OPERATOR'S MANUAL

Microtunneling System

Control Container SN: FA22300F
Remote Hydraulic Power Pack SN: FA21945F
Main Drive Power Container SN: FA22080F
SL82P MTBM SN: FA09600F

Publication No. 050128A

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SERVICE • RELIABILITY • INNOVATION

DANGER

This machine is powered by high voltage electricity.



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

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

⚠ DANGER

This machine is equipped with an accumulator.



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

If accumulator requires repair, ONLY a certified service technician can check and fill the accumulator with dry nitrogen. Refer to the accumulator manufacturer for more information. NEVER FILL AN ACCUMULATOR WITH OXYGEN! An explosion WILL occur if oil and oxygen mix under pressure, resulting in serious injury or death. Also, NEVER fill accumulator with compressed air. Compressed air can cause premature wear to the accumulator seals.

Introduction

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

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

The use of parts other than genuine Akkerman parts could affect the efficient performance of the Microtunneling 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.

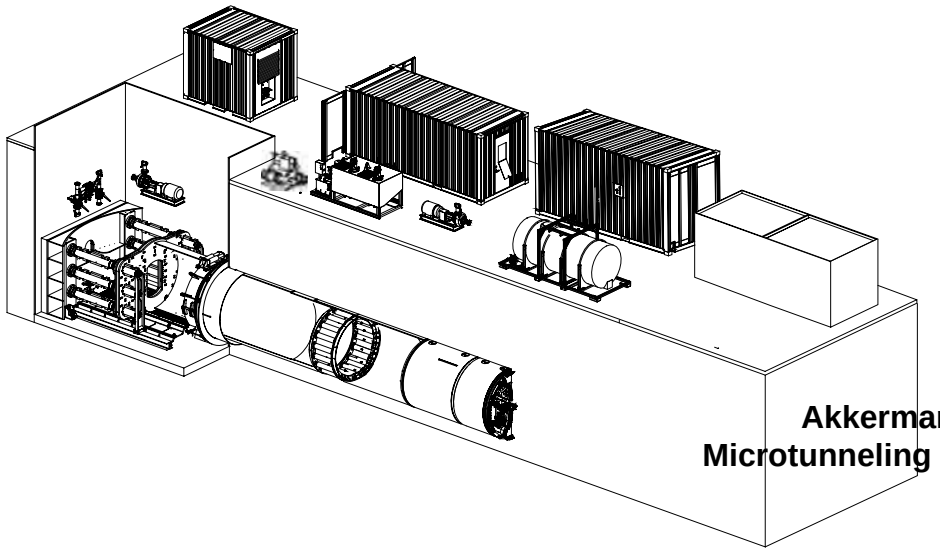
⚠DANGER Indicates an extremely hazardous situation which, if not avoided, WILL result in death or serious injury.

⚠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.



Akkerman Microtunneling System

Microtunneling is a type of "trenchless technology." It is generally defined as remotely controlled pipejacking (personnel entry is not required). Microtunneling is an extremely accurate, laser guided method for installing pipelines in varied soil conditions from flowing soft ground to hard rock. Slurry pressure balanced microtunneling systems enable installations below the water table or in very wet soil without the need for dewatering. The basic operation of a microtunneling system consists of: a microtunneling boring machine (MTBM) for piloting the course and excavating the ground. Simultaneously, slurry is pumped to the MTBM, mixed with the spoil and pumped to the surface for separation. A jacking frame with hydraulic cylinders are used to advance the MTBM and pipeline.

If you find any errors with this manual or have suggestions for improvement, please let us know. Email your comments via the Akkerman web site (Contact Us web page), or mail your suggestions to: Akkerman Inc, ATTN: Technical Publications, 58256 266th Street, Brownsdale, MN 55918.

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

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NOTES

Safety

BE ALERT FOR SAFETY INFORMATION

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

Read all safety information.

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



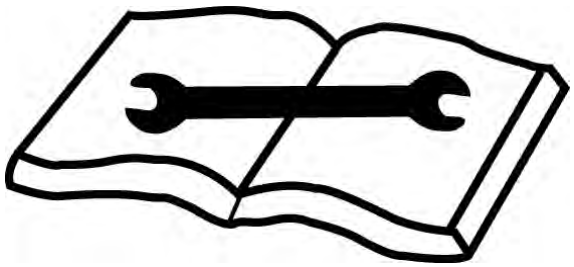
ATTENTION!
BECOME ALERT!
YOUR SAFETY IS INVOLVED!

READ OPERATOR'S MANUAL

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

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

Any unauthorized modifications will void the warranty.



WEAR PROTECTIVE CLOTHING

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

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



LOCKOUT TAGOUT POWER BEFORE SERVICING



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

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

HYDRAULIC OIL/FLUIDS UNDER PRESSURE



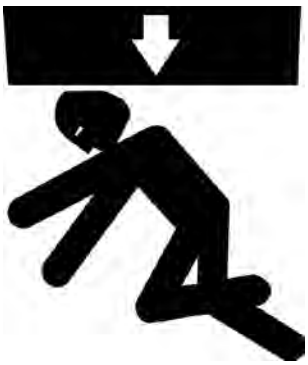
⚠WARNING Escaping oil or other fluids under pressure can penetrate your skin causing serious injury or death.

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

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

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

BEWARE OF SUSPENDED LOADS



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

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

Do not enter area under or around a load.

KEEP PERSONNEL AWAY FROM MOVING PARTS



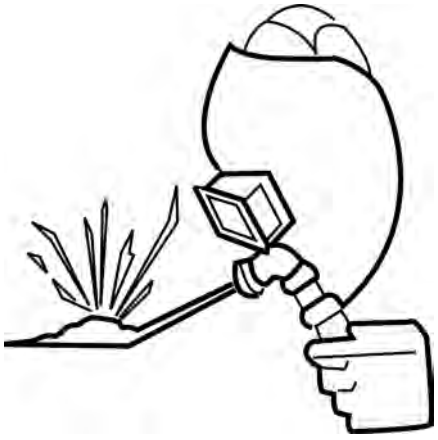
⚠WARNING Crushing hazard.
Keep personnel away from inside of jacking frame. Failure to do so could result in serious personal injury or death.

INSPECT ELECTRICAL CONNECTIONS



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

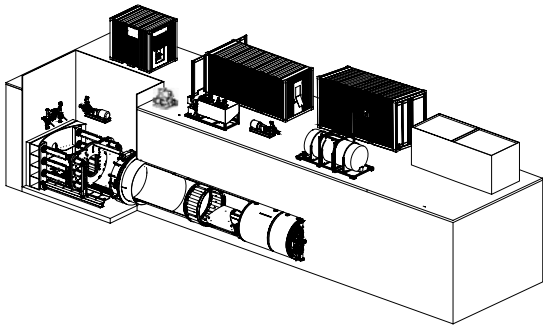
UNAUTHORIZED WELDING



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

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

REGULARLY CLEAN AND INSPECT EQUIPMENT



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

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

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.

CONTACT WITH POWER CABLE

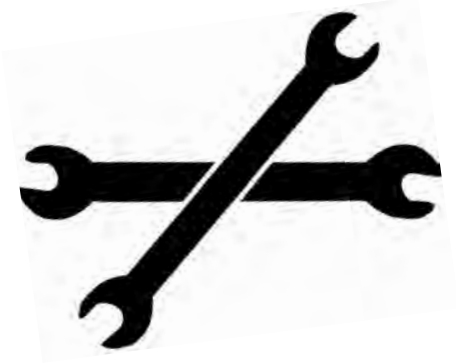


⚠DANGER Contact with a severed electrical cable WILL cause serious injury or death.

CONSTANTLY monitor electrical cables during drive to prevent cutting or stretching of any electrical cables.

PRACTICE SAFE MAINTENANCE

⚠WARNING Unexpected equipment movement may cause serious personal injury.



LOCKOUT TAGOUT power before performing any maintenance.

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

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

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

Do not service the machine while it is in motion.

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

AVOID PINCH POINTS



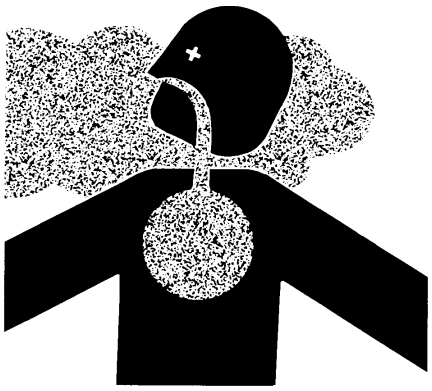
⚠WARNING Moving parts or the mishandling of parts can cause severe personal injury.

Keep hands away from moving parts.

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

Handle parts carefully to avoid crushing and pinch point hazards.

TEST TUNNEL VENTILATION





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

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

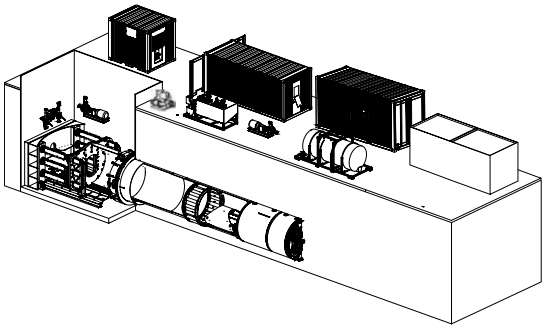
Before and during the shaft operation, test for combustible and toxic gases and oxygen deficiency.

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

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

Gases must be removed before reentering tunnel/shaft.

HIGH PRESSURE HYDRAULICS



⚠WARNING The Microtunneling System contains high pressure hydraulics.

Keep all guards in place.

SLIPPERY WHEN WET



⚠WARNING Slips and falls can cause serious personal injury.

Ensure firm footing in wet or slippery conditions.

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

Remove any buildup of grease, oil, or debris.

FIRE PREVENTION



⚠CAUTION Fires can cause injury or property damage.

Keep equipment clean. Remove all debris from equipment.

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

NO SMOKING IN SHAFT OR TUNNEL



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

Do not smoke in shaft or tunnel.

KEEP JOB SITE CLEAN AND ORGANIZED



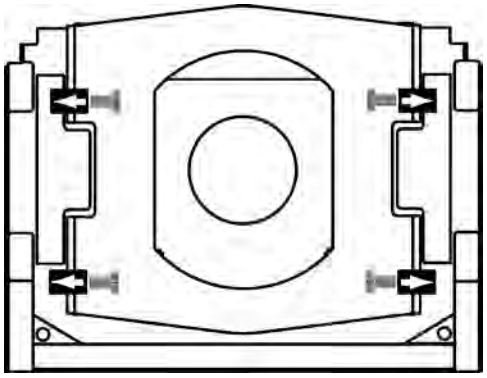
⚠WARNING Tripping can cause serious personal injury.

Be sure to keep job site clean and organized.

PREPARE JACKING FRAME



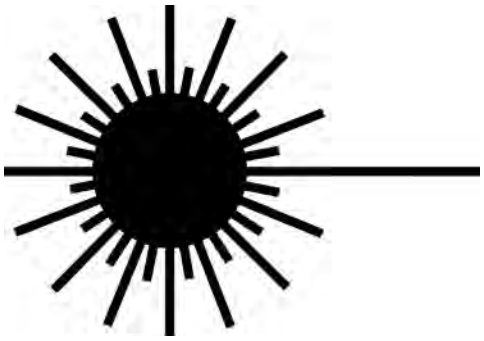
⚠WARNING Shipping or lifting jacking frame without ALL four dog blocks engaged into frame, can cause serous injury or death from sliding thrust block.



BEFORE disengaging the jacking frame hydraulics, engage ALL four dog blocks (with the red bolts) into the jacking frame.

If the four red dog bolts are extended, the dog blocks are not engaged.

AVOID LASER LIGHT EXPOSURE

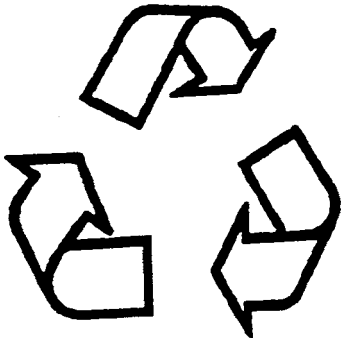


⚠DANGER Staring into laser light will cause severe injury.

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

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

RECYCLE WASTE



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

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

NOTES

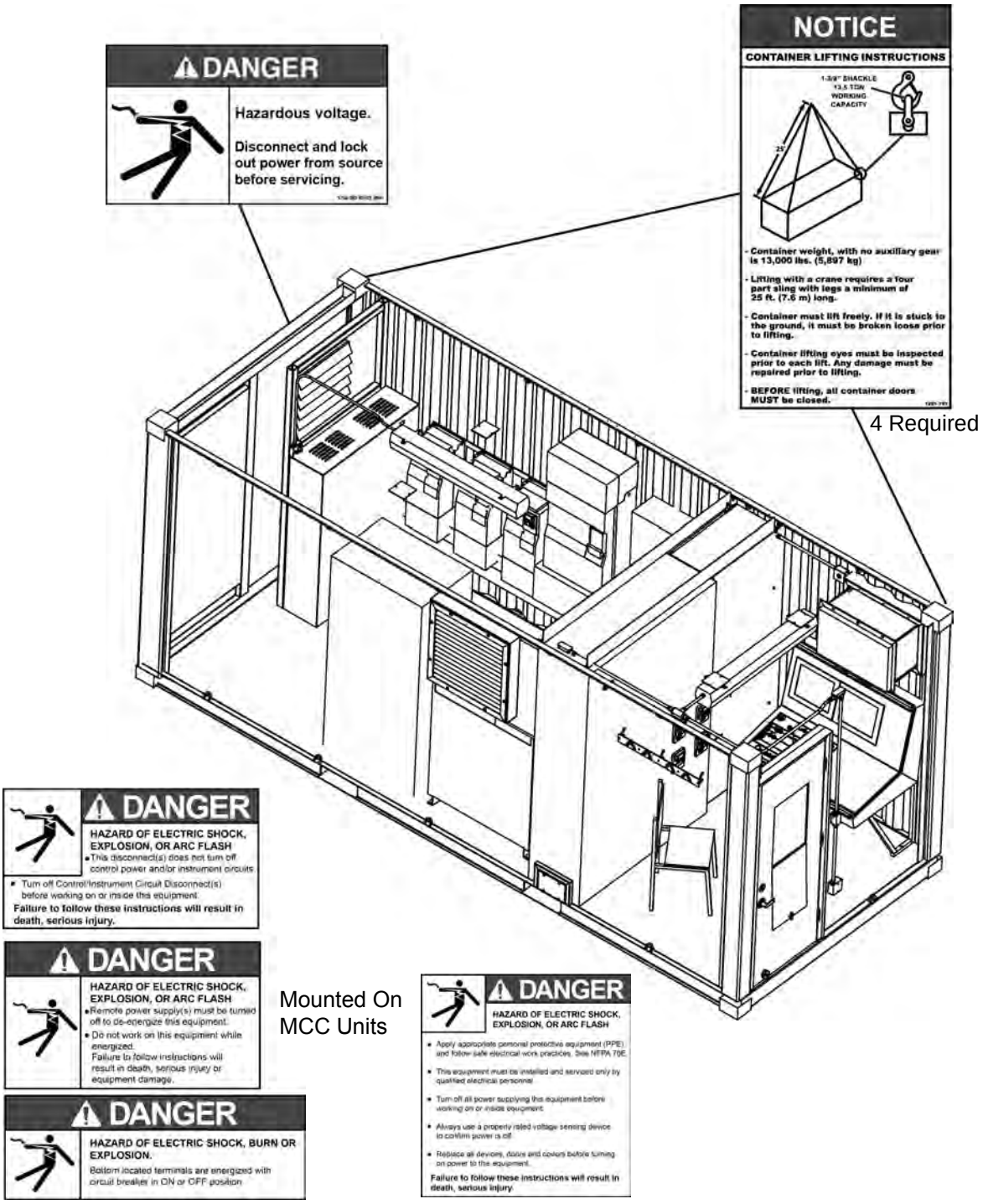
Safety Decals

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

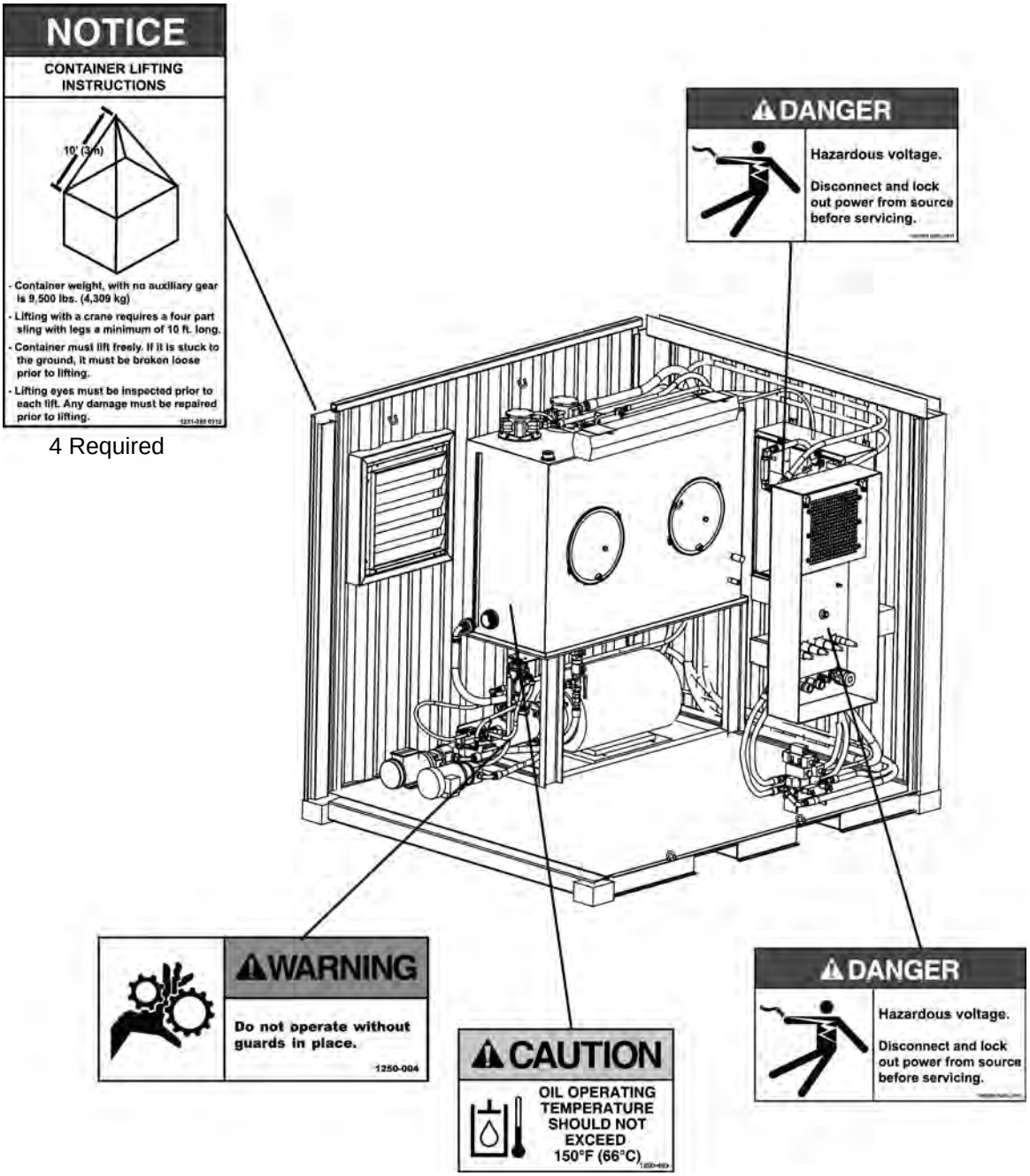
Serious injury or property damage can occur if safety instructions are not followed. Contact your Akkerman Aftermarket Support representative for free replacement safety decals.

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

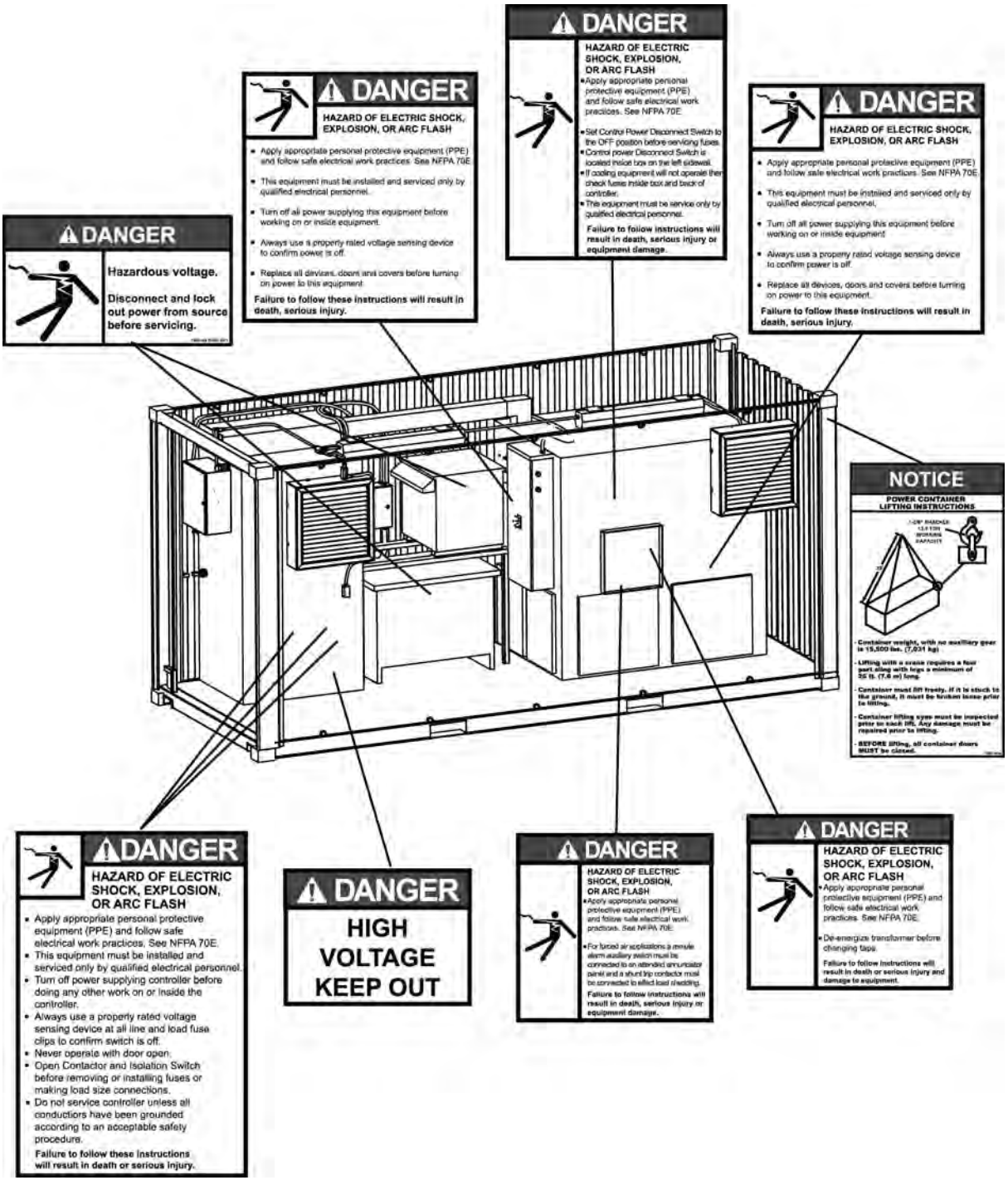
CONTROL CONTAINER



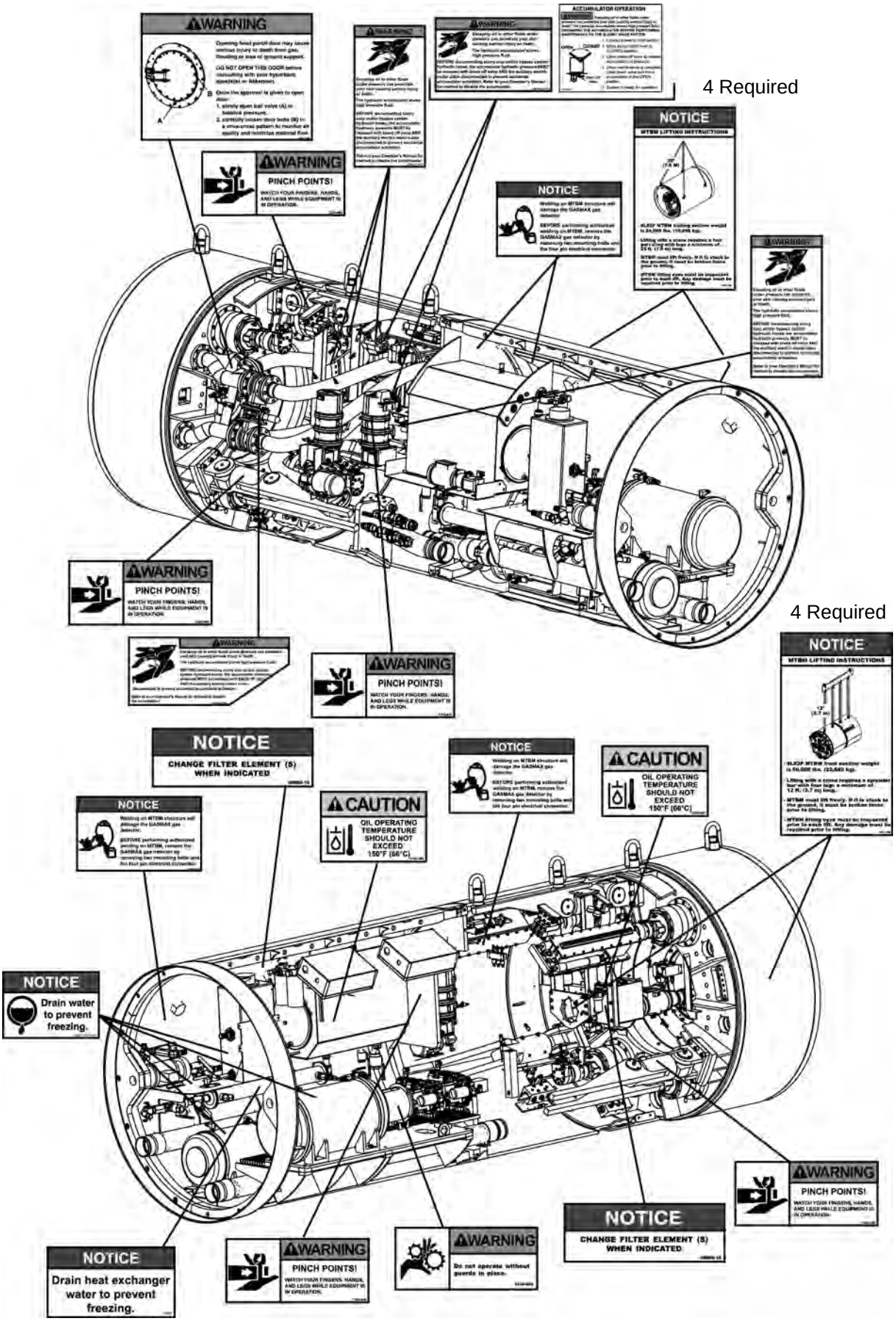
REMOTE HYDRAULIC POWER PACK



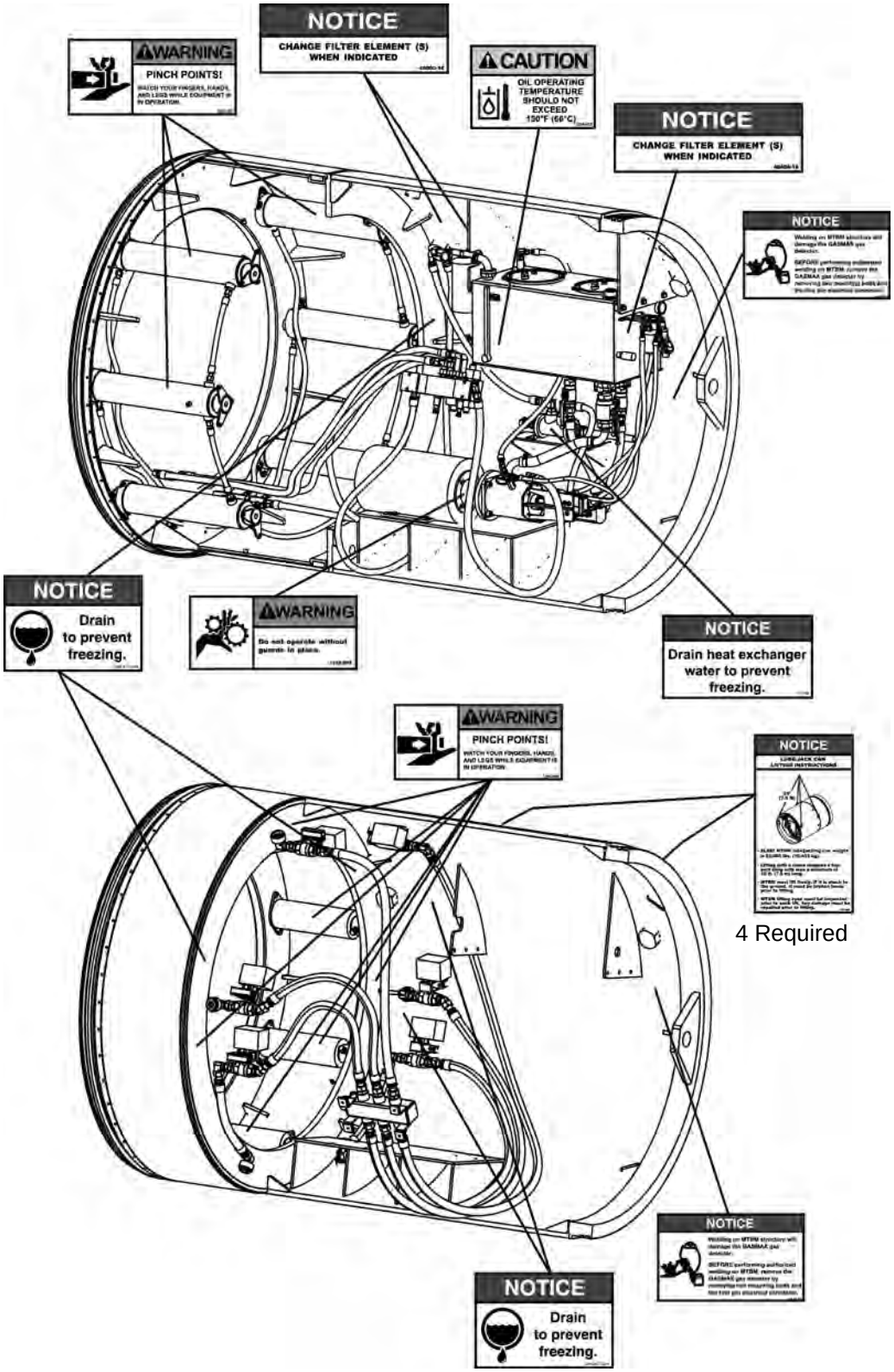
MAIN DRIVE POWER CONTAINER



MTBM SL82P

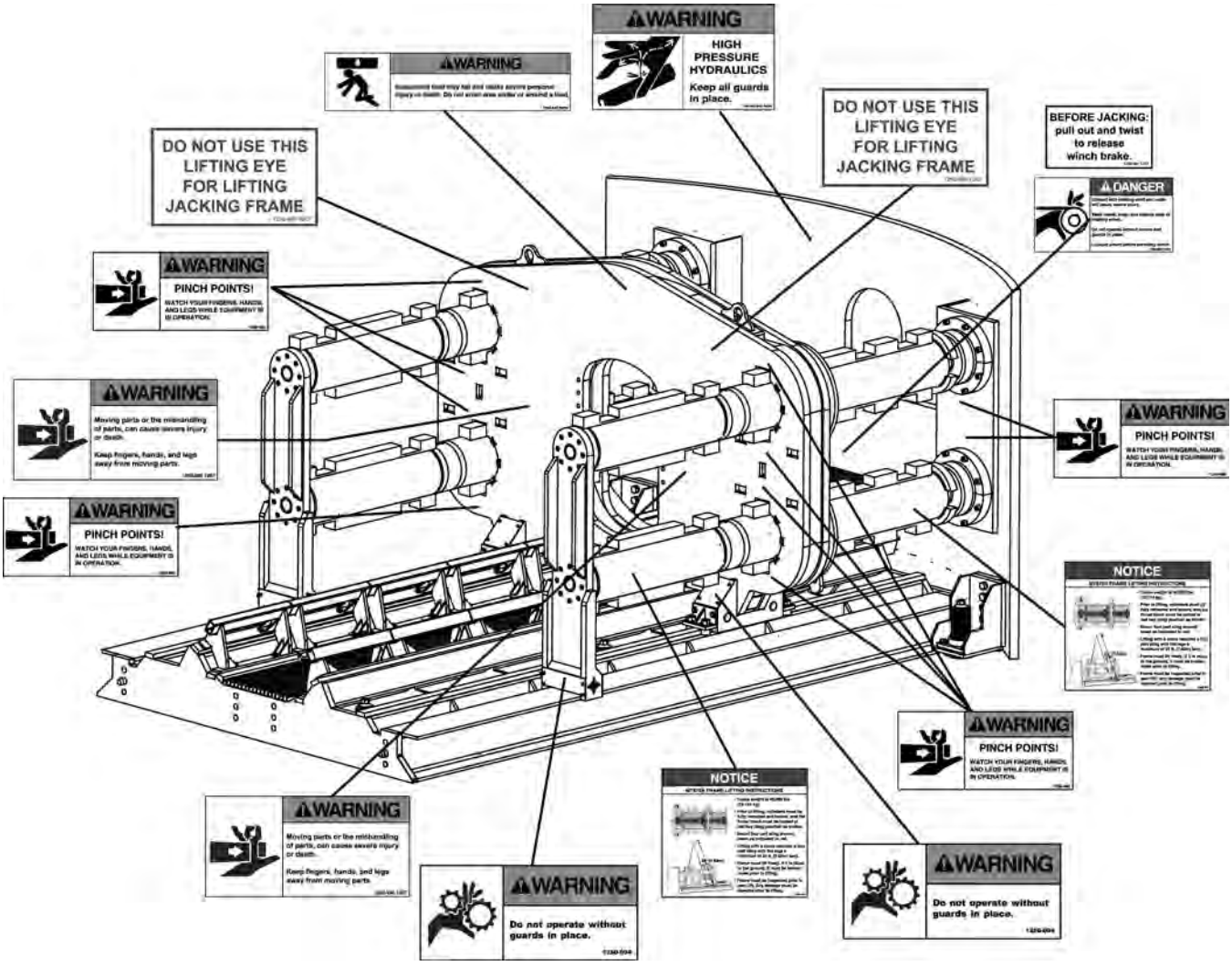

WARNING
PINCH POINTS!
WATCH YOUR FINGERS, HANDS, AND LEGS WHILE EQUIPMENT IS IN OPERATION.
NOTICE
MTBM LIFTING INSTRUCTIONS
4 Required
4 Required
NOTICE
CHANGE FILTER ELEMENT (S) WHEN INDICATED
CAUTION
OIL OPERATING TEMPERATURE SHOULD NOT EXCEED 150°F (66°C)
NOTICE
Drain water to prevent freezing.
NOTICE
Drain heat exchanger water to prevent freezing.
WARNING
Do not operate without guards in place.

LUBE/JACKING CAN



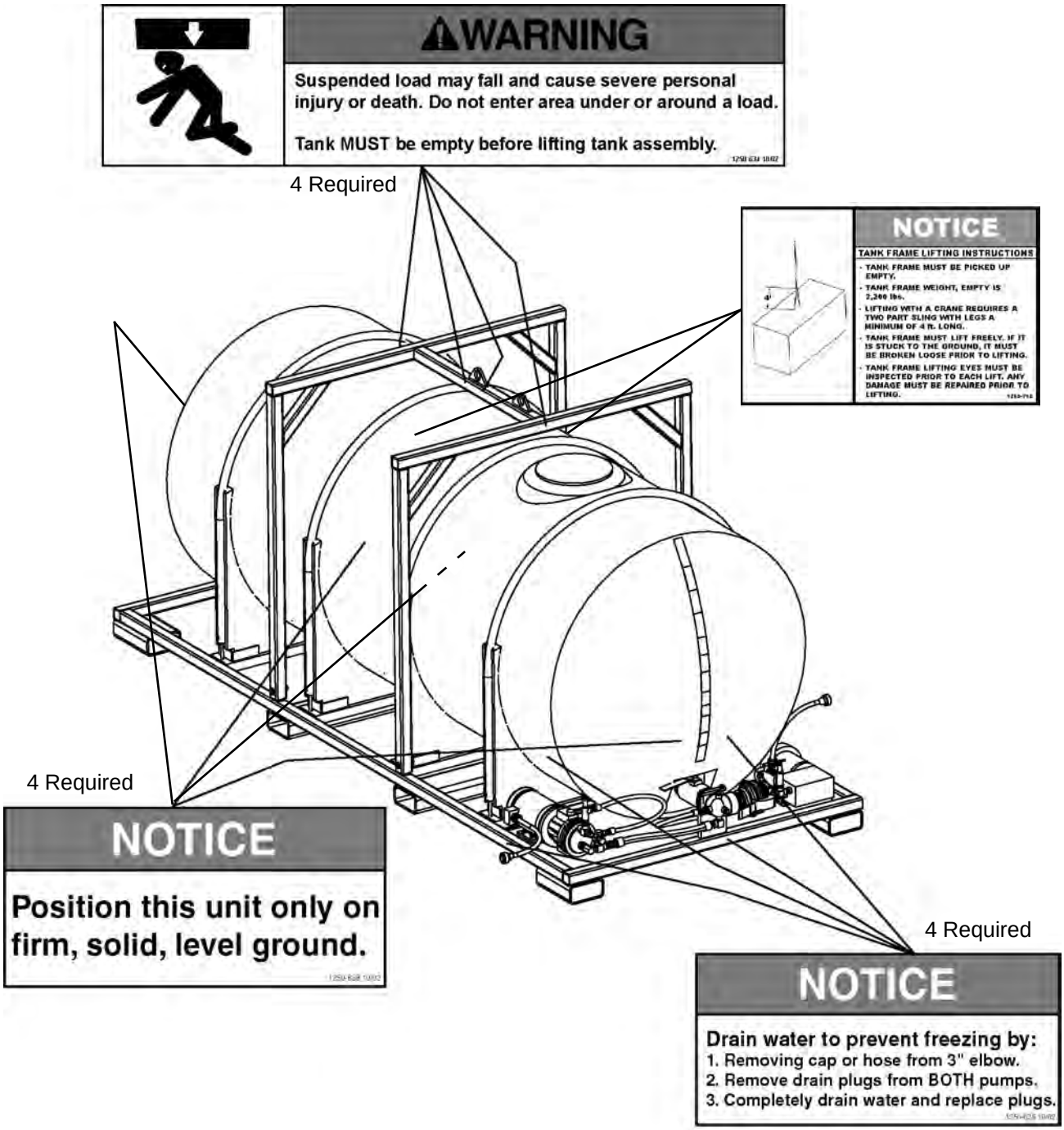
4 Required

KEYHOLE JACKING FRAMES

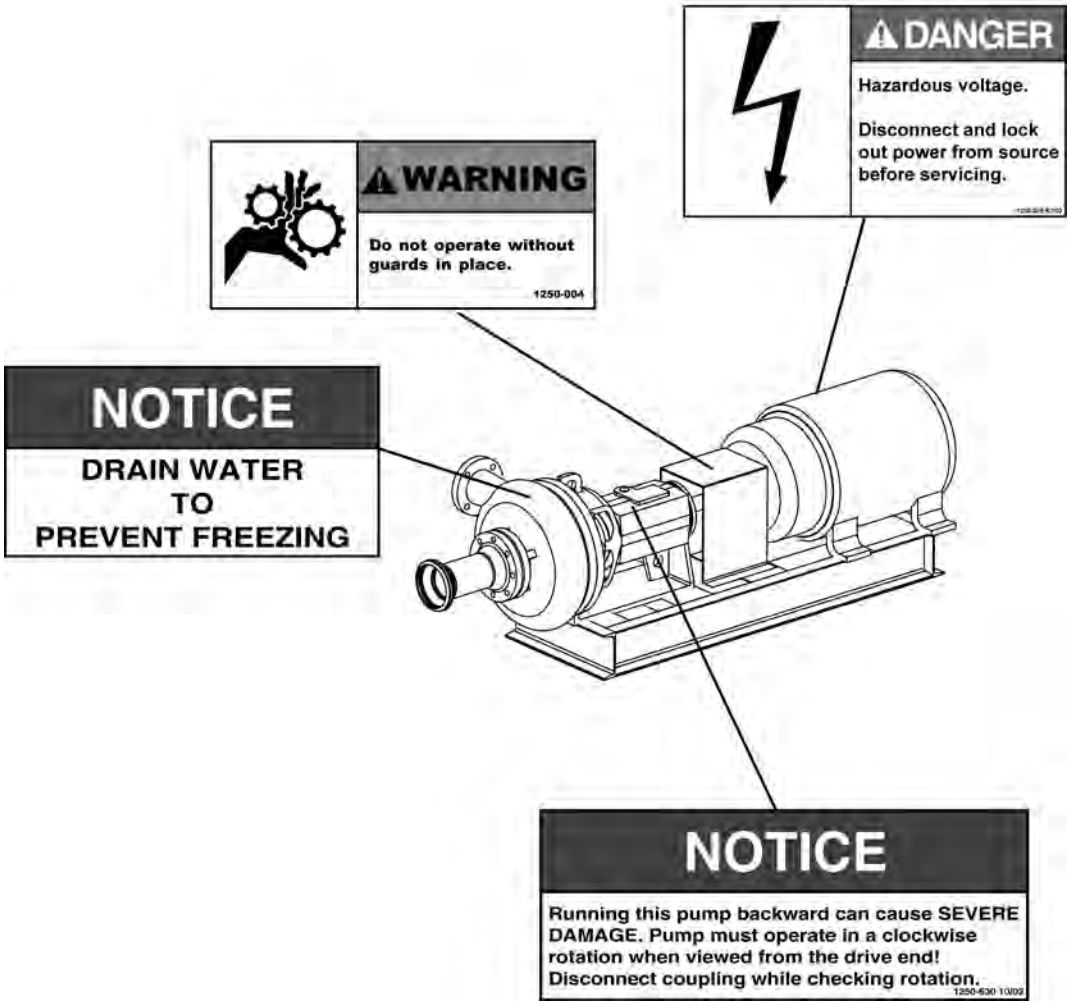


Model MT875K Shown

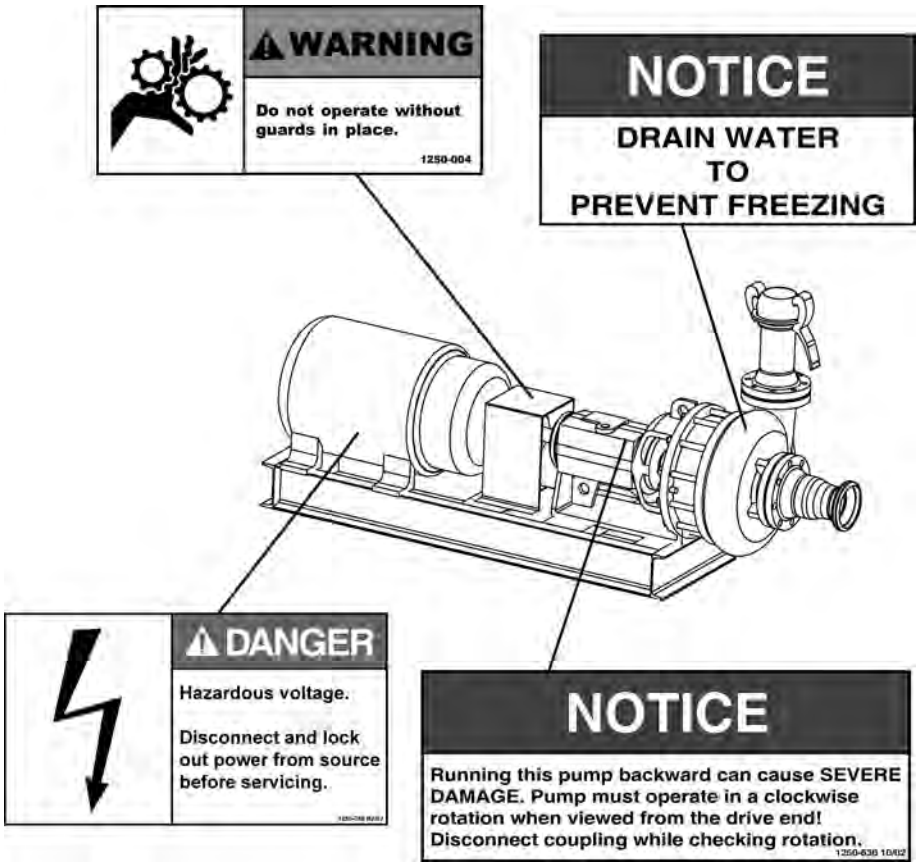
WATER COOLING TANK



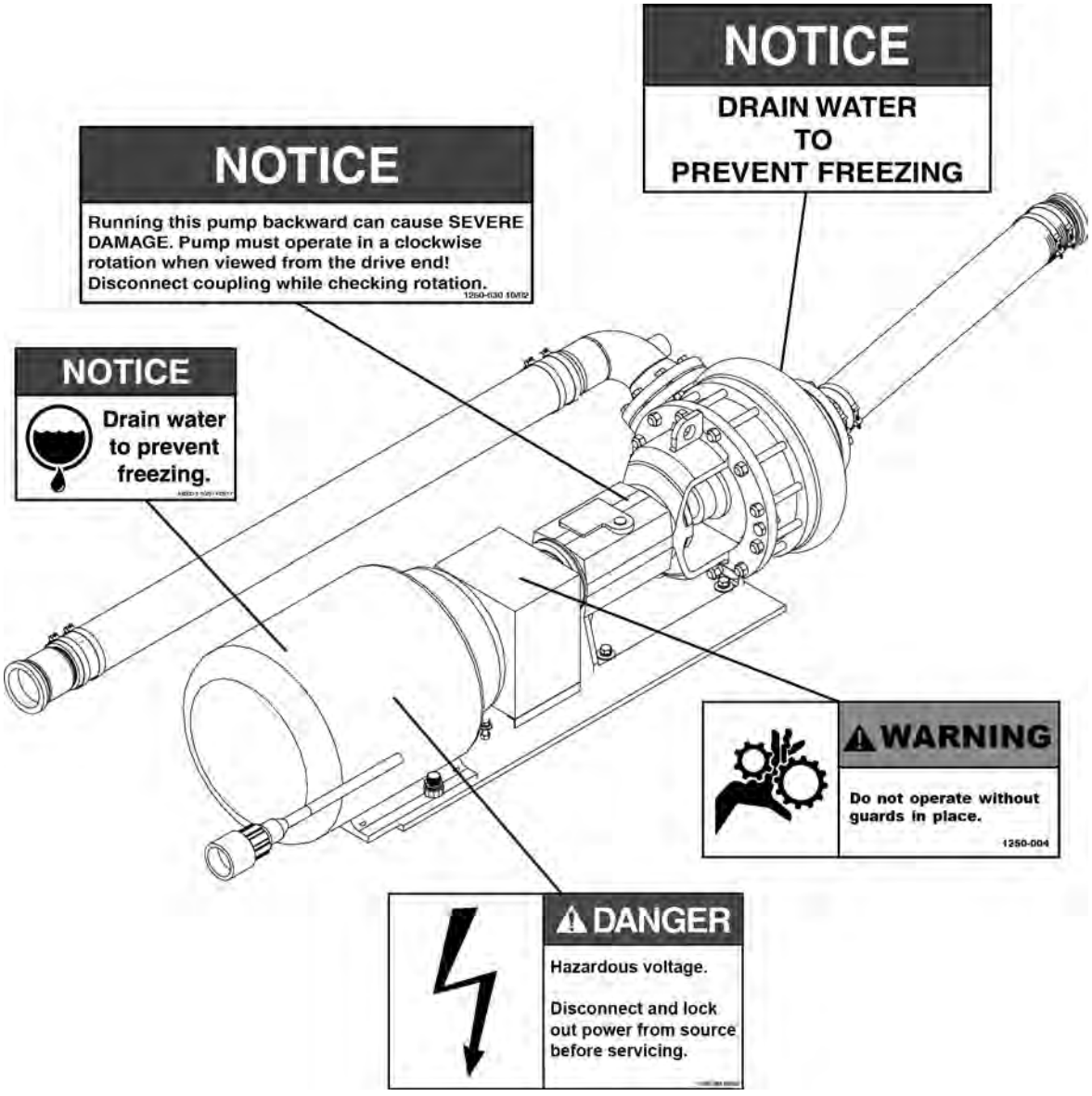
SLURRY FEED PUMP



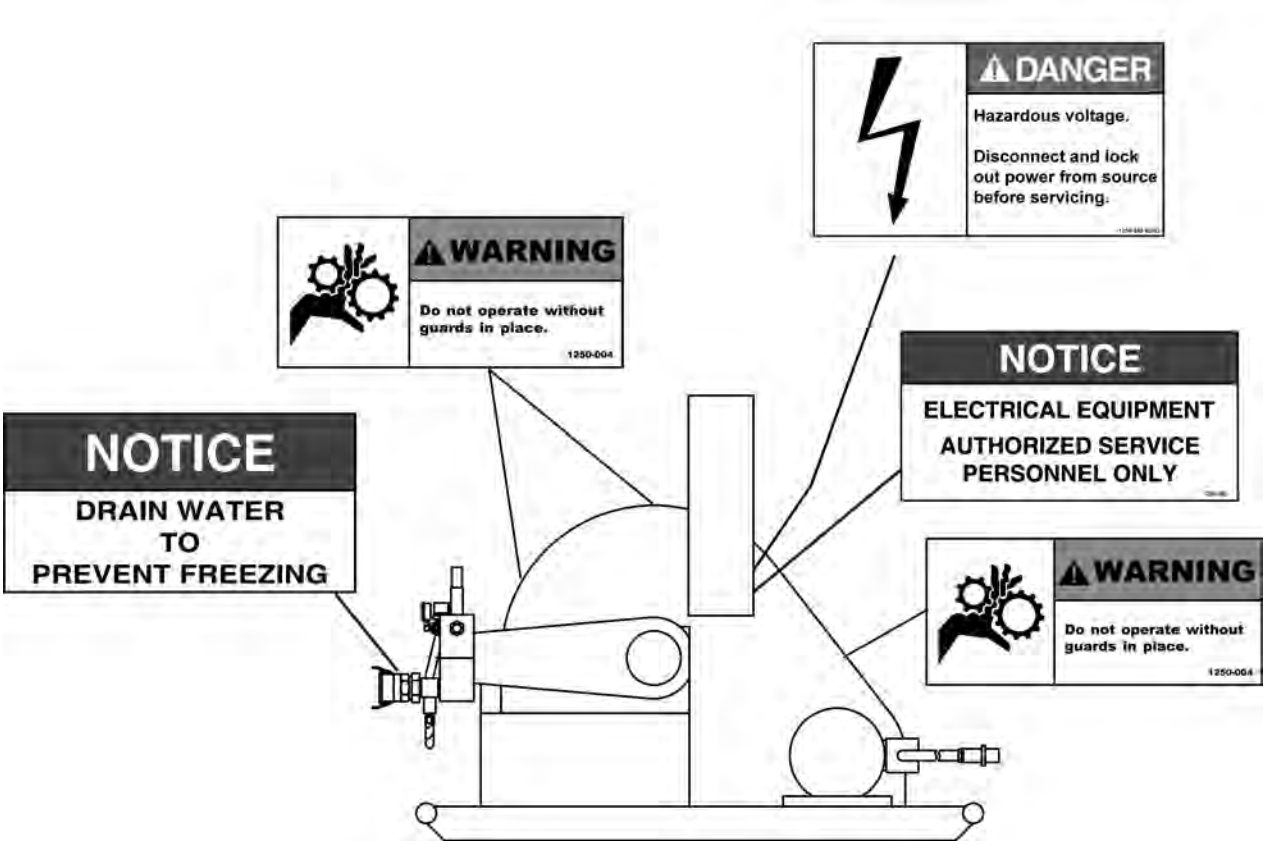
SLURRY RETURN PUMP



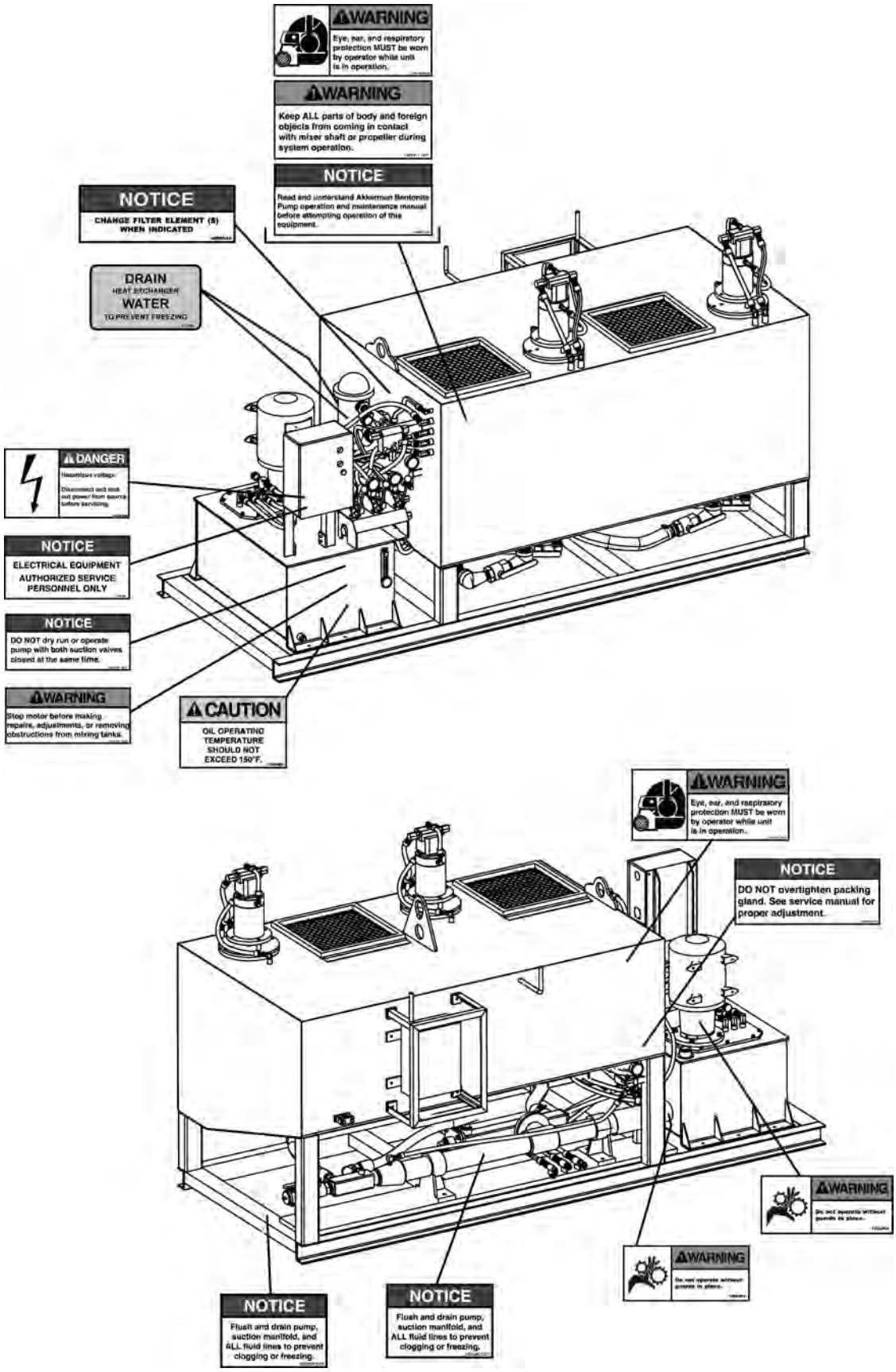
SLURRY BOOSTER PUMP



HIGH PRESSURE JETTING PUMP

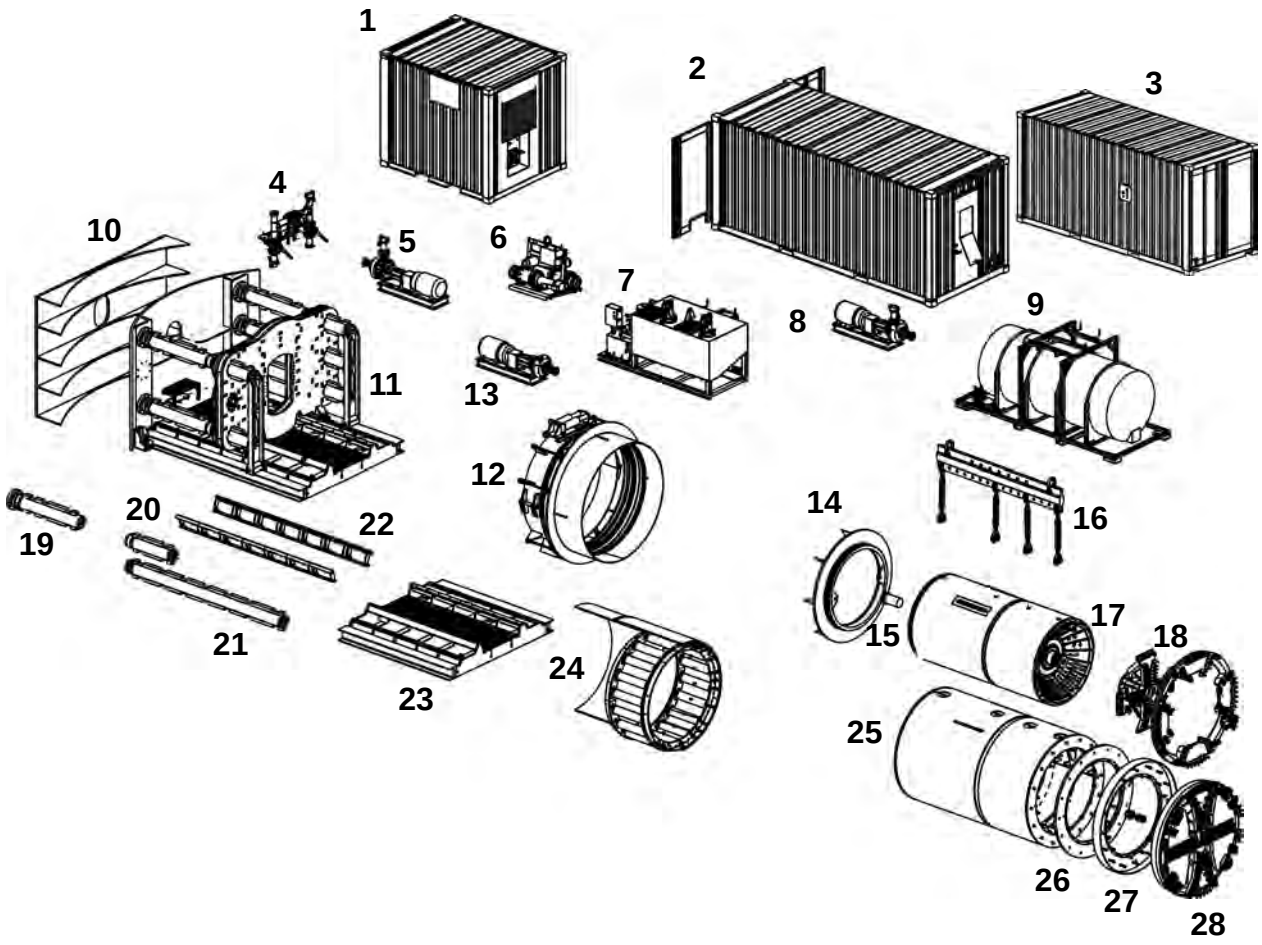


BENTONITE PUMP



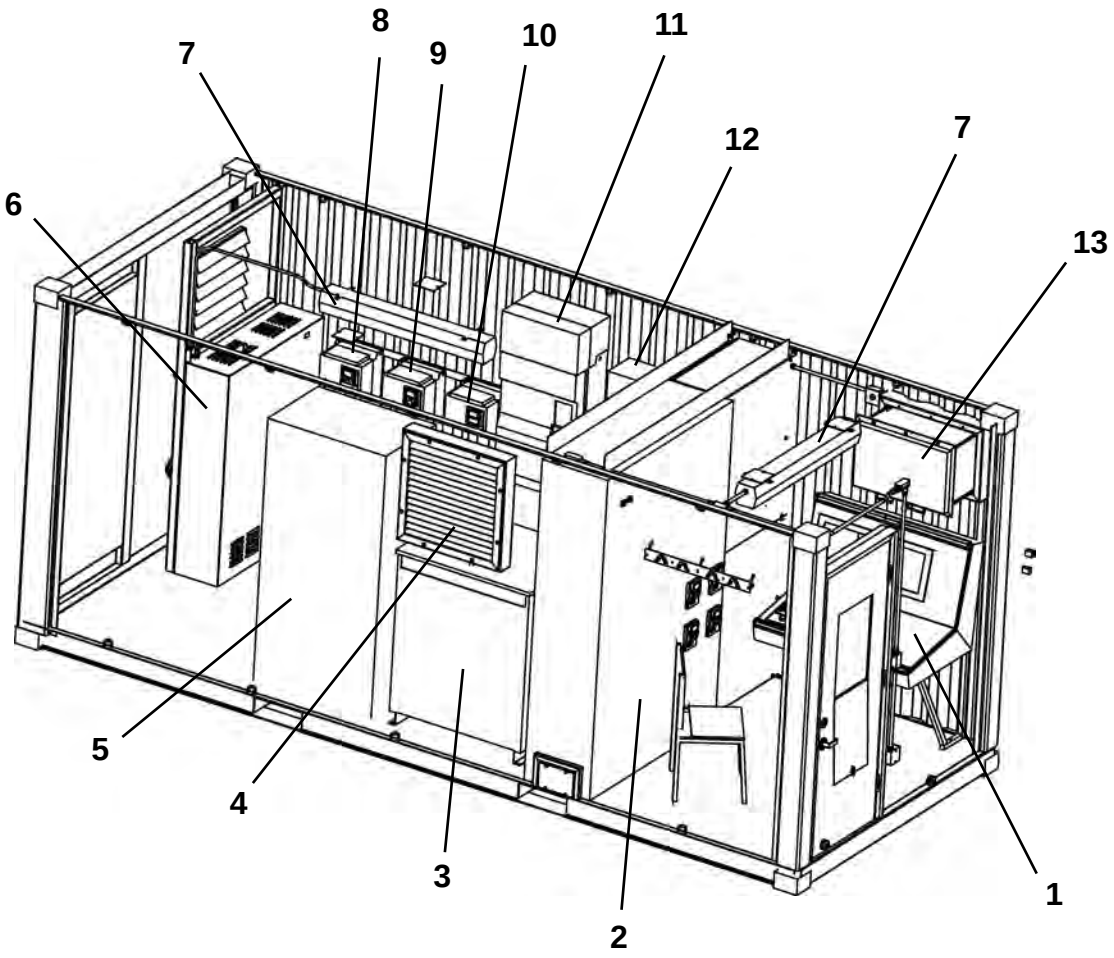
Terminology

MICROTUNNELING COMPONENTS



1. Remote Hydraulic Power Pack
2. Microtunneling Control Container
3. Power Container
4. Slurry Pit Valves
5. Slurry Return Pump
6. Flowmeter
7. Bentonite Pump
8. Slurry Feed Pump
9. Cooling Tank
10. Jacking Frame Flat Back Adapter
11. Keyhole Jacking Frame
12. Pipe Clamp/Pit Seal
13. Slurry Booster Pump
14. MTBM Pipe Adapter
15. Target
16. Lifting Beam
17. MTBM Head
18. Soft Ground Dual Gauge Cutter Head Face Plate and Cutter Ring
19. Frame Thrust Cylinder
20. Jacking Frame Thrust Cylinder Extension for 10 ft. Casings
21. Jacking Frame Thrust Cylinder Extension for 20 ft Casings
22. Jacking Frame Skid Riser
23. Jacking Frame Skid Extension for 20 ft Casing
24. Sealed Intermediate Jacking Station
25. MTBM Increase Kit
26. Soft Ground Sizing Ring
27. Sizing Ring Shroud for Disc Cutter Head
28. Mixed Face Cutter Head with Carbide Discs and Scrapers

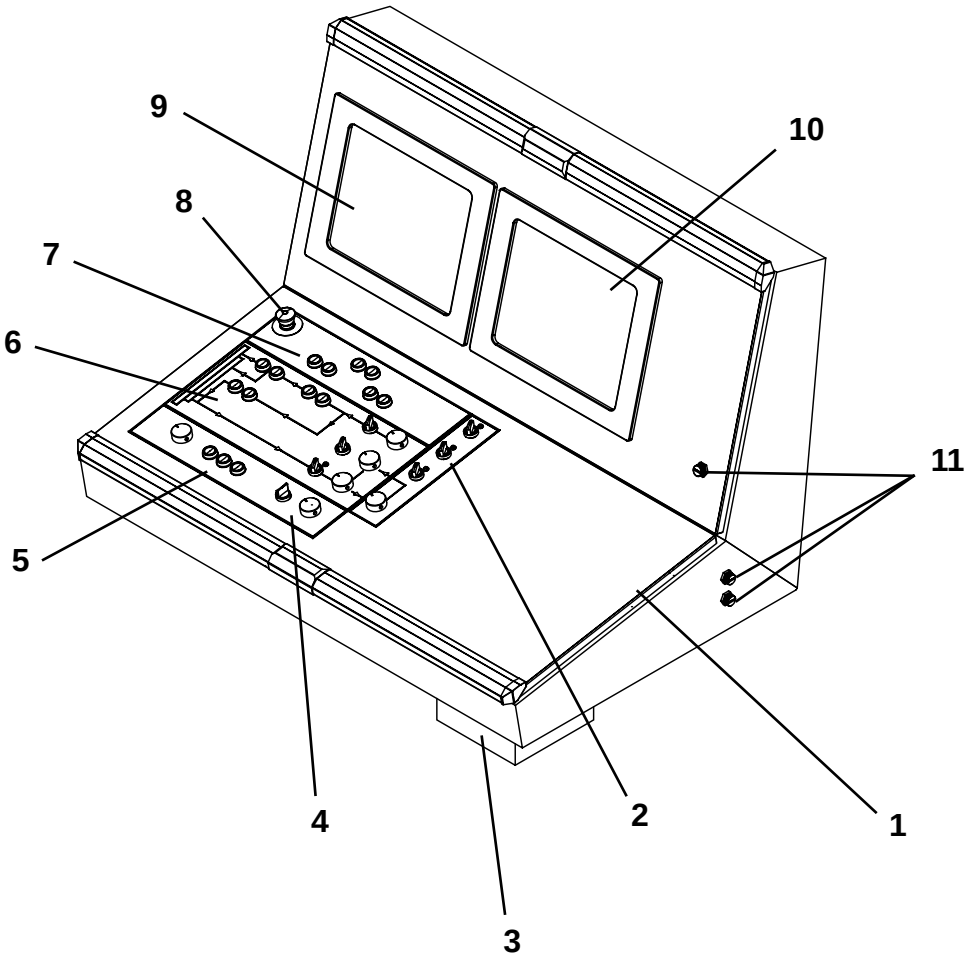
CONTROL CONTAINER



1. Operator Control Console
2. 480 Volt, 1,000 Amp MCC System
3. Transformer 480V To 575V
4. Exhaust Fan
5. 250 HP Drive Sine Wave Filter
6. Bulkhead
7. Lighting Fixture
8. Booster Pump VFD/Mid Pump VFD - 75 HP
9. Return Pump VFD - 75 HP
10. Feed Pump VFD - 100 HP
11. Main Cutterhead Drive VFD/Booster Pump VFD - 250 HP
12. Main Cutterhead Drive Disconnect - 250 HP
13. Air Conditioner

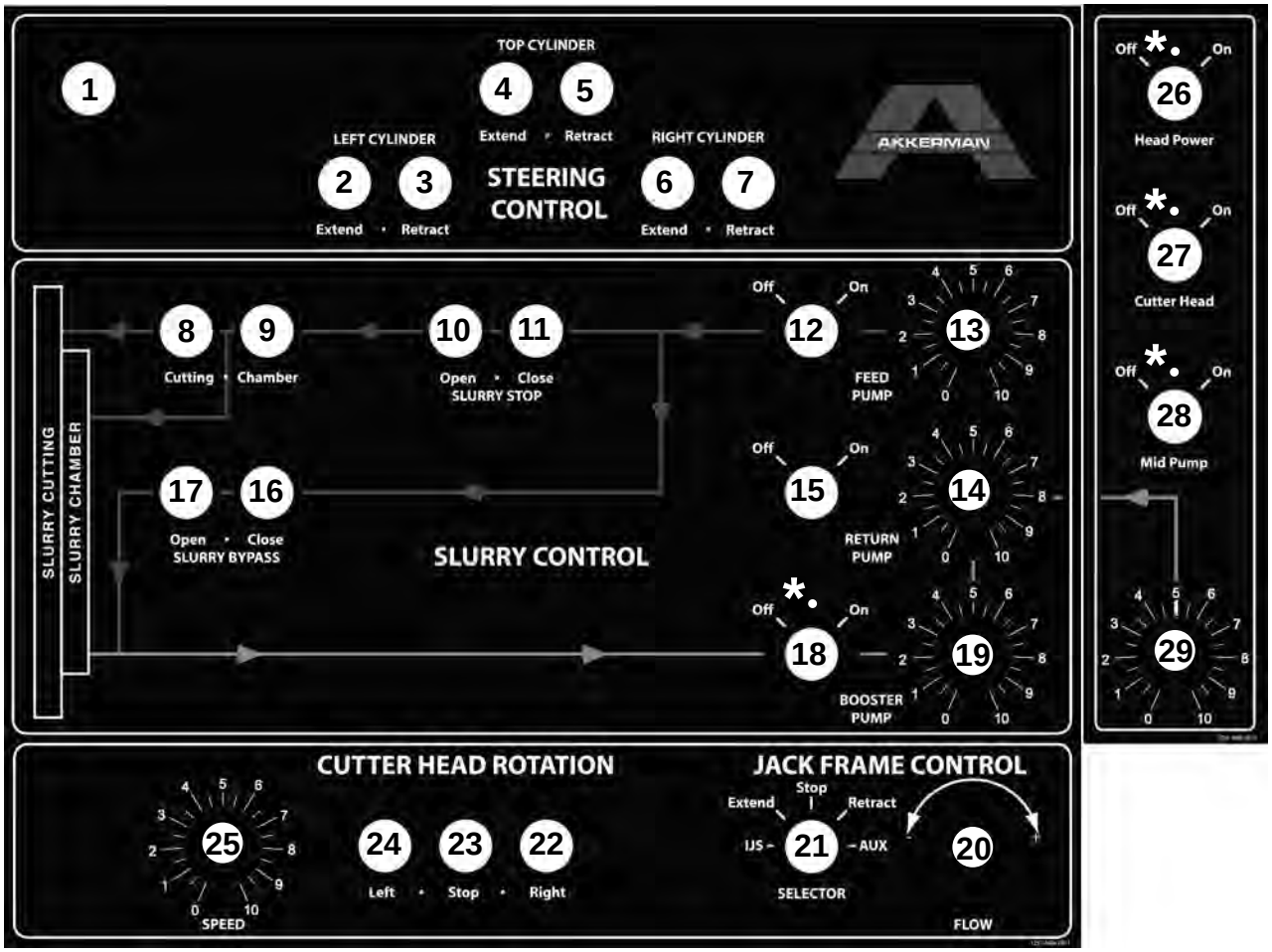
MCC - Motor Control Center

CONTROL CONSOLE



1. Control Console
2. Head Power/Cutter Head/Mid Pump Controls
3. Audio Controls
4. Jack Frame Controls
5. Cutter Head Rotation Controls
6. Slurry Controls
7. Steering Controls
8. Emergency Stop Button
9. Target Screen Monitor
10. Control Screen Monitor
11. USB Connection Ports

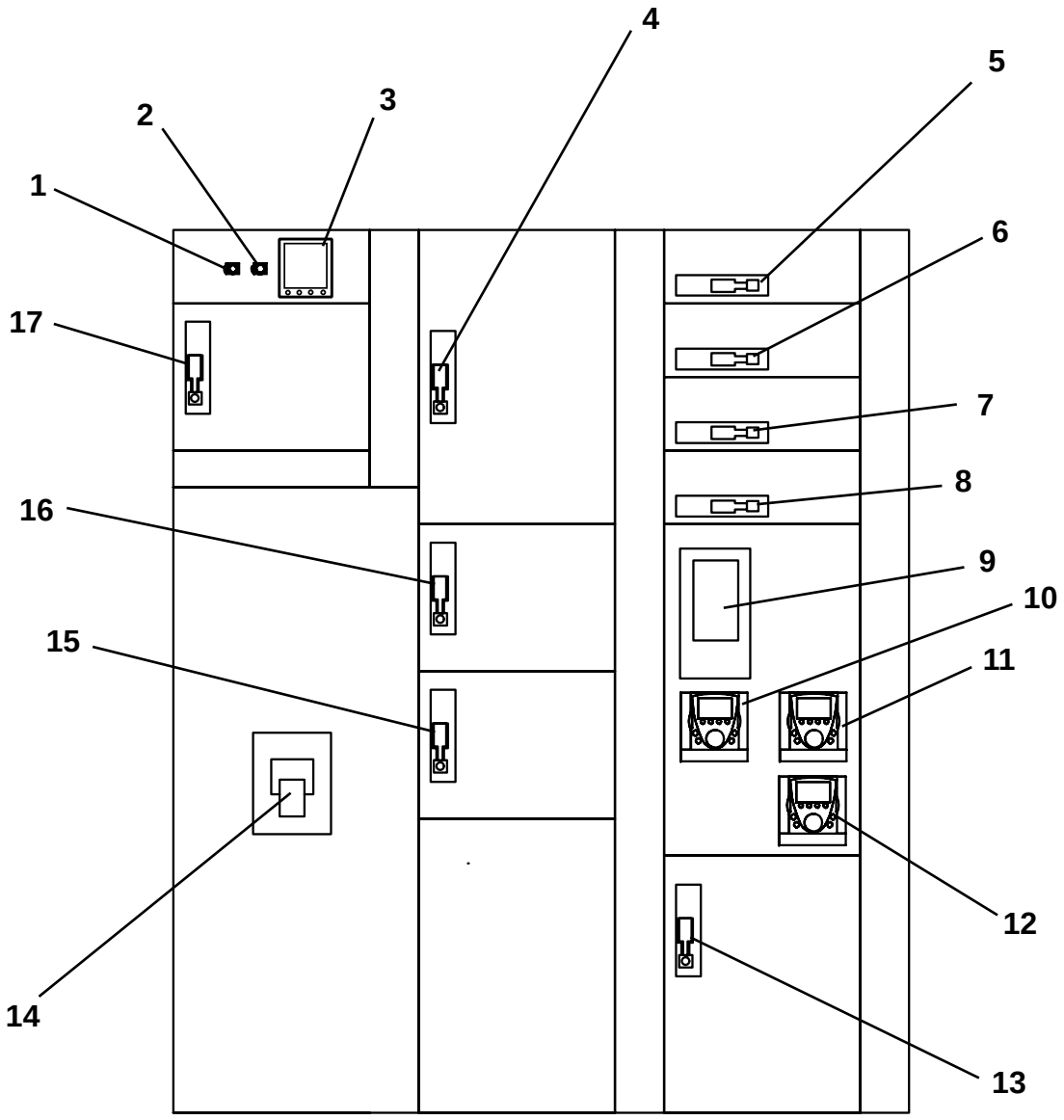
CONSOLE CONTROLS



1. Emergency Stop
2. Left Steering Cylinder - Extend
3. Left Steering Cylinder - Retract
4. Top Steering Cylinder - Extend
5. Top Steering Cylinder - Retract
6. Right Steering Cylinder - Extend
7. Right Steering Cylinder - Retract
8. Slurry Control Cutting Nozzle Valve
9. Slurry Control Chamber Valve
10. Slurry Stop Valve - Open
11. Slurry Stop Valve - Close
12. Feed Pump Control
13. Feed Pump Flow Control
14. Return Pump Flow Control
15. Return Pump Control
16. Slurry Bypass Valve - Close
17. Slurry Bypass Valve - Open
18. Booster Pump Control
19. Booster Pump Flow Control
20. Jack Frame Flow Control
21. Jack Frame Selector Control
22. Cutter Head Rotation - Right
23. Cutter Head Rotation - Stop
24. Cutter Head Rotation - Left
25. Cutter Head Rotation Speed Control
26. Head Power Control
27. Cutter Head Control
28. Mid Pump Control
29. Mid Pump Flow Control

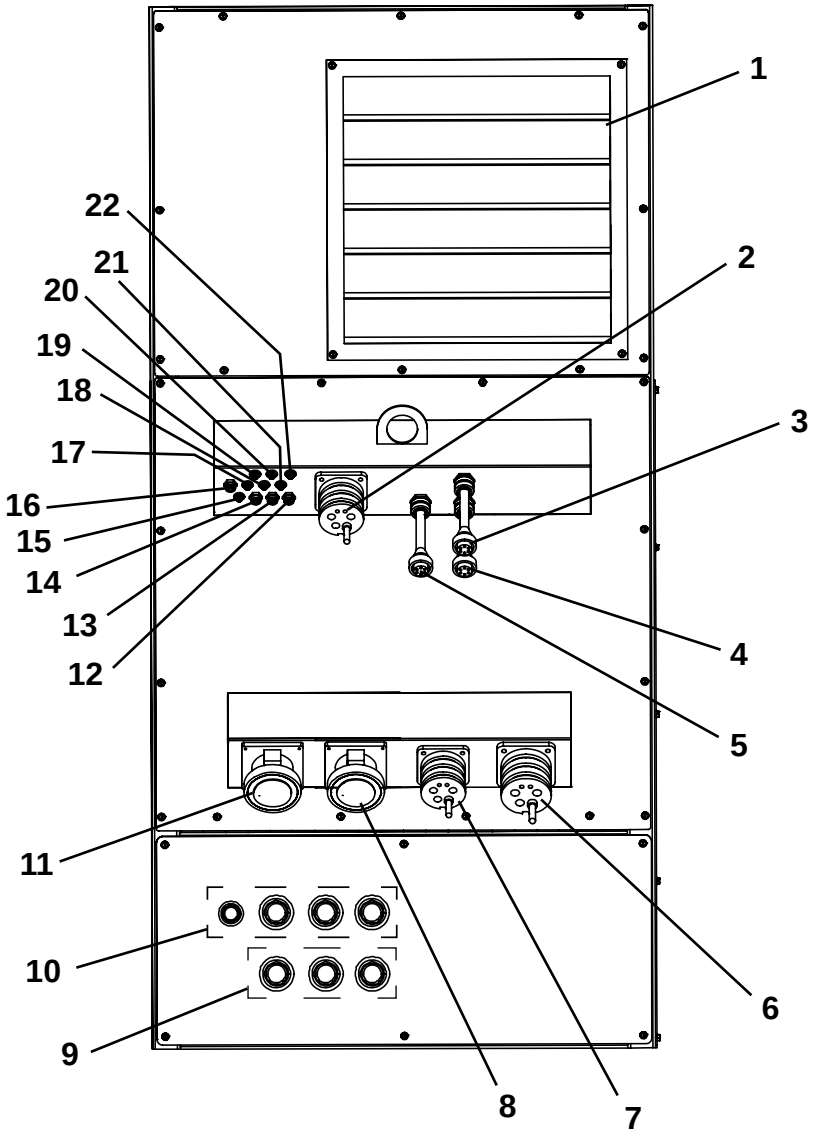
* Indicator light illuminates when the power cable is properly connected and grounded.

CONTROL CONTAINER 480 VOLT MCC SYSTEM



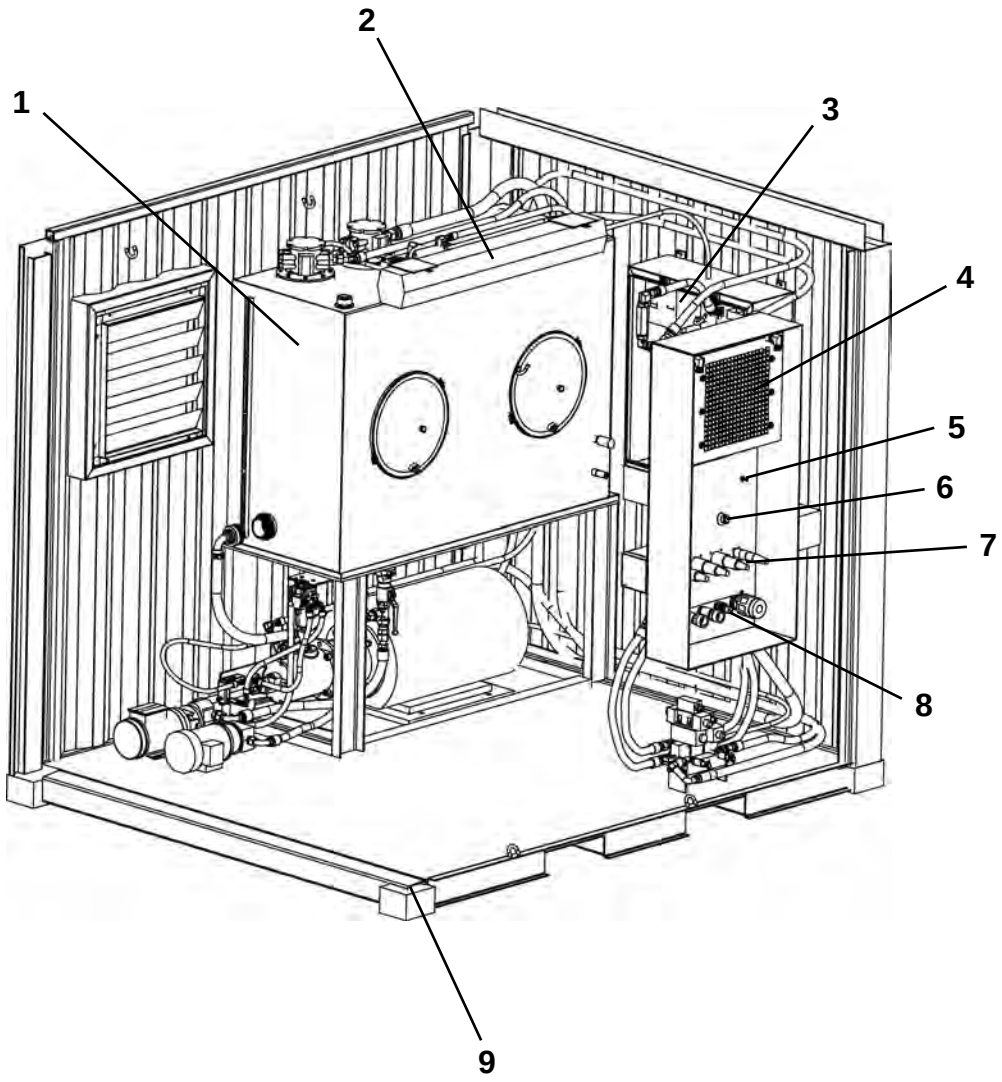
1. Phase Indicator (Green) (Phase OK)
2. Phase Indicator (Red) (Phase Error)
3. Power Monitor
4. Cutter Head 575 VAC Power Disconnect
5. Small MTBM Head Power Disconnect
6. Cooling Pump Disconnect
7. Feed Pump Disconnect
8. Return Pump Disconnect
9. Cutter VFD/Booster Pump Monitor
10. Feed Pump VFD Monitor
11. Return Pump Disconnect
12. Booster Pump VFD/Mid Pump Monitor
13. 120V/240V Transformer Disconnect
14. Main Power Disconnect
15. Booster Pump/Mid Pump Disconnect
16. Spare Disconnect
17. Large MTBM Head Power Disconnect

CONTROL CONTAINER BULKHEAD



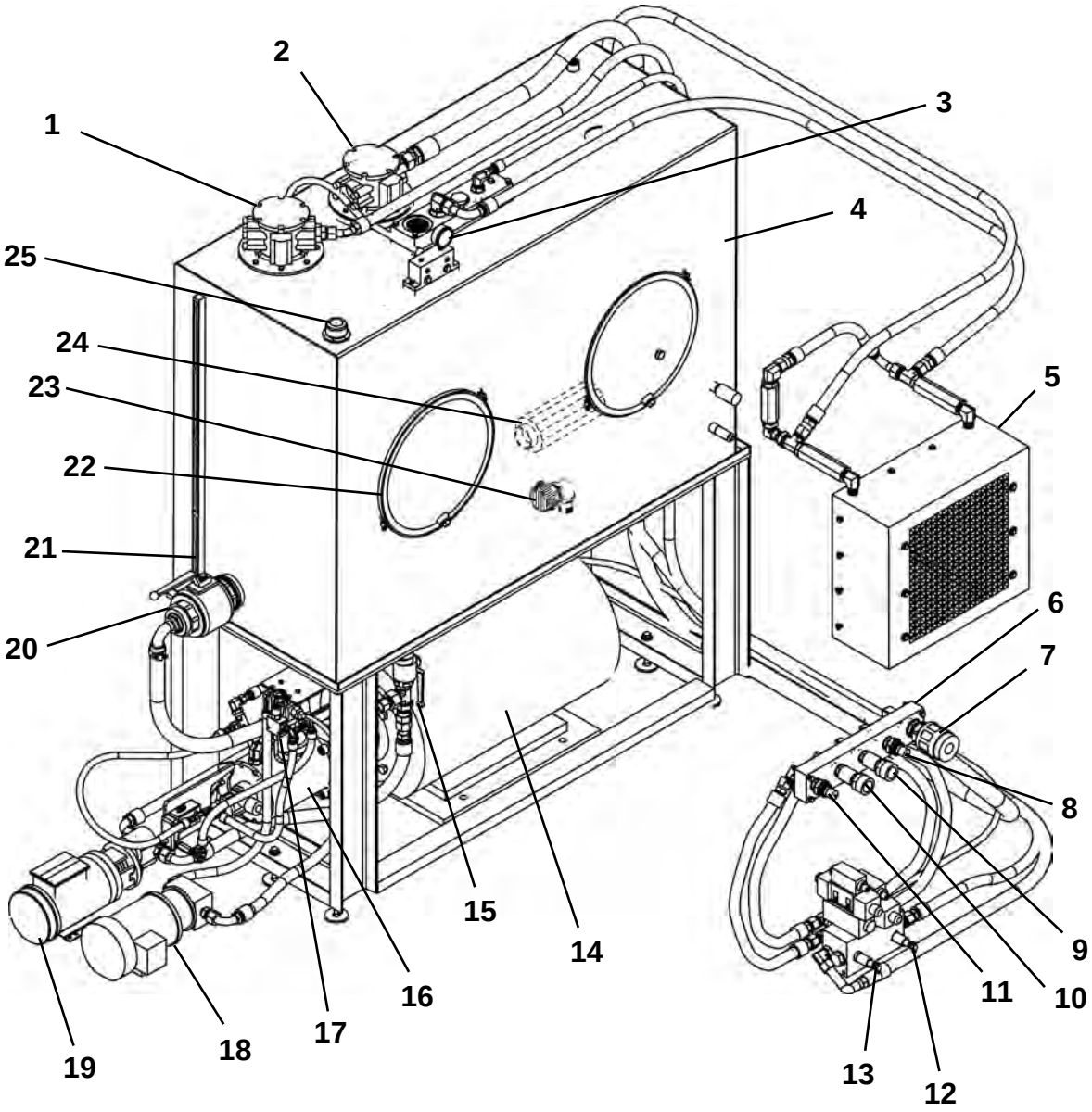
1. Air Intake Louvers
2. Large MTBM Head Power
3. Small MTBM Head Power
4. Cooling Pump Power
5. Jetting Control Power
6. Boring Head Drive/Slurry Booster Pump Power
7. Slurry Booster Pump/Slurry Mid Pump Power
8. Slurry Return Pump Power
9. Generator Power (Connection 2)
10. Generator Power With Ground (Connection 1)
11. Slurry Feed Pump Power
12. Guidance System Power
13. Pit Box Power
14. Flowmeter Power
15. MTBM/Boring Head Ethernet
16. Jetting Power 120V
17. Hydraulic Power Pack Ethernet
18. Flowmeter Ethernet
19. Guidance System Ethernet
20. Power Container Ethernet
21. Pit Box Ethernet
22. ABIS Ethernet

REMOTE HYDRAULIC POWER PACK



1. Power Pack Hydraulic Reservoir
2. Light Fixture
3. Electrical Controls
4. Oil Cooler
5. Control Container Ethernet
6. Emergency Stop Button
7. Generator Power Connections
8. Hydraulic Manifold Bulkhead
9. Hydraulic Power Pack Container

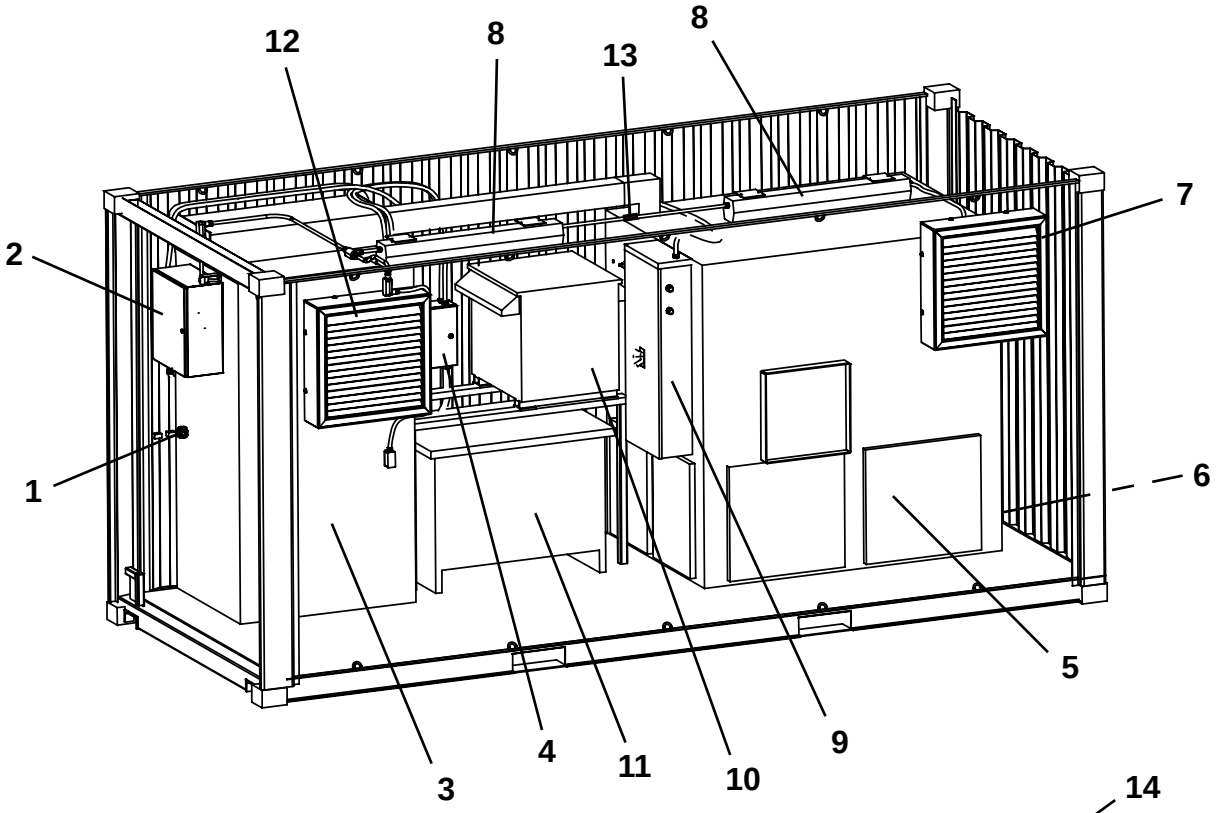
HYDRAULIC POWER PACK

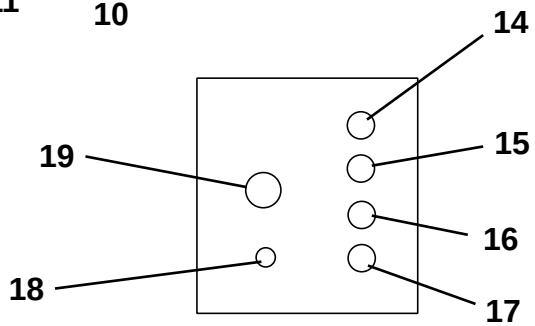


1. Jacking Frame Return Filter
2. Hi Flow Return Filter
3. Hydraulic Pressure Gauge
4. Hydraulic Oil Reservoir 330 Gallons
5. Oil Cooler Fan
6. Hydraulic Manifold Bulkhead
7. Hi Flow Return Hydraulic Connection
8. IJS Supply Hydraulic Connection
9. Auxiliary Hydraulic Connection
10. Jacking Frame Retract Hyd. Connection
11. Jacking Frame Extend Hyd. Connection
12. Auxiliary Relief Valve
13. Main Relief Valve
14. Motor 75 HP
15. Pilot Pressure Suction Valve
16. Main Hydraulic Pump
17. Pilot Pressure Oil Filter
18. Pilot Pressure Motor/Pump 1/2 HP Assembly
19. Cooling Motor/Pump Assembly 2 HP
20. Main Hydraulic Shutoff Valve
21. Oil Level Sight/Temperature Gauge
22. Inspection/Cleanout Cover
23. Suction Screen*
24. Strainer*
25. Oil Fill Cap & Breather

* located inside reservoir

MAIN DRIVE POWER CONTAINER



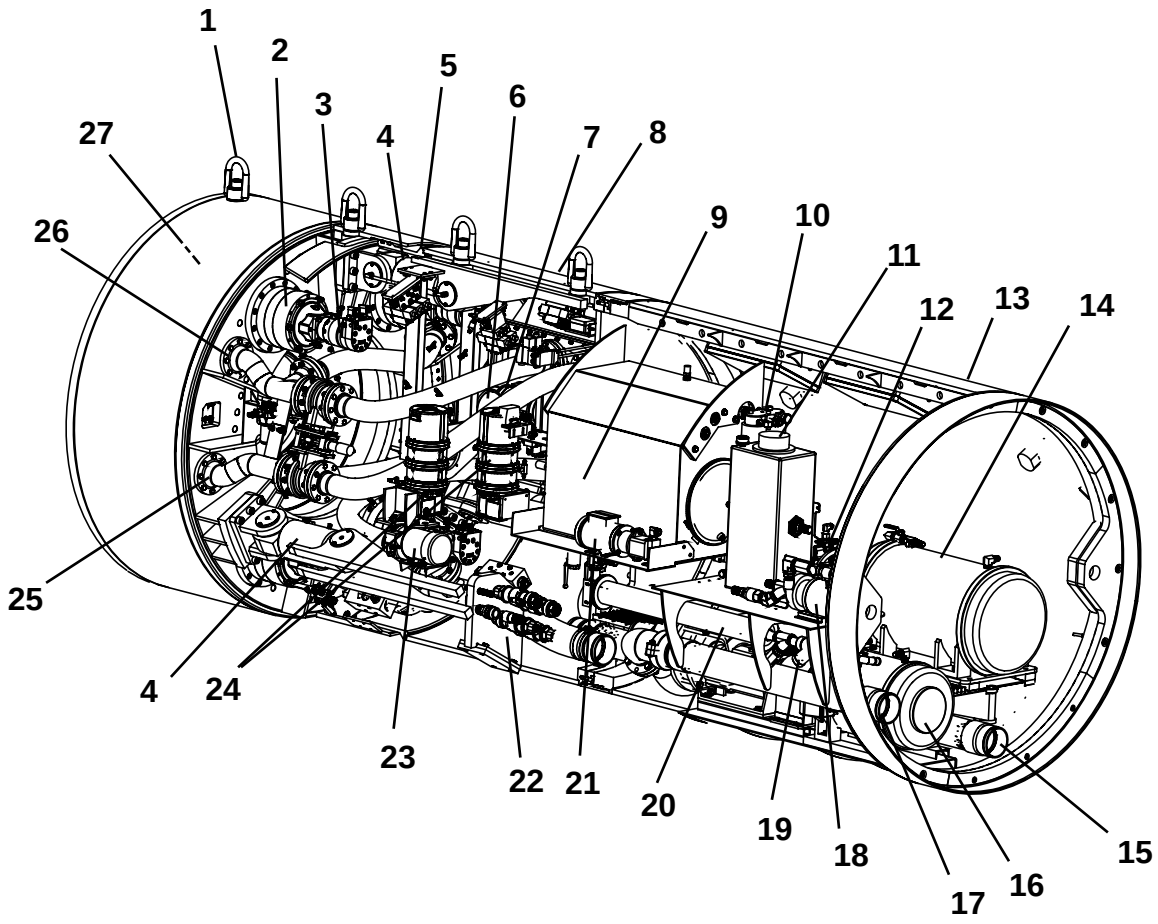


Power Status Panel
With E-Stop

1. Medium Voltage OUT To 400 HP Motor
2. Control Box 120 VAC
3. Medium Voltage MCC Softstart
4. Power Status Panel With E-Stop
5. 480V To 4160V Transformer Enclosure
6. Generator Power IN
7. Exhaust Fan
8. Light
9. Main Breaker Box With Phase Indicator Lights
10. Zig Zag (Grounding) Transformer
11. Grounding Resistor
12. Air Intake Louvers
13. Exhaust Fan Thermostat Control
14. 480V/4160V Transformer Energized Indicator Light
15. 4160V MCC Soft Start Energized Indicator Light
16. Main Drive Tunnel Cable Pilot ON Indicator Light
17. 4160V Main Drive Tunnel Power ON Indicator Light
18. Ethernet Control Container Connection
19. Emergency Stop (E-Stop) Button

MCC - Motor Control Center

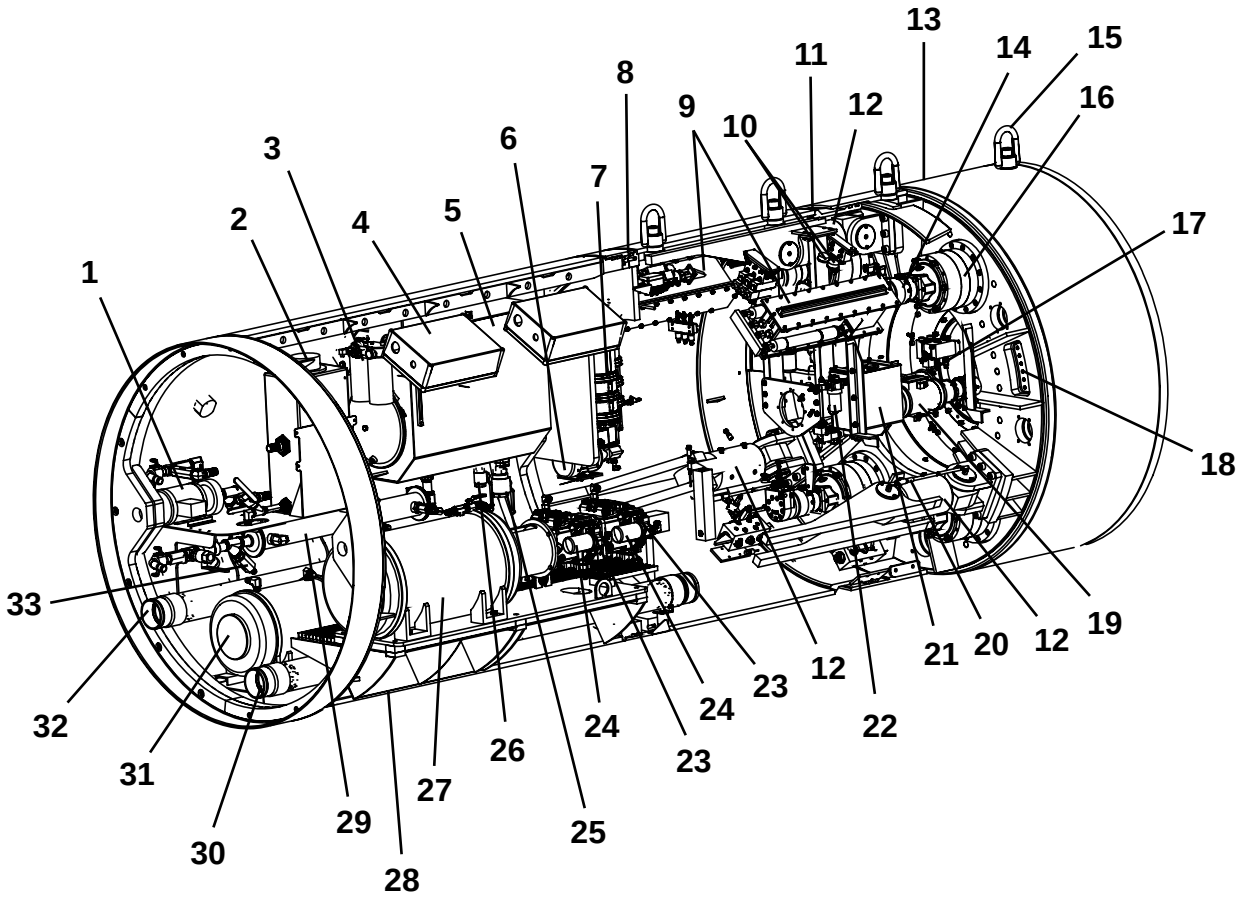
MTBM PERIPHERY DRIVE - STARTING & TRAILING SECTIONS LEFT SIDE VIEW



Model SL82P Shown

1. Hoist Ring
2. Planetary Gearbox
3. Drive Motor - 2 Speed
4. Steering Cylinders
5. Steering Joint
6. Accumulator
7. Auxiliary Hydraulic Power Pack
8. MTBM Front Section
9. MTBM Main Drive Hydraulic Tank 95 Gal.
10. Main Drive Hydraulic Return Filters
11. Water Cooling System Tank 20 Gal.
12. Hydrostatic Drive Pumps
13. Trailing Section
14. Main Drive Motor 400 HP
15. Slurry Feed
16. Booster Pump 100 HP
17. Slurry Return
18. Water Cooling System Motor/Pump
19. Water Cooling System Strainer
20. Heat Exchanger
21. Oil Cooling Pump/Motor
22. Front Section Hydraulic Connections
23. Bearing Lubrication Motor/Pump
24. Grease Pumps
25. Chamber Port
26. Cutting Port
27. Crushing Chamber

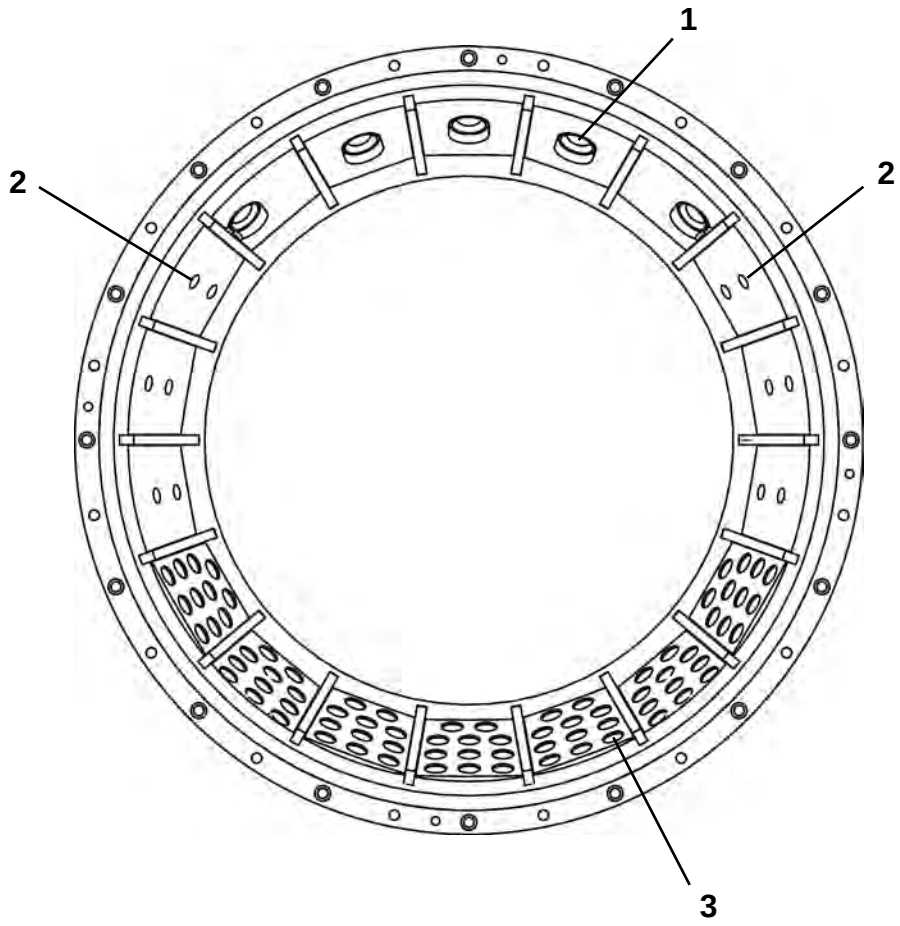
MTBM PERIPHERY DRIVE - STARTING & TRAILING SECTIONS RIGHT SIDE VIEW



Model SL82P Shown

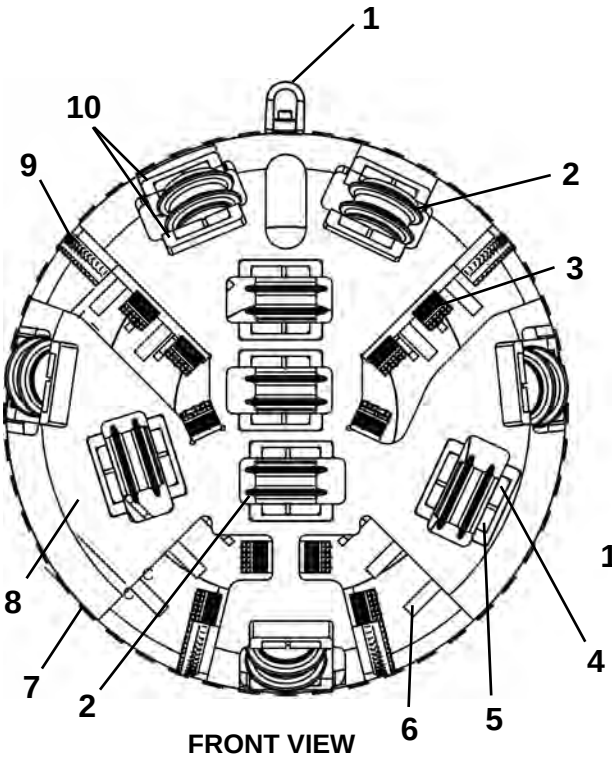
1. Water Cooling System Motor/Pump
2. Water Cooling System Tank 20 Gal.
3. Main Hydraulic Return Filters & Indicator
4. Electrical Control Box
5. MTBM Main Drive Hydraulic Tank 95 Gal.
6. Bearing Lubrication Motor/Pump
7. Grease Pumps
8. Front-Trailing Section Seals
9. Dirt Wing Assembly
10. Auxiliary System Pressure Gauges
11. Steering Joint
12. Steering Cylinders
13. MTBM Front Section
14. Drive Motor - 2 Speed
15. Hoist Ring
16. Planetary Gearbox
17. Accumulator
18. Jetting Manifold
19. Auxiliary Hydraulic Power Pack Pump
20. Steering Cylinder Linear Transducer
21. Auxiliary Hydraulic Power Pack Reservoir 5.5 Gal.
22. Hydraulic Return Filter
23. Hydrostatic Drive Pumps
24. Hydrostatic Pump Charge Filters
25. Main Drive Feed Hydraulic Shutoff
26. Oil Cooling Hydraulic Shutoff
27. Main Drive Motor 400 HP
28. Trailing Section
29. Heat Exchanger
30. Slurry Feed
31. Booster Pump 100 HP
32. Slurry Return
33. Water Cooling System Strainer

MTBM CRUSHING CONE

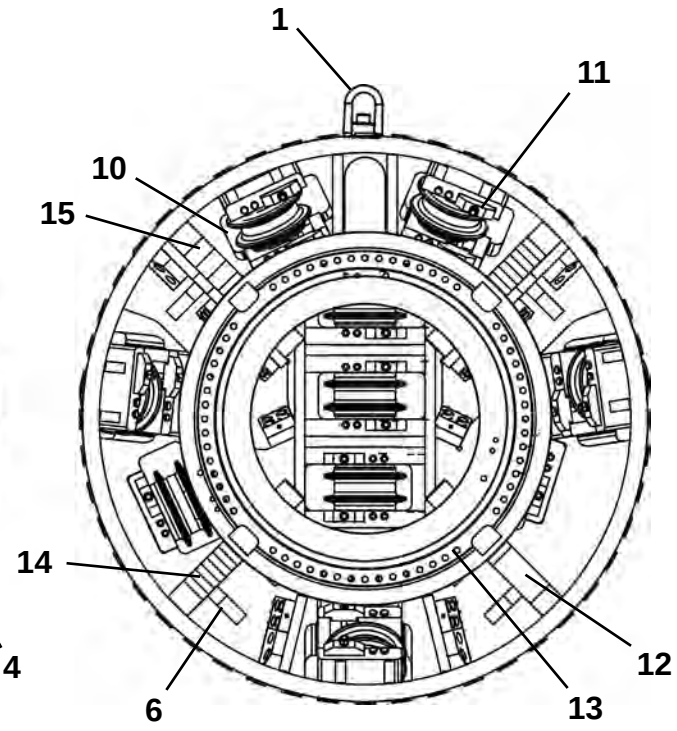


1. Slurry Cutter Ports
2. High Pressure Jetting Nozzles
3. Slurry Inlet Holes

MTBM CUTTER HEAD



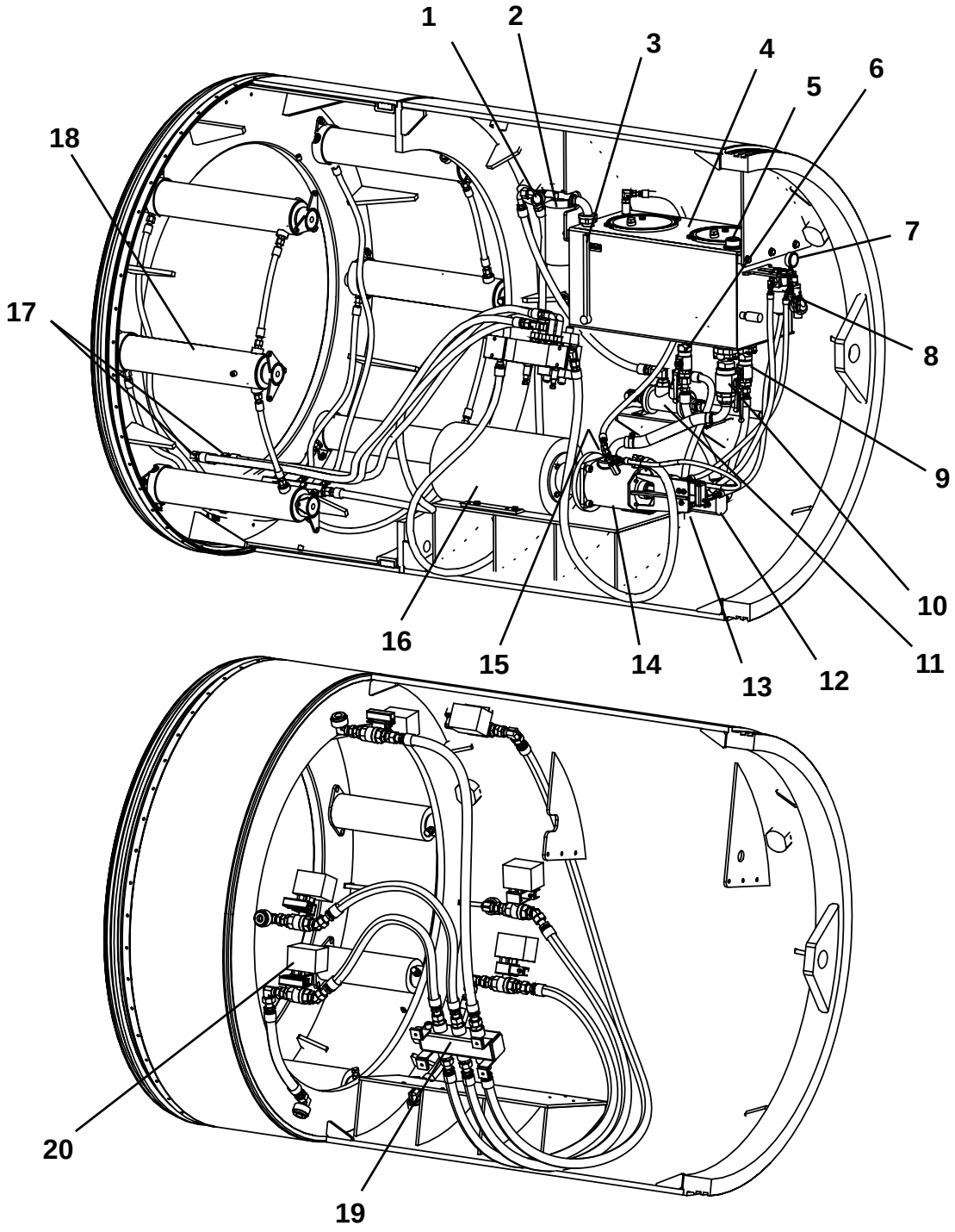
FRONT VIEW



REAR VIEW

1. Hoist Ring
2. Twin Disc Cutter
3. Face Scrapers
4. Cutter Wedge
5. Cutter Insert
6. Grizzly Bar
7. Carbide Wear Bar
8. Face Plate
9. Bucket Scrapers
10. Cutter Plates
11. Clamping Block
12. Wiper Arm
13. Cutter Head Mounting Plate
14. Mid Arm
15. Large Arm

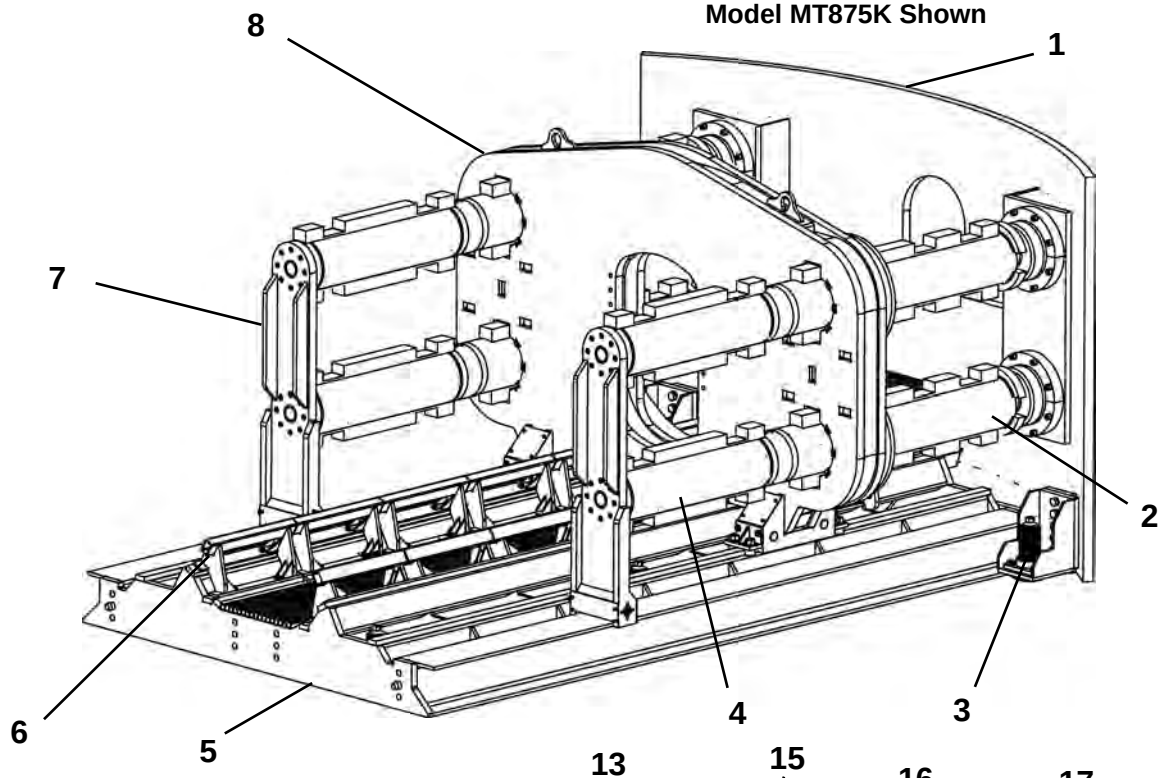
LUBE/JACKING CAN



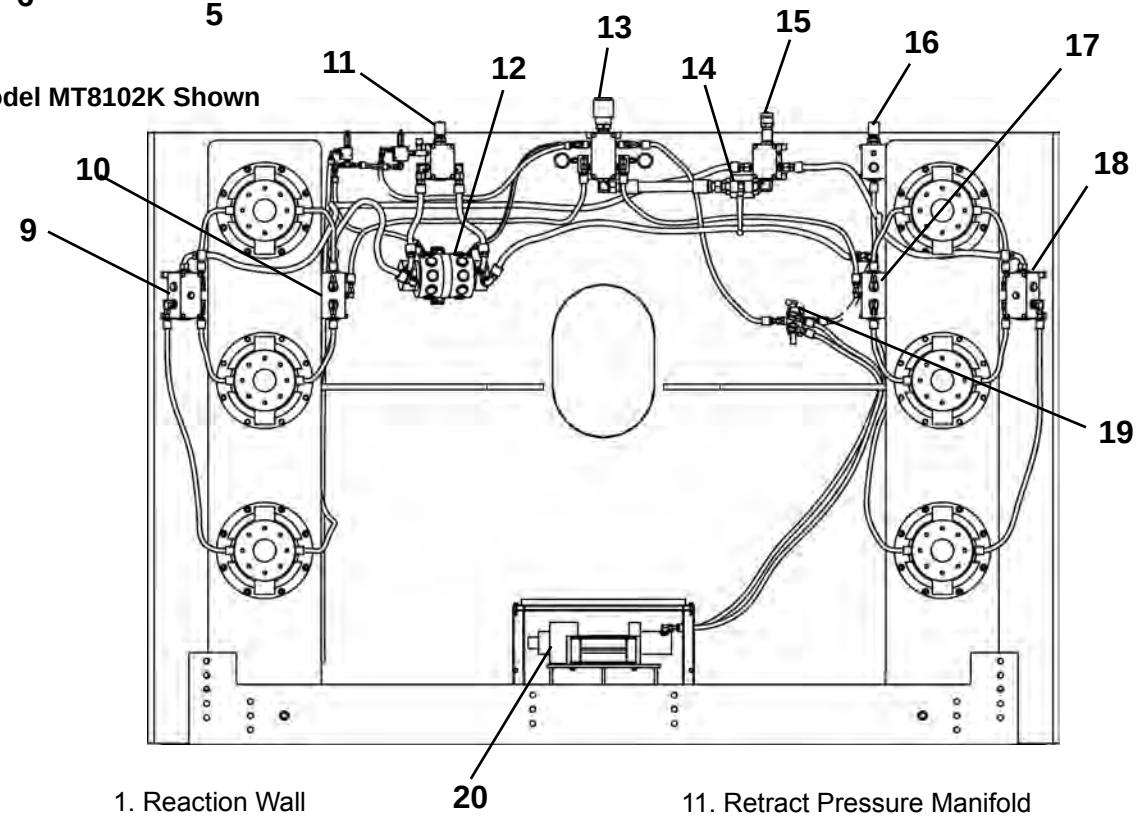
1. Filter Indicator
2. Hydraulic Return Filter
3. Sight Level Gauge
4. Hydraulic Oil Reservoir 30 Gal.
5. Oil Fill Cap & Breather
6. Cooling Pressure Hydraulic Shutoff
7. RPA Pilot Pressure Gauge
8. Pilot Pressure Oil FIlter
9. Pilot Pressure Hydraulic Shutoff
10. Main Hydraulic Shutoff
11. Heat Exchanger
12. Pilot Pressure Pump Assembly
13. Cooling Pump Assembly
14. Main Hydraulic Pump
15. Pilot/Cooling 2 HP Motor
16. Motor 20HP
17. IJS Hydraulic Supply Connections
18. Jacking Thrust Cylinder
19. Bentonite Supply Manifold
20. Lubrication Valve

KEYHOLE JACKING FRAMES

Model MT875K Shown



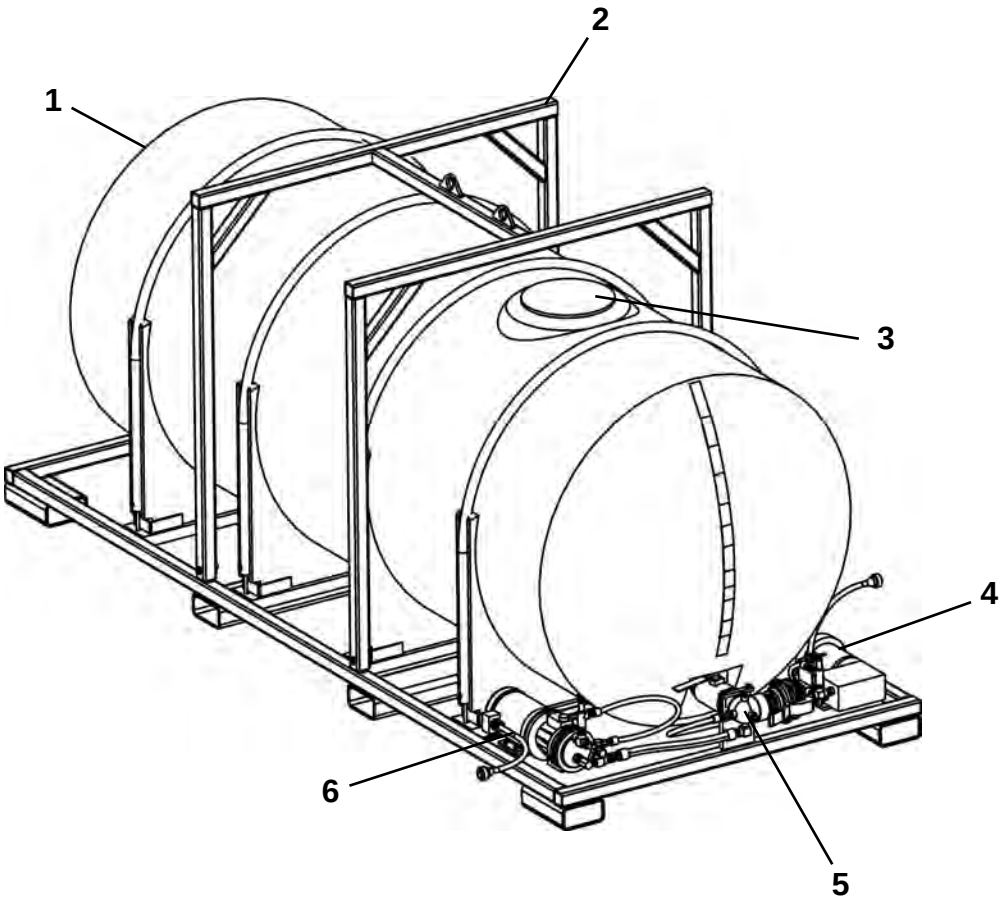
Model MT8102K Shown



1. Reaction Wall
2. Cylinder
3. Leveling Screw
4. Cylinder Extension
5. Skid Assembly
6. Skid Riser
7. Cylinder Support
8. Thrust Block
9. Extend Pressure Junction Manifold
10. Retract Pressure Junction Manifold
11. Retract Pressure Manifold
12. Flow Divider Retract Side*
13. Hi Flow Return Manifold
14. Hi Flow Return Control Valve
15. Extend Pressure Manifold
16. Auxiliary Hydraulic Manifold
17. Retract Pressure Junction Manifold
18. Extend Pressure Junction Manifold
19. Winch and Auxiliary Control Valve
20. Hydraulic Winch

* Used on earlier models

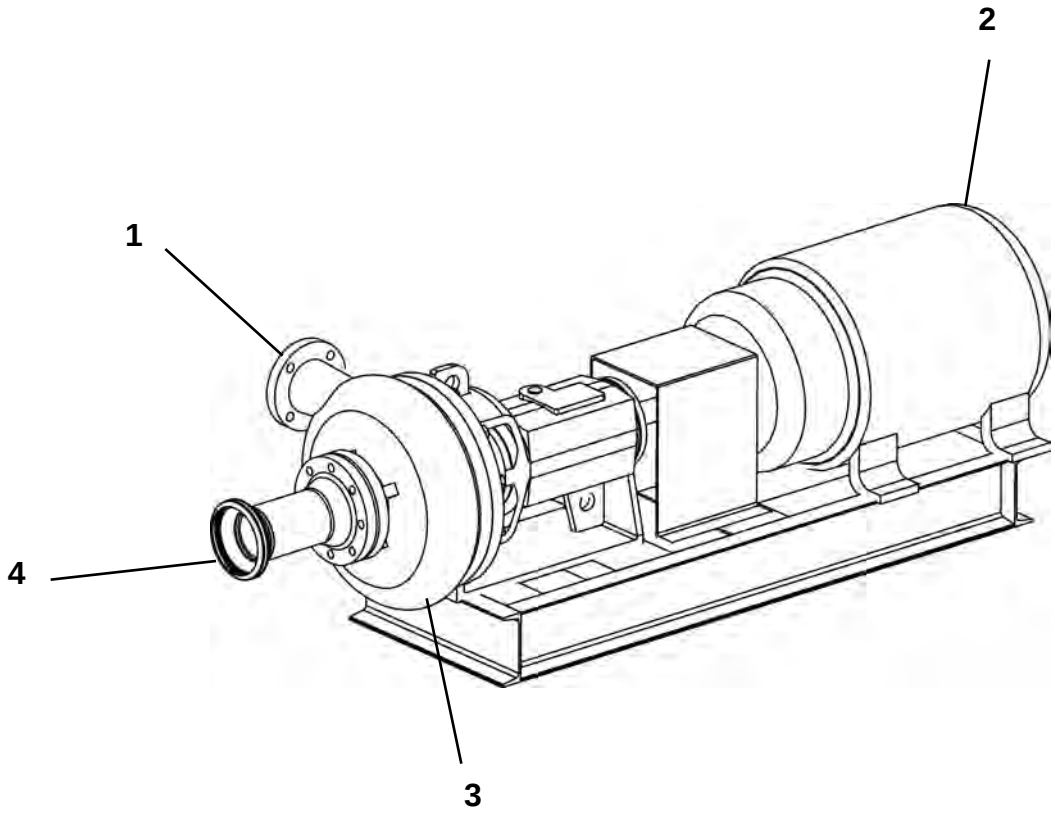
WATER COOLING TANK



1. Polyethylene Storage Tank
2. Lift Frame
3. Fill Cap
4. Main Cooling Drive Motor Pump Assembly (For Non-Periphery MTBM 30 hp & 75 hp drive motor)
5. High Pressure Jetting Supply Outlet
6. Main Cooling Drive Motor Pump Assembly* (For Non-Periphery MTBM with larger hp drive motor, water cooled booster pump, or gear reducer filtration)

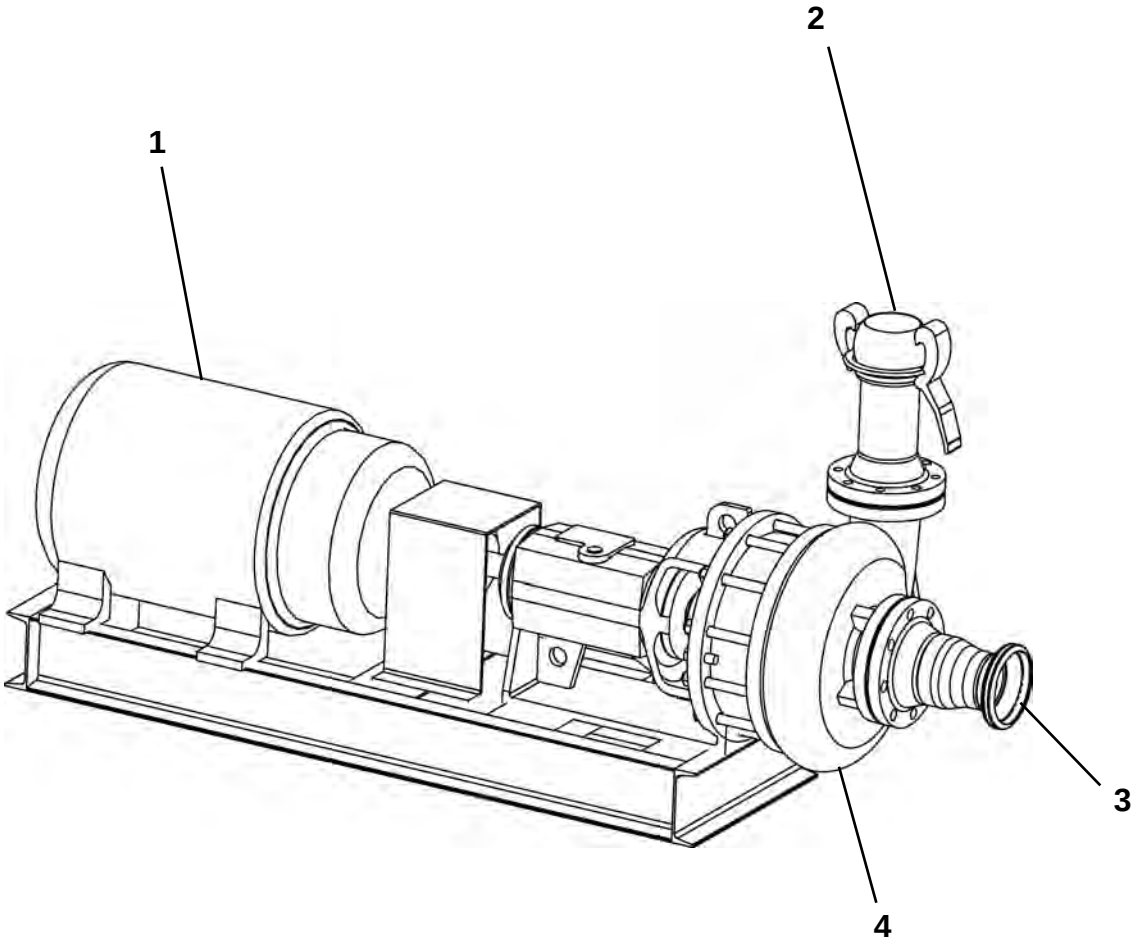
* Can be used for Periphery Drive MTBMs when additional cooling is necessary

SLURRY FEED PUMP



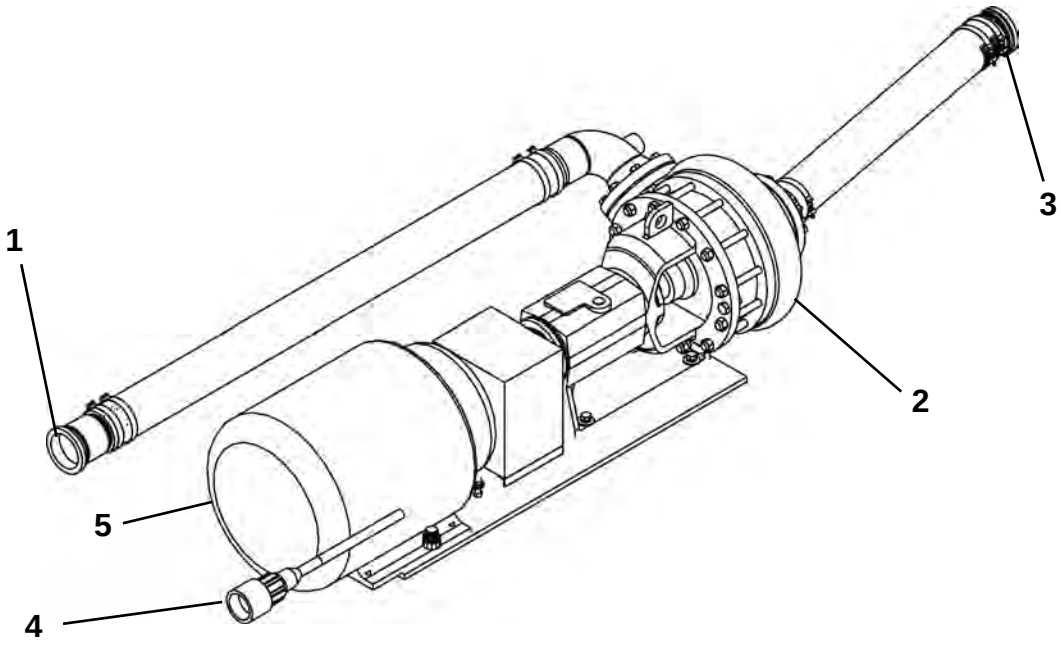
1. Feed Line Outlet
2. Motor 100HP
3. Impeller Pump Assembly
4. Water Inlet Connection

SLURRY RETURN PUMP



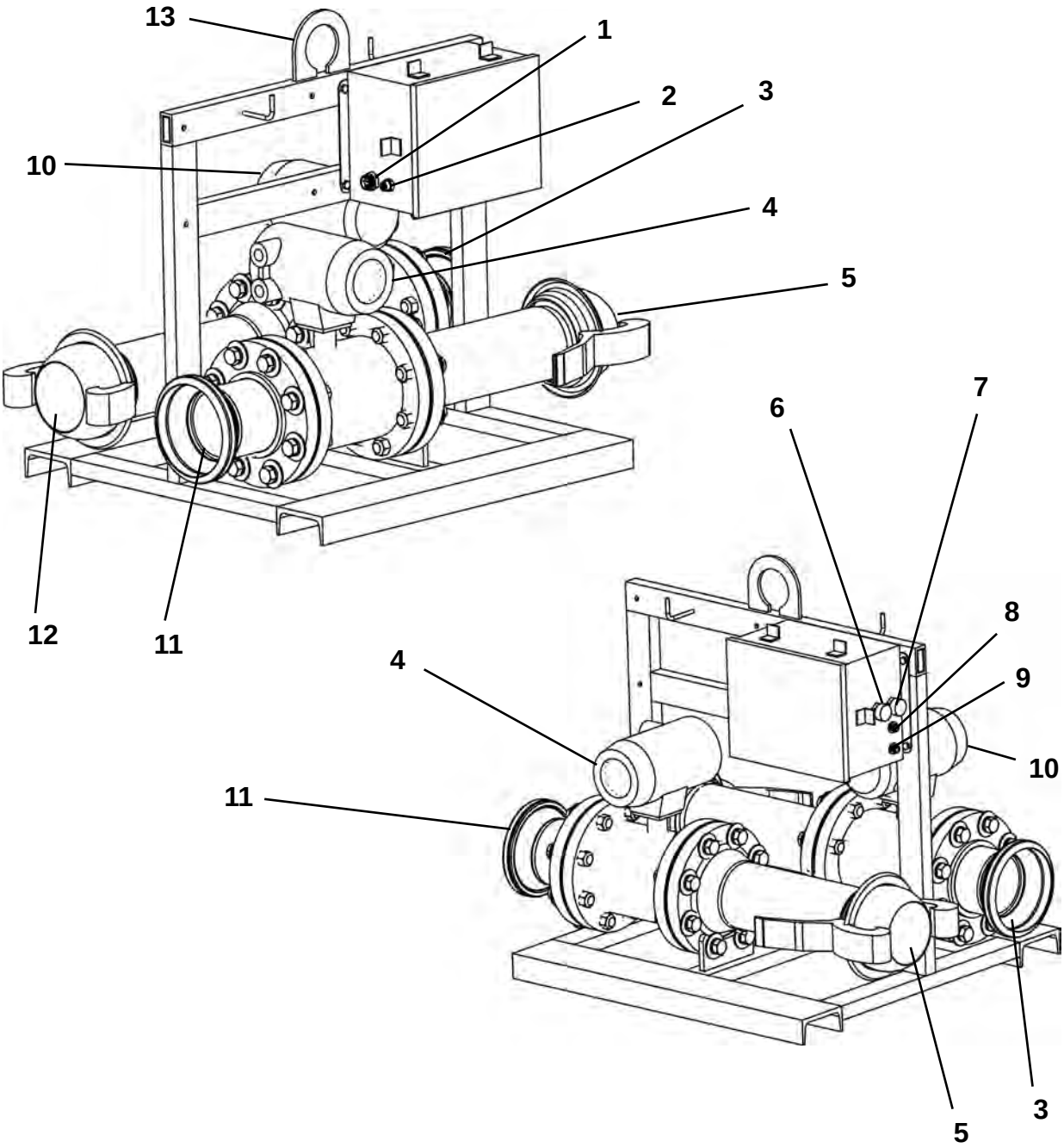
1. Motor 75 HP
2. Slurry Outlet To Tank
3. Slurry Line Inlet From Tunnel
4. Vortex Impeller Pump Assembly

SLURRY BOOSTER PUMP



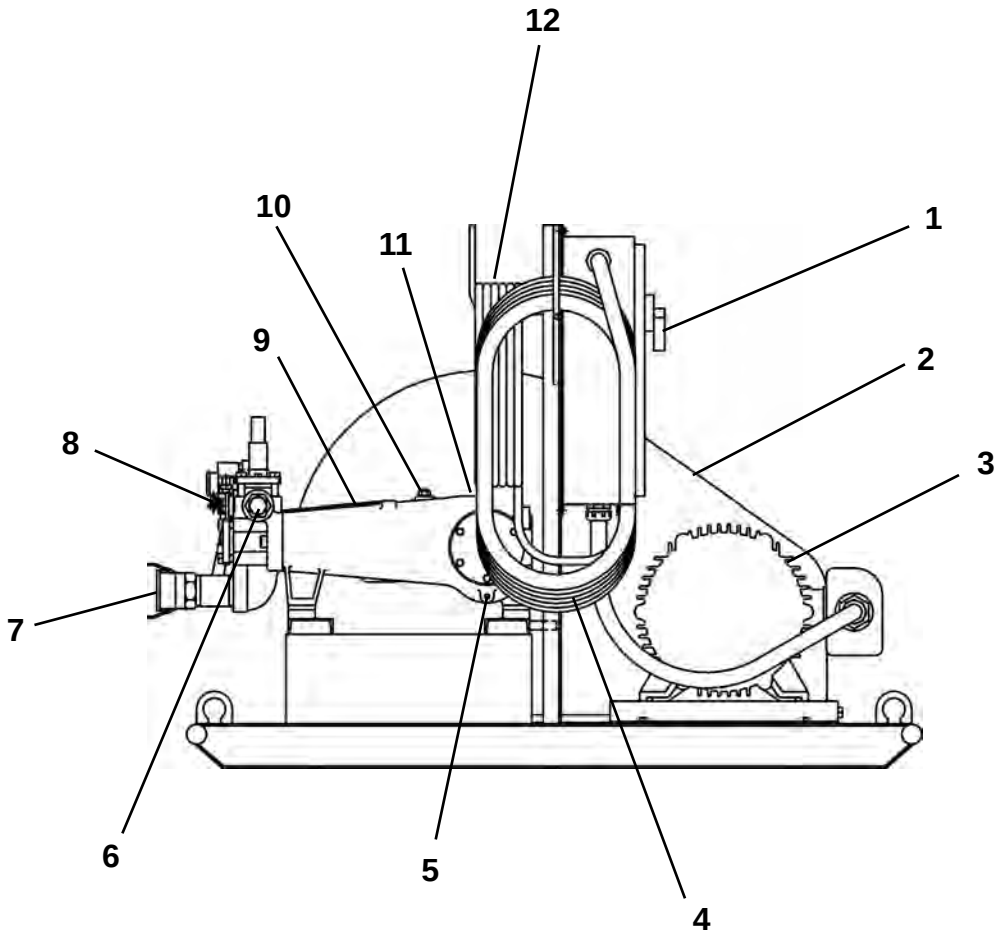
1. Outlet To Return Pump
2. Vortex Impeller Pump Assembly
3. Inlet From Head
4. Power Cable
5. Motor 100 HP

FLOWMETER



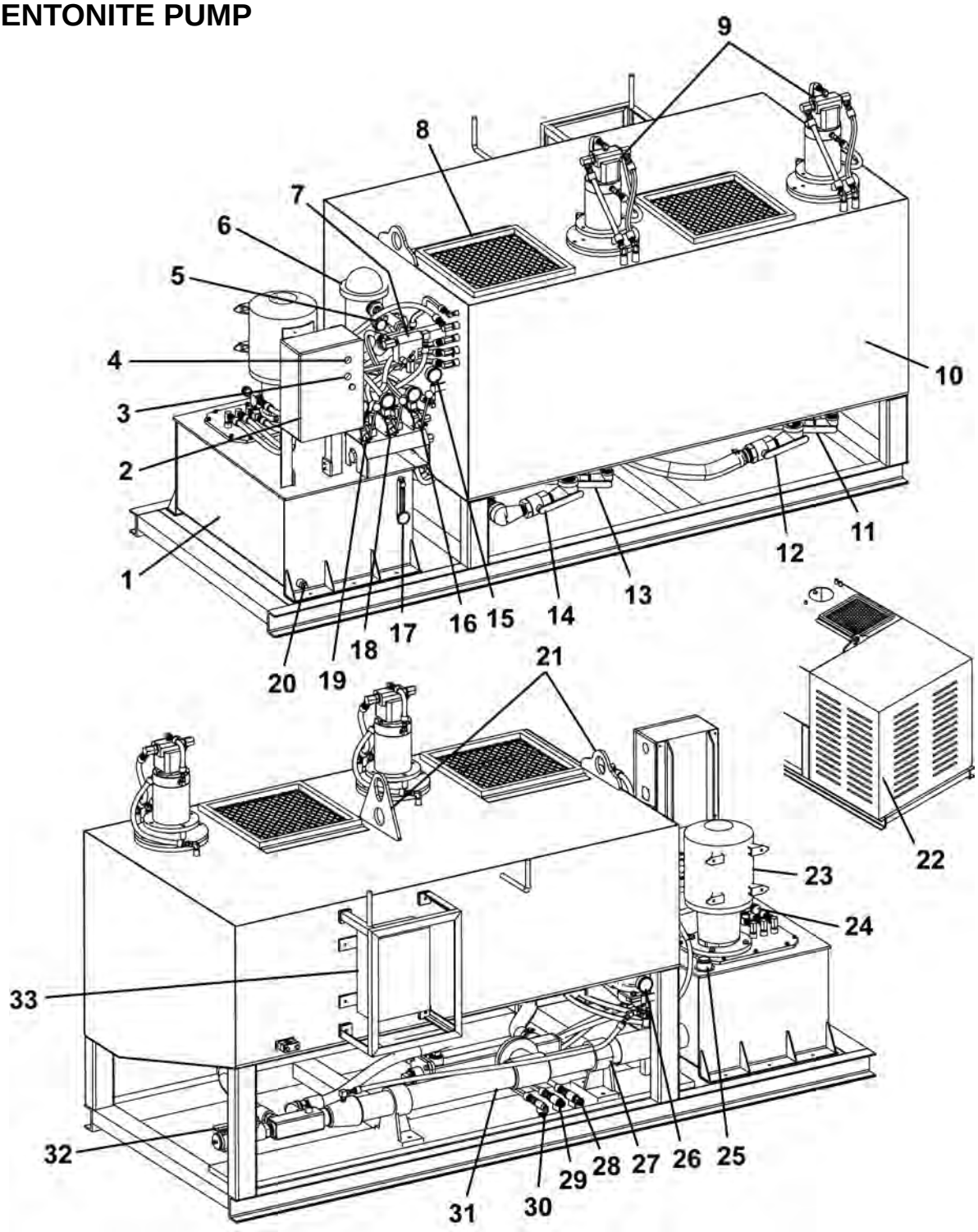
1. Input Power From Cntl Container
2. Flowmeter Ethernet From Control Container
3. Slurry Return Inlet
4. Slurry Feed Flowmeter
5. Slurry Feed Outlet
6. Output Power (Feed Flow) To Meter
7. Output Power (Return Flow) To Meter
8. Power Feed Input
9. Power Return Input
10. Slurry Return Flowmeter
11. Slurry Feed Inlet
12. Slurry Return Outlet
13. Lift Eye

HIGH PRESSURE JETTING PUMP



1. Main Power Switch
2. Belt Guard
3. Electric Motor 75 HP
4. Power Source Power Cable
5. Oil Drain Plug
6. Water Outlet To MTBM
7. Water Inlet From Water Cooling Tank
8. Bypass Pressure Relief Valve
9. Jetting Pump
10. Oil Fill Cap
11. Gear Box Dipstick
12. Control Container Power Cable

BENTONITE PUMP



1. Hydraulic Tank (60 gal)
2. Control Box
3. Stop Button
4. Start Button
5. Hydraulic Filter & Indicator Gauge
6. Heat Exchanger
7. Pump Speed Control
8. Mixer Door
9. Mixer Drive Motors
10. Hydraulic Tanks (2 @ 250 gal)
11. Right Tank Recirculation Valve
12. Right Tank Suction Valve
13. Left Tank Recirculation Valve
14. Left Tank Suction Valve
15. Bentonite Pump Discharge Pressure
16. Pump Hydraulic Control
17. Hydraulic Sight Tank/Temp. Gauge
18. Right Mixer Hydraulic Control
19. Left Mixer Hydraulic Control
20. Hydraulic Tank Drain
21. Lifting Eyes
22. Cab
23. Electric Motor 30 HP
24. Pump Relief Valve
25. Hydraulic Tank Fill
26. Bent. Pump Discharge Press.
27. Motor
28. Heat Exchanger Inlet/Outlet
29. Heat Exchanger Inlet/Outlet
30. Heat Exchanger Drain
31. Single Screw Rotary Pump
32. Pump Outlet Valve
33. Power ON/OFF

Controls & Instruments

EMERGENCY STOP (E-STOP)

⚠WARNING ALL Emergency Stop buttons MUST be functioning properly BEFORE operating the microtunneling system. Failure to do so may cause severe injury or death. Use the Emergency Stop buttons ONLY for emergency purposes. Do not use an E-Stop as a power on/off button.

There are four Emergency Stop (E-Stop) buttons installed on the Akkerman microtunneling system.

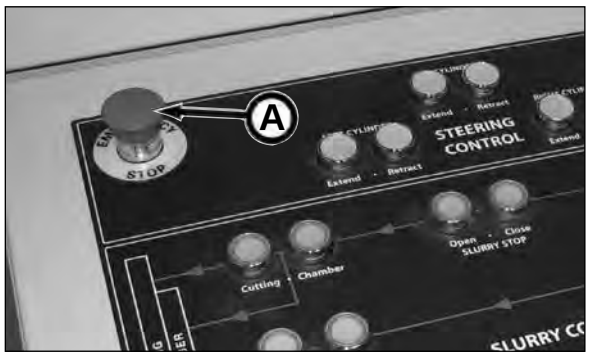
Push IN any of the four Emergency Stop buttons to deactivate ALL outgoing electrical and hydraulic power from the Akkerman control container (feed pump, return pump, booster, mid pump, *head power and cooling water tank pump [if used]), remote hydraulic power pack (hydraulic flow to jacking frame), power container (cutter head 4160V main drive tunnel power) and jacking frame.

NOTICE Using any of these four Emergency Stop buttons will not stop the power from the power source (generator). The power source (generator) must be equipped with an E-Stop.

⚠WARNING BEFORE reactivating power, be sure to communicate to all personnel that the electric and hydraulic power will resume shortly. Verification must be received from equipment operators that it is acceptable to restart. Failure to do so may cause serious injury or death from unintended equipment reactivation. **In addition,** all control container switches must be flipped to the OFF or Stop positions before resetting E-Stop button.

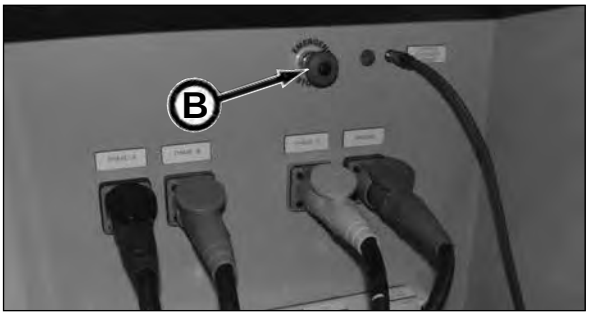
Pull OUT all E-Stop buttons to restart operation.

CONTROL CONTAINER E-STOP (A)



E-Stop (A) on Control Container Console

REMOTE HYDRAULIC POWER PACK E-STOP (B)



E-Stop (B)on Remote Hydraulic Power Pack Bulkhead

POWER CONTAINER E-STOP (C)



E-Stop (C) on Power Container

PIT BOX E-STOP (D)



E-Stop (D) on Pit Box

** If the E-Stop is pushed IN or a power outage occurs, the accumulator will automatically close the inlet and outlet stop valves and open the bypass valve.*

PHASE INDICATOR LIGHTS



⚠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 sever injury or death. Disconnect and lock out/tag out power from source before servicing

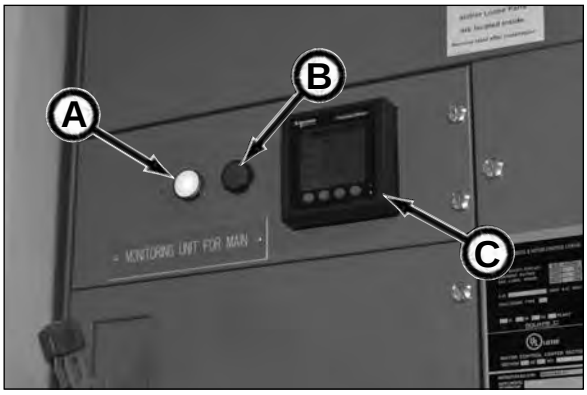
⚠WARNING Any electrical work completed on the control container or the remote hydraulic power pack must be performed by a certified electrician.

The input power on the control container, remote hydraulic power pack and power container is monitored for proper three phase electrical power. The control container, the remote hydraulic power pack and the power container have separate power hookups, therefore ALL green Phase OK lights must be illuminated before operating equipment.

IMPORTANT: DO NOT start up electric components if the green phase indicator lights are not illuminated. Doing so will run components backwards causing damage.

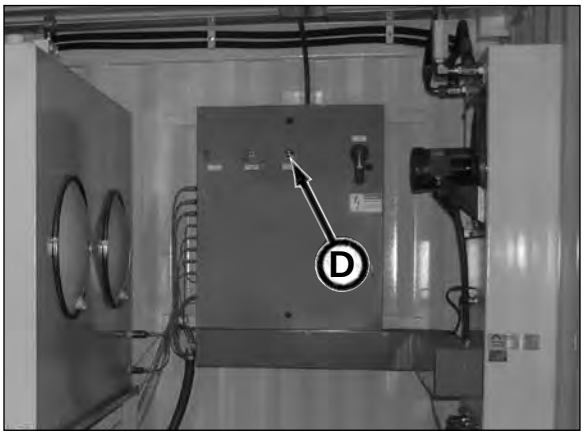
CONTROL CONTAINER

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



If the red Phase Error indicator light (B) is illuminated, disconnect and lock out/tag out ALL power before attempting to reverse two of the generator power leads on the power circuit.

NOTICE The Phase Monitor (C) will display the power source power in hertz, volts and amps. The control container must be powered with 480V and 60 Hz power. The maximum amperage is 1000 amps.



REMOTE HYDRAULIC POWER PACK

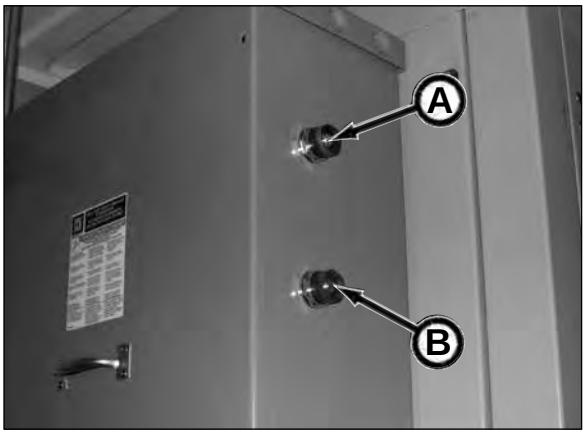
If the green Phase OK light (D) is illuminated, this indicates that the external power source phase power is installed correctly that the main power can be turned on for the power circuit.

If the green Phase OK light (D) is NOT illuminated, disconnect and lock out/tag out ALL power before attempting to reverse two of the generator power leads on the power circuit.

(continued on next page)

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

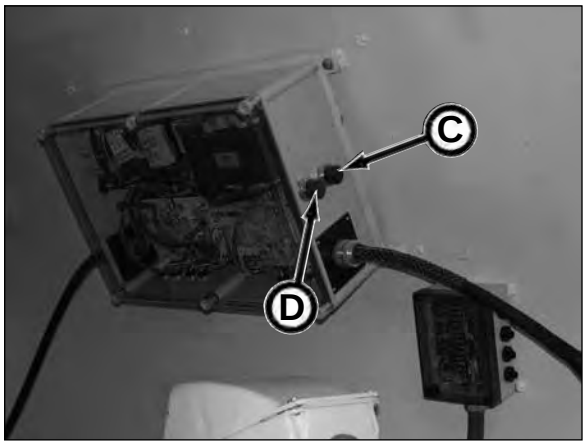
If the red Phase Error indicator light (B) is illuminated, disconnect and lock out/tag out ALL power before a certified electrician attempts to reverse the two generator power leads on the power circuit.



Power Container Phase Indicators

TRAILING SECTION
If the green Phase OK indicator light (C) is illuminated, this indicates that the control container phase power is installed correctly and that the main power can be turned on for the power circuit.

If the red Phase Error indicator light (D) is illuminated, disconnect and lock out/tag out ALL power before a certified electrician attempts to reverse the two generator power leads on the power circuit.



Trailing Section Phase Indicators

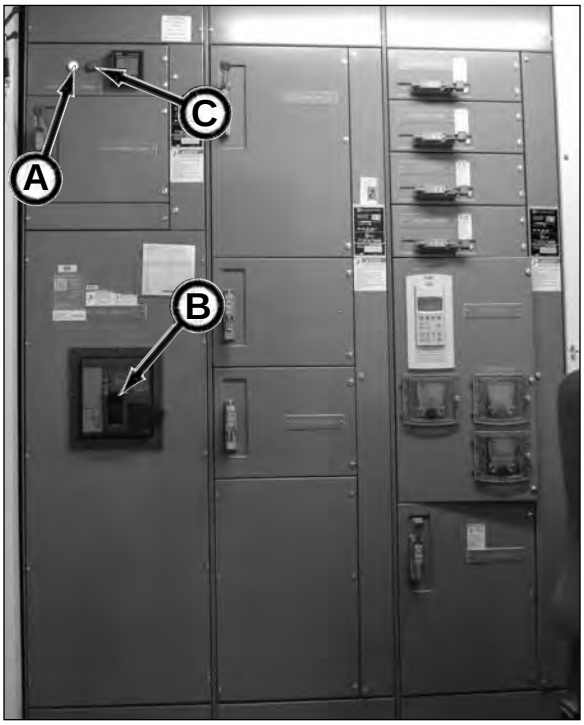
MAIN DISCONNECT (CONTROL CONTAINER)

⚠DANGER Hazardous voltage. Disconnect and lock out power from source before servicing.

With generator power cables connected to the main breaker lugs, the ground cable to the ground bus bar connection, and the green Phase Indicator light (A) ON, flip the main disconnect switch (B) up to the ON position.

DO NOT flip the main disconnect on if the red Phase Indicator light (C) is on. The red light indicates that the generator phase power is installed incorrectly. Disconnect and lock out ALL power before attempting to reverse the two generator power leads.

A - Phase Indicator (Green) (Phase OK)
B - Main Power Disconnect
C - Phase Indicator (Red) (Phase Error)

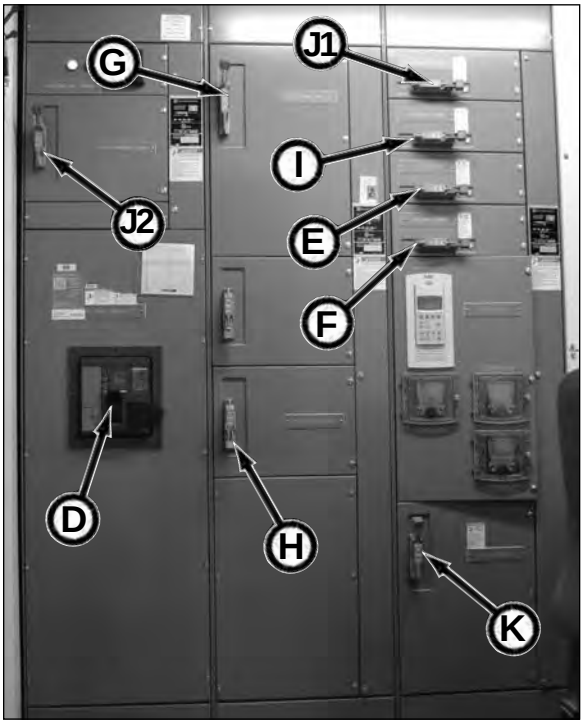


OPERATOR CONTROL DISCONNECTS (CONTROL CONTAINER)

⚠DANGER Hazardous voltage. Disconnect and lock out power from source before servicing.

With the main power disconnect (D) on, the disconnects to the feed pump (E), return pump (F), main cutter drive (G), booster pump (H), cooling pump (I), head power (J1) (smaller than SL82P) or SL82P head power (J2) (SL82P & larger), and the 120V/240V transformer (K) must be powered on before utilizing the devices.

D - Main Power Disconnect
E - Feed Pump Disconnect
F - Return Pump Disconnect
G - Main Cutter Drive Disconnect/Booster SL82P
H - Booster Pump Disconnect
I - Cooling Pump Disconnect
J1 - Head Power Disconnect (smaller than SL82P)
J2 - Head Power Disconnect (SL82P & larger)
K - 120V/240V Transformer Disconnect



MAIN POWER SWITCH (REMOTE HYDRAULIC POWER PACK)

⚠DANGER Hazardous voltage. Disconnect and lock out/tag out power from source before servicing.

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



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

NOTICE The remote hydraulic power pack, control container, power container and pit box E-Stop buttons must all be pulled out to start operation.

Use the main power switch (A) to allow power from the external power source to the remote hydraulic power pack.

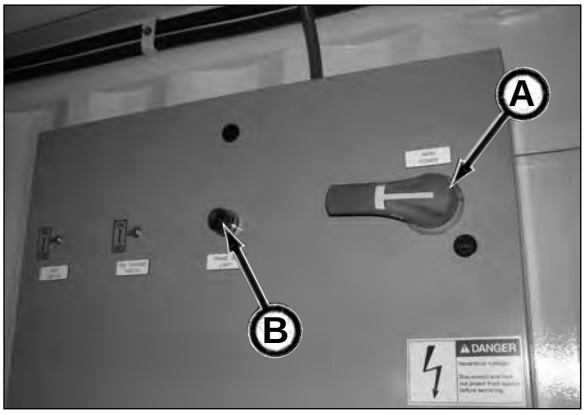
1. Check to sure the main power switch (A) is in the off position.

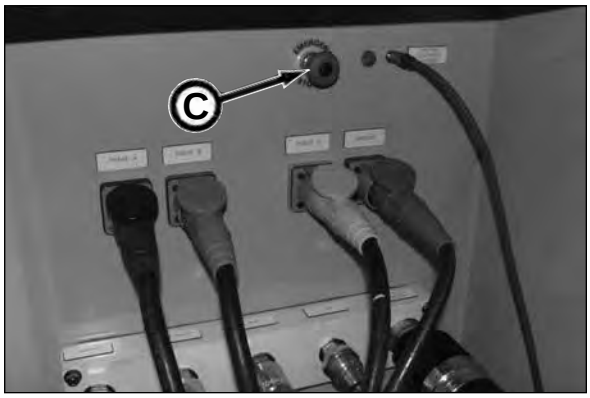
2. With the external power source power cables properly installed to the remote hydraulic power pack and the hydraulic hoses connected from the jacking frame to the remote hydraulic power pack bulkhead connections, turn generator power (external power) ON.

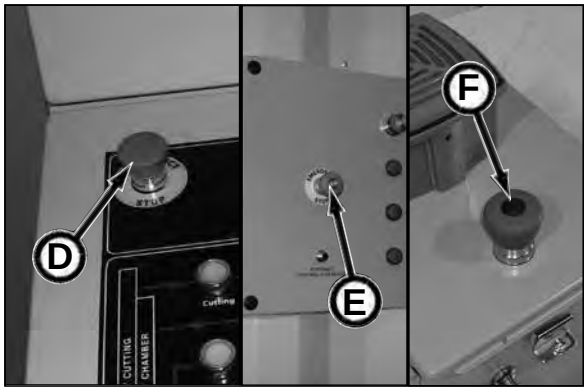
3. Check input power for proper phase. Phase OK Light (B) must be illuminated. If light is not illuminated, lock out, tag out ALL power before attempting to have a certified electrician reverse the two generator power leads on the power circuit.

4. With power in proper phase, pull out all E-Stop buttons: remote hydraulic power pack E-Stop button (C), control container E-Stop button (D), the power container E-Stop button (E), and the pit box E-Stop button (F).

5. Turn the main power switch to the ON position.







MAIN POWER SWITCH (MAIN DRIVE POWER CONTAINER)

⚠DANGER Hazardous voltage. Disconnect and lock out/tag out power from source before servicing.



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

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

NOTICE The remote hydraulic power pack, control container, power container and pit box E-Stop buttons must all be pulled out to start operation.

Use the power container main power switch (A) to allow power from the external power source to the power container as follows:

1. Check to sure the main power switch (A) is in the off position.

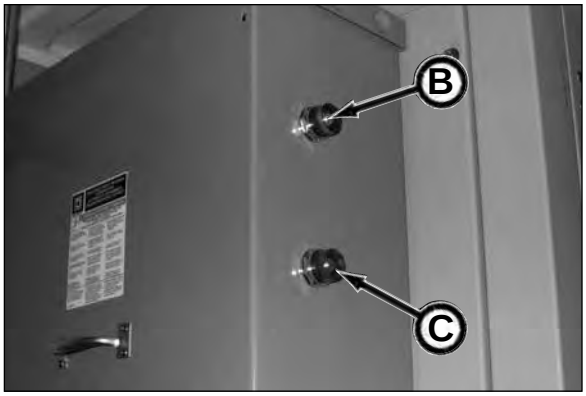
2. With the external power source power cables properly installed to the power container and the power cables connected from the power container to the MTBM SL82P, turn generator power (external power) ON.

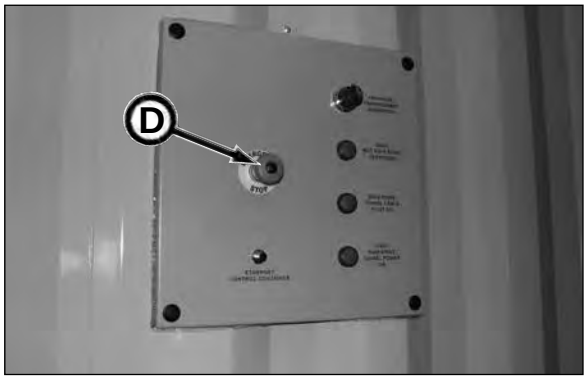
3. Check input power for proper phase. The green Phase OK Light (B) must be illuminated. If the red Phase Error light (C) is illuminated, lock out, tag out ALL power before attempting to have a certified electrician reverse the two generator power leads on the power circuit.

4. With power in proper phase, pull out all E-Stop buttons: power container E-Stop button (D), remote hydraulic power pack E-Stop button, control container E-Stop button, and the pit box E-Stop button.

5. Turn the main power switch (A) to the ON position.

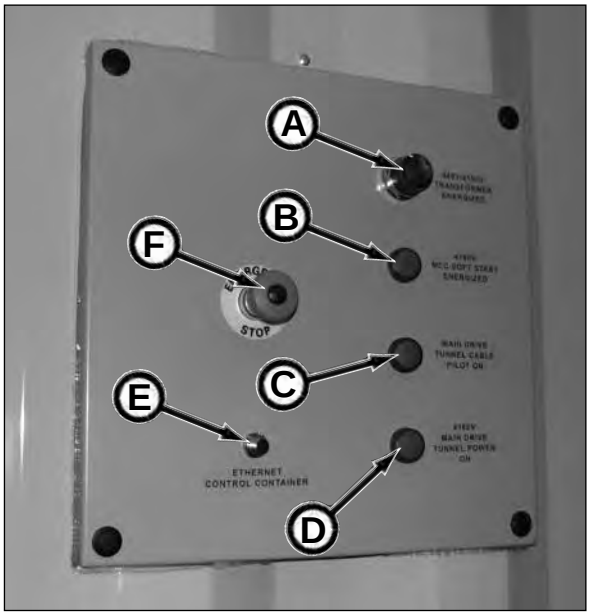






POWER STATUS PANEL (MAIN DRIVE POWER CONTAINER)

The power status panel displays lighted indicators of the power components in the main drive power container.



480V/4160V TRANSFORMER ENERGIZED (A)
Illuminates when the generator or power source is connected to power container and powered.

4160V MCC SOFT START ENERGIZED (B)
illuminates when the motor control center (MCC) soft start is properly energized and allowing the main drive motor (cutter head) to be started. Refer to Soft Start Protection System in this section for the procedure on how to energize the soft start.

MAIN DRIVE TUNNEL CABLE PILOT ON (C)
Illuminates when the tunnel cable is properly connected from power container to main drive motor in trailing section.

4160V MAIN DRIVE TUNNEL POWER ON (D)
Illuminates when the Cutter head power is powered on from the control console in the control container.

ETHERNET CONTROL CONTAINER (E)
Ethernet connection from power container to control container allowing the operator to control the drive motor from the control console in the control container.

EMERGENCY STOP (F)
Push IN Emergency Stop button (F) or any control container, remote hydraulic power pack, power container and pit box E-Stop buttons to stop tunnel power. The E-Stop button will illuminate when it is pushed in. Pull OUT all E-Stop buttons to restart operation.

SOFT START PROTECTION SYSTEM (MAIN DRIVE POWER CONTAINER)



NOTICE It is recommended the soft start protection system be locked out (de-energize soft start system) at the end of each day to prevent any accidental starting of the drive motor.

The MCC Medium Voltage Soft Start System is equipped on the power container. This is a microprocessor-based protection and control starting system to lower the starting current of the motor thus reducing electrical stresses on the main drive power system and increasing motor life.



Energize the soft start system as follows.

1. With the green Phase OK light illuminated, and the main power switch to the ON position, turn lockout key switch to the horizontal, unlock position.



2. Slide lockout latch to unlock position.



3. Install handle into disconnect and move to unlock (CW) position. Indicator color will move from green to red.

(continued on next page)

4. Remove handle and place in storage bracket.



5. Slide lockout latch to lock position.

IMPORTANT: Lockout latch MUST be moved to lock position. Otherwise a motor fault will occur. Motor will not operate with the lockout latch in the unlock position.



6. Turn control switch (A) to either Local or Control Container position.

If the drive motor is to be controlled from the control container, select CONTROL CONTAINER.

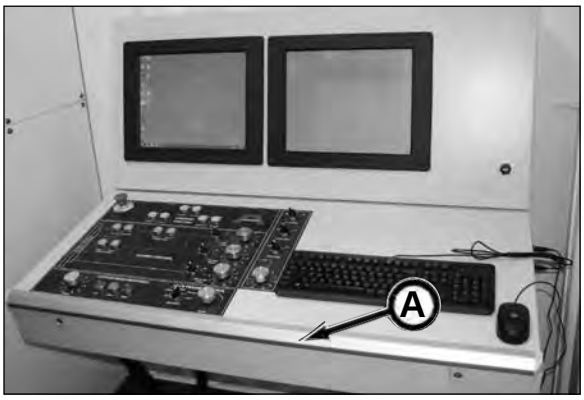
If the drive motor is to be controlled from the power container control buttons, typically for troubleshooting purposes, select LOCAL.



NOTICE To lockout the soft start protection system from starting the main drive motor, reverse this procedure.

7. The main drive motor can now be started.

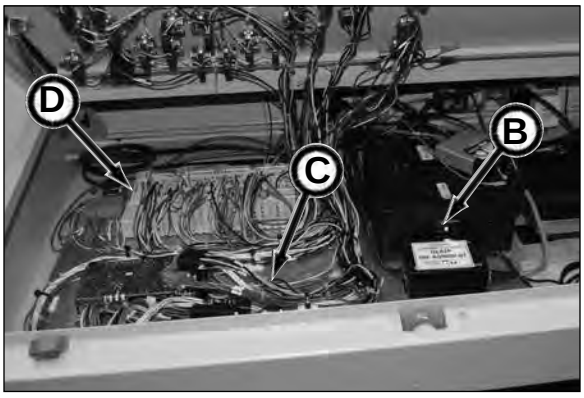
COMPUTER



With the power for the control container in proper phase, once the control container main power disconnect is on, the computer will automatically power on.

If the computer is shut down with the power on, restart the computer by opening the control container console lid (A) and press power button (B). Close console lid.

NOTICE The console lid has a racheting mechanism. To close lid, fully open lid to release the rachet mechanism, then slowly lower lid until it is closed.

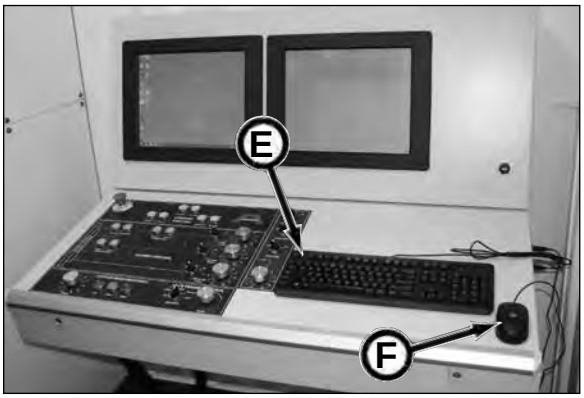


Before powering control container, be sure the console communication cable connections and the main WAGO module are properly installed for the MTBM drive system (Periphery or Non Periphery) that is being operated.

1. There are multiple cable connections (C) in the base of the control console labeled A and B that provide communication between the control container and the components in the microtunneling system. The cable connections must be properly connected based on the MTBM drive system:
   - Cable A Connections: Periphery Models (SL82P)
   - Cable B Connections: Non Periphery Models

2. The proper main WAGO module (D) must be installed based on the MTBM drive system:
   - Module A Periphery Drive (SL82P) or
   - Module B Non-Periphery Drive module

KEYBOARD & MOUSE CONTROLS



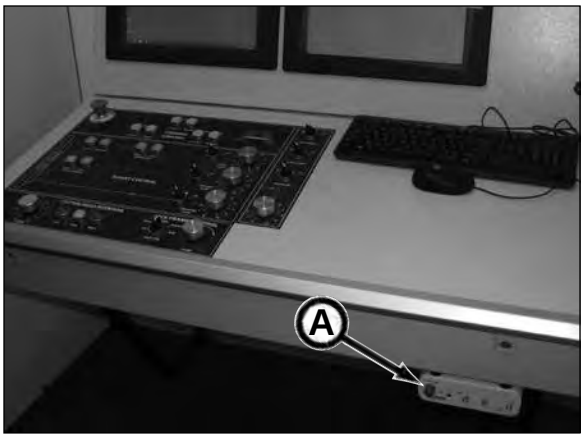
KEYBOARD
Use the keyboard (E) to enter data such as information for the report generator or for changing meter settings on the control screens.

MOUSE
The mouse (F) controls the computer screen cursor and select functions on the control monitors.

NOTICE The keyboard and mouse are typically stored inside the console during shipping. The console lid has a racheting mechanism. To close lid, fully open lid to release the rachet mechanism, then slowly lower lid until it is closed.

AUDIO SYSTEM

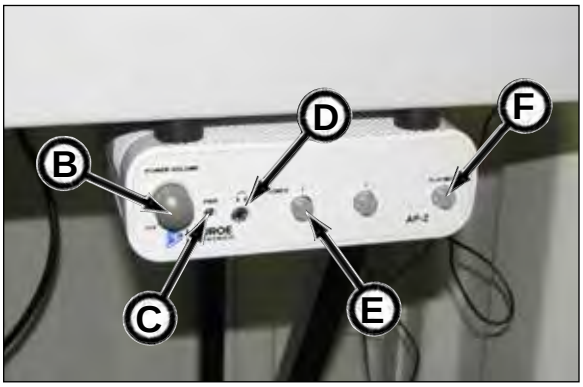
An audio system (A) is equipped for live, one-way audio monitoring from the microphone installed in the MTBM.



Turn on the power to the unit by rotating the Power-Volume knob (B) clockwise to ON position. The Power Indicator green LED light (C) will illuminate when the power is turned on. Rotate Power-Volume knob further clockwise to increase the volume of the monitored audio.

A headphone jack (D) (3.5mm stereo) is available for private listening. This connection will mute the speaker output when in use.

Press the zone selector switch (E) for desired zone. Zone 1 (standard) selects the microphone in the MTBM. Zone 2 is optional.



The Play/Mute switch (F) is used when playing back audio from a recorder or mutes the audio from the microphone.

For details on the use of the audio system, follow the operating instructions in the operating Instructions manual. The manual can be accessed from the Target Screen by clicking Help in the menu bar and then clicking AudioSystemOperatingInstructions.

AIR CONDITIONER/HEATER

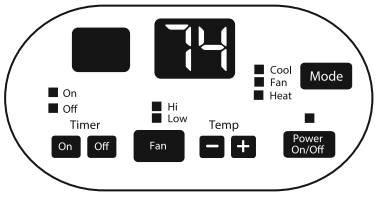
The control container is equipped with an air conditioner/heater unit in the operator station area.



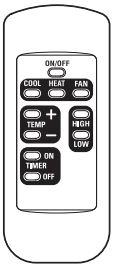
AC/Heat Unit Shown in Storage/Transport Position

For details on the use of the air conditioner/heater, follow the operating instructions in the A/C/Heater manual. The A/C/Heater manual can be accessed from the Target Screen by clicking Help in the menu bar and then clicking A/C_Manual.

NOTICE The AC/Heater unit is designed to be extended out for operating position or retracted for storage or transporting position. When repositioned, the unit MUST be secured with six 1/2 UNC x 1.25 flat socket head cap screws.

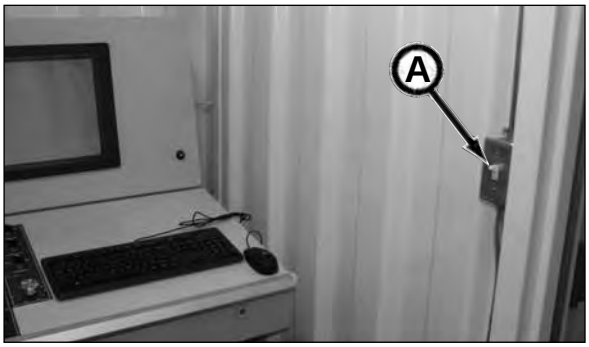


A/C Controls

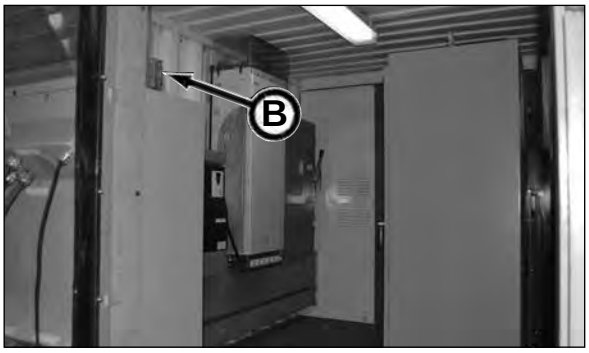


A/C Remote Control

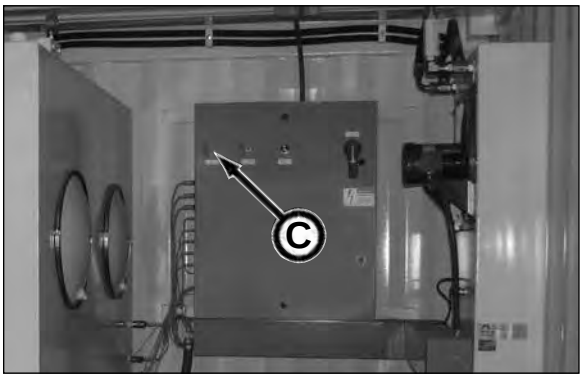
LIGHTS



CONTROL CONTAINER
There is a light switch (A) for the operator station area of the container.



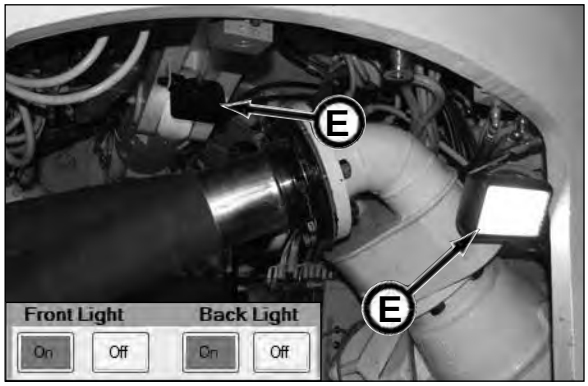
A light switch (B) is also installed in the VFD area of the control container.



REMOTE HYDRAULIC POWER PACK
There is a light switch (C) for the power pack.



POWER CONTAINER
There is a light switch (D) for the power container.



MTBM
There are two lights (E) that power on when the Head Power is activated. The lights can be moved to a desired location in the MTBM.

The lights can also be manually controlled with the Front Light and Back Light controls on the MTBM control screen (see inset).

VARIABLE FREQUENCY DRIVES (VFD)



The control container is equipped with four variable frequency drives (VFDs) to efficiently operate the electric motors for the main MTBM drive, slurry feed, slurry booster, and slurry return systems. The motors are operated with the controls on the control console.

The VFDs are capable of controlling motors up to:

- 250 HP 600V Slurry Booster/Drive Motor
- 100 HP 460V Slurry Feed Pump Motor
- 75 HP 460V Slurry Booster Pump Motor/ Mid Pump
- 75 HP 460V Slurry Return Pump Motor





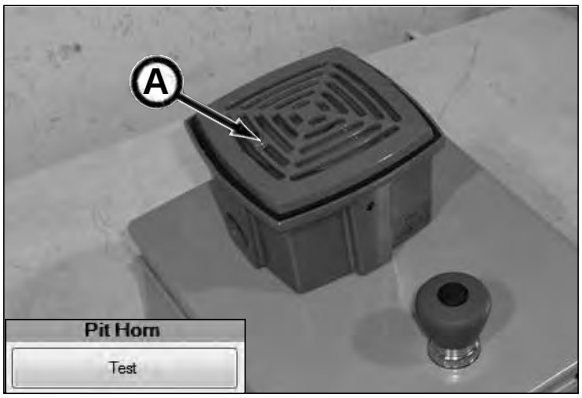
VFD Motor Monitors

The VFD motor monitors in the operator station of the control container, display the cutter (drive), feed, booster, return and mid pump motor torque and motor speed.

PIT BOX ALARM HORN

The pit box alarm horn is adjustable. The horn must be adjusted so it can be easily heard over the ambient noises of operation. Adjust the volume by using an allen wrench in the set screw (A) on the horn face. Turn the set screw clockwise to reduce the volume. Turn the set screw counterclockwise to increase the volume.

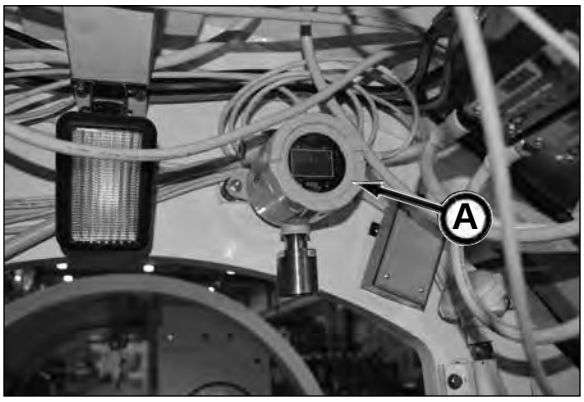
There is a Pit Horn Test button (see inset) on the MTBM control screen to test the proper operation of the pit horn.



GAS DETECTOR

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

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

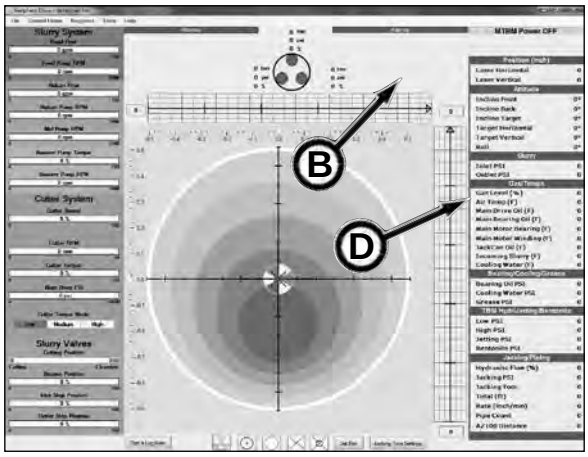


The gas detector is monitored by the control system as follows:

1. The “Gas Fault” message will appear in the alarms area (B) on the target screen when there is a problem with the gas detector sensor.

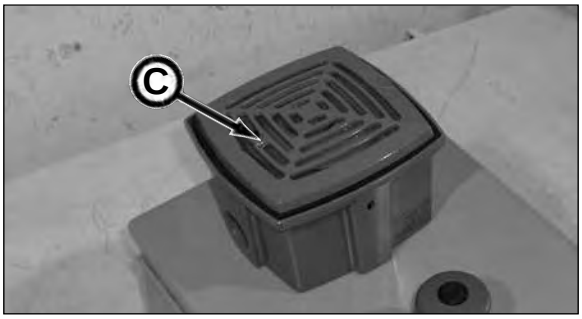
2. The “Gas Level High” message will appear in the alarms area (B) on the target screen when the gas level at the gas detector reads 10% (default setting) LEL (Lower Explosive Limit) or higher.

3. When the system detects a gas level reading of 10% LEL but less than 25% (default setting) LEL, the audible alarm (horn) (C) on the pit box will sound intermittently.



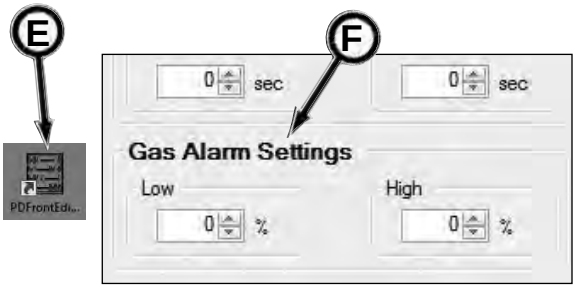
NOTICE On the MTBM control screen, there is a Pit Horn test button to test the proper operation of the horn.

4. When the system detects a gas level reading of 25% (default setting) LEL or higher, the horn on the pit box will sound constantly.



NOTICE If the high LEL setting is reached, the cutterhead rotation and the jacking frame functions will shut down.

5. The gas level % of LEL reading (D) at the gas detector is displayed on the target screen.



NOTICE To change the LEL setting alarms, double click the PDFrontEditor icon (E) to load the MTBM Operational Data Editor program. Update the Gas Alarm Settings (F) by changing the low and high % fields per job requirements.

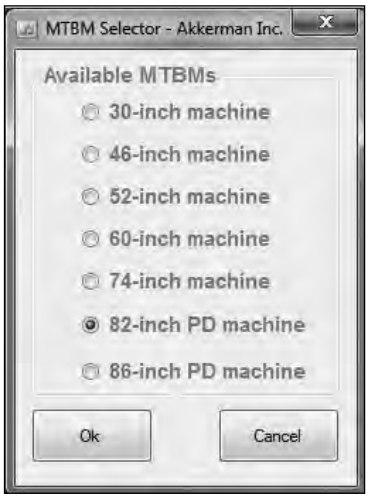
MICROTUNNELING SYSTEM SOFTWARE PROGRAMS

There are software programs that are used to control and monitor all aspects of the microtunneling system operation. Below is a summary of the microtunneling system software programs.

Machine Select



The Machine Select program loads the specific MTBM head factory set constant data values for use in the Akkerman microtunneling system software programs.
After computer start-up, double click the MTBM Select icon on the desktop and then select the MTBM head size for the current job, and click OK. The values loaded from this program are the characteristics of the machine make-up and design. If the constant values are changed or the wrong head size is selected, erroneous data will be calculated, resulting in improper monitoring of the MTBM position.

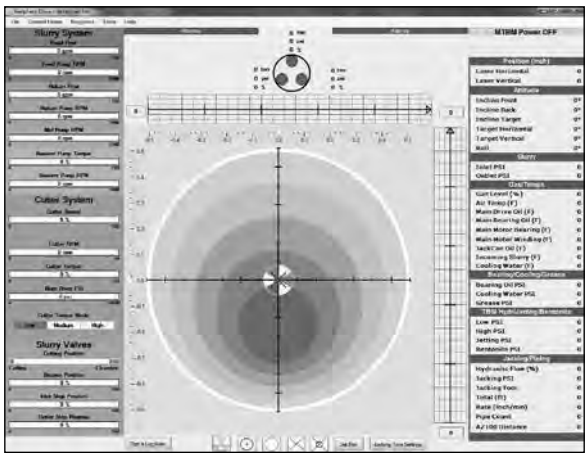


Target Screen Program

The target screen program shows all critical tunneling data.

This program automatically loads once the Machine Select program is activated.

Refer to Target Screen in this section for more information.



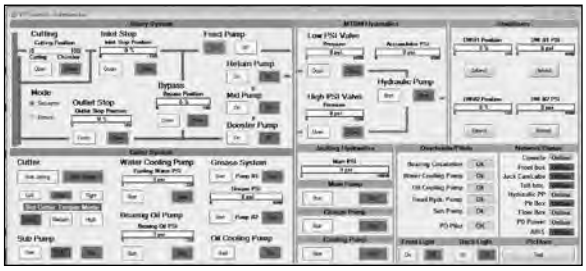
Log Messages

Once the target screen is activated, the Log Messages screen automatically appears on the monitor and displays non-critical, informative messages of the system operation.



(continued on next page)

MTBM Control Screen Program
The MTBM control screen program shows the slurry system, cutter system, MTBM hydraulics, stabilizers, Jacking Hydraulics, overloads and network status controls.



This program automatically loads once the Machine Select and Target Screen programs are activated. This program can also be accessed from the Target Screen by clicking Control Forms on the menu bar and clicking MTBM Controls from the pull down menu.

Refer to MTBM Control Screen in this section for more information.

Camera Program
A camera is installed on the inside of the front section of the MTBM for viewing the target. There is no panning, tilting or zooming with this camera.

Double click the PD Camera icon to display the camera window.





NOTICE When the camera program is booted up and the boring head ethernet cable is not connected to the MTBM control box, a window with the Akkerman logo will be visible (as shown). Once the communication is connected between the MTBM and the control container, the video feed of the MTBM front section will be visible in the camera window.

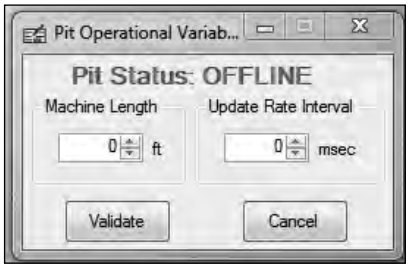
The screen image can be resized by dragging a corner of the window to the desired size.

Refer to MTBM Camera in this section for more information.

An optional pit or launch shaft video camera setup with monitor is available with two to four cameras. Contact your Akkerman Aftermarket Support representative for more information.



Pit Operational Variable Data Editor
This program editor provides the value to calculate the pipe advance rate.



The program icon is located on the desktop.

For more information, refer to section 6, Supplementary Editor Programs, Pit Editor.

(continued on next page)



MTBM Operational Data Editor

This program editor is used to calculate the position of the cutting head during the tunneling operation. Most of the fields contain constant values and should not be changed since they are the design specifications of the MTBM.

This editor also provides a method to calibrate the steering cylinders, stop valve, bypass valve, and the cutting valve.

The program icon is available on the desktop or the program can also be accessed from the Target Screen by clicking Programs on the menu bar and clicking PD Editor from the pull down menu.

For more information, refer to section 6, Supplementary Editor Programs, MTBM Editor.



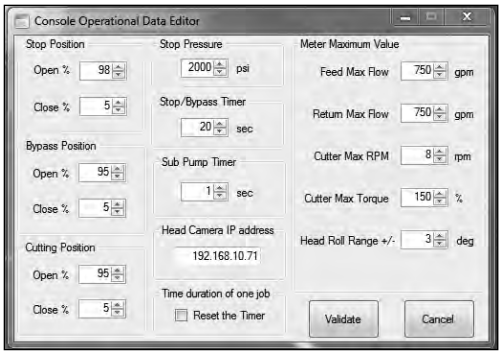


Console Operational Data Editor

This program editor allows the operator to change the console dynamic variable ranges and meter values. The meter values are visible on the target screen.

The program icon is located on the desktop or the program can also be accessed from the Target Screen by clicking Programs on the menu bar and clicking Console Editor from the pull down menu.

For more information, refer to section 6, Supplementary Editor Programs, Console Editor.



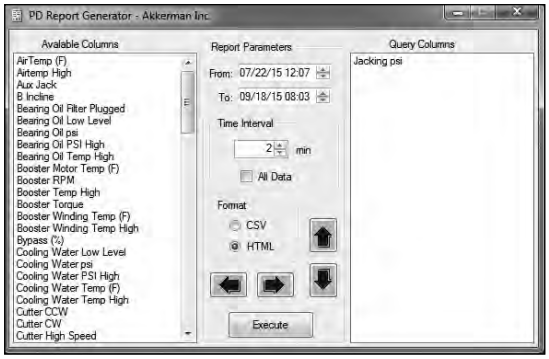


Report Generator

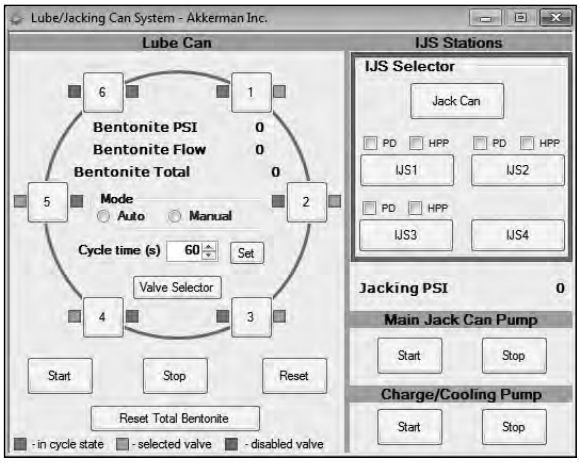
A report generator program icon is available on the desktop for creating reports of data variables collected during operation.

This program can also be accessed from the Target Screen by clicking Programs on the menu bar and clicking Report Generator from the pull down menu.

For more information, refer to section 6, Using The Report Generator.



(continued on next page)



Lube/Jacking Can System Program
The Lube/Jacking Can System program displays the lube can, jacking can pump and the IJS selector controls.

Access this program from the Target Screen by clicking Control Forms, and clicking Lube/Jacking Can from the pull down menu.

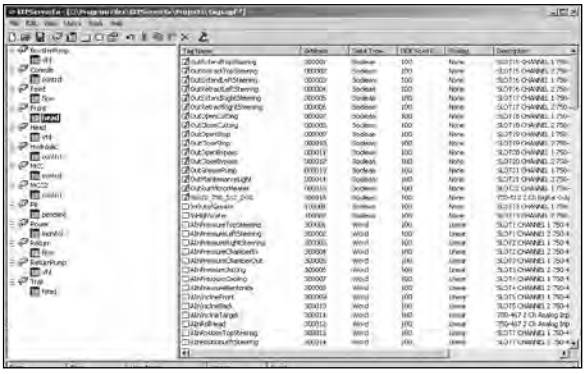
Refer to Lube/Jacking Can System Control Screen in this section for more information.



KEPServerEX5Configuration
The KEPServerEX5 Configuration is a program (automatically loads and runs in the background when the Target screen is loaded) that communicates the MTBM input and output device component data to and from the operator in the control container via the Target screen and MTBM control screens.

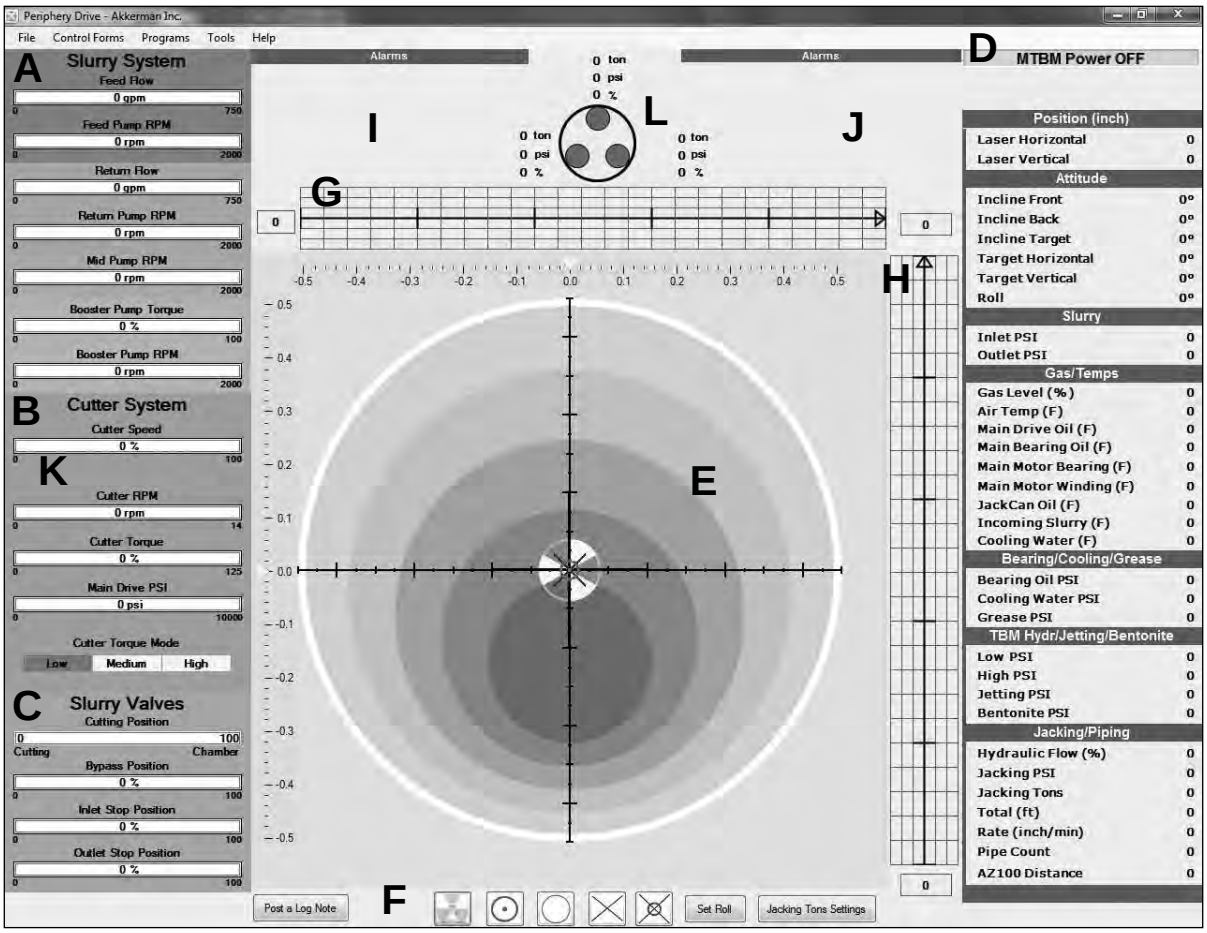
This program is also used to calibrate linear transducers (stop valve, bypass valve, steering cylinders, stabilizer and cutting nozzles valves) when the components are repaired or replaced.

For more information, refer to section 6, Transducer Calibration.



NOTES

TARGET SCREEN



The target screen shows all critical tunneling data by means of graphical and numeric meter displays. The Slurry System (A), Cutter System (B) and Slurry Valves (C) meter information is represented with bar graphs. The MTBM operational meter information (D) is represented with numeric values.

Each meter has a menu that allows the operator to set a colored visual alarm if certain specifications are met or exceeded. Simply click on the meter desired and the preferences menu will appear. Change the limit on the visual alarm as needed and click OK.

The center area of the target screen (E) shows a graphical representation of the position of the MTBM cutter head, target position, and projected cutter head position. The buttons (F) on the bottom of the screen turn these graphics on or off. There are also two marker buttons; one is the Operator Resettable Marker to set the marker on the laser position, and the other button removes the Operator Resettable Marker from the screen. These buttons make it easier to see how the MTBM is responding to steering.

Grids around center area of the target screen are the Akkerman AZ100 guidance system data plots for the final 25 feet of the x (line [G]) and y (grade [H]) coordinates.

Locations (I & J) are the Alarm Message fields.
The location (I) **alarm messages** include the: Drive Oil Filter Plugged, Drive Oil Low Level, Jacking Pump Hydraulic Oil Filter Plugged, Jacking Pump Hydraulic Oil Low Level, Bearing Oil Filter Plugged, Bearing Low PSI, Cool Water High PSI, Cool Water Low Level, Bearing Oil Low Level, Bearing Oil High PSI, Main Drive Hydraulic Oil High Temp, Jack Can Hydraulic Oil High Temp, Cool Water High Temp, and Slurry High Temp.

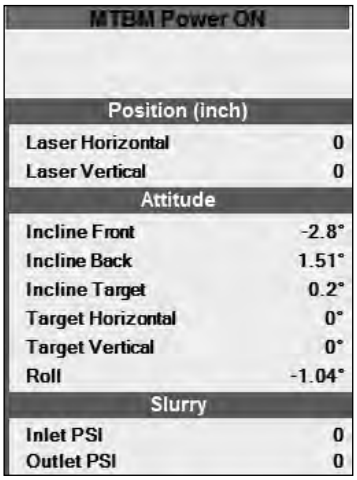
The location (J) **alarm messages** include the: Gas Fault, Gas Level High, High Water, Grease 1 Low Level, Grease 2 Low Level, Grease PSI Outside Operational Range, Main Drive Motor High Temp, Air Temp High, Main Drive Motor Winding High Temp, HPP - Return Filter, HPP - High Flow Filter, HPP - Low Oil Level, HPP - Oil Overtemp, HPP - E-Stop, Pit Box - E-Stop, PD Power - E-Stop/Pilot Loss, PD Fault/Disconnected and Console E-Stop.

Location (K) is the Cutter Stall Alarm field. The **alarm message** is Cutter Stall: Speed > 10%, No RPM.

The Steering Cylinder indicator (L) displays the MTBM steering cylinder stroke position in percent, pressure in PSI for the top, left, and right cylinders and the steering pressure in tons. The indicator graphical reference is viewed from the launch shaft going forward to the reception shaft.

(continued on next page)

MTBM POWER
The MTBM power indicator displays the head power to the MTBM, either on or off.



POSITION (Inch)
The **Laser Horizontal** and **Laser Vertical** meters, measure the deviations in inches of the laser spot with reference to the center of the target grid. Positive vertical deviation indicates that the laser spot is above the center of the target grid and positive horizontal deviation indicates that the laser spot is right of the center of the target grid.

ATTITUDE
Incline Front measures the degree of incline from level position for the MTBM front section (in front of the steering band). A positive value indicates that the front (cutter bit) is higher than the back of the front section.

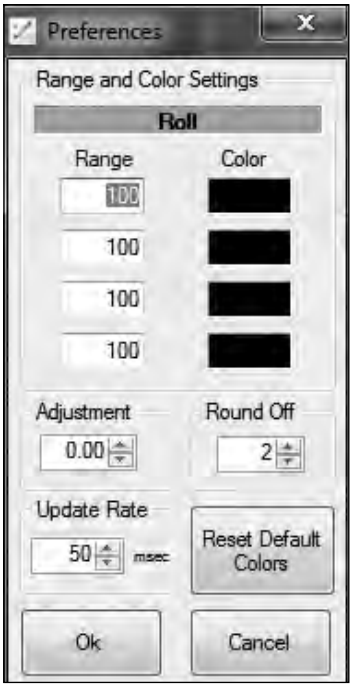
Incline Back measures the degree of incline from level position for the MTBM front section (behind the steering band). A positive value indicates that the front (steering band) is higher than the back of the front section.

Incline Target measures the degree of incline from level position for guidance target. A positive value indicates that the front (cutter bit end) of the target is higher than the back (lens) end.

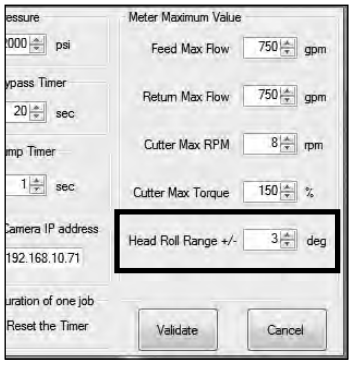
Target Horizontal measures the degree of horizontal angle for the guidance target with respect to the laser beam. A positive value indicates that the front (cutter bit) end of the target is more to the right than the back (lens) end.

Target Vertical measures the degree of vertical angle for the guidance target with respect to the laser beam. A positive value indicates that the front (cutter bit) end of the target is higher than the back (lens) end.

Roll indicates the degree of clockwise or counterclockwise roll of the MTBM. A negative reading indicates that the machine has rolled counterclockwise as viewed from the rear of the MTBM. A positive reading indicates that the machine has rolled clockwise as viewed from the rear of the MTBM. To change roll meter (refer to Roll Preferences graphic on this page), click the roll field, change the degree setting (Adjustment) and update rate (milliseconds) and press Ok button. If the degree setting parameters are exceeded, the main drive motor (rotation) and main hydraulic pump (jacking) will be shut down.
The roll range can also be changed in the Console Editor program (refer to Console Editor graphic on this page) by changing the degree value; then click Validate button.
The roll positive and negative values can be set independently by clicking the Set Roll button on the bottom right portion of the target screen (refer to Roll Setting graphic on this page). Change the degree settings and click Set button.



Roll Preferences



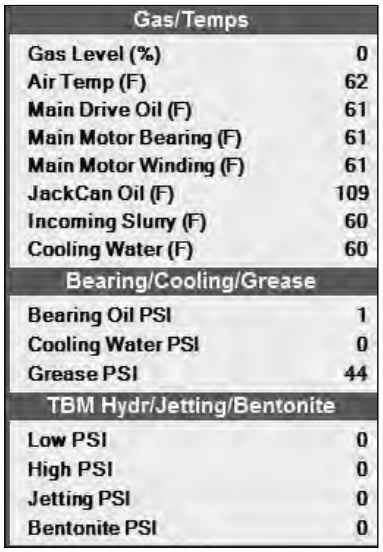
Console Editor Head Roll Meter

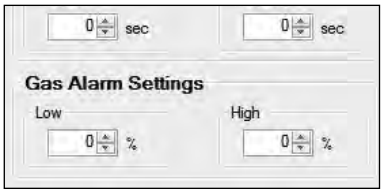
SLURRY
The slurry pressure, **Inlet PSI** and **Outlet PSI**, displays the slurry pressure in PSI as monitored at the entrance and exit of the starting section with the flow meter.



Roll Setting Meter

(continued on next page)





Gas Alarm LEL Settings In PDFrontEditor Program

GAS/TEMPS

Gas Level (%) displays the % of LEL (Lower Explosive Limit) gas concentration in the front section.
To change the LEL setting alarms, open the PDFrontEditor program to load the MTBM Operational Data Editor program. Update the Gas Alarm Settings (F) by changing the low and high % fields per job requirements (refer to Gas Alarm Settings graphic on this page).

Air Temp (F) displays the ambient air temperature (fahrenheit) of the MTBM starting section.

Main Drive Oil (F) displays the internal temperature (fahrenheit) of the main drive hydraulic reservoir oil.

Main Motor Bearing (F) displays the temperature (fahrenheit) of the 400 HP electric motor bearing. The two motor bearings are monitored with the highest temperature being displayed. Maximum temperature is 150°F (66°C).

Main Motor Winding (F) displays the temperature (fahrenheit) of the 400 HP electric motor windings. The three motor windings (1 per phase) are monitored with the highest temperature being displayed. Maximum temperature is 250°F (121°C).

JackCan Oil (F) displays the temperature (fahrenheit) of the jack/lube can hydraulic oil reservoir.

Incoming Slurry (F) displays the temperature (fahrenheit) of the incoming slurry as it enters the front section stop/bypass valves.

Cooling Water (F) displays the temperature (fahrenheit) of the trailing section water tank reservoir.

BEARING/COOLING/GREASE

Bearing Oil PSI displays the bearing oil pressure in PSI at the bearing oil pump in the front section.

Cooling Water PSI displays the cooling water pressure output in PSI at the cooling pump in the trailing section.

Grease PSI displays the grease pressure in PSI of the grease pumps in the front section.

TBM HYDR/JETTING/BENTONITE

Low PSI displays the oil pressure in PSI of the low pressure valve in the front section that controls the bypass valve, stop valve, cutting nozzles and dirt wings. Maximum pressure is 3,000 psi.

High PSI displays the oil pressure in PSI of the high pressure valve that controls the steering cylinders. Maximum pressure is 7,200 psi.

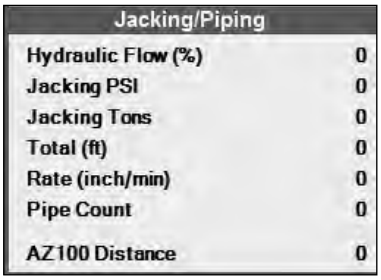
Jetting PSI, displays the jetting pressure in PSI at the jetting manifold on the front section bulkhead.

Bentonite PSI displays the lubrication pressure in PSI of the lubrication manifold in the lube/jacking can. The maximum pressure is 300 psi.

(continued on next page)

JACKING/PIPING

The following display values depend on whether the remote hydraulic power pack or jacking can is selected:



- **Hydraulic Flow (%)** displays the hydraulic pump flow rate from the remote hydraulic power pack or jacking can.
- **Jacking PSI** displays the extension pressure of the main jacking cylinders on the jacking frame from the remote hydraulic power pack or the extension pressure of the jacking can thrust cylinders from the jacking can.
- **Jacking Tons** displays the calculated tons of thrust that is being applied to the pipe by the jacking frame cylinders from the hydraulic power pack or the thrust cylinders from the jacking can.

Total (ft) displays the total linear feet that have passed the pipe length wheel counter.

Rate (inch/min) measures the jacking frame advancement rate in inches per minute.

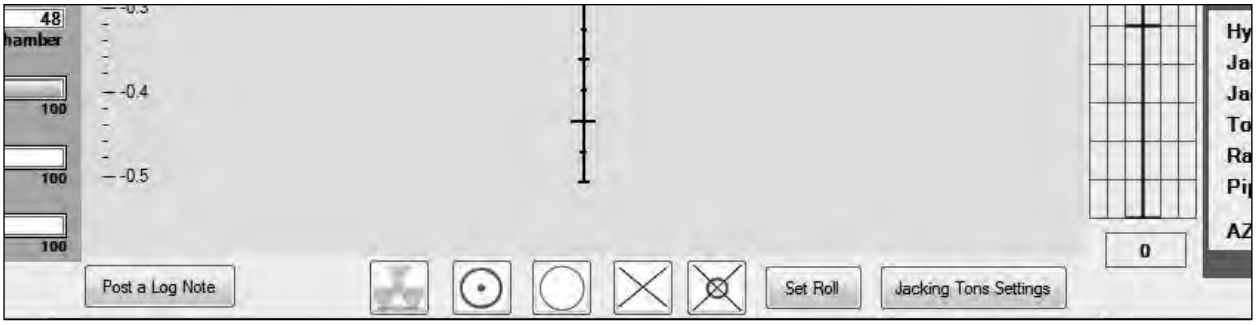
Pipe Count displays the number of pipe that have been installed. To ensure an accurate pipe count, the machine length must be updated in the MiscEditor program (refer to MiscEditor Program graphic on this page).

AZ100 (Target) Distance displays the total linear feet from jacking shaft wall (guidance system) to MTBM target.



MiscEditor Program Machine Length Value

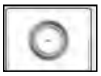
(continued on next page)



The bottom portion of the target screen allows the operator to post a note, control target screen graphics (MTBM cutter head, target position, and projected MTBM position), and set the roll and jacking ton parameters.

Post a Note (A)
Click this button to type a short note. Click POST button to save this note on the database. This note will be generated on a report providing the note was posted within the date and time parameters of the report.


MTBM Cutter Head Position (B)


Target Position (C)


Projected Cutter Head Position (D)


Operator Resettable Laser Position Marker (E)


Remove Operator Resettable Marker (F)

Set Roll (G)
Roll indicates the degree of clockwise or counterclockwise roll of the MTBM. If the degree setting parameters are exceeded, the main drive motor (rotation) and main hydraulic pump (jacking) will be shut down. The roll positive and negative values can be set independently by clicking the Set Roll button (G) on the target screen (refer to Roll Setting graphic on this page). Once the degree settings are changed, click Set button. The calculated Roll is displayed on the target screen under the Attitude heading.



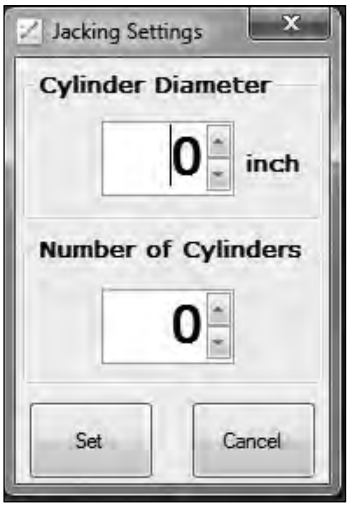
Roll Setting Meter

Jacking Tons Settings (H)
The jacking cylinder diameter and number of cylinders value fields (refer to Jacking Settings graphic on this page) are used to properly calculate the jacking tonnage during the jacking process. The calculated Jacking Tons is displayed on the target screen under the Jacking/Piping heading.

Check or update the jacking settings by clicking Jacking Tons Settings button (H).

CYLINDER DIAMETER
Adjust the Diameter of the jacking cylinders in inches by clicking the up and down arrows or by simply entering in the number.

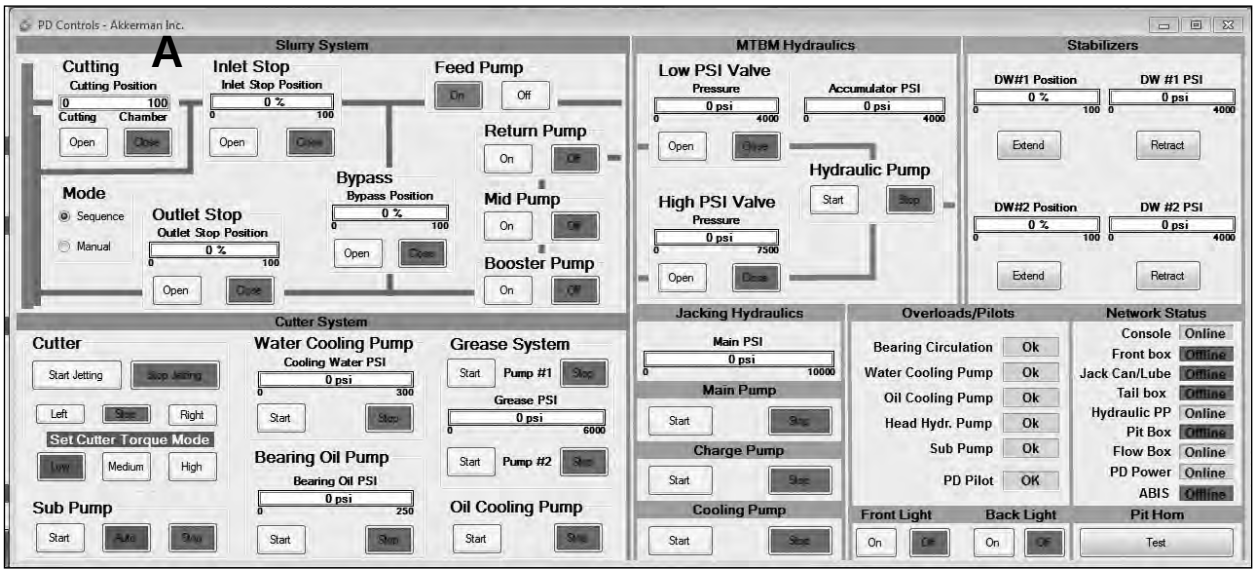
NUMBER OF CYLINDERS
Adjust the Number of Cylinders by clicking the up and down arrows or by simply entering in the number of cylinders. Once settings are updated, depress the Set button.



Jacking Settings Meter

NOTES

MTBM CONTROL SCREEN



The controls on the MTBM control screen can be activated with the mouse. Some of the controls on this screen are normally controlled from the control console.

SLURRY SYSTEMS (A)
Feed Pump: displays a visual button representation of the feed pump operation. The feed pump is controlled with the Feed Pump control on the console in the control container.

Return Pump: displays a visual button representation of the return pump operation. The return pump is controlled with the Return Pump control on the console in the control container.

Mid Pump: displays a visual button representation of the mid pump operation. The mid pump is controlled with the Mid Pump control on the console in the control container.

Booster Pump: displays a visual button representation of the booster pump operation. The booster pump is controlled with the Booster Pump control on the console in the control container.

Cutting Valve: open or close the cutting nozzle valve. Hold the buttons down to vary the valve opening. The Position reading displays the position of the valve in percent.
Opening this valve will close the slurry chamber valve by the same amount. Closing this valve will open the slurry chamber valve by the same amount. The cutting valve is controlled by either pressing the buttons on the control screen or the Cutting and Chamber buttons on the console in the control container.

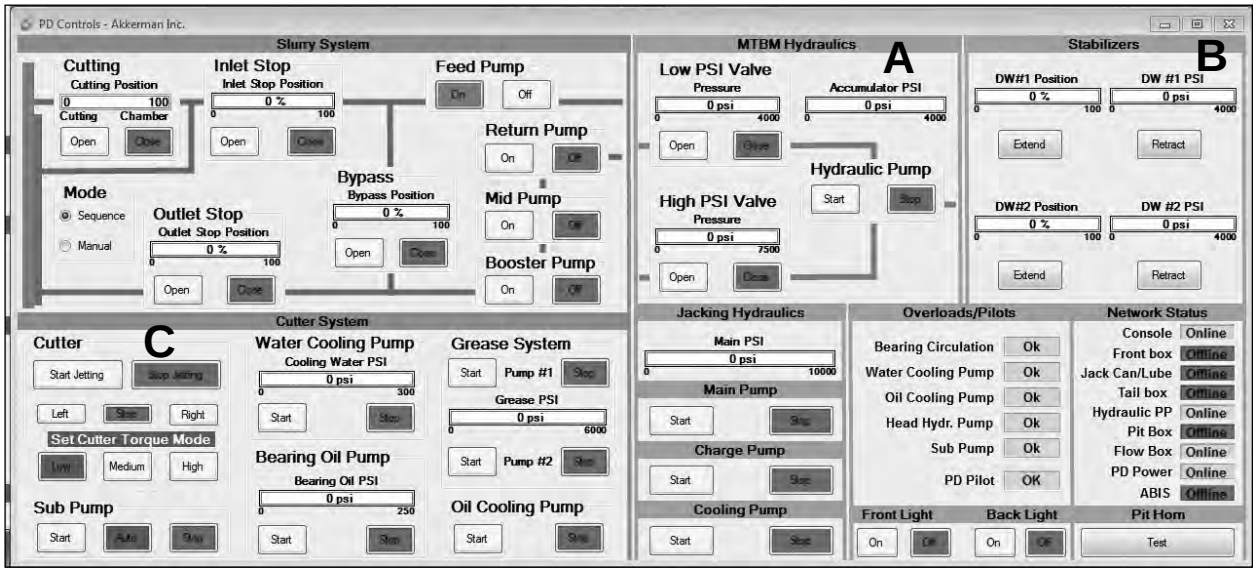
Inlet & Outlet Stop Valves: open or close the slurry stop valves. The stop valves are either fully open or fully closed (in sequence mode). The Position will display the valve position in percent; 0% (closed) or 100% (open). The stop valves are controlled by either pressing the buttons on the control screen or the slurry stop valve Open and Close buttons on the console in the control container.

Bypass Valve: open or close the slurry bypass valve. In sequence mode the bypass valve will either be fully open or fully closed. The Position will display the valve position in percent; 0% (closed) or 100% (open). In manual mode the valve position can be varied depending on operator. The Position will display the valve position in percent. The bypass valve is controlled by either pressing the buttons on the control screen or the bypass valve Open and Close buttons on the console in the control container.

Mode: Sequence mode is the default.
Select ***Sequence*** to operate the stop valve and bypass valve in opposite positions. When the stop valve is open, the bypass valve is closed and vice versa.

Select ***Manual*** to operate the stop valve and bypass valve independently of each other. Keep in mind, using this operation requires close monitoring of the slurry. Otherwise if both valves are closed, high pressure buildup in the slurry lines could cause the slurry lines to burst.

(continued on next page)



MTBM HYDRAULICS (A)
When the Head Power control (on control console) is on, all hydraulic MTBM control functions work (steering cylinders, bypass valve, stop valve, cutting nozzles, or stabilizers) when activated.

Hydraulic Pump: controls the start and stop of the MTBM hydraulic pump in the MTBM front section. The pump will automatically start when a function is activated.

Low PSI Valve: open or close the low pressure valve that controls the bypass valve, stop valve, cutting nozzles, or stabilizer. The Pressure reading displays the valve oil pressure in PSI. This valve will automatically open when the stop valve, bypass valve, cutting nozzles or stabilizers are activated. The maximum pressure is 3,000 psi.

High PSI Valve: open or close the high pressure valve that controls the steering cylinders. The Pressure reading displays the valve oil pressure in PSI. This valve will automatically open when the steering cylinders are activated. The maximum pressure is 7,200 psi.

Accumulator PSI: displays the accumulator pressure in the front section. When the MTBM loses power, the accumulator will automatically close the slurry inlet and outlet stop valves and open the slurry bypass valve. The maximum pressure is 3,500 - 4,000 psi. **IMPORTANT: Before servicing the slurry stop and bypass valves, the accumulator MUST be deactivated.**

STABILIZERS (B)
DW#1 Position, DW#2 Position controls the extend and retract of the stabilizer cylinder or dirt wing. Continuing to hold down the extend or retract buttons will cause the stabilizer cylinder to extend or retract further. The extension position percentage is displayed. A fully extended dirt wing is displayed at 100%.

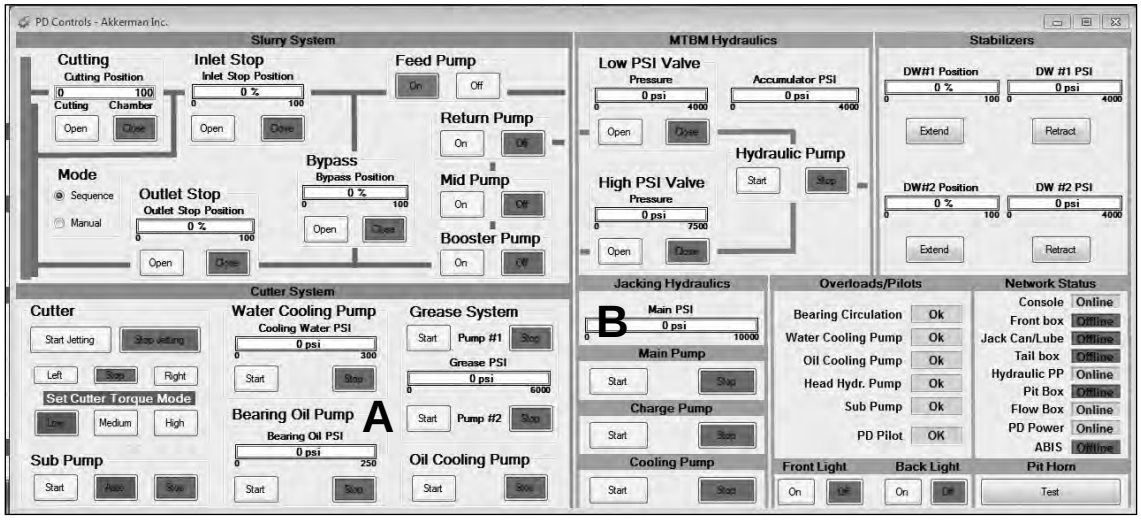
DW#1 PSI, DW#2 PSI displays the dirt wing cylinder pressure. The maximum pressure is 3,000 psi.

CUTTER SYSTEM (C)
High Pressure Jetting Pump: controls the start and stop of the high pressure jetting pump.

Cutter: displays a visual button representation of the cutter rotation operation. The cutter rotation is controlled with the Cutter Head Rotation controls on the console in the control container.

Set Cutter Torque Mode: the four, 2 speed drive motors allow the operator the ability to control the cutter torque with the drive motors versus reducing jacking speed. **Low torque:** 4 motors in high speed, **Medium torque:** 2 motors in low speed and 2 motors in high speed, **High torque:** 4 motors in low speed. Depending on ground conditions and jacking speed, reducing jacking speed may be necessary to reduce cutter torque. BEFORE changing mode, ALWAYS stop cutter rotation, wait for RPM to go to “0” and pressure to standby.

Submersion Pump: controls the start, auto, and stop modes of the submersion pump located in the trailing section. Press Start button to run the submersion pump continuously. Press Stop button to stop the pump. Press Auto button to allow the pump to be controlled by the water level float switch in the trailing section. The Auto mode is the default position.
The *“High Water”* alarm message will display, indicating water has reached the water level switch in the trailing section. The submersion pump will be turned on.
(continued on next page)



CUTTER SYSTEM (A) (continued)
Oil Cooling Pump: controls the start and stop of the hydraulic oil cooling pump (located in the trailing section). The hydraulic oil cooling pump automatically starts when the oil temperature is at 145°F and will stop when the oil temperature is at 130°F. The hydraulic oil recirculates through the pump, heat exchanger, through the return filters and back into the hydraulic tank.

Water Cooling Pump: controls the start and stop of the water cooling pump (located in the trailing section). The water cooling pump automatically starts when the oil temperature of the jacking can oil reservoir, main hydraulic oil reservoir or the 400 HP main drive electric motor bearings or windings reach 100°F and shuts off at 95°F.
The **Cooling Water PSI** is also displayed. If the water pressure is 45 psi, the "*Cool Water High PSI*" will display on the target alarm message area of the target screen, indicating the strainer may be plugged. If the water pressure reaches 60 psi, the cutter head rotation will stop.

Grease System: turns the grease pumps on or off (located in the front section). The grease pump lubricates the bearing cavity dirt seals. The grease pumps cycle automatically when the drive motor (cutter head rotation) is running. The grease pump 1 will cycle for 15 minutes, stop, grease pump 2 will cycle for 15 minutes, stop, grease pump 1 cycles etc. When the grease pump(s) is refilled, start the grease pump manually to purge air from the grease lines. Stop the pump when grease comes out the dirt seal.
The **Grease PSI** is also displayed. If the grease pressure is less than 300 psi indicating grease is not pumping, the cutter head rotation will stop. If the grease pressure is over 2,500 psi indicating the grease may be plugged, the cutter head rotation will stop. In either case, the *"Grease PSI Outside Operational Range"* will display in the alarm message area of the target screen.

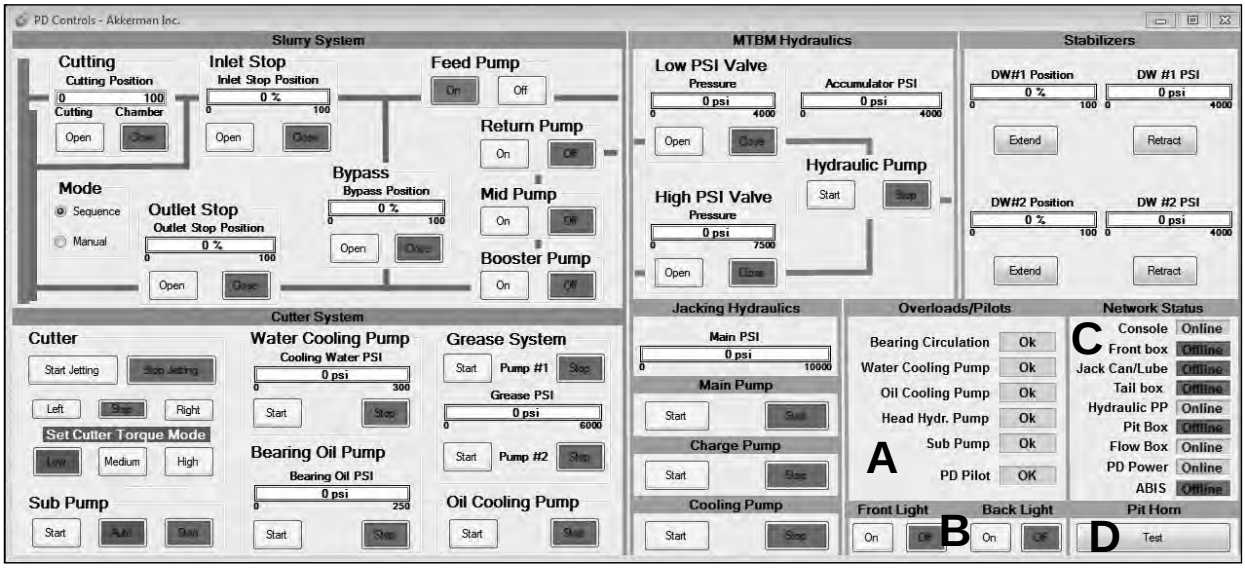
Bearing Oil Pump: turns the bearing oil pump on or off (located in the front section). The bearing oil pump recirculates oil through the bearing, bearing cavity, pump, filter, bearing oil manifold and then back through the bearing etc. The bearing oil pump automatically operates when the drive motor (cutter head rotation) is running.
The **Bearing Oil PSI** is also displayed.
If the bearing oil pressure reaches 10 psi, the *"Bearing Oil Low PSI"* will display in the alarm message area of the target screen indicating the pump is not working or a line is broken. If the bearing oil pressure reaches 300 psi indicating the filter may be plugged, the *"Bearing Oil High PSI"* will display in the alarm message area of the target screen AND the bearing pump will shut down and the cutter head rotation will stop.

JACKING HYDRAULICS (B) (Remote Hydraulic Power Pack)
Main Pump controls the start and stop of the main hydraulic pump in the remote hydraulic power pack container for the jacking system. The pump will automatically shut down if oil temperature reaches 120°F.

Charge Pump: displays a visual button representation of the charge pump operation. The charge pump controls the pilot operated control valve (stroker) on the main hydraulic pump in the remote hydraulic power pack container. The charge pump automatically starts when the main hydraulic pump is started. When the main hydraulic pump is shutdown, the charge pump will continue to run for an additional 30 seconds and then stop.

Cooling Pump: controls the start and stop of the oil cooler recirculating hydraulic pump. The oil is recirculated from oil cooler back to tank. The fan override switch in the remote hydraulic power pack container must be on to get the full benefit of oil cooling. The oil cooler recirculating pump will automatically start only when the oil temperature reaches 120°F (which will shut down the main hydraulic pump).

A fan override switch in the remote hydraulic power pack allows the operator to turn the fan off if needed during cold ambient temperatures, otherwise the switch should always be on.



OVERLOADS/PILOTS (A)
The overload indicators for the Bearing Circulation, Water Cooling Pump, Oil Cooling Pump, Head Hydr. Pump and Sub Pump are a colored visual display. A green OK display indicates the pump is running properly. A red TRIPPED display indicates that the pump is not connected or has an electrical overload causing the pump breaker to trip. Typically the self-resetting breakers will reset, but in the event that the visual indicator flashes between green and red, further inspection is required on that electrical circuit before the pumps will resume proper operation.

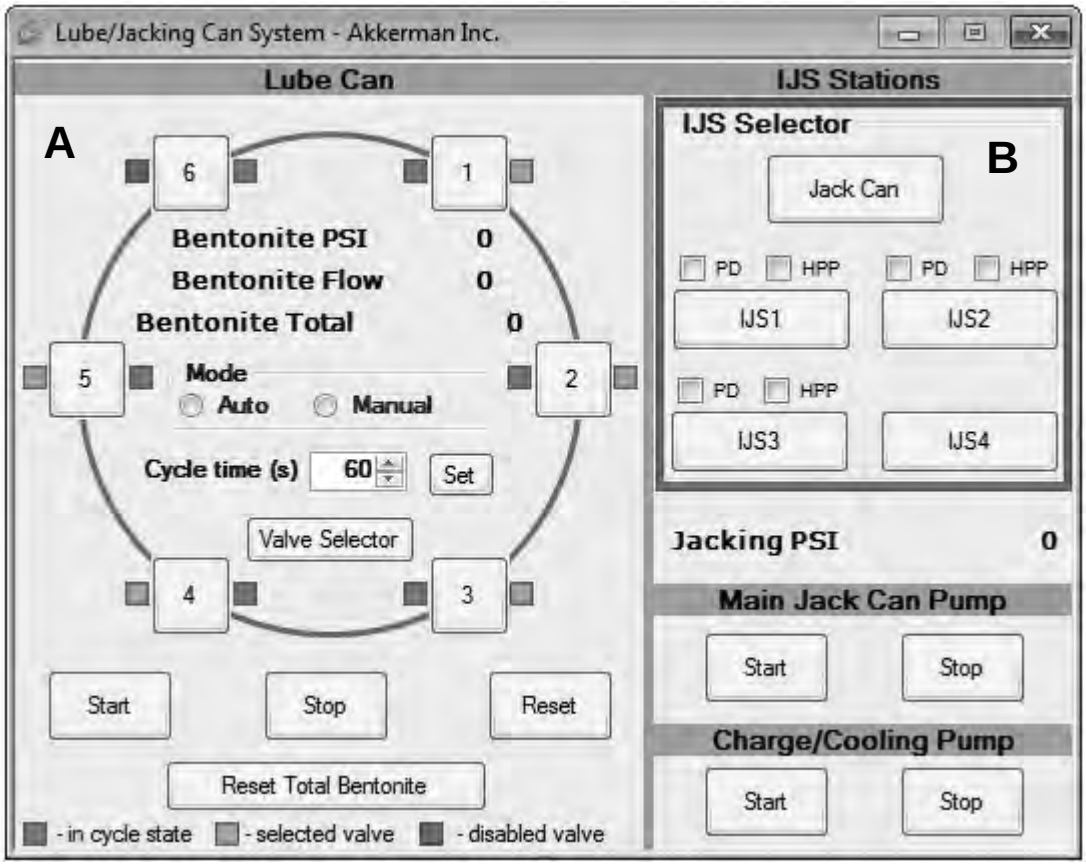
The pilot indicator for PD Pilot is a colored visual display. A green Pilot display indicates the pilot circuit is operating properly. A red No pilot indicates the pilot circuit is not connected or is not functioning properly.

FRONT LIGHT - BACK LIGHT (B)
Front Light & Back Light controls the lights in the MTBM

NETWORK STATUS (C)
The network status window indicates when the device is Online (green) or Offline (red) with the control container controls.

PIT HORN (D)
Pit Horn allows the testing of the pit horn operation in the launch shaft.

LUBE/JACKING CAN SYSTEM SCREEN



The controls on the Lube/Jacking Can System screen display the lube/jacking can lubrication valve and IJS control functions. The controls are activated with the mouse.

LUBE CAN (A)
The Lube Can display provides a visual representation of the operation of the six lubrication valves as viewed from launch shaft into tunnel. The **Start** and **Stop** buttons control the operation of the selected valves. The **Reset** button will reset the program to the factory setting.

Bentonite PSI: displays the lubrication pressure in PSI at the lubrication manifold in the lube/jacking can. The maximum bentonite pressure is 300 psi.

Bentonite Flow: displays the flow (GPM) of bentonite at the flow meter in the lube can.

Bentonite Total: displays the total accumulated gallons of bentonite pumped to all valves in the lube can.

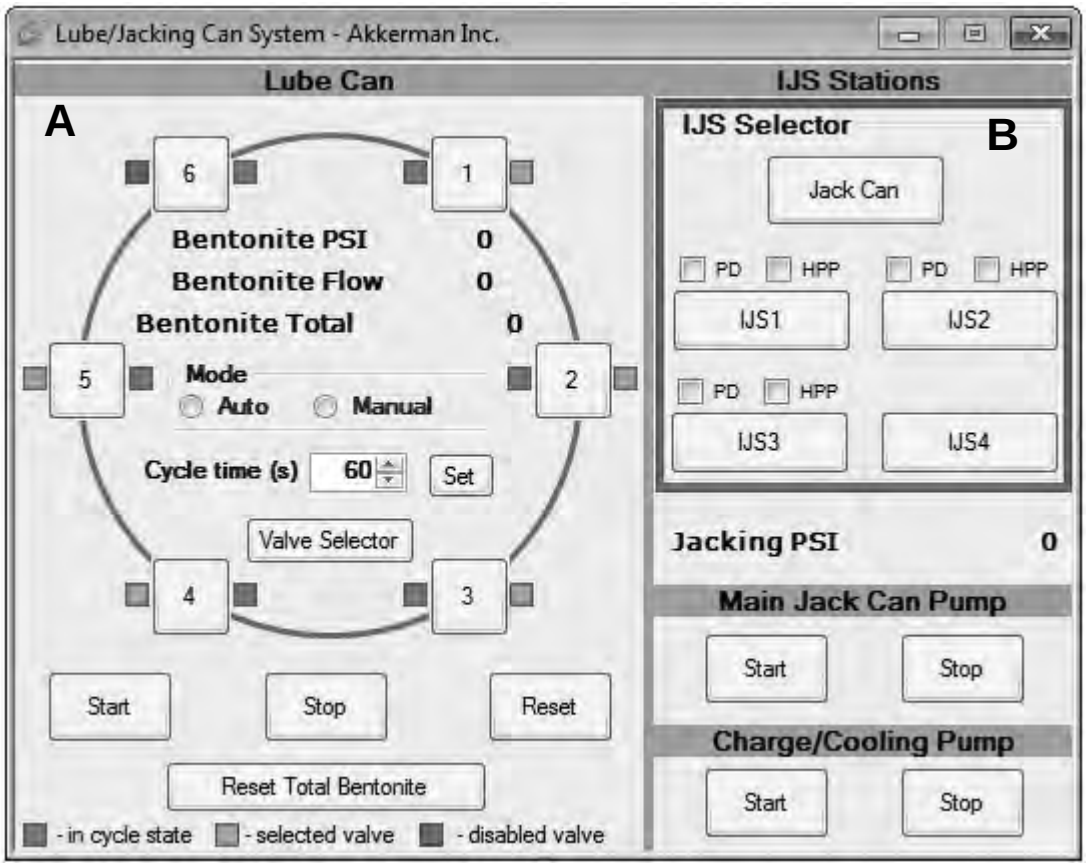
Mode:
Auto mode: is the default selection. Use the Valve Selector button to select valves (see below). In auto mode the selected valves will alternate between the selected valves based on the cycle time.
Manual mode: click Manual and click on the desired lubrication valves (2 valves maximum). Click Start and the lubrication valves will cycle until the Stop button is clicked.

Cycle time (s): (for auto mode only) displays the lubrication valve cycle time in seconds. To change cycle time, click the up or down arrows to desired time and click Set button.

Valve Selector: (for auto mode only) when Auto mode is selected, click the Valve Selector button to choose the desired lubrication valves. The **in cycle state**, **selected valve**, and **disabled valve** are represented with color coding to provide a visual representation of the lubrication valve operation.

Reset Total Bentonite: click button to reset the total accumulated bentonite pumped to 0 (zero).

(continued on next page)



IJS STATIONS (B)

IJS Selector: This window becomes active (green box) when the Jack Frame Control Selector (C) on the control console is at the IJS position.
Click the desired IJS selection; Jack Can, IJS1, IJS2, IJS3 and/or IJS4. Use flow control (D) to regulate the hydraulic flow to the jacking can thrust cylinders or the IJS stations.



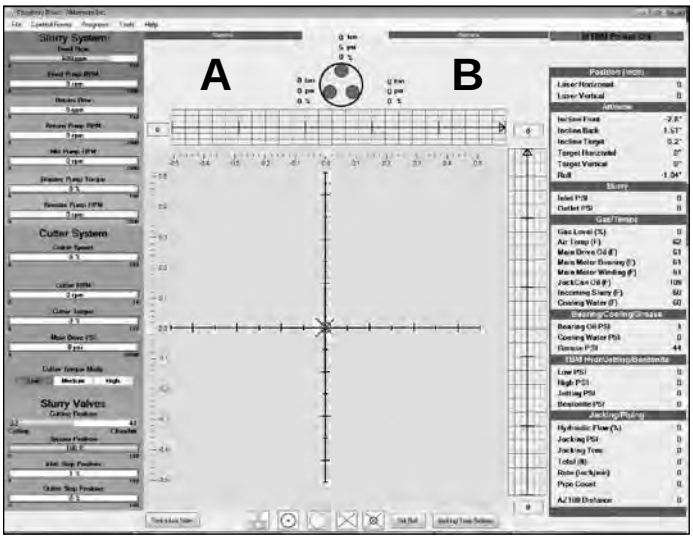
- The ***Jack Can*** selection is the jacking thrust cylinders in the jacking can and the power source is from the jack can.
- ***IJS1***, ***IJS2***, and ***IJS3*** are the IJS stations in the tunnel and the power source can be either the jacking can (PD) or the remote hydraulic power pack (HPP).
- ***IJS4*** is the IJS station in the tunnel and the power source is the remote hydraulic power pack (HPP).

Jacking PSI: displays the extension pressure of the jacking can thrust cylinders. The maximum jacking pressure is 8,000 psi.

Main Jack Can Pump: controls the start and stop of the main hydraulic pump in the jacking can. The charge and cooling pumps will automatically start up when the main hydraulic pump is started

Charge/Cooling Pump: controls the start and stop of the charge pump and the oil recirculating cooling pump in the jacking can. The charge and cooling pumps will automatically start up when the main hydraulic pump is started.

ALARM MESSAGES



The target screen contains three alarm message windows to alert the operator on potential operational issues. In some cases the alarm messages are simply warnings of a potential issue that will need attention, and other alarm messages that are an immediate issue where the machine components may be automatically shutdown to prevent damage or problems to the operation of the machine.

Refer to the items below and the effect to the machine:

Alarm Message Area (A)

1. Alarm Message: ***Drive Oil Filter Plugged***
Machine Component: Main Drive Hydraulic Oil System Filter
Effect To Machine: Pumps and cutter head rotation will be automatically stopped.

2. Alarm Message: ***Drive Oil Low Level***
Machine Component: Main Drive Hydraulic Oil Reservoir
Effect To Machine: Pumps and cutter head rotation will be automatically stopped.

3. Alarm Message: ***Jacking Pump Hydraulic Oil Filter Plugged***
Machine Component: Lube/Jacking Can Hydraulic Oil System Filter
Effect To Machine: Jacking pump automatically stopped.

4. Alarm Message: ***Jacking Pump Hydraulic Oil Low Level***
Machine Component: Lube/Jacking Can Hydraulic Oil Reservoir
Effect To Machine: Jacking pump automatically stopped.

5. Alarm Message: ***Bearing Oil Filter Plugged***
Machine Component: Bearing Oil Pump System Filter
Effect To Machine: Bearing oil pump and cutter head rotation automatically stopped.

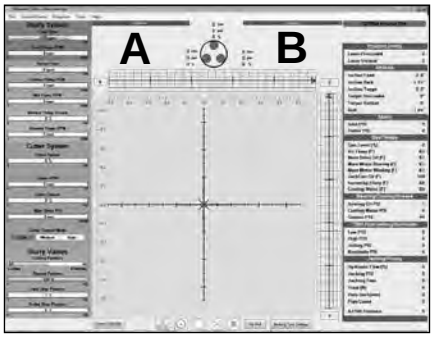
6. Alarm Message: ***Cool Water High PSI***
Machine Component: Water System Cooling Tank
Effect To Machine:
a. If the water pressure reaches 45 psi, the message is displayed indicating the filter may be plugged and that with continued operation, the systems could overheat.
b. If the water pressure reaches 60 psi, the cutter head rotation will automatically stop.

7. Alarm Message: ***Cool Water Low Level (On-Board Water Cooling System Only)***
Machine Component: Water System Cooling Tank
Effect To Machine: The message is displayed once the water level reaches the low level sensor, indicating the cooling tank must be refilled.

8. Alarm Message: ***Bearing Oil Low Level***
Machine Component: Bearing Oil Cavity
Effect To Machine: Bearing oil pump and cutter head rotation automatically stopped.

9. Alarm Message: ***Bearing Oil Low PSI***
Machine Component: Bearing Oil Pump System
Effect To Machine: If oil pressure is 10 psi or less, the message is displayed as a warning of low pressure, indicating the bearing pump may not be working or a line may be broken.

(continued on next page)



Alarm Messages
Alarm Message Area (A) continued

10. Alarm Message: ***Bearing Oil High PSI***
Machine Component: Bearing Oil Pump System
Effect To Machine: If oil pressure reaches 300 psi, the message is displayed indicating the bearing oil pressure is too high AND the cutter head rotation is automatically stopped. Also the bearing cavity filter may be plugged. Replace filter.

11. Alarm Message: ***Main Drive Hydraulic Oil High Temp***
Machine Component: Main Drive Hydraulic Oil Reservoir
Effect To Machine:
a. If the hydraulic oil temperature reaches 160°F, warning displayed.
b. If the hydraulic oil temperature reaches 180°F, the temperature is too high and the cutter head rotation will automatically stop.

12. Alarm Message: ***Jack Can Hydraulic Oil High Temp***
Machine Component: Jack Can Hydraulic Oil Reservoir
Effect To Machine:
a. If the hydraulic oil temperature reaches 150°F, warning message is displayed.
b. If the hydraulic oil temperature reaches 160°F, the temperature is too high and the jacking pump automatically stopped.

13. Alarm Message: ***Cool Water High Temp***
Machine Component: Water System Cooling Tank
Effect To Machine:
a. If the water temperature reaches 110°F, the warning message is displayed indicating the need for additional slurry cooling packs with the On-Board Water Cooling System, or more water flow or colder water with the External Water Cooling System.
b. If the water temperature rises to 125°F indicating systems will start to overheat, the cutter head rotation will automatically stop.

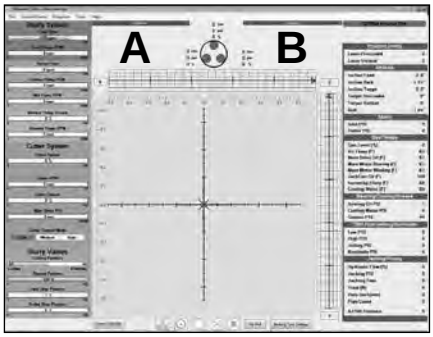
14. Alarm Message: ***Slurry High Temp***
Machine Component: Incoming Slurry Water
Effect To Machine: If the incoming slurry water temperature reaches 95°F, the warning message is displayed indicating that the slurry is too warm to cool and that with continued operation, the systems may overheat.

Alarm Message Area (B)
15. Alarm Message: ***Gas Fault***
Machine Component: Gas Detector
Effect To Machine: The message is displayed when there is a malfunction with the gas detector system. Stop immediately and troubleshoot the problem before proceeding. NEVER operate microtunneling system without a proper operating gas detector and NEVER enter a tunnel without a properly functioning portable gas detector.

16. Alarm Message: ***Gas Level High***
Machine Component: Gas Detector
Effect To Machine: The message is displayed when the gas detector detects a gas level reading of 10% (default) or higher. The horn on the pit box will sound intermittently until the system detects a gas level reading of 25% LEL (default) or higher at which time the horn will sound constantly and the cutter head rotation and jacking frame functions will stop.

(continued on next page)

Alarm Messages
Alarm Message Area (B) continued



17. Alarm Message: ***High Water***
Machine Component: Submersion Pump
Effect To Machine: The message is displayed when the water in the trailing section has reached the water level switch. The submersion pump will automatically start.

18. Alarm Message: ***Grease 1 Low Level or Grease 2 Low Level***
Machine Component: Grease Pump
Effect To Machine: The message is displayed when the grease level in the reservoir reaches the low level sensor. If a grease reservoir is low, the system will automatically shift over to the other grease pump/reservoir for 30 minutes, then the grease system and cutter rotation will shutdown requiring the refilling of the grease reservoir.

19. Alarm Message: ***Grease PSI Outside Operational Range***
Machine Component: Grease Pump
Effect To Machine:
a. The message is displayed if the grease pressure is less than 300 psi indicating grease is not pumping. The cutter head rotation will automatically stop.
b. If the grease pressure is over 2,500 psi indicating the grease filter may be plugged, the message is displayed and the cutter head rotation will automatically stop. Replace grease filter.

20. Alarm Message: ***Main Drive Motor High Temp***
Machine Component: Main Drive Motor 400 HP
Effect To Machine:
a. The message is displayed if the main drive motor bearing temperature reaches 130°F.
b. If the main drive motor bearing temperature reaches 150°F, the cutter head rotation will automatically stop.

21. Alarm Message: ***Air Temp High***
Machine Component: Main Drive Motor 400 HP
Effect To Machine: The message is displayed if the ambient temperature in the MTBM is at 100°F or greater, indicating ventilation should be increased in the tunnel.

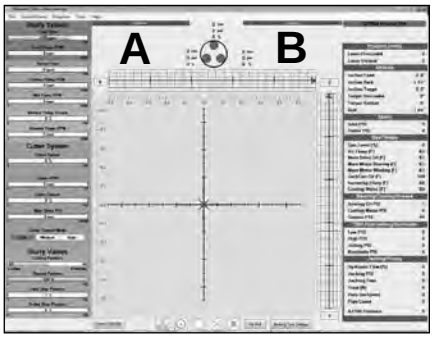
22. Alarm Message: ***Main Drive Motor Winding High Temp***
Machine Component: Main Drive Motor 400 HP
Effect To Machine:
a. The message is displayed if the main drive motor windings temperature reaches 220°F.
b. If the main drive motor windings temperature reaches 250°F, the cutter head rotation will automatically stop.

23. Alarm Message: ***HPP - Return Filter***
Machine Component: Remote Hydraulic Power Pack
Effect To Machine: The message is displayed when the remote hydraulic power pack (jacking frame extend, retract, auxiliary and IJS) return filter indicates that the filter is plugged and requires filter replacement.

24. Alarm Message: ***HPP - High Flow Filter***
Machine Component: Remote Hydraulic Power Pack
Effect To Machine: The message is displayed when the remote hydraulic power pack hi-flow return filter indicates that the filter is plugged and requires filter replacement.

(continued on next page)

Alarm Messages
Alarm Message Area (B) continued



25. Alarm Message: ***HPP - Low Oil Level***
Machine Component: Remote Hydraulic Power Pack
Effect To Machine: The message is displayed when the remote hydraulic power pack oil reservoir level is low and should be filled with fresh, clean oil. The hydraulics in the remote hydraulic power pack will shut down.

26. Alarm Message: ***HPP - Oil Overtemp***
Machine Component: Remote Hydraulic Power Pack
Effect To Machine: The message is displayed when the oil in the remote hydraulic power pack reaches 120°F and automatically turns on the cooling pump. The main hydraulic pump in the remote hydraulic power pack will shut down when the oil temperature reaches 120°F (49°C).

27. Alarm Message: ***HPP - E-Stop***
Machine Component: Remote Hydraulic Power Pack
Effect To Machine: The message is displayed when the E-Stop in the remote hydraulic power pack is activated.

28. Alarm Message: ***Pit Box - E-Stop***
Machine Component: Pit Box
Effect To Machine: The message is displayed when the E-Stop on the pit box is activated.

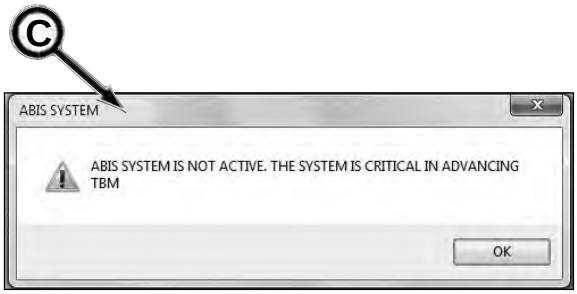
29. Alarm Message: ***PD Power Fault/Disconnected***
Machine Component: Power Container
Effect To Machine: The message is displayed when a power container fault or blown fuse occurs.

30. Alarm Message: ***PD Power E-Stop/Pilot Loss***
Machine Component: Power Container
Effect To Machine: The message is displayed when the E-Stop on the power container is activated and/or pilot circuit loss.

31. Alarm Message: ***Console E-Stop***
Machine Component: Control Container
Effect To Machine: The message is displayed when the E-Stop on the control container is activated.

ABIS ADVANCEMENT ALARM SYSTEM

The Microtunneling system is equipped with an ABIS (automatic bentonite injection system) advancement alarm system.



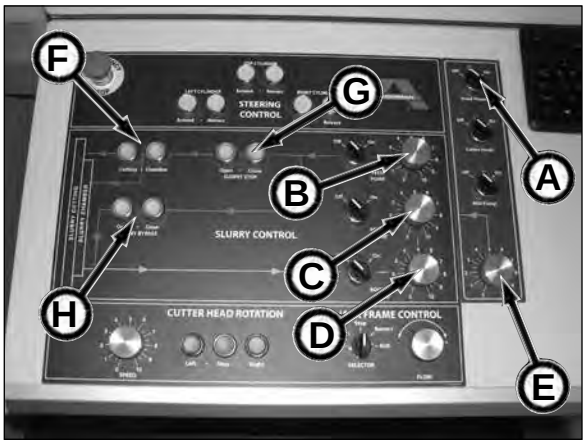
If the ABIS system is online with the control container, and after 15 minutes of the ABIS system not actively supplying lubrication to the pipe, a pop up alarm window (C) will appear on the target screen warning the operator that the ABIS system is not supplying bentonite to the pipe.

The operator will click the OK button on the alarm to disregard the alarm and/or will stop all operations to resolve the ABIS issue before continuing to advance the MTBM.

SLURRY CONTROLS

The slurry controls regulate the fluid slurry using the feed, booster, mid (if used) and return pumps to carry the cuttings away from the MTBM, out of tunnel and to the surface. Balancing the input and output of the slurry is critical to prevent over excavation.

To activate the slurry pumps, the Head power switch (A) must be to the ON position.



FEED PUMP

The Feed Pump control (B) adjusts the speed of the feed pump from 0 to 100%. When the control is turned counterclockwise (CCW), the pump will stop when it reaches 0 as shown on the target screen. When the control is turned clockwise (CW), the pump will start.

NOTICE It is recommended to start and stop the feed, booster, mid and return pumps in the order listed below to prevent excessive fluid pressure on pump components:

START: Mid (if used) Booster - Return - Feed
STOP: Feed - Return - Booster - Mid (if used)

RETURN PUMP

The return pump control (C) adjusts the speed of the return pump from 0 to 100%. When the control is turned counterclockwise (CCW) position, the pump will stop when the flow reaches 0, as shown on the target screen. When the control is turned clockwise (CW), the pump will start.

BOOSTER PUMP

The booster pump control (D) adjusts the speed of the booster pump (if used) from 0 to 100%. When the control is turned counterclockwise (CCW), the pump will stop when the torque reaches 0. When the control is turned clockwise (CW), the pump will start.

MID PUMP

The mid pump control (E) adjusts the speed of the mid pump (if used) from 0 to 100%. When the control is turned counterclockwise (CCW), the pump will stop when the torque reaches 0. When the control is turned clockwise (CW), the pump will start.

CUTTING NOZZLE

The cutting nozzle buttons (F) will open and close slurry flow to the cutting face. Opening this valve will close the slurry chamber valve by the same amount. Closing this valve will open the slurry chamber valve by the same amount.

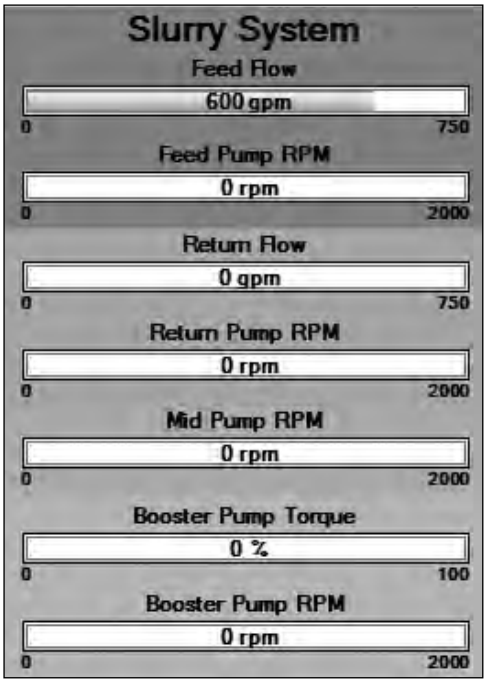
SLURRY STOP

The slurry stop buttons (G) will open or close slurry flow to the slurry chamber and cutting face. In sequence mode, the stop valve and bypass valve work in opposite positions.

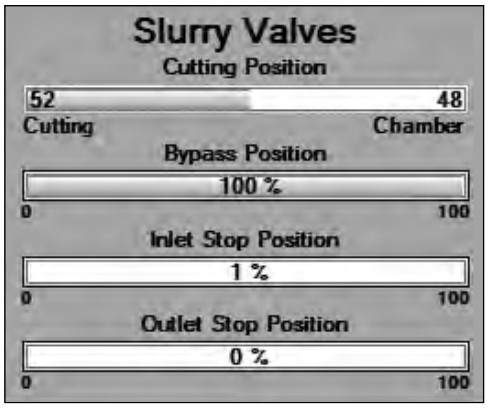
SLURRY BYPASS

The slurry bypass buttons (H) open or close the bypass valve that directs slurry flow from the feed line to the return line without entering the MTBM. In sequence mode, the bypass valve and stop valve work in opposite positions.

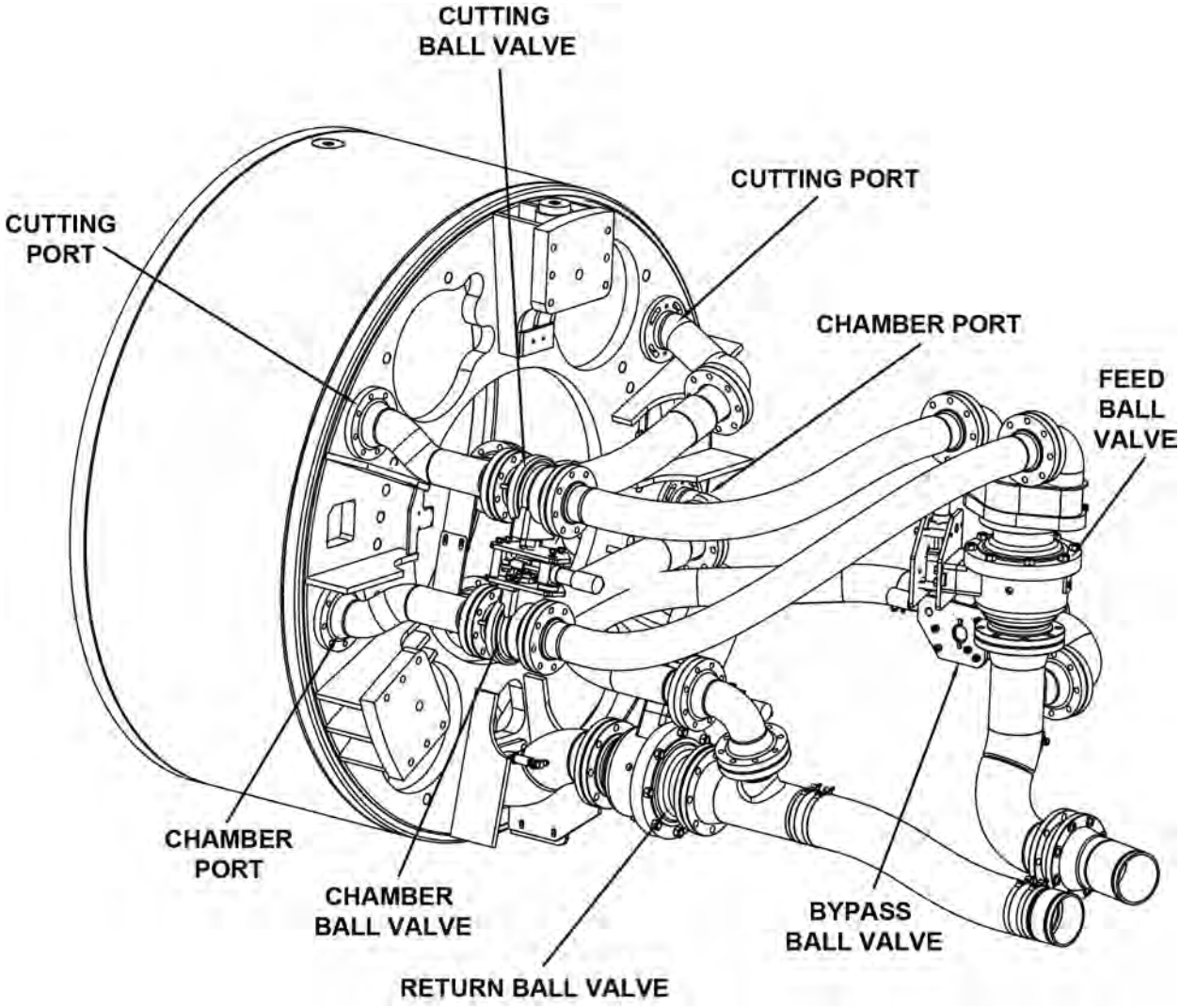
NOTICE In sequence mode, the stop and bypass valves are either in fully closed-open or fully open-closed position.



Feed, Return, Booster & Mid Pump Meters On Target Screen



Cutting Nozzle, Slurry Stop, & Slurry Bypass Meters On Target Screen



Slurry Controls

ACCUMULATOR (FRONT SECTION)

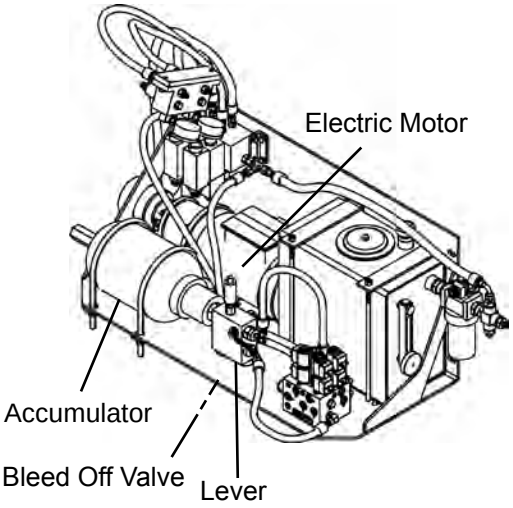


In the event of a power outage or malfunction, an accumulator is equipped on the auxiliary slurry stop and slurry bypass valve system to automatically close the inlet and outlet stop valves and open the bypass valve.

The hydraulic accumulator stores high pressure fluid. If any maintenance is to be performed or when hoses are connected or disconnected on the auxiliary bypass and/or stop valves, the accumulator MUST be fully discharged prior to servicing the components.

The accumulator assembly is equipped with:

- an accumulator which contains the steel shell and bladder.
- an accumulator charge control lever controls the accumulator safety block valve.
  - Open valve to open system to hydraulic oil pressure.
  - Close valve to close system to hydraulic oil pressure.
- a bleed off valve pressure release control which releases hydraulic pressure in the accumulator.



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

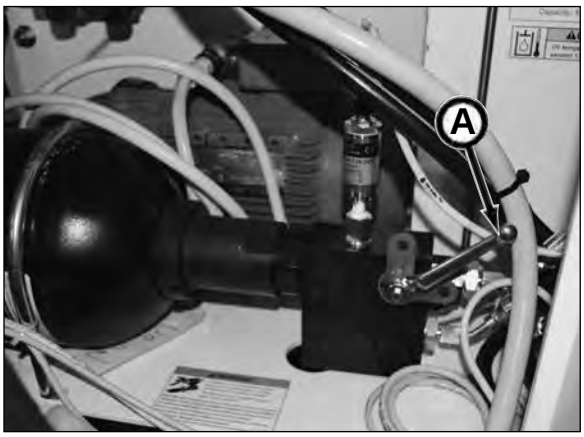
⚠DANGER If the accumulator requires repair, ONLY a certified service technician can check and fill the accumulator with dry nitrogen. Refer to the accumulator manufacturer for more information. NEVER FILL AN ACCUMULATOR WITH OXYGEN! An explosion will occur if oil and oxygen mix under pressure, resulting in serious injury or death. Also, NEVER fill accumulator with compressed air. Compressed air can cause premature wear to the accumulator seals.



DISABLE ACCUMULATOR
When any maintenance is required on the auxiliary slurry valve system, the accumulator must be fully discharged as follows:

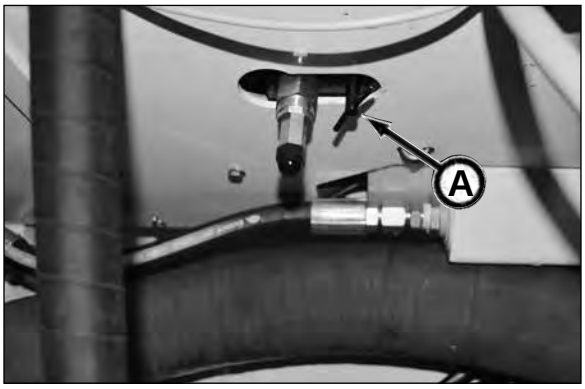
1. Shut down power to front section.

2. Move accumulator lever (A) to the right, CLOSED position.

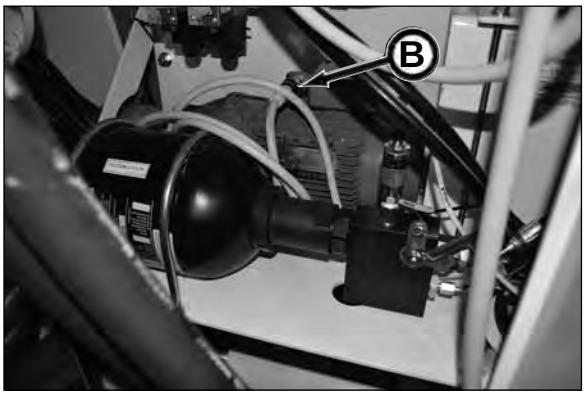


(continued on next page)

Accumulator (continued)



3. Open bleed off valve (A) to release accumulator oil pressure. Once pressure is released, close the bleed off valve.

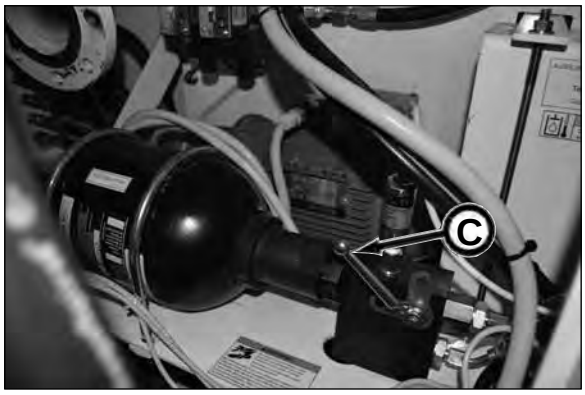


4. If power was not locked out, disconnect electric motor cable (B) to prevent any unintended motor start up.

5. Maintenance can now be performed on the auxiliary system.

ENABLE ACCUMULATOR

Once the maintenance has been performed and the auxiliary system is ready for use, prepare the accumulator for operation as follows:



1. Be sure bleed valve (A) is closed.

2. Move accumulator lever (C) to the left, OPEN position.

3. Connect electric motor cable (B) to motor.

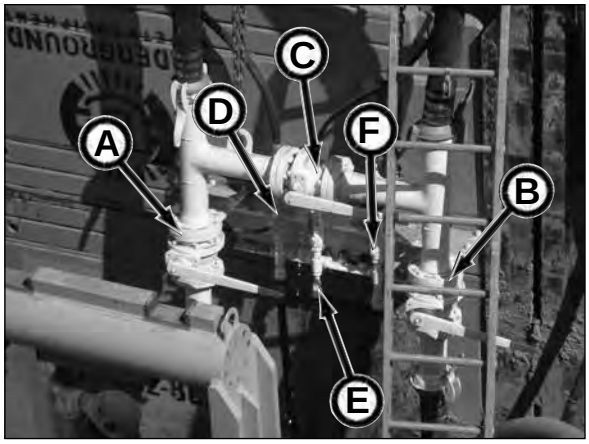
4. Communicate to the control container operator that the auxiliary system is ready for operation.

SLURRY PIT VALVES

The slurry pit valves are used to:

1. Prevent liquid slurry from draining the reservoir supply lines (separation plant reservoir, water cooling tank or bentonite pump reservoir) during system shutdown (adding pipe to the pipeline, daily shutdown, or maintenance).

2. Recirculating slurry liquid to clean up or lighten the slurry while adding pipe to the pipeline, daily shutdown or performing maintenance to the equipment.

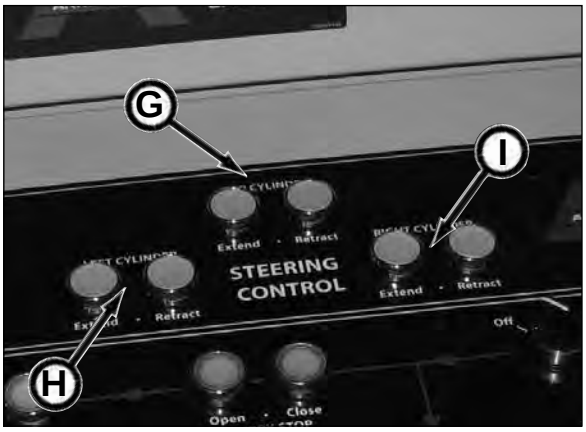


A - Slurry Return Shutoff
B - Slurry Feed Shutoff
C - Slurry Bypass Valve Shutoff
D - High Pressure Jetting Shutoff
E - Main Cooling Pump Water Supply Shutoff
F - Bentonite Supply Shutoff

STEERING CONTROLS

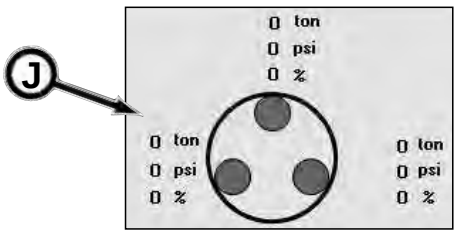
The steering controls regulate the three steering cylinders in the MTBM.

Depress extend or retract buttons to control the steering cylinders. Continuing to hold down a cylinder button will cause the cylinder to extend or retract further as indicated on the cylinder position indicator (J) on the target screen.



G - Top Cylinder Controls
H - Left Cylinder Controls
I - Right Cylinder Controls
J - Steering Cylinder Position Indicator

The operator can monitor the cylinder position in percent and pressure at the cylinder with the steering cylinder indicator on the target screen.

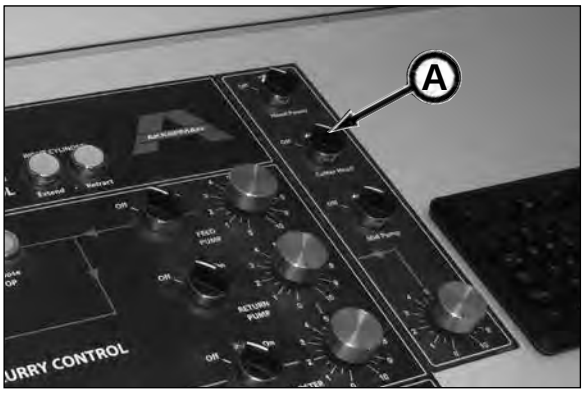


CUTTING HEAD CONTROLS



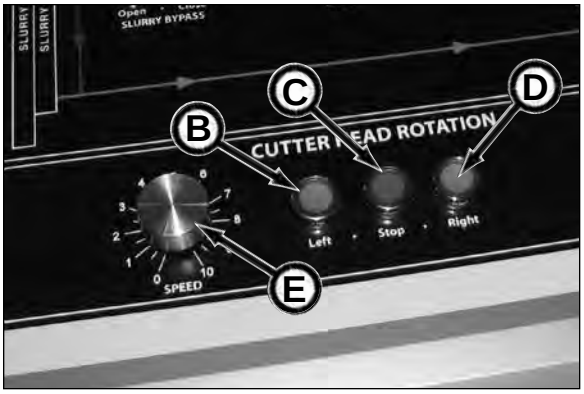
The cutting head controls regulate the speed, torque and direction of the cutting head rotation (drive motor) on the MTBM.

To activate the cutter head rotation, the main power disconnect and main cutter drive disconnect must be on and the Cutter Head power control (A) on console must be on.



LEFT
The left button (B) starts turning the MTBM drive motor CCW (as viewed from launch shaft) and automatically starts the drive motor cooling pump. The left button will light when the drive motor starts CCW rotation.

STOP
The stop button (C) stops the MTBM drive motor and the drive motor cooling pump. The stop button will light when the drive motor is stopped.

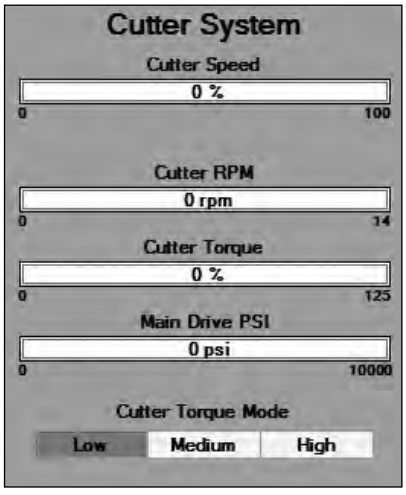


RIGHT
The right button (D) starts turning the MTBM drive motor CW (as viewed from launch shaft) and automatically starts the drive motor cooling pump. The right button will light when the drive motor starts the CW rotation.

CUTTER HEAD SPEED
The cutter head speed control (E) regulates the speed of the MTBM drive motor from 0 to 100%. The cutting head speed and torque can be monitored from the target screen (as shown).

CUTTER TORQUE MODE
The torque mode is displayed; Low, Medium and High. The cutter torque should be between 80% and 100%. If torque mode needs to be changed, select the desired Cutter Torque Mode on the MTBM Control screen.

IMPORTANT: BEFORE changing cutter torque modes, stop cutter rotation, wait for RPM to go to “0” and the pressure to standby, then select a different torque mode. Failure to do so WILL cause damage to drive motors.

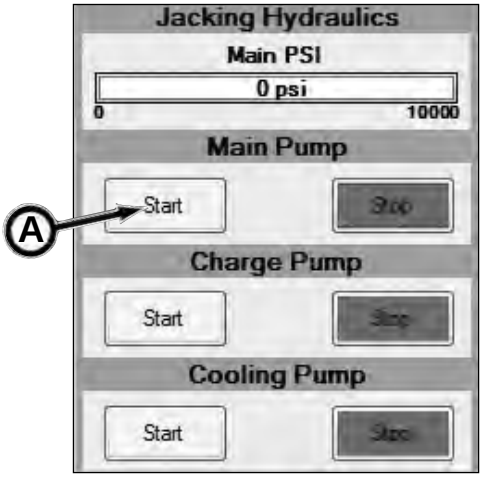


Cutter System Meters On Target Screen

JACKING FRAME CONTROLS

The jacking frame controls select the jacking function and regulate the oil flow to the jacking frame thrust cylinders, and intermediate jacking stations.

To use these controls, the Main Hydraulic Pump must be started. Click the main pump Start button (A) on the MTBM control screen.



Jacking Hydraulics Start Up On MTBM Control Screen

HYDRAULIC PUMP FLOW

The hydraulic pump flow control (B) regulates the hydraulic flow to the jacking frame or IJS functions as selected on the selector switch (C).

NOTICE The charge pump and cooling pump will automatically start when the main hydraulic pump is started. The cooling fan in the power pack is always operating unless the fan switch in the remote hydraulic power pack is in the OFF position.

SELECTOR SWITCH FUNCTIONS

STOP

Stops flow to the jacking cylinders. To enable other hydraulic functions, the switch must be in STOP position.

EXTEND

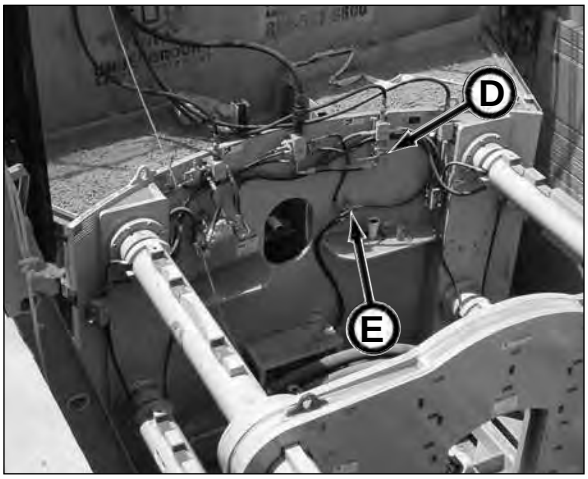
Turns the jacking cylinder extend valve ON.

RETRACT

This will retract the jacking cylinders. Cylinders should be fully retracted whenever possible to maintain cylinder timing.

High Flow Return: If using the high flow return circuit to quickly retract jacking frame cylinders, open high flow return control valve (D) with selector switch to Retract position. Then use the hydraulic pump flow control (C) to control the speed of cylinder return. Be sure to close high flow return valve after use.





MT8102K Jacking Frame Shown

IJS

Provides hydraulic flow to the intermediate jacking station cylinders. Turning the selector to IJS position will energize the IJS valves in the lube/jack can and/or remote hydraulic power pack. (See also Lube/Jack System Controls in this section.)

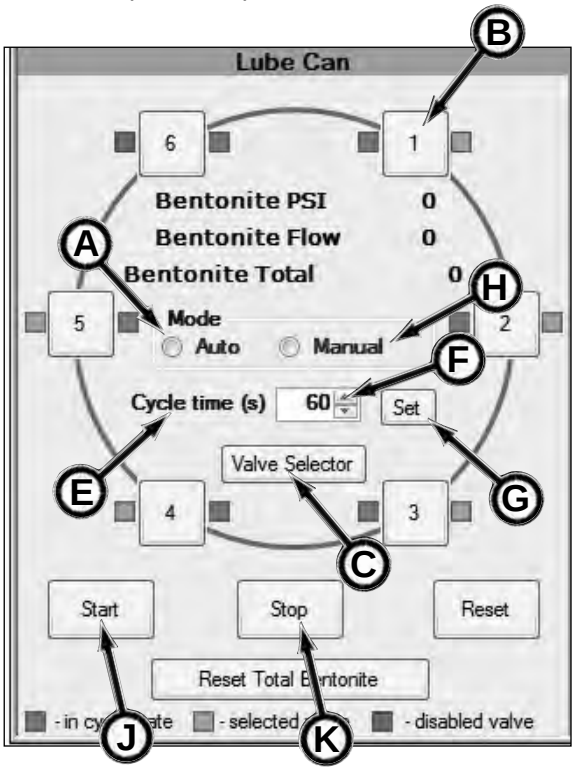
AUX

Used for auxiliary functions such as a winch.

Winch: If using the winch, the selector switch must be in the Aux position. Move the winch control valve (E) to the extend or retract position, and control the extend/retract speed with the hydraulic pump flow control (C). Place winch control valve in neutral position after winch use.

LUBRICATION VALVE CONTROLS (LUBE/JACKING CAN)

The lube can lubrication valve control regulates the flow of lubricant (bentonite) to the outside diameter of the lube/jacking can.

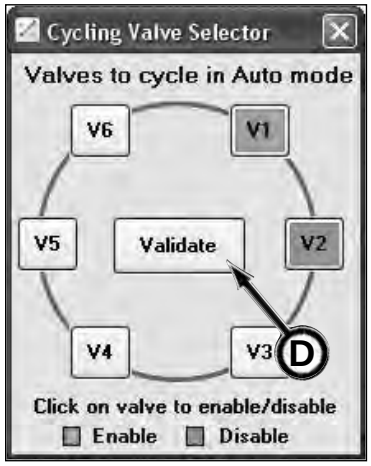


1. Before starting, select the desired lubrication mode:
   a. Auto (A): lubricant will alternately cycle through the selected valves (B) based on the cycle time.
   • Select desired valves by, clicking Valve Selector (C) button, select valves to enable or disable, click Validate (D).
   • If cycle time (E) needs to be changed, click the up or down arrows (F) to desired time and click Set (G) button.

   b. **Manual (H):** lubricant will cycle through the selected valves until valves are stopped.
   • Click desired valves (2 valves maximum). The Valve Selector and Cycle time are not functional in Manual mode.

2. With the lubrication pump hose connected to the lubrication supply manifold (I) in the lube/jacking can, click Start (J) button to cycle the lubricant through the lubrication valves.

3. Click Stop (K) button when needed.



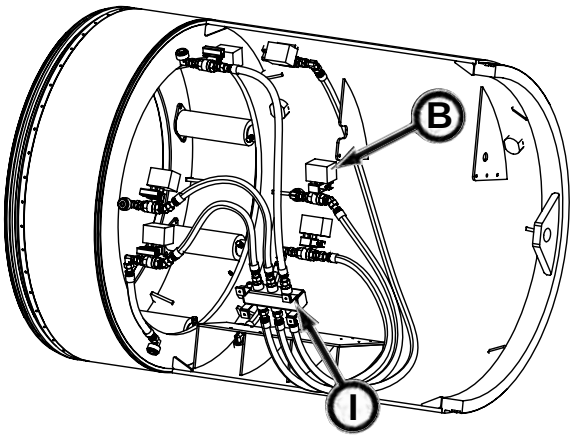
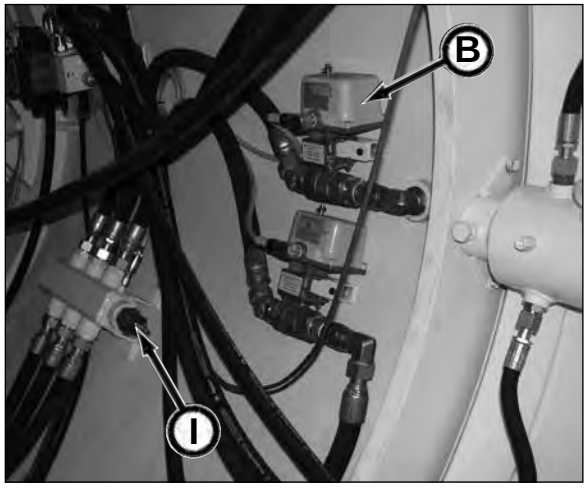


Illustration of the Lube/Jack Can Showing the Lubrication Valve Locations



IJS CONTROLS

The intermediate jacking stations (IJS) are hydraulic cylinders assemblies placed between pipe joints at intervals throughout the tunnel and are installed when the thrust pressure approaches 50% of the system capacity or installed as a planned jacking safety factor. The cylinders distribute the pipe jacking thrust to the pipeline, reducing thrust loading on the pipe at the jacking frame.

The IJS stations are controlled from the Lube/ Jacking Can System controls screen. The unique part of this system is the IJS stations can be powered from either the lube/jacking can or the remote hydraulic power pack.

If IJS are powered from the lube/jack can (PD), the IJS hoses are routed from the lube/jack can to the IJS. If IJS are powered from the remote hydraulic power pack (HPP), the IJS hoses are routed from the HPP to the IJS.

JACK FRAME CONTROL SELECTOR
To activate the IJS Selector window (A), turn the Jack Frame Control Selector switch (B) to the IJS position.

IJS SELECTOR CONTROLS
The main hydraulic pump (in the lube/jacking can or the remote hydraulic power pack) must be started for the IJS to be functional. The IJS Selector buttons simply energizes the valves in the jacking can or the IJS stations.

1. **Jack Can:** Click this button for the jacking can thrust cylinders. The power source is the lube/ jacking can main hydraulic pump (C).

2. **IJS1, IJS2 and IJS3**: for these IJS stations, select power source; PD- lube/jacking can main hydraulic pump (C) or HPP- remote hydraulic power pack main hydraulic pump (D).

3. **IJS4:** Click this button for the IJS powered by the remote hydraulic power pack main hydraulic pump.

HYDRAULIC PUMP FLOW
Use the hydraulic pump flow control (E) to regulate the hydraulic flow to the jacking can thrust cylinders or the IJS functions as selected on the IJS Selector.

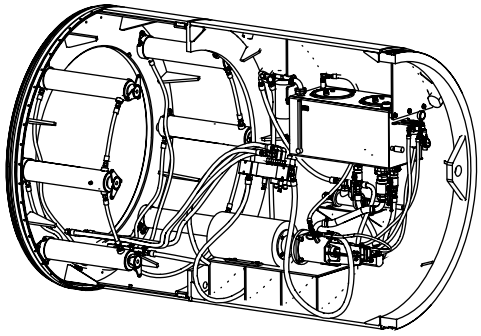
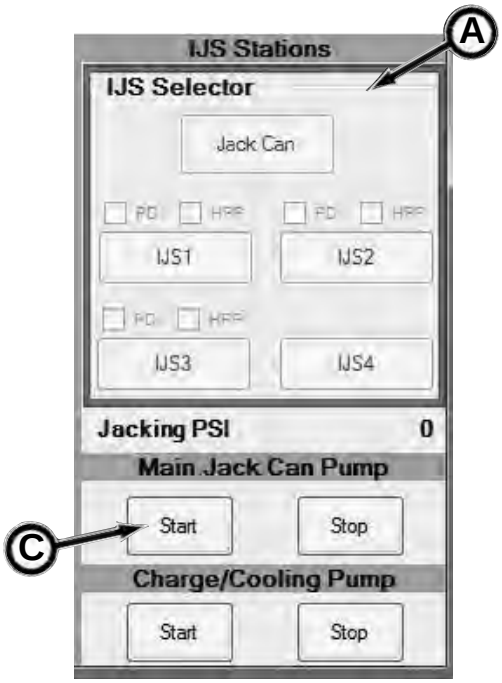
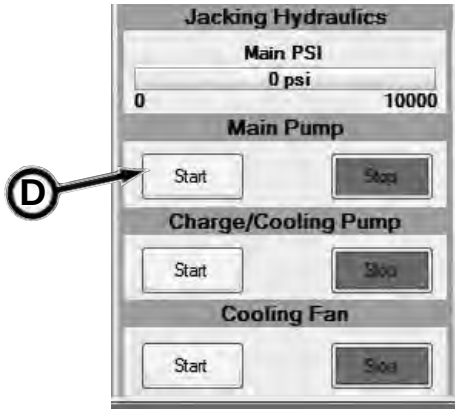


Illustration of the Lube/Jack Can Showing the Jack Can Cylinders & IJS Hydraulic System



Lube/Jacking Can IJS Controls

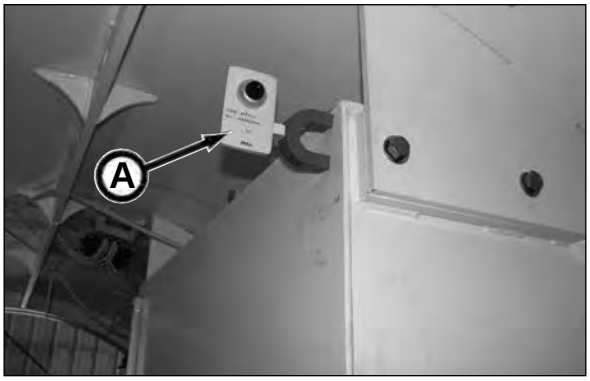




Remote Hydraulic Power Pack Main Hydraulic Pump Control

MTBM CAMERA

There is one camera (A) for viewing the target in the MTBM.

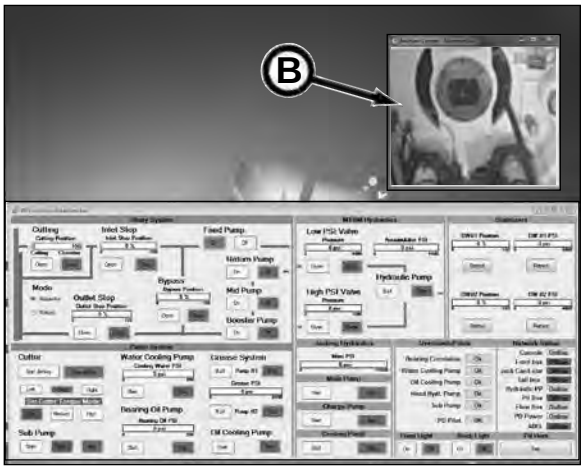


MTBM Target Camera (A)
Double click the Machine Camera icon 

to display the camera window (B).

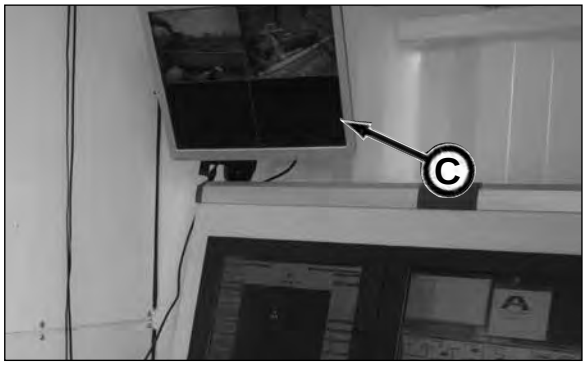
There is no panning or tilting with this camera.

The screen image can be resized by dragging a corner of the window.



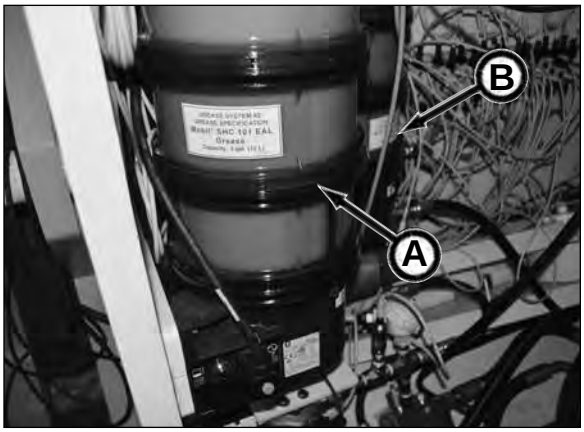
CAMERAS (OPTIONAL)

An optional video camera setup with monitor (C) is available with two to four cameras. Contact your Akkerman Aftermarket Support representative for more information.



GREASE PUMP SYSTEM (FRONT SECTION)

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

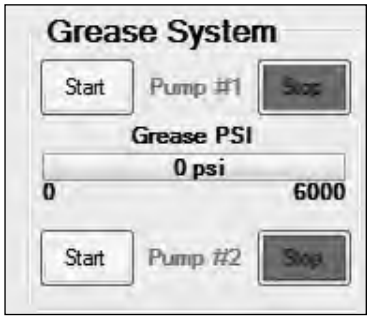


There are two grease pumps installed in the MTBM front section; Grease System 1 (A) and Grease System 2 (B). They are equipped with translucent containers to easily inspect the grease level.

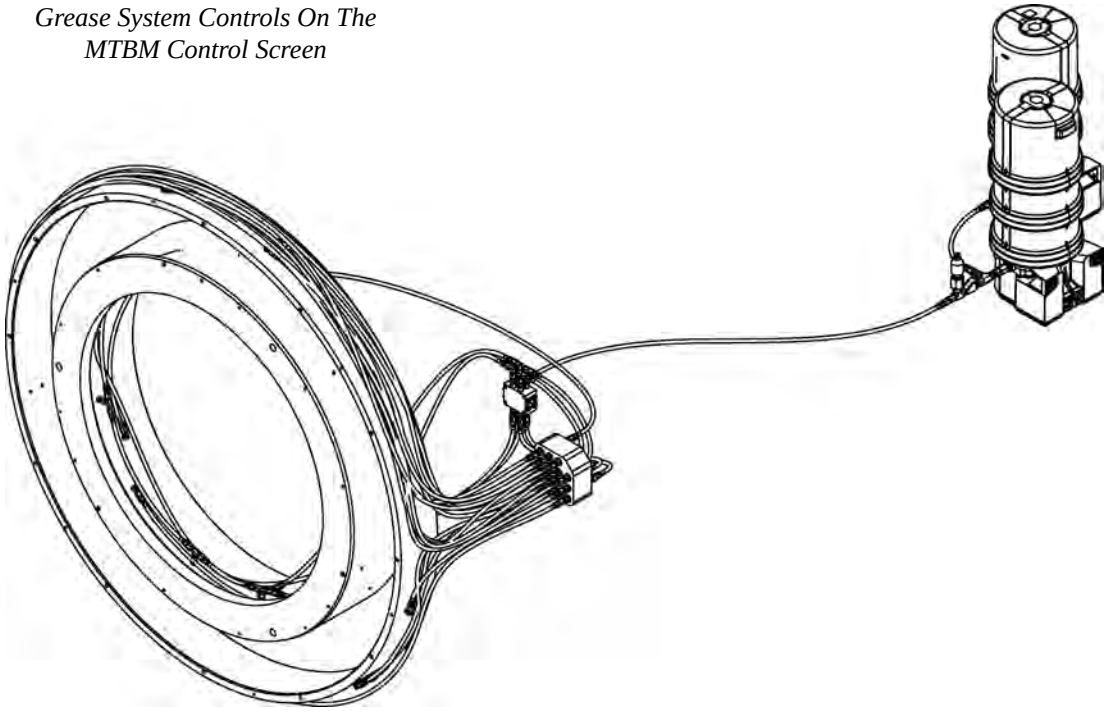
The two grease pumps will automatically alternate a 15 minute grease pumping cycle. If one grease container is low, the other container will function for two 15 minute cycles (total of 30 minutes) and then will shutdown the grease pumps and the cutterhead rotation, requiring the refilling of the grease containers.



If the *"Grease 1 Low Level"* or *"Grease 2 Low Level"* alarm message appears on the target screen, fill the grease pump reservoir with Mobil® SHC 101 EAL Grease or equivalent through the grease pump fill ports (C) on the pump until the grease container is full.

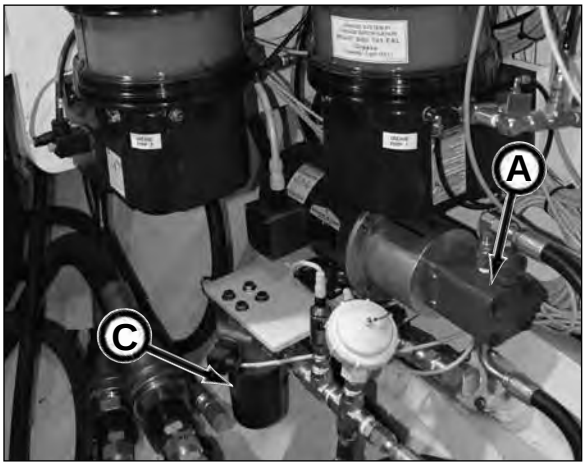


Grease System Controls On The MTBM Control Screen



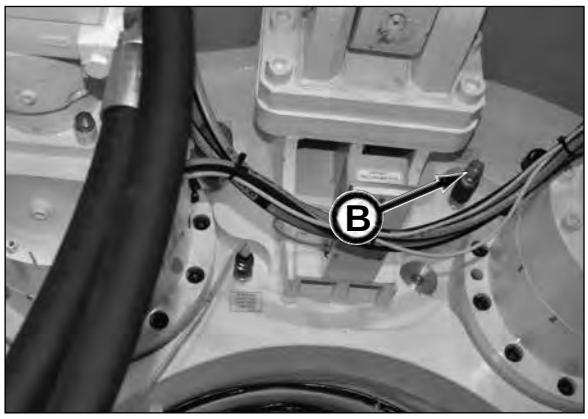
BEARING CAVITY LUBE SYSTEM (FRONT SECTION)

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



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

If the ***"Bearing Oil Low Level"*** alarm message appears on the target screen, the bearing pump and cutter rotation will stop. The bearing oil cavity level must be refilled with Mobilgear® 600XP 460 gear oil or equivalent. Oil must be level with bearing cavity check/fill port hole (B).

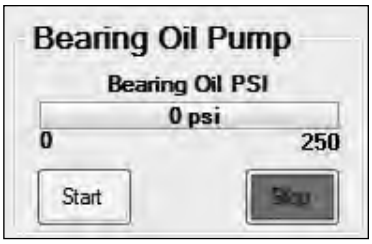


If the ***"Bearing Oil Filter Plugged"*** alarm message appears on the target screen, the bearing pump and cutter rotation will stop. The bearing oil filter (C) must be replaced.

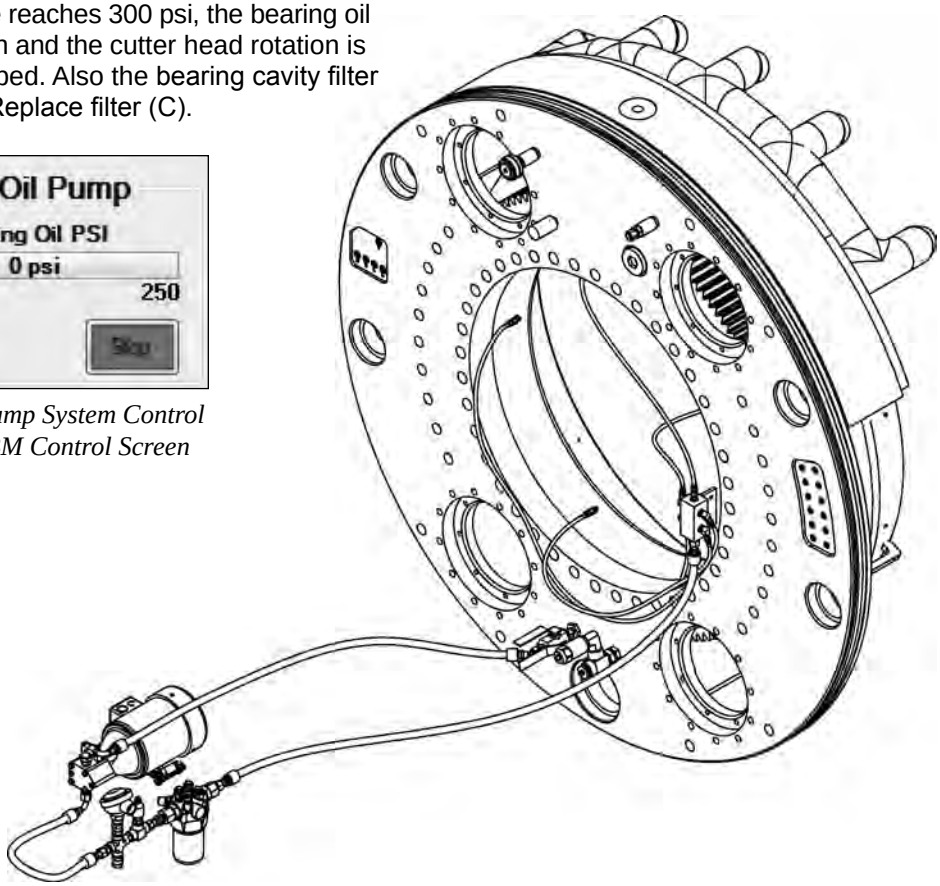
If the ***"Bearing Oil Low PSI"*** alarm message appears on the target screen, the oil pressure is 10 psi or less indicating the bearing pump (A) is not working or a line may be broken. The message is displayed as a warning of low pressure.

If the ***"Bearing Oil High PSI"*** alarm message appears on the target screen, the bearing pump and cutter rotation will stop.

• If oil pressure reaches 300 psi, the bearing oil pressure is too high and the cutter head rotation is automatically stopped. Also the bearing cavity filter may be plugged. Replace filter (C).



Bearing Oil Pump System Control On The MTBM Control Screen



WATER COOLING SYSTEM (TRAILING SECTION)

The on-board water cooling system consists of the water tank, water cooling pump, heat exchanger and slurry cooling tubes (optional, number will vary based on HP required for job). Contact your Akkerman Aftermarket Support representative for more information.



The water cooling system will cool the:

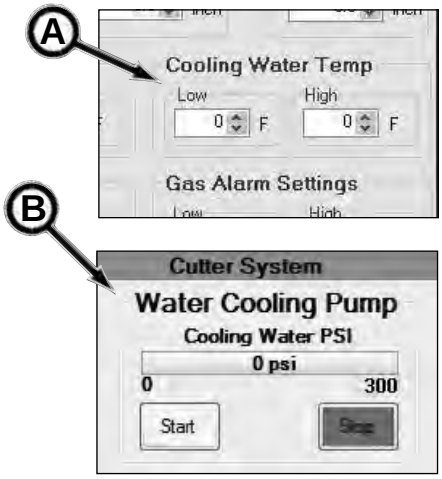
- main drive motor hydraulic oil
- the main drive motor bearing and windings
- the booster motor bearing and windings
- the lube/jacking can hydraulic oil

The water cooling system circulates water from the tank, through the water cooling pump, through slurry cooling tubes (after launch), then diverts into two paths:

1. through the booster pump water jacket, through the main drive motor water jacket and then recirculates.
2. through the heat exchanger and then recirculates.

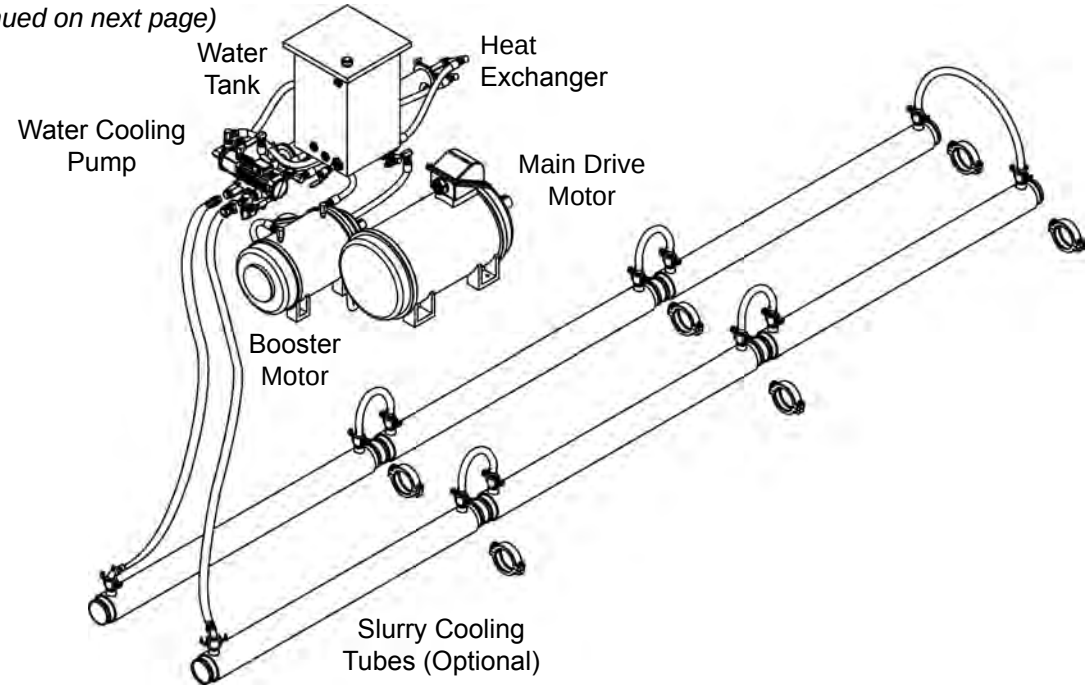
If the lube/jacking can is used, the water is also routed to the heat exchanger in the lube/jacking can for cooling the jacking can hydraulic oil.

The cooling system will automatically start and stop based on the high and low temperature settings (A) in the MTBM Front Editor program. For more information, refer to Supplementary Editor Programs, 1. MTBM Front Editor in section 6 Operation.



The cooling system can also be controlled from the cutter system controls (B) on the MTBM control screen.

(continued on next page)



Water Cooling System (Continued)

There are two water cooling system methods for the SL82P system.

1. On-Board Water Cooling System
2. External Water Pump Cooling System

1. On-Board Water Cooling System

The on-board water cooling system circulates water from the on-board tank through the water cooling pump, through the slurry cooling tubes (if used) then diverts into two paths:

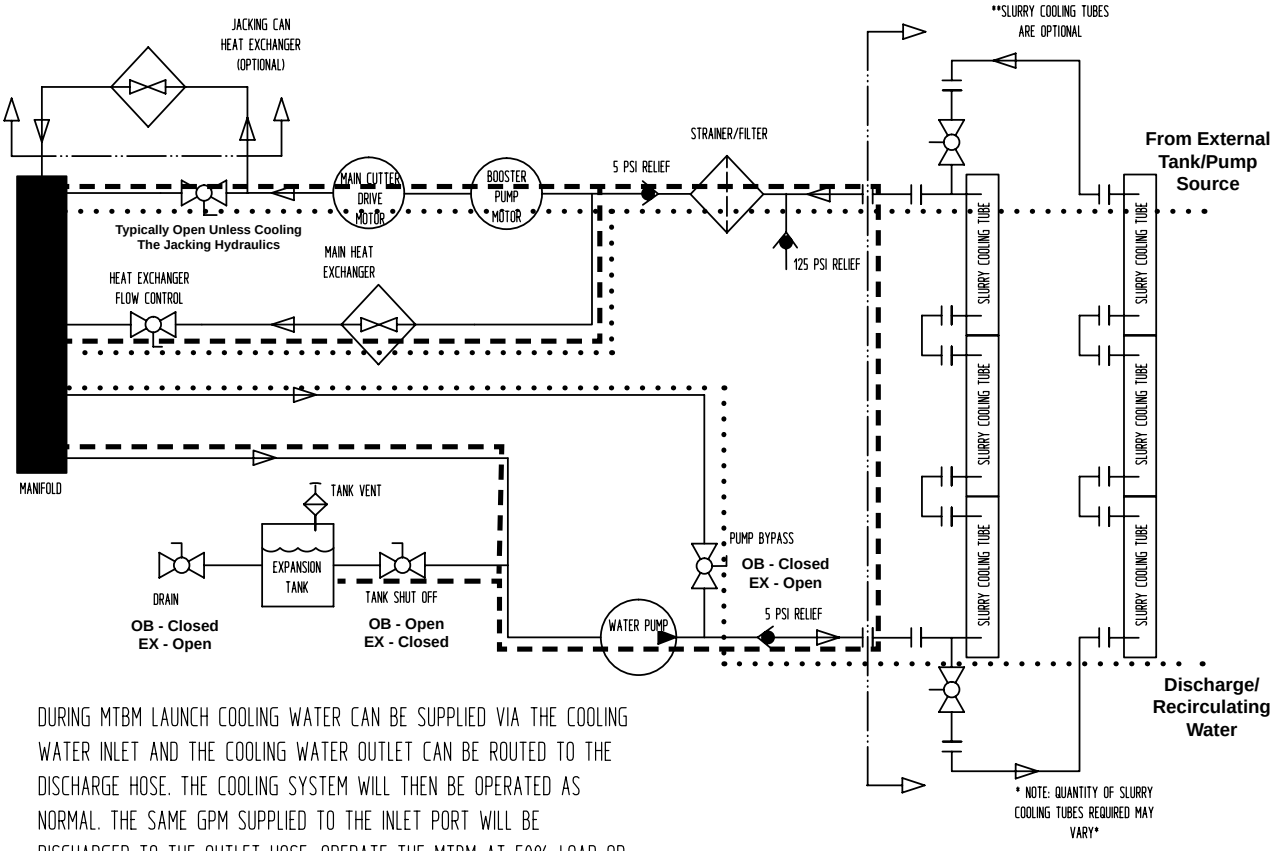
a. through the booster pump water jacket, through the main drive motor water jacket and then recirculates.

b. through the heat exchanger and then recirculates

2. External Water Cooling System

The external water cooling system circulates water from the external tank through the external water cooling pump, through the booster motor water jacket, through the main motor water jacket, through the heat exchanger and then recirculates. **The water pressure MUST be limited to 100 psi.**

Water Cooling System Routing Flows With Ball Valve Configurations



DURING MTBM LAUNCH COOLING WATER CAN BE SUPPLIED VIA THE COOLING WATER INLET AND THE COOLING WATER OUTLET CAN BE ROUTED TO THE DISCHARGE HOSE. THE COOLING SYSTEM WILL THEN BE OPERATED AS NORMAL. THE SAME GPM SUPPLIED TO THE INLET PORT WILL BE DISCHARGED TO THE OUTLET HOSE. OPERATE THE MTBM AT 50% LOAD OR LESS WHILE SUPPLYING COOLING WATER AS TABLE STATES.

40°F	10.6 GPM	55°F	15.2 GPM	70°F	20.2 GPM	85°F	26.0 GPM
45°F	12.1 GPM	60°F	16.7 GPM	75°F	22.1 GPM	90°F	28.0 GPM
50°F	13.6 GPM	65°F	18.2 GPM	80°F	24.1 GPM		

KEY

- – – – – On-Board Water Cooling System
- . . . . . External Water Cooling System

OB- On-Board System Shutoff Valve Position

EX - External System Shutoff Valve Position

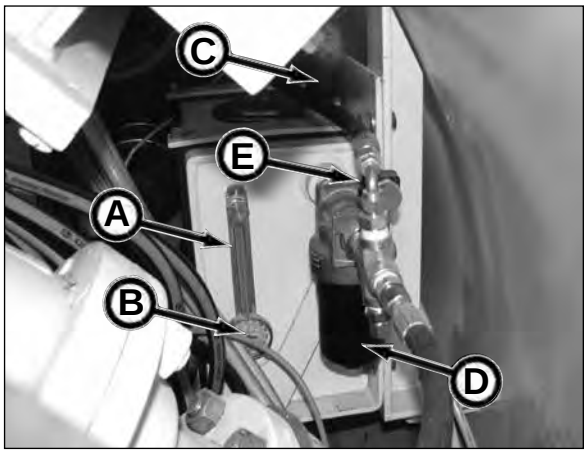
MTBM AUXILIARY HYDRAULIC POWER PACK (FRONT SECTION)

The auxiliary hydraulic power pack provides oil to the steering hydraulic system and the slurry stop and bypass valve system (including accumulator).

HYDRAULIC RESERVOIR
The hydraulic reservoir in the MTBM front section includes an oil level sight gauge (A) and temperature gauge (B).

The hydraulic oil temperature should not exceed 150°F (66°C).

Remove the fill cap (C) to fill the hydraulic reservoir.



RETURN FILTER INDICATOR
To prevent under or over servicing of the auxiliary hydraulic power pack return filter element (D), a filter indicator (E) has been installed on the return circuit.

If the filter indicator is green, the filter is functioning properly.

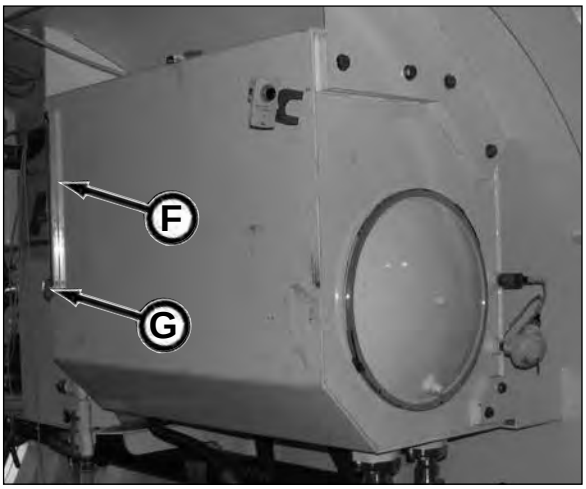
If the filter indicator is red, the filter should be replaced.

MTBM MAIN HYDRAULIC POWER PACK (TRAILING SECTION)

The main hydraulic power pack provides oil to the main drive motor hydraulic system.

HYDRAULIC RESERVOIR
The hydraulic reservoir in the MTBM trailing section includes an oil level sight gauge (F) and temperature gauge (G).

The hydraulic oil temperature should not exceed 160°F (71°C). The ***"Main Drive Hydr Oil"*** temperature is also displayed on the target screen. Remove the hose cap (H) to fill the hydraulic reservoir with an external oil fill pump.

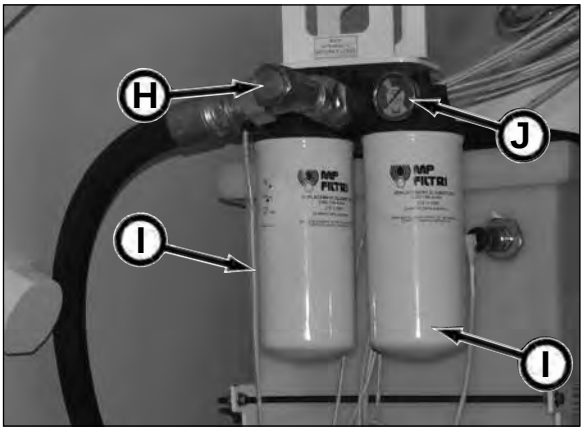


RETURN FILTER INDICATOR
To prevent under or over servicing of the main hydraulic power pack return filter elements (I), a filter indicator (J) has been installed on the return flow system. Also, an alarm message will appear, ***"Drive Oil Filter Plugged"***, on the target screen indicating the filter is plugged and must be changed.

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

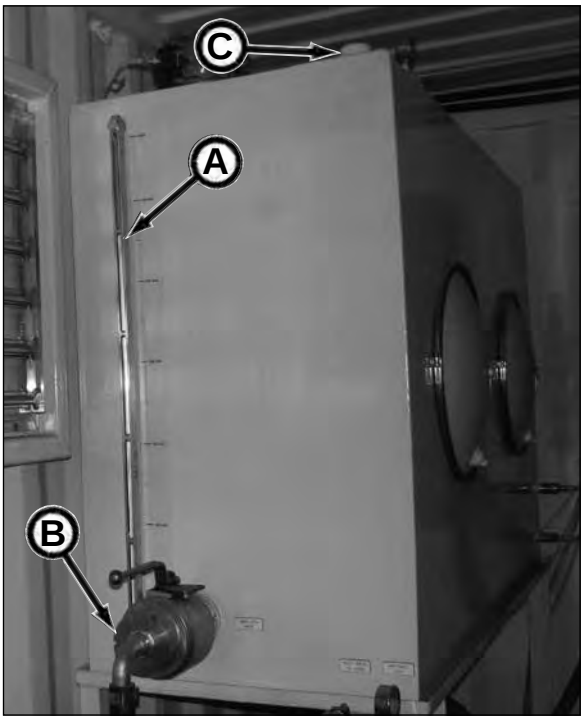
The yellow zone indicates that the filter will soon require replacement.

When the needle on the gauge is in the red CHANGE zone, replace filter as soon as possible to prevent hydraulic component damage (refer to section 9, Periodic Maintenance, 23. Check MTBM Main Hydraulic Power Pack Return Filter Indicator for proper filter replacement).



NOTES

REMOTE HYDRAULIC POWER PACK



The remote hydraulic power pack provides oil to the jacking frame and IJS stations.

HYDRAULIC RESERVOIR

The hydraulic reservoir in the remote hydraulic power pack includes an oil level sight gauge (A) and temperature gauge (B). An alarm message will appear, ***"HPP - Low Oil Level"***, on the target screen indicating the that the reservoir level is low and requires additional hydraulic oil. The alarm message, ***"HPP - Oil Overtemp"***, will appear on the target screen indicating the hydraulic oil reservoir temperature is too high.

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

Remove the fill cap (C) to fill the hydraulic reservoir.

RETURN FILTER INDICATORS

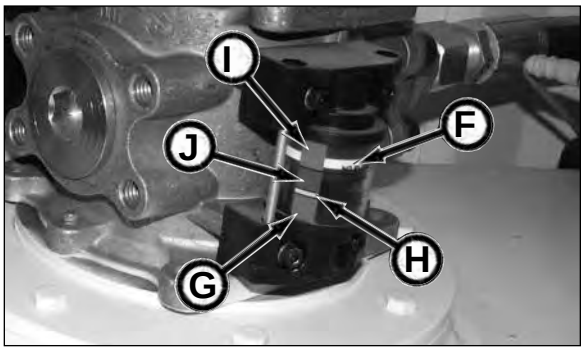
To prevent under or over servicing of the hydraulic filter elements, filter indicators have been installed on the jacking frame return circuits; manifold (jacking frame extend, retract, auxiliary and IJS) return filter (D) and hi-flow return filter (E).



If the white indicator (F) is in the clean green zone (G), the filter is functioning properly.

If the white indicator is in the caution yellow zone (H), the filter will soon require replacement.

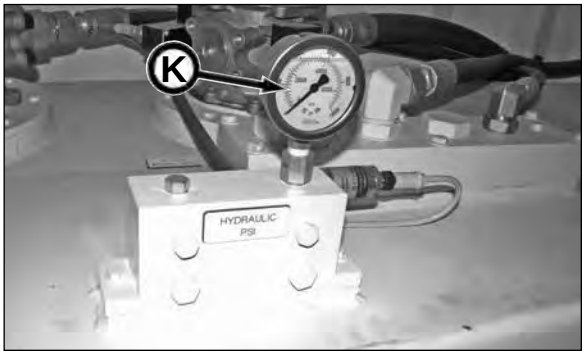
If the white indicator is in the no element red zone (I) or bypass red zone (J), replace the filter immediately to prevent contamination from entering the hydraulic reservoir (refer to section 9, Periodic Maintenance, Maintenance Charts - Remote Hydraulic Power Pack for proper filter replacement).



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

HYDRAULIC PRESSURE GAUGE

A hydraulic pressure gauge (K) is equipped in the remote hydraulic power pack to display the jacking frame hydraulic jacking pressure. The jacking pressure is also displayed on the target screen.



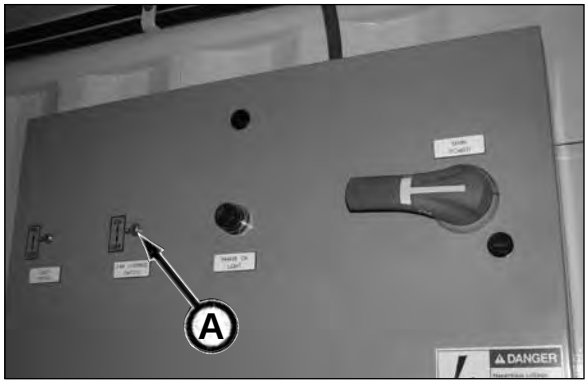
The maximum pressure for the jacking system is 8,000 psi.

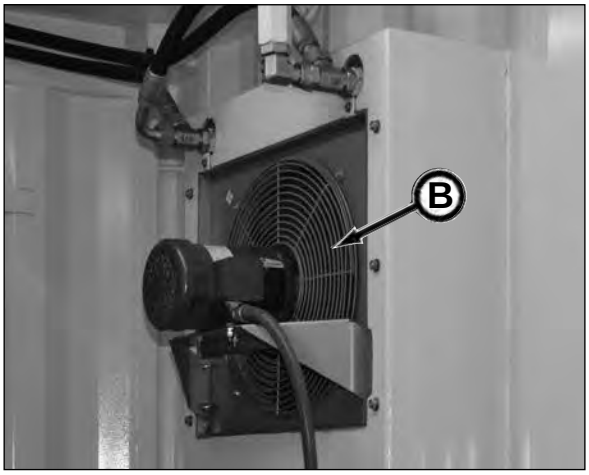
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Remote Hydraulic Power Pack (continued)

FAN OVERRIDE SWITCH
The remote hydraulic power pack is equipped with a fan override switch (A).

The fan (B) will start continuously unless it is shut off with the switch.

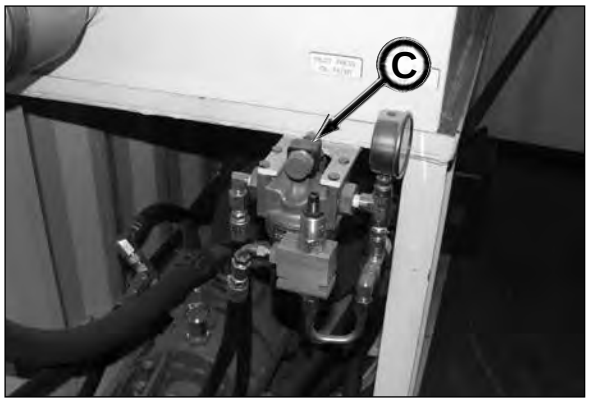




PILOT PRESSURE OIL FILTER
To prevent under or over servicing of the hydraulic filter element, a filter indicator (C) has been installed on the charge pump pilot pressure circuit.

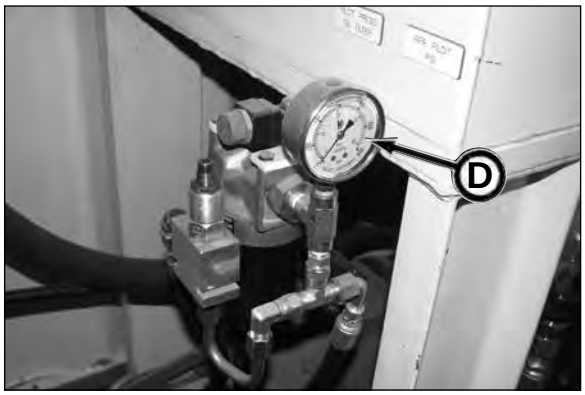
If the filter indicator is green, the filter is functioning properly.

If the filter indicator is red, the filter should be replaced.



RPA PILOT PRESSURE GAUGE
The hydraulic pressure gauge (d) installed on the charge pump pilot circuit displays the RPA pilot pressure. The RPA (remote proportion actuator) is used to control the jacking functions.

The maximum pressure for the RPA pilot pressure is 300 psi.

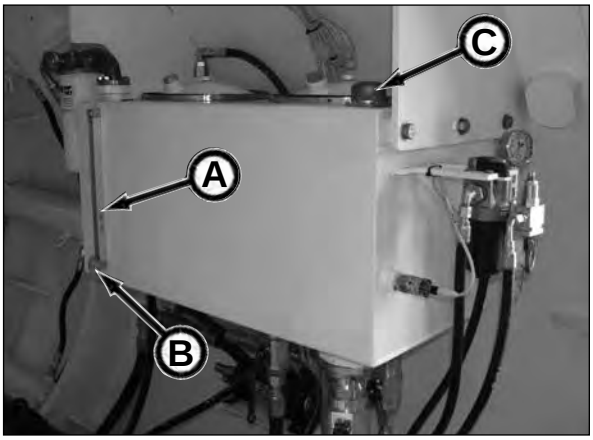


LUBE/JACKING CAN

The lube/jacking can hydraulics provide oil to the jacking can thrust cylinders and the IJS stations.

HYDRAULIC RESERVOIR

The hydraulic reservoir in the remote hydraulic power pack includes an oil level sight gauge (A) and temperature gauge (B). If oil is low, an alarm message appears on the target screen, ***"Jacking Pump Hydraulic Oil Low Level"*** indicating hydraulic oil needs to be added to the reservoir.

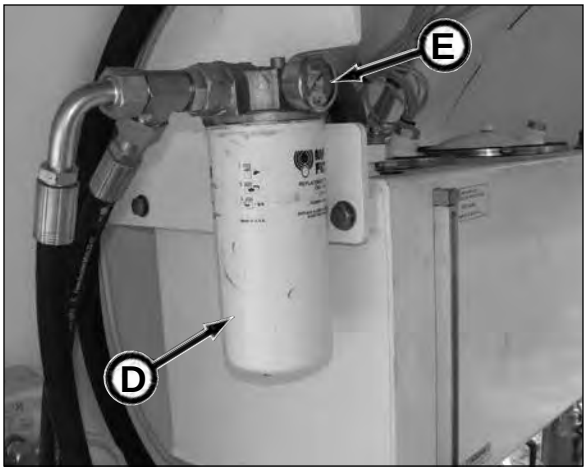


Remove the fill cap (C) to fill the hydraulic reservoir.

The hydraulic oil temperature should not exceed 125°F (52°C). An alarm message, ***"Jack Can Hydraulic Oil High Temp"*** will display on the target screen indicating the reservoir temperature is getting too high and should be inspected.

RETURN FILTER INDICATOR

There is a hydraulic return filter (D) installed on the lube/jacking can hydraulic system.



To prevent under or over servicing of the hydraulic filter element, a filter indicator (E) is installed on the jacking can return circuit. Also, an alarm message will appear, ***"Jacking Pump Hydraulic Oil Filter Plugged"*** on the target screen indicating the filter is plugged and must be replaced.

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

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

When the needle on the gauge is in the red CHANGE zone, replace filter as soon as possible to prevent hydraulic component damage (refer to section 9, Periodic Maintenance, 25, Check MTBM Lube/Jack Can Hydraulic Reservoir Return Filter Indicator for proper filter replacement).

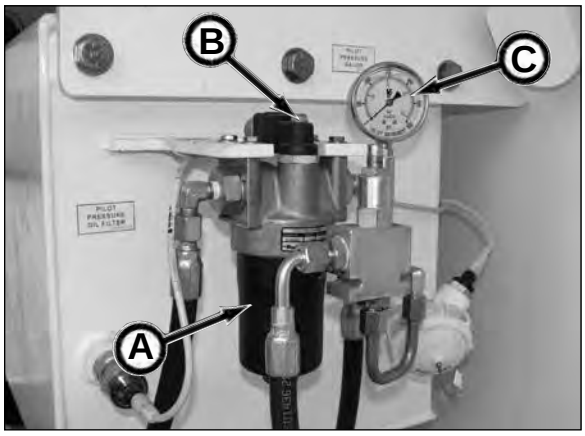
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Lube/Jacking Can (continued)

PILOT PRESSURE OIL FILTER
To prevent under or over servicing of the hydraulic filter element (A) a filter indicator (B) has been installed on the charge pump pilot pressure circuit.

If the filter indicator is green, the filter is functioning properly.

If the filter indicator is red, the filter should be replaced.



RPA PILOT PRESSURE GAUGE
The hydraulic pressure gauge (C) installed on the charge pump pilot circuit displays the RPA pilot pressure. The RPA (remote proportion actuator) is used to control the jacking functions.

The maximum pressure for the RPA pilot pressure is 300 psi.

LOG MESSAGES

The Log Messages window displays the messages as they occur on the control screen monitor in the control container. The log messages are a visual indicator to show the operator the functioning of the target, main hydraulic power pack, and the pit box component operation.



Target Log Messages:
- No laser power
- Low laser power

Main Hydraulic Power Pack Log Messages:
- Main hyd pump contactor did not open/close
- Charge pump contactor did not open/close
- Oil cooling pump contactor did not open/close
- Hyd box not connected to network

Pit Box Log Messages:
- Pit E-Stop Is Pressed
- Pit E-Stop Is Released

REMOTE ASSISTANCE SUPPORT

If your Microtunneling system is equipped with remote assistance support such as the Enterprise version of VNC (Virtual Network Connection) Server, the customer is required to keep the annual subscription up-to-date. The Enterprise version allows simple drag and drop remote support capability.

Contact your Akkerman Aftermarket Support representative for more information.



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.

	1. Use “ONE-CALL” notification to check for buried utility lines prior to tunneling.
	2. Check the excavated launch and reception shafts for proper shoring or bracing to prevent slides or cave-ins.
	3. Thoroughly clean equipment of mud and dirt.
	4. Check condition of personal protective equipment. Replace equipment if defective.
	5. Contractor is responsible for all personnel to wear proper protective equipment on the job site.
	6. Remove combustible or flammable materials from equipment. Store materials properly.
	7. Test all Emergency Stop buttons for proper operation at the start of each shift.
	8. Test air monitoring and ventilation detectors for proper operation.
	9. Thoroughly inspect all equipment for damage. Repair or replace before operating.
	10. Be sure all covers and guards are in place before operation.
	11. Check for loose or missing hardware. Replace damaged or missing hardware.
	12. Check for worn, loose, or damaged wire connections. Repair or replace wiring.
	13. Tighten loose clamps or fittings.
	14. Check electrical cables for frayed or worn insulation or wiring. Replace damaged or worn harnesses.
	15. Check for fluid leaks. Repair leak or replace components.
	16. Keep job site clean and organized.
	17. Perform all lubrication and maintenance procedures. Refer to Section 9, Periodic Maintenance.
	18. Test each function and control to ensure correct operation.
	19. Check hydraulic hoses and lines for leaks, wear and/or damage. Replace any defective hoses and/or lines.
	20. Check oil level in hydraulic oil reservoirs. Add as needed.
	21. Be sure power Phase OK lights are illuminated before starting electrical components.
	22. Be sure control container, remote hydraulic power pack and power container are properly grounded.
	23. Check that all switches are in the Off or Stop position and speed controls are at 0 (Min).
	24. Check cable for continuity and shorting before each use. Constantly check cables for damage.
	25. In operation, A/C Heater unit must be extended out and securely fastened with six 1/2 x 1.25 flat SHCS.
	26. Check power container for proper operation.
	27. Decals must be clean and legible.

NOTES

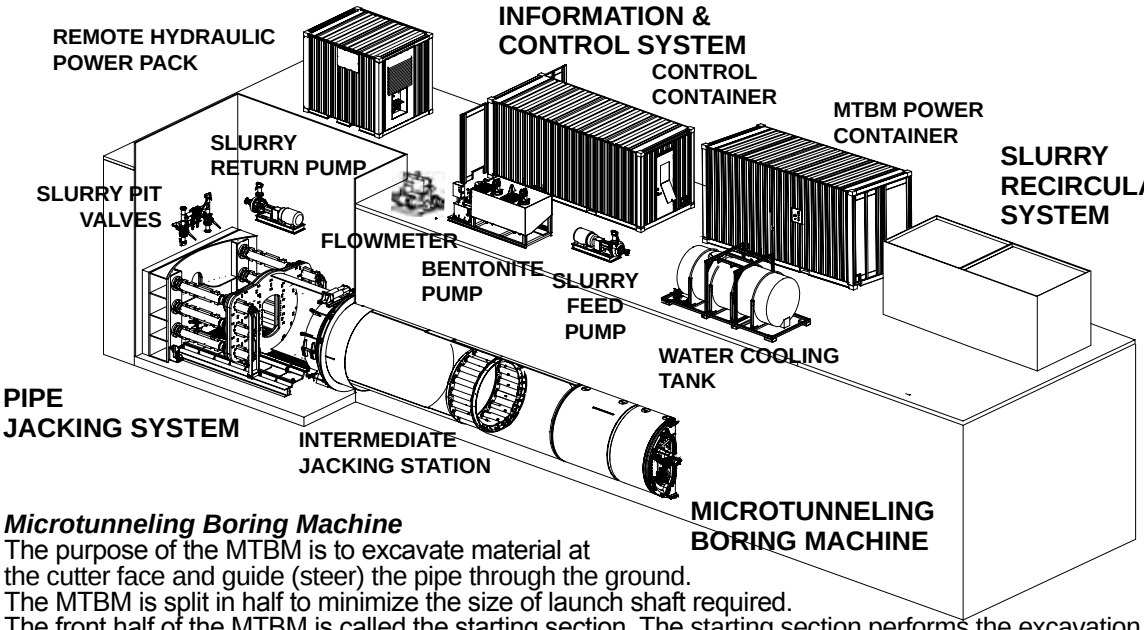
Operation

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, Operation and Maintenance sections.
2. Do not operate this equipment while under the influence of alcohol, drugs, or medication.
3. Follow all Federal, State, and Local safety regulations and procedures.
4. Be sure OSHA prescribed safety protective equipment is being worn by all personnel.
5. Be sure the area is safe for operation. Keep 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 fully charged fire extinguishers on the job site at all times.
8. Before operating, inspect all equipment and repair equipment problems. Check hoses for cuts or bulges. Replace worn or damaged hoses.
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 each function and control to make sure they work properly.
14. Lock out/tag out electrical power at the source (generator) before servicing electrical components.
15. Do not make any non-authorized modifications to any Akkerman products. Doing so could cause structural failure and will void the warranty.
16. Check shields and guards. All must be in place and undamaged.
17. Test all Emergency Stop circuits for proper operation at the start of each shift.
18. Before starting equipment, walk completely around all machines and equipment. Let all job site personnel that you are starting up the equipment. Do not start until all unauthorized personnel are clear of the equipment.
19. After start-up, observe all gauges, controls and warning devices to assure they are functioning properly and their readings are within the operating range.
20. Never leave the operator’s station without first releasing hydraulic pressure, performing daily system shutdown, and disconnecting the main power supply.
21. Perform lock out/tag out procedure to the main disconnect on all equipment and power source before performing maintenance.
22. If adjustments must be made with the equipment running, always work as a 2-person team with one person in the operator’s station while the other works on the machine.
23. Never operate jetting pump or cooling pumps without fresh water supply.
24. Check cable for continuity and shorting before each use. Do not pull or strain cables; doing so will result in damage.
25. Constantly monitor electrical cables using jacking process to prevent cutting or stretching of any electrical cables. Contact with severed electrical cables WILL cause severe injury or death.
26. Keep tunnel well ventilated to achieve a consistent temperature throughout the pipeline since changes in temperature inside the pipe can cause guidance system laser beam to stray off target.

SYSTEM OVERVIEW



Microtunneling Boring Machine
The purpose of the MTBM is to excavate material at the cutter face and guide (steer) the pipe through the ground. The MTBM is split in half to minimize the size of launch shaft required. The front half of the MTBM is called the starting section. The starting section performs the excavation, steering and stabilizing (dirt wings). The second half of the MTBM is the trailing section. The trailing section features a hydraulic power pack, control system for the MTBM, slurry booster pump, camera, and submersible pump.

MTBMs (with periphery drive) may range in sizes from approximately 86 inches through 114 inches outer pipe diameter. Ground conditions can range from dry to saturated with water, fine-grained to gravel, and loose soil to soft rock. Although consistent ground conditions work the best, the MTBM will cut through layers of different types of soil. The machine will also generally tolerate soft rocks that are up to 1/4 the diameter of the machine.

Slurry Recirculation System
The slurry recirculation system removes spoil from the cutter face. This is accomplished by pumping clean slurry water to the MTBM, mixing spoil and slurry using valve controlled slurry paths in the MTBM, and pumping the slurry to the surface for separation.

The slurry system can consist of a slurry tank, feed pump, MTBM slurry valves, booster pump, mid pump (for longer drives) and a return pump. Mechanical slurry separation systems have been used successfully instead of settling tanks where needed. Variable Frequency Drives (VFDs) are commonly used on pumps to adjust the flow and pressure of the slurry for the ground conditions encountered.

Pipe Jacking System
The pipe jacking system (jacking frame and optional intermediate jacking station) provide the horizontal thrust to push the MTBM and pipe through the ground.

There are several sizes of microtunneling jacking frames that are available. Each jacking frame has optional extensions available to optimize the jacking shaft size for the length of pipe used. The jacking frame can develop jacking forces of 300, 400, 800 or 1,200 tons depending on model used. Each frame comes with a bulkhead to mount valves for slurry, bentonite and drive-motor cooling water. This simplifies turning off the fluids for disconnecting the lines when installing another pipe. An optional electrical box which contains connections for the wheel counter, laser power, jacking stop switch, and MTBM methane system warning system can also be provided.

Information and Control System
The information and control system consists of the control container, the remote hydraulic power pack and the main drive power container which monitors all inputs such as targeting data, pressures, temperatures, positions, speeds, torques, and flows, and reports them to the operator. The control system also operates all outputs including valves, motors, pumps and pipe jacking functions.

The control container contains the control console, power distribution and VFDs for the slurry pumps and the MTBM drive motor. It also has a bulkhead panel for the electrical and hydraulic connections. The control console has a computer that interfaces to the operator and controls the machine operations. Data is logged on the projects' progress and reports can be printed for contractor or engineering firm records.

The remote hydraulic power pack contains the hydraulic power for the pipe jacking system. It has a bulkhead panel for the electrical and hydraulic connections. The control container operator controls the pipe jacking system through a communication cable between the control container and the remote hydraulic power pack.

The power container is the main drive motor power distribution center for the 480 volt incoming power, 480V to 4160V transformer, and 4160V tunnel power. This container also is equipped with a Emergency Stop button. The control container operator controls the drive motor system through a communication cable between the control container and the power container.

RECOMMENDED TOOLS & EQUIPMENT

Below is a list of tools and equipment for most complex technical construction operations. Financial resources and equipment availability are as much of a deciding factor as immediate job site requirements in determining what items should be on hand. This list contains many items, some of which may only be needed in special situations.

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

SITE PLANNING

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

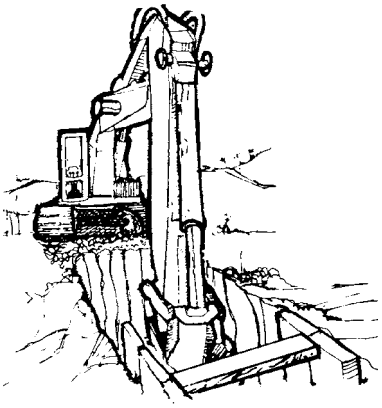
Equipment:

- MTBM
- Slurry Separation System
- Crane
- Portable Toilet
- High Pressure Jetting Pump
- Pipe Lubrication Pump
- Pipe Joint Cushions (if needed)
- Jacking Frame
- Slurry Pumps (Feed & Return)
- Fork Lift
- Portable Welders / Torch
- Small Generator
- Spoil Removal Truck
- Floor Pads (Plates)
- Control Container
- Remote Hydraulic Power Pack
- Drive Motor Cooling Water Tank
- Storage Container With Tools
- Generator 480V 3 Phase
- Slurry Reversing or Bypass Valves

Other site considerations:

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

SITE PREPARATION



AEM is the original author and publisher of the above illustration

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.

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

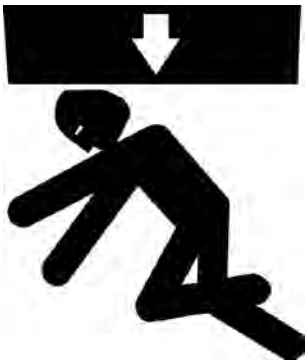


3. Construct a shaft floor with a solid base suitable for the weight of the jacking system and pipe. Consult your civil and structural engineers for your shaft floor requirements.

4. Place steel plates on the shaft floor for supporting the base of the jacking frame, MTBM and pipe.

5. Construct a concrete thrust block to withstand the applied load. A structural engineer must be consulted on the design of this block. Space must be provided for the mounting of the laser behind the jacking frame.

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



NOTICE Be sure the crane 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 may decrease.

6. Place the control container on a firm, level surface a safe distance from the launch shaft. It should be located so the bottom of the launch shaft is seen from the window in the control container.

7. Place the remote hydraulic power pack close to the control container to allow for the ethernet connection between the power pack and the control container.



8. Place the main drive power container close to the control container to allow for the ethernet connection between the power container and the control container.

(continued on next page)



9. Place the generator or main power source as far away from the launch shaft, control container and remote hydraulic power pack as possible. This will reduce the noise to the operator and make it easier to communicate with the launch and reception shaft personnel.

⚠DANGER Improper grounding can result in equipment damage or electrical shock, causing sever injury or death.

⚠DANGER Ground connection MUST be connected prior to connecting incoming power.



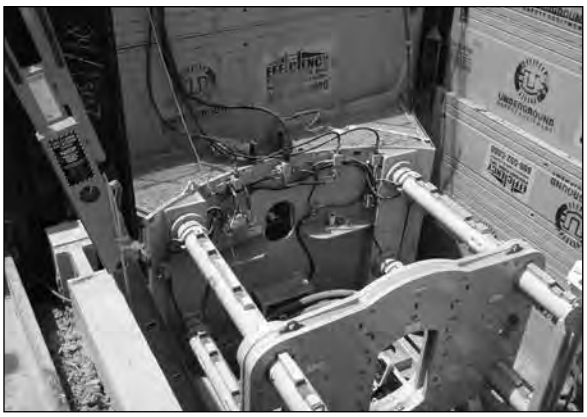
10. **Properly ground the generator (or other power sources), control container, remote hydraulic power pack and power container.**

⚠DANGER Hazardous voltage. Disconnect and lock out power from source before attempting to install electrical connections.

11. Connect and secure power cables from generator to control container, remote hydraulic power pack and power container (refer to Connecting Power Leads in this section for installation details).



12. Lower jacking frame into launch shaft and place against the thrust or reaction block. Correct the frame assembly line and grade with leveling screws. Be sure there is at least 6 inches between the front of the jacking rails and where the launch seal will be located.

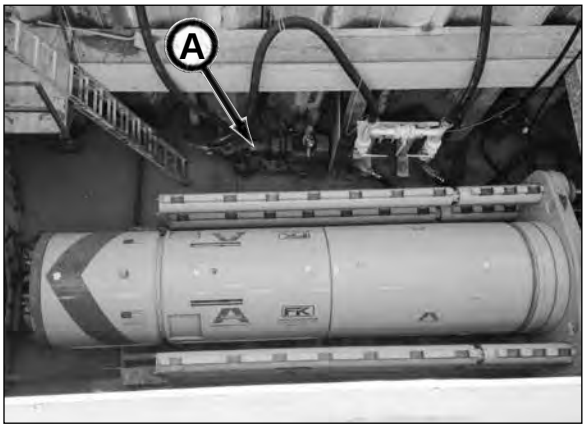


13. Connect the jacking frame (Hi-Flow return, IJS supply, auxiliary [if used], retract and extend) hydraulic hoses, electrical cables to the remote hydraulic power pack connections. Connect pit box power cable and pit box ethernet cables to control container bulkhead pit box connections. Cover sharp corners to prevent damage to the cables and hoses. Connect pipe advance wheel cable from pit box to pipe counter.

(continued on next page)



13. Construct a mount for the laser. It must be mounted behind the jacking frame and isolated from any thrust forces. The laser mount must not be attached to any part in the shaft that may move when forces are applied.



14. Lower the return pump (A) into launch shaft. The return pump should be mounted as close as possible to the jacking frame so the booster pump (not used with all MTBMs) does not have to generate excessive horse power. Be sure to allow for hose swing as the thrust ring travels on the jacking frame.

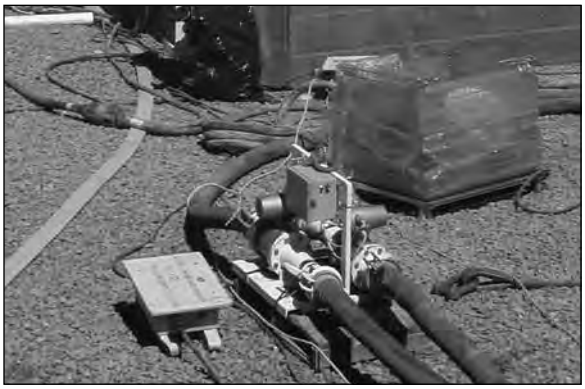
    Connect return pump power cable to control container connection on bulkhead.



15. Place the slurry tank(s) on a firm, level surface close to the control container and a safe distance from the launch shaft. Allow for drain water to flow away from launch shaft.

16. Place the feed pump near, or mount onto the slurry tank and make hose connections.

17. Connect feed pump power cable to connection on control container bulkhead.



18. Place the dual flowmeter assembly between the feed and return slurry pumps.

19. Connect the flowmeter ethernet cable to the flowmeter connection on the control container bulkhead.

20. Connect the flowmeter power cable to the flowmeter power connection on the control container bulkhead.

21. Mount slurry hoses from feed and slurry pumps to flowmeter.

(continued on next page)

22. Place water cooling tank, high pressure jetting pump and bentonite pump (if used) on the job site a safe distance from the launch shaft but close enough to the control container.

23. Connect the high pressure jetting pump feed hose and drive motor cooling hose to the drive motor cooling tank.

24. Connect the cooling pump and jetting pump power cables to the bulkhead on control container.



25. Mount the slurry pit valve assembly in the launch shaft.

26. Connect the jetting pump, slurry feed and return hoses, and the bentonite pump (if used) hoses to the slurry pit valve assembly.



27. Install the launch shaft seal and casing in the front of the launch shaft.



(continued on next page)

28. Lower the MTBM front section on the jacking frame and ensure alignment of the laser with the center of the target.

    IMPORTANT: Precise cutterhead installation to MTBM is critical otherwise failure will occur. The cutterhead installation MUST be performed by an experienced technician.

29. Place the MTBM trailing section near the launch shaft.





30. Connect all electrical cables (boring head drive, booster pump) and hoses including the MTBM front and trailing sections.

31. Connect the 150 ft starter hoses and cable between the MTBM starting and trailing sections.

32. Perform equipment checkout and system start-up. Refer to Checkout Equipment Prior To Start-Up and System Start-Up in this section.



33. After system start-up, test the feed, return, and booster pumps for proper rotation.

34. Test the jacking frame, cycle the cylinders several times to purge air from the lines and check for leaks.

35. Retract steering cylinders to the full retracted position and note readings, extend to full extend position and note readings.

36. Extend or retract steering cylinders to mid stroke position.



CONNECTING POWER CONNECTIONS

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

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

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

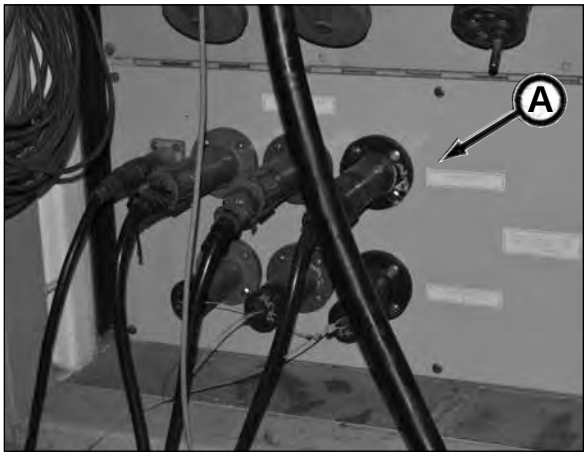


CONTROL CONTAINER

1. With generator or power source properly ground, install power cord to appropriate 480V cam lock connections (A) on the control container bulkhead.

   IMPORTANT: To achieve full power of 1,000 amps, two sets of 535 MCM cables or better are required.

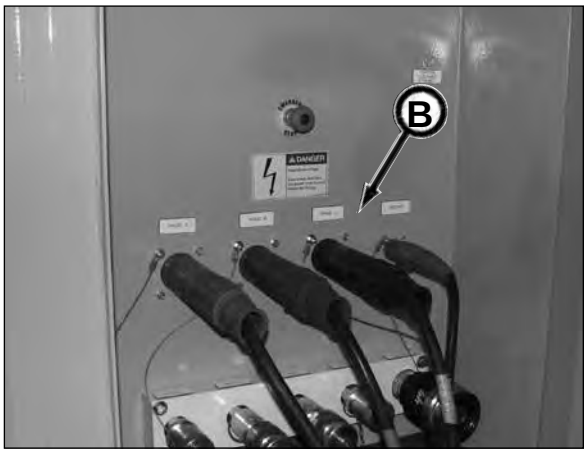
2. Proceed to step 3 to connect power leads to the remote hydraulic power pack.



REMOTE HYDRAULIC POWER PACK

3. With generator or power source properly ground, install power cord to appropriate 480V connections (B) on the bulkhead.

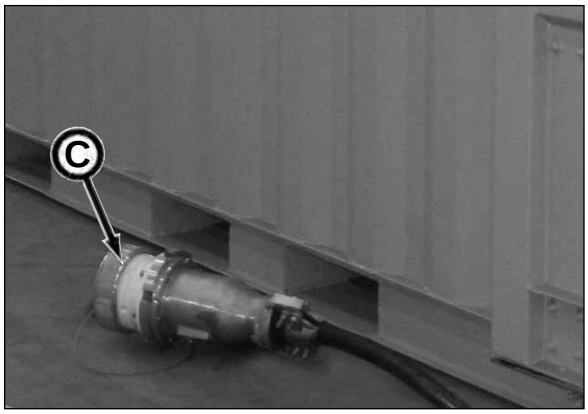
4. Proceed to step 5 to connect power to the power container.



POWER CONTAINER

5. With generator or power source properly ground, install power cord to power connection (C) on power container.

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



CHECKOUT EQUIPMENT PRIOR TO START-UP

1. Be sure to check the operation of ALL E-Stop buttons before operating microtunneling system.



2. Perform maintenance in Prior To Each Drive Launch in section 9, Periodic Maintenance before operation.

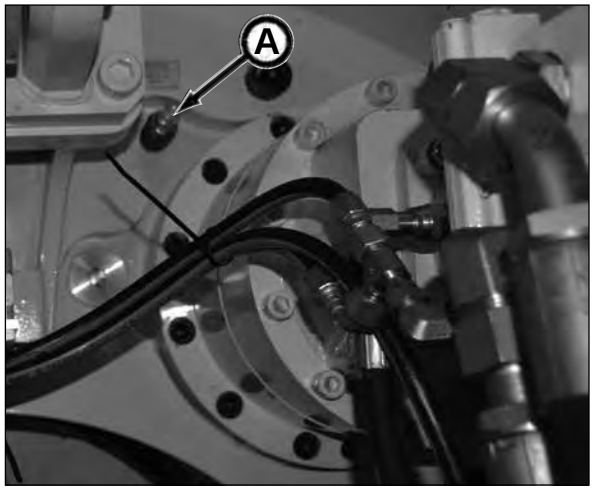
3. Be sure all electrical lines, hydraulic hoses and water lines are in good working condition and properly installed.

4. Be sure ventilation system is properly hooked up and operational.

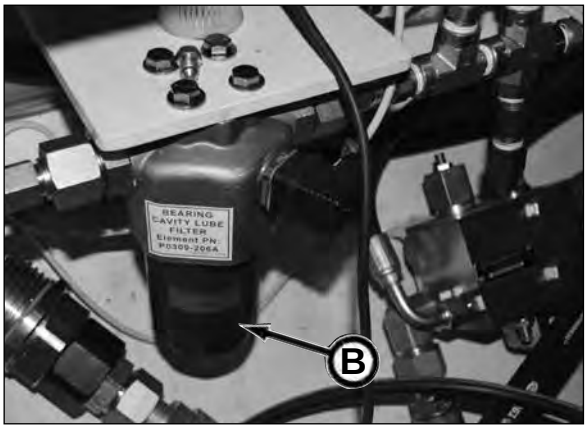
5. Fill the grease pump tanks in the MTBM.



6. Check bearing cavity oil level. Oil must be level with the check/fill port (A). Add oil if necessary.



7. Check on target screen if the bearing cavity oil filter plugged alarm message is displayed. Replace filter (B) if needed.



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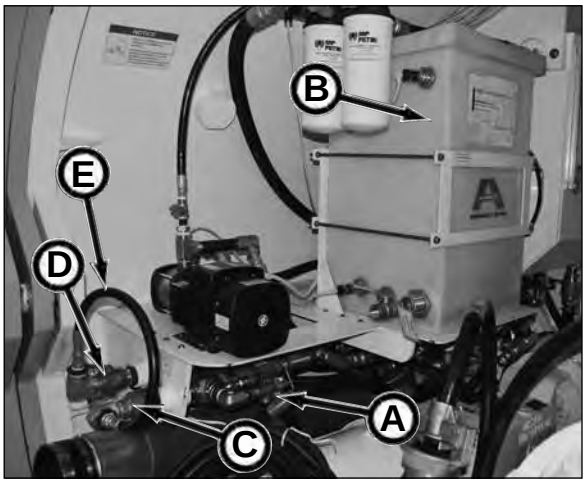


8. Fill the high pressure jetting tank with fresh, CLEAN water. Be sure water hoses and power cable are in good working condition and properly hooked up.

ON-BOARD WATER COOLING SYSTEM

9. Clean water cooling system strainer (A).

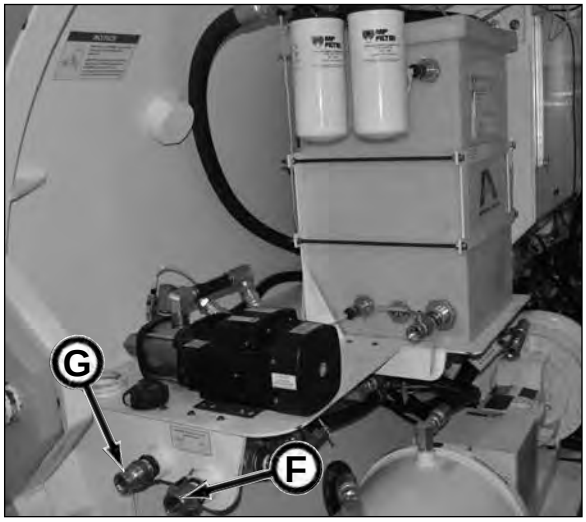
10a. Fill the water cooling system tank (B) with fresh, CLEAN water. Be sure hoses are properly installed and shutoff valves are in the proper operating positions.



NOTICE At launch, the cooling system inlet (C) and outlet (D) connections are looped (E) together since the slurry cooling tubes are not installed at this time. If needed, cool water can be supplied via the fill port and the excess will bleed out the overflow.

EXTERNAL WATER COOLING SYSTEM

10b. Fill the external water cooling system tank with fresh, CLEAN water. Be sure hoses are properly installed to inlet (F) and outlet (G) connections and the shutoff valves are in the proper operating positions.

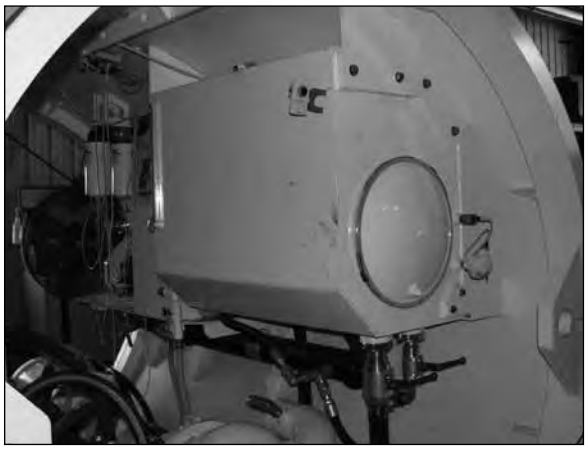




11. Check the MTBM auxiliary hydraulic power pack oil level. Add oil if necessary.

12. Check return filter element filter indicator. Replace filter if needed.

(continued on next page)



13. Check the MTBM main drive hydraulic reservoir oil level. Add oil if necessary.

14. Check return filter elements filter indicator. Replace filter(s) if needed.

15. Be sure shut off valves are open. Tie strap lever to valve to prevent accidental closure during operation.



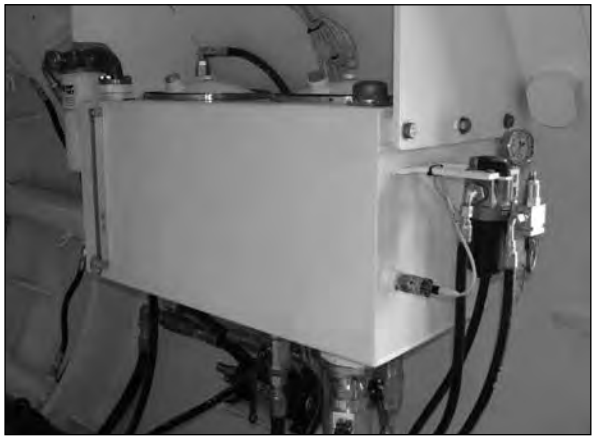
16. Check the remote hydraulic power pack hydraulic oil reservoir level. Add oil if necessary.

17. Check pilot pressure filter element filter indicator. Replace filter if needed.

18. Be sure shut off valves are open. Tie strap lever to valve to prevent accidental closure during operation.

19. Check to be sure the hydraulic hoses from power pack to jacking frame are in good working condition and properly mounted.

20. The communication cables from jacking frame to power pack to control container must be installed properly. It is recommended to hang the communication cable on the pipe wall to avoid noise interference (RFI) from the variable frequency drives (VFDs) and other high powered electronics.



21. (Lube/Jacking Can) Check the lube/jacking can hydraulic oil reservoir level. Add oil if necessary.

22. Check pilot pressure filter element filter indicator. Replace filter if needed.

23. Be sure shut off valves are open. Tie strap lever to valve to prevent accidental closure during operation.

(continued on next page)

24. Fill the slurry tank(s) with water. Be sure slurry lines are in good working condition and properly hooked up from the slurry tanks to the slurry pumps and MTBM.

25. Be sure valves on slurry pit valve are open and hoses are properly connected.



26. The bentonite pump hoses and power cable must be in good working condition and properly installed. Also, if needed, the bentonite mixture must be prepared for start-up.



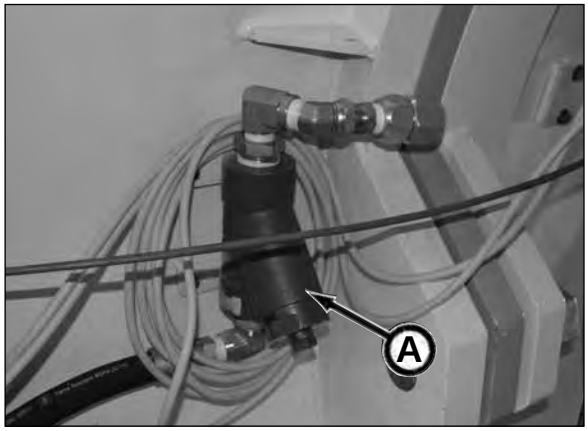
27. Check to be sure the boring head drive VFD parameters are set properly for the specific MTBM drive motor. Contact your Akkerman Aftermarket Support representative for VFD parameter details.

    IMPORTANT: It is recommended to re-energize the VFD drives at least every 6 months for 30 minutes with the rated voltage to re-form the VFD capacitors and to ensure correct VFD operation.

    <u>IF</u> the VFD drives have been in storage for 12 months or more, a certified electrician must re-apply voltage <u>PROGRESSIVELY</u> using a variable power supply to re-form the capacitors. Refer to section 9, Periodic Maintenance, Control Container, Prior To Each Drive Launch, 12. Check VFD Parameters for details.

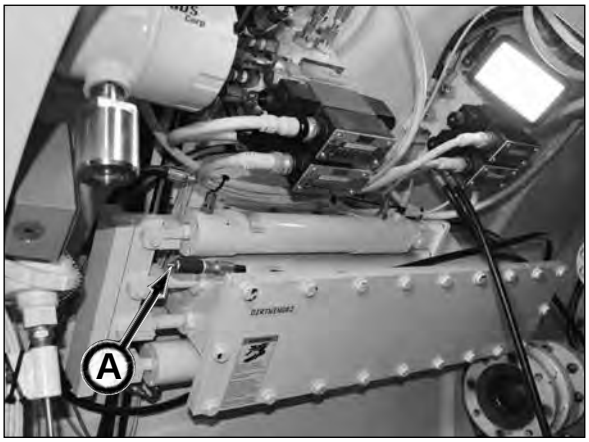


28. Clean high pressure jetting strainer (A). Check to be sure hoses are properly installed.



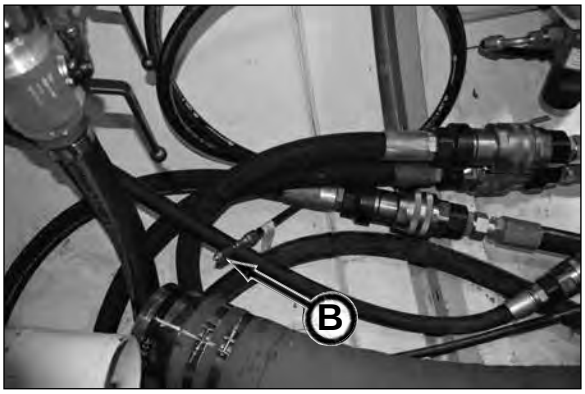
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29. Fill and purge dirt wings with grease until clean grease is visible. Use grease fill hose (A).



30. Lubricate steering joint seals using grease fill hose (B). Do not over grease. There are grease lines from the steering joint to the grease hose located near the back of the MTBM area (as shown) to lubricate the seals.

    SL82P & larger: use a full grease tube



31. Proceed to System Start-Up in this section.

SYSTEM START-UP

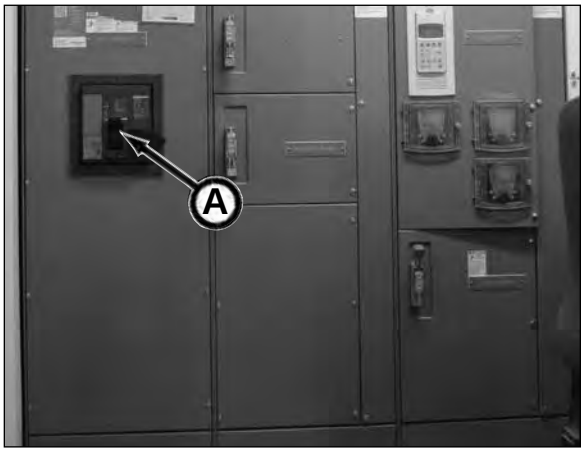


⚠DANGER Hazardous voltage. Disconnect and lock out/tag out power from source before servicing.

1. Lock out/tag out power to the control container remote hydraulic power pack and the power container.



2. Push in all E-Stop buttons (control container console, remote hydraulic power pack bulkhead, power container and pit box) to prevent accidental powering of equipment.

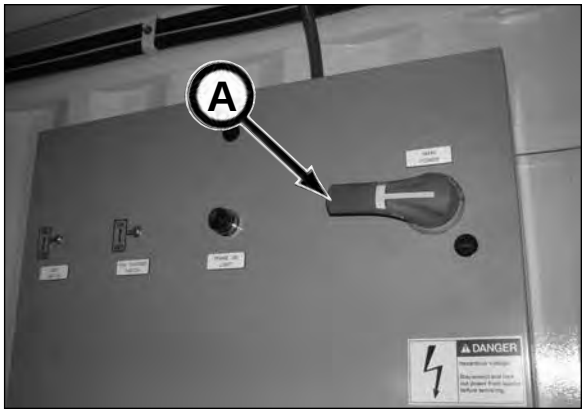


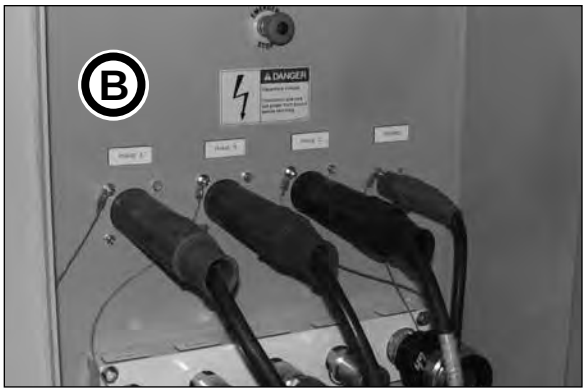
3. With main disconnect (A) in control container OFF, and all control disconnects to OFF position, hook up generator/power source cables to control container generator power connections (B) (refer to Connecting Power Connections in this section) on the control container bulkhead.



(continued on next page)

4. With main power switch (A) in remote hydraulic power pack OFF, hook up generator/power source power cables to generator power connectors (B) on bulkhead (refer to Connecting Power Connections in this section).





5. In power container, be sure the main power switch (C) is in the OFF position.



6. Connect generator/power source power plug to the power container power cord plug (D).



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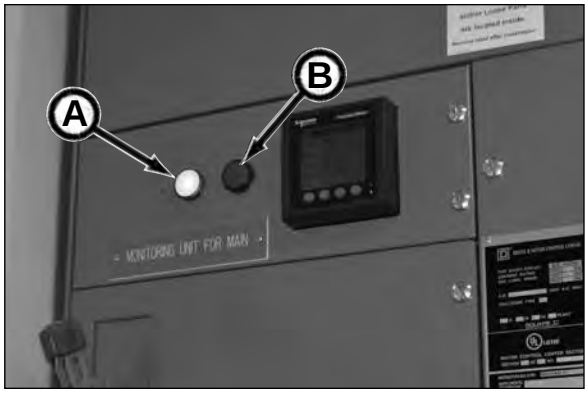


7. Turn on generator/power source power to the control container, remote hydraulic power pack and main drive power container.

8. Check the control container phase indicator lights:

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

   If the red Phase Error indicator light (B) is illuminated, disconnect and lock out/tag out ALL power before attempting to reverse the two generator power leads on the power circuit. Then recheck phase indicator lights.

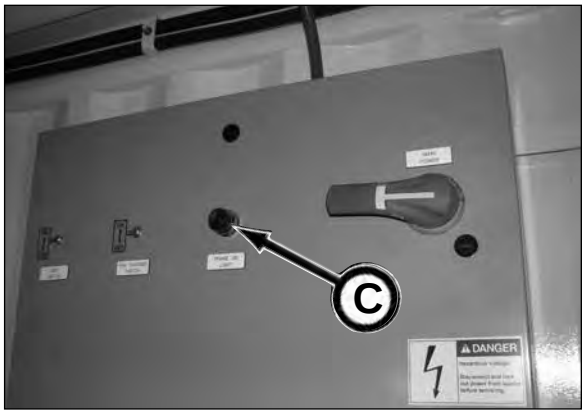


Control Container Phase Indicator Lights

9. Check the remote hydraulic power pack phase indicator light (C):

   If the remote hydraulic power pack green Phase OK indicator light is illuminated, the external power source phase power is installed correctly and that the main power can be turned on for the power circuit.

   If the remote hydraulic power pack green Phase OK indicator light is NOT illuminated, the generator phase power is installed incorrectly. Disconnect and lock out/tag out all power before attempting to rework the generator power. Reverse the two generator power leads. Then recheck the phase indicator light.

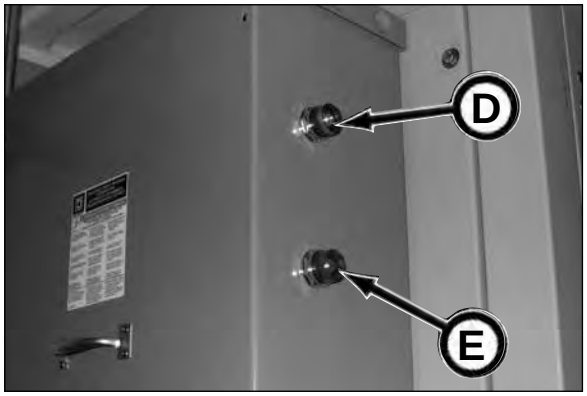


Remote Hydraulic Power Pack Phase OK Light

10. Check the power container phase indicator lights:

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

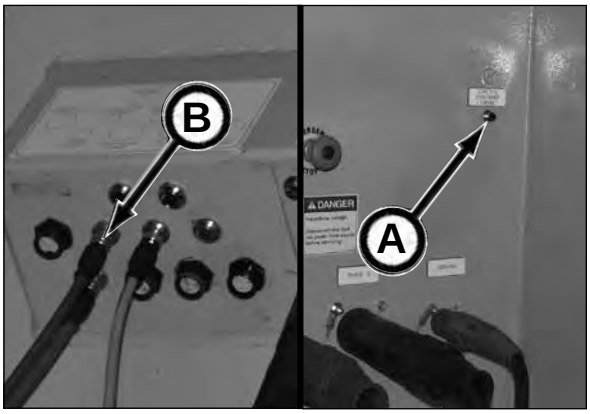
    If the red Phase Error indicator light (E) is illuminated, disconnect and lock out/tag out ALL power before attempting to reverse the two generator power leads on the power circuit. Then recheck phase indicator lights.



Main Drive Power Container Phase Indicator Lights

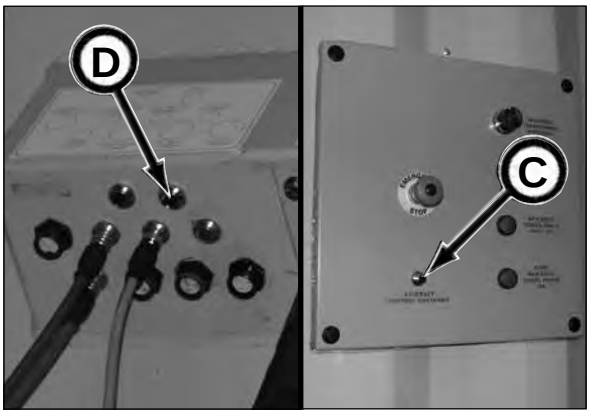
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11. If not already done so, connect ethernet cable from remote hydraulic power pack bulkhead connection (A) to control container bulkhead ethernet connection (B).



12. Connect ethernet cable from main drive power container connection (C) to control container bulkhead connection AUX Ethernet (D).

13. With verification for start up approval from all microtunneling system equipment operators, pull out ALL E-Stop buttons.



14. Flip control container disconnects to the ON position. When using the MTBM cutter drive VFD, be sure the Main Cutter drive Disconnect switch (see inset) is on.

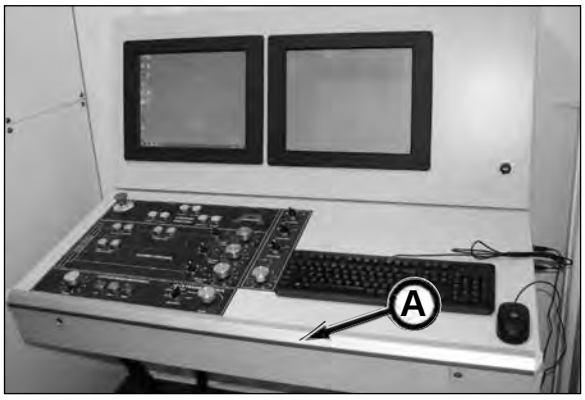


15. Power up the remote hydraulic power pack by turning the main power switch (D) to the ON position.



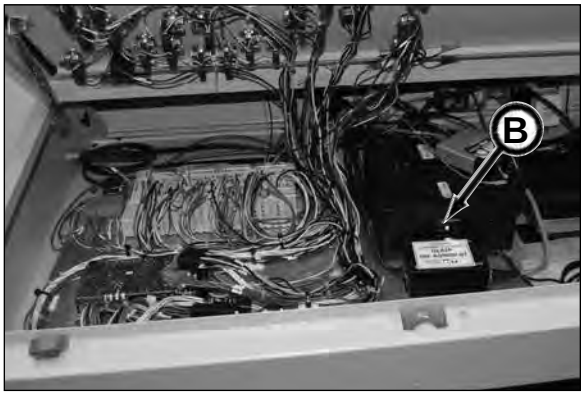
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16. Once the 120V/240V Transformer Disconnect power is flipped on, the computer will automatically boot up.



NOTICE If the computer is shut down with the power on, restart the computer by opening the control container console lid (A) and press power button (B). Close console lid. Be sure to use caution when opening console so keyboard and/or mouse do not fall off of console surface.

The console lid has a racheting mechanism. To close lid, fully open lid to release the rachet mechanism, then slowly lower lid until it is closed.

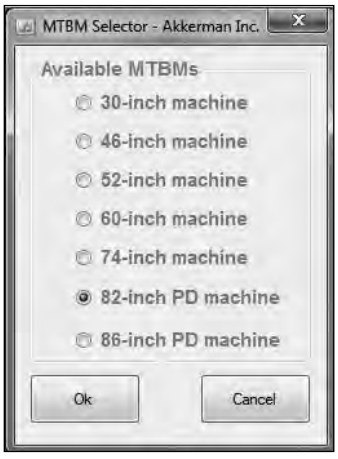


17. Once the computer boots up, the desktop screen will appear.

18. Double click the Machine Select icon (C). 

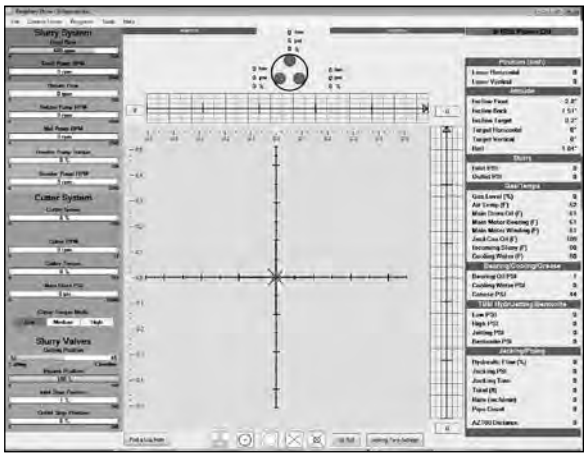


19 . The Machine Control Selector window appears. Select your MTBM head size (82-inch PD machine) and click OK.

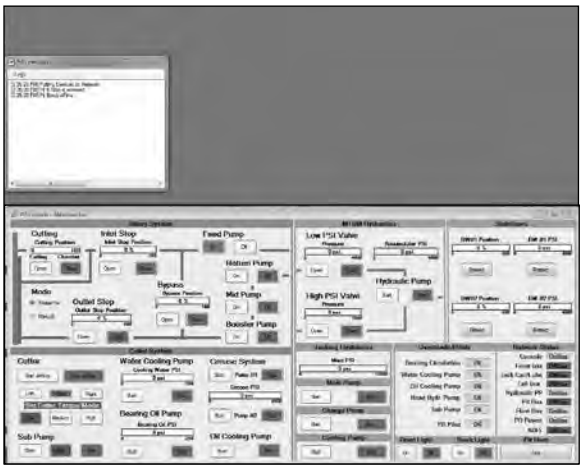


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20. After program loads, the target screen, MTBM control screen and log message screen windows appear. You may have to reposition the windows so they are not overlapping, or per operator preference, move the windows to the desired monitor. Typically after the initial window positioning, the repositioning of the control screens will not be required.



Target Screen

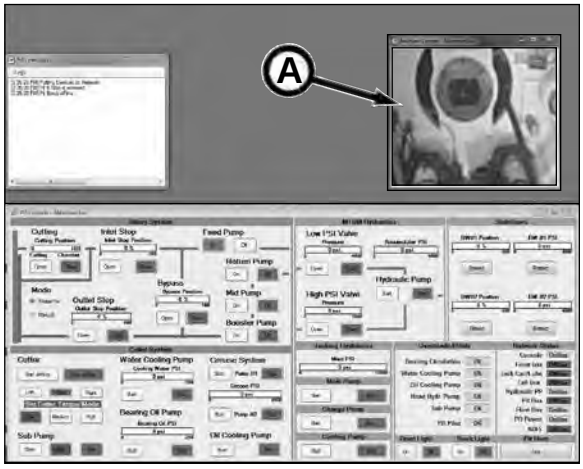


Log Message and MTBM Control Screens

21. Load the MTBM target camera program.



Double click PD Camera icon from the desktop. After initial loading of the program, you will have to reposition the camera window (A) to desired area on the monitor. Typically after the initial window positioning, the repositioning of the camera window will not be required.



Log Message, MTBM Control & MTBM Camera Screens

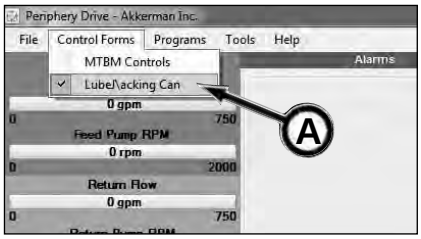
NOTICE If the PD Camera program is loaded and the boring head ethernet cable is not connected to the MTBM control box, a window with the Akkerman logo will appear (as shown). Once the communication is connected between the MTBM and the control container, the video feed of the MTBM front section will be visible in the camera window.



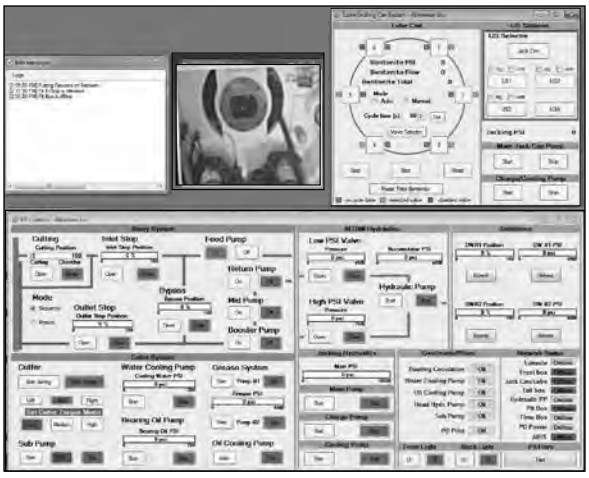
With No MTBM Ethernet Connection

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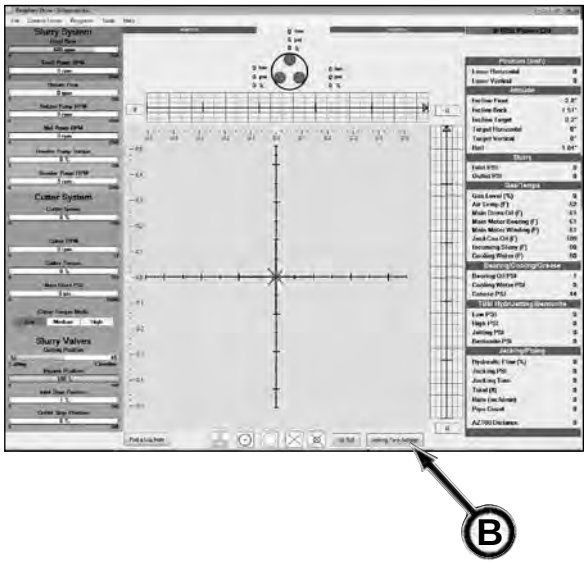
22. If using the lube/jacking can, load the Lube/ Jacking Can System program by clicking Control Forms on the Target Screen menu bar and then clicking Lube/Jacking Can (A) from the pull down menu.

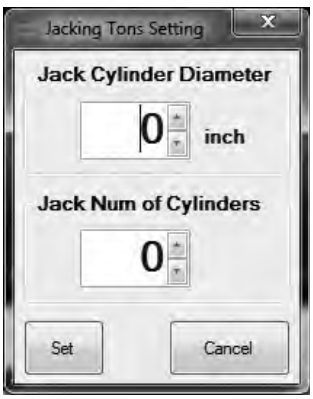


After initial loading of the program, you will have to reposition the lube/jacking can and camera windows to desired area on the monitor.



23. To properly calculate and display the jacking tons for the jacking frame being used, click the “Jacking Tons Settings” button (B) on the target screen. The Jacking Ton Setting window will appear. Enter the jacking frame cylinder diameter and the number of cylinders on the jacking frame. Click OK.





MTBM LAUNCH SEQUENCE

Perform System Start-Up procedure before launching MTBM. Refer to System Start-Up in this section.

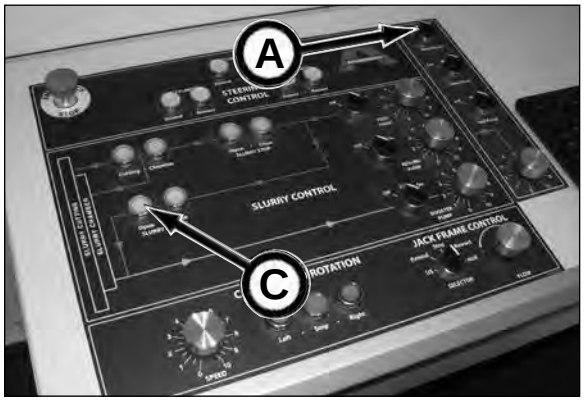


⚠WARNING Suspended loads may fall and cause severe injury or death. Do not allow anyone to enter area under or around a suspended load.

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 may decrease.

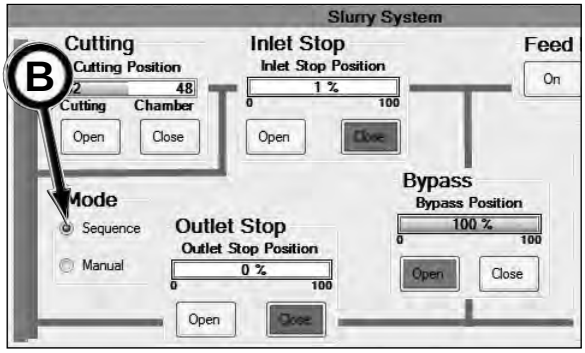


1. Starting section must be placed on jacking frame (refer to Site Preparation in this section).



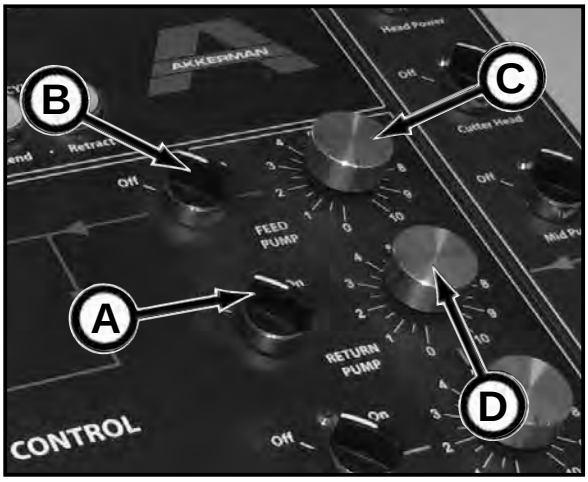
2. With the Head Power control (A) to ON position and the Slurry Flow system in the default mode in Sequence (B), press the Slurry Bypass control OPEN button (C). In the Sequence mode, the operation for the bypass and stop valves will be automatic.

NOTICE For example, pressing Slurry Bypass OPEN button will automatically CLOSE the stop valve. Pressing Slurry Stop OPEN button will automatically CLOSE the slurry bypass valve.



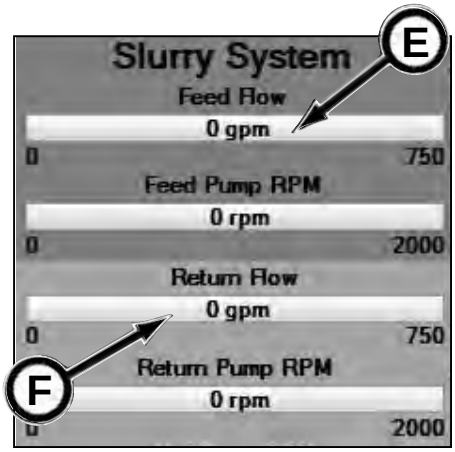
(continued on next page)

3. On the control panel, start the slurry pumps in the following sequence by turning the pump control switch to the ON position:
    1. Return Pump (A)
    2. Feed Pump (B)



NOTICE Typically the booster pump is not used during launch sequence.

4. Using the flow controls (Feed Pump (C), Return Pump (D)), set the slurry pump flow rates to low or approximately 100 GPM and check for leaks.



NOTICE The actual slurry flow in GPM can be viewed on the Slurry System meters on the target screen; Feed Flow (E) and Return Flow (F).

5. Verify that the slurry lines are open and the separation equipment is working properly. Continue to run the pumps at a low rate.

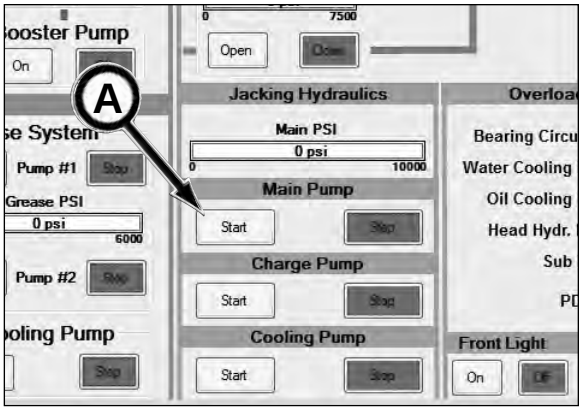
    - Feed flow should equal return flow at this time. Refer to the target screen (left monitor) Slurry System meters.





6. Lubricate the launch shaft seal (G).

7. Start hydraulic pump by clicking START button (A) on MTBM Control screen.



8. Start jacking by turning the selector switch (B) to EXTEND and turn the Flow control (C) to the right to control the pump rate about 25%.



9. Slowly push the MTBM cutter face through the launch shaft seal. Be careful not to damage the seal and to ensure proper equipment alignment.



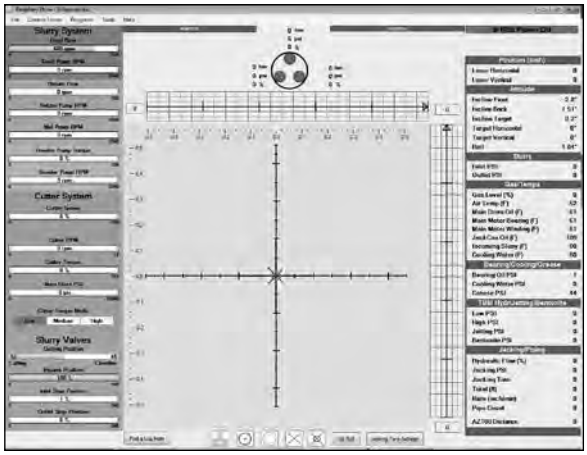
10. Continue advancing the jacking frame until the cutter face is in contact with the ground. Pressure will rise.

    • Stop jacking if pressure rises quickly.

    • With the steering cylinders in the half stroke position, write down the readings on all the inclinometers and target position. The laser should be centered on the target.

    • Make sure the pipe count is set to 0 and on manual until the first pipe is on the jacking frame, then set to automatic and set the count to 1.

    • The jacking length should also be set to 0 and set to manual until the pipe advancement wheel is in position then set to automatic and set the length to the total length of the MTBM.



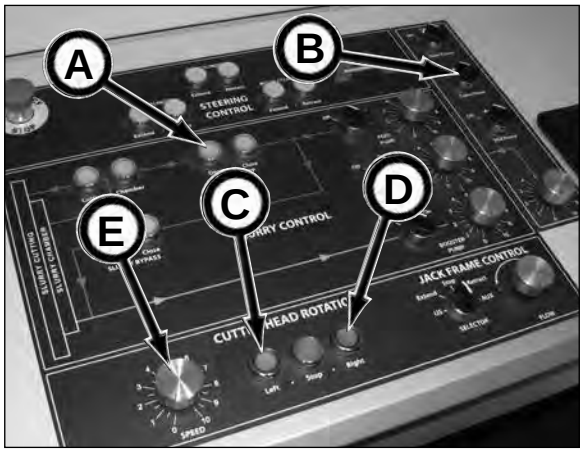
11. Press the Slurry Stop OPEN button (A). The valves automatically sequence to open stop valve and close bypass valve.

    • Keep close attention on the launch shaft seal. Water leaks should be kept to a minimum.

12. With the Cutter Head power switch (B) to the ON position, press the Cutter Head Rotation LEFT (C) or RIGHT (D) button and set the Speed control (E) at approximately 10%.

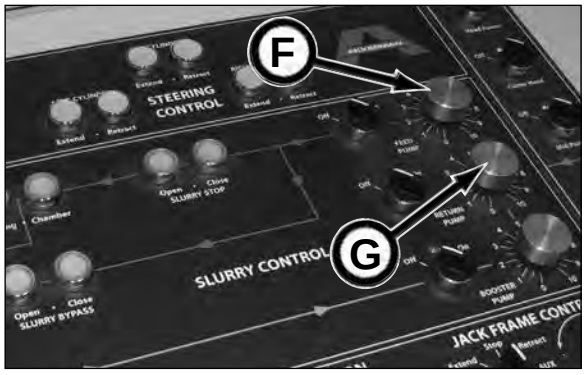
    • After the cutter head has started rotation, increase speed to about 80%.

    • (If equipped) The high pressure jetting pump should be turned OFF while jacking front section.



13. Slowly increase the slurry feed pump (F) and return pump (G) speeds. As the MTBM is pushed into the ground, launch shaft seal leakage will occur at the steering joint and access covers. Adjust feed and return pump flows to prevent getting too much flow or slurry pressure at this time.

14. Refer to Advancing the MTBM in this section, to jack the entire MTBM front section into the ground, removing the lifting eyes and installing hole plugs as the MTBM is pushed in.



15. Add the trailing section in the jacking frame.
    • Exchange the 6 pin 150’ TBM starter cable with a 9.5’ or 5.5’ cable as needed.

    • Remove MTBM hydraulic starter hoses, reconnect lines.

    • Connect slurry return lines to the slurry booster pump (if applicable).

    • While jacking the trailing section, the high pressure jetting pump may be used if shaft seal leakage does not occur.

16. Advance the section.

NOTICE If using an air lock (hyper-baric) chamber on the project, contact your hyper-baric specialist to determine the best location of when the chamber should be installed; after the trailing section or install the chamber after installing a few pipe.

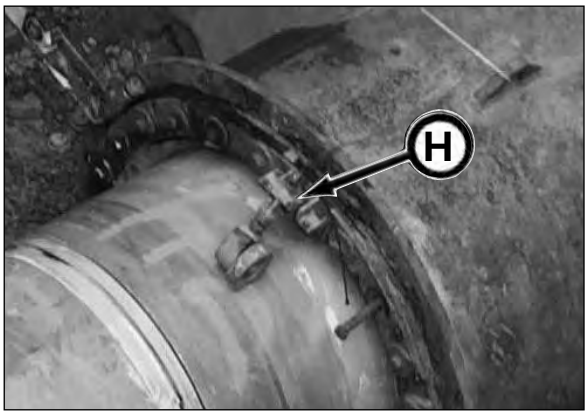
17. Install the pipe length indicator (H) (wheel counter) and set length reading to the entire MTBM length.

18. Refer to Adding New Pipe in this section, to place the first pipe in the jacking frame.

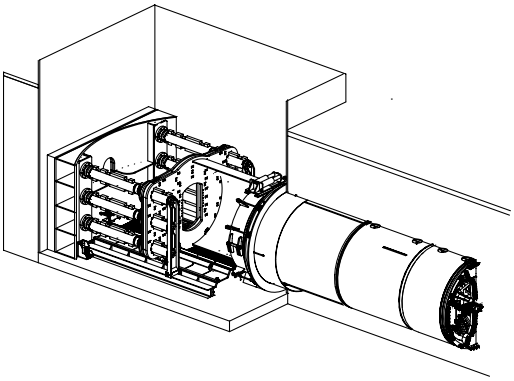
    • When connecting the pipe make sure the O-ring seals are not damaged.

    • The first pipe needs to have slurry hose assemblies used instead of steel slurry lines.

19. Install subsequent pipe. Refer to Adding New Pipe in this section.



ADVANCING THE MTBM



To begin tunnel excavation:

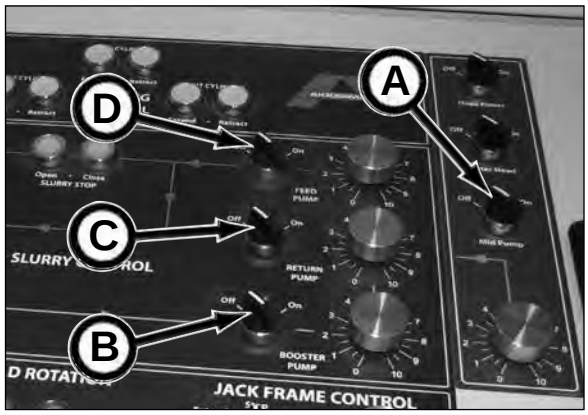
1. With the slurry stop valves closed and bypass valve open, start the slurry pumps in the following sequence by turning the pump control switch to the ON position:
    1. Mid Pump (A)
    2. Booster Pump (B)
    3. Return Pump (C)
    4. Feed Pump (D)

    Remember, too much slurry flow will cause over excavation.

    Adjust slurry flow as follows (also refer to Controlling Slurry in this section):

    - The slurry feed and return flow is a balancing act. Too much flow will cause too much pressure at the boring head.

    - Over excavation is possible and also water leaking past the over cut and launch shaft seal or slurry water leakage to the surface. Too little flow will not transport the cuttings back from the head.

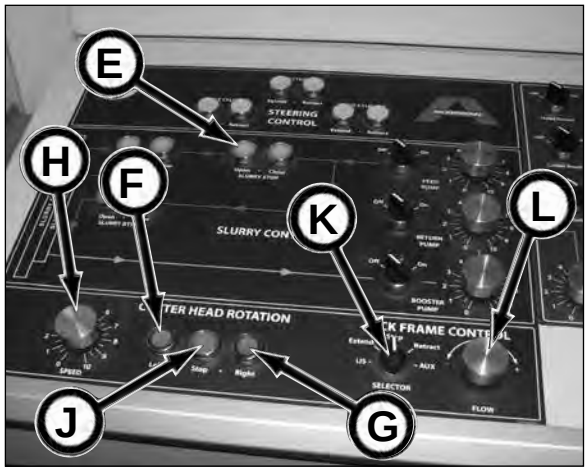


2. Press Slurry Stop OPEN button (E).

3. Press Cutter Head LEFT (F) or RIGHT (G) button and set cutting head speed (H) - 90 % is a good starting point. Reduce torque mode (I) to reduce torque. It may be necessary to reduce jacking speed to reduce torque. Watch forces.

    - The cutter head works equally well in both directions.

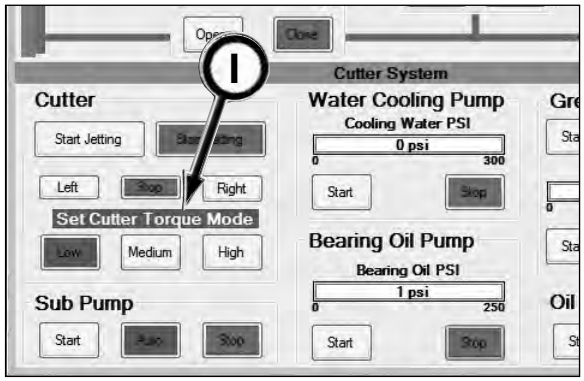
    - Watch for machine roll. If it exceeds 3 degrees, reverse the cutting head rotation. Extending the stabilizer cylinder (dirt wing) will help minimize roll, though jacking forces will increase slightly.



NOTICE It is highly recommended that the dirt wings be extended as much as possible during the mining operation to minimize potential roll.

    - Cutter head rotation can be reversed without pressing Cutter Head STOP button (J).

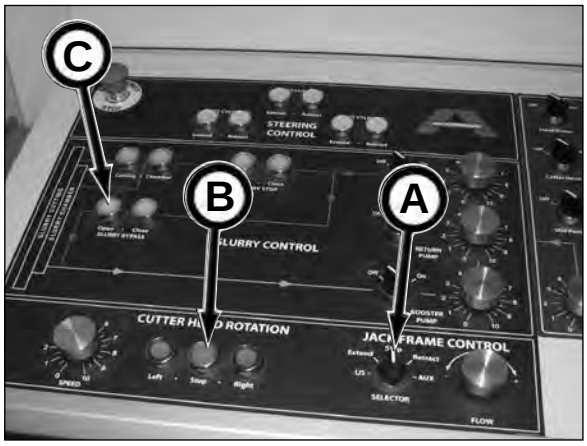
    - Operate cutter head at high speeds in stable ground, lower speeds in unstable ground.



4. Advance jacking frame forward by pressing selecting EXTEND on Selector switch (K) and setting a hydraulic flow rate with Flow control (L).

TO PAUSE TUNNELING

There are times when it will be necessary to pause the tunneling operation; equipment adjustments, jacking frame discussions among tunneling workers, etc.



1. Stop jacking hydraulics by moving Selector switch (A) to STOP.
2. To prevent over excavation once jacking operation is stopped, **IMMEDIATELY**:
   - Stop cutter head rotation by pressing Cutter Head STOP button (B).
   - Place slurry system in bypass mode by pressing Slurry Bypass OPEN button (C). Be sure slurry valves have cycled. Operator should NEVER leave operator station with tunneling machine running.

NOTICE In certain situations, you may want to open the bypass valve and close the slurry feed and return valves on the slurry pit valve assembly if there is a need to recirculate slurry liquid to clean up or lighten the slurry while adding new pipe (refer to Adding New Pipe in this section).

CUTTER HEAD OPERATION GUIDELINES

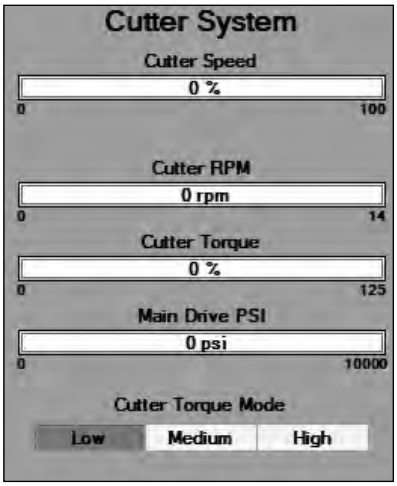
1. Jacking flow rates can be increased until the cutter drive torque is between 80% and 100%. Sixty (loose) to eighty (firm) percent is a good starting point. Reduce cutter torque mode to reduce torque. It may become necessary to lower jacking speed to reduce torque.
2. Abrupt operation may cause machine to roll.
3. The cutter head works equally well in both directions.
4. Watch for machine roll. If it exceeds 3 degrees (depending on roll setting), reverse the cutting head rotation. Extending the stabilizer cylinder (dirt wing) will help minimize roll, though, jacking forces will increase slightly.

NOTICE It is highly recommended that the dirt wings be extended as much as possible during the mining operation to minimize potential roll.

5. Cutter head rotation can be reversed without pressing Cutter Head STOP button.
6. Operate cutter head at high speeds in stable ground, lower speeds in unstable ground.
7. If cutterhead torque is too high, reduce jacking speed.

IMPORTANT: BEFORE changing cutter torque modes, stop cutter rotation, wait for RPM to go to “0” and the pressure to standby, then select a different torque mode. Failure to do so WILL cause damage to drive motors.





Cutter System on Target Screen Displaying Cutter Speed & Torque

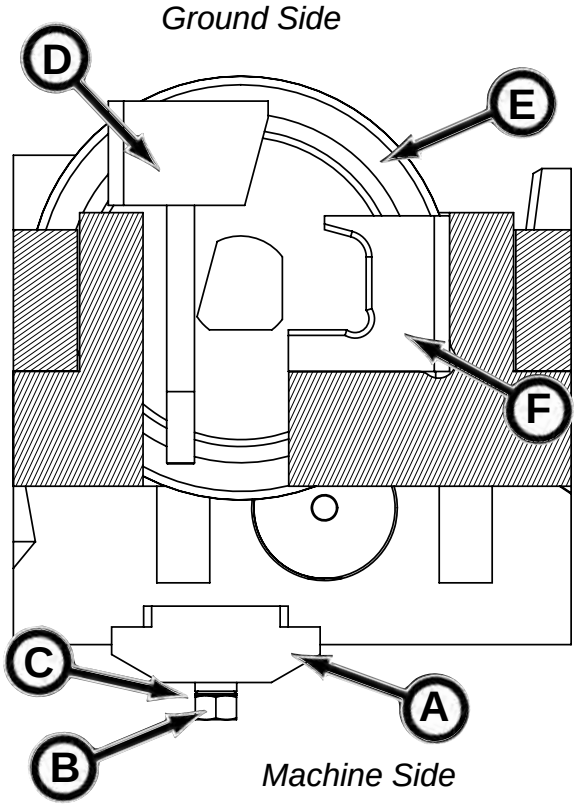
REMOVING & INSTALLING DISC CUTTERS

The disc cutters are back loaded, therefore they can be removed and installed from the back side of the cutter head.

REMOVING DISC CUTTER

1. Remove clamping block (A) by removing M20 nut (B) and conical washer (C).
2. Slide wedge block (D) to the side as shown.

   IMPORTANT: Be careful not to lose the wedge block in front of the machine.
3. Slide disc cutter (E) from C-Block (F).
4. Remove disc cutter from the back of the cutter head.

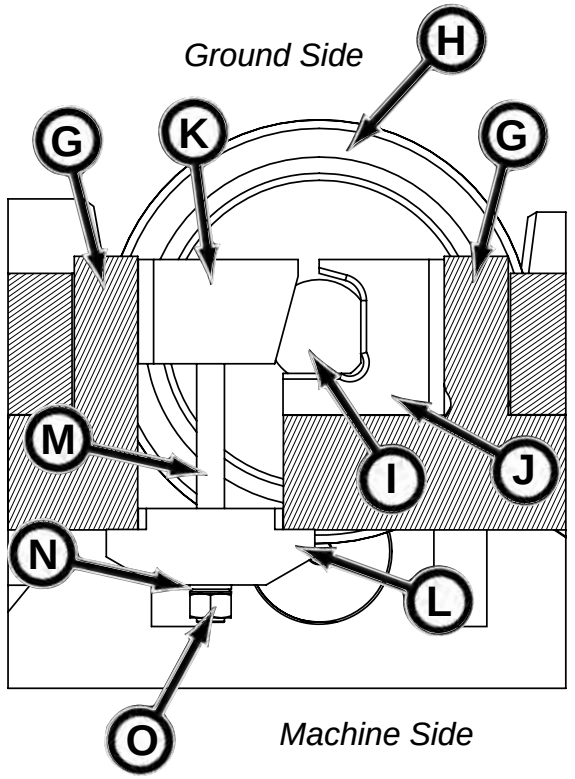


Removing Disc Cutters

INSTALLING DISC CUTTERS

1. Inspect mounts (G) for damage. If damage is visible, the mounts must be repaired or replaced before installing disc cutters.
2. In addition, the C-Block, wedge block, wedge block screw and clamping block must be inspected for excessive wear or damage before installing disc cutters. If excessive wear or damage is visible, the component must be repaired or replaced.
3. Install disc cutter (H) through mounts and properly align disc cutter shaft (I) onto C-Block (J).
4. Align wedge block (K) against mount and disc cutter shaft as shown.
5. Replace clamping block (L) by orienting it through the wedge block screw (M).
6. Install conical washer (N) and M20 nut (O) onto wedge block screw.

   IMPORTANT: Remove debris and any foreign material from ALL bolt holes and threads. Improper tightening of the bolts and/or nuts will result in premature wear to the cutter while reducing cutting performance.
7. Tighten the nut to 394 ft-lb (534 N·m) (lubricated) torque.



Installing Disc Cutters

COLD WEATHER OPERATION

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

There are various methods of keeping equipment from freezing:

- Tent working areas with a heating system when possible.
- When working with water (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 slurry pumps, bentonite pump and/or water cooling pumps will be shut off for a considerable length of time and the temperature is at or below freezing, the fluids must be drained or treated with RV anti-freeze. Refer to pump manufacturer for more information.
- Water tanks must be drained or treated with RV anti-freeze.
- Drain hoses to prevent freezing and keep low areas properly drained to prevent freezing damage.
- Motors with water jackets must be flushed including water lines and add RV anti-freeze.
- For diesel engines, use a diesel conditioner as well as a non-gelling winter fuel.
- For all equipment, use proper lubricant based on ambient temperature to prevent damage.
- Use compressed air to purge a system of water. Be sure the discharge valve is open before doing so.
- Install heaters for hydraulic systems.
- Maintain a continuous slurry bypass can prevent overnight freezing.
- A spoil (muck) dump needs to be located carefully since the wet loose material will freeze forming a pointed pile instead of a mound.

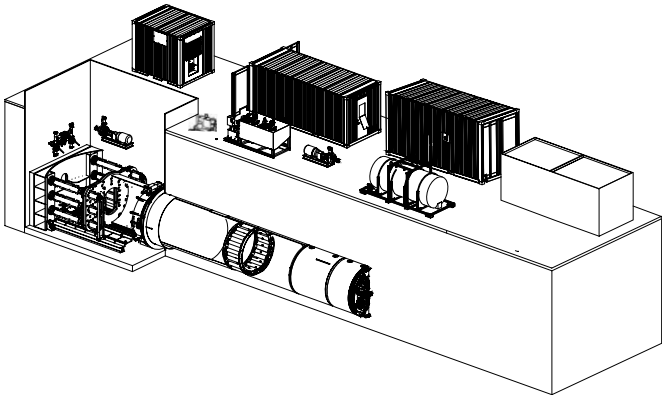




If systems were shut down for freezing weather, be sure to start systems slowly and let them run for at least five minutes to allow for warm up and in the case of a pump, to displace any surface ice that may have accumulated in the fluid before going back to full operation mode.

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.

CONTROLLING SLURRY



I. SLURRY FLOW

1. Stay within the flow rates specified below. If return flow falls below minimum, solids may settle out and clog the slurry line. If the flows rise above maximum, excessive over cutting at the face may occur.

Slurry Flows:

Pipe Size (in.)	Minimum GPM	Maximum GPM
2	80	110
3	200	300
4	300	450
5	500	700
6	700	1000

2. Typically the slurry booster pump, if smaller HP than the return pump, is set at a speed higher than the return pump. The return pump is normally operated slightly faster than the feed pump. Slurry pump speeds vary with soil condition. A starting point would be to increase the pump speeds until the booster pump torque is at about 70%. The booster pump is used to maintain outlet pressure.

3. ***In clays***, use Cutting Nozzle OPEN button to direct more water to the face and less water to the chamber of the MTBM.
   In sands, use Cutting Nozzle CLOSED button to direct more of the water to the slurry chamber and less water to the cutting nozzle.

4. **Operate the machine so that the slurry outlet pressure is less than 5 psi above the ground water pressure but not below static ground water table pressure. NEVER run in a negative pressure.** In MTBMs that have the slurry outlet pressure transducer mounted between the slurry chamber and the stop valve, the ground water pressure is measured by shutting off the slurry pumps, closing the stop valve and reading the slurry outlet pressure. The water table should provide a pressure of about 1/2 psi per foot. Therefore, multiply the psi times 2 to get the height of the water table above the machine. This is a check to see if the reading is reasonable.

5. Slurry flows and pressures vary for different machines and for different ground conditions. It is the responsibility of the operator to determine, through experience, the operating parameters for the machine in specific soil conditions.

II. SLURRY BYPASS

Switch to slurry bypass when:
- Tunneling is halted for more than 5 seconds.
- Return flow is difficult to maintain at levels near the feed flow while tunneling; bypass for at least 30 seconds. This is due to excessive material in the return lines.
- End of pipe; bypass at least 30 seconds or longer depending on length of drive.
- Beginning of pipe to check for leaks before starting cutter head or jacking.

1. Move Selector switch to STOP position.
2. Press Cutter Head rotation STOP button.
3. Press Slurry Bypass OPEN button. Slurry stop valves will close when slurry flow is in sequence mode.
4. Operate slurry feed pump, booster pump (if used), and return pump at normal operating flows.

NOTICE If after 30 seconds the feed flow and return flow have not returned to normal values, then the slurry lines are clogged. See III. Clearing Clogged Slurry Lines in this section.

(continued on next page)

III. CLEARING CLOGGED SLURRY LINES

The slurry lines are clogged if using the slurry bypass procedure does not result in normal flow rates after approximately 30 seconds.

A restriction in the head has occurred if switching to bypass brings slurry flows back to normal and normal operation results in low return flow. Also, the inlet pressure will be high, the outlet pressure low and little return flow when slurry stop valves are open. Operate the slurry in bypass long enough to clear any cuttings out of the return lines. While this is being done, operate the chamber valve to 100%, then sequence the stop/bypass and watch inlet pressure. If inlet pressure does not rise, operate the jetting nozzles to 100% and note if the slurry pressure rises. When the source of the pressure is found, reverse slurry flow will be required (see IV. Reverse Slurry Flow in this section).

A restriction in the return lines will cause inlet and outlet pressures to be high when the bypass is open. First stop all the pumps and shut off ball valves (slurry) in the jacking shaft. Then disconnect slurry hoses in the launch shaft at the trunk lines, connect them together, open ball valves and try cleaning the lines with the feed and return pumps (do not operate the booster pump at this time). If this does not clean the lines, then check the feed and return hoses for lodged obstacles.

If the restriction is not in the hose external to the tunnel, the restriction must be in the return trunk line. Reconnect the hoses to the trunk lines, try flushing in bypass. If this does not clear the restriction, reverse flush the trunk lines with the bypass valve open.

IV. REVERSE SLURRY FLOW IN MTBM

Reverse slurry flow to flush out the crushing chamber, slurry chamber, and MTBM slurry lines. Reverse slurry flow must be performed when:

- Slurry bypass and cleaning clogged slurry line procedures have failed to achieve high flow rates.
- High flow rates are achieved in slurry bypass, but return flow rate is low during tunneling (slurry chamber, crushing chamber, or slurry lines between bypass valve and slurry chamber are clogged).

1. Stop jacking frame advancement and cutter head rotation, and open the slurry bypass valve. Since the slurry flow mode is in sequence, the slurry stop valves will close.

2. Stop the slurry return pump, booster pump, and feed pump.

3. Close the two slurry return ball valve handles on the jacking frame.

4. Disconnect both slurry hoses from the bottom of the slurry valves on the jacking frame.

5. Reconnect slurry hoses to opposite slurry valve on the jacking frame (swap connections). A male-male and female-female pipe adapter will be needed.

6. Open the two slurry valves on the jacking frame.

7. Start the feed pump and return pump and set flow rates to normal operation. Do not start booster pump.

8. Allow slurry lines to flush for no more than 30 seconds.
- Open the chamber or jetting valve, whichever valve was found to be clogged to about 75%.
- If lines are clogged at this point, cycle the feed and return pump controls on and off several times with bypass valve open in order to pressure shock the restriction loose.

9. Press Slurry Stop OPEN button.
- The crushing chamber and slurry chamber are now being flushed.
- Minimize time that the slurry stop valves are open. Since jacking does not occur, any material excavated by the slurry water will form cavities in front of the MTBM.

10. Reconnect the slurry lines to their normal operating position and resume normal operation when the restriction has been cleared.

(continued on next page)

V. USING ABOVE GROUND BYPASS VALVE (SLURRY PIT VALVE)



This is typically performed during a pipe change when using a mechanical slurry separation system which allows the slurry system to continue cleaning. If slurry separation is accomplished using a settlement tank, this procedure would normally not be required.

1. Press Cutter Head STOP button.

2. Move Selector switch to STOP position.

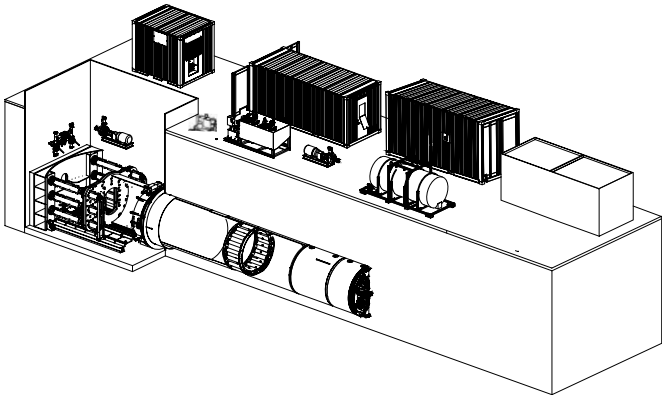
3. Stop the slurry return pump, booster pump (if used), and feed pump.

4. Open the slurry above ground bypass valve.

5. Close the shaft slurry stop valves on the jacking frame.

6. Start the feed pump. DO NOT start the booster or return pumps. The flow path goes from the settlement tank to the feed pump, followed by the slurry feed flow meter and the above ground bypass (slurry pit valve), then return flow meter and back to the settlement tank.

RELEASING A SEIZED CUTTING FACE



1. Retract the main jacking cylinders slightly to release the jacking pressure.
2. Move Selector switch to STOP position.
3. On MTBM Control screen, press Main Hydraulic STOP button.
4. Start the slurry feed pump, booster pump (if used), and return pump.
5. Press Slurry Stop OPEN button.
6. Reverse rotation several times by pressing Cutter Head LEFT and RIGHT buttons. If unsuccessful, press Cutter Head STOP button and press Slurry Bypass OPEN button.

NOTICE If equipped with a high pressure jetting pump and the pump is connected to control container bulkhead power connection, the jetting pump will operate when cutterhead is rotated.

7. Make note of top, left, and right steering cylinder positions (on target screen).
8. Press the Top Cylinder, Left Cylinder, and Right Cylinder EXTEND buttons until the cylinders are fully extended.
9. Press the Top Cylinder, Left Cylinder, and Right Cylinder RETRACT buttons until the cylinders are fully retracted.
10. Press the Slurry Stop OPEN button.
11. Reverse cutter head rotation by pressing the Cutter Head LEFT and RIGHT buttons several times.

- If cutter head becomes free, return steering cylinders to their previous positions while cutter head is rotating.
- If unsuccessful, press Cutting Head STOP button and Slurry Bypass OPEN button and repeat steps 4 through 11.

NOTES

JACKING OPERATION GUIDELINES

1. Never exceed maximum jacking thrust rating of the pipe. Consult pipe manufacturer to obtain this rating.

2. Use lower jacking pressures and lowest cutting head torque possible (below 100%), while maintaining high production rates.

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

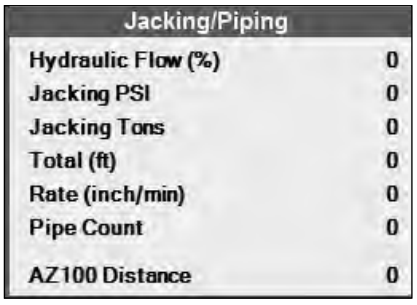
4. Using lubrication (bentonite/polymer) may in certain ground conditions, lower jacking pressure.

5. Increase main pump rate (Jacking Frame Flow control) to increase cutter head torque, jacking speed and jacking pressure.

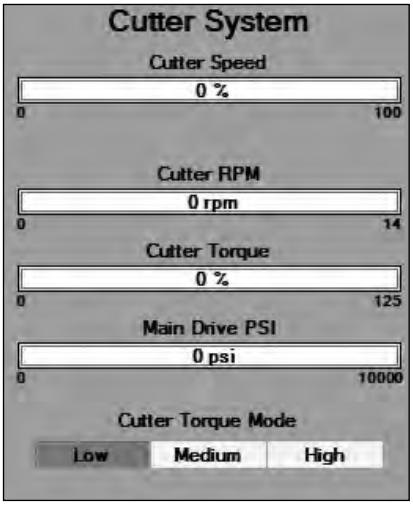
6. Decrease main pump rate to decrease cutter head torque, jacking speed and jacking pressure.

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



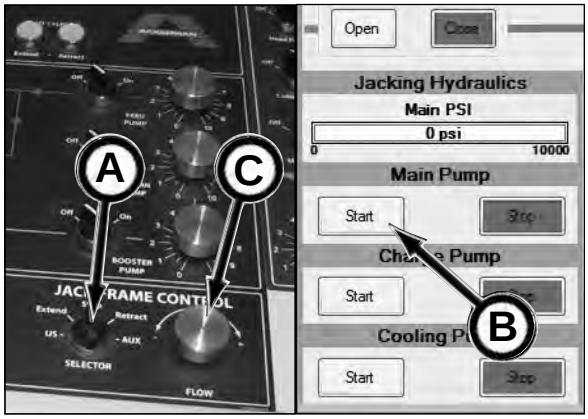


Jacking/Piping on Target Screen



Cutter System on Target Screen Displaying Cutter Speed & Torque

OPERATING KEYHOLE JACKING FRAMES



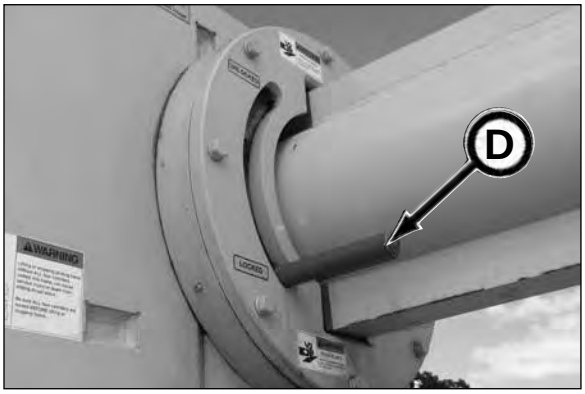
1. Turn Selector switch (A) to STOP position and press Main Hydraulic START button (B) on MTBM Control screen.

2. Turn Selector switch to RETRACT position.

3. Set the Jacking Frame Flow control (C) to 50% to start jacking cylinder retraction. Turn Selector switch to STOP when jacking cylinders are fully retracted.

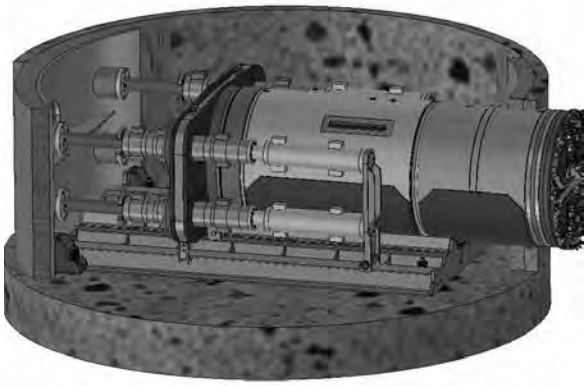
NOTICE The jacking frame hydraulic circuit contains a flow divider which synchronizes the left cylinders and the right cylinders during unrestricted extending and retracting. The flow divider eliminates the need for an operator to manually adjust the speed of the cylinders via ball valves.

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



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

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



5. Start cutterhead rotation and turn Selector switch to EXTEND to start forward thrust using the Jacking Frame Flow control to set speed rate.

- Refer to Jacking Operation Guidelines to help determine a proper hydraulic flow rate.
- Monitor jacking pressures. If pressures approach 50% of the system capacity, intermediate jacking stations may be required. Refer to Using Intermediate Jacking Stations (IJS) in this section.
- Jacking may be paused by pressing the Main Hydraulic STOP button on the MTBM Control screen, or by turning the Selector switch to STOP position.

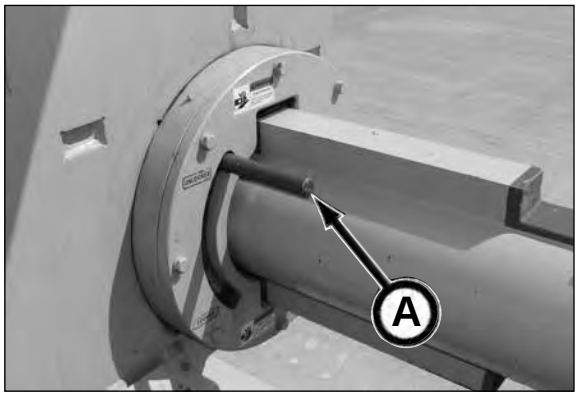
6. Once the jacking cylinders have reached full extension, press Cutter Head STOP button and turn Selector switch to STOP.

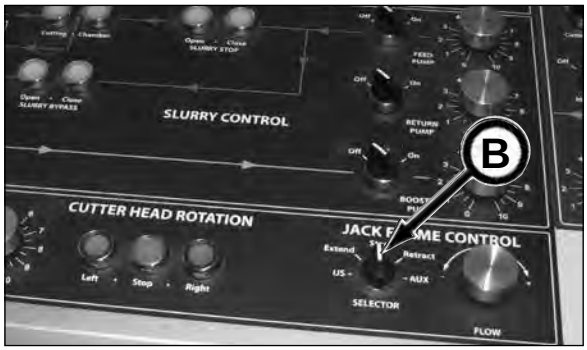
(continued on next page)

7. Unlock cam locks (with lever [A]), turn Selector switch (B) to RETRACT position and retract cylinders until they align with the next keyhole slot positions.

8. Lock cam locks and turn Selector switch to EXTEND position.

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



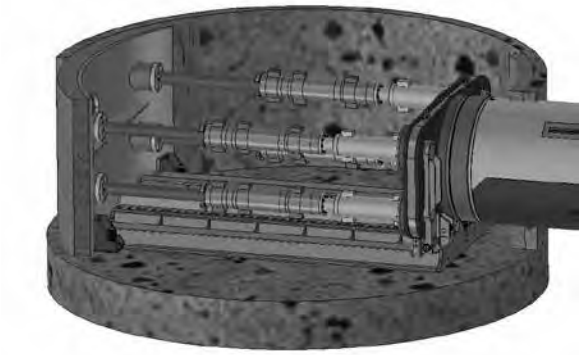


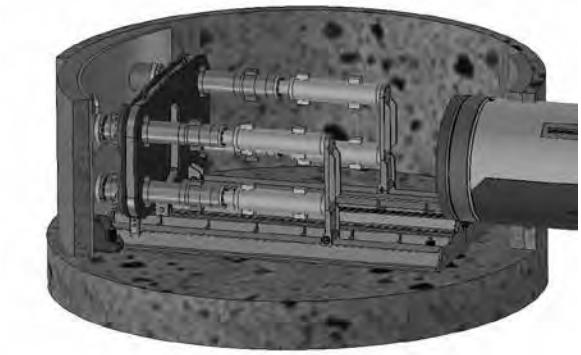
10. Repeat steps 2 through 9 until the entire length of the MTBM/pipe is at the end of the jacking frame or until there is enough room to set another pipe.

11. Once the jacking cylinders have reached full extension:
    a. Stop cutterhead rotation.
    b. Press Slurry Bypass OPEN button.

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

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





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

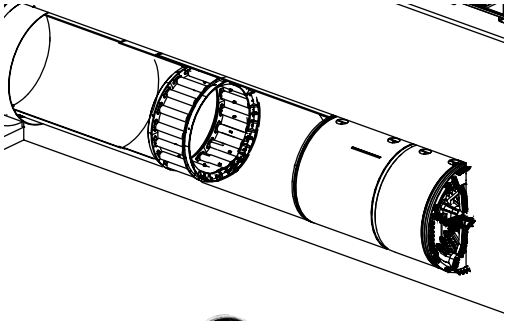


13. Press Main Hydraulic STOP button on the MTBM Control screen.

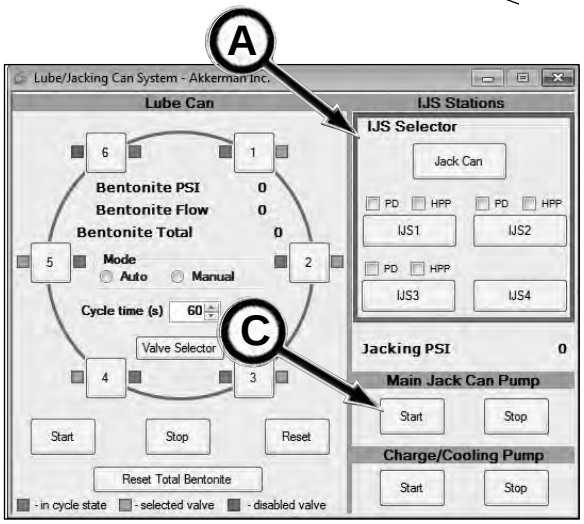
14. Lower the next pipe and repeat until the tunnel is complete.

USING JACKING CAN / INTERMEDIATE JACKING STATION (IJS)

The intermediate jacking stations (IJS) are hydraulic rams placed between pipe joints at intervals throughout the tunnel and are installed when the thrust pressure approaches 50% of the system capacity or as a planned jacking safety factor. The cylinders distribute the pipe jacking thrust to the pipeline, reducing thrust loading on the pipe at the jacking frame. A steel housing or band fits around the joint of the pipe to prevent the intrusion of ground. This component is not recoverable. Cylinders are installed within the housing, between the pipe joints during pipe change, and are extended to thrust the pipe line forward.



The IJS stations are selected on the IJS Selector window (A) from the Lube/Jacking Can System controls screen. The unique part of this system is the IJS stations can be powered from either the lube/jacking can or the remote hydraulic power pack.



If IJS are powered from the lube/jack can (PD), the IJS hoses are routed from the lube/jack can to the IJS. If IJS are powered from the remote hydraulic power pack (HPP), the IJS hoses are routed from the HPP to the IJS.

Select IJS or Jacking Can as follows:

1. To activate the IJS Selector window (A), turn the Jack Frame Control Selector switch (B) to the IJS position.

   The main hydraulic pump (in the lube/jacking can or the remote hydraulic power pack) must be started for the IJS to be functional.

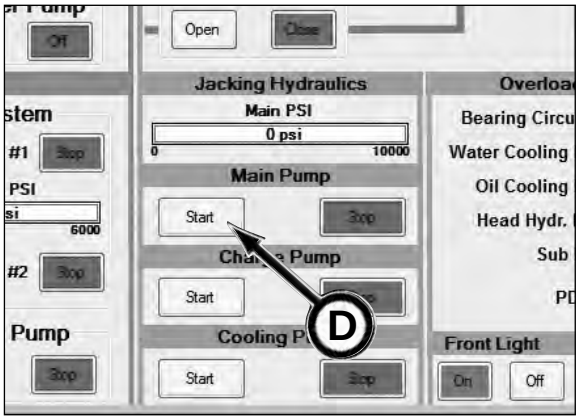


NOTICE The IJS Selector buttons simply energizes the valves in the jacking can or the IJS stations.

2. Select desired IJS:
   Jack Can: Click this button when using the jacking can thrust cylinders. The power source is the lube/jacking can main hydraulic pump (C).

   IJS1, IJS2 and IJS3: for these IJS stations, select power source; PD- lube/jacking can main hydraulic pump (C) or HPP- remote hydraulic power pack main hydraulic pump (D).

   IJS4: Click this button for the IJS powered by the remote hydraulic power pack main hydraulic pump.



HYDRAULIC PUMP FLOW

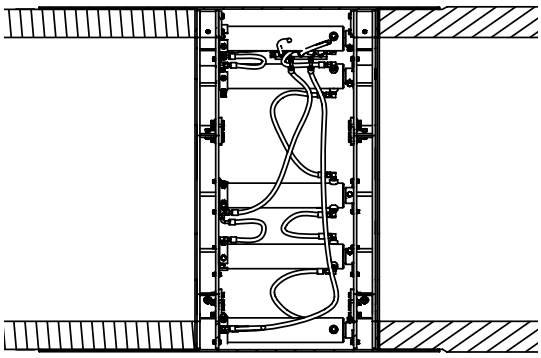
Use the hydraulic pump flow control (E) to regulate the hydraulic flow to the jacking can thrust cylinders or the IJS functions as selected on the IJS Selector.

Installing IJS or Jacking Can



⚠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 base end of the cylinders towards the launch shaft between the leading pipe and the trailing pipe.



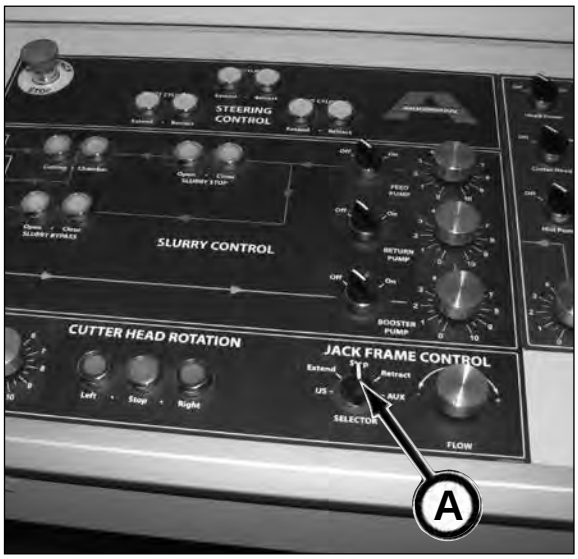
   NOTICE If using the jacking can, it is typically installed after the MTBM trailing section and before the leading pipe.

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

2. Use jacking frame to slowly jack until the trailing pipe slides into the IJS sleeve and the IJS sleeve slides over the leading pipe.

3. Torch off lifting eyes.

4. Connect IJS/jacking can hydraulic hoses to the remote hydraulic power pack or the lube/jacking can IJS hydraulic connections. Secure hydraulic hoses as needed to prevent hoses from being pinched during jacking operation.



Operating *IJS or Jacking Can*

5. Turn Selector switch (A) to STOP position.

6. Start slurry feed pump, booster pump (if used), and return pump.

7. On MTBM Control screen, click Main Hydraulic START button (A) if using remote hydraulic power pack or click Main Pump START button (B) if using the jacking can hydraulics.

8. Press Slurry Stop OPEN button (C) on console.

9. Press Cutting Head LEFT (D) or RIGHT buttons (E) and set cutting head speed with flow control (F).

10. On control console, turn Selector switch (G) to IJS. The IJS Selector window (H) on the Lube/ Jacking Can System is activated.

11. Click Jack Can or IJS1 (if Jack Can is not used). Operate the MTBM the same as if the MTBM is being jacked with the jacking frame for Jack Can or IJS1 (if Jack Can is not used).
IMPORTANT: DO NOT operate MTBM cutterhead when extending cylinders for IJS2, IJS3 etc. or when closing final IJS.

12. Use the Flow control (H) to set flow rate.

13. When the IJS/Jack Can rams are fully extended (jacking pressure should start to climb rapidly), stop flow with flow control.

14. On IJS Selector, click IJS2 and use flow control until rams are fully extended, then stop flow with flow control. This process will close the Jack Can or IJS1 cylinders.

15. Repeat this opening and closing process for additional IJS.

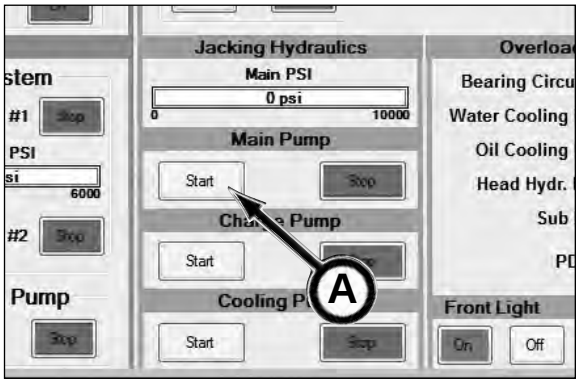
NOTICE **Keep in mind when using the Intermediate Jacking Stations, you are mining with Jacking Can (if used), closing jacking can with IJS1, closing IJS1 with IJS2, closing IJS2 with IJS3, closing IJS3 with IJS4, closing IJS4 with jacking frame main rams.**

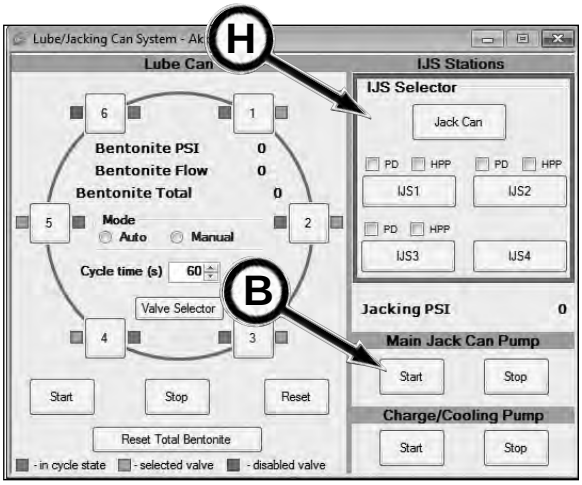
16. Turn Selector Switch (G) to STOP position.

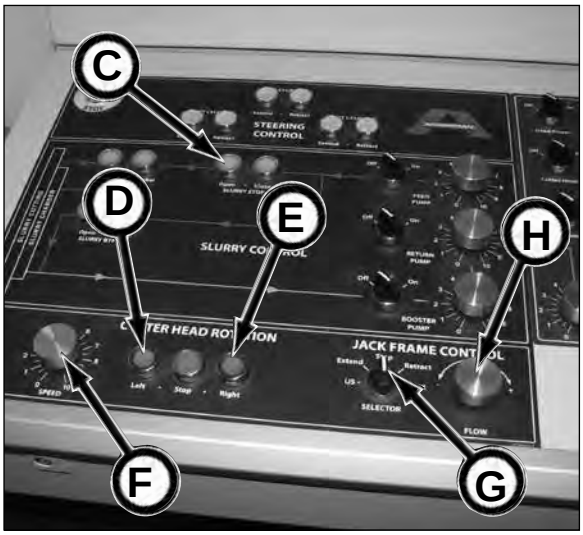
17. Pause tunneling (refer to Pause Tunneling in this section) and stop the feed pump.

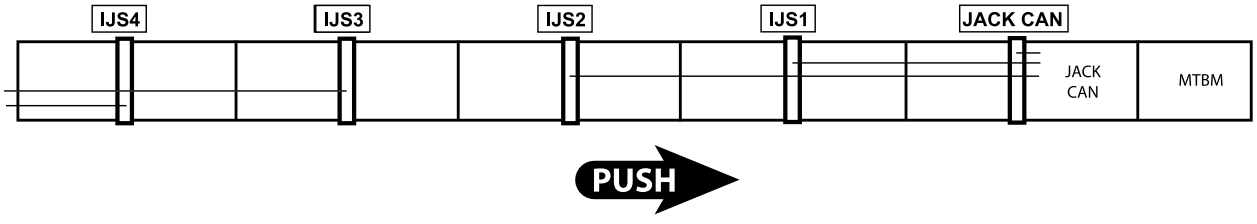
18. Repeat as needed when using the intermediate jacking stations.

19. Repeat the above procedures after installing a new pipe.









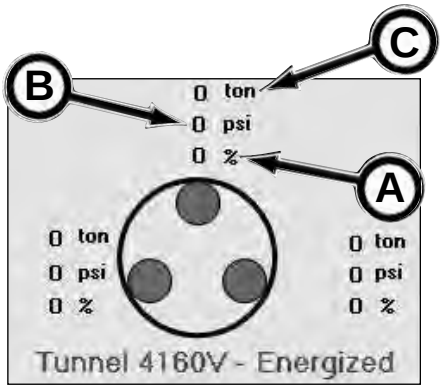
Intermediate Jacking Station Sequence

STEERING GUIDELINES & OPERATION

The steering cylinder indicator on the target screen displays the average cylinder positions in percent (A), the extend/retract pressure (B) of the cylinders and the steering pressure (C) in tons.

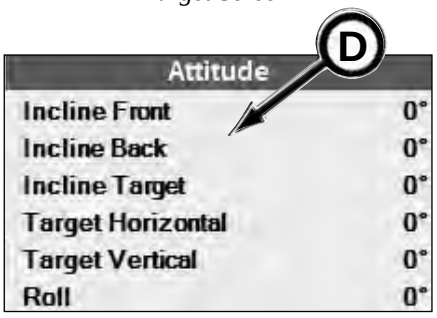
1. Steering should be carefully executed with small corrections made over many feet. Making more extreme adjustments will increase jacking forces.

2. Before making any steering adjustments, ALL three steering cylinders must be at the 50% position.



Steering Cylinder Indicator On Target Screen

3. Watch the inclinometers (D) (on target screen) to get an idea of their values for a straight run and set the pointers on the side of the target.



Attitude on Target Screen Displaying Inclinometer Values

4. To steer, press the steering control buttons on the control console as follows:

   To steer up, extend the right and left cylinders the same amount or retract the top cylinder.

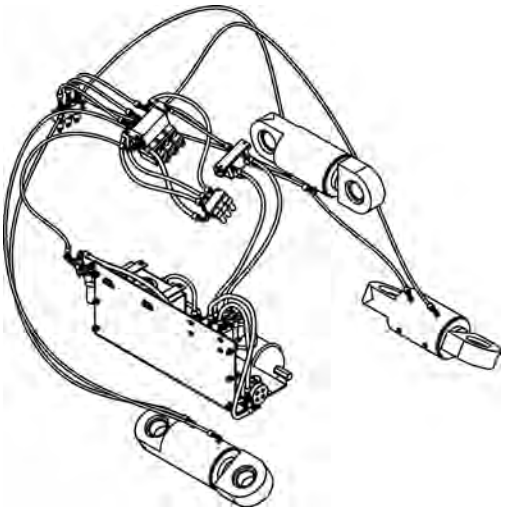
   To steer right, extend the left cylinder and then the top cylinder half the amount of the left.

   To steer left, extend the right cylinder and then the top cylinder half the amount of the right.

   To steer down, extend the top cylinder or retract the bottom cylinders.



Steering Control Buttons



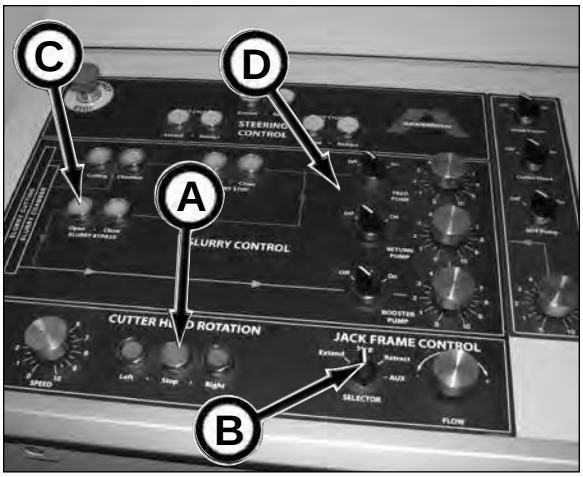
Steering Cylinders

ADDING NEW PIPE & UTILITIES

Once the MTBM is advanced far enough, additional pipe and utilities (main cutter drive cable, head power cable, booster pump cable, ethernet cable, tunnel light cable, slurry feed hose, slurry return hose, ventilation lines, bentonite supply hose, high pressure jetting hose, and other utilities) must be added to the existing pipeline, tunnel cables and hoses.



⚠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. Press STOP button (A) on Cutter Head control.

2. Perform slurry bypass:

   • Turn selector switch (B) to STOP.

   • Press Slurry Bypass OPEN button (C). Slurry stop valves will close in sequence mode.

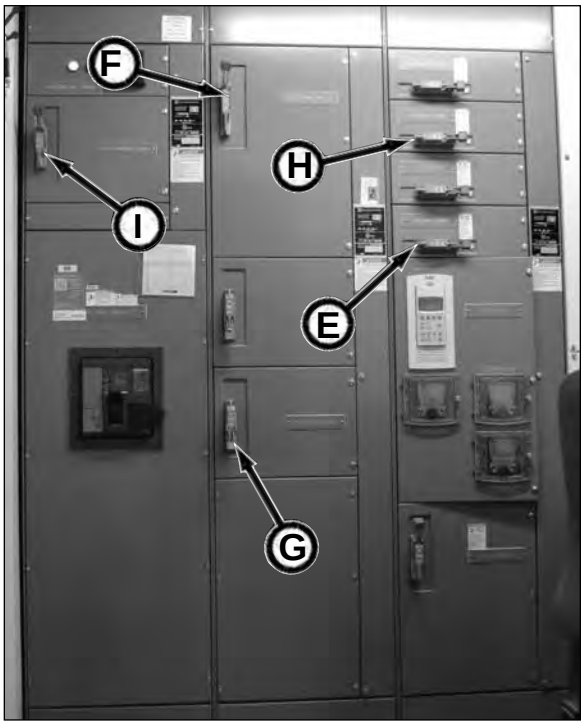
   • Operate slurry feed pump, booster pump (if used), and return pump at normal operating flows.

   • If after 30 seconds the feed flow and return flow have not returned to normal values, then the slurry lines are clogged and will require clearing.

3. Shut down the slurry pumps in the following order by turning pump power switches (D) to OFF:
   a. Feed Pump
   b. Return Pump
   c. Booster Pump
   d. Mid Pump (if used)

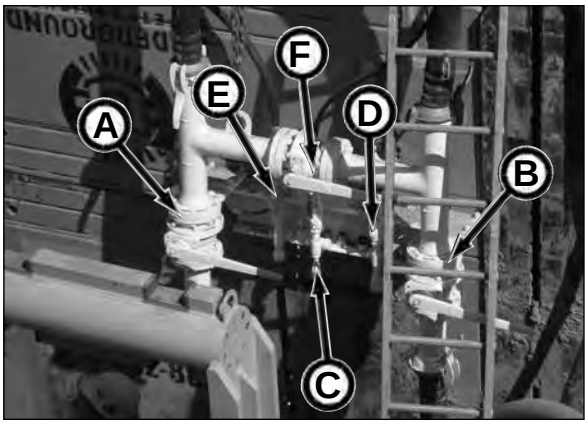
4. Flip the following control container disconnect levers to the OFF position:

   a. Slurry Return Pump Disconnect (E)
   b. Main Cutter Drive Disconnect (F)
   c. Slurry Booster Pump Disconnect (G)
   d. Cooling Pump Disconnect (H)
   e. Head Power Disconnect (I)



(continued on next page)

5. Close the slurry return valve (A), slurry feed valve (B), main cooling pump water supply valve (C), bentonite supply valve (D) (if used), and the high pressure jetting valve (E) (if used) on the slurry pit valve assembly.



NOTICE In some situations, you may want to open the bypass valve (F) if there is a need to recirculate slurry liquid to clean up or lighten the slurry while adding new pipe.

⚠DANGER Contact with severed electrical cables, damaged cable connections, or dirt in the cable connections WILL cause severe injury or death.

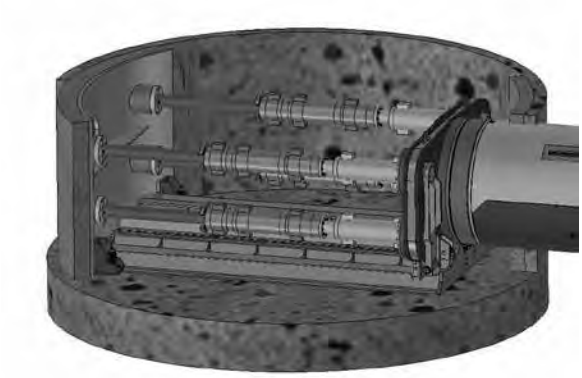


Constantly inspect electrical cables during the jacking process to prevent cutting or stretching of any electrical cables.

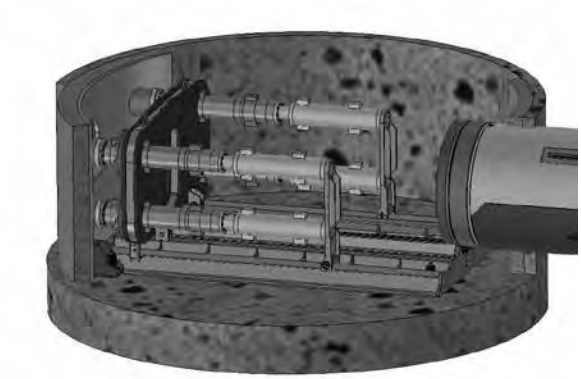
6. Disconnect the utilities (electrical cable, hoses, etc.) between the jacking frame and the MTBM/pipe:

⚠DANGER **When disconnecting cable connections to add a new pipe section to the tunnel, operators MUST power down all electrical feeds to the tunnel. Electrical cabling should be disconnected first and slurry pipes last to prevent slurry water from getting the cables wet.**

- main cutter drive cable
- head power cable
- booster pump cable
- mid pump cable (if used)
- ethernet cable
- tunnel light cable
- slurry feed hose
- slurry return hose
- ventilation lines
- bentonite supply hose
- high pressure jetting hose
- communication cables
- other utilities



Be sure all the cables and hose connections are in a clean, dry location and out of the way of the next pipe. When walking the tunnel with a cable, always hold connection ends up so water is not kicked up into the connection ends.



7. Retract jacking frame.

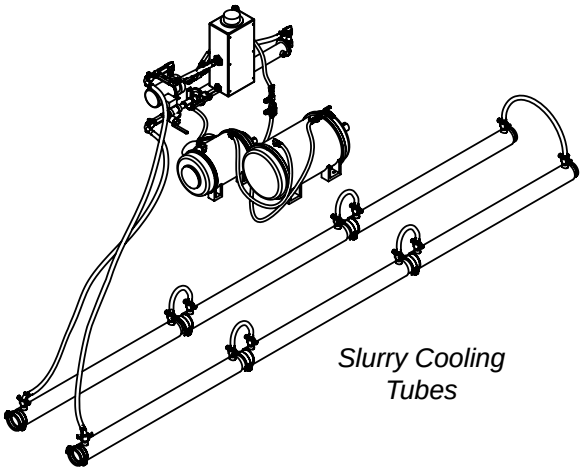
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8. Lower the next pipe into position and lubricate the sealing ring.

9. (On-Board Water Cooling System) On the first and second pipe, slurry cooling tubes must be installed to the slurry tubes in the pipeline. Depending on the amount of cooling needed, slurry cooling tubes may be required in additional pipe. Contact your Akkerman Aftermarket Support representative for more information. Install cooling hoses from slurry cooling tubes to the water cooling system.

NOTICE The water cooling system can be operated as a closed system where the slurry system provides the cooling, or if needed, cool water can be supplied via the fill port to aid in cooling the system along with the slurry. The excess cool water supplied via the fill port will bleed out the overflow.



Slurry Cooling Tubes

9. (External Water Cooling System) For setup and water flow requirements, refer to Water Cooling System in section 4, Controls & Instruments.

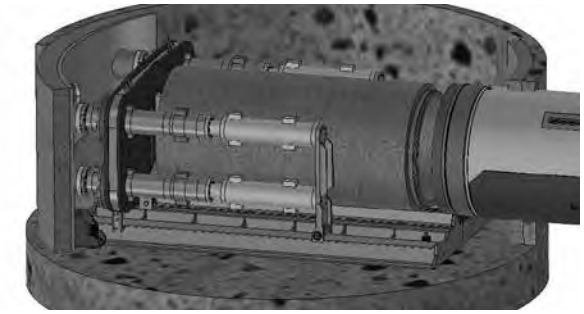
NOTICE Once pipe is set, reinstall slurry hoses and lines, then largest power cables and end with communications cable to prevent water from getting cables wet.



10. Clean slurry connections and connect slurry lines between the pipes.

11. Clean connections and connect cables and hoses and other utilities through the new pipe. When 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 airborne dust and dirt.

12. Open the slurry feed and return valves, bentonite supply valve, and high pressure jetting valve on the slurry pit valve assembly (A). Close the bypass valve.



13. Slowly advance the new pipe until it is seated in position.

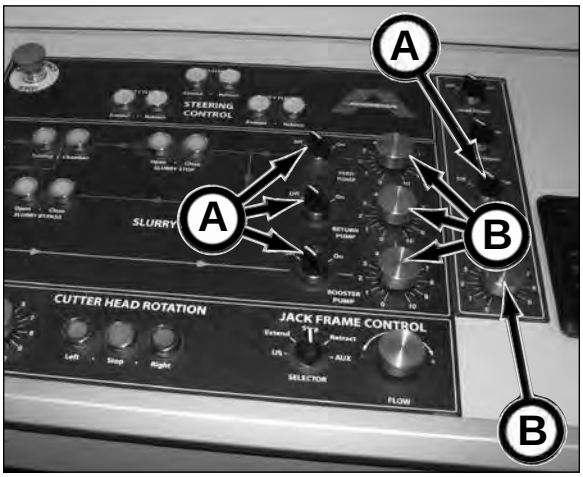
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14. Turn ON disconnects (from step 4) for the slurry return pump, slurry booster pump, main cutter drive, head power and cooling pump.

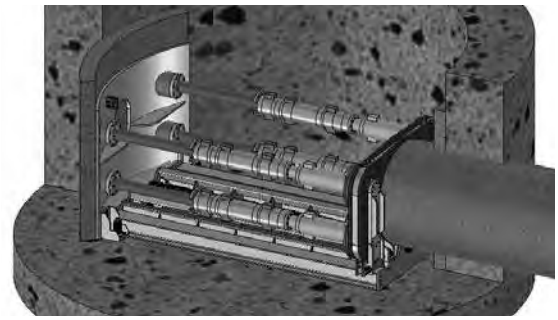


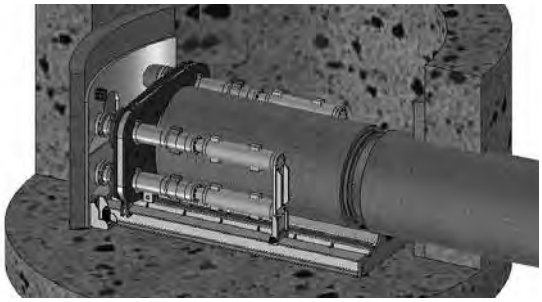
15. Turn the slurry pump controls (A) ON in the following order:
    a. mid pump (if used)
    b. booster pump
    c. return pump
    d. feed pump

16. Use the slurry pump flow controls (B) to check slurry lines for leaks and the separation system for proper operation.



17. Repeat installation for subsequent pipe.





DAILY SHUT DOWN

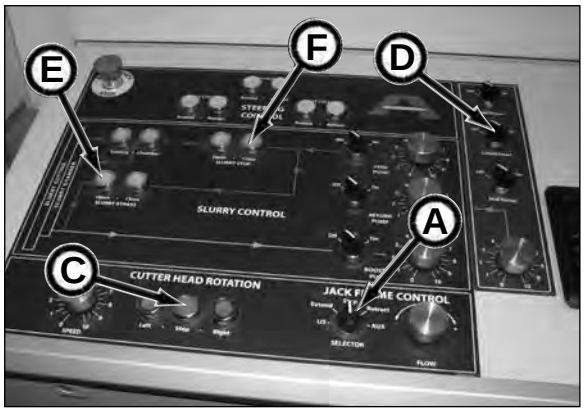
1. Stop jacking frame extension by turning the Selector switch (A) to STOP position.

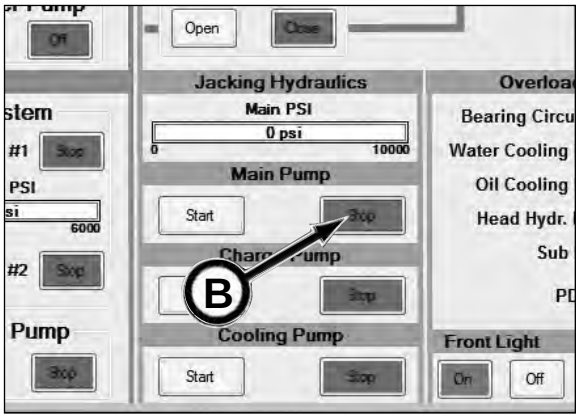
2. On MTBM Control screen, press Main Hydraulic STOP button (B).

3. Shutdown the MTBM drive motor by pressing the Cutting Head STOP button (C) and turn Cutter Head power switch (D) to the OFF position.

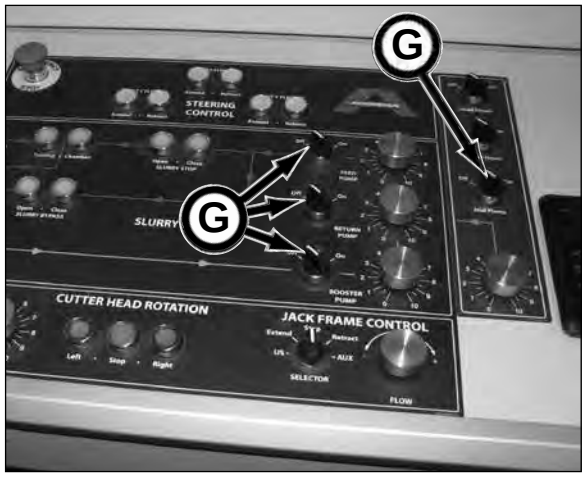
2. Open the MTBM bypass valve by pressing Slurry Bypass OPEN button (E). In sequence mode, the Slurry Stop valve will automatically close. If operating in Manual mode, close the stop valves by pressing Slurry Stop CLOSE button (F).

3. Flush water through the lines until clear.

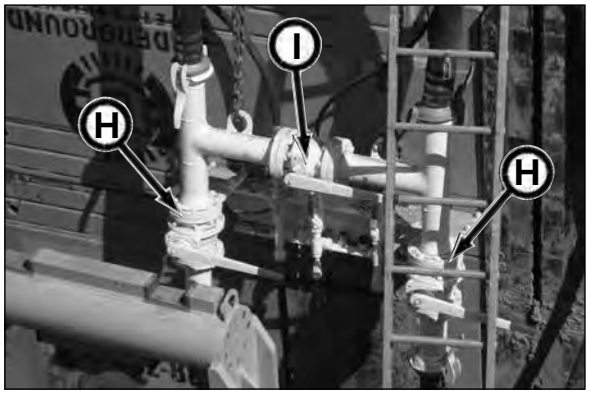




4. Turn the slurry pump power controls (G) OFF in the following order:
   a. feed pump
   b. return pump
   c. booster pump
   d. mid pump (if used)

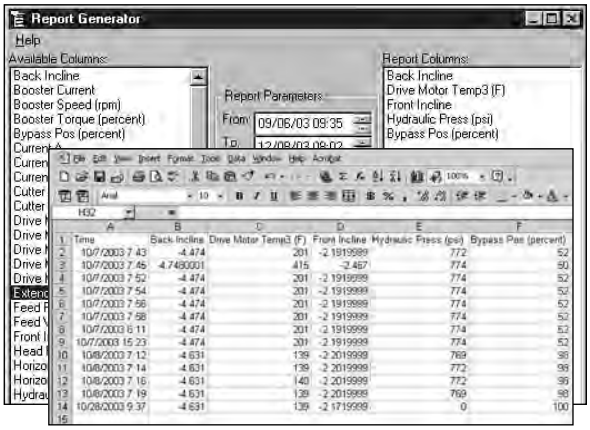


5. On the slurry pit valve, close the slurry valves (H) and open bypass valve (I). Close the feed and return side supply tanks (if used).

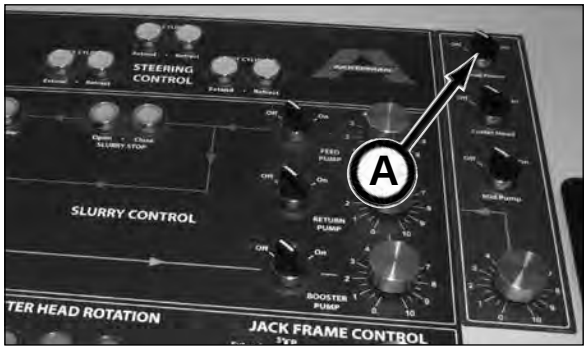


(continued on next page)

6. Generate and print a report (refer to Using The Report Generator in this section).

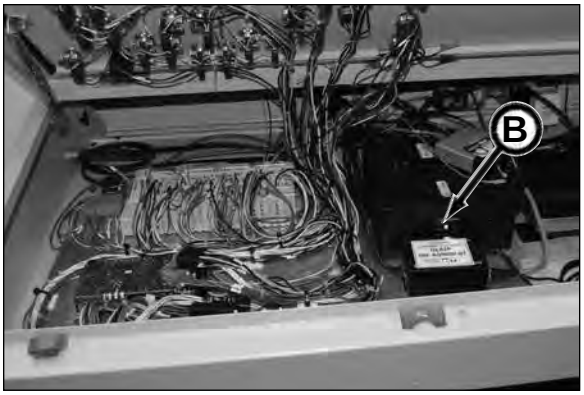


7. Turn Head Power switch (A) to the OFF position.



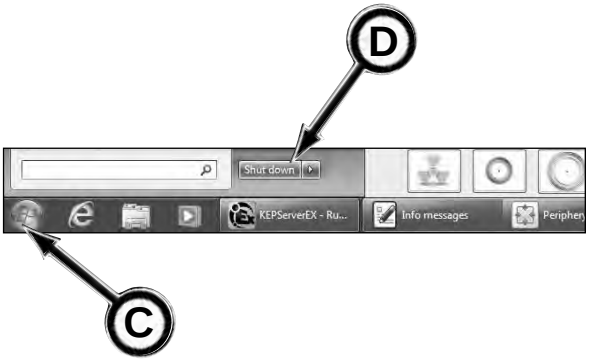
8. Shutdown the computer as follows:

NOTICE If the computer is not properly shut down, you may lose data or corrupt important Windows files or registry locations. **DO NOT shut down computer with computer power button (B) unless computer is locked up.**



a. Click on Start Button (C) to open Start Menu.

b. Once Start Menu is open, click on Shut down button (D). This will properly shut down the Windows operating system and your computer.



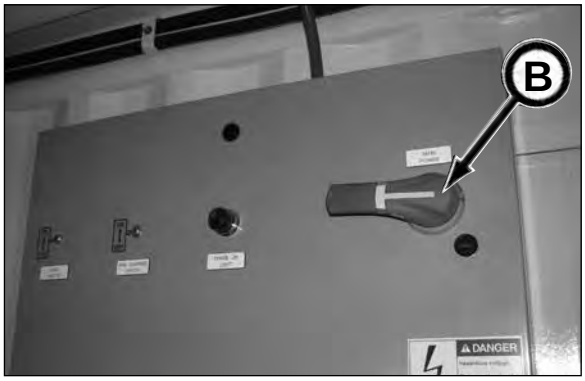
(continued on next page)

9. Shut off all disconnects.

10. Shut off main power disconnect (A) and lock out/tag out main power source.



11. Shut off the power on the remote hydraulic power pack by turning the main power switch (B) to the OFF position and lock out/tag out main power source.



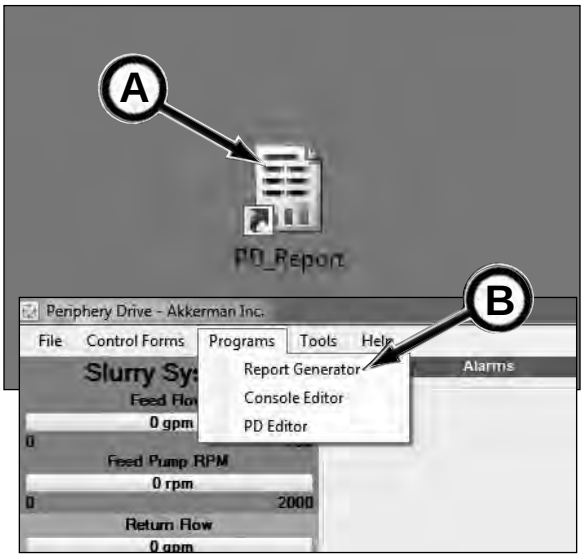
12. Shut off the power on the power container by flipping the main power switch (C) to the OFF position and lock out/tag out main power source.



NOTES

USING THE REPORT GENERATOR

1. Double click the Report Generator icon (A) on desktop or go to the Target System window, click Programs on the menu bar and click Report Generator (B) from the pull down menu.

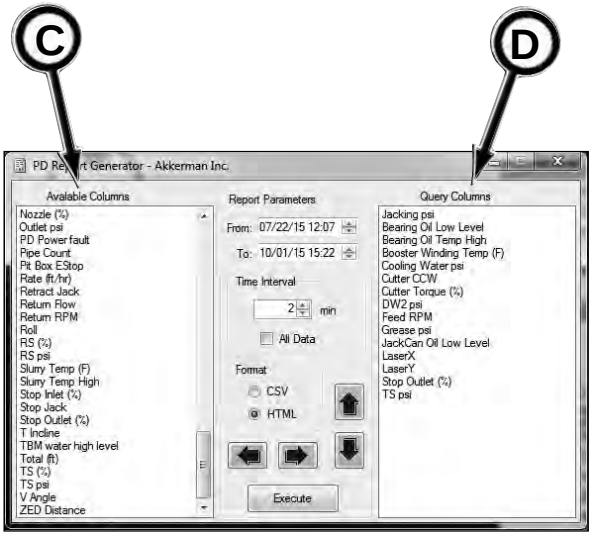


2. In the Report Generator window, the left column “Available Columns:” (C) is a list of all the data variables (54) available for your report. The right column “Query Columns” (D) is a list of the data variables you selected for your report.

3. To select the variables for your report, do one of the following:

a. Double click the variables in the Available Column that you want to appear on your report. The selected variables will now appear in the Query Column.

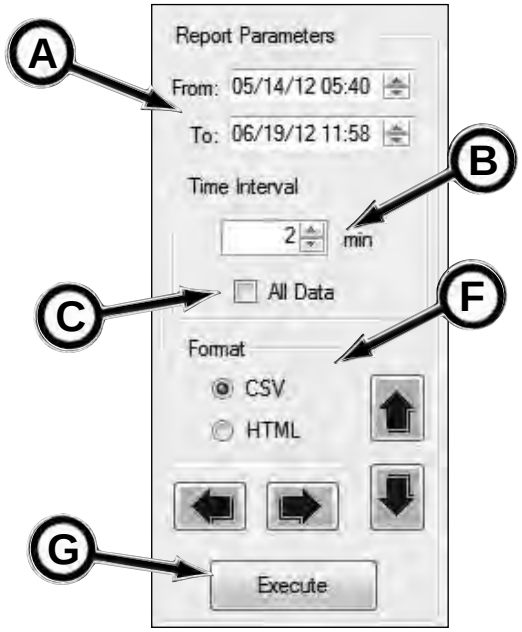
b. Or select the desired variables in the Available Column (use the Ctrl button to select multiple variables), then click the right arrow to add the selected columns to the Query Column.



If you have a variable in the Query Column that is not needed, select the variable and click the left arrow. This will remove the selected variable from the Query Column.

4. If necessary, reprioritize the variables in the Query Column, by selecting a variable and clicking the up or down Priority arrows. The top variable will appear on the left hand column of the report.

(continued on next page)

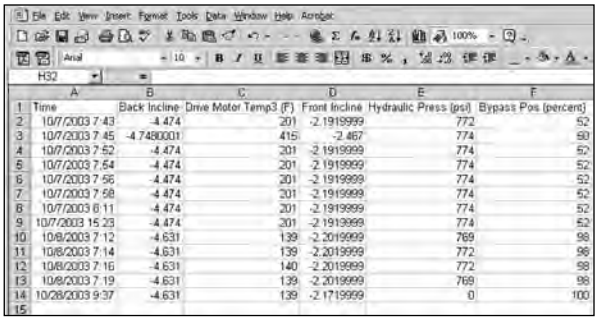


5. Modify the date and time parameters (A). Modify parameters by either clicking the month, day, year, hour, or minute fields and type in the desired number, or click one of the fields and use the up and down arrows to change the numbers.

6. Modify the Time Interval (B) by either selecting the field and typing in the desired time (2 through 20 minutes), or clicking the up or down arrows. The default time is 2 minutes.

NOTICE Data is logged every 15 seconds.

If you click the All Data box (C), the report will ignore the time interval and print the report for all logged data within your selected date and time parameters.



	A	B	C	D	E	F
1	Time	Back Incline	Drive Motor Temp3 (F)	Front Incline	Hydraulic Press (psi)	Bypass Pos (percent)
2	10/7/2003 7:43	-4.474	201	-2.1919999	772	52
3	10/7/2003 7:45	-4.7480001	415	-2.467	774	50
4	10/7/2003 7:52	-4.474	201	-2.1919999	774	52
5	10/7/2003 7:54	-4.474	201	-2.1919999	774	52
6	10/7/2003 7:56	-4.474	201	-2.1919999	774	52
7	10/7/2003 7:58	-4.474	201	-2.1919999	774	52
8	10/7/2003 8:11	-4.474	201	-2.1919999	774	52
9	10/7/2003 15:23	-4.474	201	-2.1919999	774	52
10	10/8/2003 7:12	-4.631	139	-2.2019999	769	98
11	10/8/2003 7:14	-4.631	139	-2.2019999	772	98
12	10/8/2003 7:16	-4.631	140	-2.2019999	772	98
13	10/8/2003 7:19	-4.631	139	-2.2019999	769	98
14	10/28/2003 9:37	-4.631	139	-2.1719999	0	100
15						

CSV Format In Excel

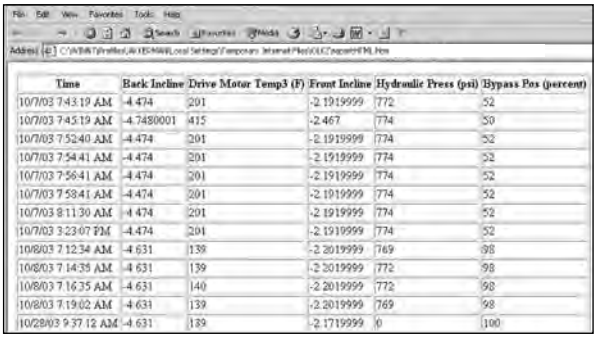
7. Select your desired report format (F).

The CSV (Comma Separated Value) selection is a spread sheet program format and will open in Microsoft® Excel.

The HTML (Hyper Text Mark Up Language) selection is a web browser program format and will open in Microsoft® Internet Explorer.

8. Click Execute button (G). The report is generated and will automatically open your CSV or HTML program on the computer screen.

9. Save or print your report from the program. If a print out of the report is needed, confirm that a printer is connected and is on and that paper is loaded into the paper tray. Print your report from the program.



Time	Back Incline	Drive Motor Temp3 (F)	Front Incline	Hydraulic Press (psi)	Bypass Pos (percent)
10/7/03 7:43:19 AM	-4.474	201	-2.1919999	772	52
10/7/03 7:45:19 AM	-4.7480001	415	-2.467	774	50
10/7/03 7:52:40 AM	-4.474	201	-2.1919999	774	52
10/7/03 7:54:41 AM	-4.474	201	-2.1919999	774	52
10/7/03 7:56:41 AM	-4.474	201	-2.1919999	774	52
10/7/03 7:58:41 AM	-4.474	201	-2.1919999	774	52
10/7/03 8:11:30 AM	-4.474	201	-2.1919999	774	52
10/7/03 3:23:07 PM	-4.474	201	-2.1919999	774	52
10/8/03 7:12:34 AM	-4.631	139	-2.2019999	769	98
10/8/03 7:14:35 AM	-4.631	139	-2.2019999	772	98
10/8/03 7:16:35 AM	-4.631	140	-2.2019999	772	98
10/8/03 7:19:02 AM	-4.631	139	-2.2019999	769	98
10/28/03 9:37:12 AM	-4.631	139	-2.1719999	0	100

HTML Format In Internet Explorer

LINEAR TRANSDUCER CALIBRATION - SLURRY VALVES & STEERING CYLINDERS

Linear transducers should be calibrated before each drive. Also, if the stop valve, bypass valve, cutting nozzle valve, or steering cylinders are repaired or replaced, the components will require recalibration so the steering cylinder or valve positions will be properly monitored. The calibration is performed through the Kepware Server software. This software collects and rewrites data to and from the device components and is then communicated to the operator in the control container.

IMPORTANT: It is the responsibility of the customer to keep the Kepware Server support agreement up to date. If a computer that is running Kepware fails or is irrevocably damaged, the support agreement will assure access to technical support and immediate assistance with license recovery.

NOTICE The raw data values for the slurry valves and/or steering cylinders must be recorded before proceeding with this calibration procedure. Refer to Supplementary Editor Program, 1. Front Editor, d. Calibration Data and e. Raw Values in this section.

NOTICE If using Kepserver 5.10 or before, proceed to step 1. If using Kepserver 5.12 or later, exit all programs, right click Kepware icon on task bar menu and select Stop Runtime Service. Then right click Kepware icon again and select Start Runtime Service. Open Kepware server program and proceed to step 2.

1. If not already running, double click KEPServerEx icon to start the calibration program.

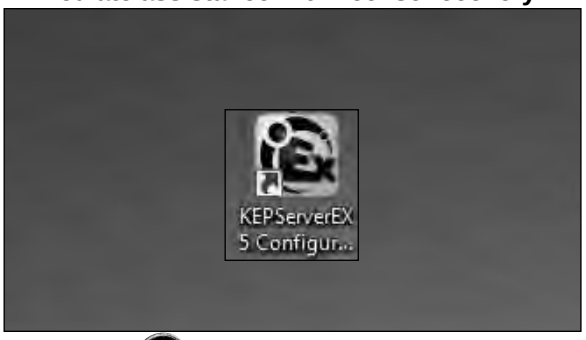
2. Click channel (A) and then device (B) on left column. Refer to channel and device selection below:

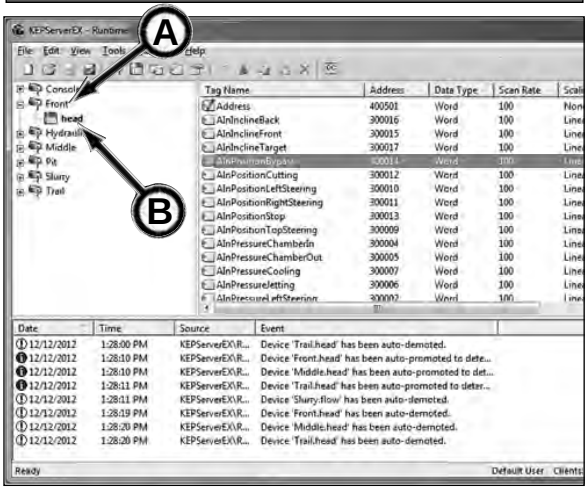
   Stop Valve, Cutting Nozzle, Steering Cylinders
   - Channel: Front
   - Device: Head

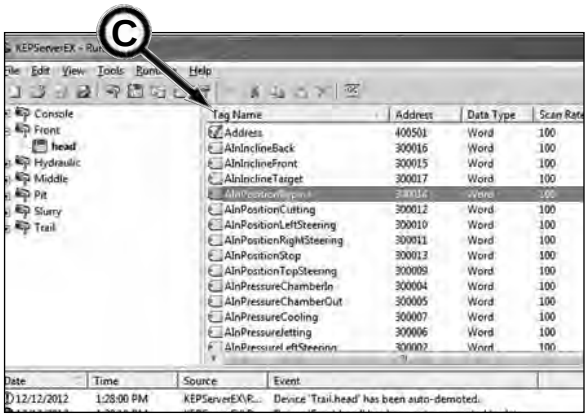
   Bypass Valve (MTBM 42 & after)
   - Channel: Front
   - Device: Head

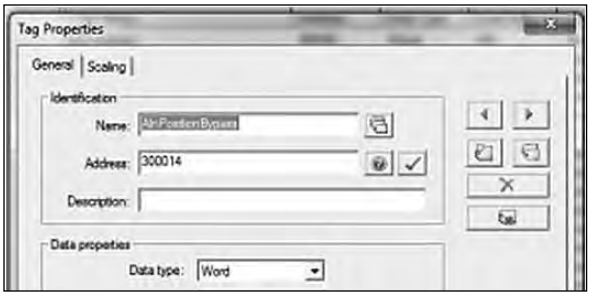
3. Double click component tag name (C) in right column to display the Tag Property window. Refer to tag name selection below:

Stop Valve:	AInPositionStop
Bypass Valve:	AInPositionBypass
Cutting Nozzle:	AInPositionCutting
Steering Cylinders:	
Top:	AInPositionTopSteering
Left:	AInPositionLeftSteering
Right:	AInPositionRightSteering







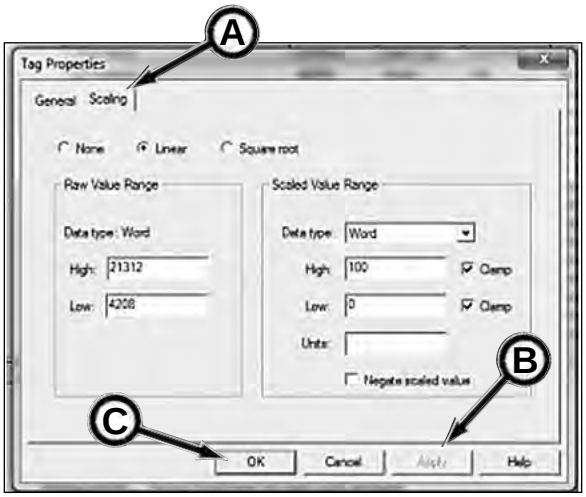


Tag Property Window

(continued on next page)

4. Click the Scaling tab (A).

5. Input the Raw Value Range data you recorded from the Front Editor program (refer to Supplementary Editor Programs in this section).



NOTICE The slurry valves and steering cylinder raw value range and scaled value range are based on the following input and data type information:

Input - Linear
Data Type: Word with Clamp (checked)
Scaled Value Range High: 100 (%)
Scaled Value Range Low: 0 (%)

NOTICE The Raw Value Range high and low data fields are:

Stop Valve & Bypass Valve:
High - Open valve position
Low - Close valve position

Cutting Nozzle Valve:
High - Cutting
Low - Chamber

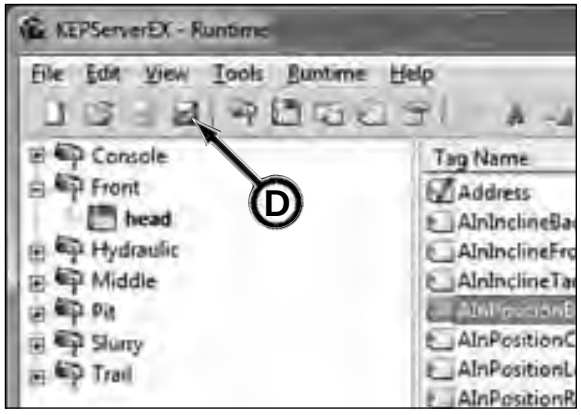
Steering Cylinders
High - Extend position
Low - Retract position

6. Click Apply (B).

7. Click OK (C).

8. Repeat steps 2 through 7 for other devices (as needed).

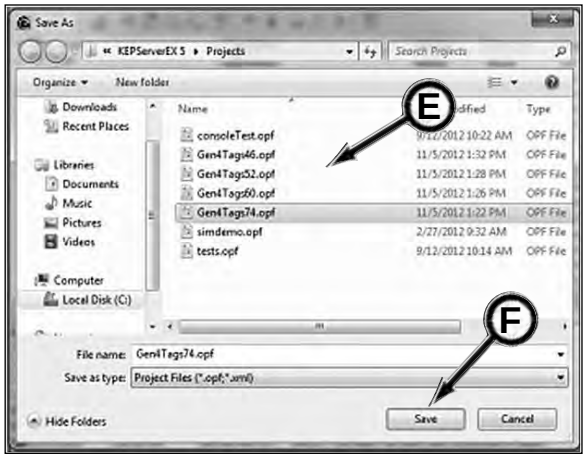
9. Click Save As button (D).



NOTICE **Be sure to click Save As,** so when restarting, the updated file is in the project directory of the Kepware Server program. Otherwise, if performing a Save, the updated file will not be in the correct location when restarting, thus it will use the old file and show erroneous data.

9. Highlight the same file name (E) or MTBM that you are calibrating.
For example: for a 74" MTBM, use a file name such as Gen4Tags74.opf.

10. Click Save (F).



11. You will be prompted to "Do you want to replace.., click Yes (G).

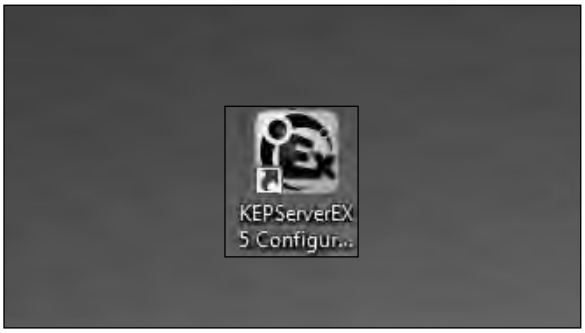
12. Restart Kepware. The device is now calibrated.



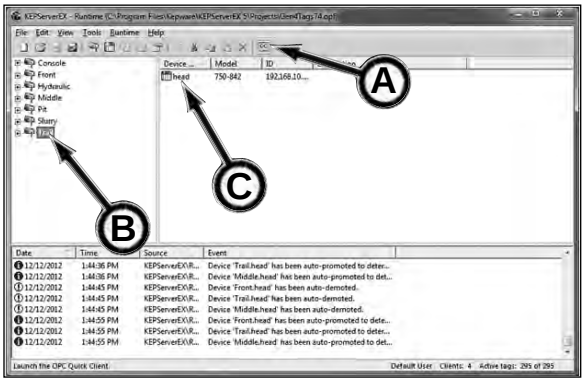
LINEAR TRANSDUCER CALIBRATION - DIRT WING

Linear transducer should be calibrated before each drive. Also, if the dirt wing cylinders are repaired or replaced, the components will require recalibration so the dirt wing cylinder positions will be properly monitored. The calibration is performed through the Kepware Server software. This software collects and rewrites data to and from the device components and is then communicated to the operator in the control container.

IMPORTANT: It is the responsibility of the customer to keep the Kepware Server support agreement up to date. If a computer that is running Kepware fails or is irrevocably damaged, the support agreement will assure access to technical support and immediate assistance with license recovery.



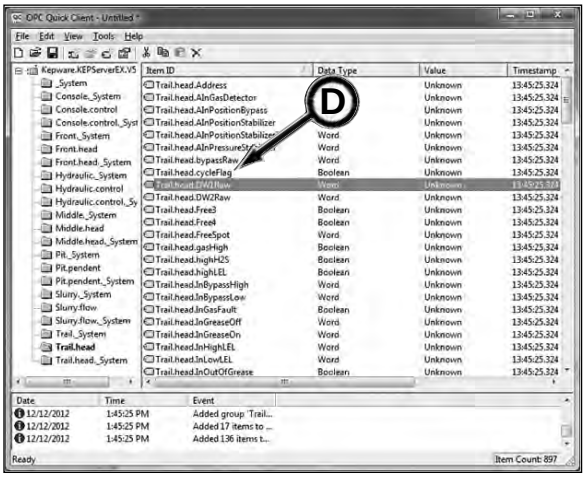
1. Start MTBM program. Once started, the Kepware server program will automatically start. Click on the KepwareServerEx program on the taskbar to make it active.



2. Click Quick Client icon (A).

3. Click on channel “Trail” (B) and then device “Head” (C).

4. Click component tag name (shown below) for dirt wing to be calibrated:
   DW#1: Trail.head.DW1Raw (D)
   DW#2: Trail.head.DW2Raw

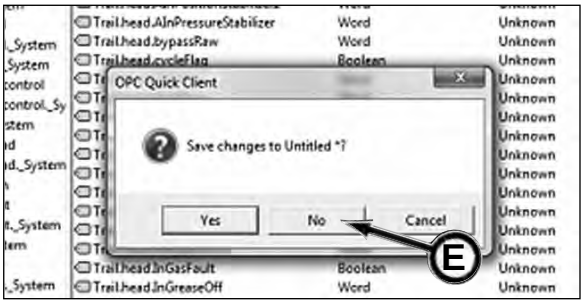


5. Operate device (dirt wing) as detailed below and record the low (retract) and high (extend) limits of the device.

   • On the MTBM Control screen, click and hold the dirt wing cylinder Extend button for the cylinder requiring calibration until the pressure rises quickly. Once the pressure rises, record the high limit (extend), then release Extend button. Repeat for Retract side of cylinder and record the low limit (retract).

6. If necessary, repeat steps 4 and 5 for other dirt wing.

NOTICE If using Kepserver 5.10 or before, proceed to step 7. If using Kepserver 5.12 or later, exit all programs, right click Kepware icon on task bar menu and select Stop Runtime Service. Then right click Kepware icon again and select Start Runtime Service. Open Kepware server program and proceed to step 9.



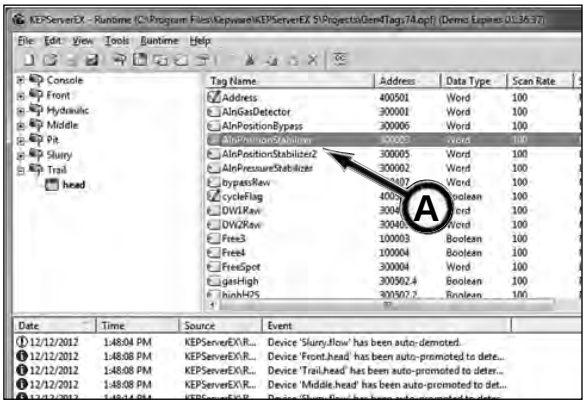
7. Close Quick Client.

8. You will be prompted to “Save changes to.., click No (E).

(continued on next page)

9. With the device selected (from step 3), double click component tag name (A) in right column to display the Tag Property window of the dirt wing being calibrated. Refer to tag name below:

   DW#1: AInPositionStabilizer
   DW#2: AInPositionStabilizer2

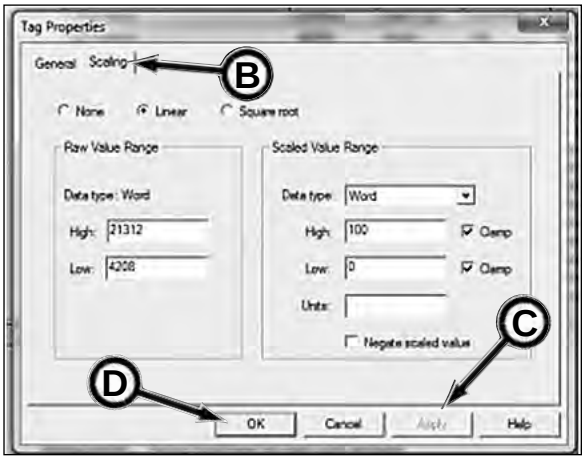


10. Click the Scaling tab (B).

11. Input the Raw Value Range data you recorded in step 5.

NOTICE The raw value range and scaled value range are based on the following input and data type information:

Input - Linear
Data Type: Word with Clamp (checked)
Scaled Value Range High: 100 (%)
Scaled Value Range Low: 0 (%)



NOTICE The Raw Value Range high and low data fields are:

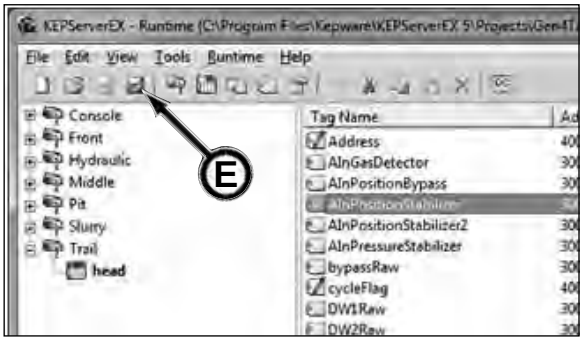
High - Extend position
Low - Retract position

12. Click Apply (C).

13. Click OK (D).

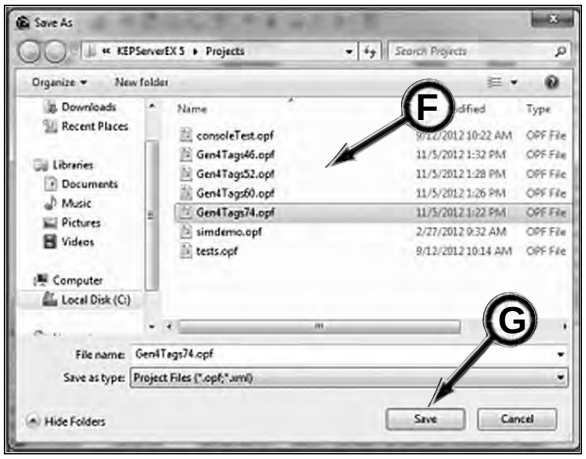
14. Repeat steps 9 through 13 for other device.

15. Once all device data is entered, click Save As button (E).



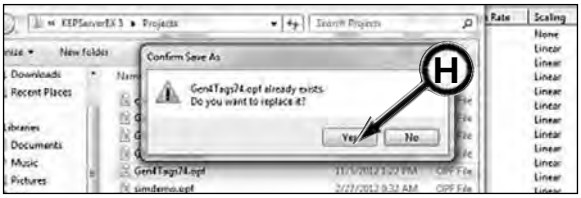
NOTICE **Be sure to click Save As,** so when restarting, the updated file is in the project directory of the Kepware Server program. Otherwise, if performing a Save, the updated file will not be in the correct location when restarting, thus it will use the old file and show erroneous data.

16. Highlight the same file name (F) or MTBM that you are calibrating.
    For example: for a 74" MTBM, use a file name such as Gen4Tags74.opf.



17. Click Save (G).

18. You will be prompted to "Do you want to replace.., click Yes (H).



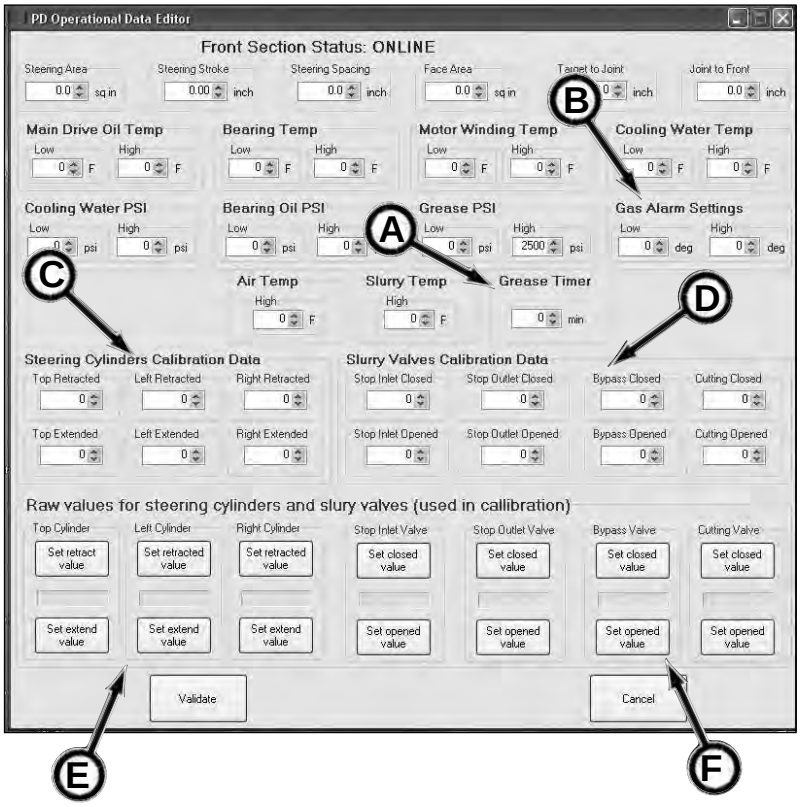
19. Restart Kepware. The device is now calibrated.

SUPPLEMENTARY EDITOR PROGRAMS

There are three supplementary editor programs that determine the metering and monitoring of the MTBM devices. The programs consist of constant values and dynamic variables.

The constant values are factory set (the non bold type component headings) and should not be changed since they are the value characteristics of the machine make-up and design. The constant values are loaded into the program at system start-up when you select the size of your MTBM in the MT Control Selector window. If the constant values are changed, erroneous data will be calculated, resulting in improper monitoring of the MTBM position.

The dynamic variables, are variables that can be changed by the operator to help in the visual metering and monitoring of the MTBM.



1. MTBM Front Editor 

This editor is used to calculate the position of the cutting head during the tunneling operation. Most of the data fields in this editor contain constant values such as steering stroke, head drive size. etc. These are items that should not be changed since they are the design specifications of the MTBM. This data is automatically entered from the Machine Head Selector program. Below are the dynamic variables and other controls in this editor.

a. *Grease (Pump) Timer* (A): The default timer setting is for the grease pumps to automatically alternate a 15 minute grease pumping cycle. Adjust accordingly. Then click the Validate button.

b. *Gas Alarm Settings* (B): The default settings are in LEL%, 10% Low and 25% High. Adjust as needed per project. Then click the Validate button.

c. *Other: Main Drive Oil Temp, Bearing Temp, Motor Winding Temp, Cooling Water Temp, Cooling Water PSI, Bearing Oil PSI, Grease PSI, Air Temp, and Slurry Temp* are components with dynamic variables. The values are factory set but can be edited by operator. If change necessary, make update and click Validate. ***Keep in mind, changing settings may void warranty if change causes premature component failure.***

d. *Steering Cylinder Calibration Data* (C) & *Slurry Valve Calibration Data* (D): if linear transducer calibration or recalibration is required, new calibration data is automatically entered once the values are generated from the raw values for steering cylinders (E) / slurry valves (F) (refer to Raw Values for steering cylinders and slurry valves below), then click Validate button. This data then must be entered in the appropriate fields in the Kepware program (refer to Linear Transducer Calibration - Slurry Valves & Steering Cylinders in this section).

e. *Raw Values for steering cylinders (E) and slurry valves (F):* Use these buttons to gather calibration data for the steering cylinders and the stop valve, bypass valve and cutting valve as follows:

- Steering Cylinder: On the control console, hold down the steering cylinder Extend button for the cylinder requiring calibration until the pressure rises quickly. Once the pressure rises, click the appropriate cylinder Set Extend Value button, then release Extend button. Repeat for Retract side of cylinder. Clicking the Set Extend/Retract Value button, will automatically put the pressure value in the appropriate Steering Cylinder Calibration Data field. Then click the Validate button.

- Slurry Valves: On the control console, hold down the slurry valve Open button for the valve requiring calibration until the pressure rises quickly. Once the pressure rises, click the appropriate valve Set Extend Value button, then release Extend button. Repeat for Closed side of valve. Clicking the Set Opened/ Closed Value button, will automatically put the pressure value in the appropriate Slurry Valve Calibration Data field. Then click the Validate button.

(continued on the next page)

2. Console Editor

This editor allows you to change the console dynamic variable ranges and meter values. The meter values are visible on the target screen. If changes are made, click the Validate button before exiting the program.

a. Stop, *Bypass, and Cutting Position*: indicates the percentage of which the valve positions are considered fully open or fully closed.

b. *Stop Pressure*: pressure at which the stop valve is open or closed.

c. *Stop/Bypass Timer*: the time it takes to recycle the stop or bypass valve. If the stop or bypass valve does not open or close in the allotted time, a message in the log window on the indicator screen will appear indicating that the valves did not open or close.

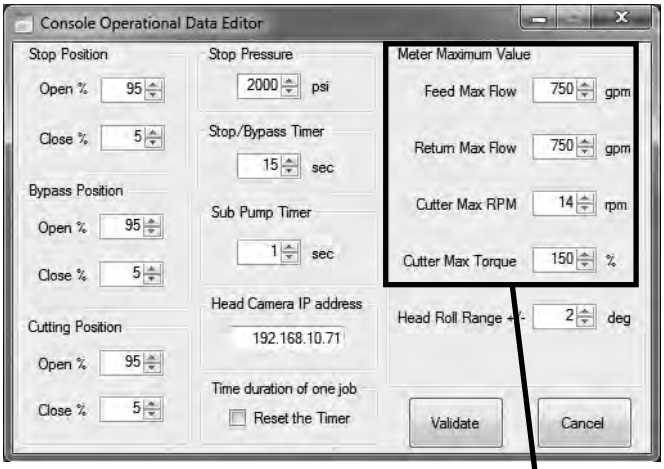
d. *Sub Pump Timer:* the time the submersion pump will continue to operate after the float level switch returns from high water level to normal operation to prevent false tripping. Default is 60 seconds.

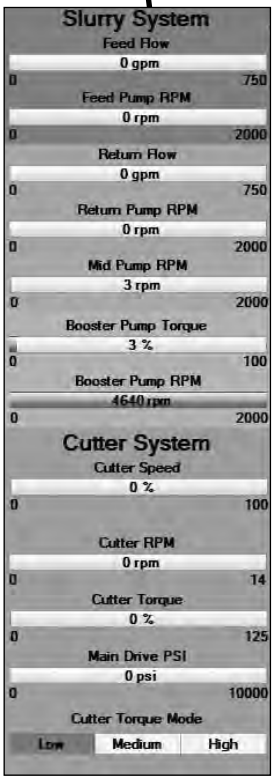
e. *Head Camera IP address*: identifier for the camera in the MTBM. Each device has a unique IP address, therefore, if the existing camera is replaced, a new IP address will be required.

f. *Time duration of one job*: click this box to reset the “This Job” timer to 0.

g. *Meter Maximum Value*: specifies the meter values on the target screen.

h. *Head Roll Range +/-*: change the degree setting to indicate the excessive clockwise roll (+) or counterclockwise (-) roll on the target screen. If roll exceeds setting, the cutter head rotation will stop and the hydraulic flow to the jacking frame will be shutoff. A message will be displayed on the Log Message window when roll exceeds parameters.





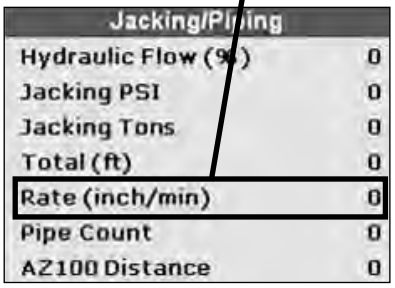
3. Misc Editor

This editor provides the value to calculate the pipe advance rate.

a. *Machine Length*: this is a factory set constant value of the actual length of the MTBM.

b. *Update Rate Interval*: this is the time interval in milliseconds to refresh the “Rate(in/min)” data on the target screen. One second equals 1,000 milliseconds.





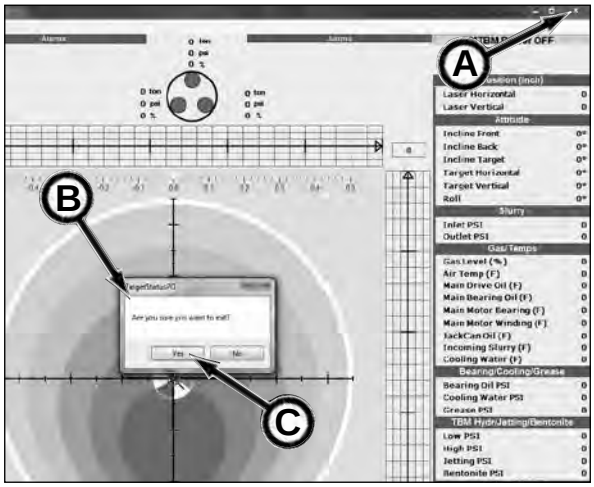
(continued on the next page)

DB BACKUP UTILITY PROGRAM



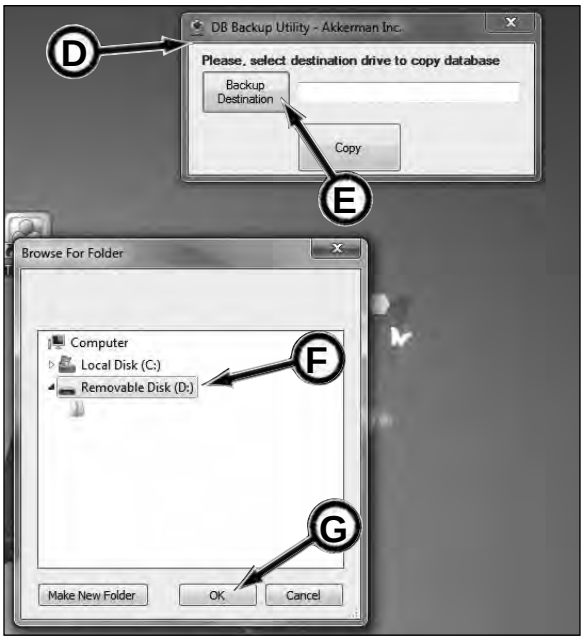
This computer system is equipped with a DB (database) Backup Utility program. This program will backup the SL82P database.

1. Insert an appropriate sized USB flash drive into one of the USB connection ports on the control console. The flash drive will appear as another storage device (Removable Disk) on your Windows Explorer (the operating system's file and folder manager) window.



2. With the target screen visible, Click X (A) to close the program.

3. The "Are you sure you want to exit?" window (B) appears. Click Yes (C) to backup database.



4. The DB Backup Utility window (D) appears. Click Backup Destination button (E) to select flash drive or other backup device for the database copy destination.

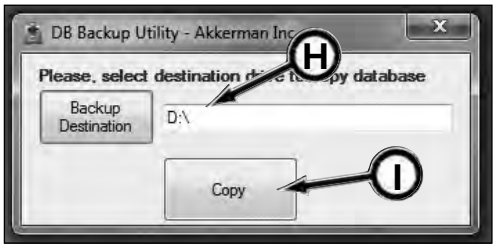
5. The Browse For Folder window appears. Click on your destination drive/folder (F) and then click OK button (G).

6. The DB Backup Utility window appears with the destination location (H).

7. Press Copy button (I).

8. Once the database is successfully copied to the destination drive, the program window will close.

9. Eject your flash drive by right clicking the flash drive (from Windows Explorer window) and select Eject or simply pull flash drive out of USB connection port.



10. The SL82P database backup is complete.

REMOVING MICROTUNNELING SYSTEM

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

When pipe line is complete and MTBM is in the reception shaft, remove the MTBM and the microtunneling system components as follows:

NOTICE Before removing the microtunneling system, be sure to review the Completion of Each Drive maintenance in section 9, Maintenance.



1. Move all main power switches (generator, control container, remote power pack, power container, etc.) to the OFF position.
2. LOCKOUT/TAGOUT power source(s). Push in ALL E-Stops.
3. Disconnect power cables from generator, control container, remote hydraulic power pack, power container, MTBM, bentonite pump, slurry pumps, flow meter and jacking frame.
4. Remove target from MTBM and place in storage box.
5. Remove gas detector from MTBM and place in storage box. Be sure to keep gas detectors and oxygen deficiency detectors in the pipeline and launch and reception shafts while personnel are working on the pipeline.
6. Remove hydraulic hoses from remote hydraulic power pack, jacking frame, and IJS.
7. Remove slurry lines (including slurry cooling tubes) from MTBM, slurry pumps, flowmeter, slurry pit assembly and separation plant.
8. Remove water hoses from water cooling system, water cooling tank, jacking frame and MTBM.
9. Remove communication lines from control container, remote hydraulic power pack and MTBM.
10. Remove ventilation lines from pipeline once it is determined that is is acceptable to remove them. Be sure to keep gas detectors and oxygen deficiency detectors in the pipeline and launch and reception shafts while personnel are working on the pipeline.
11. Remove bentonite lines from bentonite pump and MTBM.

(continued on the next page)



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

NOTICE Be sure to observe lifting instructions for each component. Refer to Lifting Instructions in the Transporting section for more information.



12. Remove MTBM and other components from reception shaft.
13. Remove other components from area around the reception shaft.



14. Remove jacking frame, skid, slurry pit assembly, slurry pumps and other components from the launch shaft.
15. Remove control container, remote hydraulic power pack, power container, slurry pumps, water cooling tank, bentonite pump and other components from area around the launch shaft.
16. Finish pipeline per job requirements such as; grout the annular space between the exterior pipe surface and the tunnel, install manholes (if required) and remove shoring etc. from the shafts and backfill them.

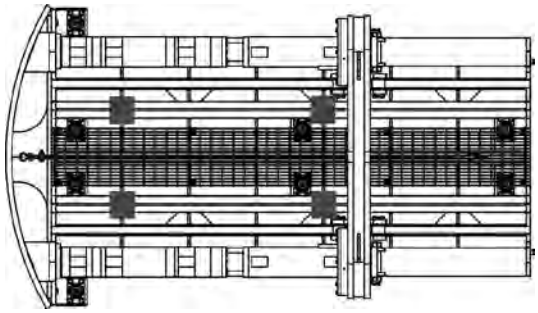
Transporting

TRANSPORTING GUIDELINES



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

Do not enter area under or around a load.



MT860K, MT875K, MT890K & MT8102K KEYHOLE JACKING FRAMES

⚠WARNING Shipping or lifting jacking frame without all cylinders fully retracted and locked, and the thrust block locked in last key (dog) position (as shown), can cause serious injury or death from sliding thrust block.



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



REPOSITION A/C-HEATER UNIT FOR TRANSPORT

BEFORE transporting the control container, the A/C-Heater unit must be retracted. Once repositioned, the unit MUST be secured with six 1/2 UNC x 1.25 flat socket head cap screws.

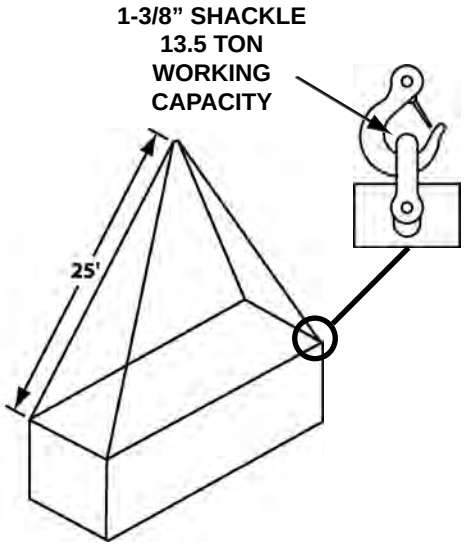


A/C Unit In Storage/Transport Position

LIFTING INSTRUCTIONS

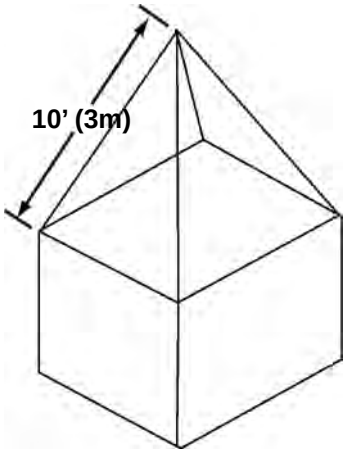
1. Control Container

- Container weight, with no auxiliary gear is 13,000 lbs. (5,897 kg).
- Lifting with a crane requires a four part sling with legs a minimum of 25 ft. (7.62 m) long.
- Container must lift freely. If it is stuck to the ground, it must be broken loose prior to lifting.
- Container lifting eyes and sling must be inspected prior to each lift. Any damage must be repaired prior to lifting.
- All container doors must be closed before lifting.



2. Remote Hydraulic Power Pack

- Container weight, with no auxiliary gear is 9,500 lbs. (4,309 kg).
- Lifting with a crane requires a four part sling with legs a minimum of 10 ft. (3 m) long.
- Container must lift freely. If it is stuck to the ground, it must be broken loose prior to lifting.
- Lifting eyes and sling must be inspected prior to each lift. Any damage must be repaired prior to lifting.
- All container doors must be closed before lifting.



(continued on next page)

3. Main Drive Power Container

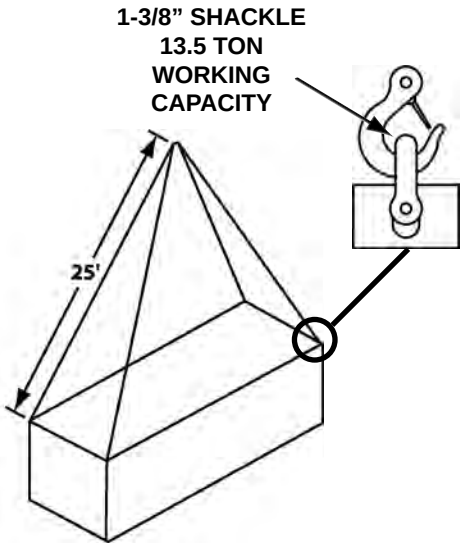
- Container weight, with no auxiliary gear is 15,500 lbs. (7,031 kg).

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

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

- Container lifting eyes and sling must be inspected prior to each lift. Any damage must be repaired prior to lifting.

- BEFORE lifitng, all container doors MUST be closed.



4. Keyhole Jacking Frame (MT860K, MT875K, MT890K, & MT8102K)

- Frame weight varies per jacking frame model. Be sure certified lifting devices are capable of lifting frame weight capacity. (Contact your Akkerman Aftermarket Support representative for more information.)

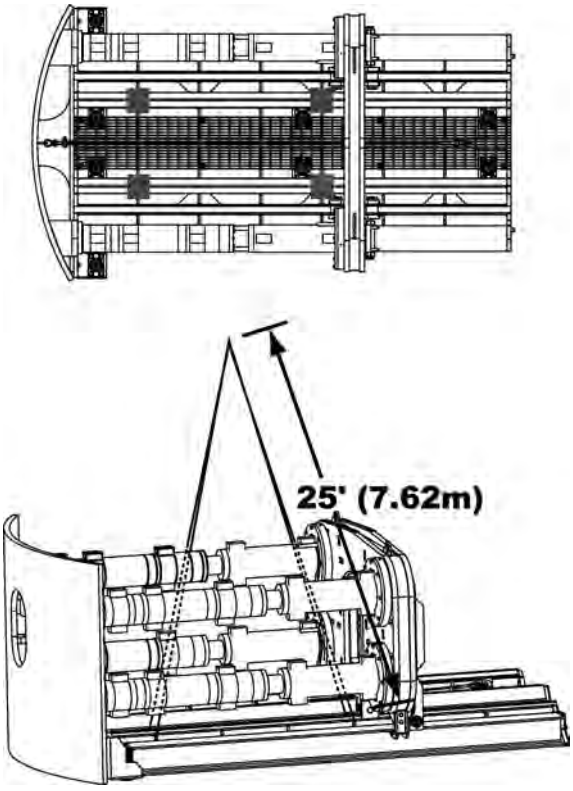
- Prior to lifting, cylinders must be fully retracted and locked, and the thrust block must be locked at last key (dog) position. Also, extensions MUST be removed.

- Lifting with a crane requires a four part sling with legs a minimum of 25 ft. (7.62 m) long, mounted at four locations (red) on the frame as shown on decal.

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

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

- If the jacking frame is equipped with extensions, follow the lifting instructions on the decal.



5. SL82P MTBM Front Section

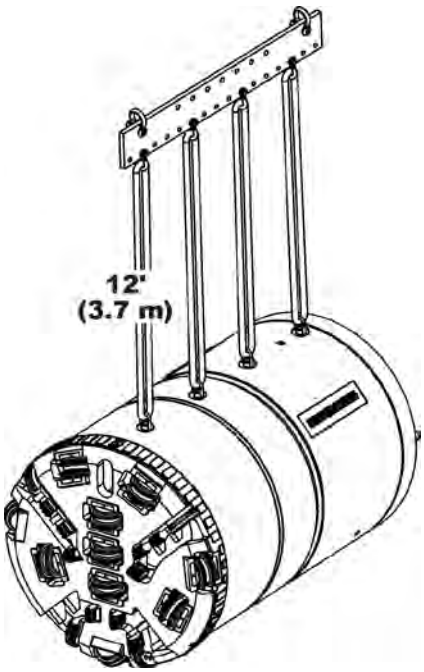
- SL82P MTBM front section weight is 50,000 lbs. (22,680 kg).

- Lifting with a crane requires a (lifting beam) spreader bar with four legs a minimum of 12 ft. (3.7 m) long.

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

- MTBM lifting eyes, lifting beam (spreader bar) and sling must be inspected prior to each lift. Any damage must be repaired prior to lifting.

- Lifting eyes must be tightened snugly against threaded insert before lifting.



It is highly recommended to use a lifting beam (spreader bar) when lifting the MTBM front section. In the event that there is low head room or the crane does not have the boom length to handle the 20ft. (6 m) leg lengths (see below), a lifting beam is required.

A four leg chain sling can be used to lift the MTBM as long as:
- the MTBM steering has been fully retracted
- a lifting sling with leg lengths equal to or greater than 20 ft. (6 m) is used
- the sling has an adequate lifting capacity
- the sling has adjustable sling hooks to snug up the short legs and they have been properly adjusted

NOTICE If using a four leg chain sling, there is a possibility that the steering cylinders may be damaged during the lifting process.

IMPORTANT: When lifting a MTBM with an increase kit from the reception shaft, the annulus inside the increase kit may have filled with water and/or soil. This may significantly increase the weight of the assembly. This additional weight must not exceed the lifting capacity of the lifting eyes or lifting device.

6. SL82P MTBM Trailing Section

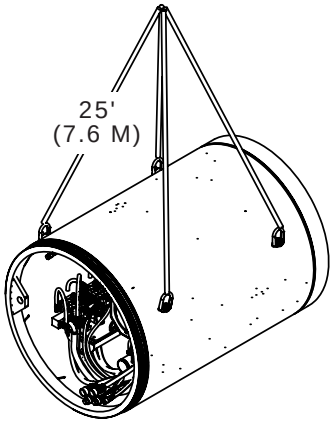
- SL82P MTBM trailing section weight is 24,000 lbs. (10,866 kg).

- Lifting with a crane requires a four part sling with legs a minimum of 25 ft. (7.6 m) long.

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

- MTBM lifting eyes, spreader bar and sling must be inspected prior to each lift. Any damage must be repaired prior to lifting.

- Lifting eyes must be tightened snugly against threaded insert before lifting.



7. SL82P MTBM Lube/Jacking Can

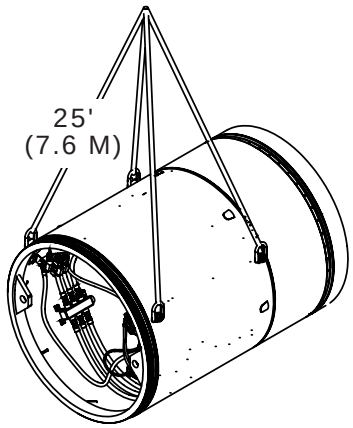
- SL82P MTBM lube/jacking can weight is 23,000 lbs. (10,433 kg).

- Lifting with a crane requires a four part sling with legs a minimum of 25 ft. (7.6 m) long.

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

- MTBM lifting eyes, spreader bar and sling must be inspected prior to each lift. Any damage must be repaired prior to lifting.

- Lifting eyes must be tightened snugly against threaded insert before lifting.



8. Cooling Water Tank

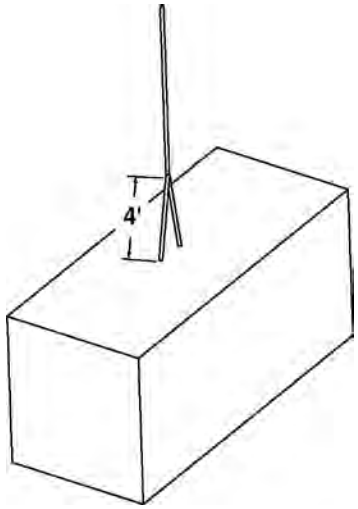
- Tank frame MUST be picked up empty.

- Frame weight, with no auxiliary gear is 2,200 lbs. (998 kg).

- Lifting with a crane requires a two part sling with legs a minimum of 4 ft. (1.22 m) long.

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

- Tank frame lifting eyes and sling must be inspected prior to each lift. Any damage must be repaired prior to lifting.



NOTES

Lubricants

NOTICE Use of inferior lubricants can affect the efficient performance of your microtunneling 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.

MTBM AUXILIARY HYDRAULIC RESERVOIR LUBRICANT

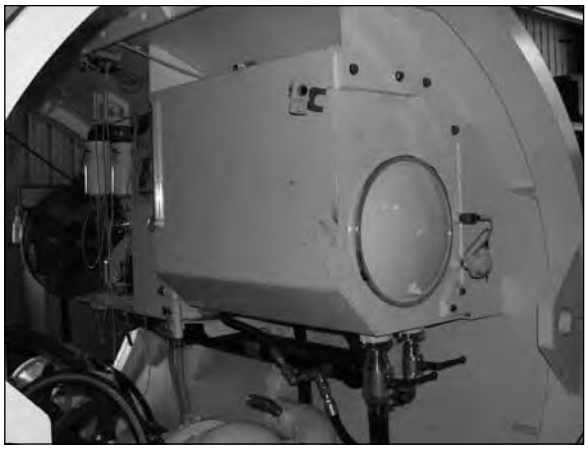


The MTBM auxiliary hydraulic reservoir (located in the front section) is filled with Tellus® Plus Oil 32, a premium AW hydraulic oil.

Use Tellus® Plus Oil 32 or equivalent when adding or changing lubricant. Tellus Plus oil is formulated with an effective anti-wear compound for hydraulic systems.

Oil capacity is approximately 5.5 US gal. (21 L).

MTBM MAIN DRIVE HYDRAULIC RESERVOIR LUBRICANT



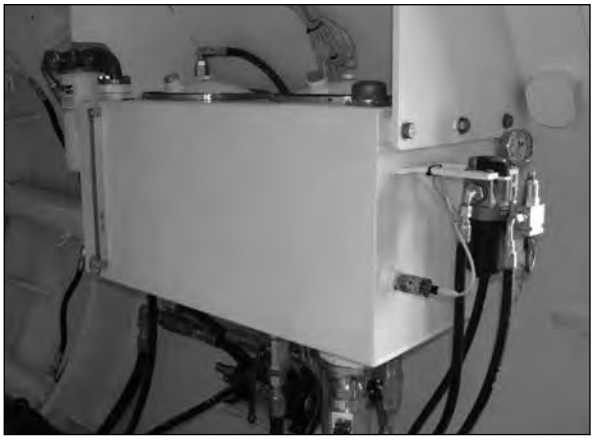
The main drive hydraulic reservoir is filled with ISO-VG-68 Premium Hydraulic Oil.

Use an API GL-1/GL-2 or equivalent when adding or changing lubricant.

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

Oil capacity is approximately 95 US gal. (360 L).

LUBE/JACK CAN HYDRAULIC RESERVOIR LUBRICANT



The lube/jack can hydraulic reservoir is filled with ISO-VG-46 Premium Hydraulic Oil.

Use an API GL-1/GL-2 or equivalent when adding or changing lubricant.

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.

Oil capacity is approximately 30 US gal. (114 L).

REMOTE HYDRAULIC POWER PACK RESERVOIR LUBRICANT



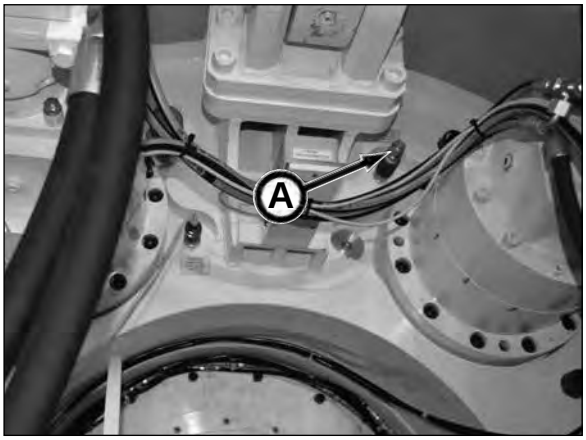
The power pack reservoir is filled with ISO-VG-46 20W Premium Hydraulic/Turbine Oil.

Use an API GL-1/GL-2 or equivalent when adding or changing lubricant.

NOTICE If you change to a different oil, use a reputable oil supplier to meet or exceed the ISO-VG-46 20W or API GL-1/GL-2 oil specification. Do not mix oil manufacturers or grades.

Oil capacity is approximately 330 US gal. (1,249 L).

BEARING CAVITY LUBRICANT



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

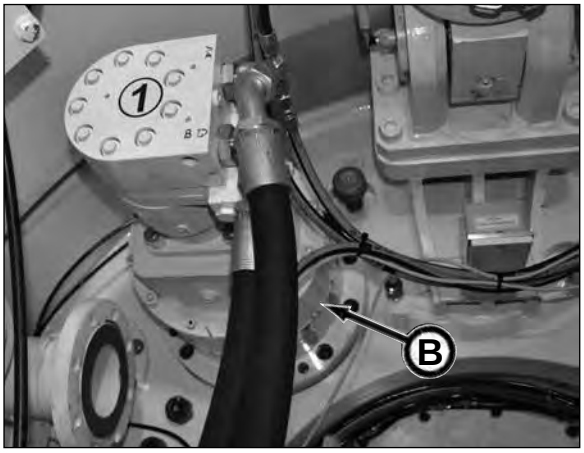
Use Mobilgear® 600XP 460 gear oil or equivalent when adding or changing lubricant. Oil must be visible in bearing cavity oil sight gauge.

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

Bearing cavity oil capacity is approximately 23 US gal. (87 L).

Bearing Cavity Check/Fill Port (A)

MAIN DRIVE PLANETARY GEAR BOX LUBRICANT



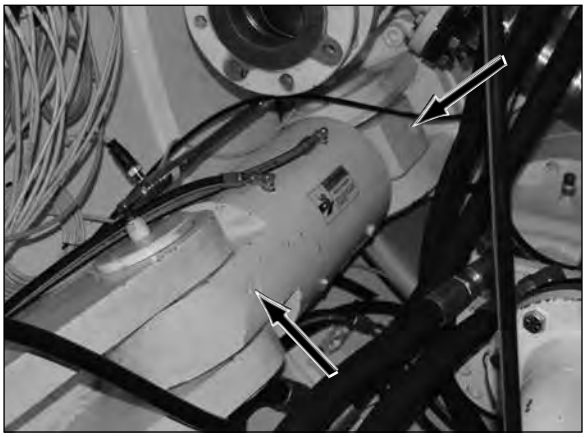
The main drive planetary gear boxes (B) are filled with Mobil SHC™ 630 Synthetic Bearing and Gear oil. This oil is formulated to provide extra protection for gears, bearings and seals.

Use Mobil SHC™ 630 gear oil or ISO-VG-220 oil equivalent when adding or changing lubricant. Oil must be visible in bearing cavity oil sight gauge.

NOTICE If you change to a different oil, use a reputable oil supplier to meet or exceed the Mobil SHC™ 630 oil specification. Do not mix oil manufacturers or grades.

Main drive planetary gear box oil capacity is approximately 3.3 qt (3.13 L).

GREASE



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

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

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

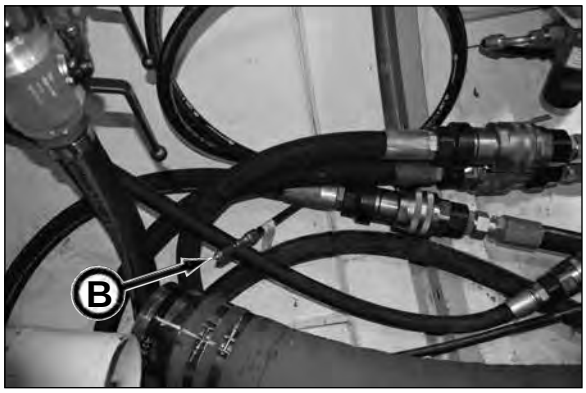
STEERING JOINT GREASE



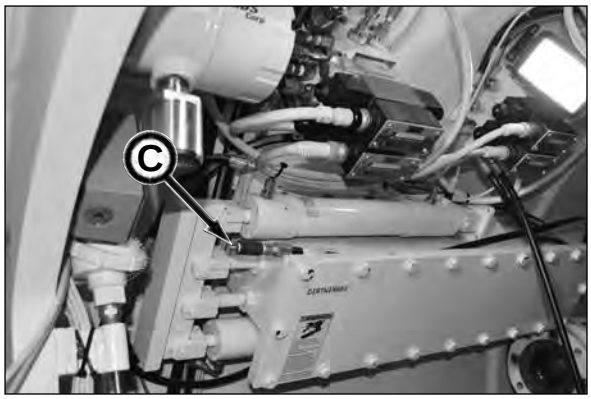
The steering joint (A) is greased with Mobil® SHC 101 EAL Grease. Use grease hose (B) to grease the steering joint.

This environmental awareness lubricant (EAL) is a multipurpose grease formulated for the lubrication of equipment in environmentally sensitive areas.

Use Mobil® SHC 101 EAL Grease or equivalent when lubricating the steering joint.



DIRT WING GREASE



The dirt wings are greased with Mobil® SHC 101 EAL Grease. Use grease hose (C) located on each dirt wing for greasing.

This environmental awareness lubricant (EAL) is a multipurpose grease formulated for the lubrication of equipment in environmentally sensitive areas.

Use Mobil® SHC 101 EAL Grease or equivalent when lubricating the dirt wings.

ELECTRIC MOTOR BEARING GREASE - MTBM

The 400 HP main drive motor (A) and booster pump motor (B) electric motor bearings are packed with Shell GadusRail® S2. Be sure to always verify the grease type listed on the nameplate prior to greasing motors.

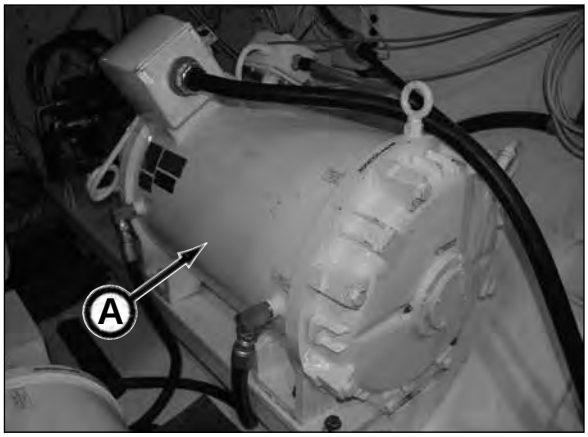
The motors require regreasing if the motor has been idle for 6 months, otherwise lubricate the bearings on an annual basis. Refer to section 9, Periodic Maintenance for more information.

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

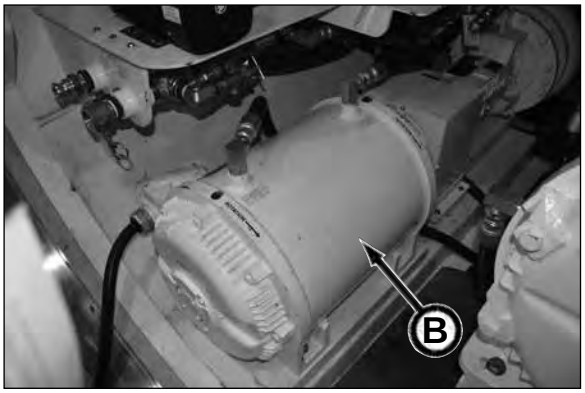
Use Shell GadusRail® S2 or equivalent when lubricating the motor bearings.

The following is a list of greases that may be used to lubricate the motor bearings. Not all of the listed grease types are compatible. **DO NOT** mix different grease types without prior approval from the motor manufacturer.

Grease Temp Operating Range F° (C°)	Brand Name
-22 to 350.6 (-30 to 177)	Chevron® SRI-2
-22 to 275 (-30 to 135	Shell GadusRail® S2
-22 to 302 (-30 to 150)	Moly Polyrex® EM
-4 to 599 (-18 to 315)	Davley Darmex® RPL-707
65.2 to 248 (-54 to 120)	Esso Beacon® 325
-0.4 to 550.4 (-18 to 288)	Molykote® 41
-40 to 399.2 (-40 to 399.2)	Molykote® 44



MTBM Main Drive Motor



MTBM Booster Pump Motor

ELECTRIC MOTOR BEARING GREASE - LUBE/JACKING CAN

The lube/jacking can main hydraulic motor (C) electric motor bearings are packed 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 motor bearings. Refer to section 9, Periodic Maintenance for more information.



Lube/Jacking Can Main Hydraulic Motor

GREASE PUMP LUBRICANT

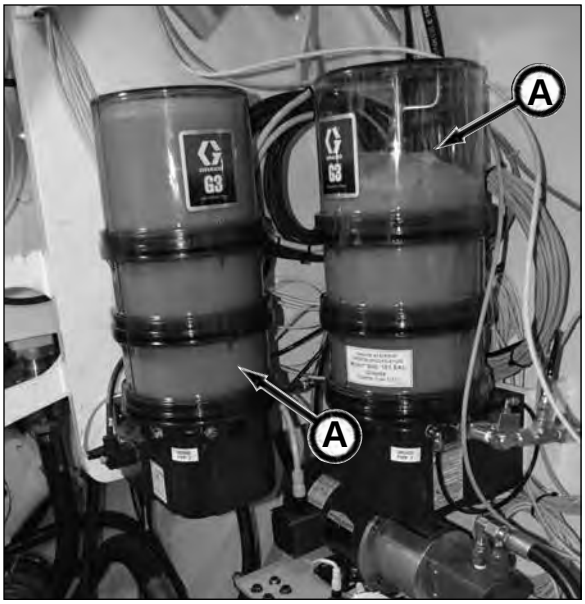
The grease pumps (A) are filled with Mobil® SHC 101 EAL Grease. The grease pump lubricates the bearing cavity lip seals and labyrinth seals.

The Mobil® SHC 101 EAL (Environmental Awareness Grease) Grease is a multipurpose grease formulated for the lubrication of equipment in environmentally sensitive areas.

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

DO NOT operate MTBM when the grease pump is out of grease.

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



WATER COOLING SYSTEM TANK

The water cooling system tank is filled with clean water.

Water capacity is approximately 40 US gal. (151 L).

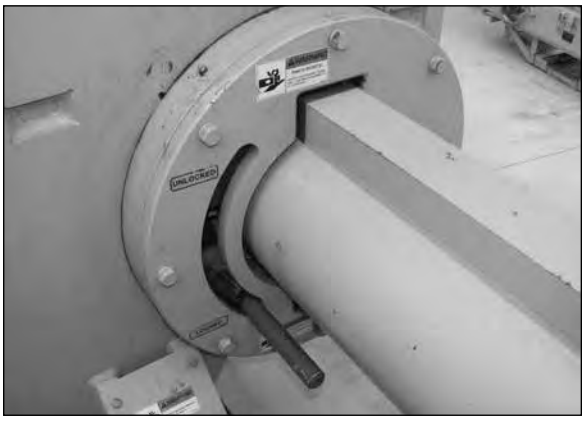


KEYHOLE JACKING FRAME CAM LOCK LUBRICANT

The keyhole jacking frame cam locks are lubricated with Lubriplate® 1200-2 heavy duty, lithium grease.

The Lubriplate® 1200-2 heavy duty, lithium grease provides a high film strength, great shear stability, anti-wear and extreme pressure additives.

Use Lubriplate® 1200-2 heavy duty, lithium grease or equivalent when lubricating the cam locks.

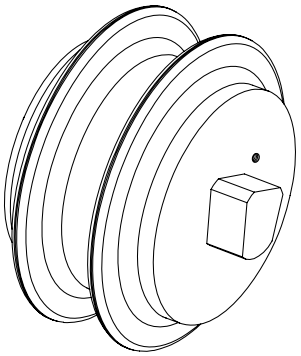


CUTTER BEARING LUBRICANT

The cutter bearings are factory lubricated with Mystik® JT7 85W-140 oil.

The Mystik® JT7 85W-140 oil is a thermally stable gear lubricant with exceptional durability under high temperature conditions.

Use Mystik® JT7 85W-140 oil or equivalent when lubricating the multi-disc cutter bearings.



NOTICE After adding lubricant to cutter, be sure drain plugs are in place before mounting cutter to cutter head.



NOTICE When the cutters are fully filled with oil, the cutters MUST be stored in a cool location, out of direct sunlight. If any cutter leaks oil from either end, new seals MUST be replaced in the cutter.

HIGH PRESSURE JETTING PUMP LUBRICANT



NOTICE For more information, refer to Aplex SC-115 user manual.

The high pressure jetting pump is filled with a 75-90W non-detergent gear oil.

Use a high quality SAE Grade 40 non-detergent industrial turbine oil when adding or changing lubricant.

Oil capacity is approximately 15 US quarts (14.2 L).

WATER TANK FOR HIGH PRESSURE JETTING PUMP



The water tank is filled with clean water.

Water capacity is approximately 1,685 US gal. (6,378 L).

SLURRY PUMP BEARING LUBRICANT



The feed, return, and booster pump bearings are lubricated with Mobilgrease® XHP222 Premium Lubricating Grease.

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

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

STORING LUBRICANTS



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

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

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

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

NOTES

Periodic Maintenance

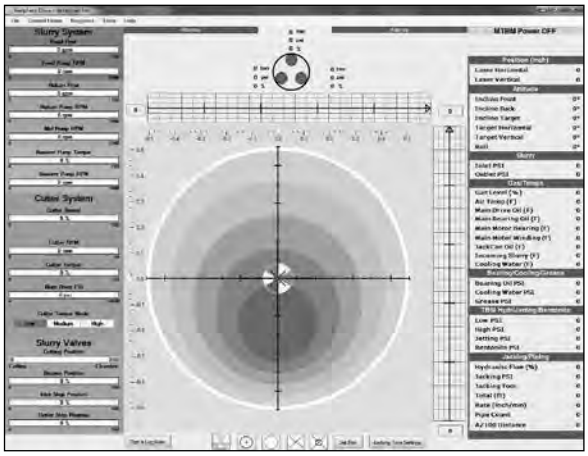
⚠WARNING Review the Safety section in this manual before performing maintenance. Failure to do so, could cause severe injury or death.

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

LUBRICATION & MAINTENANCE INTERVALS

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

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



LOCKOUT TAGOUT POWER BEFORE SERVICING

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

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



BEFORE PERFORMING MAINTENANCE

1. Push in all E-Stop button(s).

2. Relieve hydraulic pressure.

3. Disable accumulator prior to performing maintenance.

3. Perform appropriate electrical system maintenance shutdown procedure. Refer to Daily Shut Down in the Operation section.

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

5. **Lockout tagout all power. Perform lock out/tag out procedure.**

HYDRAULIC OIL/FLUIDS UNDER PRESSURE

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



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

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

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

AVOID PINCH POINTS

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



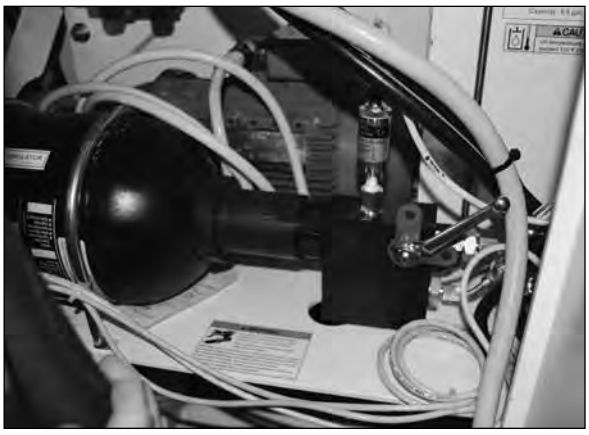
Keep hands away from moving parts.

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

Handle parts carefully to avoid crushing and pinch point hazards.

DISABLE ACCUMULATOR PRIOR TO MAINTENANCE

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



The hydraulic accumulator stores high pressure fluid. If any maintenance is to be performed or when hoses are connected or disconnected on the auxiliary bypass and/or stop valves, the accumulator **MUST** be fully discharged prior to servicing the components to prevent accidental accumulator activation.

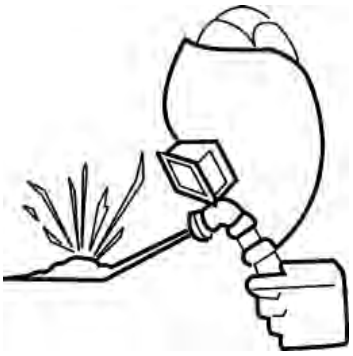
Refer to Accumulator in the Controls & Instruments section of this manual for details on how to properly disable the accumulator.

WELDING

UNAUTHORIZED WELDING

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

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



WELDING ON MTBM STRUCTURE

NOTICE Welding on MTBM structure will damage the GASMAX gas detector.

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

HOW TO USE THIS SECTION

The microtunneling system is comprised of several components, all of which require extensive periodic maintenance to keep the system in proper operation. It is critical that the maintenance is followed and performed by a qualified service technician. If at any time while performing maintenance, a doubt or question arises, contact your Akkerman Aftermarket Support representative for assistance.

The maintenance listing below designates the pages where the specific maintenance charts and accompanying maintenance detailed procedures are located. This listing also provides a quick reference to make it easier for you to go back to specific component maintenance areas.

PRIOR TO EACH DRIVE LAUNCH
- 9-5 MTBM Maintenance Chart
- 9-8 Detailed Maintenance Procedures

- 9-52 Control Container Maintenance Chart
- 9-53 Detailed Maintenance Procedures

- 9-64 Remote Power Pack Maintenance Chart
- 9-65 Detailed Maintenance Procedures

- 9-76 Main Drive Power Container Maintenance Chart
- 9-77 Detailed Maintenance Procedures

- 9-82 Water Cooling Tank Maintenance Chart
- 9-83 Detailed Maintenance Procedures

- 9-84 Keyhole Jacking Frame Maintenance Chart
- 9-85 Detailed Maintenance Procedures

- 9-90 Slurry Pumps Maintenance Chart
- 9-91 Detailed Maintenance Procedures

- 9-95 Flow Meter Maintenance Chart
- 9-96 Detailed Maintenance Procedures

- 9-98 High Pressure Jetting Pump Maintenance Chart
- 9-99 Detailed Maintenance Procedures

- 9-104 MTBM Disc Cutters & Scrapers Maintenance Chart
- 9-105 Detailed Maintenance Procedures
- 9-109 TunnelTec Disc Cutter Maintenance Instructions

DAILY OR EVERY 10 HOURS OF OPERATION
- 9-116 Microtunneling System Maintenance Chart
- 9-117 Detailed Maintenance Procedures

AFTER FIRST 50 HOURS OF OPERATION, THEN EVERY 500 HOURS THEREAFTER
- 9-124 Microtunneling System Maintenance Chart
- 9-125 Detailed Maintenance Procedures

AFTER FIRST 100 HOURS OF OPERATION, THEN EVERY 1000 HOURS THEREAFTER
- 9-124 Microtunneling System Maintenance Chart
- 9-125 Detailed Maintenance Procedures

MONTHLY OR EVERY 250 HOURS OF OPERATION
- 9-126 Microtunneling System Maintenance Chart
- 9-127 Detailed Maintenance Procedures

FIRST 250 HOURS OF OPERATION, THEN EVERY 500 HOURS THEREAFTER
- 9-126 Microtunneling System Maintenance Chart
- 9-128 Detailed Maintenance Procedures

YEARLY OR EVERY 500 HOURS OF OPERATION
- 9-130 Microtunneling System Maintenance Chart
- 9-131 Detailed Maintenance Procedures

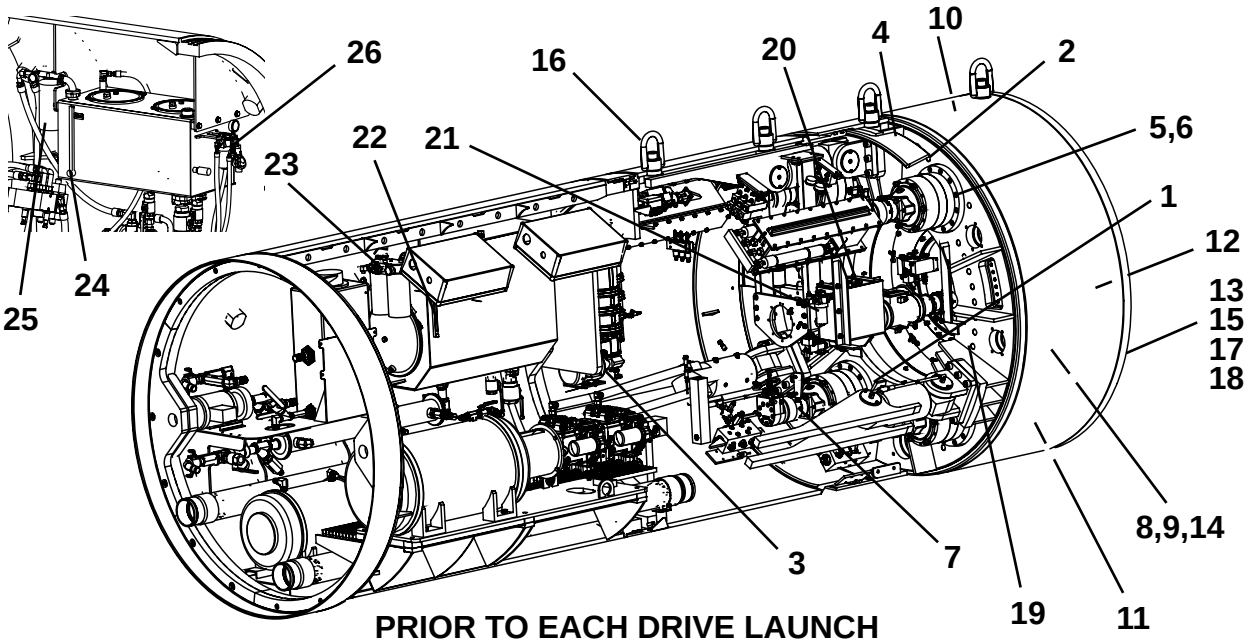
YEARLY OR EVERY 1000 HOURS OF OPERATION
- 9-134 Microtunneling System Maintenance Chart
- 9-135 Detailed Maintenance Procedures

COMPLETION OF EACH DRIVE
- 9-144 Microtunneling System Maintenance Chart
- 9-146 Detailed Maintenance Procedures

MAINTENANCE CHARTS - MTBM

IMPORTANT: The maintenance charts shown in this section are a collection of maintenance items with detailed maintenance procedures for the microtunneling system. The maintenance for the Control Container, Remote Hydraulic Power Pack, Power Container, slurry pumps, etc are found later in this section.

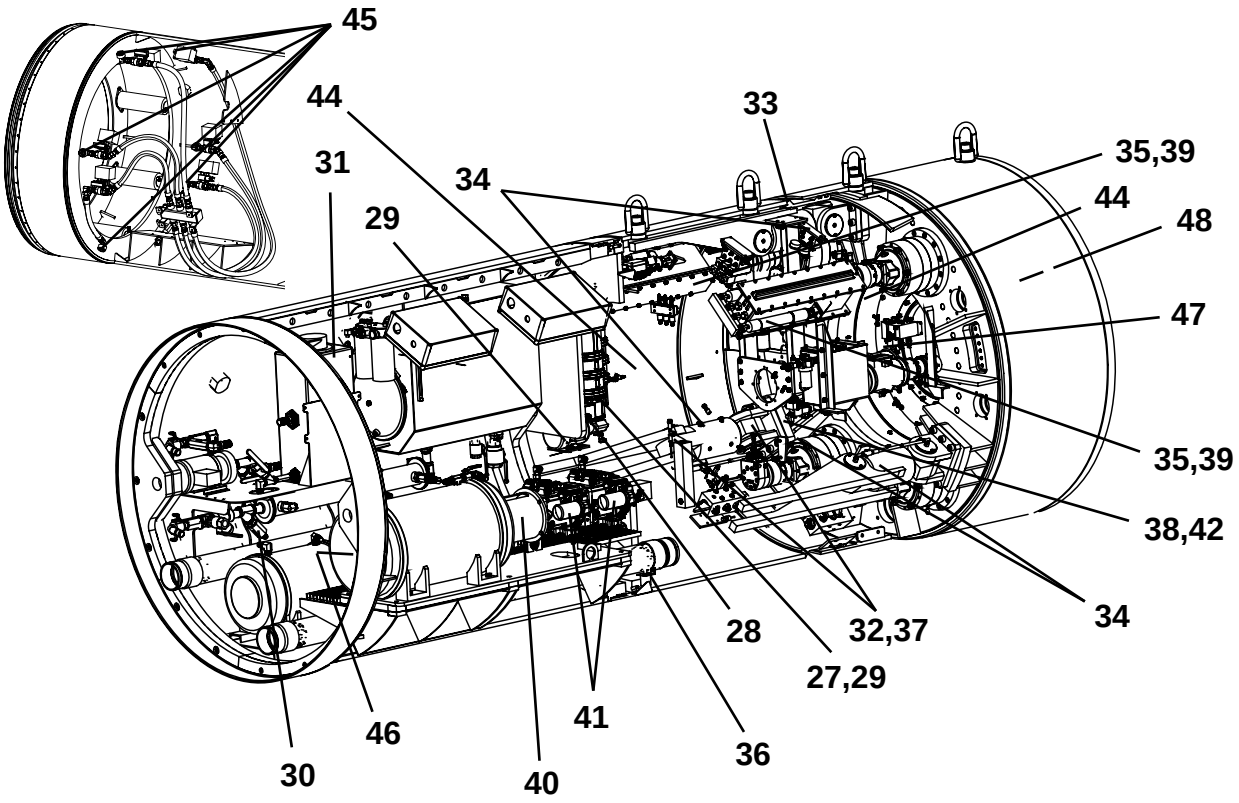
NOTICE Use the item number in the chart to refer to the detailed maintenance procedures in the following pages.



PRIOR TO EACH DRIVE LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Bearing Cavity	Inspect Oil Quality If contaminated, drain & fill.	If contamination is present, drain oil, inspect seals/bearing & fill with new oil.	Mobilgear® 600XP 460
2.	Bearing Cavity	Check Lubricant Level	Lube must be at check port.	Mobil 600XP 460
3.	Bearing Lube Filter	Check Filter	Replace as needed.	
4.	Bearing Cavity Vent	Check		
5.	Gear Boxes	Inspect Oil Quality	If contamination is present, drain oil,	Mobil 600XP 460
6.	Gear Boxes	Check Mounting Bolts	See detail for proper torque.	
7.	Drive Motors	Check Mounting Bolts	See detail for proper torque.	
8.	Lip Seals/Wear Ring	Inspect Seal Condition	If damaged, replace with new.	
9.	Lip Seals	Greasing	Grease must pass through seals.	
10.	Slurry Cutting Noz.	Inspect Nozzles	Clean if necessary.	
11.	Slurry Chamber Noz.	Inspect Nozzles	Clean if necessary.	
12.	Crushing Cone	Inspect Hardface Weld		
13.	Crushing Cone	Check Mounting Hardware	See detail for proper torque.	
14.	Outer Lip Seal Ring	Torque Retaining Ring Bolts	3/8” Bolts - 36 ft-lb torque	Torque Wrench
15.	Cutterhead	Cutterhead Installation	See detail for proper installation.	
16.	Lift Eyes	Inspect	If damaged, replace with new.	
17.	Disc Cutters	Inspect/Lube	Perform maintenance.	Mystik® JT7 85W-140 Oil
18.	Drag Bit	Bolt Torque	Tighten to 460 ft-lb torque.	Torque Wrench
19.	Drive Assy To Can	Check Bolt Torque	1-1/4” SHCS-1,500 ft-lb	Torque Wrench
20.	Aux. Hyd. Pwr Pack	Check Reservoir Oil Level	Oil Capacity 5.5 gal.	Tellus Plus Oil 32
21.	Aux. Hyd. Pwr Pack	Check Filter Indicator	Replace per indicator.	
22.	Main Hyd. Pwr Pack	Check Reservoir Oil Level	Oil Capacity 95 gal.	ISO-VG-68
23.	Main Hyd. Pwr Pack	Check Filter Indicator	Replace per indicator.	
24.	Lube/Jack Can Res.	Check Reservoir Oil Level	Oil Capacity 30 gal.	ISO-VG-46
25.	Lube/Jack Can Res.	Check Return Filter Indicator	Replace per indicator.	
26.	Lube/Jack Can Res.	Check Press. Filter Indicator	Replace per indicator.	

(continued on next page)



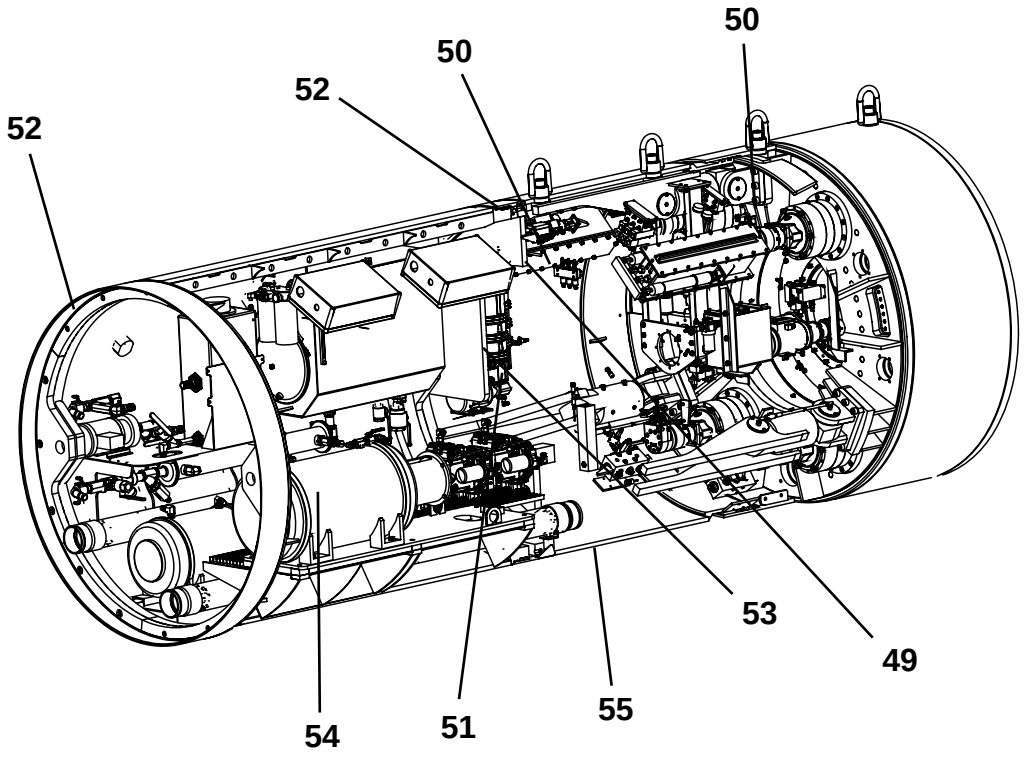
PRIOR TO EACH DRIVE LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
27.	Grease Pump	Fill (2) Containers	3 gal. (11 L) per container	SHC 101 EAL**
28.	Grease Pump Filter	Replace Grease Filter		
29.	Grease/Lube Pumps	Check Operation	Operation with Head Rotation	
30.	Water Cool System	Clean Strainer		
31.	Water Cool System	Fill Tank	40 gal. (151 L)	
32.	Steering Cyl. Pins	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
33.	Steering Joint Seals	Inspect, Lubricate, Clean	SL82P - 1 tube	SHC 101 EAL**
34.	Steering Compnts.	Check for Cracks/Wear	If damaged, repair before operation	
35.	Dirt Wing Cavity	Lubricate	Lubricate until grease is forced out.	SHC 101 EAL**
36.	Submersible Pump	Test Operation		
37.	Steering Cylinders	Calibrate Linear Transducers	Stroke reading: 0 to 100% each cyl.	
38.	Slurry Valve Cyls.	Calibrate Linear Transducers	Stroke reading: 0 to 100% each cyl.	
39.	Dirt Wing Cylinders	Calibrate Linear Transducers	Stroke reading: 0 to 100% each cyl.	
40.	Main Drive Motor	Verify Motor Rotation		
41.	Hydrostatic Pump	Check Filters (2)	Replace as needed.	
42.	Slurry Valves	Check Operation		
*43.	Hoses, Cables & Slurry Lines	Inspect	Replace if damaged. Connections: securely fastened.	
44.	Light	Check Operation		
45.	Bentonite Ports	Inspect	Clean if necessary.	
46.	HP Jetting Assembly	Clean Strainer		
47.	Accumulator	Check Operation		
48.	H.P. Jet Nozzles & Hoses	Inspect	If damaged, replace with new. Replace if cracks/wear visible.	

* Not Shown

** Mobil® SHC 101 EAL Grease

(continued on next page)



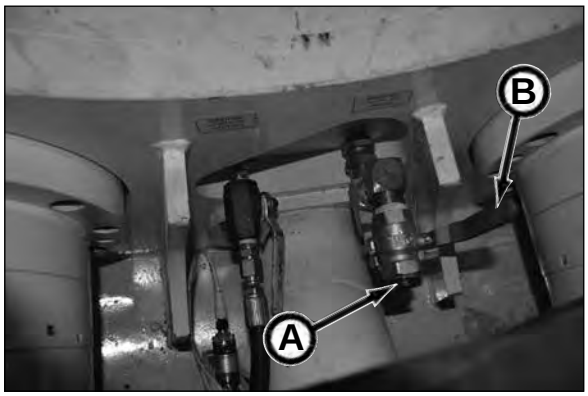
PRIOR TO EACH DRIVE LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
49.	Gas Detector	Test Operation	See Gas Detection Manual	
50.	Inclinometers	Calibrate		
51.	Target	Clean & Check Roll Incline	Use mild, abrasive-free cleaning solution and scratch free cloth	
52.	Coupling Sleeve & Orings	Inspect & Lubricate	If damaged, replace with new.	
53.	Head Temp. Sensor	Verify Temp At Target Scrn.		
54.	Drive Motor Temp.	Verify Temp At Target Scrn.		
55.	Structure	Inspect For Cracks/Wear	Repair before operation.	
*56.	Decals	Inspect	Must be legible. Replace as needed.	

* Not Shown

1. CHECK BEARING CAVITY OIL CONDITION

Check the oil condition of the bearing cavity by draining a measured sampling of the oil.

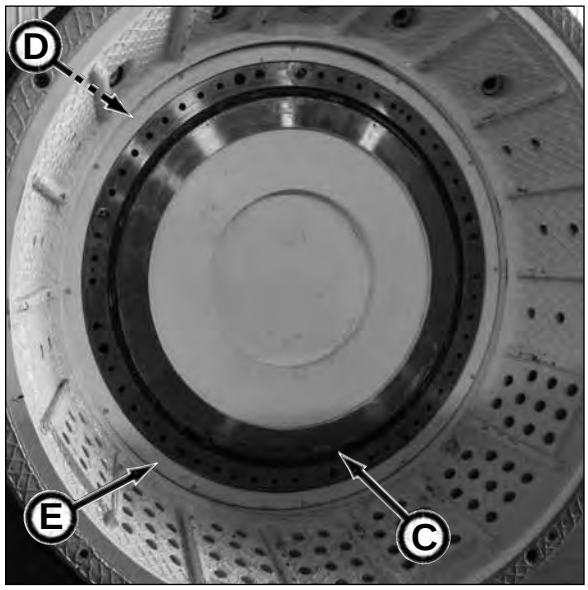


1. Be sure to the clean the area around the bearing cavity oil drain plug (A) before removing to prevent contamination from entering bearing cavity.

2. Remove drain plug and install a hose to shutoff valve. Route hose to a clean container.

3. Open shutoff valve (B) to dispense an appropriate oil sample.

4. Close bearing cavity oil drain shutoff valve.



5. Inspect the drained oil for contaminants.

   • If water and/or grease is visible in the oil, the inner lips seals (C) and outer lip seals (D) are damaged and must be replaced. See 2. Inspect Lip Seals in this section.

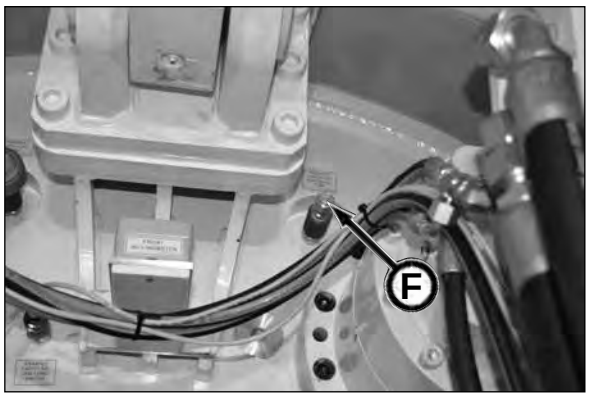
   • With any contamination, the bearing cavity must be completely drained and refilled with fresh, clean Mobilgear® 600XP 460 oil, once the lip seals are replaced.

   • Check the lip seal retaining ring (E) for damage. If ring has excessive damage, replace with new.

6. Replenish bearing cavity of the volume of oil drained when checking the condition of the oil (from step 3). Use fresh, clean Mobilgear® 600XP 460 oil. Replace fill port plug.

7. Remove hose from shutoff valve and replace drain plug.

2. CHECK BEARING CAVITY OIL LEVEL

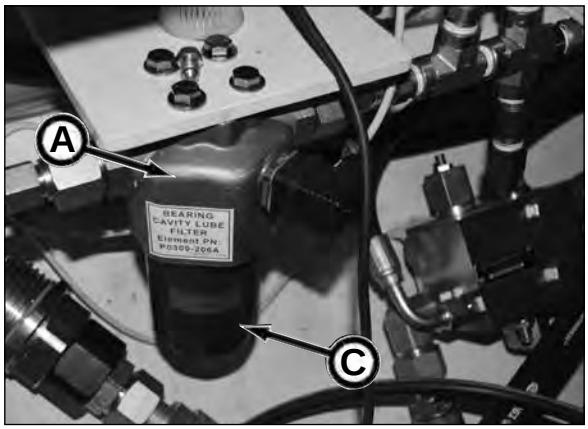


1. Check bearing cavity oil level by removing check/fill port plug (F). If oil is not at check/fill port, add Mobilgear® 600XP 460 oil until oil level is at port hole.

2. Replace check/fill port plug.

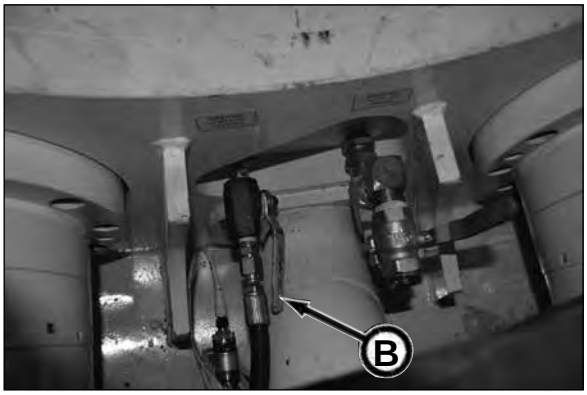
3. CHECK BEARING CAVITY OIL FILTER

To prevent under or over servicing of the bearing cavity oil lube filter, a sensor is installed in the filter head assembly (A). If the filter becomes plugged a ***Bearing Oil Filter Plugged*** alarm message will be displayed on the target screen.



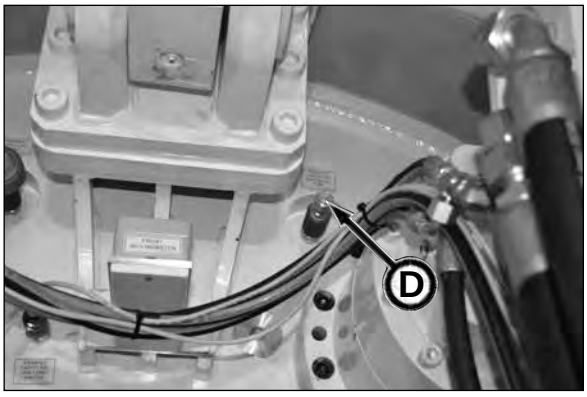
If filter requires replacement, perform the following procedure:

1. With the power locked out, clean and dry area around filter assembly.
2. Close bearing cavity oil shutoff valve (B). This will prevent bearing cavity from draining an excessive amount of oil.

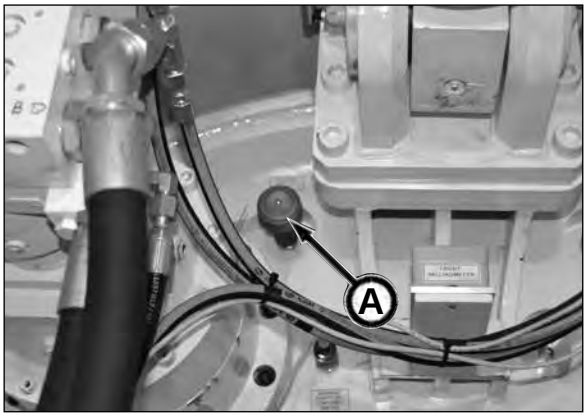


3. Remove filter housing (C) from filter head using an oil filter wrench.
4. Remove filter from housing and dispose of filter properly.
5. Remove filter o-ring if stuck in filter housing.
6. Install new o-ring with a light coat of clean oil. Check to be sure the o-ring is not twisted and that it is correctly in place.
7. Install new filter until gasket makes contact with filter head.
8. Replace and secure filter housing to filter head assembly using an oil filter wrench.
9. **Open bearing cavity oil shutoff valve (B).**

IMPORTANT: Failure to open bearing oil cavity shutoff valve before operating MTBM WILL cause bearing and bearing lube circuit component damage since the bearing oil will not be recirculating.



10. Check for leaks.
11. Check bearing cavity oil level. Oil must be level with the check/fill port hole (D). If not add Mobilgear® 600XP 460 until level with port hole (refer to 2. Check Bearing Cavity Oil Level in this section).

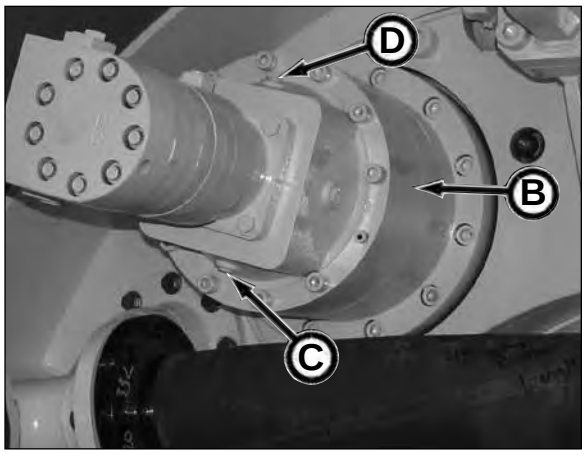


4. CHECK BEARING CAVITY VENT

Check bearing cavity vent (A) for dirt or debris build-up. Clean vent or replace if it shows signs of wear or damage.

5. CHECK MAIN DRIVE PLANETARY GEAR BOX OIL CONDITION

Check the oil condition of the main drive planetary gear box (B) by draining a measured sampling of the oil.

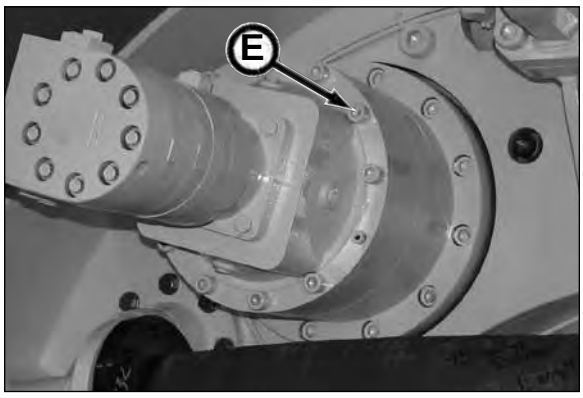


1. Be sure to the clean the area around the gear box oil drain plug (C) before removing to prevent contamination from entering gear box.
2. Loosen drain plug and dispense an appropriate oil sample into a clean container.
3. Tighten drain plug.
4. Inspect the drained oil for contaminants.

   • With any contamination, the planetary gear box must be completely drained and refilled with fresh, clean Mobilgear® 600XP 460 oil or equivalent.

   • If excessive metal particles are found, the gear box will require maintenance. Contact your Akkerman Aftermarket Support representative for more information.

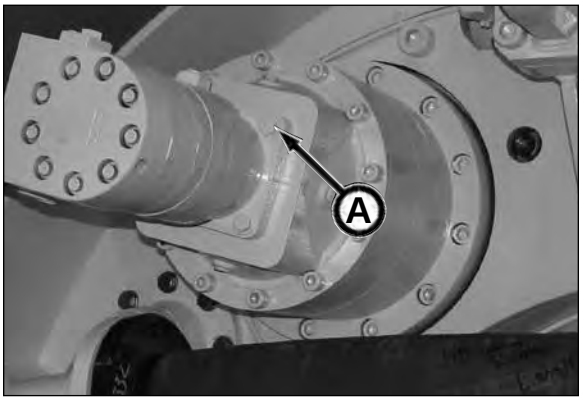
5. Remove fill port plug (D) to replenish the gear box of the volume of oil drained when checking the condition of the oil (from step 2). Use fresh, clean Mobilgear® 600XP 460 oil or equivalent. Replace fill port plug.
6. Check the oil condition on the other planetary gear boxes following steps 1 through 5.



6. CHECK GEAR BOX MOUNTING BOLTS

With a calibrated torque wrench, check gear box mounting bolts (E) for proper tightness. Tighten 3/4 UNC x 3.5 SHCS bolts* to 310 ft-lb (420 N·m) torque.

* lubricated with anti-seize lubricant



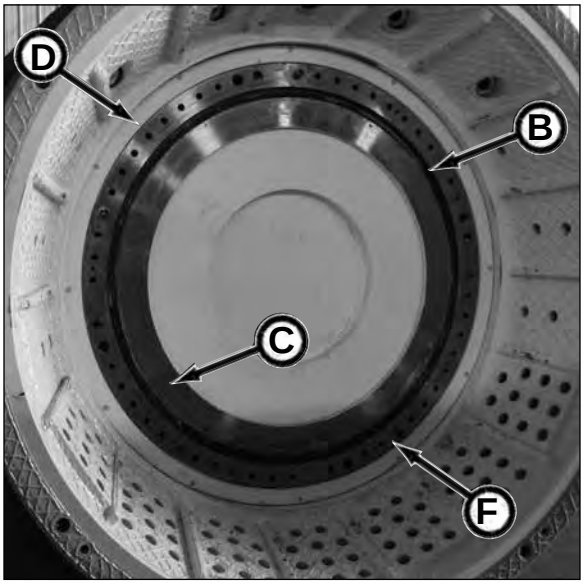
7. CHECK DRIVE MOTOR MOUNTING BOLTS

With a calibrated torque wrench, check drive motor mounting bolts (A) for proper tightness. Tighten 5/8 UNC x 1.75 Hex bolts* to 175 ft-lb (237 N·m) torque.

* lubricated with anti-seize lubricant

8. INSPECT LIP SEALS & WEAR RINGS

NOTICE It is recommended to replace the lip seals with <u>any</u> signs of contamination.

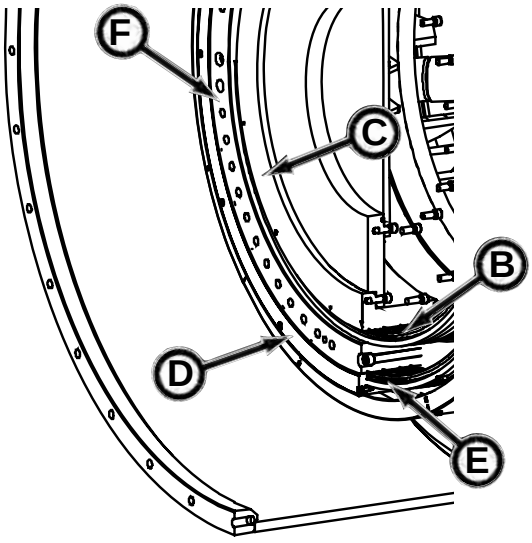


NOTICE Precise lip seal replacement is critical to prevent contamination from entering the bearing cavity. The lip seal replacement MUST be performed by an experienced technician. Contact your Akkerman Aftermarket Support representative for lip seal replacement.

1. With cutterhead removed, inspect inner lip seals (B) for wear, cracking or other damage. If seals show signs of damage, the lip seals MUST be replaced.

2. Inspect inner wear ring (C) for excessive wear, grooves or damage. If wear or damage is present, the wear ring must be replaced with new.

3. Remove outer lip seal retaining ring (D). Inspect ring for excessive wear or damage. If wear or damage is present, the ring must be replaced with new.



4. Inspect outer lip seals (E) for wear, cracking and other damage. If seals show signs of damage, the lip seals MUST be replaced. Replace lip seals if necessary.

5. Inspect outer wear ring (F) for excessive wear or damage. If wear (grooves) or damage is present, the wear ring must be replaced with new.

6. Replace outer lip seal retaining ring with twelve 3/8 UNC x .75 socket head cap screws and tighten to 36 ft-lb (49 N·m) torque.

9. CHECK LIP SEAL GREASING

The bearing cavity lip seals must be lubricated while the cutterhead is rotating to prevent contamination (dirt) from entering bearing cavity. Excess grease is removed at the front face through twelve grease ports on the inner lip seals and twelve grease ports on the outer lips seals. Check for proper lip seal greasing as follows:

1. With the cutterhead removed and grease in the grease pumps, manually start grease pump 1 by clicking Grease System Pump #1 Start button (A).

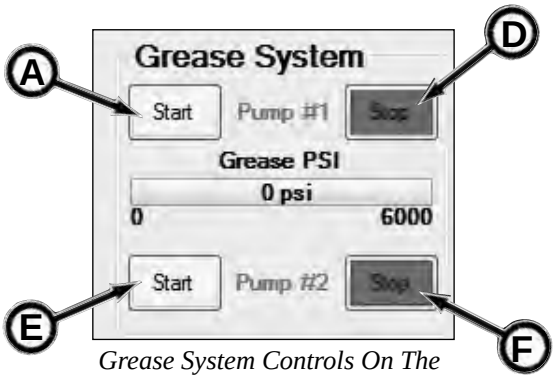
2. Check that grease is visible on the front face areas of the cutterhead. Grease must be visible at the inner lip seal area (B) AND the outer lip seal area (C). This will assure that the grease path is open to properly lubricate the lip seals. If grease is not visible in both areas, the problem must be resolved before mining with MTBM.

3. Click Grease System Pump #1 Stop button (D).

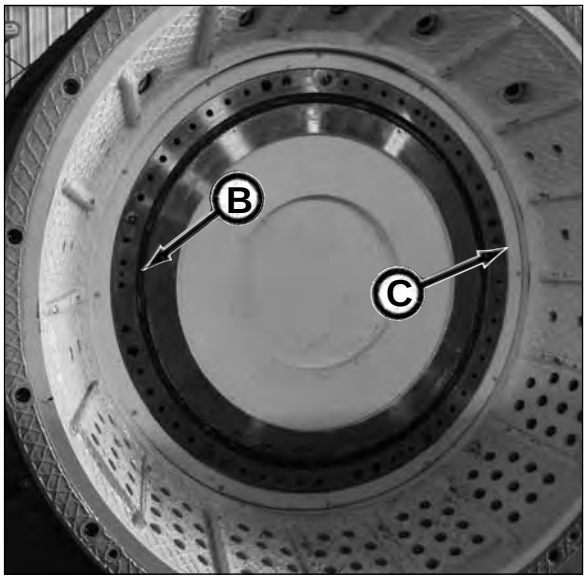
4. Click Grease System Pump #2 Start button (G).

5. Check that grease is visible on the front face areas of the cutterhead. Grease must be visible at the inner lip seal area (B) AND the outer lip seal area (C). This will assure that the grease path is open to properly lubricate the lip seals. If grease is not visible in both areas, the problem must be resolved before mining with MTBM.

6. Click Grease System Pump #2 Stop button (F).



Grease System Controls On The MTBM Control Screen



NOTICE If oil is visible with the flushed grease on the front face of the cutterhead, the lip seals have failed. In this case, the bearing cavity must be flushed, the lip seals must be replaced, and the bearing cavity filled with fresh, clean Mobilgear® 600XP 460 gear oil.

NOTICE It is recommended to replace the lip seals with any signs of contamination.

10. INSPECT SLURRY CUTTING NOZZLES

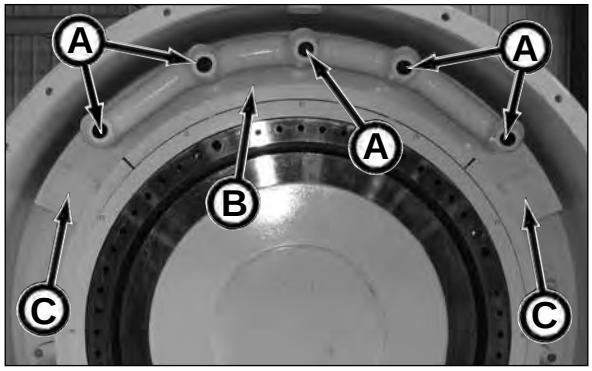
1. Remove cutterhead and crushing cone.

2. Inspect slurry cutting nozzles (A) for damage, wear or plugging.

3. If nozzles are damaged or worn, repair or replace as needed.

4. If nozzles are plugged:
   a. Remove cutting nozzle manifold (B) cleanout covers (C).
   b. Flush the nozzles and the manifold using a garden hose or pressure washer (output maximum of 100 psi). The water will drain out of the manifold cleanout cover openings.
   c. **REPLACE CLEANOUT COVERS!** Failure to replace cutting nozzle manifold cleanout covers will render the cutting nozzles useless during operation.

5. Proceed to inspect/clean slurry chamber nozzles before reinstalling crushing cone.

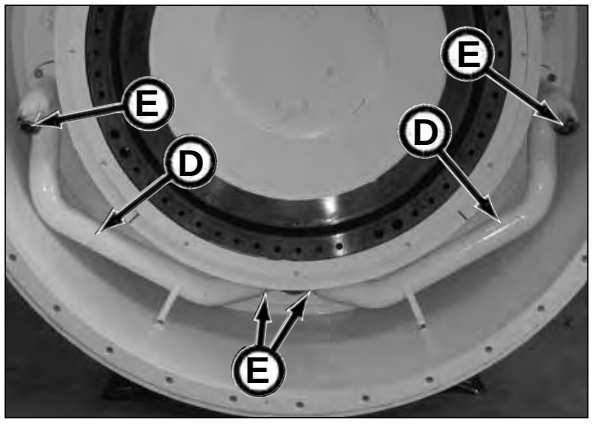


11. INSPECT SLURRY CHAMBER NOZZLES

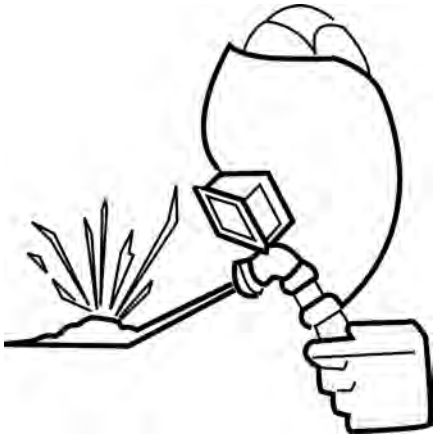
1. With the crushing cone removed, inspect chamber nozzle tubes (D) and ports (E) for damage, wear or plugging.

2. If nozzles are damaged or worn, repair or replace as needed.

3. If nozzles are plugged:
   a. use a garden hose or pressure washer (output maximum of 100 psi) to clean out the chamber nozzles.
   b. if a rock is inside the chamber nozzle tubing, you may have to cut the tube to remove the rock. Reweld with patch.



12. INSPECT CRUSHER CONE HARDFACE WELD



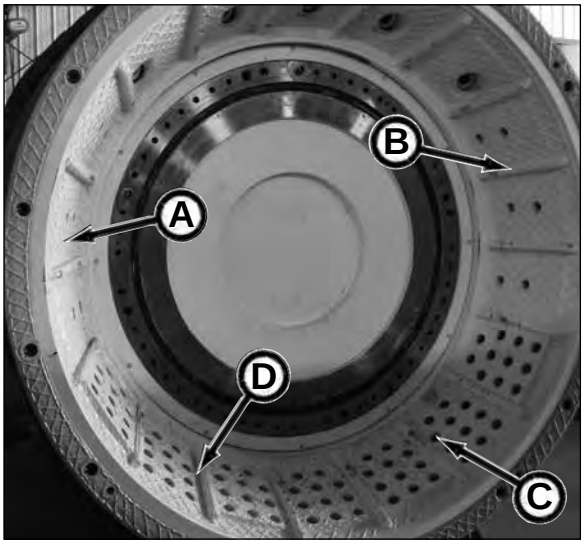
⚠WARNING Fumes, sparks, radiation and metal splatter from welding can cause serious injury or death.

Be sure to follow all OSHA welding safety and operational related regulations, such as proper personal protection equipment (nonflammable clothing, hand, eye [helmet] and respirator), proper ventilation and proper grounding of the all pieces being welded. Contact your welding equipment supplier for all safety requirements.

⚠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, remove the GASMAX gas detector. Failure to do so will cause damage to the gas detector.



1. Inspect all hardface weld (cross hatched) patterns (A) on the crusher cone and hardface welds on wear bars (B). If weld is missing or worn, the weld must be rewelded to prevent damage to the crusher cone.

2. Inspect hardfacing around inlet holes (C). Reweld if hardfacing is missing or worn. If inlet holes get enlarged due to wear, larger debris can be returned through the slurry return lines resulting in damage to the booster or return pumps.

IMPORTANT: Inlet holes must be less than 2 in. (51 mm) diameter for a 4 in. (102 mm) slurry line system.

3. Inspect panels (D) between wear bars for wear. Panels must be flat, not coned, to ensure proper removal of material.

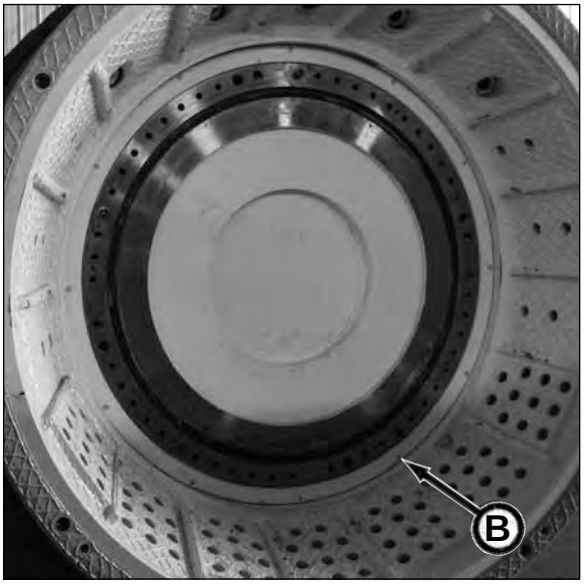
4. The gap between the crusher cone wear bars and the cutter bit bar (back bar of cutter bit) must not exceed 1/4”. Add weld to bar so gap is only around 1/8”. The cutter bit bar is designed as a wiper for clay. If this gap is larger than 1/4”, plugging may result due to under excavation.



13. CHECK CRUSHING CONE MOUNTING HARDWARE

With a calibrated torque wrench, check crushing cone mounting socket head cap screws (A) for proper tightness. Tighten 1 UNC x 2 socket head cap screws* to 798 ft-lb (1,082 N·m) torque. If cap screws do not maintain torque, they must be replaced with new.

* lubricated with anti-seize lubricant



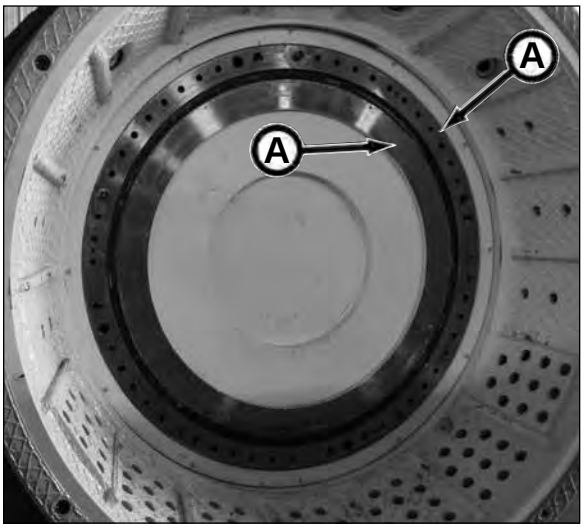
14. CHECK OUTER LIP SEAL RETAINING RING MOUNTING HARDWARE

With a calibrated torque wrench, check outer lip seal retaining ring mounting socket head cap screws (B) for proper tightness. Tighten 3/8 UNC x .75 socket head cap screws to 36 ft-lb (49 N·m) torque. If cap screws do not maintain torque, they must be replaced with new.

* lubricated with anti-seize lubricant

15. MTBM CUTTERHEAD INSTALLATION

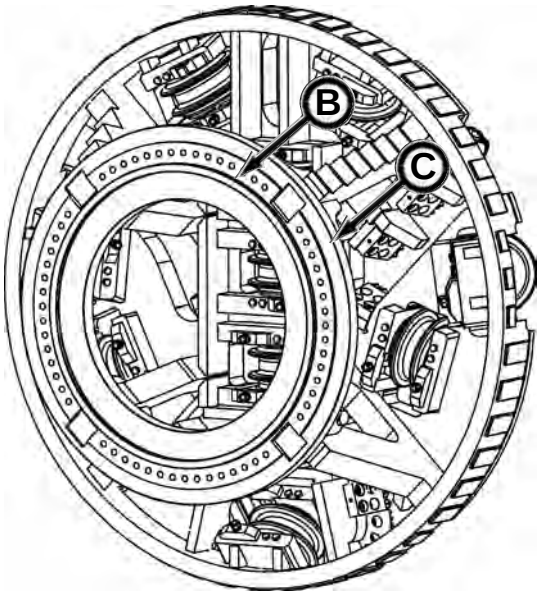
Install/reinstall cutterhead properly to MTBM.



NOTICE **Precise cutterhead installation is critical otherwise failure will occur. The cutterhead installation MUST be performed by an experienced technician.**

⚠WARNING Suspended loads may fall and cause severe personal injury or death. Cutterhead assembly is very heavy, approximately 10,000 lbs. (4,536 N·m). Do not enter area under or around the suspended cutterhead.

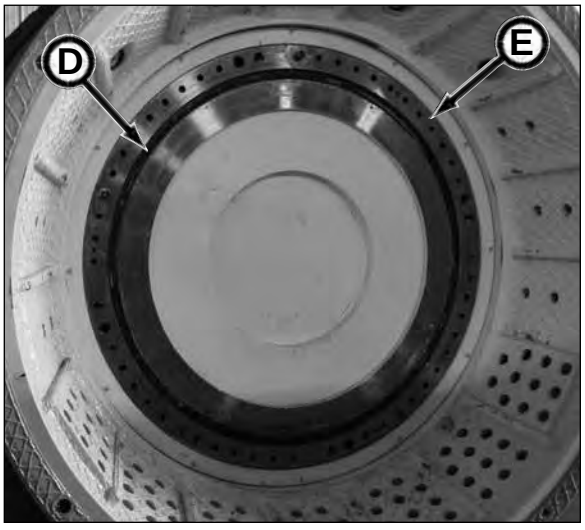
1. Clean the machined surfaces (A) of the drive assembly.



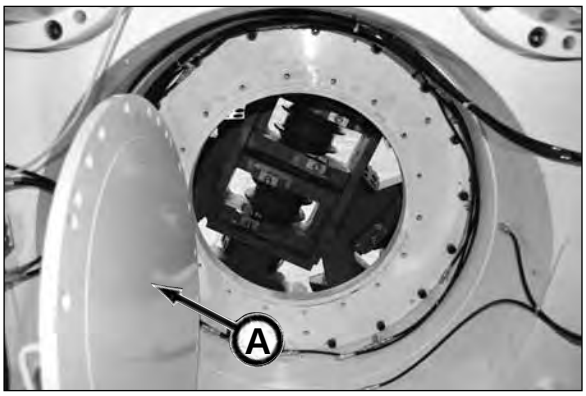
3. Carefully hoist the cutterhead assembly to the MTBM. The machined shoulder (B) of the cutterhead mount plate (C) must be aligned so it inserts into the inner lip seal gap (D). This retains the inner lip seals.

4. Visually inspect to be sure the cutterhead mount plate is flush with the seal ring surface (E).

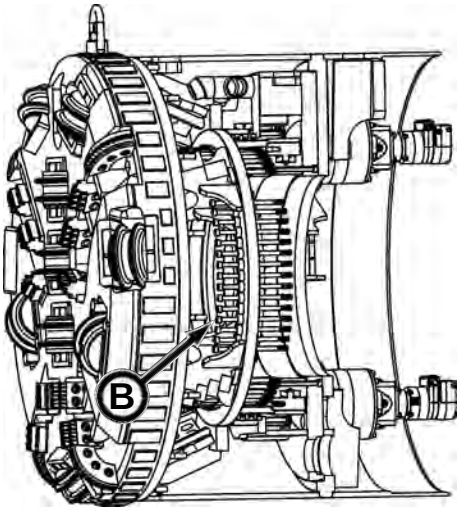
5. Rotate the cutterhead as needed to align the bolt holes from the cutterhead mount plate with the bolt holes on the seal ring.



(continued on next page)



IMPORTANT: Open the bulkhead access door (A) to gain access to the front cutterhead mounting assembly area. The cutterhead assembly must be secured before personnel can enter the cutting chamber area. Also, the MTBM power must be in lockout/tagout to prevent accidental startup.

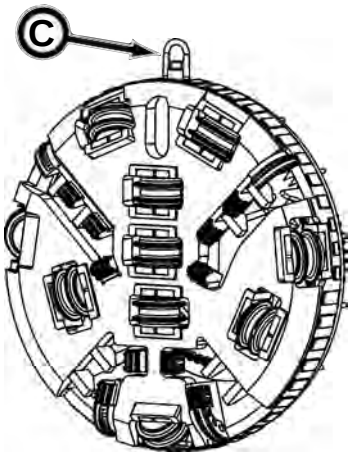


6. With a hand wrench, install and snugly tighten the sixty cutterhead mounting bolts* (B) with flat washers using a crisscross bolt installation sequence.

   * Lubricated



7. Once all bolts are snugly tightened, use a calibrated torque wrench to tighten all bolts using a crisscross bolt tightening sequence to 394 ft-lb (534 N·m) lubricated.

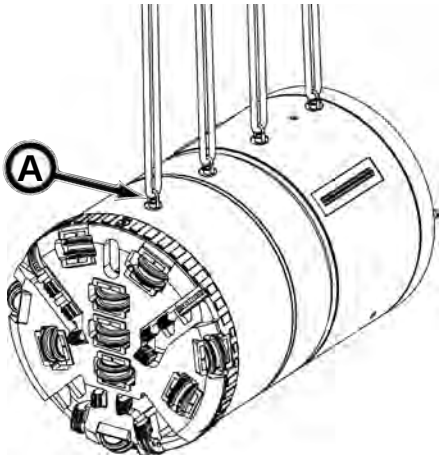


8. Remove hoist ring (C) and replace with one 1-1/4 UNC x 1 set screw. Retain lift eye for later use.

(continued on next page)

16. INSPECT LIFT EYES

Before lifting MTBM and Lube/Jacking Can, check lift eyes (A) for damage. Worn or damaged lift eyes MUST be replaced before lifting MTBM.



17. INSPECT DISC CUTTERS

IMPORTANT: Perform all cutter tooling maintenance listed on the MTBM Disc Cutters & Scrapers Maintenance Chart in this section prior to launching MTBM.

Inspect all disc cutters (B) as follows:

1. Check for signs of lubricant leakage from around the cutter end caps. If leakage is found, DO NOT install the cutter. The cutter MUST be repaired or replaced before mounting onto cutter head.

2. Inspect disc cutter shaft (both ends) for damage. If damaged, replace with new disc cutter.

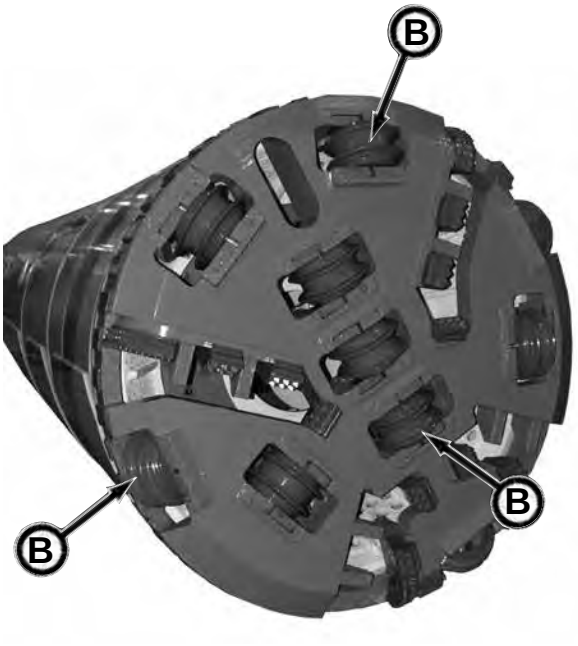
3. Check retaining ring condition. Replace if damaged or missing.

4. If any flat spots or polished marks are visible on the cutter, this is an indication that the cutter is skidding, and is most likely a result of a damaged bearing. Install a new cutter to replace any cutter with polished or flat spots.

5. Disc cutters with carbide inserts: any cutters with cracked carbides or cracks in the base metal of the cutter, must be replaced with a new disc cutter.

6. If the carbide insert has turned into the base metal of the cutter, the cutter must be replaced with new.

7. If the mounts are damaged, replace the mounts and disc cutters.



18. INSPECT SCRAPER CUTTER TOOLING

IMPORTANT: Perform all cutter tooling maintenance listed on the MTBM Disc Cutters & Scrapers Maintenance Chart in this section prior to launching MTBM.

Inspect bucket scrapers (C) and face scrapers (D), for wear or damage. The scrapers must be replaced when:

- the scraper carbide bits/bullets shows signs of damage or broken carbides
- excessive wear; wear to base metal of the cutter
- severe wear to supporting metal around the carbide

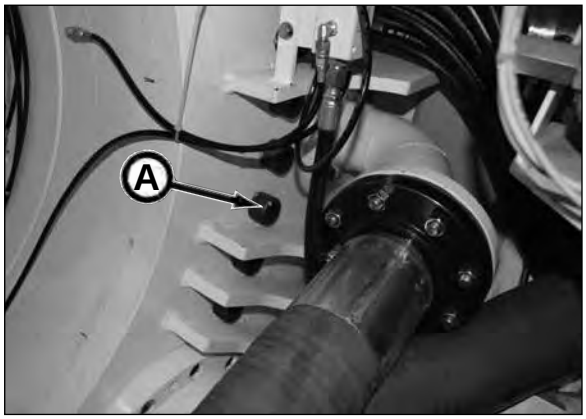


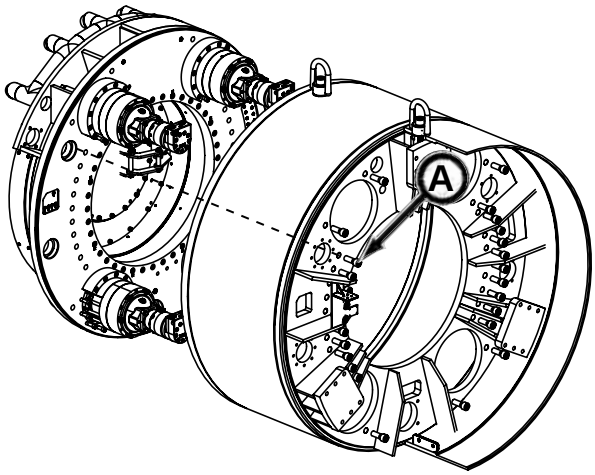
19. INSPECT DRIVE ASSEMBLY TO CAN MOUNTING HARDWARE

1. Inspect mounting socket head cap screws (A) for wear or damage. If worn, damaged or missing, replace with new.

2. With a calibrated torque wrench, check the twenty-eight mounting socket head cap screws (A) for proper tightness. Tighten 1-1/4 UNC x 3.5 socket head cap screws to 1,500 ft-lb (2,034 N·m) torque. If cap screws do not maintain torque, they must be replaced with new.

* lubricated with anti-seize lubricant





20. CHECK MTBM AUXILIARY HYDRAULIC POWER PACK OIL RESERVOIR LEVEL & CONDITION OF OIL

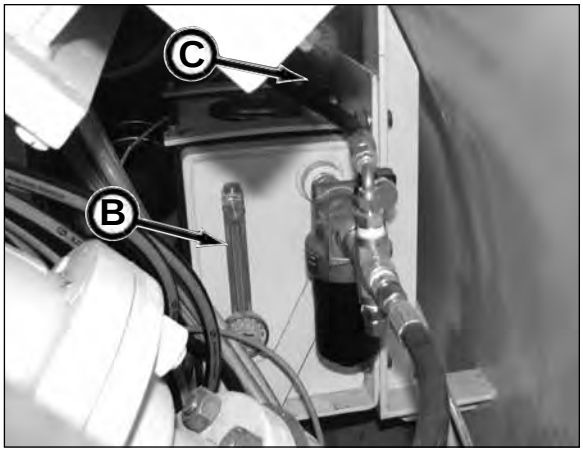
The MTBM auxiliary hydraulic power pack provides oil to control the slurry valves (bypass, stop, cutting), torque wing cylinders and steering cylinders.

1. Check condition of oil. If any of the following situations occur, the reservoir must be drained and refilled with flesh oil. The return filter must also be replaced:
   - A valve, torque wing 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.

2. Check the reservoir oil level on sight gauge (B).

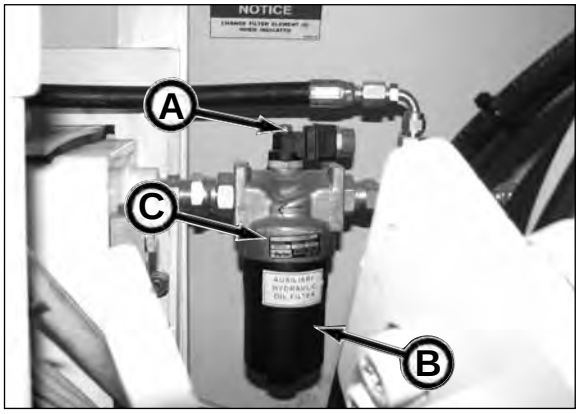
   If oil is needed, clean and dry area around fill cap (C), remove fill cap and fill until tank is at full mark with Tellus® Plus Oil 32 or equivalent. Replace oil cap.

   Oil capacity is 5.5 US gal. (21 L).



21. CHECK MTBM AUXILIARY HYDRAULIC POWER PACK RETURN FILTER INDICATOR

To prevent under or over servicing of the MTBM auxiliary hydraulic power pack return filter element, a filter indicator (A) has been installed on the return circuit.

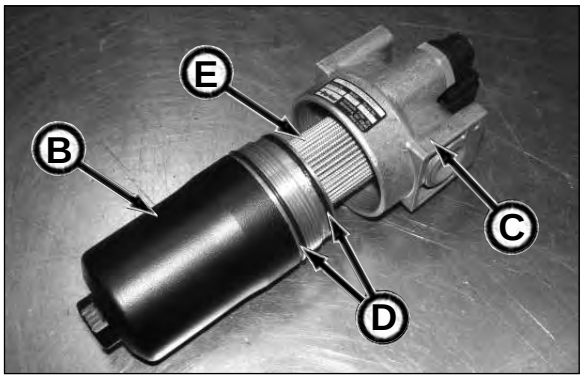


If the filter indicator is green, the filter is functioning properly.

If the filter indicator is red, the filter should be replaced as soon as possible to prevent hydraulic component damage using the following procedure:

1. Clean and dry area around filter assembly.

2. Remove housing (B) from filter head (C). Inspect housing for damage. If damaged, replace with new.



3. Inspect orings (D) on filter housing. If orings are worn or damaged, replace with new.

4. Remove filter (E) from filter head. Dispose of oil and filter properly.



5. Lubricate new filter oring (F) with a light coating of clean hydraulic oil.

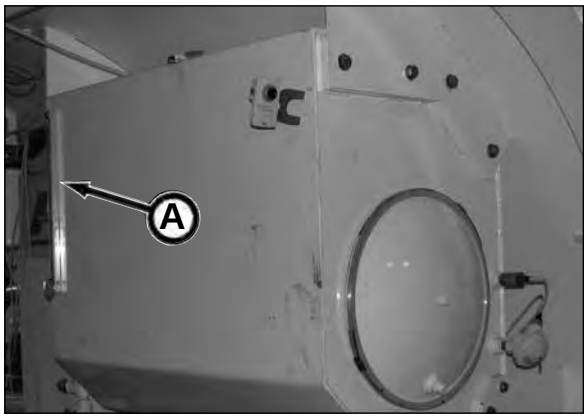
6. Carefully insert new, lubricated filter into filter housing.

7. Lubricate housing orings with a light coating of clean hydraulic oil. Be sure orings are not twisted and that they are properly seated into housing grooves.

8. Securely fasten housing to filter head.

9. Check for leaks.

22. CHECK MTBM MAIN HYDRAULIC POWER PACK OIL RESERVOIR LEVEL & CONDITION OF OIL



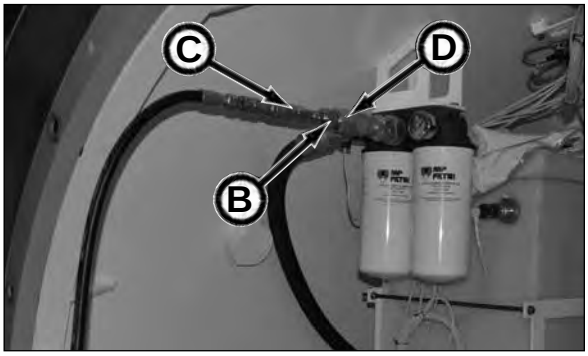
The MTBM main hydraulic power pack provides oil to main drive motor hydraulic system.

1. Check condition of oil. If any of the following situations occur, the reservoir must be drained and refilled with flesh oil. The return filters must also be replaced:
   - A 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.

2. Check the reservoir oil level on sight gauge (A).

   If oil is needed, clean and dry area around hose cap, remove hose cap (B), connect external oil fill pump hose (C) to fitting (D) to fill the hydraulic reservoir with clean hydraulic oil. Fill until tank is at full mark with ISO-VG-68 premium hydraulic oil or equivalent. Remove hose and replace oil cap.

   Oil capacity is 95 US gal. (360 L).



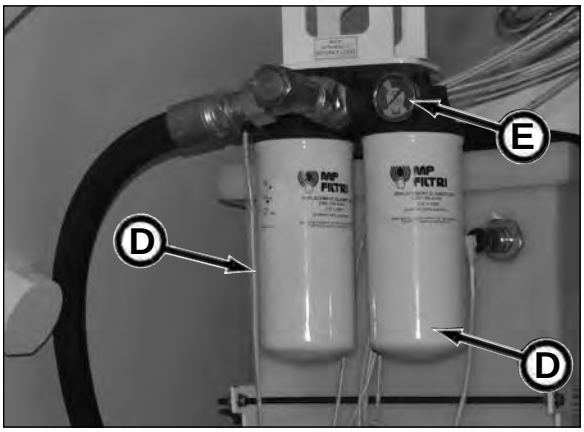
23. CHECK MTBM MAIN HYDRAULIC POWER PACK RETURN FILTER INDICATOR

To prevent under or over servicing of the MTBM main hydraulic power pack return filter elements (D), a filter indicator (E) has been installed on the return flow system. Also, an alarm message will appear, ***"Drive Oil Filter Plugged"***, on the target screen indicating the filters are plugged and must be changed.

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

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

When the needle on the gauge is in the red CHANGE zone, replace filter as soon as possible to prevent hydraulic component damage using the following procedure:



1. Clean and dry area around the return filters.

2. Remove filter. Dispose of oil and filter properly.

NOTICE Remove filter gasket if stuck in filter housing.

3. Fill new filter with clean hydraulic oil.

4. Lubricate new filter gasket with a light coating of clean hydraulic oil and install into filter housing. Be sure gasket is not twisted and that it is properly seated into housing groove.

5. Install new filters. Hand tighten only. Follow tightening instructions on filter.

6. Check for leaks.

7. Check hydraulic oil reservoir oil level. Add hydraulic oil if necessary.

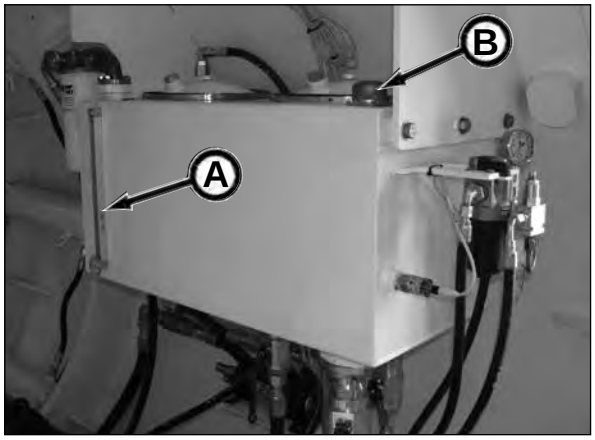
24. CHECK MTBM LUBE/JACK CAN HYDRAULIC OIL RESERVOIR LEVEL & CONDITION OF OIL

The MTBM Lube/Jack Can hydraulic oil reservoir provides oil to the jacking can thrust cylinders and the IJS stations.

1. Check condition of oil. If any of the following situations occur, the reservoir must be drained and refilled with flesh oil. The return filter must also be replaced:
   - A 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.
2. Check the reservoir oil level on sight gauge (A).

   If oil is needed, clean and dry area around fill cap (B), remove fill cap and fill until tank is at full mark with ISO-VG-46 or equivalent. Replace oil cap.

   Oil capacity is 30 US gal. (114 L).



25. CHECK MTBM LUBE/JACK CAN HYDRAULIC RESERVOIR RETURN FILTER INDICATOR

To prevent under or over servicing of the MTBM Lube/Jack Can hydraulic reservoir return filter element (C), a filter indicator (D) has been installed on the return flow system. Also, an alarm message will appear, ***"Jacking Pump Hydraulic Oil Filter Plugged"***, on the target screen indicating the filter is plugged and must be changed.

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

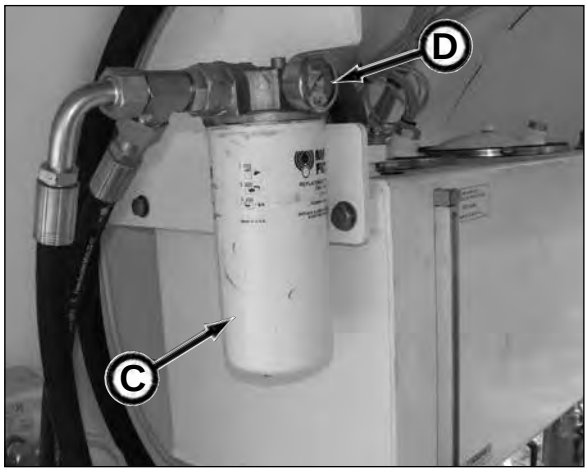
The yellow zone indicates that the filter will soon require replacement.

When the needle on the gauge is in the red CHANGE zone, replace filter as soon as possible to prevent hydraulic component damage using the following procedure:

1. Clean and dry area around the return filter.

2. Remove filter. Dispose of oil and filter properly.

NOTICE Remove filter gasket if stuck in filter housing.



3. Fill new filter with clean hydraulic oil.

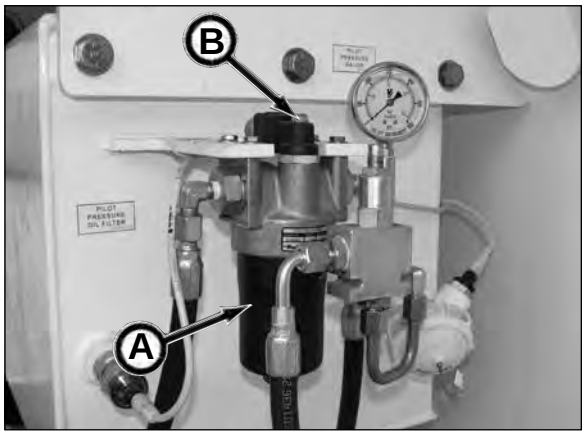
4. Lubricate new filter gasket with a light coating of clean hydraulic oil and install into filter housing. Be sure gasket is not twisted and that it is properly seated into housing groove.

5. Install new filter. Hand tighten only. Follow tightening instructions on filter.

6. Check for leaks.

7. Check hydraulic oil reservoir oil level. Add hydraulic oil if necessary.

26. CHECK MTBM LUBE/JACK CAN HYDRAULIC PILOT PRESSURE OIL FILTER INDICATOR



To prevent under or over servicing of the hydraulic filter element (A) a filter indicator (B) has been installed on the charge pump pilot pressure circuit.

If the filter indicator is green, the filter is functioning properly.

If the filter indicator is red, the filter should be replaced as follows:

1. Remove lower filter housing. Inspect housing and housing orings for damage. If damaged, replace with new.

2. Remove filter.

3. Lubricate housing orings with a light coating of clean hydraulic oil.

4. Lubricate filter inner oring with a light coating of clean hydraulic oil.

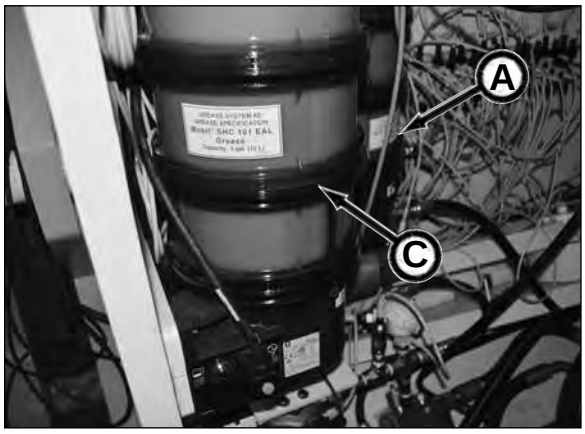
5. Carefully insert new filter into upper filter housing.

6. Securely fasten lower housing into upper filter housing.

7. Check for leaks.

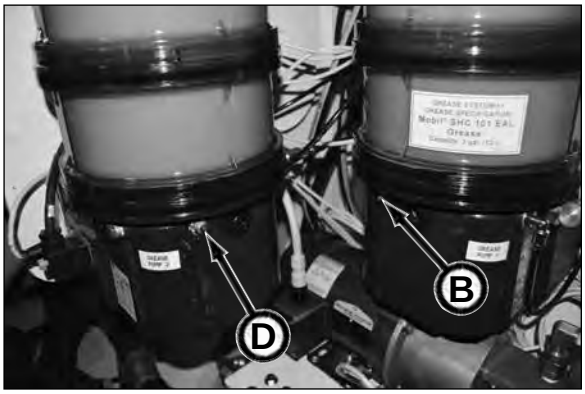
27. FILL GREASE PUMP CONTAINERS

The grease pumps lubricate the bearing cavity dirt/lip seals to prevent dirt from entering the bearing cavity. Be sure the grease pump containers are filled before operation and during drive to prevent contamination from entering bearing cavity.



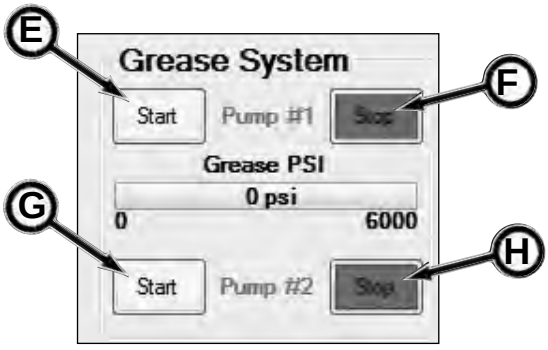
1. Fill the grease system #1 (A) with Mobil® SHC 101 EAL grease or equivalent through the grease pump fill port (B) until the grease pump container is filled.

2. Fill the grease system #2 (C) with Mobil® SHC 101 EAL grease or equivalent through the grease pump fill port (D) until the grease pump container is filled.



3. Once grease pump containers are filled, start the grease pump manually by clicking the Grease System #1 Start button (E) on the MTBM control screen to purge air from the grease lines. Click Stop button (F) when grease comes out the lip seals.

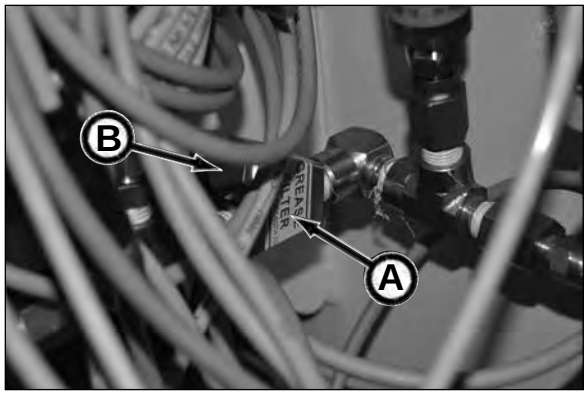
4. Start the Grease System #2 grease pump by clicking the #2 Start button (G) to purge air from the grease lines. Click Stop button (H) when grease comes out the lip seals.



Grease System Controls On The MTBM Control Screen

28. REPLACE GREASE PUMP FILTER ELEMENT

1. Gain access to the grease pump filter (A).
2. Remove plug (B).
3. Remove element and replace with new element.
4. Replace plug.

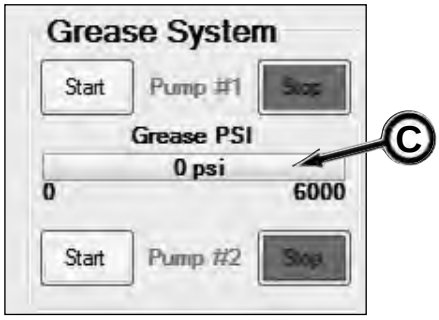


29. CHECK GREASE SYSTEM OPERATION

1. Inform all personnel that the MTBM will be started shortly and the cutterhead will be rotating.
2. Once personnel are safely away from moving parts, start the MTBM and rotate the cutterhead.
3. Check to be sure the grease system is automatically operating.
4. If the cutterhead is not rotating, check the target screen for any alarm messages that would affect the cutterhead rotation; ***"Grease Low Level, Grease PSI Outside Operational Range"***, etc.



5. Observe the Grease System controls on the MTBM Control screen to check if the Grease PSI (C) is too low (less than 300 psi) or too high (2,500 psi). Keep in mind, if the grease is cold, the pressure will be higher.
6. Troubleshoot any grease pump issues before launching MTBM.



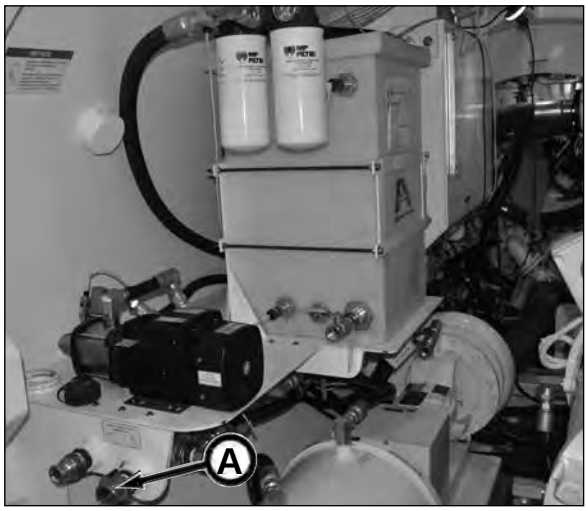
Grease System Controls On The MTBM Control Screen

30. CLEAN WATER COOLING SYSTEM STRAINER

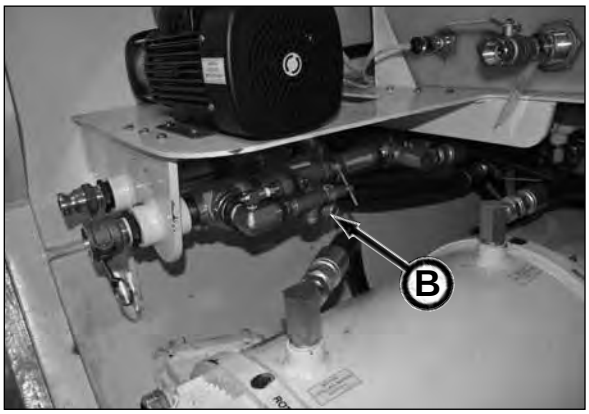
1. Close all shutoff valves to minimize water drainage when removing strainer.

2. Place a catch pan under cam-lock fitting (A) to contain drained water.

3. Remove cap or supply hose from cam-lock fitting.



4. Place a catch pan under strainer (B) to contain drained water



5. Using a catch pan, remove cap (C) on strainer to contain drained water.

6. Remove strainer and clean as necessary. If damaged, replace strainer with new.

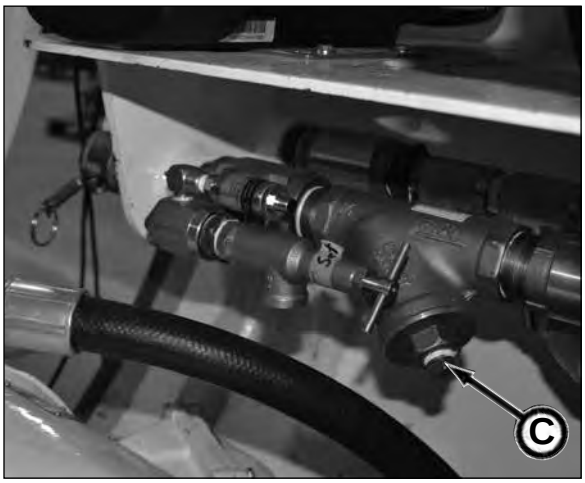
7. Replace cleaned or new strainer.

8. Check to be sure housing gasket is not damaged or cracked. If gasket is damaged or cracked, a new gasket must be installed in cap. Be sure it is not twisted before replacing cap.

9. Replace strainer cap.

10. Reinstall cap or hose removed from step 3 to cam-lock fitting.

11. Open shutoff valves as needed.

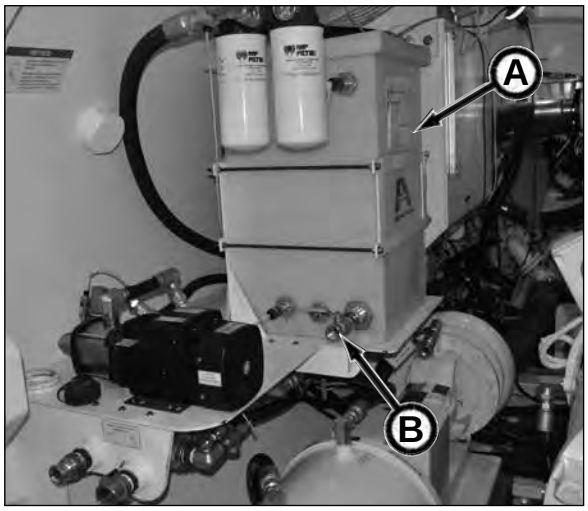


31. FILL WATER COOLING SYSTEM TANK

Fill water cooling system tank (A) with fresh, clean water. Tank capacity is 40 gal. (151 L).

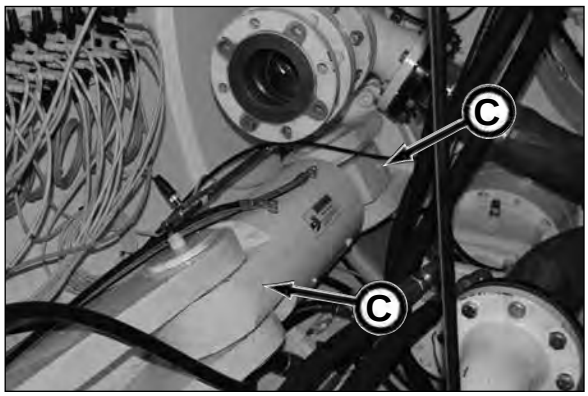
1. Connect water supply hose to drain shutoff valve (B). Open the drain shutoff valve and pump clean water until tank is full.

2. Close drain shutoff valve and remove water supply hose.



32. LUBRICATE STEERING CYLINDER PINS

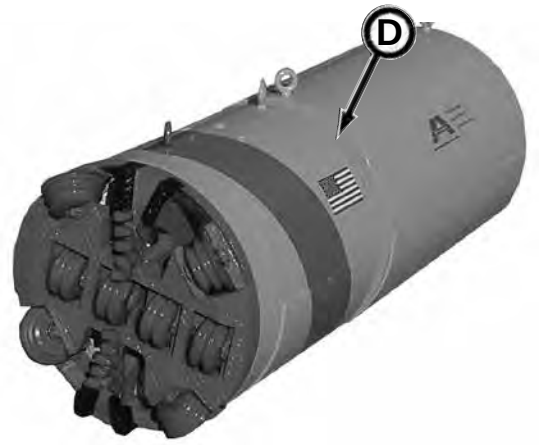
Lubricate steering cylinder pins (C) (2 places per cylinder) until grease is forced out with Mobilgrease® XHP222 or equivalent.



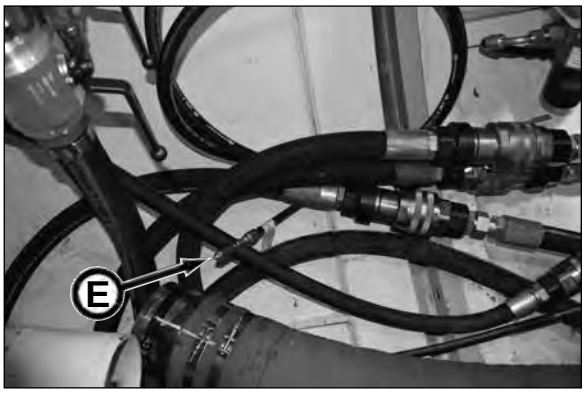
33. INSPECT STEERING JOINT SEALS

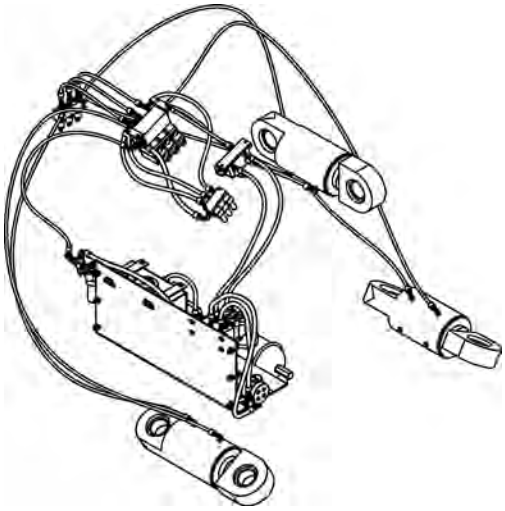
The steering joint seals must be properly maintained to protect the steering joint from contamination.

1. Inspect steering joint area (D) for dirt, debris and damage. Carefully clean area so as not to cause damage to the joint seals.



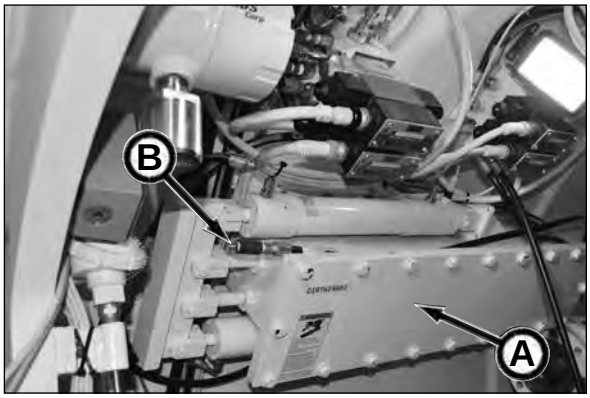
2. Lubricate the steering joint seals with 1 tube of Mobil® SHC 101 EAL Grease to flush the old grease from steering joint. Clean grease should be visible at the steering joint area. Use grease hose (E) to grease the steering joint.





34. INSPECT STEERING COMPONENTS

Inspect steering components (cylinders, steering mounts, cylinder stroke sensors, steering valves, hoses) for wear, cracked welds or other damage. If damaged, components must be repaired or replaced with new before launching MTBM.



35. LUBRICATE DIRT WING CAVITY

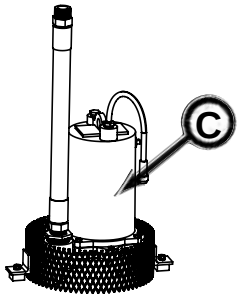
The dirt wing cavity (A) must be filled with grease to prevent dirt or other contaminates from entering cavity area.

Lubricate dirt wing cavity with Mobil® SHC 101 EAL grease or equivalent until grease is forced out. There is a grease fill hose (B) for each dirt wing.

36. CHECK SUBMERSIBLE PUMP OPERATION

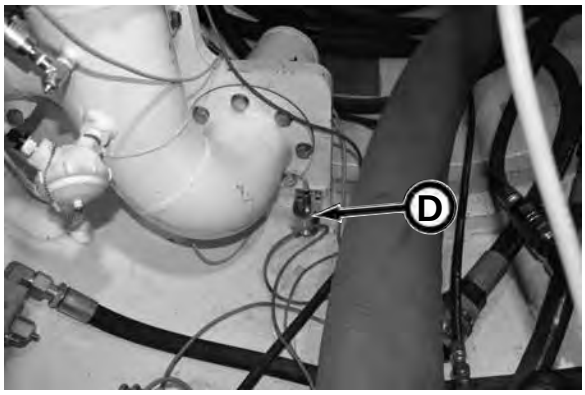
The submersible pump located in the front or trailing section removes water from the tunnel floor and expels the water to the slurry return line.

Check submersible pump (C) as follows:



1. Check to be sure water inlet holes are not plugged. Clean as needed.

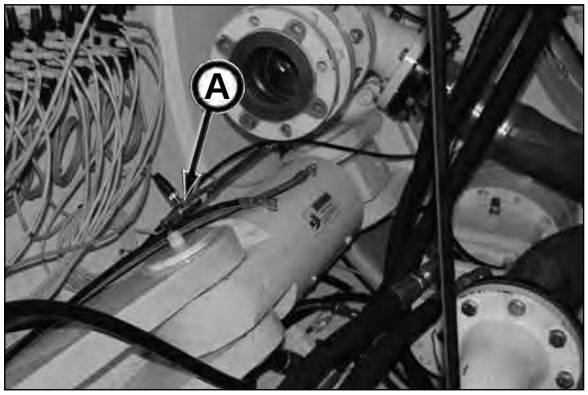
2. Test pump and float switch operation as follows:
   a. Turn Head Power switch to ON position.
   b. Start pump and check for proper rotation.
   c. Remove float switch (D) from mount and flip over. Do not remove input cable from switch.
   d. Pump should start up. Once pump starts up, replace switch to mount.
   e. Check pump time delay. Pump should operate for approximately 60 seconds and then shut off.



3. If pump fails to operate, check to be sure the Sub Pump control (E) on the MTBM control screen is either on Start or Auto mode. Or check for cable damage. Replace components as needed



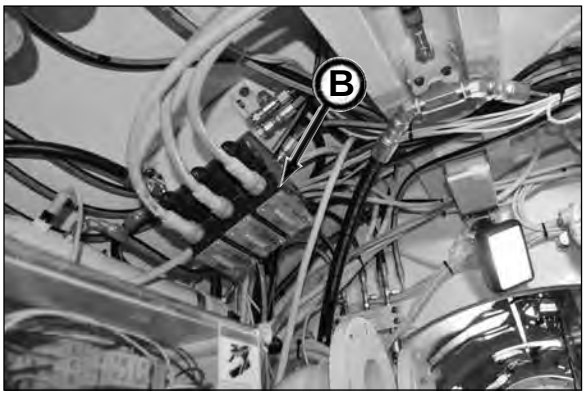
37. CALIBRATE STEERING CYLINDER LINEAR TRANSDUCERS & CHECK STEERING VALVE OPERATION



CALIBRATING LINEAR TRANSDUCERS
Linear transducers (A) on each steering cylinders allow the operator to monitor the position of the steering cylinders during the tunneling operation.

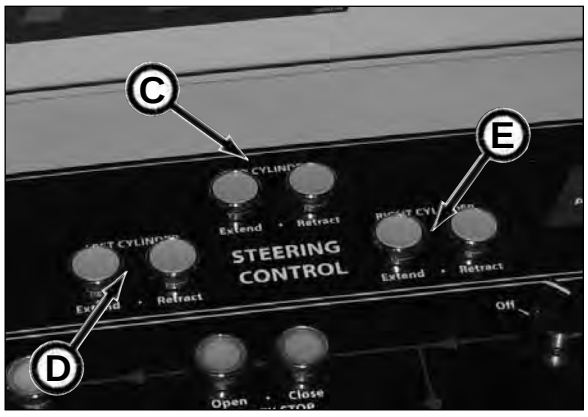
Linear transducers should be calibrated before each drive. Also, if the steering cylinders are repaired or replaced, the components will require recalibration so the steering cylinder positions will be properly monitored. The calibration is performed through the Kepware Server software. This software collects and rewrites data to and from the device components and is then communicated to the operator in the control container.

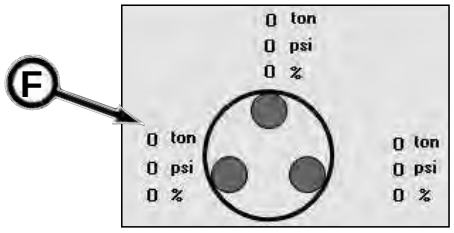
To calibrate the steering cylinder linear transducers, refer to Linear Transducer Calibration - Slurry Valves & Steering Cylinders in section 6, Operation.



CHECK STEERING VALVE OPERATION
Check steering valve (B) operation by extending and retracting each cylinder; top (C), left (D) and right (E) cylinder and verify that each position will hold pressure. The position of the cylinder must also match the steering cylinder indicator (F) on the target screen.

If the cylinders do not hold pressure, troubleshoot by determining if the problem is with the hydraulic hoses, steering cylinders or if the steering valve is malfunctioning. Repair or replace before launching MTBM.





Steering Cylinder Indicator On Target Screen

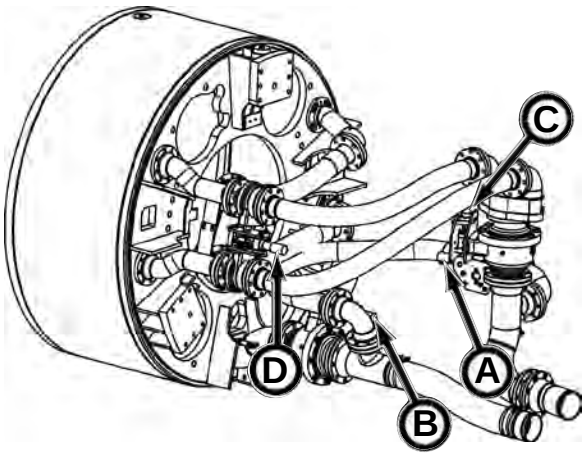
38. CALIBRATE SLURRY VALVE LINEAR TRANSDUCERS & CHECK SLURRY CONTROL VALVE OPERATION

Linear transducers on the stop valve, bypass valve and cutting nozzle valve allow the operator to monitor the position of the slurry valves during the tunneling operation.

Linear transducers should be calibrated before each drive. Also, if the stop valve, bypass valve or cutting nozzle valve are repaired or replaced, the components will require recalibration so the stop valve, bypass valve and cutting nozzle valve positions will be properly monitored. The calibration is performed through the Kepware Server software. This software collects and rewrites data to and from the device components and is then communicated to the operator in the control container.

To calibrate the stop valve, bypass valve and cutting nozzle valve linear transducers, refer to Linear Transducer Calibration - Slurry Valves & Steering Cylinders in section 6, Operation.

A - Bypass Valve Linear Transducer
B - Stop/Return Linear Transducer
C - Stop/Feed Linear Transducer
D - Chamber/Cutting Linear Transducer



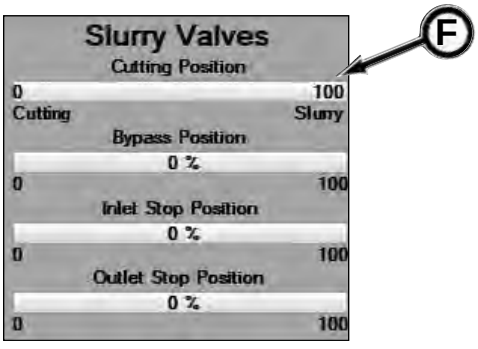
MTBM SL82P

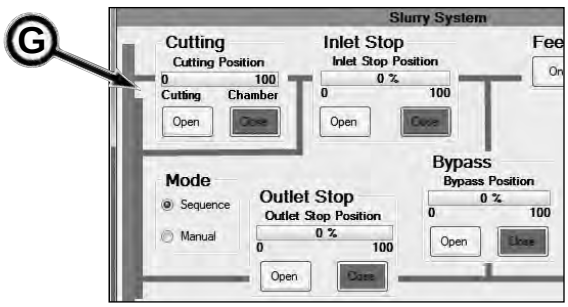
CHECK SLURRY CONTROL VALVE OPERATION
Check slurry control valve (E) operation by operating each cylinder and verify that each position will hold pressure. The position of the cylinder must also match the slurry valve positions as indicated on the slurry valve position indicator (F) on the target screen and the slurry valve position indicator (G) on the MTBM control screen.



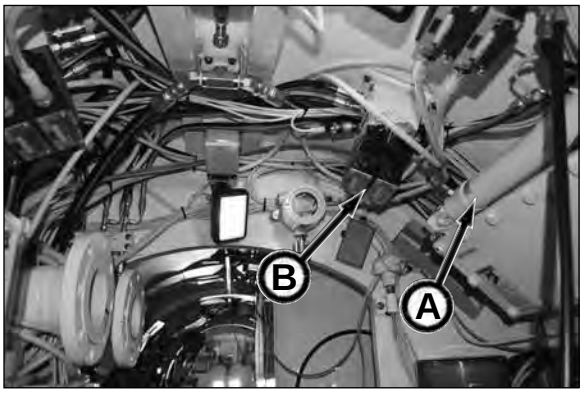
Slurry Cylinder Control Valve

If the cylinders do not hold pressure, troubleshoot by determining if the problem is with the hydraulic hoses, slurry cylinders or if the slurry control valve (E) is malfunctioning. Repair or replace before launching MTBM.





39. CALIBRATE DIRT WING LINEAR TRANSDUCERS & CHECK STABILIZER VALVE OPERATION

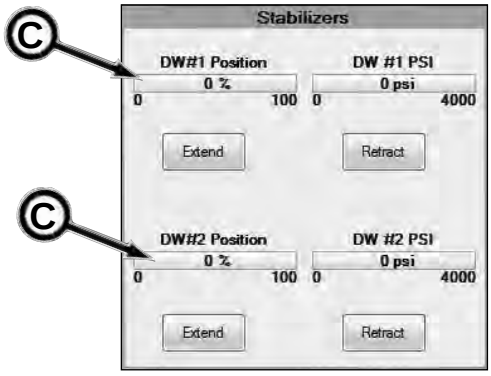


The dirt wing cylinders have built-in linear transducer(s) (A) that allow the operator to monitor the position of the dirt wing(s) during the tunneling operation.

Linear transducers should be calibrated before each drive. Also, if the dirt wing(s) are repaired or replaced, the components will require recalibration so the dirt wing(s) position will be properly monitored. The calibration is performed through the Kepware Server software. This software collects and rewrites data to and from the device components and is then communicated to the operator in the control container.

To calibrate the dirt wing cylinder linear transducer(s), refer to Linear Transducer Calibration - Dirt Wing in the Operation section.

CHECK STABILIZER VALVE OPERATION
Check stabilizer valve (B) operation by extending and retracting the dirt wing cylinder(s) and verify that each position will hold pressure. The position of the cylinder must also match the Stabilizers indicators (C) on the MTBM control screen.



Stabilizer Indicators On MTBM Control Screen

If the cylinder(s) will not hold pressure, troubleshoot by determining if the problem is with the hydraulic hoses, dirt wing cylinders or if the stabilizer valve is malfunctioning. Repair or replace before launching MTBM.

40. CHECK DRIVE MOTOR ROTATION

Check main drive motor rotation with cutter head rotation controls in control container.

1. Turn Cutter Head power control switch (A) to the ON position.

2. Press left button (B) and rotate speed control (C) slightly to check that the cutterhead is moving CCW (counterclockwise) as viewed from launch shaft into tunnel. The target screen should also indicate that the cutterhead is rotating CCW.

3. Rotate speed control to 0 position and press stop button (D) to stop rotation.

4. Press right button (E) and rotate speed control (C) slightly to check that the cutterhead is moving CW (clockwise) as viewed from launch shaft into tunnel. The target screen should also indicate that the cutterhead is rotating CW.

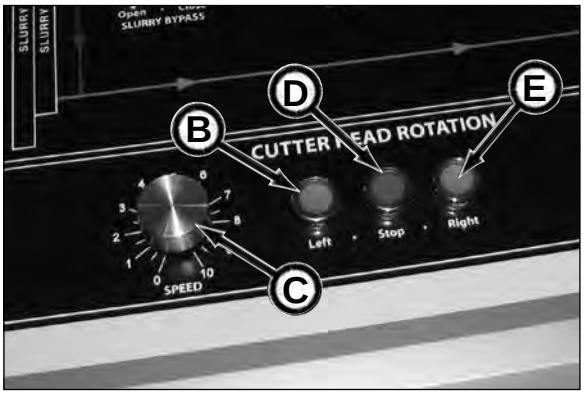
5. Rotate speed control to 0 position and press stop button to stop rotation.

6. If motor rotation is incorrect, the Main Cutter VFD parameter must be changed so the motor rotation will be correct before operation. Refer to IMPORTANT below:

IMPORTANT: Due to the complexity of the VFD parameter check and setup, Akkerman highly recommends that you contact your Akkerman Aftermarket Support representative if you have any questions before checking or changing the VFD parameter settings.







41. CHECK HYDROSTATIC PUMP FILTERS

Replace hydrostatic pump filters (A) before each drive.

1. Turn main hydraulic shutoff valve (B) to the closed position.

2. Place a catch pan below filter being removed.

3. Remove filter.

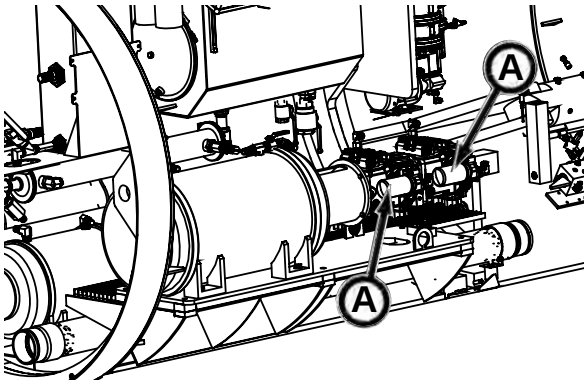
4. Install new spin-on filter (hand tighten only).

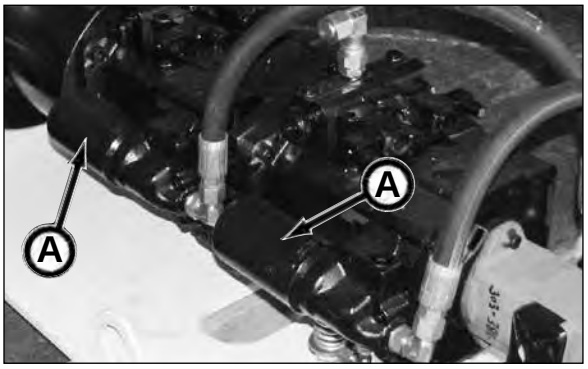
5. Dispose of oil properly.

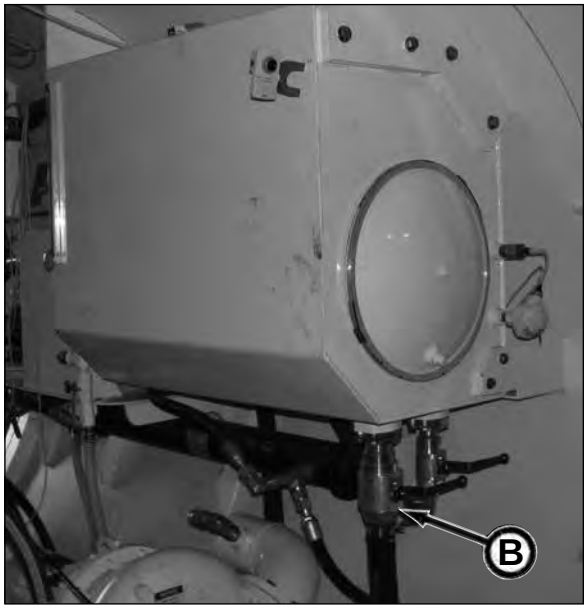
6. Replace other filter using steps 2 through 5.

7. Turn main hydraulic shutoff valve to the open position. Tie strap valve handle in the open position to prevent accidental closure while operating.

IMPORTANT: Failure to open shutoff valve (B) WILL cause damage to pumps. Be sure to tie strap valve handle in the open position to prevent accidental closure while operating.







Main Hydraulic Shutoff Valve Shown in Closed Position
Valve Must Be In Open Position Before Operating

42. CHECK SLURRY VALVE OPERATION

Check the slurry valve operation as follows:

1. Turn Head power switch (A) to the ON position.

2. Check the cutting nozzle (cutting, chamber) operation as follows. Hold buttons down to vary the valve opening.
   • Press Cutting button (B) to open valve (C) to the cutter nozzle ports (D) and close valve (E) to the slurry chamber ports (F).
   • Press Chamber button (G) to open valve (E) to the slurry chamber ports (F) and close valve (C) to the cutter nozzle ports (D).
   The cutting valve position (H) is shown on the Slurry Valve meter on the Target Screen, and the Cutting Valve meter (I) on the MTBM control screen.

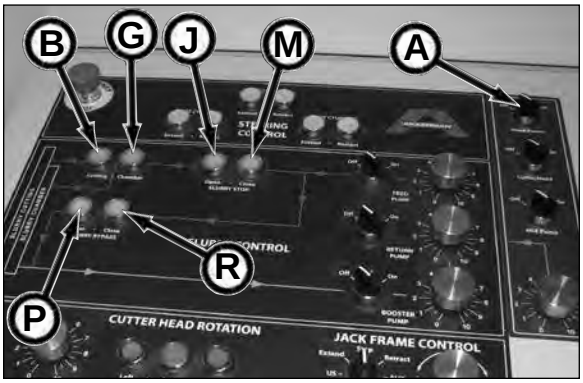
3. Check the stop valve operation as follows.
   • Press Slurry Stop open button (J) to open valves (K, L).
   • Press Slurry Stop close button (M) to close valves (K, L).
   The stop valve (Inlet and Outlet) position (N) is shown on the Slurry Valve meter on the Target Screen, and the Stop Valve (Inlet and Outlet) meters (O) on the MTBM control screen.

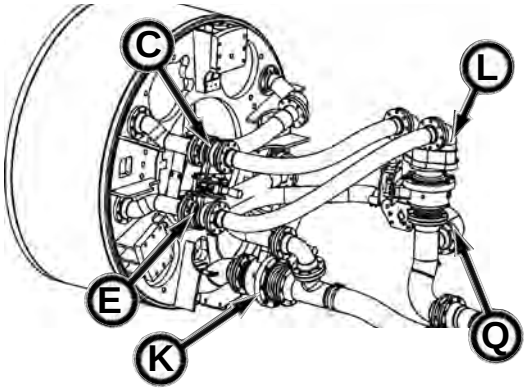
4. Check the bypass valve operation as follows.
   • Press Slurry Bypass open button (P) to open valve (Q).
   • Press Slurry Stop close button (R) to close valve (Q).
   The bypass valve position (S) is shown on the Slurry Valve meter on the Target Screen, and the Bypass Valve meter (T) on the MTBM control screen.

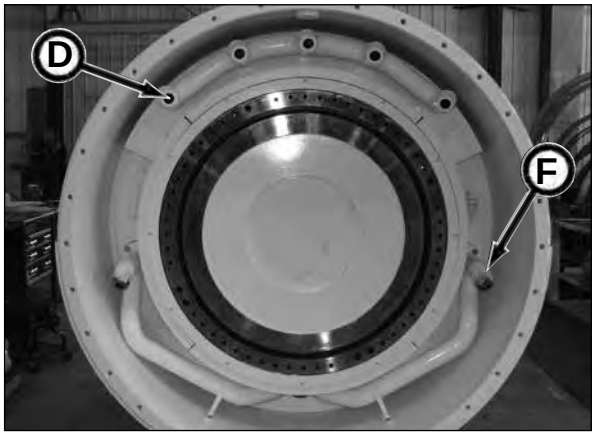
5. Check the operation of the stop valves (K, L) and the bypass valve (Q) in both sequence and manual mode by clicking desired mode button (U) on MTBM control screen.

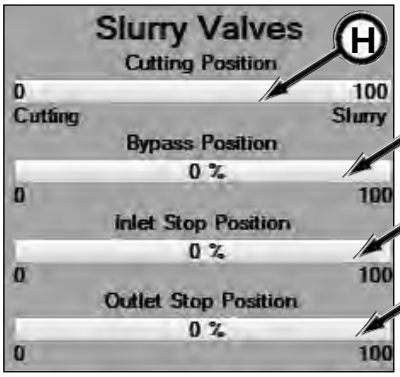
   • In sequence mode, the stop and bypass valves operate in opposite direction; stop valves closed, bypass open, etc. and are either fully closed or fully open.
   • In manual mode, the stop and bypass valve operation can be varied depending on operator.

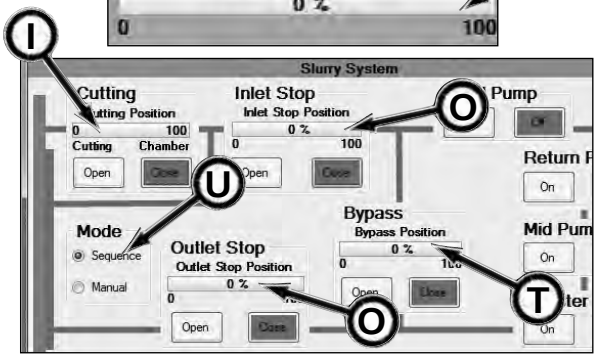
6. If any of the valves do not operate properly, the valves and cables must be repaired or replaced before operation.











43. INSPECT HOSES, CABLES & SLURRY LINES

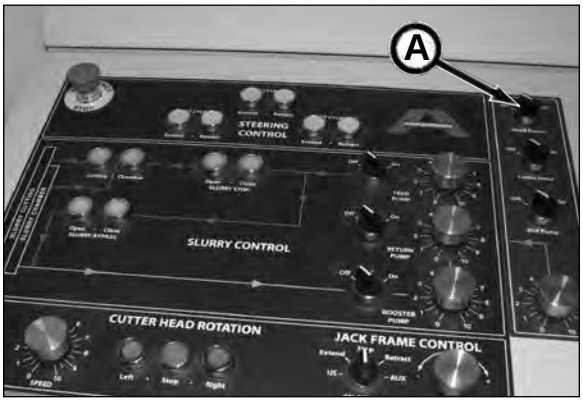


1. Inspect hydraulic/grease/cooling/jetting hoses, power cables and slurry lines for wear or damage. Repair or replace if cracks or wear are visible.

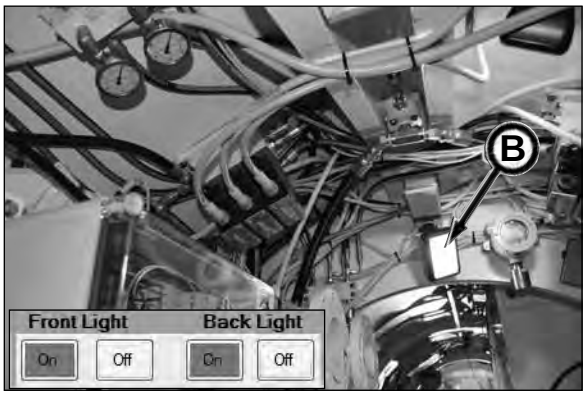
2. Be sure hoses, cables and slurry lines are securely fastened to connections.

NOTICE Keep 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.

44. CHECK LIGHT OPERATION



1. Turn Head Power switch (A) to ON position.



2. Check to be sure the lights (B) in the MTBM are illuminated. The lights are on when the Head Power is activated.

3. Check the lights with the manual (Front Light and Back Light) control from the MTBM control screen (see inset).

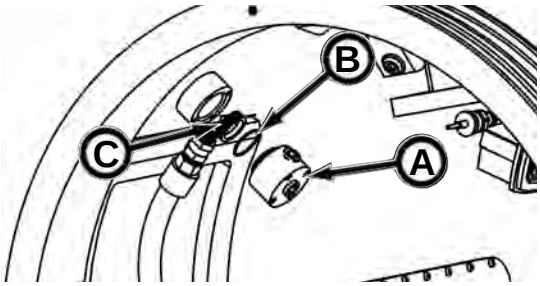
4. Check light cables for wear or damage. If cables show signs of wear or damage, repair or replace.

45. INSPECT BENTONITE PORTS

Inspect bentonite hoses and ports for hardening of bentonite.

MTBM Bentonite Ports

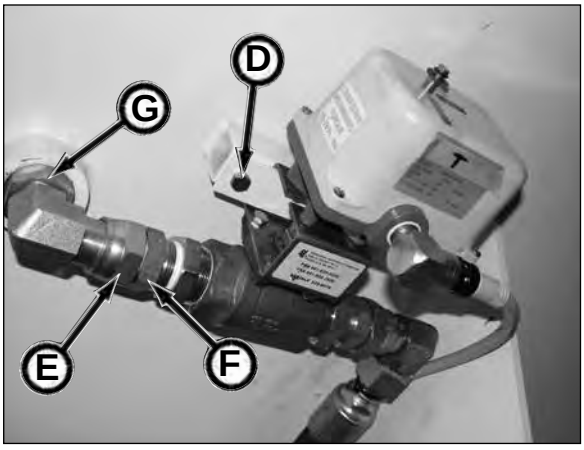
1. Test bentonite ports for plugging by flushing ports with water and check water flow out of each port. If plugging is noted, the hoses, fittings and ports must be cleaned or replaced before operation.
2. Check bentonite port by removing four bolts from cap (A).
3. Remove cap (with hose[s]) from bentonite port to gain access to oring (B) and check valve (C).
4. Check oring and check valve for wear or damage. When replacing, be sure check valve and oring are properly seated in port.
5. Replace cap and secure with bolts removed in step 3.
6. Repeat steps 2 through 6 for other bentonite ports.
7. Check pressure transducer for damage. Replace if needed.



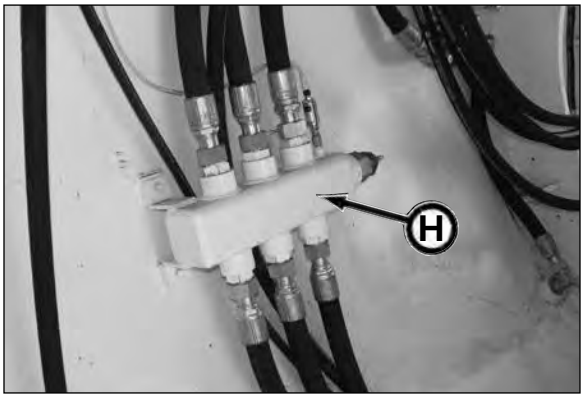
Bentonite Ports On MTBM

Lube/Jack Can Bentonite Ports

1. Test bentonite ports for plugging by flushing ports with water and check water flow out of each port. If plugging is noted, the hoses, fittings and ports must be cleaned or replaced before operation.
2. Check bentonite port by loosening two mounting bolts (D) on lubrication valve mount.
3. Disconnect fittings (E and F).
4. Loosen locknut (G).
5. Disconnect fitting from locknut.
6. Inspect and clean as needed. If damaged, repair or replace with new.
7. Reinstall bentonite port in reverse order.
8. Repeat steps 2 through 7 for other bentonite ports.
9. Inspect manifold (H) for blockage. Clean as needed.
10. Check pressure transducer for damage. Replace if needed.



Bentonite Ports On Lube/Jack Can



Bentonite Port Manifold On Lube/Jack Can

46. CLEAN HIGH PRESSURE JETTING STRAINER SCREEN

Clean strainer screen in high pressure jetting strainer assembly (A) as follows:

1. Remove cap (B).

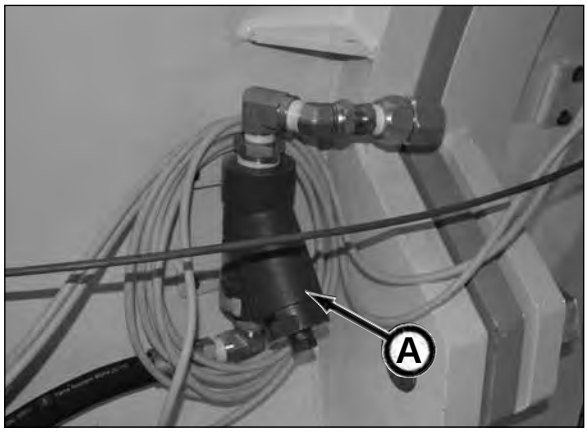
2. Remove strainer screen (C). Clean strainer or if needed, replace with new.

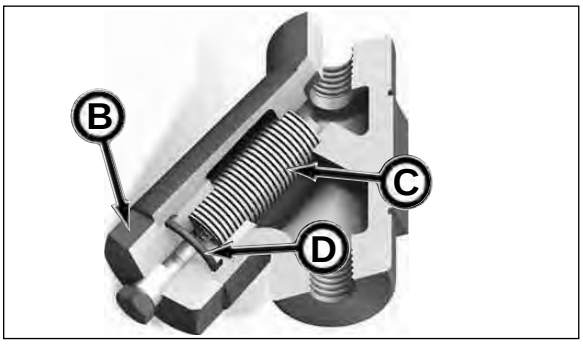
3. Install screen. Be sure it is properly seated in strainer body.

4. Inspect oring for (D) cracking or damage. Replace with new if needed.

5. Install oring. Be sure it is properly seated on cap.

6. Reinstall cap.





Strainer Cutaway Illustration

47. CHECK ACCUMULATOR OPERATION

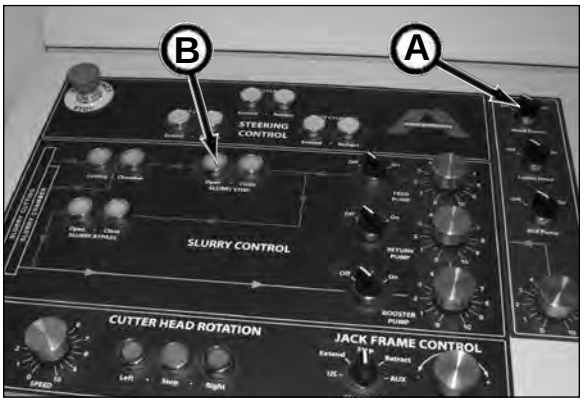
In the event of a power outage or malfunction, an accumulator is equipped on the auxiliary slurry stop and slurry bypass valve system to automatically close the inlet and outlet stop valves and open the bypass valve.

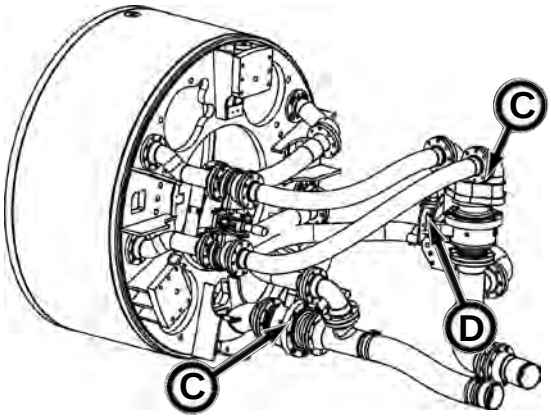
Check accumulator operation as follows:
1. Turn Head Power switch (A) to ON position.

2. With system in sequence mode, fully open Stop Valves with switch (B). This will extend the actuator cylinders on the stop valves (C) and retract the actuator cylinder on the bypass valve (D).

3. Turn Head Power switch to OFF position.

4. Verify the stop valve actuator cylinders fully retracted to close position and the bypass actuator cylinder fully extended to open position. If the stop valves are not fully closed and the bypass valve is not fully open, resolve issue before operation.

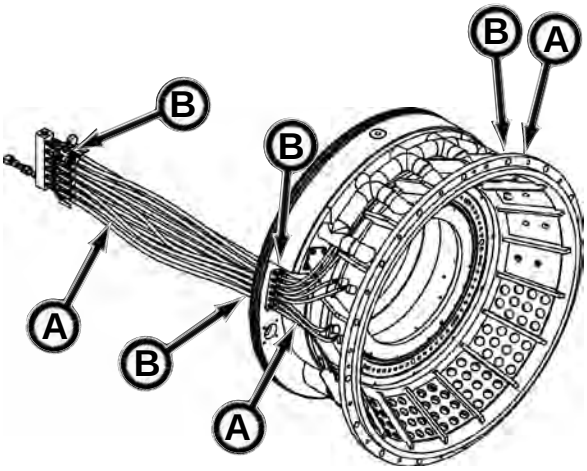




48. INSPECT HIGH PRESSURE JETTING NOZZLES, HOSES & VALVES

NOTICE Flush high pressure system before operation to remove rust flakes or sediment within the system.

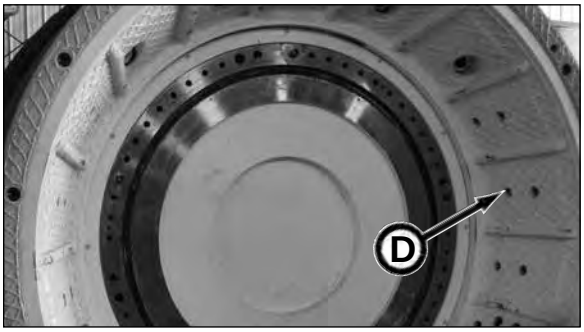
1. Inspect all high pressure jetting hoses (A), fittings (B) and power cables (C) for cracks, wear or damage. Replace as needed.



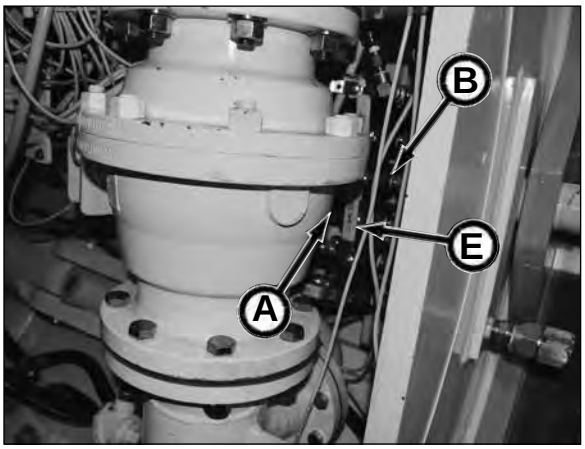
2. Check high pressure jetting pump power cables (C) for cracking, wear or damage. Replace as needed.



3. Check high pressure jetting nozzles (D) on crushing cone. Replace as needed.



4. Check jetting shut off valves (E) for proper operation. Repair or replace as needed.

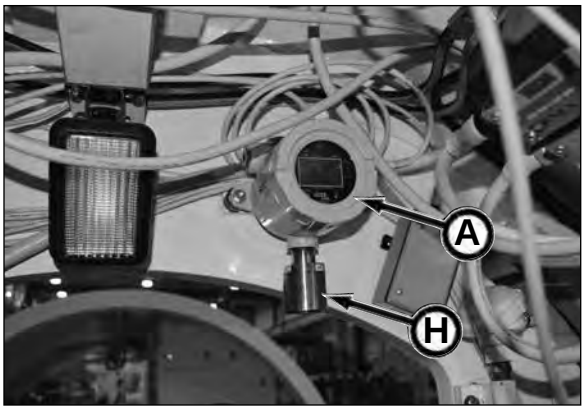


49. CHECK & TEST GAS DETECTOR

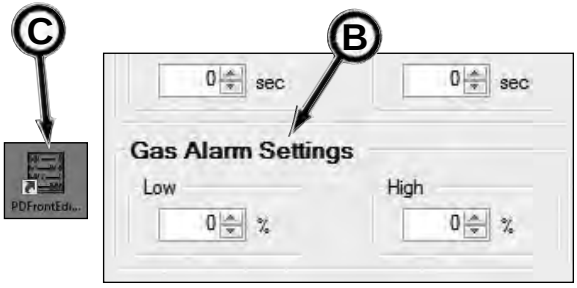
NOTICE For more information, refer to your GasMax Instruction Manual.

Check and test the gas detector (A) settings as follows:

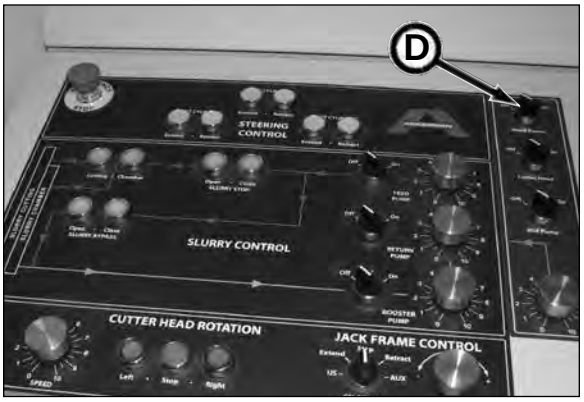
⚠DANGER The gas detection system installed in the MTBM monitors only combustible gas levels. **Monitoring of gas levels is the responsibility of the contractor.** This includes the accumulation of combustible and toxic gases, and depletion of oxygen. The contractor must keep the tunnel ventilated with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



1. Update the Gas Alarm Settings (B) per job requirements by double clicking the PDFrontEditor icon (C) to load the MTBM Operational Data Editor program. Change the low and high % fields per job requirements. If changes are made, click the Validate button.

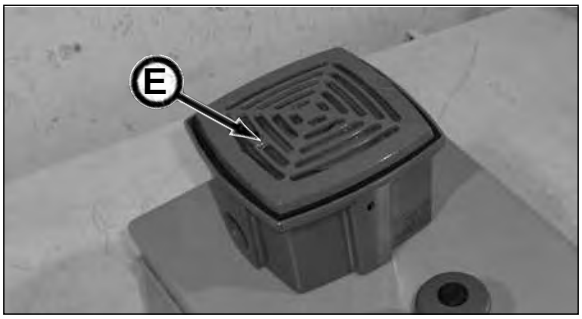


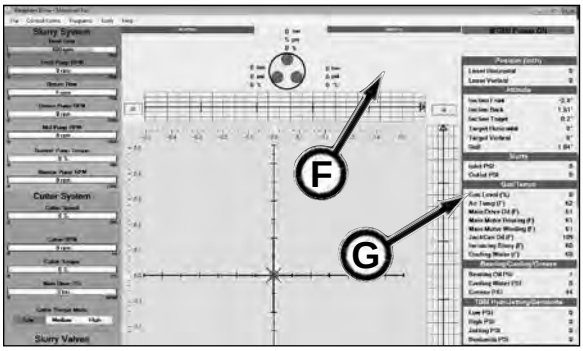
2. Turn Head Power switch (D) to ON position. If the sound from the horn (E) on the pit box comes on immediately, typically the sensor must be replaced.



3. Test the gas detector operation, horn alarm and control container screen display (F, G) as as follows:
• apply a measured gas concentration to sensor (H) or check the horn operation by using the magnetic wand and touch the following sensor points on the LCD display: Edit/Alarm Settings/ Edit/Down Cal to Relay Config/Edit (changes FailSafe from No to Yes to activate the horn and strobe). Press Edit again to stop horn and the status message.

If the audible alarm does not work properly or the status message or gas level % on the target screen does not display accurately, a qualified electrician MUST troubleshoot and repair the problem BEFORE using the MTBM.





(Gas detector maintenance continued on next page)

The gas detector is monitored by the control system as follows:

1. The “Gas Detector Fault” message will appear in the status/alarms area (A) on the target screen when there is a problem with the gas detector sensor (B)

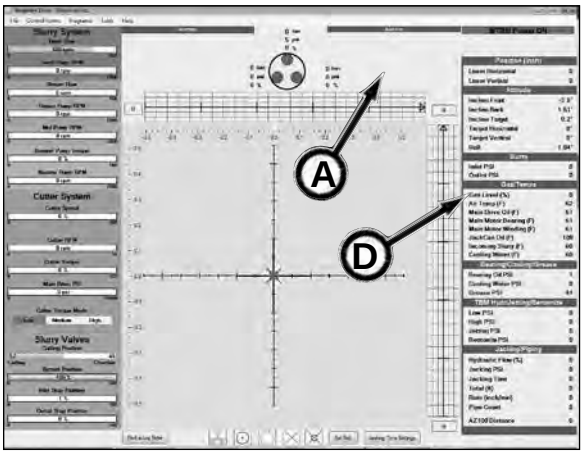
2. The “Gas Level High” message will appear in the status/alarms area (A) on the target screen when the gas level at the gas detector reads 10% (default setting) LEL (Lower Explosive Limit) or higher.

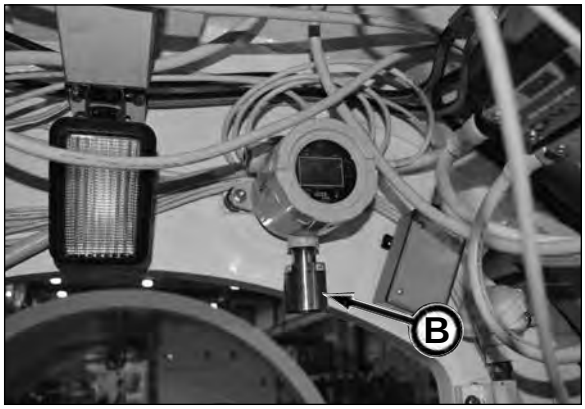
3. When the system detects a gas level reading of 10% LEL but less than 25% (default setting) LEL, the audible alarm (horn) (C) on the pit box will sound intermittently.

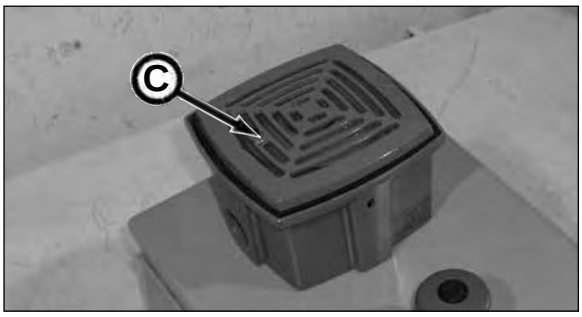
4. When the system detects a gas level reading of 25% (default setting) LEL or higher, the horn on the pit box will sound constantly.

   NOTICE If the high LEL setting is reached, the cutterhead rotation and the jacking frame functions will shut down.

5. The gas level % of LEL reading (D) at the gas detector is displayed on the target screen.







4. Check transmitter display. When the Akkerman gas detection system is activated, the transmitter will run through a start-up sequence. The display will stabilize and show the combustible gas level.

If the transmitter display does not operate or the display does not stabilize, refer to the Global Detection Systems GasMax manual.

Eventually the sensor will degrade to the point where the transmitter can no longer compensate. If this point is reached the message **“Span Fail - Error Code 5”** will be displayed on the LCD screen indicating that the sensor / sensor element must be replaced.



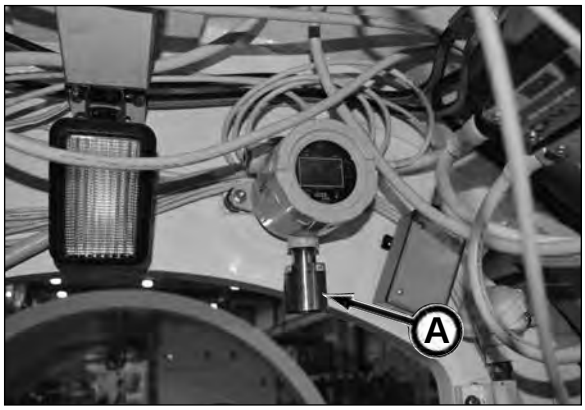
GDS GasMax II Display

(Gas detector maintenance continued on next page)

A qualified technician must replace the sensor/ sensor element.

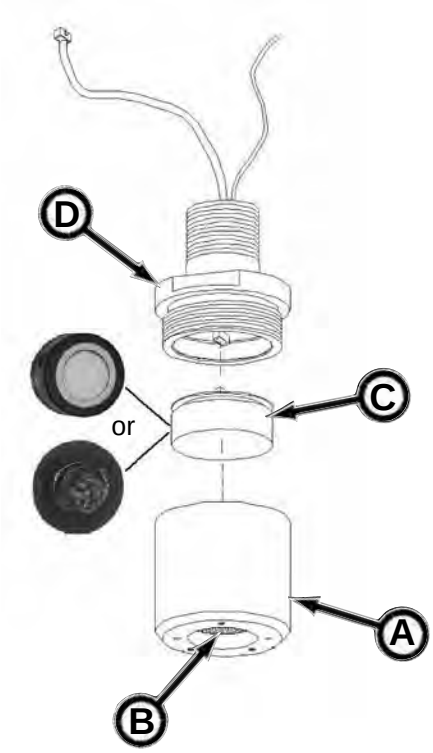
NOTICE Never install a sensor with power applied. The sensor may be permanently damaged.

5. Inspect sensor head cap (A), and sensor filter (B) for dirt, grease, or other foreign material.



If dirt, grease or foreign material is on the sensor head cap, simply wipe it off with a cloth, or use a mild cleaning agent (soap and water). DO NOT allow the sensor (C) to be subjected to water or the cleaning agent. Doing so will damage sensor.

If dirt is on the sensor head cap or sensor filter (silver disc), remove the sensor head cap from the sensor base (D) and use compressed air (maximum 40 - 75 psi) to remove the dirt. Then replace sensor head cap on sensor base. DO NOT use compressed air on the sensor. Sensor damage will occur.



If grease is on the sensor filter or cap:

1. Remove the sensor cap from the sensor base.
2. Clean filter and/or cap with a mild solvent to remove grease.
3. After cleaning, it is important that the filter and cap are dry before replacing on the sensor base.

⚠WARNING If the filter/cap is not dry, it can block gas from getting to the sensor, resulting in the environment not being properly monitored for methane gases.
Or in the case of using a solvent to clean the grease out, it may cause the sensor to go into the alarm mode as it detects the solvent out-gassing from the filter.

(Gas detector maintenance continued on next page)

6. Calibrate transmitter sensor at least every 90 days. Calibration is the most important function for insuring correct operation of the GasMax II.



The CAL MODE is designed to make calibration quick, easy and error free.

Follow these GasMax calibration guidelines:

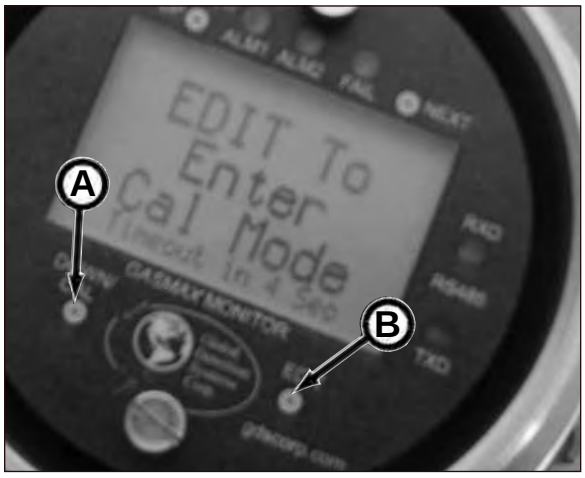
- Calibration accuracy is only as good as the calibration gas accuracy.
- Do not use a gas cylinder beyond its expiration date.
- Calibrate a new sensor before use.
- Allow the sensor to stabilize before starting calibration (approximately 5 minutes).
- Calibrate only in a clean atmosphere, which is free of background gas.

Use the following procedure to perform ZERO and SPAN calibrations.

1. Disable horn by disconnecting the horn connector. When the calibration process is complete, the horn MUST be reconnected to the system.

2. Power up gas detection system.

3. To enter the CAL MODE from either data display, press the DOWN/CAL key (A) with the magnetic wand and within 5 seconds press the EDIT key (B).



4. Using an optional process cover (Cal Cup), apply a clean ZERO gas or be sure there is no background target gas in the monitored area. After the reading is stable (approximately 1 minute), press the EDIT key (C) to perform a ZERO calibration.



NOTICE If it is known for sure that there are no interfering gasses or vapors present, ambient air may be used to set the zero point.

5. If the ZERO calibration is successful, press the NEXT key (D) to proceed to the SPAN check.

6. Apply span gas to the sensor as follows:

a. Check the label on the pressurized cylinder to be sure it contains the correct calibration gas mixture (gas composition) and LEL percentage (Methane 2.5% [50% LEL]).



(Gas detector maintenance continued on next page)

b. Close the regulator valve by turning the knob clockwise.



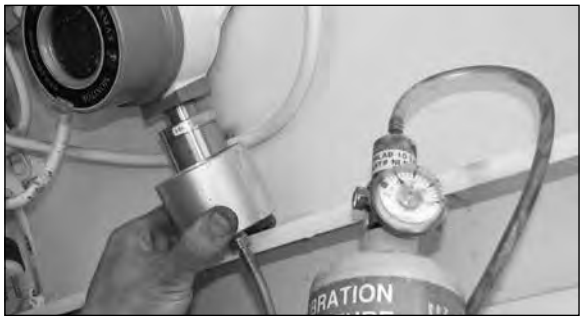
c. Screw the regulator valve onto the cylinder.



d. Attach one end of the plastic hose to the regulator.

e. Attach the calibration nozzle adapter to the other end of hose.

f. Attach calibration nozzle adapter to sensor.



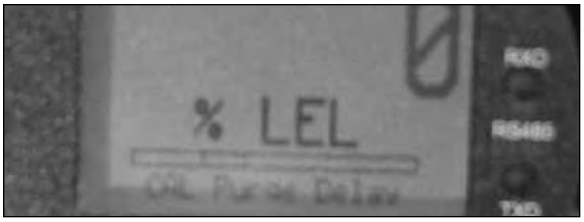
7. Apply the calibration methane 2.5% (50% LEL) gas mixture at .5 liters/min by opening the regulator valve by turning the knob counterclockwise. After the reading is stable (approximately 1 minute) press the EDIT key (A) to perform a SPAN calibration.



8. If the SPAN calibration is successful, the display flashes “REMOVE CAL GAS” and starts the CAL PURGE delay.

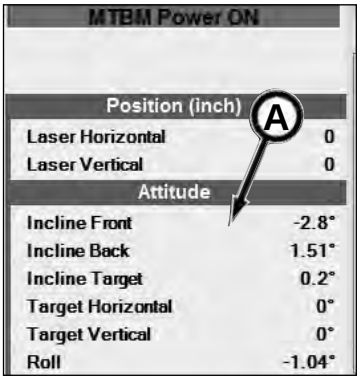


9. The CAL MODE will be complete after the end of the CAL PURGE delay.



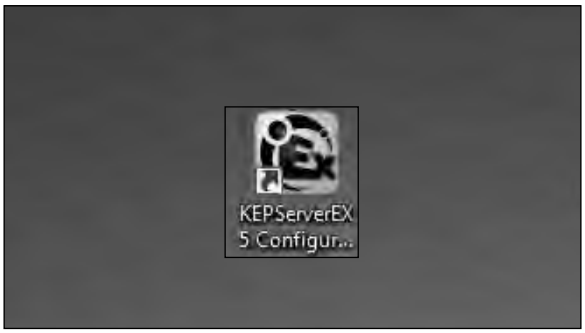
50. CALIBRATE INCLINOMETERS

Inclinometer calibration must be checked before each drive launch. The calibration is performed through the Kepware Server software. This software collects and rewrites data to and from the device components and is then communicated to the operator in the control container. The incline in degrees (A) is shown on the target screen.

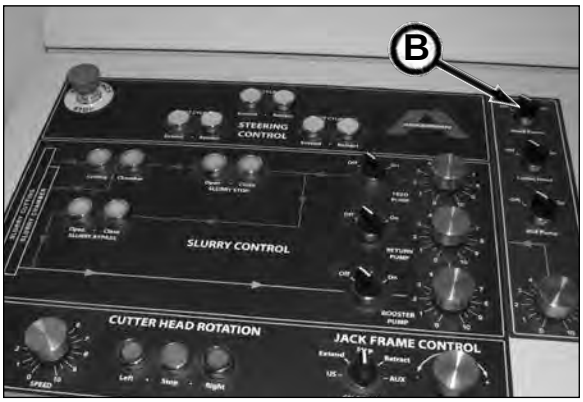


IMPORTANT: A precise inclinometer calibration is critical for the accuracy of the tunnel line and grade. It is HIGHLY recommended for an Akkerman technician to train the operator exactly how to properly calibrate the inclinometers until the operator is experienced to perform the calibration procedure. The inclinometer calibration MUST be performed by an experienced technician. Contact your Akkerman Aftermarket Support representative for more information on calibrating the inclinometers.

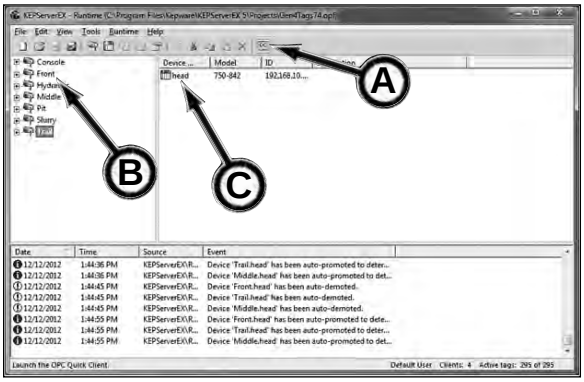
1. Start MTBM program. Once started, the Kepware server program will automatically start. Click on the KepwareServerEx program on the taskbar to make it active.



2. Turn Head Power switch (B) to ON position.

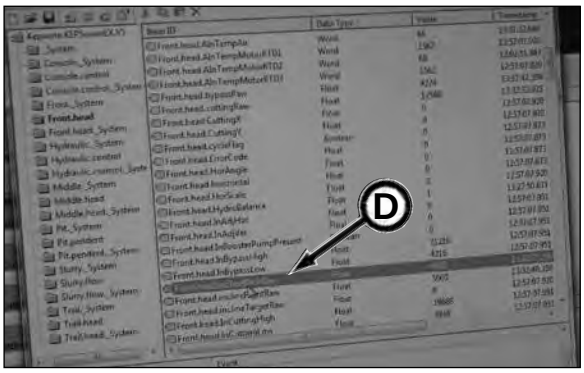


(Continued on next page)



3. Click Quick Client icon (A).

4. Click on channel “Front” (B) and then device “Head” (C).

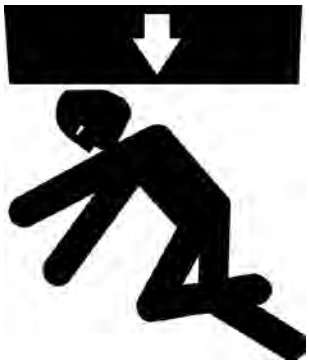


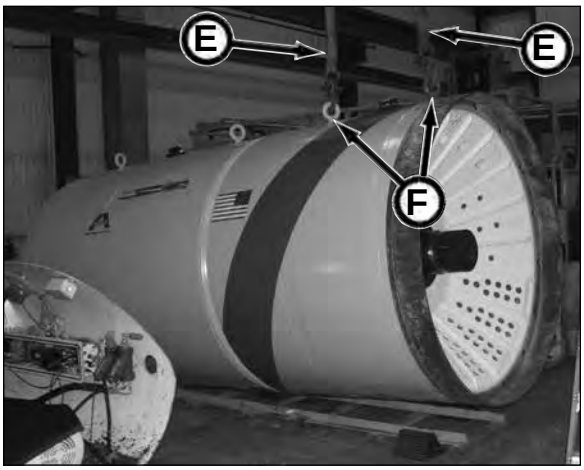
5. Click component tag name (shown below) for inclinometer to be calibrated:
   Front: Front.head.inclineFrontRaw (D)
   Back: Front.head.inclineBackRaw
   Target: Front.head.inclineTargetRaw

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

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

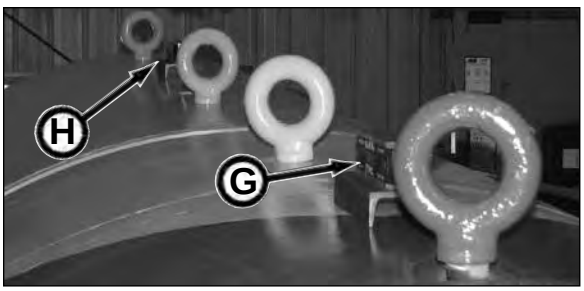
Do not enter area under or around a load.





6. With the MTBM on a level surface, securely fasten a two part sling (E) (lifting capacity of sling must be capable of lifting complete MTBM weight) to the two front lifting eyes (F) on MTBM.

NOTICE The lifting eyes shown may be different than the lift eyes on your MTBM.

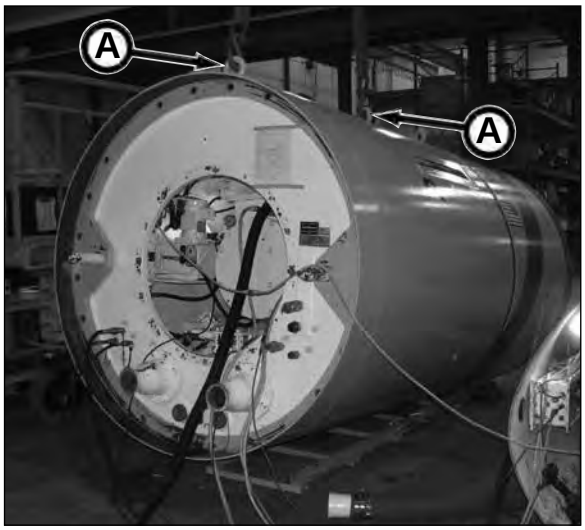


7. Place a digital level (G) between the front lifting eyes and directly on the center line of the lift eyes of the MTBM. Ideally, place another digital level (H) between the two rear lifting eyes and directly on the center line of the lift eyes.

8. Lift the front part of the MTBM to approximately 4°.

(Continued on next page)

9. Record the raw data shown on the Front, Back and Target component Tag Name lines (see step 4) and the actual degrees shown on the front digital level (this will be a positive degree value). This data will be used for the high limits for the raw value range and scaled value range fields on the Tag Properties Scale window (see step 18).



10. Remove sling from front lifting eyes and securely fasten them to the two rear lifting eyes (A) on the MTBM.
11. If not already installed, place a digital level directly on the center line of the rear lifting eyes of the MTBM.
12. Lift the rear part of the MTBM to approximately -4°.
13. Record the raw data shown on the Front, Back and Target component Tag Name lines (see step 4) and the actual degrees shown on the rear digital level (this will be a negative degree value). This data will be used for the low limits for the raw value range and scaled value range fields on the Tag Properties Scale window (see step 18).
14. Close Quick Client.

NOTICE If using Kepserver 5.10 or before, proceed to step 15. If using Kepserver 5.12 or later, exit all programs, right click Kepware icon on task bar menu and select Stop Runtime Service. Then right click Kepware icon again and select Start Runtime Service. Open Kepware server program and proceed to step 16.



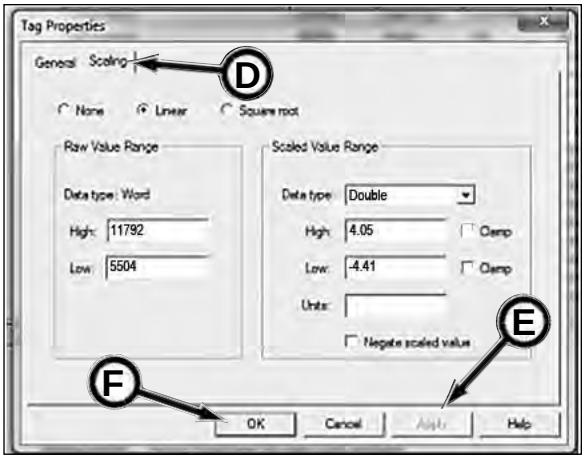
15. You will be prompted to “Save changes to.., click No (B).
16. With the device selected (from step 4), double click component tag name (C) in right column to display the Tag Property window of the inclinometer being calibrated. Refer to tag name below:

    Front: AInInclineFront
    Back: AInInclineBack
    Target: AInInclineTarget



17. Click the Scaling tab (D).
18. Input the Raw Value Range data you recorded in steps 9 and 13 for the specific inclinometer you are calibrating.

NOTICE The raw value range and scaled value range are based on the following input and data type information:
Input - Linear
Data Type: Double (with Clamp unchecked)
Scaled Value Range High: % (from digital level)
Scaled Value Range Low: % (from digital level)



NOTICE The Raw Value Range high and low data fields are:
High - Incline raw data from lifting front of MTBM
Low - Incline raw data from lifting rear of MTBM

19. Click Apply (E).
20. Click OK (F).

(Continued on next page)

21. Repeat steps 16 through 20 for the other two inclinometers.

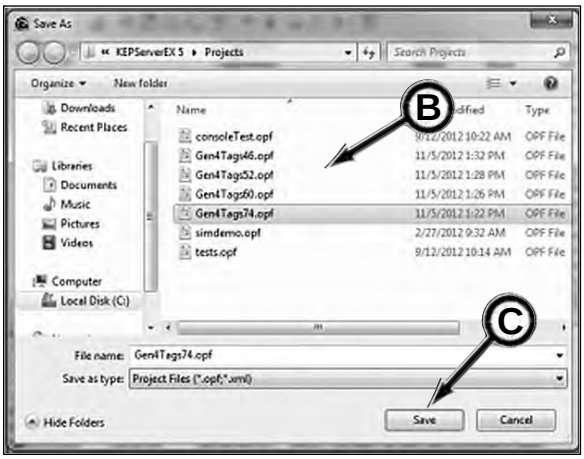
22. Click Save As button (A).



NOTICE **Be sure to click Save As,** so when restarting, the updated file is in the project directory of the Kepware Server program. Otherwise, if performing a Save, the updated file will not be in the correct location when restarting, thus it will use the old file and show erroneous data.

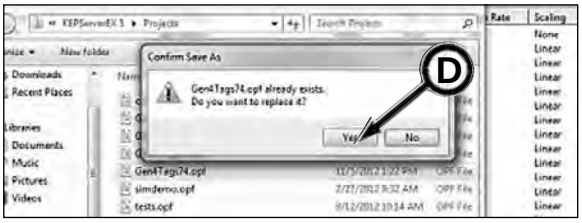
23. Highlight the same file name (B) or MTBM that you are calibrating.
    For example: for a 74" MTBM, use a file name such as Gen4Tags74.opf.

24. Click Save (C).

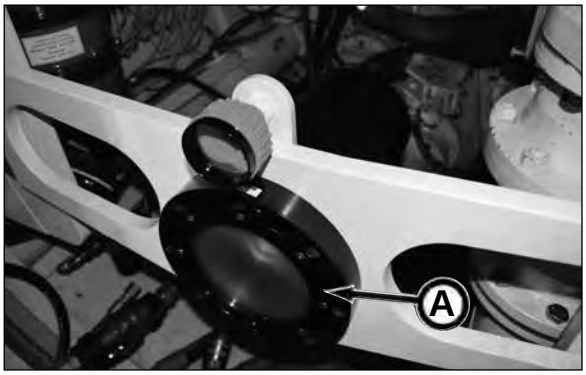


25. You will be prompted to "Do you want to replace.., click Yes (D).

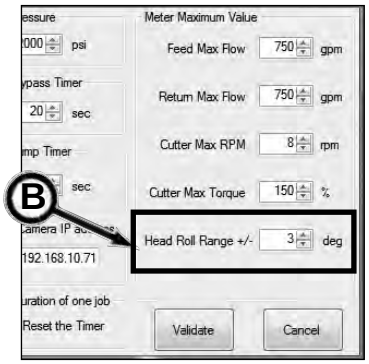
26. Restart Kepware. The inclinometers are now calibrated.



51. CLEAN & CHECK TARGET ROLL



1. Clean the target display (A) with a mild, abrasive-free cleaning solution and scratch free cloth.



Console Editor Head Roll Meter

2. To change roll setting meter, open the Console Editor program, on the Head Roll Range meter field (B), click the up or down arrows to change the roll degree, then click Validate button. If the degree setting parameters are exceeded, the main drive motor (rotation) and main hydraulic pump (jacking) will shut down.



Roll Setting Meter

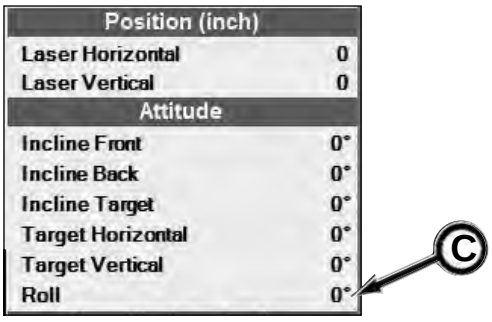
The roll positive and negative values can be set independently by clicking the Set Roll button on the bottom right portion of the target screen (refer to Roll Setting graphic on this page). Change the degree settings and click Set button.

3. Check the roll incline with MTBM on a level surface (Head Power must be on):

DIRECTIONAL CHECKS (viewed from rear of MTBM looking forward to cutter head):

Clockwise Roll Check
Slightly roll the MTBM to the right. The roll degree (C) on the target screen should indicate a positive reading and positive degree.

CounterClockwise Roll Check
Slightly roll the MTBM to the left. The roll graphic on the target screen should indicate a negative reading and negative degree.

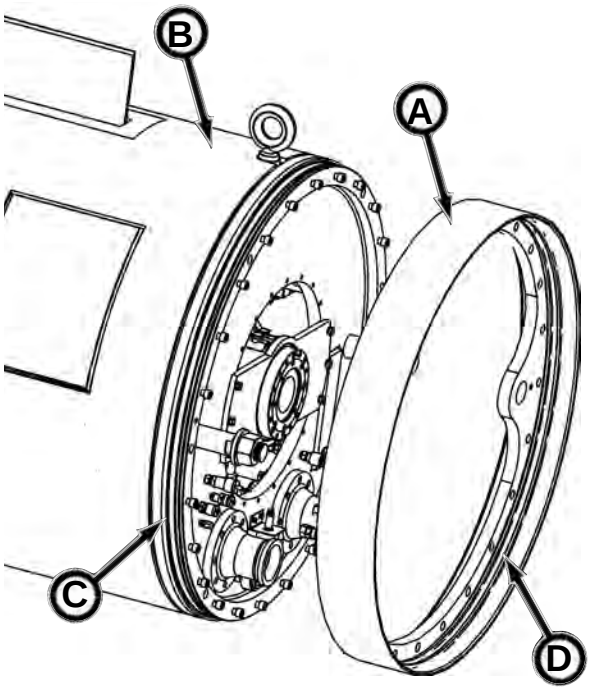


Roll Indicator On Target Screen

If the roll indicator is incorrect, the target inclinometer or electronics have malfunctioned. Contact your Akkerman Aftermarket Support representative for troubleshooting information.

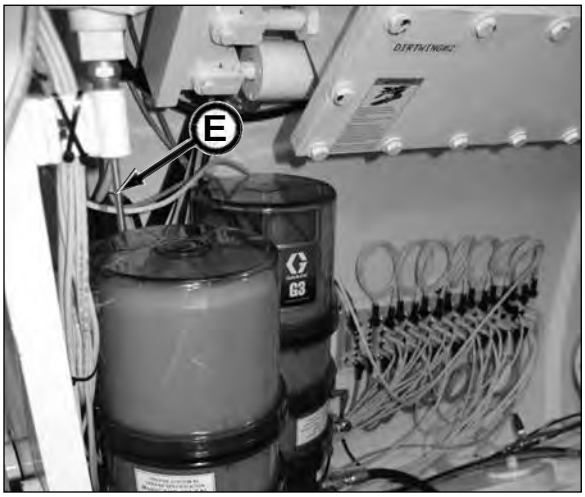
52. INSPECT & LUBRICATE COUPLING SLEEVE & ORINGS

1. Inspect coupling sleeve (A) for dents, bends or other damage that would prevent a proper seal to the back drum (B) or pipe adapter.
2. If there is any damage, the coupler sleeve must be removed and repaired or replaced (refer to steps 3 through 6). If there is no visible damage to coupler sleeve, proceed to step 7, otherwise continue to step 3.
3. Install new oring (C) to back drum and lubricate with pipe lubricant.
4. Secure repaired or new coupler sleeve to back drum with new hardware.
5. Install two new orings (D) to coupler sleeve or pipe adapter and lubricate with pipe lubricant.
6. Repeat steps 1 through 5 for trailing section.
7. Before launching MTBM, always replace two new orings (H) on coupler sleeve or pipe adapter and lubricate with pipe lubricant.



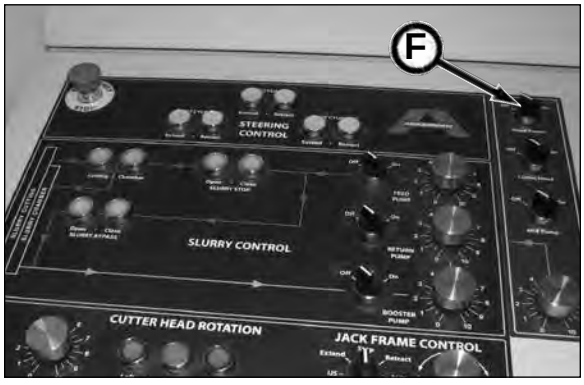
53. CHECK HEAD TEMPERATURE SENSOR

A thermocouple sensor (E) is installed in the front section of the MTBM to transmit the ambient temperature of the front section to the operator in the control container.

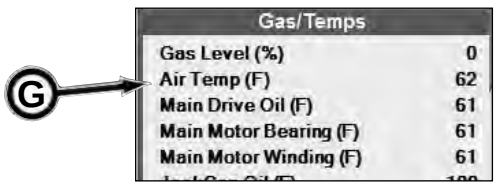


Check sensor as follows:

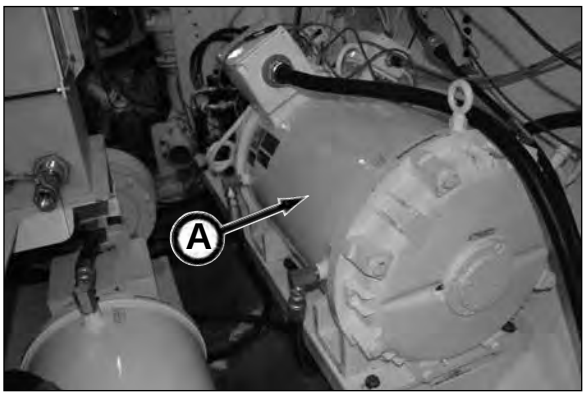
1. Turn Head Power switch (F) to ON position.
2. Check the ambient air of the MTBM with a thermometer. Compare the reading on the thermometer with the Air Temp (G) display on the target screen.
3. If the temperatures are similar, the sensor is functioning properly. If the temperatures are vastly different, check the sensor cabling for damage. If necessary, replace the sensor.



NOTICE If the MTBM has been in the sun, the temperature of the sensor will be warmer than the thermometer.

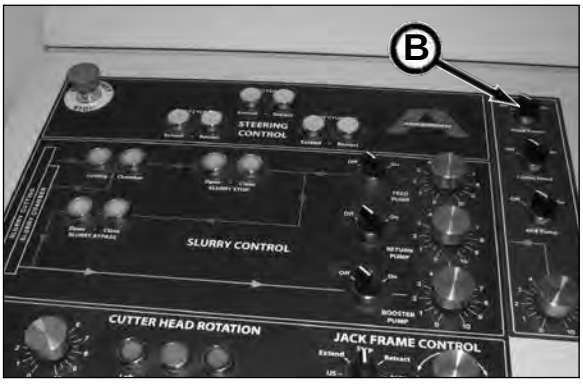


54. CHECK DRIVE MOTOR TEMPERATURE SENSOR



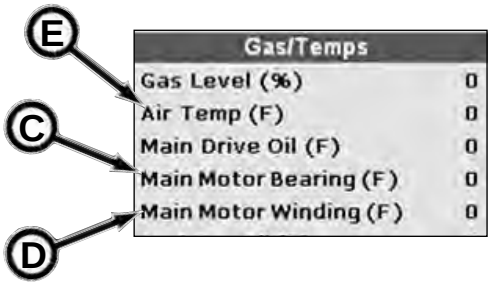
NOTICE Flush drive motor cooling system to remove rust flakes or sediment within the system before operation.

There are three RTDs (Resistance Temperature Device) internally installed in the drive motor (A) to transmit the motor winding and motor bearing temperatures to the operator in the control container.



1. Turn Head Power switch (B) to ON position.

2. Before the drive motor is started, compare the temperature reading for the Main Drive Motor Bearing (C), Main Drive Motor Winding (D) and MTBM head Air Temp (E). If the temperatures are similar, operate the drive motor to see if the main drive bearing and main drive winding temperature rises higher than the Air Temp. If so, the motor sensor is functioning properly. If not, contact your Akkerman Aftermarket Support representative for troubleshooting information.



55. INSPECT STRUCTURE

Inspect MTBM structure for cracks, wear or other damage. Repair as needed before operation.



56. INSPECT DECALS

Inspect ALL decals to be sure they are clean and legible.

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.

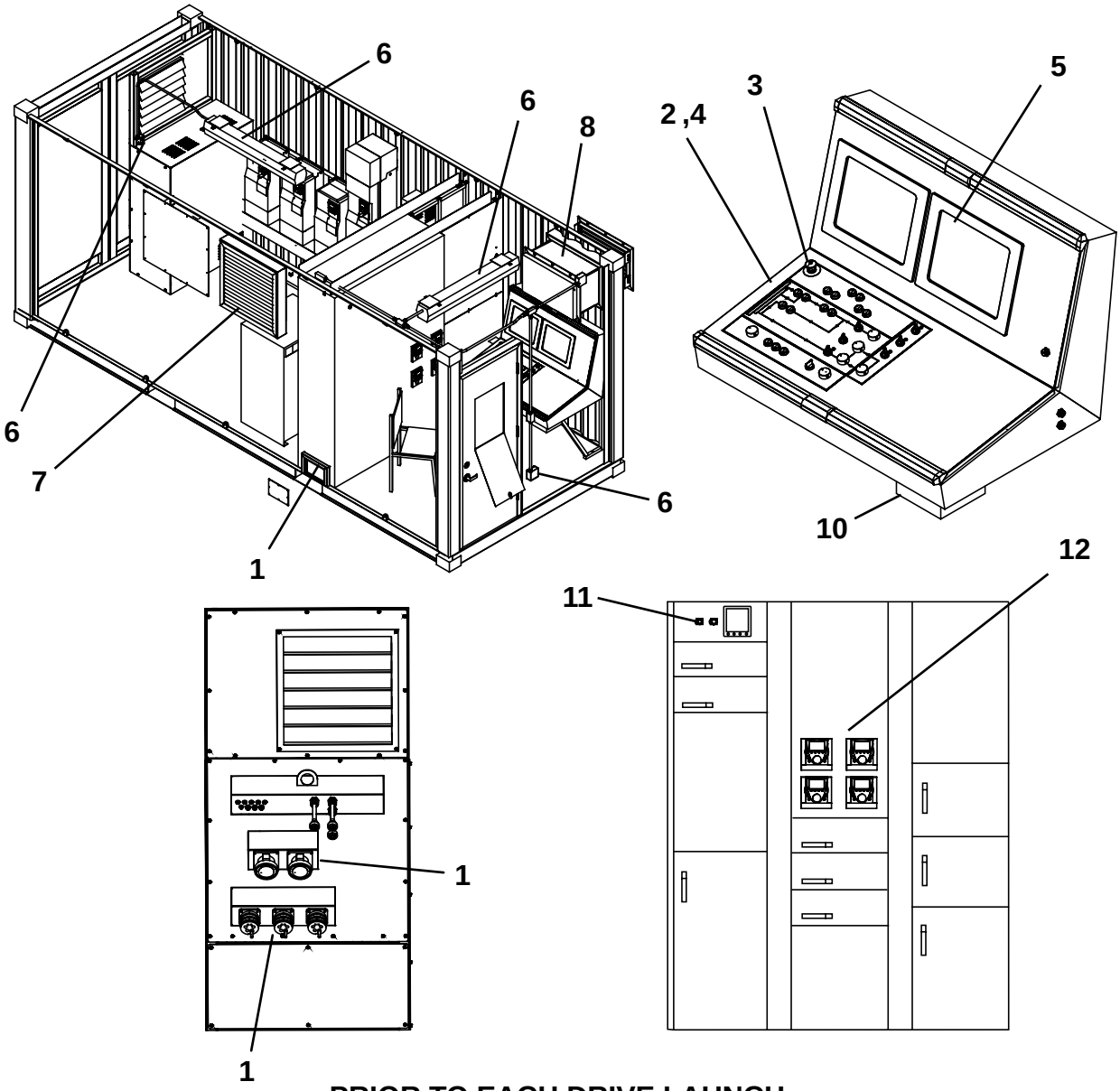
Before applying a new decal, be sure the surface is clean and dry.



NOTES

MAINTENANCE CHARTS - CONTROL CONTAINER

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



PRIOR TO EACH DRIVE LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Electrical Connect.	Check Electrical Connect.		
2.	Computer	Check Operation		
3.	E-Stop	Check Operation		
4.	Control Console	Check Operation		
5.	Video	Check Video Operation		
6.	Light & Outlet	Check Operation		
7.	Exhaust Fan	Check Operation		
8.	A/C / Heater	Check Operation		
*9.	Fire Extinguisher	Equipped & Charged		
10.	Audio	Check Audio Sound		
11.	Phase Power	Check		
12.	VFD	Check Parameters	Contact factory for proper settings.	

* Not Shown



1. CHECK ELECTRICAL CONNECTIONS

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

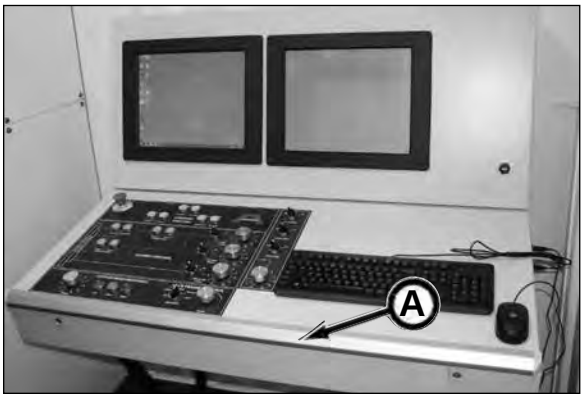
With power off and power source in LOCK OUT, TAG OUT, check electrical cables and connections for fraying, wear or damage. If damaged, the cables must be replaced BEFORE operation.



Control Container Bulkhead Connections

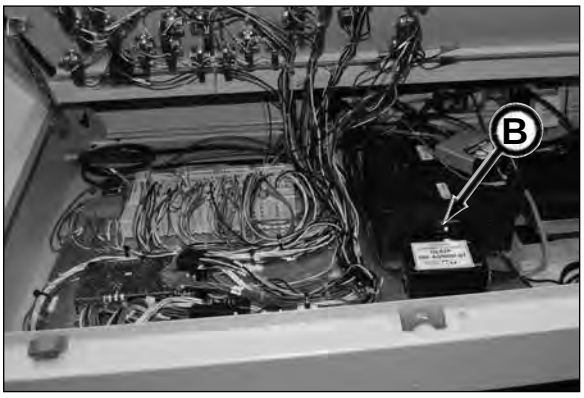
2. CHECK COMPUTER OPERATION

1. Once the 120V/240V Transformer Disconnect power is flipped on, the computer will automatically boot up.

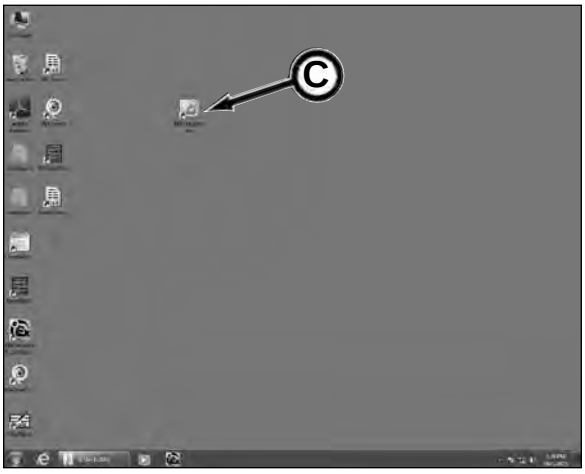


NOTICE If the computer is shut down with the power on, restart the computer by opening the control container console lid (A) and press power button (B). Close console lid. Be sure to use caution when opening console so keyboard and/or mouse do not fall off of console surface.

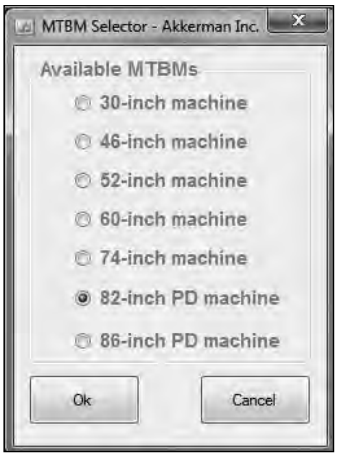
The console lid has a racheting mechanism. To close lid, fully open lid to release the rachet mechanism, then slowly lower lid until it is closed.



2. Once computer starts, the desktop screen will appear.



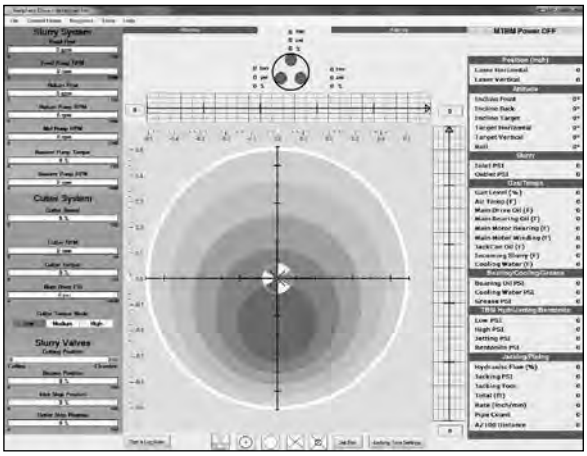
3. Double click the Machine Select icon (C). 



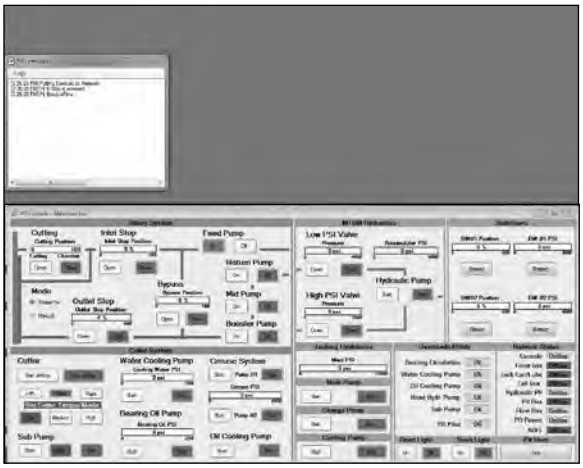
4. The Machine Control Selector window appears. Select your MTBM head size (82-inch PD machine) and click OK.

(Continued on next page)

5. After program loads, the target screen, MTBM control screen and log message screen windows appear. You may have to reposition the windows so they are not overlapping, or per operator preference, move the windows to the desired monitor. Typically after the initial window positioning, the repositioning of the control screens will not be required.



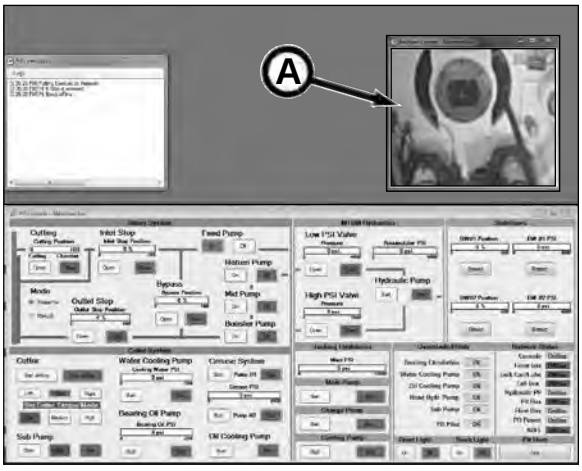
Target Screen



Log Message and MTBM Control Screens

6. Load the MTBM target camera program.

   Double click PD Camera icon from the desktop. After initial loading of the program, you will have to reposition the camera window (A) to desired area on the monitor. Typically after the initial window positioning, the repositioning of the camera window will not be required.



Log Message, MTBM Control & MTBM Camera Screens

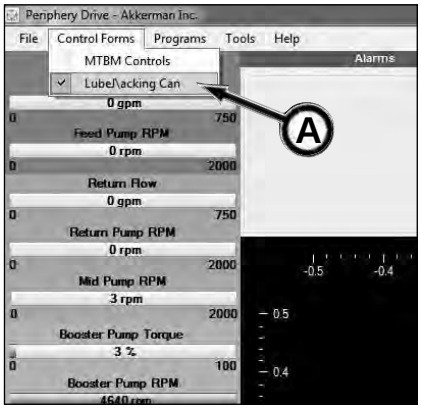
NOTICE If the PD Camera program is loaded and the boring head ethernet cable is not connected to the MTBM control box, a window with the Akkerman logo will appear (as shown). Once the communication is connected between the MTBM and the control container, the video feed of the MTBM front section will be visible in the camera window.



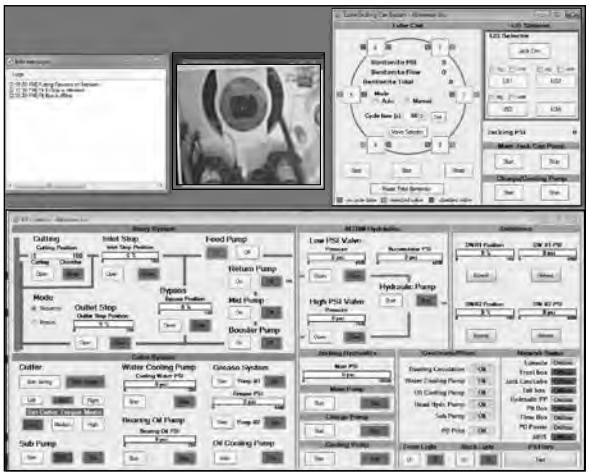
MTBM Camera Screen With No MTBM Ethernet Connection

(Continued on next page)

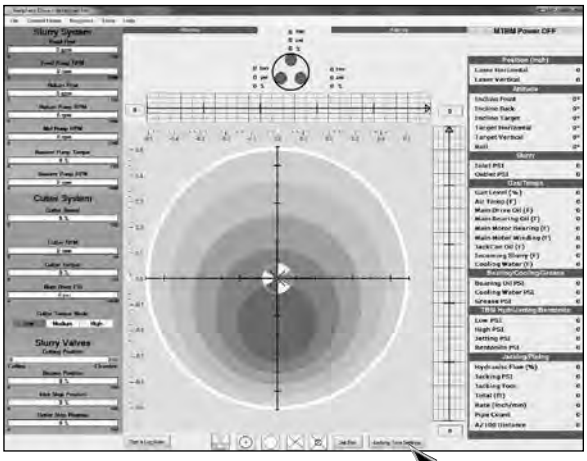
7. If using the lube/jacking can, load the Lube/ Jacking Can System program by clicking Control Forms on the Target Screen menu bar and then clicking Lube/Jacking Can (A) from the pull down menu.

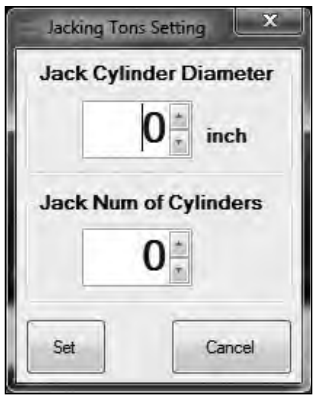


After initial loading of the program, you will have to reposition the lube/jacking can and camera windows to desired area on the monitor.



8. To properly calculate and display the jacking tons for the jacking frame being used, click the “Jacking Tons Settings” button (B) on the target screen. The Jacking Ton Setting window will appear. Enter the jacking frame cylinder diameter and the number of cylinders on the jacking frame. Click OK.





3. CHECK E-STOP OPERATION

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

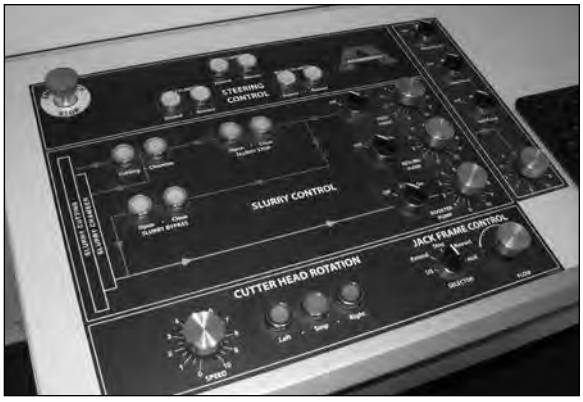


Check E-Stop button (A) for proper operation. When pushed in, the E-Stop must deactivate ALL outgoing electrical and hydraulic power from the Akkerman control container (feed pump, return pump, booster, mid pump, head power and cooling water tank pump [if used]), remote hydraulic power pack (hydraulic flow to jacking frame), power container (cutter head 4160V main drive tunnel power) and jacking frame.

If E-Stop button does not function properly, it MUST be repaired or replaced BEFORE operation.

NOTICE If any E-Stop buttons are activated in the control container, remote hydraulic power pack, power container or jacking frame pit box, ALL E-Stop buttons must be pulled out for the equipment to function.
BEFORE resetting the E-Stop buttons, be sure all control container switches are flipped to the OFF or Stop positions to prevent any unintended starting of equipment.

4. CHECK CONTROL CONSOLE OPERATION



Check VFD control operation by turning on the feed pump, return pump, booster pump and cutter head. Rotate the flow control to be sure the variable speed control is functioning properly.

If possible, check the steering cylinder control and jacking control operation.

All controls must be functioning properly before operation.

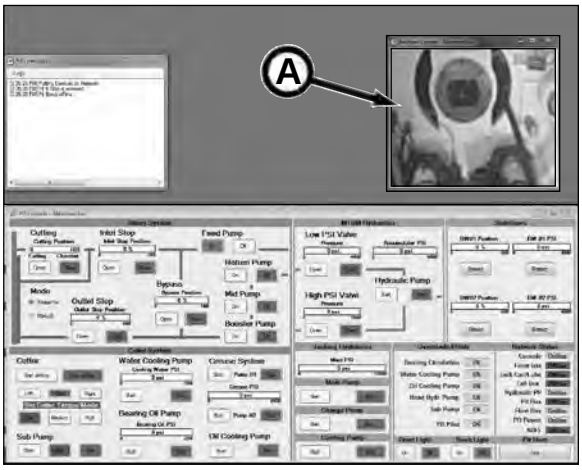
5. CHECK VIDEO OPERATION

1. Check MTBM video for proper operation.

If not already loaded, load the MTBM target camera program.



Double click PD Camera icon from the desktop. After initial loading of the program, you will have to reposition the camera window (A) to desired area on the monitor. Typically after the initial window positioning, the repositioning of the camera window will not be required.



Log Message, MTBM Control & MTBM Camera Screens

NOTICE If the PD Camera program is loaded and the boring head ethernet cable is not connected to the MTBM control box, a window with the Akkerman logo will appear (as shown). Once the communication is connected between the MTBM and the control container, the video feed of the MTBM front section will be visible in the camera window.



MTBM Camera Screen With No MTBM Ethernet Connection

2. If optional cameras are installed, such as a pit camera, be sure to check for proper operation. Refer to camera manufacturer operation manual for more information.



6. CHECK LIGHT & OUTLET OPERATION

The control container is equipped with two lights; one in operator station area and one in the VFD area of the container.

The control container is also equipped with 120V GFI (ground fault interrupter) outlets. Test the GFI outlets by using the outlet, then press the test button at which time the outlet will be shut down until you press the reset button. If the GFI does not work properly, contact a certified electrician to replace the outlet with a new GFI outlet.

The test button should be tested monthly to insure it is working correctly.





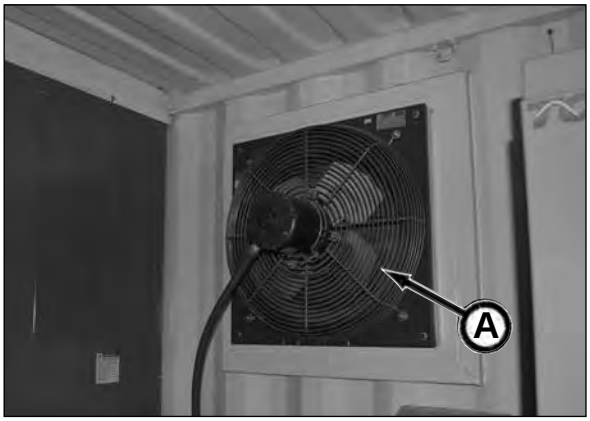
7. CHECK EXHAUST FAN OPERATION

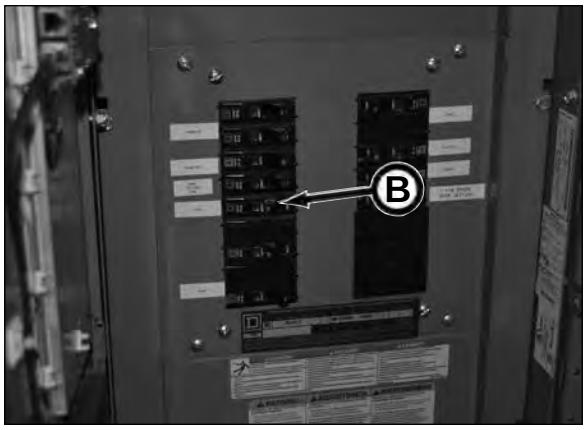
The control container is equipped with an exhaust fan (A) in the VFD area of the container to expel the heat of the 480V-575V transformer and the VFD controllers.

The exhaust fan is manually operated by accessing the exhaust fan breaker switch (B) behind the Panel Board door in the operator station area of the control container.

Check fan for bent fan blades, cracks, dents or other damage. If possible straighten blades. Otherwise repair or replace as necessary.

Test fan for proper operation. If fan does not function properly, repair or replace before operation of the microtunneling system.





8. CHECK AIR CONDITIONER & HEATER OPERATION

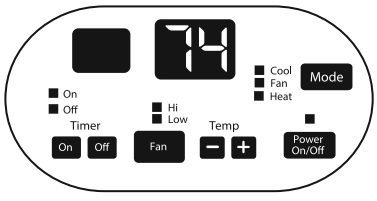
The control container is equipped with an air conditioner/heater unit in the operator station area.

For details on the use of the air conditioner/heater, follow the operating instructions in the A/C/Heater manual. The A/C/Heater manual can be accessed from the Target Screen by clicking Help in the menu bar and then clicking A/C_Manual.

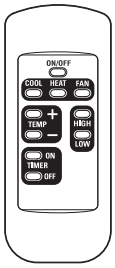
NOTICE The AC/Heater unit is designed to be extended out for operating position or retracted for storage or transporting position. When repositioned, the unit MUST be secured with six 1/2 UNC x 1.25 flat socket head cap screws.



AC/Heat Unit Shown in Storage/Transport Position



A/C Controls



A/C Remote Control

9. CHECK FIRE EXTINGUISHER



The control container is equipped with a 20 lb. ABC fire extinguisher in the operator station area of the control container.

⚠WARNING Do not puncture or incinerate extinguisher. Do use extinguisher if damaged or corroded. Do not discharge directly into face.

Inspect fire extinguisher prior to each drive launch, then monthly or more frequently when circumstances require. Be sure hose and nozzle are unobstructed.



Gauge needle must be in green operating zone for use. If gauge needle is in the red recharge or overcharged zone, have an authorized fire extinguisher recharging service company, inspect the fire extinguisher for proper operation.

When using the fire extinguisher, that is, once personnel are evacuated from the hazard area and you have determined you can effectively deal with the fire, remember to use the PASS method:

1. **P**ULL the pin at the top of the extinguisher and hold upright.



2. **A**IM at the base of the fire, not the flames.



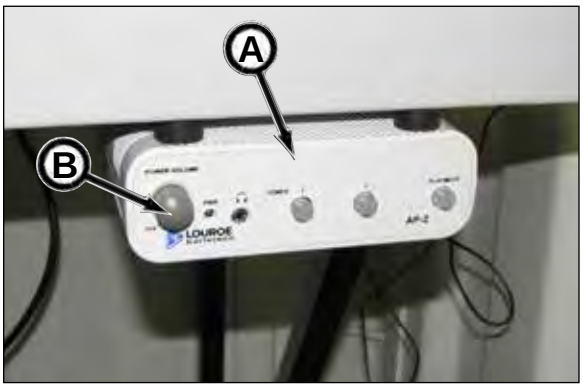
3. **S**QUEEZE the lever slowly.

4. **S**WEEP from side to side. Using a sweeping motion, move the fire extinguisher back and forth until the fire is completely out.



Recharge immediately after any use by an authorized recharging service company. Service companies that do this are listed under “fire extinguishers” in the Yellow Pages.

10. CHECK AUDIO SOUND



An audio system (A) is equipped for live, one-way audio monitoring from the microphone installed in the MTBM.

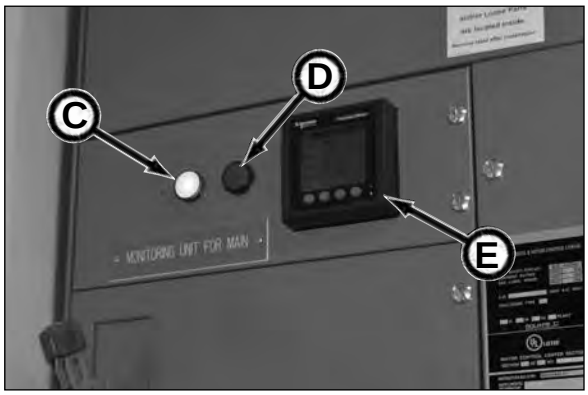
Check audio system sound by:

Turn on the power to the unit by rotating the Power-Volume knob (B) clockwise to ON position. The Power Indicator green LED light (C) will illuminate when the power is turned on. Rotate Power-Volume knob further clockwise to increase the volume of the monitored audio.

For troubleshooting the audio system, follow the instructions in the Operating Instructions manual. The manual can be accessed from the Target Screen by clicking Help in the menu bar and then clicking AudioSystemOperatingInstructions.

11. CHECK PHASE POWER

⚠WARNING Any electrical work completed on the control container or the remote hydraulic power pack must be performed by a certified electrician.



Check for proper phase power as follows:

If the green Phase OK indicator light (C) 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.

If the red Phase Error indicator light (D) is illuminated, disconnect and lock out/tag out ALL power before attempting to reverse the two generator power leads on the power circuit.



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

NOTICE The Phase Monitor (E) will display the power in hertz, voltage and amperage from the power source. This container must be powered with 480V and 60 hz. The maximum amperage is 600 amps.

12. CHECK VFD PARAMETERS

The control container is equipped with four variable frequency drives (VFDs) to efficiently operate the electric motors of the main MTBM drive, slurry feed, slurry booster, and slurry return systems.

IMPORTANT: Due to the complexity of the VFD parameter check and setup, Akkerman highly recommends that you contact your Akkerman Aftermarket Support representative if you have any questions before checking or changing the VFD parameter settings.

There are VFD parameters that are programmed to allow the VFD to be controlled so the specific motor runs smoothly.

The VFD monitors in the control container display the specific component (slurry feed, return, and booster VFD, and cutter VFD) motor rpm and motor torque.

If the motor rpm and motor torque screen do not appear on the monitor, press ESC button (A) twice.

There are several parameters for each VFD, for example (but not limited to):
- speed and torque controls
- minimum and maximum operating frequencies
- motor power, current, voltage, and speed
- phase rotation

If the VFD parameters are not set properly, it is possible that a motor overload may occur, causing component damage.



VFD Motor Controllers



VFD Motor Monitors

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



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

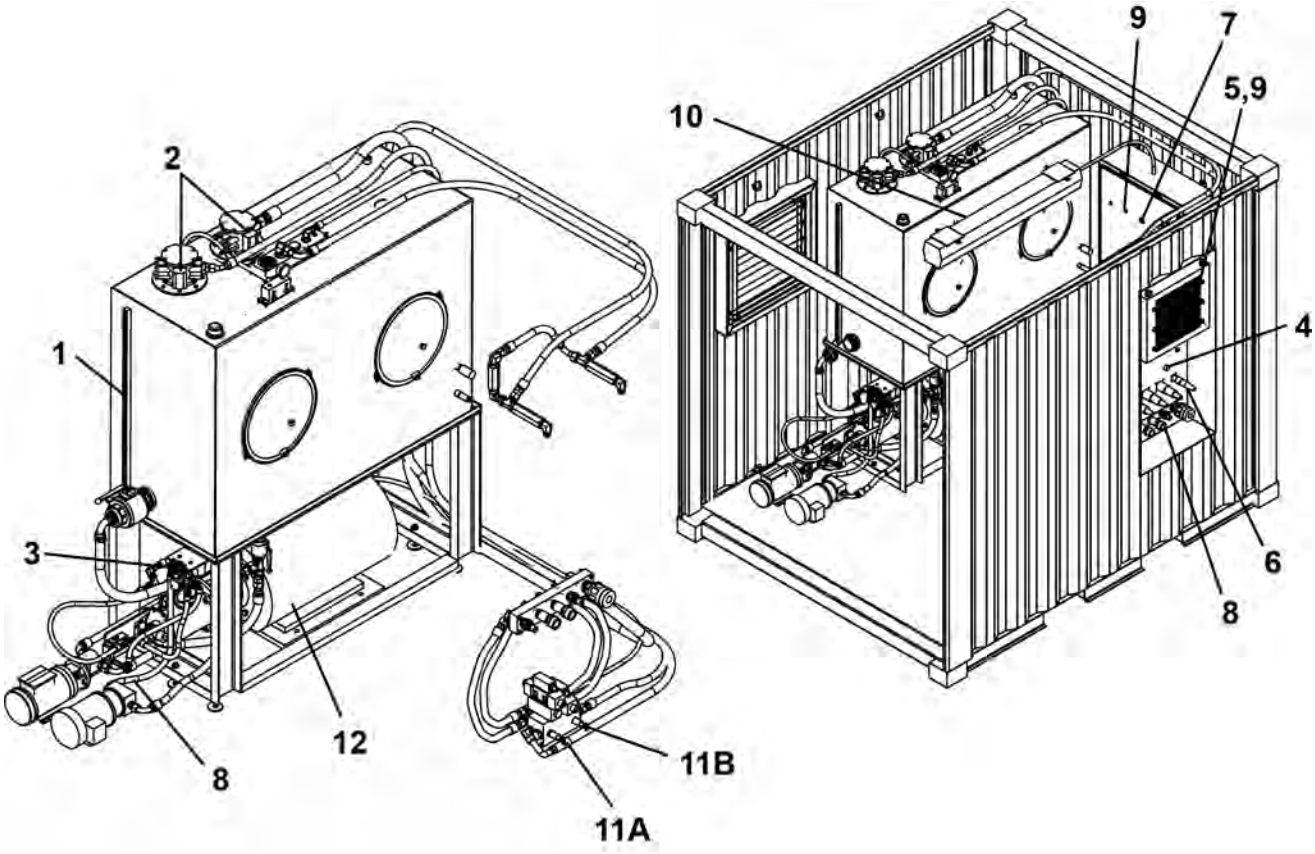
IMPORTANT: It is recommended to re-energize the VFD drives at least every 6 months for 30 minutes with the rated voltage to re-form the VFD capacitors and to ensure correct VFD operation.

IF the VFD drives have been in storage for 12 months or more, re-apply voltage PROGRESSIVELY (see below) using a variable power supply to re-form the capacitors. Immediately applying full line voltage could result in serious damage to the VFD drive and possible personal injury. The re-forming of the VFD capacitors must only be performed by a certified electrician trained in re-forming capacitors.

480V VFD	575/600V VFD
120 VAC / 30 min.	120 VAC / 30 min.
240 VAC / 30 min.	240 VAC / 30 min.
480 VAC / 30 min.	480 VAC / 30 min.
	575/600 VAC / 30 min.

MAINTENANCE CHARTS - REMOTE HYDRAULIC POWER PACK

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



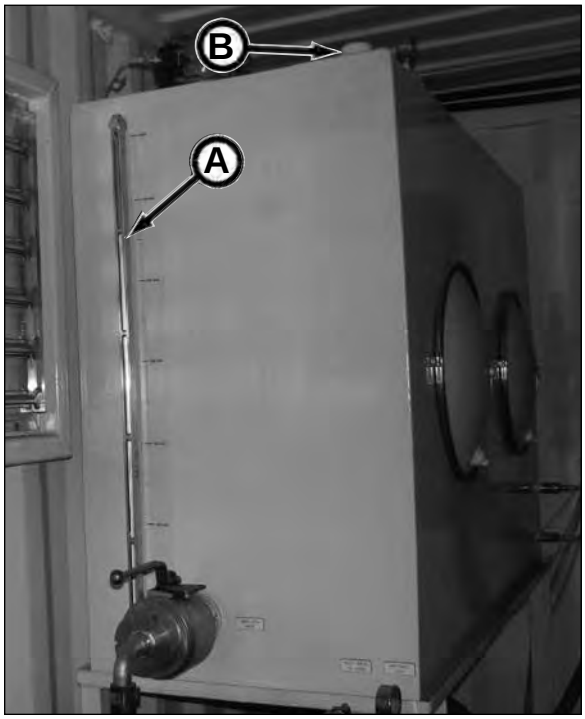
PRIOR TO EACH DRIVE LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Hydraulic Reservoir	Check Level & Condition	Refill as needed.	ISO-VG-46 20W
2.	Hydraulic Filters	Check Filter Indicators	Replace if indicated.	Filter
3.	Pilot Pressure Filter	Check Filter Indicator	Replace if indicated.	Filter
4.	E-Stop	Check Operation	E-Stop - Power Pack & Pit Box	
5.	Oil Cooler	Check Fan, Fins & Blades	If damaged, repair or replace.	
6.	Electrical Connect.	Check		
7.	Phase Monitor	Check For Phase Error		
8.	Power Pack Hyd.	Check for Operation/Leaks		
9.	Cooling Fan	Check Operation		
10.	Lights	Check		
11.	Relief Settings	Main (A), Auxiliary (B)		
12.	Motor	Verify Motor Rotation		

1. CHECK HYDRAULIC RESERVOIR OIL LEVEL & CONDITION OF OIL

1. Check hydraulic reservoir oil level with sight gauge (A).

If oil is needed, clean area around fill cap (B), remove fill cap and fill until tank level is at full mark with ISO-VG-46 20W Premium Hydraulic/Turbine Oil. Replace oil cap.



NOTICE If you change to a different oil, use a reputable oil supplier to meet or exceed the ISO-VG-46 20W or API GL-1/GL-2 oil specification. Do not mix oil manufacturers or grades.

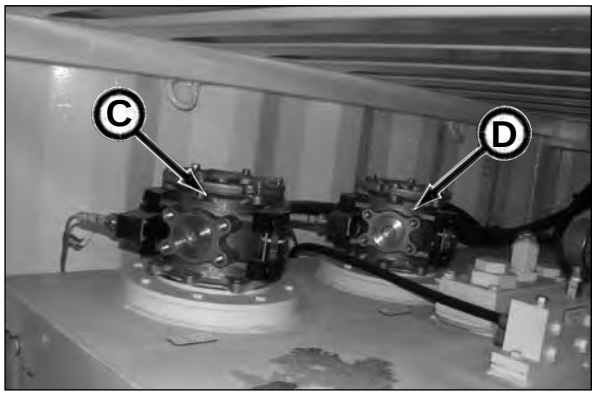
Oil capacity is approximately: 330 US gal. (1,249 L)

2. Check condition of oil. If any of the following situations occur, the reservoir must be drained and refilled with flesh oil. The return filters must also be replaced:
   - 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.

2. CHECK HYDRAULIC JACKING RETURN FILTERS

There are two hydraulic return filters; the jacking frame return and hi flow return filters.

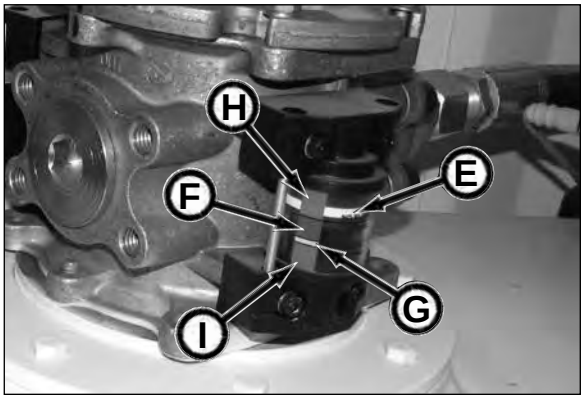
To prevent under or over servicing of the hydraulic filter elements, filter indicators have been installed on the jacking frame return circuits; manifold (jacking frame extend, retract, auxiliary and IJS) return filter (C) and hi-flow return filter (D).



If the white indicator (E) is in the clean green zone (F), the filter is functioning properly.

If the white indicator is in the caution yellow zone (G), the filter is will soon require replacement.

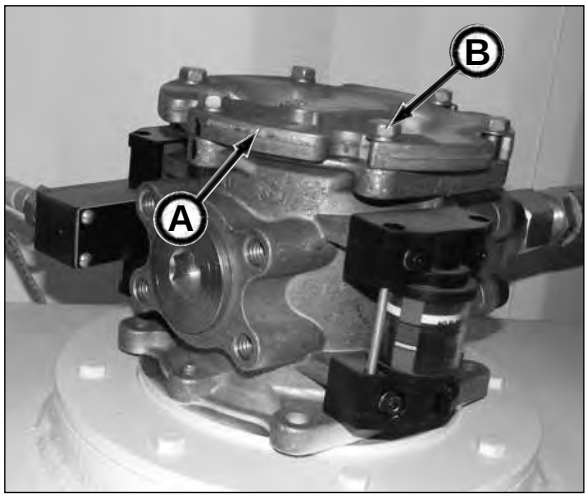
If the white indicator is in the no element red zone (H) or bypass red zone (I), replace the filter immediately to prevent contamination from entering the hydraulic reservoir.



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

(continued on next page)

Replace filter(s) as follows:



1. Clean and dry area around filter cover (A).

2. Remove cover screws (B) and lock washers. Retain for later use.

3. Remove cover.

4. Remove filter. Dispose of filter properly.

5. Remove filter oring if stuck in filter housing or cover.

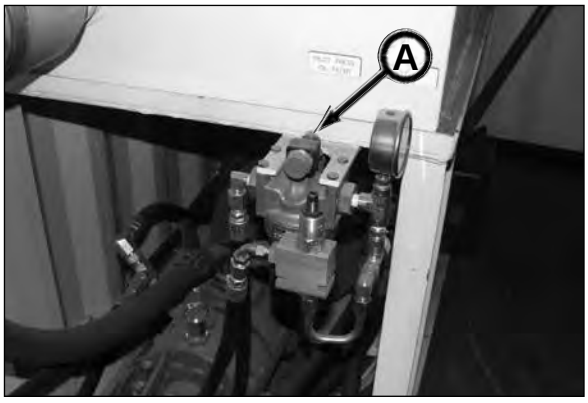
6. Install new oring in cover with a light coat of clean hydraulic oil. Check to be sure the oring is not twisted and that it is correctly seated in place.

7. Carefully install new filter into housing. Be sure filter is oriented properly.

8. Replace cap and secure with lock washers and cover screws (removed in step 2).

9. Check for leaks.

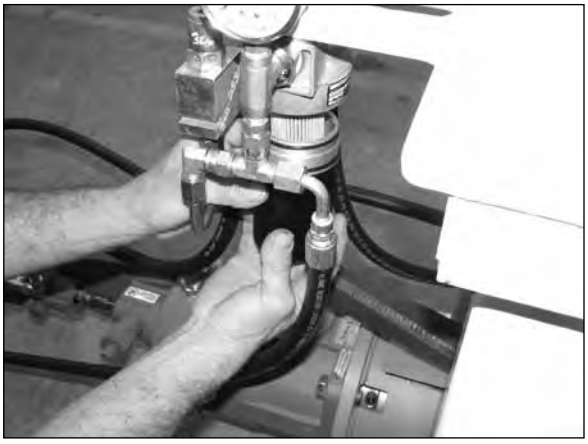
3. CHECK PILOT PRESSURE FILTER INDICATOR



To prevent under or over servicing of the hydraulic filter element, a filter indicator (A) has been installed on the charge pump pilot pressure circuit.

If the filter indicator is green, the filter is functioning properly.

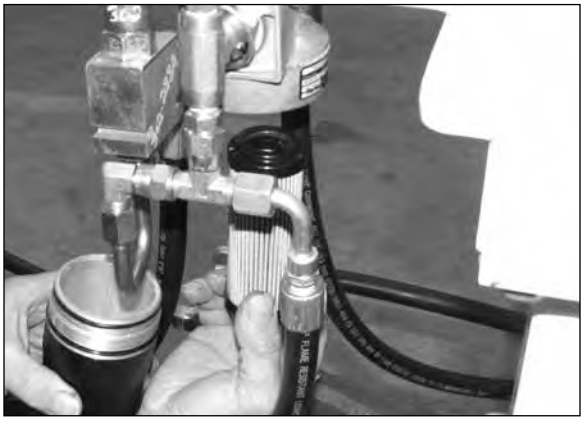
If the filter indicator is red, the filter should be replaced as follows:



1. Remove lower filter housing. Inspect housing and housing orings for damage. If damaged, replace with new.

(continued on next page)

2. Remove filter.



3. Lubricate housing orings with a light coating of clean hydraulic oil.



4. Lubricate filter inner oring with a light coating of clean hydraulic oil.

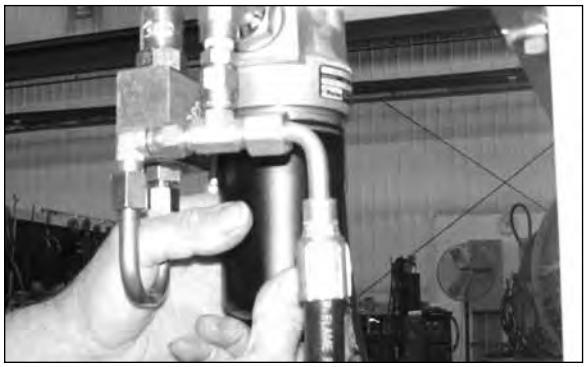


5. Carefully insert new filter into upper filter housing.



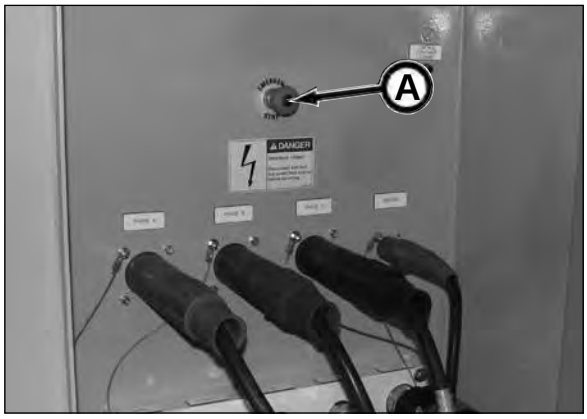
6. Securely fasten lower housing into upper filter housing.

7. Check for leaks.



4. CHECK E-STOP OPERATION

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



Check E-Stop button (A) for proper operation. When pushed in, the E-Stop must deactivate ALL outgoing electrical and hydraulic power from the Akkerman control container (feed pump, return pump, booster, mid pump, head power and cooling water tank pump [if used]), remote hydraulic power pack (hydraulic flow to jacking frame), power container (cutter head 4160V main drive tunnel power) and jacking frame.

If E-Stop button does not function properly, it MUST be repaired or replaced BEFORE operation.

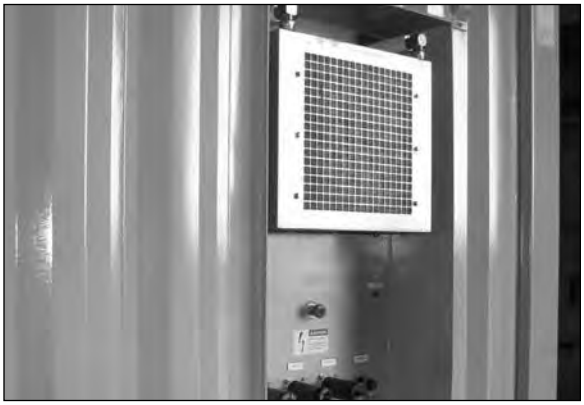
NOTICE If any E-Stop buttons are activated in the control container, remote hydraulic power pack, power container or jacking frame pit box, ALL E-Stop buttons must be pulled out for the equipment to function.
BEFORE resetting the E-Stop buttons, be sure all control container switches are flipped to the OFF or Stop positions to prevent any unintended starting of equipment.

5. CHECK OIL COOLER FAN & FINS



Check oil cooler for bent fins, bent fan blades, cracks, dents or other damage. If possible straighten fins and blades. Otherwise repair or replace as necessary.

Test fan for proper operation. If fan does not function properly, repair or replace before operation of the microtunneling system.



6. CHECK ELECTRICAL CONNECTIONS



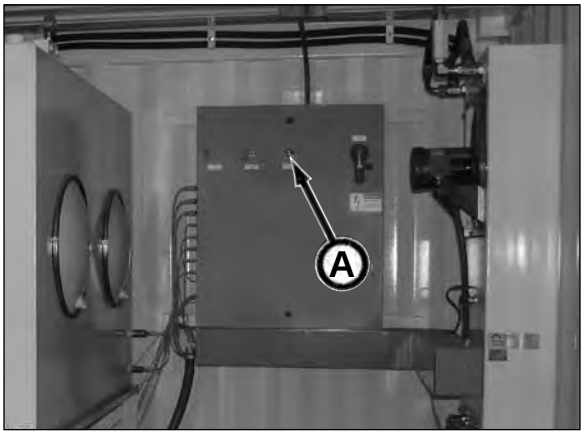
⚠DANGER If high voltage cables or cable connections are frayed, worn or damaged, contact with cables/connections will result in electrical shock causing severe injury or death.



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

7. CHECK PHASE MONITOR

⚠WARNING Any electrical work completed on the control container or the remote hydraulic power pack must be performed by a certified electrician.



In the remote hydraulic power pack, if the green Phase OK 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.

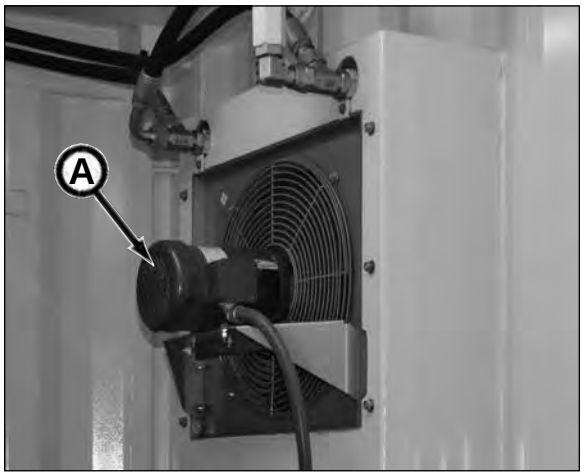
If the green phase OK light (A) is NOT illuminated, disconnect and lock out/tag out ALL power before attempting to reverse the two generator power leads on the power circuit.

IMPORTANT: DO NOT start up electric components if the green phase indicator lights are not illuminated. Doing so will run components backwards causing damage.



8. CHECK POWER PACK HYDRAULIC OPERATION

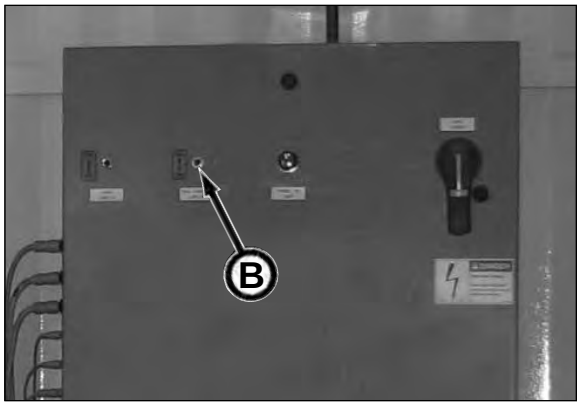
Before launching MTBM, be sure to check the operation of the power pack hydraulic pump and motors for proper operation (main hydraulic motor and pumps, charge pump, cooling pump, charge/ cooling pump motor). If components do not function properly or show signs of leaking, repair or replace before operation.

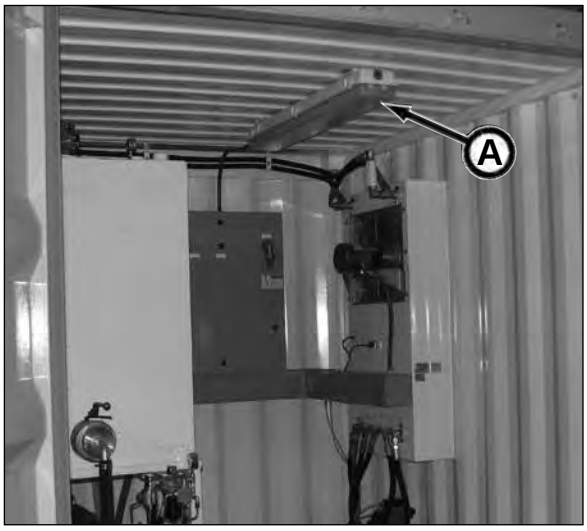


9. CHECK COOLING FAN OPERATION

The hydraulic oil cooling fan (A) is designed to operate once the power pack main power switch is turned on.

The power pack is equipped with a fan override switch (B) to power the fan off. Check the switch operation. If switch or fan does not function properly, repair or replace before operation.

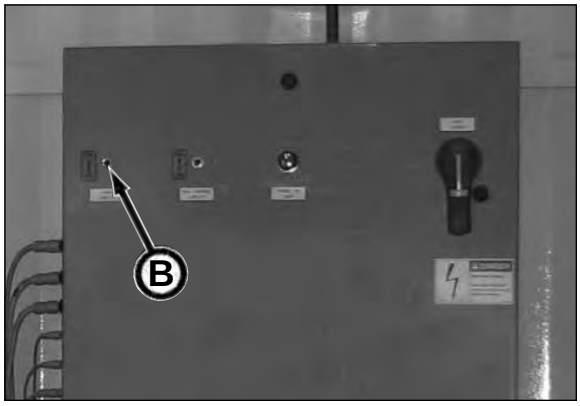




10. CHECK LIGHT OPERATION

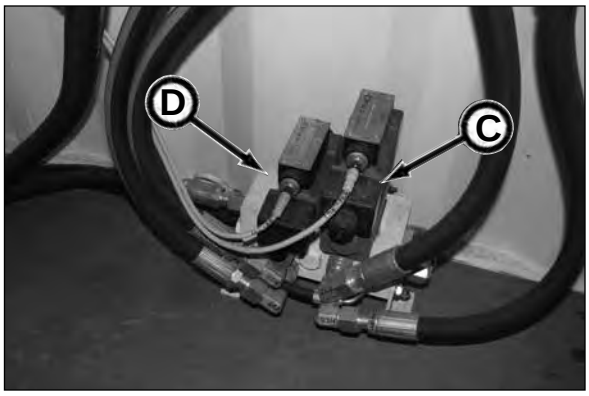
Check power pack light (A) for proper operation. Use light switch (B) to turn light on and off.

Repair or replace light and/or switch if they do not function properly.



11. CHECK MAIN & AUXILIARY RELIEF SETTINGS

Relief valves are installed in the main (C) and auxiliary (D) circuits to release excess pressure when pressures get too high. These relief valve settings should be checked prior to each drive launch.



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

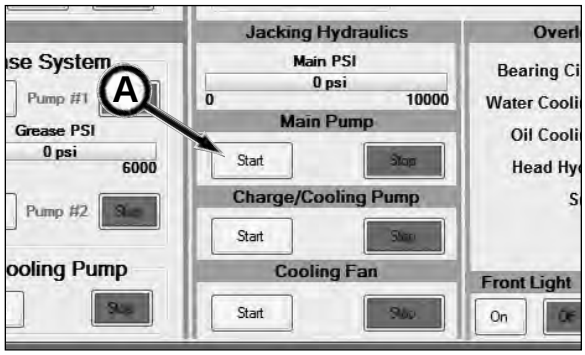
Release all pressure before performing maintenance or repairs. Never weld near pressurized fluid lines.

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

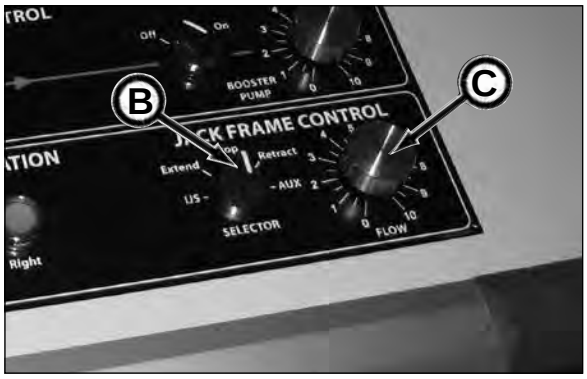


CHECKING MAIN RELIEF VALVE (Extend - IJS)
1. Disconnect hoses at bulkhead.
(Continued on next page)

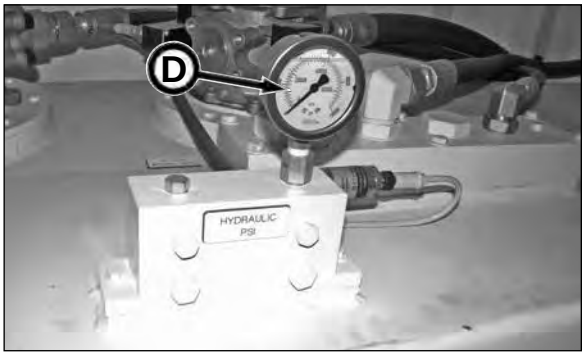
2. Check the main relief setting by starting the main hydraulic pump with Start button (A).



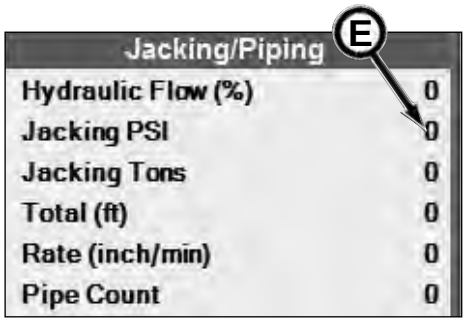
3. On control console, move selector switch (B) to Extend and move flow control (C) to the 25% position.



4. Check the hydraulic pressure gauge (D) located next to cooling fan.

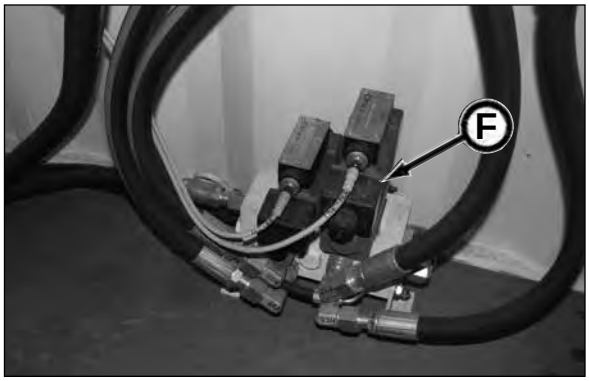


5. Check the Jacking PSI reading (E) to make sure it registers the same as the pressure gauge. If the pressures do not match, troubleshoot and resolve the problem.



6. If the pressure does not register 8,000 psi, the main relief valve must be adjusted.

7. Adjust relief valve (F) by:
   a. loosening the relief jam nut
   b. turn adjustment screw as follows to set the main pressure relief valve to 8,000 psi:
      CW - increase pressure
      CCW - decrease pressure

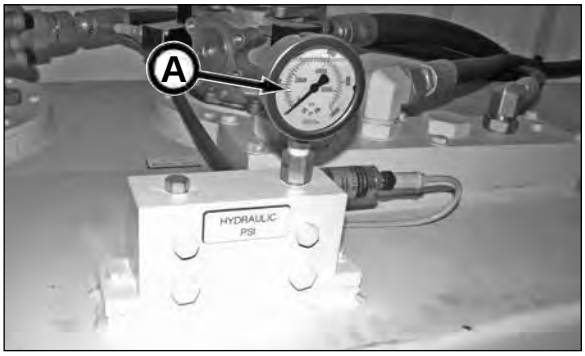


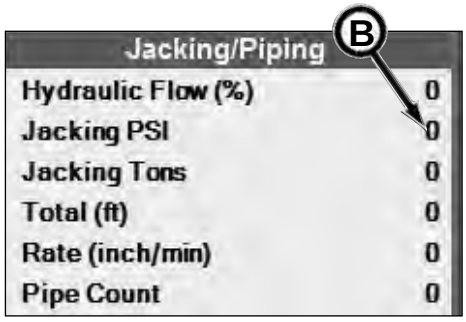
8. Secure jam nut against adjustment screw.

(Continued on next page)

9. Once jam nut is secured, recheck hydraulic pressure gauge (A) and the Jacking PSI reading (B) on target screen to make sure that the readjusted pressure setting did not change. If necessary readjust and secure with jam nut.

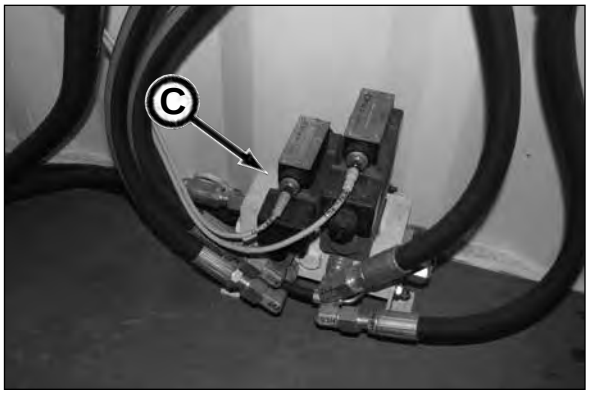
10. Proceed to checking Auxiliary Relief Valve.





CHECKING AUXILIARY RELIEF VALVE (Aux - Retract)

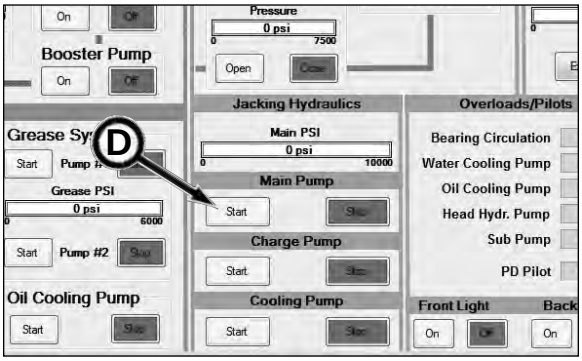
Check the auxiliary relief valve (C) setting as follows:



1. Hoses must be disconnected at bulkhead.



2. Check the auxiliary relief setting by starting the main hydraulic pump with Start button (D).

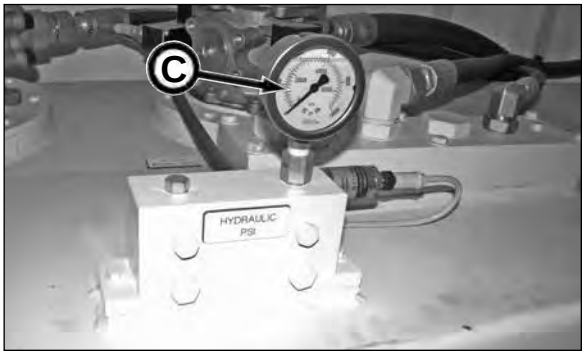


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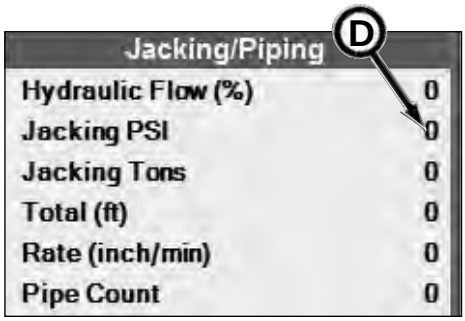
3. On control console, move selector switch (A) to Aux and move flow control (B) to the 25% position.



4. Check the hydraulic pressure gauge (C) located on top of hydraulic reservoir.



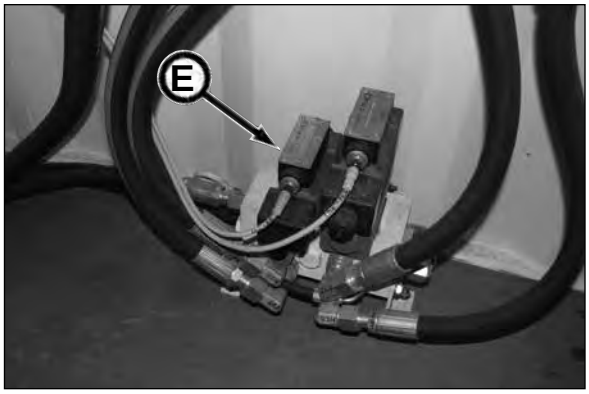
5. Check the Jacking PSI reading (D) to make sure it registers the same as the pressure gauge. If the pressures do not match, troubleshoot and resolve the problem.



6. If the pressure does not register 3,000 psi, the auxiliary relief valve must be adjusted.

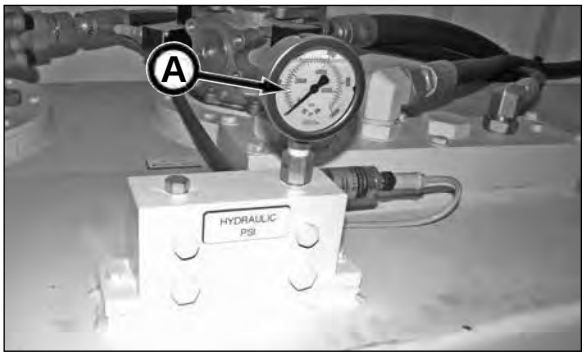
7. Adjust relief valve (E) by:
   a. loosening the relief jam nut
   b. turn adjustment screw as follows to set the main pressure relief valve to 3,000 psi:
      CW - increase pressure
      CCW - decrease pressure

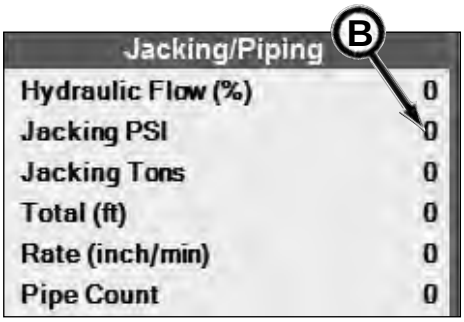
8. Secure jam nut against adjustment screw.



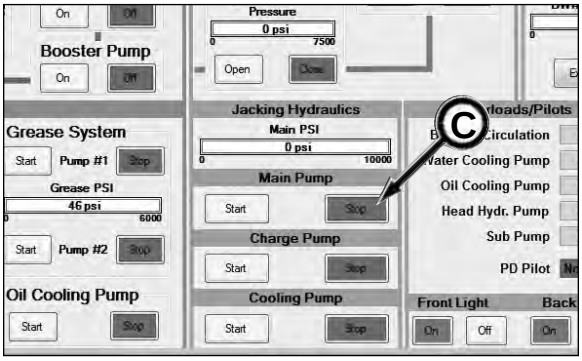
(Continued on next page)

9. Once jam nut is secured, recheck hydraulic pressure gauge (A) and the Main Hydraulic PSI reading (B) on target screen to make sure that the readjusted pressure setting did not change. If necessary readjust and secure with jam nut.





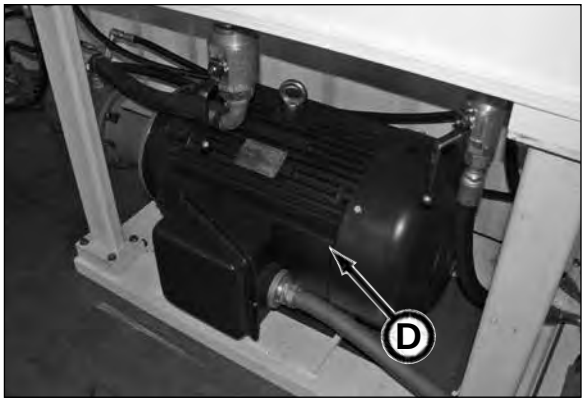
10. Stop the main hydraulic pump with Stop button (C).



12. CHECK MOTOR ROTATION

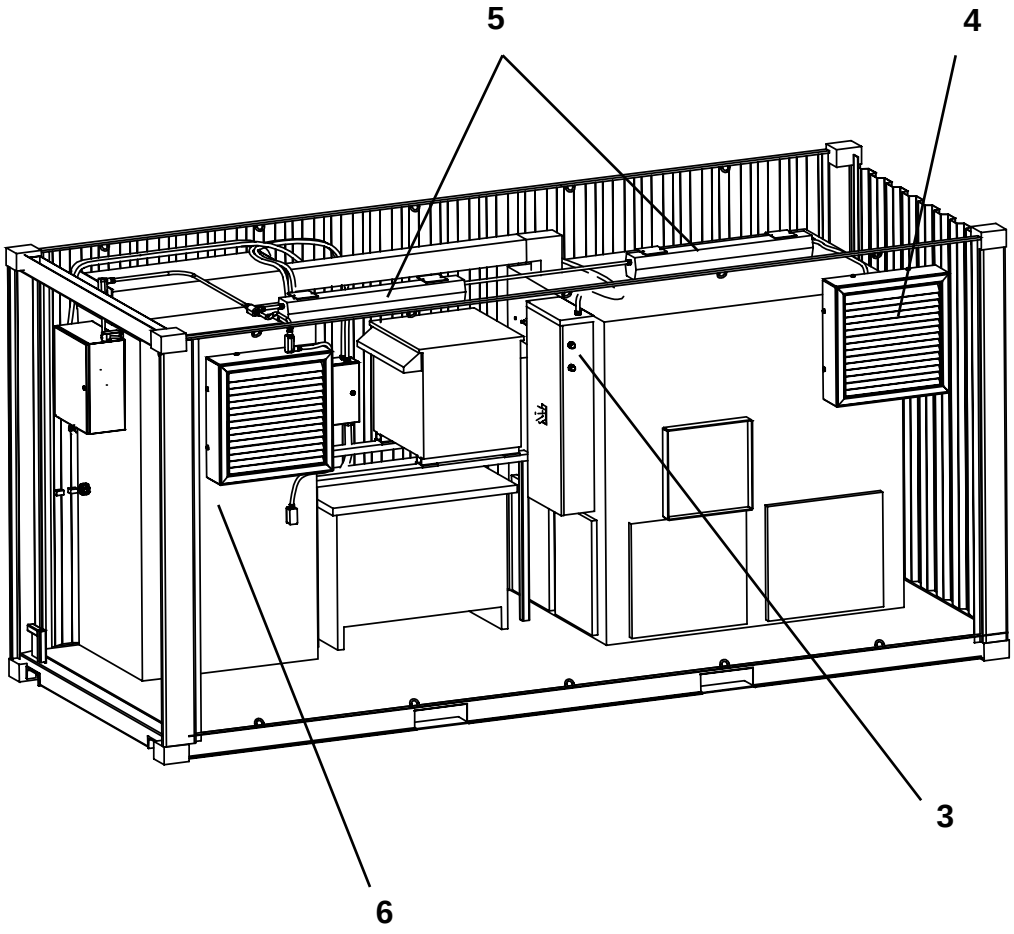
Check hydraulic motor (D) rotation for proper rotation by briefly jogging the electric motor on (at the main hydraulic pump, press Start and Stop buttons) to show rotation. When viewed from the motor fan end of the motor, the motor rotation should be clockwise (CW), otherwise match the rotation with the rotation arrow label.

NOTICE Operating the pump with the wrong rotation will cause pump and other component damage.



MAINTENANCE CHARTS - MAIN DRIVE POWER CONTAINER

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



PRIOR TO EACH DRIVE LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
*1.	E-Stop	Check Operation		
*2.	Electrical Connect.	Check		
3.	Phase Monitor	Check For Phase Error		
4.	Exhaust Fan	Check Operation		
5.	Lights	Check		
6.	Soft Start	Check Operation		

* Not Shown

1. CHECK E-STOP OPERATION

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



Check E-Stop button (A) for proper operation. When pushed in, the E-Stop must deactivate ALL outgoing electrical and hydraulic power from the Akkerman control container (feed pump, return pump, booster, mid pump, head power and cooling water tank pump [if used]), remote hydraulic power pack (hydraulic flow to jacking frame), power container (cutter head 4160V main drive tunnel power) and jacking frame.

If E-Stop button does not function properly, it MUST be repaired or replaced BEFORE operation.

NOTICE If any E-Stop buttons are activated in the control container, remote hydraulic power pack, power container or jacking frame pit box, ALL E-Stop buttons must be pulled out for the equipment to function.
BEFORE resetting the E-Stop buttons, be sure all control container switches are flipped to the OFF or Stop positions to prevent any unintended starting of equipment.

2. CHECK ELECTRICAL CONNECTIONS

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



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

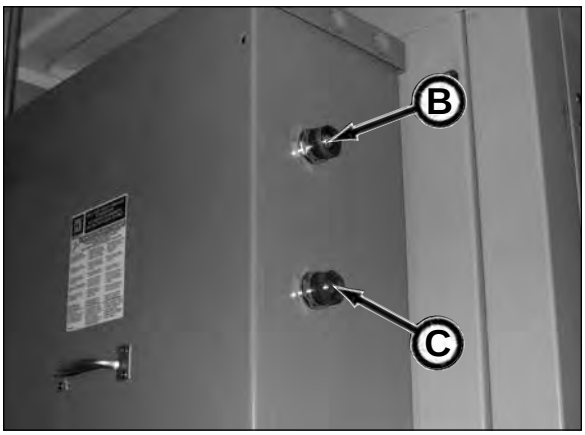
3. CHECK PHASE MONITOR

⚠WARNING Any electrical work completed on the control container or the remote hydraulic power pack must be performed by a certified electrician.

In the power container, if the green Phase OK indicator light (B) is illuminated, this indicates that the external power source phase power is installed correctly and that the main power can be turned on for the power circuit.

If the red Phase Error indicator light (C) is illuminated, disconnect and lock out/tag out ALL power before a certified electrician attempts to reverse the two generator power leads on the power circuit.

IMPORTANT: DO NOT start up electric components if the green phase indicator lights are not illuminated. Doing so will run components backwards causing damage.



Power Container Phase Indicators

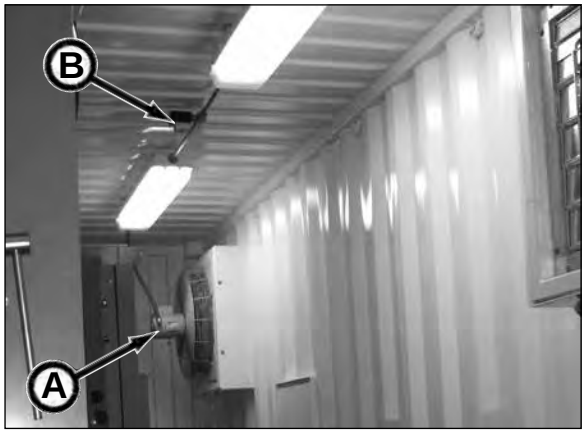
4. CHECK EXHAUST FAN OPERATION

The exhaust fan (A) operates once the ambient temperature in the power container reaches 70°F (21°C) and will shut down when the temperature reaches approximately 60°F (15.5°C).

A thermostat control (B) is installed in the power container to change the temperature setting for the exhaust fan startup. The fan will automatically shut down when the ambient temperature in the power container reaches approximately 10° less than the temperature setting.

Check the fan blades for cracks, dents or other damage. If possible straighten blades. Otherwise repair or replace as necessary.

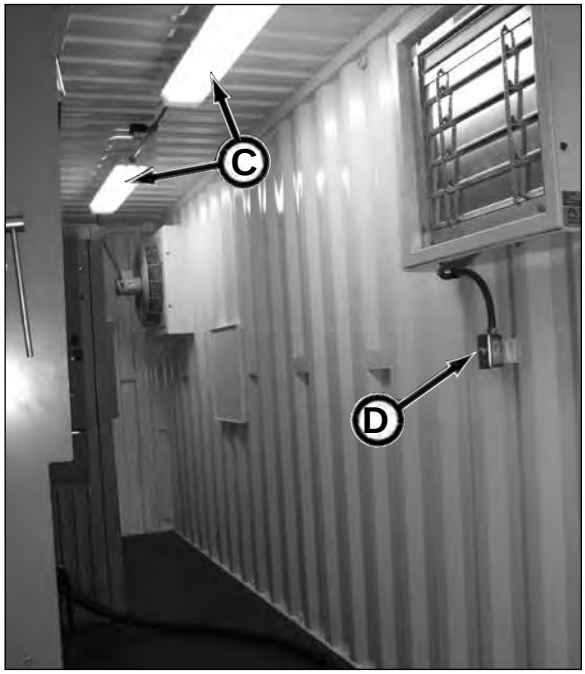
Test fan for proper operation. If fan does not function properly, repair or replace before operation of the microtunneling system.



5. CHECK LIGHT OPERATION

Check power container lights (C) for proper operation. Use light switch (D) to turn light on and off.

Repair or replace light and/or switch if they do not function properly.





6. CHECK SOFT START PROTECTION SYSTEM OPERATION

Check the soft start protection system operation. If the system does not operate properly, contact your Akkerman Aftermarket Support representative to resolve the soft start failure.



Energize the soft start system as follows.

1. With the green Phase OK light illuminated, and the main power switch to the ON position, turn lockout key switch to the horizontal, unlock position.



2. Slide lockout latch to unlock position.



3. Install handle into disconnect and move to unlock (CW) position. Indicator color will move from green to red.

(continued on next page)

4. Remove handle and place in storage bracket.



5. Slide lockout latch to lock position.

IMPORTANT: Lockout latch MUST be moved to lock position. Otherwise a motor fault will occur. Motor will not operate with the lockout latch in the unlock position.



6. Turn control switch (A) to either Local or Control Container position.

If the drive motor is to be controlled from the control container, select CONTROL CONTAINER.

If the drive motor is to be controlled from the power container control buttons, typically for troubleshooting purposes, select LOCAL.

7. Start the main drive motor. If motor starts, the soft start system is functioning properly.

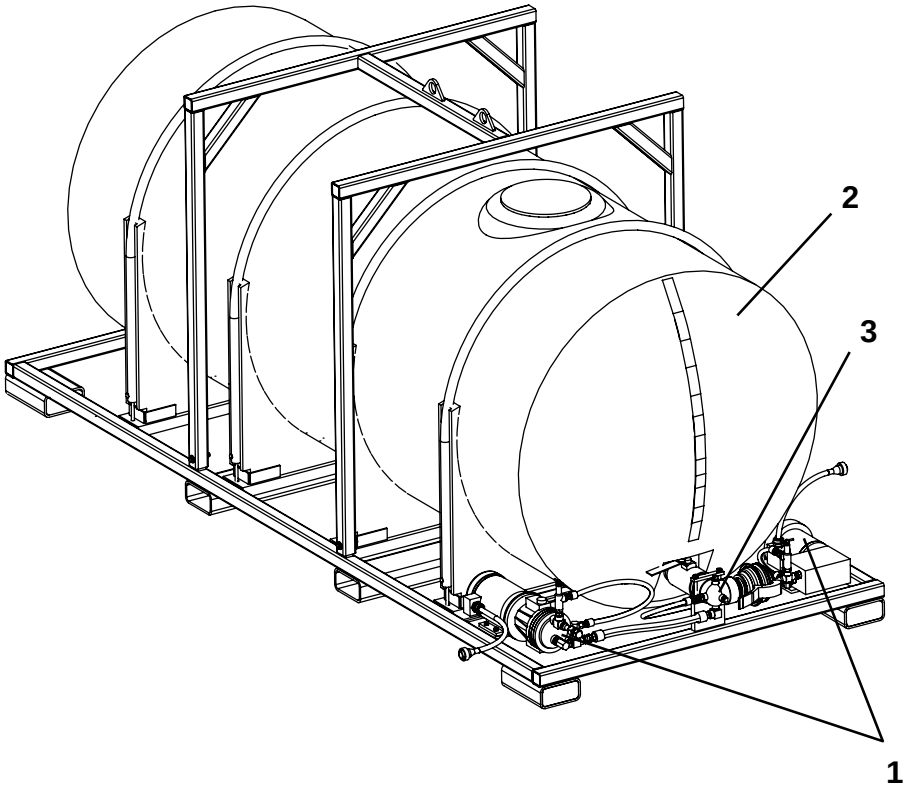
8. Reverse this procedure to lockout the soft start to prevent accidental startup.



NOTES

MAINTENANCE CHARTS - WATER COOLING TANK

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



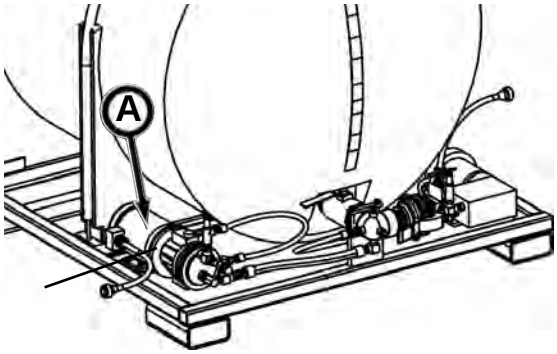
PRIOR TO EACH DRIVE LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
*1.	Water Cool. Pump	Check Oil Level		10W30 Motor Oil
2.	Tank	Fill	Fill with fresh, clean water.	

* Typically not used with SL82P and larger periphery drive MTBMs. May be used if additional cooling is necessary.

1. CHECK WATER COOL PUMP OIL LEVEL (IF USED)

Check water cool pump (A) oil levels and the condition of the oil.



1. Clean area around check/fill cap (B).

2. Remove check/fill cap. Oil level should be:

   1/4 in. (6 mm) from top of the fill port

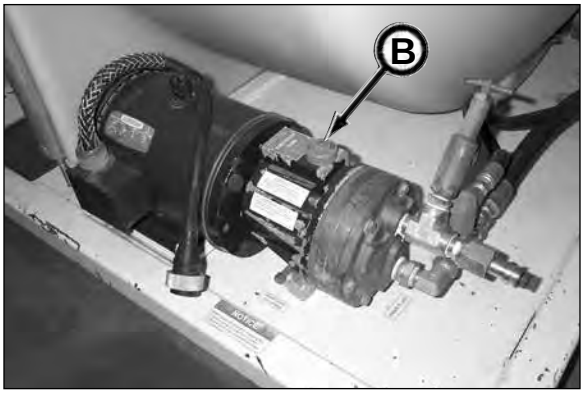
3. If additional oil is needed, add a high quality SAE 10W-30 motor oil to bring oil level to:

   1/4 in. (6 mm) from top of the fill port

Oil capacity is 1.1 US quart (1.05 L).

4. If oil shows signs of contamination, drain oil and refill with clean oil.

5. Replace check/fill cap.



2. FILL WATER TANK

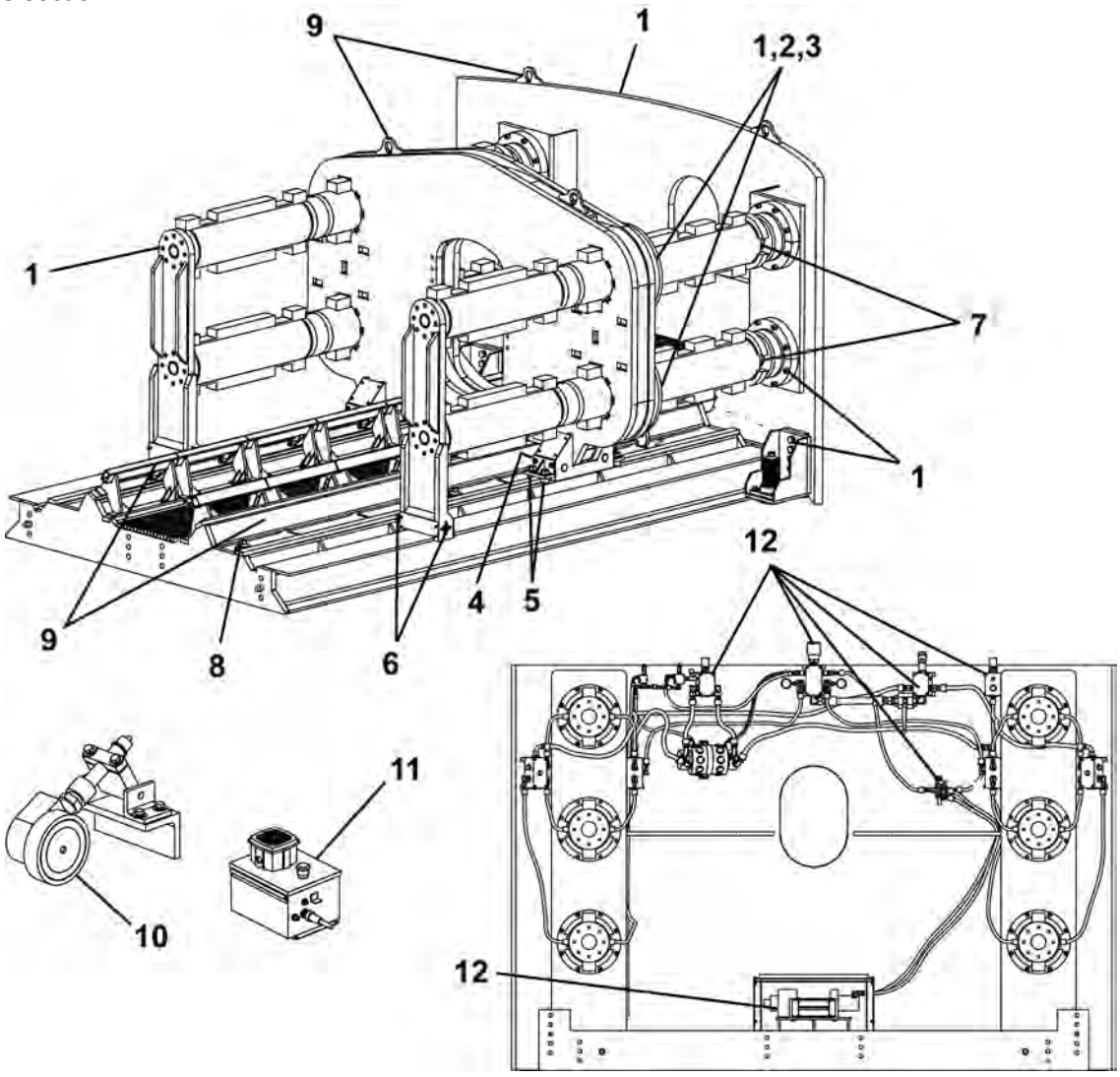
Fill water tank with fresh, clean water.

The tank capacity is 1,685 gal (6,378 L).



MAINTENANCE CHARTS - KEYHOLE JACKING FRAME

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



PRIOR TO EACH DRIVE LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Frame	Inspect Frame	Inspect for structural cracks or fatigue.	
2.	Cam Locks	Check Operation	Lever must lock and unlock.	
3.	Cam Locks	Lubricate (2 Per)	Lubricate until grease is forced out.	Lubriplate 1200-2
4.	Thrust Block Guide	Lubricate (4 Places)	Lubricate until grease is forced out.	Mobil XHP222
5.	Thrust Block Rollers	Check Operation (8 Rollers)	Rollers to roll freely. Otherwise replace.	
6.	Cyl. Support	Lubricate (4 Places)	Lubricate until grease is forced out.	Mobil XHP222
7.	Cylinder Pin	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
8.	Leveling Assembly	Lubricate	Lubricate generously.	Mobil XHP222
9.	Lift Eye	Inspect	If damaged, replace.	
10.	Pipe Counter	Check Operation		
11.	Pit Box	Check Operation		
12.	Hydraulics	Check Operation		

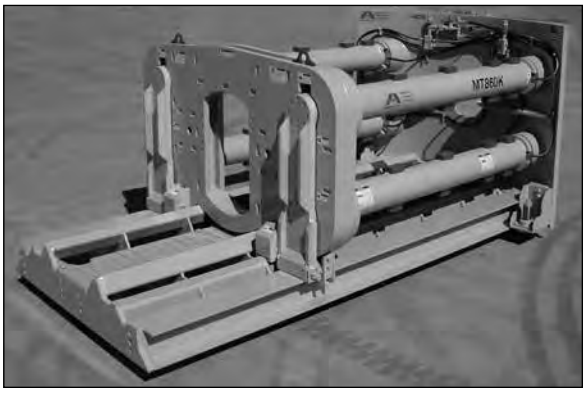
1 . CLEAN & INSPECT JACKING FRAME

Clean jacking frame of debris and build up.

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

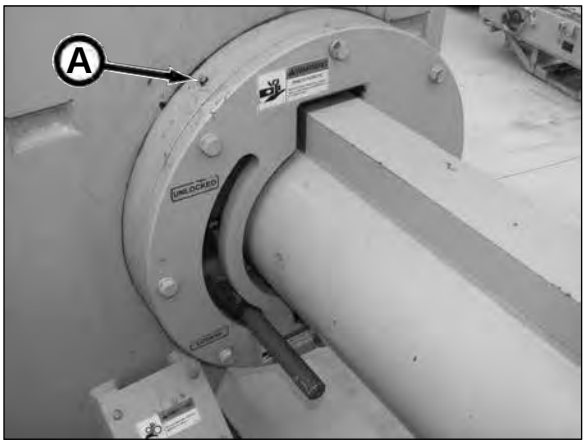
If cracks or damage are present, contact your Akkerman Aftermarket Support representative for authorized repair or replacement procedures.

Check to be sure all guards are in place and in good condition. If damaged, repair or replace before operation.



2. LUBRICATE CAM LOCKS

Lubricate the cam locks (A) (2 places per cam lock) with Lubriplate® 1200-2 heavy duty, lithium grease or equivalent until grease is forced out.



3. CHECK CAM LOCK OPERATION

Check each cam lock lever for lock to unlock movement.

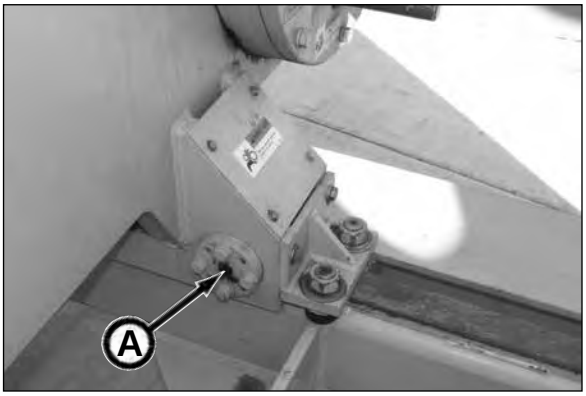
The cam lock lever will have some resistance when moving to the lock and unlock positions but if cam locks are very difficult to move, be sure they are lubricated properly or check for a mechanical failure. Repair or replace before operation.



4. LUBRICATE THRUST BLOCK GUIDES

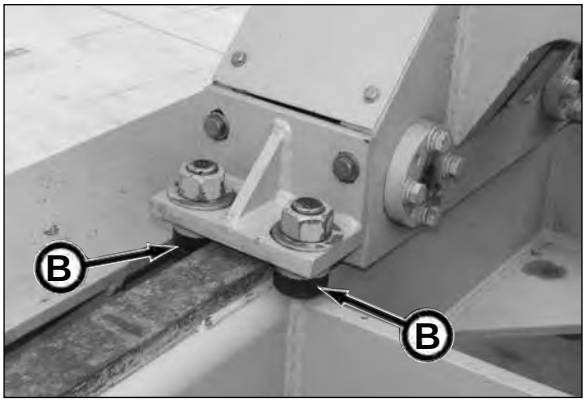
Lubricate thrust block guides (A) (4 places) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.

If guide guard was removed, be sure it is replaced.



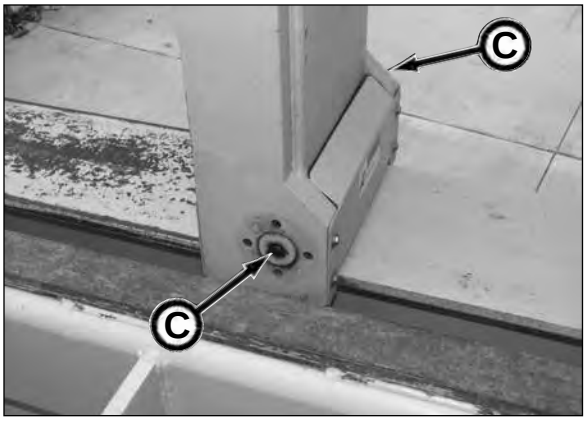
5. CHECK THRUST BLOCK ROLLER OPERATION

Check to be sure the thrust block rollers (B) roll freely. If they do not roll freely, repair or replace before operation.



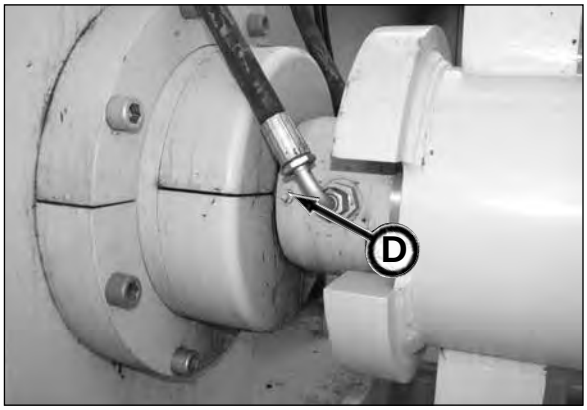
6. LUBRICATE CYLINDER SUPPORTS

Lubricate cylinder supports (C) (4 places) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.



7. LUBRICATE JACKING CYLINDER PINS

Lubricate jacking cylinder pins (D) (1 per cylinder) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.

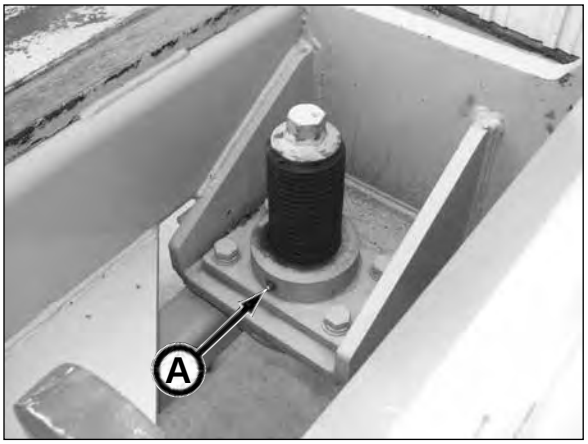


8. LUBRICATE LEVELING ASSEMBLY

Lubricate leveling screws (A) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent.

Lubricate threads thoroughly.

If a jacking frame extension is being used, be sure to lubricate the extension leveling screw grease fittings.



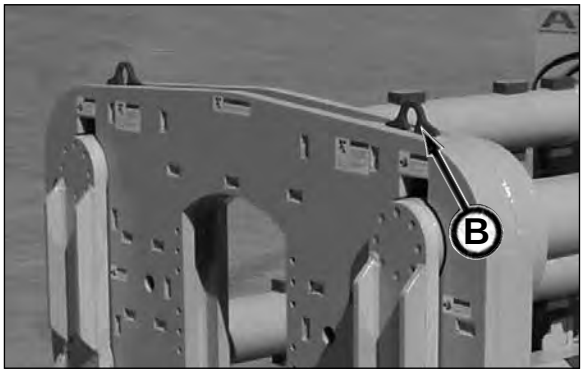
9. INSPECT LIFT EYES

Visually inspect the thrust block lift eyes (B), skid lift eyes (C) and thrust wall lift eyes (D) for cracks or damage. If cracks or other damage is present, the lift eyes MUST be replaced before lifting frame. The number of lift eyes vary per jacking frame model.

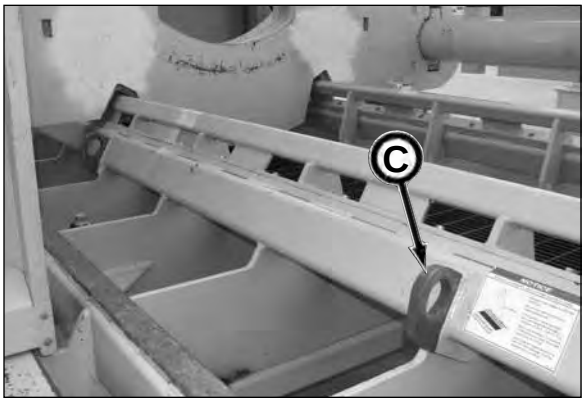
Contact your Akkerman Aftermarket Support representative for authorized repair or replacement procedure.

IMPORTANT: The thrust block lift eyes (B) are designed to lift the weight of the thrust block. **DO NOT lift frame and/or thrust wall with the thrust block lift eyes.**

IMPORTANT: The thrust wall lift eyes (D) are designed to lift the weight of the thrust wall. **DO NOT lift frame and/or thrust block with the thrust wall lift eyes.**



Thrust Block Lift Eyes

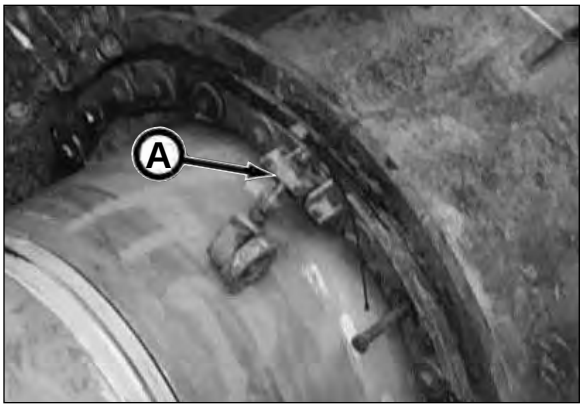


Skid Lift Eyes



Thrust Wall Lift Eyes

10. CHECK PIPE COUNTER OPERATION

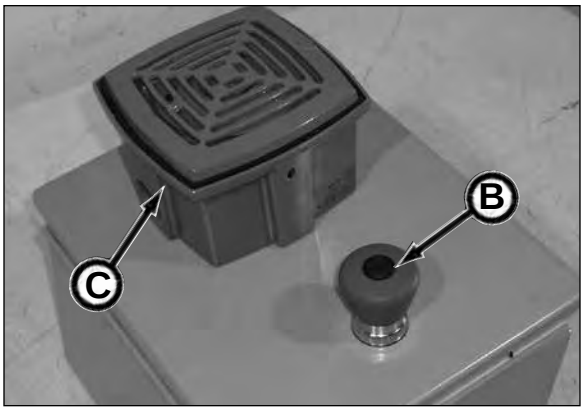


⚠WARNING ALL Emergency Stop buttons and gas detector warning devices MUST be operating properly BEFORE operating the microtunneling system. Failure to do so may cause sever injury or death.

Check the operation of the pipe counter (A). If the pipe counter does not function properly, repair or replace before operation.

11. CHECK PIT BOX OPERATION

⚠WARNING ALL Emergency Stop buttons and gas detector warning devices MUST be operating properly BEFORE operating the microtunneling system. Failure to do so may cause sever injury or death.

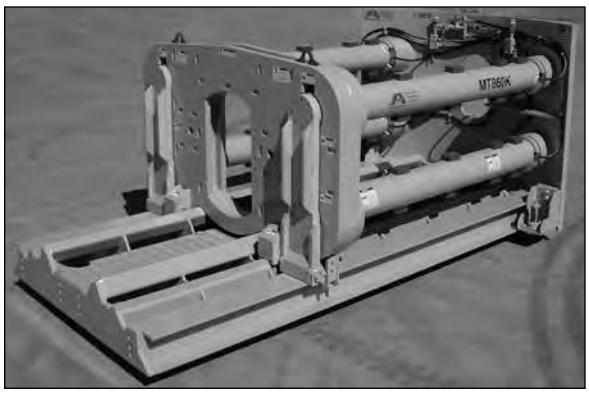


Check E-Stop button (B) and the gas detector horn (C) for proper operation. When pushed in, the E-Stop must deactivate ALL outgoing electrical and hydraulic power from the Akkerman control container (feed pump, return pump, booster, mid pump, head power and cooling water tank pump [if used]), remote hydraulic power pack (hydraulic flow to jacking frame), power container (cutter head 4160V main drive tunnel power) and jacking frame.

If the E-Stop button and/or the horn does not function properly, it MUST be repaired or replaced BEFORE operation.

NOTICE If any E-Stop buttons are activated in the control container, remote hydraulic power pack, power container or jacking frame pit box, ALL E-Stop buttons must be pulled out for the equipment to function.
BEFORE resetting the E-Stop buttons, be sure all control container switches are flipped to the OFF or Stop positions to prevent any unintended starting of equipment.

12. CHECK JACKING FRAME HYDRAULIC CONTROL OPERATION

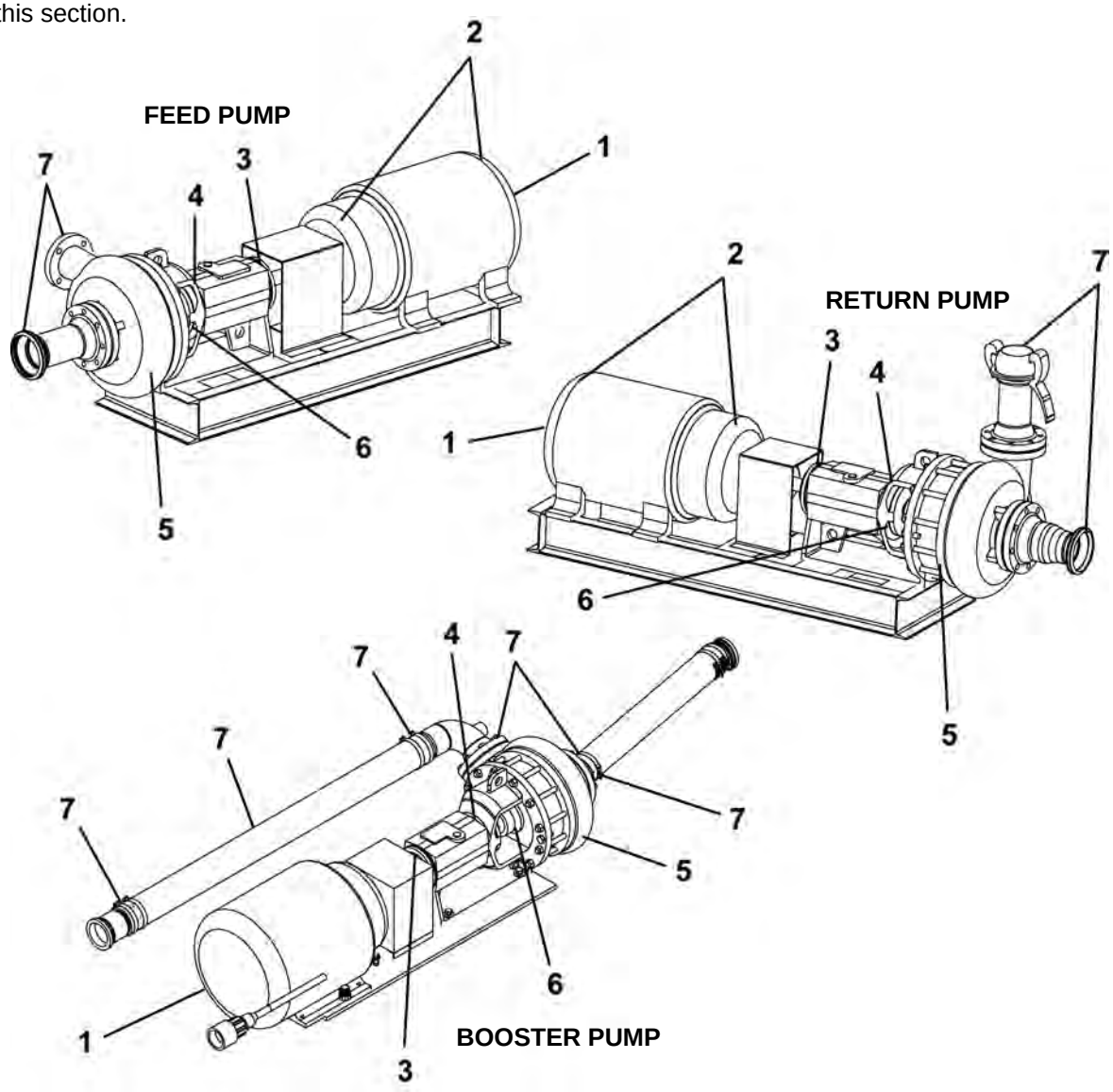


Before launching MTBM, be sure to check the operation of the jacking frame hydraulics; jacking cylinder controls and winch controls for proper operation. If controls do not function properly or show signs of leaking, repair or replace before operation.

NOTES

MAINTENANCE CHARTS - SLURRY PUMPS

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



PRIOR TO EACH DRIVE LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Motor	Check Motor Rotation	CW viewed from motor fan.	
2.	Motor Bearings	Lubricate (2 Places)	One Shot	Mobil XHP222
3.	Bearing Seals	Lubricate	Five shots	Mobil XHP222
4.	Lip Seals	Lubricate	Five shots	Mobil XHP222
5.	Impeller/Housing	Inspect For Wear	Replace if damaged or worn.	
6.	Shaft Seals	Inspect	Replace if damaged or worn.	
7.	Hoses/Hose Clmps, & Slurry Line Connections	Inspect For Wear Or Damage	Replace if damaged or worn. If damaged, replace.	
*8.	Cables	Inspect Power Cables	If damaged or worn, replace.	
*9.	Lift Eye	Inspect	Repair or replace as necessary.	
*10.	Slurry Pumps	Check	Check operation and pressure.	

NOTICE Refer to slurry pump manufacturer user manual for more information.

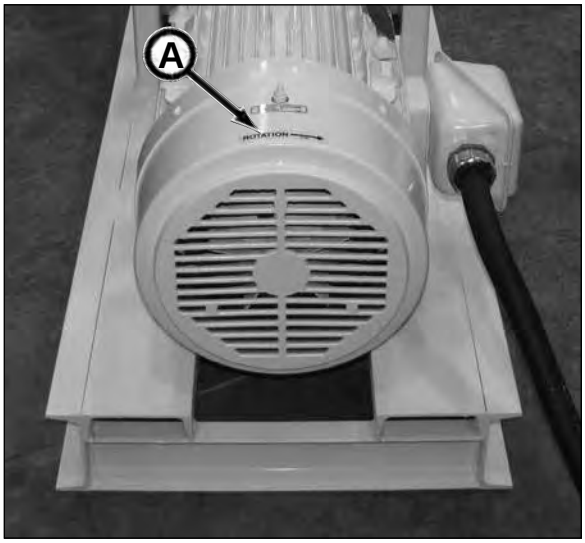
* Not Shown

1. CHECK MOTOR ROTATION
(Feed, Return & Booster Pumps)

Check slurry pump motor rotation for proper rotation by briefly jogging the electric motor on to show rotation. When viewed from the motor fan end of the motor, the motor rotation should be clockwise (CW), otherwise match the rotation with the rotation arrow label (A).

Repeat for other slurry pumps.

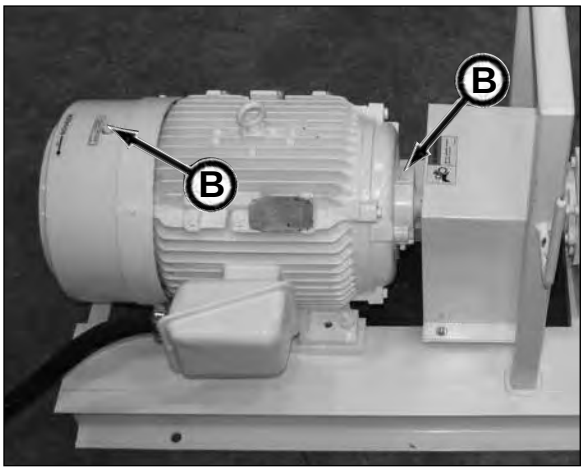
NOTICE Operating the pump with the wrong rotation will cause pump and other component damage.



2. LUBRICATE MOTOR BEARINGS
(Feed & Return Pumps Only)

1. Wipe the motor bearing lubrication fittings (B) clean. There are two lubrication fittings on each motor.

2. Lubricate motor bearings with one shot of Mobilgrease® XHP222 Premium Lubricating Grease or equivalent. Lubricate annually thereafter.

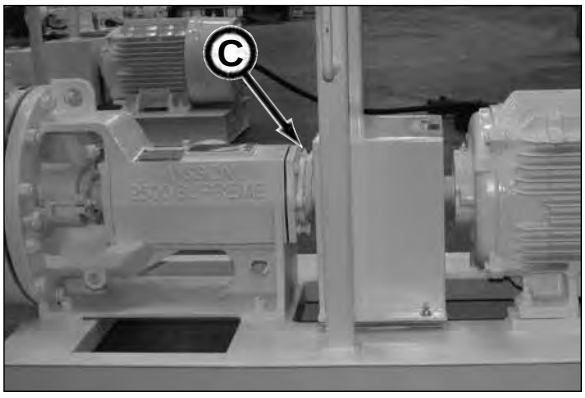


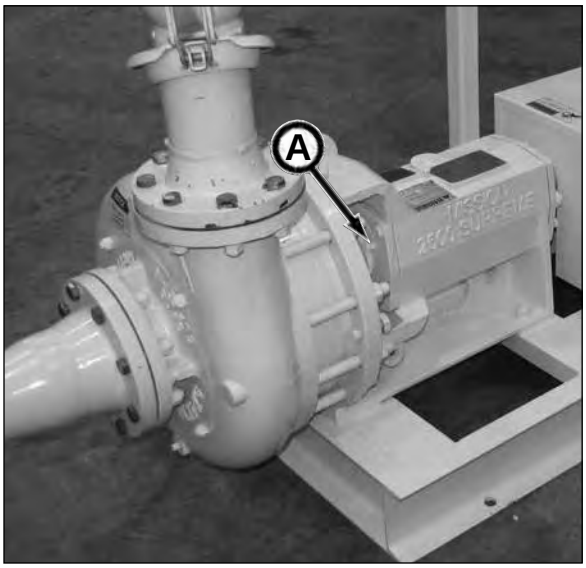
3. LUBRICATE BEARING SEALS
(Feed, Return & Booster Pumps)

1. Clean area around bearing seal lubrication fittings (C).

2. Lubricate bearing seals with five shots of Mobilgrease® XHP222 Premium Lubricating Grease or equivalent. Lubricate monthly thereafter.

NOTICE Earlier booster pump models (not shown) were equipped with oil bearing lubrication. If your booster pump contains a dipstick on the housing, use a high quality, 10W30 weight motor oil. Oil should be changed every 1000 hours. Do not overfill.

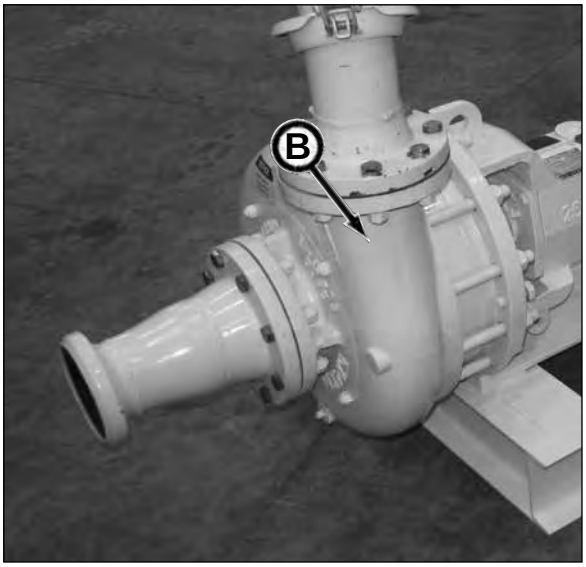




4. LUBRICATE LIP SEALS
(Feed, Return & Booster Pumps)

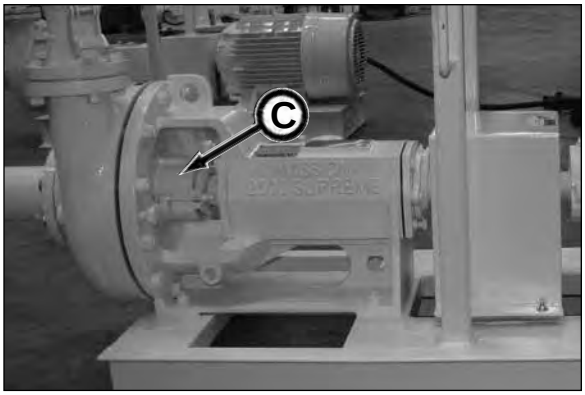
1. Clean area around lip seal lubrication fittings (A).

2. Lubricate lip seals with five shots of Mobilgrease® XHP222 Premium Lubricating Grease or equivalent. Lubricate monthly thereafter.



5. INSPECT IMPELLERS
(Feed, Return & Booster Pumps)

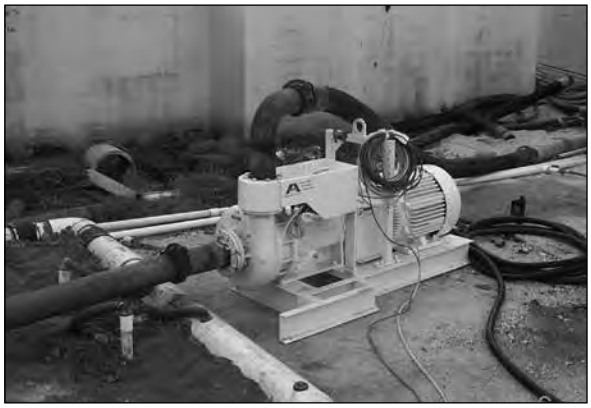
Inspect impeller (B) for excessive erosion, corrosion, extreme wear or vane damage. If impeller shows any of these signs, the impeller should be replaced. For impeller replacement, contact your Akkerman Aftermarket Support representative or refer to your Halco Installation, Operation and Maintenance Instructions for Halco 2500 Supreme Pumps Manual.



6. INSPECT MECHANICAL SHAFT SEALS
(Feed, Return & Booster Pumps)

Inspect mechanical shaft seal (C) faces, gaskets and shaft sealing members for wear or damage. Excessive leakage may result if seals are not replaced when needed.

Contact your Akkerman Aftermarket Support representative or refer to your Halco Installation, Operation and Maintenance Instructions for Halco 2500 Supreme Pumps Manual for seal replacement.



7. INSPECT SLURRY HOSES, LINES, CLAMPS & CONNECTIONS (Feed, Return & Booster Pumps)

Regularly inspect the slurry hoses and banding hose clamps. If the hoses and/or clamps are cracked, worn or damaged, they must be replaced.



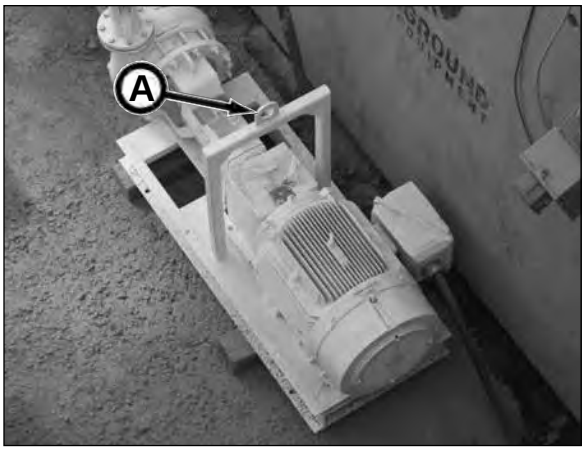
Regularly inspect the slurry line connections for wear or damage. Replace as needed.

Check to be sure the oring is not cracked, torn, worn or damaged. If needed, replace with new oring.



8. INSPECT POWER CABLES (Feed, Return & Booster Pumps)

Inspect slurry power cables for wear, fray or damage. If cables are worn, frayed or damaged, the cable(s) must be replaced BEFORE operation.



9. INSPECT LIFT EYES
(Feed & Return Pumps)

Inspect the slurry pump lift eyes (A) for wear or damage. If worn or damaged, lift eye must be repaired or replaced prior to lifting slurry pump.

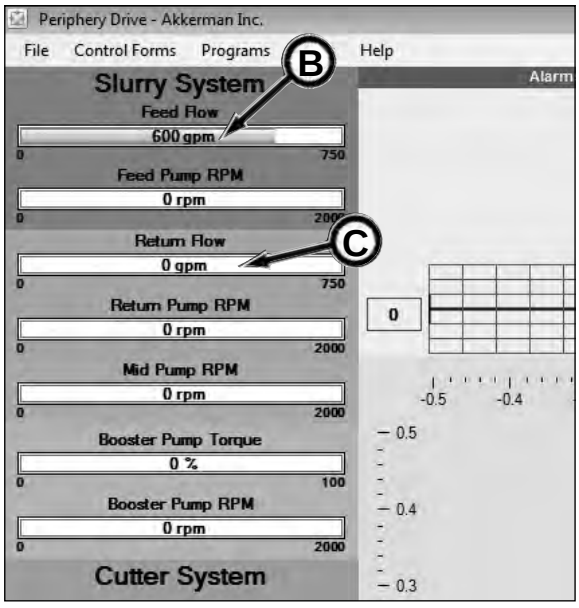
10. CHECK SLURRY PUMP OPERATION
(Feed, Return, Mid & Booster Pumps)



Check slurry feed, return, and booster (if used) pump operation. With the pump VFD on, turn the pumps on with switches on control console and turn the pump control to adjust the pump flow.

NOTICE It is recommended to start and stop the feed, mid, booster and return pumps in the order listed below to prevent excessive fluid pressure on pump components:

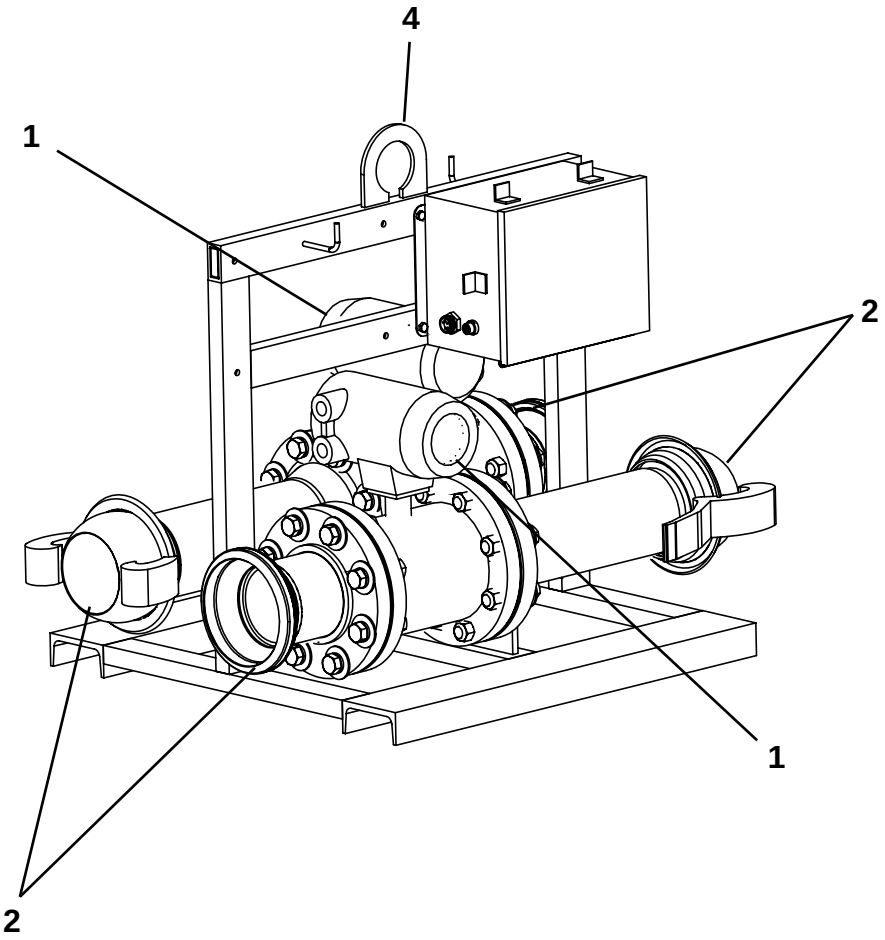
START: Mid (if used) - Booster - Return - Feed
STOP: Feed - Return - Booster - Mid (if used)



If not already done so, check to be sure the pressure from the flow meter is identical to the slurry feed and return flow readings (B,C) on the target screen.

MAINTENANCE CHARTS - FLOW METER

NOTICE Use the item number in the chart to refer to the detailed maintenance procedures in the following pages.



PRIOR TO EACH DRIVE LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Meter Reading	Check	Flow meter reading & target screen reading must be identical.	
2.	Slurry Line Connections	Inspect For Wear Or Damage	If damaged, replace.	
*3.	Cables	Inspect Ethernet & Power Cables	If damaged or worn, replace.	
4.	Lift Eyes	Inspect	Repair or replace as necessary.	

* Not Shown

1. CHECK FLOW METER READINGS

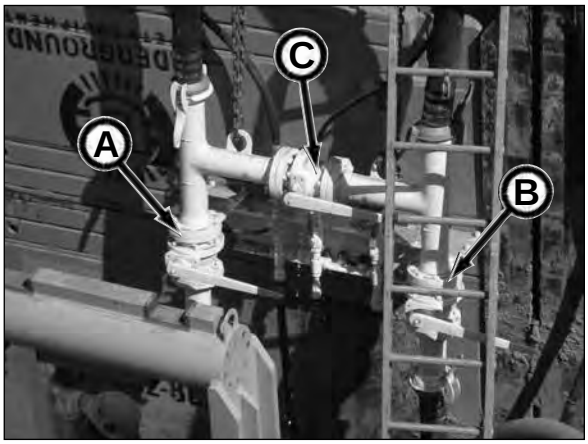
Check the flow meter as follows:

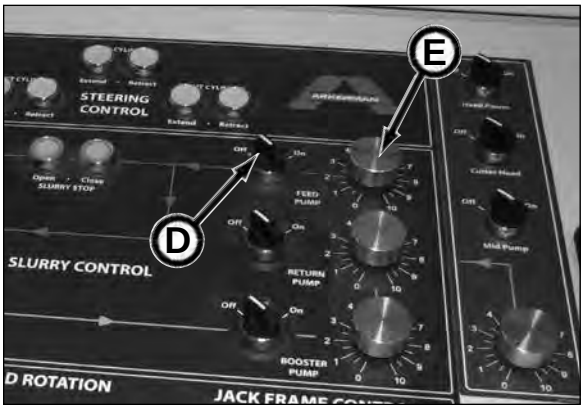
1. On the slurry pit valve, close slurry feed (A) and return (B) shutoffs.

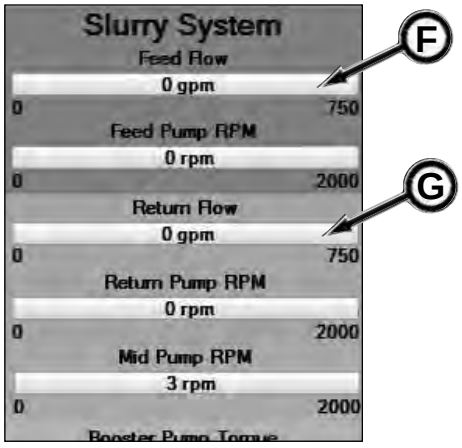
2. Open bypass valve (C) .

3. Turn feed pump switch (D) to the ON position and run at 300 to 350 gpm using feed pump flow control (E).

4. Compare the data on the feed gpm (F) and return gpm (G) on the target screen. Typically the readings should be close in bypass mode. If the readings show a difference of 10 gpm or more, contact your Akkerman Aftermarket Support representative for troubleshooting the flow meter system.

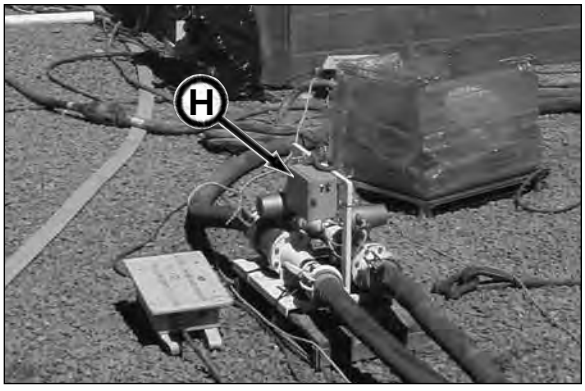






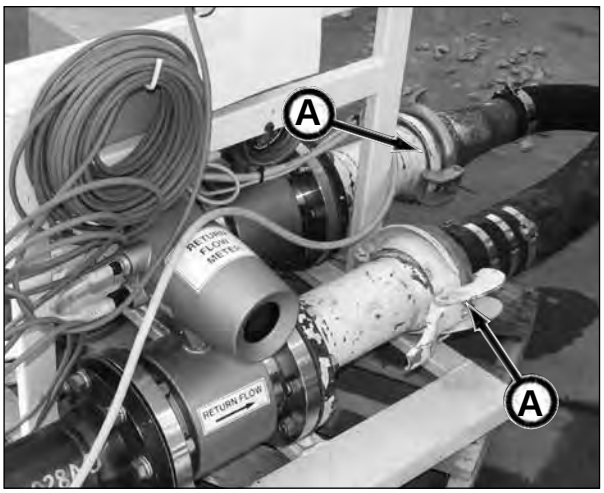
5. Be sure the feed flow meter is connected to the feed flow, not return flow. Otherwise, if the feed flow meter is connected to the return flow, it will cause operator confusion during mining operation resulting in over or under excavation.

6. Check flow meter readings on flowmeter (H) with feed and return gpm data on target screen. Both readings should be identical.



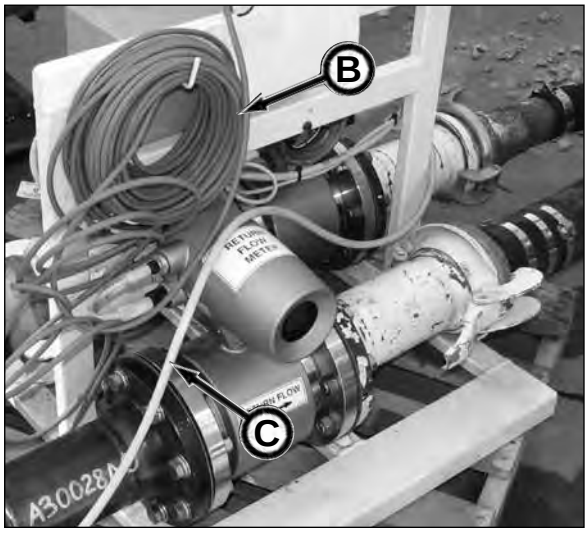
2. INSPECT SLURRY LINE CONNECTIONS

Inspect all slurry line connections (A) for wear or damage. Repair or replace as needed.



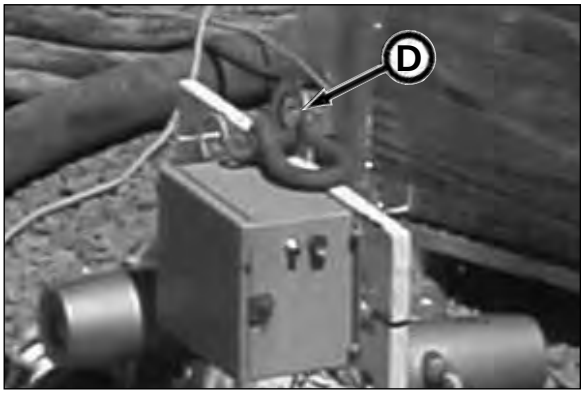
3. INSPECT CABLES

Inspect ethernet cable (B) and power cable (C) for cracking,fraying, wear or damage. Replace as needed.



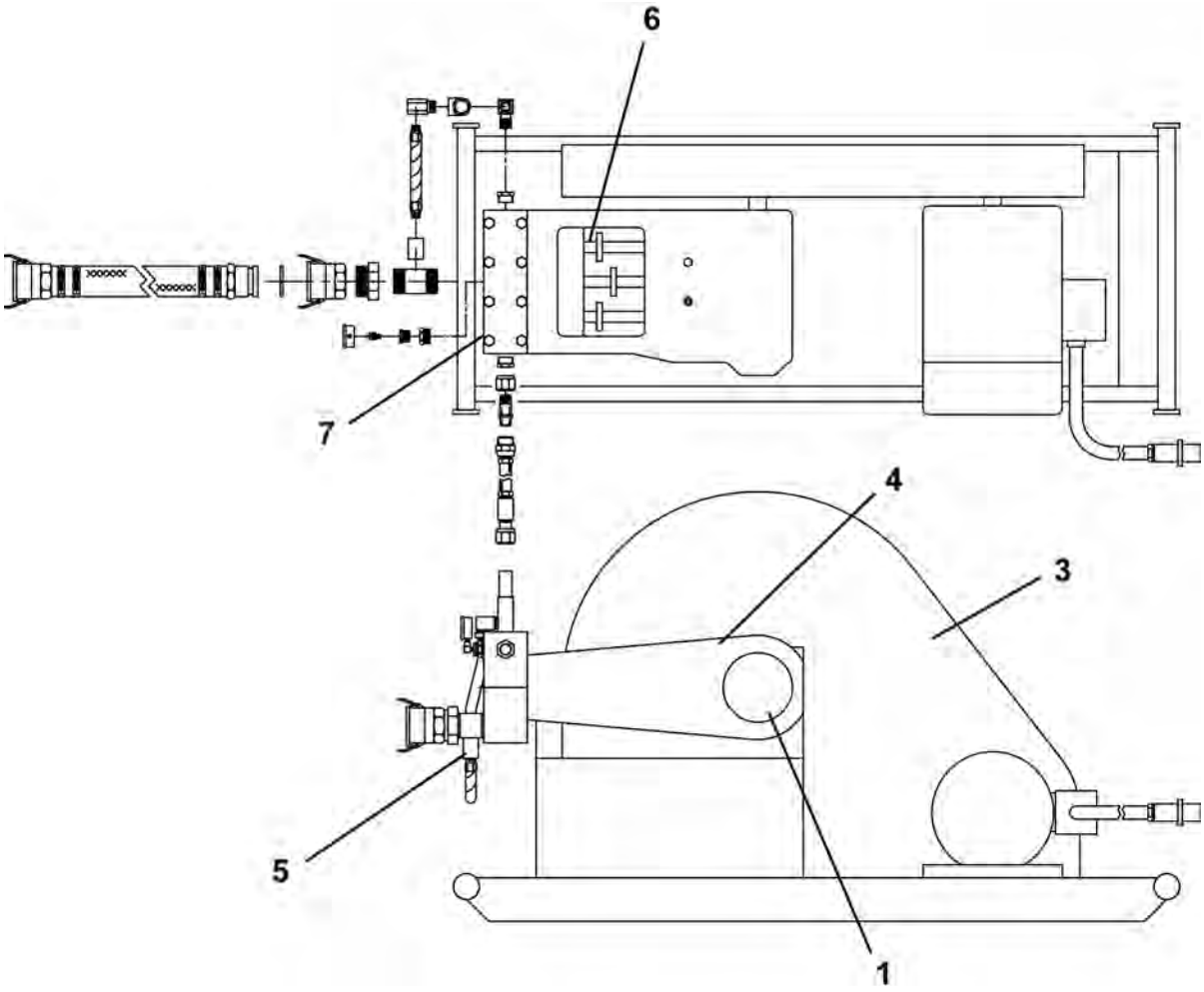
4. INSPECT LIFT EYE

Inspect lift eye (D) for wear or damage. If damaged or worn, replace with new.



MAINTENANCE CHARTS - HIGH PRESSURE JETTING PUMP

NOTICE Use the item number in the chart to refer to the detailed maintenance procedures in the following pages.



PRIOR TO EACH DRIVE LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Crankcase	Rotation		
**2.	Strainer	Clean	See MTBM maintenance.	
3.	Belt Tension	Check	Adjust if needed.	
4.	Gear Box***	Check Oil Level	Add oil if necessary.	*SAE 40 non-det.
5.	Jetting Pump	Drain	In freezing weather.	
6.	Piston Gland	Lubricate	Lubricate with 2 shots.	
7.	Stuffing Box Studs & Cap Screws	Tighten to 125 ft-lb	See detail for bolt tightening sequence.	
**8.	Cables	Inspect Power Cables	If damaged or worn, replace.	

NOTICE Refer to Aplex SC-115 User Manual for more information.

* Use SAE Grade 40 non-detergent industrial turbine oil.

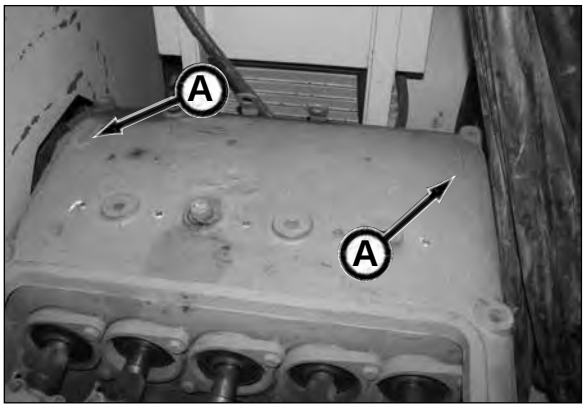
** Not Shown

*** Inspect gear box oil quality. If contamination is present, drain and fill with new oil.



1. CHECK CRANKCASE ROTATION

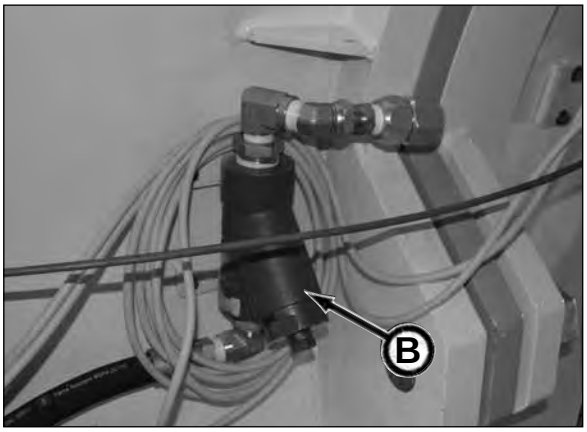
Before placing pump in operation, check that crankshaft rotation agrees with the arrows (A) cast on top of the power frame by briefly jogging the electric motor. Crankcase rotation must be clockwise as viewed from the right side of pump.

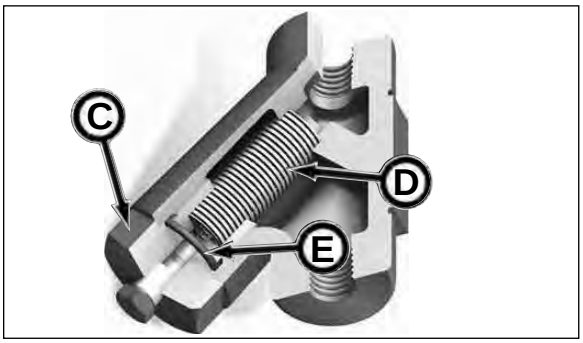


2. CLEAN STRAINER

With the water cooling tank shut down, gain access to the high pressure jetting pump strainer (B).

1. Remove cap (C).
2. Remove strainer screen (D). Clean strainer or if needed, replace with new.
3. Install screen. Be sure it is properly seated in strainer body.
4. Inspect oring for (E) cracking or damage. Replace with new if needed.
5. Install oring. Be sure it is properly seated on cap.
6. Reinstall cap.





Strainer Cutaway Illustration



3. CHECK BELT ALIGNMENT & TENSION (PUMP MODEL APLEX SC-115)

A belt will provide years of reliable service if it is properly tensioned and aligned. Refer to Aplex User Manual for more information.

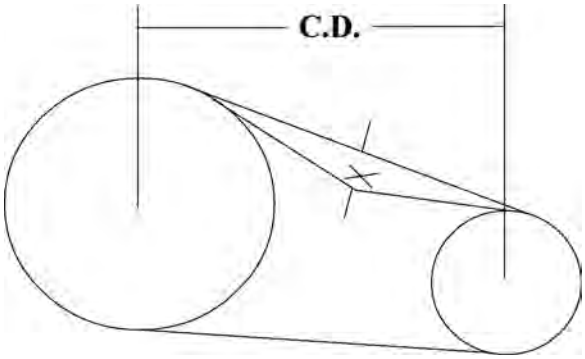
1. Remove belt cover (A).

2. Belt Alignment
Use a straight edge across the rim of the sheaves to detect and correct for misalignment.

3. Belt Tension
Insufficient tension results in slippage, burning, squealing and shortened belt life. Overtightening imposes excessive loads on pump and motor bearings and can cause early shaft fatigue failure.

Using a small spring scale, apply 17 - 30 lb (new) or 13 - 23 lb force at center distance (C.D.), adjust motor position to provide 7/16” deflection at center distance.

4. Replace belt cover.



4. CHECK GEARBOX OIL LEVEL

NOTICE Inspect gearbox oil quality. If any contamination is present in sampling, drain and fill with new oil. Refer to Aplex User Manual for more information.

1. Gain access to the gear box dipstick and check the oil level. The oil level should be at the full mark on the dipstick.



2. If needed, remove fill cap and add a high quality SAE Grade 40 non-detergent industrial turbine oil to bring oil level to full mark on dipstick.

3. Replace fill cap and dipstick.



5. DRAIN JETTING PUMP

In freezing temperatures, the jetting pump must be drained of water.

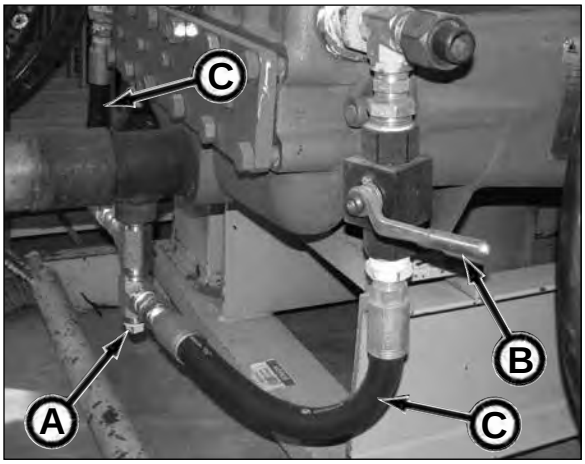
1. Remove drain plug (A).

2. Open bypass pressure relief valve (B) to allow water to drain from pump.

3. Cycle bypass pressure relief valve multiple times to be sure water in ball valve is removed.

4. Be sure water is removed from hoses (C).

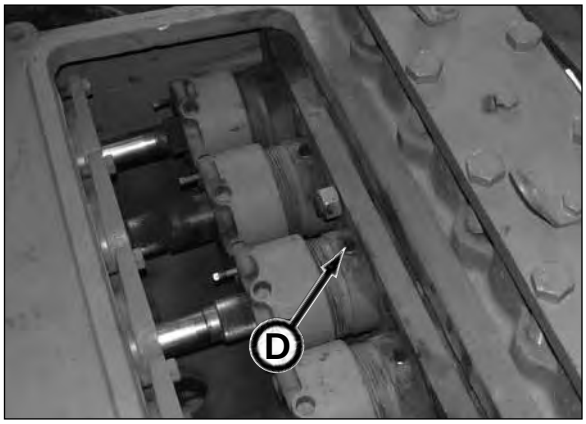
5. Replace drain plug.



6. LUBRICATE PISTON GLANDS

Lubricate each piston gland (D) with two shots of Mobilgrease XHP222 or equivalent.

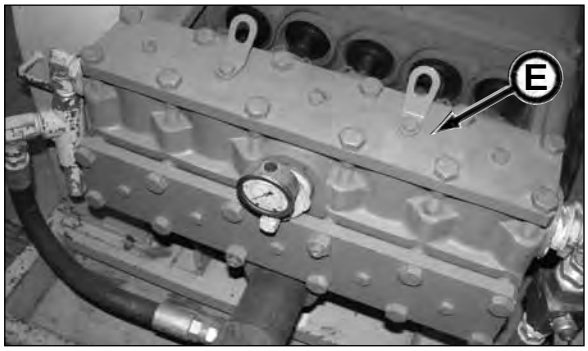
NOTICE This lubrication is only to be used with gland adjusted packing. If used with spring loaded packing, the grease can load up in the spring causing it to harden and become less effective. Refer to your Aplex SC-115 User Manual for more information.

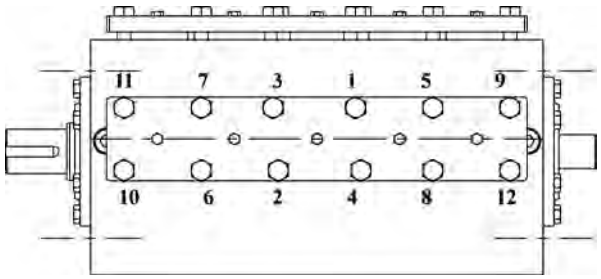


7. TIGHTEN STUFFING BOX HARDWARE

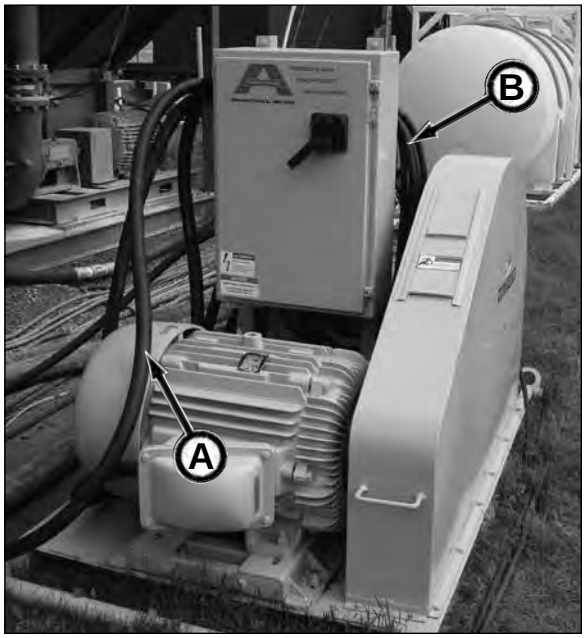
The stuffing box (E) is retained by large bolts which extend through the liquid end to clamp the box tightly against the fluid end face.

Tighten the stuffing box studs or cap screws evenly to 125 ft-lb (169 N·m) torque in the sequence shown in diagram. Retighten every 500 hours of operation.





Stuffing Box Stud/Cap Screw Tightening Sequence



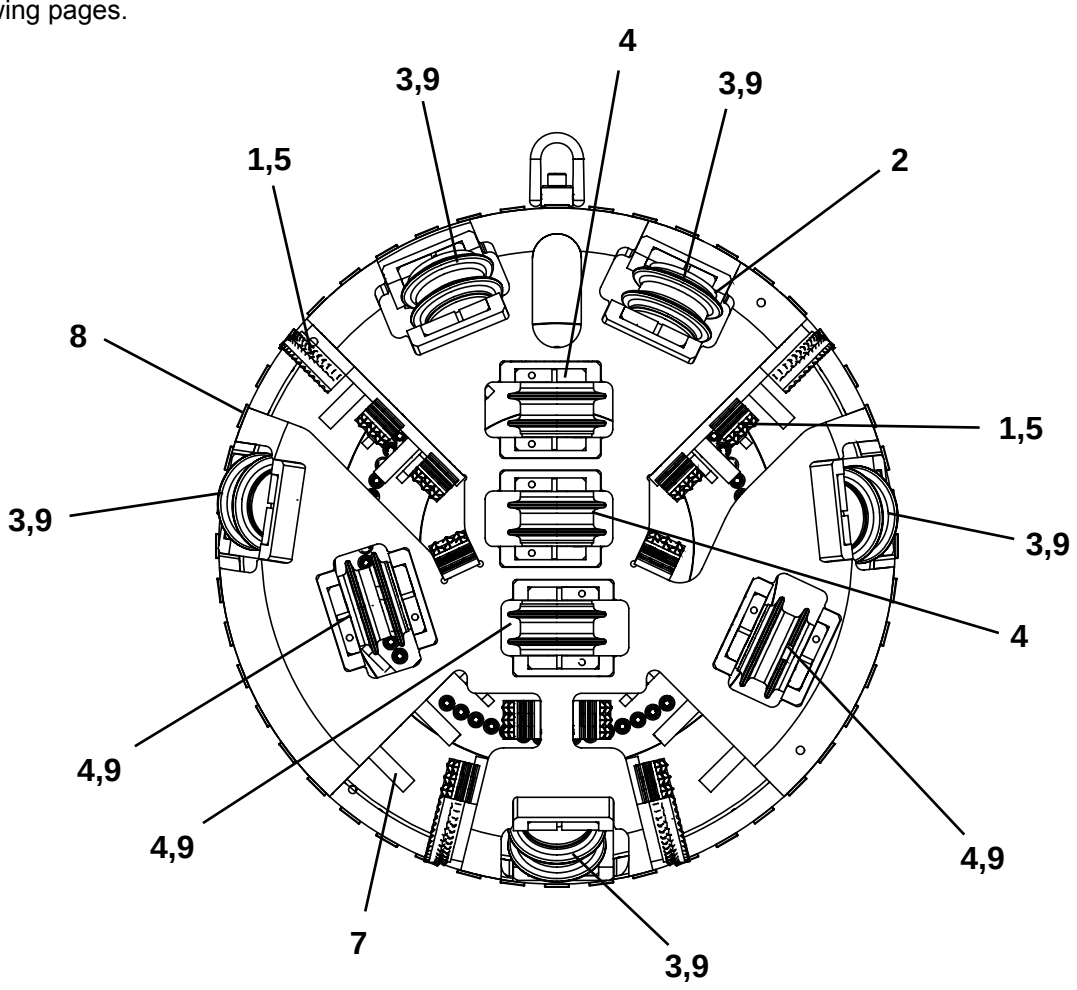
8. INSPECT CABLES

Inspect jetting pump generator cable (A) and jetting power cable (B) for cracking, fraying or other damage. Replace as needed.

NOTES

MAINTENANCE CHART - MTBM DISC CUTTERS & SCRAPERS

NOTICE Use the item number in the chart to refer to the detailed maintenance procedures in the following pages.



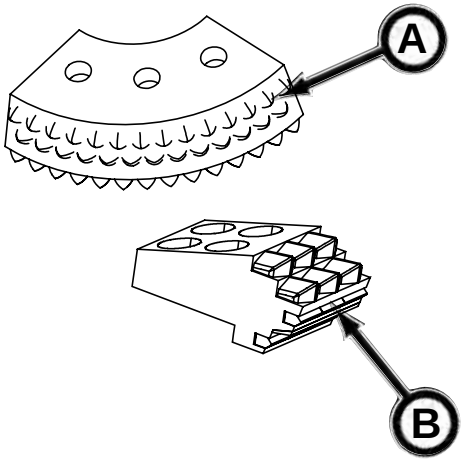
PRIOR TO EACH DRIVE LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Scraper Cutters	Inspect		
2.	Disc Cutters	Inspect		
3.	Gage Disc Cutter	Tooling Wear	Max. wear dia. limit: .75 in. (19 mm)	
4.	Face Disc Cutter	Tooling Wear	Max. wear dia. limit: 1.5 in. (38 mm)	
5.	Disc Cutter Hardware	Check Torque	M16 - 144 ft-lb (195 N·m) (lube)	Torque Wrench
			M20 - 394 ft-lb (534 N·m) (lube)	Torque Wrench
6.	Scraper Hardware	Check Torque	1 UNC -798 ft-lb (1,082 N·m) (lube)	Torque Wrench
7.	Grizzly Bars	Inspect		
8.	Gage Wear Pads			
9.	Disc Cutter Bearing	Drain/refill bearing oil cavity.	12.8 - 13.5 oz. (380 - 400 ml)	Mystik® JT7 85W-140

NOTICE Refer to cutter manufacturer user manual for more information.

Note: When replacing disc cutters, refer to Removing & Installing Disc Cutters in section 6, Operation for the proper installation process.

1. INSPECT SCRAPER CUTTER TOOLING

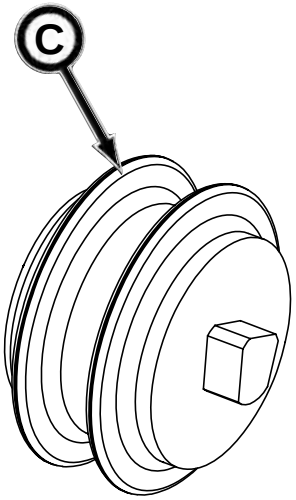


Inspect bucket scrapers (A) and face scrapers (B), for wear or damage. The scrapers must be replaced when:

- the scraper carbide bits/bullets shows signs of damage or broken carbides
- excessive wear; wear to base metal of the cutter
- severe wear to supporting metal around the carbide

2. INSPECT DISC CUTTER TOOLING

Inspect disc cutters (C) as follows:



1. Check for signs of lubricant leakage from around the cutter end caps. If leakage is found, DO NOT install the cutter. The cutter MUST be repaired or replaced before mounting onto cutter head.
2. Inspect disc cutter shaft (both ends) for damage. If damaged, replace with new disc cutter.
3. Check retaining ring condition. Replace if damaged or missing.
4. If any flat spots or polished marks are visible on the cutter, this is an indication that the cutter is skidding, and is most likely a result of a damaged bearing. Install a new cutter to replace any cutter with polished or flat spots.
5. Disc cutters with carbide inserts: any cutters with cracked carbides or cracks in the base metal of the cutter, must be replaced with a new disc cutter.
6. If the carbide insert has turned into the base metal of the cutter, the cutter must be replaced with new.
7. If the mounts are damaged, replace the mounts and disc cutters.

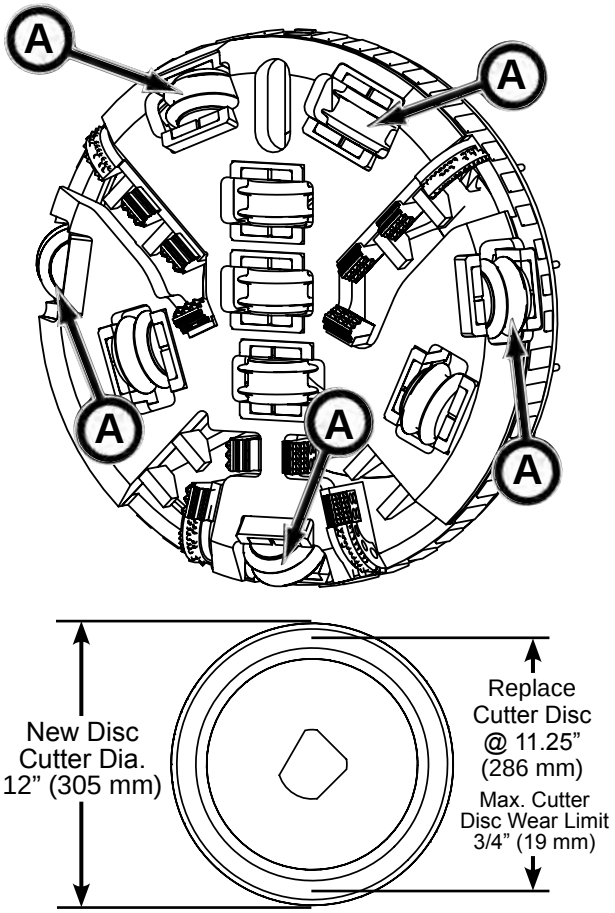
3. INSPECT GAGE DISC CUTTER TOOLING WEAR

The new disc cutters for the SL82P are 12 in. (305 mm) diameter.

All gage profile cutters (A) have a maximum cutter disc wear limit of 3/4 in. (19 mm). At the maximum disc cutter wear limit, the disc cutter diameter will be 11.25 in. (286 mm).

The gage profile disc cutters MUST be replaced with new disc cutters when the disc cutter diameter wears to 11.25 in. (286 mm).

The worn gage disc cutters can be used in the face disc cutter locations (refer to step 4 below for face disc cutter wear limit requirements) until the face disc cutter maximum wear limit is met.



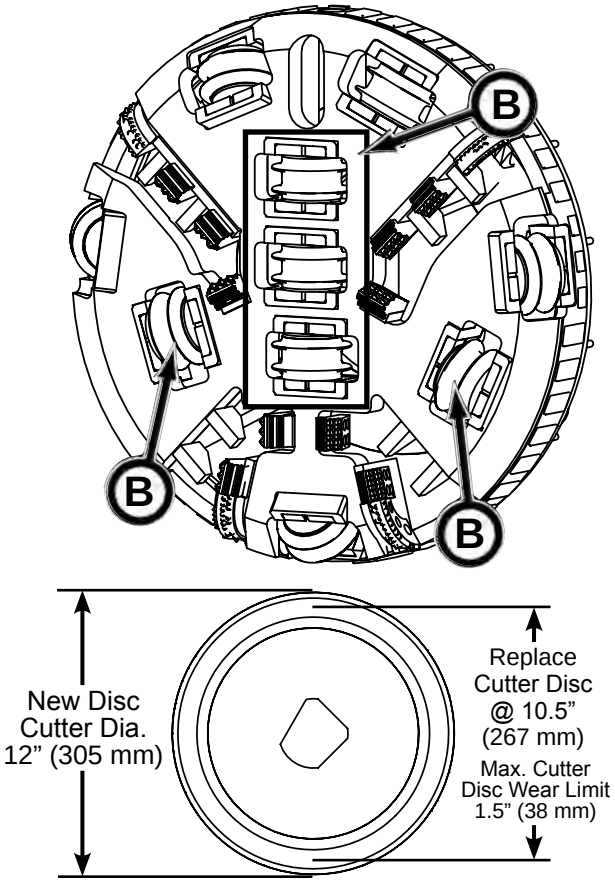
Gage Disc Cutter Maximum Wear Limit

4. INSPECT FACE DISC CUTTER TOOLING WEAR

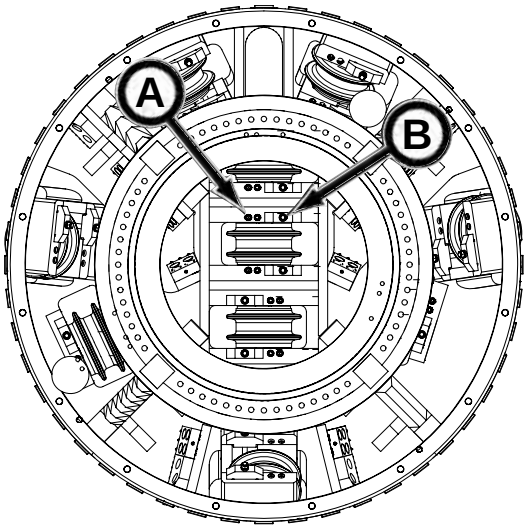
The new disc cutters for the SL82P are 12 in. (305 mm) diameter.

All face disc cutters (A) have a maximum cutter disc wear limit of 1.5 in. (38 mm). At the maximum disc cutter wear limit, the disc cutter diameter will be 10.5 in. (267 mm).

The face disc cutters MUST be replaced with new disc cutters when the disc cutter diameter wears to 10.5 in. (267 mm).



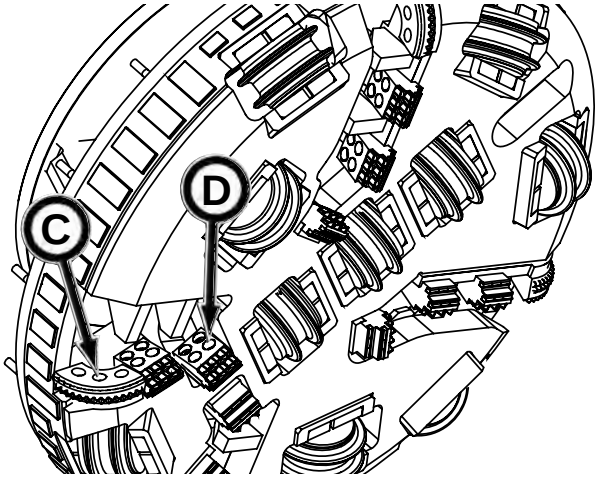
Face Disc Cutter Maximum Wear Limit



5. CHECK DISC CUTTER TOOLING HARDWARE TORQUE

1. Tighten disc cutter M16 screws (A) (qty 4 each) on C-Style blocks to 144 ft-lb (195 N·m) (lubricated) torque.

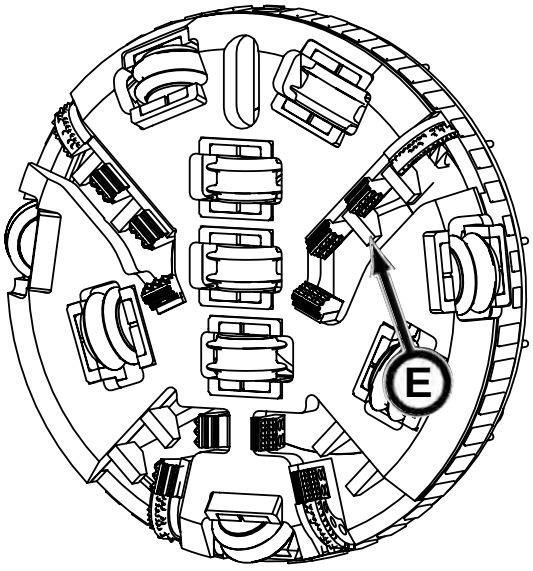
2. Tighten disc cutter M20 nuts (B) (qty 2 each) on wedge blocks to 394 ft-lb (534 N·m) (lubricated) torque.



6. CHECK SCRAPER TOOLING HARDWARE TORQUE

1. Tighten bucket scraper 1 UNC bolts (C) to 798 ft-lb (1,082 N·m) (lubricated) torque.

2. Tighten face scraper 1 UNC bolts (D) to 798 ft-lb (1,082 N·m) (lubricated) torque.

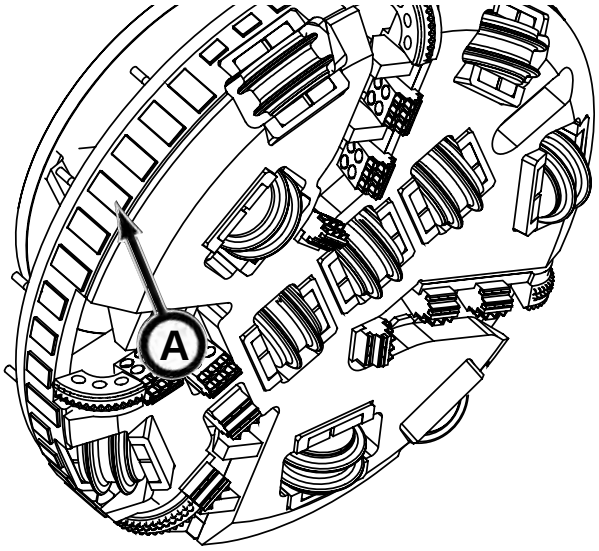


7. CHECK GRIZZLY BARS

Check all grizzly bars (E) as follows:

1. If grizzly bars are bent or broken, replace the bars with new.

2. If the grizzly bar welds are cracked, the welds must be rewelded or replaced prior to operation.



8. INSPECT GAGE WEAR PADS

Inspect gage wear pads (A) as follows:

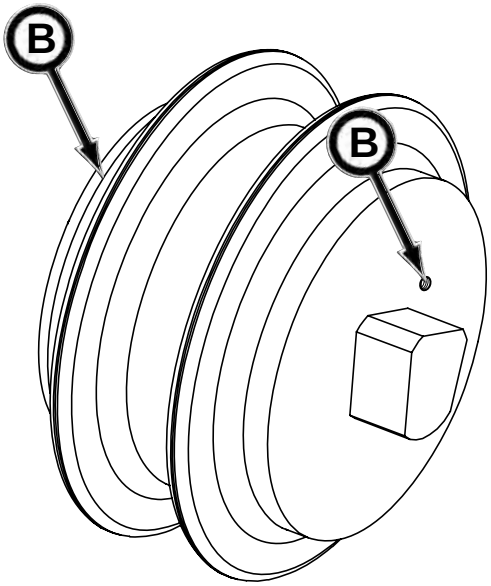
1. If wear pads are worn to the base metal, the pads must be replaced with new.

2. If wear pads are missing, the pads must be replaced with new.

3. If the gage wear pad (F) welds are cracked, the welds must be rewelded or replaced prior to operation.

9. DISC CUTTER BEARING OIL CAVITY

Prior to each job, the bearing oil cavity of each disc cutter must be drained and refilled with clean oil.



1. Remove both tapered plugs (B).

2. Drain oil into a container.

3. Replace one of the tapered plugs using Teflon™ tape to assure a good seal.

4. Be sure to inspect drained oil for any contamination. If there are any signs of contamination, the disc cutter must be replaced or rebuilt prior to operation. If rebuilding disc cutters, follow the manufacturers instructions starting on the next page.

5. Dispose of oil properly.

6. When adding oil to the disc cutter, use Mystik® JT7 85W-140 oil or equivalent. The oil capacity is approximately 12.8 - 13.5 oz. (380 - 400 ml).

   The Mystik® JT7 85W-140 oil is a thermally stable gear lubricant with exceptional durability under high temperature conditions.

   Always use clean, high quality oil when adding oil to the disc cutter bearing cavity. It is critical for the efficient operation of the disc cutters.

7. Once bearing cavity is filled, plug tapped hole with tapered plug (B) using Teflon™ tape to assure a good seal.

NOTICE The cutters should be stored in a cool location, out of direct sunlight.

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

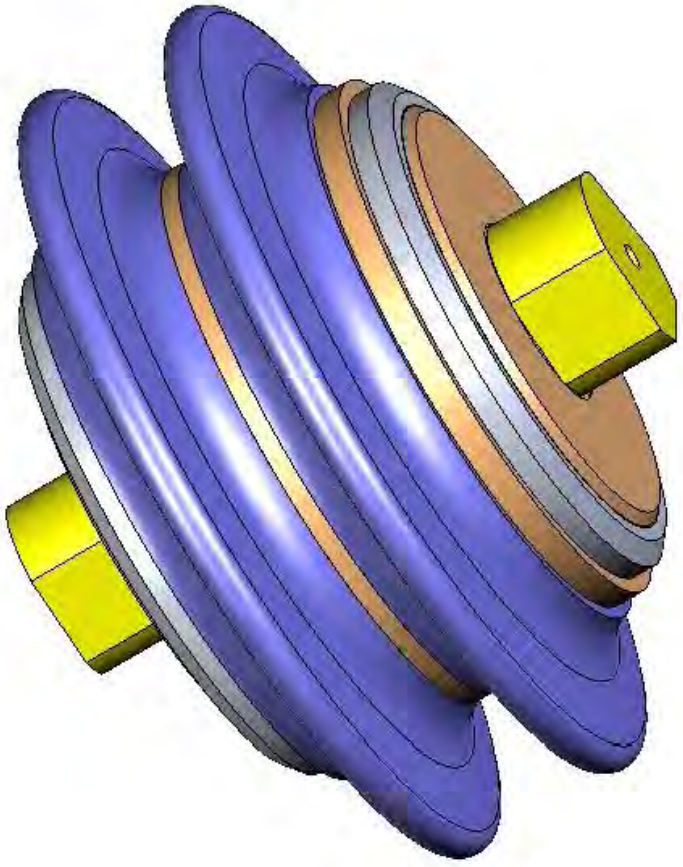
TunnelTec GmbH
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Disc Cutter Maintenance Instructions
Cutter 12D11WL-M (12inch, oil filled)

Content

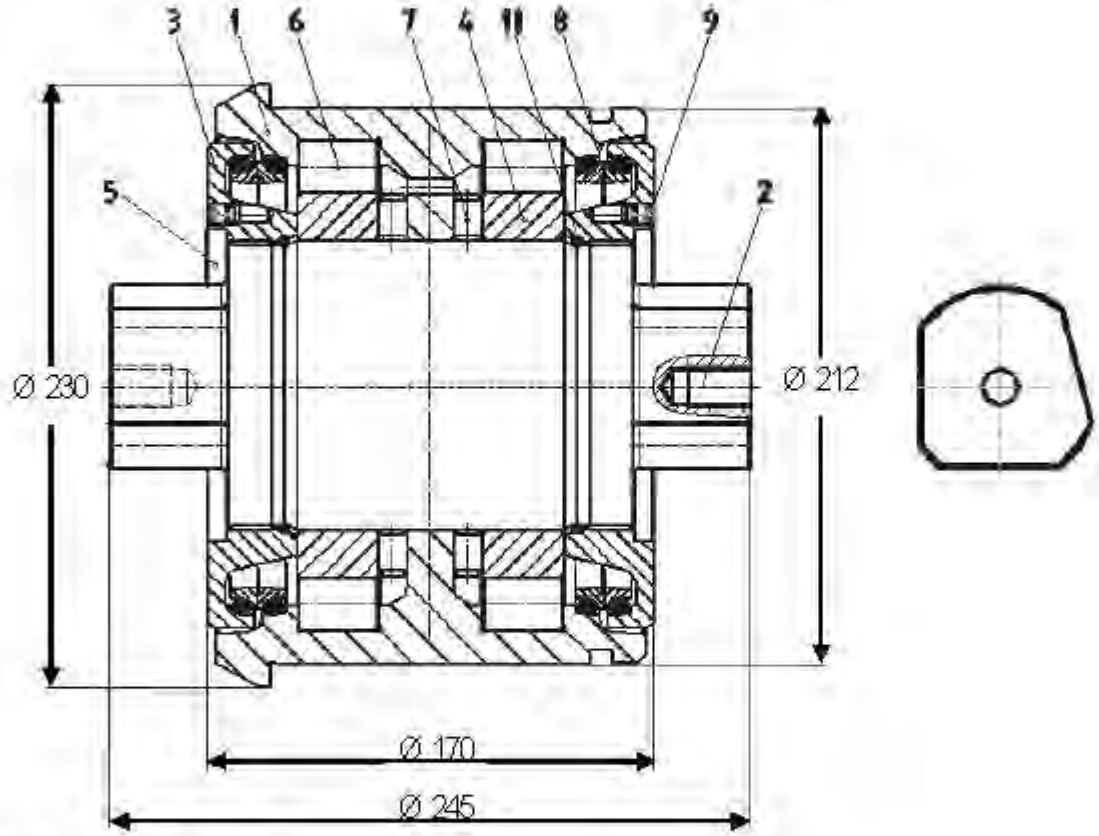
A) General information
B) Bearing assembly
C) Cutter assembly
D) Assessment of damages and wear
E) Spare Parts



A) General information

The maximum load per Roller Cutter is 18 tons (metric).
The maximum wear limit of discs is 22,5 mm.

B) Bearing assembly



1. Assembly of bearing

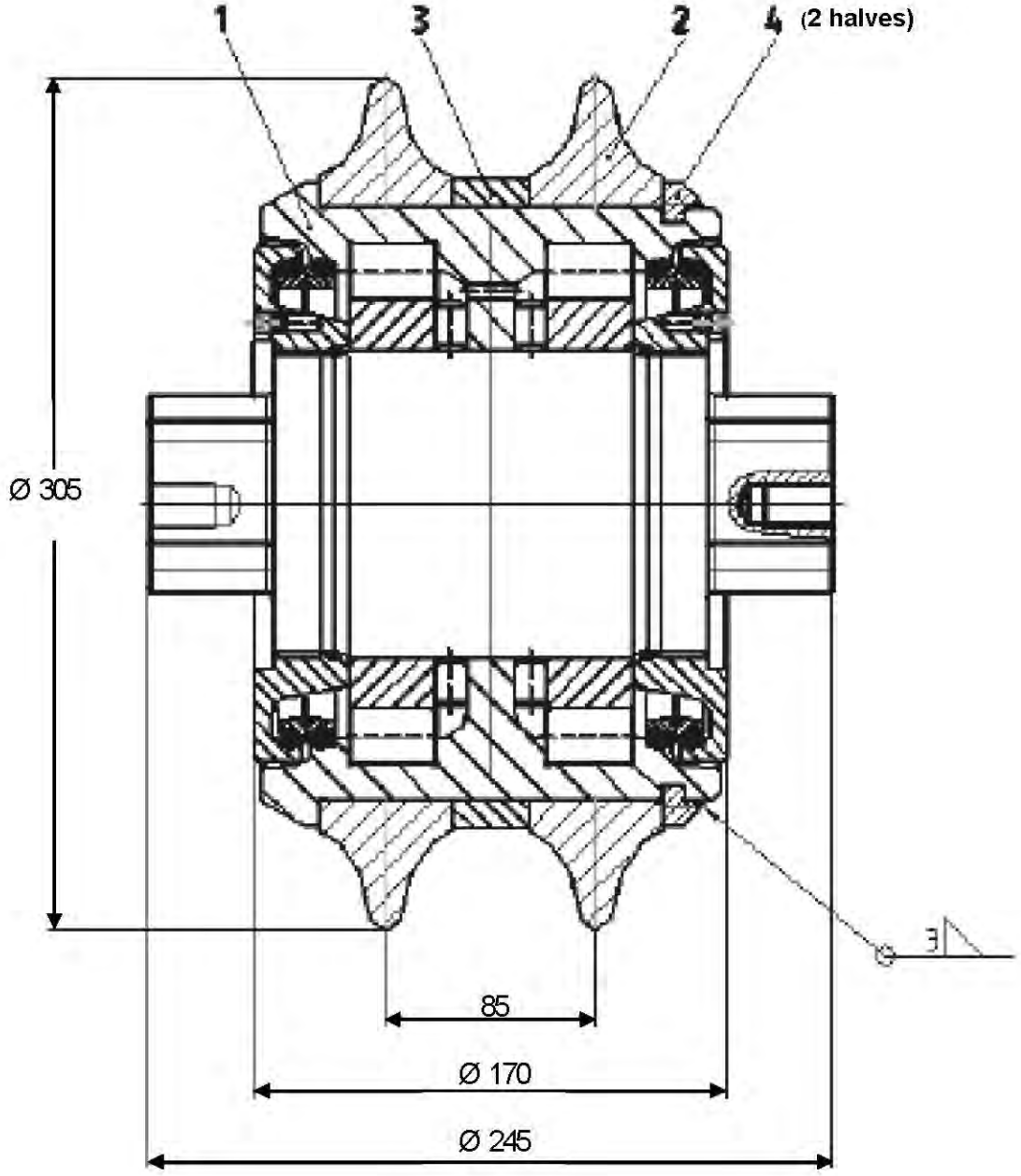
1.1 The assembly of the cutter starts with the installation of the first bearing race (4). Spray the axle with a solid lubricant paste (e.g. FUCHS Gleitmo 165) and press the race (4) onto the axle (2) by means of an assembly sleeve.
The location of the bearing race on the shaft is always the same. Screw the cover (3) onto the axle without slide ring seal.
1.2 Insert an axial bearing (7) onto the axle (2). Then insert a row of radial rollers (6) into the hub (1). Fill the cylindrical and thrust roller bearings with a little bit of oil (e.g. Mystik JT7). Turn over the axle, insert the second axial bearing (7) onto the shaft (2) and then the second row of cylindrical rollers (6) into the hub (1).
1.3 Insert the axle (2) with the assembled bearings into the hub (1) and turn it over.

1.4 Now proceed with pressing the 2nd bearing race (4) onto the axle by means of an assembly sleeve. The preload of the axial bearing is achieved by slowly pressing the bearing race against the thrust rollers while turning the hub until axial play is reduced to a point, where a smooth rotation is still possible.
1.5 Remove the previously installed cover. Insert the slide ring seals (8) into the clean sealing seats of the two covers (3) and into the seats in the hub. If assembling a used bearing, new slide ring seals are recommended. An endless spiral spring being used as assembly aid has to be inserted between O-ring and sealing ring in such a way that the O-ring cannot contact the sealing web. Prior to the installation of the covers, the sealing surfaces are to be cleaned with an oiled leather cloth.
1.6 Before the covers (3) are assembled, the O-rings (10) are put in place. After installation, the covers are fastened with a torque wrench to 50 Nm. The covers are then secured with set screws (9) engaging keeper plates (5) which are welded to the covers. The turning moment of the complete disc cutter should be approximately 15-20Nm. This can be measured by rotating the hub.
1.7 Finally the bearing is filled through a tapped hole with oil (e.g. Mystik JT7). The amount of oil is approx. 380-400ml.
Close the tapped holes with the tapered plugs, use Teflon tape to assure a good seal.

2. Disassembly of bearing

2.1 First clean the outside of the cutter assembly.
2.2 Remove the set screws by drilling them out if necessary. Remove the keeper plates (5) by grinding off the welds. Then unscrew the covers. Remove seals on each side and keep them together as a set for later inspection.
2.3 Push the axle out under a press and take care that the axle does not drop.
2.4 Remove all cylindrical rollers and axial bearings and clean all parts. Check raceways, bearings, rollers and seals for wear.
2.5 Check seal seats in covers. If surfaces are damaged, the seal housings, covers and hubs, as well as the seals have to be changed.
2.6 The bearing races are checked for wear. Even the smallest damage can result in a total loss of the cutter assembly when using it again. In case the thrust bearing races are worn, they can be turned so that the worn side faces the end cover. If the radial bearing races are only slightly worn, they can be turned 180°.
2.7 Store useable parts for later use.

C) Cutter Assembly



3. Assembly of disk to the hub.

3.1 In case the condition of the outside diameter of the hub is acceptable, a new disc is shrunk on with an interference fit of 0.18 to 0.24 mm.

3.2 The interference fit of the disc is achieved by heating it to a temperature of approx. 180 °C. Tools or special means are not required for shrinking the disc on the hub.

3.3 It is recommended to heat up the disks and spacer ring (3) in an electric furnace being regulated with a thermostat.
3.4 The heated disc (2) and the spacer ring easily slide onto the hub and have to be secured by a retaining ring (4). The halves of the retaining ring have to be welded at the positions provided for that purpose. The halves of the retaining ring should only be welded to each other and/or to the hub, not to the disc! Protect the disc during welding to avoid any heat input into the disc.

4. Removal of disc from hub.

4.1 The disc can only be removed in one direction.
4.2 Remove the retaining ring after cutting it with a disc grinder. Locally apply heat to the disc with an acetylene burner in order to fracture it and/or cut the disc to facilitate removal by pushing it off the hub.
4.3 After thoroughly cleaning and checking the hub and provided the bearing is still ok, a new disc can be assembled onto the hub.

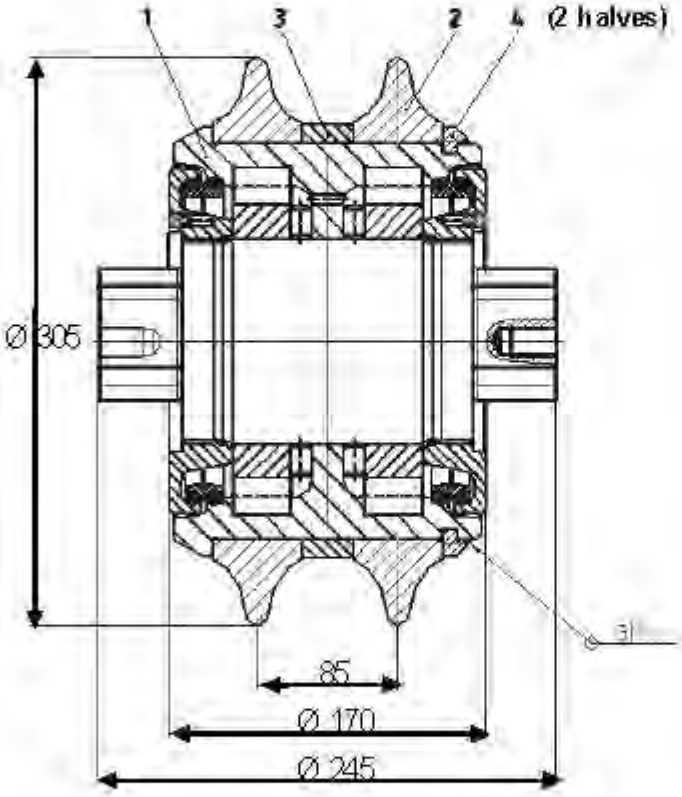
D) Assessment of damages and wear

5.1 The wear of the disc is determined by means of a wear gauge. If necessary, the disc has to be changed.
5.2 Visually inspect the cutter assemblies on the cutter head. In case of blockage or other irregularities, the cutter must be replaced.
5.3 After removal of the cutter from the saddle, the condition of the axle and saddle has to be checked. In case damage of the support surface or the cutter axle are found, the saddle and/or axle have to be repaired or changed, otherwise a correct fit cannot be guaranteed.
5.4 Examine the slide ring seals after removing the cover. If grooves are visible or can be felt in the seal surfaces, the slide ring seal must be completely replaced. Bearing races are to be checked in the same manner for any damage or wear. Even the smallest damage can lead to the total loss of the cutter, if continued use is allowed.
5.5 In order to come up to the high expectations regarding wear and tear in the gauge area, repaired cutters should be installed away from the gage area and closer to the centre, depending on their state of repair. The gauge area should only be provided with new or newly overhauled cutters.

E) Spare parts lists

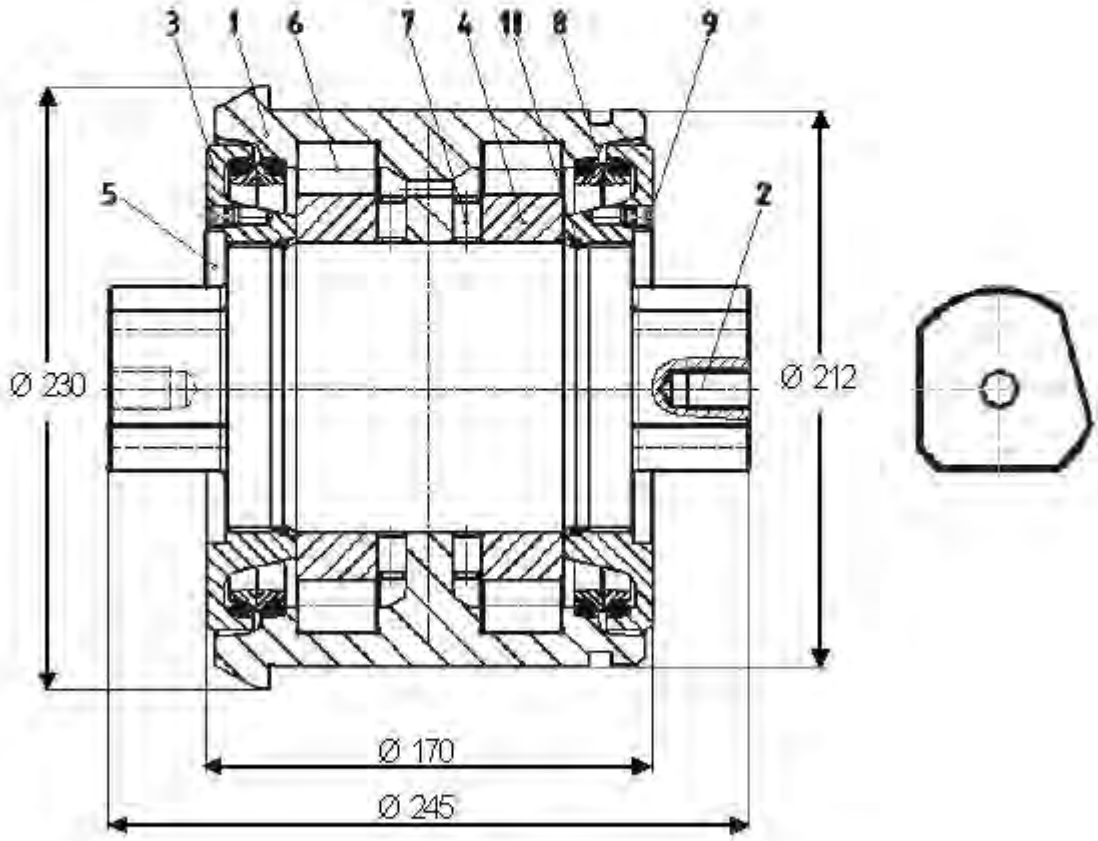
12 inch Double Roller Cutter

Item	quantity	Description	weight kg
00	1	12" cutter assembly, compl.	59.00
01	1	hub	42.00
02	2	12" disc	7.50
03	1	spacer ring	1.50
04	1	retaining ring	0.70



Hub assembly for Cutter 12 inch

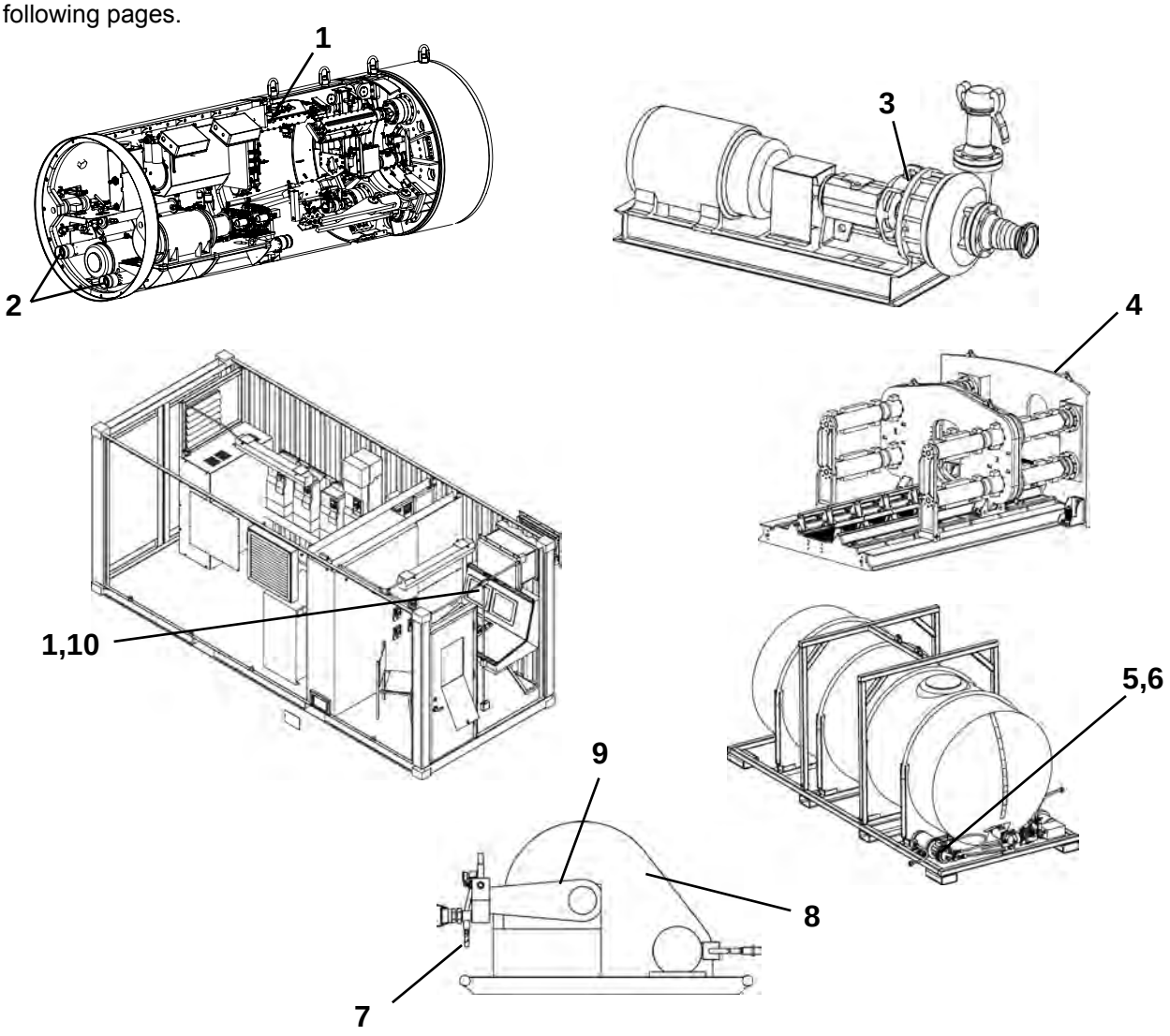
Item	quantity	Description	weight (kg)
00	1	hub assembly	42.00
01	1	hub	14.50
02	1	axle	14.00
03	2	cover	2.30
04	2	bearing race	1.80
05	2	keeper plate	0.06
06	52	cylindrical roller	0.07
07	2	axial bearing cage	0.27
08	4	slide ring seal	0.40
09	2	set screw	
10	2	O-ring	



sj, 080411

MAINTENANCE CHART - MICROTUNNELING SYSTEM

NOTICE Use the item number in the chart to refer to the detailed maintenance procedures in the following pages.



DAILY OR EVERY 10 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Gas Detector	Check display reading & check fault message.		
2.	Slurry Hoses	Inspect Banding Clamps	If damaged/worn, replace.	
3.	Slurry Pumps	Flush & Drain	In freezing weather.	
4.	Jacking Frame	Clean, Inspect & Lubricate		Mobil XHP222
5.	Water Cool. Pumps	Check Oil Level	Add oil if necessary.	SAE 10W30
6.	Water Cool. Pumps	Flush & Drain	In freezing weather.	
7.	Jetting Pump	Flush & Drain	In freezing weather.	
8.	Jetting Pump	Check Belt Tension	See maintenance detail.	
9.	Jetting Pump	Check Gear Box Oil	Add oil if necessary.	*SAE 40 non-det.
10.	Control System	Backup Database		

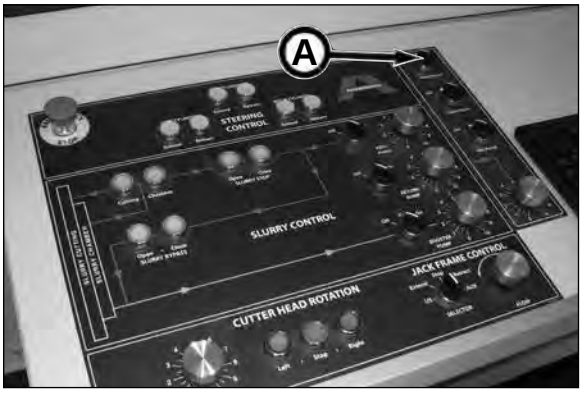
* Use SAE Grade 40 non-detergent industrial turbine oil.

1. CHECK GAS DETECTOR READINGS

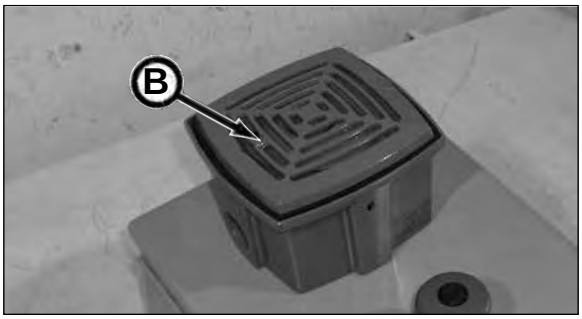
NOTICE For more information, refer to your GasMax Instruction Manual.

Check the gas detection system as follows:

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



1. Turn Head Power switch (A) to ON position. If the sound from the horn (B) on the pit box comes on immediately, typically the sensor (C) must be replaced.



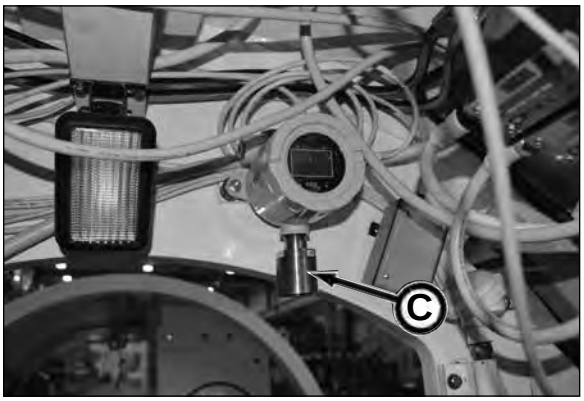
2. The gas detector is monitored by the control system as follows:

1. The “Gas Detector Fault” message will appear in the status/alarms area (D) on the target screen when there is a problem with the gas detector sensor.

2. The “Gas Level High” message will appear in the status/alarms area (D) on the target screen when the gas level at the gas detector reads 10% (default setting) LEL (Lower Explosive Limit) or higher.

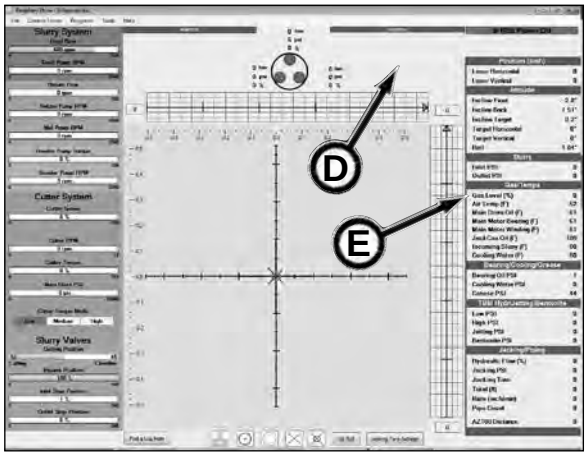
3. When the system detects a gas level reading of 10% LEL but less than 25% (default setting) LEL, the audible alarm (horn) (B) on the pit box will sound intermittently.

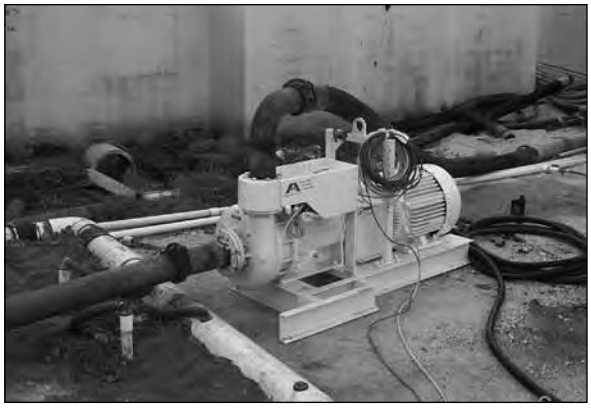
4. When the system detects a gas level reading of 25% (default setting) LEL or higher, the horn on the pit box will sound constantly.



NOTICE If the high LEL setting is reached, the cutterhead rotation and the jacking frame functions will shut down.

5. The gas level % of LEL reading (E) at the gas detector is displayed on the target screen.





2. CHECK SLURRY HOSES, LINES, CLAMPS, CONNECTIONS & POWER CABLES (Feed, Return & Booster Pumps)

1. Regularly inspect the slurry hoses and banding hose clamps. If the hoses and/or clamps are cracked, worn or damaged, they must be replaced.

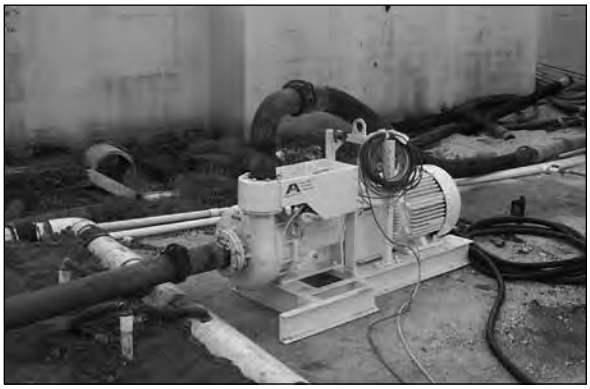


2. Regularly inspect the slurry line connections for wear or damage. Replace as needed.

Check to be sure the oring is not cracked, torn, worn or damaged. If needed, replace with new oring.



3. Inspect slurry power cables for wear, fray or damage. If cables are worn, frayed or damaged, the cable(s) must be replaced BEFORE operation.

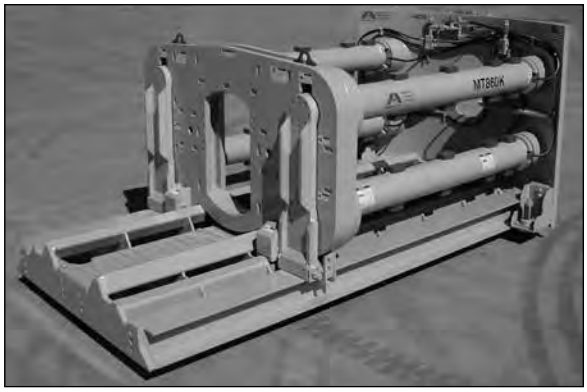


3. FLUSH & DRAIN SLURRY PUMPS & HOSES

In freezing weather, the slurry pumps and hoses/ lines must be flushed and drained to prevent damage.

4. CLEAN, INSPECT & LUBRICATE JACKING FRAMES (KEYHOLE JACKING FRAMES)

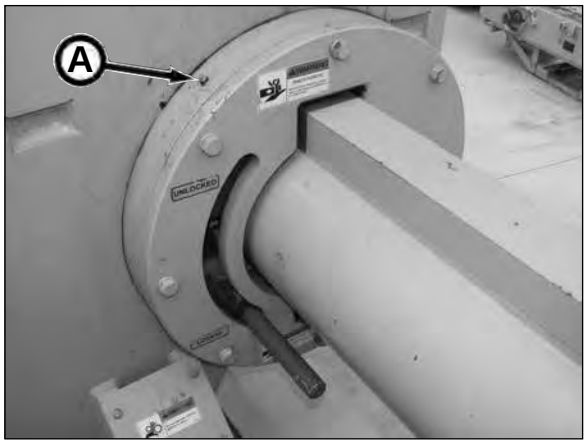
1. Clean frame to remove build up of dirt and debris.



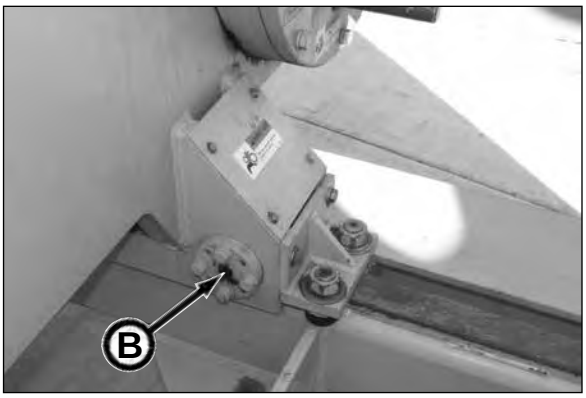
Visually inspect jacking frame for cracks or other damage. Also check for damaged, loose, or missing hardware. Replace with new.

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

Check to be sure all guards are in place and in good condition. If damaged, repair or replace before operation.

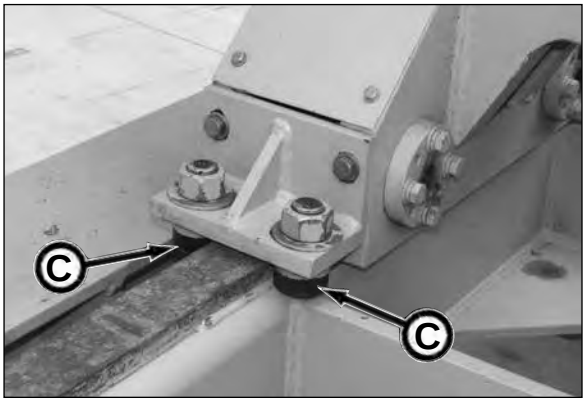


2. Lubricate the cam locks (A) (2 places per cam lock) with Lubriplate® 1200-2 heavy duty, lithium grease or equivalent until grease is forced out.



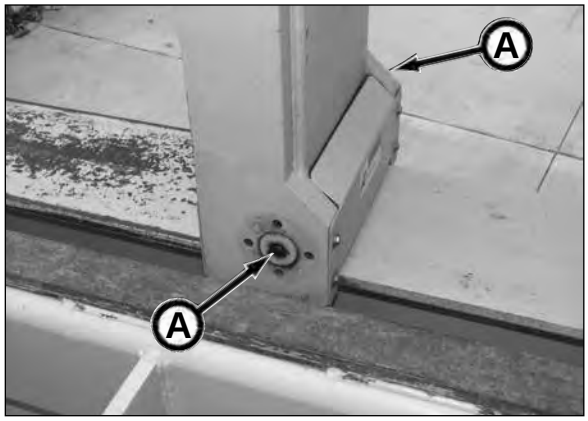
3. Lubricate thrust block guides (B) (4 places) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.

If guide guard was removed, be sure it is replaced.

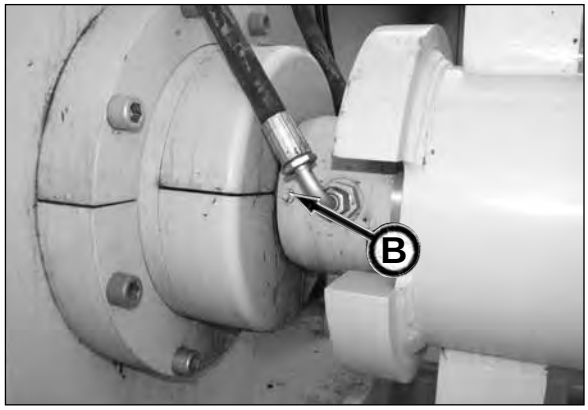


4. Check to be sure the thrust block rollers (C) roll freely. If they do not roll freely, repair or replace before operation.

(Continued on next page)



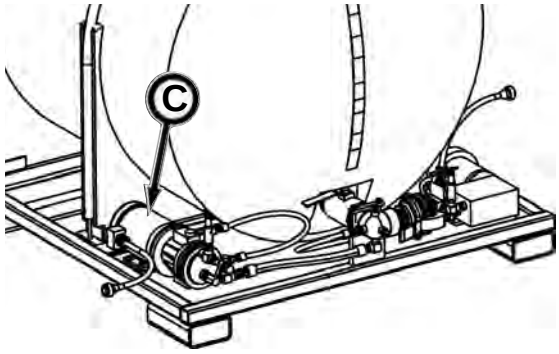
5. Lubricate cylinder supports (A) (4 places) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.



6. Lubricate jacking cylinder pins (B) (1 per cylinder) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.

5. CHECK WATER COOL PUMP OIL LEVEL (IF USED)

Check water cool pump (C) oil level and the condition of the oil.



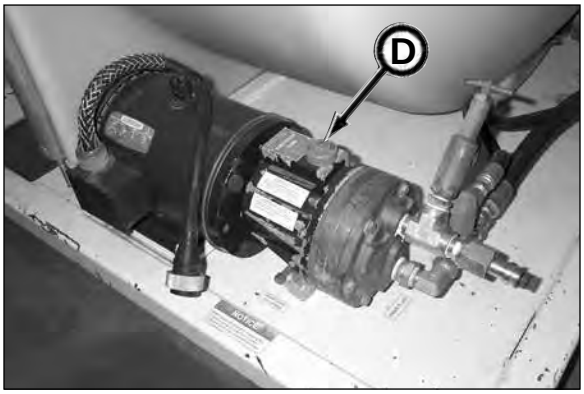
1. Clean area around check/fill cap (D).

2. Remove check/fill cap. Oil level should be:

   1/4 in. (6 mm) from top of the fill port

3. If additional oil is needed, add a high quality SAE 10W-30 motor oil to bring oil level to:

   1/4 in. (6 mm) from top of the fill port



Oil capacity is 1.1 US quart (1.05 L).

4. If oil shows signs of contamination, drain oil and refill with clean oil.

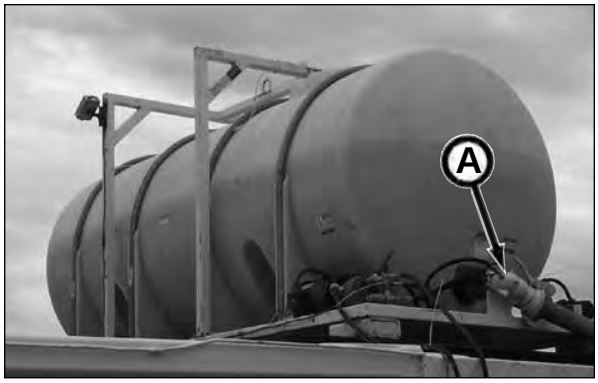
5. Replace check/fill cap.

(Continued on next page)

6. FLUSH & DRAIN WATER COOLING TANK COMPONENTS

In freezing weather, remove cap or hose from 3” elbow (A). Remove drain plugs from both pumps. Flush and drain pumps and all fluid lines. With water completely drained, replace plugs. Failure to do so will cause damage to pump components.

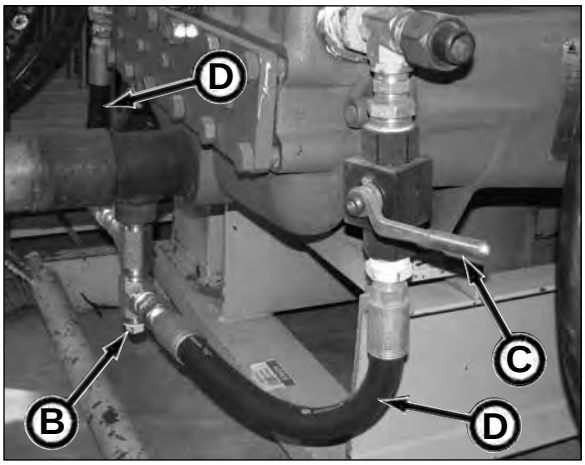
The tank must also be drained in freezing weather unless a suitable heat source is used for keeping the tank temperature above freezing.



7. FLUSH & DRAIN JETTING PUMP COMPONENTS

In freezing weather, flush and drain pump and all fluid lines. Failure to do so will cause damage to pump components.

1. Remove drain plug (B).
2. Open bypass pressure relief valve (C) to allow water to drain from pump.
3. Cycle bypass pressure relief valve multiple times to be sure water in ball valve is removed.
4. Be sure water is removed from hoses (D).
5. Replace drain plug.
6. Be sure all fluid lines are drained.





8. CHECK JETTING PUMP BELT ALIGNMENT & TENSION (PUMP MODEL APLEX SC-115)

A belt will provide years of reliable service if it is properly tensioned and aligned. Refer to Aplex User Manual for more information.

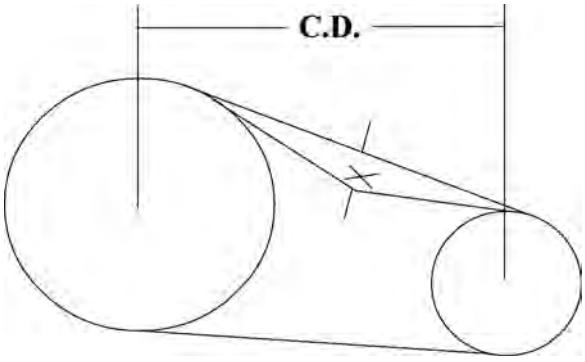
1. Remove belt cover (A).

2. Belt Alignment
   Use a straight edge across the rim of the sheaves to detect and correct for misalignment.

3. Belt Tension
   Insufficient tension results in slippage, burning, squealing and shortened belt life. Overtightening imposes excessive loads on pump and motor bearings and can cause early shaft fatigue failure.

Using a small spring scale, apply 17 - 30 lb (new) or 13 - 23 lb force at center distance (C.D.), adjust motor position to provide 7/16” deflection at center distance.

4. Replace belt cover.





9. CHECK JETTING PUMP GEARBOX OIL LEVEL

1. Gain access to the gear box dipstick and check the oil level. The oil level should be at the full mark on the dipstick.



2. If needed, remove fill cap and add a high quality SAE Grade 40 non-detergent industrial turbine oil to bring oil level to full mark on dipstick.

3. Replace fill cap and dipstick.

10. BACKUP CONTROL SYSTEM DATABASE



Even though today's hard drives are very reliable, hard drives are mechanical devices that become unusable due to age, wear, viruses, corrupted files or other unpredictable failures.

A recovery of the data on a failed hard drive is possible, but may cost hundreds of dollars in the diagnostics and retrieval process from a professional technical support service.

Therefore, in the event of a hard drive crash, a periodic **backup of the database is highly recommended**.

IMPORTANT: If backing up database, IT IS CRITICAL THAT NO FILES OR FOLDERS ARE MOVED FROM THE DATA DIRECTORY. If files or folders are moved, an error message will occur at startup of the control system program, resulting in the control system being inoperable.

If you do not feel comfortable navigating the directories of the Windows™ operating system, do not attempt to perform this backup.

NOTICE A simple, easy to use alternative for copying the SL82P database is available. Refer to DB Database Utility Program in section 6, Operation for the procedure.

1. Insert an appropriate sized USB flash drive into one of the USB connection ports on the control console. The flash drive will appear as another storage device (Removable Disk) on your Windows Explorer (the operating system's file and folder manager) window.

2. Navigate to the following location:
   C:/MySQL/Data/

3. With the MySQL/Data/ window active, perform a Select All by clicking Edit on the menu bar and click Select All to highlight all files and folders in the data directory. For a Select All shortcut, press Ctrl key and the letter A (Ctrl + A).

IMPORTANT: DO NOT move any files or folders from the data directory. If files or folders are moved, an error message will occur at startup of the control system program, resulting in the control system being inoperable.

4. With the files and folders highlighted in the data directory (window), copy the data by clicking Edit on the menu bar and click Copy (shortcut Ctrl + V).

5. Double click your flash drive storage device in Windows Explorer.

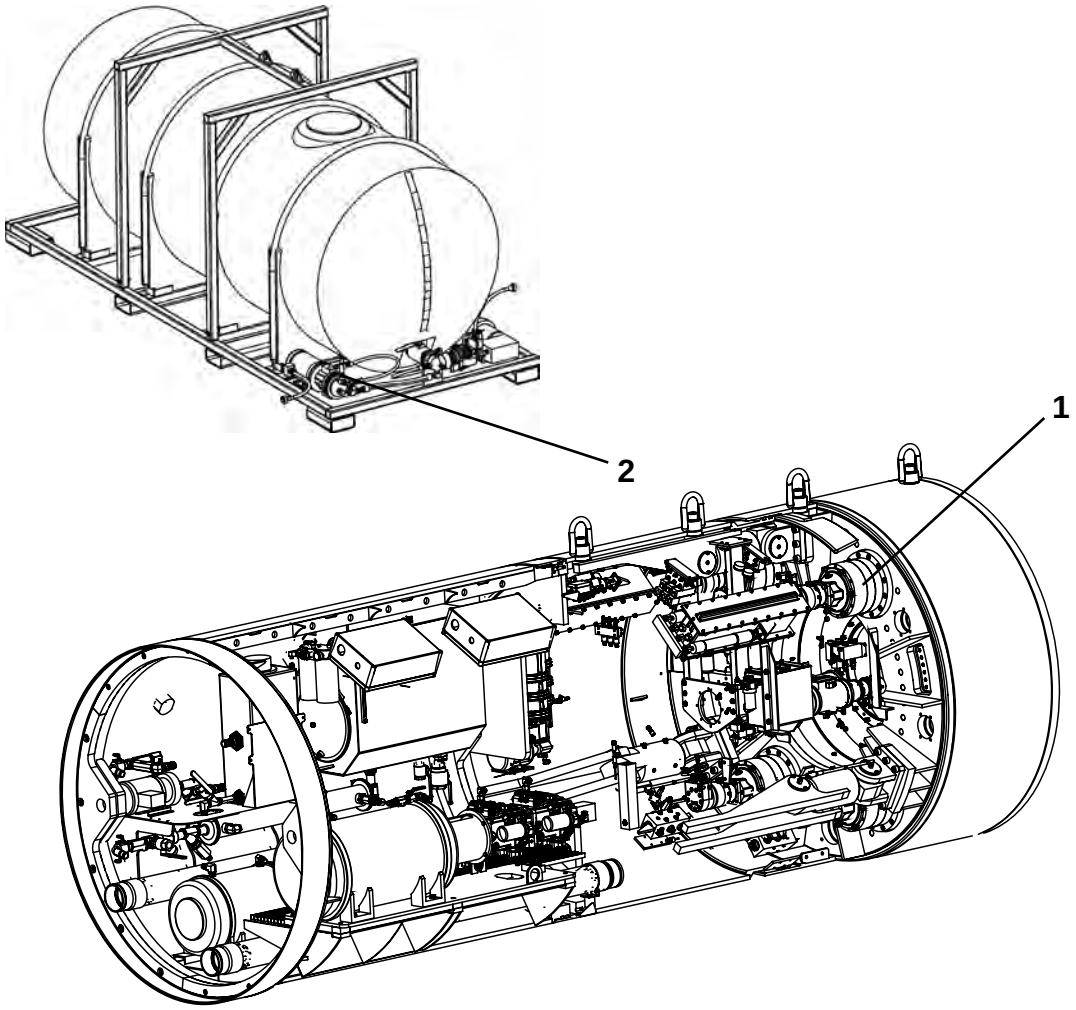
6. Paste the data files and folders that were copied in step 4 by clicking Edit on the menu bar and click Paste (shortcut Ctrl + C) into flash drive window.

7. Eject your flash drive by right clicking the flash drive and select Eject or simply pull flash drive out of USB connection port.

8. The control system database backup is complete.

MAINTENANCE CHART - MICROTUNNELING SYSTEM

NOTICE Use the item number in the chart to refer to the detailed maintenance procedures in the following pages.



AFTER FIRST 50 HOURS, THEN EVERY 500 HOURS THEREAFTER

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
* 1.	Gear Box	Drain & Fill	Capacity 3.3 qt. (3.13 L)	Mobil 600XP 460

AFTER FIRST 100 HOURS, THEN EVERY 1000 HOURS THEREAFTER

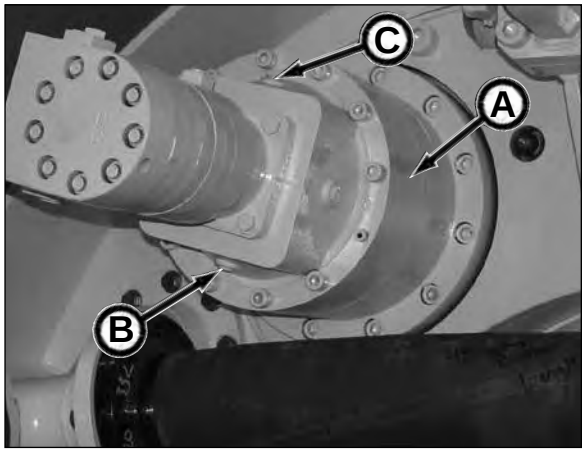
ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
*2.	Water Cool. Pumps	Drain & Fill	Large Pump - 1.1 US qt.	10W30 Motor Oil

* Drain and fill earlier with any signs of contamination.

AFTER FIRST 50 HOURS OF OPERATION, THEN EVERY 500 HOURS THEREAFTER

1. DRAIN & FILL MAIN DRIVE PLANETARY GEAR BOX

Drain and fill the main drive planetary gear box (A) as follows:

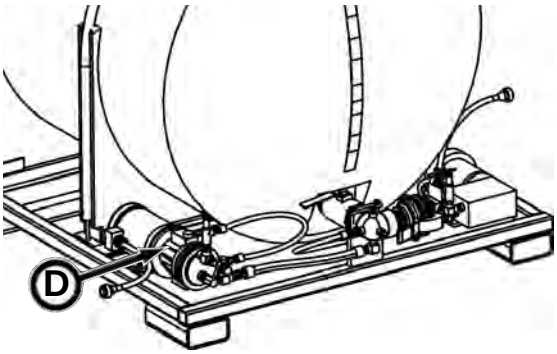


1. Be sure to the clean the area around the gear box oil drain plug (B) and fill plug (C) before removing to prevent contamination from entering gear box.
2. Remove drain plug and drain oil from gear box into a properly sized catch container..
3. Tighten drain plug.
4. Inspect the drained oil for contaminants. If excessive metal particles are found, the gear box will require maintenance.
5. Remove fill port plug.
6. Add 3.3 qt (3.13 L) of fresh, clean Mobilgear® 600XP 460 oil or equivalent through fill port.
7. Replace fill plug.
8. Replace the oil in the other planetary gear boxes following steps 1 through 7.

AFTER FIRST 100 HOURS OF OPERATION, THEN EVERY 1000 HOURS THEREAFTER

2. DRAIN & FILL COOLING PUMP OIL (IF USED)

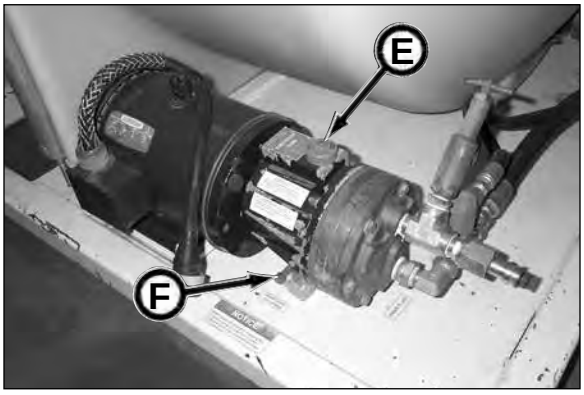
Drain and fill cooling pump (D) of oil as follows:



1. Clean area around check/fill cap (E) and gear case oil drain plug (F).
2. Loosen check/fill cap (E) for ease of draining oil. Remove gear case oil plug (F) and drain oil from gear case.
3. Replace gear case oil drain plug and remove check/fill cap.
4. Add 1.1 US quart (1.05 L) of a high quality SAE 10W-30 motor oil through check/fill port. Oil level should be:

   1/4 in. (6 mm) from top of the fill port

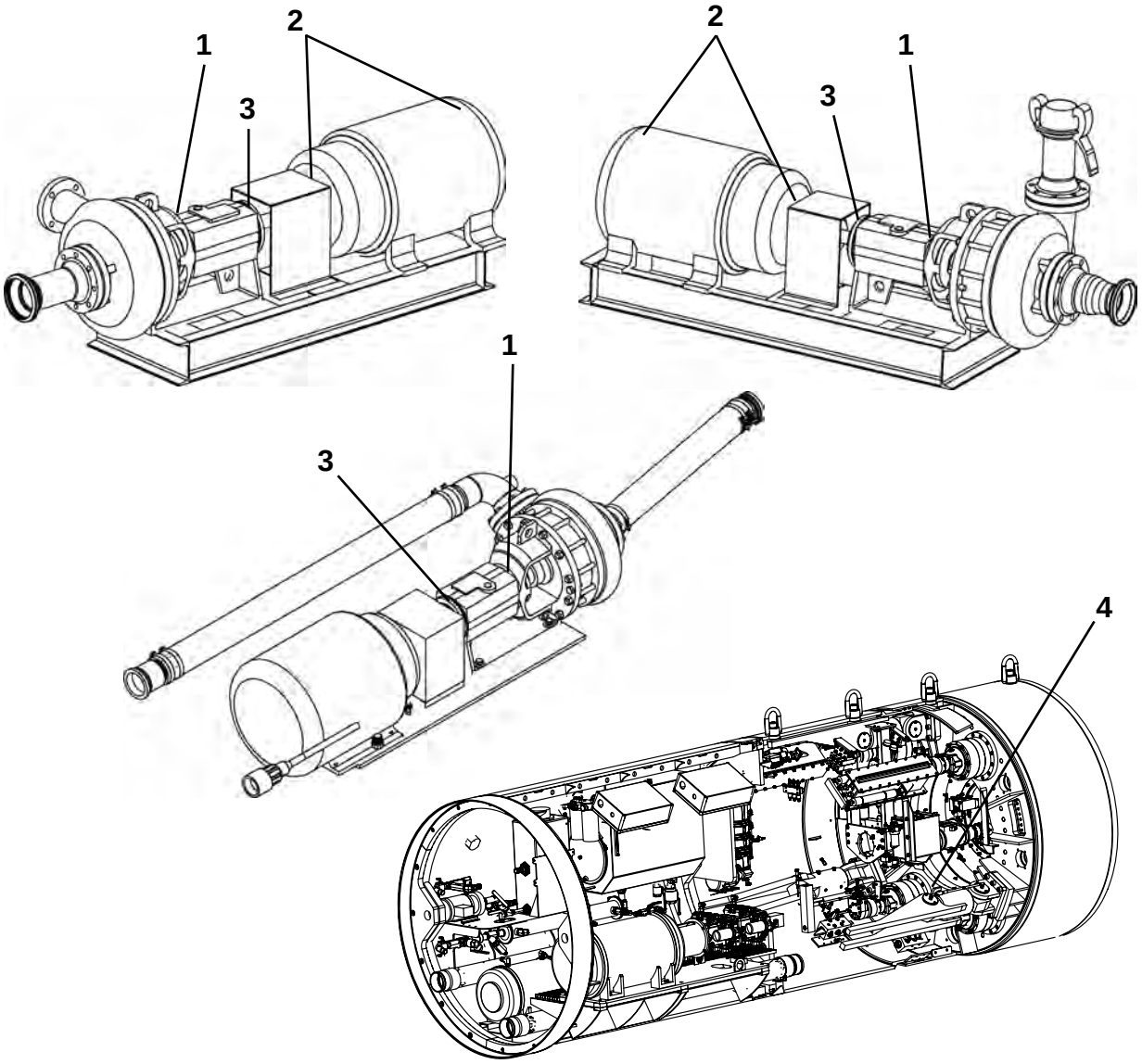
5. Replace check/fill cap.



NOTICE Anytime the oil shows signs of contamination, drain oil and refill with clean oil.

MAINTENANCE CHART - MICROTUNNELING SYSTEM

NOTICE Use the item number in the chart to refer to the detailed maintenance procedures in the following pages.



MONTHLY OR EVERY 250 HOURS OF OPERATION

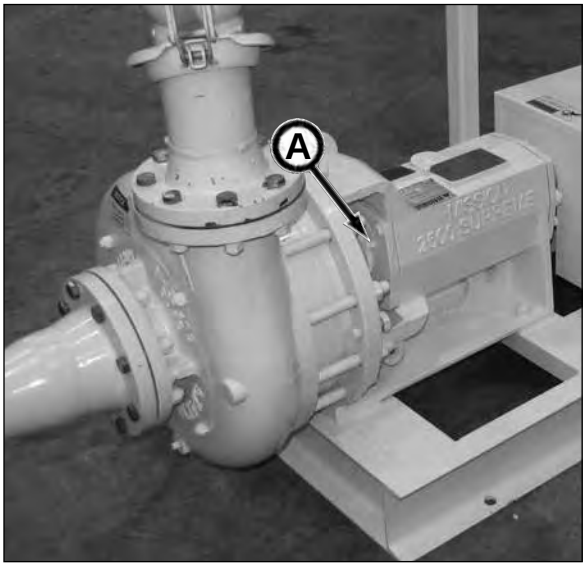
ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Slurry Pumps	Lubricate Lip Seals	See Slurry Pump Manuals	Mobil XHP222
2.	Slurry Pumps	Lubricate Motor Bearings	See Slurry Pump Manuals	Mobil XHP222
3.	Slurry Pumps	Lubricate Bearing Seals	See Slurry Pump Manuals	Mobil XHP222

NOTICE Refer to slurry pump manufacturer user manual for more information.

FIRST 250 HOURS OF OPERATION & EVERY 500 HOURS THEREAFTER

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
4.	Bearing Cavity	Drain & Fill	Capacity 23 gal. (87 L)	Mobil 600XP 460

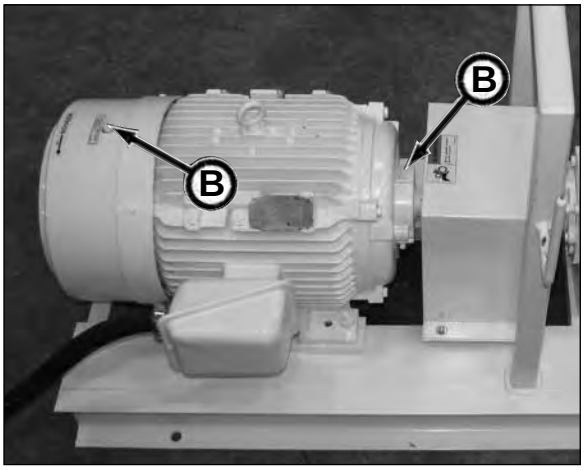
MONTHLY OR EVERY 250 HOURS OF OPERATION



1. LUBRICATE LIP SEALS (Feed, Return & Booster Pumps)

1. Clean area around lip seal lubrication fittings (A).

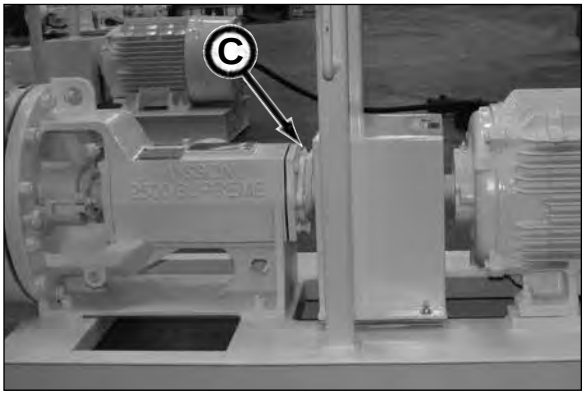
2. Lubricate lip seals with five shots of Mobilgrease® XHP222 Premium Lubricating Grease or equivalent. Lubricate monthly thereafter.



2. LUBRICATE MOTOR BEARINGS (Feed & Return Pumps Only)

1. Wipe the motor bearing lubrication fittings (B) clean. There are two lubrication fittings on each motor.

2. Lubricate motor bearings with one shot of Mobilgrease® XHP222 Premium Lubricating Grease or equivalent. Lubricate annually thereafter.



3. LUBRICATE BEARING SEALS (Feed, Return & Booster Pumps)

1. Clean area around bearing seal lubrication fittings (C).

2. Lubricate bearing seals with five shots of Mobilgrease® XHP222 Premium Lubricating Grease or equivalent. Lubricate monthly thereafter.

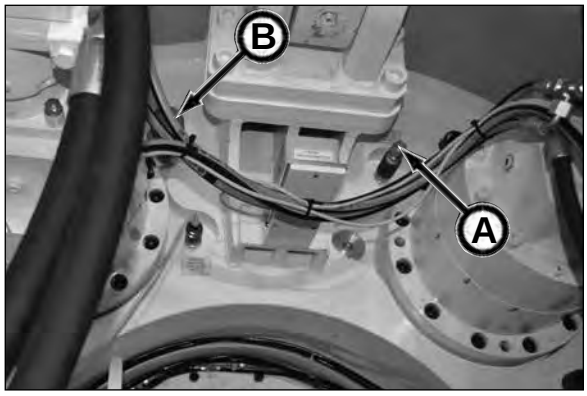
NOTICE Earlier booster pump models (not shown) were equipped with oil bearing lubrication. If your booster pump contains a dipstick on the housing, use a high quality, SAE 10W30 weight motor oil. Oil should be changed every 1000 hours. Do not overfill.

FIRST 250 HOURS OF OPERATION & EVERY 500 HOURS THEREAFTER

4. DRAIN & FILL BEARING CAVITY

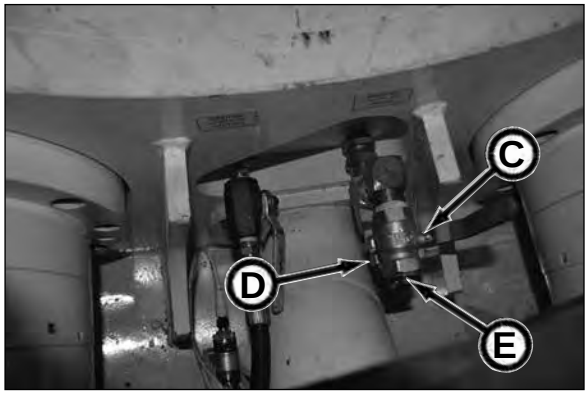
The bearing cavity maintenance consists of:

- draining bearing cavity
- check and clean suction screen
- inspect bearing cavity magnetic rod for fragments
- clean bearing cavity vent
- fill bearing cavity with new, fresh oil.



1. Clean area around bearing cavity oil check/fill port (A) and bearing cavity oil vent (B) to prevent dirt/debris from accidently entering bearing cavity.

2. Remove check/fill plug and retain for later reinstallation.

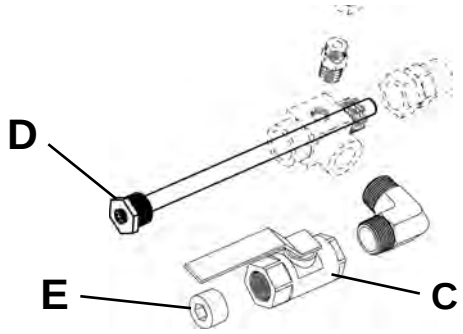


3. Clean area around bearing oil drain shutoff valve (C) and magnetic rod/plug (D).

4. Remove drain plug (E) and install a hose to shutoff valve. Route hose to a properly sized container for draining the oil from the bearing cavity.

5. Open bearing oil drain shutoff valve and drain oil into container until bearing cavity is drained.

NOTICE If possible, carefully rotate TBM to drain additional oil from bearing cavity.



6. Remove magnetic rod/plug (D). Inspect rod for metal fragments. If fragments appear to be excessive, contact your Akkerman Aftermarket Support representative for information on how to resolve this issue.

7. Clean rod and replace magnetic rod valve plug.

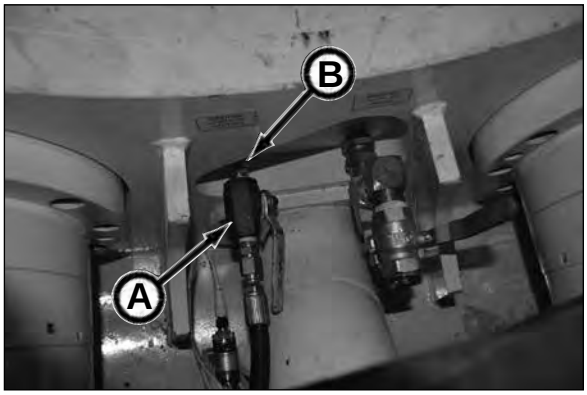
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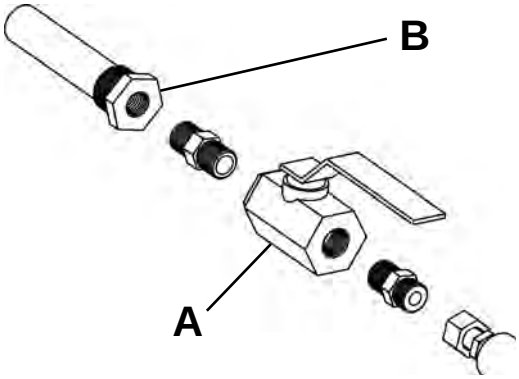
8. Clean area around bearing cavity oil shutoff valve (A) and suction strainer (B). Close valve.

9. Remove suction strainer/shutoff valve and clean strainer.

10. Replace suction strainer.

11. Open bearing cavity oil shutoff valve.



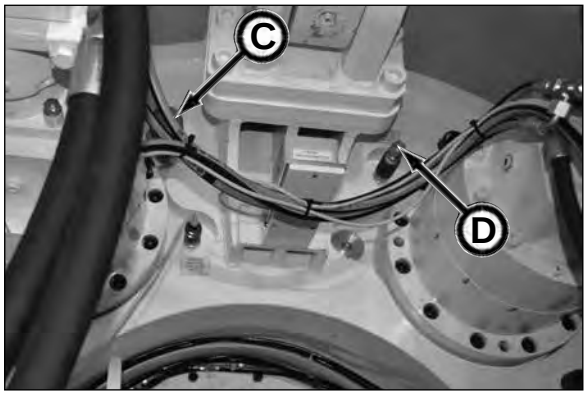


12. Check bearing cavity vent (C) for dirt or debris build-up. Clean vent or replace if it shows signs of wear or damage.

13. Fill the bearing cavity with Mobilgear® 600XP 460 gear oil or equivalent through check/fill port (D) until the oil is level with the bottom of the check/ fill port.

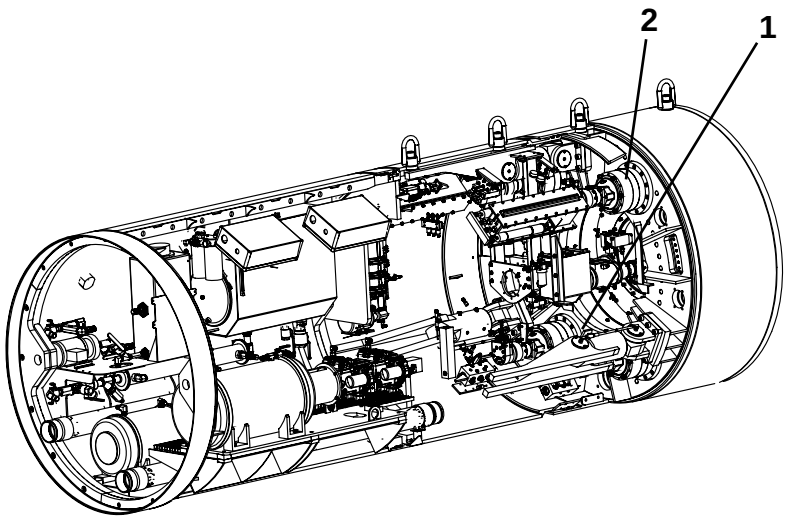
    Bearing Cavity Oil Capacity (Approximately)
    ..... 23 US gal (87 L)

14. Replace check/fill port plug.



MAINTENANCE CHART - MICROTUNNELING SYSTEM

NOTICE Use the item number in the chart to refer to the detailed maintenance procedures in the following pages.



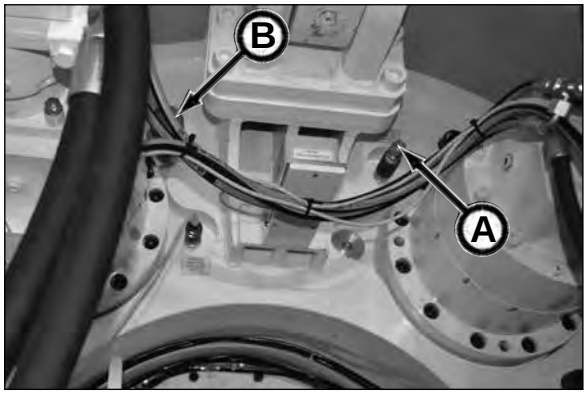
EVERY 500 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Bearing Cavity	Drain & Fill	Capacity 23 gal. (87 L)	Mobil 600XP 460
2.	Gear Box	Drain & Fill	Capacity 3.3 qt. (3.13 L)	Mobil 600XP 460

1. DRAIN & FILL BEARING CAVITY

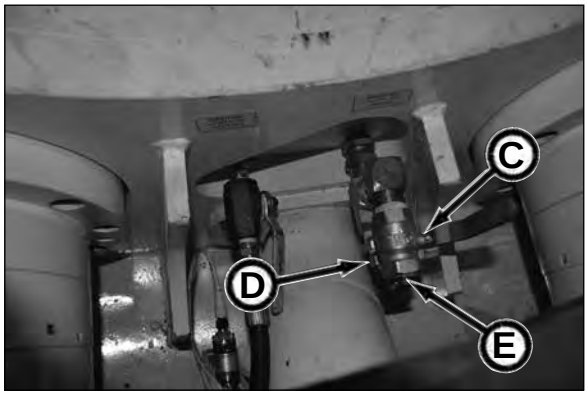
The bearing cavity maintenance consists of:

- draining bearing cavity
- check and clean suction screen
- inspect bearing cavity magnetic rod for fragments
- clean bearing cavity vent
- fill bearing cavity with new, fresh oil.



1. Clean area around bearing cavity oil check/fill port (A) and bearing cavity oil vent (B) to prevent dirt/debris from accidently entering bearing cavity.

2. Remove check/fill plug and retain for later reinstallation.

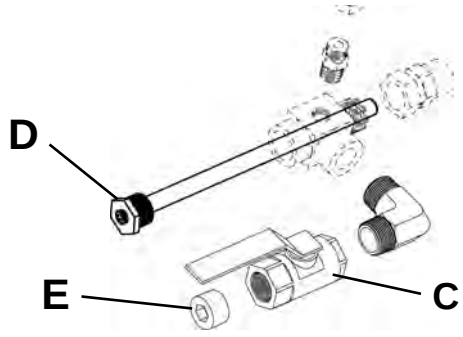


3. Clean area around bearing oil drain shutoff valve (C) and magnetic rod/plug (D).

4. Remove drain plug (E) and install a hose to shutoff valve. Route hose to a properly sized container for draining the oil from the bearing cavity.

5. Open bearing oil drain shutoff valve and drain oil into container until bearing cavity is drained.

NOTICE If possible, carefully rotate TBM to drain additional oil from bearing cavity.



6. Remove magnetic rod/plug (D). Inspect rod for metal fragments. If fragments appear to be excessive, contact your Akkerman Aftermarket Support representative for information on how to resolve this issue.

7. Clean rod and replace magnetic rod valve plug.

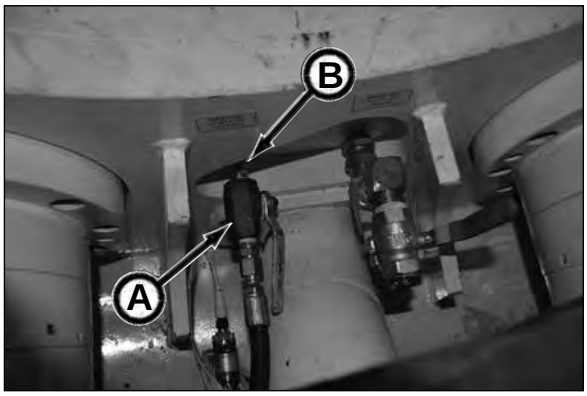
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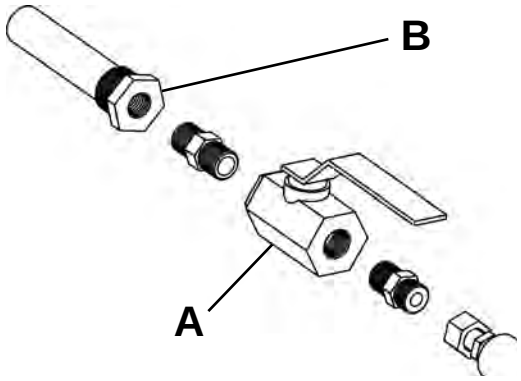
8. Clean area around bearing cavity oil shutoff valve (A) and suction strainer (B). Close valve.

9. Remove suction strainer/shutoff valve and clean strainer.

10. Replace suction strainer.

11. Open bearing cavity oil shutoff valve.



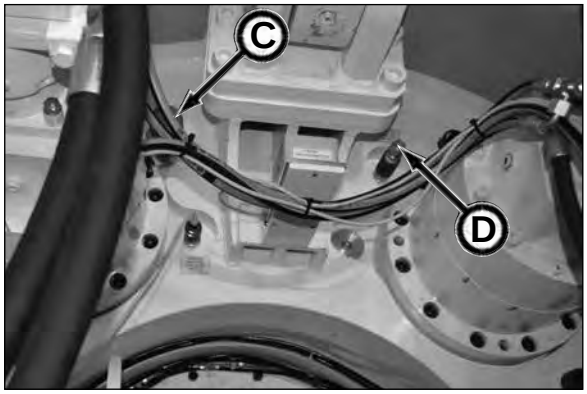


12. Check bearing cavity vent (C) for dirt or debris build-up. Clean vent or replace if it shows signs of wear or damage.

13. Fill the bearing cavity with Mobilgear® 600XP 460 gear oil or equivalent through check/fill port (D) until the oil is level with the bottom of the check/ fill port.

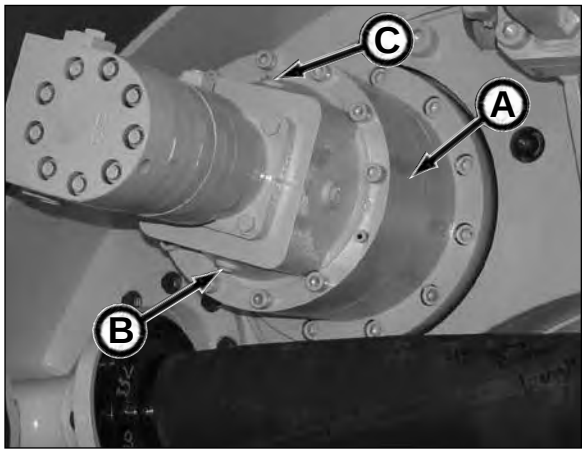
    Bearing Cavity Oil Capacity (Approximately) ..... 23 US gal (87 L)

14. Replace check/fill port plug.



2. DRAIN & FILL MAIN DRIVE PLANETARY GEAR BOX

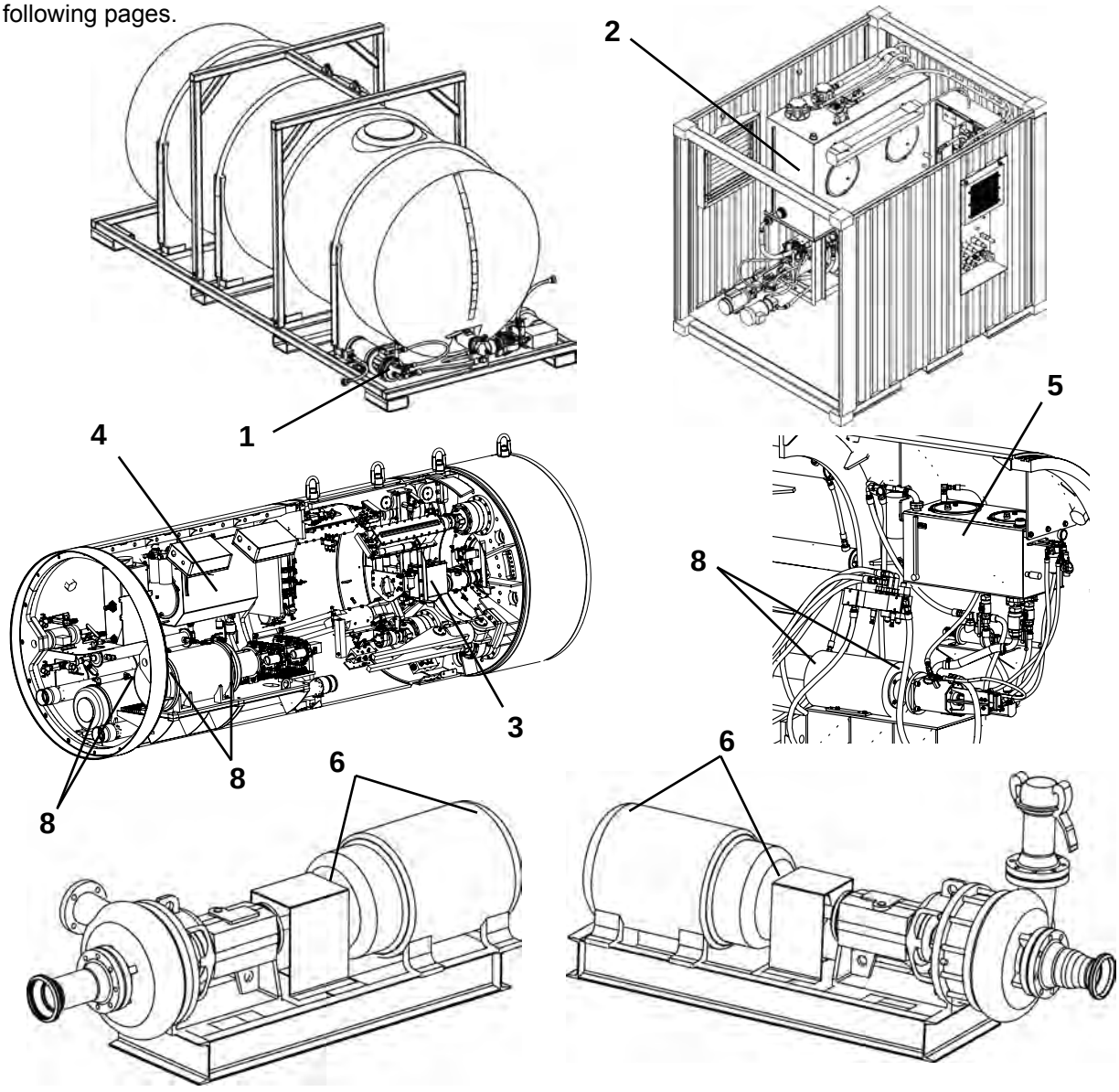
Drain and fill the main drive planetary gear box (A) as follows:



1. Be sure to the clean the area around the gear box oil drain plug (B) and fill plug (C) before removing to prevent contamination from entering gear box.
2. Remove drain plug and drain oil from gear box into a properly sized catch container..
3. Tighten drain plug.
4. Inspect the drained oil for contaminants. If excessive metal particles are found, the gear box will require maintenance.
5. Remove fill port plug.
6. Add 3.3 qt. (3.13 L) of fresh, clean Mobilgear® 600XP 460 oil or equivalent through fill port.
7. Replace fill plug.
8. Replace the oil in the other planetary gear boxes following steps 1 through 7.

MAINTENANCE CHART - MICROTUNNELING SYSTEM

NOTICE Use the item number in the chart to refer to the detailed maintenance procedures in the following pages.



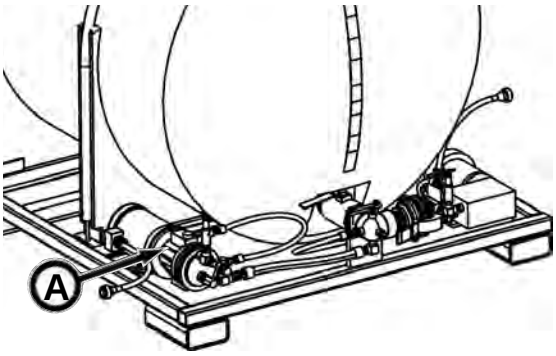
YEARLY OR EVERY 1000 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Water Cool. Pump	Drain & Fill	Large Pump - 1.1 US qt.	10W30 Motor Oil
2.	Remote Hyd. Pwr Pack Reservoir	Drain & Fill	Capacity 330 US Gal. (1,249 L)	ISO-VG-46
3.	MTBM Aux. Hyd. Reservoir	Drain & Fill	Capacity 5.5 US Gal. (21 L)	Tellus Plus Oil 32
4.	MTBM Main Drive Hyd. Reservoir	Drain & Fill	Capacity 95 US Gal. (360 L)	ISO-VG-68
5.	Lube/Jack Can Hyd. Reservoir	Drain & Fill	Capacity 30 US Gal. (114 L)	ISO-VG-46
6.	Slurry Pumps	Lubricate Motor Bearings	Refer to Slurry Pump Manuals	Mobil XHP222
*7.	Booster Pump	Drain & Fill	Refer to Booster Pump Manual	10W30 Motor Oil
8.	Elec. Motor Bearings	Lubricate	See maint. detail for lubrication.	See Maint. Detail.

* Not Shown; for earlier Booster Pump models with bearing lubrication reservoir only.

1. DRAIN & FILL COOLING PUMP OIL (IF USED)

Drain and fill cooling pump (A) of oil as follows:



1. Clean area around check/fill cap (B) and gear case oil drain plug (C).

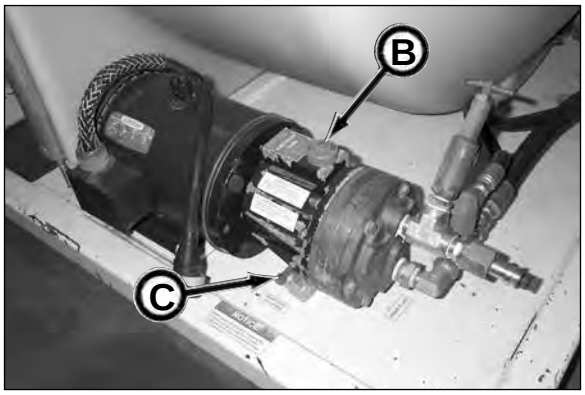
2. Loosen check/fill cap (B) for ease of draining oil. Remove gear case oil plug (C) and drain oil from gear case.

3. Replace gear case oil drain plug and remove check/fill cap.

4. Add 1.1 US quart (1.05 L) of a high quality SAE 10W-30 motor oil through check/fill port. Oil level should be:

   1/4 in. (6 mm) from top of the fill port

5. Replace check/fill cap.

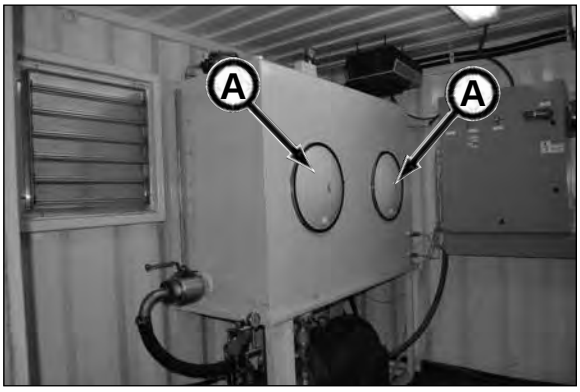


NOTICE Anytime the oil shows signs of contamination, drain oil and refill with clean oil.

2. DRAIN & FILL HYDRAULIC RESERVOIR & REPLACE FILTERS (REMOTE HYDRAULIC POWER PACK)

NOTICE If any of the following situations occur, the reservoir must be drained and refilled with flesh oil. The return filters must also be replaced:

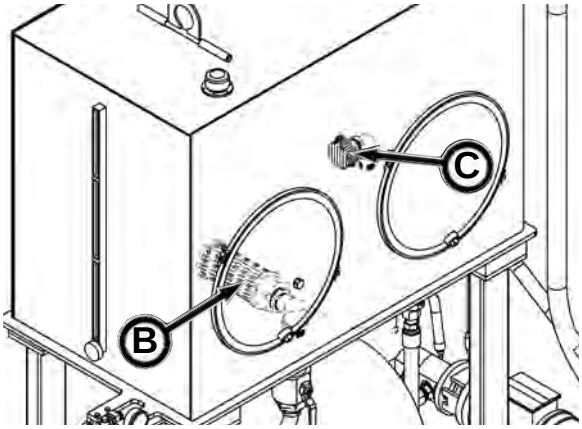
- A major component fails.
- Any sign of water contamination from an oil analysis or if oil is milky or foaming.
- A hydraulic oil sample indicates large particle contamination.



1. Clean and dry around the drain plug or hose for draining area of the reservoir.

2. Clean and dry the area around the reservoir access covers (A).

3. Drain oil into an appropriate sized catch container. Replace and secure drain plug or hose removed for draining.



4. Open the reservoir access cover(s) to gain access to the tank strainer and suction screen.

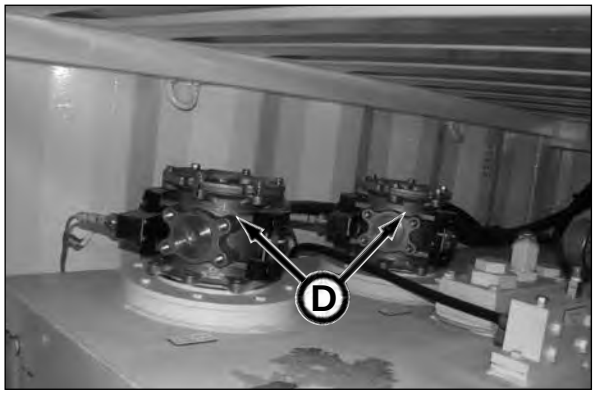
5. Clean the strainer (B) and screen (C). If damaged, replace with new.

6. Clean inside of reservoir of any contaminants.

7. Reinstall reservoir strainer and suction screen.

8. Check cover oring for cracking or damage. If cracking or damage is present, or if any leaking occurred around oring, replace with new and tighten with clamp.

9. Replace access cover(s) on reservoir and secure with cover retaining bolt.



10. Clean and dry areas around the return filters (D).

11. Remove hydraulic return filters. Be sure to check if filter gasket is stuck or damaged in filter housing. Replace gasket as needed.

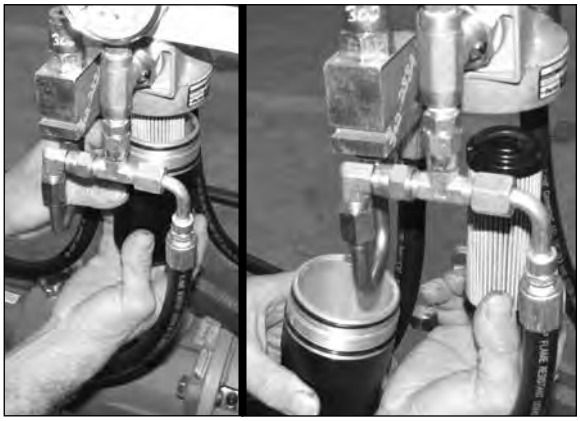
12. Install new return filters:

    Lubricate filter gasket with a light coating of clean hydraulic oil. Install new return filters in filter head assembly. Replace and secure filter covers.

(Continued on next page)

13. Clean area around the pilot pressure filter.

14. Remove lower filter housing and remove filter.



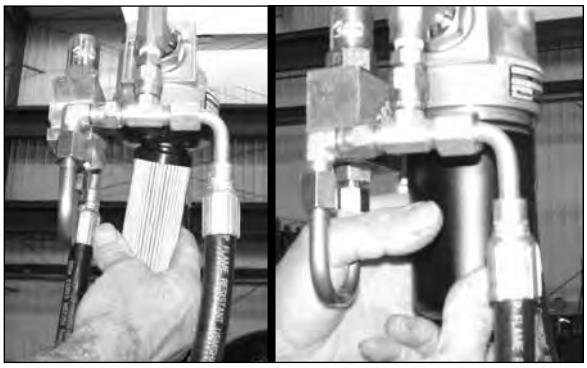
15. Lubricate housing orings with a light coating of clean hydraulic oil.

16. Lubricate filter inner oring with a light coating of clean hydraulic oil.



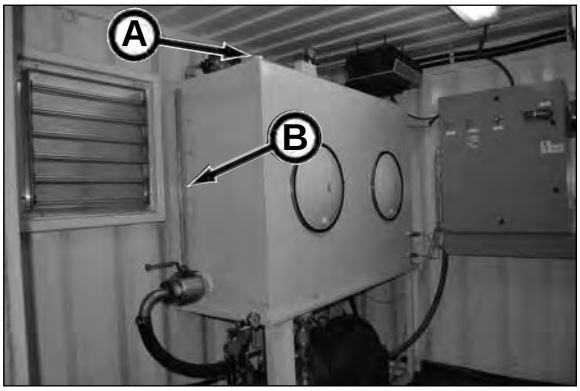
17. Carefully insert new filter into upper filter housing.

18. Securely fasten lower housing into upper filter housing.



19. Clean area around fill cap (A).

20. Remove fill cap and fill reservoir with fresh, clean ISO-VG-46 20W Premium Hydraulic/ Turbine Oil until oil is at full mark on sight gauge (B). Do not overfill.



Oil capacity is approximately 330 US gal. (1,249 L)

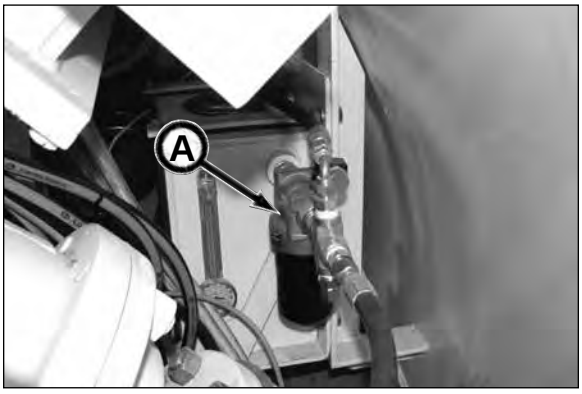
NOTICE If you change to a different oil, use a reputable oil supplier to meet or exceed the ISO-VG-46 20W or API GL-1/GL-2 oil specification. Do not mix oil manufacturers or grades.

21. Replace fill cap and check for leaks.

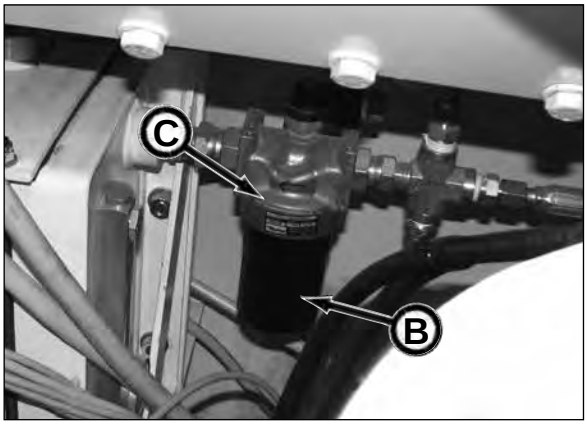
3. DRAIN & FILL MTBM AUXILIARY HYDRAULIC POWER PACK OIL RESERVOIR & FILTER

NOTICE If any of the following situations occur, the reservoir must be drained and refilled with flesh oil. The return filter must also be replaced:

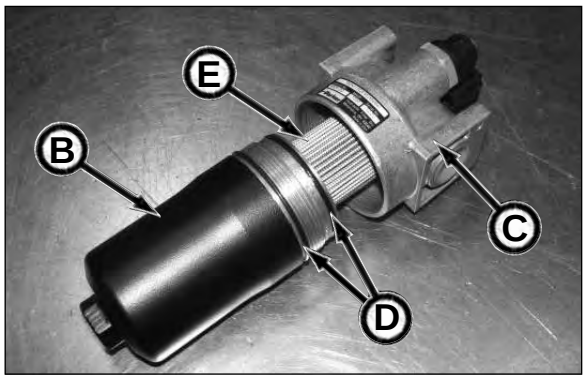
- A valve, torque wing component fails.
- Any sign of water contamination from an oil analysis or if oil is milky or foaming.
- A hydraulic oil sample indicates large particle contamination.



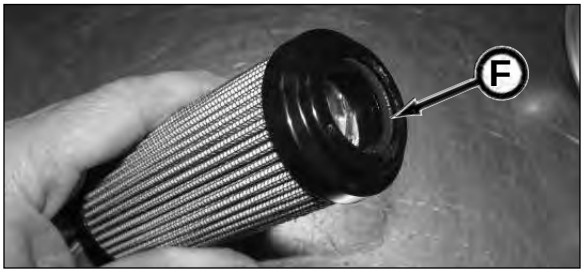
1. Clean and dry area around the power pack oil reservoir suction hose (underneath reservoir).
2. With an appropriate sized catch container, remove suction hose from reservoir and drain oil into container.



3. Replace suction hose.
4. Clean and dry area around filter assembly (A).
5. Remove housing (B) from filter head (C). Inspect housing for damage. If damaged, replace with new.
6. Inspect orings (D) on filter housing. If orings are worn or damaged, replace with new.
7. Remove filter (E) from filter head. Dispose of oil and filter properly.



8. Lubricate new filter oring (F) with a light coating of clean hydraulic oil.
9. Carefully insert new, lubricated filter into filter housing.



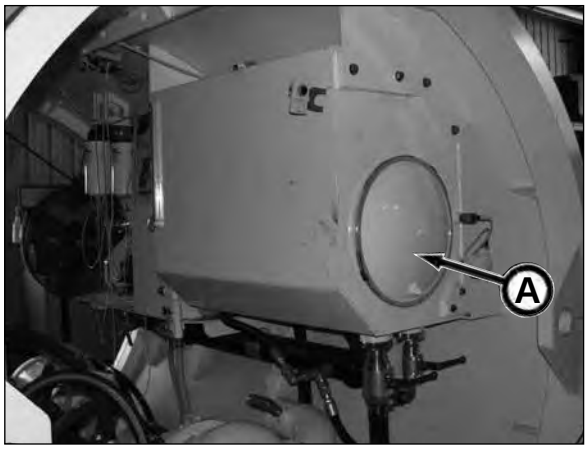
10. Lubricate housing orings with a light coating of clean hydraulic oil. Be sure orings are not twisted and that they are properly seated into housing grooves.
11. Securely fasten housing to filter head.
12. Clean and dry area around fill cap (G), remove fill cap and fill until tank is at full mark on sight gauge (H) with Tellus® Plus Oil 32 or equivalent. Replace oil cap.

    Oil capacity is approximately 5.5 US gal. (21 L).



13. Check for leaks.

4. DRAIN & FILL MTBM MAIN DRIVE HYDRAULIC RESERVOIR, FILTER & STRAINERS



NOTICE If any of the following situations occur, the reservoir must be drained and refilled with flesh oil. The return filters must also be replaced:

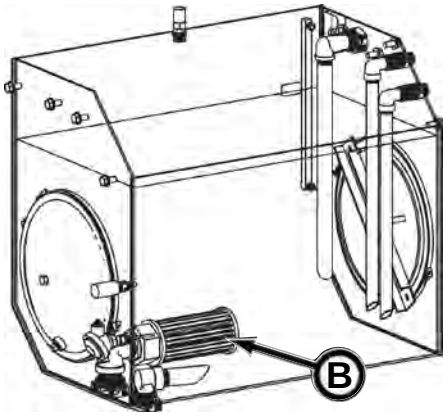
- A major component fails.
- Any sign of water contamination from an oil analysis or if oil is milky or foaming.
- A hydraulic oil sample indicates large particle contamination.

1. Clean and dry the area around the drain plug of the reservoir.

2. Clean and dry the area around the reservoir access covers (A).

3. Drain oil into an appropriate sized catch container. Replace and secure drain plug.

4. Open the reservoir access cover(s) to gain access to the tank strainer.



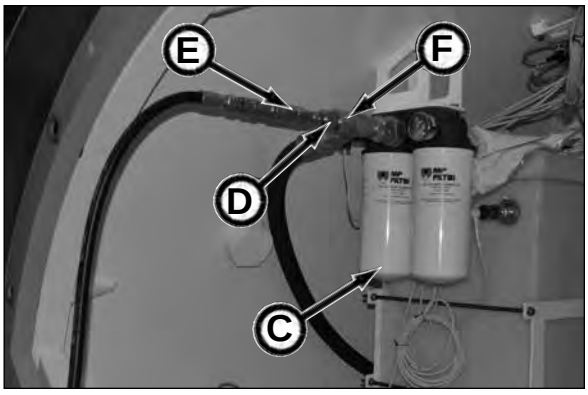
5. Clean the strainer (B). If damaged, replace with new.

6. Clean inside of reservoir of any contaminants.

7. Reinstall reservoir strainer.

8. Check cover oring for cracking or damage. If cracking or damage is present, or if any leaking occurred around oring, replace with new and tighten with clamp.

9. Replace access cover(s) on reservoir and secure with cover retaining bolt.



10. Clean and dry areas around the return filters (C).

11. Remove hydraulic return filters. Be sure to check if filter gasket is stuck or damaged in filter housing. Replace gasket as needed. Dispose of oil and filters properly.

12. Install new return filters:

    Fill new filters with clean hydraulic oil. Lubricate filter gasket with a light coating of clean hydraulic oil. Install new return filters in filter head assembly. Replace and secure filter covers.

13. Clean and dry area around hose cap (D), remove hose cap, connect external oil fill pump hose (E) to fitting (F) to fill the hydraulic reservoir with clean hydraulic oil. Fill until tank is at full mark with ISO-VG-68 premium hydraulic oil or equivalent. Remove hose and replace oil cap.

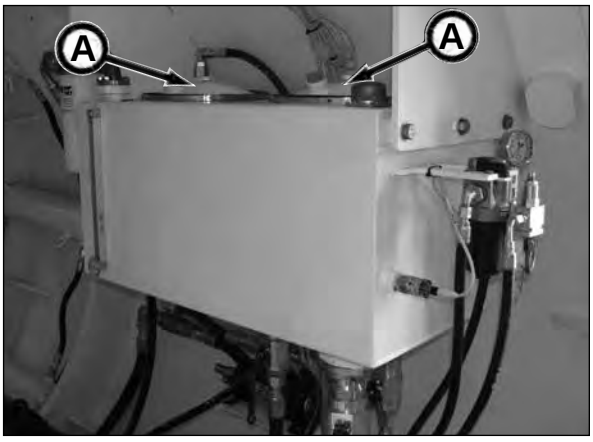
    Oil capacity is 95 US gal. (360 L).

14. Check for leaks.

5. DRAIN & FILL MTBM LUBE/JACK CAN HYDRAULIC RESERVOIR, FILTERS & STRAINERS

NOTICE If any of the following situations occur, the reservoir must be drained and refilled with flesh oil. The return filters must also be replaced:

- A major component fails.
- Any sign of water contamination from an oil analysis or if oil is milky or foaming.
- A hydraulic oil sample indicates large particle contamination.

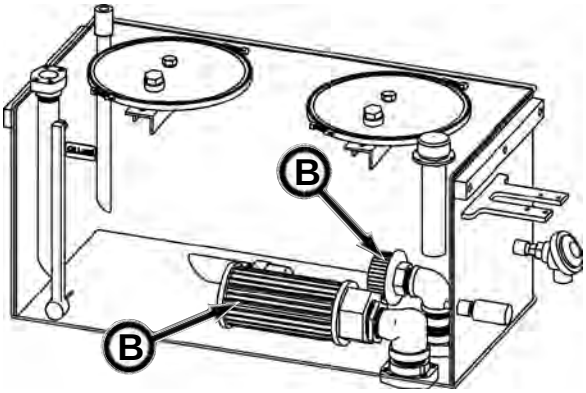


1. Clean and dry the area around the drain plug of the reservoir.

2. Clean and dry the area around the reservoir access covers (A).

3. Drain oil into an appropriate sized catch container. Replace and secure drain plug.

4. Open the reservoir access cover(s) to gain access to the tank strainers (B).



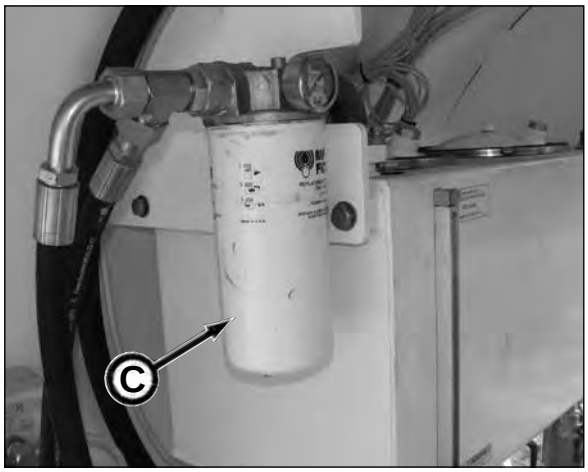
5. Clean the strainers. If damaged, replace with new.

6. Clean inside of reservoir of any contaminants.

7. Reinstall reservoir strainers.

8. Check cover oring for cracking or damage. If cracking or damage is present, or if any leaking occurred around oring, replace with new and tighten with clamp.

9. Replace access cover(s) on reservoir and secure with cover retaining bolt.



10. Clean and dry area around the return filter (C).

11. Remove hydraulic return filter. Be sure to check if filter gasket is stuck or damaged in filter housing. Replace gasket as needed. Dispose of oil and filters properly.

12. Install new return filter:

    Fill new filter with clean hydraulic oil. Lubricate filter gasket with a light coating of clean hydraulic oil. Install new return filter in filter head assembly. Replace and secure filter covers.

(Continued on next page)

13. Remove lower filter housing (A) on pilot pressure filter assembly. Inspect housing and housing orings for damage. If damaged, replace with new.

14. Remove filter (B).

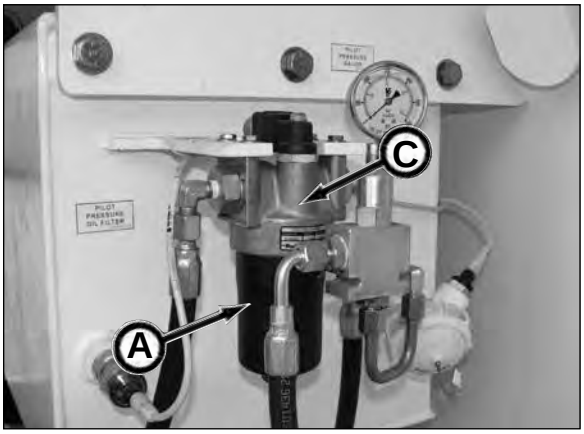
15. Lubricate housing orings with a light coating of clean hydraulic oil.

16. Lubricate filter inner oring with a light coating of clean hydraulic oil.

17. Carefully insert new filter into upper filter housing (C).

18. Securely fasten lower housing into upper filter housing.

19. Dispose of oil and filters properly. Recycle where available.

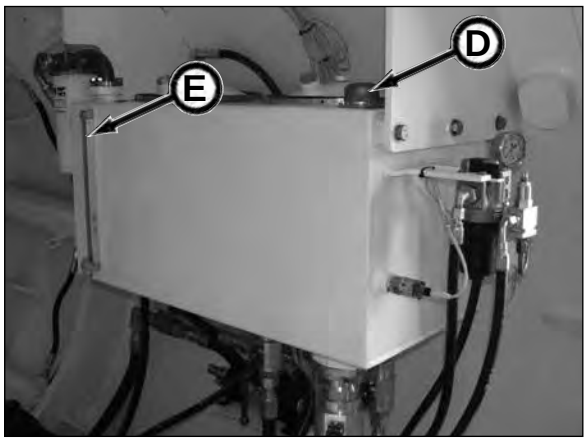




19. Clean and dry area around fill cap (D). Remove fill cap and fill until tank is at full mark (E) with ISO-VG-46 or equivalent

    Oil capacity is 30 US gal. (114 L).

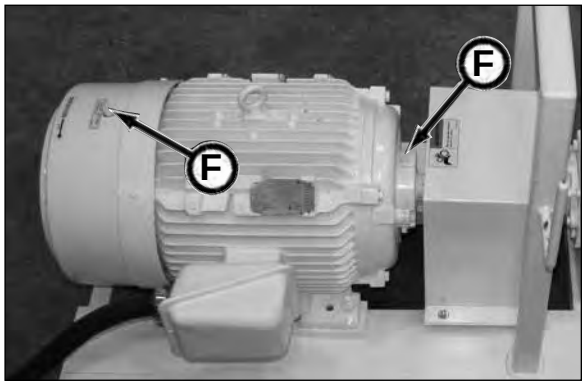
20. Check for leaks.



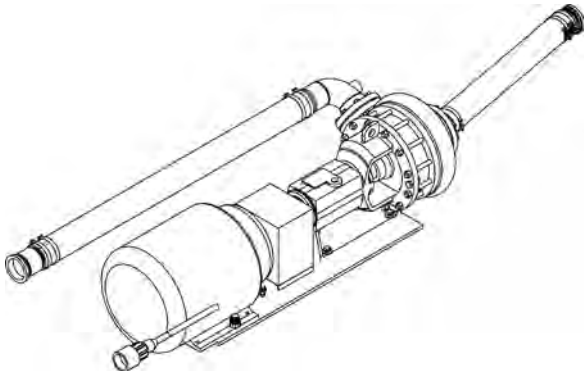
6. LUBRICATE MOTOR BEARINGS (Feed & Return Pumps Only)

1. Wipe the motor bearing lubrication fittings (F) clean. There are two lubrication fittings on each motor.

2. Lubricate motor bearings with one shot of Mobilgrease® XHP222 Premium Lubricating Grease or equivalent. Lubricate annually thereafter.



7. DRAIN & REPLACE BEARING LUBRICATION RESERVOIR OIL (Earlier Booster Pumps Only)



Earlier booster pump models were equipped with an oil bearing lubrication reservoir. If your booster pump contains a dipstick on the housing, use a high quality, SAE10W30 weight motor oil. Oil should be changed every 1000 hours. Do not overfill. Refer to your Booster Pump manual for more information.

8. LUBRICATE MOTOR BEARINGS

- **MTBM Main Hydraulic Motor**
- **MTBM Booster Pump Motor**
- **Lube/Jacking Can Main Hydraulic Motor**

MTBM Main Hydraulic Motor & Booster Pump Motor Bearings

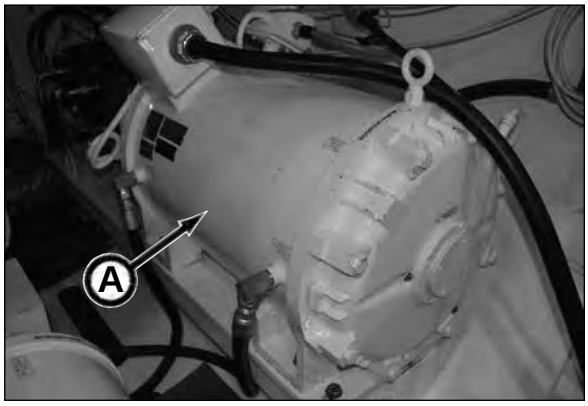
The 400 HP main drive motor (A) and booster pump motor (B) electric motor bearings are packed with Shell GadusRail® S2. Be sure to always verify the grease type listed on the nameplate prior to greasing motors.

The motors require regreasing if the motor has been idle for 6 months, otherwise lubricate the bearings on an annual basis. Refer to section 9, Periodic Maintenance for more information.

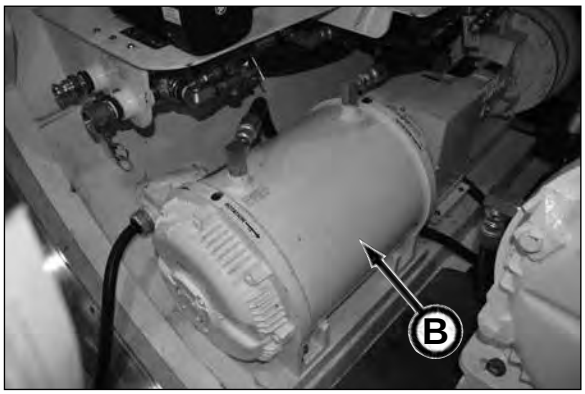
IMPORTANT: NEVER mix different grease types without contacting the motor manufacturer for recommendations prior to changing to a different grease.

Use Shell GadusRail® S2 or equivalent when lubricating the motor bearings.

The following is a list of greases that may be used to lubricate the motor bearings. Not all of the listed grease types are compatible. **DO NOT** mix different grease types without prior approval from the motor manufacturer.



MTBM Main Drive Motor



MTBM Booster Pump Motor

Grease Temp Operating Range F° (C°)	Brand Name
-22 to 350.6 (-30 to 177)	Chevron® SRI-2
-22 to 275 (-30 to 135	Shell GadusRail® S2
-22 to 302 (-30 to 150)	Moly Polyrex® EM
-4 to 599 (-18 to 315)	Davley Darmex® RPL-707
65.2 to 248 (-54 to 120)	Esso Beacon® 325
-0.4 to 550.4 (-18 to 288)	Molykote® 41
-40 to 399.2 (-40 to 399.2)	Molykote® 44

(Continued on next page)

MTBM Main Hydraulic Motor & Booster Pump Motor Bearings

Lubricate the electric motor bearings as follows:

A. Motor Bearing Equipped with Grease Fitting & Grease Relief Valve

1. Clean grease fitting (A) and area around grease relief valve (B).

2. Add grease (specified earlier) to the grease fitting while the motor is running until excess grease is expelled from the grease relief valve.

IMPORTANT: When greasing bearings with a grease relief valve, the bearing temperature will temporarily rise. Allow a minimum of 12 hours for the temperature to stabilize within the thermal specification.

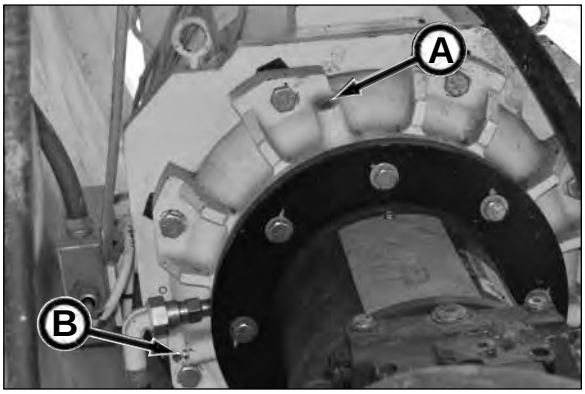
B. Motor Bearing Equipped with Grease Fitting & Plug

1. Clean grease fitting (C) and area around housing port plug (D).

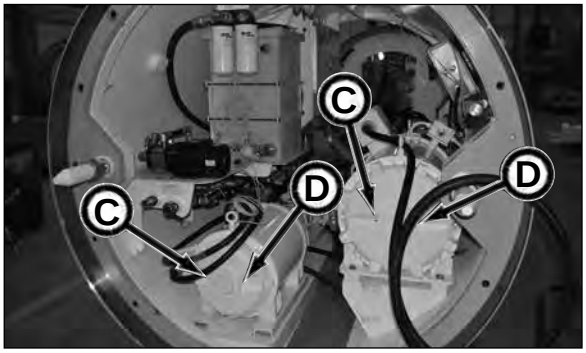
2. Remove plug.

3. Add grease (specified earlier) to the grease fitting while the motor is running until excess grease is expelled from the housing port.

4. Replace plug.



MTBM Main Hydraulic Motor



MTBM Main Hydraulic Motor & Booster Pump Motor



MTBM Booster Pump Motor

Lube/Jacking Can Main Hydraulic Motor Bearings

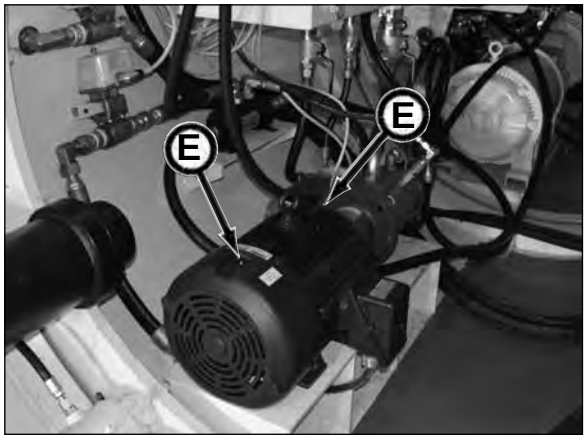
When adding lubricant, keep dirt out of the lubrication area. Wipe the fitting completely clean and use clean greasing equipment.

Lubricate the electric motor bearings (E) (2 places) with two shots of Mobil Polyrex® EM grease or equivalent (refer to Grease Type below).

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.

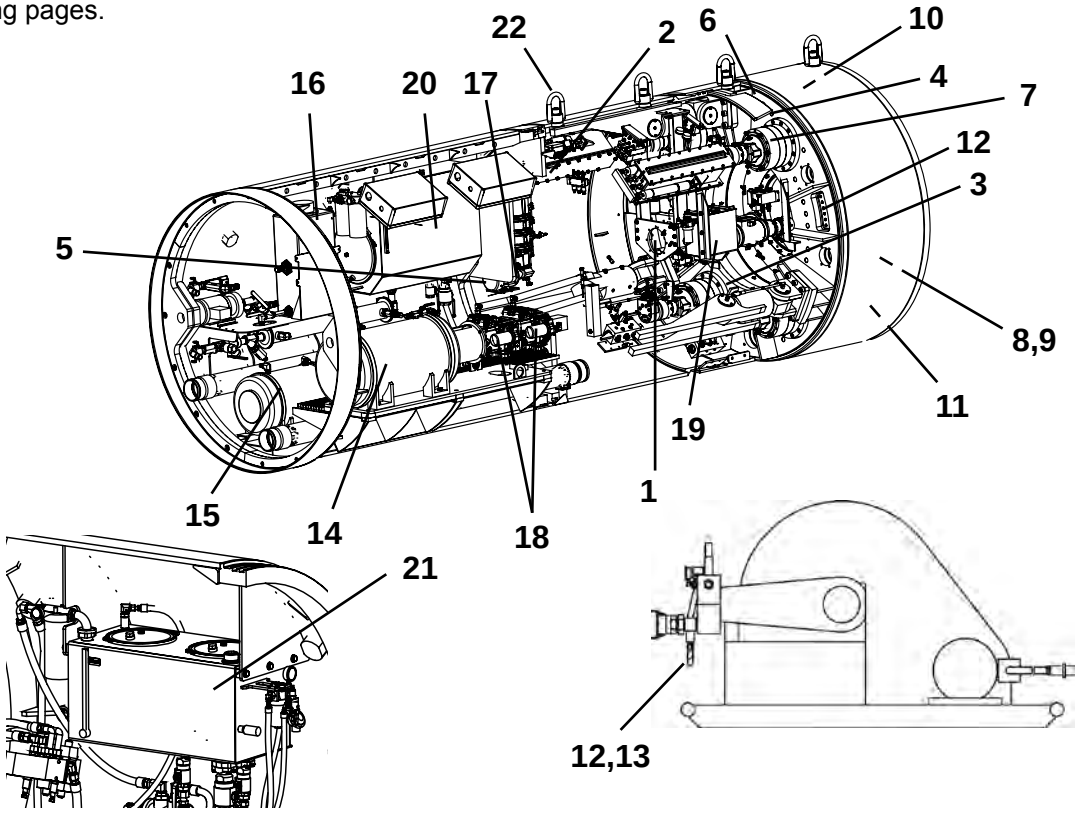
Nameplate Ambient Temperature below -22°F (-30°C): Special low temperature grease is recommended such as Aeroshell 7 or Beacon 325 for ball bearings and Mobil SHC 100 for roller bearings.



Lube/Jacking Can Main Hydraulic Motor

MAINTENANCE CHART - MICROTUNNELING SYSTEM

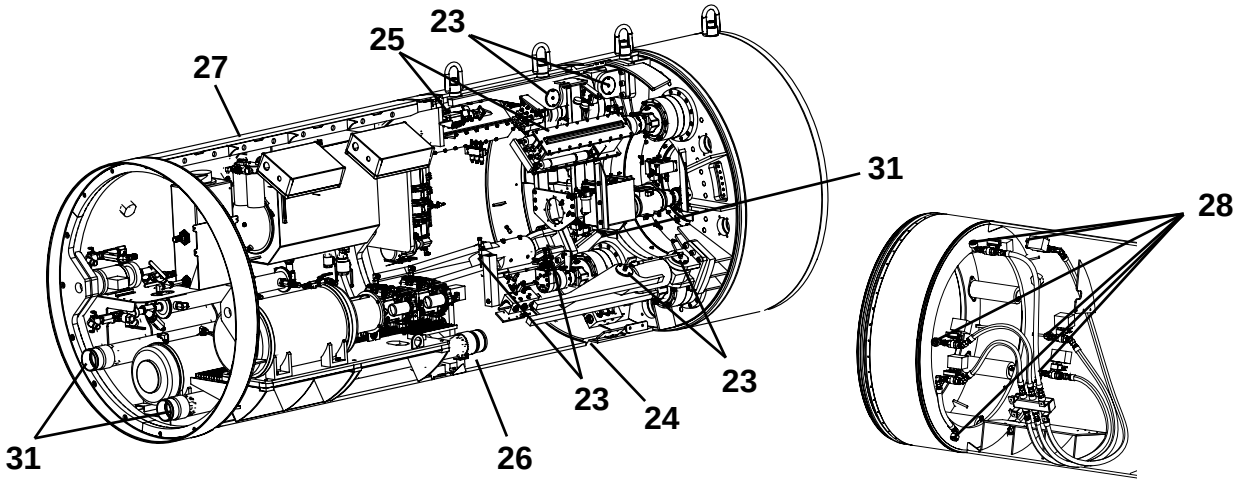
NOTICE Use the item number in the chart to refer to the detailed maintenance procedures in the following pages.

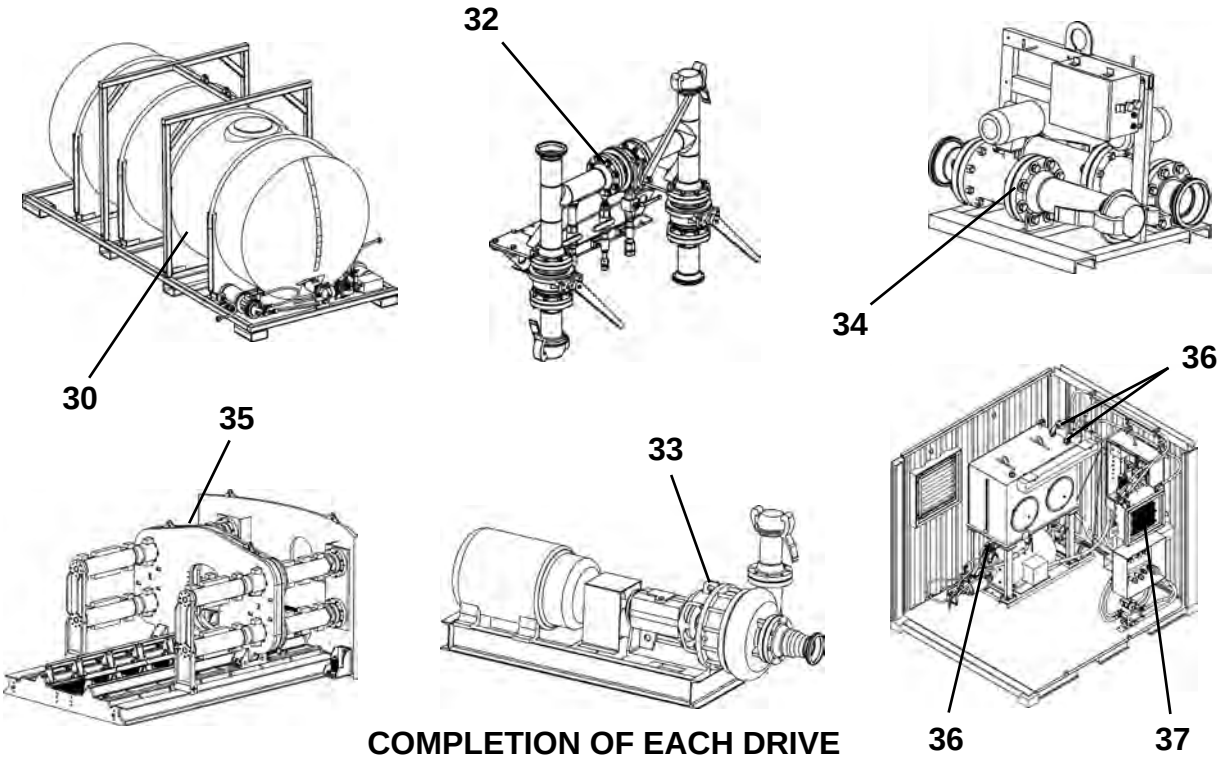


COMPLETION OF EACH DRIVE

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Target & Laser	Remove from MTBM	Clean and keep in storage box.	
2.	Gas Detector	Remove from MTBM	Clean and place in storage box.	
3.	Bearing Cavity	Inspect Oil Quality	If contamination is present, drain and fill with new oil.	
4.	Bearing Cavity	Check Lubricant Level	Lube must be at check port.	Mobil 600XP 460
5.	Bearing Lube Filter	Check FIlter	Replace as needed.	
6.	Bearing Cavity Vent	Check		
7.	Gear Boxes	Inspect Oil Quality	If contamination is present, drain oil,	Mobil 600XP 460
8.	Lip Seals/Wear Ring	Inspect Condition	If damaged, replace with new.	
9.	Lip Seals	Greasing	Grease must pass through seals.	
10.	Slurry Cut Nozzles	Inspect & Flush	Flush. Repair or replace as needed.	
11.	Slurry Chamber Noz.	Inspect & Flush	Flush. Repair or replace as needed.	
12.	HP Jetting System	Inspect, Flush, Clean	Inspect, flush and clean.	
13.	Jetting Pump Comp.	Flush & Drain	Flush and drain water.	
14.	Drive Motor	Flush Water Jacket	Flush water jacket & add antifreeze.	RV Antifreeze
15.	Booster Pump Motor	Flush Water Jacket	Flush water jacket & add antifreeze.	RV Antifreeze
16.	Water Cooling Syst.	Flush/Drain/Clean Strainer Drain Heat Exchanger	Flush, drain water & clean strainer.	RV Antifreeze
17.	Grease Pump Filter	Check Filter	Replace.	
18.	Hydrostatic Pump	Check Filters	Replace as needed.	
19.	Aux. Hyd Pwr Pack	Check Rsvr. Oil/Filter	Oil Capacity 5.5 gal.	Tellus Plus Oil 32
20.	Main Hyd Pwr Pack	Check Rsvr. Oil/Filter	Oil Capacity 95 gal.	ISO-VG-68
21.	Lube/Jack Can Rsvr.	Check Rsvr. Oil/Filter	Oil Capacity 30 gal.	ISO-VG-46
22.	Lift Eyes	Inspect	Repair or replace.	

(continued on next page)





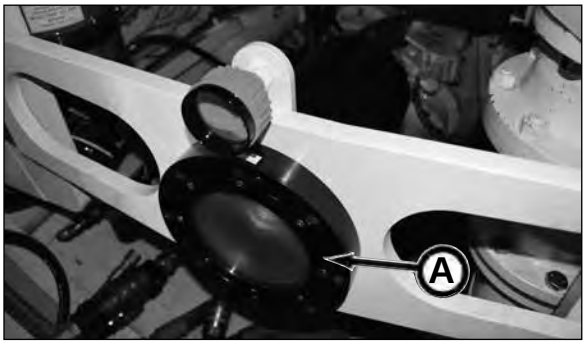
COMPLETION OF EACH DRIVE

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
23.	Steering Cyl. Pins	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
24.	Steering Joint Seals	Inspect & Lubricate	See detail for lubrication.	SHC101 EAL
25.	Dirt Wing Cavity	Lubricate	Lubricate until grease is forced out.	SHC101 EAL
26.	Submersible Pump	Clean & Flush	Clean and flush.	
27.	Structure	Inspect For Cracks/Wear	Repair before operation.	
28.	Bentonite System	Inspect & Flush	Inspect and flush.	
*29.	Hoses & Cables	Inspect	Repair or replace.	
30.	Water Cooling Tank	Flush & Drain	Flush and drain water.	
31.	Slurry Valves/Hose	Flush & Drain	Flush, clean and drain.	
32.	Slurry Pit Valve Assy.	Flush & Clean	Flush, clean and drain.	
33.	Slurry Pumps/Hose	Flush, Clean & Inspect	Flush, clean and drain.	
34.	Flowmeter	Clean	Clean	
35.	Jacking Frame	Clean, Inspect & Lubricate	Lubricate per service detail.	
36.	Remote Pwr Pk Rsvr.	Check Rsvr. Oil/Filter	Oil Capacity 195 gal.	ISO-VG-46
37.	Oil Cooler	Check Fan, Fins & Blades	If damaged, repair or replace.	

* Not Shown

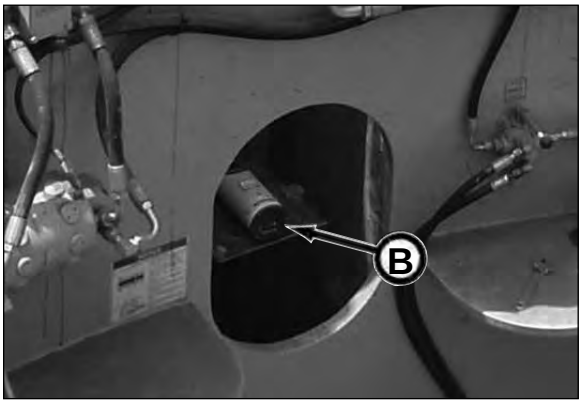
1. STORE TARGET & LASER

1. Remove target assembly (A) from MTBM. Clean target display with a mild, abrasive-free cleaning solution and scratch free cloth. Clean housing with a mild cleaning solution and place in storage box. Place box in a ventilated, preferably climate controlled area.





2. Remove laser (B) from launch shaft. Clean per manufacturer's instructions and place in storage box. Place box in a ventilated, preferably climate controlled area.



2. CLEAN & STORE GAS DETECTOR

NOTICE For more information, refer to your GasMax Instruction Manual.

Once the contractor determines the MTBM gas detector is no longer needed in the MTBM after the end of the drive:

1. Remove gas detector (C) from MTBM.



IMPORTANT: Be careful to not subject sensor to any water or cleaning solution, otherwise sensor will be damaged. Refer to gas detector manual for more maintenance information.

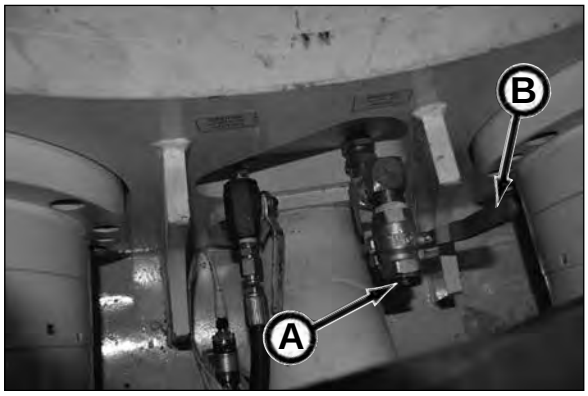
2. Clean display with a mild, abrasive-free cleaning solution and scratch free cloth.

3. Clean housing with a mild cleaning solution and place in a storage box.

4. Place box in a ventilated, preferably climate controlled area.

3. CHECK BEARING CAVITY OIL CONDITION

Check the oil condition of the bearing cavity by draining a measured sampling of the oil.

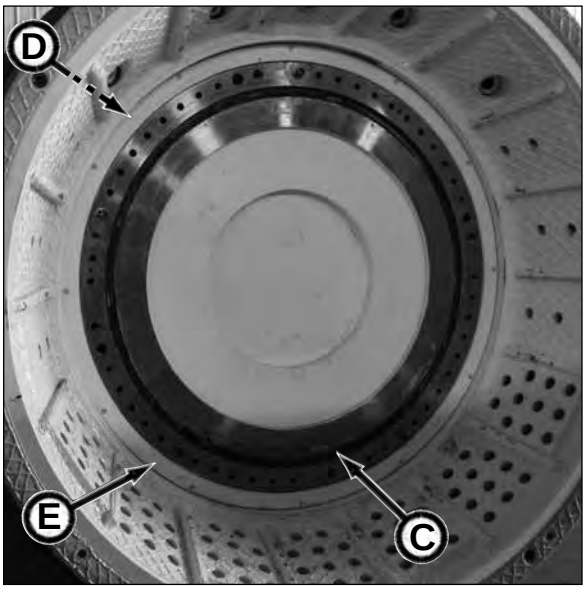


1. Be sure to the clean the area around the bearing cavity oil drain plug (A) before removing to prevent contamination from entering bearing cavity.

2. Remove drain plug and install a hose to shutoff valve. Route hose to a clean container.

3. Open shutoff valve (B) to dispense an appropriate oil sample.

4. Close bearing cavity oil drain shutoff valve.



5. Inspect the drained oil for contaminants.

   • If water and/or grease is visible in the oil, the inner lips seals (C) and outer lip seals (D) are damaged and must be replaced. See 2. Inspect Lip Seals in this section.

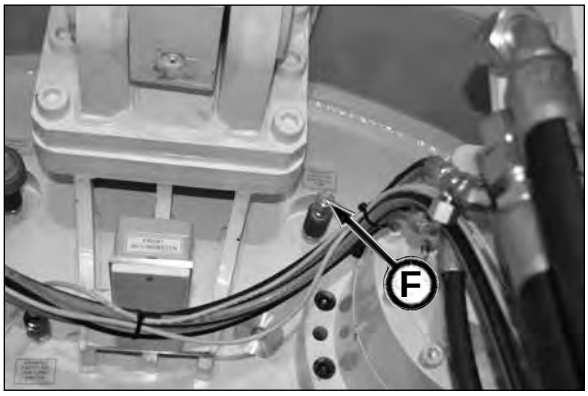
   • With any contamination, the bearing cavity must be completely drained and refilled with fresh, clean Mobilgear® 600XP 460 oil, once the lip seals are replaced.

   • Check the lip seal retaining ring (E) for damage. If ring has excessive damage, replace with new.

6. Replenish bearing cavity of the volume of oil drained when checking the condition of the oil (from step 3). Use fresh, clean Mobilgear® 600XP 460 oil. Replace fill port plug.

7. Remove hose from shutoff valve and replace drain plug.

4. CHECK BEARING CAVITY OIL LEVEL



1. Check bearing cavity oil level by removing check/fill port plug (F). If oil is not at check/fill port, add Mobilgear® 600XP 460 oil until oil level is at port hole.

2. Replace check/fill port plug.

5. CHECK BEARING CAVITY OIL FILTER

To prevent under or over servicing of the bearing cavity oil lube filter, a sensor is installed in the filter head assembly (A). If the filter becomes plugged a "***Bearing Oil Filter Plugged"*** alarm message will be displayed on the target screen.

If filter requires replacement, perform the following procedure:

1. With the power locked out, clean and dry area around filter assembly.

2. Close bearing cavity oil shutoff valve (B). This will prevent bearing cavity from draining an excessive amount of oil.

3. Remove filter housing (C) from filter head using an oil filter wrench.

4. Remove filter from housing and dispose of filter properly.

5. Remove filter o-ring if stuck in filter housing.

6. Install new o-ring with a light coat of clean oil. Check to be sure the o-ring is not twisted and that it is correctly in place.

7. Install new filter until gasket makes contact with filter head.

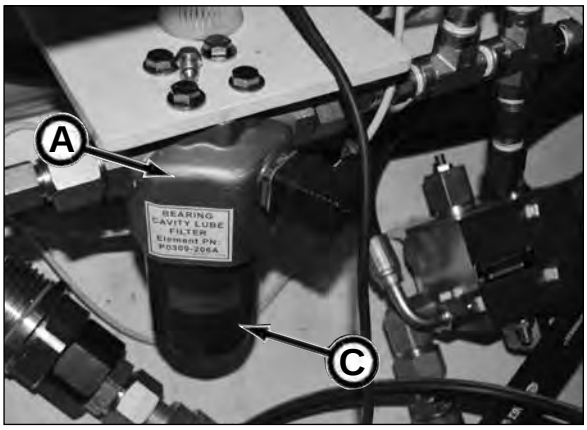
8. Replace and secure filter housing to filter head assembly using an oil filter wrench.

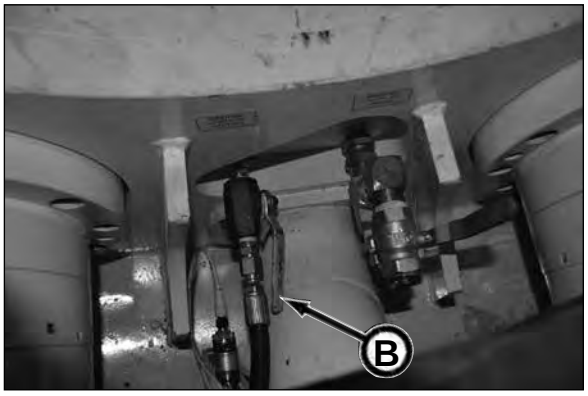
9. **Open bearing cavity oil shutoff valve (B).**

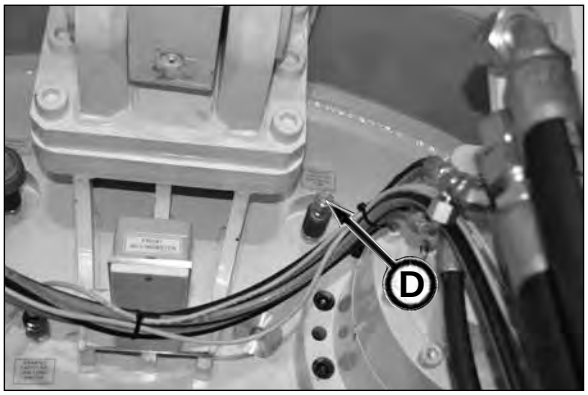
IMPORTANT: Failure to open bearing oil cavity shutoff valve before operating MTBM WILL cause bearing and bearing lube circuit component damage since the bearing oil will not be recirculating.

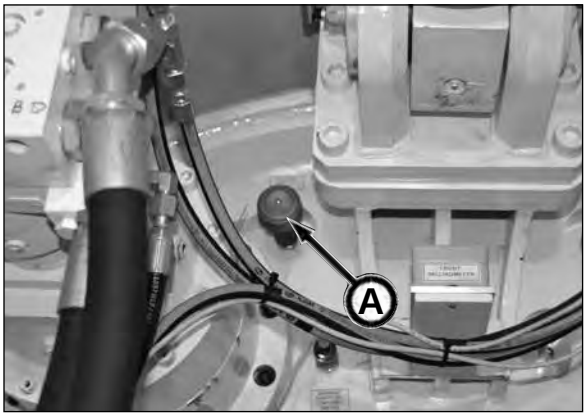
10. Check for leaks.

11. Check bearing cavity oil level. Oil must be level with the check/fill port hole (D). If not add Mobilgear® 600XP 460 until level with port hole (refer to 4. Check Bearing Cavity Oil Level in this section).





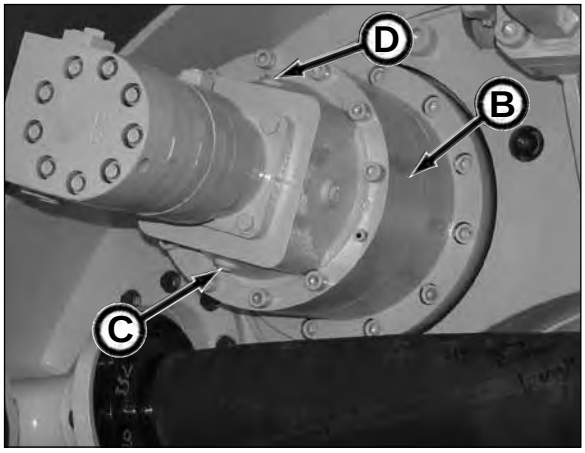




6. CHECK BEARING CAVITY VENT

Check bearing cavity vent (A) for dirt or debris build-up. Clean vent or replace if it shows signs of wear or damage.

7. CHECK MAIN DRIVE PLANETARY GEAR BOX OIL CONDITION



Check the oil condition of the main drive planetary gear box (B) by draining a measured sampling of the oil.

1. Be sure to the clean the area around the gear box oil drain plug (C) before removing to prevent contamination from entering gear box.
2. Loosen drain plug and dispense an appropriate oil sample into a clean container.
3. Tighten drain plug.
4. Inspect the drained oil for contaminants.

   • With any contamination, the planetary gear box must be completely drained and refilled with fresh, clean Mobilgear® 600XP 460 oil or equivalent.

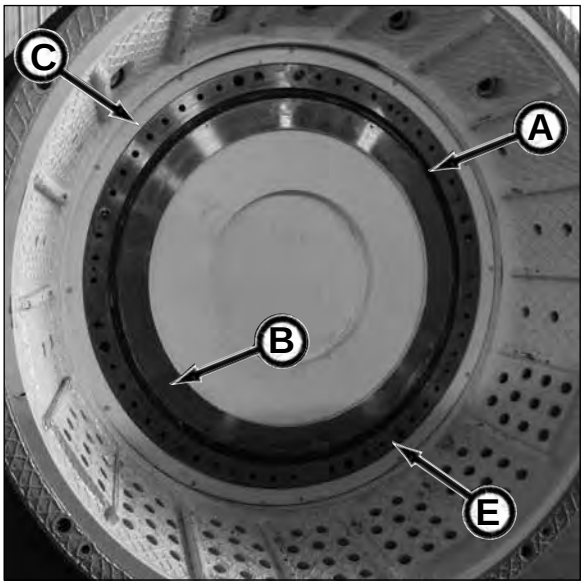
   • If excessive metal particles are found, the gear box will require maintenance. Contact your Akkerman Aftermarket Support representative for more information.

5. Remove fill port plug to replenish the gear box of the volume of oil drained when checking the condition of the oil (from step 2). Use fresh, clean Mobilgear® 600XP 460 oil or equivalent. Replace fill port plug.
6. Check the oil condition on the other planetary gear boxes following steps 1 through 5.

8. INSPECT LIP SEALS & WEAR RINGS

NOTICE It is recommended to replace the lip seals with <u>any</u> signs of contamination.

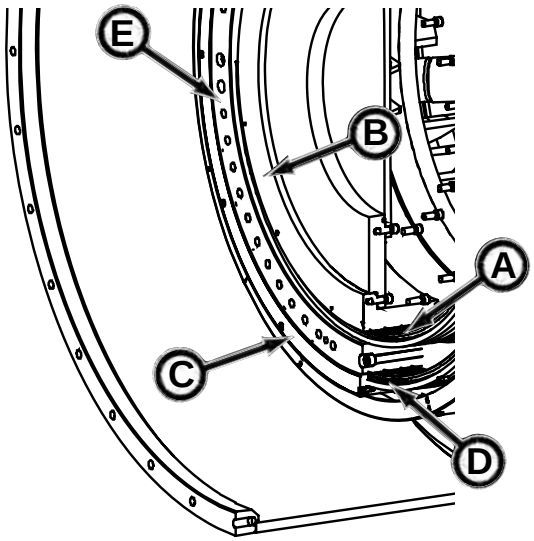
NOTICE Precise lip seal replacement is critical to prevent contamination from entering the bearing cavity. The lip seal replacement MUST be performed by an experienced technician. Contact your Akkerman Aftermarket Support representative for lip seal replacement.



1. With cutterhead removed, inspect inner lip seals (A) for wear, cracking or other damage. If seals show signs of damage, the lip seals MUST be replaced.

2. Inspect inner wear ring (B) for excessive wear, grooves or damage. If wear or damage is present, the wear ring must be replaced with new.

3. Remove outer lip seal retaining ring (C). Inspect ring for excessive wear or damage. If wear or damage is present, the ring must be replaced with new.



4. Inspect outer lip seals (D) for wear, cracking and other damage. If seals show signs of damage, the lip seals MUST be replaced. Replace lip seals if necessary.

5. Inspect outer wear ring (E) for excessive wear or damage. If wear (grooves) or damage is present, the wear ring must be replaced with new.

6. Replace outer lip seal retaining ring with twelve 3/8 UNC x .75 socket head cap screws and tighten to 36 ft-lb (49 N·m) torque.

9. CHECK LIP SEAL GREASING

The bearing cavity lip seals must be lubricated to prevent contamination (dirt) from entering bearing cavity. Excess grease is removed at the front face through twelve grease ports on the inner lip seals and twelve grease ports on the outer lips seals. Check for proper lip seal greasing as follows:

1. With the cutterhead removed and grease in the grease pumps, manually start grease pump 1 by clicking Grease System Pump #1 Start button (A).

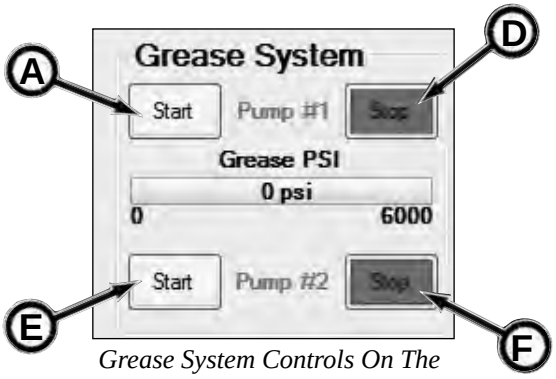
2. Check that grease is visible on the front face areas of the cutterhead. Grease must be visible at the inner lip seal area (B) AND the outer lip seal area (C). This will assure that the grease path is open to properly lubricate the lip seals. If grease is not visible in both areas, the problem must be resolved before mining with MTBM.

3. Click Grease System Pump #1 Stop button (D).

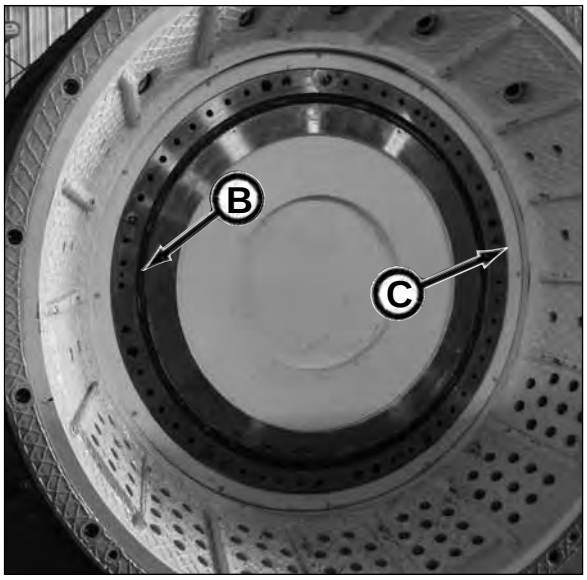
4. Click Grease System Pump #2 Start button (G).

5. Check that grease is visible on the front face areas of the cutterhead. Grease must be visible at the inner lip seal area (B) AND the outer lip seal area (C). This will assure that the grease path is open to properly lubricate the lip seals. If grease is not visible in both areas, the problem must be resolved before mining with MTBM.

6. Click Grease System Pump #2 Stop button (F).



Grease System Controls On The MTBM Control Screen



NOTICE If oil is visible with the flushed grease on the front face of the cutterhead, the lip seals have failed. In this case, the bearing cavity must be flushed, the lip seals must be replaced, and the bearing cavity filled with fresh, clean Mobilgear® 600XP 460 gear oil.

NOTICE It is recommended to replace the lip seals with any signs of contamination.

10. INSPECT & FLUSH SLURRY CUTTING NOZZLES

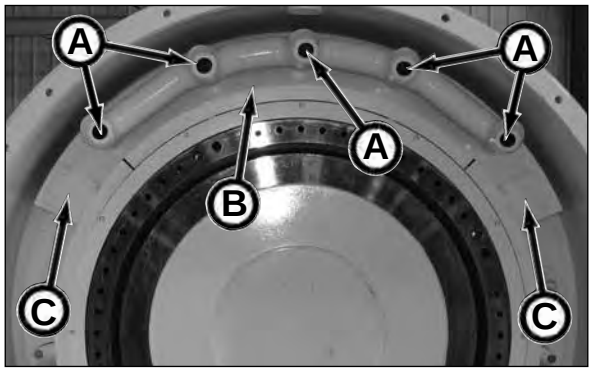
1. Remove cutterhead and crushing cone.

2. Inspect slurry cutting nozzles (A) for damage, wear or plugging.

3. If nozzles are damaged or worn, repair or replace as needed.

4. Flush nozzles as follows:
   a. Remove cutting nozzle manifold (B) cleanout covers (C).
   b. Flush the nozzles and the manifold using a garden hose or pressure washer (output maximum of 100 psi). The water will drain out of the manifold cleanout cover openings.
   c. **REPLACE CLEANOUT COVERS!** Failure to replace cutting nozzle manifold cleanout covers will render the cutting nozzles useless during operation.

5. Proceed to inspect/clean slurry chamber nozzles before reinstalling crushing cone.

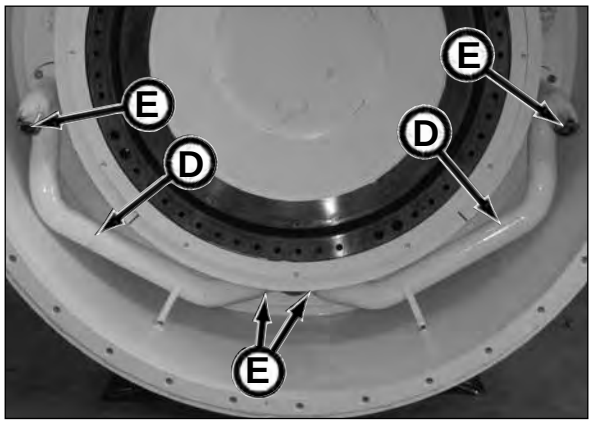


11. INSPECT & FLUSH SLURRY CHAMBER NOZZLES

1. With the crushing cone removed, inspect chamber nozzle tubes (D) and ports (E) for damage, wear or plugging.

2. If nozzles are damaged or worn, repair or replace as needed.

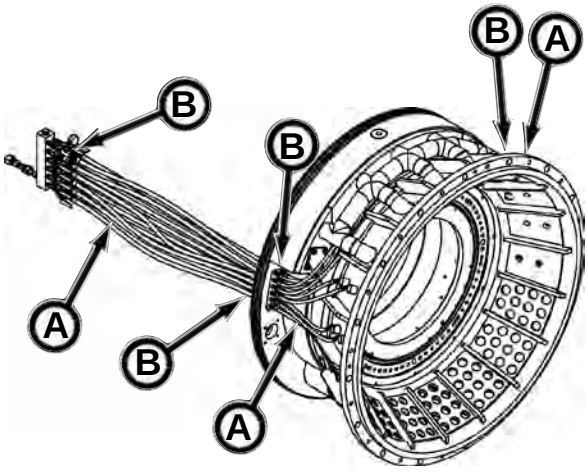
3. Flush nozzles as follows:
   a. use a garden hose or pressure washer (output maximum of 100 psi) to clean out the chamber nozzles.
   b. if a rock is inside the chamber nozzle tubing, you may have to cut the tube to remove the rock. Reweld with patch.



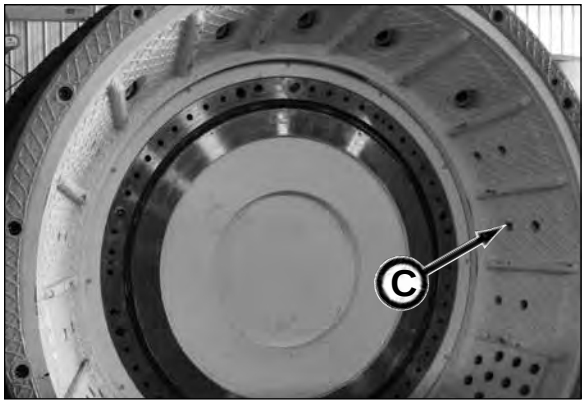
12. INSPECT, FLUSH & CLEAN HIGH PRESSURE JETTING SYSTEM

1. Flush and clean high pressure system; all jetting hoses (A) and fittings (B) to remove rust flakes and sediment within the jetting system.

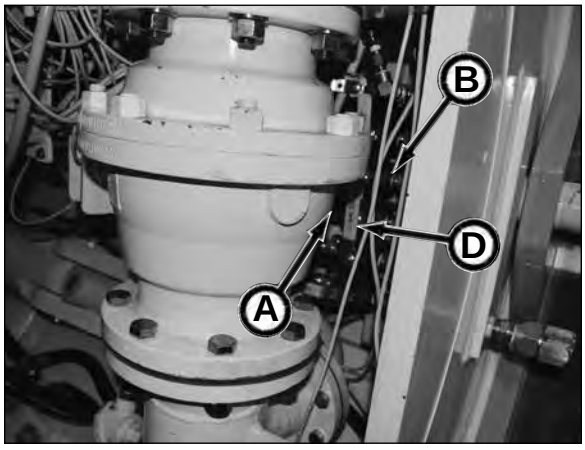
2. Inspect for cracks, wear or damage. Replace as needed.



3. On crushing cone, check jetting nozzles (C), hoses, lines and fittings for damage. Replace as necessary.



4. Check jetting shut off valves (D) for proper operation. Repair or replace as needed.



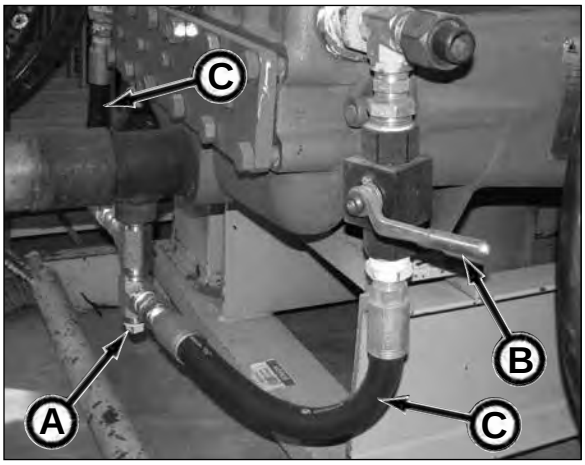
5. Clean strainer screen in high pressure jetting strainer assembly (not shown) and drive motor cooling assembly (if used) (not shown).

6. Check high pressure jetting pump power cables (E) for cracking, wear or damage. Replace as needed.



13. FLUSH & DRAIN JETTING PUMP COMPONENTS

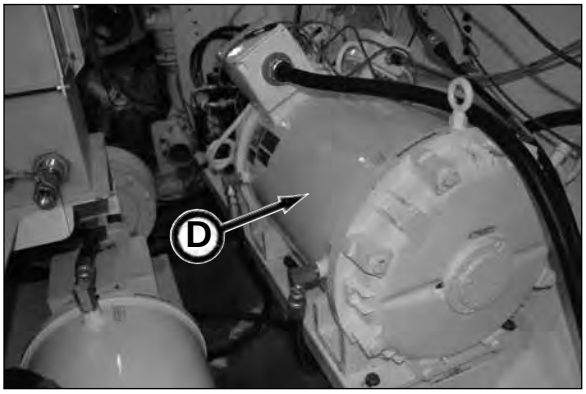
1. Remove drain plug (A).
2. Open bypass pressure relief valve (B) to allow water to drain from pump.
3. Cycle bypass pressure relief valve multiple times to be sure water in ball valve is removed.
4. Be sure water is removed from hoses (C).
5. Replace drain plug.
6. Be sure all fluid lines are drained.



NOTICE If necessary, in freezing weather, drain and flush with RV antifreeze.

14. FLUSH DRIVE MOTOR WATER JACKET

Flush the MTBM drive motor (A) water jacket and cooling lines with RV antifreeze to prevent corrosion and damage from possible freezing weather. Remove and drain cooling lines if desired and store in a cool dry area.
BEFORE OPERATION, COOLING LINES MUST BE REINSTALLED.



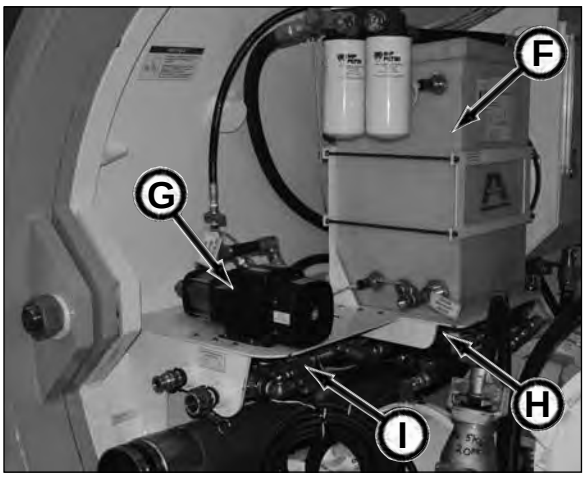
15. FLUSH BOOSTER PUMP MOTOR WATER JACKET

Flush the booster pump motor (A) water jacket and cooling lines with RV antifreeze to prevent corrosion and damage from possible freezing weather. Remove and drain cooling lines if desired and store in a cool dry area.
BEFORE OPERATION, COOLING LINES MUST BE REINSTALLED.



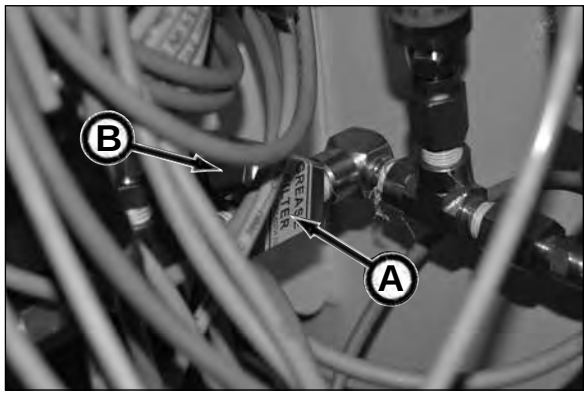
16. FLUSH WATER COOLING SYSTEM

1. Flush the water cooling system with RV antifreeze to prevent corrosion and damage from possible freezing weather.
2. Drain water tank (F) and remove hoses if desired and store in a cool dry area. ***BEFORE OPERATION, ALL WATER SYSTEM HOSES MUST BE REINSTALLED & THE TANK REFILLED.***
3. Drain water pump (G) and replace drain plug.
4. Drain heat exchanger (H) and replace drain plug.
5. Drain strainer assembly (I) and clean strainer. Replace plug.
6. Drain slurry cooling tubes (not shown) if used.



17. REPLACE GREASE PUMP FILTER ELEMENT

1. Gain access to the grease pump filter (A).
2. Remove plug (B).
3. Remove element.
4. Inspect element and replace with new element as needed.
5. Replace plug.

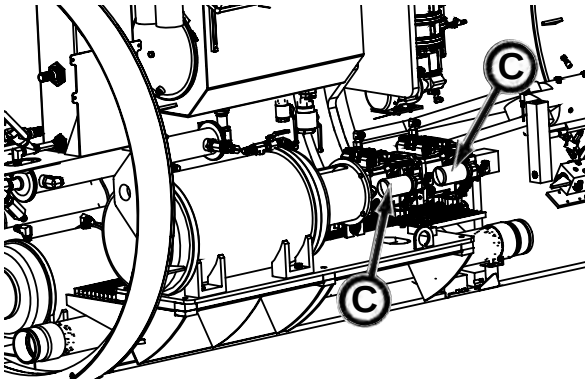


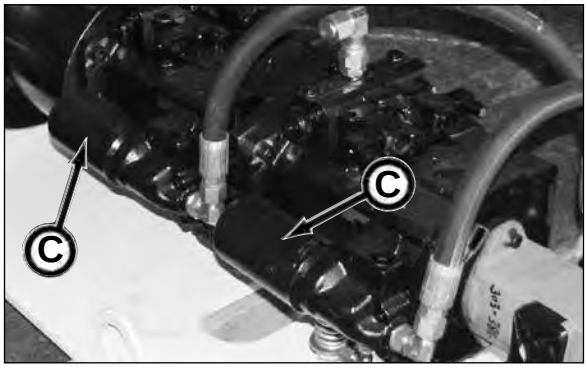
18. CHECK HYDROSTATIC PUMP FILTERS

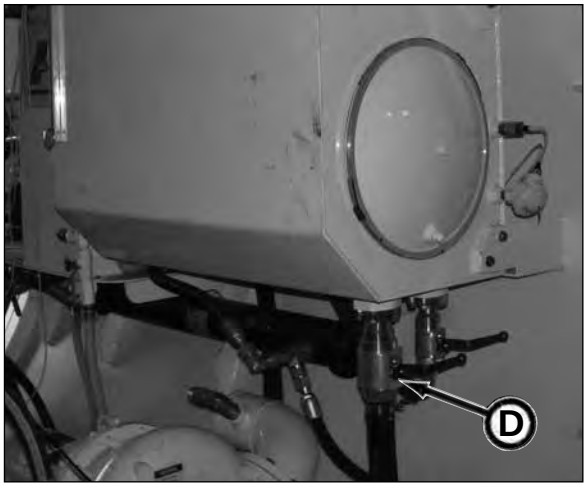
Inspect hydrostatic pump filters (C). Replace as needed.

1. Turn main hydraulic shutoff valve (D) to the closed position.
2. Place a catch pan below filter being removed.
3. Remove filter.
4. Install new spin-on filter (hand tighten only).
5. Dispose of oil properly.
6. Replace other filter using steps 2 through 5.
7. Turn main hydraulic shutoff valve to the open position. Tie strap valve handle in the open position to prevent accidental closure while operating.

IMPORTANT: Failure to open shutoff valve (D) WILL cause damage to pumps. Be sure to tie strap valve handle in the open position to prevent accidental closure while operating.







Main Hydraulic Shutoff Valve Shown in Closed Position
Valve Must Be In Open Position Before Operating

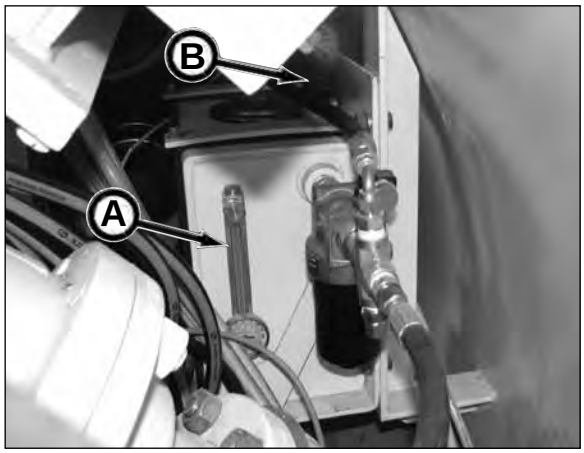
19. CHECK MTBM AUXILIARY HYDRAULIC POWER PACK OIL RESERVOIR LEVEL, CONDITION OF OIL & FILTER

1. Check condition of oil. If any of the following situations occur, the reservoir must be drained and refilled with flesh oil. The return filter must also be replaced:
   - A valve, torque wing 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.

2. Check the reservoir oil level on sight gauge (A).

   If oil is needed, clean and dry area around fill cap (B), remove fill cap and fill until tank is at full mark with Tellus® Plus Oil 32 or equivalent. Replace oil cap.

   Oil capacity is 5.5 US gal. (21 L).



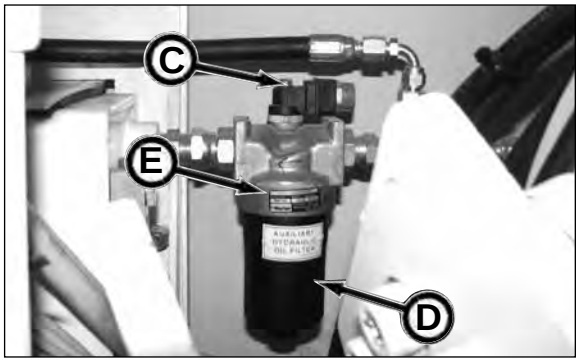
3. Check filter indicator (C). If the filter indicator is green, the filter is functioning properly. If the filter indicator is red, the filter should be replaced as soon as possible to prevent hydraulic component damage using the following procedure:

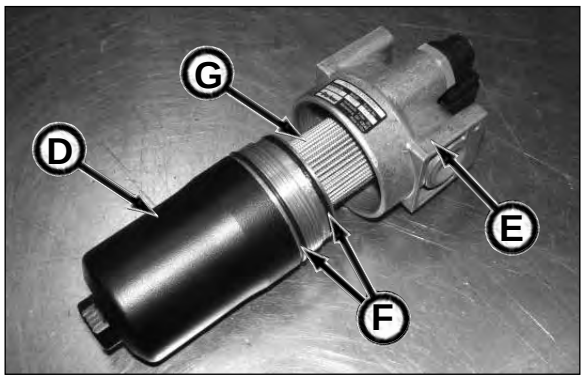
   1. Clean and dry area around filter assembly.

   2. Remove housing (D) from filter head (E). Inspect housing for damage. If damaged, replace with new.

   3. Inspect orings (F) on filter housing. If orings are worn or damaged, replace with new.

   4. Remove filter (G) from filter head. Dispose of oil and filter properly.





   5. Lubricate new filter oring (H) with a light coating of clean hydraulic oil.

   6. Carefully insert new, lubricated filter into filter housing.

   7. Lubricate housing orings with a light coating of clean hydraulic oil. Be sure orings are not twisted and that they are properly seated into housing grooves.

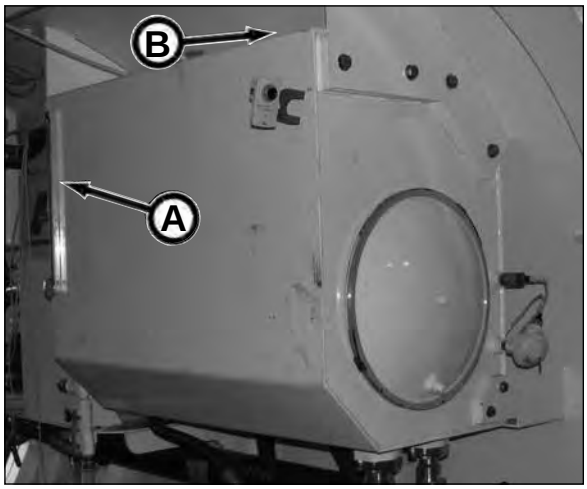
   8. Securely fasten housing to filter head.

   9. Check for leaks.



20. CHECK MTBM MAIN HYDRAULIC POWER PACK OIL RESERVOIR LEVEL, CONDITION OF OIL & FILTERS

1. Check condition of oil. If any of the following situations occur, the reservoir must be drained and refilled with flesh oil. The return filters must also be replaced:
   - A 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.



2. Check the reservoir oil level on sight gauge (A).

   If oil is needed, clean and dry area around fill cap (B), remove fill cap and fill until tank is at full mark with ISO-VG-68 premium hydraulic oil or equivalent. Replace fill cap.

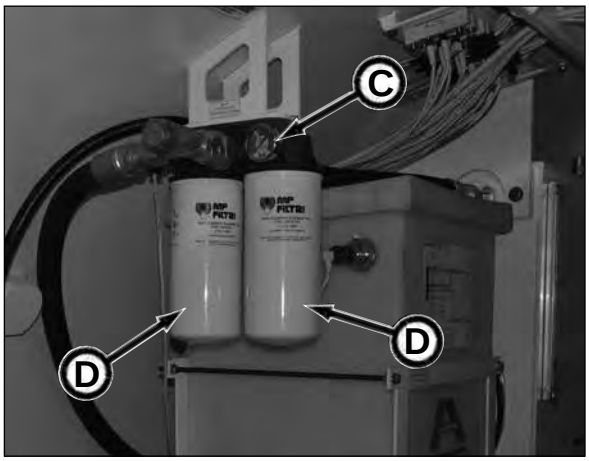
   Oil capacity is 95 US gal. (360 L).

3. Check filter indicator (C). If the filter indicator is in the green zone, the filter is functioning properly. The yellow zone indicates that the filter will soon require replacement. When the needle on the gauge is in the red CHANGE zone, replace filter as soon as possible to prevent hydraulic component damage using the following procedure:

   1. Clean and dry area around the return filters (D).

   2. Remove filter. Dispose of oil and filter properly.

   NOTICE Remove filter gasket if stuck in filter housing.



   3. Fill new filter with clean hydraulic oil.

   4. Lubricate new filter gasket with a light coating of clean hydraulic oil and install into filter housing. Be sure gasket is not twisted and that it is properly seated into housing groove.

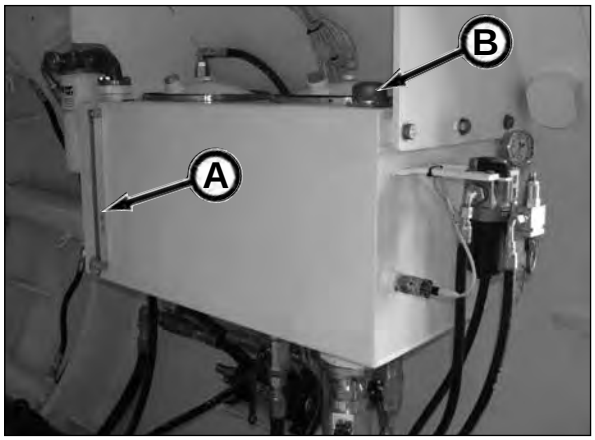
   5. Install new filters. Hand tighten only. Follow tightening instructions on filter.

   6. Check for leaks.

   7. Check hydraulic oil reservoir oil level. Add hydraulic oil if necessary.

21. CHECK MTBM LUBE/JACK CAN HYDRAULIC OIL RESERVOIR LEVEL, CONDITION OF OIL & FILTERS

1. Check condition of oil. If any of the following situations occur, the reservoir must be drained and refilled with flesh oil. The return filter must also be replaced:
   - A 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.

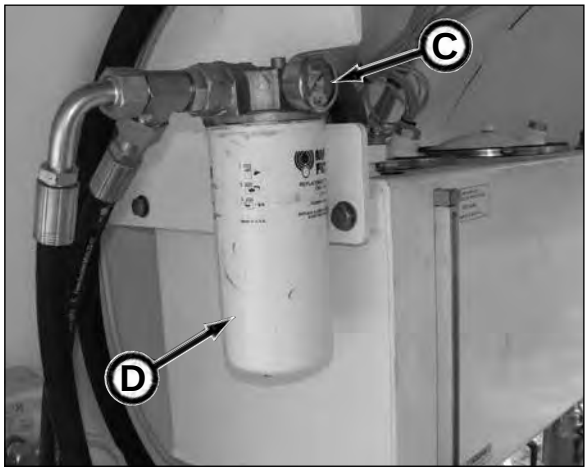


2. Check the reservoir oil level on sight gauge (A).

   If oil is needed, clean and dry area around fill cap (B), remove fill cap and fill until tank is at full mark with ISO-VG-46 or equivalent. Replace fill cap.

   Oil capacity is 30 US gal. (114 L).

3. Check return filter indicator (C). If the filter indicator is in the green zone, the filter is functioning properly. The yellow zone indicates that the filter will soon require replacement. When the needle on the gauge is in the red CHANGE zone, replace filter as soon as possible to prevent hydraulic component damage using the following procedure:



   1. Clean and dry area around the return filter (D).

   2. Remove filter. Dispose of oil and filter properly.

   NOTICE Remove filter gasket if stuck in filter housing.

   3. Fill new filter with clean hydraulic oil.

   4. Lubricate new filter gasket with a light coating of clean hydraulic oil and install into filter housing. Be sure gasket is not twisted and that it is properly seated into housing groove.

   5. Install new filter. Hand tighten only. Follow tightening instructions on filter.

   6. Check for leaks.

   7. Check hydraulic oil reservoir oil level. Add hydraulic oil if necessary.

(continued on next page)

4. Check pilot pressure filter indicator (A). If the filter indicator is green, the filter is functioning properly. If the filter indicator is red, the filter should be replaced as soon as possible to prevent hydraulic component damage using the following procedure:

    1. Clean and dry area around the filter assembly.

    2. Remove lower filter housing (B). Inspect housing and housing orings for damage. If damaged, replace with new.

    3. Remove filter.

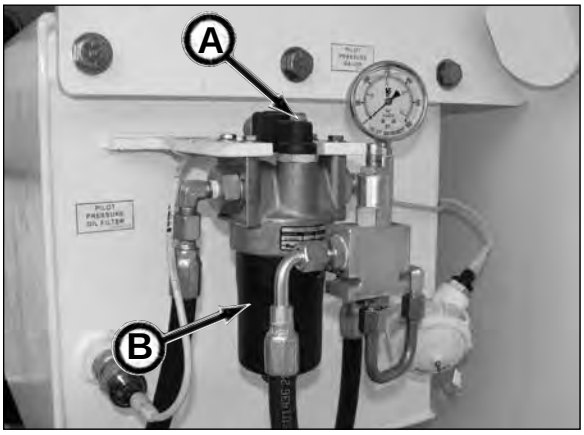
    4. Lubricate housing orings with a light coating of clean hydraulic oil.

    5. Lubricate filter inner oring with a light coating of clean hydraulic oil.

    6. Carefully insert new filter into upper filter housing.

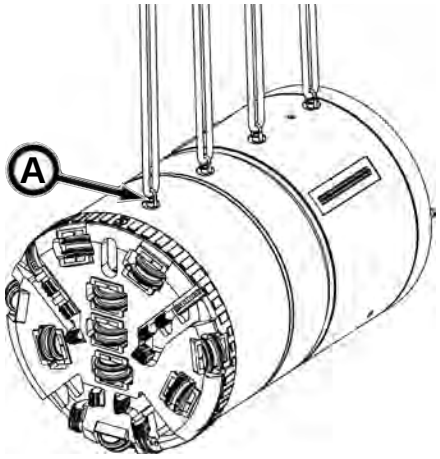
    7. Securely fasten lower housing into upper filter housing.

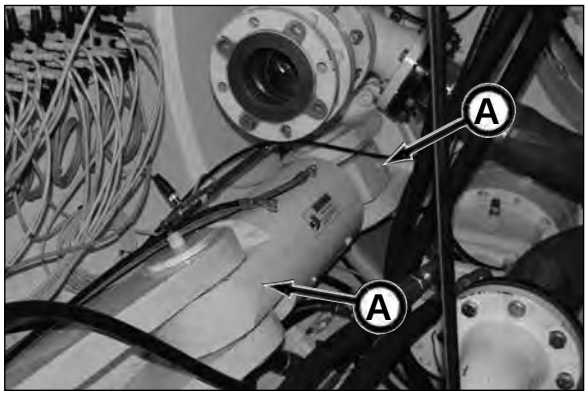
    8. Check for leaks.



22. INSPECT LIFT EYES

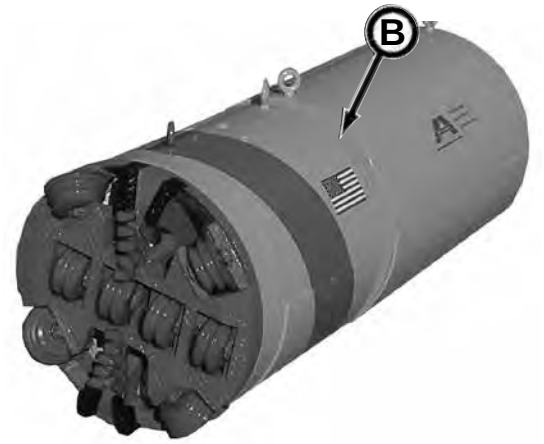
Before lifting MTBM and Lube/Jacking Can, check lift eyes (A) for damage. Worn or damaged lift eyes MUST be replaced before lifting MTBM.





23. LUBRICATE STEERING CYLINDER PINS

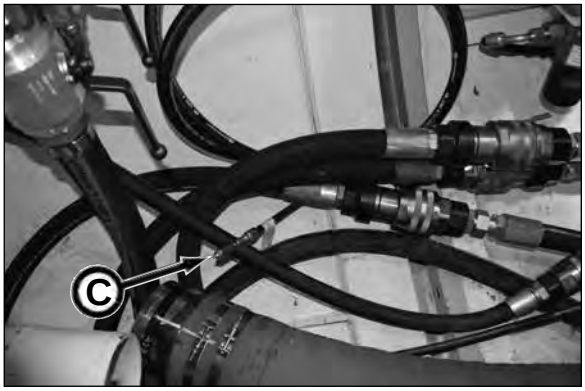
Lubricate steering cylinder pins (A) (2 places per cylinder) until grease is forced out with Mobilgrease® XHP222 or equivalent.



24. INSPECT STEERING JOINT SEALS

The steering joint seals must be properly maintained to protect the steering joint from contamination.

1. Inspect steering joint area (B) for dirt, debris and damage. Carefully clean area so as not to cause damage to the joint seals.

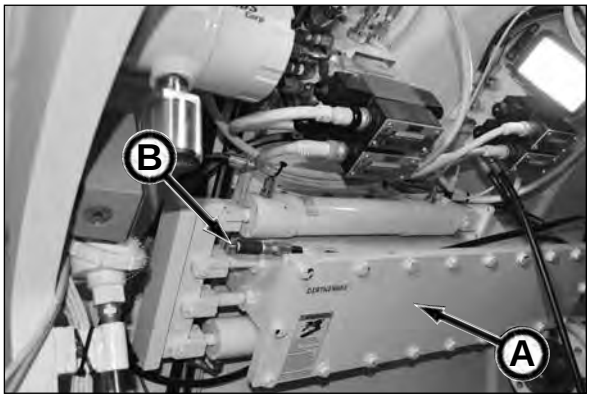


2. Lubricate the steering joint seals with 1 tube of Mobil® SHC 101 EAL Grease to flush the old grease from steering joint. Clean grease should be visible at the steering joint area. Use grease hose (C) to grease the steering joint.

25. LUBRICATE DIRT WING CAVITY

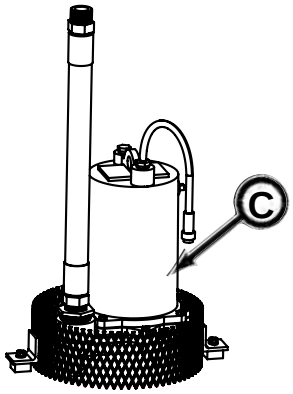
The dirt wing cavity (A) must be filled with grease to prevent dirt or other contaminates from entering cavity area.

Lubricate dirt wing cavity with Mobil® SHC 101 EAL grease or equivalent until grease is forced out. There is a grease fill hose (B) for each dirt wing.



26. CLEAN & FLUSH SUBMERSIBLE PUMP OPERATION

Clean and flush pump water inlet holes, pump and hose to remove all contamination. Remove water to prevent damage from freezing temperatures.



27. INSPECT STRUCTURE

Inspect MTBM structure for cracks, wear or other damage. Repair as needed before operation.

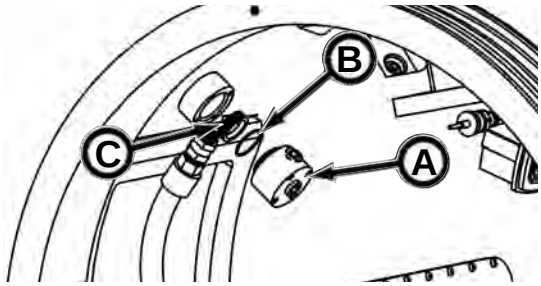


28. INSPECT BENTONITE PORTS

Bentonite hoses and ports must be flushed after the completion of each drive to prevent hardening of bentonite in the bentonite hoses and ports.

MTBM Bentonite Ports

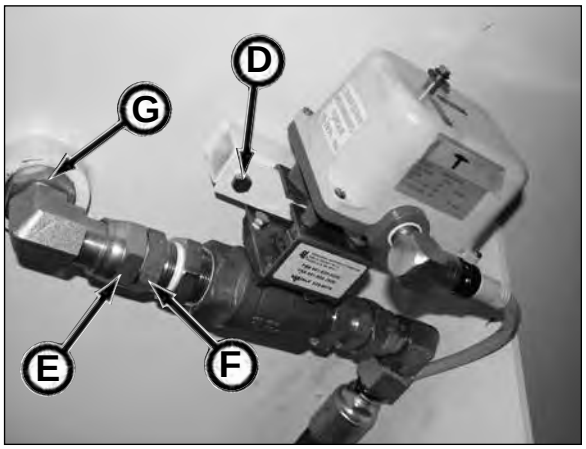
1. Flush bentonite ports by flushing ports with water and check water flow out of each port. If plugging is noted, the hoses, fittings and ports must be cleaned or replaced.
2. Check bentonite port by removing four bolts from cap (A).
3. Remove cap (with hose[s]) from bentonite port to gain access to oring (B) and check valve (C).
4. Check oring and check valve for wear or damage. When replacing, be sure check valve and oring are properly seated in port.
5. Replace cap and secure with bolts removed in step 3.
6. Repeat steps 2 through 6 for other bentonite ports.
7. Check pressure transducer for damage. Replace if needed.



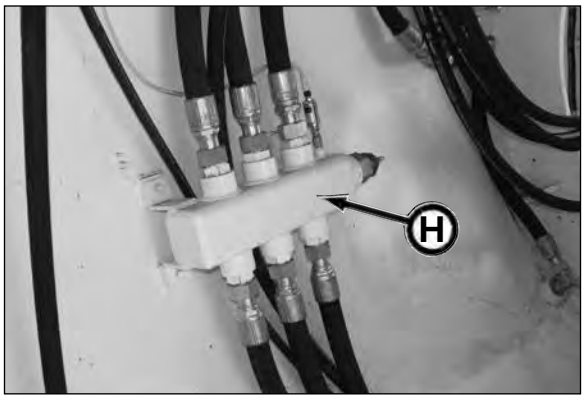
Bentonite Ports On MTBM

Lube/Jack Can Bentonite Ports

1. Flush bentonite ports with water and check water flow out of each port. If plugging is noted, the hoses, fittings and ports must be cleaned or replaced.
2. Check bentonite port by loosening two mounting bolts (D) on lubrication valve mount.
3. Disconnect fittings (E and F).
4. Loosen locknut (G).
5. Disconnect fitting from locknut.
6. Inspect and clean as needed. If damaged, repair or replace with new.
7. Reinstall bentonite port in reverse order.
8. Repeat steps 2 through 7 for other bentonite ports.
9. Inspect manifold (H) for blockage. Clean as needed.
10. Check pressure transducer for damage. Replace if needed.

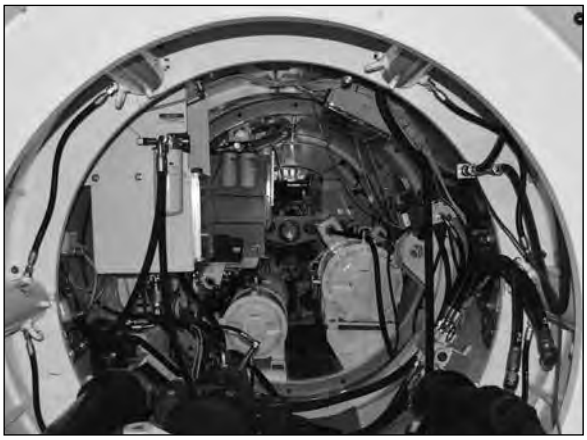


Bentonite Ports On Lube/Jack Can



Bentonite Port Manifold On Lube/Jack Can

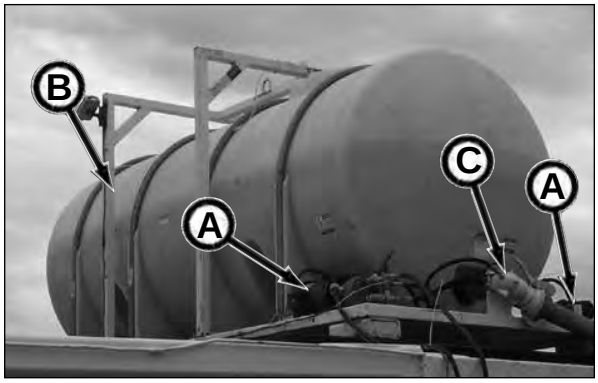
29. INSPECT HOSES & CABLES



Inspect hydraulic/jetting hoses, power cables for wear or damage. Repair or replace if cracks or wear are visible.

Power cable lengths and connections must be visually inspected, cleaned with electric contact cleaner and blown dry with compressed air. Use industrial strength bags to cover all ends of cable connections, then tape the bags to the cable to prevent contamination. Cables should be neatly coiled and stored in a container that is protected from the elements.

30. FLUSH & DRAIN WATER COOLING TANK COMPONENTS



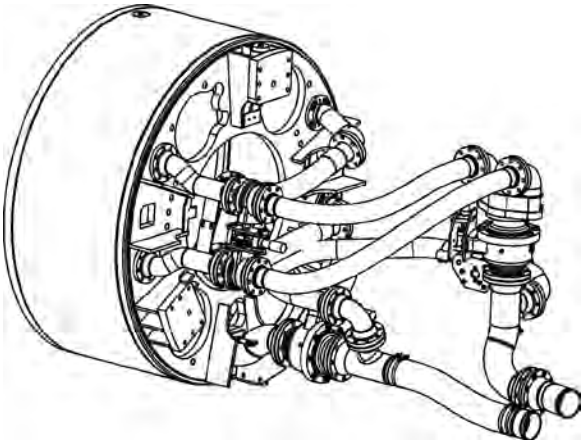
Remove drain plugs from both pumps (A). Flush and drain pumps and all fluid lines. With water completely drained, replace plugs. Failure to do so will cause damage to pump components.

The tank (B) must also be drained in freezing weather unless a suitable heat source is used for keeping the tank temperature above freezing.

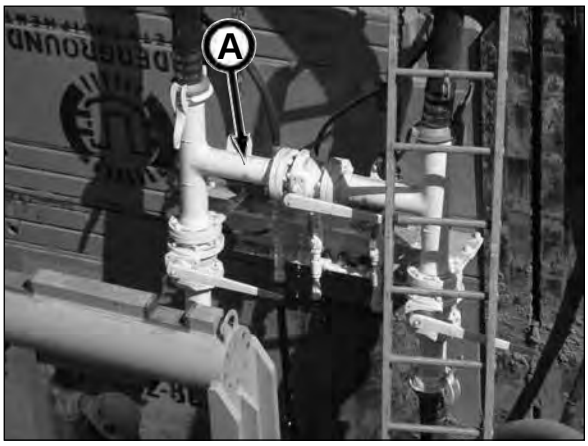
In freezing weather, remove cap or hose from 3" elbow (C).

NOTICE If freezing weather is anticipated, drain and flush with RV antifreeze.

31. FLUSH & DRAIN SLURRY VALVES & HOSES



Flush and drain the MTBM slurry valves and hoses to remove contamination and to prevent component damage from freezing weather.



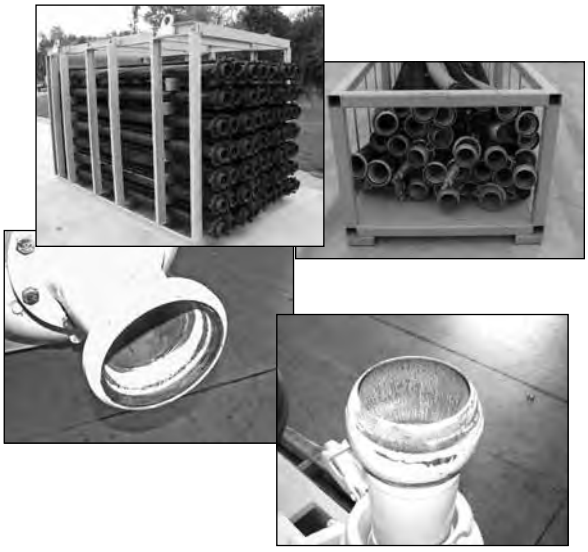
32. FLUSH & CLEAN SLURRY PIT ASSEMBLY

Flush and clean slurry pit assembly (A) to remove contamination. Be sure to open and close valves to remove all contamination.



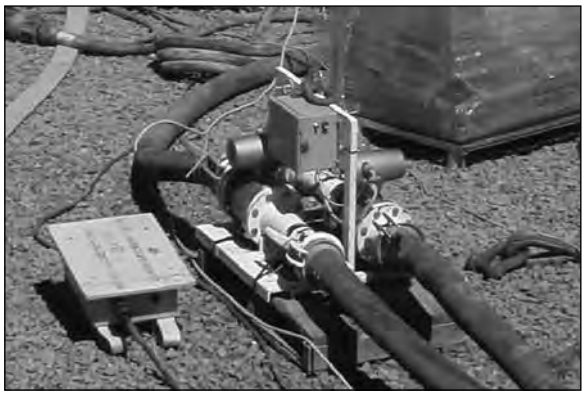
33. INSPECT & FLUSH SLURRY PUMPS, HOSES, LINES, CLAMPS & CONNECTIONS

1. Flush and drain slurry pumps and flush slurry hoses and slurry lines.



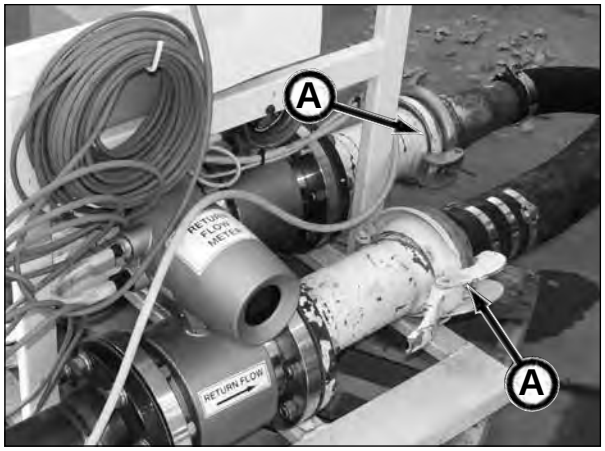
2. Inspect the slurry hoses. slurry lines and slurry line connections for wear or damage. Replace as needed. Clean hoses. lines and connections to remove contamination.

   Check to be sure the oring is not cracked, torn, worn or damaged. If needed, replace with new oring.



34. CLEAN FLOWMETER & SLURRY CONNECTIONS

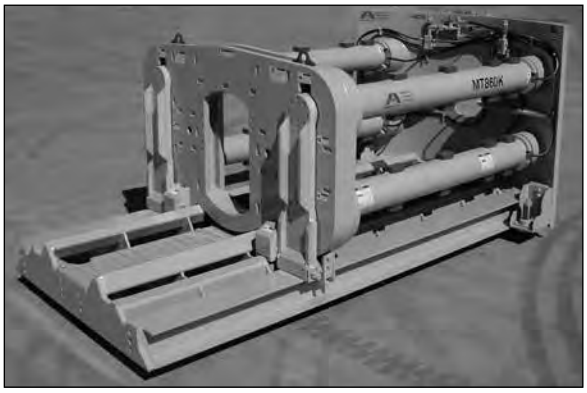
1. Flush flowmeter slurry inlets and outlets with clean water to remove contamination.



2. Inspect all slurry line connections (A) for wear or damage. Repair or replace as needed.

35. CLEAN, INSPECT & LUBRICATE JACKING FRAMES

1. Clean frame to remove build up of dirt and debris.



2. Visually inspect jacking frame 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.

3. Check to be sure all guards are in place and in good condition. If damaged, repair or replace.

4. Lubricate the jacking frame per instructions on the Maintenance Charts - Keyhole Jacking Frame in this section.

36. CHECK REMOTE HYDRAULIC POWER PACK OIL RESERVOIR LEVEL, CONDITION OF OIL & FILTERS

1. Check condition of oil. If any of the following situations occur, the reservoir must be drained and refilled with flesh oil. The return filters and pilot pressure filter must also be replaced:
   - A 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.

2. Check the reservoir oil level on sight gauge (A).

   If oil is needed, clean and dry area around fill cap (B), remove fill cap and fill until tank is at full mark with ISO-VG-46 or equivalent. Replace oil cap.

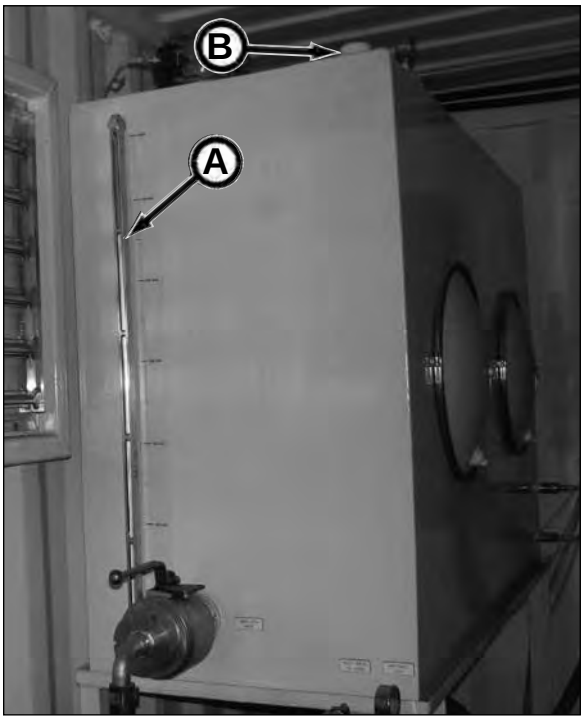
   Oil capacity is 330 US gal. (1,249 L).

3. Check return filter indicators (C). If the white indicator (D) is in the clean green zone (E), the filter is functioning properly.

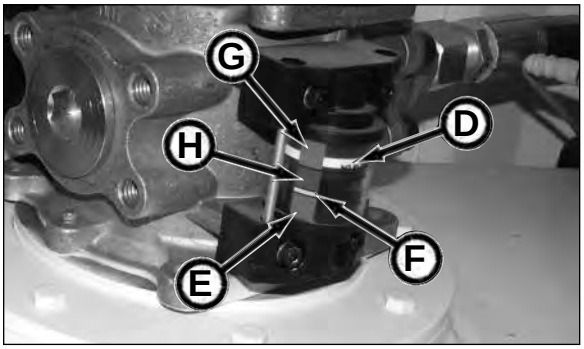
   If the white indicator is in the caution yellow zone (F), the filter will soon require replacement.

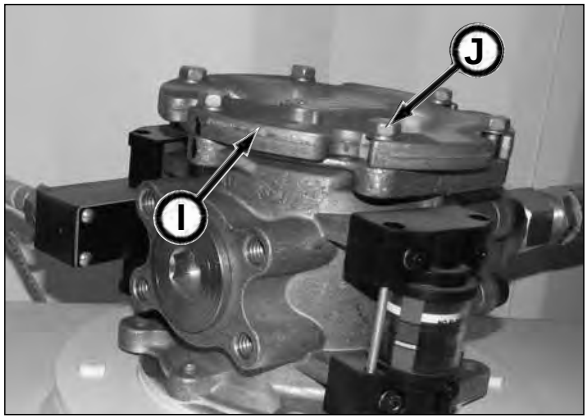
   If the white indicator is in the no element red zone (G) or bypass red zone (H), replace the filter(s)immediately to prevent contamination from entering the hydraulic reservoir using the following procedure:

   1. Clean and dry area around filter cover (I).
   2. Remove cover screws (J) and lock washers. Retain for later use.
   3. Remove cover.
   4. Remove filter. Dispose of filter properly.
   5. Remove filter oring if stuck in filter housing or cover.
   6. Install new oring in cover with a light coat of clean hydraulic oil. Check to be sure the oring is not twisted and that it is correctly seated in place.
   7. Carefully install new filter into housing. Be sure filter is oriented properly.
   8. Replace cap and secure with lock washers and cover screws (removed in step 2).
   9. Check for leaks.
   10. Check hydraulic oil reservoir oil level. Add hydraulic oil if necessary.









(continued on next page)

4. Check pilot pressure filter indicator (A). If the filter indicator is green, the filter is functioning properly. If the filter indicator is red, the filter should be replaced as soon as possible to prevent hydraulic component damage using the following procedure:

    1. Clean and dry area around the filter assembly.

    2. Remove lower filter housing (B). Inspect housing and housing orings for damage. If damaged, replace with new.

    3. Remove filter.

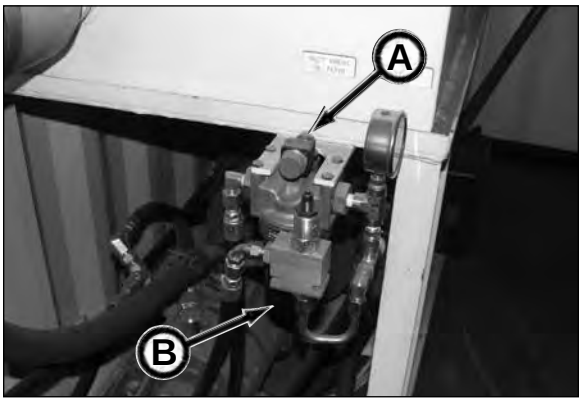
    4. Lubricate housing orings with a light coating of clean hydraulic oil.

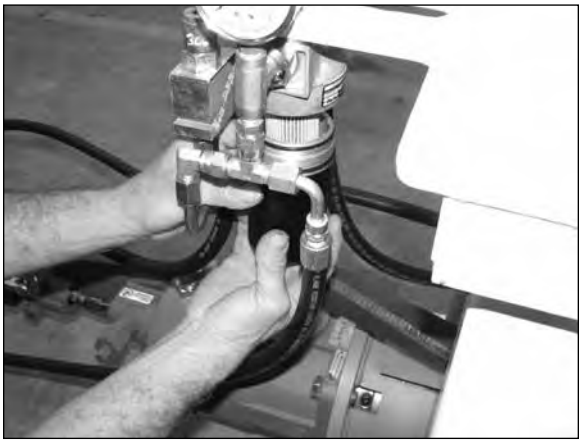
    5. Lubricate filter inner oring with a light coating of clean hydraulic oil.

    6. Carefully insert new filter into upper filter housing.

    7. Securely fasten lower housing into upper filter housing.

    8. Check for leaks.

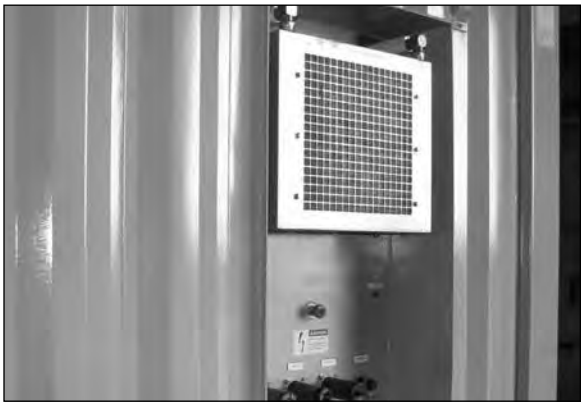




37. CHECK OIL COOLER FAN & FINS

Check oil cooler for bent fins, bent fan blades, cracks, dents or other damage. If possible straighten fins and blades. Otherwise repair or replace as necessary.





NOTES

Storage

PREPARING FOR STORAGE

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

1. Repair worn or damaged parts.
2. Wash all equipment thoroughly.
3. Inspect all equipment for damage. Perform repairs prior to placing equipment into storage.
4. Lubricate all grease points. Grease threads on bolts used for adjustments. Refer to section 8, Lubrication for grease specifications.
5. Check bearing cavity and drive motor oil level. Add Mobilgear® 600XP 460 gear oil or equivalent if needed.
6. Lubricate steering joint with one tube of Mobil® SHC 101 EAL grease.
7. Retract all hydraulic cylinders if possible. If not, coat exposed cylinder rods with a corrosion preventive.
8. Repaint equipment where necessary.
9. Flush (with RV antifreeze) and drain heat exchangers and water cooling system to prevent freezing.
10. Drain hydraulic oil, flush oil reservoir, change hydraulic filters, and refill hydraulic reservoirs. Check for leaks.
11. Wipe up lube spills. Dispose of rags and trash properly.
12. If possible, store equipment under cover and out of the weather in a ventilated area.
13. Electric cable lengths and connections must be visually inspected, cleaned with electric contact cleaner and blown dry with compressed air. Use industrial strength bags to cover all ends of cable connections, then tape the bags to the cable to prevent contamination. Cables should be neatly coiled and stored in a container that is protected from the elements.
14. Remove guidance target and place it in the storage box.
15. The slurry valve assembly must be cleaned and flushed with RV antifreeze; the valves should be left in the half open position to prevent damage from freezing.
16. Flush (with RV antifreeze) and drain pumps of all fluid lines to prevent clogging or freezing during storage.
17. Flush (with RV antifreeze) and drain all slurry cooling tubes to prevent clogging or freezing during storage.
18. Each valve on the jetting valve bank should be opened one at a time, flushed with RV antifreeze all the way to the cutter face and the jetting valve left in the half open position.
19. The control container and remote hydraulic power pack container must be stored with rodent protection (industrial mouse traps) and ventilation control to keep the electrical components moisture free.
20. Fully drain the water cooling tank. After the suction inlet on the cooling tank is flooded with RV antifreeze, it should be operated to displace trapped water and stored with the suction valve in the half open position.
21. The high pressure jetting pump contains a series of suction and discharge valves. Flood the suction inlet and discharge outlet with RV antifreeze to prevent damage from freezing. This will also provide corrosion protection.
22. **IMPORTANT: It is recommended to re-energize the VFD drives at least every 6 months for 30 minutes with the rated voltage to re-form the VFD capacitors and to ensure correct VFD operation.**
23. Refer to your Slurry Pump/Motor and High Pressure Jetting Pump manuals for long term pump and motor storage.
24. Review this Operator's Manual and supporting equipment manuals for additional information on preparing equipment for storage.

REMOVING FROM STORAGE

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

1. Clean equipment thoroughly.

2. Check to make sure all decals including safety decals are clean and readable.

3. Check condition of wires and cables. Repair or replace as necessary.

4. Check bearing cavity oil quality. If any contaminants are present, the bearing cavity must be drained, flushed and filled with Mobilgear® 600XP 460 gear oil. Check oil level. Add if necessary.

5. Check drive motor oil quality. If any contaminants are present, the drive motor(s) must be drained, flushed and filled with Mobilgear® 600XP 460 gear oil. Check oil level. Add if necessary.

6. Remove the cylinder corrosion preventive from the cylinder rods if it is not compatible with hydraulic oil or seal materials.

7. Check for leaks. Repair or replace as necessary.

8. Fill water cooling system tank with clean water.

9. Check grease pump containers grease level. If necessary, add Mobil® SHC 101 EAL grease into containers.

10. Check the hydraulic reservoirs oil level. If fluid is low, check for leaks and add oil as required. Refer to Section 8, Lubricants for oil specification. IMPORTANT; not all hydraulic reservoirs use the same oil specifications.

11. Check condition of all hoses and connections. Tighten, repair or replace with new as needed.

12. Remove bags from electrical cable connections and visually inspect to be sure there is no damage.

13. Test ALL Emergency Stop buttons for proper performance before operation.

14. **IMPORTANT: It is recommended to re-energize the VFD drives at least every 6 months for 30 minutes with the rated voltage to re-form the VFD capacitors and to ensure correct VFD operation.**

    IF the VFD drives have been in storage for 12 months or more, re-apply voltage PROGRESSIVELY (refer to 12. Check VFD Parameters in section 9, Periodic Maintenance, Control Container, Prior To Each Drive Launch) using a variable power supply to re-form the capacitors. Immediately applying full line voltage could result in serious damage to the VFD drive and possible personal injury. The re-forming of the VFD capacitors must only be performed by a certified electrician trained in re-forming capacitors.

15. Before operating, cycle hydraulic functions several times to purge air from the hydraulic system.

16. Review this Operator's Manual and supporting equipment manuals for additional information on removing equipment from storage.

Troubleshooting

CONTROL CONTAINER

Problem	Cause	Solution
No power.	Power source is Off.	Turn On power source.
	Power cables from power source not connected to control container.	Secure power cables from power source to control container.
	Computer console is Off.	Turn on computer.
	An E-Stop is activated.	All E-Stops must be pulled out.
Cannot extend/retract steering cylinders.	Head Power switch is Off.	Turn On Head Power switch.
	Hydraulic pump not operational.	Inspect & repair hydraulic pump.
	High pressure valve is closed.	Open high pressure valve.
	Worn or damaged cylinder seals.	Replace seals.
	Steering cylinders are not calibrated.	Calibrate steering cylinders.
Erroneous data appears on software programs.	Incorrect head size selected in Machine Select program.	Double click Machine Select Program and select correct MTBM head size.
	External power source (generator) output is erratic.	Inspect and troubleshoot generator.
Camera video feed is not visible.	Camera program is not running.	Boot up camera program.
	Boring head ethernet cable is not connected between the MTBM control box and the control container bulkhead.	Attach boring head ethernet cable.
Control container components do not function or operate erratically.	Improper phase power.	NEVER operate system with improper phase power. Reverse two of the generator or power source leads to attain proper phase power.
	Improper input voltage.	Repair generator or power source output voltage.
	Loss of ethernet communication.	Inspect ethernet cable for damage.
		Connect ethernet cable from control container to component.

MTBM

Problem	Cause	Solution
No power at MTBM.	Power cables not connected.	MTBM boring head communication (ethernet) cable not connected to control container bulkhead.
		Connect all power cables to control container bulkhead.
	An E-Stop button(s) is pushed in.	Pull out ALL E-Stop buttons.
	Head Power switch is off.	Turn On Head power (console).
	Main and/or operator control disconnects are Off.	Flip disconnects (control container) to On position.
		Be sure main cutter drive disconnect in operator & VFD areas of control container is ON.
Cutter head will not make full revolution.	Obstruction in cut path.	Remove obstruction.
	Advancement rate too fast.	Slow advancement rate.
Cutter head will not rotate or is stalled.	Cutter Head speed control set at 0.	Increase CH speed control.
	Gas level too high.	Ventilate tunnel to reduce gas concentration.
	MTBM roll exceeds parameters.	Change roll setting meter & reverse head rotation.
	Obstruction against cutter ring.	Remove obstruction. Retract steering cylinders and rotate cutter head.
	Excessive thrust pressure.	Reduce thrust pressure. Retract steering cylinders and rotate cutter head.
	Insufficient over-cut clearance.	If possible, change over-cut.
	No bentonite out of bentonite ports or ports are plugged.	Turn bentonite pump on or unplug ports.
MTBM over excavating.	Slurry flow too high.	Reduce slurry flow.
	Stop and bypass valves are in Manual mode.	Place slurry system valve in Sequence mode.
	Feed flowmeter is connected to the return flow.	Connect feed flow to feed flowmeter.

(continued on next page)

MTBM (continued)

Problem	Cause	Solution
MTBM flooding.	Sub pump in Stop position.	Turn Sub Pump to On or Auto.
MTBM drive motor is hot.	Sub pump float switch malfunction.	Repair or replace switch.
	Main cooling pump water supply shutoff on the slurry pit valve is in Off position.	Open supply shutoff valve.
	No water in cooling tank.	Refill cooling tank with water.
	Blockage in cooling pump strainer or supply hose.	Remove blockage in strainer or hose.
	Water cooling tank pump malfunction.	Repair or replace pump.
	Water ports at front face are plugged.	Water ports must be cleaned. Do not operate with plugged ports, otherwise lip seal damage will occur.
	Water cooling hose connected to small cooling drive motor pump on water cooling tank.	Reconnect water cooling hose to larger cooling drive motor pump.
MTBM disc cutter failure.	Excessive thrust.	Reduce thrust load.
	Air in MTBM disc cutter bearing cavity.	Remove all air from cavity.
	Seal damaged due to storage in heat and sunlight.	Replace cutter seals. Store in cool location, no sun.
Dirt wing (stabilizers) will not extend/retract.	Worn or damaged cylinder seal.	Replace seals.
	Material buildup or obstruction in dirt wing cavity or travel area.	Remove dirt wing, disassembly and clean.
	Head Power switch is off.	Turn On Head power (console).
	No oil in the MTBM hydraulic power pack oil reservoir.	Fill power pack tank with oil.
	Stabilizers not calibrated.	Calibrate stabilizers.
Submersion pump does not operate.	Sub pump switch is in stop position.	Place Sub Pump switch in Start or Auto mode.
	Blockage in pump.	Remove blockage.
	Electrical overload.	Self-resetting breakers will reset. If not, inspect.
Slurry valves do not operate.	No oil in the MTBM hydraulic power pack oil reservoir.	Fill power pack tank with oil.
	Slurry valves are not calibrated.	Calibrate slurry valves.
	Stop valve activated.	Select Sequence mode to operate stop valve and bypass in opposite positions.
Laser in tunnel is refracting.	Inconsistent temp. in tunnel; warm, moist air.	Properly ventilate tunnel.

REMOTE HYDRAULIC POWER PACK

Problem	Cause	Solution
Power pack does not operate.	E-Stop button(s) is pushed in.	Pull out ALL E-Stop buttons.
	Power pack main power switch is Off.	Flip switch to On position.
	Power source is off.	Turn on power source.
	Ethernet (communication) cable not connected between power pack and control container.	Connect ethernet cable.
	Loose ethernet cable connection.	Tighten ethernet connection.
	Hydraulic power pack network status is offline.	Connect ethernet cable.
	Tank oil level is low.	Fill hydraulic tank with oil.
	Main fuse blown.	Replace fuse.
	Damaged power cable(s).	Repair or replace pwr cable(s).
Hydraulic oil temp is high (120°F).	Load too high.	Reduce load.
	Fan override switch is Off.	Turn On fan override switch.
	Relief valve malfunction.	Repair or replace relief valve.
Power pack components do not function or operate erratically.	Improper phase power.	NEVER operate system with improper phase power. Reverse two of the generator or power source leads to attain proper phase power.
	Improper input voltage.	Repair generator or power source output voltage.

JACKING FRAMES

Problem	Cause	Solution
Jacking frame will not operate.	An E-Stop button(s) is pushed in.	Pull out ALL E-Stop buttons.
	Main power switch Off.	Turn On power switch.
	Main hydraulic pump is Off.	Turn On main hydraulic pump (MTBM control screen).
	Hydraulic hoses/power cables not connected.	Hydraulic hoses must be connected from power pack to jacking frame.
	Hydraulic temperature is at or above 120°F.	Reduce load.
		Turn on oil cooler pump.
		Turn On fan override switch.
		Check oil cooler pump in remote hydraulic power pack for malfunction.
	Excessive roll.	Reset roll degree parameter, retract dirt wing 50% from position, reverse cutter head direction, rotate to proper roll degree, extend dirt wing.
	Charge pump malfunction.	Repair or replace charge pump.
Jacking frame operational but no thrust available.	Jack Frame control is not to Extend.	Move control to Extend.
	Jack Frame flow control is at 0.	Move flow to higher than 0.
Cylinder timing is off.	Cylinders not fully retracted.	Completely retract cylinders.
No thrust pressure on jacking frame.	Main power switch Off.	Turn On power switch.
	Main hydraulic pump is Off.	Turn On main hydraulic pump (MTBM control screen).
	Hydraulic hoses/power cables not connected.	Hydraulic hoses must be connected from power pack to jacking frame.
	Hi-Flow return valve is open.	Close valve.
	Jacking Frame selector switch in Off position.	Move switch to Extend, Retract, Aux, IJS position.
	Jack Frame flow control is at 0.	Move flow to higher than 0.

SLURRY PUMPS

For more information, refer to your Slurry Pump user manuals.

Problem	Cause	Solution
Return flow rate is low.	Slurry chamber, crushing chamber, or slurry lines clogged.	Reverse slurry flow to flush slurry chambers and lines.
	After 30 seconds of slurry bypass, feed and return flows are not normal, slurry lines are clogged.	Refer to Clearing Clogged Slurry Lines in section 6.
	Return or booster pump not running.	Turn on return or booster pump.
No slurry flow.	Power cables and/ or slurry lines not connected.	Connect cables/lines.
	An E-Stop button(s) is pushed in.	Pull out ALL E-Stop buttons.
	Slurry VFDs/pumps not powered On.	Flip slurry VFDs and slurry pump main power switch to the On position.
	Slurry pit valves are closed.	Open slurry pit valves as needed.
	Separation plant supply valve closed.	Open valve.
	Flow meter network status is offline.	Connect ethernet cable from flow meter to control container.
	Slurry valves are not calibrated.	Calibrate slurry valves.
Over/under excavation.	Feed flowmeter is connected to the return flow hose and return flowmeter is connected to the feed flow hose. resulting in incorrect flow data.	Connect feed supply hose to feed flowmeter and return flow hose to the return flowmeter.
Pump flows are inconsistent.	External power source (generator) output is erratic.	Inspect and troubleshoot generator.

HIGH PRESSURE JETTING PUMP

For more information, refer to your Aplex Pump user manual.

Problem	Cause	Solution
No jetting flow from pump.	Main drive motor is Off.	Turn cooling pump on or rotate cutter head.
	No power.	Connect jetting pump to power source.
		Turn main power switch ON.
		Replace damaged cables.
	An E-Stop button(s) is pushed in.	Pull out ALL E-Stop buttons.
	Communication cable from pump is not connected to Jetting Control Pump on control container bulkhead.	Connect cable from jetting pump to control container bulkhead connection.
	Supply hose from cooling tank not connected to pump.	Connect supply hose.
	Blockage in jetting strainer or supply hose.	Remove blockage in strainer or hose.
	HP Jetting shutoff valve on slurry pit valve is closed.	Open valve.
	No water in cooling tank.	Refill cooling tank with water.
Pump flows are inconsistent.	External power source (generator) output is erratic.	Inspect and troubleshoot generator.

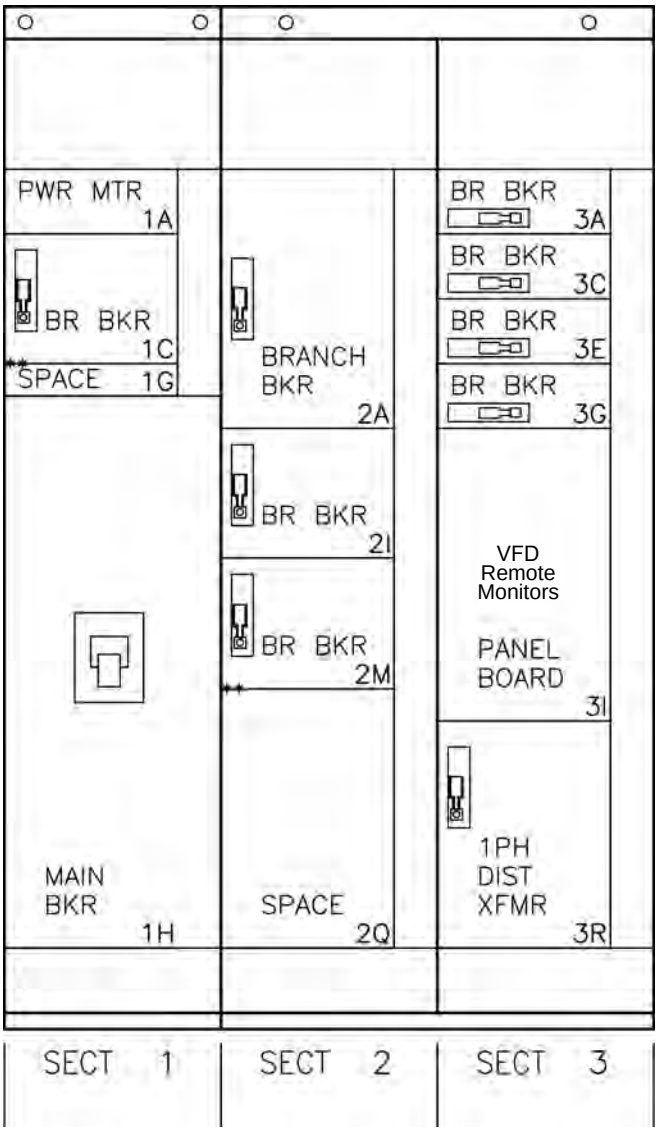
WATER COOLING TANK

Problem	Cause	Solution
No flow from tank.	Main drive motor is Off.	Turn cooling pump on or rotate cutter head.
	No power.	Connect jetting pump to power source.
		Turn main power switch ON.
	An E-Stop button(s) is pushed in.	Pull out ALL E-Stop buttons.
	Pump malfunction.	Repair or replace pump.
Pump flows are inconsistent.	External power source (generator) output is erratic.	Inspect and troubleshoot generator.

MOTOR CONTROL CENTER (MCC) ELECTRICAL SCHEMATICS

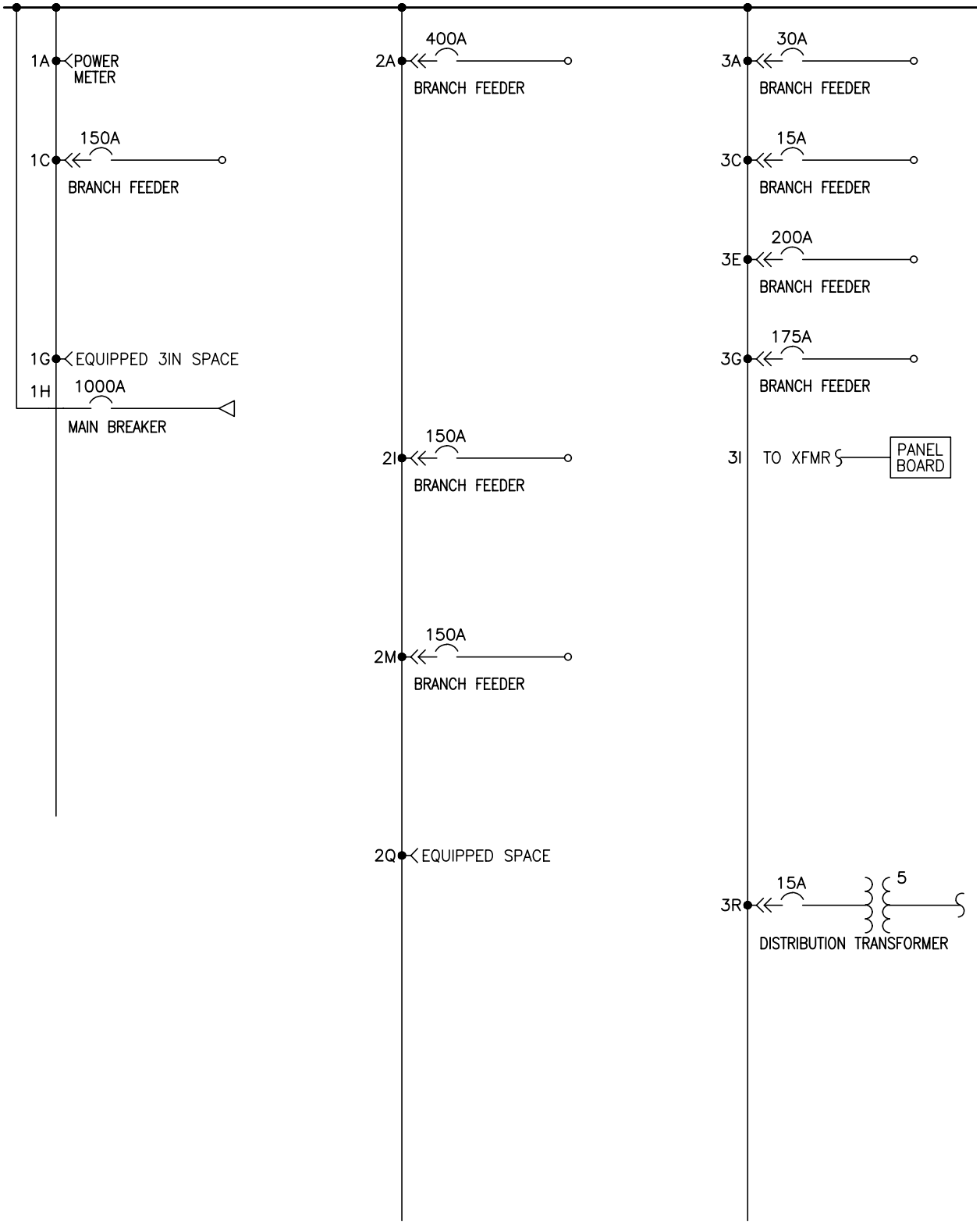
The Motor Control Center (MCC) is made of standardized vertical sections consisting of totally enclosed, dead front, free standing structures bolted together. These sections support and house control units, a common bus bar for distributing power to the control units, and a network of wire trough and conductor entrance areas to accommodate outgoing load and control wires.

Use the illustration below to locate the control units that are referenced in the MCC electrical schematics on the following pages.



(continued on next page)

MCC Electrical Schematics - One Line Diagram



(continued on next page)

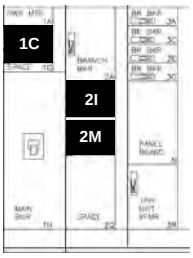
MCC Electrical Schematics - Component Information

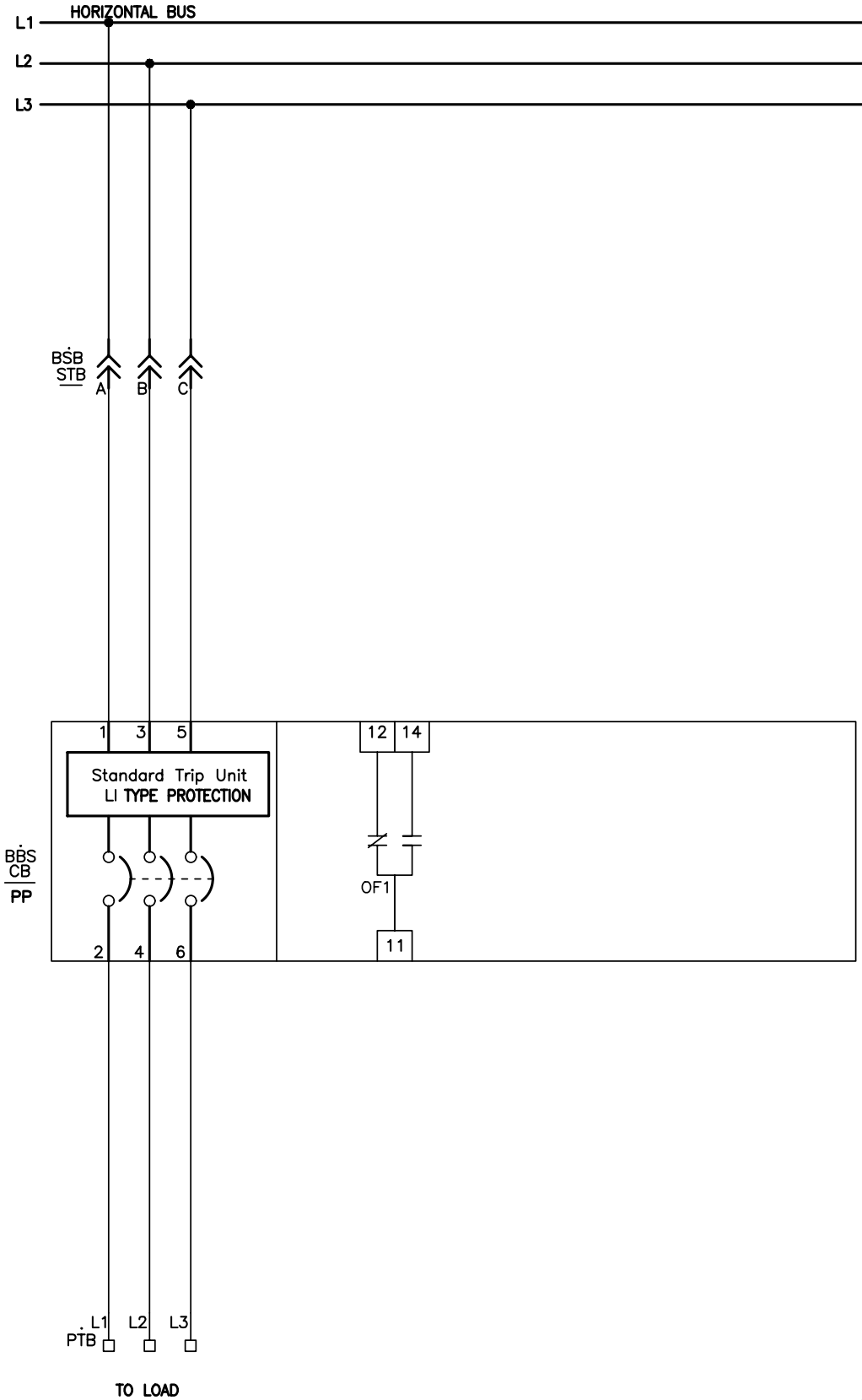
UNIT LOC	NAMEPLATE DESIGNATION	UNIT TYPE	SIZE	HP	FRAME AMPS	TRIP AMPS	CONTROL SOURCE	VA	FUSE PRI	FUSE SIZE SEC	INTERLOCKS NO	INTERLOCKS NC	PILOT DEVICES: ON LIGHT	PILOT DEVICES: OFF LIGHT	22 mm ** ADDL P/L	22 mm ** SS / PB	OTHER UNIT FEATURES	ELEMENTARY #
1A	MONITORING UNIT FOR MAIN	POWER METER															PM5563 W/DISPLAY	E36573618-CR2-02
1C	LARGE MTBM HEAD POWER	BRANCH BKR			HJ 150	150											14-2/0AWG 1 LUG/PH, 80% RATED, ADJ. L, ADJ. I TRIP FUNCTION, AL MECH LUG AL/CU CABLE,	E36573618-CR2-01
																	ELECTRONIC STANDARD TRIP UNIT, INT INTLK 1A/1B FORM C	
1G		SPACE																
1H	MAIN BREAKER	MAIN BKR			PL 1200	1000											3/0-500KCMIL 4 LUGS/PH, 80% RATED, AL MECH LUG AL/CU CABLE, ELECTRONIC STANDARD TRIP UNIT,	E36573618-CR2-02
																	INT INTLK 1A/1B FORM C, LSI TRIP FUNCTION, PHASE FAILURE/REV/UV RELAY, UV TRIP	
2A	CUTTER HEAD 575 VAC	BRANCH BKR			LJ 400	400											(2)3/0-500KCMIL 1 LUGS/PH, 80% RATED, ADJ. L, ADJ. I TRIP FUNCTION, AL MECH LUG AL/CU CABLE,	E36573618-CR2-03
																	ELECTRONIC STANDARD TRIP UNIT, INT INTLK 1A/1B FORM C	
2I	BOOSTER PUMP	BRANCH BKR			HJ 150	150											14-2/0AWG 1 LUG/PH, 80% RATED, ADJ. L, ADJ. I TRIP FUNCTION, AL MECH LUG AL/CU CABLE,	E36573618-CR2-01
																	ELECTRONIC STANDARD TRIP UNIT, INT INTLK 1A/1B FORM C	
2M	RETURN PUMP	BRANCH BKR			HJ 150	150											14-2/0AWG 1 LUG/PH, 80% RATED, ADJ. L, ADJ. I TRIP FUNCTION, AL MECH LUG AL/CU CABLE,	E36573618-CR2-01
																	ELECTRONIC STANDARD TRIP UNIT, INT INTLK 1A/1B FORM C	
2Q		SPACE																
3A	SMALL MTBM HEAD POWER	6" BRANCH BKR			HJ 150	30											14-3/0AWG 1 LUG/PH, 80% RATED, AL MECH LUG AL/CU CABLE, INT INTLK 1A/1B FORM C	E36573618-CR2-04
3C	COOLING PUMP	6" BRANCH BKR			HJ 150	15											14-3/0AWG 1 LUG/PH, 80% RATED, AL MECH LUG AL/CU CABLE, INT INTLK 1A/1B FORM C	E36573618-CR2-05
3E	FUTURE MID PUMP	6" BRANCH BKR			JJ 250	200											3/0-250 1 LUG/PH, 80% RATED, AL MECH LUG AL/CU CABLE, INT INTLK 1A/1B FORM C	E36573618-CR2-06
3G	FEED PUMP	6" BRANCH BKR			JJ 250	175											4-4/0 AWG 1 LUG/PH, 80% RATED, AL MECH LUG AL/CU CABLE, INT INTLK 1A/1B FORM C	E36573618-CR2-07
3I	PANELBOARD	PANEL BOARD	100A		OD												16 CIRCUITS, FULLY RATED, NQ PANELBOARD	E36573618-CR2-08
3R		1PH DIST XFMR	5 kVA		HJ 150	15											SECONDARY WIRE TO PANELBOARD	E36573618-CR2-09
UNIT LOC	NAMEPLATE DESIGNATION	UNIT TYPE	SIZE	HP	FRAME AMPS	TRIP AMPS	CONTROL SOURCE	VA	PRI FUSE	SEC FUSE SIZE	NO INTERLOCKS	NC INTERLOCKS	ON LIGHT PILOT DEVICES:	OFF LIGHT PILOT DEVICES:	ADDL P/L 22 mm **	SS / PB 22 mm **	OTHER UNIT FEATURES	ELEMENTARY #

(continued on next page)

MCC Electrical Schematics - Large MTBM Head Power, Pumps: Booster - Return

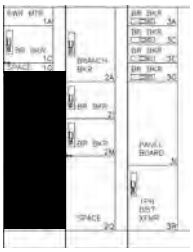
- *Large MTBM Head Power: Bucket Unit 1C*
- *Booster Pump: Bucket Unit 2I*
- *Return Pump: Bucket Unit 2M*

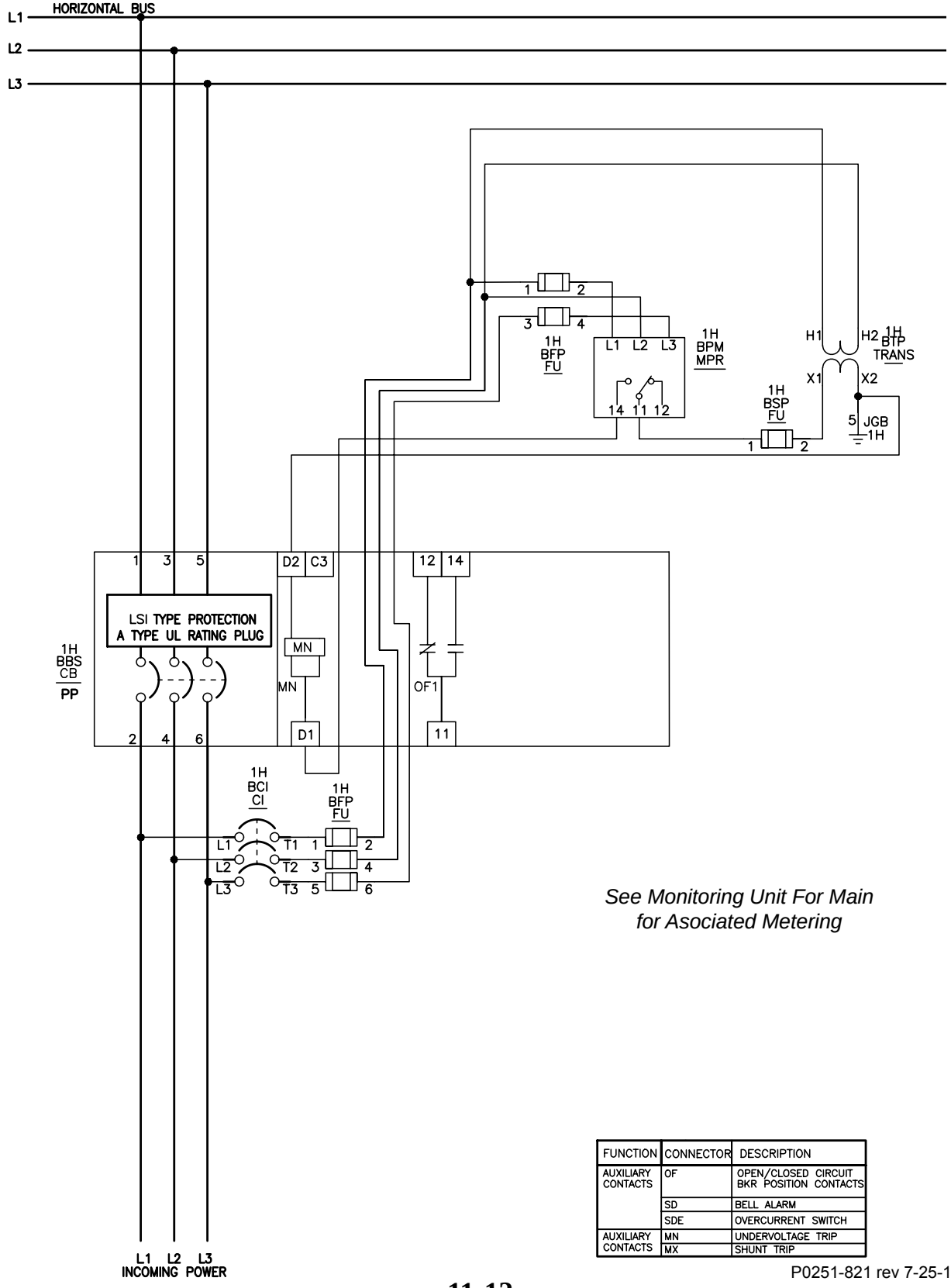




MCC Electrical Schematics - Main Breaker

- Bucket Unit 1H





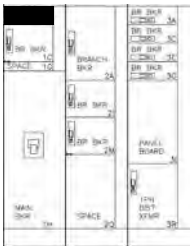
See Monitoring Unit For Main for Asociated Metering

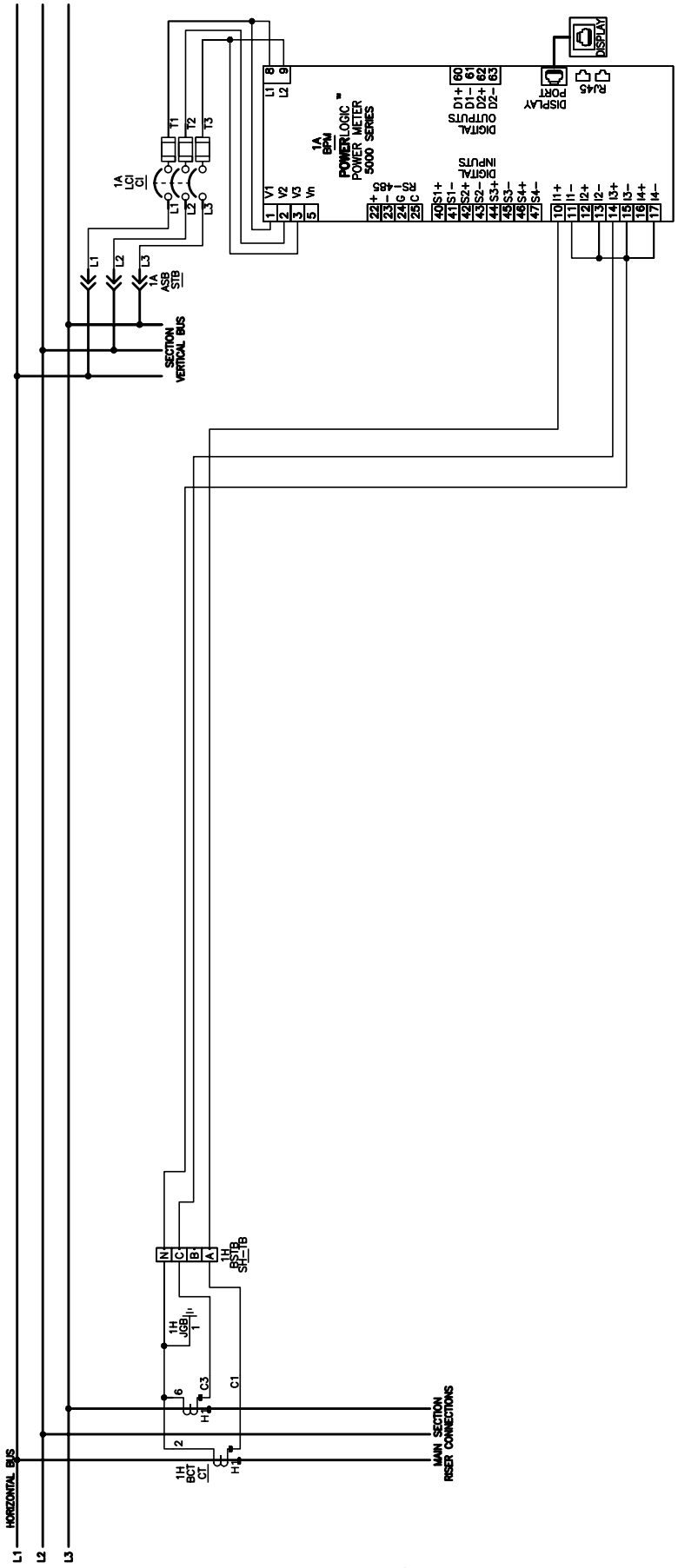
FUNCTION	CONNECTOR	DESCRIPTION
AUXILIARY CONTACTS	OF	OPEN/CLOSED CIRCUIT BKR POSITION CONTACTS
	SD	BELL ALARM
	SDE	OVERCURRENT SWITCH
AUXILIARY CONTACTS	MN	UNDERVOLTAGE TRIP
	MX	SHUNT TRIP

P0251-821 rev 7-25-17

MCC Electrical Schematics - Monitoring Unit For Main

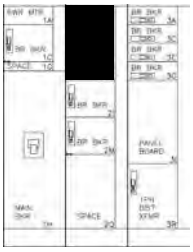
- Bucket Unit 1A

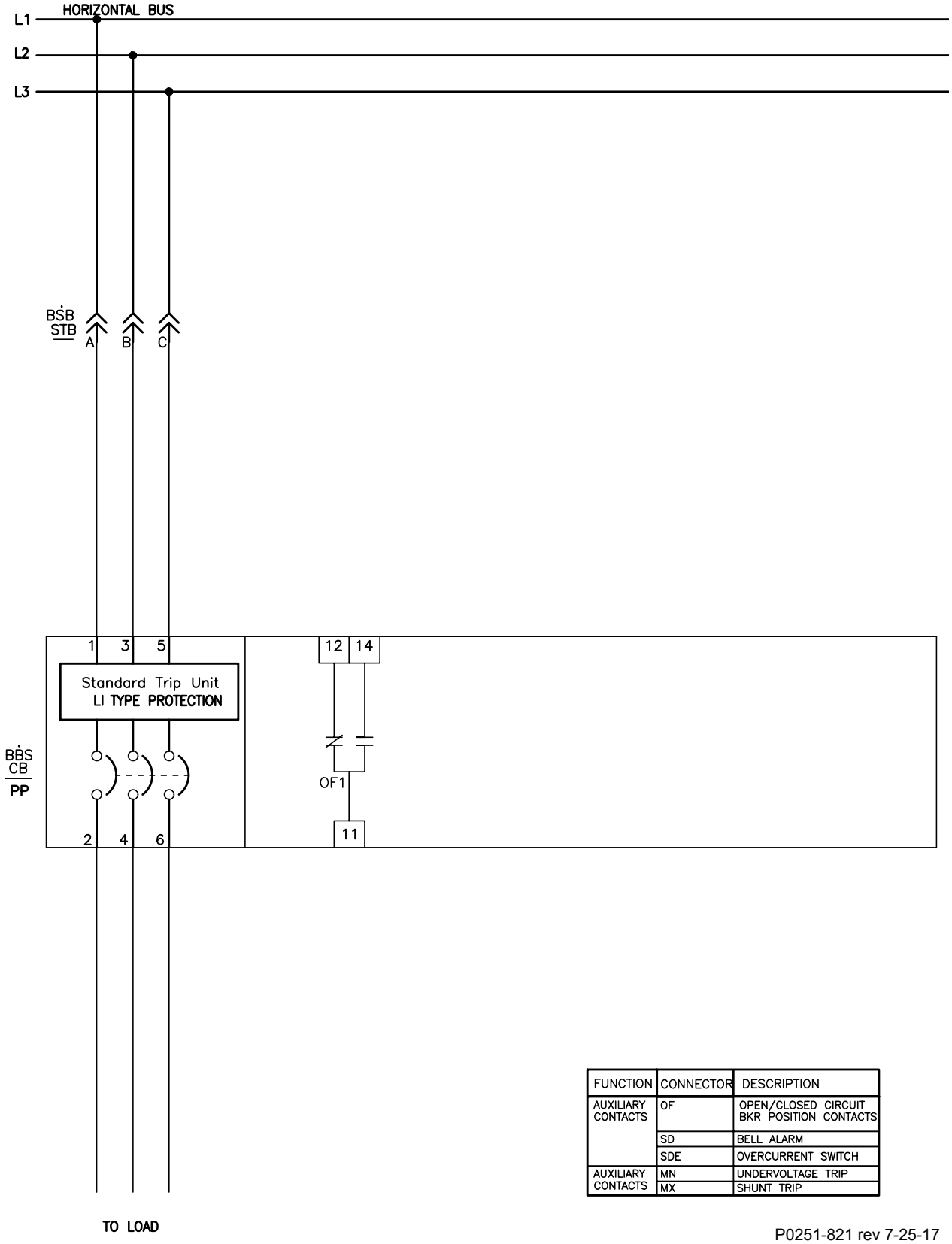




MCC Electrical Schematics - Cutter Head 575 VAC

- Bucket Unit 2A

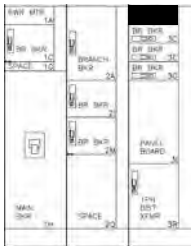


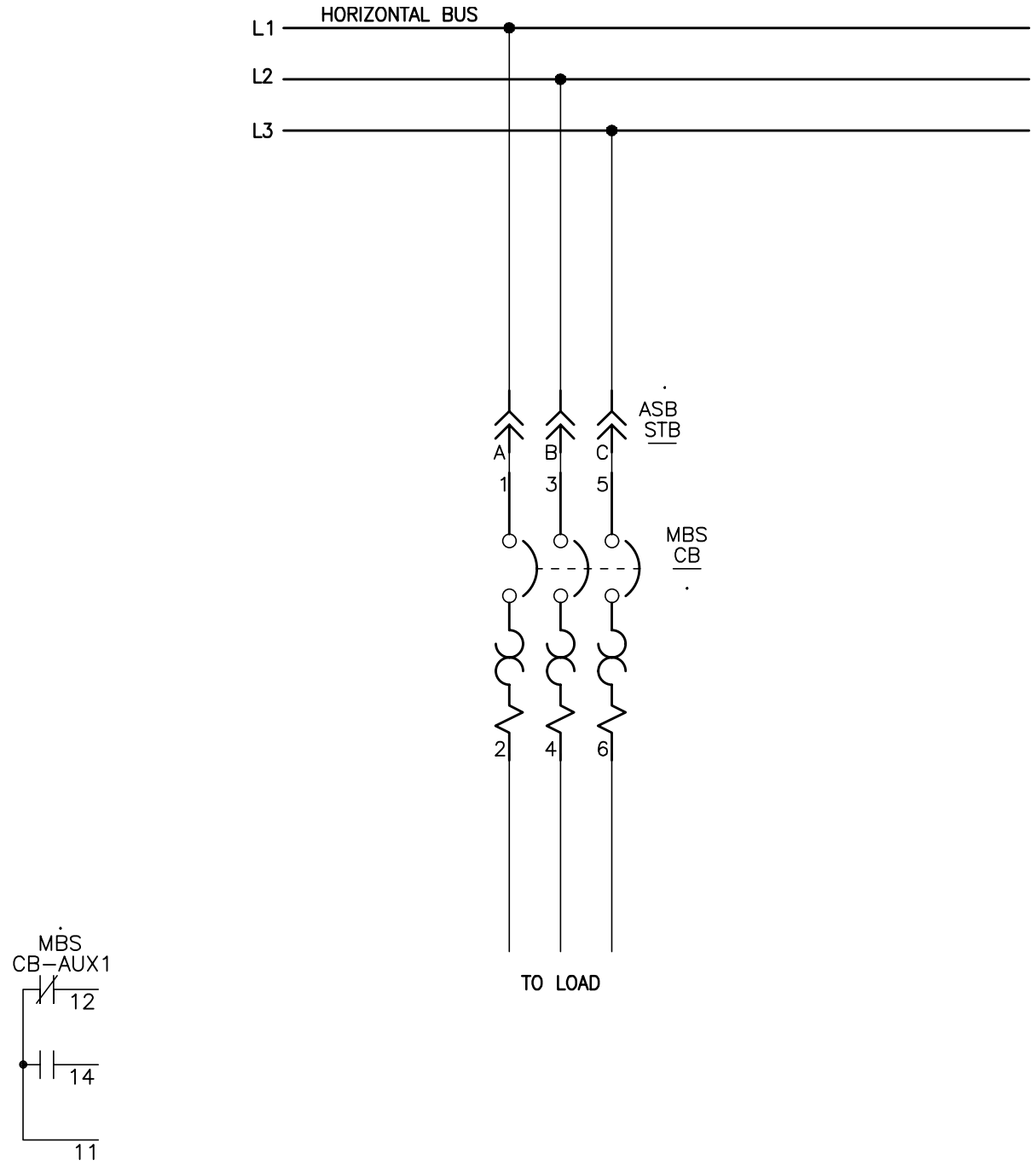


FUNCTION	CONNECTOR	DESCRIPTION
AUXILIARY CONTACTS	OF	OPEN/CLOSED CIRCUIT BKR POSITION CONTACTS
	SD	BELL ALARM
	SDE	OVERCURRENT SWITCH
AUXILIARY CONTACTS	MN	UNDERVOLTAGE TRIP
	MX	SHUNT TRIP

MCC Electrical Schematics - Small MTBM Head Power

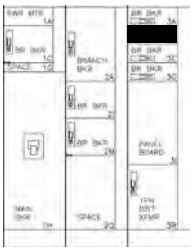
- Bucket Unit 3A

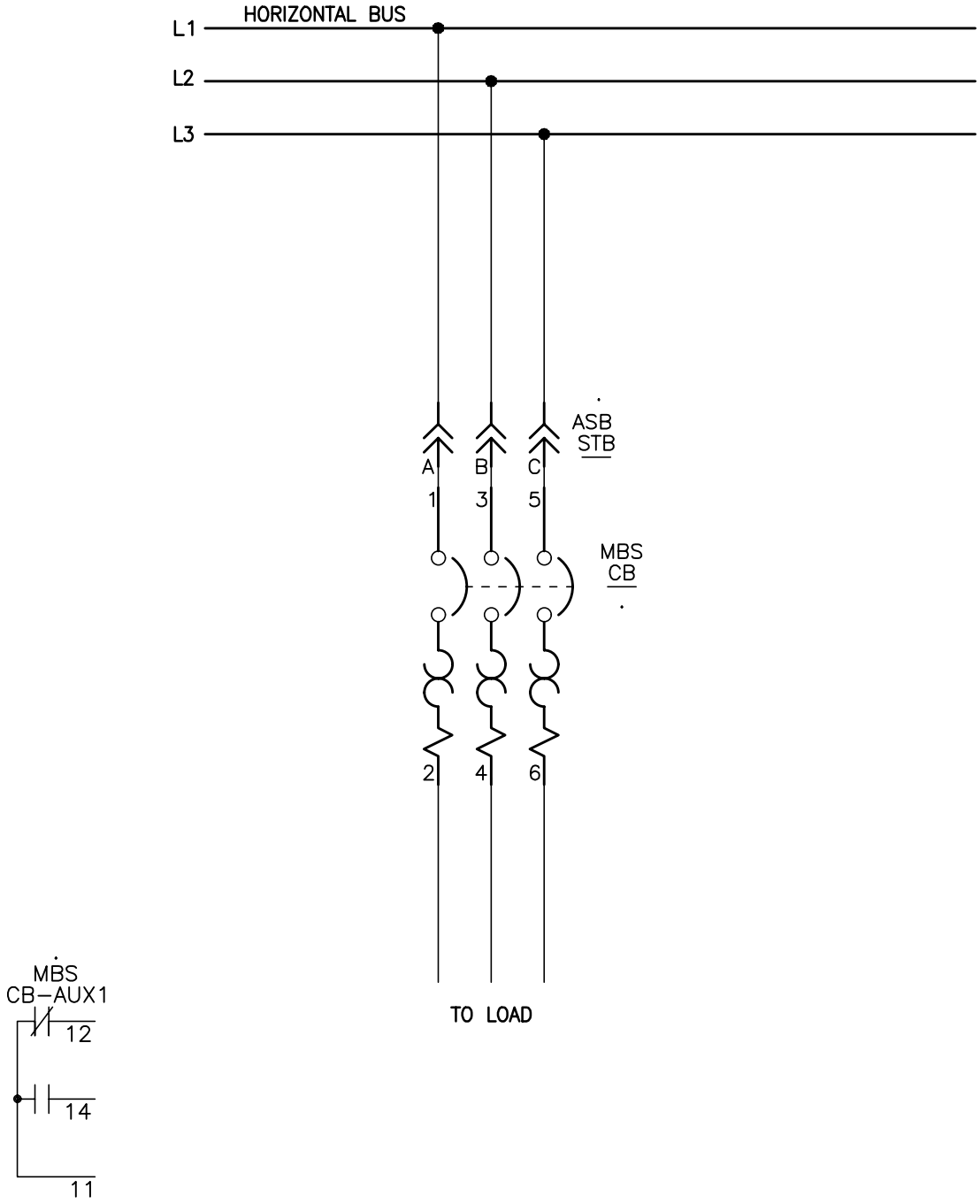




MCC Electrical Schematics - Cooling Pump

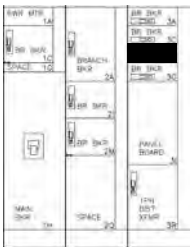
- Bucket Unit 3C

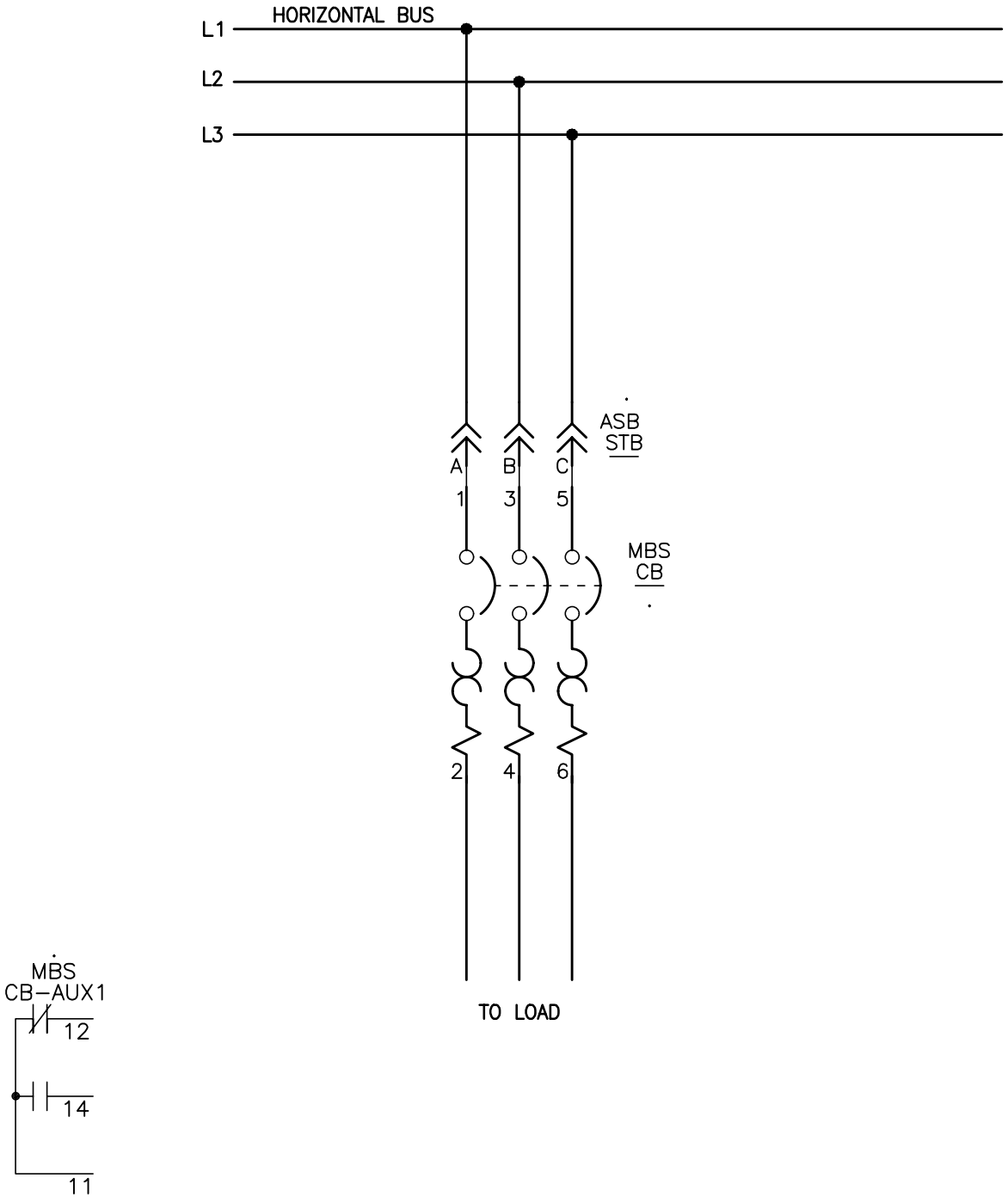




MCC Electrical Schematics - Future Mid Pump

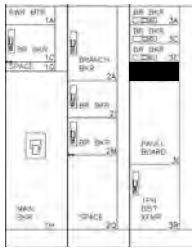
- Bucket Unit 3E

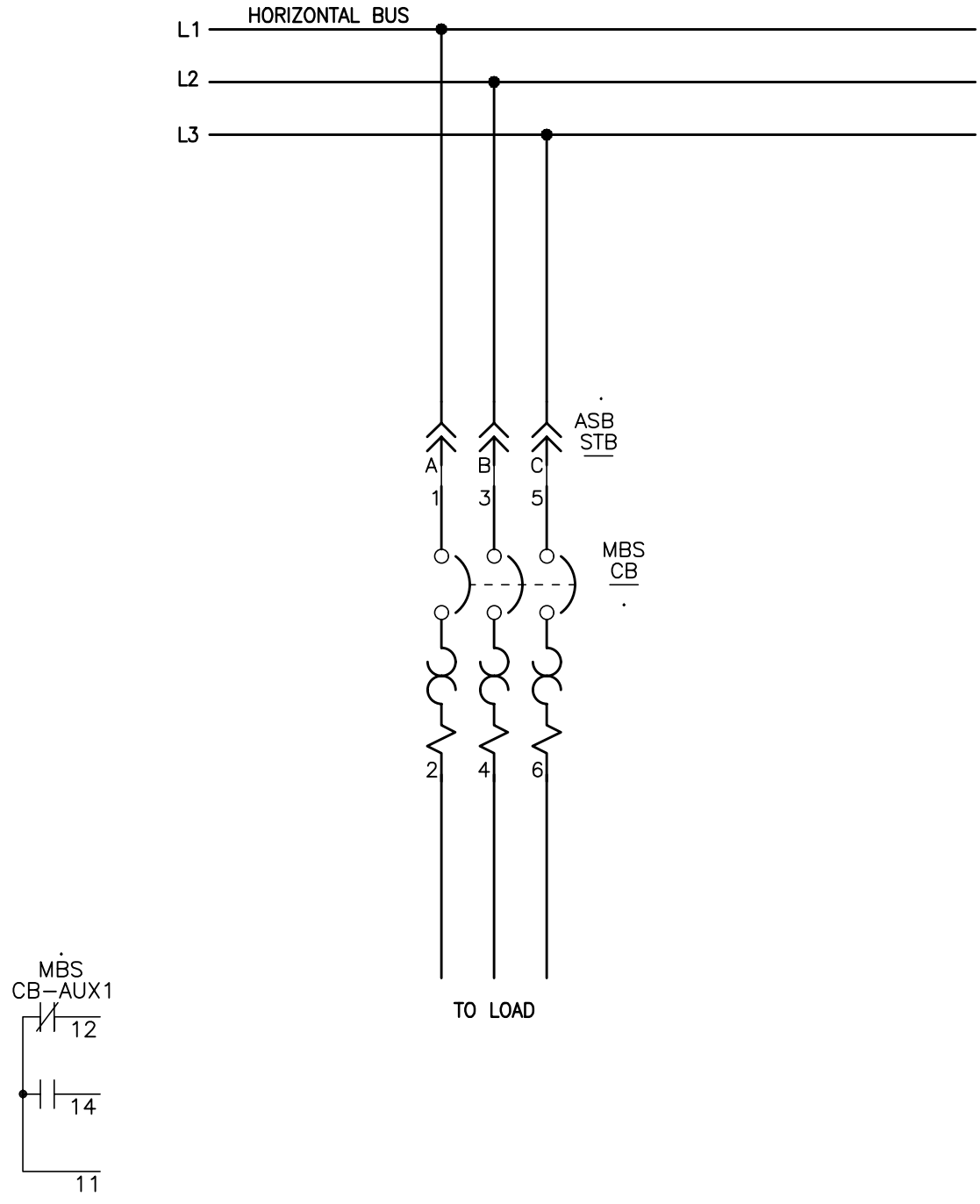




MCC Electrical Schematics - Feed Pump

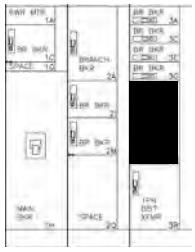
- Bucket Unit 3G

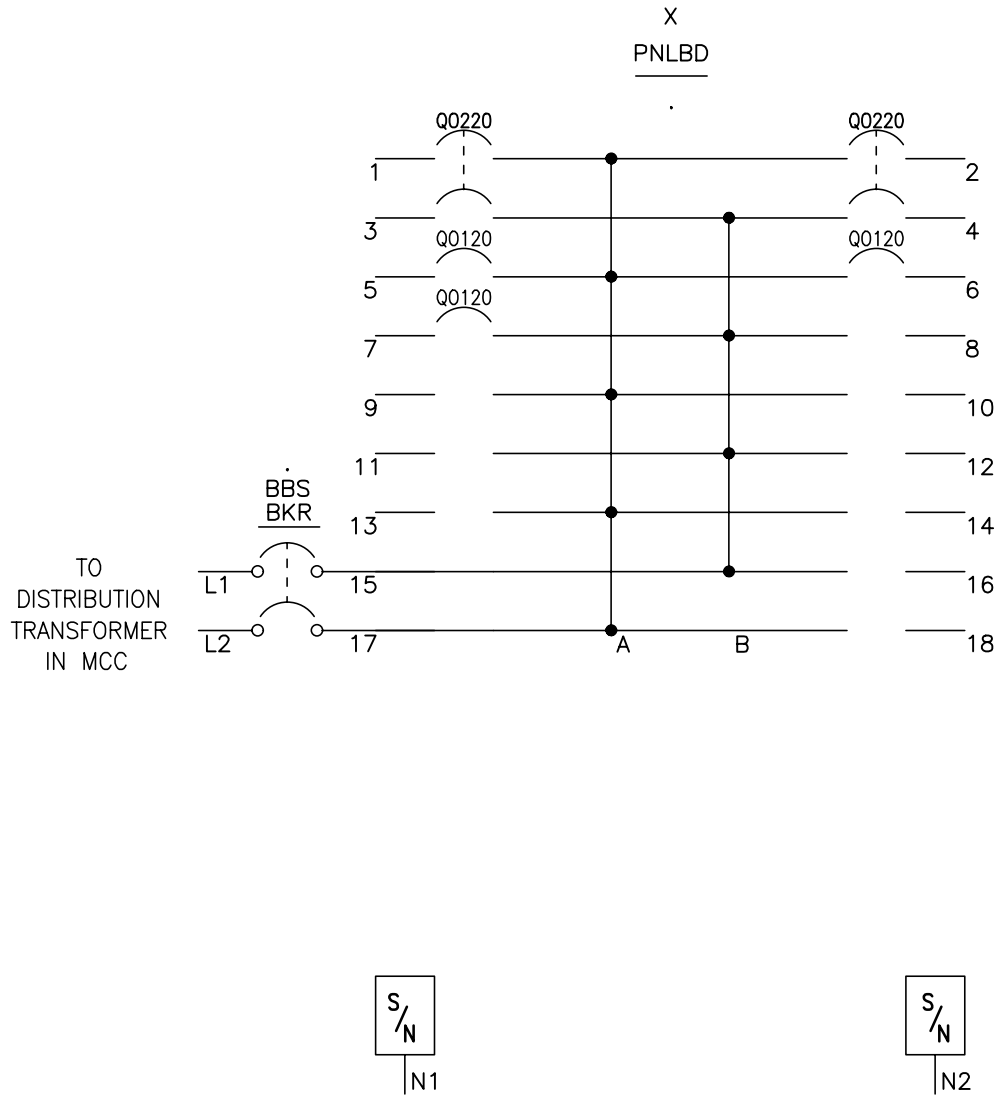




MCC Electrical Schematics - Panel Board

- Bucket Unit 3I

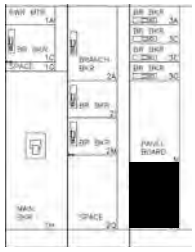


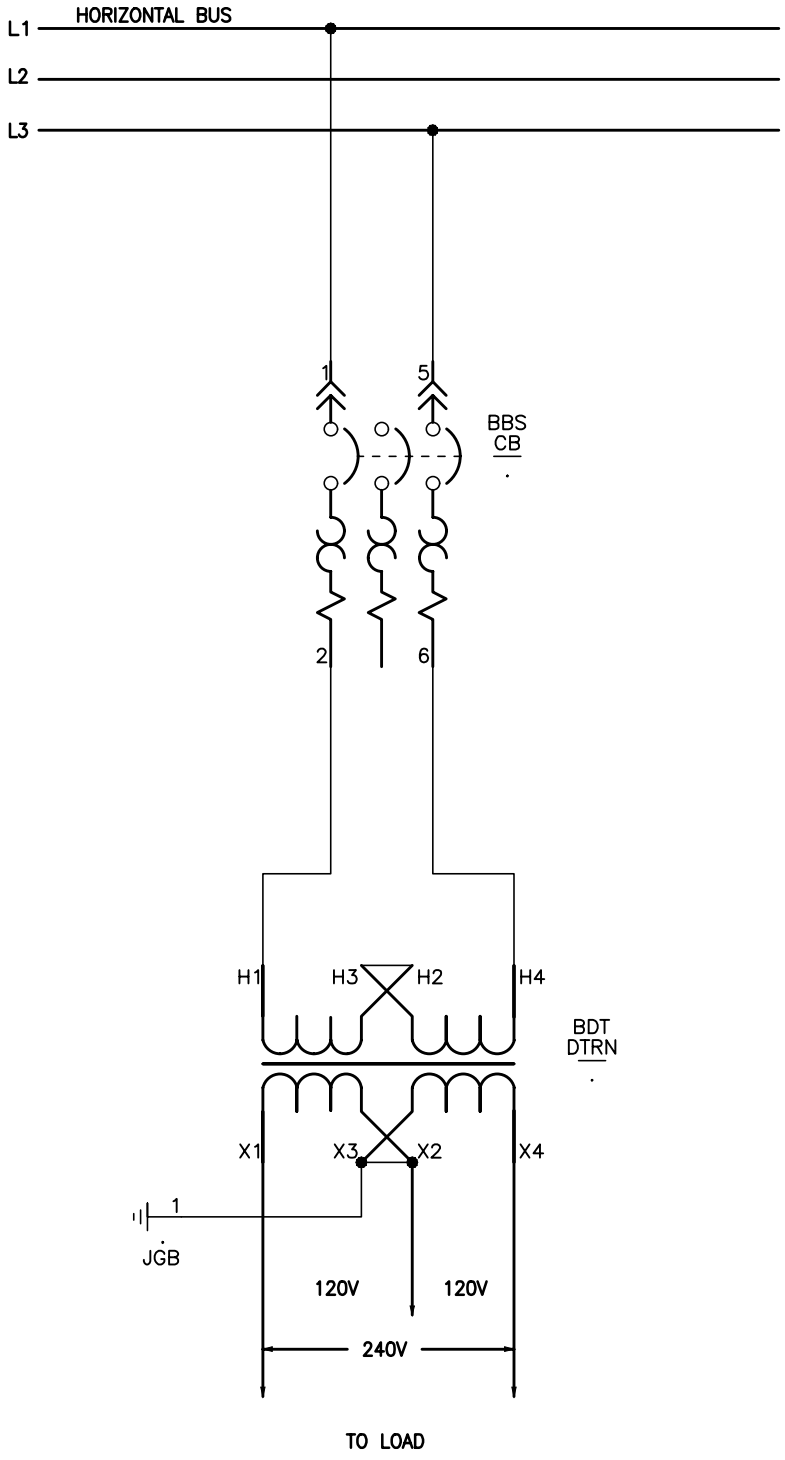


Note: Connect GFI/EPD/EPE
Neutral to Panel Neutral

MCC Electrical Schematics - Transformer

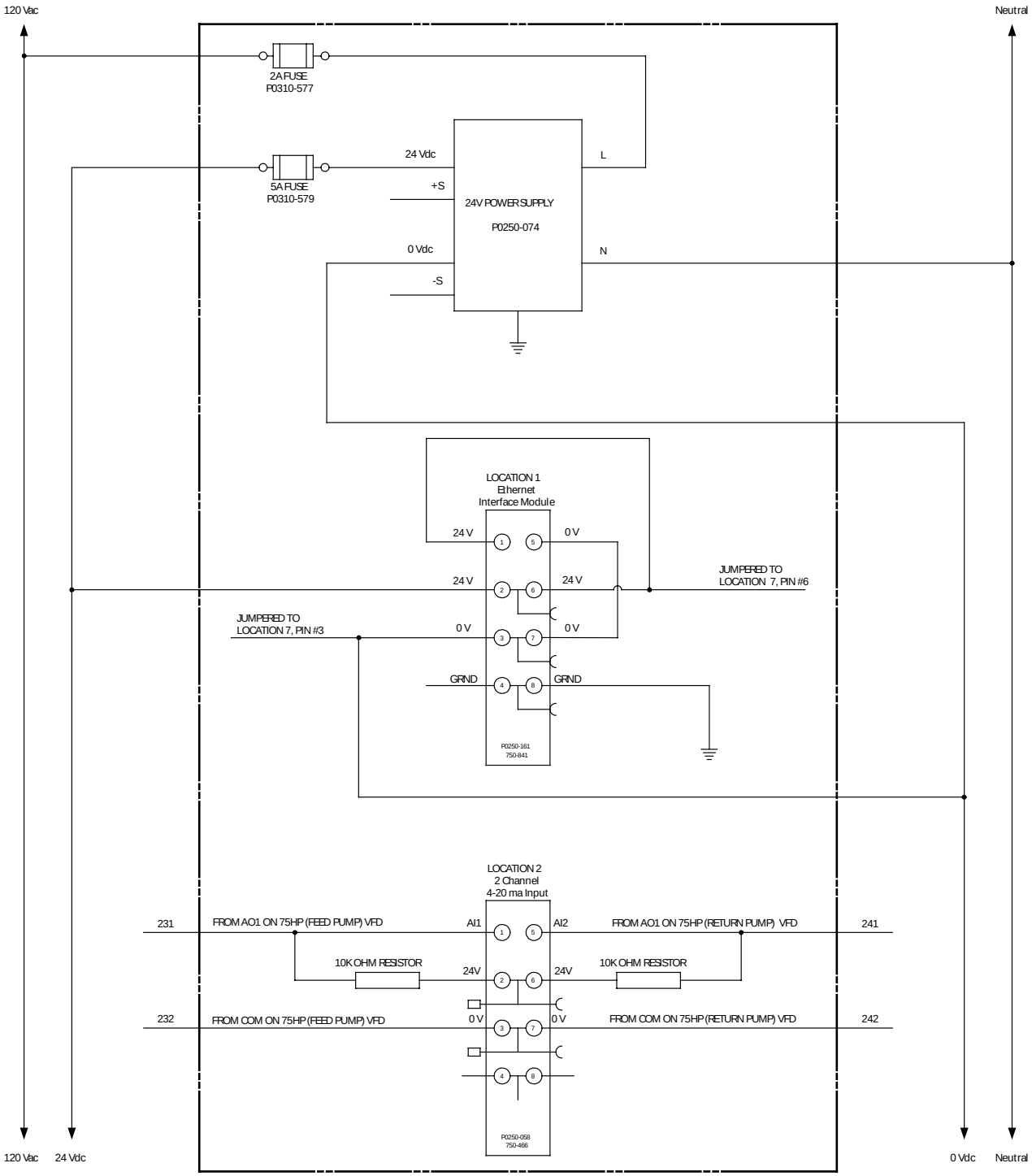
- Bucket Unit 3R





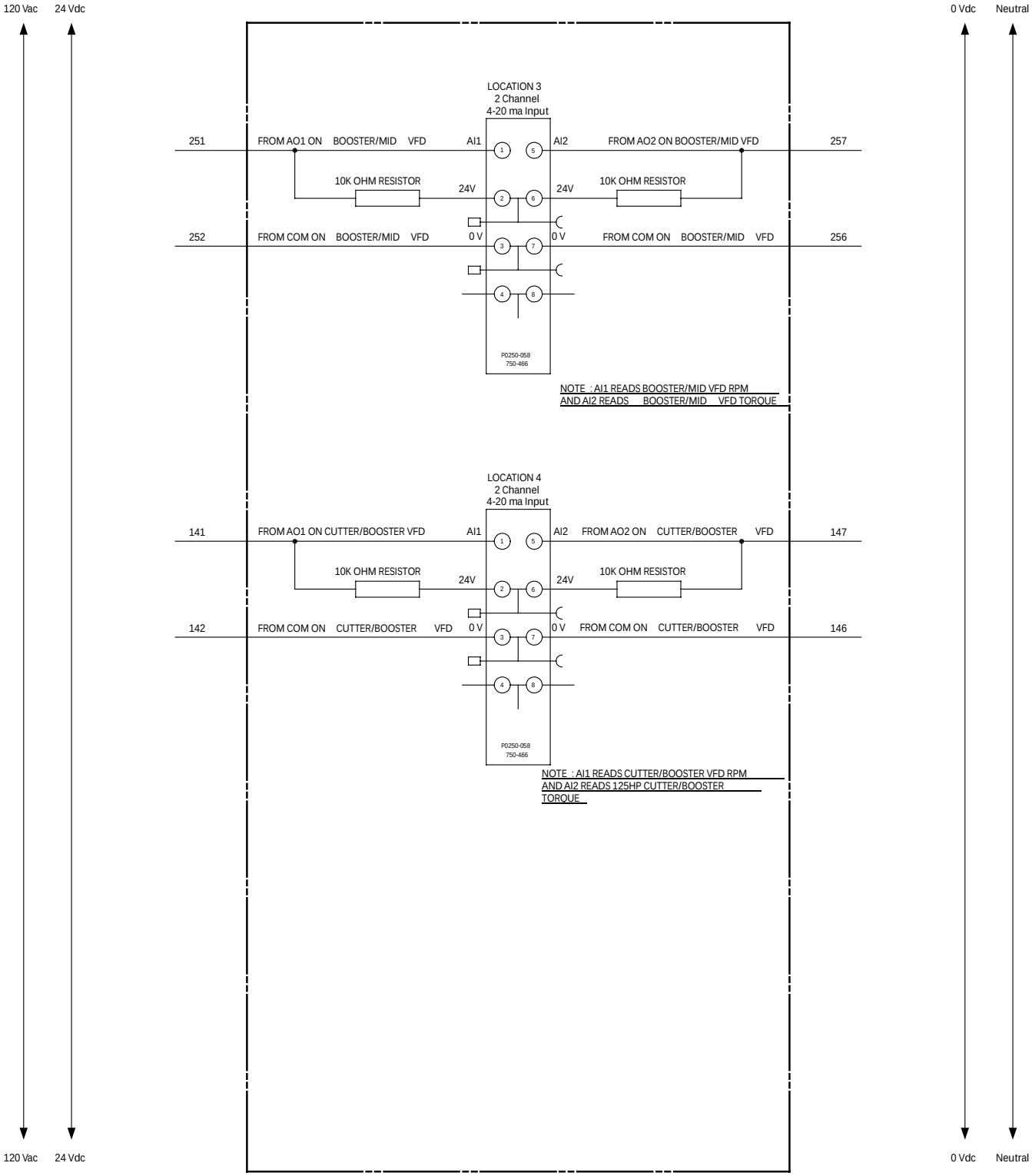
CONTROL CONSOLE ELECTRICAL SCHEMATICS

Electrical Schematic - Part 1 of 13



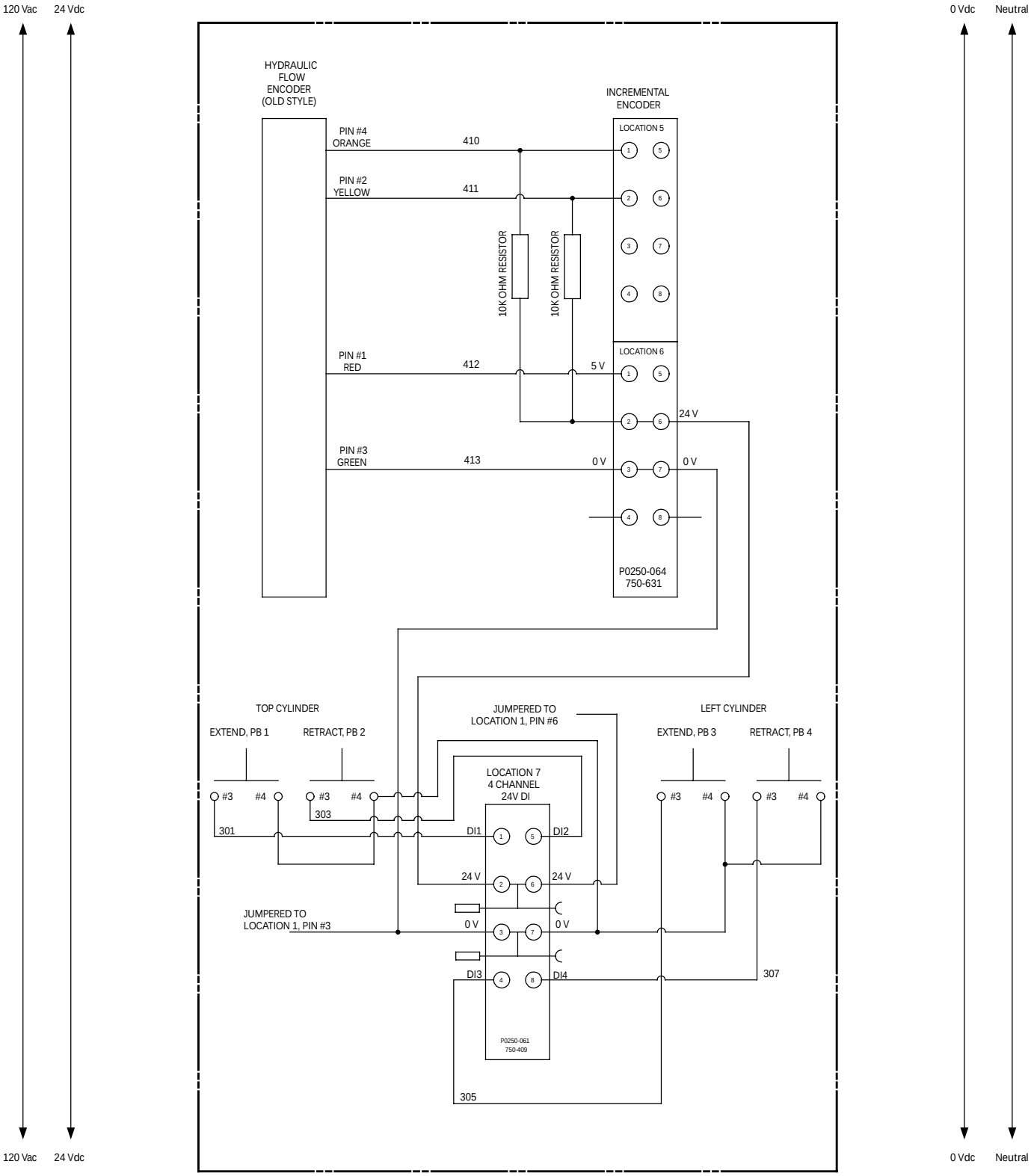
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Control Console Electrical Schematics (continued)
Electrical Schematic - Part 2 of 13



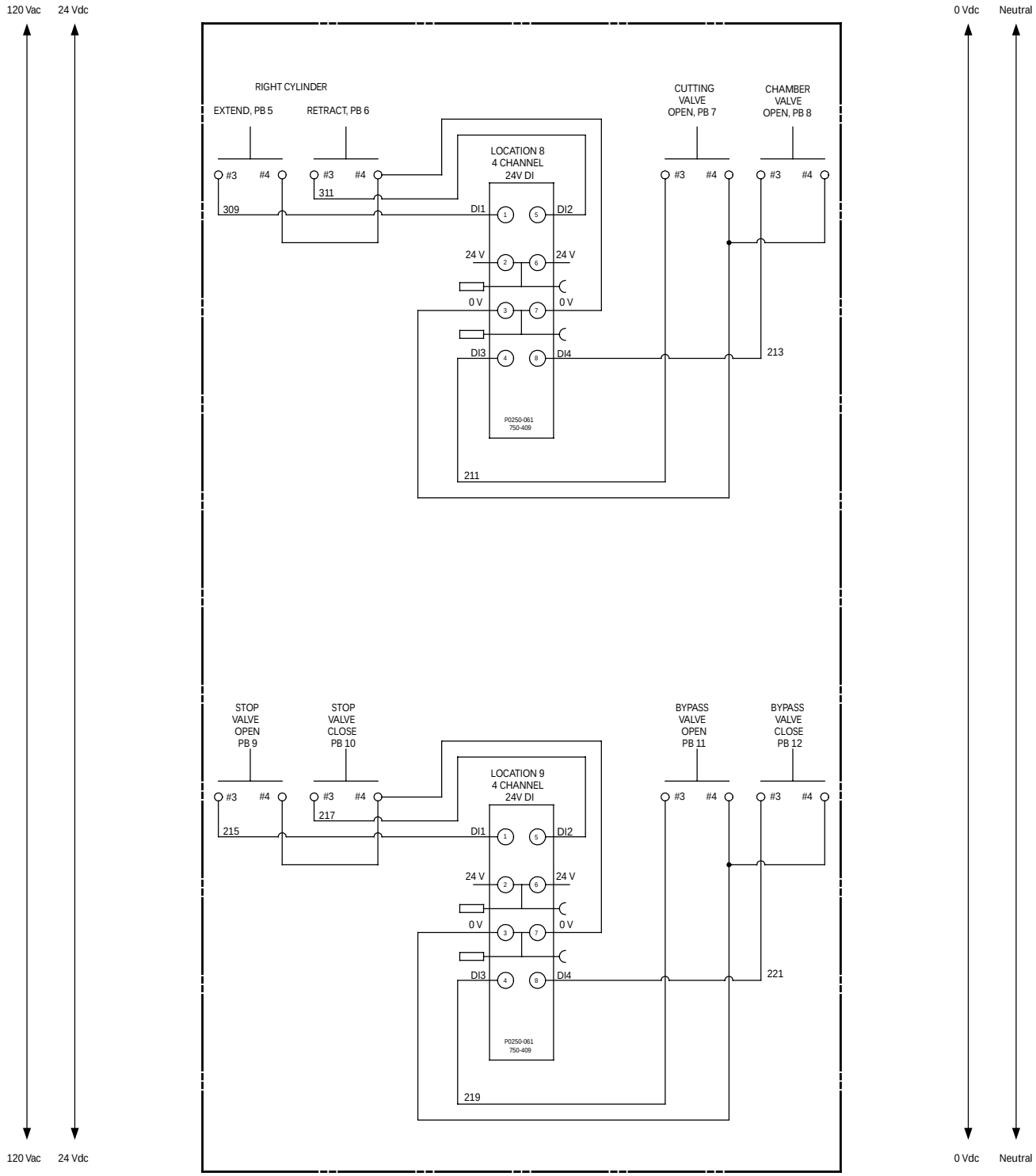
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Control Console Electrical Schematics (continued)
Electrical Schematic - Part 3 of 13



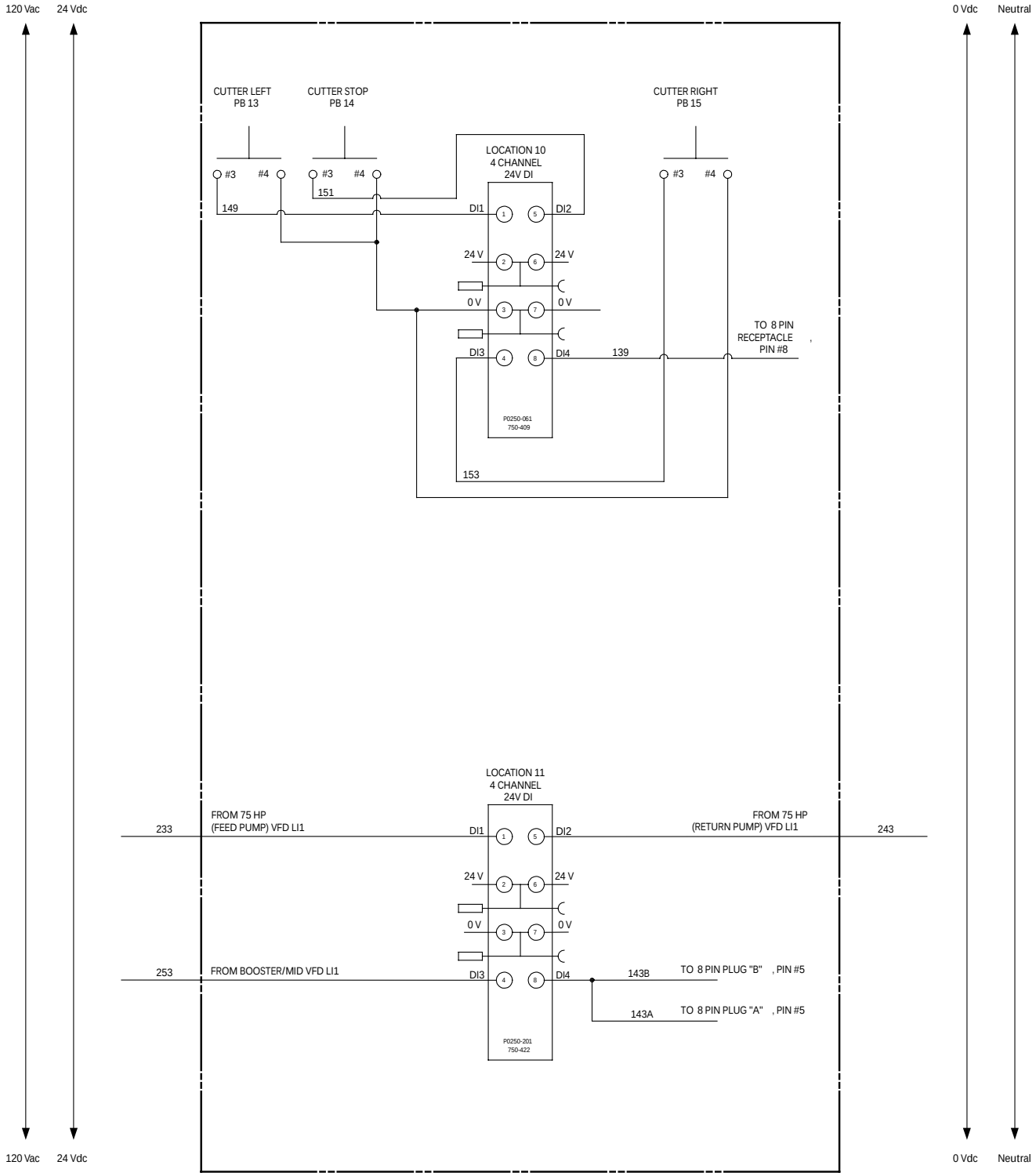
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Control Console Electrical Schematics (continued)
Electrical Schematic - Part 4 of 13



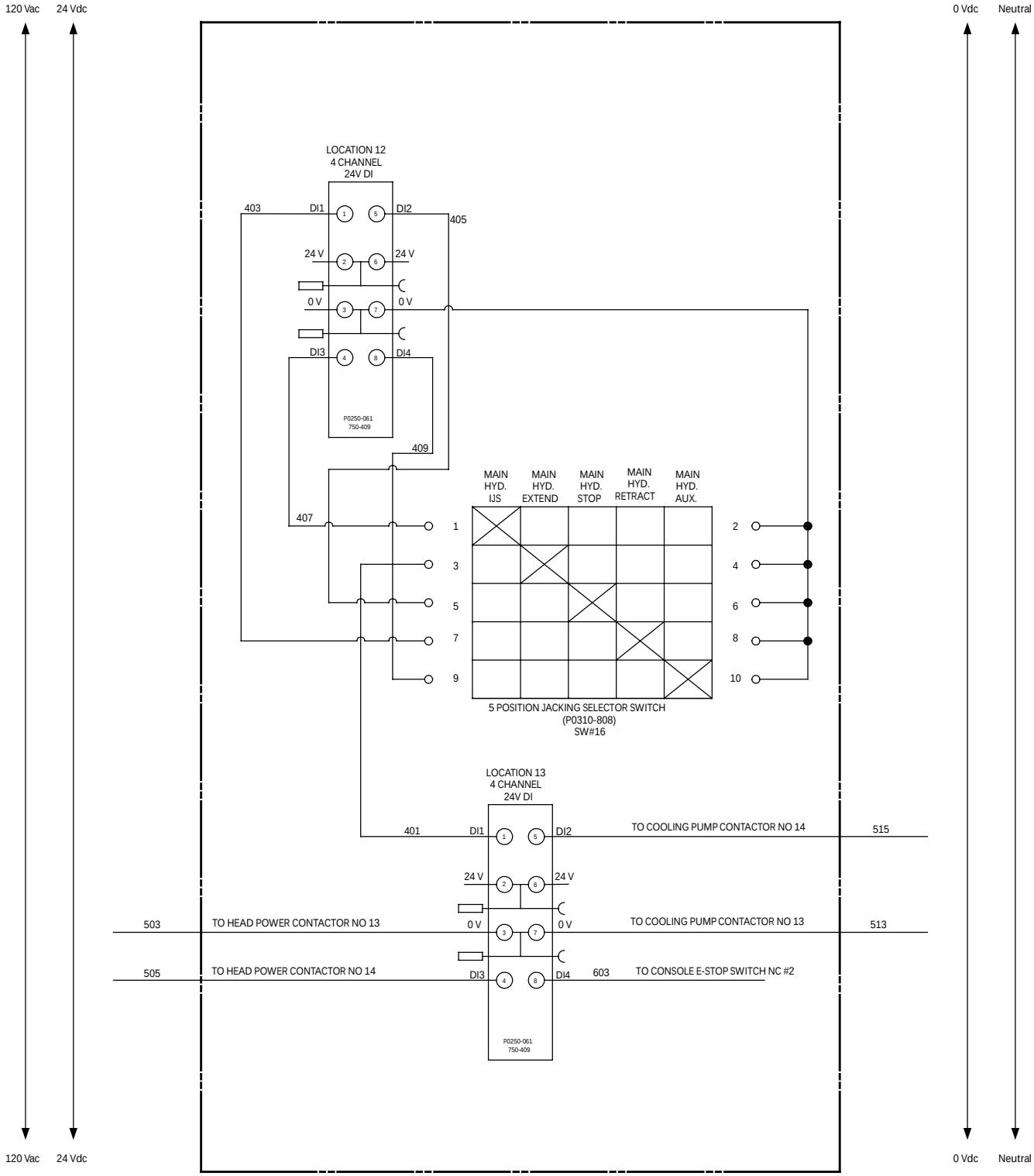
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Control Console Electrical Schematics (continued)
Electrical Schematic - Part 5 of 13



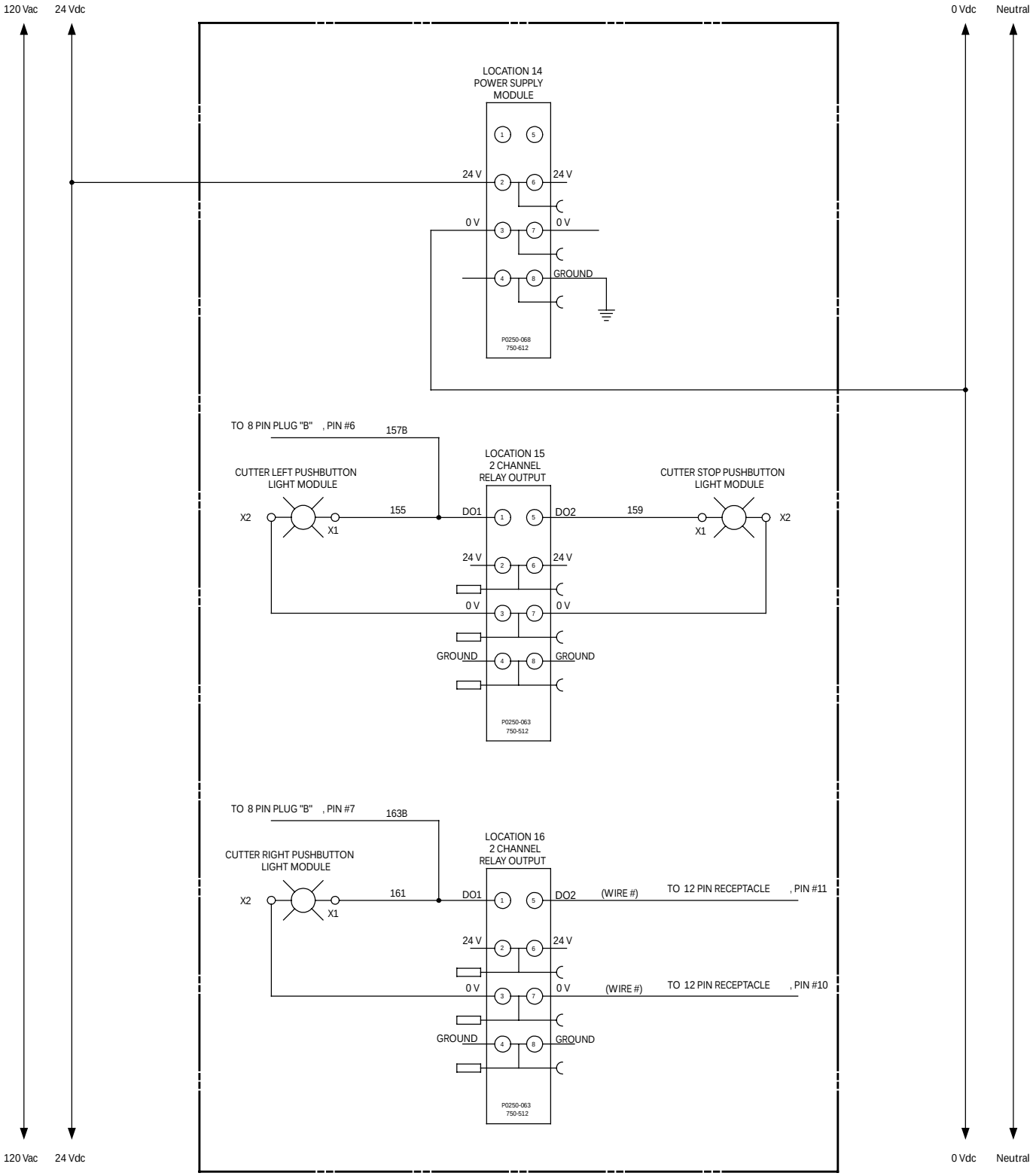
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Control Console Electrical Schematics (continued)
Electrical Schematic - Part 6 of 13



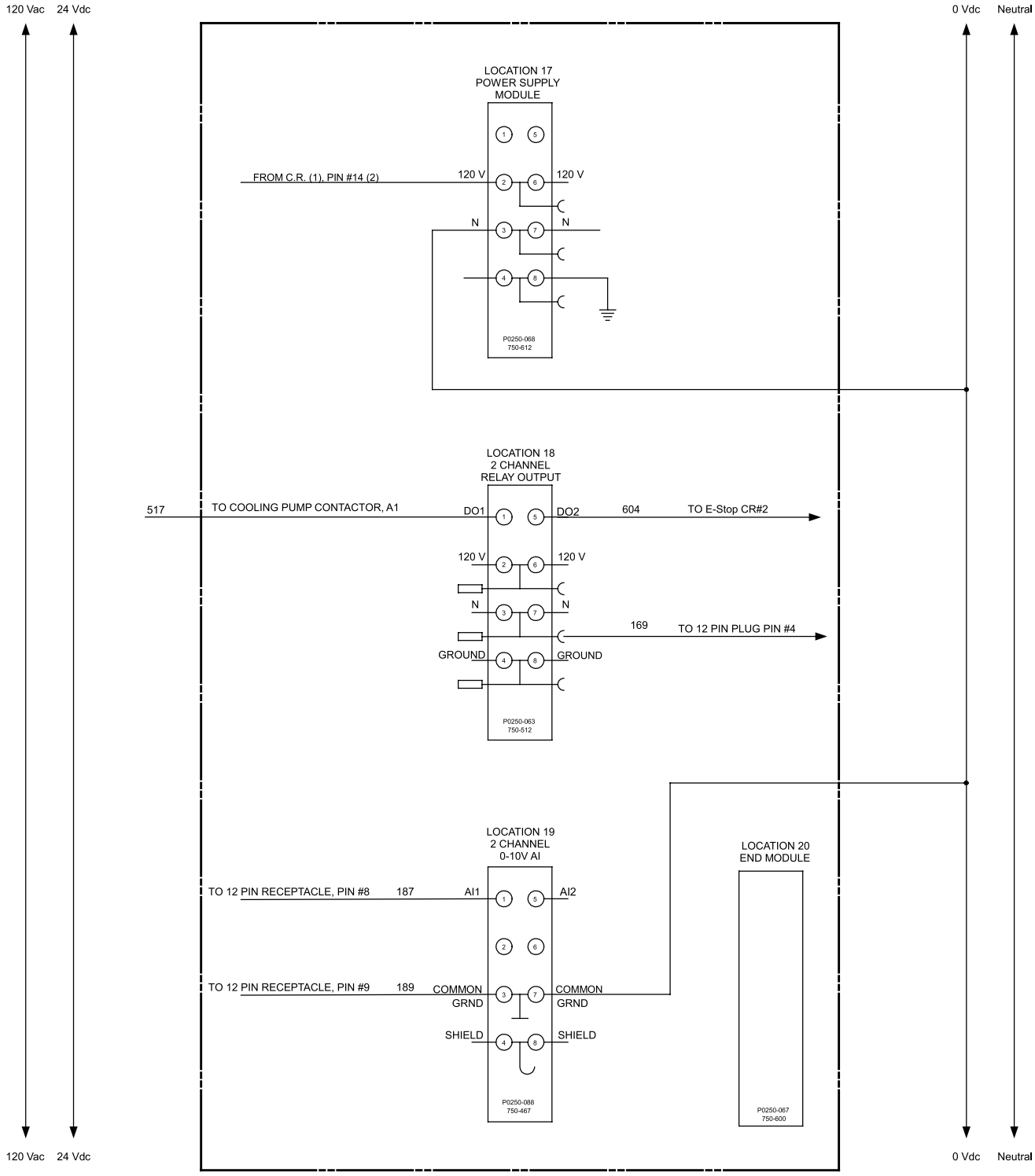
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Control Console Electrical Schematics (continued)
Electrical Schematic - Part 7 of 13



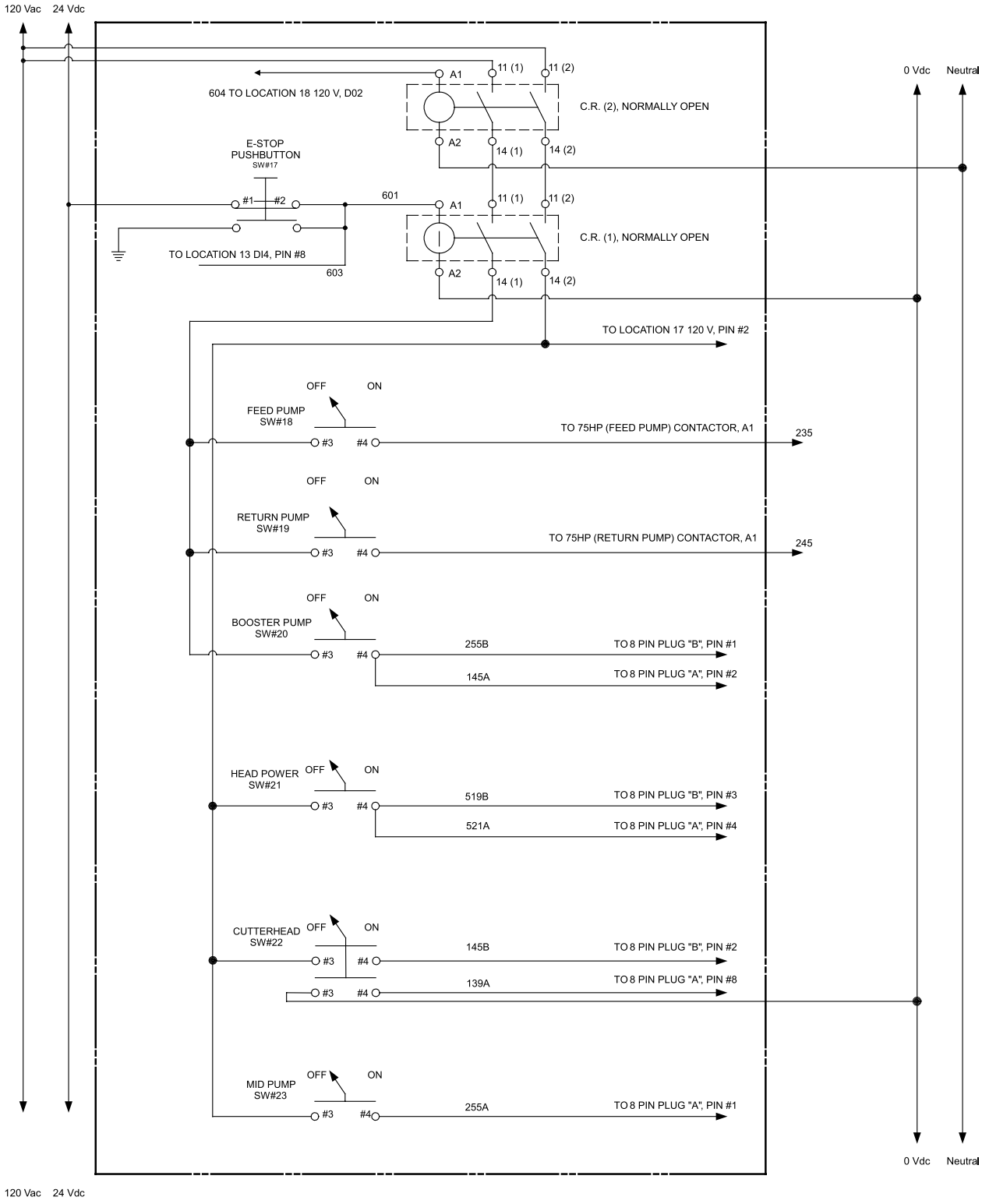
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Control Console Electrical Schematics (continued)
Electrical Schematic - Part 8 of 13



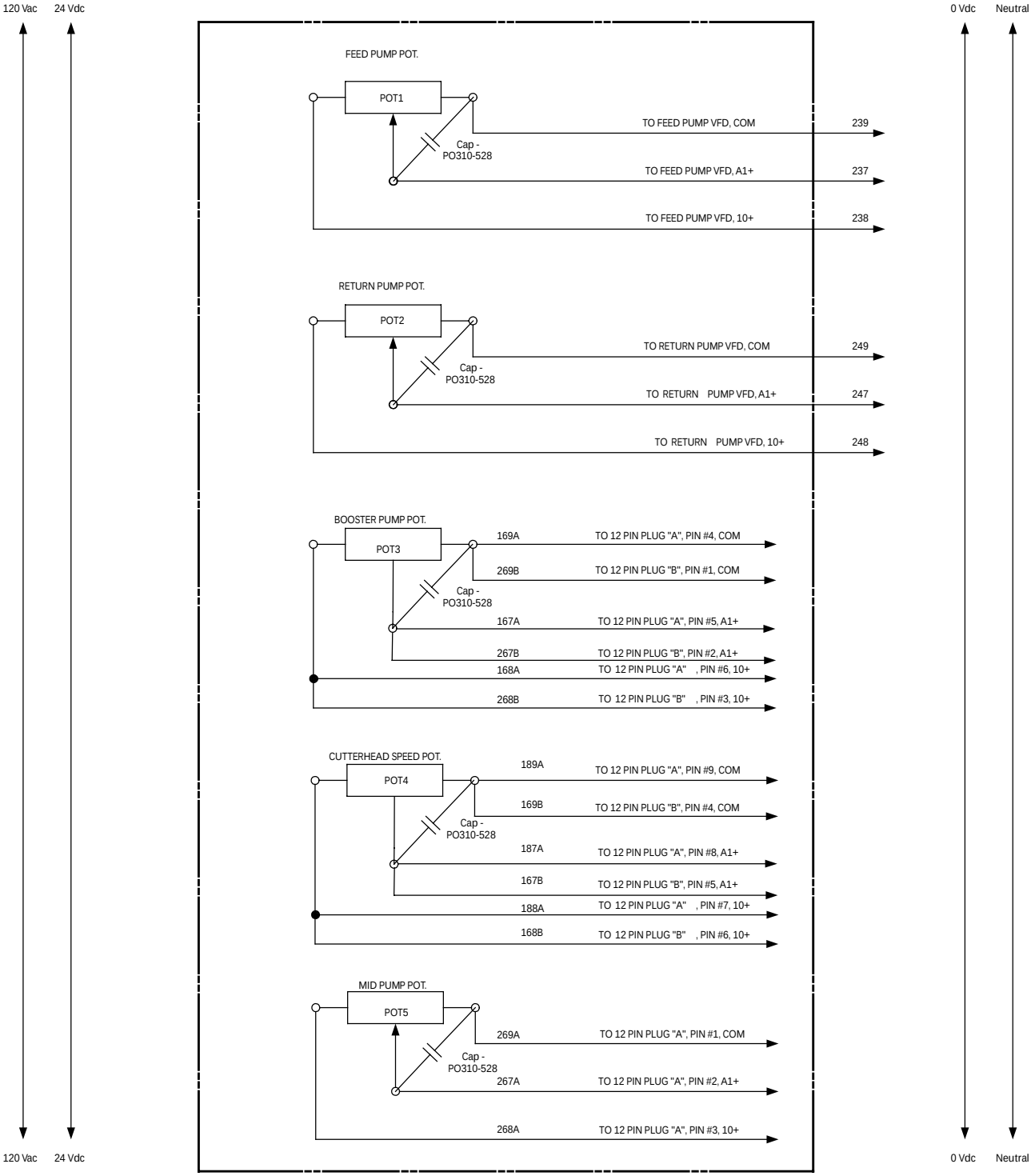
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Control Console Electrical Schematics (continued)
Electrical Schematic - Part 9 of 13



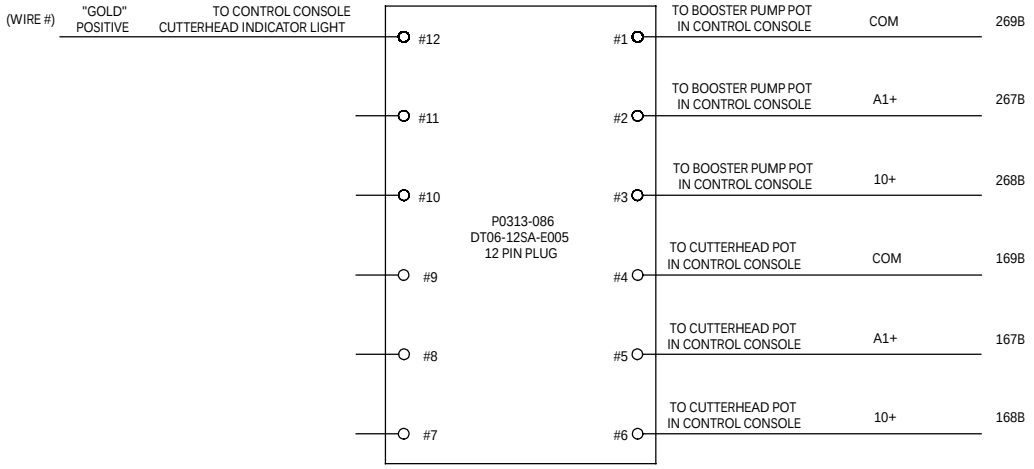
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Control Console Electrical Schematics (continued)
Electrical Schematic - Part 10 of 13

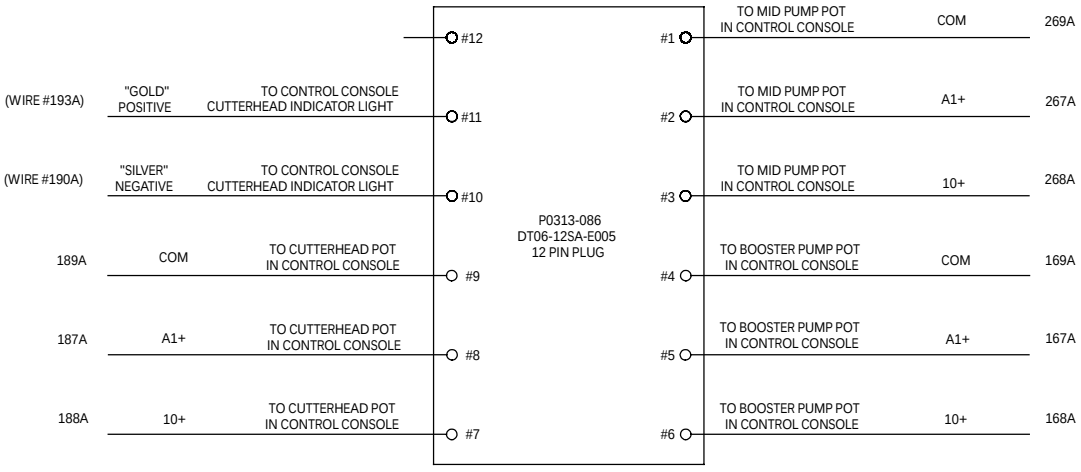


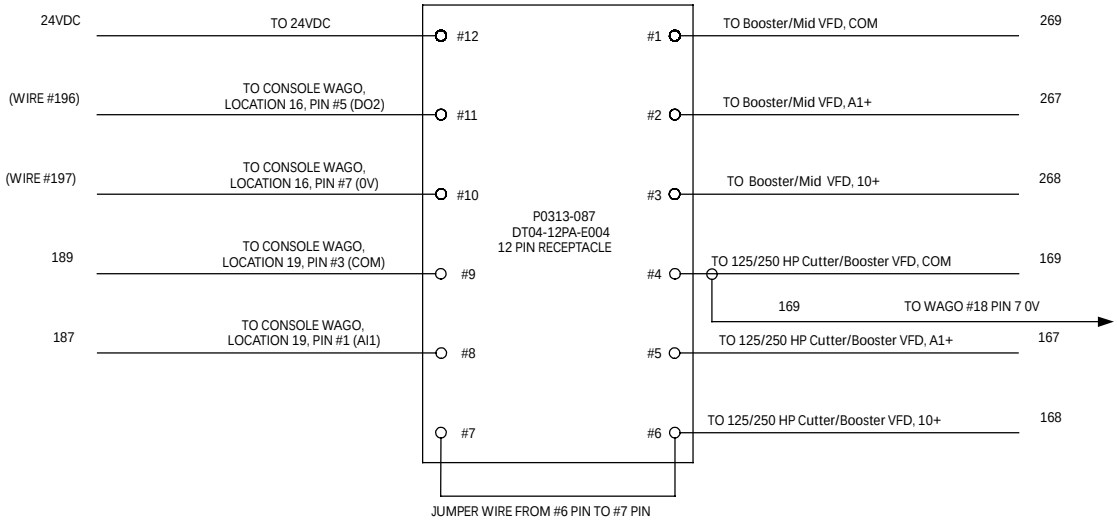
Control Console Electrical Schematics (continued)
Electrical Schematic - Part 11 of 13

"B" PLUG FOR SMALL MTBM



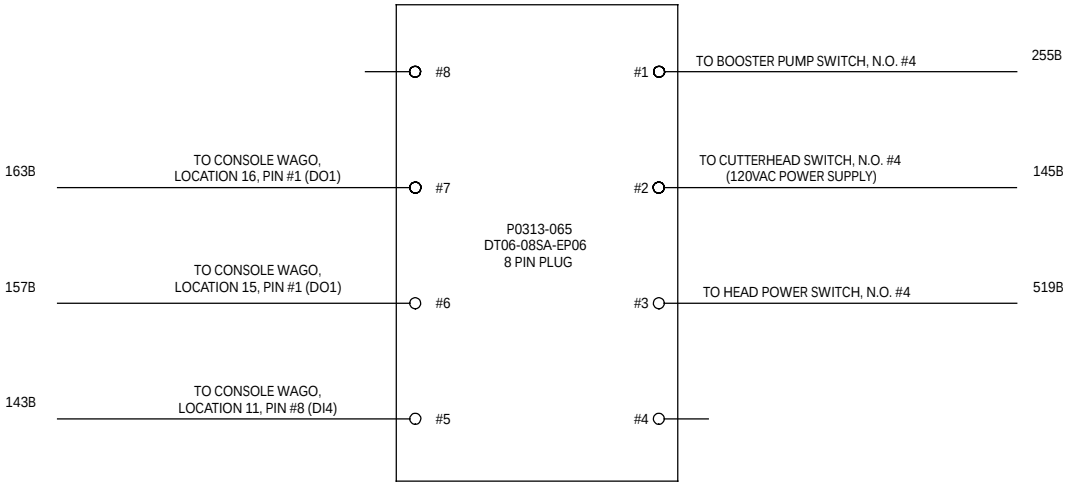
"A" PLUG FOR LARGE MTBM



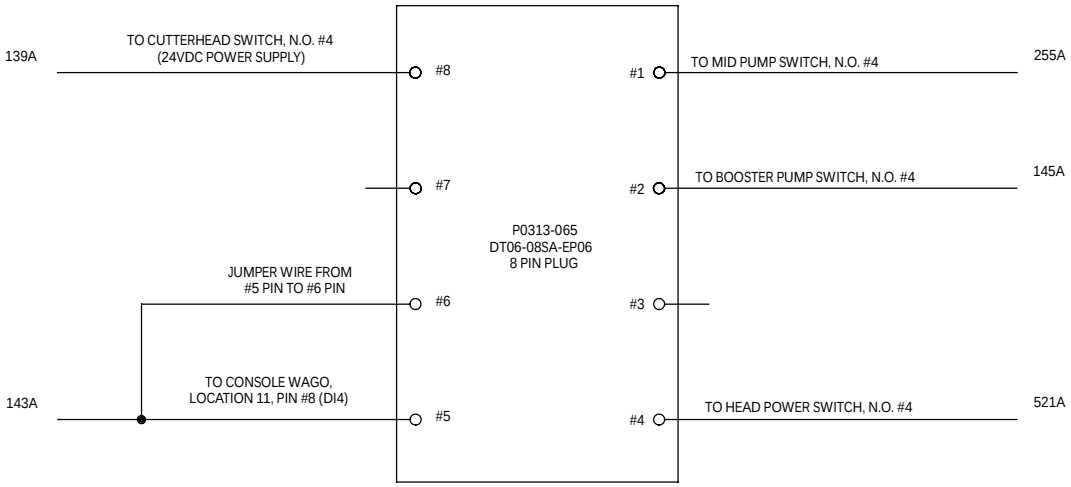


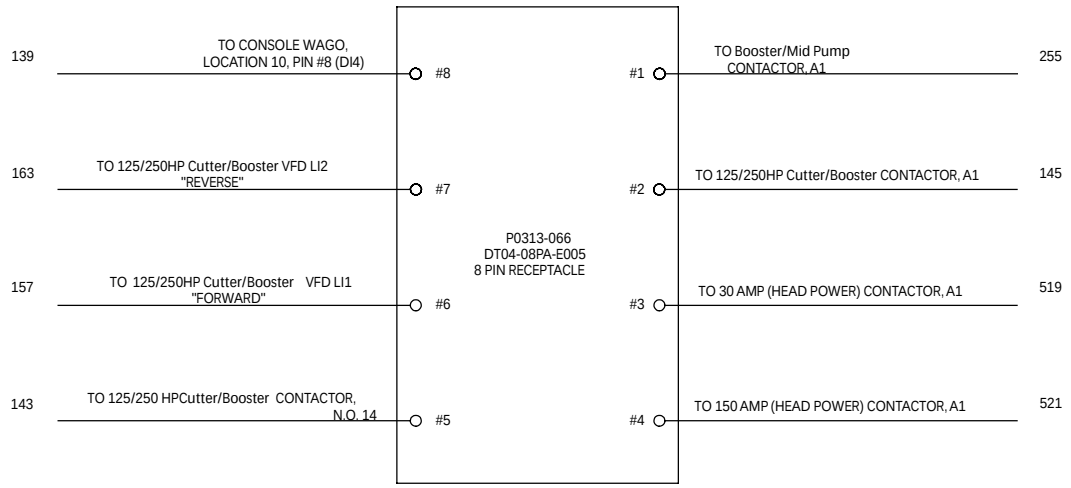
Control Console Electrical Schematics (continued)
Electrical Schematic - Part 12 of 13

"B " PLUG FOR SMALL MTBM

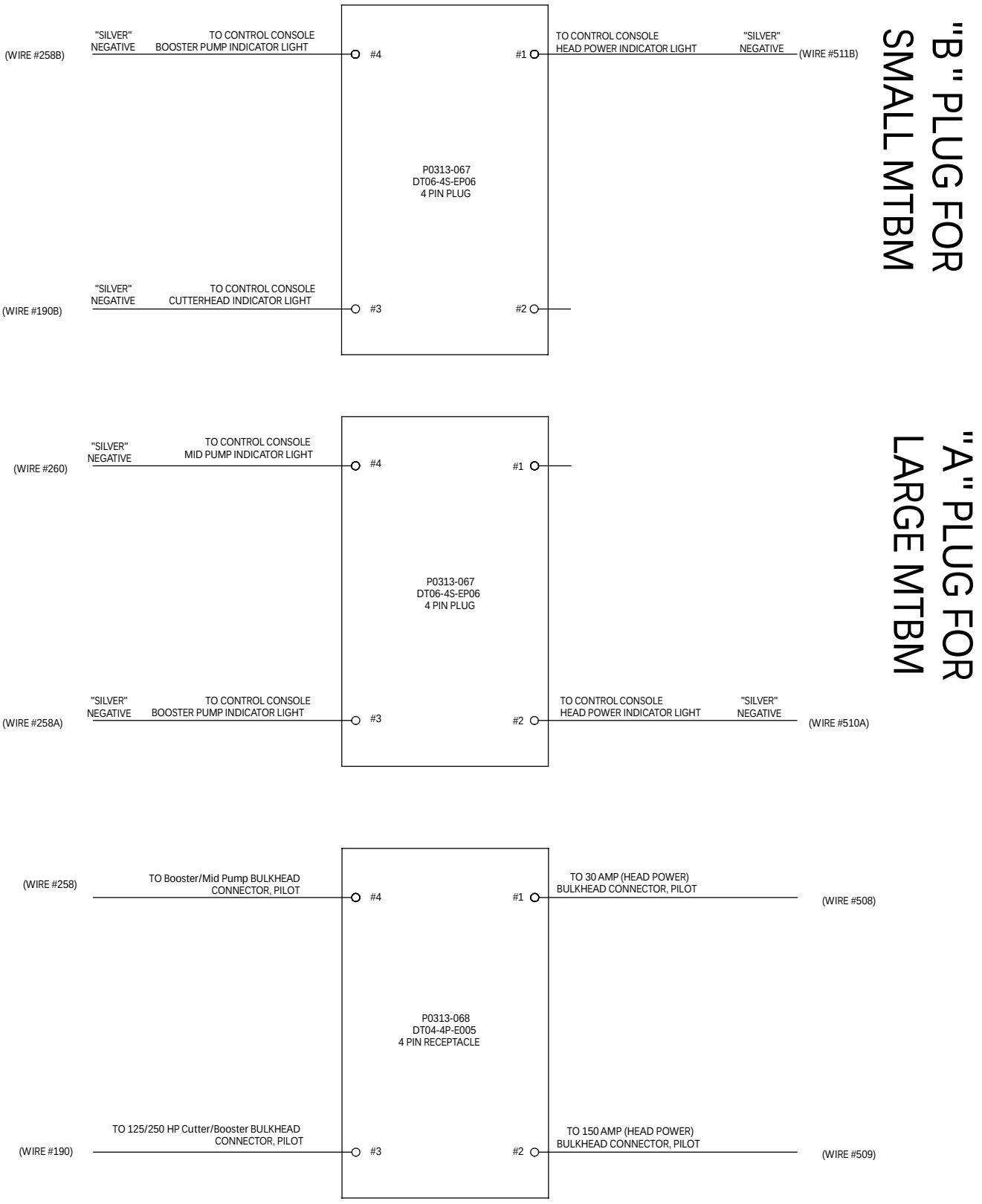


"A " PLUG FOR LARGE MTBM

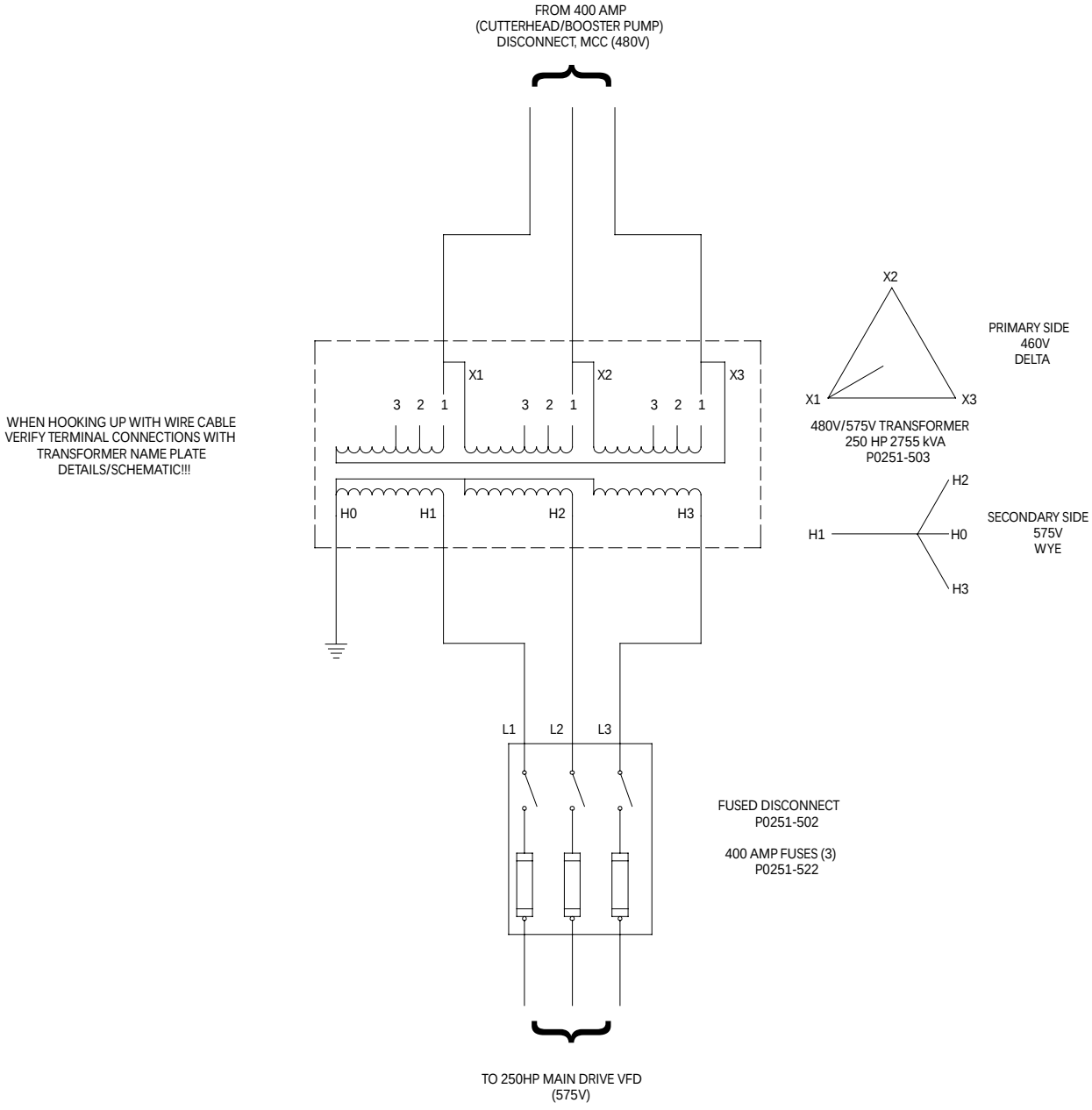




Control Console Electrical Schematics (continued)
Electrical Schematic - Part 13 of 13

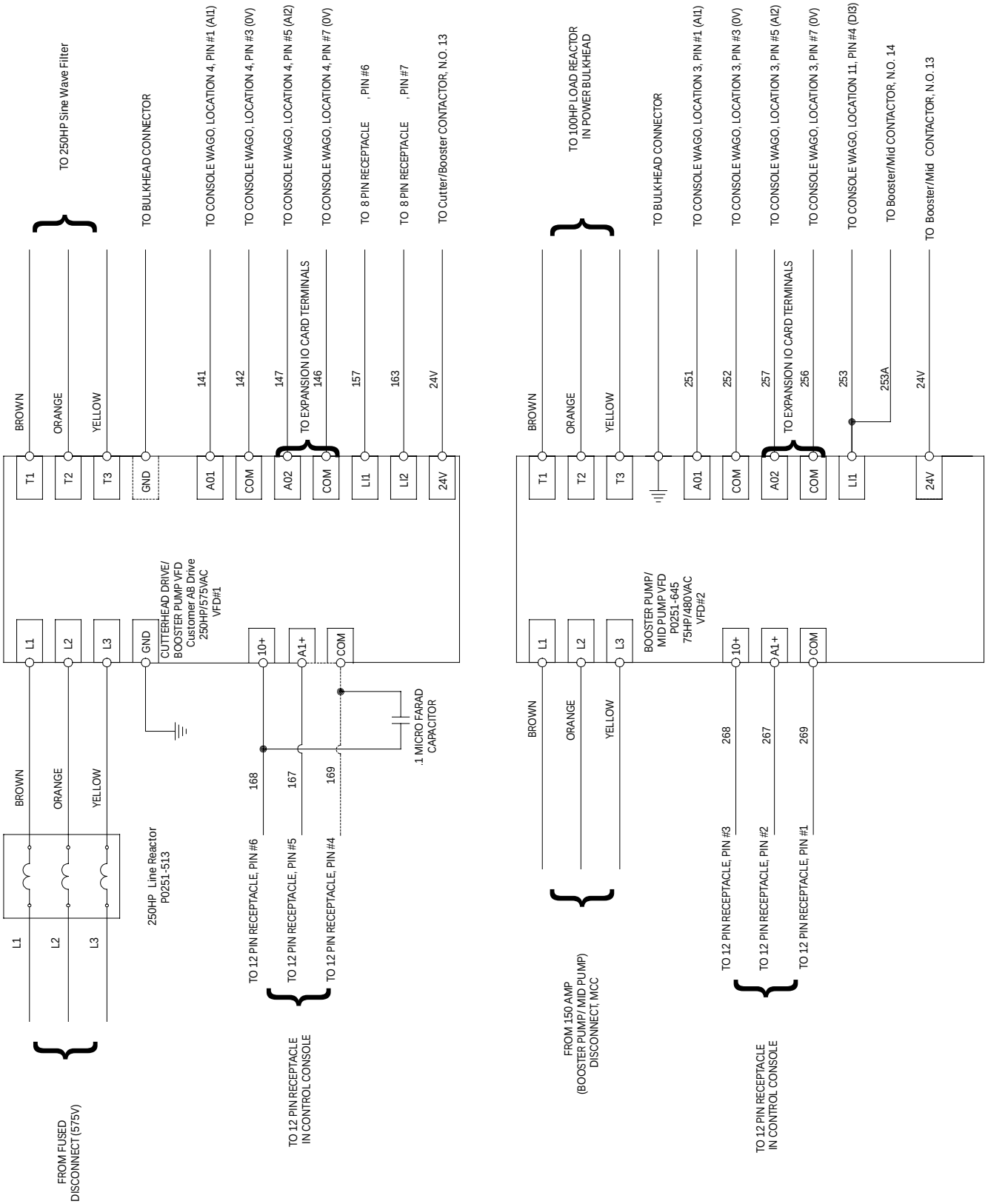


CONTROL CONTAINER TRANSFORMER ELECTRICAL SCHEMATIC



CONTROL CONTAINER VFD ELECTRICAL SCHEMATICS

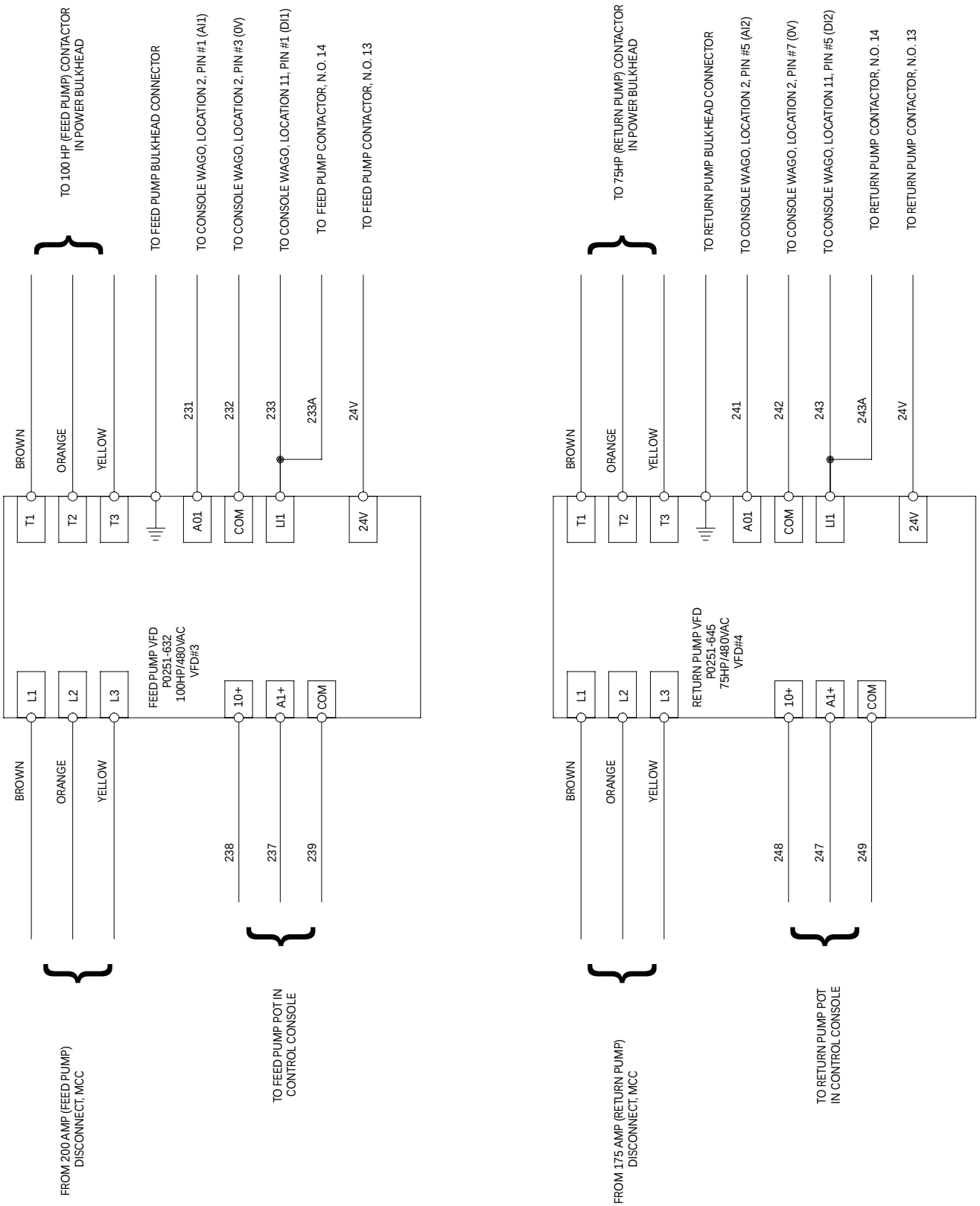
Electrical Schematic - Part 1 of2



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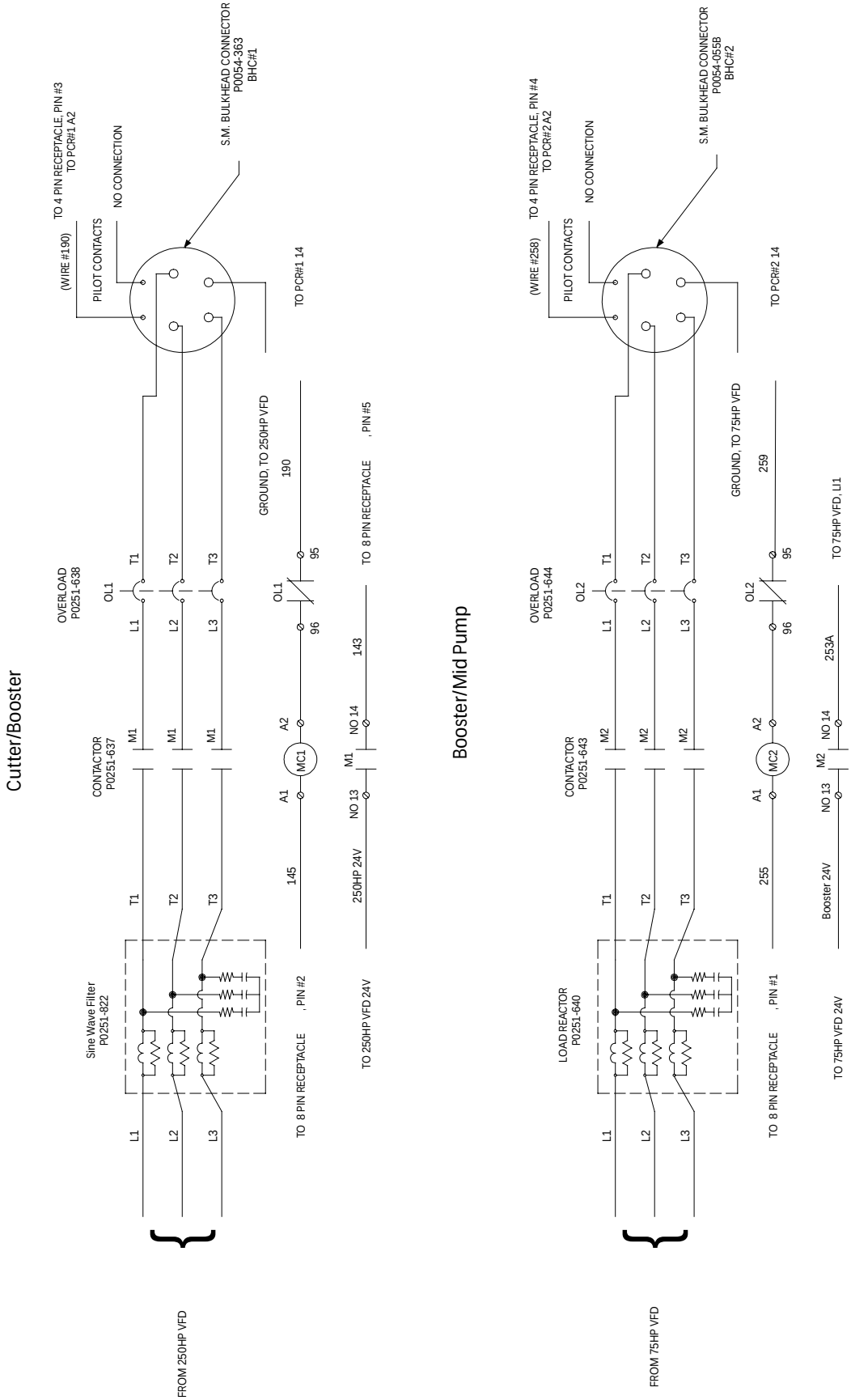
Control Container VFD Electrical Schematics (continued)

Electrical Schematic - Part 2 of 2



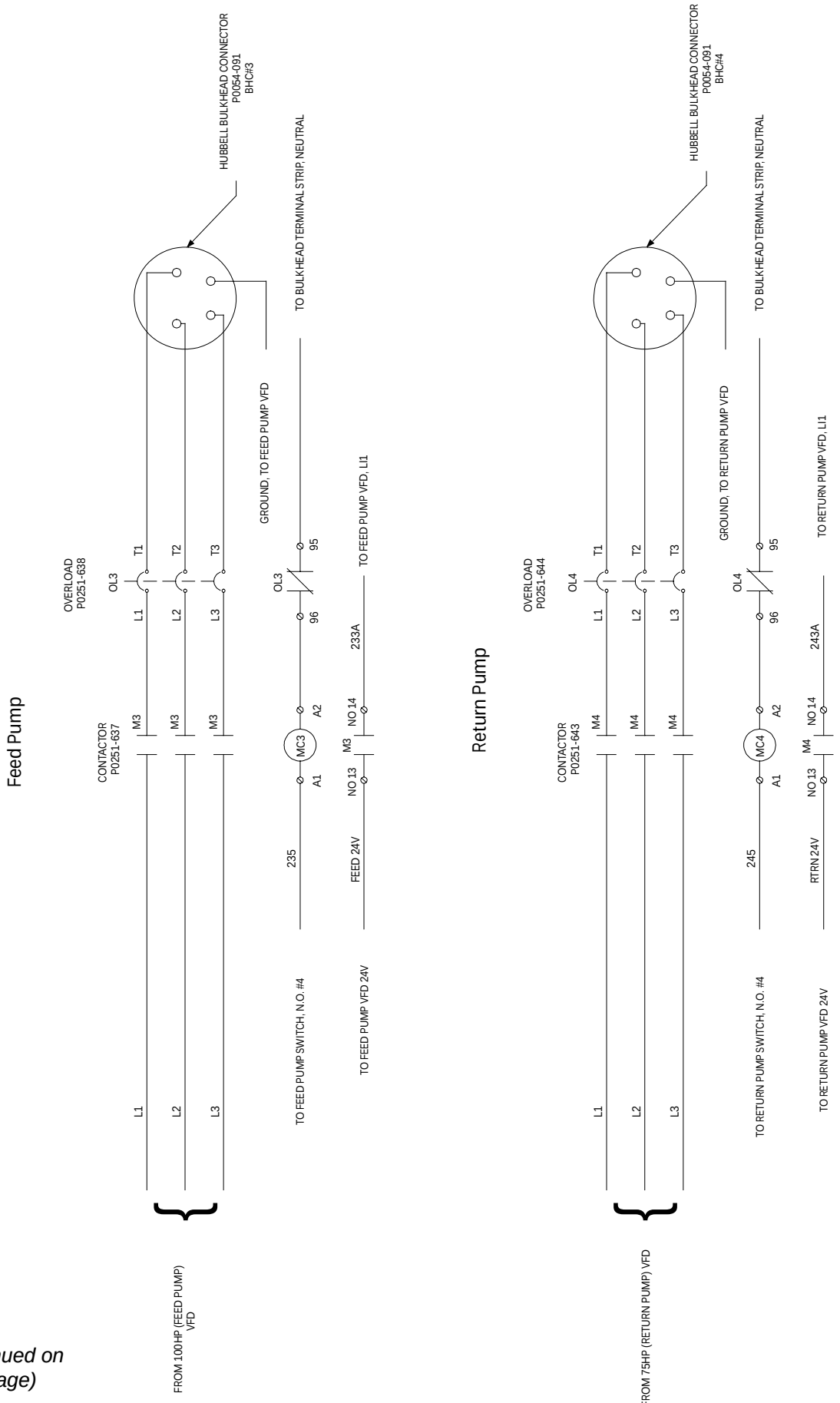
CONTROL CONTAINER BULKHEAD ELECTRICAL SCHEMATICS

Electrical Schematic - Part 1 of 3



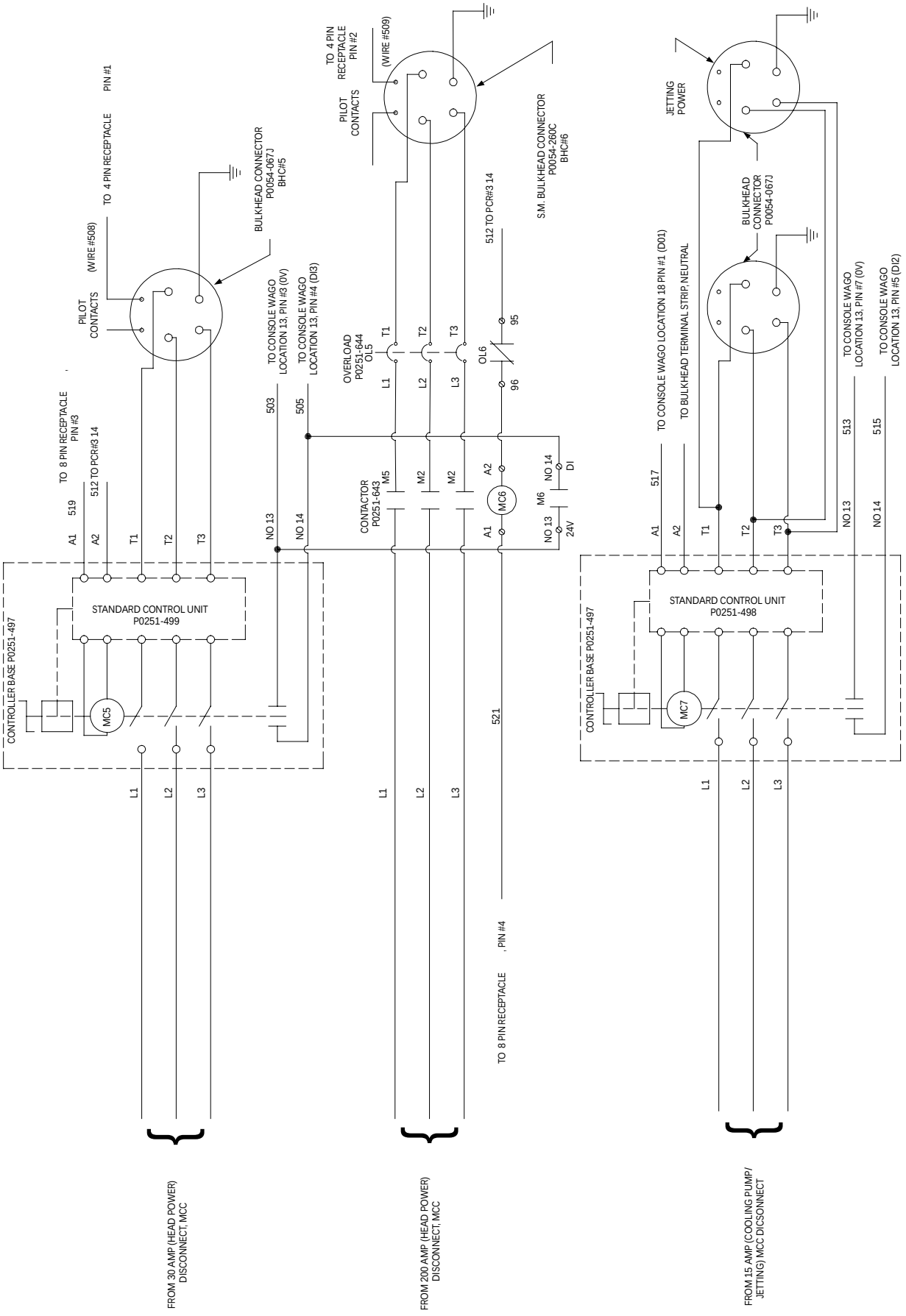
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Control Container Bulkhead Electrical Schematics (continued)
Electrical Schematic - Part 2 of 3

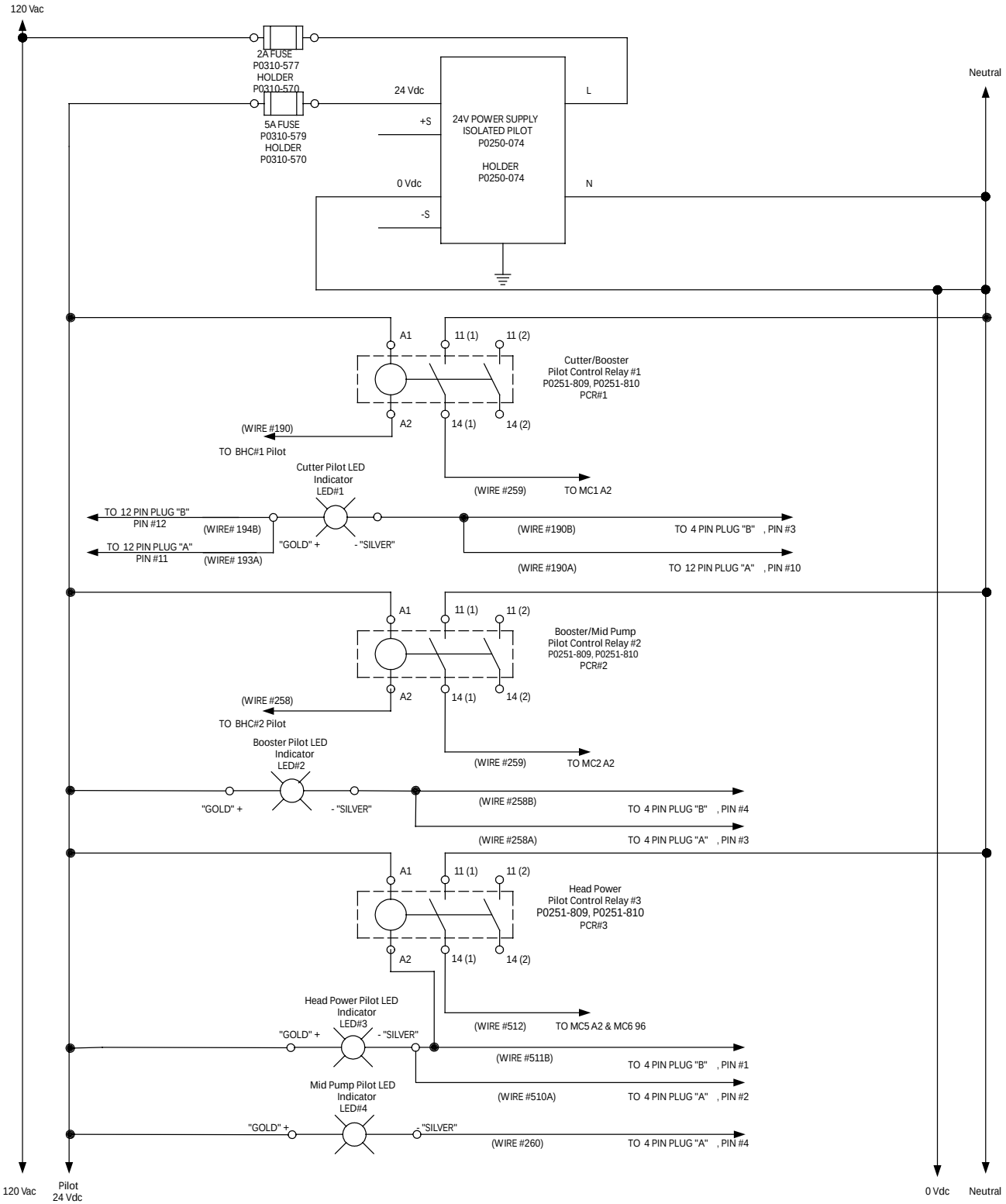


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Control Container Bulkhead Electrical Schematics (continued)
Electrical Schematic - Part 3 of 3



BULKHEAD PILOT CIRCUIT INDICATOR WITH INDICATORS IN CONTROL CONSOLE



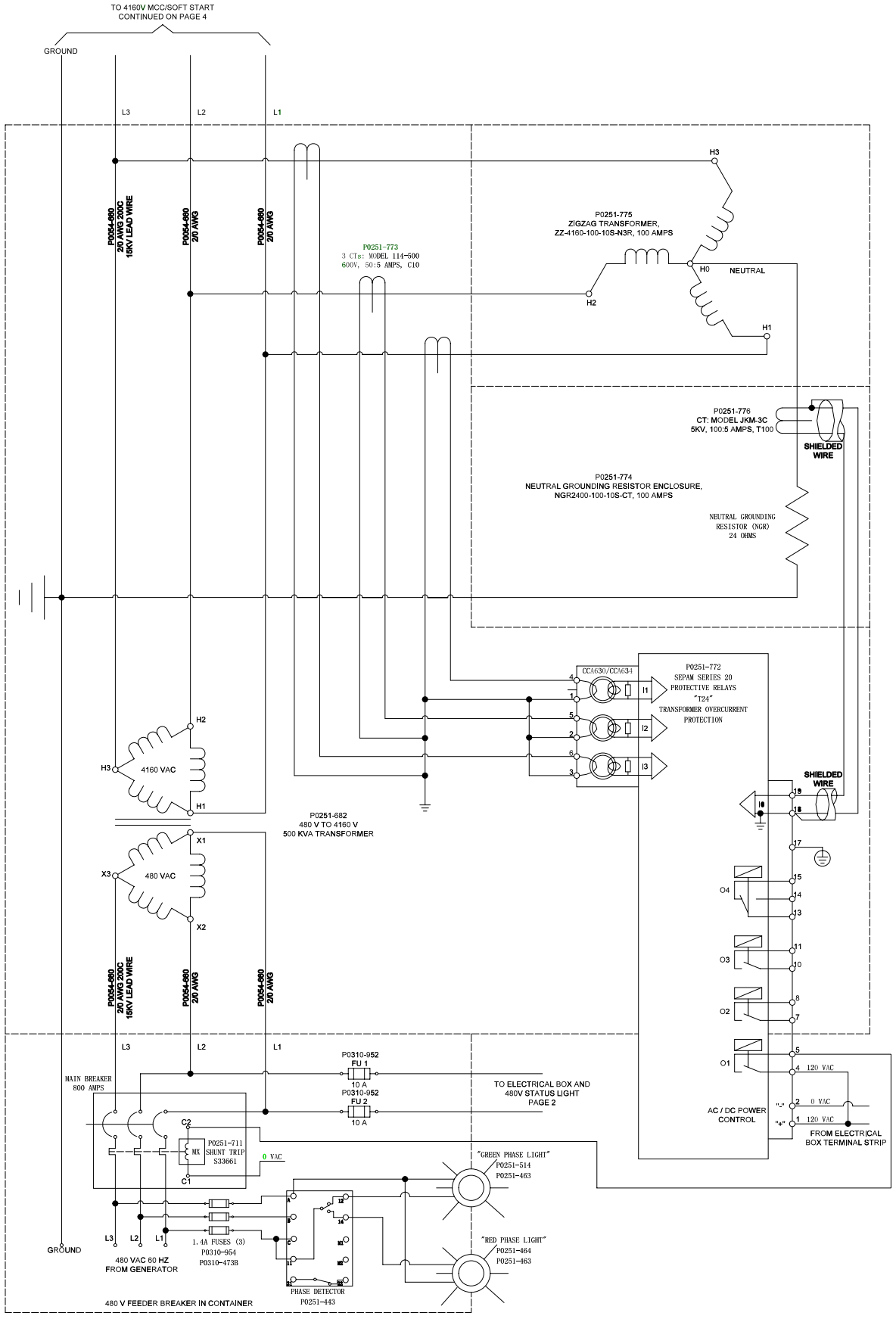
WIRE NUMBER TABLE - CONTROL CONTAINER

Wire Numbe	Description	From Location #1	To Location #2	Wire Color/Gauge
0v	Ground	various	various	Wht/Blu 16 AWG
24v	24 Volt	various	various	Blu/Wht 16 AWG
120 N	120VAC Neutral	various	various	White 16 AWG
120 L	120VAC Line	various	various	Black 16 AWG
139	Cutter Head Switch	8 Pin Rec Pin 8	Wago #10 DI4	White 20 AWG
139A	Cutter Head Switch	SW22 NO#2 Pin #4	8 Pin Plug A Pin 8	White 20 AWG
141	Cutter Head RPM Analog 4-20mA	Cutter Head VFD#1 A01	Wago #4 AI1	Sheilded CBL#1 Black 1
142	Cutter Head Common	Cutter Head VFD#1 Com	Wago #4 0V	Sheilded CBL#1 White 1
143	Large Contactor In	M1 NO	8 Pin Rec Pin 5	Blue 20 AWG
143A	Booster Contactor In - Large MTBM	8 Pin Plug Pin 5/ Pin 6	Wago #11 DI4	Blue 20 AWG
143B	Cutter Contactor In - Small MTBM	8 Pin Plug Pin 5	Wago #11 DI4	Blue 20 AWG
145	Cutter/Booster Contactor	MC1 A1	8 Pin Rec Pin 2	Blu/Blk 16 AWG
145A	Booster Pump Switch +120VAC	8 Pin Plug Pin 2	8 Pin Plug A Pin 2	Blu/Blk 16 AWG
145B	Cutterhead Switch	SW22 NO#1 Pin #4	8 Pin Plug B Pin 2	Blu/Blk 16 AWG
146	Cutter Head Common	Cutter Head VFD#1 Com	Wago #4 0V	Sheilded CBL#1 White 2
147	Cutter Head Torque Analog 4-20mA	Cutter Head VFD#1 A02	Wago #4 AI2	Sheilded CBL#1 Black 2
149	Cutter Left	Cutter Left PB13	Wago #10 DI1	Blue 20 AWG
151	Cutter Stop	Cutter Stop PB14	Wago #13 DI2	Blue 20 AWG
153	Cutter Right	Cutter Right PB15	Wago #10 DI3	Blue 20 AWG
155	Cutter Left Button Light	Light X1	Wago #15 DO1	Blue 20 AWG
157	125/250HP VFD Run Forward	VFD#1 LI1	8 Pin Rec Pin 6	Blue 20 AWG
157B	Cutter Left Command	8 Pin Plug Pin 6	Wago #15 DO1	Blue 20 AWG
159	Cutter Stop Button Light	Light X1	Wago #15 DO2	Blue 20 AWG
161	Cutter Right Button Light	Light X1	Wago #16 DO1	Blue 20 AWG
163	125/250HP VFD Run Reverse	VFD#1 LI2	8 Pin Rec Pin 7	Blue 20 AWG
163B	Cutter Right Command	8 Pin Plug Pin 7	Wago #16 DO1	Blue 20 AWG
167	Cutter/Booster Speed Command	VFD#1 AI1	12 Pin Rec Pin 5	Sheilded CBL#1 Black 3
167A	Booster Pump Speed Command	POT3	12 Pin Plug A Pin 5	Black 20 AWG
167B	Cutterhead Pot Signal	POT4	12 Pin Plug B Pin 5	Black 20 AWG
168	Cutter/Booster POT +	VFD#1 10+	12 Pin Rec Pin 3	Sheilded CBL#1 Black 4
168A	Booster Pump Pot +	POT3	12 Pin Plug A Pin 6	Black 20 AWG
168B	Cutterhead Pot +	POT4	12 Pin Plug B Pin 6	Black 20 AWG
169	Cutter/Booster POT Common	VFD#1 COM	12 Pin Rec Pin 1	Sheilded CBL#1 White 4
169A	Booster Pump Pot COM	POT3	12 Pin Plug A Pin 4	White 20 AWG
169B	Cutterhead Pot COM	POT4	12 Pin Plug B Pin 4	White 20 AWG
187	Cutterhead Pot Signal	12 Pin Rec Pin 8	Wago #19 AI1	White 20 AWG
187A	Cutterhead Pot Signal	POT4	12 Pin Plug A Pin 8	White 20 AWG
188A	Cutterhead Pot +	POT4	12 Pin Plug A Pin 7	Black 20 AWG
189	Cutterhead Pot COM	12 Pin Rec Pin 9	Wago #19 Common	White 20 AWG
189A	Cutterhead Pot COM	POT4	12 Pin Plug A Pin 9	White 20 AWG
190	Cutter/Booster Pilot Relay Ground	BHC#1 Pilot	4 Pin Rec Pin 3	Blu/Wht 16 AWG
190A	Booster Pilot LED Ground	12 Pin Plug A Pin 10	LED#1 Silver-	White 20 AWG
190B	Cutter Pilot LED Ground	4 Pin Plug B Pin 3	LED#1 Silver-	White 20 AWG
193A	Cutter Pilot LED Supply	12 Pin Plug A Pin 11	LED#1 Gold+	Black 20 AWG
194B	Cutter Pilot LED Supply	12 Pin Plug B Pin 12	LED#1 Gold+	Black 20 AWG
195	Cutter Pilot Contactor Ground	PCR#1	MC1 OL1 95	White 16 AWG
196	Cutter Pilot LED Wago Supply	12 Pin Rec Pin 11	Wago #16 D02	Blue 20 AWG
197	Cutter Pilot LED Wago 0v	12 Pin Rec Pin 10	Wago #16 0v	White 20 AWG
211	Cutting Valve Open	Extend PB7	Wago #8 DI1	Blue 20 AWG
213	Chamber Valve Open	Retract PB8	Wago #8 DI2	Blue 20 AWG
215	Stop Valve Open	Extend PB9	Wago #9 DI1	Blue 20 AWG
217	Stop Valve Close	Retract PB10	Wago #9 DI2	Blue 20 AWG
219	Bypass Valve Open	Extend PB11	Wago #11 DI3	Blue 20 AWG
221	Bypass Valve Close	Retract PB12	Wago #12 DI4	Blue 20 AWG
231	Feed Pump RPM Analog 4-20mA	Feed Pump VFD A01	Wago #2 AI1	Sheilded CBL#2 Black 1
232	Feed Pump Common	Feed Pump VFD Com	Wago #2 0V	Sheilded CBL#2 White 1
233	Feed Pump Contactor In	VFD#3 LI1	Wago #11 DI1	Sheilded CBL#2 White 2
233A	Feed Pump Contactor In	M3 NO	VFD#3 LI1	Blue 20 AWG
235	Feed Pump Switch +120VAC	SW#18 NO Pin#4	MC3 A1	Blu/Blk 16 AWG
237	Feed Pump Speed Command	POT1	VFD#3 AI1	Sheilded CBL#2 Black 2
238	Feed Pump Pot +	POT1	VFD#3 10V+	Sheilded CBL#2 Black 3
239	Feed Pump Pot COM	POT1	VFD#3 COM	Sheilded CBL#2 White 3
241	Return Pump RPM Analog 4-20mA	Return Pump VFD A01	Wago #2 AI2	Sheilded CBL#3 Black 2
242	Return Pump Common	Return Pump VFD Com	Wago #2 0V	Sheilded CBL#3 White 2
243	Return Pump Contactor In	VFD#4 LI1	Wago #11 DI2	Sheilded CBL#3 White 2

Wire Numbe	Description	From Location #1	To Location #2	Wire Color/Gauge
243A	Return Pump Contactor In	M4 NO	VFD#4 LI1	Blue 20 AWG
245	Return Pump Switch +120VAC	SWx #4	MC4 A1	Blu/Blk 16 AWG
247	Return Pump Speed Command	POT2	VFD#4 AI1	Sheilded CBL#3 Black 2
248	Return Pump Pot +	POT2	VFD#4 10V+	Sheilded CBL#3 Black 3
249	Return Pump Pot COM	POT2	VFD#4 COM	Sheilded CBL#3 White 3
251	Booster Pump RPM Analog 4-20mA	Booster Pump VFD A01	Wago #3 AI1	Sheilded CBL#4 Black 1
252	Booster Pump Common	Booster Pump VFD Com	Wago #3 0V	Sheilded CBL#4 White 1
253	Booster Pump Contactor In	VFD#2 LI1	Wago #11 DI3	Sheilded CBL#4 White 3
253A	Booster Pump Contactor In	M2 NO	VFD#2 LI1	Blue 20 AWG
255	Booster/Mid Pump Contactor	8 Pin Rec Pin 1	MC2 A1	Blu/Blk 16 AWG
255A	Mid Pump Switch +120VAC	SW20 #4	8 Pin Plug A Pin 1	Blu/Blk 16 AWG
255B	Booster Pump Switch +120VAC	SW20 #4	8 Pin Plug B Pin 1	Blu/Blk 16 AWG
256	Booster Pump Common	Booster Pump VFD Com	Wago #3 0V	Sheilded CBL#4 White 2
257	Booster Pump Torque Analog 4-20mA	Booster Pump VFD A02	Wago #3 AI2	Sheilded CBL#4 Black 2
258	Booster/Mid Pilot Relay/Ground	BHC#2 Pilot	4 Pin Rec Pin 4	Blu/Wht 16 AWG
258A	Mid Pump Pilot LED Ground	4 Pin Plug A Pin 3	Mid Pilot Relay	Blu/Wht 16 AWG
258B	Booster Pilot LED Ground	4 Pin Plug B Pin 4	Booster Pilot Relay	Blu/Wht 16 AWG
259	Booster Pilot Contactor Ground	PCR#2	MC2 OL2 95	White 16 AWG
260	Mid Pilot LED Ground	LED#3 Silver -	4 Pin Plug A Pin 4	White 20 AWG
267	Mid/Booster Pump Speed Command	VFD#2 AI1	12 Pin Rec Pin 2	Sheilded CBL#4 Blk 3
267A	Mid Pump Pot Speed Command	POT5	12 Pin Plug A Pin 2	Black 20 AWG
267B	Booster Pump Speed Command	POT3	12 Pin Plug B Pin 2	Black 20 AWG
268	Mid/Booster Pump POT +	VFD#2 10+	12 Pin Rec Pin 2	Black 20 AWG
268A	Mid Pump Pot +	POT5	12 Pin Plug A Pin 3	Black 20 AWG
268B	Booster Pump Pot +	POT3	12 Pin Plug B Pin 3	Black 20 AWG
269	Mid/Booster Pump POT COM	VFD#2 COM	12 Pin Rec Pin 1	Black 20 AWG
269A	Mid Pump Pot COM	POT5	12 Pin Plug A Pin 1	White 20 AWG
269B	Booster Pump Pot COM	POT3	12 Pin Plug B Pin 1	White 20 AWG
301	Steering Top Cylinder Extend	Extend PB1	Wago #7 DI1	Blue 20 AWG
303	Steering Top Cylinder Retract	Retract PB2	Wago #7 DI2	Blue 20 AWG
305	Steering Left Cylinder Extend	Extend PB3	Wago #7 DI3	Blue 20 AWG
307	Steering Left Cylinder Retract	Retract PB4	Wago #7 DI4	Blue 20 AWG
309	Steering Right Cylinder Extend	Extend PB5	Wago #8 DI1	Blue 20 AWG
311	Steering Right Cylinder Retract	Retract PB6	Wago #8 DI2	Blue 20 AWG
401	Jacking Selector Switch	Jacking Switch #3	Wago #13 DI1	Blue 20 AWG
403	Jacking Selector Switch	Jacking Switch #7	Wago #12 DI1	Blue 20 AWG
405	Jacking Selector Switch	Jacking Switch #5	Wago #12 DI2	Blue 20 AWG
407	Jacking Selector Switch	Jacking Switch #1	Wago #12 DI3	Blue 20 AWG
409	Jacking Selector Switch	Jacking Switch #5	Wago #12 DI4	Blue 20 AWG
410	Hydraulic Encoder Phase A	Encoder Dial Pin 4	Wago #5 Pin 1	Orange
411	Hydraulic Encoder Phase B	Encoder Dial Pin 2	Wago #5 Pin 2	Yellow
412	Hydraulic Encoder 5 Volt	Encoder Dial Pin 1	Wago #6 Pin 1	Red
413	Hydraulic Encoder 0 Volt	Encoder Dial Pin 3	Wago #6 Pin 3	Green
503	Head Power Contactor NO 13	MC6 NO 13	Wago #13 0V	Blu/Wht 16 AWG
505	Head Power Contactor NO 14	MC6 NO 14	Wago #13 DI3	Blu/Wht 16 AWG
508	Small MTBM Pilot Relay Ground	BHC#5 Pilot	4 Pin Rec Pin 1	Blu/Wht 16 AWG
509	Large MTBM Pilot Relay Ground	BHC#6 Pilot	4 Pin Rec Pin 2	Blu/Wht 16 AWG
510A	Head Power LED Ground	LED#3 Silver -	4 Pin Plug A Pin 2	White 20 AWG
511B	Head Power LED Ground	LED#3 Silver -	4 Pin Plug B Pin 1	White 20 AWG
512	Head Pilot Contactor Ground	PCR#3	MC5 A2 & MC6 OL6 95	White 16 AWG
513	Cooling Pump Contactor NO 13	MC7 NO 13	Wago #13 0V	Blu/Wht 16 AWG
515	Cooling Pump Contactor NO 14	MC7 NO 14	Wago #13 DI2	Blu/Wht 16 AWG
517	Cooling Pump Contactor A1	MC7 A1	Wago #18 DO1	Black 16 AWG
519B	Head Power Switch	SW#21 #4	8 Pin Plug B Pin 3	Black 16 AWG
521	Large MTBM Head Power Contactor	8 Pin Rec Pin 4	MC6 A1	Black 16 AWG
521A	Head Power Switch	SW#21 #4	8 Pin Plug A Pin 4	Black 16 AWG
601	Console E-Stop NC #2	E-Stop NC #2	A1 E-Stop CR#1	Blue 16 AWG
603	Console E-Stop NC #2	E-Stop NC #2	Wago #13 DI4	Blue 16 AWG
604	Wago E-Stop Trip	A1 E-Stop CR#2	Wago #18 DO2	Black 16 AWG

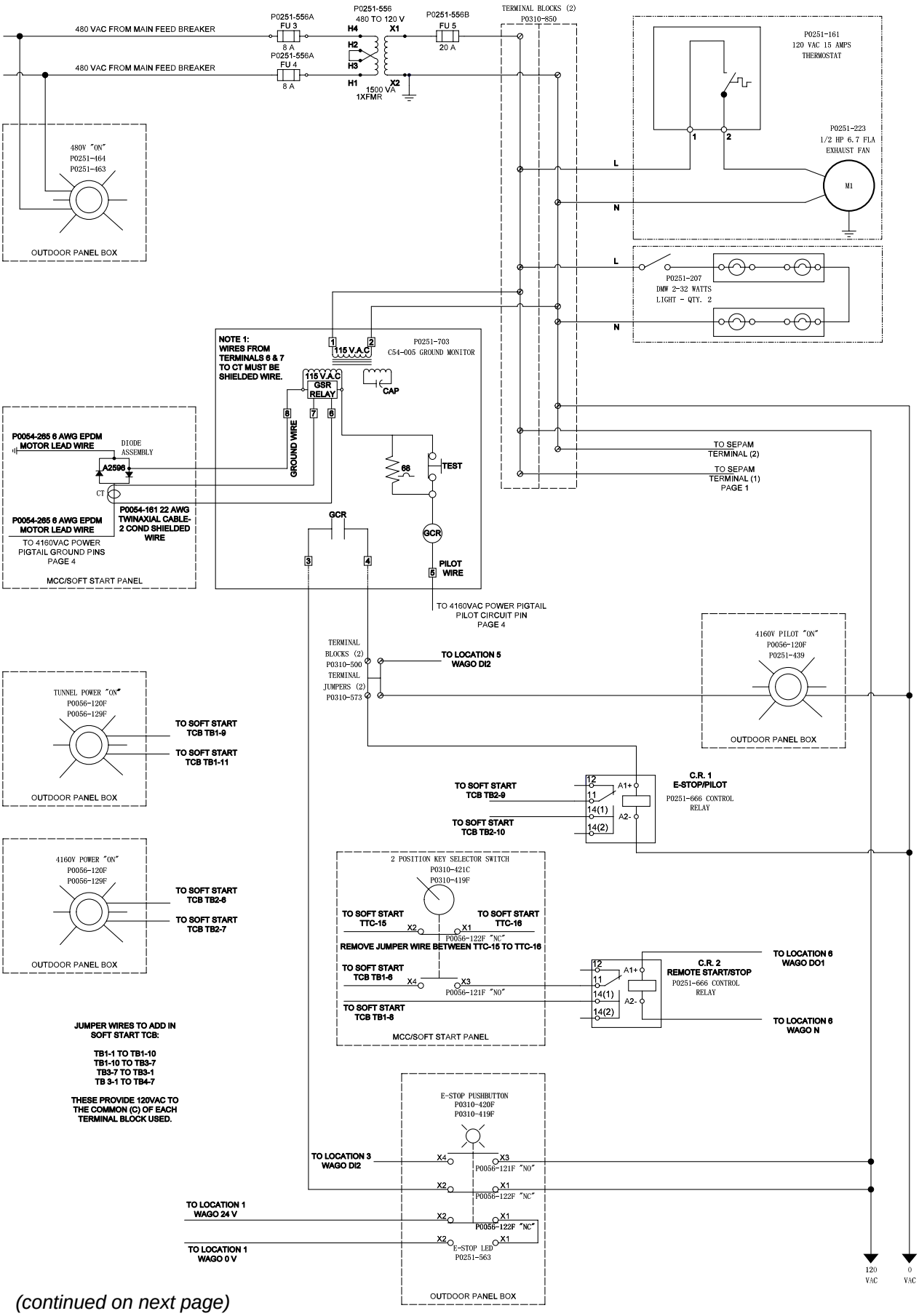
POWER CONTAINER ELECTRICAL SCHEMATICS

Electrical Schematic - Part 1 of 4



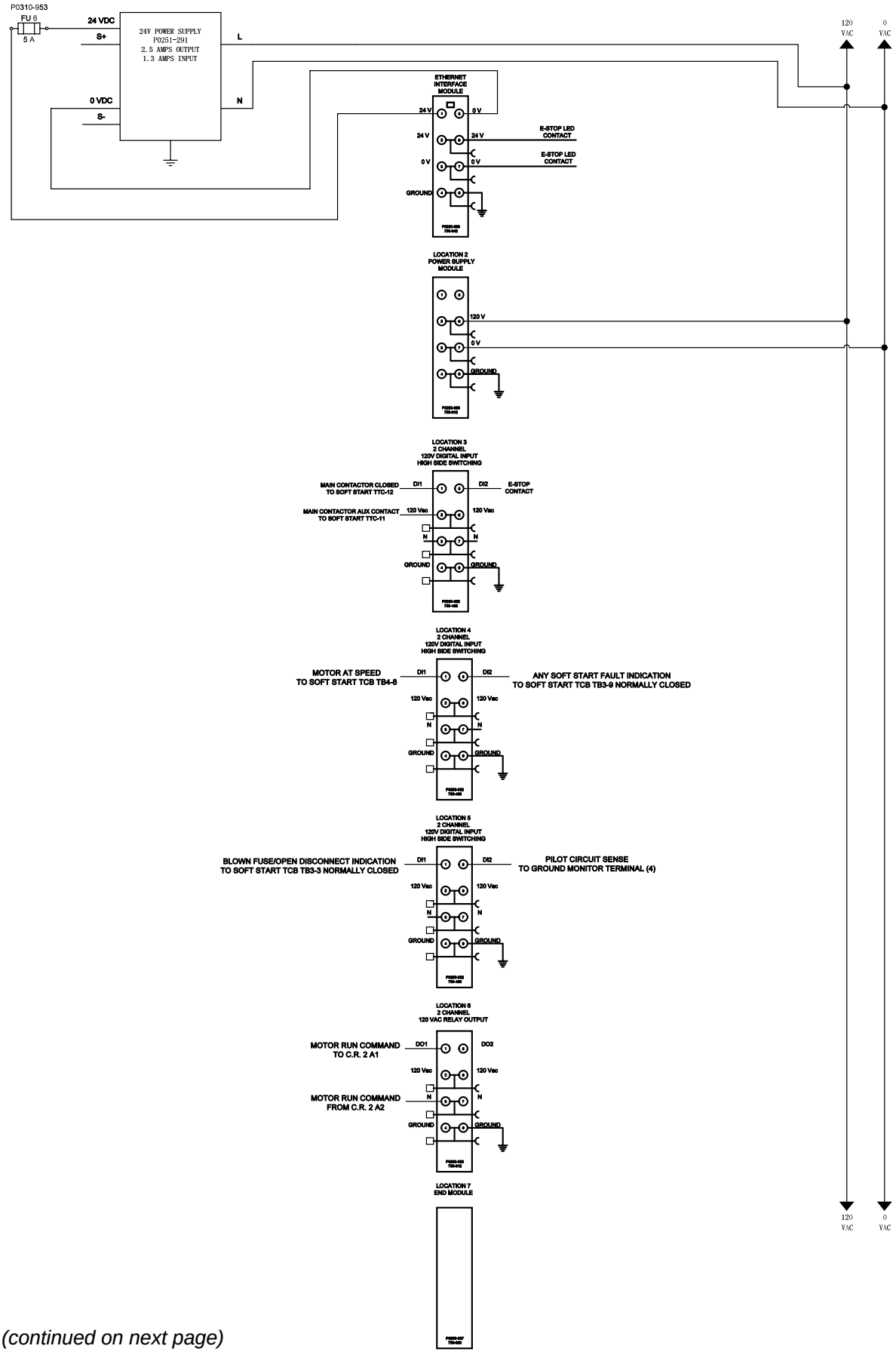
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Power Container Electrical Schematics (continued)
Electrical Schematic - Part 2 of 4



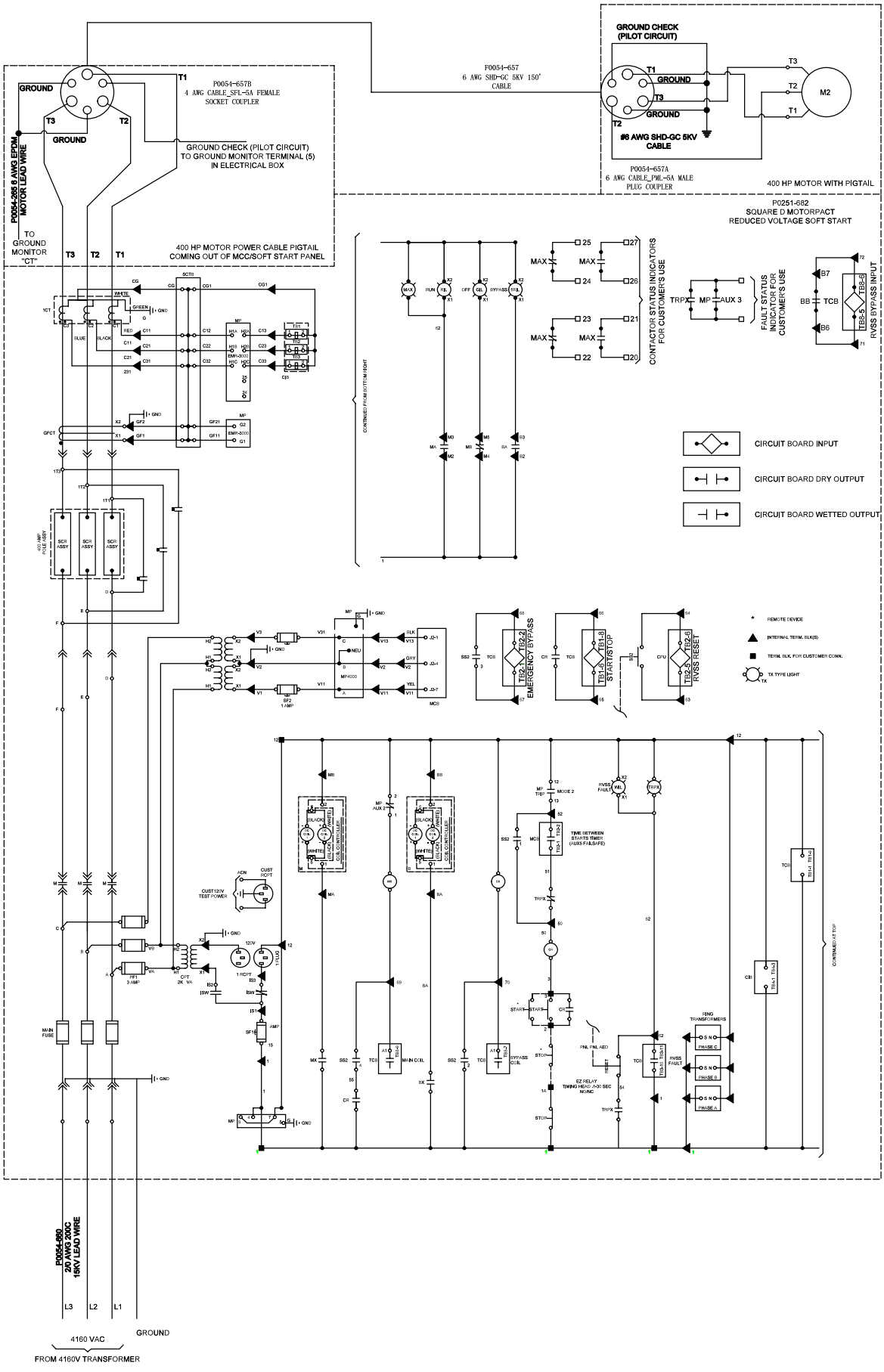
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Power Container Electrical Schematics (continued)
Electrical Schematic - Part 3 of 4



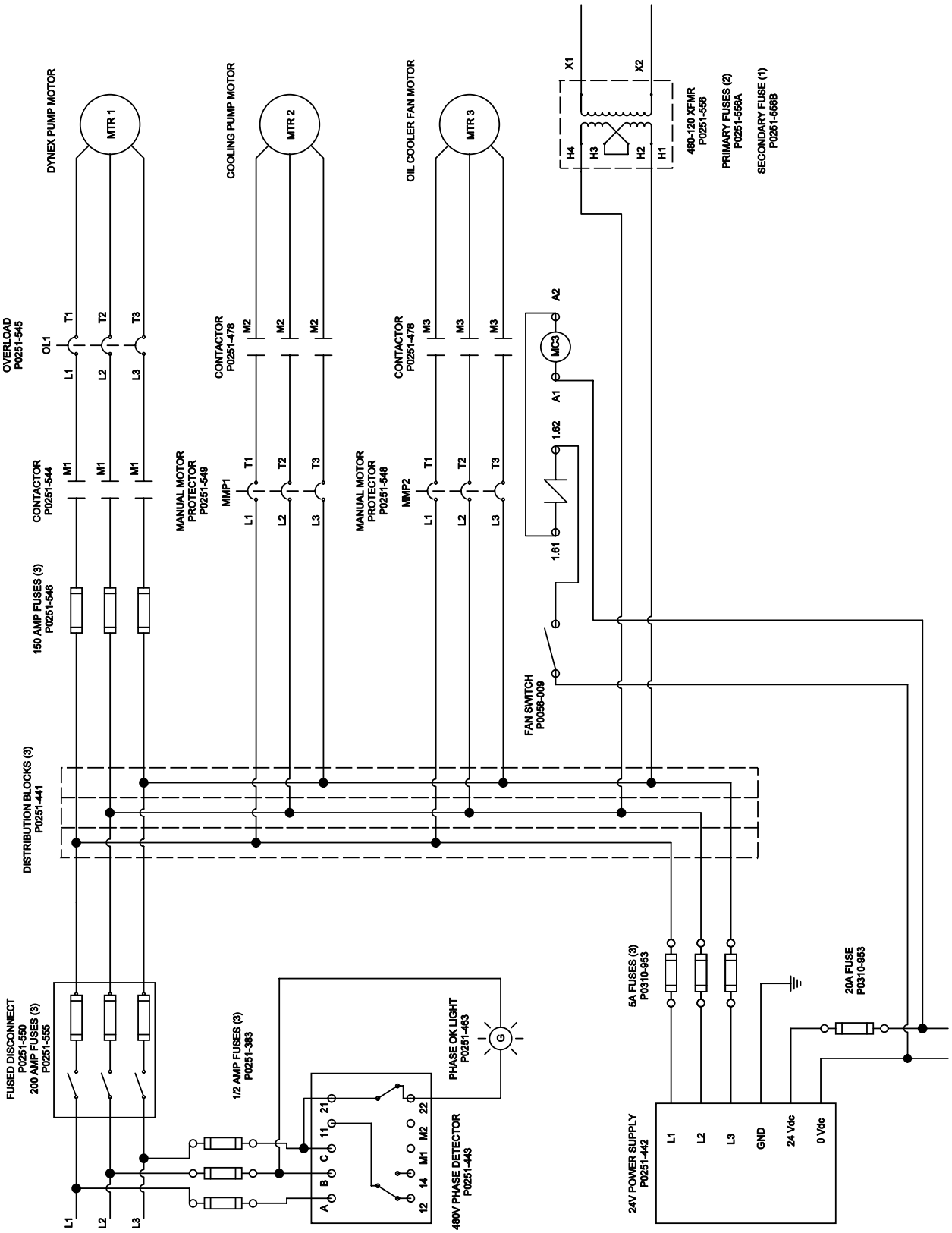
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Power Container Electrical Schematics (continued)
Electrical Schematic - Part 4 of 4



REMOTE HYDRAULIC POWER PACK ELECTRICAL SCHEMATICS

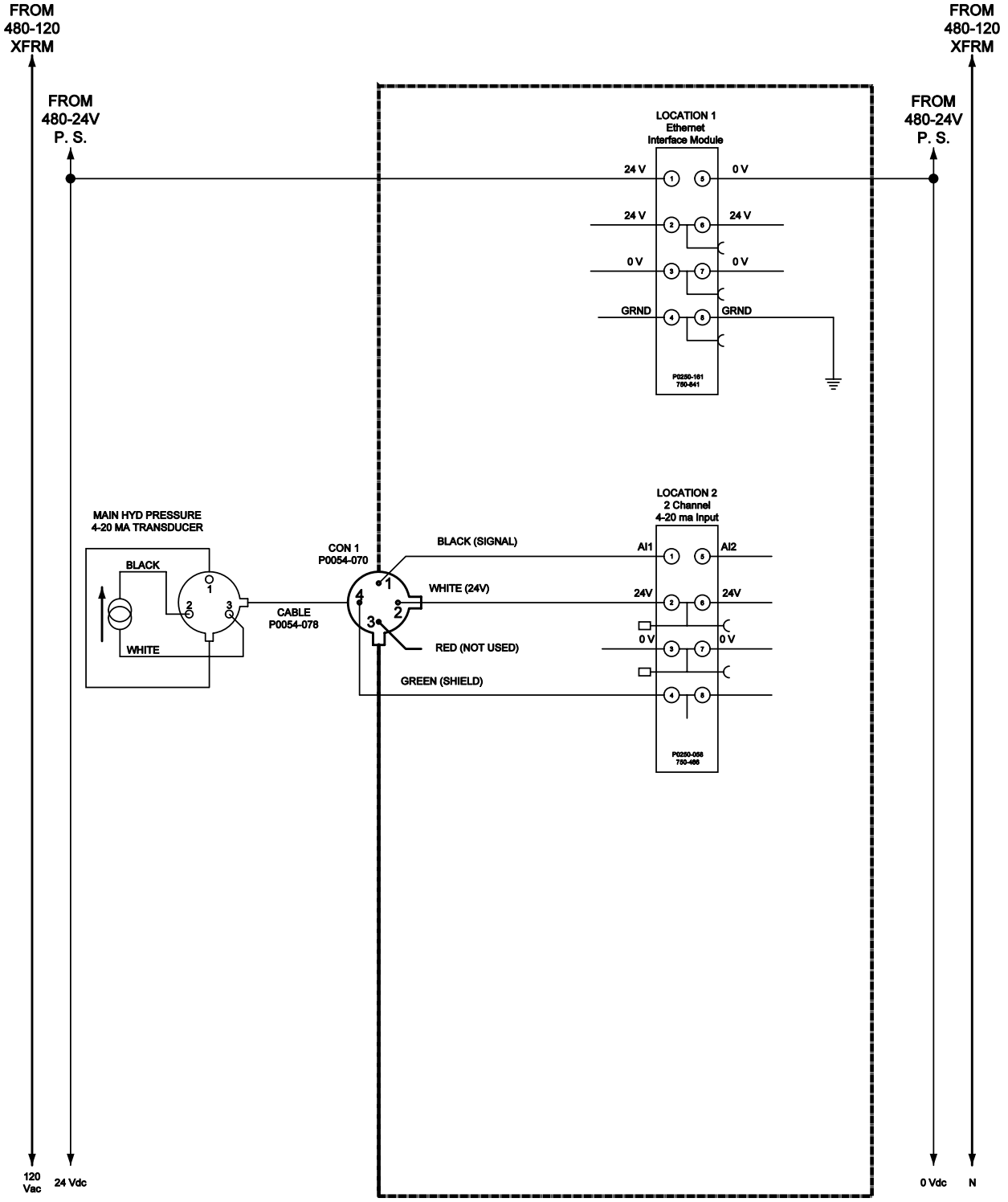
Electrical Schematic - Part 1 of 6



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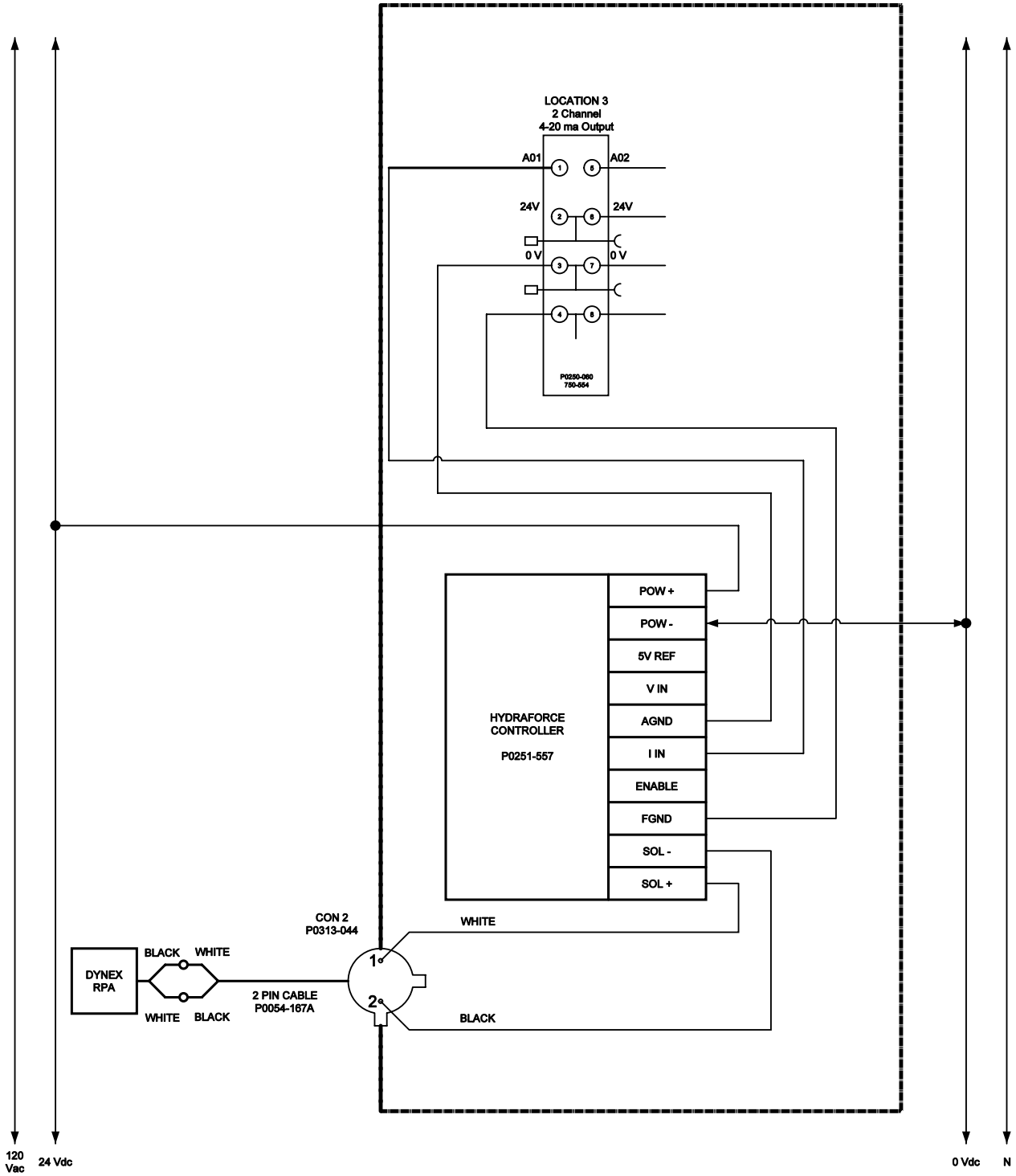
Remote Hydraulic Power Pack Electrical Schematics (continued)

Electrical Schematic - Part 2 of 6



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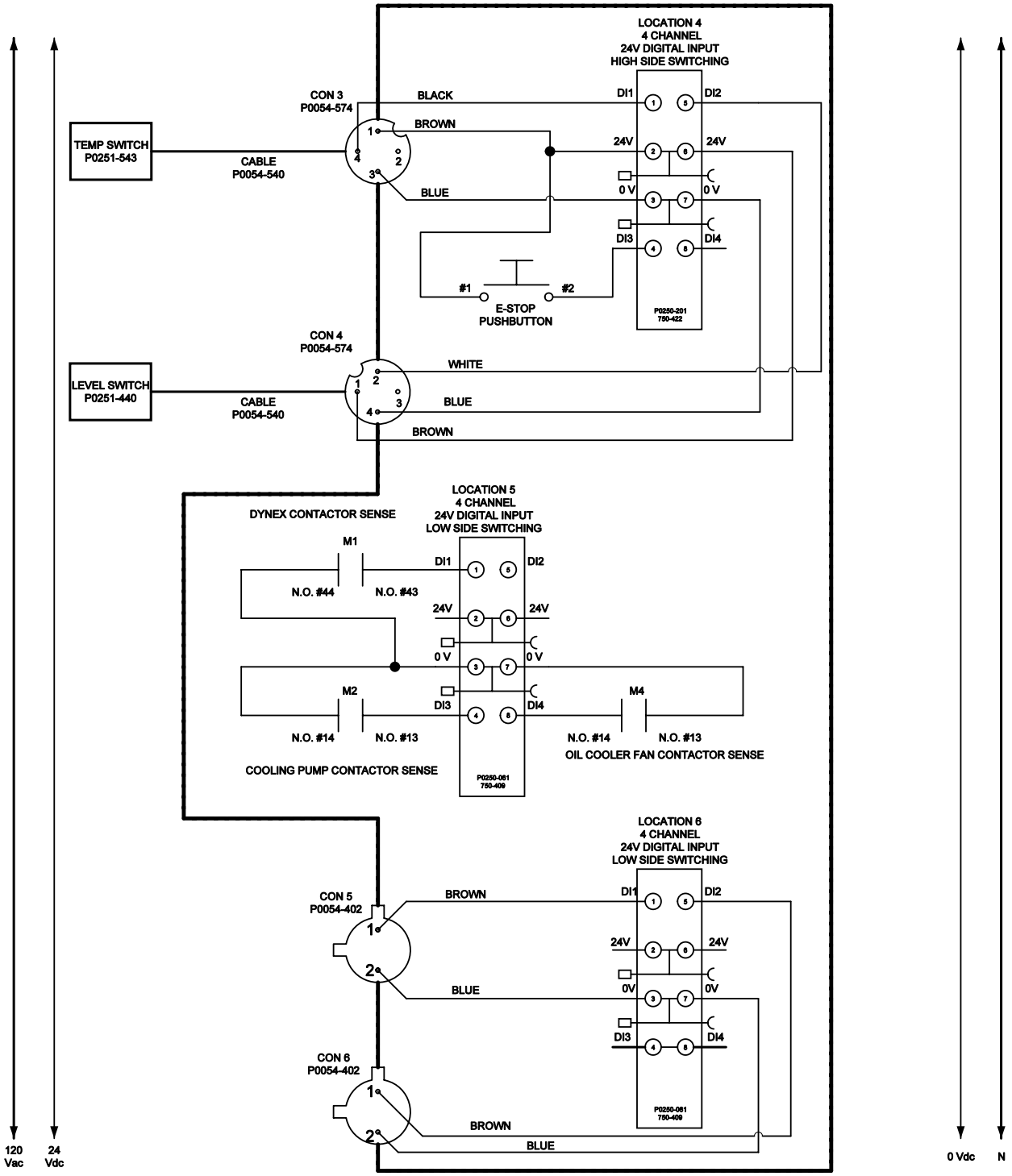
Remote Hydraulic Power Pack Electrical Schematics (continued)
Electrical Schematic - Part 3 of 6



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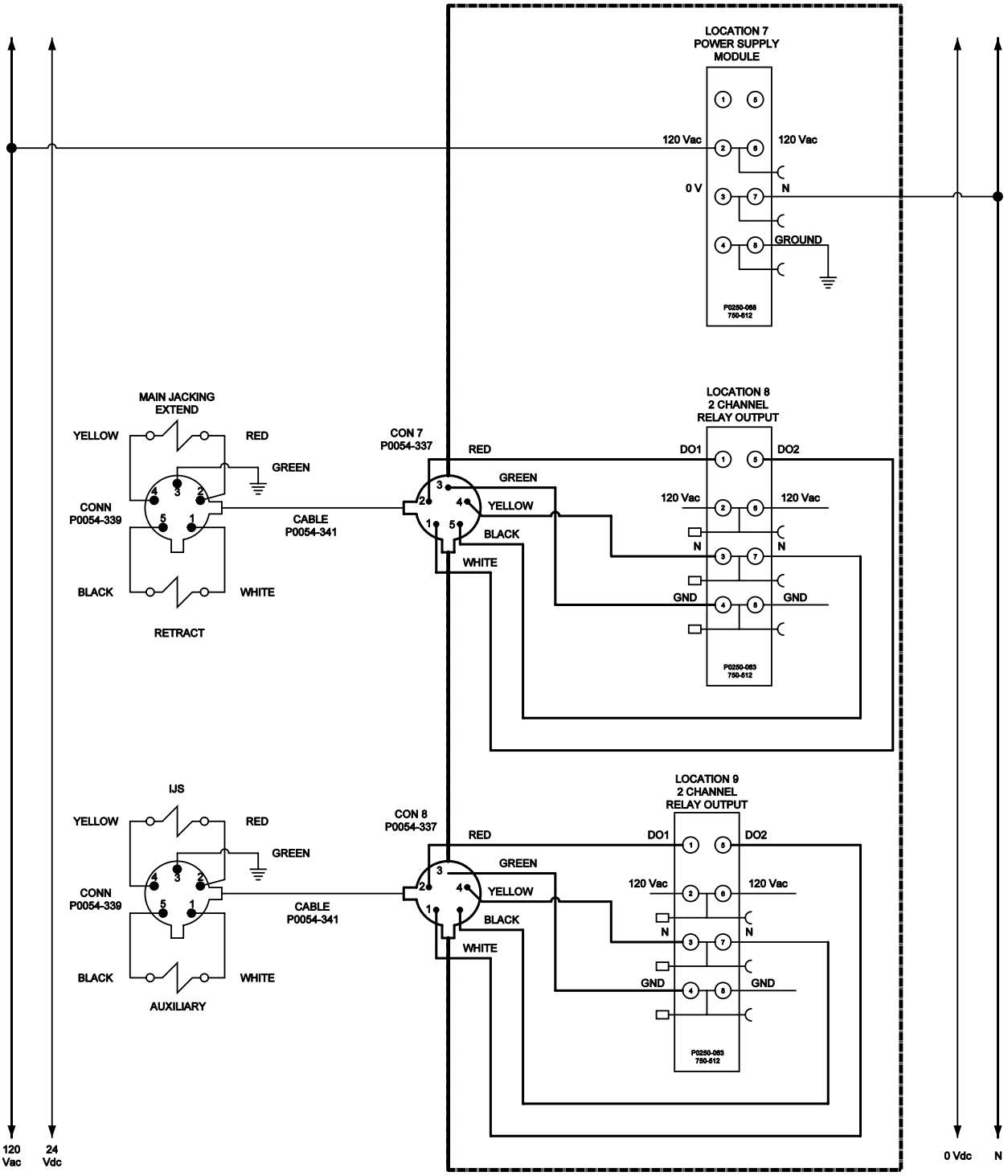
Remote Hydraulic Power Pack Electrical Schematics (continued)

Electrical Schematic - Part 4 of 6



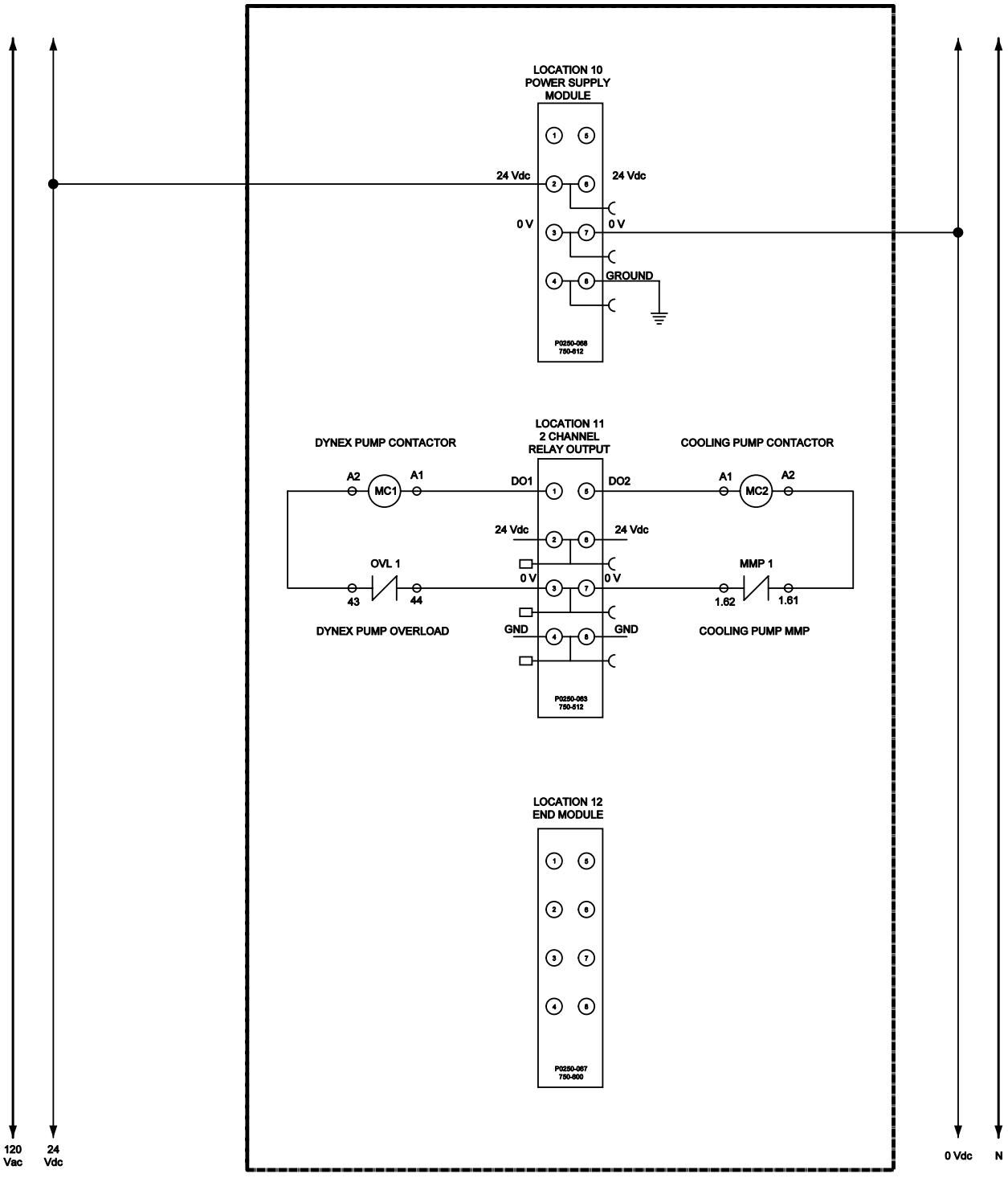
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Remote Hydraulic Power Pack Electrical Schematics (continued)
Electrical Schematic - Part 5 of 6



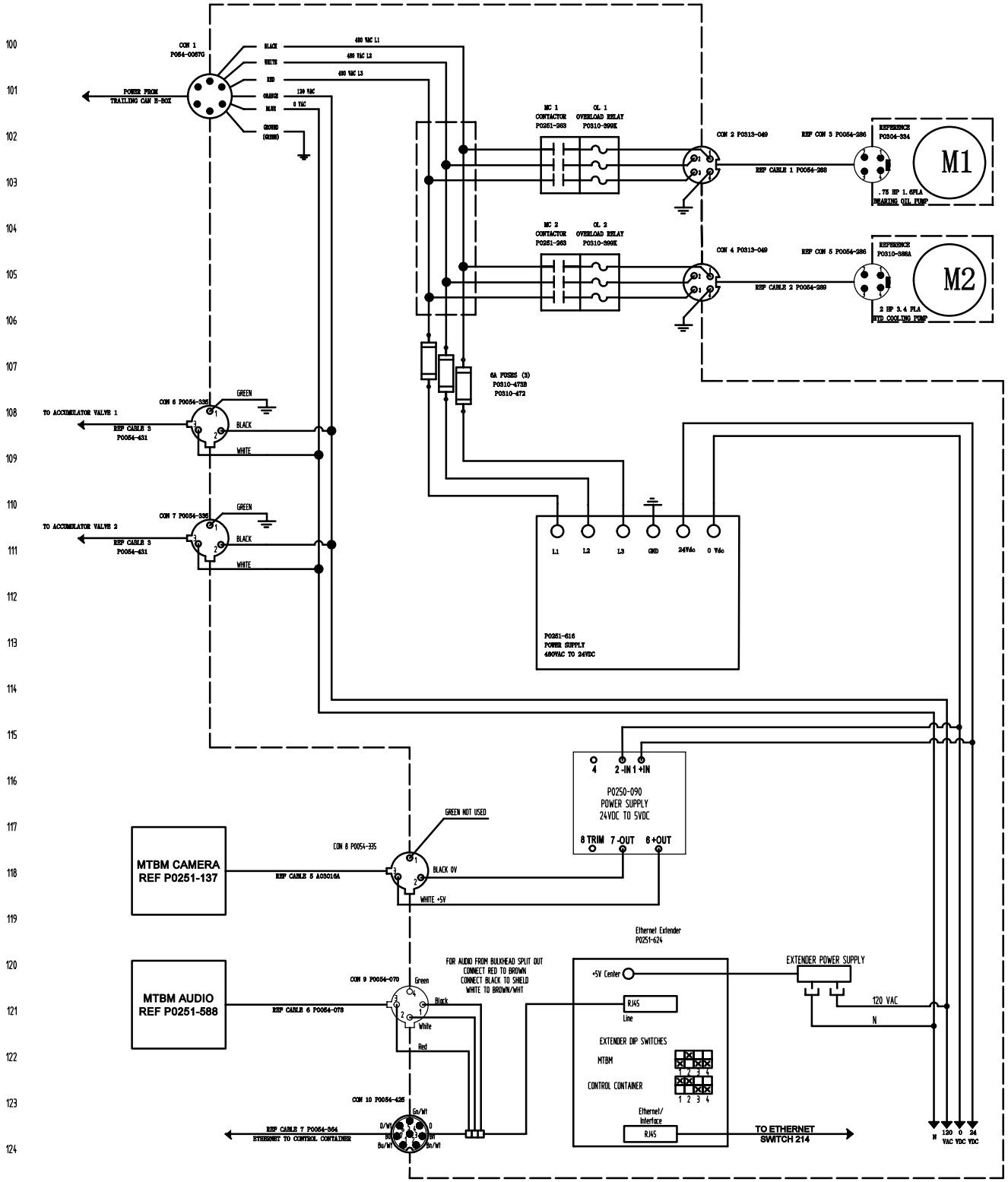
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Remote Hydraulic Power Pack Electrical Schematics (continued)
Electrical Schematic - Part 6 of 6



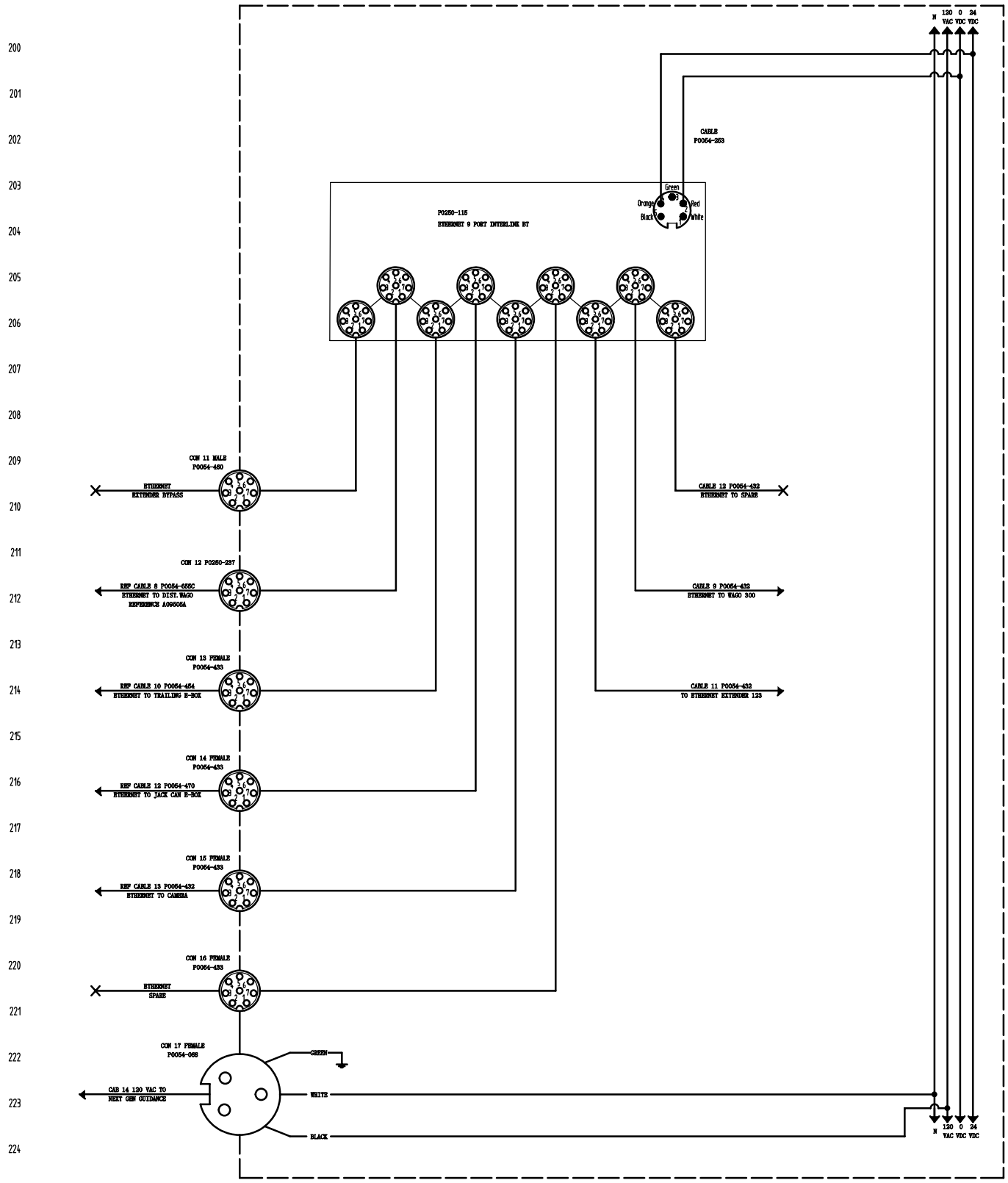
MTBM FRONT SECTION CONTROL BOX ELECTRICAL SCHEMATICS

Electrical Schematic - Part 1 of 12



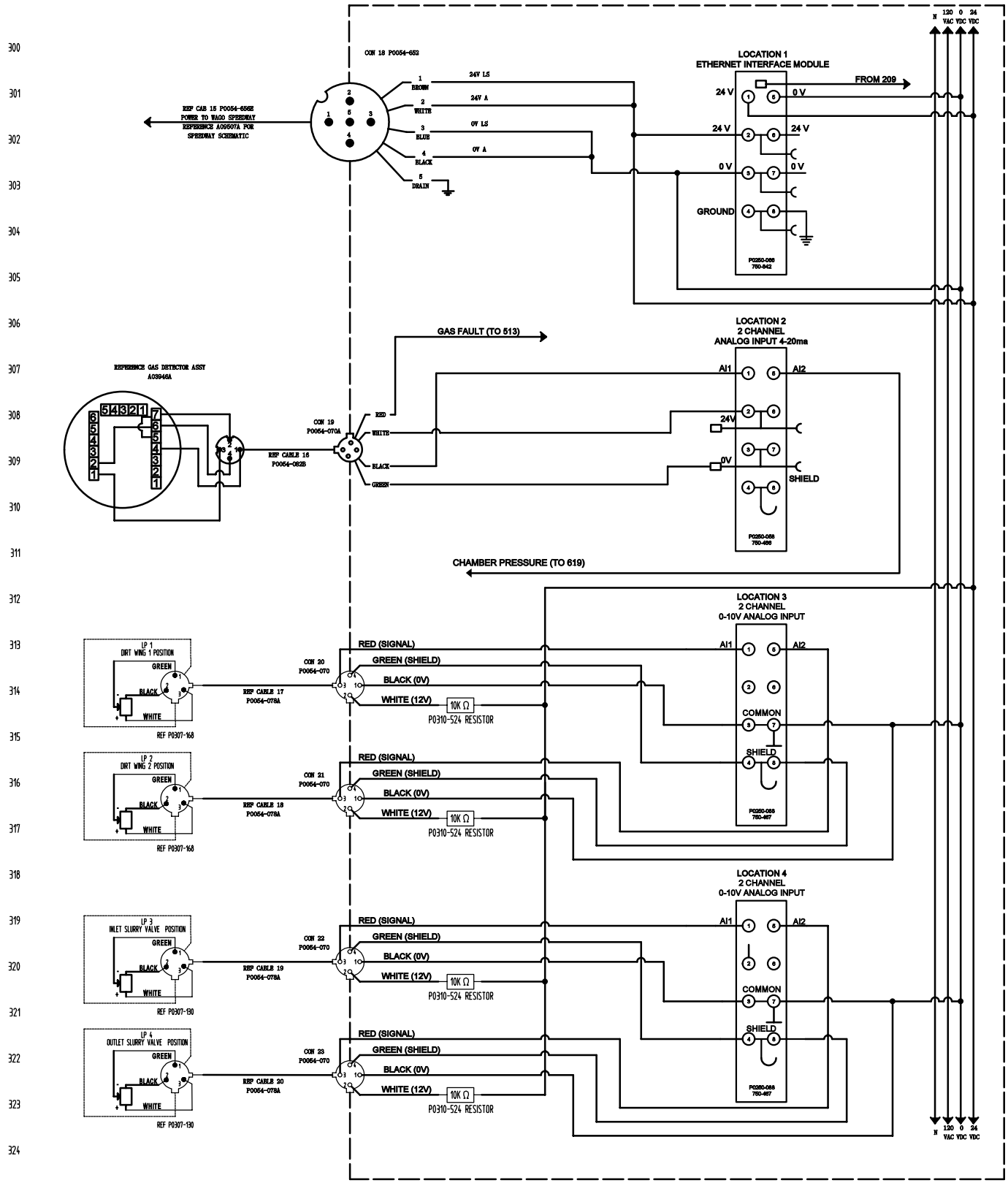
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MTBM Front Section Control Box Electrical Schematics (continued)
Electrical Schematic - Part 2 of 12



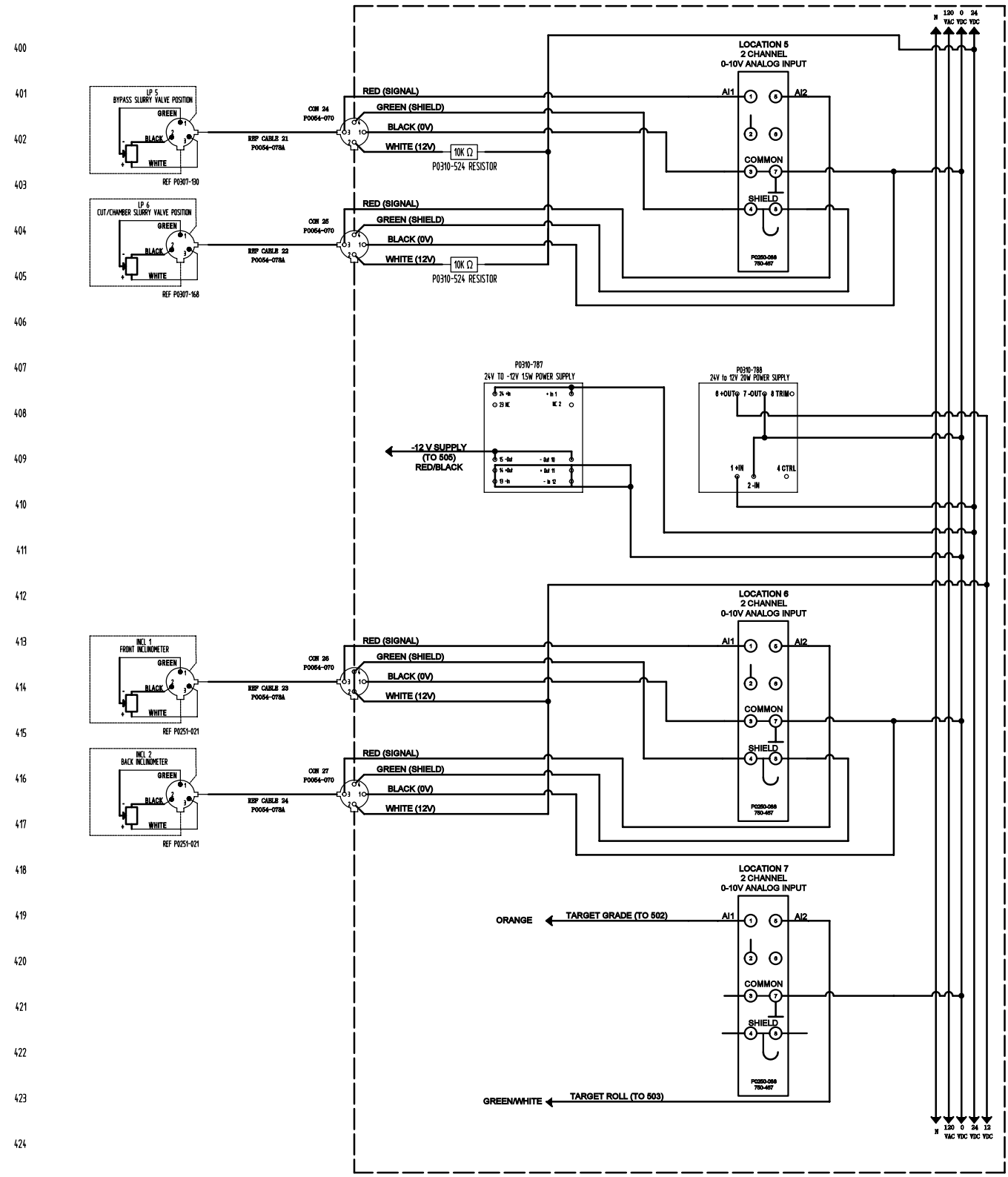
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MTBM Front Section Control Box Electrical Schematics (continued)
Electrical Schematic - Part 3 of 12



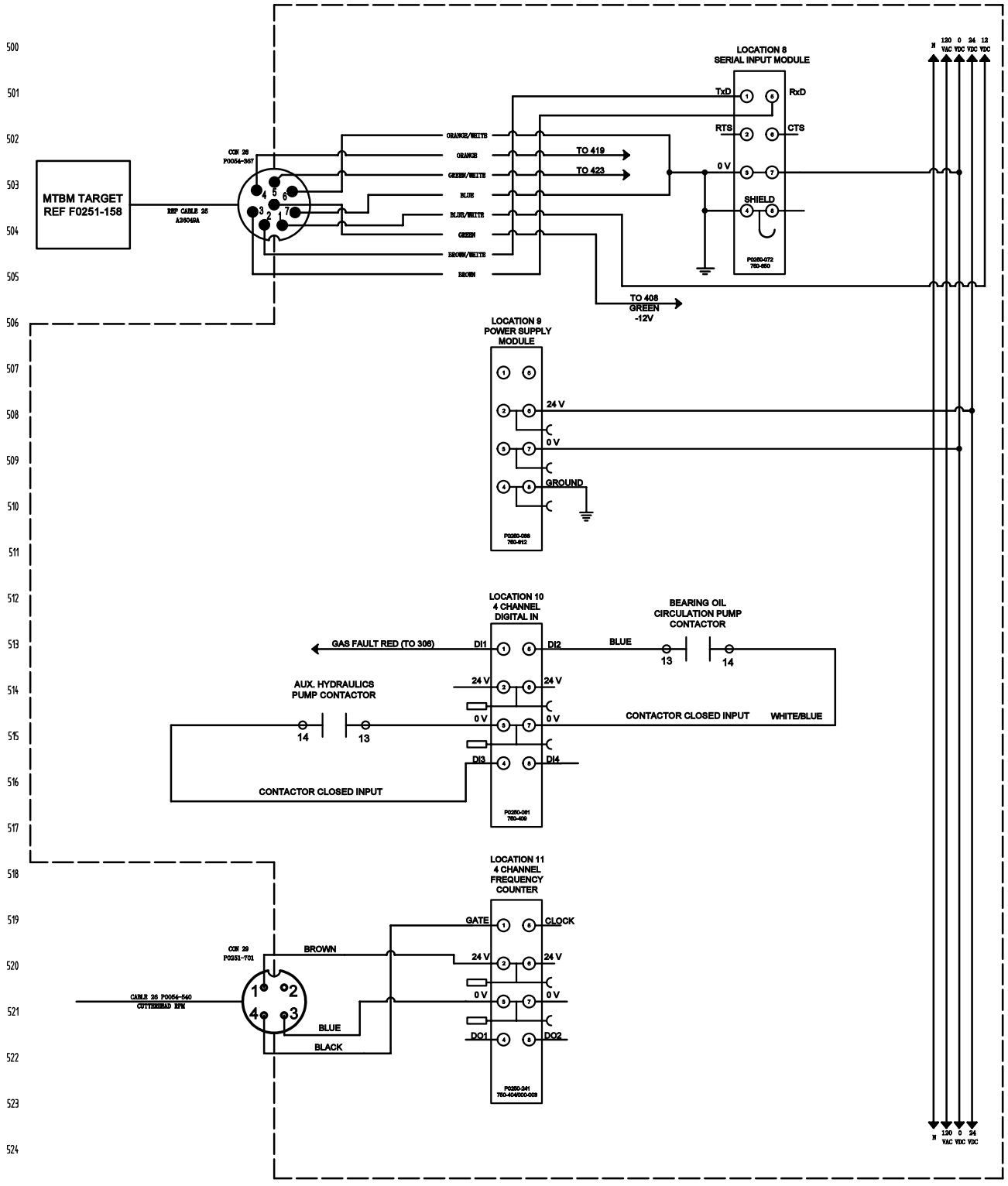
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MTBM Front Section Control Box Electrical Schematics (continued)
Electrical Schematic - Part 4 of 12



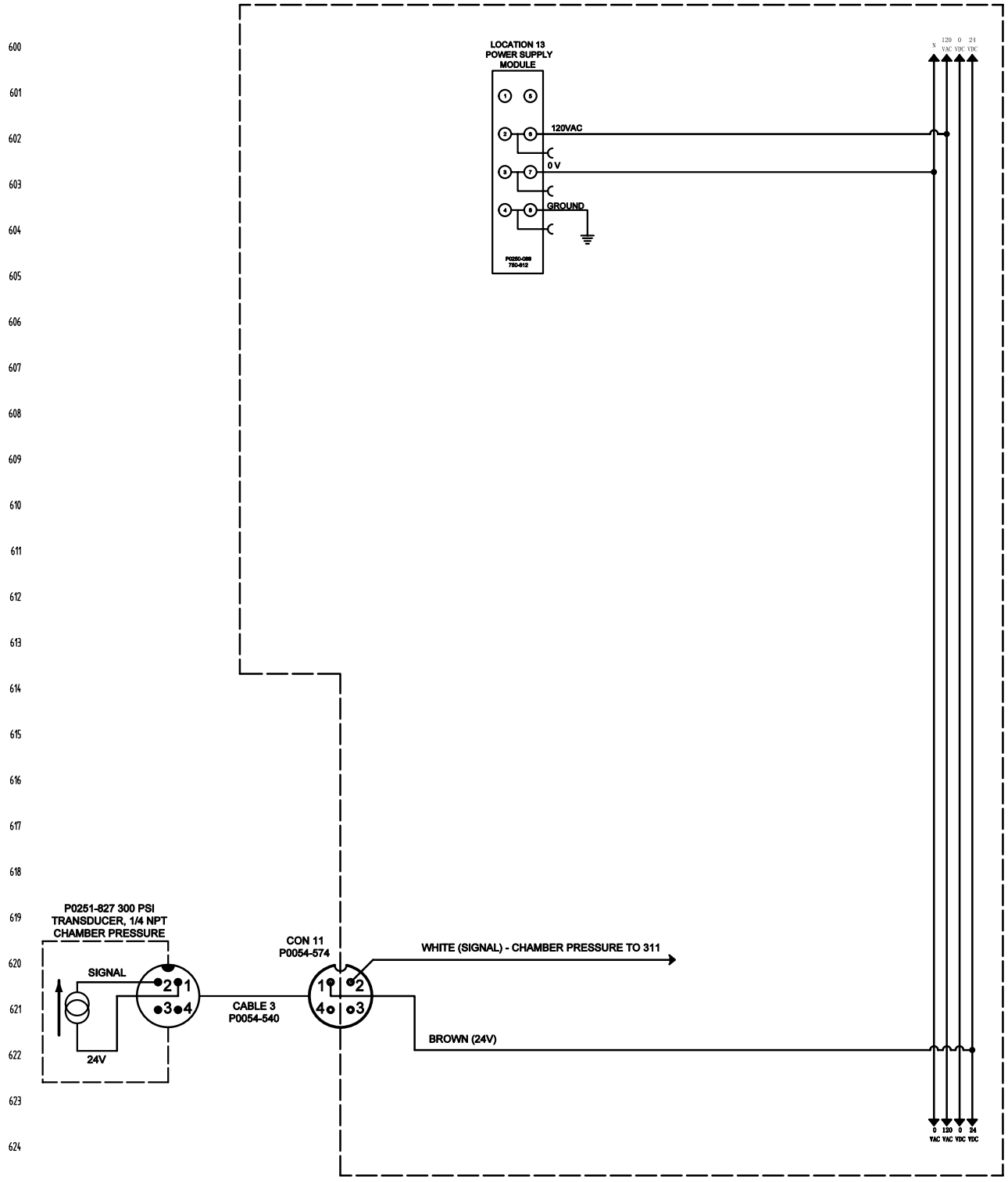
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MTBM Front Section Control Box Electrical Schematics (continued)
Electrical Schematic - Part 5 of 12



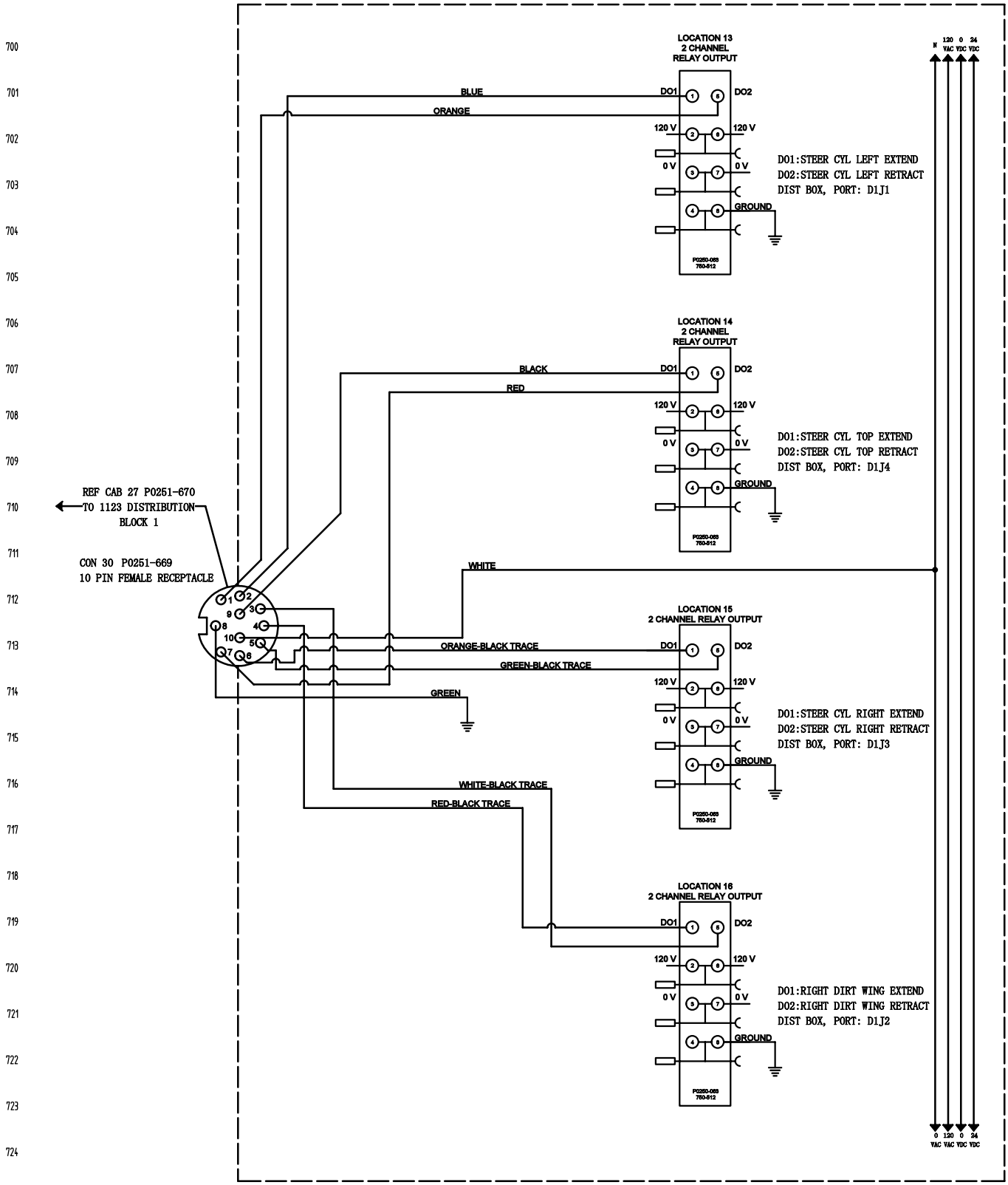
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MTBM Front Section Control Box Electrical Schematics (continued)
Electrical Schematic - Part 6 of 12



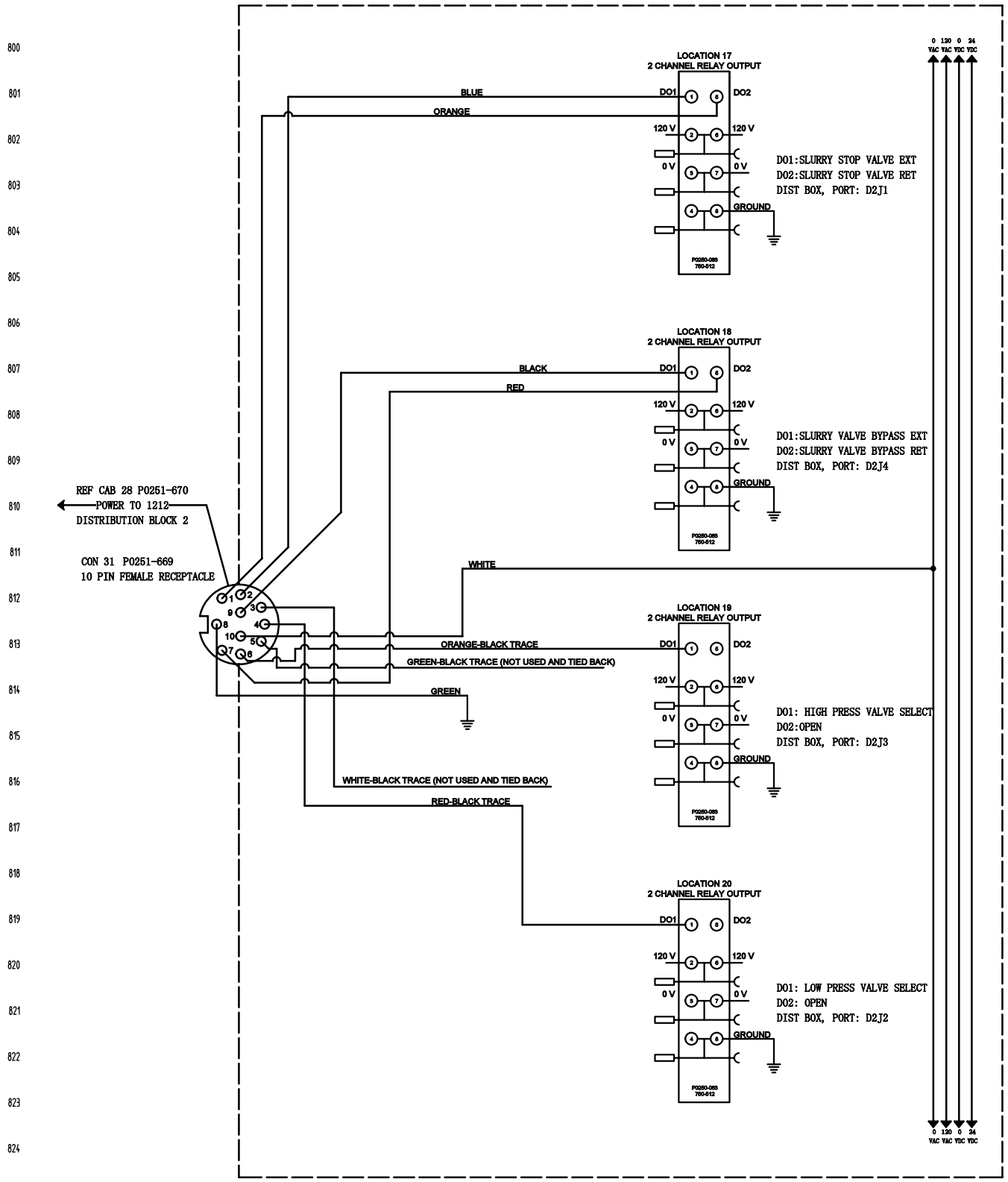
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MTBM Front Section Control Box Electrical Schematics (continued)
Electrical Schematic - Part 7 of 12



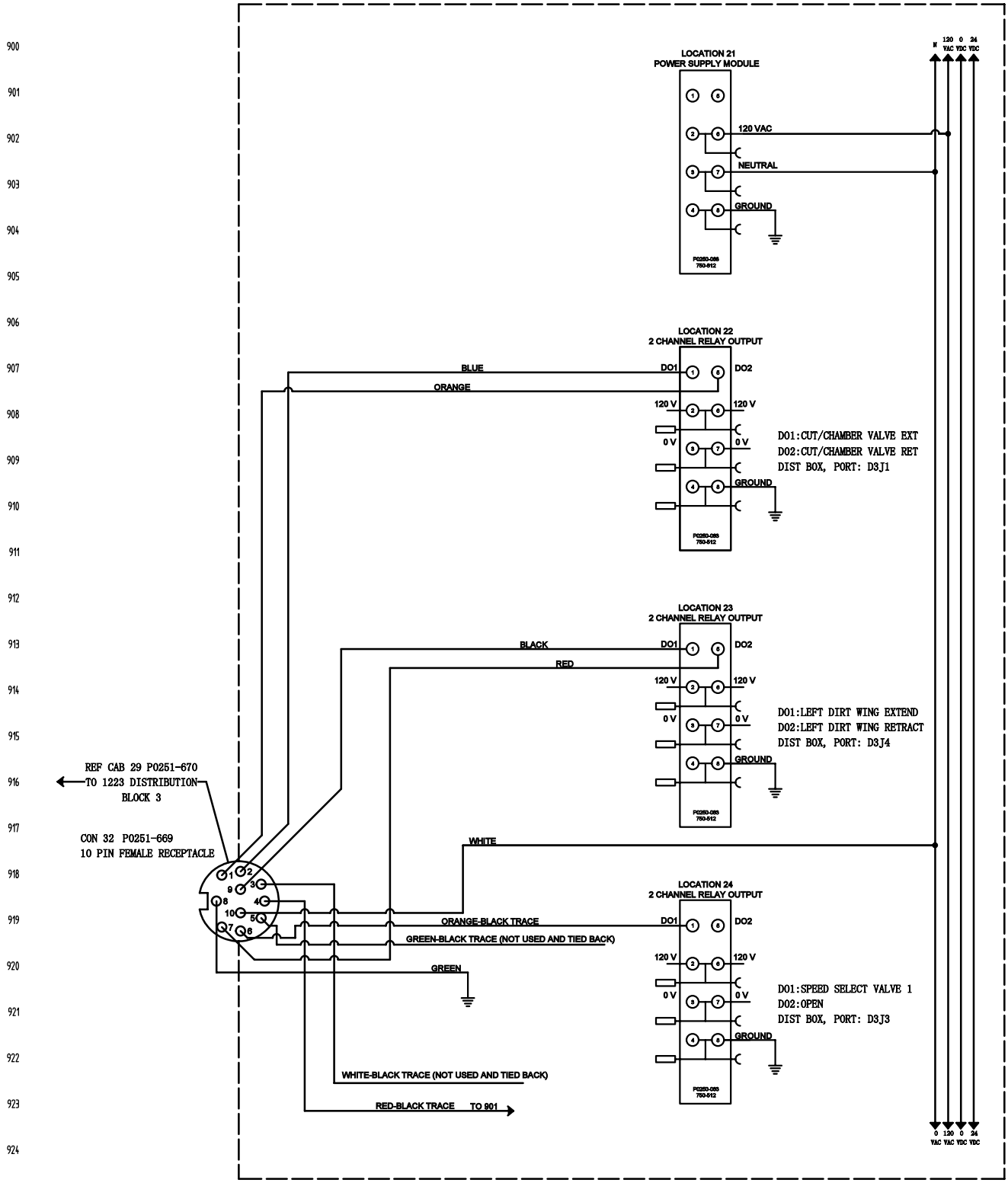
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MTBM Front Section Control Box Electrical Schematics (continued)
Electrical Schematic - Part 8 of 12



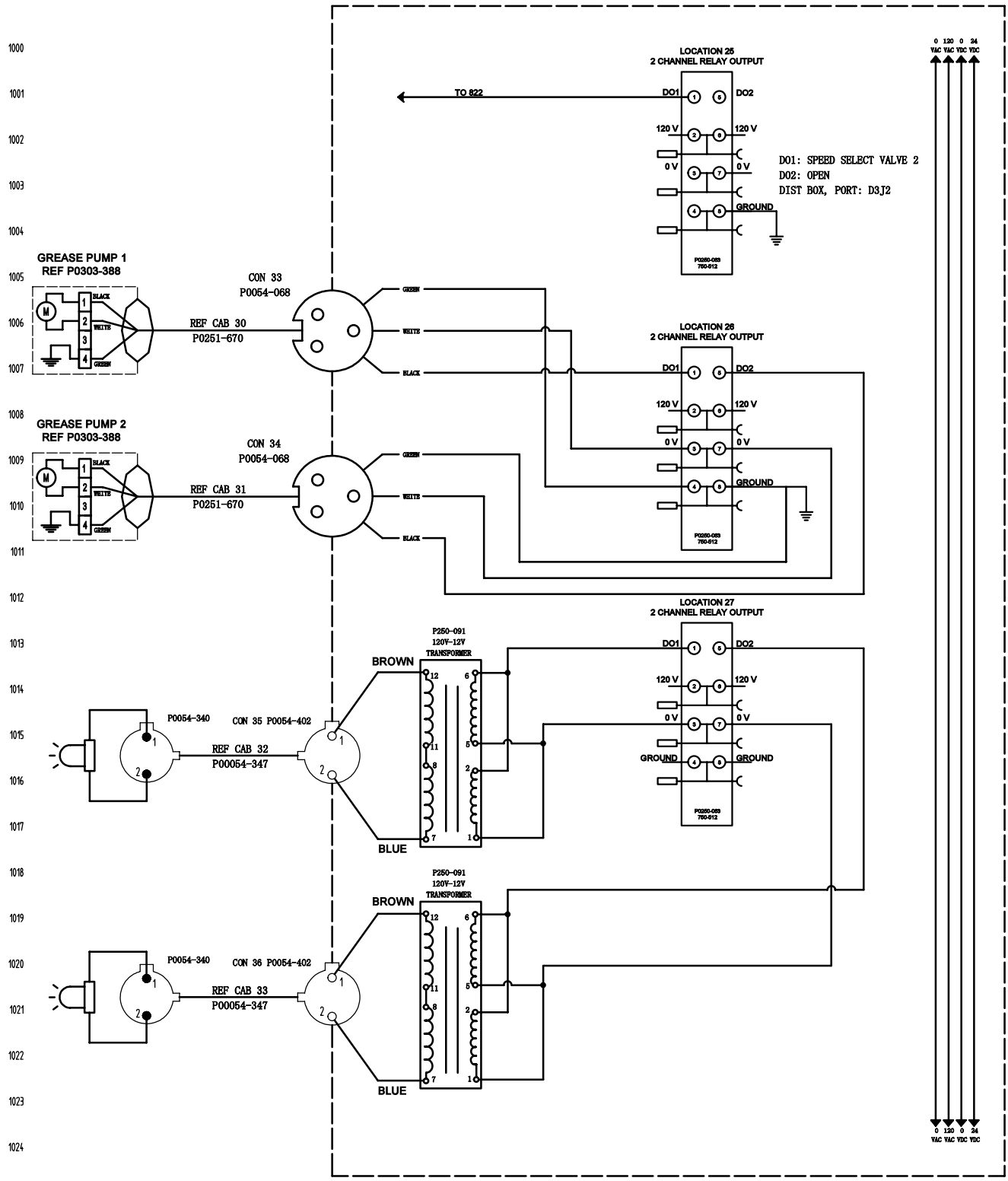
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MTBM Front Section Control Box Electrical Schematics (continued)
Electrical Schematic - Part 9 of 12



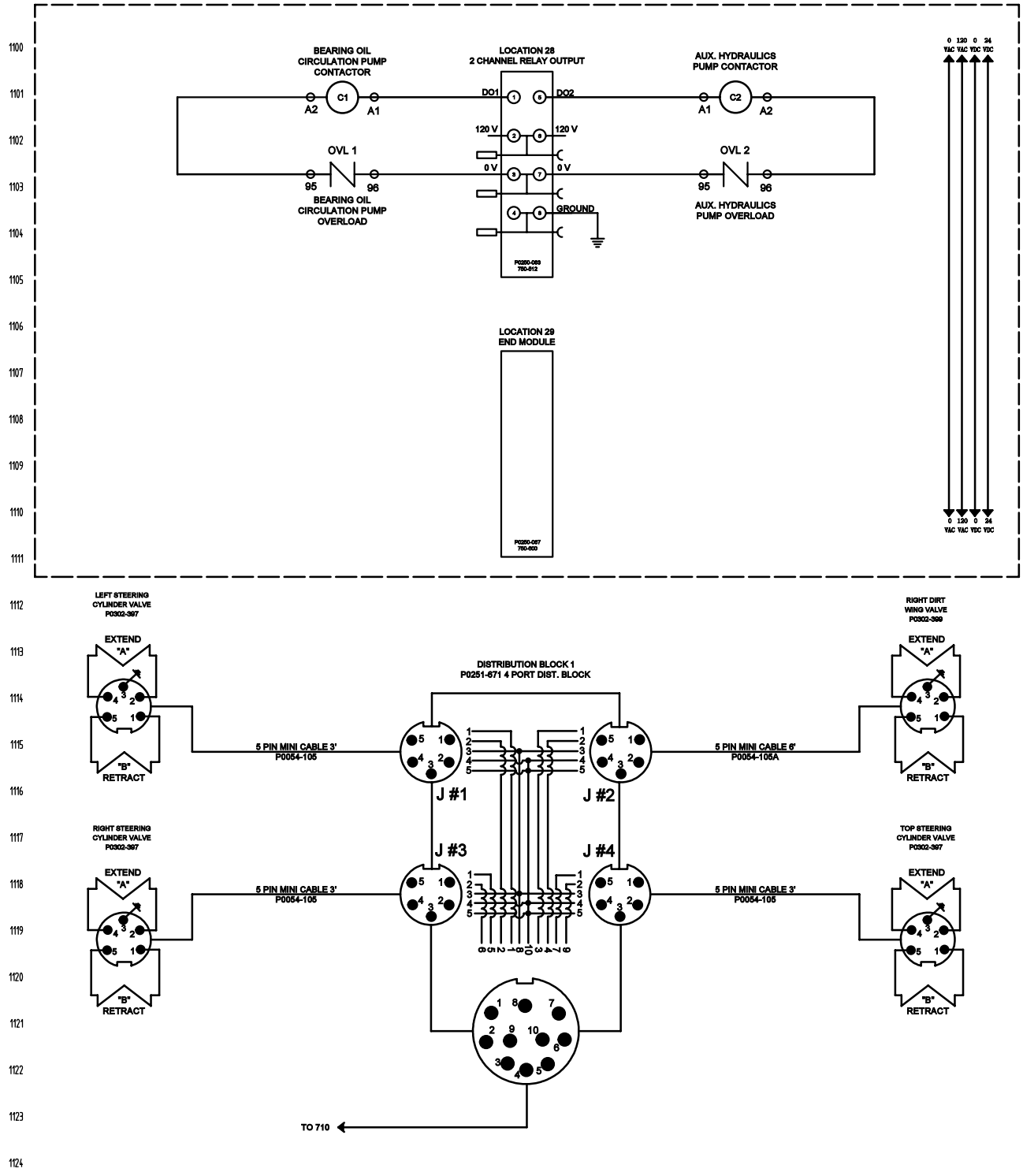
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MTBM Front Section Control Box Electrical Schematics (continued)
Electrical Schematic - Part 10 of 12



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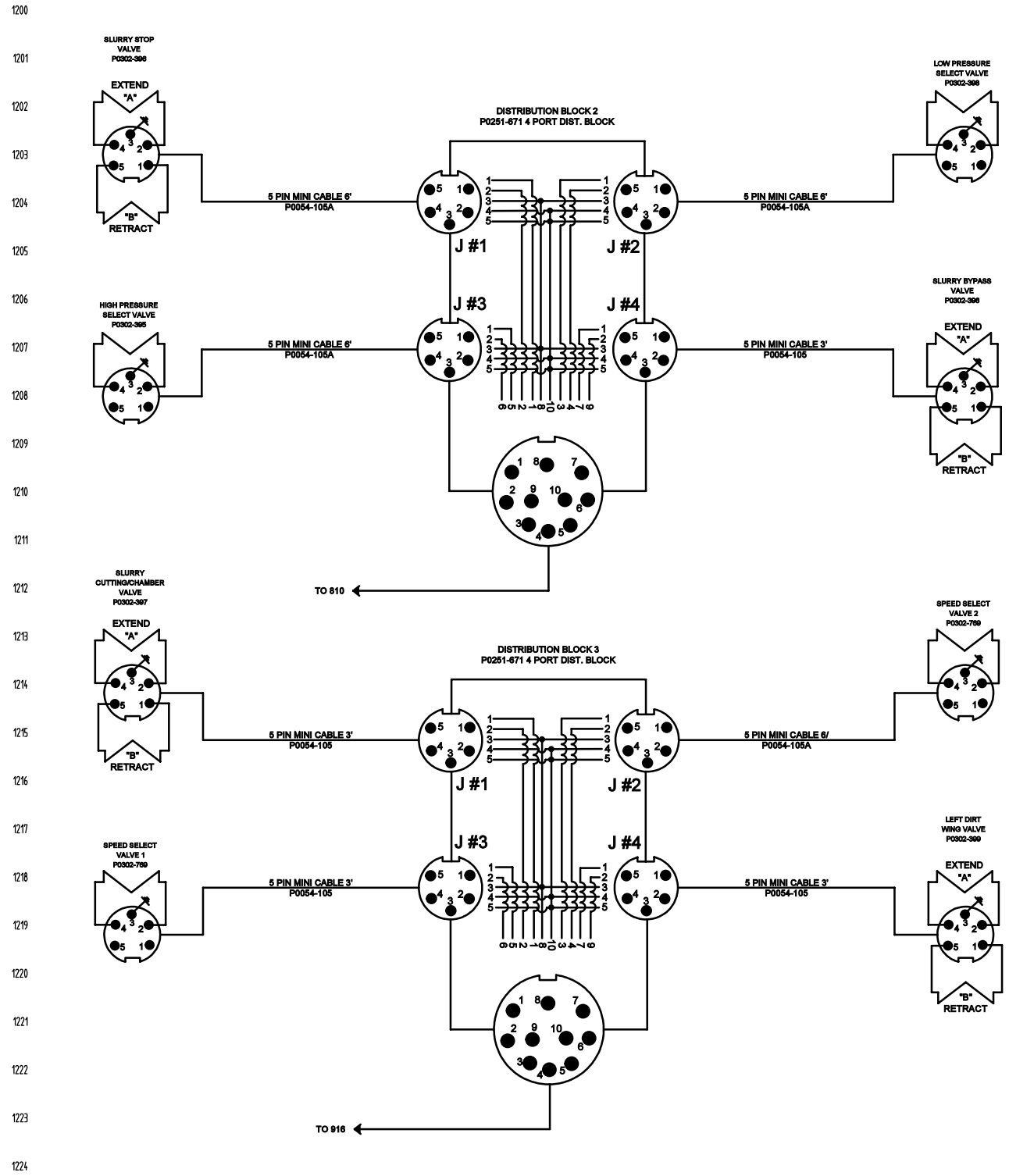
MTBM Front Section Control Box Electrical Schematics (continued)
Electrical Schematic - Part 11 of 12



*DISTRIBUTION BLOCKS, CABLES, AND VALVE BLOCKS ARE SHOWN FOR REFERENCE. THEY ARE LOCATED IN SL86 HEAD SECTION.

(continued on next page)

MTBM Front Section Control Box Electrical Schematics (continued)
Electrical Schematic - Part 12 of 12

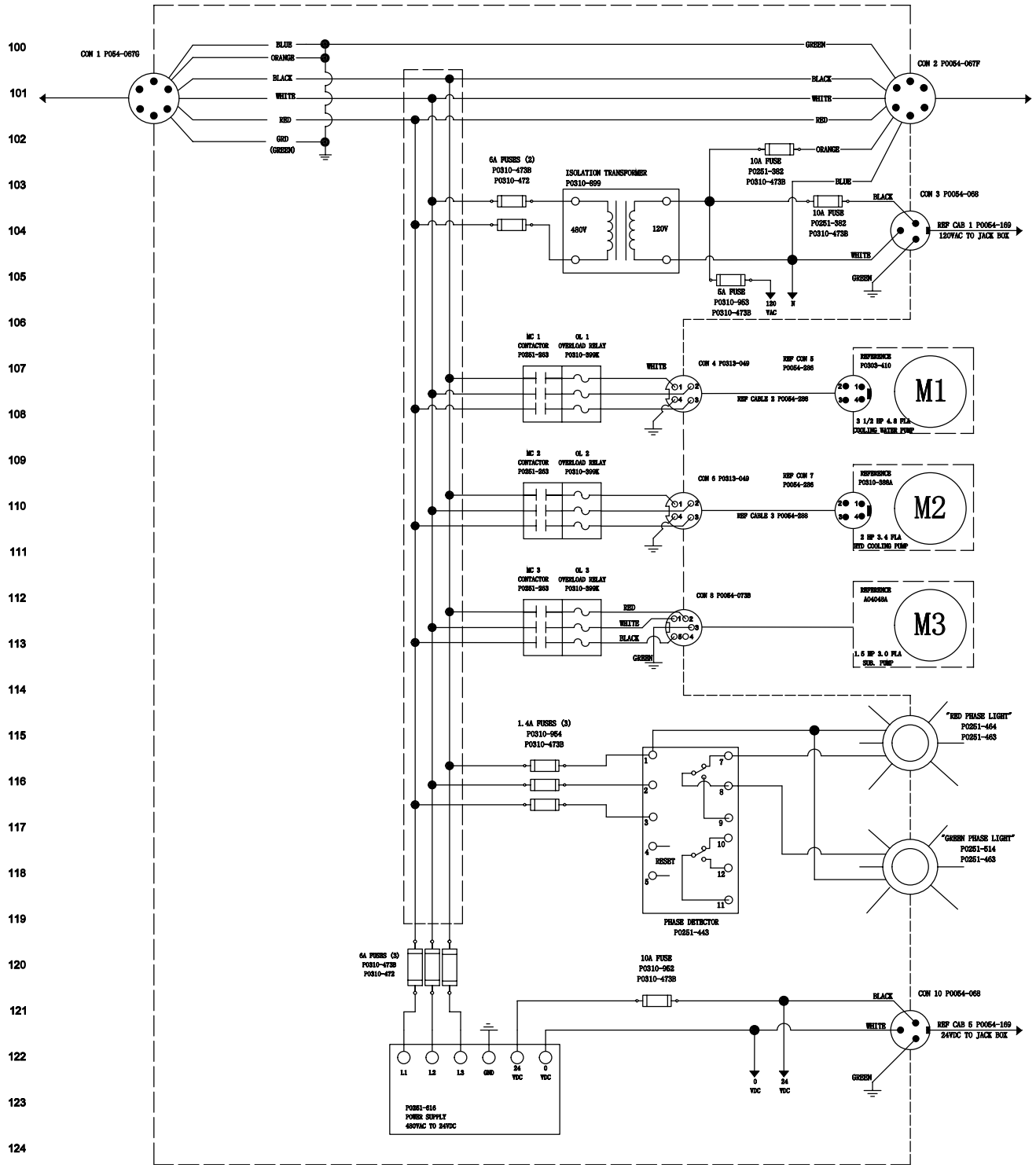


*DISTRIBUTION BLOCKS, CABLES, AND VALVE BLOCKS ARE SHOWN FOR REFERENCE. THEY ARE LOCATED IN SL86 HEAD SECTION.

(continued on next page)

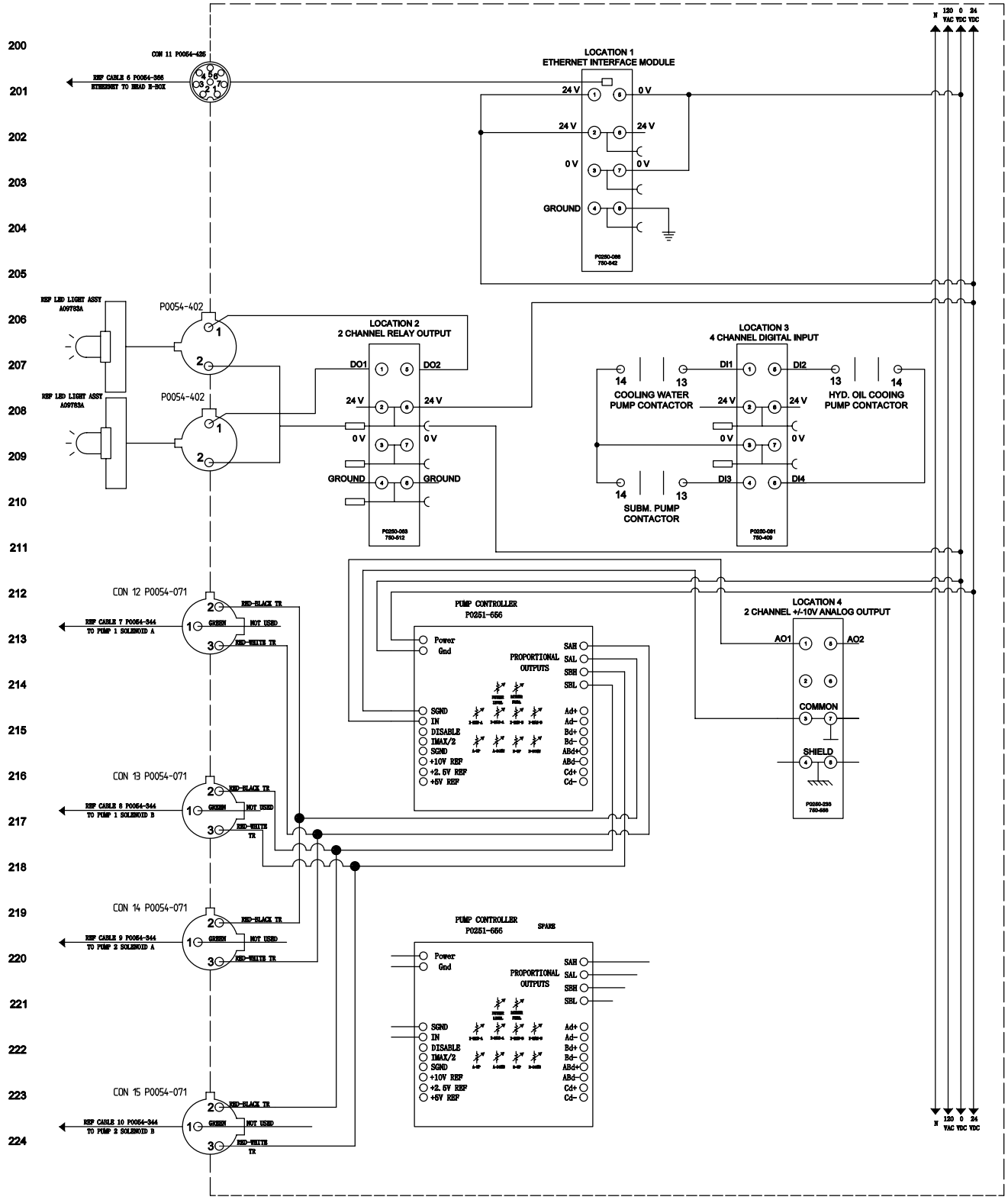
MTBM TRAILING SECTION CONTROL BOX ELECTRICAL SCHEMATICS

Electrical Schematic - Part 1 of 3



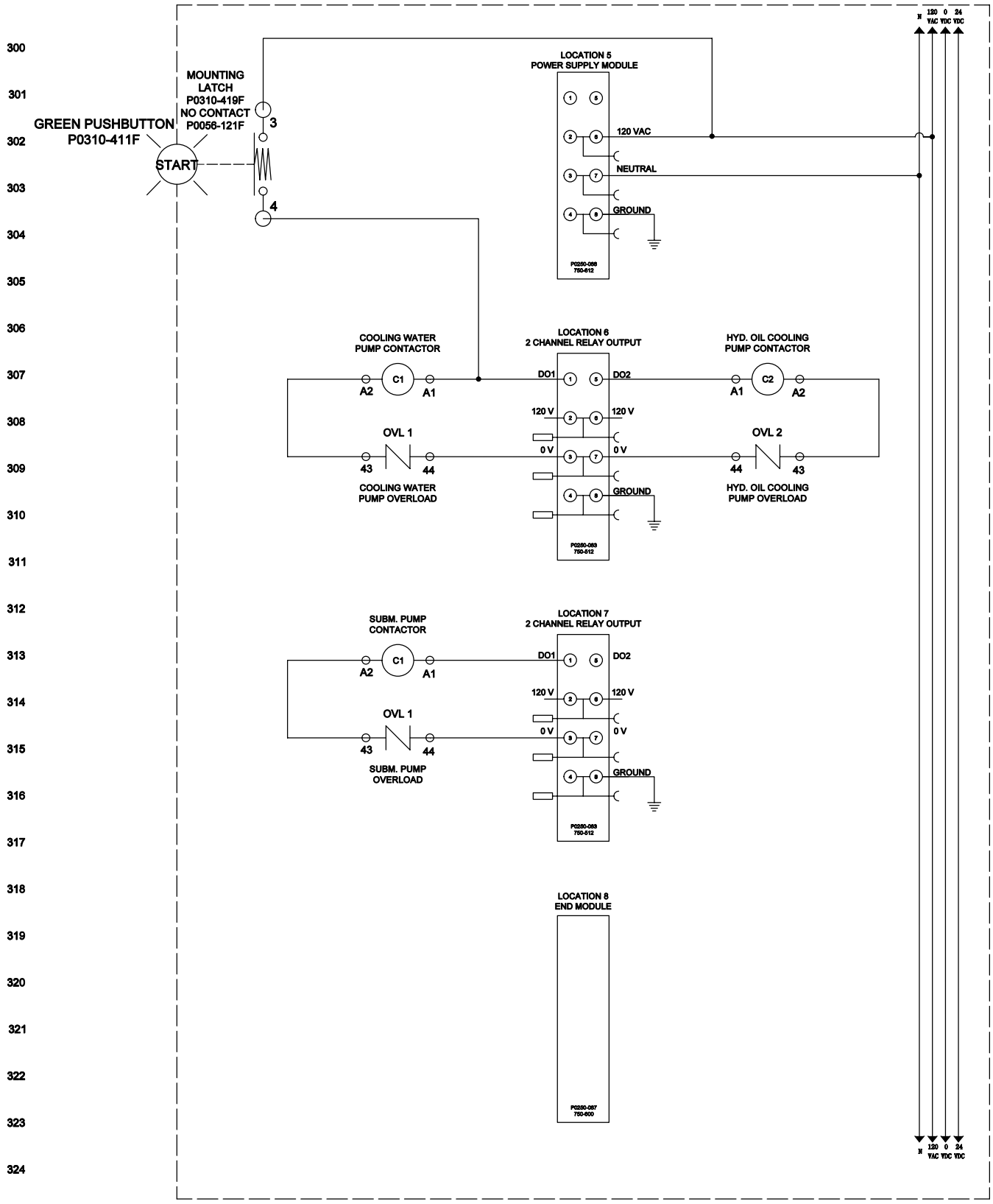
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MTBM Trailing Section Electrical Schematics (continued)
Electrical Schematic - Part 2 of 3



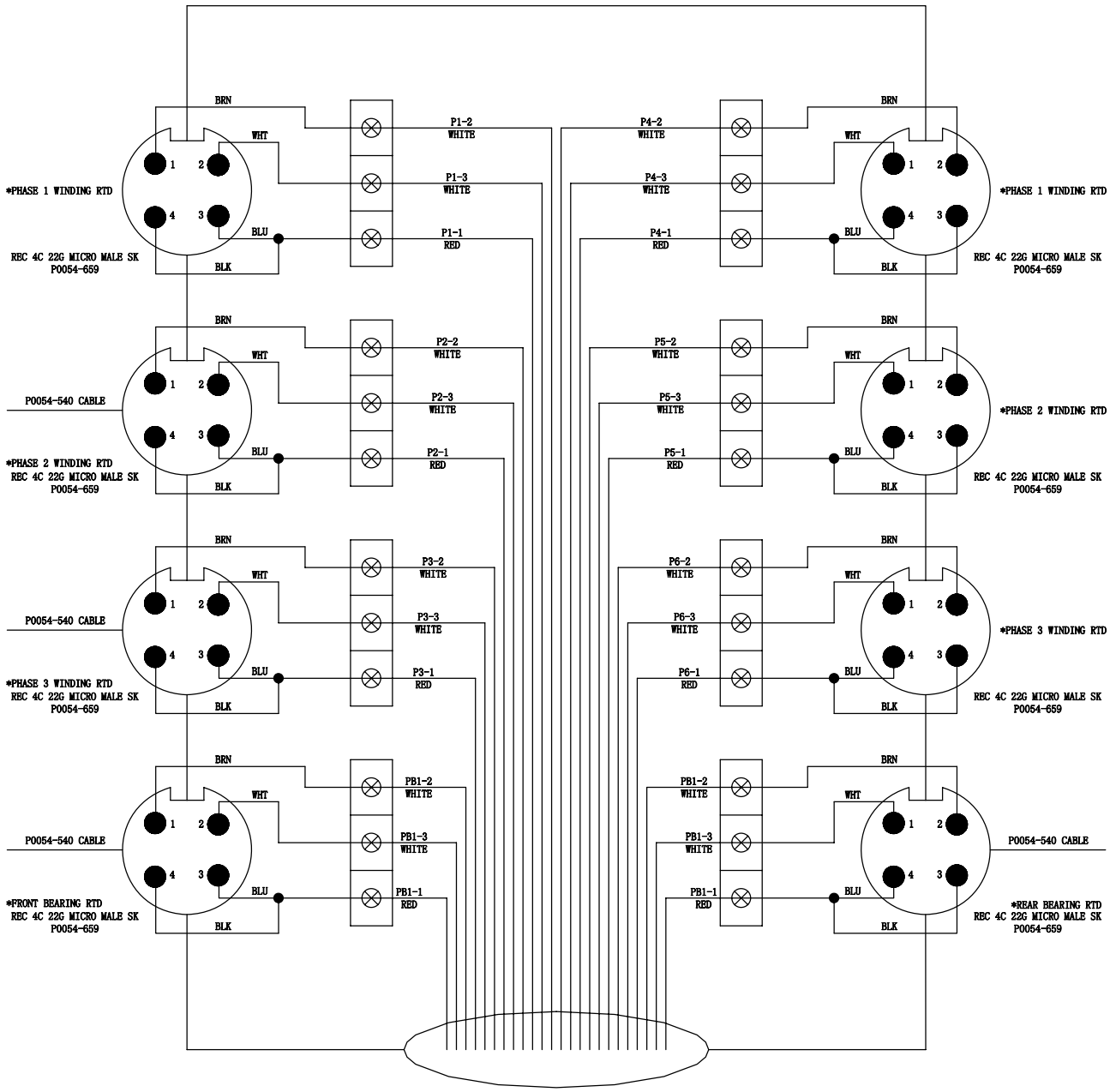
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MTBM Trailing Section Electrical Schematics (continued)
Electrical Schematic - Part 3 of 3



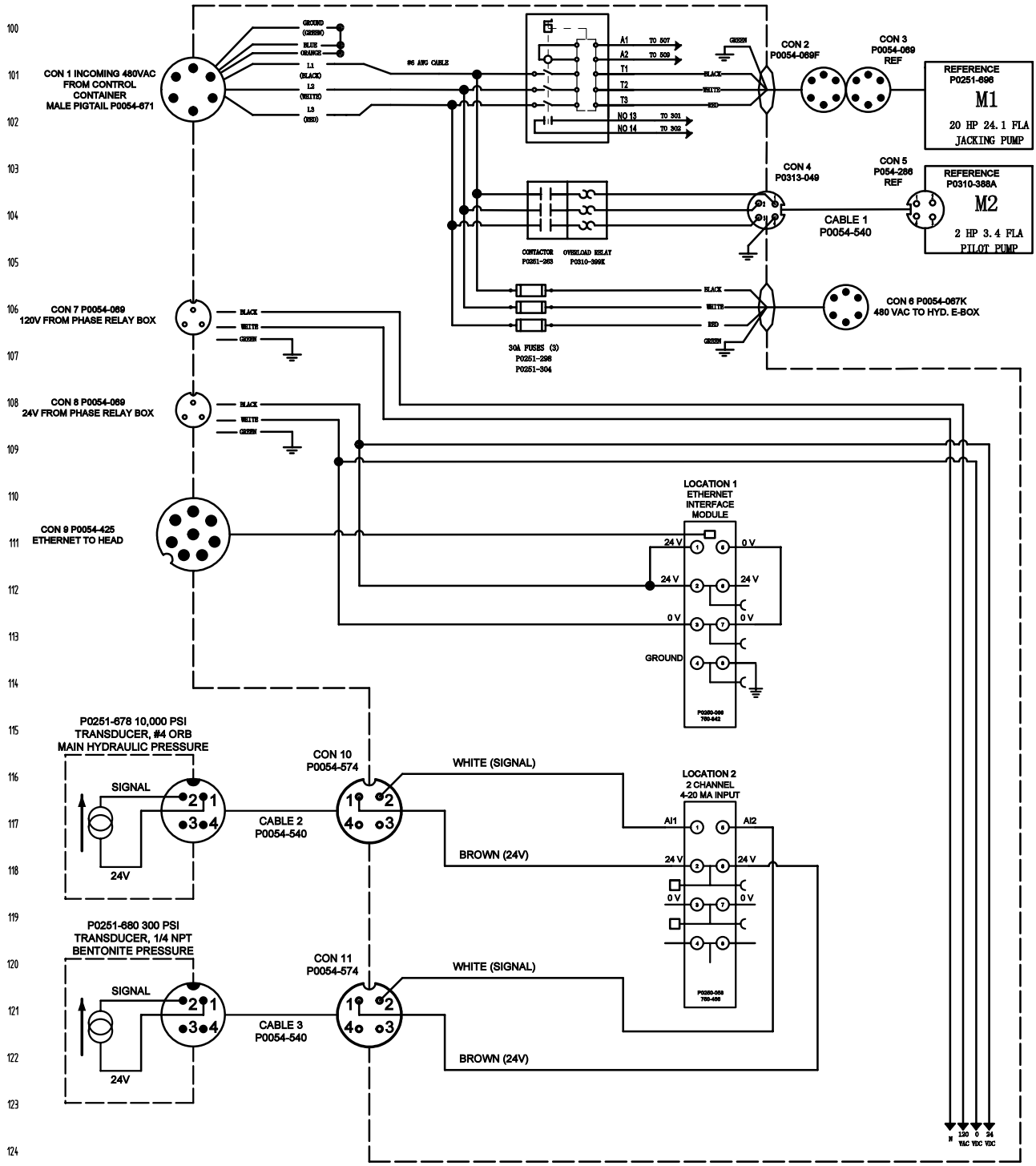
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MTBM MOTOR RTD BOX ELECTRICAL SCHEMATIC



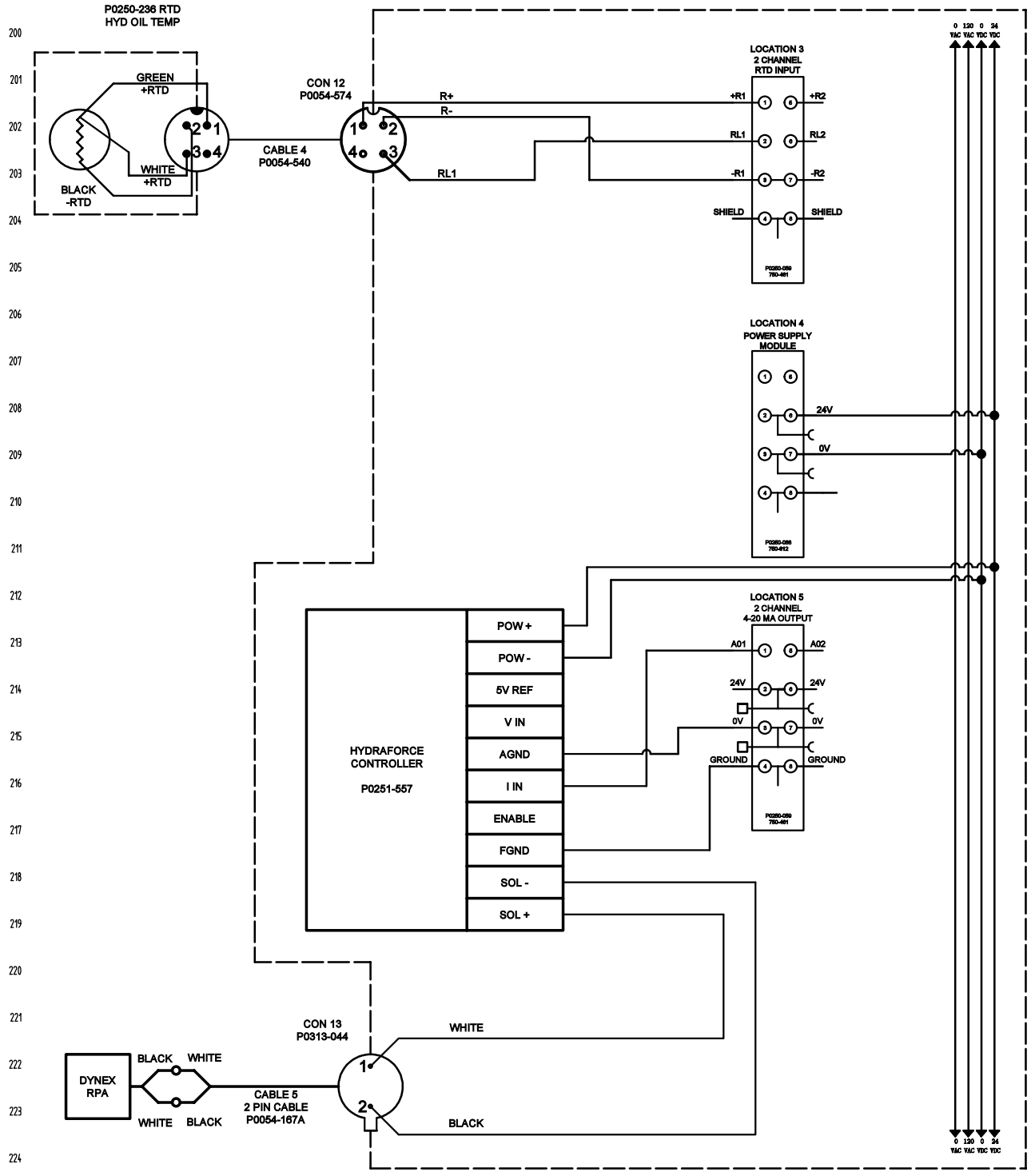
MTBM JACK CAN CONTROL BOX ELECTRICAL SCHEMATICS

Electrical Schematic - Part 1 of 7



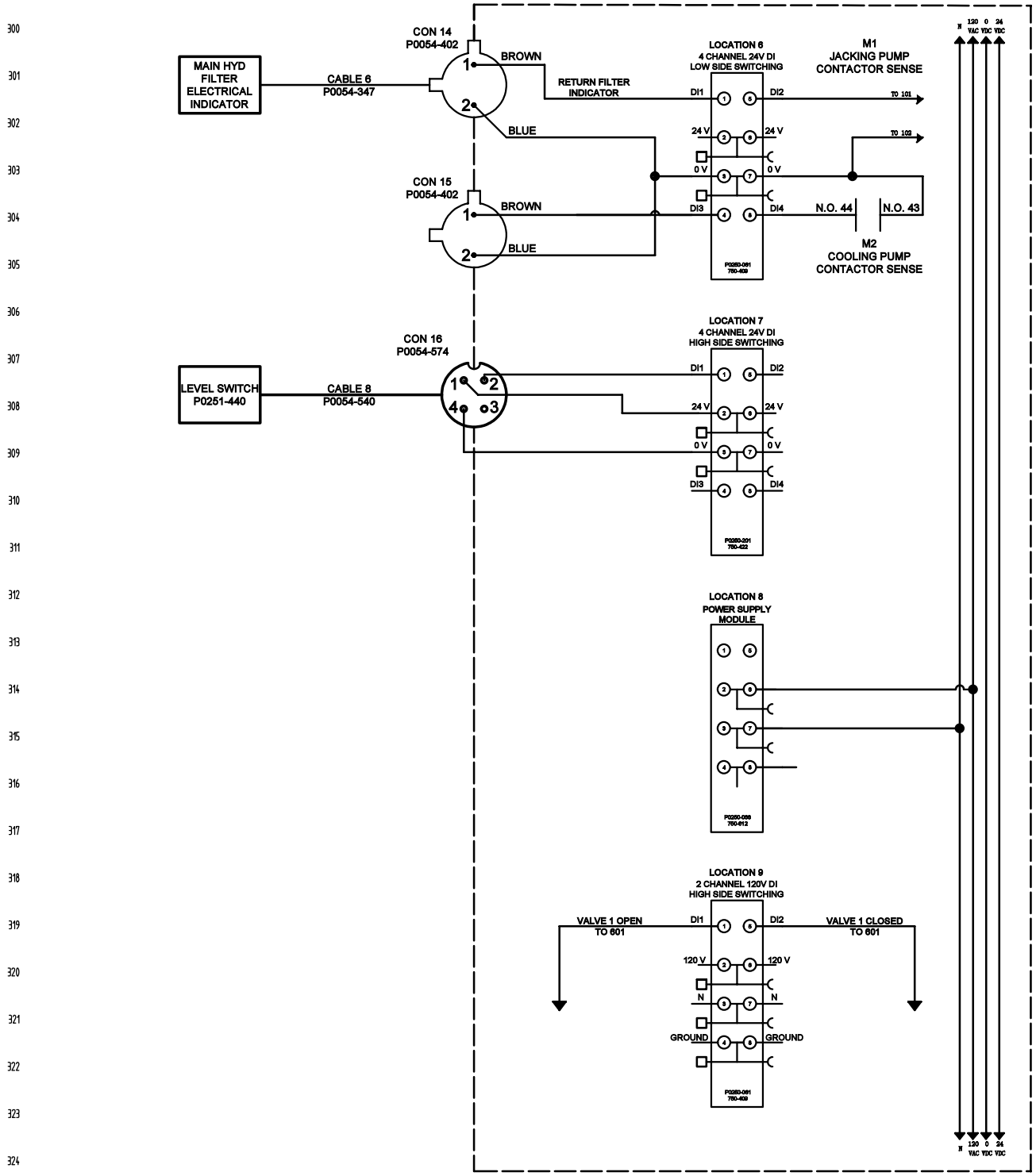
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MTBM Jack Can Control Box Electrical Schematics (continued)
Electrical Schematic - Part 2 of 7



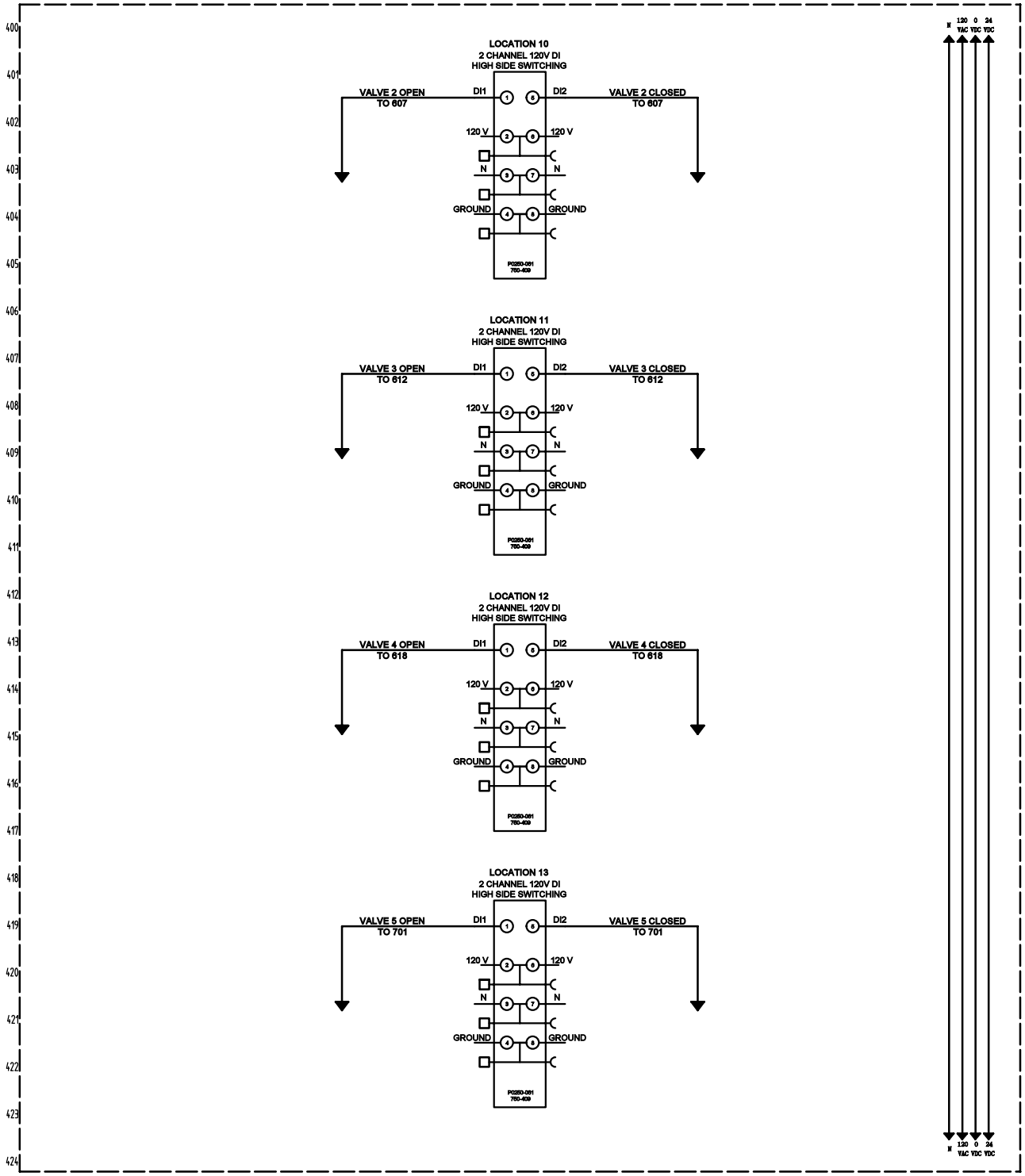
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MTBM Jack Can Control Box Electrical Schematics (continued)
Electrical Schematic - Part 3 of 7



(continued on next page)

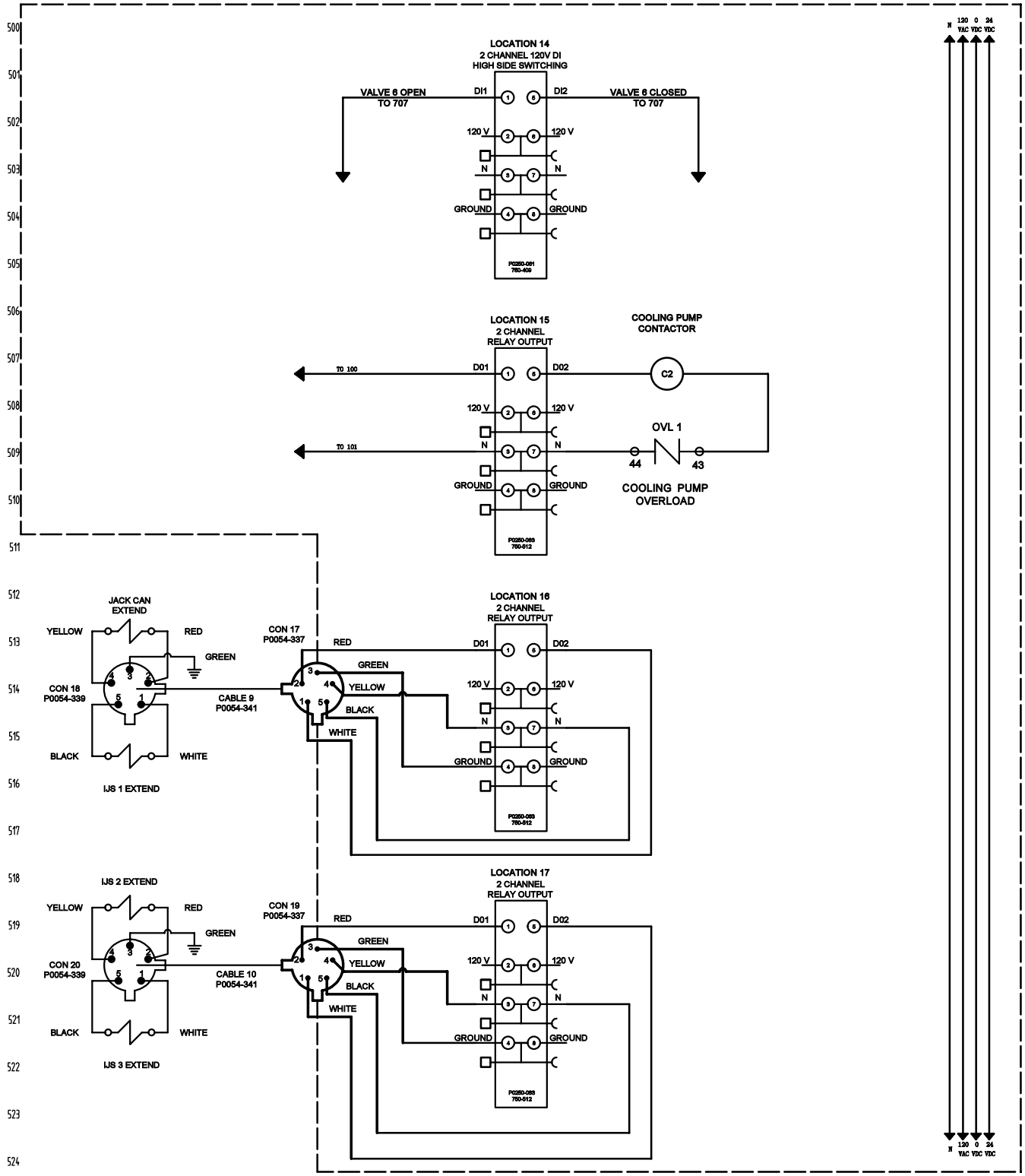
MTBM Jack Can Control Box Electrical Schematics (continued)
Electrical Schematic - Part 4 of 7



(continued on next page)

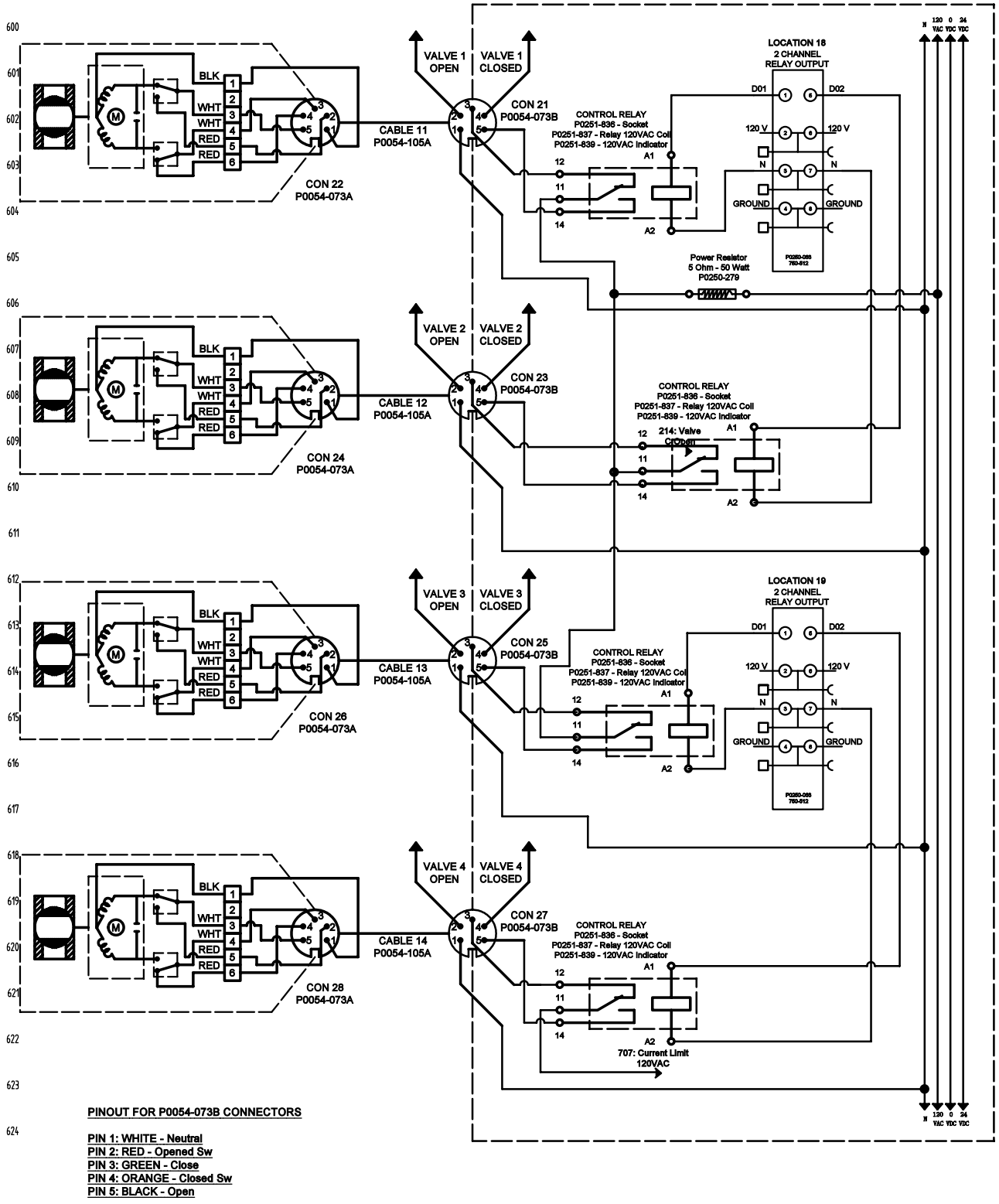
MTBM Jack Can Control Box Electrical Schematics (continued)

Electrical Schematic - Part 5 of 7



(continued on next page)

MTBM Jack Can Control Box Electrical Schematics (continued)
Electrical Schematic - Part 6 of 7

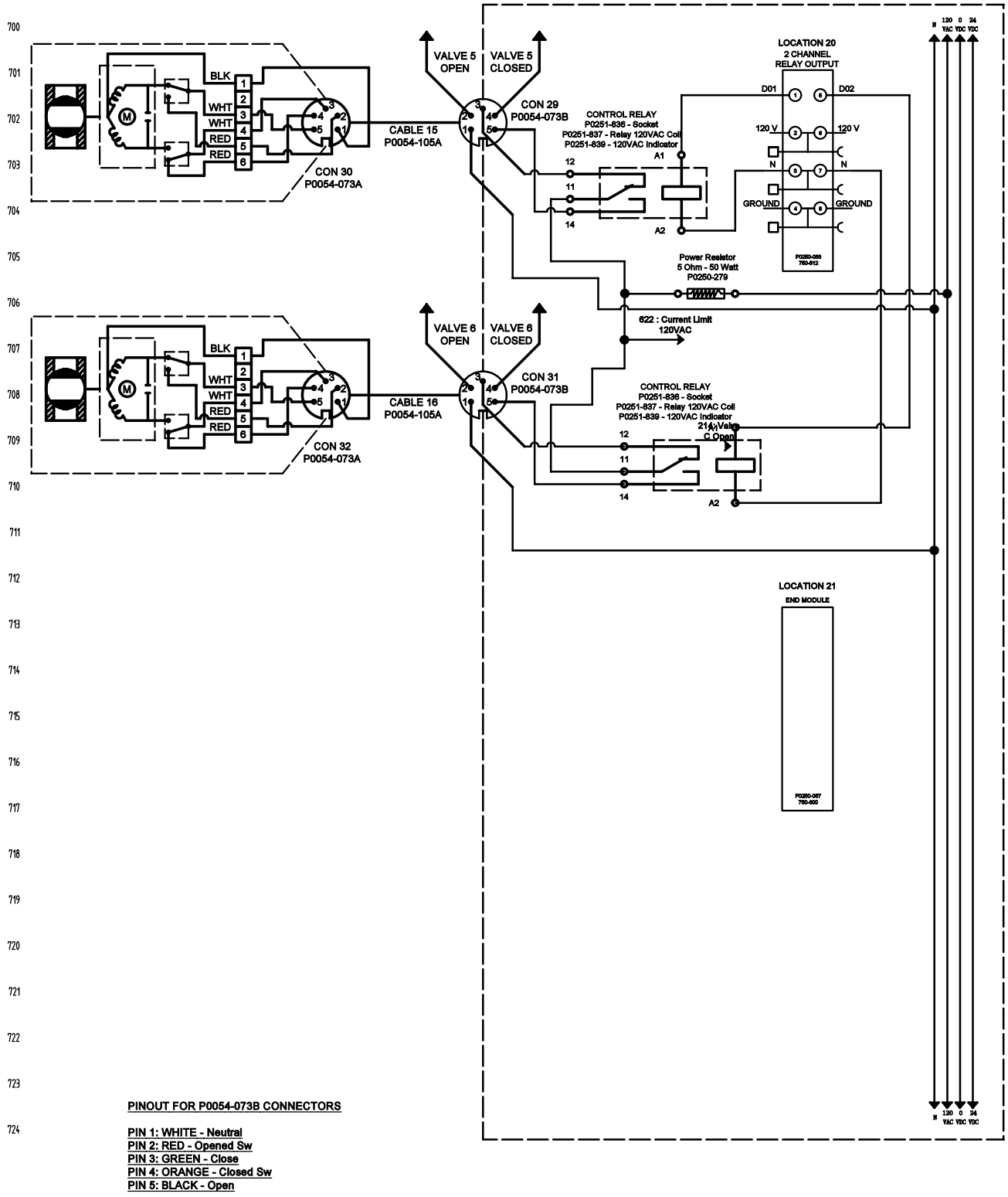


PINOUT FOR P0054-073B CONNECTORS

PIN 1: WHITE - Neutral
PIN 2: RED - Opened Sw
PIN 3: GREEN - Close
PIN 4: ORANGE - Closed Sw
PIN 5: BLACK - Open

MTBM Jack Can Control Box Electrical Schematics (continued)

Electrical Schematic - Part 7 of 7

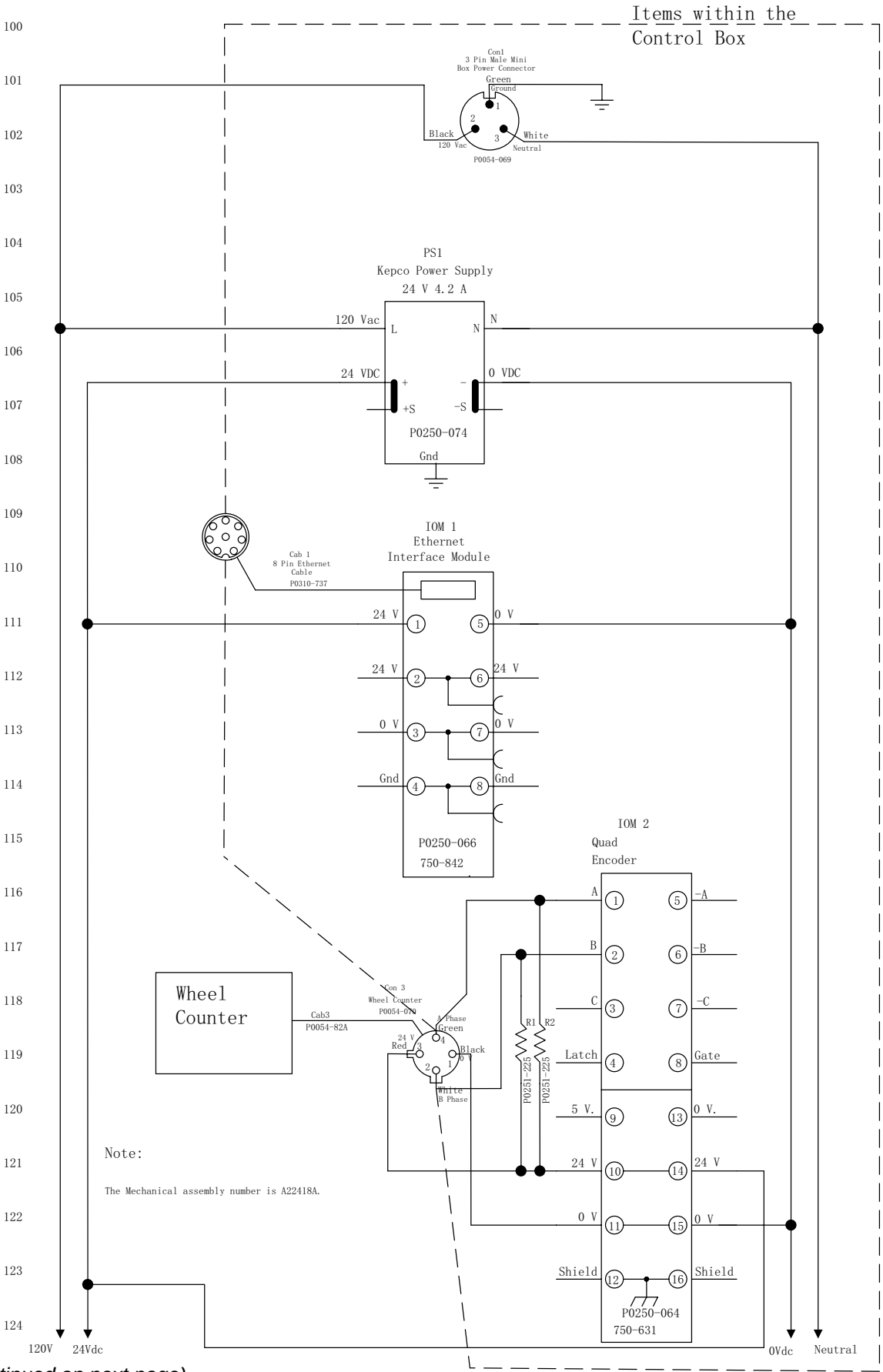


PINOUT FOR P0054-073B CONNECTORS

PIN 1: WHITE - Neutral
PIN 2: RED - Opened Sw
PIN 3: GREEN - Close
PIN 4: ORANGE - Closed Sw
PIN 5: BLACK - Open

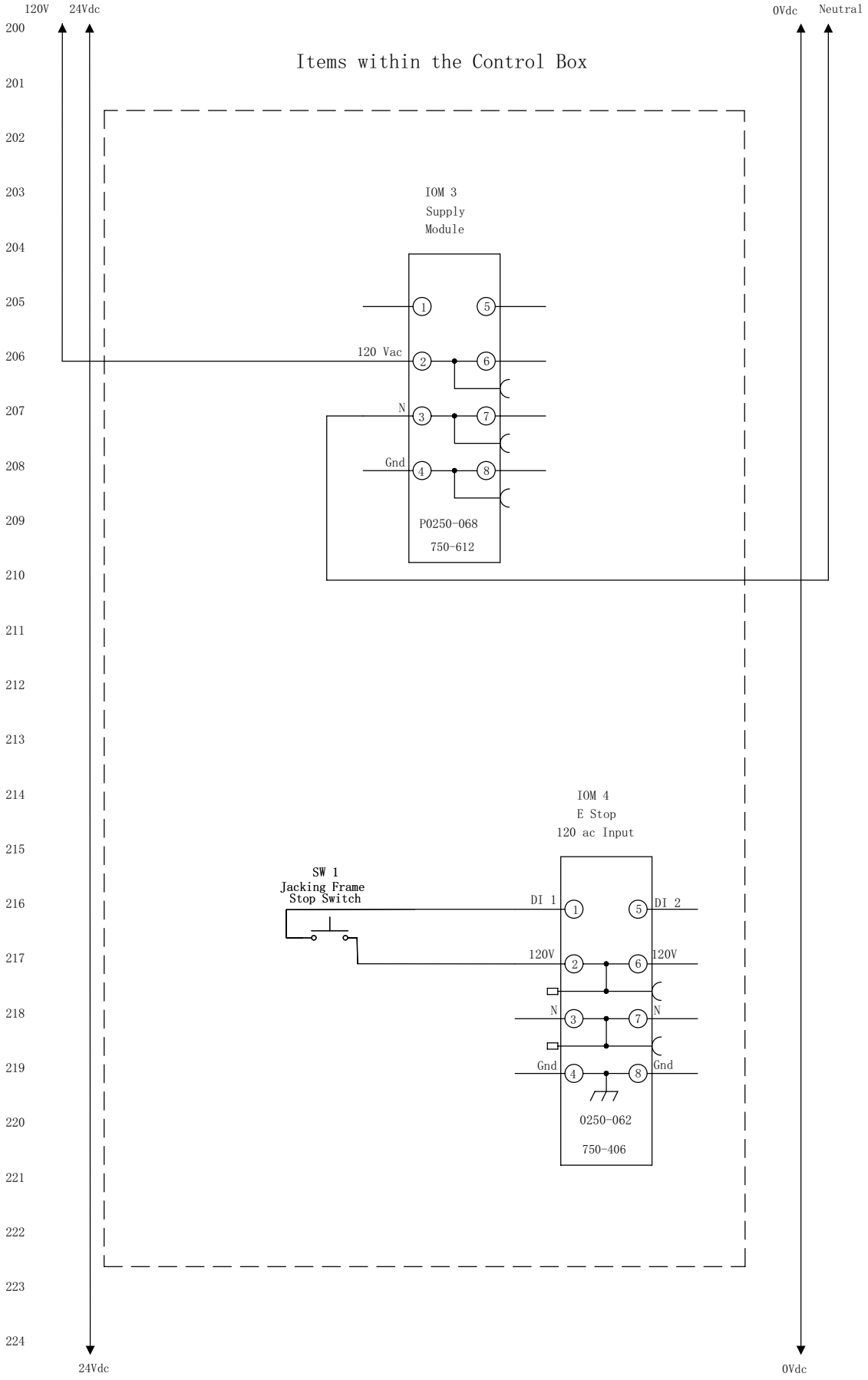
PIT BOX ELECTRICAL SCHEMATICS

Electrical Schematic - Part 1 of 3



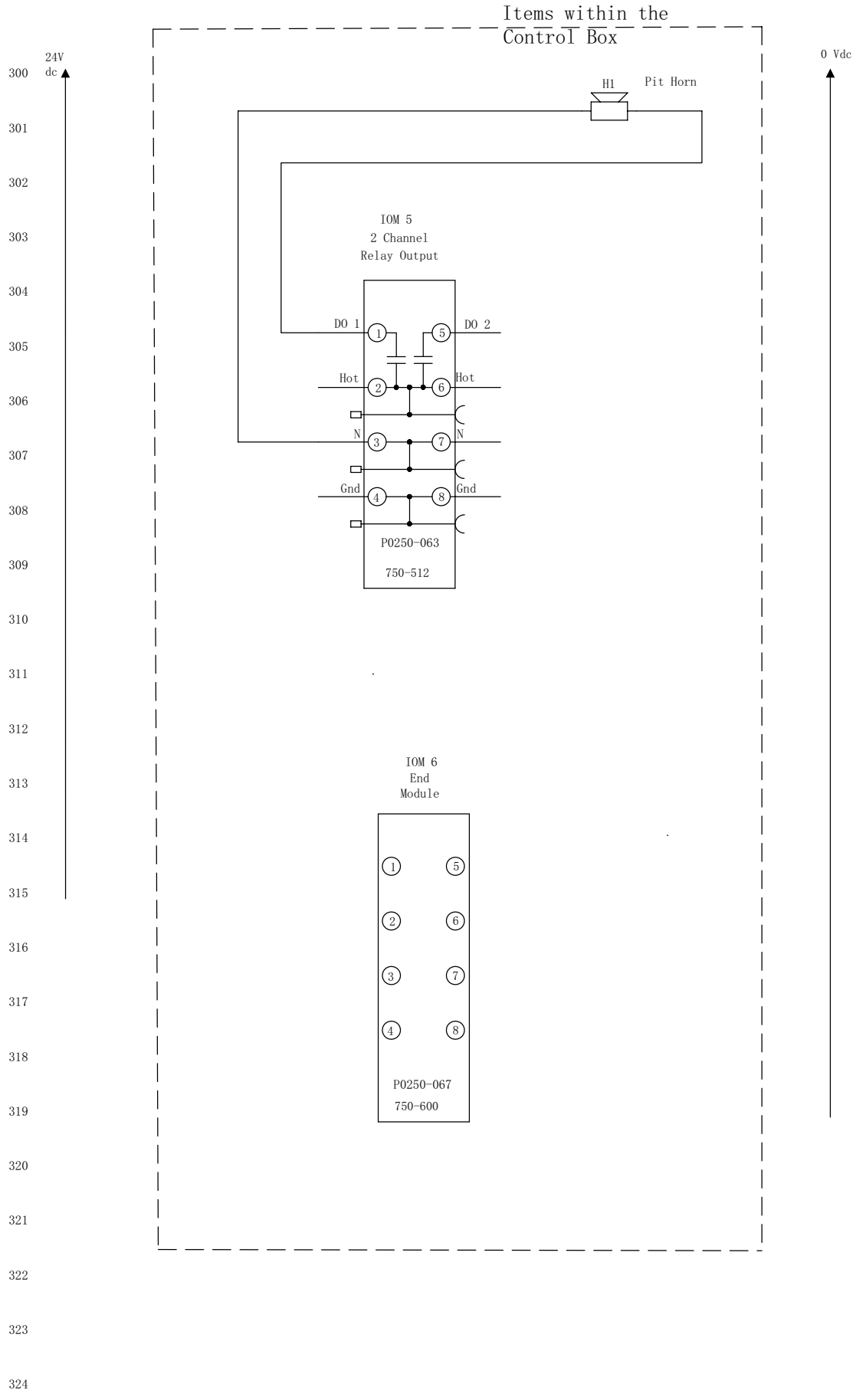
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Pit Box Electrical Schematics (continued) - Part 2 of 3

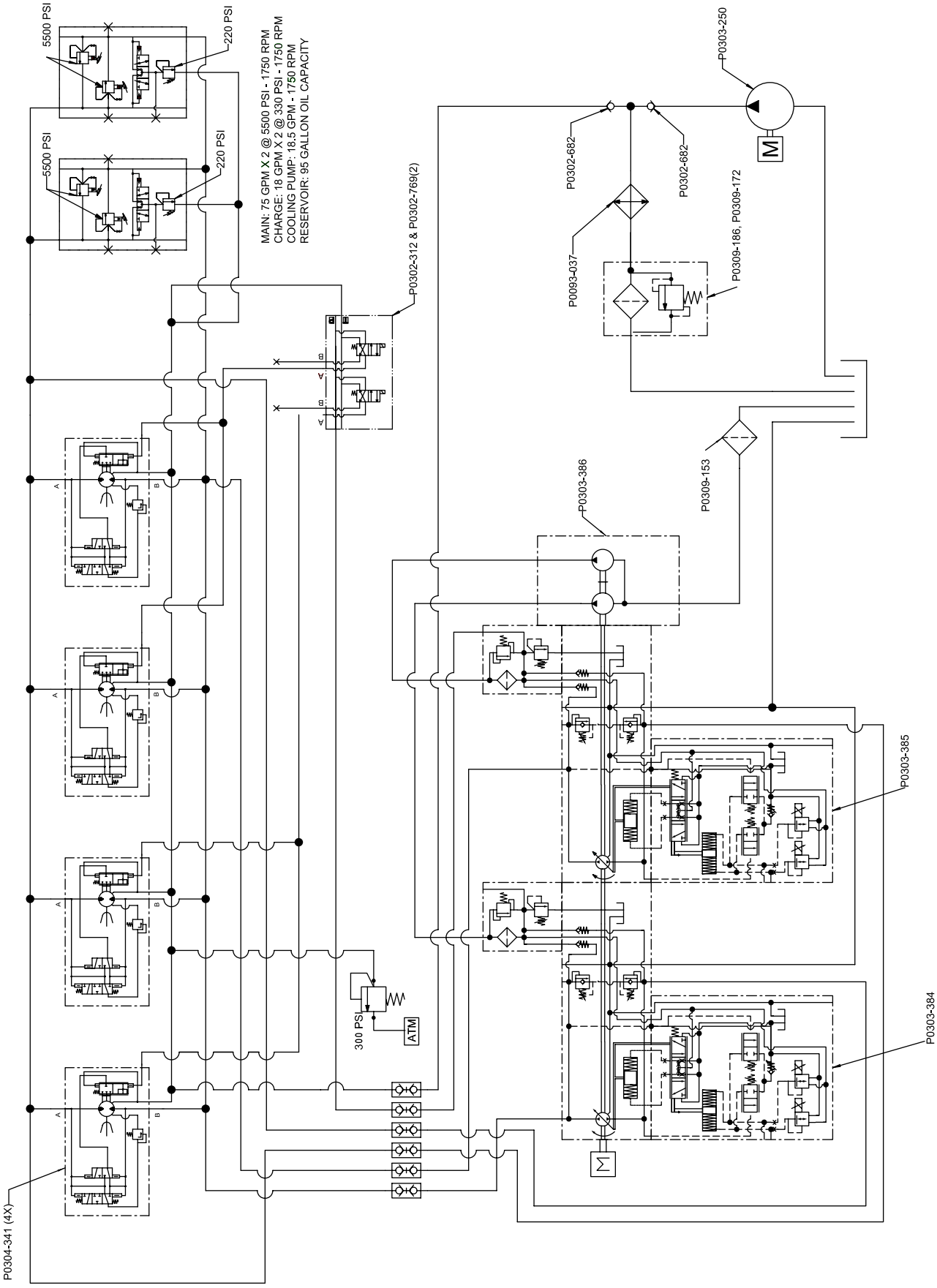


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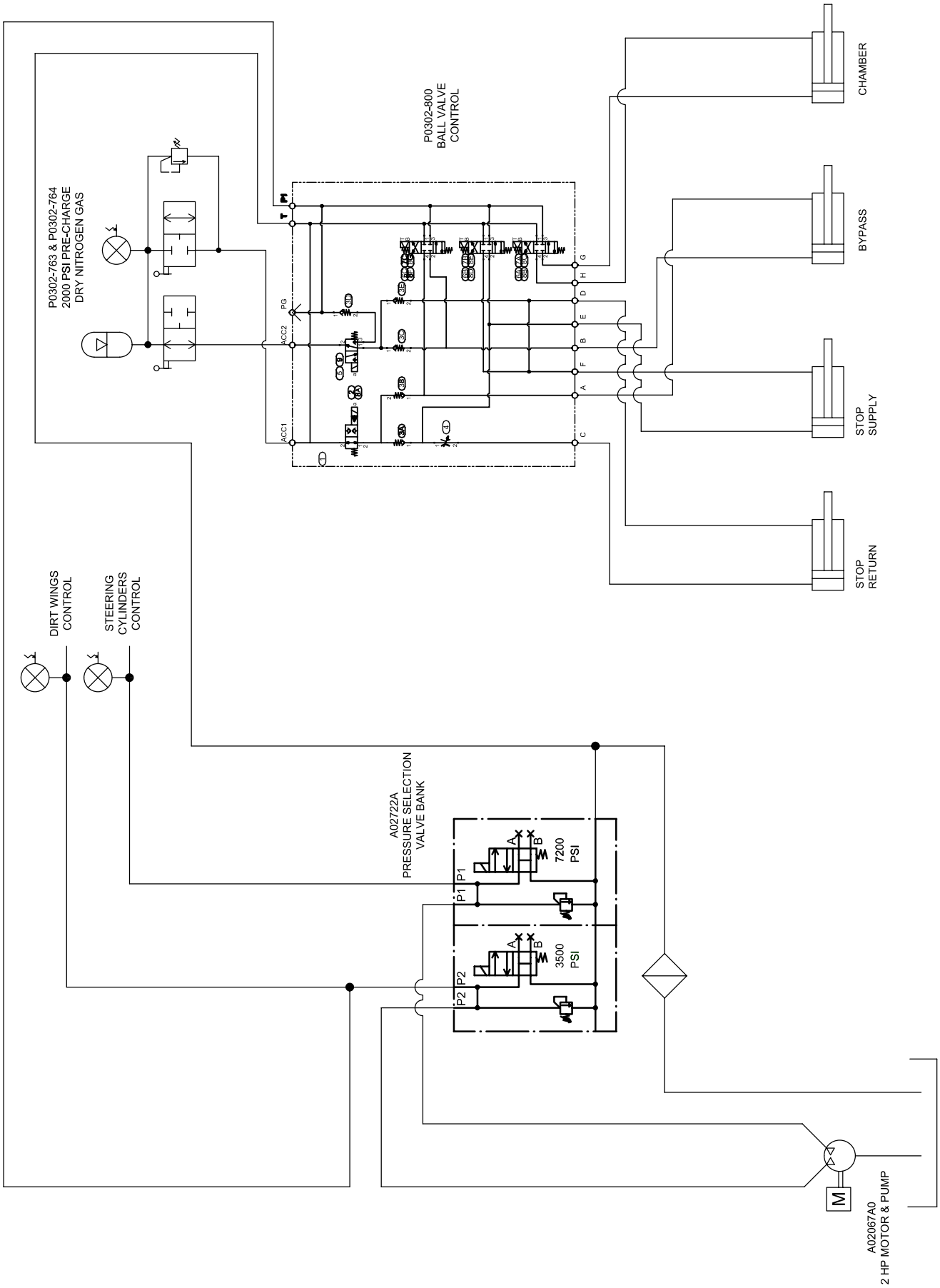
Pit Box Electrical Schematics (continued) - Part 3 of 3



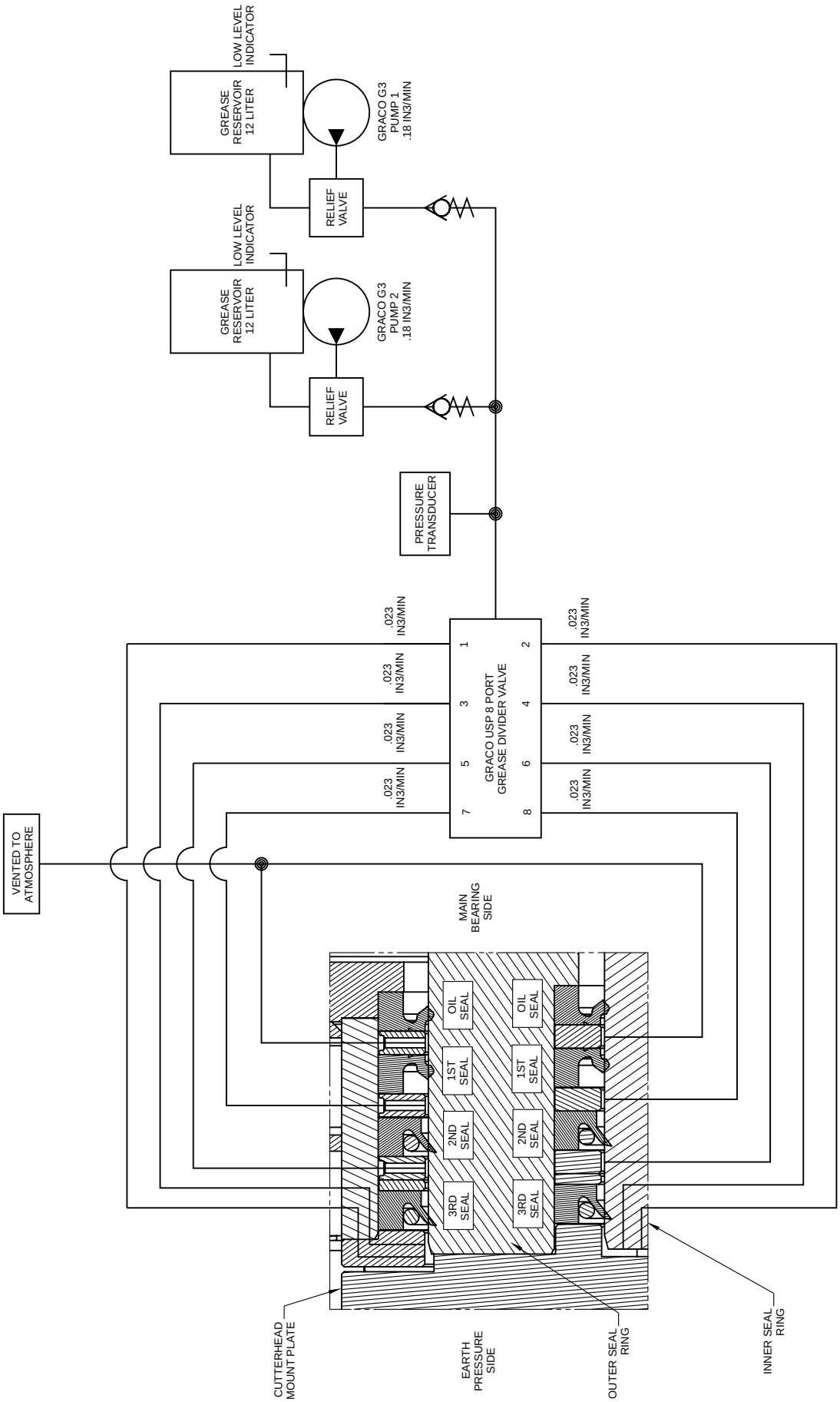
SL82P MTBM HYDRAULIC SCHEMATICS



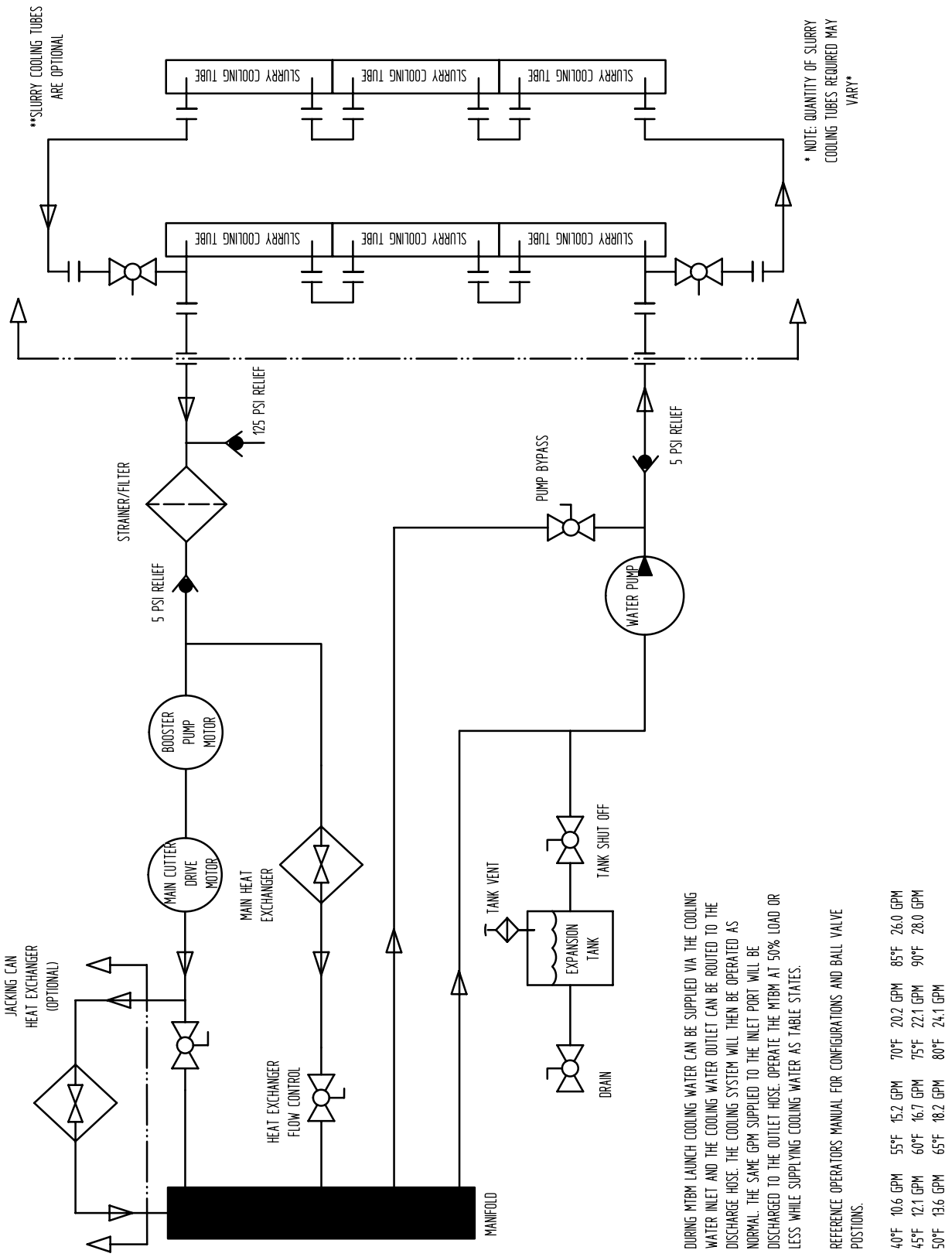
MTBM AUXILIARY HYDRAULIC SCHEMATIC



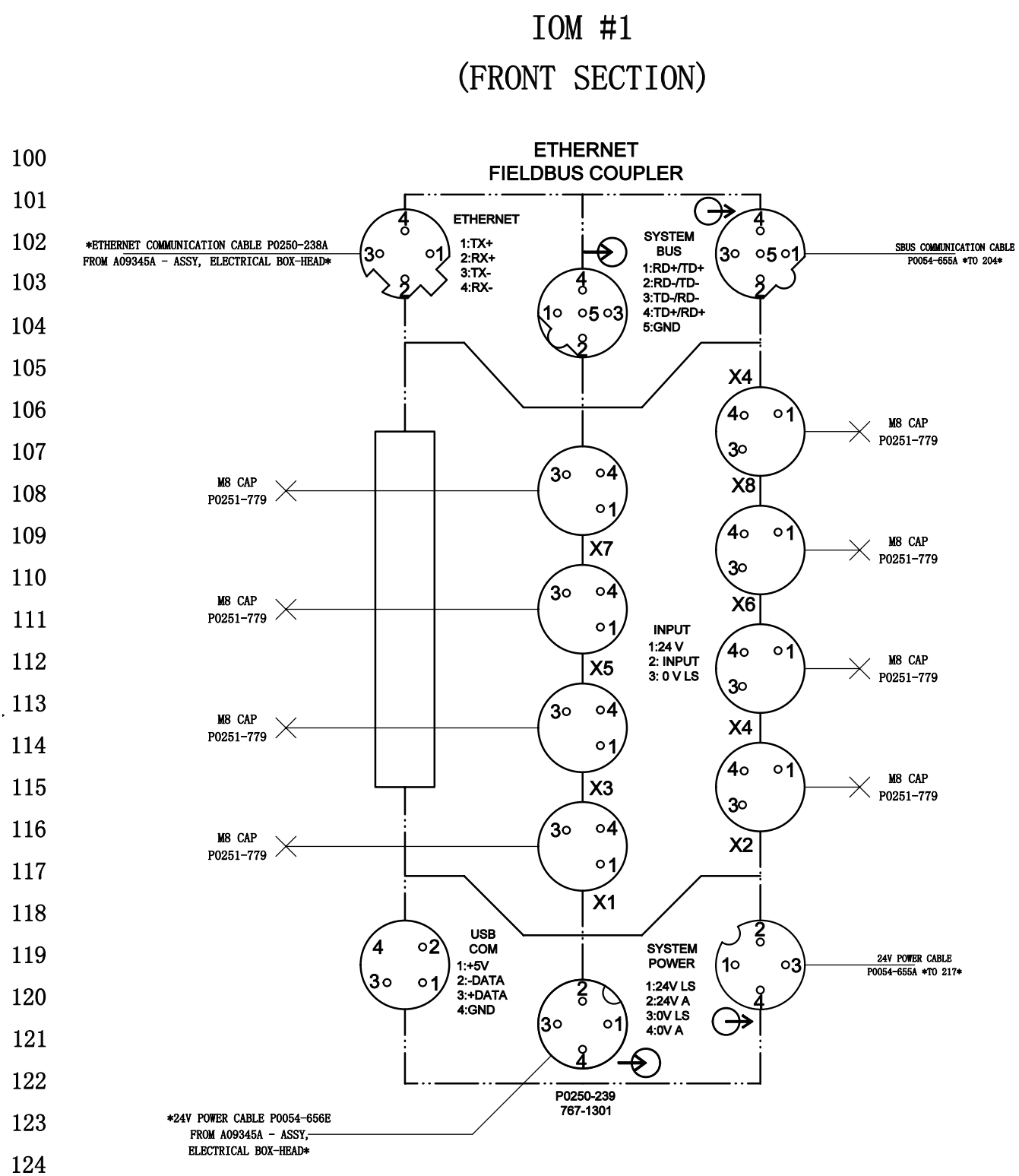
MAIN SEAL GREASE SCHEMATIC



MTBM WATER COOLING SYSTEM SCHEMATIC

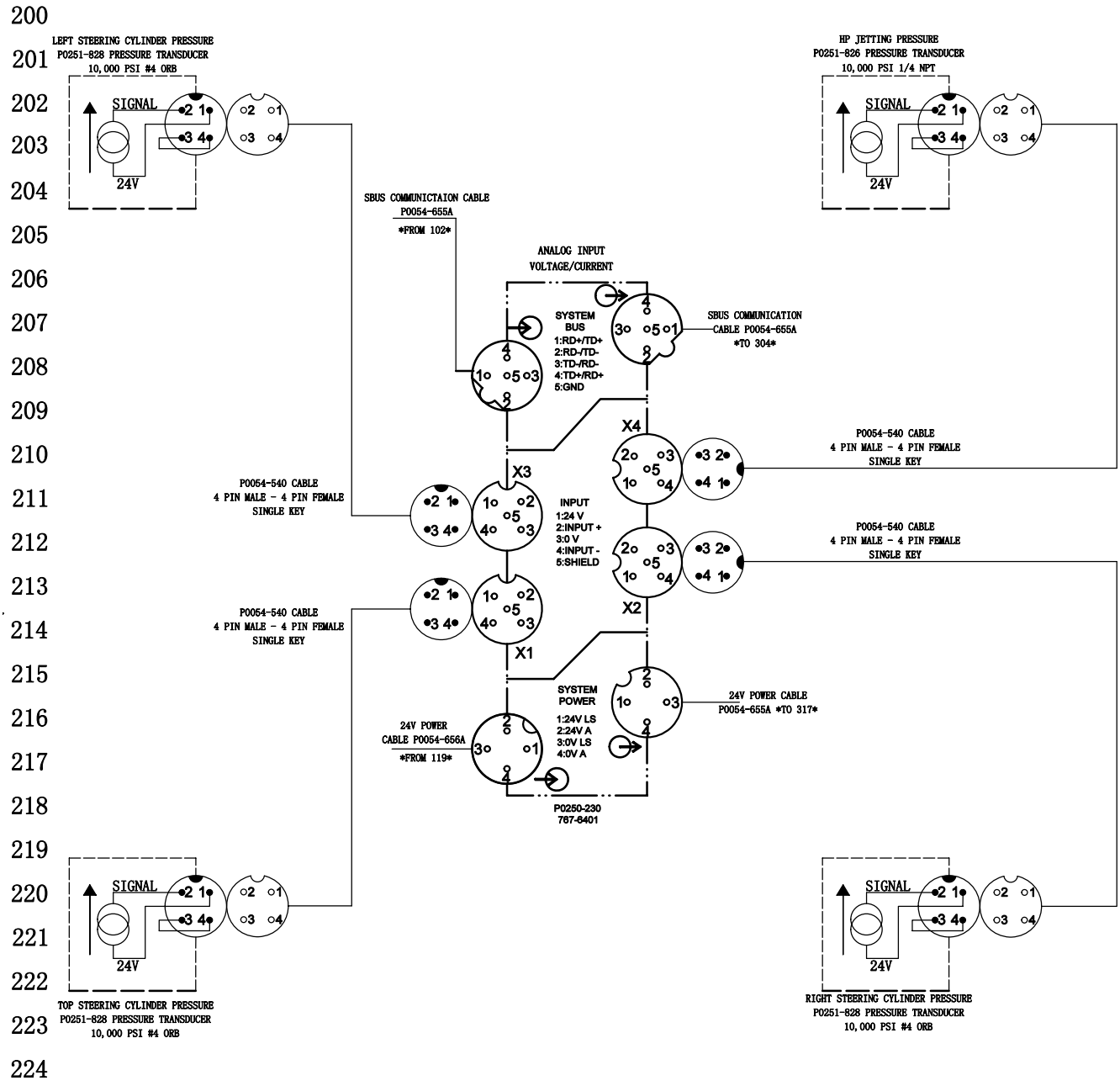


SL82P MTBM SPEEDWAY I/O MODULE SCHEMATICS



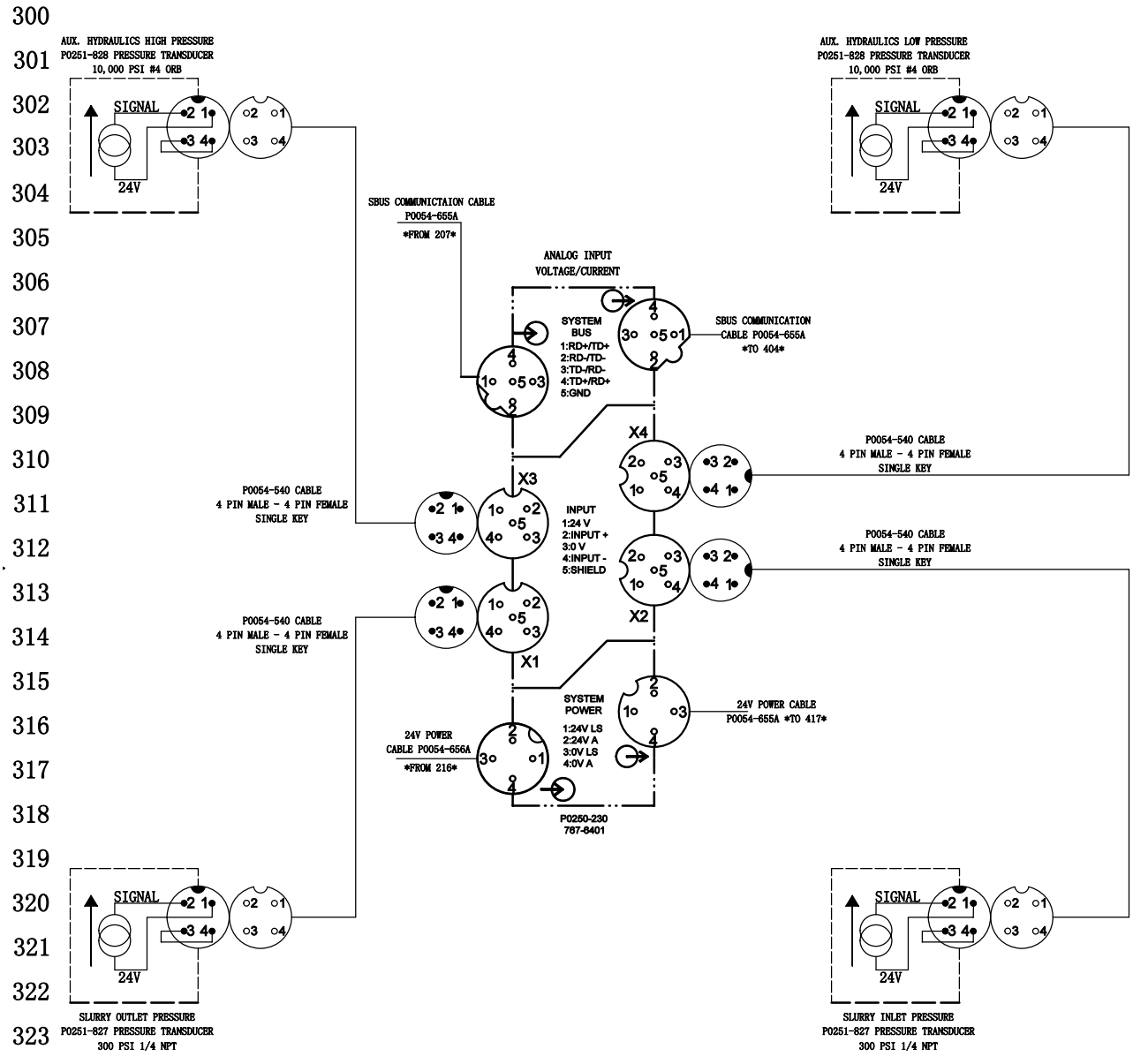
SL82P MTBM Speedway I/O Module Schematics (continued)

IOM #2
(FRONT SECTION)



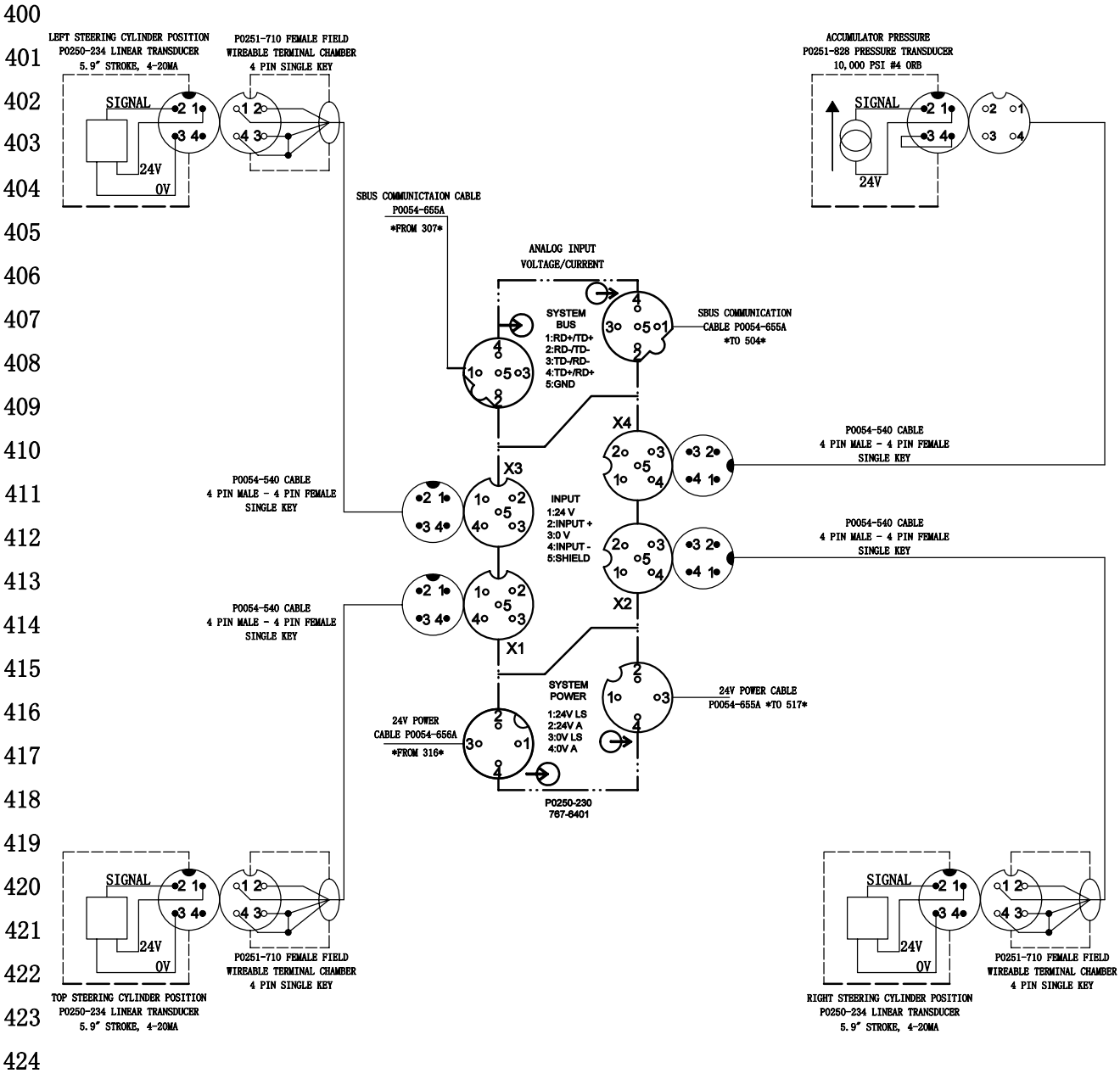
SL82P MTBM Speedway I/O Module Schematics (continued)

IOM #3
(FRONT SECTION)



SL82P MTBM Speedway I/O Module Schematics (continued)

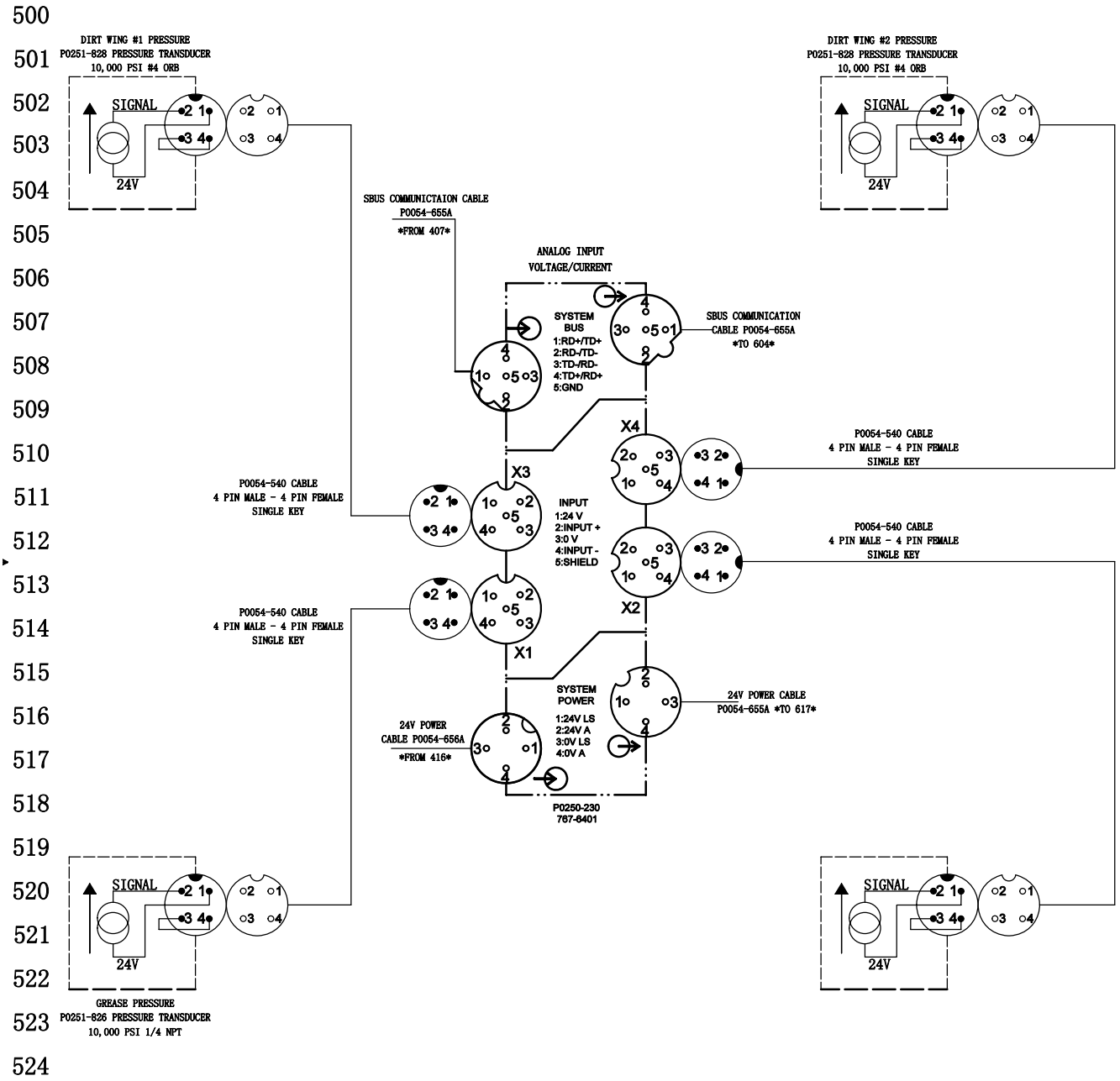
IOM #4
(FRONT SECTION)



*LINEAR TRANSDUCER CABLES HAVE FIELD WIREABLE TERMINAL CHAMBER AT THE SENSOR END. CABLES WIRES ARE CONNECTED TO THE CORRESPONDING TERMINAL CHAMBER PIN, I.E., 1-1, 2-2, 3-3, & 4-4. TERMINAL CHAMBER PINS 3 AND 4 SHOULD ALSO BE JUMPERED TOGETHER.

SL82P MTBM Speedway I/O Module Schematics (continued)

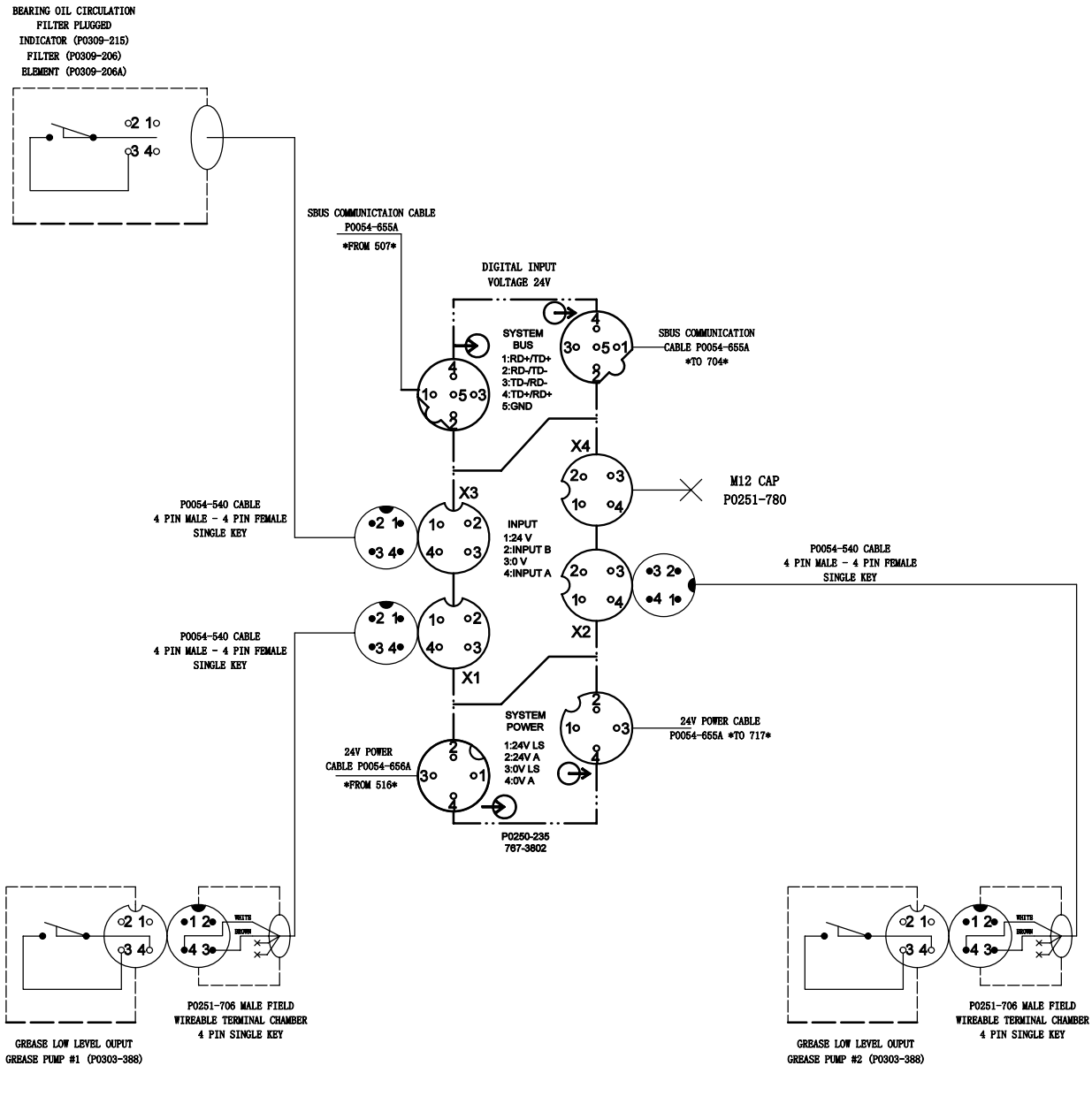
IOM #5
(FRONT SECTION)



SL82P MTBM Speedway I/O Module Schematics (continued)

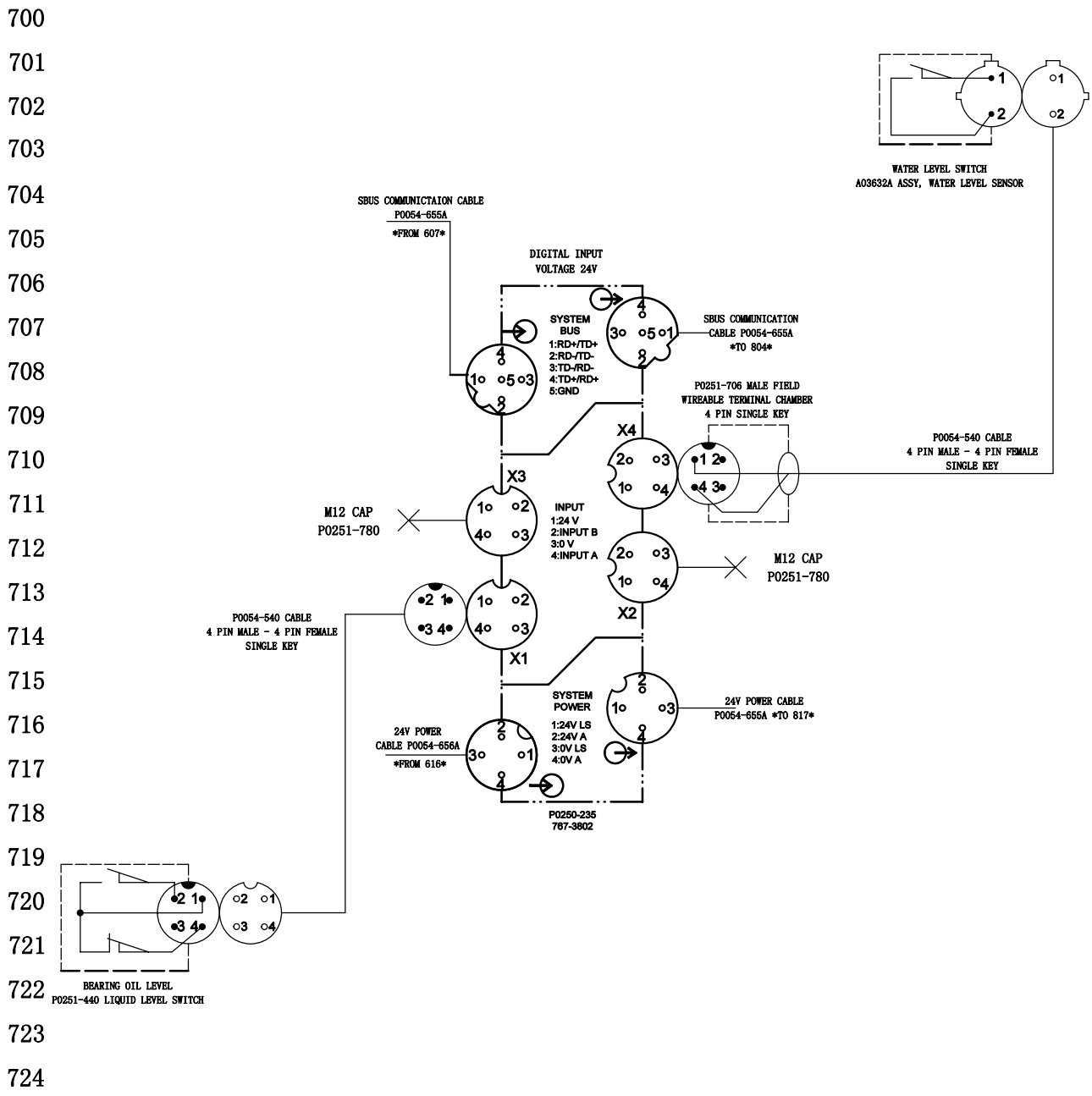
*GREASE PUMP LOW LEVEL SWITCH CABLES HAVE MALE FEILD WIREABLE TERMINAL CHAMBER AT THE PUMP END THAT REPLACES CABLE FEMALE END. WIRES 1 AND 2 OF THE CABLE ARE CONNECTED TO PINS 3 AND 4 OF THE TERMINAL CHAMBER AND CABLE WIRES 3 AND 4 ARE NOT USED

IOM #6
(FRONT SECTION)

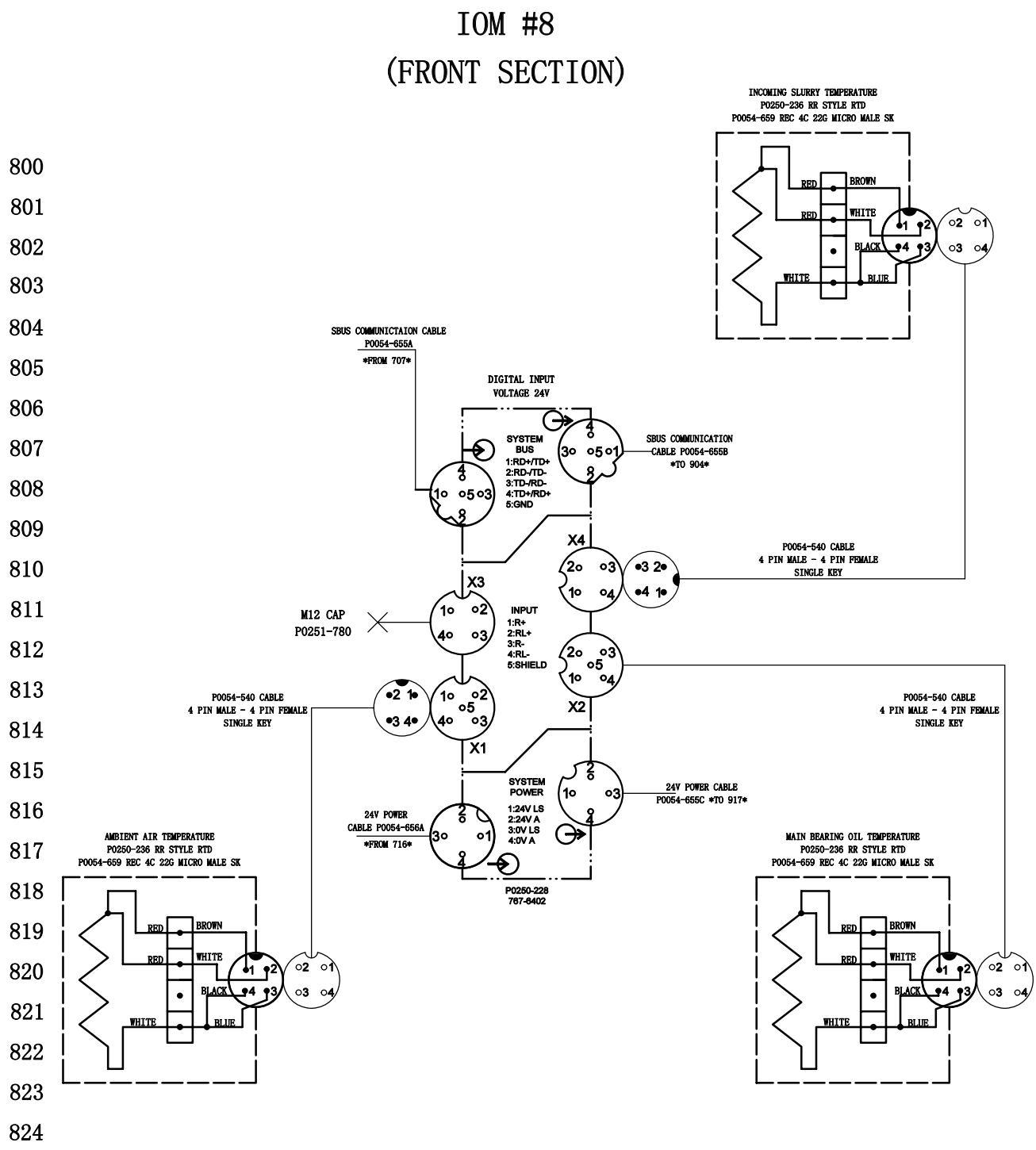


SL82P MTBM Speedway I/O Module Schematics (continued)

IOM #7
(FRONT SECTION)

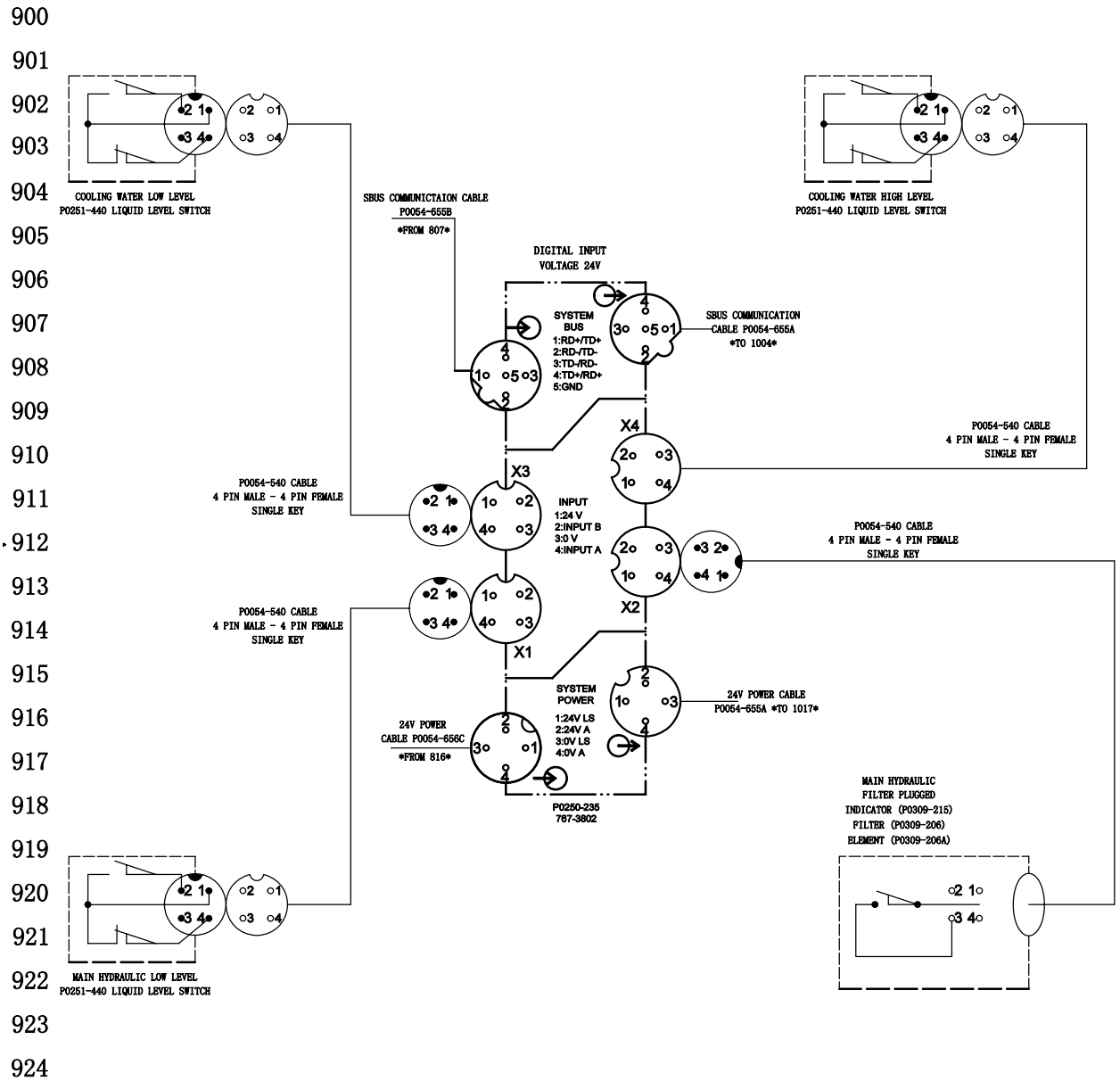


SL82P MTBM Speedway I/O Module Schematics (continued)



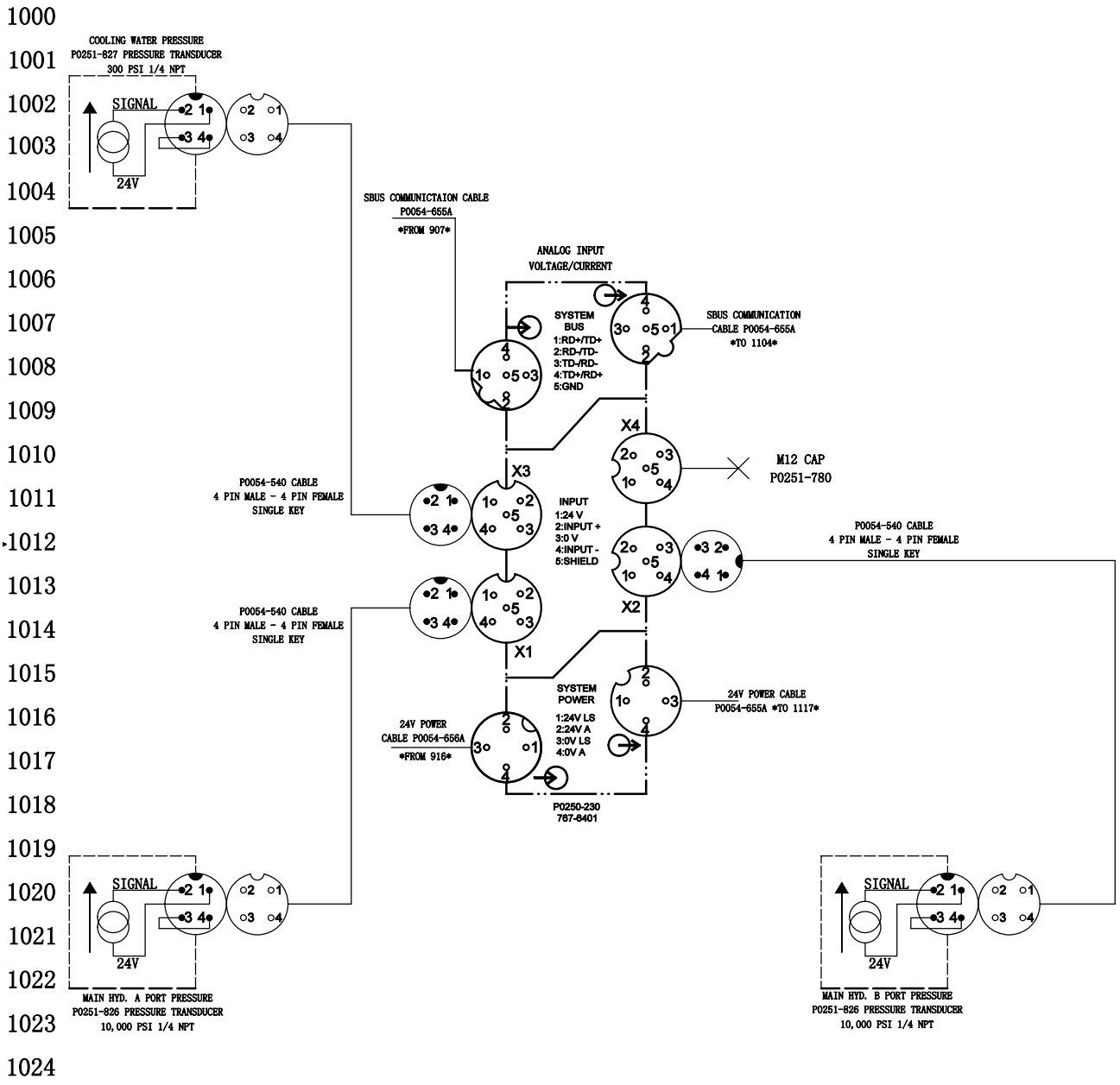
SL82P MTBM Speedway I/O Module Schematics (continued)

IOM #9
(BACK SECTION)



SL82P MTBM Speedway I/O Module Schematics (continued)

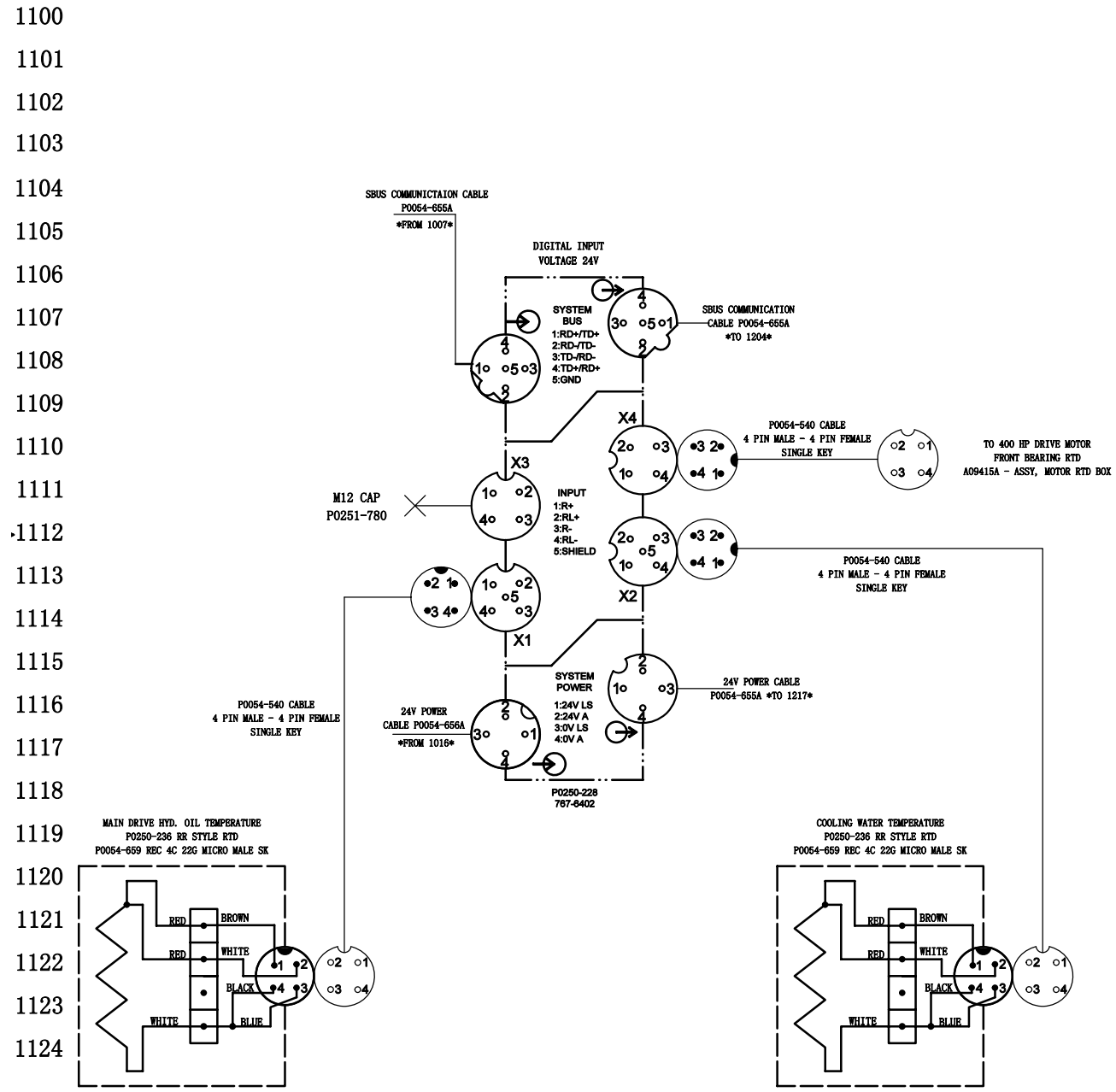
IOM #10
(BACK SECTION)



SL82P MTBM Speedway I/O Module Schematics (continued)

*SEE DRAWING A09415A - ASSY, MOTOR RTD BOX-SL86 MTBM FOR TERMINAL LAYOUT OF THE 400 HP MOTOR RTD CONNECTIONS.

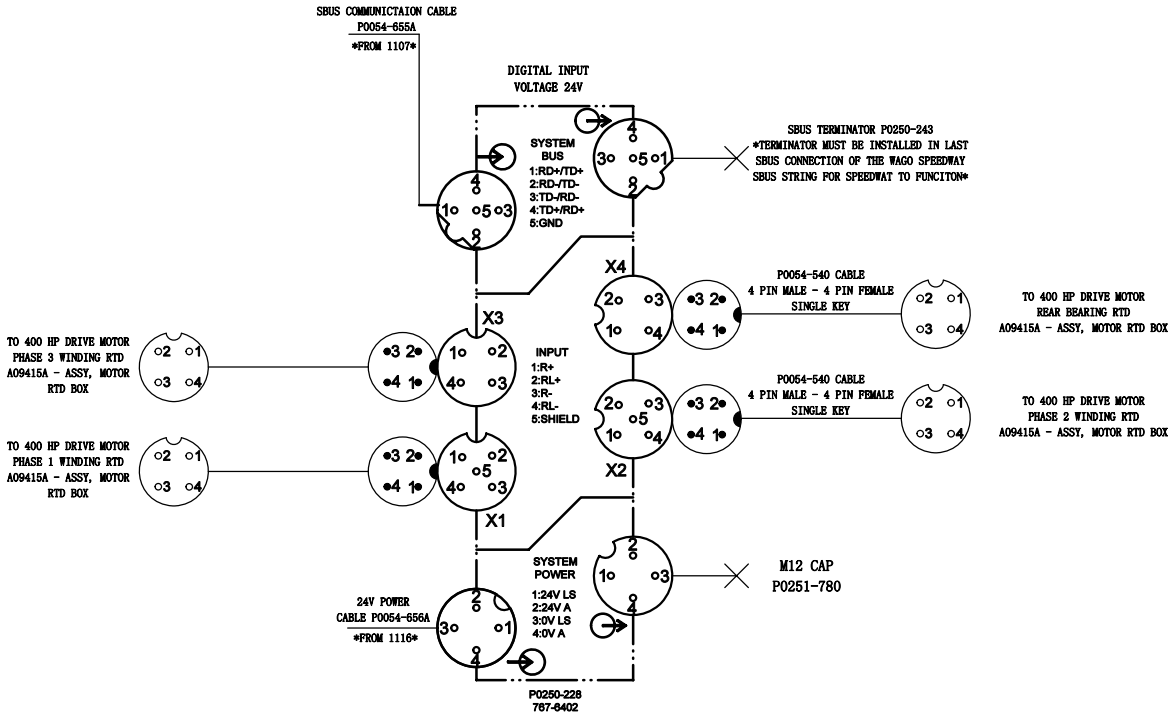
IOM #11
(BACK SECTION)



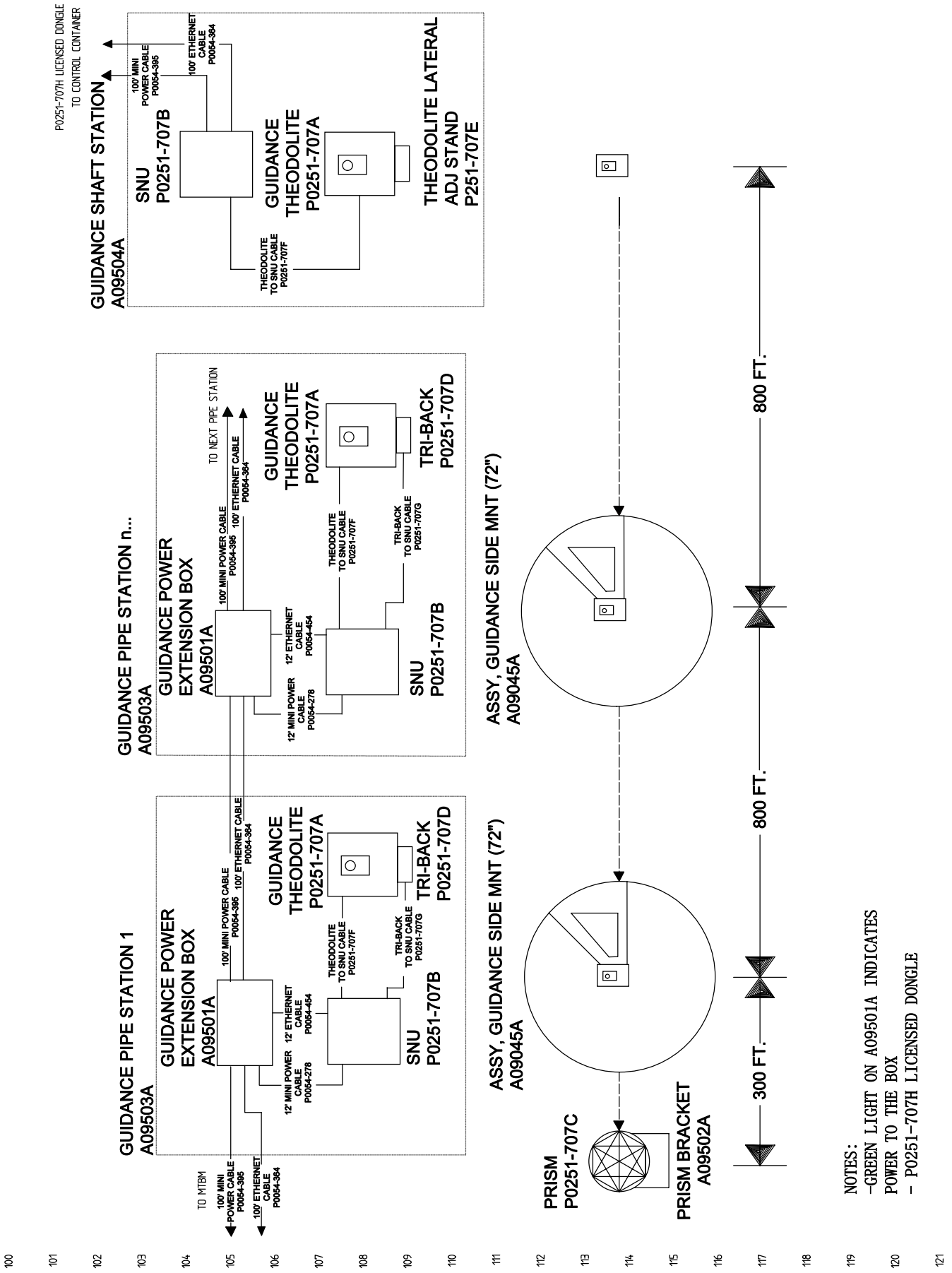
SL82P MTBM Speedway I/O Module Schematics (continued)

*SEE DRAWING A09415A - ASSY, MOTOR RTD BOX-SL86 MTBM FOR TERMINAL LAYOUT OF THE 400 HP MOTOR RTD CONNECTIONS.

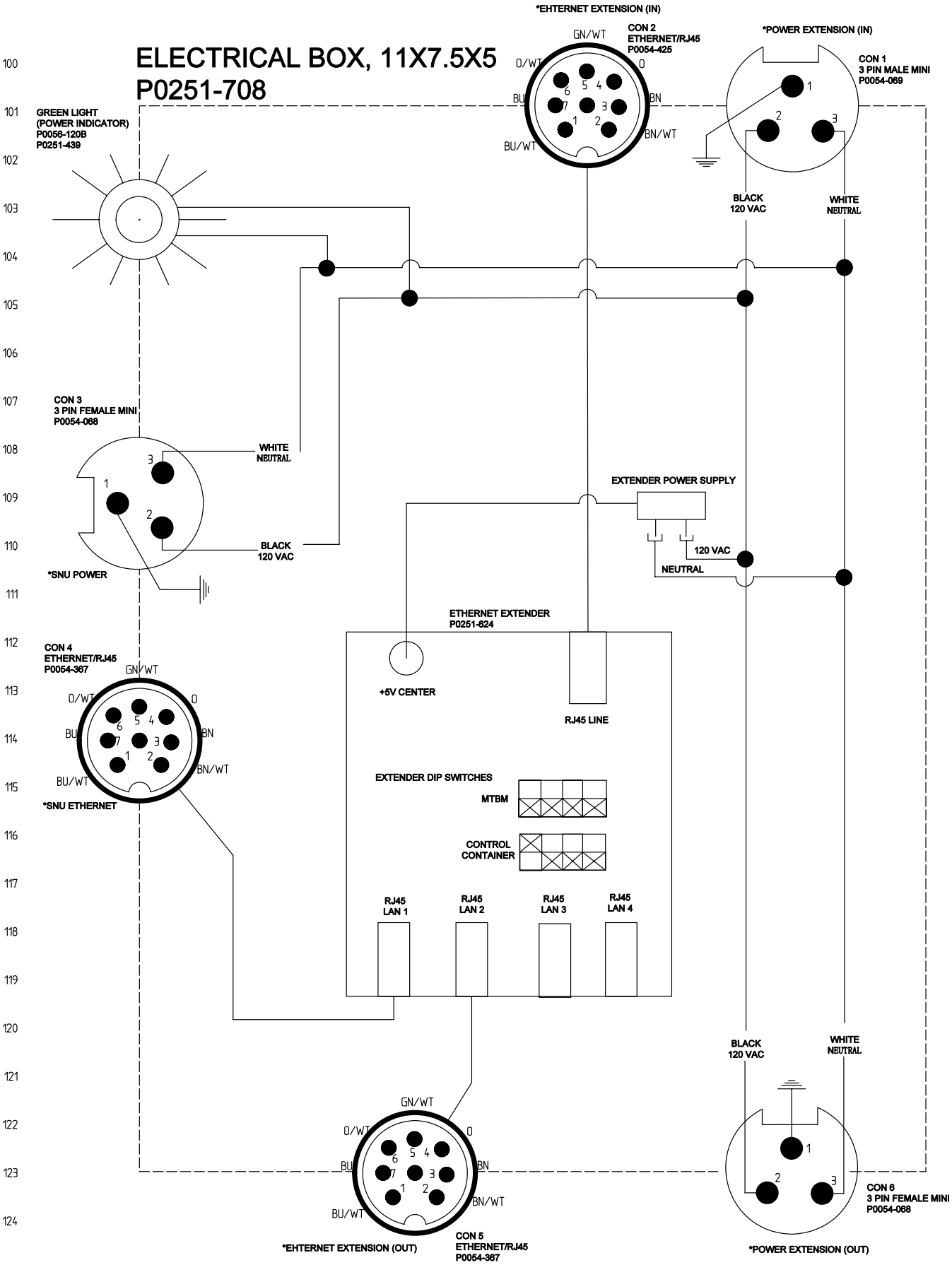
IOM #12
(BACK SECTION)



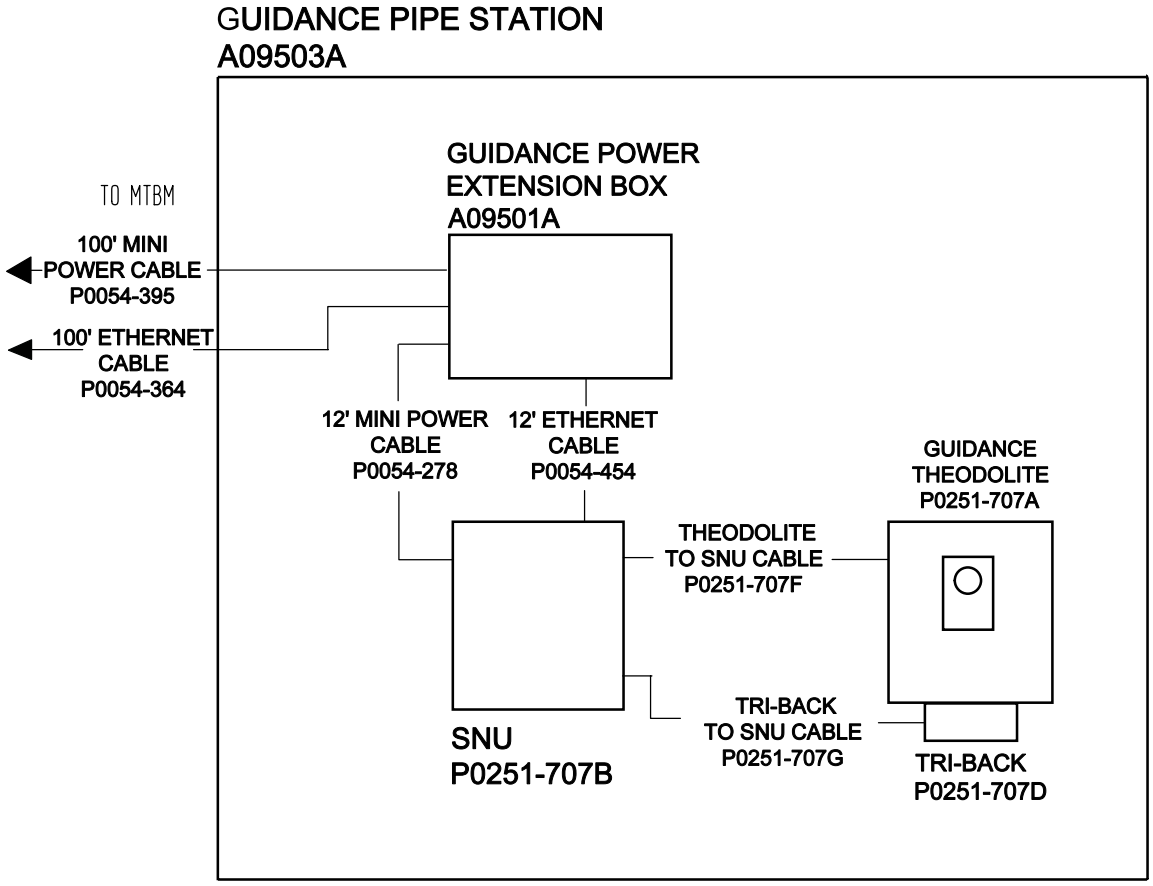
GUIDANCE SYSTEM ASSEMBLY SCHEMATIC



GUIDANCE SYSTEM ELECTRICAL EXTENSION ASSEMBLY SCHEMATIC

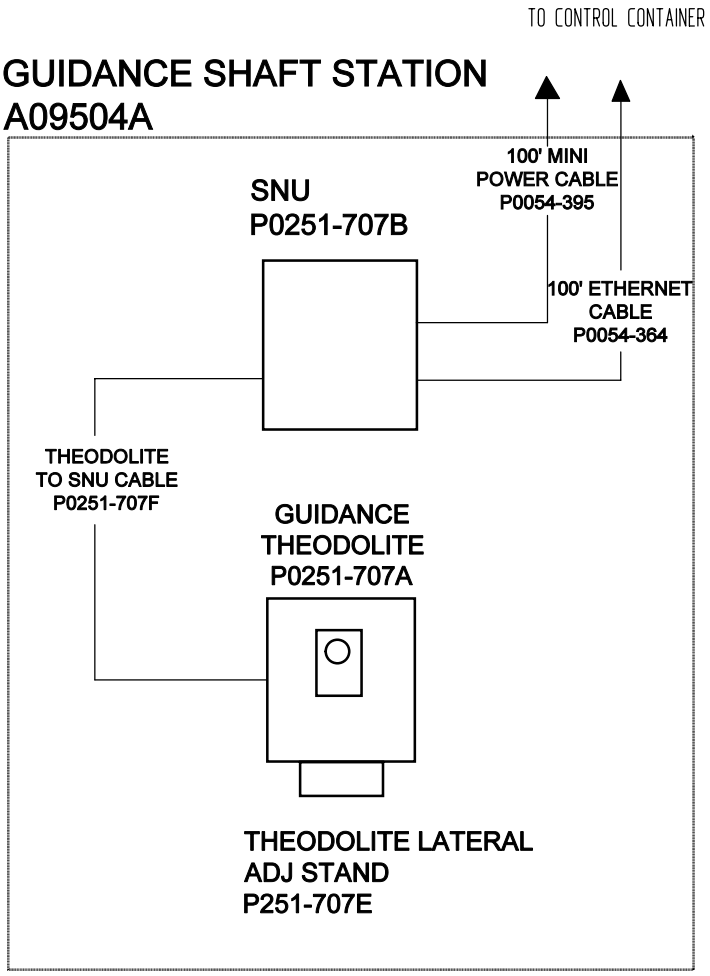


GUIDANCE SYSTEM PIPE STATION KIT SCHEMATIC

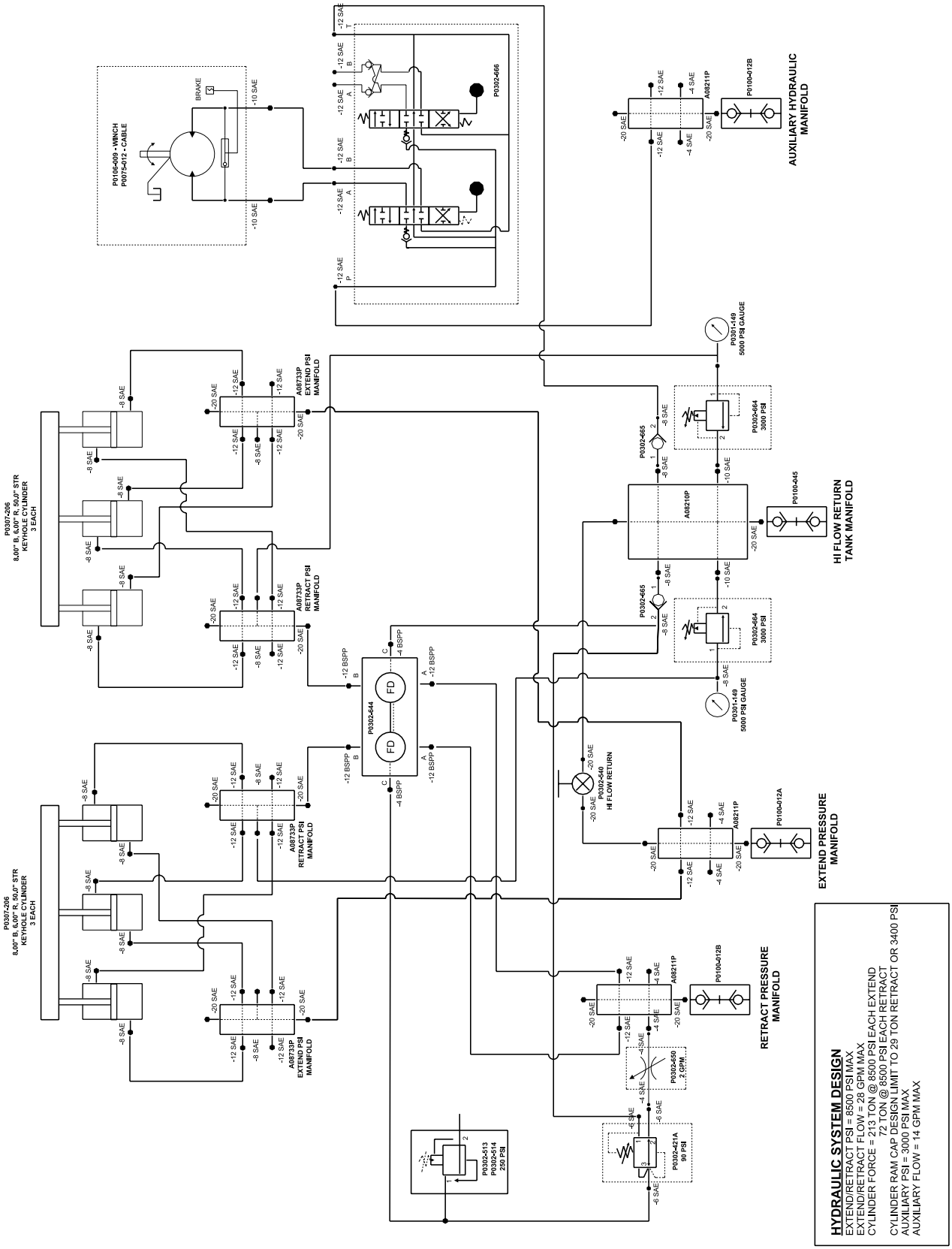


NOTES:
-GREEN LIGHT ON A09501A INDICATES
POWER TO THE BOX

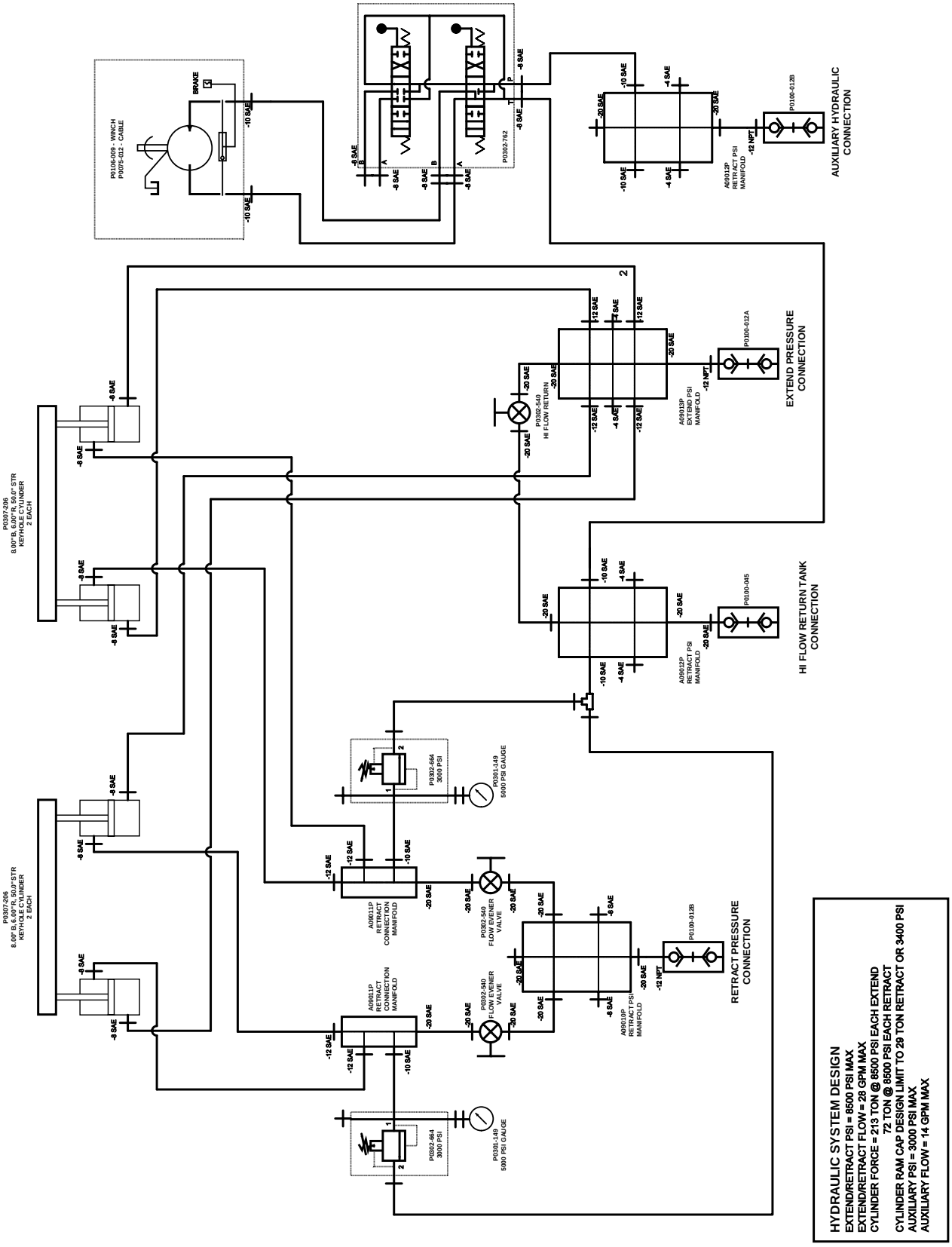
GUIDANCE SYSTEM SHAFT STATION SCHEMATIC



KEYHOLE FRAME HYDRAULIC SCHEMATICS - MT875K



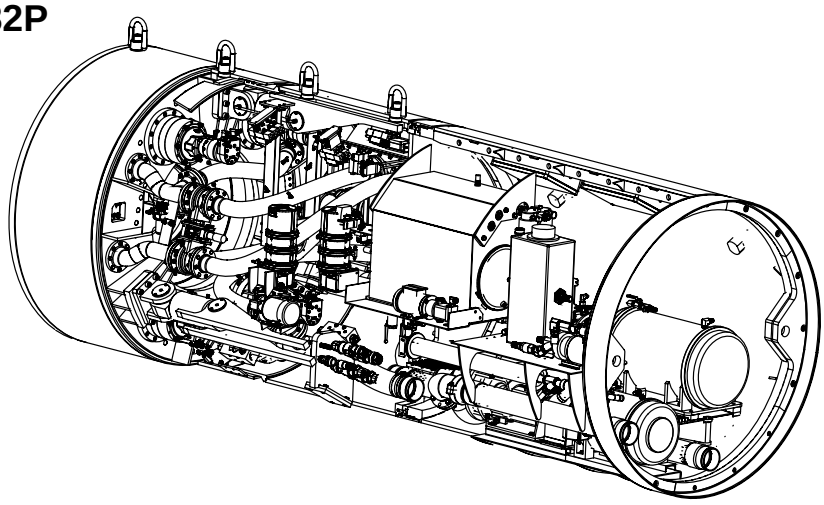
KEYHOLE FRAME HYDRAULIC SCHEMATICS - MT860K - MT890K - MT8102K



NOTES

Specifications

MTBM - SL82P



Machine Type ..... Slurry, Earth Pressure Balance Cutting Chamber

Machine Diameter (Base) ..... 82” (2,083 mm)

Length
- SL82P (Front Section/Total) ..... 11.5 ft (3.5 m) / 21.5 ft (6.5 m)
- Lube/Jacking Can ..... 10 ft (3 m)

Weight
- SL82P - Front Section ..... 50,000 lbs. (22,680 kg)
- SL82P - Trailing Section ..... 24,000 lbs. (10,866 kg)
- Lube/Jacking Can ..... 23,000 lbs. (10,433 kg)

Overcut ..... 1.5 - 2.0 in. (38 - 51 mm)

Cutter Head Types ..... Soft ground, mixed ground, rock

Drive Type ..... Hydrostatic Drive Motor

Hydrostatic Drive Motor ..... 400 HP water cooled, electric motor

Cutter Head Drive
- Speed (in HSLT) Maximum..... 9 rpm
- Max Torque (in LSHT) Maximum..... 350,000 ft-lbs. (474,537 N·m)
- Rotational Speed ..... Continuously variable in CW or CCW
- Drive Motors ..... Four, Two Speed, 480cc, 29.3 in^3

Cutter Head Bearing & Sealing
- Bearing Type ..... Three-row roller slewing bearing with integral drive gear
- Sealing System ..... Lip seals with automated, pressurized grease flushing
- Bearing Cavity Oil Capacity (approx.) ..... 23 gal (87 L)
- Lubrication System Fully automated oil circulation system continuously pressurized and filtered
- Seal Grease Container ..... Two, 3 Gal. (12 L)

Safety Circuit ..... E-Stop Button Control

(continued on next page)

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

MTBM Specifications (continued)

Steering System
- Articulation ..... 3 Degrees
- Steering Control System ..... 3 point
- Number of Cylinders ..... Three
- Cylinder Stroke ..... 4.0 in. (102 mm)
- Pressure ..... 7,250 psi (50 mPa)
- Bore ..... 7.0 in. (178 mm)

Gas Detector ..... Methane Gas

Camera ..... Passive target & MTBM maintenance

Machine Control System ..... Akkerman Gen 3 control system with ethernet

Auxiliary Hydraulic Power Pack (Steering, Slurry Stop & Bypass Valves & Dirt Wings)
- Motor ..... 2 HP, 480V, 3 Phase
- System Flow ..... 0.50 gpm
- Steering System Pressure ..... 7,250 psi (50 mPa) max.
- Slurry Valves & Dirt Wings Pressure ..... 3,500 psi (24 mPa) max.
- Filtration ..... 10 micron

Main Drive Hydraulic System (Trailing Section)
- Motor ..... 400 HP (298 kW)
- System Flow ..... 0 to 150 gpm (0 to 568 L/min)
- Hydrostatic Pumps ..... Two, 165 cc, 10.1 in^3

Electrical
- Power Supply to MTBM 4160V
- Tunnel Cable ..... 6AWG/SHD-GC 5 kv

Submersible Pump
- Motor ..... 2 HP, 480VAC, 3 Phase
- Flow ..... 25 gpm max. @ 200 ft head (87 psi)

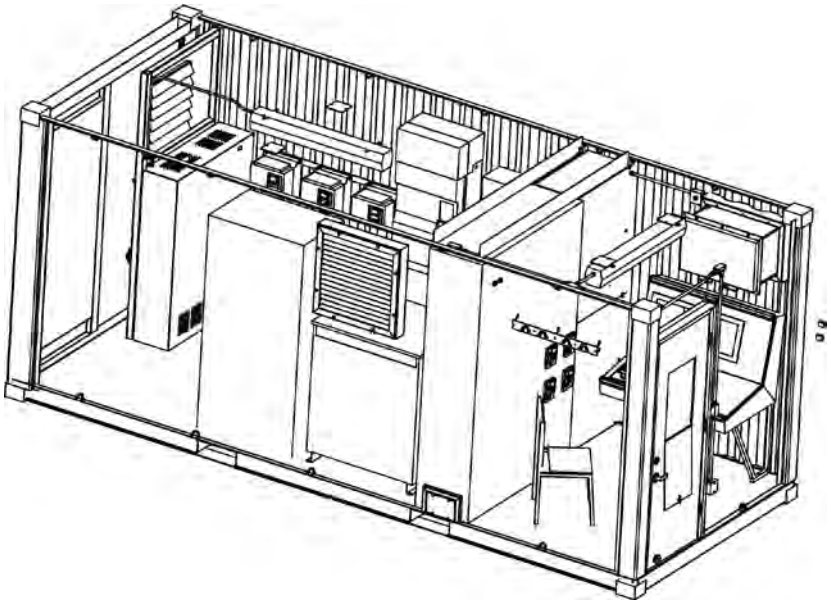
Jetting Nozzles
- Number of Nozzles ..... 0 - 12
- Recommended System Pressure ..... 2,300 psi (15.9 mPa)

Accumulator
- Hydraulic Charge ..... 3,500 psi (24 mPa)
- Nitrogen Charge ..... 2,500 psi (17 mPa)

Slurry
- Feed/Return* ..... 6 in. (152 mm)
- Cutting/Chamber ..... 4 in. (102 mm)
- Bypass ..... 4 in. (102 mm) with automatic activation on power loss

* automatic activation on power loss

CONTROL CONTAINER



Dimensions (width x length x height) ..... 8 x 20 x 8.5 ft. (2.4 x 6 x 2.6 m)

Container Weight..... 13,000 lbs. (5,897 kg)

Electrical

Main Disconnect ..... 1,200 amp, 480V, 3 Phase
Transformer ..... 480V to 575V
Cutter Head Drive VFD ..... (Sine Filter) 250 HP, 575V
Feed Pump VFD ..... 75 HP, 480V
Return Pump VFD ..... 75 HP, 480V
Booster/Mid Pump VFD ..... 100 HP, 480V
Power Outlets - Auxiliary ..... Six, 120V
Power Input for console & lights 240V/120V

Communications

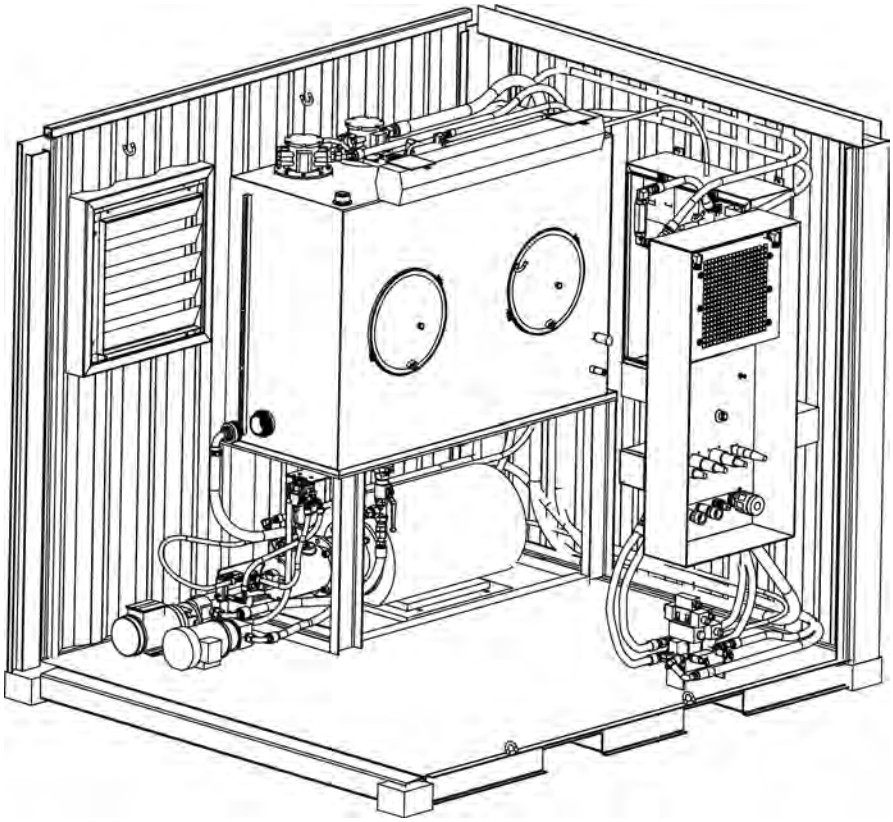
Wired .....Ethernet
Distributed Computing .....Wago® PLC
Audio .....One way wired
Video ..... Ethernet
Hardware
Computer .....Intel® Core™ i5
Graphics Card ..... Dual Monitor
Software
Computer OS .....Windows® 7 / 32 bit
MTBM Control Software ..... Akkerman Proprietary
OPC Server* ..... Kepware®

* It is the responsibility of the customer to keep the Kepware Server support agreement up to date. If a computer that is running Kepware fails or is irrevocably damaged, the support agreement will assure access to technical support and immediate assistance with license recovery.

Note: If your Microtunneling system is equipped with remote assistance support such as the Enterprise version of VNC (Virtual Network Connection) Server, the customer is required to keep the annual subscription up-to-date. The Enterprise version allows simple drag and drop remote support capability. Contact your Akkerman Aftermarket Support representative for more information.

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

REMOTE HYDRAULIC POWER PACK



Dimensions (width x length x height) ..... 8 x 9.8 x 8.5 ft. (2.4 x 3 x 2.6 m)

Container Weight..... 9,500 lbs. (4,309 kg)

Reservoir Capacity ..... 330 gal (1,249 L)

Hydraulics

Main Hydraulic Pump
- Speed ..... 1,800 rpm
- Flow ..... 0 - 13 gpm
- Pressure ..... 8,000 psi

Pilot Pressure Pump ..... 1 gpm @ 300 psi

Cooling Pump ..... 12 gpm

Jacking Functions
- Jacking ..... 13 gpm @ 8,000 psi
- IJS ..... 13 gpm @ 8,000 psi
- Auxiliary ..... 13 gpm @ 3,000 psi

Electrical

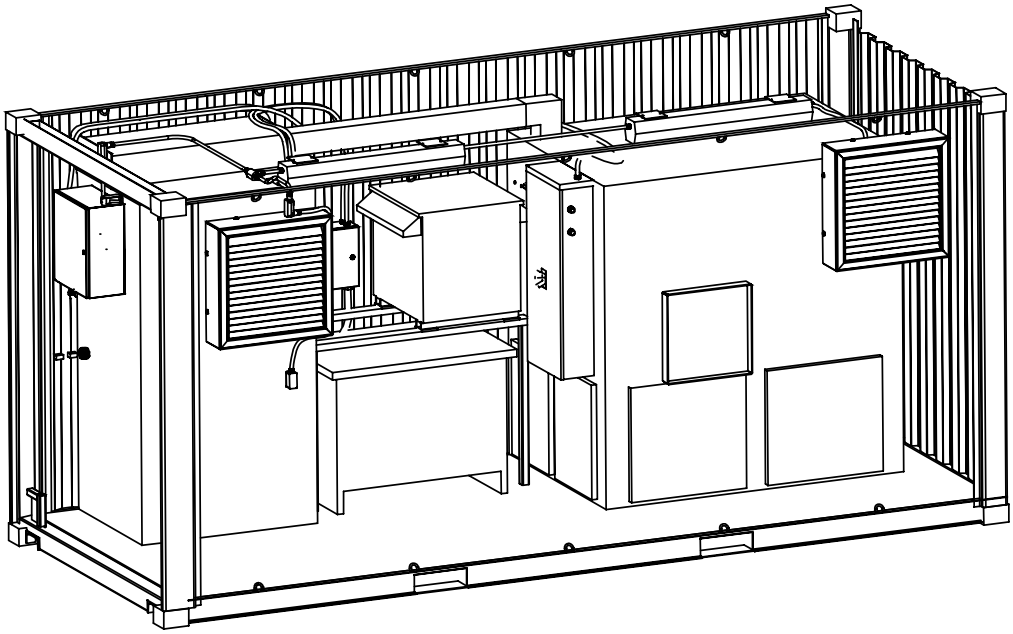
Power Requirement ..... 200 amp, 480V, 3 Phase

Main Hydraulic Motor ..... 75 HP, 480V

Cooling/Pilot Pressure Motor ..... 2 HP, 480V

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

MAIN DRIVE POWER CONTAINER



Dimensions (width x length x height) ..... 8 x 20 x 9.5 ft. (2.4 x 6 x 2.9 m)

Container Weight..... 15,500 lbs. (7,031 kg)

Electrical

Required Power ..... 480 VAC, 3 Phase, 60 Hz

Main Circuit Breaker ..... 800 amp

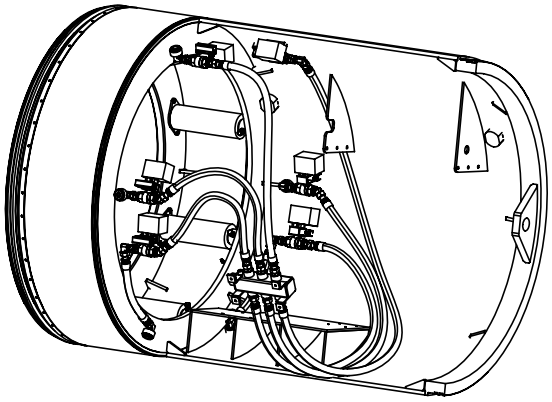
Transformer ..... 500 kVA

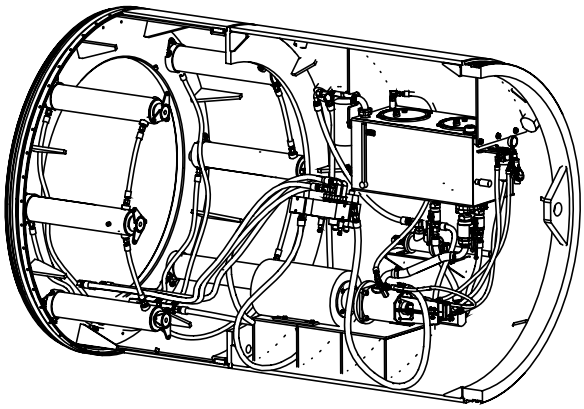
Tunnel Cable Voltage 4,160V

Power Input For Lighting 120V

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LUBE/JACKING CAN





Length ..... 10 ft. (3.048 m)

Weight ..... 23,000 lbs. (10,433 kg)

Reservoir Capacity ..... 30 gal (114 L)

Hydraulics

Main Hydraulic Pump

Speed ..... 1,800 rpm

Flow ..... 0 - 13 gpm

Pressure ..... 8,000 psi

Pilot Pressure Pump ..... 1 gpm @ 300 psi

Cooling Pump ..... 12 gpm

Jacking Functions

Jacking ..... 13 gpm @ 8,000 psi

IJS ..... 13 gpm @ 8,000 psi

Electrical

Main Hydraulic Motor ..... up to 60 HP, 480V

Cooling/Pilot Pressure Motor ..... 2 HP, 480V

Jacking

Cylinders ..... up to 8

Cylinder Stroke ..... up to 24”

Thrust Capacity ..... up to 400 Ton

Lubrication

Bentonite Ports 6

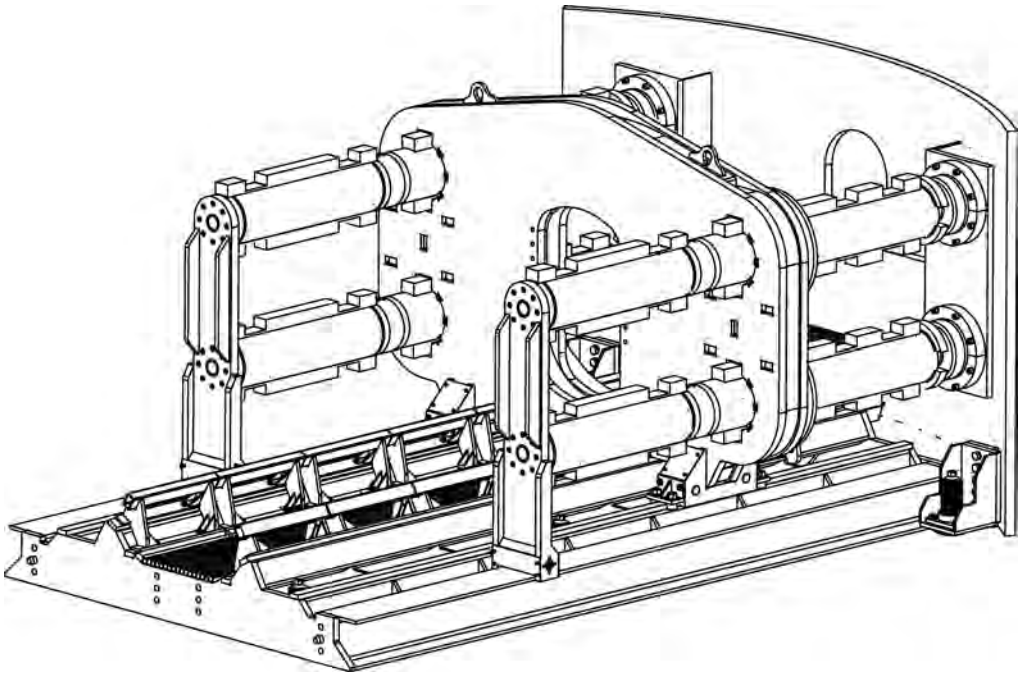
Electric 120V

Size ..... 1.5 ”

Controller ..... Manual On-Off/Timed

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KEYHOLE JACKING FRAMES



Dimensions (width x length x height)

MT860K .....9 x 15.6 x 6.5 ft. (2.7 x 4.8 x 2 m)
MT875K .....10.9 x 15.9 x 7.3 ft. (3.3 x 4.8 x 2.2 m)
MT890K .....12.7 x 16.3 x 8.5 ft. (3.9 x 5 x 2.6 m)
MT8102K .....13 x 16.4 x 9.6 ft. (4 x 5 x 2.9 m)

Cylinders ..... 4 or 6
Cylinder Stroke ..... 50 in. (1,270 mm)

Weight (without extensions)

MT860K.....30,000 lbs. (13,608 kg)
MT875K.....40,000 lbs. (18,144 kg)
MT890K.....50,500 lbs. (22,906 kg)
MT8102K.....58,000 lbs. (26,308 kg)

Thrust Capacity ..... 800 ton @ 8,500 psi

Pipe Capacity (OD)

	Minimum OD	Maximum OD
MT860K.....	-	60 in. (1,524 mm)
MT875K.....	60 in. (1,524 mm)	75 in. (1,905 mm)
MT890K.....	75 in. (1,905 mm)	90 in. (2,286 mm)
MT8102K.....	90 in. (2,286 mm)	102 in. (2,591 mm)

Hydraulics

Functions ..... Extend, Retract, High Flow Return, Auxiliary Control
Pressure (from Remote Hydraulic Power Pack)..... 8,000 psi

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

LASER REQUIREMENT FOR AKKERMAN EXCLUSIVE TARGET (NON-AZ100 TARGET SYSTEM)



Type .....Helium-neon (HeNe) or laser diode
- ..... Must have well-collimated beam
- ..... Cannot have cross wires

Laser Wavelength 633nm

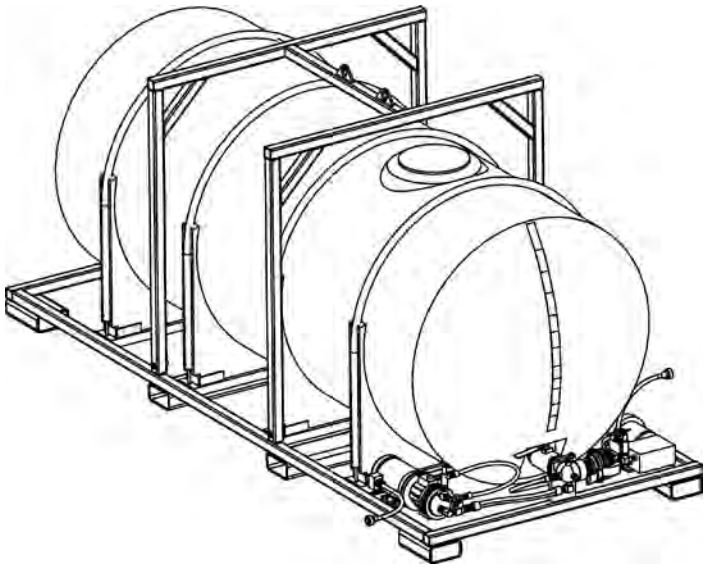
Beam Energy Range .....2 – 5mW

Energy At Target .....0.5 – 2mW

Spot Diameter ..... 8 – 25mm

NOTE: The laser positioning system is not supplied/sold by Akkerman Inc. The contractor is responsible for purchasing the laser device from a reputable laser positioning manufacturer.

WATER COOLING TANK



Dimensions (width x length x height) ..... 6 x 14.5 x 6.5 ft. (1.8 x 4.4 x 2.0 m)

Weight (Empty) ..... 2,200 lbs. (998 kg)

Tank Capacity ..... 1,685 gal (6,378 L)

Larger Drive Motor Pump Assembly (Not Used With Periphery Drive MTBMs)
(For 125 HP+ Drive Motor, Water Cooled Booster Pump or Gear Reducer Filtration)

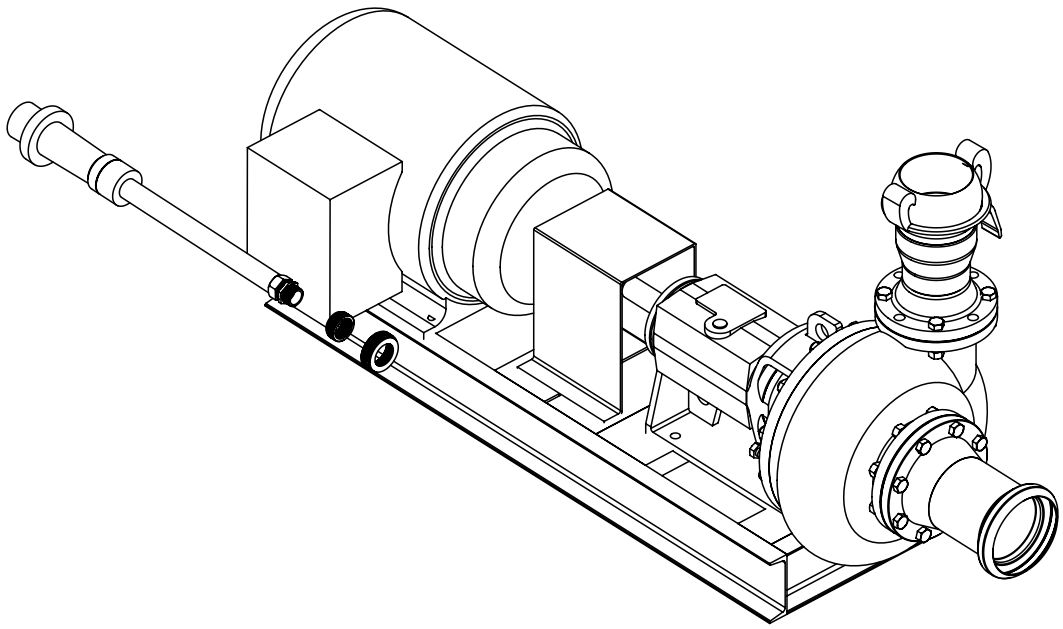
- Motor ..... 3 HP (2.2 kW)
  - RPM 1,740
- Pump
  - Maximum GPM Capacity ..... 6 gpm (22.7 L/min)
  - Delivery @ Max. Pressure ..... 292 revs/gal (78 revs/L)
  - Max. Inlet Pressure ..... 250 psi (1,724 kPa)
  - Oil Capacity ..... 1.1 US qt (1.05 L)

Smaller Drive Motor Pump Assembly (Not Used With Periphery Drive MTBMs)
(For 30 & 75 HP Drive Motor)

- Motor ..... 1/2 HP (0.37 kW)
  - RPM 1,725
- Pump
  - Maximum GPM Capacity ..... 1.8 gpm (6.8 L/min)
  - Delivery @ Max. Pressure ..... 972 revs/gal (258 revs/L)
  - Max. Inlet Pressure ..... 250 psi (1,724 kPa)
  - Oil Capacity ..... 1.0 US qt (0.95 L)

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

SLURRY FEED PUMP



Weight ..... 2,000 lbs. (907 kg)

Size (width x length x height) .....25 x 84 x 39 in. (635 x 2,134 x 991 mm)

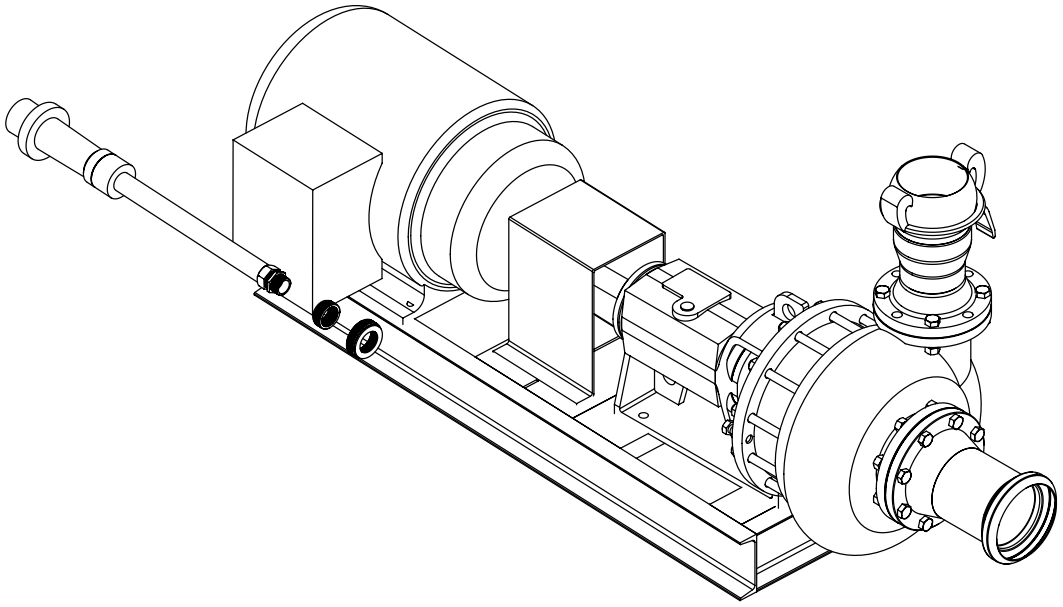
Motor ..... up to 75 HP (56 kW)

Maximum GPM (capacity limit does not consider suction line velocity):

4x3x13..... 750 gpm (2,839 L/min) (Up to 60HP)
5x4x14 ..... 1100 gpm (4,163 L/min) (Up to 60HP)
6x5x14 ..... 1200 gpm (4,163 L/min) (Up to 100HP)

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

SLURRY RETURN PUMP / MID PUMP



Weight ..... 2,200 lbs. (998 kg)

Size (width x length x height) ..... 25 x 87 x 39 in. (635 x 2,210 x 991 mm)

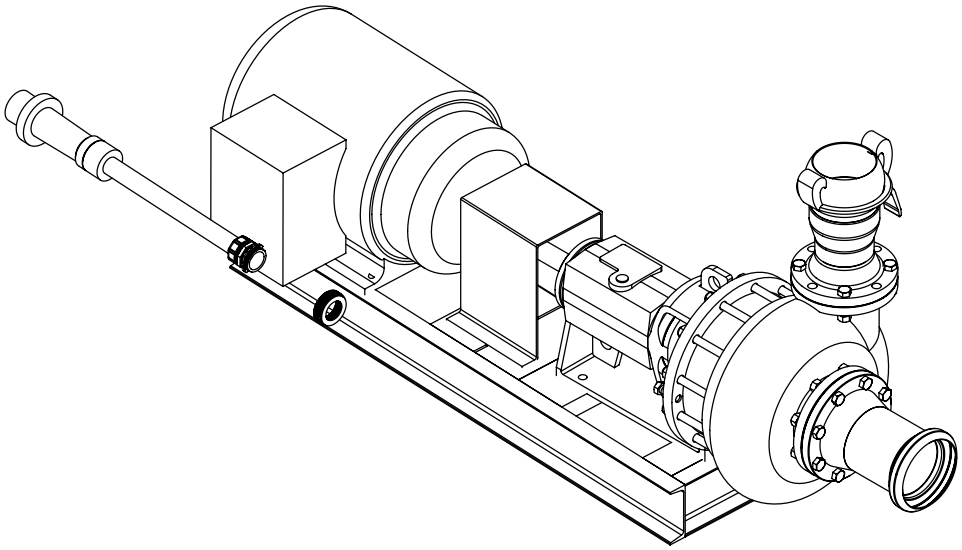
Motor (Return/Mid) ..... up to 75/100 HP (56/75 kW)

Maximum GPM (capacity limit does not consider suction line velocity):

4x3x13 (Vortex) ..... 750 gpm (2,839 L/min)
5x4x14 (Vortex) ..... 1100 gpm (4,164 L/min)
6x5x14 (Vortex) ..... 1100 gpm (4,542 L/min)

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

SLURRY BOOSTER PUMP



Weight ..... 2,200 lbs. (998 kg)

Size (width x length x height) ..... 25 x 87 x 39 in. (635 x 2,210 x 991 mm)

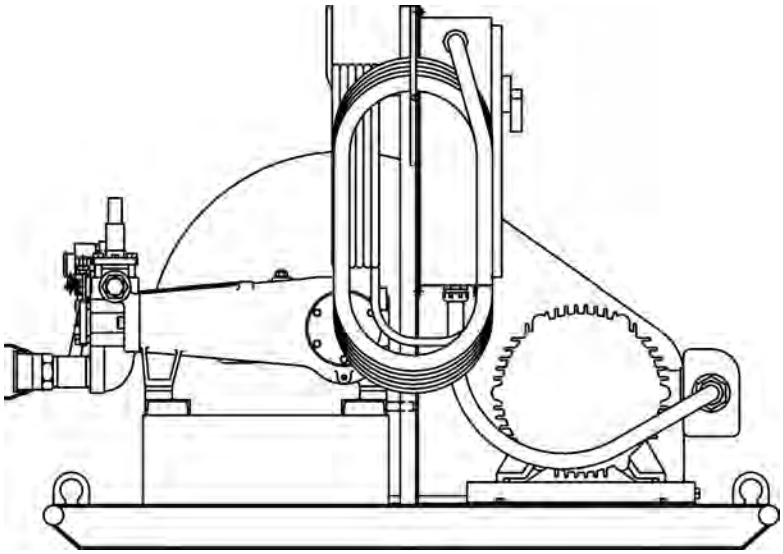
Motor ..... up to 100 HP (75 kW)

Maximum GPM (capacity limit does not consider suction line velocity):

4x3x13 (Vortex) ..... 750 gpm (2,839 L/min)
5x4x14 (Vortex) ..... 1,100 gpm (4,164 L/min)
6x5x14 (Vortex) ..... 1,200 gpm (4,542 L/min)

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

HIGH PRESSURE JETTING PUMP



Model SC-115

Dimensions (width x length x height) ..... 37.75 x 36.25 x 14.75 in. (959 x 921 x 375 mm)

Weight ..... 1,240 lbs. (562 kg)

Main Pump Data

- Rated Input HP Speed (Maximum) ..... 154 @ 550 rpm
- Continuous Speed Range (Normal) ..... 150 to 450 rpm
- Rated Continuous Speed (Maximum) ..... 550 rpm
- Speed (Minimum) ..... 100 rpm
- Oil Capacity ..... 15 US Qt (14.2 L)

Liquid Data

- Plunger Size Diameter Range ..... 1.75 in. (44 mm)
- Rated Discharge Pressure (Maximum) ..... 3,000 psi
- Displacement
  - U.S. Gallons Per Revolution 1432
  - U.S. GPM @ Rated RPM 78.7
- Hydrostatic Test ..... 5,250 psi

Belt Tension

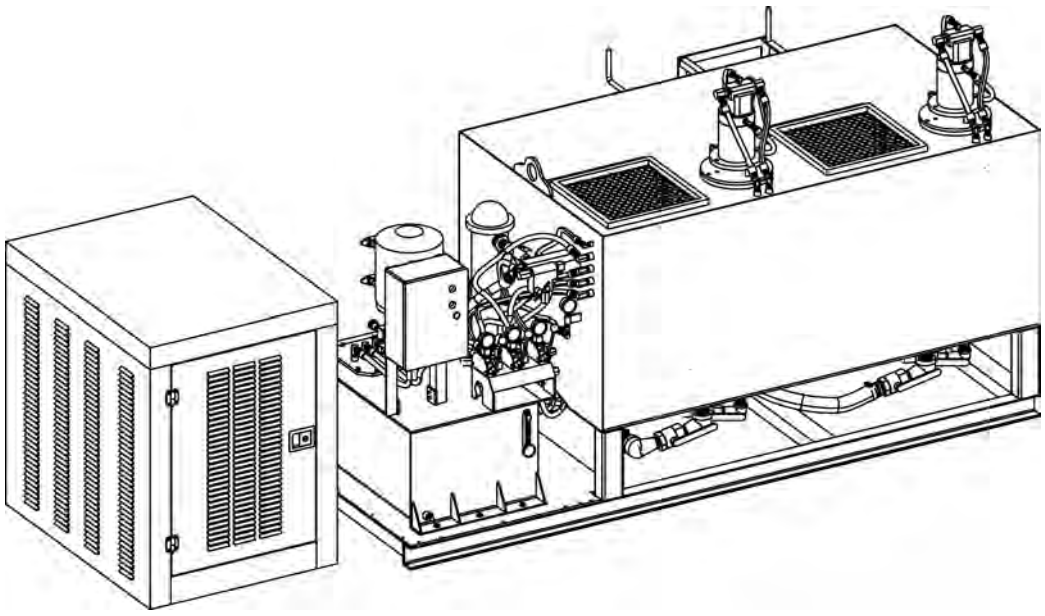
- New Belt ..... 17-30 lb.
- Used Belt ..... 13-23 lb.
- Center Distance Span (approx.) ..... 28 in.

Fluid Capacity

- Gearbox Oil (SAE Grade 40 non-detergent industrial turbine oil) ..... 15 qts. (14.2 L)

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

BENTONITE PUMP



Dimensions (width x length x height) ..... 48 x 125 x 70 in. (1,219 x 3,175 x 1,778 mm)

Weight (empty mixing tanks) ..... 4,200 lbs. (1,905 kg)

Power
Electric Over Hydraulic ..... 30 HP, 480V, 60Hz

Pump
Non-pulsating screw pump ..... 20 gpm @ 250 psi (variable pump rate)

Mixer Type
Hydraulic Motor Driven ..... Propeller Each Tank

Hydraulic Pressure (maximum) ..... 3,000 psi

Heat Exchanger
Oil Over Water ..... Cooling Water Must Be Supplied For Heat Exchanger

Speed
Motor (hydraulic power) ..... 1,775 rpm
Pump ..... 0 to 450 rpm
Mixer ..... 1,750 rpm

Capacities
Mixing Tank(s) ..... 2 @ 250 gal (946 L)
Hydraulic Reservoir ..... 60 gal (227 L)

Pump Outlet Size ..... 2 in. (51 mm)

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

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 ft. lbs.**	**(N·m)**	**Bolt Size**	**Torque 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

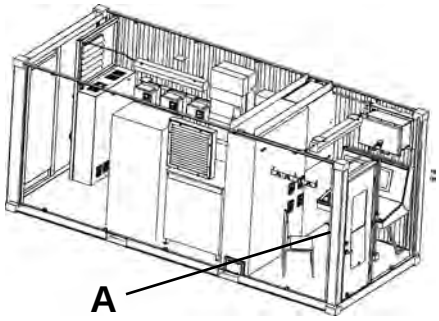
Identification Numbers

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

CONTROL CONTAINER (A)

Model Number _____

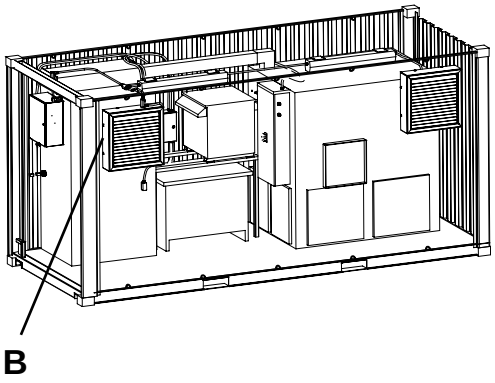
Serial Number _____



POWER CONTAINER (B)

Model Number _____

Serial Number _____



MTBM (C)

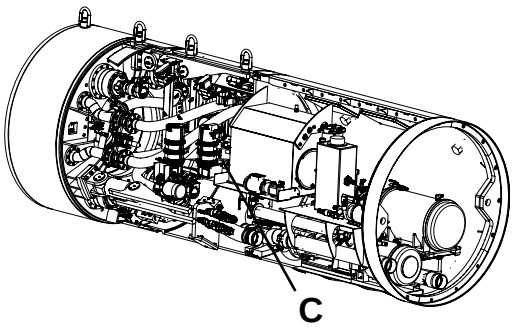
Model Number _____

Serial Number _____

TARGET (Not Shown)

Model Number _____

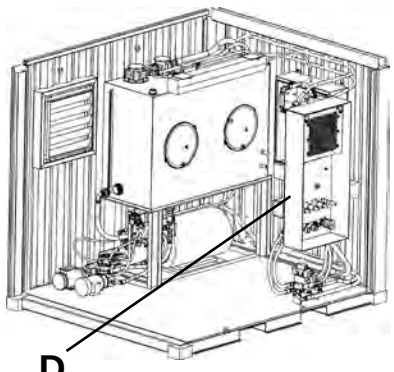
Serial Number _____



REMOTE HYDRAULIC POWER PACK (D)

Model Number _____

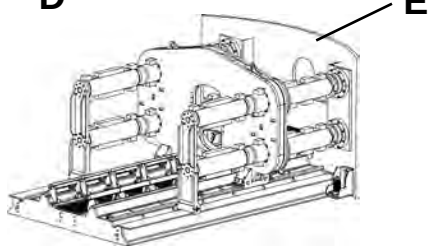
Serial Number _____



JACKING FRAME (E)

Model Number _____

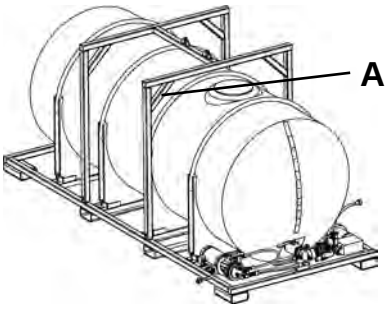
Serial Number _____



WATER COOLING TANK (A)

Model Number _____

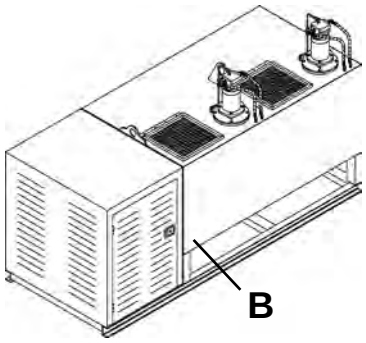
Serial Number _____



BENTONITE PUMP (B)

Model Number _____

Serial Number _____



Safety Data Sheets

The Federal Occupational, Safety, and Health Administration (OSHA) Standard 29 CFR 1910.1200, require that specific safety data sheets (SDS) be available to employees before operating this equipment. This may include information on substances contained in this equipment such as hydraulic fluid and gear lubricant.

Akkerman Inc. will provide, at no cost, SDS which apply to its product line. Simply contact your Akkerman Product Support representative for a copy.

To ensure a prompt response to your SDS request, include your return address (including zip or postal code) and the equipment's model numbers and serial numbers with your request.

NOTES

Warranty

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

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

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