OPERATOR'S MANUAL

Main Drive Power Container

Power Container SN FA22062F

Supplement for the Microtunneling System Operator's Manual

Publication No. 050146A

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

SERVICE • RELIABILITY • INNOVATION

DANGER

This machine is powered by high voltage electricity.

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

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

NOTES

Introduction

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

The contractor is responsible for the overall safety program on the job site. Use this supplement and your Microtunneling Operator's Manual as a part of the safety program.

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

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

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

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

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

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

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

Akkerman
Main Drive Power Container

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

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

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

NOTES

Contents

NOTES

Safety

BE ALERT FOR SAFETY INFORMATION

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

Read all safety information.

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

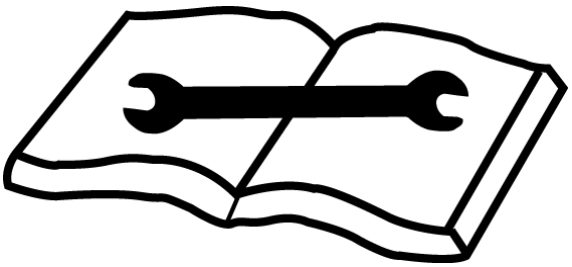
ATTENTION!
BECOME ALERT!
YOUR SAFETY IS INVOLVED!

READ OPERATOR'S MANUAL

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

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

Any unauthorized modifications will void the warranty.



WEAR PROTECTIVE CLOTHING

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

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

PROPERLY GROUND ELECTRICAL EQUIPMENT

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

Be sure equipment is properly ground before engaging power.

WORKING WITH ELECTRICAL EQUIPMENT

⚠DANGER **HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH.**

Failure to follow these instructions will result in death or serious injury.

• Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E.

• This equipment must be installed and serviced only by qualified electrical personnel.

• Turn off all power supplying this equipment before working on or inside equipment.

• Always use a properly rated voltage sensing device to confirm power is off.

• Replace all devices, doors and covers before turning on power to this equipment.

LOCKOUT/TAGOUT POWER BEFORE SERVICING

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

Lockout/tagout main power supply before servicing. Electrical repairs must be performed only by a certified electrician.

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.

USING TUNNEL POWER CABLE

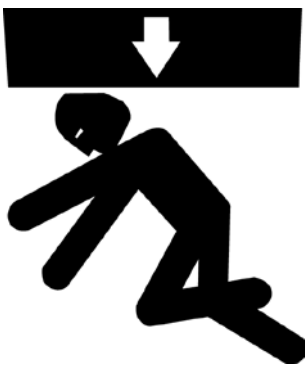
⚠DANGER NEVER disconnect tunnel power cables when tunnel power is ON. Doing so WILL cause severe injury or death from electrical shock.

CONTACT WITH POWER CABLE

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

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

BEWARE OF SUSPENDED LOADS



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

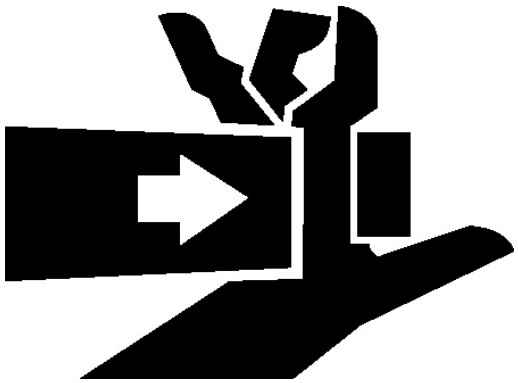
If a hydraulic hose from the boom of a crane or excavator breaks, the boom can fall instantly.

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.

AVOID PINCH POINTS



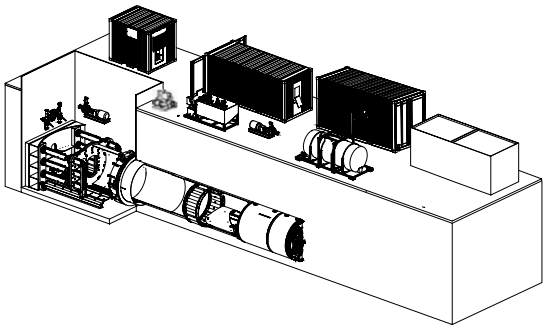
⚠WARNING Moving parts or the mishandling of parts can cause severe personal injury.

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.

REGULARLY CLEAN AND INSPECT EQUIPMENT



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

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

PRACTICE SAFE MAINTENANCE

⚠WARNING Unexpected equipment movement may cause serious personal injury.

Lockout/tagout power before performing any maintenance.

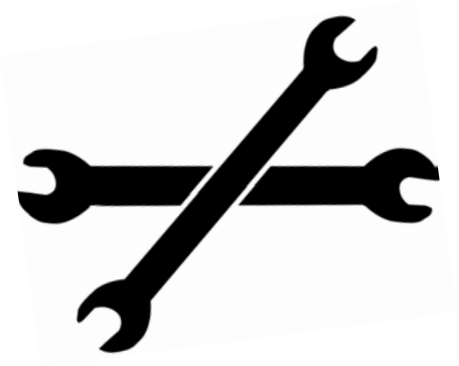
Shut down equipment before making repairs, adjustments, or removing obstructions.

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

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

Do not service the machine while it is in motion.

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



TEST TUNNEL VENTILATION

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

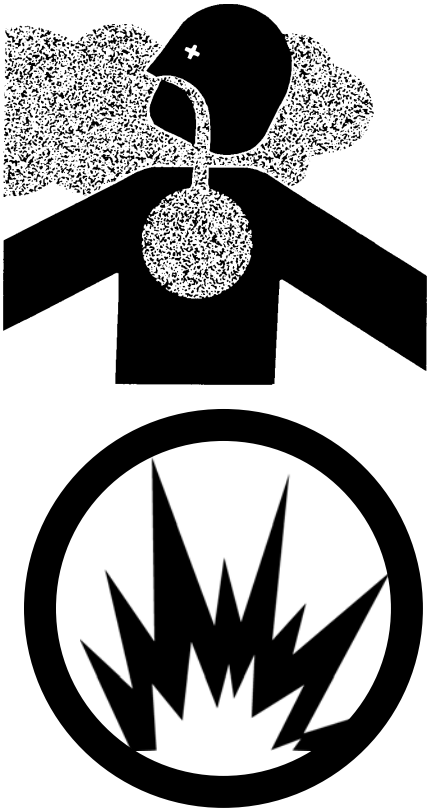
Use an approved air analyzer to detect hazardous gases and oxygen content.

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

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

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

Gases must be removed before reentering tunnel/shaft.



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.

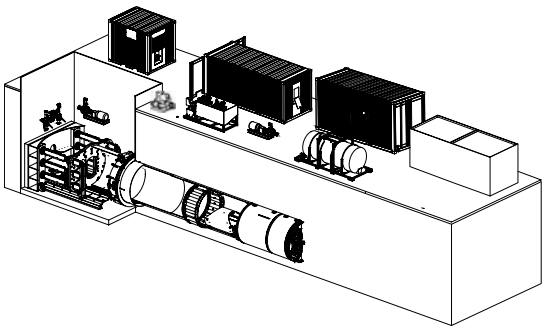
DO NOT use your hands to check for leaks. When searching for leaks, use a piece of wood or cardboard.

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.

HIGH PRESSURE HYDRAULICS

⚠WARNING The Microtunneling System contains high pressure hydraulics.

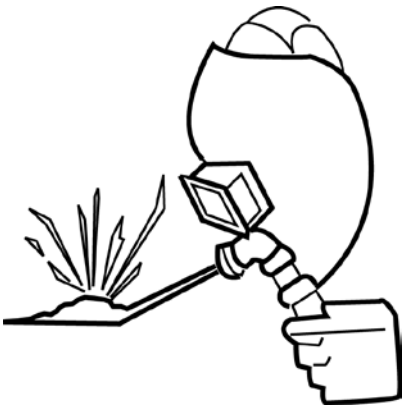
Keep all guards in place.



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.



KEEP JOB SITE CLEAN AND ORGANIZED

⚠WARNING Tripping can cause serious personal injury.

Be sure to keep job site clean and organized.

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.

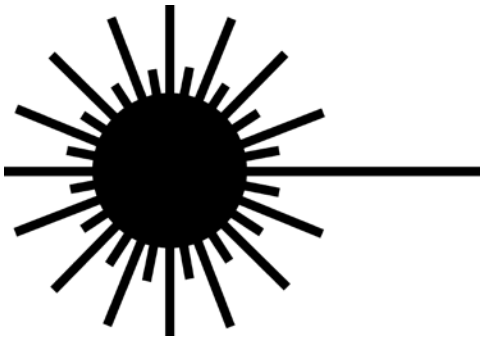
Do not smoke in shaft or tunnel.

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.

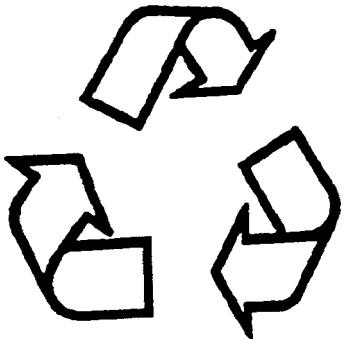
To avoid possible exposure to radiation in excess of acceptable emission limits, all repairs to laser must be performed by the original manufacturer or an authorized service technician.



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



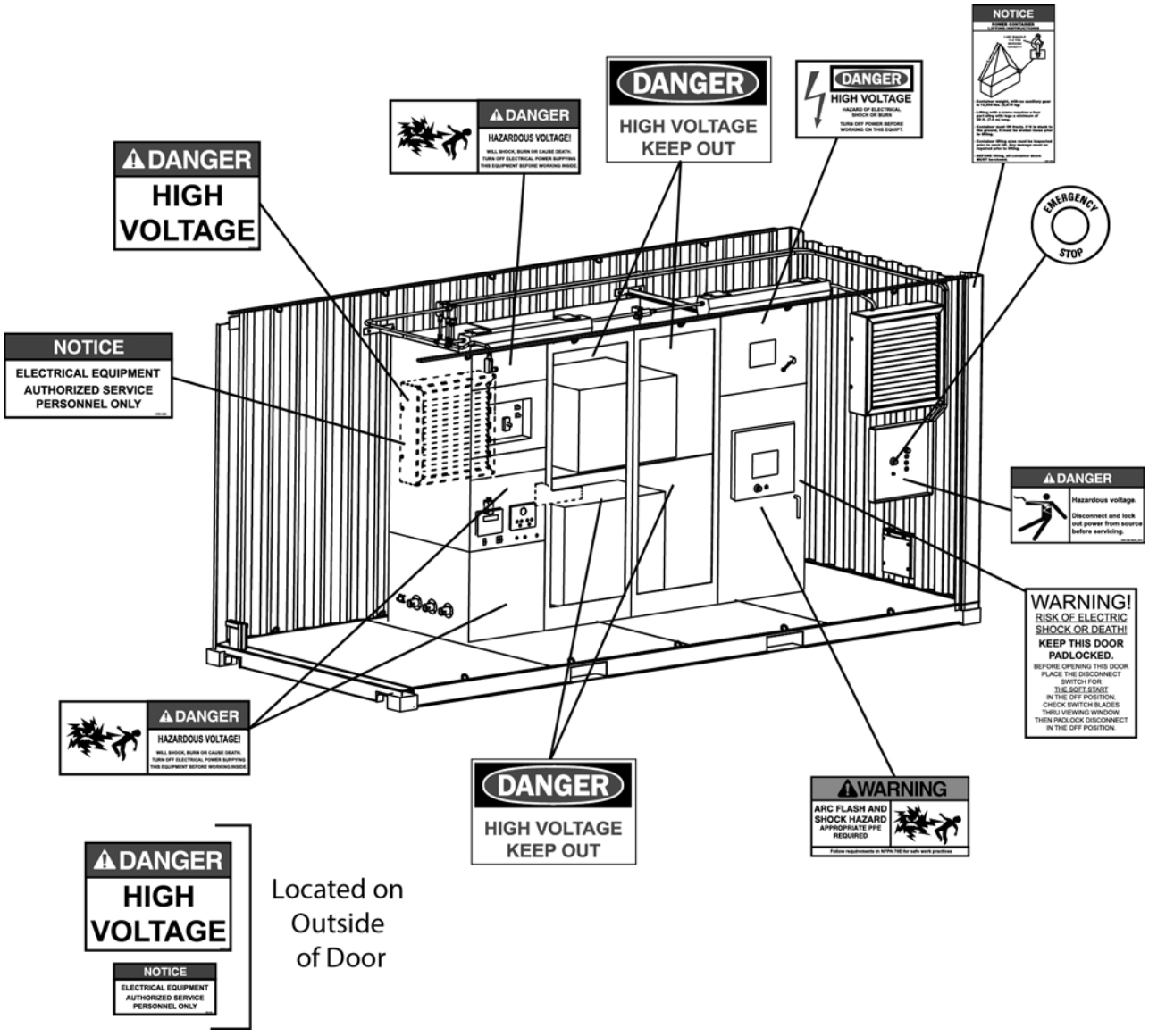
Safety Decals

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

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

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

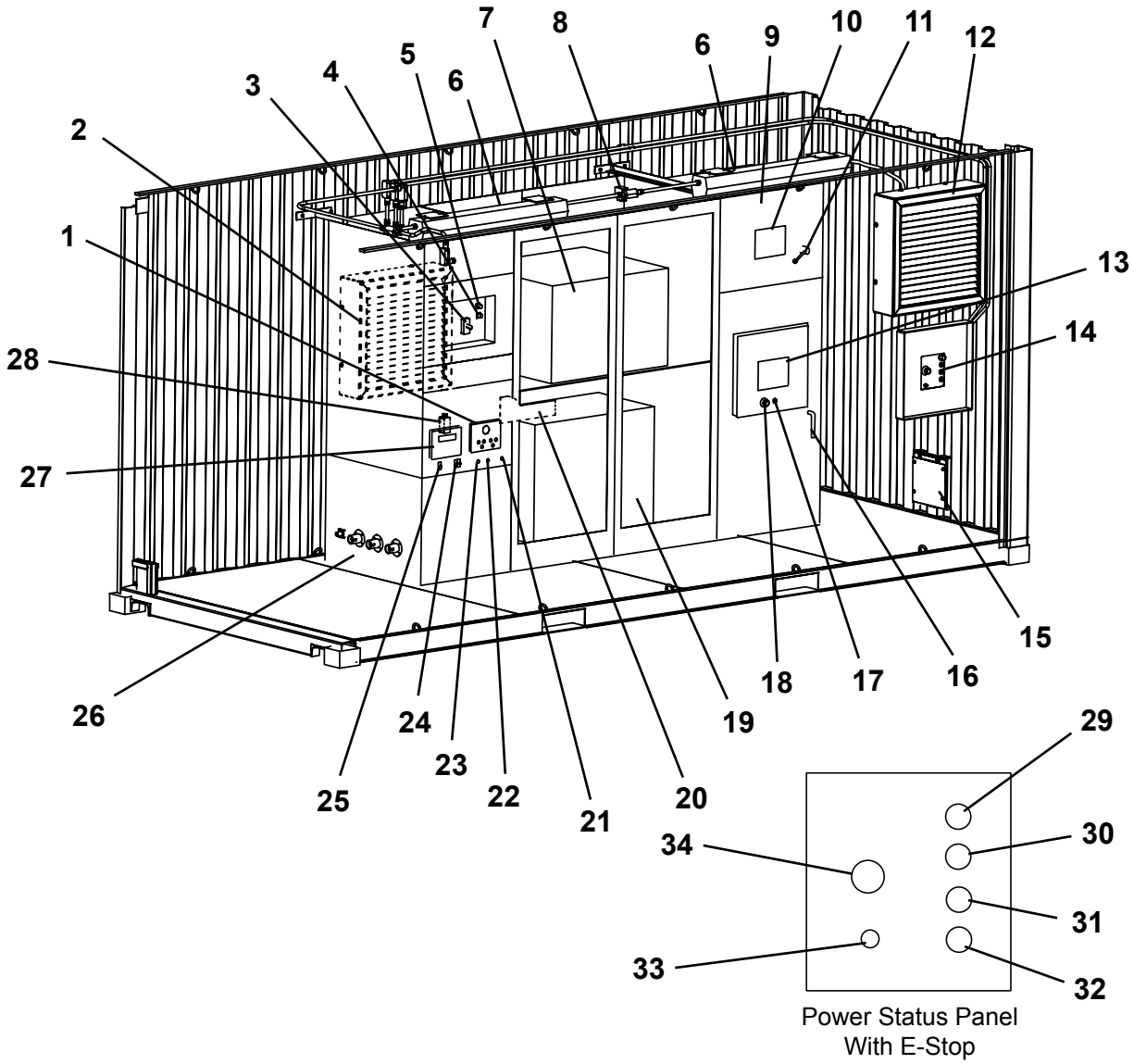
MAIN DRIVE POWER CONTAINER



NOTES

Terminology

MAIN DRIVE POWER CONTAINER



Power Status Panel
With E-Stop

1. Pilot Ground Monitor
2. Air Intake Louvers
3. Main Power Breaker 480V
4. Phase OK (Green) Light
5. Phase Error (Red) Light
6. Overhead Light
7. NGR (Neutral Grounding Resistor)
8. Exhaust Fan Thermostat Control
9. Medium Voltage Soft Start System
10. Viewing Window
11. Soft Start Disconnect Handle
12. Exhaust Fan
13. Starter Display
14. Power Status Panel With E-Stop
15. Rubber Pass-Thru Door For Electrical Cable
16. Soft Start Door Handle/Lock
17. Soft Start Selector Switch
18. Soft Start E-Stop Button (Stops MTBM Cutter Drive Pwr)
19. 480V To 4160V Step-Up Transformer
20. Breakout Wrench Mount
21. Control Switch: Local - Control Container
22. Starter Stop Button
23. Starter Start Button
24. Control Disconnect Circuit Breaker
25. Power Center Control Circuit Breaker
26. Generator Power IN (480V 3 Phase) Connections
27. Feeder Protection Relay
28. Light Switch
29. 4160V ON Indicator Light
30. 4160V Enabled Indicator Light
31. 4160V Pilot ON Indicator Light
32. 4160V Cutter Head Power ON Indicator Light
33. Ethernet Control Container Connection
34. Emergency Stop (E-Stop) Button (Stops Microtunneling System Power)

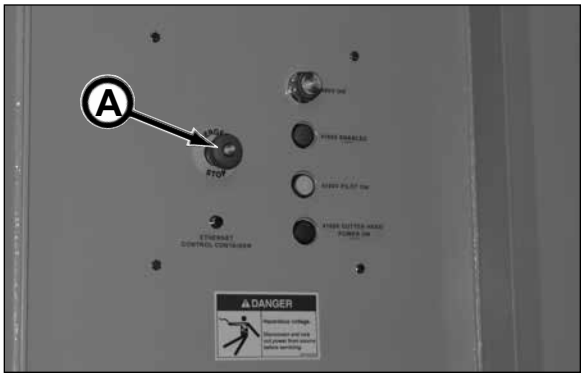
NOTES

Controls & Instruments

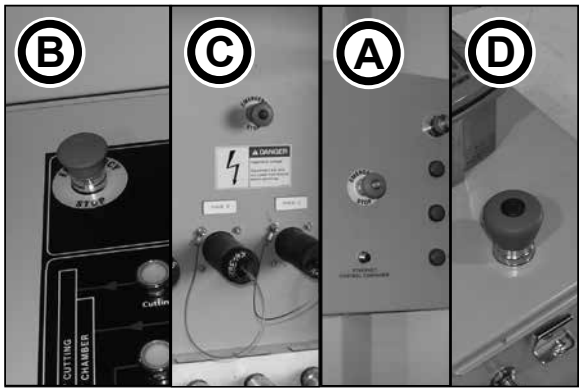
EMERGENCY STOP (E-STOP)

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

There are two E-Stop buttons on the Power Container.

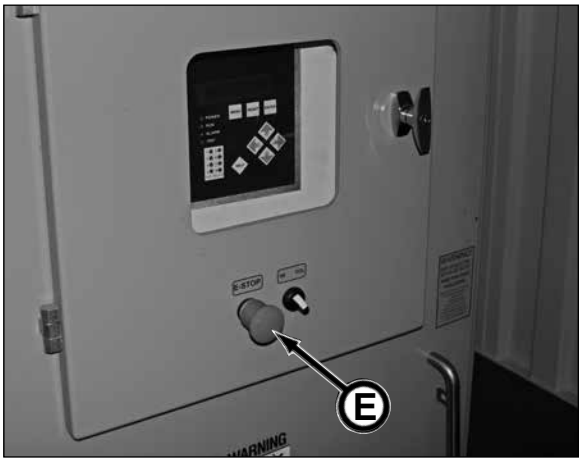


OUTSIDE PANEL E-STOP
The E-Stop button (A) on the outside panel or the control container console (B), remote hydraulic power pack bulkhead (C) and pit box (D) will deactivate ALL outgoing electrical and hydraulic power from the Akkerman control container (feed pump, return pump, booster, mid pump, head power and cooling water tank pump [if used]), remote hydraulic power pack (hydraulic flow to jacking frame), power container (cutter head 4160V main drive tunnel power) and jacking frame.



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

INSIDE PANEL E-STOP
The E-Stop button (A) on the inside panel will deactivate the power to the MTBM cutter drive only. This E-Stop ***will not*** deactivate power to any other microtunneling system components.



PHASE INDICATOR LIGHTS

⚠DANGER Hazardous voltage. Disconnect and lockout/tagout power from source before servicing.

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

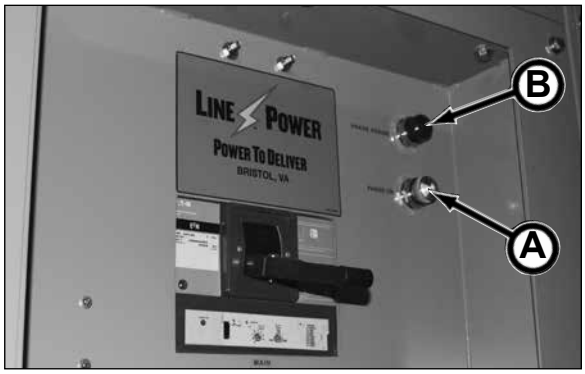
⚠WARNING Any electrical work completed on the control container or the remote hydraulic power pack must be performed by a certified electrician.

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

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

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

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



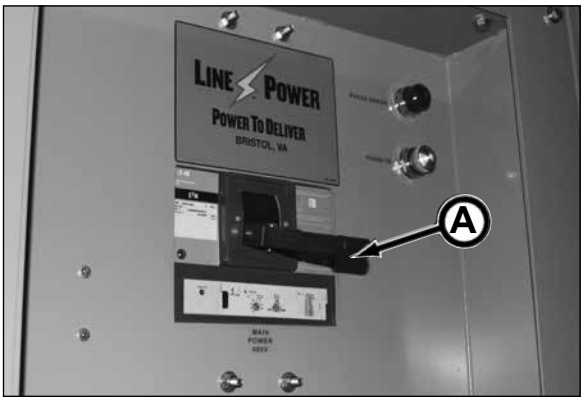
MAIN POWER SWITCH

⚠DANGER Hazardous voltage. Disconnect and lockout/tagout power from source before servicing.

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

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

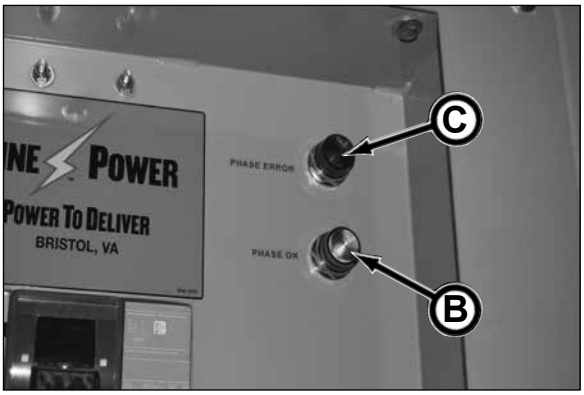
NOTICE The control container, remote hydraulic power pack, power container (two E-Stop buttons located on outside and inside panels) and pit box E-Stop buttons must ALL be pulled out to start operation.



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

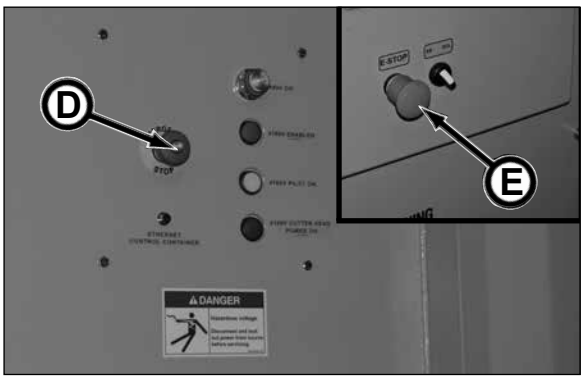
1. Check to sure the main power switch (A) is down in the OFF position.

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



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

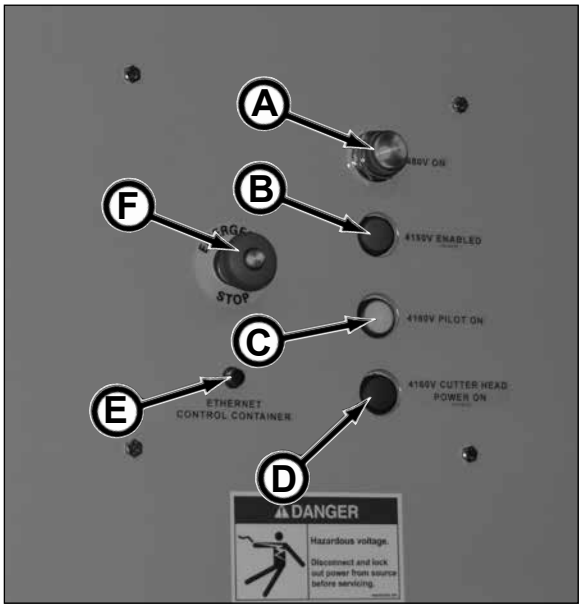
4. With power in proper phase, pull out all E-Stop buttons:
   • power container E-Stop buttons (D, E), control container E-Stop button, remote hydraulic power pack E-Stop button, and the pit box E-Stop button.



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

POWER STATUS PANEL

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



480V ON (A)
Illuminates when the generator or power source is connected to power container and powered.

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

4160V PILOT ON (C)
Illuminates when the tunnel cable is properly connected from power container to main drive motor in trailing section.

4160V CUTTER HEAD POWER ON (D)
Illuminates when the Cutter head power is powered on from either the control console in the control container or the local control.

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

EMERGENCY STOP (F)
Push IN Emergency Stop button (F) to stop Microtunneling System power. The E-Stop button will illuminate when it is pushed in. Pull OUT E-Stop button to restart operation.

NEUTRAL GROUNDING RESISTOR (NGR)

The power container is equipped with a Neutral Grounding Resistor (NGR). The main purpose of a NGR is to limit ground fault currents to safe levels so that all the electrical equipment in the power container is protected, and at the same time allowing enough current flow to operate the protective relays that will alarm or clear the fault.

⚠DANGER Hazardous voltage. Disconnect and lockout/tagout power from source before servicing.

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

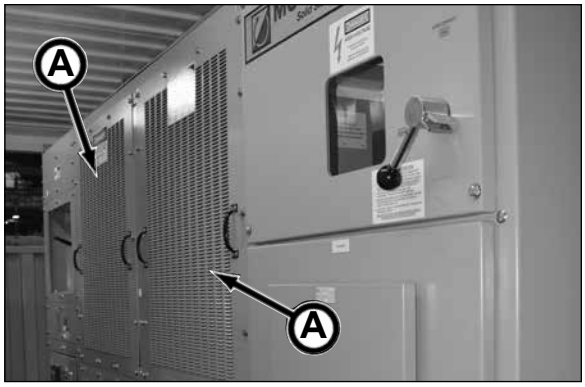
⚠WARNING Any electrical work performed on the electrical components of the power container must be completed by a certified electrician.

An inspection of the NGR **MUST** be performed by a certified electrician as follows:
- when the power container is transported
- prior to each job launch
- a ground fault occurs

INSPECTING THE NEUTRAL GROUNDING RESISTOR (NGR)

1. Lockout/tagout power sources.

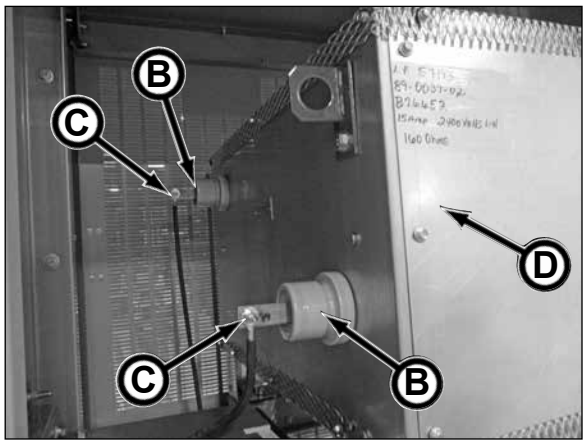
2. Remove the two NGR panels (A).



3. Visually inspect NGR:
   - terminals (B)
   - cable connections (C)
   - excessive box damage (D)

   If there are any signs of wear or damage, the NGR MUST be repaired or replaced BEFORE operation.

4. Using a multimeter, test the NGR from terminal to terminal and measure the resistance. The resistance measurement must be at 160 ohm +/- 20 ohms. **If the measurement is not within this specification, the NGR MUST be repaired or replaced BEFORE operation.**



5. Replace panels.

SOFT START SYSTEM

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

IMPORTANT: The soft start system MUST be de-energized before disconnecting utilities, at each pipe set and at the end of each day to prevent any accidental starting of the drive motor. Refer to De-Energizing Soft Start System in this section.

⚠DANGER Hazardous voltage. Disconnect and lockout/tagout power from source before servicing.

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

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

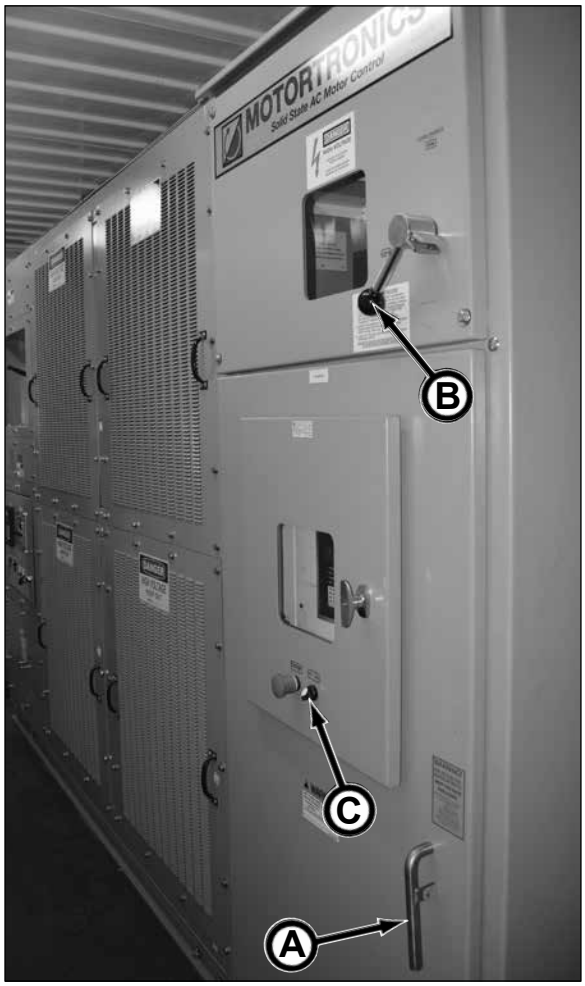
ENERGIZING SOFT START SYSTEM

Energize the soft start system as follows:

1. Check to be sure the soft start cabinet door handle (A) is closed and padlocked and the soft start disconnect handle (B) is in the OFF position.

2. Be sure the soft start selector switch (C) is on the SS (Soft Start) position.

NOTICE In the event there is a problem with the soft start system, the DOL (Direct On Line) soft start selector switch position allows the soft start system to be bypassed permitting the main drive motor to be started.



(continued on next page)

ENERGIZING SOFT START SYSTEM (continued)

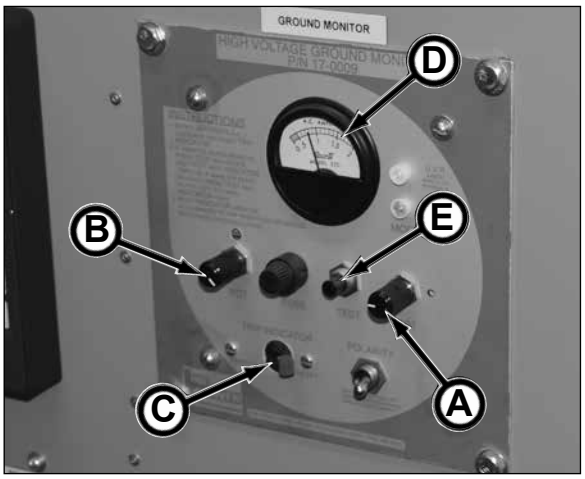
3. With the power container green Phase OK light illuminated, pull out all E-Stop buttons and flip the main power switch up to the ON position (refer to Main Power Switch in this section).

4. Adjust the ground monitor for cable resistance as follows (shown on the ground monitor instructions):

   a. Rotate both right Pot (A) and left Pot (B) fully clockwise and reset Trip Indicator (C).

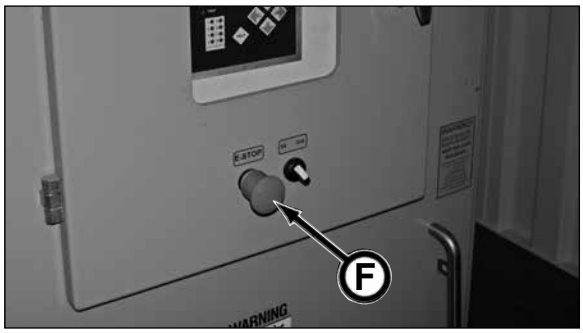
   b. If ammeter (D) reads above 0.5 amps, press Test button (E) and rotate right Pot (A) until trip indicator (C) trips.
   OR, if ammeter reads below 0.5 amps, press Test button and rotate left Pot (B) until trip indicator (C) trips.

   c. Reset trip indicator (C). Monitor is now calibrated to trip when pilot or ground resistance increases 3 ohms.



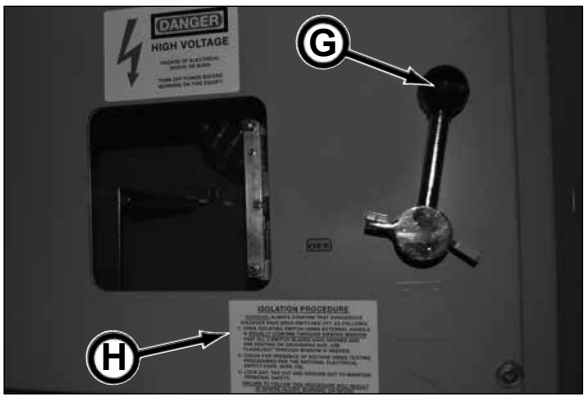
5. With **verification** for start up approval from all equipment operators, remove lockout/tagout on power container.

6. Pull out the Soft Start E-Stop button (F). Be sure the E-Stop button on the outside panel of the power container is pulled out.



7. Flip the soft start disconnect handle (G) up to the 4160V Enable ON position.

IMPORTANT: BEFORE breaking utility connections or when setting new pipe, de-energize the soft start by flipping the soft start disconnect handle (G) to the OFF position and follow the ISOLATION PROCEDURE (H) to confirm that all voltages are switched off and in lockout/tagout. Refer to De-Energizing Soft Start System in this section.



NOTICE If the external E-Stop faults on the soft starter or if the pilot circuit is tripped due to breaking utility connections when setting a new pipe, the Soft Start must be reset. Press Reset button (as shown). The display will read Motor Ready To Start when the main drive motor can be started.

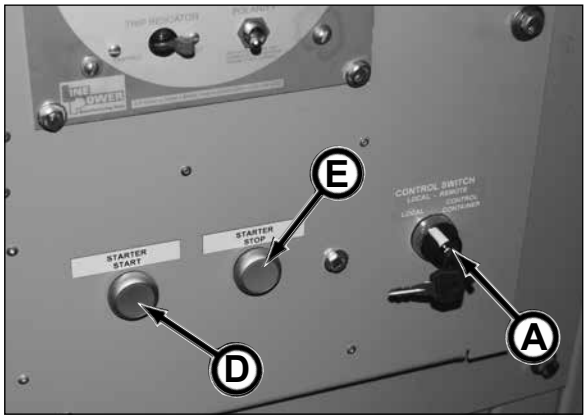
(continued on next page)

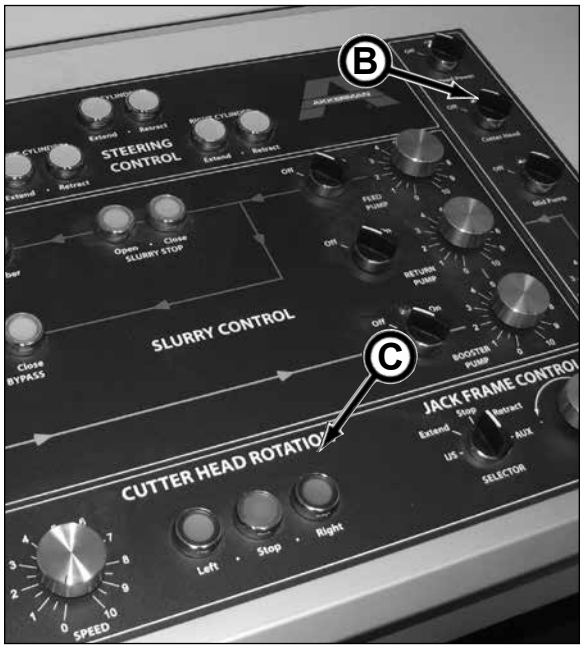
ENERGIZING SOFT START SYSTEM (continued)

8. Turn control switch (A) to either Local or Control Container position. Once selected, remove key to prevent accidental changing of the switch.

   If the cutter head drive motor is to be controlled from the control container with the Cutter Head On/Off button (B) and the cutter head rotation controls (C), select CONTROL CONTAINER.

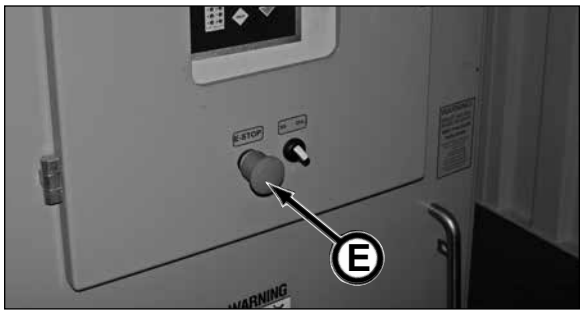
   If the cutter head drive motor is to be controlled from the power container start (D) and stop (E) control buttons, typically for troubleshooting purposes, select LOCAL.





NOTICE To prevent the soft start system from starting the main drive motor, push in the Soft Start E-Stop button (F). When using the cutter head, refer to Cutter Head Controls in section 4, Controls & Instruments in your Microtunneling System Operator's Manual.

9. The main drive motor can now be started.



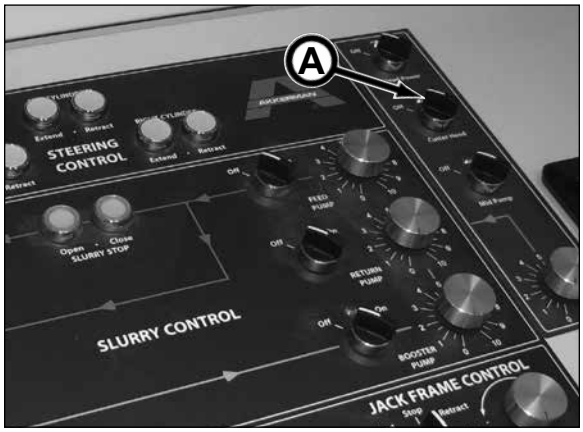
De-Energizing Soft Start System begins on the next page.

DE-ENERGIZING SOFT START SYSTEM

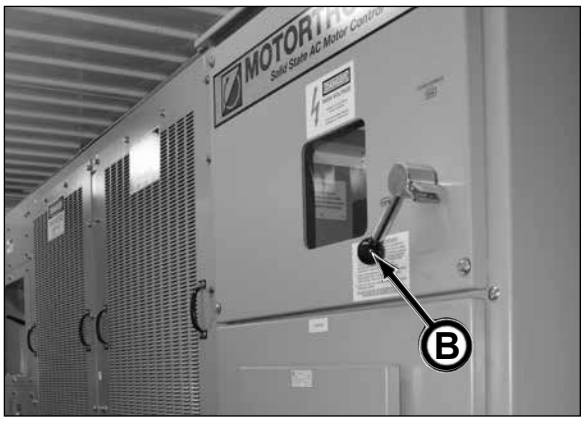
IMPORTANT: The soft start system MUST be de-energized before disconnecting utilities, at each pipe set and at the end of each day to prevent any accidental starting of the drive motor.

De-Energize the soft start system as follows:

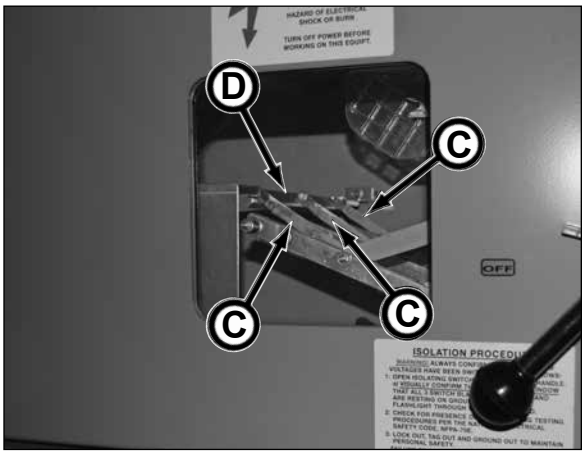
1. Turn Cutter Head switch (A) to the OFF position.



2. Turn soft start disconnect switch (B) to OFF position and secure switch with padlock to prevent accidental start up. Perform lockout/ tagout procedure.



3. Visually confirm through viewing window that the ALL three switch blades (C) are resting on the grounding bar (D). If needed, use a flashlight through the window.

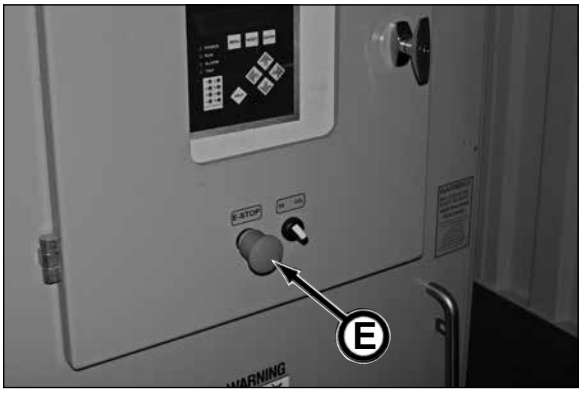


4. Push IN Soft Start E-Stop button (E).

5. Check for presence of voltage using testing procedures per National Electrical Safety Code, NFPA-70E.

6. Lockout/tagout and ground out to maintain personal safety.

7. The soft start is now de-energized.



NOTES

Pre-Start Inspection

⚠WARNING Do not operate this equipment until you read, study, and understand this manual and your Microtunneling System Operator's Manual. A daily inspection of the equipment must be performed to prevent severe personal injury or death and equipment damage.

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

Use the following checklist ✓ as a guide for your daily pre-start inspection.

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

NOTES

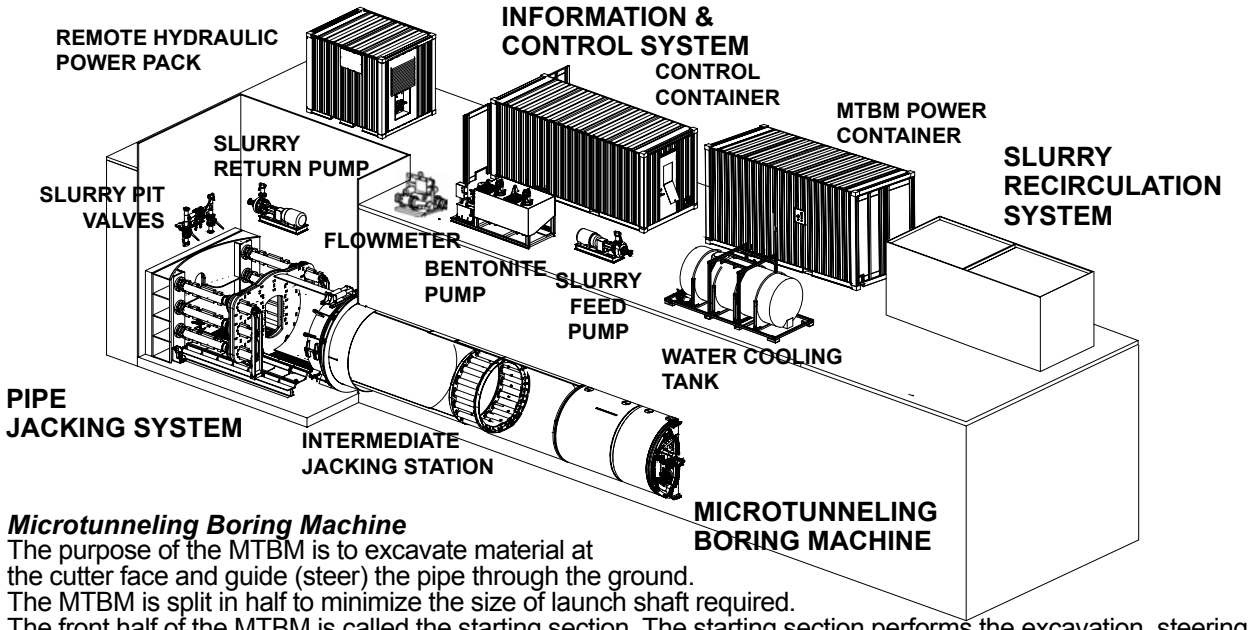
Operation

OPERATING GUIDELINES

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

1. Before operating, read and understand the Safety, Pre-Start Inspection, Operation and Maintenance sections.
2. Do not operate this equipment while under the influence of alcohol, drugs, or medication.
3. Follow all Federal, State, and Local safety regulations and procedures.
4. Be sure OSHA prescribed safety protective equipment is being worn by all personnel.
5. Be sure the area is safe for operation. Keep worksite clean and orderly.
6. NEVER operate equipment if it has been engulfed with water. Contact your Akkerman Aftermarket Support representative for proper procedures on how to restore equipment for operation.
7. Have fully charged fire extinguishers on the job site at all times.
8. Before operating, inspect all equipment and repair equipment problems. Check hoses for cuts or bulges. Replace worn or damaged hoses.
9. Be sure the excavated launch and reception shafts are properly shored or braced to prevent slides or cave-ins.
10. Test air monitoring and ventilation detectors for proper operation. Never enter a tunnel without detectors.
11. A fully trained and qualified signal person must direct the excavator or crane operator when lifting and lowering equipment into the launch or reception shafts.
12. Never walk or work under any part of the excavator or crane and suspended loads.
13. Test each function and control to make sure they work properly.
14. Lockout/tagout electrical power at the source (generator) before servicing electrical components.
15. Do not make any non-authorized modifications to any Akkerman products. Doing so could cause structural failure and will void the warranty.
16. Check shields and guards. All must be in place and undamaged.
17. Test all Emergency Stop circuits for proper operation at the start of each shift.
18. Before starting equipment, walk completely around all machines and equipment. Let all job site personnel that you are starting up the equipment. Do not start until all unauthorized personnel are clear of the equipment.
19. After start-up, observe all gauges, controls and warning devices to assure they are functioning properly and their readings are within the operating range.
20. Never leave the operator's station without first releasing hydraulic pressure, performing daily system shutdown, and disconnecting the main power supply.
21. Perform lockout/tagout procedure to the main disconnect on all equipment and power source before performing maintenance.
22. If adjustments must be made with the equipment running, always work as a 2-person team with one person in the operator's station while the other works on the machine.
23. Never operate jetting pump or cooling pumps without fresh water supply.
24. Check cable for continuity and shorting before each use. Do not pull or strain cables; doing so will result in damage.
25. Constantly monitor electrical cables using jacking process to prevent cutting or stretching of any electrical cables. Contact with severed electrical cables WILL cause severe injury or death.
26. Keep tunnel well ventilated to achieve a consistent temperature throughout the pipeline since changes in temperature inside the pipe can cause guidance system laser beam to stray off target.

SYSTEM OVERVIEW



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

MTBMs (with periphery drive) may range in sizes from approximately 60 inches through 114 inches outer pipe diameter. Ground conditions can range from dry to saturated with water, fine-grained to gravel, and loose soil to soft rock. Although consistent ground conditions work the best, the MTBM will cut through layers of different types of soil. The machine will also generally tolerate soft rocks that are up to 1/4 the diameter of the machine.

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

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

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

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

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

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

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

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

CONNECTING POWER CONNECTIONS

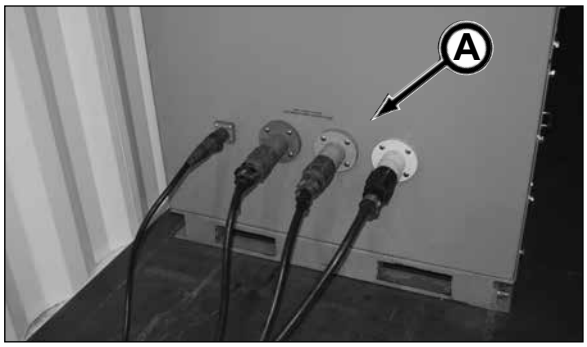
⚠DANGER Hazardous voltage.
This system is powered by high voltage electricity.

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

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

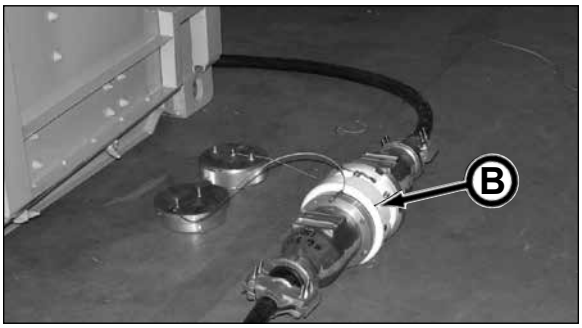
NOTICE For recommended power requirements, refer to section 11, Specifications in this manual.

1. With generator or power source properly ground, install power cord to power connections (A) on power container.

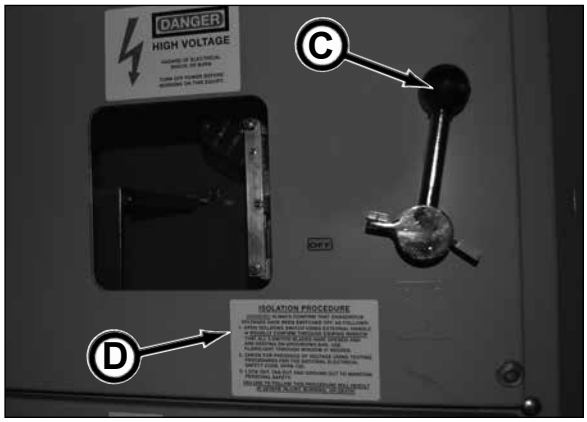


2. Connect power container power cable plug to MTBM cutter drive power cable plug (B).

3. Proceed to Checkout Equipment Prior To Start-Up in section 4, Controls & Instruments of your Microtunneling System Operator's Manual.



IMPORTANT: BEFORE breaking utility connections or when setting new pipe, de-energize the soft start by flipping the soft start disconnect handle (C) to the OFF position and follow the ISOLATION PROCEDURE (D) to confirm that all voltages are switched off and in lockout/tagout. Refer to Soft Start System, De-Energizing Soft Start System in section 4, Controls & Instruments of this manual.



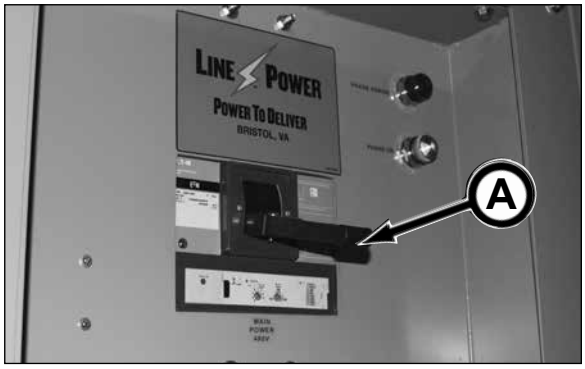
SYSTEM START-UP

⚠DANGER Hazardous voltage. Disconnect and lockout/tagout power from source before servicing.

NOTICE For recommended power requirements, refer to section 11, Specifications in this manual.

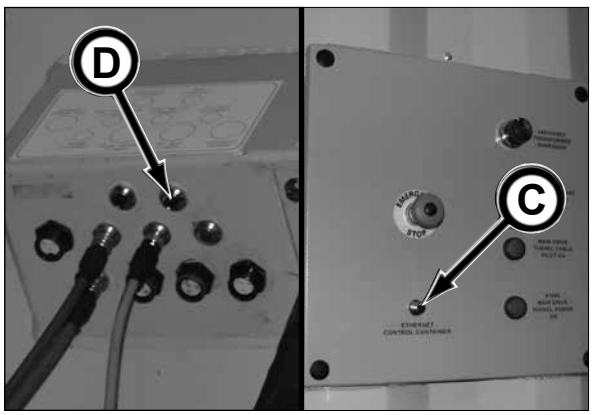
1. Refer to System Start-Up procedure in your Microtunneling System Operator's Manual.

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



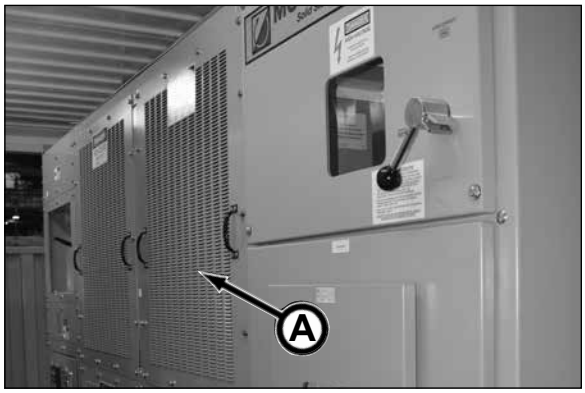
3. Connect power container power cable plug to MTBM cutter drive power cable plug (B).

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



(continued on next page)

5. The power container is equipped with a Neutral Grounding Resistor (NGR) (A). Inspection of the NGR **MUST** be performed any time the power container has been transported, a ground fault occurs or prior to each drive launch. Refer to the inspection procedure, Neutral Grounding Resistor, Inspecting The Neutral Grounding Resistor (NGR) in section 4, Controls & Instruments of this manual.

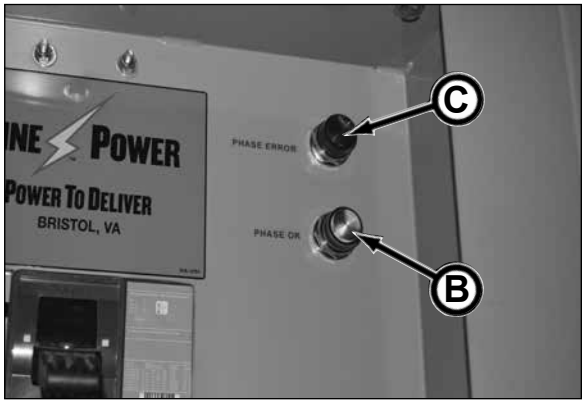


6. With verification for generator power up from all microtunneling system equipment operators, turn on generator/power source power to the control container, remote hydraulic power pack and main drive power container.

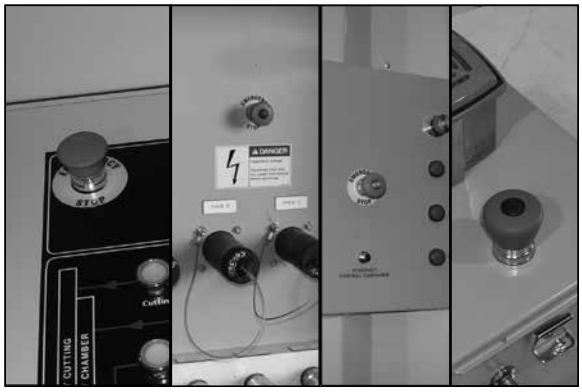
7. Check the power container phase indicator lights:

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

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



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



9. Energize the soft start system on the power container for the main drive motor, following the Energizing Soft Start System procedure in section 4, Controls & Instruments, Soft Start System in this manual.

10. The main drive motor can now be started.

MTBM LAUNCH SEQUENCE

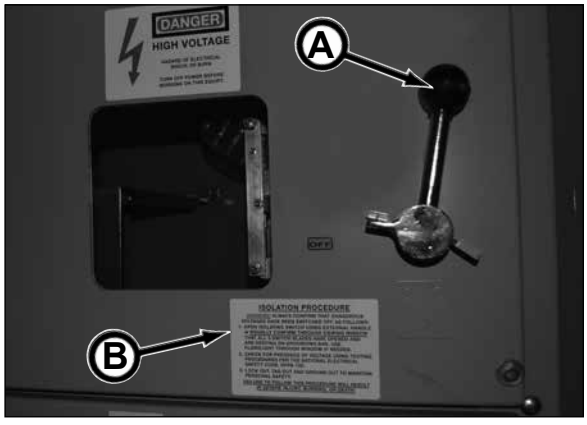
Perform System Start-Up procedure before launching MTBM. Refer to System Start-Up in this section.

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

NOTICE Be sure the crane or excavator and all lifting equipment is rated to lift load. Remember, you may be able to lift the load in close at ground level, but as the load radius and elevation change, the lifting capacity of the crane or excavator or other lifting equipment may decrease.

- Follow the launch sequence, MTBM Launch Sequence in section 6, Operation of your Microtunneling System Operator's Manual.

IMPORTANT: BEFORE breaking utility connections or when setting new pipe, de-energize the soft start by flipping the soft start disconnect handle (A) to the OFF position and follow the ISOLATION PROCEDURE (B) to confirm that all voltages are switched off and in lockout/tagout. Refer to Soft Start System, De-Energizing Soft Start System in section 4, Controls & Instruments of this manual.



ADDING NEW PIPE & UTILITIES

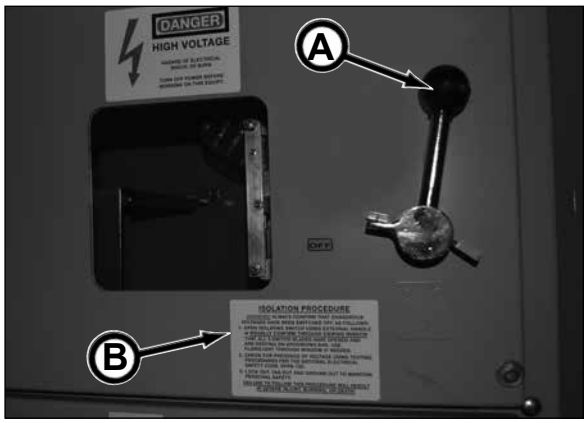
Once the MTBM is advanced far enough, additional pipe and utilities (main cutter drive cable, head power cable, booster pump cable, ethernet cable, tunnel light cable, slurry feed hose, slurry return hose, ventilation lines, bentonite supply hose, high pressure jetting hose, and other utilities) must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

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

1. Follow the Adding New Pipe & Utilities procedure in section 6, Operation of your Microtunneling System Operator's Manual.

2. **BEFORE breaking utility connections or when setting new pipe, de-energize the soft start by flipping the soft start disconnect handle (A) to the OFF position and follow the ISOLATION PROCEDURE (B) to confirm that all voltages are switched off and in lockout/ tagout.**
   Refer to Soft Start System, De-Energizing Soft Start System in section 4, Controls & Instruments in this manual.

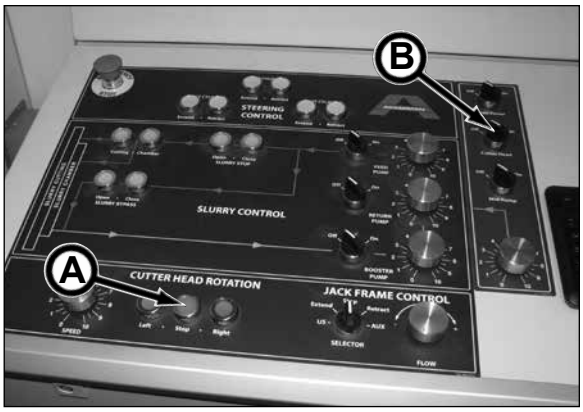
3. Once new pipe and utilities have been added and all systems are back on-line, energize the power container soft start. Refer to Energizing Soft Start System in section 4, Controls & Instruments in this manual.



DAILY SHUT DOWN

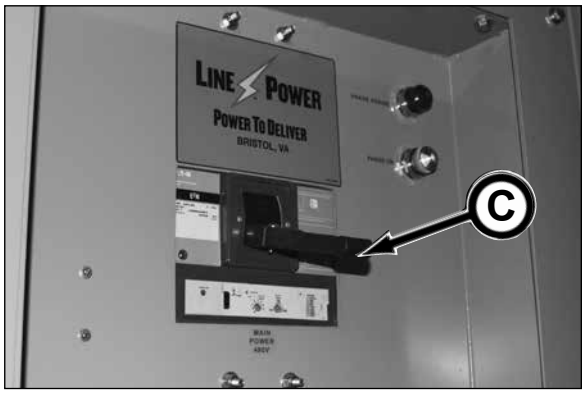
NOTICE For more information, refer to Daily Shutdown in section 6, Operation of your Microtunneling System Operator's Manual.

1. Shutdown the MTBM drive motor by pressing the Cutting Head STOP button (A) and turn Cutter Head power switch (B) to the OFF position.



2. De-energize the power container soft start (refer to De-Energizing Soft Start System in section 4, Controls & Instruments, Soft Start System).

3. Shut off the power on the power container by flipping the main power switch (A) to the OFF position. Lockout/tagout power container and main power source.



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 in control container.
9. Observe the lifting instructions on the following pages.

LIFTING INSTRUCTIONS

- Container weight varies per container model. Be sure certified lifting devices are capable of lifting container weight capacity. Refer to the lifting instruction decal (contact your Akkerman Aftermarket Support representative for more information).

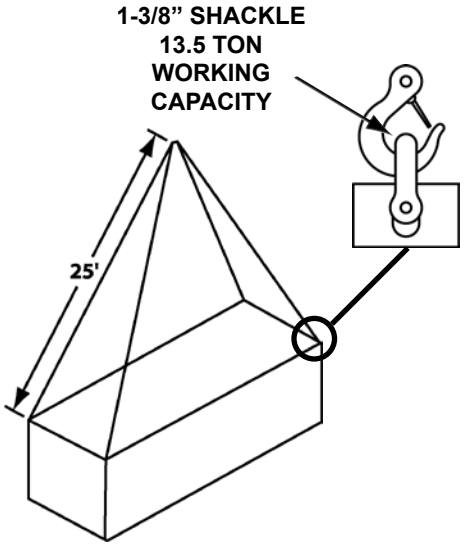
  With no auxiliary gear:
  FA22062F 12,500 lbs. (5,670 kg).

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

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

- Container lifting eyes and sling must be inspected prior to each lift. Any damage must be repaired prior to lifting.

- BEFORE lifting, all container doors MUST be closed.



NOTES

Periodic Maintenance

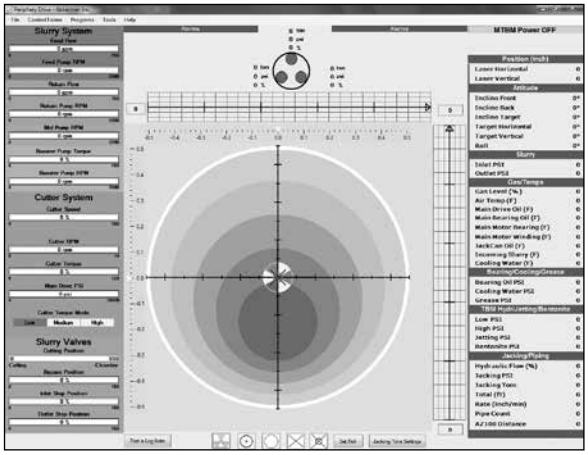
⚠WARNING Review the Safety section in this manual and your Microtunneling System Operator's Manual before performing maintenance. Failure to do so, could cause severe injury or death.

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

MAINTENANCE INTERVALS

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

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



LOCKOUT/TAGOUT POWER BEFORE SERVICING

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

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

BEFORE PERFORMING MAINTENANCE

1. Push in all E-Stop button(s).

2. Relieve hydraulic pressure.

3. Disable MTBM accumulator prior to performing maintenance.

3. Perform appropriate electrical system maintenance shutdown procedure. Refer to Daily Shut Down in the Operation section.

4. Do not work on hydraulic system if oil temperature exceeds 150° F (66° C).

5. **Lockout/tagout all power. Perform lockout/tagout procedure.**

HYDRAULIC OIL/FLUIDS UNDER PRESSURE

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

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

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

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

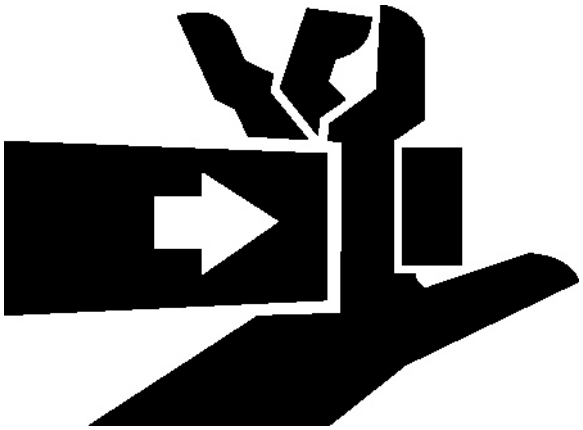
AVOID PINCH POINTS

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

Keep hands away from moving parts.

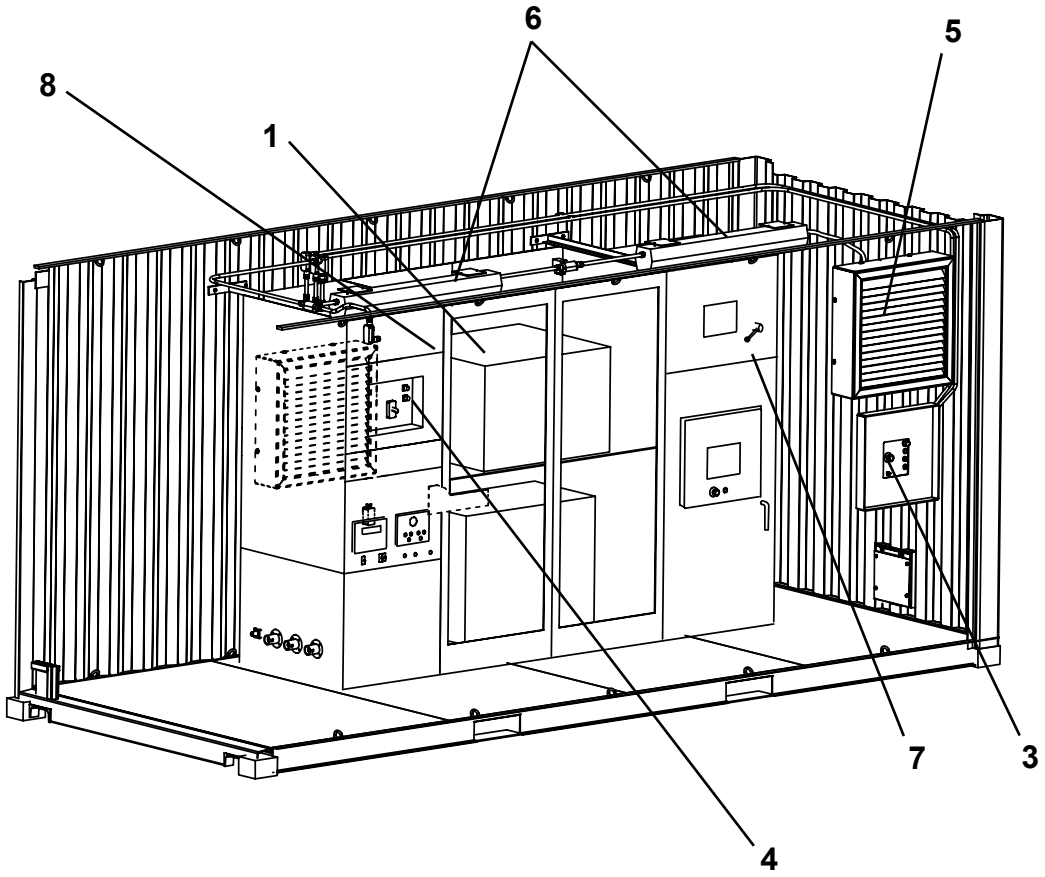
Watch your fingers, hands, and legs while equipment is in operation.

Handle parts carefully to avoid crushing and pinch point hazards.



MAINTENANCE CHARTS - MAIN DRIVE POWER CONTAINER

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



PRIOR TO EACH DRIVE LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	NGR	Inspect	If damaged, replace before operation.	
*2.	Electrical Connect.	Check Connect & Cables	If damaged, replace before operation.	
3.	E-Stop	Check Operation		
4.	Phase Monitor	Check For Phase Error		
5.	Exhaust Fan	Check Operation		
6.	Lights	Check		
7.	Soft Start	Check Operation		

WEEKLY OR EVERY 50 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
8.	Electrical Equipment	Clean		

ANNUALLY

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
*9.	Hardware	Check	Check tightness of bolt torque.	Torque Wrench

* Not Shown

PRIOR TO EACH DRIVE LAUNCH

1. INSPECT NEUTRAL GROUNDING RESISTOR (NGR)

The power container is equipped with a Neutral Grounding Resistor (NGR). The main purpose of a NGR is to limit ground fault currents to safe levels so that all the electrical equipment in the power container is protected, and at the same time allowing enough current flow to operate the protective relays that will alarm or clear the fault.

⚠DANGER Hazardous voltage. Disconnect and lockout/tagout power from source before servicing.

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

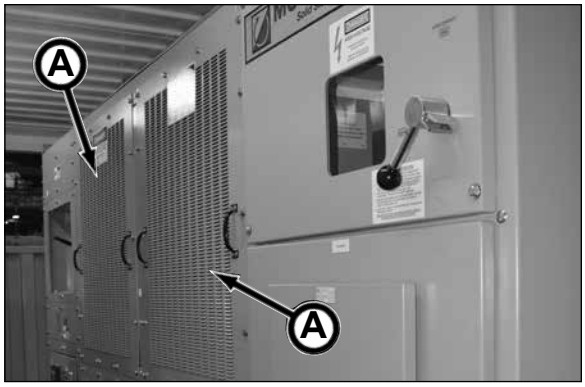
⚠WARNING Any electrical work performed on the electrical components of the power container must be completed by a certified electrician.

An inspection of the NGR **MUST** be performed by a certified electrician as follows:
- when the power container is transported
- prior to each job launch
- a ground fault occurs

INSPECTING THE NEUTRAL GROUNDING RESISTOR (NGR)

1. Lockout/tagout power sources.

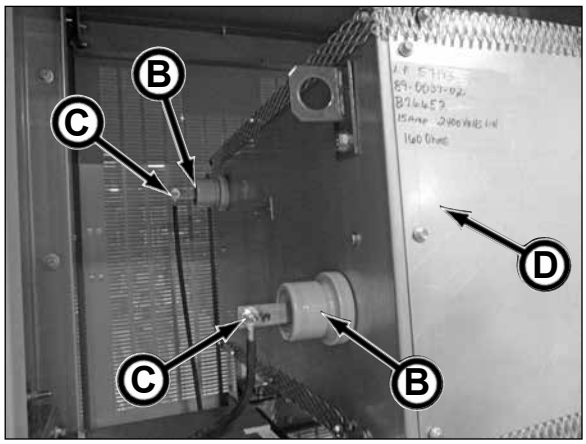
2. Remove the two NGR panels (A).



3. Visually inspect NGR:
   - terminals (B)
   - cable connections (C)
   - excessive box damage (D)

   If there are any signs of wear or damage, the NGR MUST be repaired or replaced BEFORE operation.

4. Using a multimeter, test the NGR from terminal to terminal and measure the resistance. The resistance measurement must be at 160 ohm +/- 20 ohms. **If the measurement is not within this specification, the NGR MUST be repaired or replaced BEFORE operation.**



5. Replace panels.

2 CHECK ELECTRICAL CONNECTIONS

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

With power in lockout/tagout, check electrical cables and connections for fraying, wear or damage. If damaged, the cables must be replaced BEFORE operation.

3. CHECK E-STOP OPERATION

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

Check E-Stop button (A) for proper operation. When pushed in, the E-Stop must deactivate ALL outgoing electrical and hydraulic power from the Akkerman control container (feed pump, return pump, booster, mid pump, head power and cooling water tank pump [if used]), remote hydraulic power pack (hydraulic flow to jacking frame), power container (cutter head 4160V main drive tunnel power) and jacking frame.

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

NOTICE If any E-Stop buttons are activated in the control container, remote hydraulic power pack, power container or jacking frame pit box, ALL E-Stop buttons must be pulled out for the equipment to function.
BEFORE resetting the E-Stop buttons, be sure all control container switches are flipped to the OFF or Stop positions to prevent any unintended starting of equipment.

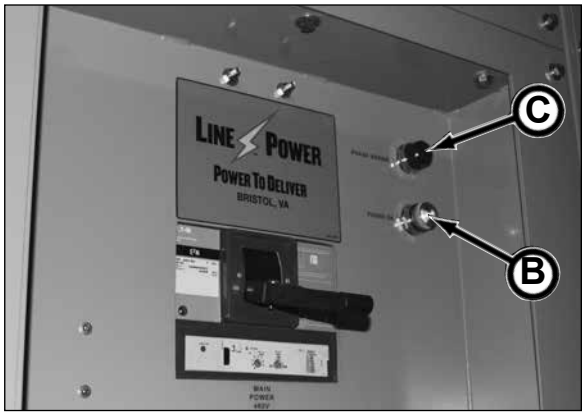
4. CHECK PHASE MONITOR

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

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

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

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



Power Container Phase Indicators

5. CHECK EXHAUST FAN OPERATION

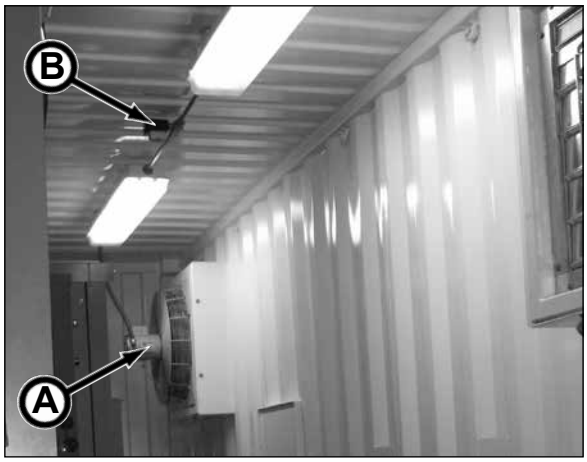
The exhaust fan (A) operates once the ambient temperature in the power container reaches 70°F (21°C) and will shut down when the temperature reaches approximately 60°F (15.5°C).

A thermostat control (B) is installed in the power container to change the temperature setting for the exhaust fan startup. The fan will automatically shut down when the ambient temperature in the power container reaches approximately 10° less than the temperature setting.

Check the fan blades for cracks, dents or other damage. If possible straighten blades. Otherwise repair or replace as necessary.

Clean fan as needed.

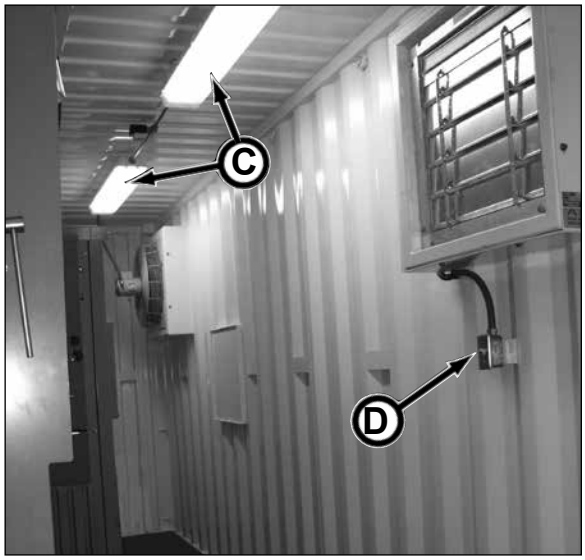
Test fan for proper operation. If fan does not function properly, repair or replace before operation of the microtunneling system.



6. CHECK LIGHT OPERATION

Check power container lights (C) for proper operation. Use light switch (D) to turn light on and off.

Repair or replace light and/or switch if they do not function properly.



7. CHECK SOFT START SYSTEM OPERATION

Check the soft start system energizing and de-energizing operation.

If the system does not operate properly, contact your Akkerman Aftermarket Support representative to resolve the soft start failure BEFORE operation.

IMPORTANT: The soft start system MUST be de-energized before disconnecting utilities, at each pipe set and at the end of each day to prevent any accidental starting of the drive motor. Refer to De-Energizing Soft Start System in this section.

⚠DANGER Hazardous voltage. Disconnect and lockout/tagout power from source before servicing.

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

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

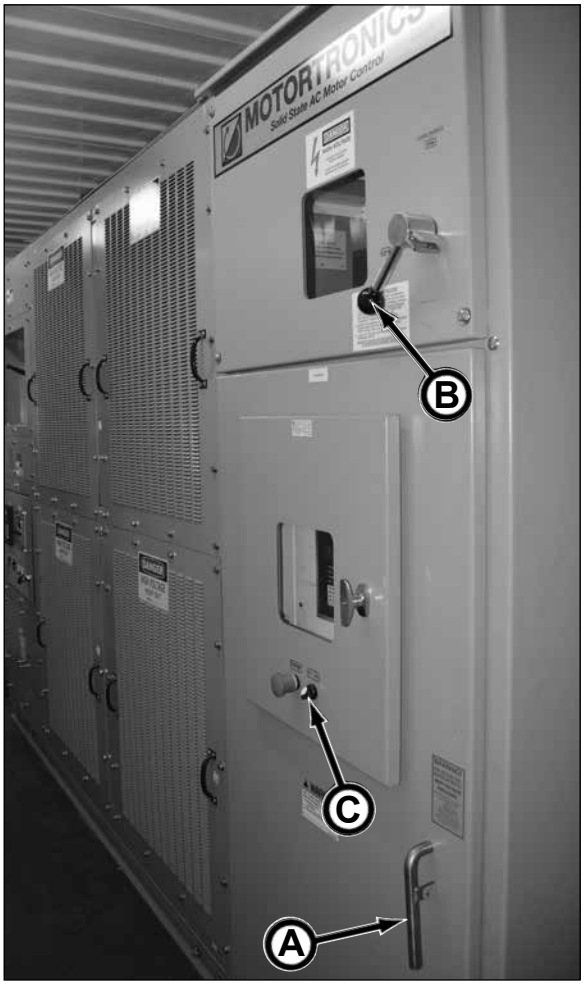
ENERGIZING SOFT START SYSTEM

Energize the soft start system as follows:

1. Check to be sure the soft start cabinet door handle (A) is closed and padlocked and the soft start disconnect handle (B) is in the OFF position.

2. Be sure the soft start selector switch (C) is on the SS (Soft Start) position.

NOTICE In the event there is a problem with the soft start system, the DOL (Direct On Line) soft start selector switch position allows the soft start system to be bypassed permitting the main drive motor to be started.



(continued on next page)

ENERGIZING SOFT START SYSTEM (continued)

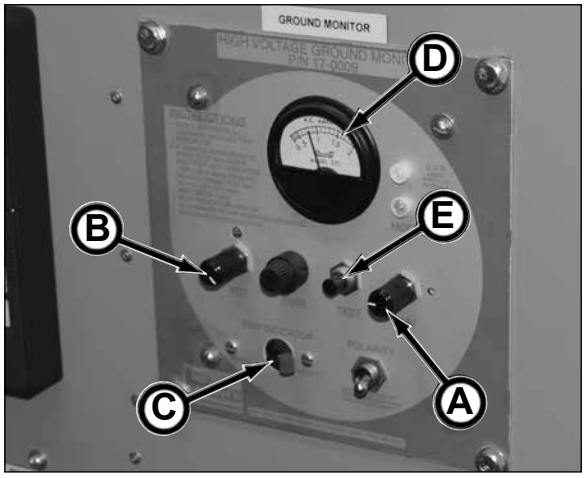
3. With the power container green Phase OK light illuminated, pull out all E-Stop buttons and flip the main power switch up to the ON position (refer to Main Power Switch (Main Drive Power Container in this section).

4. Adjust the ground monitor for cable resistance as follows (shown on the ground monitor instructions):

   a. Rotate both right Pot (A) and left Pot (B) fully clockwise and reset Trip Indicator (C).

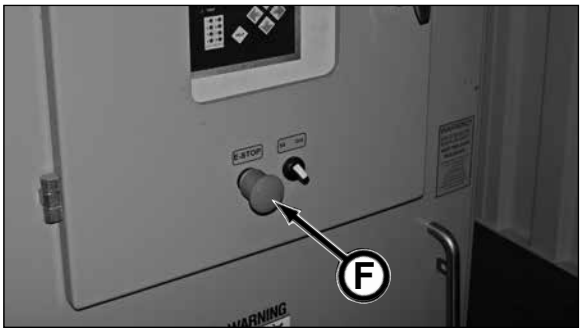
   b. If ammeter (D) reads above 0.5 amps, press Test button (E) and rotate right Pot (A) until trip indicator (C) trips.
   <u>OR</u>, if ammeter reads below 0.5 amps, press Test button and rotate left Pot (B) until trip indicator (C) trips.

   c. Reset trip indicator (C). Monitor is now calibrated to trip when pilot or ground resistance increases 3 ohms.



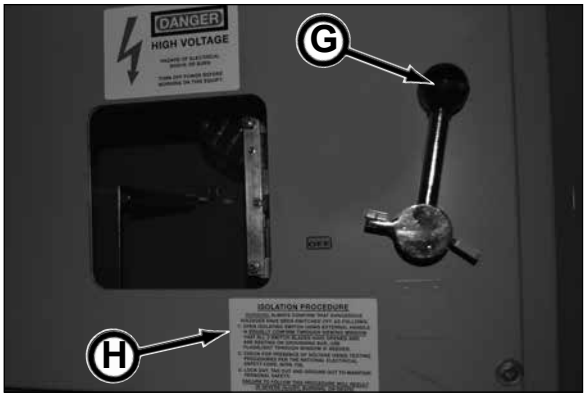
5. With **verification** for start up approval from all equipment operators, remove lockout/tagout on power container.

6. Pull out the Soft Start E-Stop button (F). Be sure the E-Stop button on the outside panel of the power container is pulled out.



7. Flip the soft start disconnect handle (G) up to the 4160V Enable ON position.

IMPORTANT: BEFORE breaking utility connections or when setting new pipe, de-energize the soft start by flipping the soft start disconnect handle (G) to the OFF position and follow the ISOLATION PROCEDURE (H) to confirm that all voltages are switched off and in lockout/tagout. Refer to De-Energizing Soft Start System in this section.



NOTICE If the external E-Stop faults on the soft starter or if the pilot circuit is tripped due to breaking utility connections when setting a new pipe, the Soft Start must be reset. Press Reset button (as shown). The display will read Motor Ready To Start when the main drive motor can be started.

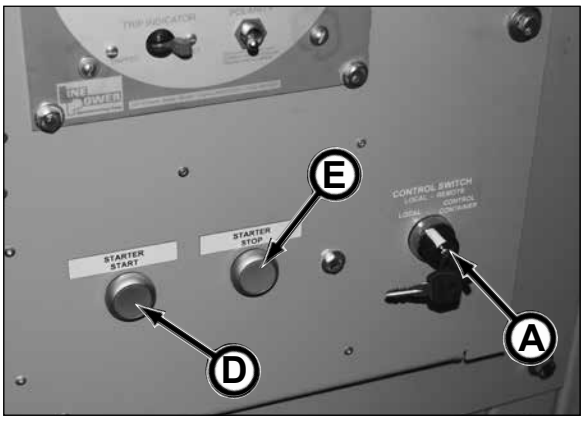
(continued on next page)

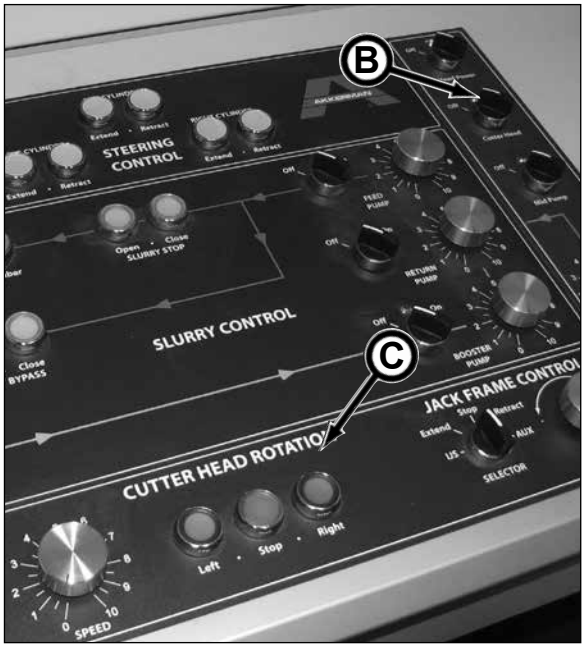
ENERGIZING SOFT START SYSTEM (continued)

8. Turn control switch (A) to either Local or Control Container position. Once selected, remove key to prevent accidental changing of the switch.

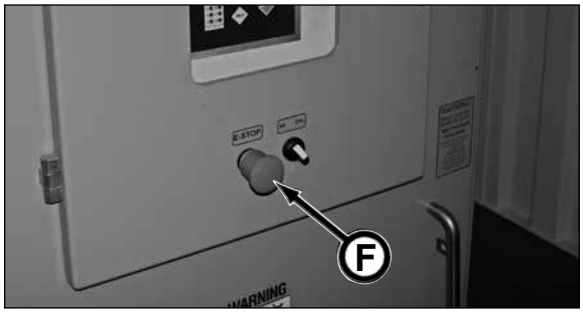
   If the cutter head drive motor is to be controlled from the control container with the Cutter Head On/Off button (B) and the cutter head rotation controls (C), select CONTROL CONTAINER.

   If the cutter head drive motor is to be controlled from the power container start (D) and stop (E) control buttons, typically for troubleshooting purposes, select LOCAL.





NOTICE To prevent the soft start system from starting the main drive motor, push in the Soft Start E-Stop button (F). When using the cutter head, refer to Cutter Head Controls in this section.



9. The soft start system is now energized. **If the system did not energize properly, contact your Akkerman Aftermarket Support representative to resolve the soft start failure BEFORE operation.**

   If the energizing of the soft start operation works properly, proceed to De-Energizing Soft Start System on next page.

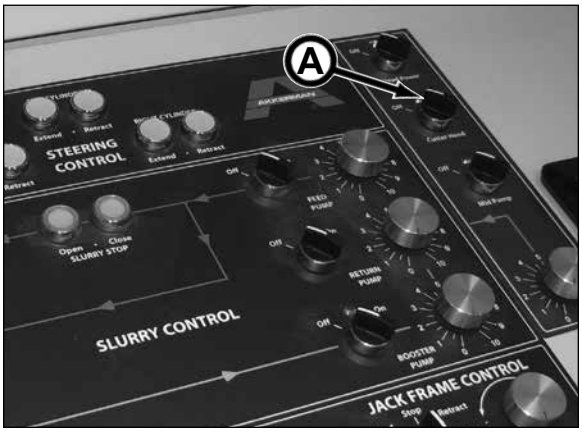
De-Energizing Soft Start System begins on the next page.

DE-ENERGIZING SOFT START SYSTEM

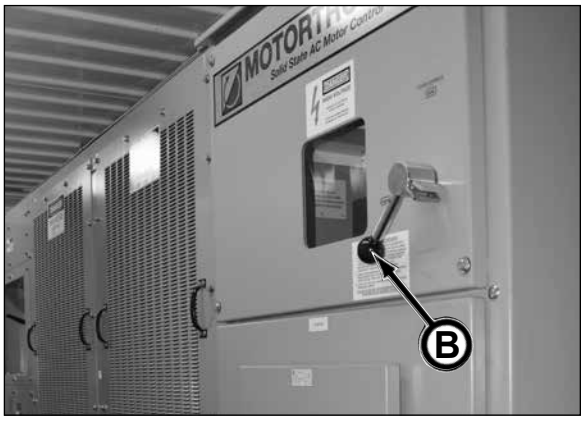
IMPORTANT: The soft start system MUST be de-energized before disconnecting utilities, at each pipe set and at the end of each day to prevent any accidental starting of the drive motor.

De-Energize the soft start system as follows:

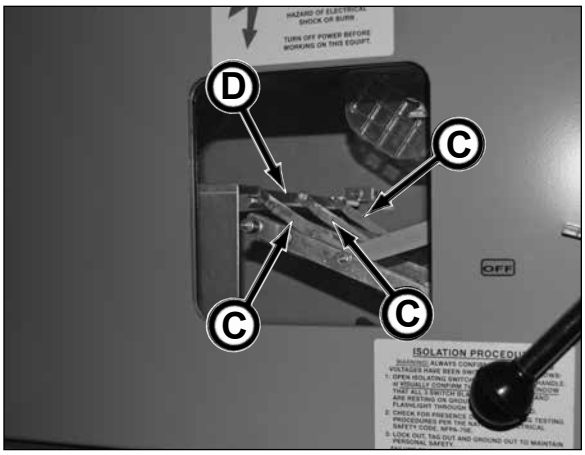
1. Turn Cutter Head switch (A) to the OFF position.



2. Turn soft start disconnect switch (B) to OFF position and secure switch with padlock to prevent accidental start up. Perform lockout/ tagout procedure.



3. Visually confirm through viewing window that the ALL three switch blades (C) are resting on the grounding bar (D). If needed, use a flashlight through the window.

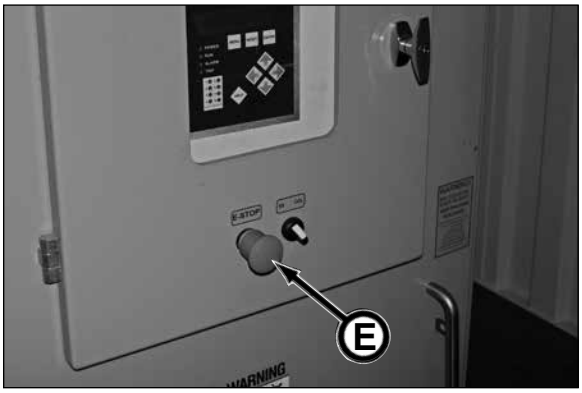


4. Push IN Soft Start E-Stop button (E).

5. Check for presence of voltage using testing procedures per National Electrical Safety Code, NFPA-70E.

6. Lockout/tagout and ground out to maintain personal safety.

7. The soft start is now de-energized. **If the system did not de-energize properly, contact your Akkerman Aftermarket Support representative to resolve the soft start failure BEFORE operation.**



WEEKLY OR EVERY 50 HOURS OF OPERATION

8. CLEAN ELECTRICAL EQUIPMENT

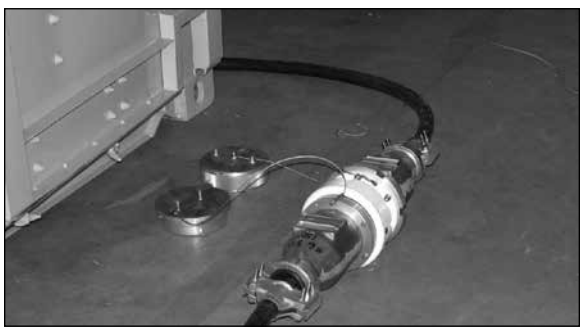
NOTICE For more information, refer to your electrical equipment manuals.

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

1. Place power sources in lockout/tagout.

2. Check electrical equipment for build-up of dirt, moisture or industrial contaminants. Clean components as needed. Failure to do so can cause high voltage arc-over, carbon tracking or prevent proper cooling of the units.

3. With power sources in lockout/tagout, check electrical cables and connections for fraying, wear or damage. If damaged, the cables must be replaced BEFORE operation.



ANNUALLY

9. CHECK HARDWARE FOR PROPER TIGHTNESS

NOTICE For more information, refer to your electrical equipment manuals.

All hardware should be checked annually for proper tightness using a calibrated torque wrench.

Use the torque values in section 11, Specifications, Torque Chart in this manual.

Storage

PREPARING FOR STORAGE

NOTICE Follow the lubrication and maintenance requirements in the Periodic Maintenance section of this manual and your Microtunneling System Operator's Manual.

1. Repair worn or damaged parts.

2. Wash all equipment thoroughly.

3. Inspect all equipment for damage. Perform repairs prior to placing equipment into storage.

4. Repaint equipment where necessary.

5. Wipe up lube spills. Dispose of rags and trash properly.

6. If possible, store equipment under cover and out of the weather in a ventilated area.

7. Electric cable lengths and connections must be visually inspected, cleaned with electric contact cleaner and blown dry with compressed air. Use industrial strength bags to cover all ends of cable connections, then tape the bags to the cable to prevent contamination. Cables should be neatly coiled and stored in a container that is protected from the elements.

8. The control container, remote hydraulic power pack and power containers must be stored with rodent protection (industrial mouse traps) and ventilation control to keep the electrical components moisture free.

9. Review this Operator's Manual, your Microtunneling System Operator's Manual and supporting equipment manuals for additional information on preparing equipment for storage.

REMOVING FROM STORAGE

NOTICE Follow the lubrication and maintenance requirements in the Periodic Maintenance section of this manual and your Microtunneling System Operator's Manual.

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 BEFORE operation.

4. Inspect all equipment for damage. Perform repairs before operation.

5. Check condition of all electrical connections. Tighten, repair or replace with new as needed.

6. Remove bags from electrical cable connections and visually inspect to be sure there is no damage.

7. Test ALL Emergency Stop buttons for proper performance before operation.

8. Review this Operator's Manual, your Microtunneling System Operator's Manual and supporting equipment manuals for additional information on removing equipment from storage.

NOTES

Troubleshooting

MAIN DRIVE POWER CONTAINER

When a fault occurs, the LCD will display the fault error while the listed LED and AUX Relay will be illuminated. Clear all faults before attempting to restart the unit.

NOTICE If the problem persists after the required programming changes have been made, and all correction action has been taken, contact your Akkerman Aftermarket Support representative.

Problem	CPU LCD Display	LED	AUX Relay	Possible Cause	Solutions
One of the main fuses blows or circuit breaker opens when the power is applied or disconnect is closed.	**TCB FAULT TRIP**	Trip	AUX1	Short circuit between the inputs	Locate and remove short
				Faulty SCRs	Remove power and test SCR(s). Refer to Section 7.1.1 for the SCR testing procedure
				Emergency Stop Activated	Check Emergency Stop Normally Closed Input. TB2: Terminal 9 & 10
Short Circuit Trip	**SHORT CIRCUIT TRIP**	Trip	AUX1	Short circuit or ground fault in motor/cabling	Locate and remove short or ground
				Phase Loss	Repair cause of phase loss
				Branch circuit protection not correctly sized	Verify correct sizing of branch circuit protection
				Faulty main circuit board	Remove power and replace main circuit board.
				Faulty SCRs	Remove power and test SCR(s). Refer to Section 7.1.1 for the SCR testing procedure
Single Phase Trip	**SINGLE PHASE TRIP** **(Check LCD display for possible fault indicators)**	Trip	AUX1	Single phase incoming power	Correct problem with incoming power
				Faulty SCRs	Remove power and test SCR(s). Refer to Section 7.1.1 for the SCR testing procedure
				Environment Temperature over 122° F (ambient temperature for chassis units) or over 104°F (ambient temperature for enclosed version	Place unit in environment temperature less than 122°F for panel version or less than 104°F for enclosed version.
				Bypass failed to close	Check bypass contactor and wiring. The "At Speed" delay is incorrectly programmed. Reprogram back to factory default value.

(continued on next page)

Main Drive Power Container (Continued)

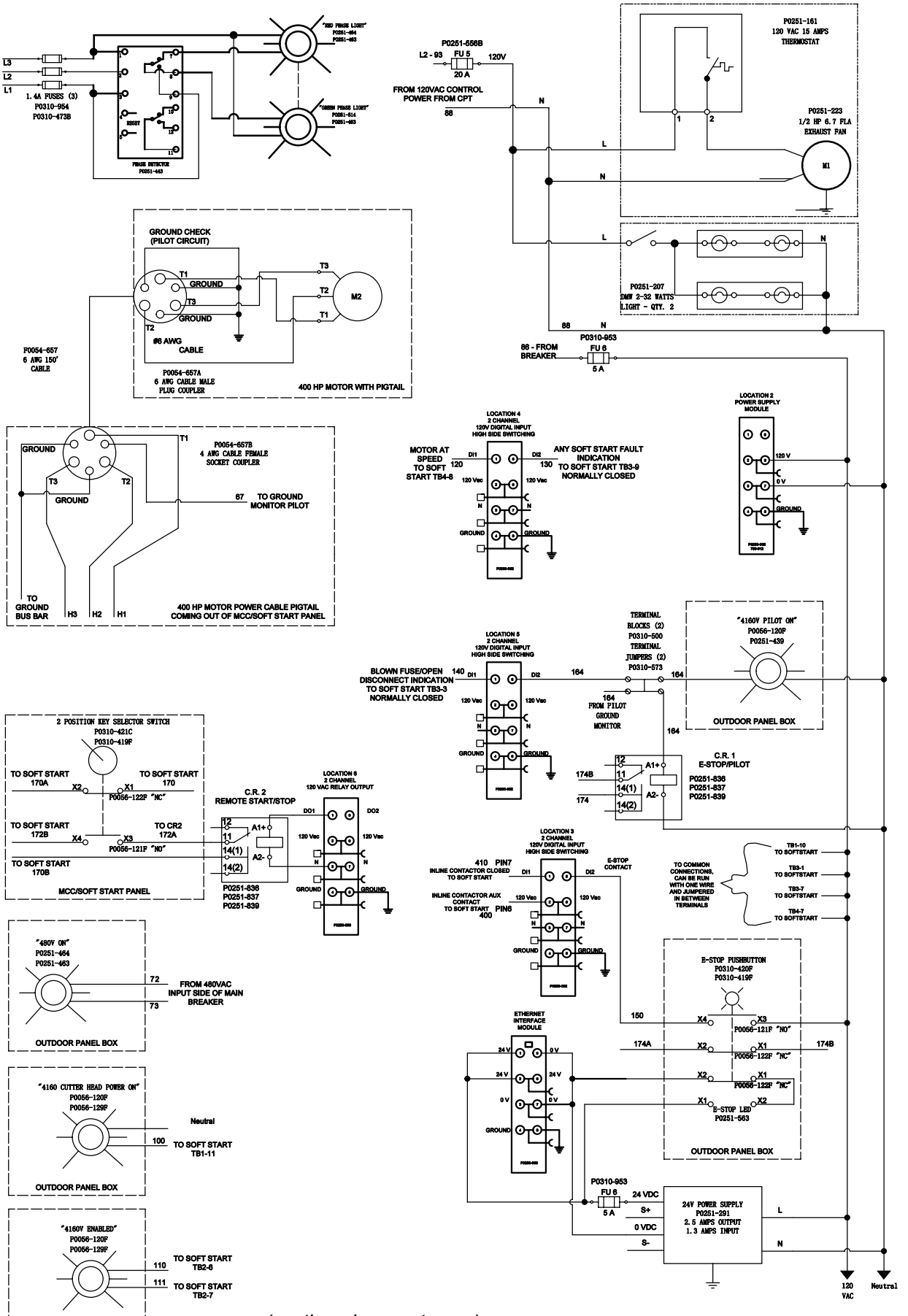
Problem	CPU LCD Display	LED	AUX Relay	Possible Cause	Solutions
Thermostat trips during run	**EXTERNAL TRIP ON THERMOSTAT**	Trip	AUX1	Fan(s) not functioning (If supplied)	If fans have power, remove power and replace fan(s). If fans do not have power, find cause of power loss and repair.
				Heatsink coated with dirt	Remove power and clean heatsink with high pressure air (80 - 100 psi max clean and dry air).
				Overcurrent on unit	Verify that running current does not exceed unit rating.
				Environment temperature over 122° F (ambient temperature for chassis units) or over 104°F (ambient temperature for enclosed version	Place unit in environment temperature less than 122°F for panel version or less than 104°F for enclosed version.
				Bypass failed to close	Check bypass contactor and wiring.
Phase Loss	**PHASE LOSS**	Trip	AUX1	Loss of 1 or more phases of power from utility or generated power.	Check power source.
				Blown power fuses	Check for short circuits.
Overload	**OVERLOAD TRIP**	Trip	AUX1	Improper programming	Check motor nameplate versus programmed parameters.
				Possible load damage or jammed load	Check motor currents.
Stall prevention	**ACCEL TIME TRIP**	Trip	AUX1	Improper setting for motor load condition	Verify current limit setting.
				Damaged load	Check for load failure.
Under Voltage Trip	**UNDER VOLTAGE TRIP**	Trip	AUX1	Improper programming	Check Setpoint settings.
				Wrong position of disconnect or breaker	Check disconnect or open breaker
				Main contactor failed to close	Check internal connections
				Transformer too small	Reduce current limit setting, saturation or sagging power supply transformer
				Unloaded motor	Check load
Under Current Trip	**UNDER CURRENT TRIP**	Trip	AUX1	Improper programming	Check setpoint settings
				Unloaded motor	Check load
Self-test Failure	**SELF-TEST FAILURE**	Trip	AUX1	Failed CPU or Main Firing Board	Contact factory
				Vibration	Check internal wiring connections
Line Frequency Trip	**OVER OR UNDER FREQUENCY TRIP**	Trip	AUX1	Generator Power Problem or grid change	Troubleshoot and repair generator
					Contact utility company
					Main board failure
					Three phase power removed from Main

(continued on next page)

Main Drive Power Container (Continued)

Problem	CPU LCD Display	LED	AUX Relay	Possible Cause	Solutions
Any Ground Fault Trip	**GROUND FAULT HI-SET OR LO-SET**	Trip	AUX1	Improper programming	Check Setpoint settings
				Any wire going to ground (I.e. stator ground, motor ground, soft start ground)	Check with megger or Hi-pot motor leads and motor
				High vibration or loose connections	Check internal connections
Motor Stopped during run	**Check for fault indication**	Trip	AUX1	**⚠ WARNING** This is a serious fault condition. Ensure that the fault condition is cleared on the load side before attempting to restart the motor.	
				Load shorted	Remove power and repair.
				Faulty main circuit board	Replace the main circuit board
Control circuit fuses blow after control power is applied.	**None**	None	None	Short in Control Circuit	Remove Power, locate and remove the short.
				Wrong Control Voltage	Apply the correct voltage to the control circuit.
Motor will not start	***Any fault indication message***	Trip	AUX1	No Control Voltage applied to Control Board	Apply control voltage to TCB board.
				Control Power Transformer failure or CPT Fuse failure	Remove power and replace the power transformer or the CPT fuse
				Start Circuit Wired Incorrectly	Remove power and correct the start circuit wiring.
				No Start Command	Apply the start command.
				No 3 Phase Line Voltage	Apply 3 phase line voltage to the unit.
				Shorted SCR in Starter	Remove power and Test SCR(s). Refer to Sec. 7.1.1 for the testing procedure.
				Faulty Control Logic	Remove power and repair the Control Logic.
				Failure of Main Circuit Board	Replace the Main Circuit Board.
Motor vibrates / Motor growls while starting or extremely unbalanced motor currents run mode	**IMBALANCE TRIP**	Trip	AUX1	Faulty Motor	Check the Motor and the Motor connections.
				Faulty SCR(s)	Remove Power and perform the SCR device checks.
				Faulty Gate / Cathode on SCR(s)	Remove Power and Test SCR(s). Refer to Sec. 7.1.1 for the testing procedure.
				Faulty Main Circuit Board.	Replace the Main Circuit Board.
	IMBALANCE ALARM	Alarm	AUX2	Faulty Motor / Wiring	Troubleshoot and repair / replace wiring.
				Faulty Main Circuit Board	Replace the Main Circuit Board.

ELECTRICAL SCHEMATICS



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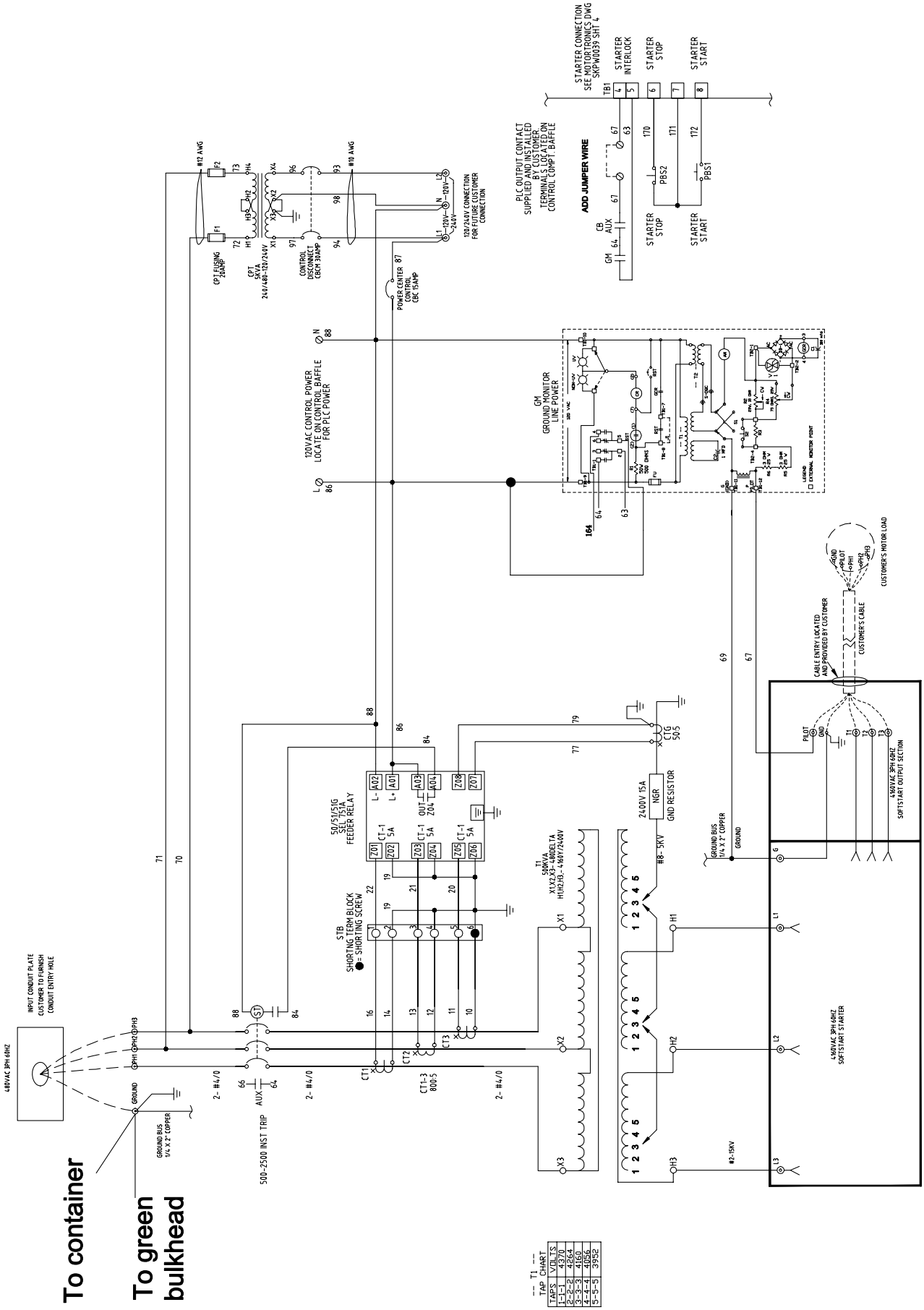
Electrical Schematics (Continued)



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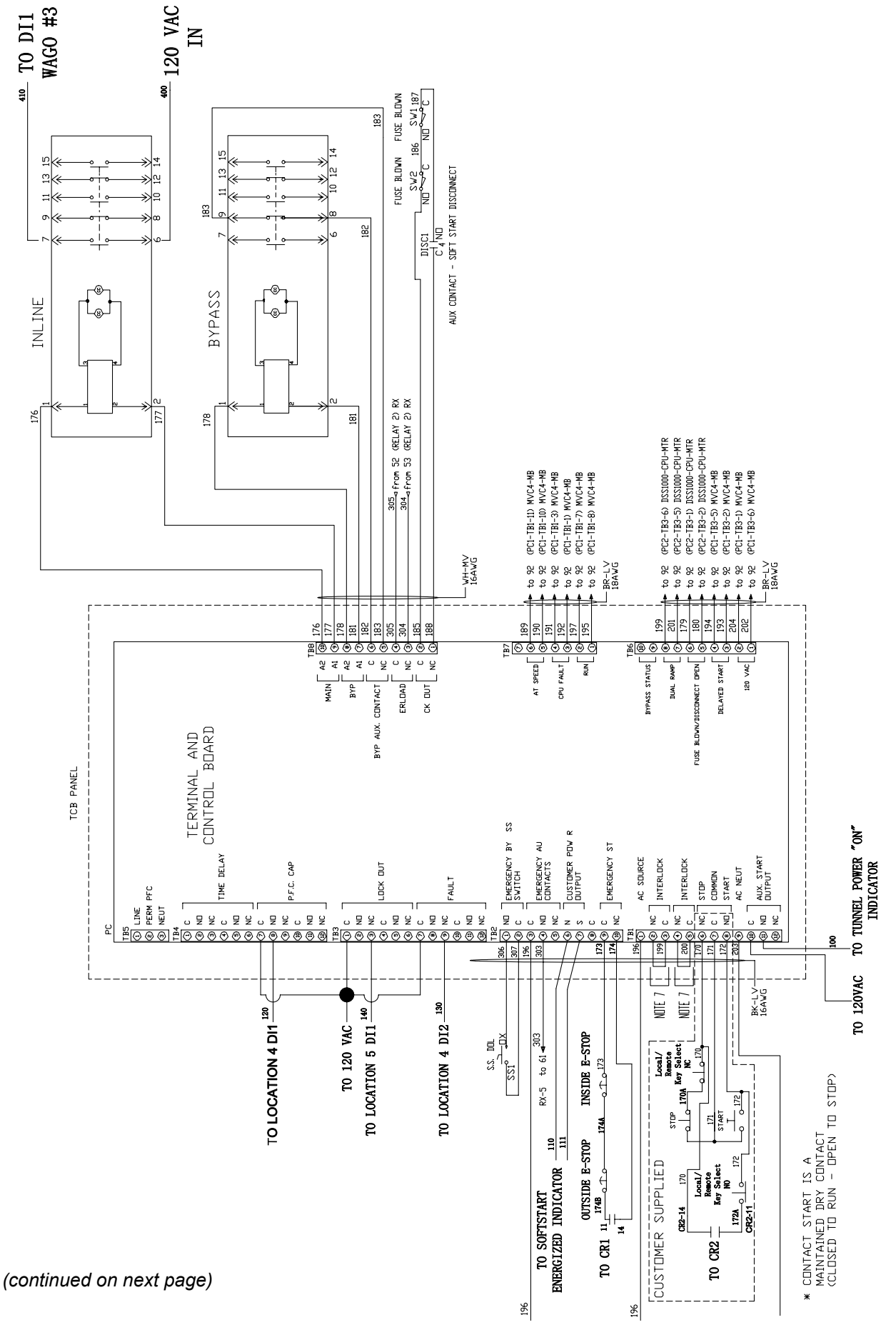
Electrical Schematics (Continued)



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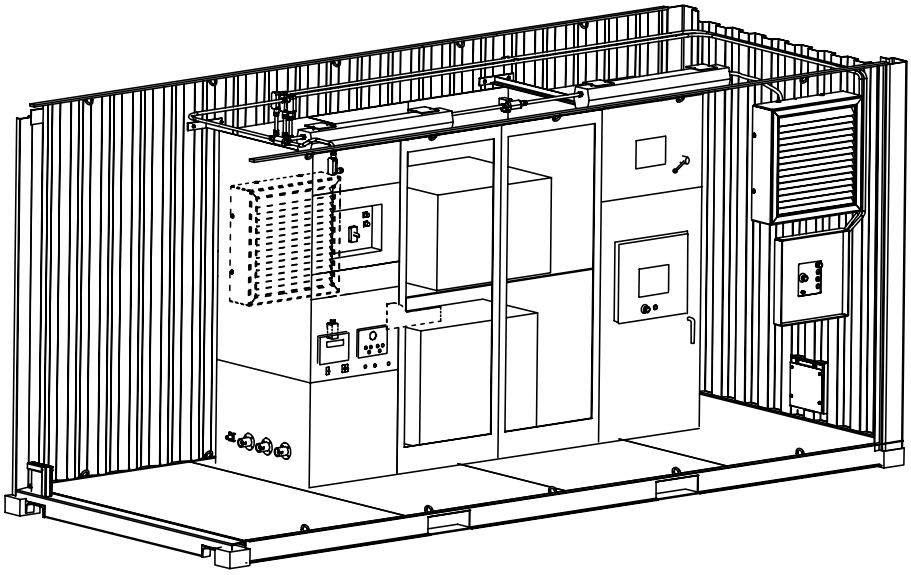
Electrical Schematics (Continued)

WIRE NUMBER	DESCRIPTION	FROM LOCATION #1	TO LOCATION #2	WIRE COLOR/GAUGE
0v	Ground	various	various	Wht/Blu 16 AWG
24v	24 Volt	various	various	Blu/Wht 16 AWG
120 N	120VAC Neutral	Low Voltage Section	Outside Control Box	White 16 AWG
120 L	120VAC Line	Low Voltage Section	Outside Control Box	Black 16 AWG
120 N	120VAC Neutral	Low Voltage Section	Lights & Fan	White 12 AWG
120 L	120VAC Line	Low Voltage Section	Lights & Fan	Black 12 AWG
70	480V Power On	High Voltage L2	Outside Control Box LIT#1	Black 16 AWG
71	480V Power On	High Voltage L3	Outside Control Box LIT#1	Black 16 AWG
100	Tunnel Power On	MV Soft Start TB1-11	Outside Control Box LIT#2	RED/WHITE 16 AWG
110	Soft Start Energised	MV Soft Start TB2-6	Outside Control Box LIT#3	RED 16 AWG
111	Soft Start Energised	MV Soft Start TB2-7	Outside Control Box LIT#3	ORANGE 16 AWG
120	Motor At Speed	MV Soft Start TB4-8	LV Section Wago#4 DI1	YELLOW 16 AWG
130	Soft Start Fault	MV Soft Start TB3-9	LV Section Wago#4 DI1	ORANGE 16 AWG
140	Soft Start Fuse Blown - Disconnect	MV Soft Start TB3-3	LV Section Wago#5 DI1	WHITE 16 AWG
150	Soft Start E-Stop NO	Outside Control Box E-Stop NO	LV Section Wago#3 DI2	BLUE 16 AWG
164	Ground Monitor Output	Low Voltage Section Term	LV Section Term,CR1,Wago#5 DI2 - Outside Box LIT#4	RED/BLACK 16 AWG
170	Soft Start Local/Remote 1	MV Soft Start TB1-6	LV Section Key Switch NC	WHITE 16 AWG
170A	Soft Start Local/Remote 2	LV Section Key Switch NC	LV Section Stop Sw NC	WHITE 16 AWG
170B	Soft Start Local/Remote 3	LV Section Key Switch NC	LV Section CR2 14	WHITE 16 AWG
172	Soft Start Local/Remote 4	LV Section Start Sw NO	MV Soft Start TB1-8	WHITE 16 AWG
172A	Soft Start Local/Remote 5	LV Section Start Sw NO	LV Section Key Switch NO	WHITE 16 AWG
172B	Soft Start Local/Remote 6	LV Section Key Switch NO	LV Section CR2 11	WHITE 16 AWG
173	Soft Start E-Stop Common	MV Soft Start TB2-9	Inside E-Stop NC	WHITE 16 AWG
174A	E-Stop NC 1	Inside Control Box E-Stop NC	Outside Control Box E-Stop NC	ORANGE 16 AWG
174B	E-Stop NC 2	Outside Control Box E-Stop NC	LV Section CR1 11	YELLOW 16 AWG
174	E-Stop CR1 Input	MV Soft Start TB2-10	LV Section CR1 14	YELLOW 16 AWG
400	Inline Contactor NO Supply	Low Voltage Section 120VAC	MV Soft Start Inline Contactor	WHITE 16 AWG
410	Inline Contactor NO Output	MV Soft Start Inline Contactor	LV Section Wago#3 DI1	WHITE 16 AWG

NOTES

Specifications

MAIN DRIVE POWER CONTAINER



Dimensions (width x length x height) ..... 8 x 20 x 9.5 ft. (2.4 x 6 x 2.9 m)

Container Weight..... 12,500 lbs. (5,670 kg)

Electrical

Required Power ..... 480 VAC, 3 Phase, 60 Hz

Main Circuit Breaker ..... 800 amp

Main Circuit Breaker Setting For Motor Starting Inrush..... 1,200 amp

Transformer ..... 500 kVA

Tunnel Cable Voltage 4,160V

Power Input For Lighting 120V

Recommended Power Requirements*

400 HP Cutter Drive

Recommended Operating Power ..... 1,000kW / 1,250kVA @ 480 VAC

Generator Minimum Motor Starting kVA (sKVA):

.....1,500 sKVA with less than 35% instantaneous voltage drop and

..... 90% sustained voltage at 480VAC

250 HP Cutter Drive

Recommended Operating Power ..... 600kW / 750kVA @ 480 VAC

Generator Minimum Motor Starting kVA (sKVA):

.....950 sKVA with less than 35% instantaneous voltage drop and

..... 90% sustained voltage at 480VAC

** The power requirements are dependent on the HP of the cutter head drive motor being driven by the power container. Contact your Akkerman Aftermarket Support representative for the power requirements for the cutter drives not listed.*

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)

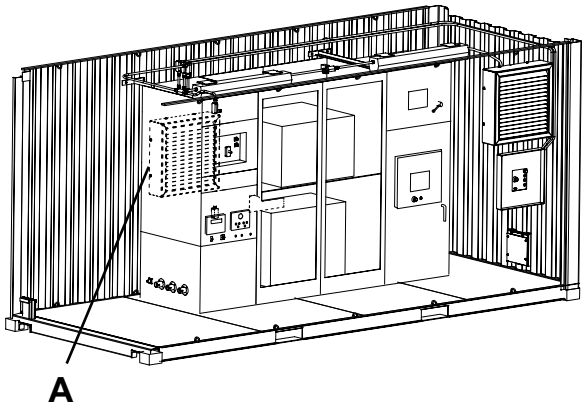
Identification Numbers

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

POWER CONTAINER (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 Inc. will provide, at no cost, SDS which apply to its product line. Simply contact your Akkerman Product Support representative for a copy.

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

NOTES

Warranty

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

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

NOTES

Index

P (continued)

R

S

S (continued)

T

U

V

W

NOTES