



OPERATOR'S MANUAL

Microtunneling System

Control Container S/N: FA21900F
Remote Hydraulic Power Pack
SN: FA21945F & FA21965F

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SERVICE • RELIABILITY • INNOVATION

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.

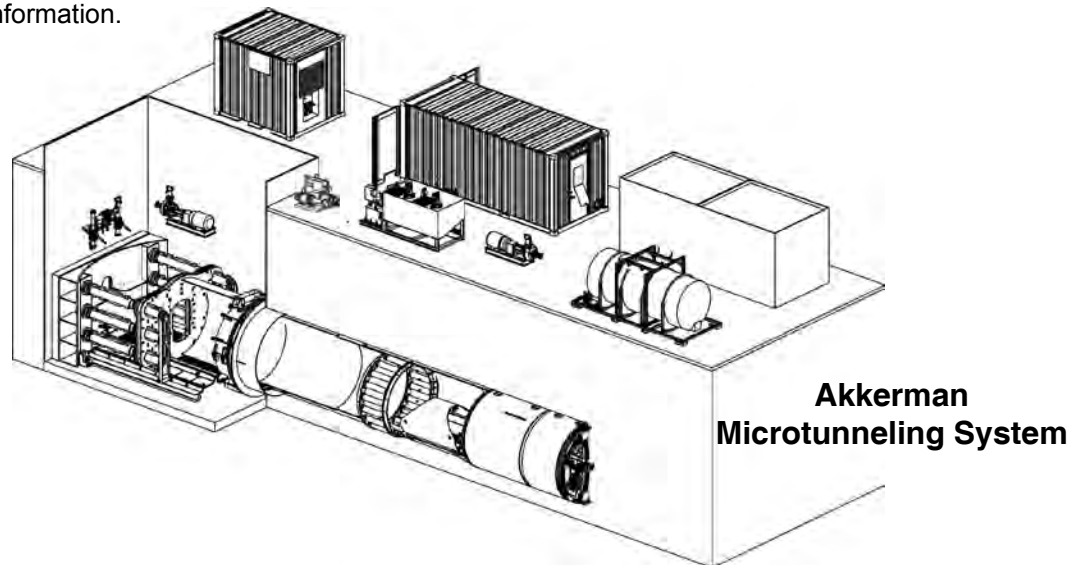
▲ DANGER Indicates an extremely hazardous situation which, if not avoided, WILL result in death or serious injury.

▲ 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.



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.



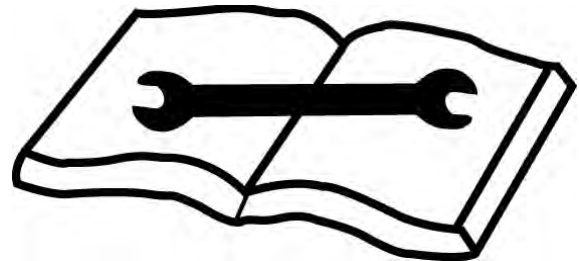
**ATTENTION!
BECOME ALERT!
YOUR SAFETY IS INVOLVED!**

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 POWER BEFORE SERVICING

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

LOCKOUT 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.

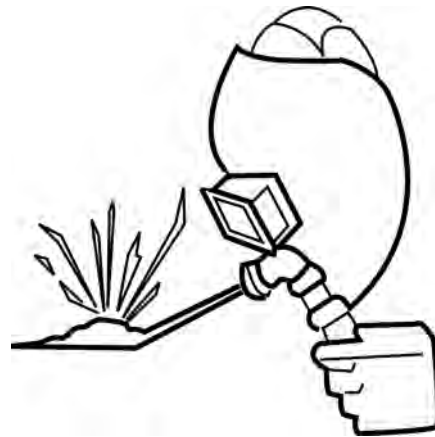


UNAUTHORIZED WELDING

⚠ WARNING

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

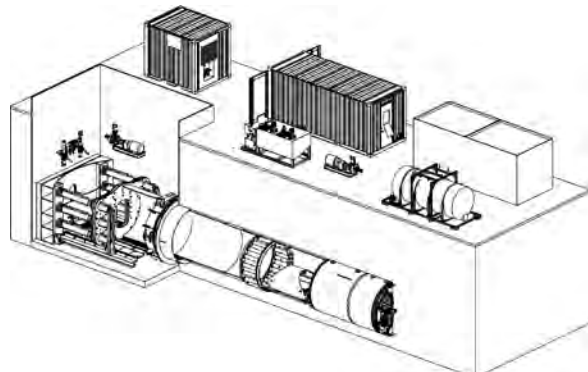
Do not weld on any structural member. Unauthorized welding or repair will void the warranty.



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 power before performing any maintenance.

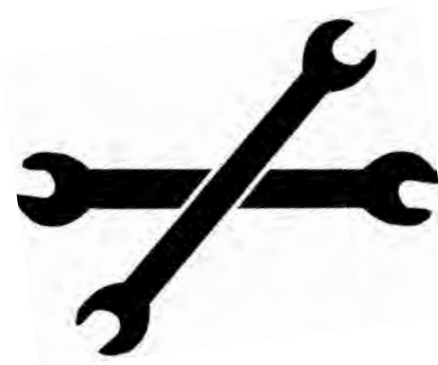
Shut down equipment before making repairs, adjustments, or removing obstructions.

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.

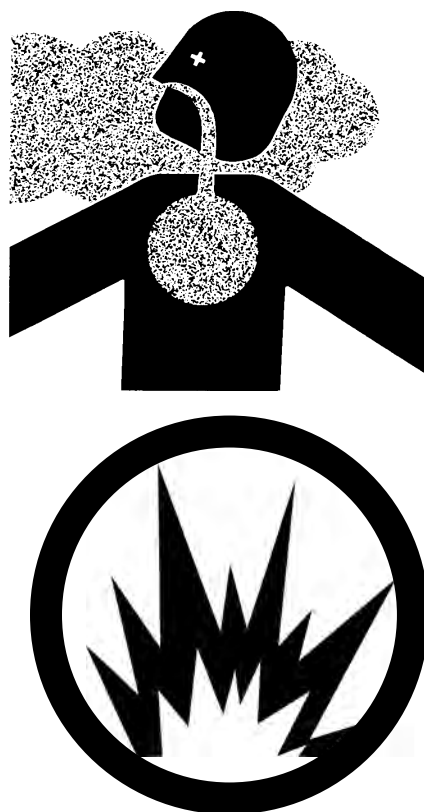
Use an approved air analyzer to detect hazardous gases and oxygen content.

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.

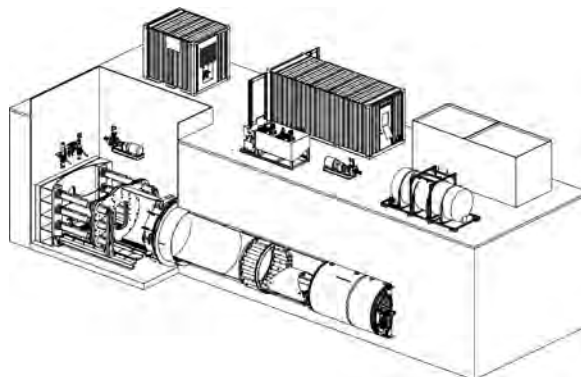
Gases must be removed before reentering tunnel/shaft.



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 serious 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.

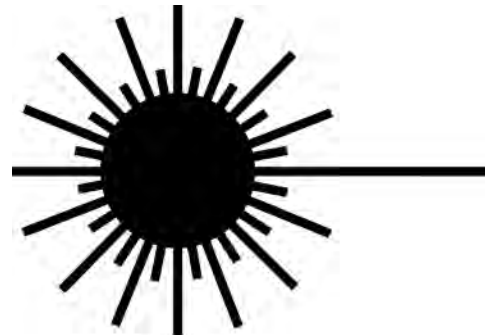


AVOID LASER LIGHT EXPOSURE

⚠ DANGER Staring into laser light will cause severe injury.

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

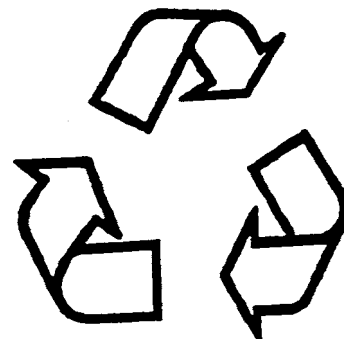
To avoid possible exposure to radiation in excess of acceptable emission limits, all repairs to laser must be performed by the original manufacturer or an authorized service technician.



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

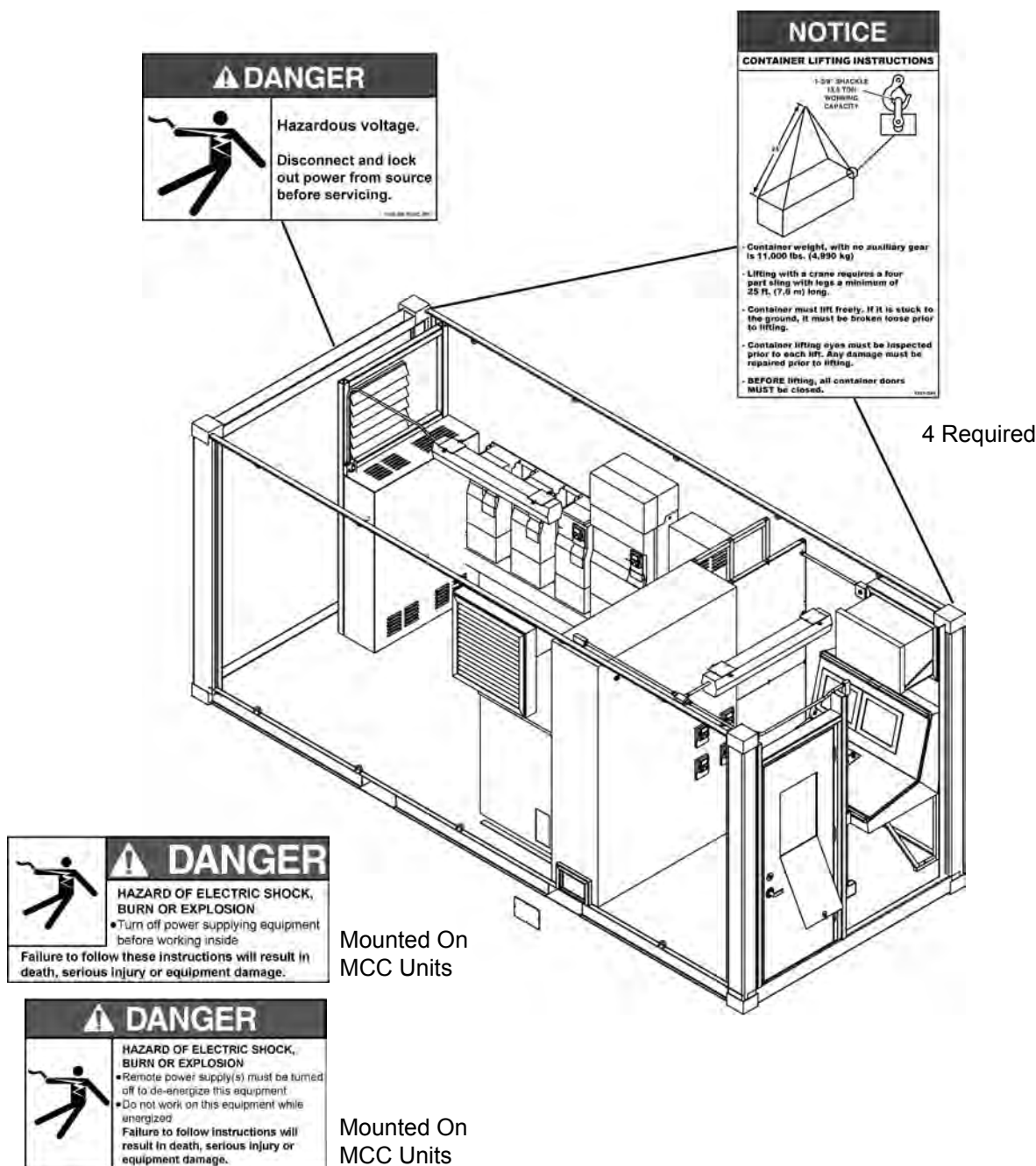
Safety Decals

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.

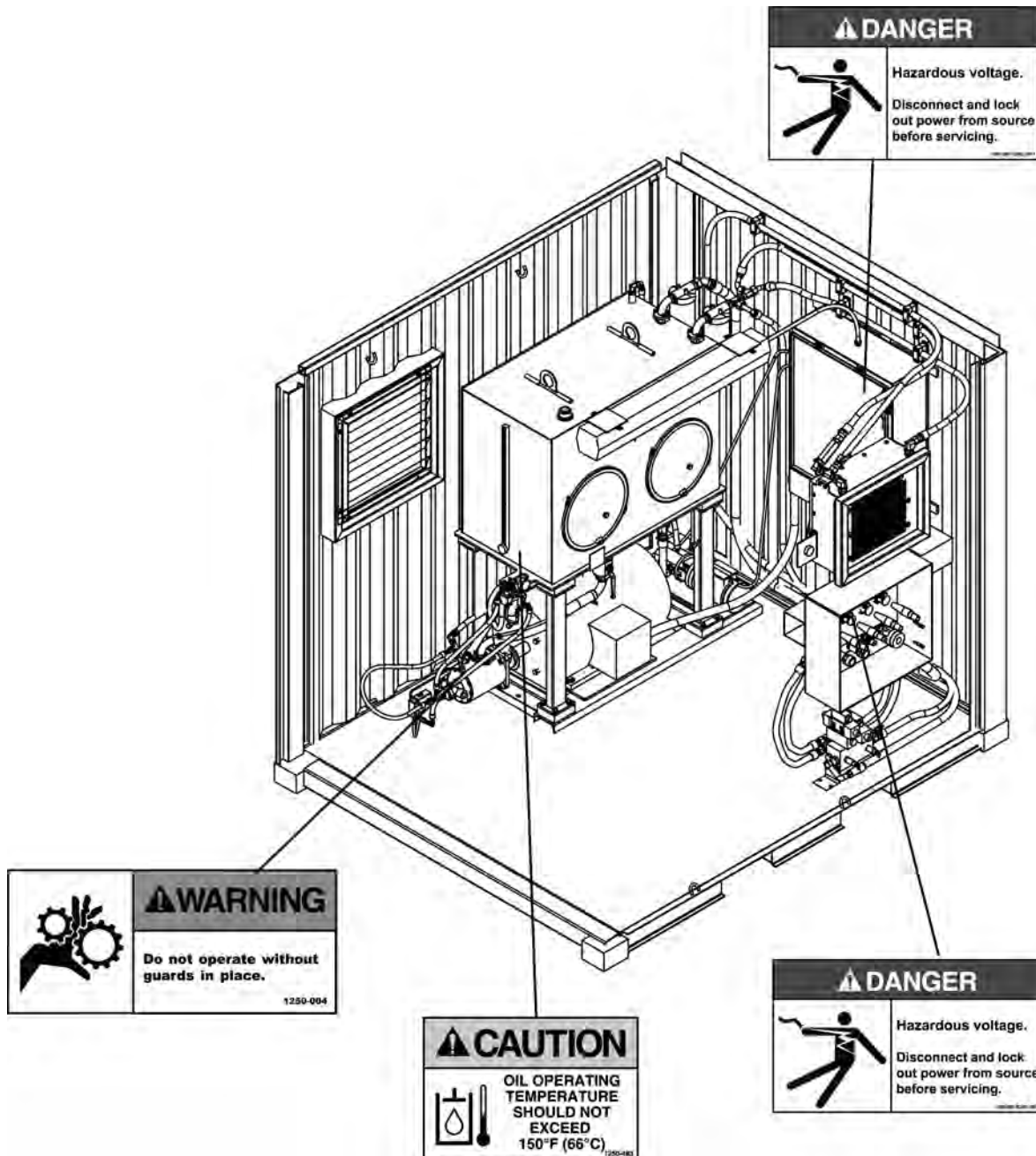
Serious injury or property damage can occur if safety instructions are not followed. Contact your Akkerman Aftermarket Support representative for free replacement safety decals.

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.

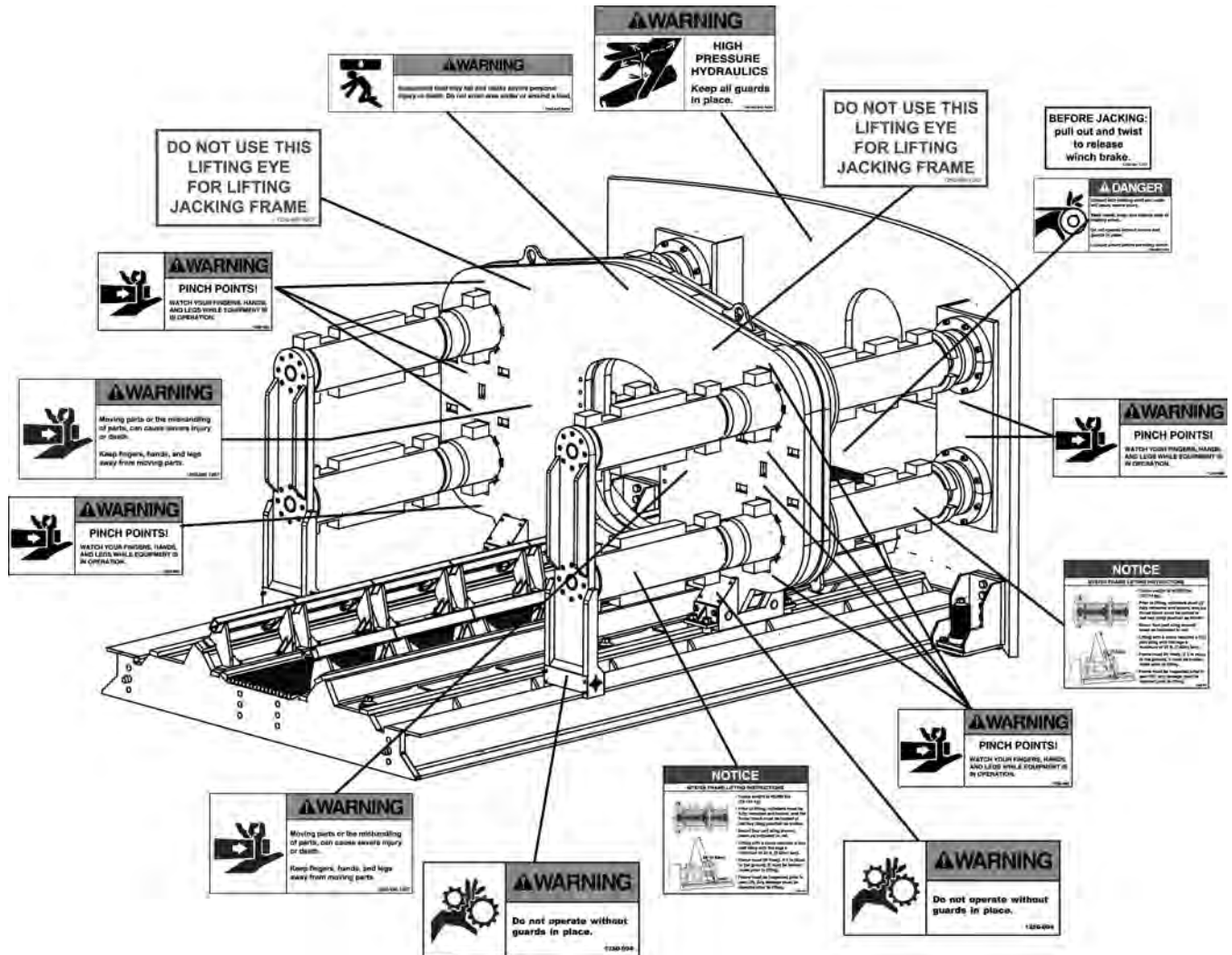
CONTROL CONTAINER



REMOTE HYDRAULIC POWER PACK

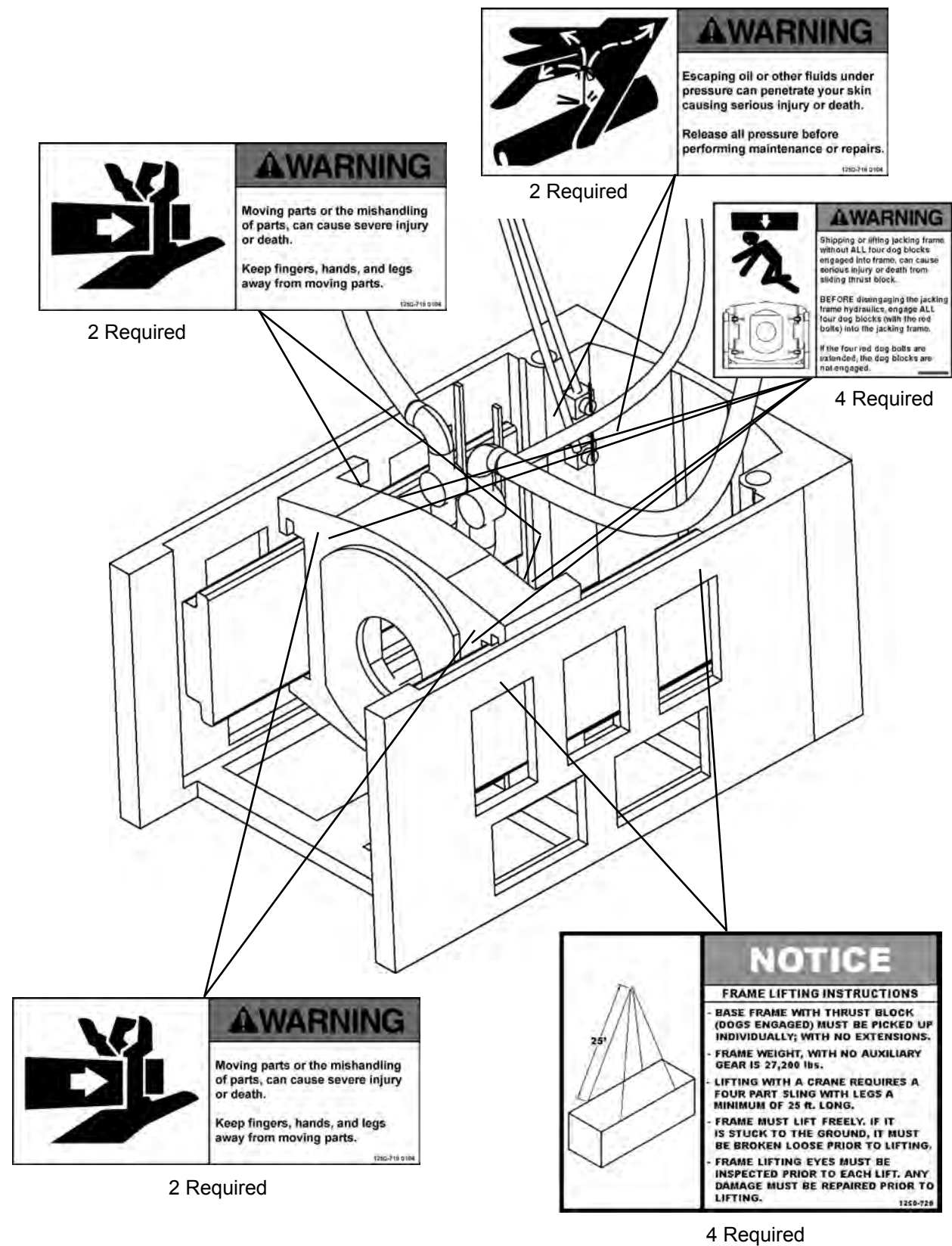


KEYHOLE JACKING FRAMES



Model MT875K Shown

SLIDE THRUST JACKING FRAMES



WATER COOLING TANK



⚠ WARNING

Suspended load may fall and cause severe personal injury or death. Do not enter area under or around a load.

Tank **MUST** be empty before lifting tank assembly.

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4 Required

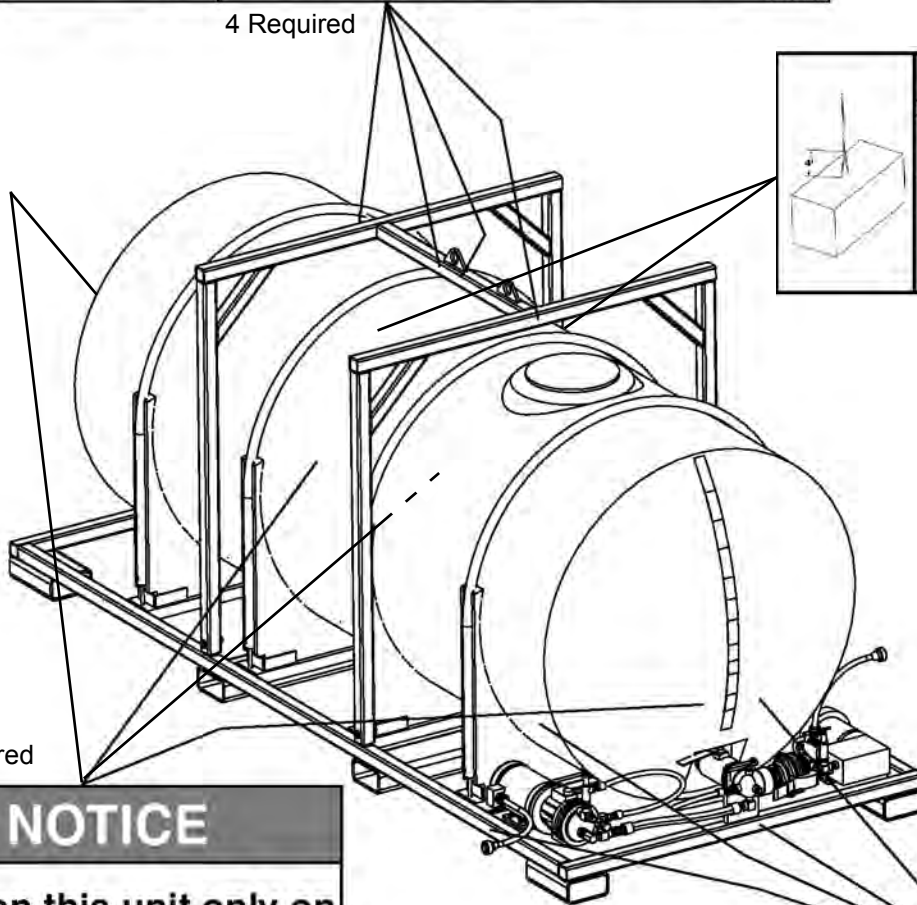


NOTICE

TANK FRAME LIFTING INSTRUCTIONS

- TANK FRAME MUST BE PICKED UP EMPTY.
- TANK FRAME WEIGHT, EMPTY IS 2,200 lbs.
- LIFTING WITH A CRANE REQUIRES A TWO PART SLING WITH LEGS A MINIMUM OF 4 FT. 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 MUST BE INSPECTED PRIOR TO EACH LIFT. ANY DAMAGE MUST BE REPAIRED PRIOR TO LIFTING.

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4 Required

NOTICE

Position this unit only on firm, solid, level ground.

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4 Required

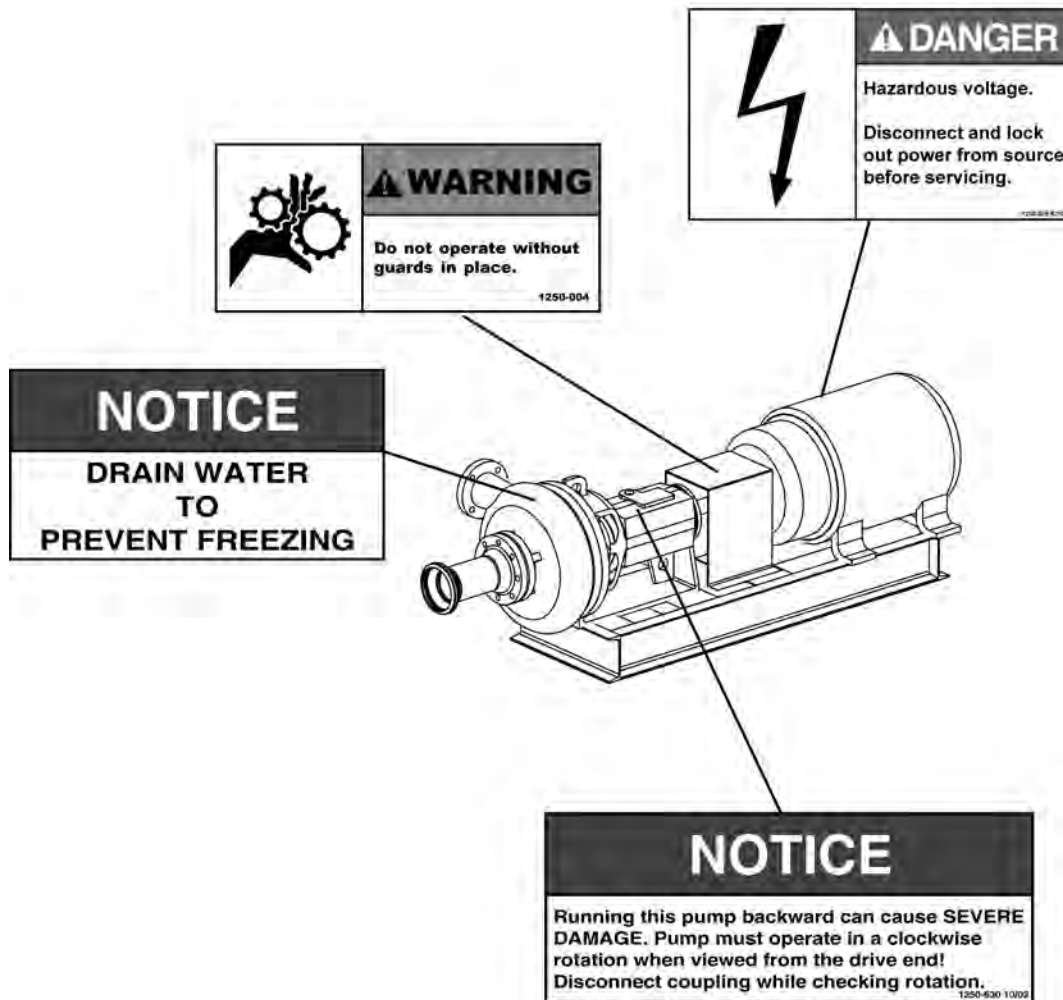
NOTICE

Drain water to prevent freezing by:

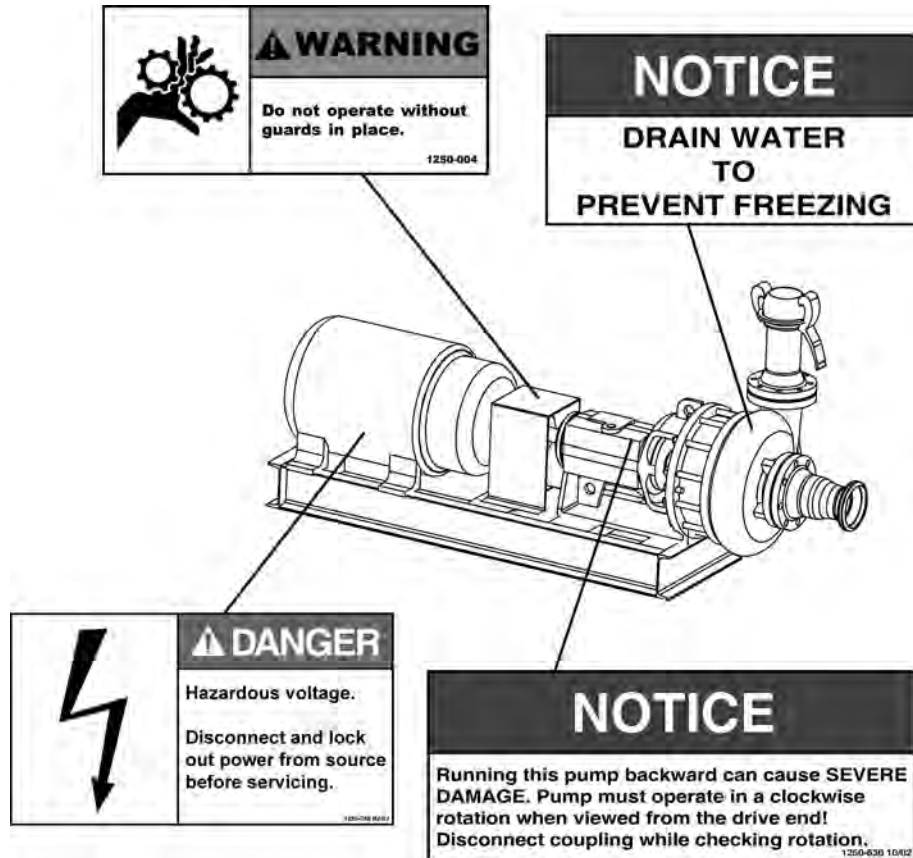
1. Removing cap or hose from 3" elbow.
2. Remove drain plugs from BOTH pumps.
3. Completely drain water and replace plugs.

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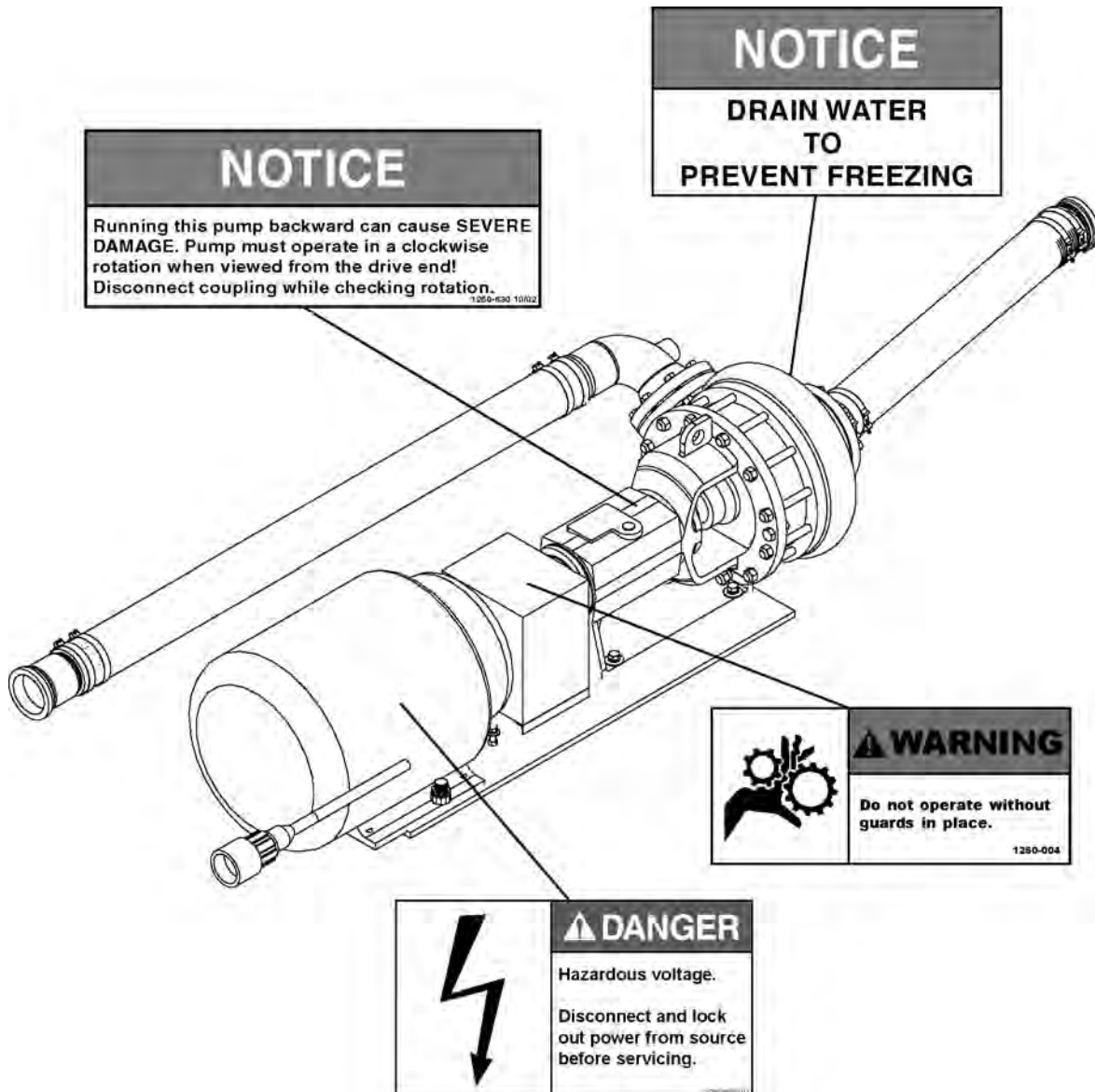
SLURRY FEED PUMP



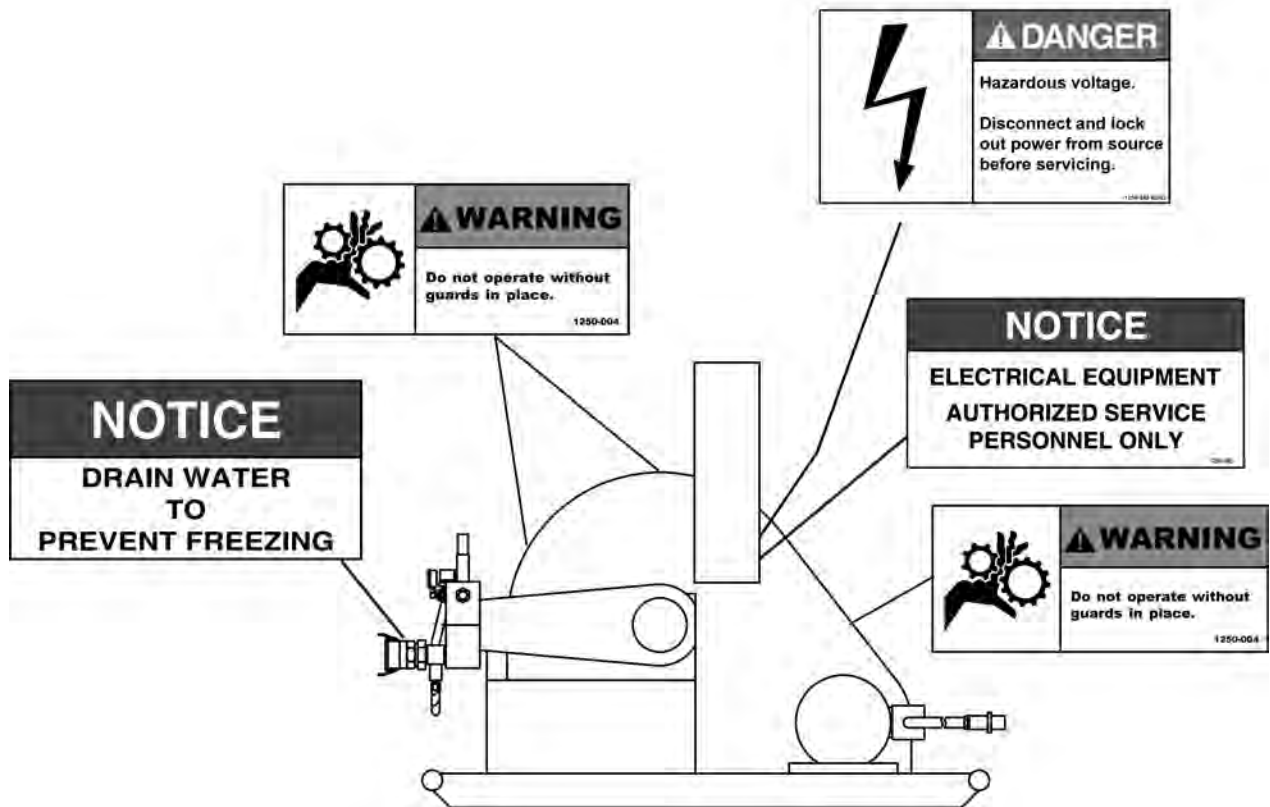
SLURRY RETURN PUMP



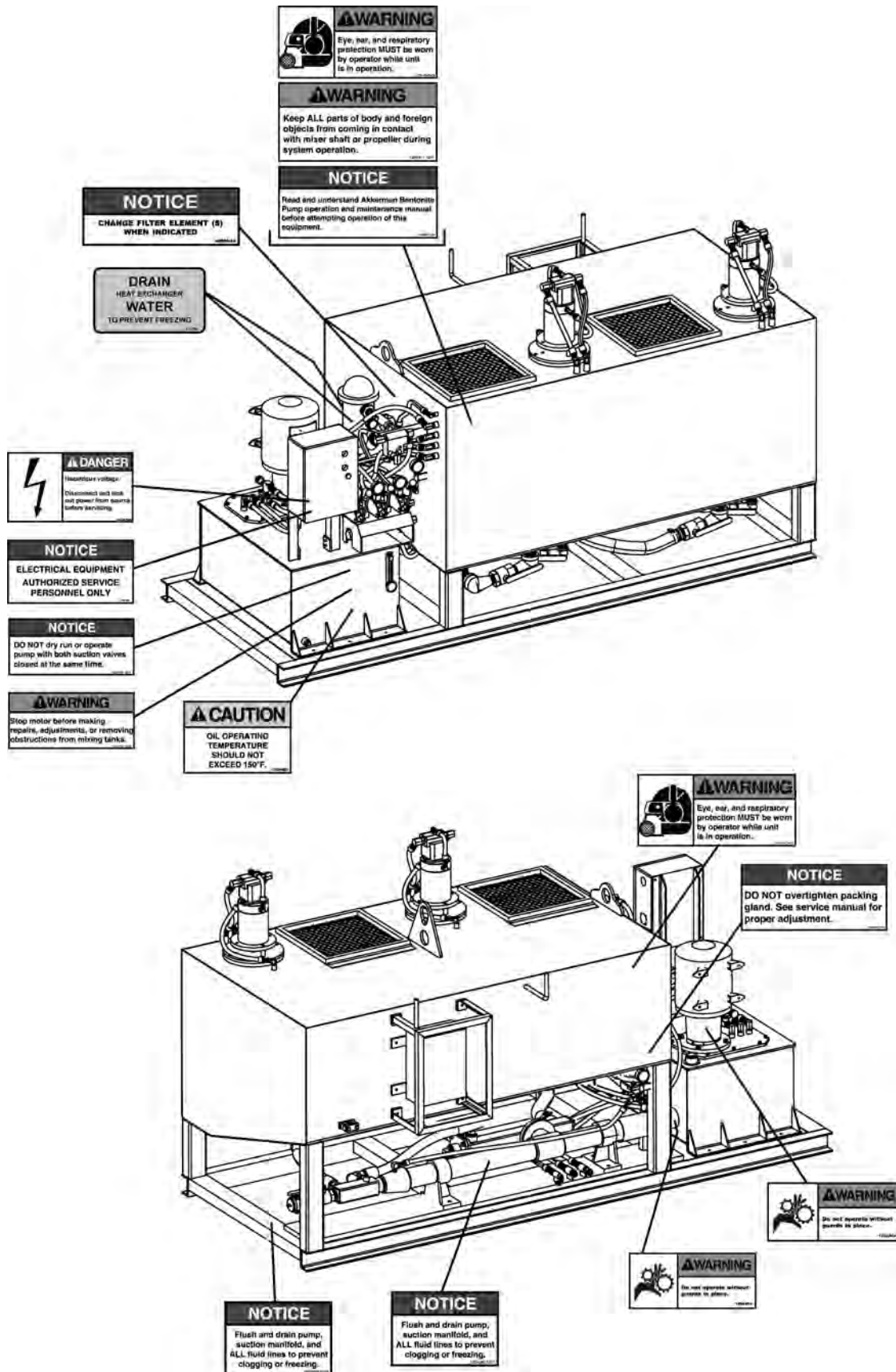
SLURRY BOOSTER PUMP



HIGH PRESSURE JETTING PUMP

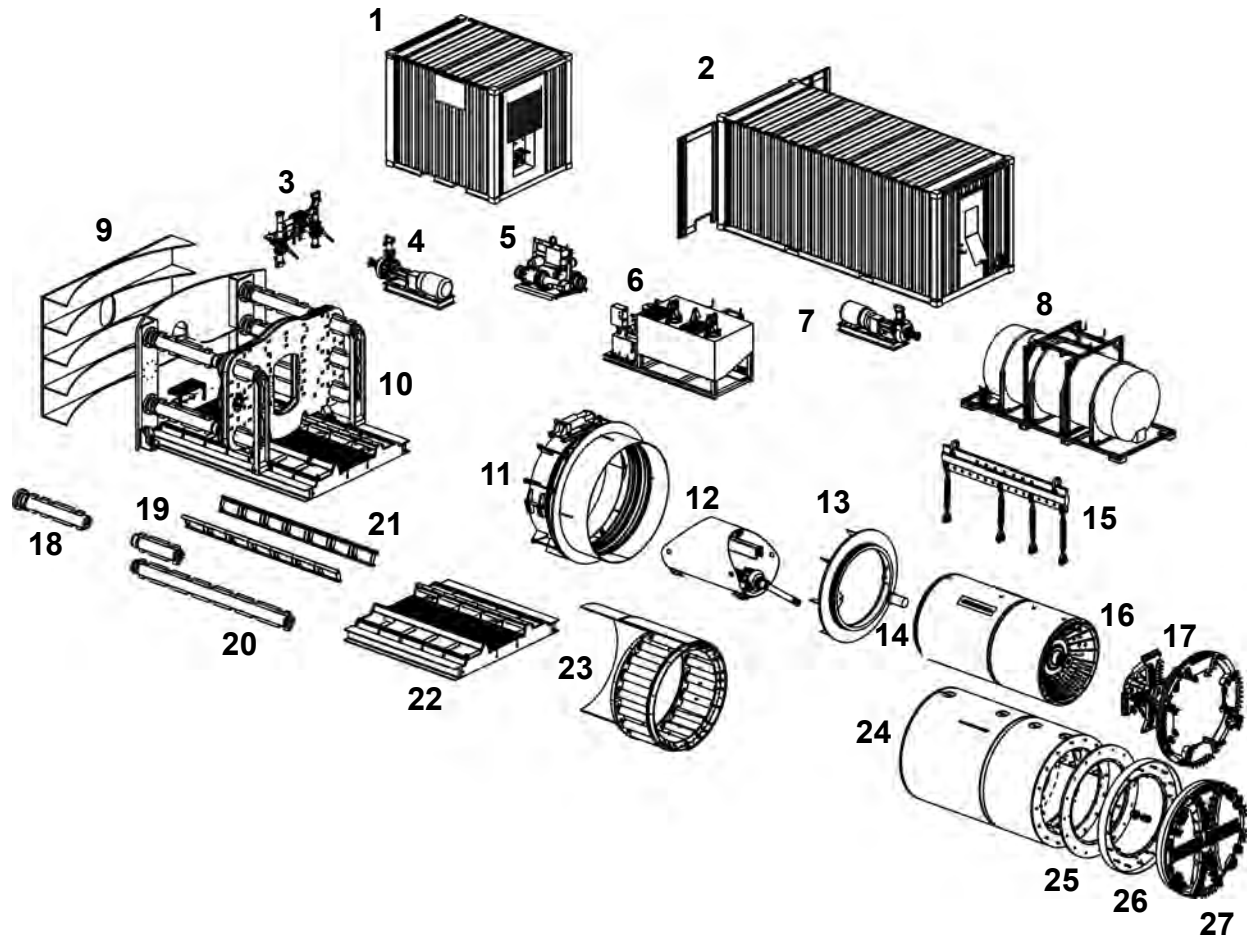


BENTONITE PUMP



Terminology

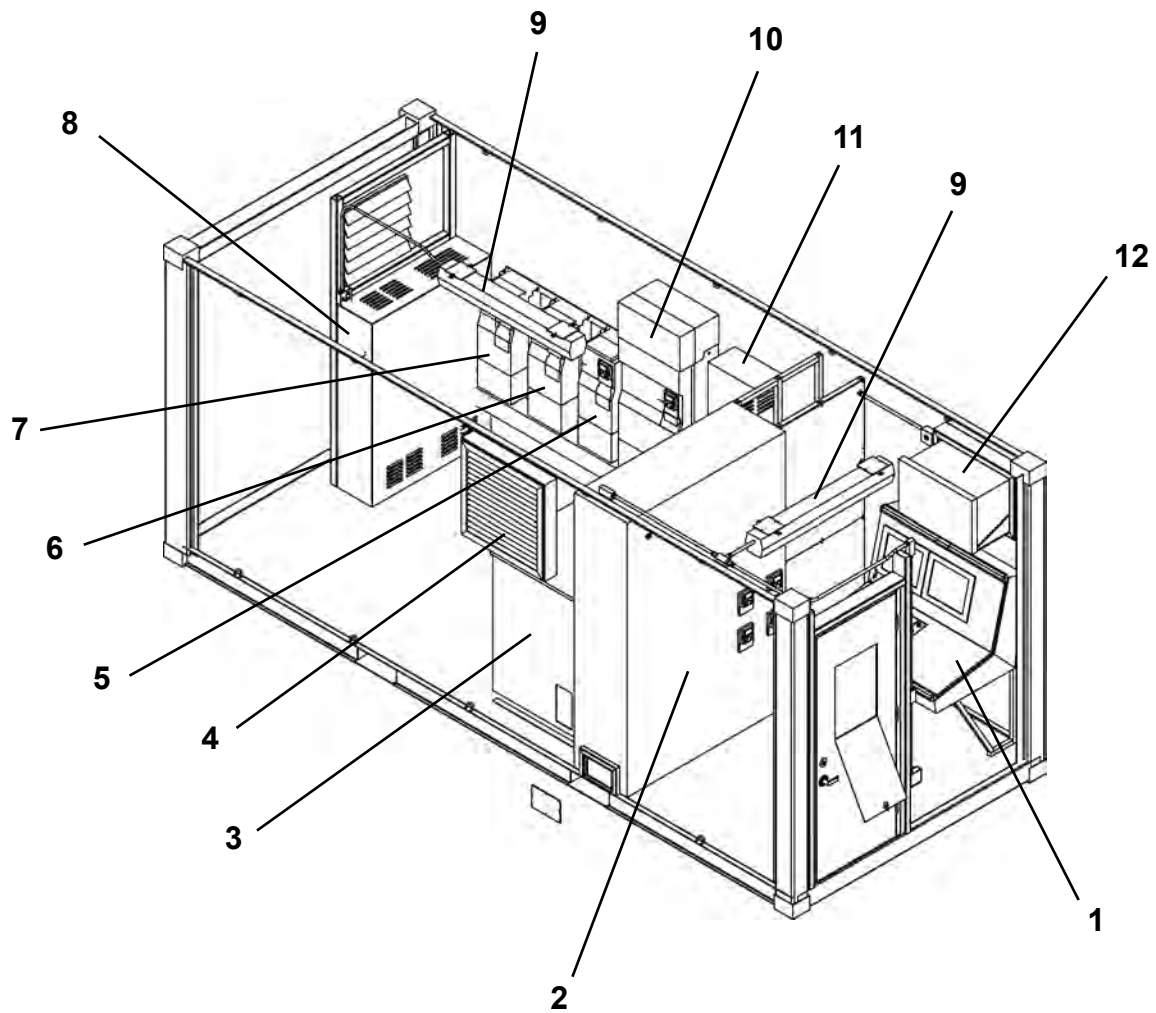
MICROTUNNELING COMPONENTS



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

* The trailing dolly is used in place of the trailing section when the pipe ID is 48" or larger.

CONTROL CONTAINER



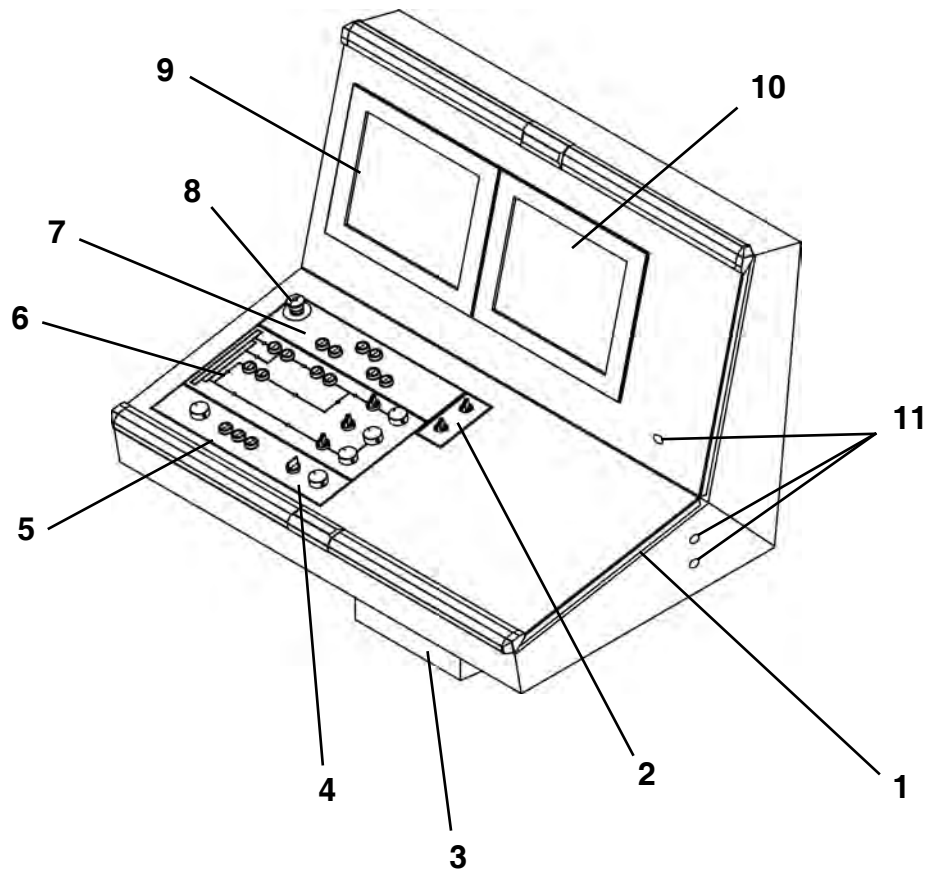
1. Operator Control Console
2. 480 Volt MCC System
3. Transformer 480V To 575V
4. Exhaust Fan

5. Feed Pump VFD
6. Return Pump VFD
7. Booster Pump VFD
8. Bulkhead

9. Lighting Fixture
10. Main Cutter VFD
11. Main Cutter Drive Disconnect
12. Air Conditioner

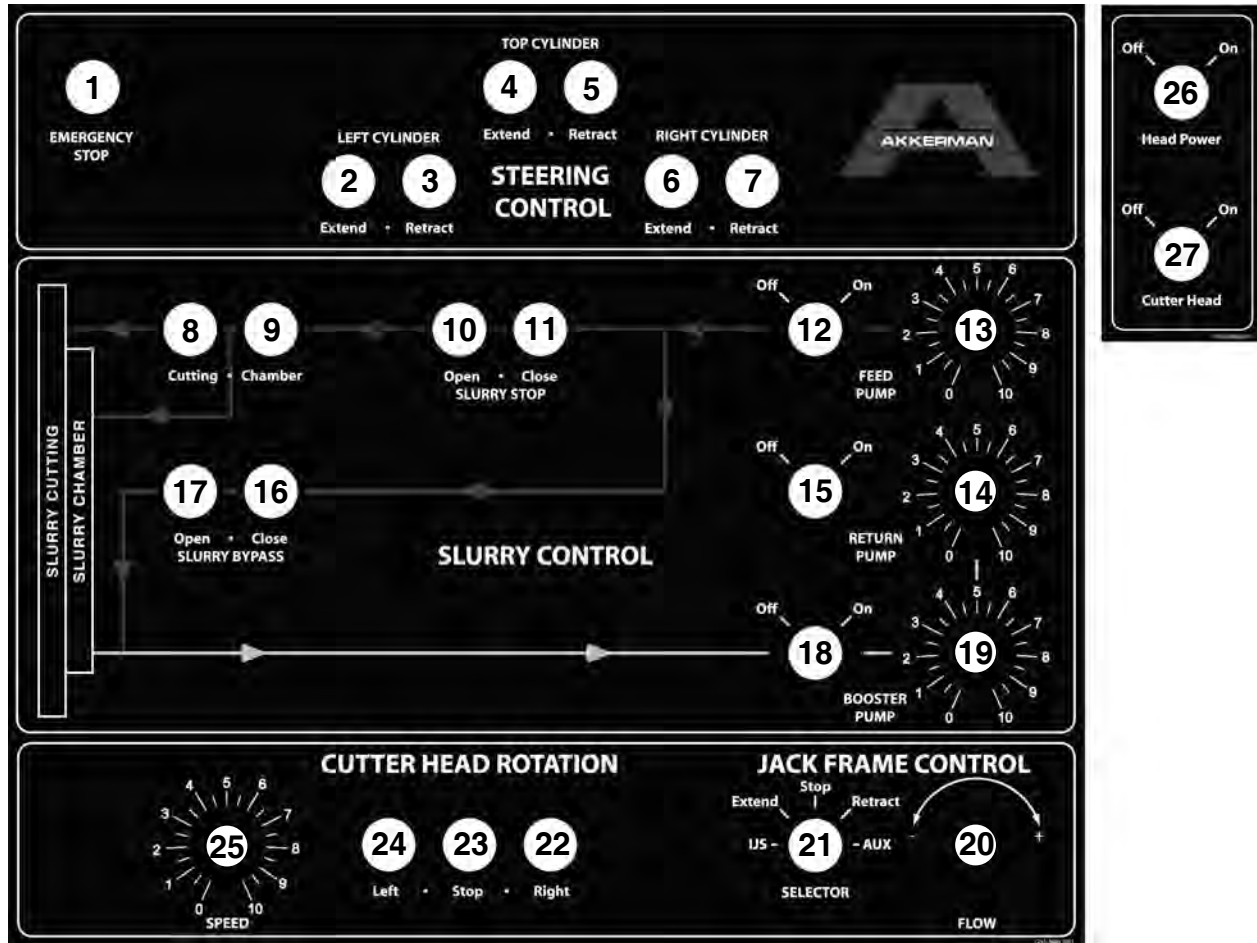
MCC - Motor Control Center

CONTROL CONSOLE



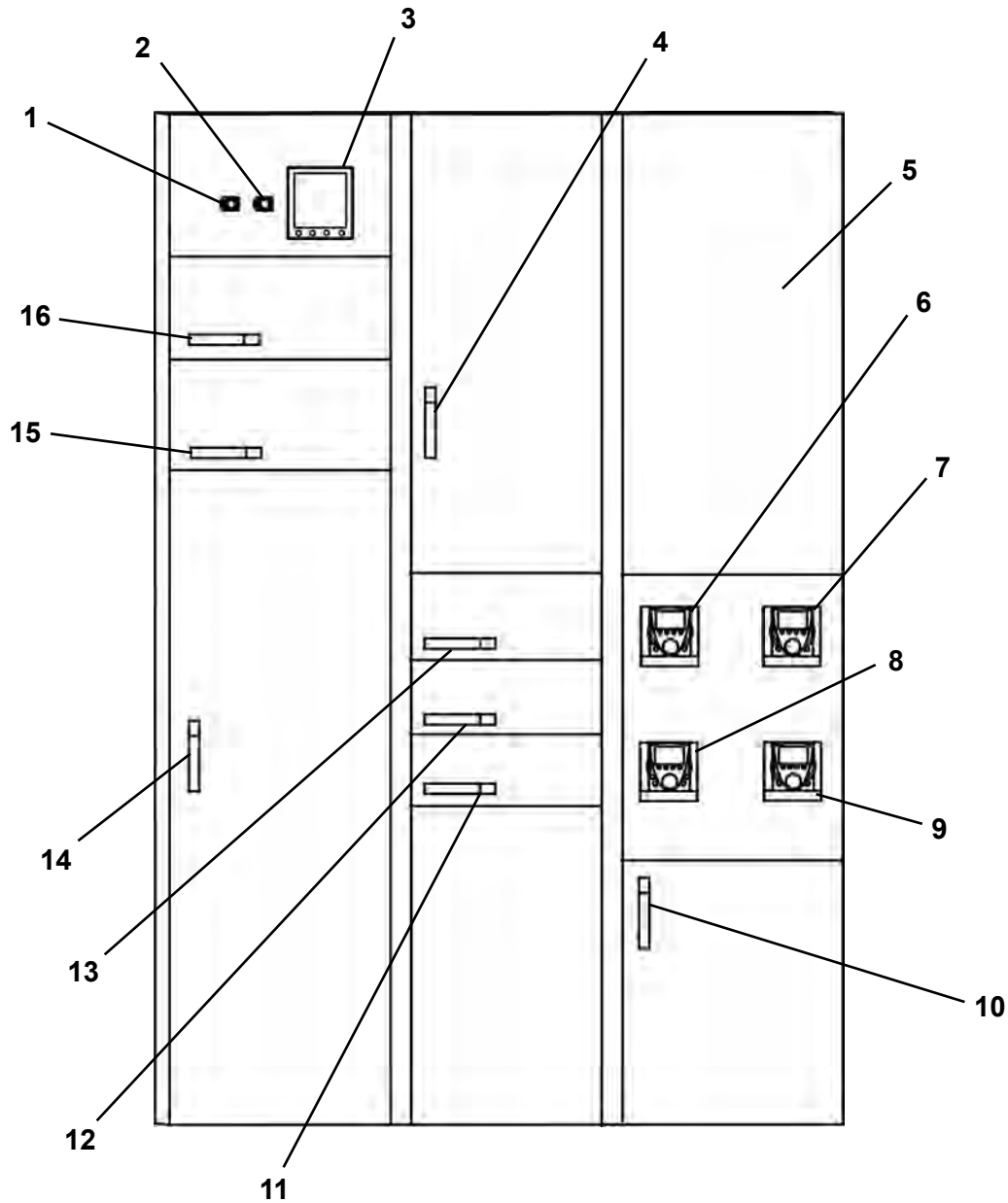
1. Control Console	6. Slurry Controls
2. Head Power/Cutter Head Controls	7. Steering Controls
3. Audio Controls	8. Emergency Stop Button
4. Jack Frame Controls	9. Target Screen Monitor
5. Cutter Head Rotation Controls	10. Control Screen Monitor
	11. USB Connection Ports

CONSOLE CONTROLS



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

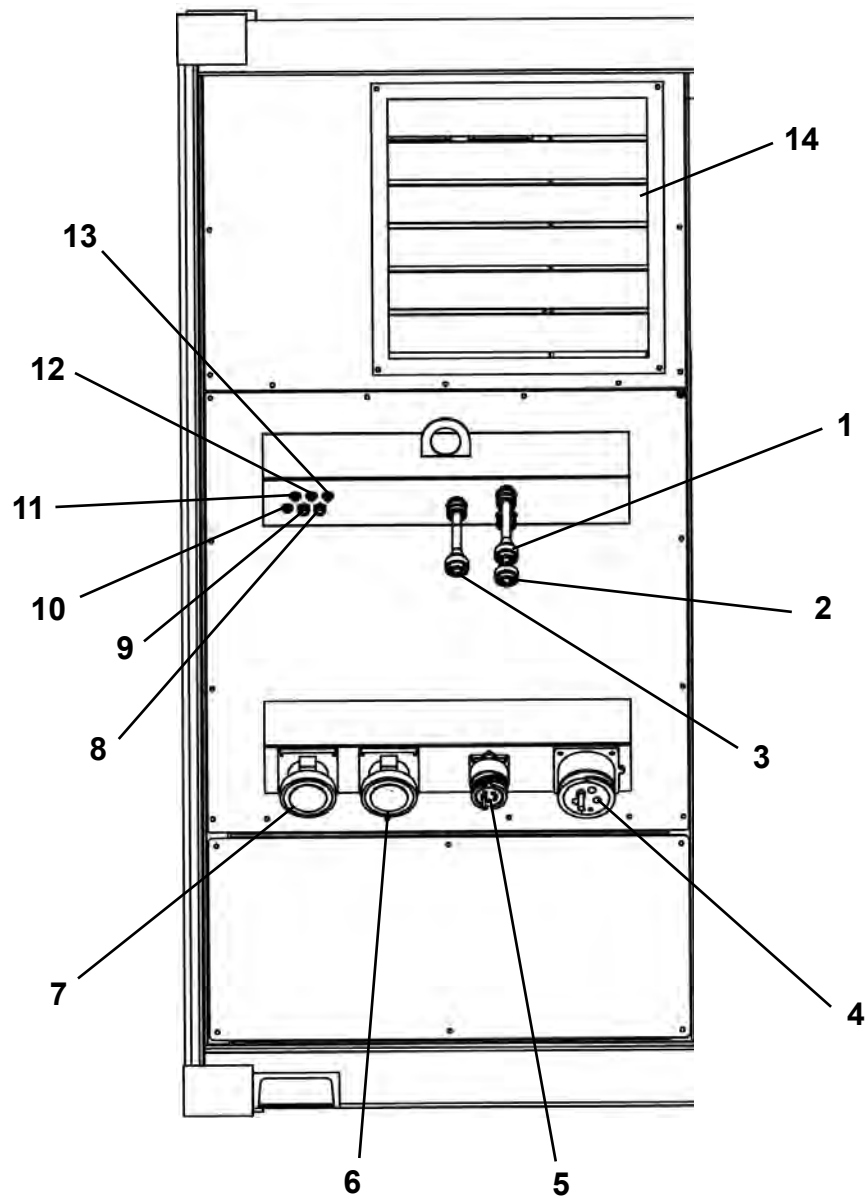
CONTROL CONTAINER 480 VOLT MCC SYSTEM



- 1. Phase Indicator (Green) (Phase OK)
- 2. Phase Indicator (Red) (Phase Tripped)
- 3. Power Monitor
- 4. Main Cutter Drive Disconnect
- 5. Panel Board (Circuit Breakers)
- 6. Feed Pump VFD Monitor
- 7. Cutter VFD Monitor
- 8. Return Pump VFD Monitor
- 9. Booster Pump VFD Monitor

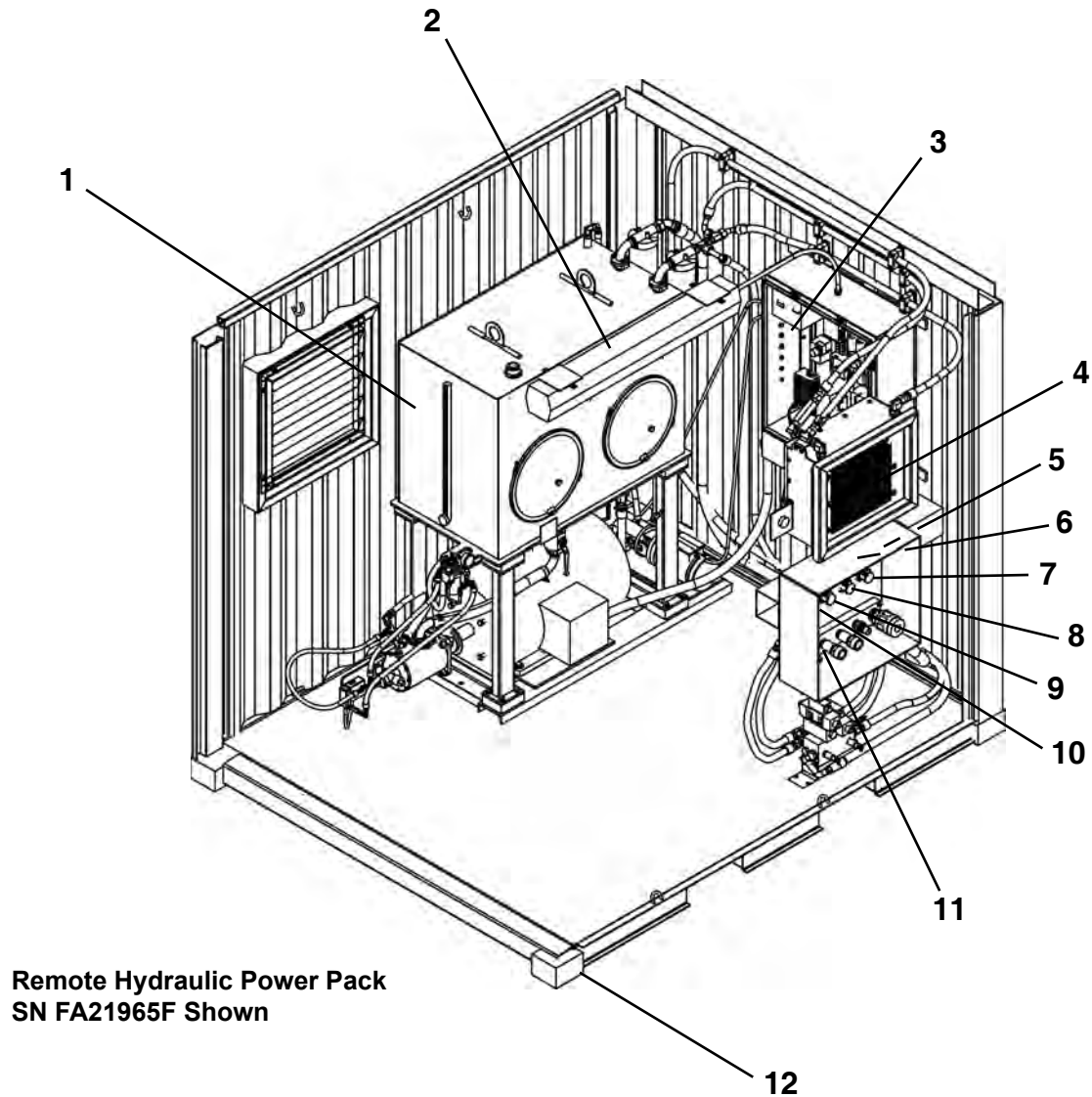
- 10. 120V/240V Transformer Disconnect
- 11. Head Power Disconnect
- 12. Cooling Pump Disconnect
- 13. Booster Pump Disconnect
- 14. Main Power Disconnect
- 15. Return Pump Disconnect
- 16. Feed Pump Disconnect

CONTROL CONTAINER BULKHEAD



1. Cooling Pump Power	10. Boring Head Ethernet
2. Jetting Control Power (Optional)	11. Hydraulic Power Pack Ethernet
3. MTBM Boring Head Power	12. Flowmeter Ethernet
4. Boring Head Drive Power	13. Pit Box Ethernet
5. Slurry Booster Pump Power	14. Air Intake Louvers
6. Slurry Return Pump Power	
7. Slurry Feed Pump Power	
8. Pit Box Power	
9. Flowmeter Power	

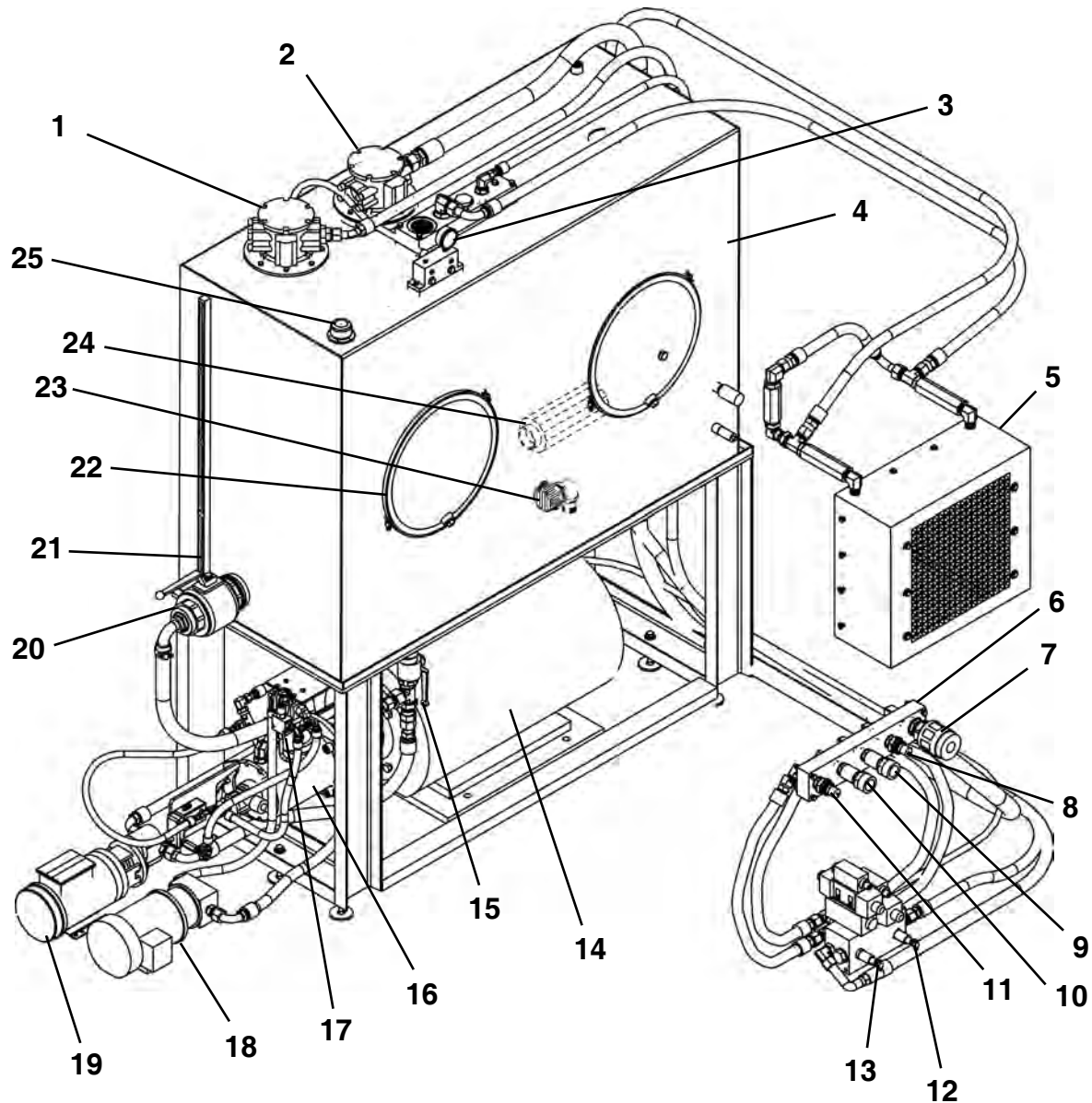
REMOTE HYDRAULIC POWER PACK



1. Power Pack Hydraulic Reservoir
2. Light Fixture
3. Electrical Controls
4. Oil Cooler
5. Control Container Ethernet
6. Emergency Stop Button

7. Ground Generator Power
8. Phase C Generator Power
9. Phase B Generator Power
10. Phase A Generator Power
11. Hydraulic Manifold Bulkhead
12. Hydraulic Power Pack Container

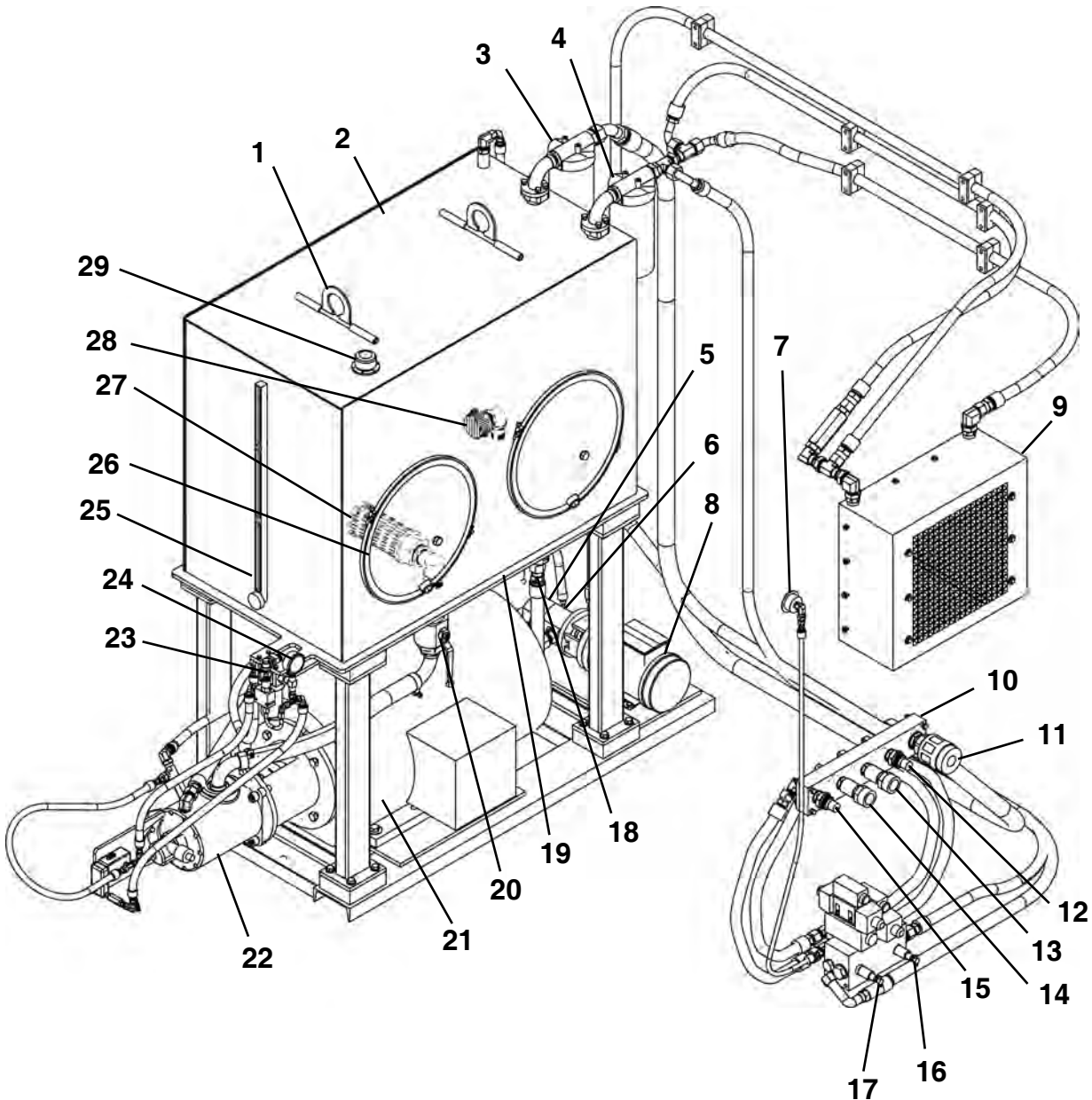
HYDRAULIC POWER PACK (SN FA21945F)



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

* located inside reservoir

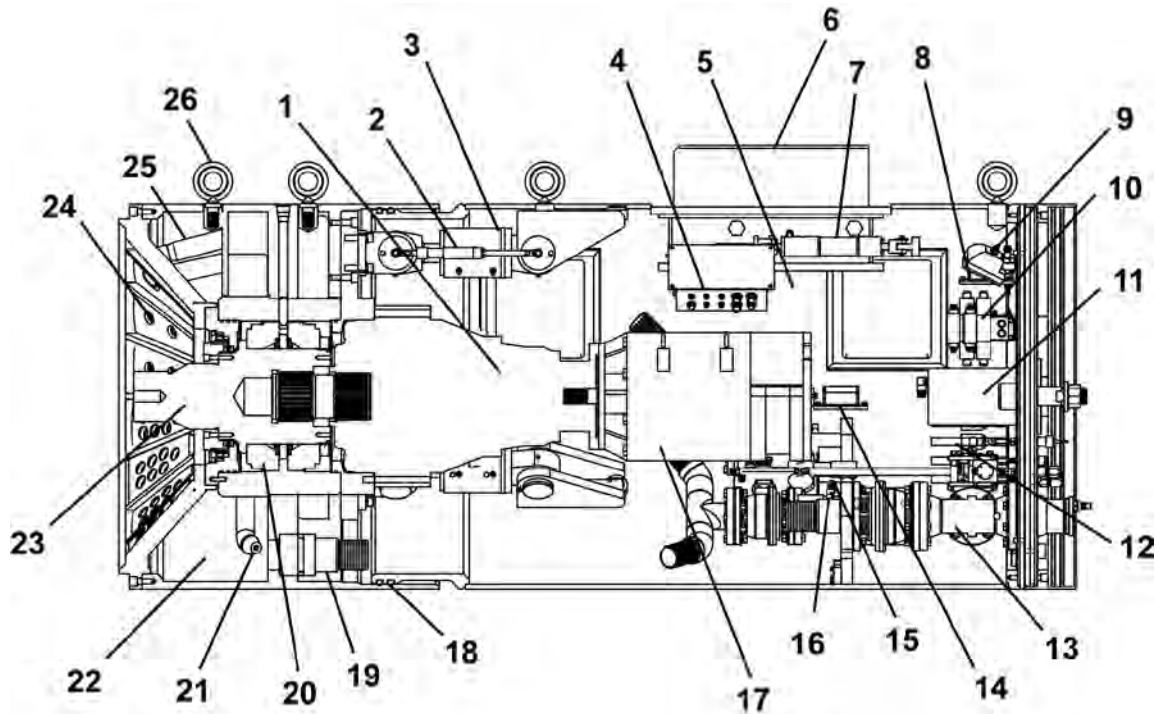
HYDRAULIC POWER PACK (SN FA21965F)



1. Lift Eye	16. Auxiliary Relief Valve
2. Hydraulic Oil Reservoir 195 Gallons	17. Main Relief Valve
3. Hi Flow Return Filter	18. Cooling Pressure Suction Valve
4. Jacking Frame Return Filter	19. Pilot Pressure Suction Valve
5. Pilot Pressure Pump Assembly	20. Main Hydraulic Shutoff Valve
6. Cooling Pump Assembly	21. Motor 75 HP
7. Hydraulic Pressure Gauge	22. Main Hydraulic Pump
8. Pilot/Cooling 2 HP Motor	23. Pilot Pressure Oil Filter
9. Oil Cooler Fan	24. Pilot Pressure Gauge
10. Hydraulic Manifold Bulkhead	25. Oil Level Sight/Temperature Gauge
11. Hi Flow Return Hydraulic Connection	26. Inspection/Cleanout Cover
12. IJS Supply Hydraulic Connection	27. Strainer*
13. Auxiliary Hydraulic Connection	28. Suction Screen*
14. Jacking Frame Retract Hyd. Connection	29. Oil Fill Cap & Breather
15. Jacking Frame Extend Hyd. Connection	

* located inside reservoir

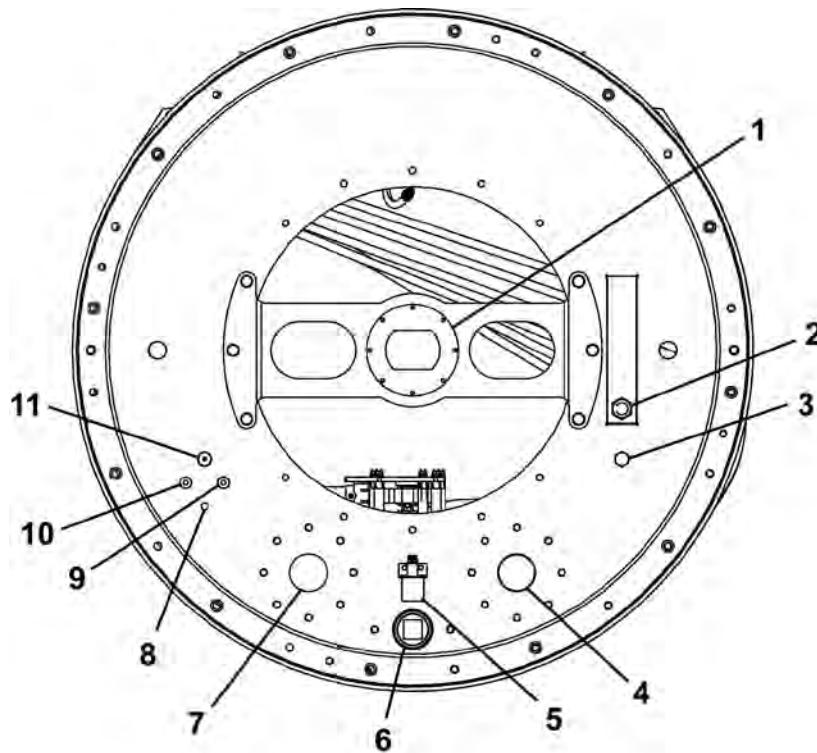
MTBM STARTING SECTION



Model SL51 Shown

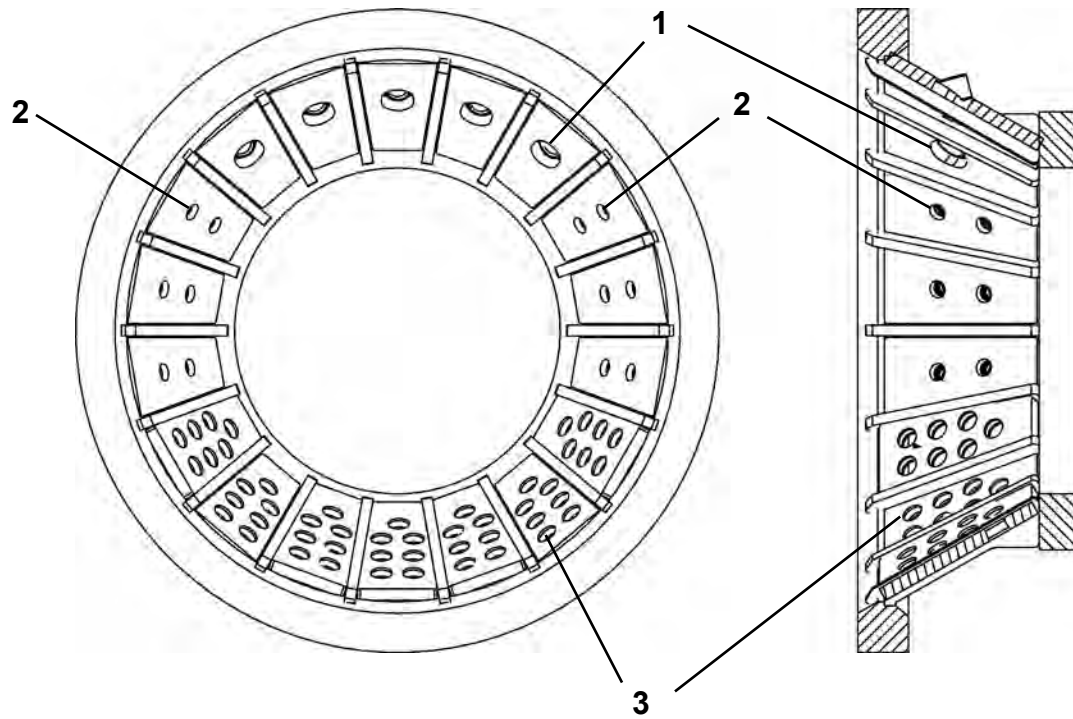
1. Planetary Gearbox	14. Front Inclinometer
2. Steering Cylinder Linear Transducer	15. Slurry Inlet PSI Transducer
3. Steering Cylinders	16. Slurry Outlet PSI Transducer
4. Control Box	17. Electric Motor
5. Grease Pump (Location for larger MTBMs)	18. Steering Joint Seals
6. Dirt Wing	19. Slurry Return
7. Dirt Wing Cylinder	20. Drive Bearing
8. Back Inclinometer	21. Slurry Chamber Port
9. Lights	22. Slurry Chamber
10. Hydraulic Control Valves	23. Drive Shaft
11. Target Assembly	24. Crushing Chamber
12. High Pressure Jetting	25. Cutter Ports
13. Slurry Valves	26. Lifting Eye

MTBM STARTING SECTION BULKHEAD



1. Target Assembly
2. High Pressure Jetting Port
3. Main Drive Cooling Water Port
4. Slurry Inlet
5. Submersible Pump Float Switch
6. Plug
7. Slurry Outlet
8. Grease Pump Port
9. High Pressure Hydraulic Port
10. Low Pressure Hydraulic Port
11. Tank (Return) Hydraulic Port

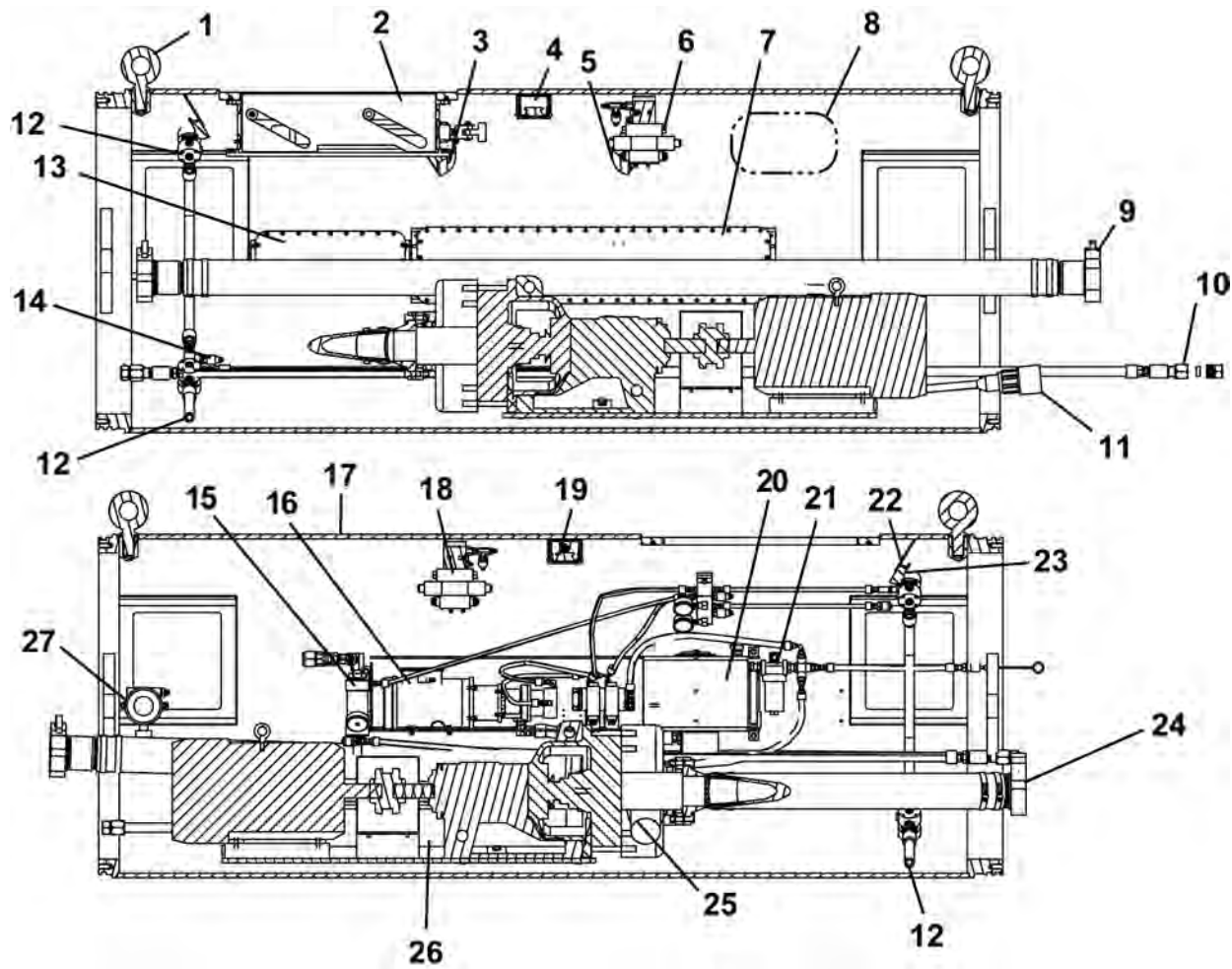
MTBM CRUSHING CONE



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

MTBM TRAILING SECTION

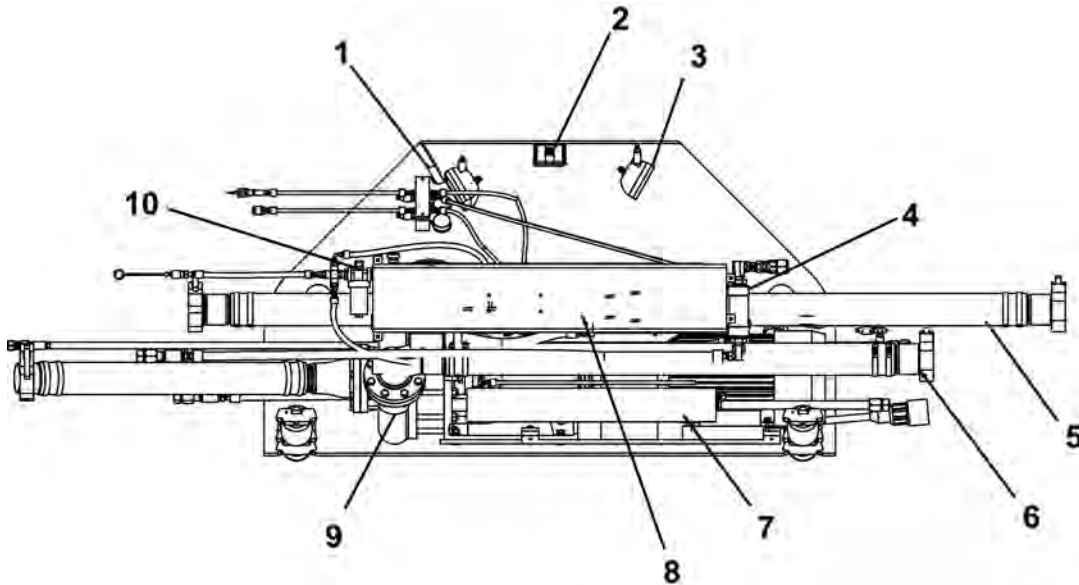
The trailing section is used when the pipe ID is smaller than 48”.



1. Lifting Eye	15. High Pressure Jetting/Cooling Pump Strainers
2. Dirt Wing Assembly	16. Motor 2 HP
3. Light	17. Trailing Section Can
4. Speaker	18. Hydraulic Control Manifold
5. Light	19. Speaker
6. Hydraulic Control Manifold	20. Hydraulic Power Pack
7. Electrical Control Box	21. Hydraulic Power Pack Filter
8. Grease Pump	22. Camera Mount
9. Slurry Supply	23. Camera
10. Bentonite Supply	24. Slurry Return
11. Booster Pump Power Cable	25. Booster Pump
12. Bentonite Port	26. Submersible Pump
13. Electrical Control Box	27. Gas Detector
14. Bentonite Pressure Transducer	

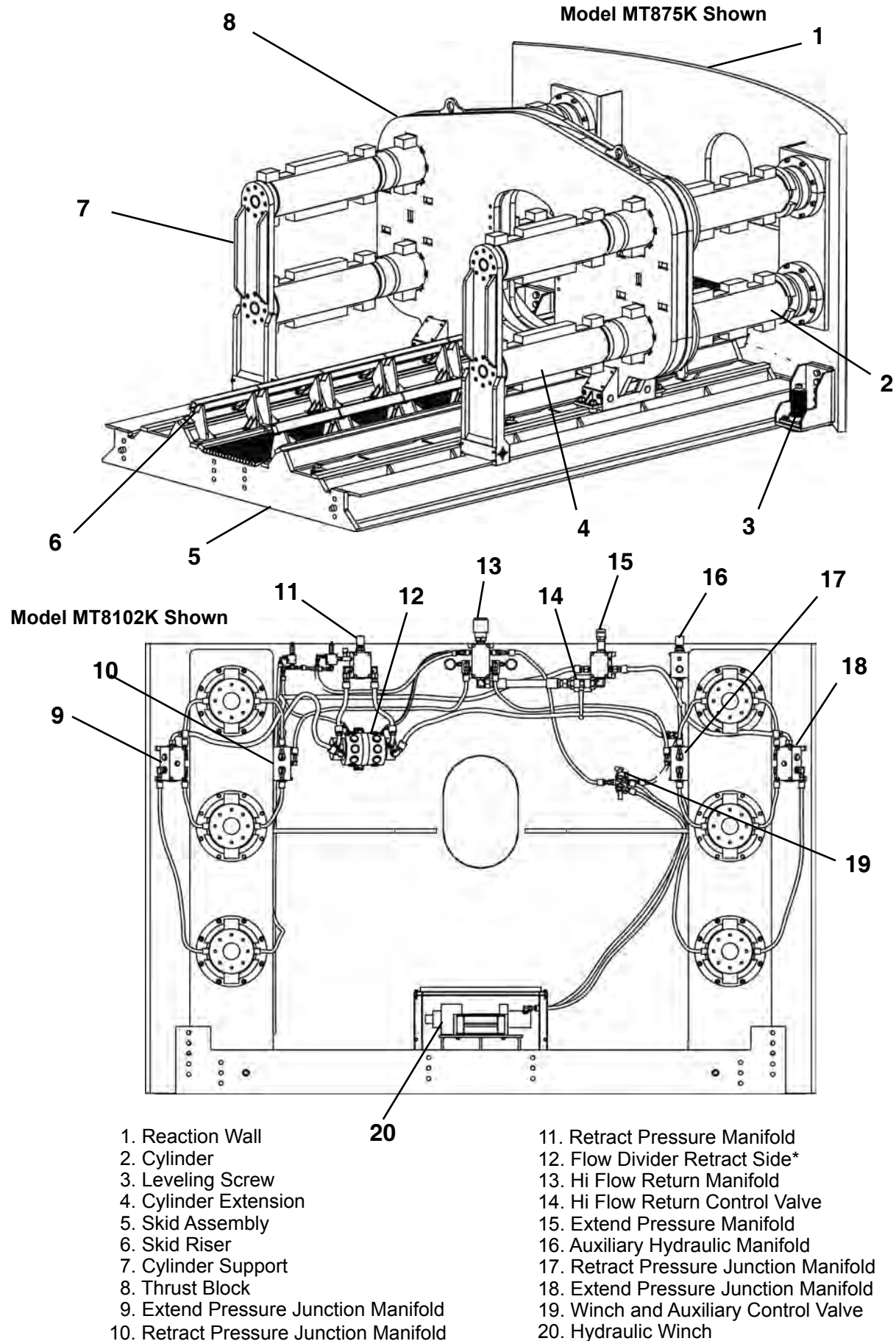
MTBM TRAILING DOLLY

The trailing dolly is used in place of the trailing section when the pipe ID is 48" or larger.

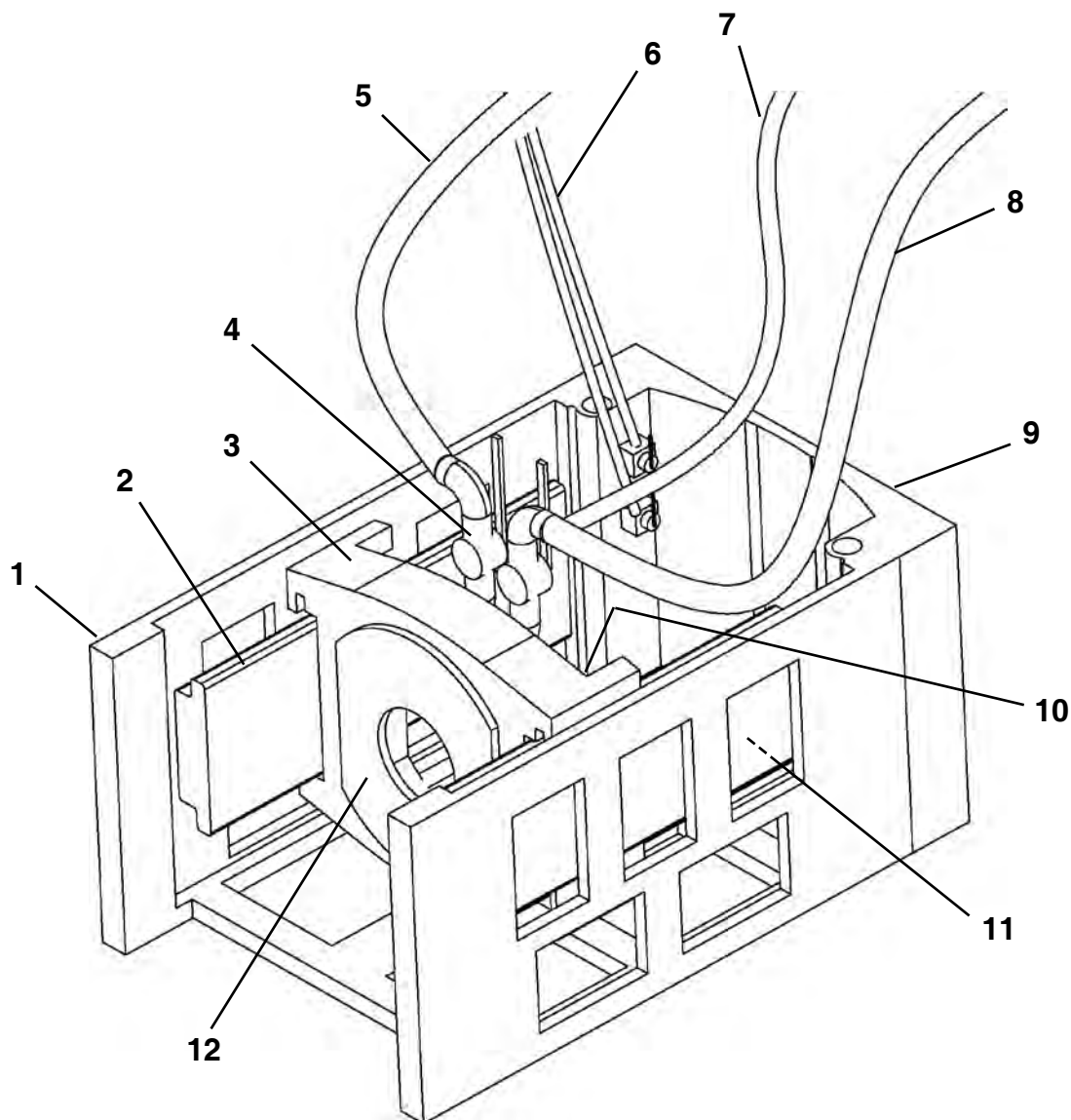


1. Camera
2. Speaker
3. Light
4. High Pressure Jetting/Cooling Pump Strainers
5. Slurry Supply
6. Slurry Return
7. Submersible Pump
8. Hydraulic Power Pack
9. Booster Pump
10. Hydraulic Power Pack Filter

KEYHOLE JACKING FRAMES



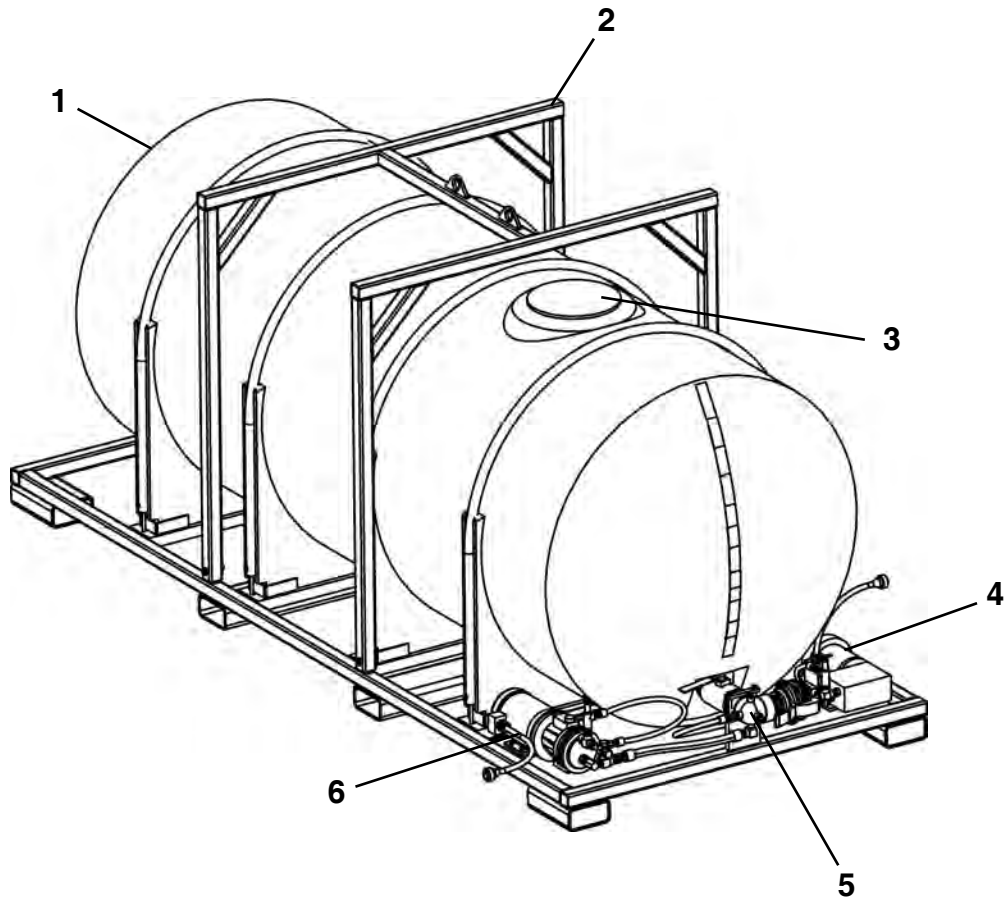
SLIDE THRUST JACKING FRAMES



- 1. Jacking Frame
- 2. Ram Extension Arm
- 3. Thrust Block
- 4. Slurry Pit Valves
- 5. Slurry Feed Line
- 6. Hydraulic Supply & Return Hoses
- 7. MTBM Cooling Water Line

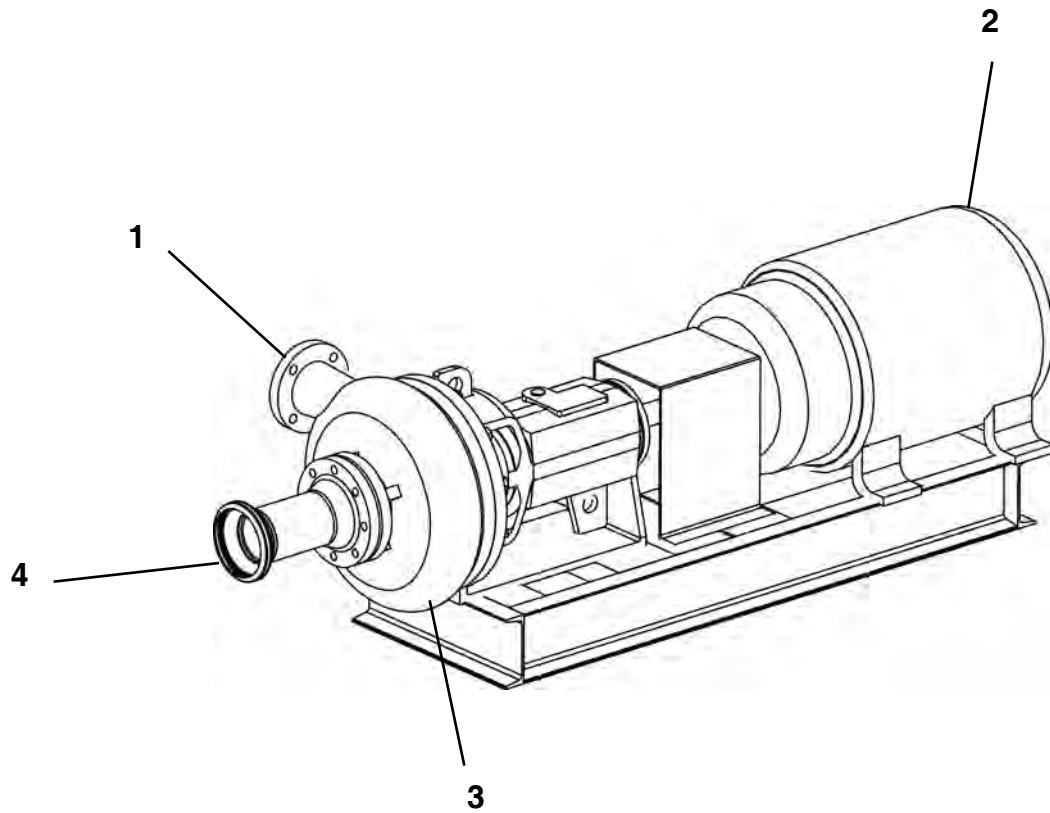
- 8. Slurry Return Line
- 9. Jacking Frame Back Stop
- 10. Dog Controls
- 11. Thrust Cylinders
- 12. Pipe Adapter

WATER COOLING TANK



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

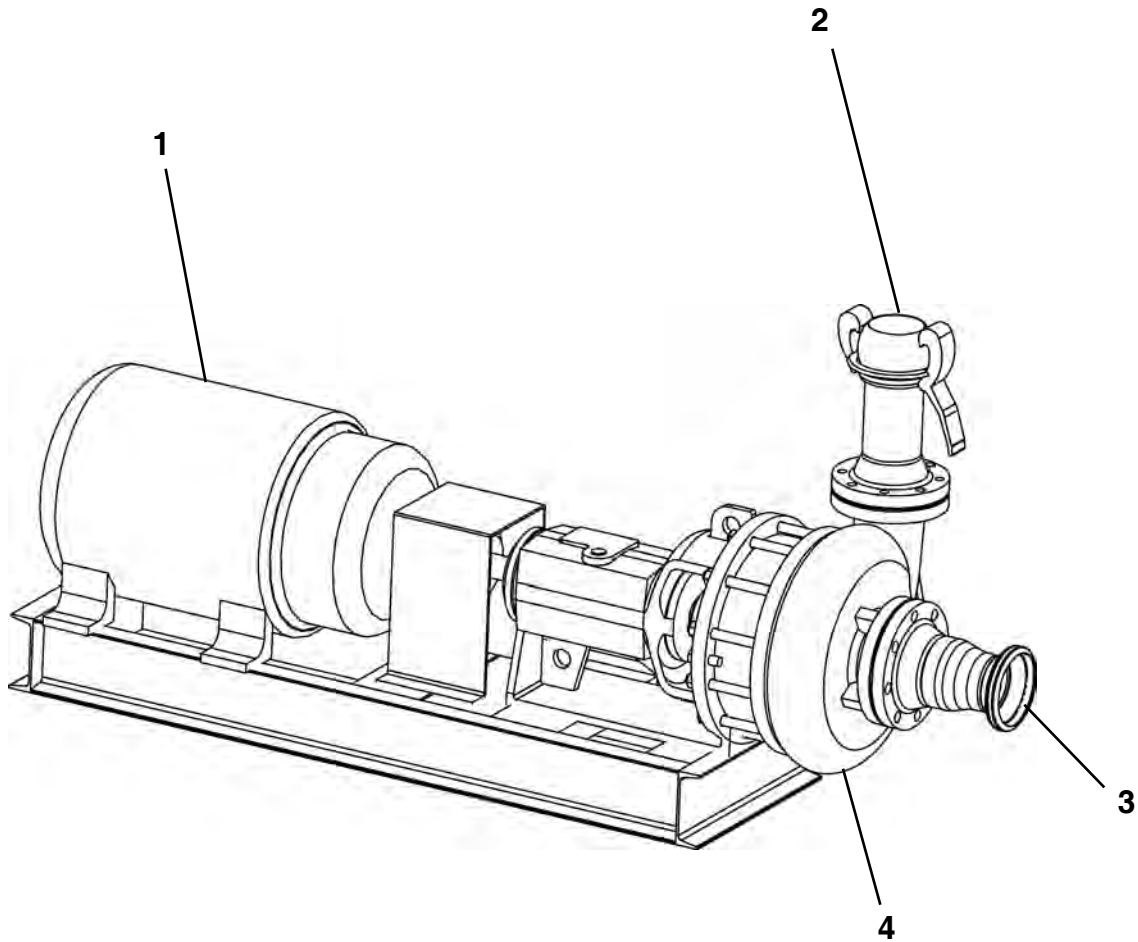
SLURRY FEED PUMP



1. Feed Line Outlet
2. Motor 50HP

3. Impeller Pump Assembly
4. Water Inlet Connection

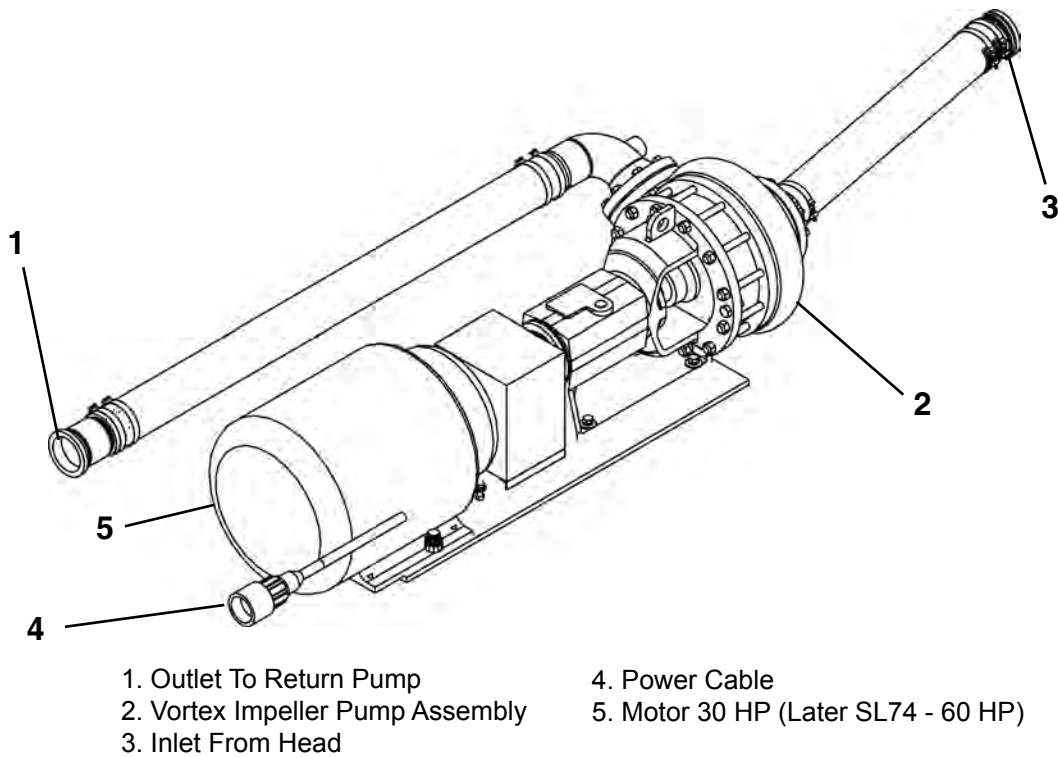
SLURRY RETURN PUMP



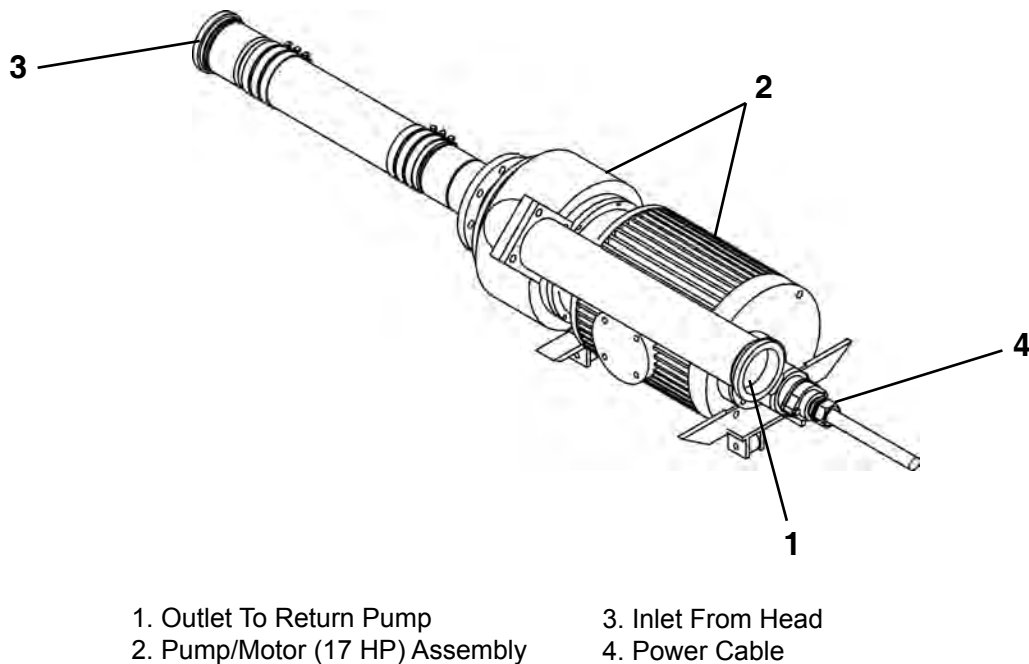
- 1. Motor 60 HP
- 2. Slurry Outlet To Tank

- 3. Slurry Line Inlet From Tunnel
- 4. Vortex Impeller Pump Assembly

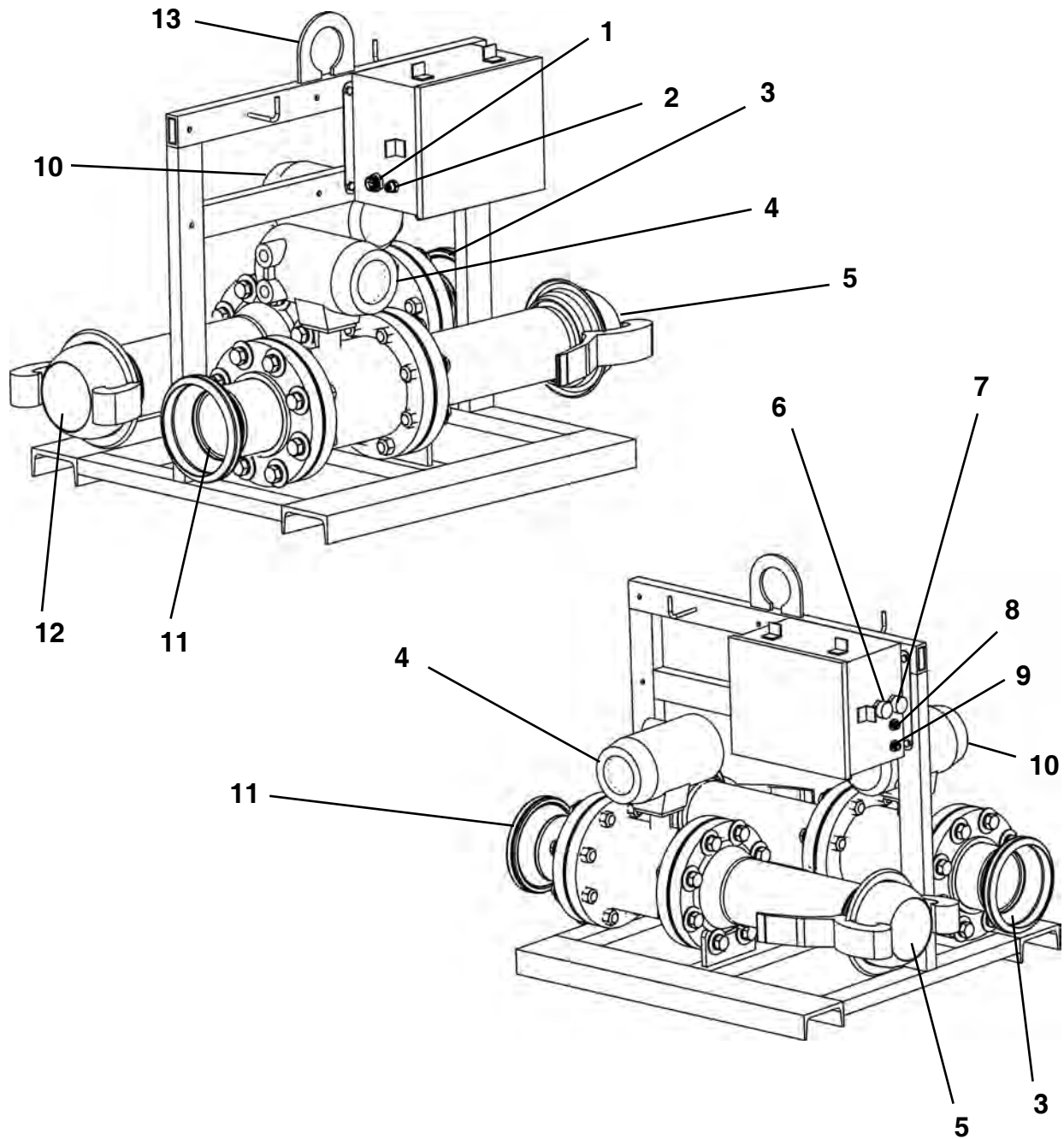
SLURRY BOOSTER PUMP (SL44 & ABOVE)



SLURRY BOOSTER PUMP (SL36 & BELOW)



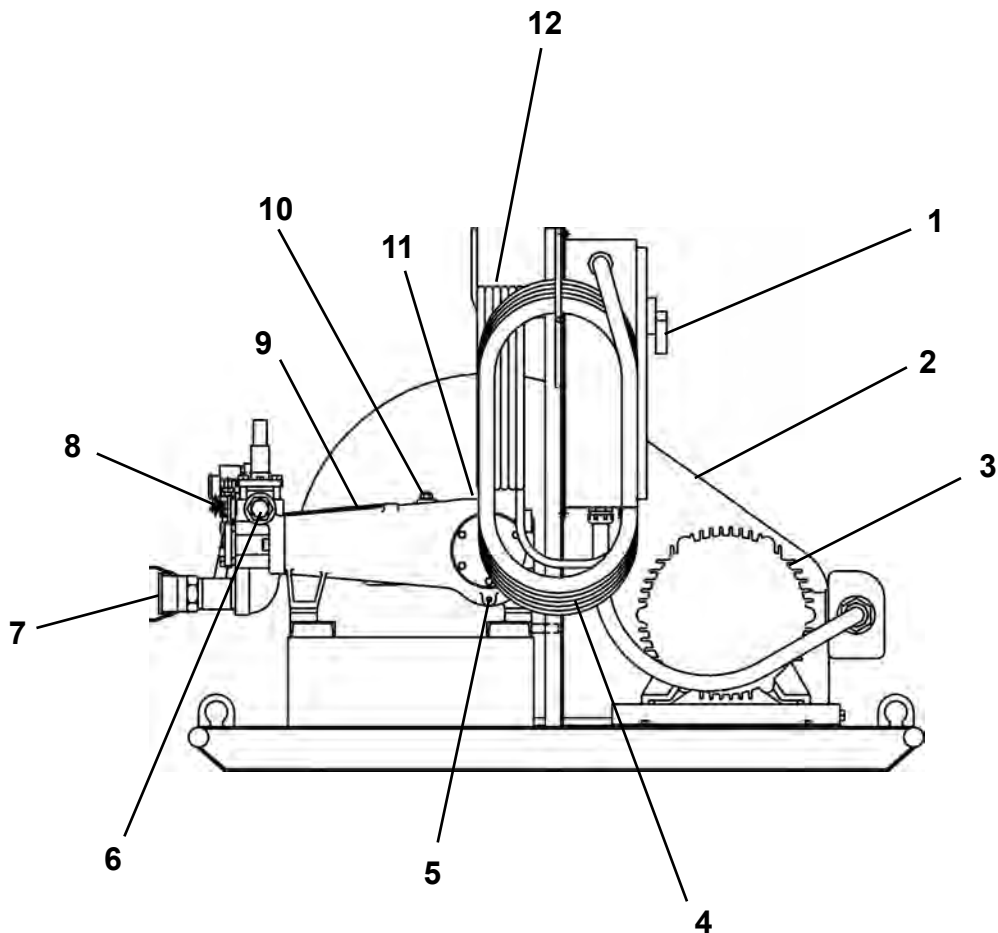
FLOWMETER



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

NOTES

Controls & Instruments

EMERGENCY STOP (E-STOP)

⚠ WARNING ALL Emergency Stop buttons **MUST** be operating properly **BEFORE** operating the microtunneling system. Failure to do so may cause severe injury or death.

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

CONTROL CONTAINER E-STOP (A)

Push IN Emergency Stop button (A) to stop all control container electrical bulkhead component functions.

Pull OUT E-Stop button to restart operation.



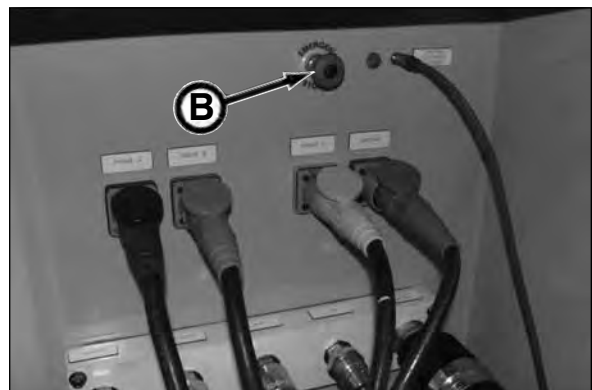
E-Stop on Control Container Console

REMOTE HYDRAULIC POWER PACK E-STOP (B)

Push IN Emergency Stop button (B) to stop all power pack electrical and hydraulic bulkhead components functions.

The E-Stop button will illuminate when it is pushed in.

Pull OUT E-Stop button to restart operation.



E-Stop on Remote Hydraulic Power Pack Bulkhead

PIT BOX E-STOP (C)

Push IN Emergency Stop button (C) to stop all jacking frame hydraulic component functions.

The E-Stop button will illuminate when it is pushed in.

Pull OUT E-Stop button to restart operation.



E-Stop on Pit Box

PHASE ERROR 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 severe 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.



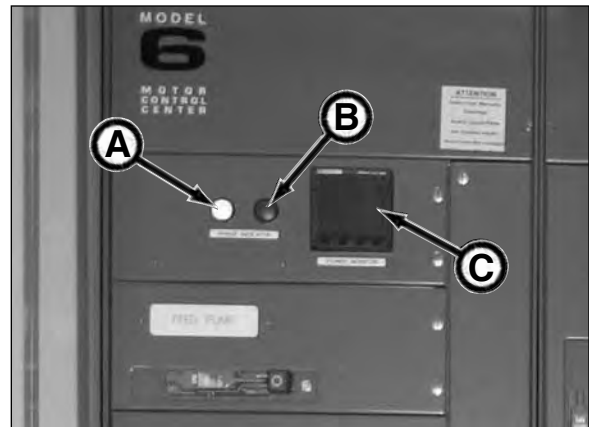
The input power on the control container and the remote hydraulic power pack is monitored for proper three phase electrical power. The control container and the remote hydraulic power pack have separate power hookups, therefore BOTH green Phase OK lights must be illuminated before operating equipment.

CONTROL CONTAINER

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

If the red phase 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 600 amps.

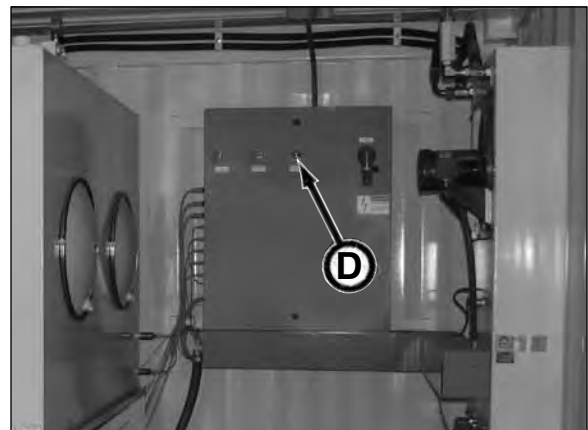


REMOTE HYDRAULIC POWER PACK

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.

NOTICE There is also a green Phase OK light located in the trailing section/trailing dolly



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

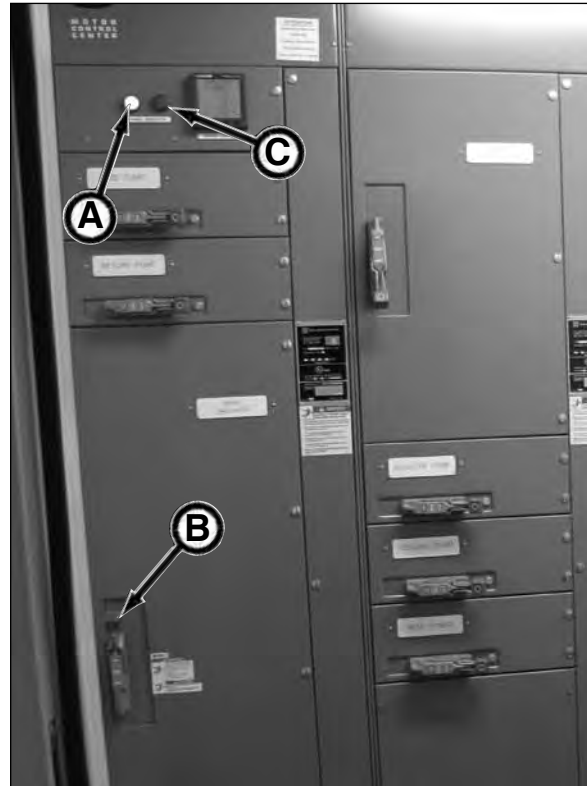
MAIN DISCONNECT (CONTROL CONTAINER)

⚠ 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 Tripped)

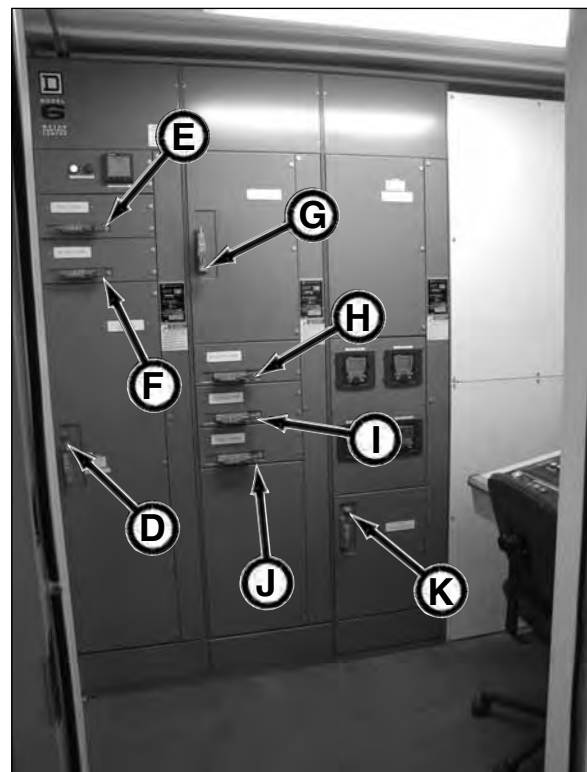


OPERATOR CONTROL DISCONNECTS (CONTROL CONTAINER)

⚠ 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 (J), 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
- H - Booster Pump Disconnect
- I - Cooling Pump Disconnect
- J - Head Power Disconnect
- 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.

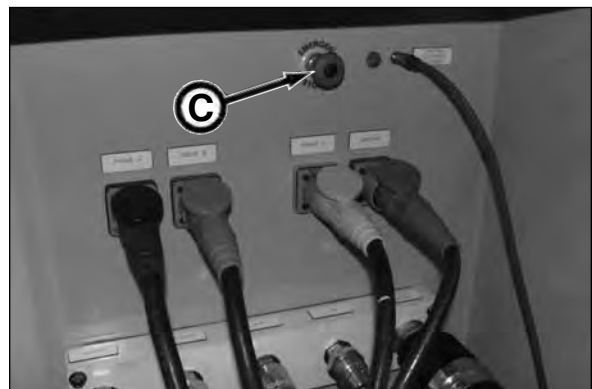
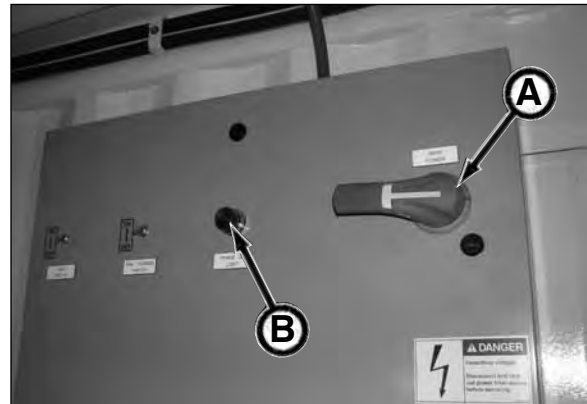
⚠ DANGER If high voltage cables or cable connections are damaged, contact with cables/connections may result in electrical shock causing severe injury or death. Disconnect and lock out/tag out power from source before servicing.

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

NOTICE The remote hydraulic power pack and pit box E-Stop buttons must 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. 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.
2. 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 reverse two of the generator power leads on power circuit.
3. With power in proper phase, pull out the remote hydraulic power pack E-Stop button (C) and the pit box E-Stop button (not shown).
4. Turn the main power switch to the ON position.

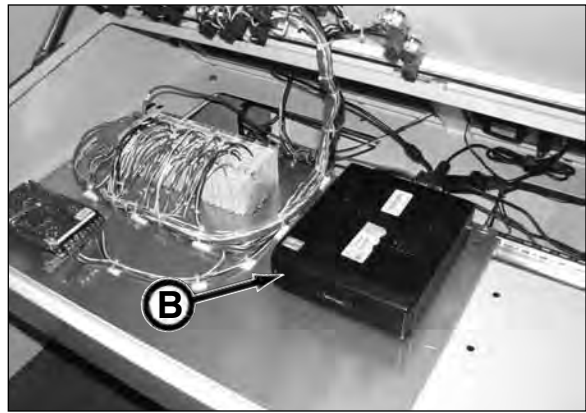


COMPUTER

Turn on the control container 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.



KEYBOARD & MOUSE CONTROLS

KEYBOARD

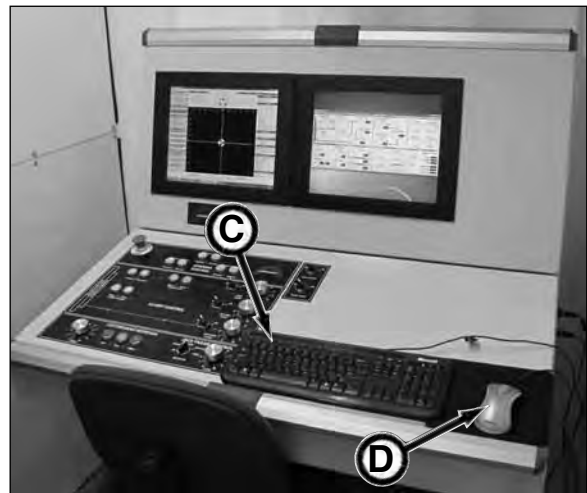
Use the keyboard (C) to enter data such as information for the report generator or for changing meter settings on the control screens.

MOUSE

The mouse (D) 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.

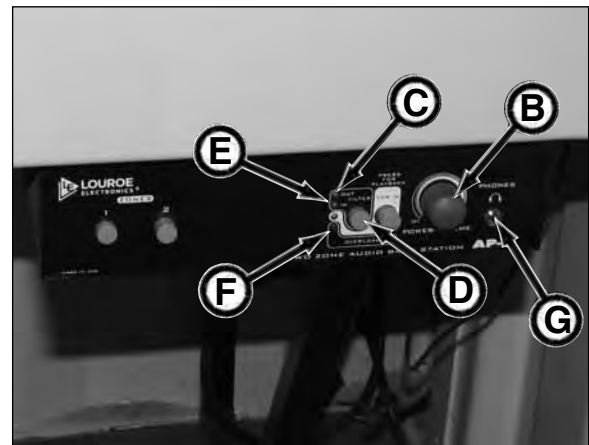
Turn on the power to the unit by rotating the Power-Volume knob (B) clockwise to ON position. The Filter-OUT green LED light (C) will illuminate (and when the audio filter is not in use). Rotate Power-Volume knob further clockwise to increase the volume of the monitored audio.

Push Filter switch (D) in to ON position. The orange LED light (E) will illuminate.

When a short or overcurrent in the power supply occurs, a red LED light (F) will illuminate. If this occurs, turn Power-Volume knob off and check wiring connections.

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

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.

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.

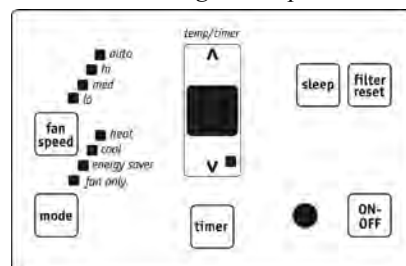
NOTICE

(FA21900F-05 & After)

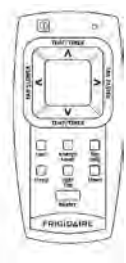
The AC/Heater unit is designed to be extended out for operating position or retracted for storage or transporting position. When repositioned, the unit **MUST** be secured with six 1/2 UNC x 1.25 flat socket head cap screws.



FA21900F-05 & After Shown in Storage/Transport Position



A/C Controls



*A/C Remote Control
0513 R0215*

LIGHTS

CONTROL CONTAINER

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

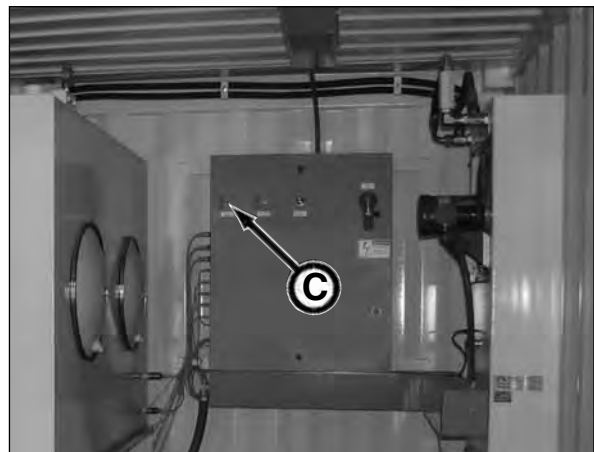


A light switch (B) is installed in the VFD area of the control container.



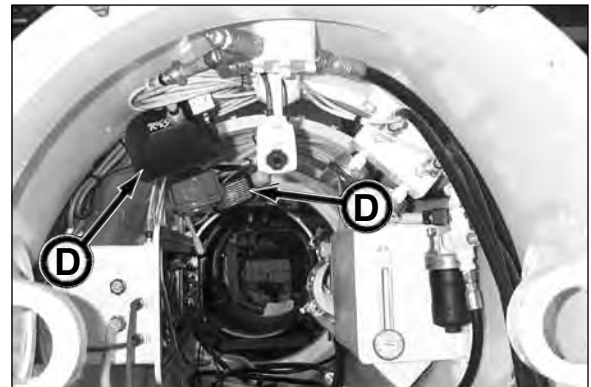
REMOTE HYDRAULIC POWER PACK

There is a light switch (C) for the power pack.



MTBM

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



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 Drive Motor
- 60 HP Slurry Feed Pump Motor
- 60 HP Slurry Booster Pump Motor
- 60 HP Slurry Return Pump Motor



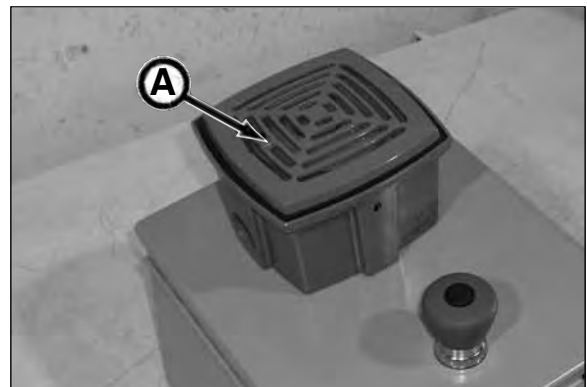
The VFD motor monitors in the operator station of the control container, display the drive, feed, booster and return motor torque and motor speed.



VFD Motor Monitors

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.



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.

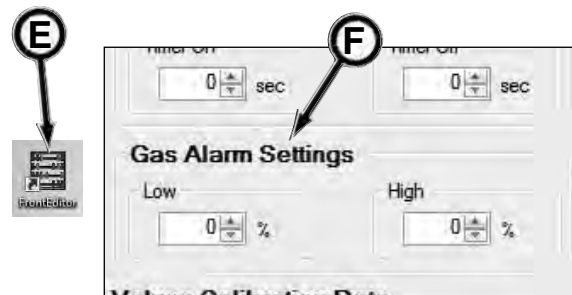
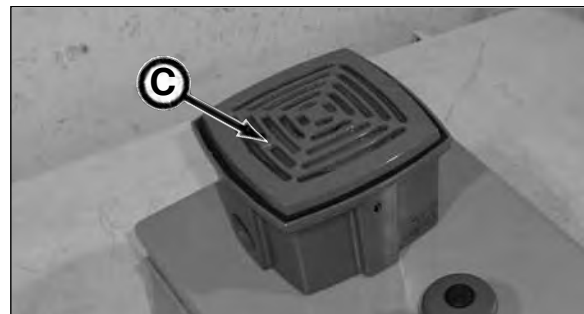
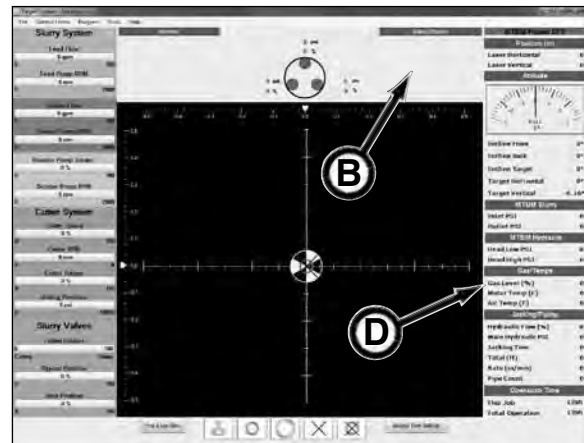
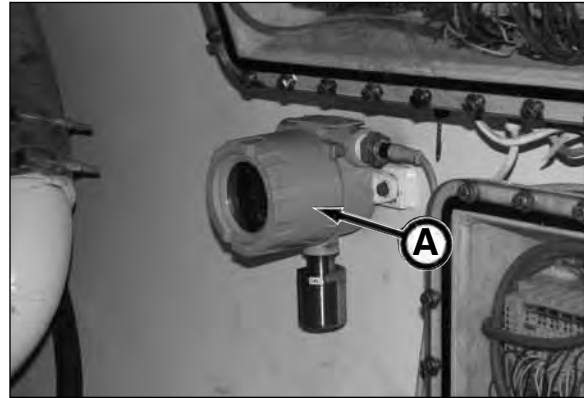
The gas detector is monitored by the control system as follows:

1. The "Gas Detector Fault" message will appear in the status/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 status/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.
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 FrontEditor 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.

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.



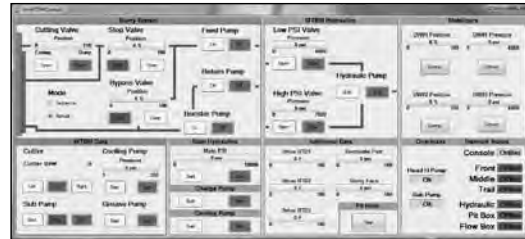
(continued on next page)



Machine Screen Program

The MTBM machine screen program shows all the slurry system, MTBM hydraulics, Jacking Hydraulics, stabilizer and network status controls.

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 Machine 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.

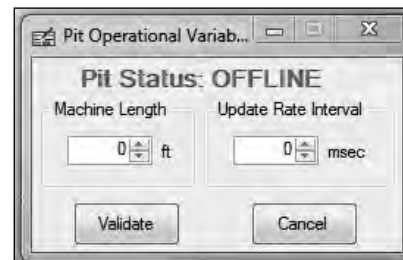
An optional pit or launch shaft video camera setup with monitor is available with two to four cameras. Contact your Akkerman Aftermarket Support representative for more information.



Pit Operational Variable Data Editor

This program editor provides the value to calculate the pipe advance rate.

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.

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.

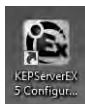
For more information, refer to section 6, Supplementary Editor Programs, Console Editor.



Report Generator

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

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



KEPServerEX5 Configuration

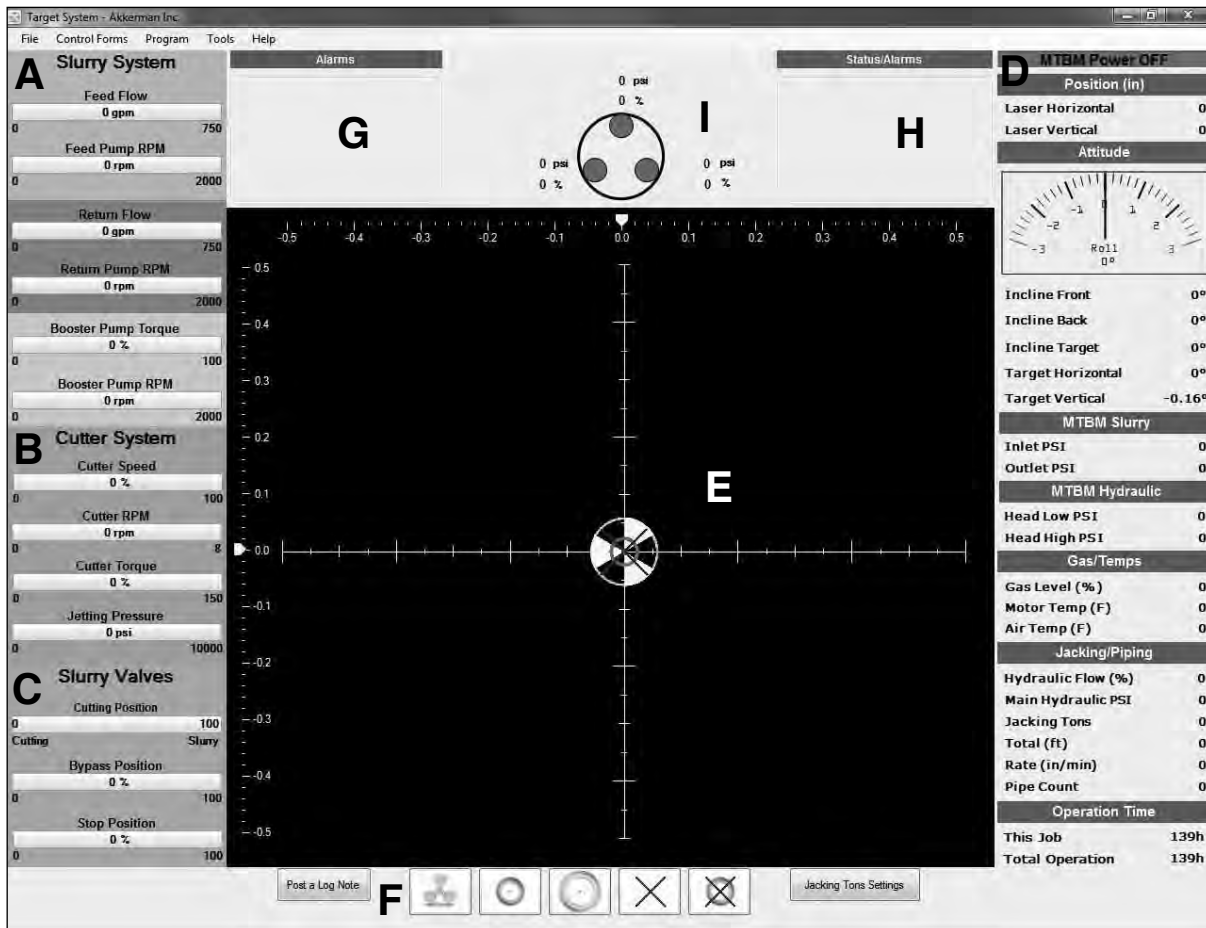
The KEPServerEX5 Configuration is a program (automatically loads and runs in the background when the Target screen is loaded) that communicates the MTBM input and output device component data to and from the operator in the control container via the Target screen and MTBM control screens.

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).

Variable	Device	Unit	Scale	Offset	Display
2-Aux Jack	Booster	psi	1.00	0.00	70-100 2 CH Analog
2-B Incline	Booster	psi	1.00	0.00	70-100 2 CH Analog
2-Booster RPM	Booster	RPM	1.00	0.00	70-100 2 CH Analog
2-Booster Torque	Booster	Torque	1.00	0.00	70-100 2 CH Analog
2-Bypass (%)	Booster	%	1.00	0.00	70-100 2 CH Analog
2-Cutter RPM	Booster	RPM	1.00	0.00	70-100 2 CH Analog
2-Cutter Torque	Booster	Torque	1.00	0.00	70-100 2 CH Analog
2-Extend Jack	Booster	psi	1.00	0.00	70-100 2 CH Analog
2-F Incline	Booster	psi	1.00	0.00	70-100 2 CH Analog
2-Feed Flow	Booster	gpm	1.00	0.00	70-100 2 CH Analog
2-Feed RPM	Booster	RPM	1.00	0.00	70-100 2 CH Analog
2-Gas level (%)	Booster	%	1.00	0.00	70-100 2 CH Analog
2-H Angle	Booster	deg	1.00	0.00	70-100 2 CH Analog
2-H Balance (psi)	Booster	psi	1.00	0.00	70-100 2 CH Analog
2-H Dev	Booster	psi	1.00	0.00	70-100 2 CH Analog
2-H Flow (%)	Booster	%	1.00	0.00	70-100 2 CH Analog
2-H psi	Booster	psi	1.00	0.00	70-100 2 CH Analog
2-US Jack	Booster	psi	1.00	0.00	70-100 2 CH Analog
2-Inlet psi	Booster	psi	1.00	0.00	70-100 2 CH Analog
2-Jack Tons	Booster	tons	1.00	0.00	70-100 2 CH Analog
2-Jet psi	Booster	psi	1.00	0.00	70-100 2 CH Analog
2-L Thrust (ton)	Booster	ton	1.00	0.00	70-100 2 CH Analog
2-LS (%)	Booster	%	1.00	0.00	70-100 2 CH Analog

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

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 with the exception of the visual roll in degrees graphic.

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 pull down the menu. 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.

Location (G) is the Alert Message field and location (H) is the Operational Message field.

The **alert messages** (Alarms) include the: Main Hydraulic E-Stop, Main Hydraulic Filter, Main Hydraulic - Low Oil Level, Main Hydraulic - Oil Overtemp, Machine Hydraulic Filter, and Machine Hydraulic Overload. The **operational messages** (Status/Alarms) include the: Sub Pump On, Sub Pump Overload, Grease Pump On, Out of Grease, Gas Level High, and Gas Detector Fault.

The Steering Cylinder indicator (I) displays the MTBM steering cylinder stroke position in percent and pressure in PSI for the top, left, and right cylinders. 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 power to the MTBM, either on or off.

POSITION (IN)

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

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 setting meter (refer to Roll Setting graphic below), click the roll graphic and change the degree setting and update rate (milliseconds) and press Set button. If the degree setting parameters are exceeded, the main drive motor (rotation) and main hydraulic pump (jacking) will be shut down.

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.

MTBM SLURRY

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

MTBM HYDRAULIC

Head Low PSI displays the head low pressure valve oil pressure.

Head High PSI displays the head high pressure valve oil pressure.

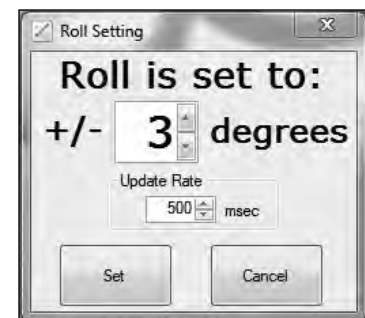
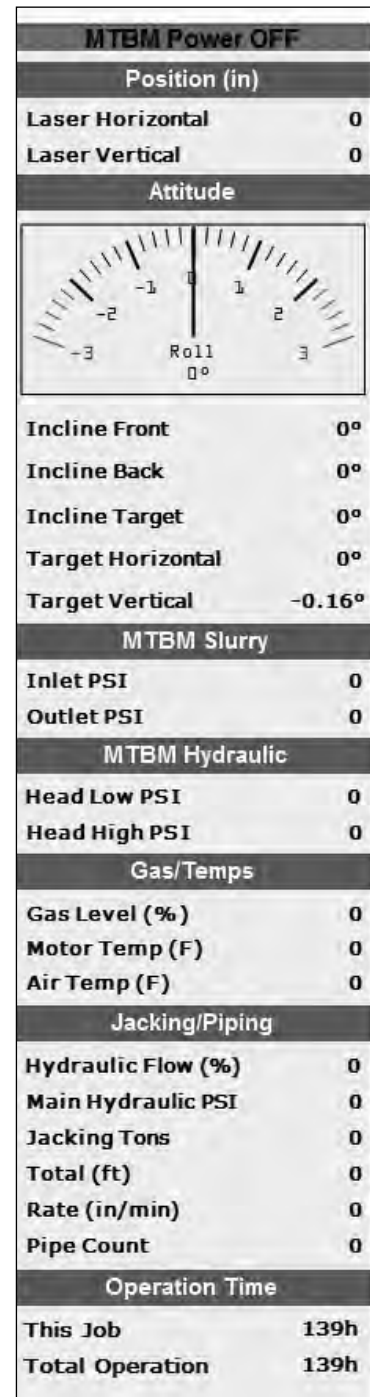
GAS/TEMPS

Gas Level (%) displays the % of LEL (Lower Explosive Limit) gas concentration in the front or trailing section (depending on model).

Motor Temp (F) displays the internal temperature (fahrenheit) of the cutter bit drive motor.

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

(continued on next page)



Roll Setting Meter

JACKING/PIPING

Hydraulic Flow (%) displays the main jacking hydraulic pump flow rate.

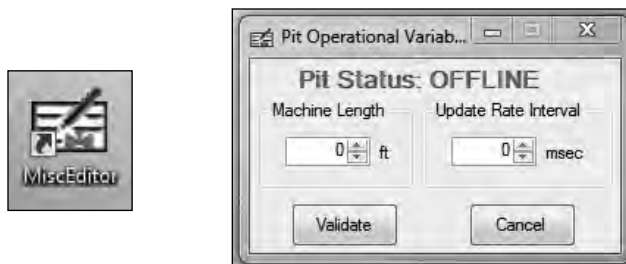
Main Hydraulic PSI displays the extension pressure of the main jacking cylinders.

Jack Tons displays the calculated tons of thrust that is being applied to the pipe by the jacking frame.

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

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

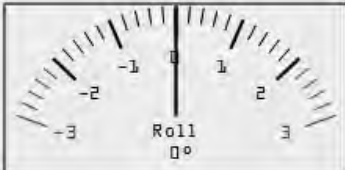
Pipe Count displays the number of pipe that have been installed. To ensure an accurate pipe count, the machine length must be updated in the MiscEditor program as shown below.



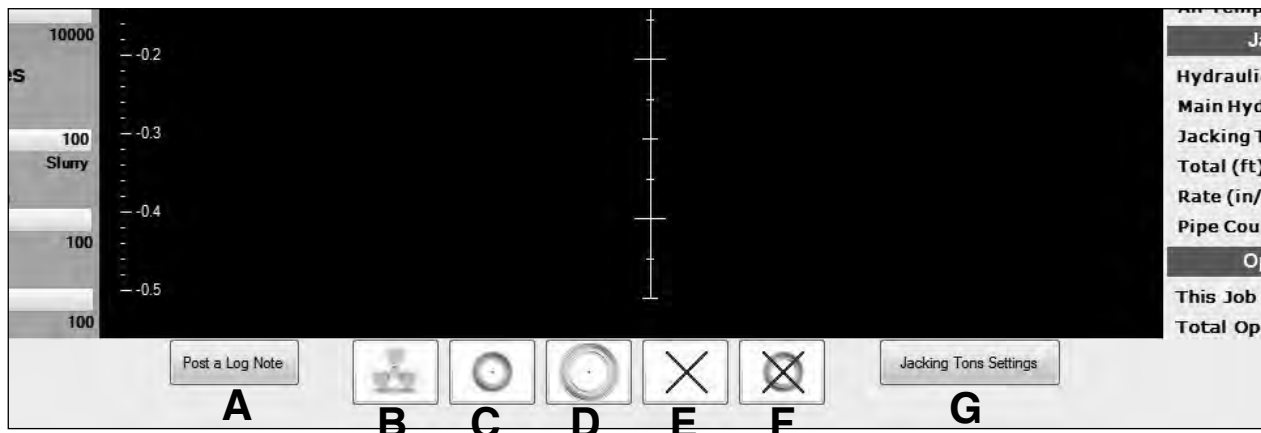
OPERATION TIME

This Job displays the total job time in hours.

Total Operation displays the total number of computer hours used.

MTBM Power OFF	
Position (in)	
Laser Horizontal	0
Laser Vertical	0
Attitude	
	
Incline Front	0°
Incline Back	0°
Incline Target	0°
Target Horizontal	0°
Target Vertical	-0.16°
MTBM Slurry	
Inlet PSI	0
Outlet PSI	0
MTBM Hydraulic	
Head Low PSI	0
Head High PSI	0
Gas/Temps	
Gas Level (%)	0
Motor Temp (F)	0
Air Temp (F)	0
Jacking/Piping	
Hydraulic Flow (%)	0
Main Hydraulic PSI	0
Jacking Tons	0
Total (ft)	0
Rate (in/min)	0
Pipe Count	0
Operation Time	
This Job	139h
Total Operation	139h

(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 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)

Jacking Tons Settings (G)

The jacking cylinder diameter and number of cylinders value fields 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 (G).

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.

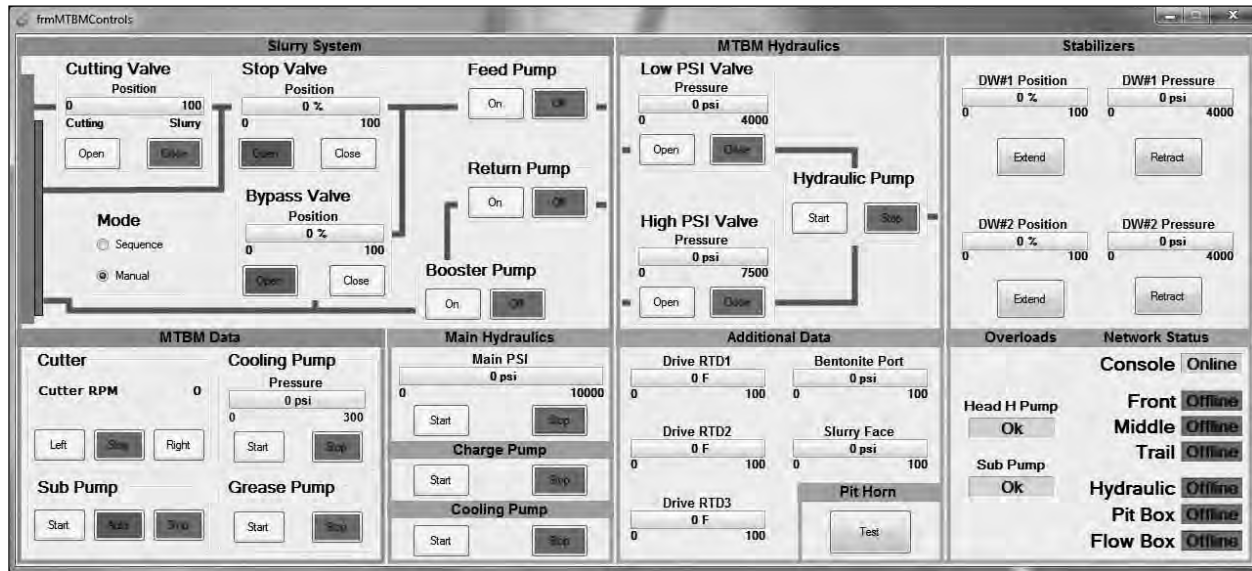
NUMBER OF CYLINDERS

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.

The screenshot shows a dialog box titled "Jacking Settings". It has two main sections: "Cylinder Diameter" and "Number of Cylinders". Each section has a numeric input field with up and down arrows. The "Cylinder Diameter" field shows "0" and "inch". The "Number of Cylinders" field shows "0". At the bottom of the dialog are two buttons: "Set" and "Cancel".

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 console.

SLURRY SYSTEMS

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.

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.

Stop Valve: open or close the slurry stop valve. The stop valve is 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 valve is controlled by either pressing the buttons on the control screen or the stop valve Open and Close buttons on the console in the control container.

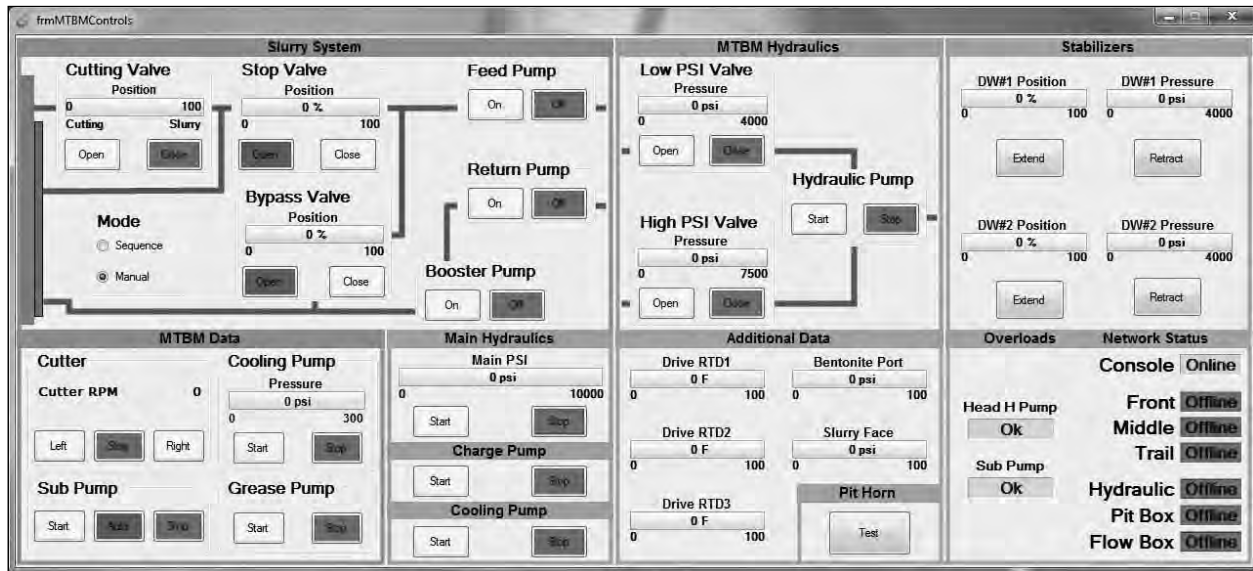
Bypass Valve: open or close the slurry bypass valve. In sequence mode the bypass valve will either be fully open or fully closed. The Position will display the valve position in percent; 0% (closed) or 100% (open). In manual mode the valve position can be varied depending on operator. The Position will 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

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. Also, on MTBMs with gear box oil recirculating pump, the pump will operate with the Head Power switch control.

Hydraulic Pump: controls the start and stop of the MTBM hydraulic pump in the middle, dolly or trailing section (location of pump depends on MTBM model). 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.

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.

MTBM DATA

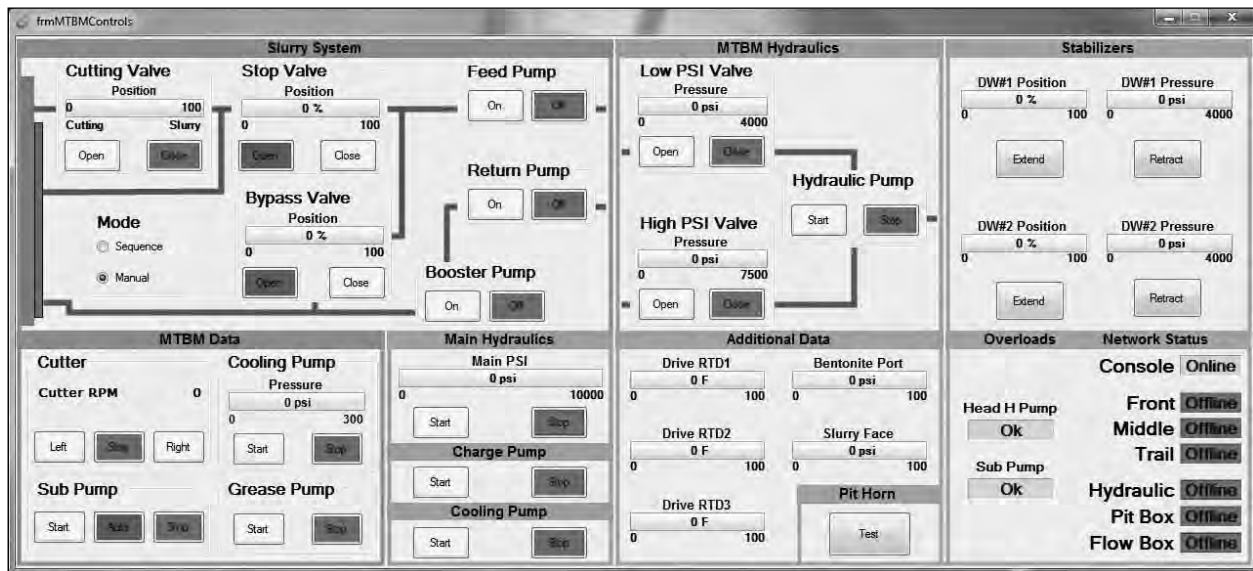
Cooling Pump: controls the start and stop of the MTBM cooling pump. The head cooling pump automatically starts when the cutter head is rotating. The Pressure displays cooling hydraulic pump pressure. The cooling pump draws clean water from the MTBM water cooling tank. This water is pumped through a valve on the jacking frame and through the tunnel into the water strainer and then through the water jacket surrounding the electric drive motor. Heated water is then expelled past the front lip seals into the cutterhead face where it mixes in with the spoils and slurry water. On larger MTBMs, the water will go through the heat exchanger on the oil recirculating pump, then into the cutterhead face.

Grease Pump: turns the grease pump on or off. The grease pump works automatically when the drive motor (cutter head rotation) is running. The grease pump will cycle on for 10 seconds, then off for 50 seconds. When the grease pump is refilled, start the grease pump manually to purge air from the grease lines. Stop the pump when grease comes out the lip seal. The "Grease Pump" message will display in the operational message area of the target screen. The grease pump lubricates the bearing cavity lip seals.

Submersion Pump: controls the start, auto, and stop modes of the submersion pump located in the middle, dolly or 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 MTBM. The "Submersion Pump" message will display in the operational message area of the target screen (when it is in operation). The Auto mode is the default position.

Cutter: the cutter RPM is displayed along with 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.

(continued on next page)



MAIN HYDRAULICS (Jacking Functions)

Main Hydraulic 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.

(SN FA21945F) The oil cooler recirculating pump will automatically start only when the oil temperature reaches 120°F (which will shut down the main hydraulic pump).

(SN FA21965F) The oil cooler recirculating pump will automatically start when the main hydraulic pump is started. If the oil temperature reaches 120°F the main hydraulic pump will automatically shut down.

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.

STABILIZERS

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 Pressure, DW#2 Pressure displays the dirt wing cylinder pressure.

ADDITIONAL DATA

Drive RTD1, RTD2, RTD3 indicates the internal temperature of the main drive motor.

Bentonite Port indicates the pressure transducer reading at the outlet pressure of the bentonite port.

Slurry Face indicates the pressure reading at the slurry pressure transducer outlet pressure.

Pit Horn allows the testing of the pit horn operation in the launch shaft.

OVERLOADS

The overload indicators for the **Head H (hydraulic) 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 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.

NETWORK STATUS

The network status window indicates when the boring head (front, middle, and trailing), hydraulic power pack, pit box and flow meter box are Online (green) or Offline (red) with the control container communication controls.

SLURRY CONTROLS

The slurry controls regulate the fluid slurry using the feed, booster 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 and return pumps in the order listed below to prevent excessive fluid pressure on pump components:

START: Booster - Return - Feed

STOP: Feed - Return - Booster

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.

CUTTING NOZZLE

The cutting nozzle buttons (E) 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

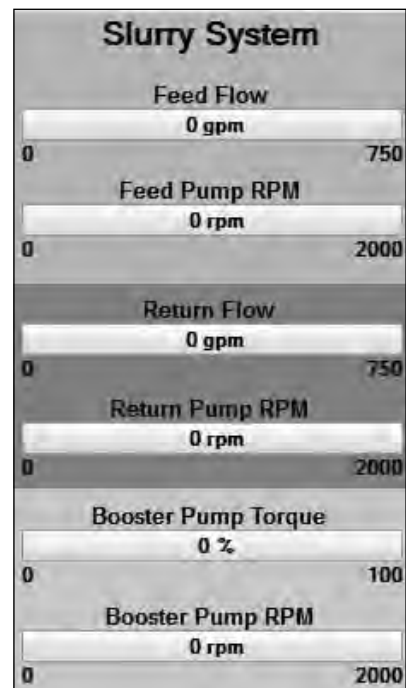
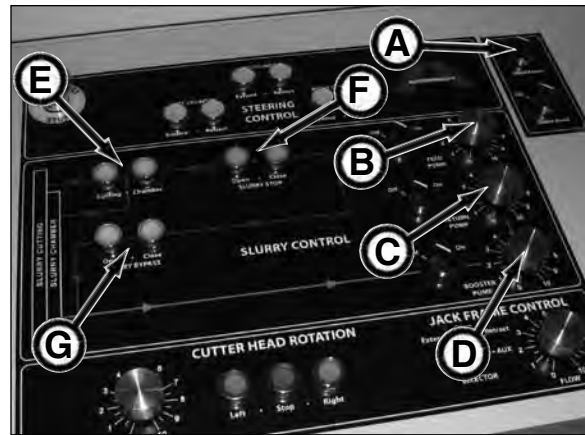
The slurry stop buttons (F) will open or close slurry flow to the slurry chamber and cutting face. In sequence mode, the stop valve and bypass valve work in opposite positions.

SLURRY BYPASS

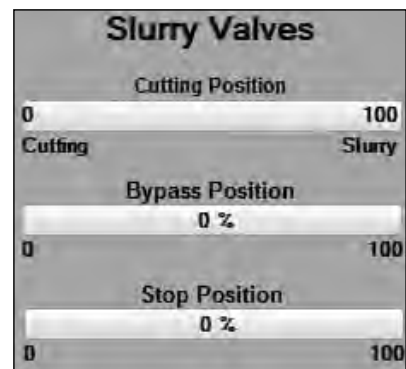
The slurry bypass buttons (G) open or close the bypass valve that directs slurry flow from the feed line to the return line without entering the MTBM. In sequence mode, the bypass valve and stop valve work in opposite positions.

NOTICE

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



Feed, Return, & Booster Pump Meters On Target Screen

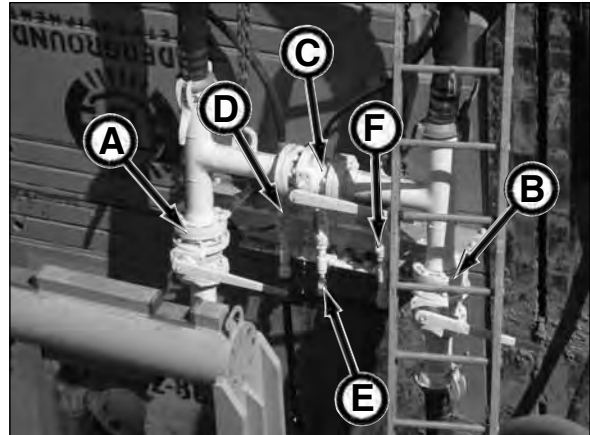


Cutting Nozzle, Slurry Stop, & Slurry Bypass Meters On Target Screen

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.



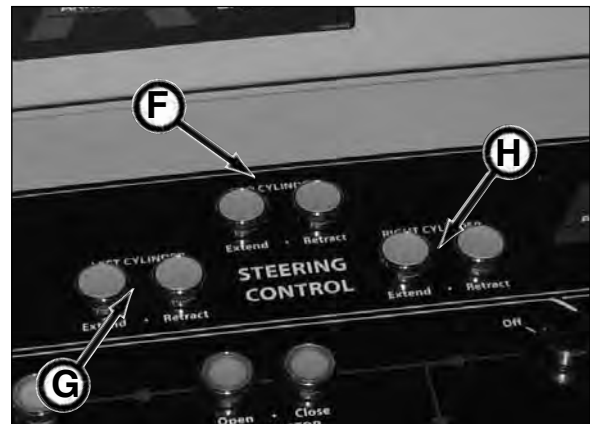
- A - Slurry Return Shutoff
- B - Slurry Feed Shutoff
- C - Slurry Bypass Valve Shutoff
- D - High Pressure Jetting Shutoff
- E - Main Cooling Pump Water Supply Shutoff
- F - Bentonite Supply Shutoff

STEERING CONTROLS

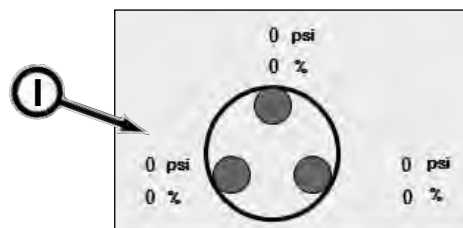
The steering controls regulate the three steering cylinders in the MTBM.

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 (I) on the target screen.

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

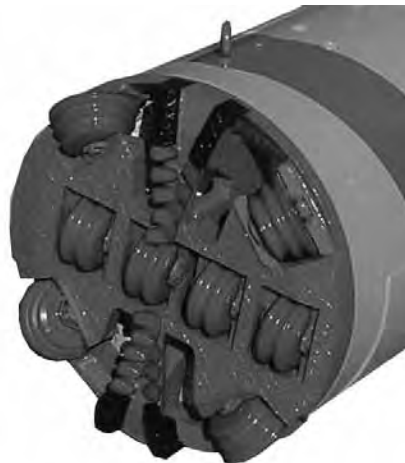


The operator can monitor the cylinder position in percent and pressure at the cylinder with the steering cylinder indicator on the target screen.



CUTTING HEAD CONTROLS

The cutting head controls regulate the speed 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

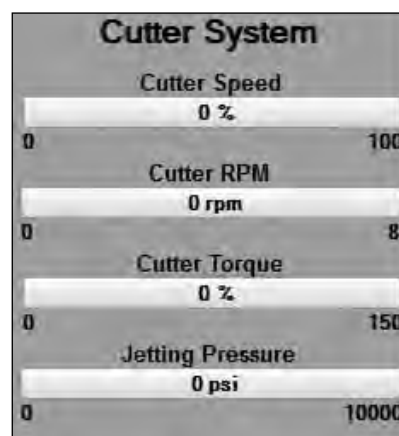
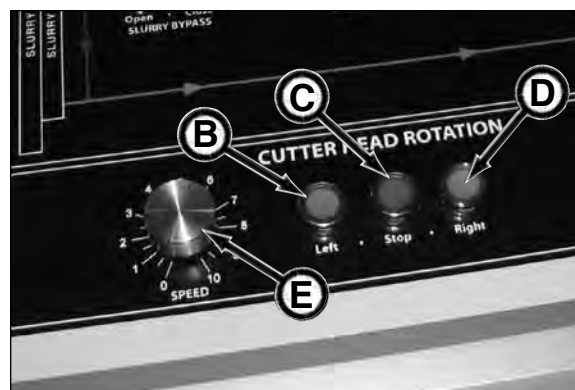
The right button (D) starts turning the MTBM drive motor CW (as viewed from launch shaft) and automatically starts the drive motor cooling pump. The right button will light when the drive motor starts the CW rotation.

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).

JETTING PRESSURE

If the high pressure jetting pump is connected to the jetting control power connection (if equipped) on the control container bulkhead, the pump will operate when the MTBM cutterhead rotates, along with the main drive motor cooling pump. The pressure is monitored as it enters the MTBM starting section manifold.



*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 hydraulic Start button (A) on the 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).

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.

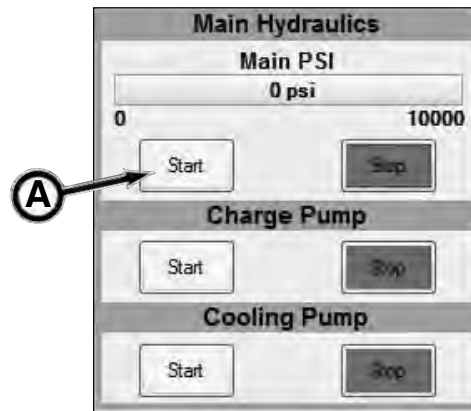
IJS

Provides hydraulic flow to the intermediate jacking station cylinders.

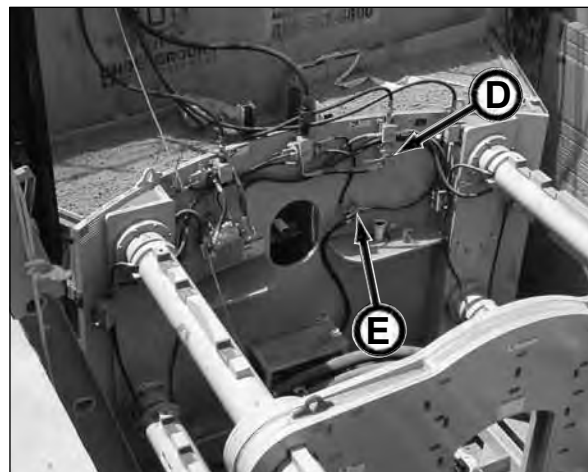
AUX

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.



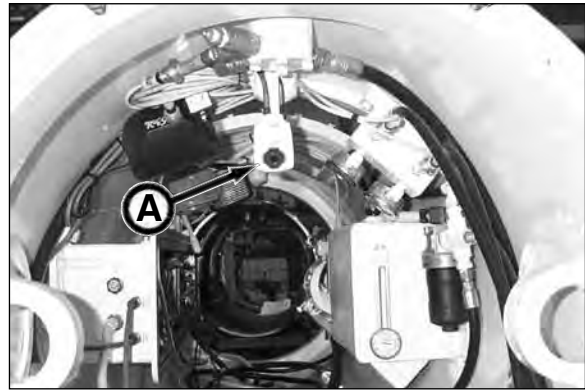
*Main Hydraulic Start Up
On MTBM Control Screen*



MT8102K Jacking Frame Shown

MTBM CAMERA

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



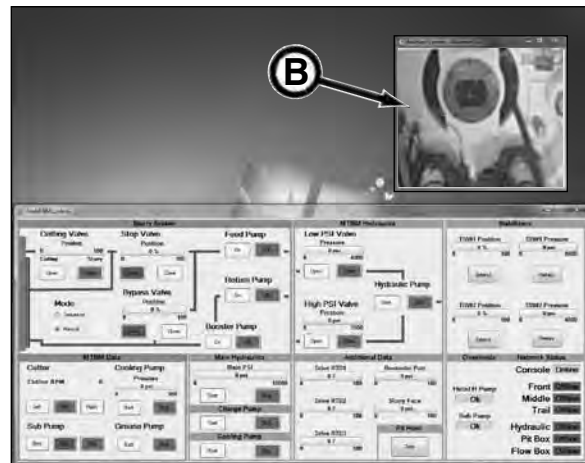
MTBM Target Camera (A)

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.



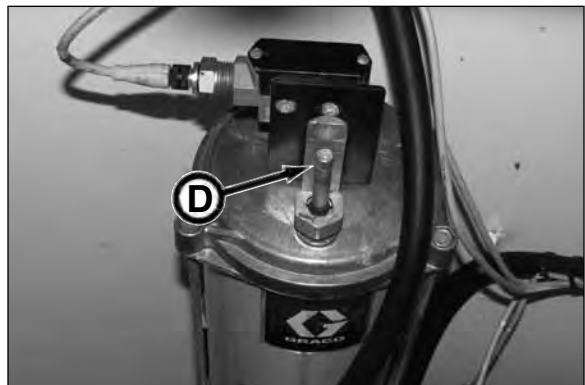
GREASE PUMP LEVEL INDICATOR

The grease pump is equipped with a grease level indicator (D).

If the "Out Of Grease" alarm message appears on the target screen, immediately fill the grease pump reservoir with Mobil® SHC 101 EAL Grease or equivalent through the grease pump fill port (on MTBM bulkhead) or grease line (depending upon model) until the indicator reaches the full mark.

NOTICE

The grease pump location:
MTBM 44 and larger - front section
Smaller MTBMs - trailing section

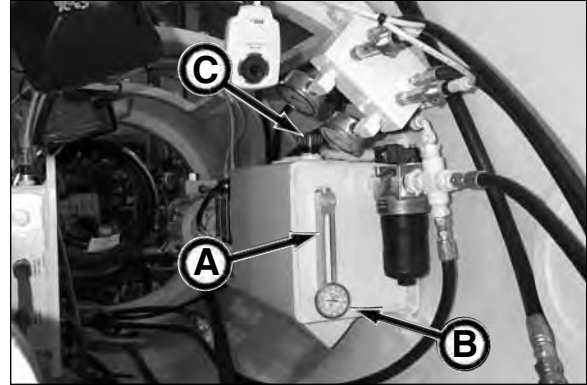


MTBM HYDRAULIC POWER PACK OIL RESERVOIR

The hydraulic reservoir in the MTBM dolly or trailing section (depending on the MTBM model) includes an oil level sight gauge (A) and temperature gauge (B).

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

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

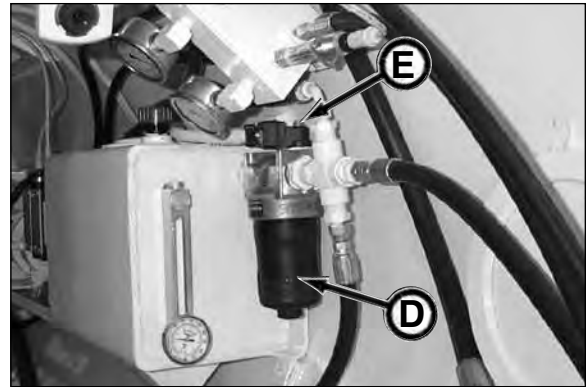


MTBM HYDRAULIC POWER PACK RETURN FILTER INDICATOR

To prevent under or over servicing of the MTBM 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.

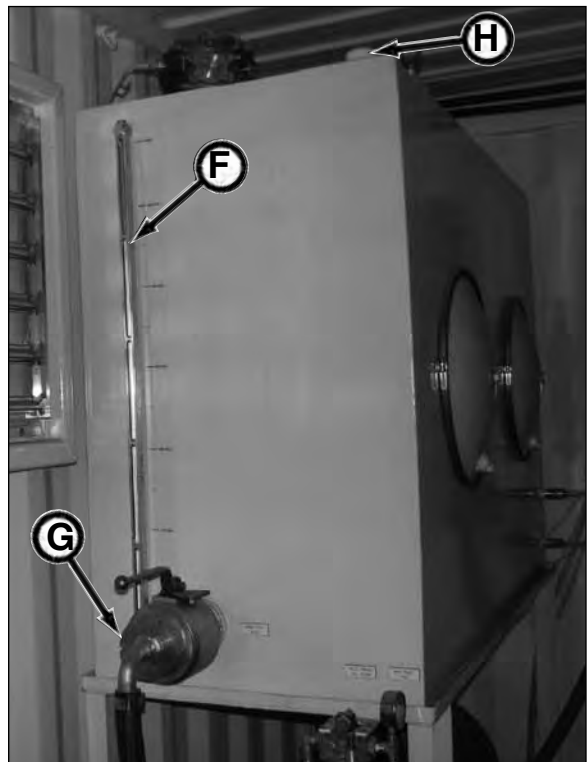


HYDRAULIC POWER PACK OIL RESERVOIR

The hydraulic reservoir in the remote hydraulic power pack includes an oil level sight gauge (F) and temperature gauge (G).

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

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



Reservoir From Power Pack (SN FA21945F) Shown

RETURN FILTER INDICATORS

There are two hydraulic return filters; the jacking frame return and hi flow return filters. There are also two different filter styles based on power pack serial number as noted below:

1. Power Pack SN FA21945F

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 (A) and hi-flow return filter (B).

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

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

If the white indicator is in the no element red zone (F) or bypass red zone (G), 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.

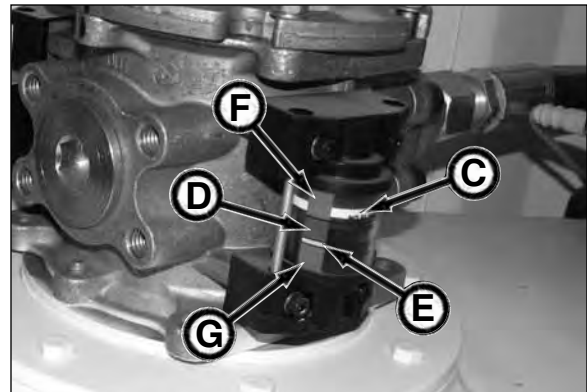
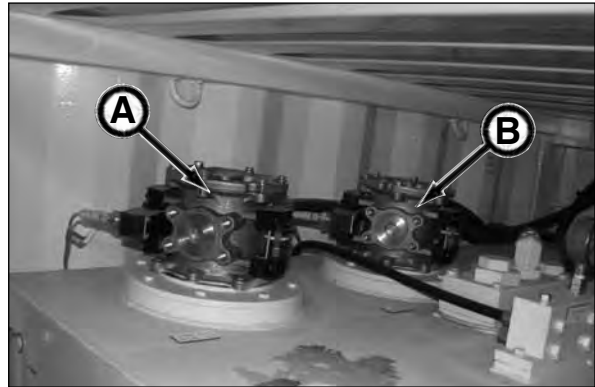
2. Power Pack SN FA21965F

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 (H) and hi-flow return filter (I).

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

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

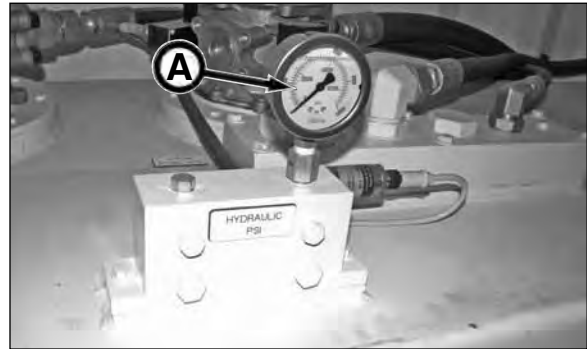
When the needle on the gauge is in the red CHANGE zone, replace filter as soon as possible to prevent hydraulic component damage (refer to section 9, Periodic Maintenance, Maintenance Charts - Remote Hydraulic Power Pack for proper filter replacement).



HYDRAULIC PRESSURE GAUGE

A hydraulic pressure gauge (A) is equipped in the remote hydraulic power pack to display the jacking frame hydraulic jacking pressure.

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



Power Pack SN FA21945F Shown

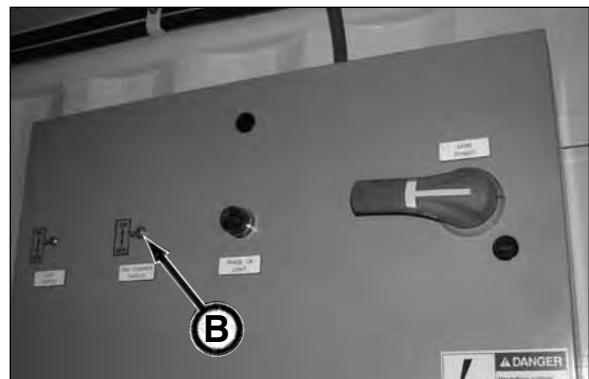


Power Pack SN FA21965F Shown

FAN OVERRIDE SWITCH

The remote hydraulic power pack is equipped with a fan override switch (B).

The fan will start continuously unless it is shut off with switch.



PILOT PRESSURE OIL FILTER

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.



RPA PILOT PRESSURE GAUGE

The hydraulic pressure gauge (B) 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.

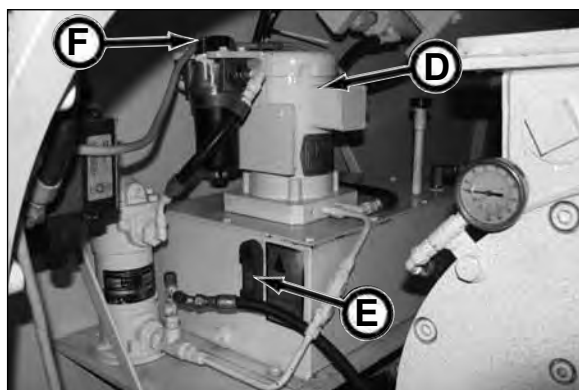


MTBM DRIVE GEAR BOX OIL LEVEL AND FILTER INDICATOR

The MTBM 60 and larger are equipped with an oil recirculating pump (D) to lubricate the gear box. There is a sight gauge (E) on the oil reservoir in the MTBM front section and a filter indicator (F) on the circuit.

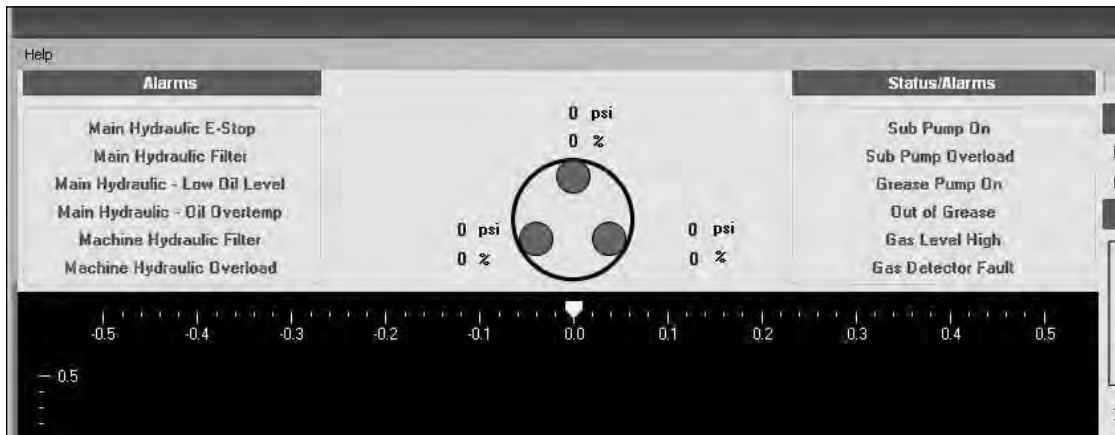
If the filter indicator is green, the filter is functioning properly.

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



ALARM/STATUS MESSAGES

The target screen displays alarm or status messages (in red) when certain occurrences take place or an error(s) is detected.



Main Hydraulic E-Stop: displays when the E-Stop on the remote hydraulic power pack or pit box is pushed in.

Main Hydraulic Filter: displays when the remote hydraulic power pack manifold (jacking frame extend, retract, auxiliary and IJS) return filter or the hi-flow return filter indicates that the filter is plugged and requires filter replacement. Check filter indicators on top of reservoir in remote hydraulic power pack.

Main Hydraulic - Low Oil Level: displays when the remote hydraulic power pack reservoir oil level is low and should be filled with fresh, clean oil. The hydraulics in the remote hydraulic power pack will shut down.

Main Hydraulic - Oil Overtemp: displays 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 oil temp reaches 120°F (49°C).

Machine Hydraulic Filter: displays when the MTBM head oil reservoir filter requires replacement.

Machine Hydraulic Overload: displays when the 2 HP hydraulic power pack motor draws excessive current and causes an overload. This overload resets automatically.

Sub Pump On: displays when the submersible pump is operating.

Sub Pump Overload: displays when the submersible pump draws excessive current and causes an overload. This overload resets automatically.

Grease Pump On: displays when the grease pump is operating; lubricating the bearing cavity lip seals.

Out of Grease: displays when the grease pump is out of grease. Immediately stop grease pump and fill with grease to lubricate the bearing cavity lip seals.

Gas Level High: displays when the gas detector detects a gas level reading of 10% LEL (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.

NOTICE

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

Gas Detector Fault: displays 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.

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, MTBM, main hydraulic power pack, and the pit box component operation.

Target Log Messages:

- Laser overload
- No laser power
- Calibration table overload
- Data overflow
- Low laser power
- Slow scan
- Doc signal fault

MTBM Function Log Messages:

- Head hyd pump not connected to network
- High PSI valve not connected to network
- Low PSI valve not connected to network
- Grease pump not connected to network
- Stop valve not connected to network
- Bypass valve not connected to network
- Cutter valve not connected to network
- Stabilizer not connected to network
- Head cooling pump contactor did not open/close

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



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 <u>all</u> 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 and remote hydraulic power pack 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. A/C Heater unit must be extended out and securely fastened with six 1/2 x 1.25 flat SHCS.
	26. Decals must be clean and legible.

NOTES

Operation

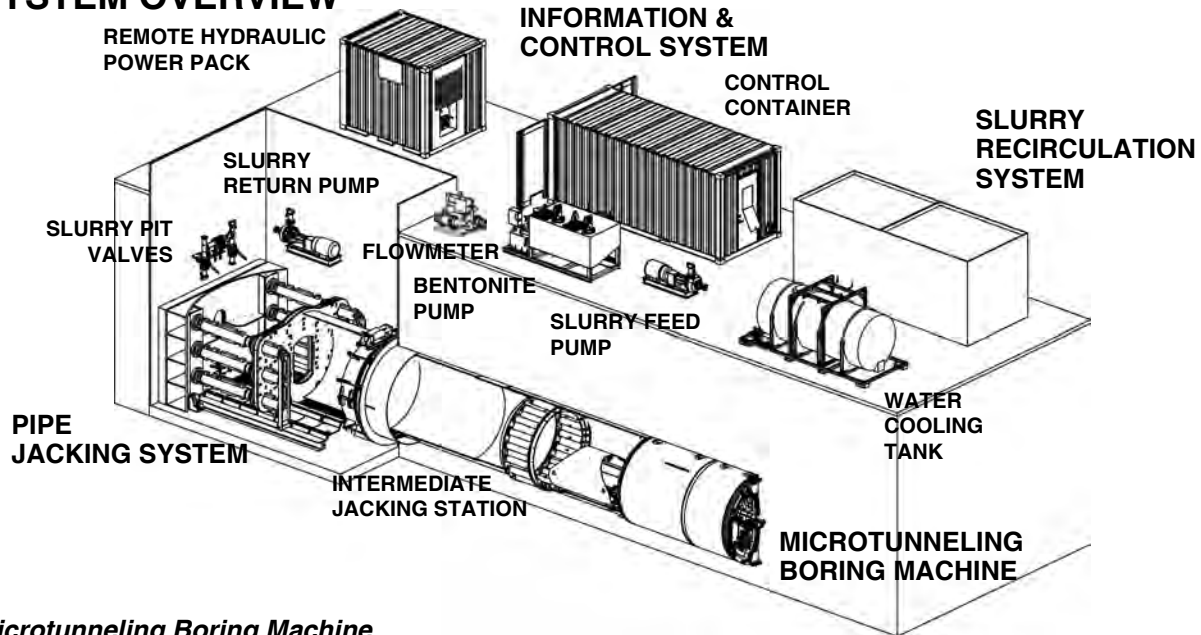
OPERATING GUIDELINES

⚠ WARNING

Do not operate this equipment until you read, study, and understand this manual. 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 Product Support representative for proper procedures on how to restore equipment for operation.
7. Have fully charged fire extinguishers on the job site at all times.
8. 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 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 the 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 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.

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 (thirds on small diameter MTBMs) 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 and steering. The second half of the MTBM is the trailing section (less than 48" ID pipe) or trailing dolly (48" ID pipe or larger). The trailing section features a small on-board hydraulic power pack, control system for the MTBM, camera, submersible pump, and stabilizer wing (dirt wing). Larger diameter MTBMs may also include a slurry booster pump in the trailing section/trailing dolly.

MTBM diameters may range in sizes from approximately 30 inches through 90 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, and 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 and the remote hydraulic power pack 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 project's 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.

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, portapower hydraulic jack cylinder kit.
21. Log chains, shackles and clevis'.
22. Chain or cable-type "come-alongs."
23. Arc welder and cutting torch rigs, eye shields and required protective gear.
24. Disc and mini-disc grinders, and extra discs.
25. Mechanic's tools, including but not limited to; wrenches, sockets, allen wrenches, torque wrenches, pliers, screwdrivers, hammers, etc.
26. Grease gun.
27. Electrician's tools, including test meters, voltage indicator, ground fault indicator, and specialty hand tools.
28. Pipe wrenches, water pump pliers, pump packing removal kit.

SITE PLANNING

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

Equipment:

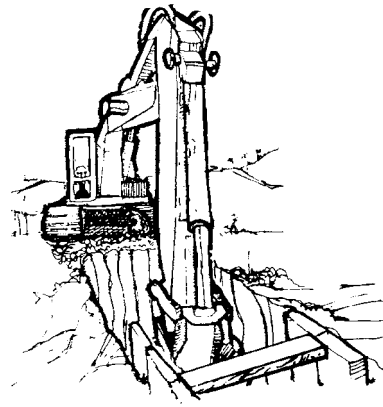
- MTBM	- Jacking Frame	- Control Container
- Slurry Separation System	- Slurry Pumps (Feed & Return)	- Remote Hydraulic Power Pack
- Crane	- Fork Lift	- Drive Motor Cooling Water Tank
- Portable Toilet	- Portable Welders / Torch	- Storage Container With Tools
- High Pressure Jetting Pump	- Small Generator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

Other site considerations:

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

SITE PREPARATION

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.



AEM is the original author and publisher of the above illustration



⚠ 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 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 severe injury or death.

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

9. Properly ground the generator (or other power source), control container and remote hydraulic power pack.

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



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



12. 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.



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 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.



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 cooling pump, 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.



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. For proper cutterhead installation, refer to 21A or 21B, MTBM Cutterhead Installation in section 9, Periodic Maintenance, MTBM - Prior To Each Drive Launch. The cutterhead installation MUST be performed by an experienced technician.

29. Place the MTBM mid (if applicable) and trailing sections near the launch shaft.



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

31. Connect the 150 ft starter hoses and cable between the MTBM starting, mid, and trailing (dolly) 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 LEADS

⚠ DANGER

Hazardous voltage.

This system is powered by high voltage electricity.

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

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



NOTICE

ONLY a certified electrician can connect the generator/power source power leads to the 480V power connections on the control container and the remote hydraulic power pack.

CONTROL CONTAINER

1. With all power in lockout tagout and the generator or power source properly ground, open Main Disconnect panel (A) in the control container to gain access to the 480V terminal lugs.



2. Remove terminal cover (2 screws).



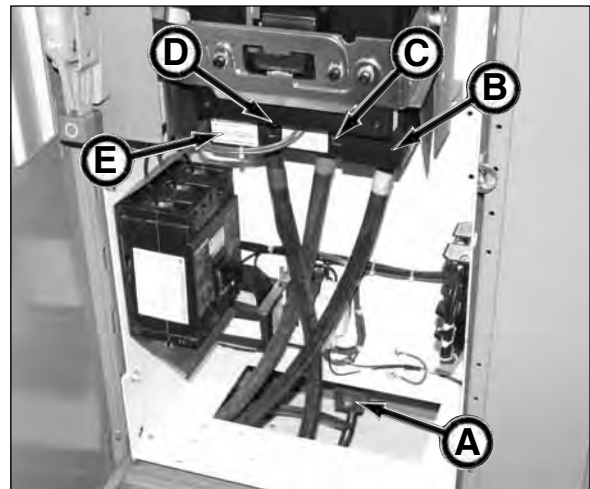
3. Route generator/power source 480V power cord through container access.



4. Install power cord to appropriate 480V terminal lugs as follows:

Green wire to ground terminal (A)
Yellow wire to terminal (B)
Orange wire to terminal (C)
Brown wire to terminal (D)

5. Reinstall terminal cover (E).
6. Secure Main Disconnect panel.
7. Proceed to step 8 to connect power leads to the remote hydraulic power pack.

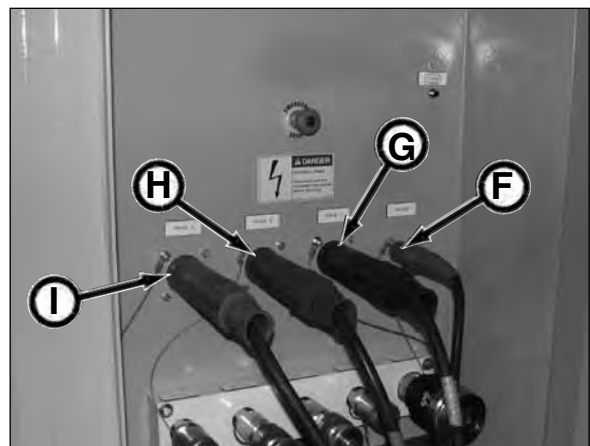


REMOTE HYDRAULIC POWER PACK

8. With generator or power source properly ground, install power cord to appropriate 480V connections on the bulkhead as follows:

Green wire to ground connection (F)
Yellow wire to connection (G)
Orange wire to connection (H)
Brown wire to connection (I)

9. 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.



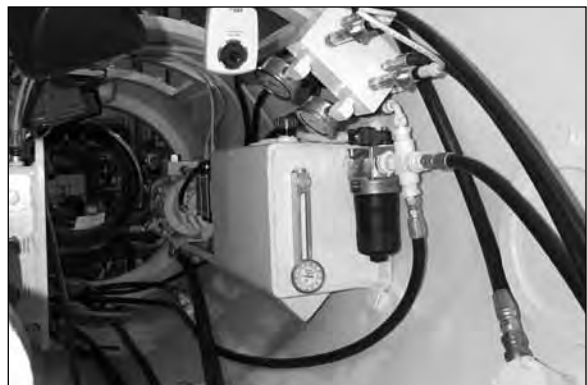
5. Fill the grease pump in the MTBM until indicator is at full mark.



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



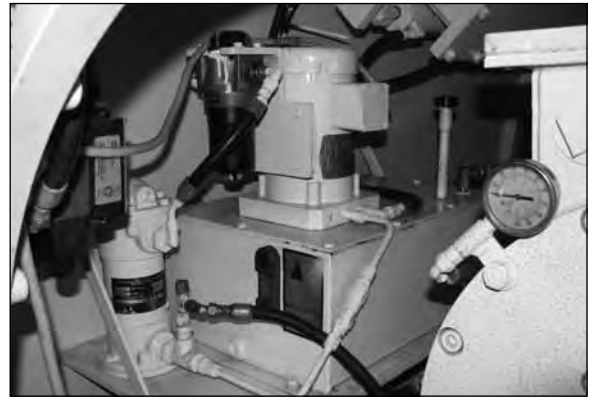
7. Check the MTBM hydraulic power pack oil level. Add oil if necessary.



8. Check the MTBM gear box oil level on larger MTBMs:

Larger MTBMs: sight gauge on gear box oil recirculation pump reservoir

Add oil if necessary.



9. Check the remote hydraulic power pack hydraulic oil reservoir level. Add oil if necessary.
10. Be sure pump supply shut off valves are open. Tie strap lever to valve to prevent accidental closure during operation.
11. Check to be sure the hydraulic hoses from power pack to jacking frame are in good working condition and properly mounted.
12. 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.
13. 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.



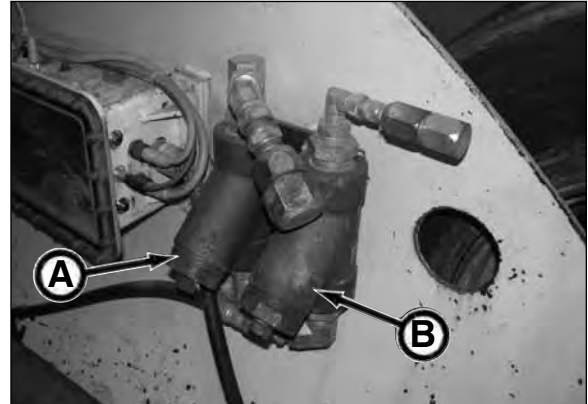
14. Be sure valves on slurry pit valve are open and hoses are properly connected.
15. The bentonite pump hoses and power cable must be in good working condition and properly installed. Also, if needed, the bentonite mixture must be prepared for start-up.



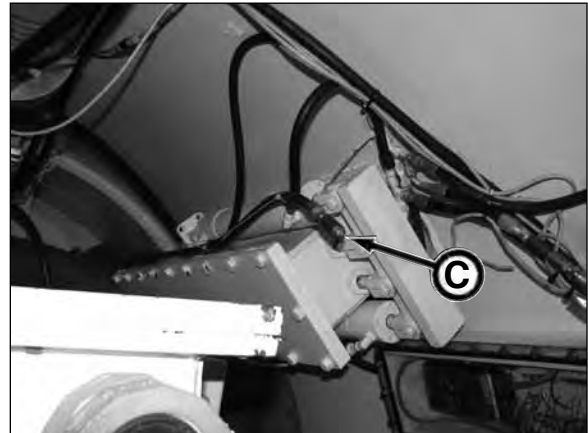
16. Check to be sure the boring head drive VFD parameters are set properly for the specific MTBM drive motor. Contact your Akkerman Aftermarket Support representative for VFD parameter details.



17. Clean high pressure jetting strainer (A) and cooling pump (water tank) strainer (B). Check to be sure hoses are properly installed.



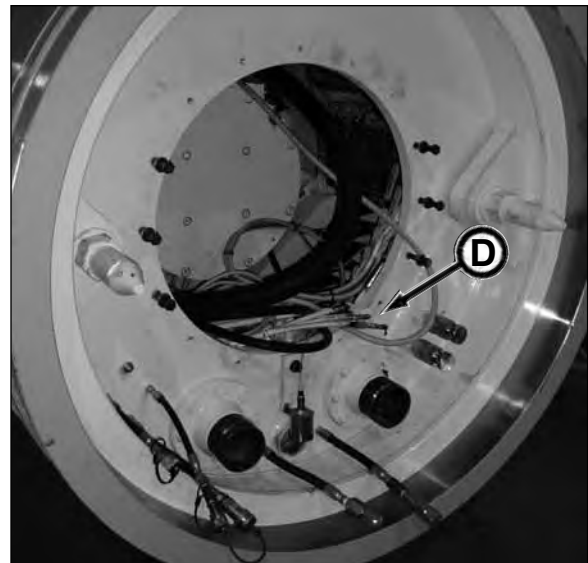
18. Fill and purge dirt wings with grease until clean grease is visible. Use grease fill hose (C).



19. Lubricate steering joint seals. Do not over grease. There are grease lines (D) from the steering joint to the MTBM bulkhead area that are used to easily lubricate the seals.

SL44 & smaller: use 1/2 grease tube
SL51 & larger: use a full grease tube

20. 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.

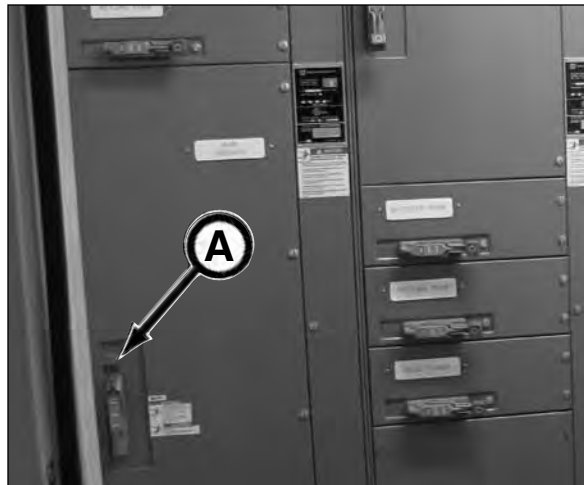
1. Lock out/tag out power to the control container and the remote hydraulic power pack.



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

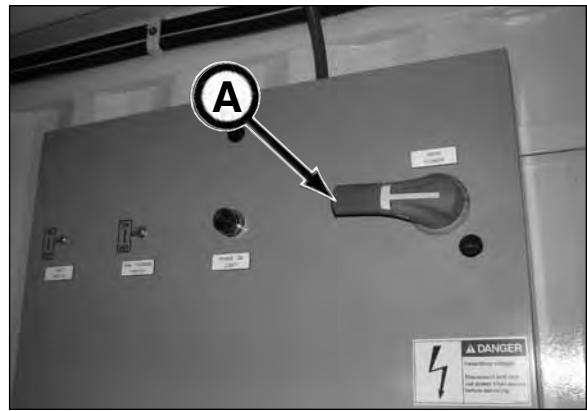


3. With main disconnect (A) in control container OFF, and all control disconnects to OFF position, hook up generator/power source cables to control container generator power connectors (B) (refer to Connecting Power Leads in this section).



(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.



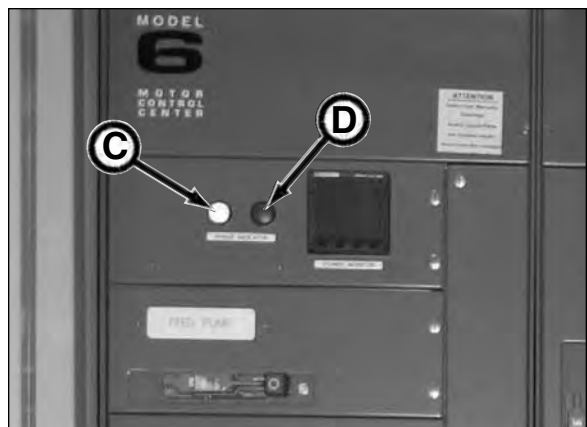
5. Turn on generator power to the control container and the remote hydraulic power pack.



6. Check the control container phase indicator lights:

If the green phase indicator light (C) 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.

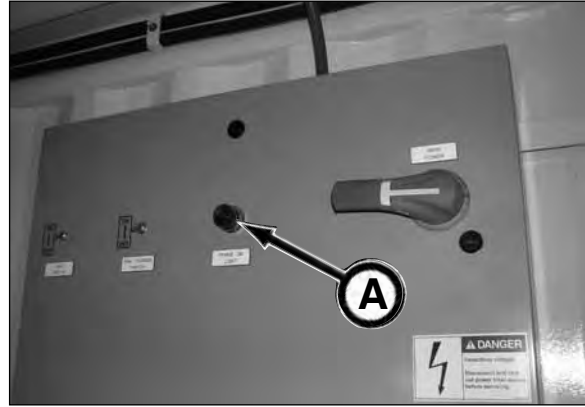
If the red phase indicator light (D) is illuminated, disconnect and lock out/tag out ALL power before attempting to reverse the two generator power leads on the power circuit. Then recheck phase indicator lights.



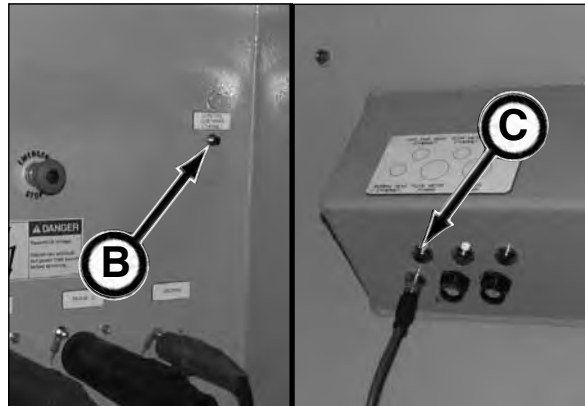
7. Check the remote hydraulic power pack phase indicator light (A):

If the remote hydraulic power pack green phase 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 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.



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



9. 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.



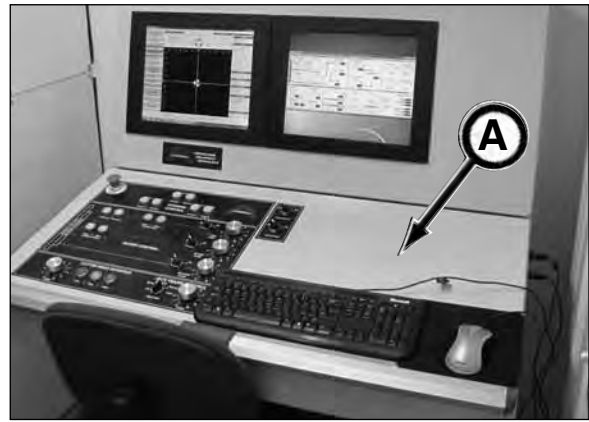
10. Power up the remote hydraulic power pack by turning the main power switch (D) to the ON position.



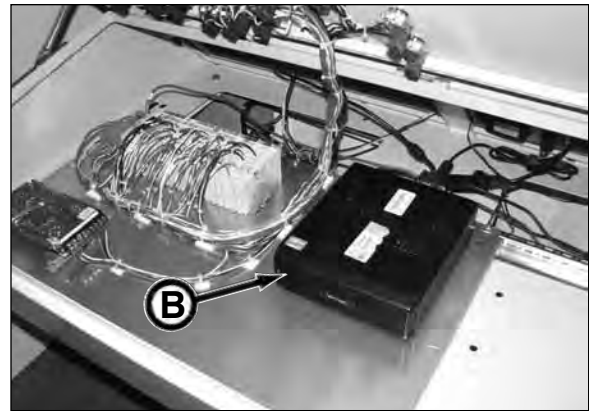
11. Gain access to computer power button by opening console lid (A).

NOTICE

Be sure to use caution when opening console so keyboard and/or mouse do not fall off of console surface.

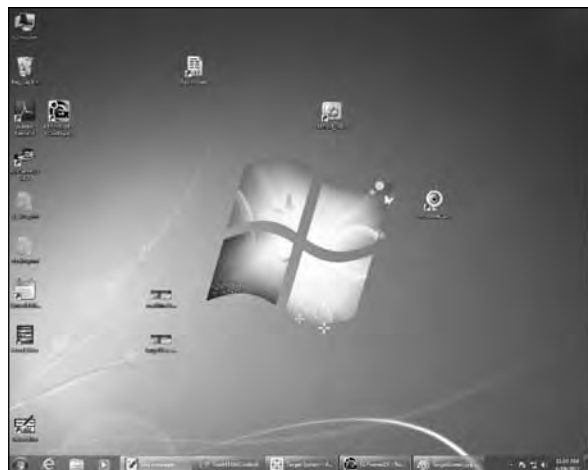


12. Turn on computer with power button (B) and close console lid. The console lid has a racheting mechanism. To close lid, fully open lid to release the rachet mechanism, then slowly lower lid until it is closed.



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

14. Double click the Machine Select icon.



15. The Machine Control Selector window appears. Select your MTBM head size and click OK.



16. After program loads, the target screen, MTBM control screen and log message screen 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.



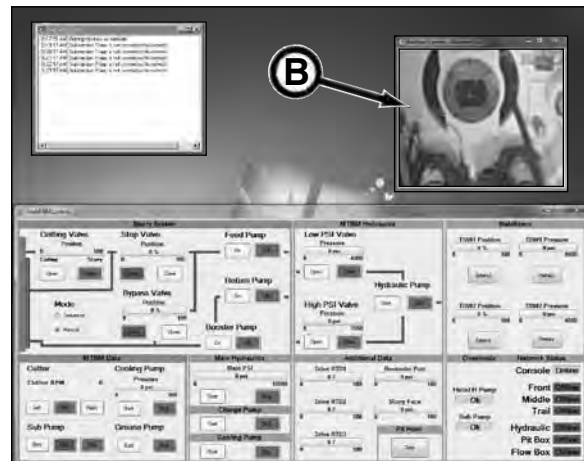
Target Screen



Log Message and MTBM Control Screens

17. Load the MTBM target camera program.

Double click Machine Camera icon from the desktop. After initial loading of the program, you will have to reposition the camera window 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

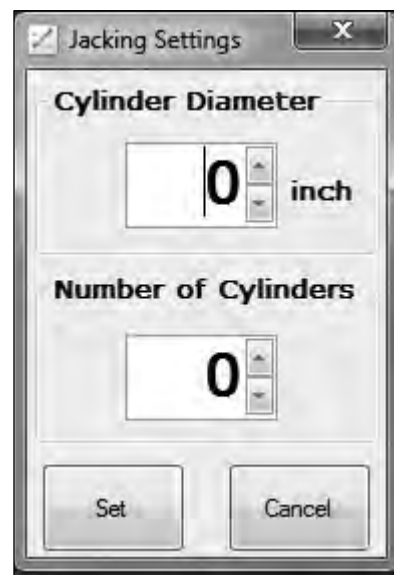
NOTICE

If the Machine 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

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

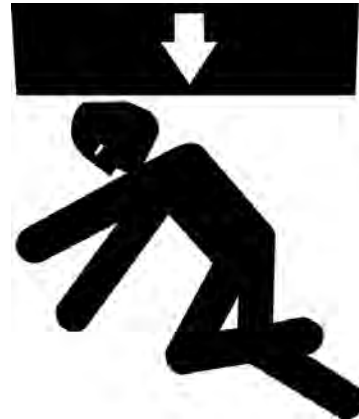


MTBM LAUNCH SEQUENCE

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.

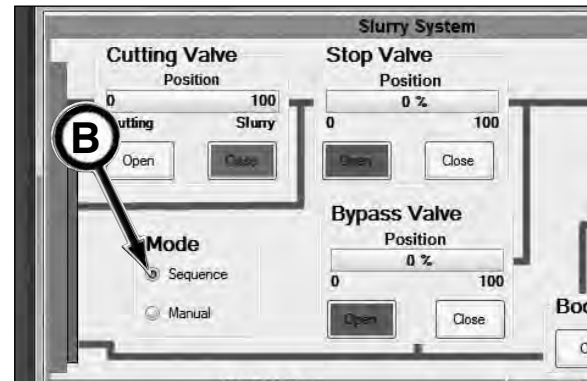
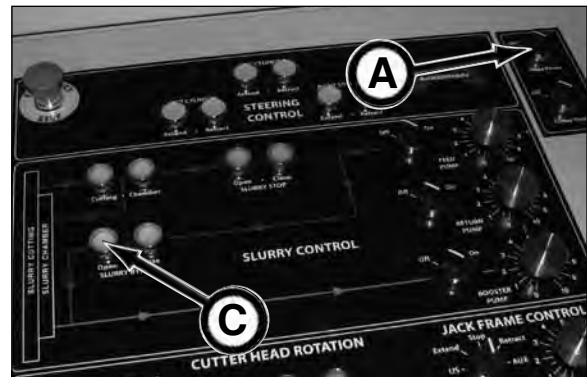


1. Starting section must be placed on jacking frame (refer to Site Preparation in this section).



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)

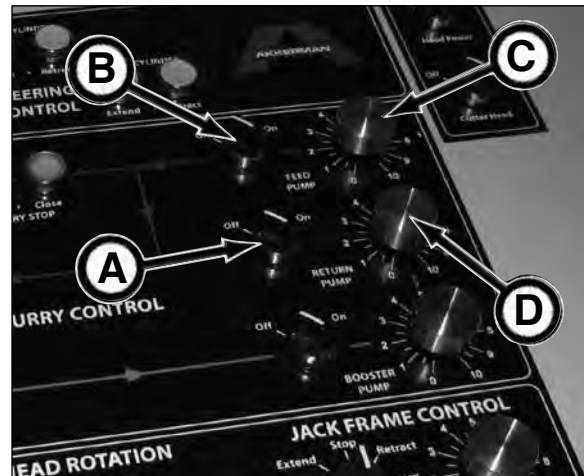
3. On the control panel, start the slurry pumps in the following sequence by turning the pump control switch to the ON position:

1. Return Pump (A)
2. Feed Pump (B)

NOTICE

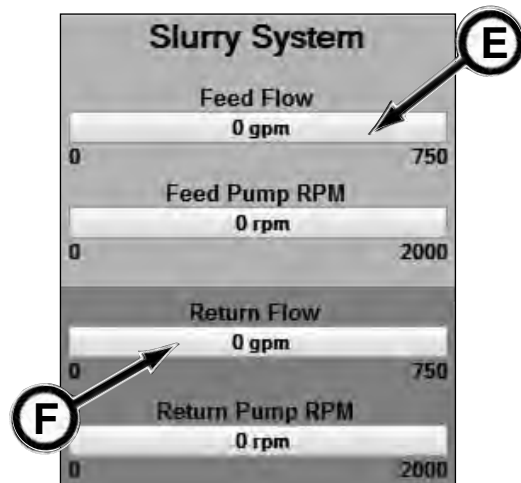
Typically the booster pump is not used during launch sequence.

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.

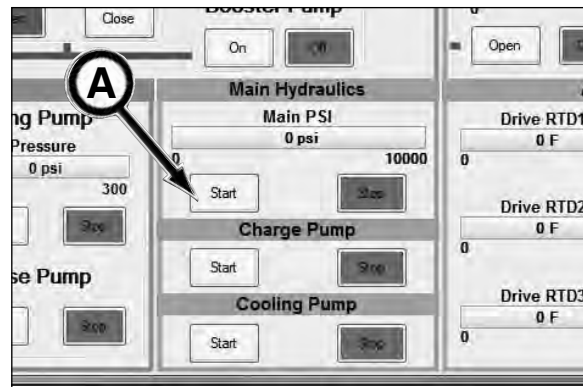
- Feed flow should equal return flow at this time. Refer to the target screen (left monitor) Slurry System meters.



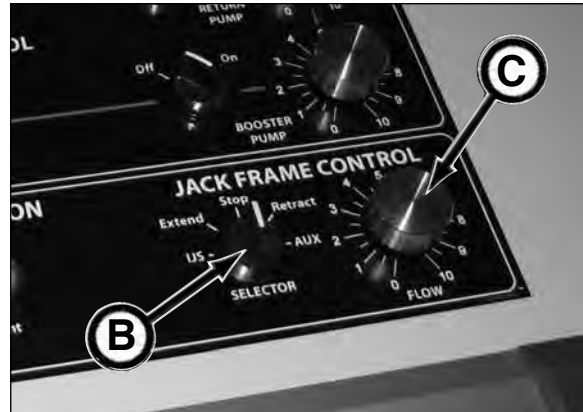
6. Lubricate the launch shaft seal (G).



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%.



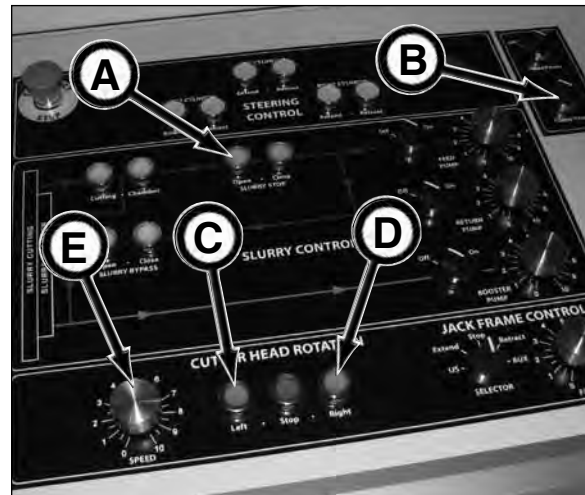
9. Slowly push the MTBM cutter face through the launch shaft seal. Be careful not to damage the seal and to ensure proper equipment alignment.
10. Continue advancing the jacking frame until the cutter face is in contact with the ground. Pressure will rise.

- 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.

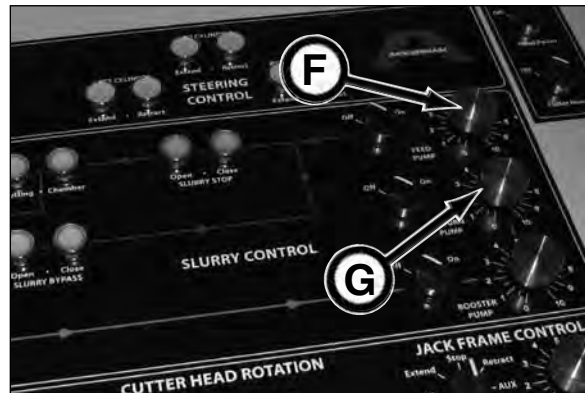


Operation - MTBM Launch Sequence

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.

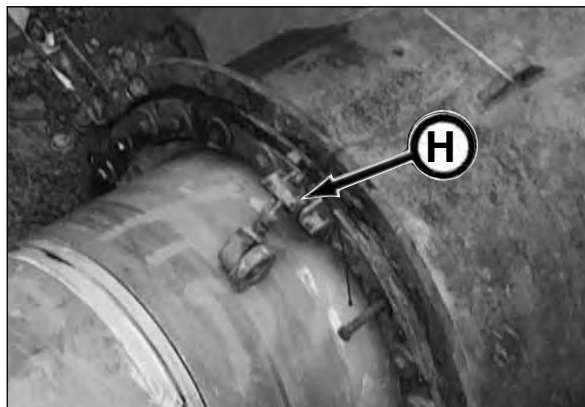


15. Add the mid (if used) and trailing sections in the jacking frame.
 - Exchange the 6 pin 150' TBM starter cable with a 9.5' or 5.5' cable as needed.
 - Remove MTBM hydraulic starter hoses, reconnect lines.
 - Connect slurry return lines to the slurry booster pump (if applicable).
 - While jacking the mid or trailing sections, the high pressure jetting pump may be used if shaft seal leakage does not occur.

NOTICE

If using a trailing dolly, the dolly is secured into the first pipe (to prevent it from rolling out of the pipe while being lowered into shaft) and lowered onto the jacking frame. Connect hoses and cables.

16. Advance the section.
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. Booster Pump (A)
 2. Return Pump (B)
 3. Feed Pump (C)

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 (D).
3. Press Cutter Head LEFT (E) or RIGHT (F) button and set cutting head speed (G) - 90 % is a good operating point. Reduce jacking speed to reduce torque. Watch forces.

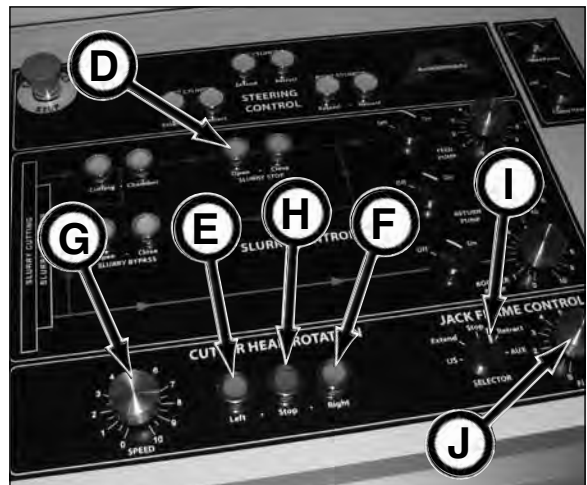
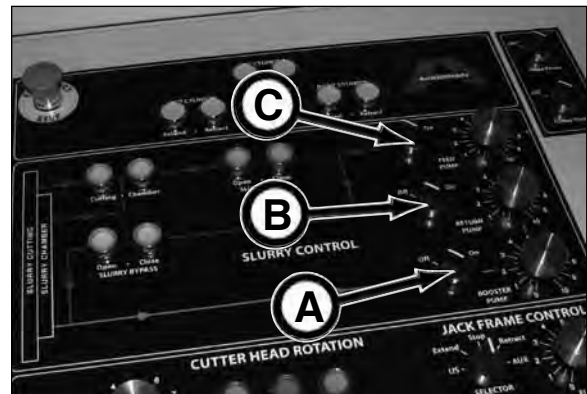
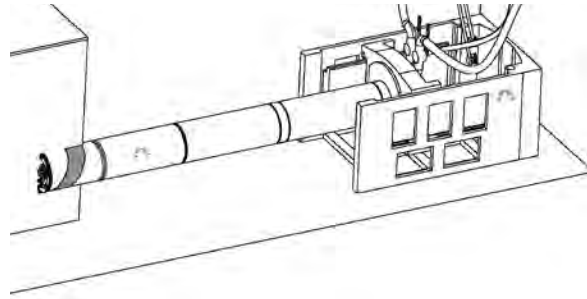
- The cutter head works equally well in both directions.
- Watch for machine roll. If it exceeds 3 degrees, reverse the cutting head rotation. Extending the stabilizer cylinder (dirt wing) will help minimize roll, though jacking forces will increase slightly.

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

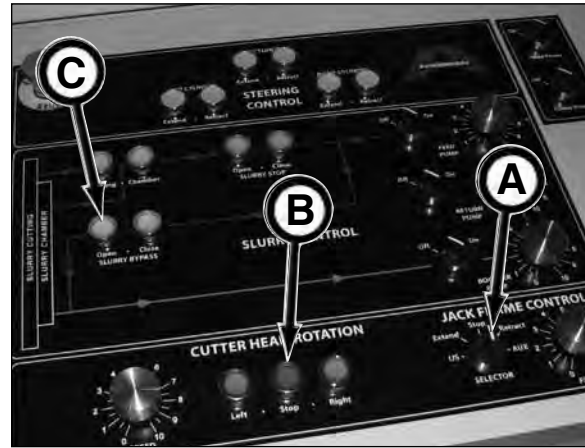
4. Advance jacking frame forward by pressing selecting EXTEND on Selector switch (I) and setting a hydraulic flow rate with Flow control (J).



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.

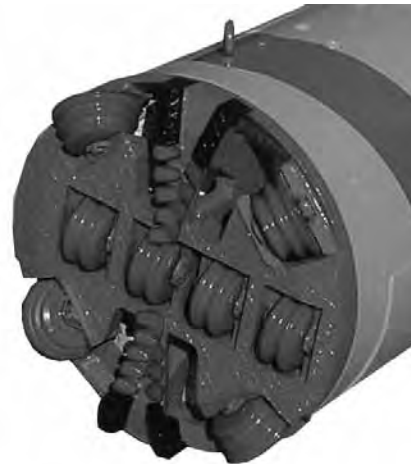


NOTICE

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

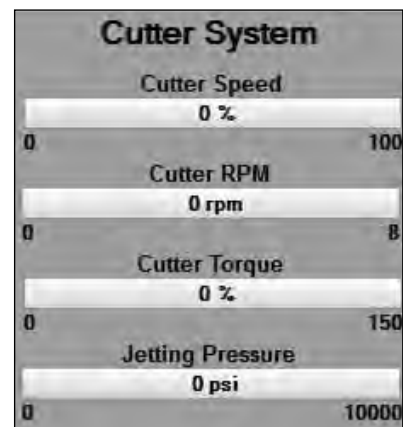
1. Jacking flow rates can be increased until the cutter drive torque is between 80% and 100%. Sixty (loose) to eighty (firm) percent is a good operating point depending on ground conditions. Reduce jacking speed to reduce torque.
2. Abrupt operation may cause machine to roll.
3. The cutter head works 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.



*Cutter System on Target Screen
Displaying Cutter Speed & Torque*

COLD WEATHER OPERATION

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

There are various methods of keeping equipment from freezing:

- Tent working areas with a heating system when possible.
- When working with water, it needs to be constantly circulated to prevent freezing. Otherwise the equipment must be drained and/or treated with a RV anti-freeze solution to prevent freezing.
- If 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.
- 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.

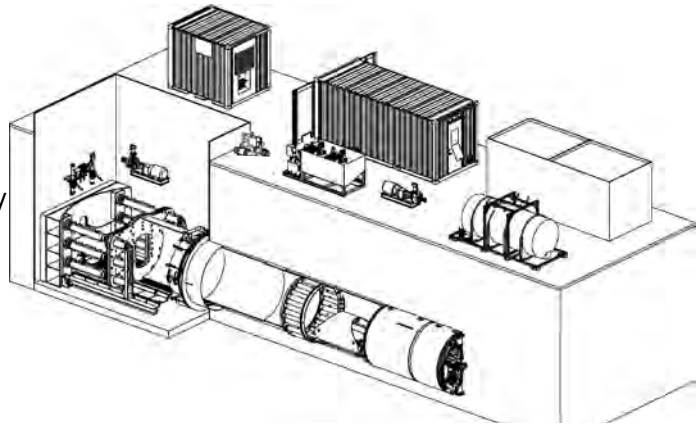


NOTES

CONTROLLING SLURRY

I. SLURRY FLOW

- 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

- Typically the slurry booster 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%.
- 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.
- Operate the machine so that the slurry outlet pressure is less than 5 psi above the ground water 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.
- 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.

- Move Selector switch to STOP position.
- Press Cutter Head rotation STOP button.
- Press Slurry Bypass OPEN button. Slurry stop valves will close when slurry flow is in sequence mode.
- 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)

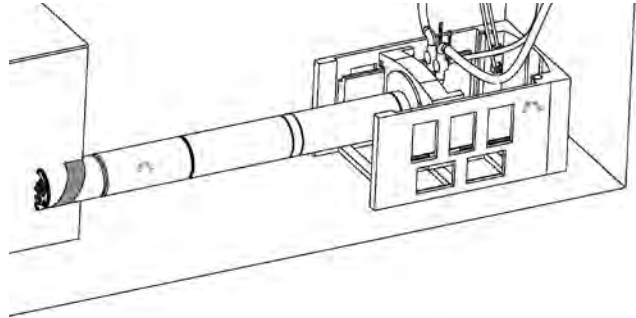
This is typically performed during a pipe change when using a mechanical slurry separation system which allows the slurry system to continue cleaning. If slurry separation is accomplished using a settlement tank, this procedure would normally not be required.

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.

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 3000 PSI 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	
Hydraulic Flow (%)	0
Main Hydraulic PSI	0
Jacking Tons	0
Total (ft)	0
Rate (in/min)	0
Pipe Count	0

Jacking/Piping on Target Screen

Cutter System	
Cutter Speed	
0	100
0 %	
Cutter RPM	
0	8
0 rpm	
Cutter Torque	
0	150
0 %	
Jetting Pressure	
0	10000
0 psi	

*Cutter System on Target Screen
Displaying Cutter Speed & Torque*

OPERATING SLIDE THRUST JACKING FRAMES (MT-400, MT-460, MT-860 & MT890)

1. Turn Selector Switch to STOP position and on MTBM Control screen, press Main Hydraulic START button. The oil cooler will automatically start.

2. Turn Selector switch to RETRACT position. Fully retract the jacking frame cylinders each time RETRACT is selected. This will allow the locking blocks to engage into the pockets as far forward as possible in the thrust ring locking guide and ensure locking guide cylinder timing.

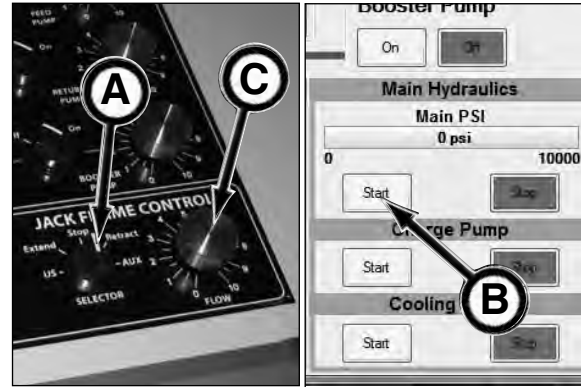
- 3 Set the Hydraulic Pump Flow control to 50% to start jacking cylinder retraction. Turn Selector switch to STOP when jacking cylinders are fully retracted.



4. By communicating with jacking shaft worker, ensure that all position locking blocks (dogs) align with pockets of an equal relationship on either side of the frame.
5. Turn Selector switch to EXTEND to start forward thrust and use 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, or by turning the Selector switch to STOP position.
6. Once the jacking cylinders have reached full extension:
 - a. Turn the Selector switch to STOP position.
 - b. Press Cutter Head STOP button.
 - c. Press Slurry Bypass OPEN button.
7. Repeat steps 2 through 6 for the entire length of the pipe and the locking ring is at the end of the jacking frame.
8. To retract the locking ring, release thrust pressure by turning the Selector switch to RETRACT position and set flow rate to 50%. Turn the Selector switch to STOP position when retraction is completed, release and pin position locks and turn the Selector switch to AUX position to provide flow to the locking ring travel valve. The manual valve on the jacking frame is then used to travel the locking ring to the back of the jacking frame. Use caution when retracting the locking ring away from the pipe joint to prevent pipe damage.
9. Press Main Hydraulic STOP button on the MTBM Control screen.
10. Remove the pins from the position locks, install pipe (per Pipe Change in this section), and repeat the above procedures.

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).

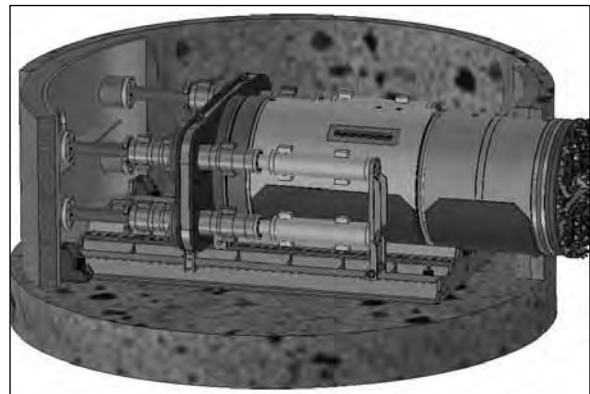
NOTICE

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.

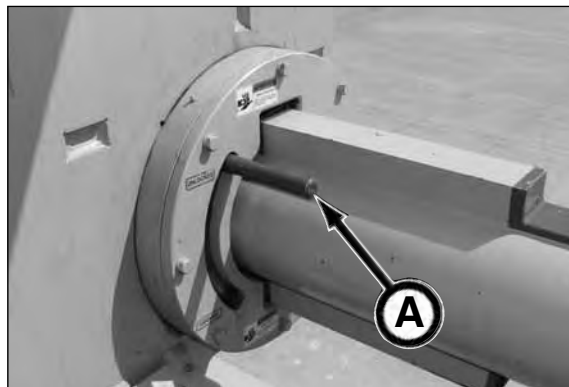
- Refer to Jacking Operation Guidelines to help determine a proper hydraulic flow rate.
- Monitor jacking pressures. If pressures approach 50% of the system capacity, intermediate jacking stations may be required. Refer to Using Intermediate Jacking Stations (IJS) in this section.
- Jacking may be paused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



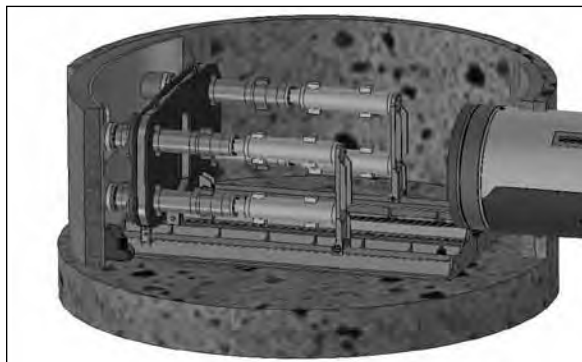
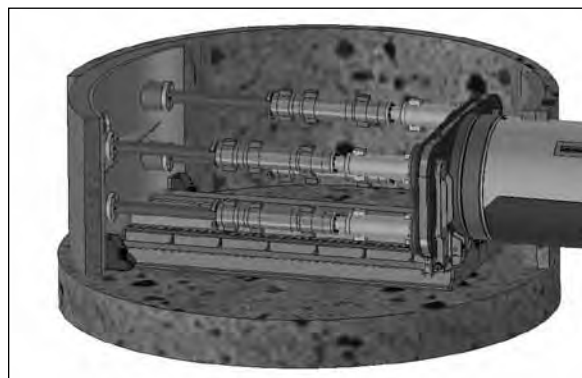
6. Once the jacking cylinders have reached full extension, press Cutter Head STOP button and turn Selector switch to STOP.

(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:

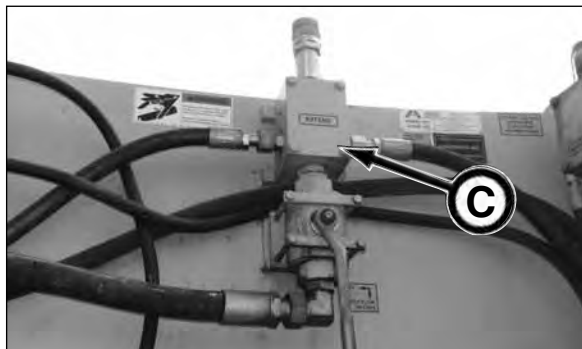


Fully retract cylinders with frame locked to cylinders using the High Return Flow valve (C) on the jacking frame (the Selector switch must be to the RETRACT position). Then, unlock frame from cylinders. Hook winch cable to frame and retract winch cable until it aligns to desired keyhole slot.

NOTICE

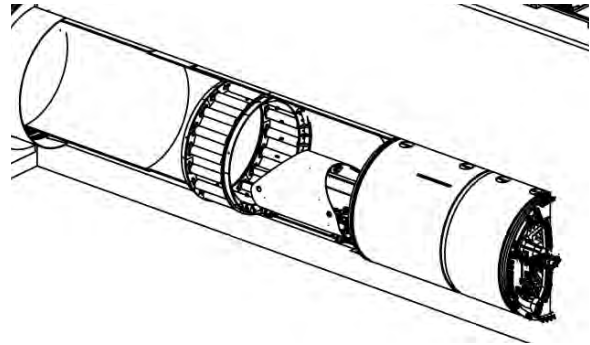
If winch is not available, use the jacking frame cylinders as follows: retract frame, unlock cam locks, extend cylinders, lock cam locks, retract cylinders, etc until frame is at back of jacking frame.

13. Press Main Hydraulic STOP button on the MTBM Control screen.
14. Lower the next pipe and repeat until the tunnel is complete.

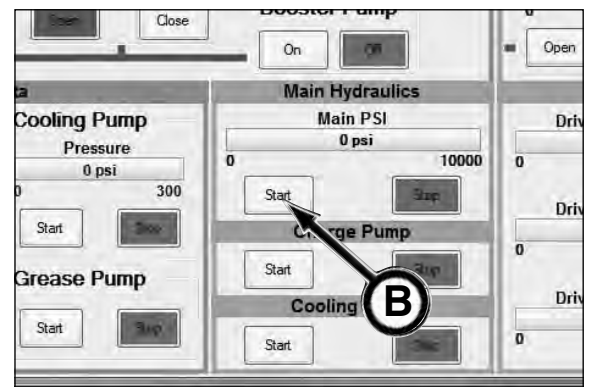
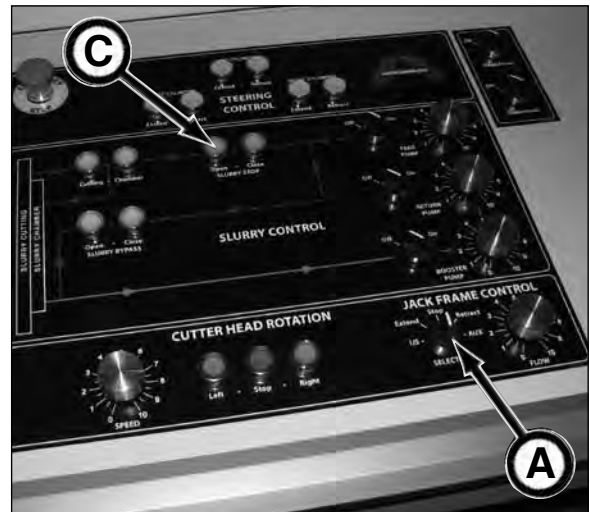


USING INTERMEDIATE JACKING STATION (IJS)

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.



1. Turn Selector switch (A) to STOP position.
2. Start slurry feed pump, booster pump (if used), and return pump.
3. On MTBM Control screen, press Main Hydraulic START button (B).
4. Press Slurry Stop OPEN button (C) on console.
5. Press Cutting Head LEFT or RIGHT buttons (D) and set cutting head speed with flow control (E).
6. Turn Selector switch to IJS. Use Flow control (F) to set flow rate.
7. When the IJS rams are fully extended, turn Selector Switch to STOP position.
8. Pause tunneling (refer to Pause Tunneling in this section) and stop the feed pump.
9. Repeat as needed for additional intermediate jacking stations.
10. Extend jacking frame.
11. Repeat the above procedures after installing a new pipe.



STEERING GUIDELINES & OPERATION

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

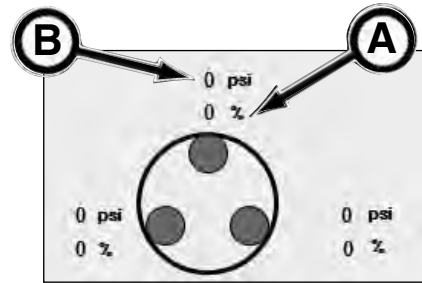
1. Steering should be carefully executed with small corrections made over many feet. Making more extreme adjustments will increase jacking forces.
2. Before making any steering adjustments, ALL three steering cylinders must be at the 50% position.
3. Watch the inclinometers (C) (on target screen) to get an idea of their values for a straight run and set the pointers on the side of the target.
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.

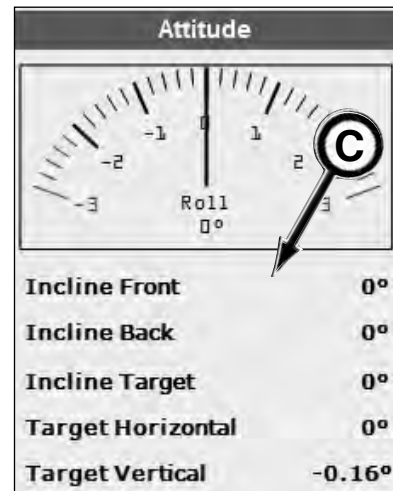
To steer right, extend the left cylinder and then the top cylinder half the amount of the left.

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 Cylinder Indicator On Target Screen



*Attitude on Target Screen
Displaying Inclinometer Values*

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, main cooling pump water hose, bentonite supply hose, high pressure jetting hose, and other utilities) must be added to the existing pipeline, tunnel cables and hoses.

⚠ WARNING

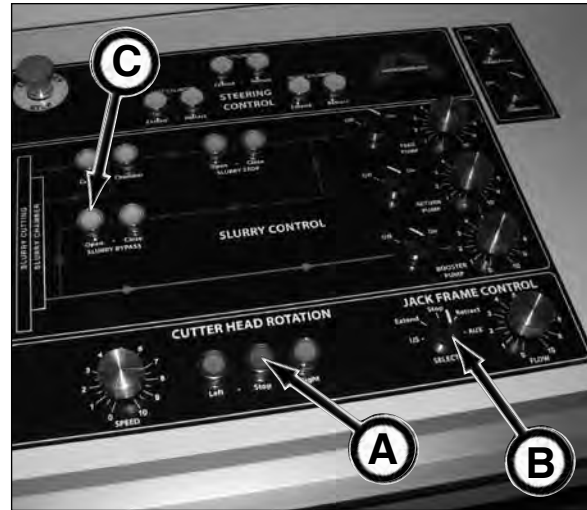
Suspended loads may fall and cause severe injury or death. Do not allow anyone to enter area under or around a suspended load.



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.

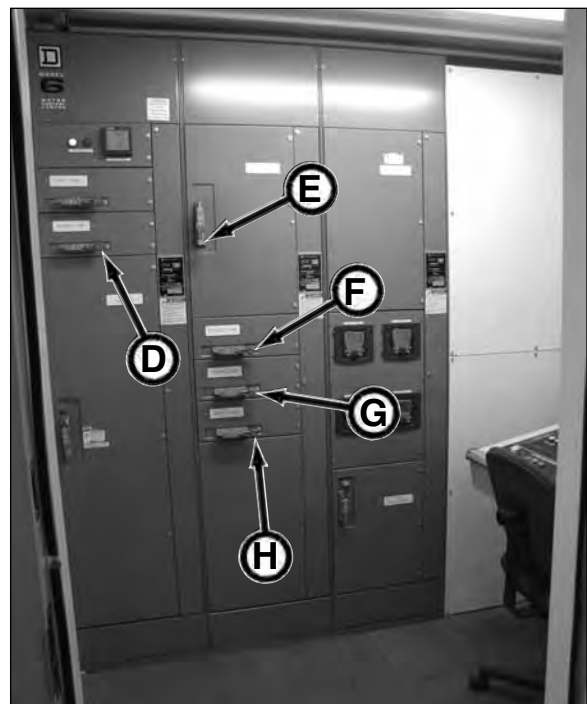


3. Shut down the slurry pumps in the following order by turning pump power switch to OFF:

- a. Feed Pump
- b. Return Pump
- c. Booster Pump

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

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

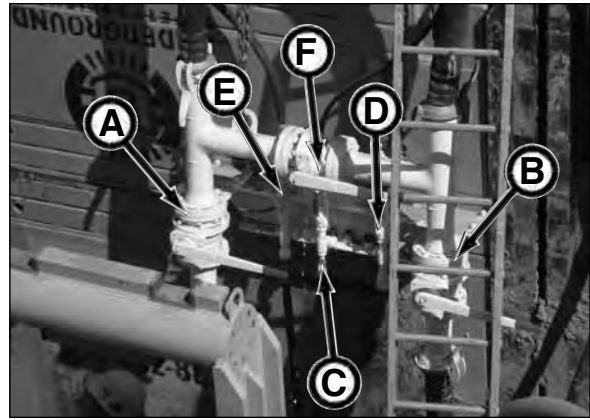


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- Close the slurry return valve (A), slurry feed valve (B), main cooling pump water supply valve (C), bentonite supply valve (D) (if used), and the high pressure jetting valve (E) (if used) on the slurry pit valve assembly.

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.

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

NOTICE

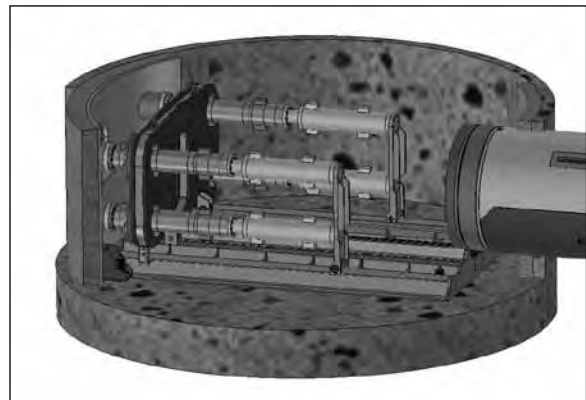
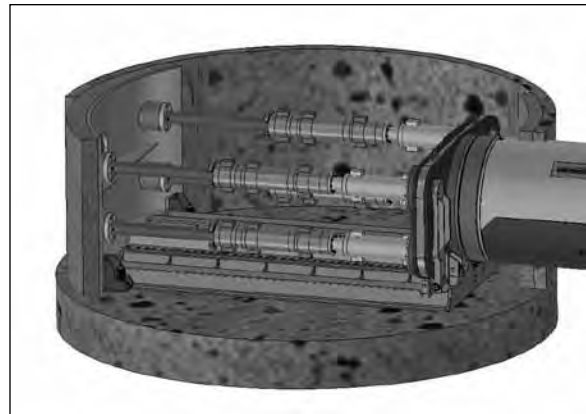
When disconnecting cable connections to add a new pipe section to the tunnel, operators should power down all electrical feeds to the tunnel. Electrical cabling should be disconnected first and slurry pipes last to prevent slurry water from getting the cables wet.

- main cutter drive cable
- head power cable
- booster pump cable
- ethernet cable
- tunnel light cable
- slurry feed hose
- slurry return hose
- ventilation lines
- main cooling pump water hose
- bentonite supply hose
- high pressure jetting hose
- 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.

- Retract jacking frame.

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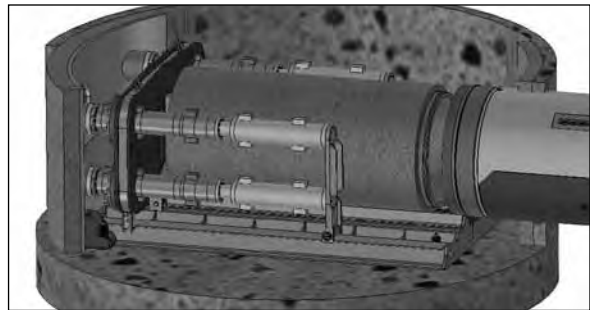


8. Lower the next pipe into position and lubricate the sealing ring.

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.

9. Clean slurry connections and connect slurry lines between the pipes.
10. 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.
11. Open the slurry feed and return valves, main cooling water supply valve, bentonite supply valve, and high pressure jetting valve on the slurry pit valve assembly (A). Close the bypass valve.
12. Slowly advance the new pipe until it is seated in position.



13. Turn ON disconnects (from step 4) for the slurry return pump, slurry booster pump, main cutter drive, head power and cooling pump.

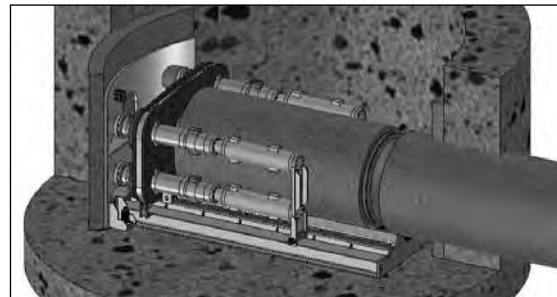
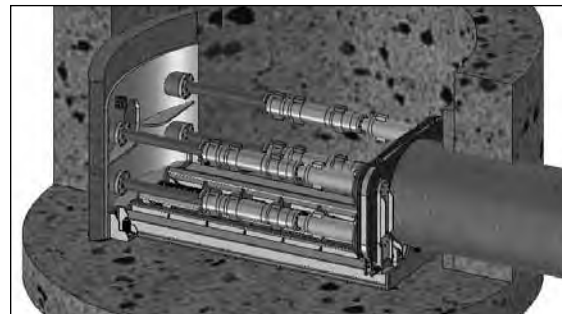


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14. Turn the slurry pump controls (A) ON in the following order:
 - a. booster pump
 - b. return pump
 - c. feed pump
15. Use the slurry pump flow controls (B) to check slurry lines for leaks and the separation system for proper operation.

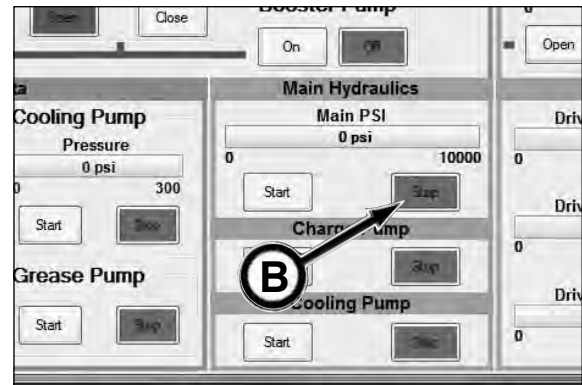
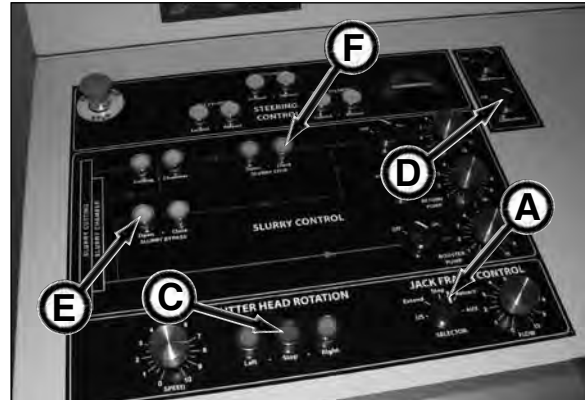


16. Repeat installation for subsequent pipe.



DAILY SHUT DOWN

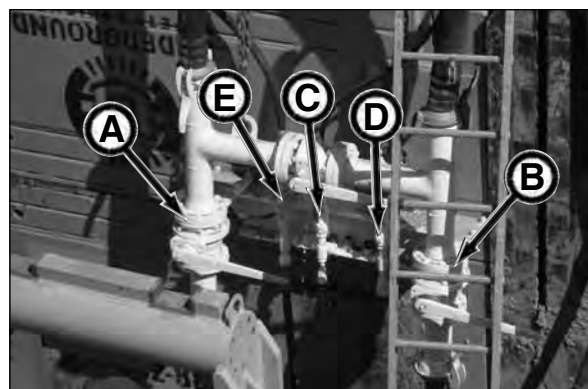
1. Stop jacking frame extension by turning the Selector switch (A) to STOP position.
2. On MTBM Control screen, press Main Hydraulic START button (B).
3. Shutdown the MTBM drive motor by pressing the Cutting Head STOP button (C) and turn Cutter Head power switch (D) to the OFF position.
2. Open the MTBM 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



5. Close the valves on the slurry pit valve and open bypass valve on slurry pit valve and close the feed and return side and supply tanks (if used).



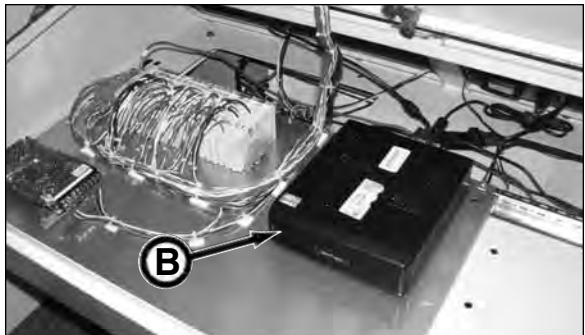
6. Generate and print a report (refer to Using The Report Generator in this section).

	Time	Back Incline	Drive Motor Temp3 (F)	Front Incline	Hydraulic Press (psi)	Bypass Pos (percent)
1	10/7/2003 7:43	-4.474	201	-2 1919999	772	52
2	10/7/2003 7:45	-4.7490001	415	-2 467	774	50
3	10/7/2003 7:52	-4.474	201	-2 1919999	774	52
4	10/7/2003 7:54	-4.474	201	-2 1919999	774	52
5	10/7/2003 7:56	-4.474	201	-2 1919999	774	52
6	10/7/2003 7:58	-4.474	201	-2 1919999	774	52
7	10/7/2003 8:11	-4.474	201	-2 1919999	774	52
8	10/7/2003 8:23	-4.474	201	-2 1919999	774	52
9	10/8/2003 7:12	-4.631	139	-2 2019999	769	96
10	10/8/2003 7:14	-4.631	139	-2 2019999	772	96
11	10/8/2003 7:16	-4.631	140	-2 2019999	772	96
12	10/8/2003 7:19	-4.631	139	-2 2019999	769	96
13	10/26/2003 9:37	-4.631	139	-2 1719999	0	100

7. Turn Head Power switch to the OFF position.



8. Shutdown the computer with power button (B).



9. Shut off all disconnects.

10. Shut off main power disconnect (C) and lock out/tag out main power source.

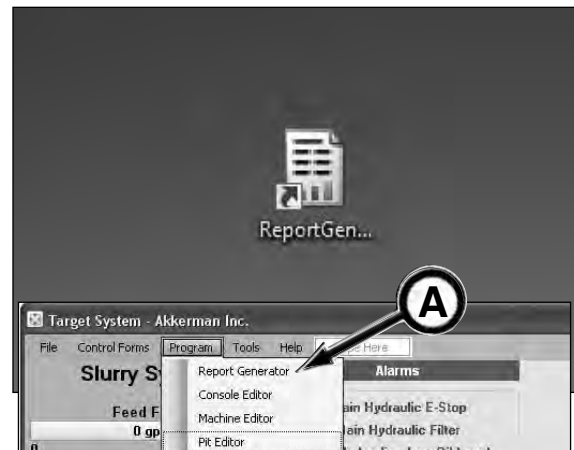


11. Shut off the power on the remote hydraulic power pack by turning the main power switch (D) to the OFF position and lock out/tag out main power source.

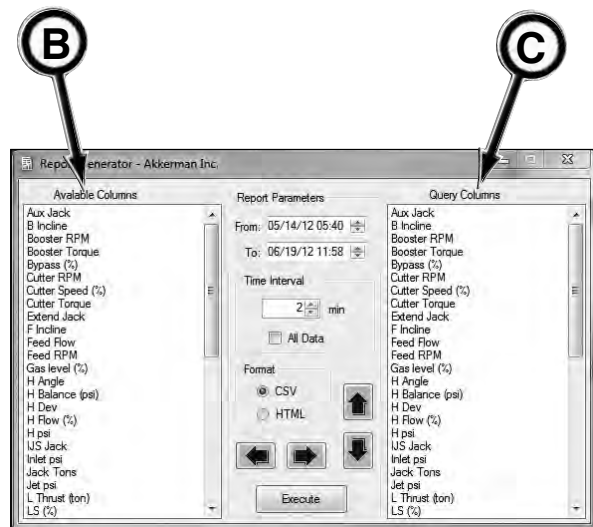


USING THE REPORT GENERATOR

1. Double click the Report Generator icon on desktop or go to the Target System window, select the Program pulldown menu and select Report Generator (A).



2. In the Report Generator window, the left column "Available Columns:" (B) is a list of all the data variables (54) available for your report. The right column "Query Columns" (C) 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.

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.

Time	Back Incline	Drive Motor Temp3 (F)	Front Incline	Hydraulic Press (psi)	Bypass Pos (percent)
10/7/2003 7:43	-4.474	201	-2.1919999	772	52
10/7/2003 7:45	-4.7480001	415	-2.467	774	50
10/7/2003 7:52	-4.474	201	-2.1919999	774	52
10/7/2003 7:54	-4.474	201	-2.1919999	774	52
10/7/2003 7:56	-4.474	201	-2.1919999	774	52
10/7/2003 7:58	-4.474	201	-2.1919999	774	52
10/7/2003 8:11	-4.474	201	-2.1919999	774	52
10/7/2003 8:12	-4.474	201	-2.1919999	774	52
10/8/2003 7:12	-4.631	139	-2.2019999	769	98
10/8/2003 7:14	-4.631	139	-2.2019999	772	98
10/8/2003 7:16	-4.631	140	-2.2019999	772	98
10/8/2003 7:19	-4.631	139	-2.2019999	769	98
10/28/2003 9:37	-4.631	139	-2.1719999	0	100

CSV Format In Excel

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 8:23:07 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.

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

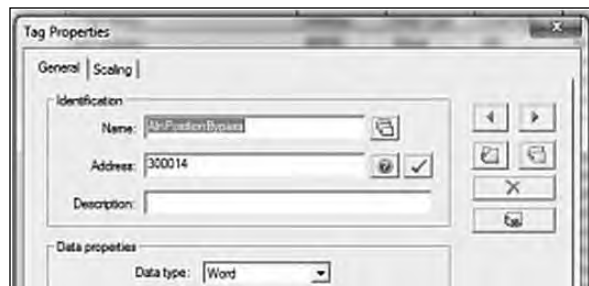
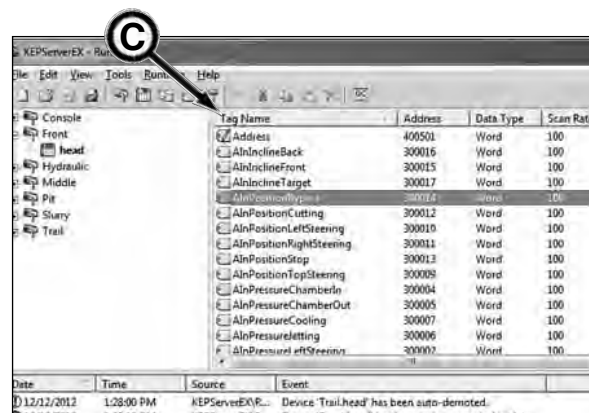
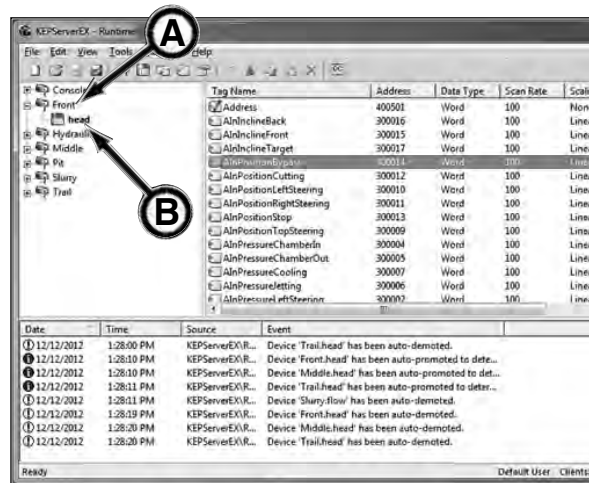
Bypass Valve (MTBM 36 & below)
Channel: Trail
Device: Head

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:	AlnPositionStop
Bypass Valve:	AlnPositionBypass
Cutting Nozzle:	AlnPositionCutting
Steering Cylinders:	
Top:	AlnPositionTopSteering
Left:	AlnPositionLeftSteering
Right:	AlnPositionRightSteering

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).

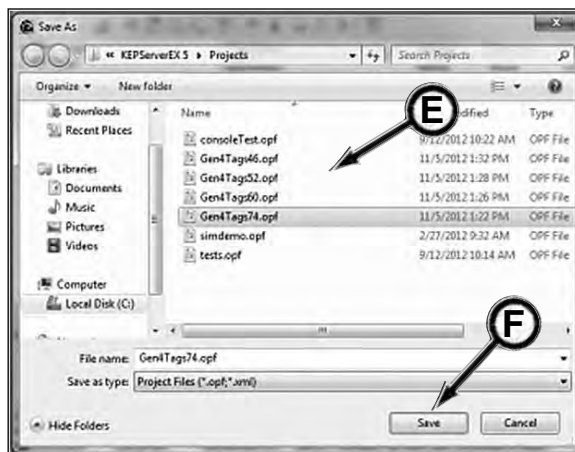
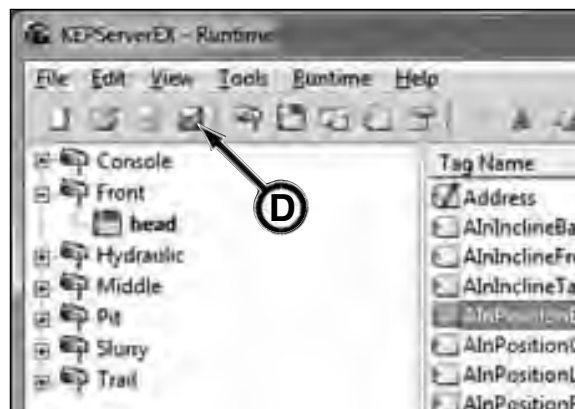
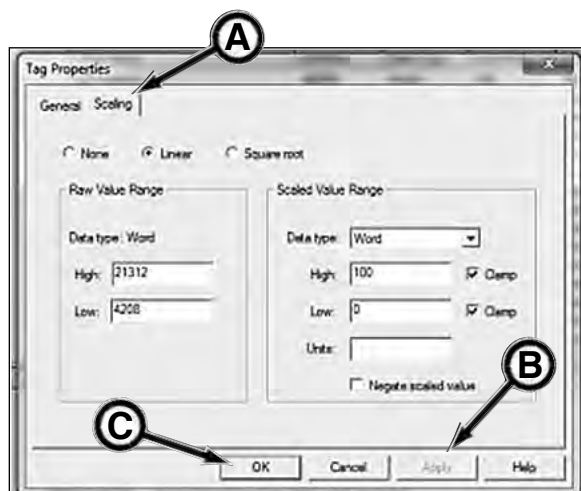
NOTICE Be sure to click **Save As**, so when restarting, the updated file is in the project directory of the Kepware Server program. Otherwise, if performing a Save, the updated file will not be in the correct location when restarting, thus it will use the old file and show erroneous data.

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.



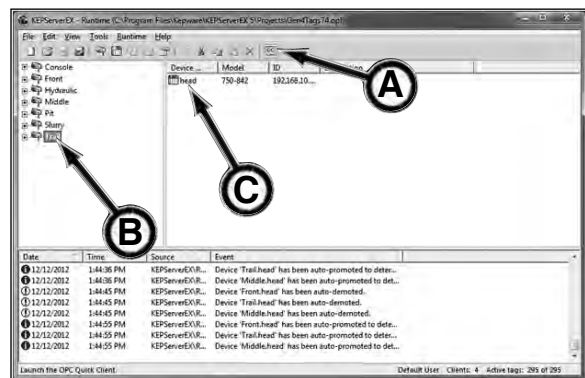
LINEAR TRANSDUCER CALIBRATION - DIRT WING

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.

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).



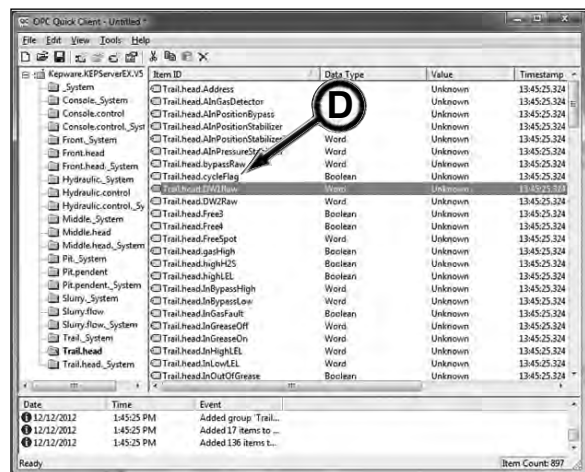
4. Click component tag name (shown below) for dirt wing to be calibrated:

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.

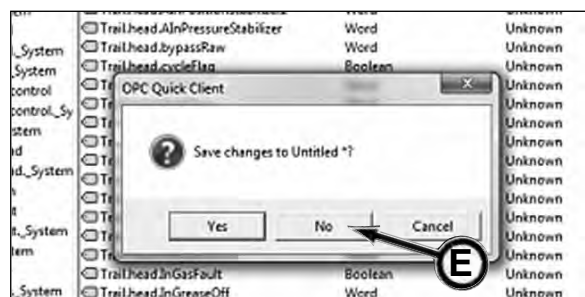
NOTICE

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: AlnPositionStabilizer

DW#2: AlnPositionStabilizer2

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.

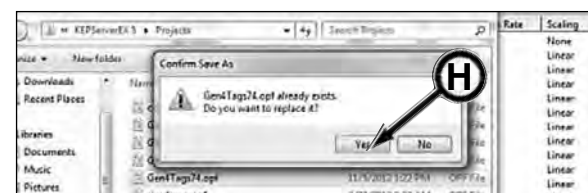
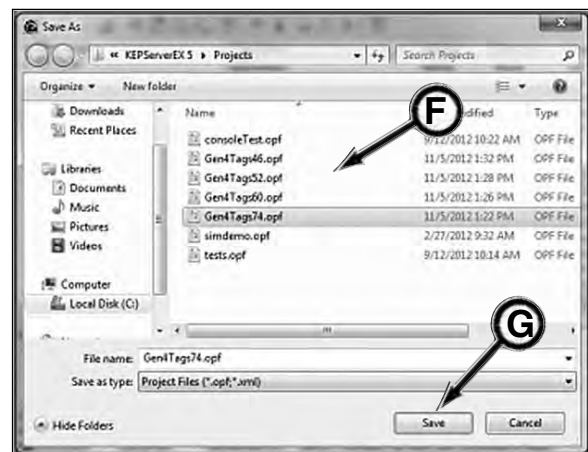
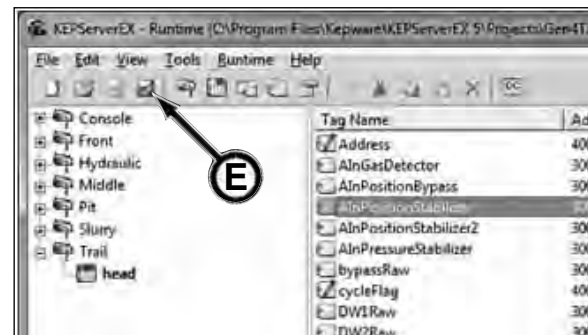
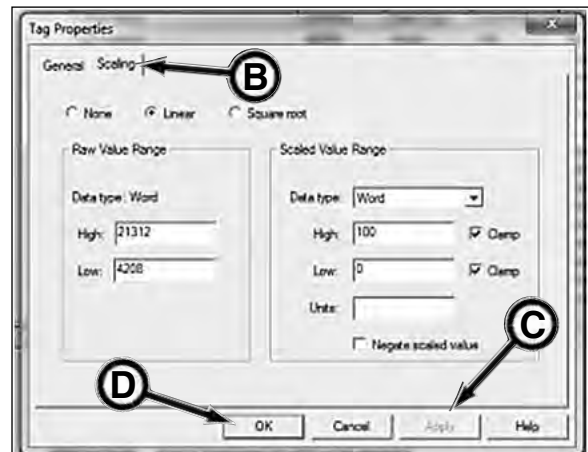
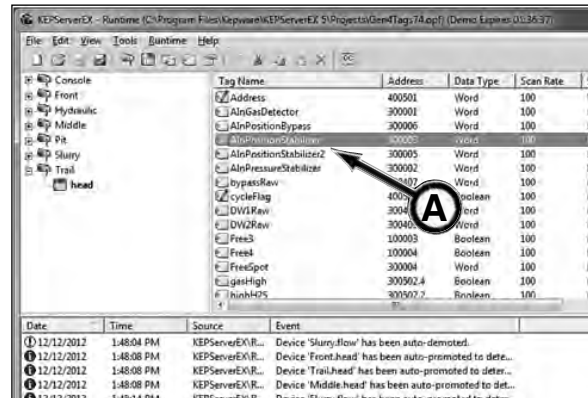
16. Highlight the same file name (F) or MTBM that you are calibrating.

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 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. 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. *Projection Distance (A)*: distance that is projected on the target screen which is based on the current path of the MTBM. The default distance is 120 inches or 10 feet. If you desire to change this distance, type in the new value or use the up and down arrows. Then click the Validate button.

b. *Grease Pump Timer (B)*: The default timer settings are 10 seconds on and 50 seconds off. Adjust accordingly. Then click the Validate button.

c. *Gas Alarm Settings (C)*: The default settings are in LEL%, 10% Low and 25% High. Adjust as needed per project. Then click the Validate button.

d. *Steering Cylinder Calibration Data (D) & Slurry Valve Calibration Data (E)*: 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 (F) / slurry valves (G) (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 (F) and slurry valves (G)*: 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.

- Stop, Bypass, and Cutting Position:** indicates the percentage of which the valve positions are considered fully open or fully closed.
- Stop Pressure:** pressure at which the stop valve is open or closed.
- 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.
- 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.
- 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.
- Time duration of one job:** click this box to reset the "This Job" timer to 0.
- Meter Maximum Value:** specifies the meter values on the target screen.
- Head Roll Range +/-:** change the degree setting to indicate the excessive clockwise (+) 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.

Operation Time	
This Job	139h
Total Operation	139h

3. Misc Editor



This editor provides the value to calculate the pipe advance rate.

- Machine Length:** this is a factory set constant value of the actual length of the MTBM.
- 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.

Jacking/Piping	
Hydraulic Flow (%)	0
Main Hydraulic PSI	0
Jacking Tons	0
Total (ft)	0
Rate (in/min)	0
Pipe Count	0

(continued on the next page)

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:

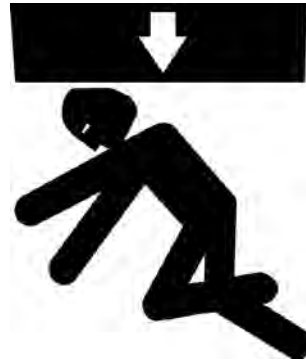
NOTICE Before removing the microtunneling system, be sure to perform the Completion of Each Drive maintenance in section 9, Maintenance.

1. Move all main power switches (generator, control container, remote power pack, 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, MTBM, water cooling pump, 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 from MTBM, slurry pumps, flowmeter, slurry pit assembly and separation plant.
8. Remove water hoses from 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 it 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.



⚠ 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, 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.



NOTES

Transporting

TRANSPORTING GUIDELINES

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

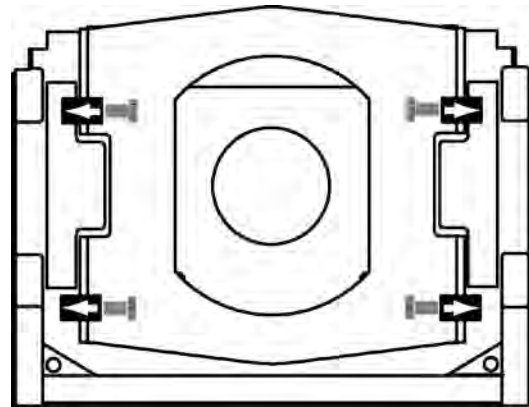
Do not enter area under or around a load.



MT400, MT460, MT860 & MT890 SLIDE THRUST JACKING FRAMES

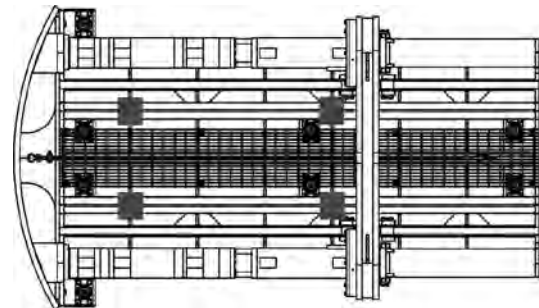
⚠ WARNING Shipping or lifting jacking frame without ALL four dog blocks engaged into frame, can cause serious injury or death from sliding thrust block.

BEFORE disengaging the jacking frame hydraulics, engage ALL four dog blocks (with red bolts) into the jacking frame. If the four red bolts are extended, the dog blocks are not engaged.



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

(FA21900F-05 & After) 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.

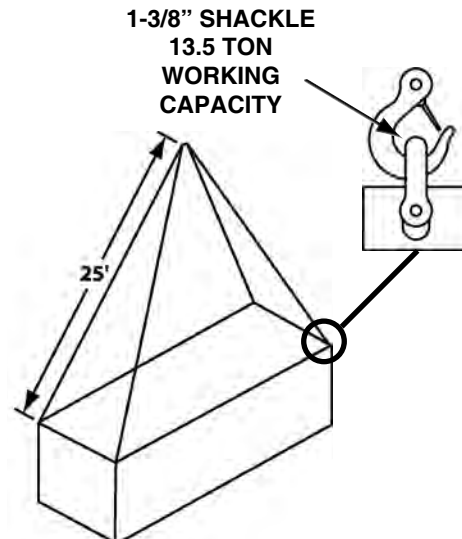


FA21900F-05 & After Shown in Storage/Transport Position

LIFTING INSTRUCTIONS

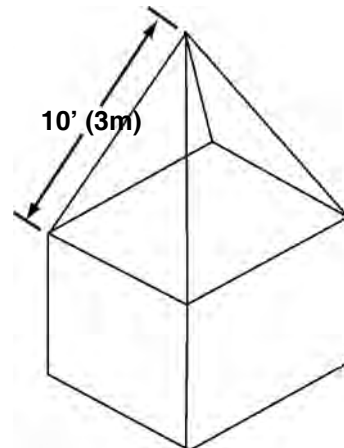
1. Control Container

- Container weight, with no auxiliary gear is 11,000 lbs. (4,990 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.



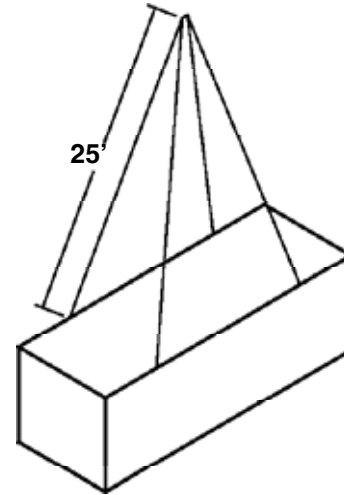
2. Remote Hydraulic Power Pack

- 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.



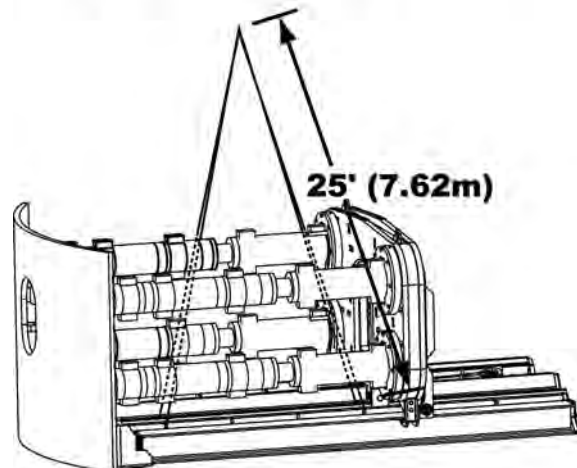
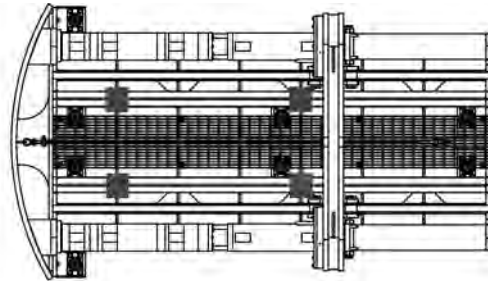
3. Slide Thrust Jacking Frame (MT-400, MT-460, MT-860 & MT-890)

- Base frame with thrust block (dogs engaged) must be picked up individually; with no extensions.
- 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.)
- Lifting with a crane requires a four part sling with legs a minimum of 25 ft. (7.62 m) long.
- Frame must lift freely. If it is stuck to the ground, it must be broken loose prior to lifting.
- Frame lifting eyes 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.



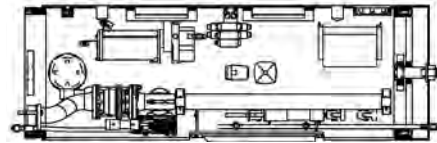
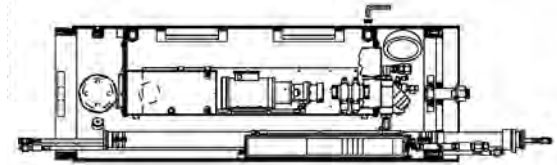
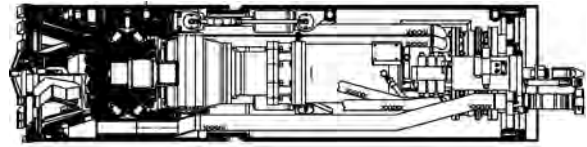
4. Keyhole Jacking Frame (MT860K, MT875K, MT890K, & MT8102K)

- 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.



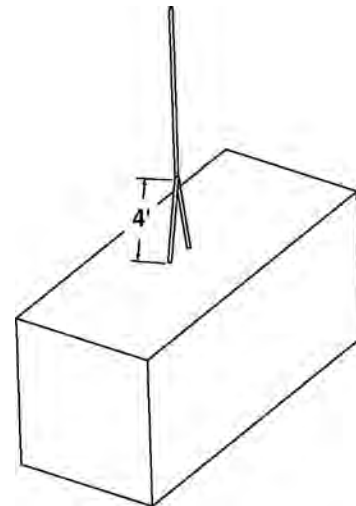
5. MTBM Starting, Mid (if used) & Trail Sections

- Each MTBM sections must be picked up individually.
- Frame weight varies per MTBM section model. Be sure certified lifting devices are capable of lifting each MTBM section weight capacity. (Contact your Akkerman Aftermarket Support representative for more information.)
- Lifting with a crane requires a two part sling with legs a minimum of 10 ft. (3 m) long.
- Before lifting section, it 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.
- Lifting eyes must be tightened snugly against threaded insert before lifting.



6. 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.



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.

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:

SN FA21945F	330 US gal. (1,249 L)
SN FA21965F	195 US gal. (738 L)



SN FA21945F Reservoir Shown

MTBM HYDRAULIC RESERVOIR LUBRICANT

The MTBM hydraulic reservoir (located in the MTBM dolly or trailing section depending on MTBM model) 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 4.5 US gal. (17 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.



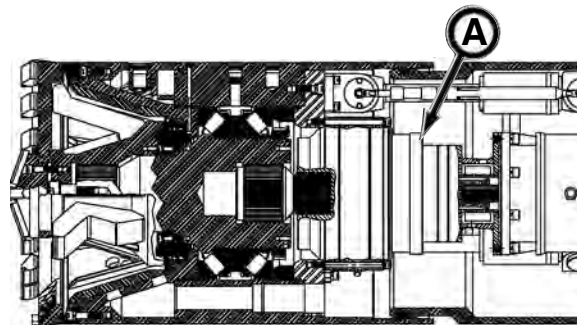
MTBM DRIVE GEAR BOX LUBRICANT

The MTBM drive gear box (A) is filled with Mobil SHC™ 630 Synthetic Bearing and Gear Oil.

Use Mobil SHC™ 630 or equivalent ISO-VG-220 oil when adding or changing lubricant.

NOTICE

The Mobil SHC™ 630 Synthetic Bearing and Gear oil is a synthetic oil specifically designed for this application. 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.



The oil capacity of the MTBM gear box varies depending upon the MTBM model:

- Non oil recirculating pump MTBMs are considered full capacity when the oil level in gear box is at 3/4 full.
- Oil recirculating pump MTBMs are considered full capacity when the oil level is at full level on reservoir sight gauge.

OIL RECIRCULATING RESERVOIR LUBRICANT

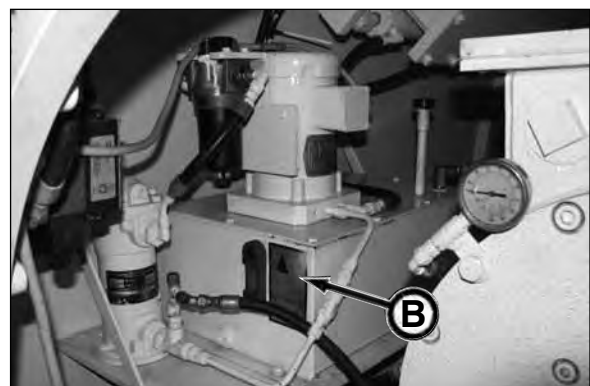
The larger MTBMs are equipped with an oil recirculating pump to lubricate the gear box.

The oil recirculating pump reservoir (B) is filled with Mobil SHC™ 630 Synthetic Bearing and Gear Oil.

Use Mobil SHC™ 630 or equivalent ISO-VG-220 oil when adding or changing lubricant.

NOTICE

The Mobil SHC™ 630 Synthetic Bearing and Gear oil is a synthetic oil specifically designed for this application. 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.



MTBM DRIVE BEARING CAVITY OIL

The MTBM bearing cavity (A) is filled with Mobil SHC™ 630 Synthetic Bearing and Gear Oil.

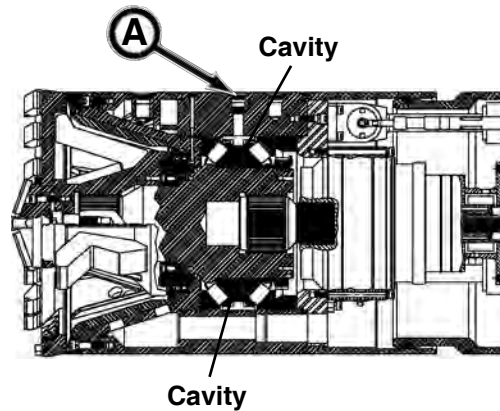
Use Mobil SHC™ 630 or equivalent ISO-VG-220 oil when adding or changing lubricant.

NOTICE

The Mobil SHC™ 630 Synthetic Bearing and Gear oil is a synthetic oil specifically designed for this application. 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.

The bearing cavity oil capacity is full when oil level in bearing cavity is at 3/4 full:

SL 44	3.4 gal (12.9 L)
SL 52.5	3.2 gal (12 L)
SL 60	21.5 gal (81.4 L)
SL72	21.5 gal (81.4 L)
SL74	21.5 gal (81.4 L)

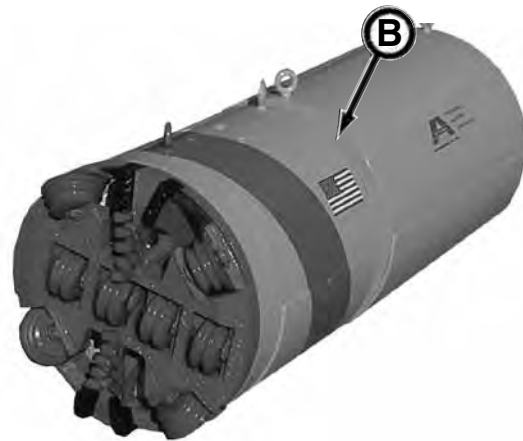


STEERING JOINT GREASE

The steering joint (B) is 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 steering joint.

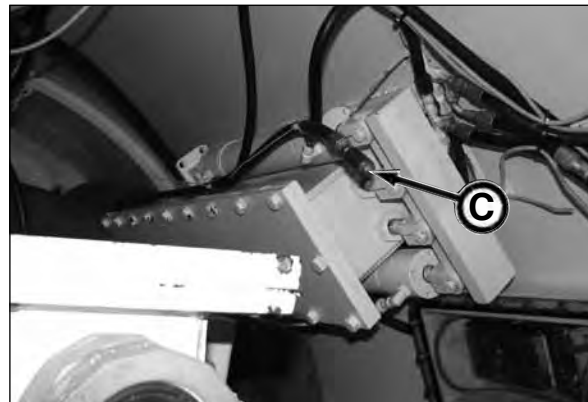


DIRT WING GREASE

The dirt wings (C) 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 dirt wings.



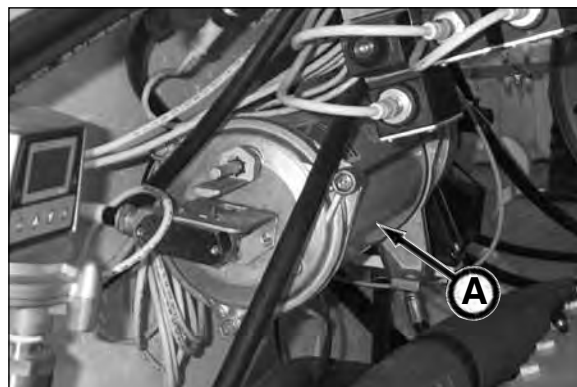
GREASE PUMP

The grease pump (A) is filled with Mobil® SHC 101 EAL Grease. The grease pump lubricates the bearing cavity lip 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.



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.

NOTICE

(Not Shown) Earlier booster pump models were equipped with an oil reservoir for lubricating the bearings. The oil reservoir is filled with a high quality grade of 10W30 weight motor oil. Use the dip stick to check for proper oil level. If it necessary to add oil, there is a check port on the side of the bearing frame. Add oil until it runs out of check port. Do not overfill. Do not use grease.



MTBM ACCESS COVER THREAD LUBRICANT

The MTBM access cover (if equipped) threads are lubricated with Lubriplate No. 1200-2 extreme pressure heavy-duty lubricant.

Use a high quality marine wheel bearing grease when lubricating the access cover threads.



CUTTER BEARING GREASE

The cutter bearings are factory lubricated with Paragon® 3000 (NLGI-2) grease.

The Paragon® 3000 grease is a special high temperature, high performance, lithium grease.

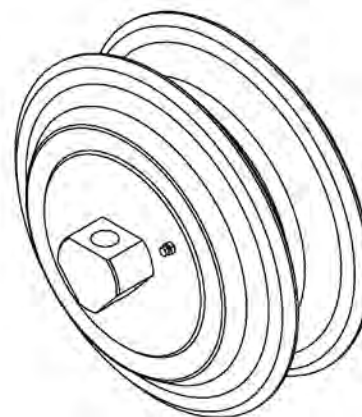
Use Paragon® 3000 grease or equivalent when lubricating the multi-disc cutter bearings.

NOTICE

Grease fitting is used only for lubricating the cutter. The grease fitting **MUST** be replaced with drain plug before mounting cutter to cutter head.

NOTICE

When the cutters are fully filled with grease, the cutters **MUST** be stored in a cool location, out of direct sunlight, otherwise the grease may expand and damage the seals at one or both ends of the cutter. If any cutter leaks grease from either end, new seals **MUST** be replaced in the cutter.



HIGH PRESSURE JETTING PUMP LUBRICANT

NOTICE

For more information, refer to Apex 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).



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.



COOLING TANK DRIVE MOTOR COOLING PUMP OIL

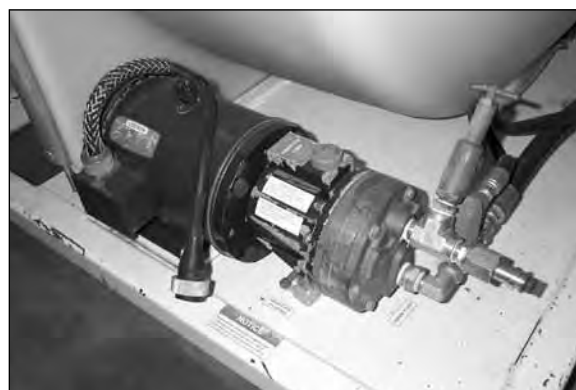
The drive motor cooling pumps, located on the cooling tank, are filled with 10W-30 motor oil.

Use a high quality 10W-30 motor oil when adding or changing lubricant.

Main Cooling Drive Motor Pump Assembly For 30 HP & 75 HP Drive Motor
Oil capacity is 1.0 US quart (0.95 L).



Main Cooling Drive Motor Pump Assembly For Larger HP Drive Motor, Water Cooled Booster Pump, or Gear Reducer Filtration
Oil capacity is 1.1 US quart (1.05 L).



STORING LUBRICANTS

Your equipment can operate at maximum performance only if clean lubricants are used. Use clean containers to handle all lubricants.

Lubricants should be stored in an area protected from dust, moisture, and other contaminants.

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 contaminants cannot be drawn in around the bung.



Periodic Maintenance

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

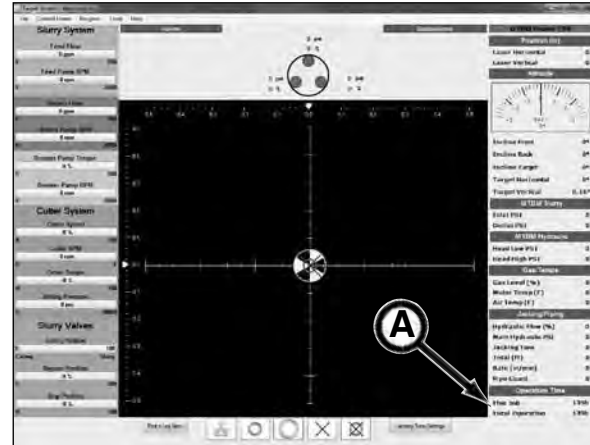
Maintenance and repairs must only be performed by a qualified service technician.

LUBRICATION & MAINTENANCE INTERVALS

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

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

Use the Total Time meter (A) on the target screen to help determine proper maintenance intervals.



LOCKOUT POWER BEFORE SERVICING

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

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



BEFORE PERFORMING MAINTENANCE

1. Push in all E-Stop button(s).
2. Relieve hydraulic pressure.
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 125° F (51° 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.



WELDING

UNAUTHORIZED WELDING

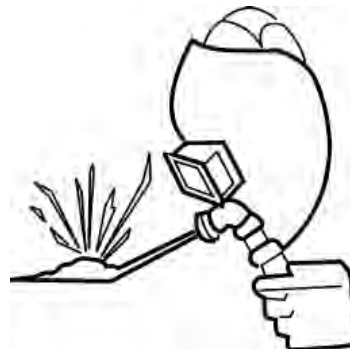
⚠ WARNING Unauthorized welding can cause structural failure resulting in possible injury or death.

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

- 9-4 MTBM Maintenance Chart
- 9-7 Detailed Maintenance Procedures

- 9-44 Control Container Maintenance Chart
- 9-45 Detailed Maintenance Procedures

- 9-56 Remote Power Pack Maintenance Chart
- 9-57 Detailed Maintenance Procedures

- 9-70 Water Cooling Tank Maintenance Chart
- 9-71 Detailed Maintenance Procedures

- 9-74 Keyhole Jacking Frame Maintenance Chart
- 9-75 Detailed Maintenance Procedures

- 9-80 MT (Slide Thrust) Jacking Frame Maintenance Chart
- 9-81 Detailed Maintenance Procedures

- 9-86 Slurry Pumps Maintenance Chart
- 9-87 Detailed Maintenance Procedures

- 9-92 Flow Meter Maintenance Chart
- 9-93 Detailed Maintenance Procedures

- 9-96 High Pressure Jetting Pump Maintenance Chart
- 9-97 Detailed Maintenance Procedures

- 9-102 MTBM Disc Cutters Maintenance Chart
- 9-103 Detailed Maintenance Procedures

DAILY OR EVERY 10 HOURS OF OPERATION

- 9-108 Microtunneling System Maintenance Chart
- 9-109 Detailed Maintenance Procedures

AFTER FIRST 100 HOURS OF OPERATION, THEN EVERY 1000 HOURS THEREAFTER

- 9-118 Microtunneling System Maintenance Chart
- 9-119 Detailed Maintenance Procedures

MONTHLY OR EVERY 250 HOURS OF OPERATION

- 9-120 Microtunneling System Maintenance Chart
- 9-121 Detailed Maintenance Procedures

YEARLY OR EVERY 1000 HOURS OF OPERATION

- 9-122 Microtunneling System Maintenance Chart
- 9-123 Detailed Maintenance Procedures

COMPLETION OF EACH DRIVE

- 9-128 Microtunneling System Maintenance Chart
- 9-130 Detailed Maintenance Procedures

MAINTENANCE CHECK LISTS

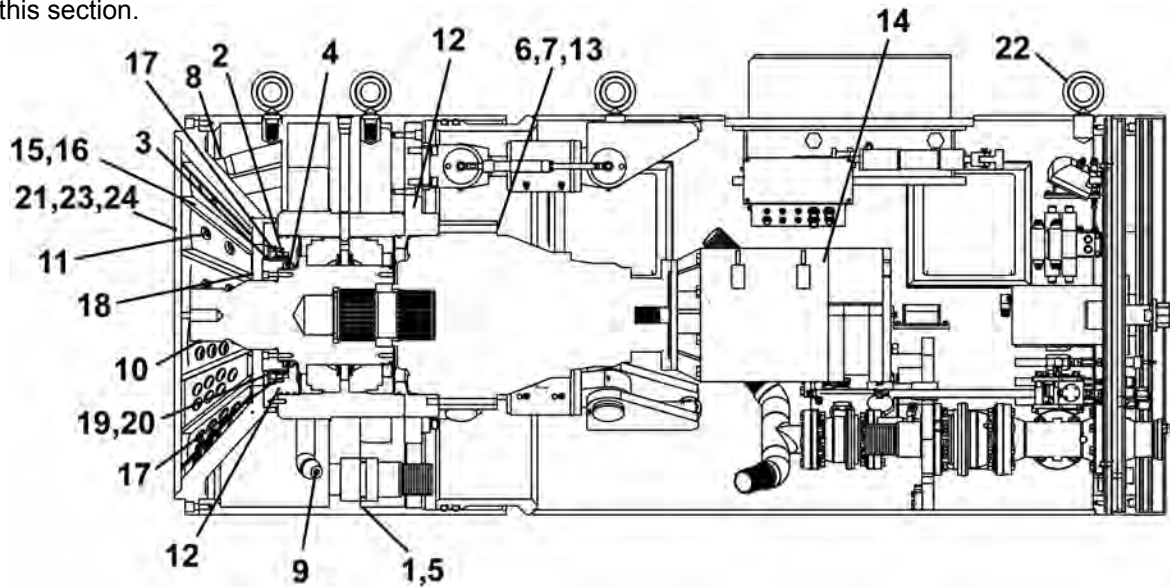
- 9-144 Pre-Launch
- 9-149 End Of Bore
- 9-151 MTBM Service Check List

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. For a comprehensive listing of periodic maintenance for the microtunneling system, refer to the Maintenance Check Lists at the end of this section.

NOTICE

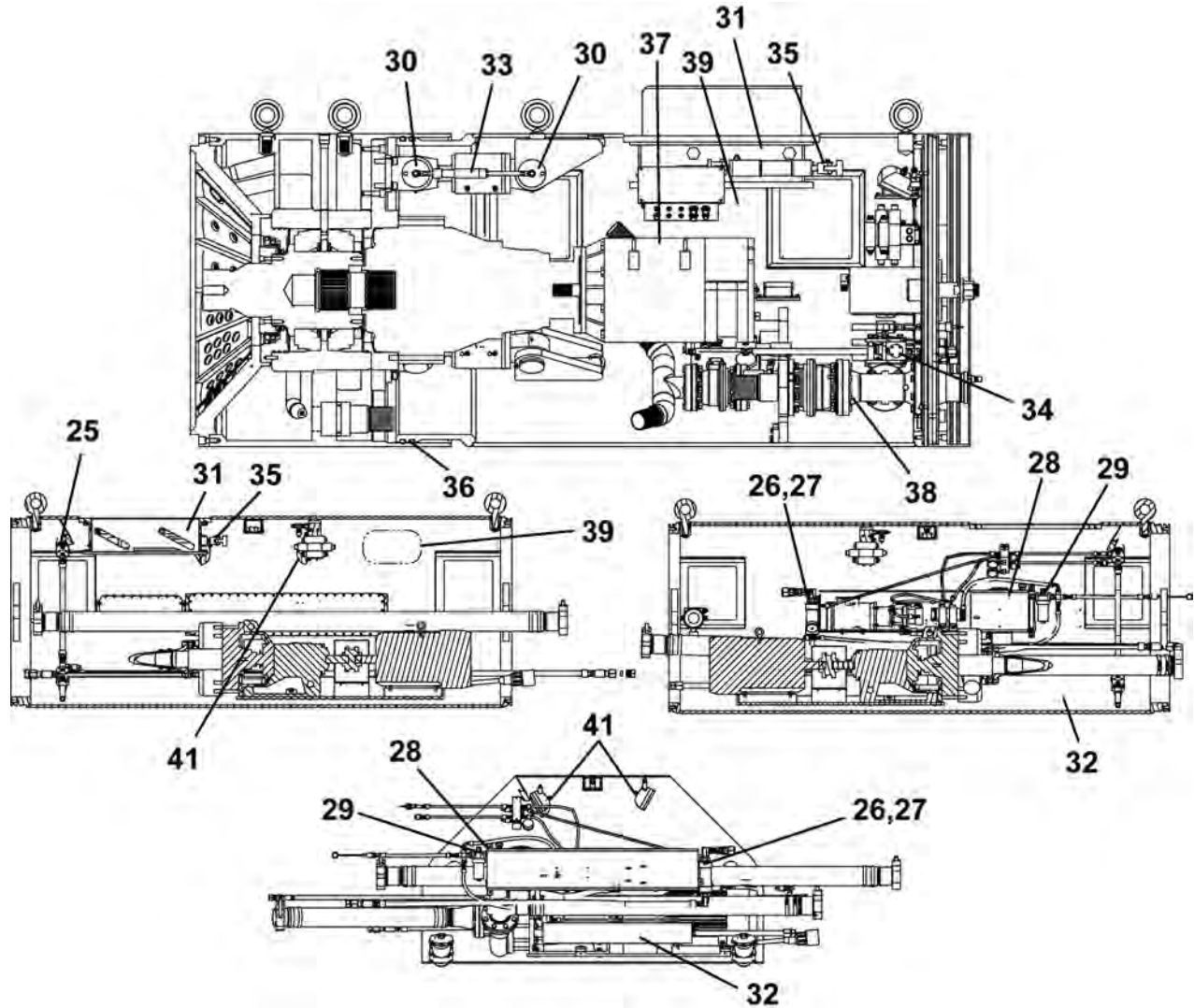
Use the item number in the chart to refer to the detailed maintenance procedures later in this section.



PRIOR TO EACH DRIVE LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Bearing Cavity	Inspect Oil Quality	If contamination is present, drain oil inspect seals/bearing & fill with new oil.	Mobil SHC630
2.	Lip Seals	Inspect Seal Condition	If damaged, replace with new.	
3.	Stellite Ring	Inspect	If damaged, replace with new.	
4.	Mechanical Seal	Inspect	If damaged, replace with new.	
5.	Bearing Cavity	Drain & Fill		Mobil SHC630
6.	Gear Box	Inspect Oil Quality	If contamination is present, drain and fill with new oil.	
7.	Gear Box	Drain & Fill		Mobil SHC630
8.	Slurry Cutting Noz.	Inspect Nozzles	Clean if necessary.	
9.	Slurry Chamber Noz.	Inspect Nozzles	Clean if necessary.	
10.	Drive Shaft	Inspect Output Splines		
11.	H.P. Jet Nozzles & Hoses	Inspect	If damaged, replace with new. Replace if cracks/wear visible.	
12.	Brg Retain. Plate	Torque Bearing Ret. Bolts	Tighten to 310 ft-lb torque.	
13.	Gear Box	Check Mounting Bolts	See detail for proper torque.	
14.	Drive Motor	Check Mounting Bolts	See detail for proper torque.	
15.	Crushing Cone	Inspect Hardface Weld		
16.	Crushing Cone	Check Mounting Hardware	See detail for proper torque.	
17.	Lip Seal Retain Ring	Torque Retaining Ring Bolts	See detail for proper torque.	
18.	Mechanical Seal Retaining Ring	Torque Retaining Ring Bolts	See detail for proper torque.	
19.	Lip Seals	Greasing	Grease must pass through seals.	
20.	Lip Seals	Water Flushing	Water must pass over seals.	
21.	Cutterhead	Cutterhead Installation	See detail for proper installation.	
22.	Lift Eyes	Inspect	If damaged, replace with new.	
23.	Conical Bits	Inspect	Installed with keepers, able to rotate. replace if damaged.	
24.	Drag Bit	Bolt Torque	Tighten to 460 ft-lb torque.	

(continued on next page)



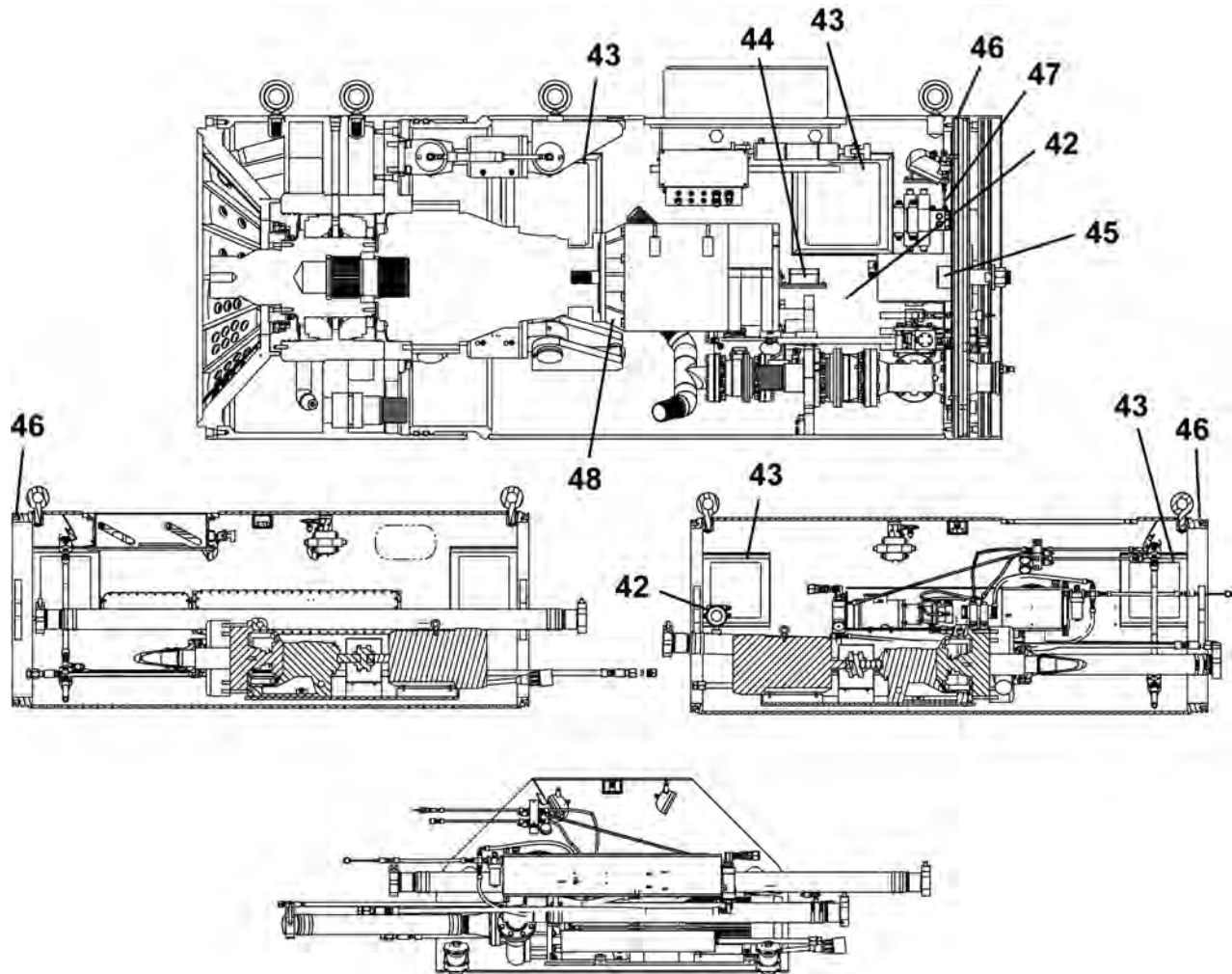
PRIOR TO EACH DRIVE LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
25.	Bentonite Ports	Inspect	Clean if necessary	
26.	Water Cool Pump	Clean Strainer		
27.	HP Jetting Pump	Clean Strainer		
28.	Hyd. Power Pack	Check Reservoir Oil Level	Oil Capacity 4.5 gal.	Tellus Plus Oil 32
29.	Hyd. Power Pack	Check Filter Indicator	Replace per indicator.	
30.	Steering Cyl. Pins	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
31.	Dirt Wing Cavity	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
32.	Submersible Pump	Test Operation		
33.	Steering Cylinders	Calibrate Linear Transducers	Stroke reading: 0 to 100% each cyl.	
34.	Slurry Valve Cyls.	Calibrate Linear Transducers	Stroke reading: 0 to 100% each cyl.	
35.	Dirt Wing Cylinders	Calibrate Linear Transducers	Stroke reading: 0 to 100% each cyl.	
36.	Steering Joint Seals	Inspect, Lubricate, Clean	SL44 - 1/2 tube; SL51 - 1 tube	SHC 101 EAL**
37.	Main Drive Motor	Verify Motor Rotation		
38.	Slurry Valves	Check Operation		
39.	Fill Grease Pump	Fill		Mobil XHP222
*40.	Hoses, Cables & Slurry Lines	Inspect	Replace if damaged.	
41.	Light	Check Operation	Connections: securely fastened.	

* Not Shown

** Mobil® SHC 101 EAL Grease

(continued on next page)



PRIOR TO EACH DRIVE LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
42.	Gas Detector	Test Operation	See Gas Detection Manual	Marine Brg Grs.
43.	Access Covers	Lubricate		
44.	Inclinometers	Calibrate		
45.	Target	Clean & Check Roll Incline	Use mild, abrasive-free cleaning solution and scratch free cloth If damaged, replace with new.	
46.	Coupling Sleeve & Orings	Inspect & Lubricate		
47.	Head Temp. Sensor	Verify Temp At Target Scm.		
48.	Drive Motor Temp.	Verify Temp At Target Scm.		
*49.	Decals	Inspect	Must be legible. Replace as needed.	

* Not Shown

1. CHECK BEARING CAVITY OIL CONDITION

1. Check the oil condition of the bearing cavity (A) by draining a measured sampling of the oil. Be sure to clean the area around the ports/hose cap before removing them to prevent contamination from entering bearing cavity.

Typical Port Locations

- SL52.5 & smaller have external ports (B) in the 3, 9 and 12 o'clock positions.
- SL60 & greater have internal ports. A drain hose (C) is connected to the drain port (D) and is routed to the front section bulkhead area for ease of draining the bearing cavity.

2. Inspect the drained oil for contaminants.

- If water is visible in the oil, the lip seals and mechanical seals are damaged and must be replaced. See 2. Inspect Lip Seals in this section.
- If grease is visible in the oil, the mechanical seals are damaged and must be replaced. See 4. Inspect Mechanical Seals in this section.
- With any contamination, the bearing cavity must be completely drained and refilled with new, clean Mobil SHC™ 630 oil, once the mechanical seals and lip seals are replaced.

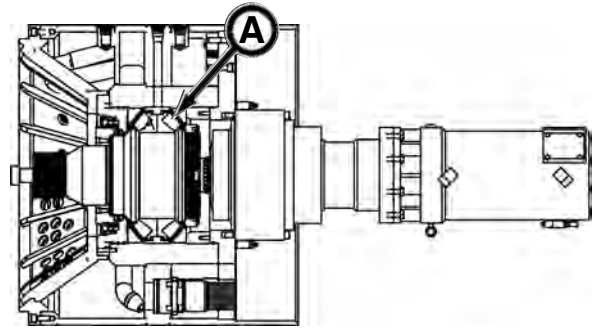
NOTICE

It is recommended to replace the mechanical seals and lip seals with any signs of contamination.

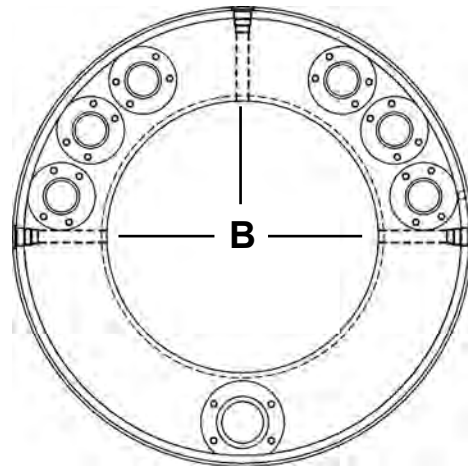
- Check the lip seal retaining ring and mechanical seal retaining ring for damage. If rings have excessive damage, replace with new.

3. Replenish bearing cavity of the volume of oil drained when checking the condition of the oil (from step 1). Use new, clean Mobil SHC™ 630 oil. Replace fill plug/hose cap.

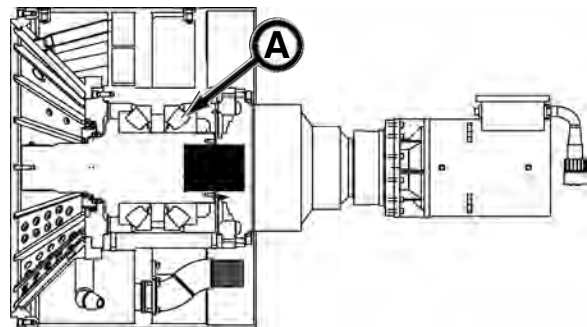
4. Be sure all bearing cavity plugs are in place and sealed.



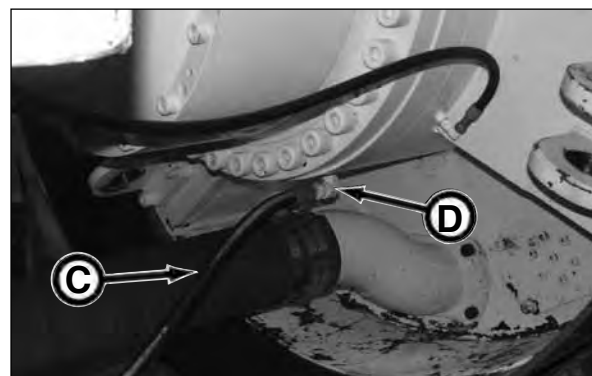
SL44 (SN FA04200F) Drive Assembly Shown



SL44 (SN FA04200F) External Port Locations Shown



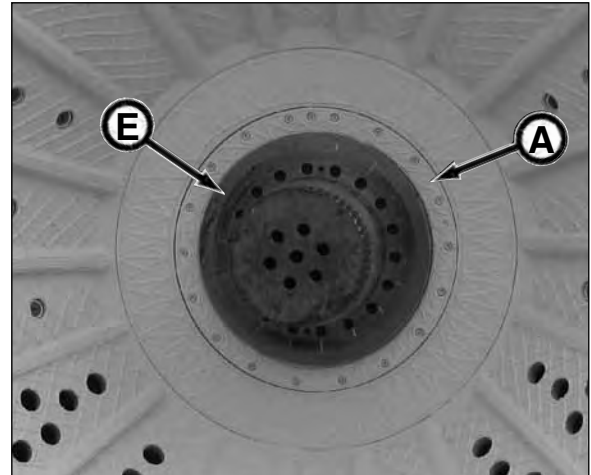
SL72 (SN FA07100F) Drive Assembly Shown



SL72 (SN FA07100F) Bearing Cavity Drain Hose Shown With Back Drum Removed

2. INSPECT LIP SEALS

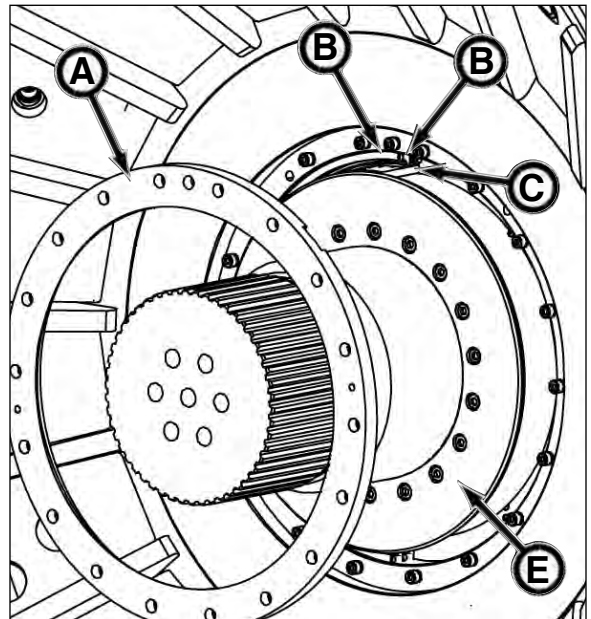
1. With cutterhead removed, remove lip seal retaining ring (A). Inspect ring for excessive wear or damage. If wear or damage is present, the ring must be replaced with new.



2. Inspect lip seals (B) for wear, cracking and other damage. If seals show signs of damage, the lip seals must be replaced. Replace lip seals if necessary.
3. While the lip seal retaining ring is removed, check the stellite ring (C). Refer to 3. Inspect Stellite Ring in this section.

NOTICE

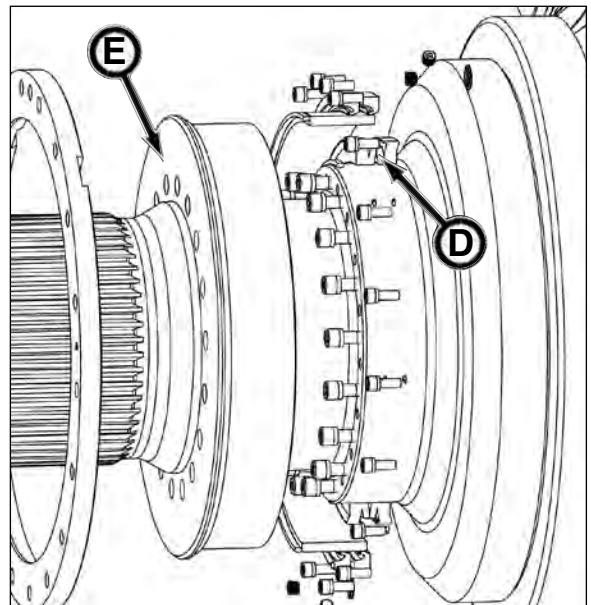
Precise lip seal replacement is critical to prevent contamination from entering the bearing cavity. The lip seal replacement **MUST** be performed by an experienced technician. Contact your Akkerman Aftermarket Support representative for lip seal replacement.



NOTICE

It is recommended to replace the mechanical seals (D) and lip seals with any signs of contamination. Remove mechanical seal retaining ring (E) to gain access to the mechanical seals.

- Check the lip seal retaining ring (A) and mechanical seal retaining ring (E) for damage. If rings have excessive damage, replace with new.



3. INSPECT STELLITE RING

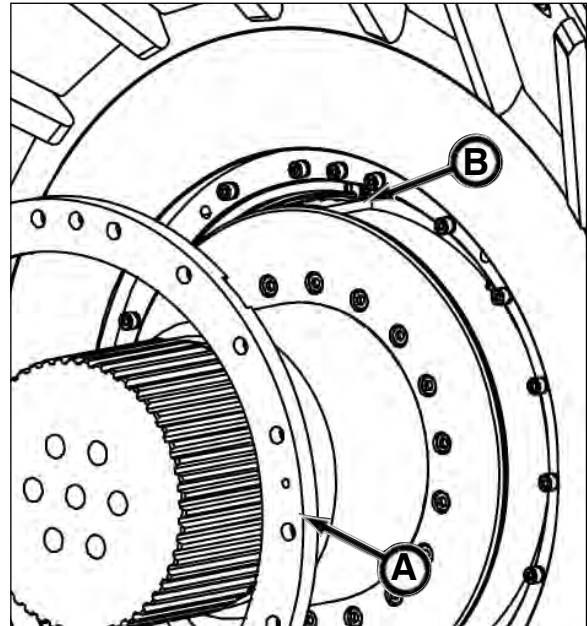
1. With the lip seal retaining ring (A) removed, check the stellite ring (B) for grooves.
2. Apply a thin coat of oil on a flat feeler gauge.
3. Insert the gauge between the lip seals and the stellite ring at four to six positions around the ring.
4. If grooves are discovered, the stellite ring must be replaced.

NOTICE

Precise stellite ring replacement is critical to prevent contamination from entering the bearing cavity. The stellite ring must be cut off from the mechanical seal retaining ring, then a new stellite ring must be heated and fit onto the mechanical seal retaining ring. The stellite ring replacement **MUST** be performed by an experienced technician. Contact your Akkerman Aftermarket Support representative for stellite ring replacement.

NOTICE

It is recommended to replace both the mechanical seals and lip seals with any signs of contamination.



4. INSPECT MECHANICAL SEALS

If the bearing cavity oil shows signs of contamination, the mechanical seal must be inspected.

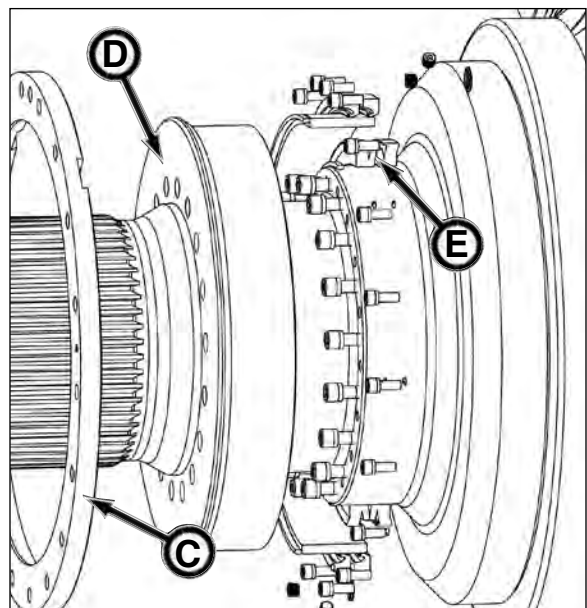
1. With the lip seal retaining ring removed (C), remove the mechanical seal retaining ring (D).
2. Inspect mechanical seal (E) for wear, cracking or damage. If there are any signs of wear or damage the mechanical seal must be replaced.

NOTICE

Precise mechanical seal replacement is critical to prevent contamination from entering the bearing cavity. The mechanical seal replacement **MUST** be performed by an experienced technician. Contact your Akkerman Aftermarket Support representative for mechanical seal replacement.

NOTICE

It is recommended to replace both the mechanical seals and lip seals with any signs of contamination.



5. DRAIN & FILL BEARING CAVITY OIL

If there are any signs of contamination, after a drive with difficult ground conditions, or the oil requires replacing due to a maintenance interval, replace the bearing cavity (A) oil as follows:

1. Clean area around drain, check and fill plugs/ hose caps.
2. Remove bearing cavity drain plug/hose cap and drain oil completely into an appropriate sized catch pan. Replace drain plug/hose cap. Recycle oil properly. Smaller MTBMs may have to be rotated to drain oil from one of the ports.

Typical Port Locations

- SL52.5 & smaller have external ports (B) in the 3, 9 and 12 o'clock positions.
- SL60 & greater have internal ports. A drain hose (C) is connected to the drain port (D) and is routed to the front section bulkhead area for ease of draining the bearing cavity.

3. Remove bearing cavity fill plug (E).

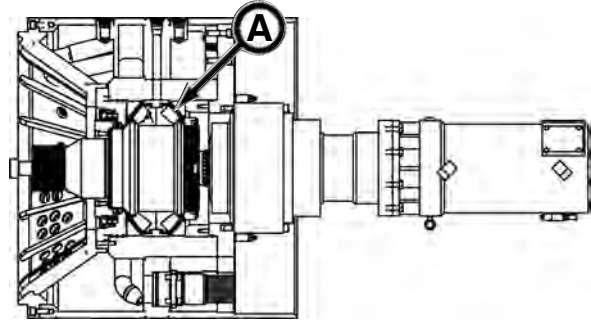
4. Add oil with the following oil volume:

SL 44	3.4 gal (12.9 L)
SL 52.5	3.2 gal (12 L)
SL 60	21.5 gal (81.4 L)
SL72	21.5 gal (81.4 L)
SL74	21.5 gal (81.4 L)

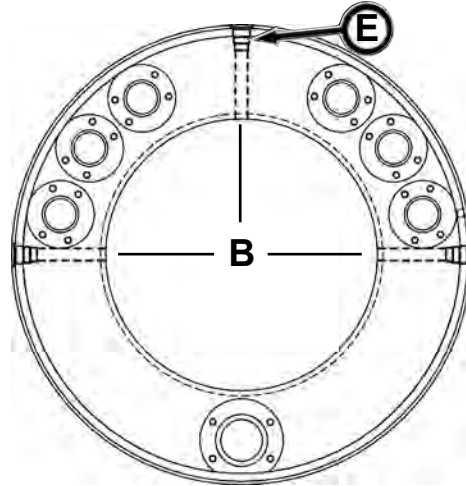
NOTICE

The bearing cavity oil capacity is considered full when oil level in bearing cavity is at 3/4 full.

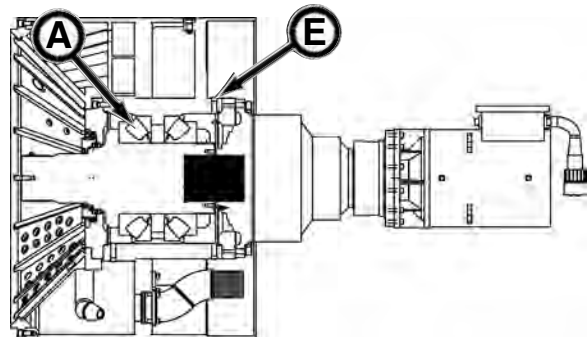
5. Replace fill plug.



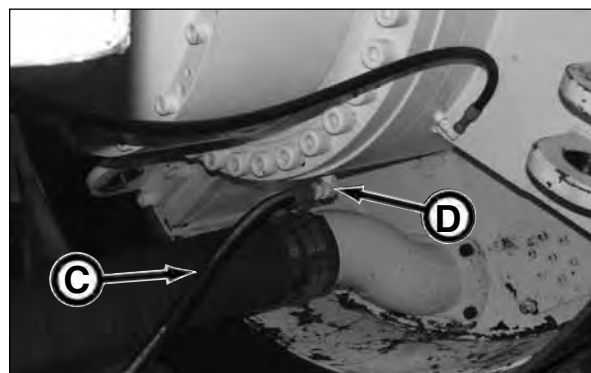
SL44 (SN FA04200F) Drive Assembly Shown



SL44 (SN FA04200F) External Port Locations Shown



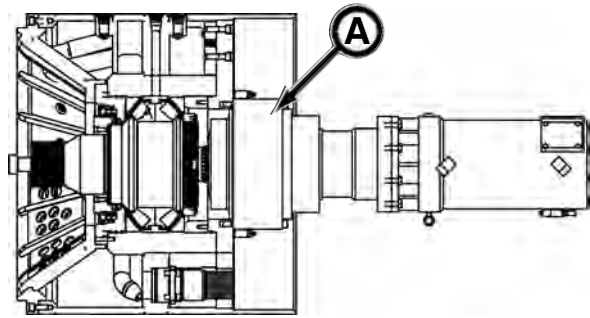
SL72 (SN FA07100F) Drive Assembly Shown



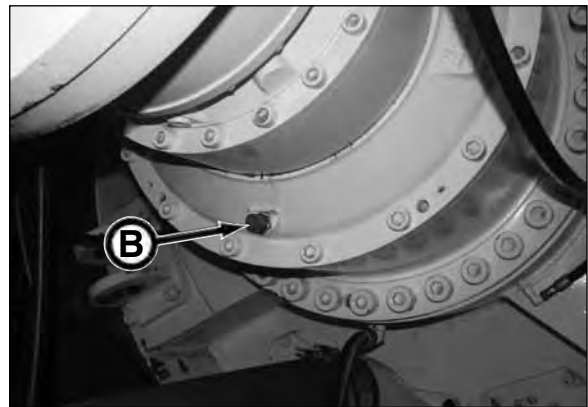
SL72 (SN FA07100F) Bearing Cavity Drain Hose Shown With Back Drum Removed

6. CHECK GEAR BOX OIL CONDITION

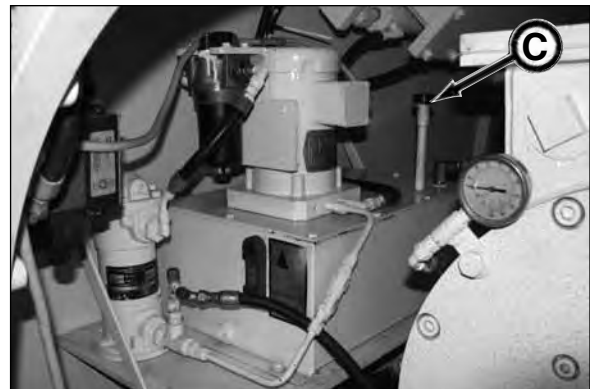
1. Check the gear box (A) oil condition by draining a measured sampling of the oil from the drain port (B). Be sure to clean the area around the ports before removing them to prevent contamination from entering gear box housing.
 2. Inspect the drained oil for contaminants. If there are any signs of contamination; water, metal fragments etc, the gear box oil must be replaced (refer to 7. Drain and Fill Gear Box Oil in this section).
 3. If there are any signs of oil leakage around the gear box, the gear box oil must be replaced (refer to 7. Drain and Fill Gear Box Oil in this section).
 4. Replenish gear box housing of the volume of oil drained when checking the condition of the oil (from step 1). Use new, clean Mobil SHC™ 630 oil.
- Non oil recirculating pump MTBMs: add oil through fill port on gear box.
 - Oil Recirculating pump MTBMs: add oil through fill port (C) on recirculating pump reservoir.



Non Oil Recirculating Pump MTBM Shown



Gear Box Drain Port



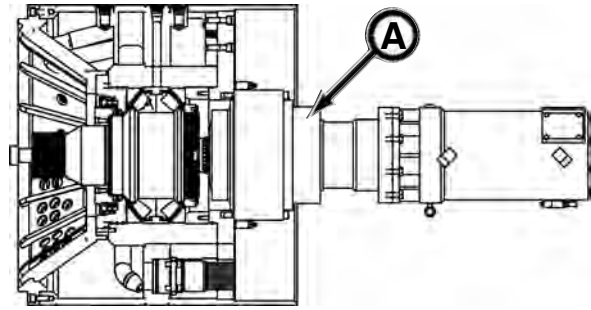
Oil Recirculating Pump MTBM Shown

7. DRAIN & FILL GEAR BOX OIL

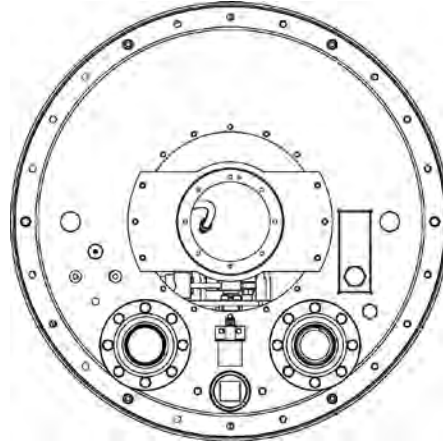
If there are any signs of oil leakage or contamination, replace the gear box (A) oil as follows:

Non Oil Recirculating Pump Models

1. Clean area around drain, check and fill port hose caps. Typically there is a hose to the drain, check and fill ports and routed to the front section bulkhead for ease of draining, checking and filling gear box.
2. Remove fill and drain hose caps. Drain gear box oil completely into an appropriate sized catch pan.
3. Once oil is drained, replace drain hose cap. Recycle oil properly.
4. Remove check hose cap.
5. Fill gear box by measuring oil volume with new, clean Mobil SHC™ 630 oil through fill hose until oil runs out of check hose.
6. Cap check hose.
7. Add 1/2 the oil volume amount added in step 5. Replace fill hose cap. This will fill the gear box to the proper 3/4 full level. The gear box is considered full at the 3/4 level.
8. Cap fill hose.



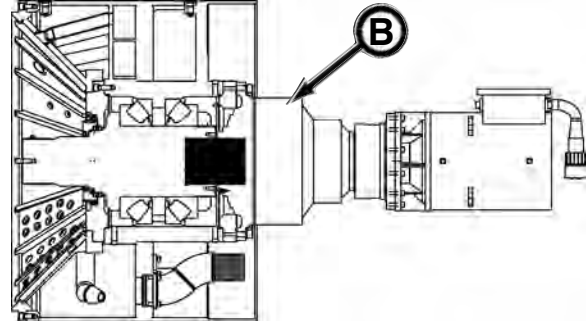
SL44 (SN FA04200F) Drive Assembly Shown



SL44 (SN FA04200F) Backdrum Bulkhead Shown

Oil Recirculating Pump Models

1. Clean area around the gear box (B) drain and fill ports.
2. Remove fill and drain plugs and drain oil completely into an appropriate sized catch pan.
3. Once oil is drained, replace drain plug. Recycle oil properly.
4. Add oil to the oil recirculating pump reservoir (C) until it reaches the full mark on the sight gauge (D). Start pump by turning Head Power switch (E) to ON position, and recheck oil level on sight gauge. Do not overfill. If oil is at full mark on sight gauge, oil level is correct.
5. If oil level is less than full mark on sight gauge, turn Head Power switch (E) to OFF position to stop oil recirculating pump.
6. Add oil to full mark on oil recirculating pump reservoir. Start pump and recheck oil level on sight gauge. Do not overfill.
7. Check oil filter indicator and replace filter if necessary.

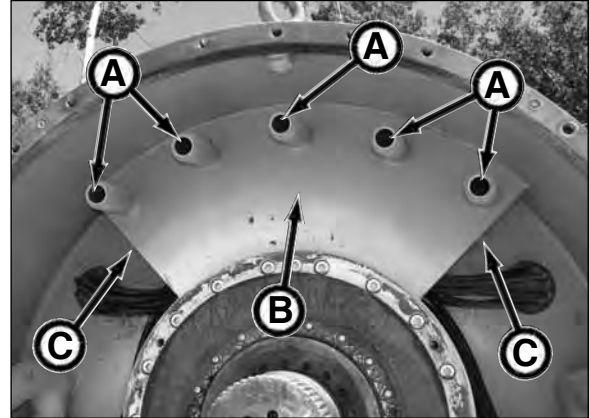


SL72 (SN FA07100F) Drive Assembly Shown



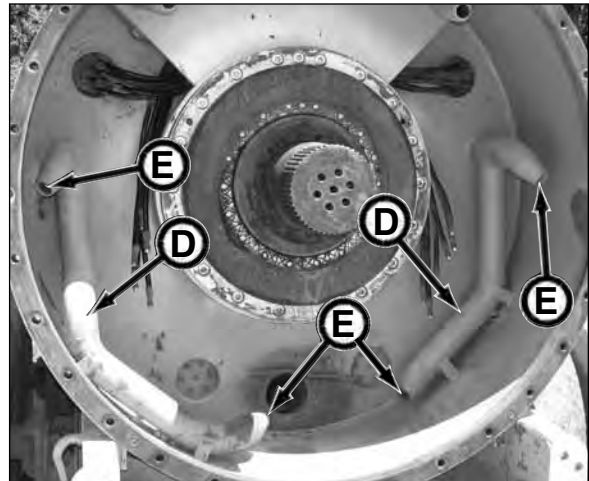
8. INSPECT SLURRY CUTTING NOZZLES

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 plugs (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 ports.
 - c. **REPLACE CLEANOUT PLUGS!** Failure to replace cutting nozzle manifold cleanout plugs will render the cutting nozzles useless during operation.
5. Proceed to inspect/clean slurry chamber nozzles before reinstalling crushing cone.



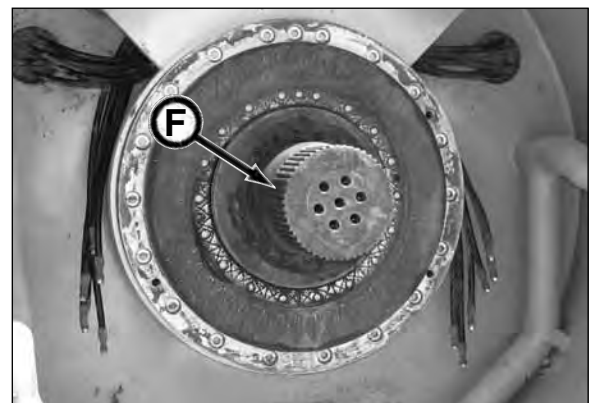
9. INSPECT SLURRY CHAMBER NOZZLES

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.



10. INSPECT DRIVE SHAFT SPLINES

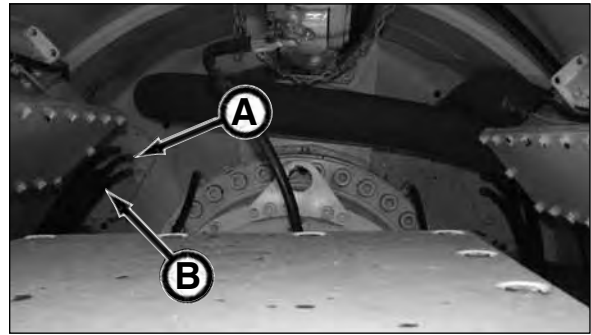
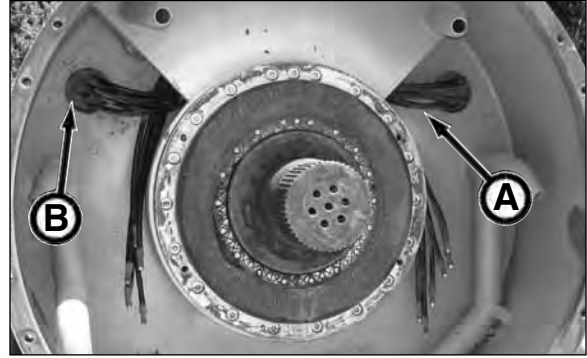
With the crushing cone removed, inspect the drive shaft output splines (F). If damage to the splines is visible, repair or replace.



11. INSPECT HIGH PRESSURE JETTING NOZZLES, HOSES & VALVES

NOTICE Flush high pressure system before operation to remove rust flakes or sediment within the system.

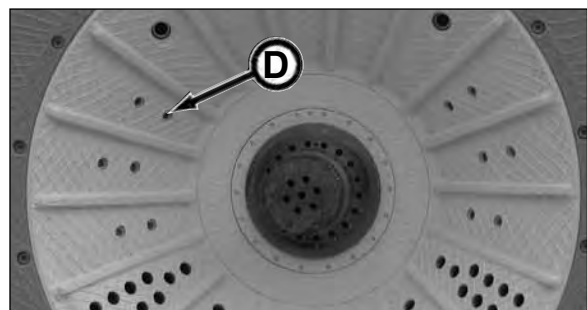
1. Inspect high pressure all jetting hoses (A), fittings (B) and power cables (C) for cracks, wear or damage. Replace as needed.



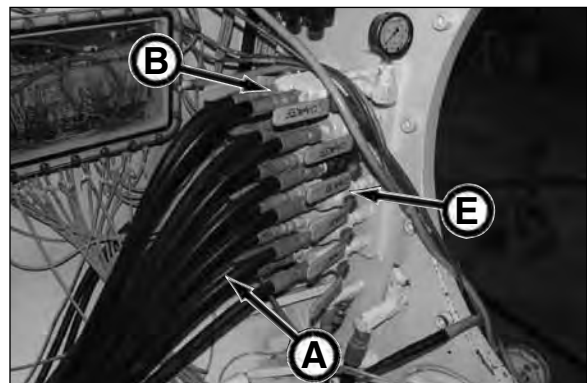
2. Check high pressure jetting pump power cables (C) for cracking, wear or damage. Replace as needed.



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.



12. CHECK FRONT & REAR BEARING RETAINING PLATE MOUNTING HARDWARE (IF EQUIPPED)

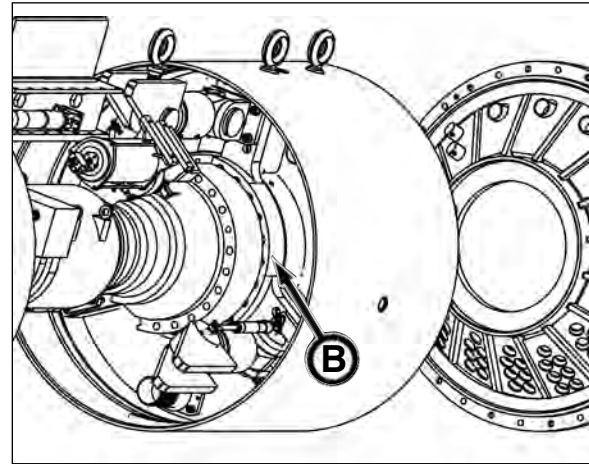
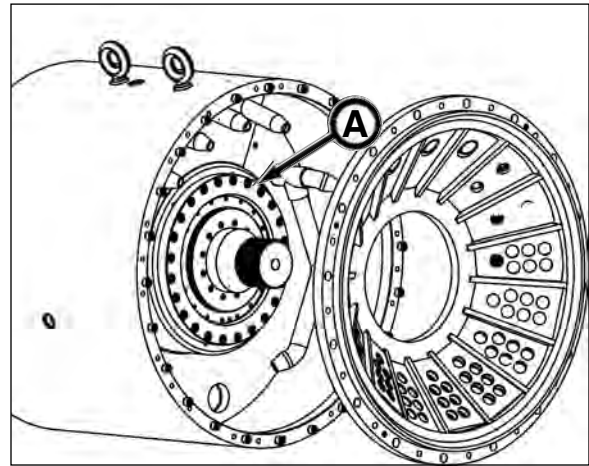
With a calibrated torque wrench, check bearing retaining plate (if equipped) mounting 3/4 socket head cap screw torque to 310 ft-lb (425 N·m) *.

Front Bearing Retaining Plate (A)

Rear Bearing Retaining Plate (B)

* Lubricated

SL51 Shown



13. CHECK GEAR BOX MOUNTING HARDWARE

With a calibrated torque wrench, check gear box mounting socket head cap screw (C) torque as follows:

MTBM	Hardware	Torque
SL44	3/4 SHCS	310 ft-lb (425 N·m) *
SL51	3/4 SHCS	310 ft-lb (425 N·m) *
SL52.5	3/4 SHCS	310 ft-lb (425 N·m) *
SL60	1-1/4 SHCS	1,500 ft-lb (2,050 N·m) *
SL72	1-1/4 SHCS	1,500 ft-lb (2,050 N·m) *
SL74	1-1/4 SHCS	1,500 ft-lb (2,050 N·m) *

* Lubricated

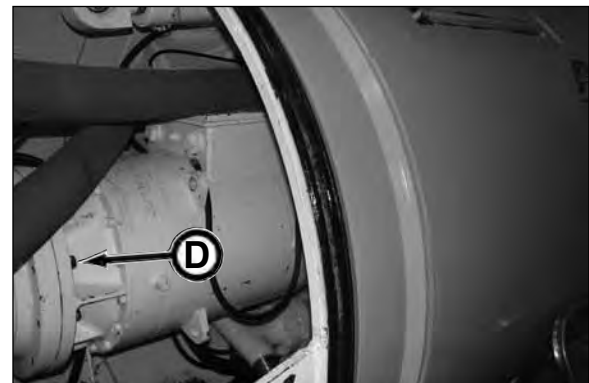


14. CHECK DRIVE MOTOR MOUNTING HARDWARE

With a calibrated torque wrench, check drive motor mounting socket head cap screw (D) torque as follows:

MTBM	Hardware	Torque
SL44	3/4 SHCS	310 ft-lb (425 N·m) *
SL51	3/4 SHCS	310 ft-lb (425 N·m) *
SL52.5	3/4 SHCS	310 ft-lb (425 N·m) *
SL60	M20 SHCS	460 ft-lb (625 N·m) *
SL72	M20 SHCS	460 ft-lb (625 N·m) *
SL74	M20 SHCS	460 ft-lb (625 N·m) *

* Lubricated



15. INSPECT CRUSHER CONE HARDFACE WELD

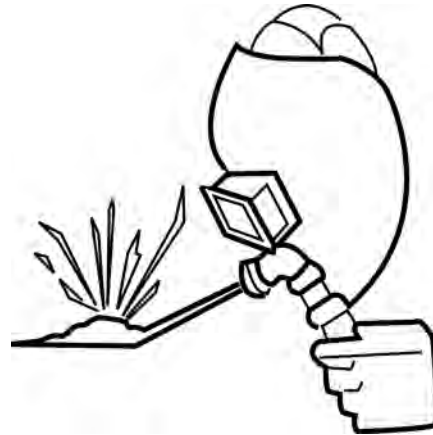
⚠ WARNING Fumes, sparks, radiation and metal splatter from welding can cause serious injury or death.

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.



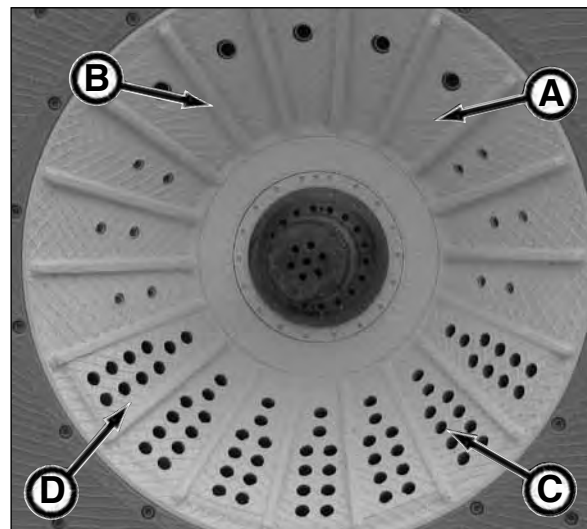
1. Inspect all hardface weld (cross hatched) patterns (A) on the crusher cone and hardface welds on wear bars (B). If weld is missing or worn, the weld must be rewelded to prevent damage to the crusher cone.

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.

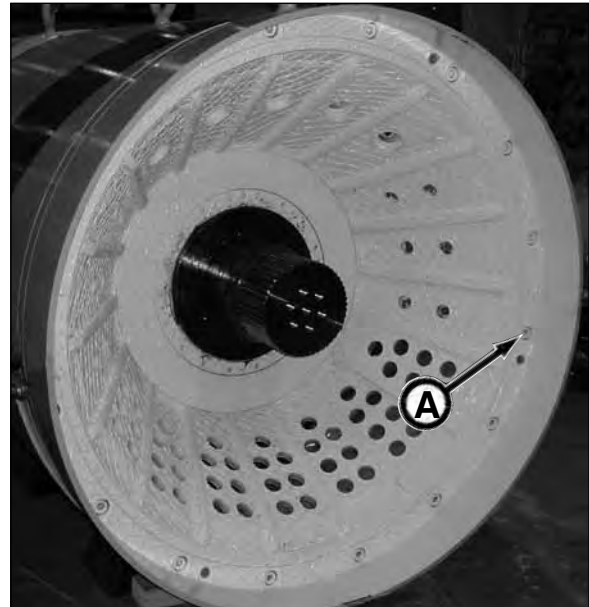


16. CHECK CRUSHING CONE MOUNTING HARDWARE

With a calibrated torque wrench, check crushing cone mounting socket head cap screw (A) torque as follows:

MTBM	Hardware	Torque
SL44	3/4 SHCS	310 ft-lb (425 N·m) *
SL51	3/4 SHCS	310 ft-lb (425 N·m) *
SL52.5	3/4 SHCS	310 ft-lb (425 N·m) *
SL60	1 SHCS	750 ft-lb (1,050 N·m) *
SL72	1 SHCS	750 ft-lb (1,050 N·m) *
SL74	1 SHCS	750 ft-lb (1,050 N·m) *

* Lubricated

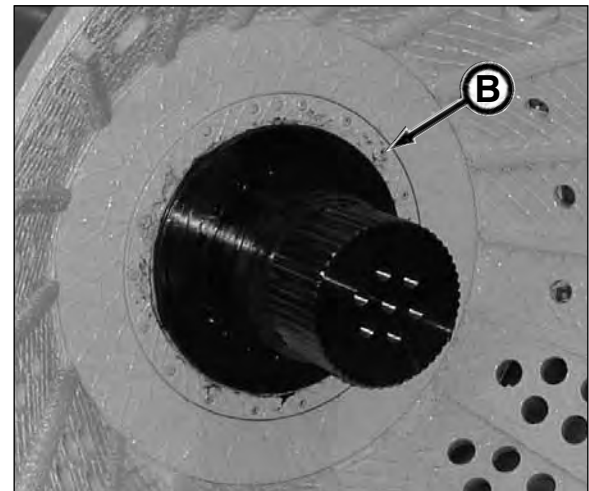


17. CHECK LIP SEAL RETAINING RING MOUNTING HARDWARE

With a calibrated torque wrench, check lip seal retaining ring mounting socket head cap screw (B) torque as follows:

MTBM	Hardware	Torque
SL44	5/16 SHCS	21 ft-lb (28 N·m) *
SL51	5/16 SHCS	21 ft-lb (28 N·m) *
SL52.5	5/16 SHCS	21 ft-lb (28 N·m) *
SL60	3/8 SHCS	36 ft-lb (50 N·m) *
SL72	3/8 SHCS	36 ft-lb (50 N·m) *
SL74	3/8 SHCS	36 ft-lb (50 N·m) *

* Lubricated



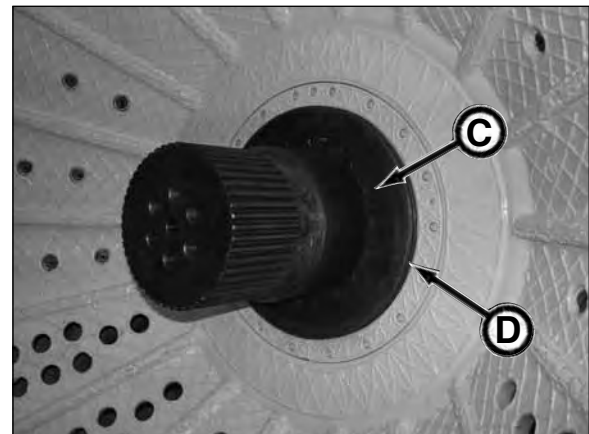
18. CHECK MECHANICAL SEAL RETAINING RING MOUNTING HARDWARE & ORING

1. With a calibrated torque wrench, check mechanical seal retaining ring mounting socket head cap screw (C) torque as follows:

MTBM	Hardware	Torque
SL44	1/2 SHCS	90 ft-lb (120 N·m) *
SL51	1/2 SHCS	90 ft-lb (120 N·m) *
SL52.5	1/2 SHCS	90 ft-lb (120 N·m) *
SL60	1/2 SHCS	90 ft-lb (120 N·m) *
SL72	1/2 SHCS	90 ft-lb (120 N·m) *
SL74	1/2 SHCS	90 ft-lb (120 N·m) *

* Lubricated

2. Check to be sure oring is properly installed in retaining ring groove (D). If oring is cracked, worn or damaged, oring must be replaced.



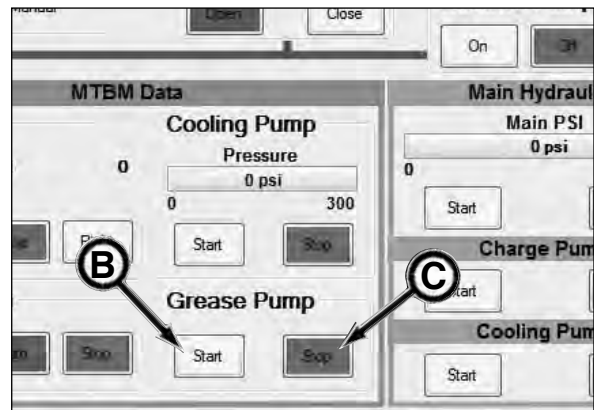
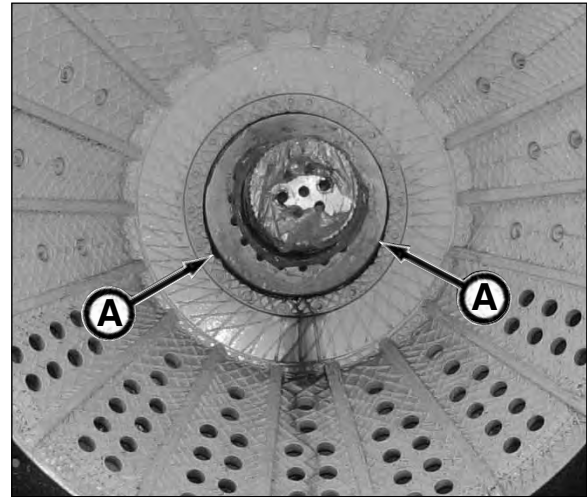
19. CHECK LIP SEAL GREASING

The bearing cavity lip seals must be lubricated to prevent contamination from entering bearing cavity. Excess grease is removed at front face through two grease ports (A).

Turn grease pump on by clicking Grease Pump Start button (B) on the MTBM control screen. Check that grease is visible on the front face area of the cutterhead. This will assure that the grease path is open to properly lubricate the lip seals. Click Grease Pump Stop button (C) once grease is visible on front face.

NOTICE

If oil is visible with the flushed grease on the front face of the cutterhead, the mechanical seal has failed. In this case, the bearing cavity must be flushed, the mechanical seal and lip seals must be replaced, and the bearing cavity filled with new, clean Mobil SHC™ 630 oil.



20. CHECK WATER FLUSHING OF LIP SEALS

The front of the bearing cavity lip seals must be flushed with water to keep abrasives away from the seals.

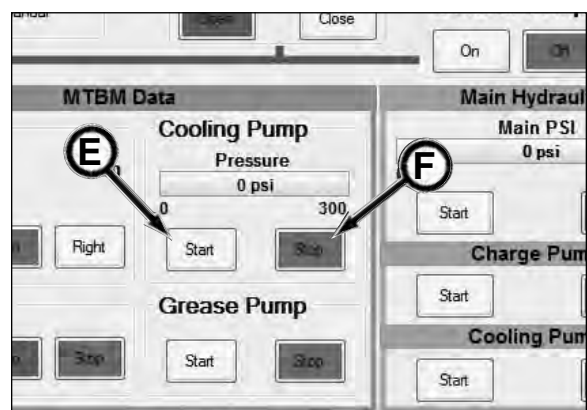
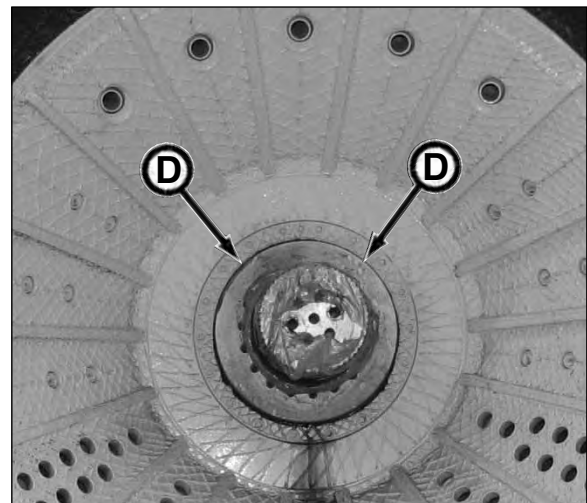
The water cooling the MTBM main drive motor (from the water cooling tank) is removed at the front face through two water ports (D) to keep the seals clean.

If the two water ports become plugged, the pressure buildup will cause the water to bypass to the slurry feed circuit.

Turn cooling pump on by clicking Cooling Pump Start button (E) on the MTBM control screen. Check that water is visible on the front face area of the cutterhead. This will assure that the lip seals are being properly flushed. Click Cooling Pump Stop button (F) once water is visible on front face.

NOTICE

If drive motor is getting warm, it may be a sign that the two water ports are plugged. Do not operate with plugged water ports. Lip seals will be damaged resulting in possible contamination to the bearing cavity.

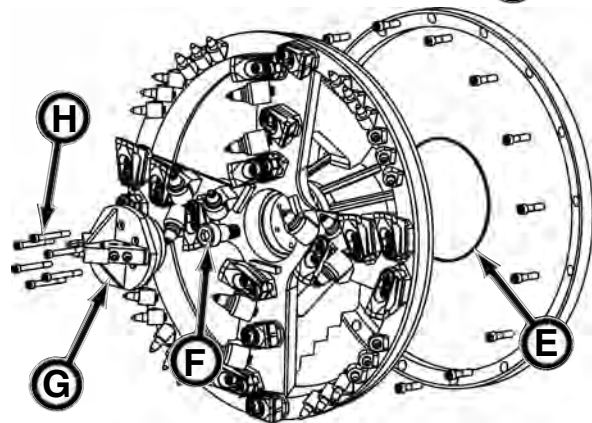
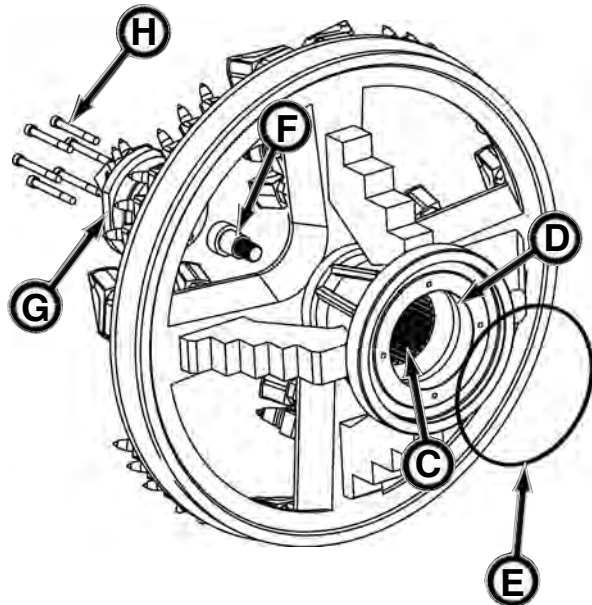
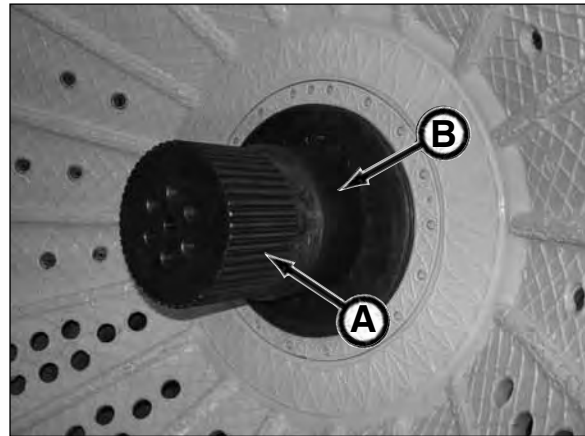


21A. MTBM CUTTERHEAD INSTALLATION SL34, SL36, SL44, SL46, SL51, SL52.5

Install/reinstall cutterhead properly to MTBM.
Depending upon MTBM model, use 21A or 21B to properly install the cutterhead.

NOTICE Precise cutterhead installation is critical otherwise failure will occur. The cutterhead installation **MUST** be performed by an experienced technician.

1. Inspect driveshaft splines (A) for damage.
If damage to the splines is visible, repair or replace.
2. Inspect shaft pilot diameter (B) for damage or excessive wear. The minimum acceptable shaft diameter is 8.746 in.
3. Inspect cutterhead drive hub (rotating crushing cone) splines (C) and pilot diameter (D) for damage and/or excessive wear (maximum acceptable hub pilot diameter 8.756 in.). If damage to the splines is visible, repair or replace.
4. Install and lubricate driveshaft to rotating crushing cone o-ring (E) (Akkerman P/N P0085-383. Replace this o-ring with a new o-ring every time the cutterhead is removed and reinstalled.
5. Lubricate driveshaft and splines with an anti-sieze compound.
6. Install cutterhead by aligning splines of hub and shaft. Push on cutterhead until it seats tightly against mechanical seal retainer ring.
Check dimension: tip of drive shaft to bottom counter bore on cutter head should be 1.938 in.
7. Install cutterhead shoulder bolt (F) (Akkerman P/N A03903P), use medium strength thread locker on the threads and tighten bolt to 1,200 ft-lb torque. DO NOT OVER TORQUE. This bolt must be replaced every time the cutterhead is reinstalled.
8. Insure that shoulder bolt is seated onto drive shaft and the bolt head is not seated onto cutterhead. Cutterhead should have some "endplay" on driveshaft (approximately 1/16 in), otherwise the cutterhead is not installed correctly.
9. Install shoulder bolt retainer plate (mixed ground head) (not shown) or center cutter insert (G) (soft ground head) and tighten retainer bolts (H) to 160 ft-lbs torque.



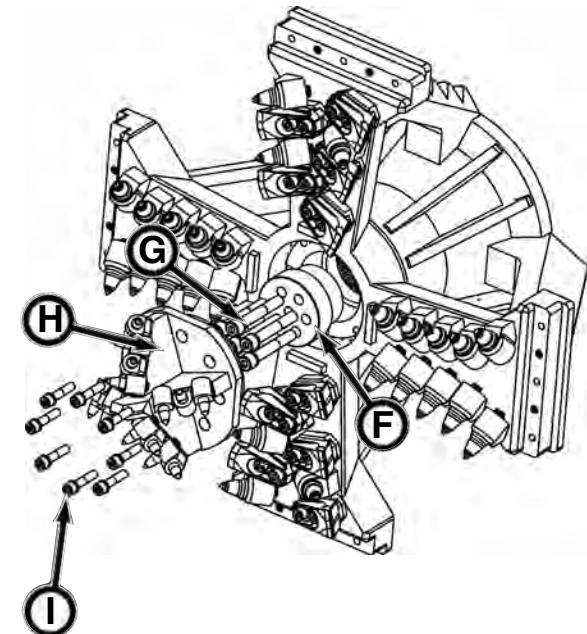
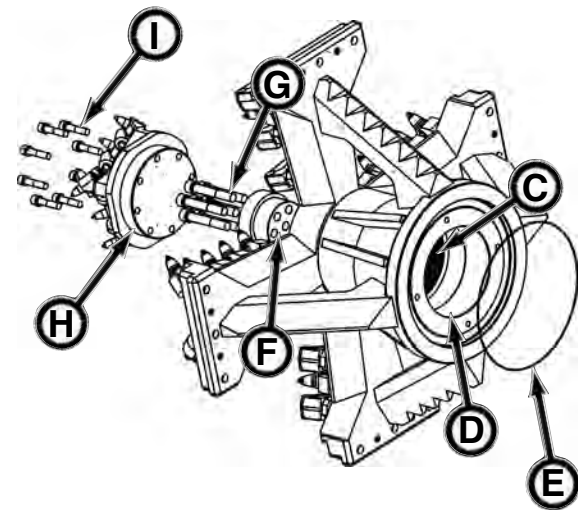
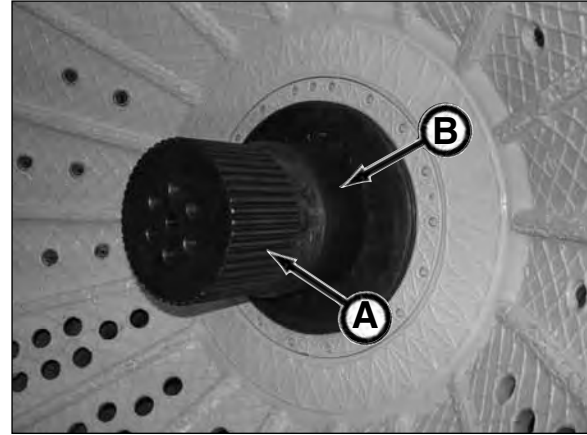
21B. MTBM CUTTERHEAD INSTALLATION SL60, SL72, SL74

Install/reinstall cutterhead properly to MTBM.
Depending upon MTBM model, use 21A or 21B to properly install the cutterhead.

NOTICE

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

1. Inspect driveshaft splines (A) for damage.
If damage to the splines is visible, repair or replace.
2. Inspect shaft pilot diameter (B) for damage or excessive wear. The minimum acceptable shaft diameter is 10.994 in.
3. Inspect cutterhead drive hub (rotating crushing cone) splines (C) and pilot diameter (D) for damage and/or excessive wear (maximum acceptable hub pilot diameter 11.009 in.).
If damage to the splines is visible, repair or replace.
4. Install and lubricate driveshaft to rotating crushing cone o-ring (E) (Akkerman P/N P0085-386. Replace this o-ring with a new o-ring every time the cutterhead is removed and reinstalled.
5. Lubricate driveshaft and splines with an anti-sieze compound.
6. Install cutterhead by aligning splines of hub and shaft. Push on cutterhead until it seats tightly against mechanical seal retainer ring.
7. Install cutterhead retainer (F) (Akkerman P/N A07353P0) and seven grade 8 1 UNC x 6.5 SH bolts (G) (Akkerman P/N P0031-16-026) using an anti-sieze compound on the threads and tighten bolts to 545 ft-lbs torque. **DO NOT OVER TORQUE.** These bolts must be replaced every time the cutterhead is reinstalled.
8. Cutterhead should have some "endplay" on driveshaft (approximately 1/16 in), otherwise the cutterhead is not installed correctly.
9. Install retainer cover plate (H) and tighten bolts (I) to 250 ft-lbs torque.



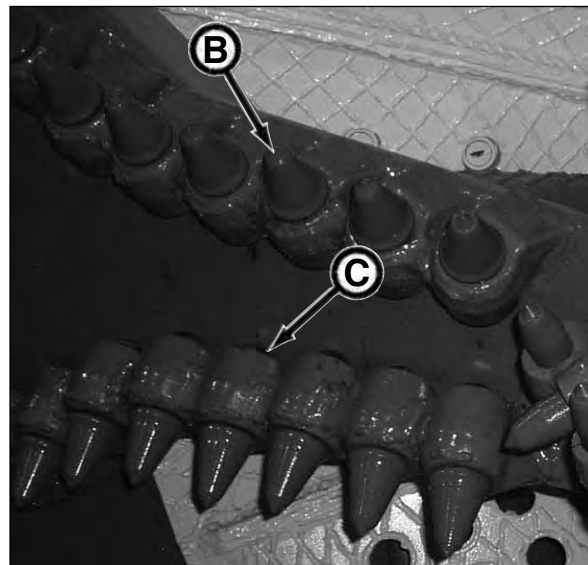
22. INSPECT LIFT EYES

Before lifting MTBM, check lift eyes (A) for damage. Worn or damaged lift eyes **MUST** be replaced before lifting MTBM.



23. INSPECT CONICAL BITS

1. Inspect conical bits (B) for damage. If worn, damaged or missing, replace with new.
2. Check to be sure snap ring keepers (C) are in place and not damaged. If damaged, the keeper must be replaced.
3. Check to be sure the conical bit can rotate. The bit must be able to rotate for even wear on the carbide tip. If bit does not rotate, replace bit.

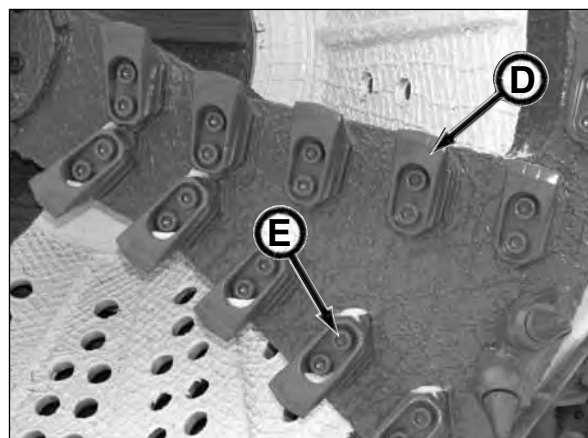


24. INSPECT DRAG BITS

1. Inspect drag bits (D) for wear or damage. If worn, damaged or missing, replace with new.
2. If cap screws require retightening, replace with new. Then with a calibrated torque wrench, tighten drag bit socket head cap screws (E) to the following torque:

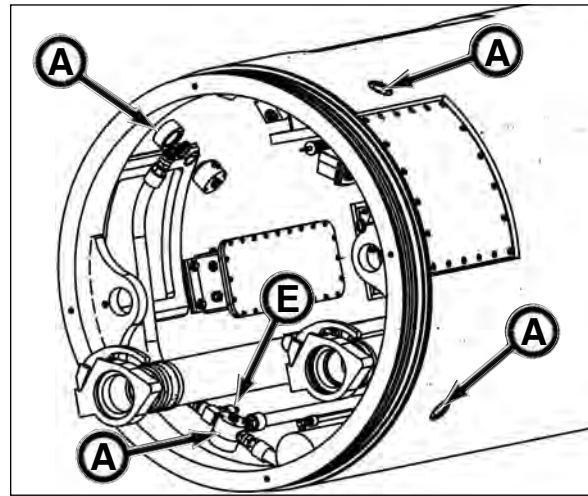
M20 SHCS 460 ft-lb (625 N·m) *

* Lubricated

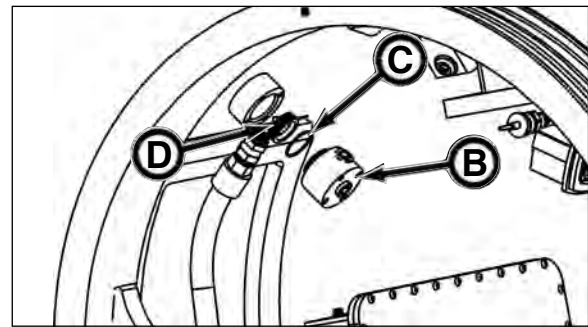


25. INSPECT BENTONITE PORTS

1. Bentonite hoses and ports must be flushed after the completion of each drive to prevent hardening of bentonite in the bentonite hoses and ports.
2. Test ports (A) 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.
3. Check bentonite port by removing four bolts from cap (B).
4. Remove cap (with hose[s]) from bentonite port to gain access to oring (C) and check valve (D).
5. Check oring and check valve for wear or damage. When replacing, be sure check valve and oring are properly seated in port.
6. Replace cap and secure with bolts removed in step 3.
7. Repeat steps 3 through 6 for other bentonite ports.
8. Check pressure transducer (E) for damage. Replace if needed. Also, check that the transducer is operational as shown on the Additional Data MTBM control screen.



SL44 (SN FA04200F) Shown



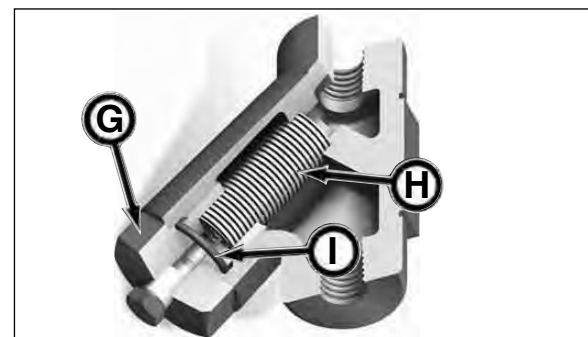
26. CLEAN DRIVE MOTOR WATER COOLING STRAINER SCREEN

Clean strainer screen in drive motor water cooling strainer assembly (F) as follows:

1. Remove cap (G).
2. Remove strainer screen (H). Clean strainer or if needed, replace with new.
3. Install screen. Be sure it is properly seated in strainer body.
4. Inspect oring for (I) cracking or damage. Replace with new if needed.
5. Install oring. Be sure it is properly seated on cap.
6. Reinstall cap.



Strainer Shown In Trailing Dolly



Strainer Cutaway Illustration

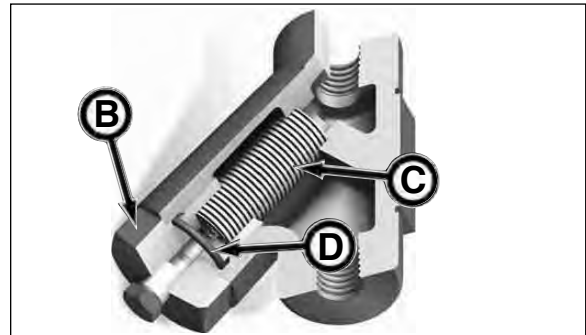
27. CLEAN HIGH PRESSURE JETTING STRAINER SCREEN

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 Shown In Trailing Dolly



Strainer Cutaway Illustration

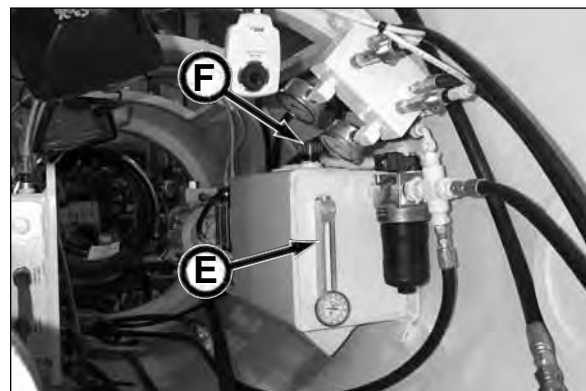
28. CHECK MTBM HYDRAULIC POWER PACK OIL RESERVOIR LEVEL & CONDITION OF OIL

The MTBM 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 fresh 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 (E).

If oil is needed, clean and dry area around fill cap (F), remove fill cap and fill until tank is at full mark with Tellus® Plus Oil 32 or equivalent. Replace oil cap.

Oil capacity is 4.5 US gal. (17 L).



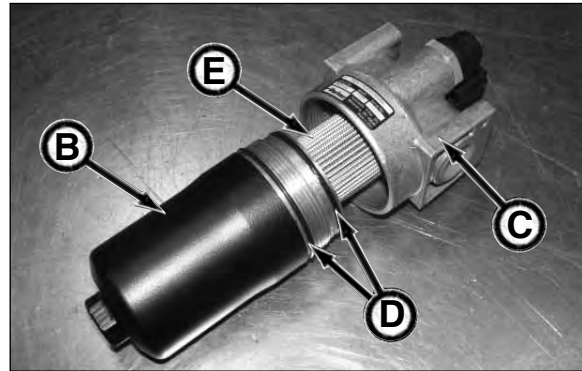
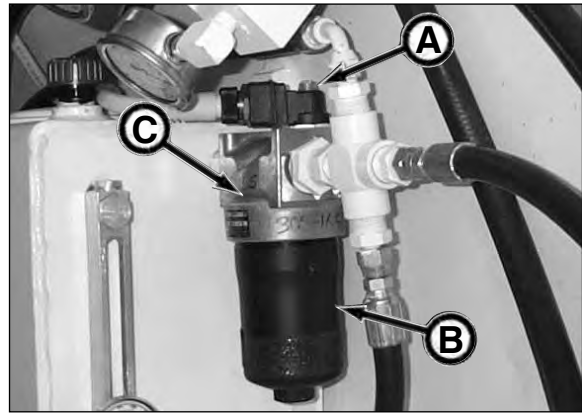
29. CHECK MTBM HYDRAULIC POWER PACK RETURN FILTER INDICATOR

To prevent under or over servicing of the MTBM 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.

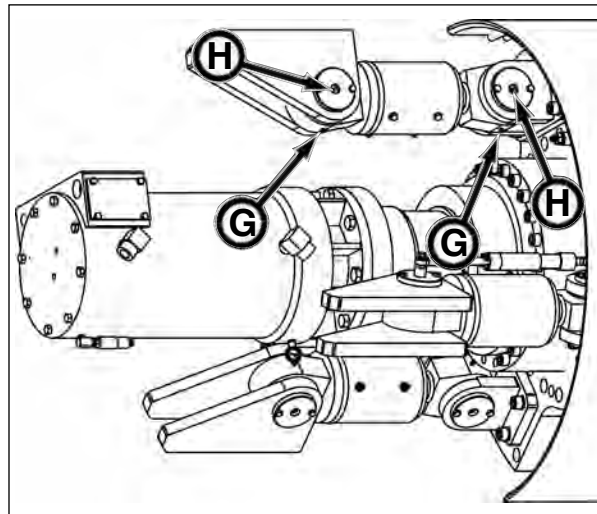
If the filter indicator is red, the filter should be replaced as soon as possible to prevent hydraulic component damage using the following procedure:

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.



30. LUBRICATE STEERING CYLINDERS

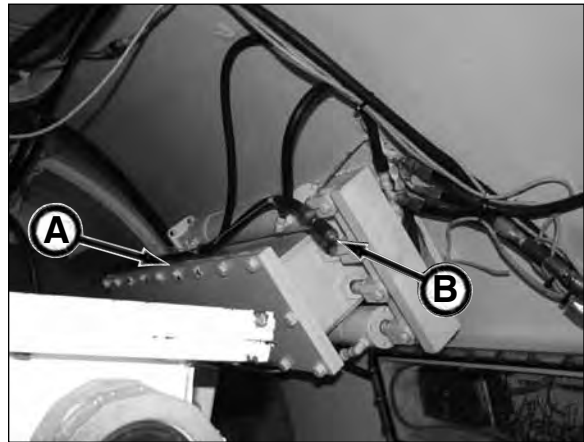
Lubricate steering cylinder pins (G) (2 places per cylinder) and cylinder bearings (H) (2 places per cylinder) until grease is forced out with Mobilgrease® XHP222 or equivalent.



31. LUBRICATE DIRT WING CAVITY

The dirt wing cavity (A) must be filled with grease to prevent dirt or other contaminants from entering cavity area.

Lubricate dirt wing cavity with Mobilgrease® XHP222 or equivalent until grease is forced out. Use grease fill hose (B) to fill cavity.

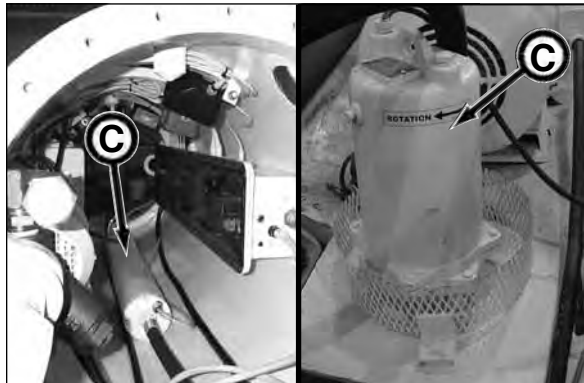


32. CHECK SUBMERSIBLE PUMP OPERATION

The submersible pump located in the trailing section or trailing dolly, removes water from the tunnel floor and expels the water to the slurry return line.

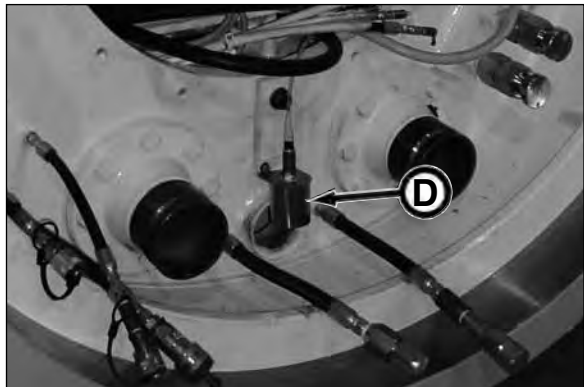
Check submersible pump (C) as follows:

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 submersion Pump control on the MTBM control screen is either on Start or Auto mode. Or check for cable damage. Replace components as needed



MTBM SL30

MTBM SL74



33. CALIBRATE STEERING CYLINDER LINEAR TRANSDUCERS & CHECK STEERING VALVE OPERATION

CALIBRATING LINEAR TRANSDUCERS

Linear transducers (A) on the steering cylinders allow the operator to monitor the position of the steering cylinders during the tunneling operation.

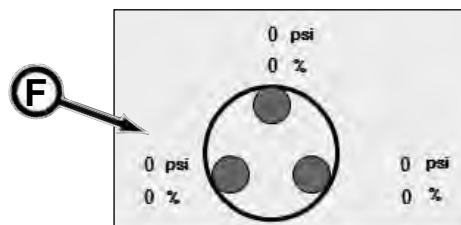
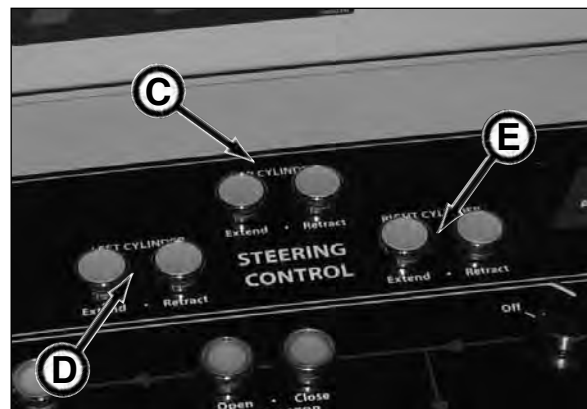
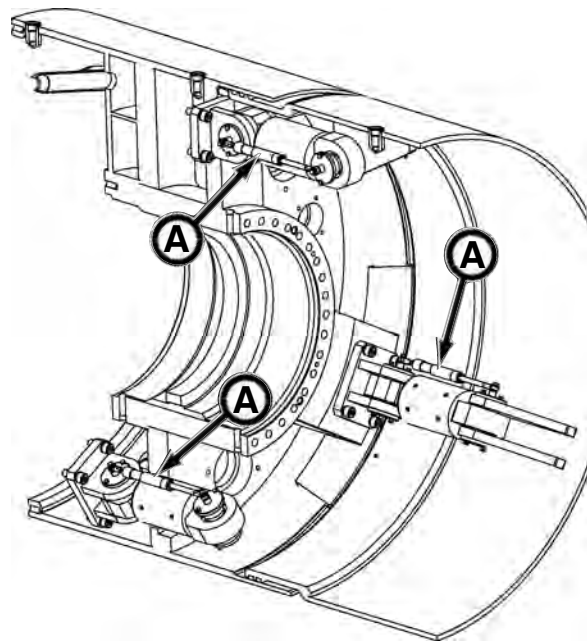
Linear transducers should be calibrated before each drive. Also, if the steering cylinders are repaired or replaced, the components will require recalibration so the steering cylinder positions will be properly monitored. The calibration is performed through the Kepware Server software. This software 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 the Operation section.

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

34. 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.

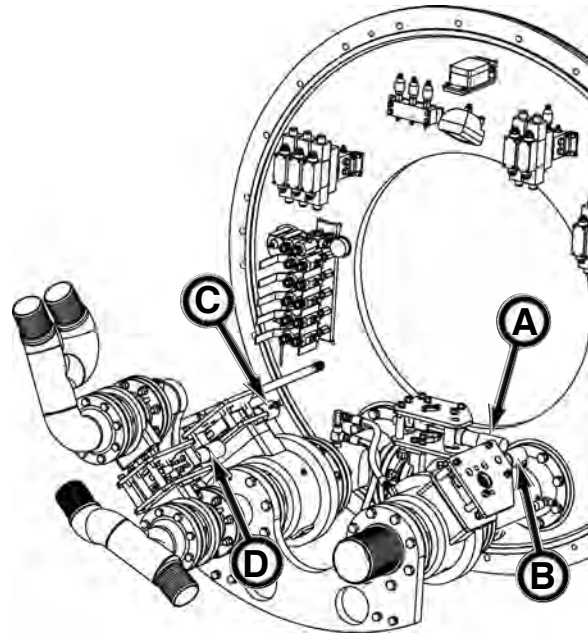
To calibrate the stop valve, bypass valve and cutting nozzle valve linear transducers, refer to Linear Transducer Calibration - Slurry Valves & Steering Cylinders in the Operation section.

- A - Bypass Valve Linear Transducer
- B - Stop/Return Linear Transducer*
- C - Stop/Feed Linear Transducer*
- D - Chamber/Cutting Linear Transducer

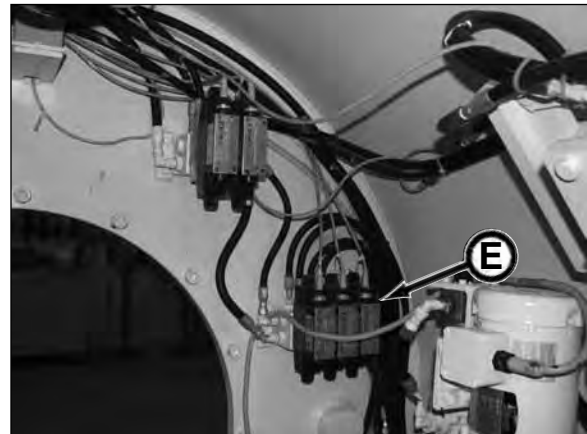
* Smaller MTBMs are equipped with only one stop valve versus the two stop valves on larger MTBMs (as shown).

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.

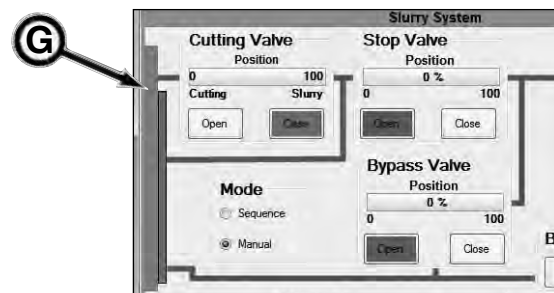
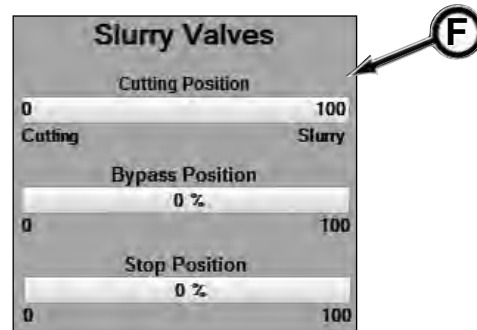
If the cylinders do not hold pressure, troubleshoot by determining if the problem is with the hydraulic hoses, slurry cylinders or if the slurry control valve (E) is malfunctioning. Repair or replace before launching MTBM.



MTBM SL72



Slurry Cylinder Control Valve



35. CALIBRATE DIRT WING LINEAR TRANSDUCERS & CHECK STABILIZER VALVE OPERATION

The linear transducer(s) (A) on the dirt wing cylinders allow the operator to monitor the position of the dirt wing(s) during the tunneling operation.

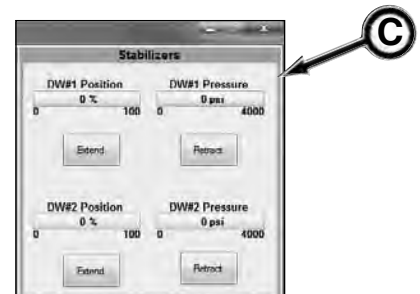
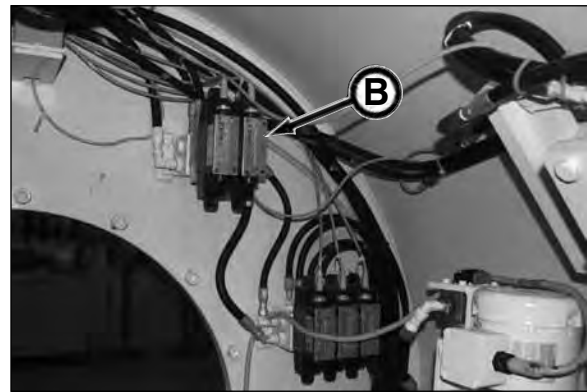
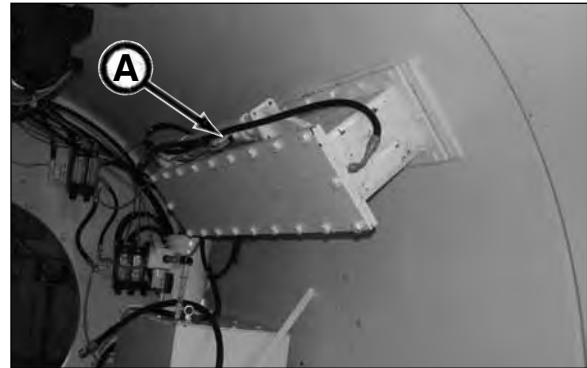
Linear transducers should be calibrated before each drive. Also, if the dirt wing(s) are repaired or replaced, the components will require recalibration so the dirt wing(s) position will be properly monitored. The calibration is performed through the Kepware Server software. This software collects and 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.

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.



Stabilizer Indicators On MTBM Control Screen

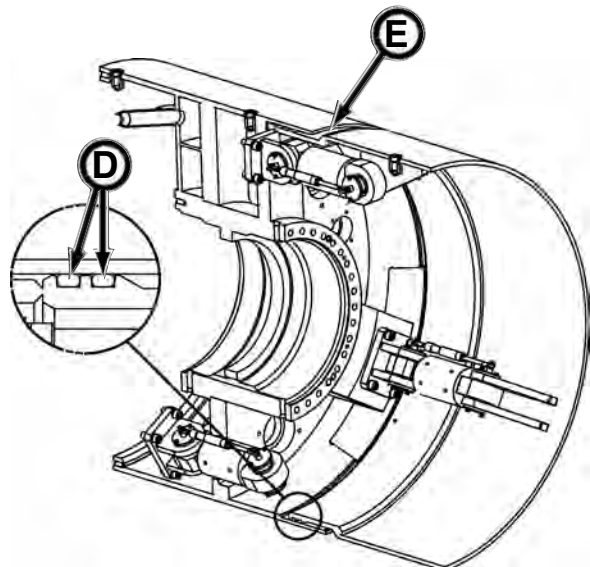
36. INSPECT, LUBRICATE & CLEAN STEERING JOINT SEALS

The steering joint seals (D) must be properly maintained to protect the steering joint from contamination.

1. Inspect steering joint area (E) 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 Mobilgrease® XHP222 until clean grease is visible on steering joint area (refer to grease guideline below). Depending on MTBM model, there may be 1, 3 or 4 steering joint grease hoses routed to front section bulkhead for greasing the seals.

Grease Guideline:

- On MTBM SL44 & smaller: use 1/2 grease tube
- On MTBM SL51 & larger: use full grease tube

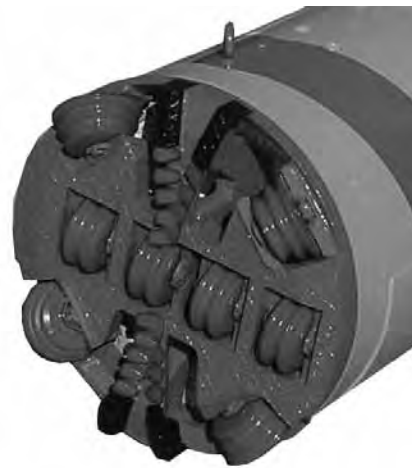


37. CHECK DRIVE MOTOR ROTATION

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.



38. 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 (D) 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).

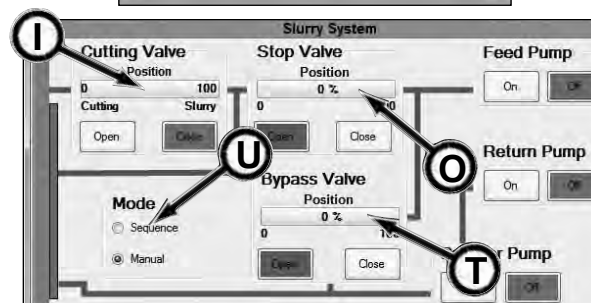
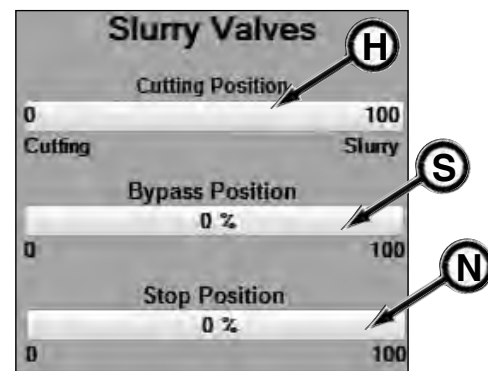
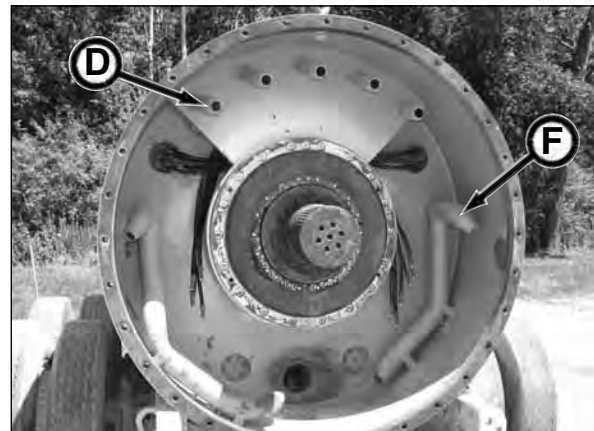
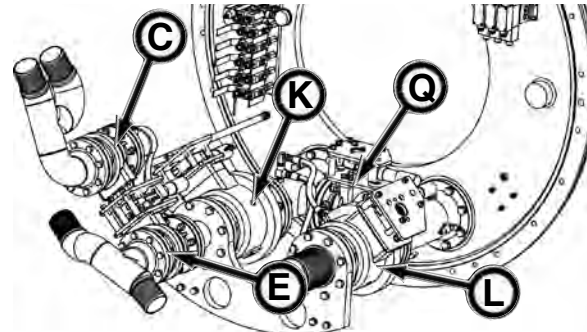
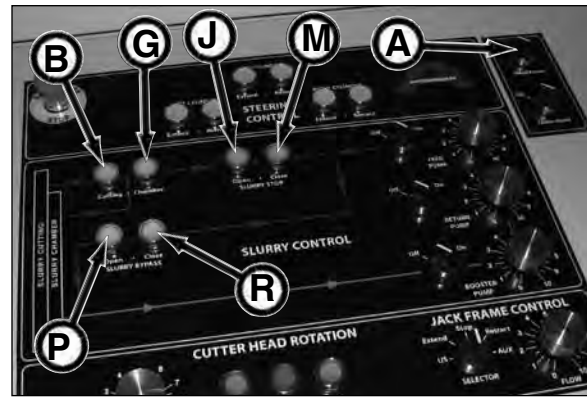
The stop valve position (N) is shown on the Slurry Valve meter on the Target Screen, and the Stop Valve meter (O) on the MTBM control screen.

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.



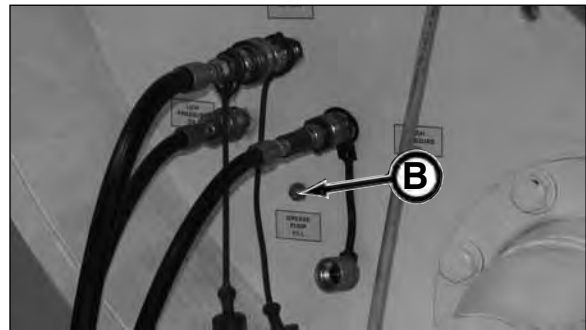
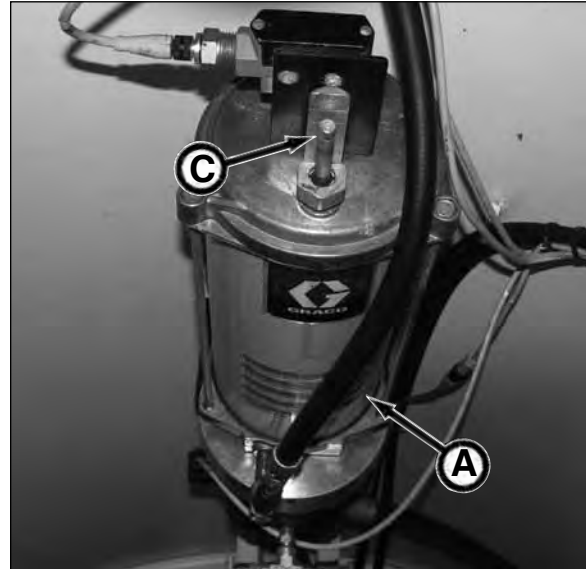
39. FILL GREASE PUMP

The grease pump lubricates the bearing cavity lip seals. Be sure the grease pump is filled before operation and during drive to prevent contamination from entering bearing cavity.

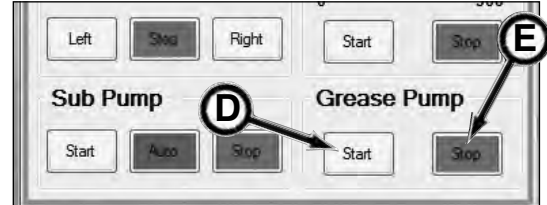
1. Fill the grease pump (A) with Mobil® SHC 101 EAL Grease or equivalent through the grease pump fill port (B) (on MTBM bulkhead) or grease line (depending upon model) until the grease level indicator (C) reaches the full mark.

NOTICE

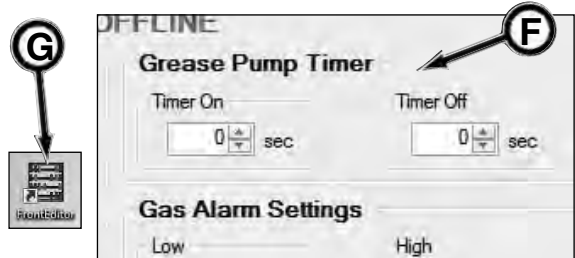
The grease pump location:
MTBM 44 and larger - front section
Smaller MTBMs - trailing section



2. Once grease pump is filled, start the grease pump manually by clicking Start button (D) on the MTBM control screen to purge air from the grease lines. Click Stop button (E) when grease comes out the lip seals.



3. Check the grease pump timer settings (F): Double click the FrontEditor icon (G) to load the MTBM Operational Data Editor program. Change the Timer On and Timer Off settings as needed. The default timer settings are 10 seconds on and 50 seconds off. If changes are made, click the Validate button.

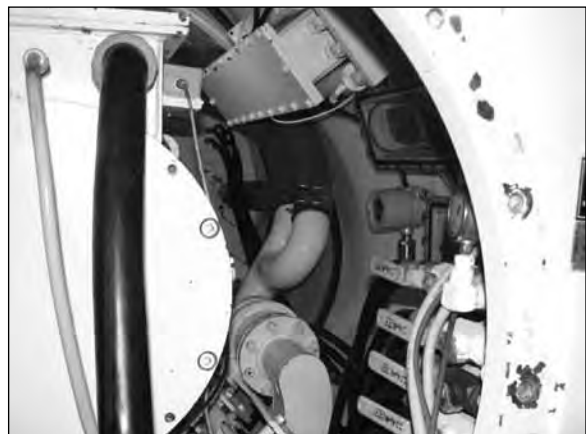


40. INSPECT HOSES, CABLES & SLURRY LINES

1. Inspect hydraulic/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.

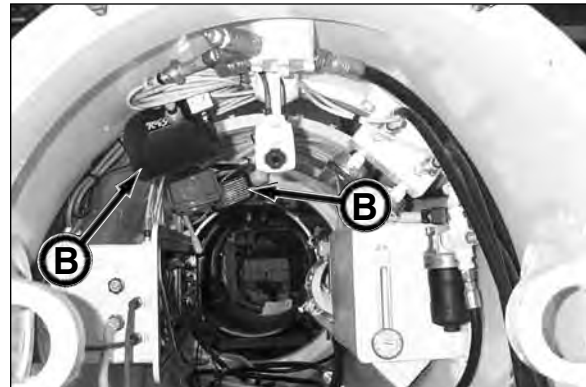
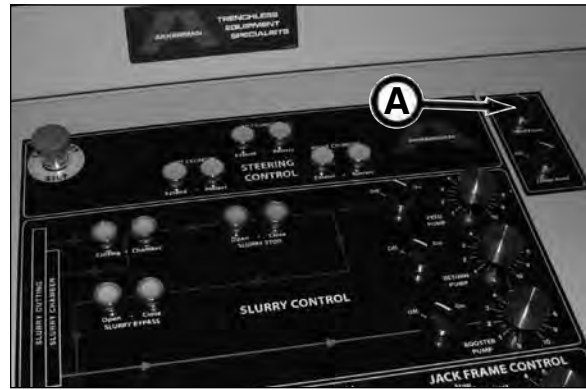
NOTICE

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.



41. 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.
3. Check light cables for wear or damage. If cables show signs of wear or damage, repair or replace.



42. CHECK & TEST GAS DETECTOR

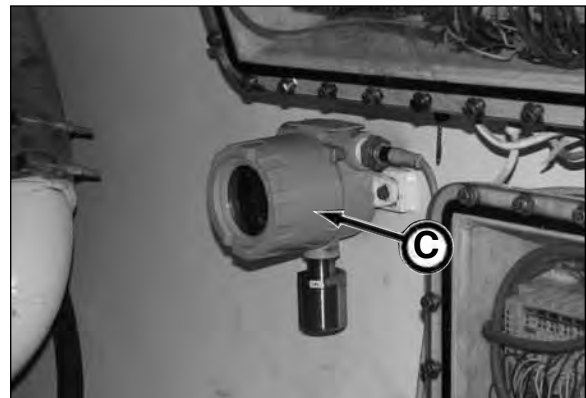
NOTICE

For more information, refer to your GasMax Instruction Manual.

Check and test the gas detector (C) 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 (D) per job requirements by double clicking the FrontEditor icon (E) 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.



(Gas detector maintenance continued on next page)

2. 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 must be replaced.
3. Test the gas detector operation, horn alarm and control container screen display (C, D) as follows:
 - apply a measured gas concentration to sensor (E) 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, have a qualified electrician troubleshoot and repair the problem BEFORE using the MTBM.

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

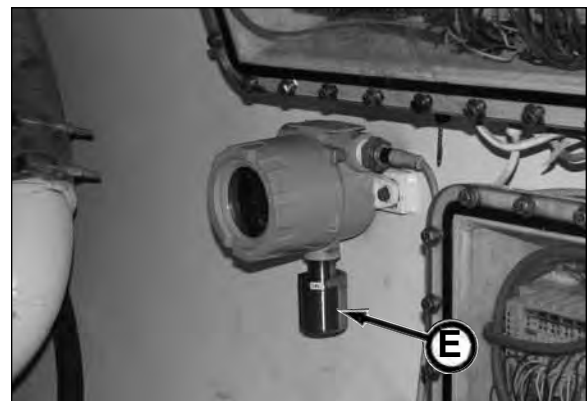
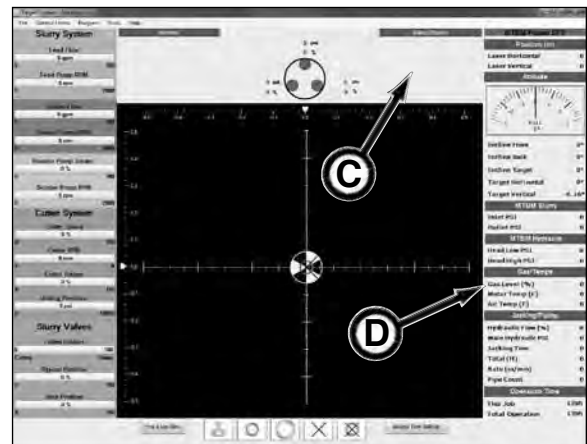
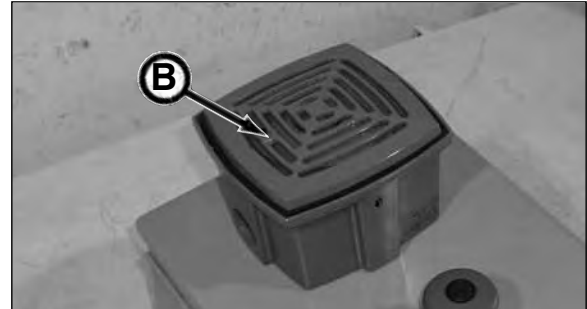
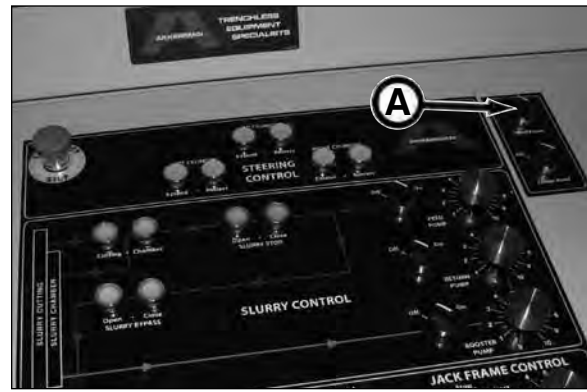
1. The "Gas Detector Fault" message will appear in the status/alarms area (C) on the target screen when there is a problem with the gas detector sensor.
2. The "Gas Level High" message will appear in the status/alarms area (C) on the target screen when the gas level at the gas detector reads 10% (default 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 (D) at the gas detector is displayed on the target screen.

(Gas detector maintenance continued on next page)



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.

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

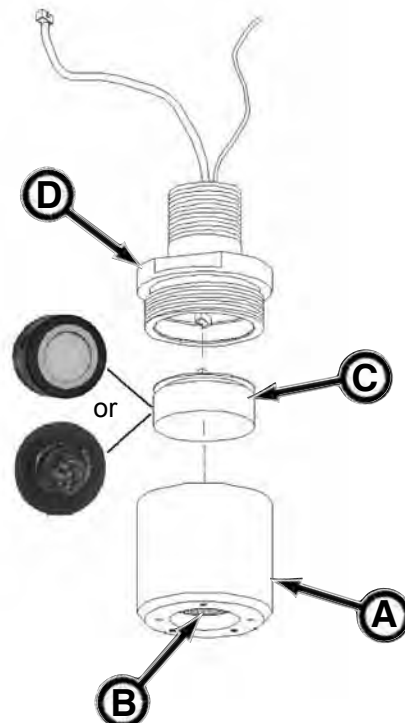
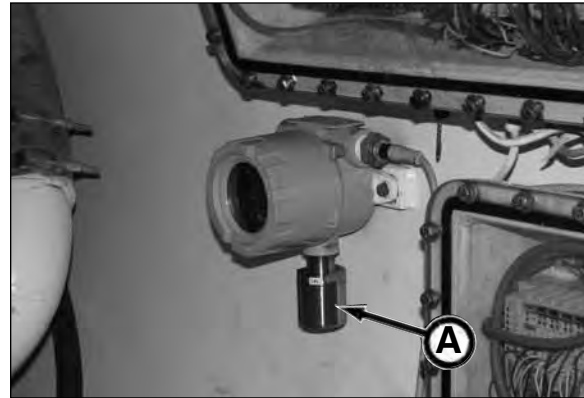
If the filter/cap is not dry, it can block gas from getting to the sensor, resulting in the environment not being properly monitored for methane gases.

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)



GDS GasMax II



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

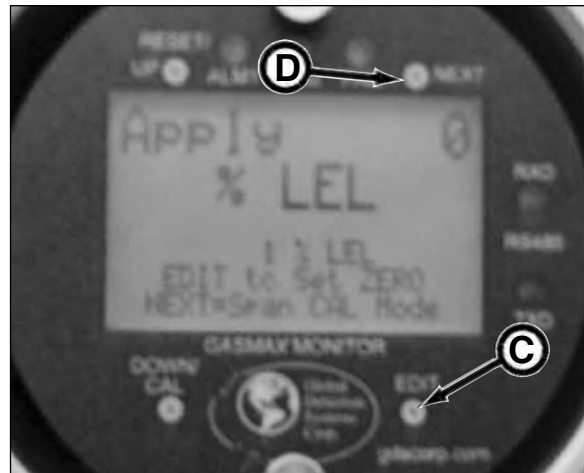
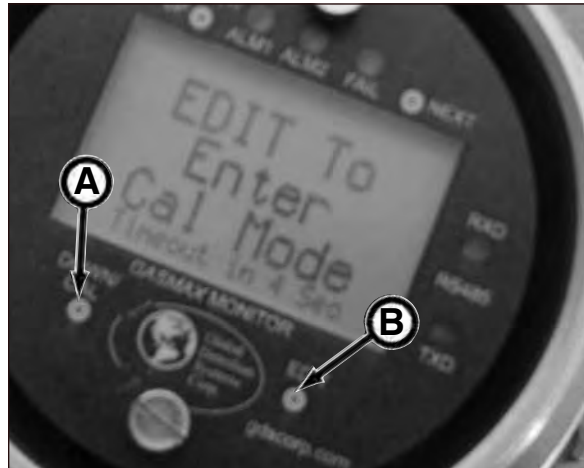
If it is known for sure that there are no interfering gasses or vapors present, ambient air may be used to set the zero point.

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.

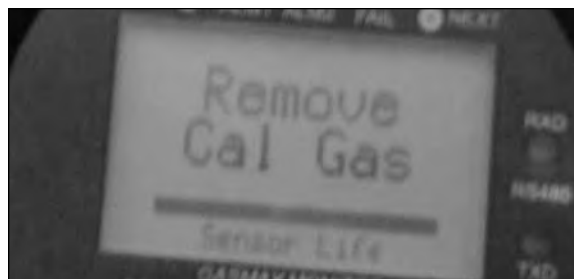
- f. Attach calibration nozzle adapter to sensor.



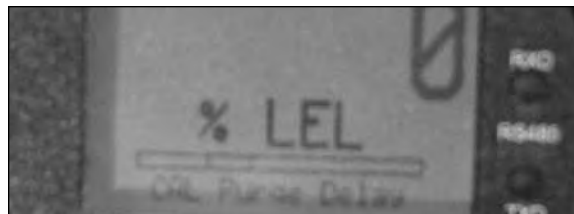
7. Apply the calibration methane 2.5% (50% LEL) gas mixture at .5 liters/min by opening the regulator valve by turning the knob counterclockwise. After the reading is stable (approximately 1 minute) press the EDIT key (A) to perform a SPAN calibration.



8. If the SPAN calibration is successful, the display flashes "REMOVE CAL GAS" and starts the CAL PURGE delay.



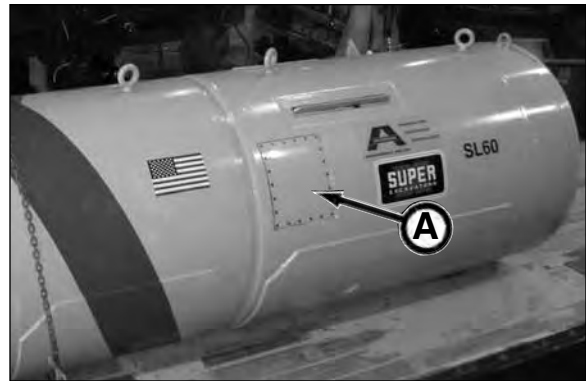
9. The CAL MODE will be complete after the end of the CAL PURGE delay.



43. LUBRICATE ACCESS COVERS (IF EQUIPPED)

Lubricate access covers with a petroleum based product to prevent covers from rusting to MTBM and contamination from entering MTBM.

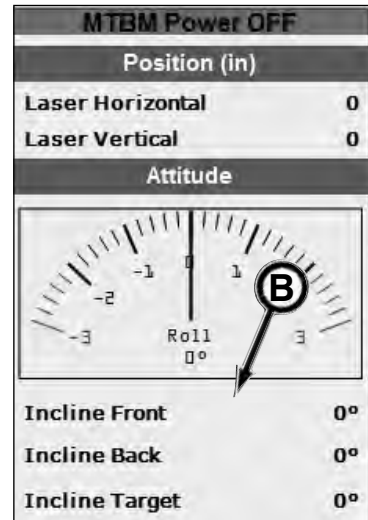
If MTBM is equipped with threaded covers, be sure threads are lubricated properly.



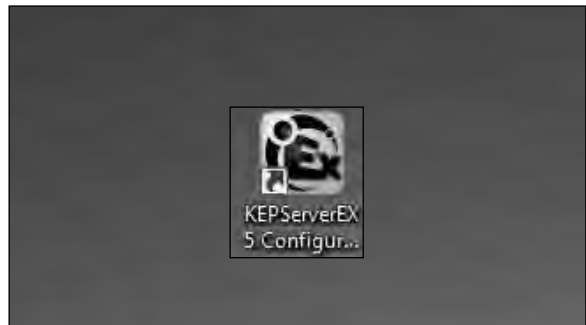
44. CALIBRATE INCLINOMETERS

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 (B) 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.

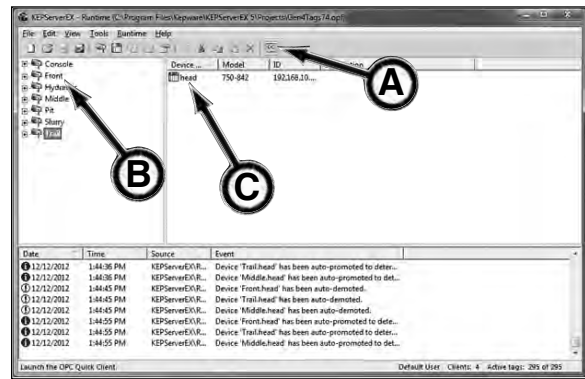


2. Turn Head Power switch (C) to ON position.

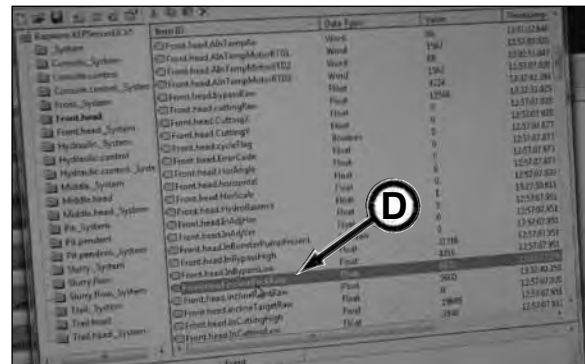
(Continued on next page)



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



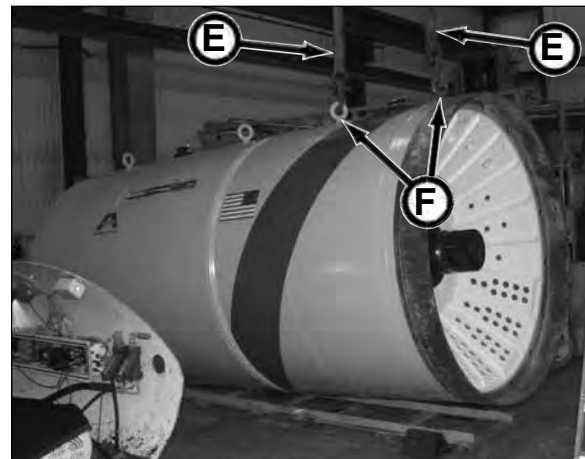
WARNING Suspended loads may fall and cause severe personal injury or death.

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

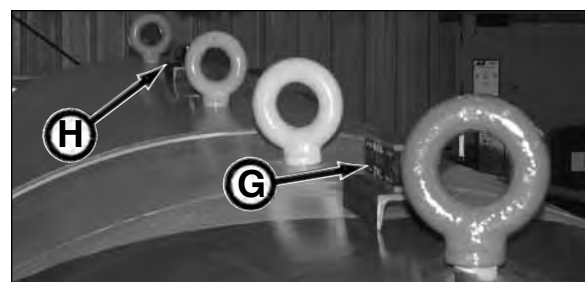
Do not enter area under or around a load.



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.

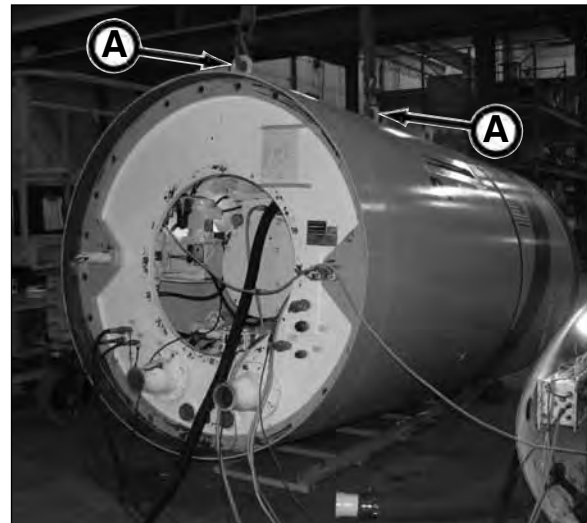


7. Place a digital level (G) between the front lifting eyes and directly on the center line of the lift eyes of the MTBM. Ideally, place another digital level (H) between the two rear lifting eyes and directly on the center line of the lift eyes.



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: AlnInclineFront
Back: AlnInclineBack
Target: AlnInclineTarget

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:

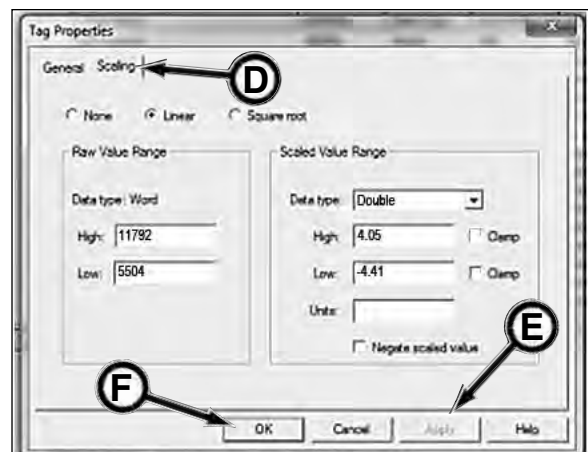
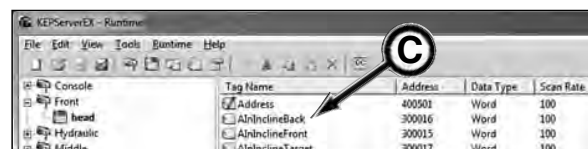
High - Incline raw data from lifting front of MTBM

Low - Incline raw data from lifting rear of MTBM

19. Click Apply (E).
20. Click OK (F).

(Continued on next page)

050077A_microtunomGen3



21. Repeat steps 16 through 20 for the other two inclinometers.

22. Click Save As button (A).

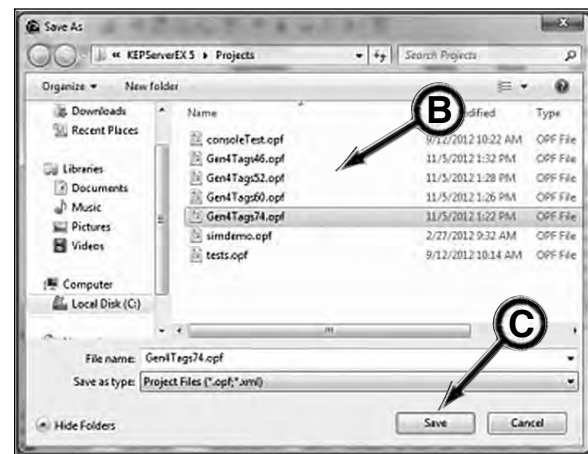


NOTICE

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.



45. CLEAN & CHECK TARGET ROLL

1. Clean the target display (A) with a mild, abrasive-free cleaning solution and scratch free cloth.
2. To change roll setting meter (B), click the roll indicator graphic (C) and change the degree setting and update rate (milliseconds) and press Set button. If the degree setting parameters are exceeded, the main drive motor (rotation) and main hydraulic pump (jacking) will be shut down.
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):

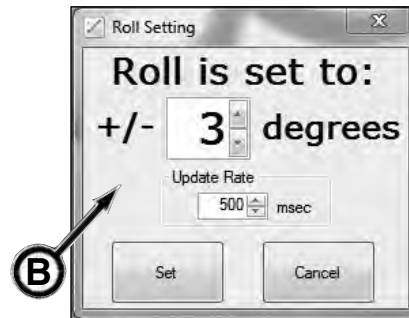
Clockwise Roll Check

Slightly roll the MTBM to the right. The roll graphic (C) on the target screen should indicate a positive reading and positive degree.

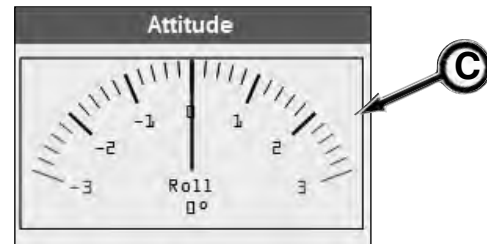
CounterClockwise Roll Check

Slightly roll the MTBM to the left. The roll graphic on the target screen should indicate a negative reading and negative degree.

If the roll indicator is incorrect, the target inclinometer or electronics have malfunctioned. Contact your Akkerman Aftermarket Support representative for troubleshooting information.



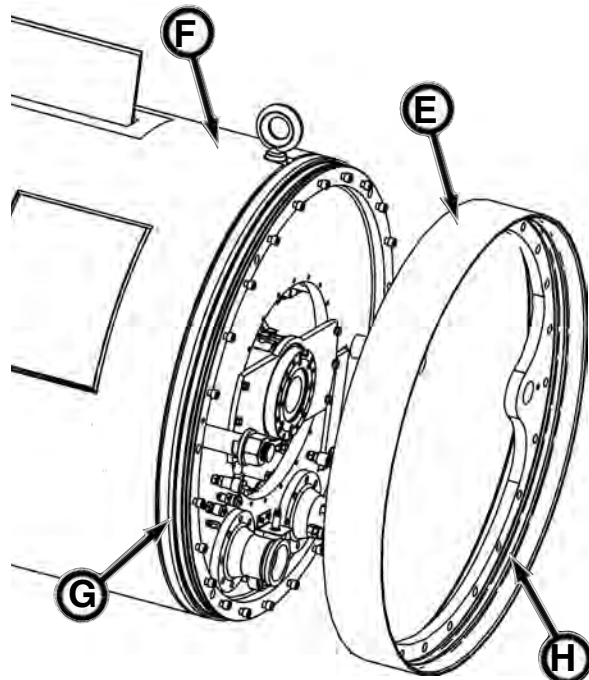
Roll Setting Meter



Roll Indicator Graphic On Target Screen

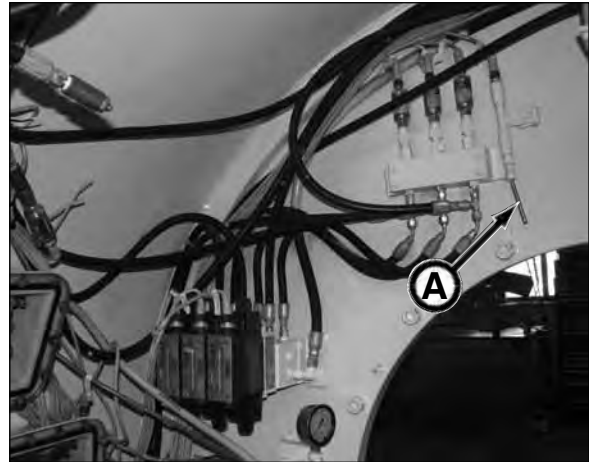
46. INSPECT & LUBRICATE COUPLING SLEEVE & ORINGS

1. Inspect coupling sleeve (E) for dents, bends or other damage that would prevent a proper seal to the back drum (F) 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 (G) 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 (H) to coupler sleeve or pipe adapter and lubricate with pipe lubricant.
6. Repeat steps 1 through 5 if MTBM is equipped with trailing section.
7. Before launching MTBM, always replace two new orings (H) on coupler sleeve or pipe adapter and lubricate with pipe lubricant.



47. CHECK HEAD TEMPERATURE SENSOR

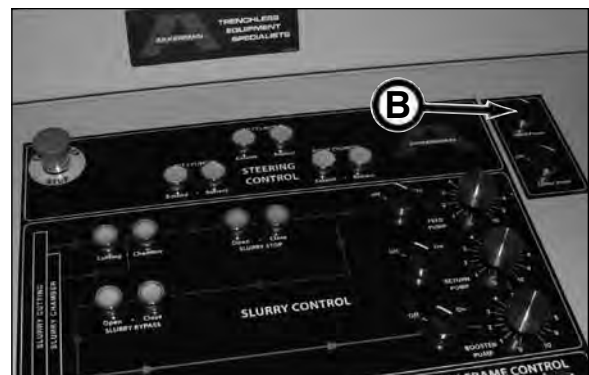
A thermocouple sensor (A) is installed in the front section of the MTBM to transmit the ambient temperature of the front section to the operator in the control container.



MTBM SL74 Shown

Check sensor as follows:

1. Turn Head Power switch (B) to ON position.
2. Check the ambient air of the MTBM with a thermometer. Compare the reading on the thermometer with the Air Temp (C) 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.

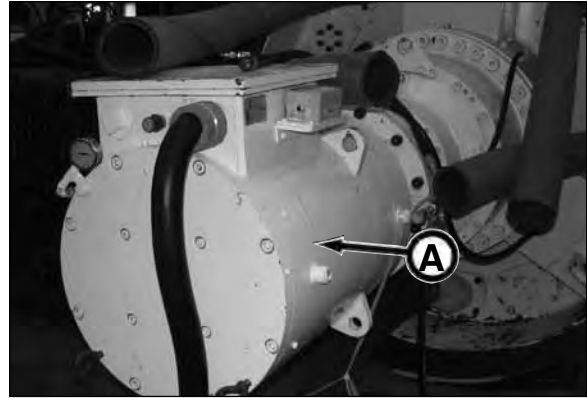
Gas/Temps	
Gas Level (%)	0
Motor Temp (F)	0
Air Temp (F)	0

48. CHECK DRIVE MOTOR TEMPERATURE SENSOR

NOTICE

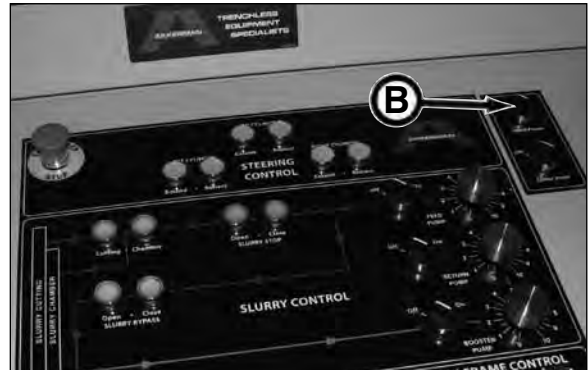
Flush drive motor cooling system to remove rust flakes or sediment within the system before operation.

There are three RTDs (Resistance Temperature Device) internally installed in the drive motor (A) to transmit the motor temperature to the operator in the control container.



MTBM SL74 Shown

1. Turn Head Power switch (B to ON position.



2. Before the drive motor is started, compare the temperature reading for the drive Motor Temp (F) and MTBM head Air Temp (C). If the temperatures are similar, operate the drive motor to see if the motor temperature raises. If so, the motor sensor is functioning properly. If not, contact your Akkerman Aftermarket Support representative for troubleshooting information.

Gas/Temps	
Gas Level (%)	0
Motor Temp (F)	0
Air Temp (F)	0

49. INSPECT DECALS

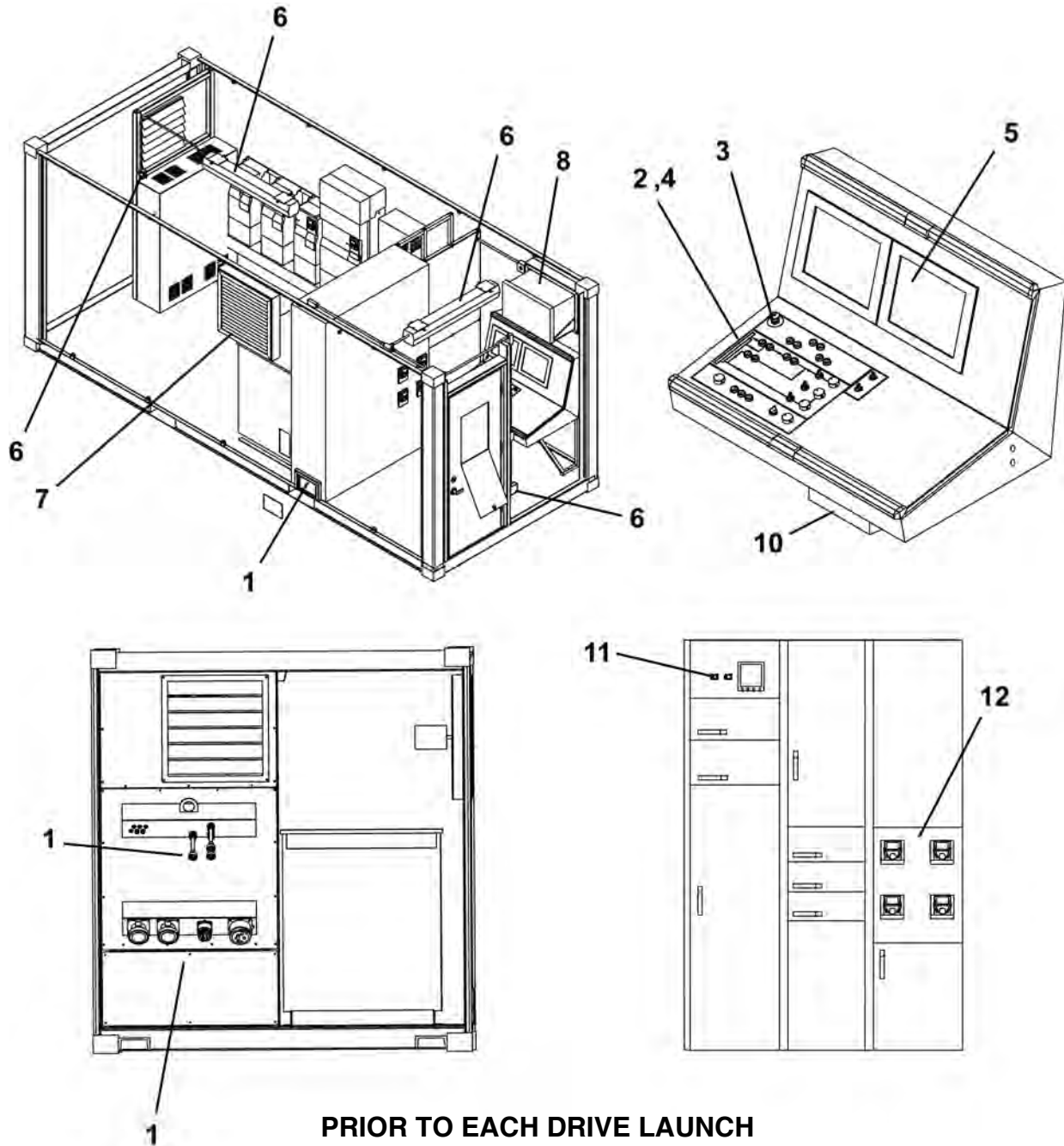
Inspect ALL decals to be sure they are clean and legible.

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

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



MAINTENANCE CHARTS - CONTROL CONTAINER



PRIOR TO EACH DRIVE LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Electrical Connect.	Check Electrical Connect.	Contact factory for proper settings.	
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		

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



Control Container Power Lead Connections

2. CHECK COMPUTER OPERATION

1. Boot up the computer by gaining access to the power button under the console lid.

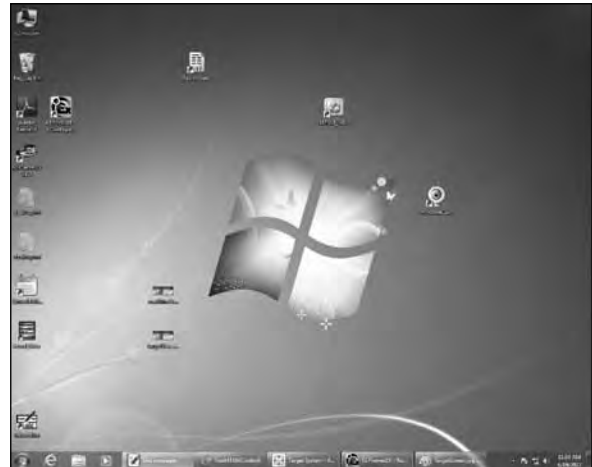
NOTICE

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.



2. Once computer starts, the desktop screen will appear.

3. Double click the Machine Select icon.



4. The Machine Control Selector window appears. Select your MTBM head size and click OK.



(Continued on next page)

- 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.



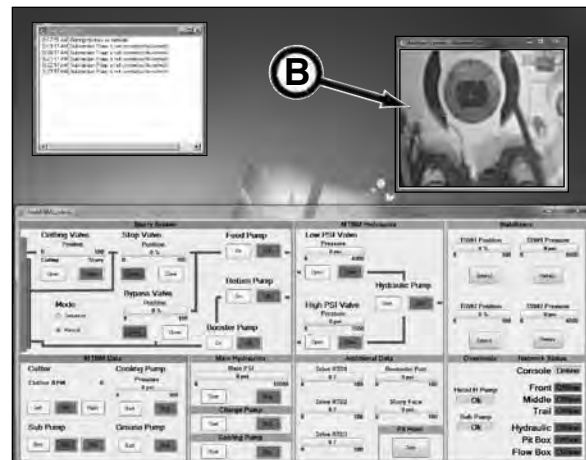
Target Screen



Log Message and MTBM Control Screens

- Load the MTBM target camera program.

Double click Machine Camera icon from the desktop. After initial loading of the program, you will have to reposition the camera window 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 Machine 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.

(Continued on next page)

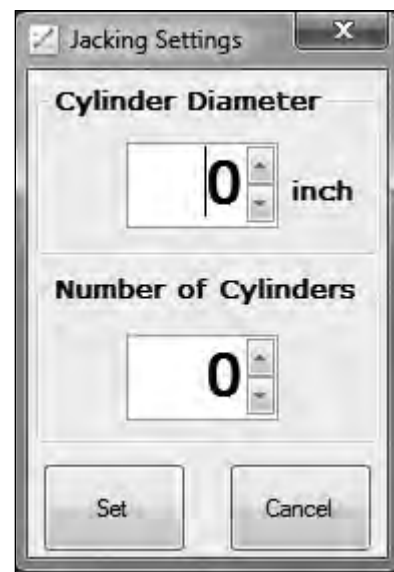


MTBM Camera Screen With No MTBM Ethernet Connection

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



8. If any of these programs do not load properly or are displaying erroneous data, contact your Akkerman Aftermarket Support representative before starting the drive. The computer must function properly before operating the microtunneling system.



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 stop all control container electrical bulkhead functions.

If E-Stop button does not function properly, it MUST be repaired or replaced BEFORE operation.



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 Machine Camera icon from the desktop. After initial loading of the program, you will have to reposition the camera window 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 Machine 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.



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.



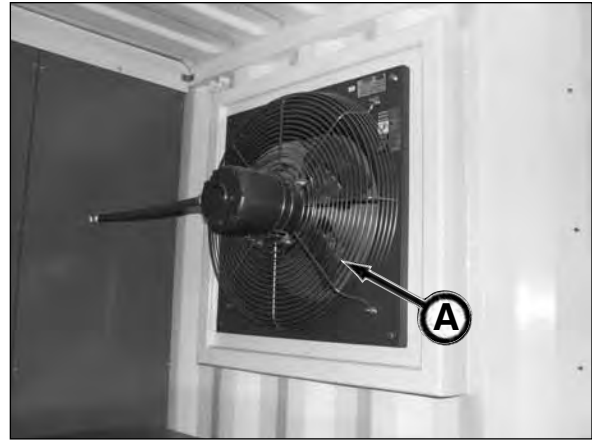
7. CHECK EXHAUST FAN OPERATION

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.

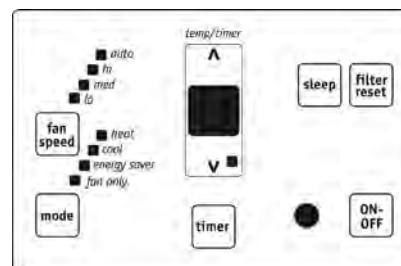
Test fan for proper operation. If fan does not function properly, repair or replace before operation of the microtunneling system.



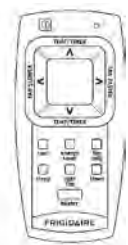
8. CHECK AIR CONDITIONER & HEATER OPERATION

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 Frigidaire Use & Care manual. The Use and Care manual can be accessed from the Target Screen by clicking Help in the menu bar and then clicking A/C_Manual.



A/C Controls



A/C Remote Control

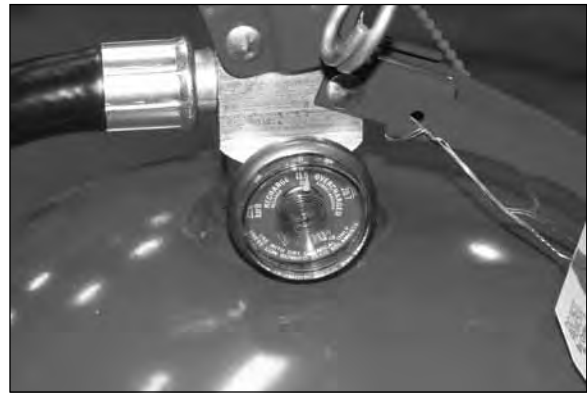
9. CHECK FIRE EXTINGUISHER

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 not 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. **PULL** the pin at the top of the extinguisher and hold upright.
2. **AIM** at the base of the fire, not the flames.
3. **SQUEEZE** the lever slowly.
4. **SWEEP** 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

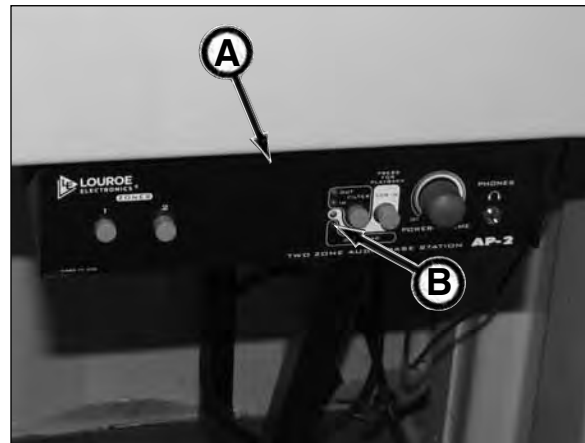
An audio system (A) is equipped for live, one-way audio monitoring from the microphone installed in the MTBM.

Check audio system sound by:

1. Turn on the power to the unit by rotating the Power-Volume knob clockwise to ON position. The Filter-OUT green LED light will illuminate (and when the audio filter is not in use). Rotate Power-Volume knob further clockwise to increase the volume of the monitored audio.
2. Push Filter switch in to ON position. The orange LED light will illuminate.

When a short or overcurrent in the power supply occurs, a red LED light (B) will illuminate. If this occurs, turn Power-Volume knob off and check wiring connections.

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.

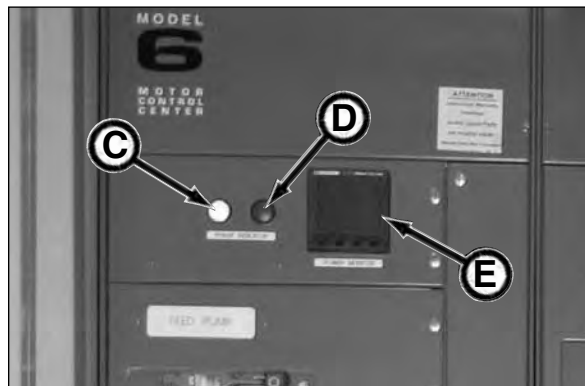
Check for proper phase power as follows:

If the green phase 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 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 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.



VFD Motor Controllers

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.

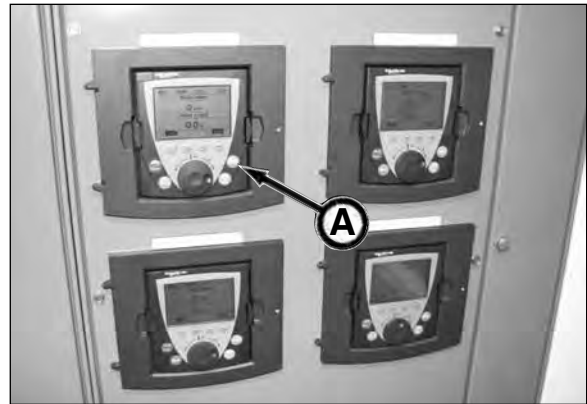
If the motor rpm and motor torque screen does not appear on the monitor, press esc button (A) twice.

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.

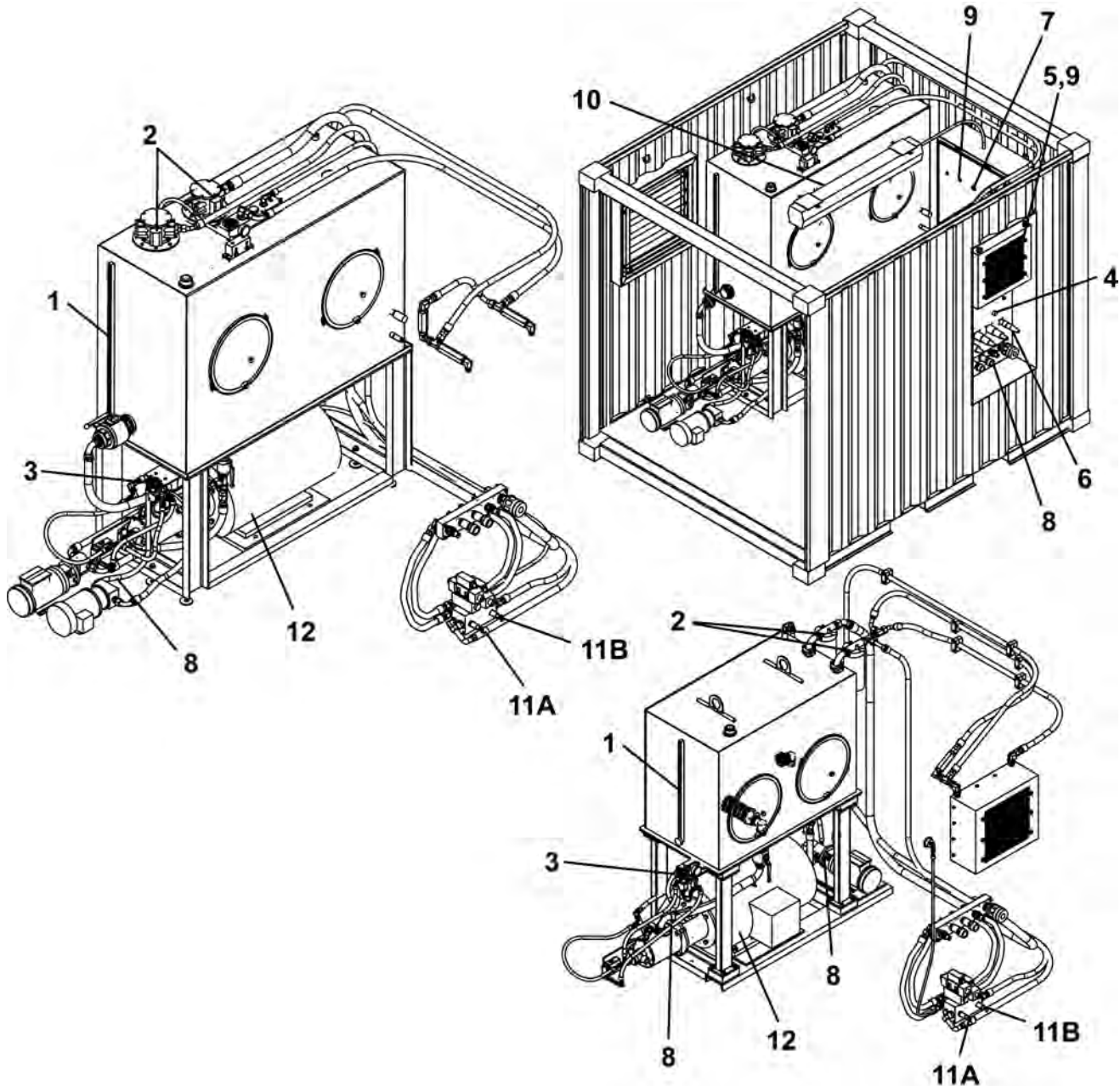
IMPORTANT: Due to the complexity of the VFD parameter check and setup, Akkerman highly recommends that you contact your Akkerman Aftermarket Support representative if you have any questions before checking or changing the VFD parameter settings.



VFD Motor Monitors

NOTES

MAINTENANCE CHARTS - REMOTE HYDRAULIC POWER PACK



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:

SN FA21945F	330 US gal. (1,249 L)
SN FA21965F	195 US gal. (738 L)

2. Check condition of oil. If any of the following situations occur, the reservoir must be drained and refilled with fresh 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. There are also two different filter styles based on power pack serial number as noted below:

1. Power Pack SN FA21945F

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).

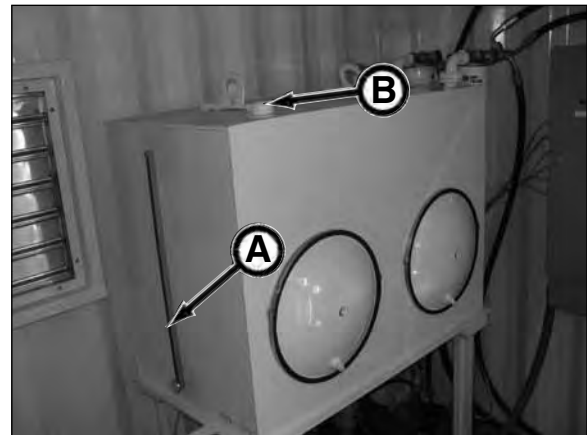
If the white indicator (E) is in the clean green zone (F), the filter is functioning properly.

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

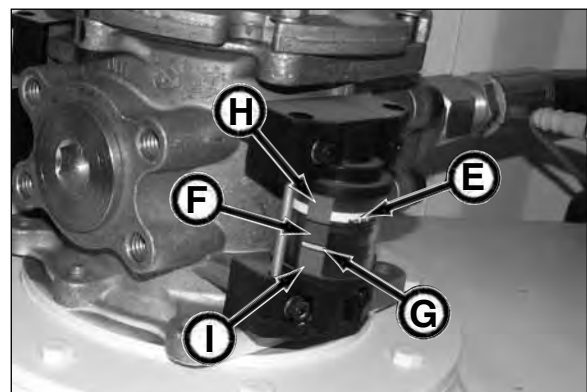
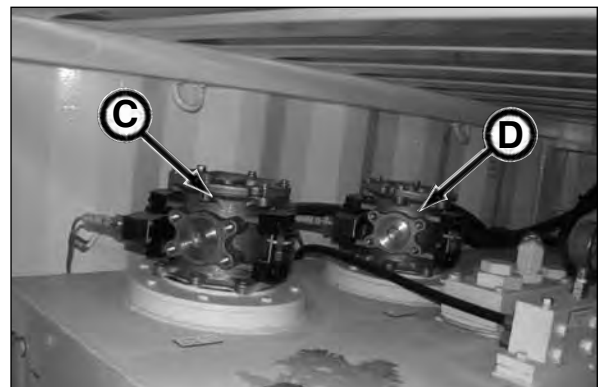
If the white indicator is in the no element red zone (H) or bypass red zone (I), replace the filter immediately to prevent contamination from entering the hydraulic reservoir.

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.

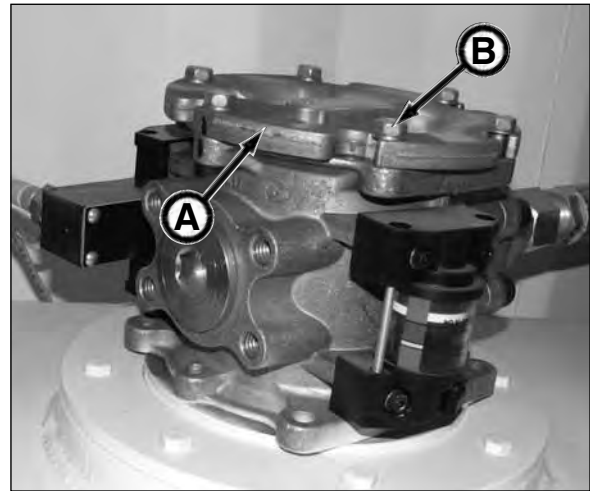


Hydraulic Reservoir for SN FA21965F Shown



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.



2. Power Pack SN FA21965F

To prevent under or over servicing of the hydraulic filter elements, filter indicators (C) have been installed on both hydraulic return filter housings.

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(s).
2. Remove filter. Dispose of oil and filter properly.

NOTICE Remove filter gasket if stuck in filter housing.

(continued on next page)



3. Lubricate new filter gasket with a light coating of clean hydraulic oil and install into filter housing. Be sure gasket is not twisted and that it is properly seated into housing groove.



4. Fill new filter with clean hydraulic oil.
5. Install new filter. Hand tighten only. Follow tightening instructions on filter.
6. Check for leaks.
7. Check hydraulic oil reservoir oil level. Add hydraulic oil if necessary.



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.



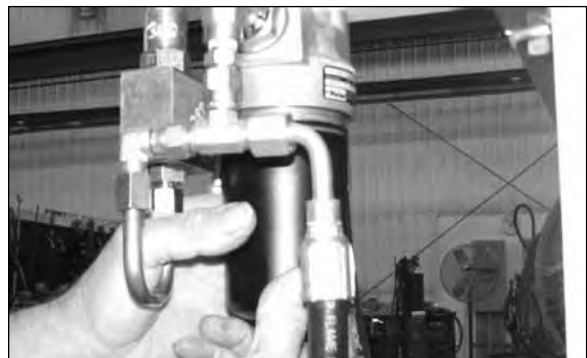
4. Lubricate filter inner oring with a light coating of clean hydraulic oil.



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 stop all power pack electrical and hydraulic bulkhead component functions.

The E-Stop button will illuminate when it is pushed in.

If E-Stop button does not function properly, it MUST be repaired or replaced BEFORE operation.



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.



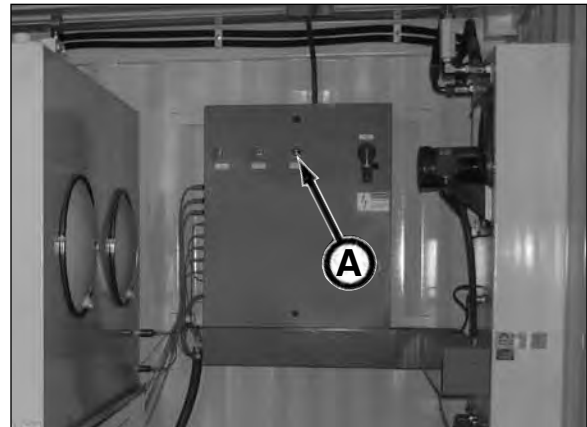
7. CHECK PHASE MONITOR

⚠ 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

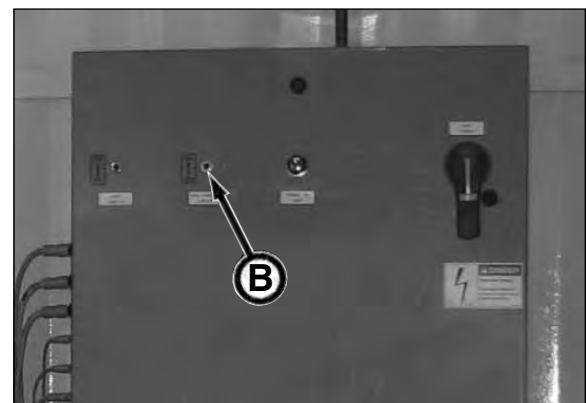
Before launching MTBM, be sure to check the operation of the power pack hydraulic pump and motors for proper operation (main hydraulic motor and pumps, charge pump, cooling pump, charge/cooling pump motor). If components do not function properly or show signs of leaking, repair or replace before operation.



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.

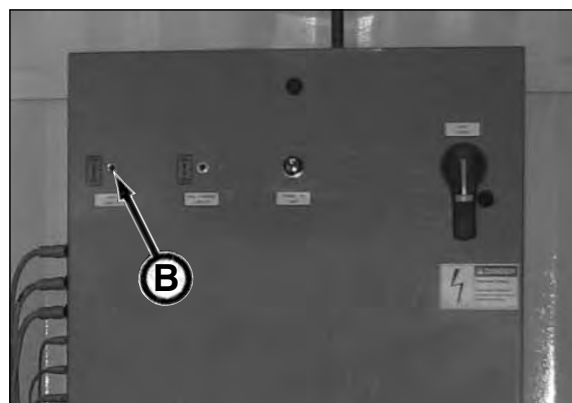
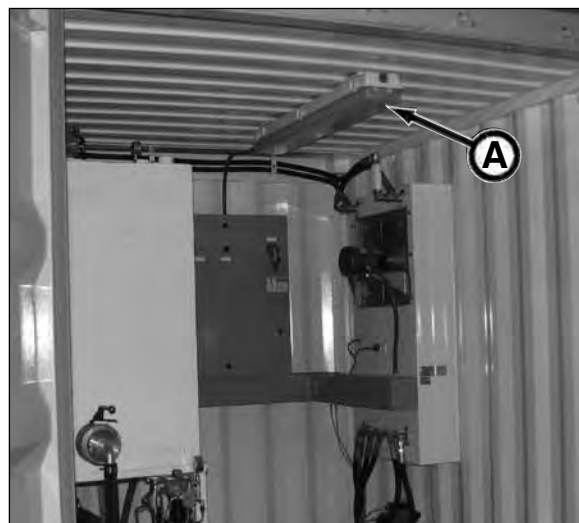
The power pack is equipped with a fan override switch (B) to power the fan off. Check the switch operation. If switch or fan does not function properly, repair or replace before operation.



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.

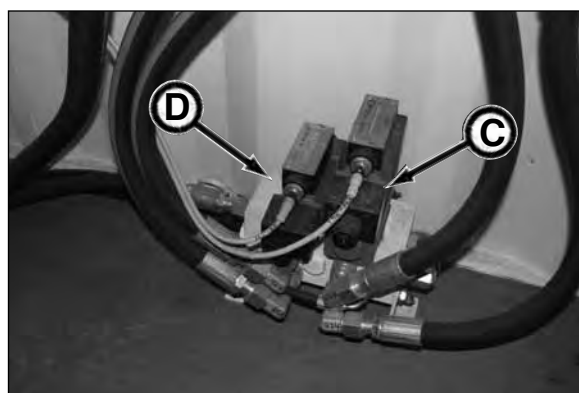
Release all pressure before performing maintenance or repairs. Never weld near pressurized fluid lines.

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

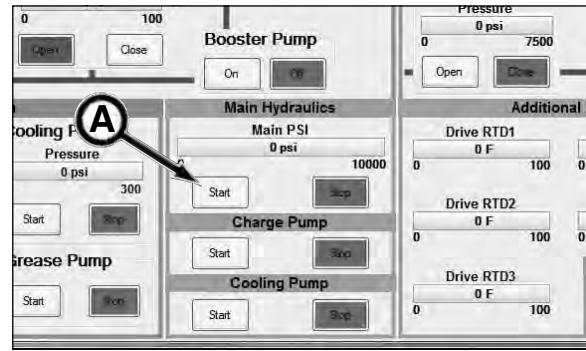
CHECKING MAIN RELIEF VALVE (Extend - IJS)

1. Disconnect hoses at bulkhead.

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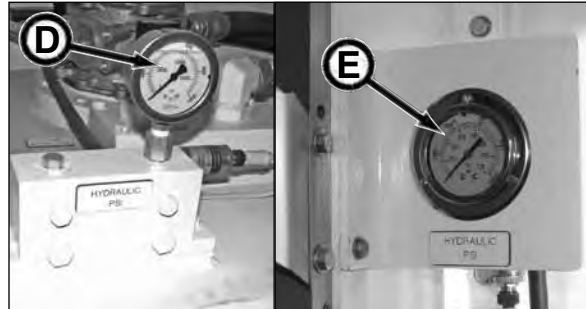
2. Check the main relief setting by starting the main hydraulic pump with Start button (A).



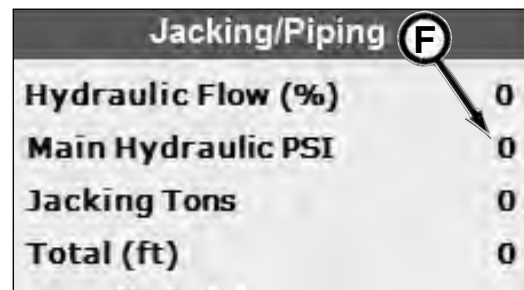
3. On control console, move selector switch (B) to Extend and move flow control (C) to the 25% position.



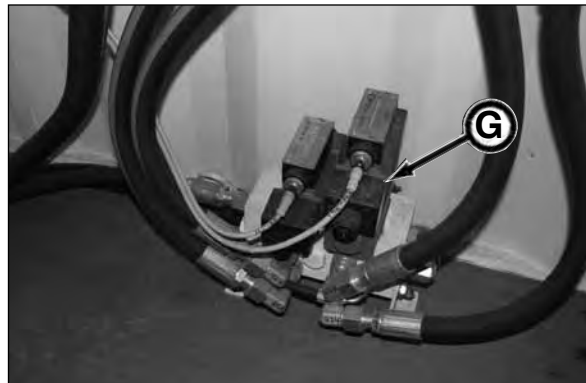
4. Check the hydraulic pressure gauge:
 SN FA21945F: gauge (D) located on top of reservoir
 SN FA21965F: gauge (E) located next to cooling fan



5. Check the Main Hydraulic PSI reading (F) to make sure it registers the same as the pressure gauge. If the pressures do not match, troubleshoot and resolve the problem.



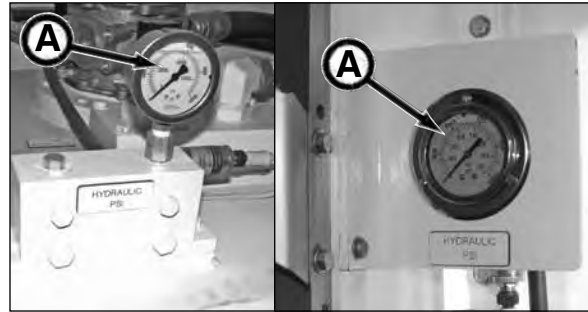
6. If the pressure does not register 8,000 psi, the main relief valve must be adjusted.
7. Adjust relief valve (G) by:
 - a. loosening the relief jam nut
 - b. turn adjustment screw as follows to set the main pressure relief valve to 8,000 psi:
 - CW - increase pressure
 - CCW - decrease pressure



8. Secure jam nut against adjustment screw.
(Continued on next page)

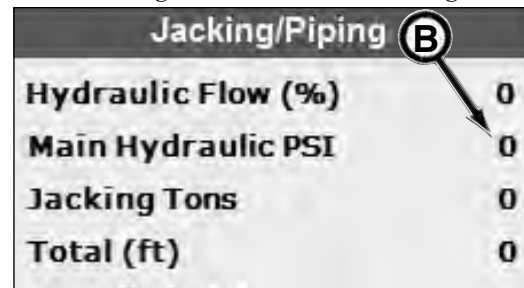
9. Once jam nut is secured, recheck hydraulic pressure gauge (A) and the Main Hydraulic PSI reading (B) on target screen to make sure that the readjusted pressure setting did not change. If necessary readjust and secure with jam nut.

10. Proceed to checking Auxiliary Relief Valve.



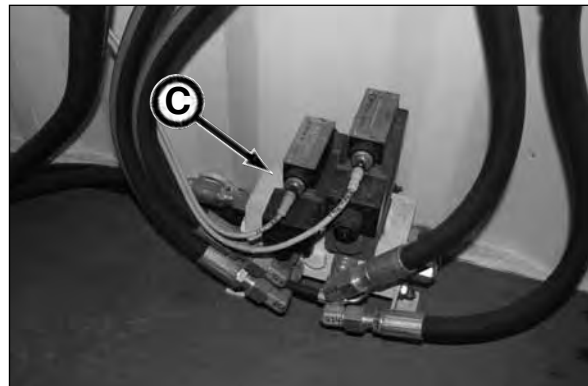
SN FA21945F
PSI Gauge

SN FA21965F
PSI Gauge



CHECKING AUXILIARY RELIEF VALVE (Aux - Retract)

Check the auxiliary relief valve (C) setting as follows:

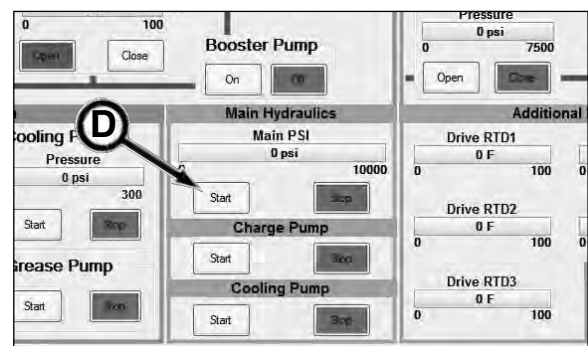


1. Hoses must be disconnected at bulkhead.

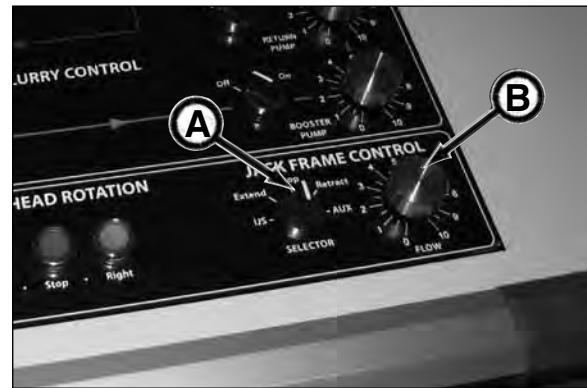


2. Check the auxiliary relief setting by starting the main hydraulic pump with Start button (D).

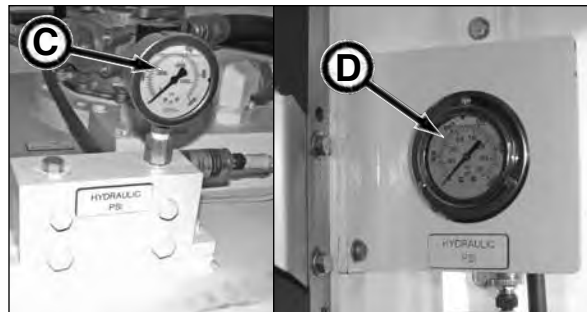
(Continued on next page)



3. On control console, move selector switch (A) to Aux and move flow control (B) to the 25% position.



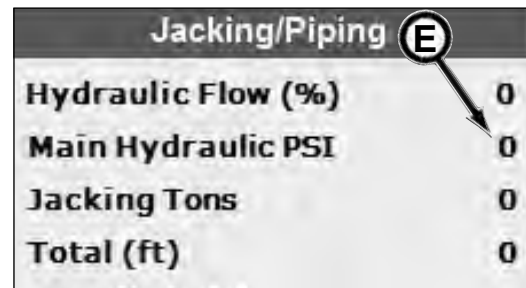
4. Check the hydraulic pressure gauge:
SN FA21945F: gauge (C) located on top of reservoir
SN FA21965F: gauge (D) located next to cooling fan



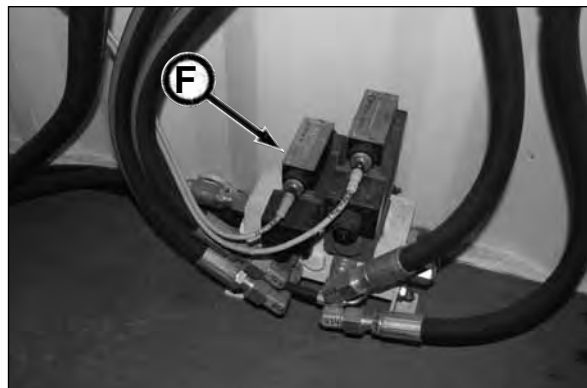
SN FA21945F
PSI Gauge

SN FA21965F
PSI Gauge

5. Check the Main Hydraulic 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.

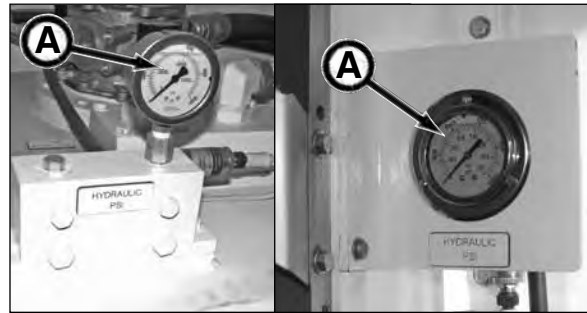


6. If the pressure does not register 3,000 psi, the auxiliary relief valve must be adjusted.
7. Adjust relief valve (F) by:
- a. loosening the relief jam nut
 - b. turn adjustment screw as follows to set the main pressure relief valve to 3,000 psi:
 - CW - increase pressure
 - CCW - decrease pressure
8. Secure jam nut against adjustment screw.



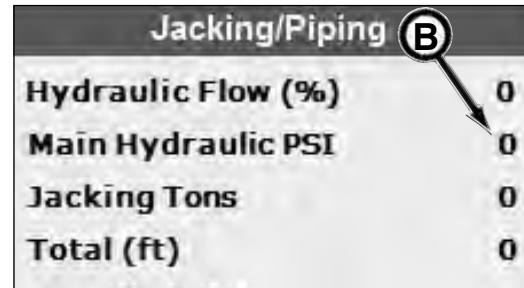
9. Once jam nut is secured, recheck hydraulic
(Continued on next page)

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.

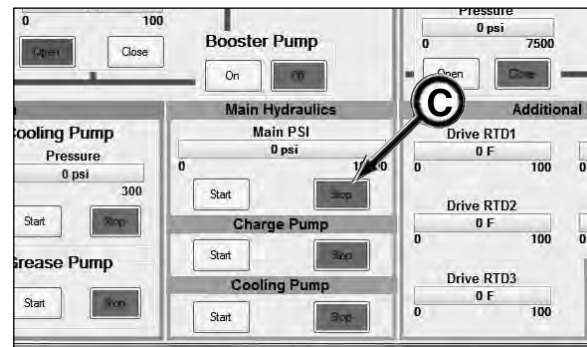


SN FA21945F
PSI Gauge

SN FA21965F
PSI Gauge



10. Stop the main hydraulic pump with Stop button (C).

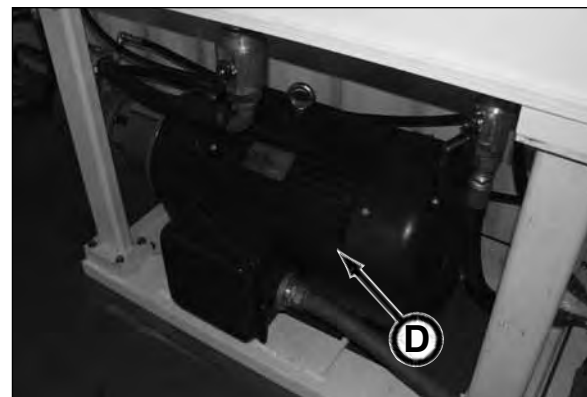


12. CHECK MOTOR ROTATION

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.

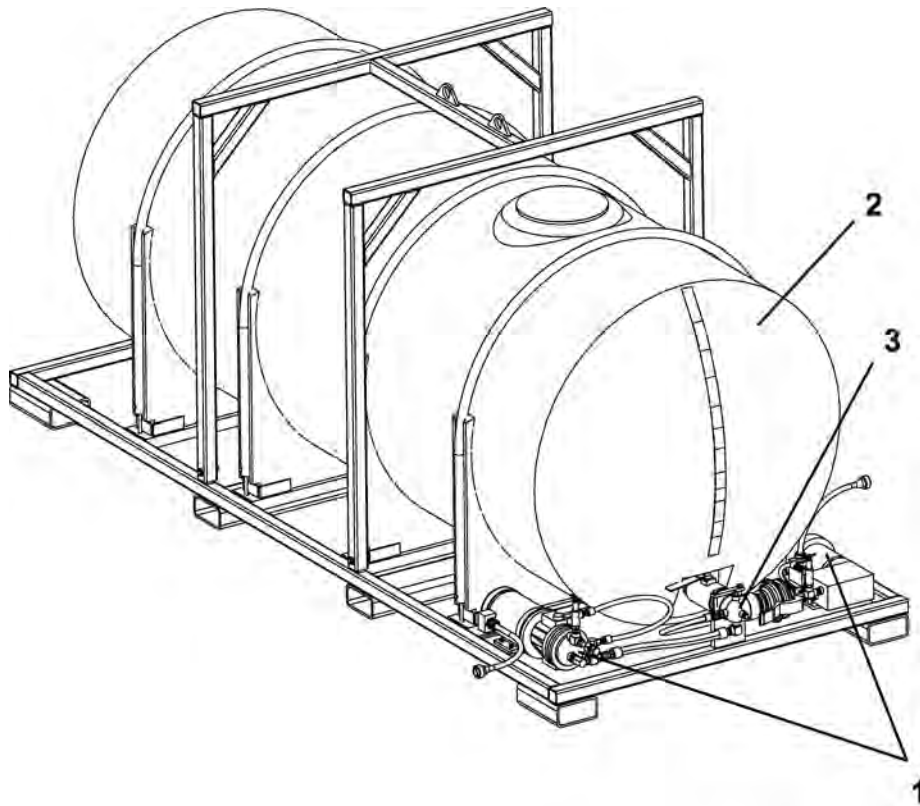
NOTICE

Operating the pump with the wrong rotation will cause pump and other component damage.



NOTES

MAINTENANCE CHARTS - WATER COOLING TANK



PRIOR TO EACH DRIVE LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Water Cool. Pumps	Check Oil Level	Fill with fresh, clean water.	10W30 Motor Oil
2.	Tank	Fill		
3.	Water Cooling	Check Operation		

1. CHECK WATER COOL PUMP OIL LEVEL

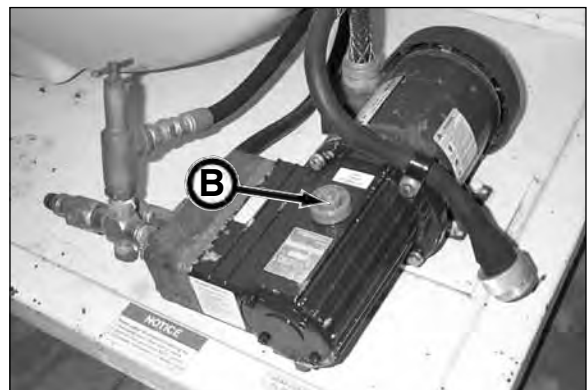
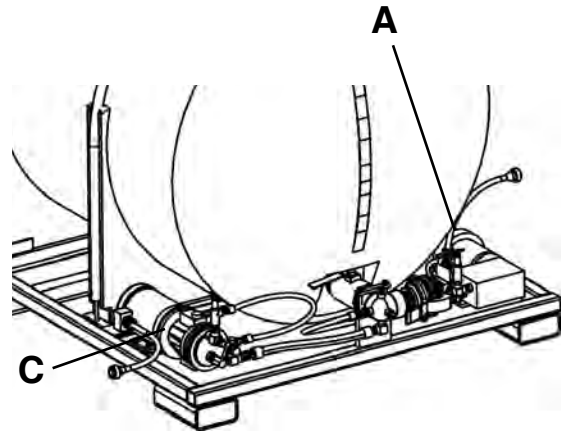
Check both water cool pump oil levels and the condition of the oil.

Main Cooling Drive Motor Pump Assembly (A) For 30 HP & 75 HP Drive Motor

1. Clean area around check/fill cap (B).
 2. Remove check/fill cap. Oil level should be:

3/4 in. (20 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:

3/4 in. (20 mm) from top of the fill port
- Oil capacity is 1.0 US quart (0.95 L).
4. If oil shows signs of contamination, drain oil and refill with clean oil.
 5. Replace check/fill cap.



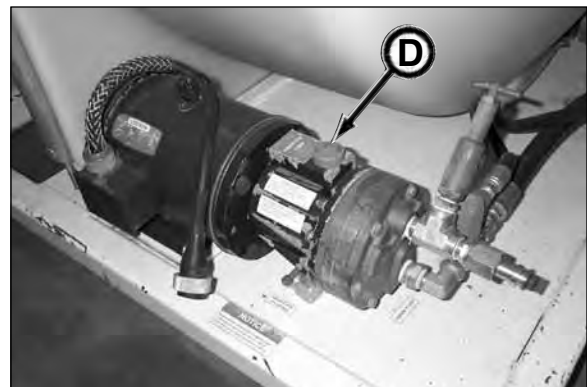
Main Cooling Drive Motor Pump Assembly For 30 HP & 75 HP Drive Motor

Main Cooling Drive Motor Pump Assembly (C) For Larger HP Drive Motor, Water Cooled Booster Pump, or Gear Reducer Filtration

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.



Main Cooling Drive Motor Pump Assembly For Larger HP Drive Motor, Water Cooled Booster Pump, or Gear Reducer Filtration

2. FILL WATER TANK

Fill water tank with fresh, clean water.

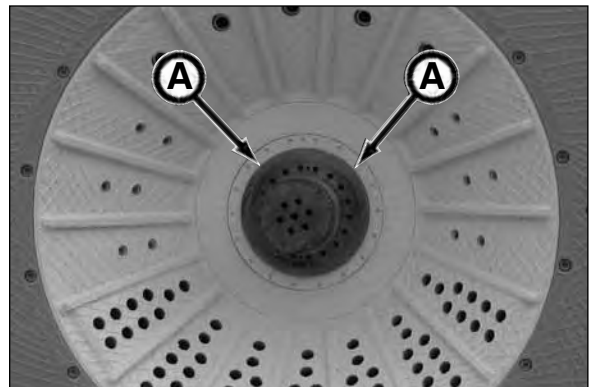
The tank capacity is 1,685 gal (6,378 L).



3. CHECK WATER COOLING OPERATION

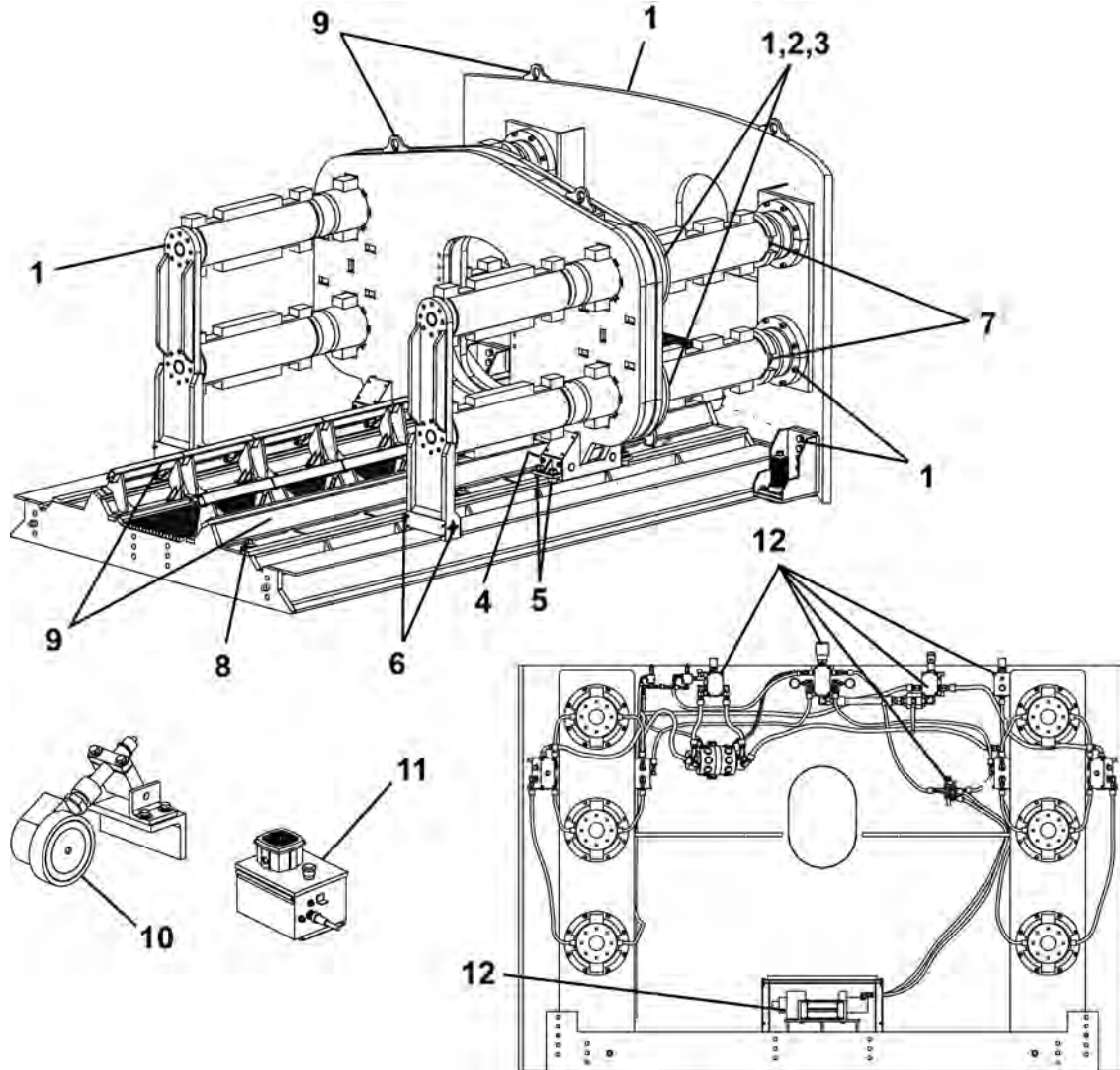
With the water tank full, start the cooling pump and check to make sure water is being expelled past the front lip seals retaining ring (A). Normal operating cooling pressure is 50 to 100 psi. Be sure the cooling pressure does not exceed 100 psi.

If not, troubleshoot and resolve the problem before operating. NEVER operate MTBM without proper drive motor cooling.



NOTES

MAINTENANCE CHARTS - KEYHOLE JACKING FRAME



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		

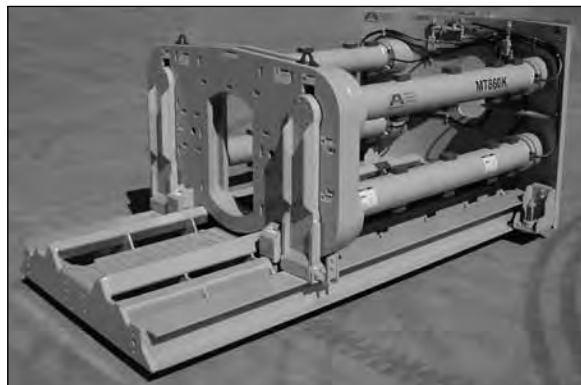
1 . CLEAN & INSPECT JACKING FRAME

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.

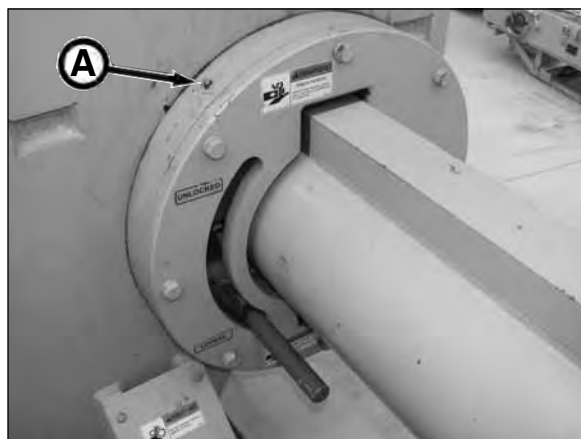
If cracks or damage are present, contact your Akkerman Aftermarket Support representative for authorized repair or replacement procedures.

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.

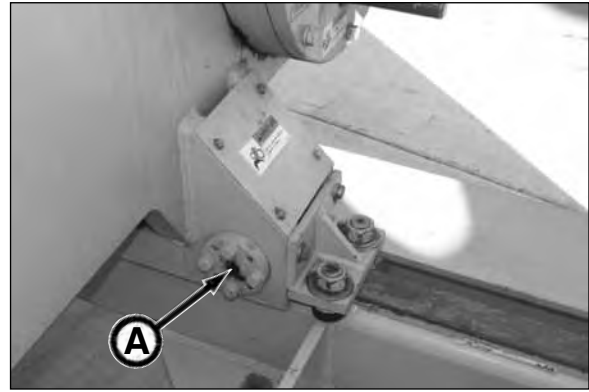
The cam lock lever will have some resistance when moving to the lock and unlock positions but if cam locks are very difficult to move, be sure they are lubricated properly or check for a mechanical failure. Repair or replace before operation.



4. LUBRICATE THRUST BLOCK GUIDES

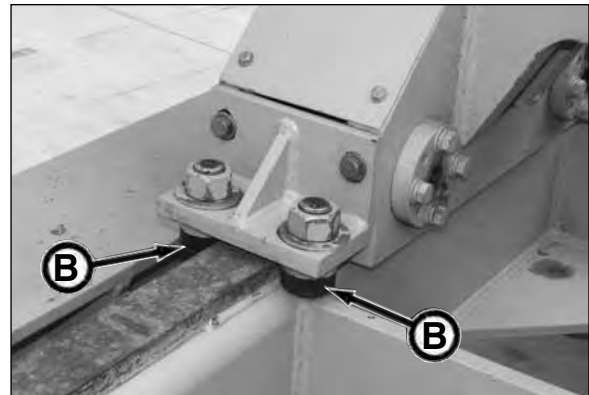
Lubricate thrust block guides (A) (4 places) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.

If guide guard was removed, be sure it is replaced.



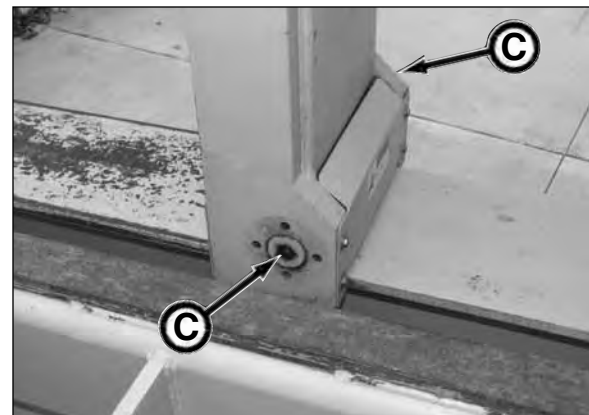
5. CHECK THRUST BLOCK ROLLER OPERATION

Check to be sure the thrust block rollers (B) roll freely. If they do not roll freely, repair or replace before operation.



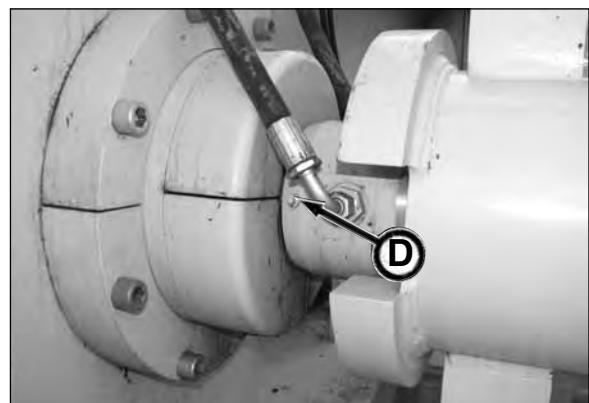
6. LUBRICATE CYLINDER SUPPORTS

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.

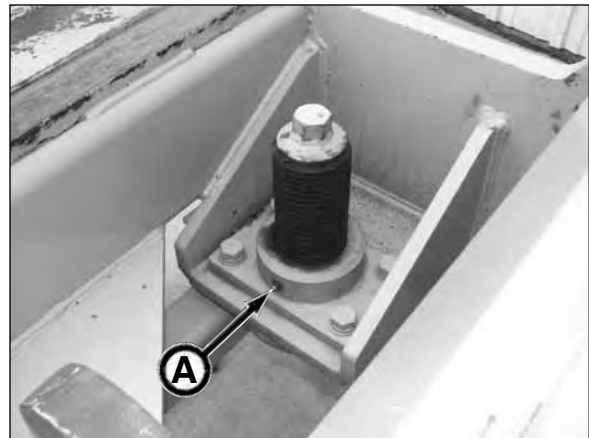


8. LUBRICATE LEVELING ASSEMBLY

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.



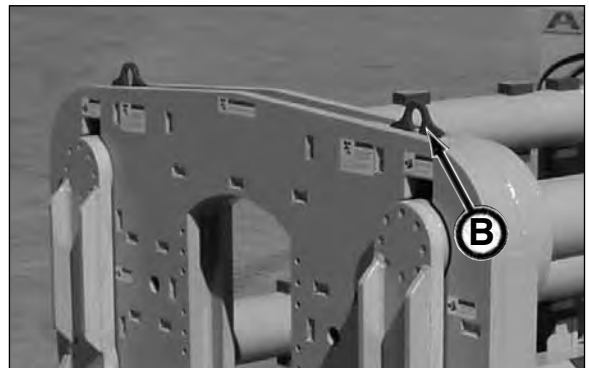
9. INSPECT LIFT EYES

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

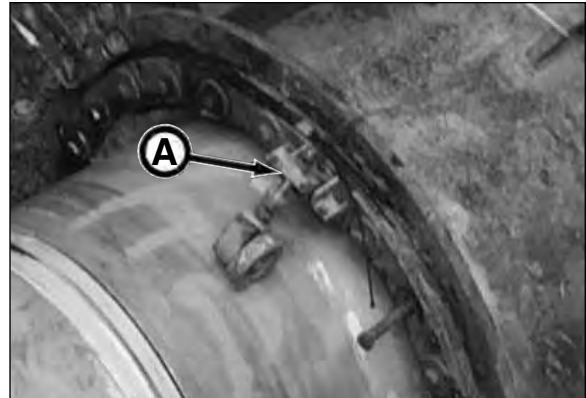


Thrust Wall Lift Eyes

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.

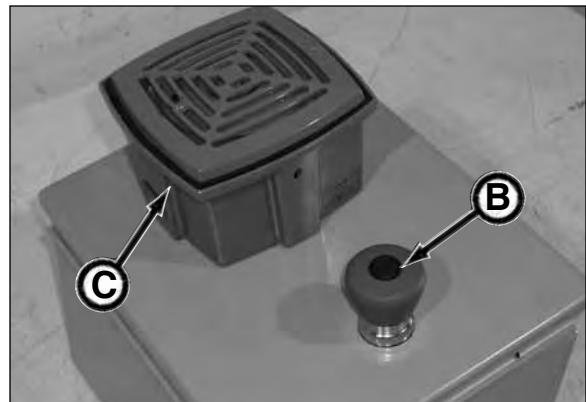
Check the operation of the pipe counter (A). If the pipe counter does not function properly, repair or replace before operation.



11. CHECK PIT BOX OPERATION

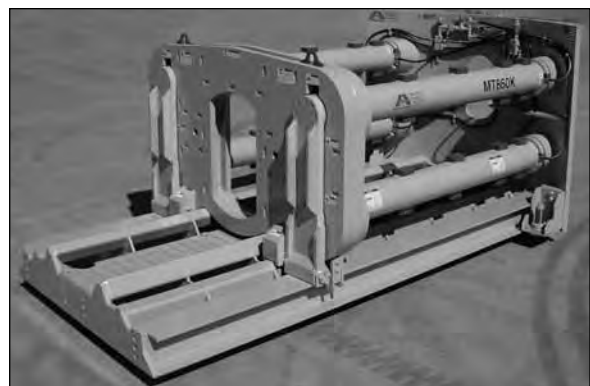
⚠ WARNING ALL Emergency Stop buttons and gas detector warning devices **MUST** be operating properly **BEFORE** operating the microtunneling system. Failure to do so may cause sever injury or death.

Check the operation of the pit box emergency stop button (B) and the gas detector horn (C). If the E-Stop button and/or the horn does not function properly, it **MUST** be repaired or replaced **BEFORE** operation.



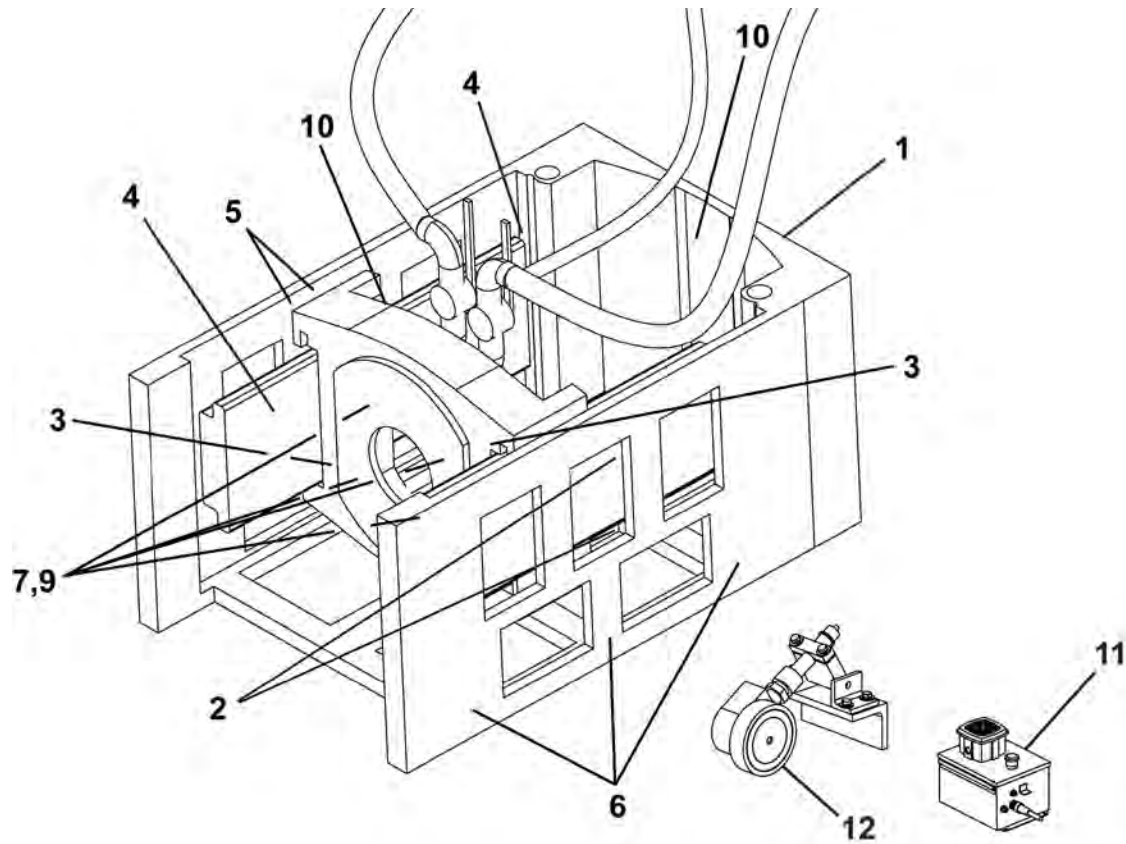
12. CHECK JACKING FRAME HYDRAULIC CONTROL OPERATION

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 - MT (SLIDE THRUST) JACKING FRAMES



PRIOR TO EACH DRIVE LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Jacking Frame	Clean & Inspect		
2.	Jacking Frame	Lubricate Frame Slide Rails	Lubricate until grease is forced out.	Mobil XHP222
3.	Dog Cyl Pins	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
4.	Jacking Cyl Pins	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
5.	Thrust Block Rollers	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
6.	Leveling Assembly	Lubricate	Lubricate generously.	Mobil XHP222
7.	Locking Blocks	Lubricate		Lt. Wt. Motor Oil
*8.	Lift Eyes	Inspect	Repair or replace as necessary.	
9.	Locking Blocks	Inspect	Repair or replace.	
10.	Hydraulic Controls	Check Operation	Repair or replace as necessary.	
11.	Pit Box	Check Operation	Repair or replace as necessary.	
12.	Pipe Counter	Check Operation	Repair or replace as necessary.	

* Not Shown

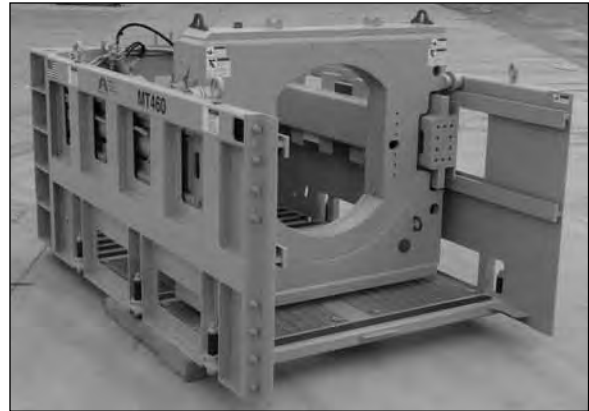
1. CLEAN & INSPECT JACKING FRAME

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 FRAME SLIDE RAILS

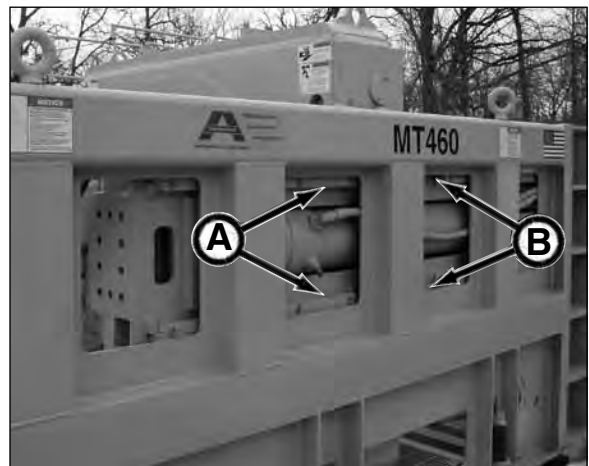
Lubricate the jacking frame slide rail grease fittings (A) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.

NOTICE

The MT460 has 8 grease fittings per side, 16 total. Other models may have more or less lubrication points.

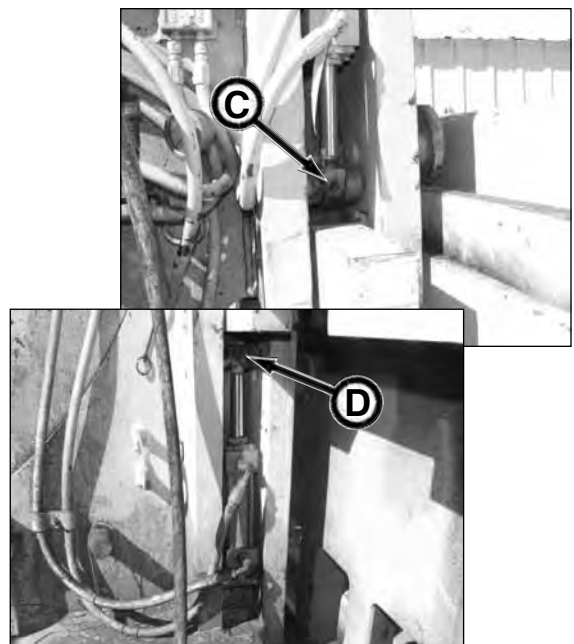
Lubricate the open rail slots (B) with a bead of grease.

If a jacking frame extension is being used, be sure to lubricate the slide rail grease fittings and open slots as described above.



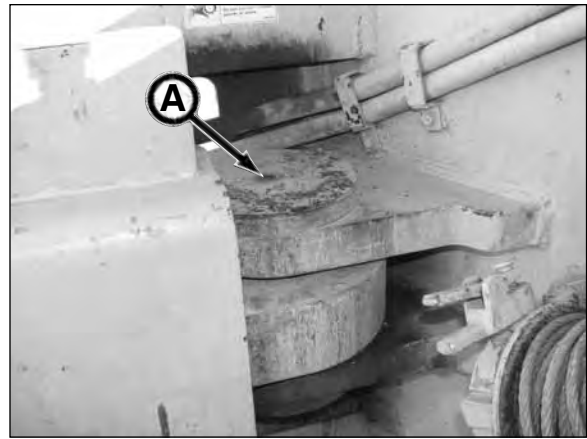
3. LUBRICATE DOG CYLINDER PINS

Lubricate the upper dog cylinder pins (C) (2 places) and lower dog cylinder pins (D) (2 places) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.

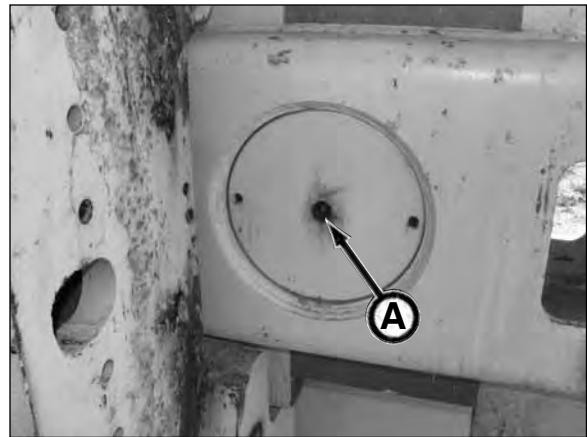


4. LUBRICATE JACKING CYLINDER PINS

Lubricate the jacking cylinder pins (A) (4 places) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.



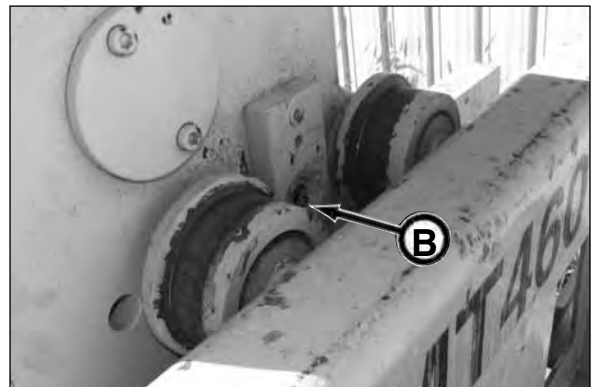
Jacking Cylinder Base End Lubrication



Jacking Cylinder Rod End Lubrication

5. LUBRICATE THRUST BLOCK ROLLERS

Lubricate thrust block rollers (B) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.



6. LUBRICATE LEVELING ASSEMBLY

Lubricate leveling screws (C) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent.

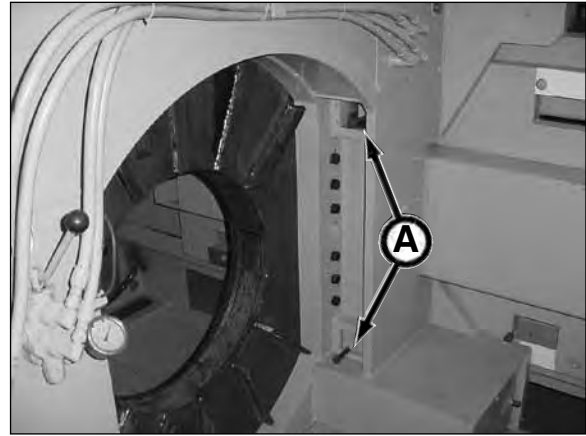
Lubricate threads thoroughly.

If a jacking frame extension is being used, be sure to lubricate the extension leveling screw grease fittings.



7. LUBRICATE DOG LOCKING BLOCKS (IF EQUIPPED)

Lubricate the dog locking blocks (A) (4 places) with a high quality light weight motor oil.

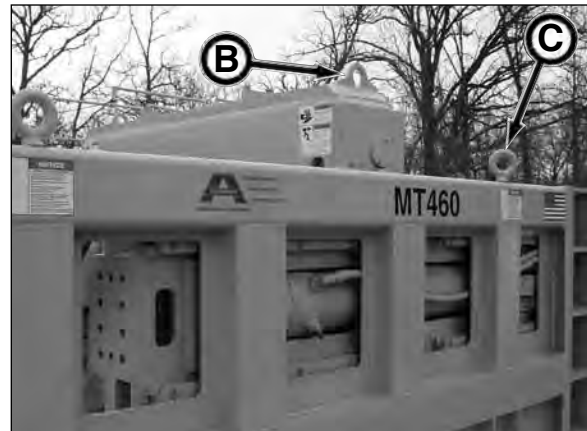


8. INSPECT LIFT EYES

Visually inspect lift eyes (B,C) for cracks or damage. If cracks or other damage is present, the lift eye **MUST** be replaced before lifting frame.

On the removable lift eyes (C), be sure to check lift eye threads for damage. Also check lift eye threads in frame for damage.

Contact your Akkerman Aftermarket Support representative for authorized repair or replacement procedure.



9. INSPECT DOG LOCKING BLOCKS

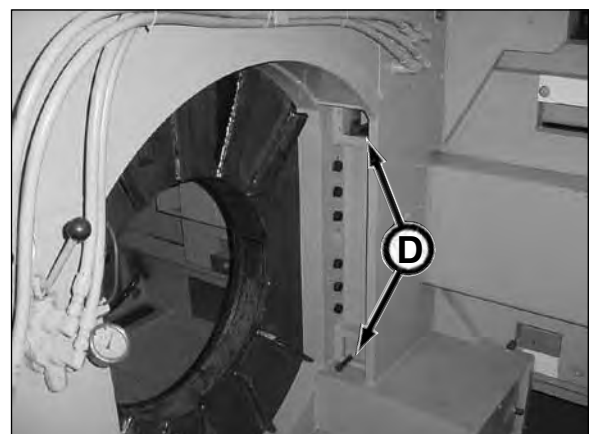
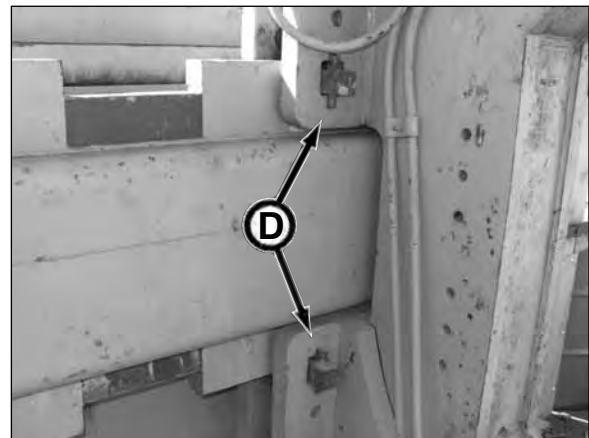
Visually inspect dog locking blocks (D) for cracks or damage. The four locking blocks **MUST** be replaced **BEFORE** shipping or lifting jacking frame.

NOTICE

There are various locking block styles as shown in the photos.

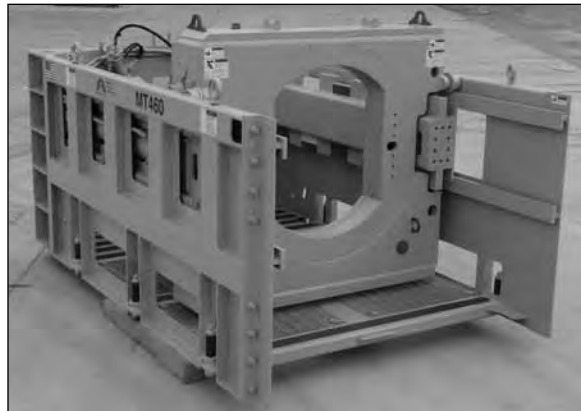
⚠ WARNING

Shipping or lifting jacking frame without **ALL** four dog blocks engaged into frame, can cause serious injury or death from sliding thrust block. **BEFORE** disengaging the jacking frame hydraulics, engage **ALL** four dog blocks into the jacking frame.



10. CHECK JACKING FRAME HYDRAULIC CONTROLS OPERATION

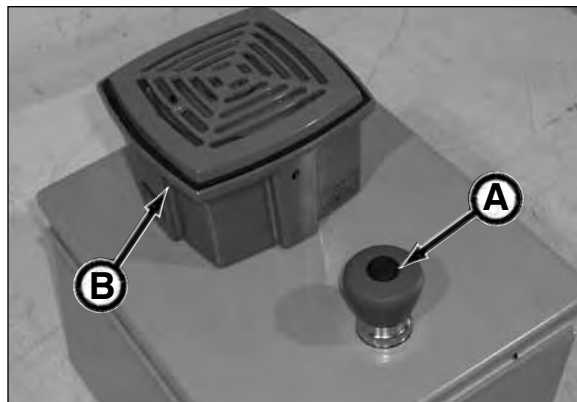
Before launching MTBM, be sure to check the operation of the jacking frame hydraulic: jacking cylinder controls, dogging controls and winch controls for proper operation. If controls do not function properly or show signs of leaking, repair or replace before operation.



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 the operation of the pit box emergency stop button (A) and the gas detector horn (B). If the E-Stop button and/or the horn does not function properly, it **MUST** be repaired or replaced **BEFORE** operation.



12. CHECK PIPE COUNTER OPERATION

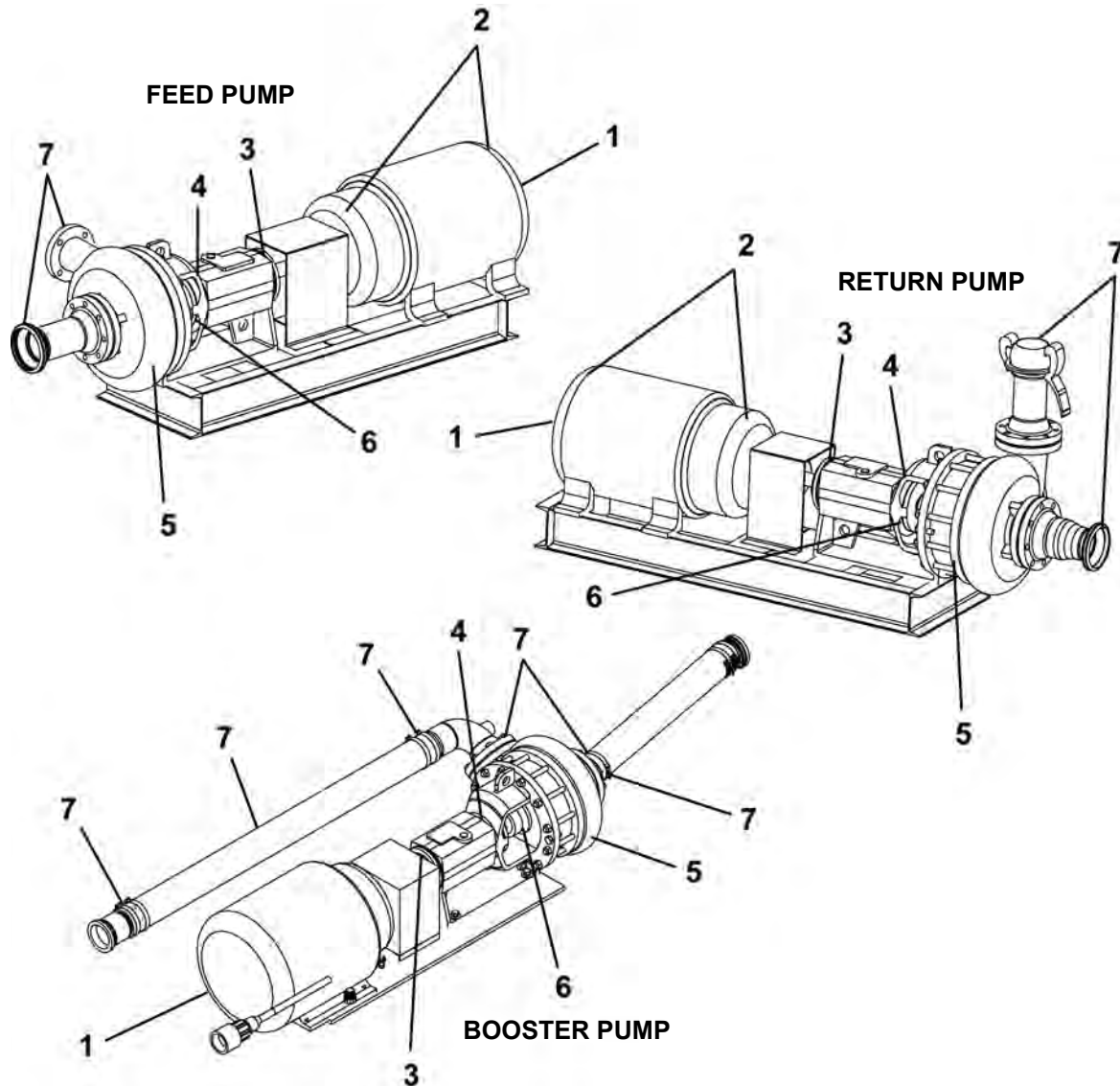
⚠ WARNING ALL Emergency Stop buttons and gas detector warning devices **MUST** be operating properly **BEFORE** operating the microtunneling system. Failure to do so may cause sever injury or death.

Check the operation of the pipe counter (C). If the pipe counter does not function properly, repair or replace before operation.



NOTES

MAINTENANCE CHARTS - SLURRY PUMPS



PRIOR TO EACH DRIVE LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Motor	Check Motor Rotation	CW viewed from motor fan.	Mobil XHP222 Mobil XHP222 Mobil XHP222
2.	Motor Bearings	Lubricate (2 Places)	One Shot	
3.	Bearing Seals	Lubricate	Five shots	
4.	Lip Seals	Lubricate	Five shots	
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.	

* Not Shown

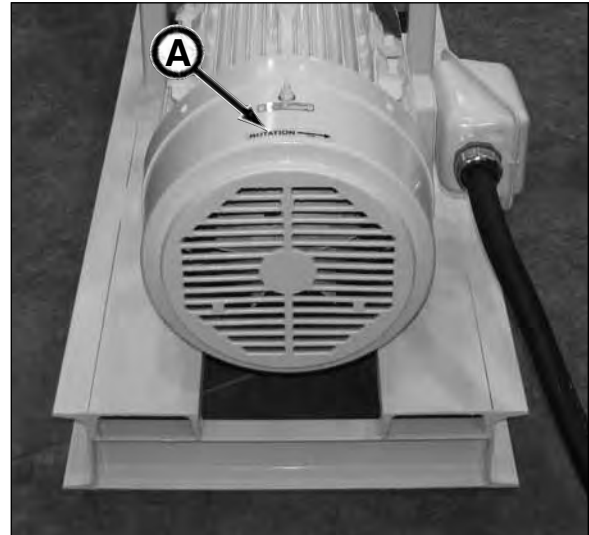
1. CHECK MOTOR ROTATION (Feed, Return & Booster Pumps)

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.

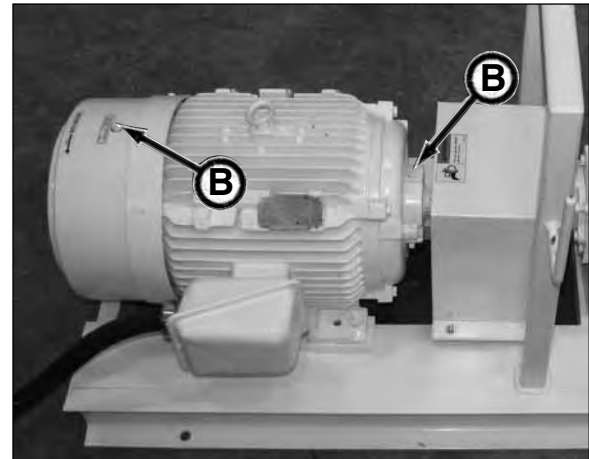
NOTICE

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.

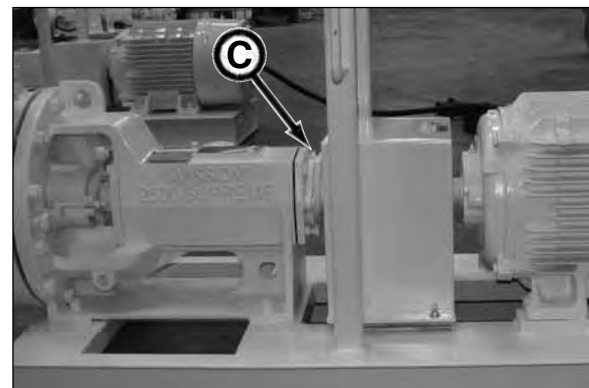


3. LUBRICATE BEARING SEALS (Feed, Return & Booster Pumps)

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.

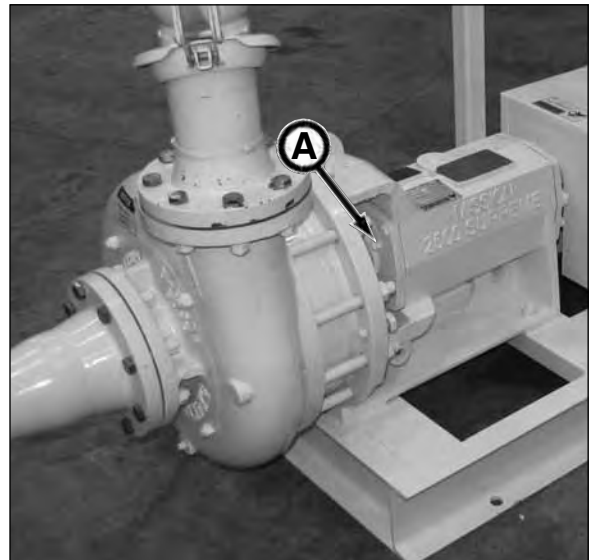
NOTICE

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.



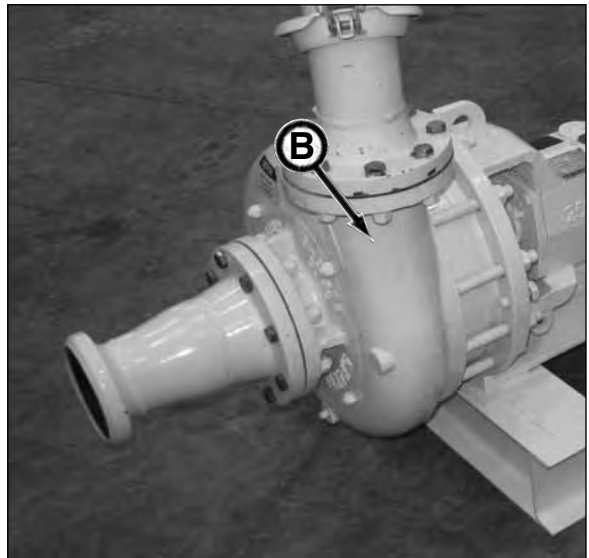
4. LUBRICATE LIP SEALS (Feed, Return & Booster Pumps)

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)

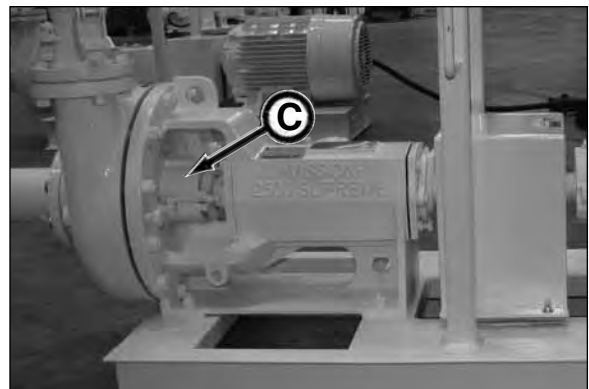
Inspect impeller (B) for excessive erosion, corrosion, extreme wear or vane damage. If impeller shows any of these signs, the impeller should be replaced. For impeller replacement, contact your Akkerman Aftermarket Support representative or refer to your Halco Installation, Operation and Maintenance Instructions for Halco 2500 Supreme Pumps Manual.



6. INSPECT MECHANICAL SHAFT SEALS (Feed, Return & Booster Pumps)

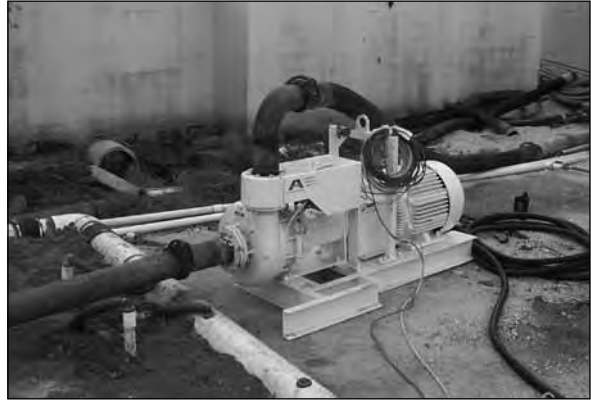
Inspect mechanical shaft seal (C) faces, gaskets and shaft sealing members for wear or damage. Excessive leakage may result if seals are not replaced when needed.

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.



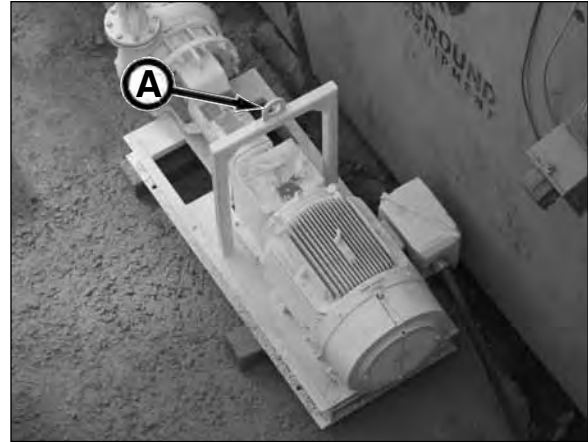
8. INSPECT POWER CABLES (Feed, Return & Booster Pumps)

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 & 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

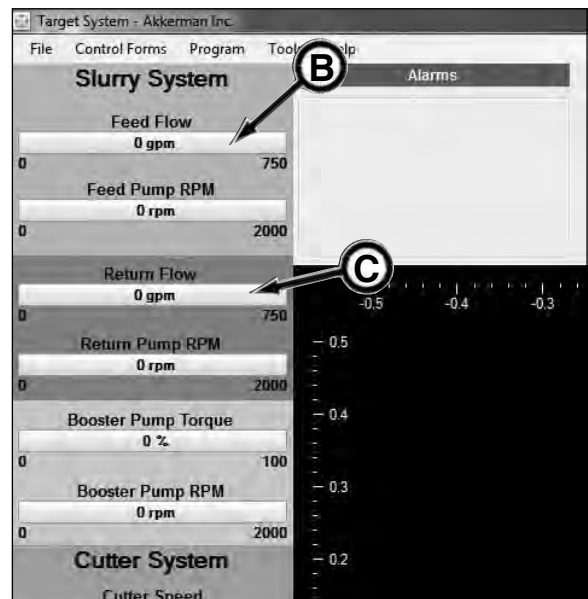
It is recommended to start and stop the feed, booster and return pumps in the order listed below to prevent excessive fluid pressure on pump components:

START: Booster - Return - Feed

STOP: Feed - Return - Booster

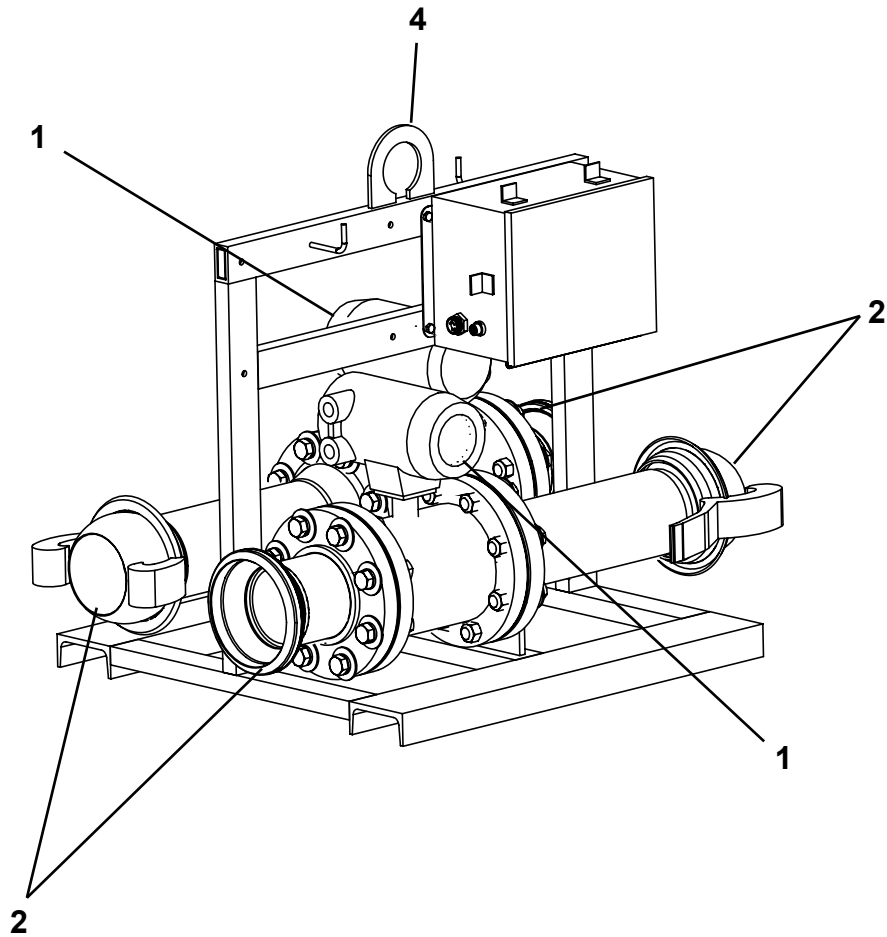


If not already done so, check to be sure the pressure from the flow meter is identical to the slurry feed and return flow readings (B,C) on the target screen.



NOTES

MAINTENANCE CHARTS - FLOW METER



PRIOR TO EACH DRIVE LAUNCH

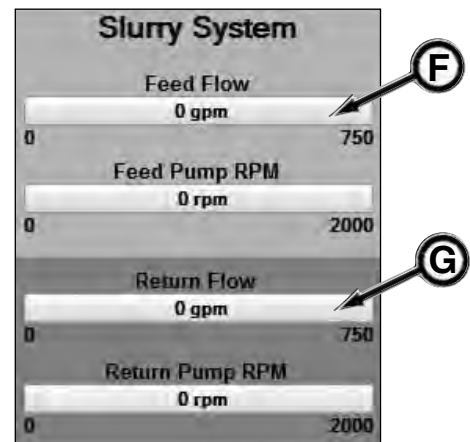
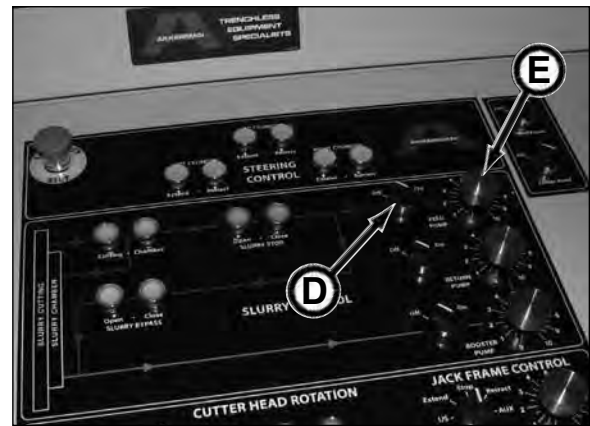
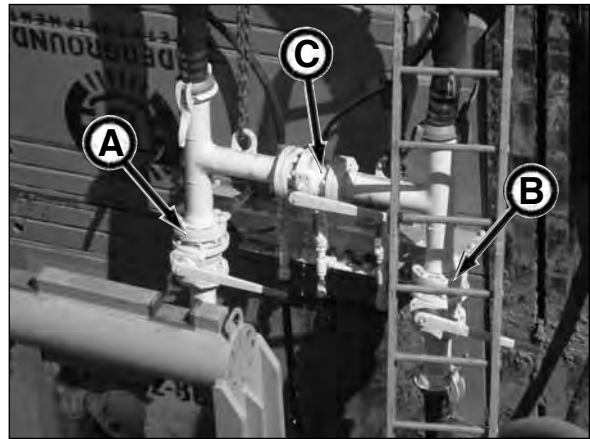
ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Meter Reading	Check	Flow meter reading & target screen reading must be identical.	
2.	Slurry Line Connections	Inspect For Wear Or Damage	If damaged, replace.	
*3.	Cables	Inspect Ethernet & Power Cables	If damaged or worn, replace.	
4.	Lift Eyes	Inspect	Repair or replace as necessary.	

* Not Shown

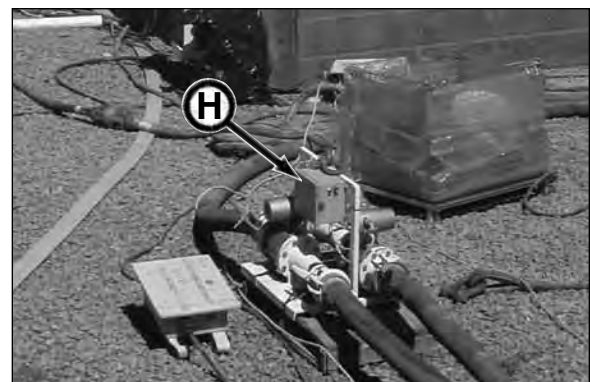
1. CHECK FLOW METER READINGS

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.

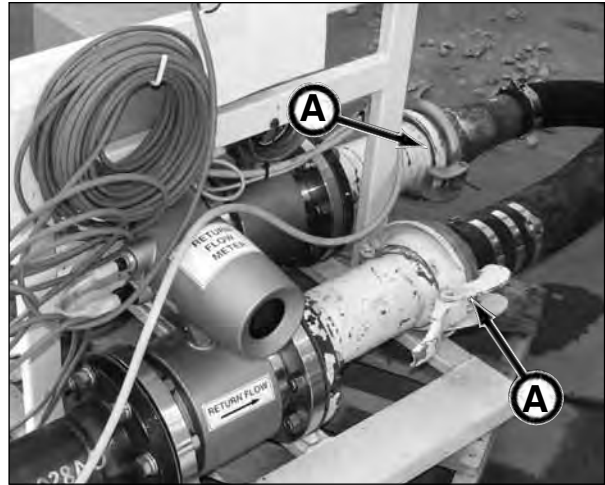


5. Be sure the feed flow meter is connected to the feed flow, not return flow. Otherwise, if the feed flow meter is connected to the return flow, it will cause operator confusion during mining operation resulting in over or under excavation.
6. Check flow meter readings on flowmeter (H) with feed and return gpm data on target screen. Both readings should be identical.



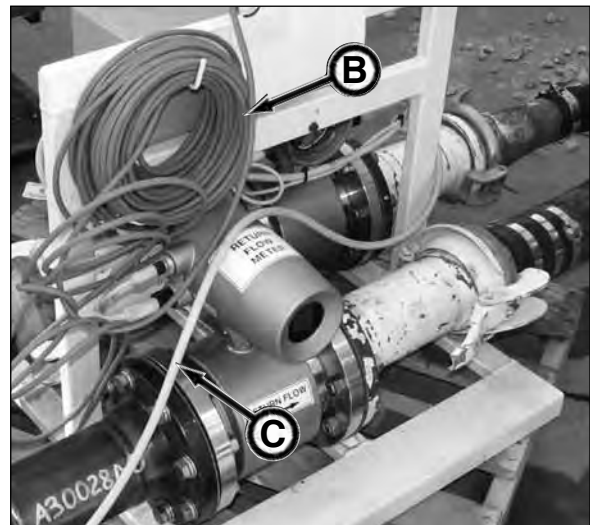
2. INSPECT SLURRY LINE CONNECTIONS

Inspect all slurry line connections (A) for wear or damage. Repair or replace as needed.



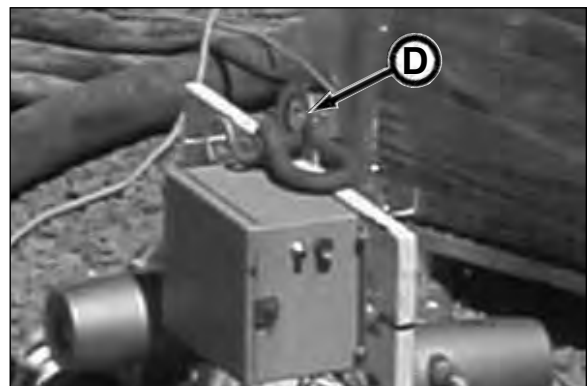
3. INSPECT CABLES

Inspect ethernet cable (B) and power cable (C) for cracking, fraying, wear or damage. Replace as needed.



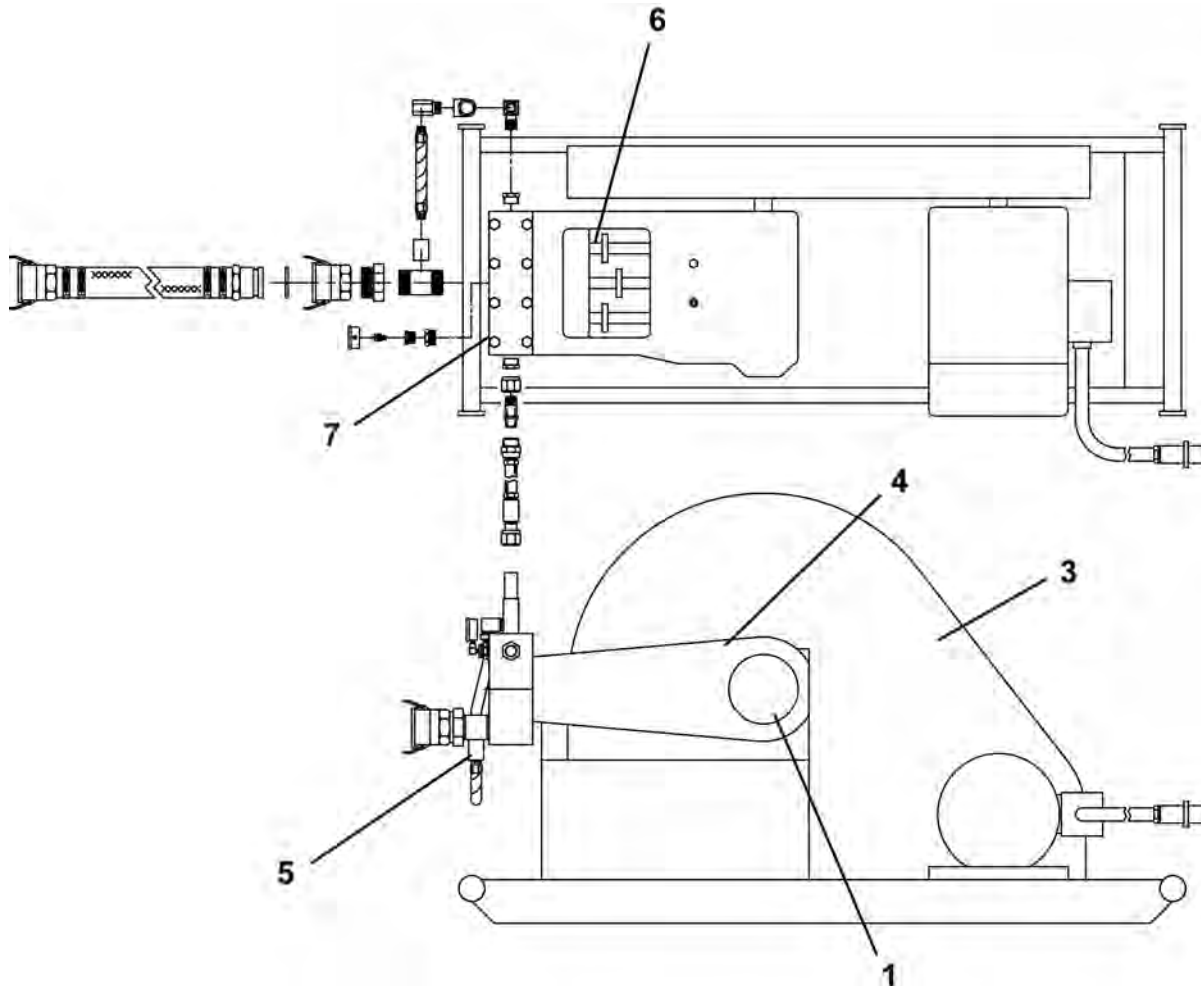
4. INSPECT LIFT EYE

Inspect lift eye (D) for wear or damage. If damaged or worn, replace with new.



NOTES

MAINTENANCE CHARTS - HIGH PRESSURE JETTING PUMP



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.	

Note: Refer to Apex SC-115 User Manual for more information.

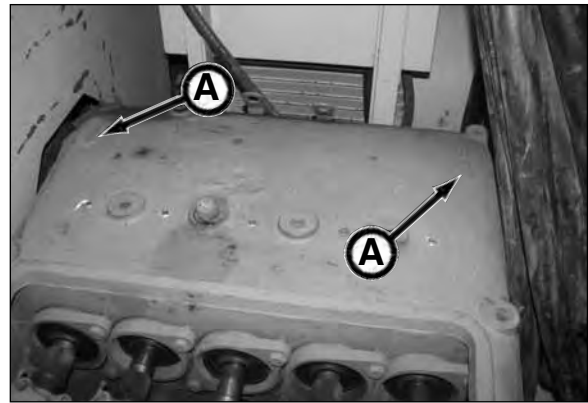
* Use SAE Grade 40 non-detergent industrial turbine oil.

** 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.

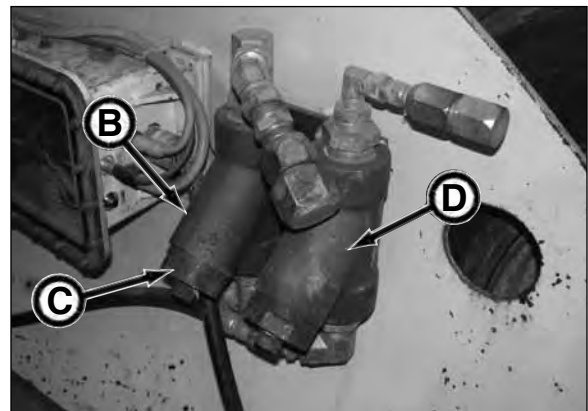


2. CLEAN STRAINER

With the water cooling tank shut down, gain access to the high pressure jetting pump strainer. Depending on the size of MTBM, the strainer will be located in the trailing section or the trailing dolly.

To clean the strainer:

1. Clean area around the high pressure jetting pump strainer base (B).
2. Remove the nut (C) from the strainer base.
3. Remove the strainer from the base.
4. Clean the strainer by flushing it with water or compressed air (low pressure). If strainer is damaged, replace with new.
5. Replace the strainer.
6. Secure the nut to the strainer base.
7. Repeat steps 1 through 6 for the water cooling pump strainer assembly (D).



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 Apex User Manual for more information.

1. Remove belt cover (A).

2. Belt Alignment

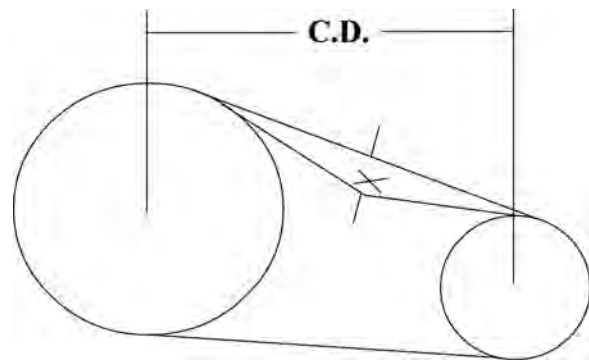
Use a straight edge across the rim of the sheaves to detect and correct for misalignment.

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 Apex 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.

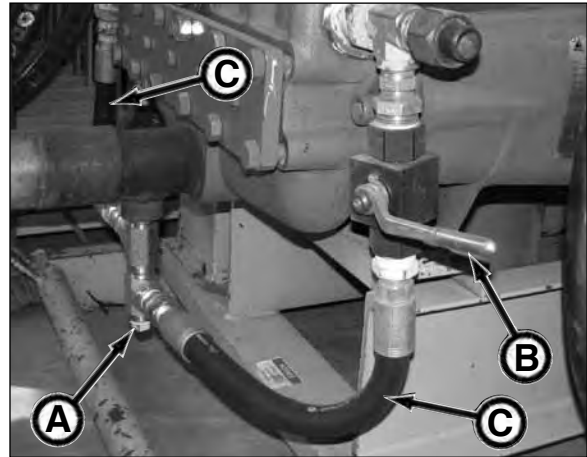
3. Replace fill cap and dipstick.



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.

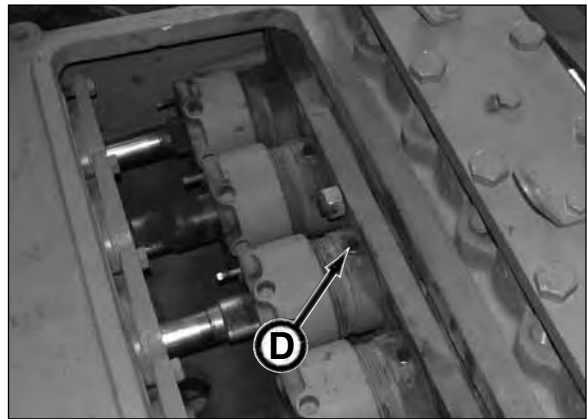


6. LUBRICATE PISTON GLANDS

Lubricate each piston gland (D) with two shots of Mobilgrease XHP222 or equivalent.

NOTICE

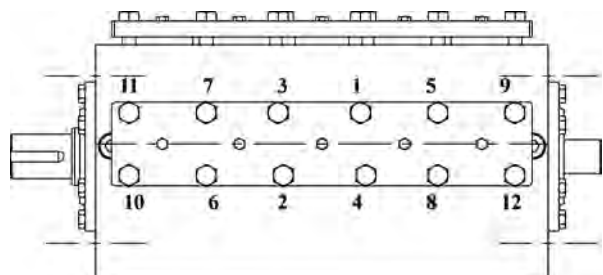
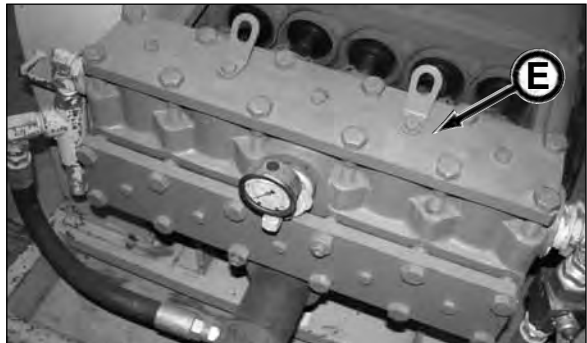
This lubrication is only to be used with gland adjusted packing. If used with spring loaded packing, the grease can load up in the spring causing it to harden and become less effective. Refer to your Apex SC-115 User Manual for more information.



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.

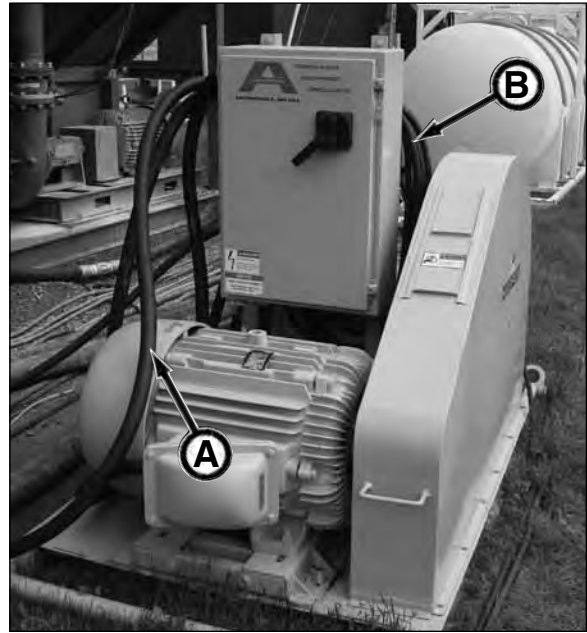
Tighten the stuffing box studs or cap screws evenly to 125 ft-lb (169 N·m) torque in the sequence shown in diagram. Retighten every 500 hours of operation.



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.



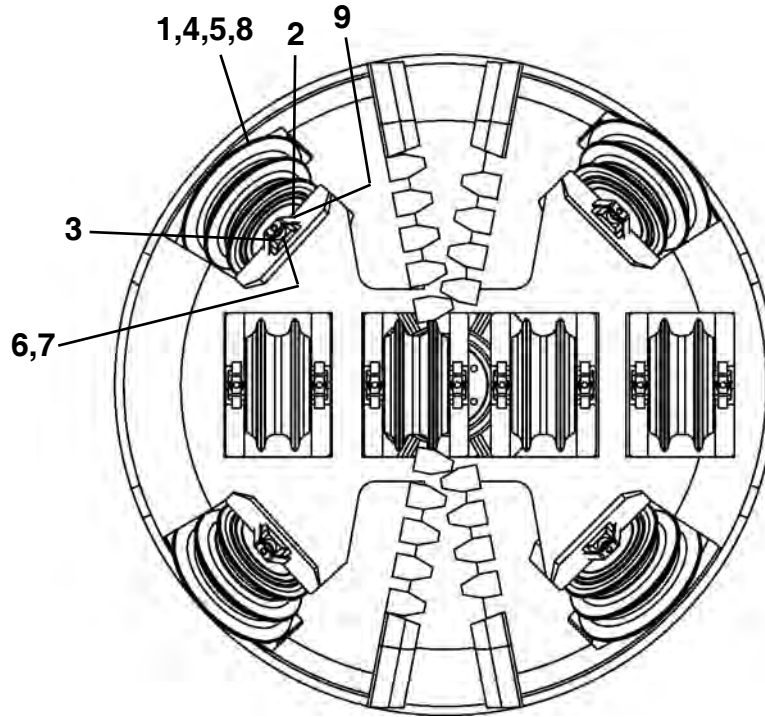
NOTES

MAINTENANCE CHART - MTBM DISC CUTTERS

NOTICE

For more information, refer to your Multi-Disc Rock Cutter Operator's Manual (050012A0).

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.	Cutter	Lubricate	See maintenance detail.	Paragon® 3000
2.	Cutter Housing	Clean "V" of Housing		
3.	Threaded Bolt Hole	Check Helical Inserts	Remove foreign material/dirt.	
4.	Cutter	Inspect		
5.	Cutter	Check Cutter Placement	Contact Product Support.	
6.	Retaining Bolts	Install New Hardware		Torque Wrench
7.	Retaining Bolts	Torque	Tighten to 375 ft-lb torque.	
8.	Cutter	Rotate Cutters Freely	Cutters must rotate otherwise requires repair or replacement.	
9.	Bolt Keepers	Weld	Use strap (A04396P) & hex plug (A04397P)	Low Hydrogen Welding Rod

1. LUBRICATE CUTTERS

BEFORE EVERY LAUNCH, remove and lubricate ALL cutters as follows:

⚠ WARNING Use face shield, hand and body protection while cutting off bolt keepers to avoid serious injury.

1. Cut and remove all bolt keepers from mounting plates.
2. Carefully remove cutters. Dispose of bolts and lock washers. New hardware must be used when installing new or used cutters.
3. Remove a plug from the drain port and thread a grease fitting (A) into the same port.
4. Remove drain port (s) from the opposite end cap of the cutter.
5. Stand the cutter on its end (shaft vertical) and clamp the shaft in a vice with the grease fitting end pointing down.
6. Pump in grease while rotating the cutter by hand. Continue pumping grease and rotating the cutter until the old grease is removed and the new grease comes through the top drain port (s) (B). This will remove all air so the cutter is completely filled with lubricant.

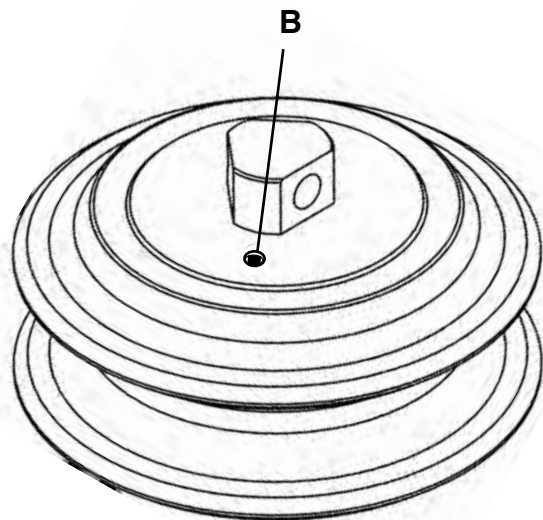
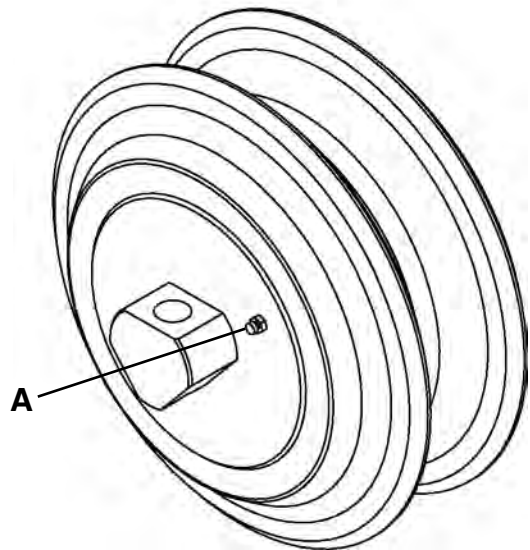
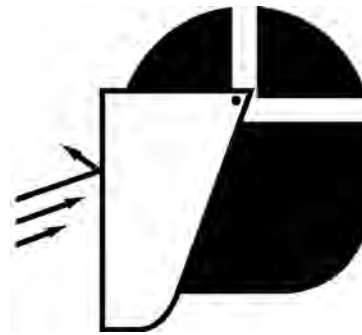
NOTICE All air MUST be removed from bearing cavity. Failure to do so, will cause bearing and cutter failure due to the build up of water, air, and grit in the bearing cavity while under pressure.

7. Replace drain plug (s) in top port (s) (B) by putting an anti-seize lubricant on the threads of the plug and then secure plug to end cap.
8. Remove the cutter from the vise and turn it over so the grease fitting is on top. Clamp the shaft in vice.
9. Remove the grease fitting and immediately apply anti-seize lubricant on the threads of the plug and then secure plug to end cap.

NOTICE When the cutters are properly lubricated, they must be stored in a cool location, out of direct sunlight. If the cutters are subjected to heat and sunlight, the grease may expand and damage the seals at one or both ends of the cutter. If any cutter leaks grease from either end, new seals MUST be replaced in the cutter.

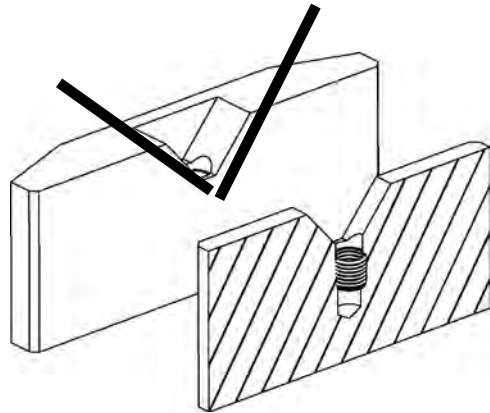
DO NOT USE CUTTERS WITH DAMAGED SEALS. Irreplaceable damage to the cutter and cutter head could occur. Contact your Akkerman Product Support representative for details on replacing cutter seals.

050077A_microtunomGen3



2. CLEAN CUTTER HOUSING

With the cutters removed, clean the V-shaped portion of the cutter housing. Be sure the housing is clean and free of any sharp edges, protrusions and other foreign matter.



3. CHECK & CLEAN THREADED BOLT HOLES

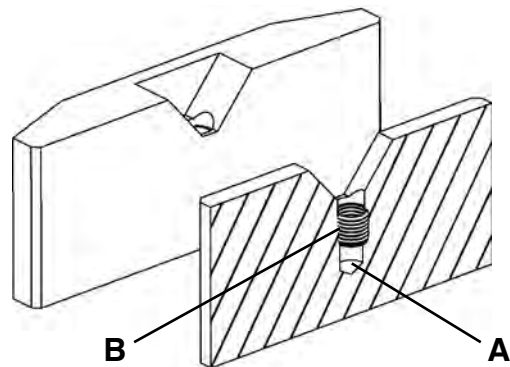
Visually inspect and clean EACH threaded hole (A) in the cutter housings.

Be sure that the helical thread inserts (B) are in good condition.

NOTICE

Do not chase insert threads with a tap. There must be some resistance while tightening cutter retaining bolts.

Remove debris and any foreign material from ALL bolt holes. Any debris that reduces the depth of the bolt holes can interfere with the proper tightening of the bolts. Improper tightening of the bolts will result in premature wear to the cutter while reducing cutting performance.



4. INSPECT CUTTERS

Visually inspect each cutter thoroughly BEFORE installing. Always keep in mind that it will take significantly more force to penetrate a formation with a blunt cutter than a new cutter.

Check for signs of lubricant leakage from around the cutter end caps (A). If leakage is found, DO NOT install the cutter. The cutter MUST be repaired or replaced before mounting on cutter head.

Be sure ALL drain plugs (B) are securely in place. The drain plugs are located on both cutter end caps.

Inspect cutter shaft (C) (both ends) for damage. If damaged, contact your Akkerman Product Support representative.

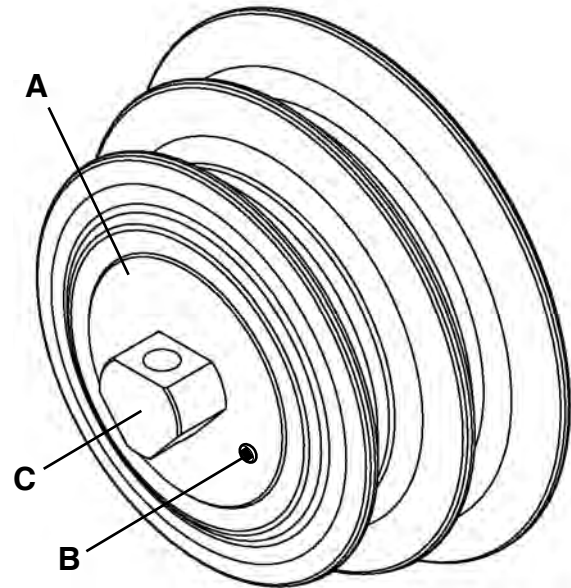
CUTTER WEAR

If any flat spots 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 flat spots.

For the 280mm to 320mm size cutter, typically no more than 3/4 in. (19mm) of diameter wear is acceptable until considerable ground experience is achieved.

In cutters with tungsten carbide inserts (TCI), any cutters with cracked carbides or cracks in the base metal of the cutter, must be replaced with a new cutter.

If the carbide insert has turned into the base metal of the cutter, the cutter should be replaced with new, otherwise unplanned cutter failure will result.



5. CHECK CUTTER PLACEMENT

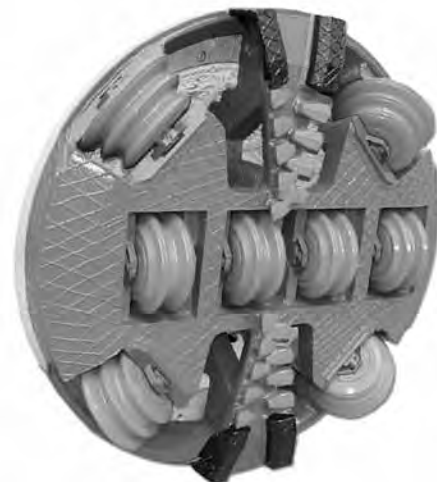
NOTICE

Pinch points! Moving parts or the mishandling of parts can cause serious injury. Handle parts carefully to avoid crushing and pinch point hazards.

Make sure when replacing the cutters on the cutter head, that the correct style of cutter (twin or triple, straight or conical cutters) is in the proper location and orientation.

If necessary, contact your Akkerman Product Support representative for a drawing for the proper cutter layout for your cutter head.

If the twin and triple cutters are not properly located and oriented, damage will result to your cutters, cutter head, and tunnel boring machine.



6. INSTALL NEW RETAINING HARDWARE

When installing cutters, ALWAYS replace with new cutter retaining bolts (A) and lock washers (B).

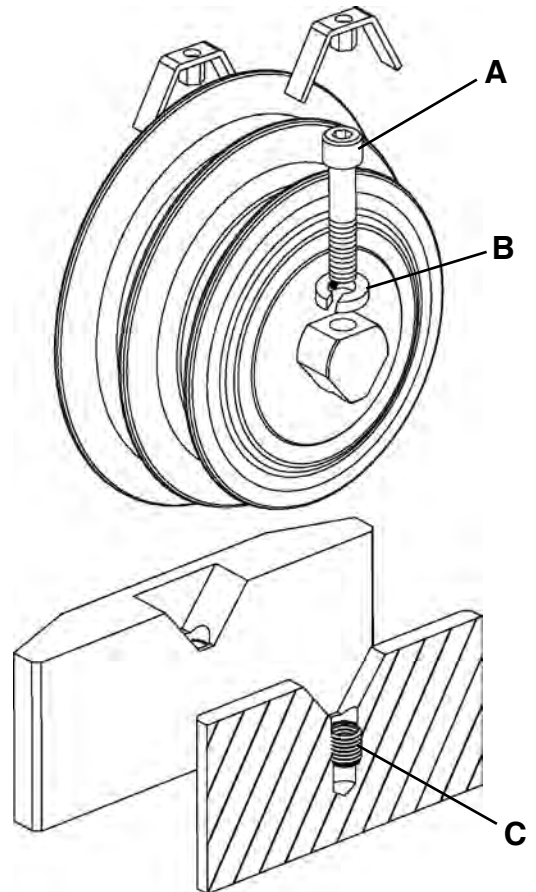
When replacing hardware, replace only with IDENTICAL size and grade. Contact your Akkerman Product Support representative for proper hardware.

The bolts must reach through the lock washer and shaft of cutter with at least one and one-half times the bolt diameter to engage the threads of the helical thread inserts (C).

To tighten hardware, refer to “7. Tighten Retaining Bolts” below.

NOTICE

Do not chase insert threads with a tap. There must be some resistance while tightening cutter retaining bolts.

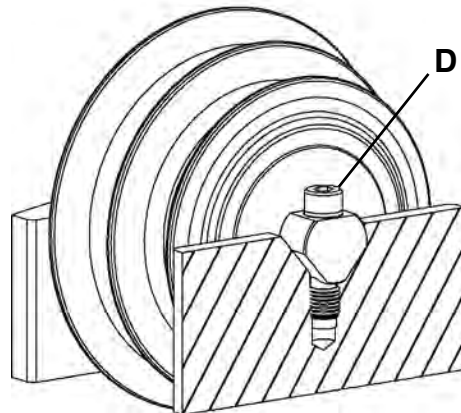


7. TIGHTEN RETAINING BOLTS

When securing the cutters in place, tighten all retaining bolts (D) to 375 ft-lb (508 N·m) torque with a calibrated torque wrench.

NOTICE

It is helpful to mark each bolt after tightening, so any bolts that have not been tightened, are clearly visible at a glance.

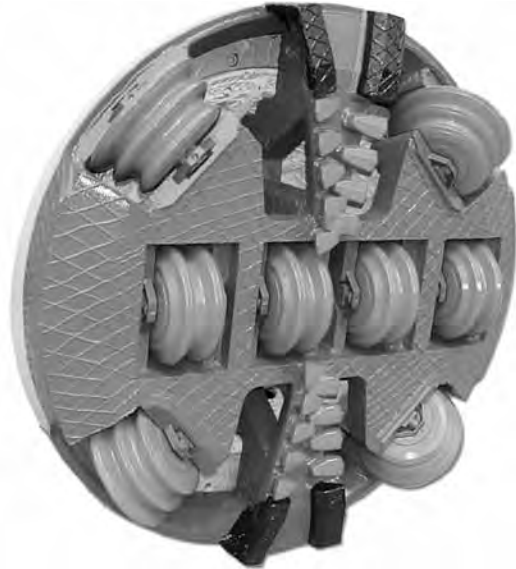


8. ROTATE CUTTERS

After the cutter retaining bolts are properly torqued, be sure the cutters rotate freely by hand.

It is normal to take some effort in rotating the cutters to overcome the bearing pre-load and friction in the seals.

If the cutter cannot be turned by hand, it may be wedged against debris behind the cutter or part of the cutter head structure. If after removing the debris and the cutter still does not rotate, the cutter must be repaired or replaced.



9. APPLY BOLT KEEPERS

Once the cutters are installed and the retaining bolts properly tightened, bolt keepers must be welded in place to prevent the bolts from working loose while mining.

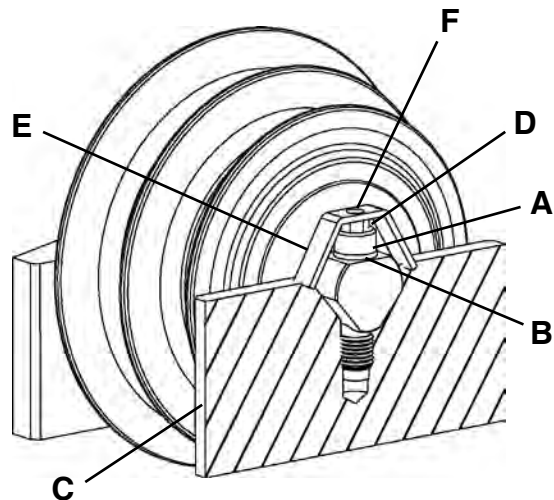
1. With the bolt (A) and lock washer (B) properly tightened into mounting plate (C), place bolt retainer hex plug (D) (PN A04397P) into socket head of bolt.
2. Place bolt retainer strap (E) (PN A04396P) over bolt/hex plug, aligning hole (F) of strap over hex plug.

NOTICE

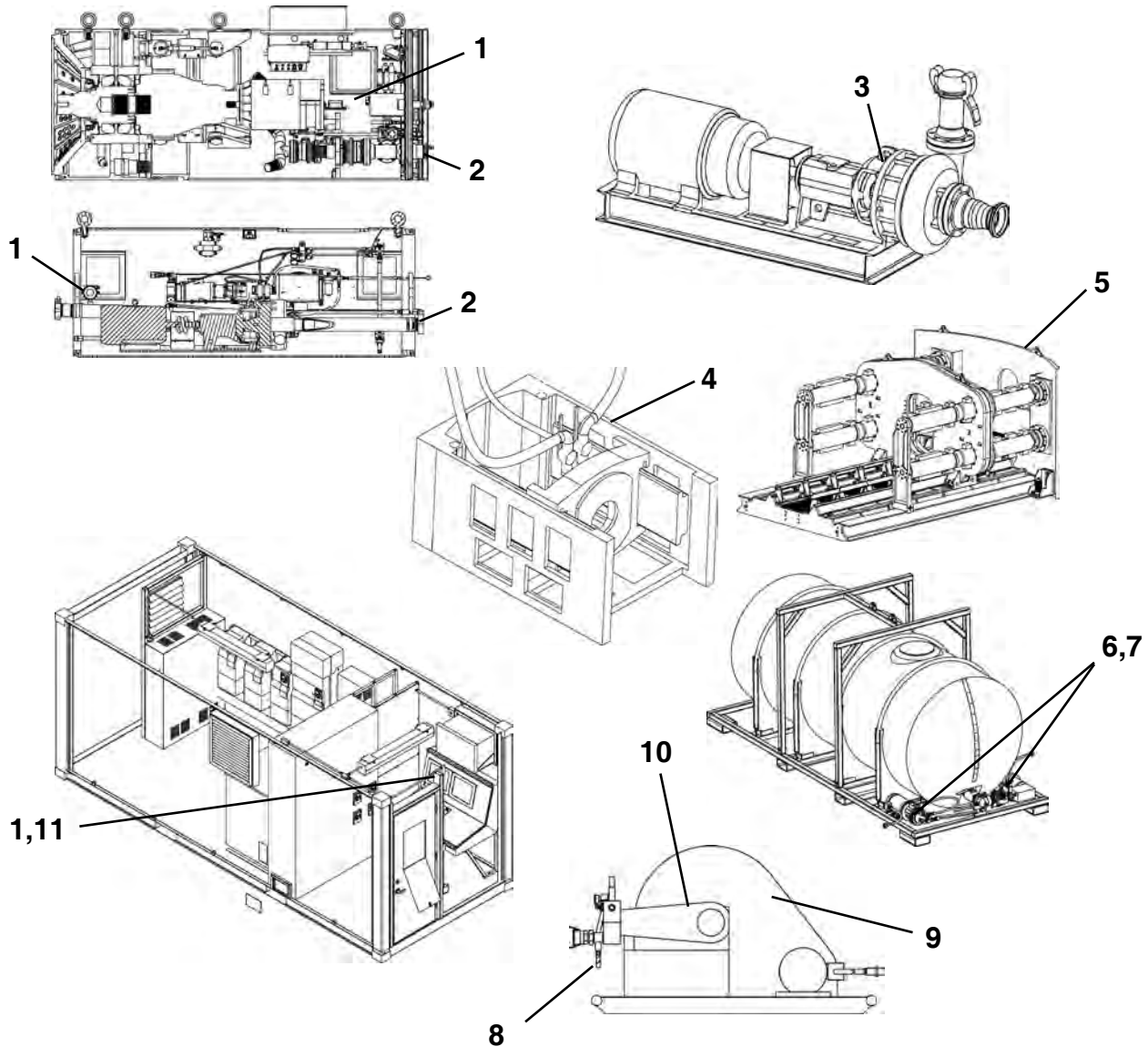
To avoid premature damage to bearing and cutter:

- **DO NOT** attach welding ground cable to cutter.
- **DO NOT** flash any arcs against cutter hub.
- **Hold a shield between cutter and work while attaching bolt keepers to keep weld spatter from hitting cutters.**
- **Apply stitch welds using low-hydrogen welding rods.**
- **DO NOT** weld on cutter surfaces. Otherwise cracks will develop.

3. Using a low-hydrogen welding rod, stitch weld strap to mounting plate.
4. Stitch weld hex plug to strap.
5. Continue steps 1 through 4 for other side of cutter and all other cutters.



MAINTENANCE CHART - MICROTUNNELING SYSTEM



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 (Slide Thrust Frame)	Clean, Inspect & Lubricate		Mobil XHP222
5.	Jacking Frame (Key Hole Frame)	Clean, Inspect & Lubricate		Mobil XHP222
6.	Water Cool. Pumps	Check Oil Level	Add oil if necessary.	SAE 10W30
7.	Water Cool. Pumps	Flush & Drain	In freezing weather.	
8.	Jetting Pump	Flush & Drain	In freezing weather.	
9.	Jetting Pump	Check Belt Tension	See maintenance detail.	
10.	Jetting Pump	Check Gear Box Oil	Add oil if necessary.	*SAE 40 non-det.
11.	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.

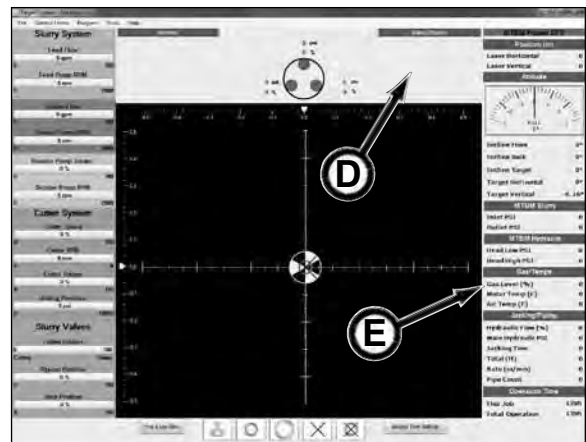
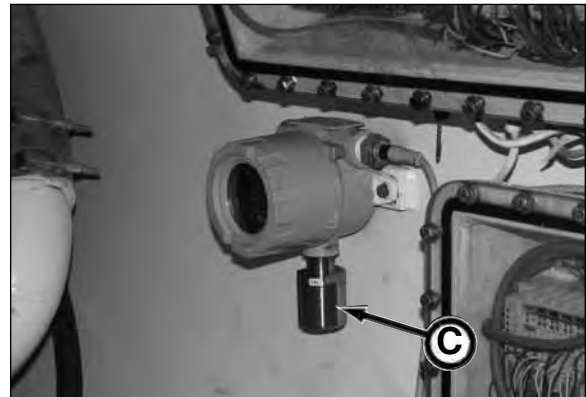
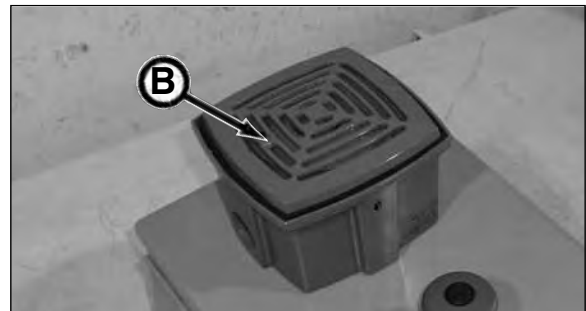
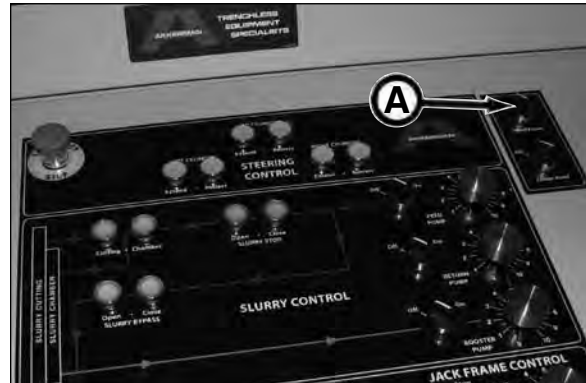
2. The gas detector is monitored by the control system as follows:

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 (C) 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

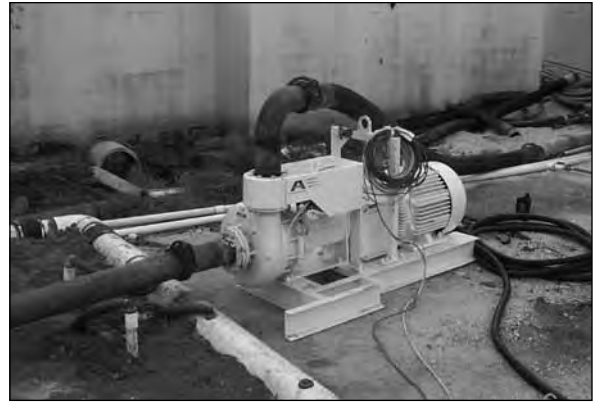
If the high LEL setting is reached, the cutterhead rotation and the jacking frame functions will shut down.

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.

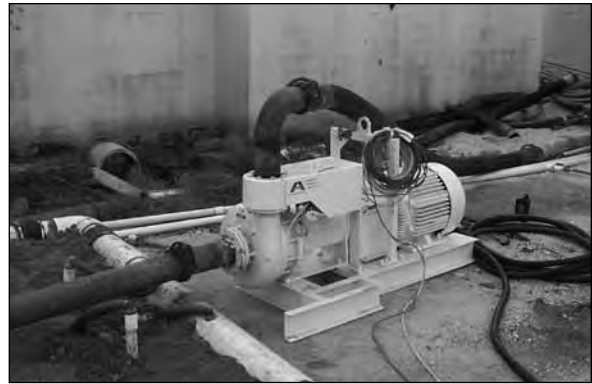


3. Inspect slurry power cables for wear, fray or damage. If cables are worn, frayed or damaged, the cable(s) must be replaced BEFORE operation.



3. FLUSH & DRAIN SLURRY PUMPS & HOSES

In freezing weather, the slurry pumps and hoses/lines must be flushed and drained to prevent damage.



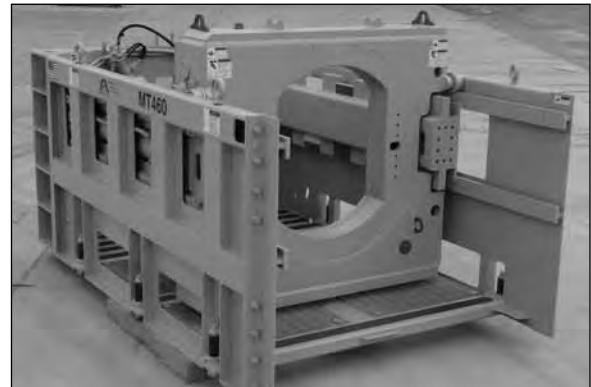
4. CLEAN, INSPECT & LUBRICATE JACKING FRAMES (SLIDE THRUST JACKING FRAMES)

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.



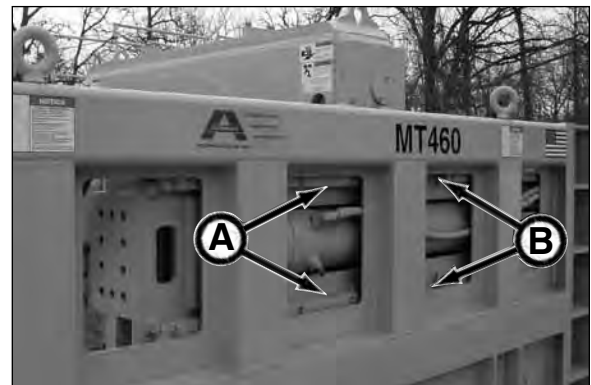
2. Lubricate the jacking frame slide rail grease fittings (A) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.

NOTICE

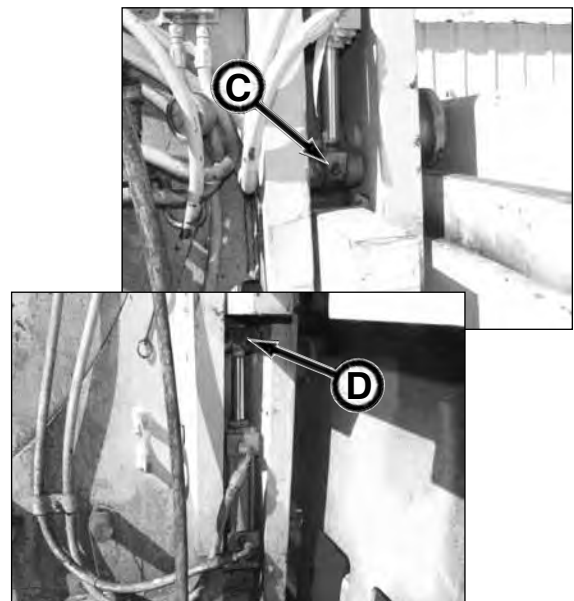
The MT460 has 8 grease fittings per side, 16 total. Other models may have more or less lubrication points.

Lubricate the open rail slots (B) with a bead of grease.

If a jacking frame extension is being used, be sure to lubricate the slide rail grease fittings and open slots as described above.

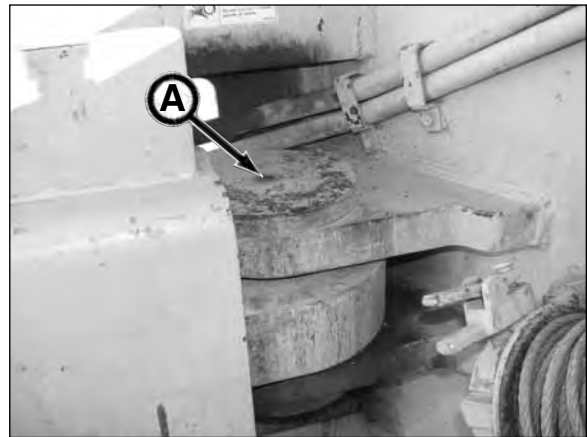


3. Lubricate the upper dog cylinder pins (C) (2 places) and lower dog cylinder pins (D) (2 places) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.

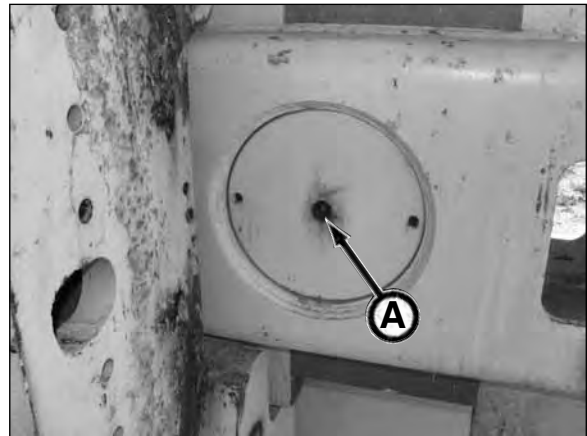


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4. Lubricate the jacking cylinder pins (A) (4 places) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.

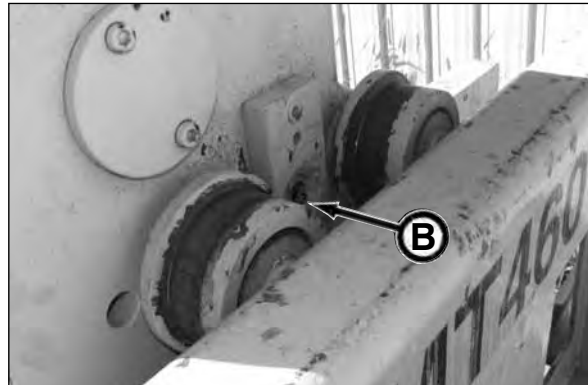


Jacking Cylinder Base End Lubrication

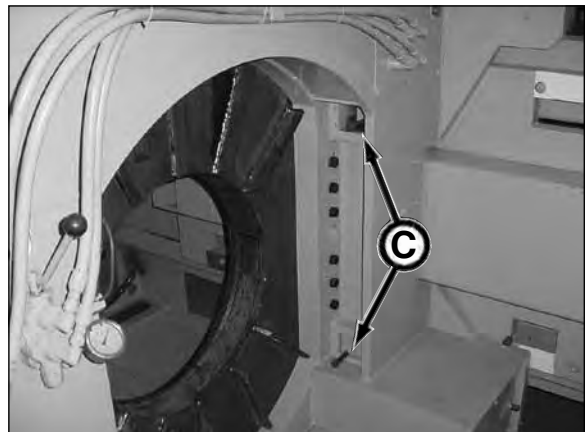


Jacking Cylinder Rod End Lubrication

5. Lubricate thrust block rollers (B) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.



6. Lubricate the dog locking blocks (C) (4 places) with a high quality light weight motor oil.



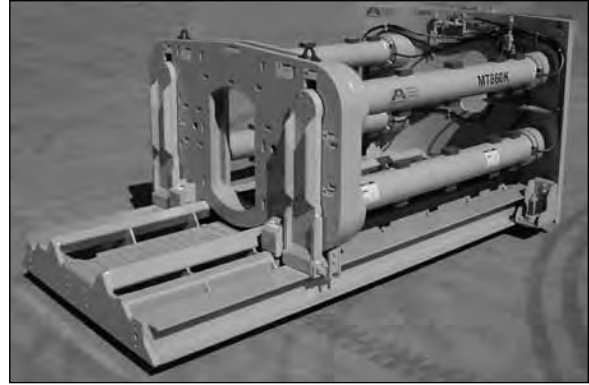
5. CLEAN, INSPECT & LUBRICATE JACKING FRAMES (KEYHOLE JACKING FRAMES)

1. Clean frame to remove build up of dirt and debris.

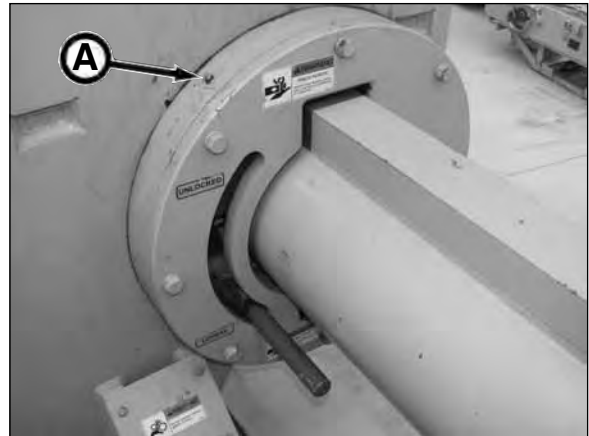
Visually inspect jacking frame for cracks or other damage. Also check for damaged, loose, or missing hardware. Replace with new.

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.

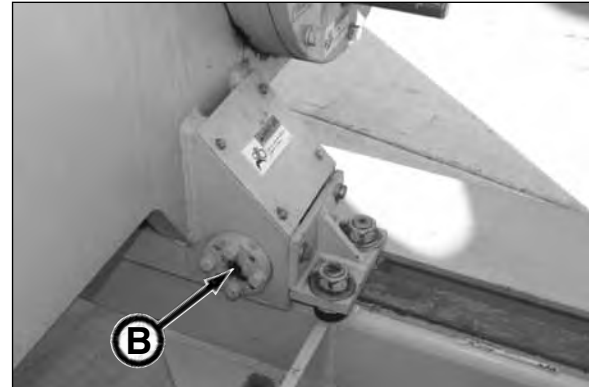


2. Lubricate the cam locks (A) (2 places per cam lock) with Lubriplate® 1200-2 heavy duty, lithium grease or equivalent until grease is forced out.

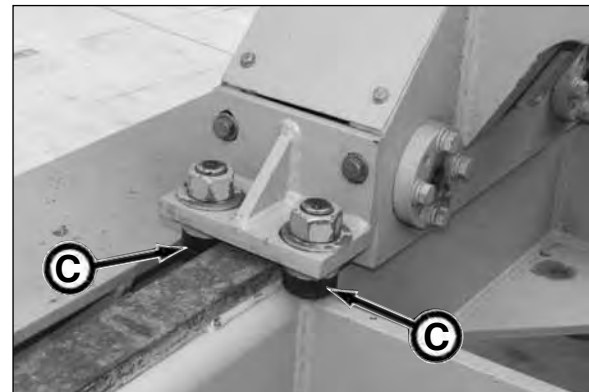


3. Lubricate thrust block guides (B) (4 places) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.

If guide guard was removed, be sure it is replaced.

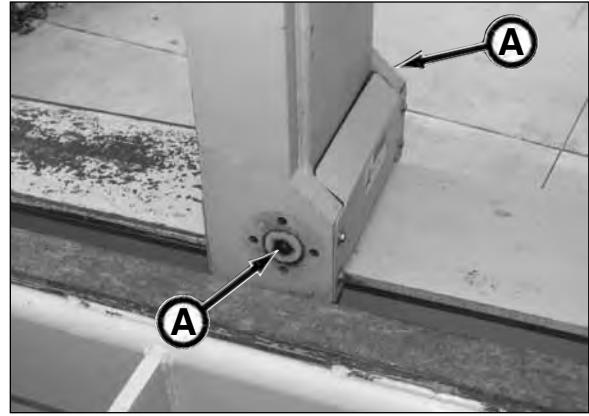


4. Check to be sure the thrust block rollers (C) roll freely. If they do not roll freely, repair or replace before operation.

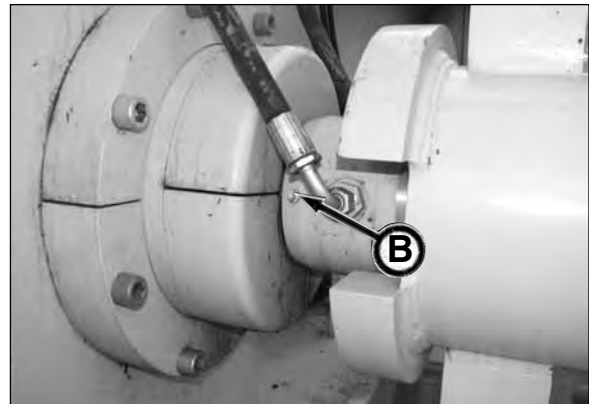


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5. Lubricate cylinder supports (A) (4 places) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.



6. Lubricate jacking cylinder pins (B) (1 per cylinder) with Mobilgrease® XHP222 Premium Lubricating Grease or equivalent until grease is forced out.



6. CHECK WATER COOL PUMP OIL LEVEL

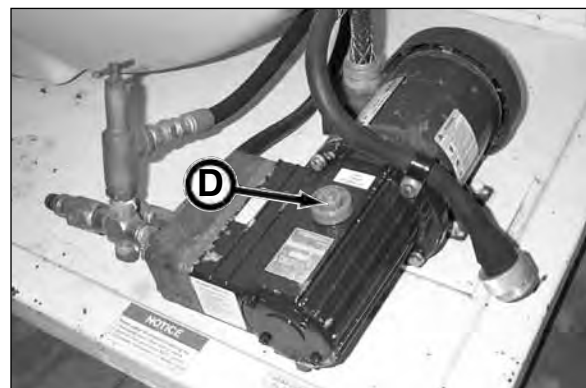
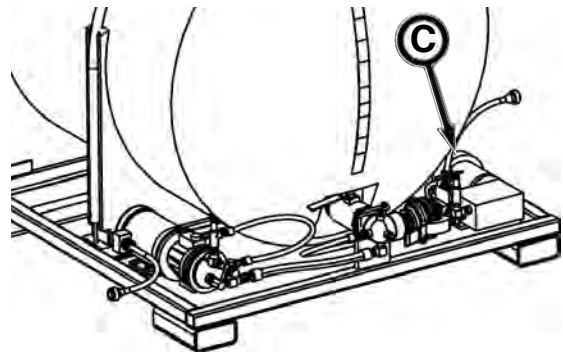
Check both water cool pump oil levels and the condition of the oil.

Main Cooling Drive Motor Pump Assembly (C) For 30 HP & 75 HP Drive Motor

1. Clean area around check/fill cap (D).
 2. Remove check/fill cap. Oil level should be:

3/4 in. (20 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:

3/4 in. (20 mm) from top of the fill port
- Oil capacity is 1.0 US quart (0.95 L).
4. If oil shows signs of contamination, drain oil and refill with clean oil.
 5. Replace check/fill cap.



*Main Cooling Drive Motor Pump Assembly For 30
HP & 75 HP Drive Motor*

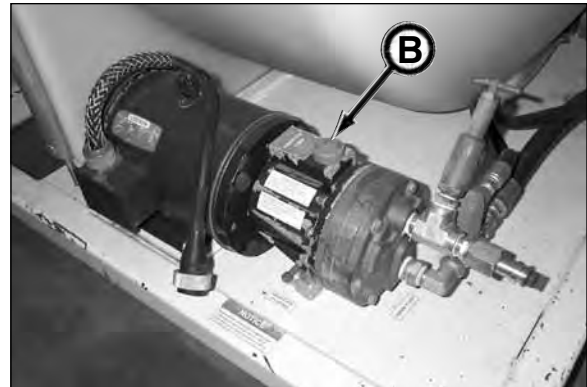
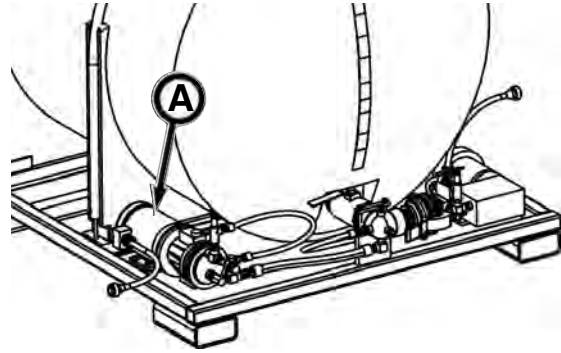
Refer to Next page for:
**Main Cooling Drive Motor Pump Assembly
For Larger HP Drive Motor, Water Cooled
Booster Pump, or Gear Reducer Filtration**
(Continued on next page)

**Main Cooling Drive Motor Pump Assembly (A)
For Larger HP Drive Motor, Water Cooled
Booster Pump, or Gear Reducer Filtration**

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.



*Main Cooling Drive Motor Pump Assembly
For Larger HP Drive Motor, Water Cooled Booster
Pump, or Gear Reducer Filtration*

**7. FLUSH & DRAIN WATER COOLING TANK
COMPONENTS**

In freezing weather, remove cap or hose from 3" elbow (C). 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.

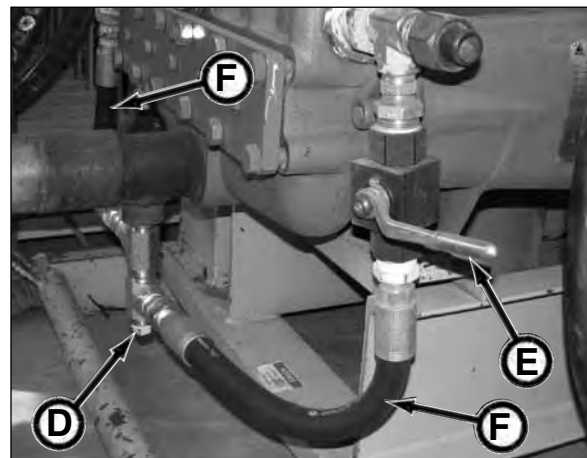
The tank must also be drained in freezing weather unless a suitable heat source is used for keeping the tank temperature above freezing.



8. 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 (D).
2. Open bypass pressure relief valve (E) 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 (F).
5. Replace drain plug.
6. Be sure all fluid lines are drained.



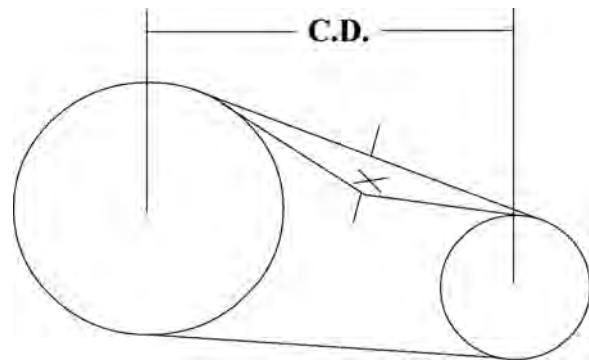
9. CHECK JETTING PUMP BELT ALIGNMENT & TENSION (PUMP MODEL APLEX SC-115)

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.



10. 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.



11. 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 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.



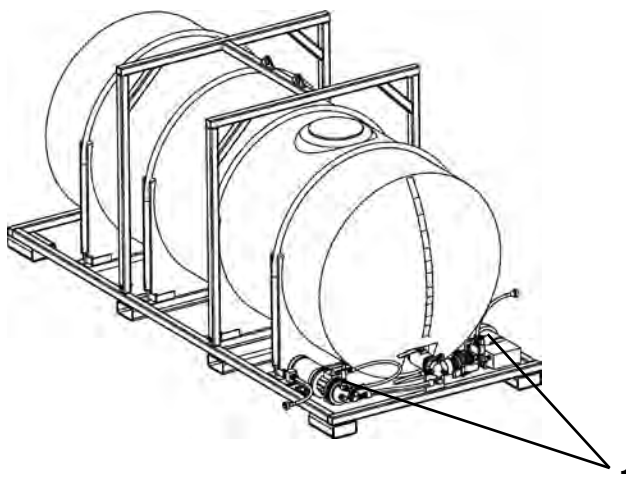
1. Insert an appropriate sized USB flash drive into one of the USB connection ports on the control console. The flash drive will appear as another storage device (Removable Disk) on your Windows Explorer (the operating system's file and folder manager) window.
2. Navigate to the following location:
C:/MySQL/Data/
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



AFTER FIRST 100 HOURS, THEN EVERY 1000 HOURS THEREAFTER

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.*	Water Cool. Pumps	Drain & Fill	a. Small Pump - 1.0 US qt. b. Large Pump - 1.1 US qt.	10W30 Motor Oil

* Drain and fill after the first 100 hours, then every 1000 hours thereafter. Drain and fill earlier with any signs of contamination.

1. DRAIN & FILL COOLING PUMP OIL

Drain and fill both cooling pumps of oil as follows:

Main Cooling Drive Motor Pump Assembly (A) For 30 HP & 75 HP Drive Motor

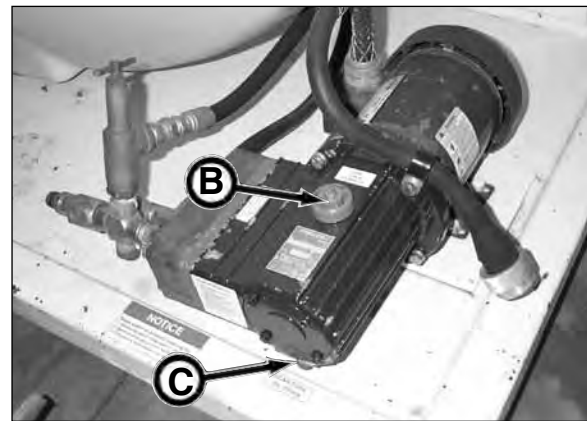
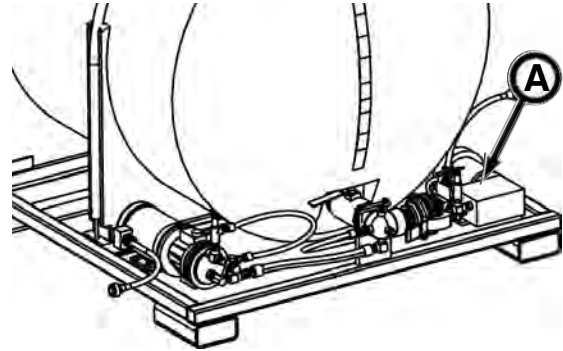
1. Clean area around check/fill cap (B) and gear case oil drain plug (C).
2. Loosen check/fill cap (B) for ease of draining oil. Remove gear case oil plug (C) and drain oil from gear case.
3. Replace gear case oil drain plug and remove check/fill cap.
4. Add 1.0 US quart (0.95 L) of a high quality SAE 10W-30 motor oil through check/fill port. Oil level should be:

3/4 in. (20 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.



*Main Cooling Drive Motor Pump Assembly For
30 HP & 75 HP Drive Motor*

Main Cooling Drive Motor Pump Assembly (D) For Larger HP Drive Motor, Water Cooled Booster Pump, or Gear Reducer Filtration

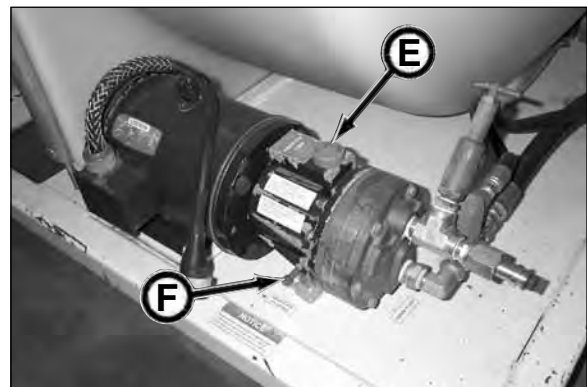
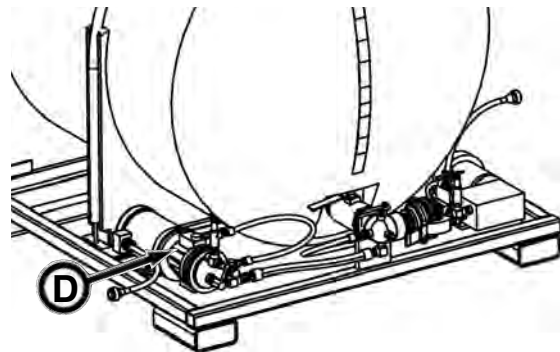
1. Clean area around check/fill cap (E) and gear case oil drain plug (F).
2. Loosen check/fill cap (E) for ease of draining oil. Remove gear case oil plug (F) and drain oil from gear case.
3. Replace gear case oil drain plug and remove check/fill cap.
4. Add 1.1 US quart (1.05 L) of a high quality SAE 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.

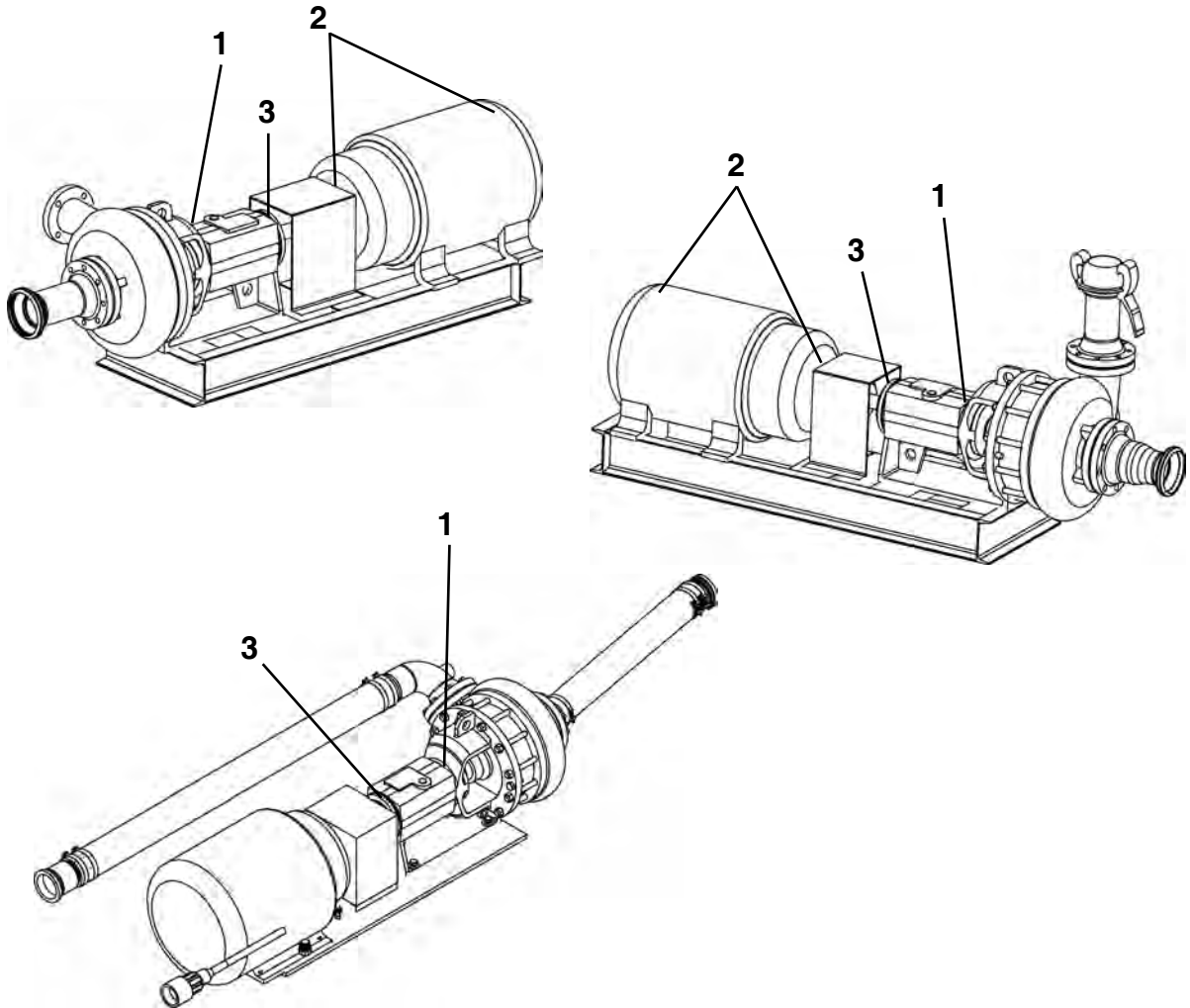
NOTICE

Anytime the oil shows signs of contamination, drain oil and refill with clean oil.



*Main Cooling Drive Motor Pump Assembly
For Larger HP Drive Motor, Water Cooled Booster
Pump, or Gear Reducer Filtration*

MAINTENANCE CHART - MICROTUNNELING SYSTEM

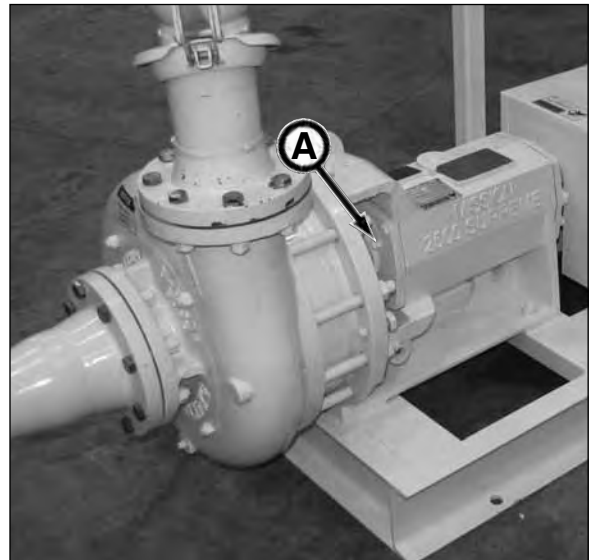


MONTHLY OR EVERY 250 HOURS OF OPERATION

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

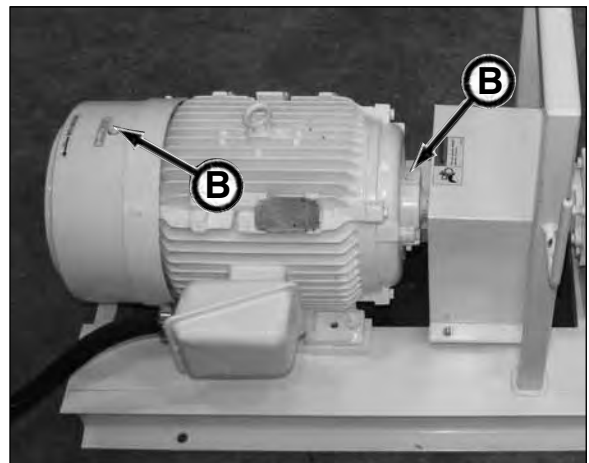
1. LUBRICATE LIP SEALS (Feed, Return & Booster Pumps)

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.



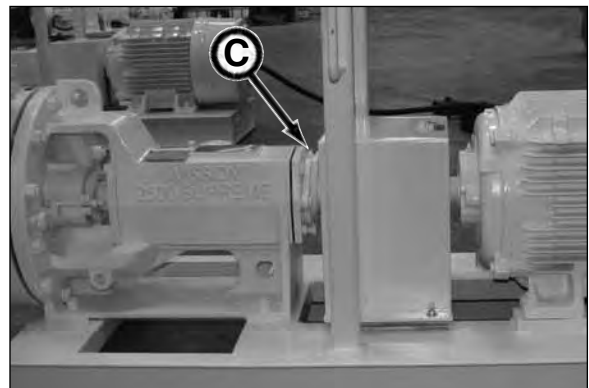
2. LUBRICATE MOTOR BEARINGS (Feed & Return Pumps Only)

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)

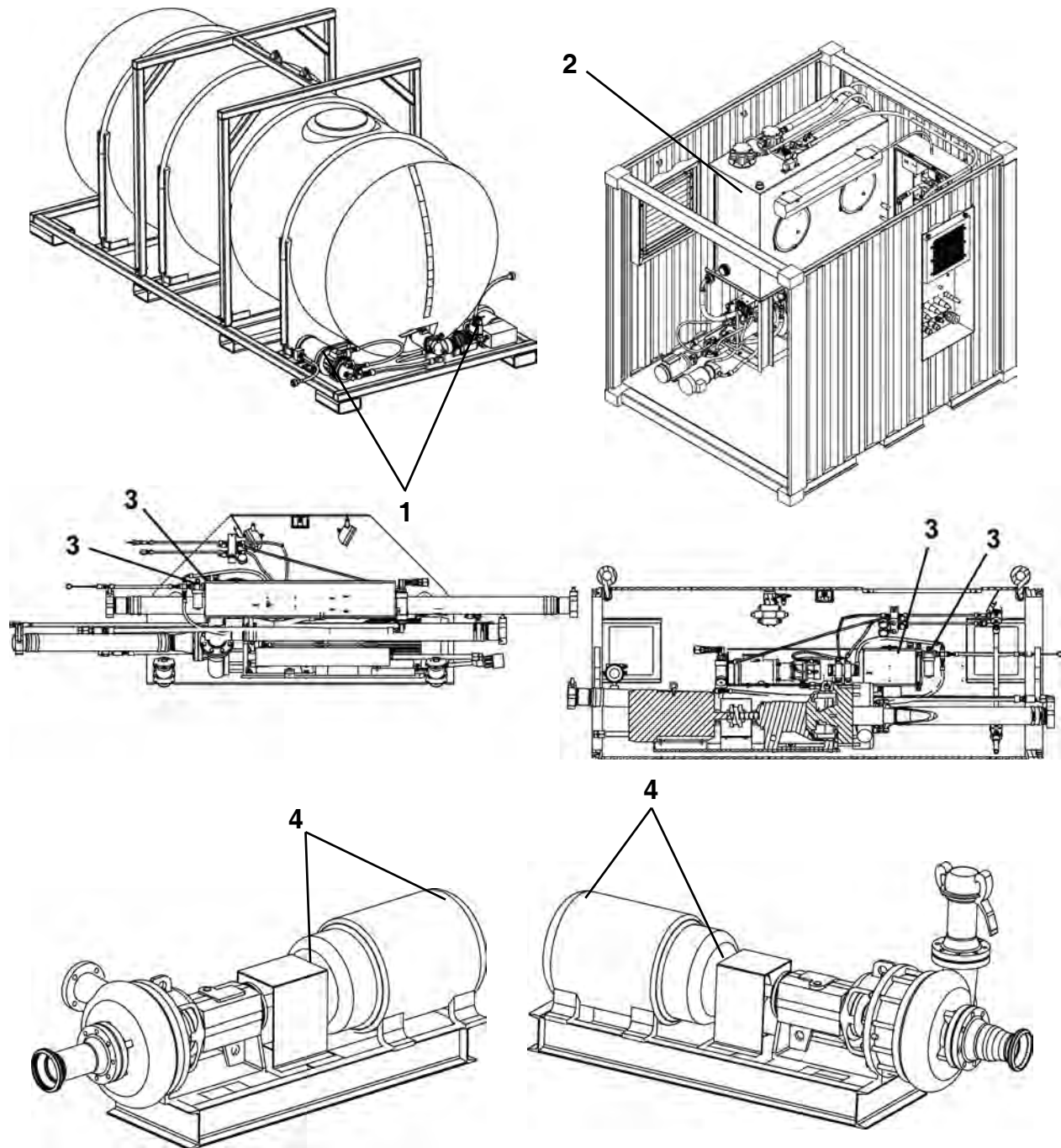
1. Clean area around bearing seal lubrication fittings (C).
2. Lubricate bearing seals with five shots of Mobilgrease® XHP222 Premium Lubricating Grease or equivalent. Lubricate monthly thereafter.



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, 10W30 weight motor oil. Oil should be changed every 1000 hours. Do not overfill.

MAINTENANCE CHART - MICROTUNNELING SYSTEM



YEARLY OR EVERY 1000 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Water Cool. Pumps	Drain & Fill	a. Small Pump - 1.0 US qt. b. Large Pump - 1.1 US qt.	10W30 Motor Oil
2.	Remote Hyd. Pwr Pack Reservoir	Drain & Fill	Capacity varies per Power Pk SN	ISO-VG-46 20W
3.	Hyd. MTBM Pwr Pack Reservoir	Drain & Fill	Capacity 4.5 US Gal. (17 L)	Tellus Plus Oil 32
4.	Slurry Pumps	Lubricate Motor Bearings	Refer to Slurry Pump Manuals	Mobil XHP222
*5.	Booster Pump	Drain & Fill	Refer to Booster Pump Manual	10W30 Motor Oil

* Not Shown; for earlier Booster Pump models with bearing lubrication reservoir only.

1. DRAIN & FILL COOLING PUMP OIL

Drain and fill both cooling pumps of oil as follows:

Main Cooling Drive Motor Pump Assembly (A) For 30 HP & 75 HP Drive Motor

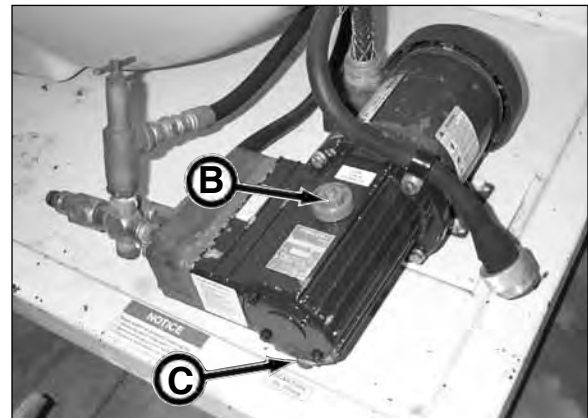
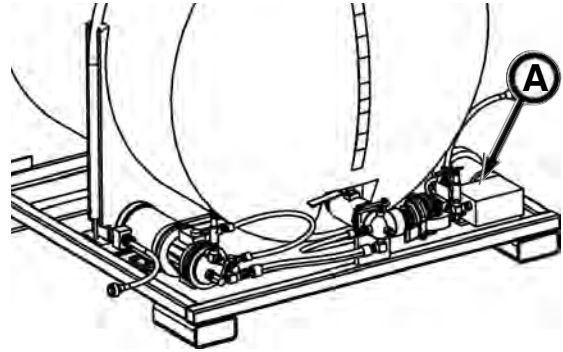
1. Clean area around check/fill cap (B) and gear case oil drain plug (C).
2. Loosen check/fill cap (B) for ease of draining oil. Remove gear case oil plug (C) and drain oil from gear case.
3. Replace gear case oil drain plug and remove check/fill cap.
4. Add 1.0 US quart (0.95 L) of a high quality SAE 10W-30 motor oil through check/fill port. Oil level should be:

3/4 in. (20 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.



*Main Cooling Drive Motor Pump Assembly For
30 HP & 75 HP Drive Motor*

Main Cooling Drive Motor Pump Assembly (D) For Larger HP Drive Motor, Water Cooled Booster Pump, or Gear Reducer Filtration

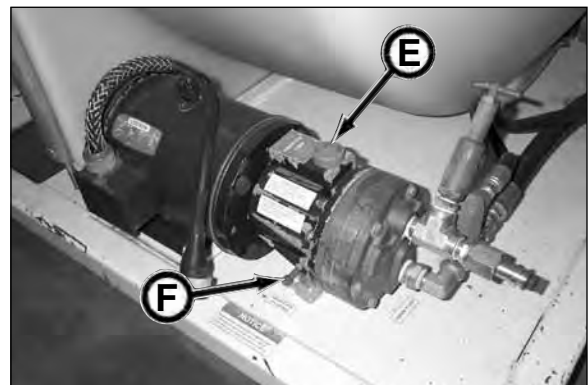
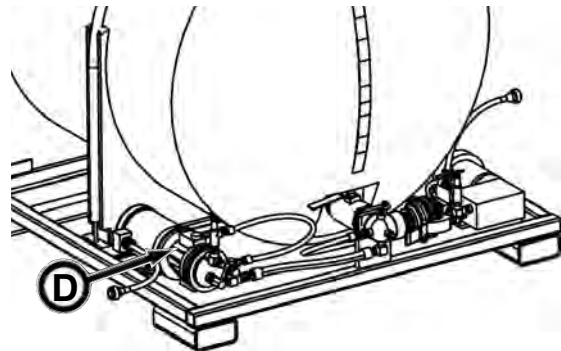
1. Clean area around check/fill cap (E) and gear case oil drain plug (F).
2. Loosen check/fill cap (E) for ease of draining oil. Remove gear case oil plug (F) and drain oil from gear case.
3. Replace gear case oil drain plug and remove check/fill cap.
4. Add 1.1 US quart (1.05 L) of a high quality SAE 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.



*Main Cooling Drive Motor Pump Assembly
For Larger HP Drive Motor, Water Cooled Booster
Pump, or Gear Reducer Filtration*

2. DRAIN & FILL HYDRAULIC RESERVOIR & REPLACE FILTERS

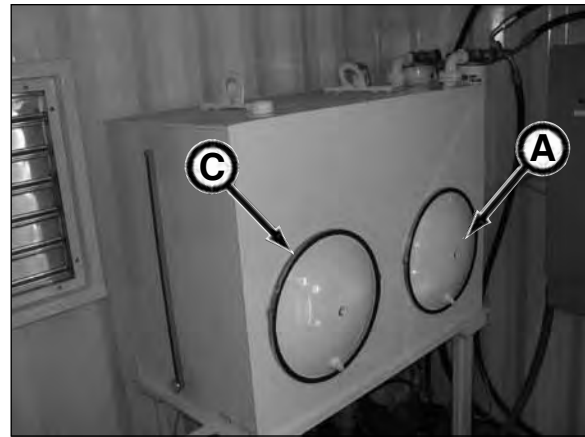
NOTICE

If any of the following situations occur, the reservoir must be drained and refilled with fresh oil. The return filters must also be replaced:

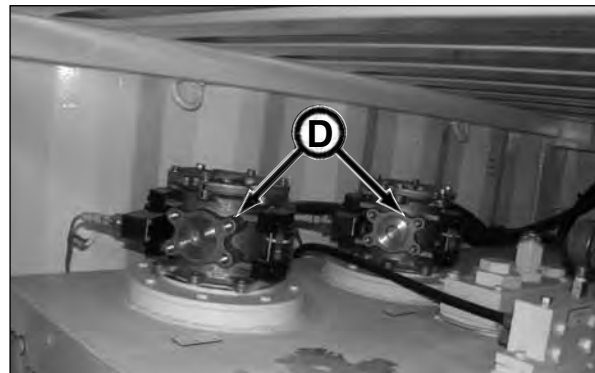
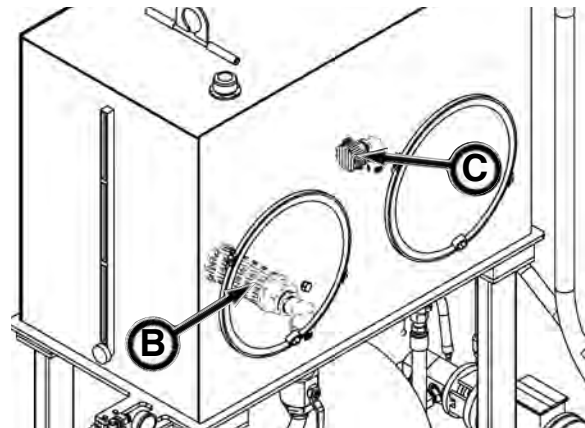
- A major component fails.
- Any sign of water contamination from an oil analysis or if oil is milky or foaming.
- A hydraulic oil sample indicates large particle contamination.

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:
 - A. (SN FA21945F only) Lubricate filter gasket with a light coating of clean hydraulic oil. Install new return filters. Replace and secure filter covers.
 - B. (SN FA21965F only) Lubricate filter gasket with a light coating of clean hydraulic oil. Fill new return filters with clean hydraulic oil. Install new filters on filter head assembly. Hand tighten only per instructions on filter. Check for leaks.

(Continued on next page)



Hydraulic Reservoir for SN FA21965F Shown



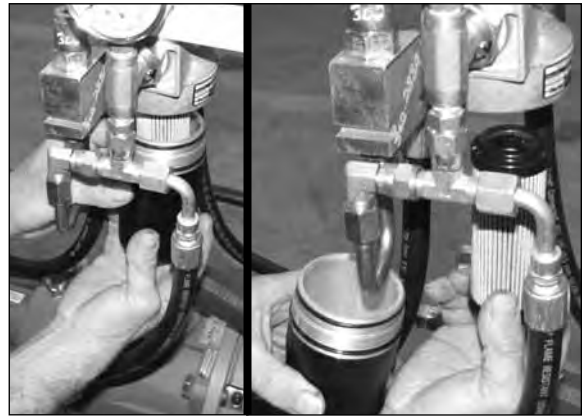
Hydraulic Reservoir for SN FA21945F Shown



Hydraulic Reservoir for SN FA21965F Shown

13. Clean area around the pilot pressure filter.

14. Remove lower filter housing and remove filter.



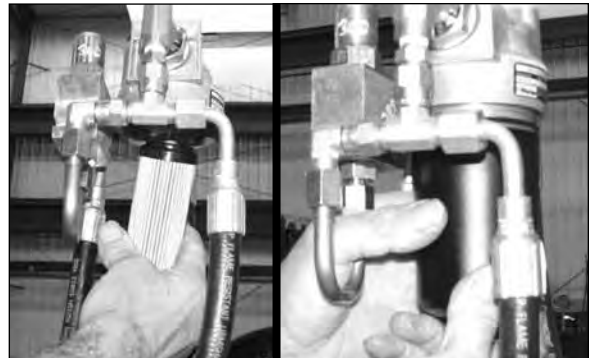
15. Lubricate housing orings with a light coating of clean hydraulic oil.

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).

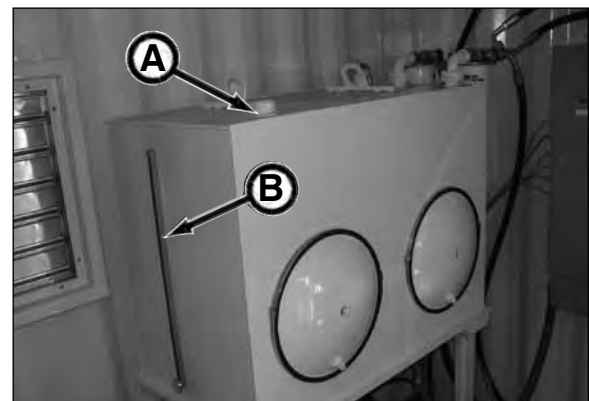
20. Remove fill cap and fill reservoir with fresh, clean ISO-VG-46 20W Premium Hydraulic/Turbine Oil until oil is at full mark on sight gauge (B). Do not overfill.

Oil capacity is approximately:

SN FA21945F	330 US gal. (1,249 L)
SN FA21965F	195 US gal. (738 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.



Hydraulic Reservoir for SN FA21965F Shown

21. Replace fill cap and check for leaks.

3. DRAIN & FILL MTBM HYDRAULIC POWER PACK OIL RESERVOIR & FILTER

NOTICE

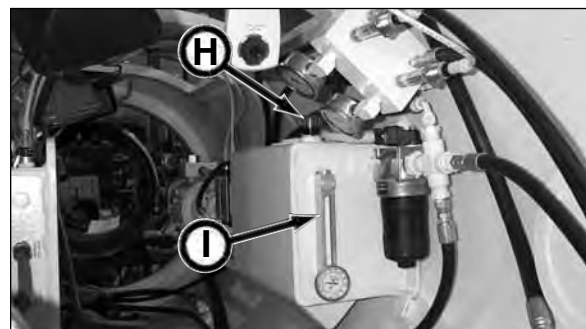
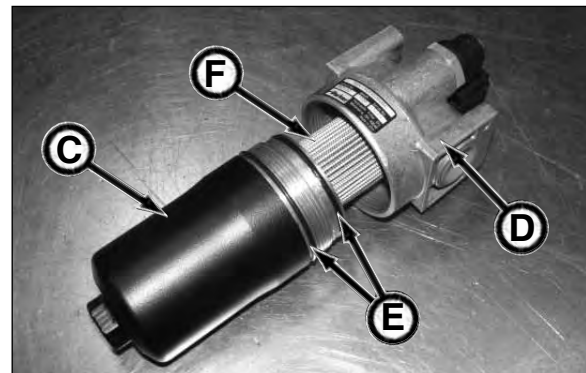
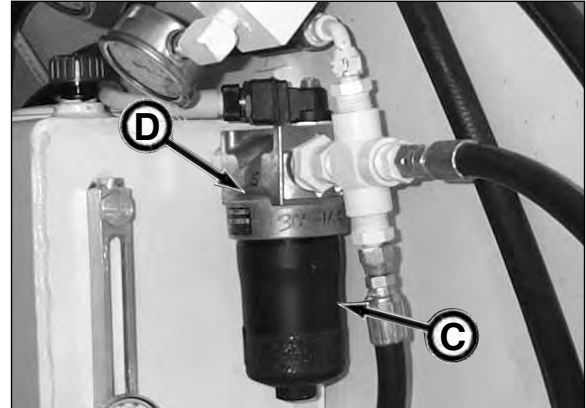
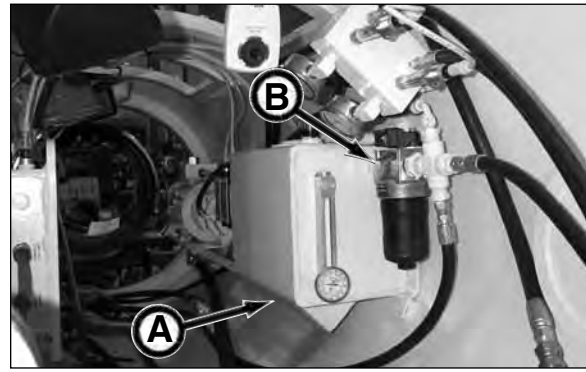
If any of the following situations occur, the reservoir must be drained and refilled with fresh oil. The return filter must also be replaced:

- 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 (A).
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 (B).
5. Remove housing (C) from filter head (D). Inspect housing for damage. If damaged, replace with new.
6. Inspect orings (E) on filter housing. If orings are worn or damaged, replace with new.
7. Remove filter (F) from filter head. Dispose of oil and filter properly.
8. Lubricate new filter oring (G) 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 (H), remove fill cap and fill until tank is at full mark on sight gauge (I) with Tellus® Plus Oil 32 or equivalent. Replace oil cap.

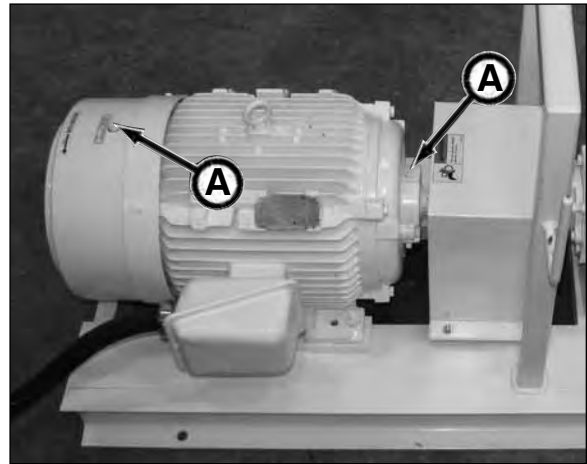
Oil capacity is approximately 4.5 US gal. (17 L).

13. Check for leaks.



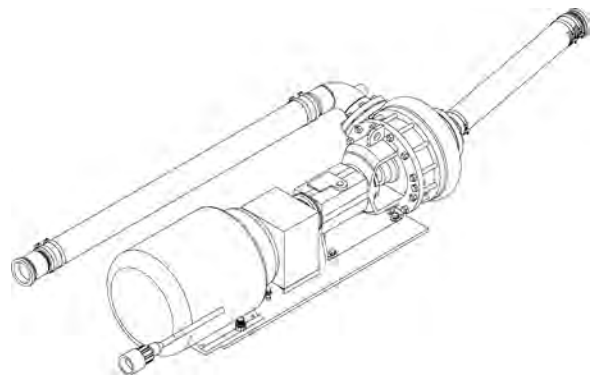
4. LUBRICATE MOTOR BEARINGS (Feed & Return Pumps Only)

1. Wipe the motor bearing lubrication fittings (A) 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.

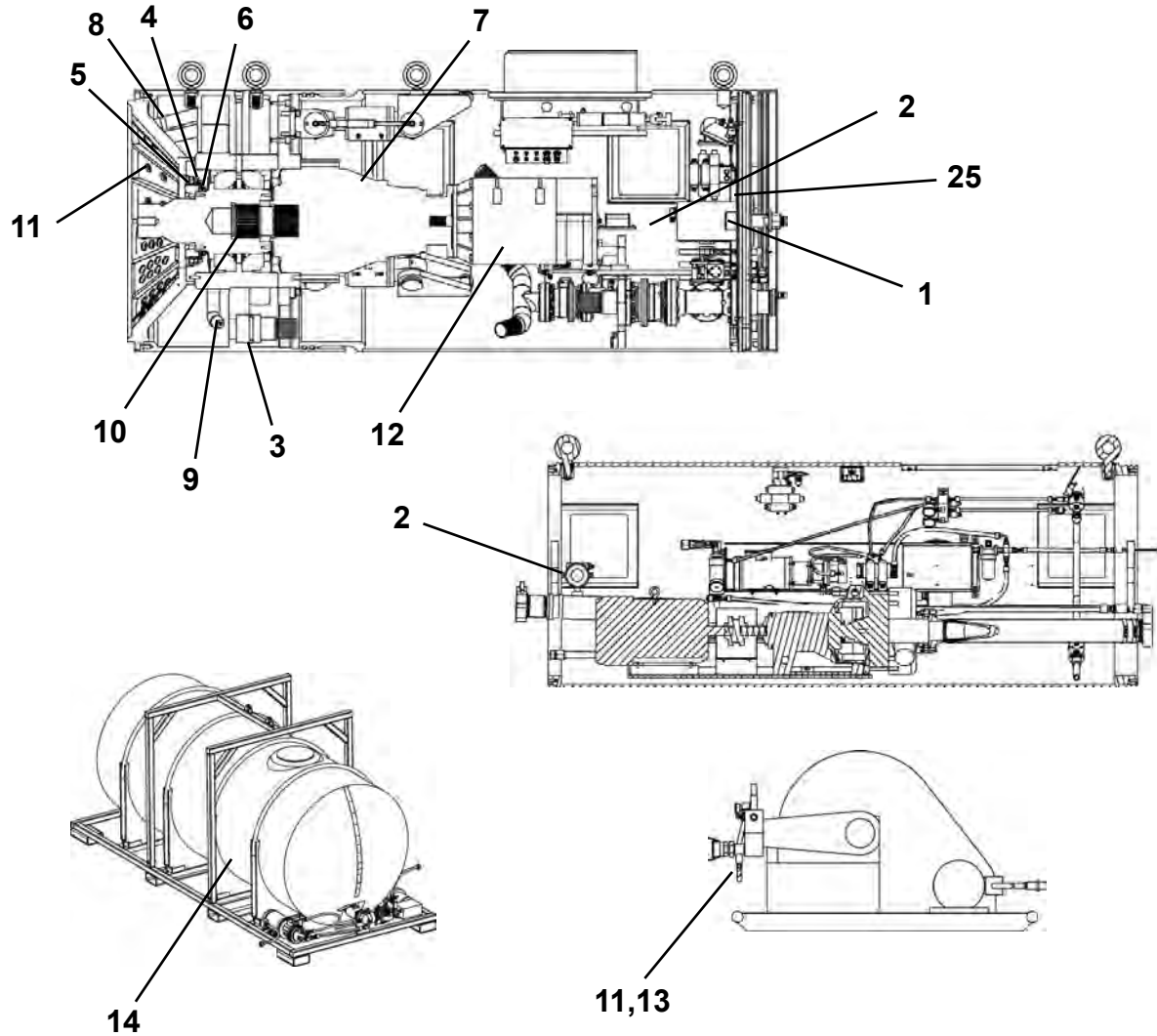


5. DRAIN & REPLACE BEARING LUBRICATION RESERVOIR OIL (Earlier Booster Pumps Only)

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, 10W30 weight motor oil. Oil should be changed every 1000 hours. Do not overfill. Refer to your Booster Pump manual for more information.



MAINTENANCE CHART - MICROTUNNELING SYSTEM

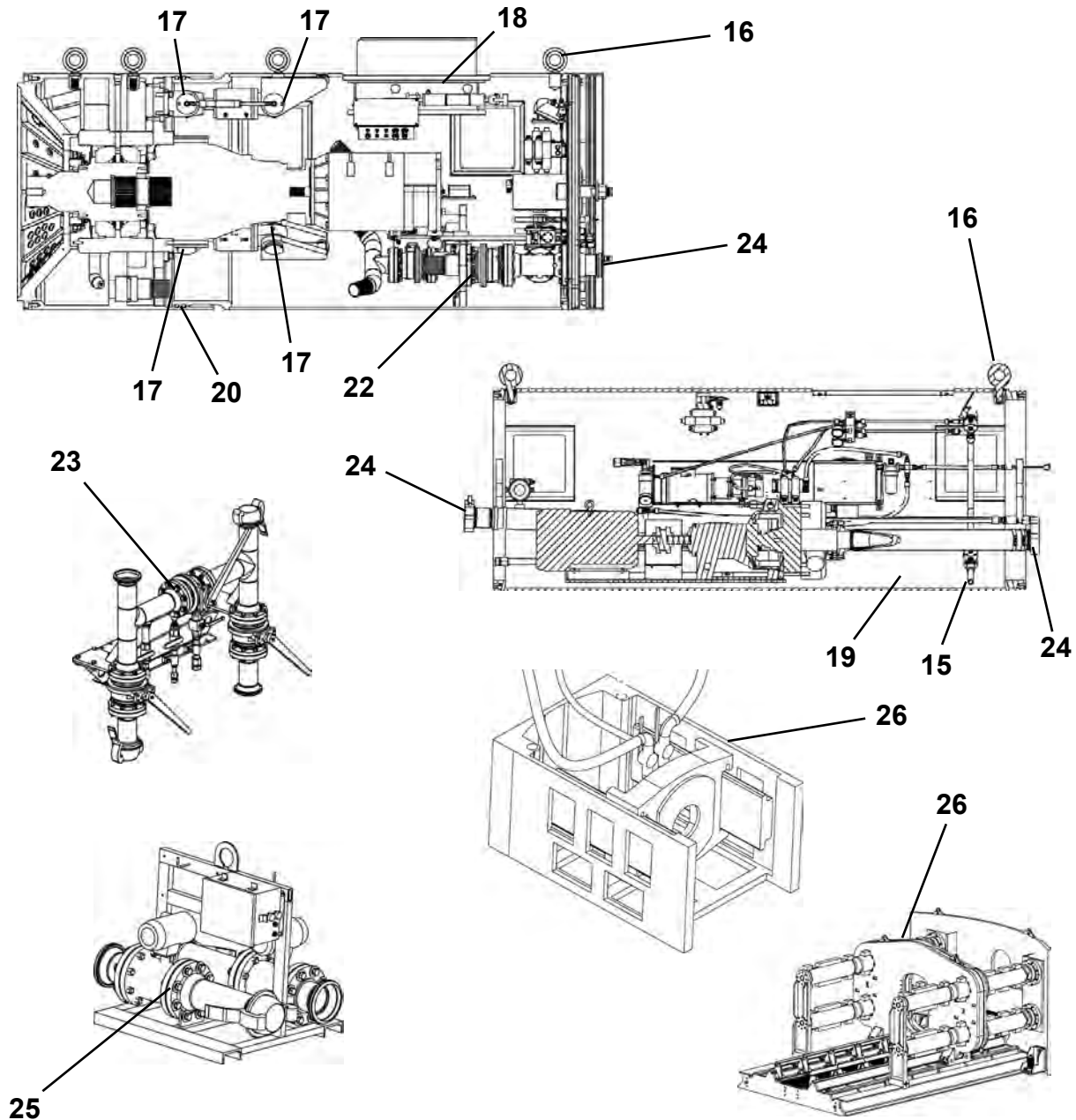


COMPLETION OF EACH DRIVE

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Target & Laser*	Remove from MTBM	Clean and keep in storage box.	Mobil SHC 630
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.	Lip Seals	Inspect	If worn or damaged, replace.	
5.	Stellite Ring	Inspect	If grooves are present, replace.	
6.	Mechanical Seals	Inspect	If worn or damaged, replace.	
7.	Gear Box	Check Oil Quality	If contamination present, drain/fill.	
8.	Slurry Cut Nozzles	Inspect & Flush	Flush. Repair or replace as needed.	
9.	Slurry Chamber Noz.	Inspect & Flush	Flush. Repair or replace as needed.	
10.	Drive Shaft Splines	Inspect	Repair or replace.	
11.	HP Jetting System	Inspect, Flush, Clean	Inspect, flush and clean.	
12.	Drive Motor	Flush Water Jacket or Heat Exchanger	Flush water jacket or heat exchanger.	
13.	Jetting Pump Comp.	Flush & Drain	Flush and drain water.	
14.	Water Cooling Tank	Flush & Drain	Flush and drain water.	

* Not Shown

(continued on next page)



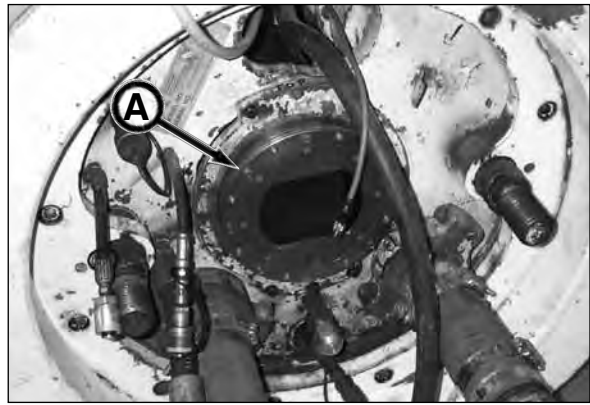
COMPLETION OF EACH DRIVE

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
15.	Bentonite System	Inspect & Flush	Inspect and flush.	Mobil XHP222
16.	Lift Eyes	Inspect	Repair or replace.	
17.	Steering Cyl. Pins	Lubricate	Lubricate until grease is forced out.	
18.	Dirt Wing Cavity	Lubricate	Lubricate until grease is forced out.	
19.	Submersible Pump	Clean & Flush	Clean and flush.	
20.	Steering Joint Seals	Inspect & Lubricate	See detail for lubrication.	
*21.	Hoses & Cables	Inspect	Repair or replace.	
22.	Slurry Valves	Flush & Drain	Flush and drain.	
23.	Slurry Pit Valve Assy.	Flush & Clean	Flush and clean.	
24.	Slurry Hose/Line	Flush & Inspect	Flush and inspect.	
25.	Flowmeter	Clean	Clean	Mobil XHP222
26.	Jacking Frame	Clean, Inspect & Lubricate	Lubricate per service detail.	

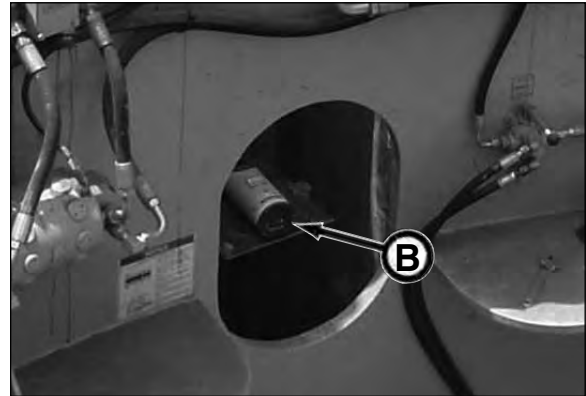
* Not Shown

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

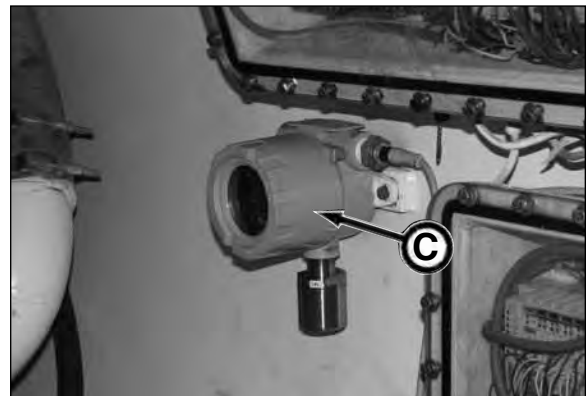
For more information, refer to your GasMax Instruction Manual.

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

1. Check the oil condition of the bearing cavity (A) by draining a measured sampling of the oil. Be sure to clean the area around the ports/hose cap before removing them to prevent contamination from entering bearing cavity.

Typical Port Locations

- SL52.5 & smaller have external ports (B) in the 3, 9 and 12 o'clock positions.
- SL60 & greater have internal ports. A drain hose (C) is connected to the drain port (D) and is routed to the front section bulkhead area for ease of draining the bearing cavity.

2. Inspect the drained oil for contaminants.

- If water is visible in the oil, the lip seals and mechanical seals are damaged and must be replaced. See 4. Inspect Lip Seals in this section.
- If grease is visible in the oil, the mechanical seals are damaged and must be replaced. See 6. Inspect Mechanical Seals in this section.
- With any contamination, the bearing cavity must be completely drained and refilled with new, clean Mobil SHC™ 630 oil, once the mechanical seals and lip seals are replaced. To drain and refill bearing cavity, refer to MTBM maintenance, Prior To Each Drive Launch, 5. Drain & Fill Bearing Cavity Oil in this section.

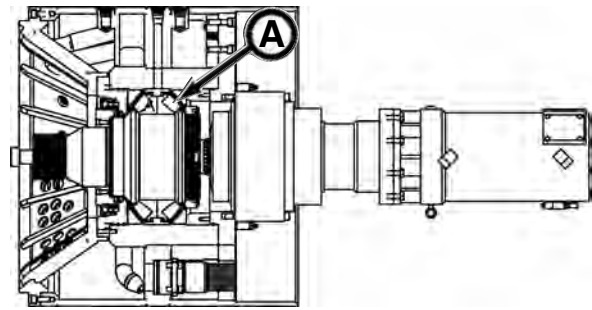
NOTICE

It is recommended to replace the mechanical seals and lip seals with any signs of contamination.

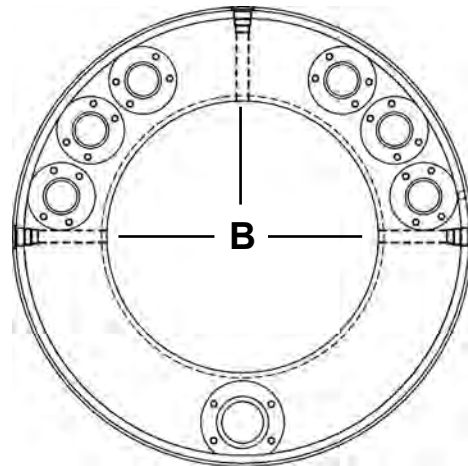
- Check the lip seal retaining ring and mechanical seal retaining ring for damage. If rings have excessive damage, replace with new.

3. Replenish bearing cavity of the volume of oil drained when checking the condition of the oil (from step 1). Use new, clean Mobil SHC™ 630 oil. Replace fill plug/hose cap.

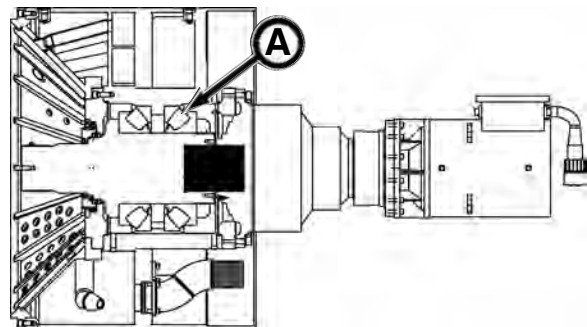
4. Be sure all bearing cavity plugs are in place and sealed.



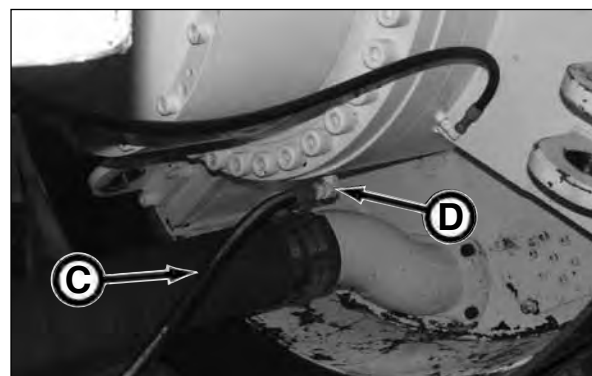
SL44 (SN FA04200F) Drive Assembly Shown



SL44 (SN FA04200F) External Port Locations Shown



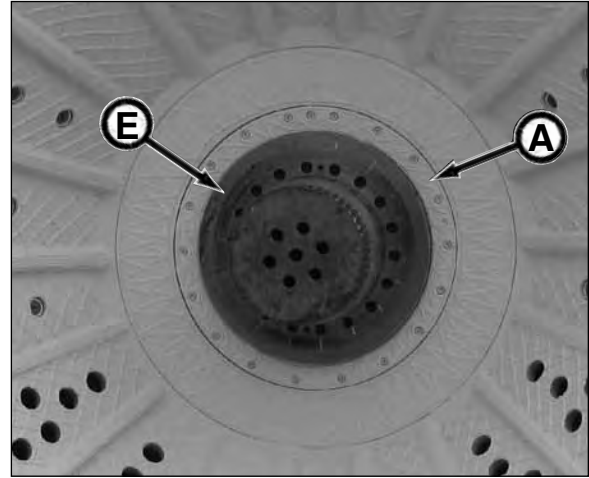
SL72 (SN FA07100F) Drive Assembly Shown



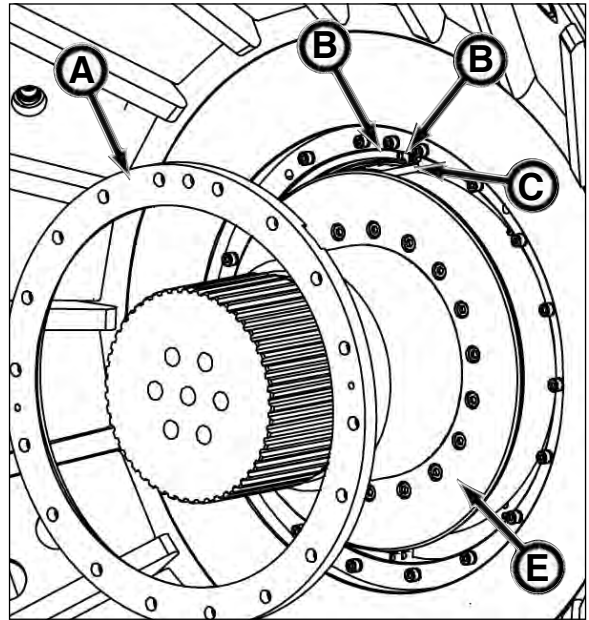
SL72 (SN FA07100F) Bearing Cavity Drain Hose Shown With Back Drum Removed

4. INSPECT LIP SEALS

1. With cutterhead removed, remove lip seal retaining ring (A). Inspect ring for excessive wear or damage. If wear or damage is present, the ring must be replaced with new.



2. Inspect lip seals (B) for wear, cracking and other damage. If seals show signs of damage, the lip seals must be replaced. Replace lip seals if necessary.
3. While the lip seal retaining ring is removed, check the stellite ring (C). Refer to 5. Inspect Stellite Ring in this section.



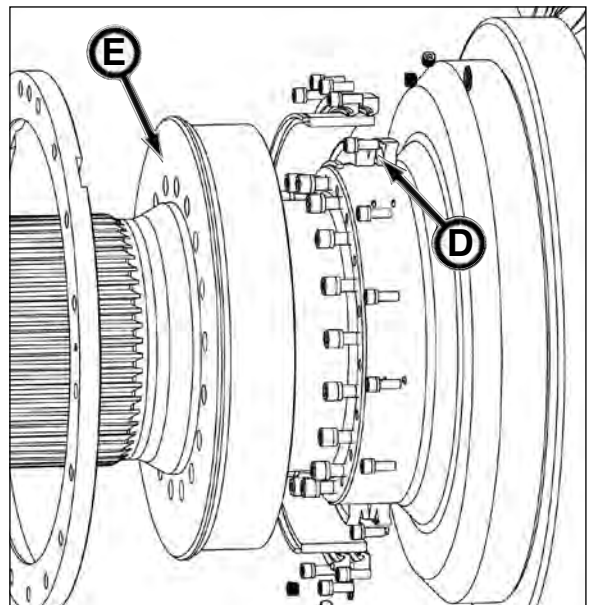
NOTICE

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.

NOTICE

It is recommended to replace the mechanical seals (D) and lip seals with any signs of contamination. Remove mechanical seal retaining ring (E) to gain access to the mechanical seals.

- Check the lip seal retaining ring (A) and mechanical seal retaining ring (E) for damage. If rings have excessive damage, replace with new.

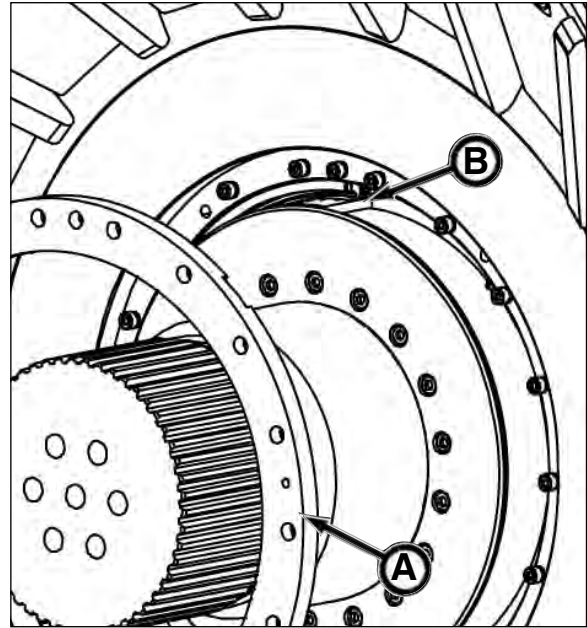


5. INSPECT STELLITE RING

1. With the lip seal retaining ring (A) removed, check the stellite ring (B) for grooves.
2. Apply a thin coat of oil on a flat feeler gauge.
3. Insert the gauge between the lip seals and the stellite ring at four to six positions around the ring.
4. If grooves are discovered, the stellite ring must be replaced.

NOTICE

Precise stellite ring replacement is critical to prevent contamination from entering the bearing cavity. The stellite ring must be cut off from the mechanical seal retaining ring, then a new stellite ring must be heated and fit onto the mechanical seal retaining ring. The stellite ring replacement **MUST** be performed by an experienced technician. Contact your Akkerman Aftermarket Support representative for stellite ring replacement.



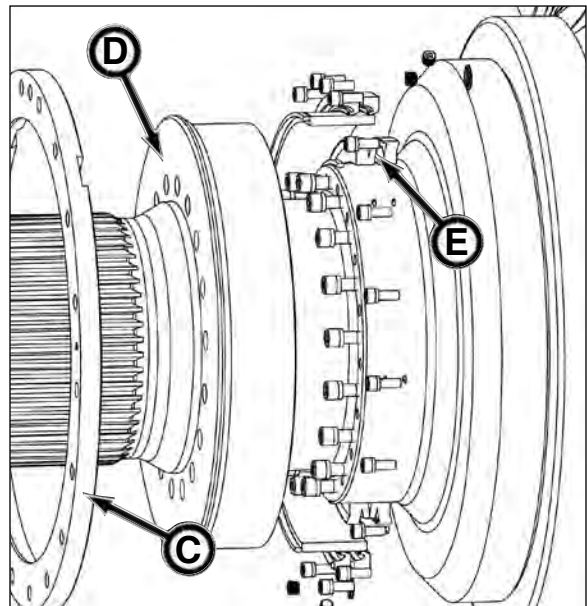
6. INSPECT MECHANICAL SEALS

If the bearing cavity oil shows signs of contamination, the mechanical seal must be inspected.

1. With the lip seal retaining ring removed (C), remove the mechanical seal retaining ring (D).
2. Inspect mechanical seal (E) for wear, cracking or damage. If there are any signs of wear or damage the mechanical seal must be replaced.

NOTICE

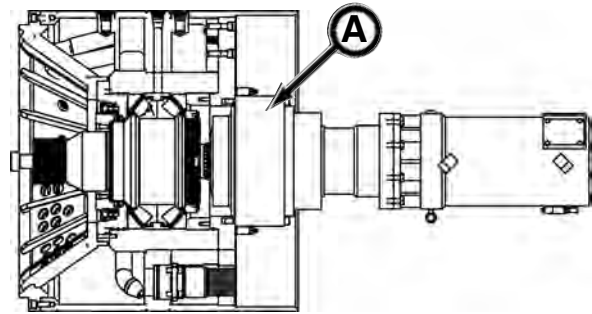
Precise mechanical seal replacement is critical to prevent contamination from entering the bearing cavity. The mechanical seal replacement **MUST** be performed by an experienced technician. Contact your Akkerman Aftermarket Support representative for mechanical seal replacement.



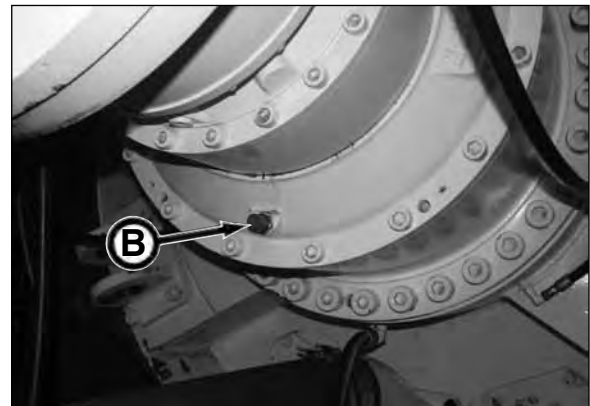
7. CHECK GEAR BOX OIL CONDITION

1. Check the gear box (A) oil condition by draining a measured sampling of the oil from the drain port (B). Be sure to clean the area around the ports before removing them to prevent contamination from entering gear box housing.
2. Inspect the drained oil for contaminants. If there are any signs of contamination; water, metal fragments etc, the gear box oil must be replaced (refer to MTBM maintenance, Prior To Each Drive Launch, 7. Drain and Fill Gear Box Oil in this section).
3. If there are any signs of oil leakage around the gear box, the gear box oil must be replaced (refer to MTBM maintenance, Prior To Each Drive Launch, 7. Drain and Fill Gear Box Oil in this section).
4. Replenish gear box housing of the volume of oil drained when checking the condition of the oil (from step 1). Use new, clean Mobil SHC™ 630 oil.

- Non oil recirculating pump MTBMs: add oil through fill port on gear box.
- Oil Recirculating pump MTBMs: add oil through fill port (C) on recirculating pump reservoir.



Non Oil Recirculating Pump MTBM Shown



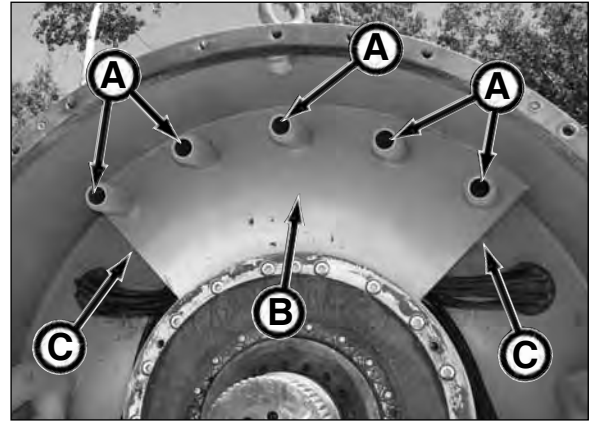
Gear Box Drain Port



Oil Recirculating Pump MTBM Shown

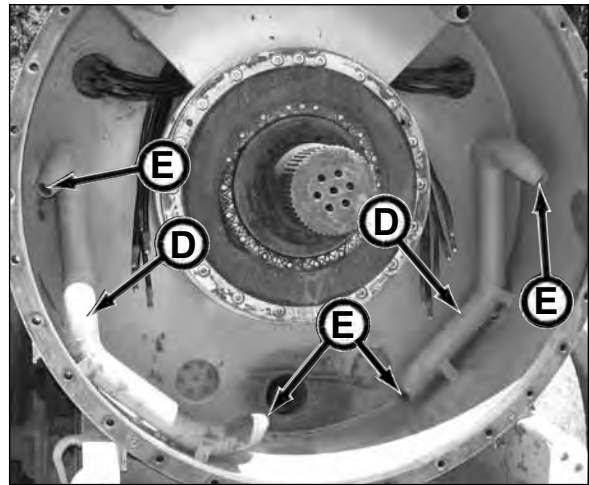
8. INSPECT & FLUSH SLURRY CUTTING NOZZLES

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 plugs (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 ports.
 - c. **REPLACE CLEANOUT PLUGS!** Failure to replace cutting nozzle manifold cleanout plugs will render the cutting nozzles useless during operation.
5. Proceed to inspect and flush slurry chamber nozzles before reinstalling crushing cone.



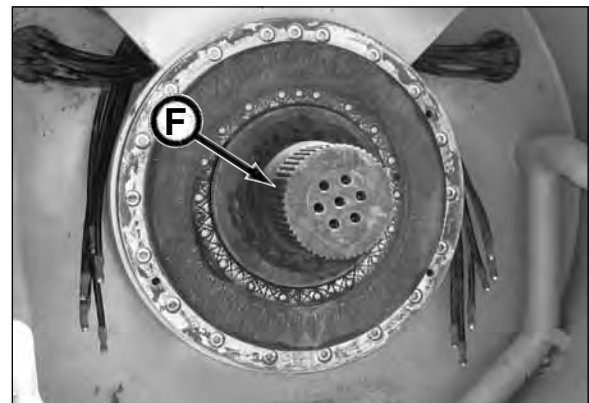
9. INSPECT & FLUSH SLURRY CHAMBER NOZZLES

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.
4. Proceed to inspect drive shaft splines before reinstalling crushing cone.



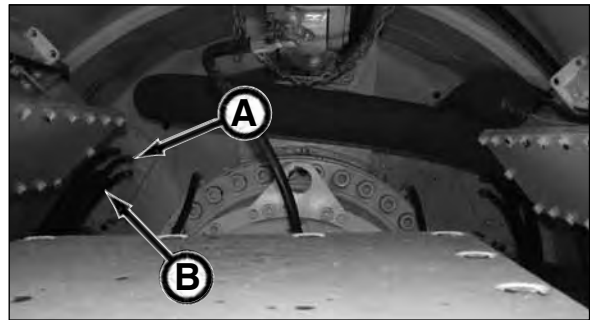
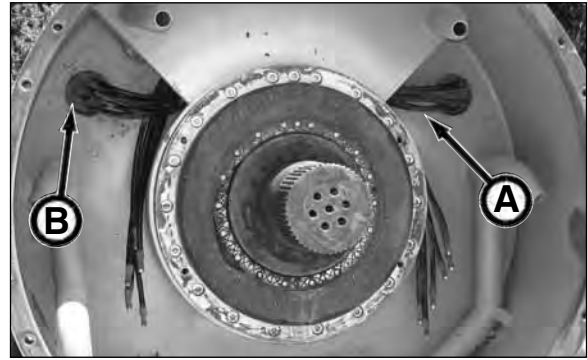
10. INSPECT DRIVE SHAFT SPLINES

With the crushing cone removed, inspect the drive shaft output splines (F). If damage to the splines is visible, repair or replace.

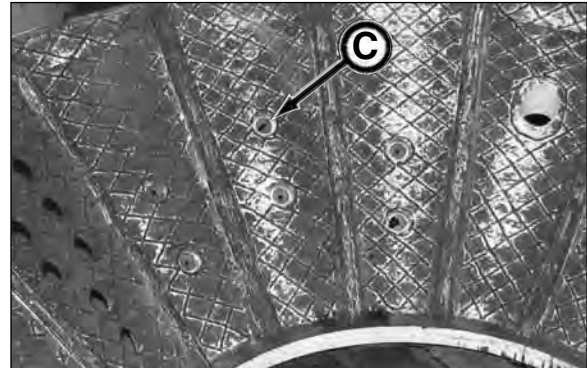


11. INSPECT, FLUSH & CLEAN HIGH PRESSURE JETTING SYSTEM

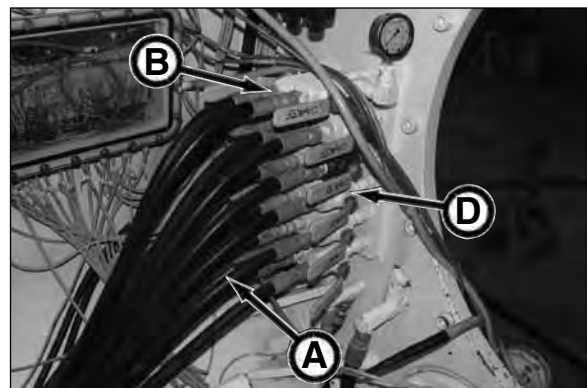
1. Flush and clean high pressure system; all jetting hoses (A) and fittings (B).
2. Inspect for cracks, wear or damage. Replace as needed.



3. With crushing cone removed, 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. Check high pressure jetting pump power cables (E) for cracking, wear or damage. Replace as needed.

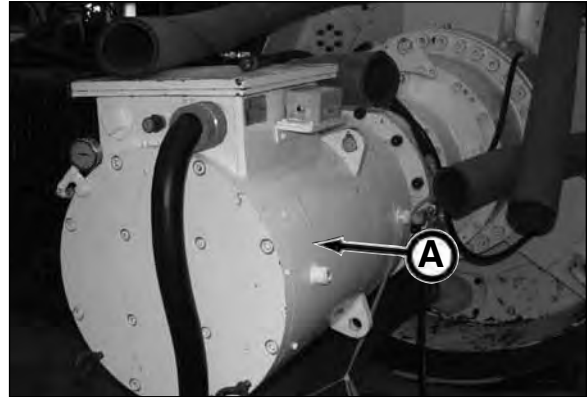


12. FLUSH DRIVE MOTOR WATER JACKET OR HEAT EXCHANGER

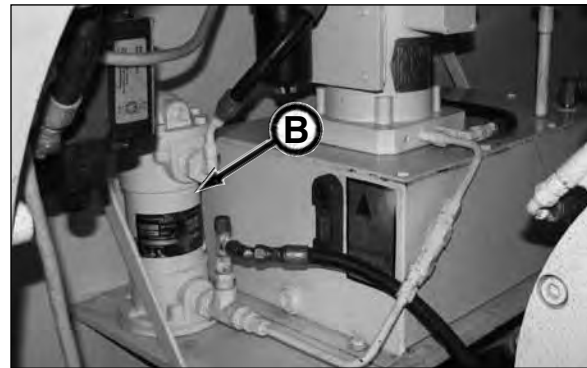
Flush the MTBM drive motor (A) cooling lines and water jacket (smaller MTBMs) or heat exchanger (B) (larger MTBMs).

NOTICE

If necessary, in freezing weather, drain and flush with RV antifreeze.



MTBM SL74 Shown



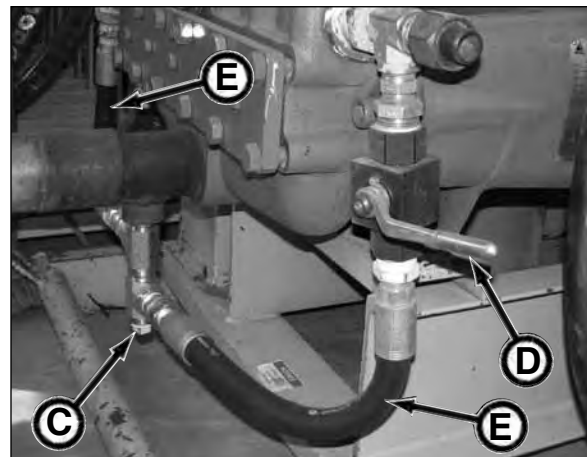
Heat Exchanger (B) In Larger MTBMs

13. FLUSH & DRAIN JETTING PUMP COMPONENTS

1. Remove drain plug (C).
2. Open bypass pressure relief valve (D) 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 (E).
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 & DRAIN WATER COOLING TANK COMPONENTS

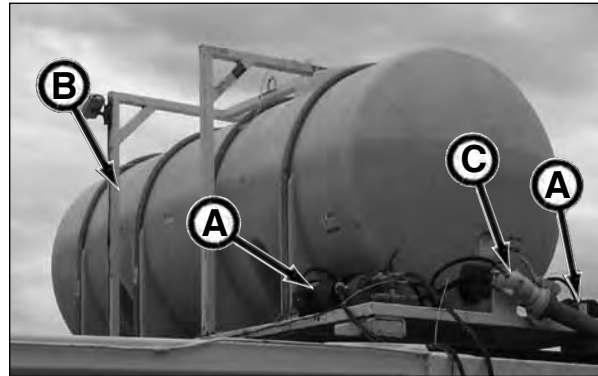
Remove drain plugs from both pumps (A). Flush and drain pumps and all fluid lines. With water completely drained, replace plugs. Failure to do so will cause damage to pump components.

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).

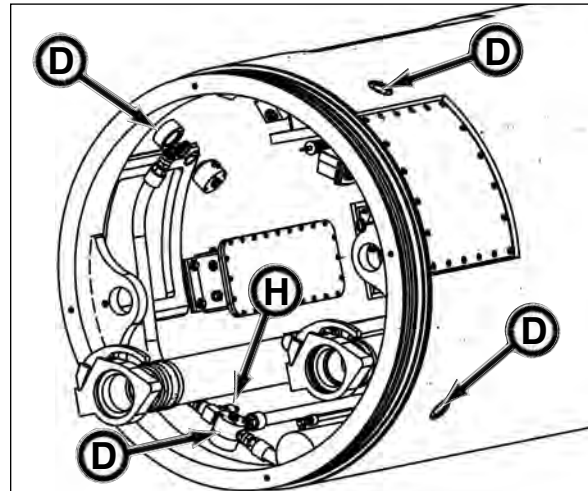
NOTICE

If necessary, in freezing weather, drain and flush with RV antifreeze.

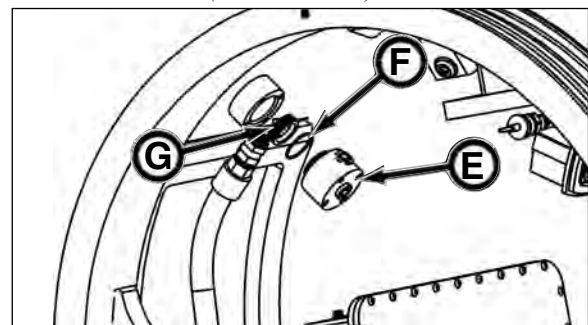


15. INSPECT & FLUSH BENTONITE SYSTEM

1. Bentonite hoses and ports must be flushed after the completion of each drive to prevent hardening of bentonite in the bentonite hoses and ports.
2. Flush and clean hoses, fittings and ports with water.
3. Inspect bentonite port (D) by removing four bolts from cap (E).
4. Remove cap (with hose[s]) from bentonite port to gain access to oring (F) and check valve (G).
5. Check oring and check valve for wear or damage. When replacing, be sure check valve and oring are properly seated in port.
6. Replace cap and secure with bolts removed in step 3.
7. Repeat steps 3 through 6 for other bentonite ports.
8. Check pressure transducer (H) for damage. Replace if needed.



SL44 (SN FA04200F) Shown



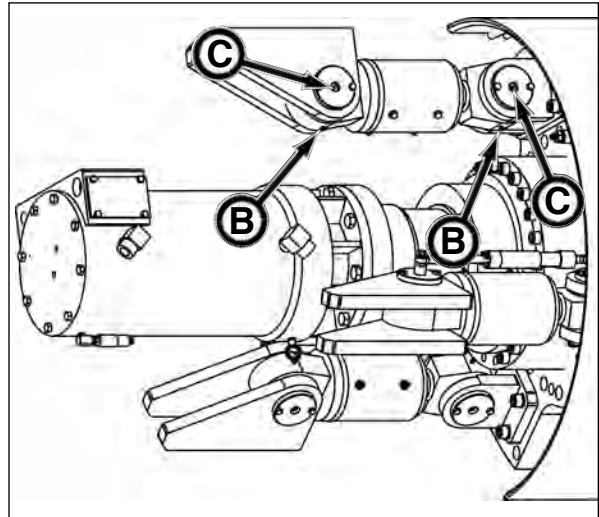
16. INSPECT LIFT EYES

Check lift eyes (A) for damage. Worn or damaged lift eyes MUST be replaced before lifting MTBM.



17. LUBRICATE STEERING CYLINDERS

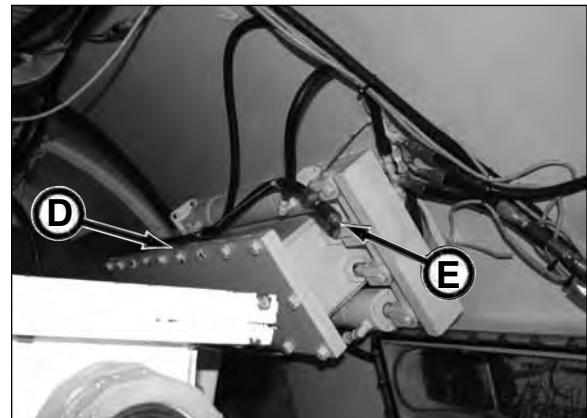
Lubricate steering cylinder pins (B) (2 places per cylinder) and cylinder bearings (C) (2 places per cylinder) until grease is forced out with Mobilgrease® XHP222 or equivalent.



18. LUBRICATE DIRT WING CAVITY

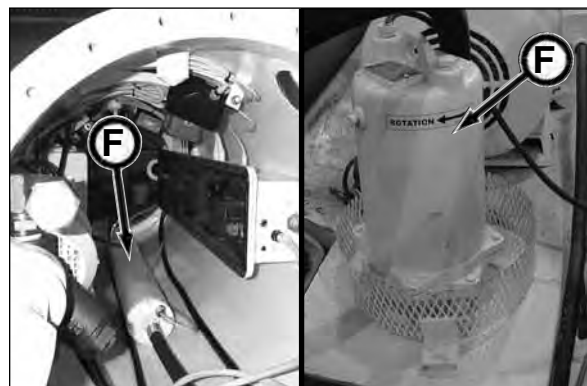
The dirt wing cavity (D) must be filled with grease to remove dirt or other contaminants from cavity area after completion of the drive.

Lubricate dirt wing cavity with Mobilgrease® XHP222 or equivalent until grease is forced out. Use grease fill hose (E) to fill cavity.



19. CLEAN & FLUSH SUBMERSIBLE PUMP

Clean and flush pump water inlet holes, pump (F) and hose to remove all contamination.



MTBM SL30

MTBM SL74

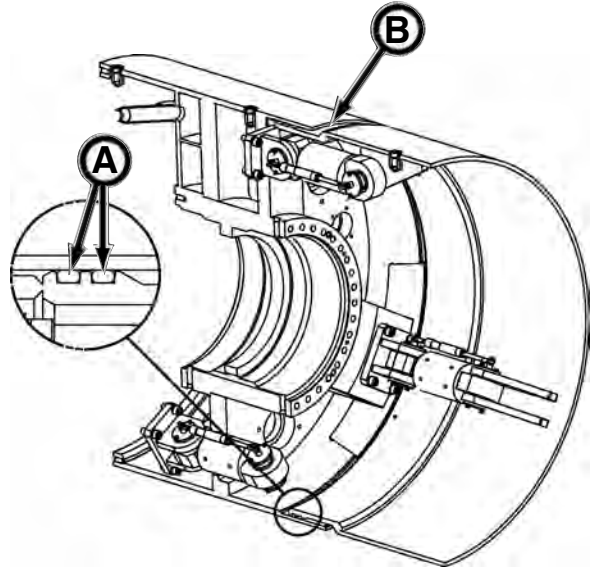
20. INSPECT, LUBRICATE & CLEAN STEERING JOINT SEALS

The steering joint seals (A) 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 Mobilgrease® XHP222 until clean grease is visible on steering joint area (refer to grease guideline below). Depending on MTBM model, there may be 1, 3 or 4 steering joint grease hoses routed to front section bulkhead for greasing the seals.

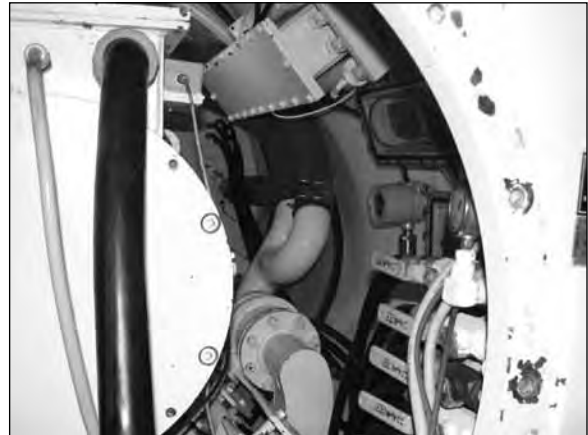
Grease Guideline:

- On MTBM SL44 & smaller: use 1/2 grease tube
- On MTBM SL51 & larger: use full grease tube



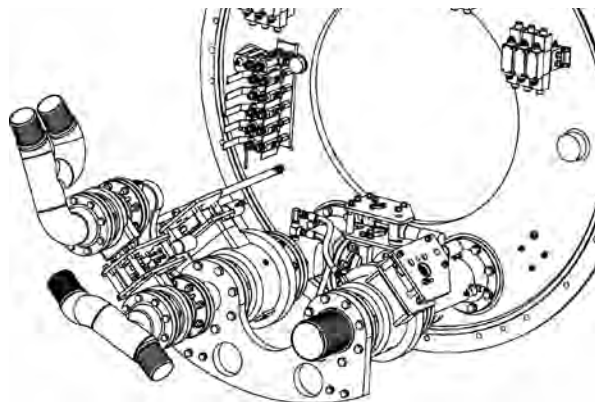
21. INSPECT HOSES & CABLES

Inspect hydraulic/jetting hoses, power cables for wear or damage. Repair or replace if cracks or wear are visible.



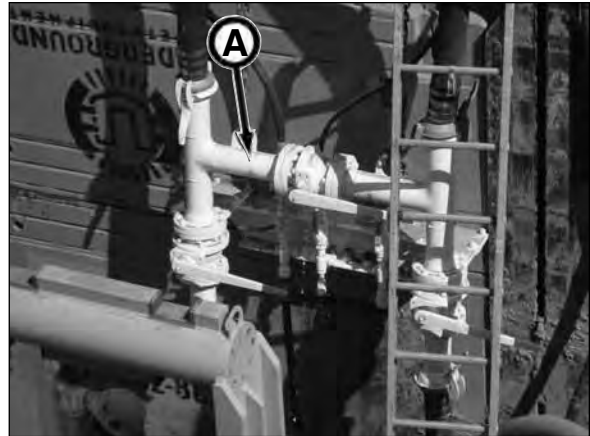
22. FLUSH & DRAIN SLURRY VALVES

Flush and drain the MTBM slurry valves to remove contamination.



23. 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.



24. INSPECT & FLUSH SLURRY HOSES, LINES, CLAMPS & CONNECTIONS

1. Flush and drain slurry pumps and flush slurry hoses and slurry lines.



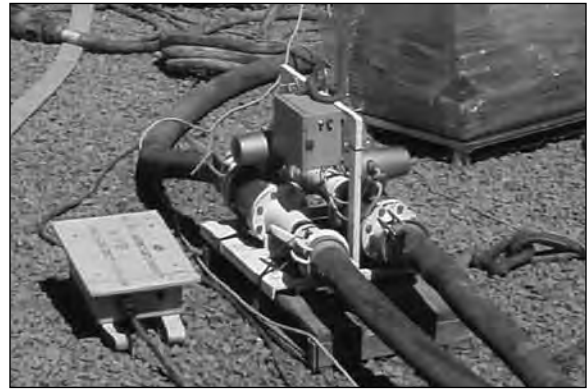
2. Inspect the slurry hoses, slurry lines and slurry line connections for wear or damage. Replace as needed. Clean hoses, lines and connections to remove contamination.

Check to be sure the oring is not cracked, torn, worn or damaged. If needed, replace with new oring.

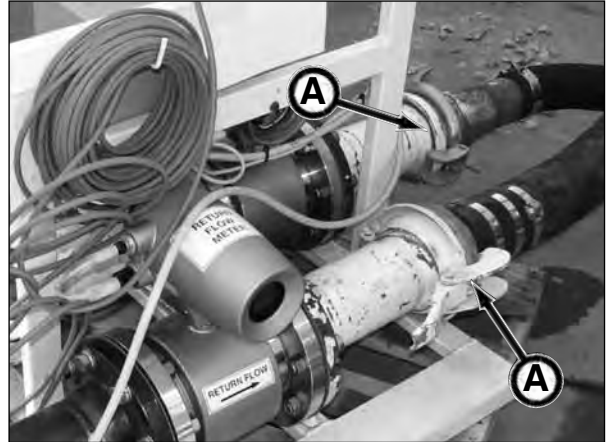


25. CLEAN FLOWMETER & SLURRY CONNECTIONS

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.

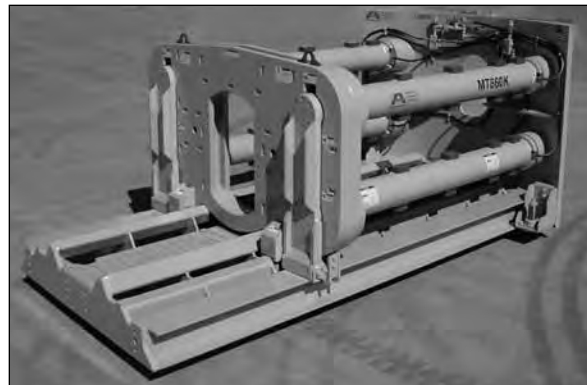


26. CLEAN, INSPECT & LUBRICATE JACKING FRAMES

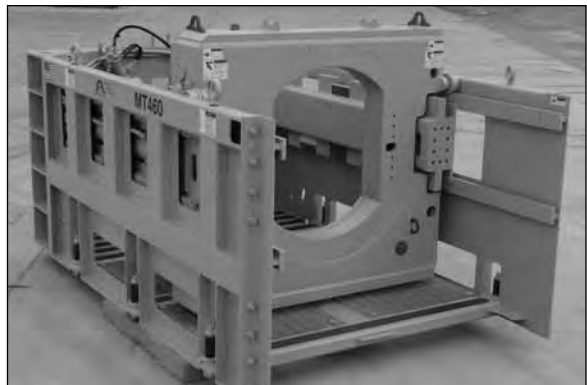
1. Clean frame to remove build up of dirt and debris.
2. Visually inspect jacking frame for cracks or other damage. Also check for damaged, loose, or missing hardware. Replace with new.

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 and Maintenance Charts - MT (Slide Thrust) Jacking Frames in this section.



Keyhole Jacking Frame



MT (Slide Thrust) Jacking Frame

NOTES

MAINTENANCE CHECK LISTS

Use these maintenance check lists to identify system function procedures and maintenance for your pre launch, end of bore, and MTBM service requirements. Copy the check lists in this section. Once the maintenance/service is complete, check off, initial, and date each maintenance/service item, and file the copy as a record of maintenance. **DO NOT perform this maintenance unless you are trained to do so. This maintenance is critical to proper functioning of the microtunneling system. Inferior maintenance will have an effect on the performance of the equipment and accuracy of the drive.**

Pre Launch Check List

Contractor _____ Date _____

Head Diameter _____ Bore Length _____

Date of Launch _____ Project Name _____

Check	Operation	Initial	Date

	MBTM service sheet		
	- Attach to this pre launch record		

Initial System Settings

	Check Target Screen for any "Adjustment" values left from a previous bore. Record these: TH (Target Horizontal) & TV (Target Vertical)		
	- If this is the first bore for this MBTM "0" all adjustments - If the next bore is a continuation with same MTBM leave adjustments or if adjustment values are known (recorded from a previous job) for MBTM enter them		
	Check all alarm settings on target screen		
	- Add alarms if new system - If settings are not appropriate for machine diameter, jacking frame, conditions, etc. make changes. - Record settings:		
	Set values for total Feet Jacked and Pipe Number		
	Check setting of Pipe Location versus Laser Spot Location		
	- Laser Spot (red); Spot is laser location and cross hairs are center of machine		
	Use Light Test push button to test panel lights		

Jacking System

	Check power pack reservoir hydraulic oil level - in container		
	Pit box must be connected to operate frame		
	E-Stop on Pit Box must be pulled out for JF to extend		
	With hoses disconnected from building verify or set pressure relief's		
	- With selector switch in EXTEND operate pump to 25% flow rate. Target screen and gauge should be at 8000 PSI - Extend only PSI		

	Loop Jacking frame hose - connect quick couplers together · Operate pump at 100% flow - to remove air from drop hoses		
	Jacking frame · Lubricate frame · Check "dog" operation & gripper operation · Extend jacking cylinders out · Operate winch - forward and reverse		
	Operate frame in extend · Operate frame in retract ·		
	Test jacking shaft audio - connected at container		
	Check wheel counter operation connected on pit box		
	Check site camera(s) video feedback		
	Cycle jacking frame · Check "swing" of slurry hoses (full of water), cables, etc. · Pinch points · Abrasion problems		

VFD / Drives

	Check settings of Boring Drive VFD · If the previous job used a different horse power drive - drive settings need to be changed · Also change heater setting on contactor for boring drive		
	Operate cutting wheel · Note actual rotation direction agrees with push button		
	Note no load torque for drive:		
	Verify operation and proper rotation of Booster pump · Check at slow rotation speed		
	Verify operation and proper rotation of Feed pump · Check at slow rotation speed		
	Verify operation and proper rotation of Return pump · Check at slow rotation speed		
	Return pump service done · Vortex ring and impeller checked		
	Booster pump service done · Vortex ring and impeller checked		

Submersible Pump

	Make sure pump is plugged in		
	Check vent hose is in place with check valve located high in machine		
	Make certain no contamination is plugging intake holes		

Steering System

	Verify steering operation in extend and retract · Top		

	- Left - Right		
	Record steering position feed back on target screen		
	- Top Extended Retracted - Left Extended Retracted - Right Extended Retracted		
	Calibrate steering cylinder linear outputs if necessary		

Lighting

	Both lights in: middle section (SL24 & 30 only) or trailing section (all other MTBMs) should turn on with Head Power in container		

MTBM Camera / Audio

	Verify video signal is operating from TBM		
	Check operation of MTBM Speaker/Microphone		

Temperature sensors

	Verify head temp is functioning properly at target screen		
	Verify drive motor temp is functioning properly at target screen		
	Check all windings on Additional Meter Screen		

Incline Feedback

	Use digital level (two decimal place level required) to compare with inclines displayed on target screen		
	- Check inclines with no roll - raise machine with lifting eyes - Check proper scaling and values through about 3 degrees		
	Verify calibration of target incline		
	Verify calibration of Back incline		
	Verify calibration of front incline		
	Verify that back and target inclines display same sign and value as inclines change		
	Verify calibration of roll incline		
	- Use SS (Starting Section) hanging from lifting eyes as 0 rotational angle - Roll clockwise is positive - viewed from rear - Roll counter clockwise is negative - viewed from rear		

Flushing

	Next procedures to be done with MTBM hanging from crane - before pushing through seal. Note: If there is no room on frame to connect slurry & etc. hoses with machine on crane do next steps on surface		
	Flush cooling water prior to connecting hose to starting section - Check cooling pressure in additional meter screen < 80 psi - Make certain water is coming out front		
Slurry	Valves Flush water through bypass hose on jacking frame prior to launch and return water to separation plant before connecting to MBTM - purpose is to flush any contamination out of feed hoses that could get caught in slurry nozzles		
	With slurry pumps on check feed and return pressure on target screen Pressure should be the same # 3 psi		
	Cycle the stop valve/bypass valve in manual and sequence operation		
	Operate Chamber/Nozzle valve - meter and lighted push buttons should be in agreement - Check slurry flow out nozzles only with 100% nozzle position - Check slurry flow out chamber only with 100% nozzle position		
	Flush HP jetting prior to connecting to starting section - Operate HP jetting - Cutting nozzle pressure on target screen should agree with pressure gauge on HP jetting pump		

Final Guidance Check

	Record grade of bore: Direction (+ or -) of grade Convert grade in % to degrees: Purpose is to get "ballpark" agreement of actual grade and incline values. Example: 1% = .01 Do: Start $\exists$ Programs $\exists$ Accessories $\exists$ Calculator Now in "View" select "Scientific" Enter ".01" push "INV" then "TAN". Angle in degrees is displayed: ".5729" degrees.		
	Operate steering cylinders to equal stroke positions		
	Center and level MTBM with jacking frame - Machine on line and grade		
	Check horizontal and vertical position of laser Record laser position:		
Record	rd inclines:		

	IF (Incline Front)	IB (Incline Back)	IT (Incline Target)		
	Verify horizontal angle feedback				
	- Record TH (Target Horizontal) - Angle machine to left - TH should decrease in value - Angle machine to right - TH should increase in value				
	Verify vertical angle feedback				
	- Record TV (Target Vertical) - Steer machine down - TV should increase in value - Steer machine up - TV should decrease in value				
	Lubricate launch seal				
	If launch rails are being used:				
	- Measure distance machine needs to be jacked past the seal for the cutting bit to clear the rails - Mark MBTM with this value - Push drive into seal until bit is clear of launch rails - to mark - MBTM should be sitting on launch rails - with steering even				
	Make certain MTBM is centered in launch casing				
	If material being launched into is relatively hard add left - right "kickers" for launch				
	Record guidance feed back information again while sitting on launch rails:				
	H (Horizontal) Position		V (Vertical) Position		
	IF	IB	IT		
	TH Angle		TV Angle		
	Compare these values with ones recorded while MBTM was on crane				

Final Checks

	Before starting boring head drive		
	- Check speed setting of drive - Is the HP jetting "Auto" switch on? This is typically <u>off</u> during launch.		
	Set slurry chamber / nozzle valve to initial setting for launch		
	Set Dirt Wing to <u>Retracted</u> position		

End of Bore Check List

Contractor _____ Date _____

Head Diameter _____ Bore Length _____

Date of TBM Recovery _____ Project Name _____

Before MTBM is Disconnected

Check	Operation	Initial	Date
	Retract dirt wing		
	Retract steering rams to 10% stroke on Left and Right and 0 Top		
	Shut off head power		

After MTBM Recovery

	Remove target and store in case		
	Note any oil in TBM - should be able to smell gear lube.		
	Check for source of any water leaks • Water marks from access doors • Dripping fittings		
	Clean chamber • Power wash with front of head elevated and stop valves open • Removing cutting wheel can aid in cleaning chamber		
	If freezing weather is anticipated do cold weather service on TBM • Drain and flush Cooling system with RV antifreeze • Drain and flush HP Jetting system with RV antifreeze • Drain slurry valves		
	If freezing weather is anticipated do cold weather service on surface equipment • Drain cooling tank • Drain and flush cooling pump with RV antifreeze • Drain and flush HP Jetting pump with RV antifreeze • Drain slurry flow meters		
	Drain sample of final drive oil and check for water/contamination • If service is to be done soon this step can be skipped		

Equipment Inspection List

MBTM Service Check List

Contractor _____ Date _____

Head Diameter _____ Previous Bore Length _____

Date of last service _____ Project Name _____

Make additional notes and list parts installed on back of sheet

Drive / Seals Service

Check	Operation	Initial	Date
	Remove cutting wheel · After cap screw is removed lift wheel and check for spline "play" · Clean splines		
	Check visually for spline wear		
	Remove lip seal guard ring		
	Note condition of rotating and stationary crushing bars:		
	Note condition or damage to intake holes:		
	Note condition of hard facing on cutting wheel and cone:		
	Note condition of cutting tools: Note replacement:		
	Drain and inspect planetary gear box oil · Note contamination in oil: · Note amount of gear lube removed from gear box - compare to spec		
	Fill planetary gear box with proper amount of gear lube - 2/3 full *		
	Drain and inspect final drive gear lube · Grease in oil indicates damaged mechanical seals, water indicates damaged lip seals and mechanical seals · Note contamination in oil: · Note amount of gear lube removed from final drive - compare to spec * If oil circulation pump model, planetary should be full.		
	Drive bearings filled with proper amount of gear lube - 3/4 - 7/8 full		
	Check condition of lip seals or wear groove in stellite ring		
	Note no load torque and amp draw of drive:		
	Pump grease past lip seals · Note condition of grease passing seals · Water and contamination in grease can indicate damaged lip seals or worn stellite ring		

	Pump grease on left hose side and right side hose individually • Force pump ON to pump grease or use a grease gun • Release force on pump when done		
	Check condition of grease pump cartridge • A worn cartridge will not pump under pressure • Operate pump under pressure - use gauge and 250 psi relief valve assembly		
	Fill canister with grease • Do not over fill ! - Take note of bleed hole at end of canister for overfilling protection. Pump housing can be damaged from too much pressure • If new grease canister purge air and refill		
	Check operation of low grease pump switch • Switch is to be wired NC when canister is full		

Cooling System Service

	Remove check valves and T assemblies		
	Flush motor and gear box with garden hose - increased flow • Flush both directions until clean discharge		
	Remove all adapters and fittings from check valves • Clean check valves • Note condition of check valves: • Note spring force on check - is 50 psi:		
	Flush each hose independently • Left side hose to front - discharge in front of lip seals, left side • Right side hose to front - discharge in front of lip seals, right side • Bypass hose to slurry input		
	Assemble cooling system plumbing per schematic • Note check valve flow direction during assembly • Test system, Check for leaks and proper flow out front and bypass		
	Flush cooling line in trailing section		
	If cold is anticipated blow out water and flush with RV antifreeze		

High Pressure Jetting System

	Remove nozzles and checks valves inspect • Note nozzle wear: • Contamination in check valves • Oring in check valve - it can be partially popped out		
	Clean check valves • Note any replaced		
	Clean jetting nozzles • Note any replaced		
	Flush jetting lines one at a time		
	Install check valves, oring and nozzles • Operate jetting, checking for leaks		
	Remove strainer element and clean		
	Flush HP jetting line in trailing section		

	If cold weather is anticipated blow out water and flush with RV antifreeze		

Cutting Wheel Service

	Install lip seal guard ring with retraction screws in place		
	Install new drive cone oring on stellite ring - lubricate		
	Cutting wheel installation: • Clean mating splines • Lubricate splines with grease		
	Lift cutting wheel, noting "play" or spline clearance: • Do this with cap screw removed		
	Torque cutting wheel cap screw		
	Operate cutting wheel • Note actual rotation direction agrees with push button • Note clearance from back of wheel to machine • Proper clearance is 1/8 inch # 1/16 inch		
	Note no load torque for drive		
	Install center hub		

Electric Inspection

	Visually inspect condition of junction boxes		
	Check pins and key ways on connectors		
	Condition of cables		
	Tighten all connectors on electric box and junction boxes		
	• Note condition of seal		
	Note water, condensation or corrosion damage in electric box:		

Submersible Pump Service

	Remove pump from casing • Clean pump casing / suction holes		
	Run pump in water to verify rotation • Place in water deep enough to cover suction inlet		
	Check flow and pressure of pump output • Observe full flow with no restriction • Restrict outlet and check pressure		
	Remove float from float switch assembly and clean		
	Verify float switch operation of submersible pump - lifting float turns on pump		
	Remove and clean pump discharge hoses and check valve		
	Air vent / check hose assembly • Inspect and clean hose • Test check valve operation • Check that fittings are tight		

Hydraulic Pump Service

	Note oil level of hydraulic reservoir - fill if needed • If level is low look for hydraulic leaks		
	Note condition of all hydraulic hoses and quick fittings:		
	Force on Low PSI • Note gauge reading of low pressure • Adjust low pressure relief to 3000 psi • Release Forces		
	Force on High PSI • Note gauge reading of high pressure • Adjust high pressure relief to 7500 psi • Release Forces		

Slurry Valves Service

	Operate valves with console • Note any "play" in pivot points at actuator rotation • Note if valves fully open and close • Note position feedback on console 1) Stop - open and closed light 2) Bypass - open and closed light 3) Chamber/Nozzle - open and closed light		
	Deviation from original calibration values may indicate: • Pivot point wear • Mechanical adjustment at thread on end of cylinder • Contamination in valve limiting operation • Mechanical: Seat, ball, bushing, etc. wear or failure • New hydraulic cylinder		
	Stop Valve • Does hydraulic pump cycle off and on in open or closed positions of the stop valve		

Dirt Wing

	Note condition of blade:		
	Clean and lubricate		
	Operate dirt wing extended and retracted • Note operation on console • If one or both lights do not work check feed back or calibration		
	Make certain blade retracts all the way		

	• Retracted light will come on when retracted to original calibration • Observe amount of blade extended from skin when retracted		
	Check pressure required to extend and retract blade		

Pressure Transducers

	Extend steering cylinders until hydraulic flow passes over relief - maintain push buttons in extend Record pressures: • High pressure - additional meter screen • Top pressure - additional meter screen and target screen • Left pressure - additional meter screen and target screen • Right pressure - additional meter screen and target screen		
	Release extend push buttons then record pressure of check valves after several minutes to verify PO checks are maintaining pressure: Left Top Right		
	Extend dirt wing until hydraulic flow passes over relief - maintain push buttons in extend Record pressures: • Low pressure - additional meter screen • Dirt wing pressure - additional meter screen		
	Cutting nozzle pressure transducer should agree with pressure gauge on HP jetting pump and Target screen • Can test with cooling pump - adapter and gauge assembly		
	Cooling pressure transducer should agree with pressure gauge on cooling pump - additional meter screen • If no pressure gauge is available the transducer needs to be removed and installed in a test fixture where up to 300 psi can be applied to the transducer - shop air is sufficient		
	Remove slurry inlet and outlet pressure transducers and test with calibration fixture Pressure up to no more than 90 psi with shop air Record feedback at target screen and gauge readings at 10, 30 and 50 psi • Slurry inlet pressure • Slurry outlet pressure		

Booster Pump

	Note condition of vortex ring: • Note if replaced		
	Note condition of impeller: • Note if replaced		
	Note condition of stuffing box: • Plate wear behind impeller • Note if replaced		
	Note condition of mechanical seals: • Any leakage at stuffing box • Note if replaced		
	Pump grease to fitting at bearing cover		
	Check condition and level of oil in shaft housing		
	Verify proper rotation of booster pump		
	Drain booster pump if cold weather is anticipated		

Bentonite System

	Remove bentonite nozzles and/or check valves and clean		
	Flush all bentonite ports and hoses		
	Connect system and test for operation / leaks		

Additional Check Points

	Gas Detector • Check feedback with calibration gas • Note values at additional meter screen agrees with gas detector • Pit box horn should sound at 25% gas		
	Oil filter indicator • Check operation while retracting steering rams and dirt wing at same time		
	Check condition of inner tube on slurry hoses - especially return		
	Inspect condition of machine sealing bells and spigots • O-ring grooves • Nicks or gauges • Flat spots - damage from dropping		
	Replace machine oring seals		
	Check victaulic rubber seals		
	Inspect condition of torque bolts • Thread damage • Are nuts installed		
	On 72" TBM check gear oil circulation flow and pressure on the gear box		
	If motor is equipped with correct voltage motor heater verify it is functioning properly • Turn motor heater switch "ON" • Motor temperature should rise • Turn motor heater switch "OFF"		

Storage

PREPARING FOR STORAGE

NOTICE

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

1. Repair worn or damaged parts.
2. Wash all equipment thoroughly.
3. Lubricate all grease points. Grease threads on bolts used for adjustments.
4. Drain and fill gear reducer and drive bearing cavity. Add Mobil SHC™ 630 or equivalent.
5. Retract all hydraulic cylinders if possible. If not, coat exposed cylinder rods with a corrosion preventive.
6. Repaint equipment where necessary.
7. Drain hydraulic oil, flush oil reservoir, change hydraulic filters, and refill hydraulic reservoir. Check for leaks.
8. Wipe up lube spills. Dispose of rags and trash properly.
9. If possible, store equipment under cover and out of the weather in a ventilated area.
10. 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.
11. Remove guidance target and place it in the storage box.
12. Flush and drain pumps and all fluid lines to prevent clogging or freezing during storage.
13. Refer to your Slurry Pump/Motor and High Pressure Jetting Pump manuals for long term pump and motor 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 gear reducer and drive bearing cavity oil level. Add Mobil SHC630 oil as needed.
5. Remove the cylinder corrosion preventive from the cylinder rods if it is not compatible with hydraulic oil or seal materials.
6. Check for leaks. Repair or replace as necessary.
7. Check power pack hydraulic oil level. If fluid is low, check for leaks and add oil as required. See Power Pack Oil Reservoir Lubricant in Lubricants section.
8. Check condition of all hoses and connections. Tighten, repair or replace with new as needed.
9. Remove bags from electrical cable connections and visually inspect to be sure there is no damage.
10. Before operating, cycle hydraulic functions several times to purge air from the hydraulic system.
11. Review this Operator's Manual and supporting equipment manuals.

NOTES

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.
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.

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.
	E-Stop button(s) 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.
MTBM disc cutter failure.	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.
	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.	Power Pack and/or Pit box E-Stop buttons are pushed in.	Pull out 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.
Hydraulic oil temp is high (120°F).	Damaged power cable(s).	Repair or replace pwr cable(s).
	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.	Power pack or pit box E-Stop is pushed in.	Pull E-Stop button(s) out.
	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.
Jacking frame operational but no thrust available.	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.
	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.
Over/under excavation.	Slurry valves are not calibrated.	Calibrate slurry valves.
	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 Apex 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.
	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.

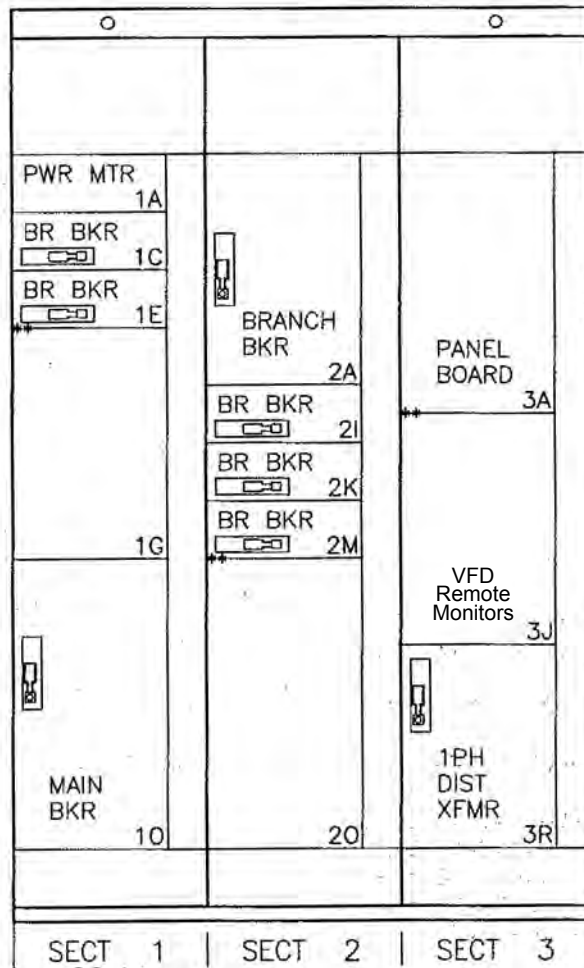
WATER COOLING TANK

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.
	Pump malfunction.	Repair or replace pump.
	External power source (generator) output is erratic.	Inspect and troubleshoot generator.
Pump flows are inconsistent.	External power source (generator) output is erratic.	Inspect and troubleshoot generator.

MOTOR CONTROL CENTER (MCC) ELECTRICAL SCHEMATICS

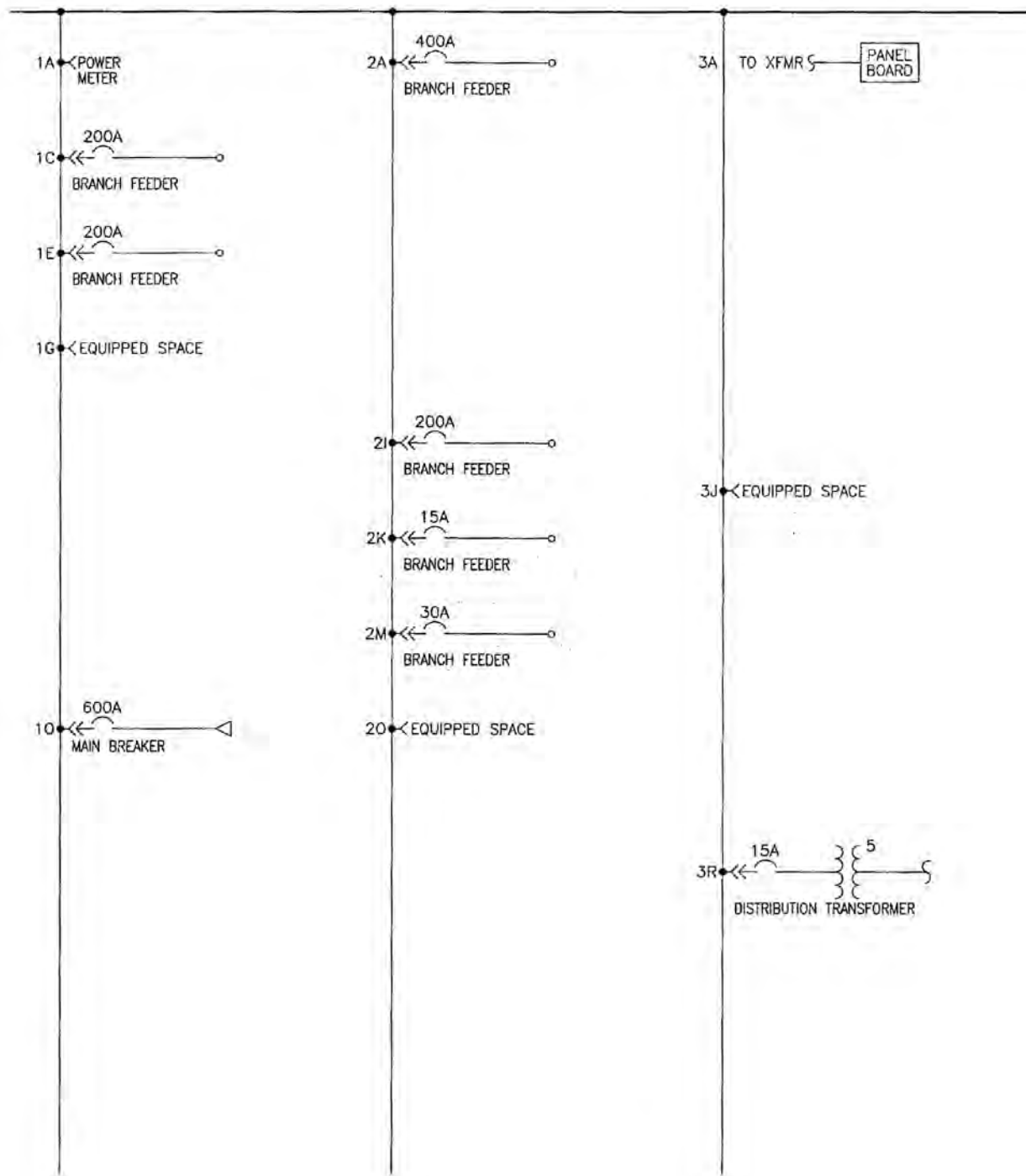
The Motor Control Center (MCC) is made of standardized vertical sections consisting of totally enclosed, dead front, free standing structures bolted together. These sections support and house control units, a common bus bar for distributing power to the control units, and a network of wire trough and 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.



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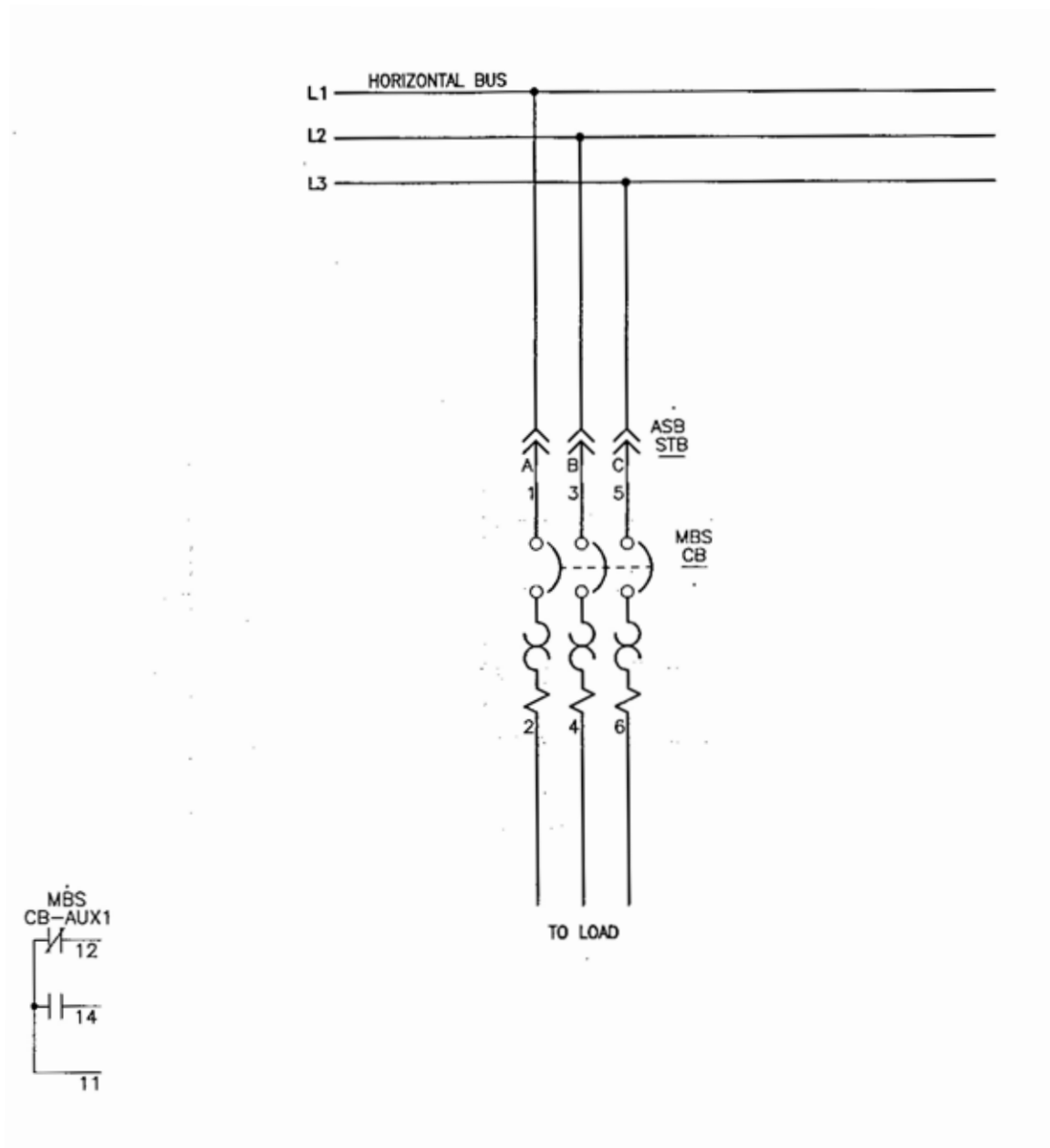
MCC Electrical Schematics (continued)



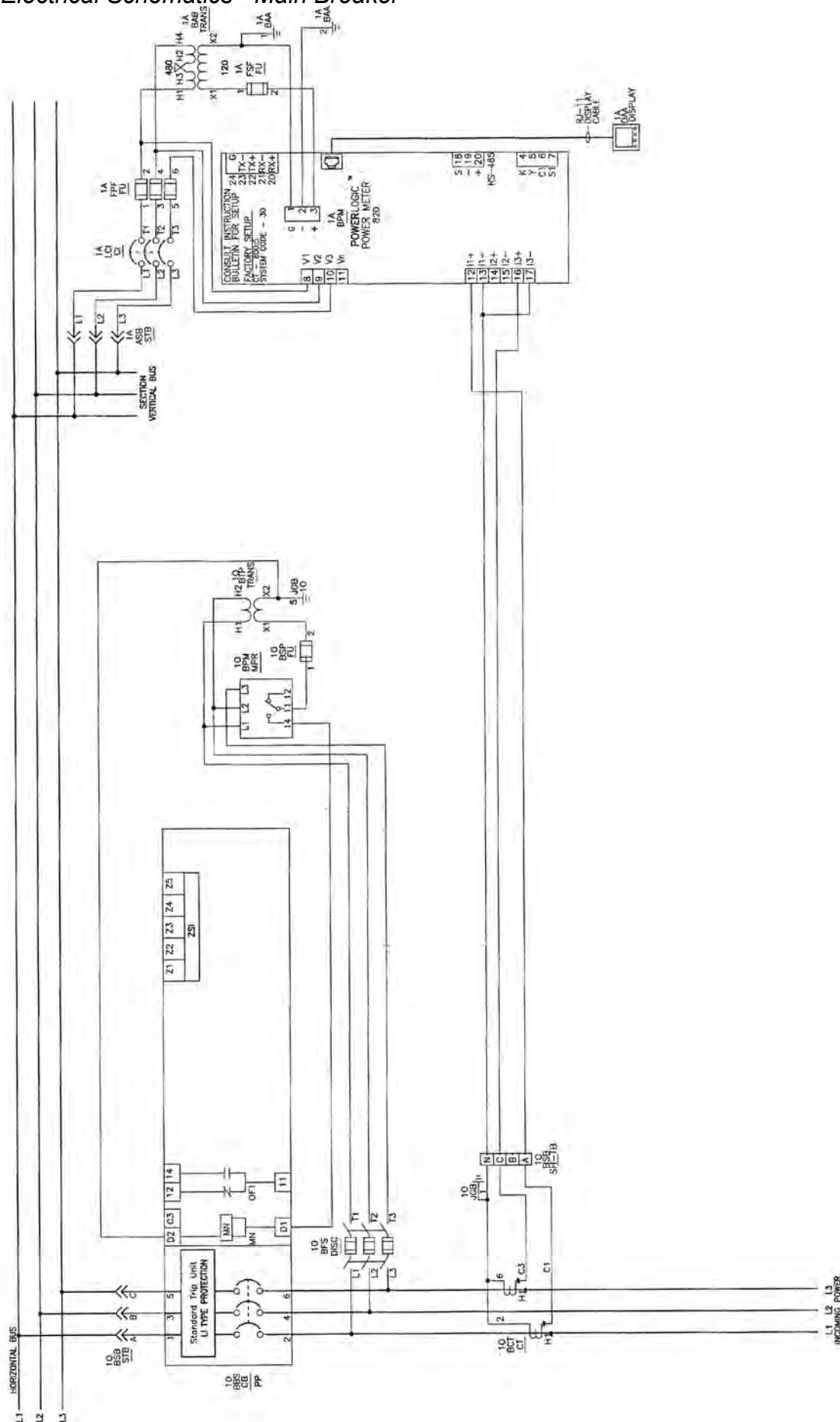
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MCC Electrical Schematics - Pumps: Feed - Booster - Return

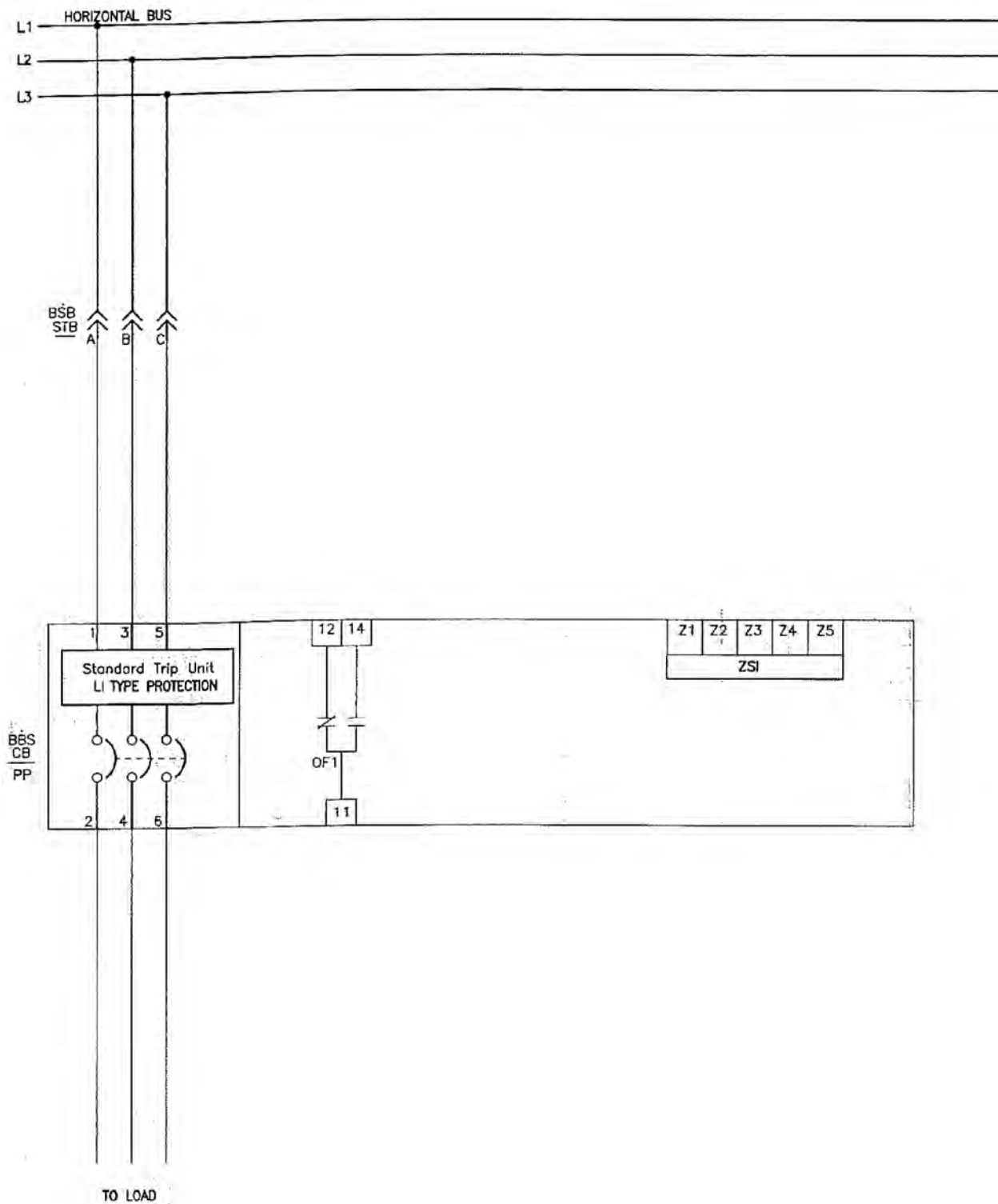


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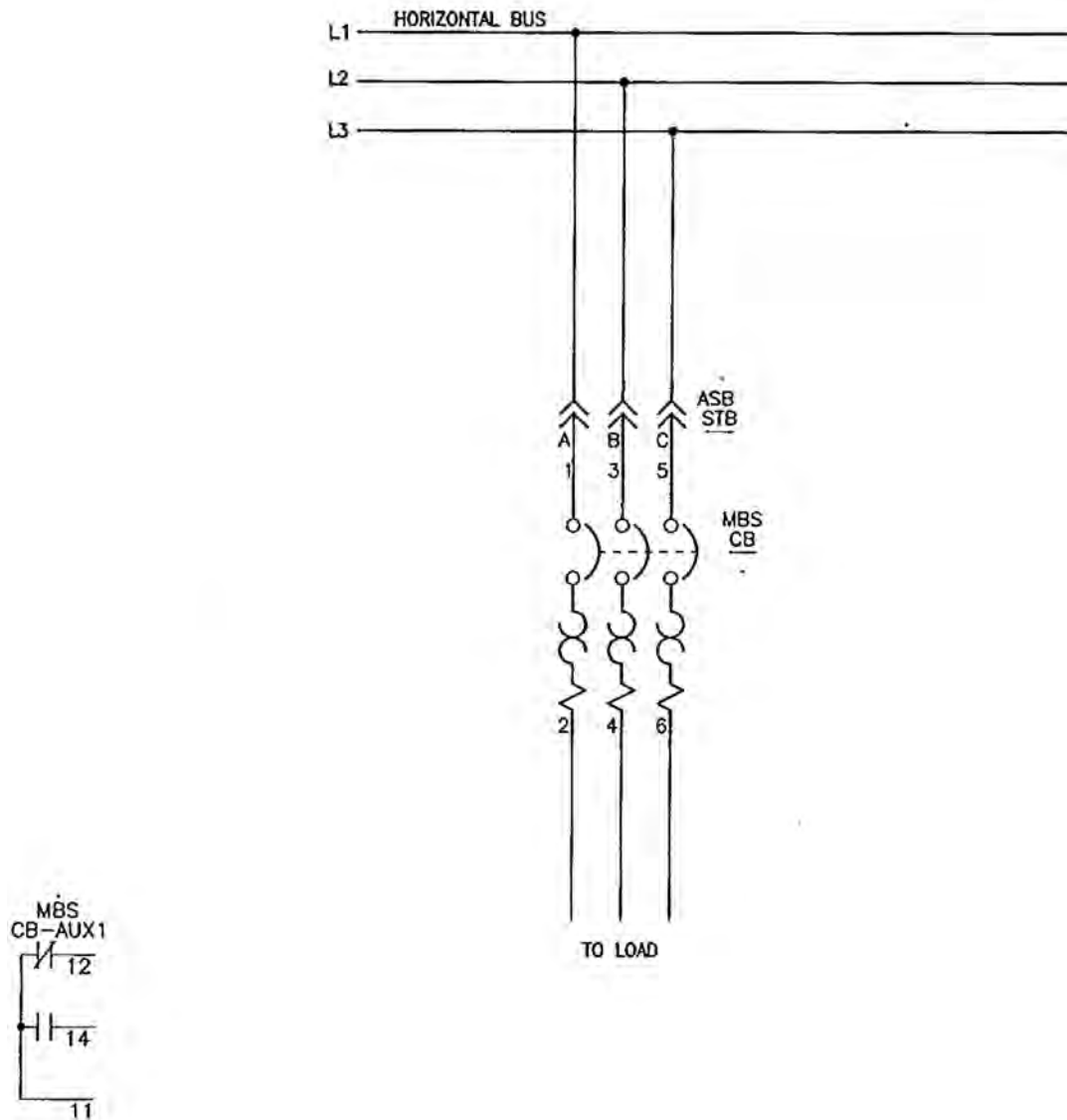
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MCC Electrical Schematics - Main Cutter Drive



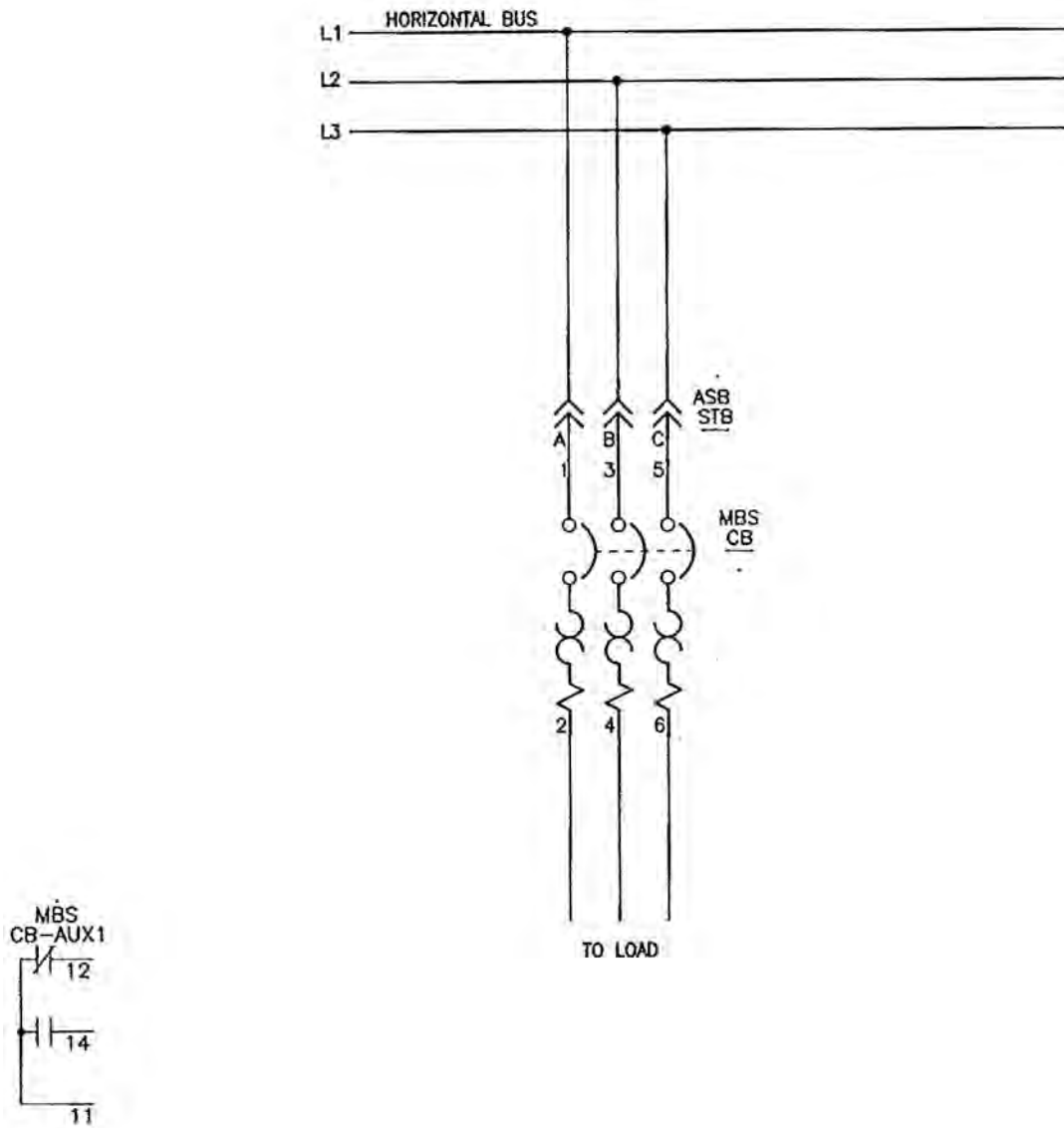
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MCC Electrical Schematics - Cooling Pump



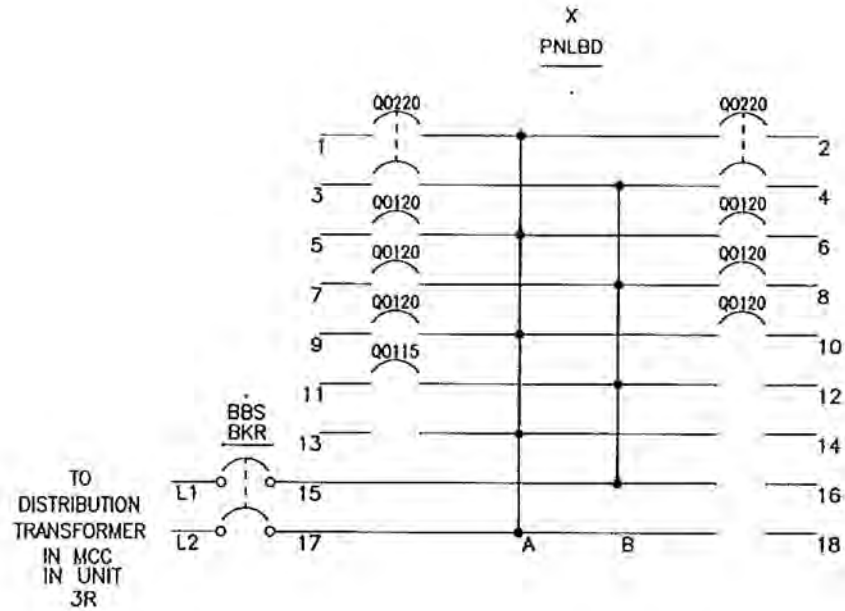
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MCC Electrical Schematics - Head Power



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MCC Electrical Schematics - Panelboard

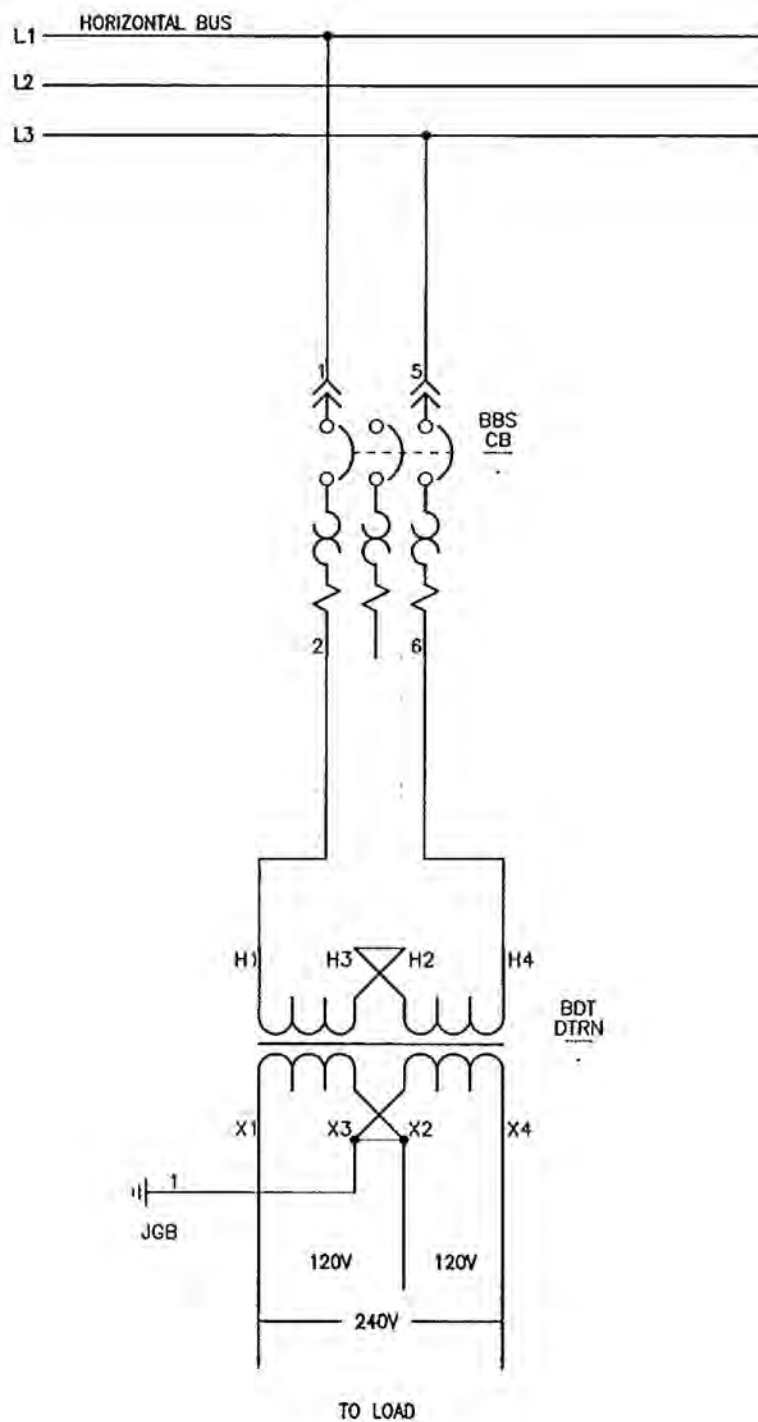


Note: Connect GFI/EPD/EPE
Neutral to Panel Neutral

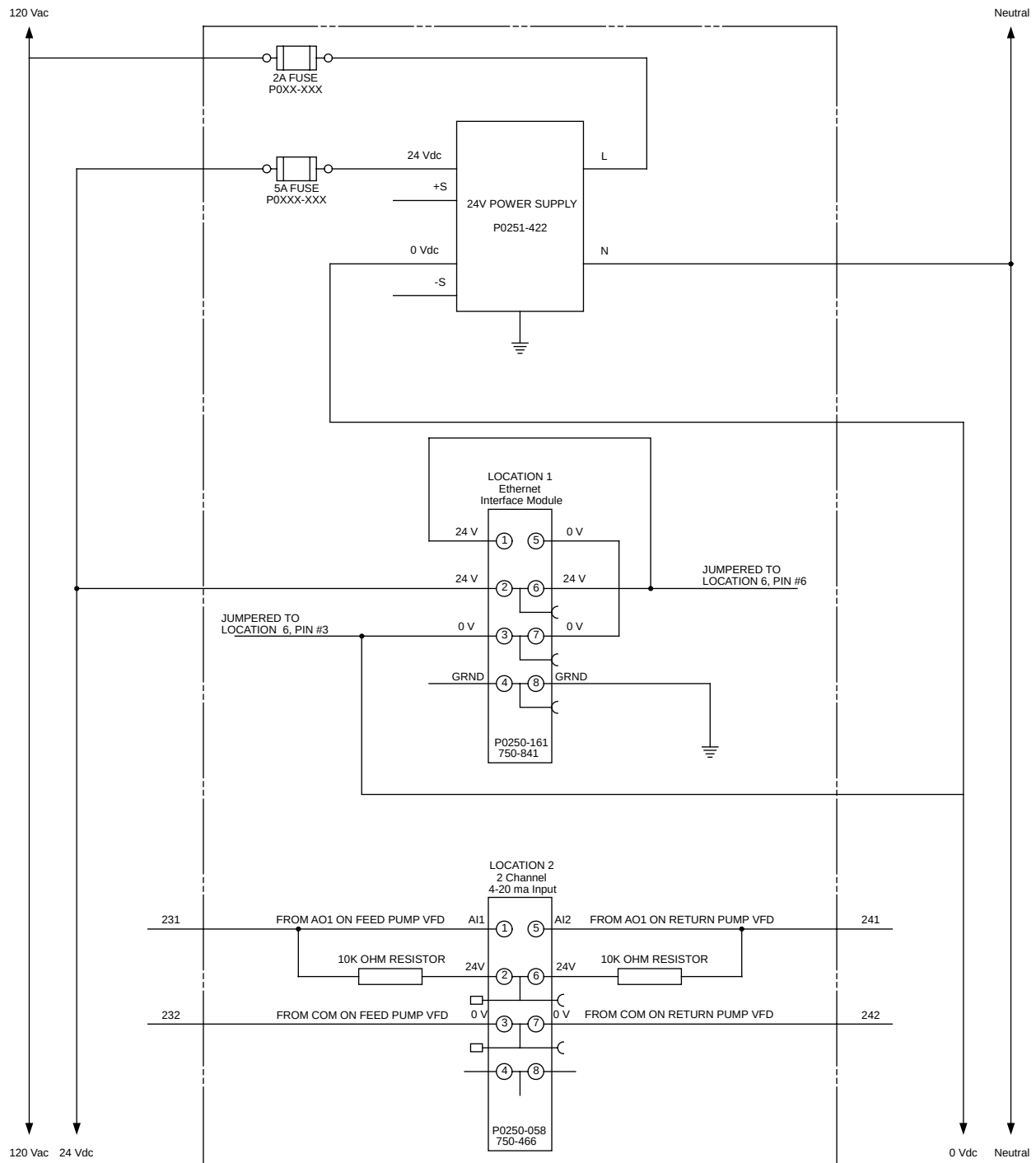


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MCC Electrical Schematics - Transformer

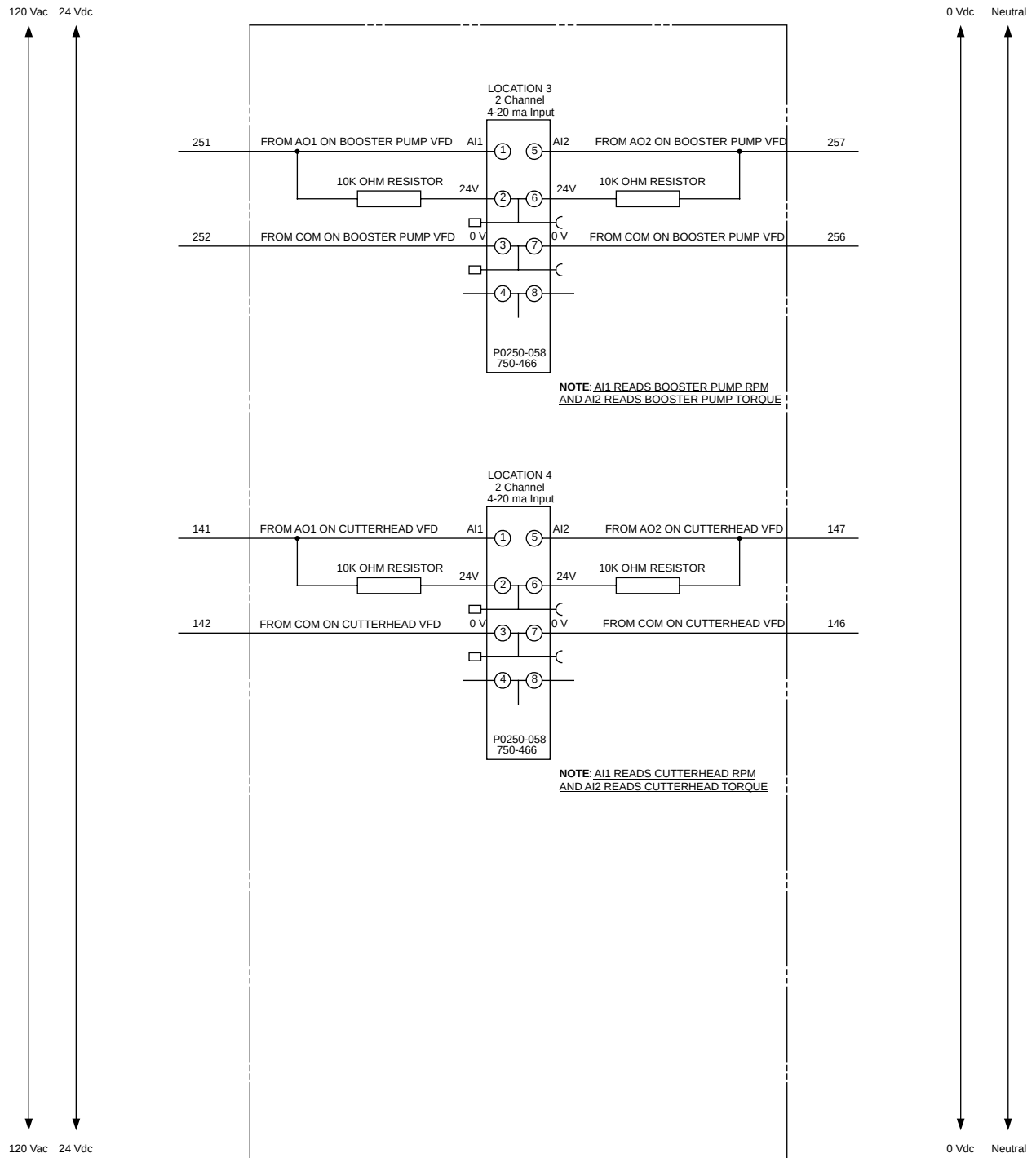


CONTROL CONSOLE ELECTRICAL SCHEMATICS



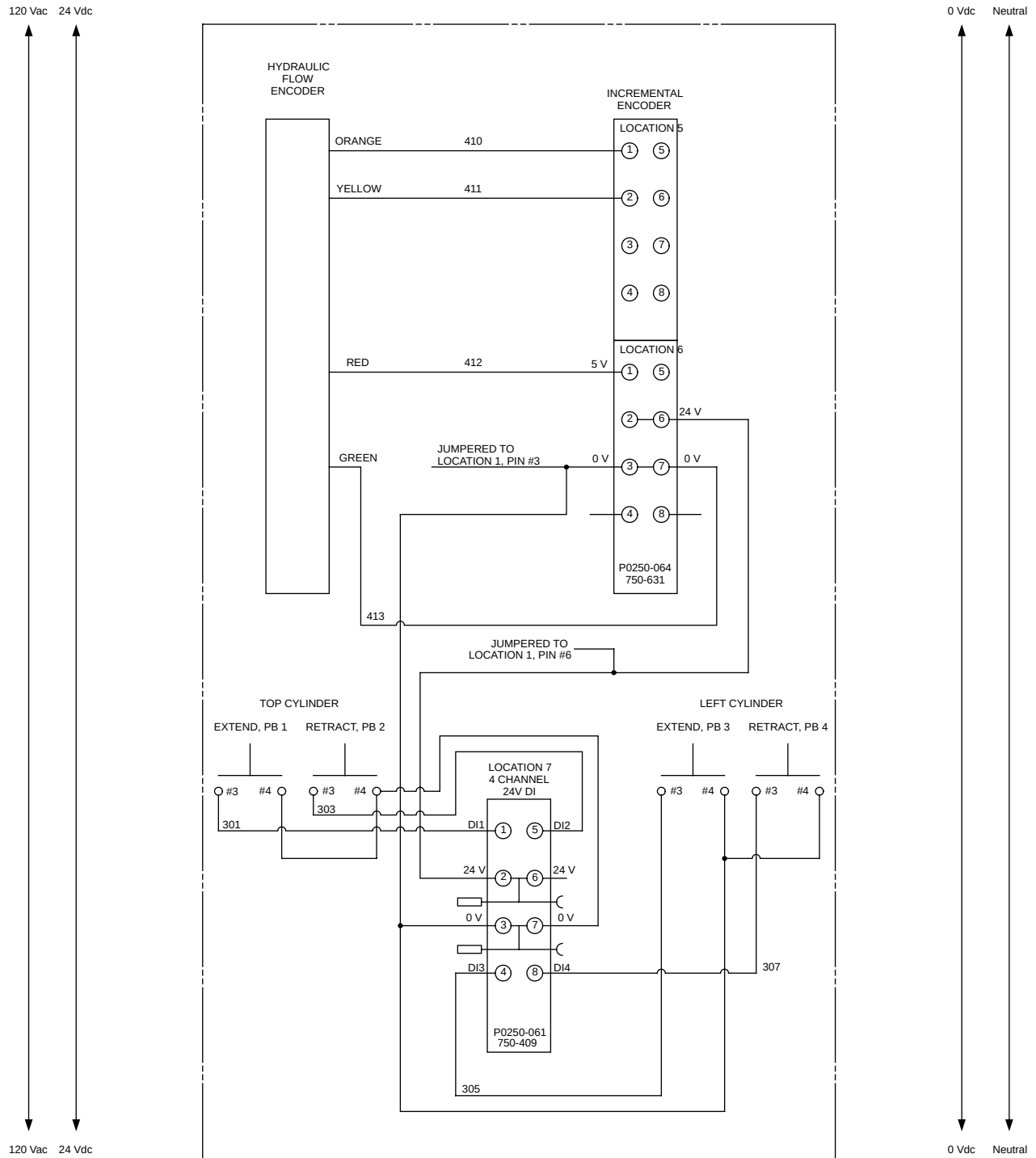
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Control Console Electrical Schematics (continued)



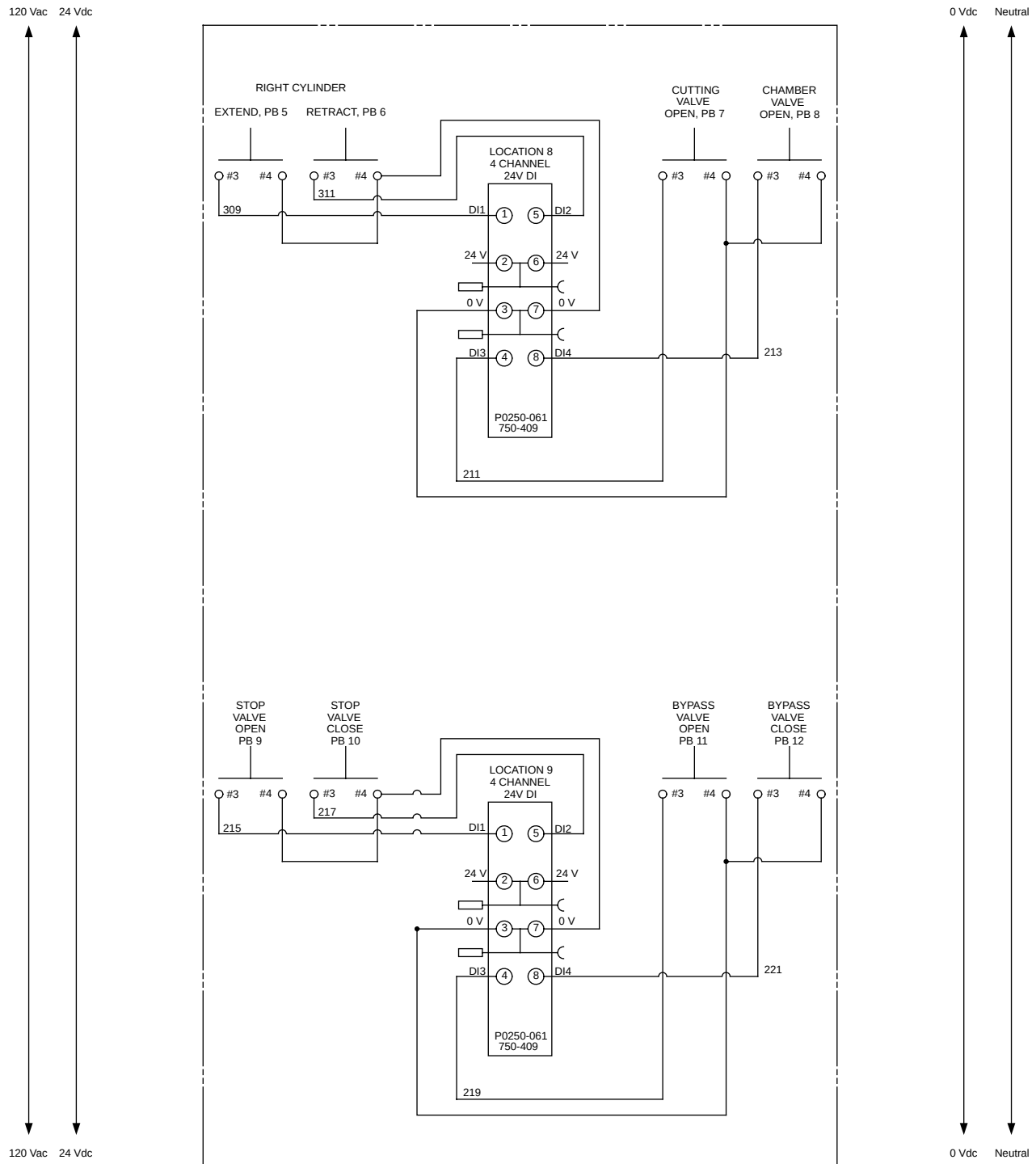
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Control Console Electrical Schematics (continued)



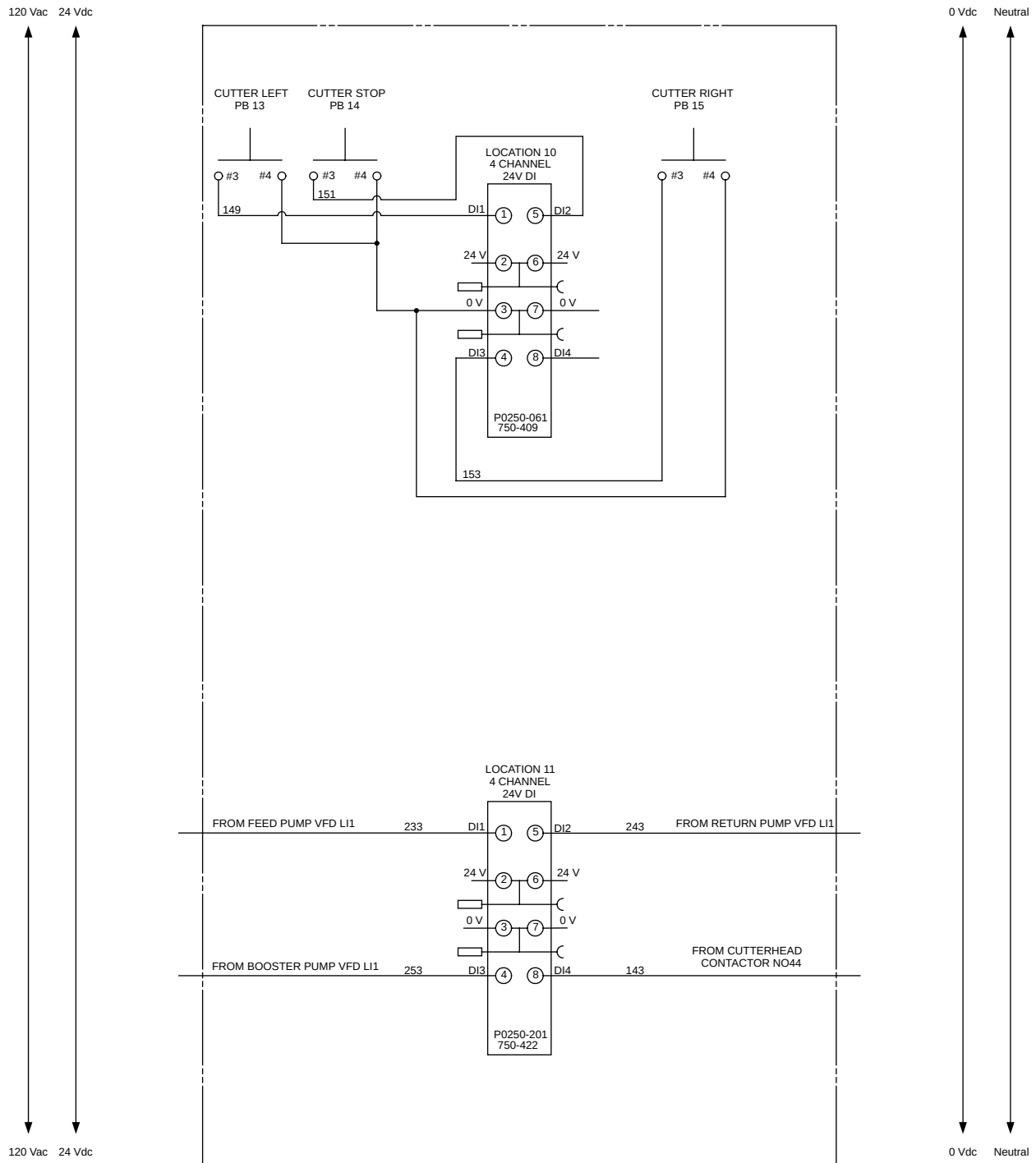
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Control Console Electrical Schematics (continued)



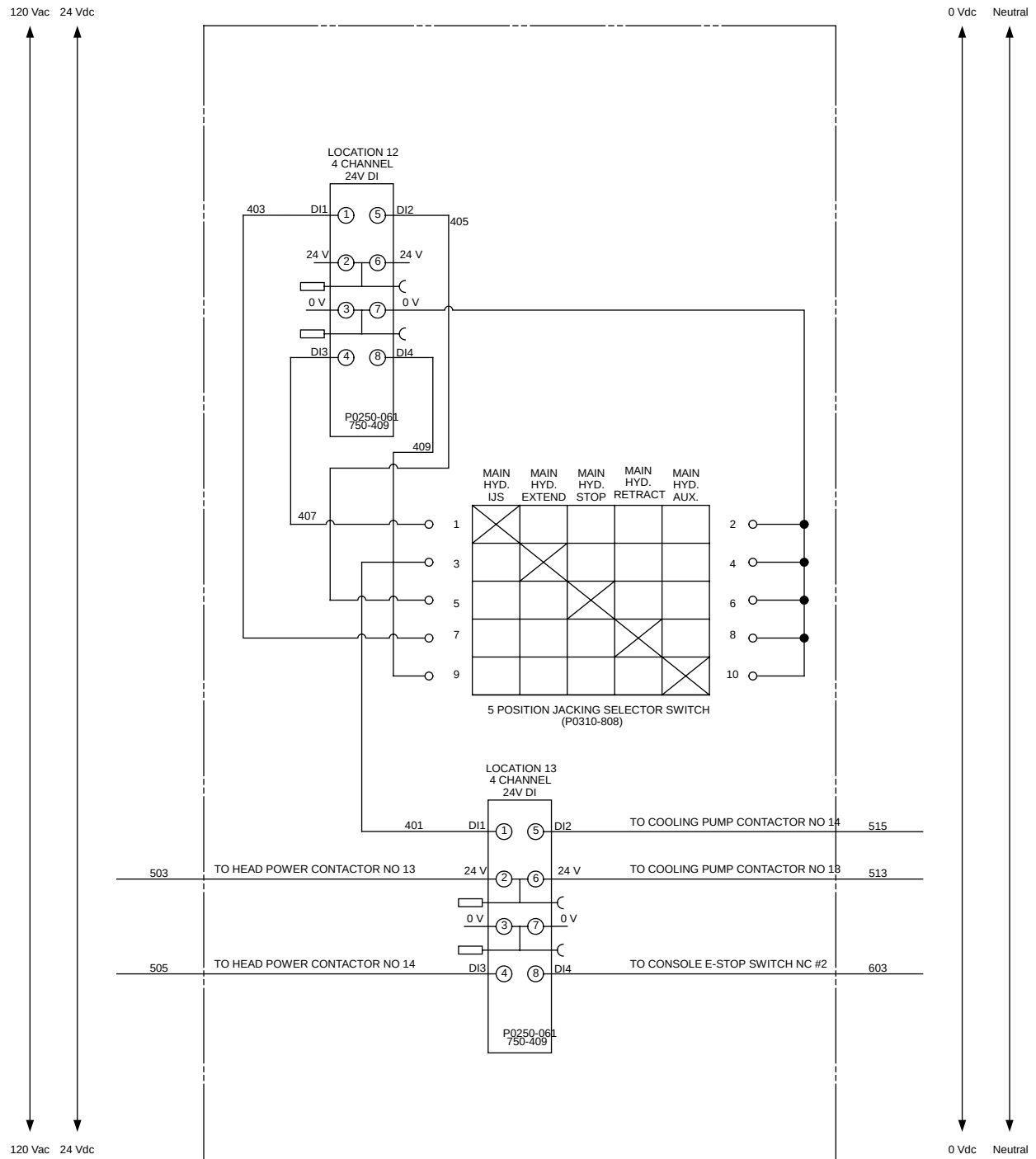
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Control Console Electrical Schematics (continued)



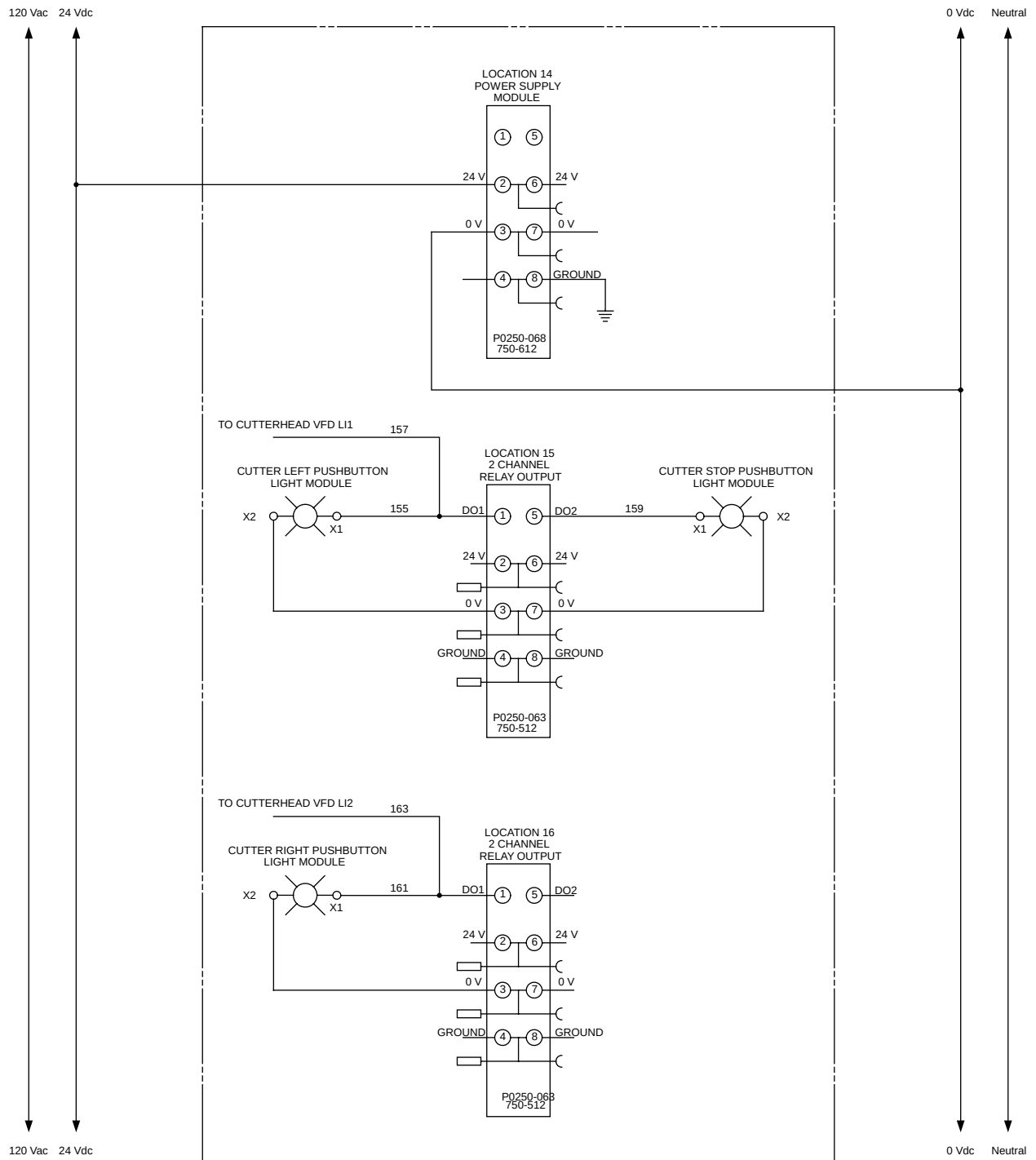
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Control Console Electrical Schematics (continued)



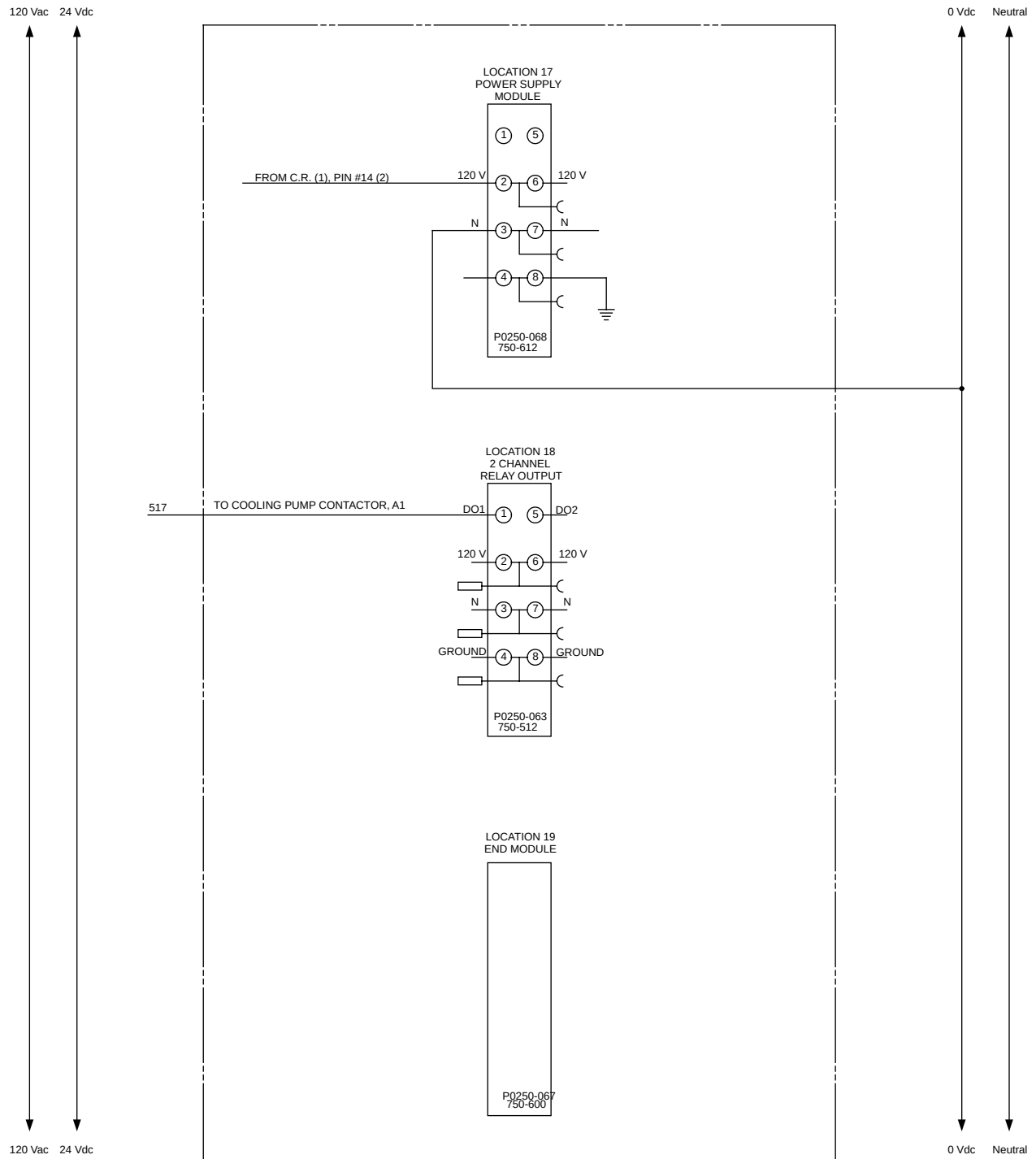
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Control Console Electrical Schematics (continued)



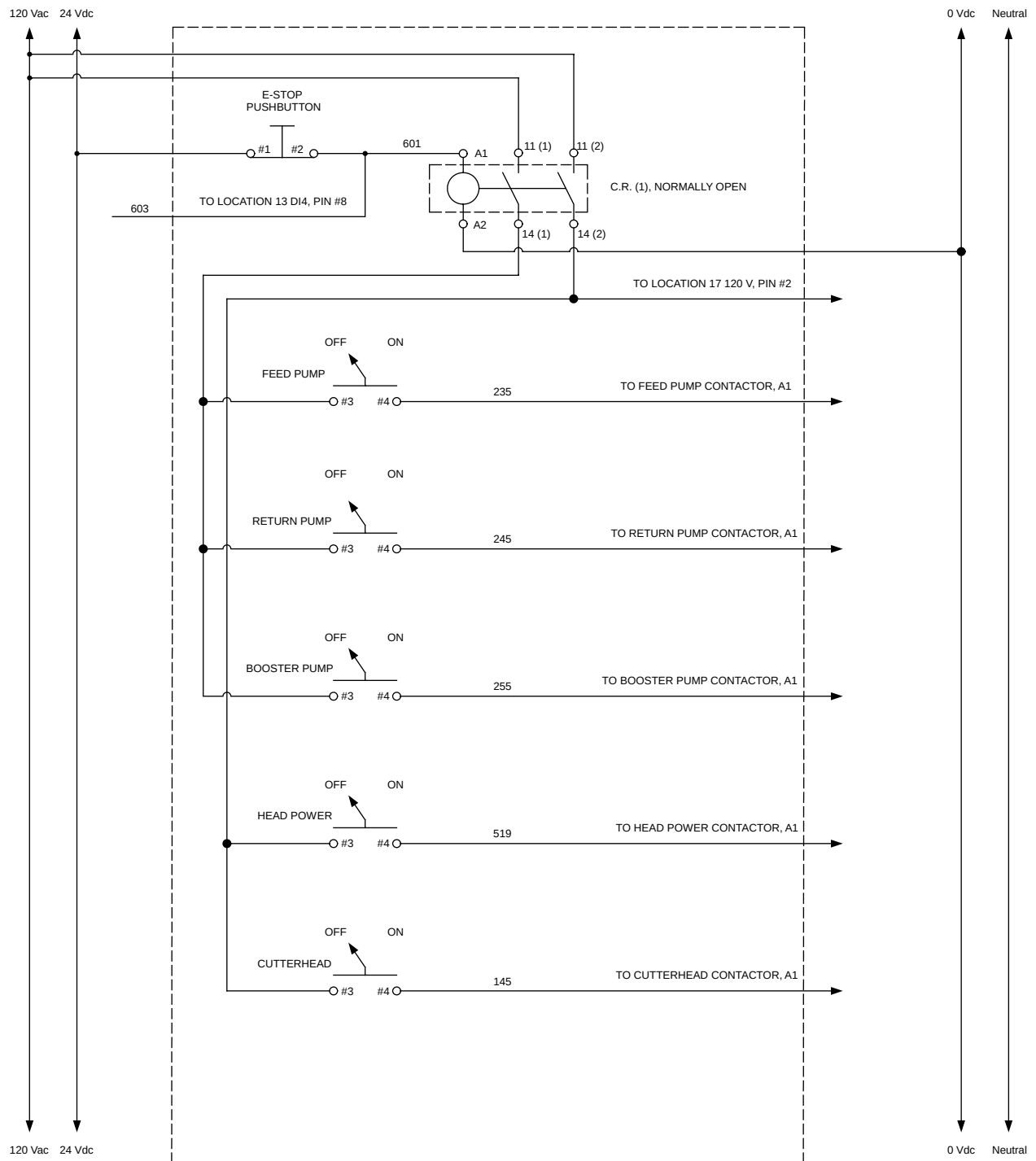
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Control Console Electrical Schematics (continued)



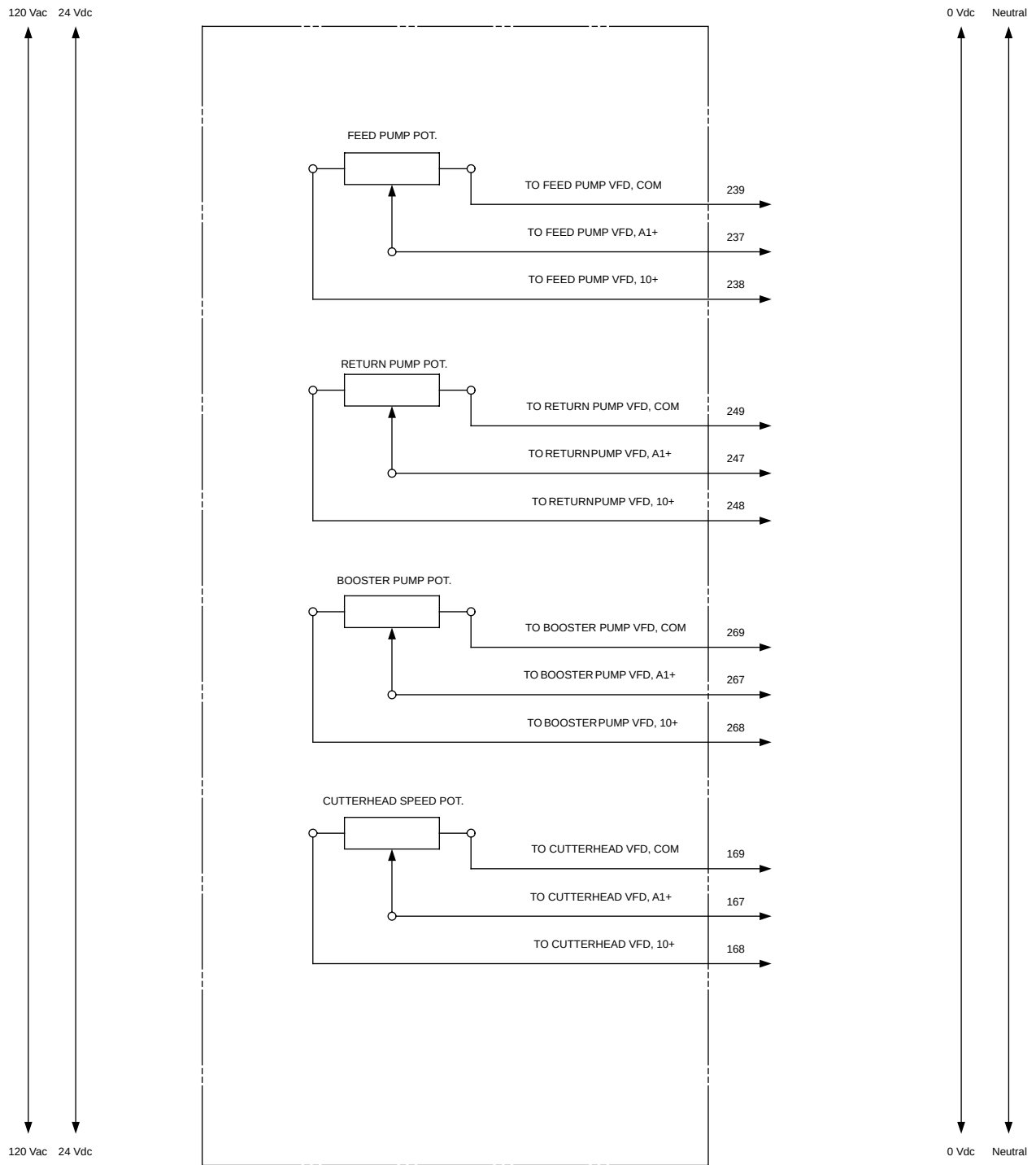
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Control Console Electrical Schematics (continued)

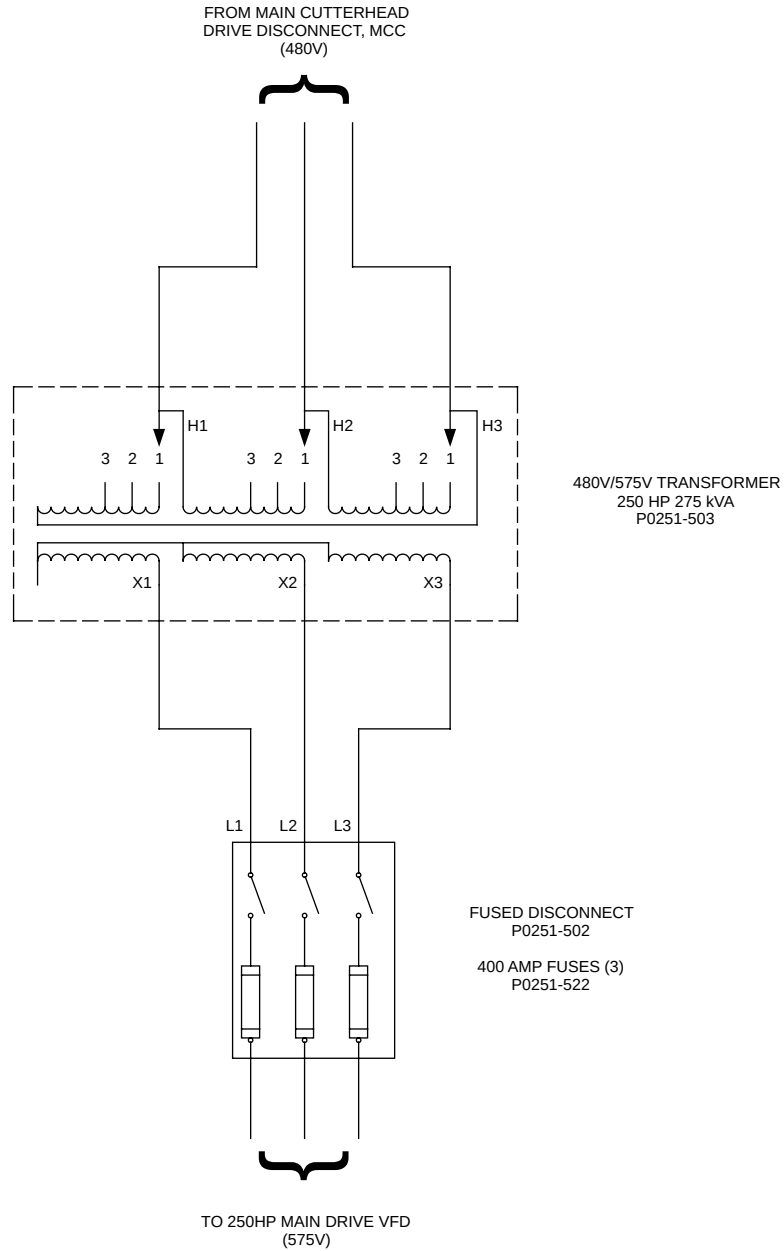


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Control Console Electrical Schematics (continued)

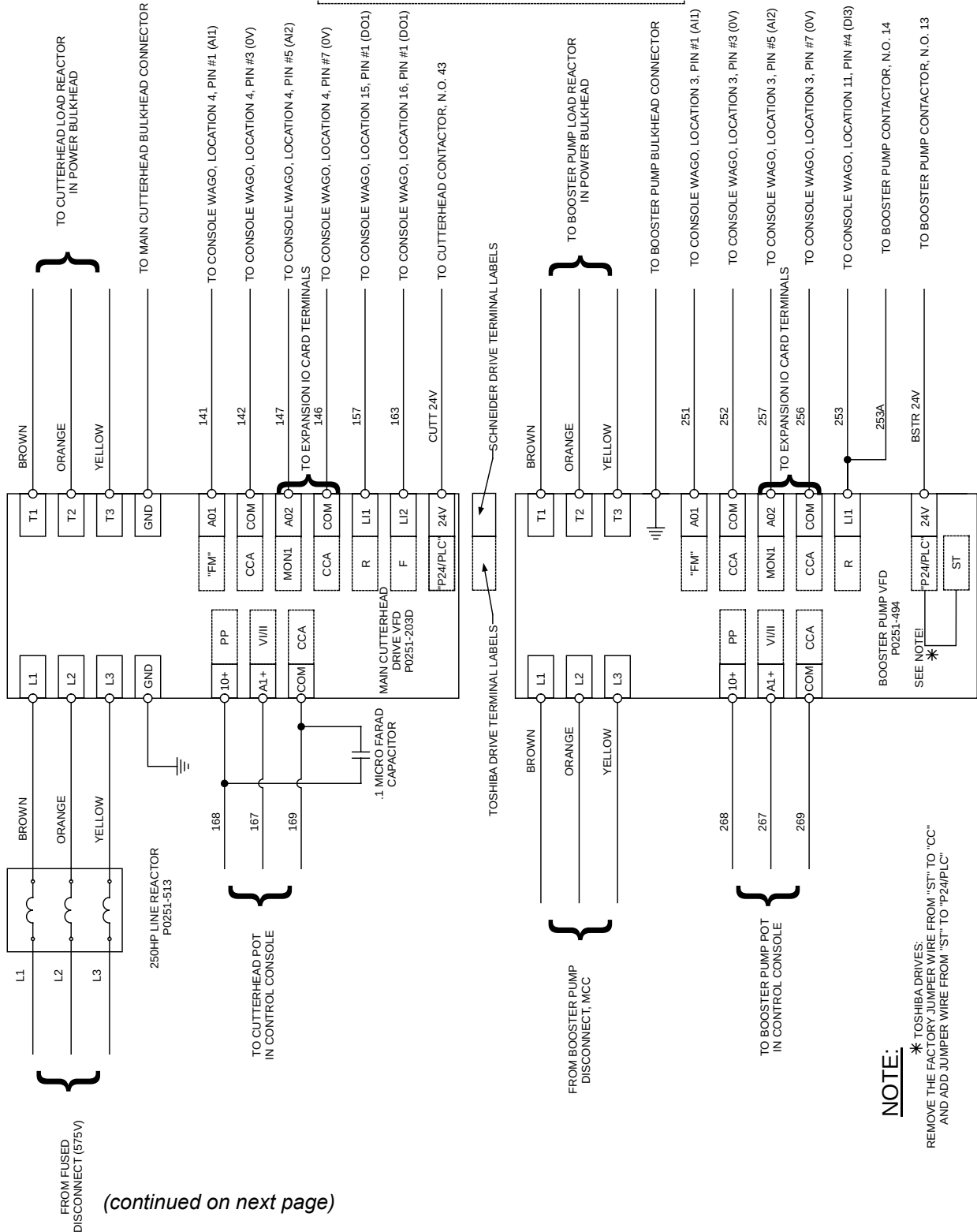


CONTROL CONTAINER TRANSFORMER ELECTRICAL SCHEMATIC



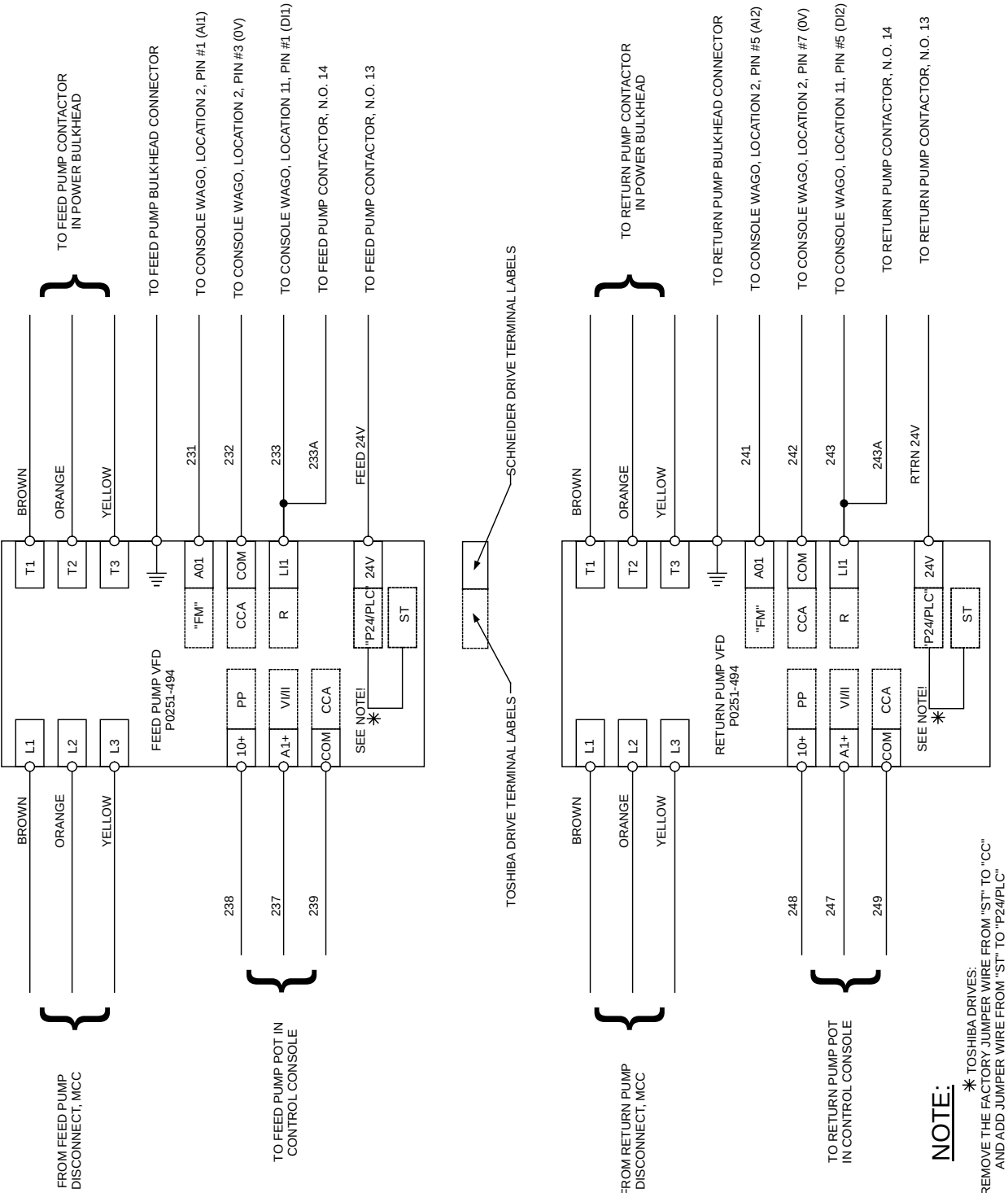
NOTES

CONTROL CONTAINER VFD ELECTRICAL SCHEMATICS

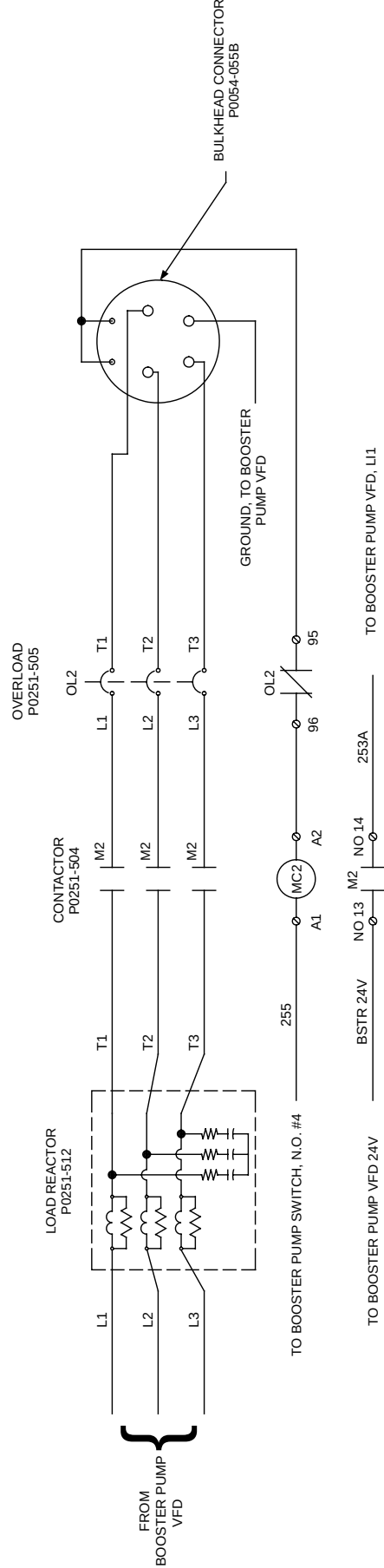
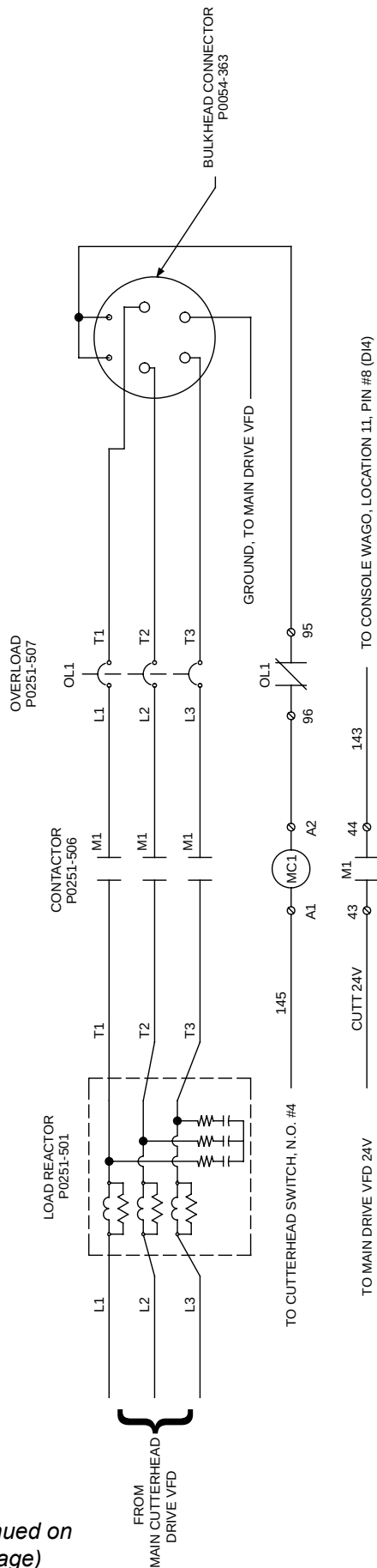


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Control Container VFD Electrical Schematics (continued)

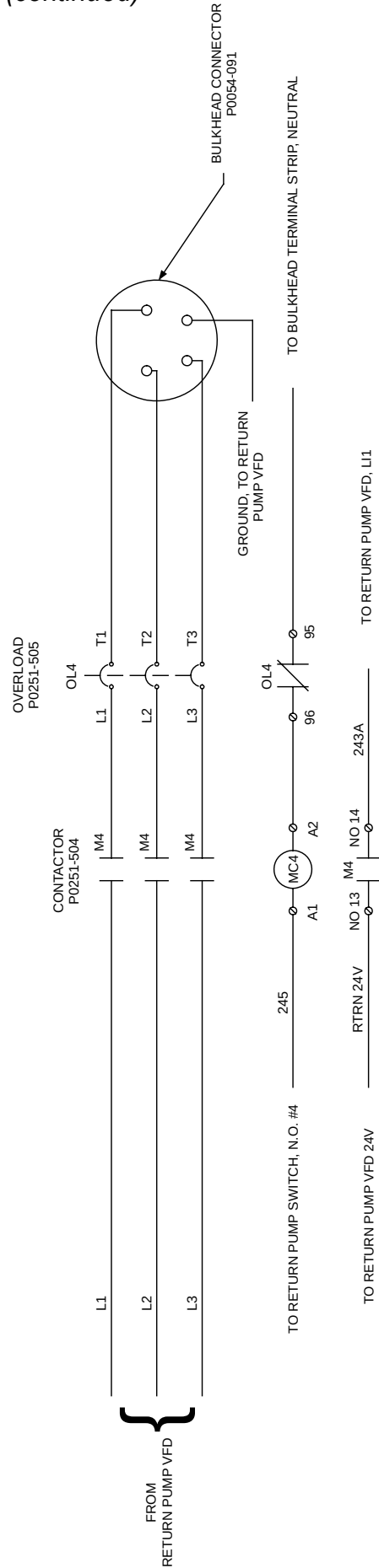
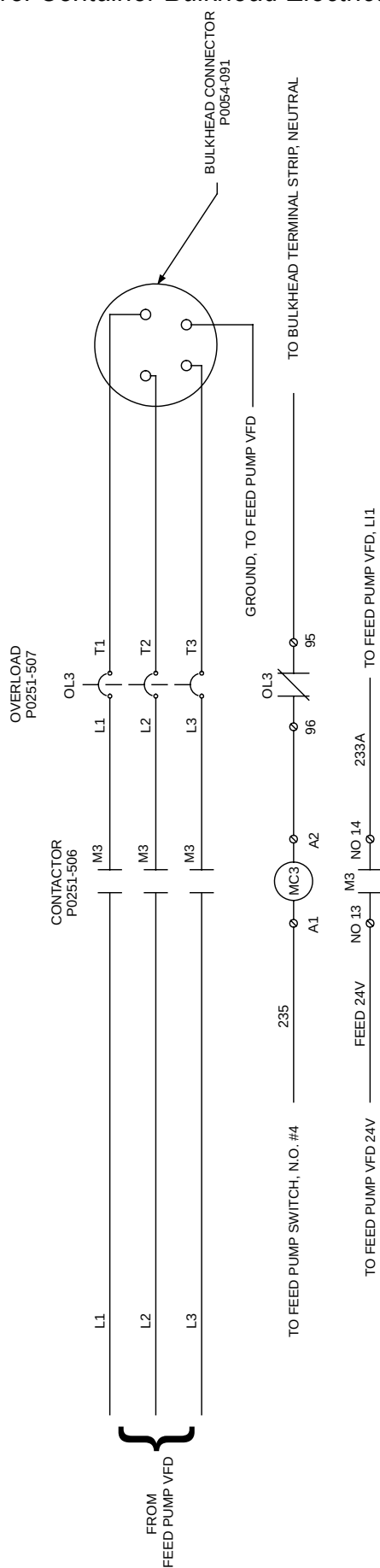


CONTROL CONTAINER BULKHEAD ELECTRICAL SCHEMATICS



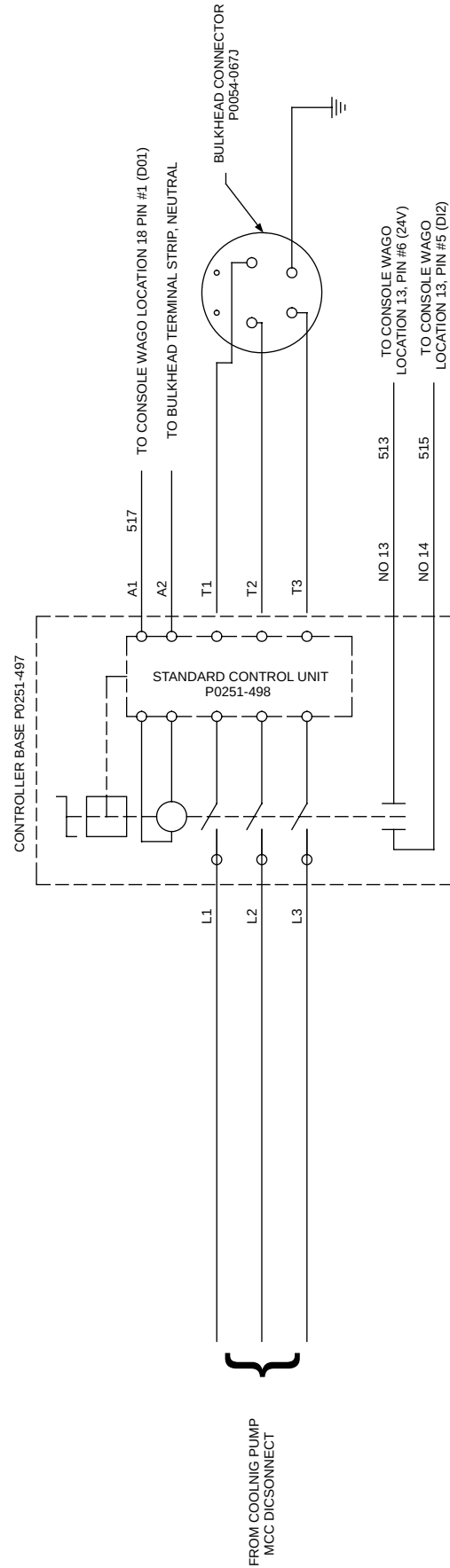
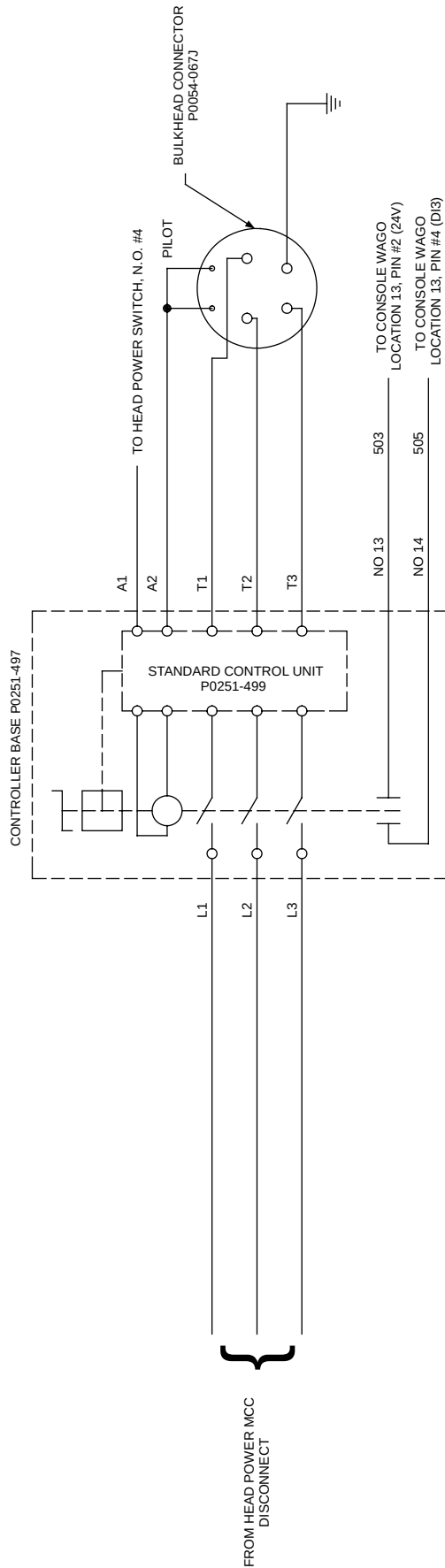
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Control Container Bulkhead Electrical Schematics (continued)

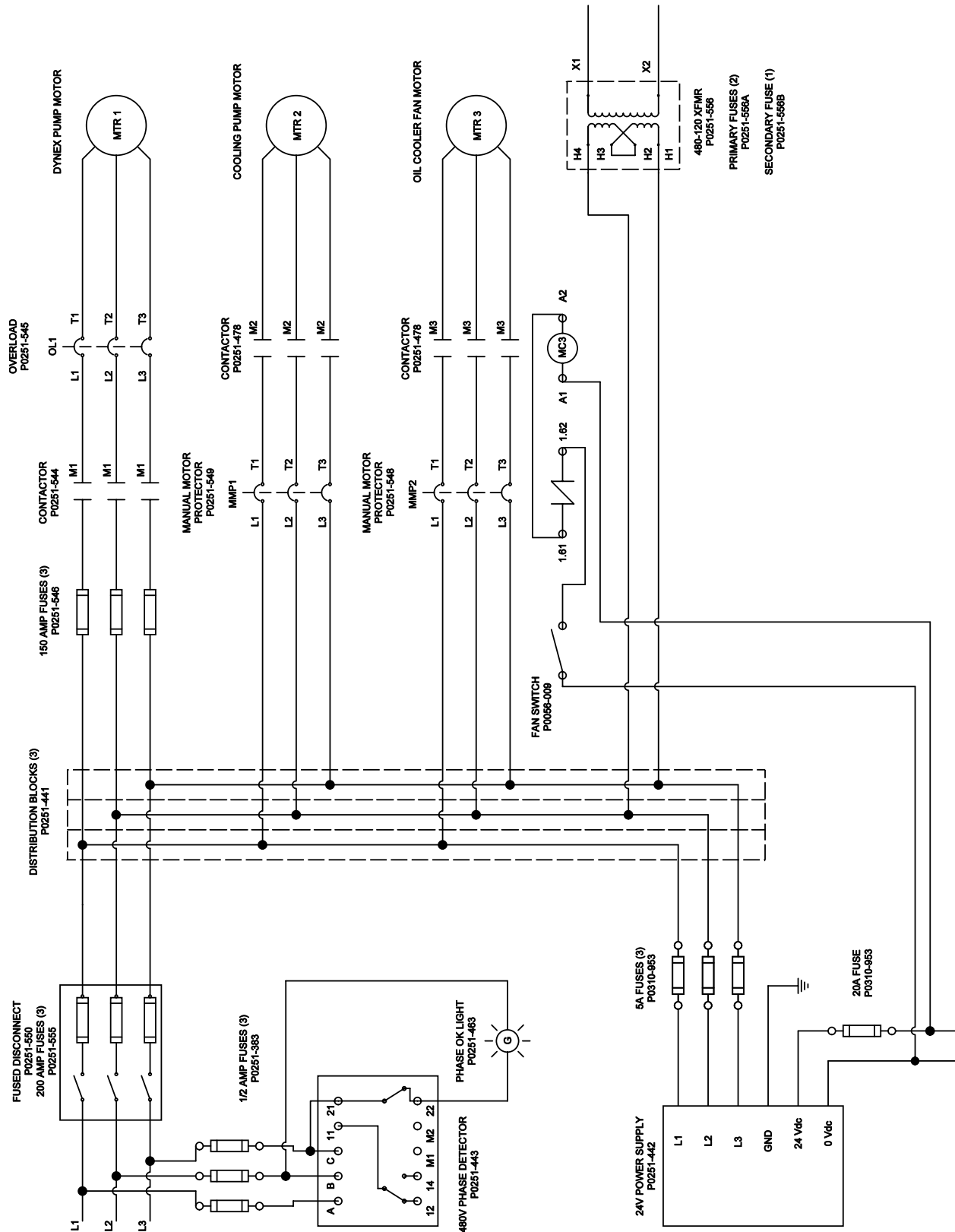


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Control Container Bulkhead Electrical Schematics (continued)

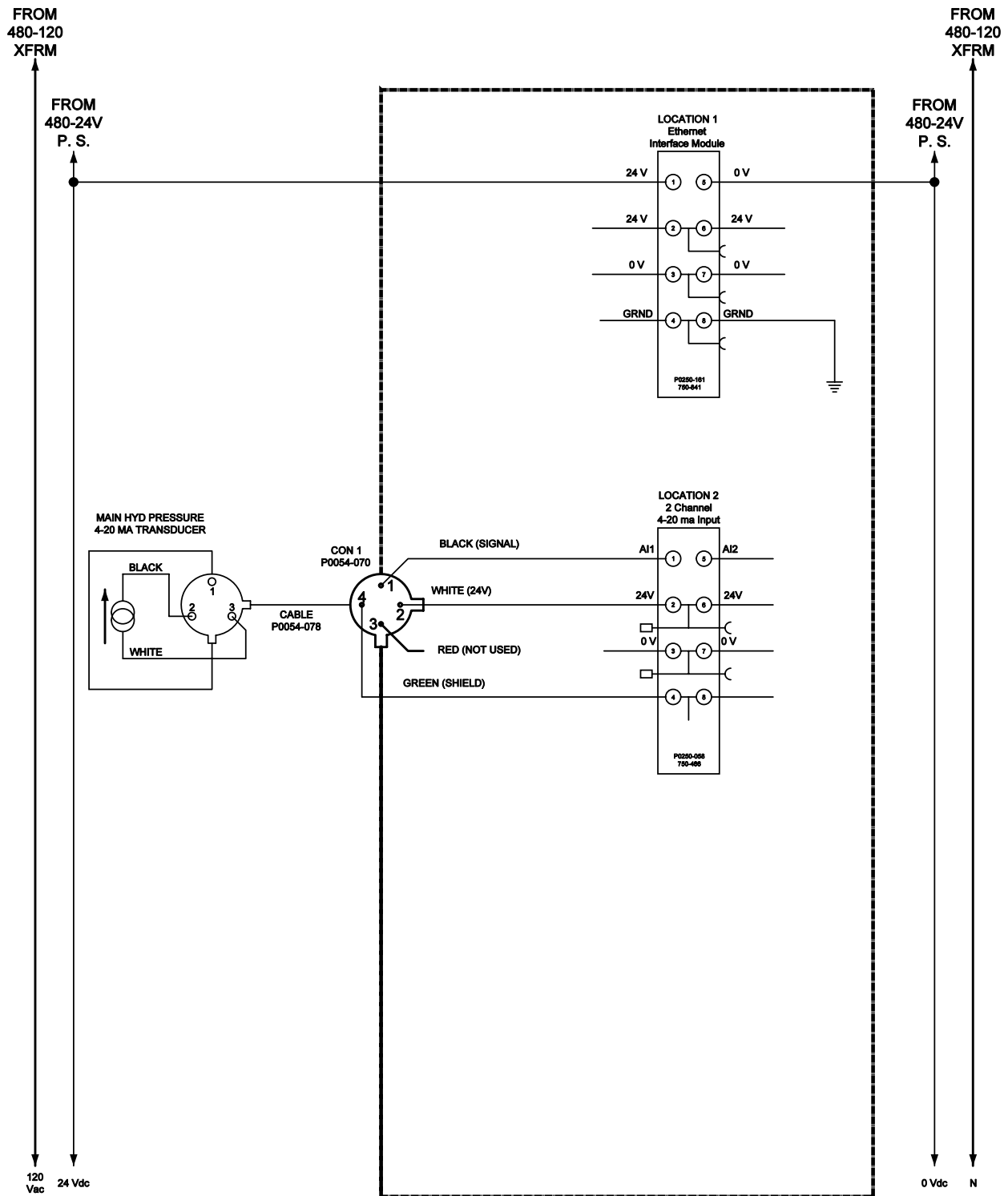


REMOTE HYDRAULIC POWER PACK ELECTRICAL SCHEMATICS



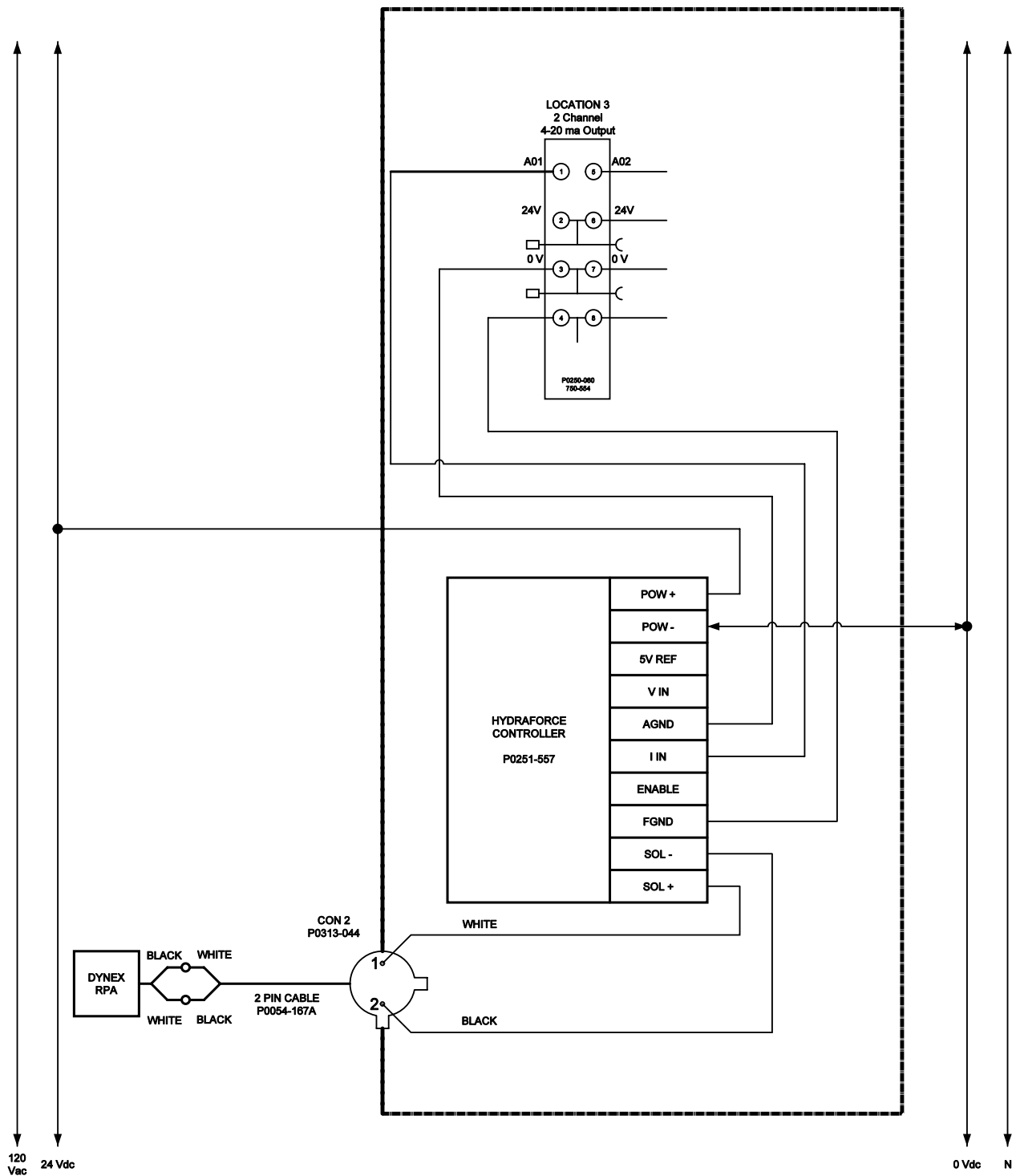
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Remote Hydraulic Power Pack Electrical Schematics (continued)



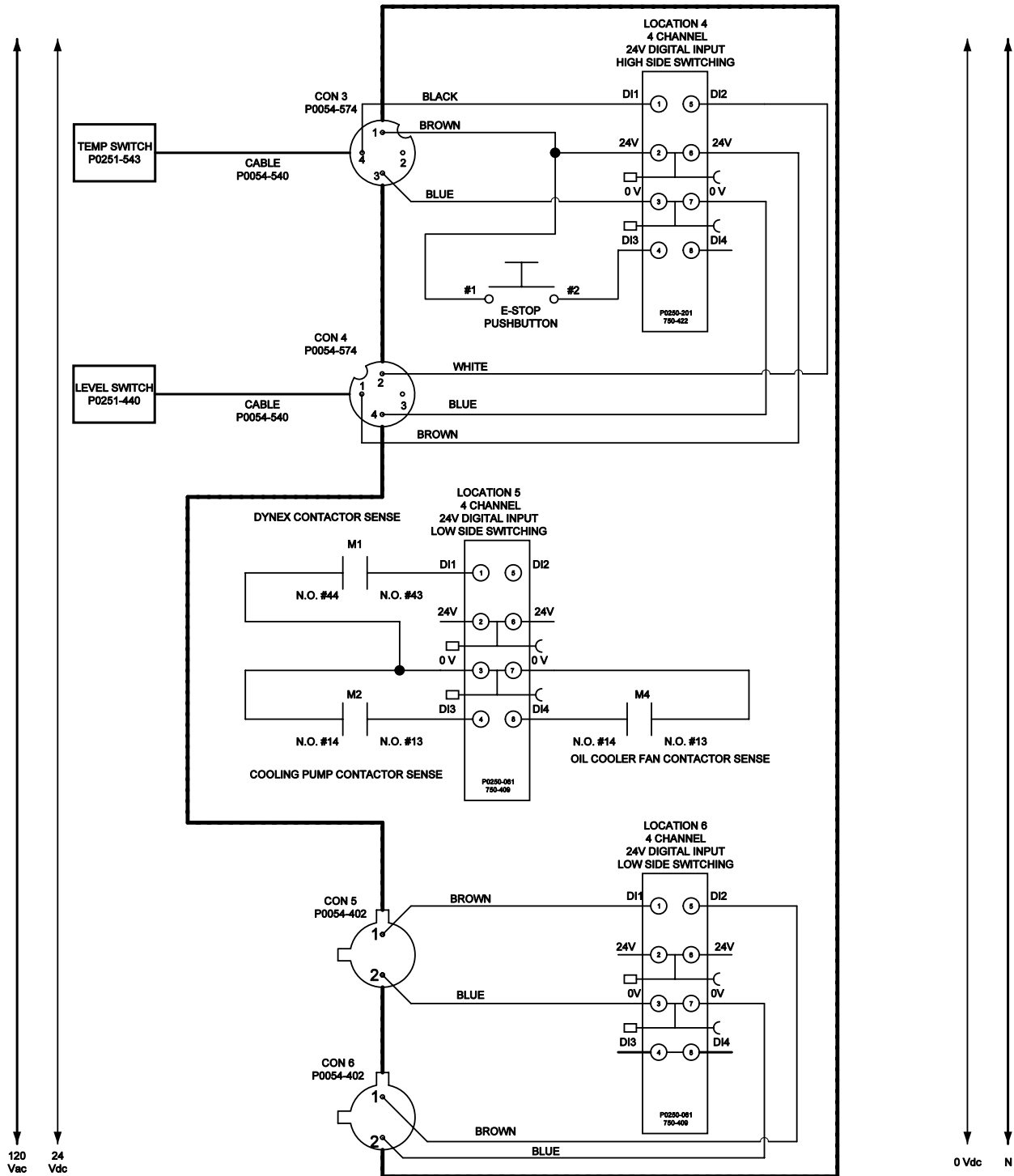
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Remote Hydraulic Power Pack Electrical Schematics (continued)



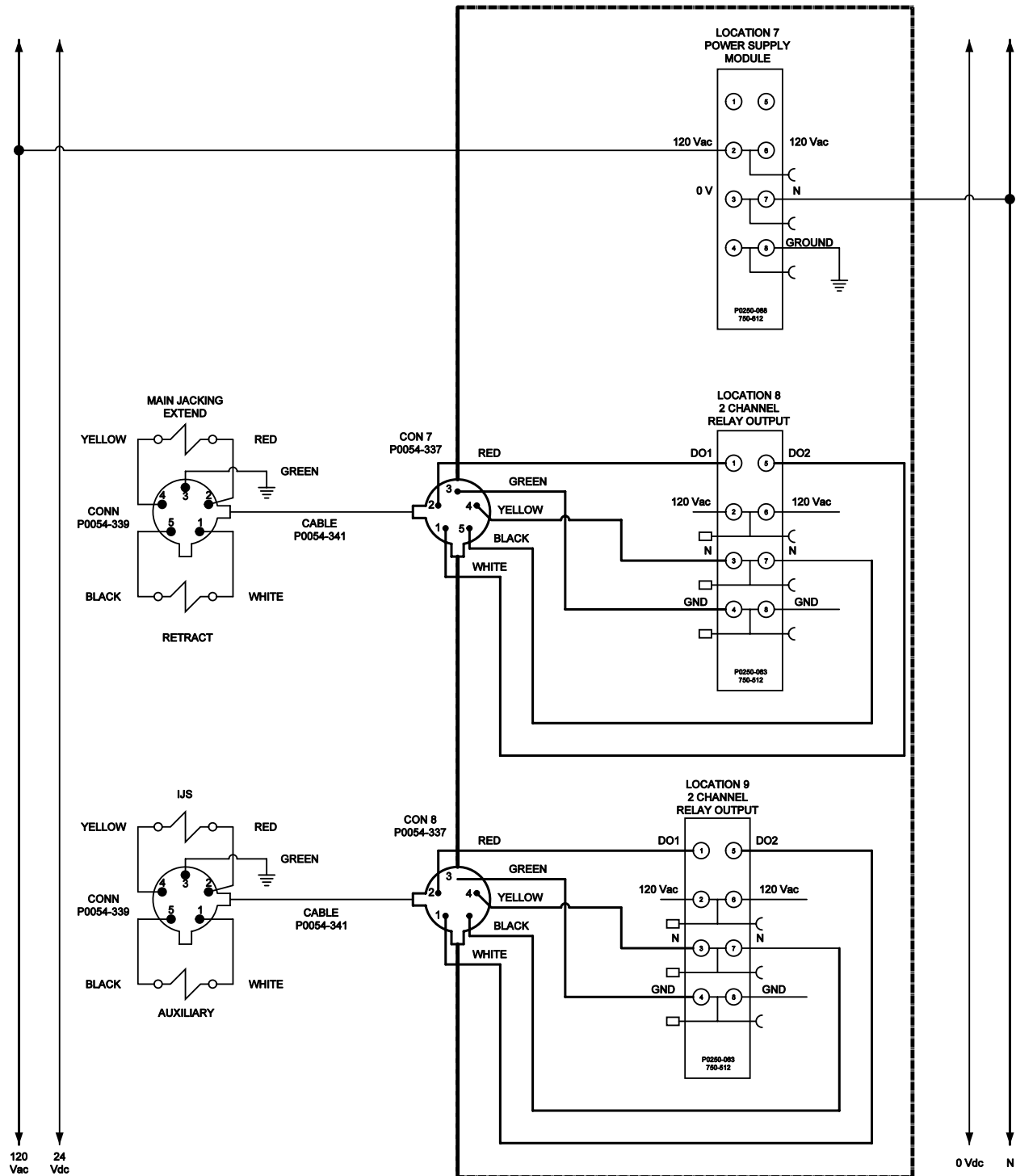
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Remote Hydraulic Power Pack Electrical Schematics (continued)



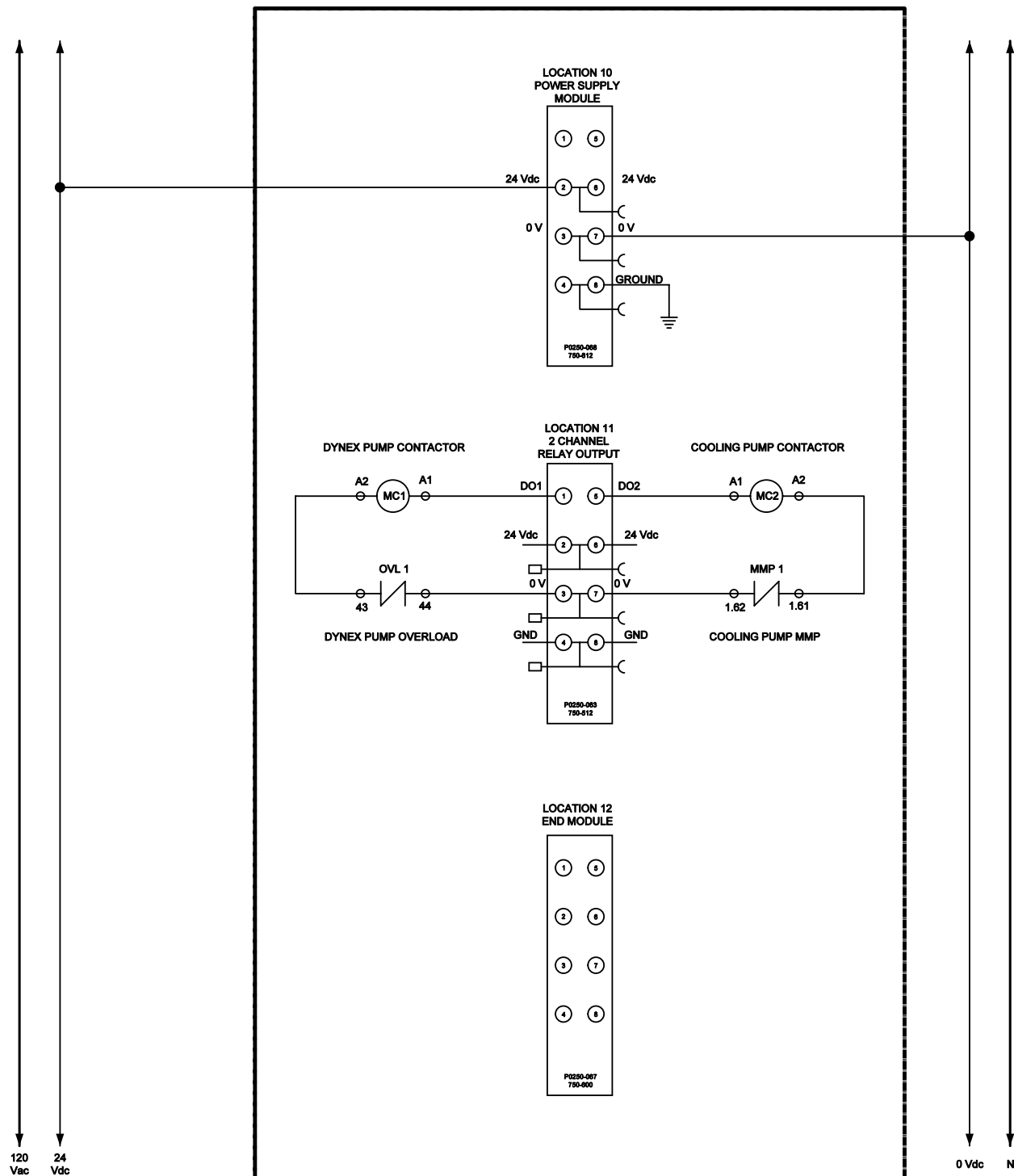
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Remote Hydraulic Power Pack Electrical Schematics (continued)

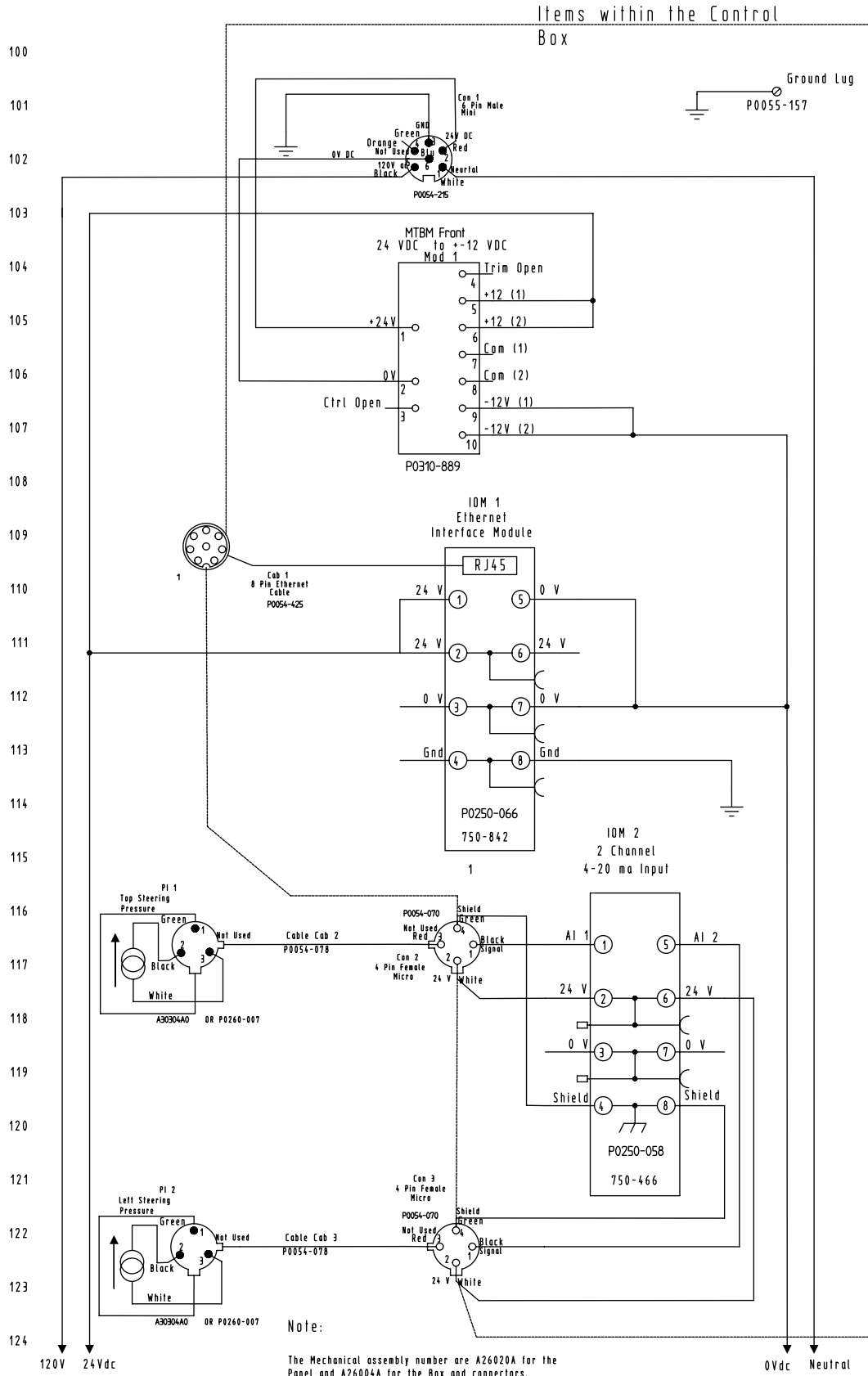


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Remote Hydraulic Power Pack Electrical Schematics (continued)

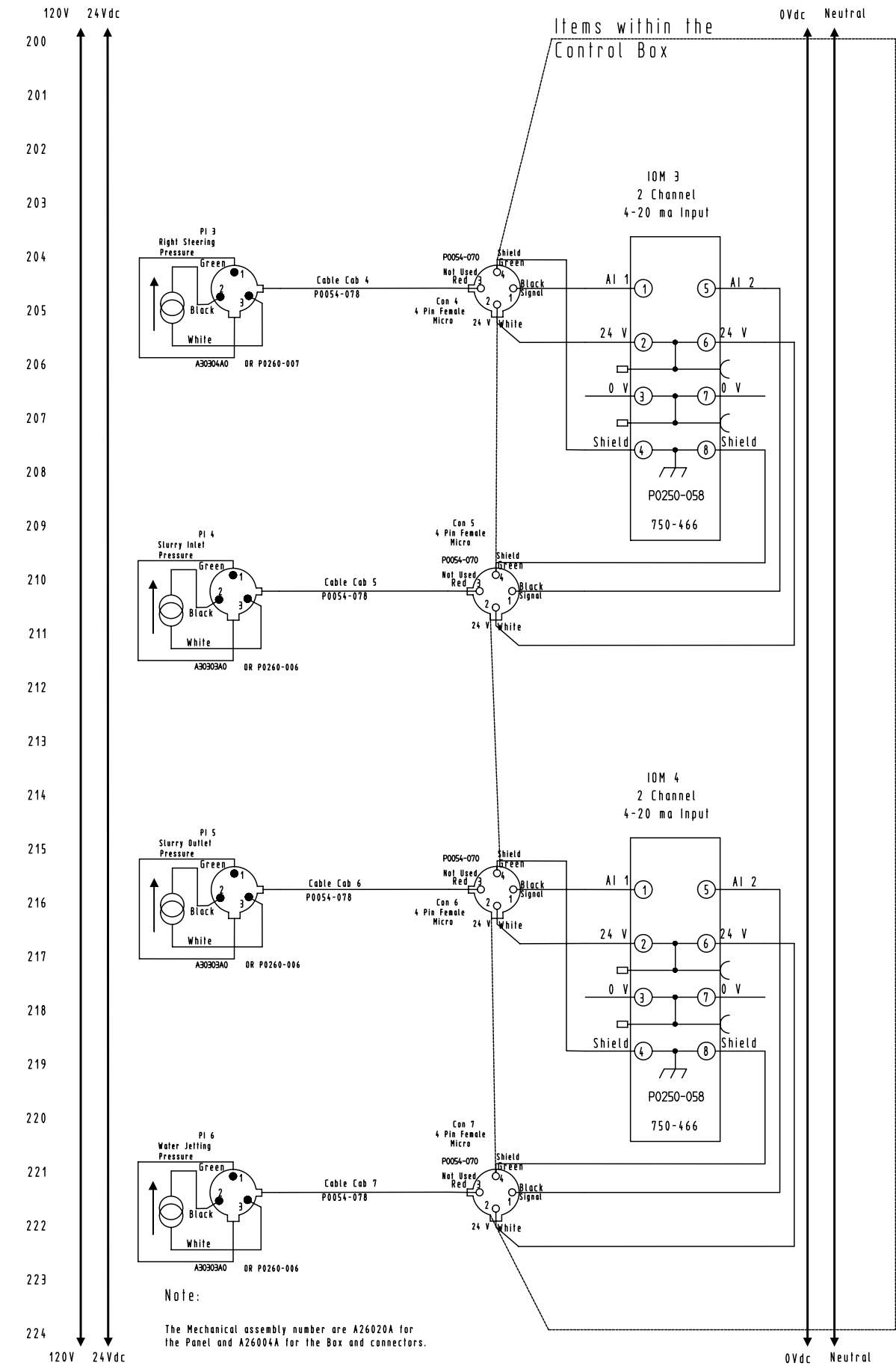


MTBM FRONT SECTION CONTROL BOX ELECTRICAL SCHEMATICS



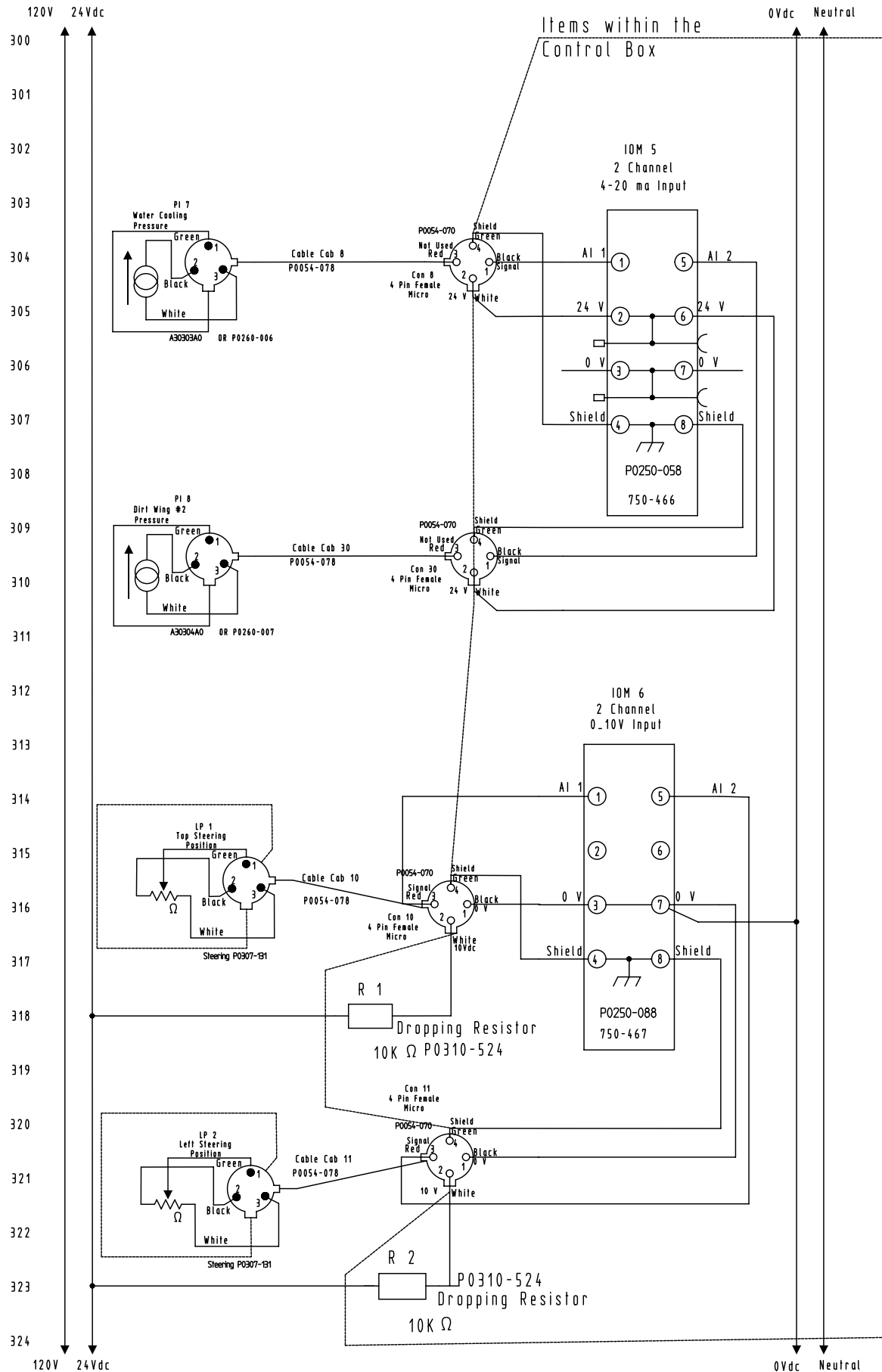
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MTBM Front Section Control Box Electrical Schematics (continued)



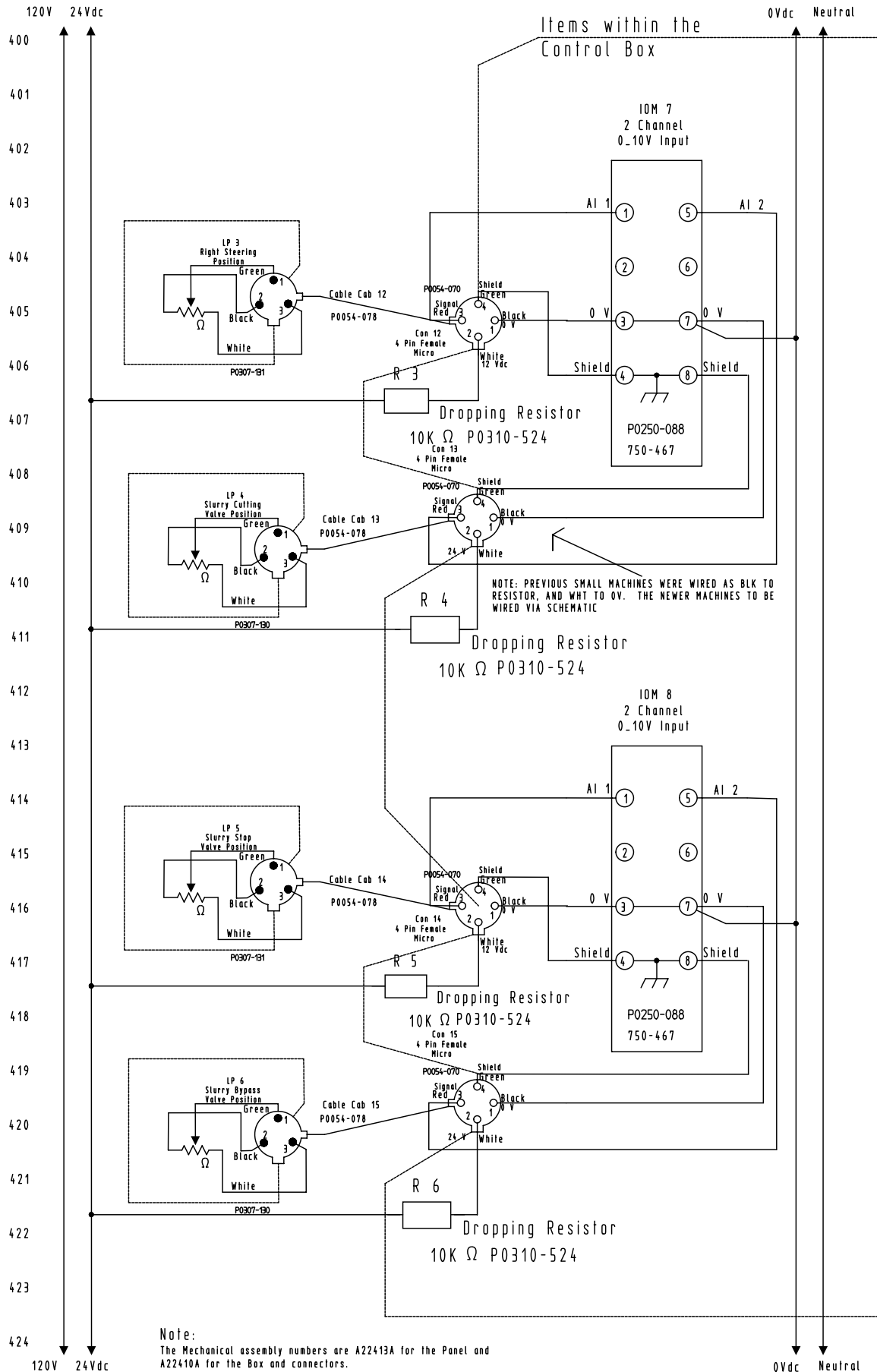
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MTBM Front Section Control Box Electrical Schematics (continued)



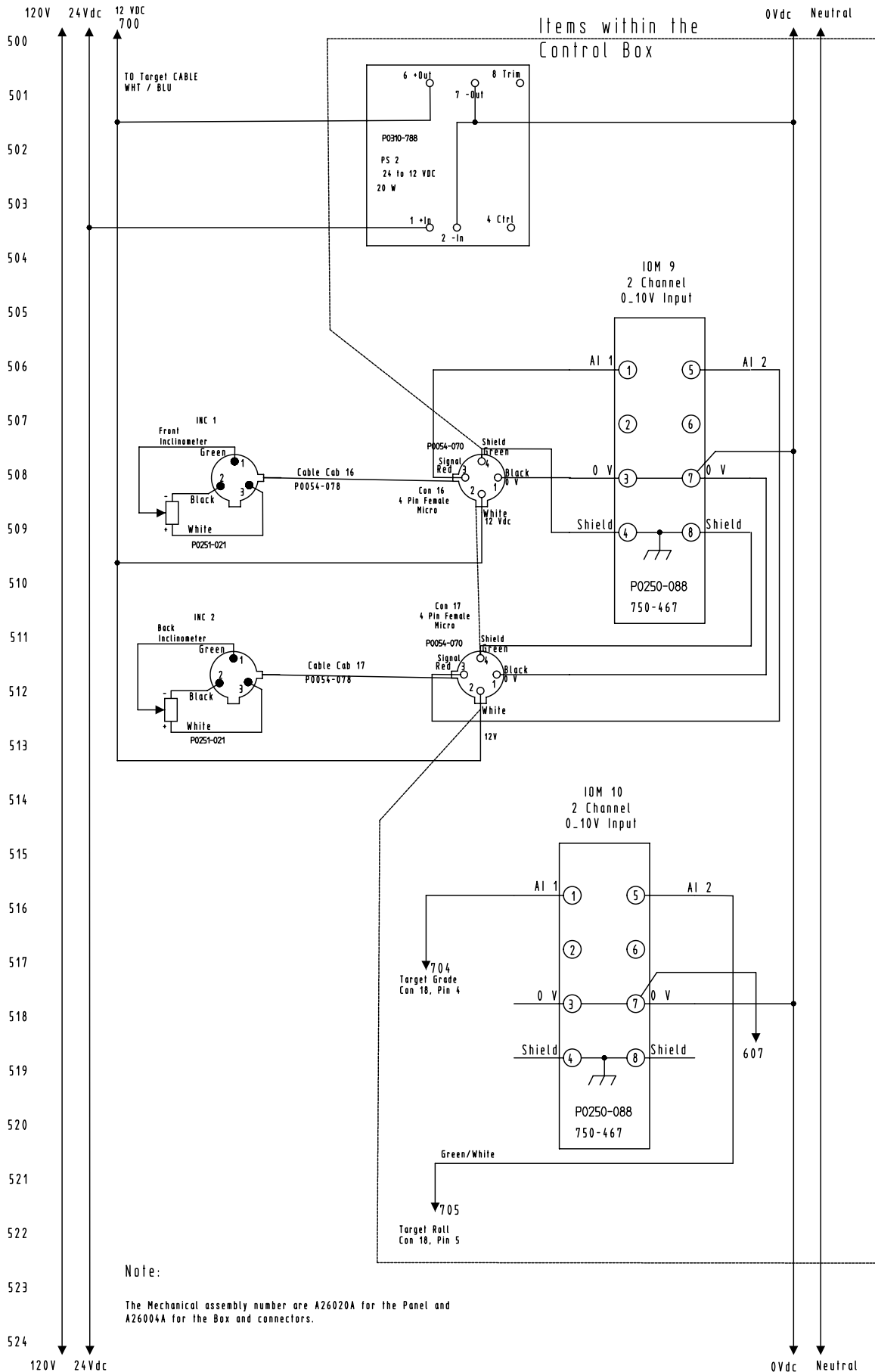
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MTBM Front Section Control Box Electrical Schematics (continued)



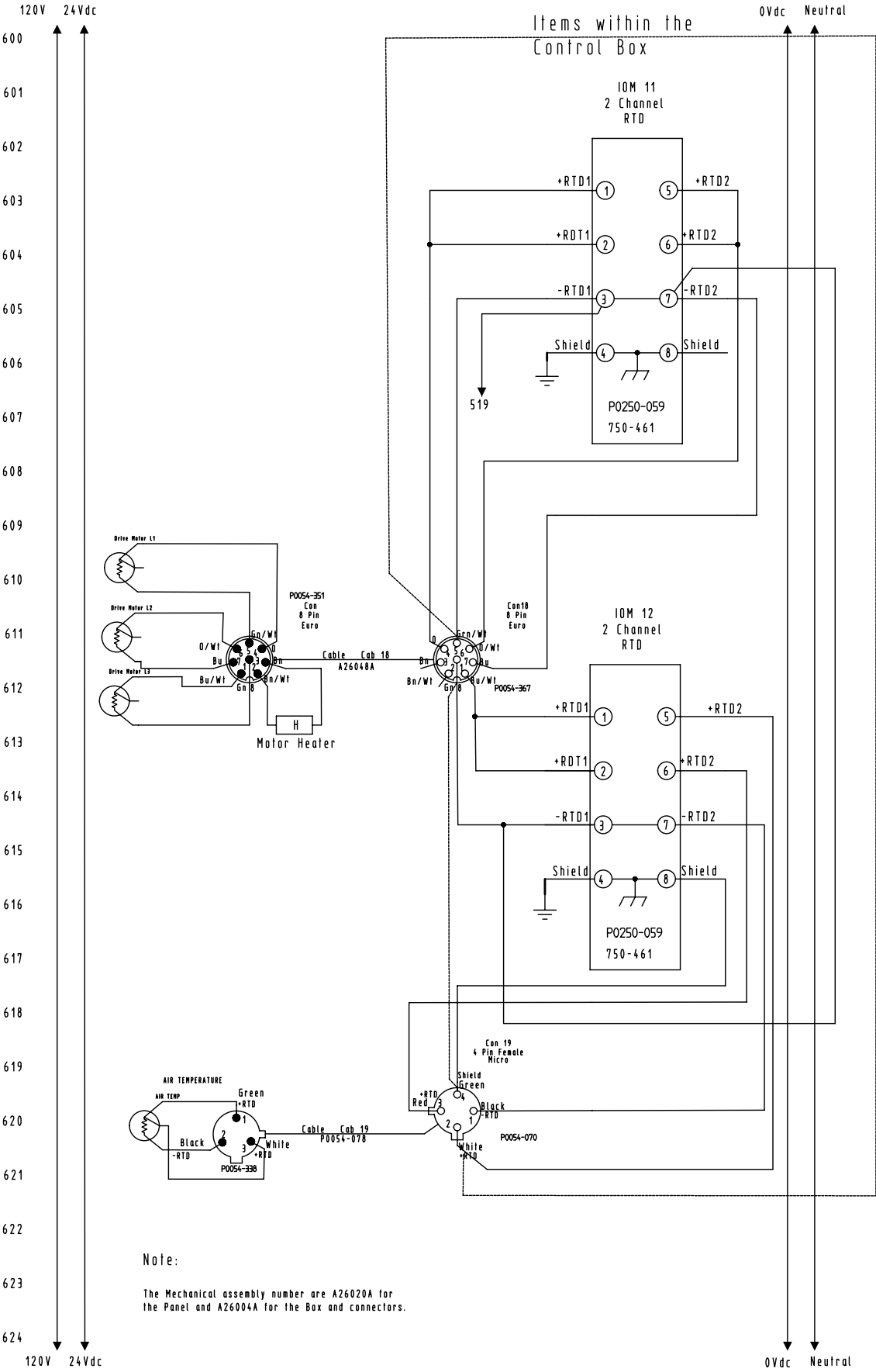
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MTBM Front Section Control Box Electrical Schematics (continued)



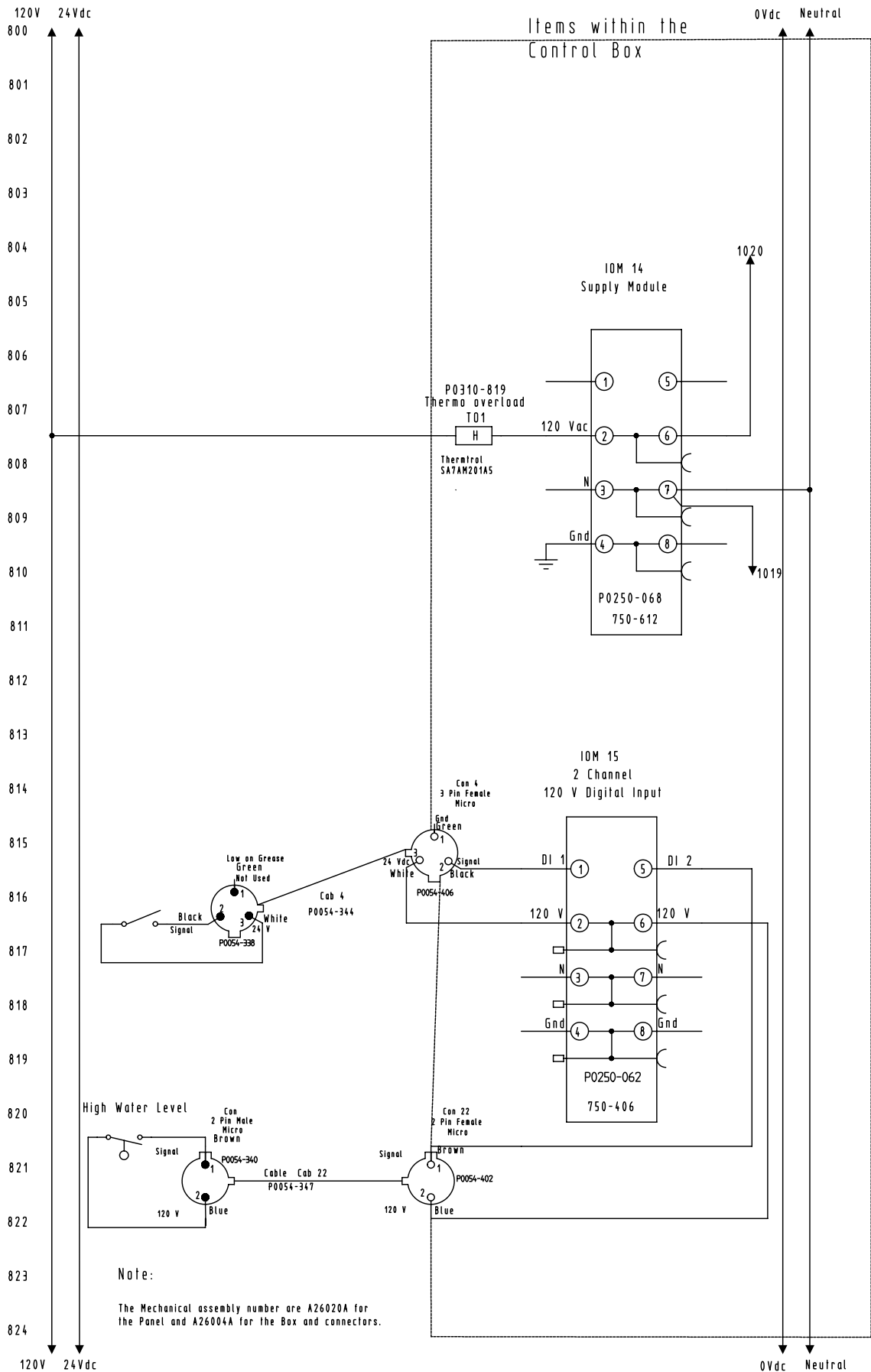
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MTBM Front Section Control Box Electrical Schematics (continued)



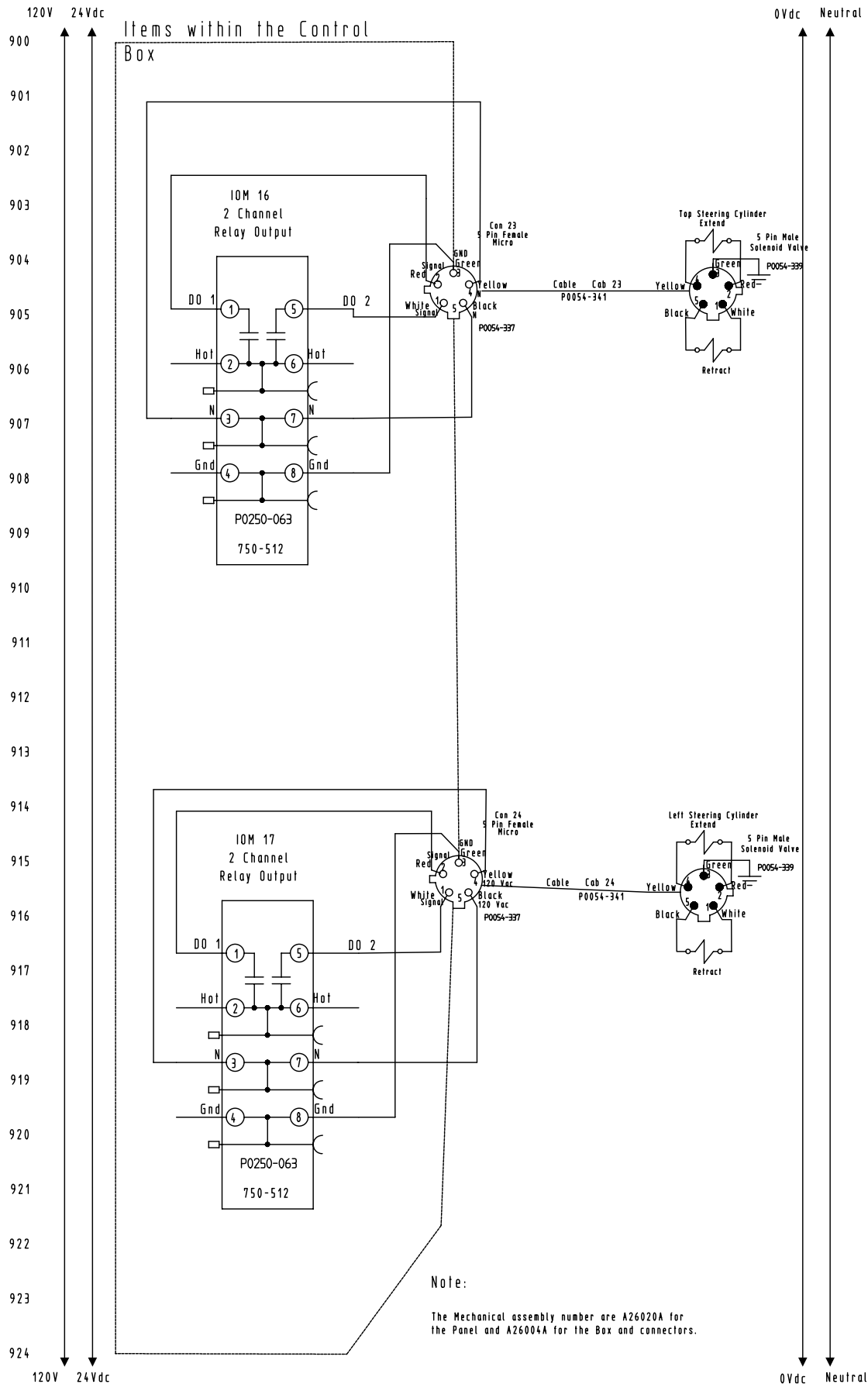
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MTBM Front Section Control Box Electrical Schematics (continued)



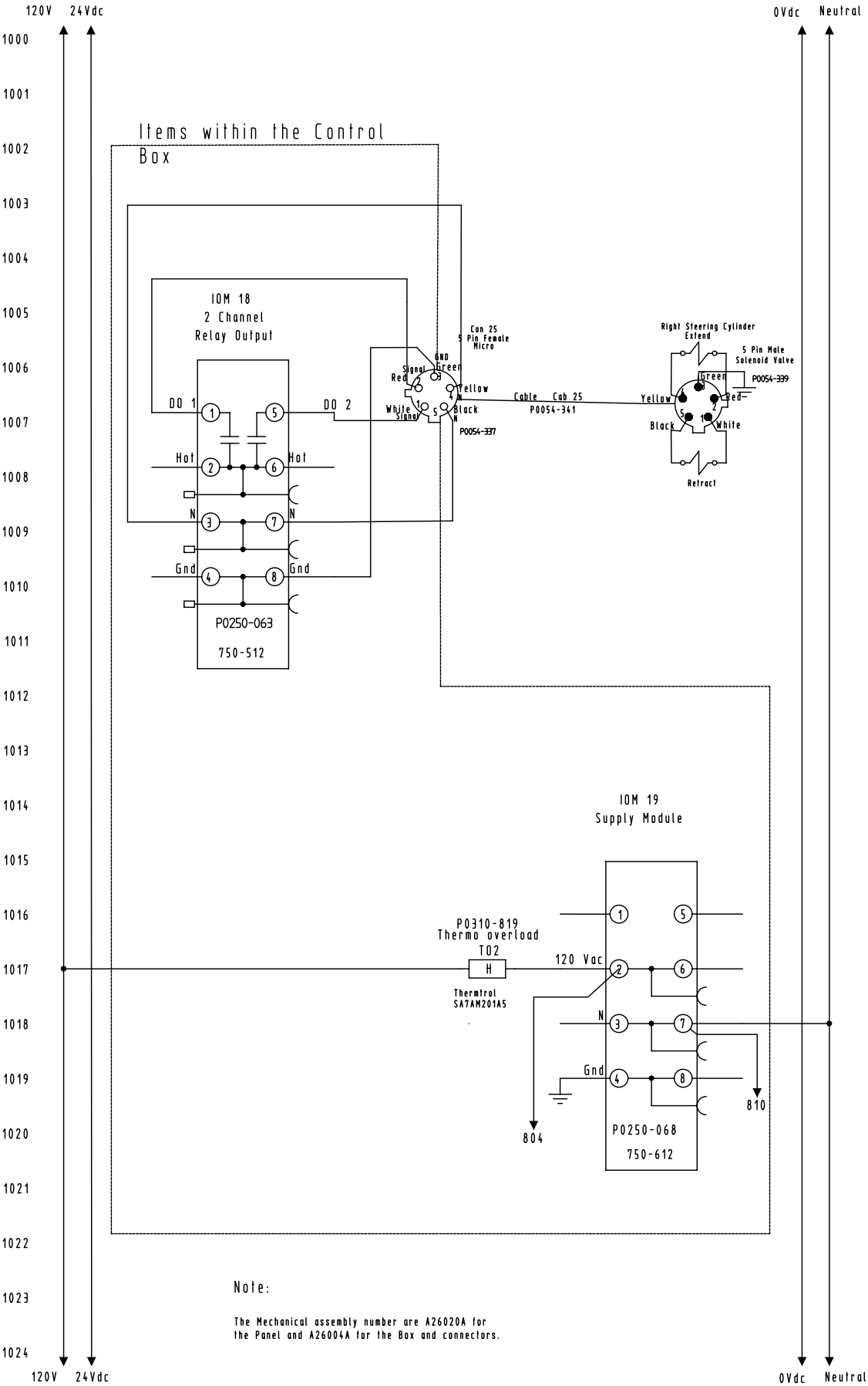
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MTBM Front Section Control Box Electrical Schematics (continued)



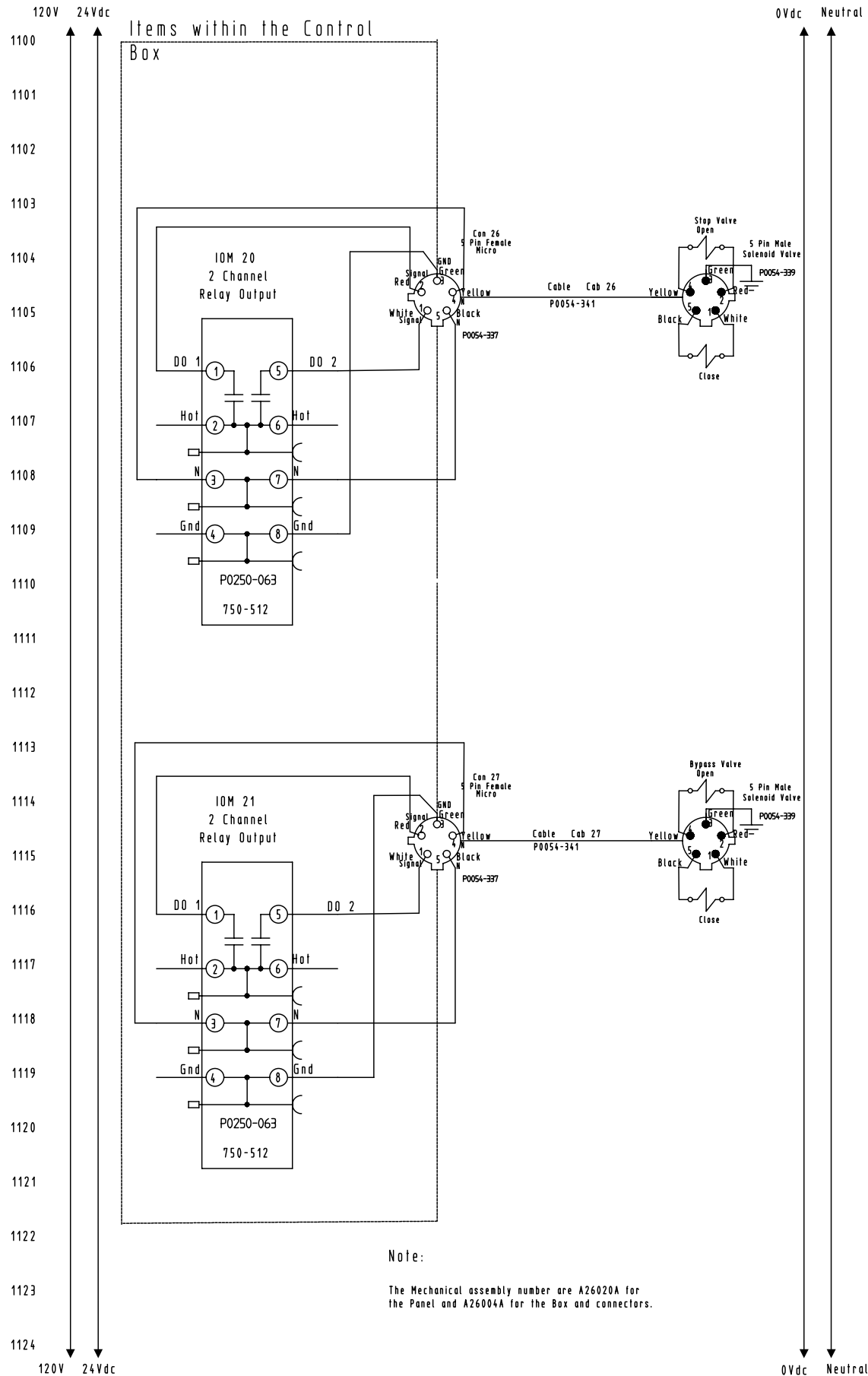
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MTBM Front Section Control Box Electrical Schematics (continued)



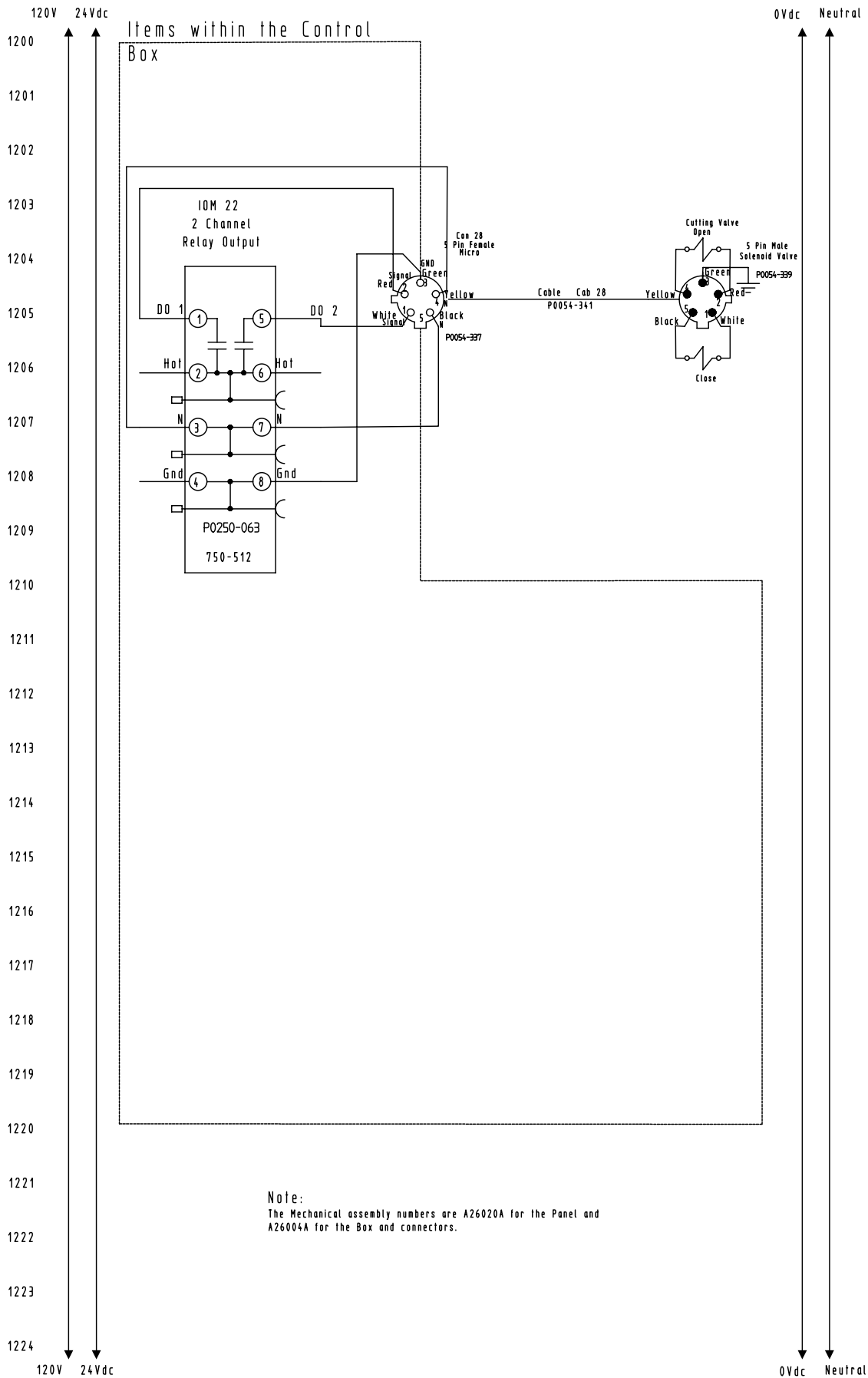
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MTBM Front Section Control Box Electrical Schematics (continued)



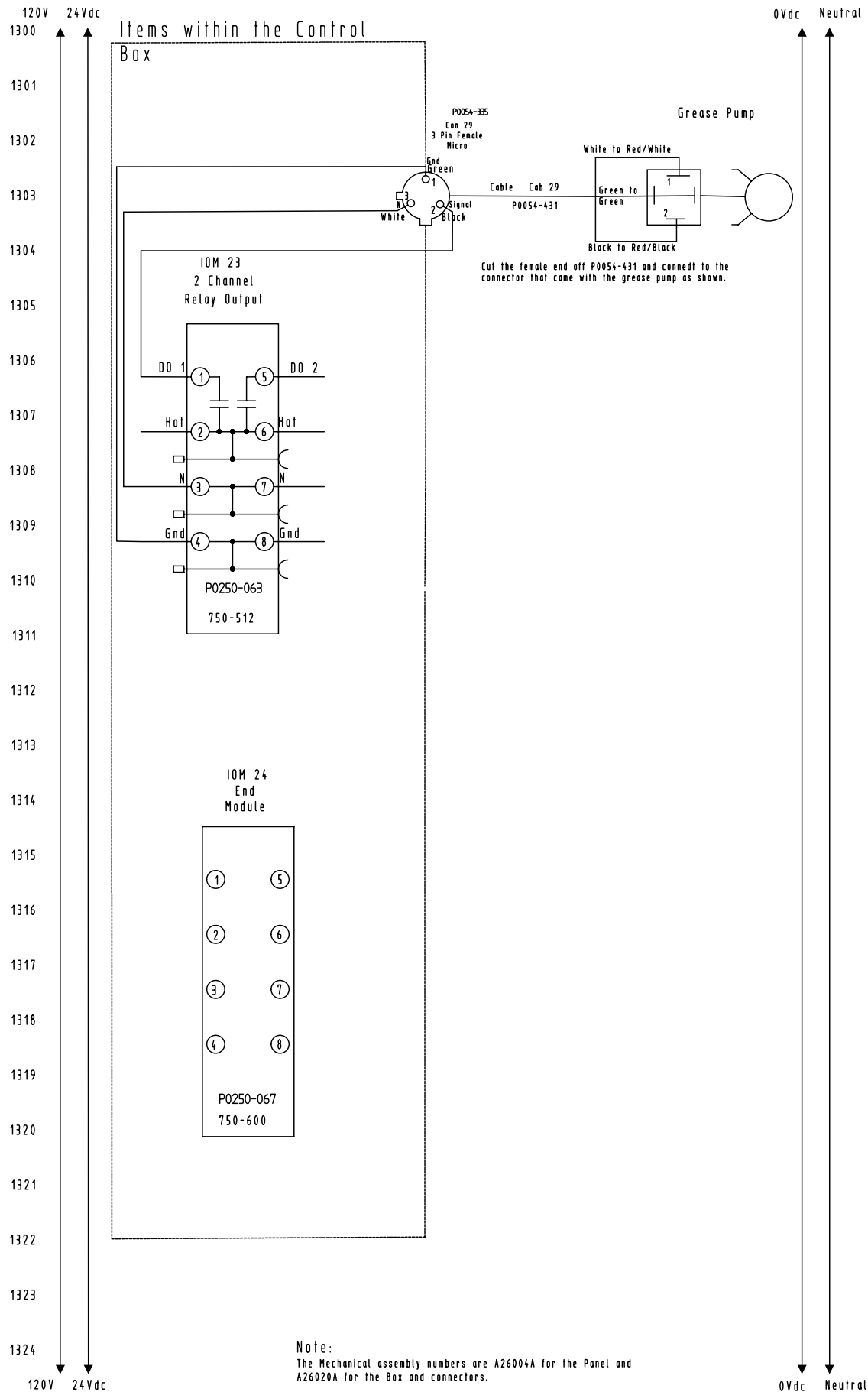
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MTBM Front Section Control Box Electrical Schematics (continued)

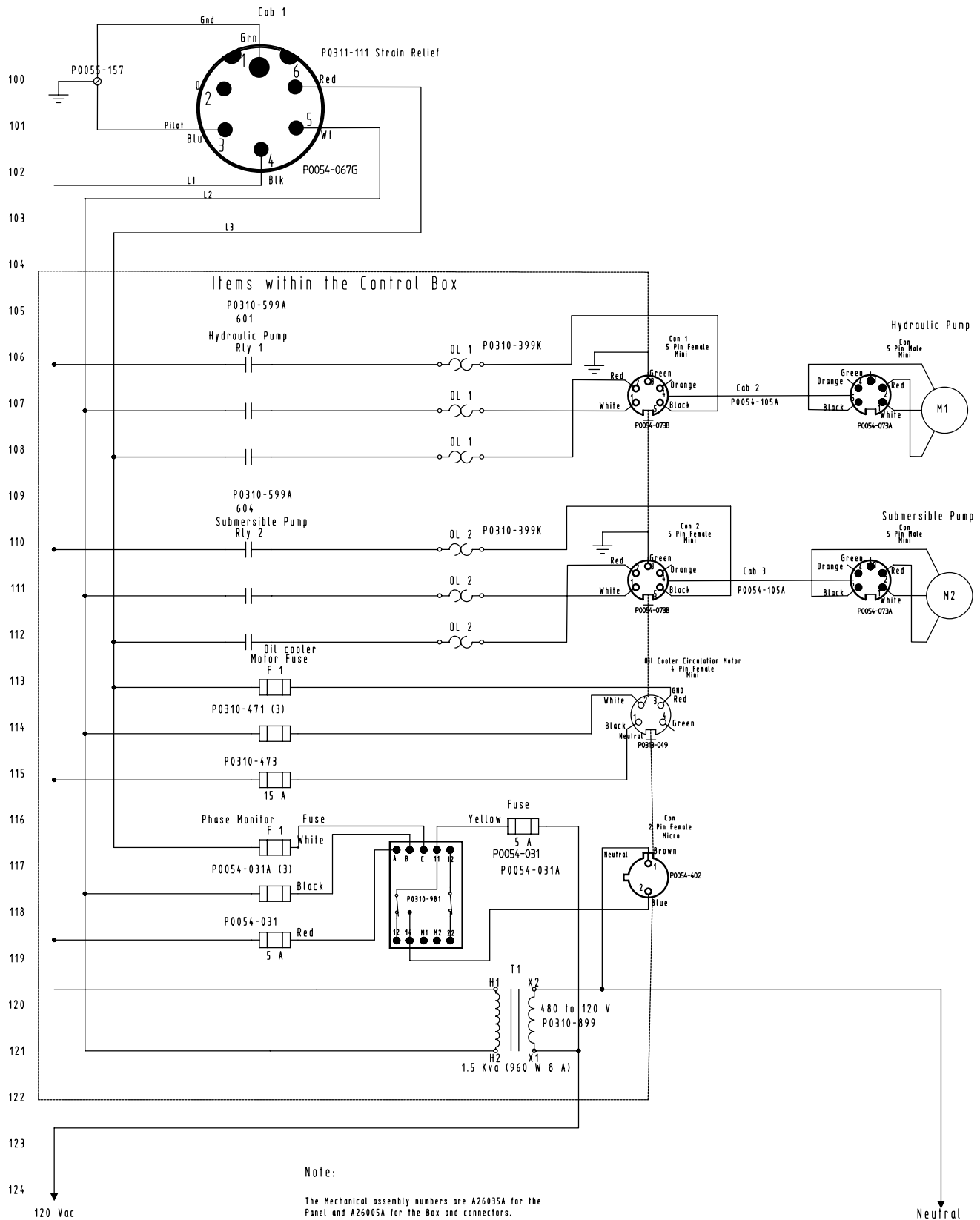


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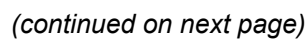
MTBM Front Section Control Box Electrical Schematics (continued)



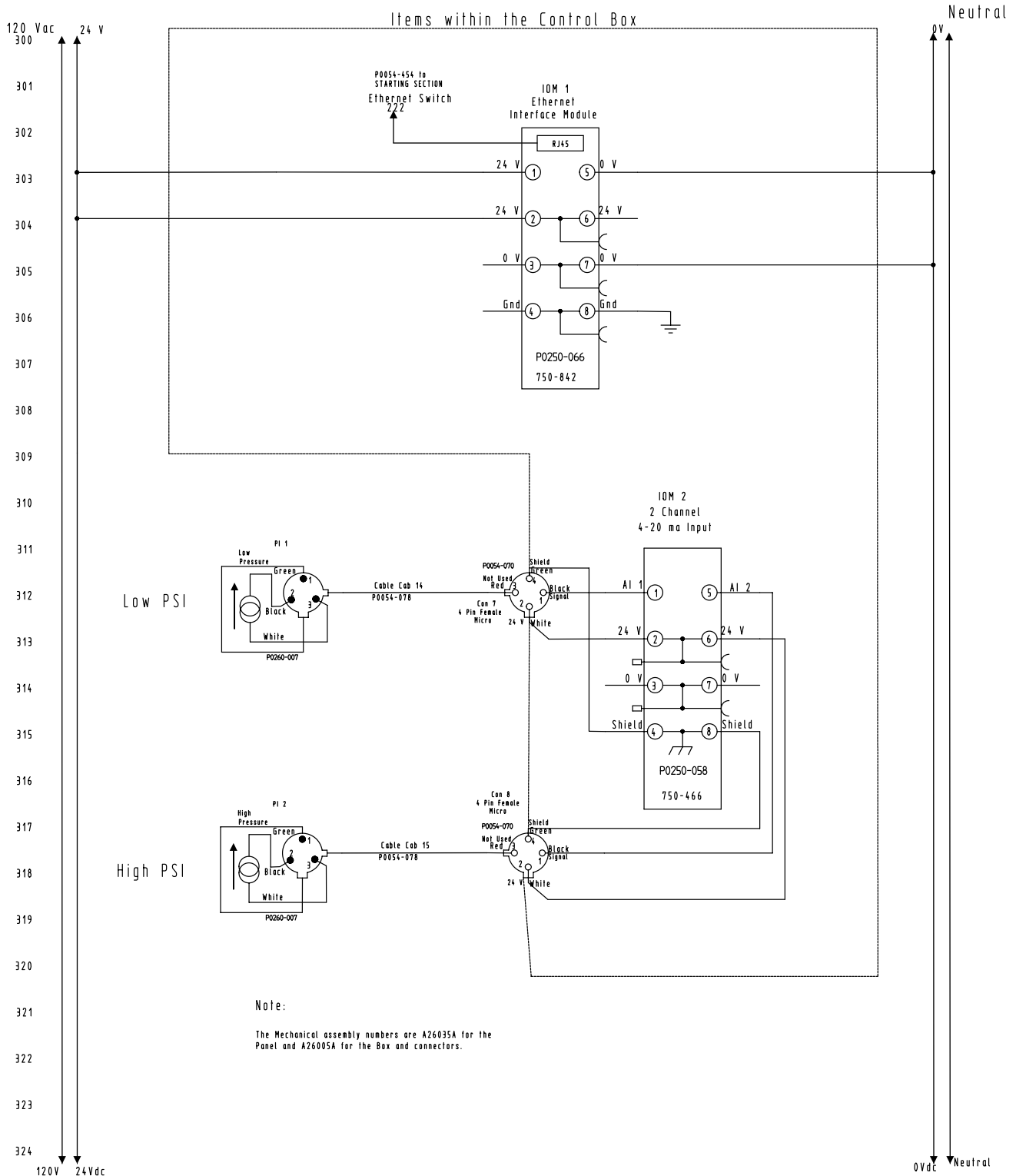
MTBM MID SECTION CONTROL BOX ELECTRICAL SCHEMATICS



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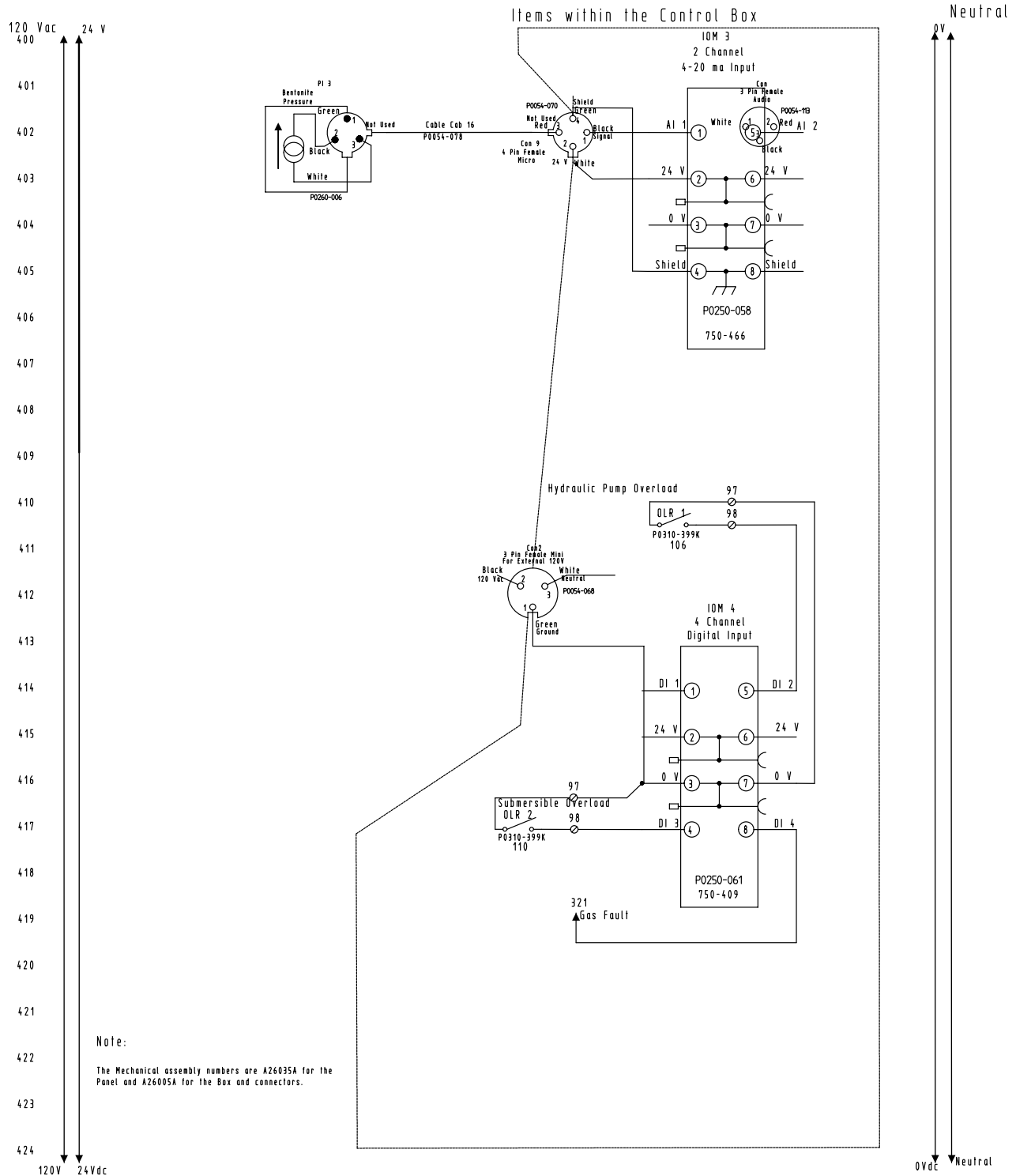


MTBM Mid Section Control Box Electrical Schematics (continued)



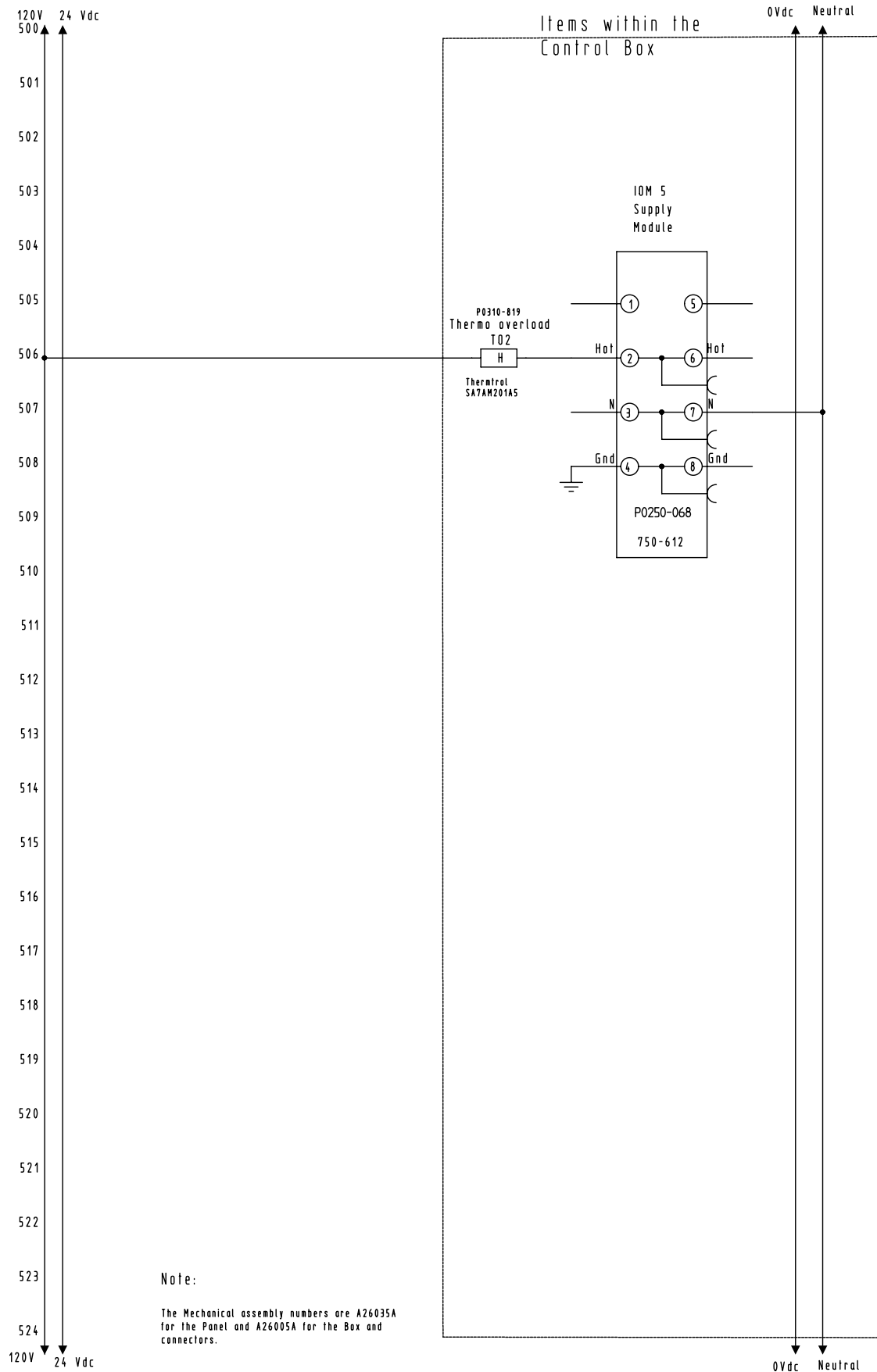
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MTBM Mid Section Control Box Electrical Schematics (continued)



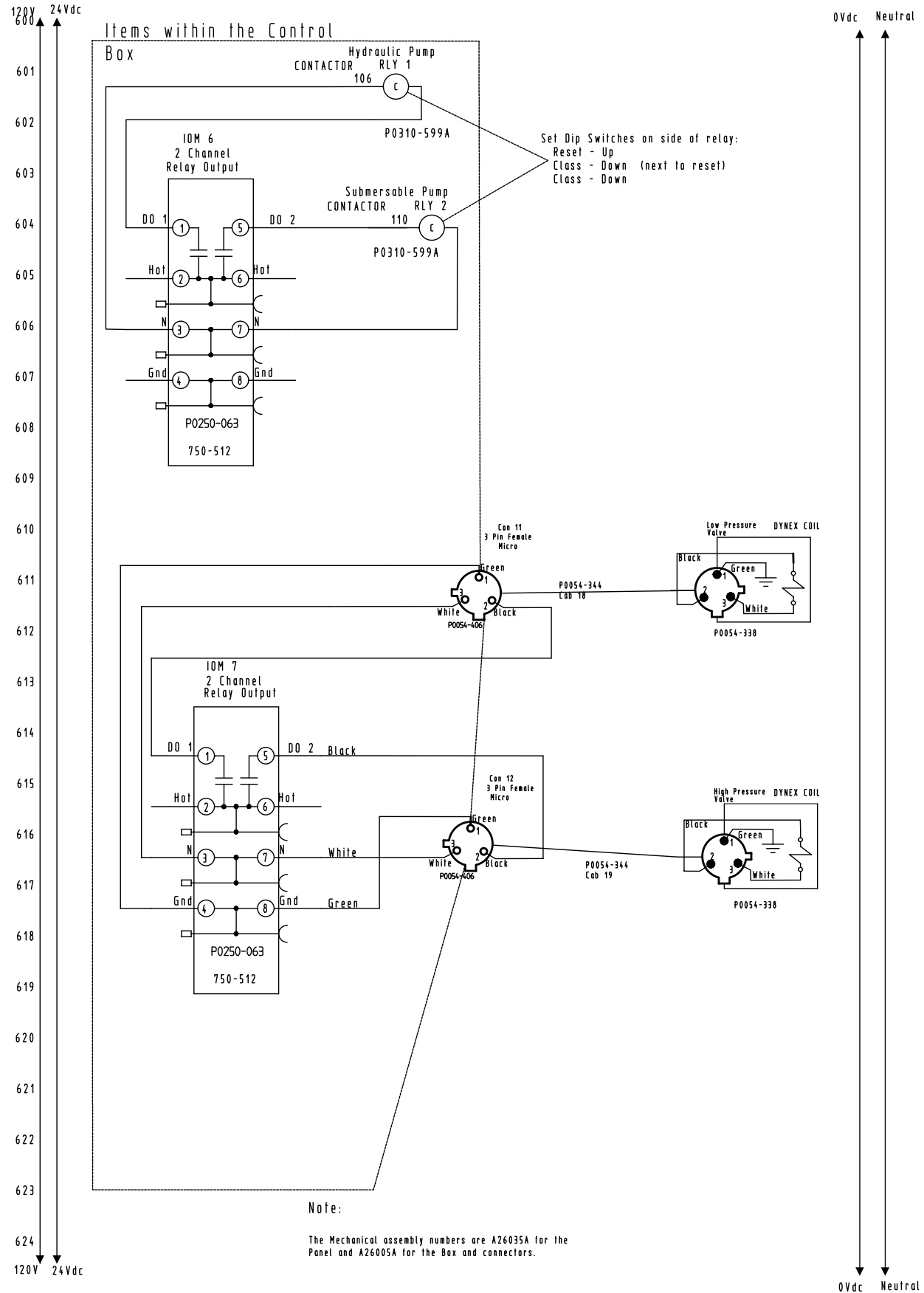
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MTBM Mid Section Control Box Electrical Schematics (continued)



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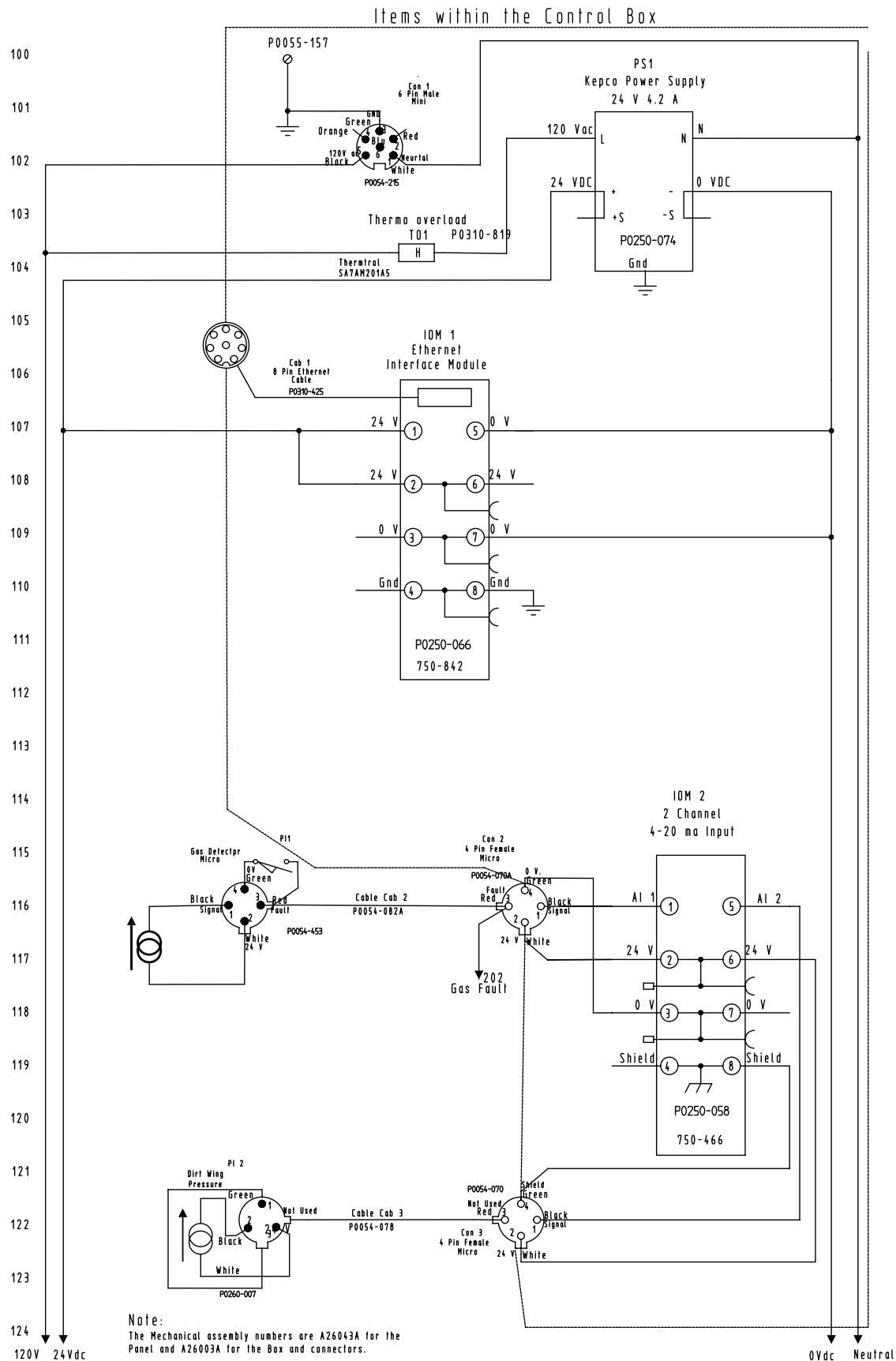
MTBM Mid Section Control Box Electrical Schematics (continued)



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MTBM TRAILING SECTION CONTROL BOX ELECTRICAL SCHEMATICS

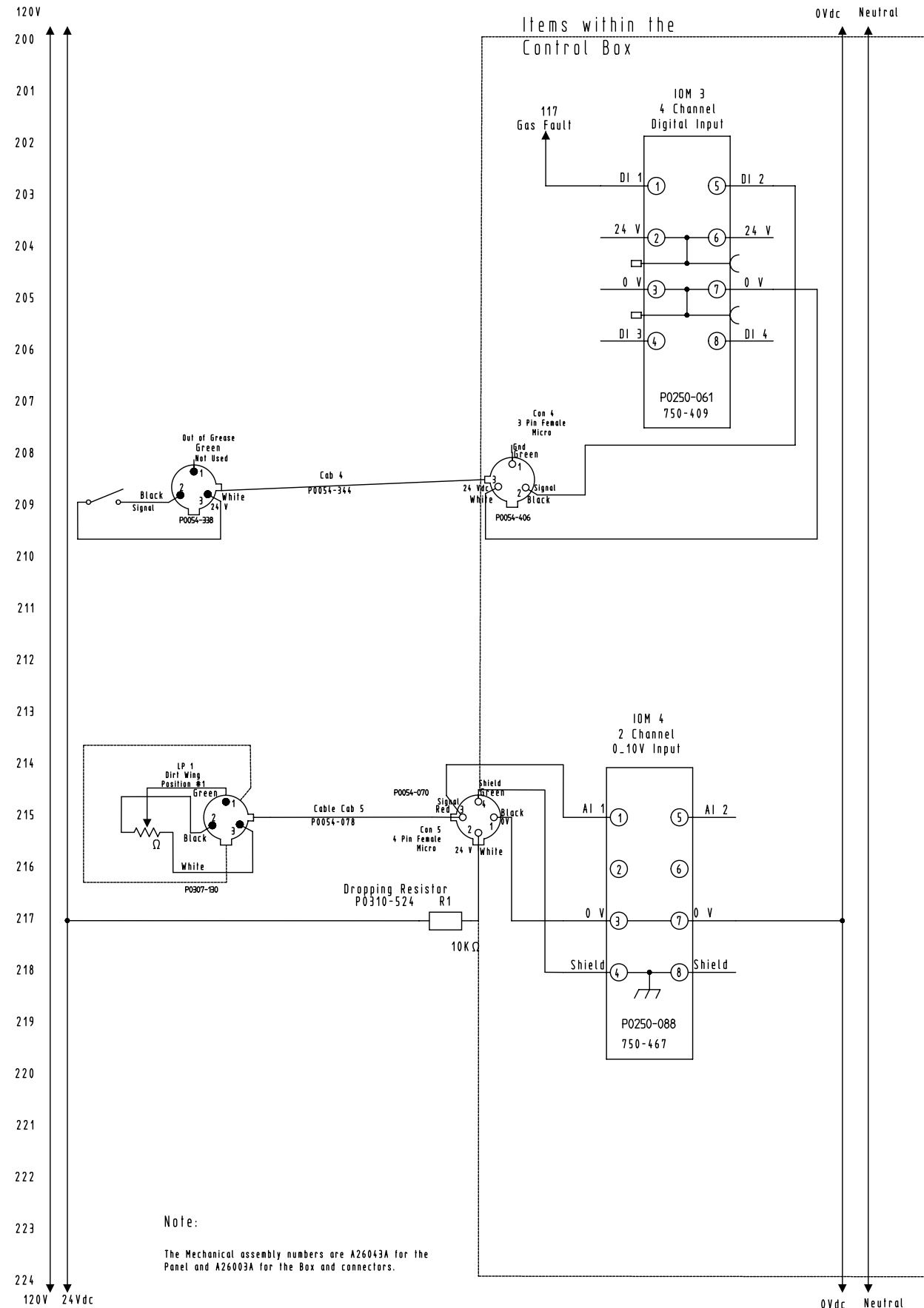


Note:
The Mechanical assembly numbers are A26043A for the
Panel and A26003A for the Box and connectors.

Note:
ALL POWER SUPPLY WIRING 18 GA. & ALL CONTROL WIRING 20 GA.

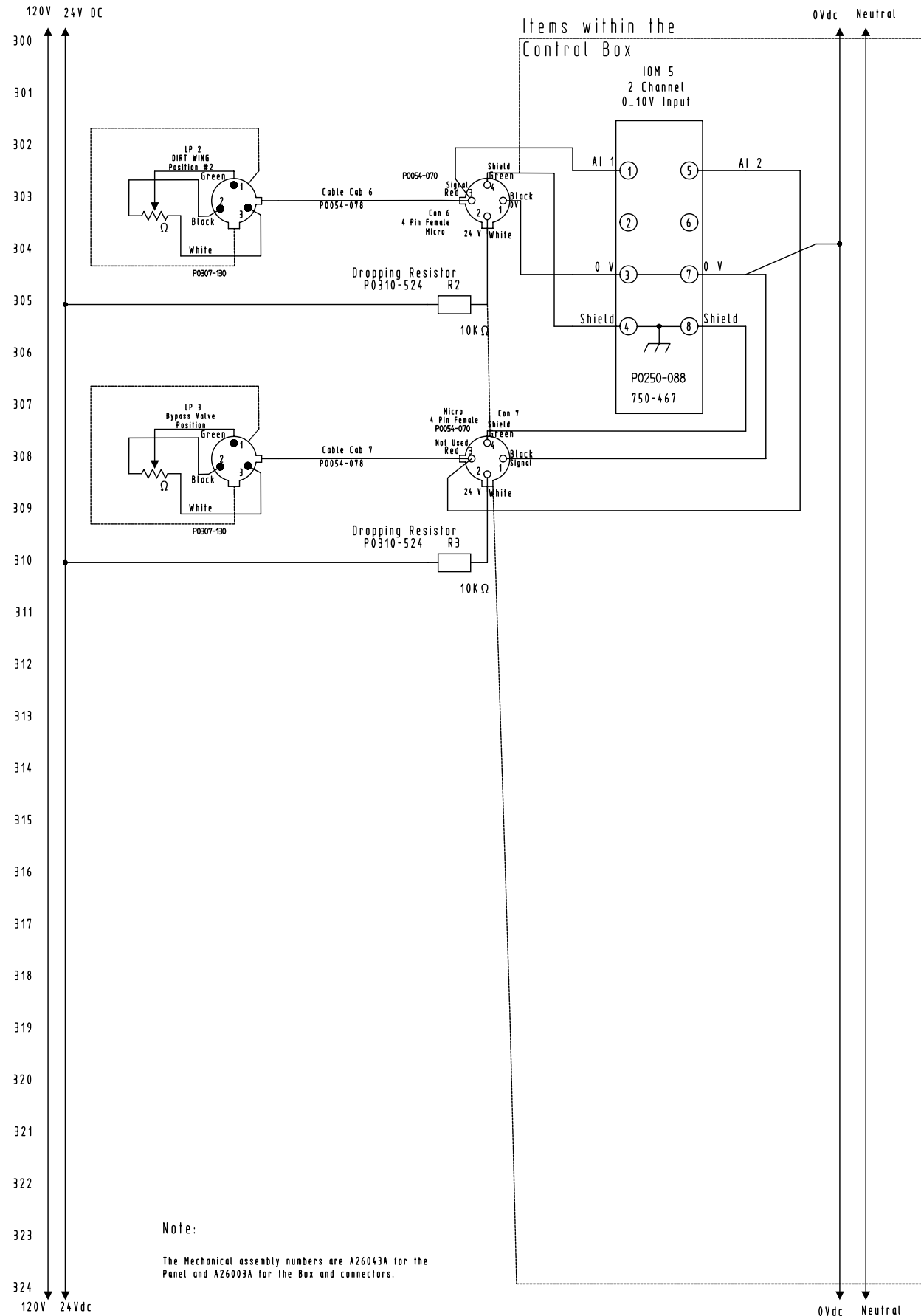
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MTBM Trailing Section Control Box Electrical Schematics (continued)



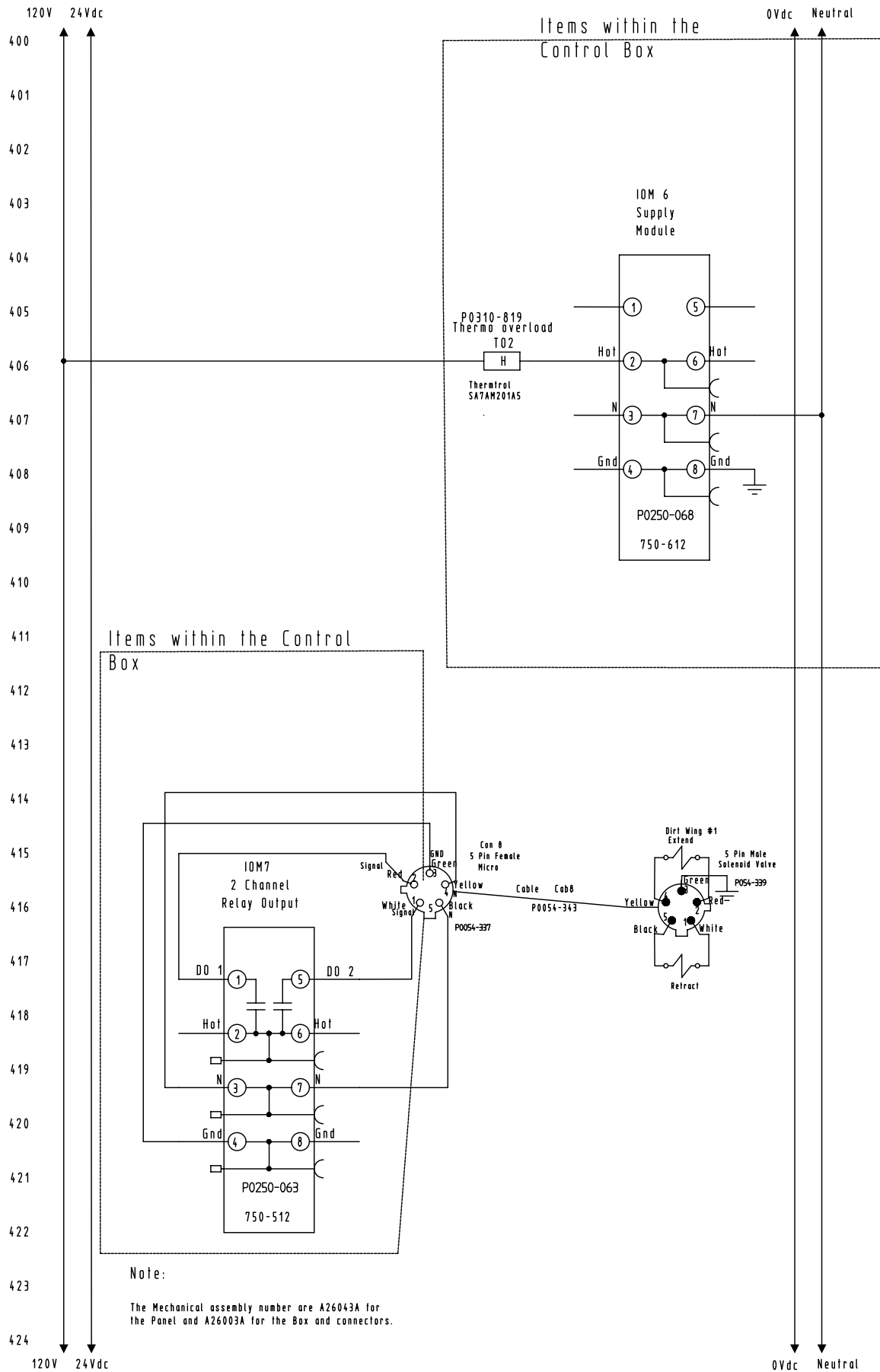
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MTBM Trailing Section Control Box Electrical Schematics (continued)



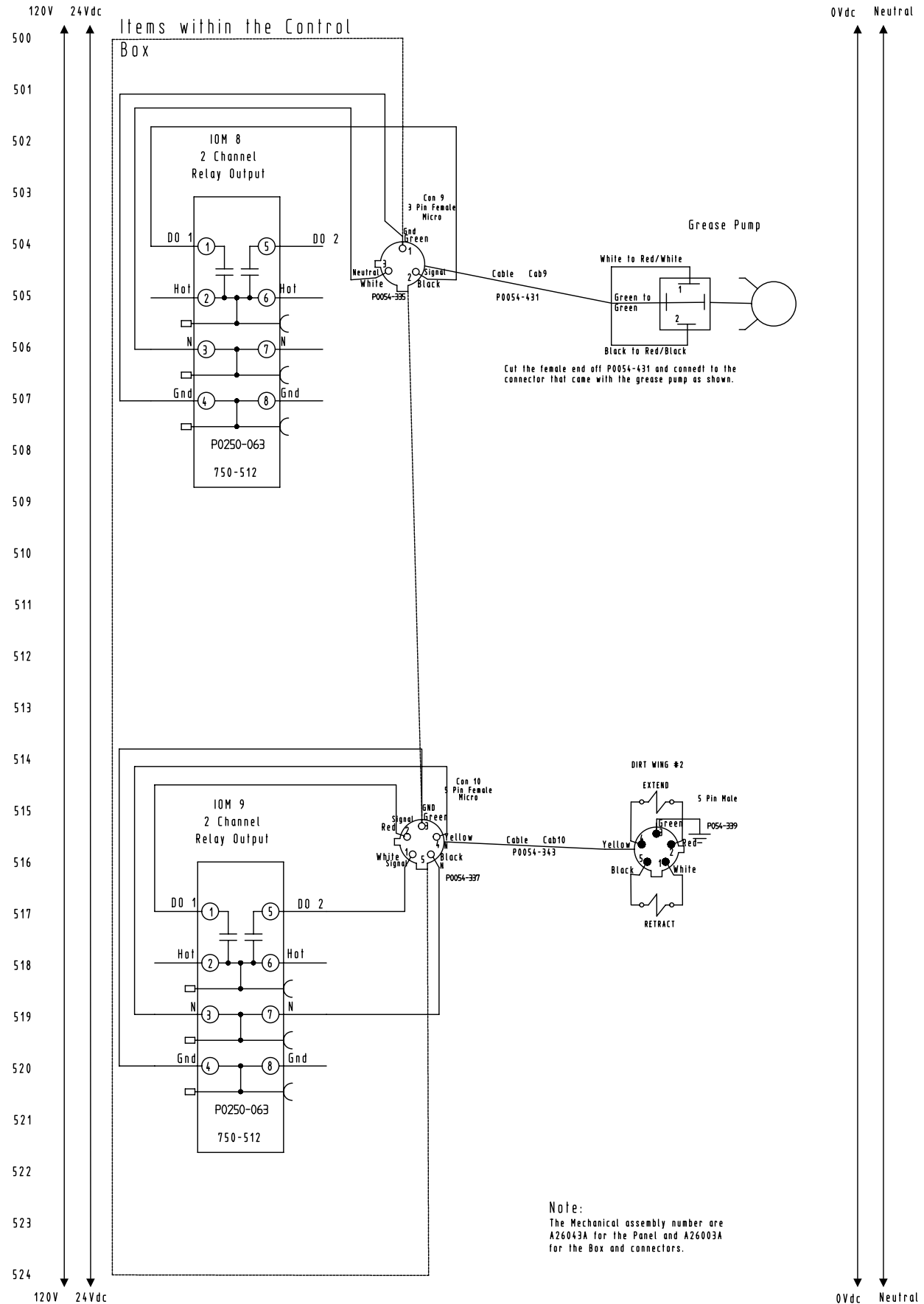
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MTBM Trailing Section Control Box Electrical Schematics (continued)



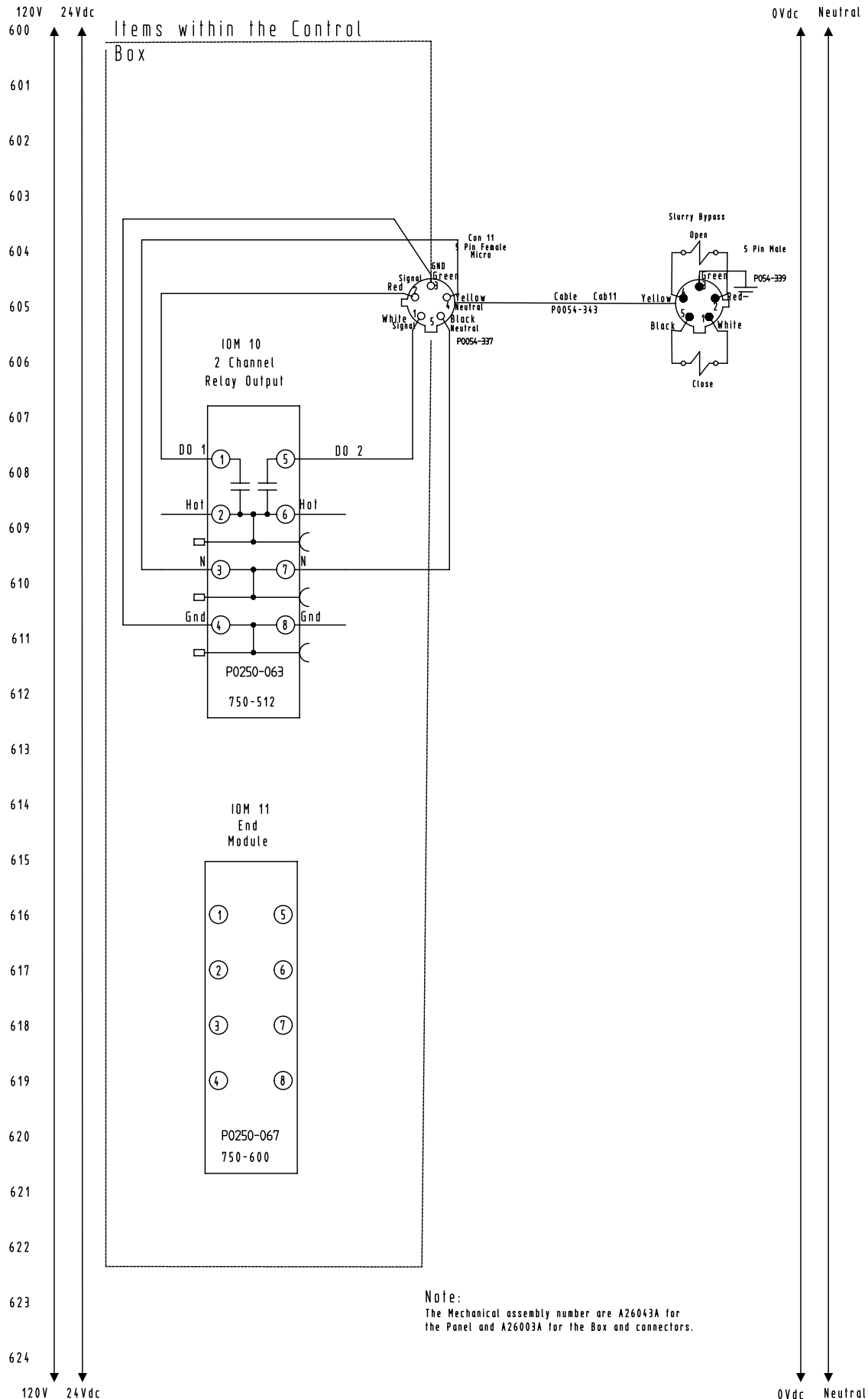
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MTBM Trailing Section Control Box Electrical Schematics (continued)

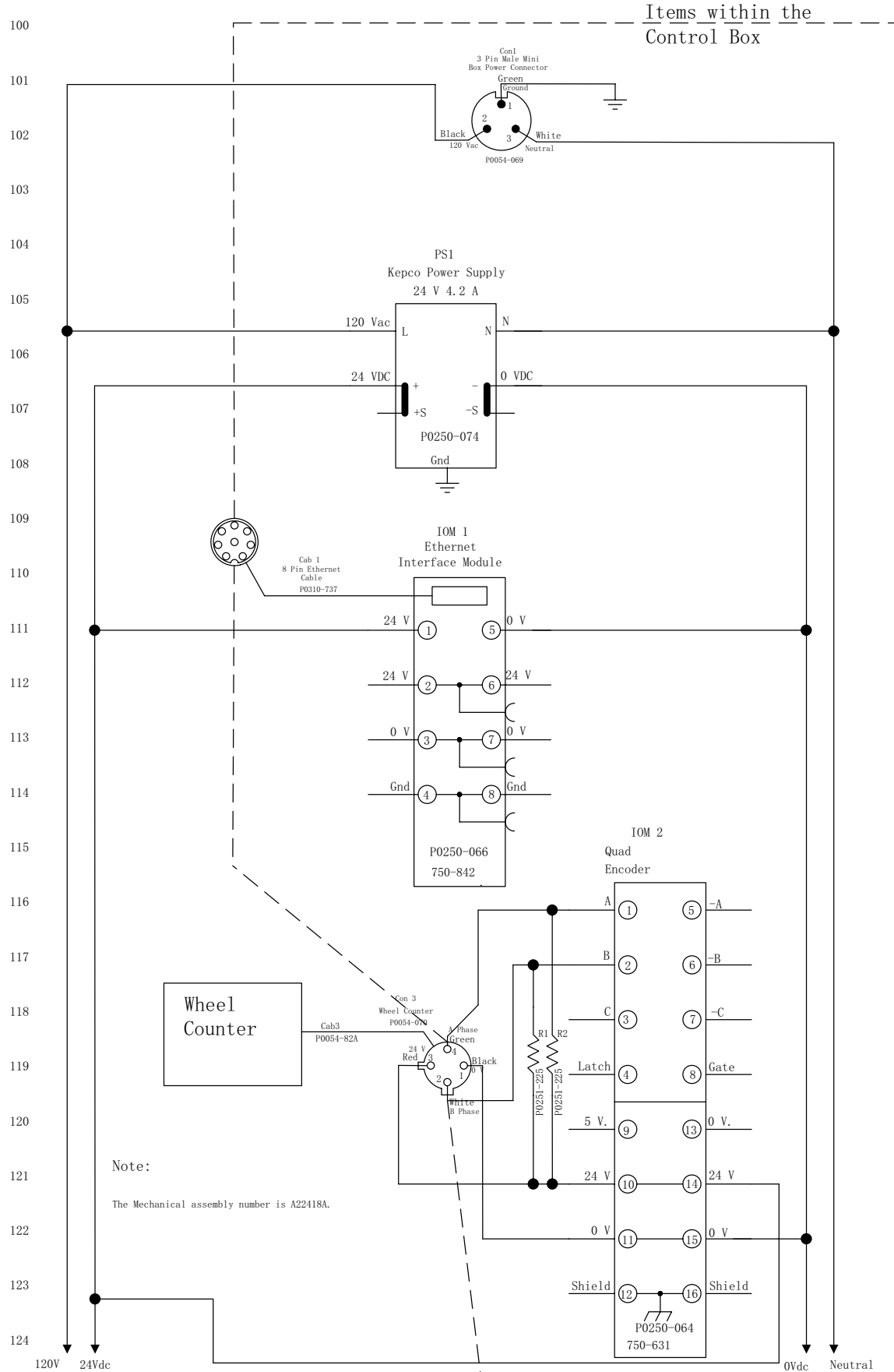


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MTBM Trailing Section Control Box Electrical Schematics (continued)

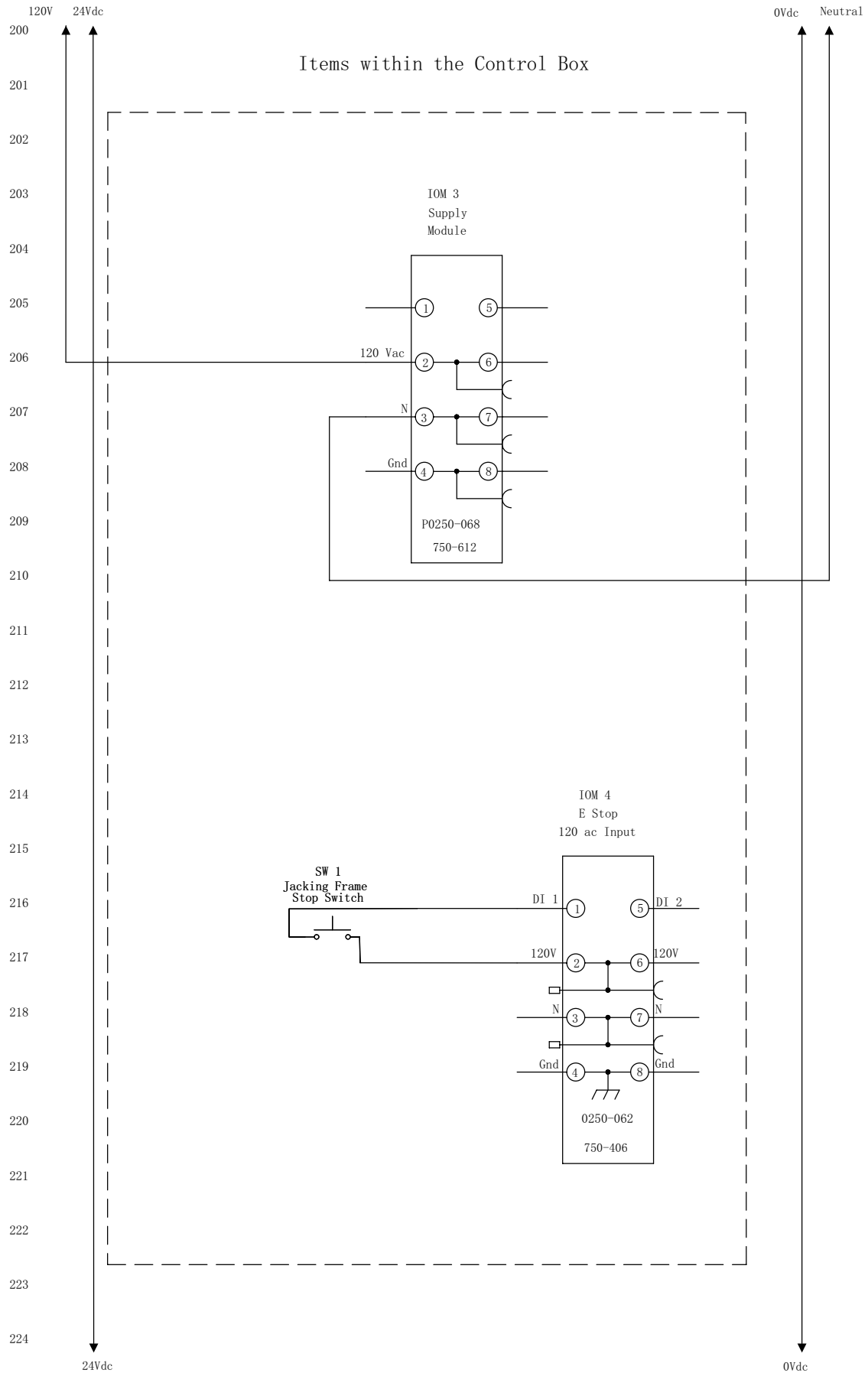


PIT BOX ELECTRICAL SCHEMATICS



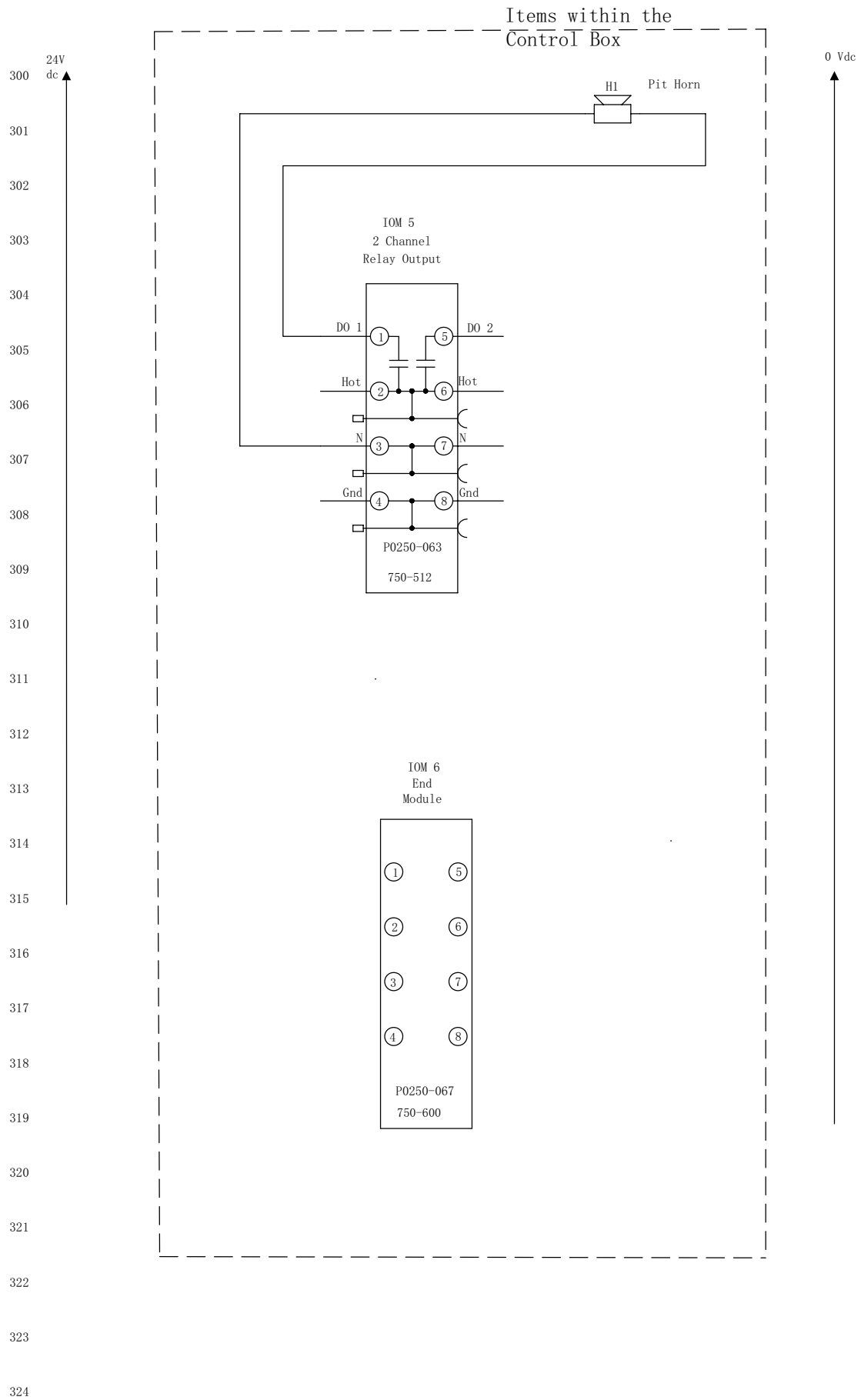
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Pit Box Electrical Schematics (continued)

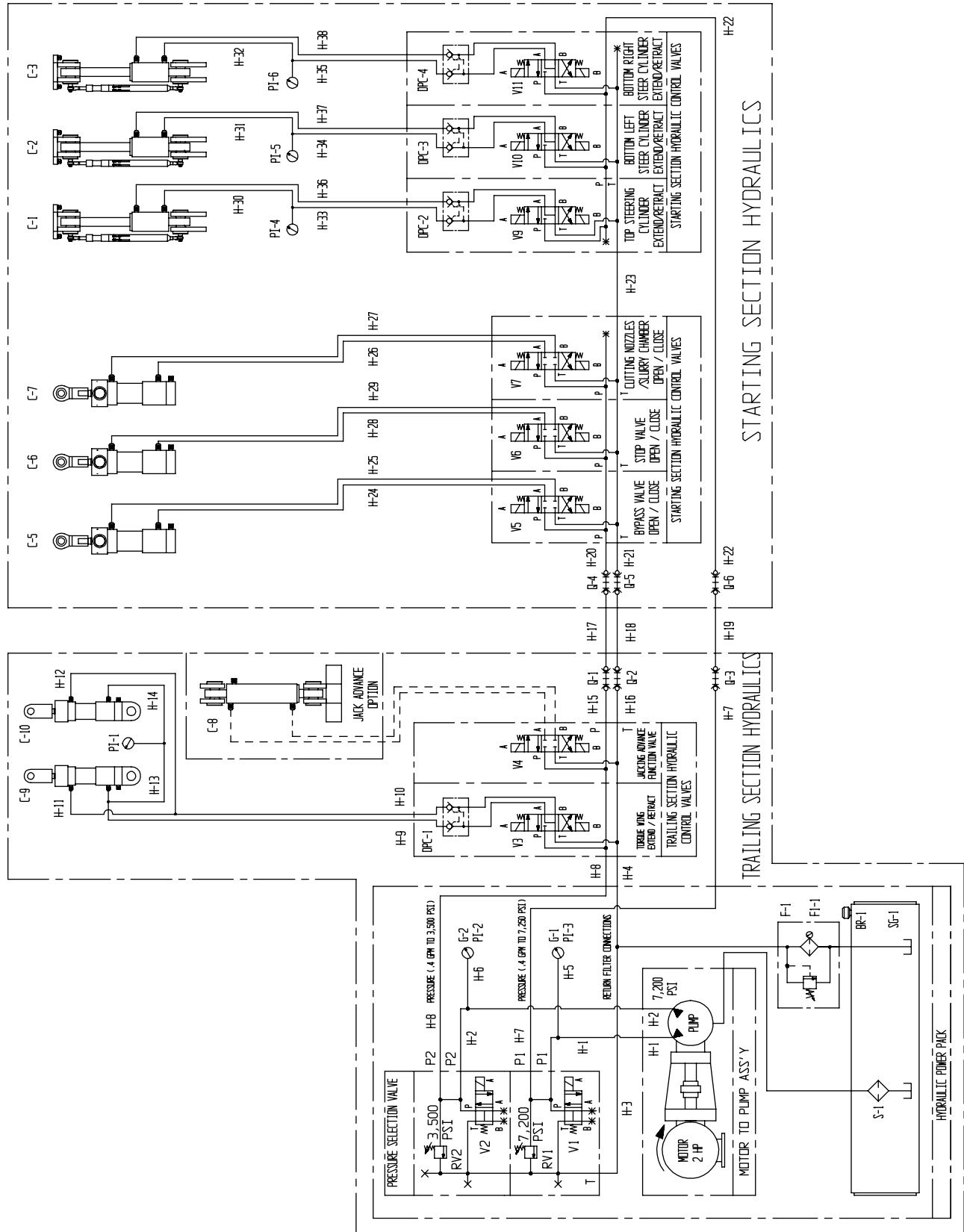


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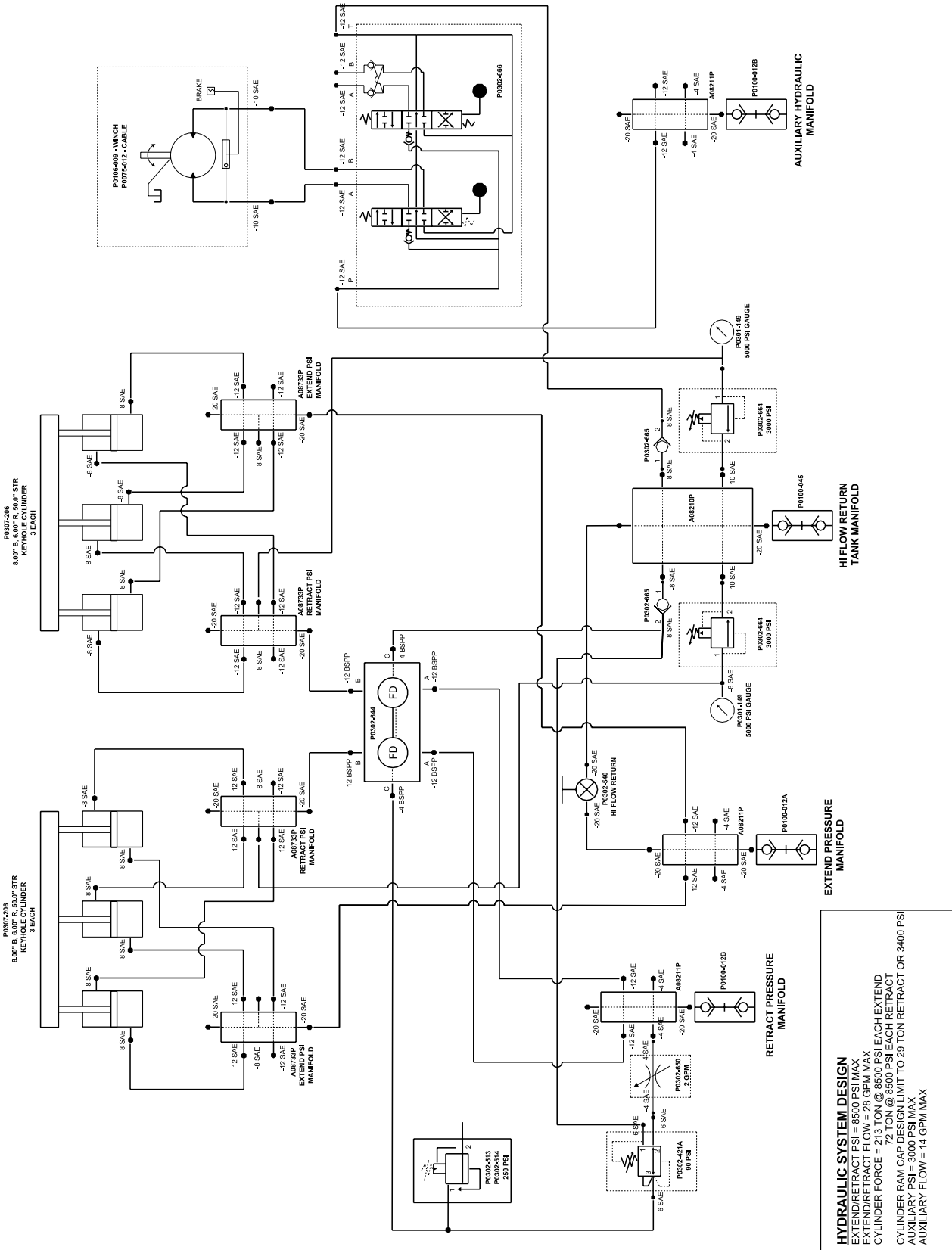
Pit Box Electrical Schematics (continued)



MTBM HYDRAULIC SCHEMATICS

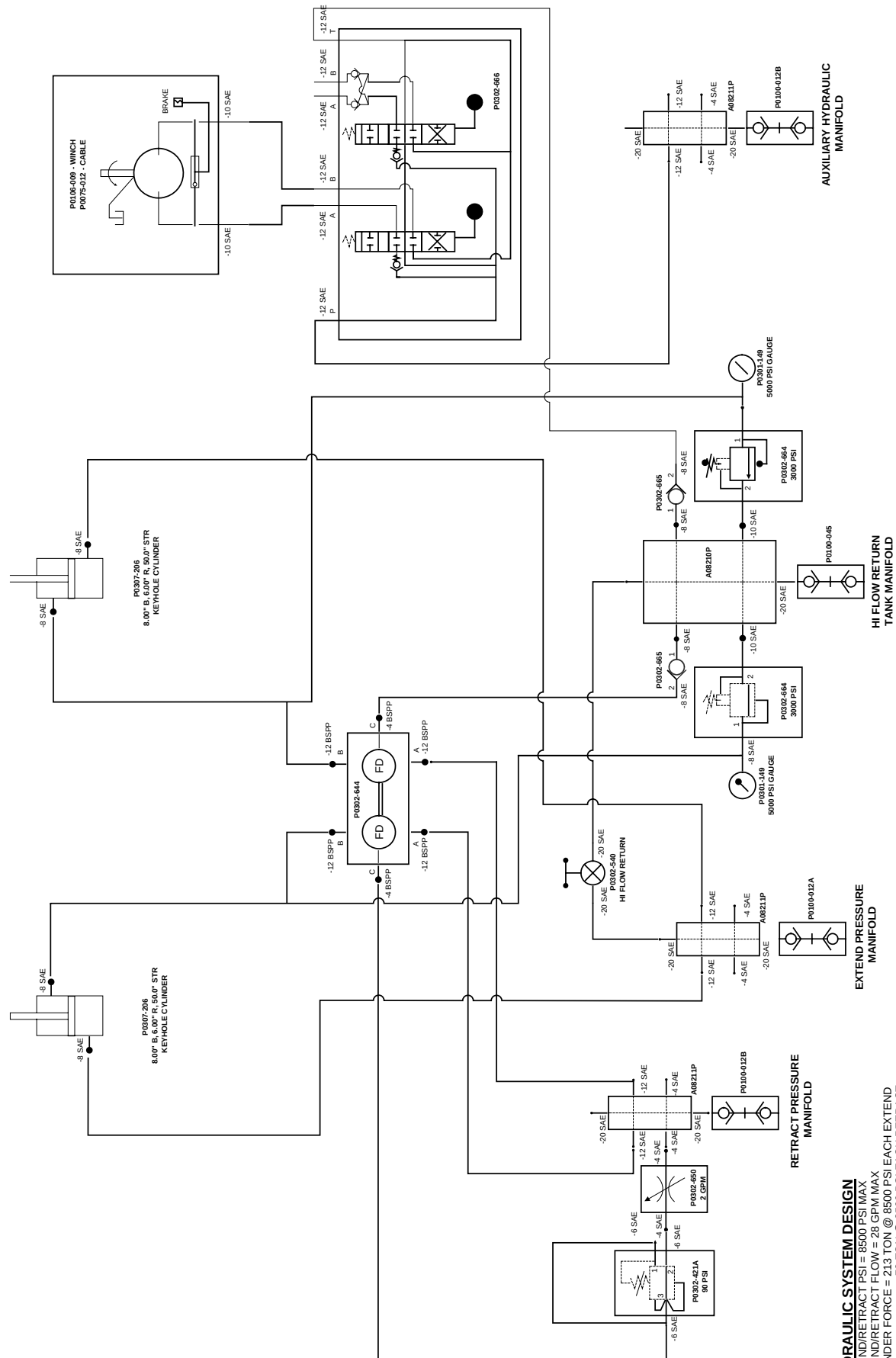


KEYHOLE FRAME HYDRAULIC SCHEMATICS - MT875K





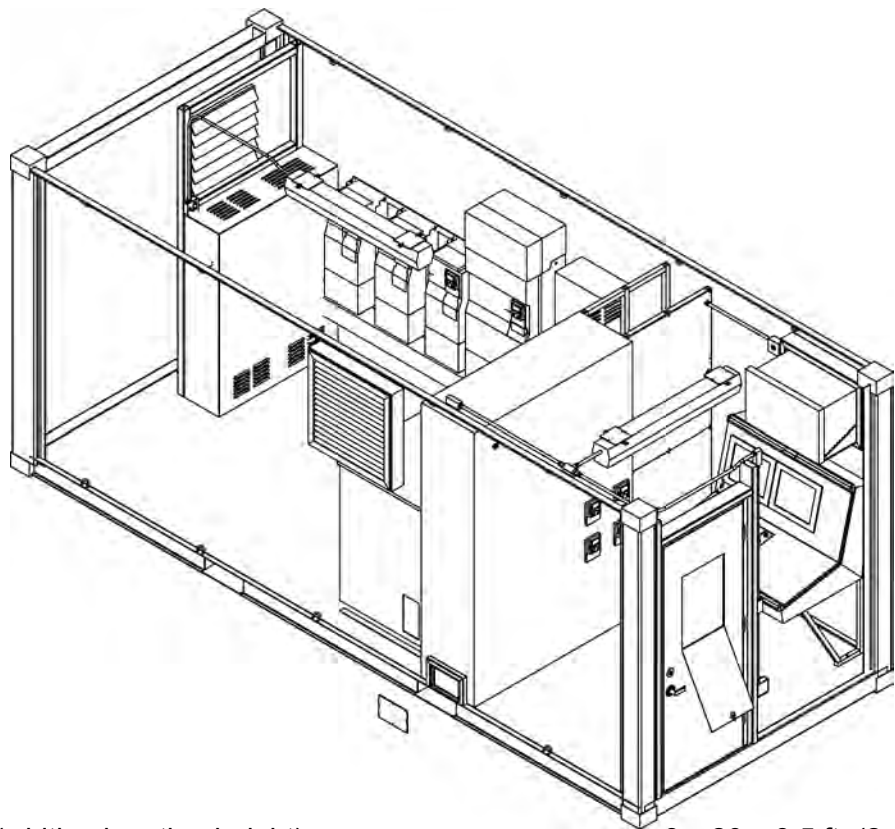
MT 400 SERIES HYDRAULIC SCHEMATICS



NOTES

Specifications

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..... 11,000 lbs. (4,990 kg)

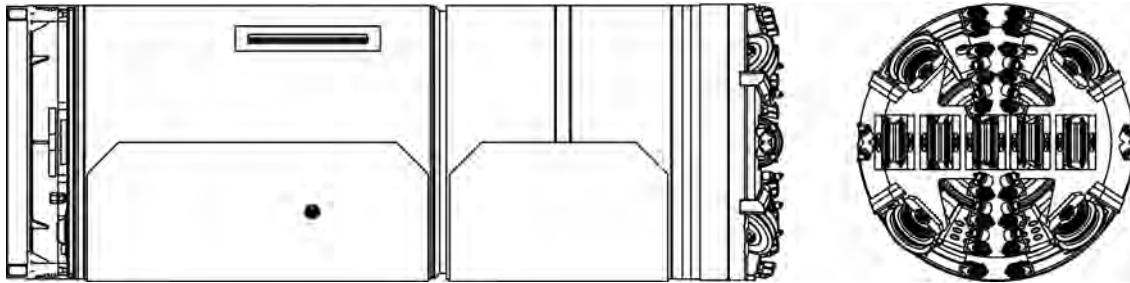
Electrical

Main Disconnect	600 amp, 480V, 3 Phase
Transformer	480V to 575V
Cutter Head Drive VFD	75-250 HP, 575V
Feed Pump VFD	60 HP, 480V
Return Pump VFD	60 HP, 480V
Booster Pump VFD	60 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	Keeware®

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

MTBM**Machine Type**

..... Slurry, Earth Pressure
Balanced Cutting Chamber

Machine Diameter (Base)

SL30	30"
SL34	34"
SL36	36"
SL44	44"
SL46	46"
SL51	51"
SL52.5	52.5"
SL60	60"
SL72	72"
SL74	74"

Length: Starting Section / Total

SL30	129.9" / 257.4"
SL34	125" / 253.1"
SL36	138.6" / 260.9"
SL44	123" / 249.1"
SL46	123" / 249.1"
SL51	126" / 252.1"
SL52.5	126" / 252.1"
SL60	162.5"
SL72	162.5"
SL74	162.5"

Overcut 1.5"

Cutter Head Types

..... Soft ground, mixed ground, rock

Drive Type Electric, 575 Volt, 3 Phase

Drive Motor (water cooled, electric motor VFD)

SL30/SL34/SL36/SL44/SL46	75 HP
SL51/SL52.5	125 HP
SL60	150/250 HP
SL72/74	250 HP

Cutter Head Speed/Cutter Head Max. Torque

SL30	0 to 13 rpm / 45,400 ft-lbs
SL34	0 to 11 rpm / 52,800 ft-lbs
SL36	0 to 8 rpm / 74,000 ft-lbs
SL44	0 to 11.0 rpm / 52,800 ft-lbs
SL46	0 to 8 rpm / 74,000 ft-lbs
SL51	0 to 10.0 rpm / 85,867 ft-lbs
SL52.5	0 to 10.0 rpm / 97,800 ft-lbs
SL60	0 to 13.5 rpm / 145,800 ft-lbs
SL60/SL72/74 ...	0 to 7.7 rpm / 255,700 ft-lbs

Steering

Steering control system	3 point
Cylinder thrust capacity (each)	
SL30/SL34/SL36	69,750 lbs
SL44/SL46/SL51/SL52.5	114,000 lbs
SL60/SL72/SL74	172,250 lbs

Camera . Passive target & MTBM maintenance

Machine Control System

Akkerman Gen 2 control system with ethernet

Hydraulic Power Pack

Motor	2 HP, 480 Volt, 3 Phase
System Flow	0.50 gpm
Steering System	7,250 psi max.
Torque Wing System	5,000 psi max.

Submersible Pump

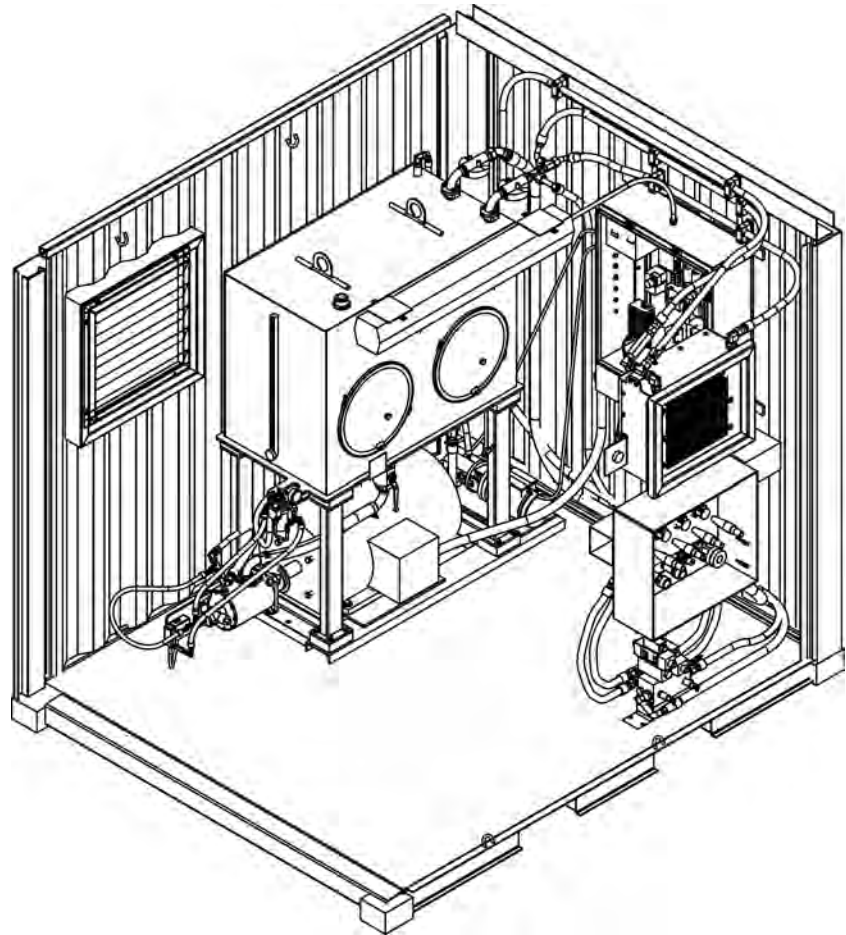
Motor	2 HP, 480 Volt, 3 Phase
Flow	
SL30/SL34/SL36	18.5 gpm max. @ 300 feet head (130 psi)
SL44/SL46/SL51/SL52.5	25 gpm max. @ 200 feet head (87 psi)
SL60/SL72/SL74	25 gpm max. @ 200 feet head (87 psi)

Jetting Nozzles

Number of nozzles	0 - 6
Recommended system pressure ..	2,300 psi

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

SN FA21945F 330 gal (1,249 L)
SN FA21965F 195 gal (738 L)

Hydraulics

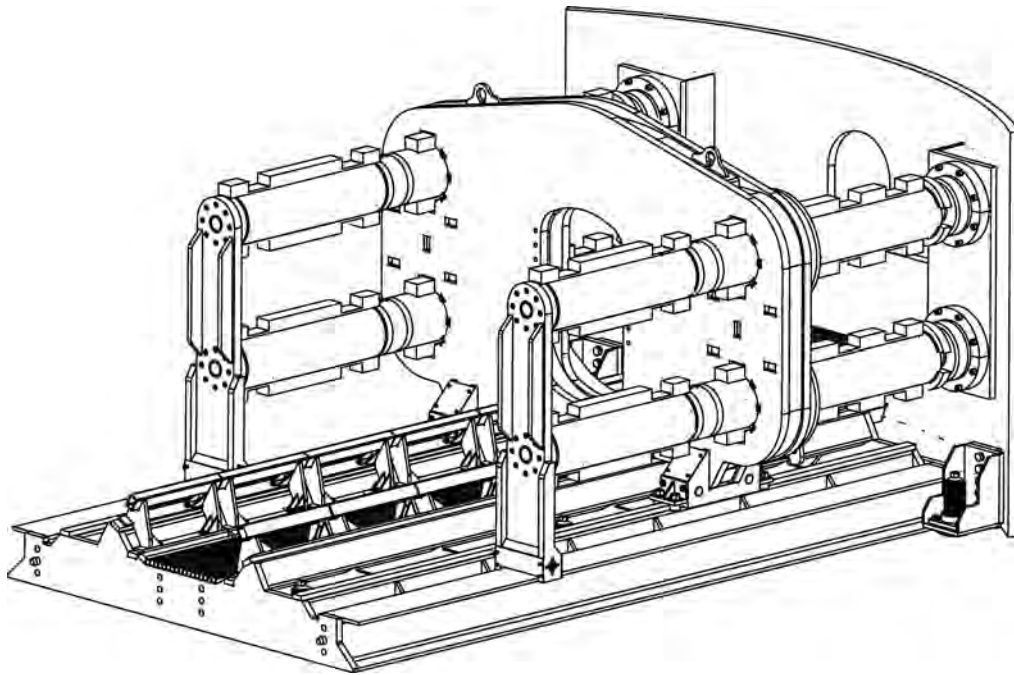
Main Hydraulic Pump
Speed 1,800 rpm
Flow 0 - 13 gpm
Pressure 8,000 psi
Pilot Pressure Pump 1 gpm @ 300 psi
Cooling Pump 12 gpm
Jacking Functions
Jacking 13 gpm @ 8,000 psi
IJS 13 gpm @ 8,000 psi
Auxiliary 13 gpm @ 8,000 psi

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.

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)
MT860K	43,500 lbs. (19,731 kg)
MT8102K	58,000 lbs. (26,308 kg)

Thrust Capacity	800 ton @ 8,500 psi

Pipe Capacity (OD)

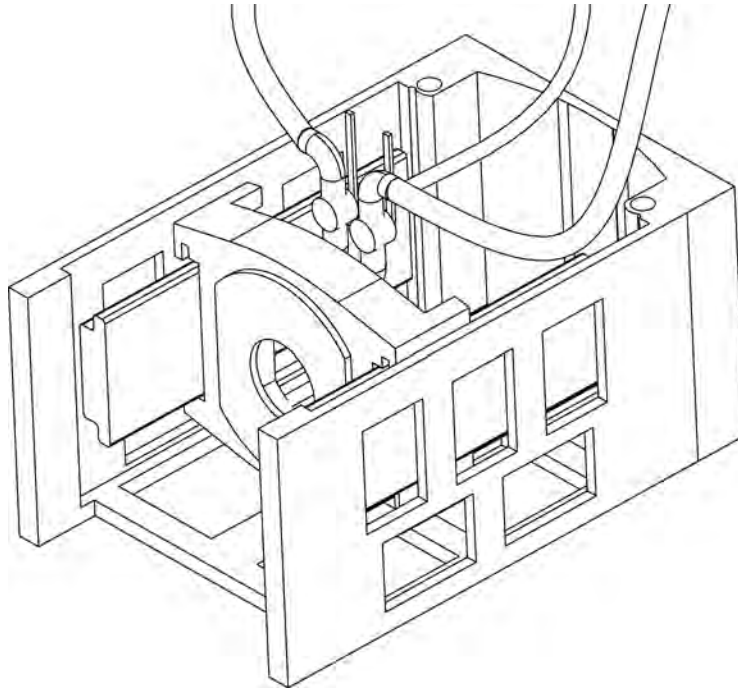
	Minimum OD	Maximum OD
MT860K	-	60 in. (1,524 mm)
MT875K	60 in. (1,524 mm)	75 in. (1,905 mm)
MT860K	75 in. (1,905 mm)	90 in. (2,286 mm)
MT8102K	90 in. (2,286 mm)	102 in. (2,591 mm)

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.

SLIDE THRUST JACKING FRAMES



Weight (without extensions) (approx.)

MT400 (Jacking Frame With Locking Ring & Pipe Adapter).....	27,260 lbs. (12,365 kg)
MT460 (Jacking Frame With Locking Ring)	24,730 lbs. (11,217 kg)
MT860 (Jacking Frame).....	31,000 lbs. (14,061 kg)
MT890 (Jacking Frame).....	34,000 lbs. (15,422 kg)

Cylinders

MT400/MT460	2
MT860/MT890	4
Cylinder Stroke	42 in. (1,067 mm)

Lock Position

Distance Between Locking (dogs)	36 in. (76 mm)
Locking Ring Movement	114 in. (2,896 mm)

Thrust Capacity (Maximum)

MT400/MT460	400
MT860/MT890	800

Pipe Diameter OD (Maximum)

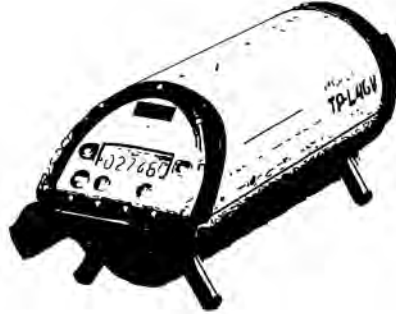
MT400/MT460/MT860	60 in. (1,524 mm)
MT890	90 in. (2,286 mm)

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



Type Helium-neon (HeNe) or laser diode
•..... Must have well-collimated beam
•..... Cannot have cross wires

Laser Wavelength 633nm

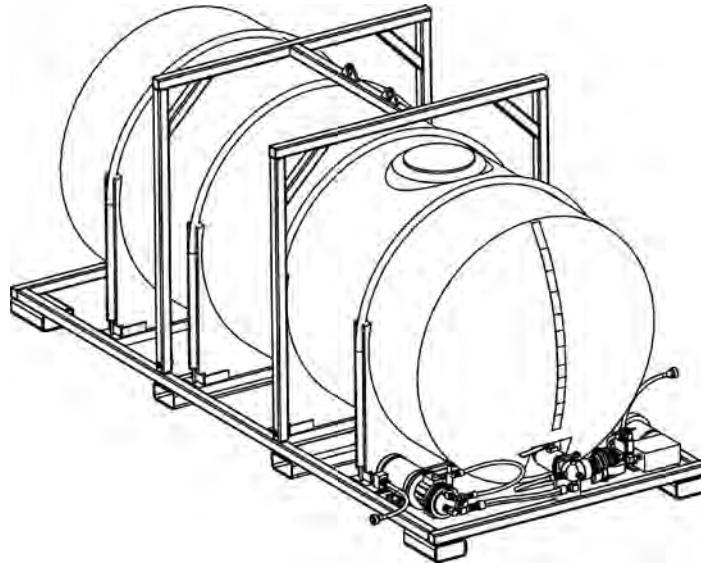
Beam Energy Range 2 – 5mW

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

(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 (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)

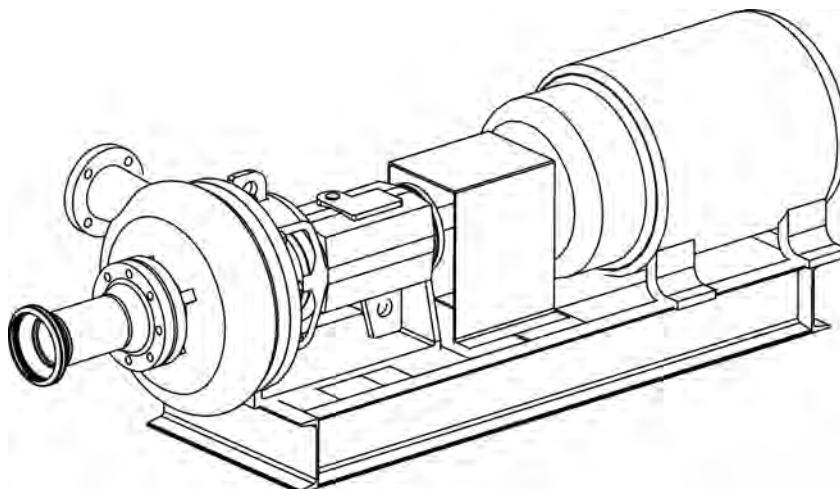
Delivery @ Max. Pressure 972 revs/gal (258 revs/L)

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 depth) 47 x 78 x 44.5 in. (1,194 x 1,981 x 1,130 mm)

Motor up to 60 HP (44.7 kW)

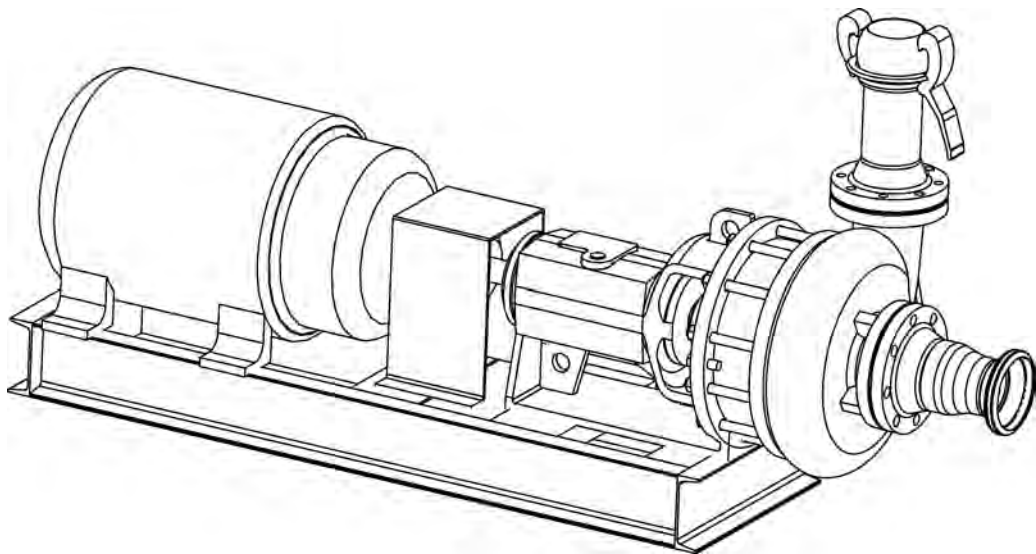
Maximum GPM (capacity limit does not consider suction line velocity):

4x3x13 750 gpm (2,839 L/min)

5x4x14 1100 gpm (4,163 L/min)

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

SLURRY RETURN PUMP



Weight 2,000 lbs. (907 kg)

Size (width x length x depth) 32 x 83 x 44.5 in. (2,108 x 813 x 1,130 mm)

Motor up to 60 HP (44.7 kW)

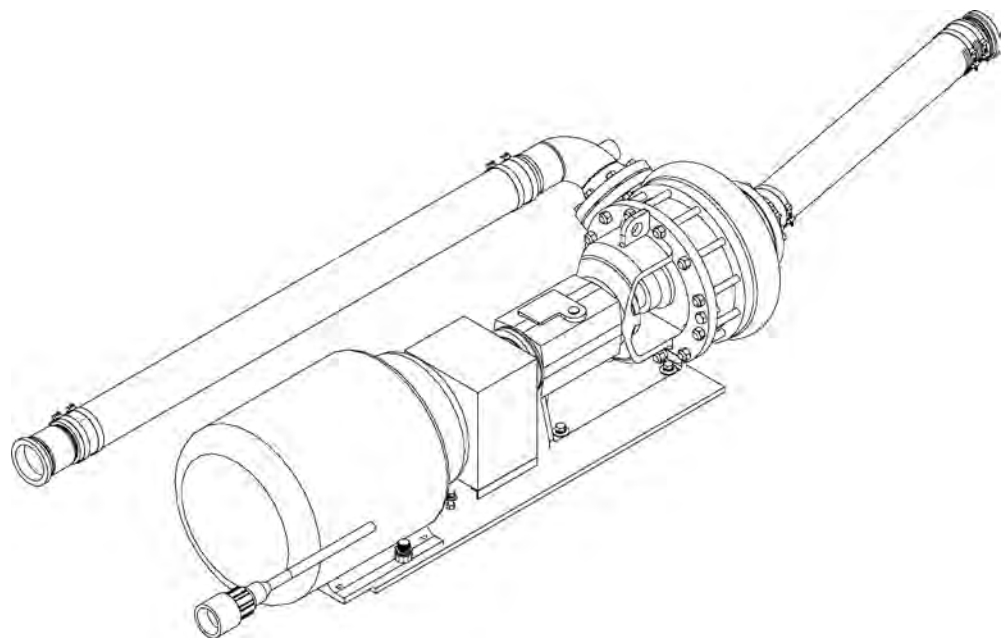
Maximum GPM (capacity limit does not consider suction line velocity):

4x3x13 750 gpm (2,839 L/min)

5x4x14 1100 gpm (4,163 L/min)

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

SLURRY BOOSTER PUMP (SL44 & ABOVE)



Weight 2,000 lbs. (907 kg)

Size (width x length x depth) 25 x 85 x 25 in. (635 x 2,159 x 635 mm)

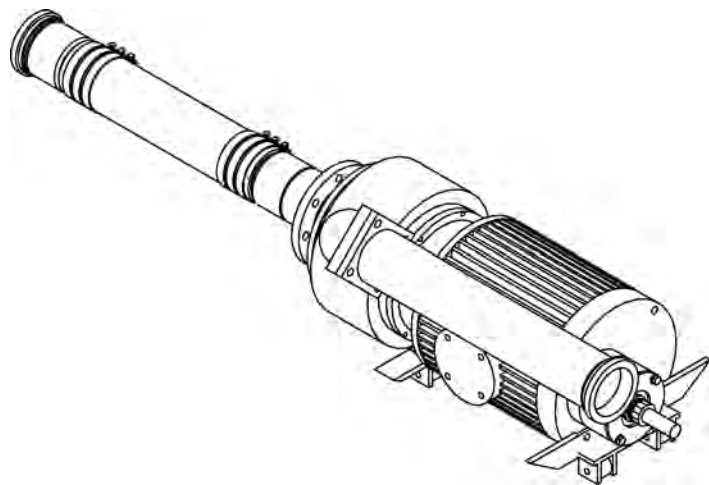
Motor up to 60 HP (44.7 kW)

Maximum GPM (capacity limit does not consider suction line velocity):

 4x3x13 750 gpm (2,839 L/min)

 5x4x14 1,100 gpm (4,163 L/min)

SLURRY BOOSTER PUMP (SL36 & BELOW)



Weight 551 lbs. (250 kg)

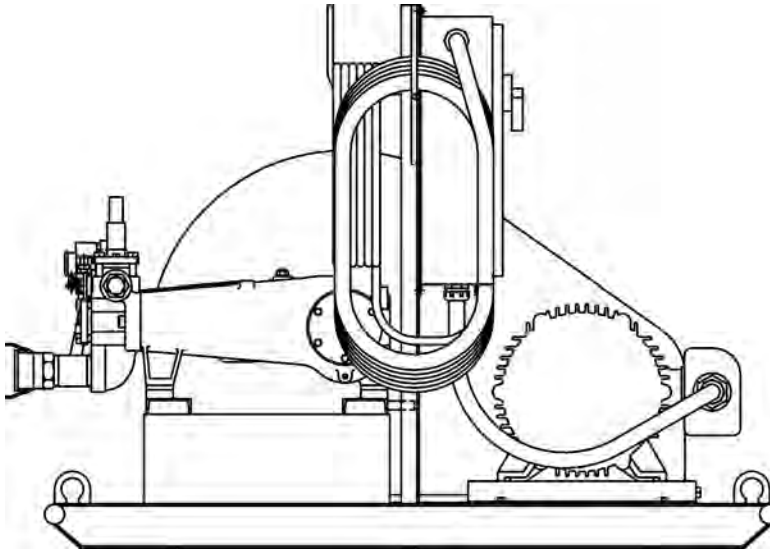
Motor 17.4 HP (13 kW)

Maximum GPM 370 gpm (1,400 L/min)

Rotation 1,740 rpm

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

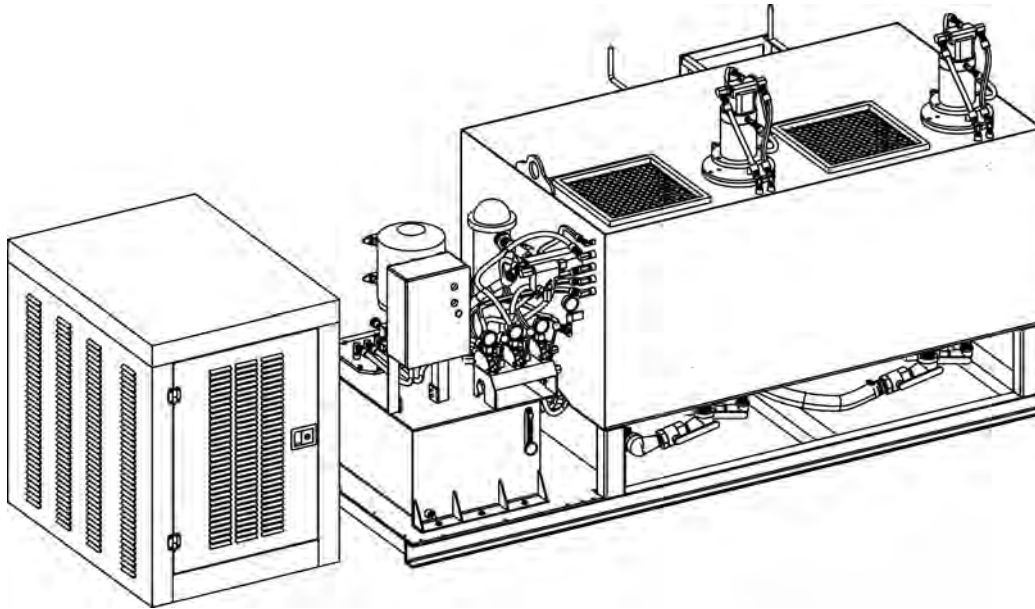
New Belt 17-30 lb.
Used Belt 13-23 lb.
Center Distance Span (approx.) 28 in.

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

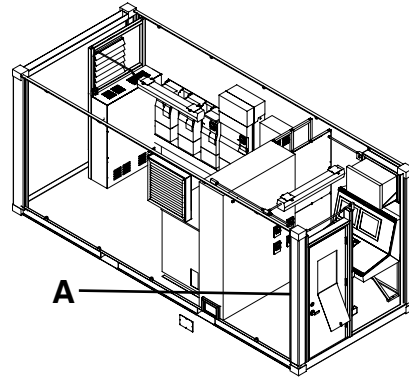
Identification Numbers

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 _____

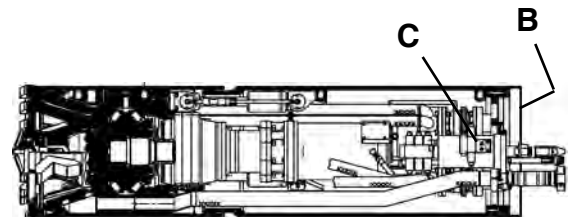
Serial Number _____



MTBM (B)

Model Number _____

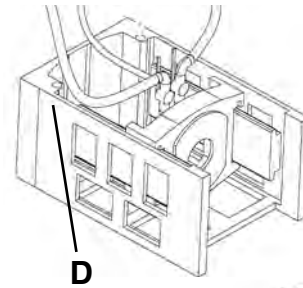
Serial Number _____



TARGET (C)

Model Number _____

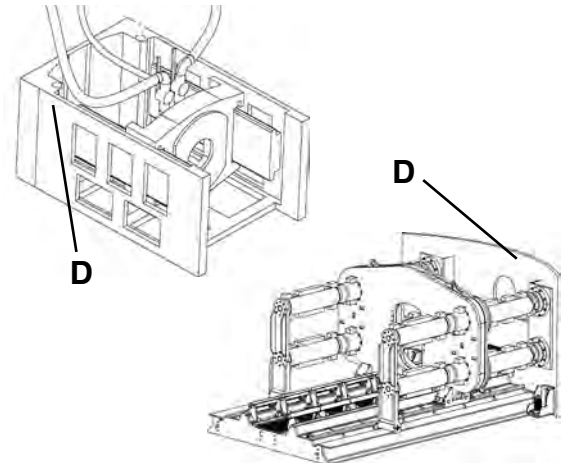
Serial Number _____



JACKING FRAME (D)

Model Number _____

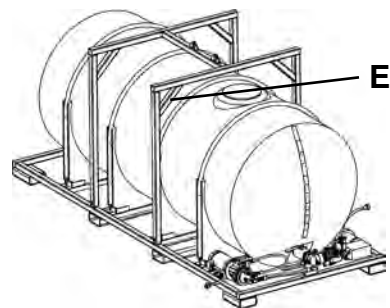
Serial Number _____



WATER COOLING TANK (E)

Model Number _____

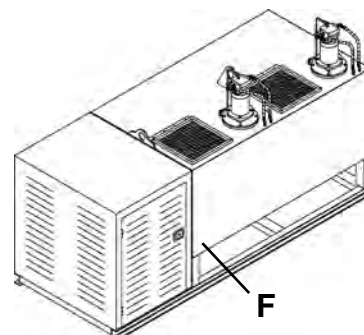
Serial Number _____



BENTONITE PUMP (F)

Model Number _____

Serial Number _____



NOTES

Safety Data Sheets

The Federal Occupational, Safety, and Health Administration (OSHA) Standard 29 CFR 1910.1200, require that specific safety data sheets (SDS) be available to employees before operating this equipment. This may include information on substances contained in this equipment such as hydraulic fluid and gear lubricant.

Akkerman Inc. will provide, at no cost, SDS which apply to its product line. Simply contact your Akkerman Product Support representative for a copy.

To ensure a prompt response to your SDS request, include your return address (including zip or postal code) and the equipment's model numbers and serial numbers with your request.

NOTES

Warranty

Akkerman Inc. warrants that all equipment manufactured by it be free from defects due to workmanship or material under normal use and service for a period of 90 days. This warranty does not apply to normal wear items such as cutter teeth, filters, etc. Akkerman Inc. does not warrant the fitness of its equipment for a particular purpose or application.

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