to the UP detent position.

To lower cylinders, SLOWLY move control from detent to neutral position. Releasing control lever will lower cylinders.

NOTICE The Auxiliary/Cooling Pump ON/OFF switch must be ON for the travel, skid lock and ram lift controls to function.

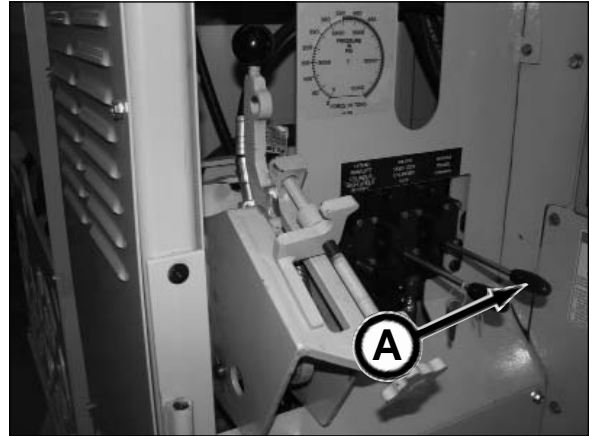


TRAVEL CONTROL

The travel control (A) regulates the pump unit drive movement on the skid assembly. Move travel control as follows:

- UP - Reverse movement
- DOWN - Forward movement

NOTICE The Auxiliary/Cooling Pump ON/OFF switch must be ON for the travel, skid lock and ram lift controls to function.



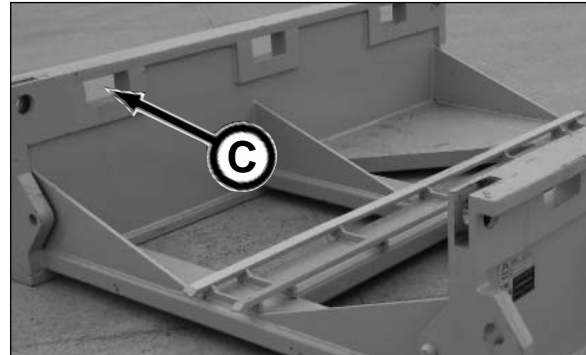
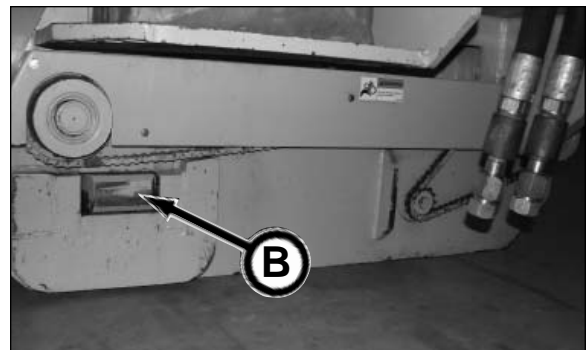
SKID LOCK CONTROL

The skid lock control (A) extends and retracts the cylinder to lock or unlock the pump unit skid lock blocks (B) with the skid pockets (C).

Move skid lock control lever to extend or retract the skid lock blocks to lock or unlock with the skid pockets as follows:

- UP - retract (unlock) blocks
- DOWN - extend (lock) blocks

NOTICE The Auxiliary/Cooling Pump ON/OFF switch must be ON for the travel, skid lock and ram lift controls to function.



The lock indicators illuminate once the lock blocks are completely in place:

- Left Skid Lock Cylinder
 - Lock (Extend) Light (D)
 - Unlock (Retract) Light (E)

- Right Skid Lock Cylinder
 - Lock (Extend) Light (F)
 - Unlock (Retract) Light (G)



FILTER INDICATOR GAUGES

To prevent under or over servicing of the hydraulic filter elements, filter indicators are installed on the 5200 Pump Unit. Always check gauges when the oil is at normal operating temperature and the system is at normal operating flow.

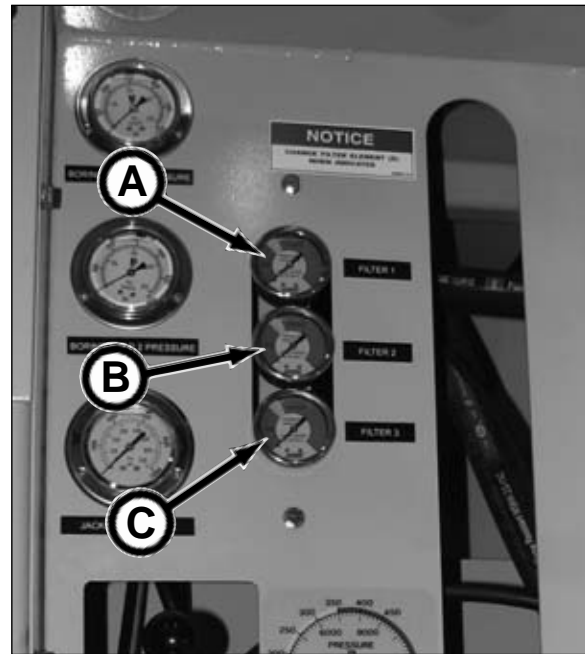
RETURN FILTER INDICATORS:

The green OK zone indicates that the filters are functioning properly.

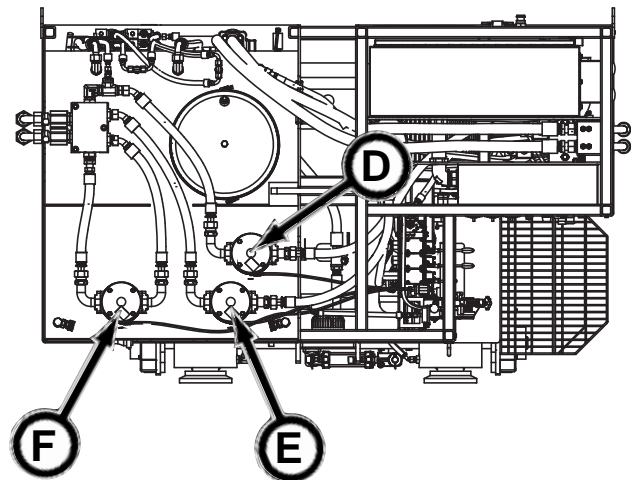
The yellow zone indicates that the filters will require replacement shortly.

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

- A - Return Filter 1 Indicator
- B - Return Filter 2 Indicator
- C - Return Filter 3 Indicator



- D - Return Filter Assembly 1
- E - Return Filter Assembly 2
- F - Return Filter Assembly 3



HYDRAULIC RESERVOIR

The hydraulic reservoir (A) includes an oil level sight gauge (B). The sight gauge can also be viewed through the cutaway slot (C) in the operator control panel.

The reservoir capacity is 240 gal. (908 L).

The pump unit is also equipped with a digital temperature display (D) along with a low oil level indicator (E).

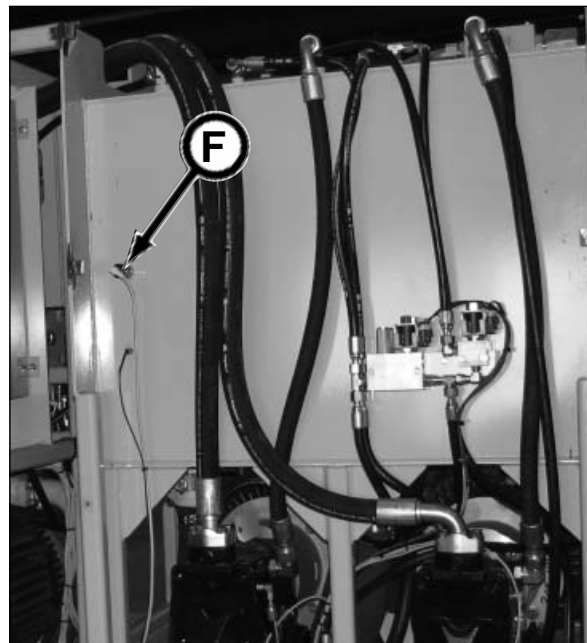
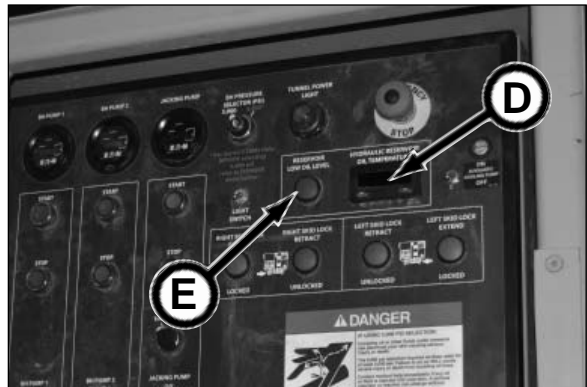
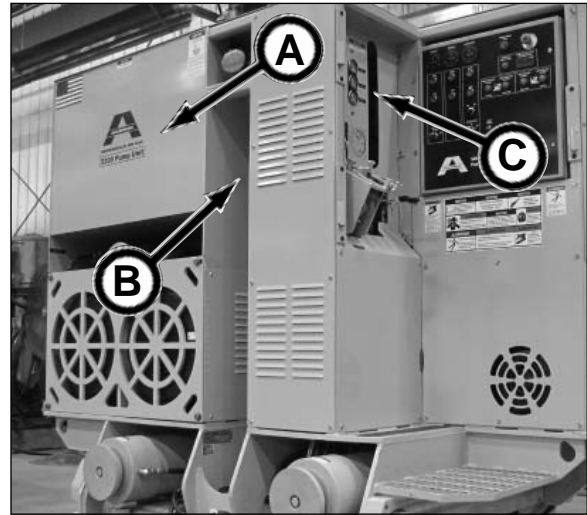
If the oil level in the reservoir reaches the low oil level sensor (F), the low oil level indicator will illuminate providing the operator a visual warning that the reservoir must be refilled. The light will continue to illuminate until the oil level in the reservoir is above the low oil level sensor.

IMPORTANT: When oil reaches the low oil level sensor, the electrical and hydraulic systems are automatically shut down to prevent damage to components. Refill reservoir immediately.

The hydraulic oil temperature should not exceed 125°F (52°C).

NOTICE A high oil temperature will not shut down the pump unit.

To fill reservoir, refer to Filling Hydraulic Reservoirs in Section 6, Operation.



Rear View Shown With Rear Panels Removed

NOTES

Pre-Start Inspection

▲WARNING

Do not operate this equipment until you read, study, and understand this manual. A daily inspection of the equipment must be performed to prevent severe personal injury or death and equipment damage.

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

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

	1. Use "ONE-CALL" notification to check for buried utility lines prior to tunneling.
	2. Check the excavated launch and reception pits or shafts for proper shoring or bracing to prevent slides or cave-ins.
	3. A qualified electrician must check that all electrical connections are properly secured and grounded prior to operation.
	4. The user's electrical distribution panel should be equipped with a ground-fault circuit interrupter for personnel protection.
	5. Thoroughly clean equipment of mud and dirt.
	6. Check condition of personal protective equipment. Replace equipment if defective.
	7. Contractor is responsible for all personnel to wear proper protective equipment on the job site.
	8. Remove combustible or flammable materials from equipment. Store materials properly.
	9. Test air monitoring and ventilation detectors for proper operation.
	10. Test E-Stop (Emergency Stop) buttons for proper operation at the start of each shift.
	11. Inspect pump unit, yoke and skid (and 200 HP Aux if equipped) for damage. Repair or replace as needed.
	12. Be sure all covers and guards are in place before operation.
	13. Be sure skid lock blocks are locked into skid.
	14. Check for proper motor rotation on all electric motors.
	15. Check for loose or missing hardware. Replace damaged or missing hardware.
	16. Check for worn, loose, or damaged wire and wire connections. Repair or replace wiring.
	17. Tighten loose clamps or fittings.
	18. Check wire harnesses for frayed or worn insulation or wires. Replace damaged or worn harnesses.
	19. No riders are allowed on the pump unit or yoke.
	20. Check for fluid leaks. Repair leak or replace components.
	21. Keep job site clean and organized.
	22. Check equipment for proper lubrication. Refer to Section 9, Periodic Maintenance.
	23. Remove all personnel from on or inside of yoke, skid, or on or behind pump unit (or 200 HP Aux if equipped) during jacking.
	24. Check for leaks in hydraulic hoses and/or lines (replace defective hoses and/or lines).
	25. Check hydraulic hoses and lines for wear and/or damage. Replace any defective hoses and/or lines.
	26. Be sure all suction valves are open and secured to prevent accidental closure.
	27. BEFORE starting, ALL controls must be in the OFF or neutral position.

NOTES

Operation

OPERATING GUIDELINES

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

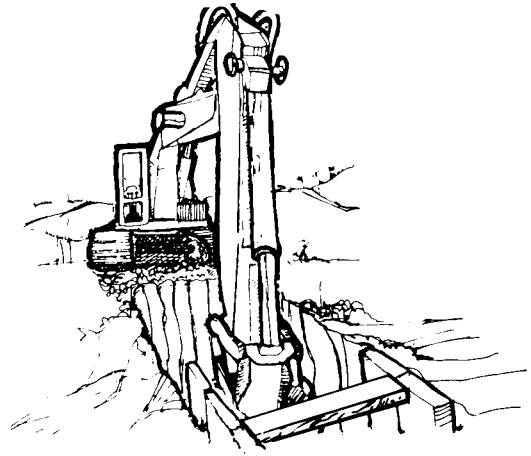
1. Before operating, read and understand the Safety, Pre-Start Inspection, and Operation sections.
2. Do not operate this equipment while under the influence of alcohol, drugs, or medication.
3. Follow all Federal, State, and Local safety regulations and procedures.
4. Be sure OSHA prescribed safety protective equipment is being worn by all personnel.
5. Be sure the area is safe for operation. Keep worksite clean and orderly.
6. NEVER operate equipment if it has been engulfed with water. Contact your Akkerman Aftermarket Support representative for proper procedures on how to restore equipment for operation.
7. Have a fully charged fire extinguisher on the job site at all times.
8. Before operating, repair equipment problems.
9. Be sure the excavated launch and reception shafts are properly shored or braced to prevent slides or cave-ins.
10. Test air monitoring and ventilation detectors for proper operation. Never enter a tunnel without detectors.
11. A fully trained and qualified signal person must direct the excavator or crane operator when lifting and lowering equipment into the launch or reception shafts.
12. Never walk or work under any part of the excavator or crane and suspended loads.
13. Test the electrical motors for proper rotation prior to operating the pump unit.
14. Operate jacking system at lowest pressure possible to prevent excessive heat build up.
15. Operate all controls to make sure they work properly. Be sure to check all Emergency Stop buttons for proper operation.
16. Pressure peaks cause hoses to jump without notice. Keep all personnel away from hoses during operation of equipment.
17. Lock out electrical power at the source (generator) before servicing electrical components.
18. Beware of pinch points.
19. If this manual becomes lost, contact your Akkerman Aftermarket Support Representative for a new manual or download this manual from the Akkerman web site at www.akkerman.com.
20. High pressure hydraulics are used on the jacking system. Be sure all covers and guards are in place before operating. They must be in place and undamaged.
21. Check laser beam often to avoid misalignment. Keep boring head 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.
22. Check line and grade alignment often.
23. Do not make any modifications to any Akkerman products. Doing so could cause structural failure and will void the warranty.
24. Do not make adjustments or repairs to the hydraulic system components while in operation or until all pressure is released and electrical power is in lock out/tag out.
25. Before startup, be sure controls are in the OFF, standby or neutral position.
26. NEVER disconnect tunnel power cables when tunnel power light is ON.

SETTING UP THE JACKING SYSTEM

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

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

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



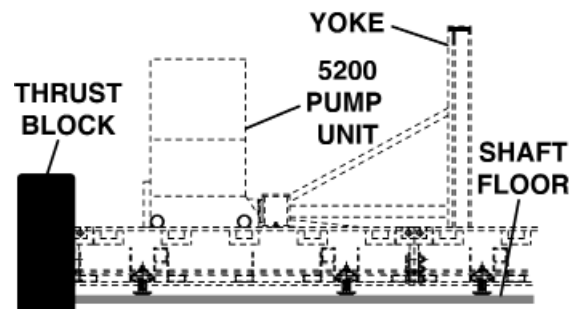
AEM is the original author and publisher of the above illustration

3. Construct a shaft floor with a solid base suitable for the weight of the jacking system and pipe. Typically a shaft uses 6 to 8 inches of stone for a dry pit or a 6 inch or more concrete base for a moist shaft. Consult your civil and structural engineers for your shaft floor requirements.

4. If using stone for the shaft floor base, place road plates (1 inch plate of steel) or other solid material where the skid assembly leveling screws will be located to prevent jacking assembly from shifting during operation.



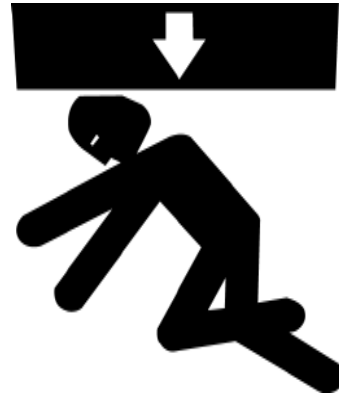
5. Construct concrete thrust block designed to withstand at least 400 tons of applied load. A structural engineer must be consulted on the design of this block. This block must be square with the line of the tunnel axis and skid assembly which will be added in the next step.



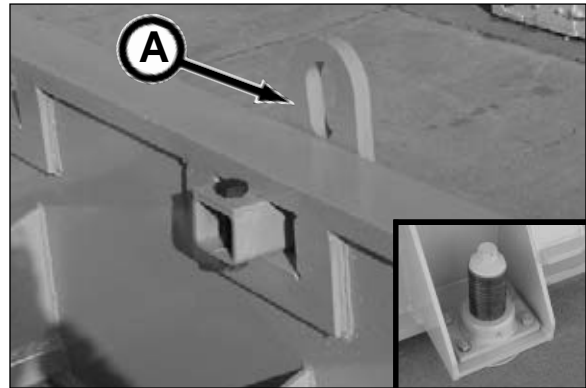
(Continued on next page)

⚠ 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 or excavator 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 will decrease.

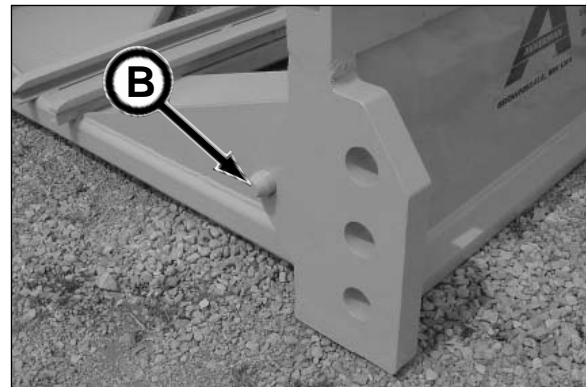


6. Lower skid assembly into launch shaft using lift eye assemblies (A) and place against the thrust block. Correct the skid assembly line and grade with leveling screws (see inset). Be sure there is at least 6 inches between the front of skid rails and where the launch seal will be located.



If necessary, lower other skid assembly(s) into launch shaft and mount to first skid assembly as follows.

A. Align the skid sections using the locator pin (B).

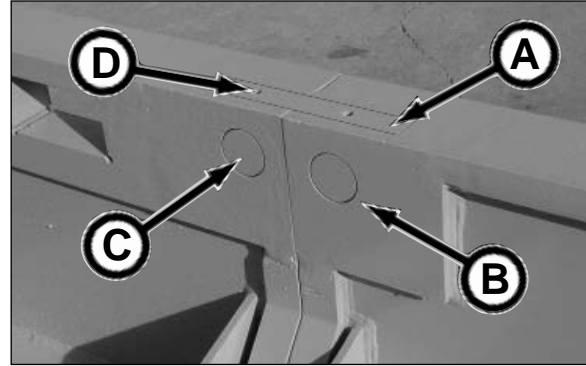


B. When skid assemblies are properly aligned, mount with six 2 in. bolts and nuts.



(Continued on next page)

C. To complete mounting, install skid split bars (A) into side skid base assembly making sure the holes of the bar line up with the holes (B) in the skid assembly. Insert skid split pins (C) with slot of pin at the 12 o'clock position for set screw. Secure skid split pin with set screws (D).



D. Continue mounting other skid sections, if required.

E. Check to make sure that the skid assembly is making full contact against thrust block.

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



F. Once skid assemblies are properly joined, correct the skid assembly line and grade with leveling screws.

7. Lower the pump unit onto the skid assembly, checking to be sure the drive wheels are resting on the skid assembly top rails.

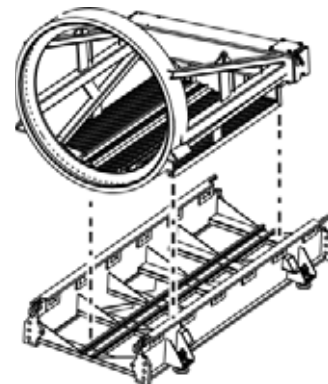
WARNING Once the pump unit is lowered onto the skid assembly, the pump unit may roll depending on grade. The Pump Unit must be secured to skid before unhooking from lifting device. Failure to do so may cause serious injury or death from pump unit rolling unexpectedly.



NOTICE If installing 200 HP Auxiliary unit, refer to 200 HP Auxiliary Hookup to 5200 Pump Unit in this section.



8. Lower the yoke onto the lower skid assembly rails, while making sure the yoke wheels are resting on the top skid assembly rails.



(Continued on next page)

9. Lower tunnel boring machine (TBM) onto the front of the skid assembly, making sure the cutter teeth on the TBM will not strike the skid assembly when the cutter head is rotated.



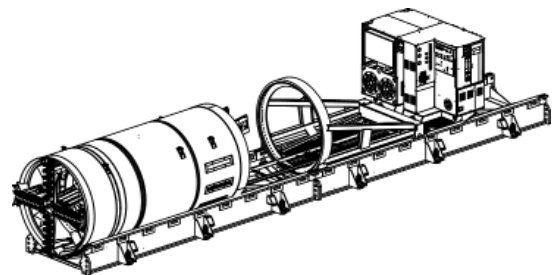
10. Lower the stand for the laser guidance system as close to the rear of the jacking shaft as possible without contacting skid assembly or pump unit. Be sure the guidance system will not be affected by thrust applied to jacking system.



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



11. Recheck the jacking system base grade and alignment. Check machine elevation and make final pipe line calculations allowing for the cutter bit "over cut."
12. Set up the 5200 Pump Unit for operation. Refer to Setting Up The Pump Unit - Start-Up Check in this section.



PREPARING PUMP UNIT FOR OPERATION

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. Readjust drive chain tension to 1/4 to 1/2" deflection at the midpoint of the chain.
7. Check condition of all hoses and connections. Tighten, repair or replace with new as needed.
8. Before operating, be sure the jacking system, and pump unit are properly set up, check operation of Emergency Stop buttons and cycle hydraulic functions several times to purge air from the hydraulic system.

SETTING UP THE 5200 PUMP UNIT - START-UP CHECK

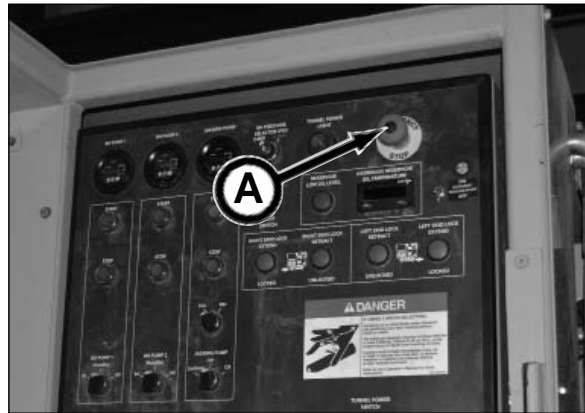
⚠ WARNING Any electrical work completed on the jacking system **MUST** be performed by a certified electrician.

NOTICE Any time the power cables are removed from either the generator or pump unit, this start-up check must be performed to assure proper operation of pump unit.

1. Turn OFF your external power source and perform the Lockout/Tagout procedure.
2. Test to ensure no voltage is present.
3. Hook up power cables to external power source.

Recommended Power Requirements:

- Recommended Operating Power:
275kW / 340kVA @ 480VAC
 - Generator Minimum Motor Starting kVA:
385skVA with less than 35% instantaneous voltage dip and greater than 90% sustained voltage
4. Push pump unit E-Stop button (A) IN to prevent accidental starting of electric motors.



5. Connect power cables from external power source to cam lock connections on pump unit.



6. Fasten power cord on hook (B) so the cord does not come in contact with any moving parts.



(Continued on next page)

7. Connect a water supply hose (1" cam lock) with 8 GPM minimum of CLEAN water to heat exchanger supply fitting (A). Be sure hose does not come in contact with moving parts.

NOTICE Be sure heat exchanger vent plug is installed before turning on water supply.

WARNING To avoid serious personal injury, the discharge must not flow into any electrical or machine areas and must drain safely away from the pump unit.

8. Connect a discharge hose (1" cam lock) to heat exchanger discharge fitting (B). Be sure hose does not come in contact with moving parts.

NOTICE Be sure to drain heat exchanger in cold weather. If heat exchanger freezes without being drained, damage will occur to the heat exchanger internal parts resulting in improper oil cooling and potential water contamination in the oil.

9. Move all pump unit controls to OFF, standby or neutral position. Be sure E-Stop button is pushed in to prevent any accidental start up.
10. Turn on external power source.

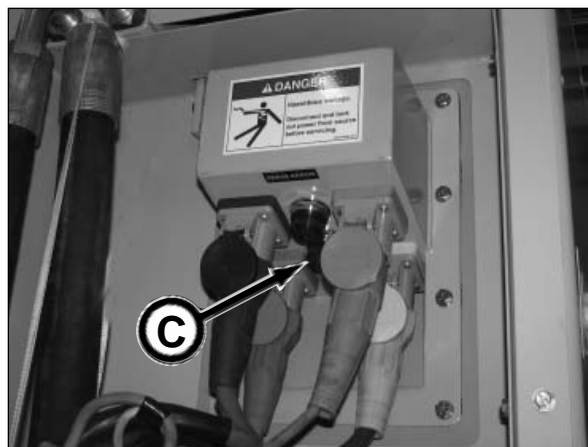
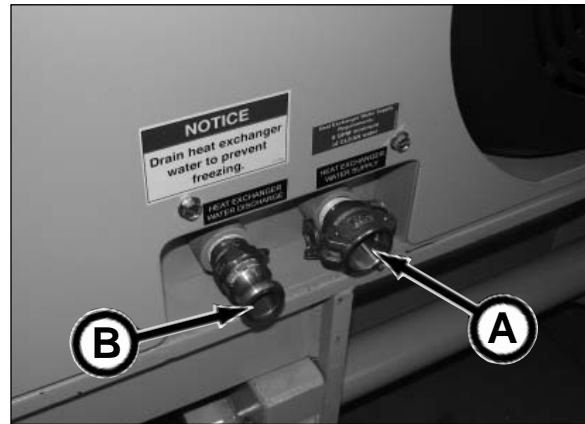
11. Check red Phase Error light (C). If light is illuminated, this indicates that the external power source phase power is installed incorrectly. Shut down external power source and lock out/tag out ALL power before attempting to reverse the two generator power leads. If power leads require adjustment, ONLY a certified electrician can perform this electrical service.

If green Phase OK light is illuminated, proceed to step 13.

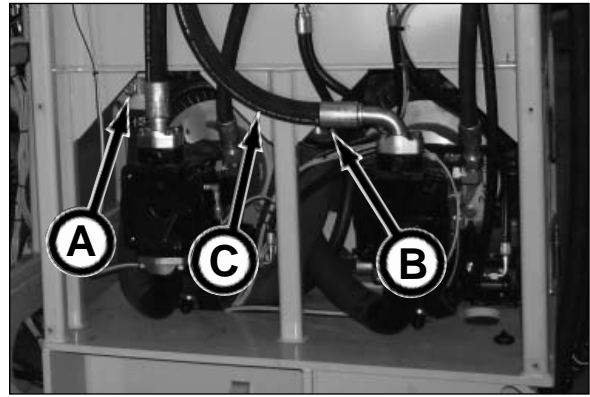
12. Once power leads are reversed, recheck phase by turning on external power source. Once phase is correct proceed to step 13.

IMPORTANT: DO NOT start up electric motors if red Phase Error light (C) is illuminated. Doing so will run motors backwards causing component damage.

(Continued on next page)



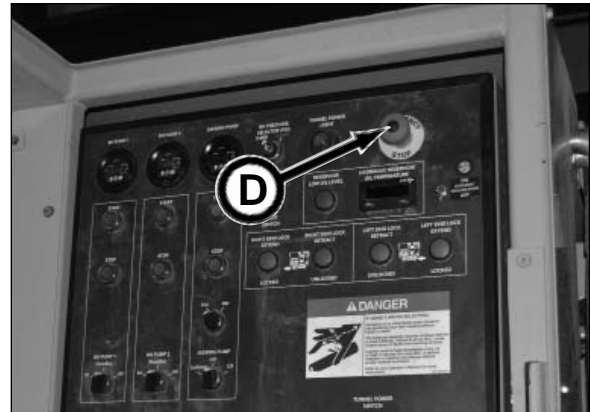
13. Check to be sure ALL hydraulic pump supply shut off valves (jacking [A], boring head 1 [B] and boring head 2 [C]) are open. With the valves open, be sure all shut off valve pins are in the locked position to prevent accidental closure during operation.



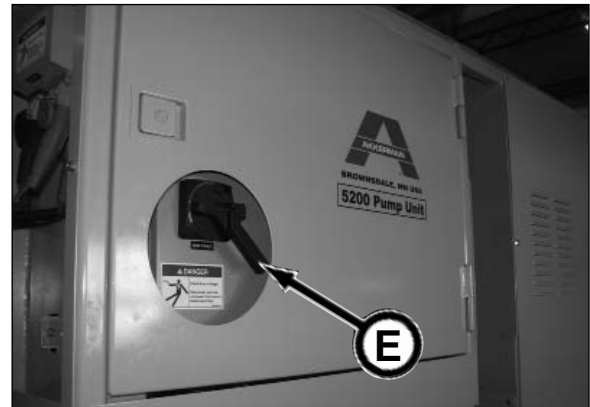
NOTICE Check to be sure the tank drain valve is closed.

14. Pull out E-Stop button (D).

NOTICE All E-Stop buttons must be pulled out for pump unit to operate.



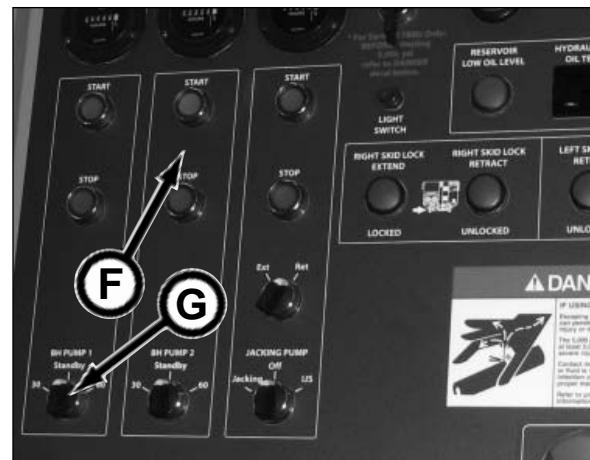
15. Turn pump unit main power switch (E) to ON position.



TESTING BORING HEAD 1 ELECTRIC MOTOR ROTATION

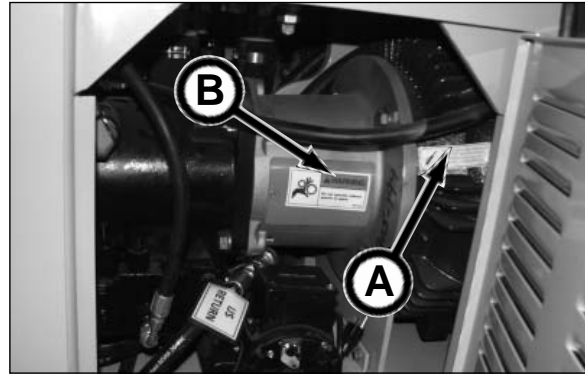
16. Depress Boring Head 1 Motor START button (F).

NOTICE Motor will start only when the pump control (G) is in the Standby position.

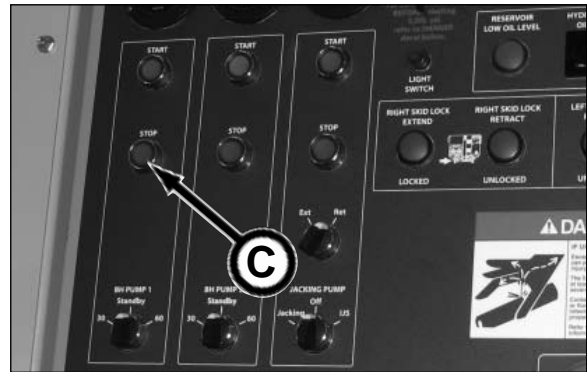


(Continued on next page)

17. Check the 100 HP boring head 1 motor (A) for proper rotation. A rotation arrow is located on the motor base. Loosen inspection cover (B) and move cover to check motor rotation. Once checked, replace and retighten cover. Then depress Boring Head 1 Motor STOP button (C) to stop motor rotation.

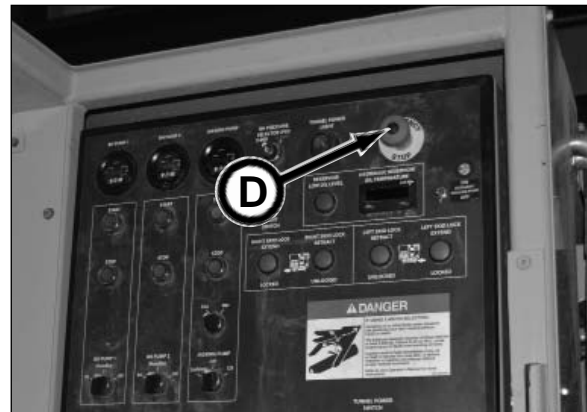


If rotation is incorrect, have your certified electrician perform the following procedure. Push E-Stop button (D) IN and turn main power switch to OFF, and lock out/tag out the main power source. Test to ensure no voltage is present, then rewire for proper motor rotation. Then turn on main power source, pull E-Stop button OUT and turn main power switch to ON position. Repeat steps 16 and 17 to recheck for proper motor rotation.



NOTICE Improper motor rotation WILL damage hydraulic components.

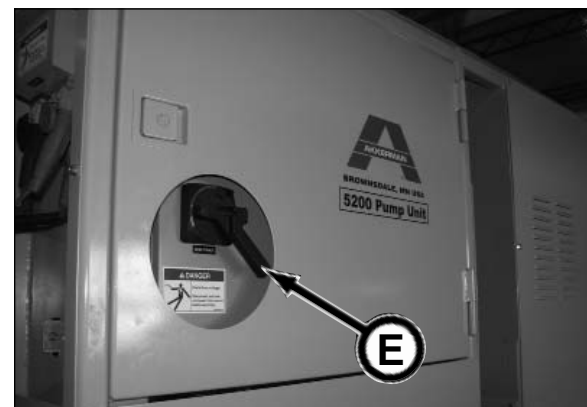
18. With the 100 HP boring head motor running, push E-Stop IN to stop the motor. This will check to be sure the E-Stop button is functioning properly. If the motor does not stop, lockout/tagout the main power source and have an electrician repair the E-Stop **IMMEDIATELY!** Check the remote E-Stop for proper operation.



19. If E-Stop is functioning properly, pull E-Stop button OUT.

NOTICE All E-Stop buttons must be pulled out for pump unit to operate.

20. Turn pump unit main power switch (E) to ON position.

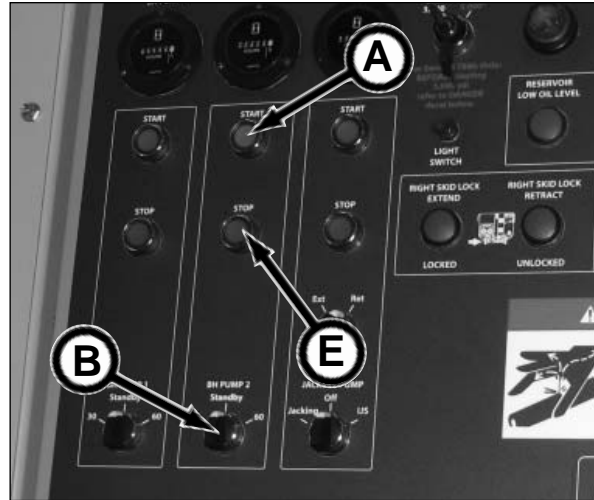


(Continued on next page)

TESTING BORING HEAD 2 ELECTRIC MOTOR ROTATION

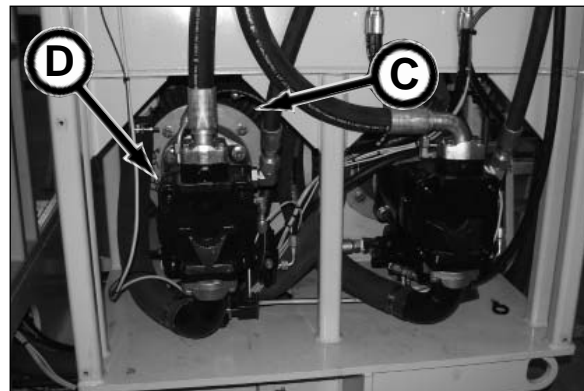
21. Depress Boring Head 2 Motor START button (A).

NOTICE Motor will start only when the pump control (B) is in the Standby position.



22. Check the 100 HP boring head 2 motor (C) for proper rotation. A rotation arrow is located on the motor base. Loosen inspection cover (D) and move cover to check motor rotation. Once checked, replace and retighten cover. Then depress Boring Head 2 Motor STOP button (E) to stop motor rotation.

If rotation is incorrect, have your certified electrician perform the following procedure. Push E-Stop button (F) IN and turn main power switch to OFF, and lock out/tag out the main power source. Test to ensure no voltage is present, then rewire for proper motor rotation. Then turn on main power source, pull E-Stop button OUT and turn main power switch to ON position. Repeat steps 21 and 22 to recheck for proper motor rotation.



NOTICE Improper motor rotation WILL damage hydraulic components.

23. With the 100 HP boring head motor running, push E-Stop button IN to stop the motor. This will check to be sure the E-Stop button is functioning properly. If the motor does not stop, lockout/tagout the main power source and have an electrician repair the E-Stop **IMMEDIATELY!** Check the remote E-Stop for proper operation.

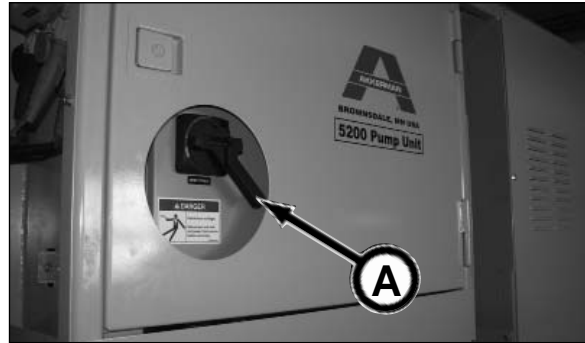


24. If E-Stop is functioning properly, pull E-Stop button OUT.

NOTICE All E-Stop buttons must be pulled out for pump unit to operate.

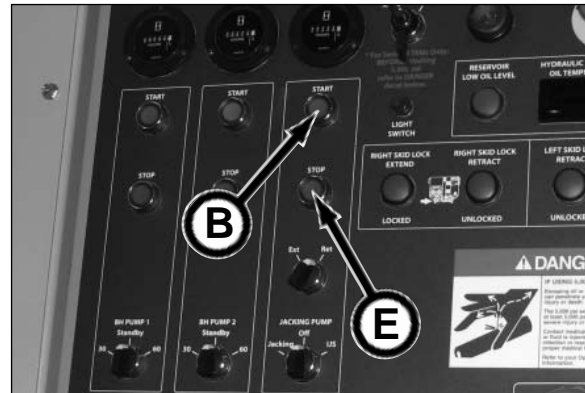
(Continued on next page)

25. Turn pump unit main power switch (A) to ON position.



TESTING JACKING ELECTRIC MOTOR ROTATION

26. Depress Jacking Motor START button (B).
27. Check the 60 HP jacking motor (C) for proper rotation. A rotation arrow is located on the motor base. Loosen inspection cover (D) and move cover to check motor rotation. Once checked, replace and retighten cover. Then depress Jacking Motor STOP button (E) to stop motor rotation.



If rotation is incorrect, have your certified electrician perform the following procedure. Push E-Stop button (F) IN and turn main power switch to OFF, and lock out/tag out the main power source. Test to ensure no voltage is present, then rewire for proper motor rotation. Then turn on main power source, pull out E-Stop button and turn main power switch to ON position. Repeat steps 26 and 27 to recheck for proper motor rotation.



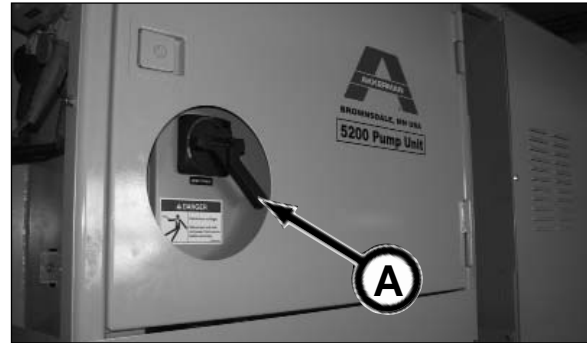
28. With the 60 HP jacking motor running, push in E-Stop to stop the motor. This will check to be sure the E-Stop button is functioning properly. If the motor does not stop, lockout/tagout the main power source and have an electrician repair the E-Stop **IMMEDIATELY!** Check the remote E-Stop for proper operation.



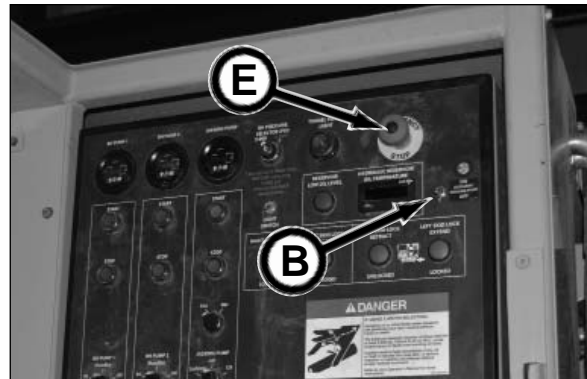
(Continued on next page)

TESTING 5 HP COOLING ELECTRIC MOTOR ROTATION

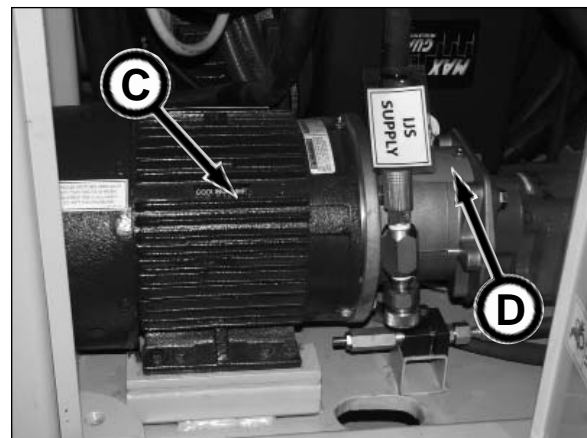
29. Turn pump unit main power switch (A) to ON position.



30. Turn Cooling Pump switch (B) to ON position.



31. Check the 5 HP cooling motor (C) for proper rotation. Rotation arrow decals are mounted on the motor. If needed, loosen inspection cover (D) and move cover to check motor rotation. Once checked, replace and retighten cover, then turn Cooling Pump switch to OFF position. If rotation is correct, proceed to step 32.



If rotation is incorrect, have your certified electrician perform the following procedure:

- Push E-Stop button (E) IN and turn main power switch on pump unit AND auxiliary to OFF position. Lockout/tagout the main power source.
- Test to ensure no voltage is present, then rewire for proper motor rotation.
- Turn main power source ON, pull E-Stop OUT and turn main power switch on pump unit to ON position.
- Repeat steps 30 and 31 to recheck for proper motor rotation.

NOTICE

Improper motor rotation WILL damage hydraulic components.

32. With the 5 HP cooling motor running, push the pump unit E-Stop button (F) IN to stop the motor. This will check to be sure the E-Stop button is functioning properly. If the motor does not stop the E-Stop function has failed. Lockout/tagout the main power source and IMMEDIATELY have an electrician repair the E-Stop!

33. If E-Stop is functioning properly, pull E-Stop button OUT.

34. After Start-Up Check procedure is complete, proceed to Setting Up The Pump Unit & TBM Supply/Return Hydraulics on the next page.

SETTING UP THE PUMP UNIT & TBM SUPPLY/RETURN HYDRAULICS

There are two hydraulic supply/return options available for setting up the 5200 Pump Unit with the Tunnel Boring Machine; single feed supply and dual feed supply.

The single feed option supplies 60 GPM of low pressure oil to the boring head, steering, and spoil conveyor.

The dual feed option supplies an additional 60 GPM of low pressure oil with the use of the boring head 2 motor. Typically the boring head 1 supply will run the boring head, and steering of the TBM. The boring head 2 supply primarily powers the conveyor unit. Though the boring head 2 supply can power the conveyor and provide additional power to the boring head.

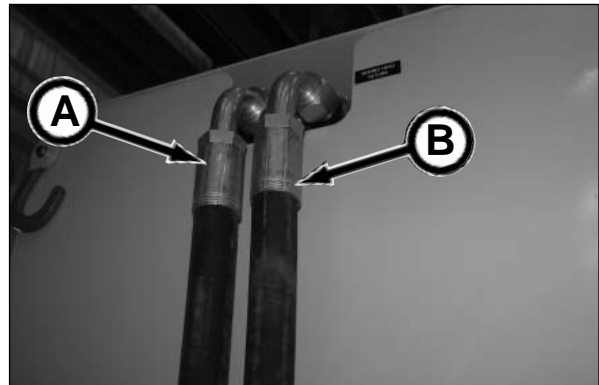
⚠ WARNING Escaping oil or other fluids under pressure can penetrate your skin causing serious injury. Contact medical help immediately if any oil or fluid is injected into your skin. Before hooking up the supply hoses, ALWAYS use gloves before connecting or disconnecting hydraulic oil hoses/lines.

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

NOTICE When using the 200 HP Auxiliary, you must connect the single feed assembly, F27624F to the 5200 boring head supply pressure hoses. Refer to 200 HP Auxiliary Hookup To 5200 Pump Unit in this section for more information.

Single Feed (60 GPM Maximum)

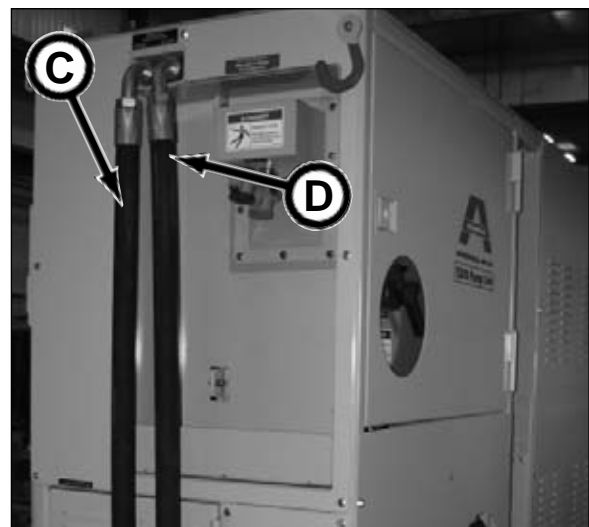
1. Connect return line quick coupler hose (A or B) to the TBM return line quick coupler. Cap other return line quick coupler hose. The pump unit return lines are common, thus either return line hose can be used.
2. Connect boring head 1 supply quick coupler hose (C) to the TBM supply quick coupler hose. Cap boring head 2 supply quick coupler hose (D) for single feed option.



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

Dual Feed (120 GPM Maximum)

1. Connect return line quick coupler hoses (A and B) to the TBM return line quick coupler hoses.
2. Connect boring head 1 supply quick coupler hose (C) to the TBM supply quick coupler hose.
3. Connect boring head 2 supply quick coupler hose (D) to the other TBM supply quick coupler hose.
4. If using a 200 HP Auxiliary, proceed to 200 HP Auxiliary Hookup To 5200 Pump Unit in this section, otherwise proceed to Operating The Pump Unit in this section.

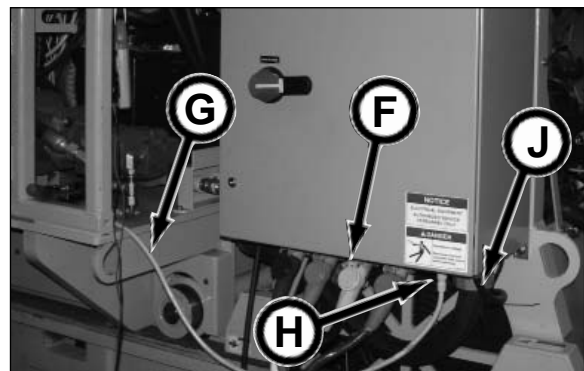
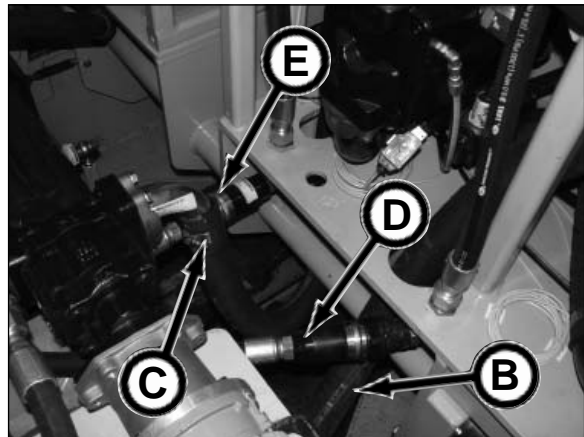
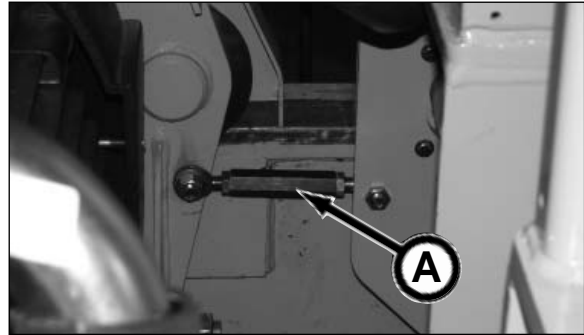


200 HP AUXILIARY HOOKUP TO 5200 PUMP UNIT

IMPORTANT: BEFORE installing and hooking up 200 HP Auxiliary to pump unit, perform Setting Up The Pump Unit - Start-Up Check in this section.

⚠ WARNING Any electrical work **MUST** be performed by a certified electrician.

1. Lockout/tagout power **BEFORE** installing auxiliary unit.
2. Lower 200 HP Auxiliary onto skid and secure auxiliary unit to 5200 Pump Unit with two couplers (A45092P) (A).
3. Connect auxiliary unit hydraulics to 5200 Pump Unit as follows:
 - a. Install 2.5 in. supply hose (B) from 5200 to auxiliary pump supply connection.
 - b. Install 1.5 in. supply hose (C) from 5200 to auxiliary unit pump supply connection.
 - c. Install 5200 return quick disconnect (D) to auxiliary unit cooling pump return quick disconnect.
 - d. Install 5200 return quick disconnect (E) to auxiliary pump case drain quick disconnect.
4. Connect power cables from external source to cam lock connections (F) on pump unit.
5. Connect 24V power supply cord (G) to connection (H) on auxiliary cabinet box and route cord to 24V connection (I) on bottom of 5200 operator panel box.
6. With auxiliary pendant at 5200 operator station, route pendant cable back to auxiliary unit and connect auxiliary pendant cable to end of pendant cord (J) connected to electrical box.



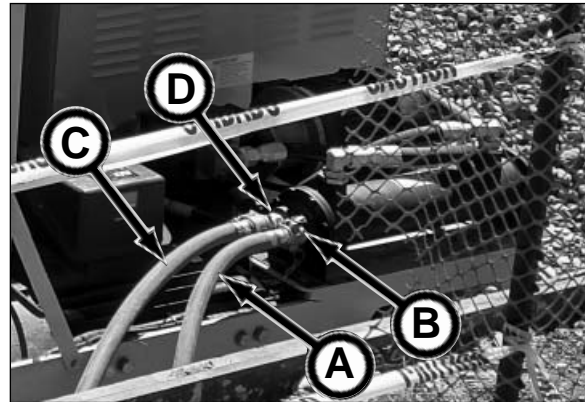
(Continued on next page)

7. Connect a clean water supply hose (A) (1 in. cam lock) with a minimum of 8 gpm of CLEAN water to heat exchanger supply fitting (B). Be sure hose does not come in contact with moving parts.

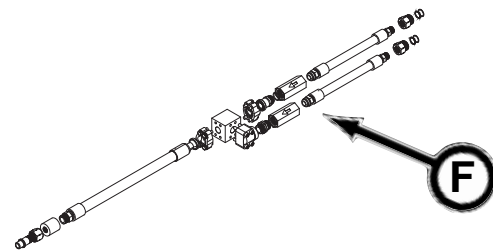
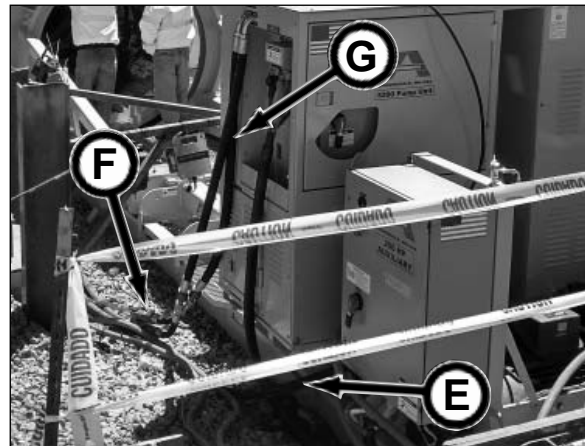
⚠ WARNING To avoid serious personal injury, the discharge must not flow into any electrical or machine areas and must drain safely away from the pump unit.

8. Connect a discharge hose (C) (1 in. cam lock) to heat exchanger discharge fitting (D). Be sure hose does not come in contact with moving parts.

NOTICE Be sure to drain heat exchanger in cold weather. If heat exchanger freezes without being drained, damage will occur to the heat exchanger internal parts resulting in improper oil cooling and potential water contamination in the oil.



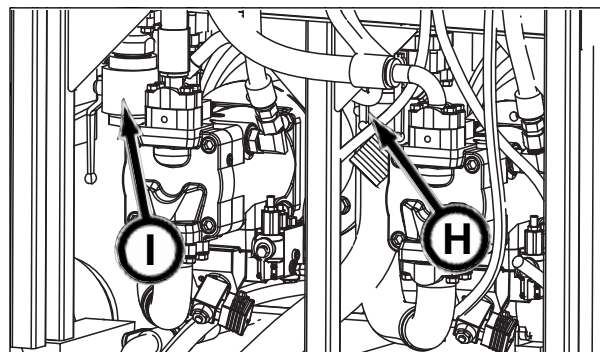
9. Connect auxiliary unit supply pressure hose (E) to TBM hydraulics (60 gpm @ 5,000 psi).
10. When using the 200 HP Auxiliary, you must connect the single feed assembly, F27624F (F) to the 5200 boring head supply pressure hoses (G) (60 gpm @ 5,000 psi).



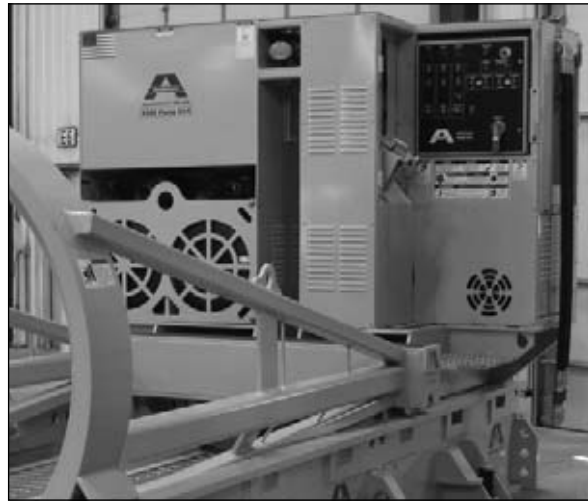
11. Open main (H) and cooling (I) suction valves. Secure valves in open position.

IMPORTANT: BEFORE operating the 5200 Pump Unit with the 200 HP Auxiliary, the 200 HP main suction valve AND the 200 HP cooling suction valve MUST be open. Attempting to operate the 200 HP Auxiliary with suction valves closed WILL damage the pumps. In addition, all 5200 suction valves MUST also be secured open.

(Continued on next page)



12. Move all pump unit controls to OFF, standby or neutral position. Be sure E-Stop button is pushed IN to prevent any accidental start-up.



13. Move all auxiliary controls to OFF or standby position.

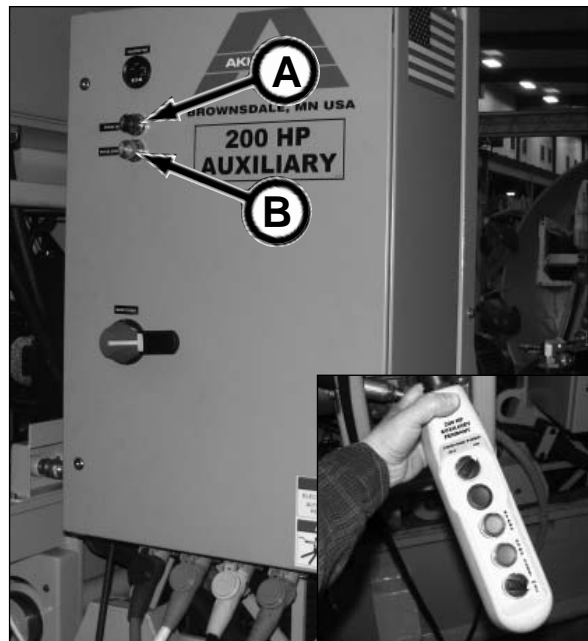
14. Turn on external power source.

- 200 HP Auxiliary Unit Power Requirements

- Recommended Operating Power: 225kW / 280kVA @ 480VAC
- Generator Minimum Motor Starting kVA: 770skVA with less than 35% instantaneous voltage dip and greater than 90% sustained voltage

15. If green Phase OK light (A) is illuminated, the input power is in proper phase. Proceed to step 17.

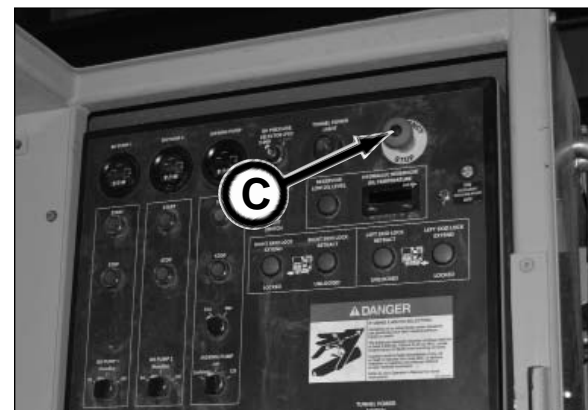
If red Phase Error Light (B) is illuminated, this indicates that the external power source phase power is installed incorrectly. Shut down external power source and lockout/tagout ALL power before attempting to reverse the two generator power leads. If power leads require adjustment, ONLY a certified electrician can perform this electrical service.



16. Once power leads are reversed, recheck phase by turning on external power source. Once phase is correct, proceed to step 17.

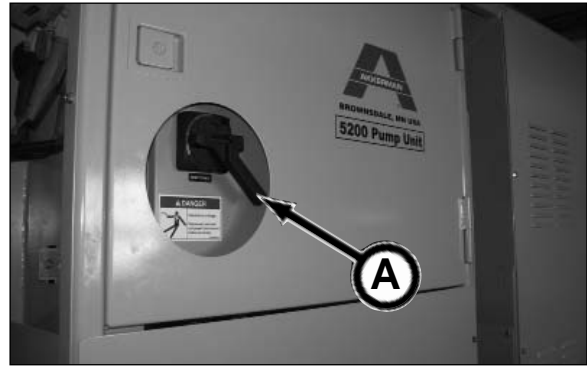
IMPORTANT: DO NOT start up electric motors if red Phase Error light (B) is illuminated. Doing so will run motors backwards causing component damage.

17. With ALL suction valves open, pull out E-Stop button (C).

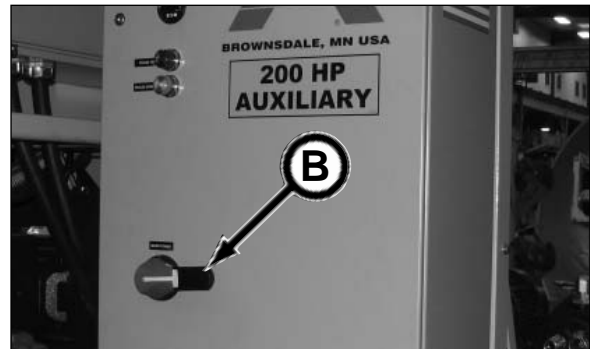


(Continued on next page)

18. Turn pump unit main power switch (A) to ON position.



19. Turn auxiliary unit main power switch (B) to ON position.



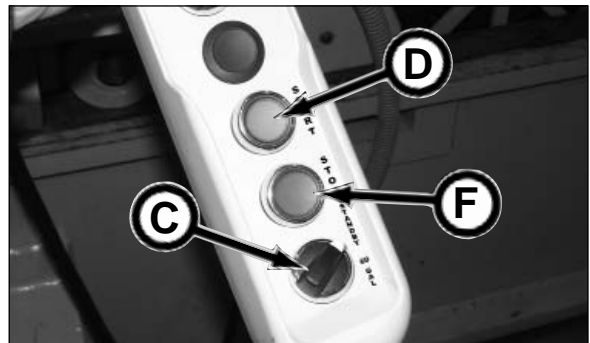
TESTING 200 HP ELECTRIC MOTOR ROTATION

20. With pump control (C) in Standby position, press green Start button (D).

NOTICE

Motor will start only when the pump control is in Standby position.

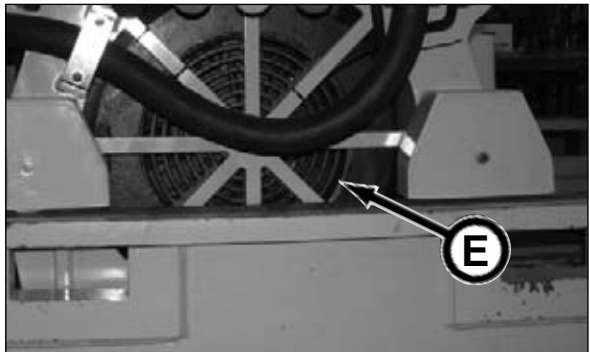
21. Check the 200 HP auxiliary motor (E) for proper rotation. Rotation arrow decals are mounted on the motor. Once checked, press red Stop button (F).



If rotation is correct, proceed to step 22.

If rotation is incorrect, have your certified electrician perform the following procedure:

- Push E-Stop button (G) IN and turn main power switch on pump unit AND auxiliary to OFF position. Lockout/tagout the main power source.
- Test to ensure no voltage is present, then rewire for proper motor rotation.
- Turn main power source ON, pull E-Stop OUT and turn main power switch on pump unit AND auxiliary to ON position.
- Repeat steps 20 and 21 to recheck for proper motor rotation.



NOTICE

Improper motor rotation WILL damage hydraulic components.

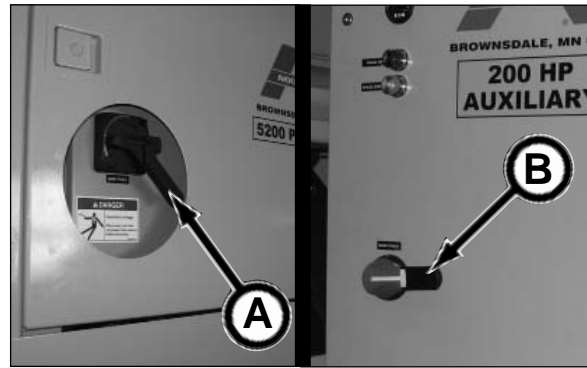
22. With the 200 HP auxiliary motor running, push the pump unit E-Stop button (G) IN to stop the motor. This will check to be sure the E-Stop button is functioning properly. If the motor does not stop the E-Stop function has failed. Lockout/tagout the main power source and IMMEDIATELY have an electrician repair the E-Stop!
23. If E-Stop is functioning properly, pull E-Stop button OUT.



(Continued on next page)

5200jacksysom_050096

24. Be sure pump unit power switch (A) and auxiliary main power switch (B) are flipped to ON position.

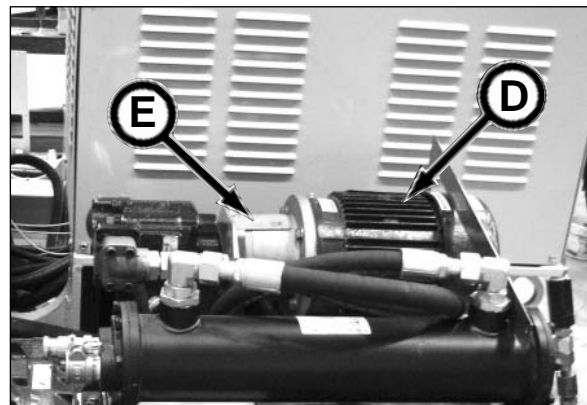


TESTING 5 HP COOLING ELECTRIC MOTOR ROTATION

25. Turn Cooling Pump switch (C) to ON position.



26. Check the 5 HP cooling motor (D) for proper rotation. Rotation arrow decals are mounted on the motor. If needed, loosen inspection cover (E) and move cover to check motor rotation. Once checked, replace and retighten cover, then turn Cooling Pump switch to OFF position. If rotation is correct, proceed to step 27.



- If rotation is incorrect, have your certified electrician perform the following procedure:
- Push E-Stop button (F) IN and turn main power switch on pump unit AND auxiliary to OFF position. Lockout/tagout the main power source.
 - Test to ensure no voltage is present, then rewire for proper motor rotation.
 - Turn main power source ON, pull E-Stop OUT and turn main power switch on pump unit AND auxiliary to ON position.
 - Repeat steps 25 and 26 to recheck for proper motor rotation.

NOTICE

Improper motor rotation WILL damage hydraulic components.

27. With the 5 HP cooling motor running, push the pump unit E-Stop button (F) IN to stop the motor. This will check to be sure the E-Stop button is functioning properly. If the motor does not stop the E-Stop function has failed. Lockout/tagout the main power source and IMMEDIATELY have an electrician repair the E-Stop!
28. If E-Stop is functioning properly, pull E-Stop button OUT.
29. After this procedure is complete, proceed to Operating The Pump Unit on the next page.



OPERATING THE PUMP UNIT

There are several steps to safely operate the 5200 Pump Unit. Be sure to follow these steps until you have studied and understand how to properly operate the Pump Unit.

For ease of referencing certain pump unit operation procedures at a later date, subsections are listed below with the corresponding page number(s).

- A. Attaching Main Jacking Rams To Yoke, pg 6-20 - 6-21
- B. Positioning Pump Unit/Yoke With TBM, pg 6-22
- C. Installing Conveyor & Dirt Bucket, pg 6-23
- D. Positioning TBM For Jacking Operation, pg 6-24
- E. Jacking Operation, pg 6-25 - 6-34

WARNING FAILURE TO LOCKOUT POWER BEFORE SERVICING CAN CAUSE SEVERE PERSONAL INJURY OR DEATH.

This machine is powered by high-voltage electricity. LOCKOUT main power supply before servicing. Electrical repairs must be performed only by a certified electrician.

NOTICE NEVER operate equipment if it has been engulfed with water. Contact your Akkerman Aftermarket Support representative for proper procedures on how to restore equipment for operation.

NOTICE Recheck jacking system line and grade often.

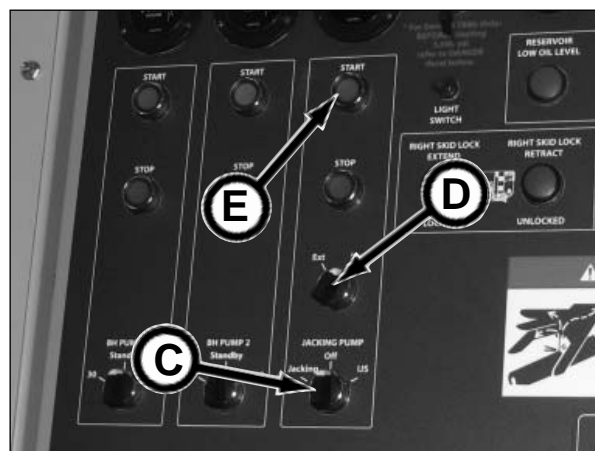
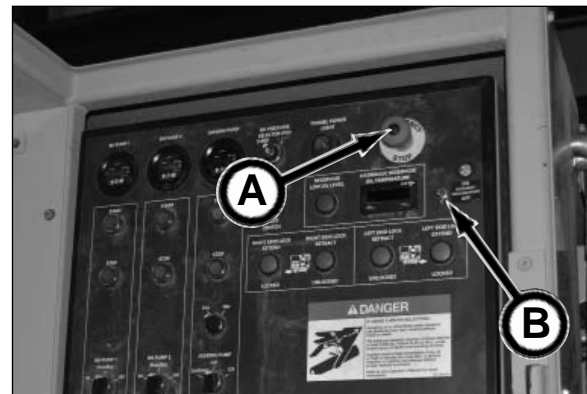
A. ATTACH MAIN JACKING RAMS TO YOKE

1. With the power source properly connected to the Pump Unit with proper phase, move all controls to OFF, standby or neutral position. Pull the E-Stop button (A) OUT and turn the main power switch to ON position.
2. (If equipped) Flip Auxiliary/Cooling Pump switch (B) to ON position.

NOTICE The Auxiliary/Cooling Pump ON/OFF switch must be ON for the travel, skid lock and ram lift controls to function.

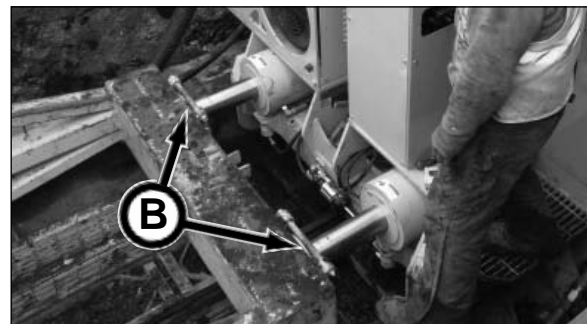
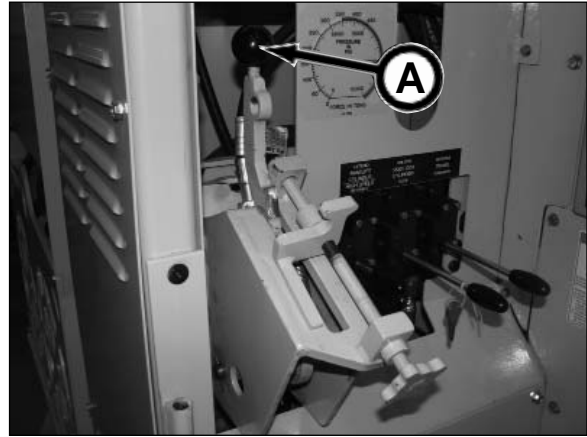
3. Turn Jacking Pump Selector (C) to Jacking position.
4. Turn Jacking Cylinder Selector (D) to Ext position.
5. Start Jacking Motor by depressing START button (E).

(Continued on next page)



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

6. Pull jacking cylinder variable speed control (A) down to extend the main ram jacking cylinders until the rams are at the yoke ram cradles (B). Release lever.



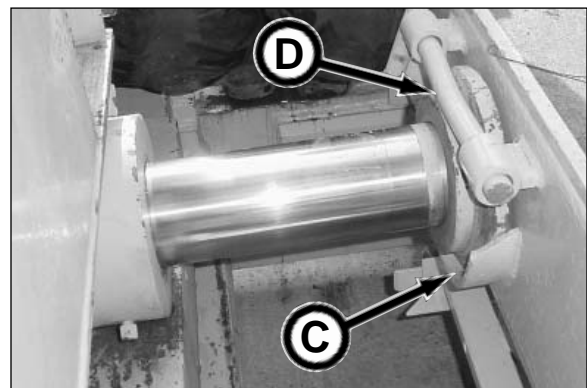
7. Use ram lift cylinder lever to position main rams onto the yoke ram cradles (C). Move the main rams into position as needed for locking.



8. Secure pump unit dual rams to yoke ram cradles with locking pins (D). This will allow the yoke to move with the pump unit when it is being retracted.

⚠ WARNING PINCH POINTS! Watch your fingers, hands, and legs while equipment is in operation. Ram cylinders will drop instantly when the ram lift cylinder is released.

9. SLOWLY release ram lift cylinder lever.



(Continued on next page)

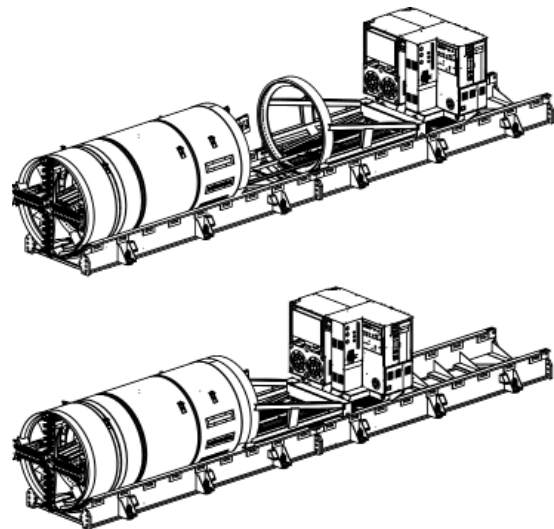
B. POSITIONING PUMP UNIT/YOKE WITH TBM

⚠WARNING Unexpected Jacking System movement may cause riders to slip or fall resulting in serious personal injury.

Do not allow riders on the Pump Unit or the Yoke when they are moving.

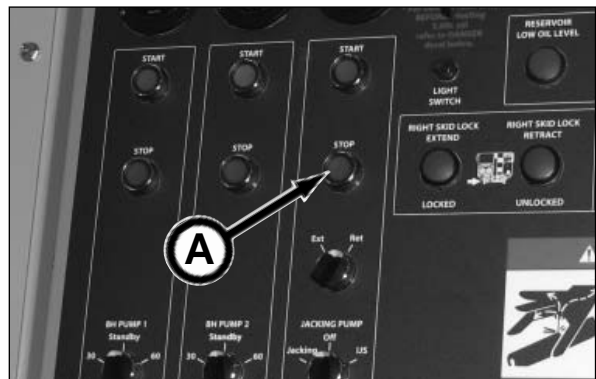


10. Move travel lever DOWN to propel the pump unit and yoke forward into position behind tunnel boring machine (TBM).



11. Stop Jacking Motor by depressing STOP button (A).

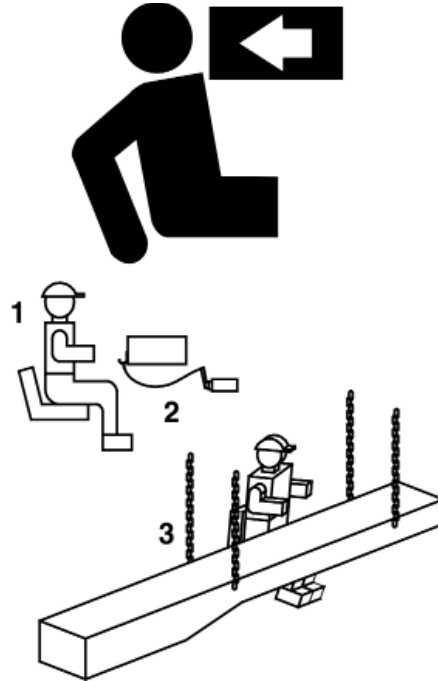
(Continued on next page)



C. INSTALLING CONVEYOR & DIRT BUCKET

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

- 1) Operator **MUST** remain seated in normal operating position.
- 2) Cutter head drive dump valve **MUST** be tethered to conveyor.
- 3) **ALL FOUR** safety chains **MUST** be secured to conveyor before operating inner drum.



12. Install conveyor. Be sure safety chains are mounted to conveyor and dump valve is tethered to conveyor.

NOTICE There are certain combinations of yokes and conveyors that will not allow the conveyor to be installed with the yoke against the TBM. In these situations, move yoke back until there is enough room to install the conveyor. Then remate the yoke with the TBM.

13. Connect pump unit hydraulics to TBM hydraulics. Refer to Setting Up The Pump Unit & TBM Supply/Return Hydraulics in this section for proper hose connections.

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

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



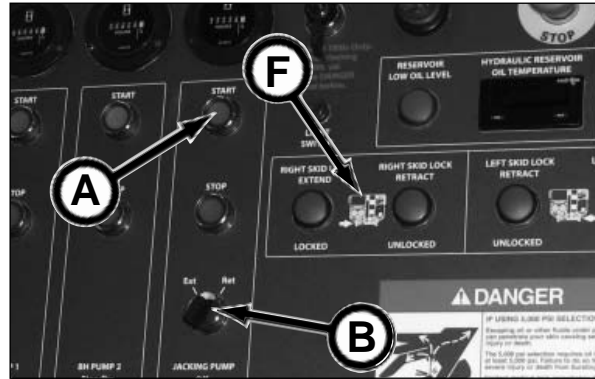
14. Lower dirt bucket into yoke behind conveyor.

(Continued on next page)



D. POSITIONING TBM FOR JACKING OPERATION

15. Start the jacking motor by depressing the Jacking Motor START button (A). Flip the Jacking Cylinder Selector switch (B) to Ext.

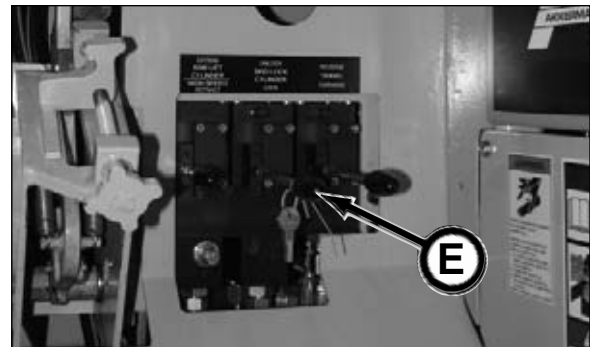
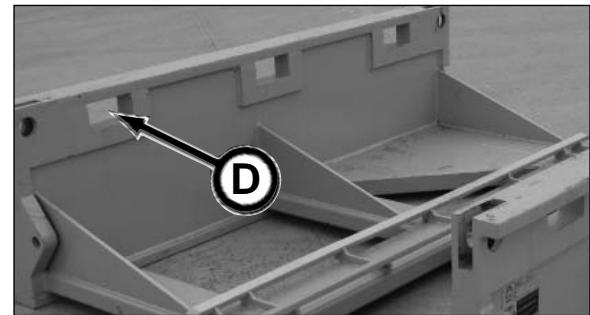
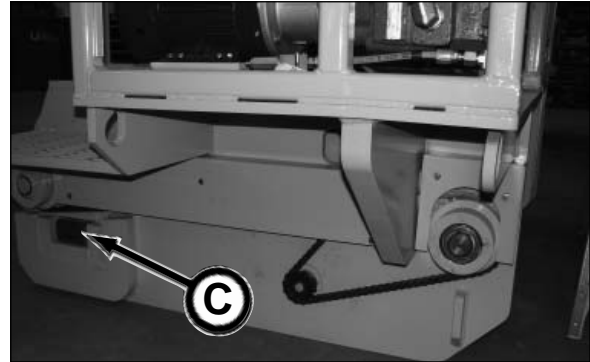


16. Lock skid lock blocks (C) into skid pockets (D) by operating the skid lock control (E). The skid lock blocks must be fully engaged into skid pockets before jacking.

NOTICE

It will be necessary to periodically reposition the skid lock blocks; at the end of jacking ram cylinder stroke, or when unloading dirt bucket.

The lock position indicators (F) will illuminate once the lock blocks are completely in the lock or unlock position.



17. Pull jacking cylinder variable speed control (G) down to move the yoke and Tunnel Boring Machine (TBM) along the skid rail until the TBM is at the shaft (pit) wall.



(Continued on next page)

E. JACKING OPERATION

NOTICE

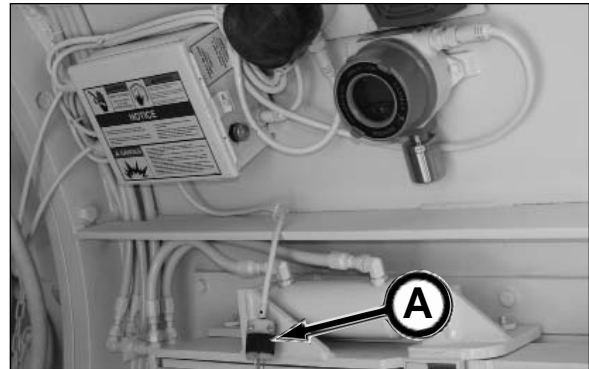
The TBM operator controls the boring head and conveyor. The Pump Unit operator controls the oil flow to the TBM components and the pump unit high pressure jacking cylinders. **The TBM and Pump Unit operators MUST be in constant communication to insure proper tunnel installation.** Before rotating the cutter head, make sure the cutter teeth will not interfere with skid frame.

18. Attach electrical connections to TBM. The non-Series II TBM connection (A) requires 110 VAC. The Series II TBM connection (B) requires a 400 Amp 480 VAC 3 Phase power supply from the pump unit/power source.

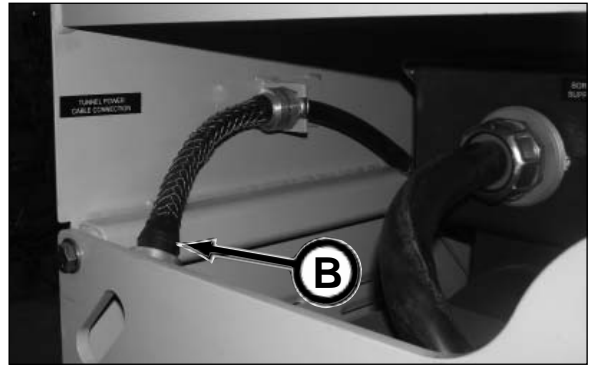
Recommended Power Requirements:

- 5200 Pump Unit

- Recommended Operating Power:
275kW / 340kVA @ 480VAC
- Generator Minimum Motor Starting kVA:
385skVA with less than 35% instantaneous voltage dip and greater than 90% sustained voltage



Non-Series II TBM Power Connection



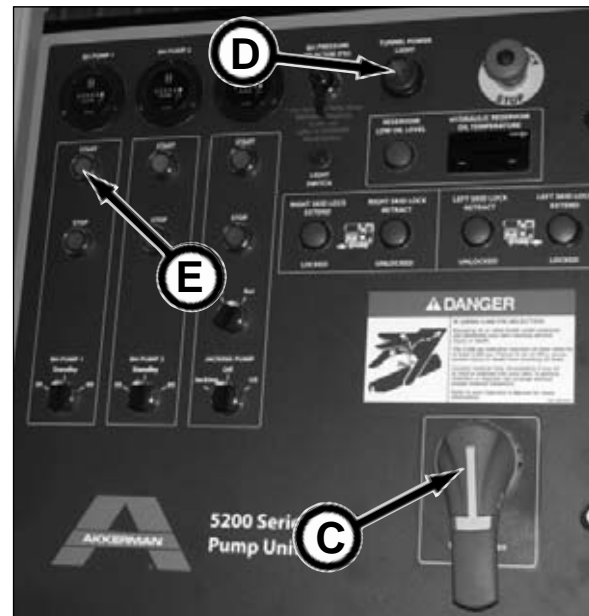
Series II TBM Power Connection From Pump Unit

19. (Series II TBMs Only) With the pump unit main power switch ON and all E-Stop buttons pulled out, flip Tunnel Power Switch (C) to the ON position. This will illuminate the Tunnel Power ON light (D) which provides the operator a quick visual indicator that power is ON in the tunnel and to take all necessary precautions with high voltage electricity.

20. Start the boring head 1 motor by depressing the Boring Head 1 Motor START button (E).

NOTICE

Boring Head 2 motor system can be used in place of the Boring Head 1 system. The Boring Head 1 and 2 motor systems are identical 100 HP hydraulic systems.



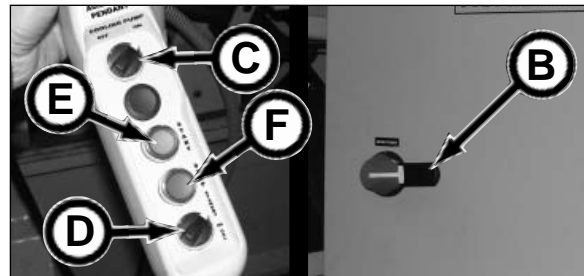
(Continued on next page)

21. With the Jacking and Boring Head 1 motors running, start the Boring Head 2 motor (if needed for dual feed) by depressing the Boring Head 2 Motor START button (A).



NOTICE

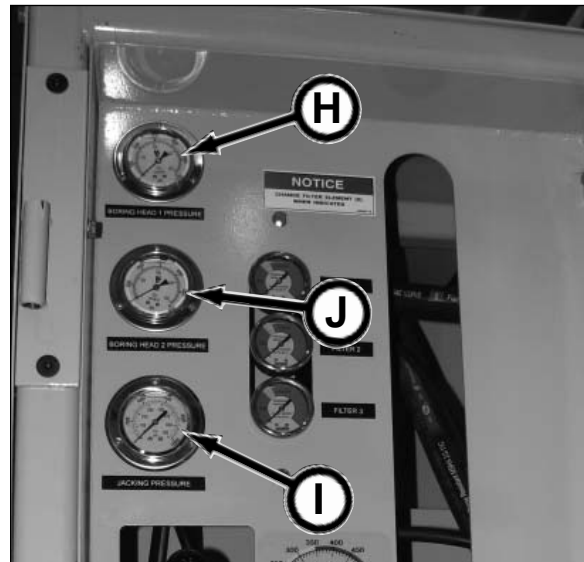
If equipped with 200 HP Auxiliary: Turn auxiliary power switch (B) ON. On the control pendant, flip the Cooling Pump switch (C) to ON position and the Flow control switch (D) to 60 Gal. Press the green Start button (E) and red Stop button (F) as needed.



22. Start jacking by using the jacking cylinder speed control (G) to regulate the main jacking cylinders while the boring head operator is controlling the TBM cutter head and conveyor functions. Monitor the boring head 1 pressure gauge (H), jacking pressure gauge (I), and boring head 2 pressure gauge (J) (if additional power is used) and make adjustments as needed.



The normal working pressure for the low pressure 3,000/5,000 psi system in firm soils is 2,200/4,000 psi. The low pressure system will start to slow down or go over relief at 2,800/4,800 psi and will be completely over relief at 3,000/5,000 psi suspending operation, while retaining 3,000/5,000 psi within the pressure lines. When this happens, the pump unit operator must stop jacking, and the TBM operator must either rotate the cutter head back and forth to loosen the obstruction, or the operator can move the drum advance back to remove the obstruction or change teeth. High pressure in the low pressure system (boring head system) may also be a result of hard ground.



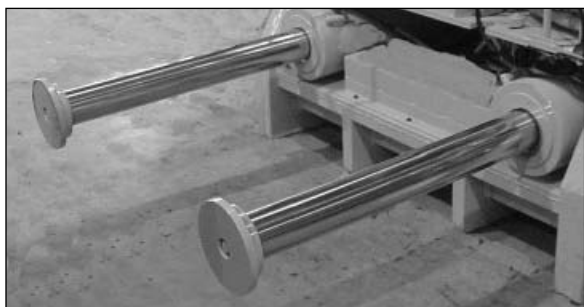
The high pressure (jacking) maximum system pressure is 8,000 psi.

23. When the main rams are fully extended, the rams will stop and the jacking system pressure gauge indicates, as a general rule, decreased pressure due to the relief valve at the end of the ram cylinders.

NOTICE

The extended cylinders are shown without the skid and yoke for photographic purposes only.

At this time, you will need to unload the dirt bucket (if needed) and reposition the pump unit on the skid. Refer to steps 24 through 27.



(Continued on next page)

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

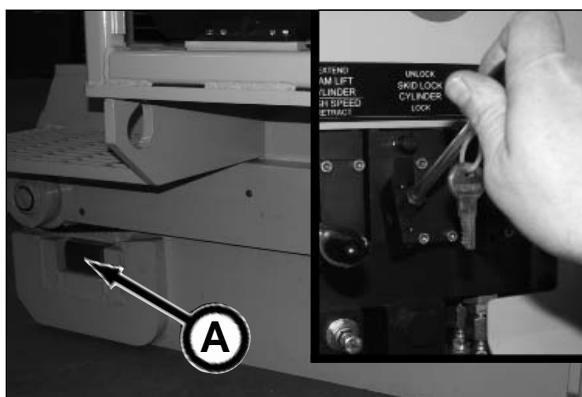


24. Unload dirt bucket.



25. Unlock skid lock blocks (A) from skid using skid lock control (inset).

(Continued on next page)



Unlocking Skid Lock Blocks

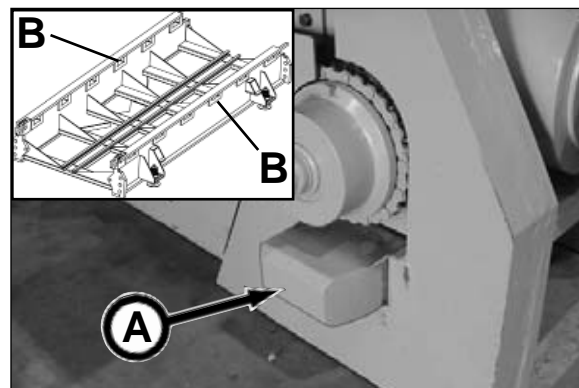
26. Simultaneously retract main ram cylinders (with jacking cylinder selector switch to Ret and using the jacking cylinder variable speed control) and move pump unit forward (with travel control) to keep the yoke in contact with the pipe.

NOTICE

To quickly retract the main ram cylinders, the 5200 Pump Unit is equipped with a high speed jacking retract control (see inset).



27. Lock pump unit skid lock blocks (A) into skid pockets (B) with the skid lock control. The skid lock blocks must be fully engaged (refer to lock indicators on control panel) into skid pockets before jacking.



Locking Skid Lock Blocks

CAUTION

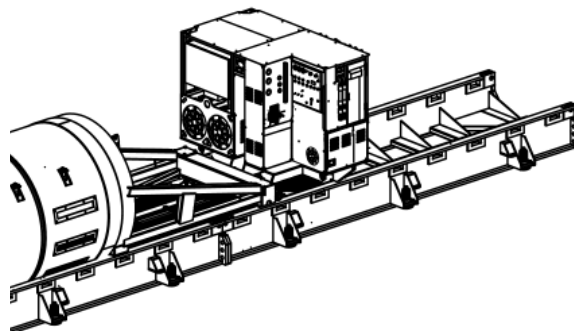
Pressure peaks cause hoses to jump without notice. Keep all personnel away from hoses during operation of equipment.

DANGER

Contact with electrical power WILL cause severe injury or death. NEVER disconnect tunnel power cables when tunnel power light is ON.

28. Continue jacking until the TBM has been jacked far enough into the ground to allow enough space to add one section of pipe.

(Continued on next page)

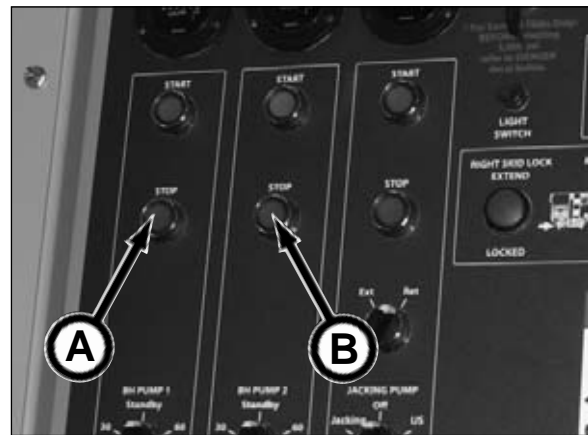


29. Return all controls to the neutral, standby or OFF position.

NOTICE Once dirt bucket is removed, 30 gpm may be needed by the operator so the conveyor can be moved to check line and grade.



30. Stop the boring head and motors by depressing the Boring Head 1 Motor STOP button (A) and the Boring Head 2 Motor STOP button (B).



⚠ DANGER Contact with electrical power WILL cause severe injury or death. NEVER disconnect tunnel power cables when tunnel power light is ON.



31. (For Series II TBMs only) Move Tunnel Power switch (C) to the OFF position.



(Continued on next page)

⚠ WARNING Escaping oil or other fluids under pressure can penetrate your skin causing serious injury. Contact medical help immediately if any oil or fluid is injected into your skin.

BEFORE connecting or disconnecting hydraulic oil hoses/lines, ALWAYS move controls to the OFF or neutral position, STOP the boring head and auxiliary motors AND use gloves.



32. With gloves, clean hose connections before disconnecting hoses to prevent contamination from entering hoses. Disconnect pump unit supply and return hoses from boring head supply and return line hoses. Clean hose ends. Cap hoses.



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

33. Disconnect the ventilation, electrical and communication lines and position them to quickly route through next pipe.

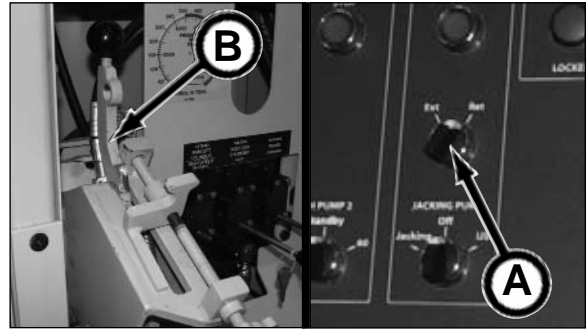


34. If not already running, start the jacking motor by depressing Jacking Motor START button (A).

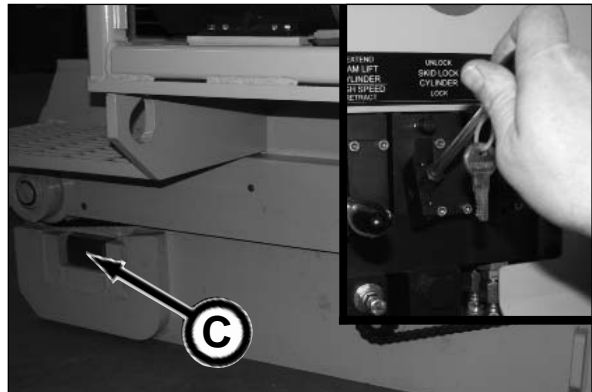


(Continued on next page)

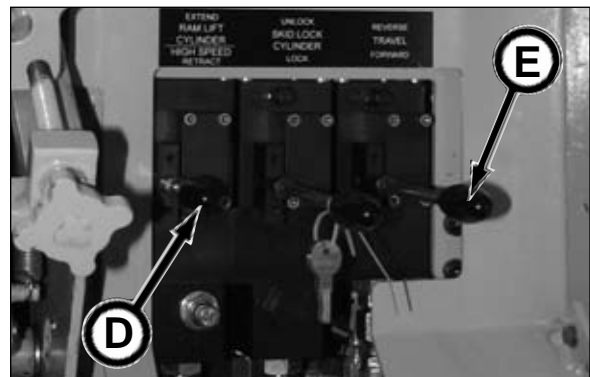
35. Flip Jacking Cylinder Selector switch (A) to Ret position and retract main ram cylinders using jacking cylinder speed control (B).



36. Unlock skid lock blocks (C) from skid using skid lock control (inset).



37. Move pump unit and yoke back far enough to lower the first section of pipe by moving the ram lift cylinder control (D) up and holding the travel control (E) up to reverse position.



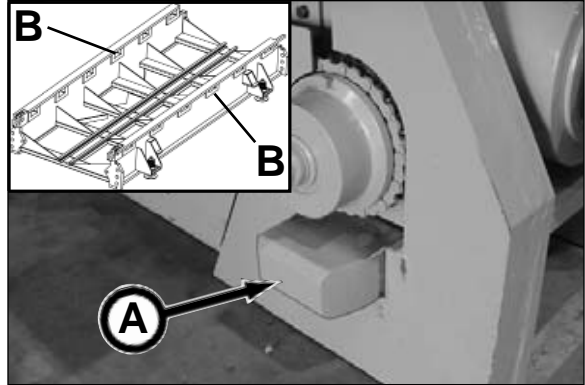
(Continued on next page)

38. Lower the first section of pipe into position on skid between the TBM and yoke. Then travel up to back of pipe to mate the yoke with the pipe.

NOTICE Though the pipeline layout is determined during the pipeline project design phase, generally the bell end of the pipe will be towards the TBM.



39. Lock pump unit skid lock blocks (A) into skid pockets (B) with the skid lock control. The skid lock blocks must be fully engaged (refer to lock indicators on control panel) into skid pockets before jacking.



Locking Skid Lock Blocks

40. With jacking cylinder speed control and jacking cylinder selector switch to Ext, extend cylinders until trailing section mates with the TBM.

NOTICE Relock the skid lock blocks as needed.

41. Install first track section and secure to TBM. Refer to your Haul Unit Operator's Manual for track installation.

NOTICE Sections of track will need to be added as new pipe are lowered. Also, be sure there is always track connecting the pipeline and the yoke, for the haul unit and the loading and unloading of the dirt bucket.



(Continued on next page)

⚠ WARNING Escaping oil or other fluids under pressure can penetrate your skin causing serious injury. Contact medical help immediately if any oil or fluid is injected into your skin.

BEFORE connecting or disconnecting hydraulic oil hoses/lines, ALWAYS move controls to the OFF or neutral position, STOP the boring head and auxiliary motors AND use gloves.

42. Reconnect boring head supply and return line hoses, adding additional hoses as necessary.



⚠ DANGER Contact with electrical power WILL cause severe injury or death. NEVER connect or disconnect tunnel power cables when tunnel power light is ON.

43. Reconnect the ventilation, electrical and communication lines, adding additional lines as necessary.



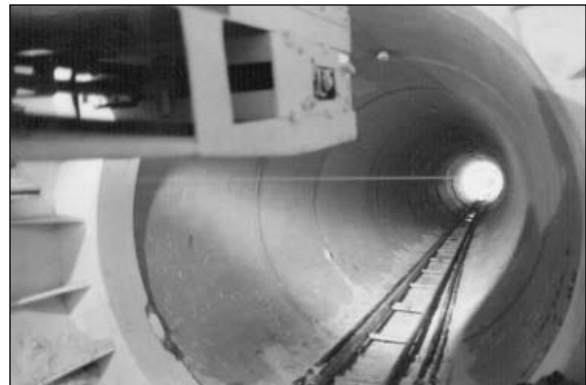
⚠ WARNING Suspended loads may fall and cause severe injury or death. Do not allow anyone to enter area under or around a suspended load.

44. Lower haul unit into place with battery box end toward the TBM. Refer to your Haul Unit Operator's Manual for haul unit installation.
45. Lower dirt bucket into place on the haul unit. The haul unit will then be moved to the front of the tunnel until the dirt bucket is underneath the conveyor.



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

46. Recheck laser guidance system accuracy often, with and without forward thrust applied, to avoid making improper steering corrections. Typically, the conveyor must be raised to check line and grade target.



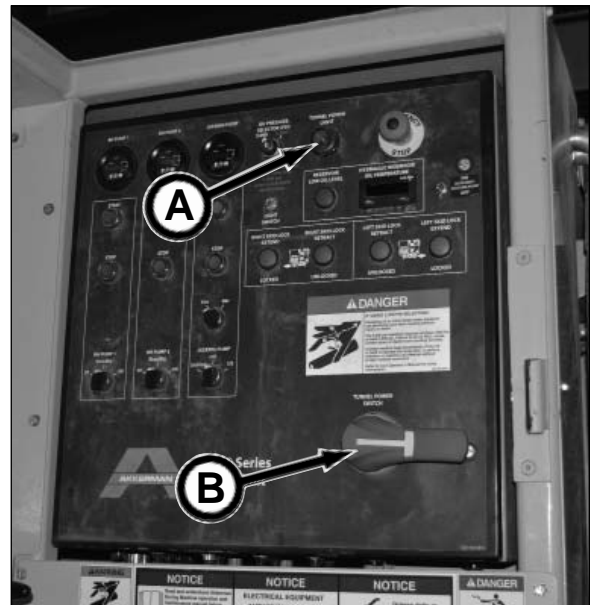
(Continued on next page)

NOTICE

If there is a possibility that the maximum jacking capability of 400 tons may be exceeded, Intermediate Jacking Stations should be installed. See Using Intermediate Jacking Stations in this section.



47. (Series II TBMs Only) With the pump unit main power switch ON and all E-Stop buttons pulled out, flip Tunnel Power Switch (A) to the ON position. This will illuminate the Tunnel Power ON light (B) which provides the operator a quick visual indicator that power is ON in the tunnel and to take all necessary precautions with high voltage electricity.



48. Continue jacking until pipe line is complete. When pipe line is complete, refer to Removing Jacking System in this section.



USING INTERMEDIATE JACKING STATIONS (IJS)

Intermediate Jacking Stations (IJS) are generally used when the thrust pressure reaches one third of the maximum pressure capacity of the pump unit or one half of the thrust capacity of the IJS, which ever occurs first. Contact the Akkerman Aftermarket Support Department for more information on the proper setup and usage of IJS.

INSTALLING IJS

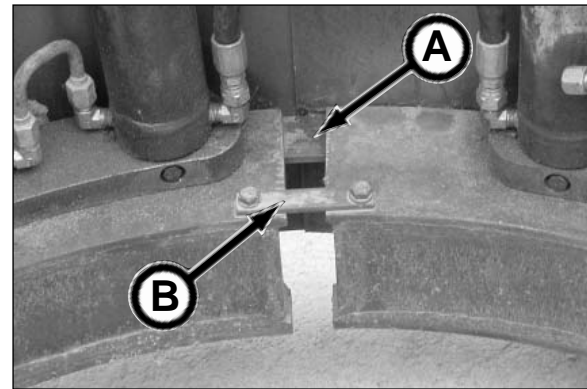
⚠ WARNING Suspended loads may fall and cause severe injury or death. Do not allow anyone to enter area under or around a suspended load.

1. Lower IJS with the inner ring towards the front of the tunnel, between the leading pipe and the trailing pipe.



NOTICE IJS configurations may vary depending upon project requirements.

2. Cut inner ring flange (A), located at seam of sleeve, with torch and unbolt plate (B) before mating pipe with IJS.



⚠ WARNING Pinch Points! Watch your fingers, hands, and legs while installing IJS sleeve.

3. SLOWLY jack until the trailing pipe slides into IJS sleeve and the IJS sleeve slides over leading pipe.
4. Use a winch or turn-buckle to squeeze the IJS sleeve until it mates with the leading and trailing pipe.
5. Tack weld seam.
6. Torch off lifting eyes.
7. Completely weld seam. Reweld flange (A) if possible.
8. Install track and sliding track. Be sure no track joints are in IJS opening.



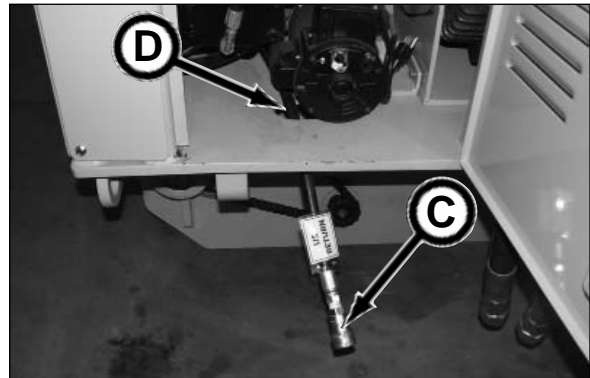
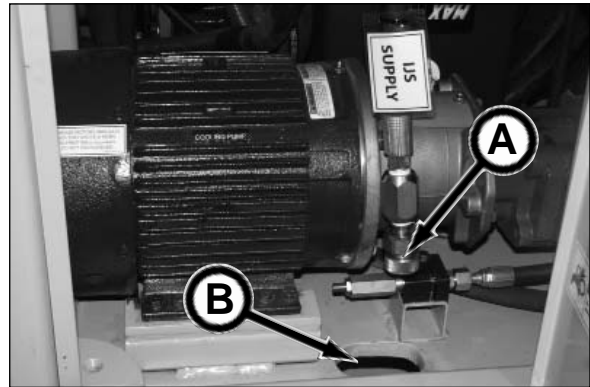
(Continued on next page)

9. Connect IJS hydraulic hoses to Pump Unit.

- a. Connect intermediate jacking station valve pressure port hose coupler to pump unit IJS supply hose quick coupler (A). Route hose through slotted hole (B) in frame. Be sure hose does not come in contact with any moving parts.

IMPORTANT: ONLY use hose rated for at least 8,000 psi working pressure.

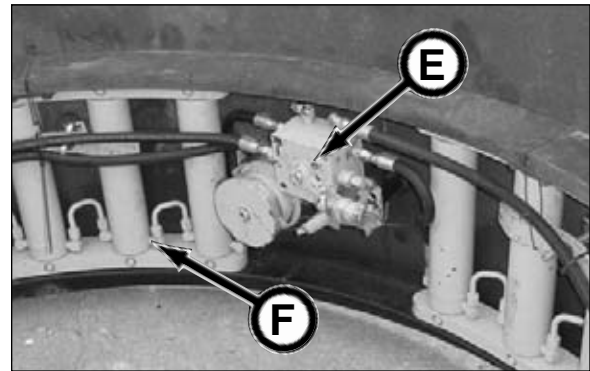
- b. Connect IJS tunnel return hose coupler to pump unit IJS return quick coupler (C). Route hose through slotted hole (D) in frame. Be sure hose does not come in contact with any moving parts.



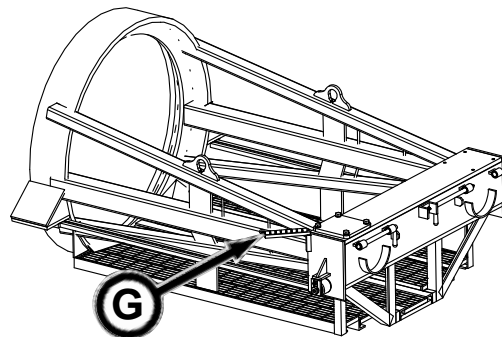
10. Mount the IJS valve (E) between cylinder segments (F).

11. Connect hydraulic hoses to IJS valve:

- a. Pressure to port P
- b. Return to port T
- c. Connect cylinders to C ports



12. Secure cable weight to IJS line holder (G) on yoke.



OPERATING IJS

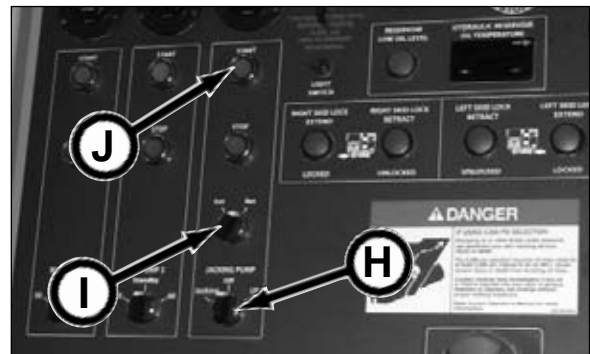
13. Flip jacking pump control switch (H) to IJS.

NOTICE

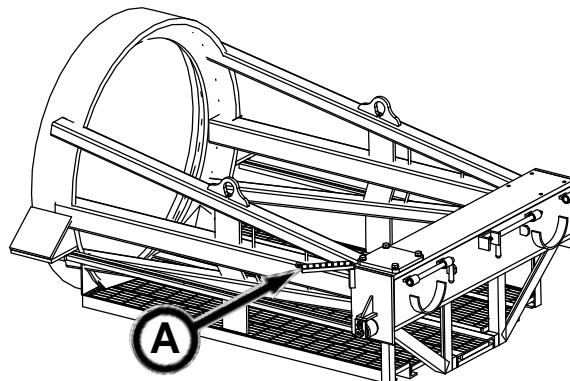
Once the jacking pump control switch is turned to IJS, the jacking cylinder control switch (I) becomes inactive. Therefore it is not necessary to flip the switch to Ext when extending IJS cylinders.

14. Start jacking motor by depressing jacking START button (J).

(Continued on next page)

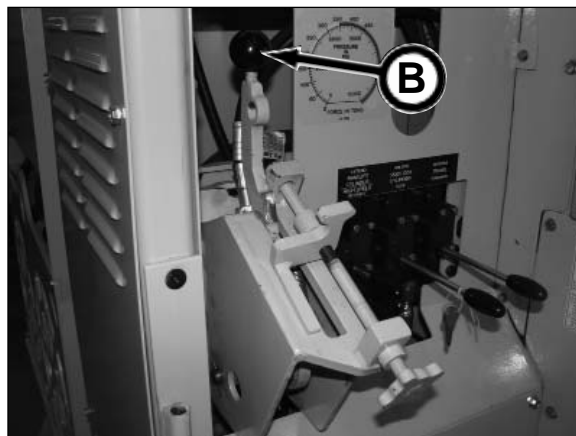


15. Pull cable for IJS #1 on IJS line holder (A) to open valve and extend IJS cylinders by moving the jacking cylinder speed control (B) DOWN. Operate the boring head the same as if the TBM is being jacked with the main ram cylinders for IJS #1.
16. When the IJS cylinders (for IJS #1) are at full extension, the pressure on the jacking pressure gauge should start to climb rapidly.
17. Release cable and jacking cylinder speed control.
18. Pull cable for IJS #2 to open and operate IJS cylinder control to close IJS #1 by extending cylinders. When the IJS cylinders are at full extension, the pressure on the jacking pressure gauge should start to climb rapidly.

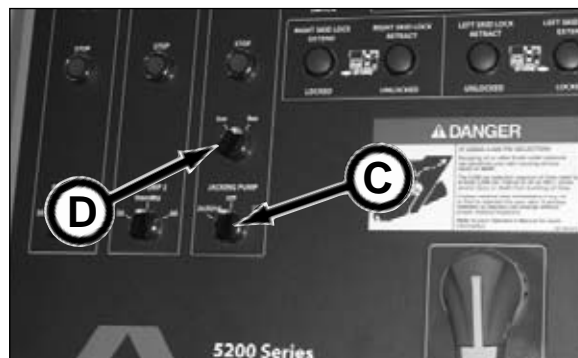


NOTICE DO NOT operate TBM cutterhead when extending cylinders for IJS #2, IJS #3, etc. or when closing final IJS.

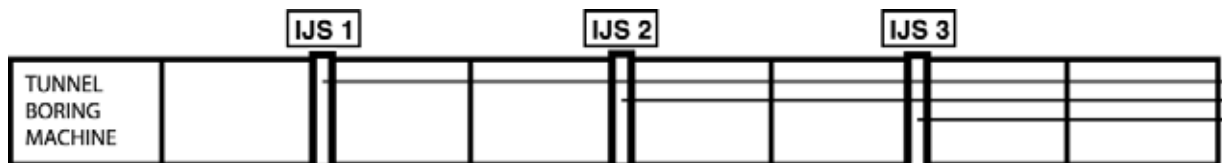
19. Release cable and IJS cylinder control.
20. Pull cable for IJS #3 to open and operate jacking cylinder speed control (extend IJS cylinders) to close IJS #2. When the IJS cylinders are at full extension, the pressure should start to climb rapidly.
21. Release cable and IJS cylinder control.
22. Repeat this opening and closing process for any additional IJS.
23. Flip jacking pump selection switch (C) to Jacking and jacking cylinder switch (D) to Ext. Continue jacking by extending the main rams cylinders using the jacking cylinder speed control to close the last IJS.



NOTICE Keep in mind when using the Intermediate Jacking Stations, you are mining with IJS #1, closing IJS #1 with IJS #2, closing IJS #2 with IJS #3, and closing IJS #3 with main rams.

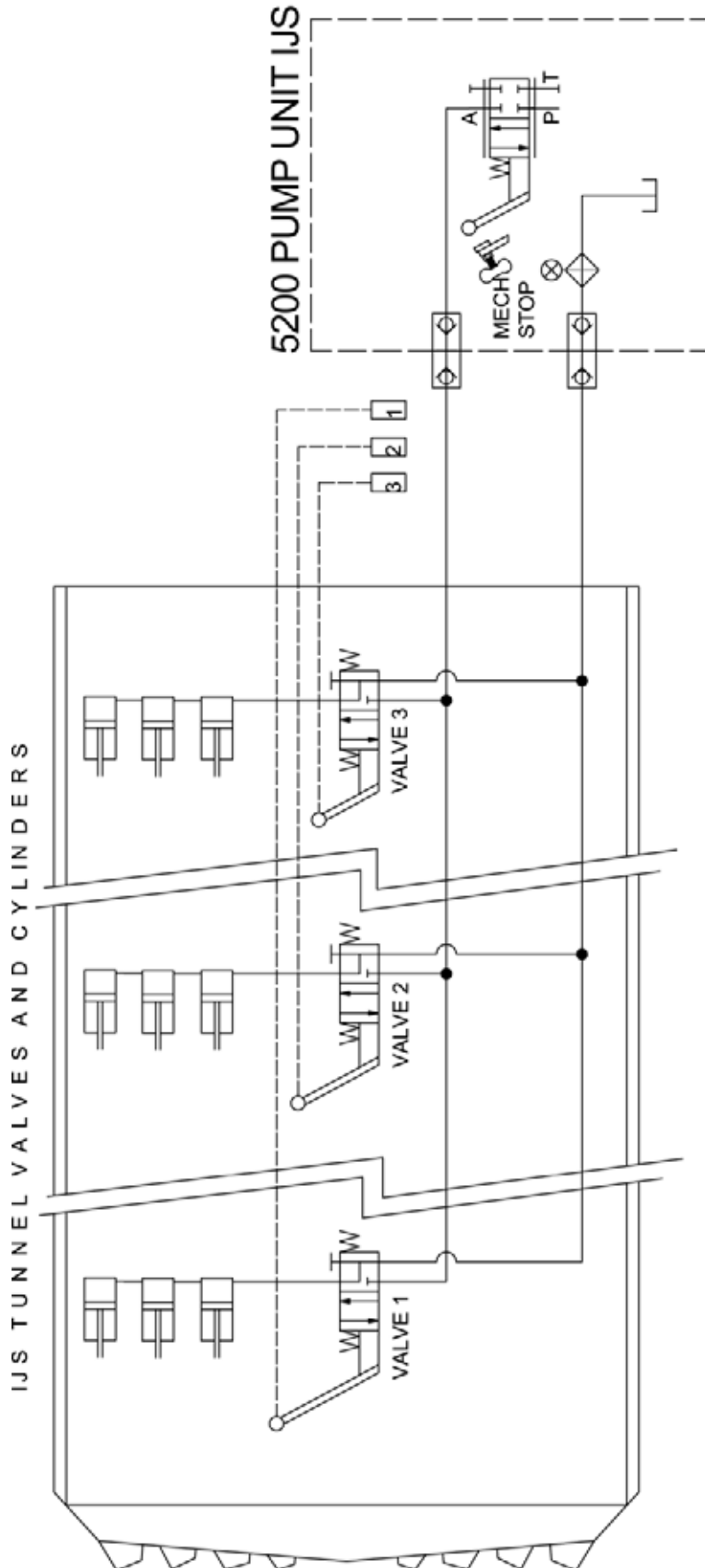


Refer to the IJS Schematic on the next page.



Intermediate Jacking Station Sequence

IJS SCHEMATIC



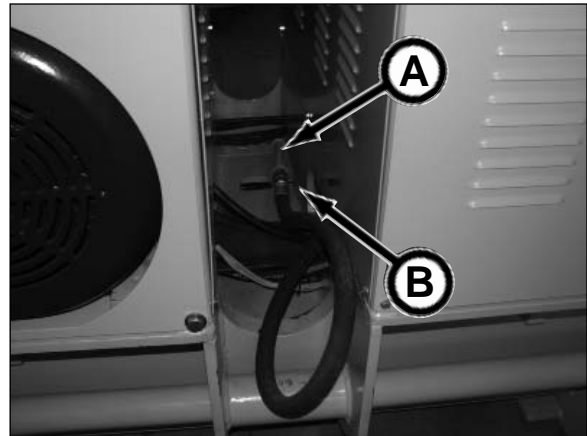
FILLING HYDRAULIC RESERVOIR

An oil transfer pump (8 gal/min) is equipped on the 5200 Pump Unit to provide an on-board means of filling the hydraulic reservoir.

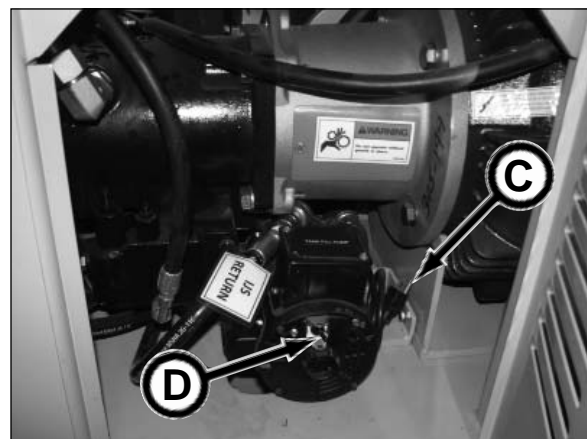
NOTICE A customer supplied oil pump can be used instead of the on-board pump by hooking up the pump to the IJS return quick coupler hose. Do not overfill reservoir.

NOTICE If reclaiming hydraulic oil from tunnel lines, refer to Purging Fluid From Tunnel Lines in this section.

1. Gain access to transfer pump fill tube (A) (located in the laser line chamber of the pump unit).
2. Clean outside of fill tube and area around cap. Remove cap and connect fill tube to clean oil supply container (barrel).



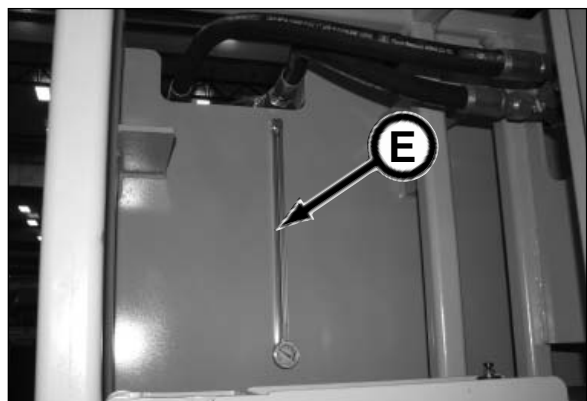
3. Connect transfer pump plug (C) to 110V power source outlet.
4. Open ball valve (B) on fill tube.
5. Flip the switch (D) on the transfer pump to start pumping oil into the reservoir.



6. Carefully watch the tank volume on the level gauge (E). DO NOT OVERFILL!

NOTICE To display the level gauge, components were removed for photographic purposes only.

7. Once reservoir is filled, close ball valve and flip switch on the transfer pump to stop the pumping of oil.
8. Unplug transfer pump plug (D) from power source.
9. Remove fill tube from supply container.
10. Clean outside of fill tube and cap. Reinstall cap and replace fill tube back into laser line chamber of the pump unit.



COLD WEATHER OPERATION

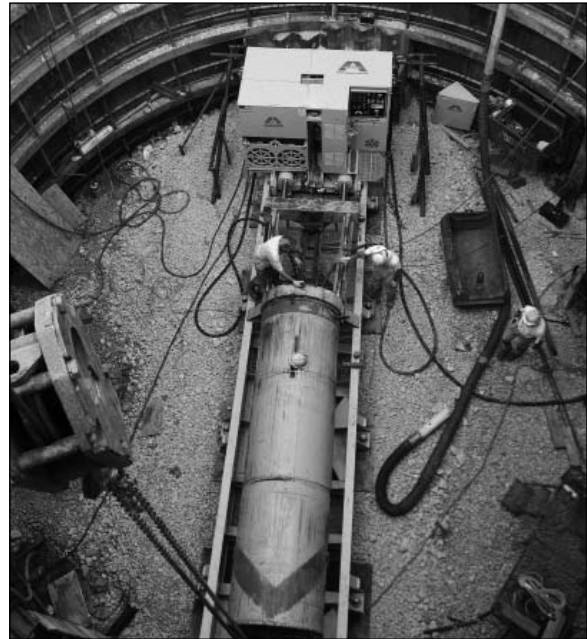
Freezing temperatures during the tunneling process, creates the necessity to prepare the site and equipment for the cold weather. Failure to do so will cause damage to components and supporting equipment.

There are various methods of keeping equipment from freezing:

- Tent working areas with a heating system when possible.
- Be sure to drain heat exchanger and hoses in cold weather. If heat exchanger freezes without being drained, damage will occur to the heat exchanger internal parts resulting in improper oil cooling and potential water contamination in the oil.
- When working with water (including bentonite), it needs to be constantly circulated to prevent freezing. Otherwise the equipment must be drained and/or treated with a RV anti-freeze solution to prevent freezing.
- If bentonite pump and/or water cooling pumps are used and will be shut off for a considerable length of time and the temperature is at or below freezing, the fluids must be drained or treated with RV anti-freeze. Refer to pump manufacturer for more information.
- Water tanks must be drained or treated with RV anti-freeze.
- Drain hoses to prevent freezing and keep low areas properly drained to prevent freezing damage.
- For all equipment, use proper lubricant based on ambient temperature to prevent damage.
- Use compressed air to purge a system of water. Be sure the discharge valve is open before doing so.
- Install heaters for hydraulic systems.
- A spoil (muck) dump needs to be located carefully since the wet loose material will freeze forming a pointed pile instead of a mound.

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

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



Operation

NOTES

PURGING FLUID FROM TUNNEL LINES WITH NON SERIES II TBM

⚠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.

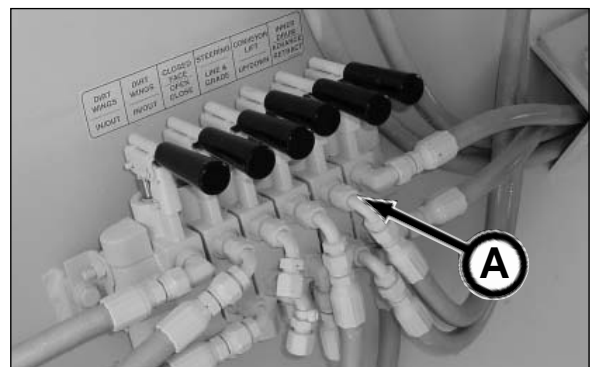
Contact medical help immediately if any oil or fluid is injected into your skin. A serious infection or reaction can emerge without proper medical treatment.



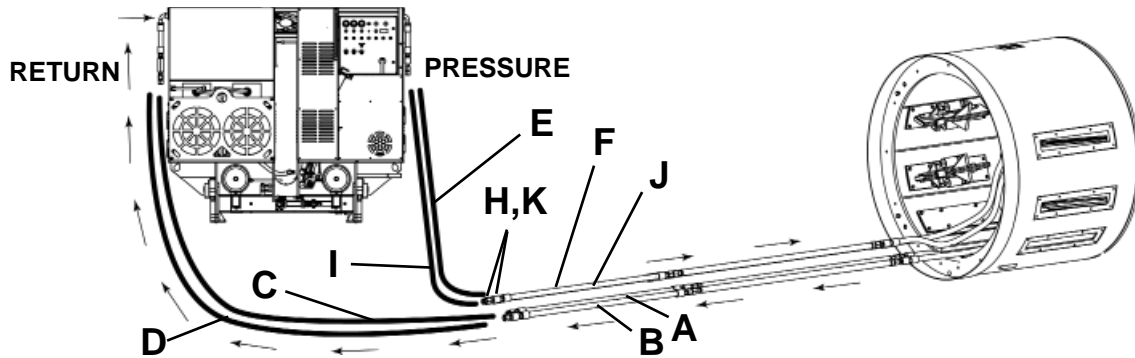
Once the tunnel pipeline is complete, the tunnel lines should be purged (reclaim oil in lines) of hydraulic fluid. Using compressed air, the oil will flow through the pressure lines, TBM, out of the return lines and into a separate hydraulic tank reservoir. The purpose of reclaiming the oil in a separate reservoir is to avoid an overflow of oil in the pump unit reservoir and possible pump unit tank rupture.



1. Relieve pressure from pressure lines by cycling controls on the TBM 6 way control valve (A).



(continued on next page)



2. To prevent tank rupture when purging tunnel lines, disconnect both tunnel return lines (A and B) from 5200 Pump Unit hoses (C and D). Securely attach tunnel lines (A, B) to a separate CLEAN hydraulic tank reservoir (vented barrel). Cap pump unit hoses (C,D).

NOTICE

Be sure tank is large enough to accommodate oil being purged.

3. Disconnect 5200 pump Unit boring head 1 pressure hose (E) from tunnel line (F). Cap pressure hose (E) to pump unit.
4. Install air/hydraulic adapter (G), or similar adapter, to boring head pressure 1 tunnel line connection (H) and connect hose from compressor to adapter.
5. Turn on compressor, open valve on air/hydraulic adapter and purge tunnel lines of hydraulic fluid to separate hydraulic tank reservoir.
6. Once line is purged, remove adapter, cap line (F).
7. Disconnect 5200 pump unit boring head 2 pressure hose (I) from tunnel line (J). Cap pressure hose (I) to pump unit.
8. Install air/hydraulic adapter (G), or similar adapter, to boring head 2 pressure tunnel line connection (K) and connect hose from compressor to adapter.
9. Turn on compressor, open valve on air/hydraulic adapter and purge tunnel lines of hydraulic fluid to pump unit boring head hydraulic tank.
10. Once line is purged, remove adapter, cap line (J).



NOTICE

When the pump unit is hooked up for dual feed supply hydraulics, both return lines are common, therefore when purging fluid from tunnel lines, one return line may hold some fluid after the purging process. Be sure both return lines are free of fluid.

11. Remove tunnel lines (A,B) from collection tank. Cap tunnel lines.

PURGING FLUID FROM TUNNEL LINES WITH SERIES II TBM

⚠ 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.



Once the tunnel pipeline is complete, the tunnel lines should be purged (reclaim oil in lines) of hydraulic fluid. Using compressed air, the oil will flow through the pressure lines, TBM, out of the return lines and into a separate hydraulic tank reservoir. The purpose of reclaiming the oil in a separate reservoir is to avoid an overflow of oil in the pump unit reservoir and possible pump unit tank rupture.



1. Relieve pressure from pressure lines by cycling controls on the TBM control valves.

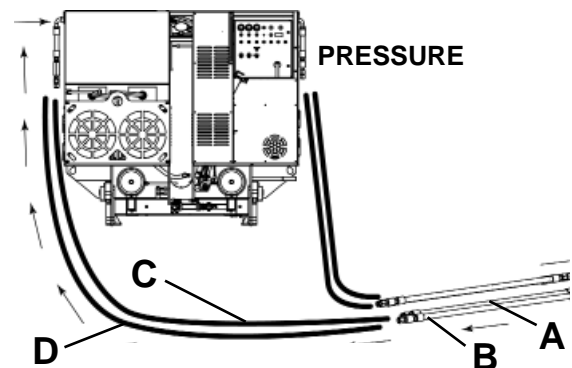


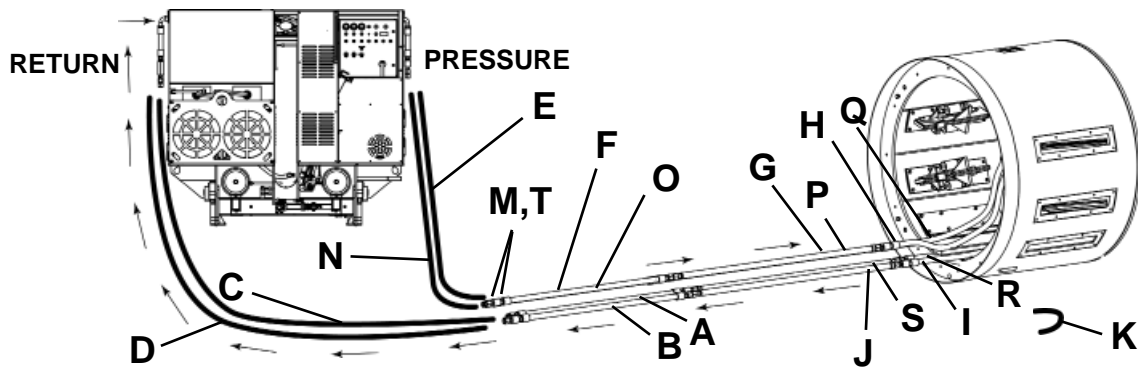
2. To prevent tank rupture when purging tunnel lines, disconnect both tunnel return lines (A and B) from 5200 Pump Unit return hoses (C and D). Securely attach tunnel lines (A, B) to a separate CLEAN hydraulic tank reservoir (vented barrel). Cap pump unit hoses (C,D).

NOTICE Be sure collection tank is large enough to accommodate oil being purged.

(continued on next page)

RETURN





3. Disconnect 5200 pump unit boring head 1 pressure hose (E) from tunnel line (F). Cap pressure hose (E) to pump unit.
4. Disconnect tunnel line (G) from TBM pressure hose (H). Disconnect TBM return hose (I) from tunnel line (J).
5. Cap TBM pressure hose (H) and TBM return hose (I).
6. Install jumper hose (K) to tunnel lines (G) and (J).

7. Install air/hydraulic adapter (L), or similar adapter, to boring head 1 pressure tunnel line connection (M) and connect hose from compressor to adapter.
8. Turn on compressor, open valve on air/hydraulic adapter and purge tunnel lines of hydraulic fluid to separate hydraulic tank reservoir.
9. Once line is purged, remove adapter, cap line (F).

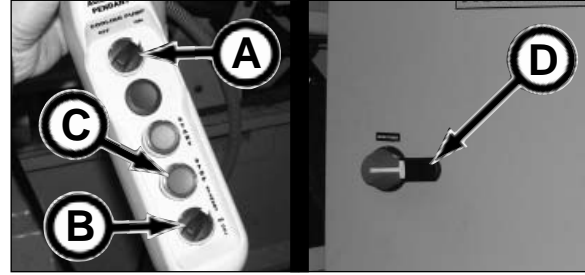


10. Remove jumper hose (K) from tunnel lines (G) and (J). Cap tunnel lines.
11. Disconnect 5200 pump unit boring head 2 pressure hose (N) from tunnel line (O). Cap pressure hose (N) to pump unit.
12. Disconnect tunnel line (P) from TBM pressure hose (Q). Disconnect TBM return hose (R) from tunnel line (S).
13. Cap TBM pressure hose (Q) and TBM return hose (R).
14. Install jumper hose (K) to tunnel lines (P) and (S).
15. Install air/hydraulic adapter (L), or similar adapter, to boring head 2 pressure tunnel line connection (T) and connect hose from compressor to adapter.
16. Turn on compressor, open valve on air/hydraulic adapter and purge tunnel lines of hydraulic fluid to pump unit boring head hydraulic tank.
17. Once line is purged, remove adapter, cap line (O).
18. Remove jumper hose (K) from tunnel lines (P) and (S). Cap tunnel lines.
19. Remove tunnel lines (A,B) from collection tank. Cap tunnel lines.

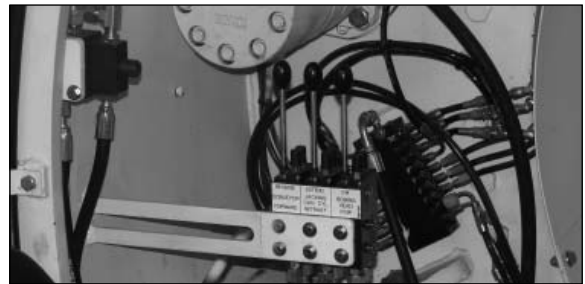
DAILY SHUT DOWN

NOTICE

If equipped with 200 HP Auxiliary: On the control pendant, flip the Cooling Pump switch (A) to OFF position and the Flow control switch (B) to Standby. Press the red Stop button (C). Turn auxiliary power switch (D) OFF. Shut off main power source and perform lockout/tagout.

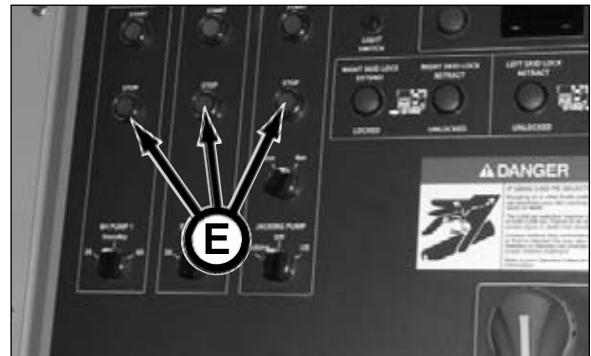


1. Return all hydraulic controls on the pump unit and TBM to the OFF or neutral position.



TBM Series II

2. Stop the boring head 1, boring head 2 and jacking motors (E).



3. (TBM Series II) Move the TBM main power switch to the OFF position.



TBM Series II

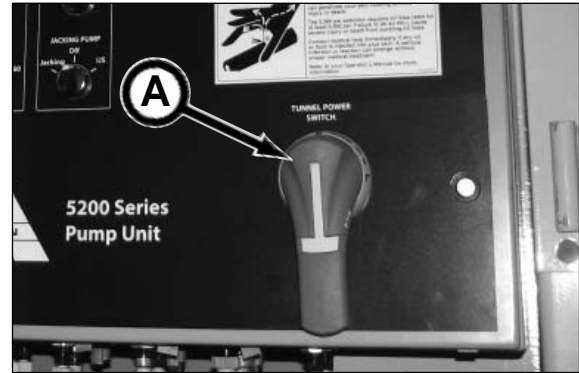
(Continued on next page)

- (TBM Series II) Push TBM E-Stop button IN.

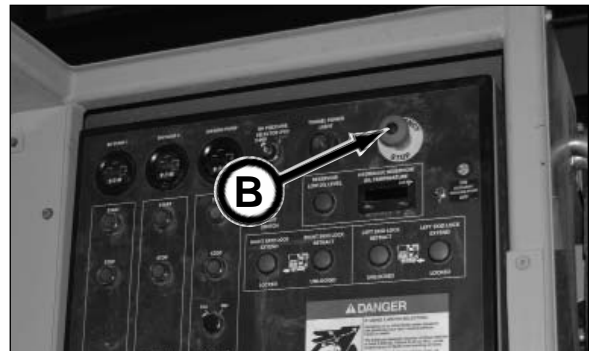


TBM Series II

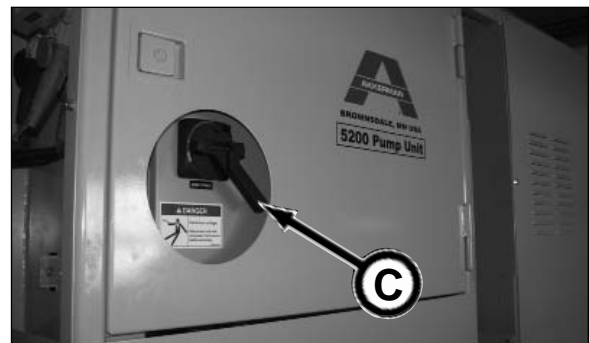
- Move Tunnel Power switch (A) to the OFF position. Place switch in lockout/tagout.



- Press pump unit E-Stop button (B) IN.



- Move pump unit Main Power switch (C) to the OFF position and perform lockout/tagout.



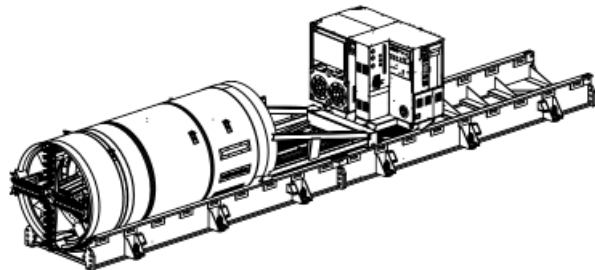
- Shut off water supply to pump unit heat exchanger. Drain water if freezing temperatures are possible. Purge any remaining water in heat exchanger with compressed air (maximum 25 psi). Refer to 34. Drain Heat Exchanger in section 9, Periodic Maintenance.

- Shut off main power source and perform lockout/tagout.

- Perform a visual system inspection by checking the following items: all fluid levels, leaks, and machine damage. Make repairs before operating. Also check to be sure all electrical and hydraulic connections are properly connected and secured.

NOTICE

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



REMOVING JACKING SYSTEM

When pipe line is complete:

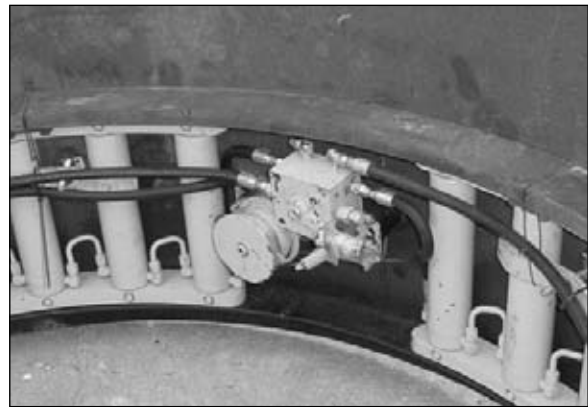
⚠WARNING Escaping oil or other fluids under pressure can penetrate your skin causing serious injury. Contact medical help immediately if any oil or fluid is injected into your skin.

ALWAYS use gloves when connecting or disconnecting hydraulic oil hoses/lines.

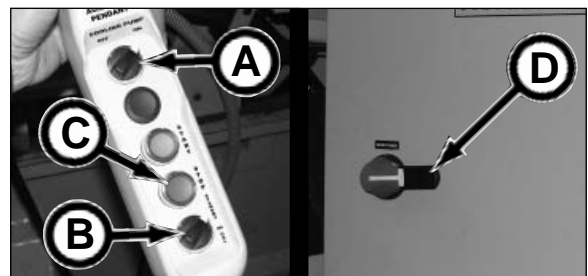
NOTICE If using Intermediate Jacking Stations, the outer shell will remain in pipe line.



1. If IJS are used:
 - a. Remove IJS #1 valve, cylinder segments, and cap hoses, lines, valve and cylinder ports. Cut off valve and cylinder segment bolts. Close IJS #1 gap by operating IJS #2.
 - b. Remove IJS #2 valve, cylinder segments, and cap hoses, lines, valve and cylinder ports. Cut off valve and cylinder segment bolts. Close IJS #2 gap by operating IJS #3.
 - c. Remove IJS #3 valve, cylinder segments, and cap hoses, lines, valve and cylinder ports. Cut off valve and cylinder segment bolts. Close IJS #3 gap by operating main rams (if IJS #3 is the last IJS).
2. Reclaim hydraulic oil from tunnel lines (refer to Purging Fluid From Tunnel Lines in this section).
3. Disconnect hydraulic hoses from inside of TBM and cap hoses.



NOTICE If equipped with 200 HP Auxiliary: On the control pendant, flip the Cooling Pump switch (A) to OFF position and the Flow control switch (B) to Standby. Press the red Stop button (C) Turn auxiliary power switch (D) OFF. Shut off main power source and perform lockout/tagout.



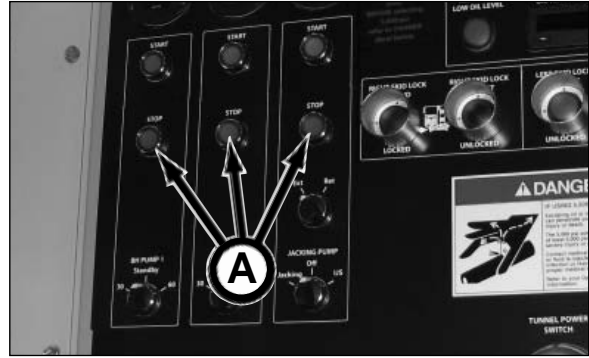
⚠WARNING Any electrical work completed on the jacking system **MUST** be performed by a certified electrician.

4. Turn Tunnel Power switch (E) to OFF position and perform lockout/tagout.

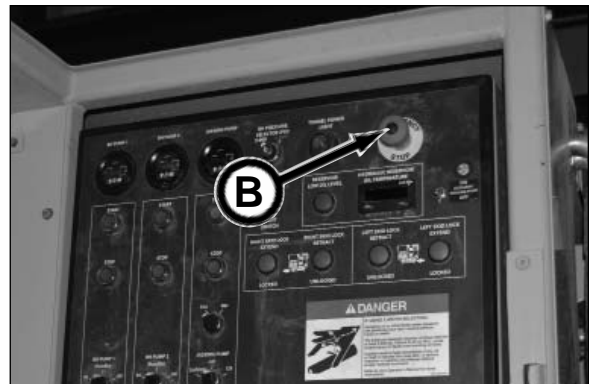


Operation - Removing Jacking System

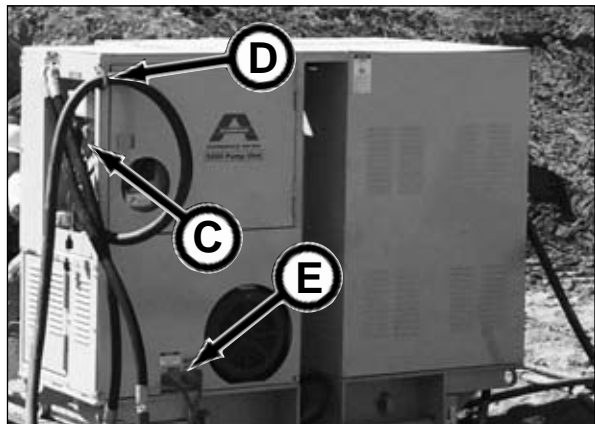
5. Depress STOP button (A) on all motors; boring head, auxiliary and jacking motors.



6. Push E-Stop button (B) IN and LOCKOUT, TAGOUT power source(s).



7. Disconnect tunnel power cables leads from camlock connections (C).
8. Disconnect tunnel power cable from pump unit power cable hook (D).
9. Disconnect heat exchanger supply and discharge hoses (E).



If equipped with 200 HP Auxiliary (steps 10 and 11):

10. Disconnect power cables leads from camlock connections (F).
11. Disconnect heat exchanger supply and discharge hoses (G).



⚠ WARNING

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

12. Remove TBM, haul unit and track.
13. Remove 200 HP Auxiliary (if equipped), Pump Unit, yoke, and skid(s).



Operation

NOTES

Transporting

TRANSPORTING GUIDELINES

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 Pump Unit.
5. Lift pump unit using the single lift point lift eye or by using a two part sling with both lift points to keep the pump unit level. Prior to lifting, the lifting points must be inspected (if damaged, lifting points must be repaired before lifting pump unit), and the pump unit must lift freely. If it is stuck to the ground, it must be broken loose before lifting.

NOTICE

NEVER attempt to lift the pump unit by any other means than the pump unit designed lift eyes. The crane or lifting equipment must be 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, excavator or other lifting equipment will decrease.

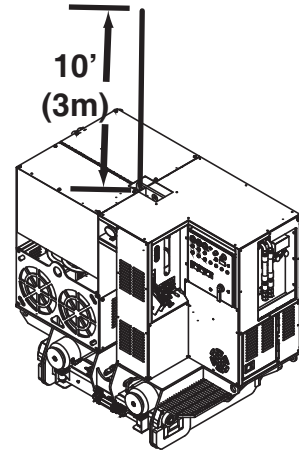
6. Load and unload on level ground.
7. Securely fasten pump unit doors prior to shipping to prevent damage to pump unit components.
8. Use chains to fasten the pump unit (see 10 below), yoke, skid, and intermediate jacking stations to trailer floor.
9. Use straps around pump unit assembly for added protection during shipment.
10. Use tie down eyes to secure Pump Unit to trailer floor.
11. Observe the lifting instructions on the following page.



LIFTING INSTRUCTIONS

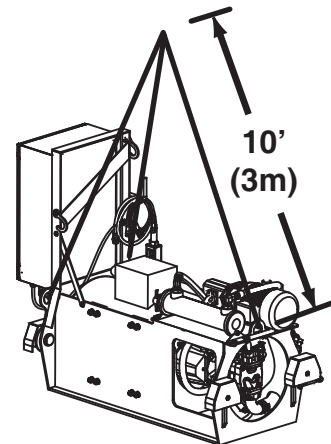
1. Pump Unit

- Pump Unit weight is 17,200 lbs. (7,802 kg).
- Pump Unit can be hoisted with a crane from either single lift point lift eyes or by using a two part sling with both lift points to keep the pump unit level.
- Chain or sling must be properly rated for the load and must have legs a minimum of 10 ft. (3 m) long.
- Pump Unit must lift freely. If it is stuck to the ground, it must be broken loose prior to lifting.
- Lifting eyes must be inspected prior to each lift. Any damage must be repaired prior to lifting.



2. 200 HP Auxiliary Unit

- Auxiliary Unit weight is 3,600 lbs. (1,633 kg).
- Lifting with a crane requires a three-part sling and legs a minimum of 10 ft. (3 m) long.
- Auxiliary unit must be separated from the pump unit prior to lifting.
- Auxiliary Unit must lift freely. If it is stuck to the ground, it must be broken loose prior to lifting.
- 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 5200 Jacking System. Always use high quality lubricants as specified in this section. Refer to the Periodic Maintenance section for proper lubrication quantity, maintenance intervals, and procedures.

HYDRAULIC RESERVOIR LUBRICANT

The 5200 Pump Unit hydraulic reservoir is filled with ISO-VG-46 Premium Hydraulic Oil unless otherwise specified on hydraulic reservoir.

Reservoir Capacity: 240 gal (908 L)

NOTICE

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

Recommended hydraulic oil:

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

NOTICE

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



ELECTRIC MOTOR BEARING GREASE

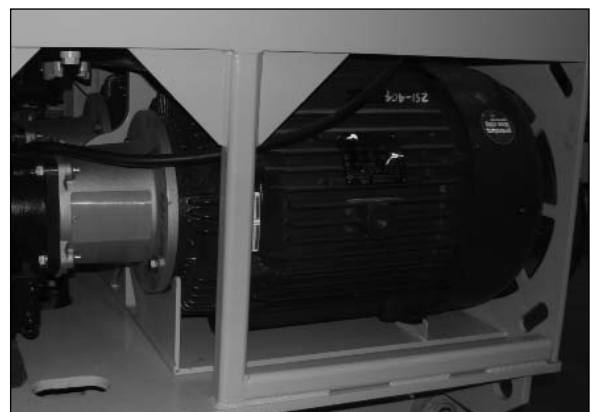
The electric motor lubrication grease fittings are lubricated with Mobil Polyrex® EM grease.

The Polyrex EM grease is a specially formulated grease for electric-motor bearings.

Use Mobil Polyrex® EM grease or equivalent when lubricating the lubrication fittings.

IMPORTANT: Be sure to ALWAYS verify the grease type listed on the nameplate prior to greasing motors.

IMPORTANT: NEVER mix different grease types without contacting the motor manufacturer for recommendations prior to changing to a different grease.

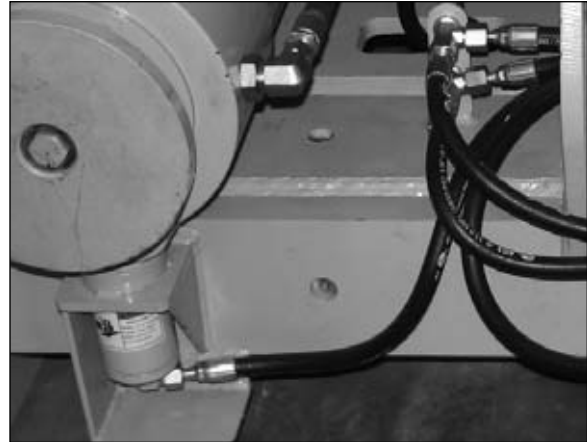


SKID LOCK BLOCK GREASE

The eight skid lock block lubrication fittings are greased with Mobilgrease® XHP220 Premium Lubricating Grease. Use Mobilgrease® XHP005 in lower temperatures as shown in the chart below.

The XHP220 and XHP005 greases are a high performance, lithium grease featuring high temperature, water contamination, shock loading and extended re-lubrication operations, and where extreme cold temperature pumpability is important.

Use Mobilgrease® XHP220 or XHP005 Lubricating Grease or equivalent when greasing the lubrication fittings.



Recommended grease:

Ambient Temp.	Grease
-25°F to 32°F (-32°C to 0°C)	XHP005
0°F to 105°F (-18°C to 41°C)	XHP220

GREASE

The lubrication fittings on the skid and yoke are greased with Mobilgrease® XHP222 Premium Lubricating Grease.

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

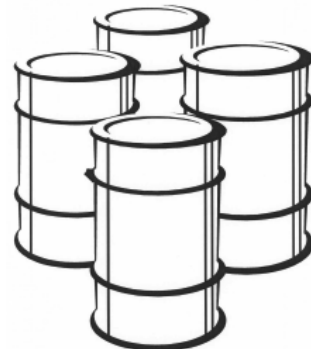
Use Mobilgrease® XHP222 Premium Lubricating Grease or equivalent when greasing the lubrication fittings.



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 contaminants.



Periodic Maintenance

▲WARNING Review the Safety section in this manual before performing maintenance. Failure to do so, could cause severe injury or death.

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.

LUBRICATION & MAINTENANCE INTERVALS

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

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

Use the hour meters on the 5200 Pump Unit and the 200 HP Auxiliary Unit (if used) to help determine proper maintenance intervals.

The hour meters register in full hours and 1/10ths hours.



5200 Pump Unit Hourmeters



200 HP Auxiliary Unit Hourmeter

BEFORE PERFORMING MAINTENANCE

1. Push IN all E-Stop buttons.
2. Relieve hydraulic pressure.
3. Perform appropriate electrical system maintenance shutdown procedure. Refer to Daily Shut Down in section 6, Operation.
4. Do not work on hydraulic system if oil temperature exceeds 150°F (66°C)
5. **Lockout/tagout all power. Perform lockout/tagout procedure.**



HYDRAULIC OIL/FLUIDS UNDER PRESSURE

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

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.



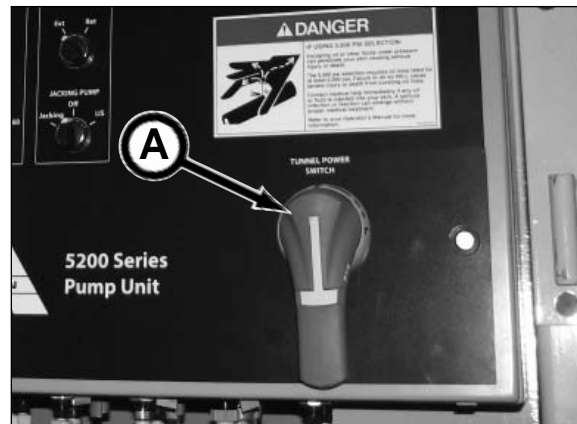
LOCKOUT/TAGOUT POWER BEFORE SERVICING

⚠ WARNING Severe personal injury or death can result from unexpected pump unit startup 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. Turn Tunnel power switch (A) to the OFF position.



2. Push E-STOP button (B) IN.



3. Lockout/tagout power source.

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.

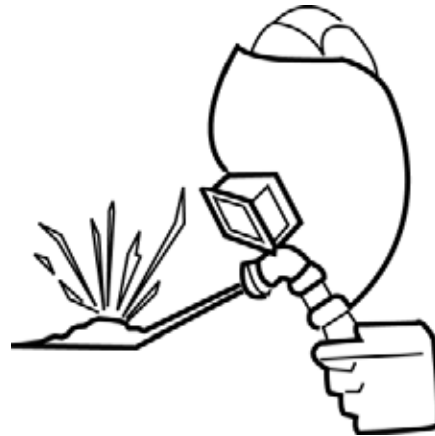


UNAUTHORIZED WELDING

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

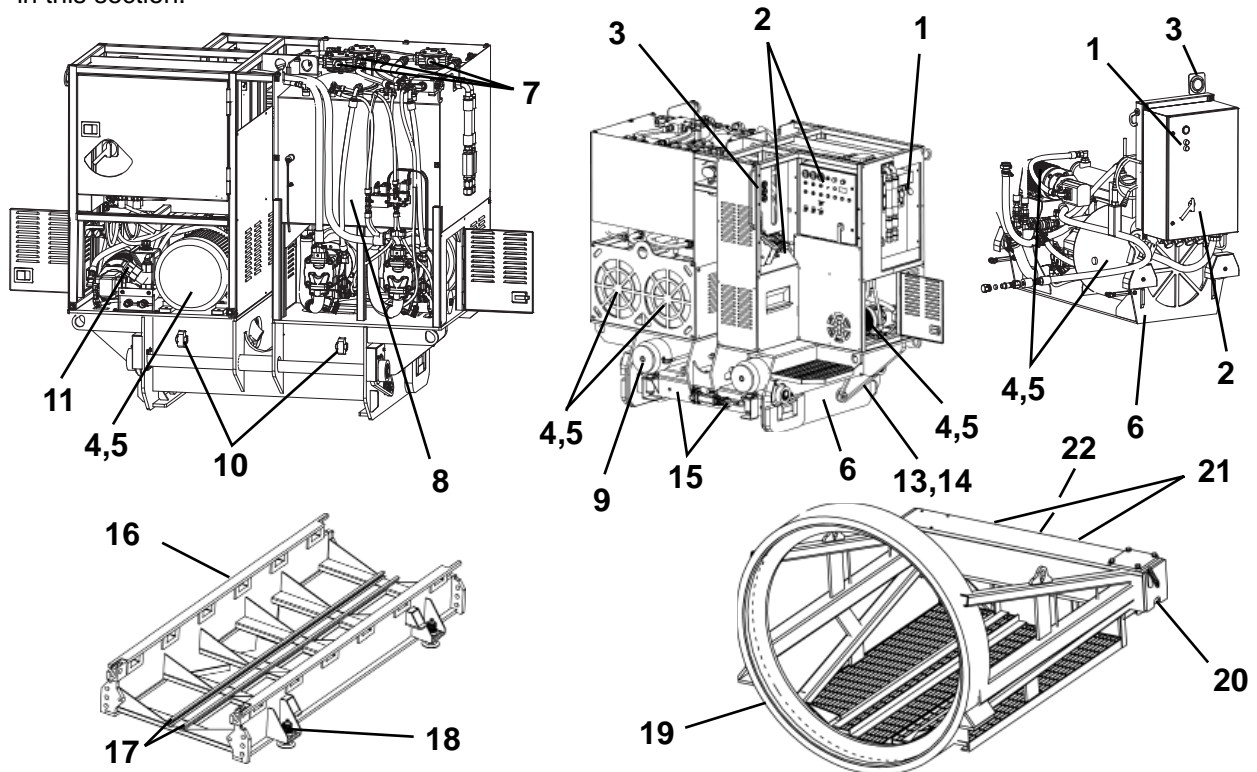
Do not weld on any structural member. Unauthorized welding or repair will void the warranty.

BEFORE performing authorized welding on TBM, remove gas detector to prevent damage.



MAINTENANCE CHARTS

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



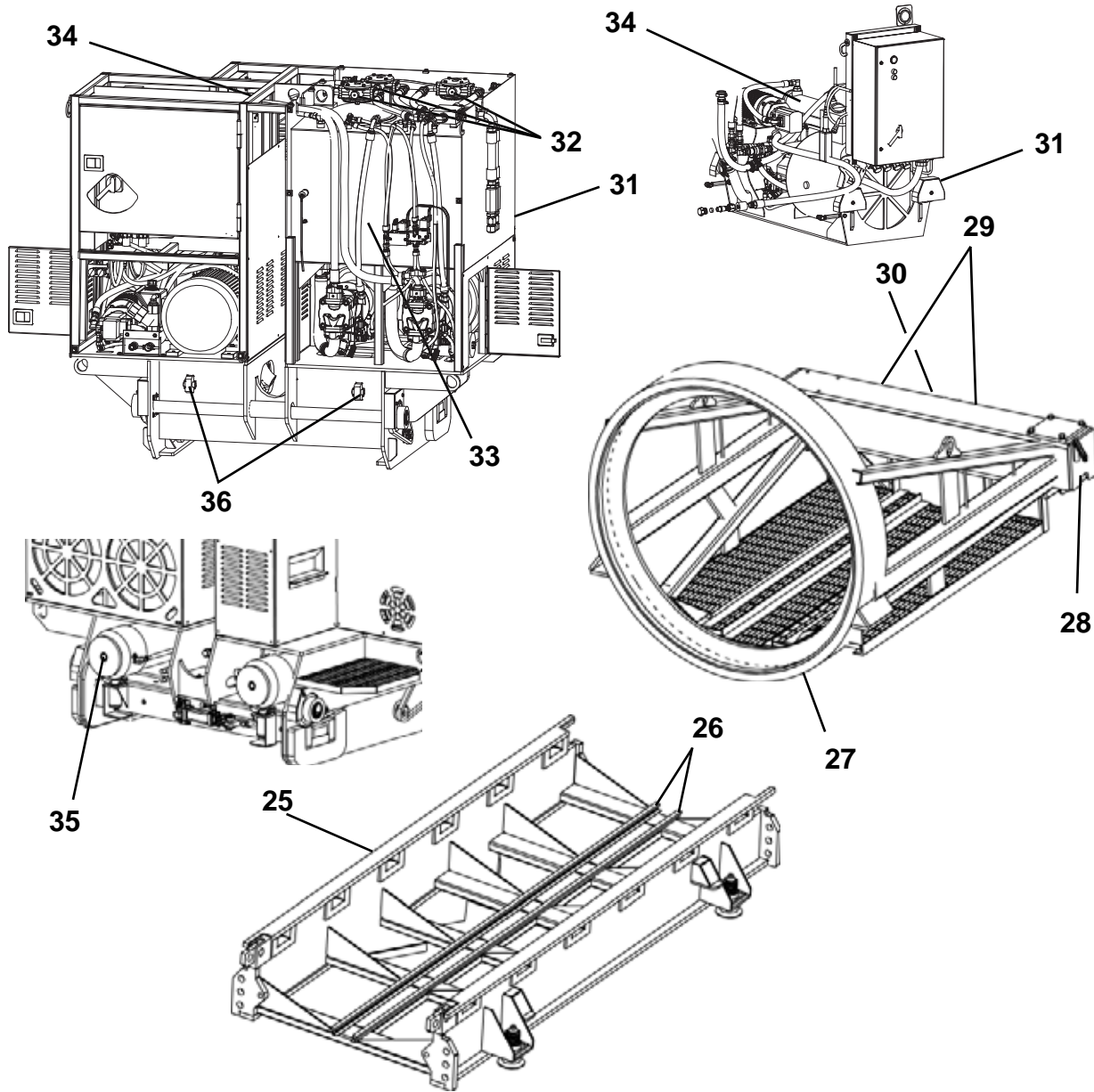
PRIOR TO EACH JOB LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Phase Power	Check		
2.	Controls	Check Operation		
3.	Gauges	Check Operation		
4.	Motors	Check	Ventilation openings clean and drain holes open.	
5.	Motors	Verify Proper Rotation		
6.	Pump/Aux Frames	Inspect	If damaged, repair or replace.	
7.	Return Filters	Check	Replace filters per indicator.	Return Filters
8.	Hydraulic Oil	Check Level & Condition	Refill as needed.	ISO-VG-46
9.	Cyl. Ram Cap	Check	Tighten as required.	
10.	Cyl. Mount Pin	Check (2 Places)	If damaged, replace with new.	
11.	Water Inlet Strainer	Clean		
*12.	Hyd Hoses/Pwr Cables	Inspect		
13.	Drive Chain	Adjustment (2 Places)	1/4-1/2" deflection.	
14.	Chain	Lubricate (2 Places)		Lt. Wt. Motor Oil
15.	Skid Lock Linkage	Check (2 Places)	Hdwr tightness and dirt buildup.	
16.	Skid Base	Inspect	If damaged, repair or replace.	
17.	Rails	Inspect	If damaged, repair or replace.	
18.	Leveling Screws	Lubricate (4 Places)	Lubricate generously.	Mobil XHP222
19.	Yoke Frame	Inspect	If damaged, repair or replace.	
20.	Yoke Wheels	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
21.	Ram Retaining Pins	Inspect	If damaged, repair or replace.	
22.	Retaining Pin Stop	Inspect	If damaged, replace with new.	
*23.	Decals	Inspect	Must be legible. Replace as needed.	
*24.	Supporting Equip.	Perform Maintenance	Refer to your machine's maintenance manual.	

* Not Shown
5200jacksysom_050096

NOTICE

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

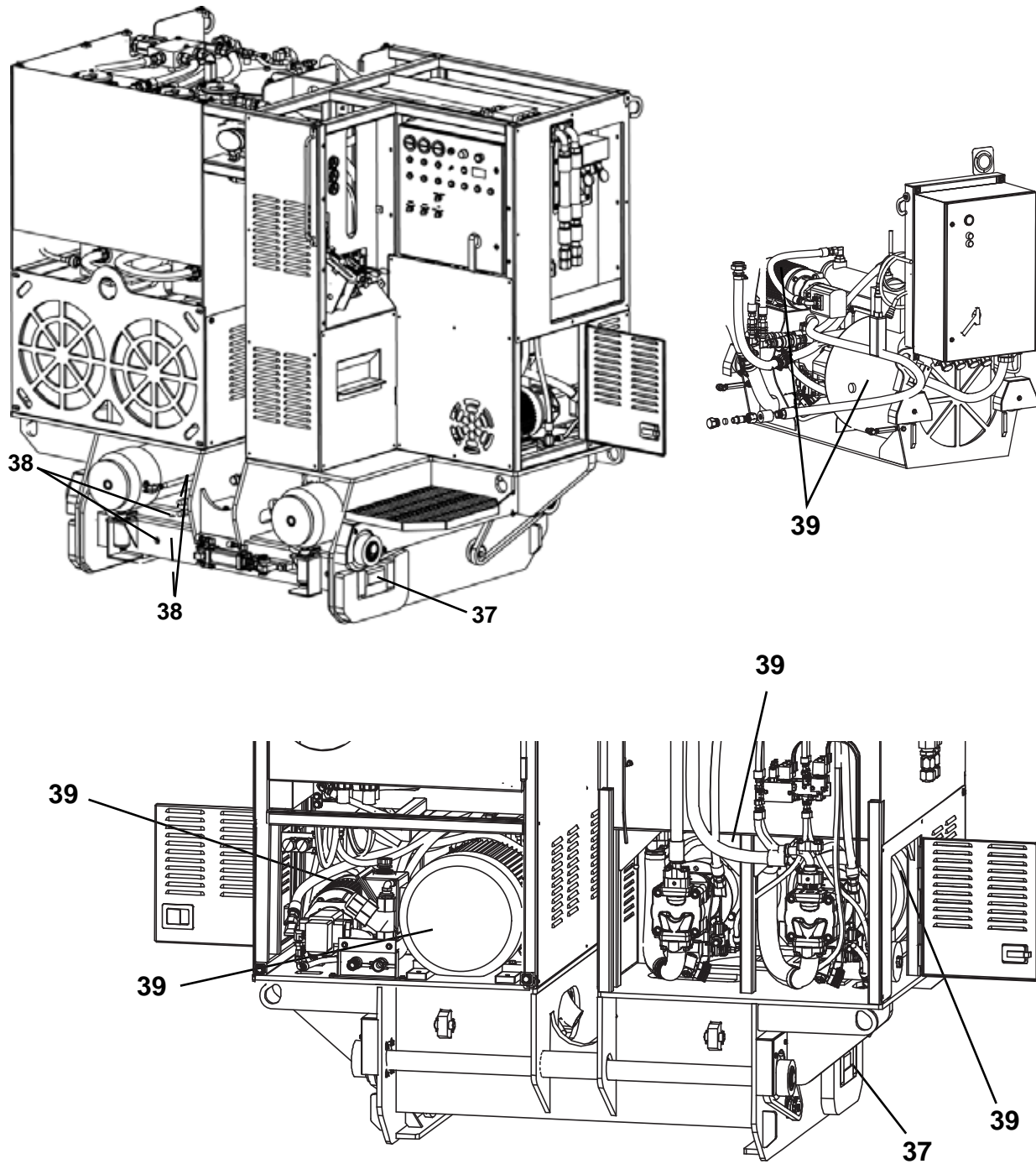


DAILY OR EVERY 10 HOURS OF OPERATION OR SHIFT CHANGE

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL	
25.	Skid Base	Inspect	If damaged, repair or replace.	Mobil XHP222	
26.	Rails	Inspect	If damaged, repair or replace.		
27.	Yoke Frame	Inspect	If damaged, repair or replace.		
28.	Yoke Wheels	Lubricate	Lubricate until grease is forced out.		
29.	Ram Retaining Pins	Inspect	If damaged, repair or replace.		
30.	Retaining Pin Stop	Inspect	If damaged, replace with new.		
31.	Pump/Aux Frames	Inspect	If damaged, repair or replace.		
32.	Return Filters	Check	Replace filters per indicator.		Return Filters ISO-VG-46
33.	Hydraulic Oil	Check Level & Condition	Refill as needed.		
34.	Heat Exchanger	Drain	Drain in freezing weather.		
35.	Cyl. Ram Cap	Check	Tighten as required.		
36.	Cyl. Mount Pin	Check (2 Places)	If damaged, replace with new.		

NOTICE

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



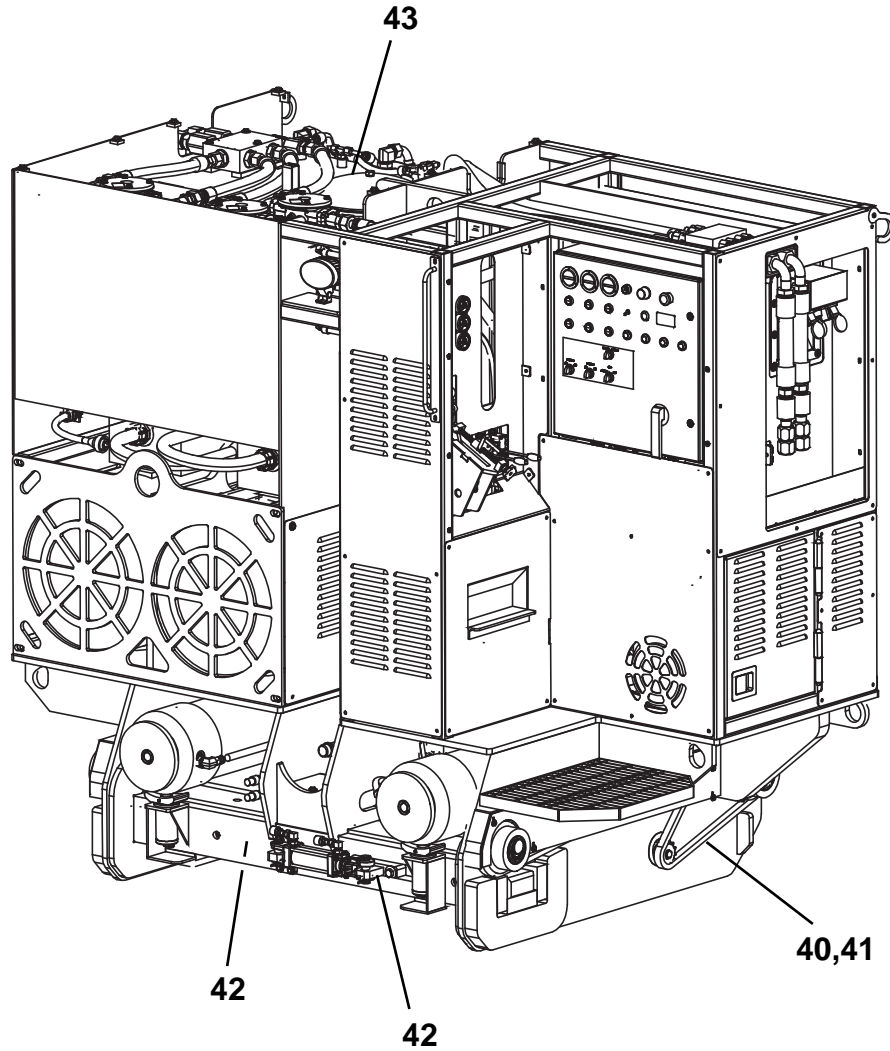
WEEKLY OR EVERY 50 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
37.	Skid Lock Blocks	Inspect (2 Places)	Repair or replace.	Mobil XHP222*
38.	Skid Lock Blocks	Lubricate (8 Places)	2 to 4 shots.	
39.	Motors	Check	Ventilation openings clean and drain holes open.	

* Refer to Section 8, Lubricants for the proper grease per ambient temperature: Mobilgrease® XHP222 or XHP005.

NOTICE

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

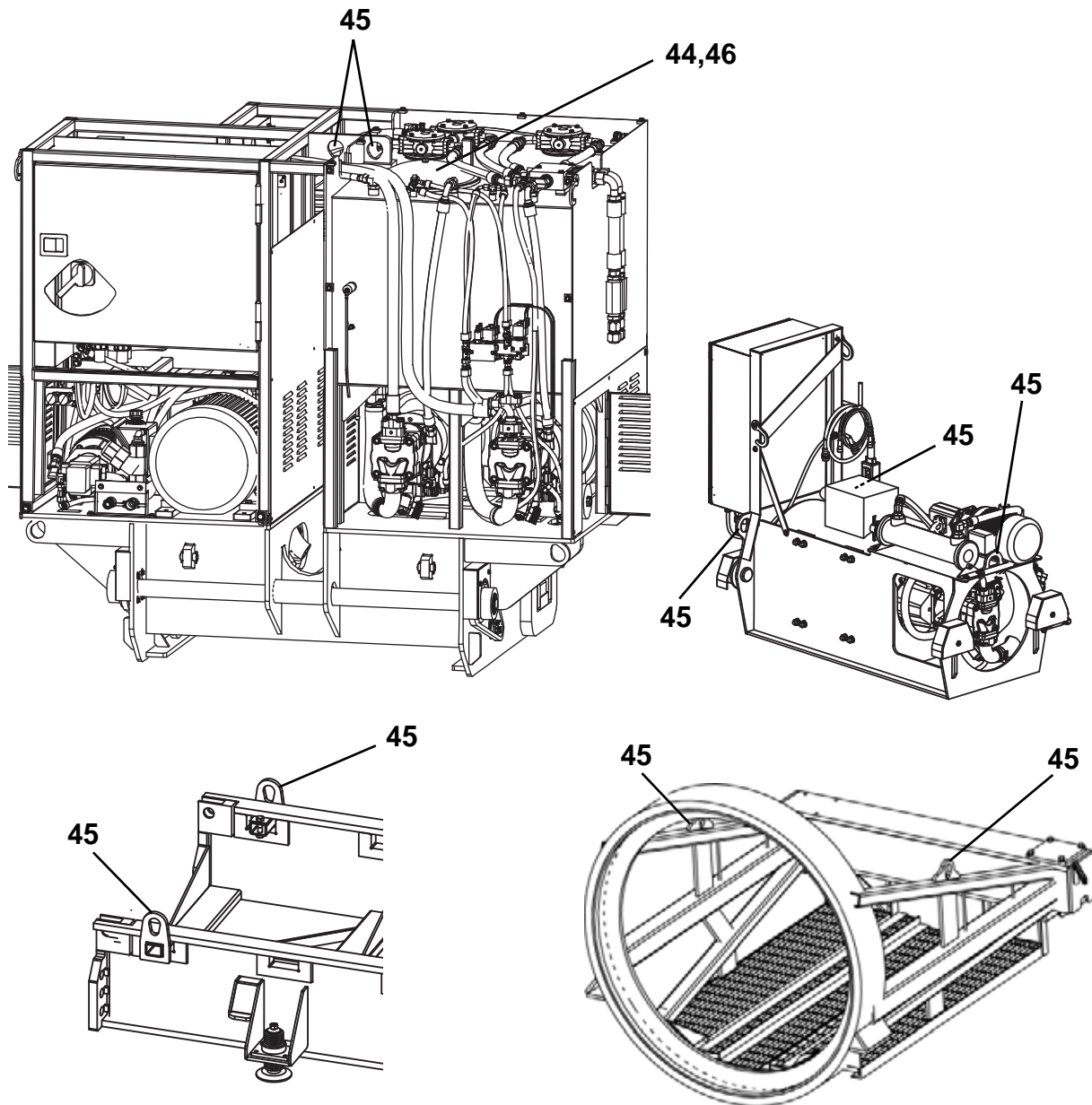


MONTHLY OR EVERY 250 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
40.	Drive Chain	Adjustment (2 Places)	1/4-1/2" deflection.	Lt. Wt. Motor Oil
41.	Chain	Lubricate (2 Places)		
42.	Skid Lock Linkage	Check (2 Places)	Hdwr tightness and dirt buildup.	
43.	Oil Analysis	Perform analysis	Oil sample.	

NOTICE

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



COMPLETION OF EACH DRIVE

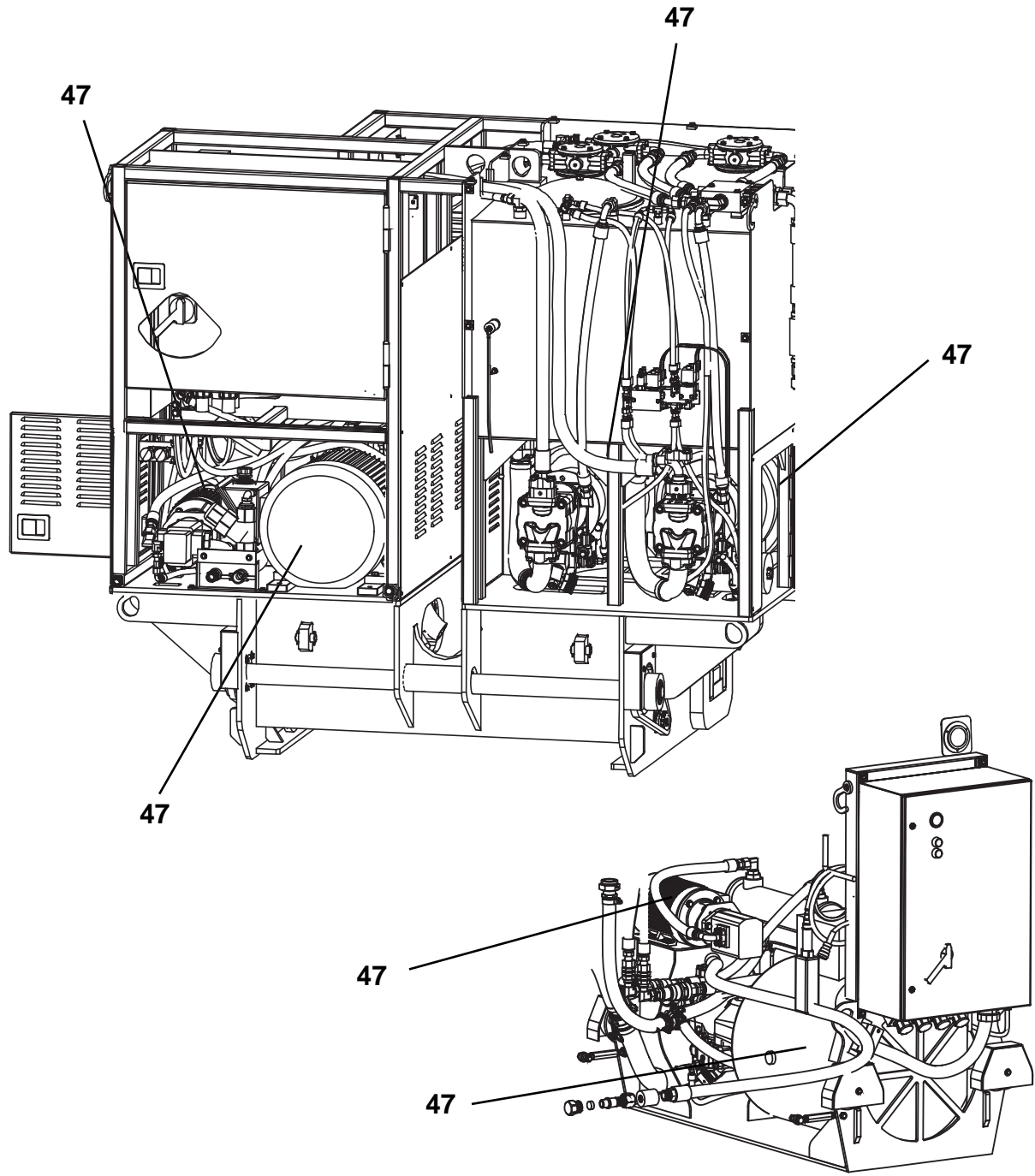
ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
44. 45.	Hydraulic Reservoir Lift Eyes	Drain water Inspect	Drain until water is removed. If damaged, repair or replace before lifting.	

EVERY 1000 HOURS OF OPERATION

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

NOTICE

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



ANNUALLY

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
*47.	Electric Motor Brgs.	Lubricate	2 Shots	Mobil Polyrex EM

* 2 places per motor.

PRIOR TO EACH JOB LAUNCH

1. CHECK PHASE POWER

⚠ WARNING Any electrical work completed on the pump unit or 200 HP Auxiliary unit must be performed by a certified electrician.

The input power on both the Pump Unit and the 200 HP Auxiliary is monitored for proper three phase electrical power.

Check for proper phase power as follows:

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

If the red Phase Error indicator light (B) is illuminated, this indicates that the external power source phase power is installed incorrectly. Disconnect and lock out ALL power before attempting to reverse the two generator power leads.

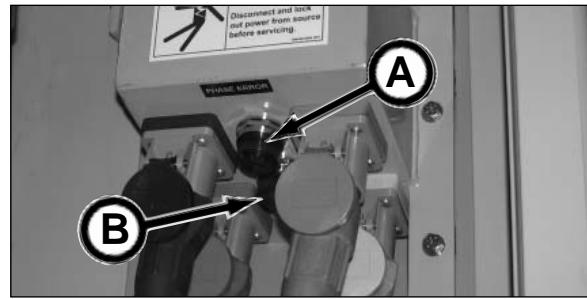
The red Phase Error light will also illuminate in the following conditions:

- Undervoltage (Less than 95%)
- Overvoltage (greater than 110%)
- Phase imbalance
- Phase loss

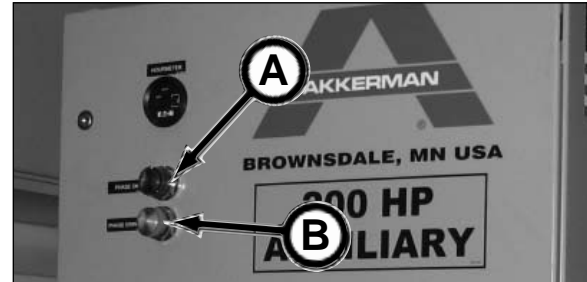
If it becomes necessary to troubleshoot the electrical fault, the 5200 Pump Unit and the 200 HP Auxiliary are equipped with a Phase Detector (C) (includes fault indicators). Gain access to the Phase Detector ONLY if it is required to help diagnose electrical issues. Lockout, tagout power, then open the 5200 main power electrical panel cover (D) and/or the 200 HP Auxiliary electrical panel cover (E) to gain access to the Phase Detector.

Refer to the table to the right for the Phase Error LED status indicator codes. The LED status light is located on the inside of the main disconnect electrical box.

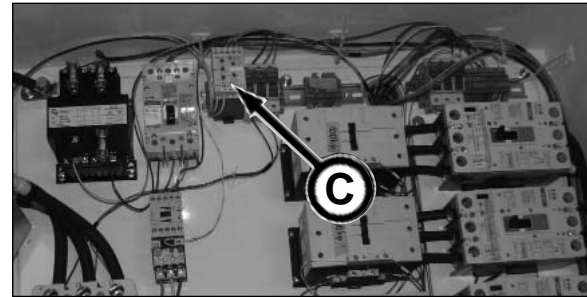
IMPORTANT: DO NOT start up electric motors if the red Phase Error light (B) is illuminated. Doing so will run motors backwards causing component damage.



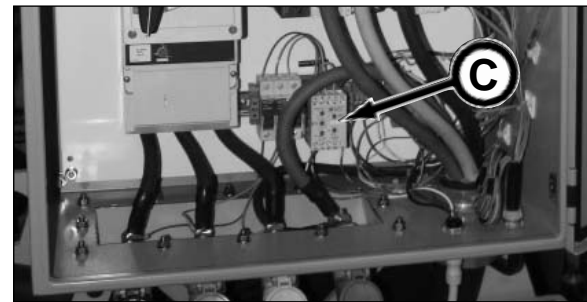
5200 Pump Unit



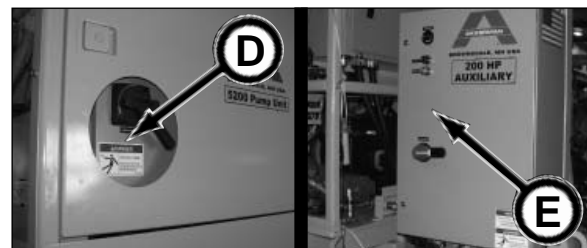
200 HP Auxiliary



5200 Pump Unit



200 HP Auxiliary



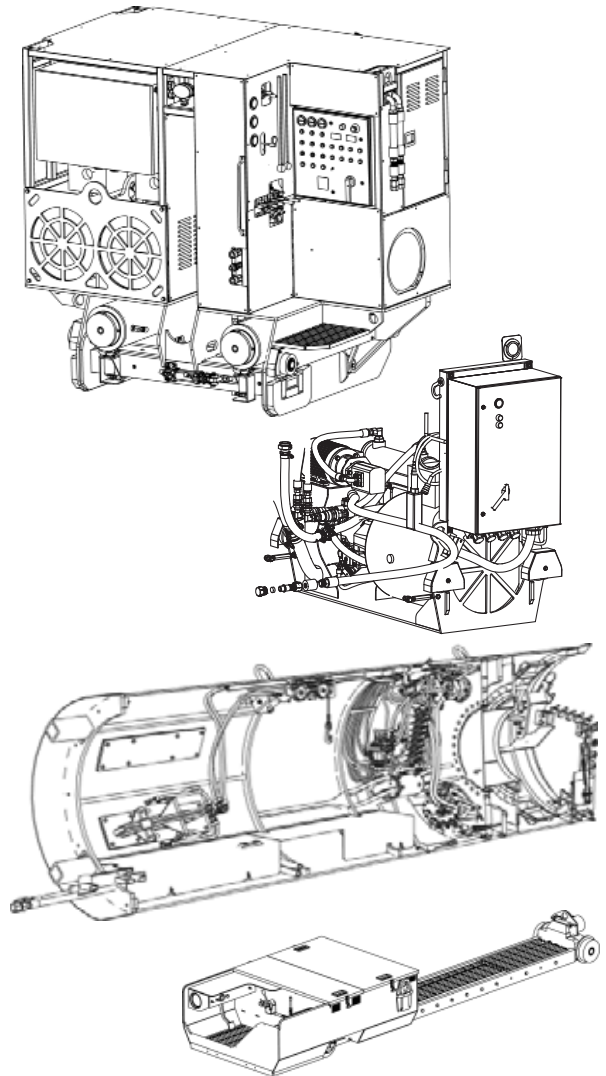
FAULT INDICATION CODE TABLE	
Led Status	Indicator
Green Steady	Normal / Relay ON
Green Flashing	Power Up / Restart Delay
Red Steady	Unbalance
Red Flashing	Under Voltage / Overvoltage
Amber Steady	Reversal
Amber Flashing	Loss
Green/Red Alternating	Under / Overvoltage Trip Pending
Red/Amber Alternating	Nominal Voltage Set Error

2. CHECK CONTROL OPERATION

Check Pump Unit/200 HP Auxiliary controls and other supporting equipment for proper operation. If controls do not function properly, repair or replace BEFORE operation.

CHECK THE FOLLOWING CONTROLS FOR PROPER OPERATION:

1. ALL E-Stop buttons
2. Power pack frame controls
3. Control pendant operation
4. Light operation
5. Supporting equipment control operations including gas detectors



3. CHECK GAUGE OPERATION

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

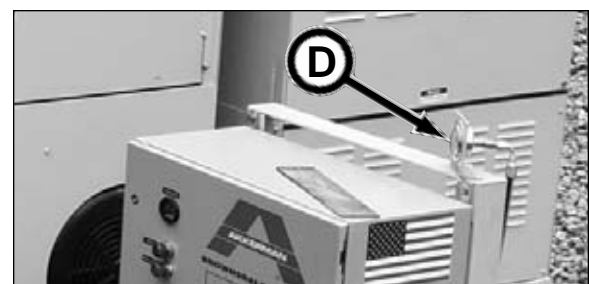
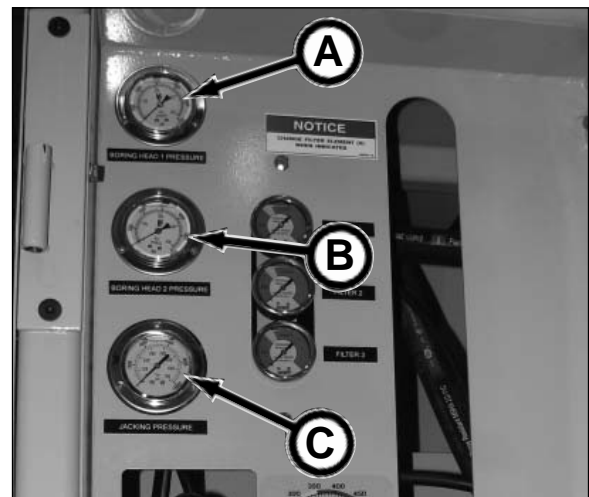
5200 Pump Unit

Boring head 1 pressure* (A) 3,000/5,000 psi
 Boring head 2 pressure* (B) 3,000/5,000 psi
 Jacking/IJS high pressure (C) 8,000 psi

200 HP Auxiliary Unit

TBM supply pressure* (A) 5,000 psi

* Based on hydraulic supply flow source 3,000/5,000 psi



4. CHECK MOTORS

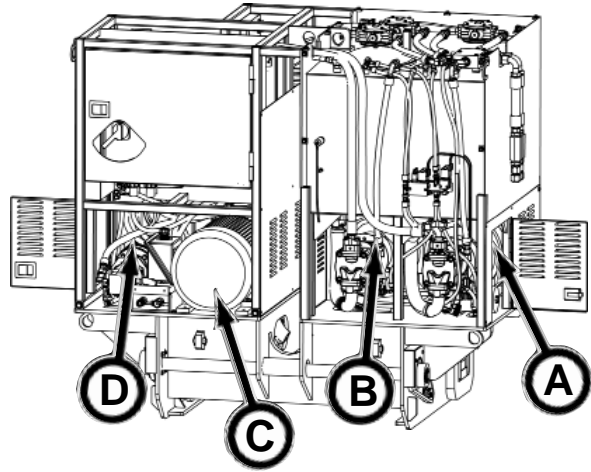
Inspect the ventilation openings of each motor so they are clear to allow the free passage of air. Also, be sure the drain holes are open.

5200 Pump Unit

- A - Boring Head 1 Motor - 100 HP
- B - Boring Head 2 Motor - 100 HP
- C - Jacking Motor - 60 HP
- D - Cooling System Motor - 5 HP

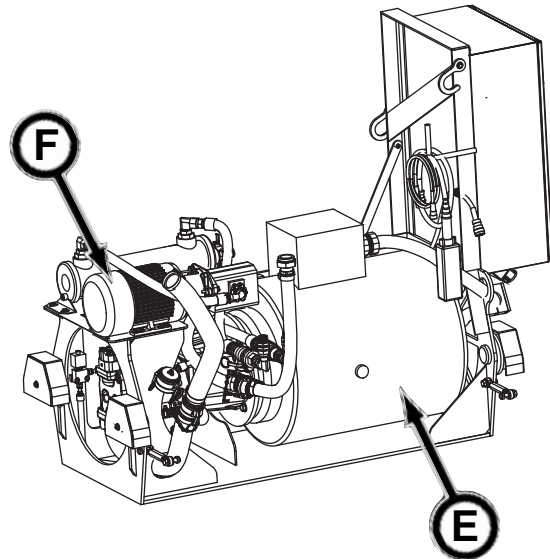
200 HP Auxiliary

- E - Auxiliary Motor - 200 HP
- F - Cooling System Motor - 5 HP



Use compressed air (maximum 50 psi) to clear openings.

Grease and oil can be removed from the motors with a petroleum solvent.



5. CHECK MOTOR ROTATION

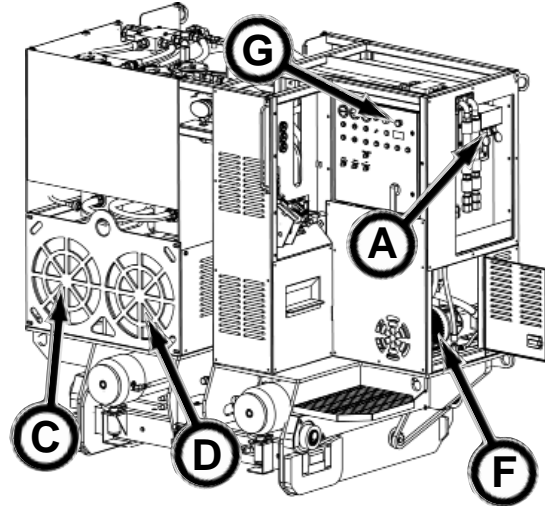
Check motor rotation. Improper motor rotation will cause component damage.

PUMP UNIT

1. With external power source ON and in pump unit in proper phase (A), flip pump unit main power switch (B) to ON position.
2. Bump start* the following motor buttons/switch to start and then quickly stop motor to check rotation.

* “bump start” is an intermittent push of the button, then turned off immediately.

- Boring Head Pump 1 Motor (C)
- Boring Head Pump 2 Motor (D)
- Jacking Pump Motor (E)
- Cooling Pump Motor (F)



3. If rotation is incorrect on any of the motors, have your certified electrician perform the following procedure on the motor(s).

- a. Flip main power switch (B) to OFF position and push E-Stop button IN (G).

- b. Turn external power source OFF and perform lockout/tagout procedure.

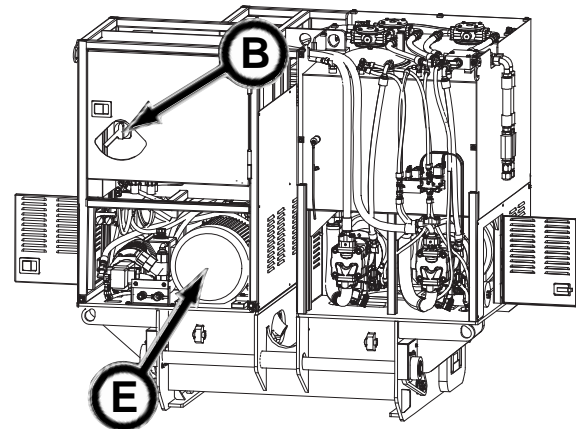
- c. Test to ensure no voltage is present, then rewire for proper motor rotation.

- d. Turn external power source ON, pull E-Stop button OUT and flip main power switch (B) to ON position.

- e. Repeat steps 1 and 2 to verify proper motor rotation.

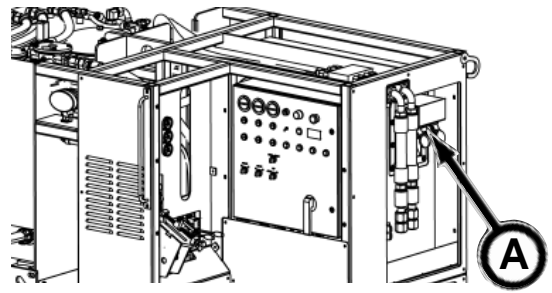
4. Once motor rotation is correct, turn main power switch to OFF position.
5. Push E-Stop button IN to prevent any accidental starting. Perform lockout/tagout procedure.
6. If equipped with a 200 HP Auxiliary, proceed to step 7.

(continued on next page)

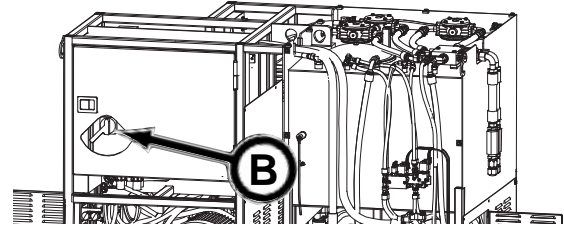


200 HP AUXILIARY

7. With pump unit external power source ON and pump unit in proper phase (A), flip pump unit main power switch (B) to ON position.



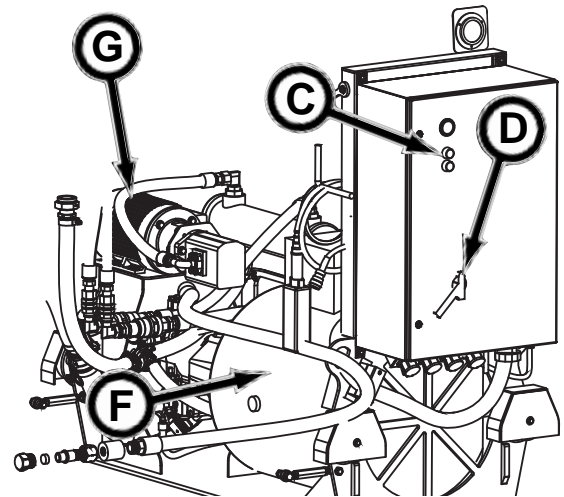
8. With auxiliary unit external power source ON and auxiliary unit in proper phase (C), flip auxiliary unit main power switch (D) to ON position.



9. Bump start* the following motor buttons/switch on control pendant (E) to start and then quickly stop motor to check rotation.

* “bump start” is an intermittent push of the button, then turned off immediately.

- Auxiliary Motor (F)
- Cooling Pump Motor (G)



10. If rotation is incorrect on any of the motors, have your certified electrician perform the following procedure on the motor(s).

a. With motors off, flip auxiliary main power switch (D) to OFF position.

b. Flip pump unit main power switch (B) to OFF position and push E-Stop button IN (H).

c. Turn external power sources (pump unit and auxiliary unit) OFF and perform lockout/tagout procedure.

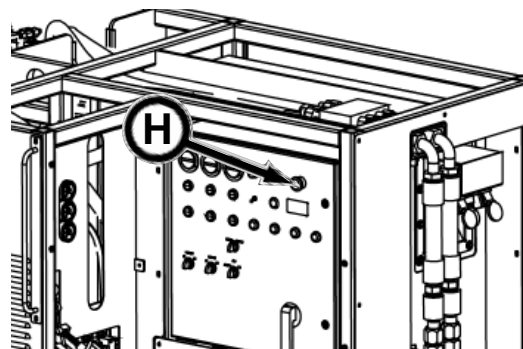
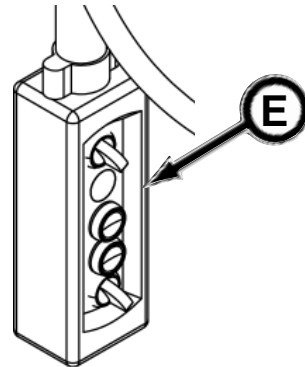
d. Test to ensure no voltage is present, then rewire for proper motor rotation.

e. Turn pump unit and auxiliary unit external power sources ON, pull E-Stop button OUT and flip main power switch (B) to ON position.

f. Repeat steps 8 and 9 to verify proper motor rotation.

11. Once motor rotation is correct, turn main power switches to OFF position.

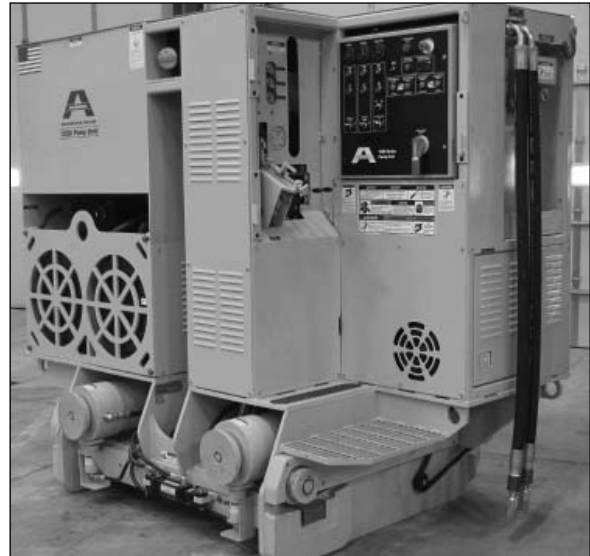
12. Push E-Stop button IN to prevent any accidental starting. Perform lockout/tagout procedure.



6. INSPECT PUMP UNIT & 200 HP AUXILIARY FRAMES

Visually inspect pump unit and 200 HP auxiliary (if equipped) frames for cracks or other damage. Also check for damaged, loose, or missing hardware. Replace with new.

If cracks or damage are present, contact your Akkerman Aftermarket Support representative for authorized repair or replacement procedures.



7. CHECK FILTER INDICATORS

To prevent under or over servicing of the return hydraulic filter elements, filter indicator gauges have been installed on your 5200 Pump Unit.

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.

RETURN FILTER INDICATORS for each system:

- A - Return Filter 1 Indicator
- B - Return Filter 2 Indicator
- C - Return Filter 3 Indicator

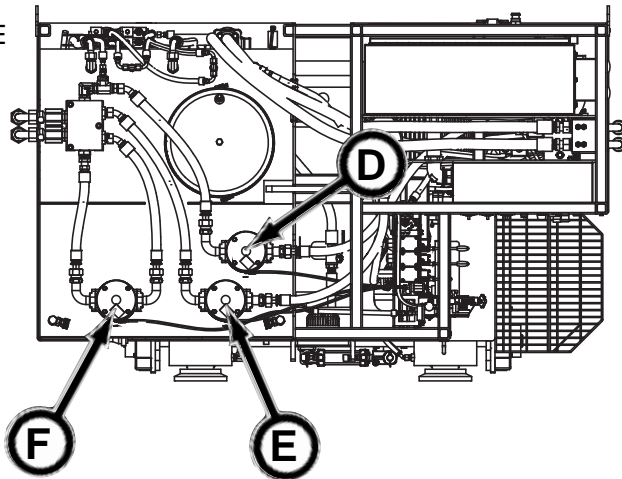
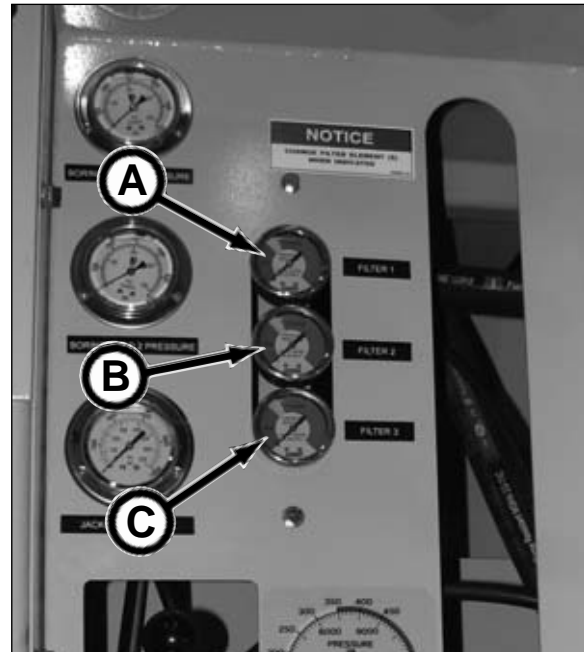
The green OK zone indicates that the filters are functioning properly.

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

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

It is not necessary to replace any of the other return filters unless the filter indicator designates that it is necessary to replace the filter.

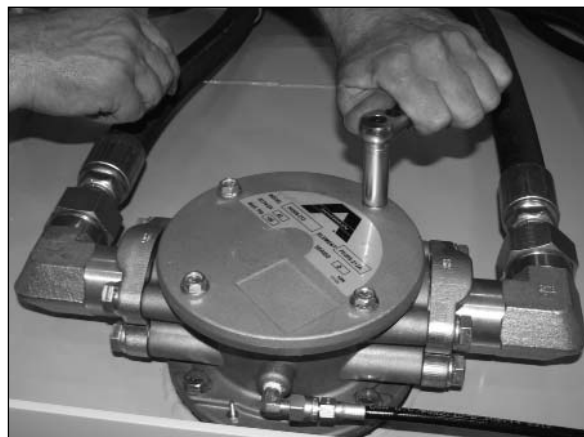
- D - Return Filter Assembly 1
- E - Return Filter Assembly 2
- F - Return Filter Assembly 3



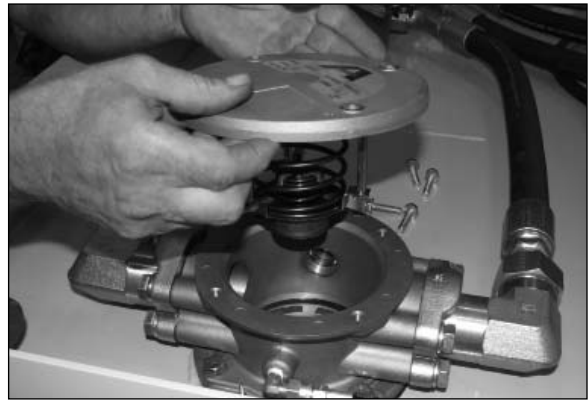
REPLACING FILTER (S)

1. With pump unit power shutdown, clean and dry area around the filter head assembly.
2. Remove filter head fasteners and retain for later use.

(continued on next page)



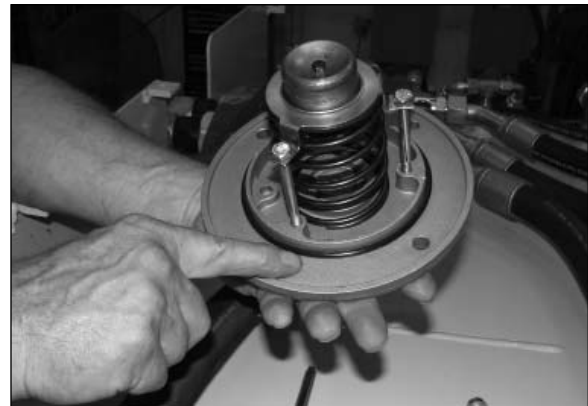
3. Remove head assembly from housing.



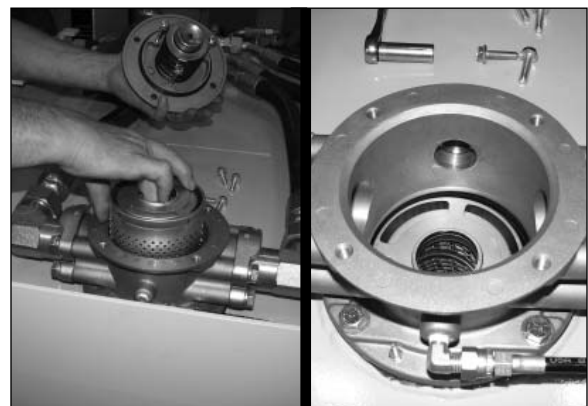
4. Remove filter.
5. Check for metal flakes on filter. If metal flakes are visible, replace all filters and reservoir oil.
6. Dispose of filter properly.



7. Check filter gasket in filter head. If worn or damaged replace with new. Install new gasket (if needed) with a light coat of clean hydraulic oil into filter head. Be sure the gasket is not twisted and is correctly in place.



8. Carefully install new filter into filter housing until it is fully seated into housing.



(continued on next page)

9. Replace filter head assembly onto housing and secure with fasteners removed in step 2.
10. Start up pump unit and run until hydraulic system is warm, start boring head and jacking motors and check for leaks.
11. Stop motors and shutdown pump unit. Replace other filter(s) as needed.



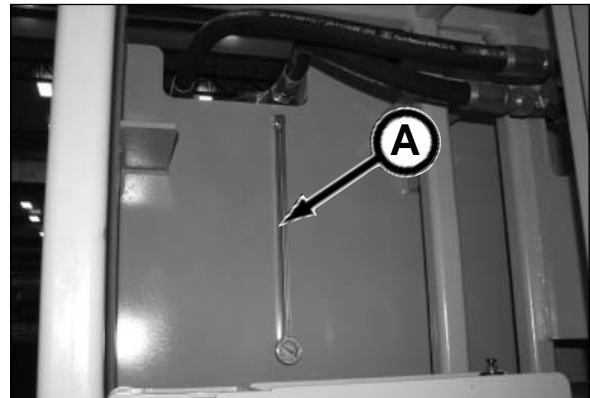
8. CHECK HYDRAULIC OIL RESERVOIR LEVEL & CONDITION OF OIL

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.

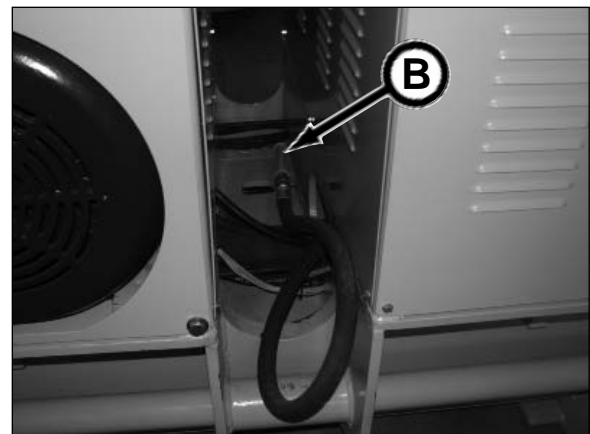
If any of these conditions are found, the reservoir must be drained, cleaned, and refilled with new, clean hydraulic oil. Refer to Every 1000 Hours of Operation, "46. Drain & Replace Hydraulic Oil" in this section.

2. Check the hydraulic reservoir gauge (A) for the proper oil level. Keep oil maintained between the low and high marks on the gauge. If needed, add oil to the reservoir (refer to Filling Hydraulic Reservoirs in Section 6, Operation).

Oil Transfer Pump Fill Tube (B)



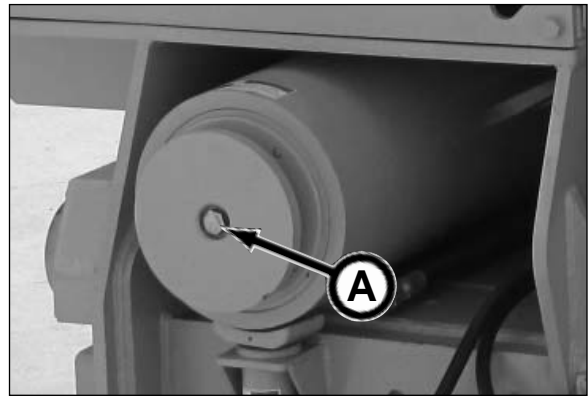
Components Removed For Photographic Purposes



9. CHECK CYLINDER RAM CAP HARDWARE

Check cylinder ram cap bolts (A) for damage. Be sure they are securely fastened against plate.

If damaged, replace with new 3/4 UNC x 2.5 bolt.

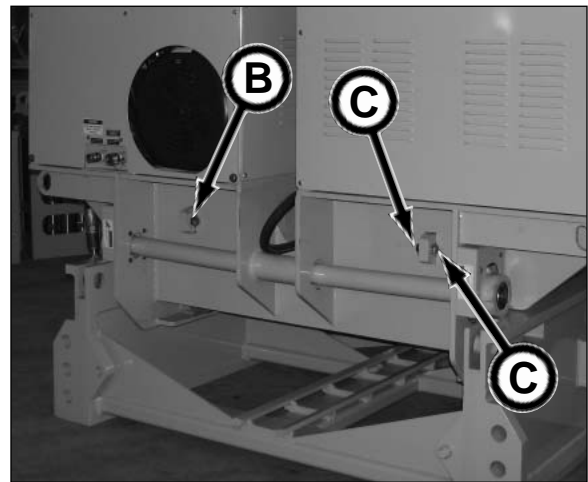


10. CHECK CYLINDER MOUNT PINS

Check cylinder mount pins (two places) for damage.

If damaged, replace with new:

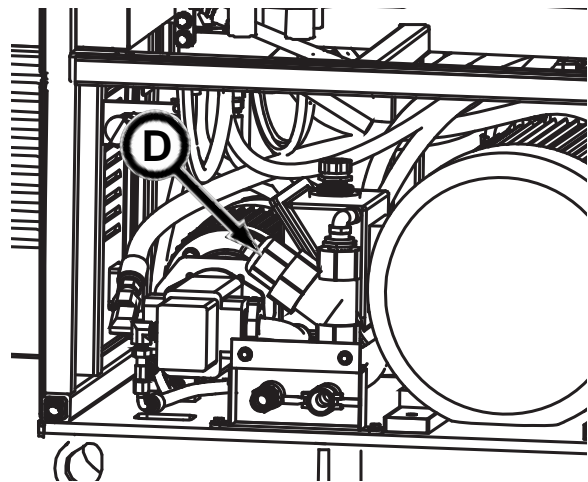
- PIN, 1.25 x 3 (PN 020314P) Qty 1 (B)
- PIN, Cotter 5/32 x 1.5 (PN P0048-035) Qty 2 (C)



11. CLEAN INLET WATER STRAINER

Clean strainer (D) with water or other non-abrasive cleaner.

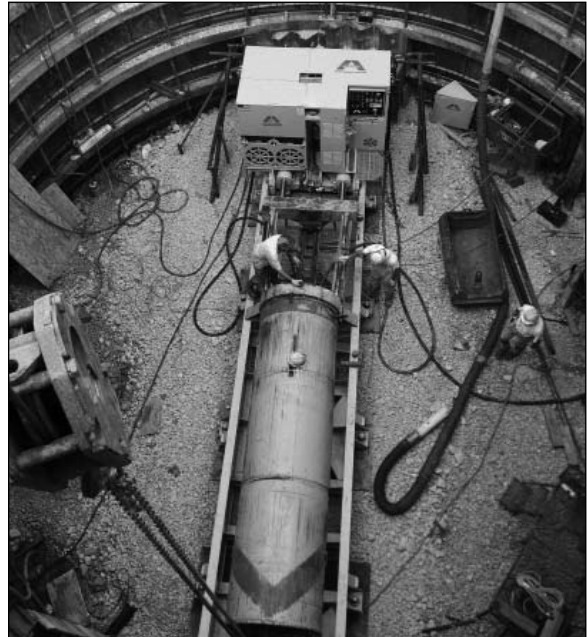
If damaged, replace with new.



12. INSPECT HYDRAULIC HOSES & POWER CABLES

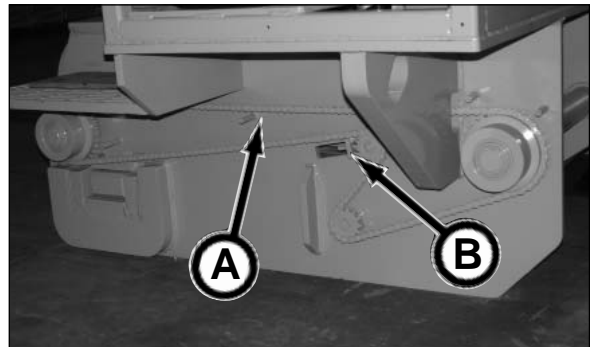
1. Inspect ALL hydraulic hoses and power cables for cracks, wear or other damage. Repair or replace BEFORE operation.
2. Be sure hoses and power cables are securely fastened to connections.

IMPORTANT: Keep power cables clear of debris, water and fluids. Before connecting power cables, clean all connections with a non oil-based electric contact cleaner. Do not use electric contact grease since it tends to collect dust and dirt.



13. CHECK DRIVE CHAIN TENSION

1. Remove covers.
2. Check chain deflection at (A) on both right and left sides. Deflection should be 1/4 to 1/2 in. at midpoint of chain. Use chain tightener (B) if chain requires adjustment.
3. Lubricate drive chain. Refer to "14. Lubricate Drive Chain" in this section.
4. Replace covers.



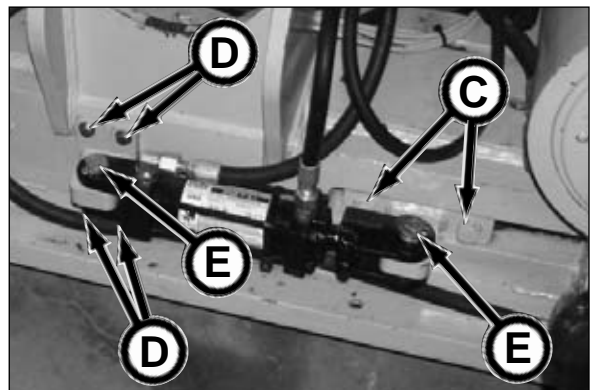
14. LUBRICATE DRIVE CHAIN

1. Remove covers.
2. Lubricate chain with a high quality chain lubricant.
3. Replace covers.



15. CHECK SKID LOCK LINKAGE

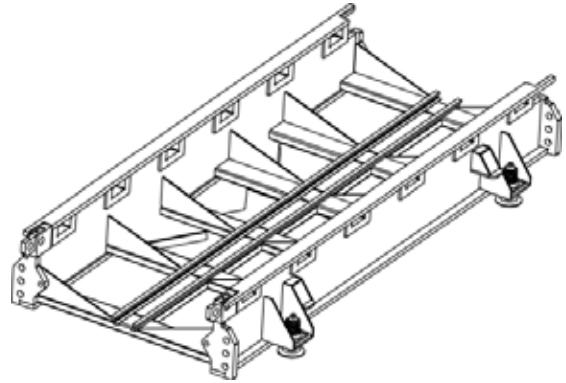
1. Check front skid lock linkage hardware (C), cylinder mount hardware (D) and cylinder pins (E) for tightness and damage. Replace loose or damaged hardware or pins as necessary.
2. Remove any dirt buildup.
3. Check rear skid lock linkage repeating steps 1 and 2.



16. INSPECT SKID BASE

Visually inspect skid base for cracks or other damage. Also check for damaged, loose, or missing hardware. Replace with new.

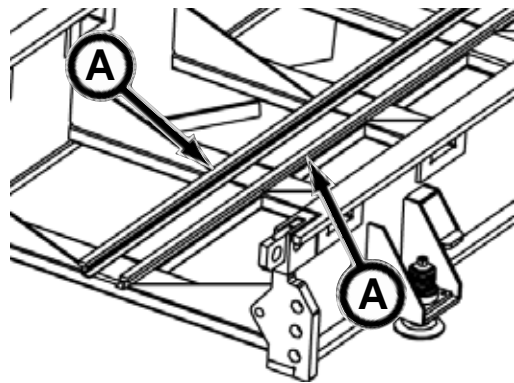
If cracks or damage are present, contact your Akkerman Product Support representative for authorized repair or replacement procedures.



17. INSPECT RAILS

Clean and inspect rails (A) for cracks or other damage.

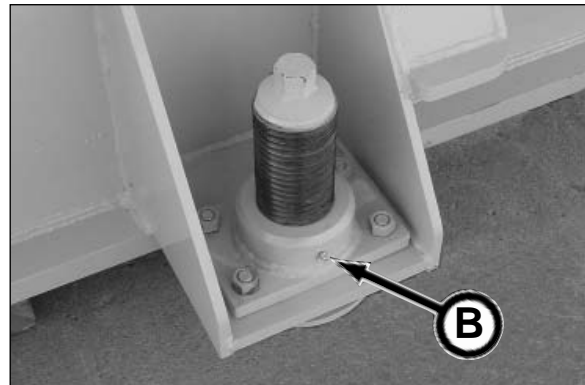
If cracks or damage are present, contact your Akkerman Product Support representative for authorized repair or replacement procedures.



18. LUBRICATE LEVELING SCREWS

Lubricate leveling screw assemblies (B) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent.

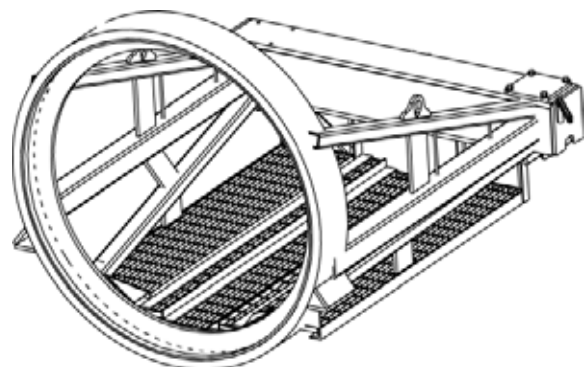
Lubricate threads thoroughly.



19. INSPECT YOKE FRAME

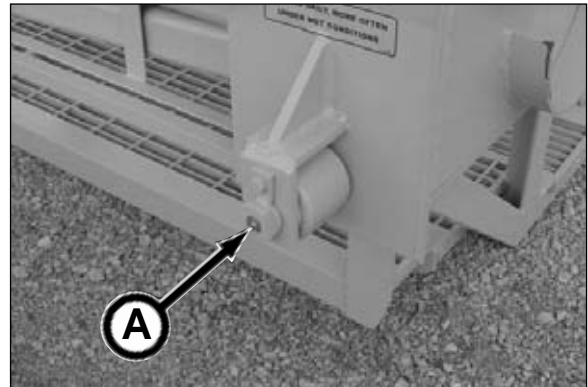
Visually inspect yoke for cracks or other damage. Also check for damaged, loose, or missing hardware. Replace with new.

If cracks or damage are present, contact your Akkerman Product Support representative for authorized repair or replacement procedures.



20. LUBRICATE YOKE WHEELS

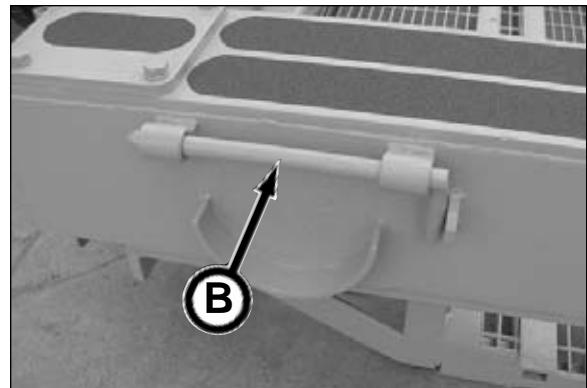
Lubricate yoke wheels (A) (2 places) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until greased is forced out.



21. INSPECT RAM RETAINING PINS

Visually inspect retaining pins (B) (2 places) for damage.

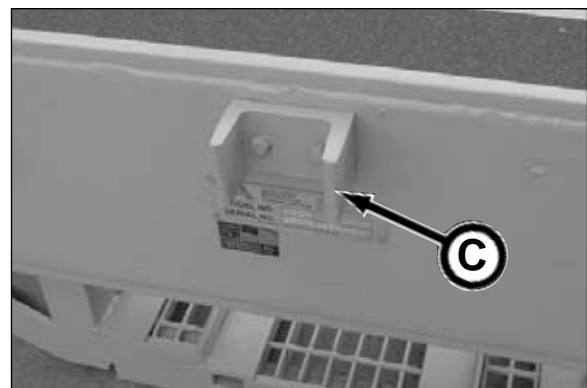
If damage is present, replace with new.



22. INSPECT RAM RETAINING PIN STOP

Visually inspect stop (C) or hardware for damage.

If damaged or missing, replace with new.

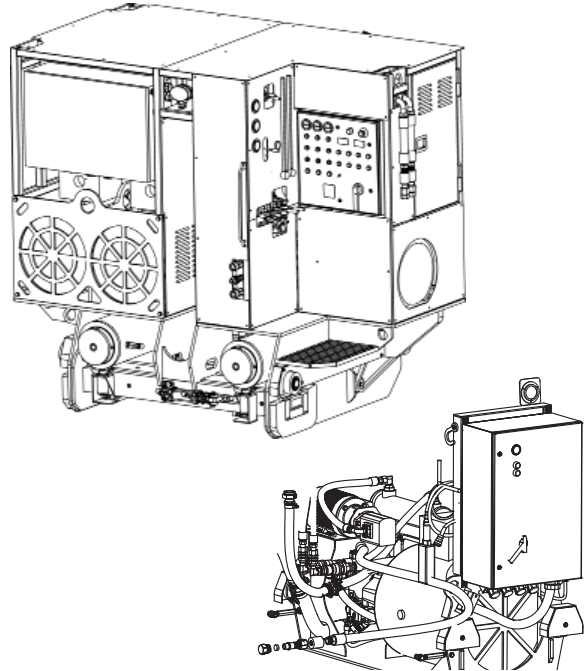


23. INSPECT DECALS

Inspect ALL operational and safety decals to be sure they are clean and readable.

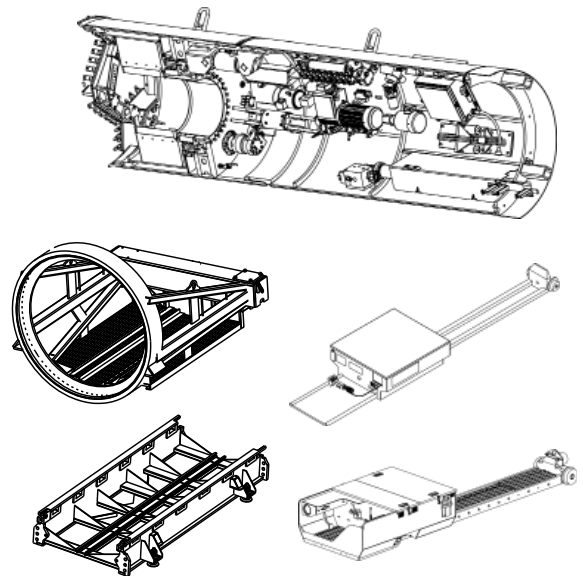
Use soft cloth, water, and a mild soap to clean the decals if they are too dirty to read. DO NOT clean decals with solvent. Solvent will damage decals. Replace decals immediately if they are damaged, missing, or hard to read.

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



24. PERFORM MAINTENANCE ON ALL SUPPORTING EQUIPMENT

Be sure all equipment such as the TBM, skid, haul unit, jacking frame, and generator are properly maintained and are operating properly. Be sure to repair or replace equipment before operating TBM. Refer to the operation and maintenance manuals of the equipment.

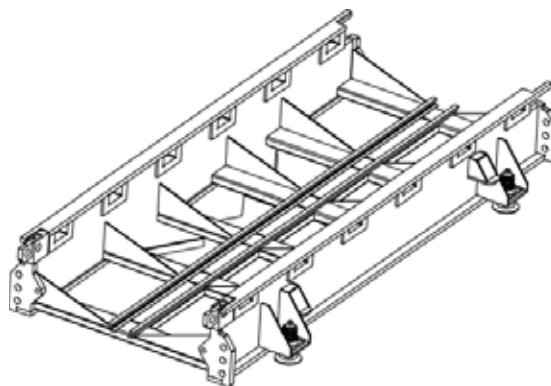


DAILY OR EVERY 10 HOURS OF OPERATION OR SHIFT CHANGE

25. INSPECT SKID BASE

Visually inspect skid base for cracks or other damage. Also check for damaged, loose, or missing hardware. Replace with new.

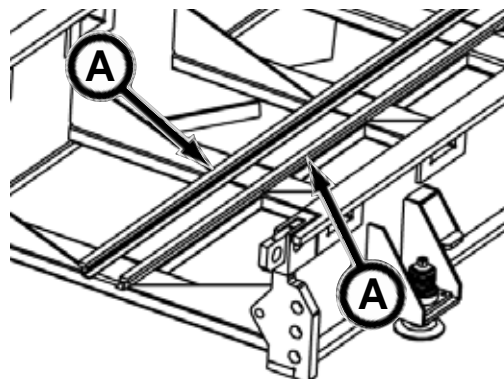
If cracks or damage are present, contact your Akkerman Product Support representative for authorized repair or replacement procedures.



26. INSPECT RAILS

Clean and inspect rails (A) for cracks or other damage.

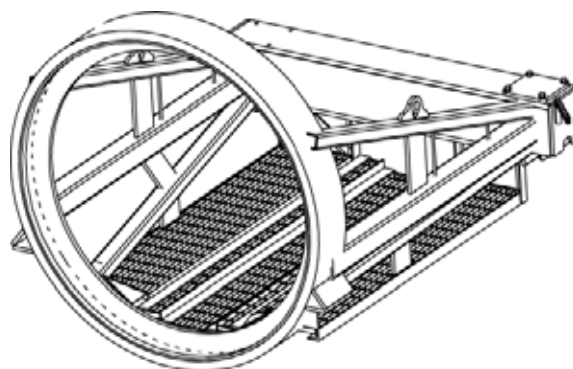
If cracks or damage are present, contact your Akkerman Product Support representative for authorized repair or replacement procedures.



27. INSPECT YOKE FRAME

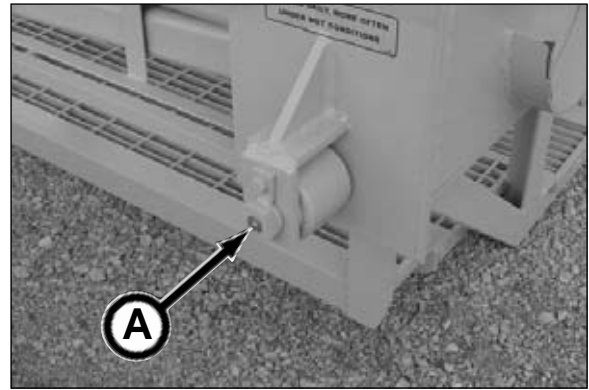
Visually inspect yoke for cracks or other damage. Also check for damaged, loose, or missing hardware. Replace with new.

If cracks or damage are present, contact your Akkerman Product Support representative for authorized repair or replacement procedures.



28. LUBRICATE YOKE WHEELS

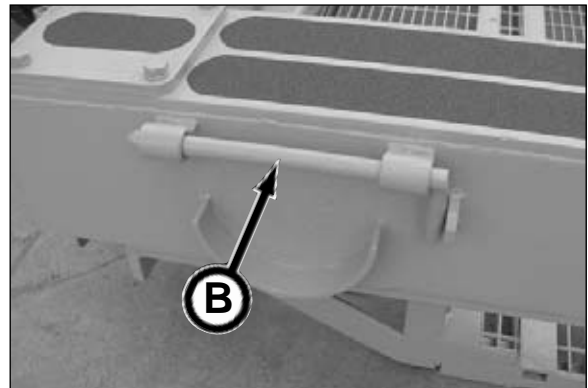
Lubricate yoke wheels (A) (2 places) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until greased is forced out.



29. INSPECT RAM RETAINING PINS

Visually inspect retaining pins (B) (2 places) for damage.

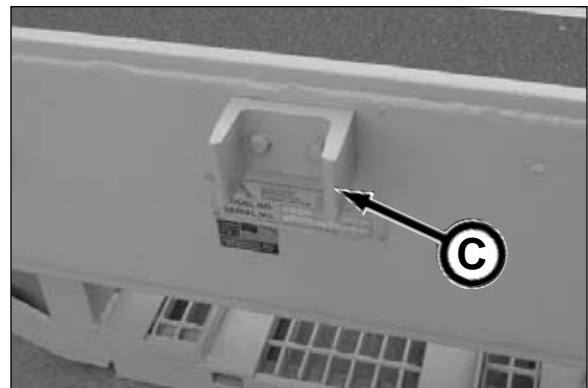
If damage is present, replace with new.



30. INSPECT RAM RETAINING PIN STOP

Visually inspect stop (C) or hardware for damage.

If damaged or missing, replace with new.



31. INSPECT PUMP UNIT & 200 HP AUXILIARY FRAMES

Visually inspect pump unit and 200 HP auxiliary (if equipped) frames for cracks or other damage. Also check for damaged, loose, or missing hardware. Replace with new.

If cracks or damage are present, contact your Akkerman Aftermarket Support representative for authorized repair or replacement procedures.



32. CHECK FILTER INDICATORS

To prevent under or over servicing of the return hydraulic filter elements, filter indicator gauges have been installed on your 5200 Pump Unit.

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.

RETURN FILTER INDICATORS for each system:

- A - Return Filter 1 Indicator
- B - Return Filter 2 Indicator
- C - Return Filter 3 Indicator

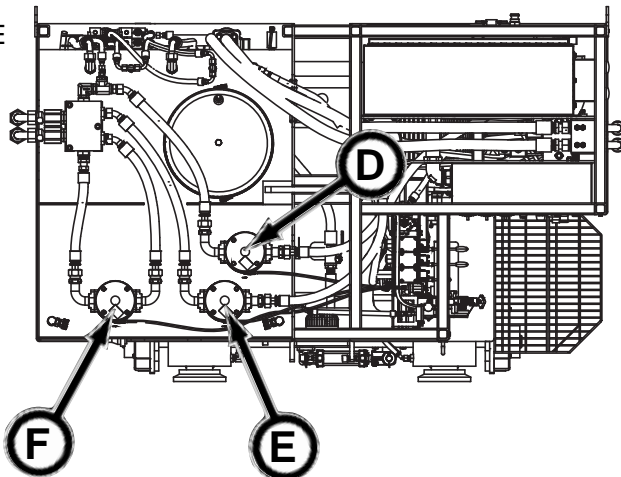
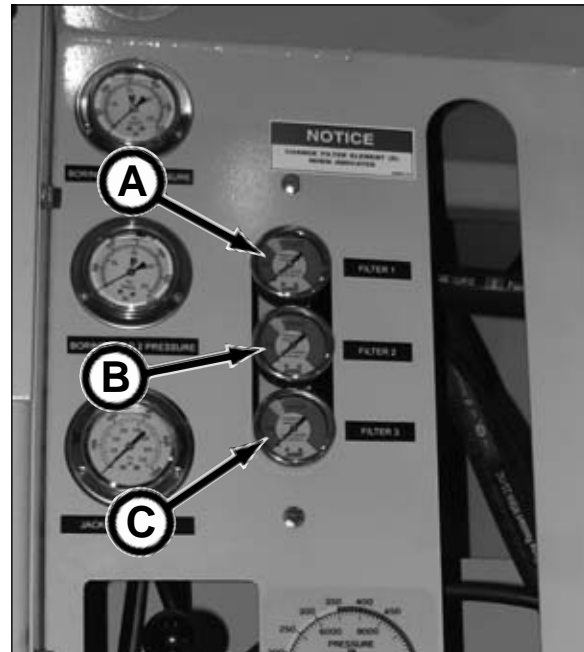
The green OK zone indicates that the filters are functioning properly.

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

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

It is not necessary to replace any of the other return filters unless the filter indicator designates that it is necessary to replace the filter.

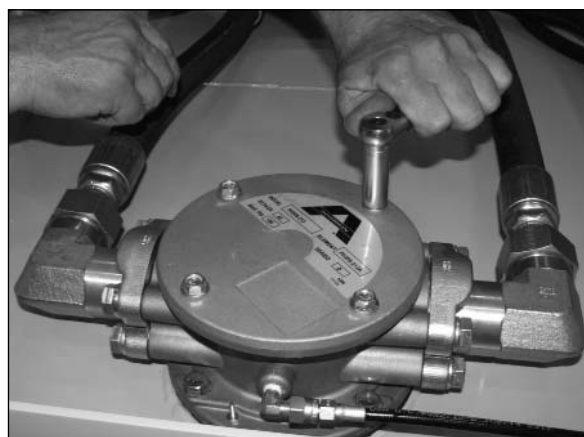
- D - Return Filter Assembly 1
- E - Return Filter Assembly 2
- F - Return Filter Assembly 3



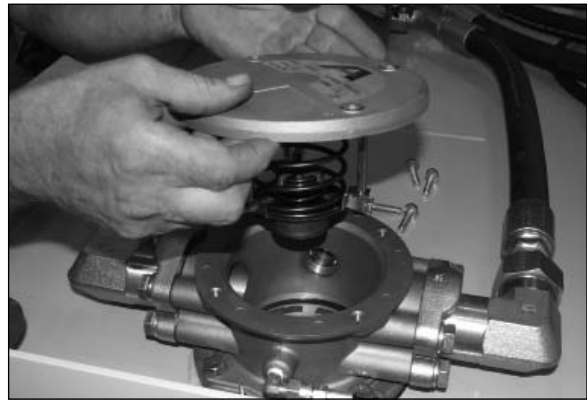
REPLACING FILTER (S)

1. With pump unit power shutdown, clean and dry area around the filter head assembly.
2. Remove filter head fasteners and retain for later use.

(continued on next page)



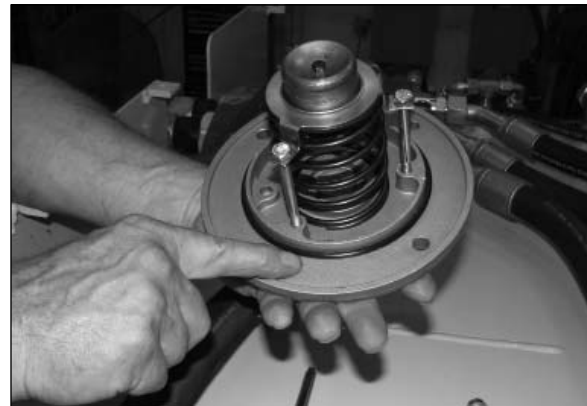
3. Remove head assembly from housing.



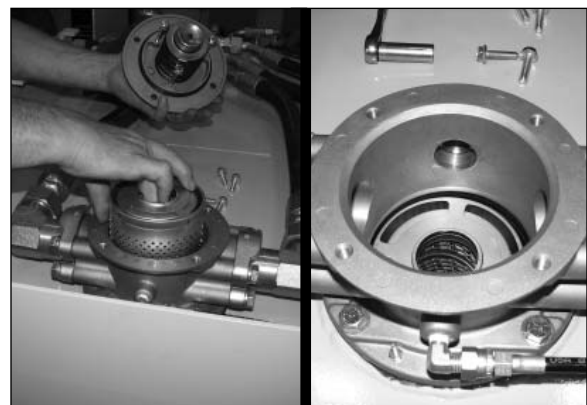
4. Remove filter.
5. Check for metal flakes on filter. If metal flakes are visible, replace all filters and reservoir oil.
6. Dispose of filter properly.



7. Check filter gasket in filter head. If worn or damaged replace with new. Install new gasket (if needed) with a light coat of clean hydraulic oil into filter head. Be sure the gasket is not twisted and is correctly in place.



8. Carefully install new filter into filter housing until it is fully seated into housing.



(continued on next page)

9. Replace filter head assembly onto housing and secure with fasteners removed in step 2.
10. Start up pump unit and run until hydraulic system is warm, start boring head and jacking motors and check for leaks.
11. Stop motors and shutdown pump unit. Replace other filter(s) as needed.

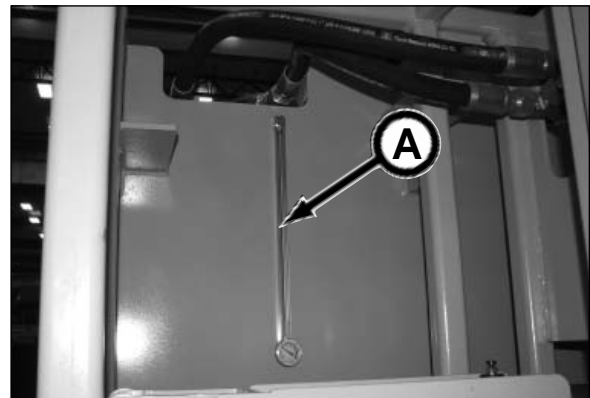


33. CHECK HYDRAULIC OIL RESERVOIR LEVEL & CONDITION OF OIL

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.

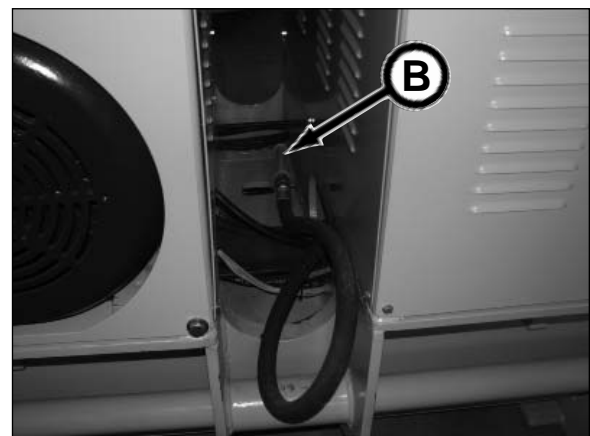
If any of these conditions are found, the reservoir must be drained, cleaned, and refilled with new, clean hydraulic oil. Refer to Every 1000 Hours of Operation, "21. Drain & Replace Hydraulic Oil" in this section.

2. Check the hydraulic reservoir gauge (A) for the proper oil level. Keep oil maintained between the low and high marks on the gauge. If needed, add oil to the reservoir (refer to Filling Hydraulic Reservoirs in Section 6, Operation).



Components Removed For Photographic Purposes

Oil Transfer Pump Fill Tube (B)



34. DRAIN HEAT EXCHANGER

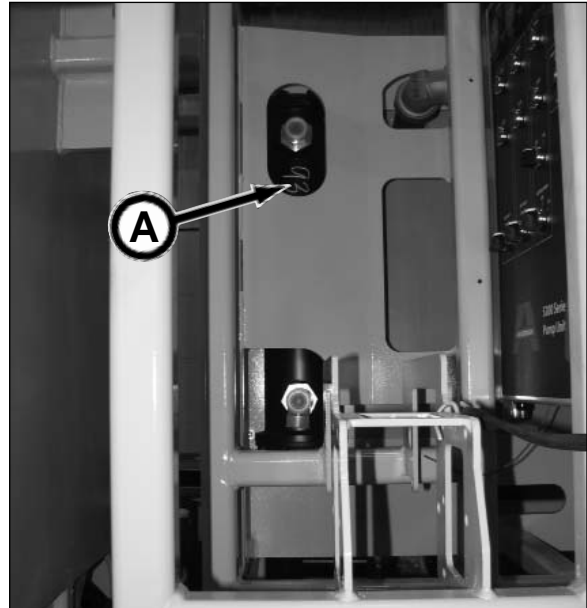
If the ambient temperature is expected to be near freezing 32°F (0°C) or below, drain the water from heat exchanger (A). **Failure to drain water from heat exchanger will cause component damage.**

NOTICE

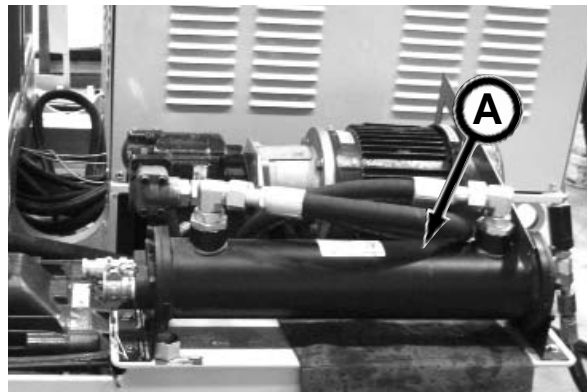
Components were removed to expose heat exchanger for photographic purposes only.

Drain heat exchanger as follows:

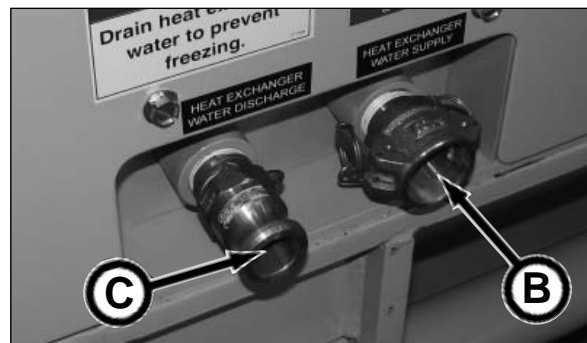
1. Attach an air line to the heat exchanger water supply fitting (B).
2. Turn on air compressor (maximum 25 psi) and run until water no longer runs out of the heat exchanger water discharge outlet (C).
3. Remove air line from supply and replace water supply hose.



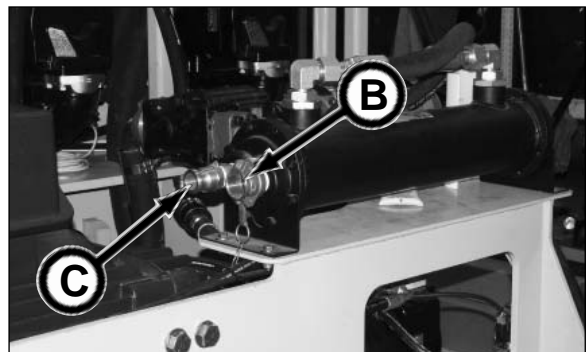
Pump Unit Heat Exchanger



200 HP Auxiliary Heat Exchanger



Pump Unit Water Connections

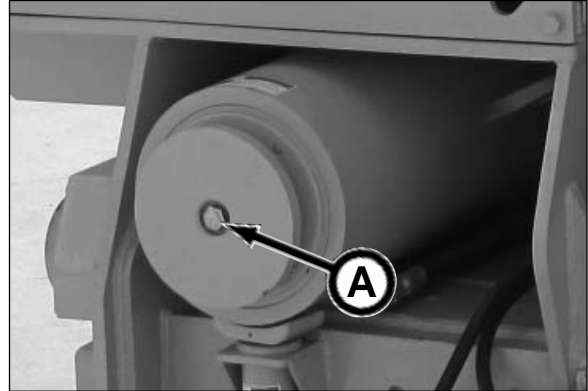


200 HP Auxiliary Water Connections

35. CHECK CYLINDER RAM CAP HARDWARE

Check cylinder ram cap bolts (A) for damage. Be sure they are securely fastened against plate.

If damaged, replace with new 3/4 UNC x 2.5 bolt.

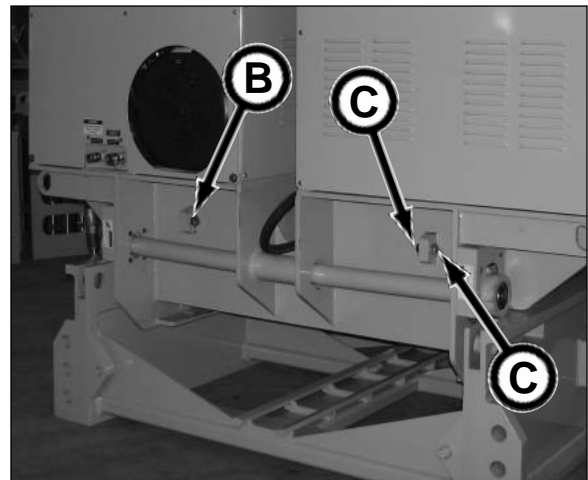


36. CHECK CYLINDER MOUNT PINS

Check cylinder mount pins (two places) for damage.

If damaged, replace with new:

- PIN, 1.25 x 3 (PN 020314P) Qty 1 (B)
- PIN, Cotter 5/32 x 1.5 (PN P0048-035) Qty 2 (C)

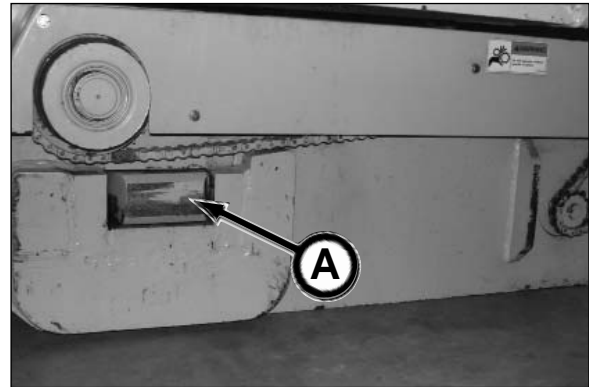


WEEKLY OR EVERY 50 HOURS OF OPERATION

37. INSPECT SKID LOCK BLOCKS

Inspect the skid lock blocks (A) (2 places) for burrs or damage from jacking.

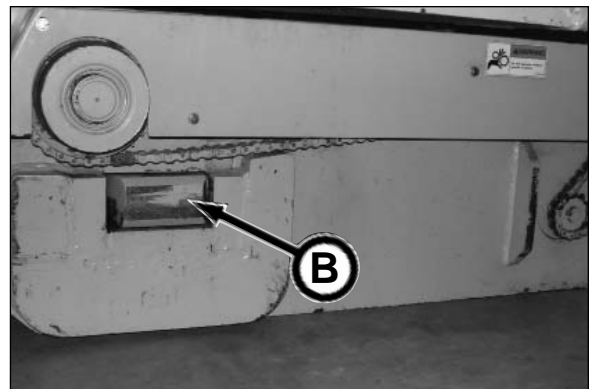
If burrs or damage are present, repair or replace dogs.



38. LUBRICATE SKID LOCK BLOCKS

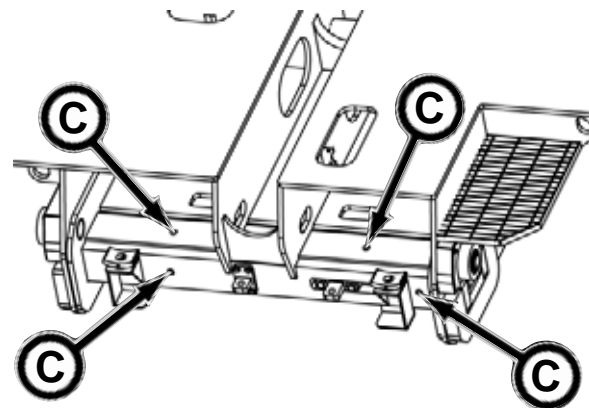
Grease the skid lock blocks (B) with 2 to 4 shots of Mobilgrease® XHP220 Premium Lubricating Grease at each of the eight skid lock block lubrication fittings (C) on the pump unit. Use Mobilgrease® XHP005 in lower temperatures as shown in the chart below.

Use Mobilgrease® XHP220 or XHP005 Lubricating Grease or equivalent when greasing the lubrication fittings.

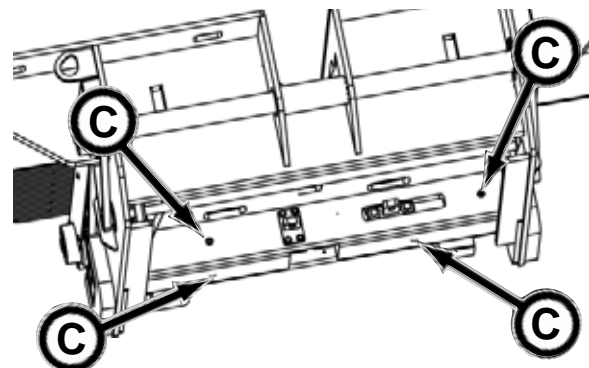


Recommended grease:

Ambient Temp.	Grease
-25°F to 32°F (-32°C to 0°C)	XHP005
0°F to 105°F (-18°C to 41°C)	XHP220



Front View Of Skid Lock Block Lubrication Fittings



Rear View Of Skid Lock Block Lubrication Fittings

39. CHECK MOTORS

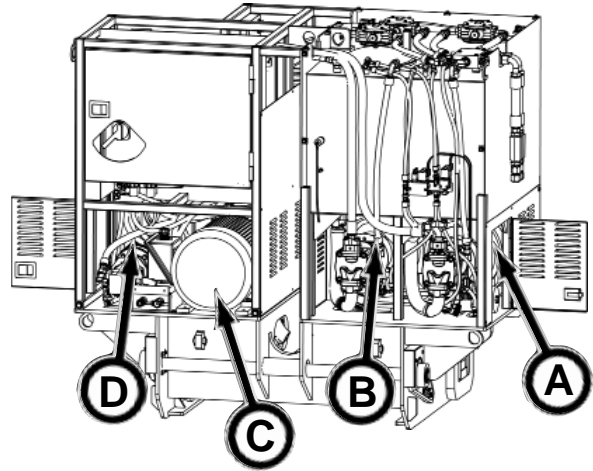
Inspect the ventilation openings of each motor so they are clear to allow the free passage of air. Also, be sure the drain holes are open.

5200 Pump Unit

- A - Boring Head 1 Motor - 100 HP
- B - Boring Head 2 Motor - 100 HP
- C - Jacking Motor - 60 HP
- D - Cooling System Motor - 5 HP

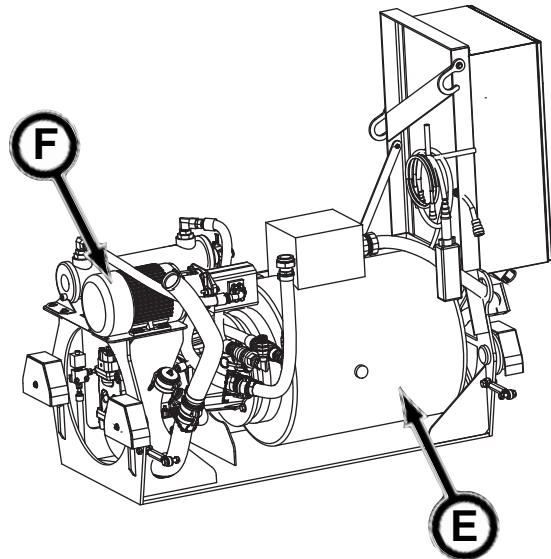
200 HP Auxiliary

- E - Auxiliary Motor - 200 HP
- F - Cooling System Motor - 5 HP



Use compressed air (maximum 50 psi) to clear openings.

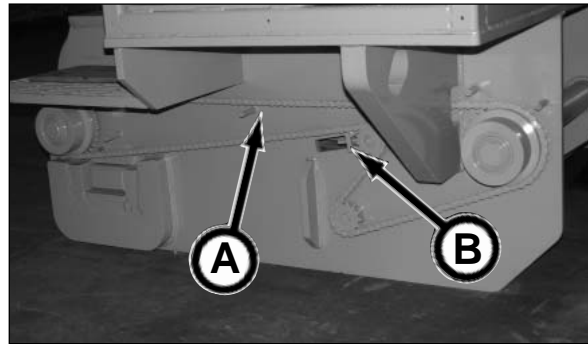
Grease and oil can be removed from the motors with a petroleum solvent.



MONTHLY OR EVERY 250 HOURS OF OPERATION

40. CHECK DRIVE CHAIN TENSION

1. Remove covers.
2. Check chain deflection at (A) on both right and left sides. Deflection should be 1/4 to 1/2 in. at midpoint of chain. Use chain tightener (B) if chain requires adjustment.
3. Lubricate drive chain. Refer to “41. Lubricate Drive Chain” in this section.
4. Replace covers.



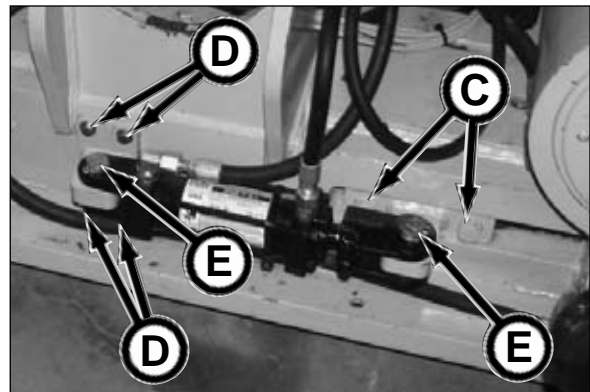
41. LUBRICATE DRIVE CHAIN

1. Remove covers.
2. Lubricate chain with a high quality chain lubricant.
3. Replace covers.



42. CHECK SKID LOCK LINKAGE

1. Check front skid lock linkage hardware (C), cylinder mount hardware (D) and cylinder pins (E) for tightness and damage. Replace loose or damaged hardware or pins as necessary.
2. Remove any dirt buildup.
3. Check rear skid lock linkage repeating steps 1 and 2.



43. 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.

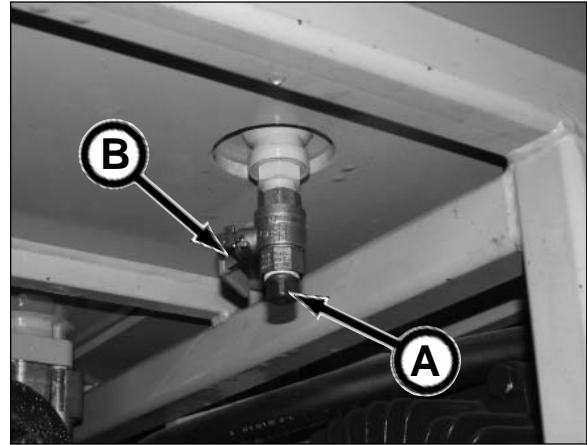


COMPLETION OF EACH DRIVE

44. DRAIN WATER FROM HYDRAULIC RESERVOIRS

Remove water contamination from the hydraulic reservoir by draining water from the reservoir at the completion of each drive.

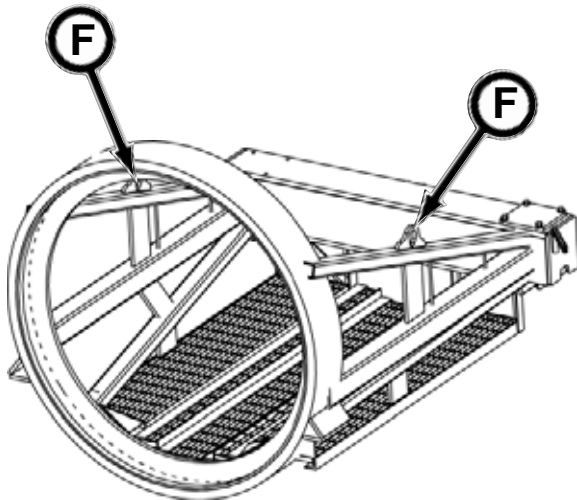
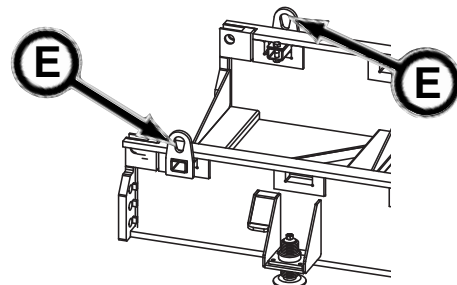
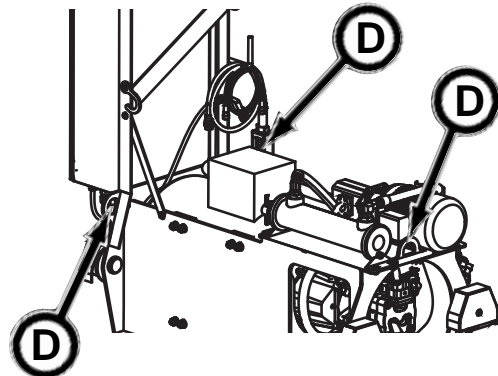
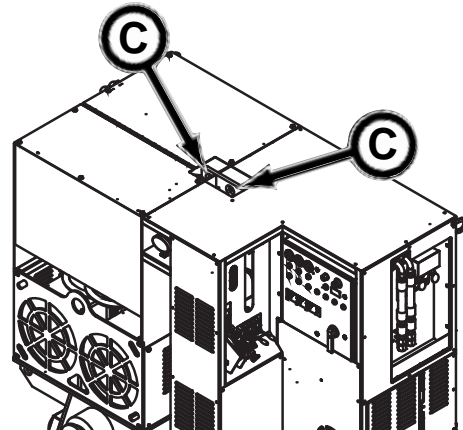
1. With pump unit on level ground, allow oil in hydraulic reservoir to settle overnight.
2. Remove plug (A) and slightly open tank drain ball valve (B) and drain (into a properly sized catch pan) until there is no water in oil.
If desired to prevent drained fluids on pump unit components, install a 1/2" NPT hose to tank valve fitting and route hose to catch pan.
3. Once water is removed from tank, close tank drain ball valve, remove hose (if used) and reinstall plug.



45. INSPECT LIFTING EYES

Inspect lifting eyes for wear or damage. Worn or damaged lifting eyes **MUST** be replaced before lifting.

- 5200 Pump Unit (C) 2 places
- 200 HP Auxiliary (D) 3 places
- Skid (E) 2 / 4 places
- Yoke (F) 2 places



EVERY 1000 HOURS OF OPERATION

46. DRAIN & REPLACE HYDRAULIC OIL

Drain and replace the hydraulic oil reservoir every 1000 hours or 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.
- Pump unit becomes engulfed in water.

To Drain/Fill Oil Reservoir:

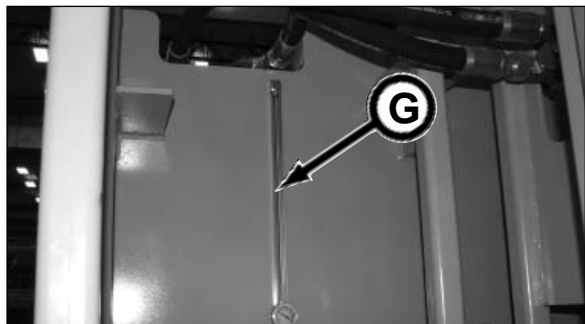
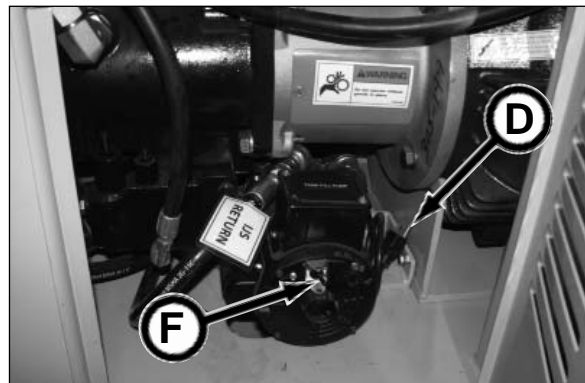
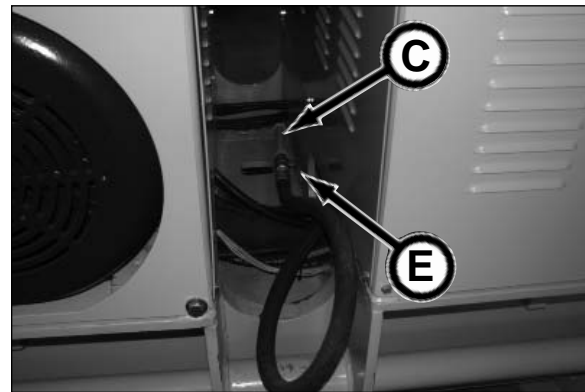
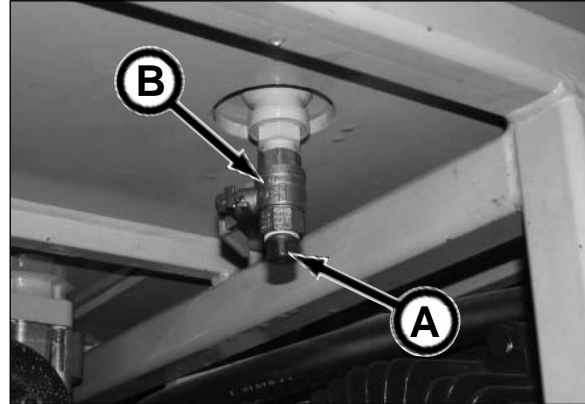
1. Remove plug (A) from tank drain valve (B).
2. Install a 1/2" NPT drain hose to tank drain valve fitting. Route/connect hose to a properly sized container.
3. Open tank drain valve (B) to drain reservoir oil.
4. Once oil is drained, close drain valve, remove drain hose (if used) and reinstall drain plug (A).
5. Dispose of oil properly.
6. Gain access to transfer pump fill tube (C) (located in the laser line chamber of the pump unit).
7. Clean outside of fill tube and area around cap. Remove cap and connect fill tube to clean oil supply container. Refer to Section 8, Lubricants for proper hydraulic oil specification.
8. Connect transfer pump plug (D) to 110V power source outlet.
9. Open ball valve (E) on fill tube.
10. Flip the switch (F) on the transfer pump to start pumping oil into the reservoir.
11. Carefully watch the tank volume on the level gauge (G). DO NOT OVERFILL!

NOTICE

Components were removed, for photographic purposes only, to show the level gauge.

12. Once reservoir is filled, close fill tube ball valve and flip switch on the transfer pump to stop the pumping of oil.

(continued on next page)



13. Unplug transfer pump plug from power source.
14. Remove fill tube from supply container.
15. Clean outside of fill tube and cap. Reinstall cap and replace fill tube back into laser line chamber of the pump unit.
16. Check for leaks.



ANNUALLY

47. LUBRICATE MOTOR BEARINGS

NOTICE

For additional electric motor maintenance information, contact your Akkerman Aftermarket Support representative.

Lubricate the electric motor bearings (A) with two shots of Mobil Polyrex® EM grease or equivalent (refer to Grease Type below). There are two lubrication fittings on each of the four pump unit (boring head 1, boring head 2, jacking and cooling) electric motors.

There are also two lubrication fittings on each of the two 200 HP Auxiliary (auxiliary and cooling) electric motors.

When adding lubricant, keep dirt out of the lubrication area. Wipe the fitting completely clean and use clean greasing equipment.

The motors should be regreased if the motors have been idle for 6 months, otherwise lubricate the bearings on an annual basis.

GREASE TYPE (unless nameplate states otherwise:

Nameplate Ambient Temperature between -22°F (-30°C) to 150°F (65°C) inclusive:

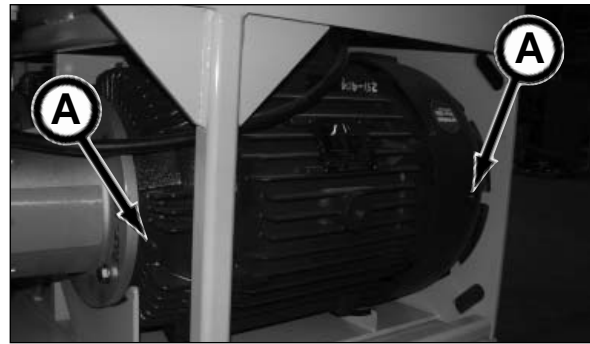
Recommended grease for standard service conditions is Mobil Polyrex® EM. Equivalent and compatible greases include: Texaco Polystar RB, Rykon Premium #2, Pennzoil Pen 2 Lube, Chevron SRI & Mobil SHC 100.

Nameplate Ambient Temperature below -22°F (-30°C):

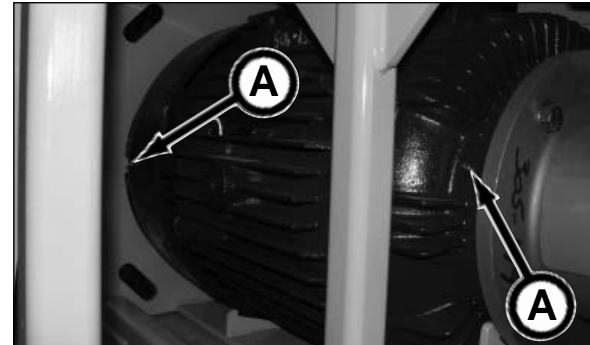
Special low temperature grease is recommended such as Aeroshell 7 or Beacon 325 for ball bearings and Mobil SHC 100 for roller bearings.

IMPORTANT: Be sure to ALWAYS verify the grease type listed on the nameplate prior to greasing motors.

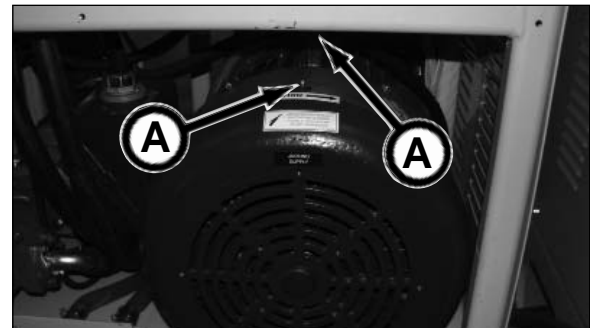
IMPORTANT: NEVER mix different grease types without contacting the motor manufacturer for recommendations prior to changing to a different grease.



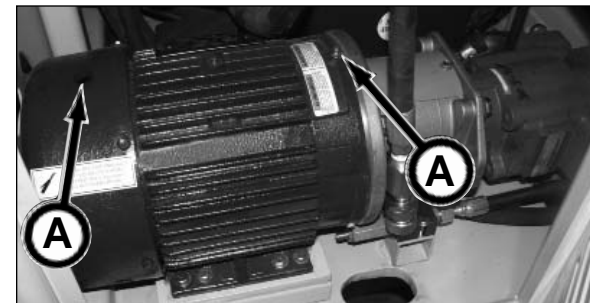
Boring Head 1 Motor



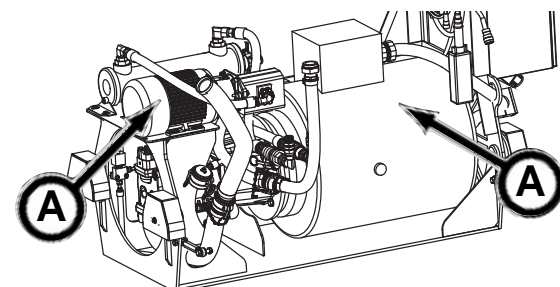
Boring Head 2 Motor



Jacking Motor



Cooling Motor



200 HP Auxiliary Motors

NOTES

Storage

PREPARING FOR STORAGE

1. Repair worn or damaged parts.
2. Wash all equipment thoroughly.
3. Lubricate all grease fittings on the skid, yoke, and 5200 Pump Unit. 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. Loosen drive chain.
7. Drain heat exchanger(s) on pump unit and 200 HP auxiliary unit.
8. Drain hydraulic oil, replace with new hydraulic filters and refill hydraulic reservoir. Check for leaks.
9. Wipe up lube spills. Dispose of rags and trash properly.
10. If possible, store equipment under cover and out of the weather in a ventilated area.
11. Review this Operator's Manual.

REMOVING FROM STORAGE

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. Readjust drive chain tension to 1/4 to 1/2" deflection at the midpoint of the chain.
7. Check condition of all hoses and connections. Tighten, repair or replace with new as needed.
8. Perform a oil analysis on the oil in the hydraulic reservoir. Replace the hydraulic oil and filters if the test reveals contamination.
9. Check the return filter indicators. Replace filter(s) as needed.
10. Before operating, cycle hydraulic functions several times to purge air from the hydraulic system.
11. Review this Operator's Manual.

Storage

NOTES

Troubleshooting

Problem	Cause	Solution
Pump Unit push cylinders stall before reaching max. operating pressure (8,000 psi).	Pump compensator set below maximum setting.	Adjust.
	Main relief set below max. setting.	Adjust.
	Worn or damaged cylinder seals.	Replace seals.
	Worn or damaged control valve seals.	Replace seals.
	If cylinders continue to stall, contact your Akkerman Aftermarket Representative.	
Pump Unit cylinder(s) collapse when forward thrust is stopped or intermediate jacks are used.	Pilot operated check valve leaking.	Repair or replace.
	Worn or damaged cylinder seals.	Replace seals.
	If cylinders continue to collapse, contact your Akkerman Aftermarket Support Representative.	
The 60 HP and 100 HP motors will not start.	Emergency stop switch is engaged.	Pull E-STOP button out.
	Motor controls in 30 or 60 mode.	Switch motor controls to Standby.
	Main disconnect tripped or not turned ON.	Turn disconnect ON.
	Low hydraulic oil level.	Fill reservoir with oil.
	(Non-Series II TBM) Tunnel power switch is ON.	Flip Tunnel Power switch OFF for non-series II TBM to operate.
	Motor overload.	Reset overload.
	Generator or power supply faulty.	Repair or replace.
	Faulty Start/Stop switch.	Replace switch.
	Faulty low oil level switch or relay.	Replace switch.
	If motors will still not start, contact your Akkerman Aftermarket Support Representative.	
Hydraulic oil temperature gauge exceeds 150°F (66°C).	Heat exchanger water supply not adequate.	Water supply must be a minimum of 8 gpm.
	Aux/Cooling switch is OFF.	Turn Aux/Cooling switch ON.
	Inlet water strainer clogged.	Clean inlet water strainer.
	Operating with a 90/30 GPM supply.	Reset to 60/60 GPM supply.
	Excessive water ambient temperature.	Provide fresh, clean, cold water source.
	Excessive horsepower required by boring machine or jacking operation.	Reduce advancement rate or install IJS.
	Heat exchanger water passages plugged.	Clean heat exchanger.
	If oil temperature continues to exceed 150°F (66°C), contact your Akkerman Aftermarket Support Representative.	

Troubleshooting

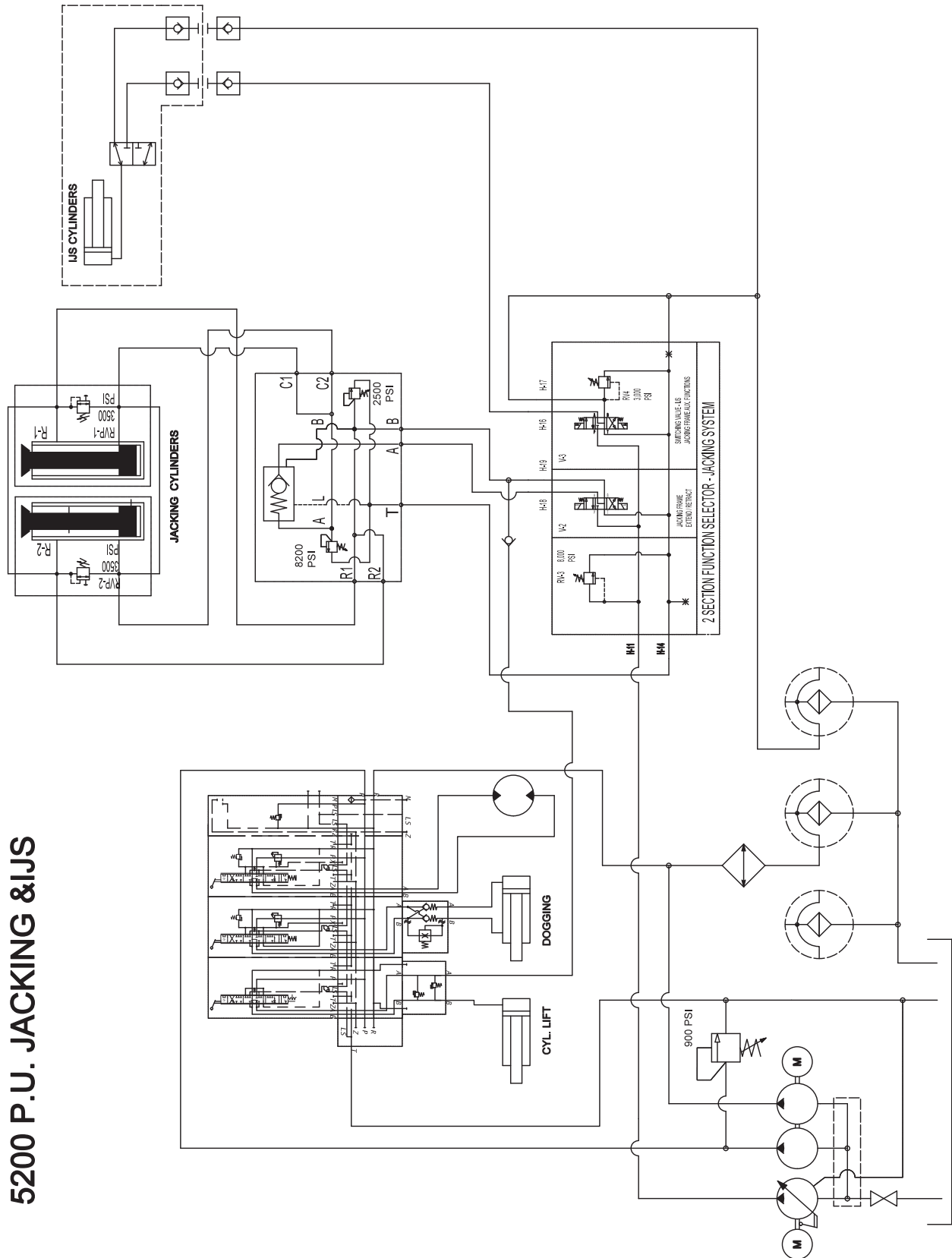
Problem	Cause	Solution
Boring head supply gauge frequently reaches 2,800/4,800 psi.*	Tank ball valve closed.	Open ball valve.
	Pipe advancement rate too fast.	Slow main ram thrust.
	Too few cutter bar drive motors.	Reduce advancement rate or install additional motors, if possible.
	Single feed supply to boring head	Change to dual feed supply.
	Incorrect cutter bar selected for ground condition.	Change cutter head.
	(Non Series II TBMs Only) Worn or damaged TBM inner drum thrust roller bearings.	Replace bearings.
	(Non Series II TBMs Only) Worn or damaged TBM inner drum rollers.	Replace rollers.
	If boring head supply gauge continues to frequently reach 2,800/4,800 psi, contact your Akkerman Aftermarket Support Representative.	
Pump Unit motors start but no oil pressure is available.	Tank ball valve closed.	Open supply shutoff valve.
	Incorrect motor rotation.	Rewire motor for proper rotation.
	Electrical phase error.	Reverse power leads.
	Faulty relief valve.	Replace valve.
	Low standby pressure.	Adjust to 220 psi.
	Worn or damaged hydraulic pump.	Repair or replace pump.
	If there continues to be no oil pressure, contact your Akkerman Aftermarket Support Representative.	
Valve functions (jacking, travel, IJS, cylinder lift and skid lock controls) do not operate.	Tank ball valve closed.	Open jacking supply shutoff valve.
	Aux/Cooling switch is OFF. Valve pump is not running.	Turn Aux/Cooling switch ON. Start up jacking motor.
	Low oil level reaches empty sensor.	Fill reservoir with oil.
	Load sense filter clogged.	Replace load sense filter.
	Low or no standby pressure.	Adjust to 220 psi.
	If the jacking valve functions continue to not operate, contact your Akkerman Aftermarket Support Representative.	

* Refers to 2,800 psi on the 3,000 psi low pressure system and 4,800 psi on the 5,000 psi low pressure system.

NOTES

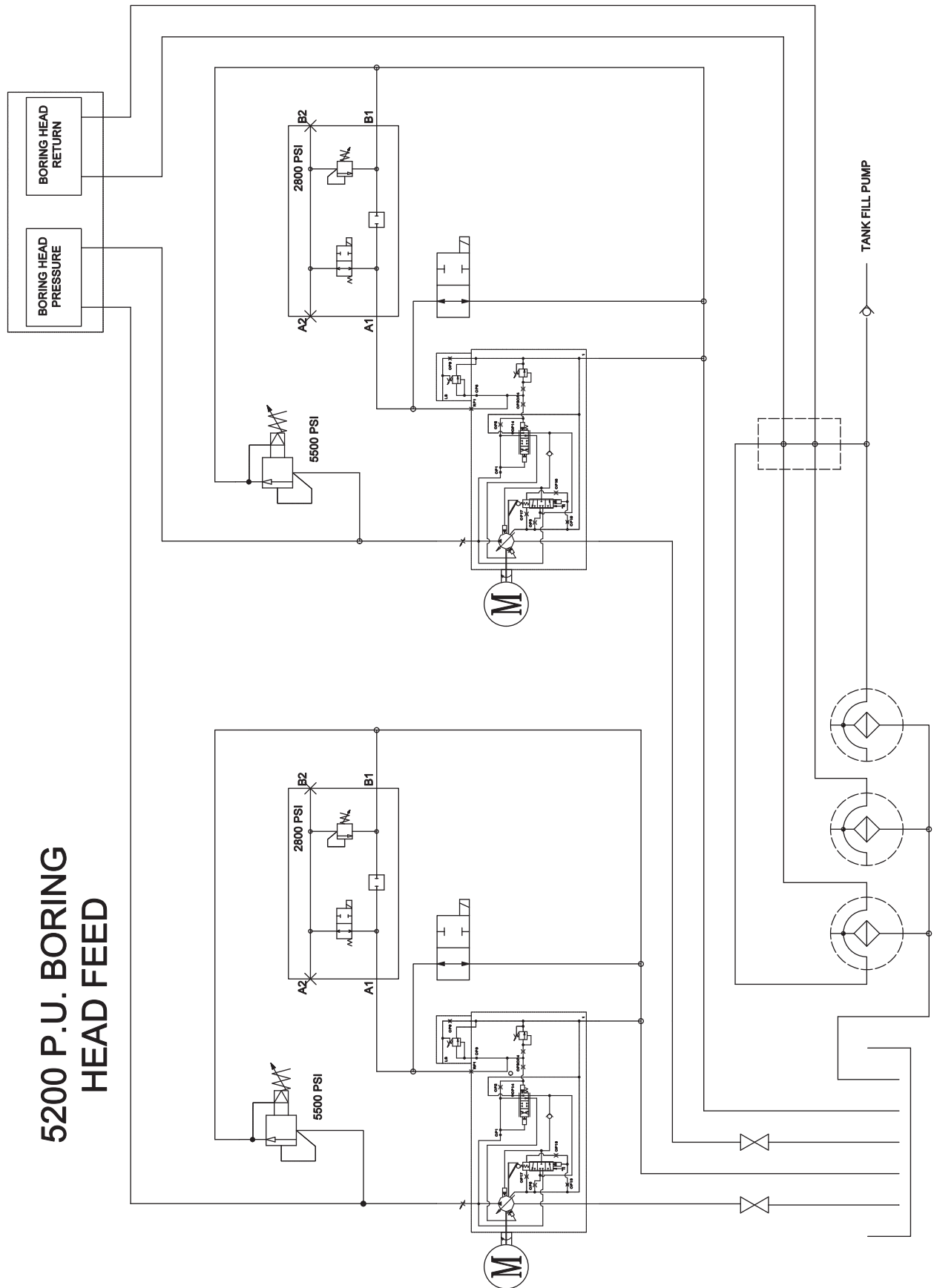
5200 PUMP UNIT HYDRAULIC SCHEMATIC

Hydraulic Schematic - Part 1 of 2



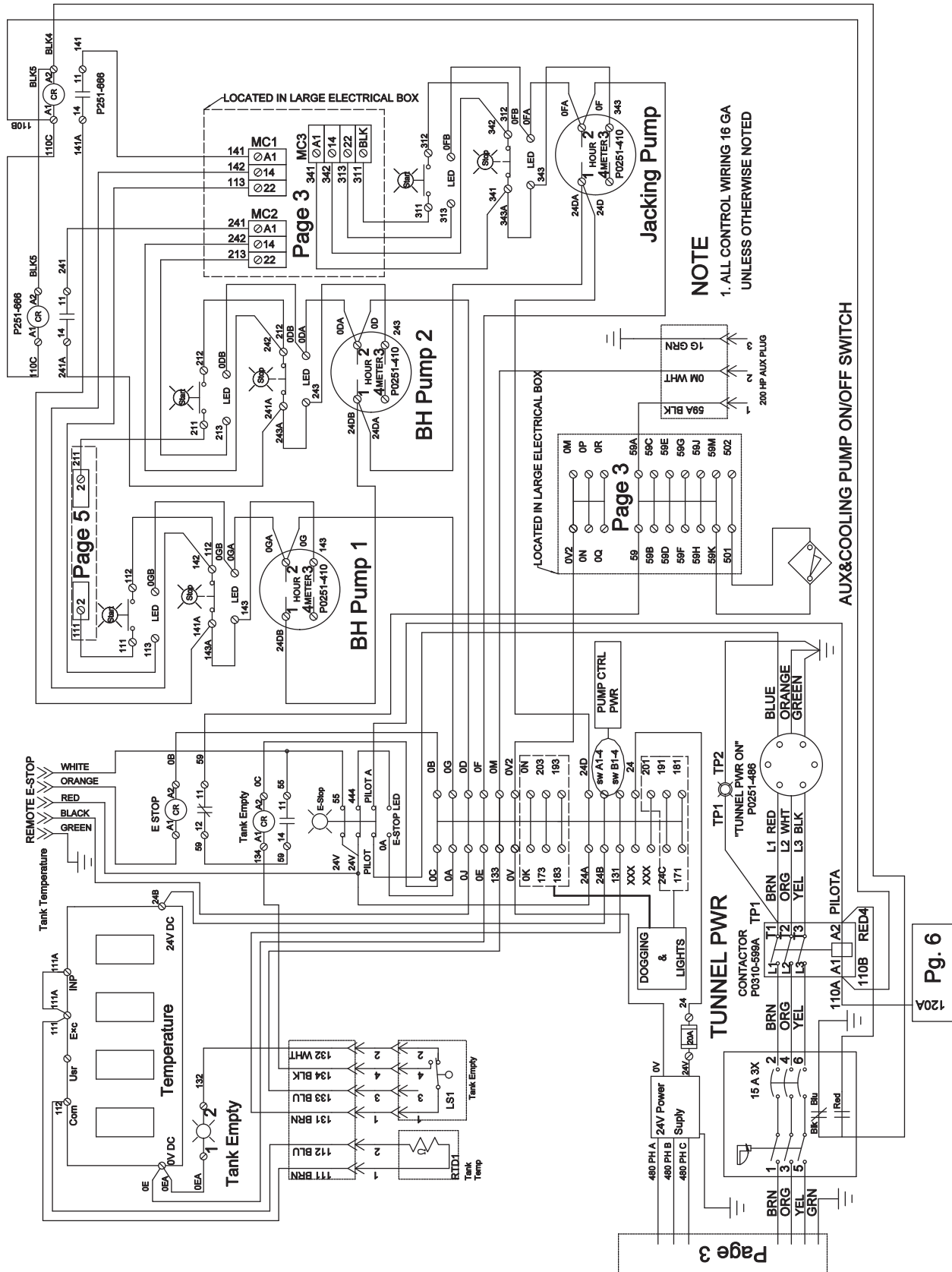
5200 P.U. JACKING & IJS

5200 Pump Unit Hydraulic Schematic (continued)
Hydraulic Schematic - Part 2 of 2

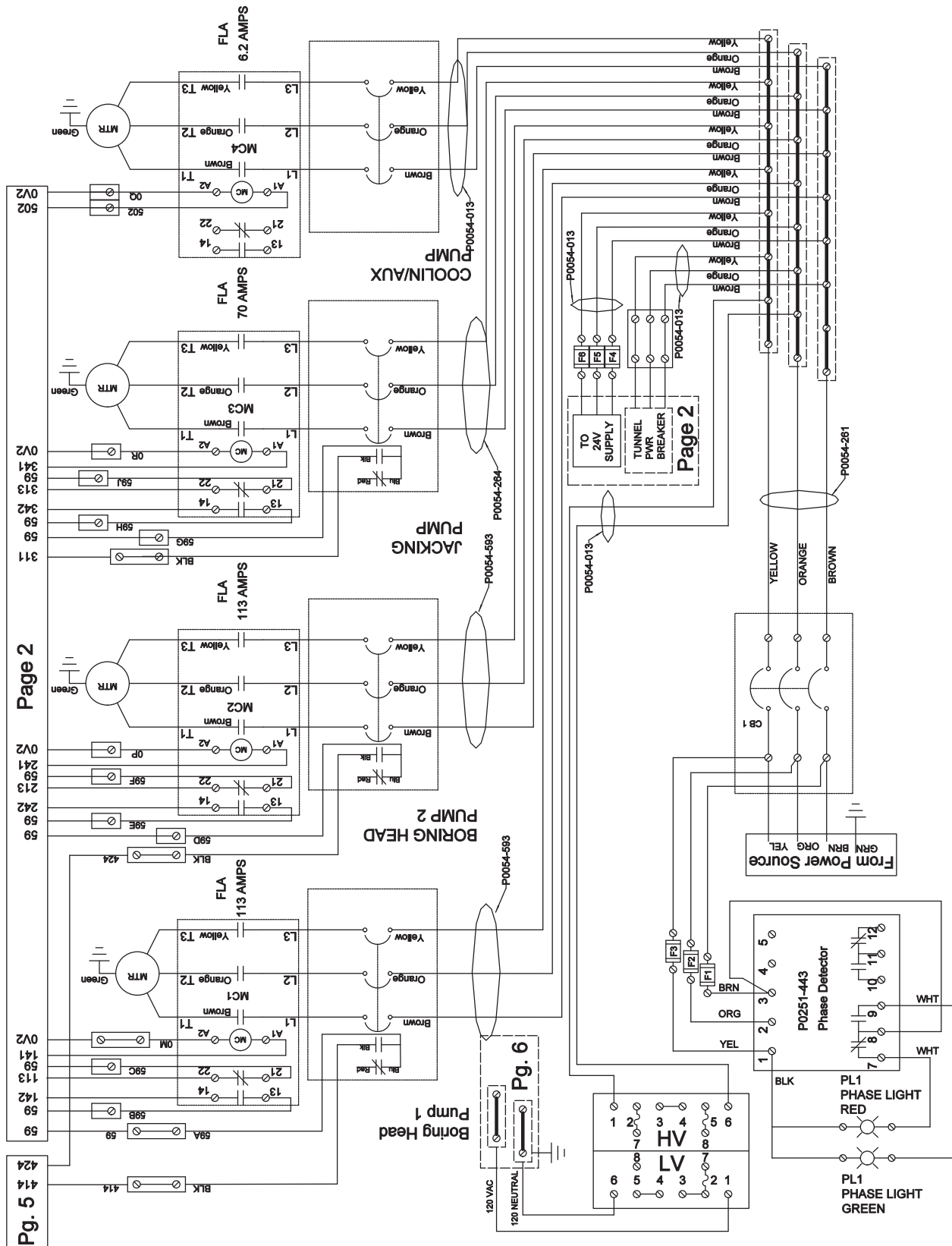


5200 PUMP UNIT ELECTRICAL SCHEMATIC (SN F27700F-11 & BEFORE)

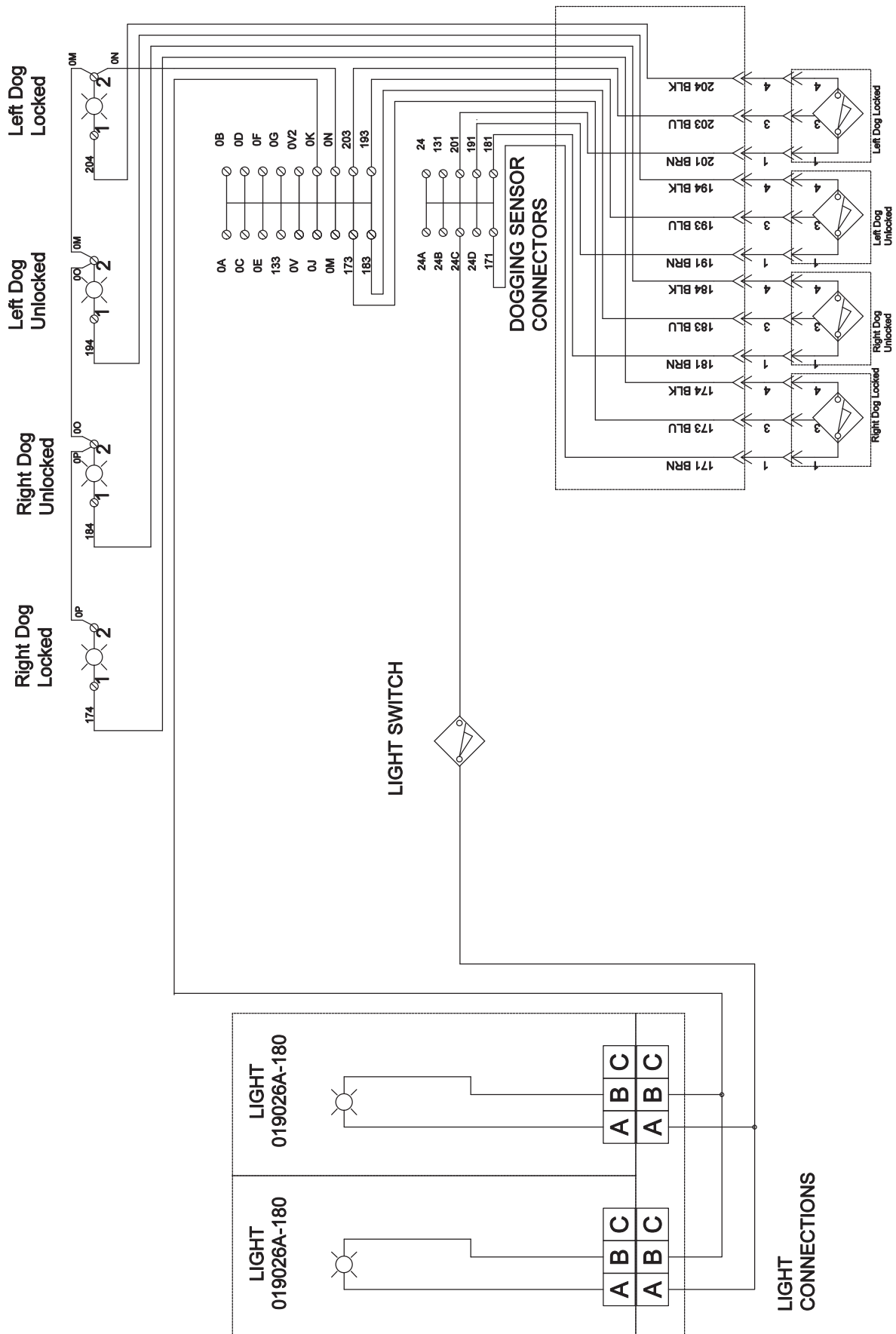
Hydraulic Schematic - Part 1 of 5 (Page 2)



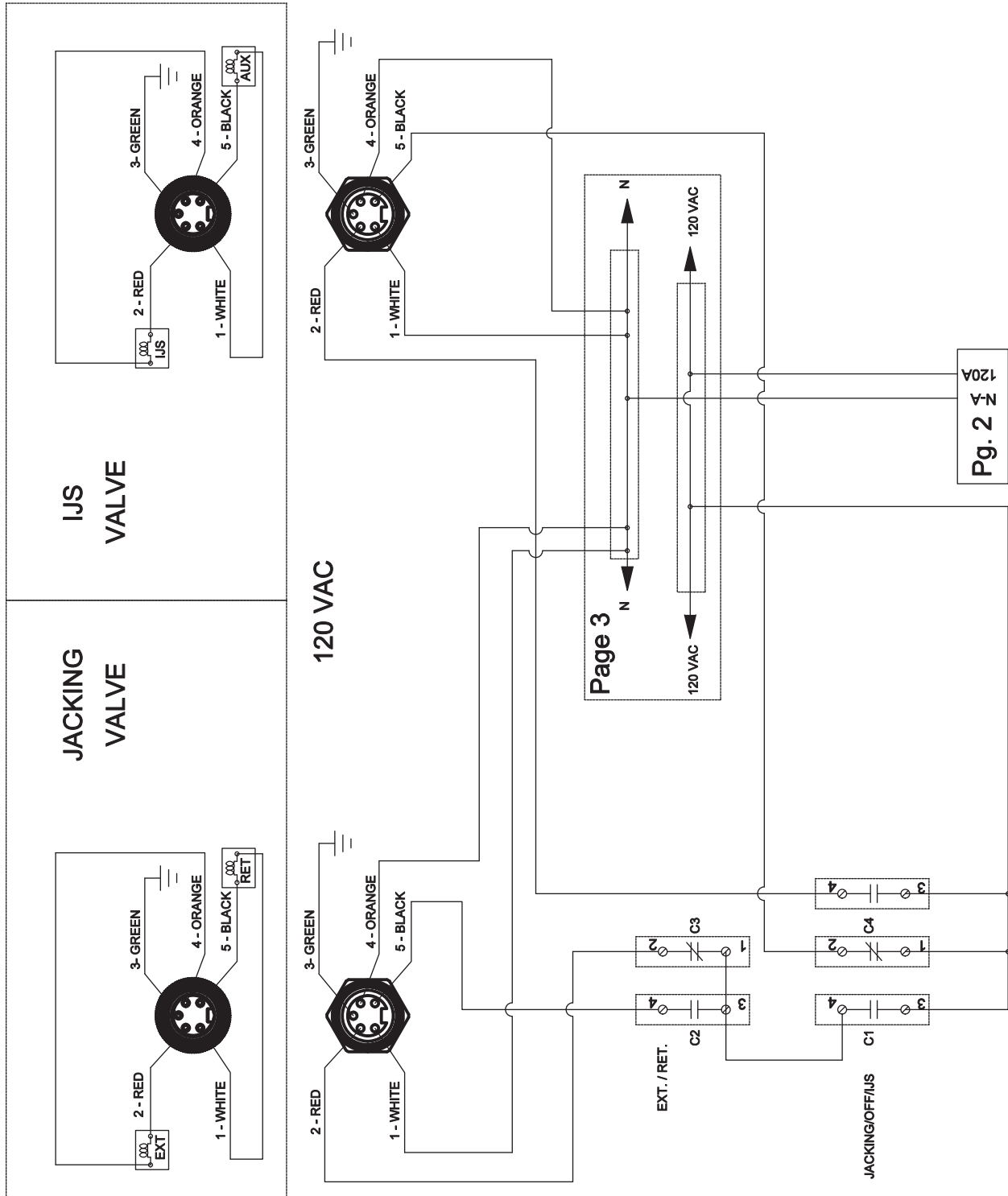
5200 Pump Unit Electrical Schematic - (SN F27700F-11 & Before) (continued)
 Electrical Schematic - Part 2 of 5 (Page 3)



5200 Pump Unit Electrical Schematic - (SN F27700F-11 & Before) (continued)
 Electrical Schematic - Part 3 of 5 (Page 4)



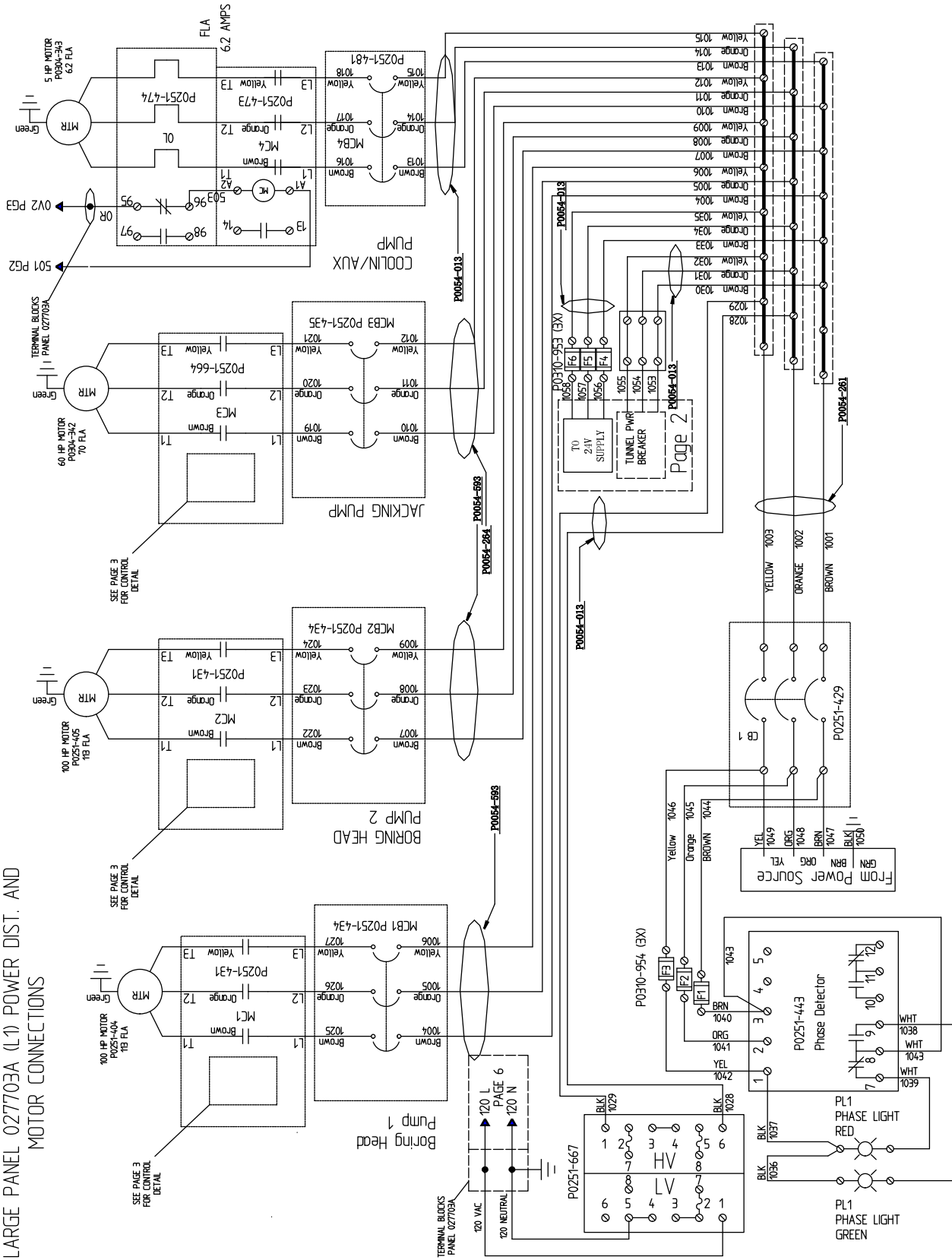
5200 Pump Unit Electrical Schematic - (SN F27700F-11 & Before) (continued)
 Electrical Schematic - Part 5 of 5 (Page 6)



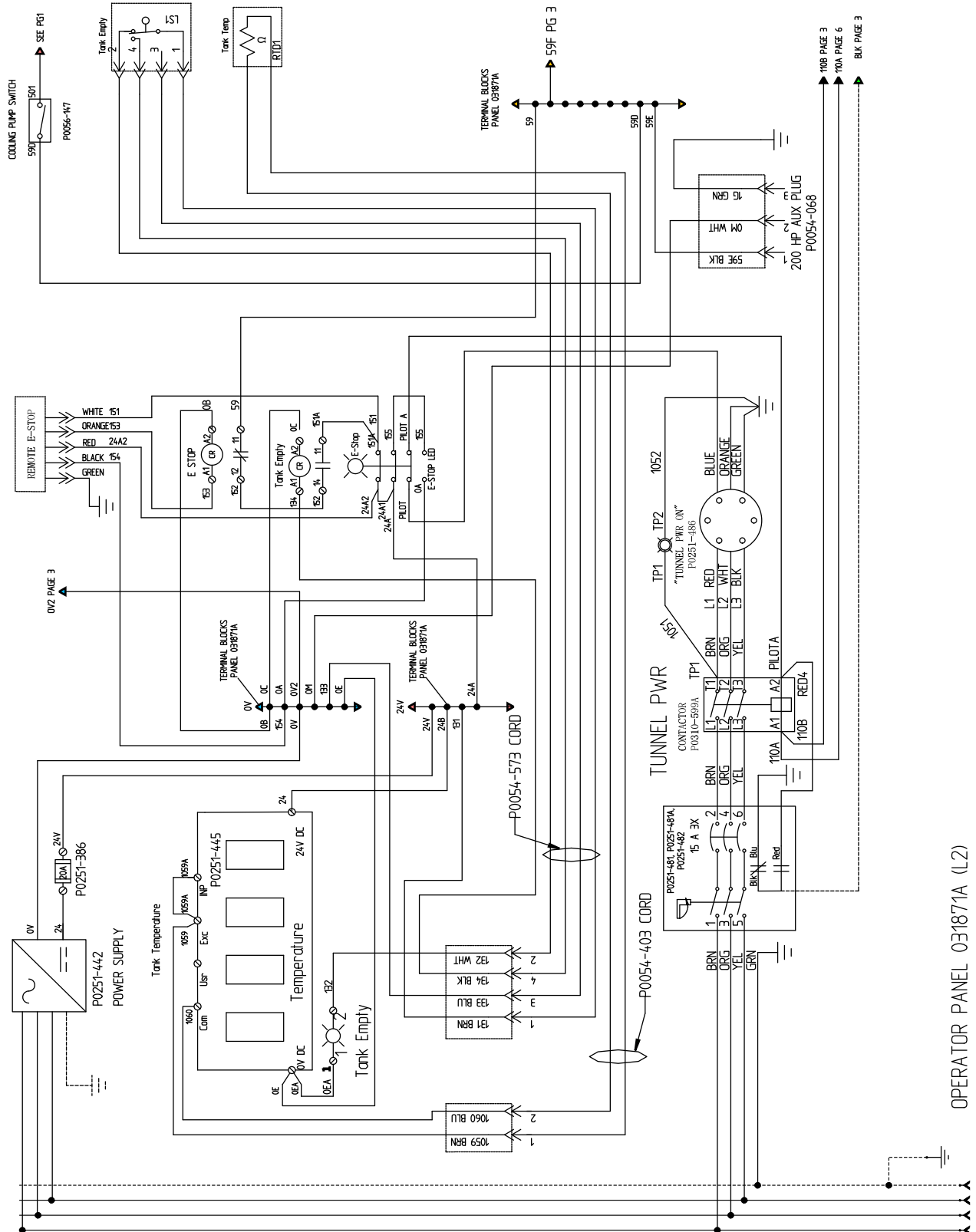
5200 PUMP UNIT ELECTRICAL SCHEMATIC - PART 1 OF 6 (PAGE 1)

(SN F27700F-12 & AFTER)

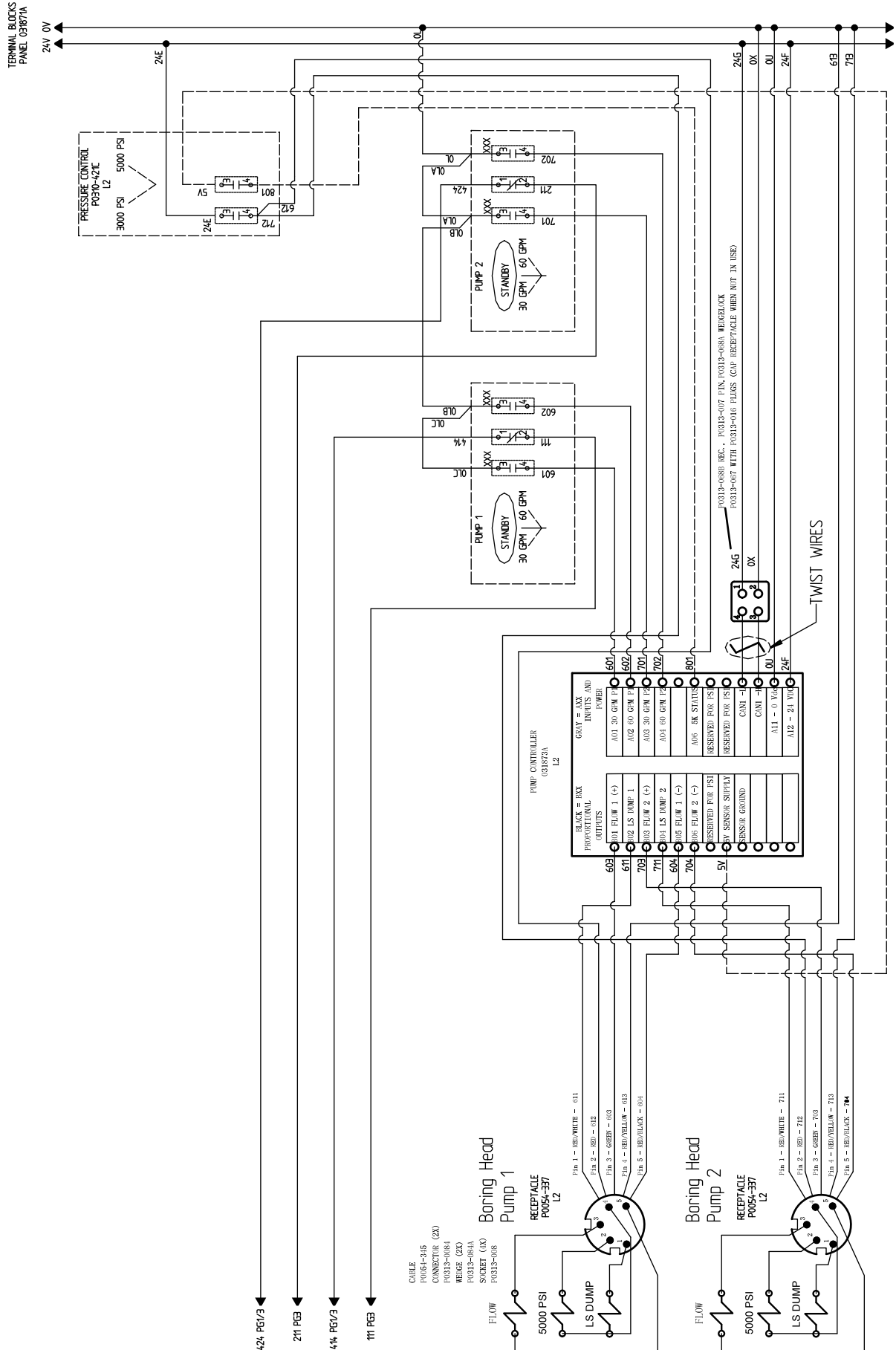
LARGE PANEL 027703A (L1) POWER DIST. AND MOTOR CONNECTIONS



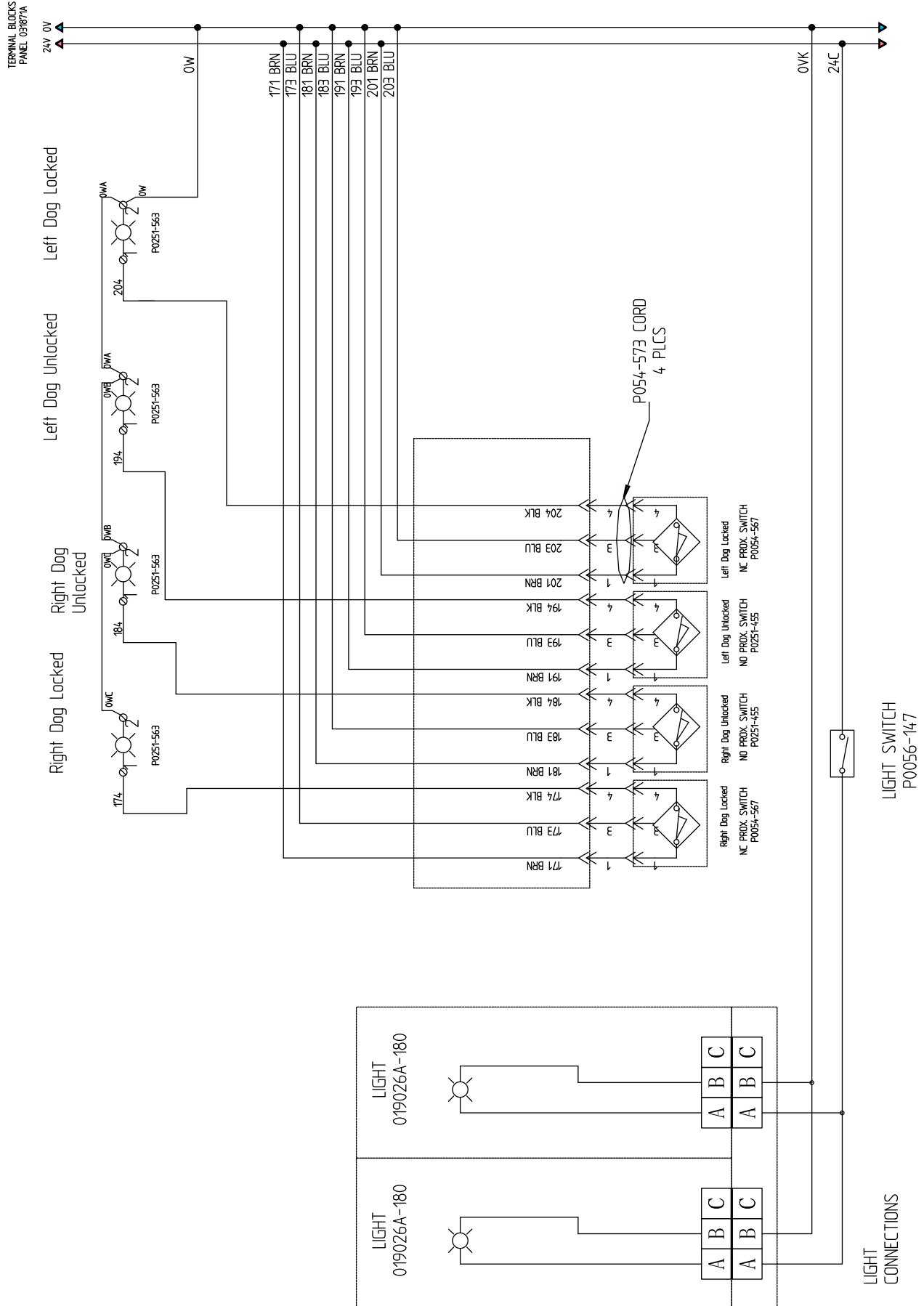
5200 Pump Unit Electrical Schematic - (SN F27700F-12 & After) (continued)
 Electrical Schematic - Part 2 of 6 (Page 2)



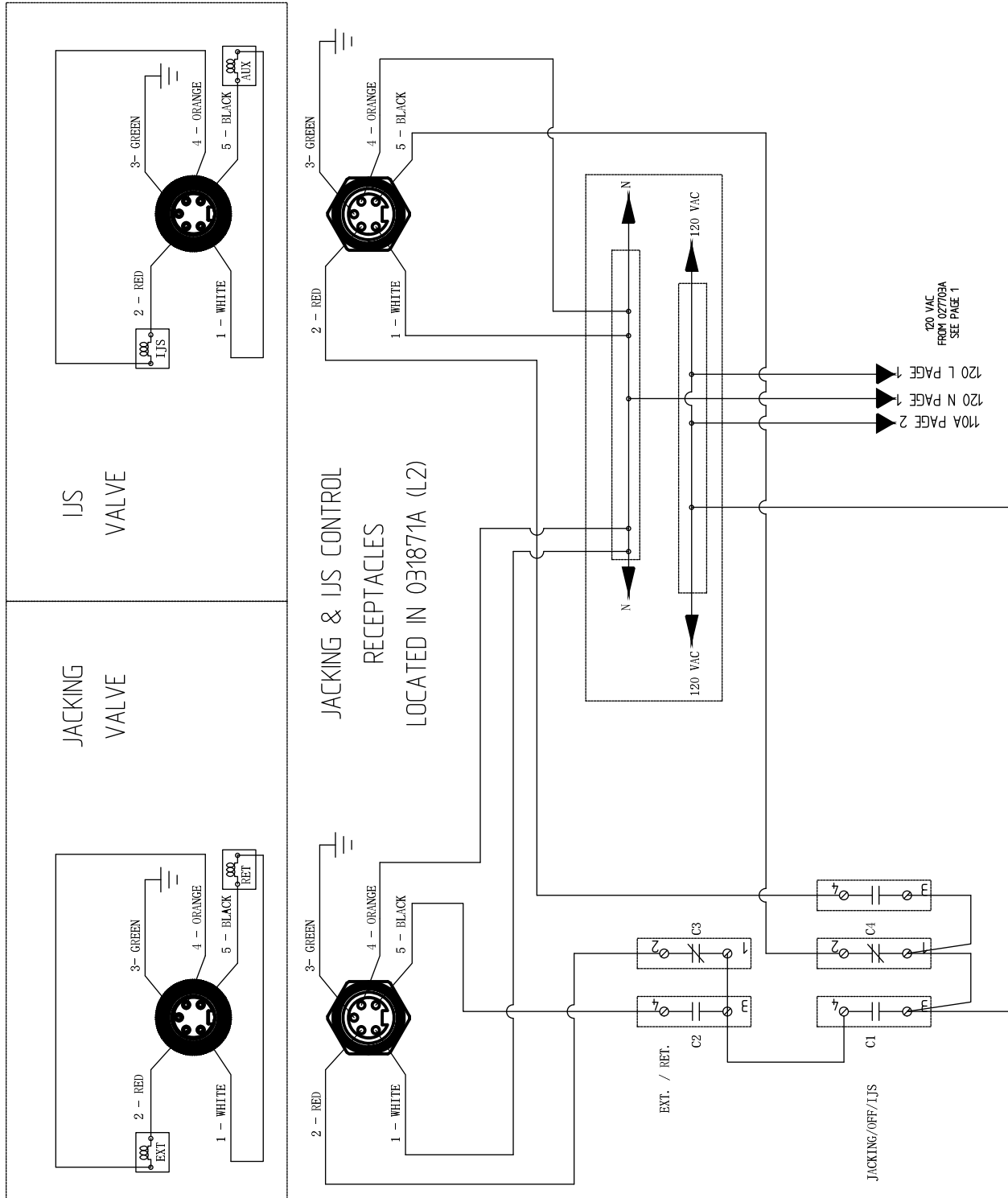
5200 Pump Unit Electrical Schematic - (SN F27700F-12 & After) (continued)
 Electrical Schematic - Part 4 of 6 (Page 4)



5200 Pump Unit Electrical Schematic - (SN F27700F-12 & After) (continued)
 Electrical Schematic - Part 5 of 6 (Page 5)



5200 Pump Unit Electrical Schematic - (SN F27700F-12 & After) (continued)
 Electrical Schematic - Part 6 of 6 (Page 6)



5200 PUMP UNIT ELECTRICAL SCHEMATIC WIRE LIST (PART 1 OF 3) (SN F27700F-12 & AFTER)

WIRE NUMBER	DESCRIPTION	FROM LOCATION #1	TO LOCATION #2	WIRE COLOR/GAUGE
24V	24 Volt	24V FUSE	24V TERMINAL BLOCKS	Blu/Wht 16 AWG
24A	24 Volt	24V TERMINAL BLOCK	E-STOP SW NC #1	Blu/Wht 16 AWG
24A1	24 Volt	E-STOP SW NC #1	E-STOP SW NC #1	Blu/Wht 16 AWG
24A2	24 Volt	E-STOP SW NC #1	REMOT E-STOP RECP RED	RED 16 AWG
24B	24 Volt	24V TERMINAL BLOCK	TEMP DISPLAY PWR	Blu/Wht 16 AWG
24C	24 Volt	24V TERMINAL BLOCK	LIGHT SWITCH PWR	Blu/Wht 16 AWG
24D	24 Volt	24V TERMINAL BLOCK	HOURLMETER 3 #1	Blu/Wht 16 AWG
24DA	24 Volt	HOURLMETER 3 #1	HOURLMETER 2 #1	Blu/Wht 16 AWG
24DB	24 Volt	HOURLMETER 2 #1	HOURLMETER 1 #1	Blu/Wht 16 AWG
24E	24 Volt	5K SW TERM RIGHT #3	24V TERMINAL BLOCKS	Blu/Wht 16 AWG
24F	24 Volt	24V TERMINAL BLOCK	CONTROLLER GRAY A12	Blu/Wht 20 AWG
24G	24 Volt	24V TERMINAL BLOCK	DIAGNOSTIC 1	Blu/Wht 16 AWG
0V	GROUND	24V POWERSUPPLY 0V	0V TERMINAL BLOCK	Wht/Blu 16 AWG
0V2	GROUND	0V TERMINAL BLOCK	0V2 TERMINAL BLOCK	Wht/Blu 16 AWG
0	GROUND	E-STOP LED NEG (-)	0V TERMINAL BLOCK	Wht/Blu 16 AWG
0B	GROUND	E-STOP RLY A2	0V TERMINAL BLOCK	Wht/Blu 16 AWG
0C	GROUND	TANK EMPTY RLY A2	0V TERMINAL BLOCK	Wht/Blu 16 AWG
0D	GROUND	HOURLMETER 2 #2	0V TERMINAL BLOCK	Wht/Blu 16 AWG
0DA	GROUND	HOURLMETER 2 #2	STOP SW 2 LED X2	Wht/Blu 16 AWG
0DB	GROUND	STOP SW 2 LED X2	START SW2 LED X2	Wht/Blu 16 AWG
0E	GROUND	TEMP DISPLAY NEG (-)	0V TERMINAL BLOCK	Wht/Blu 16 AWG
0EA	GROUND	TEMP DISPLAY NEG (-)	TANK EMPTY LED NEG (-)	Wht/Blu 16 AWG
0F	GROUND	HOURLMETER 3 #2	0V TERMINAL BLOCK	Wht/Blu 16 AWG
0FA	GROUND	HOURLMETER 3 #2	STOP SW3 LED X2	Wht/Blu 16 AWG
0FB	GROUND	STOP SW3 LED X2	START SW3 LED X2	Wht/Blu 16 AWG
0G	GROUND	HOURLMETER 1 #2	0V TERMINAL BLOCK	Wht/Blu 16 AWG
0GA	GROUND	HOURLMETER 1 #2	STOP SW1 LED X2	Wht/Blu 16 AWG
0GB	GROUND	STOP SW1 LED X2	START SW1 LED X2	Wht/Blu 16 AWG
0K	GROUND	LIGHTS NEG (-)	0V TERMINAL BLOCK	Wht/Blu 16 AWG
0L	GROUND	60 GPM SW2 #3	0V TERMINAL BLOCK	Wht/Blu 16 AWG
0LA	GROUND	60 GPM SW2 #3	30 GPM SW2 #3	Wht/Blu 16 AWG
0LB	GROUND	30 GPM SW2 #3	60 GPM SW1 #3	Wht/Blu 16 AWG
0LC	GROUND	60 GPM SW1 #3	30 GPM SW1 #3	Wht/Blu 16 AWG
0M	GROUND	200 HP AUX PLUG WHT	0V2 TERMINAL BLOCK	Wht/Blu 16 AWG
0N	GROUND	MC1 A2	0V TERMINAL BLOCK	Wht/Blu 16 AWG
0.5	GROUND	MC2 A2	0V2 TERMINAL BLOCK	Wht/Blu 16 AWG
0Q	GROUND	MC3 A2	0V2 TERMINAL BLOCK	Wht/Blu 16 AWG
0R	GROUND	M4 OL 95	0V2 TERMINAL BLOCK	Wht/Blu 16 AWG
0S	GROUND	5 PIN RECP PIN 4 RED/YEL	0V TERMINAL BLOCK	Wht/Blu 16 AWG
0T	GROUND	5 PIN RECP PIN 4 RED/YEL	0V TERMINAL BLOCK	Wht/Blu 16 AWG
0U	GROUND	CONTROLLER GRAY A11	0V TERMINAL BLOCK	Wht/Blu 20 AWG
0W	DOG INDICATOR GROUND	LEFT DOG LOCKED NEG	0V TERMINAL BLOCK	Wht/Blu 16 AWG
0WA	DOG INDICATOR GROUND	LEFT DOG LOCKED NEG	LEFT DOG UNLOCKED NEG	Wht/Blu 16 AWG
0WB	DOG INDICATOR GROUND	LEFT DOG UNLOCKED NEG	R DOG UNLOCKED NEG	Wht/Blu 16 AWG
0WC	DOG INDICATOR GROUND	R DOG UNLOCKED NEG	R DOG LOCKED NEG	Wht/Blu 16 AWG
0X	GROUND	DIAGNOSTIC PIN 2	0V TERMINAL BLOCK	Wht/Blu 16 AWG
59A	E-STOP 24V	59 TERMINAL BLOCK	MCB1 AUX BLU	Blu/Wht 16 AWG
59B	E-STOP 24V	59 TERMINAL BLOCK	MC2 AUX BLU	Blu/Wht 16 AWG
59C	E-STOP 24V	59 TERMINAL BLOCK	MC3 AUX BLU	Blu/Wht 16 AWG
59D	E-STOP 24V	59 TERMINAL BLOCK	COOLING PUMP SW	Blu/Wht 16 AWG
59E	E-STOP 24V	59 TERMINAL BLOCK	200HP AUX PIN 1 BLK	Blu/Wht 16 AWG
59F	E-STOP 24V	59 TERMINAL BLOCK	59 TERMINAL BLOCK	Blu/Wht 16 AWG
120 N	120VAC Neutral	various	various	Wht 16 AWG
120 L	120VAC Line	various	various	Blk 16 AWG
110A	120VAC TO TNL PWR CTR A1	120 VAC STRIP	TNL PWR CTR A1	Blk 16 AWG
110B	120VAC TO REMOTE ESTOP RELAY COIL 1	TNL PWR CTR A1	RMT ESTOP RELAY1 A1	Blk 16 AWG
110C	120VAC TO REMOTE ESTOP RELAY COIL 2	RMT ESTOP RELAY1 A1	RMT ESTOP RELAY2 A1	Blk 16 AWG
BLK4	REMOTE ESTOP RELAY COIL 1 GROUND	RMT ESTOP RELAY1 A2	TNL PWR CB BLK	Blk 16 AWG
BLK5	REMOTE ESTOP RELAY COIL 2 GROUND	RMT ESTOP RELAY1 A2	RMT ESTOP RELAY2 A2	Blk 16 AWG
111	START PWR	PUMP SW1 STANDBY #2	START SW1 NO #3	Blu/Wht 20 AWG
112	START PWR	START SW1 NO #4	STOP SW1 NC #2	Blu/Wht 20 AWG
113	START LED PWR	MC1 #22	START SW1 LED X1	Blu/Wht 16 AWG
131	TANK LEVEL PWR	TANK LEVEL RECP #1 BRN	24V TERMINAL BLOCK	Brn 20 AWG
132	TANK EMPTY LED PWR	TANK LEVEL RECP #2 WHT	TANK EMPTY LED #2	Wht 20 AWG
133	TANK LEVEL 0V	TANK LEVEL RECP #3 BLU	0V TERMINAL BLOCK	Blu 20 AWG
134	TANK LEVEL CTRL	TANK LEVEL RECP #4 BLK	TANK EMPTY RELAY A1	Blk 20 AWG
141	TUNNEL POWER ESTOP	TUNL PWR ESTOP RLY1 #11	MC1 A1	Blu/Wht 16 AWG
142	TUNNEL POWER ESTOP	TUNL PWR ESTOP RLY1 #14	STOP SW1 NC#1	Blu 16 AWG
142A	"RUN" - STOP LED PWR	STOP SW1 NC #1	STOP SW 1 LED X1	Blu/Wht 16 AWG
142B	"RUN"-HOUR METER	STOP LED X1	HOURLMETER 1 #3	Blu/Wht 16 AWG
143	RUN	STOP SW1 NC #2	MC1 NO#14	Blu/Wht 16 AWG
144	RUN	MC1 NO#13	VARIOUS RUN1 PWR	Blu/Wht 16 AWG
145	RUN	MCB1 AUX BLK	VARIOUS RUN1 PWR	Blu/Wht 16 AWG
146	RUN	VARIOUS RUN1 PWR	MC1 NC#21	Blu/Wht 16 AWG
151	REMOTE ESTOP 24V IN	REMOT ESTOP WHITE	E-STOP #2	Wht 16 AWG
151A	ESTOP 24V	E-STOP #2	TANK EMPTY #11	Blu/Wht 16 AWG
152	ESTOP 24V	TANK EMPTY #14	ESTOP RLY #14	Blu/Wht 16 AWG

5200 Pump Unit Electrical Schematic Wire List (continued)
(SN F27700F-12 & After) Wire List - Part 2 of 3

WIRE NUMBER	DESCRIPTION	FROM LOCATION #1	TO LOCATION #2	WIRE COLOR/GAUGE
153	REMOTE ESTOP 24V OUT	REMOT ESTOP RECP ORG	ESTOP COIL A1	Org 16 AWG
154	REMOTE ESTOP 0V	REMOT ESTOP RECP BLK	0V TERMINAL BLOCK	Blk 16 AWG
155	ESTOP LED PWR	E-STOP #2	ESTOP LED #2	Blu/Wht 16 AWG
PILOT	TUNNE POWER PILOT	E-STOP #1	TNL PWR RECP ORANGE	Blu 16 AWG
PILOTA	TUNNE POWER PILOT	TNL PWR CTR A2	E-STOP #2	Blu/Wht 16 AWG
171	24V TO DOGGING PROX SW	RT DOG LOCK RECP # 1 BRN	24V TERMINAL BLOCK	Brn 20 AWG
173	DOGGING PROX SW GROUND	RT DOG LOCK RECP # 3 BLU	0V TERMINAL BLOCK	Blu 20 AWG
174	DOGGING PROX SW CTRL	RT DOD LOCK RECP #4 BLK	RT DOG LOCK LED #1	Blk 20 AWG
181	24V TO DOGGING PROX SW	RT DOG UNLOCK # 1 BRN	24V TERMINAL BLOCK	Brn 20 AWG
183	DOGGING PROX SW GROUND	RT DOG UNLOCK # 3 BLU	0V TERMINAL BLOCK	Blu 20 AWG
184	DOGGING PROX SW CTRL	RT DOG UNLOCK #4 BLK	RT DOG UNLOCK LED #1	Blk 20 AWG
191	24V TO DOGGING PROX SW	L DOG UNLOCK # 1 BRN	24V TERMINAL BLOCK	Brn 20 AWG
193	DOGGING PROX SW GROUND	L DOG UNLOCK # 3 BLU	0V TERMINAL BLOCK	Blu 20 AWG
194	DOGGING PROX SW CTRL	L DOG UNLOCK #4 BLK	L DOG UNLOCK LED #1	Blk 20 AWG
201	24V TO DOGGING PROX SW	L DOG LOCK RECP # 1 BRN	24V TERMINAL BLOCK	Brn 20 AWG
203	DOGGING PROX SW GROUND	L DOG LOCK RECP # 3 BLU	0V TERMINAL BLOCK	Blu 20 AWG
204	DOGGING PROX SW CTRL	L DOG LOCK RECP #4 BLK	L DOG LOCK LED #1	Blk 20 AWG
211	START PWR	PUMP SW2 STANDBY #2	START SW2 NO #3	Blu/Wht 16 AWG
212	START SWR	START SW2 NO #4	STOP SW2 NC #2	Blu/Wht 16 AWG
213	START LED PWR	MC2 #22	START SW2 LED X1	Blu/Wht 16 AWG
241	TUNNEL POWER ESTOP	TUNL PWR ESTOP RLY2 #11	MC2 A1	Blu/Wht 16 AWG
242	TUNNEL POWER ESTOP	TUNL PWR ESTOP RLY2 #14	STOP SW2 NC#1	Blu 16 AWG
242A	"RUN 2" - STOP LED PWR	STOP SW2 NC #1	STOP SW 2 LED X1	Blu/Wht 16 AWG
242B	"RUN 2"-HOUR METER	STOP LED 2 X1	HOURLMETER 2 #3	Blu/Wht 16 AWG
243	RUN 2	STOP SW2 NC #2	MC2 NO#14	Blu/Wht 16 AWG
244	RUN 2	MC2 NO#13	VARIOUS RUN2 PWR	Blu/Wht 16 AWG
245	RUN 2	MCB2 AUX BLK	VARIOUS RUN2 PWR	Blu/Wht 16 AWG
246	RUN 2	VARIOUS RUN2 PWR	MC2 NC#21	Blu/Wht 16 AWG
311	START	VARIOUS RUN2 PWR	START SW3 NO #3	Blu/Wht 16 AWG
312	START	START SW3 NO #4	STOP SW3 NC #2	Blu/Wht 16 AWG
313	START LED PWR	MC3 NC #22	START SW3 LED X1	Blu/Wht 16 AWG
314	Run 3	MC3 NC #21	VARIOUS RUN3 PWR	Blu/Wht 16 AWG
342	RUN	STOP SW3 NC #1	MC3 A1	Blu/Wht 16 AWG
342A	"RUN 3" - STOP LED PWR	STOP SW3 NC #1	STOP LED 3 X1	Blu/Wht 16 AWG
342B	"RUN 3"-HOUR METER	STOP LED 3 X1	HOUR METER 3 #3	Blu/Wht 16 AWG
343	RUN 3	STOP SW3 NC #2	MC3 NO #14	Blu/Wht 16 AWG
344	RUN 3	MC3 NO#13	VARIOUS RUN3 PWR	Blu/Wht 16 AWG
345	RUN 3	MCB3 AUX BLK	VARIOUS RUN3 PWR	Blk 16 AWG
414	PUMP 1 STANDBY	PUMP SW1 STANDBY #1	VARIOUS RUN1 PWR	Blu/Wht 16 AWG
424	PUMP 2 STANDBY	PUMP SW2 STANDBY #1	VARIOUS RUN2 PWR	Blu/Wht 16 AWG
501	COOLING PUMP CONTROL	COOLING PUMP SW	MC4 A1	Blu/Wht 16 AWG
503	COOLING PUMP CONTROL	CONTACTOR/OL A2	OL 96	Wht/Blu 16 AWG
601	30 GPM P1	CONTROLLER GRAY A01	PUMP 1 STANDBY #4	Blk 20 AWG
602	60 GPM P1	CONTROLLER GRAY A02	PUMP 1 60 GPM #4	Blk 20 AWG
603	FLOW CONTROL P1 PWM(+)	CONTROLLER BLACK B01	5 PIN RECP PIN 3 GREEN	Gm 20 AWG
604	P1 FLOW CONTROL NEG (-)	CONTROLLER BLACK B05	5 PIN RECP PIN 5 RED/BLK	Blk 20 AWG
611	LS DUMP/BLOCK SOL. 1	CONTROLLER BLACK B02	5 PIN RECP PIN 1 RED/WH	Wht 20 AWG
612	PRESSURE SOL. 1 PWR	5K SW TERM LEFT #4	5 PIN RECP PIN 2 RED	Red 20 AWG
613	LS DUMP/BLK & PRESS NEG(-)	5 PIN RECP PIN 4 RED/YEL	0V TERMINAL BLOCK	Yel 20 AWG
701	30 GPM P2	CONTROLLER GRAY A03	PUMP 2 STANDBY #4	Blk 20 AWG
702	60 GPM P2	CONTROLLER GRAY A04	PUMP 2 60 GPM #4	Blk 20 AWG
703	FLOW CONTROL P2 PWM(+)	CONTROLLER BLACK B03	5 PIN RECP PIN 3 GREEN	Gm 20 AWG
704	P2 FLOW CONTROL NEG (-)	CONTROLLER BLACK B06	5 PIN RECP PIN 5 RED/BLK	Blk 20 AWG
711	LS DUMP/BLOCK SOL. 2	CONTROLLER BLACK B04	5 PIN RECP PIN 1 RED/WH	Wht 20 AWG
712	PRESSURE SOL. 2 PWR	5K SW TERM LEFT #4	5 PIN RECP PIN 2 RED	Red 20 AWG
713	LS DUMP/BLK & PRESS NEG(-)	5 PIN RECP PIN 4 RED/YEL	0V TERMINAL BLOCK	Yel 20 AWG
801	5000 PSI MODE ON STATUS	CONTROLLER GRAY A06	KEY SW CENTER TERM 4	Blu 20 AWG
CAN1-L	CAN1 -L	CONTROLLER GRAY A09	P0313-070 B	Gm 16 AWG
CAN1-H	CAN1 -H	CONTROLLER GRAY A10	P0313-070 A	Yel 16 AWG
0V TBD	0 Vdc	CONTROLLER GRAY A11	0V TERMINAL BLOCK	Wht / Blu 16 AWG
24V TBD	24 Vdc	CONTROLLER GRAY A12	24V TERMINAL BLOCKS	Blu / Wht 16 AWG
5V	5V (USED FOR 5K STATUS)	CONTROLLER BLACK B08	KEY SW CENTER TERM 3	Blu 20 AWG
1001	BROWN DISTRIBUTION FEED	MAIN BREAKER T1	DISTRUBUTION BLOCK BRN	3/O
1002	ORANGE DISTRIBUTION FEED	MAIN BREAKER T2	DISTRUBUTION BLOCK ORG	3/O
1003	YELLOW DISTRIBUTION FEED	MAIN BREAKER T3	DISTRUBUTION BLOCK YEL	3/O
1004	BH PUMP 1	DISTRUBUTION BLOCK BRN	BREAKER BH PUMP 1 L1	2 AWG
1005	BH PUMP 1	DISTRUBUTION BLOCK ORG	BREAKER BH PUMP 1 L2	2 AWG
1006	BH PUMP 1	DISTRUBUTION BLOCK YEL	BREAKER BH PUMP 1 L3	2 AWG
1007	BH PUMP 2	DISTRUBUTION BLOCK BRN	BREAKER BH PUMP 2 L1	2 AWG
1008	BH PUMP 2	DISTRUBUTION BLOCK ORG	BREAKER BH PUMP 2 L2	2 AWG
1009	BH PUMP 2	DISTRUBUTION BLOCK YEL	BREAKER BH PUMP 2 L3	2 AWG
1010	JACK PUMP	DISTRUBUTION BLOCK BRN	BREAKER JACKING PUMP L1	4 AWG
1011	JACK PUMP	DISTRUBUTION BLOCK ORG	BREAKER JACKING PUMP L2	4 AWG
1012	JACK PUMP	DISTRUBUTION BLOCK YEL	BREAKER JACKING PUMP L3	4 AWG
1013	COOLING/AUX PUMP	DISTRUBUTION BLOCK BRN	BREAKER COOL/AUX L1	Brn 14 AWG

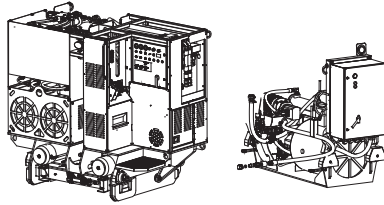
5200 Pump Unit Electrical Schematic Wire List (continued)
(SN F27700F-12 & After) Wire List - Part 3 of 3

WIRE NUMBER	DESCRIPTION	FROM LOCATION #1	TO LOCATION #2	WIRE COLOR/GAUGE
1014	COOLING/AUX PUMP	DISTRUBUTION BLOCK ORG	BREAKER COOL/AUX L2	Org 14 AWG
1015	COOLING/AUX PUMP	DISTRUBUTION BLOCK YEL	BREAKER COOL/AUX L3	Yel 14 AWG
1016	COOLING/AUX PUMP	BREAKER COOL/AUX T1	CONTACTOR COOL/AUX L1	Bm 14 AWG
1017	COOLING/AUX PUMP	BREAKER COOL/AUX T2	CONTACTOR COOL/AUX L2	Org 14 AWG
1018	COOLING/AUX PUMP	BREAKER COOL/AUX T3	CONTACTOR COOL/AUX L3	Yel 14 AWG
1019	JACK PUMP	BREAKER JACKING PUMP T1	CONTACTOR JACK PUMP L1	4 AWG
1020	JACK PUMP	BREAKER JACKING PUMP T2	CONTACTOR JACK PUMP L2	4 AWG
1021	JACK PUMP	BREAKER JACKING PUMP T3	CONTACTOR JACK PUMP L3	4 AWG
1022	BH PUMP 2	BREAKER BH PUMP 2 T1	CONTACTOR BH PUMP 2 L1	2 AWG
1023	BH PUMP 2	BREAKER BH PUMP 2 T2	CONTACTOR BH PUMP 2 L2	2 AWG
1024	BH PUMP 2	BREAKER BH PUMP 2 T3	CONTACTOR BH PUMP 2 L3	2 AWG
1025	BH PUMP 1	BREAKER BH PUMP 1 T1	CONTACTOR BH PUMP 1 L1	2 AWG
1026	BH PUMP 1	BREAKER BH PUMP 1 T2	CONTACTOR BH PUMP 1 L2	2 AWG
1027	BH PUMP 1	BREAKER BH PUMP 1 T3	CONTACTOR BH PUMP 1 L3	2 AWG
1028	FEED 120 POWER SUPPLY	DISTRUBUTION BLOCK ORG	120 POWER SUPPLY 6 HV	Blk 14 AWG
1029	FEED 120 POWER SUPPLY	DISTRUBUTION BLOCK YEL	120 POWER SUPPLY 1 HV	Blk 14 AWG
1030	TUNNEL POWER BREAKER	DISTRUBUTION BLOCK BRN	TP BREAK TERMINAL BLOCK	Bm 14 AWG
1031	TUNNEL POWER BREAKER	DISTRUBUTION BLOCK ORG	TP BREAK TERMINAL BLOCK	Org 14 AWG
1032	TUNNEL POWER BREAKER	DISTRUBUTION BLOCK YEL	TP BREAK TERMINAL BLOCK	Yel 14 AWG
1033	24V POWER SUPPLY	DISTRUBUTION BLOCK BRN	24V POWER SUPPLY BRN F4	Bm 14 AWG
1034	24V POWER SUPPLY	DISTRUBUTION BLOCK ORG	24V POWER SUPPLY ORG F5	Org 14 AWG
1035	24V POWER SUPPLY	DISTRUBUTION BLOCK YEL	24V POWER SUPPLY YEL F6	Yel 14 AWG
1036	PHASE LIGHT	PHASE LIGHT RED	PHASE LIGHT GREEN	Red/Blk 18 AWG
1037	PHASE LIGHT	PHASE DETECTOR 1	PHASE LIGHT RED	Red/Blk 18 AWG
1038	PHASE LIGHT	PHASE DETECTOR 9	PHASE LIGHT GREEN	Red/Wht 18 AWG
1039	PHASE LIGHT	PHASE DETECTOR 7	PHASE LIGHT RED	Red/Wht 18 AWG
1040	PHASE DETECTOR	PHASE DETECTOR FUSE F1	PHASE DETECTOR 3	Bm 14 AWG
1041	PHASE DETECTOR	PHASE DETECTOR FUSE F2	PHASE DETECTOR 2	Org 14 AWG
1042	PHASE DETECTOR	PHASE DETECTOR FUSE F3	PHASE DETECTOR 1	Yel 14 AWG
1043	PHASE DETECTOR	PHASE DETECTOR 8	PHASE DETECTOR 3	Bm 16 AWG
1044	PHASE DETECTOR	MAIN BREAKER L1	PHASE DETECTOR FUSE F1	Bm 14 AWG
1045	PHASE DETECTOR	MAIN BREAKER L2	PHASE DETECTOR FUSE F2	Org 14 AWG
1046	PHASE DETECTOR	MAIN BREAKER L3	PHASE DETECTOR FUSE F3	Yel 14 AWG
1047	INCOMING POWER	INCOMING CAM LOCK BRN	MAIN BREAKER L1	3/O
1048	INCOMING POWER	INCOMING CAM LOCK ORG	MAIN BREAKER L2	3/O
1049	INCOMING POWER	INCOMING CAM LOCK YEL	MAIN BREAKER L3	3/O
1050	INCOMING GROUND	INCOMING CAM LOCK GRN	GROUND "LUG"	2 AWG
1051	TUNNEL POWER LIGHT	TUNNEL PWR CONTACT T1	TUNNEL POWER LIGHT	BLK 18 AWG
1052	TUNNEL POWER LIGHT	TUNNEL POWER LIGHT	GROUND LUG	GRN 18 AWG
1053	LARGE BOX TERMINAL BLOCK	LARGE BOX TERM BLOCK	TUNNEL POWER BRAKER	BRN 14 AWG
1054	LARGE BOX TERMINAL BLOCK	LARGE BOX TERM BLOCK	TUNNEL POWER BRAKER	ORG 14 AWG
1055	LARGE BOX TERMINAL BLOCK	LARGE BOX TERM BLOCK	TUNNEL POWER BRAKER	YEL 14 AWG
1056	24V POWER SUPPLY FEED	F4 FUSE	24V POWER SUPPLY	BLU 16 AWG
1057	24V POWER SUPPLY FEED	F5 FUSE	24V POWER SUPPLY	BLU 16 AWG
1058	24V POWER SUPPLY FEED	F6 FUSE	24V POWER SUPPLY	BLU 16 AWG
1059	TEMP DISP	TEMP RECEPTICLE # 1	TEMP DISPLAY EXC	BLU 16 AWG
1059A	TEMP DISP	TEMP DISPLAY EXC	TEMP DISPLAY INP	BLU 16 AWG
1060	TEMP DISP	TEMP RECEPTICLE # 2	TEMP DISPLAY COM	BLU 16 AWG

NOTES

Specifications

5200 PUMP UNIT & 200 HP AUXILIARY



Dimensions

	5200	200 HP Aux
Height	90" (2,286 mm)	63.5" (1,613 mm)
Width	107" (2,718 mm)	79.32" (2,015 mm)
Depth	64" (1,626 mm)	37.45" (951 mm)

Weight

5200 With Oil	17,200 lbs. (7,802 kg)
200 HP Auxiliary	3,600 lbs. (1,633 kg)

Thrust Cylinders

Total .. (Two 220 ton, 36" Stroke) 400 Ton (363 t)

Hydraulic Supply

- Three independent hydraulic systems for jacking and TBM supply functions.
- Single hydraulic oil cooler for the jacking and TBM hydraulic systems. Clean cooling water must be supplied for heat exchanger.

Low Pressure (TBM & Conveyor)

- A 100 HP (74 kW) electric motor provides power for 40/60 gpm variable volume, pressure compensated pump @ 3,000 psi. Maximum pressure is 3,000 psi.
- A second 100 HP electric motor provides power for an additional 40/60 gpm variable volume, pressure compensated pump @ 3,000 psi. Maximum pressure is 3,000 psi.
- A 5,000 psi selection is available for TBM Series II: 100HP @ 40 gpm, *200HP @ 60 or 40/40 gpm
* with optional 200 HP auxiliary unit

High Pressure (Jacking & IJS Cylinders)

- A 60 HP electric motor provides power for 0 to 13 gpm variable volume, pressure compensated pump @ 8,000 psi. Maximum pressure is 8,000 psi.

Hydraulic Reservoir Capacity..... 240 gal. (908 L)

Heat Exchanger Cooling Water Supply

Minimum Clean Water 8 GPM

Electrical

- 5200 Pump Unit

- Recommended Operating Power: 275kW / 340kVA @ 480VAC
- Generator Minimum Motor Starting kVA: 385skVA with less than 35% instantaneous voltage dip and greater than 90% sustained voltage

- 200 HP Auxiliary

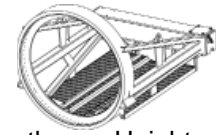
- Recommended Operating Power: 225kW / 280kVA @ 480VAC
- Generator Minimum Motor Starting kVA: 770skVA with less than 35% instantaneous voltage dip and greater than 90% sustained voltage

Shaft (Pit) Height Minimum

With Pump Unit and Skid 110" (2,794 mm)

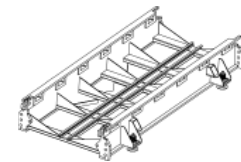
Akkerman reserves the right to improve its product without notice or obligation.

YOKE



Model	Width	Length	Height
360	72.75" (1,848mm)	91.5" (2,324mm)	44" (1,118mm)
420	72.75" (1,848mm)	93.5" (2,375mm)	51" (1,295mm)
480	72.75" (1,848mm)	93.5" (2,375mm)	58" (1,473mm)
540	72.75" (1,848mm)	93.5" (2,375mm)	65" (1,651mm)
540 Extended	72.75" (1,848mm)	123.5" (3,137mm)	65" (1,651mm)
600	77.5" (1,969mm)	93.75" (2,381mm)	72" (1,829mm)
600 Extended	77.5" (1,969mm)	123.75" (3,137mm)	72" (1,829mm)
660	79" (2,007mm)	93.75" (2,381mm)	79" (2,007mm)
720	86" (2,184mm)	93.75" (2,381mm)	86" (2,184mm)
720 Extended	86" (2,184mm)	123.75" (3,137mm)	86" (2,184mm)
780	93" (2,362mm)	123.75" (3,137mm)	93" (2,362mm)
840 Extended	100" (2,540mm)	123.75" (3,137mm)	100" (2,540mm)

SKID

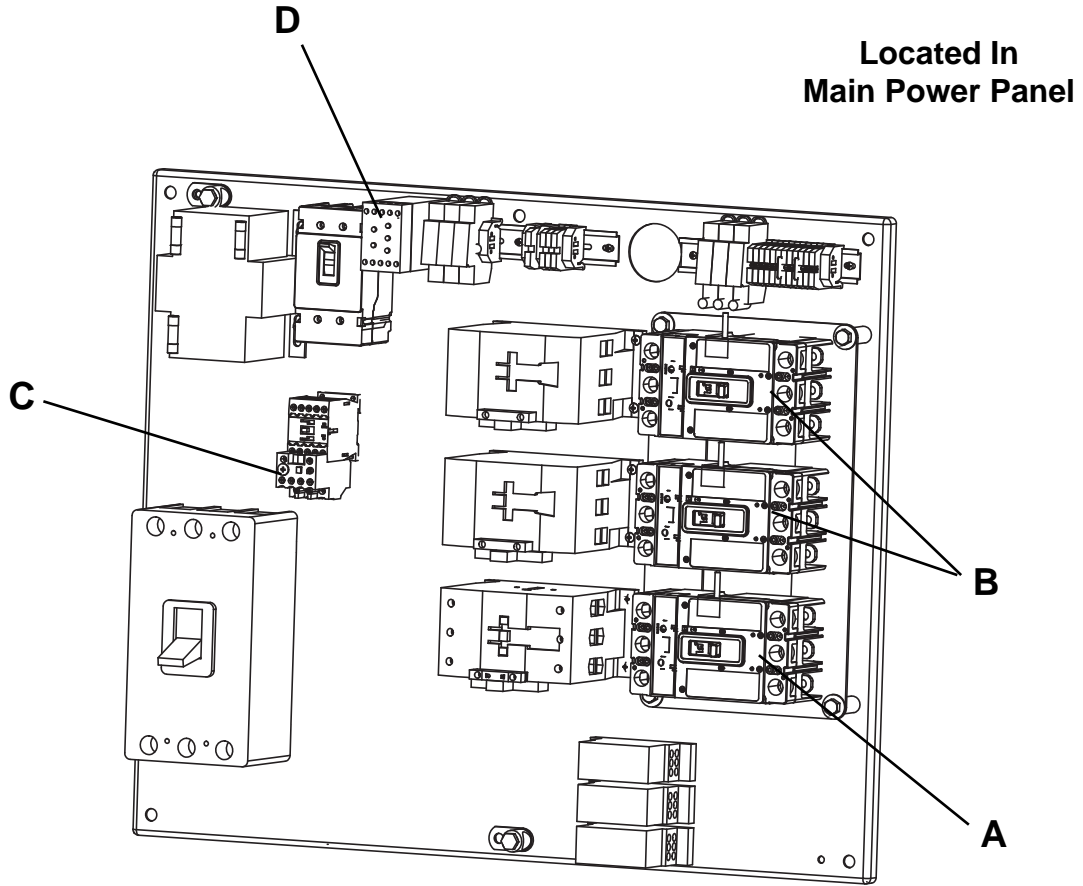


Model	Width	Length	Height
Skid 2.5 Foot	80" (2,032mm)	30" (762mm)	25.5" (648mm)
Skid 7.5 Foot	91" (2,311mm)	90" (2,286mm)	25.5" (648mm)
Skid 15 Foot	91" (2,311mm)	180" (4,572mm)	25.5" (648mm)
Skid 22.5 Foot	91" (2,311mm)	270" (6,858mm)	25.5" (648mm)

Weight:

Skid 2.5'	1,500 lbs. (680 kg)
Skid 7.5'	4,200 lbs. (1,905 kg)
Skid 15'	8,400 lbs. (3,810 kg)
Skid 22.5'	12,600 lbs. (5,715 kg)

RELAY SETTINGS



60 HP Overload Relay (A)

FLA	E
Class	N

100 HP Overload Relay (B)

FLA	F
Class	N

5 HP Overload Relay (C)

Amps	6.2
------------	-----

Phase Check Relay (D)

Undervoltage	80%
Nominal Voltage	480
Unbalance	10%
Time Delay Undervoltage (Seconds)	0.1
Time Delay Restart (Seconds)	1

TORQUE CHART

Use these torque values as a guideline when tightening hardware unless otherwise specified in this manual.

Lubricated Coarse UNC Threads Grade 8 Fasteners			Lubricated Fine UNF Threads Grade 8 Fasteners		
Bolt Size	Torque		Bolt Size	Torque	
	ft. lbs.	(N·m)		ft. lbs.	(N·m)
1/4 - 20	10	(14)	1/4 - 28	11	(15)
5/16 - 18	20	(27)	5/16 - 24	22	(30)
3/8 - 16	35	(47)	3/8 - 24	39	(53)
7/16 - 14	56	(76)	7/16 - 20	62	(84)
1/2 - 13	85	(115)	1/2 - 20	96	(130)
9/16 - 12	123	(167)	9/16 - 18	137	(186)
5/8 - 11	170	(231)	5/8 - 18	192	(260)
3/4 - 10	301	(408)	3/4 - 16	336	(456)
7/8 - 9	450	(610)	7/8 - 14	500	(678)
1 - 8	680	(922)	1 - 12	740	(1003)
1-1/8 - 7	960	(1302)	1-1/8 - 12	1030	(1397)
1-1/4 - 7	1360	(1844)	1-1/4 - 12	1500	(2034)
1-1/2 - 6	2360	(3200)	1-1/2 - 12	2660	(3607)

NOTES

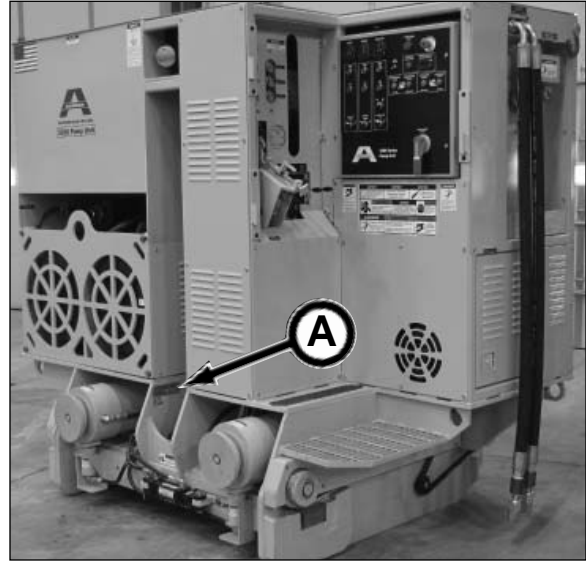
Identification Numbers

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

5200 PUMP UNIT (A)

Model Number _____

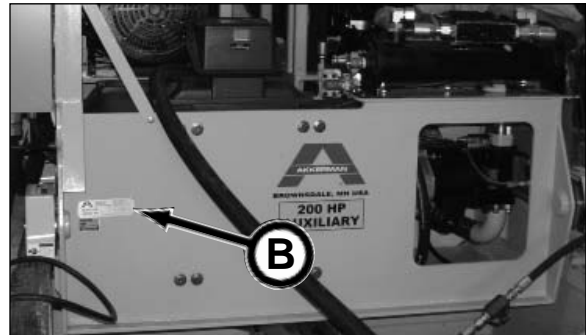
Serial Number _____



200 HP AUXILIARY UNIT (B)

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 will provide, at no cost, SDS which apply to its product line. Simply contact your Akkerman Aftermarket 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.

Warranty

NOTES

Index

A

Air compressor	9-29
Air/hydraulic adapter	6-43, 6-45
Alignment	6-6
Alignment, line and grade	6-1
Analysis, hydraulic oil	9-33
Annually	9-9
Annually - maintenance procedures	9-37
Applying new decal	2-1
Attach main jacking rams to yoke	6-20
Auxiliary controls	6-17
Auxiliary hookup to pump unit	6-15
Auxiliary main power switch	6-18, 6-19
Auxiliary pendant	6-15
Auxiliary pump case drain qd	6-15
Auxiliary unit, 200 hp	3-7
Auxiliary unit hydraulics	6-15
Auxiliary unit cooling pump return qd	6-15
Auxiliary unit pump supply connection	6-15
Auxiliary unit specifications	12-1
Auxiliary unit to pump unit, hookup.....	6-15
Avoid laser light exposure	1-6
Avoid pinch points	1-7, 9-3
Axis, tunnel	6-3

B

Before performing maintenance	9-1
Beware of suspended loads	1-4
Block grease, skid lock	8-2
Blocks, skid lock	4-13
Block, thrust	6-3
Boring head 1 electric motor rotation, testing ..	6-9
Boring head 1 motor	6-10
Boring head 1 motor start button	6-9, 6-25
Boring head 1 motor stop button	6-29
Boring head 1 system	4-6
Boring head 2 electric motor rotation	6-11
Boring head 2 motor start button	6-26
Boring head 2 motor stop button	6-29
Boring head 2 motor system	6-25
Boring head 2 system	4-6
Boring head supply controls	4-7
Boring head supply pressure hoses	6-16

C

Cable connection, tunnel power	4-4
Cable, tunnel	4-4
Cam lock connections	6-15
Capability, maximum jacking	6-34
Capacity, reservoir	4-15, 8-1
Chain	9-4, 9-7
Chain deflection	9-20, 9-33
Chain tightener	9-20, 9-33

C (Continued)

Charts, maintenance	
Annually	9-9
Completion Of Each Drive	9-8
Daily or Every 10 Hours or Shift Change ...	9-5
Every 1000 Hours Of Operation	9-8
Monthly or Every 250 Hours	9-7
Prior To Each Job Launch	9-4
Weekly or Every 50 Hours	9-6
Check drive chain tension	9-20, 9-33
Check filter indicators	9-16, 9-26
Check hydraulic oil reservoir level & condition of oil	9-18, 9-28
Check motors	9-12, 9-32
Check, start-up	6-7
Check valve assembly	4-7
Clean and inspect equipment	1-3
Clothing, wear protective	1-1
Codes, led status indicator	4-2, 9-10
Cold weather operation	6-40
Completion of each drive	9-8
Completion of each drive -Maint. Procedure ...	9-34
Confined space permit	5-1
Connection, tunnel power cable	4-4
Contents	iii
Control, dogging	4-13
Control, high speed jacking retract	6-28
Control, IJS cylinder	4-10
Control, jacking/IJS variable speed	4-9
Control panel	3-3
Control, ram lift cylinder	4-11
Controls, boring head supply	4-7
Controls & instruments	4-1
Controls, jacking cylinder	4-9
Control, skid lock	4-13
Controls, motor	4-6
Control, travel	4-12
Control, variable speed	4-10
Conveyor	6-23
Conveyor & dirt bucket, installing	6-23
Cooling electric motor rotation	6-13, 6-19
Cooling pump switch	6-19
Cooling system, hydraulic oil	4-8
Corrosion preventive, cylinder	10-1
Cradles, yoke ram	4-11
Cylinder control, IJS	4-10
Cylinder control, ram lift	4-11
Cylinder controls, jacking	4-9
Cylinder corrosion preventive	10-1
Cylinder ram plate	9-4, 9-5
Cylinder ram plate bolts	9-19, 9-30
Cylinder ram plate hardware	9-19, 9-30
Cylinder retract, high speed jacking	4-9
Cylinder retraction, jacking	4-9
Cylinder selector, jacking	4-10
Cylinder, skid lock	4-13
Cylinders, main ram	4-11
Cylinder speed control	4-10, 6-37

D

Daily or every 10 hours of operation or shift change	9-5
Daily or every 10 hours of operation or shift change - maintenance procedures	9-24
Daily pre-start inspection	5-1
Daily shut down	6-46
Decal, applying new	2-1
Decals, safety	2-1
Decals, safety, auxiliary unit	2-2
Decals, safety, 5200 pump unit	2-1
Decals, yoke safety	2-3
Deflection, chain	9-20, 9-33
Detectors, ventilation	6-1
Detent position	4-11
Digital temperature display	4-15
Dirt bucket	6-23, 6-27, 6-33
Dirt bucket, installing conveyor &	6-23
Discharge hose	6-8
Dogging control	4-13
Drain heat exchanger	9-29
Drain & replace hydraulic oil	9-35
Drain water from hydraulic reservoir	9-34
Drive chain	9-4, 9-7, 9-20, 9-33, 10-1
Drive chain tension	6-6, 10-1
Drive chain tension, check	9-20, 9-33
Drive motor rotation	9-13
Dual feed	4-7, 6-14
Dual feed supply	6-14

E

Electrical connections	3-6
Electrical connections, inspect	1-7
Electrical panel, main power	3-5
Electrical schematic	11-6, 11-11, 11-17
Electric motor bearing grease	8-1
Electric motor bearings	9-9, 9-37
Electric motor rotation, testing auxiliary	6-18
Electric motor rotation, testing aux. cooling	6-19
Electric motor rotation, testing boring head 1	6-9
Electric motor rotation, testing boring head 2	6-11
Electric motor rotation, testing cooling	6-13
Electric motor rotation, testing jacking	6-12
Elements, hydraulic filter	4-14
Emergency stop	4-1
Engineer, structural	6-3
Engulfed in water	9-35
Escaping oil	6-33
E-stop button	6-7, 6-8, 6-9, 6-10, 6-11, 6-12 ... 6-17, 6-18, 6-20, 6-25, 6-34, 6-47, 6-49, 9-2
Every 1000 hours of operation	9-8
Every 1000 hours of operation maintenance procedures	9-35

F

Fault indication code table	4-2, 9-10
Feed, dual	4-7, 6-14
Feed, single	4-7, 6-14
Filling hydraulic reservoir	6-39
Fill tube, transfer pump	9-35

F (Continued)

Filter	9-17, 9-27
Filter elements, hydraulic	4-14
Filter gasket	9-17, 9-27
Filter head assembly	9-17, 9-18, 9-27, 9-28
Filter indicator gauges	4-14
Filter indicators	9-16, 9-26
Filter indicators, return	4-14
Filter, replacing	9-16, 9-26
Filters, return	9-4, 9-5
Fire prevention	1-2
Floor, shaft	6-3
Foaming oil	9-18, 9-28
Freezing temperatures	6-40
Front components	3-1

G

Gauge, level	6-39
Gauge operation	9-11
Gauges, filter indicator	4-14
Gauges, pressure	4-5
Gauges, system pressure	4-5
Generator power leads	6-17
Grease	8-2
Grease, electric motor bearing	8-1
Grease, skid lock block	8-2, 9-31
Guidance system, laser	6-6, 6-33
Guidelines, operating	6-1
Guidelines, transporting	7-1

H

Haul unit	6-33
Haul unit operator's manual	6-32
Heat exchanger	4-8, 6-8, 6-47, 9-5, 10-1, 11-1
Heat exchanger, drain	9-29
Heat exchanger supply	6-8, 6-16
Heat exchanger water supply requirement	4-8
High pressure hydraulics	1-6, 6-1
High pressure (jacking) maximum system pressure	6-26
High pressure system	i, 4-5
High speed jacking cylinder retract	4-9
High speed jacking retract control	6-28
Hook, power cord	6-7
Hookup auxiliary unit to pump unit	6-15
Hose, discharge	6-8
Hourmeters	4-6, 9-1
Hydraulic filter elements	4-14
Hydraulic oil	9-4, 9-5
Hydraulic oil analysis	9-33
Hydraulic oil cooling system	4-8
Hydraulic oil, drain & replace	9-35
Hydraulic oil/fluids under pressure	1-2, 9-2
Hydraulic oil, recommended	8-1
Hydraulic oil level & condition of oil	9-18, 9-28
Hydraulic oil temperature	4-8, 4-15, 11-1
Hydraulic pump supply shut off valves	6-9
Hydraulic reservoir	4-15, 9-8, 9-34
Hydraulic reservoir capacity	4-15
Hydraulic reservoir, filling	6-39

H (Continued)

Hydraulic reservoir lubricant	8-1
Hydraulic schematic	11-4
Hydraulics, auxiliary unit	6-15
Hydraulics, high pressure	1-6
Hydraulic tank	4-15
Hydraulic tank capacity	4-15

I

Identification numbers	13-1
IJS	6-35, 6-48
IJS cylinder control	4-10, 6-37
IJS cylinders	6-37
IJS hydraulic hoses	6-36
IJS, installing	6-35
IJS line holder	6-36, 6-37
IJS, operating	6-36
IJS schematic	6-38
IJS sleeve	6-35
IJS valve	6-36
IJS variable speed control	4-9, 4-10
Indicator codes, led status	4-2, 9-10
Indicator gauges, filter	4-14
Indicator, low oil level	4-15
Indicators, filter	9-16, 9-26
Indicators, lock	4-13
Indicators, return filter	4-14
Information, safety	1-1
Inner ring flange	6-35
Inspect and clean equipment	1-3
Inspect electrical connections	1-7
Inspection cover	6-10, 6-11
Inspection, pre-start	5-1
Inspect pump unit	9-15, 9-25
Inspect skid lock blocks	9-31
Installing conveyor & dirt bucket	6-23
Installing IJS	6-35
Instructions, lifting	7-2
Instruments & controls	4-1
Intermediate jacking stations	6-35
Introduction	i

J

Jacking capability, maximum	6-34
Jacking cylinder	4-9
Jacking cylinder controls	4-9
Jacking cylinder retract, high speed	4-9
Jacking cylinder retraction	4-9
Jacking cylinder selector	4-9, 4-10, 6-20
Jacking cylinder selector switch. 6-24,6-31,6-28,6-32	
Jacking cylinder speed control .. 6-26, 6-31, 6-32	
Jacking electric motor rotation, testing	6-12
Jacking/IJS variable speed control	4-9, 4-10
Jacking motor	6-12, 6-20, 6-22, 6-36
Jacking motor start button	6-12, 6-24, 6-30
Jacking motor stop button	6-12
Jacking operation	6-25
Jacking pressure gauge	6-37
Jacking pump control switch	6-36
Jacking pump selection switch	6-37
Jacking pump selector	4-9, 4-10, 6-20

J (Continued)

Jacking rams to yoke, attach main	6-20
Jacking retract control, high speed	6-28
Jacking system	4-6
Jacking system layout, pipe	6-2
Jacking system, no riders on	1-4
Jacking system, removing	6-48
Jacking system, setting up the	6-3
Jacking variable speed control	4-9

K

Keep away from conveyors	1-6
Keep job site clean and organized	1-5
Keep personnel away from moving parts	1-3

L

Laser beam	6-1
Laser guidance system	6-6, 6-33
Laser light exposure, avoid	1-6
Launch and reception shafts	6-3
Layout, pipe jacking system	6-2
Led status indicator codes	4-2, 9-10
Level gauge	6-39
Leveling screws	6-4, 9-2, 9-4
Lifting instructions	7-2
Light	4-5
Light, phase error	4-2, 4-3
Light, phase ok	4-2
Lights, operating	4-1, 4-5
Lights, phase indicator	4-2, 4-3
Light, tunnel power on	4-4
Line and grade alignment	6-1
Loads, suspended	1-4
Locator pin	6-4
Lock blocks	4-13
Lock indicators	4-13
Lockout power before servicing	1-5, 9-2
Lockout power source	9-2
Lockout/tagout	6-7, 6-15, 6-17, 6-47, 6-49, 9-2
Lockout/tagout power before servicing	1-5, 9-2
Lock position indicators	6-24
Low oil level indicator	4-15
Low oil level sensor	4-15
Low pressure system	i, 4-5
Lubricant, hydraulic reservoir	8-1
Lubricants	8-1
Lubricants, storing	8-2
Lubricate motor bearings	9-37
Lubrication & maintenance intervals	9-1

M

Main jacking cylinder retraction	4-9
Main power	4-8
Main power electrical panel	3-5
Main power switch	4-3, 6-9, 6-10, 6-12
..... 6-13, 6-20, 6-25, 6-47	
Main ram cylinders	4-11, 6-28
Maintenance, before performing	9-1

M (Continued)

Maintenance charts	9-4
Annually	9-9
Completion Of Each Drive	9-8
Daily or Every 10 Hours or Shift Change ...	9-5
Every 1000 Hours Of Operation	9-8
Monthly or Every 250 Hours	9-7
Prior To Each Job Launch	9-4
Weekly or Every 50 Hours	9-6
Maintenance & lubrication intervals	9-1
Maintenance, periodic	9-1
Maintenance, practice safe	1-3
Maintenance procedures	
Annually	9-37
Completion Of Each Drive	9-34
Daily or Every 10 Hours or Shift Change .	9-24
Every 1000 Hours Of Operation	9-35
Monthly or Every 250 Hours	9-33
Prior To Each Job Launch	9-10
Weekly or Every 50 Hours	9-31
Maximum jacking capability	6-34
Maximum pressure capacity	6-35
Metal flakes	9-17, 9-27
Milky oil	9-18, 9-28
Misalignment	6-1
Monthly or every 250 hours of operation	9-7
Monthly or every 250 hours of operation	
maintenance procedures	9-33
Motor bearings, electric	9-9
Motor bearings, lubricate	9-37
Motor controls	4-6
Motor rotation	6-10
Motor rotation, testing jacking electric	6-12
Motors	9-6
Motors, check	9-12, 9-32
Motor stop button	6-49
Msds	14-1

N

No riders on jacking system	1-4
No smoking in tunnel	1-6

O

Oil analysis	9-7, 10-1
Oil analysis, hydraulic	9-33
Oil bubbles	9-18, 9-28
Oil level indicator, low	4-15
Oil level sensor, low	4-15
Oil, milky	9-18, 9-28
Oil, recommended hydraulic	8-1
Oil reservoir level & condition of oil,	
hydraulic	9-18, 9-28
Oil temperature, hydraulic	4-15
Oil transfer pump	6-39
On-board pump	6-39
Operating guidelines	6-1
Operating IJS	6-36
Operating lights	4-1
Operating the pump unit	6-20
Operation	6-1

O (Continued)

Operation, cold weather	6-40
Operation, jacking	6-25
Operator control panel	3-4
Operator's manual, read	1-1
Osha	6-3
Osha regulations	5-1
Over cut	6-6
Overvoltage	4-2, 9-10

P

Particle contamination	9-18, 9-28, 9-35
Performing maintenance, before	9-1
Periodic maintenance	9-1
Permit, confined space	5-1
Phase detector	4-2, 9-10
Phase error light	4-2, 4-3, 4-6, 6-8, 9-10
Phase imbalance	4-2, 9-10
Phase indicator lights	4-2, 4-3, 4-6, 6-8, 9-10
Phase loss	4-2, 9-10
Phase ok light	4-2, 4-3, 4-6, 6-8, 9-10
Phase power	9-10
Pinch points, avoid	1-7, 9-3
Pipe jacking system layout	6-2
Pipeline layout	6-32
Plug, transfer pump	6-39, 9-35
Pockets, skid	4-13
Positioning pump unit/yoke with tbm	6-22
Power cable, using tunnel	1-7
Power cord hook	6-7
Power on light, tunnel	4-4
Power supply cord	6-15
Power switch, main	4-3
Power, tunnel	4-4
Practice safe maintenance	1-3
Preparing for storage	10-1
Preparing pump unit for operation	6-6
Pressure gauges	4-5
Pressure gauges, system	4-5
Pressure peaks	6-28
Pressure system, high	i
Pressure system, low	i
Pre-start inspection	5-1
Prior To Each Job Launch	9-4
Prior To Each Job Launch	
maintenance procedures	9-10
Procedures, maintenance	
Annually	9-37
Completion Of Each Drive	9-34
Daily or Every 10 Hours or Shift Change .	9-24
Every 1000 Hours Of Operation	9-35
Monthly or Every 250 Hours	9-33
Prior To Each Job Launch	9-10
Weekly or Every 50 Hours	9-31
Program, safety	5-1
Protective clothing, wear	1-1
Pump compensator	11-1
Pump control	6-9
Pump fill tube, transfer	6-39
Pump, oil transfer	6-39
Pump, on-board	6-39

P (Continued)

Pump supply shut off valves, hydraulic	6-9
Pump unit for operation, preparing	6-6
Pump unit frame	9-4, 9-5
Pump unit hydraulics	6-23
Pump unit, inspect	9-15, 9-25
Pump unit operation	6-20
Pump unit, setting up the - start-up check	6-7
Pump unit specifications	12-1
Pump unit/yoke with tbm, positioning	6-22
Purging fluid from tunnel lines with non series ii tbm	6-42
Purging fluid from tunnel lines with series ii tbm	6-44

R

Rails	9-4, 9-5, 9-21, 9-24
Ram lift cylinder control	4-11, 6-31
Ram lift cylinder lever	6-21
Ram retaining pins	9-4, 9-5, 9-22, 9-25
Ram retaining pin stop	9-22, 9-25
Read operator's manual	1-1
Rear components	3-2
Reception shafts, launch and	6-3
Recommended hydraulic oil	8-1
Recycle waste	1-3
Regulations, osha	5-1
Relay settings	12-2
Removing from storage	10-1
Removing jacking system	6-48
Replace hydraulic oil	9-35
Replacing filter	9-16, 9-26
Requirement, heat exchanger water supply	4-8
Reservoir capacity	4-15, 8-1
Reservoir, filling hydraulic	6-39
Reservoir, hydraulic	4-15
Reservoir lubricant, hydraulic	8-1
Retaining pin stop	9-4, 9-5
Retract control, high speed jacking	6-28
Retract, high speed jacking cylinder	4-9
Retraction, jacking cylinder	4-9
Return filter assembly	4-14, 9-16, 9-26
Return filter indicators	4-14, 9-16, 9-26, 10-1
Return filters	9-4, 9-5
Road plates	6-3
Rotation, testing aux cooling electric motor	6-19
Rotation, testing aux 200 hp electric motor	6-19
Rotation, testing boring head 1 electric motor	6-9
Rotation, testing boring head 2 electric motor	6-11
Rotation, testing cooling electric motor	6-13
Rotation, testing jacking electric motor	6-12

S

Safety	1-1
Safety data sheets	14-1
Safety decals	2-1
Safety decals, auxiliary unit	2-2
Safety decals, 5200 pump unit	2-1
Safety decals, yoke	2-3
Safety information	1-1

S (Continued)

Safety program	5-1
Schematic, electrical	11-6, 11-11, 11-17
Schematic, hydraulic	11-4
Schematic, IJS	6-38
SDS	14-1
Selector, jacking cylinder	4-9, 4-10
Selector, jacking pump	4-9, 4-10
Sensor, low oil level	4-15
Serial numbers	13-1
Series ii tbm	6-25
Settings, relay	12-2
Setting up the 5200 pump unit - start-up check	6-7
Setting up the jacking system	6-3
Setting up the pump unit	6-14
Setting up the pump unit - start-up check	6-7
Setting up the pump unit & tbm supply/return hydraulics	6-14
Setting up the tbm supply/return hydraulics	6-14
Shaft floor	6-3
Shaft floor base	6-3
Shaft layout design	6-3
Shafts, launch and reception	6-3
Shoring	6-3
Shut down, daily	6-46
Shut off valves, hydraulic pump supply	6-9
Single feed	4-7, 6-14
Single feed supply	4-7, 6-14, 6-16
Skid assembly	4-12, 6-4
Skid assembly rails	6-5
Skid base	i, 9-4, 9-5,
Skid base assembly	6-5
Skid lock block grease	8-2, 9-31
Skid lock block lubrication fittings	9-31
Skid lock blocks ...4-13, 6-24, 6-27, 6-28, 6-31, 6-32, 9-6, 9-31	
Skid lock control	4-13, 6-24, 6-27, 6-31, 6-32
Skid lock cylinder	4-13
Skid lock linkage	9-4, 9-7, 9-20, 9-33
Skid pockets	4-13, 6-24, 6-28, 6-32
Skid sections	6-4
Skid specifications	12-1
Skid split bars	6-5
Skid & yoke	3-8
Skid & yoke terminology	3-8
Sliding track	6-35
Slippery when wet	1-5
Soil analysis	6-3
Specifications	12-1
Specifications, auxiliary unit	12-1
Specifications, pump unit	12-1
Specifications, skid	12-1
Specifications, yoke	12-1
Speed control, jacking/ijs variable	4-9
Speed control, variable	4-10
Start-up check	6-7
Stay away from crane	1-7
Stop button	6-49
Stop, emergency	4-1
Storage	10-1

S (Continued)

Storage, preparing for	10-1
Storage, removing from	10-1
Storing lubricants	8-2
Structural engineer	6-3
Supply controls, boring head	4-7
Survey	6-3
Suspended loads	1-4, 6-4, 6-5, 6-23, 6-35, 6-49
Switch, main power	4-3
Switch, tunnel power	4-4
System, high pressure	i
System layout, pipe jacking	6-2
System, low pressure	i
System pressure gauges	4-5

T

Tank drain valve	9-35
Tank, hydraulic	4-15
Tbm 6 way control valve	6-42, 6-44
Tbm hydraulics	6-23
Tbm, positioning pump unit/yoke with	6-22
Tbm series ii	6-25, 6-46
Temperature display, digital	4-15
Temperature, hydraulic oil	4-8, 4-15
Tension, check drive chain	9-20, 9-33
Tension, drive chain	6-6, 10-1
Terminology	3-1
Terminology, auxiliary unit	3-7
Terminology, 5200 - control panel	3-3
Terminology, 5200 - electrical connections	3-6
Terminology, 5200 front components	3-1
Terminology, 5200 - main power electrical panel... ..	3-5
Terminology, 5200 - operator control panel	3-4
Terminology, 5200 - rear components	3-2
Terminology, skid & yoke	3-8
Testing auxiliary electric motor rotation	6-18
Testing auxiliary cooling electric motor rotation	6-19
Testing boring head 1 electric motor rotation	6-9
Testing boring head 2 electric motor rotation	6-11
Testing cooling electric motor rotation	6-13
Testing jacking electric motor rotation	6-12
Test tunnel ventilation	1-4
Thrust block	6-3
Tightener, chain	9-20, 9-33
Torque chart	12-3
Trailing pipe	6-35
Transfer pump fill tube	6-39, 9-35
Transfer pump plug	6-39, 9-35
Transporting	7-1
Transporting guidelines	7-1
Transporting lifting instructions	7-2
Travel control	4-12, 6-31
Travel lever	6-22
Troubleshooting	11-1
Tunnel axis	6-3
Tunnel boring machine	6-6, 6-14, 6-24
Tunnel cable	4-4
Tunnel power	4-4
Tunnel power cable connection	4-4

T (Continued)

Tunnel power cables leads	6-49
Tunnel power cable, using	1-7
Tunnel power on light	4-4, 6-34
Tunnel power switch	6-25, 6-29, 6-34
.....	6-47, 6-48, 9-2
Tunnel ventilation, test	1-4

U

Unauthorized welding	1-2, 9-3
Undervoltage	4-2, 9-10
Using tunnel power cable	1-7

V

Valve, tank drain	9-35
Variable speed control	4-10, 6-21, 6-24
Variable speed control, jacking/ljs	4-9
Ventilation detectors	6-1
Ventilation, test tunnel	1-4

W

Warranty	15-1
Waste, recycle	1-3
Water supply requirement, heat exchanger	4-8
Wear protective clothing	1-1
Weather operation, cold	6-40
Weekly or every 50 hours of operation	9-6
Weekly or every 50 hours of operation maintenance procedures	9-31
Welding, unauthorized	1-2, 9-3
Wheels, yoke	6-5

Y

Yoke	i, 6-5, 6-23
Yoke, attach main jacking rams to	6-20
Yoke frame	9-4, 9-5, 9-21, 9-24
Yoke ram cradles	4-11, 6-21
Yoke safety decals	2-3
Yoke & skid	3-8
Yoke & skid terminology	3-8
Yoke specifications	12-1
Yoke wheels	6-5, 9-4, 9-5, 9-22, 9-25
Yoke with tbm, positioning pump unit	6-22