OPERATOR'S MANUAL

P6000E Power Pack

Power Pack S/N: F31560F

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SERVICE • RELIABILITY • INNOVATION

⚠ DANGER

This power pack is capable of supplying 5,000 psi hydraulic oil to the TBM and 8,000 psi to the jacking frame.

THE LOW PRESSURE MODULE 5,000 PSI SELECTION REQUIRES OIL HOSES/LINES RATED FOR AT LEAST 5,000 PSI. FAILURE TO DO SO WILL CAUSE SEVERE INJURY OR DEATH FROM BURSTING OIL HOSES/ LINES. NEVER USE OIL HOSES/LINES RATED LESS THAN 5,000 PSI WHEN USING 5,000 PSI SUPPLY OIL.

THE HIGH PRESSURE MODULE REQUIRES OIL HOSES/ LINES RATED FOR AT LEAST 8,000 PSI. FAILURE TO DO SO WILL CAUSE SEVERE INJURY OR DEATH FROM BURSTING OIL HOSES/LINES. NEVER USE OIL HOSES/LINES RATED LESS THAN 8,000 PSI.

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

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

NOTES

Introduction

This operator's manual contains important safety, operation, and maintenance information for your Akkerman P6000E Power Pack. You must read and understand this manual, your TBM operator's manual, haul unit operator's manual, gas detection system operation manual and any other equipment manuals before you operate and maintain this equipment. Keep this manual with your power pack 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 second rate parts could affect the efficient performance of the power pack. ALWAYS use genuine Akkerman parts.

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

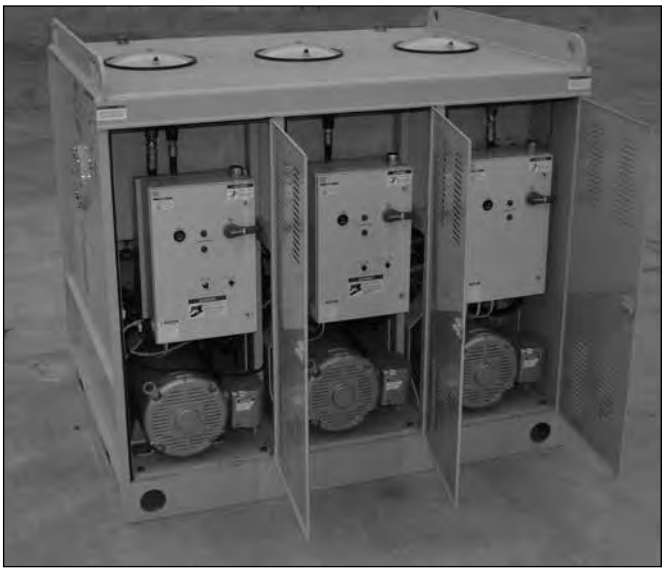
⚠DANGER Indicates an extremely hazardous situation which, if not avoided, WILL result in death or serious injury.

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

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

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

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



Akkerman P6000E Power Pack

The *P6000E Power Pack* is used to provide low and high pressure hydraulics for the tunnel boring machine and jacking systems designed for small shaft or high capacity multiple cylinder jacking systems

If you find any errors with this manual or know of ways to improve procedures, please let us know. Email your comments via the form on the Contact Us page of the Akkerman web site, 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.

Contents

Safety

BE ALERT FOR SAFETY INFORMATION

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

Read all safety information.

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

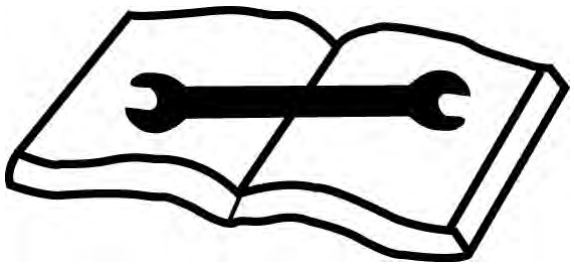
ATTENTION!
BECOME ALERT!
YOUR SAFETY IS INVOLVED!

READ OPERATOR'S MANUAL

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

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

Any unauthorized modifications will void the warranty.



WEAR PROTECTIVE CLOTHING

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

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

LOCKOUT TAGOUT POWER BEFORE SERVICING

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

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

HYDRAULIC OIL/FLUIDS UNDER PRESSURE

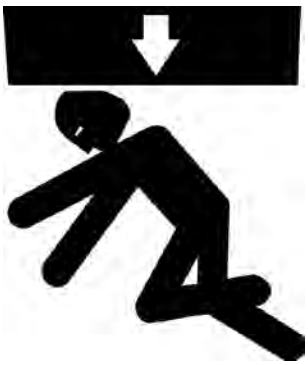
⚠WARNING Escaping oil or other fluids under pressure can penetrate your skin causing serious injury or death.

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

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

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

BEWARE OF SUSPENDED LOADS



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

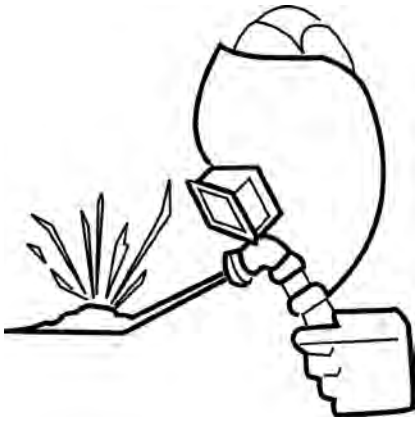
If a hydraulic hose from the boom of a crane or excavator breaks, the boom can fall instantly.

Do not enter area under or around a load.

KEEP PERSONNEL AWAY FROM MOVING PARTS

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

UNAUTHORIZED WELDING



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

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

REGULARLY CLEAN AND INSPECT EQUIPMENT

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

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

INSPECT ELECTRICAL CONNECTIONS

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

PRACTICE SAFE MAINTENANCE

⚠WARNING Unexpected equipment movement may cause serious personal injury.

LOCKOUT power before performing any maintenance.

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

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

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

Do not service the machine while it is in motion.

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

AVOID PINCH POINTS

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

Keep hands away from moving parts.

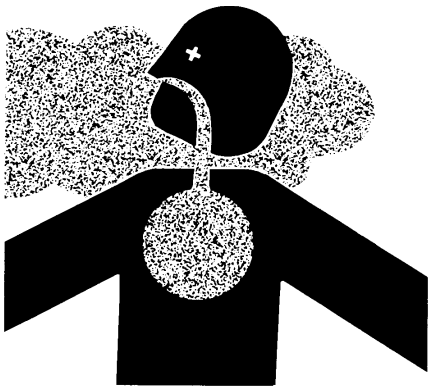
Watch your fingers, hands, and legs while equipment is in operation.

Handle parts carefully to avoid crushing and pinch point hazards.

STAY AWAY FROM CRANE

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

TEST TUNNEL VENTILATION



⚠WARNING Keep TBM, 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 sparks could cause an explosion.

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

Gases must be removed before reentering tunnel/shaft.

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.

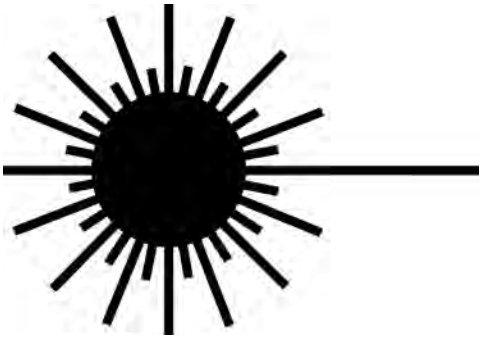
Do not smoke in shaft or tunnel.

KEEP JOB SITE CLEAN AND ORGANIZED

⚠WARNING Tripping can cause serious personal injury.

Be sure to keep job site clean and organized.

AVOID LASER LIGHT EXPOSURE

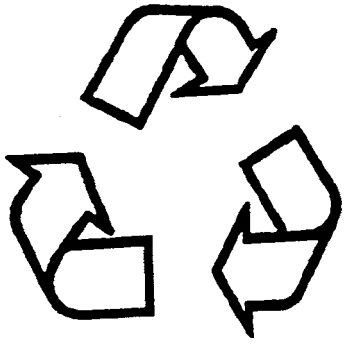


⚠DANGER Staring into laser light will cause severe injury.

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

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

RECYCLE WASTE



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

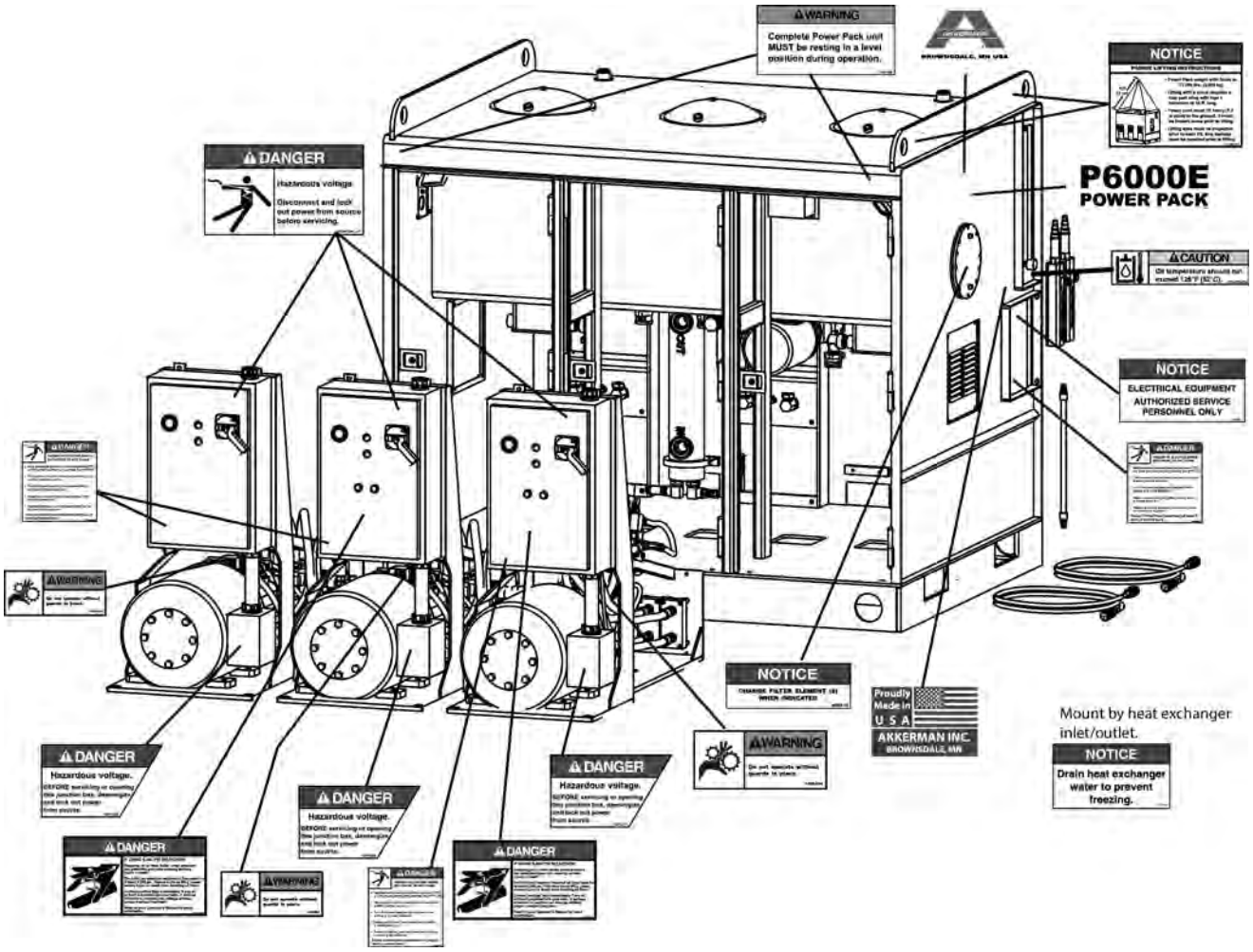
Use leakproof containers when draining fluids/oil. Do not pour waste on the ground, down a drain, or into any water source.

Decals

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

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

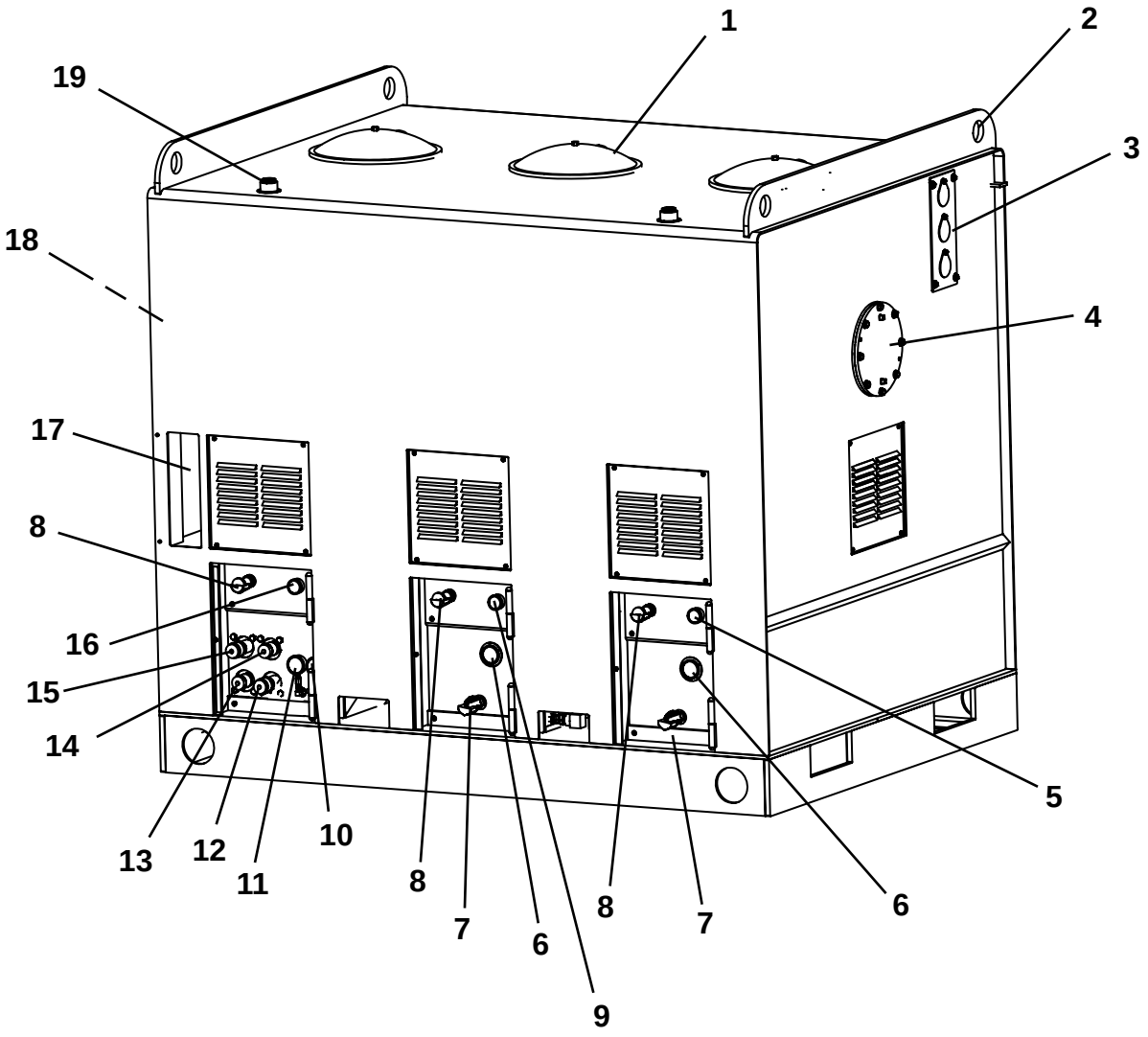
If a part is replaced that has a safety or operational decal on it, apply a new decal to the replacement part. Before applying a new decal, be sure the surface is clean and dry.



NOTES

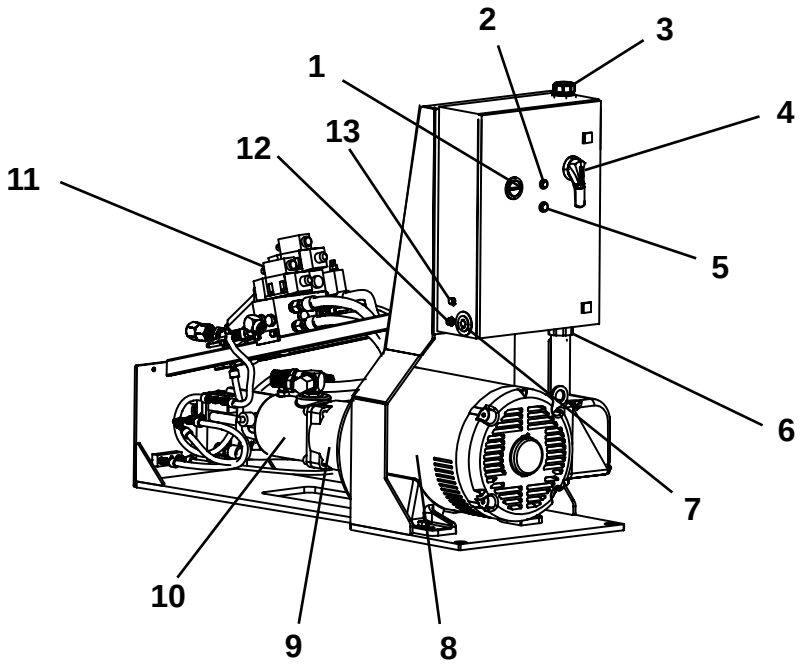
Terminology

P6000E FRAME ASSEMBLY



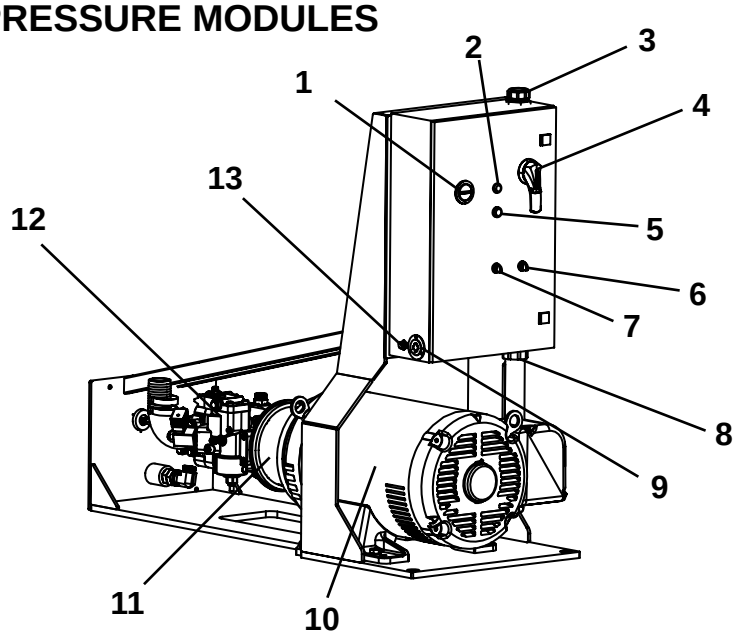
1. Reservoir Cover
2. Lift Eye
3. Power Connection Bulkhead
4. Return Filter Assembly (RFA) 1
5. Filter Indicator for RFA 1
6. Low Module Pressure Gauge
7. Hydraulic Supply Connection - 3,000/5,000 psi
8. Hydraulic Return Connection
9. Charge/Cooling Pump Filter Indicator
10. Pilot Pressure Gauge
11. System Pressure Gauge
12. IJS Hydraulic Supply Connection - 8,000 psi
13. Auxiliary Supply Hydraulic Connection - 3,000 psi
14. Jacking Frame Retract Hydraulic Connection - 3,000 psi
15. Jacking Frame Extend Hydraulic Connection - 8,000 psi
16. Filter Indicator for RFA 2
17. Frame Controls
18. Return Filter Assembly (RFA) 2
19. Breather/Hyd. Reservoir Fill Port

P6000E HIGH PRESSURE MODULE



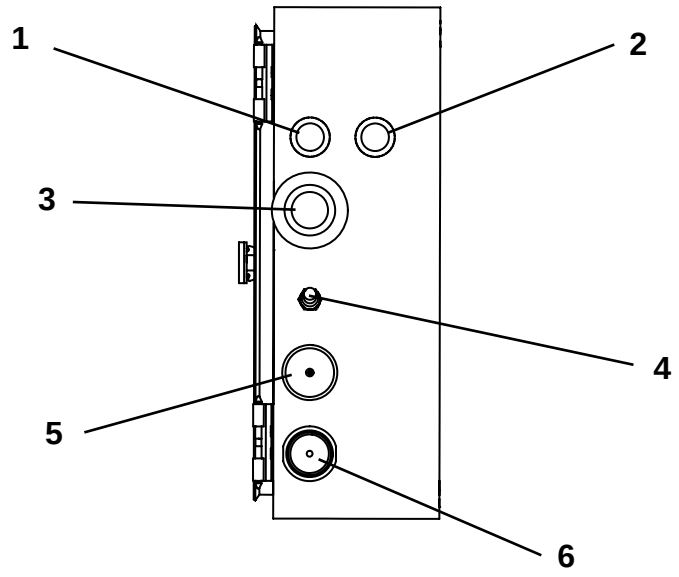
1. Hourmeter
2. Phase OK Indicator (Green)
3. 480 VAC 3 Phase IN 150A
4. Main Power Disconnect Switch
5. Phase Error Indicator (Red)
6. Out To 100 HP Motor
7. 480VAC Out To Frame Box
8. Motor 100 HP
9. Motor To Pump Housing
10. High Pressure Pump
11. High Pressure Valve Assembly
12. Frame Control Box: Start-Stop Control Signals
13. Pendant: Extend, Retract, IJS, Auxiliary Control Signals

P6000E LOW PRESSURE MODULES



1. Hourmeter
2. Phase OK Indicator (Green)
3. 480 VAC 3 Phase IN 150A
4. Main Power Disconnect Switch
5. Phase Error Indicator (Red)
6. GPM Selector Switch (30 - 60)
7. Pressure Selector Switch 3000/5000 psi
8. Out To 100 HP Motor
9. 480VAC Out To Frame Box
10. Motor 100 HP
11. Motor To Pump Housing
12. Low Pressure Pump
13. Frame Control Box: Start-Stop Control Signals

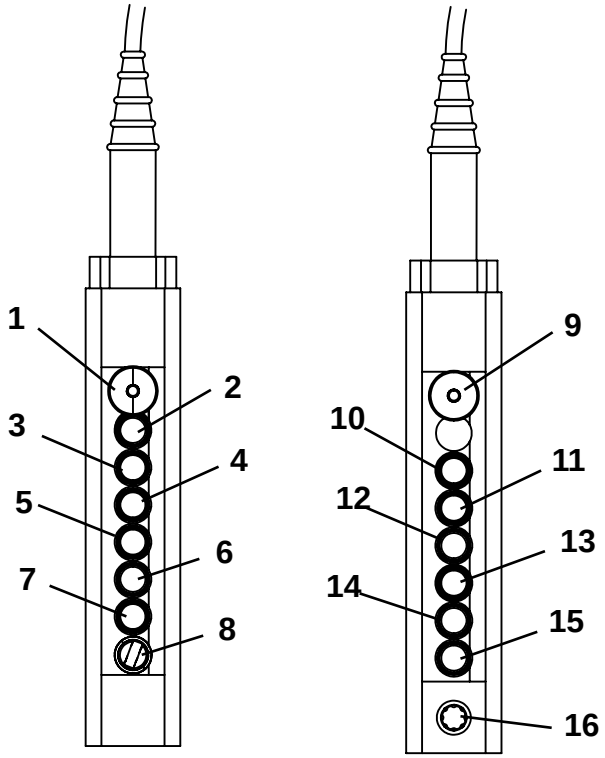
P6000E FRAME CONTROLS



1. Low Oil Level Indicator
2. High Oil Temperature Indicator
3. Emergency Stop
4. Light Switch
5. High Pressure Pendant Connection*
6. Low Pressure Pendant Connection*

* If pendant connection is not being used, the Pendant Bypass Plug must be installed. Failure to do so will not allow the power pack to function.

PENDANT CONTROLS



Low Pressure Pendant

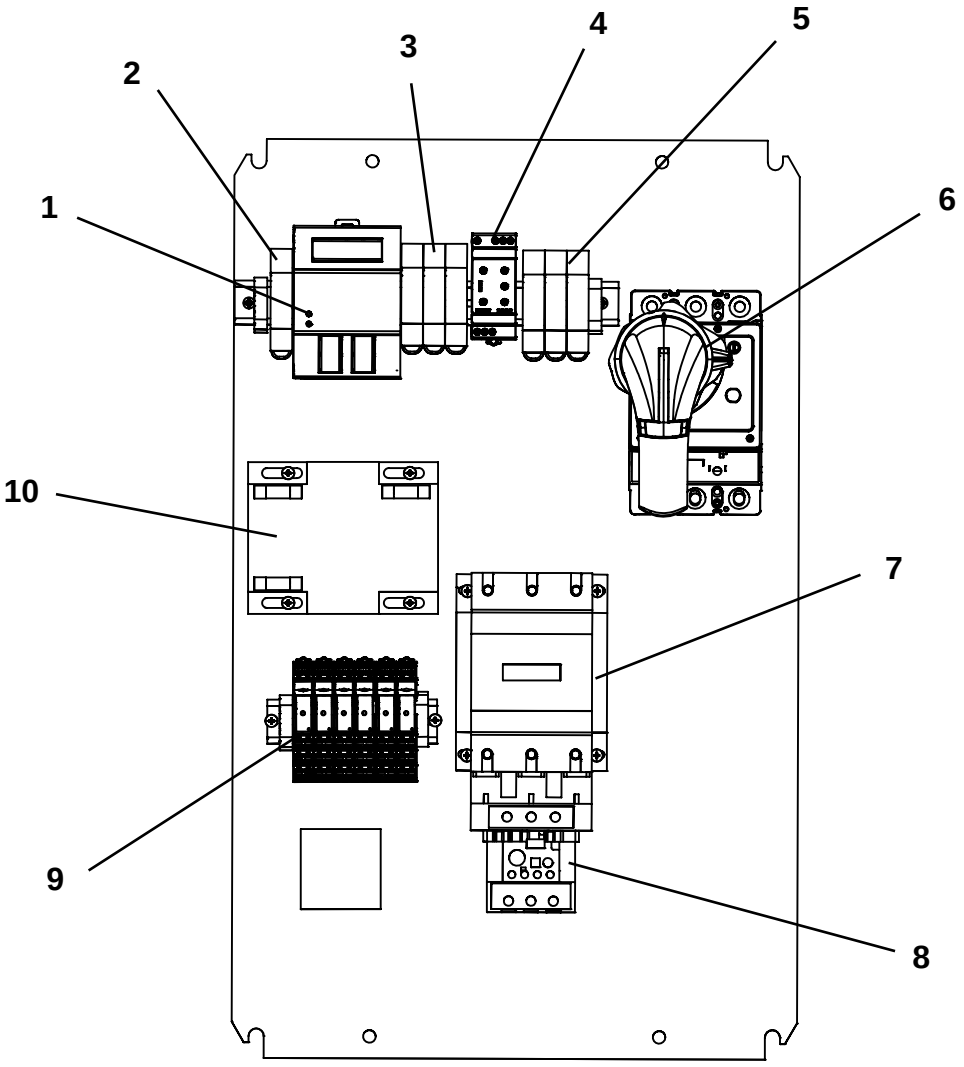
High Pressure Pendant

1. Emergency Stop Button
2. Low PSI 1 Start Button
3. Low PSI 1 Stop Button
4. Low PSI 2 Start Button
5. Low PSI 2 Stop Button
6. Low PSI 3 Start Button
7. Low PSI 3 Stop Button
*8. Standby-Flow Selector Switch
9. Emergency Stop Button
10. High Pressure Pump Start Button
11. High Pressure Pump Stop Button**
12. Jack Extend Button
13. Jack Retract Button
14. IJS Button
15. Auxiliary Button
16. Flow Control Switch

* The Standby-Flow Selector Switch must be in standby position at startup. Otherwise the module start button will not be enabled.

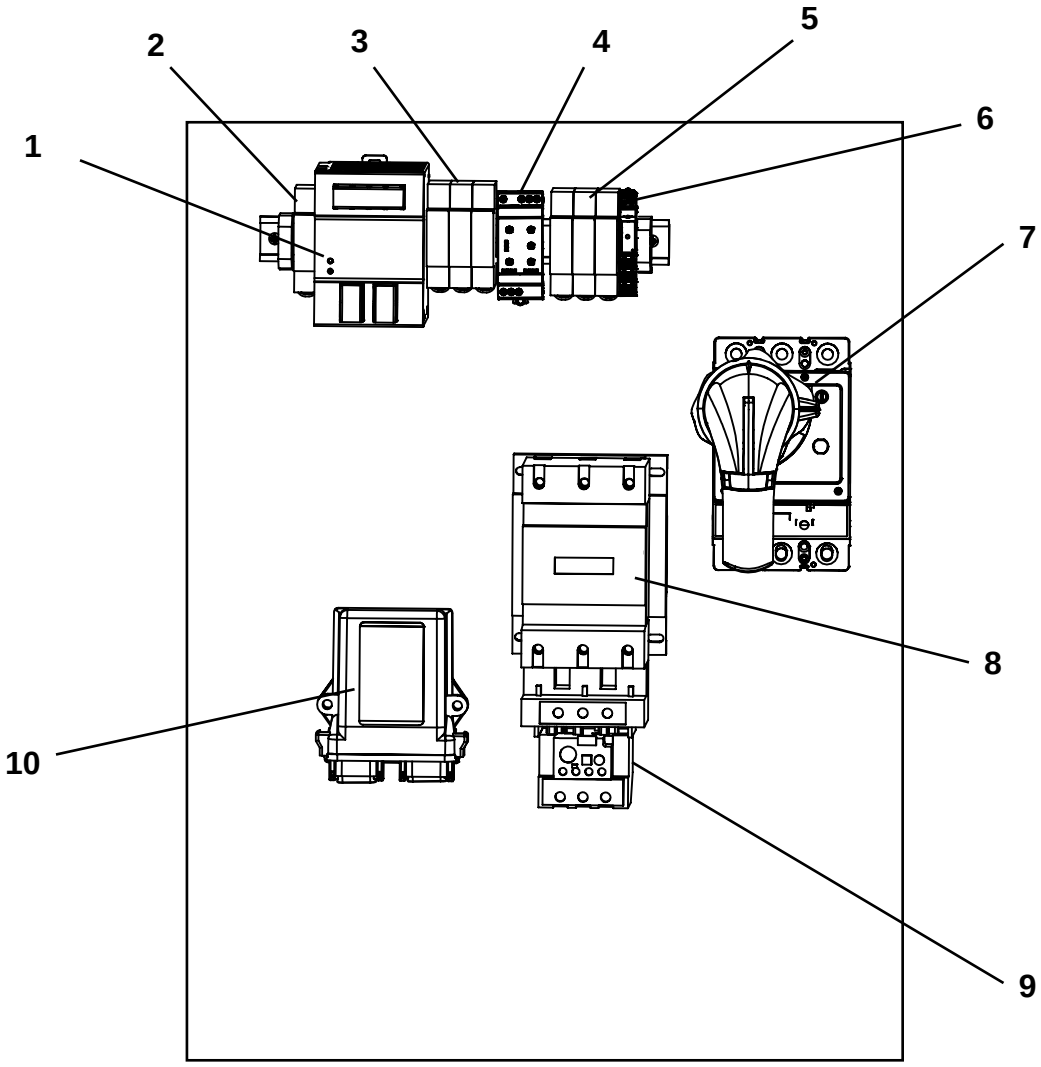
** Hold start button for five seconds until the high pressure pump starts.

HIGH PRESSURE MODULE PANEL (INTERIOR)



1. Power Supply, 24V
2. Power Supply Output Fuses
3. Power Supply Input Fuses
4. Phase Monitor
5. Phase Monitor Fuses
6. Main Power Disconnect
7. Contactor
8. Overload Relay
9. Control Relay
   (Extend/Retract/IJS/Aux/RPA/TimeDelay)
10. Transformer

LOW PRESSURE MODULE PANEL (INTERIOR)



1. Power Supply, 24V
2. Power Supply Output Fuses
3. Power Supply Input Fuses
4. Phase Monitor
5. Phase Monitor Fuses
6. Pump Start Control Relay
7. Main Power Disconnect
8. Contactor
9. Overload Relay
10. Pressure Control Module

NOTES

Controls & Instruments

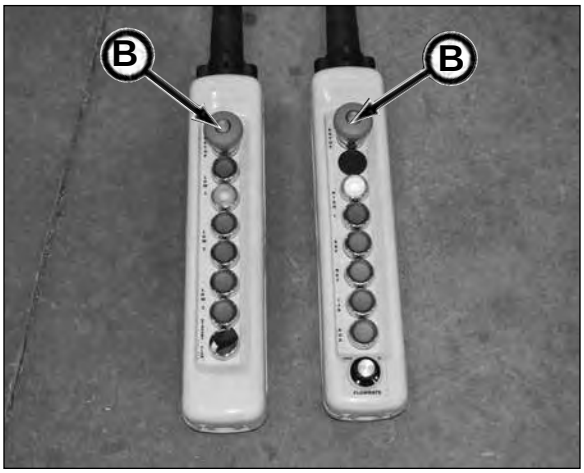
EMERGENCY STOP (E-STOP) BUTTON

The Emergency Stop buttons on the Power Pack control panel (A) and pendants (B) will stop the electrical motor rotation and hydraulic power.

The Power Pack operating lights are not controlled by the E-Stop button. Thus if the operating lights are on before the E-Stop button is pushed in, the operating lights will remain on.

The button functions as follows.

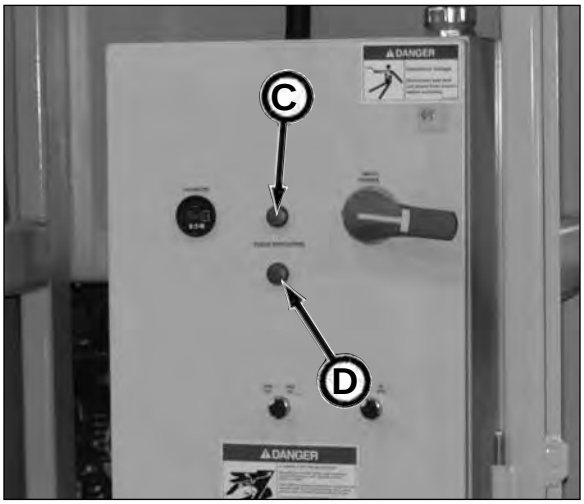
STOP - Push button IN
Power for Start Circuit - Pull button OUT



POWER PHASE INDICATORS

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

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



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

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

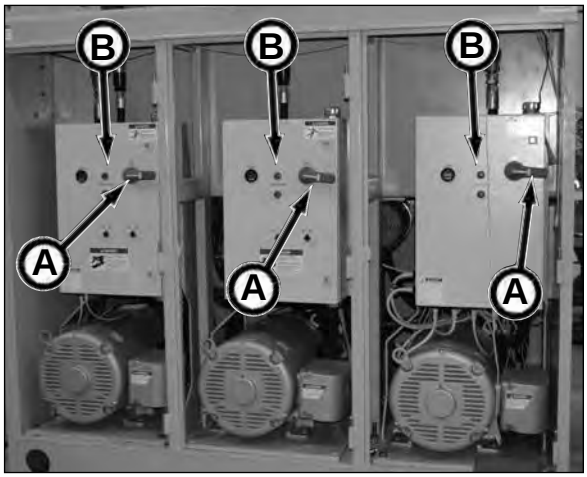
MAIN POWER DISCONNECT SWITCH

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

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

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

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

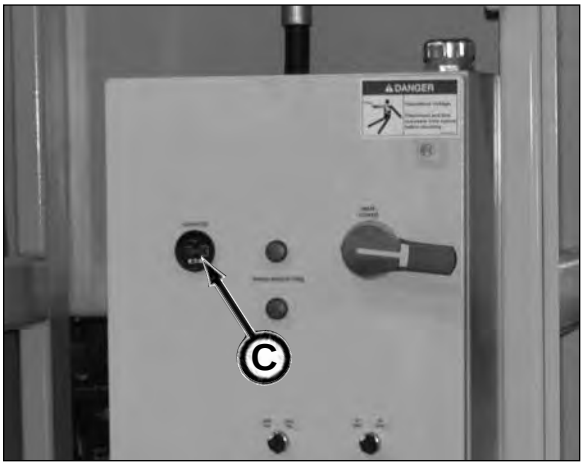


Use the main power disconnect switches (A) to allow electrical power from an external power source to the power pack modules. This will supply hydraulic oil to the TBM, conveyor and jacking frame components.

1. Turn on external power source and check Power Phase Indicators (B) for proper phase (refer to Power Phase Indicators in this section).

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

HOURMETER



A hourmeter (C) is installed on each power module electrical box to help determine proper maintenance intervals.

The hourmeter registers in full hours and 1/10ths hours.

Time accumulates when pump is running.

LOW PRESSURE MODULE BORING HEAD SUPPLY CONTROLS

The low pressure (LP) power module contains the boring head supply controls that regulate the hydraulic oil flow to the boring head components and conveyor.

The P6000E maximum flow is 120 GPM. The maximum pressure is 3,000/5,000 psi. ***(5,000 psi requires TBM Series II and hoses/supply lines rated at a minimum of 5,000 psi)***.

NOTICE The frame electrical and pendant controls are powered by LP1. Low pressure module 2 (LP2) can be used in place of the low pressure module 1 (LP1). The low pressure module 1 and 2 motor systems are identical 100 HP hydraulic systems.

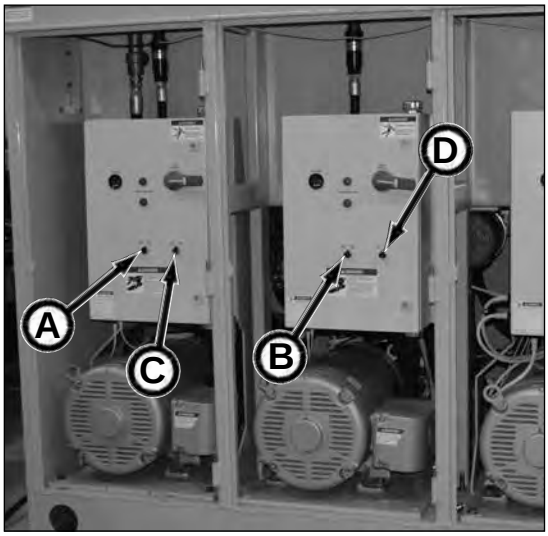
When using 3,000 psi selection on the low pressure modules, the low pressure adapter PN 027699A is required.

- ***USING PRESSURE SELECTOR SWITCH (A &/or B) AT 3,000 PSI POSITION***

Single Feed (60 gal) for all TBMs:
LP module 1 GPM Selector switch (C) to 60 gal position.

Dual Feed (90 gal) for all TBMs:
LP module 1 GPM Selector switch (C) to 60 gal position.
LP module 2 GPM Selector switch (D) to 30 gal position.

Dual Feed (120 gal) for TBM 540, 600, 660, 720, 780 & Series II TBMs:
LP module 1 GPM Selector switch (C) to 60 gal position.
LP module 2 GPM Selector switch (D) to 60 gal position.



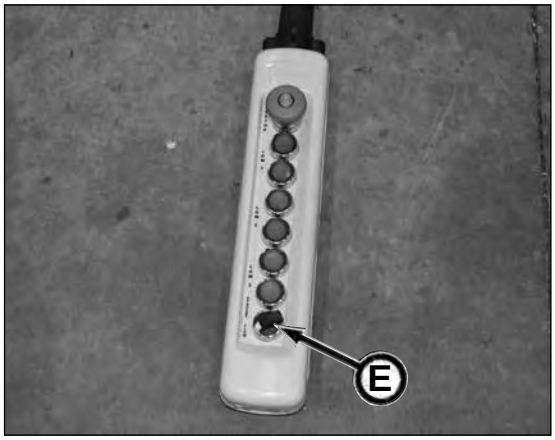
- ***USING PRESSURE SELECTOR SWITCH (A &/or B) AT 5,000 PSI POSITION***

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

Single Feed (40 gal) for Series II TBMs:
LP module 1 GPM Selector switch (C) to 30 gal position.

Single Feed (80 gal) for Series II TBMs:
(Check Valve Assembly F27624F Required)
LP module 1 GPM Selector switch (C) to 30 gal position.
LP module 2 GPM Selector switch (D) to 30 gal position.

Dual Feed (80 gal) for Series II TBMs:
LP module 1 GPM Selector switch (C) to 30 gal position.
LP module 2 GPM Selector switch (D) to 30 gal position.



NOTICE Though it is possible for a 90 GPM (3,000 psi) or 80 GPM (5,000 psi) single feed flow through the main supply line, it is highly **NOT** recommended to do so since it will cause additional heat and pressure loss due to back pressure in the system. It is recommended to use a maximum of 60 GPM flow through each of the boring head supply lines for a maximum flow of 120 GPM.

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

The low pressure pendant Standby-Flow switch (E) must be in Flow position for the TBM functions.

A - LP Module 1 Pressure Selector Switch
B - LP Module 2 Pressure Selector Switch
C - LP Module 1 GPM Selector Switch
D - LP Module 2 GPM Selector Switch
E - Low Pressure Pendant Standby-Flow Selector Switch

LOW OIL LEVEL INDICATOR

The Power Pack is equipped with a low oil level indicator (A). When the oil level in the hydraulic oil reservoir reaches the low oil level sensor, the low oil level indicator will illuminate on the frame control providing the operator a visual warning that the hydraulic reservoir must be refilled.

In addition, the power pack will shut down the hydraulic power from the pumps preventing damage to components.

HIGH OIL TEMPERATURE INDICATOR

The high oil temperature indicator (B) on the frame control will illuminate when the oil temperature in the hydraulic oil reservoir reaches a preset temperature (160°F factory setting) on the high oil temperature shutdown control.

In addition, the power pack hydraulic power will shutdown to prevent damage to components. The hydraulic operation will resume once the oil reservoir temperature lowers to 150°F (factory setting).

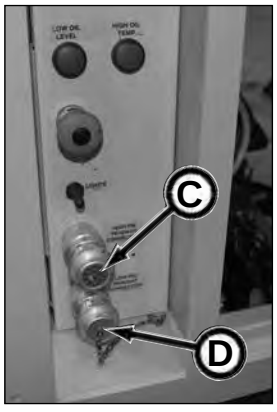
CONTROL PENDANTS

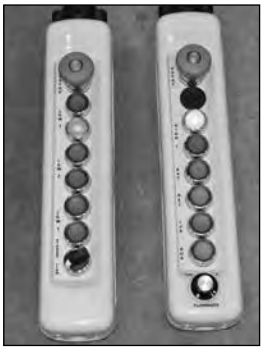
The control pendants allow the operator to control the power pack high and low pressure modules in the launch shaft.

The low pressure control pendant provides hydraulic oil flow to the TBM and conveyor components. Connect the low pressure pendant to receptacle (C).

The high pressure control pendant regulates the hydraulic high pressure oil to the jacking frame, IJS and other auxiliary components. Connect the high pressure pendant to receptacle (D).

NOTICE If one of the control pendants is not connected to the pendant receptacle, the Pendant Bypass Plug (PN 028268A00) must be installed into the unused receptacle. Failure to do so will not allow the power pack to function.

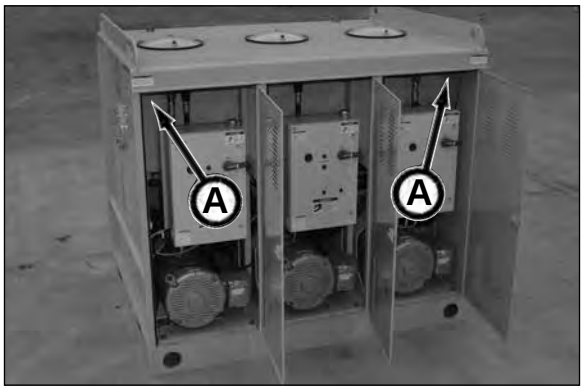




Low Pressure Pendant

High Pressure Pendant

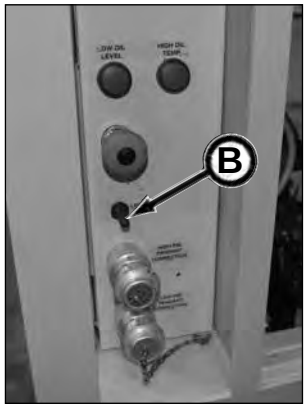
LIGHTS



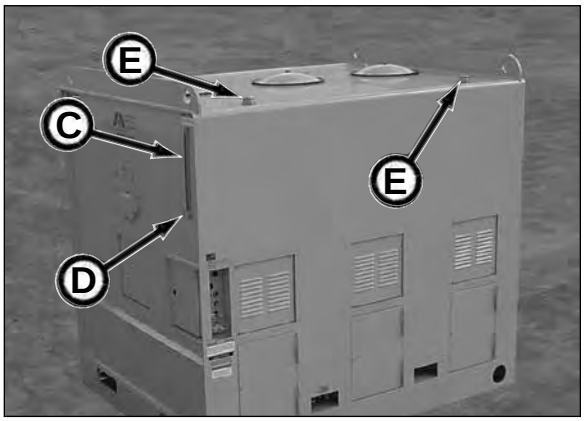
The power pack is equipped with operating lights (A).

Flip light switch (B) to turn lights on or off.

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



HYDRAULIC OIL RESERVOIR



The hydraulic reservoir includes an oil level sight gauge (C) and temperature gauge (D).

The reservoir capacity is 600 gal. (2,271 L).

Filling oil reservoir:

1. Clean area around fill cap(s) (E).

2. Remove fill cap(s).

3. Fill reservoir with clean, fresh, **FILTERED** ISO-VG-46 20W Premium Hydraulic/Turbine Oil or equivalent. Filling reservoir with unfiltered oil will cause component damage.

NOTICE If you change to a different oil, use a reputable oil supplier to meet or exceed the ISO-VG-46 20W or API GL-1/GL-2 oil specification. Do not mix oil manufacturers or grades.

4. Replace fill cap(s).

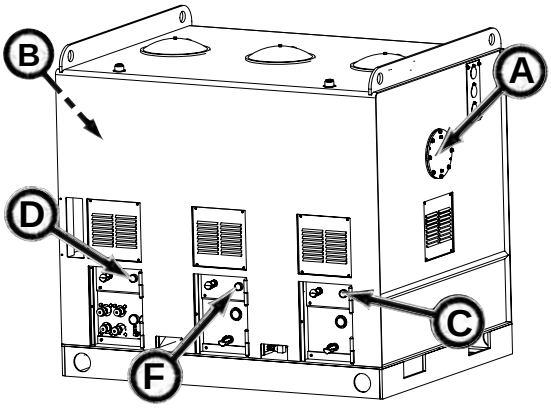
The Power Pack is equipped with a low oil level indicator. When the oil level in the hydraulic oil reservoir reaches the low oil level sensor, the low oil level indicator will illuminate on the frame control and the hydraulic power will shut down to prevent damage to components.

The Power Pack is also equipped with an automatic temperature control. The cooling pump will automatically start at 130°F (54°C) and will continue to operate until the E-Stop is engaged or the power is shut off.

The high oil temperature indicator on the frame control will illuminate when the oil temperature in the hydraulic oil reservoir reaches 160°F (71°C). This will shut down hydraulic power to prevent damage to components. The hydraulic operation will resume once the oil reservoir temperature lowers to 150°F.

RETURN FILTER INDICATORS

To prevent under or over servicing of the hydraulic filter elements, filter indicators are installed on your power pack.



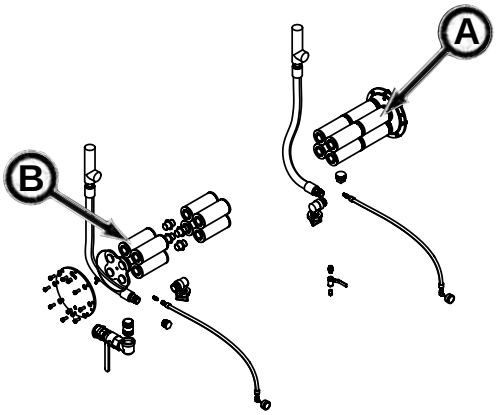
Return Filter Assembly (RFA1 (A) & RFA2 (B))
Filter Indicator (C & D)

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

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

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

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



Charge/Cooling Filter Assembly (E)
Filter Indicator (F)

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

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

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

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

PRESSURE GAUGES

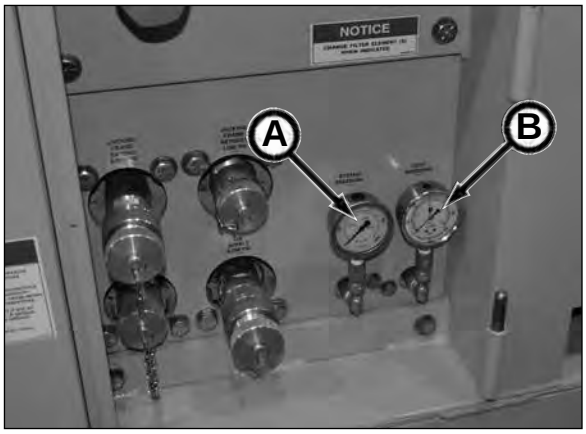
The P6000E Power Pack is equipped with four pressure gauges to monitor the high pressure module system and pilot pressures, and the low pressure modules system pressures.

High Pressure Module
The high pressure module is used to control the jacking frame and the intermediate jacking station (IJS). The jacking and IJS systems are capable of 8,000 psi.

System Pressure Gauge (A)
This system is capable of 8,0000 psi.

Pilot Pressure Gauge (B)
This system is capable of 350 psi.

IMPORTANT: The Extend and IJS connections require hoses/lines rated for at least 8,000 psi. Failure to do so WILL cause severe injury or death from bursting oil hoses/lines.



High Pressure Module

Low Pressure Modules
The pressure modules are used to control the boring head components and conveyor.

Low Pressure Module 1
System Pressure Gauge (C)
This system is capable of 3,000/5,000 psi

Low Pressure Module 2
System Pressure Gauge (D)
This system is capable of 3,000/5,000 psi

IMPORTANT: The 5,000 psi selection requires oil hoses/lines rated for at least 5,000 psi. Failure to do so WILL cause severe injury or death from bursting oil hoses/lines.

Low Pressure Modules

HYDRAULIC OIL COOLING SYSTEM

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

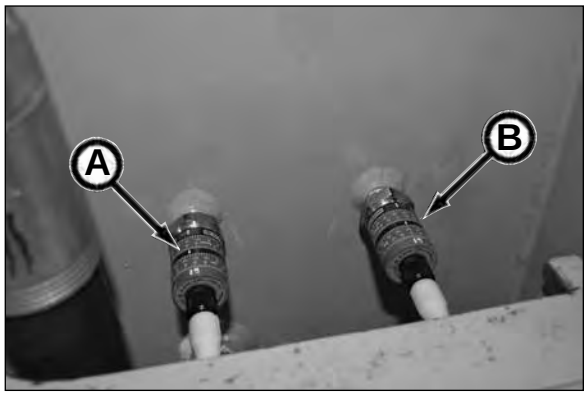
The heat exchanger water supply must be a minimum of 8 GPM of CLEAN water.

IMPORTANT: If power pack is powered on, the cooling/charge pump will start automatically if:
• the high pressure module is engaged or
• the oil reservoir temperature reaches 130°F (54°C), the factory setting. The pump will continue to operate until; the E-Stop is engaged, the reservoir oil temperature reaches the oil shutdown temperature 160°F or the power is shut off.

Heat Exchanger Supply Connection, Discharge Connection & Drain Plug Location (E)

TEMPERATURE CONTROLS

The power pack is equipped with two temperature controls; the cooling pump oil temperature control (A) and the high oil temperature shutdown control (B).

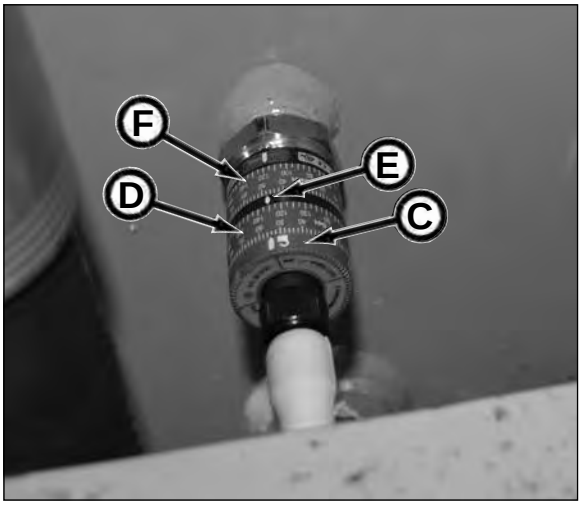


IMPORTANT: If the power is connected to the power pack and the main power disconnect is in the ON position, the cooling pump will operate at anytime the hydraulic oil reaches 130°F (54°C) and will continue to operate until an E-Stop button is engaged or the power is shutoff.

To change the temperature settings from the factory settings:

COOLING PUMP OIL TEMPERATURE CONTROL

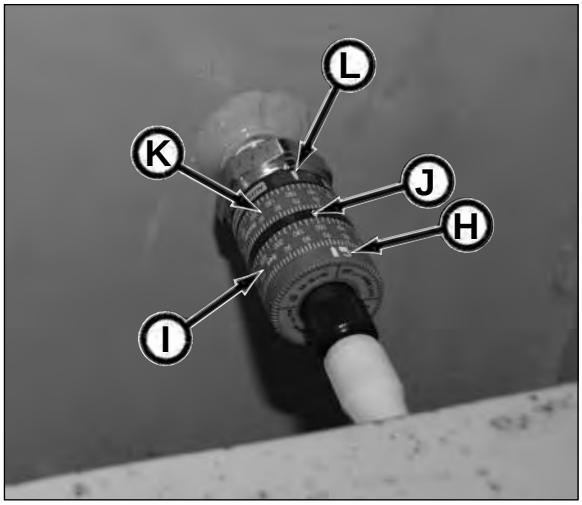
1. Gain access to the cooling pump oil temperature switch (A).
2. Turn lock/unlock dial (C) to the unlock position.
3. Turn set dial (D) to desired temperature for cooling pump to turn on and align with arrow (E). The factory setting is 130°F (54°C).
4. Reset dial (F) is not used since the cooling pump will continue to operate until an E-Stop button is engaged or the power is shutoff.
5. Once the dials are set, turn the lock/unlock dial to the lock position.



Cooling Pump Oil Temperature Control (A)

HIGH OIL TEMPERATURE SHUTDOWN CONTROL

1. Gain access to the high oil temperature shutdown switch (B).
2. Turn lock/unlock dial (H) to the unlock position.
3. Turn hydraulic system shutdown set dial (I) to desired temperature to shutdown the hydraulic system and align with arrow (J). The factory shutdown setting is 160°F (71°C).
4. Turn hydraulic system reset dial (K) to desired temperature to restart the hydraulic system and align with arrow (L). The factory reset setting is 150°F (65.5°C).
5. One the dials are set, turn the lock/unlock dial to the lock position.



High Oil Temperature Shutdown Control (B)

Pre-Start Inspection

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

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

Use the following checklist ✓ as a guide for your daily pre-start inspection. Make a copy of this Pre-Start Inspection checklist. Once it is complete, check off, initial and date each item and file the copy as a recored of 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. Keep job site clean and organized.
	4. Check condition of personal protective equipment. Replace equipment if defective.
	5. Contractor is responsible for all personnel to wear proper protective equipment on the job site.
	6. Remove combustible or flammable materials from equipment. Store materials properly.
	7. Test ALL Emergency Stop buttons for proper operation at the start of each shift. Repair if needed.
	8. Test air monitoring and ventilation detectors for proper operation.
	9. Thoroughly inspect all equipment for damage, including loose or missing hardware. Repair or replace before operating.
	10. Be sure all covers and guards are in place before operation.
	11. Check electrical lines for frayed, damaged, or worn insulation or wires. Replace damaged or worn electrical lines/connections.
	12. Check for fluid leaks. Repair leak or replace components.
	13. Keep job site clean and organized.
	14. Test the electrical motors for proper rotation prior to operating the pump unit or power pack.
	15. Test each function and control to ensure correct operation.
	16. Check hydraulic hoses and lines for leaks, wear and/or damage. Replace any defective hoses and/or lines.
	17. Check oil level in hydraulic oil reservoirs. Add as needed.
	18. Perform pre-start inspection on your equipment. Refer to your equipment’s operation manuals.
	19. Perform all lubrication and maintenance procedures. Refer to Section 9, Periodic Maintenance.

NOTES

Operation

OPERATING GUIDELINES

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

1. Before operating, read and understand the Safety, Pre-Start Inspection, Operation and Maintenance sections.

2. Do not operate this equipment while under the influence of alcohol, drugs, or medication.

3. Follow all Federal, State, and Local safety regulations and procedures.

4. Be sure OSHA prescribed safety protective equipment is being worn by all personnel.

5. Be sure the area is safe for operation. Keep worksite clean and orderly.

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

7. Have a fully charged fire extinguisher on the job site at all times.

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

9. Wear reasonably close fitting clothing and remove jewelry to prevent an entanglement hazard.

10. Be sure the excavated launch and reception shafts are properly shored or braced to prevent slides or cave-ins.

11. Test air monitoring and ventilation detectors for proper operation. Never enter a tunnel without air monitoring and ventilation detectors.

12. A fully trained and qualified signal person must direct the excavator or crane operator when lifting and lowering equipment, pipe and supplies into the launch or reception shafts.

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

14. Test each function and control to make sure they work properly.

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

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

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

18. Before starting equipment, thoroughly inspect all equipment. Inform all job site personnel that the equipment will be starting up. Do not start until all unauthorized personnel are clear of the equipment.

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

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

(continued on next page)

Operating Guidelines (continued)

21. Check line and grade alignment often. Keep in mind if you are off one degree, the bore will be off nearly two feet per one hundred feet.

22. If this manual becomes lost, contact your Akkerman Aftermarket Support representative for a new manual or download this manual from the Akkerman web site at www.akkerman.com.

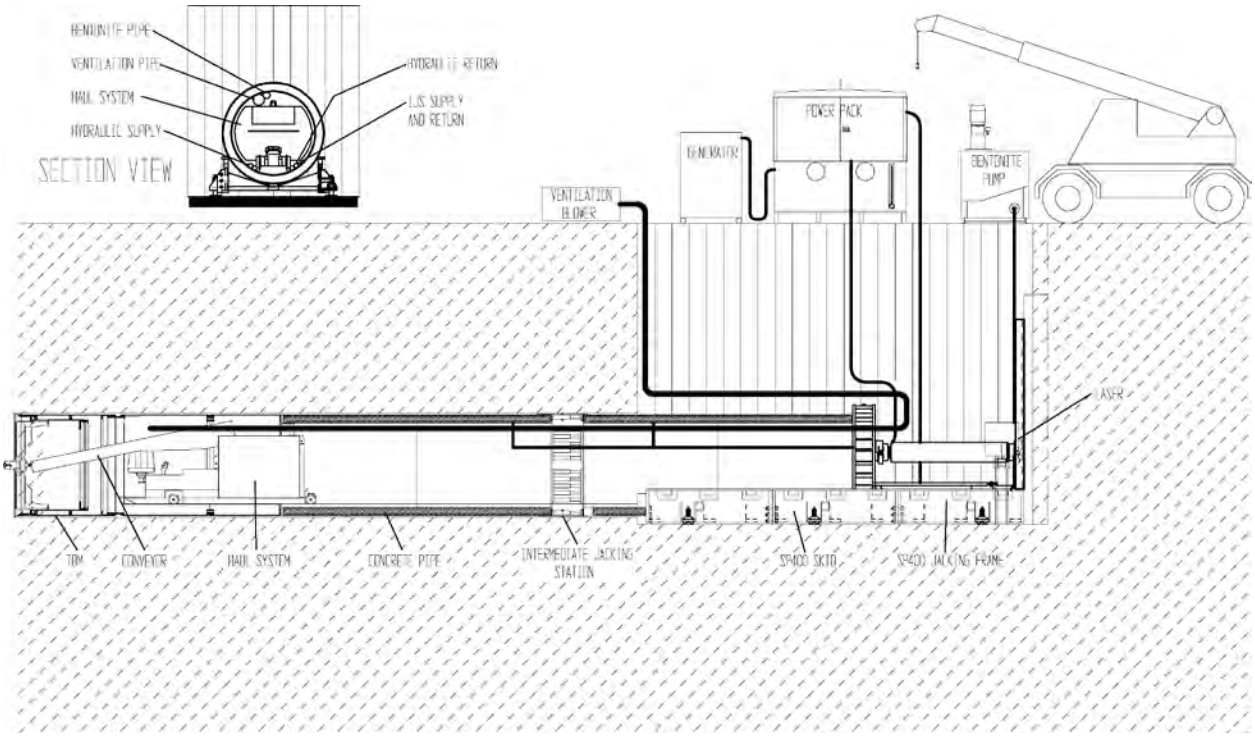
23. The operator must note and report any slow down of machine operating time that might be an early warning of future problems.

24. Do not make adjustments or repairs to any of the system components while in operation. All pressure must be released and electrical power must be locked out, tagged out.

25. High pressure hydraulics are used on the jacking system. Be sure all cover and guards are in place before operating.

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

TYPICAL POWER PACK/JACKING FRAME SYSTEM LAYOUT



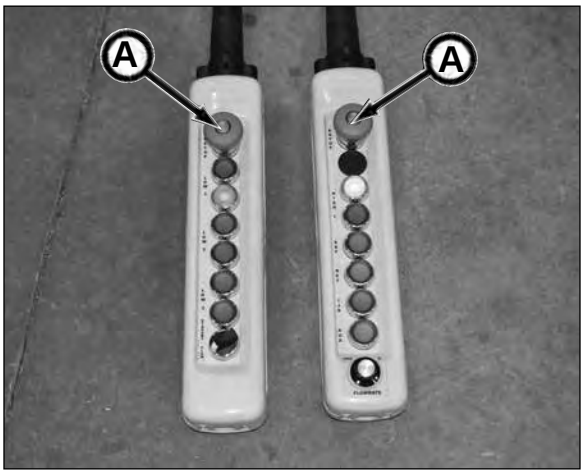
USING EMERGENCY STOP (E-STOP)

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

Push any Emergency Stop button (A) IN to stop the electrical motor rotation and hydraulic flow.

This button must be pulled out to restart operation.

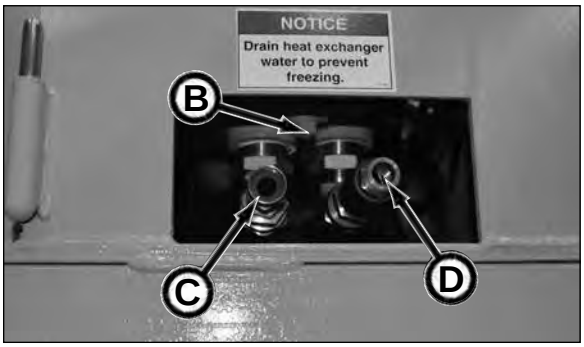
The operating lights will shutoff when the Emergency Stop is pushed IN.



P6000E POWER PACK SETUP

1. Power Pack must be placed on a level, solid foundation.

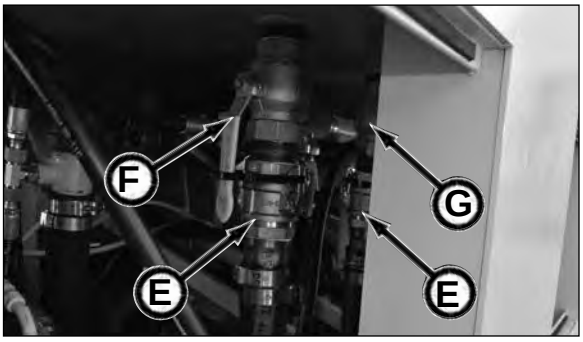
2. Check hydraulic on oil level gauge (A). If needed, add ISO-VG-46 20W Premium Hydraulic/Turbine Oil as necessary.



3. Install heat exchanger drain plug (B).

4. Connect a fresh, clean water supply hose with 8 GPM minimum to heat exchanger fitting (C). The water must be clean otherwise any sediment or debris in the water will plug heat exchanger.

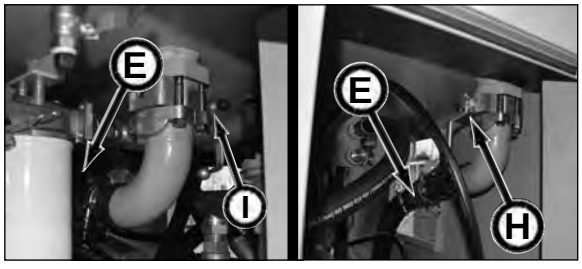
⚠WARNING To avoid serious personal injury, the water discharge must not flow into any electrical or machine areas and must drain safety away from the power pack.



5. Connect a water discharge hose (D) to heat exchanger.

   Be sure hoses do not come in contact with moving parts.

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



6. Check to be sure pump suction cam locks (E) in are securely connected.

7. Open all pump suction valves; HP pump (F), charge pump (G), LP1 (H) & LP2 pumps (I). To prevent accidental closure of valves while operating, tie strap the HP and charge pump valves open and lock the LP1 and LP2 valves in the open position.

(continued on next page)

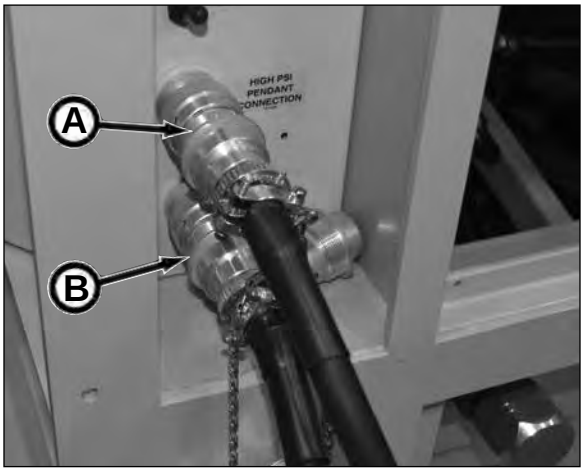
⚠DANGER Hazardous voltage. Disconnect and lock out power from source before connecting power leads. Only a certified electrician must connect the generator power leads to the power pack connections. Guards and shields must be in place at all times.

NOTICE A certified electrician must connect the generator power leads to the 480 Volt power module connections.

8. Connect generator power leads to Power Pack. Remove cover. Route generator power cables through panel and secure to main power disconnect power leads (see inset). Repeat for other modules.

9. Connect the control pendant(s) to the appropriate high pressure (A) and/or low pressure (B) receptacles on the Power Pack control panel.

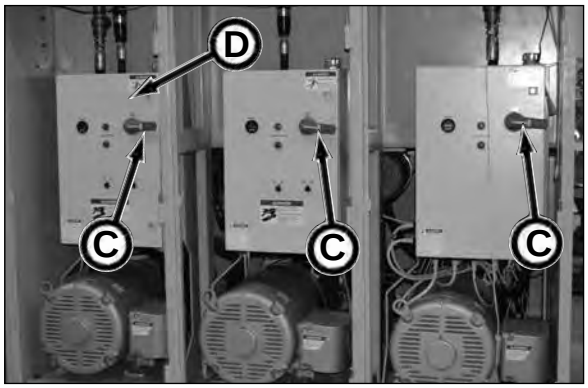
10. Install Pendant Bypass Plug (PN 028268A00) on any unused control box pendant receptacles. Failure to do so will not allow the Power Pack to function.



11. Turn on main power source.

NOTICE LP1 module (D) must be powered ON before the other modules will operate.

12. Flip module main power disconnect switch(s) (C) to ON position.



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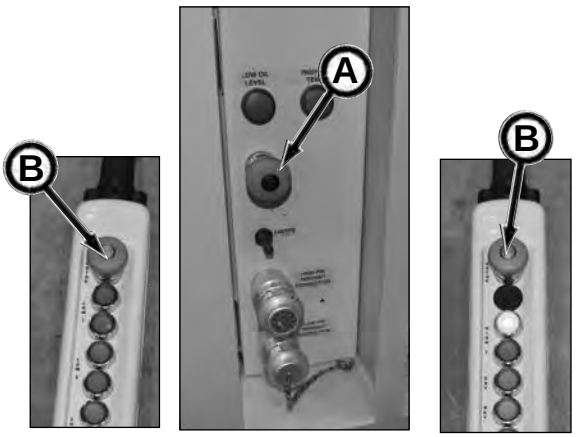
13. Pull out E-Stop button (A), including E-Stop buttons (B) on control pendants.

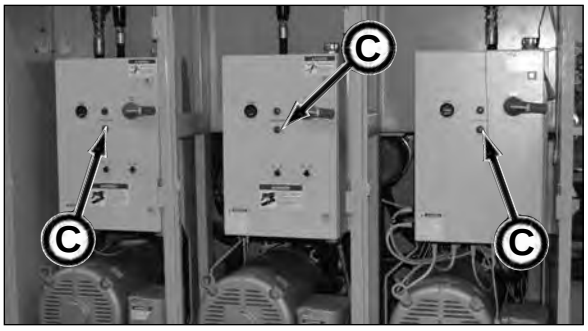
14. Test each E-Stop button for proper operation. If any E-Stop button fails to operate properly, IMMEDIATELY turn main power disconnect switch OFF, LOCKOUT TAGOUT the power source and have a certified electrician repair the E-Stop button(s) before the equipment is operated.



Low Pressure Pendant

High Pressure Pendant

15. With proper E-Stop operation, check the phase indicators on each module. If the red Phase Error indicator (C) is illuminated on any of the modules, LOCKOUT TAGOUT all power and have a certified electrician reverse any two generator electrical phase conductors on the power circuit and recheck phase power. The starting interlock equipped in each module disables the starting if the red Phase Error indicator is illuminated.

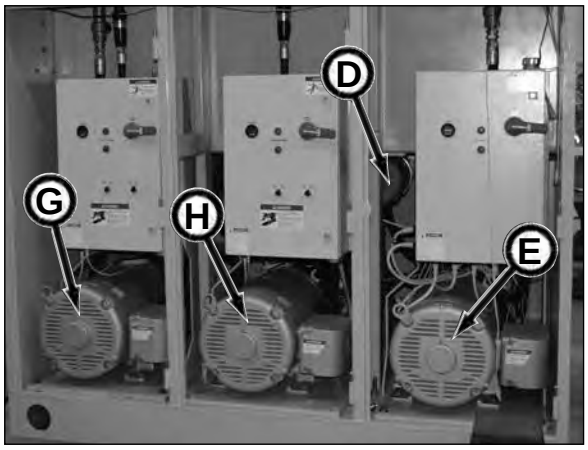


16. With proper E-Stop operation and electrical phase, start each module motor and check for proper operation.

    • The Cooling/Charge Motor/Pump (D) automatically starts when the high pressure pump start button is depressed or the oil reservoir temperature reaches 130F° (54°C).

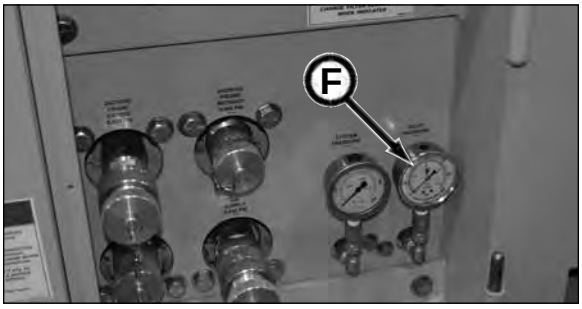
    • With the high pressure 100 HP (E) and 5 HP (D) motors running properly, check pilot pressure gauge (F) on high pressure module. Gauge should read approximately 350 psi.

    • With the low pressure 100 HP LP1 (G) and LP2 (H) motors running properly, the system pressure gauge (I) on the low pressure module should read up to 3,000/5,000 psi depending on the Pressure Selector Switch setting.



17. Stop all motors.

18. Proceed to P6000E Power Pack Hydraulic Setup in this section.



P6000E POWER PACK HYDRAULIC SETUP

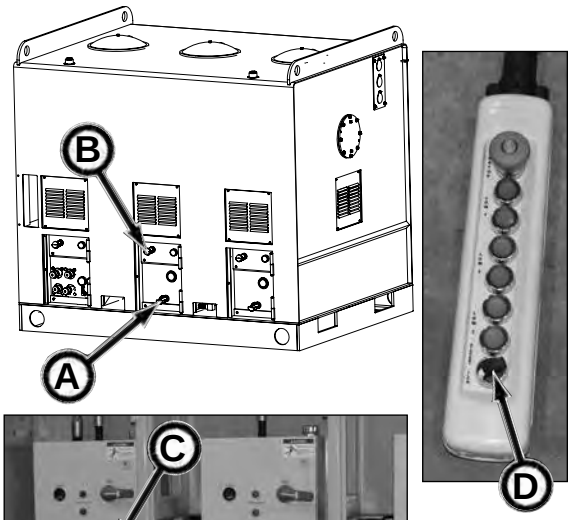
NOTICE **BEFORE** setting up the Power Pack hydraulics, refer to the Low Pressure Module Boring Head Supply Controls in section 4, Controls & Instruments and Power Pack Setup in this section.

⚠WARNING Escaping oil or other fluids under pressure can penetrate your skin causing serious injury. Contact medical help immediately if any oil or fluid is injected into your skin.
ALWAYS switch power supply switches to the STOP position, release hydraulic pressure AND use gloves before connecting or disconnecting hydraulic oil hoses/lines.

IMPORTANT: If operating the low pressure module in 5,000 psi mode, the supply hoses/lines MUST be rated at a minimum of 5,000 psi. If using the high pressure Extend and IJS connections, the supply hoses/lines MUST be rated at a minimum of 8,000 psi.

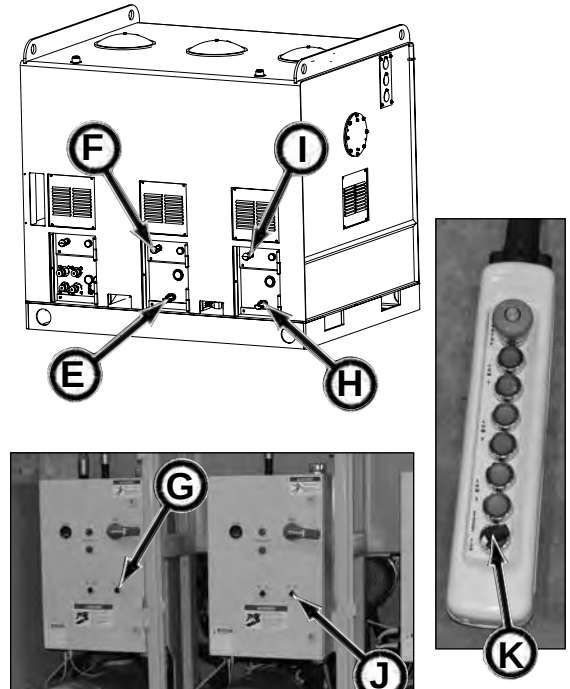
LOW PRESSURE HYDRAULIC SETUP

When using 3,000 psi selection on the low pressure modules, the low pressure adapter PN 027699A is required.



Single Feed Hydraulic Supply
(60 gpm of low pressure oil)

1. Connect the TBM main pressure supply hose to fitting (A) on a low pressure module.
2. Connect the TBM main return hose to fitting (B).
3. Select 60 GPM on the low pressure module 1 GPM Selector switch (C). This will supply 60 gpm to the TBM cutter head drive functions; inner drum advance and rotation, steering cylinders, conveyor lift, conveyor speed and dirt wings.
4. Setup TBM for single feed hydraulic connection (refer to your TBM operation manual for information).
5. Before starting, Standby-Flow control (D) must be at Standby position. To operate TBM functions, turn control to Flow position.
6. Proceed to High Pressure Hydraulic Setup on next page or to Checkout Equipment Prior To Start-Up in this section.



Dual Feed Hydraulic Supply
(90 gpm of low pressure oil)

1. Connect the TBM main pressure supply hose to fitting (E) on low pressure module 1.
2. Connect the TBM main return hose to fitting (F) on low pressure module 1.
3. Select 60 GPM on the low pressure module 1 GPM Selector switch (G). This will supply 60 gpm to the TBM cutter head drive functions; inner drum advance and rotation, steering cylinders, conveyor lift and dirt wings.
4. Connect conveyor supply hose to fitting (H) on low pressure module 2.
5. Connect the TBM conveyor return hose to fitting (I) on low pressure module 2.
6. Select 30 GPM on the low pressure module 2 GPM Selector switch (J). This will supply 30 gpm to the TBM conveyor drive.
7. Setup TBM for dual feed hydraulic connection (refer to your TBM operation manual for information).
8. Before starting, Standby-Flow control (K) must be at Standby position. To operate TBM functions, turn control to Flow position.
9. Proceed to High Pressure Hydraulic Setup on next page or to Checkout Equipment Prior To Start-Up in this section.

(continued on next page)

Dual Feed Hydraulic Supply
(120 gpm of low pressure oil)

1. Connect the TBM main pressure supply hose to fitting (A) on low pressure module 1.

2. Connect the TBM main return hose to fitting (B) on low pressure module 1.

3. Select 60 GPM on the low pressure module 1 GPM Selector switch (C). This will supply 60 gpm to the TBM cutter head drive functions; inner drum advance and rotation, steering cylinders, conveyor lift and dirt wings.

4. Connect conveyor supply hose to fitting (D) on low pressure module 2.

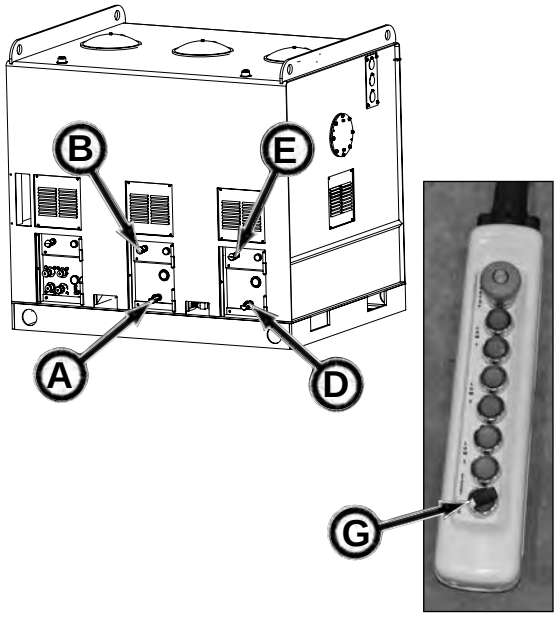
5. Connect the TBM conveyor return hose to fitting (E)on low pressure module 2.

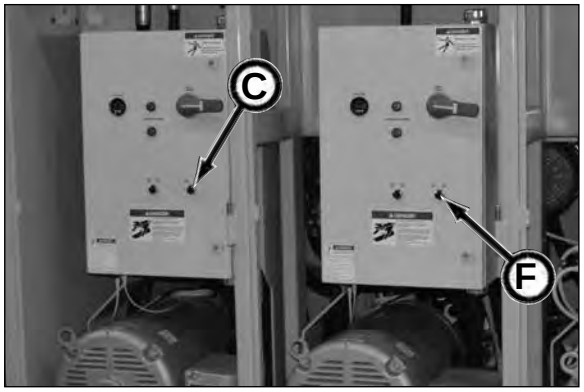
6. Select 60 GPM on the low pressure module 2 GPM Selector switch (F). This will supply 60 gpm to the TBM conveyor drive.

7. Setup TBM for dual feed hydraulic connection (refer to your TBM operation manual for information).

8. Before starting, pendant Standby-Flow control (G) must be at Standby position. To operate TBM functions, turn control to Flow position.

9. Proceed to High Pressure Hydraulic Setup below or to Checkout Equipment Prior To Start-Up in this section.





HIGH PRESSURE HYDRAULIC SETUP

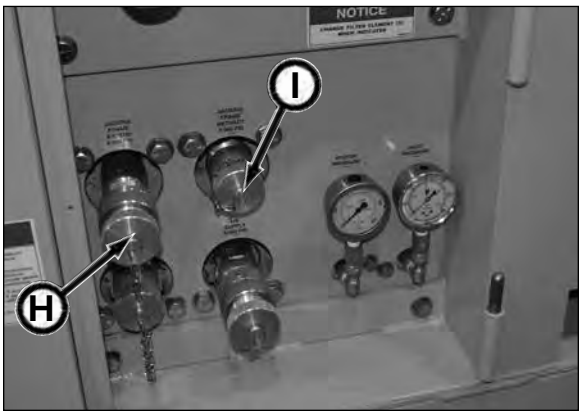
IMPORTANT: Jacking frame supply hoses/ lines MUST be rated at a minimum of 8,000 psi working pressure.

1. Connect the jacking frame supply hose to Extend connection (H) on the high pressure module.

2. Connect the jacking frame return hose to Retract connection (I).

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

4. If using an IJS system, refer to Using Intermediate Jacking Stations (IJS) in this section for hydraulic setup.



CHECKOUT EQUIPMENT PRIOR TO START-UP

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

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

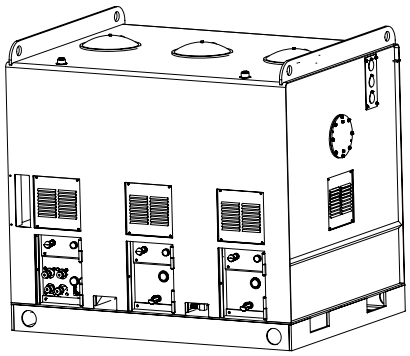
3. Check the oil level in the power pack hydraulic reservoir. Add oil if necessary.

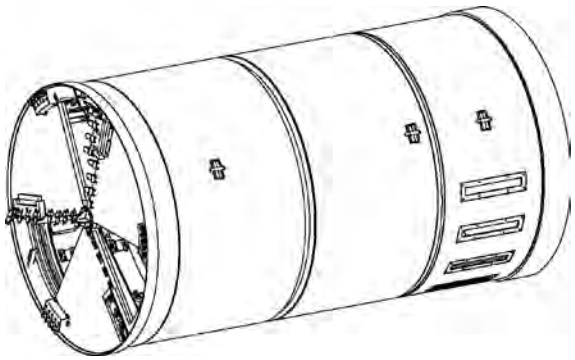
4. Check to be sure all suction valves are open and tie strapped to prevent accidental closing of valves.

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

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

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

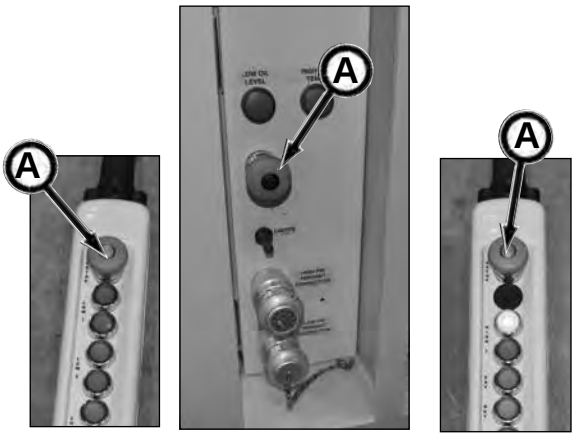




START UP PROCEDURE

NOTICE **BEFORE** starting Power Pack, be sure to follow Power Pack Setup and Power Pack Hydraulic Setup instructions in this section.

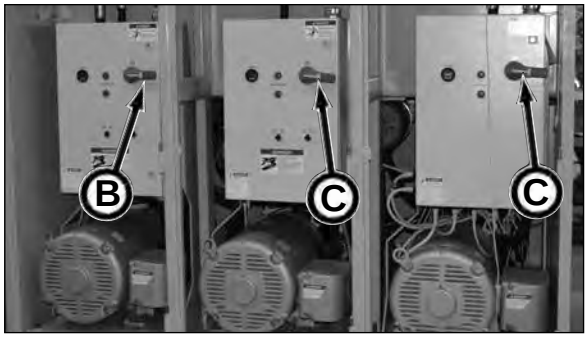
1. With hydraulic hoses and electrical cables properly installed and generator or power source ON, pull out all E-Stop buttons (A).



NOTICE LP1 module (D) must be powered ON before the other modules will operate.

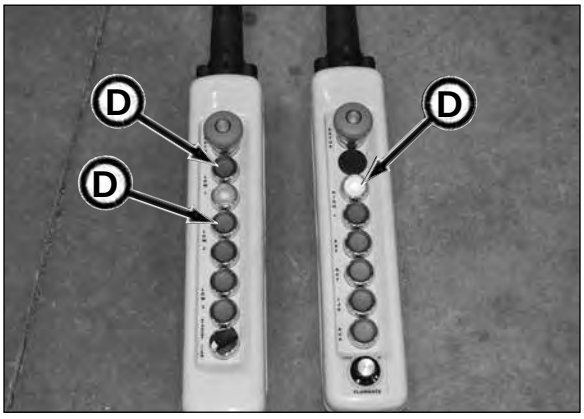
2. Flip LP1 module main power disconnect switches (B) to ON position.

3. Flip LP2 and/or HP1 module main power disconnect switches (C) to ON position.



4. Turn the low pressure and high pressure motors on one at a time to prevent overload by pressing the appropriate module(s) Start button (D) on low and high pressure pendants.

5. Check hoses for leaks.

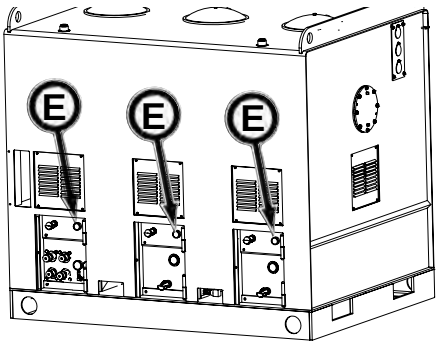


Low Pressure Pendant *High Pressure Pendant*

6. Check filter indicators (E). Replace filters as needed.

7. Be sure all air is purged from system.

8. Proceed to TBM Start-Up Procedure in your TBM operation manual.



ADDING NEW PIPE

⚠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. Retract jacking system cylinders.
2. Turn all switches to OFF.
3. Turn all control valves to the OFF position.
4. Shut down power source and perform lock out, tag out procedure.
5. With power locked out, relieve hydraulic pressure and disconnect TBM hydraulic pressure and return hoses, vent supply, 480V electrical line, bentonite hoses (if used), and IJS hydraulic hoses and cable (if used). Be sure all of the electrical lines, hose connections and cables are in a clean, dry location and are out of the way of the next pipe.
6. Disconnect track from pipeline.

7. Perform a visual machine inspection by checking the following items: all fluid levels, leaks, and machine damage. Make repairs before operating.
8. Lower the next pipe into shaft and wipe off and lubricate the sealing ring to ensure proper sealing before setting pipe.
9. Clean electrical and hose connections before reinstalling.
10. Reinstall TBM hydraulic pressure and return hoses, vent supply, 480V electrical line, bentonite hoses (if used), IJS hydraulic hoses and cable (if used) and communication lines. Check to be sure all connections are properly connected and secured.
11. Once it is communicated to all job site personnel that the power and machine operation will be resumed, start up power source.
12. Perform TBM and Power Pack system start-up.
13. Slowly advance the new pipe with the launch shaft jacking frame until pipe is set.
14. Install new pipe track to pipeline track. Sections of track will need to be added as new pipe is lowered. Also, be sure there is always track connecting the pipeline and the jacking frame/yoke for the haul unit and the loading and unloading of the dirt bucket.
15. After start-up, check target to be sure the laser was not bumped in the launch shaft.
16. Repeat installation for subsequent pipe.

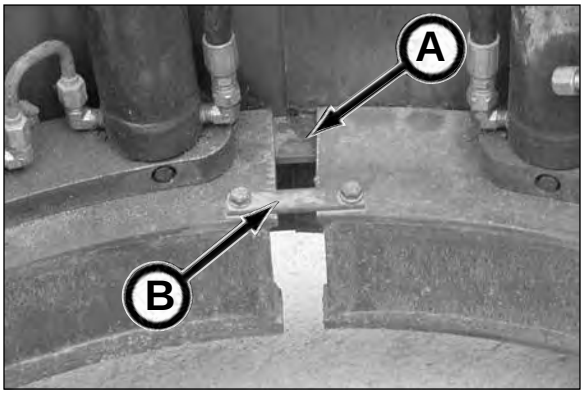
USING INTERMEDIATE JACKING STATIONS (IJS)

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

INSTALLING IJS

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

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



NOTICE IJS configurations may vary depending upon project requirements.

2. With the IJS lowered onto the skid assembly, cut inner ring flange (A), located at seam of sleeve, with torch and unbolt plate (B) before mating pipe with IJS.

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

3. SLOWLY jack until the trailing pipe slides into IJS sleeve and the IJS sleeve slides over leading pipe.

4. Use a winch or turn-buckle to squeeze the IJS sleeve until it mates with the leading and trailing pipe.

5. Tack weld seam.

6. Torch off lifting eyes.

7. Completely weld seam. Reweld flange (A) if possible.

8. Install track and sliding track. Be sure no track joints are in IJS opening.

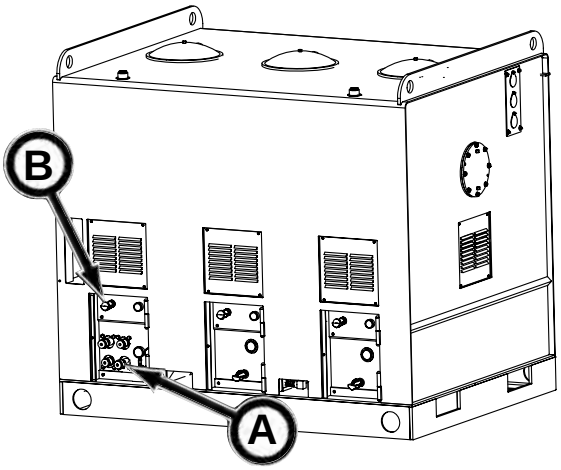
(continued on next page)

9. Connect hydraulic hoses to Power Pack.

   IMPORTANT: IJS supply hoses/lines MUST be rated at a minimum of 8,000 psi working pressure.

   a. Connect intermediate jacking station valve pressure port hose to quick coupler (A). Use hose rated for 8,000 psi minimum working pressure ONLY.

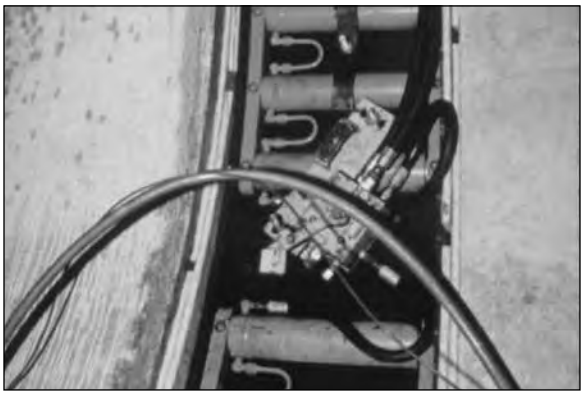
   b. Connect IJS tunnel return hose to coupler (B).

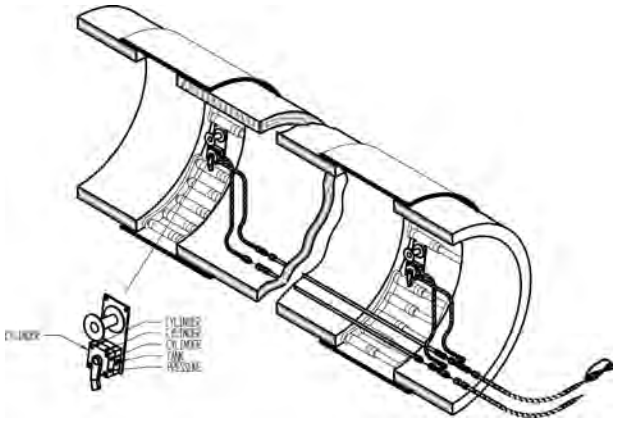


10. Mount the IJS valve between cylinder segments.

11. Connect hydraulic hoses to IJS valve:
    a. Pressure to port P
    b. Return to port T
    c. Connect cylinders to C ports

12. Secure cable weight to IJS line holder (not shown) on jacking frame.





(continued on next page)

OPERATING IJS

13. With the power pack running, depress the IJS button (A) on the high pressure pendant while adjusting flow rate with control (B).

14. Pull cable for IJS #1 to open valve and depress IJS (A) on pendant while adjusting flow rate. Operate the boring head the same as if the TBM is being jacked with the jacking frame cylinders.

15. When the IJS cylinders are at full extension, the pressure should start to climb rapidly. Maximum pressure is 8,000 psi.

16. Release cable and pendant IJS button.

17. Pull cable for IJS #2 to open and depress IJS on pendant to close IJS #1. When the IJS cylinders are at full extension, the pressure should start to climb rapidly.

NOTICE **Do not** operate TBM cutterhead when using IJS #2, IJS #3, etc. or when closing final IJS. Doing so could result in a pipe joint separation.

18. Release pendant IJS button.

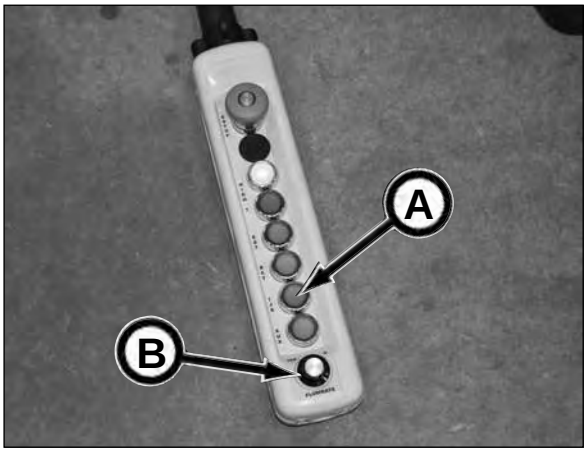
19. Pull cable for IJS #3 to open and depress IJS button on pendant to close IJS #2. When the IJS cylinders are at full extension, the pressure should start to climb rapidly.

20. Release pendant IJS button.

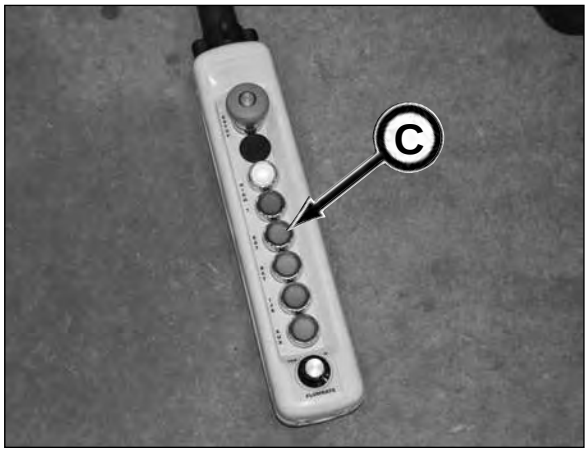
21. Repeat this opening and closing process for any additional IJS.

22. Continue jacking with jacking frame cylinders using the Extend button (C) on pendant to close the last IJS.

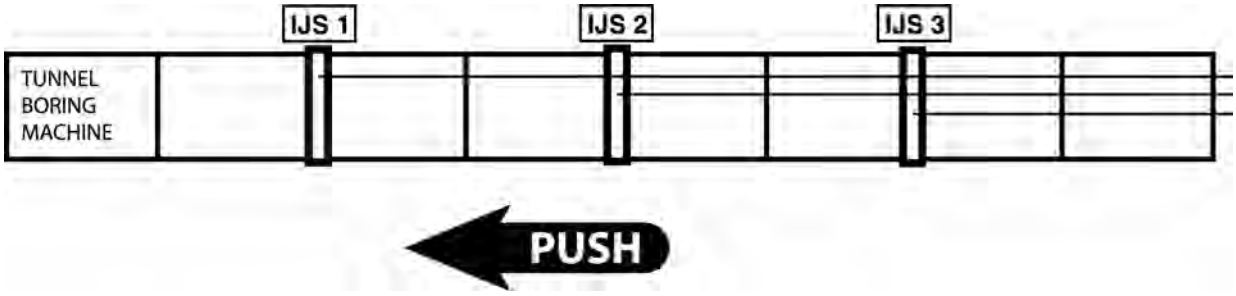
NOTICE Keep in mind when using the Intermediate Jacking Stations, you are only mining with IJS #1, then closing IJS #1 with IJS #2, closing IJS #2 with IJS #3, and closing IJS #3 with jacking frame cylinders



High Pressure Pendant



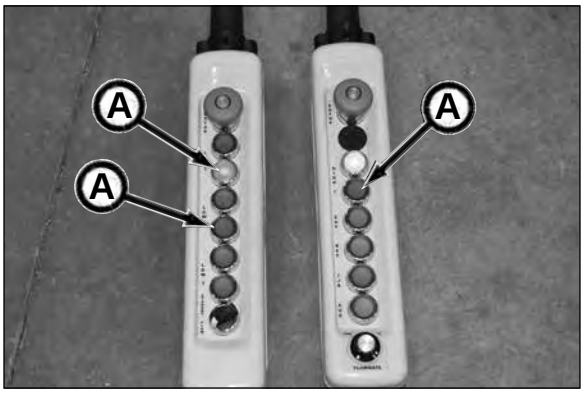
High Pressure Pendant



Intermediate Jacking Station Sequence

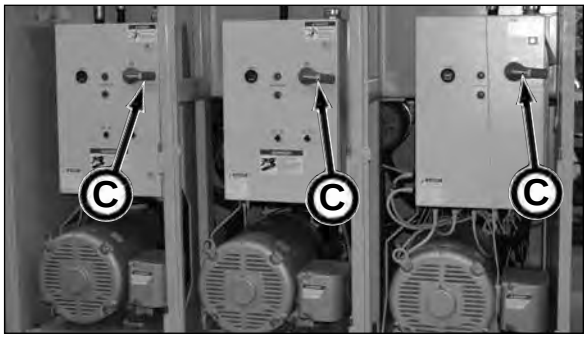
DAILY SHUT DOWN

1. Stop jacking frame hydraulics by depressing high pressure pendant STOP button (A).



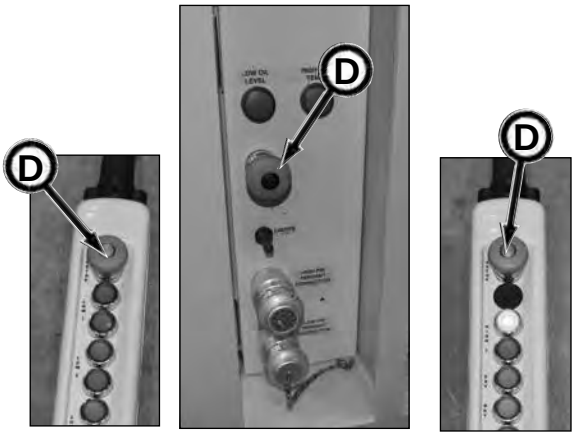
2. Shutdown all low pressure pumps/motors by depressing STOP buttons (B) on low pressure pendant.

Low Pressure Pendant *High Pressure Pendant*



3. Flip all power pack main power disconnect switches (C) to the OFF position.

4. Push IN all E-Stop buttons (D): Power Pack, power pack pendants and launch or reception shaft E-stop buttons (if equipped) to shut down power.



5. Shut off water supply to power unit/power pack heat exchanger. Drain water if freezing temperatures are possible.

6. Shut off main power source and perform lock out, tag out procedure.

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

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.

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.

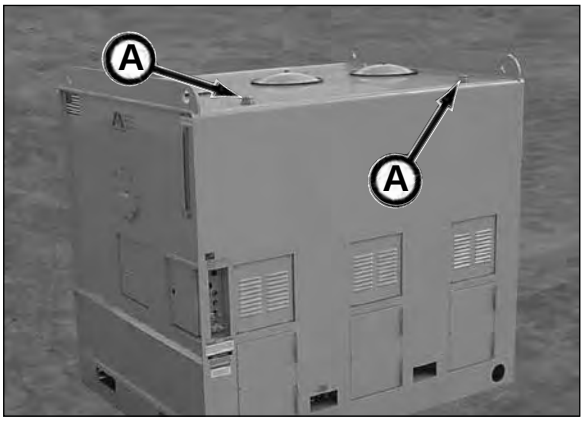
NOTES

Lubricants

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

HYDRAULIC RESERVOIR LUBRICANT

The P6000E Power Pack is filled with ISO-VG-68 20W Premium Hydraulic/Turbine Oil unless otherwise specified on hydraulic reservoir.



Hydraulic Oil Reservoir Capacity: 600 gal. (2,271 L)

NOTICE If using a too heavy of viscosity oil in cold temperatures, hydraulic oil pump damage could result due to pump cavitation. On the contrary, using ISO 32 oils above 150°F (65.5C°) operating temperatures (oil temp. in reservoir) will result in reduced hydraulic power to functions.

Recommended hydraulic oil:

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

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

Replace fill cap(s) (A) after refilling reservoir.

ELECTRIC MOTOR BEARING GREASE

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

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

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

STORING LUBRICANTS

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

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

NOTES

Periodic Maintenance

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

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

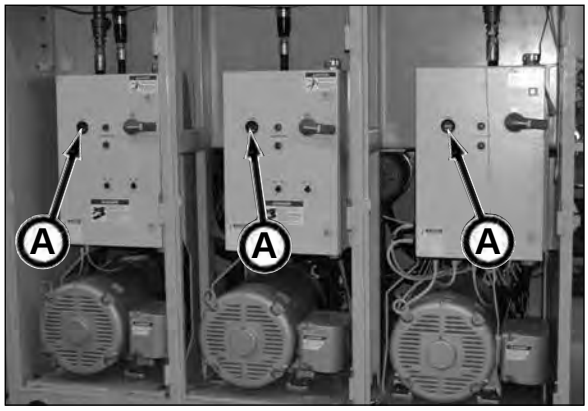
LUBRICATION & MAINTENANCE INTERVALS

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

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

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

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



BEFORE PERFORMING MAINTENANCE

1. Push IN all E-Stop button(s).
2. Relieve hydraulic pressure.
3. Do not work on hydraulic system if oil temperature exceeds 125° F (51° C).
4. **Lockout 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.

LOCKOUT TAGOUT POWER BEFORE SERVICING

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

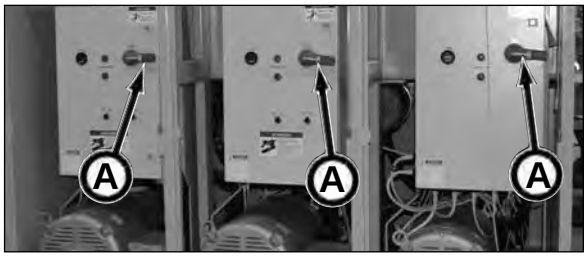
LOCKOUT, TAGOUT power before attempting to make repairs or adjustments to this equipment, unless otherwise indicated. Proper lockout, tagout will prevent accidents and save lives. Performing the lockout, tagout will also prevent the equipment from moving or operating unexpectedly.

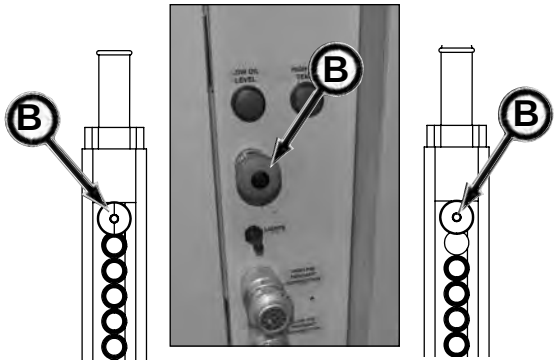
1. Flip main power disconnect switches (A) on ALL power modules to the OFF position.

2. Push all E-STOP buttons (B) IN including any remote E-STOP buttons.

3. Shutdown power from the power source.

4. Lockout/tagout all power sources.





AVOID PINCH POINTS

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

Keep hands away from moving parts.

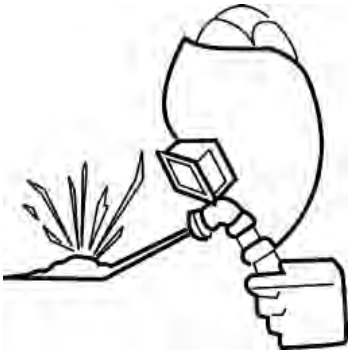
Watch your fingers, hands, and legs while equipment is in operation.

Handle parts carefully to avoid crushing and pinch point hazards.

UNAUTHORIZED WELDING

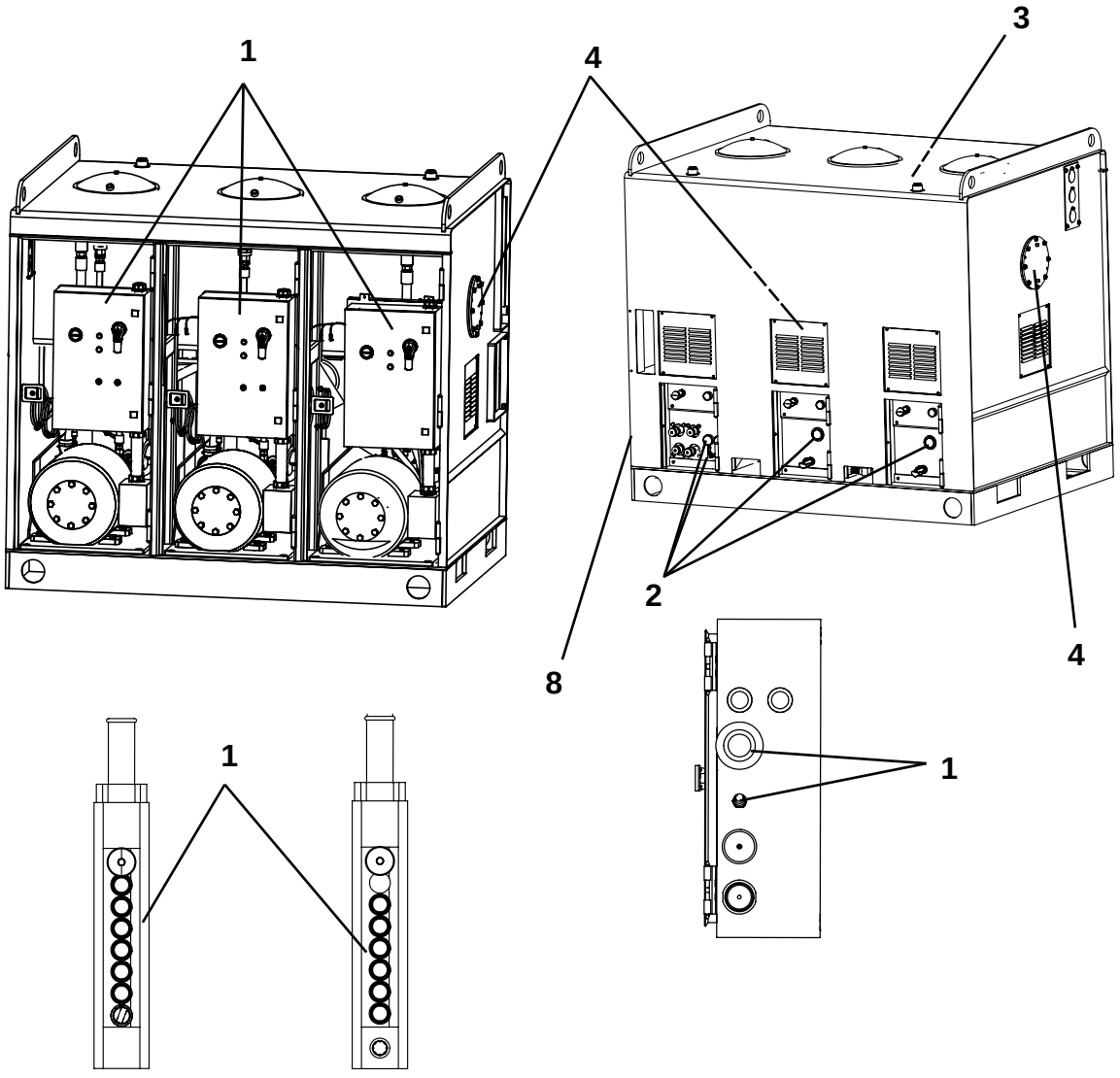
⚠WARNING Unauthorized welding can cause structural failure resulting in possible injury or death.

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



MAINTENANCE CHARTS - POWER PACK

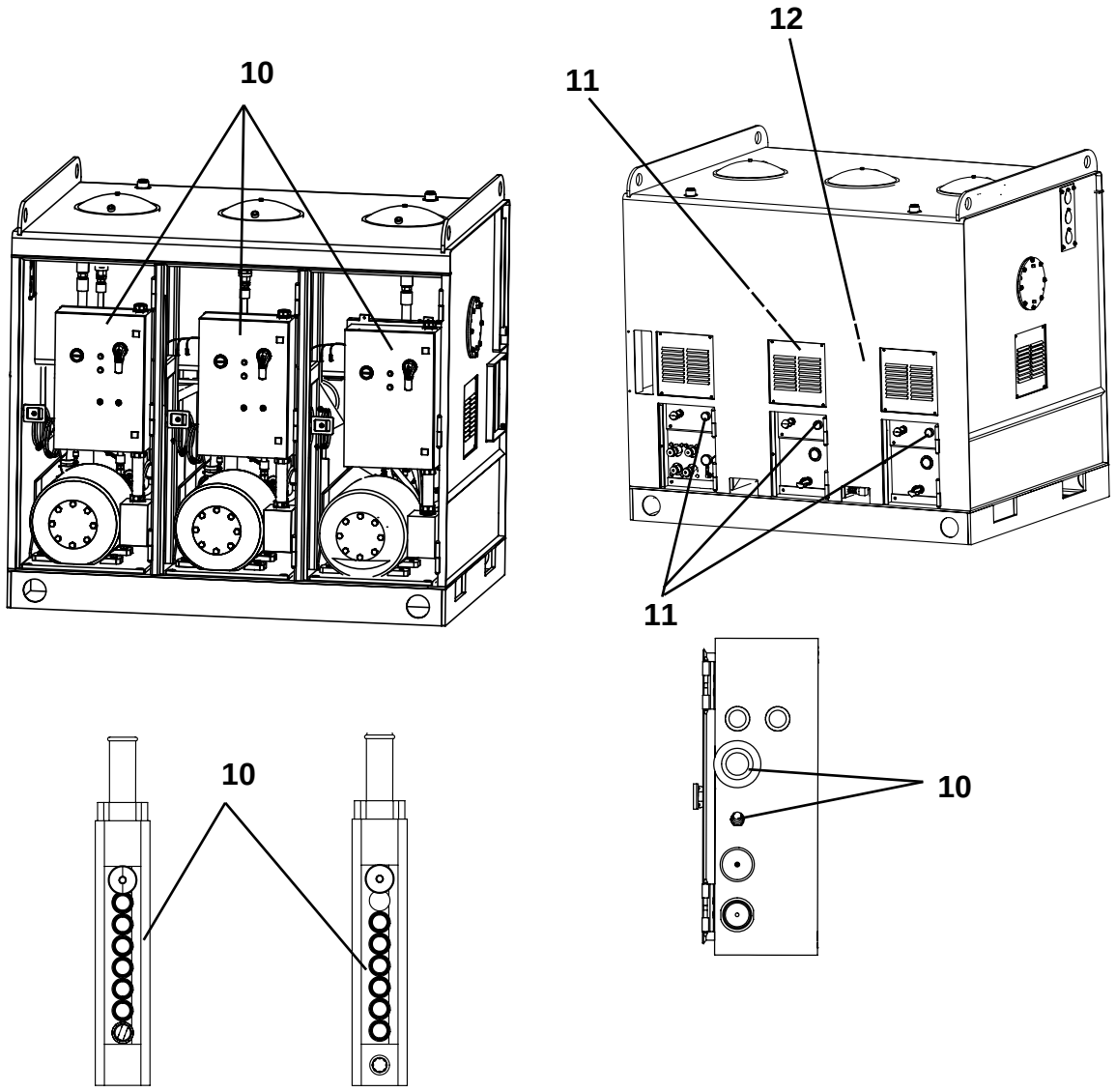
Use the item number in the chart to refer to the detailed maintenance procedures later in this section.



PRIOR TO EACH JOB LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Controls	Check Operation		
2.	Gauge	Check Operation		
3.	Hydraulic Oil	Check Level & Condition	Refill as needed.	ISO-VG-46
4.	Return Filters	Check	Replace filters per indicator	Return Filters
*5.	Hyd Hoses/ Prw Cables	Inspect	Replace if cracks/wear visible.	
*6.	Decals	Inspect	Must be legible. Replace as needed.	
*7.	Supporting Equip.	Perform Maintenance	Refer to your machine's maintenance manual.	
8.	Power Pack Frame	Inspect	If damaged, repair or replace with new.	

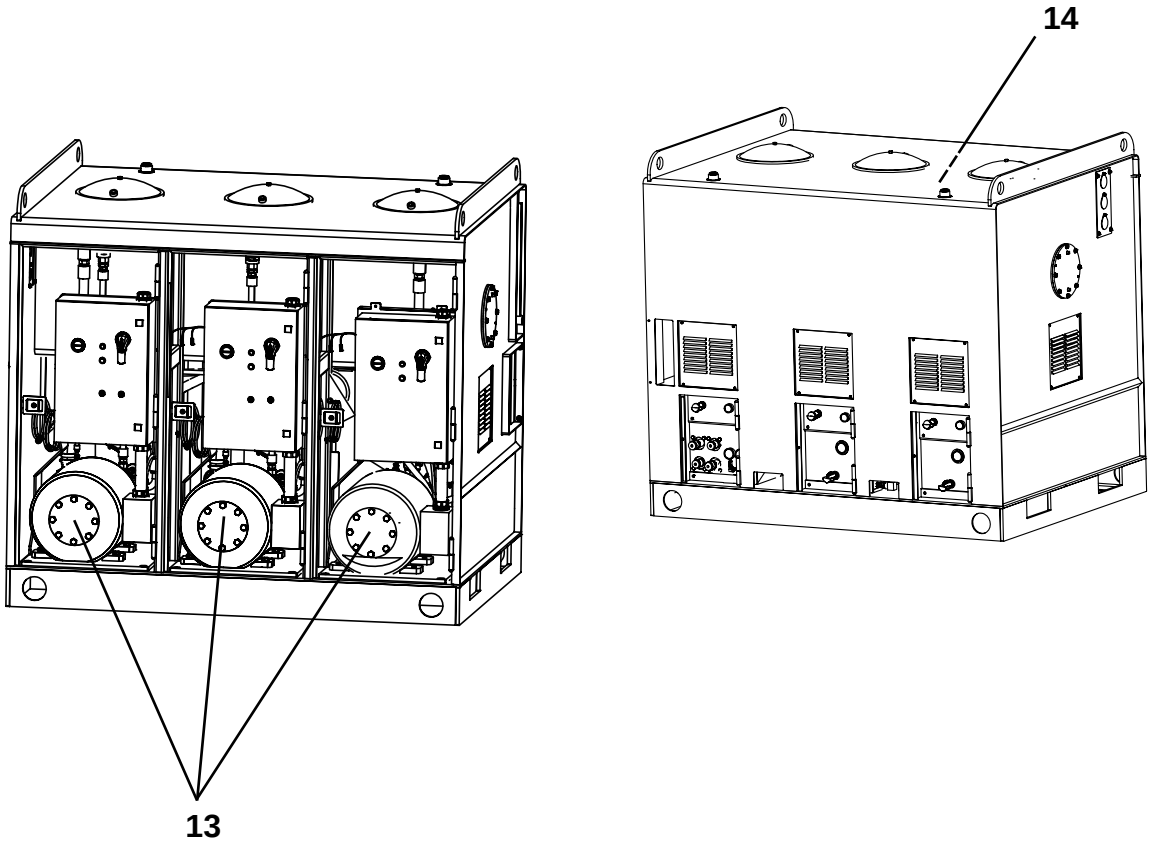
* Not Shown



DAILY OR EVERY 10 HOURS OF OPERATION OR SHIFT CHANGE

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
*9.	Hoses/Pwr Cables	Inspect	Replace if damaged before operating.	
10.	Controls	Check For Proper Operation		
11.	Return Filters	Check	Replace filters per indicator	Return Filters
12.	Heat Exchanger	Drain	Drain in freezing weather.	

* Not Shown

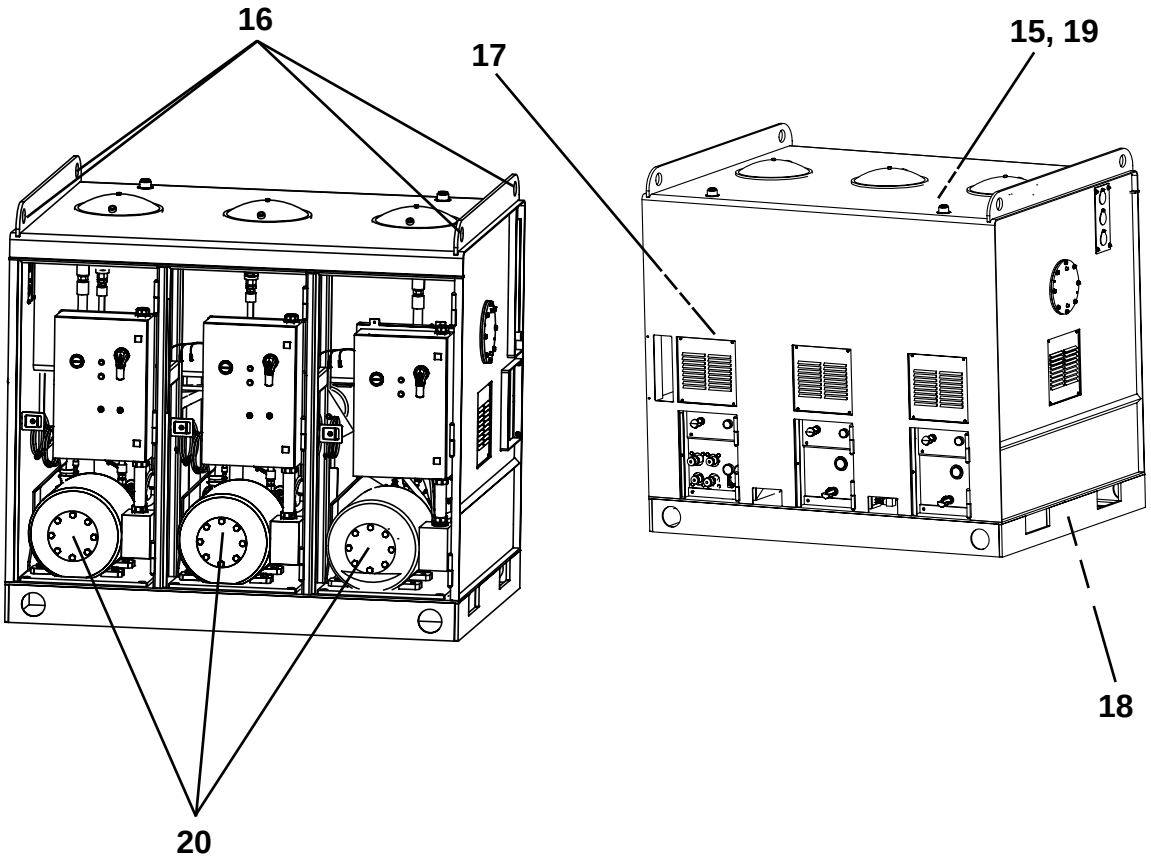


WEEKLY OR EVERY 50 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
13.	Motors	Check	Ventilation openings clean and drain holes open.	

MONTHLY OR EVERY 250 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
14.	Oil Analysis	Perform Analysis	Oil Sample	



COMPLETION OF EACH DRIVE

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
15.	Hydraulic Reservoir	Drain Water	Drain until water is removed.	
16.	Lift Eye	Inspect	Repair or replace before lifting.	
17.	Filter Indicator	Check Pilot Pressure	Replace filter per indicator.	
18.	Containment Resv.	Empty Reservoir		

EVERY 1000 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
19.	Hydraulic Reservoir	Drain and Replace	Drain and fill with new oil..	

ANNUALLY

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

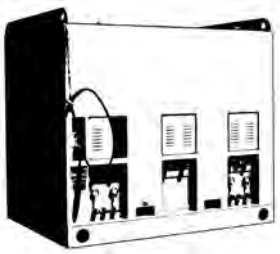
PRIOR TO EACH JOB LAUNCH

1. CHECK CONTROL OPERATION

Check controls and other supporting equipment for proper operation. If controls do not function properly, repair or replace BEFORE operation.

CHECK THE FOLLOWING CONTROLS FOR PROPER OPERATION:

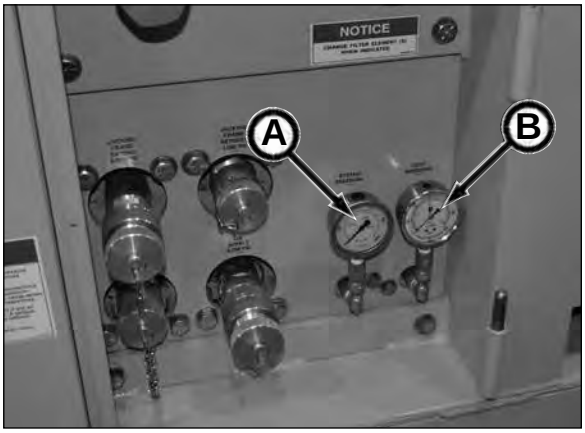
1. ALL E-Stop buttons
2. Gas detectors
3. Control pendant operation
4. Power pack frame controls
5. Light operation



2. CHECK PRESSURE GAUGE OPERATION

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

HIGH PRESSURE MODULE
System high pressure (A) ..... 8,000 psi
Pilot Pressure (B) ..... 350 psi



High Pressure Module

LOW PRESSURE MODULES
System low pressure (C) ..... 3,000/5,000 psi

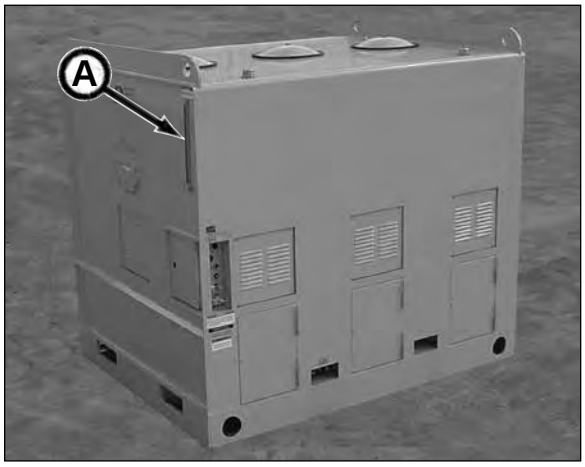
Low Pressure Modules

3. CHECK HYDRAULIC OIL RESERVOIR LEVEL & CONDITION OF OIL

1. Check reservoir hydraulic oil for the following:

   a. Check for oil bubbles or foaming oil. This may indicate an air leak in the system.
   b. Check for milky oil. This indicates that there is water in the system. Be sure your oil is being properly stored.
   c. Large particle contamination from oil sample.

If any of these conditions are found, the reservoir must be drained, cleaned, and refilled with new, clean filtered hydraulic oil. All hydraulic filters also require replacement. Refer to Every 1000 Hours of Operation, “19. Drain & Replace Hydraulic Oil” in this section.

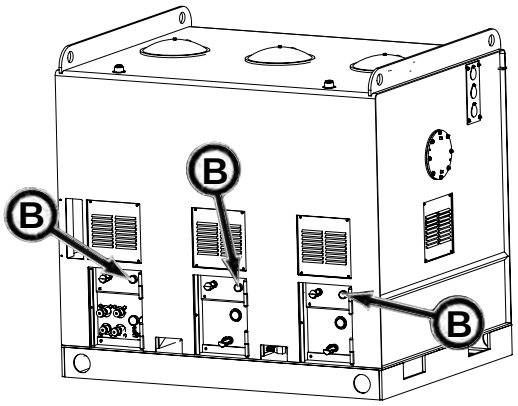


2. Check the hydraulic reservoir sight gauge (A) for the proper oil level. Keep oil maintained between the low and high marks on the gauge. If needed, add clean, filtered oil to the reservoir.

4. CHECK FILTER INDICATORS

To prevent under or over servicing of the hydraulic filter elements, filter indicators (B) are installed on the power pack.

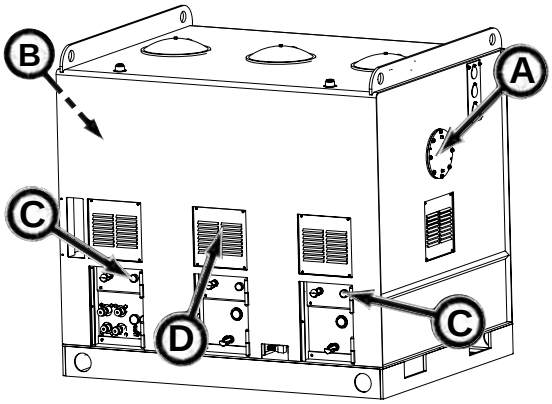
Always check indicators when the oil is at normal operating temperature and the system is at normal operating flow. Otherwise, the gauges may indicate a false reading.



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

(continued on next page)

IN-TANK FILTERS
Return Filter Assembly (RT81 (A) & RT82 (B))
Filter Indicator (C)

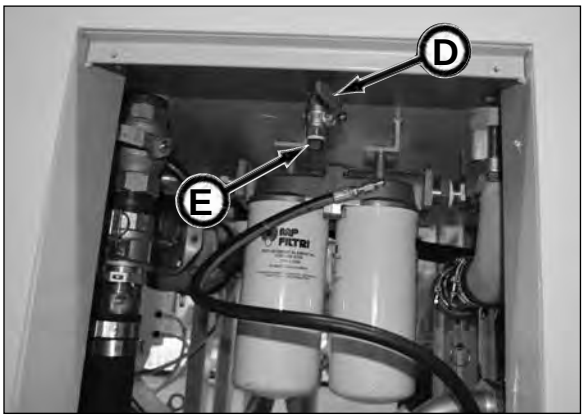


The green OK zone indicates that the filters are functioning properly.

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

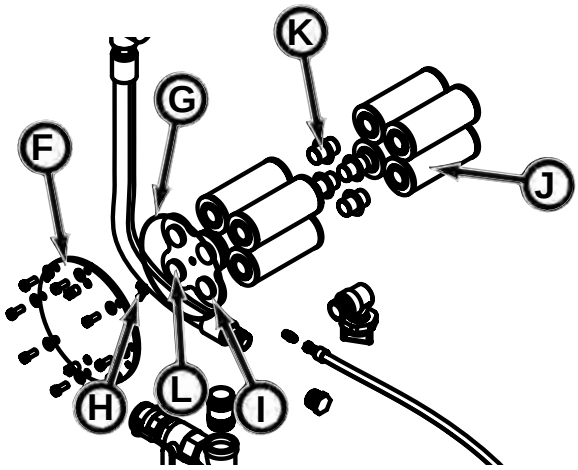
Replace filters when the needle on the gauge is in the red CHANGE zone.

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



REPLACING IN-TANK FILTERS

1. With power pack shutdown, gain access to tank drain valve (D).
2. With tank drain valve closed, remove plug (E) from tank drain valve.
3. Install a 1/2” NPT drain hose to tank drain valve fitting. Route/connect hose to a properly sized container.
4. Open tank drain valve to drain reservoir oil.
5. Once oil is drained below filter assembly, close drain valve, remove drain hose and reinstall drain plug.
6. Dispose of oil properly.
7. Clean and dry area around the filter cover (F).
8. Remove cover and retain hardware.
9. Inspect o-ring (G) for nicks, cuts or other damage. Replace if damaged.
10. Remove wing nut (H) and retain for reassembly.
11. Carefully remove the clover plate (I) and the filter elements (J). Retain spacers (K) and clean barrel assembly with hydraulic oil specified in the section 8, Lubricants. Dispose of oil and filter elements properly.
12. Carefully install new filters with spacers (retained in step 11) and secure filters with clover plate and wing nut. Be careful not to contaminate barrel assembly while installing new filters.



NOTICE Be sure the filters are properly seated in the reservoir filter seats (not shown) and the filter seats (L).

13. Apply a light coat of clean hydraulic oil on the o-ring.
14. Reinstall cap with hardware removed in step 8. If hardware is damaged, replace with new.
15. Repeat steps 2 through 14 for other filter assembly if filter replacement is required.
16. Run hydraulic system until warm and check for leaks.
17. Check hydraulic reservoir oil level on sight gauge. Add hydraulic oil if necessary.

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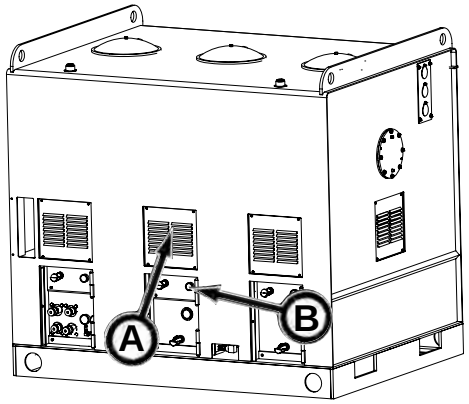


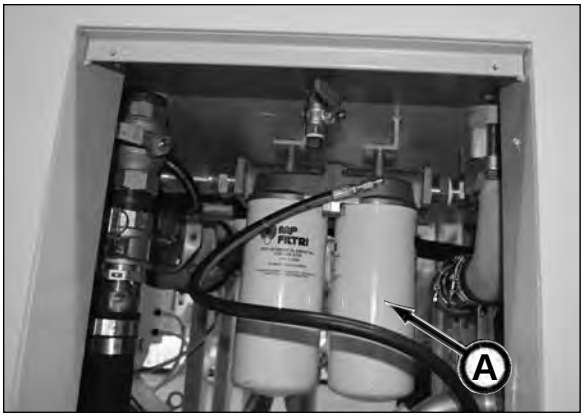
SPIN-ON FILTERS
Charge/Cooling Filter Assembly (A)
Filter Indicator (B)

To prevent under or over servicing of the hydraulic charge/cooling filter elements, a filter indicator (B) has been installed on the filter assembly.

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

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

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



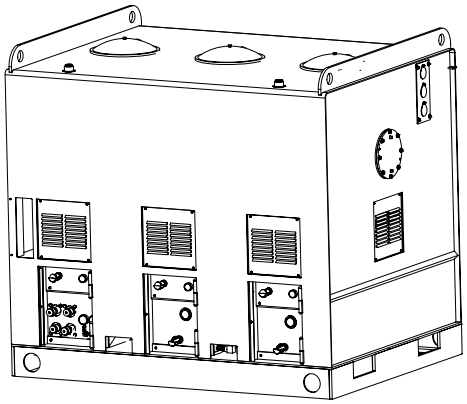
NOTICE The red band may display at initial start-up until the oil reaches normal operating temperature. If the red band continues to display after reaching normal operating temperature, replace filters to prevent contamination.

REPLACING SPIN-ON FILTERS

1. With power pack shutdown, clean and dry area around filter assembly.
2. Remove filter. Inspect filter for metal flakes. If metal flakes are visible, replace all filters on the power pack and reservoir oil.
3. Dispose of oil and filter properly.

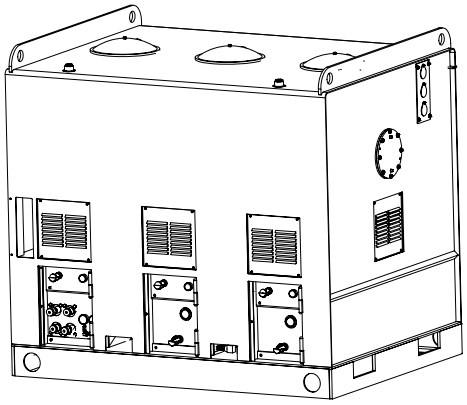
NOTICE Remove filter gasket if stuck in filter housing.

4. Fill new filter with clean, filtered hydraulic oil.
5. Lubricate new filter gasket with a light coating of clean hydraulic oil.
6. Install new filter. Hand tighten only.
7. Repeat steps 2 through 6 for other filter.
8. Run hydraulic system until warm and check for leaks.
9. Check hydraulic reservoir oil level on sight gauge. Add hydraulic oil if necessary.



5. INSPECT HYDRAULIC HOSES & POWER CABLES

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

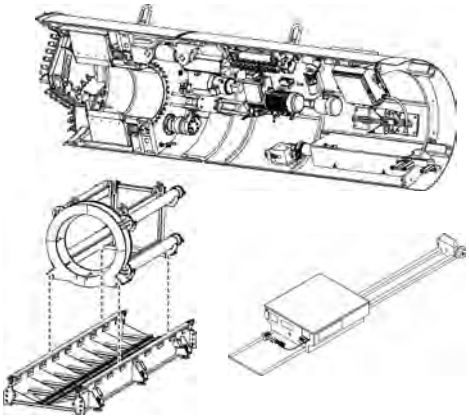


6. INSPECT DECALS

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

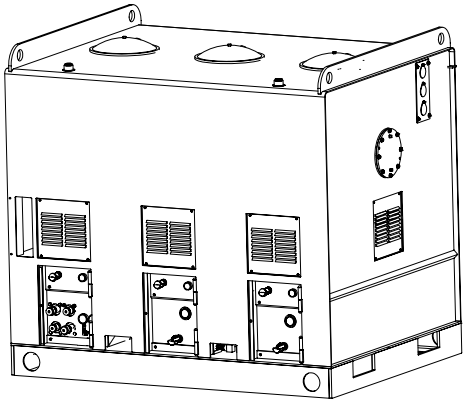
Use soft cloth, water, and a mild soap to clean the decals if they are too dirty to read. DO NOT clean decals with solvent. Solvent will damage decals. Replace decals immediately if they are damaged, missing, or hard to read.

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



7. PERFORM MAINTENANCE ON ALL SUPPORTING EQUIPMENT

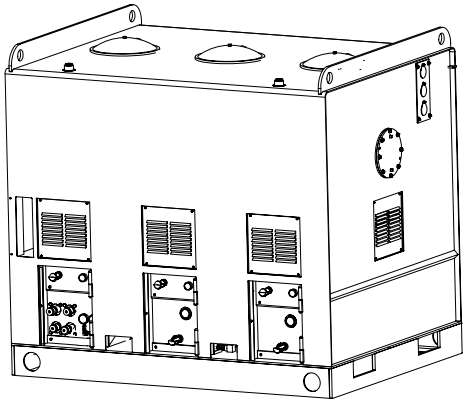
Be sure all TBM equipment such as the TBM, skid, haul unit, jacking frame, and generator are properly maintained and are operating properly. Be sure to repair or replace equipment before operating TBM. Refer to the operation and maintenance manuals of the equipment.



8. INSPECT POWER PACK FRAME

Thoroughly inspect the power pack frame for cracks, wear or other damage. Repair or replace BEFORE operation.

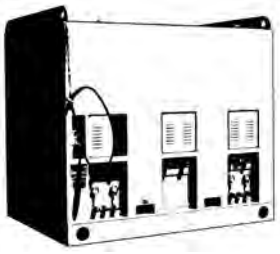
DAILY OR EVERY 10 HOURS OF OPERATION OR SHIFT CHANGE



9. INSPECT HYDRAULIC HOSES & POWER CABLES

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

10. CHECK CONTROL OPERATION



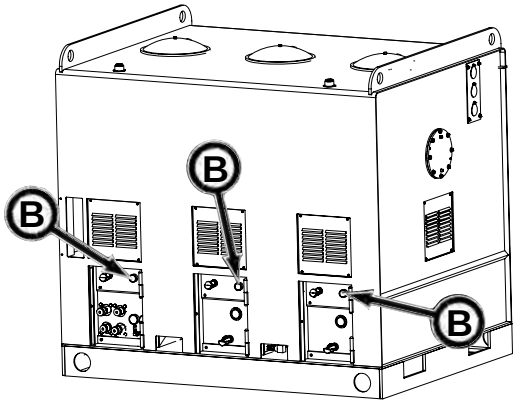
Check controls and other supporting equipment for proper operation. If controls do not function properly, repair or replace BEFORE operation.

CHECK THE FOLLOWING CONTROLS FOR PROPER OPERATION:

1. ALL E-Stop buttons
2. Gas detectors
3. Control pendant operation
4. Power pack frame controls
5. Light operation

11. CHECK FILTER INDICATORS

To prevent under or over servicing of the hydraulic filter elements, filter indicators (B) are installed on the power pack.



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

All filters and oil require replacement if any of the following situations occur:

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

If filters require replacement, refer to 4. Check Filter Indicators - Spin-On Filters in this section.

12. DRAIN HEAT EXCHANGER

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

Drain heat exchanger as follows:

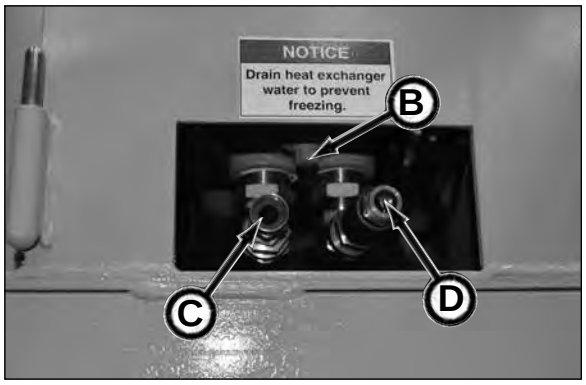
1. Open drain plug (B). Drain water.

2. Attach an air line to the heat exchanger water supply fitting (C).

3. Turn on air compressor (maximum 25 psi) and run until water no longer runs out of the heat exchanger water discharge outlet (D).

4. Remove air line from supply and replace water supply hose.

5. Replace drain plug.



WEEKLY OR EVERY 50 HOURS OF OPERATION

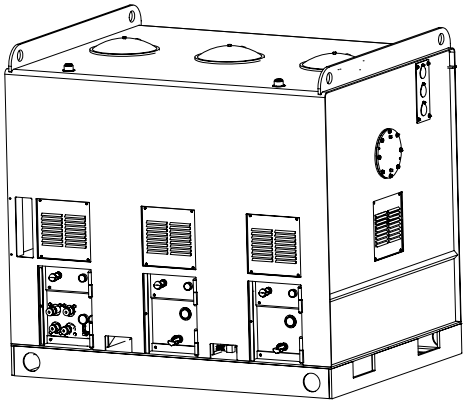
13. CHECK MOTORS

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

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

MONTHLY OR EVERY 250 HOURS OF OPERATION

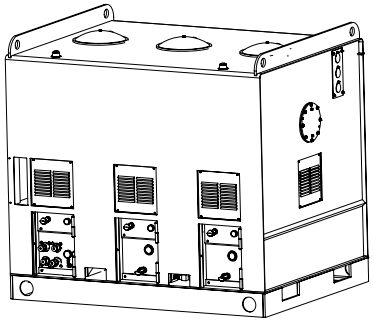
14. PERFORM HYDRAULIC OIL ANALYSIS



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

If the test reveals higher contamination levels than allowed by your oil manufacturer, or if your oil is milky or discolored, drain and replace the hydraulic reservoir oil. If draining and replacing the hydraulic oil reservoir is required, all hydraulic filters should also be replaced.

COMPLETION OF EACH DRIVE



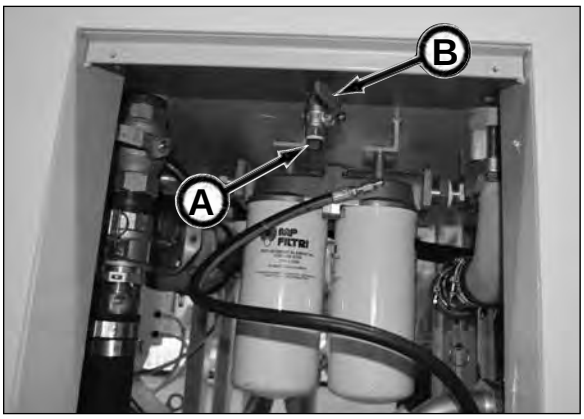
15. DRAIN WATER FROM HYDRAULIC RESERVOIRS

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

1. With power pack on level ground, allow oil in hydraulic reservoir to settle overnight.

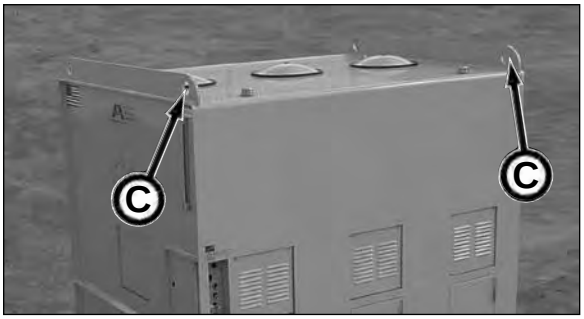
2. Remove plug (A) and slightly open tank drain ball valve (B) and drain (into a properly sized catch pan) until there is no water in oil.
   If desired to prevent drained fluids on pump unit components, install a 1/2” NPT hose to tank valve fitting and route hose to catch pan.

3. Once water is removed from tank, close tank drain ball valve, remove hose (if used) and reinstall plug.



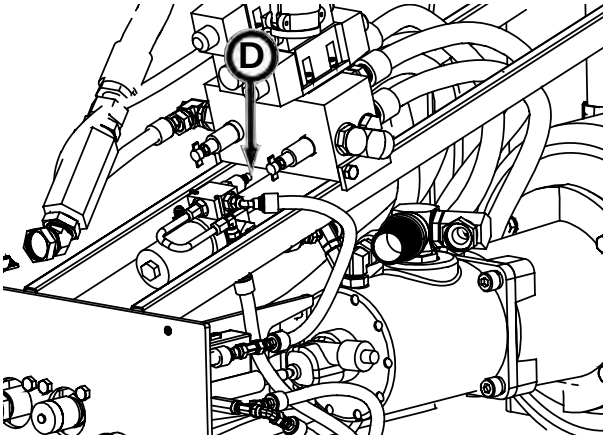
16. INSPECT LIFTING EYES

Inspect lifting eyes (C) (4 locations) for wear or damage. Worn or damaged lifting eyes MUST be replaced before lifting.



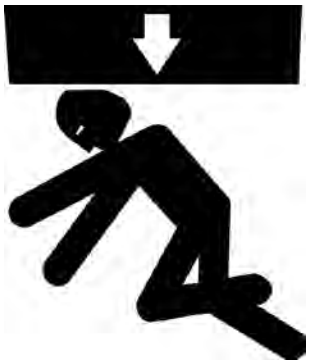
17. CHECK HIGH PRESSURE MODULE PILOT PRESSURE FILTER

4. Check pilot pressure filter indicator (D). 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.
   1. Clean and dry area around the filter assembly.
   2. Remove lower filter housing. Inspect housing and housing orings for damage. If damaged, replace with new.
   3. Remove filter.
   4. Lubricate housing orings with a light coating of clean hydraulic oil.
   5. Lubricate filter inner oring with a light coating of clean hydraulic oil.
   6. Carefully insert new filter into upper filter housing.
   7. Securely fasten lower housing into upper filter housing.
   8. Check for leaks.



18. EMPTY POWER PACK CONTAINMENT RESERVOIR

The power pack is equipped with a containment reservoir (A) to collect water or oil that may have accumulated in the power pack frame.



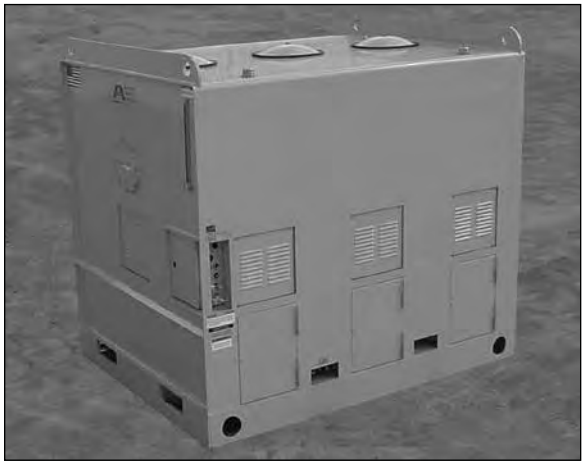
⚠WARNING Suspended loads may fall and cause severe personal injury or death.
If a hydraulic hose from the boom of a crane or excavator breaks, the boom can fall instantly.
Do not enter area under or around a load without being properly braced and secured.

To empty containment reservoir:

1. Carefully lift power pack frame to gain access to reservoir plug.
2. Properly brace and secure frame before entering area under frame.
3. Place a catch container under drain plug.
4. Remove drain plug and empty fluid in reservoir.
5. Replace drain plug.
6. Carefully lower power pack to ground level.
7. Dispose of drained fluids properly.

EVERY 1000 HOURS OF OPERATION

19. DRAIN & REPLACE HYDRAULIC OIL

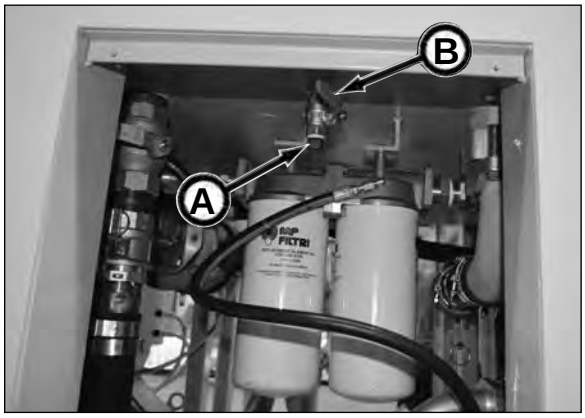


Drain and replace the hydraulic oil reservoir every 1000 hours.

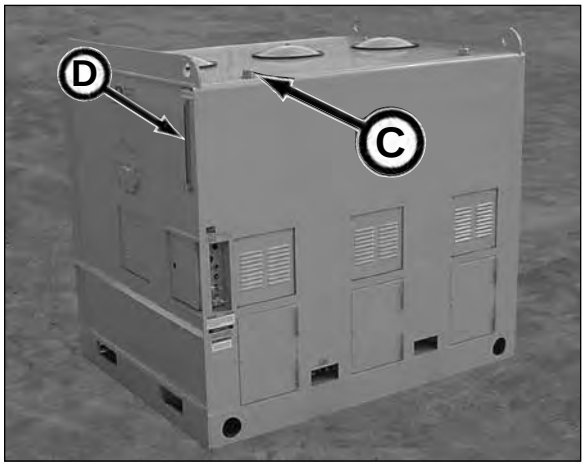
If any of the following situations occur, the reservoir must be drained, cleaned, and refilled with new, clean filtered hydraulic oil. All hydraulic filters also require replacement.

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

To Drain/Fill Oil Reservoir:



1. Remove plug (A) from tank drain valve (B).
2. Install a 1/2” NPT drain hose to tank drain valve fitting. Route/connect hose to a properly sized container.
3. Open tank drain valve (B) to drain reservoir oil.
4. Once oil is drained, close drain valve, remove drain hose (if used) and reinstall drain plug (A).
5. Dispose of oil properly.
6. Clean area around breather/fill cap(s) (C).
7. Remove fill cap(s).



8. Fill reservoir with clean, fresh, **FILTERED** ISO-VG-46 20W Premium Hydraulic/Turbine Oil or equivalent.

IMPORTANT: Filling reservoir with unfiltered oil will cause component damage.

NOTICE If you change to a different oil, use a reputable oil supplier to meet or exceed the ISO-VG-46 20W or API GL-1/GL-2 oil specification. Do not mix oil manufacturers or grades.

9. While filling, carefully watch the tank volume on the level gauge (D). DO NOT OVERFILL! Keep oil maintained between the low and high marks on the gauge.
10. Replace fill cap(s).
11. Check for leaks.

ANNUALLY

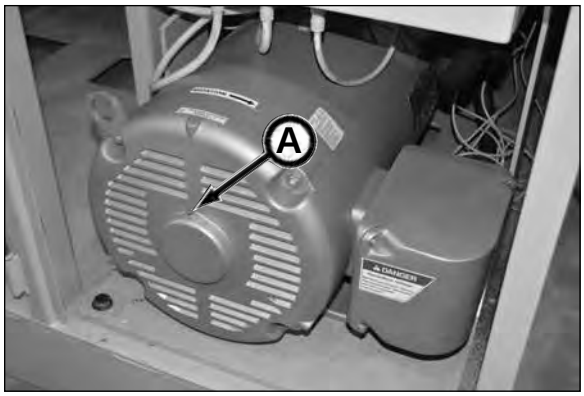
20. LUBRICATE MOTOR BEARINGS

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

Bearings should be lubricated while stationary and the motor is warm. Always use clean greasing equipment.

1. Locate and clean the area around the grease fittings.

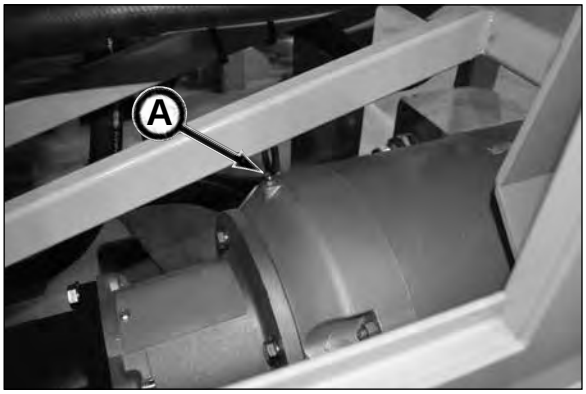
2. Lubricate the electric motor bearings (A) (two locations per motor) with two shots of Mobil Polyrex® EM grease or equivalent.



3. Run the motor for 15 minutes.

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

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



NOTES

Storage

PREPARING FOR STORAGE

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

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

REMOVING FROM STORAGE

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

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

NOTES

Troubleshooting

P6000E POWER PACK

Problem	Cause	Solution
100 HP motor will not start.	Emergency stop button pushed IN.	Pull E-STOP button out.
	Main disconnect switch is OFF	Turn disconnect ON.
	LP1 module is not powered on.	Turn LP1 main disconnect to ON position.
	Generator or power supply faulty.	Repair or replace.
	Low pressure module pendant in Flow position.	Turn low pressure module pendant to Standby position.
	Faulty Start/Stop switch.	Replace switch.
	Low oil level.	Fill reservoir with oil.
	Faulty low oil level switch or relay.	Replace switch or relay.
	Oil has reached high temp shutdown setting.	Check cooling water supply and allow time for circuit to reset.
	Pendant bypass plug not installed on unused pendant receptacle.	Install jumper plug.
	Faulty high temp switch or relay.	Replace switch or relay.
	5 HP pilot pressure pump not operating (High pressure module only).	Reset 5 HP overload relay and check fuses.
No power pack motor will start.	Emergency stop button is depressed.	Pull out all E-Stop buttons.
	Main disconnect not turned ON.	Turn ON main disconnect.
	Generator or power supply faulty.	Repair or replace.
	Pendant controller not connected.	Connect pendant or install Pendant Bypass Plug.
	Faulty pendant extension cable.	Test without extension cable, repair cable.
	Pendant bypass plug not installed on unused pendant receptacle.	Install jumper plug.
	Low oil level.	Add oil.
	Oil has reached high temp shutdown setting.	Check cooling water supply and allow time for circuit to reset.
	Faulty low oil level switch, cable or relay.	Replace switch, cable or relay.
	Faulty E-stop cable, switch or relay.	Replace switch, cable or relay.

(continued on next page)

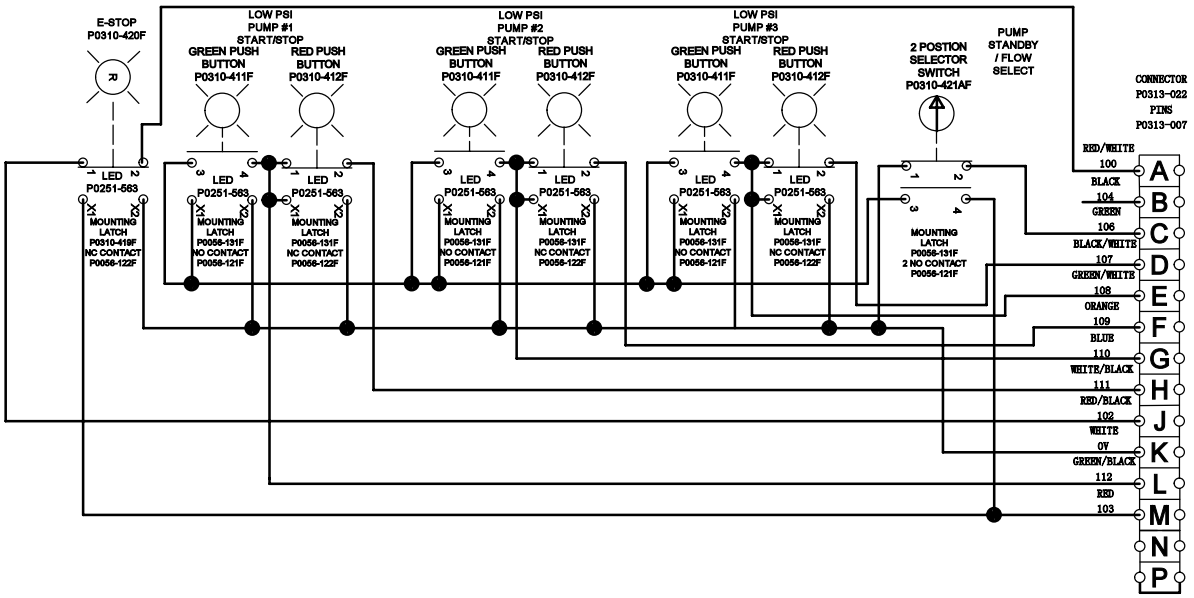
Problem	Cause	Solution
Temperature gauge exceeds 150 degrees.	Heat exchanger water supply not adequate.	Water supply must be a minimum of 8 gpm.
	Oil supply to heat exchanger turned off.	Turn on oil supply.
	Excessive hydraulic circuit pressure to boring machine.	Reduce steering flow control. Replace boring head filters.
	Hydraulic circuit disconnected causing a safety relief to be activated.	Connect hoses.
	Excessive ambient temperature.	Provide fresh, clean, cold water source.
	Excessive horsepower required by TBM or jacking operation.	Reduce advancement rate or install IJS.
	Heat exchanger water passages plugged.	Clean heat exchanger.
Power pack motors start but no oil pressure available.	**NOTICE** DO NOT operate for extended periods with this condition. Doing so will result in pump damage.	
	Incorrect motor rotation.	Rewire motor for proper rotation.
	Low oil level.	Add hydraulic oil as needed.
	Closed pump suction valve.	Open valve.
	Control valve not turned ON.	Turn control valve ON.
	Faulty control valve switch.	Repair or replace switch.
	Flow rate turned too low.	Readjust flow rate.
	Worn or damaged hydraulic pump.	Repair or replace pump.
Jacking frame thrust cylinders stall at less than 500 psi.	Cylinder at full extension	Retract.
	Worn or damaged cylinders seals.	Replace seals.
	Worn or damaged control valve seals.	Replace seals.
	Cylinder piston relief leaking.	Replace relief.
	Faulty pendant controller switch.	Replace switch.
	Faulty pendant extension cable.	Remove cable and re-test, repair cable.
	Worn or damaged hydraulic pump.	Test/replace pump.
Jacking frame cylinder(s) collapse when forward thrust is stopped or intermediate jacks are used.	Pilot operated check valve leaking.	Replace valve.
	Worn or damaged cylinder seals.	Replace seals.
	Cylinder piston relief leaking.	Replace relief.

(continued on next page)

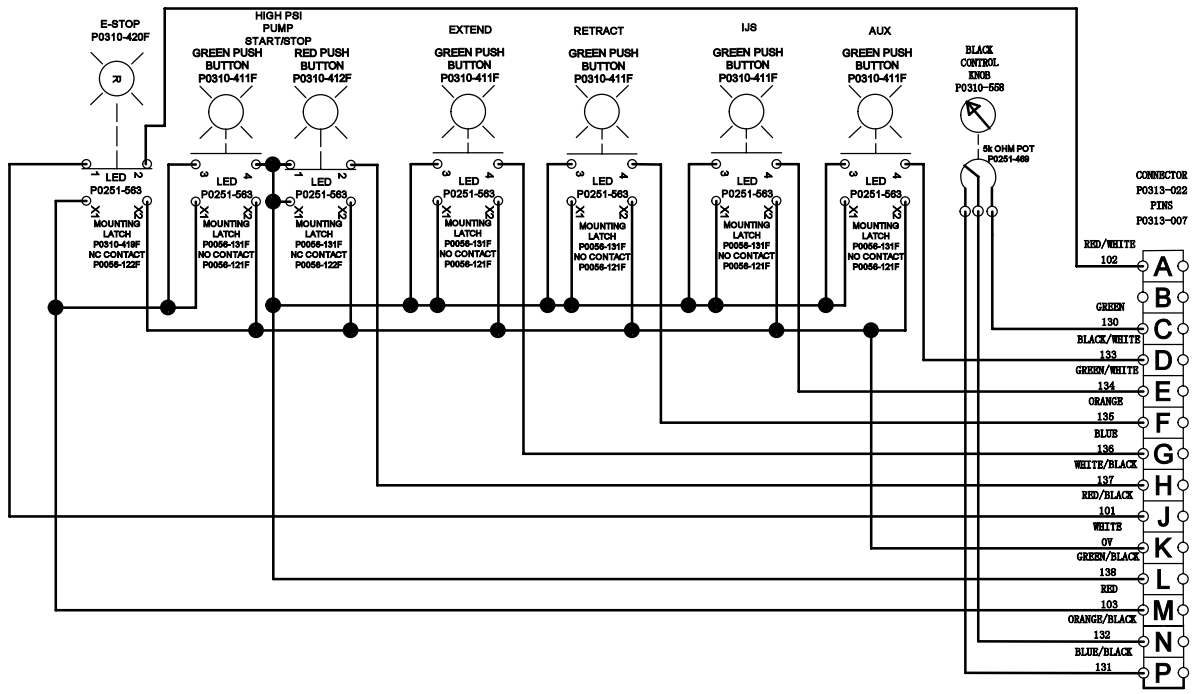
Problem	Cause	Solution
Jacking pressure gauge pressure drops when forward thrust is stopped.	Low cylinder load.	Avoid over excavation at tunnel face.
	Worn or damaged cylinder seals.	Replace seals.
	Pilot operated check leaking.	Replace valve.
Intermediate jacks do not operate.	*TEST: Select IJS position on control pendant, operate stroke and read system pressure gauge. Gauge reads 0 - 1,000 psi.*	
	Faulty control switch.	Replace switch.
	Intermediate jack valve not in full ON position.	Turn valve fully ON.
	Worn or damaged control valve seals.	Replace seals.
	Intermediate jack valve previously operated not in full OFF position.	Check valve, turn valve fully OFF.
	Worn or damaged hydraulic pump.	Repair or replace pump.
	Faulty pendant exterior cable.	Repair or replace cable
	If intermediate jacks still do not operate, contact your Akkerman Aftermarket Support Representative.	

P6000E FRAME ELECTRICAL SCHEMATIC - PART 1 OF 3

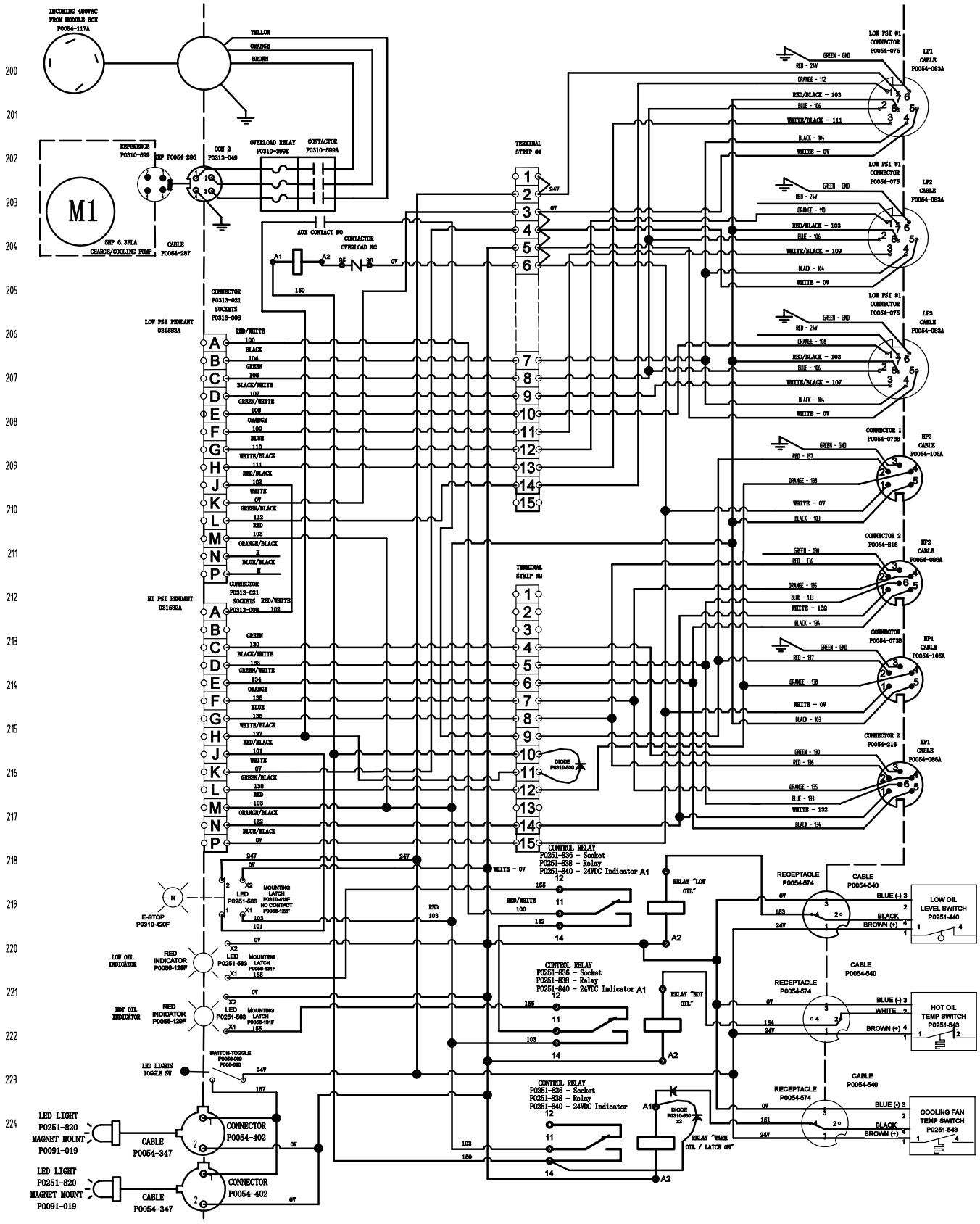
LOW PSI PENDANT
031583A



HIGH PSI PENDANT
031582A

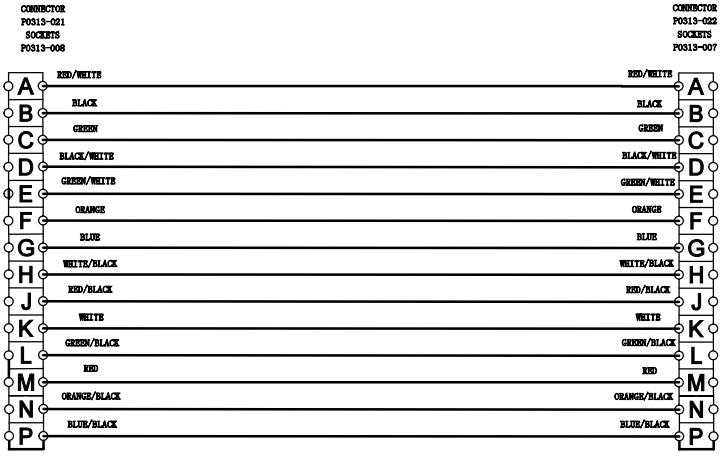


P6000E FRAME ELECTRICAL SCHEMATIC - PART 2 OF 3



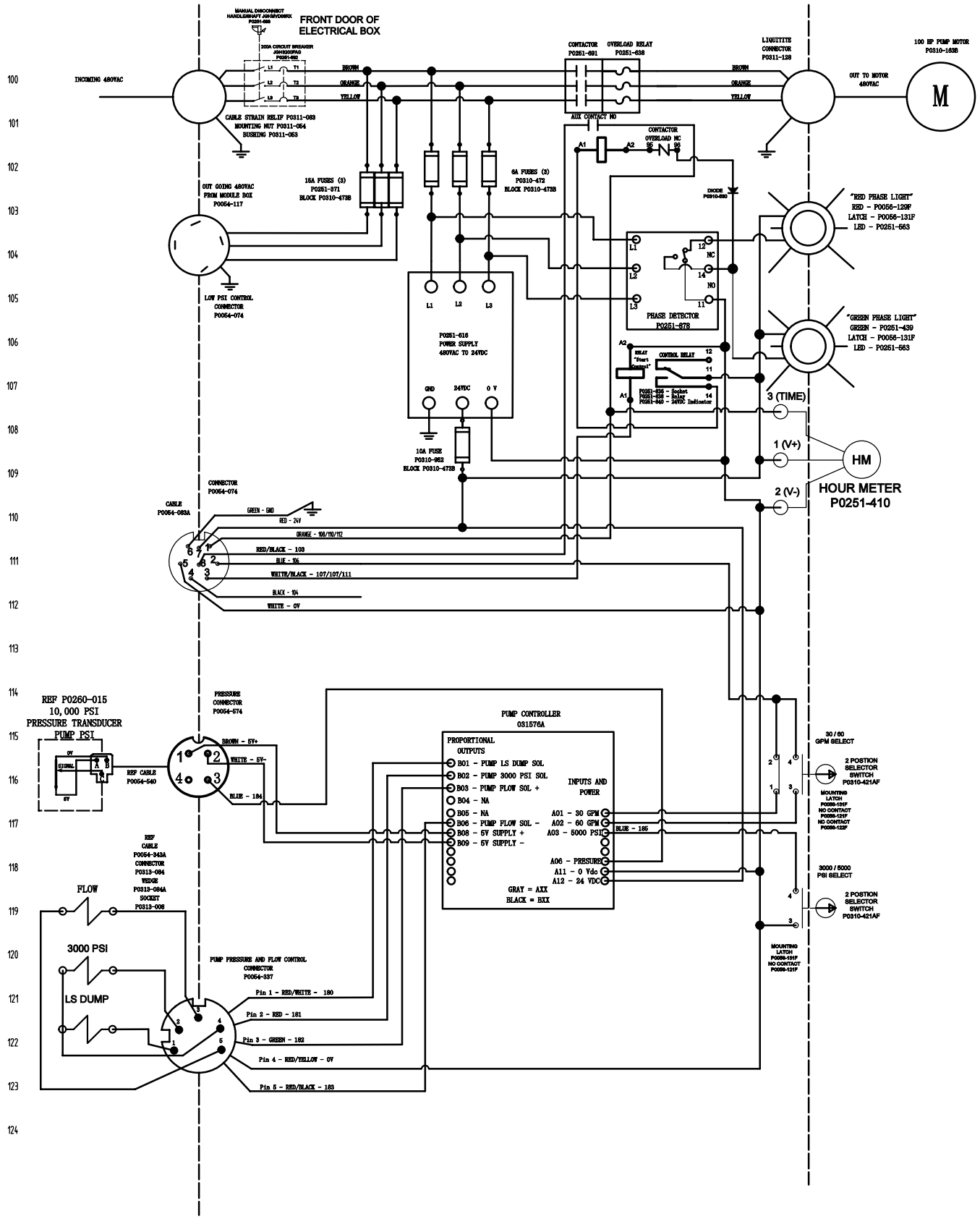
P6000E FRAME ELECTRICAL SCHEMATIC - PART 3 OF 3

PENDANT EXTENSION
028273A

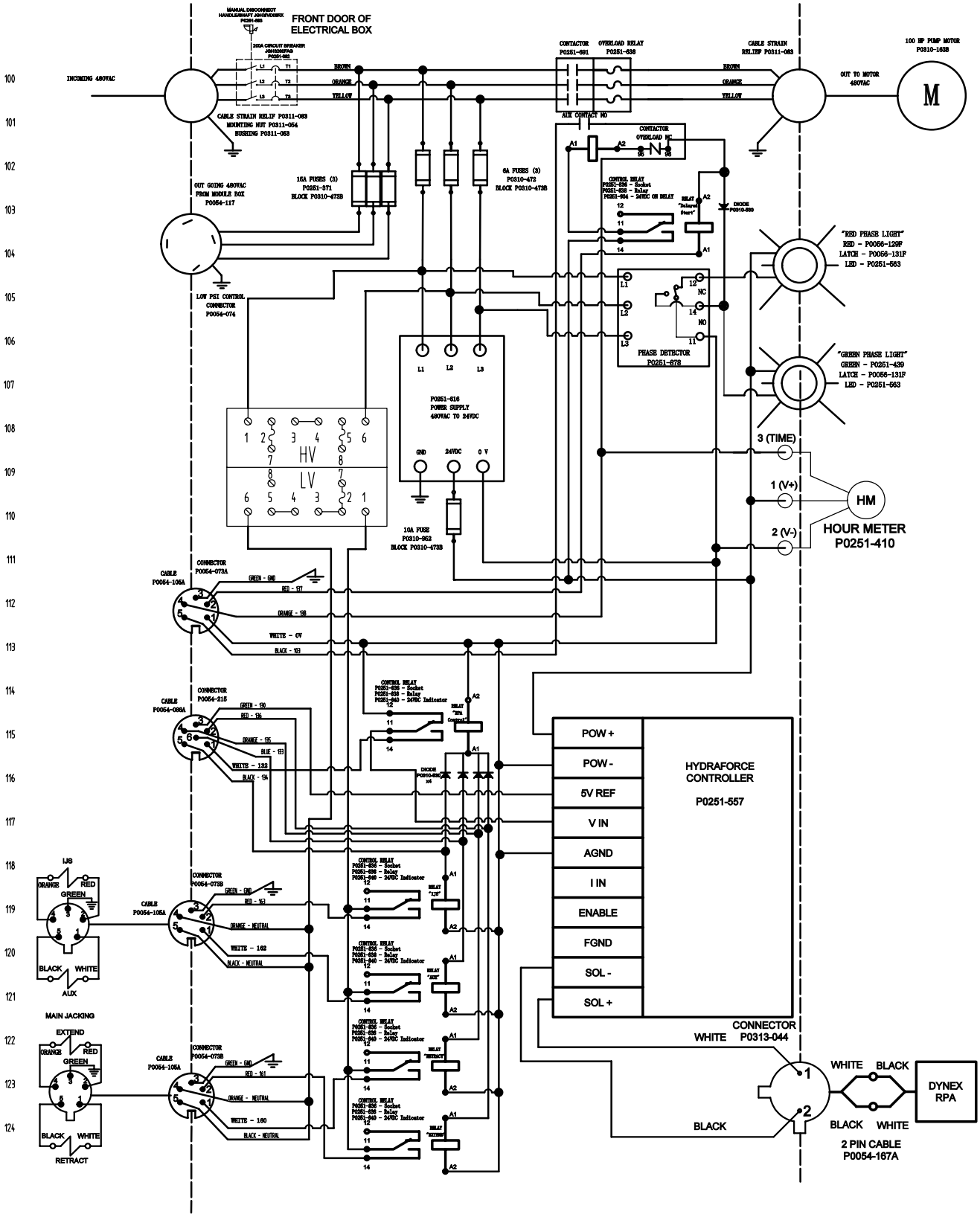


Description	Wire Number	Color Gauge	Circuit Orgin	Circuit Destination
E-Stop Low PSI Pendant	100	Red/White 16	Low PSI E-Stop	Low Oil Relay
E-Stop Frame Box	101	Red/Black 17	Frame Box E-Stop	High PSI E-Stop
E-Stop High PSI Pendant	102	Red/White 16 + Red/Black 16	Hi PSI E-Stop	Low PSI E-Stop
Run Enabled	103	Red 16	Hot Oil Relay 14	Controls
Low PSI 30 GPM Select	104	Black 16	Selector Switch	Pump Controller
Low PSI Stand by Select	105	Blue 16	Selector Switch	Start Switches
Low PSI 60 GPM Select	106	Green 16	Selector Switch	Pump Controller
Low PSI Pump 3 Run	107	Black/White 16	Pump 3 Stop Switch	Pump 3 Contactor
Low PSI Pump 3 Run Latch	108	Green/White 16	Pump 3 Contactor NO	Pump 3 Stop Switch
Low PSI Pump 2 Run	109	Orange 16	Pump 2 Stop Switch	Pump 2 Contactor
Low PSI Pump 2 Run Latch	110	Blue 16	Pump 2 Contactor NO	Pump 2 Stop Switch
Low PSI Pump 1 Run	111	White/Black 16	Pump 1 Stop Switch	Pump 1 Contactor
Low PSI Pump 1 Run Latch	112	Green/Black 16	Pump 1 Contactor NO	Pump 1 Stop Switch
High PSI 5V +	130	Green	High PSI RPA Controller	Pendant POT
High PSI 5V -	131 / 0V	Blue/Black 16	High PSI RPA Controller	Pendant POT
High PSI FLOW	132	Orange/Black 16	High PSI RPA Controller	Pendant POT
High PSI Aux	133	Black/White 16	Aux Pendant Sw	Aux Control Relay
High PSI IJS	134	Green/White 16	IJS Pendant Sw	IJS Control Relay
High PSI Retract	135	Orange 16	Retract Pendant Sw	Retract Control Relay
High PSI Extend	136	Blue 16	Extend Pendant Sw	Extend Control Relay
High PSI Pump Run	137	White/Black 16	High PSI Pump Stop Switch	High PSI Pump Contactor
High PSI Pump Run Latch	138	Green/Black 16	High PSI Pump Contactor NO	High PSI Pump Stop Switch
Charge/Cooling Run	150	Red 16	Warm Oil Relay/Hi PSI Diode	Contactor A1
Warm Oil Signal	151	Black 16	Cooling Fan Temp Switch	Warm Oil Relay A1
Low Oil E-Stop	152	Red 16	Low Oil Relay 14	Hot Oil Relay 11
Low Oil Signal	153	Black 16	Low Oil Level Sw	Low Oil Relay A1
Hot Oil Signal	154	White 16	Hot Oil Sw	Hot Oil Relay A1
Low Oil Light	155	Blue 16	Low Oil Relay 12	Low Oil Light A1
Hot Oil Light	156	Yellow 16	Hot Oil Relay 12	Hot Oil Light A1
Lights	157	Red 16	Lights Toggle Sw	Lights
High PSI Aux Solenoid	160		Aux Control Relay	Aux Solenoid
High PSI IJS Solenoid	161		IJS Control Relay	IJS Solenoid
High PSI Retract Solenoid	162		Retract Control Relay	Retract Solenoid
High PSI Extend Solenoid	163		Extend Control Relay	Extend Solenoid
Pump LS Dump Solenoid	180	RED/WHITE 16	Pump Controller	LS Dump Solenoid
Pump 3000 PSI Solenoid	181	Red 16	Pump Controller	3000 PSI Solenoid
Pump Flow Solenoid +	182	Green 16	Pump Controller	Flow Solenoid +
Pump Flow Solenoid -	183	RED/BLACK 16	Pump Controller	Flow Solenoid -
Pump Pressure Signal	184	BLUE 18	Pressure Transducer	Pump Controller
5000 PSI On	185	BLUE 16	Pump Controller	PSI Selector Switch
PRESSURE TRANDUCER	5V+	BROWN	Pump Controller	Pressure Transducer
PRESSURE TRANDUCER	5V-	WHITE	Pump Controller	Pressure Transducer

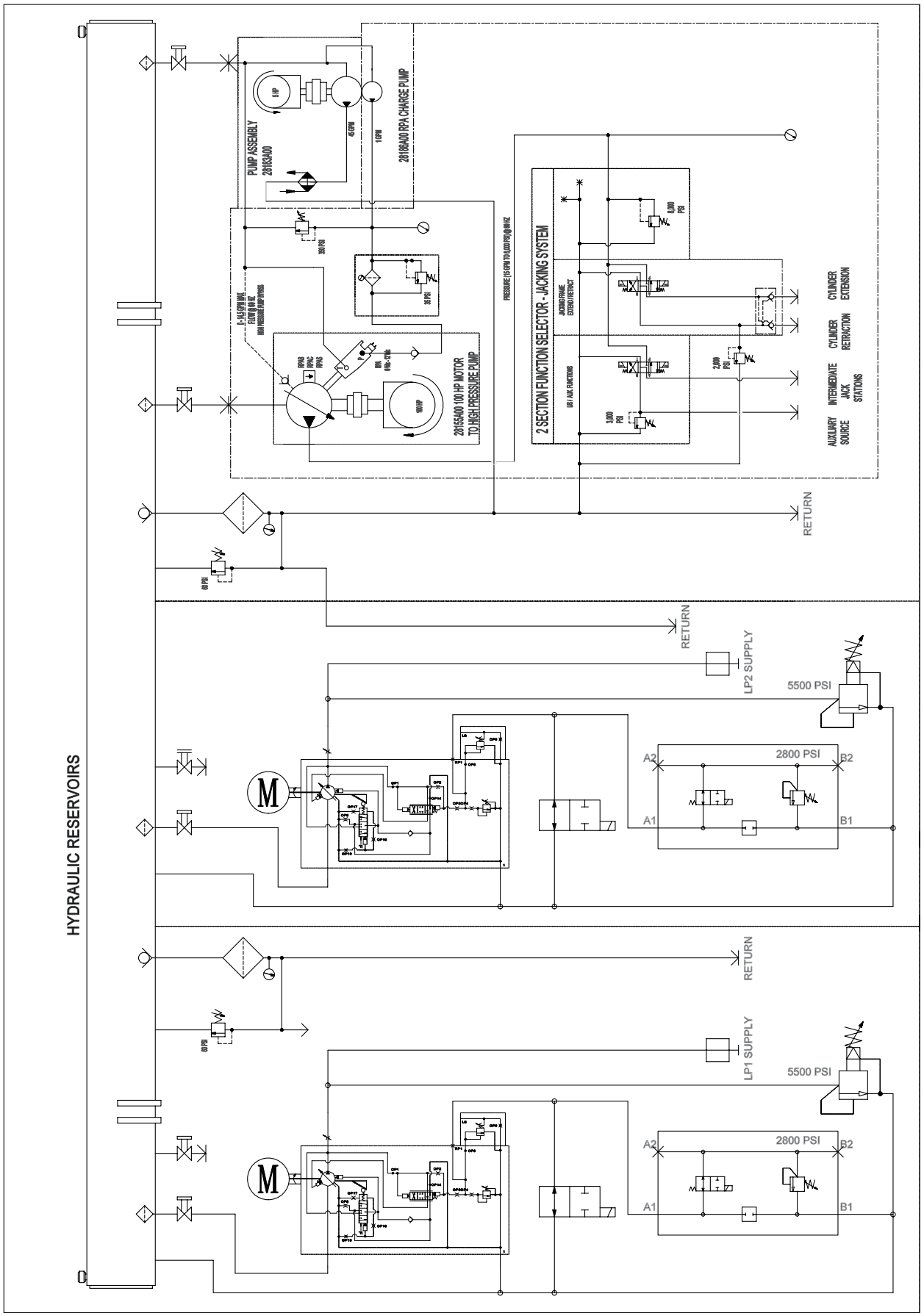
P6000E LOW PSI BOX ELECTRICAL SCHEMATIC



P6000E HIGH PSI BOX ELECTRICAL SCHEMATIC



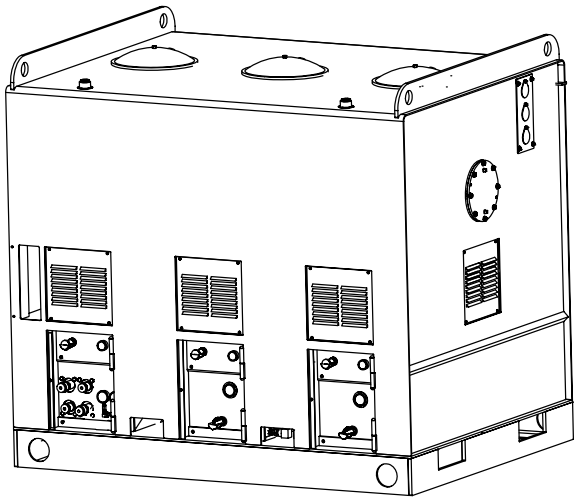
P6000E HYDRAULIC SCHEMATIC



NOTES

Specifications

P6000E POWER PACK



Dimensions (l x w x h) ..... 96 x 72.5 x 88 in. (2,438 x 1,842 x 2,235 mm)

Weight (without fluids)
- Frame Only ..... 6,880 lbs (3,121 kg)
- Low Pressure Module (per unit) ..... 1,670 lbs (758 kg)
- High Pressure Module (per unit) ..... 1,720 lbs (780 kg)

Hydraulic Reservoir Capacity ..... 600 gal (2,271 L)

Hydraulics ..... three independent hydraulic systems for TBM supply functions & jacking

Low Pressure Power Modules (for TBM & Conveyor functions)
- Motor ..... Two 100 HP (74 kW)
- Supply Flow ..... 30 / 60 / 90 / 120 Gal
- Rating (maximum per module) ..... 60 gpm @ 3,000 psi
  ..... 40 gpm @ 5,000 psi
- Hydraulic Supply Operating Pressure ..... 3,000 psi
- Hydraulic Supply Operating Pressure (Maximum)* ..... 5,000 psi

***Note: If operating between 3,000 - 5,000 psi, the TBM supply lines/hoses MUST be rated at 5,000 psi minimum.**

High Pressure Power Module (for Jacking & IJS)
- Motor ..... One 100 HP (74 kW)
- Supply Flow ..... 13.5 Gal
- Rating (maximum) ..... 13.5 gpm @ 8,000 psi
- Hydraulic Supply Operating Pressure (Maximum)** ..... 8,000 psi

****Note: Supply lines/hoses MUST be rated at 8,000 psi minimum.**

Filtration
- Pilot ..... 10 micron filters
- Return ..... 10 micron filters

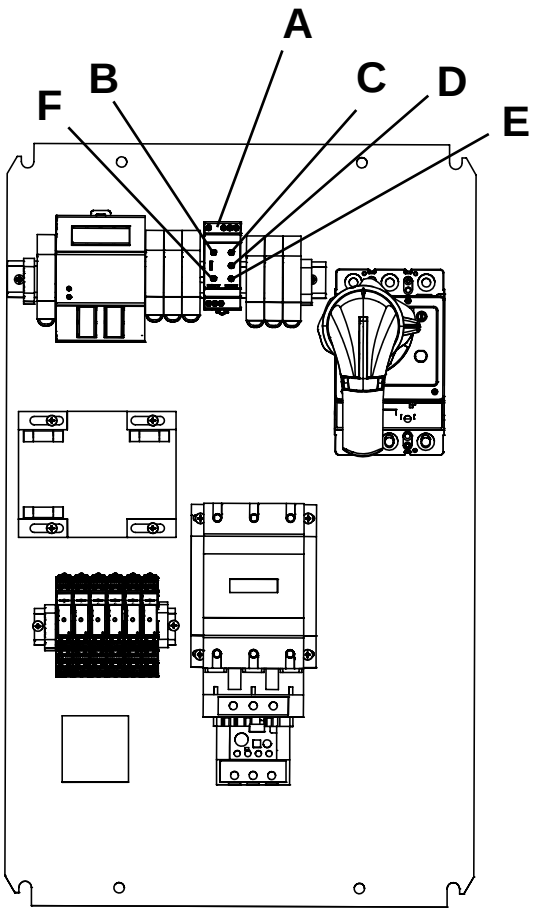
Heat Exchanger ..... Water Over Oil
- Cooling Water Supply (minimum) ..... 8 gpm
- Oil Flow ..... 45 gpm (170 L/min)

Electrical

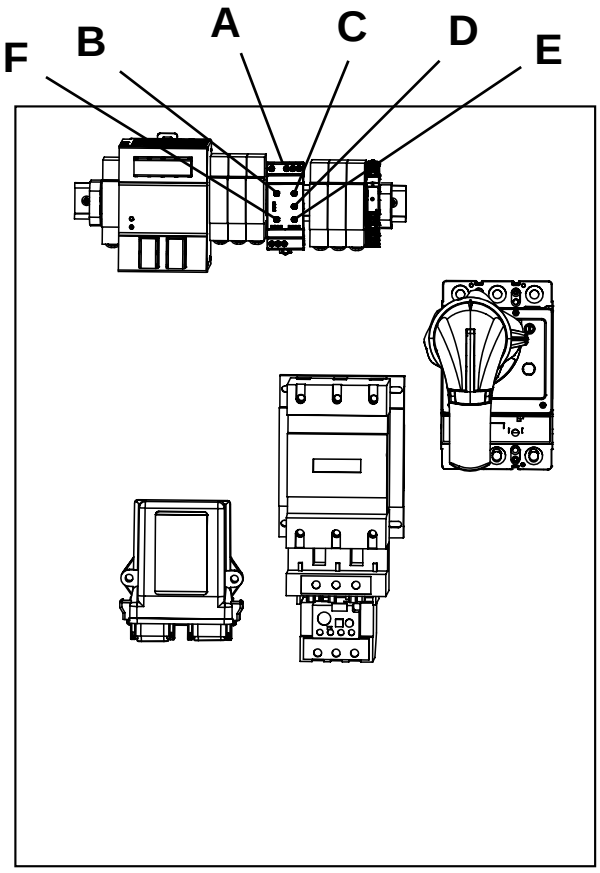
Recommended Power Requirements
- Recommended Operating Power..... 275kW / 300kVA @ 480VAC
- Generator Minimum Motor Starting kVA (sKVA) .....385skVA with less than 35% instantaneous
  .....voltage dip and greater than 90% sustained voltage
- Cable ..... 2/0 x 100' per module

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

RELAY SETTINGS



High Pressure Module



Low Pressure Module

Phase Check Relay (A)

Monitoring (B) ..... Without N-Line Monitoring
Maximum Voltage (C) 480
Unbalance (D) 20%
Voltage Minimum (E) 400V
Time Delay (Seconds) (F) 30

TORQUE CHART

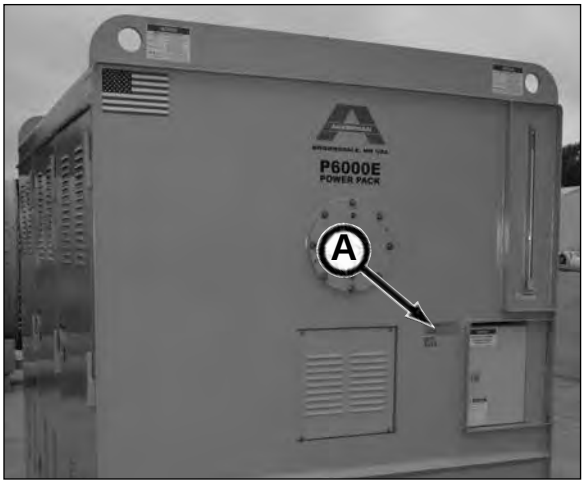
Use these torque values as a guideline when tightening hardware unless otherwise specified in this manual.

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.



P6000E POWER PACK (A)

Model Number _____

Serial Number _____

NOTES

Safety Data Sheets

The Federal Occupational, Safety, and Health Administration (OSHA) Standard 29 CFR 1910.1200, require that specific safety data sheets (SDS) be available to employees before operating this equipment. This may include information on substances contained in this equipment such as hydraulic fluid and gear lubricant.

Akkerman will provide, at no cost, SDS which apply to its product line. Simply contact your Akkerman Aftermarket Support representative for a copy.

To ensure a prompt response to your SDS request, include your return address (including zip or postal code) and the equipment's model numbers and serial numbers with your request.

NOTES

Warranty

Akkerman warrants that all equipment manufactured by it be free from defects due to workmanship or material when normally used and serviced for a period of 90 days from the date of shipment by Akkerman. Normal wear and tear to the equipment, including, but not limited to, wear on the cutter face tooling, hydraulic filters, augers, casings, slurry line and seals is not covered by this warranty. Akkerman does not warrant that the equipment meets the requirements of any particular safety code or rule governing equipment classification. If the Customer has questions about local safety codes, rules or ordinances, authorities local to the project should be consulted.

In order to be considered as a potential warranty claim, the component in question must be returned to Akkerman (freight prepaid) for factory inspection and analysis, and determination of warranty applicability. No warranty is provided for electronics or electrical components of any kind. The validity of all warranty claims are subject to the discretion and determination of the Akkerman Aftermarket Support Department. All such determinations are final.

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