AKKERMAN®

TRENCHLESS EQUIPMENT SPECIALISTS

OPERATOR'S MANUAL

Microtunneling System

Control Container S/N: A22100A

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SERVICE • RELIABILITY • INNOVATION

Introduction

This operator's manual contains important safety, operation, and maintenance information for your Akkerman MicroTunneling System. You must read and understand this manual before you operate and maintain this equipment. Keep this manual in your Control Container at all times. Additional copies of this manual may be purchased from the Akkerman Product 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 Microtunneling System. ALWAYS use genuine Akkerman parts.

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

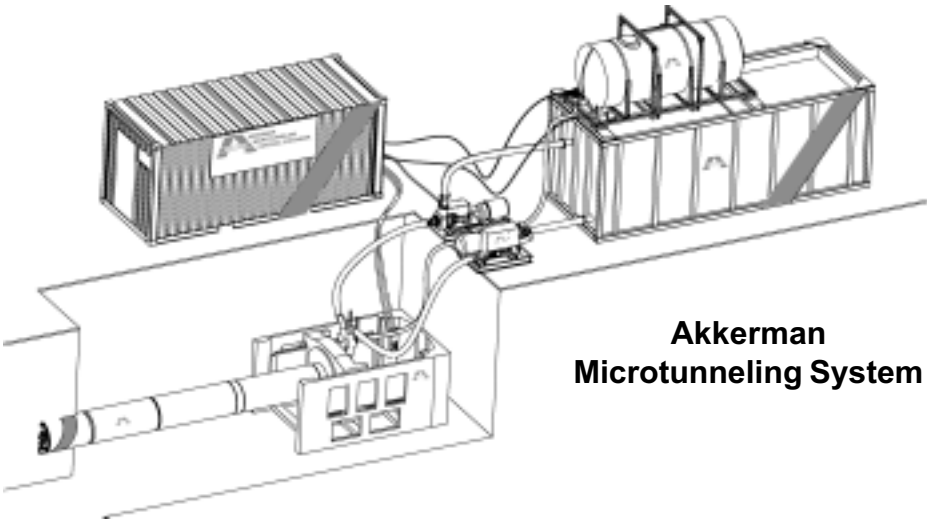
⚠ DANGER Indicates an extremely hazardous situation which, if not avoided, WILL result in death or serious injury.

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

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

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

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



Akkerman
Microtunneling System

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

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

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

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Safety

BE ALERT FOR SAFETY INFORMATION

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

Read all safety information.

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

ATTENTION!
BECOME ALERT!
YOUR SAFETY IS INVOLVED!

READ OPERATOR'S MANUAL

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

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

Any unauthorized modifications will void the warranty.

WEAR PROTECTIVE CLOTHING

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

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

LOCKOUT POWER BEFORE SERVICING

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

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

HYDRAULIC OIL/FLUIDS UNDER PRESSURE

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

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

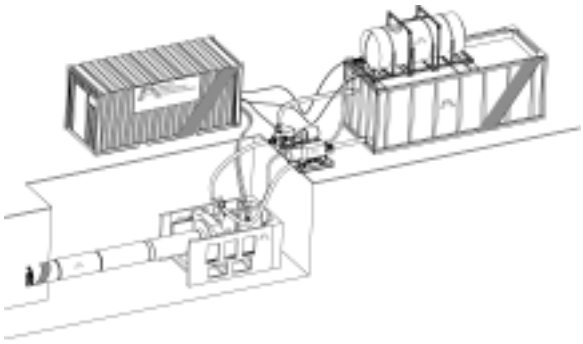
⚠WARNING Crushing hazard.
Keep personnel away from inside of jacking frame. Failure to do so could result in serious personal injury or death.

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.

PRACTICE SAFE MAINTENANCE

⚠WARNING Unexpected equipment movement may cause serious personal injury.

LOCKOUT power before performing any maintenance.

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

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

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

Do not service the machine while it is in motion.

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

AVOID PINCH POINTS

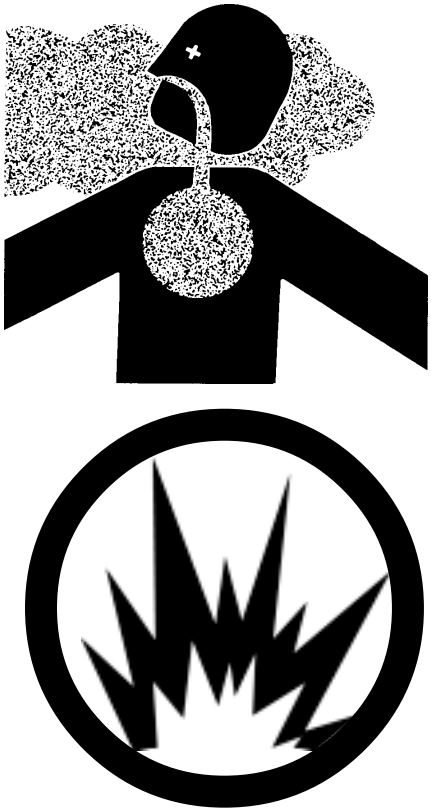
⚠WARNING Moving parts or the mishandling of parts can cause severe personal injury.

Keep hands away from moving parts.

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

Handle parts carefully to avoid crushing and pinch point hazards.

TEST TUNNEL VENTILATION



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

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

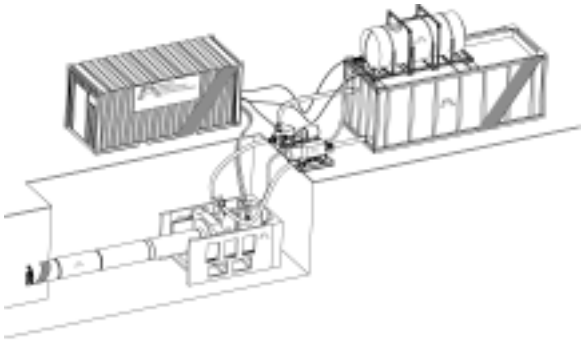
Before and during the shaft operation, test for combustible and toxic gases and oxygen deficiency.

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.

HIGH PRESSURE HYDRAULICS



⚠WARNING The Microtunneling System contains high pressure hydraulics.

Keep all guards in place.

SLIPPERY WHEN WET

⚠WARNING Slips and falls can cause serious personal injury.

Ensure firm footing in wet or slippery conditions.

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

Remove any buildup of grease, oil, or debris.

FIRE PREVENTION

⚠CAUTION Fires can cause injury or property damage.

Keep equipment clean. Remove all debris from equipment.

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

NO SMOKING IN SHAFT OR TUNNEL

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

Do not smoke in shaft or tunnel.

KEEP JOB SITE CLEAN AND ORGANIZED

⚠WARNING Tripping can cause serious personal injury.

Be sure to keep job site clean and organized.

KEEP AWAY FROM AUGER

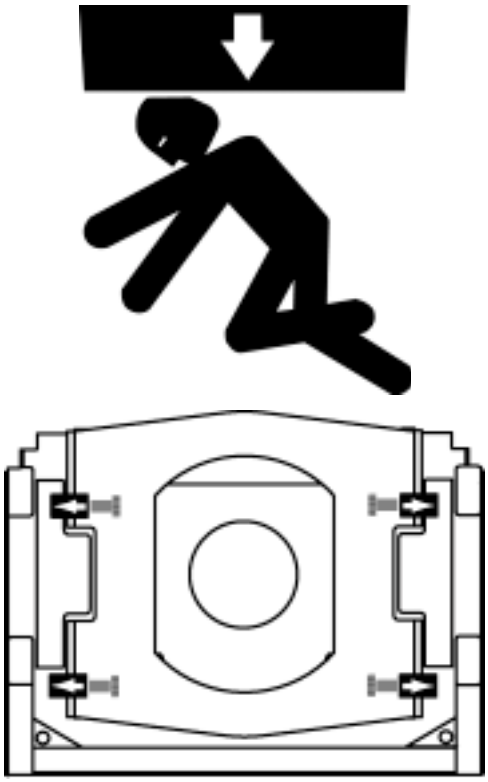
⚠DANGER Contact with rotating auger will cause severe injury or death.

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

Do not operate without covers and guards in place.

Lockout power before servicing.

PREPARE JACKING FRAME

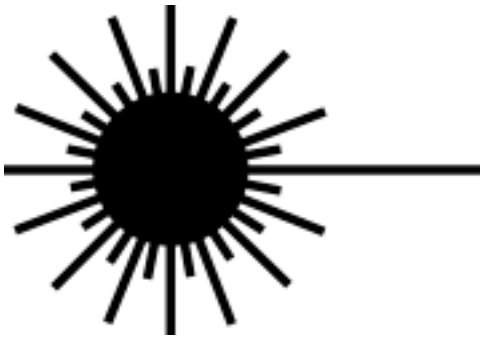


⚠WARNING Shipping or lifting jacking frame without ALL four dog blocks engaged into frame, can cause serous injury or death from sliding thrust block.

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

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

AVOID LASER LIGHT EXPOSURE

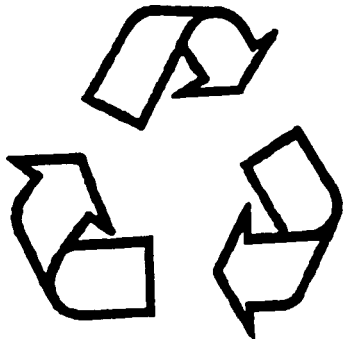


⚠DANGER Staring into laser light will cause severe injury.

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

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

RECYCLE WASTE



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

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

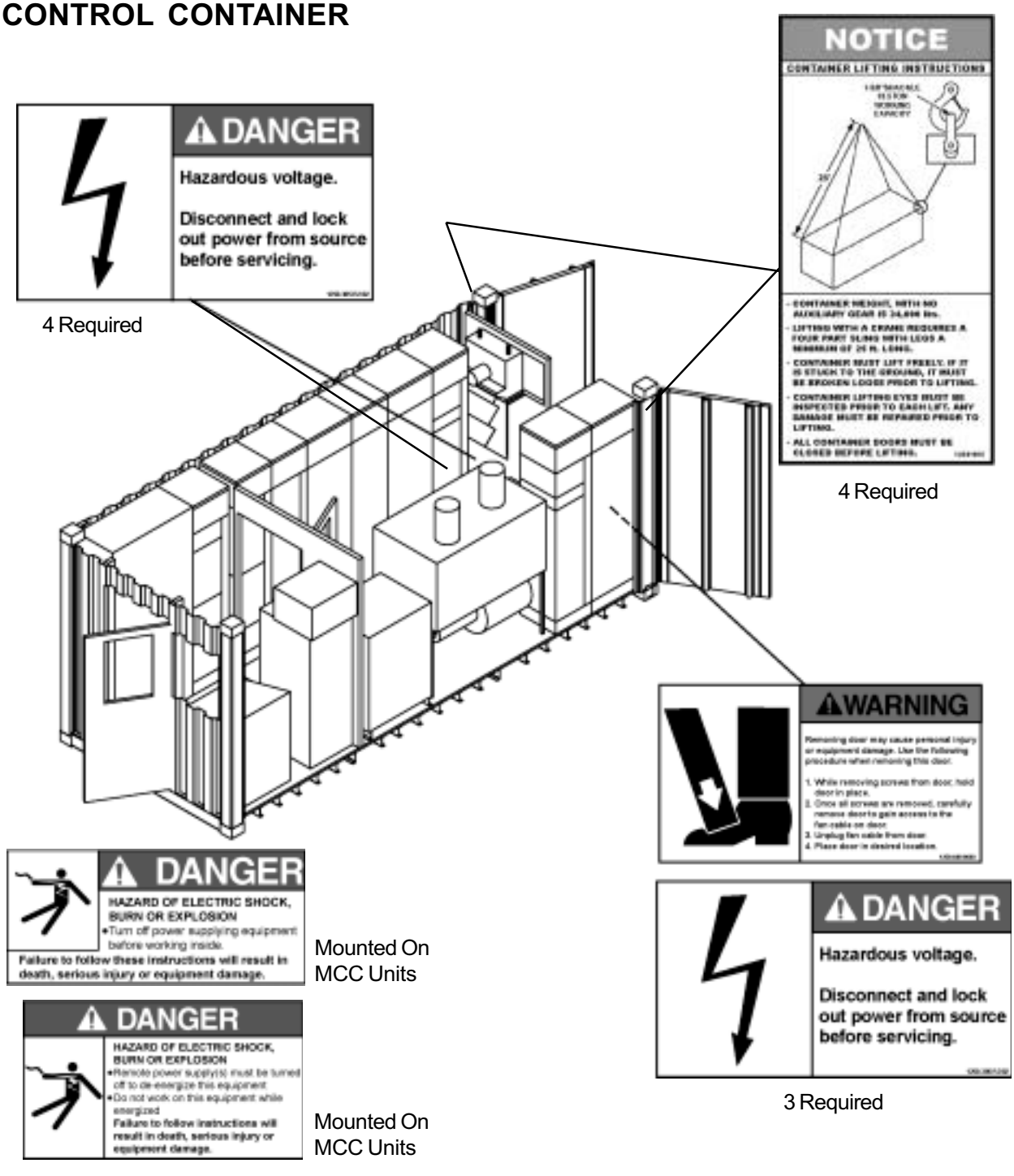
Safety Decals

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

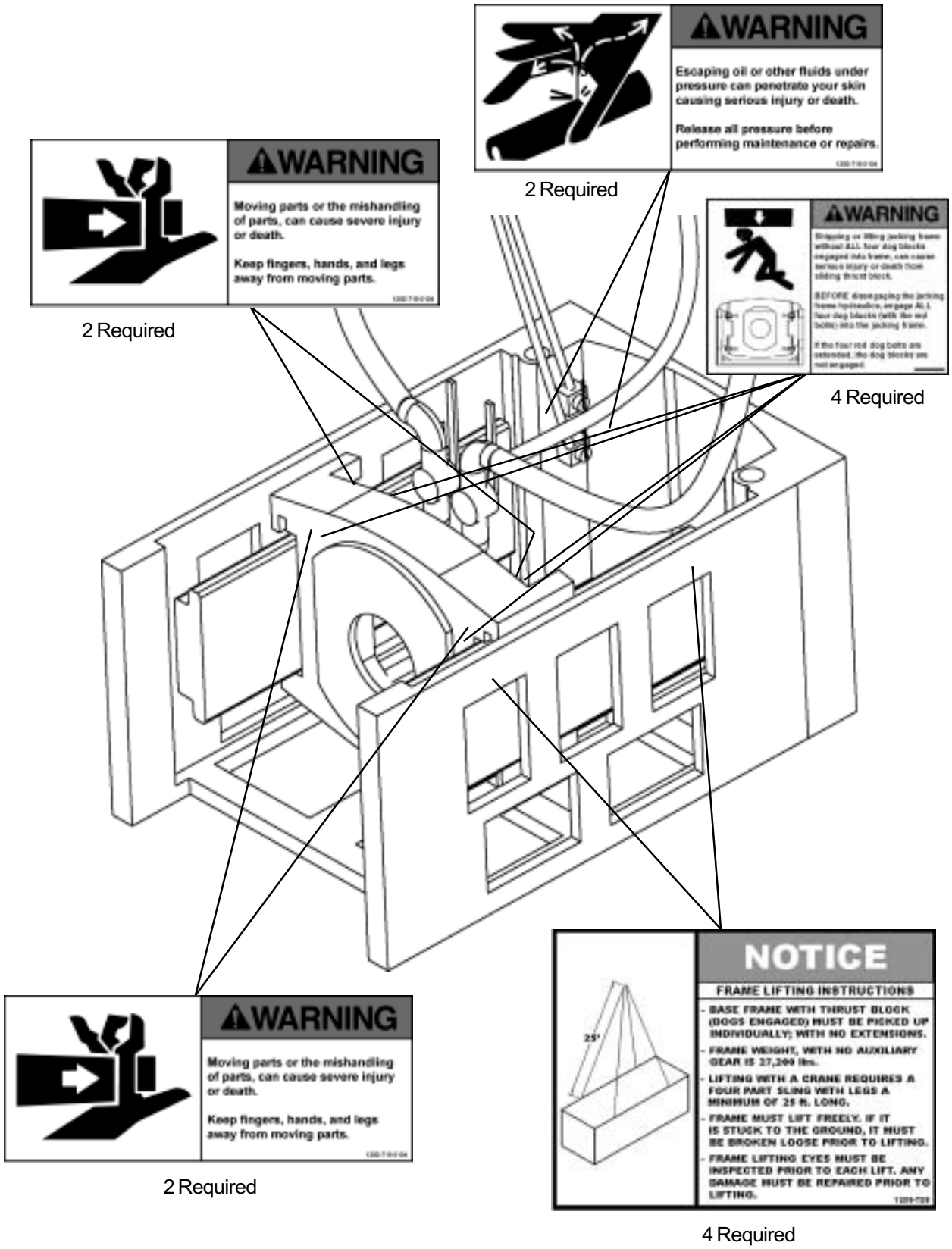
Serious injury or property damage can occur if safety instructions are not followed. Contact your Akkerman Product Support representative for free replacement safety decals.

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

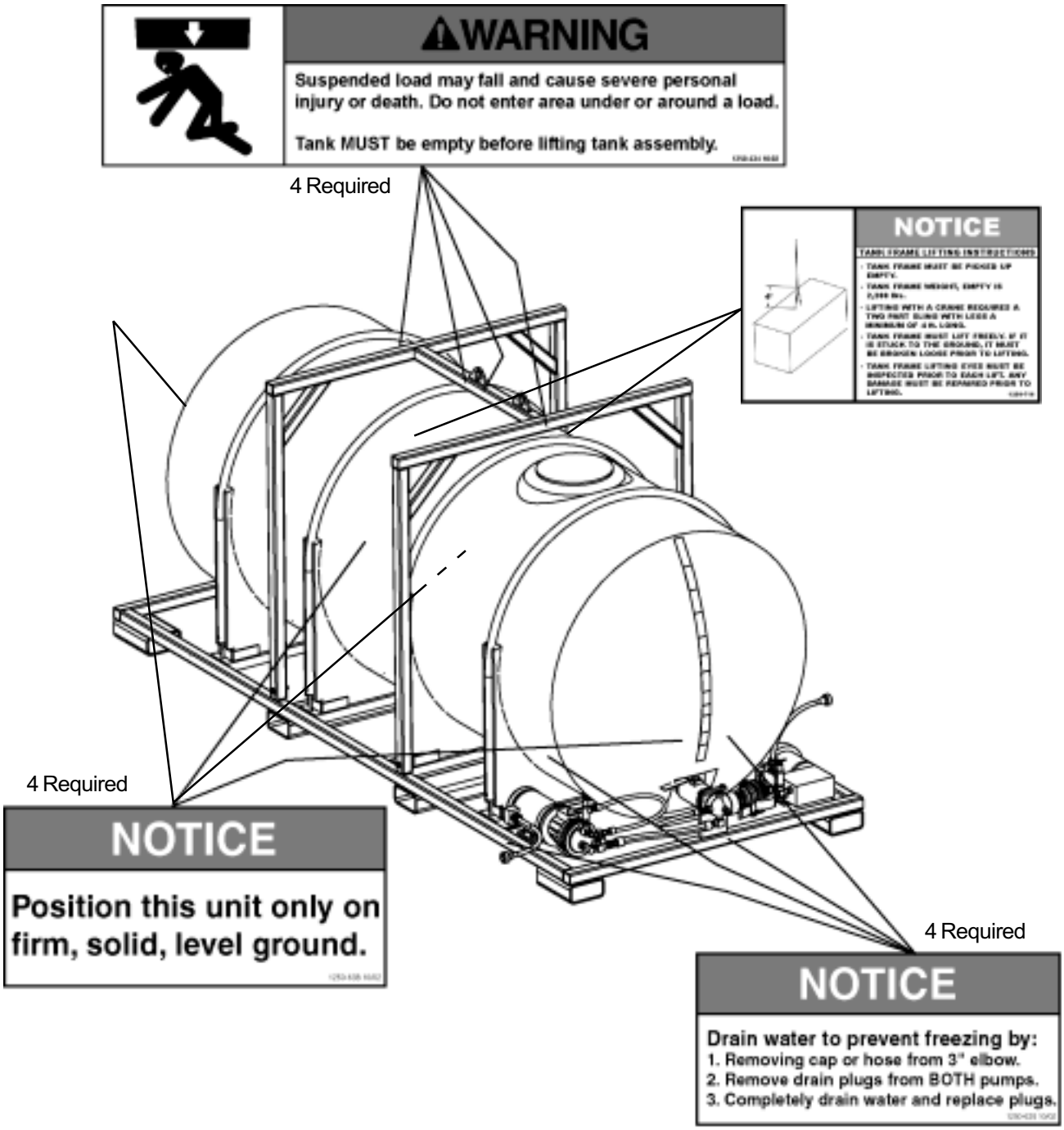
CONTROL CONTAINER



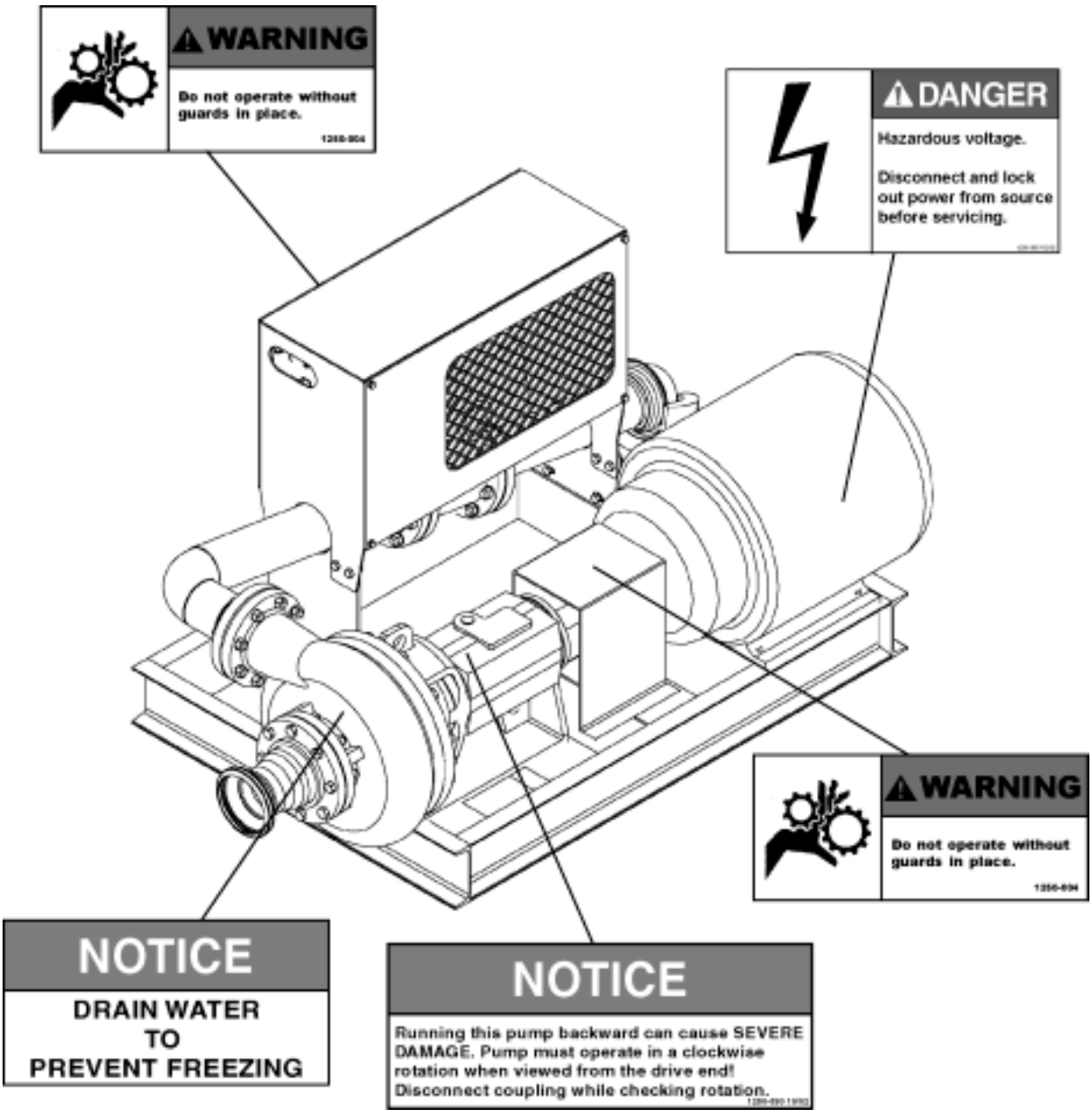
MT400 JACKING FRAME



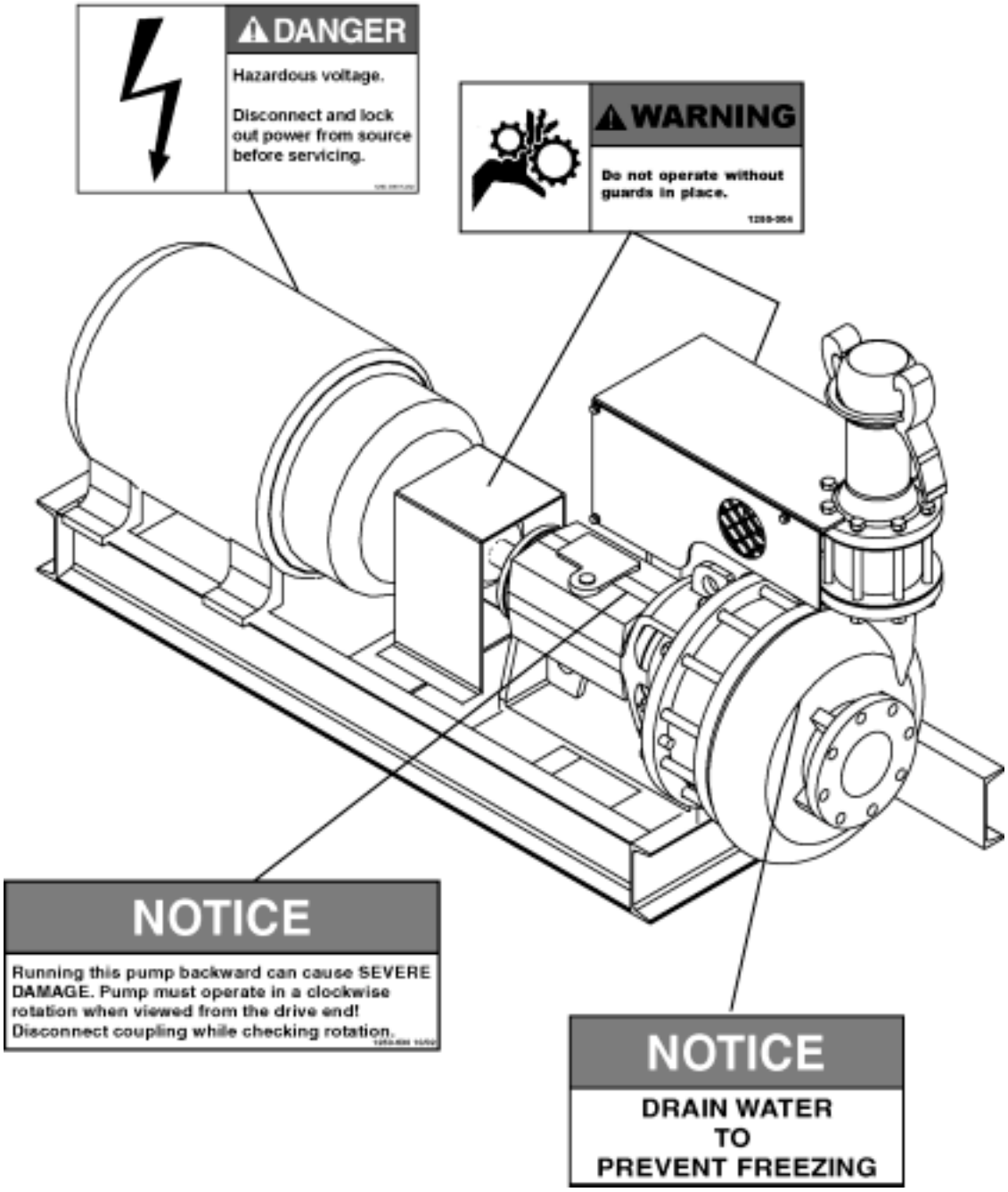
WATER COOLING TANK



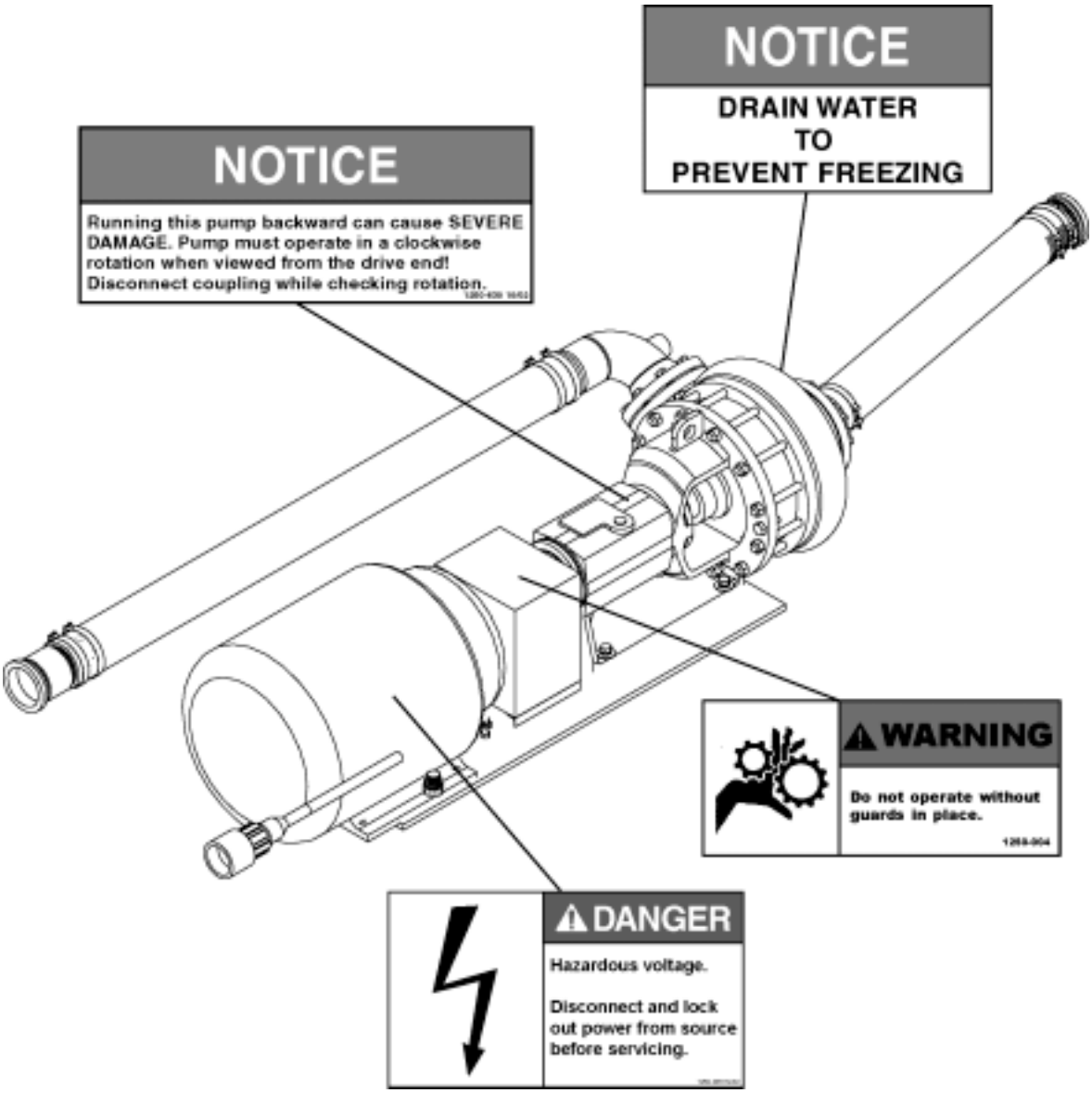
SLURRY FEED PUMP



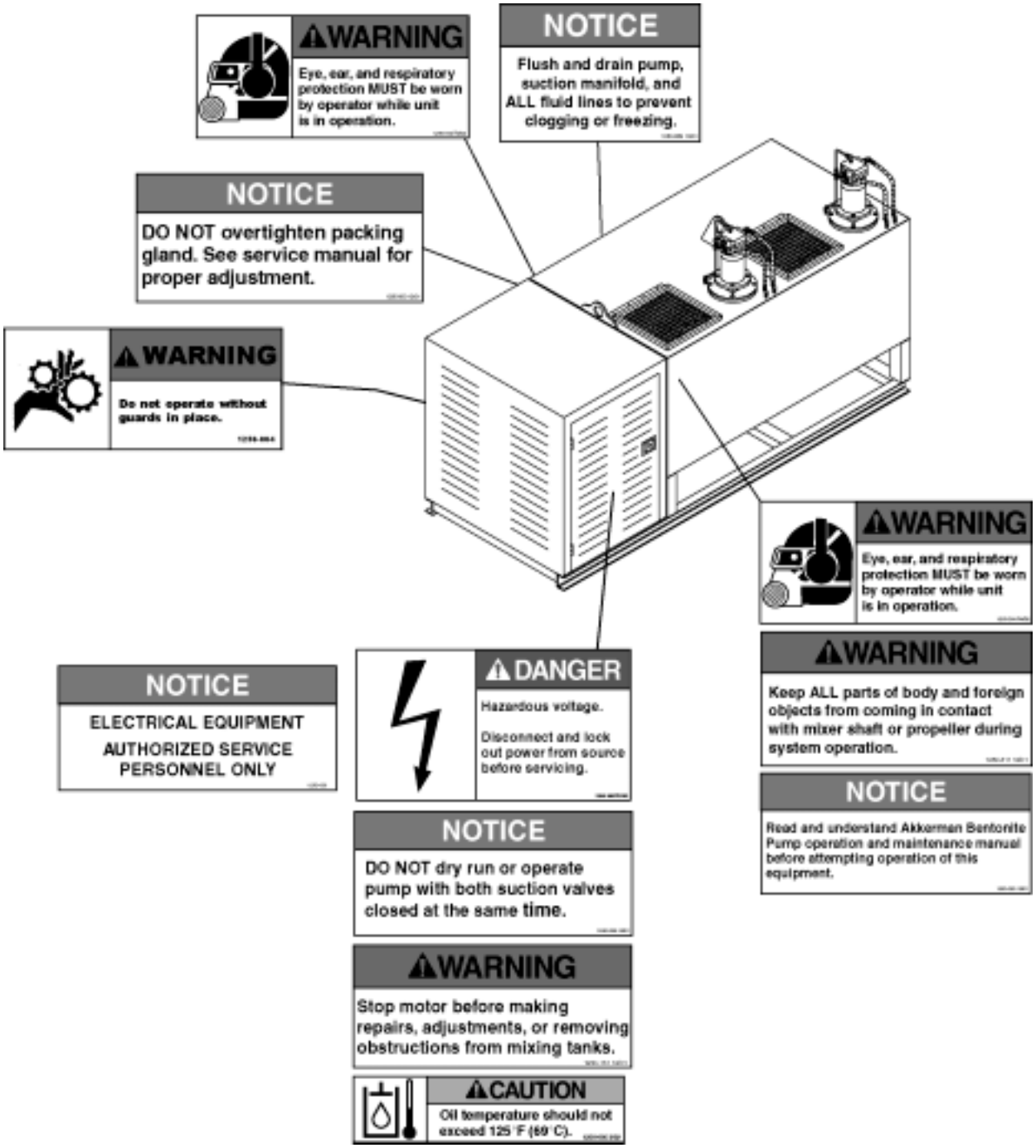
SLURRY RETURN PUMP



SLURRY BOOSTER PUMP

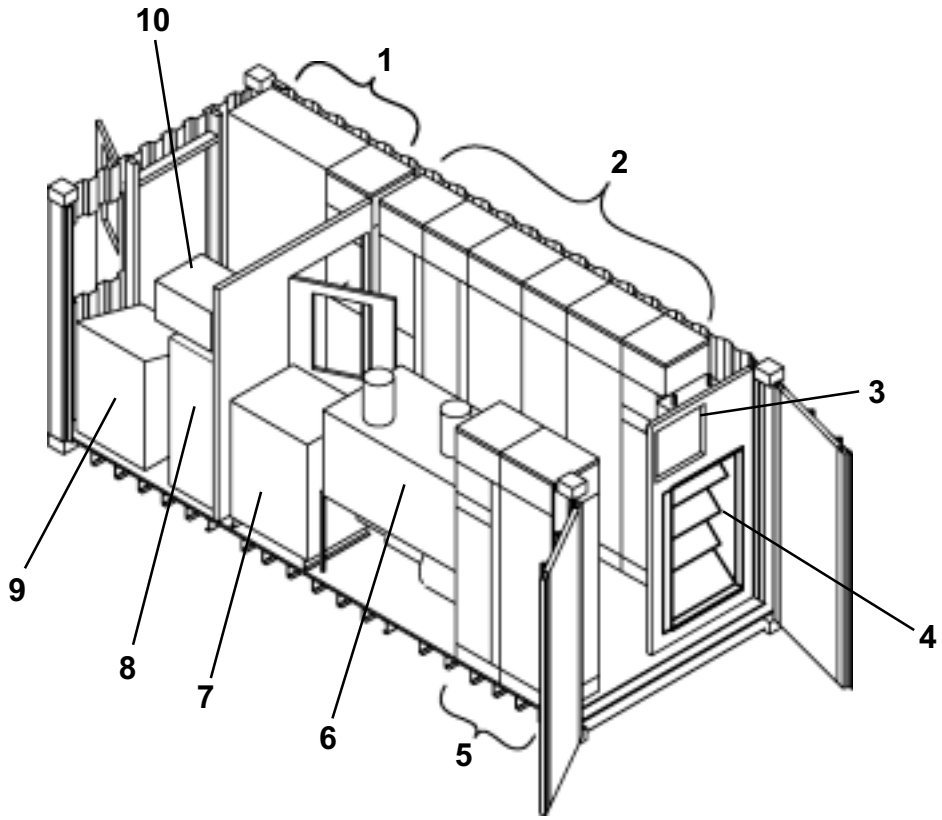


BENTONITE PUMP



Terminology

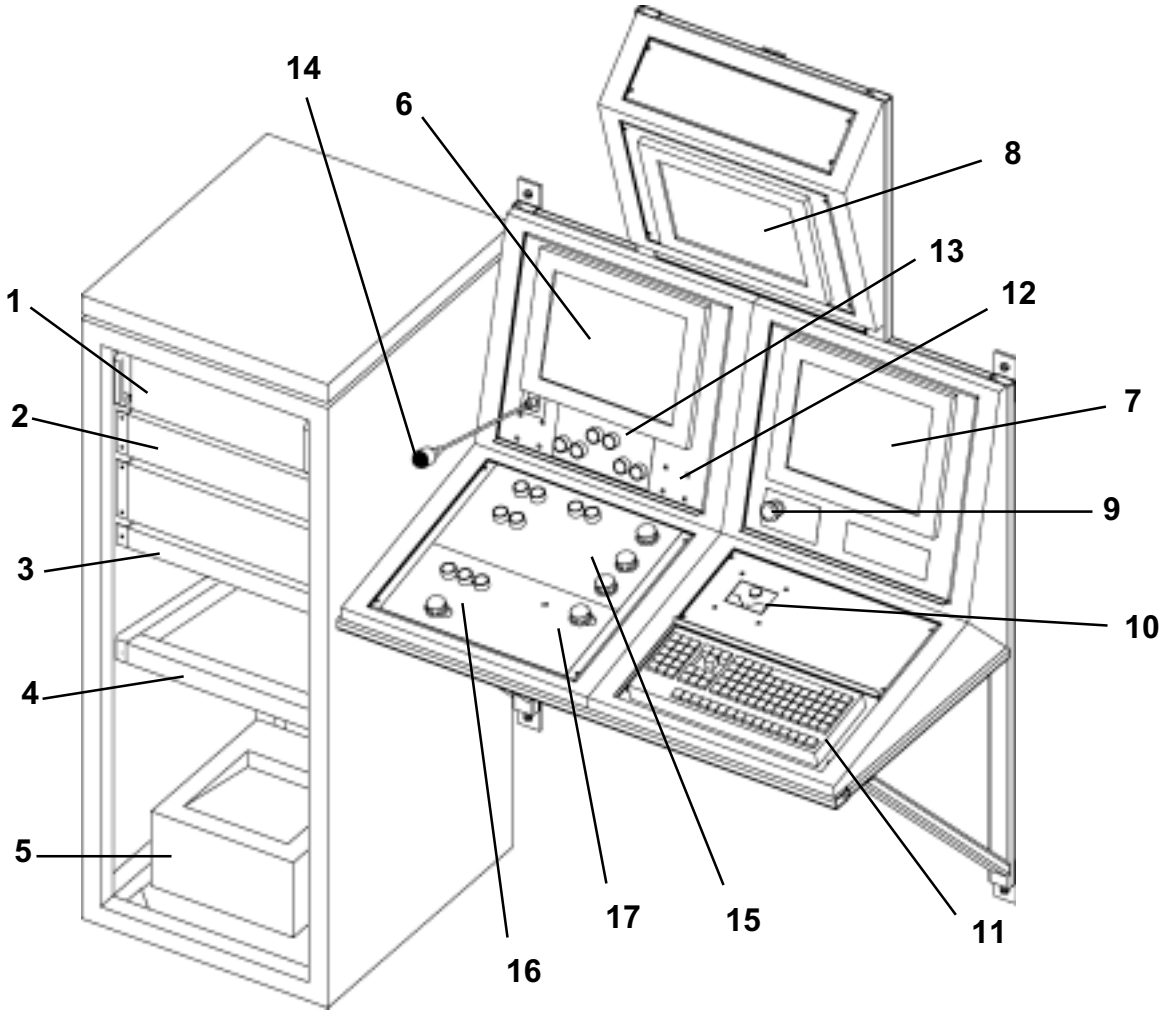
CONTROL CONTAINER



1. 240 Volt MCC System
2. 480 Volt MCC System
3. Oil Cooler Fan
4. Bulkhead
5. 575 Volt MCC System
6. Power Pack
7. Transformer
8. Computer/Printer Cabinet
9. Control Panel
10. Air Conditioner

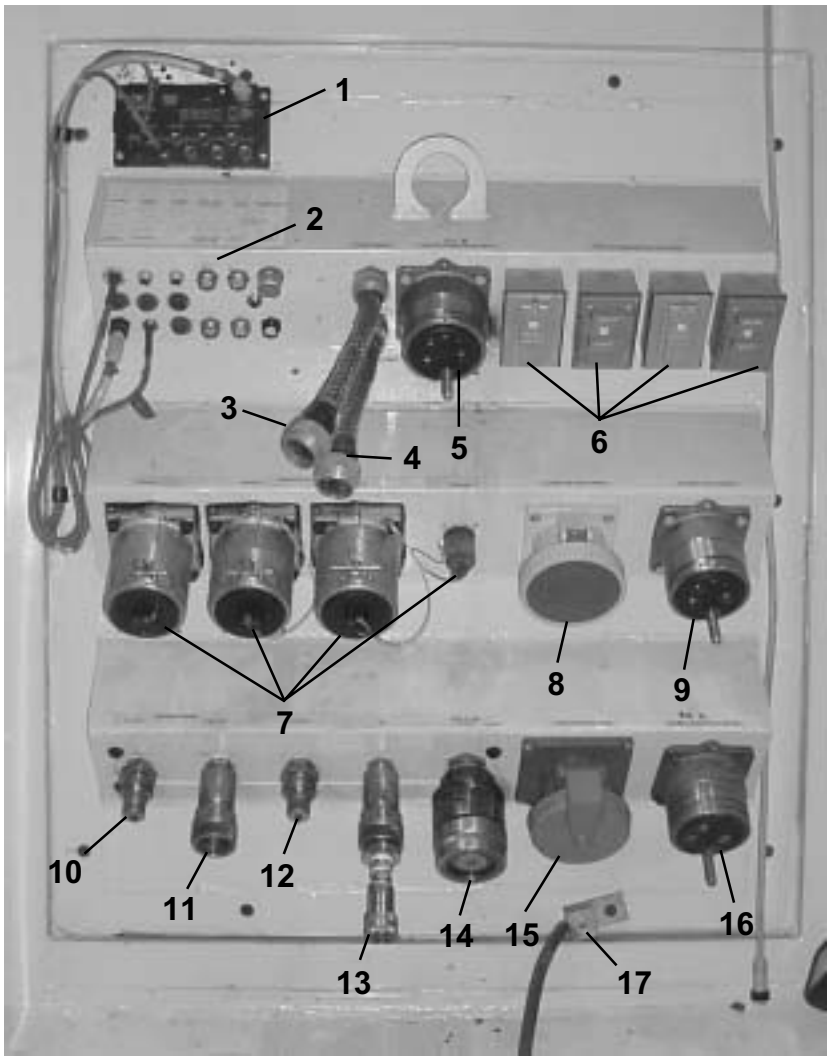
MCC - Motor Control Center

CONTROL CONSOLE & COMPUTER/PRINTER CABINET



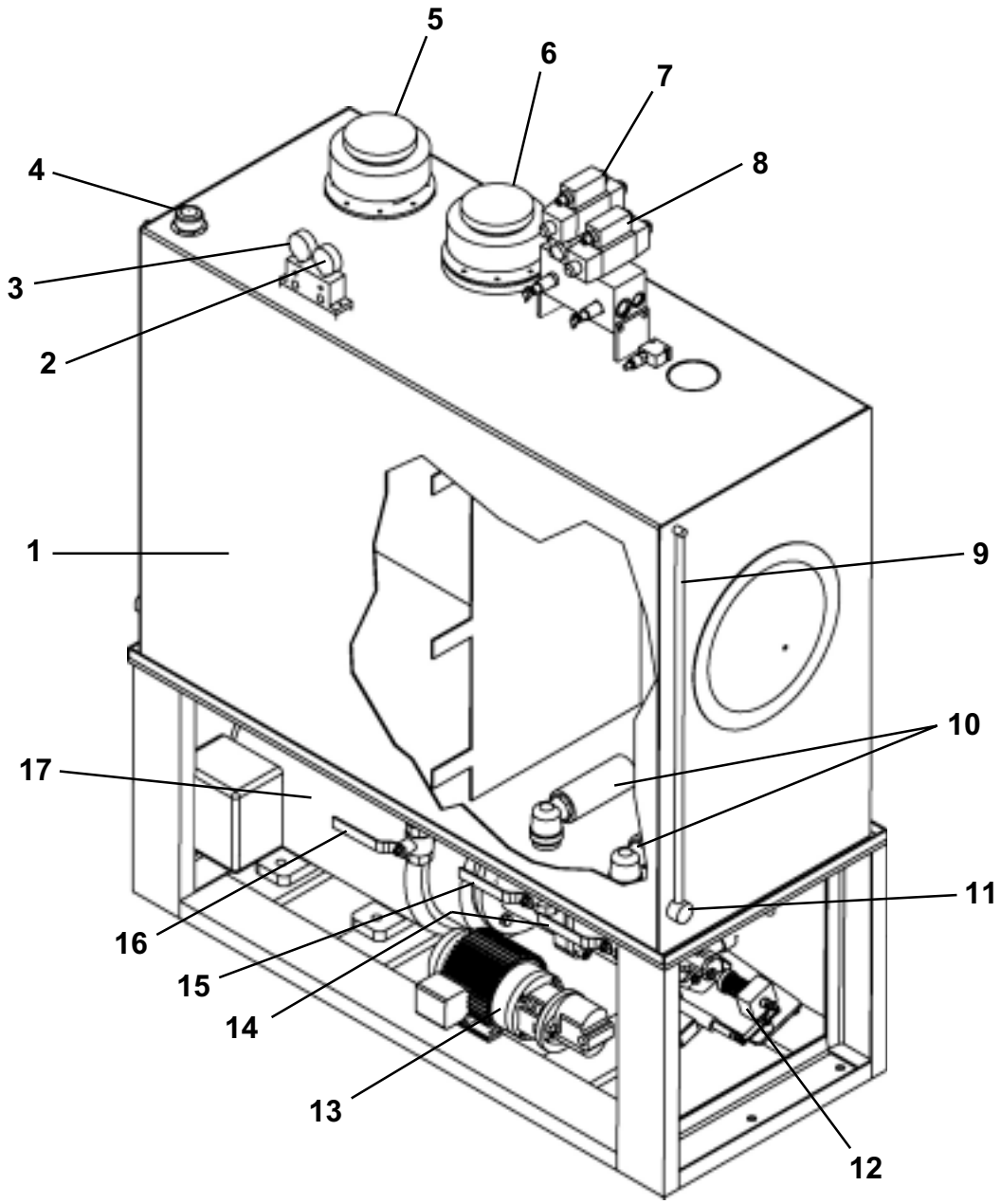
1. Computer
2. UPS (Uninterruptable Power Supply)
3. Intercom
4. Surge Protector
5. Printer
6. Target Screen
7. Slurry, Main Drive Control Screen
8. Network Control & Camera Screen
9. Emergency Stop
10. Mouse
11. Keyboard
12. Microphone Controls
13. Steering Controls
14. Microphone
15. Slurry Removal System Controls
16. Cutting Head Controls
17. Jacking Frame Controls

CONTROL CONTAINER BULKHEAD CONNECTIONS



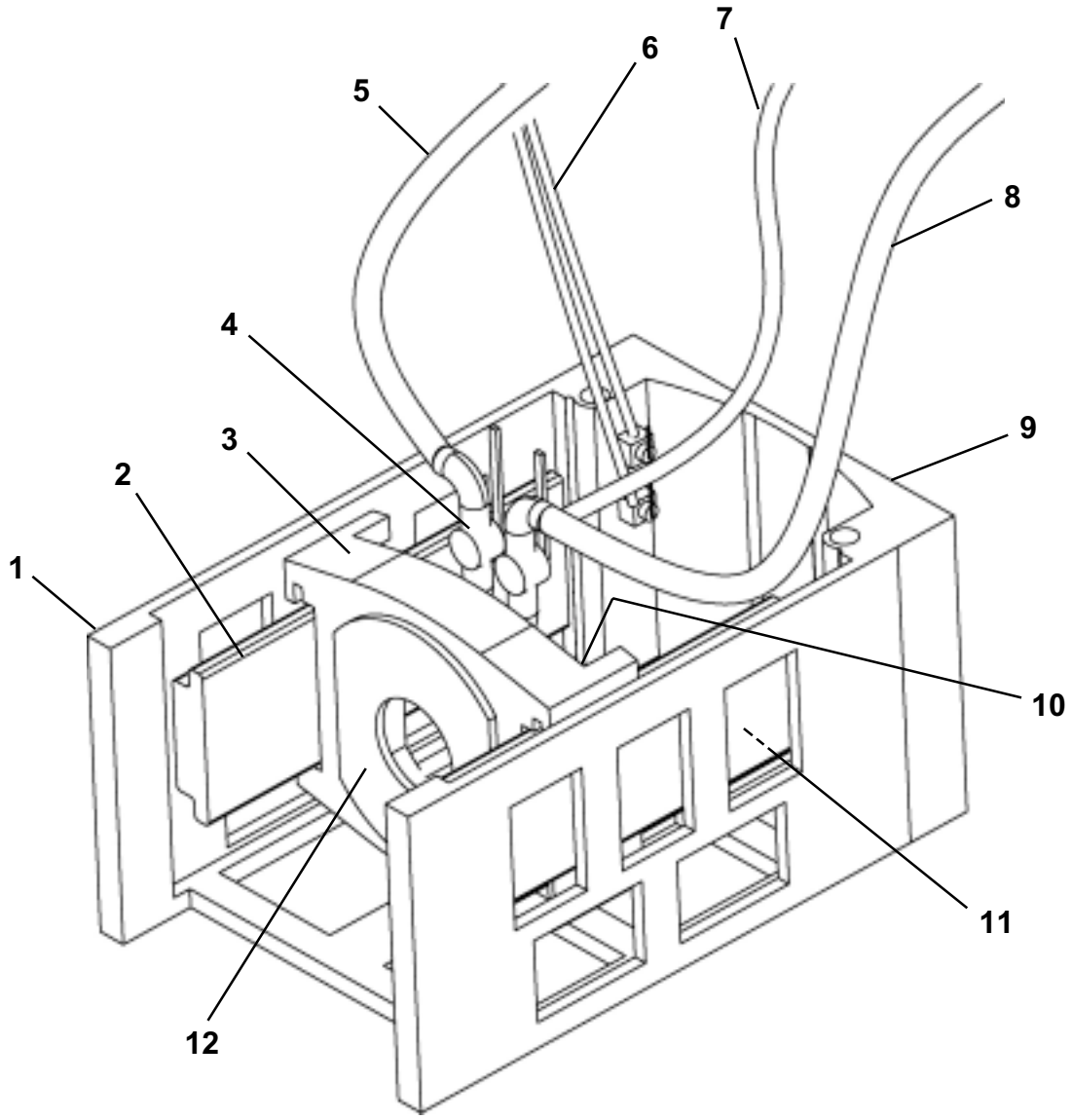
1. Ethernet Switch Box
2. Ethernet Communication
3. Head Power
4. Cooling Water Tank
5. Booster Pump Drive
6. 120V GFI Protected Outlets
7. Generator Power
8. Slurry Return Power
9. Slurry Feed Power
10. Jacking Frame - Retract
11. Jacking Frame - Extend
12. Auxiliary
13. IJS
14. High Flow Return
15. High Pressure Pump
16. MTBM Cutterhead Motor
17. Ground

CONTROL CONTAINER HYDRAULIC POWER PACK



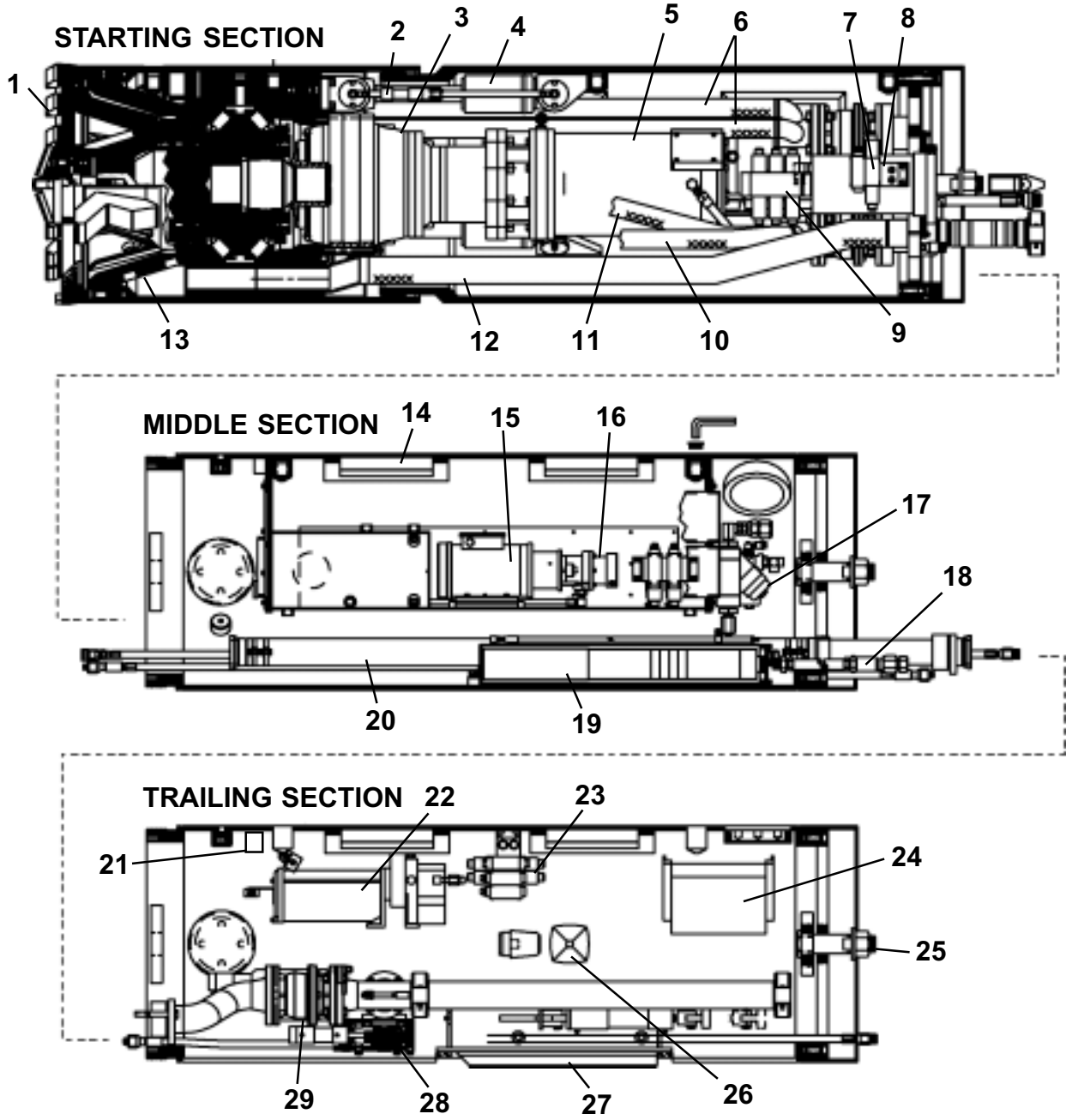
1. Reservoir
2. Main Pressure Gauge
3. Oil Cooler Pressure Gauge
4. Oil Fill Cap & Breather
5. Oil Cooler Pressure Filter Assembly
6. Main Pressure Filter Assembly
7. Extend/Retract Valve
8. IJS/Auxiliary Valve
9. Oil Level Sight Gauge
10. Suction Screen
11. Temperature Gauge
12. Proportional Actuator
13. Oil Cooler Assembly
14. Oil Cooler Pump Suction Valve
15. Main Pump Suction Valve
16. Tank Drain Valve
17. Motor 100 HP

MT400 JACKING FRAME



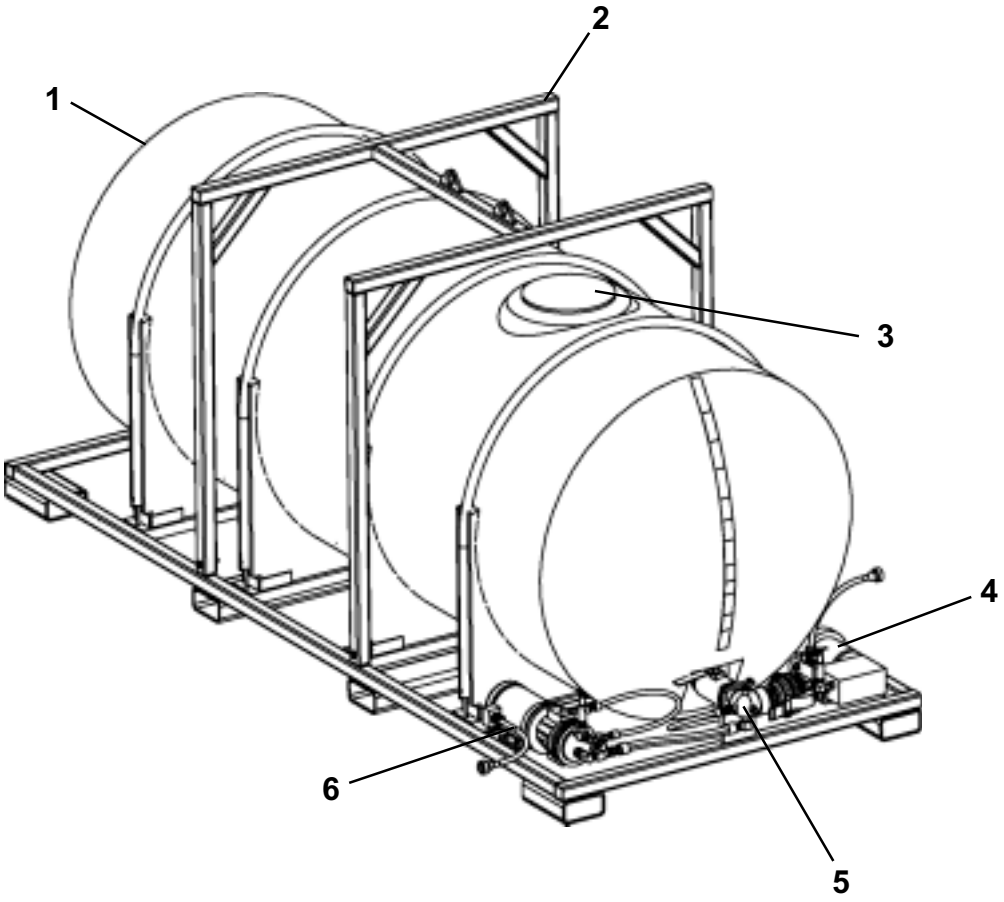
1. Jacking Frame
2. Ram Extension Arm
3. Thrust Block
4. Slurry Pit Valves
5. Slurry Feed Line
6. Hydraulic Supply & Return Hoses
7. MTBM Cooling Water Line
8. Slurry Return Line
9. Jacking Frame Back Stop
10. Dog Controls
11. Thrust Cylinders
12. Pipe Adapter

MTBM - SL30



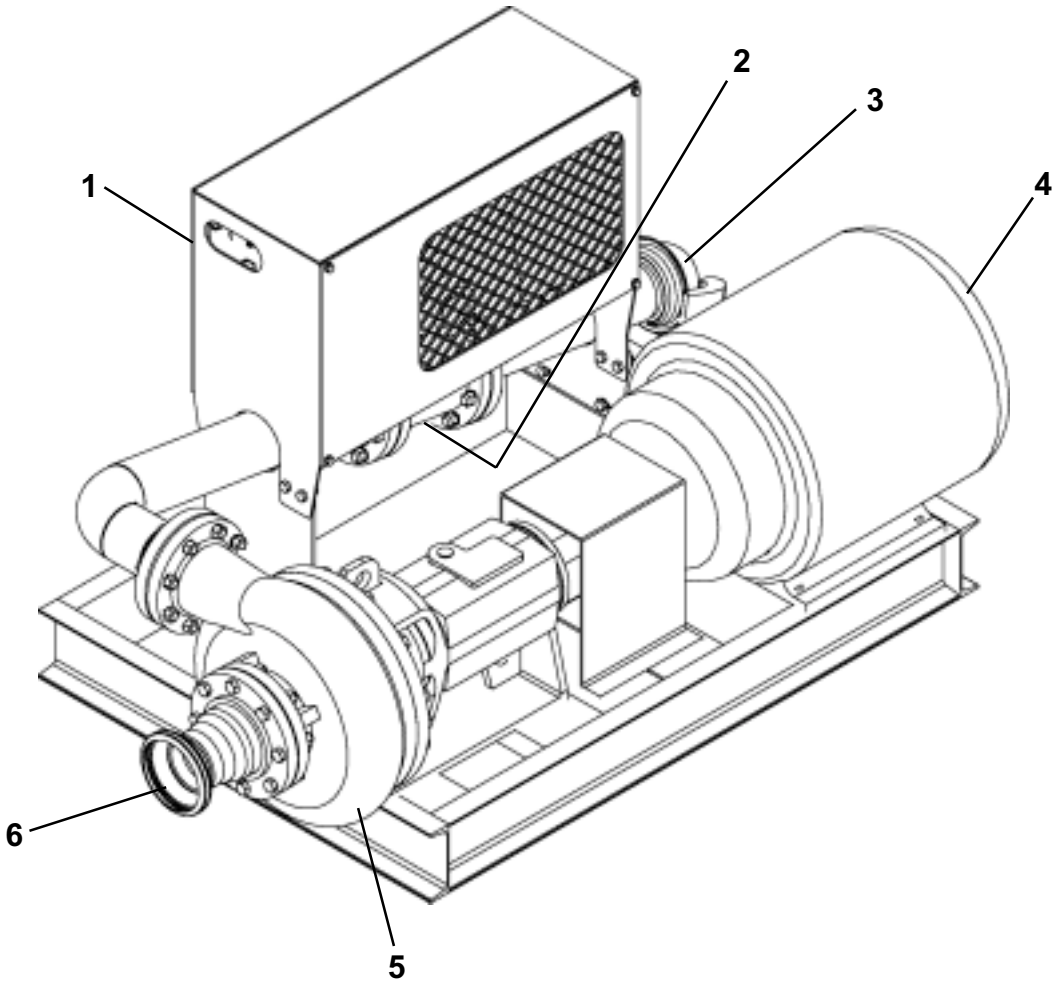
1. Cutter Wheel
2. Steering Stroke Sensor
3. Gear Reducer
4. Steering Cylinder
5. Drive Motor
6. Slurry Crusher Cone Supply
7. Chamber/Cone Nozzle Hyd. Valve
8. Target Assembly
9. Steering Cylinder Control Valve
10. Slurry Chamber Supply
11. Slurry/Nozzle Supply
12. Slurry Outlet Tube
13. Crushing Cone
14. Maintenance Door
15. Hydraulic Power Pack
16. Motor To Pump Assembly
17. Jetting Pump Strainer
18. High Pressure Jetting
19. Submersible Pump
20. Slurry Hoses
21. Gas Detector
22. Main Bearing Grease Pump
23. Hydraulic Control Valve
24. Trailing Section Junction Box
25. Alignment Pin
26. Communication Speaker
27. Stabilizer
28. Slurry Pressure Transducer
29. Slurry Stop & Bypass Valve

WATER COOLING TANK



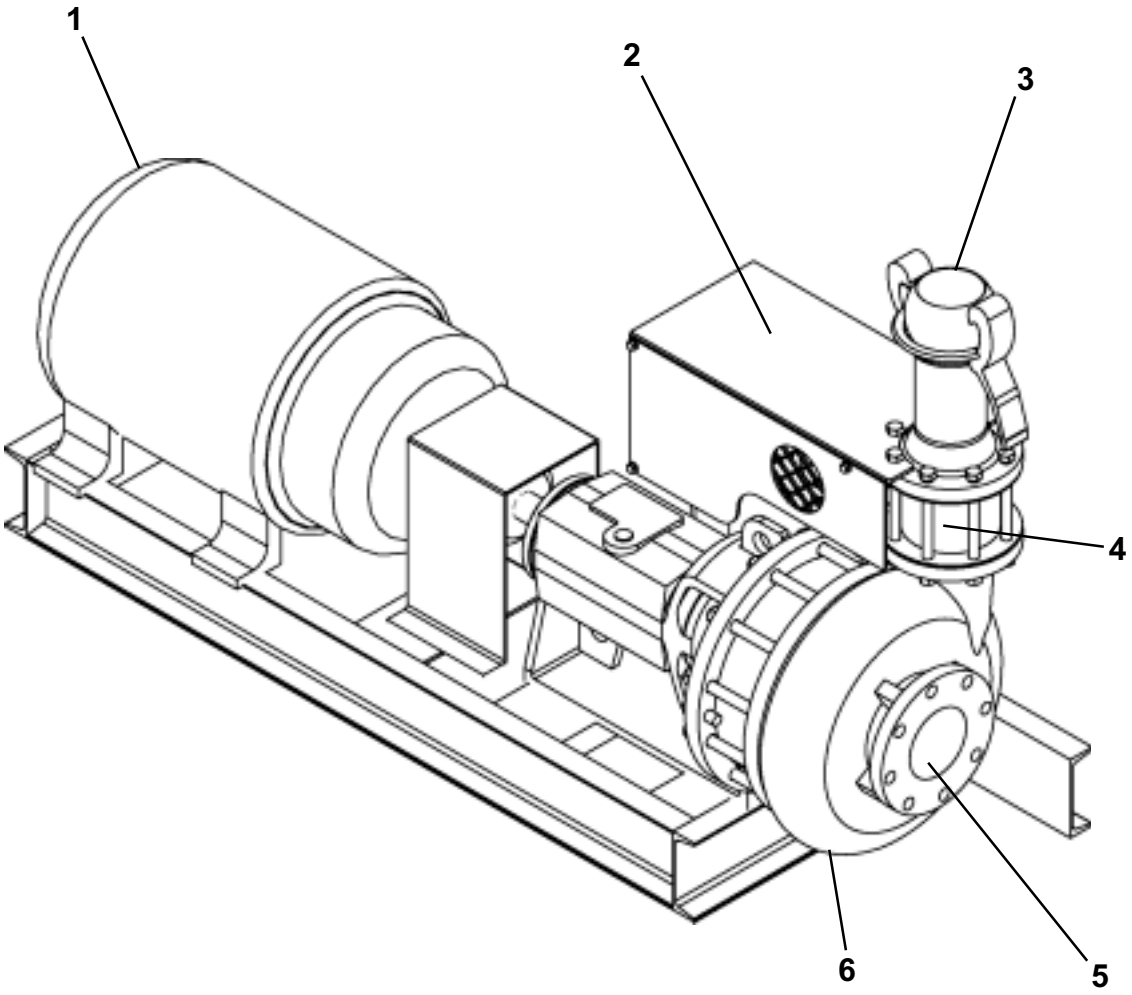
1. Polyethylene Storage Tank
2. Lift Frame
3. Fill Cap
4. Main Cooling Drive Motor Pump Assembly
   (For 30 hp & 75 hp drive motor)
5. Supply Outlet
6. Main Cooling Drive Motor Pump Assembly
   (For larger hp drive motor, water cooled booster pump, or gear reducer filtration)

SLURRY FEED PUMP



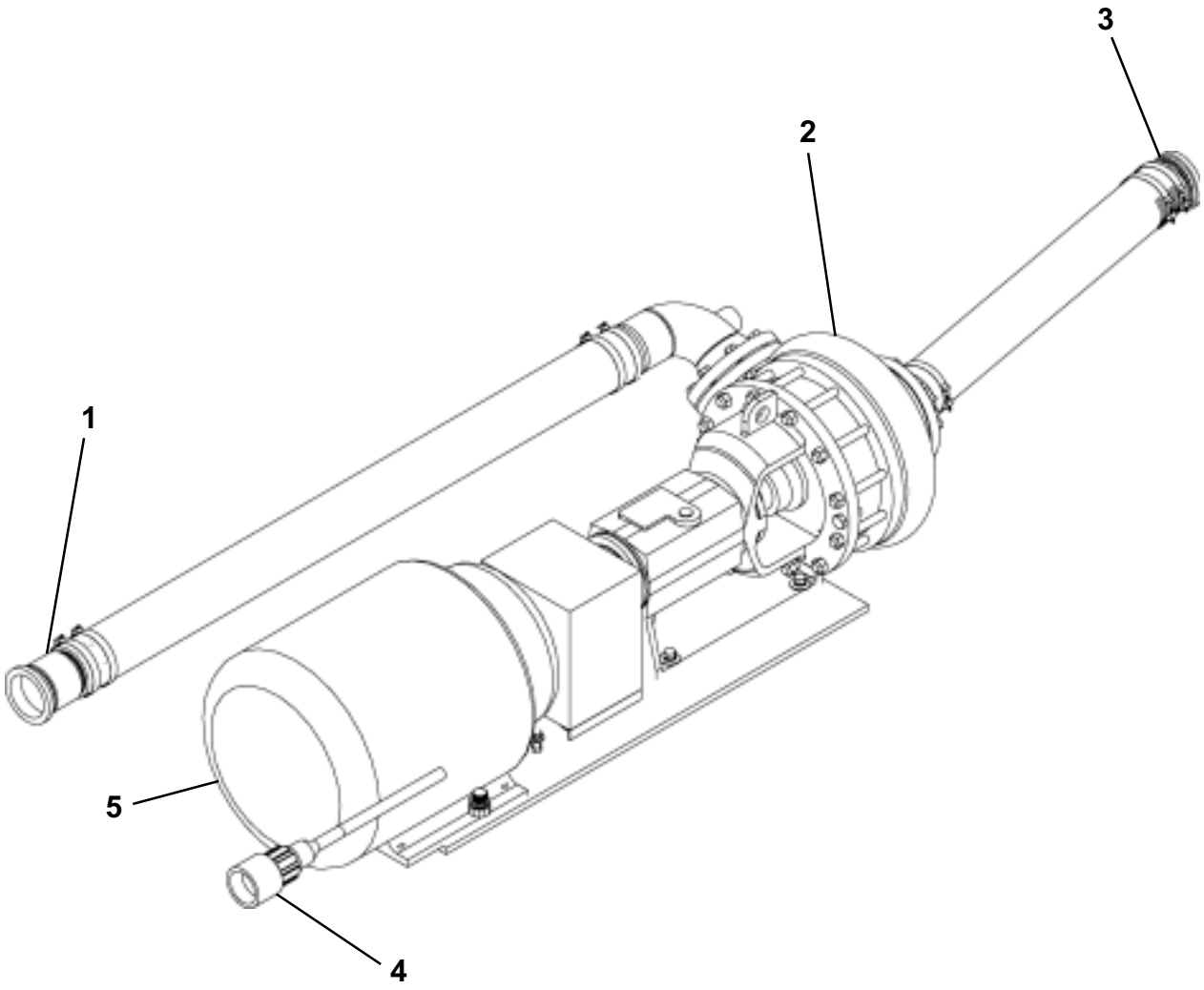
1. Control Box
2. Flow Meter
3. Feed Line Outlet
4. Motor
5. Impeller Pump Assembly
6. Water Inlet Connection

SLURRY RETURN PUMP



1. Motor
2. Control Box
3. Slurry Outlet To Tank
4. Flow Meter
5. Slurry Line Inlet From Tunnel
6. Pump Assembly

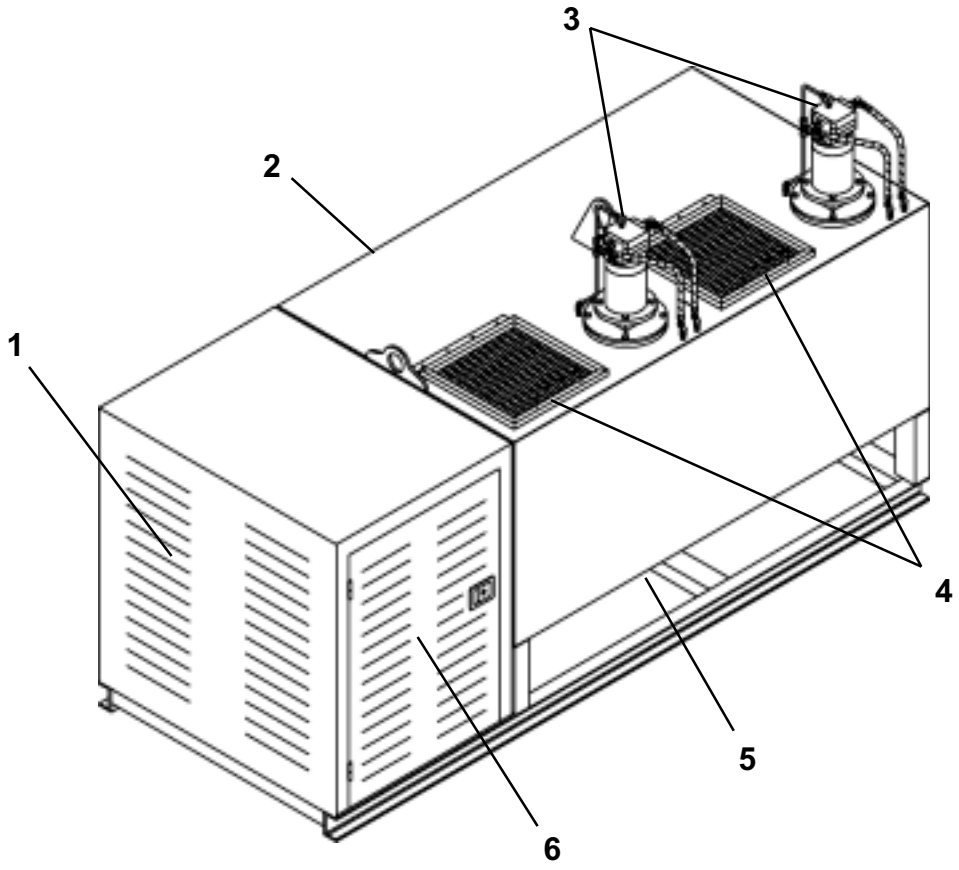
SLURRY BOOSTER PUMP



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

* Not used on SL24 or SL30 MTBMs

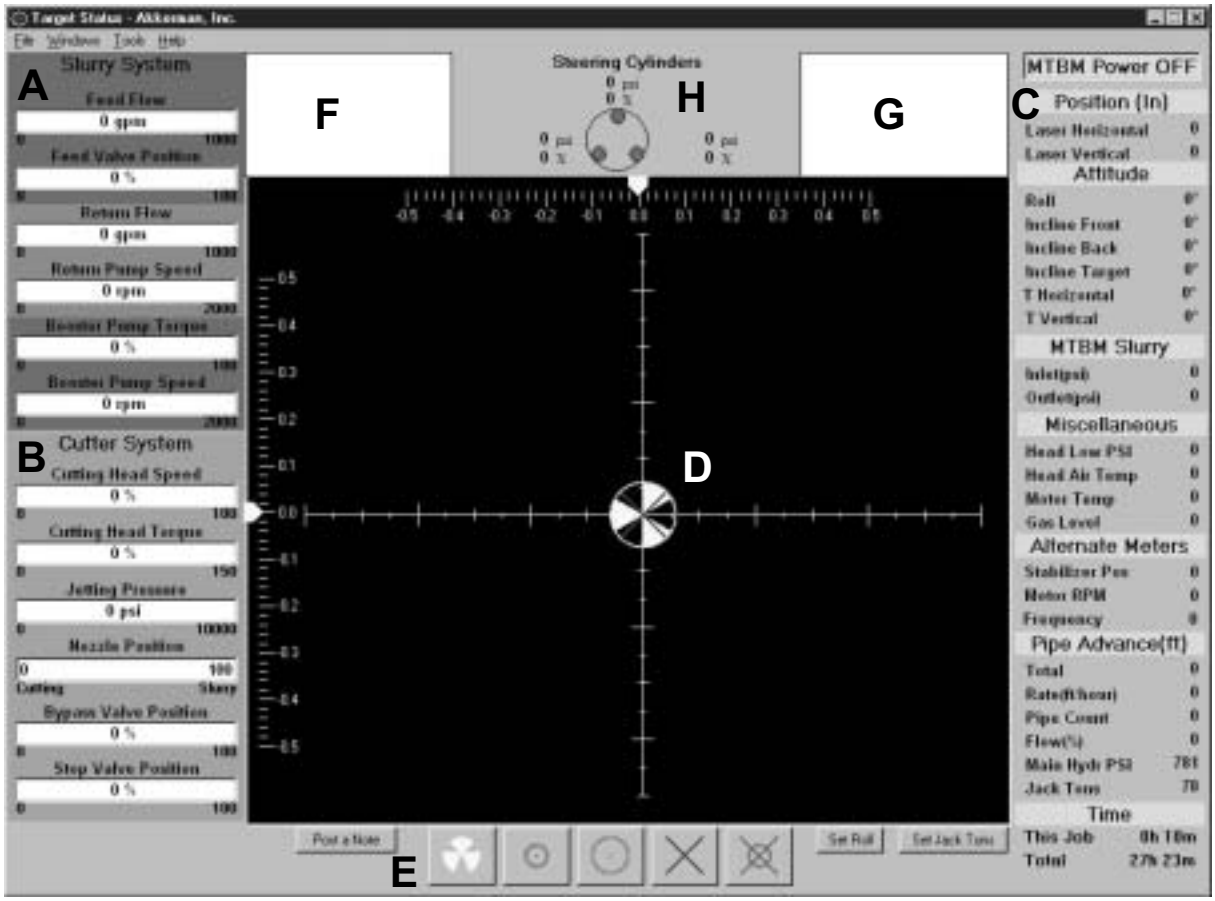
BENTONITE PUMP



1. Electric Motor
2. Tank
3. Hydraulic Mixer Drive
4. Mixer Door
5. Controls

Controls & Instruments

TARGET SCREEN (LEFT MONITOR)



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

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

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

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

The **alert messages** include the: hydraulic power pack Oil Cooler Filter and Return Filter, Head Hyd Filter Clogged, Head Hyd Overload, Sub Pump Overload, and Gas Detector Fault.

The **operational messages** include the: MTBM Motor Heater, Submersion Pump, Jetting Pump, Grease Pump, Out of Grease, and Gas Level High.

The Steering Cylinder indicator (H) displays the MTBM steering cylinder stroke position in percent and pressure in PSI for the top, left, and right cylinders.

(continued on next page)

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

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

ATTITUDE
Roll indicates the degree of clockwise roll of the MTBM. A negative reading indicates that the machine has rolled counterclockwise as viewed from the rear of the MTBM.

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

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

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

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

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

MTBM SLURRY
The slurry pressure, inlet and outlet, display the slurry pressure in PSI at the entrance and exit of the starting section.

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

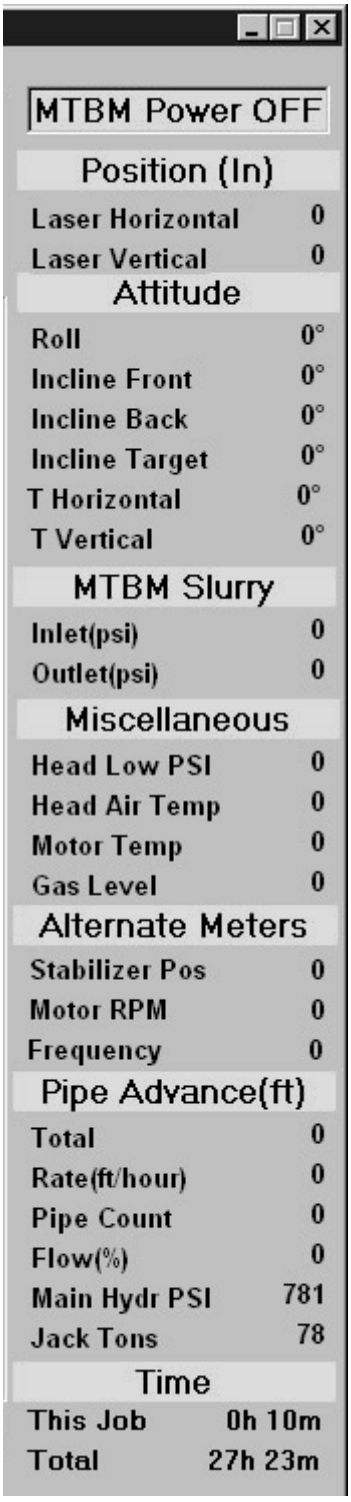
Head Air Temp displays the ambient air temperature of the MTBM starting section.

Motor Temp displays the internal temperature of the cutter bit drive motor.

Gas Level displays the % of LEL (Lower Explosive Limit) gas concentration in the trailing section.

ALTERNATE METERS
The operator can add or change three meters that would be convenient to have located on the target screen. Click on an alternate meter. In the drop down menu, select the desired meter. Click OK.

(continued on next page)



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

Rate (ft/hour) measures the jacking frame advancement rate in feet per hour.

Pipe Count displays the number of pipe that have been installed.

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

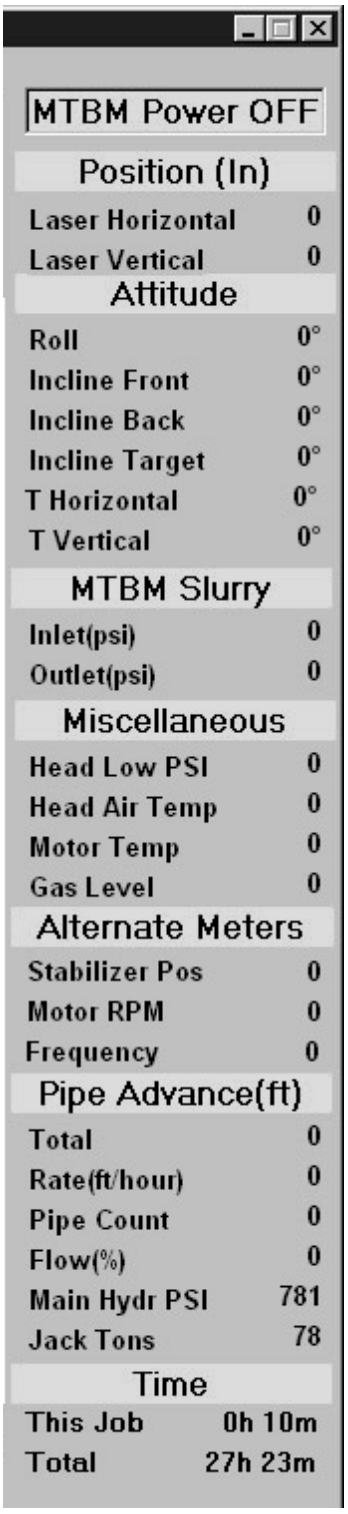
Main Hydr PSI displays the extension pressure of the main jacking cylinders.

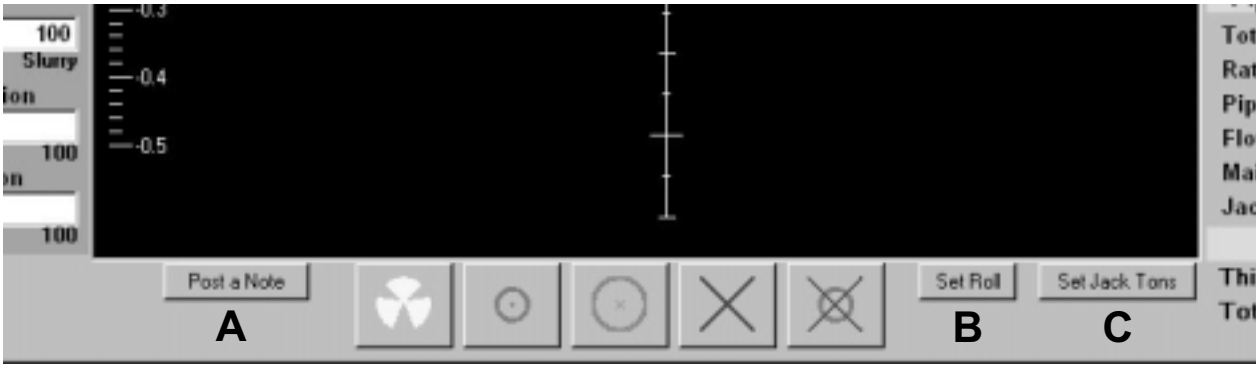
Jack Tons displays the calculated tons of thrust that is being applied to the pipe by the jacking frame.

TIME
This Job displays the total job time in hours and minutes.

Total displays the total number of computer hours used.

(continued on next page)

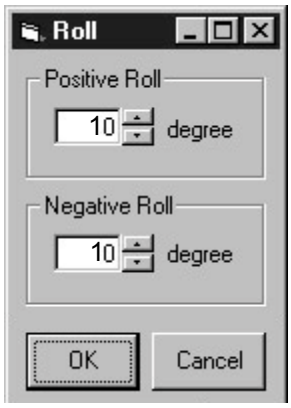




The bottom portion of the target screen allow you to post a note and set the roll and jacking ton parameters.

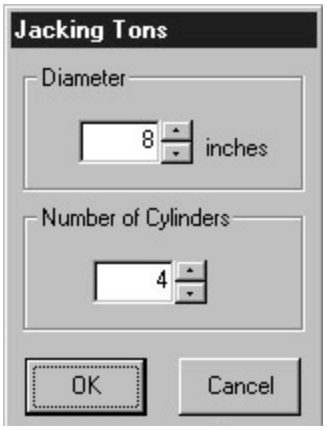
Post a Note (A)
Click this button to type a short note. Click POST button to save this note on the database. This note will be generated on a report providing the note was posted within the date and time parameters of the report.

Set Roll (B)
The positive and negative roll parameters communicate to the system if the positive or negative roll exceed these degree parameters, to shut down the main drive motor (rotation) and the main hydraulic pump (jacking). Ten percent positive and negative roll is the default.
Adjust the Positive Roll and Negative Roll by clicking the up and down arrows or by simply typing in the number.

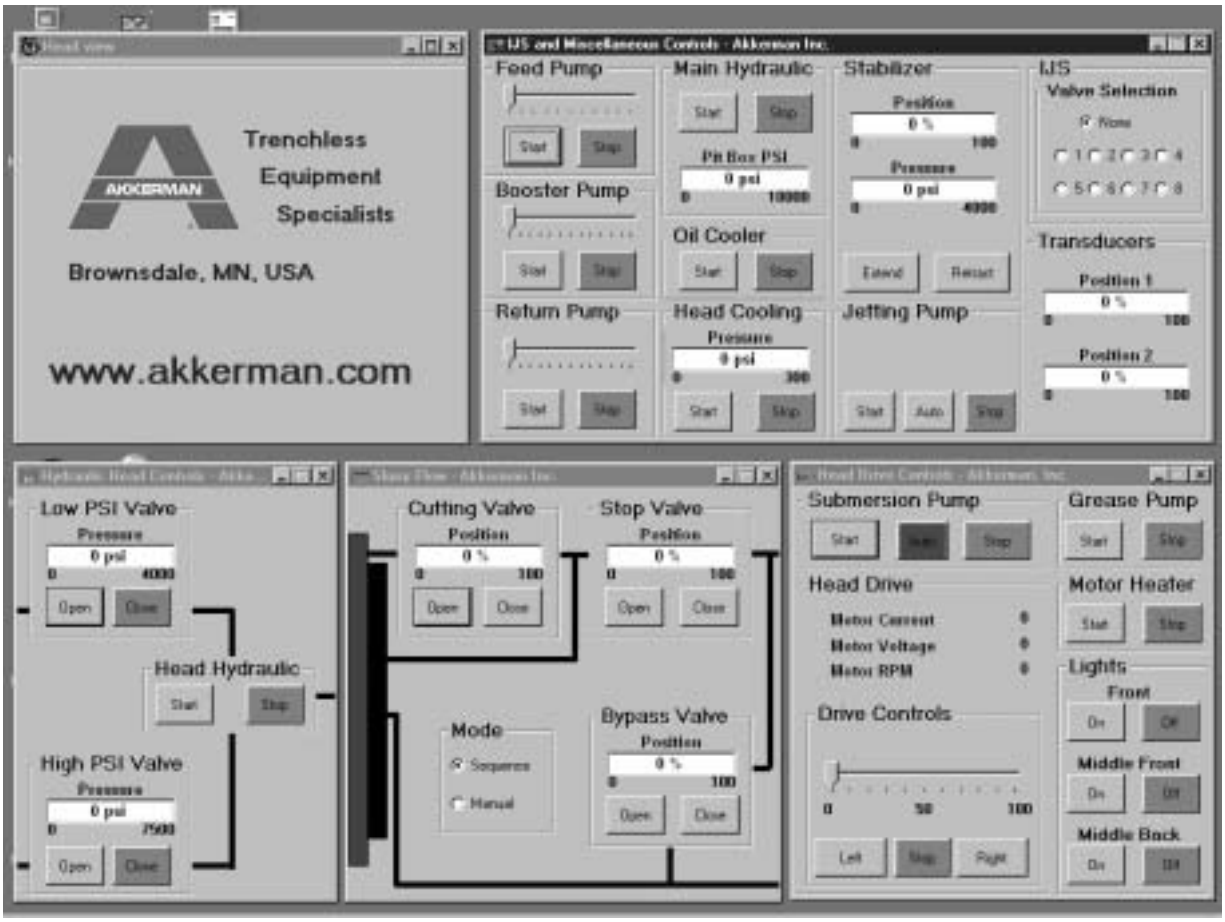


Set Jack Tons (C)
The jacking cylinder diameter and number of cylinders value fields are used to properly calculate the jacking tonnage during the jacking process. The calculated Jack Tons is displayed on the target screen under the Pipe Advance(ft) heading.

Adjust the Diameter of the jacking cylinders in inches by clicking the up and down arrows or by simply typing in the number. Adjust the Number of Cylinders by clicking the up and down arrows or by simply typing in the number.



CONTROL SCREEN (RIGHT MONITOR)



The control screen is a touch screen. The controls can be activated with your finger or by using the mouse. Most of these controls on this screen are normally controlled from the console.

IJS AND MISCELLANEOUS CONTROLS

Feed Pump: controls the start and stop of the feed pump. When the feed pump is stopped, the return and booster pumps will automatically stop. The slider adjusts the speed of the feed pump.
The feed pump is normally controlled with the Feed Pump control on the console.

Booster Pump: controls the start and stop of the booster pump. The slider adjusts the speed of the pump.
The booster pump is normally controlled with the Booster Pump control on the console.

Return Pump: controls the start and stop of the return pump. The slider adjusts the speed of the pump.
The return pump is normally controlled with the Return Pump control on the console.

Main Hydraulic controls the start and stop of the main hydraulic pump The oil cooler recirculating hydraulic pump, and the cooling fan automatically start when the main hydraulic pump is started.
The Pit Box PSI displays the main hydraulic pump oil pressure.

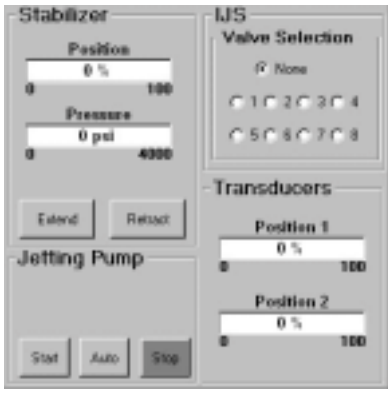
Oil Cooler: controls the start and stop of the oil cooler recirculating hydraulic pump. The cooling fan automatically starts when the oil cooler pump is started.

Head Cooling: controls the start and stop of the head cooling pump. The head cooling pump automatically starts when the cutter head is rotating. The Pressure displays cooling hydraulic pump pressure. The cooling pump draws clean water from the MTBM water cooling tank. This water is pumped through a valve on the jacking frame and through the tunnel into the water jacket surrounding the electric drive motor. Heater water is then expelled past the front lip seals into the slurry water.

(continued on next page)

RIGHT SCREEN - IJS AND MISCELLANEOUS (continued)

Stabilizer: controls the extend and retract of the stabilizer cylinder or dirt wing. Continuing to hold down the extend or retract buttons will cause the stabilizer cylinder to extend or retract further.
The Position percentage and the cylinder pressure is displayed.



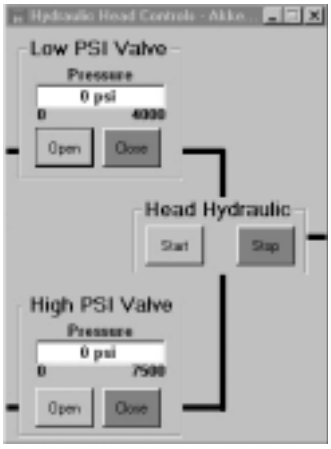
Jetting Pump: controls the start, auto and stop of the high pressure jetting pump. Select Auto to run the jetting pump automatically with the MTBM drive motor. The “Jetting Pump” message will appear on the operational message area on the target screen when the jetting pump is operating.

IJS Valve Selections: controls the specific IJS cylinder section. Refer to Using Intermediate Jacking Stations (IJS) in the Operation section.

Transducers: this feature is not used at this time.

HYDRAULIC HEAD CONTROLS

All hydraulic head control functions work automatically when the steering cylinders, bypass valve, stop valve, cutting nozzles, or stabilizer are activated.



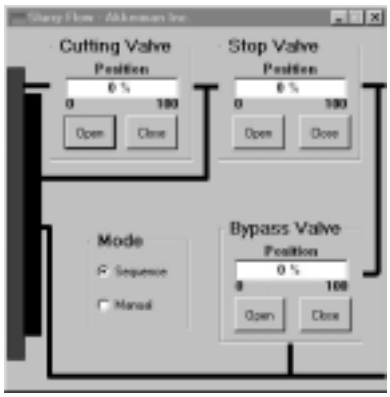
Head Hydraulic: controls the start and stop of the head hydraulic pump in the middle or trailing section.

Low PSI Valve: open or close the low pressure valve that controls the bypass valve, stop valve, cutting nozzles, or stabilizer. The Pressure reading displays the valve oil pressure in PSI.

High PSI Valve: open or close the high pressure valve that controls the steering cylinders. The Pressure reading displays the valve oil pressure in PSI.

SLURRY FLOW

The Cutting Valve, Stop Valve, and Bypass Valve are normally controlled from the console.



Cutting Valve: open or close the cutting nozzle valve. Hold the buttons down to vary the valve opening. The Position reading displays the position of the valve in percent.
Opening this valve will close the slurry chamber valve by the same amount. Closing this valve will open the slurry chamber valve by the same amount.

Stop Valve: open or close the slurry stop valve. The stop valve is either fully open or fully closed. The Position will display the valve position in percent; 0% (closed) or 100% (open).

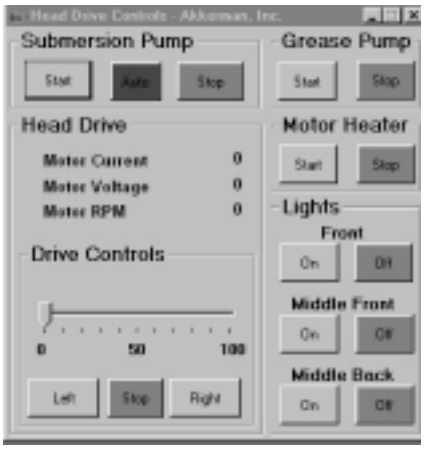
Bypass Valve: open or close the slurry bypass valve. In sequence mode the bypass valve will either be fully open or fully closed. The Position will display the valve position in percent; 0% (closed) or 100% (open). In manual mode the valve position can be varied depending on operator. The Position will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

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

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

(continued on next page)

RIGHT SCREEN - HEAD DRIVE CONTROLS



Submersion Pump: controls the start, auto, and stop modes of the submersion pump located in the middle or trailing section. Press Start button to run the submersion pump continuously. Press Stop button to stop the pump. Press Auto button to allow the pump to be controlled by the water level float switch in the MTBM. The “Submersion Pump” message will display in the operational message area of the target screen. The Auto mode is the default position.

Head Drive: displays the drive motor current, voltage, and RPM.

Drive Controls: control the drive motor cutter head rotation (left, stop, right) which is normally controlled from the console. The slider controls the cutting head rotation speed.

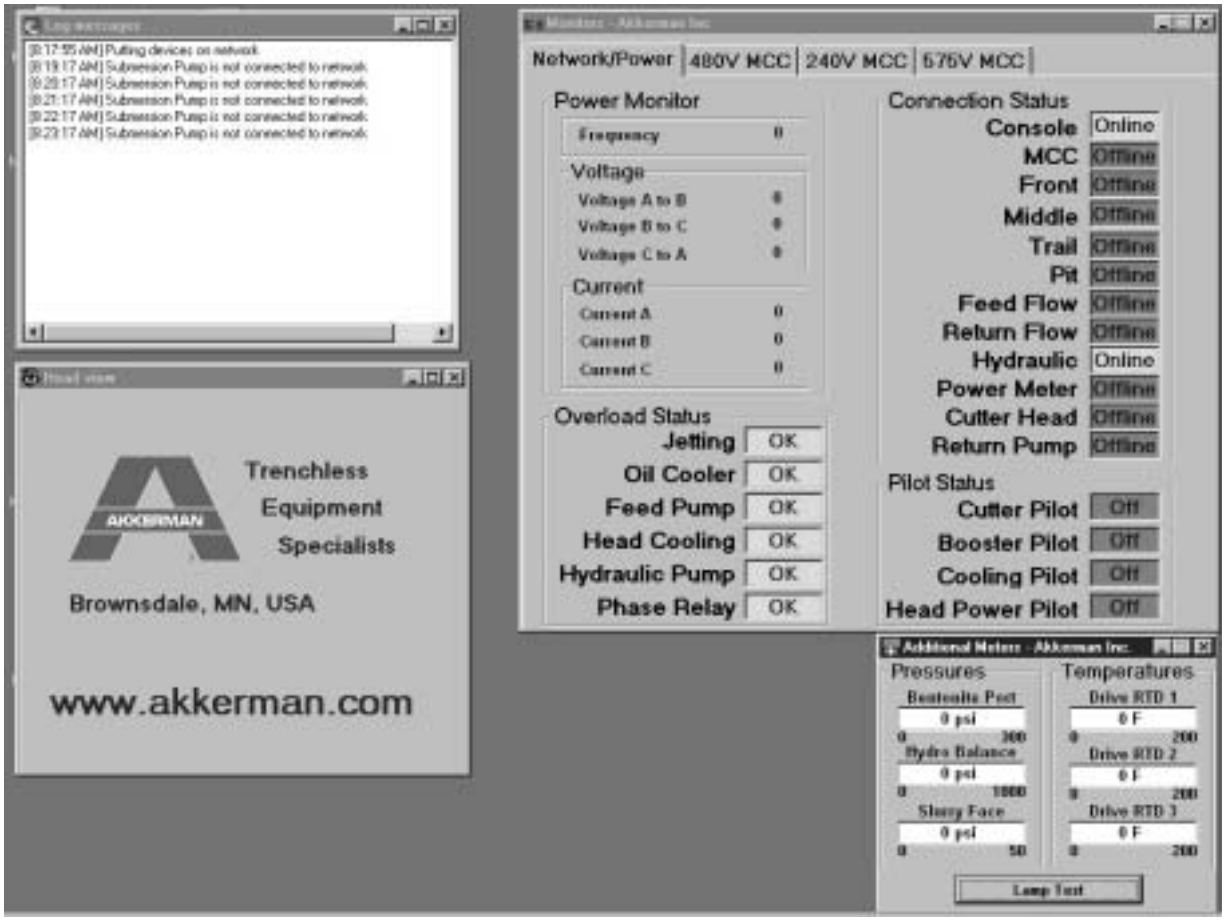
Grease Pump: turns the grease pump in the trailing section on or off. The grease pump works automatically when the drive motor (cutter head rotation) is running. In this mode the grease pump is on for 12 seconds, then off for 48 seconds. When the grease pump is refilled, start the grease pump manually to purge air from the grease lines. Stop the pump when grease comes out the lip seal. The “Grease Pump” message will display in the operational message area of the target screen.

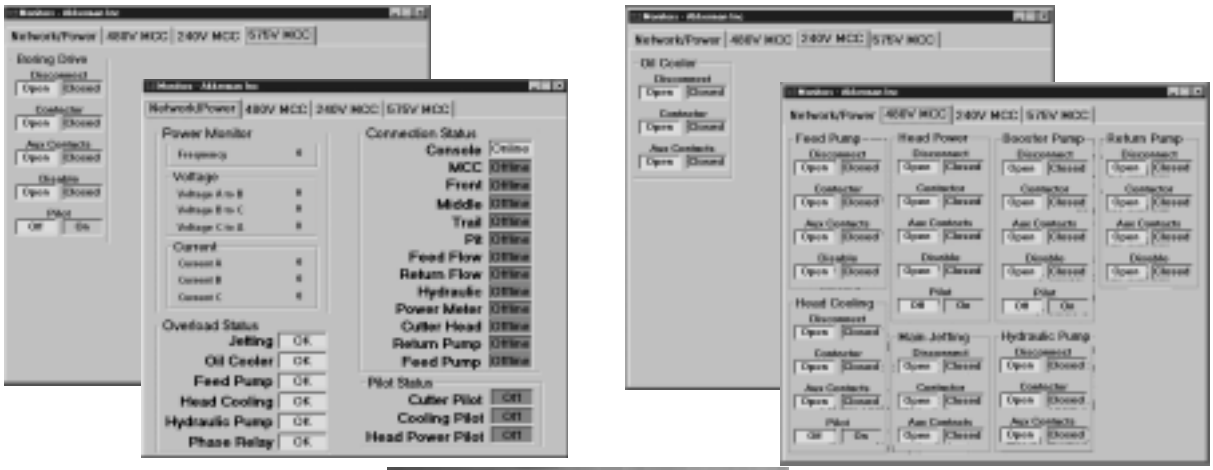
Motor Heater: turns the MTBM main drive motor heater on or off. The “MTBM Motor Heater” message will display in the operational message area of the target screen.

Lights: turns the MTBM lights on or off.

INDICATOR SCREEN (TOP MONITOR)

The indicator screen displays the status of the Network/Power, 240V MCC, 480V MCC, and the 575V MCC monitors. This screen also displays the log messages, the additional meter pressures and temperatures, and the MTBM camera and floating camera (launch shaft) views.





SLURRY REMOVAL SYSTEM CONTROLS

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

NOTICE The return and booster (if used) pumps will automatically stop when the feed pump is stopped.

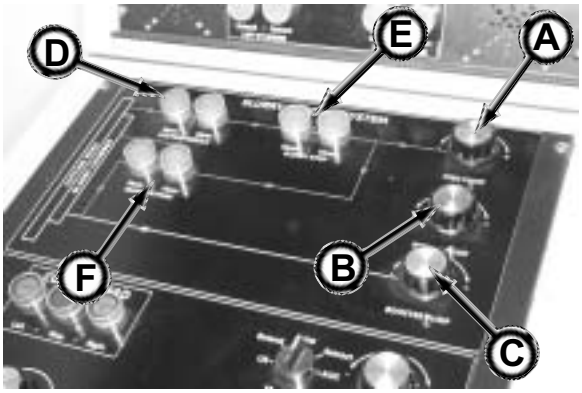
RETURN PUMP
The Return Pump control (B) adjusts the speed of the return pump from 0 to 100%. When the control is turned counterclockwise (CCW) position, the pump will stop when the flow reaches 0, as shown on the target screen. When the control is turned clockwise (CW), the pump will start.

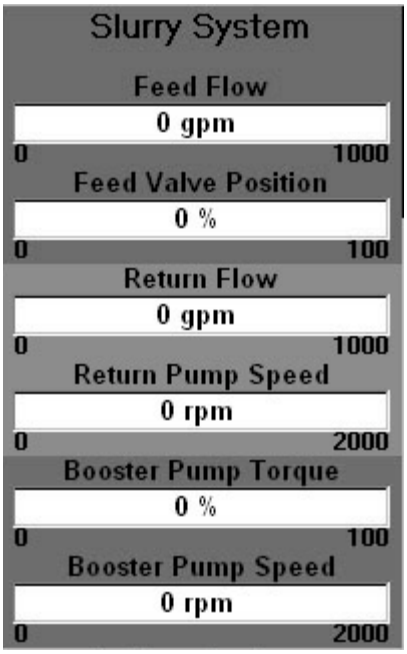
BOOSTER PUMP
The Booster Pump control (C) adjusts the speed of the booster pump (if used) from 0 to 100%. When the control is turned counterclockwise (CCW), the pump will stop when the torque reaches 0. When the control is turned clockwise (CW), the pump will start.

CUTTING NOZZLE
The Cutting Nozzle buttons (D) will open and close slurry flow to the cutting face. Opening this valve will close the slurry chamber valve by the same amount. Closing this valve will open the slurry chamber valve by the same amount. The open button will light when the valve is partially open. The close button will light when the valve is fully closed.

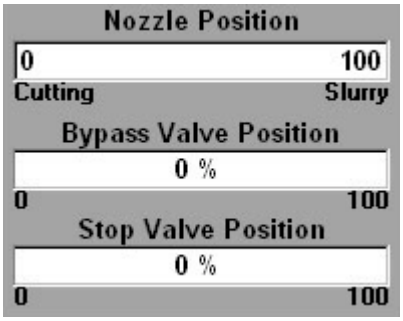
SLURRY STOP
The Slurry Stop buttons (E) will open or close slurry flow to the slurry chamber and cutting face. The open button will light when the valve is open. The close button will light when the valve is closed. In sequence mode, the stop valve and bypass valve work in opposite positions.

SLURRY BYPASS
The Slurry Bypass buttons (F) open or close the bypass valve that directs slurry flow from the feed line to the return line without entering the MTBM. The open button will light when the valve is fully open. The close button will light when the valve is fully closed. In sequence mode, the stop valve and bypass valve work in opposite positions.





Feed, Return, & Booster Pump Meters On Target Screen

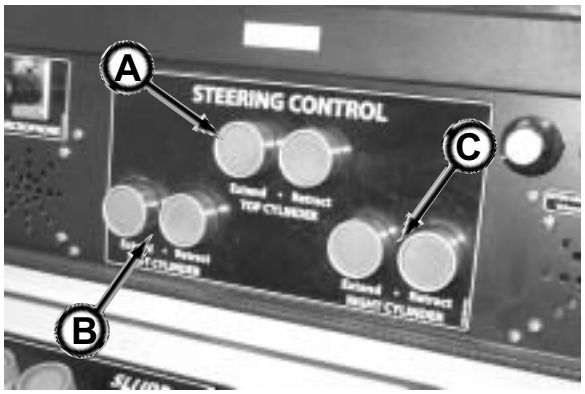


Cutting Nozzle, Slurry Stop, & Slurry Bypass Meters On Target Screen

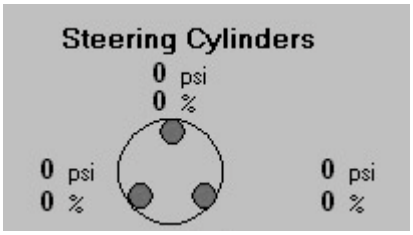
STEERING CONTROLS

Depress extend or retract buttons to control the steering cylinders. Continuing to hold down a cylinder button will cause the cylinder to extend or retract further.

A - Top Cylinder Controls
B - Left Cylinder Controls
C - Right Cylinder Controls



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

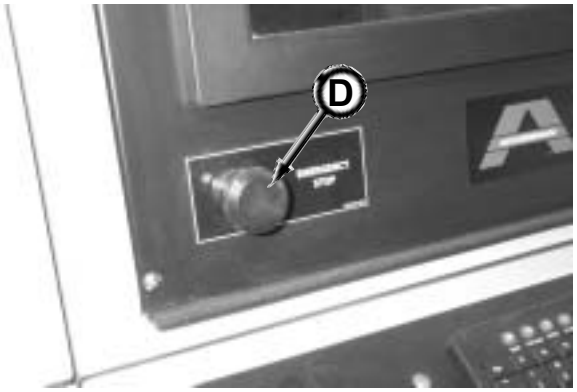


EMERGENCY STOP

Push IN Emergency Stop button (D) to stop all electrical and hydraulic bulkhead connections and components, excluding the 120V GFI protected outlets.

The button will light when it is pushed in.

This button must be pushed in to restart operation.



KEYBOARD & MOUSE CONTROLS

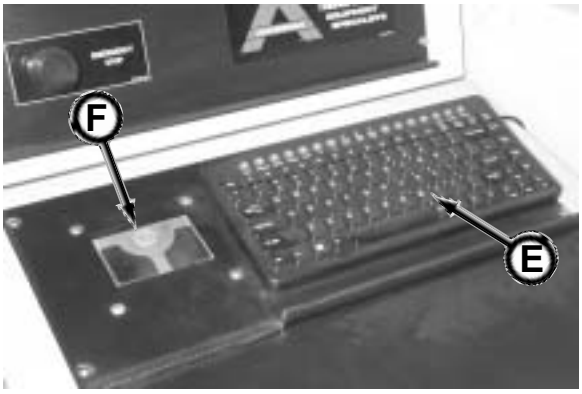
Use the keyboard (E) to enter information.

MOUSE
The mouse (F) controls the computer screen pointer and select functions on all three monitors.

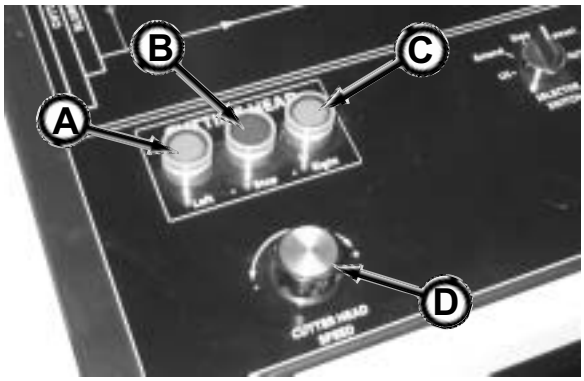
The left and right black switches represent the left and right mouse buttons.

The round button, located between the left and right buttons is pressure and direction sensitive. To move the pointer in a direction, push the button in that direction. To move the pointer faster, push on the button harder.

If you cannot find the pointer on any of the monitors, touch the right monitor (touch screen) with your finger and the pointer will appear at that spot.



CUTTING HEAD CONTROLS



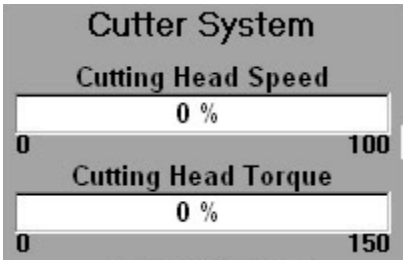
The cutting head controls regulate the speed and direction of the cutting head rotation (drive motor) on the MTBM.

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

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

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

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

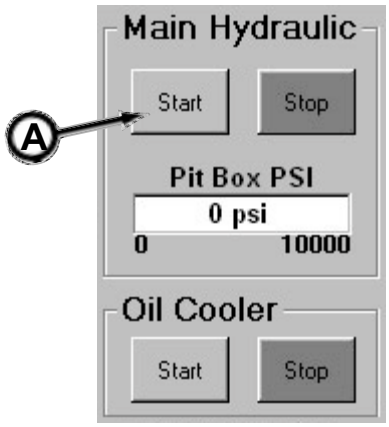


Cutting Head Meters
On Target Screen

JACKING FRAME CONTROLS

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

To use these controls, the Main Hydraulic Pump must be started. Click or touch the main hydraulic Start button (A) on the right screen.



Main Hydraulic Start Up
On Right Screen

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

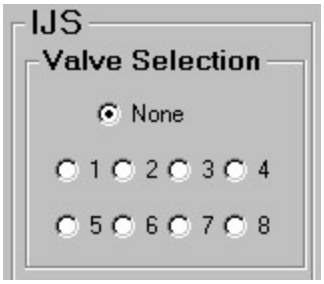
SELECTOR SWITCH FUNCTIONS
STOP
Stops flow to the jacking cylinders. To enable other hydraulic functions, the switch must be in STOP position.

EXTEND
Turns the jacking cylinder extend valve ON.

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

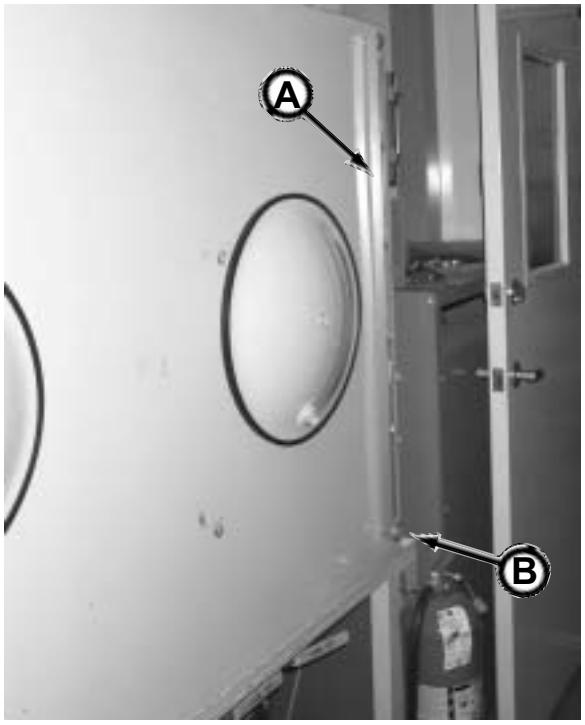
IJS
Provides hydraulic flow to the intermediate jacking valve bank. The valve sections are selected from the right screen.

AUX
Used for auxiliary functions such as a winch.



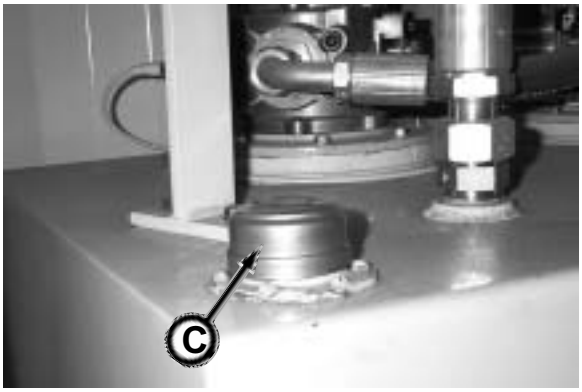
IJS Valve Selection
On Right Screen

HYDRAULIC POWER PACK OIL RESERVOIR



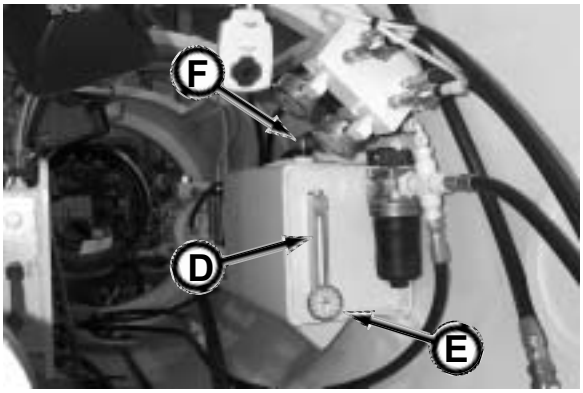
The hydraulic reservoir in the control container includes an oil level sight gauge (A) and temperature gauge (B).

The hydraulic oil temperature should not exceed 125 degrees F.



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

MTBM HEAD OIL RESERVOIR



The hydraulic reservoir in the MTBM middle section or trailing section (depending on the MTBM model) includes an oil level sight gauge (D) and temperature gauge (E).

The hydraulic oil temperature should not exceed 125 degrees F.

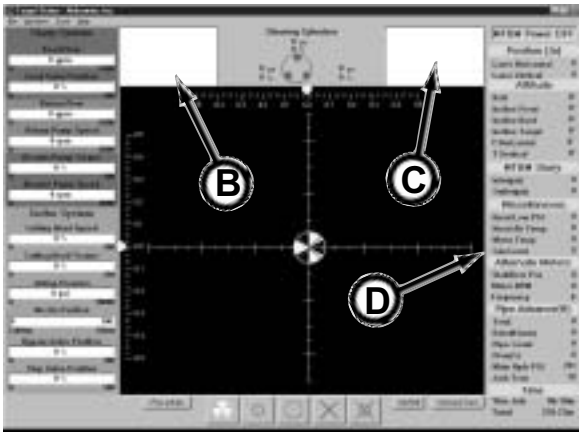
Remove the fill cap (F) to fill the hydraulic reservoir.

GAS DETECTOR

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

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

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



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

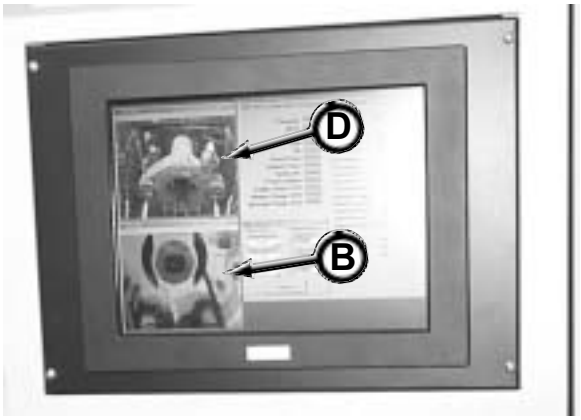
2. The “Gas Level High” message will appear in the operational messages area (C) on the target screen when the gas level at the gas detector reads 25% LEL (Lower Explosive Limit) or higher.

3. When the system detects a gas level reading of 25% LEL but less than 50% LEL, the horn in the pit will sound intermittently.

4. When the system detects a gas level reading of 50% LEL or higher, the horn in the pit will sound constantly.

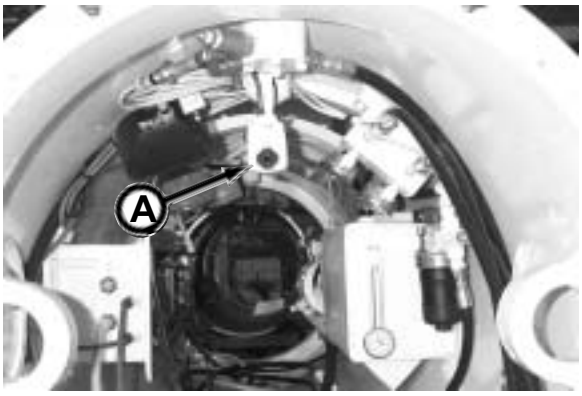
5. The gas level % of LEL reading (D) at the gas detector is displayed on the target screen.

CAMERAS



There are two cameras for viewing the target in the MTBM and launch shaft. The camera windows will be displayed in the upper monitor.

MTBM Target Camera (A)
Double click the Machine Camera icon to display the camera window (B).



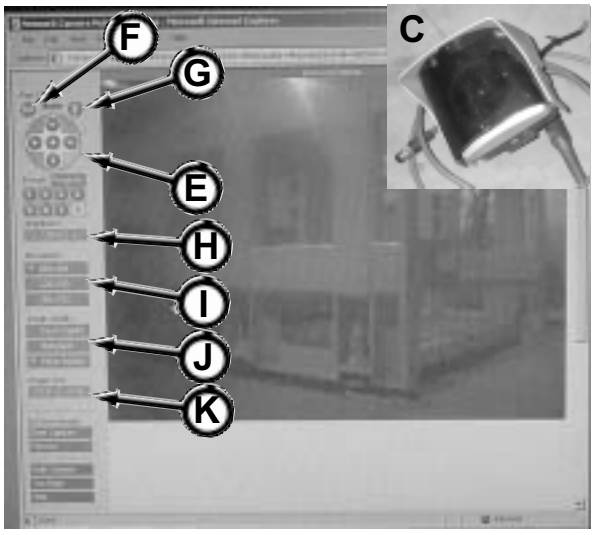
There is no panning or tilting with this camera.

The screen image can be resized by dragging a corner of the window to one of three pre-set window sizes.

Launch Shaft or Floater Camera (C)

1. Double click the Pit Camera icon to display the camera window (D) and controls.

2. Pan/Tilt (left, right, up, and down) can be performed using the software controls (see below) or by clicking the mouse on the image to center that area of the image. For example, if you want to pan left, click the mouse on the left side of the camera screen. The area you clicked will now be at the center of the screen.



Camera Controls: Click on the controls (E) to pan left or right, and tilt up or down. Click the scan side to side arrow button (F) to automatically pan the camera left, right, and back to center position. Click the up and down arrow button (G) to automatically tilt the camera up, down, and back to center position.

Brightness (H): Click +, -, or Std (Standard) to control the image brightness.

Resolution (I): Click the desired image resolution. An * will appear next to the selected resolution.
Large Image - 640 x 480 Medium Image - 320 x 240 Small Image - 160 x 120

Image Quality (J): Click the desired image quality. An * will appear next to the selected quality.
Favor Quality - Best image quality
Standard - Standard image quality
Favor Motion - Good image quality

Image Size (K): Click the desired image size.

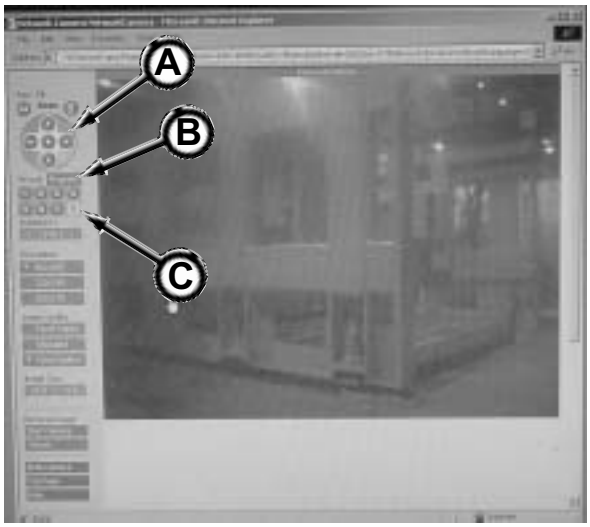
(continued on next page)

3. Pre-program eight positions using the camera software as follows:

a. Use the pan and tilt controls (A) to set your preset view.

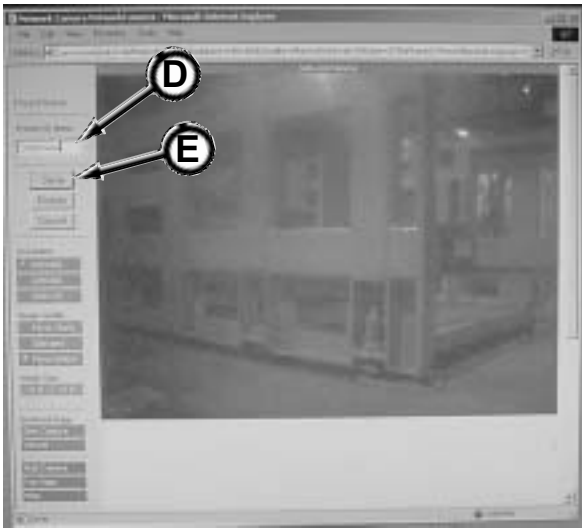
b. Click Program button (B).

c. Click desired numbered button (C) for preset view.



d. Type in a preset name (D).

e. Click Save (E).



f. When you move the cursor over the numbered preset buttons, the preset name will appear.

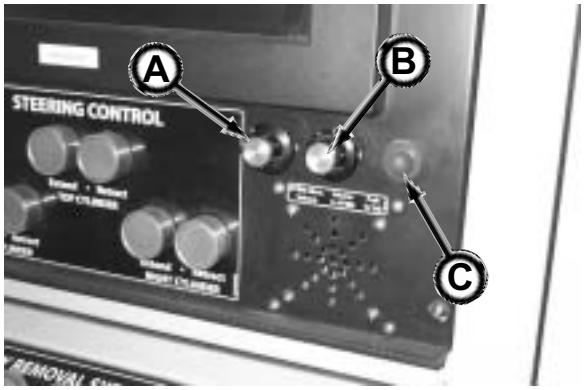
g. Click any of the preset buttons to recall the preset view.

COMMUNICATIONS (INTERCOM) SYSTEM

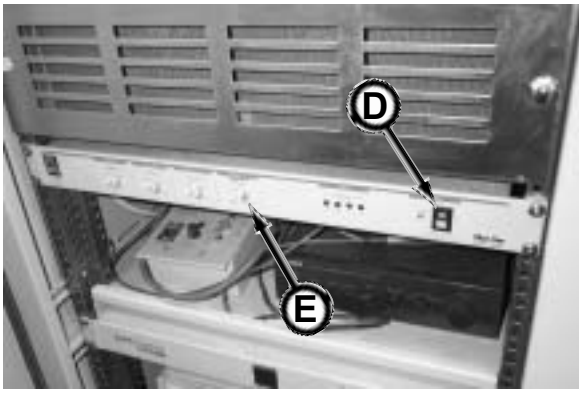
MTBM Micro. Volume (A)
Adjust the volume of the sound coming from the MTBM into the control container.

Volume in MTBM (B)
Adjust the volume of the MTBM speaker to hear the control container console operator.

Push To Talk (C)
Depress this button for the console operator to speak to person in the MTBM.



The intercom power system must be on (D) and the appropriate channel program (E) must be on.

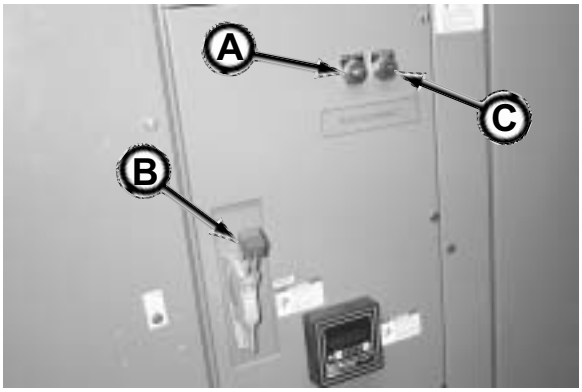


MAIN DISCONNECT

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

With generator power connected to bulkhead connectors, and the Green Phase Relay OK (A) light ON, flip the main disconnect switch (B) UP to the ON position.

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



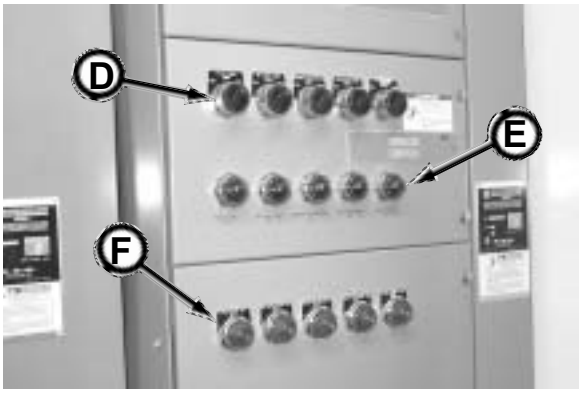
OPERATOR CONTROL DISCONNECTS

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

The power to the feed pump, return pump, boring drive motor, booster pump and head power must be turned on before using the device.

With the main power on and the operator control disconnects (D) off, the green lights (E) will illuminate indicating there is no power at the bulkhead connector device(s).

With the main power on and the operator control disconnects on, the red lights (F) will illuminate indicating there is power at the bulkhead connector device(s).



NOTES

Pre-Start Inspection

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

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

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

	1. Use "ONE-CALL" notification to check for buried utility lines prior to tunneling.
	2. Check the excavated launch and reception pits or shafts for proper shoring or bracing to prevent slides or cave-ins.
	3. 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 Emergency Stop button 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 wire harnesses for frayed or worn insulation or wires. Replace damaged or worn harnesses.
	15. Check for fluid leaks. Repair leak or replace components.
	16. Keep job site clean and organized.
	17. Perform all lubrication and maintenance procedures. Refer to Section 9, Periodic Maintenance.
	18. Test each function and control to ensure correct operation.
	19. Check hydraulic hoses and lines for leaks, wear and/or damage. Replace any defective hoses and/or lines.

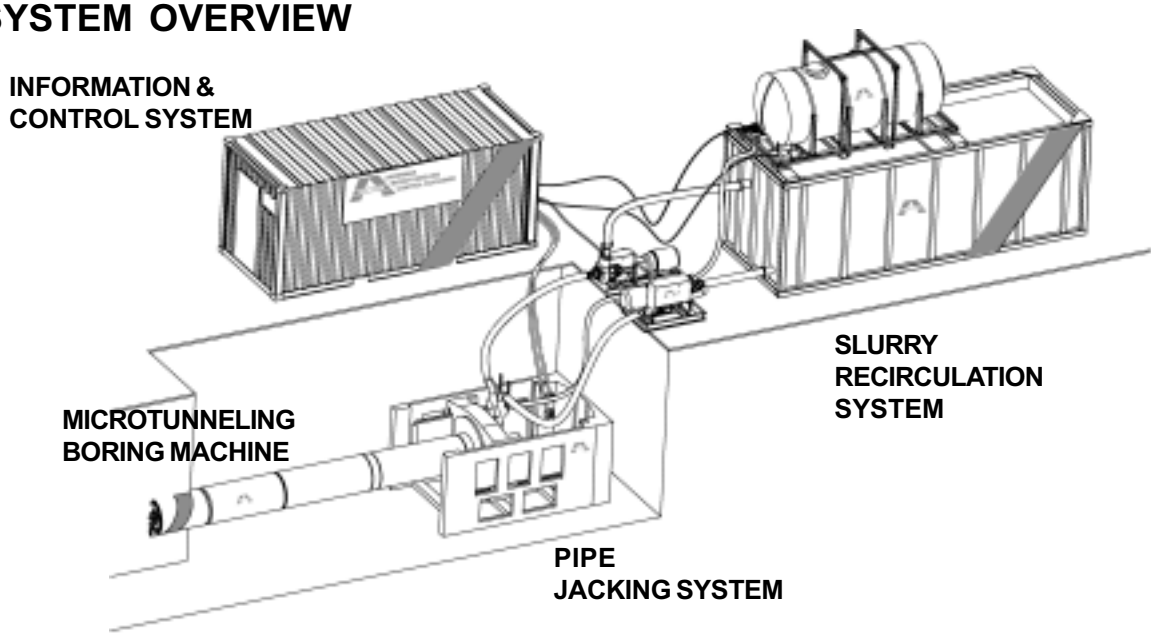
Operation

OPERATING GUIDELINES

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

1. Before operating, read and understand the Safety, Pre-Start Inspection, Operation and Maintenance sections.
2. Do not operate this equipment while under the influence of alcohol, drugs, or medication.
3. Follow all Federal, State, and Local safety regulations and procedures.
4. Be sure OSHA prescribed safety protective equipment is being worn by all personnel.
5. Be sure the area is safe for operation. Keep worksite clean and orderly.
6. NEVER operate equipment if it has been engulfed with water. Contact your Akkerman Product Support representative for proper procedures on how to restore equipment for operation.
7. Have a fully charged fire extinguisher 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 cane operator when lifting and lowering equipment into the launch or reception shafts.
12. Never walk or work under any part of the excavator or crane and suspended loads.
13. Test each function and control to make sure they work properly.
14. Lock out electrical power at the source (generator) before servicing electrical components.
15. Do not make any modifications to any Akkerman products. Doing so could cause structural failure and will void the warranty.
16. Check shields and guards. All must be in place and undamaged.
17. Test the Emergency Stop circuit 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. Start the equipment from the control container operator's station only.
20. After start-up, observe all gauges, controls and warning devices to assure they are functioning properly and their readings are within the operating range.
21. Never leave the operator's station without first releasing hydraulic pressure, performing daily system shutdown, and disconnecting the main power supply.
22. Lock out the main disconnect and attach a DO NOT OPERATE tag or similar warning tag to the main power disconnect before performing maintenance.
23. 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.
24. Never operate jetting pump or cooling pumps without fresh water supply.
25. Check cable for continuity and shorting before each use. Do not pull or strain cables; doing so will result in damage.

SYSTEM OVERVIEW



Microtunneling Boring Machine
The purpose of the MTBM is to excavate material at the cutter face and guide (steer) the pipe through the ground. The MTBM is split in half (thirds on small diameter MTBMs) to minimize the size of launch shaft required. The front half of the MTBM is called the starting section. The starting section performs the excavation and steering. The second half of the MTBM is the trailing section. The trailing section features a small on-board hydraulic power pack, control system for the MTBM, camera, submersible pump, and stabilizer wing (dirt wing). Larger diameter MTBMs may also include a slurry booster pump in the trailing section.

MTBM diameters may range in sizes from approximately 24 inches through 90 inches outer pipe diameter. Ground conditions can range from dry to saturated with water, fine-grained to gravel, and loose soil to soft rock. Although consistent ground conditions work the best, the MTBM will cut through layers of different types of soil. The machine will also tolerate soft rocks that are up to 1/3 the diameter of the machine.

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

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

Pipe Jacking System
The pipe jacking system (jacking frame and optional intermediate jacking) 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, or 800 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 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, etc.

The control container contains the control console, power distribution, hydraulic power 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's progress and reports can be printed for contractor or engineering firm records.

RECOMMENDED TOOLS & EQUIPMENT

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

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

SITE PLANNING

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

Equipment:

- MTBM
- Slurry Separation System
- Crane
- Portable Toilet
- High Pressure Jetting Pump
- Pipe Lubrication Pump
- Jacking Frame
- Slurry Pumps (Feed & Return)
- Fork Lift
- Portable Welders
- Small Generator
- Spoil Removal Truck
- Control Container
- Drive Motor Cooling Water Tank
- Storage Container With Tools
- Generator Or Power Source
- Slurry Reversing or Bypass Valves

Other site considerations:

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

SITE PREPARATION

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

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

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

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

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

6. Lower the jacking frame into launch shaft. The frame elevation can be adjusted to grade by the jacks on the bottom of the frame. Be sure there is at least 6 inches between the front of the jacking rails and where the launch seal will be located.

7. Connect the jacking frame hydraulic hoses, electrical cables and pit box. Cover sharp corners to prevent damage to the cables and hoses.

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

9. Lower the return pump into launch shaft. The return pump should be mounted as close as possible to the jacking frame so the booster pump (not used with 24” and 30” MTBMs) does not have to generate excessive horse power. Be sure to allow for hose swing as the thrust ring travels on the jacking frame.

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

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

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

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

14. Connect the cooling pump, jetting pump and the lubrication system to the pit manifold.

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

16. Connect the cooling pump and jetting pump to the bulkhead on control container.

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

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

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

20. Connect all electrical cables and hoses including the MTBM front, mid, and trailing sections.

21. Connect the 150 ft starter hoses and cable between the MTBM starting, mid, and trailing sections.

22. Perform system start-up. Refer to System Start-Up in this section.

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

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

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

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

CHECKOUT EQUIPMENT PRIOR TO START-UP

1. Fill the grease pump in the MTBM.

2. Fill the drive motor cooling tank with fresh water.

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

4. Check the MTBM main drive bearing oil level.

5. Check the MTBM gear reducer oil level.

6. Test the MTBM submersible pump float switch.

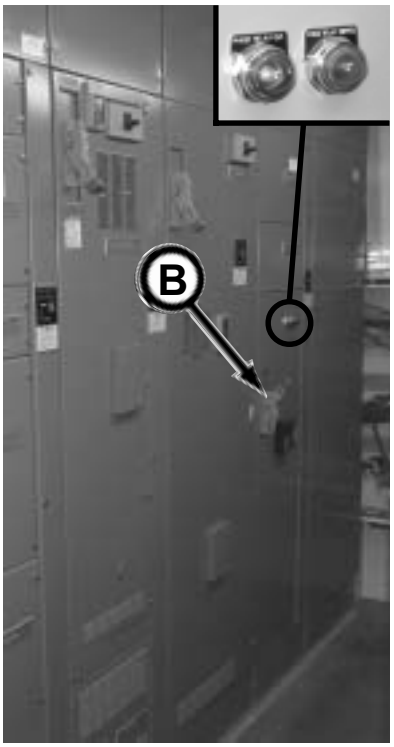
7. Check the container power pack hydraulic oil level,

8. Fill the slurry tank(s) with water.

9. Check the full load amperage setting from boring head starter, booster pump starter, boring head VFD, and if applicable, the booster pump VFD.

SYSTEM START-UP

1. With main disconnect in control container OFF, hook up generator to generator power connectors (A) on bulkhead.



2. With the generator power ON and all control container disconnect switches OFF, check the phase relay lights (see inset). If the green Phase Relay OK light is ON, flip the main disconnect switch up to the ON position.

NOTICE If the red Phase Relay Tripped (see inset) light is ON, the generator phase power is installed incorrectly. Reverse two generator power leads, such as the red and black leads, on bulkhead. Disconnect all power before attempting to rework the generator power.

3. Flip other disconnects to the ON position as needed.

4. Open the computer/printer cabinet. Turn ON surge protector.

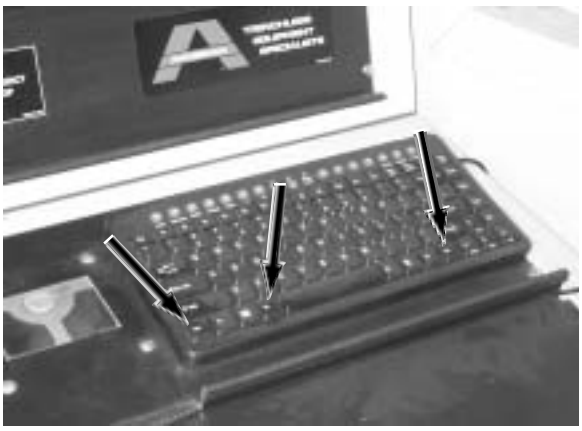
(continued on next page)

5. Turn ON UPS.

6. Turn ON intercom system.

7. Turn ON computer. (Gain access to computer power switch by flipping door down.) It will take a few minutes for the computer system to boot up.

8. Once the CTRL + ALT + DEL window appears, depress the CTRL + ALT + DEL keys on the keyboard.



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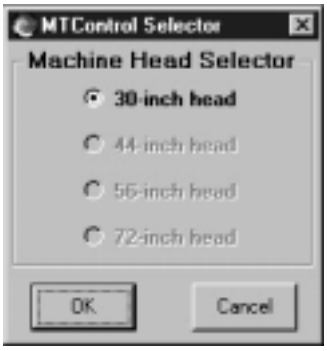
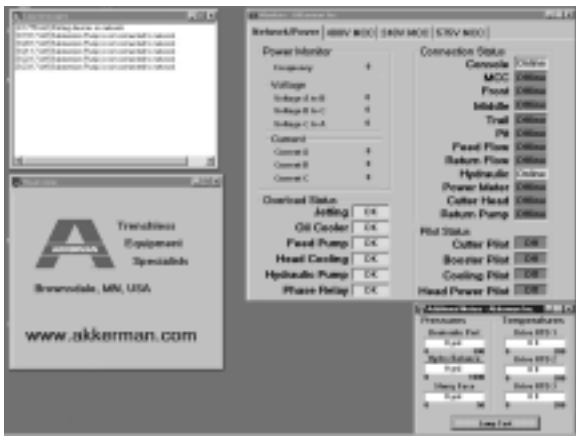
9. When the logon window appears, type “akkerman” in the user name field and leave the password field blank. This logon can be changed if desired.

10. Click OK.

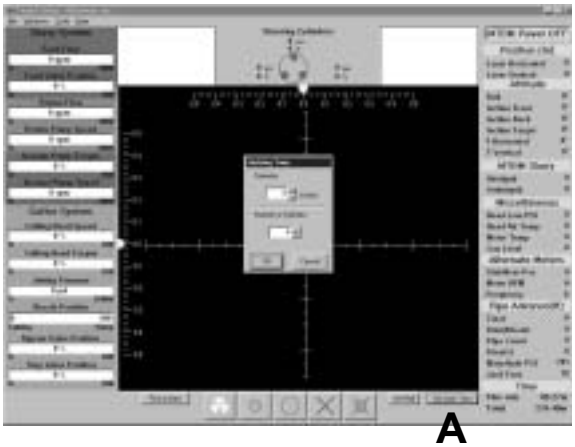
11. The MT Control Selector window appears. Select your MTBM head size and click OK.



12. After program loads, you must also load the camera devices. Double click Head Camera icon and Pit Camera icon from the desktop. These windows will appear on the right monitor.



13. To properly calculate and display the jacking tons for the jacking frame being used, click the “Set Jack Tons” button (A) and enter the jacking frame cylinder diameter and the number of cylinders on the jacking frame. Click OK.



MTBM LAUNCH SEQUENCE

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

2. With the Slurry Flow system in the default mode of Sequence, press the OPEN button on the Slurry Bypass control. In the Sequence mode, the operation for the bypass and stop valves will be automatic.

For example, press OPEN button on Slurry Bypass will automatically CLOSE the stop valves. Press OPEN button on SLURRY STOP will automatically CLOSE the slurry bypass valve.

3. On the control panel, start the Feed Pump, Booster Pump (if used in the circuit), and Return Pump by turning the controller clockwise.

    - Set flow rates to low (approx 100 GPM) and check for leaks.

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

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

4. Lubricate the launch shaft seal.

5. Start hydraulic pump.

5. Start jacking by turning the selector switch to EXTEND and turn the Hydraulic Pump Flow control to the right to control the pump rate about 25%.

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

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

    - Stop jacking if pressure rises quickly.

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

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

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

8. Press the Slurry Stop OPEN button. The valves automatically sequence to stop valves open and bypass valve closed.

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

9. Set the cutting head speed at about 10%. Press Cutting Head button to LEFT or RIGHT.

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

    - The high pressure jetting pump should be turned OFF while jacking front section.

(continued on next page)

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

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

12. Refer to Pipe Change in this section to place the mid and trailing sections in the jacking frame.
    - Exchange the 6 pin 150' TBM starter cable with a 9.5' or 5.5' cable as needed.

    -Remove MTBM hydraulic starter hoses, reconnect lines.

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

    - While jacking the mid or trailing sections, the high pressure jetting pump may be used if shaft seal leakage does not occur.

13. Advance the section.

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

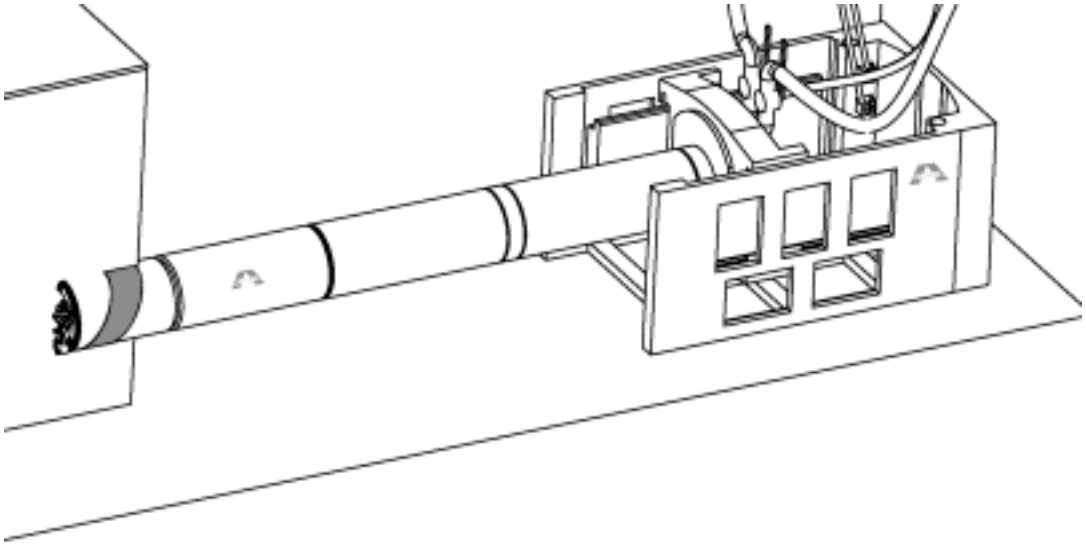
15. Refer to Pipe Change in this section, to place the first pipe in the jacking frame.

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

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

16. Install subsequent pipe.

ADVANCING THE MTBM



To begin tunnel excavation:

1. With the slurry stop valves closed and bypass valve open, start the slurry feed pump, booster pump (if used), and return pump. Too much slurry flow will cause over excavation.

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

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

2. Press Slurry Stop OPEN button.

3. Press Cutting Head LEFT or RIGHT button and set cutting head speed - 90 % is a good operating point. Reduce jacking speed to reduce torque. Watch forces.

    - The cutter head works equally well in both directions.

    - Watch for machine roll. If it exceeds 5 degrees, reverse the cutting head rotation. Extending the stabilizer cylinder (dirt wing) will help minimize roll, though jacking forces will increase slightly.

    - Cutter head rotation can be reversed without pressing cutting head STOP button.

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

4. Advance jacking frame forward by pressing selecting EXTEND on selector switch and setting a hydraulic flow rate with Hydraulic Pump Flow control.

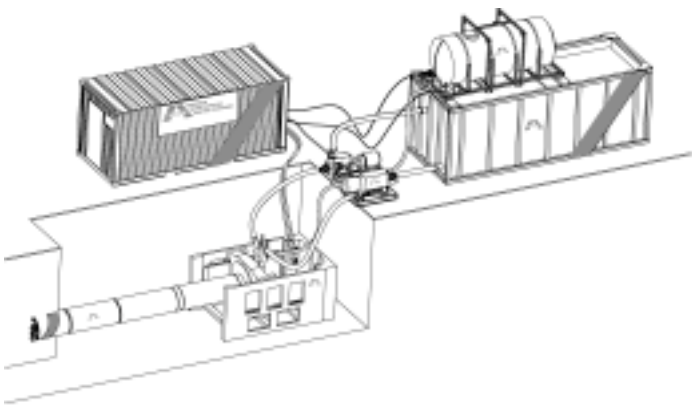
TO PAUSE TUNNELING

1. Move Selector Switch to STOP.

2. Press Cutting Head button to STOP.

3. Press Slurry Bypass OPEN button. Be sure slurry valves have cycled. Operator should NEVER leave operator station with tunneling machine running

CONTROLLING SLURRY



I. SLURRY FLOW

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

Slurry Flows:

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

2. Typically the slurry booster pump is set at a speed higher than the return pump. The return pump is normally operated slightly faster than the feed pump. Slurry pump speeds vary with soil condition. A starting point would be to increase the pump speeds until the booster pump torque is at about 90%.

3. Use Cutting Nozzle OPEN button to direct more water to the face and less water to the chamber of the MTBM in clays. Use Cutting Nozzle CLOSED button to direct more of the water to the slurry chamber and less water to the cutting nozzle in sands.

4. Operate the machine so that the slurry outlet pressure is less than 5 psi above the ground water pressure. In MTBMs that have the slurry outlet pressure transducer mounted between the slurry chamber and the stop valve, the ground water pressure is measured by shutting off the slurry pumps, closing the stop valve and reading the slurry outlet pressure. The water table should provide a pressure of about 1/2 psi per foot. Therefore, multiply the psi times 2 to get the height of the water table above the machine. This is a check to see if the reading is reasonable.

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

II. SLURRY BYPASS

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

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

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

(continued on next page)

III. CLEARING CLOGGED SLURRY LINES

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

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

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

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

IV. REVERSE SLURRY FLOW IN MTBM

Reverse slurry flow to flush out the crushing chamber, slurry chamber, and MTBM slurry lines. Reverse slurry flow must be performed when:
• Slurry bypass and cleaning clogged slurry line procedures have failed to achieve high flow rates.
• High flow rates are achieved in slurry bypass, but return flow rate is low during tunneling (slurry chamber, crushing chamber, or slurry lines between bypass valve and slurry chamber are clogged).

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

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

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

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

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

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

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

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

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

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

(continued on next page)

V. USING ABOVE GROUND BYPASS VALVE

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

1. Press Cutting Head STOP button.

2. Move Selector Switch to STOP position.

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

4. Open the slurry above ground bypass valve.

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

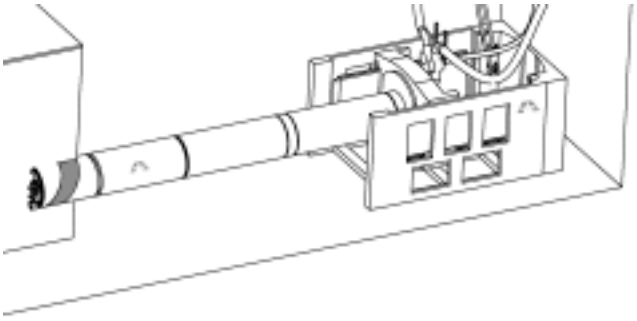
6. Start the feed pump. DO NOT start the booster or return pumps. The flow path does from the settlement tank to the feed pump, followed by the slurry feed flow metered and the above ground bypass, then return flow meter and back to the settlement tank.

CUTTER HEAD OPERATION

1. Jacking flow rates can be increased until the drive torque is between 80% and 100%. Ninety percent is a good operating point. Reduce jacking speed to reduce torque.

2. The cutter head works equally well in both directions.

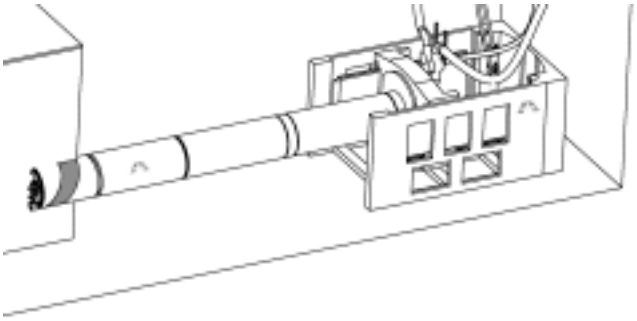
3. Watch for machine roll. If it exceeds 5 degrees, reverse the cutting head rotation. Extending the stabilizer cylinder (dirt wing) will help minimize roll, however, jacking forces will increase slightly.



4. Cutter head rotation can be reversed without pressing Cutting Head STOP button.

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

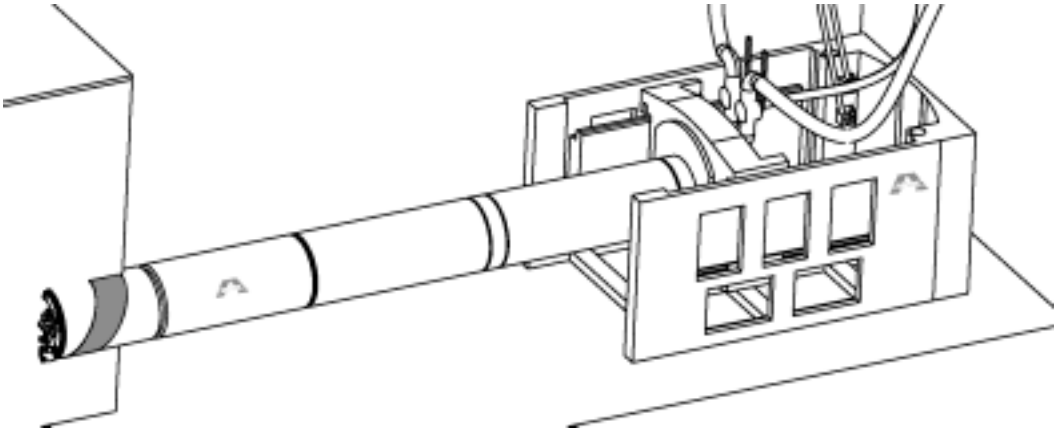
RELEASING A SEIZED CUTTING FACE



1. Retract the main jacking cylinders slightly to release the jacking pressure.
2. Move Selector Switch to STOP position.
3. On right screen, press Main Hydraulic STOP button.
4. Start the slurry feed pump, booster pump (if used), and return pump.
5. Press Slurry Stop OPEN button.
6. On right screen, press Jetting Pump AUTO position.
7. Reverse rotation several times by pressing Cutting Head LEFT and RIGHT buttons.
   If unsuccessful, press Cutting Head STOP button and press Slurry Bypass OPEN button.
8. Make note of top, left, and right steering cylinder positions (on target screen).
9. Press the Top Cylinder, Left Cylinder, and Right Cylinder EXTEND buttons until the cylinders are fully extended.
10. Press the Top Cylinder, Left Cylinder, and Right Cylinder RETRACT buttons until the cylinders are fully retracted.
11. Press the Slurry Stop OPEN button.
12. Reverse cutter head rotation by pressing the Cutting Head LEFT and RIGHT buttons several times.

    • If cutter head becomes free, return steering cylinders to their previous positions while cutter head is rotating.
    • If unsuccessful, press Cutting Head STOP button and Slurry Bypass OPEN button and repeat steps 4 through 12.

JACKING OPERATION GUIDELINES



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

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

3. Increase main pump rate (Hydraulic Pump Flow control) to increase cutter head torque, jacking speed and jacking pressure.

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

5. Maintaining proper grade and alignment of the tunnel to ensure low jacking pressure.

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

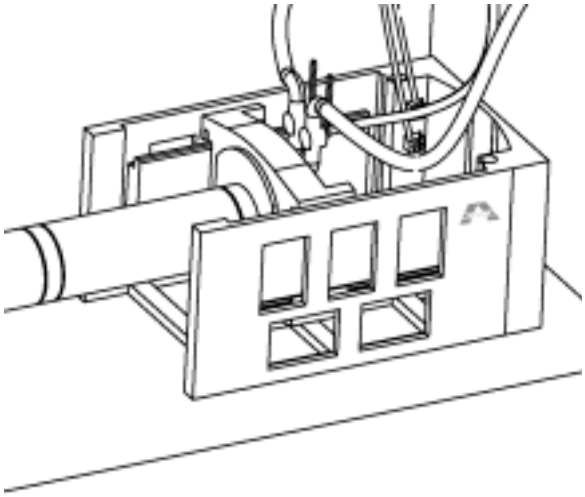
7. Do not allow steering pressures to rise above 3000 PSI for soft ground. Reduce advancement rate, increase cutting nozzle flow (increase feed pump speed) or increase cutter head rotation speed to reduce pressure.

OPERATING MT-340, MT-400, MT-460, AND MT-866 JACKING FRAME

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

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

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



4. By communicating with jacking shaft worker, ensure that all position locking blocks (dogs) align with pockets of an equal relationship on either side of the frame.

5. Turn Selector Switch to EXTEND to start forward thrust and use the Hydraulic Pump Flow control to set speed rate.

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

6. Once the jacking cylinders have reached full extension:
   a. Turn the Selector Switch to STOP position.
   b. Press Cutting Head STOP button.
   c. Press Slurry Bypass OPEN button.

7. Repeat steps 2 through 6 for the entire length of the pipe and the locking ring is at the end of the jacking frame.

8. To retract the locking ring, release thrust pressure by turning the Selector Switch to RETRACT position and set flow rate to 50%. Turn the Selector Switch to STOP position when retraction is completed, release and pin position locks and turn the Selector Switch to AUX position to provide flow to the locking ring travel valve. The manual valve on the jacking frame is then used to travel the locking ring to the back of the jacking frame. Use caution when retracting the locking ring away from the pipe joint to prevent pipe damage.

9. Press Main Hydraulic STOP button.

10. Remove the pins from the position locks, install pipe (per Pipe Change in this section), and repeat the above procedures.

USING INTERMEDIATE JACKING STATIONS (IJS)

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

1. Turn Selector Switch to STOP.

2. On IJS Valve Selection on right screen, click 1.

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

4. Press Main Hydraulic START button.

5. Press Slurry Stop OPEN button.

6. Press Cutting Head LEFT or RIGHT button and set cutting head speed.

7. Turn Selector Switch to IJS. Use Hydraulic Pump Flow control to set flow rate.

8. When the IJS rams are fully extended, turn Selector Switch to STOP position.

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

10. On IJS Valve Selection, click 2.

11. Repeat steps 3 through 9.

12. Set the IJS Valve Selection screen to the next highest number.

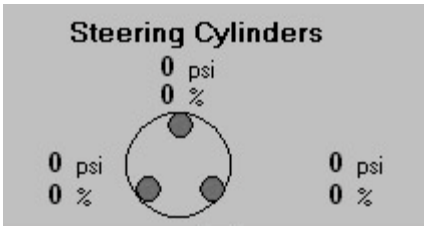
13. Repeat procedure until all intermediate jacking stations have been extended.

14. Reset IJS Valve Selection to None.

15. Extend jacking frame.

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

STEERING GUIDELINES & OPERATION



1. Steering should be carefully executed with small corrections made over many feet.

2. Watch the inclinometers to get an idea of their values for a straight run and set the pointers on the side of the target.

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

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

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

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

PIPE CHANGE

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

1. Press STOP on Cutting Head control.

2. Perform slurry bypass:

   - Turn selector switch to STOP.

   - Press OPEN button on by pass valve. Slurry stop valves will close in sequence mode.

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

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

3. Turn the slurry return pump, booster pump (if used), and feed pump controls to 0.

4. Turn OFF disconnects in the control container for the slurry pumps, boring head, head power, and tunnel light.

5. Close the slurry, cooling water, bentonite (if used), and high pressure jetting valves on the jacking frame manifold.

6. Disconnect all the hoses and cables going into the pipe being jacked.
   - Make sure all the cables and hose connections are in a clean, dry location and out of the way of the next pipe.

7. Retract jacking frame.

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

9. Clean connections and connect slurry lines between the pipes.

10. Install cables and hoses through the new pipe.

11. Clean connections and connect cables and hoses.

12. Open the slurry, cooling water, bentonite, and high pressure jetting valves on the jacking frame.

13. Slowly advance the new pipe until it is seated in position.

14. Turn ON disconnects for the slurry pumps, boring head, head power, and tunnel light.

15. Turn the slurry feed pump, booster pump (if used), and return pump output controls to the right.

    - Check slurry lines for leaks and the separation system for proper operation.

16. Repeat installation for subsequent pipe.

HIGH PRESSURE JETTING PUMP OPERATION

The high pressure jetting pump can increase production in clays and other sticky material. The pump should not be used in other ground conditions except to be turned on periodically to keep the nozzles clean.

The jetting pump controls are located on the control screen:

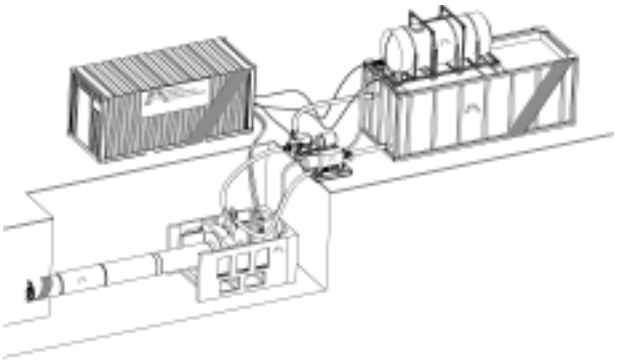
1. The START button will start the high pressure jetting pump and will remain on until the STOP button is pressed. The message “Jetting Pump” will appear on the target screen operational message window to indicate that the jetting pump is on.

2. The AUTO button will energize the high pressure jetting pump only when the cutting head LEFT or RIGHT button is selected. The message “Jetting Pump” will appear on the target screen operational message window to indicate that the jetting pump is on.

3. The STOP button will shut the high pressure jetting pump off.

The high pressure jetting pump and drive motor cooling pump automatically turn off if the water tank level drops below minimum.

DAILY SHUT DOWN



1. Stop jacking frame extension by turning the Selector Switch to STOP position and turn off the MTBM drive motor by pressing the Cutting Head STOP button.

2. Open the MTBM bypass valve by pressing Slurry Bypass OPEN button and close the stop valves by pressing Slurry Stop CLOSE button.

3. Flush water through the lines until clear.

4. Shut off the slurry pumps by turning the Feed Pump control CCW until it is stopped. The booster pump and return pump will automatically shut off when the feed pump is shut off.

5. Close the valves on the manifold at the jacking frame and supply tanks (if used).

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

7. Turn off head power.

8. Shut off all disconnects.

9. Shutdown the computer.

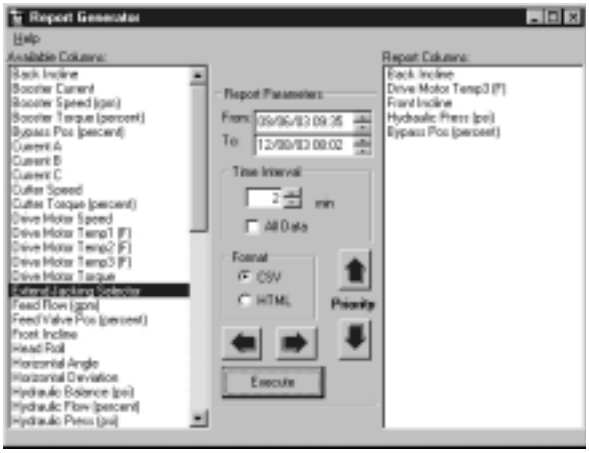
10. Shut off main power disconnect or turn off the main power source.

USING THE REPORT GENERATOR

1. Double click the Report Generator icon on desktop.

2. In the Report Generator window, the left column “Available Columns:” is a list of all the data variables (54) available for your report. The right column “Report Columns” is a list of the data variables you selected for your report.

3. To select the variables for your report, do one of the following:



a. Double click the variables in the Available Column that you want to appear on your report. The selected variables will now appear in the Report Column.

b. Or select the desired variables in the Available Column (use the Ctrl button to select multiple variables), then click the right arrow to add the selected columns to the Report Column.

If you have a variable in the Report Column that is not needed, select the variable and click the left arrow. This will remove the selected variable from the Report Column.

4. If necessary, reprioritize the variables in the Report Column, by selecting a variable and clicking the up or down Priority arrows. The top variable will appear on the left hand column of the report.

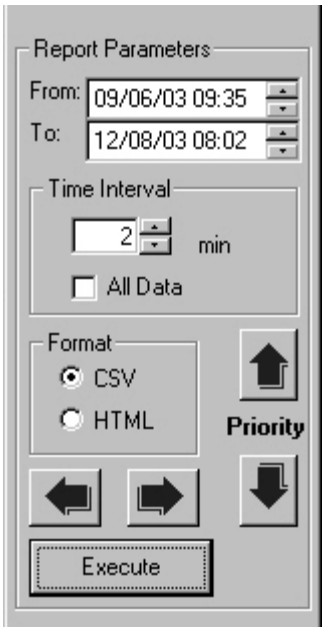
(continued on next page)

5. Modify the date and time parameters. Modify parameters by either clicking the month, day, year, hour, or minute fields and type in the desired number, or click one of the fields and use the up and down arrows to change the numbers.

6. Modify the Time Interval by either selecting the field and typing in the desired time (2 through 20 minutes), or clicking the up or down arrows. The default time is 2 minutes.

NOTICE Data is logged every 15 seconds.

If you click the All Data box, the report will ignore the time interval and print the report for all logged data within your selected date and time parameters.



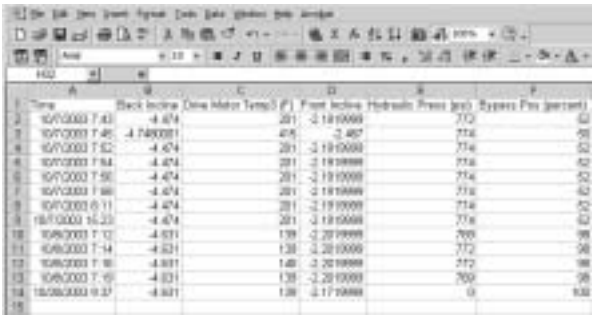
7. Select your desired report format.

The CSV (Comma Separated Value) selection is a spread sheet program format and will open in Microsoft Excel.

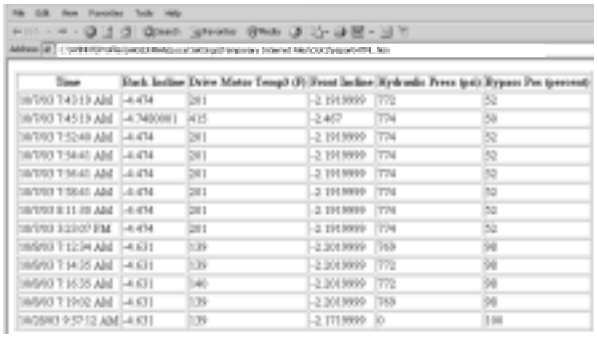
The HTML (Hyper Text Mark Up Language) selection is a web browser program format and will open in Microsoft Internet Explorer.

8. Click Execute button. The report is generated and will automatically open your CSV or HTML program in the right monitor.

9. Save or print your report from the program. If a print out of the report is needed, confirm that the printer is on and that paper is loaded into the paper tray. Print your report from the program.



CSV Format In Excel



HTML Format In Internet Explorer

TRANSDUCER CALIBRATION

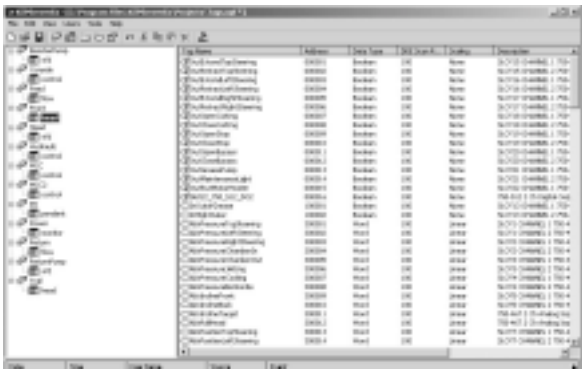
Transducer calibration is performed at the factory and should not be required in the field. There are cases when adjustments to the linear transducers may require calibration. If the stop valve, bypass valve, steering cylinders, stabilizer or cutting nozzle valves are repaired or replaced, the components will require recalibration so the steering cylinder or valve positions will be properly monitored. The calibration is performed through the Kepware Server software. This software collects and rewrites data to and from the device components and is then communicated to the operator in the control container.

1. Double click KEPServerEx icon to start the calibration program.

2. The left hand column displays the devices that are communicated with the Kepware software.

3. Click the desired component that requires calibration. The right column will display the components of the device.

4. Double click the component that requires calibration. This will display the Tag Properties window.



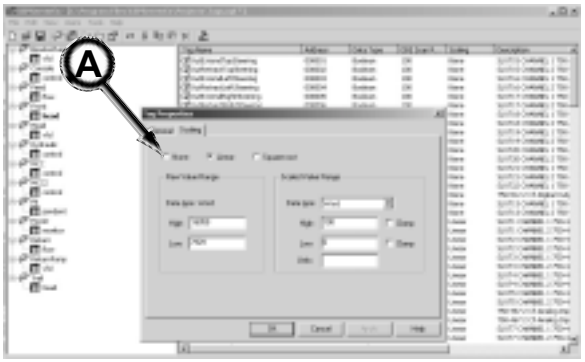
5. In the Tag Properties window. Click the Scaling tab.

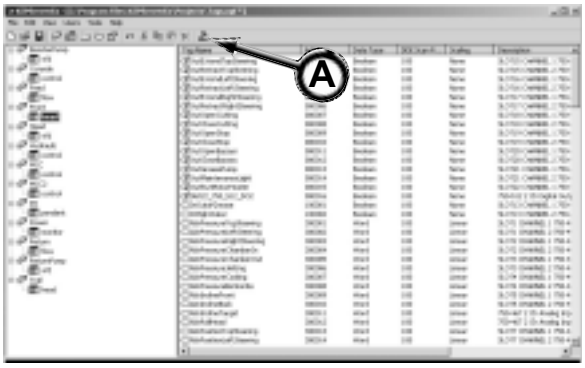
6. Click the None button (A).

NOTICE You may want to record the Raw Value Range and Scaled Value Range settings in case you need to reinput these values.

7. Click OK.

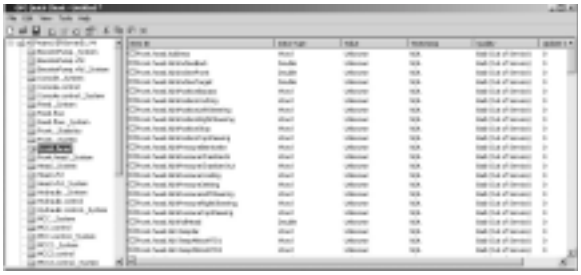
8. Close the Kepware program.





9. Restart Kepware.

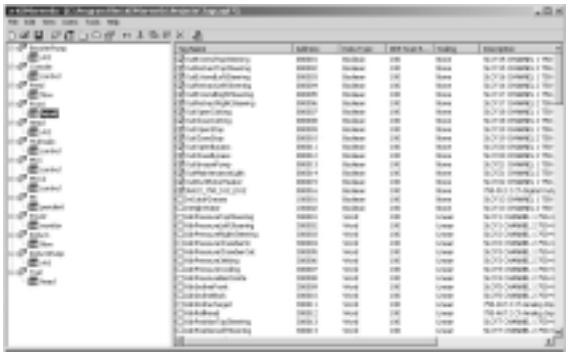
10. Click Quick Client icon (A).



11. Click on device on left column.

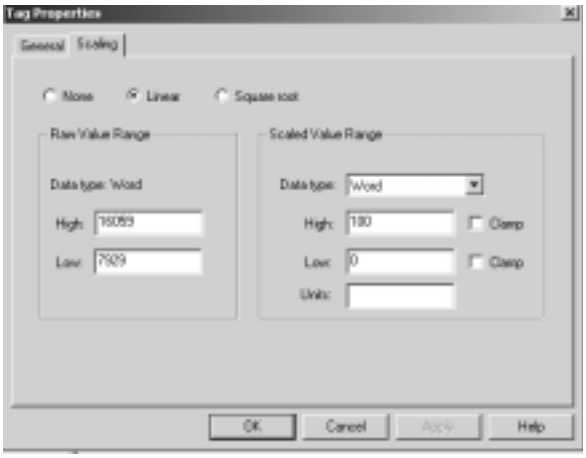
12. Operate device and record the low and upper limits of the device. Use the Calibration program to assist in gathering the calibration data (see Supplementary Editor Programs in this section).

13. Close Quick Client.



14. Click on device.

15. Double click component to display the Tag Property window.



16. Click the Scaling tab.

17. Click Linear.

18. Input the Raw Value Range data you recorded in step 12.

19. In the Scaled Value Range:
    a. Select Data type: Word for integer (whole number) or Double for floating point
    b. Input your High and Low values. Linear transducers are measured from 0 to 100%.

20. Click Apply.

21. Click OK.

22. Restart Kepware. The device is now calibrated.

SUPPLEMENTARY EDITOR PROGRAMS

There are five supplementary editor programs that determine the metering and monitoring of the MTBM devices. The programs consist of constant values and dynamic variables.

The constant values are factory set and should not be changed since they are the value characteristics of the machine make-up and design. The constant values are loaded into the program at system start-up when you select the size of your MTBM in the MT Control Selector window. If the constant values are changed, erroneous data will be calculated, resulting in improper monitoring of the MTBM position.

The dynamic variables, are variables that can be changed by the operator to help in the visual metering and monitoring of the MTBM.

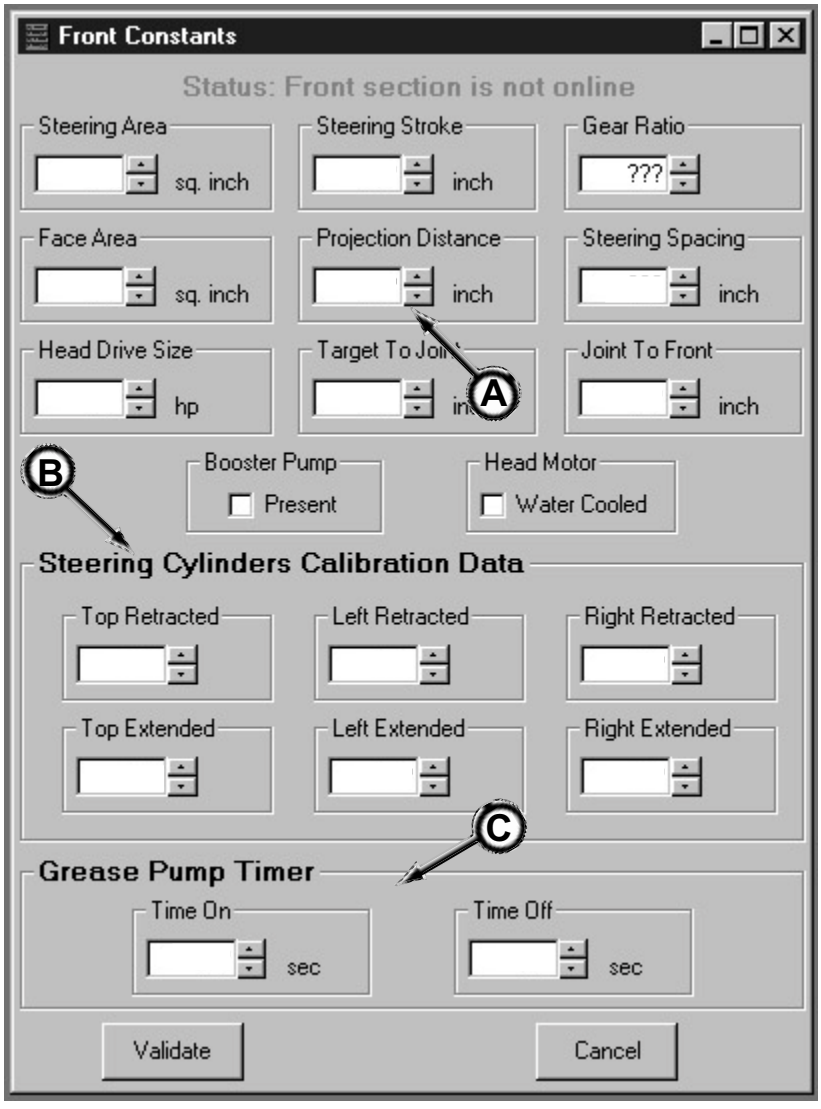
1. Front Editor 

This editor is used to calculate the position of the cutting head during the tunneling operation. Most of the fields in this editor contain constant values such as steering stroke, head drive size. etc. These are items that should not be changed since they are the design specifications of the MTBM. Below are the dynamic variables in this editor.

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

b. *Steering Cylinder Calibration Data* (B): if recalibration is required, the new data (from the Calibration program) must be entered in the appropriate fields and then click the Validate button.

c. *Grease Pump Timer* (C): The default timer settings are 12 seconds on and 48 seconds off. At this time, these values cannot be changed.



(continued on the next page)

2. Console Editor 

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

a. *Bypass, Cutting, and Stop Position*: indicates the percentage of which the valve positions are considered fully open or fully closed.

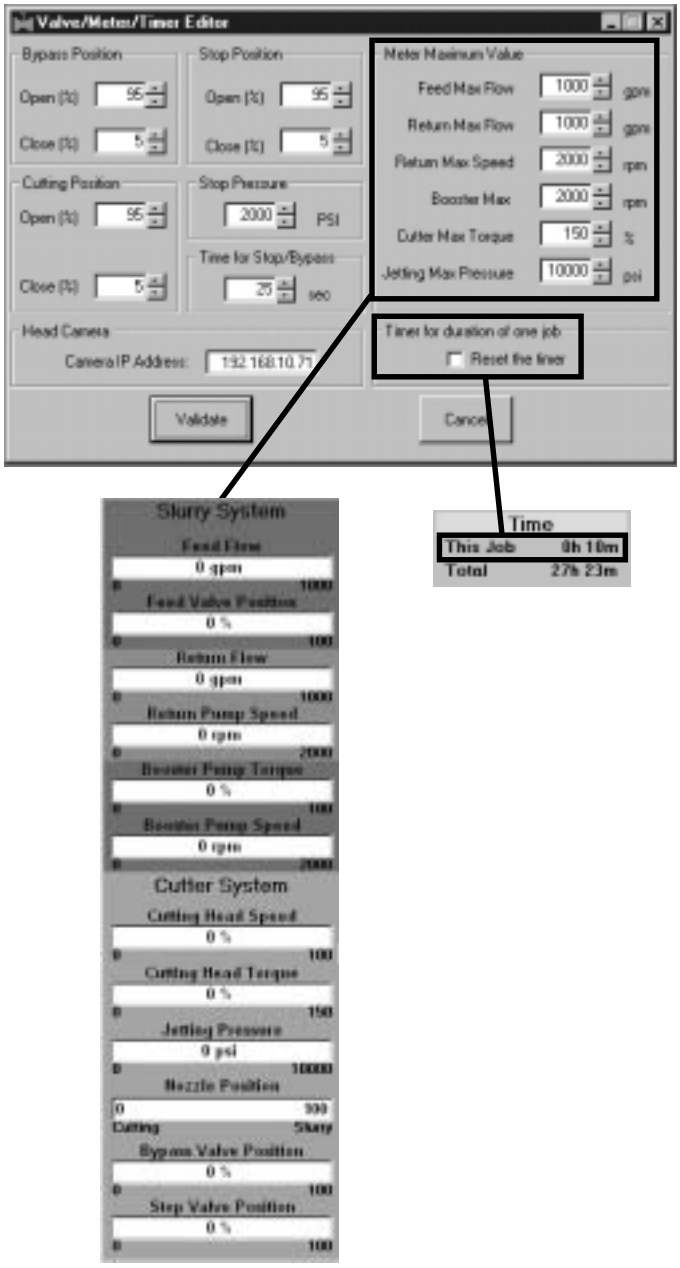
b. *Stop Pressure*: pressure at which the stop valve is open or closed.

c. *Time for Stop/Bypass*: the time it takes to recycle the stop or bypass valve. If the stop or bypass valve does not open or close in the allotted time, a message in the log window on the indicator screen will appear indicating that the valves did not open or close.

d. *Meter Maximum Value*: specifies the meter values on the target screen.

e. *Head Camera IP address*: identifier for the camera in the MTBM. Each device has a unique IP address, therefore, if the existing camera is replaced, a new IP address will be required.

f. *Time for duration of one job*: click this box to reset the “This Job” timer to 0.

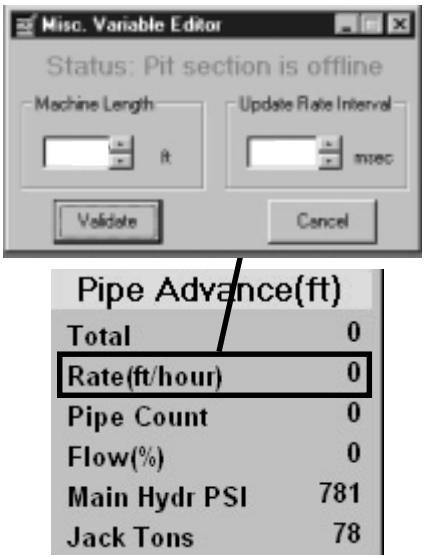


3. Misc Editor 

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

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

b. *Update Rate Interval*: this is the time interval in milliseconds to refresh the “Rate(ft/hour)” data on the target screen. One second equals 1,000 milliseconds.



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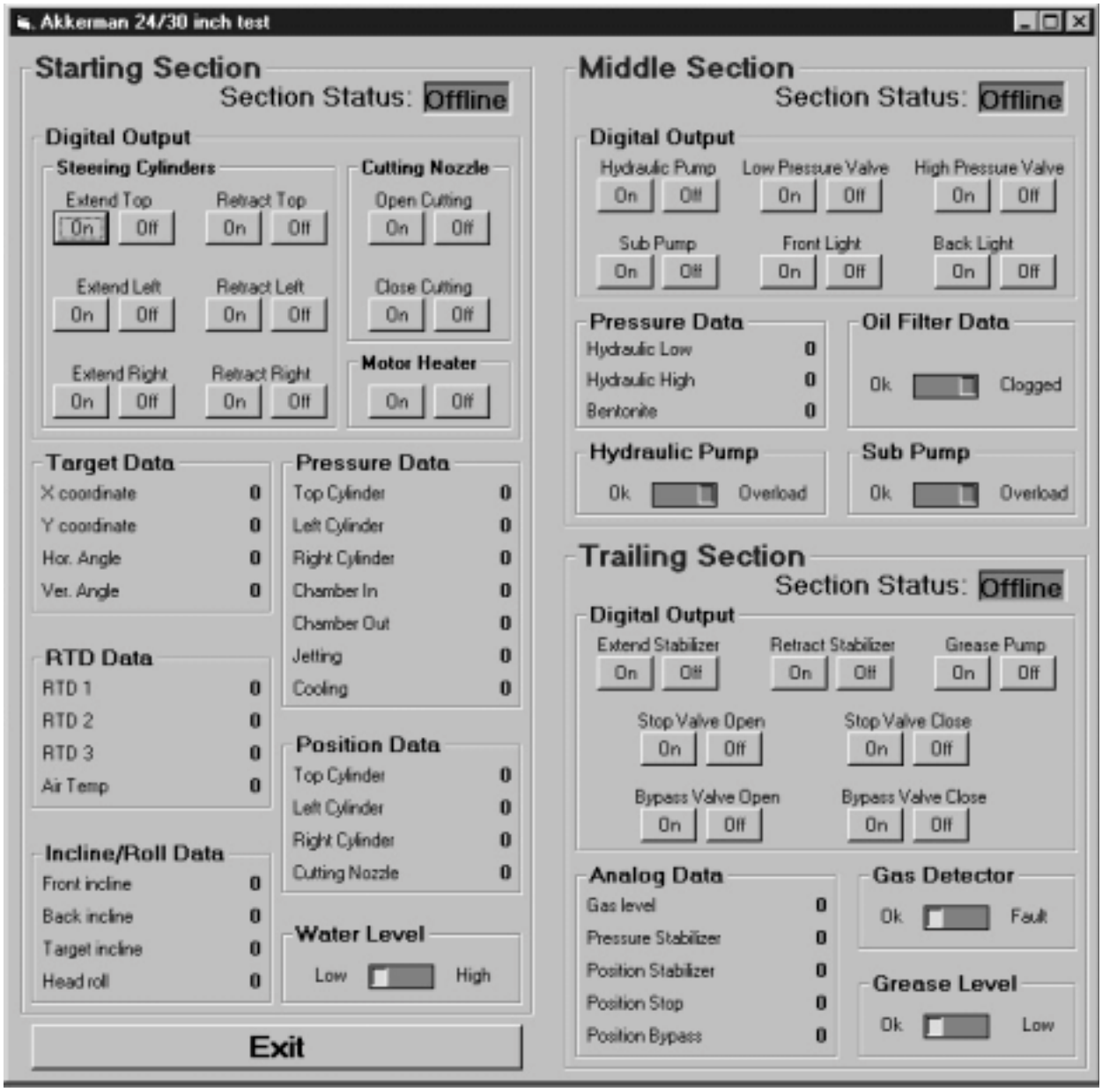
4. Test30 

This program is used for the maintenance and repair of the MTBM digital inputs and outputs, and analog inputs. The 30 in Test30, represents the size of the MTBM being used. This number will change depending on the size of your MTBM.



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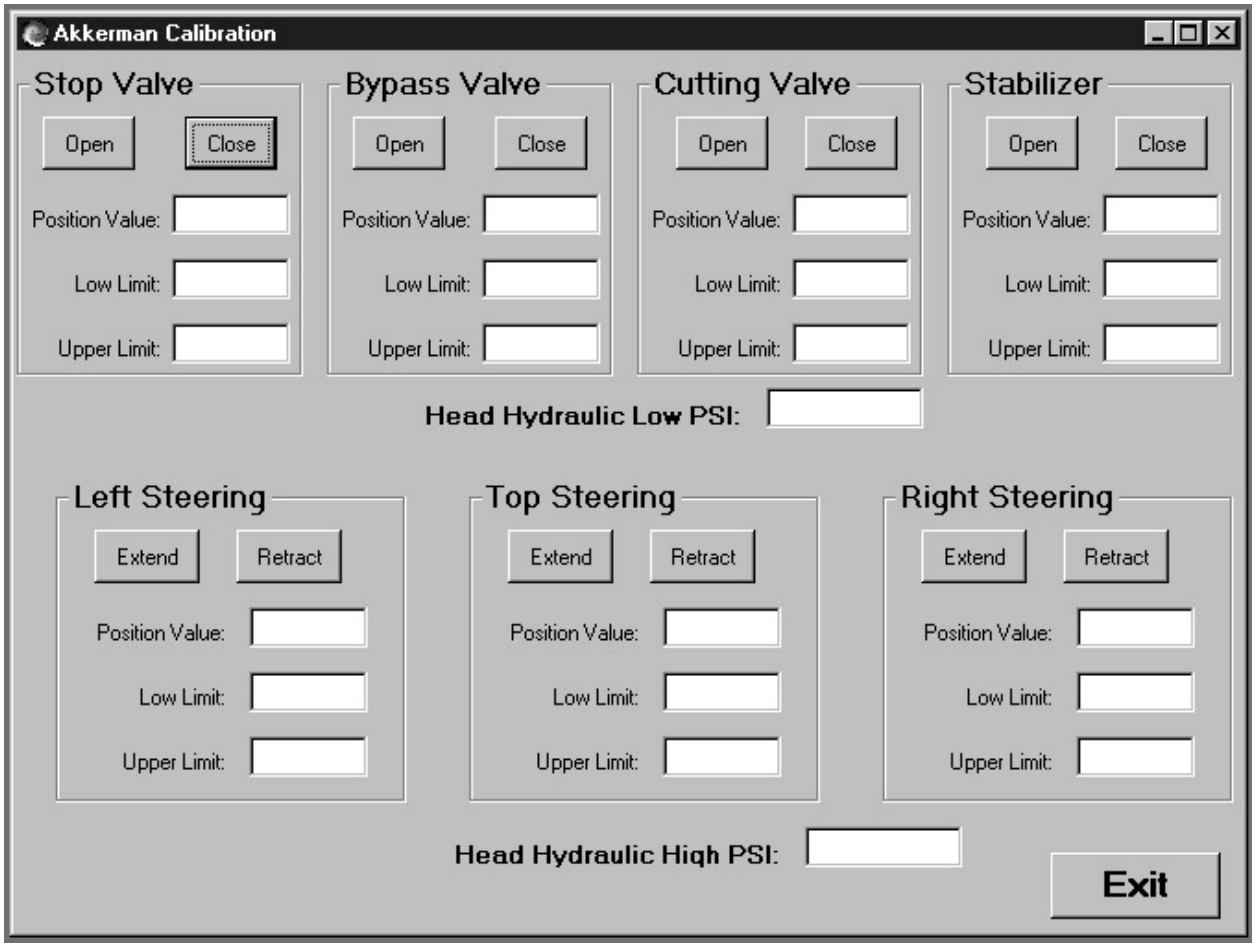
5. Calibration30 

This program is used to gather the calibration data for the steering cylinders and the stop valve, bypass valve, cutting valve, and stabilizer wing. The upper and lower limits must be entered into the Kepware Server program so the cylinder or valve positioning will be scaled properly. The steering cylinders low and high limits must also be entered into the Front Editor program.

The 30 in Calibration30, represents the size of the MTBM being used. This number will change depending on the size of your MTBM.

a. *Stop Valve, Bypass Valve, Cutting Valve, and Stabilizer*: hold the open or closed button until the Head Hydraulic Low PSI rises quickly. Once the pressure rises, release the button to automatically place the value in the low or high limit value field. The value in the Low and High Limit field will be the values used for recalibration. The low limit is the closed position of the valve; the upper limit is the open position of the valve. The Position Value is the raw data received while running the device.

b. *Steering Cylinders - Left, Top, and Right*: hold the extend or retract button until the Head Hydraulic High PSI rises quickly. Once the pressure rises, release the button to automatically place the value in the low or high limit value field. The value in the Low and High Limit field will be the values used for recalibration. The low limit is the retract position of the cylinder; the upper limit is the extend position of the cylinder. The Position Value is the raw data received while running the device.



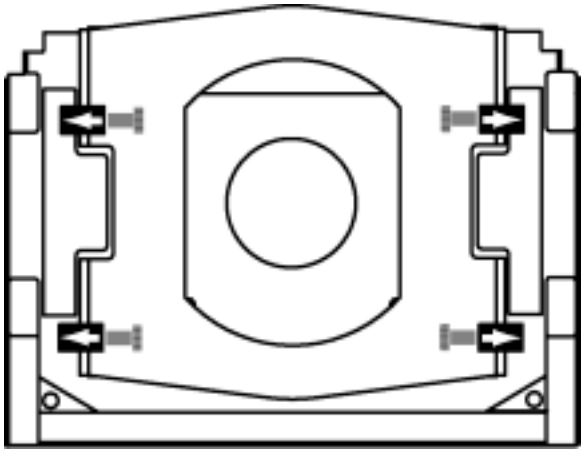
Transporting

TRANSPORTING GUIDELINES

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

Do not enter area under or around a load.

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

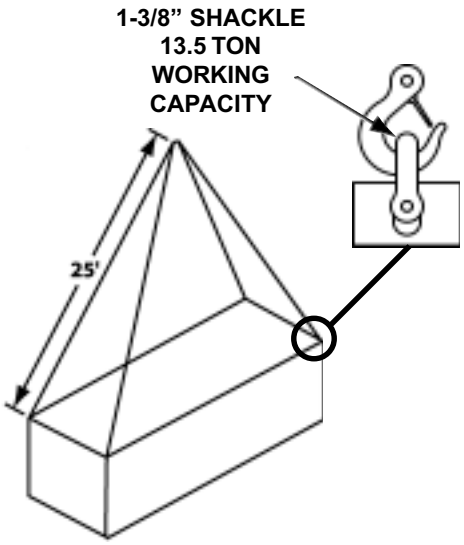


BEFORE disengaging the jacking frame hydraulics, engage ALL four dog blocks (with red bolts) into the jacking frame. If the four red bolts are extended, the dog blocks are not engaged.

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

1. Control Container



- Container weight, with no auxiliary gear is 24,000 lbs. (10,886 kg).

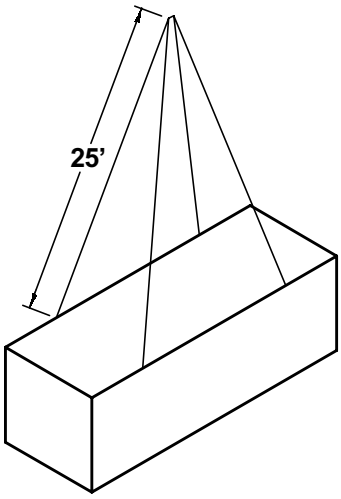
- Lifting with a crane requires a four part sling with legs a minimum of 25 ft. (7.62 m) long.

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

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

- All container doors must be closed before lifting.

2. Jacking Frame



- Base frame with thrust block (dogs engaged) must be picked up individually; with no extensions.

- Frame weight, with no auxiliary gear is 27,200 lbs. (59,965 kg).

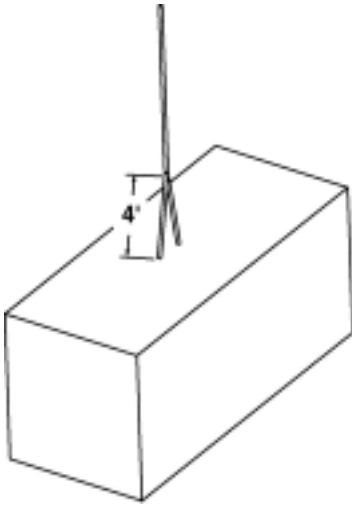
- Lifting with a crane requires a four part sling with legs a minimum of 25 ft. (7.62 m) long.

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

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

- Lifting eyes must be tightened snugly against threaded insert before lifting.

3. Cooling Water Tank



- Tank frame MUST be picked up empty.

- Frame weight, with no auxiliary gear is 2,200 lbs. (998 kg).

- Lifting with a crane requires a two part sling with legs a minimum of 4 ft. (1.22 m) long.

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

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

(continued on next page)

4. MTBM Sections - SL30

- Each MTBM sections must be picked up individually.

- MTBM front section weight is 9,000 lbs. (4,082 kg).

- MTBM middle section weight is 3,000 lbs. (1,361 kg).

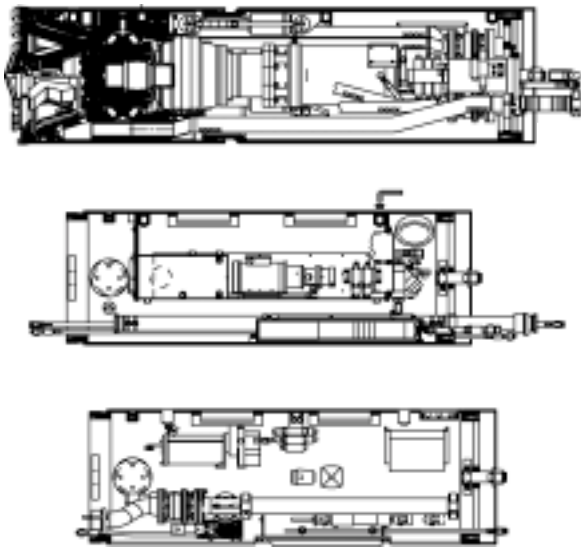
- MTBM trailing section weight is 3,000 lbs. (1,361 kg).

- Lifting with a crane requires a two part sling with legs a minimum of 6 ft. (1.83 m) long.

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

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

- Lifting eyes must be tightened snugly against threaded insert before lifting.



Lubricants

NOTICE Use of inferior lubricants can affect the efficient performance of your 5000 Jacking System. Always use high quality lubricants as specified in this section.
Refer to the Periodic Maintenance section for proper lubrication quantity, maintenance intervals, and procedures.

HYDRAULIC POWER PACK RESERVOIR LUBRICANT

The power pack reservoir is filled with ISO-VG-46 20W Premium Hydraulic/Turbine Oil.

Use an API GL-1/GL-2 or equivalent when adding or changing lubricant.

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

MTBM HYDRAULIC RESERVOIR LUBRICANT

The MTBM hydraulic reservoir is filled with Tellus® Plus Oil 32, a premium AW hydraulic oil.

Use Tellus® Plus Oil 32 or equivalent when adding or changing lubricant.

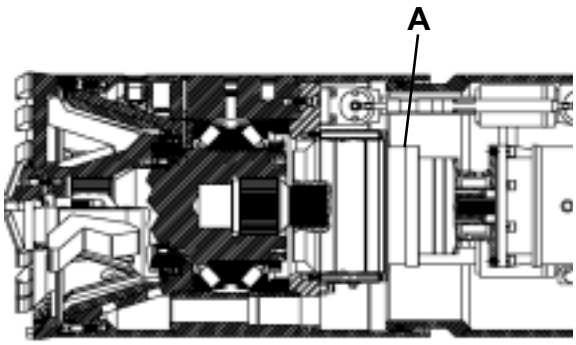
GREASE

The lubrication points are greased with Mobilgrease® XHP222 Premium Lubricating Grease.

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

Use Mobilgrease® XHP222 Premium Lubricating Grease or equivalent when lubricating the lubrication points.

DRIVE GEAR BOX



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

Use Mobil SHC 630 or equivalent when adding or changing lubricant.

NOTICE The Mobil SHC 630 Synthetic Bearing and Gear oil is a synthetic oil specifically designed for this application. If you change to a different oil, use a reputable oil supplier to meet or exceed the Mobil SHC 630 oil specification. Do not mix oil manufacturers or grades.

DRIVE MOTOR COOLING PUMPS

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

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

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

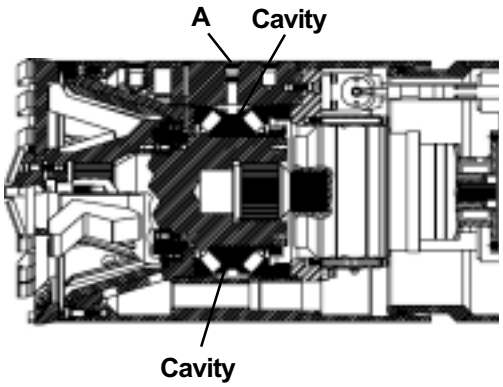
Main Cooling Drive Motor Pump Assembly For Larger HP Drive Motor, Water Cooled Booster Pump, or Gear Reducer Filtration
Oil capacity is 1.1 US quart (1.05 L).

DRIVE BEARING CAVITY

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

Use Mobil SHC 630 or equivalent when adding or changing lubricant.

NOTICE The Mobil SHC 630 Synthetic Bearing and Gear oil is a synthetic oil specifically designed for this application. If you change to a different oil, use a reputable oil supplier to meet or exceed the Mobil SHC 630 oil specification. Do not mix oil manufacturers or grades.

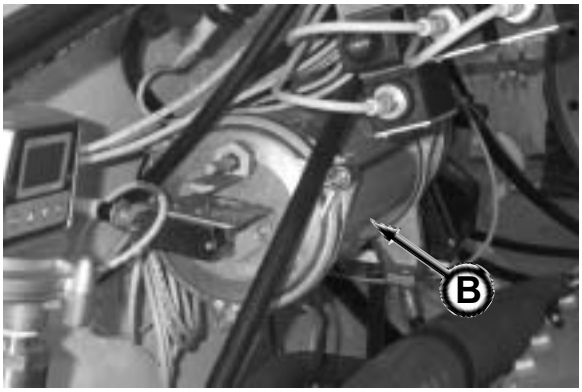


GREASE PUMP

The grease pump (B) is lubricated with Mobilgrease® XHP222 Premium Lubricating Grease.

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

Use Mobilgrease® XHP222 Premium Lubricating Grease or equivalent when refilling grease pump.



SLURRY PUMP LUBRICANT

The feed, return, and booster pumps are lubricated with Mobilgrease® XHP222 Premium Lubricating Grease.

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

Use Mobilgrease® XHP222 Premium Lubricating Grease or equivalent when lubricating the lubrication points.

MTBM ACCESS COVER THREAD LUBRICANT

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

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

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.

Periodic Maintenance

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

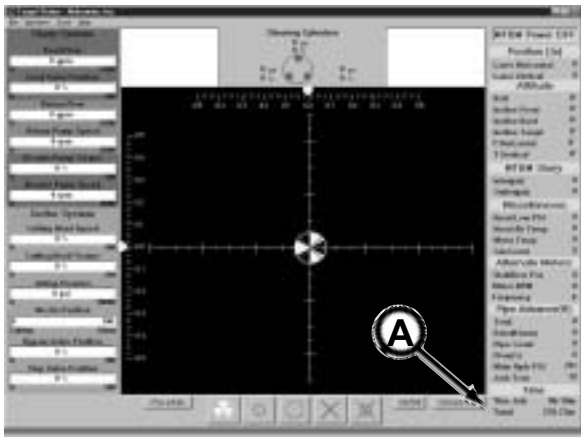
Maintenance and repairs must only be performed by a qualified service technician.

LUBRICATION & MAINTENANCE INTERVALS

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

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

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



LOCKOUT POWER BEFORE SERVICING

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

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

AVOID PINCH POINTS

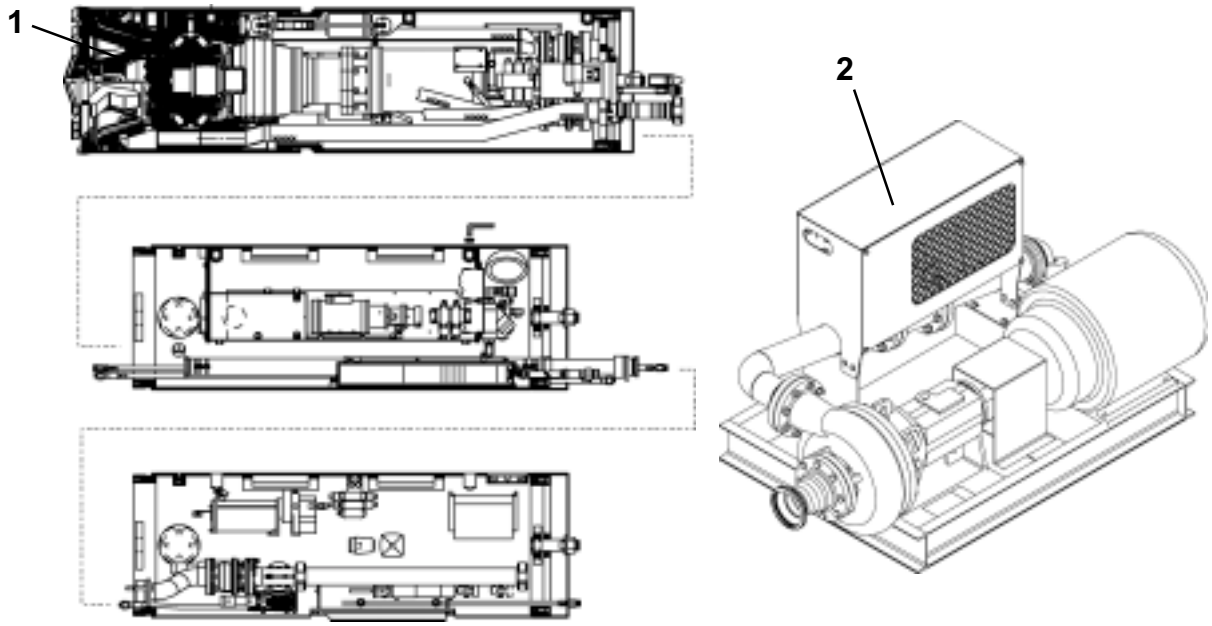
⚠WARNING Moving parts or the mishandling of parts can cause severe personal injury.

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.

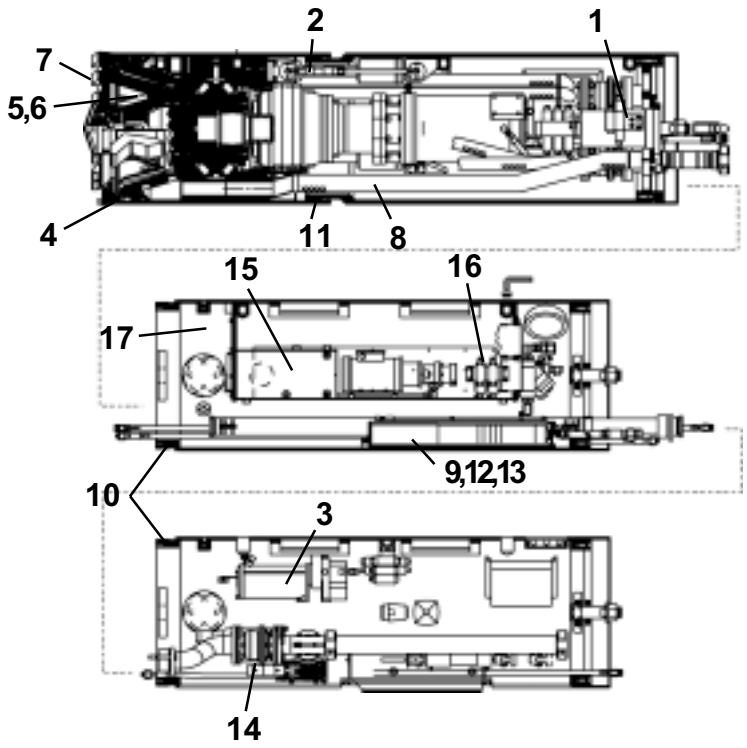
MAINTENANCE CHARTS



START OF TUNNELING PROJECT

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Drive Seals	Inspect Seal Mating Surface		
2..	Flow Meters	Inspect	Linings & Electrodes	
3.*	Cables	Inspect Pin/Socket Prior To Mating	Clean & Dry As Necessary	

* Not Shown



PRIOR TO EACH DRIVE LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Target	Clean	Use mild, abrasive-free cleaning solution and scratch free cloth	
2.	Steering Cylinders	Calibrate Linear Transducers	Stroke reading: 0 to 100% each cyl.	
3.	Grease Pump	Fill	Fill with new grease.	Mobil XHP222
4.	MTBM Front Sect.	Test Seal Flushing	Test for grease flow.	
5.	MTBM Front Sect.	Inspect Jetting Nozzles	Clean and inspect.	
6.	MTBM Front Sect.	Rasp Bar Clearance	1/4” or less	
7.	MTBM Front Sect.	Inspect Cutter Teeth & Surfaces	Repair or replace as necessary.	
8.	Slurry Hoses	Inspect	Replace if cracks/wear visible.	
9.	Submersible Pump	Test Operation		
10.	Coupling Sleeve & O-rings	Inspect/Lubricate	Replace if damaged.	
11.	Steering Joint	Clean/Lubricate	Check for leaks and seal wear.	
12.	Submersible Pump	Check Float Operation	Clean water inlet holes.	
13.	Submersible Pump	Check pump shut off delay	More delay for down grade bores.	
14.	Slurry Cntl. Valves	Check Operation & Pressure	1,000 psi max. for operating.	
15.	Hyd. Pump Reservoir	Check Oil Level	Fill as necessary.	
16.	Hydraulic Pump	Check Relief Settings	High and low pressure	
17.	Camera (In MTBM)	Test	Operation & orientation.	

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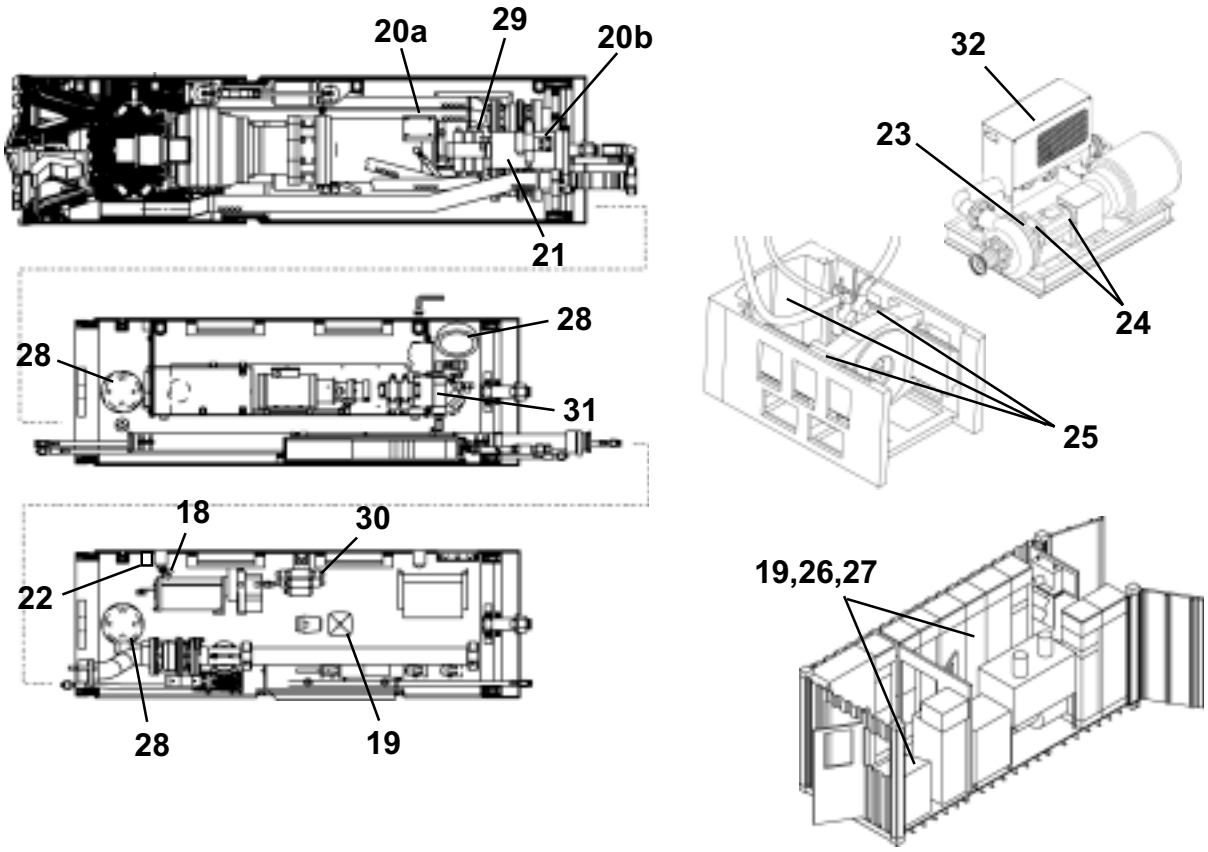
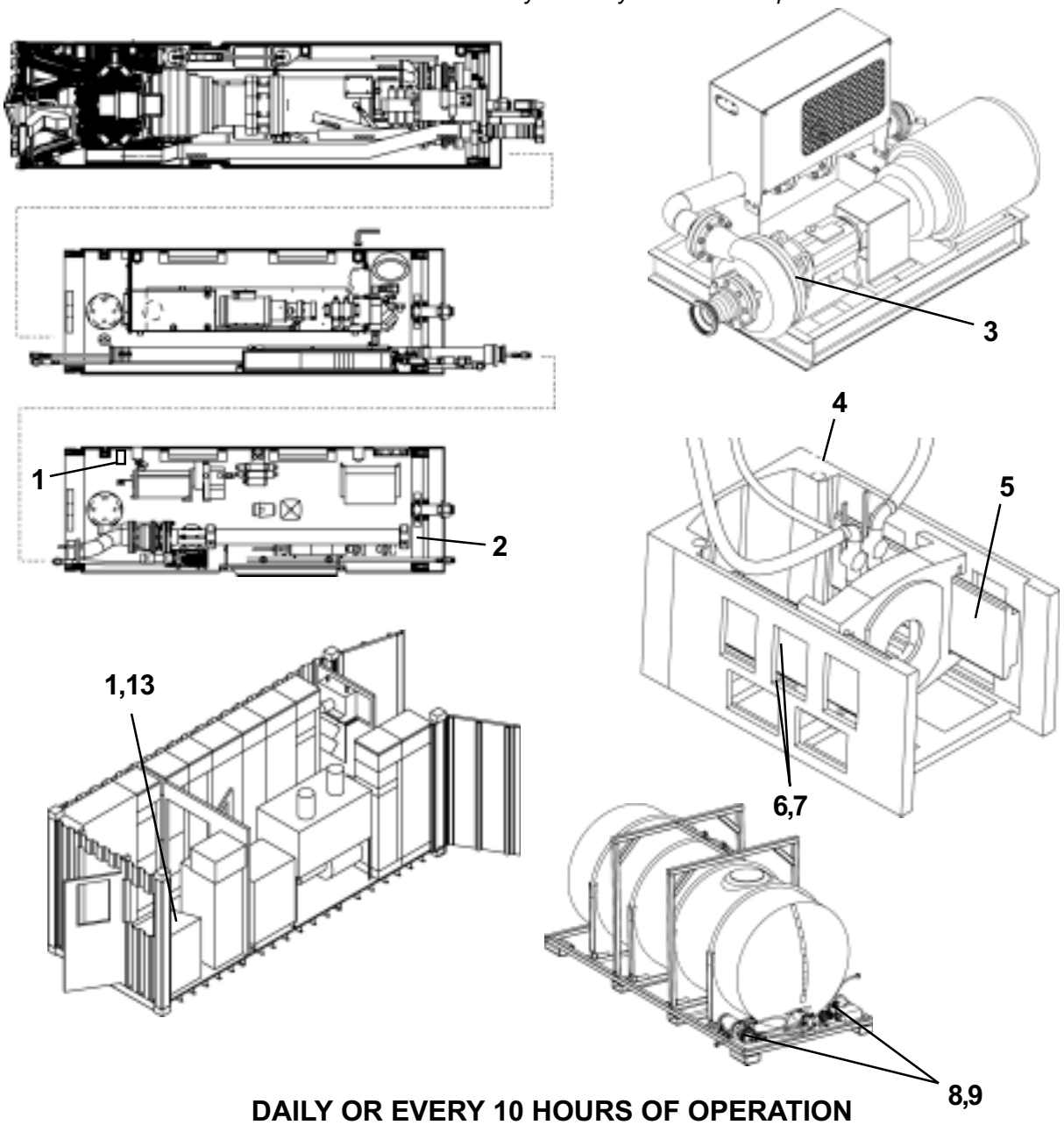


PRIOR TO EACH DRIVE LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
18.	Camera (In Shaft)	Test Control Functions	(not shown)	
19.	Audio Controls	Test Operation & Control		
20.	Inclinometers	Verify Incline a. Front b. Back	Use digital level & calibrate if necessary.	
21.	Target	Check Roll Incline	Roll Right (+); Roll Left (-)	
22.	Gas Detector	Test Operation	See Gas Detection Manual	
23.	Slurry Pumps	Inspect For Wear	Impellers, vortex rings.	
24.	Slurry Pumps	Check Shaft Seals	Replace if damaged/worn.	
25.	Jacking Frame MT400	Check Dog, Winch, & Gripper Operation	Adjust as necessary.	
26.	Control System	Verify Motor Rotation & Phase Monitor	All electric motors.	
27.	Lights	Test Lamp Operation	SL30-Middle section.	
28.	MTBM Sections	Lubricate Access Cover Threads		Marine Wheel Bearing Grease
29.	Steering Valve	Check Operation	Extend & retract-verify that each will hold pressure. Verify on screen values agree with cyl position.	
30.	Stabilizer Valve	Check Operation	Extend & retract-verify that it will hold pressure.	
31.	Jetting Pump	Clean Strainer	SL30 - located in middle sect.	
32.	Flow Meters	Compare Readings	While running above ground bypass.	
33.*	Cables	Inspect Outer Jacket	Replace if damaged.	

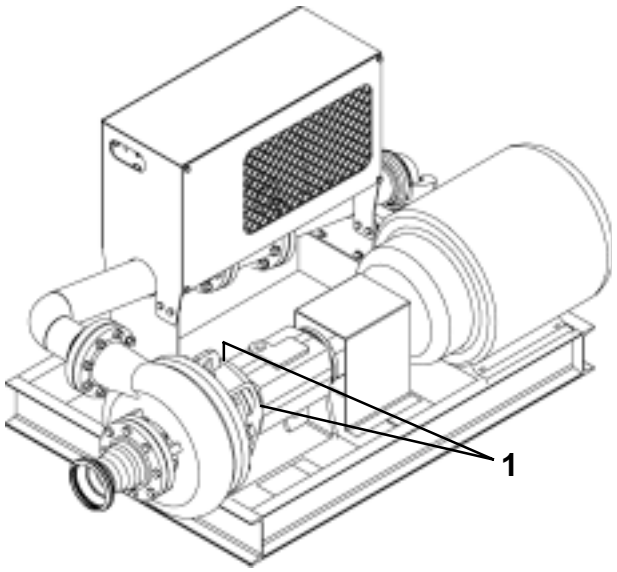
* Not Shown



DAILY OR EVERY 10 HOURS OF OPERATION

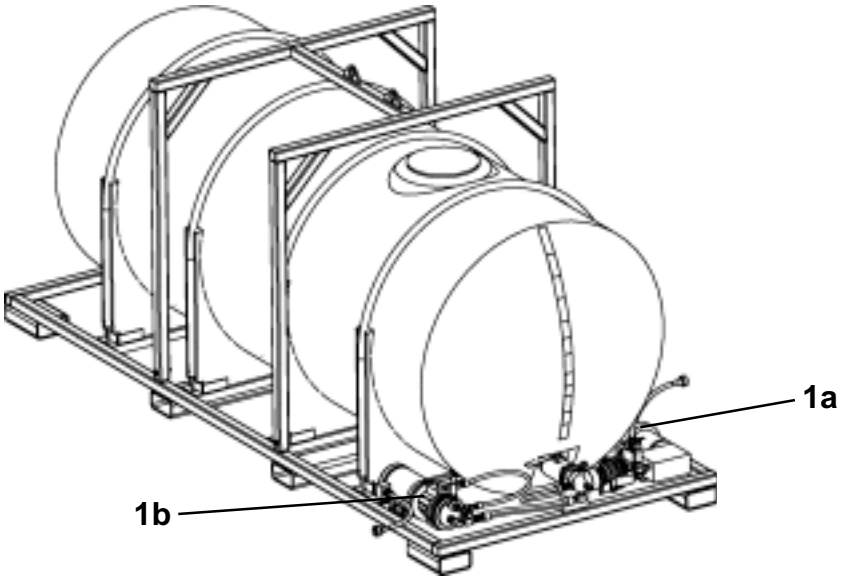
ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Gas Detector	Check display reading & check fault message.		
2.	Slurry Hoses	Inspect Banding Clamps	If damaged/worn, replace.	
3.	Slurry Pumps	Flush & Drain	In freezing weather.	
4.	Jacking Frame	Clean	Remove all build up.	
5.	Jacking Frame	Clean & Lubricate Frame Slide Rails& Travel Ring Assy.		
6.	Jacking Frame	Inspect Locking Blocks (Dogs)	Repair or replace.	
7.	Jacking Frame	Lubricate Locking Blocks (Dogs)		Lt. Wt. Motor Oil
8.	Water Cool. Pumps	Check Oil Level		10W30 Motor Oil
9.	Water Cool. Pumps	Flush & Drain	In freezing weather.	
10.*	Jetting Pump	Flush & Drain	In freezing weather.	
11.*	Jetting Pump	Check Belt Tension		
12.*	Jetting Pump	Check Gear Box Oil		
13.	Control System	Backup Database		

* Not Shown



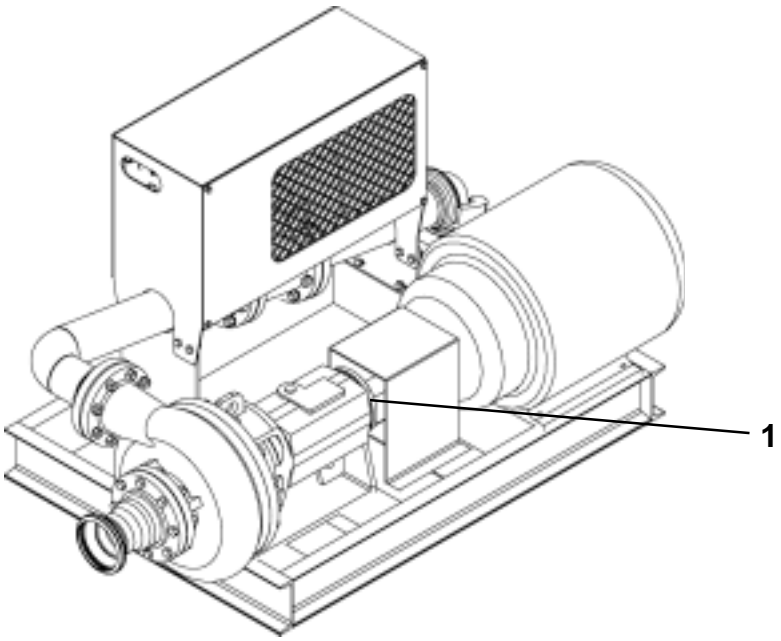
WEEKLY OR EVERY 50 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Slurry Pump	Lubricate Lip Seals	See Slurry Manuals	Mobil XHP222



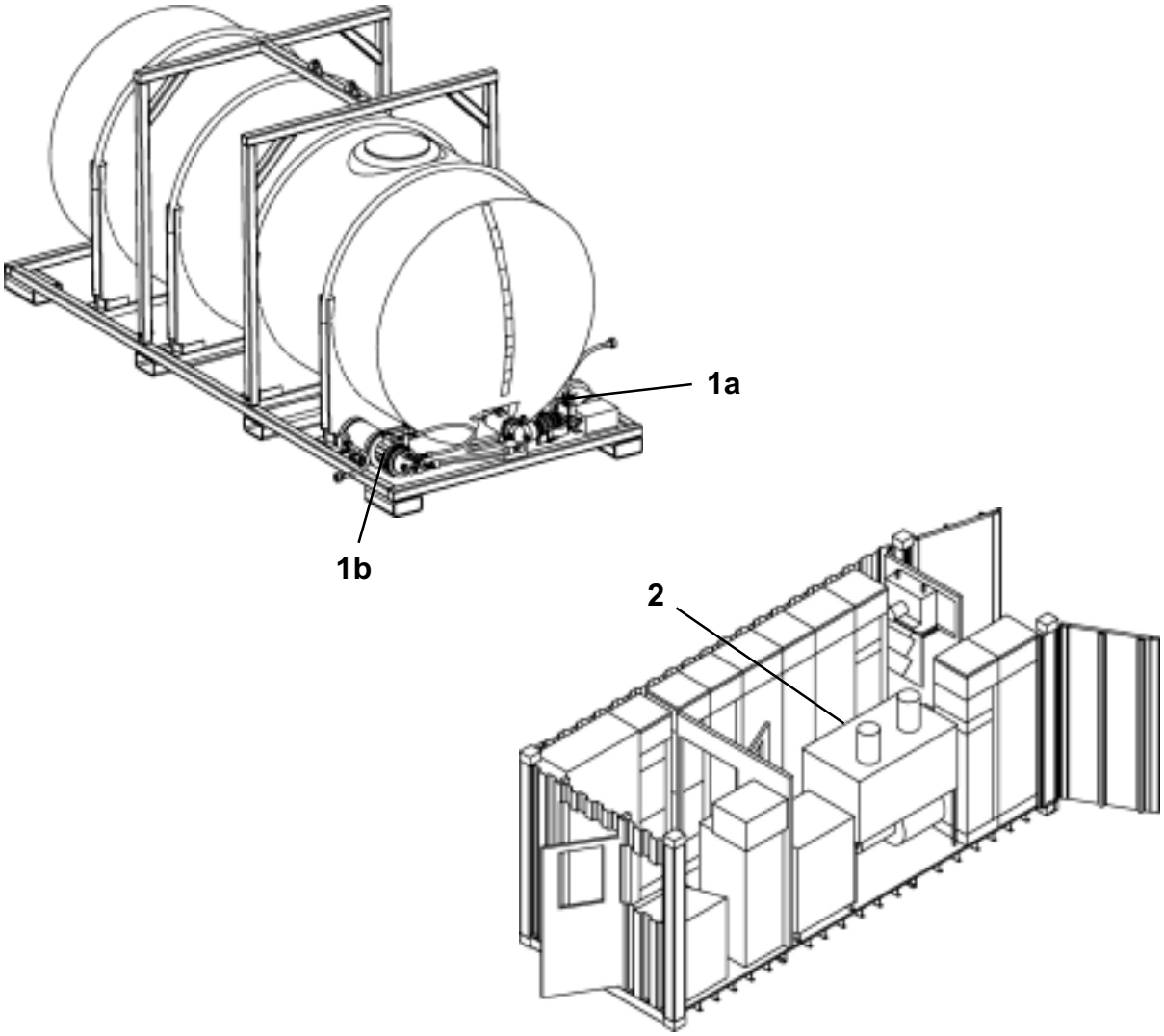
AFTER FIRST 100 HOURS, THEN EVERY 1000 HOURS THEREAFTER

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



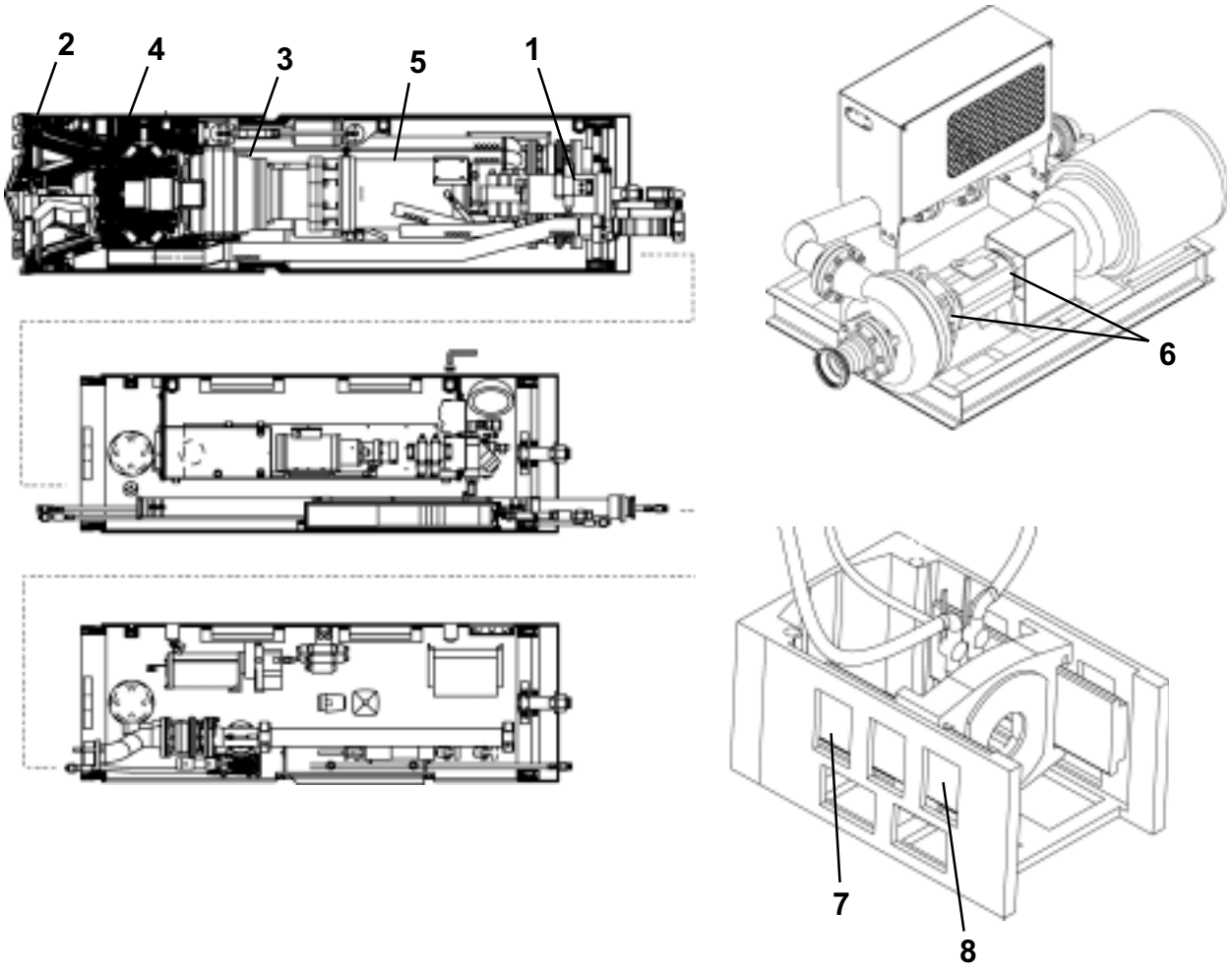
MONTHLY OR EVERY 250 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Slurry Pumps	Lubricate Bearings	See Slurry Pump Manuals	Mobil XHP222



EVERY 1000 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Water Cool. Pumps	Drain & Fill	a. Small Pump - 1.0 US qt. b. Large Pump - 1.1 US qt.	10W30 Motor Oil
2.	Hyd. Power Pack Reservoir	Drain & Fill	300-350 gal. capacity	ISO-VG-46 20W



COMPLETION OF EACH DRIVE

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Target	Remove from MTBM	Keep in storage box.	
2.	Drive Seals	Inspect For Water & Grease	Cutter bit, lip seal retaining ring, & lip seals. Flush water flushing ports. If seals are cracked/worn, replace.	
3.	Gear Reducer	Drain & Fill	Fill with new oil.	Mobil SHC 630
4.	Drive Bearings	Drain & Fill	Fill with new oil.	Mobil SHC 630
5.	Drive Motor	Drain & Flush	Water jacket. Fill with RV anti-freeze in freezing weather.	
6.	Slurry Pumps	Lubricate	See Slurry Pump Manuals.	Mobil XHP222
7.	Cyl. Base End Pins	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
8.	Cyl. Rod End Pins	Lubricate	Lubricate until grease is forced out.	Mobil XHP222

MAINTENANCE CHECK LISTS

Use these maintenance check lists to identify system function procedures and maintenance for your pre launch, end of bore, and MTBM service requirements. Copy the check lists in this section. Once the maintenance/service is complete, check off, initial, and date each maintenance/service item, and file the copy as a record of maintenance.

Pre Launch Check List

Contractor_____ Date_____

Head Diameter_____ Bore Length_____

Date of Launch_____ Project Name _____

Check	Operation	Initial	Date
	MBTM service sheet • Attach to this pre launch record		

Initial System Settings

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

Jacking System

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

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

VFD / Drives

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

Submersible Pump

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

Steering System

	Verify steering operation in extend and retract • Top		

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

Lighting

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

MBTM Camera / Audio

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

Temperature sensors

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

Incline Feedback

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

Flushing

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

Final Guidance Check

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

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

Final Checks

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

End of Bore
Check List

Contractor_____ Date_____

Head Diameter_____ Bore Length_____

Date of TBM Recovery_____ Project Name _____

Before MTBM is Disconnected

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

After MTBM Recovery

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

Equipment Inspection List

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Equipment Repair List

MBTM Service Check List

Contractor_____ Date_____

Head Diameter_____ Previous Bore Length_____

Date of last service_____ Project Name _____

Make additional notes and list parts installed on back of sheet

Drive / Seals Service

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

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

Cooling System Service

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

High Pressure Jetting System

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

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

Cutting Wheel Service

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

Electric Inspection

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

Submersible Pump Service

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

Hydraulic Pump Service

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

Slurry Valves Service

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

Dirt Wing

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

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

Pressure Transducers

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

Booster Pump

	Note condition of vortex ring: • Note if replaced		
	Note condition of impeller: • Note if replaced		
	Note condition of stuffing box: • Plate wear behind impeller • Note if replaced		
	Note condition of mechanical seals: • Any leakage at stuffing box • Note if replaced		
	Pump grease to fitting at bearing cover		
	Check condition and level of oil in shaft housing		
	Verify proper rotation of booster pump		
	Drain booster pump if cold weather is anticipated		

Bentonite System

	Remove bentonite nozzles and/or check valves and clean		
	Flush all bentonite ports and hoses		
	Connect system and test for operation / leaks		

Additional Check Points

	Gas Detector • Check feedback with calibration gas • Note values at additional meter screen agrees with gas detector • Pit box horn should sound at 25% gas		
	Oil filter indicator • Check operation while retracting steering rams and dirt wing at same time		
	Check condition of inner tube on slurry hoses - especially return		
	Inspect condition of machine sealing bells and spigots • O-ring grooves • Nicks or gauges • Flat spots - damage from dropping		
	Replace machine oring seals		
	Check victaulic rubber seals		
	Inspect condition of torque bolts • Thread damage • Are nuts installed		
	On 72" TBM check gear oil circulation flow and pressure on the gear box		
	If motor is equipped with correct voltage motor heater verify it is functioning properly • Turn motor heater switch "ON" • Motor temperature should rise • **Turn motor heater switch "OFF"**		

NOTES

Storage

PREPARING FOR STORAGE

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

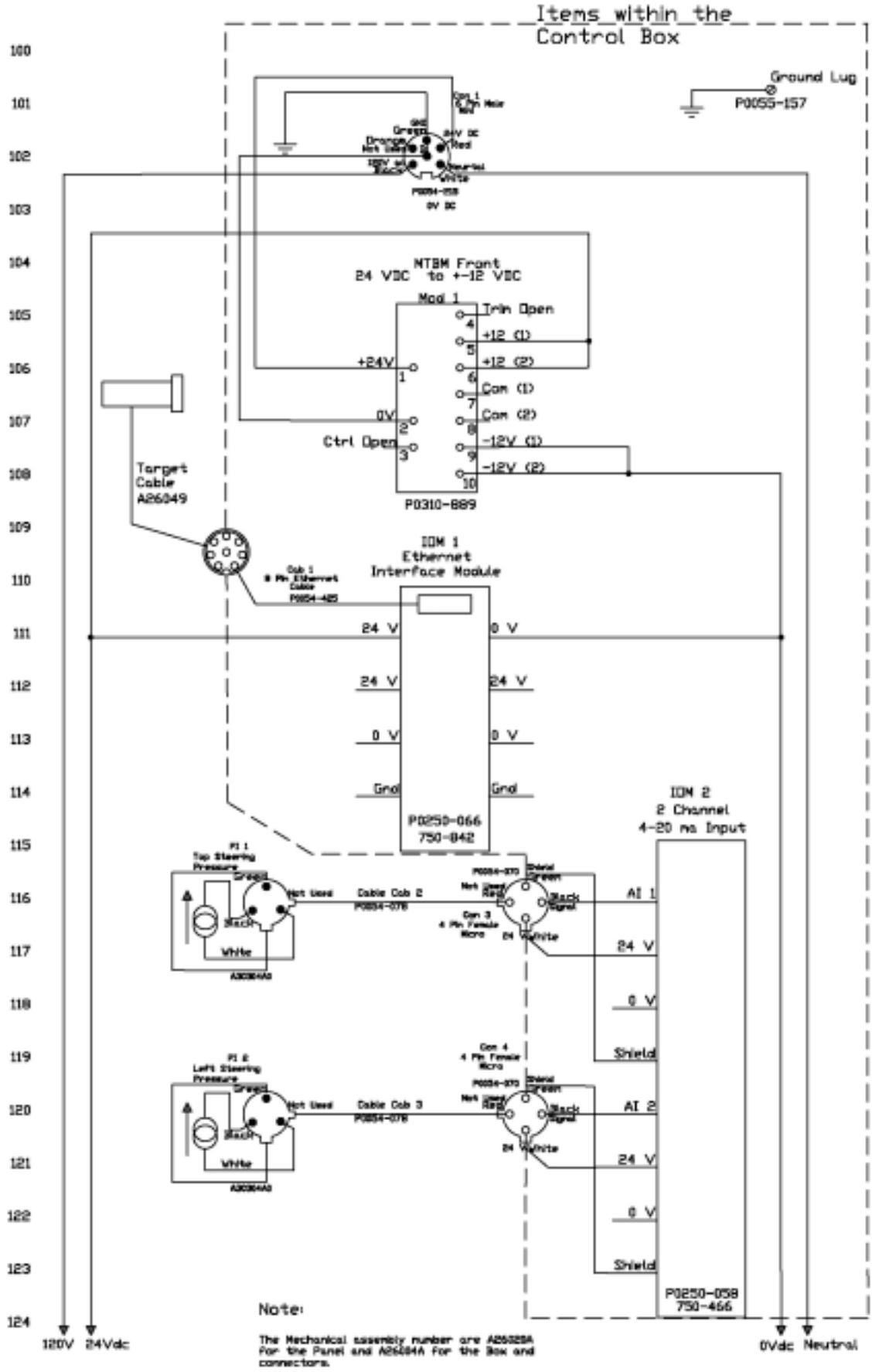
1. Repair worn or damaged parts.
2. Wash all equipment thoroughly.
3. Lubricate all grease points. Grease threads on bolts used for adjustments.
4. Drain and fill gear reducer and drive bearing cavity. Add Mobil SHC 630 or equivalent.
5. Retract all hydraulic cylinders if possible. If not, coat exposed cylinder rods with a corrosion preventive.
6. Repaint equipment where necessary.
7. Drain hydraulic oil, flush oil reservoir, change hydraulic filters, and refill hydraulic reservoir. Check for leaks.
8. Wipe up lube spills. Dispose of rags and trash properly.
9. If possible, store equipment under cover and out of the weather in a ventilated area.
10. Remove guidance target and place it in the storage box.
11. Refer to your Slurry Pump and Motor manuals for long term pump and motor storage.

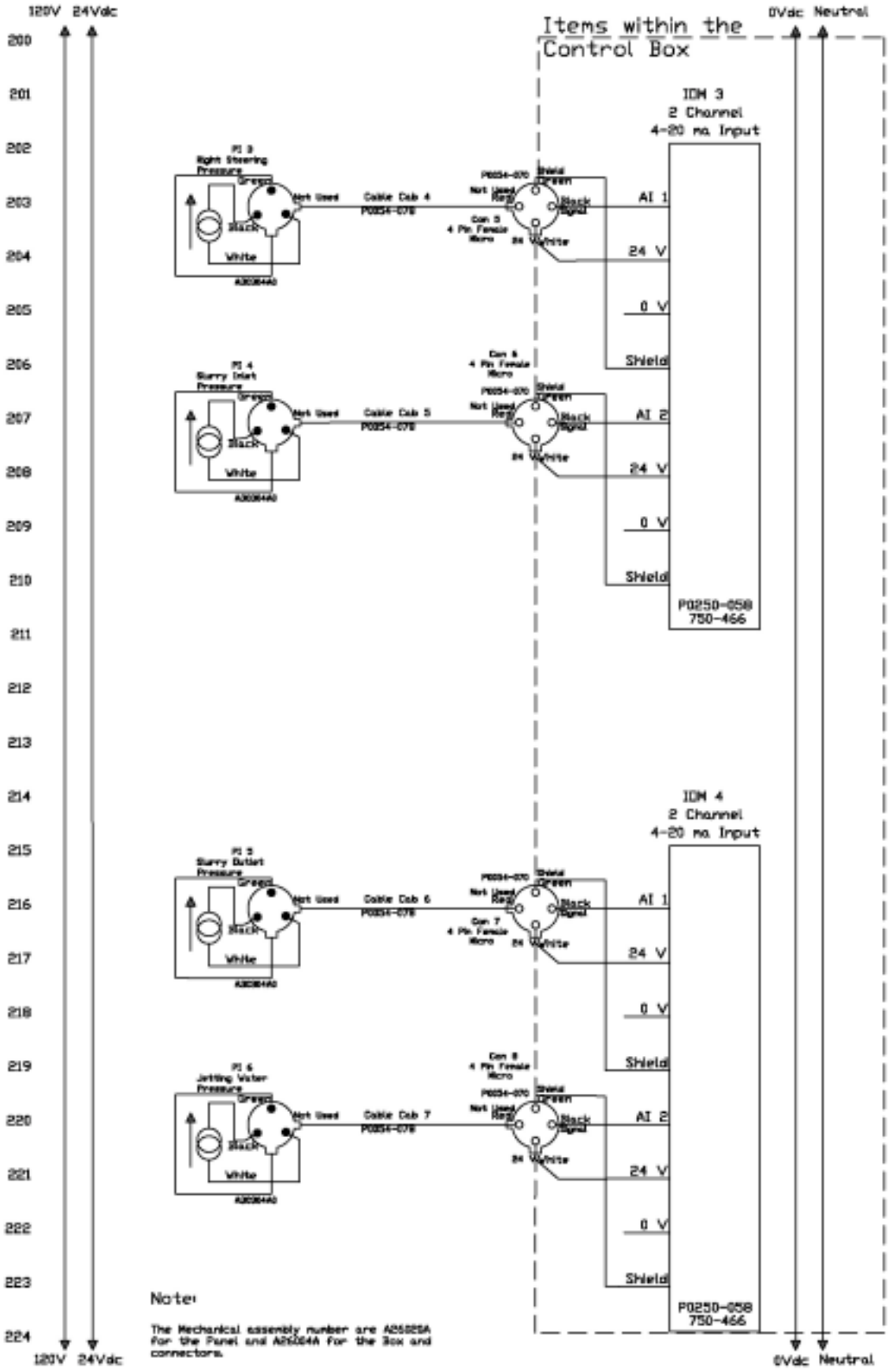
REMOVING FROM STORAGE

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

1. Clean equipment thoroughly.
2. Check to make sure all decals including safety decals are clean and readable.
3. Check condition of wires and cables. Repair or replace as necessary.
4. Check gear reducer and drive bearing cavity oil level. Add Mobil SHC630 oil as needed.
5. Remove the cylinder corrosion preventive from the cylinder rods if it is not compatible with hydraulic oil or seal materials.
6. Check for leaks. Repair or replace as necessary.
7. Check power pack hydraulic oil level. If fluid is low, check for leaks and add oil as required. See Power Pack Oil Reservoir Lubricant in Lubricants section.
8. Check condition of all hoses and connections. Tighten, repair or replace with new as needed.
9. Before operating, cycle hydraulic functions several times to purge air from the hydraulic system.
10. Review this Operator's Manual.

SL30 FRONT SECTION SCHEMATICS




120V 24Vdc
0Vdc Neutral
Items within the Control Box
IDM 3
2 Channel
4-20 ma Input
PI 3
Right Steering Pressure
Green
Black
White
Not Used
Cable Cab 4
P0254-078
Con 5
4 Pin Female Micro
Shield
Green
Not Used
Red
Black
Signal
24
White
AI 1
24 V
0 V
Shield
PI 4
Slurry Inlet Pressure
Cable Cab 5
Con 6
4 Pin Female Micro
AI 2
P0250-058
750-466
IDM 4
PI 5
Slurry Outlet Pressure
Cable Cab 6
Con 7
4 Pin Female Micro
PI 6
Jetting Water Pressure
Cable Cab 7
Con 8
4 Pin Female Micro
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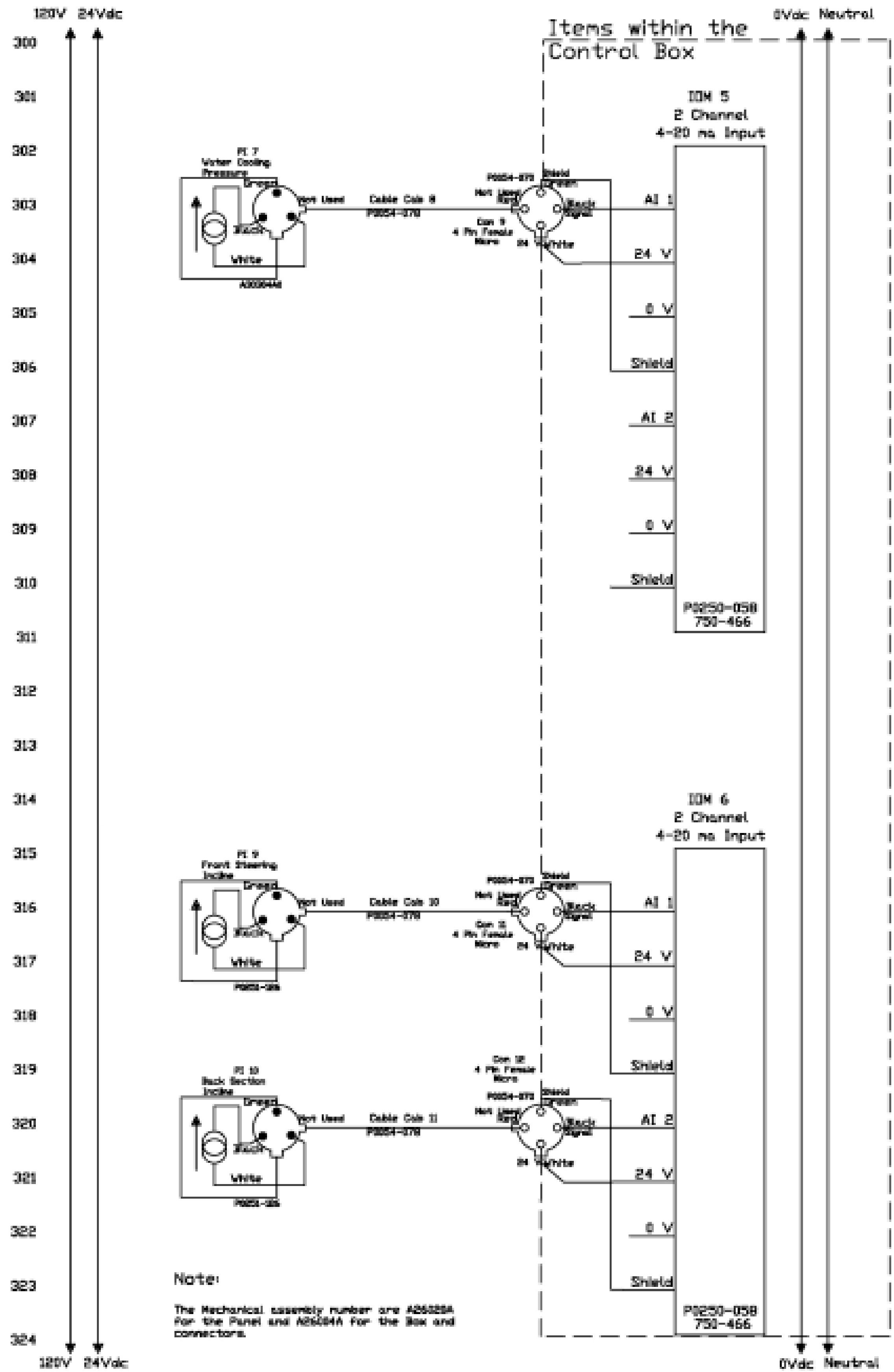
120V
24Vdc
0Vdc
Neutral
Items within the Control Box
IOM 5
2 Channel
4-20 ma Input
AI 1
24 V
0 V
Shield
AI 2
24 V
0 V
Shield
P0250-058
750-466
IOM 6
2 Channel
4-20 ma Input
AI 1
24 V
0 V
Shield
AI 2
24 V
0 V
Shield
P0250-058
750-466
Green
Black
White
Not Used
Cable Cab 9
Cable Cab 10
Cable Cab 11
4 Pin Female
300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
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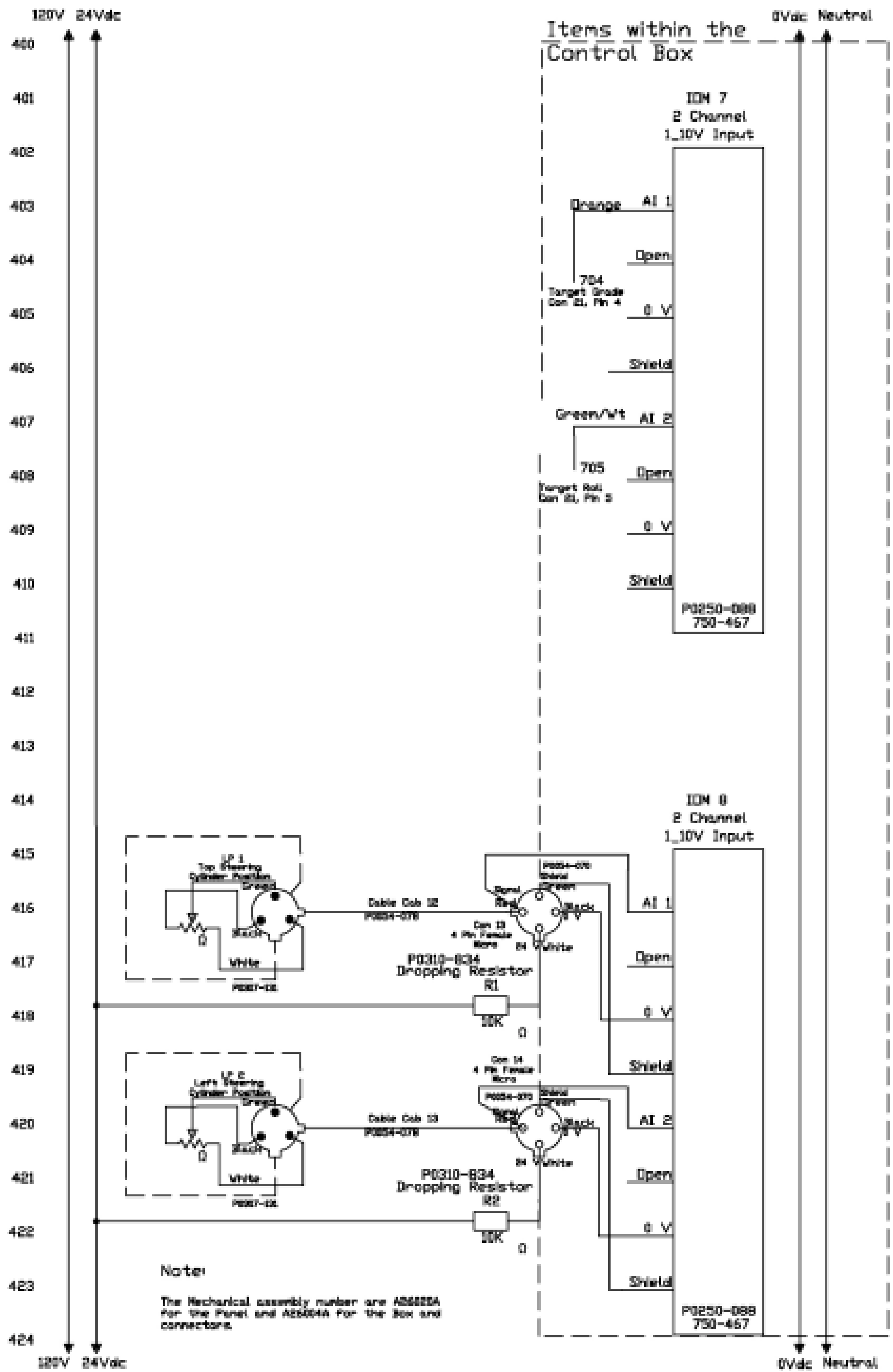
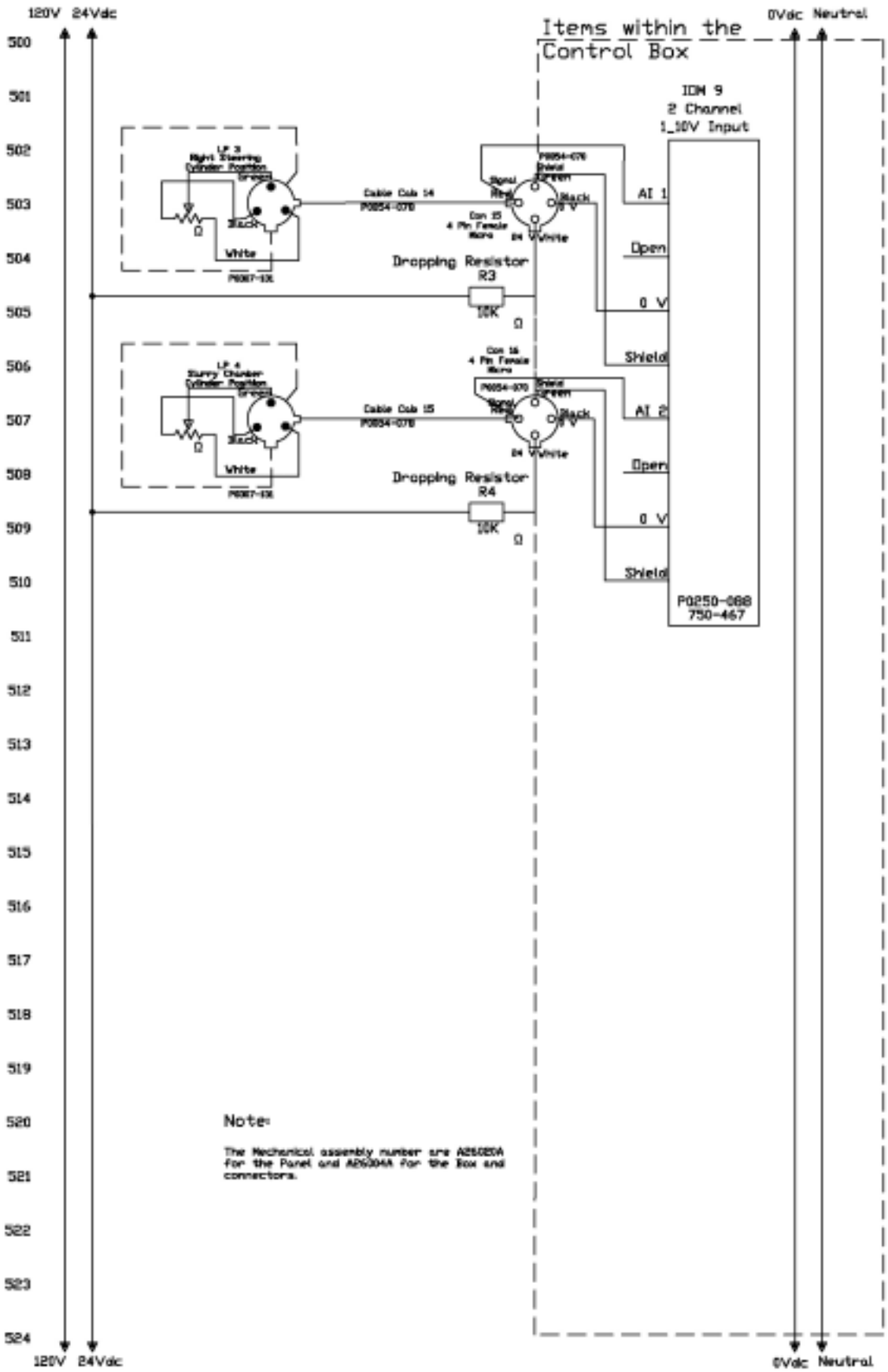
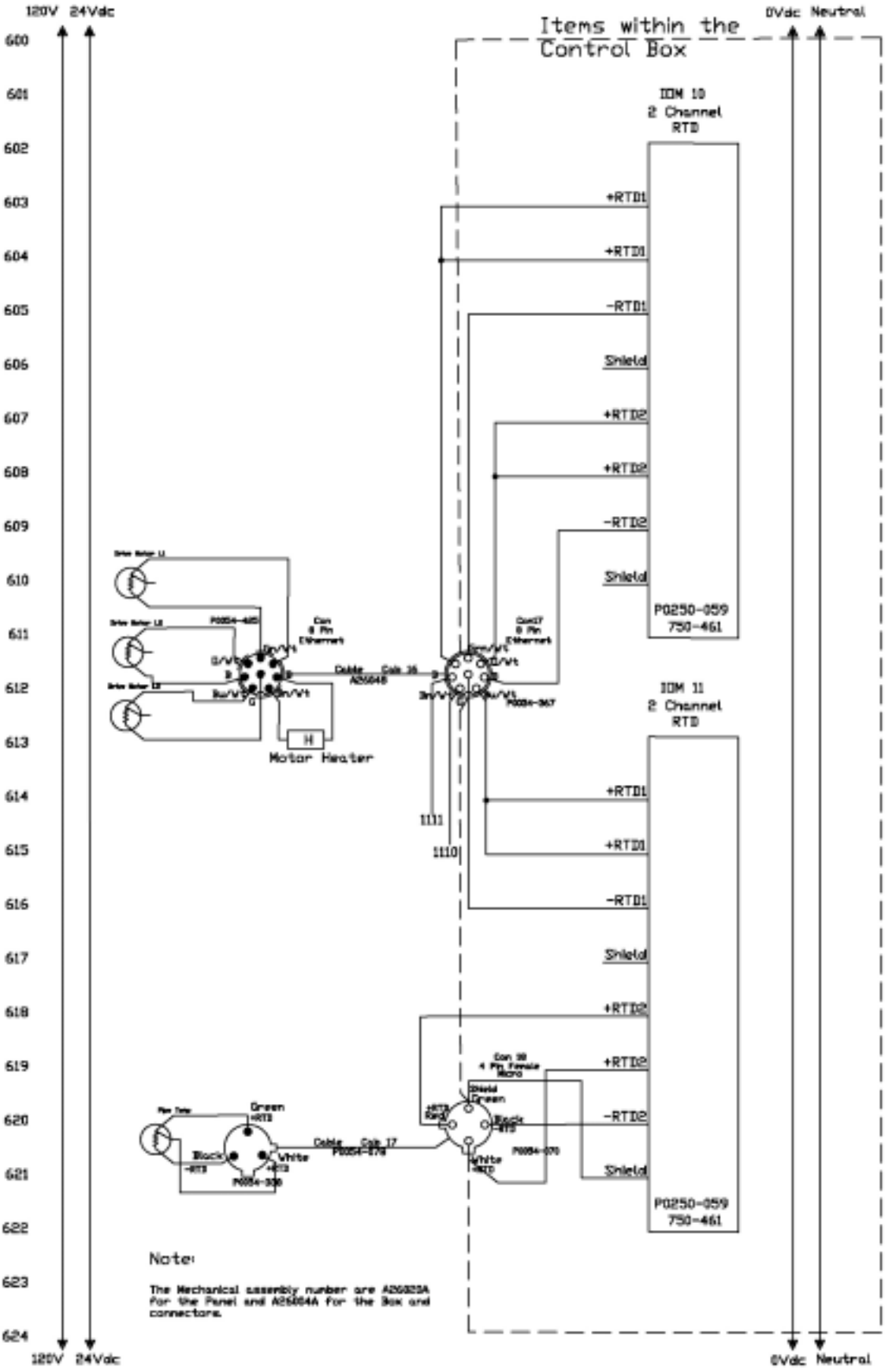

120V
24Vdc
0Vdc
Neutral
400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
Items within the
Control Box
IOM 7
2 Channel
1_10V Input
Orange
AI 1
Open
704
0 V
Shield
Green/Wt
AI 2
705
Open
0 V
Shield
P0250-088
750-467
IOM 8
2 Channel
1_10V Input
AI 1
Open
0 V
Shield
AI 2
Open
0 V
Shield
P0250-088
750-467
P0310-834
Dropping Resistor
R1
10K
P0310-834
Dropping Resistor
R2
10K
Note:
120V
24Vdc
0Vdc
Neutral


120V 24Vdc
Items within the Control Box
0Vdc Neutral
IDM 9
2 Channel
1_10V Input
AI 1
Open
0 V
Shield
AI 2
Open
0 V
Shield
P0250-088
750-467
Dropping Resistor R3
10K Ω
Dropping Resistor R4
10K Ω
Cable Cab 14 P0854-078
Cable Cab 15 P0854-078
Black
White
Note:
The Mechanical assembly number are A25020A for the Panel and A25304A for the Box and connectors.
120V 24Vdc
0Vdc Neutral


120V 24Vdc
0Vdc Neutral
Items within the Control Box
IOM 10
2 Channel RTD
+RTD1
+RTD1
-RTD1
Shield
+RTD2
+RTD2
-RTD2
Shield
P0250-059
750-461
IOM 11
2 Channel RTD
+RTD1
+RTD1
-RTD1
Shield
+RTD2
+RTD2
-RTD2
Shield
P0250-059
750-461
Motor Heater
1111
1110
Green
White
Black
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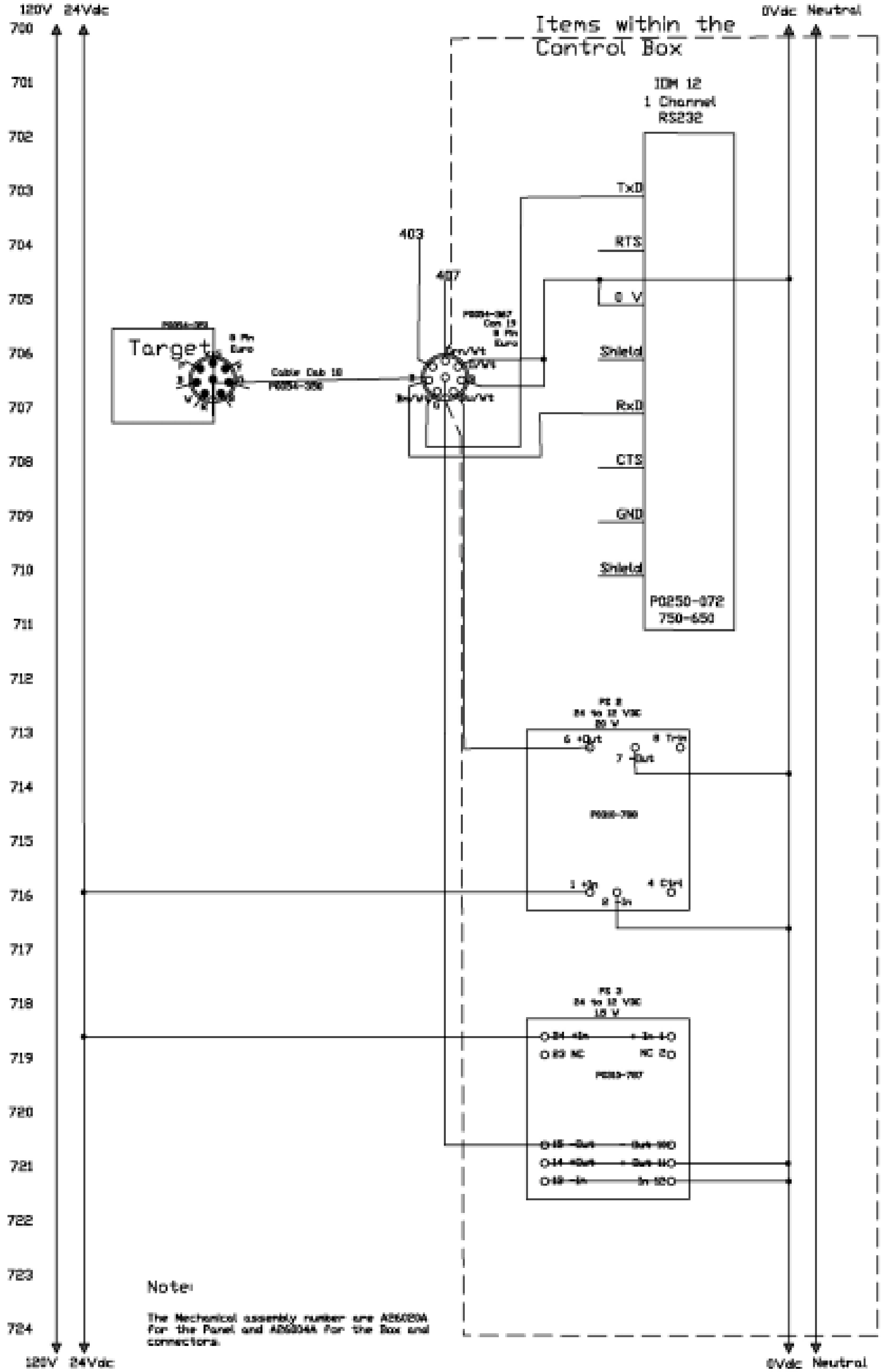
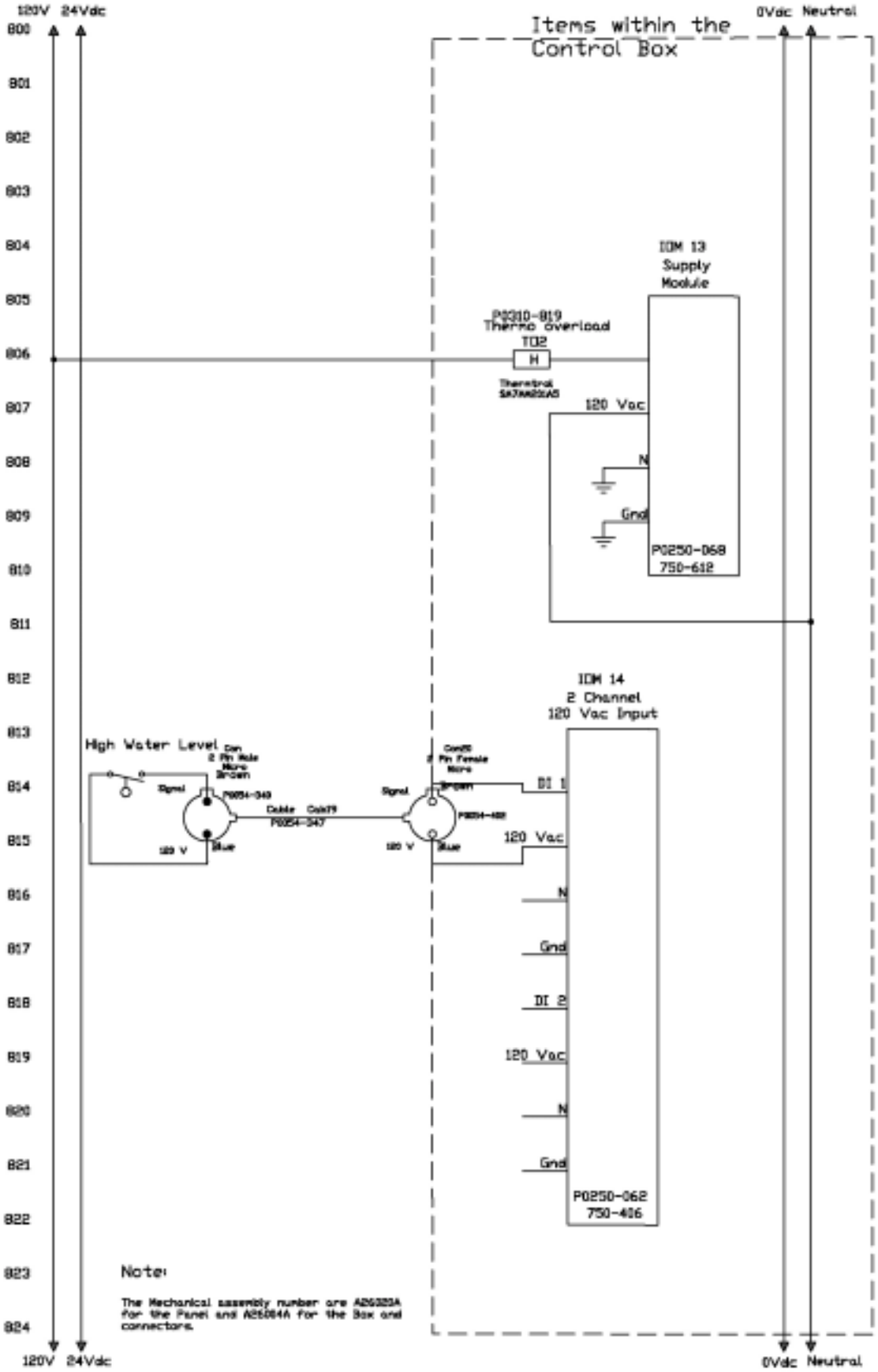
0Vdc Neutral


120V 24Vdc
0Vdc Neutral
Items within the Control Box
IDM 12
1 Channel
RS232
TxD
RTS
0 V
Shield
RxD
CTS
GND
Shield
P0250-072
750-650
403
407
Target
Cable Cab 18
PS 2
24 to 12 VDC
PS 3
24 to 12 VDC
Note:
The Mechanical assembly number are A26020A for the Panel and A26004A for the Box and connectors.


120V 24Vdc
0Vdc Neutral
Items within the Control Box
IDM 13 Supply Module
P0310-019 Thermo overload
TO2
H
120 Vac
N
Gnd
P0250-068
750-612
IDM 14 2 Channel 120 Vac Input
High Water Level
Signal
Blue
DI 1
120 Vac
N
Gnd
DI 2
120 Vac
N
Gnd
P0250-062
750-406
Note:
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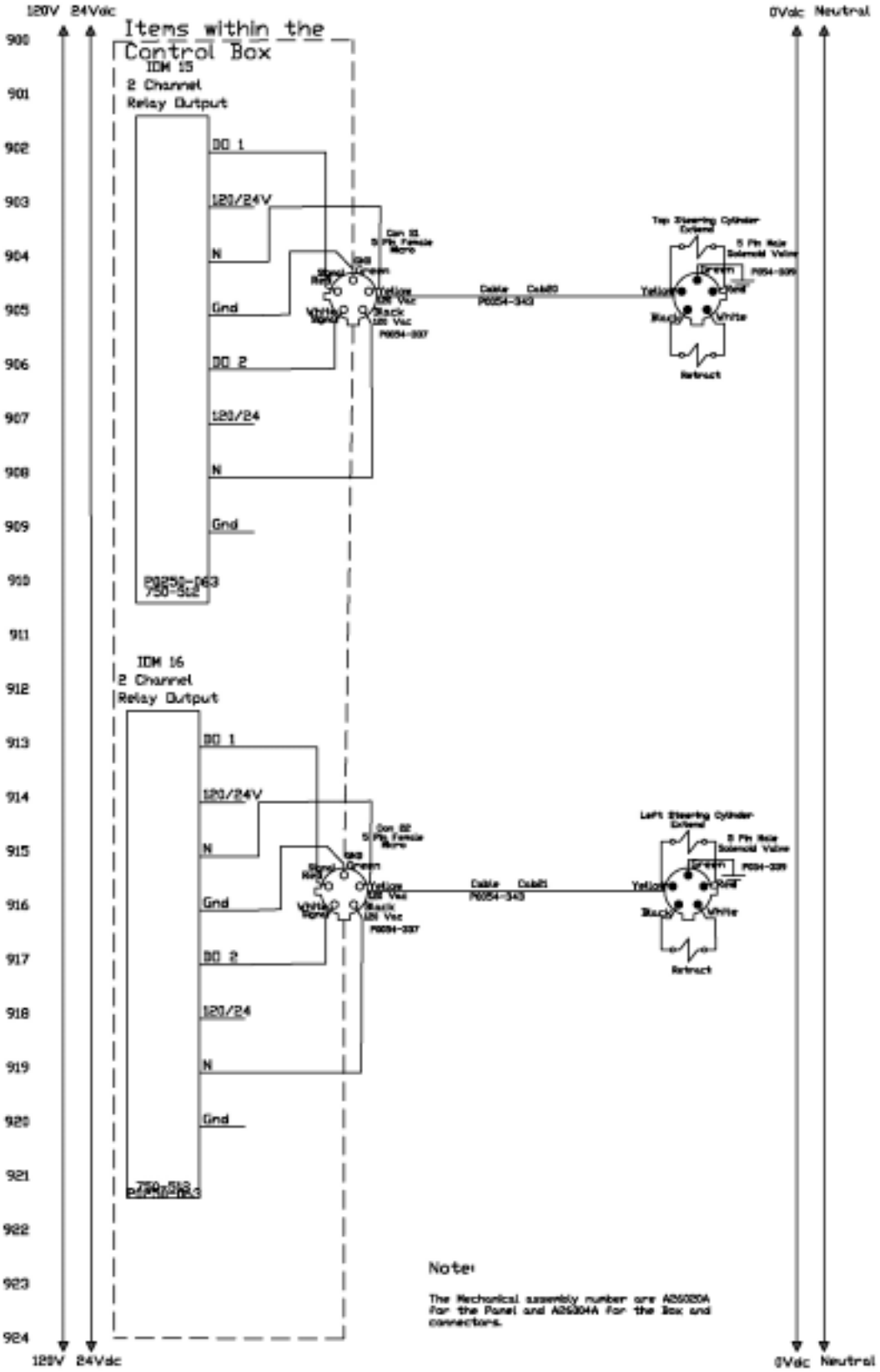
0Vdc Neutral


120V 24Vdc
0Vdc Neutral
Items within the Control Box
IDM 15
2 Channel Relay Output
DO 1
120/24V
N
Gnd
DO 2
120/24
N
Gnd
IDM 16
2 Channel Relay Output
DO 1
120/24V
N
Gnd
DO 2
120/24
N
Gnd
Top Steering Cylinder Extend
5 Pin Male Solenoid Valve
Retract
Left Steering Cylinder Extend
5 Pin Male Solenoid Valve
Retract
Note:
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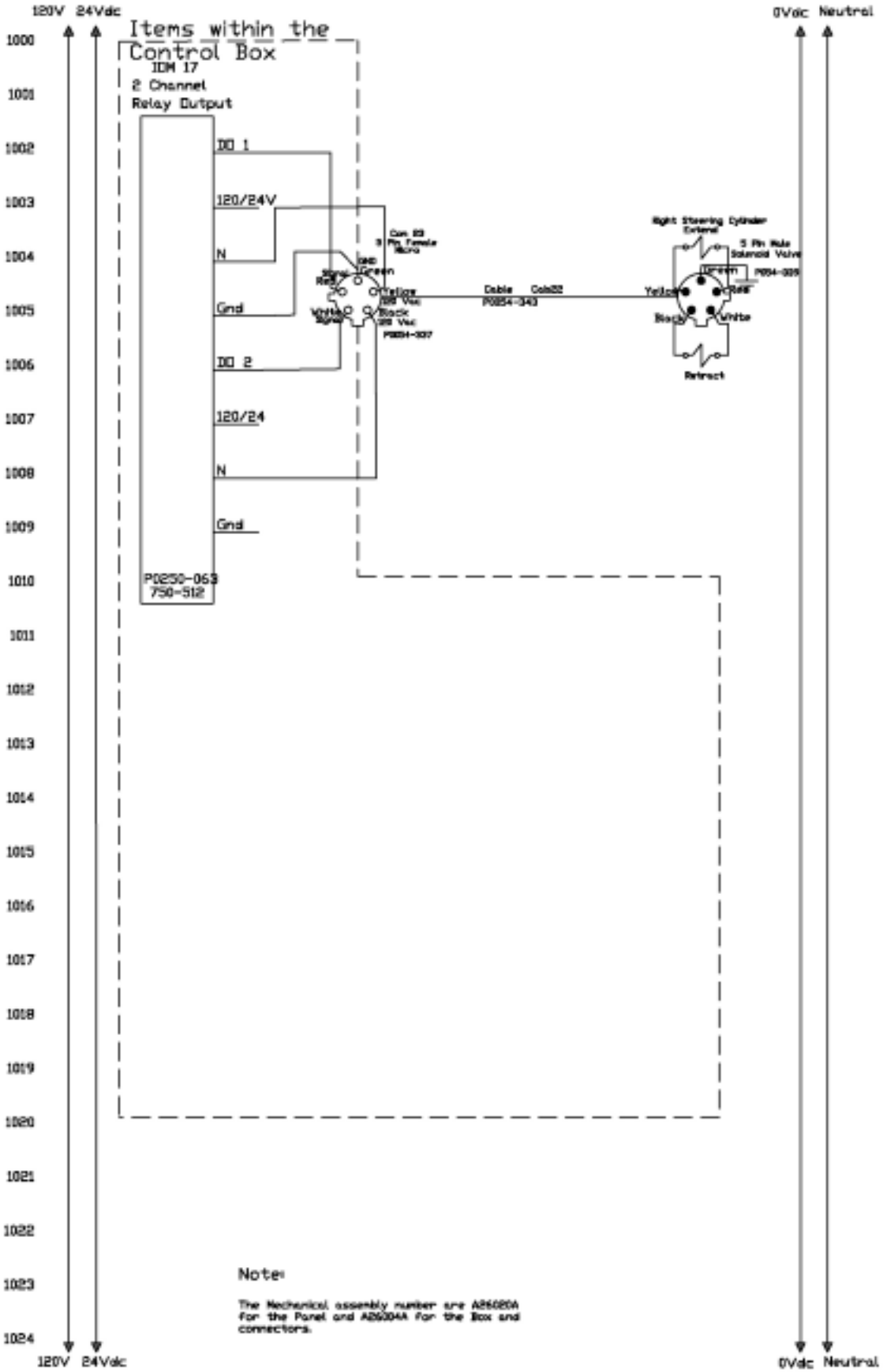
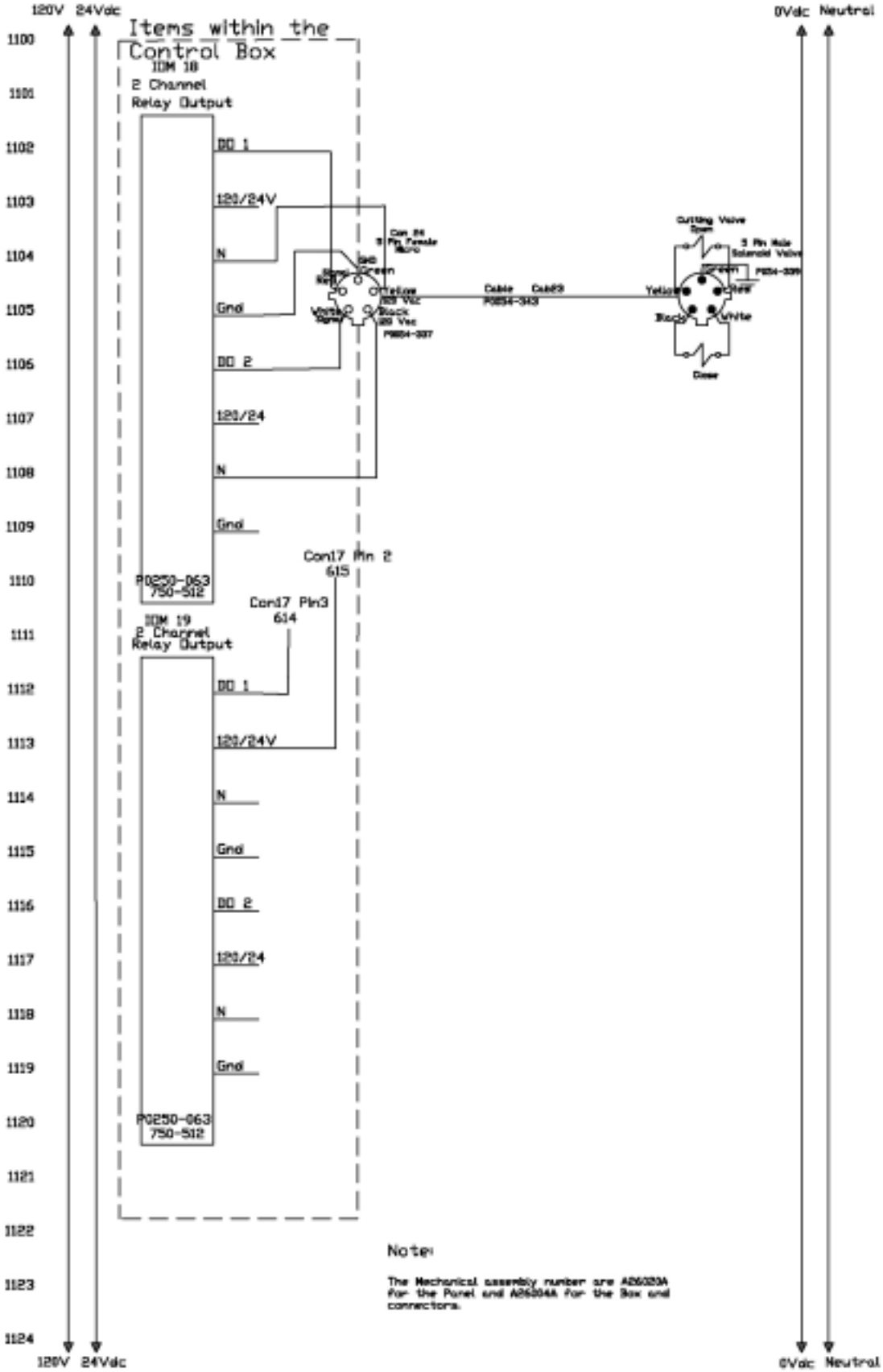
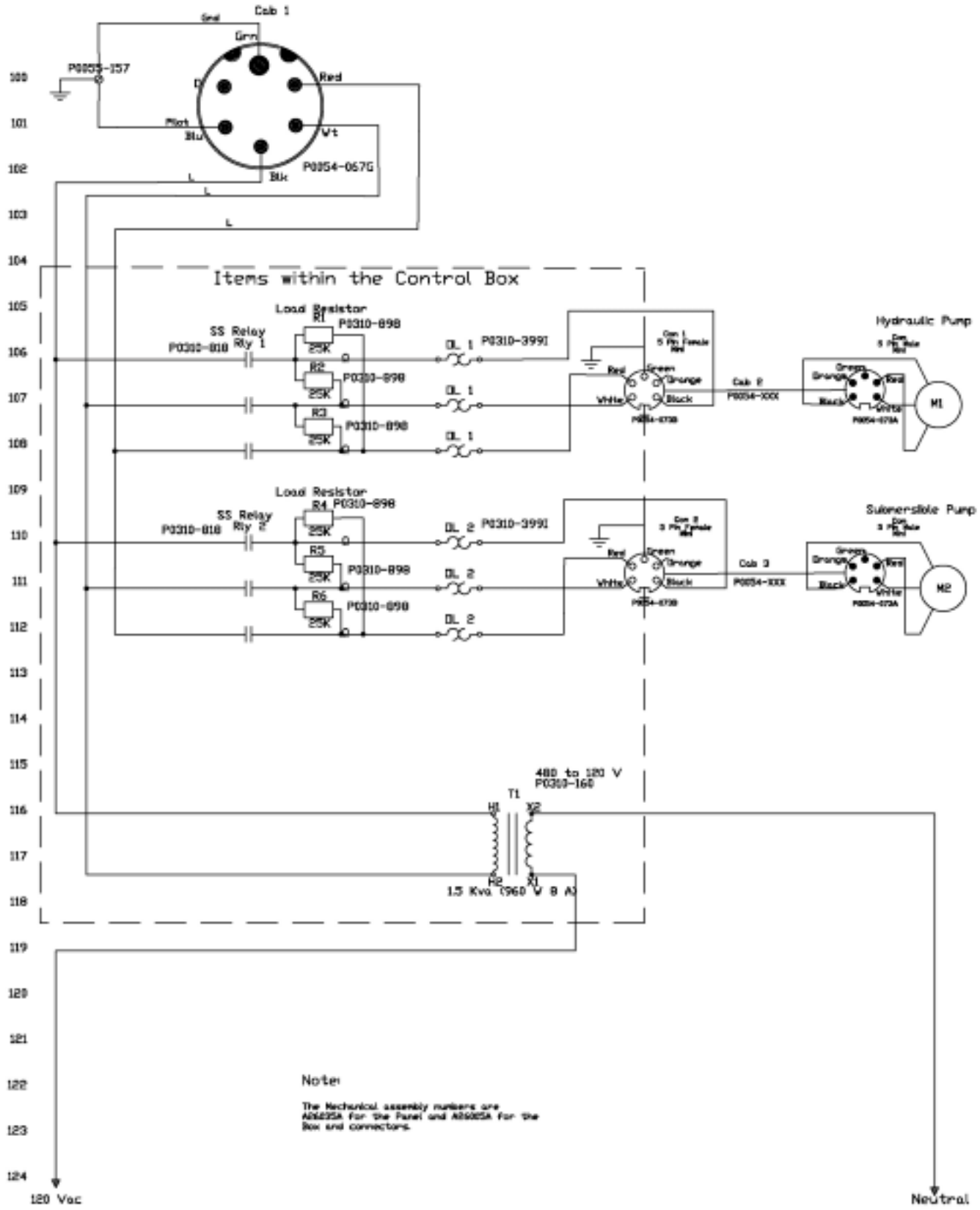
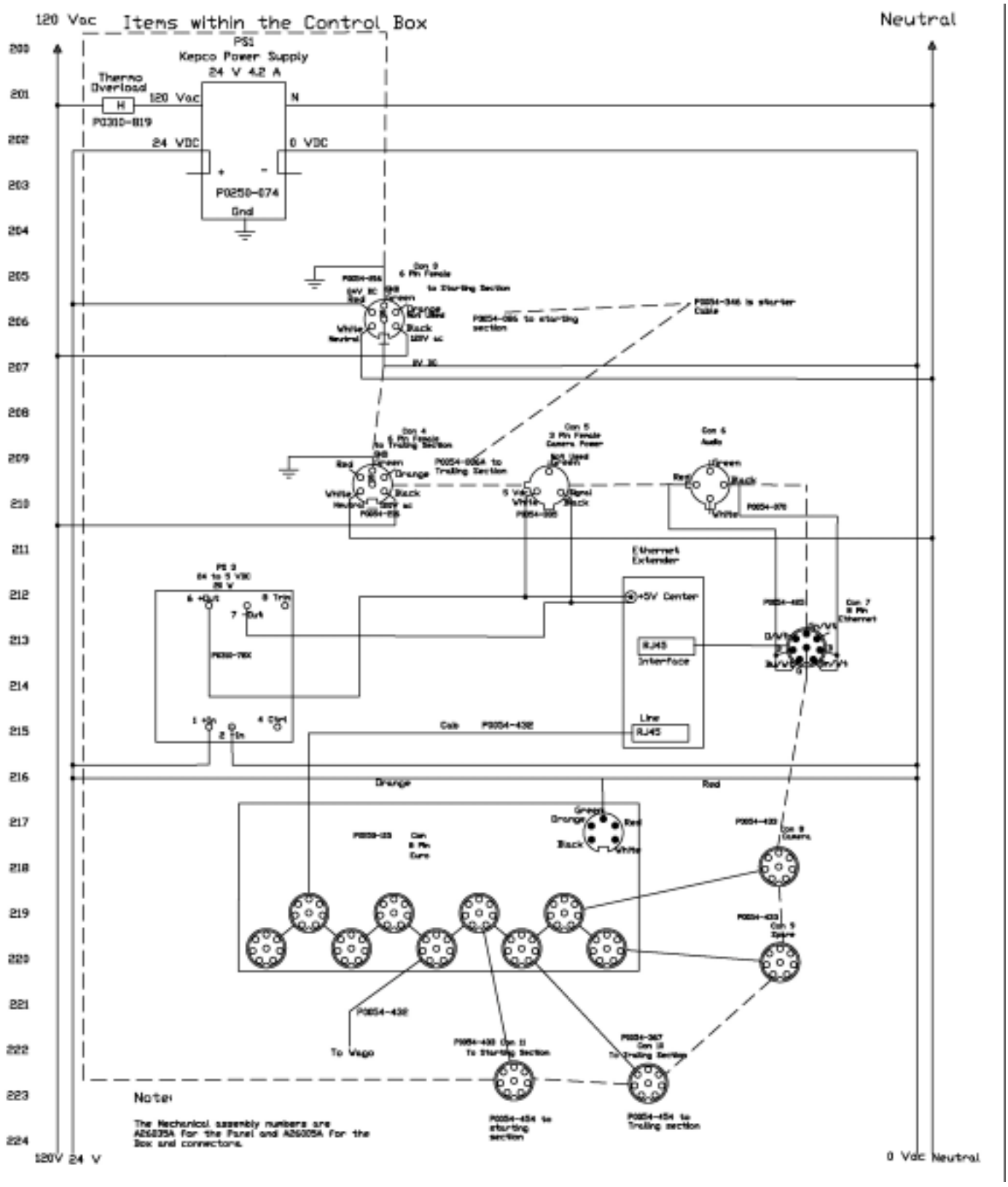
0Vdc Neutral

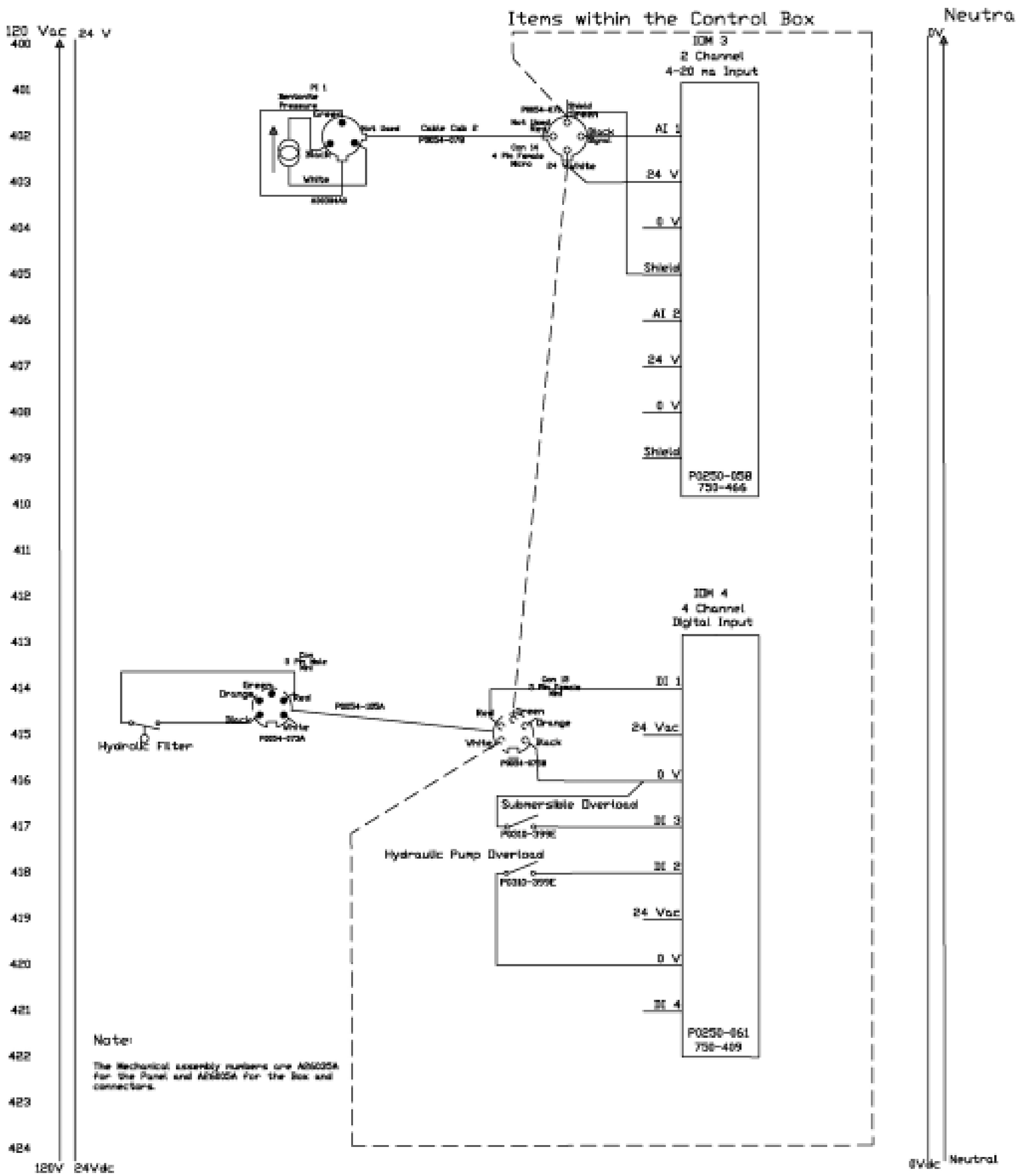

120V 24Vdc
0Vdc Neutral
Items within the Control Box
IDM 17
2 Channel
Relay Output
DO 1
120/24V
N
Gnd
DO 2
120/24
N
Gnd
P0250-063
750-512
Right Steering Cylinder External
5 Pin Male Solenoid Valve
Green
Red
Yellow
Black
White
Retract
Cable
P0854-343
Note:
The Mechanical assembly number are A26020A for the Panel and A26304A for the Box and connectors.
120V 24Vdc
0Vdc Neutral

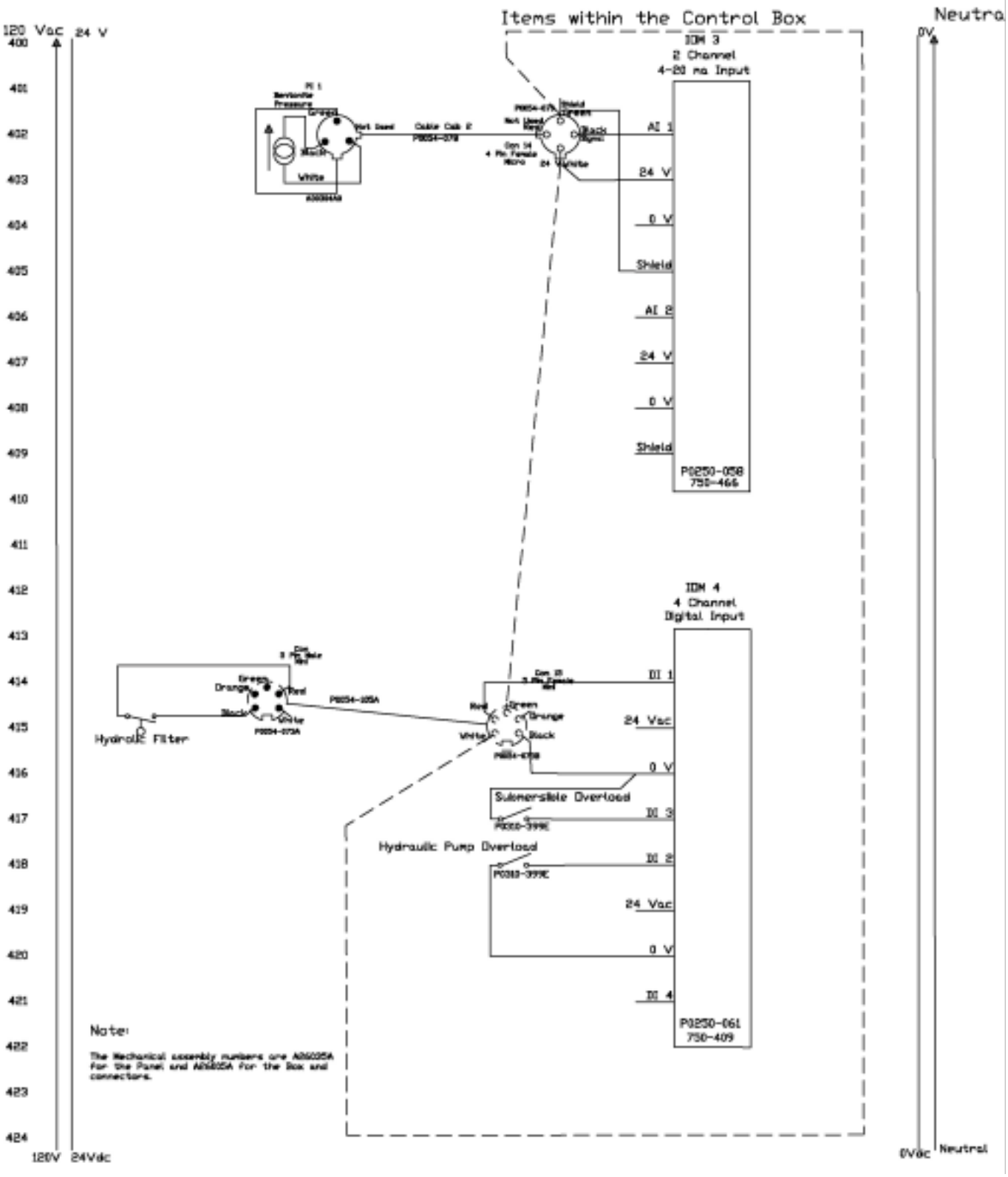

120V 24Vdc
0Vdc Neutral
Items within the Control Box
IOM 18
2 Channel Relay Output
DO 1
120/24V
N
Gnd
DO 2
120/24
N
Gnd
P0250-063
750-512
Con17 Pin 2
615
Con17 Pin3
614
IOM 19
2 Channel Relay Output
DO 1
120/24V
N
Gnd
DO 2
120/24
N
Gnd
P0250-063
750-512
Cable P0854-343
Cutting Valve Open
3 Pin Male Solenoid Valve
Yellow
Black
White
Close
Note:
The Mechanical assembly number are A26303A for the Panel and A26304A for the Box and connectors.
120V 24Vdc
0Vdc Neutral

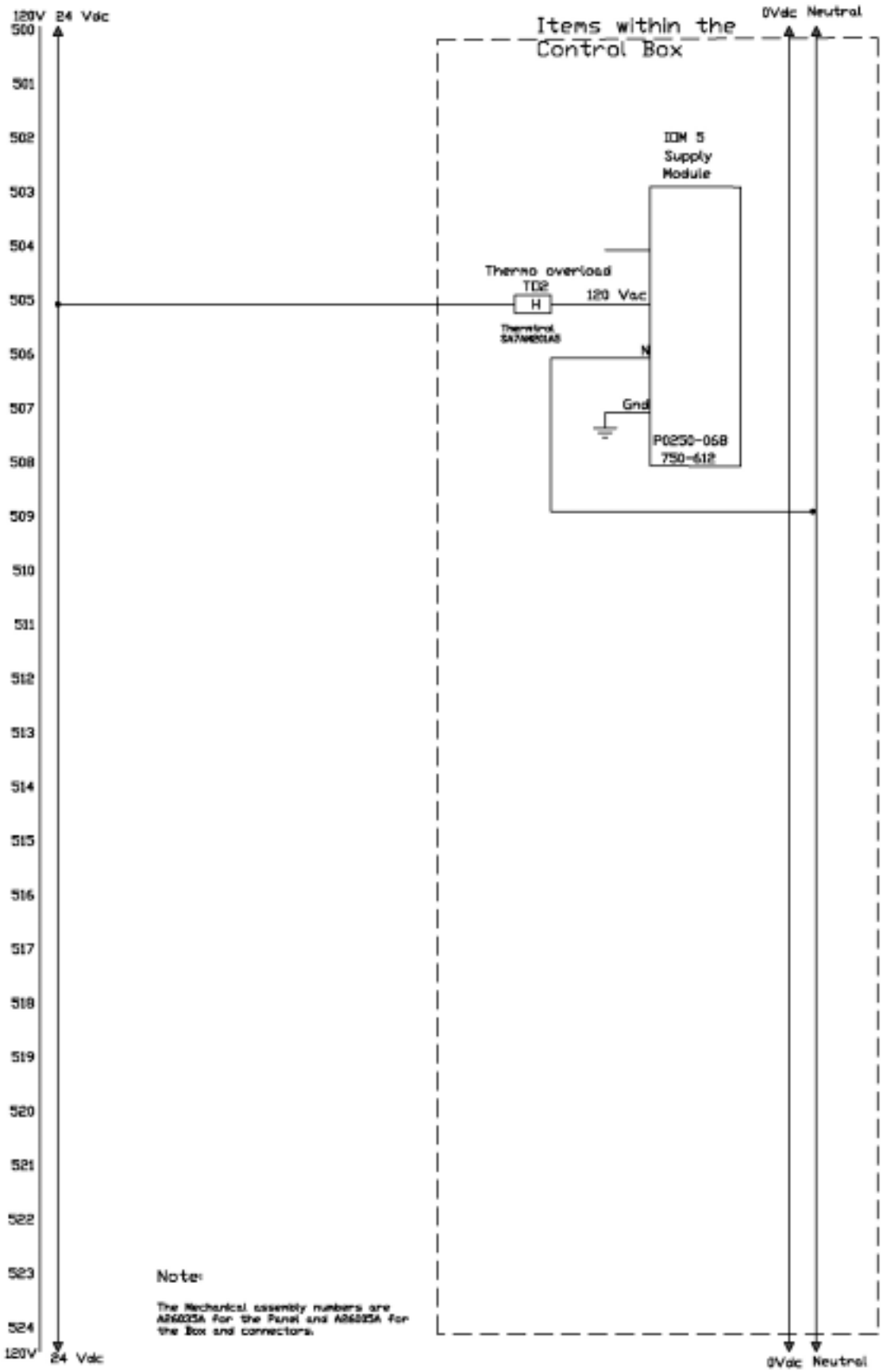
SL30 MIDDLE SECTION SCHEMATICS

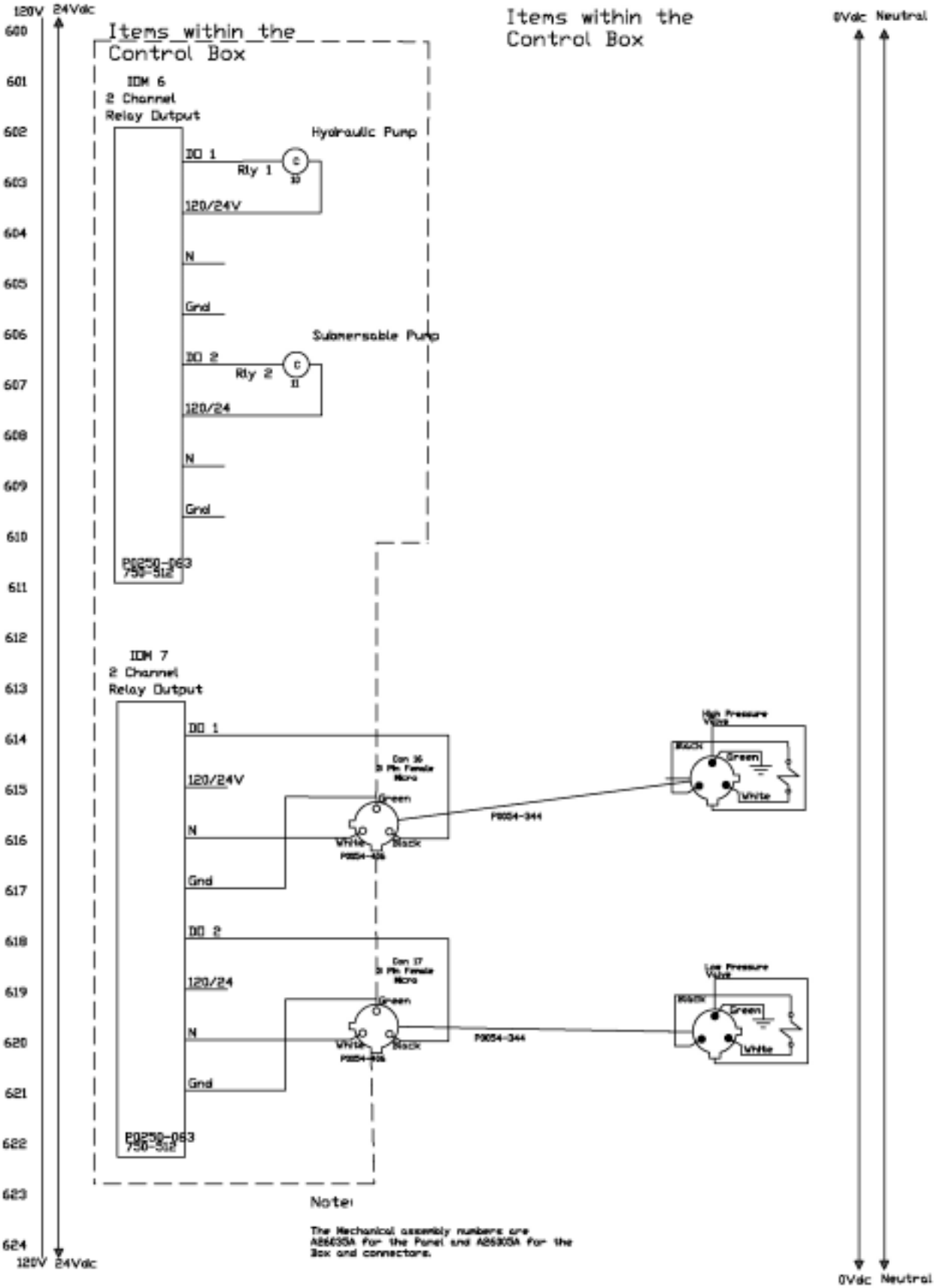


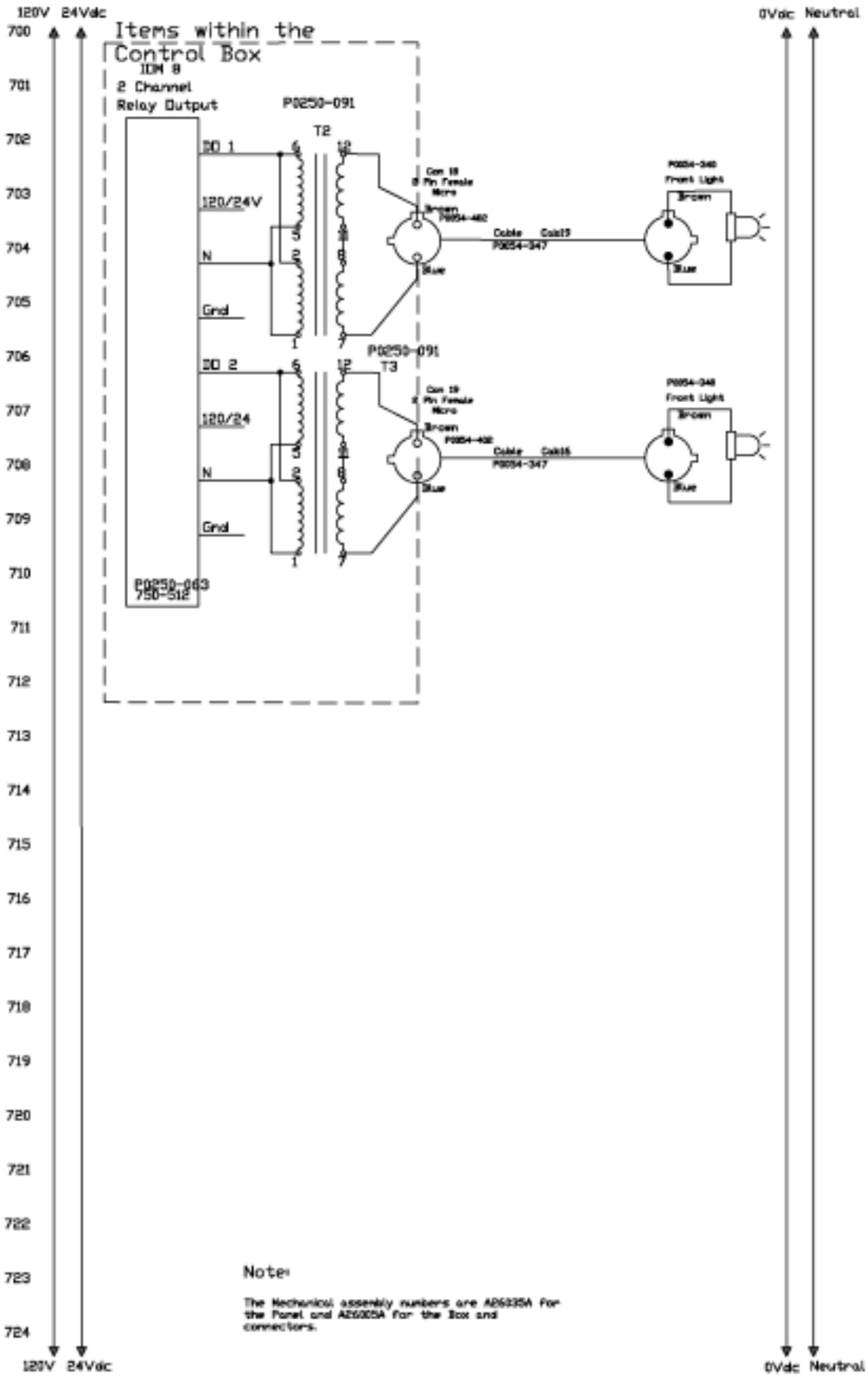

120 Vac
Items within the Control Box
Neutral
PS1
Kepco Power Supply
24 V 4.2 A
Thermo Overload
120 Vac
N
24 VDC
0 VDC
P0250-074
Gnd
Ethernet Extender
+5V Center
RJ45 Interface
Line
RJ45
Orange
Red
To Vago
Note:
The Mechanical assembly numbers are A26035A for the Panel and A26005A for the Box and connectors.
120V 24 V
0 Vdc Neutral


Items within the Control Box
Neutral
120 Vac
24 V
0V
400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
IOM 3
2 Channel
4-20 ma Input
AI 1
24 V
0 V
Shield
AI 2
24 V
0 V
Shield
P0250-058
750-466
IOM 4
4 Channel
Digital Input
DI 1
24 Vac
0 V
Submersible Overload
DI 3
Hydraulic Pump Overload
DI 2
24 Vac
0 V
DI 4
P0250-061
750-409
Hydraulic Filter
Note:
120V
24Vdc
0Vdc
Neutral

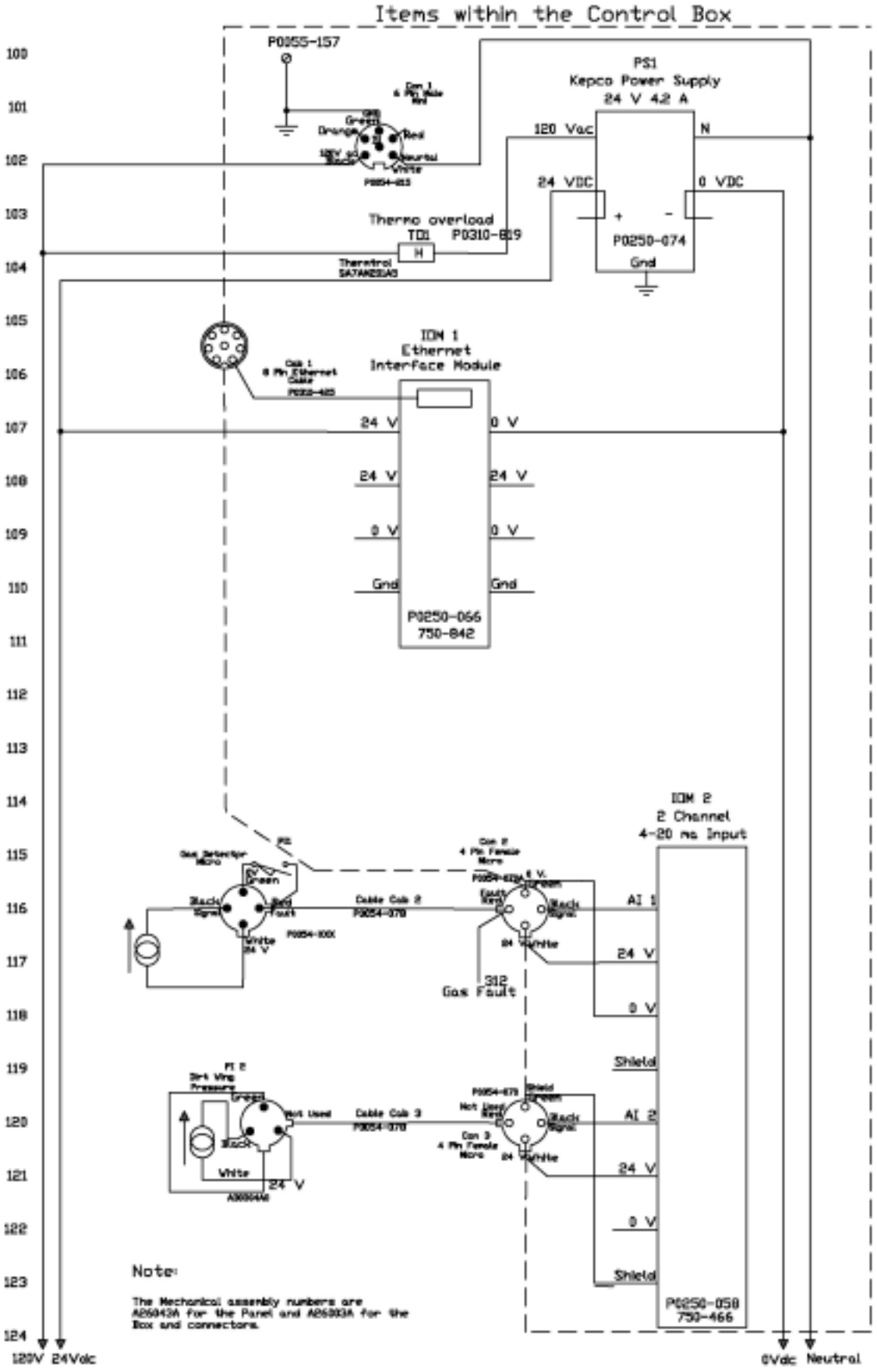

Items within the Control Box
120 Vac
24 V
Neutral
0V
IDM 3
2 Channel
4-20 ma Input
AI 1
24 V
0 V
Shield
AI 2
24 V
0 V
Shield
P0250-058
750-466
IDM 4
4 Channel
Digital Input
DI 1
24 Vac
0 V
DI 3
DI 2
24 Vac
0 V
DI 4
P0250-061
750-409
Submersible Overload
Hydraulic Pump Overload
Hydraulic Filter
Note:
The Mechanical assembly numbers are A05035A For the Panel and A05805A For the Box and connectors.
120V
24Vdc
0Vdc
Neutral

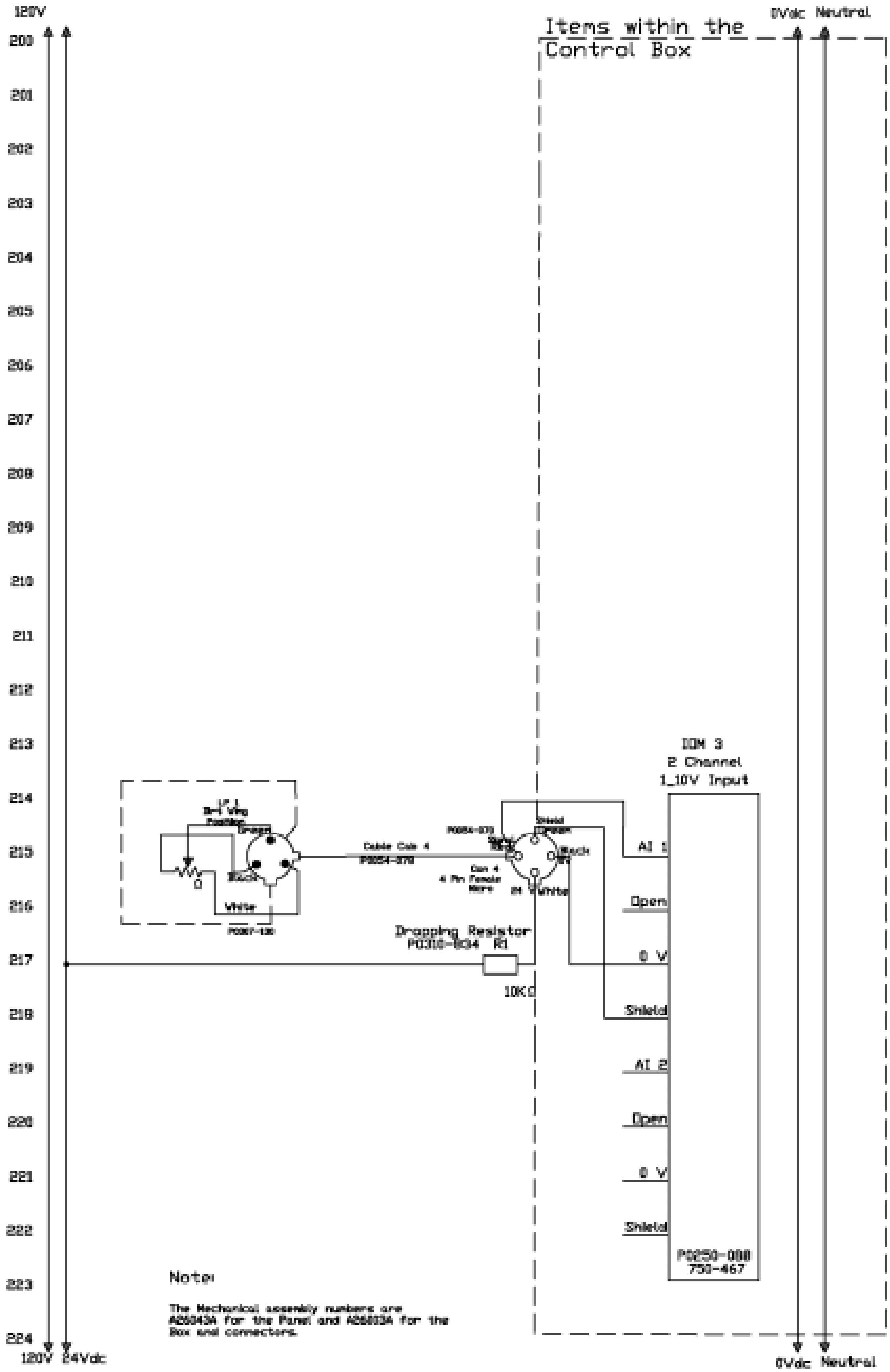

120V 24 Vdc
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
521
522
523
524
120V 24 Vdc
Items within the Control Box
0Vdc Neutral
IDM 5
Supply
Module
Thermo overload
TD2
H
120 Vac
N
Gnd
P0252-068
750-612
Note:
The Mechanical assembly numbers are A96025A for the Panel and A96035A for the Box and connectors.
0Vdc Neutral

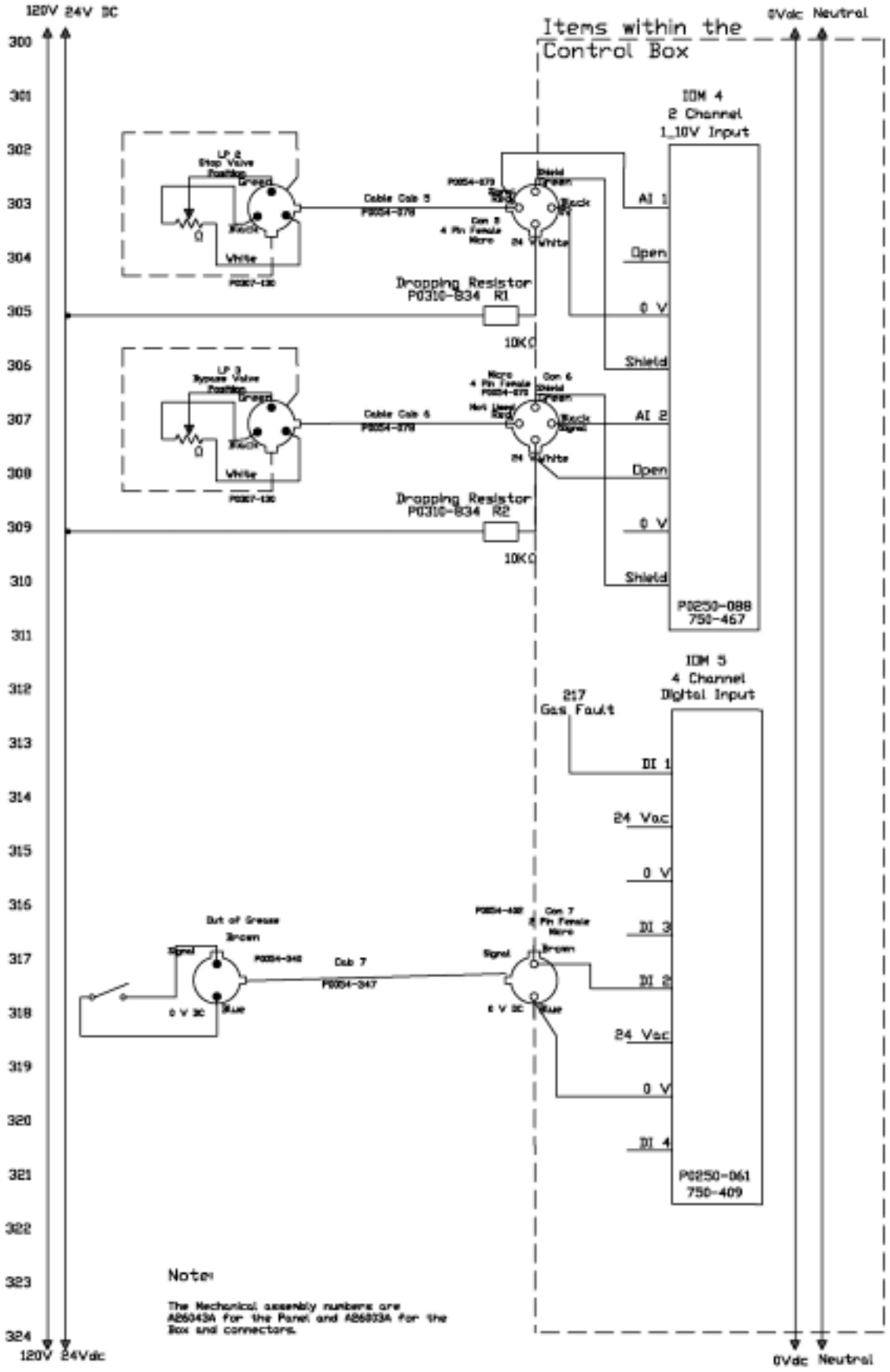

120V
24Vdc
Items within the Control Box
IDM 6
2 Channel
Relay Output
Hydraulic Pump
DO 1
Rly 1
120/24V
N
Gnd
Submersable Pump
DO 2
Rly 2
120/24
N
Gnd
P0250-063
750-512
IDM 7
2 Channel
Relay Output
DO 1
120/24V
N
Gnd
DO 2
120/24
N
Gnd
P0250-063
750-512
Green
White
Black
P0054-344
Items within the Control Box
0Vdc
Neutral
Note:
The Mechanical assembly numbers are A86035A for the Panel and A86305A for the Box and connectors.
120V
24Vdc
0Vdc
Neutral

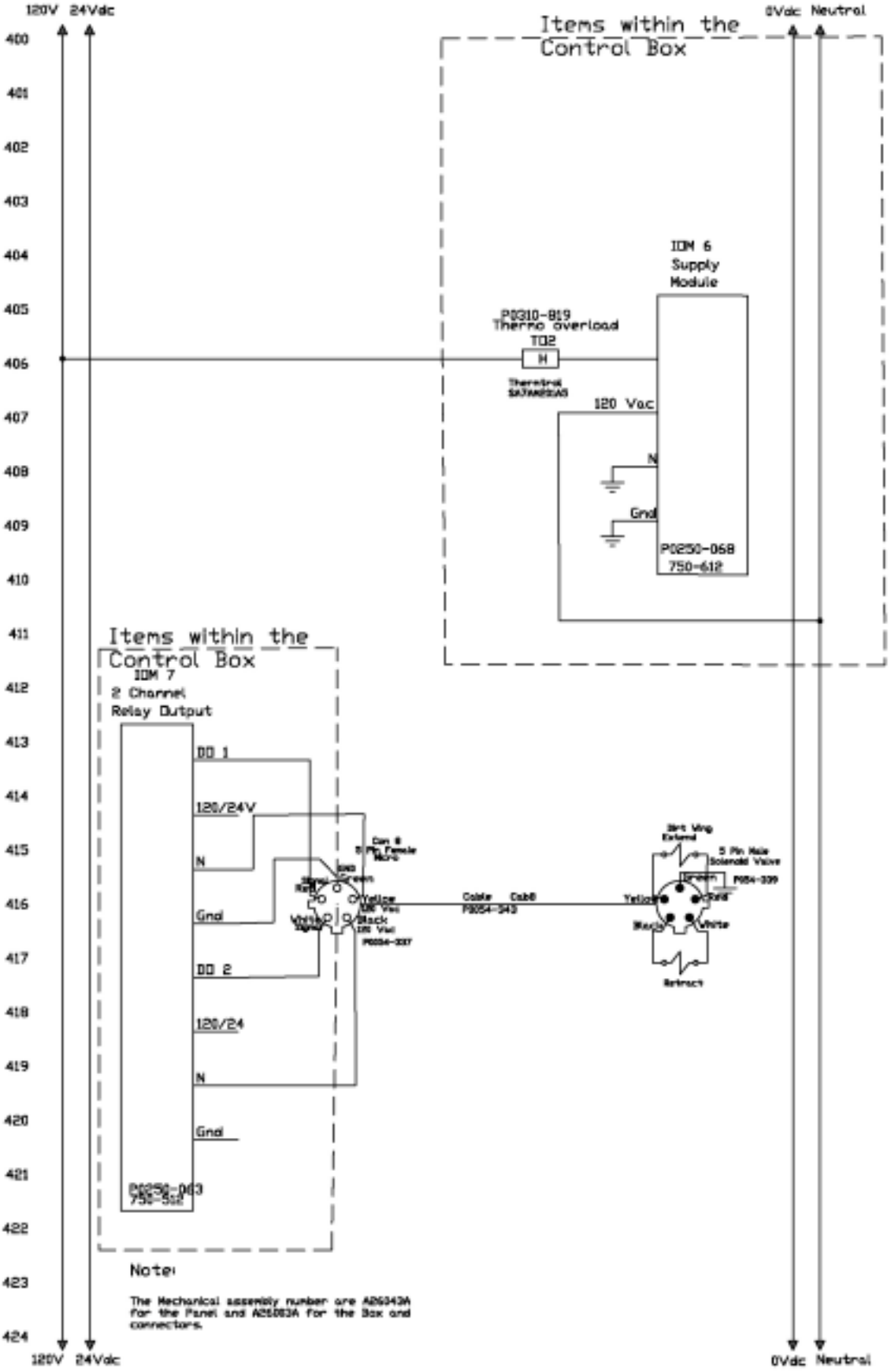

120V 24Vdc
0Vdc Neutral
Items within the Control Box
IOM 8
2 Channel
Relay Output
P0250-091
T2
DO 1
120/24V
N
Gnd
P0250-091
T3
DO 2
120/24
N
Gnd
P0250-063
750-512
Front Light
Brown
Blue
Cable
P0054-347
Note:
The Mechanical assembly numbers are A25335A for the Panel and A25005A for the Box and connectors.
120V 24Vdc
0Vdc Neutral

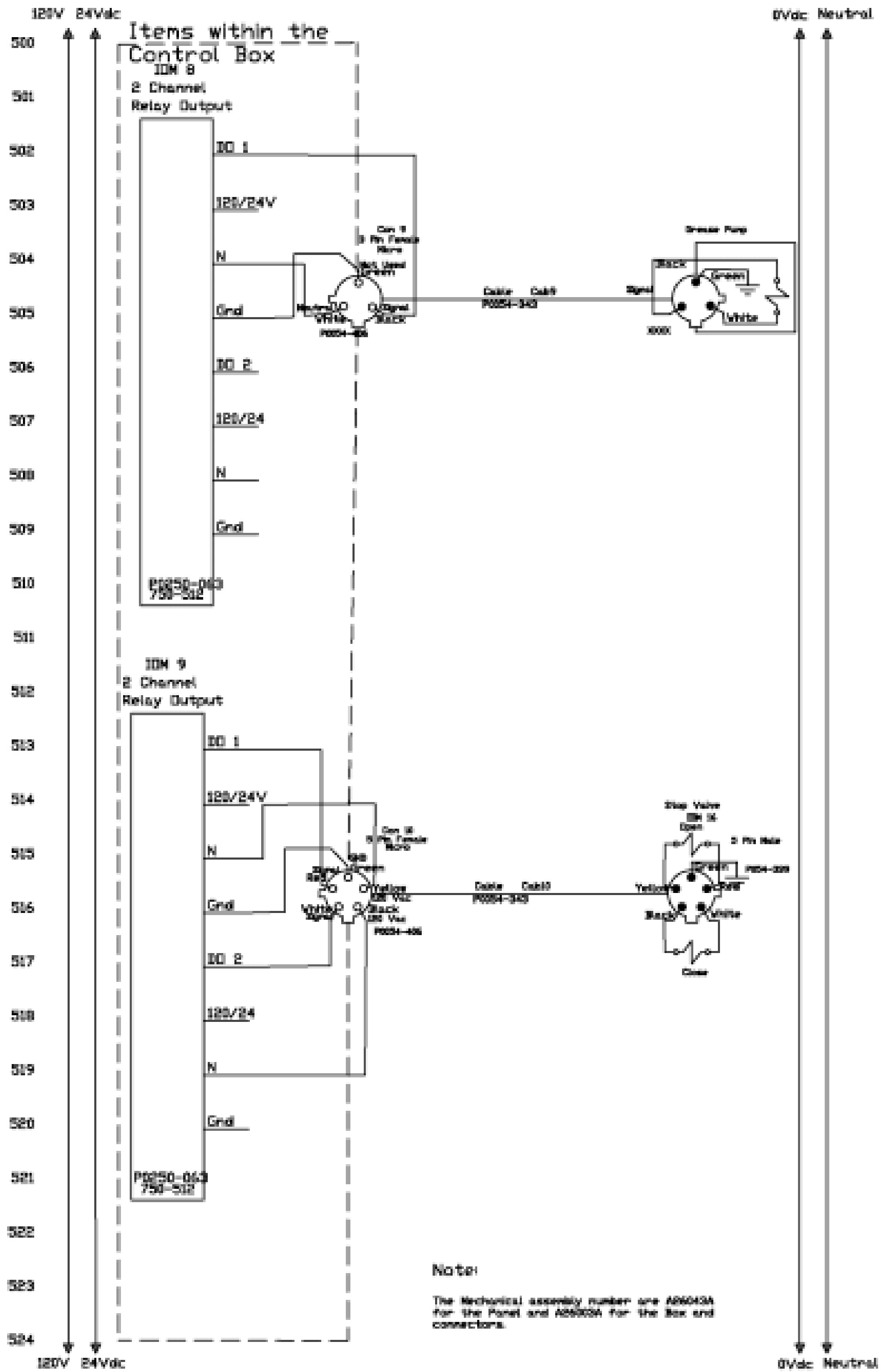
SL30 TRAILING SECTION SCHEMATICS

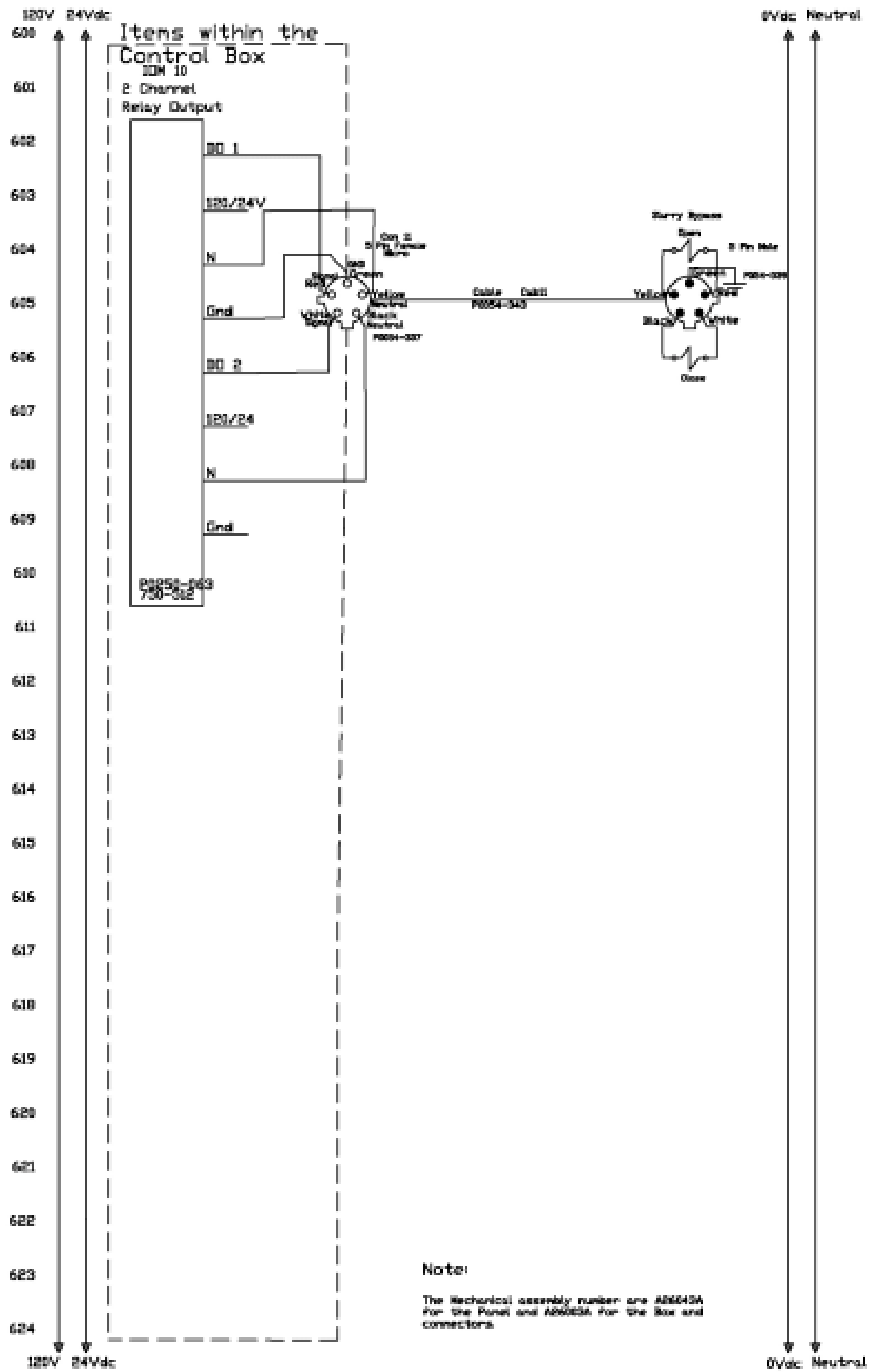



120V
200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
120V 24Vdc
Items within the Control Box
0Vdc Neutral
IOM 3
2 Channel
1_10V Input
AI 1
Open
0 V
Shield
AI 2
Open
0 V
Shield
P5250-000
750-467
Cable Cab 4
White
Black
Green
Dropping Resistor
P0310-8034 R1
10KΩ
24 V White
Note:
The Mechanical assembly numbers are A26343A for the Panel and A26803A for the Box and connectors.
0Vdc Neutral


120V 24V DC
0Vdc Neutral
Items within the Control Box
IOM 4
2 Channel
1_10V Input
AI 1
Open
0 V
Shield
AI 2
Open
0 V
Shield
P0250-088
750-467
Dropping Resistor
P0310-834 R1
10KΩ
Dropping Resistor
P0310-834 R2
10KΩ
LP 2
Stop Valve
Position
Cable Cab 5
P0054-378
Con 5
4 Pin Female
Micro
LP 3
Bypass Valve
Position
Cable Cab 6
P0054-378
Con 6
4 Pin Female
Micro
IOM 5
4 Channel
Digital Input
217
Gas Fault
DI 1
24 Vac
0 V
DI 3
DI 2
24 Vac
0 V
DI 4
P0250-061
750-409
Out of Grease
Brown
Blue
0 V DC
Cab 7
P0054-347
Con 7
8 Pin Female
Micro
Signal
Brown
6 V DC
Blue
Note:
The Mechanical assembly numbers are
A26043A for the Panel and A26033A for the
Box and connectors.
120V 24Vdc
0Vdc Neutral


120V 24Vdc
0Vdc Neutral
Items within the Control Box
IDM 6
Supply
Module
P0310-819
Thermo overload
TD2
H
120 Vac
N
Gnd
P0250-068
750-612
Items within the Control Box
IDM 7
2 Channel
Relay Output
DO 1
120/24V
N
Gnd
DO 2
120/24
N
Gnd
P0250-003
Cable
P0254-343
Note:
The Mechanical assembly number are A05343A for the Panel and A05083A for the Box and connectors.
120V 24Vdc
0Vdc Neutral

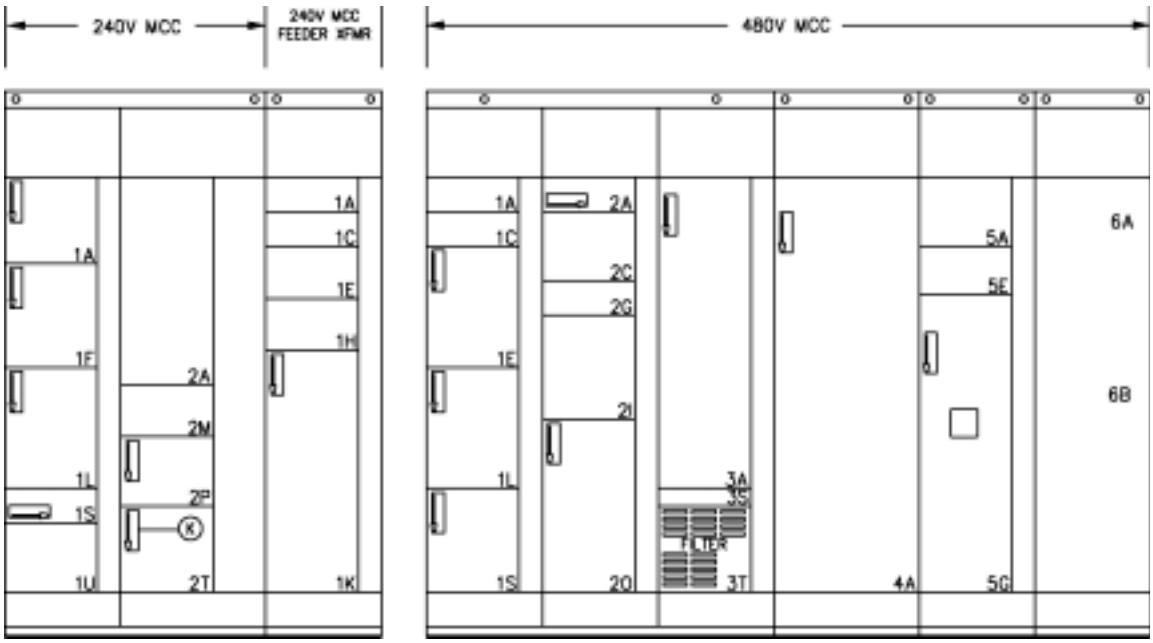

120V 24Vdc
0Vdc Neutral
Items within the Control Box
500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
521
522
523
524
IDM 8
2 Channel
Relay Output
DO 1
120/24V
N
Gnd
DO 2
120/24
N
Gnd
P0250-063
750-512
IDM 9
2 Channel
Relay Output
DO 1
120/24V
N
Gnd
DO 2
120/24
N
Gnd
P0250-063
750-512
Grease Pump
Green
White
Cable Cab9
Cable Cab10
Yellow
Black
White
Close
Note:
120V 24Vdc
0Vdc Neutral


120V 24Vdc
Items within the Control Box
IOM 10
2 Channel
Relay Output
BO 1
120/24V
N
Gnd
BO 2
120/24
N
Gnd
0Vdc Neutral
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
621
622
623
624
Note:

MOTOR CONTROL CENTER (MCC) SCHEMATICS

The Motor Control Center (MCC) is made of standardized vertical sections consisting of totally enclosed, dead front, free standing structures bolted together. These sections support and house control units, a common bus bar for distributing power to the control units, and a network of wire trough and conductor entrance areas to accommodate outgoing load and control wires.

Use the illustration below to locate the control units that are referenced in the MCC electrical schematics on the following pages.



NOTICE: THIS DOCUMENT REPRESENTS AN ELECTRONIC TRANSLATED VERSION OF THE ORIGINAL SQUARE D DRAWING. DESPITE THE USE OF REASONABLE PRECAUTION, THE TRANSLATION PROCESS MAY HAVE INTRODUCED SOME ERRORS. THE ORIGINAL DRAWING SHOULD BE CONSULTED IF THERE IS ANY DOUBT ABOUT THE INTEGRITY OF THE DRAWING DATA.

REV	DESCRIPTION	BY	DATE

COMPONENT INFORMATION

MCC DESIGNATION: 480V MCC

ADDRESS SPX1	ADDRESS SPX2	UNIT LOC	NAMEPLATE DESIGNATION	UNIT TYPE	SIZE	HP	DISC AMPS	CONTROL (or DISTRIBUTION) TRANSFORMER VA	FUSE SIZE PRI	FUSE SIZE SEC	UNIT FEATURES	DRAWING NUMBER
		1A	240 1 Feed LUGS	240 Feed LUGS			600				U676,DID	[illegible]
		1C		SPACE							U676	
		1E	FEED PUMP Control (VFD)	FVNR	4	75					FS,X22,K01,U273, Y535,Y741,Y145,DID, R179,BR04,U678	[illegible]
A=16 A=17		1L	HYDRAULIC PUMP	FVNR	4	100	200				FS,X22,K01,U273, Y535,Y741,Y145,DID, R179,BR04,U678	[illegible]
A=18 A=19		1S	WATER JETTING PUMP	FVNR	3	50	100				FS,X22,K01,U273, Y512,Y535,Y741,DID, Y144,R179,BR04,	[illegible]
A=20 A=21											U678	
		2A	Simplex Power	SPACE							U676	
		2C	Simplex Base	SPACE							U676	
		2I	BORING HEAD FEEDER	MLBKR			200				DID,U676,Y741, U042,U103	[illegible]
A=22 A=23		2O	Head Power	FVNR	3	50	100				[illegible]	[illegible]
A=24 A=25	A=26 A=27	3A	BOOSTERPUMP Control	VFDC/T W/LOAD CONT.	D50	60		300 / 50	1.5	2.5	FT1,U272,DID,M11, GM04,Y741,X22,FT1, R179,U678	[illegible]
		3E		SPACE								
		3F	BOOSTERPUMP OUTPUT FILTER	LOAD FILTER							U676,K01	[illegible]
A=28 A=29		4A	RETURN PUMP	VFDC/T W/LOAD CONT.	D50	60	150	300	1.5	2.5	FT1,BR04,Y741,U272, U676,DID,M11	[illegible]
		5A	MODBUS/ETHERNET BRIDGE	MT.UNIT							U676,ETH,DID	[illegible]
		5E		SPACE							U678	
		5G	MAIN	AB/MBR			800				PL1,PL2,DID,U271, U232,Y522,U678, Y144,Y741,G982	[illegible]
		6A	BOOSTERPUMP VFD									
		6B	Feed Pump VFD									

ADDRESS SPX1	ADDRESS SPX2	UNIT LOC	NAMEPLATE DESIGNATION	UNIT TYPE	SIZE	HP	DISC AMPS	CONTROL (or DISTRIBUTION) TRANSFORMER VA	FUSE SIZE PRI	FUSE SIZE SEC	UNIT FEATURES	DRAWING NUMBER

H01 SS/OR HUX
BR04 SQD4/SPX2A2X2,M1ST
U271 TYPE K OPER.
U678 UNIT NP GREY
Y512 HIGH IC BREAKER
Y35 GRD. O/L RELAY
GFM GRD. FLT. MOD.
PL1 RED LED P.L.

FS FUSED SEP CTRL
X22 2 NO 2 NC INTK.
Y535 THERMAL MAG.BRKR
FT 120V-24 XFMR
#9070 T500 D
CR CR/DC66 RELAY
J872/24RA12
P2 GREEN LED P.L.

FT1 FUSED CTRL XFMR
R179 INTERPOSING RELAY
U103 3" DR/UNIT EXT.
U386 STARTER G.F.I.
Y145 TRANS SUPPRESS
Y741 SPDT C/B INTK
011 LOAD FILTER
U272 OMIT CSP

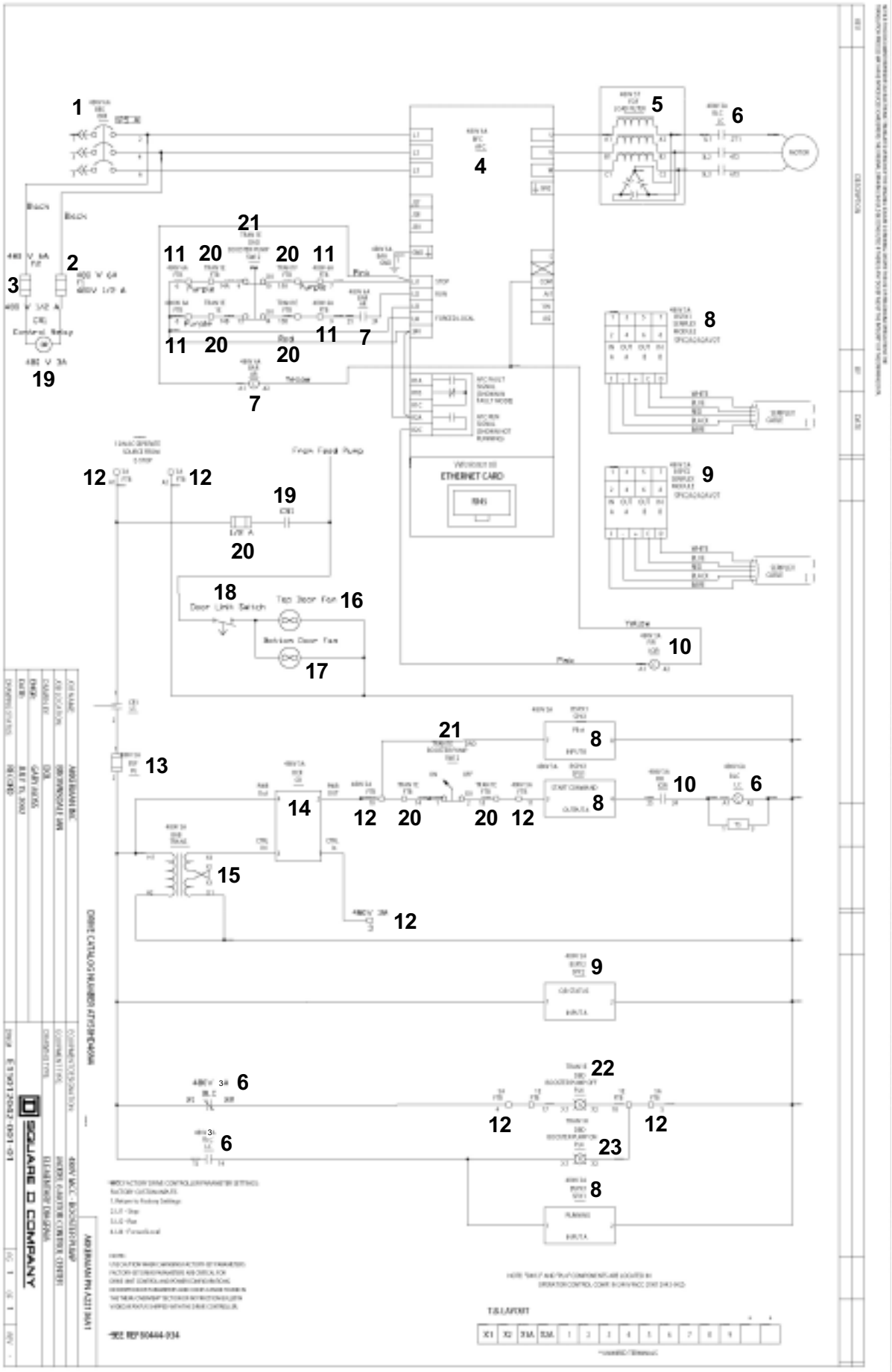
G982 PM620
U232 500V EMTR LABEL
U042 CURR LIMIT BRKR
Y144 PHASE FAIL REL.
ETH ETHERNET BRIDGE
8174CE100014
DID DIAGRAM IN DOOR
AA1 ETHERNET CARD

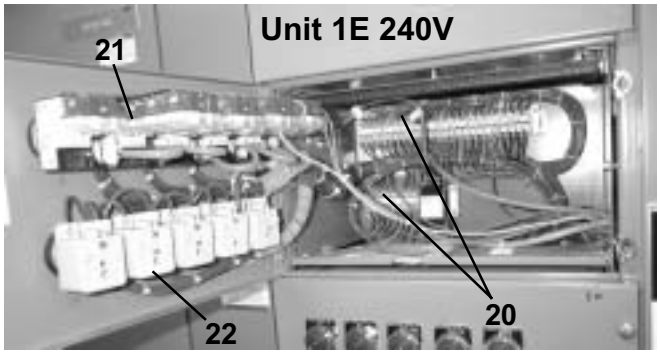
Akkerman PN A22136A0

JOB NAME:	AKKERMAN INC
JOB LOCATION:	BROWNSDALE MN
DRAWN BY:	DOL
ENGR:	GARY MOSS
DATE:	JULY 12 2002
DRAWING STATUS:	RECORD
EQUIPMENT DESIGNATION	480V MCC
EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWING TYPE:	COMPONENT INFORMATION

SQUARE D COMPANY

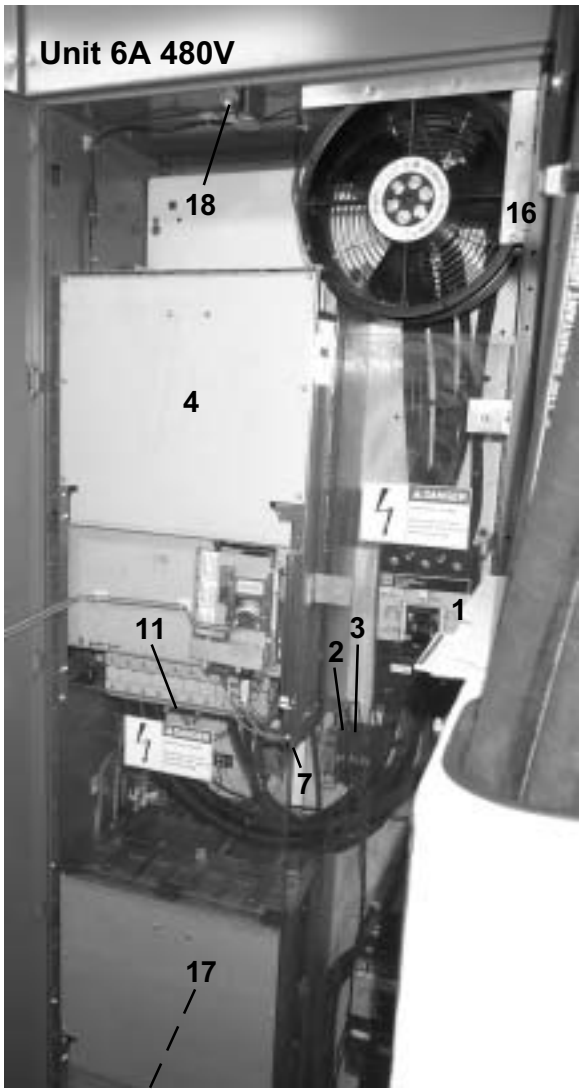
Dwg: I1501 2042-001-01   PG 1 OF 1   REV -

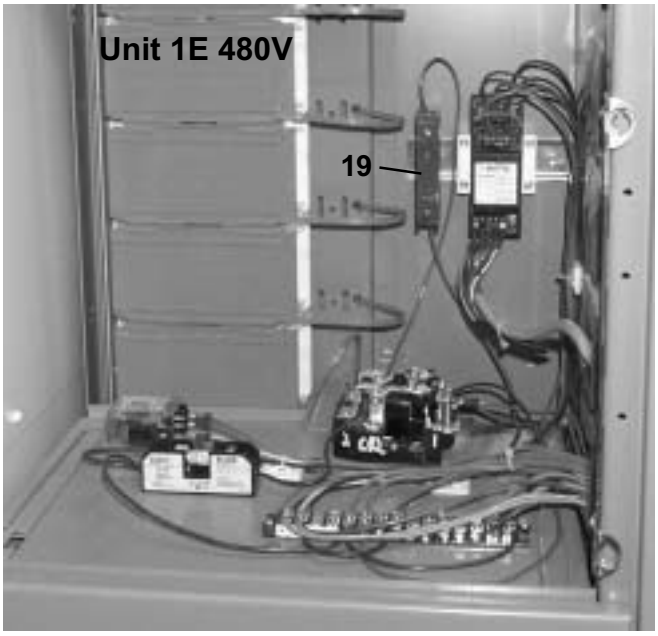

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
ETHERNET CARD
From Feed Pump
Top Door Fan
Bottom Door Fan
Door Limit Switch
SQUARE D COMPANY

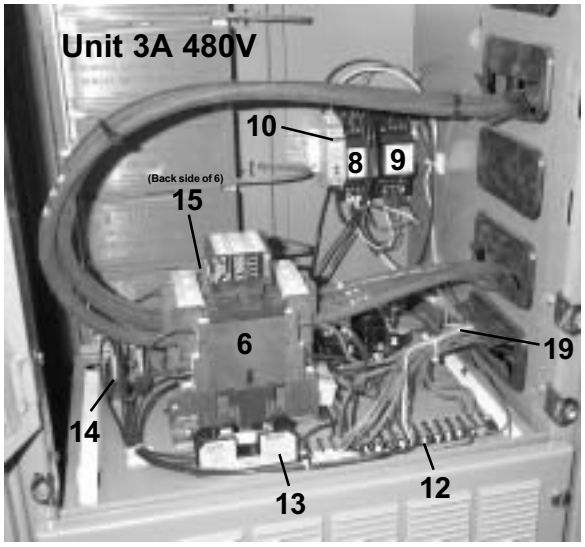

Unit 1E 240V
21
22
20

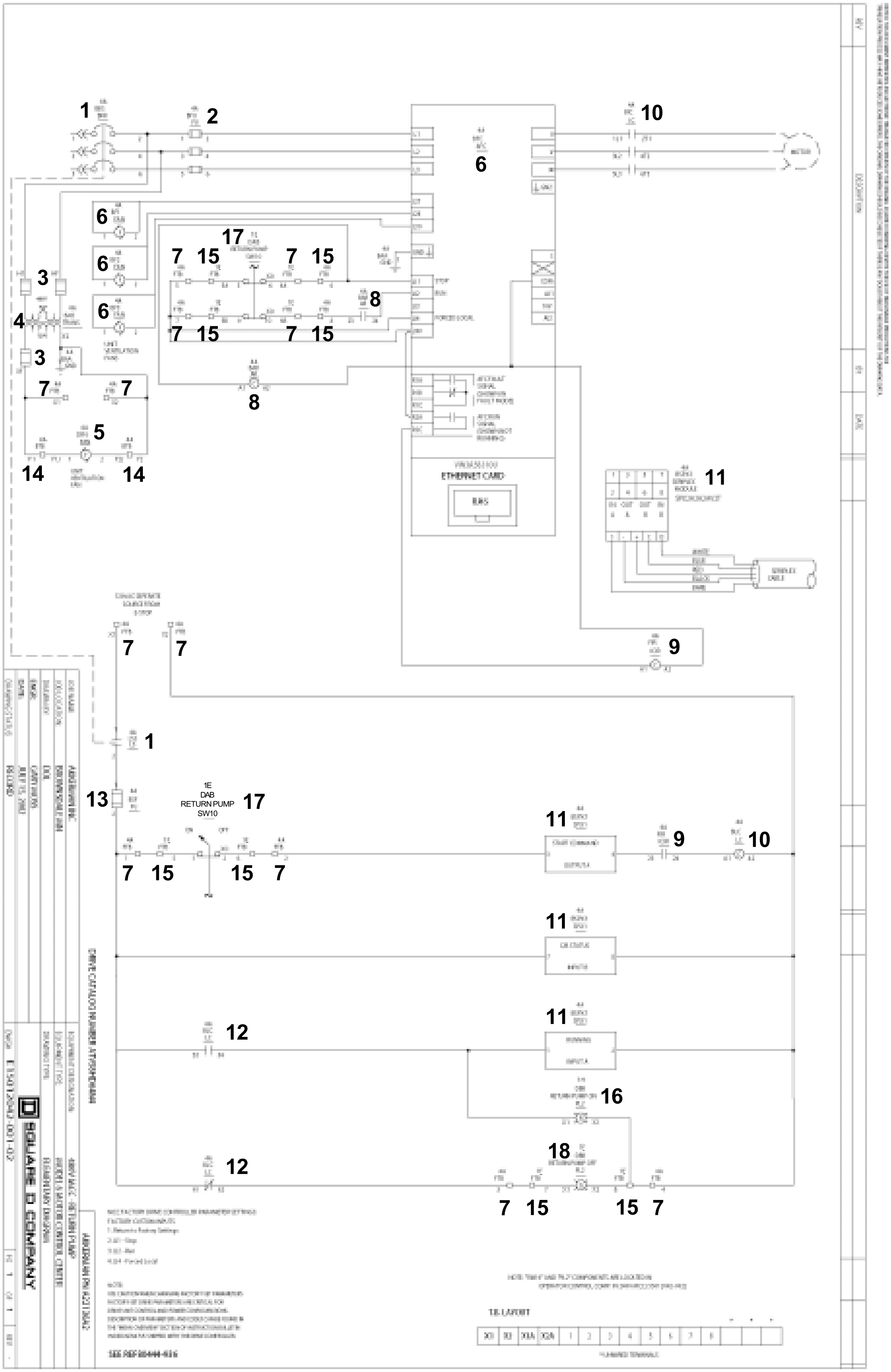

Unit 1H 240V
23

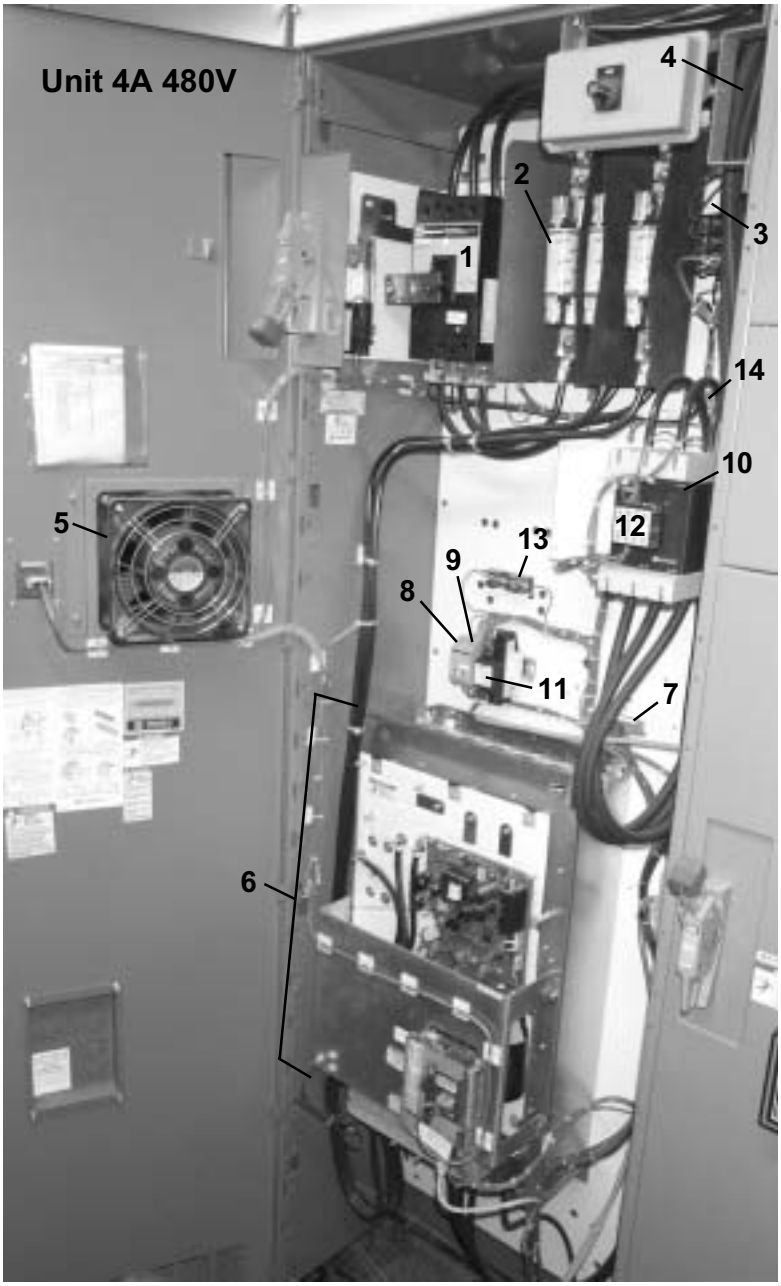

Unit 3T 480V
5

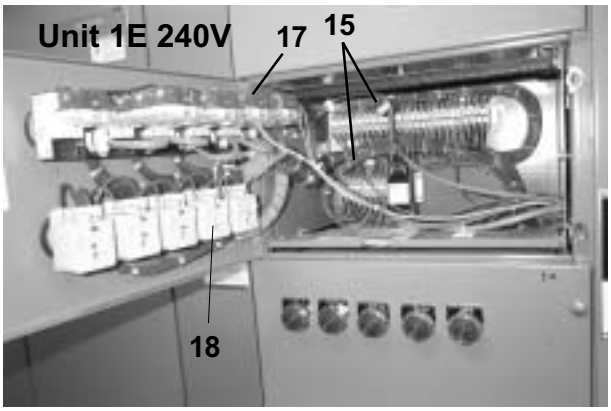

Unit 6A 480V
18
16
4
1
11
2
3
7
17


Unit 1E 480V
19

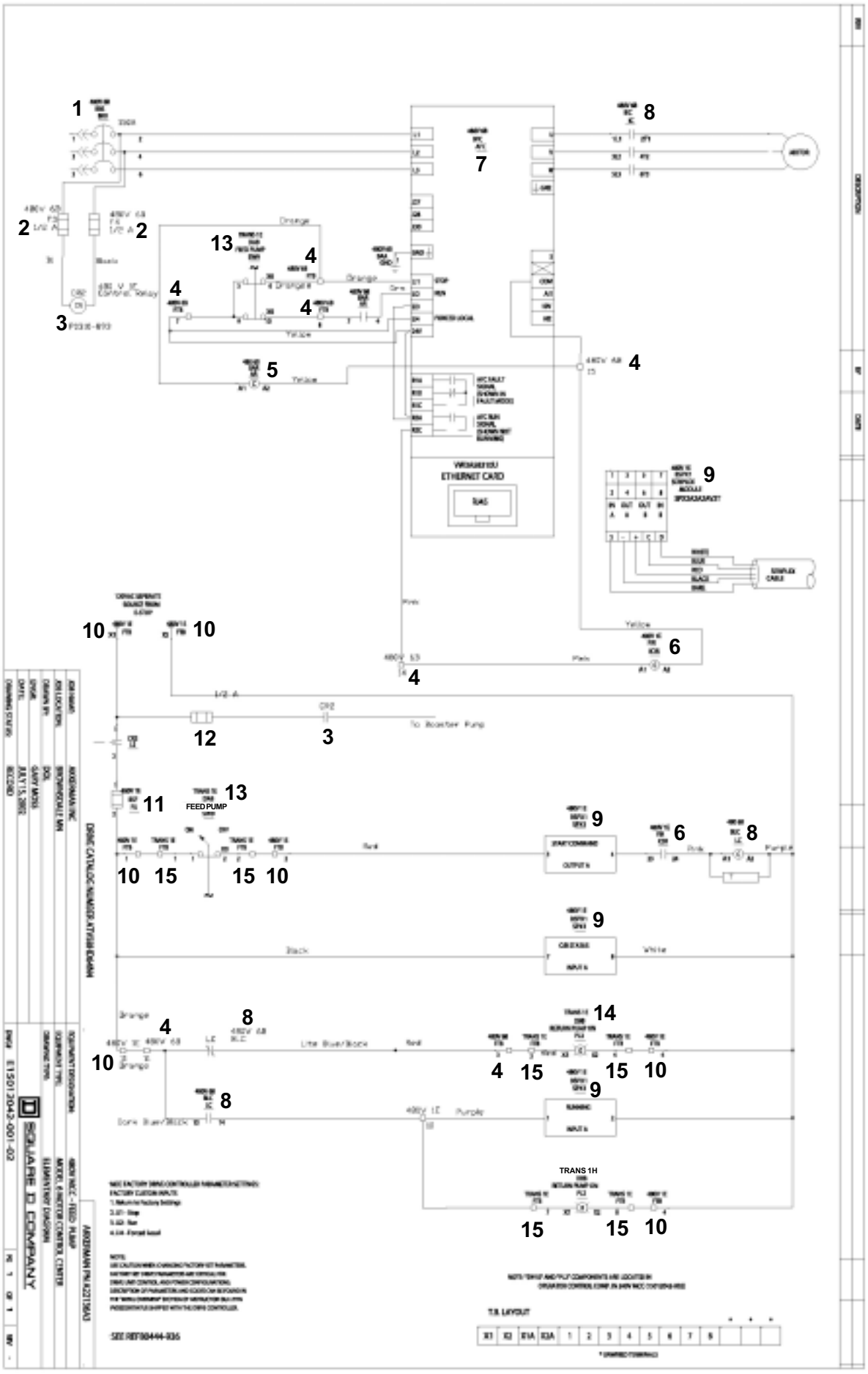

Unit 3A 480V
10
8
9
(Back side of 6)
15
6
19
14
13
12

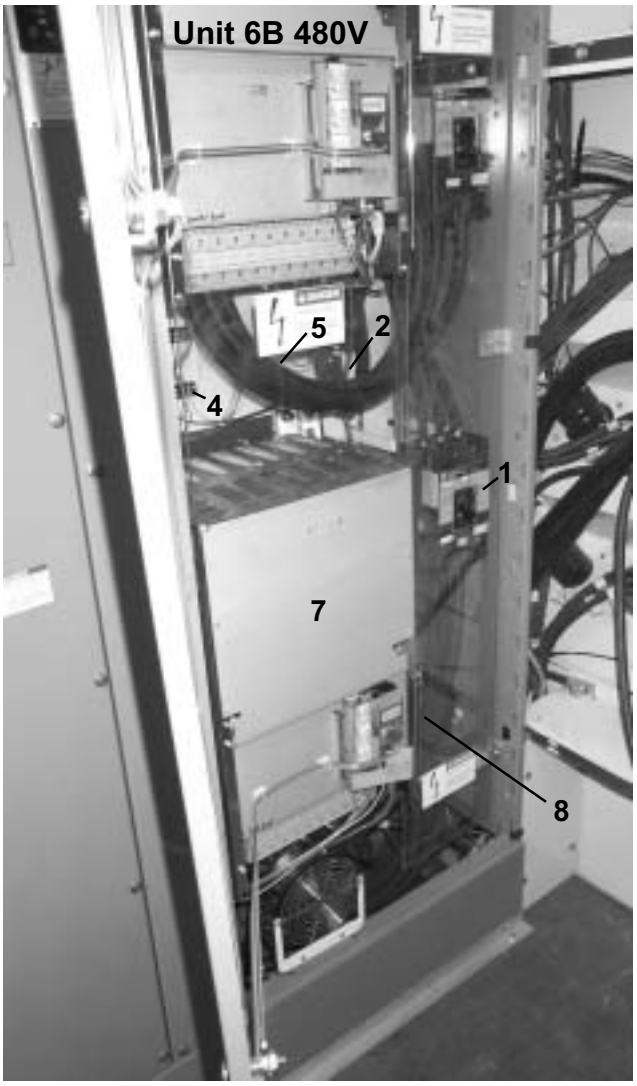

1
2
10
6
17
7
15
8
3
4
5
14
9
11
ETHERNET CARD
13
1E
DAB
RETURN PUMP
SW10
12
16
18
SQUARE D COMPANY
T.B. LAYOUT

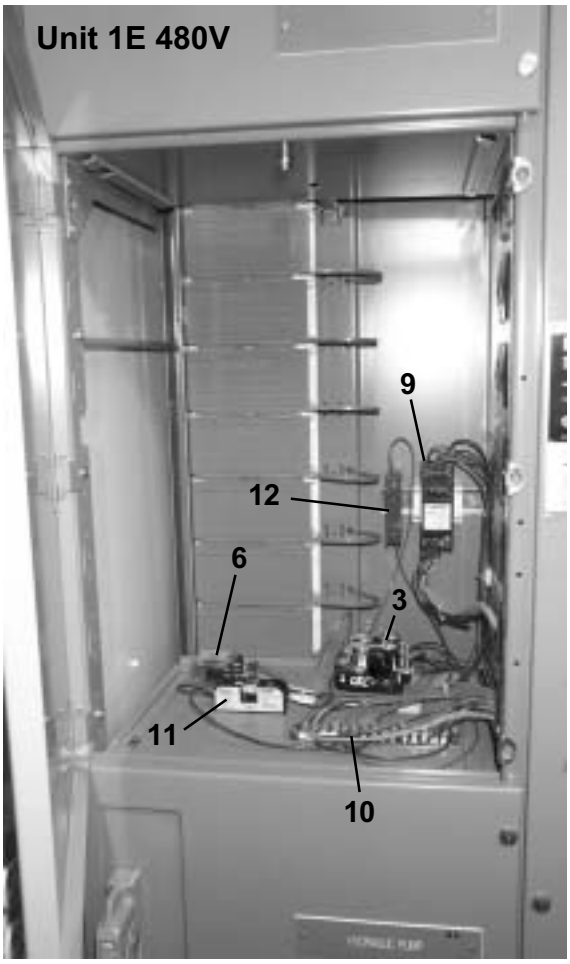

Unit 4A 480V
4
2
3
1
14
10
5
12
13
9
8
11
7
6

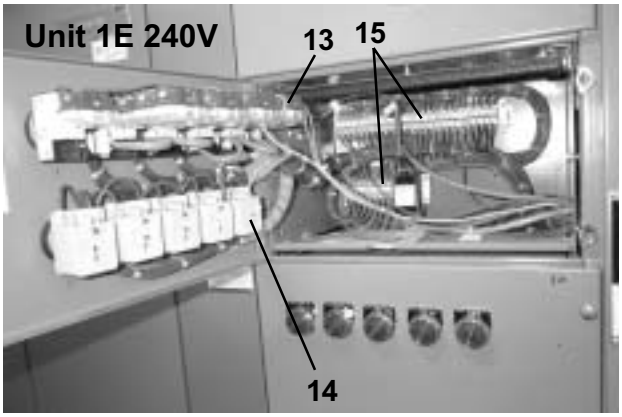

Unit 1E 240V
17
15
18

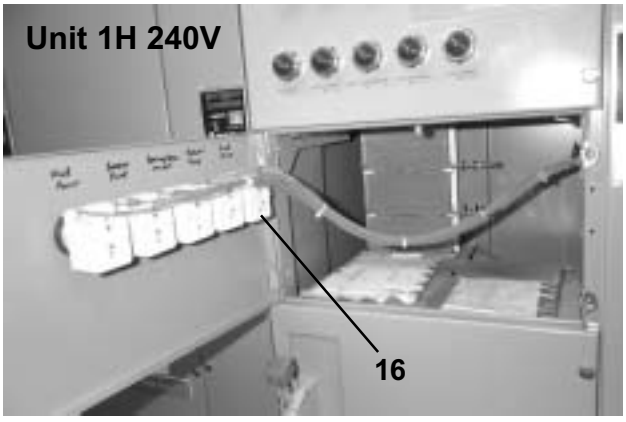

Unit 1H 240V
16

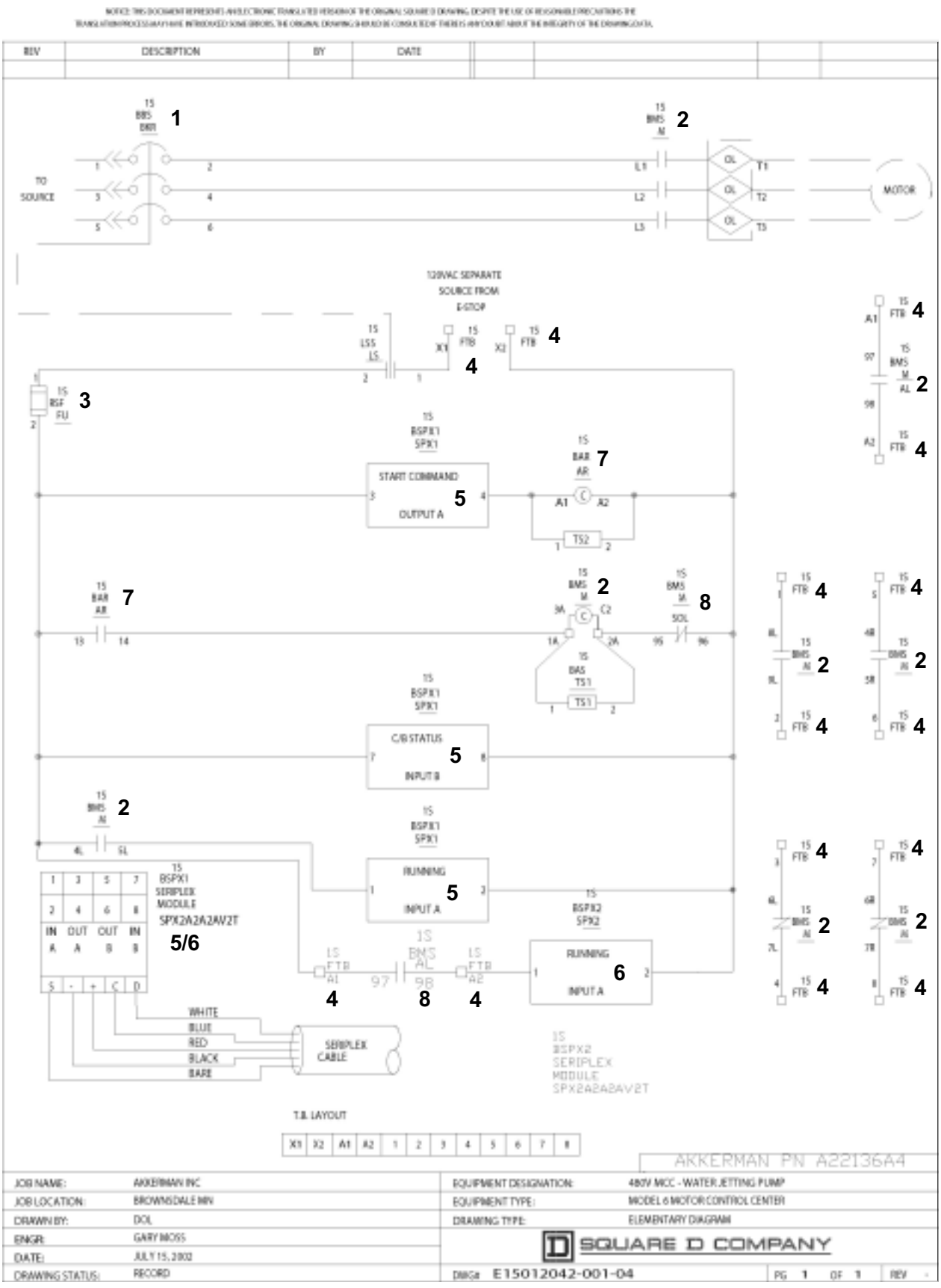

ETHERNET CARD
FEED PUMP
To Booster Pump
TRANS 1H
SQUARE D COMPANY


Unit 6B 480V
5
2
4
1
7
8

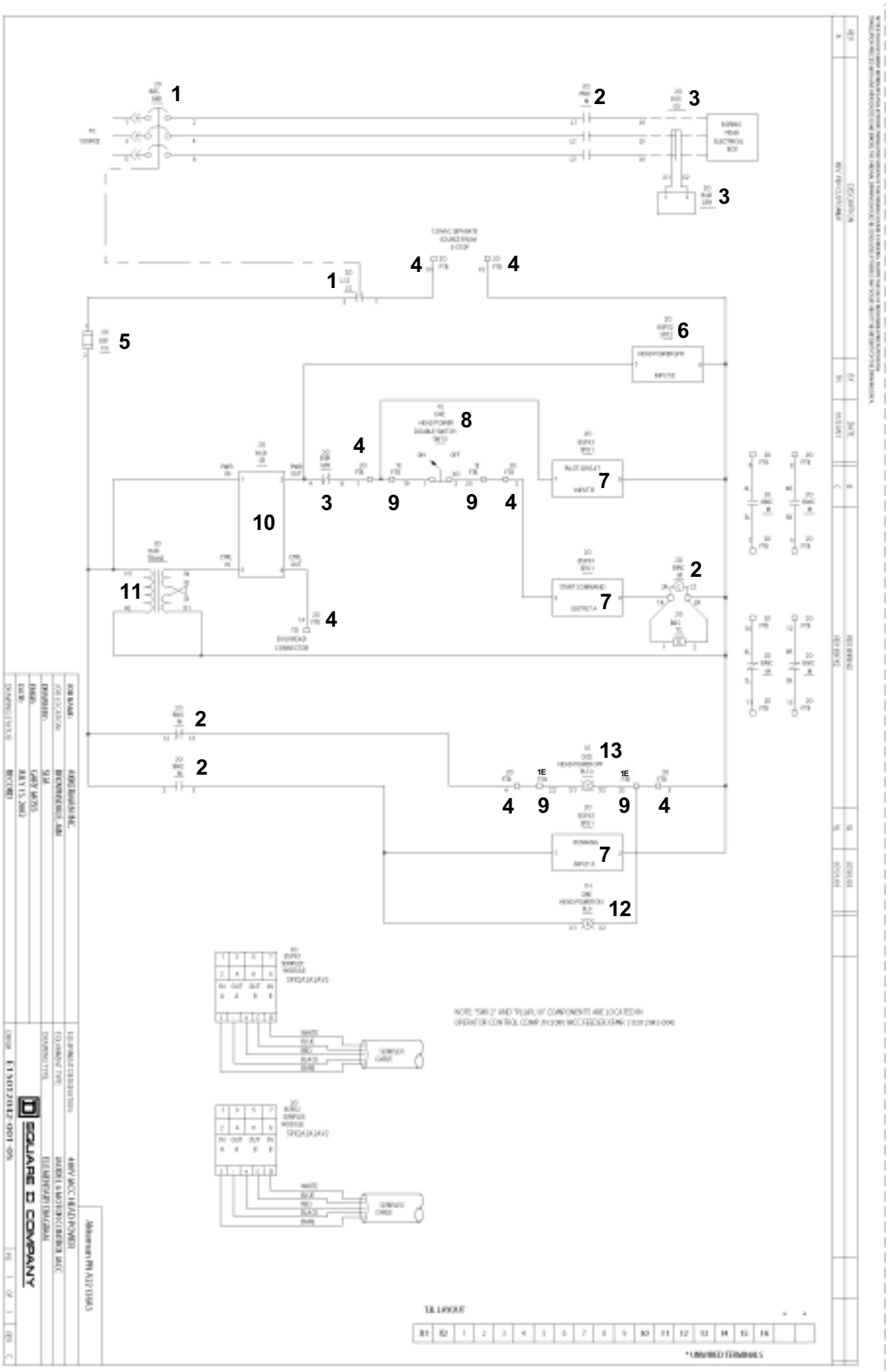

Unit 1E 480V
9
12
6
3
11
10


Unit 1E 240V
13
15
14


Unit 1H 240V
16


REV
DESCRIPTION
BY
DATE
TO SOURCE
MOTOR
120VAC SEPARATE SOURCE FROM E-STOP
START COMMAND
OUTPUT A
C/B STATUS
INPUT B
RUNNING
INPUT A
SERIPLEX MODULE
SPX2A2A2AV2T
5/6
WHITE
BLUE
RED
BLACK
BARE
SERIPLEX CABLE
T.B. LAYOUT
X1 X2 A1 A2 1 2 3 4 5 6 7 8
AKKERMAN P/N A22136A4
JOB NAME: AKKERMAN INC.
JOB LOCATION: BROWNSDALE MN
DRAWN BY: DOL
ENGR: GARY MOSS
DATE: JULY 15, 2002
DRAWING STATUS: RECORD
EQUIPMENT DESIGNATION: 480V MCC - WATER JETTING PUMP
EQUIPMENT TYPE: MODEL 6 MOTOR CONTROL CENTER
DRAWING TYPE: ELEMENTARY DIAGRAM
SQUARE D COMPANY
DWG# E15012042-001-04
PG 1 OF 1
REV -


Unit 1S 480V
8
1
2
8
5
6
3
7
4


1
2
3
3
4
4
1
5
6
8
4
7
3
9
9
4
10
11
2
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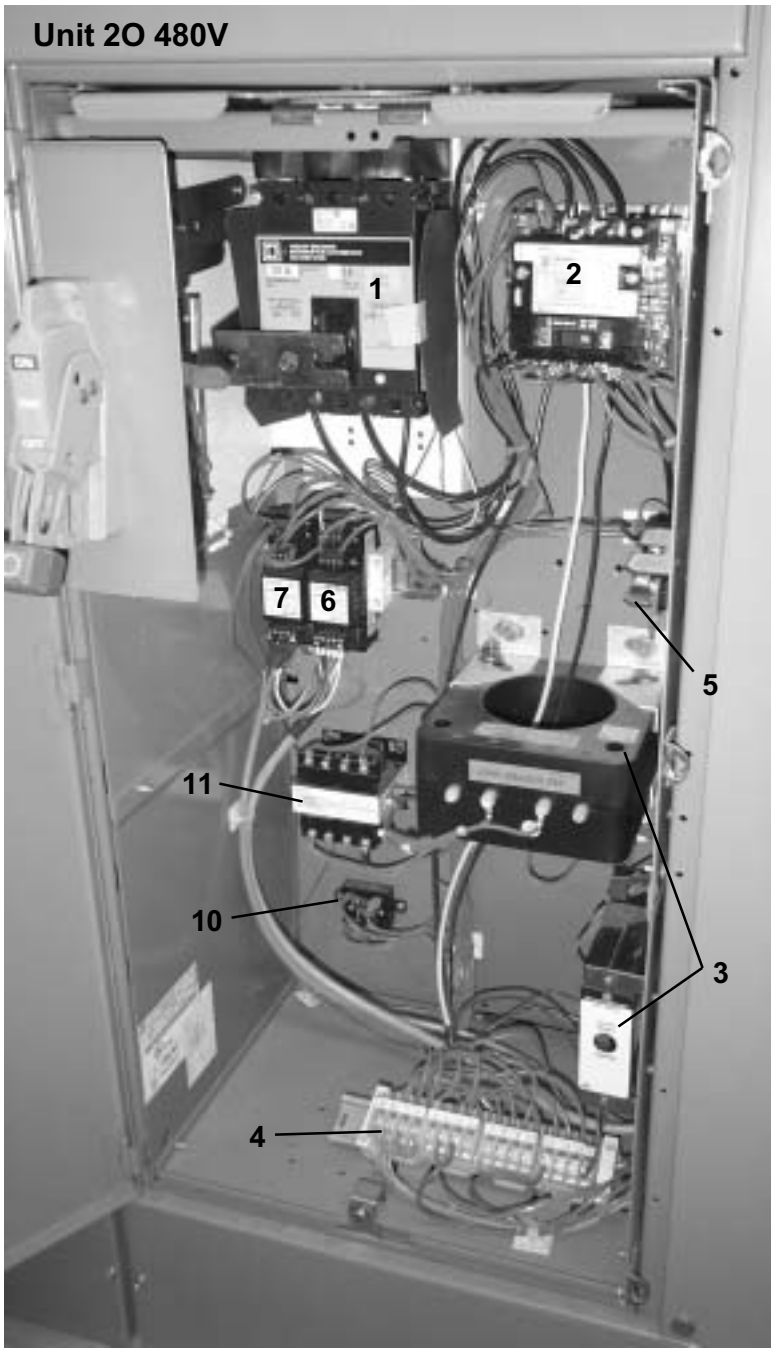
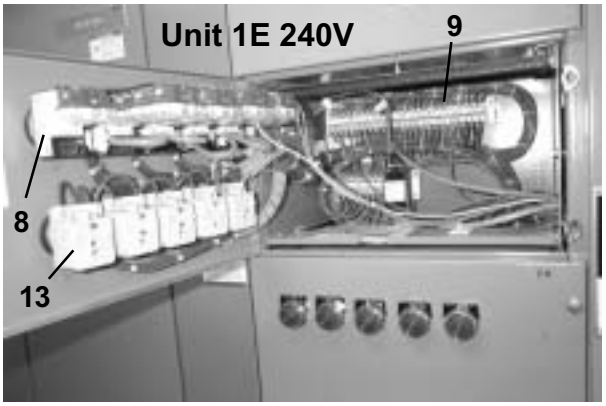
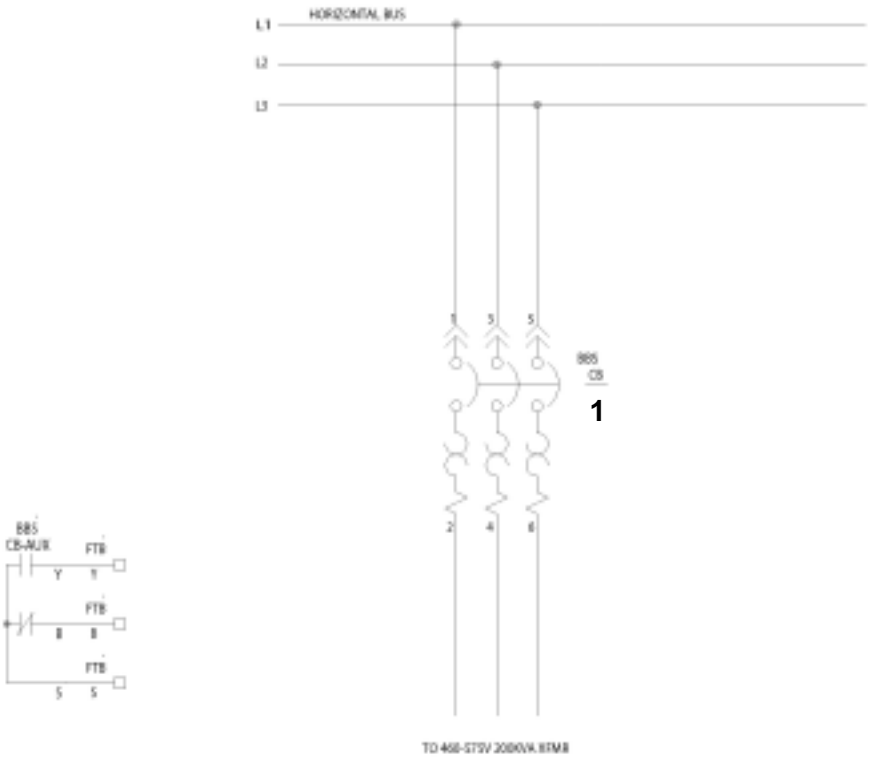
4
2
2
13
4
9
9
4
7
12
SQUARE D COMPANY


Unit 2O 480V
1
2
7
6
5
11
10
3
4


Unit 1E 240V
9
8
13


Unit 1H 240V
12

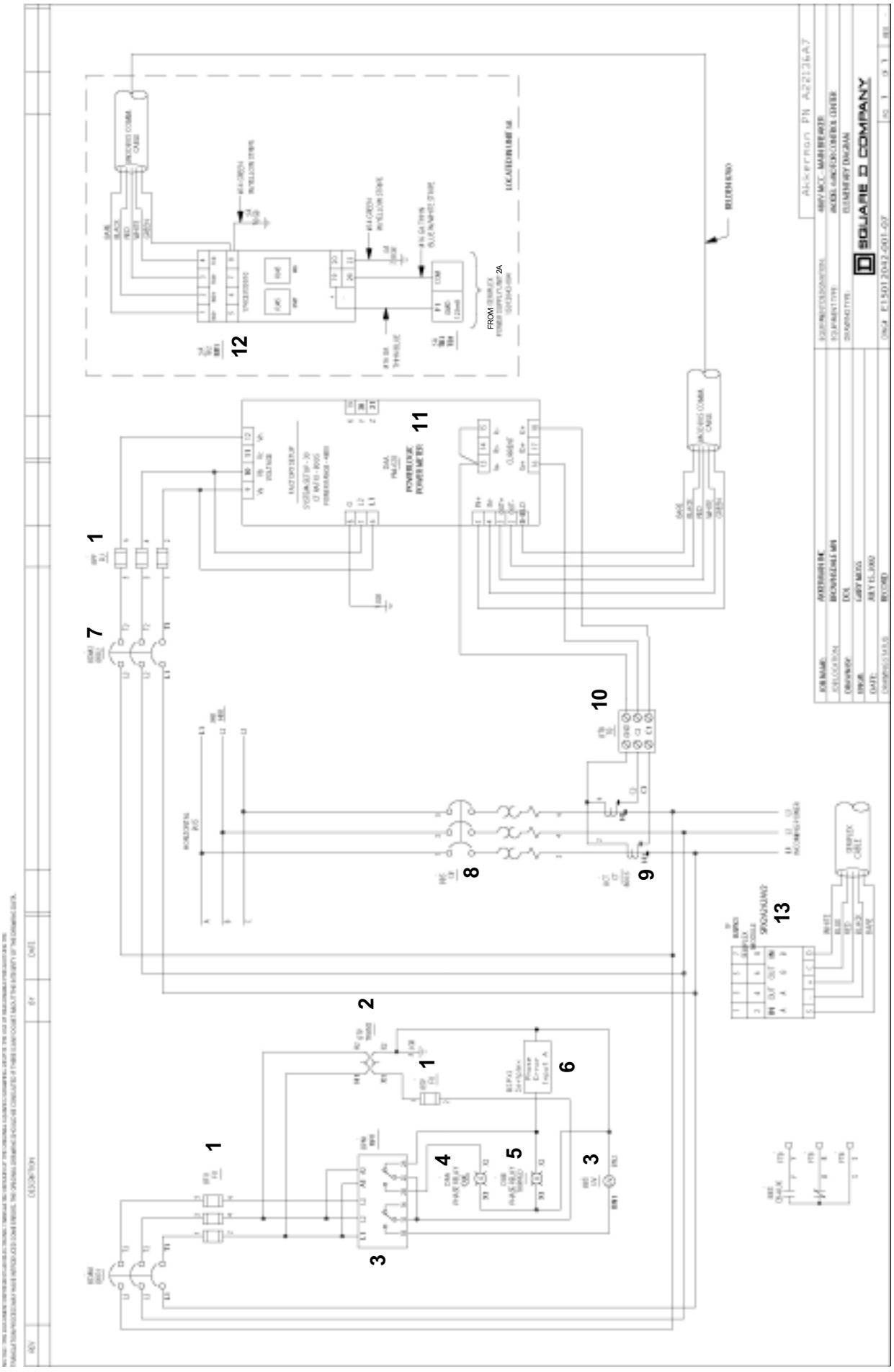
REV	DESCRIPTION	BY	DATE				

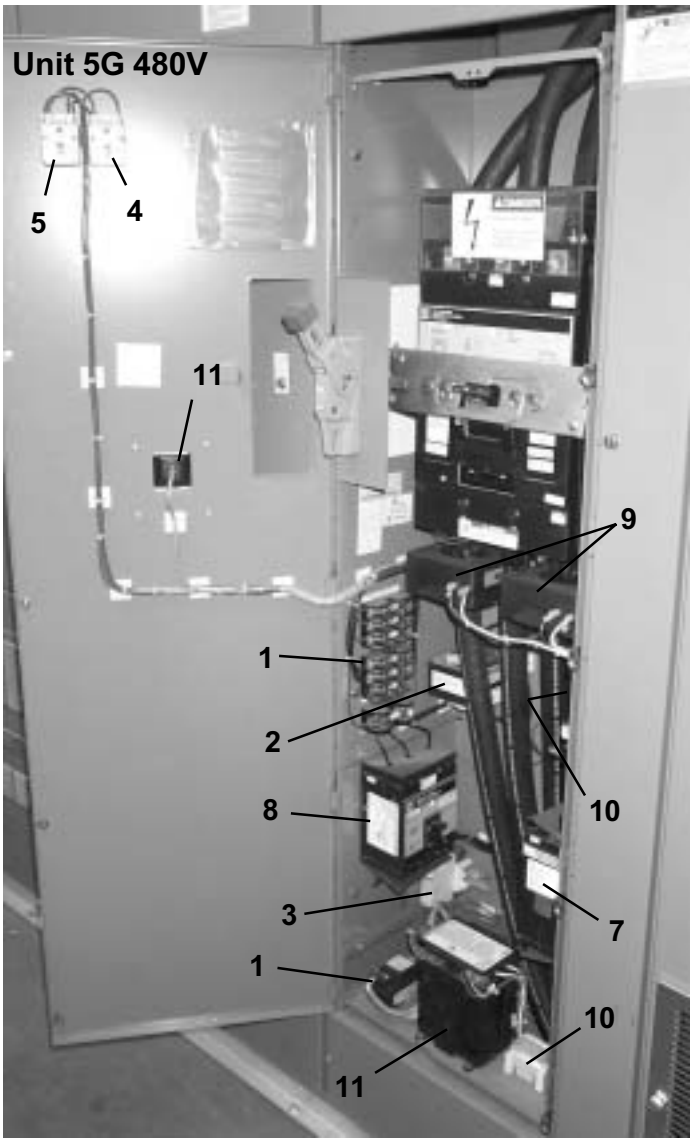


Akkerman PN A22136A6

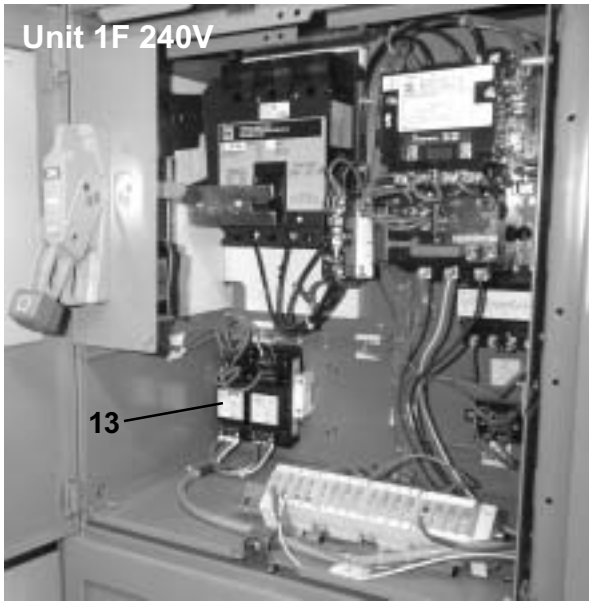
JOB NAME:	AKKERMAN INC	EQUIPMENT DESIGNATION:	480V MCC - BORING HEAD FEEDER
JOB LOCATION:	BROWNSDALE MN	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	DOL	DRAWING TYPE:	ELEMENTARY DIAGRAM
ENGR:	GARY MOSS		SQUARE D COMPANY
DATE:	JULY 15, 2002		
DRAWING STATUS:	RECORD	DWG# E15012042-001-D6	PG 1 OF 1 REV -

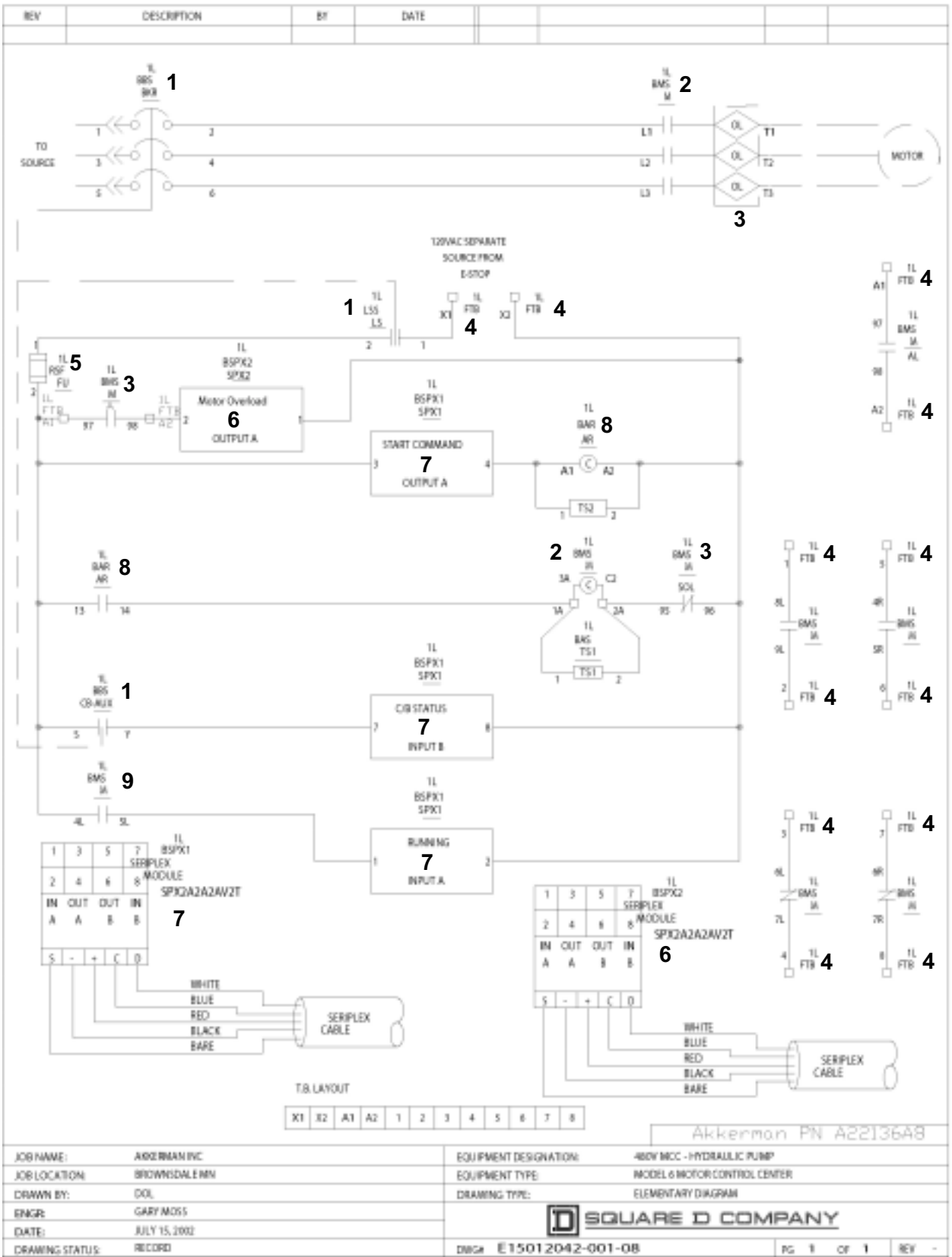

Unit 2I 480V
1
ON
OFF




Unit 5G 480V
5
4
11
9
1
2
8
10
3
7
1
10
11

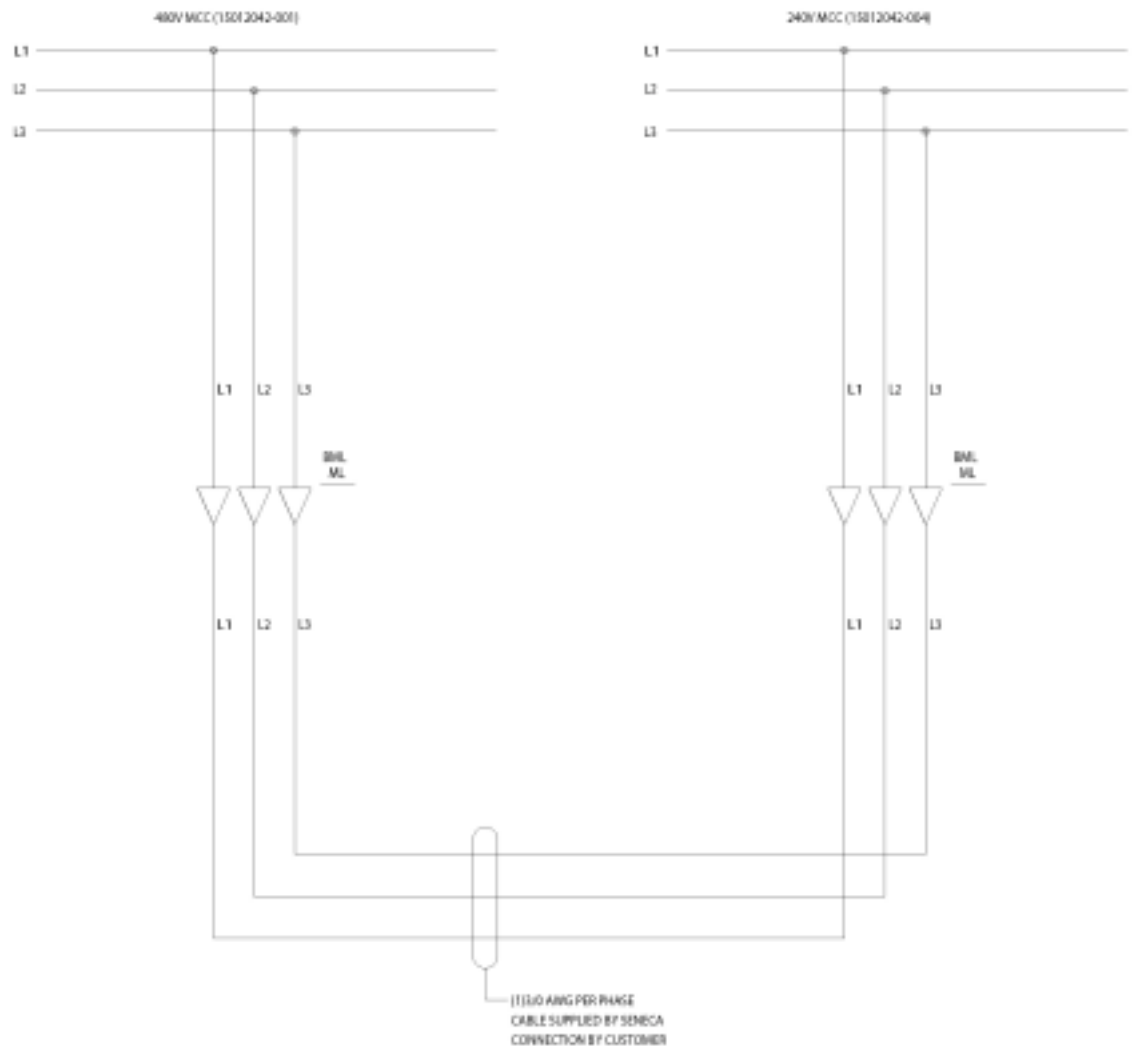

Unit 5A 480V
12


Unit 1F 240V
13


REV
DESCRIPTION
BY
DATE
TO SOURCE
MOTOR
120VAC SEPARATE SOURCE FROM E-STOP
Motor Overload
OUTPUT A
START COMMAND
OUTPUT A
C/B STATUS
INPUT B
RUNNING
INPUT A
SERIPLEX MODULE
SPX2A2A2AV2T
WHITE
BLUE
RED
BLACK
BARE
SERIPLEX CABLE
T.B. LAYOUT
X1 X2 A1 A2 1 2 3 4 5 6 7 8
Akkerman PN A22136A8
JOB NAME: AKKERMAN INC
JOB LOCATION: BROWNSDALE MN
DRAWN BY: DOL
ENGR: GARY MOSS
DATE: JULY 15, 2002
DRAWING STATUS: RECORD
EQUIPMENT DESIGNATION: 480V MCC - HYDRAULIC PUMP
EQUIPMENT TYPE: MODEL 6 MOTOR CONTROL CENTER
DRAWING TYPE: ELEMENTARY DIAGRAM
SQUARE D COMPANY
DWG# E15012042-001-08
PG 1 OF 1
REV -


Unit 1L 480V
1
2
9
7
6
8
3
5
4

REV	DESCRIPTION	BY	DATE				

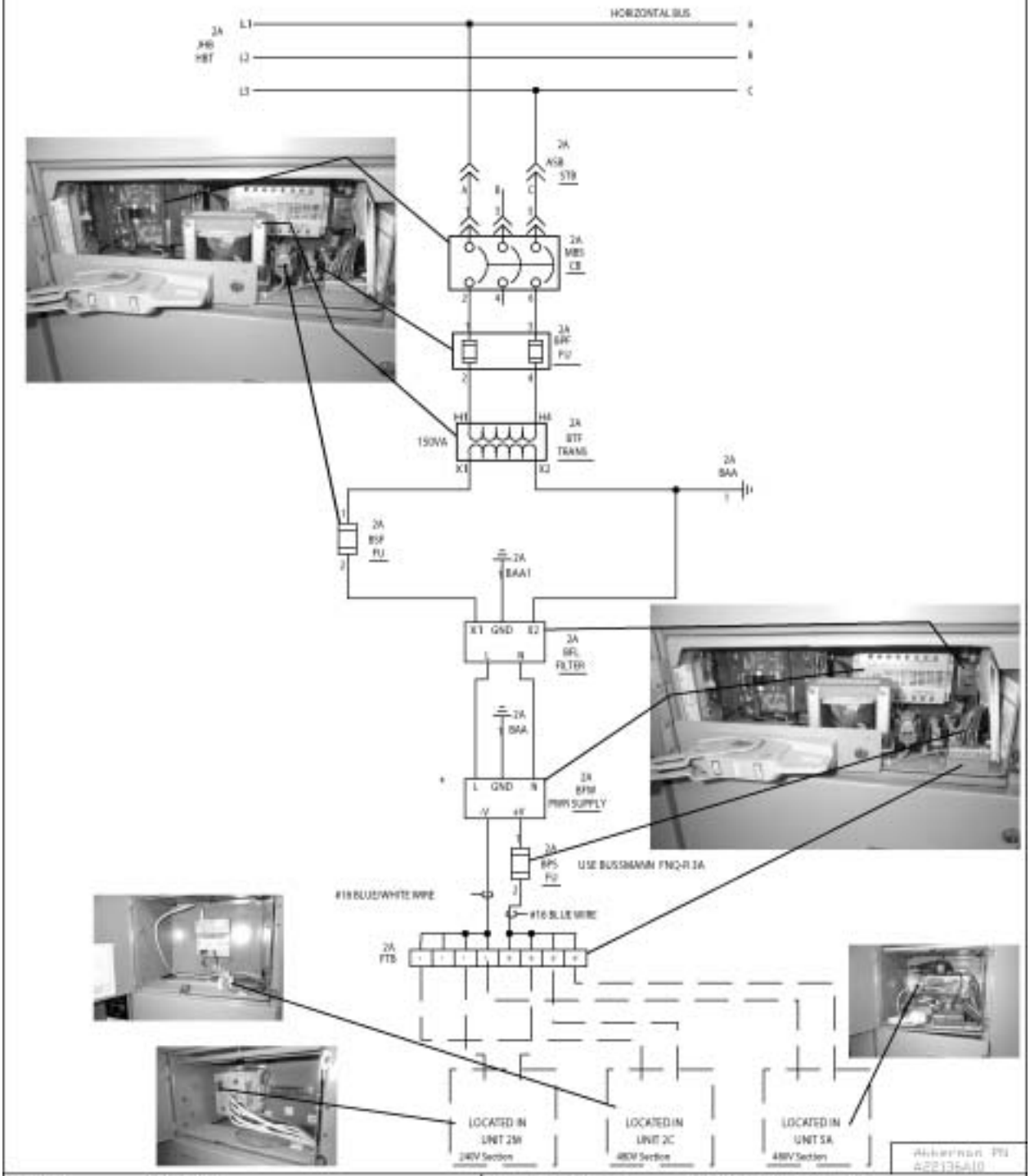


Akkerman PN A22136A9

JOB NAME:	AKKERMAN INC	EQUIPMENT DESIGNATION:	
JOB LOCATION:	BROWNSDALE MN	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	DOL	DRAWING TYPE:	ELEMENTARY DIAGRAM
ENGR:	GARY MOSS	SQUARE D COMPANY	
DATE:	JULY 15, 2002		
DRAWING STATUS:	RECORD	DWG# E15012042-001-09	PG 1 OF 1 REV -

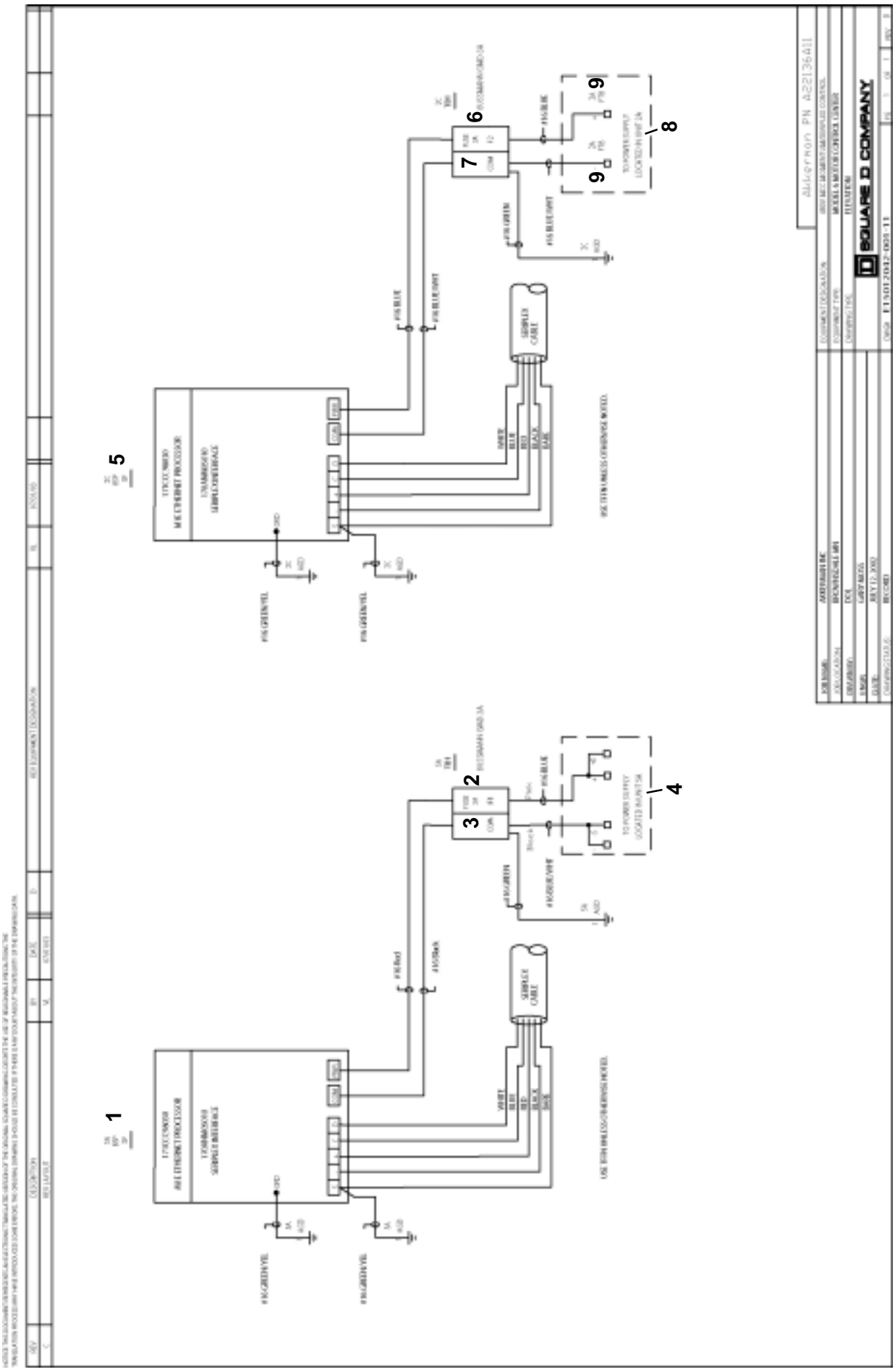
NOTES

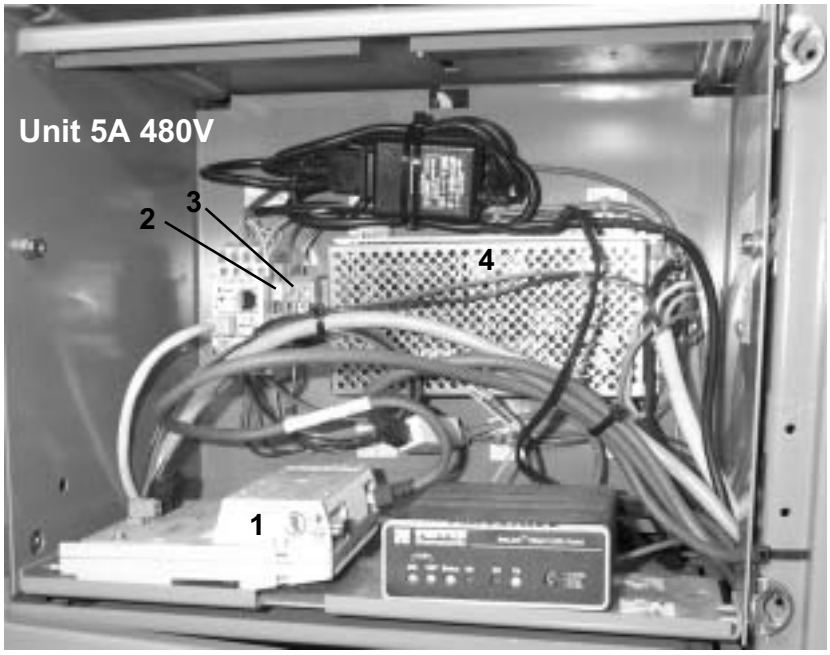
REV	DESCRIPTION	BY	DATE	REV	DESCRIPTION	BY	DATE
A	REWISE FTB CONNECTIONS	WGM	08/09/02	C	REV WIRING	WL	07/01/03

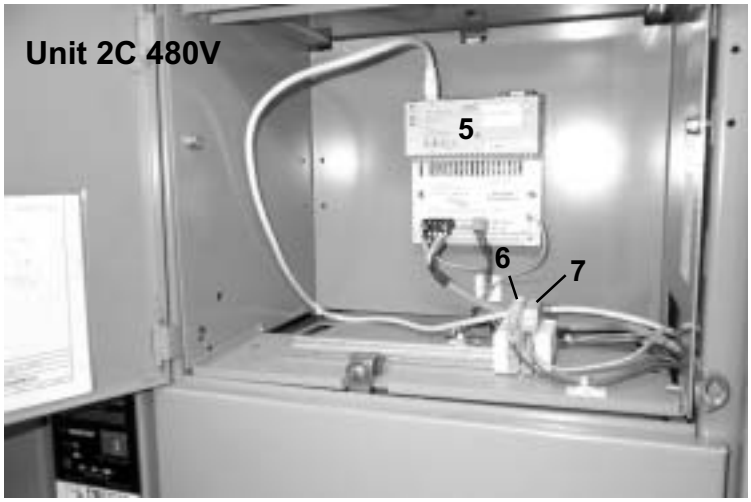


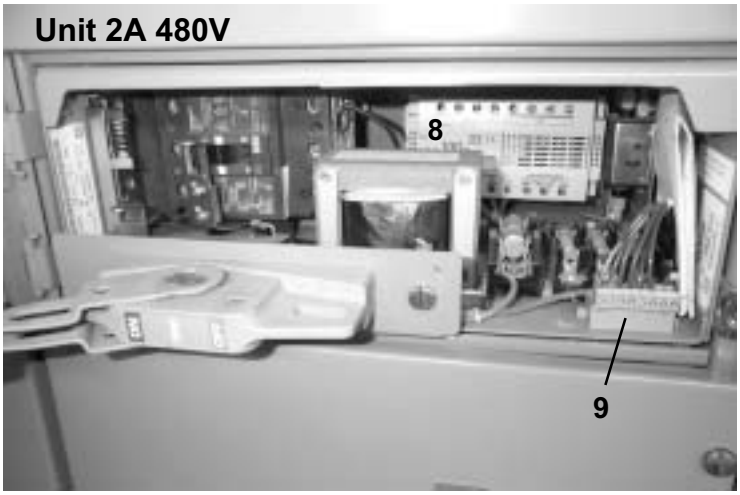
JOB NAME:	AKKERMAN INC.	EQUIPMENT DESIGNATION:	480V MCC - SERIPLEX POWER SUPPLY
JOB LOCATION:	BROWNSDALE, MN	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	SLM	DRAWING TYPE:	ELEMENTARY DIAGRAM
ENGR:	GARY MOSS		SQUARE D COMPANY
DATE:	JULY 15, 2002		
DRAWING STATUS:	RECORD	DWG#: E15012042-001-10	PG 1 OF 1 REV C

NOTES

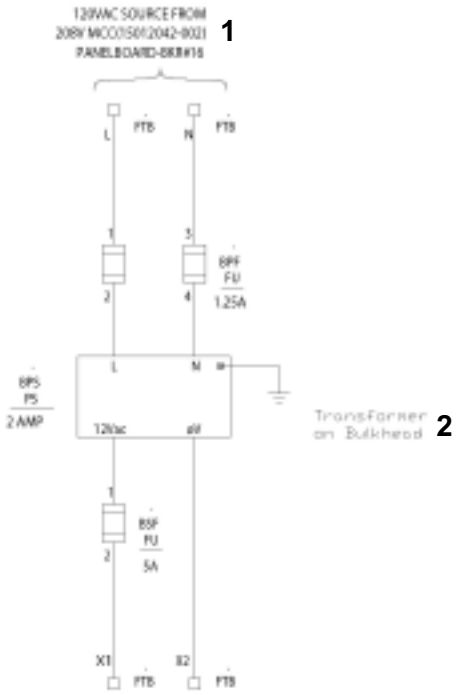



Unit 5A 480V
1
2
3
4


Unit 2C 480V
5
6
7


Unit 2A 480V
8
9

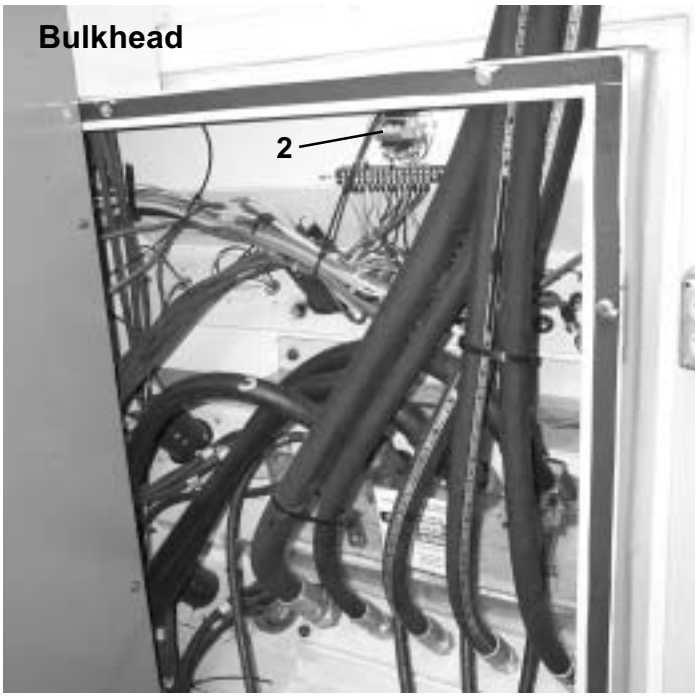
REV	DESCRIPTION	BY	DATE	REV	REV TEXT	WL	07/01/03
A	REV. PER CUSTOMER	TR	01/23/03	C	REV BPS	WL	07/01/03



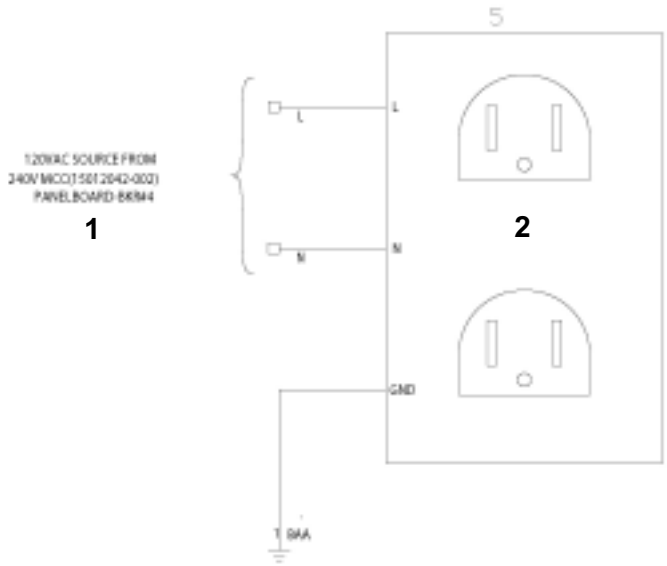
Akkerman PN A22136A12

JOB NAME:	AKKERMAN INC	EQUIPMENT DESIGNATION:	480V MCC - 12VDC POWER SUPPLY
JOB LOCATION:	BROWNSDALE MN	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	DOL	DRAWING TYPE:	ELEMENTARY DIAGRAM
ENGR:	GARY MOSS		SQUARE D COMPANY
DATE:	JULY 15, 2002		
DRAWING STATUS:	RECORD	DWG# E15012042-001-12	PG 1 OF 1 REV C


Unit 2A 240V
1


Bulkhead
2

REV	DESCRIPTION	BY	DATE	REV	REV TEXT	VL	07/01/03
A	REV. PER CUSTOMER	TR	01/23/03	C	REV EQUIPMENT DESIGNATION	VL	07/31/03



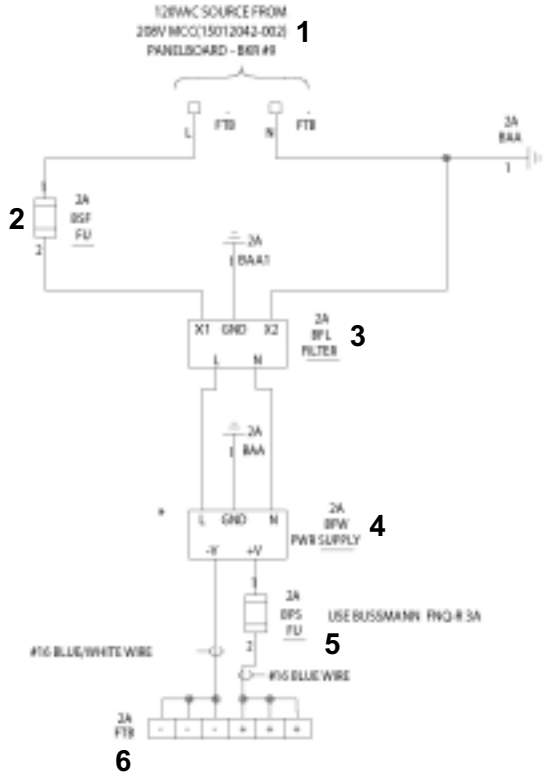
Akkerman PN A22136A13

JOB NAME:	AKKERMAN INC	EQUIPMENT DESIGNATION:	480V MCC - Extender Power
JOB LOCATION:	BROWNSDALE MN	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	DOL	DRAWING TYPE:	ELEMENTARY DIAGRAM
ENGR:	GARY MOSS		SQUARE D COMPANY
DATE:	JULY 15, 2002		
DRAWING STATUS:	RECORD	DWG#: E15012042-001-13	PG 1 OF 1 REV C


Unit 2A 240V
1


Unit 2A 480V
2

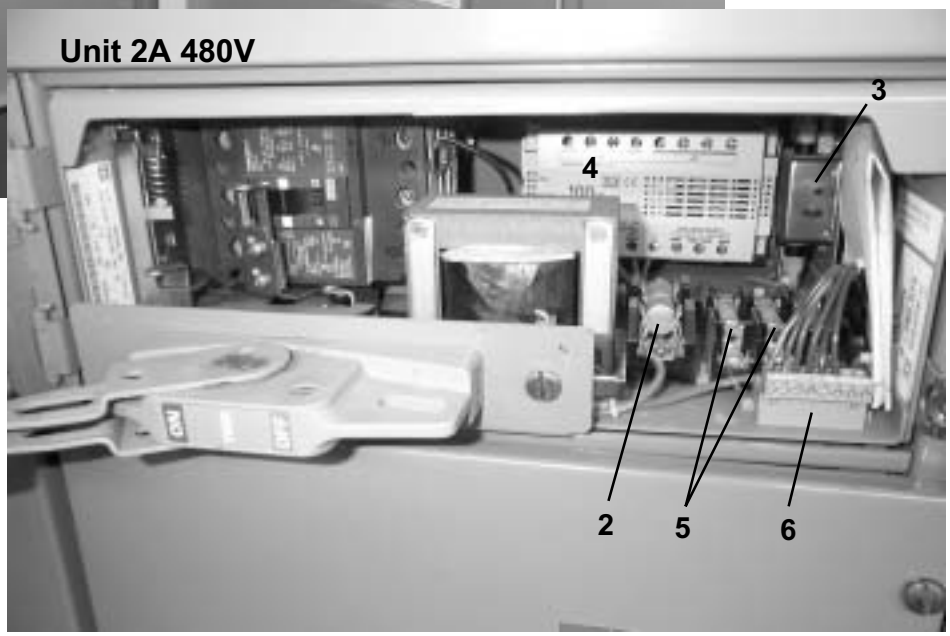
REV	DESCRIPTION	BY	DATE				
D	REV TEXT	VL	07/01/03				



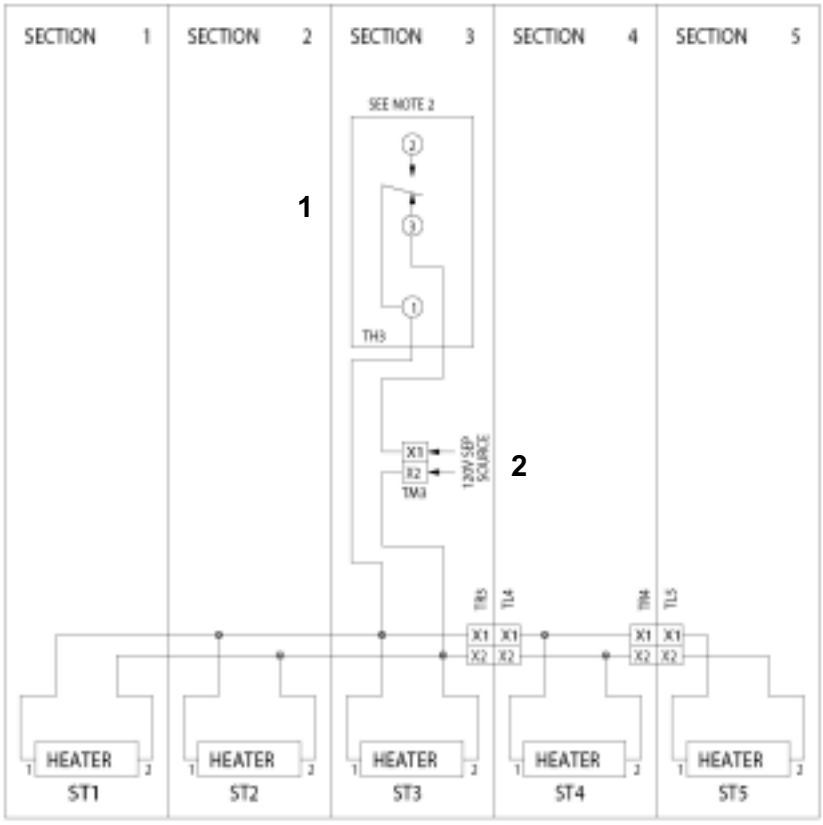
Akkerman PN A22136A14

JOB NAME:	AKKERMAN INC.	EQUIPMENT DESIGNATION:	480V MCC - ETHERNET EXT. POWER SUPPLY
JOB LOCATION:	BROWNSDALE, MN	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	SLW	DRAWING TYPE:	ELEMENTARY DIAGRAM
ENGR:	GARY MOSS	SQUARE D COMPANY	
DATE:	JULY 15, 2002		
DRAWING STATUS:	RECORD	DWG# E15012042-001-14	PG 1 OF 1 REV D


Unit 2A 240V
1


Unit 2A 480V
3
4
2
5
6

REV	DESCRIPTION	BY	DATE				



NOTE 1: STRIP HEATER (200W, 120V) HOTWATT #CS12 OR EQUIVALENT.
CUSTOMER MUST PROVIDE PROTECTIVE POWER SUPPLY.

NOTE 2: THERMOSTAT IS LOCATED IN VERTICAL WIRE TROUGH.
(30°F-110°F, 120V) PENN CONTROLS #A19BAC-1.
MOUNT PER REFERENCE DRAWING A80455-300.

Akkerman PN A22136A15

JOB NAME:	AKKERMAN INC	EQUIPMENT DESIGNATION:	480V MCC
JOB LOCATION:	BROWNSDALE MN	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	DOL	DRAWING TYPE:	WIRING DIAGRAM
ENGR:	GARY MOSS		SQUARE D COMPANY
DATE:	JULY 15, 2002		
DRAWING STATUS:	RECORD	DWG# C15012042-001-01	PG 1 OF 1 REV -


Unit Located Between
Units 3A & 4A 480V
1
2

REV	DESCRIPTION	BY	DATE	S	REV. UNIT LAYOUT	SUM	8/8/02
A	REV. XFMR	MRU	07-16-02				

COMPONENT INFORMATION

MCC DESIGNATION

ADDRESS		240V MCC FEEDER XFMR						CONTROL (or DISTRIBUTION) TRANSFORMER				
SPX1	SPX2	UNIT LOC	NAMEPLATE DESIGNATION	UNIT TYPE	SIZE	HP	DISC AMPS	VA	FUSE SIZE PRI	FUSE SIZE SEC	UNIT FEATURES	DRAWING NUMBER
		1A	INCOMING LUGS FROM 480V MCC	MN LUGS			600				U678,DID	E15012042-004-02-1
		1C		SPACE							U678	
SW9 A=30 B=31		1E	OPERATOR CONTROLS	MT.UNIT							U678,(S)C6X,(5)P1, DID,U271	E15012042-004-03-1
SW10 A=32 B=33												
SW11 A=34 B=35												
SW12 A=36 B=37												
SW13 A=38 B=39												
		1H	Indicators								U678	
		1K	240V MCC FEEDER XFMR	3PXFMR			60	45K			Y532,U678,DID, U305,XFMR	E15012042-004-01-1

XFMR SPL 3Ø XFMR
480V/240V
#6F-45T6HDC

U678 UNIT NP GREY
DID DIAGRAM IN DOOR
C6X 2 POS TYPE K SS
W/SERIPLEX MODULES

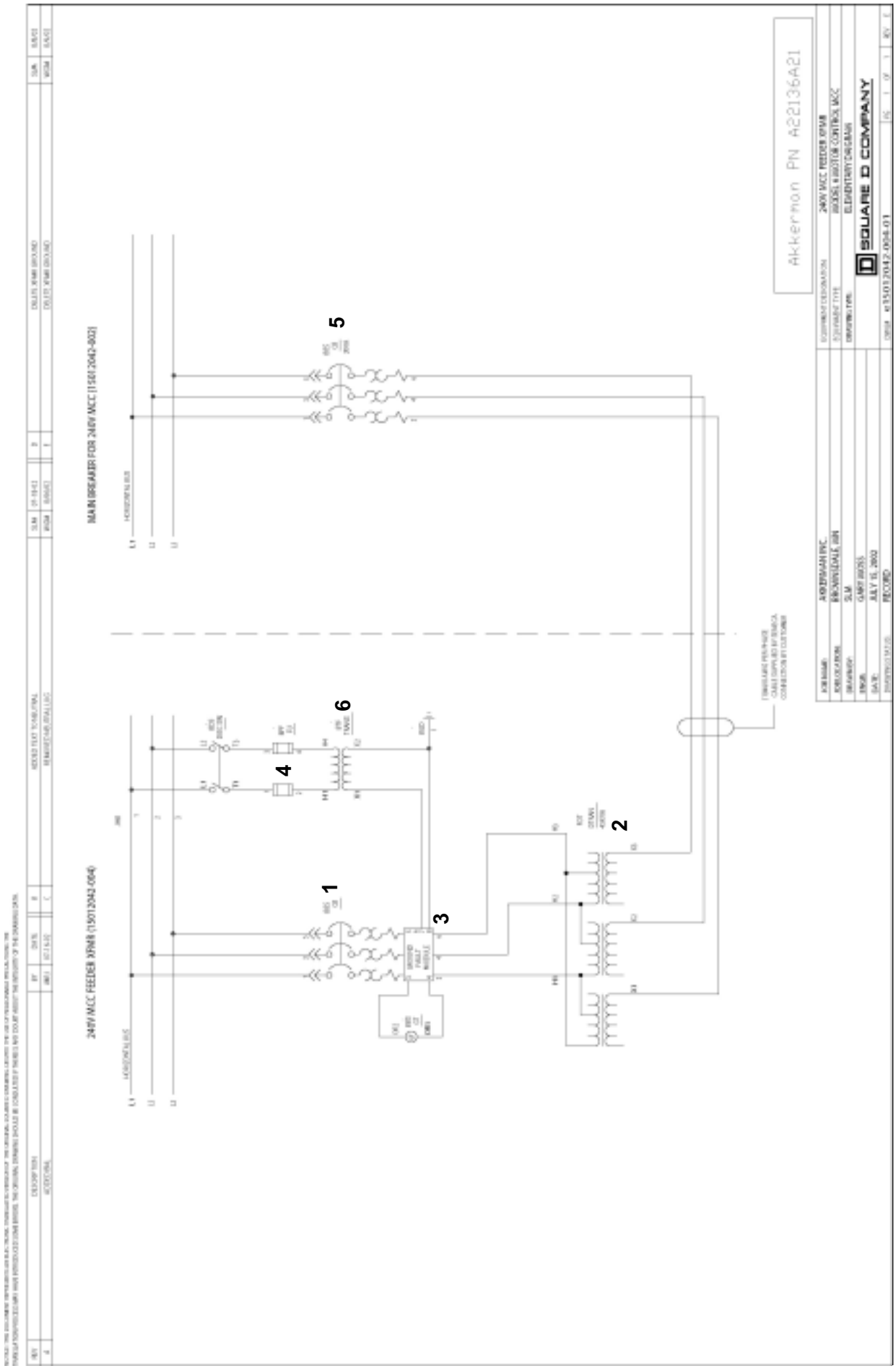
Y532 HIGH IC BREAKER
P1 RED ON PL

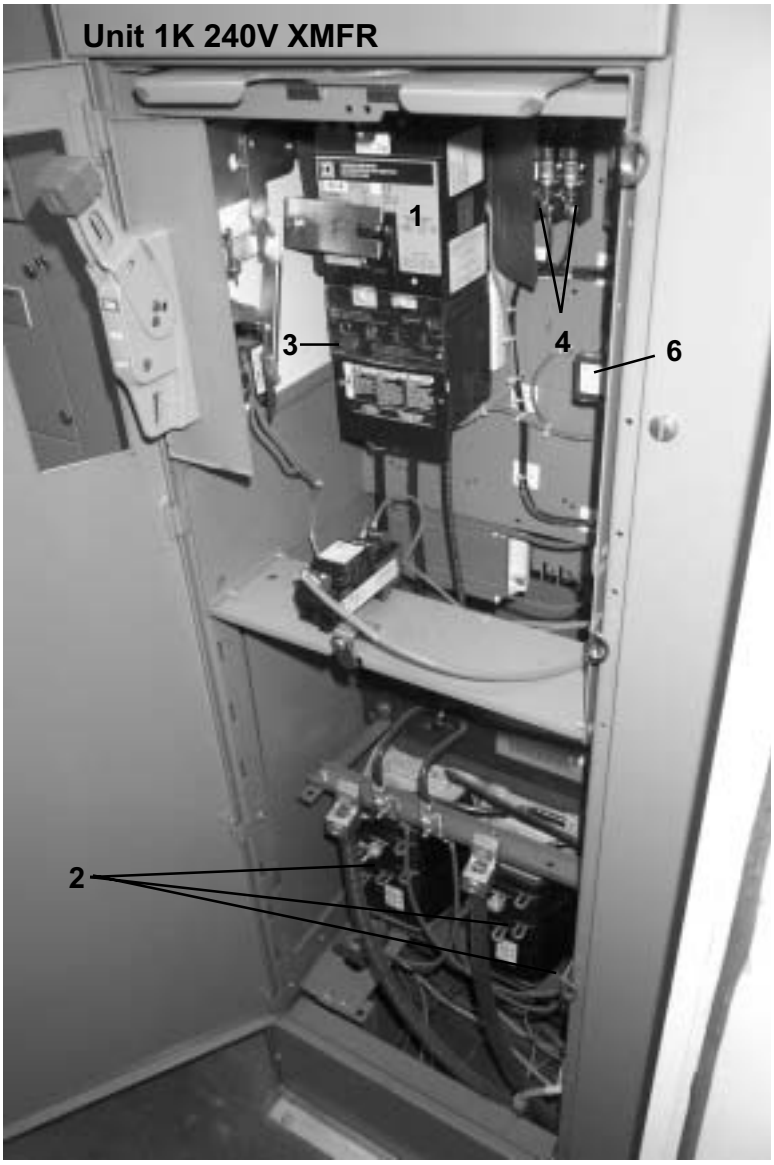
U305 GRD FLT MODULE
U271 TYPE K DEVICES

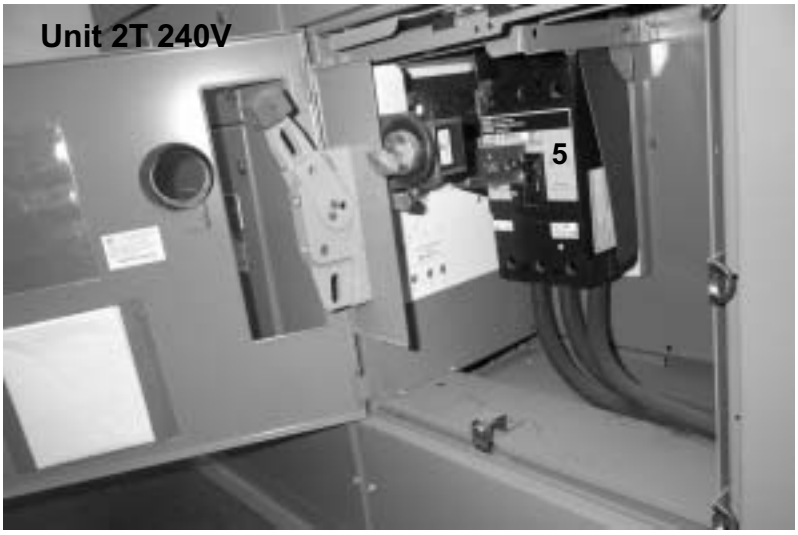
Akkerman PN A22136A20

JOB NAME:	AKKERMAN INC.	EQUIPMENT DESIGNATION:	240V MCC FEEDER XFMR
JOB LOCATION:	BROWNSDALE, MN	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	SLM	DRAWING TYPE:	COMPONENT INFORMATION
ENGR:	GARY MOSS		SQUARE D COMPANY
DATE:	JULY 15, 2002		
DRAWING STATUS:	RECORD	DWG# 15012042-004-01	PG 1 OF 1 REV B

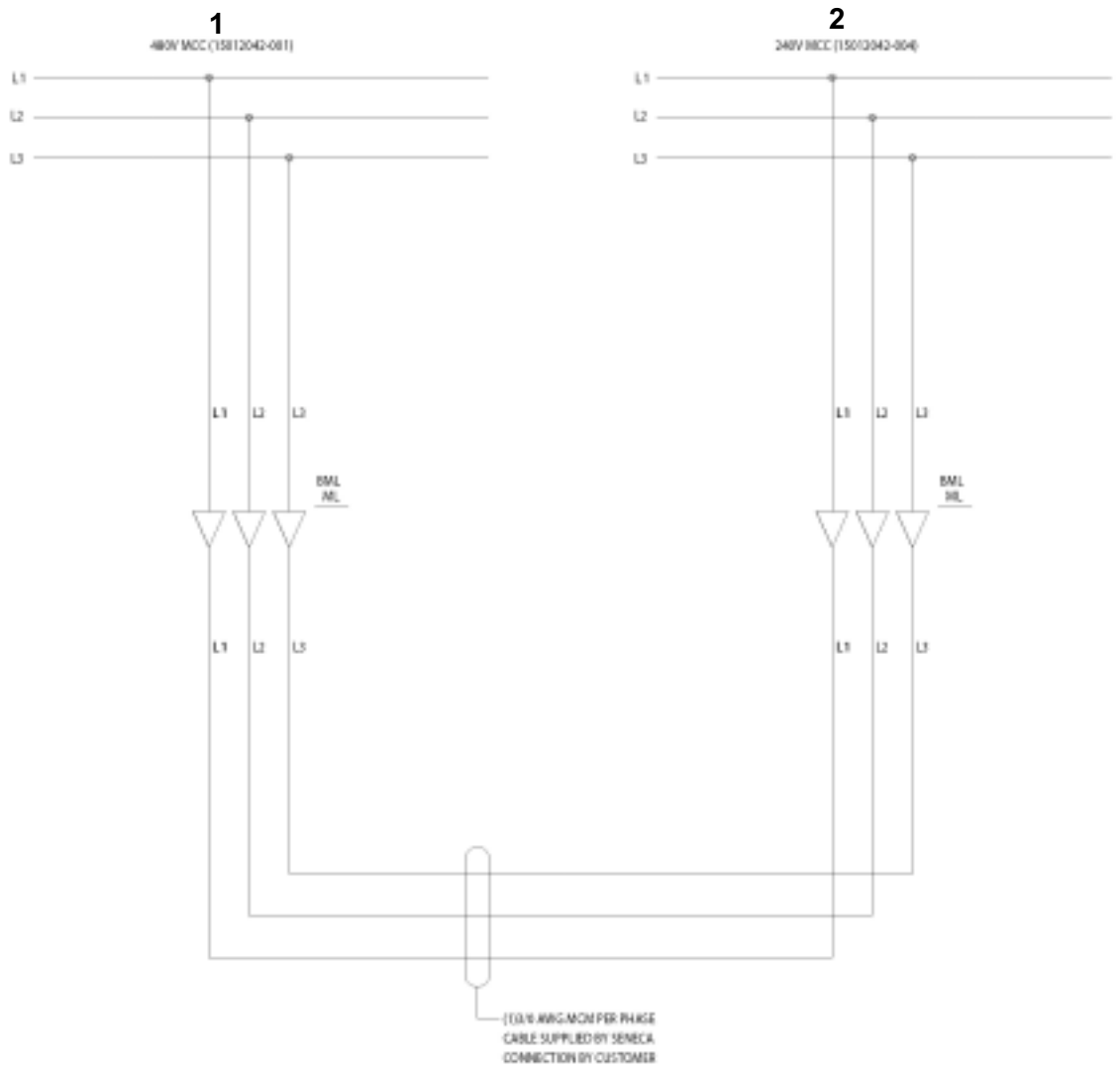
NOTES


Akkerman PN A22136A21
SQUARE D COMPANY
240V MCC FEEDER XFMR
ELEMENTARY DIAGRAM
MAIN BREAKER FOR 240V MCC (15012042-002)
240V MCC FEEDER XFMR (15012042-004)
1
2
3
4
5
6


Unit 1K 240V XMFR
1
3
4
6
2


Unit 2T 240V
5

REV	DESCRIPTION	BY	DATE				



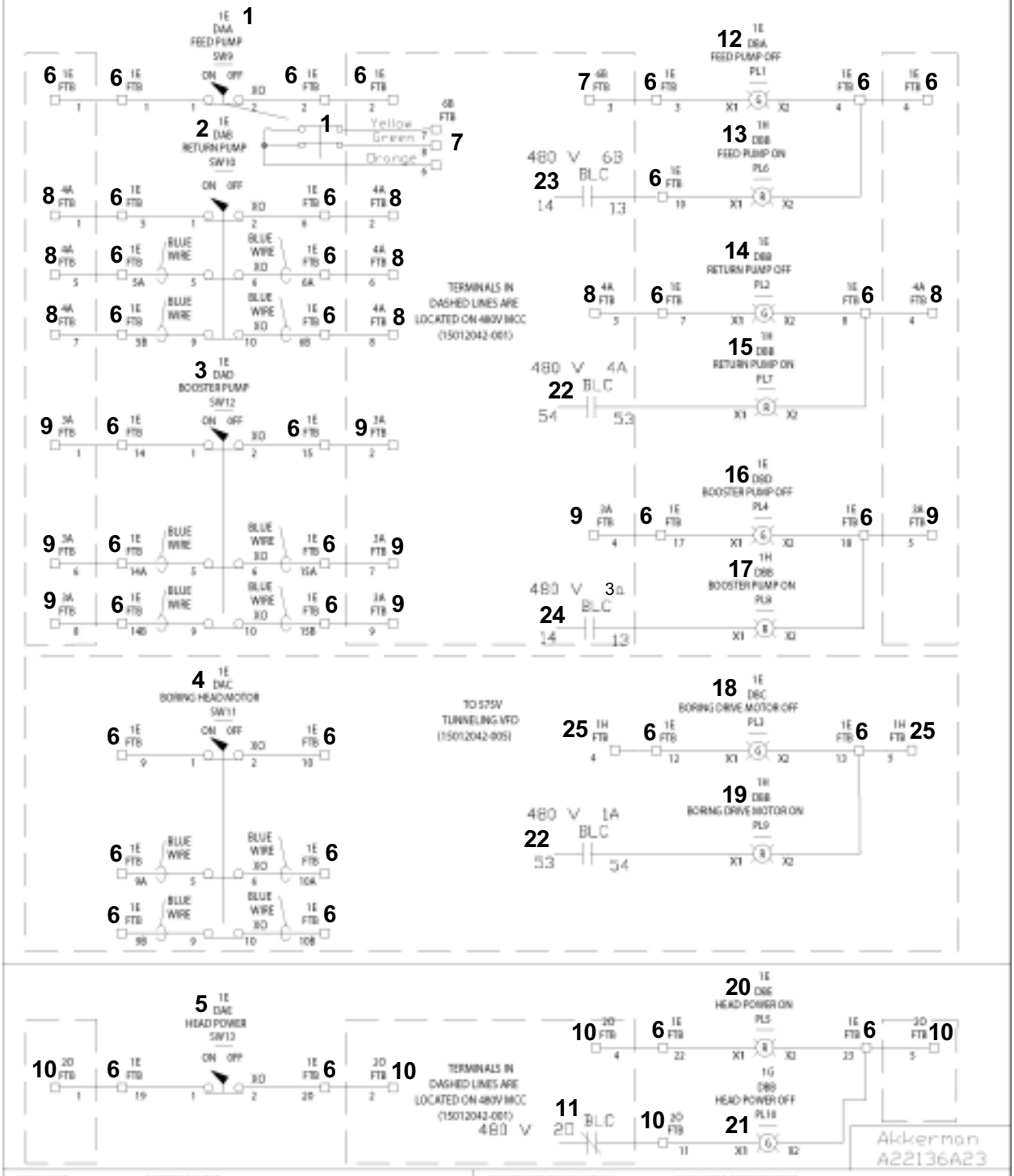
Akkerman PN A22136A22

JOB NAME:	AKKERMAN INC.	EQUIPMENT DESIGNATION:	240V MCC FEDER XFMR
JOB LOCATION:	BROWNSDALE, MN	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	SLM	DRAWING TYPE:	ELEMENTARY DIAGRAM
ENGR:	GARY MOSS		SQUARE D COMPANY
DATE:	JULY 15, 2002		
DRAWING STATUS:	RECORD	DWG# E15012042-004-02	PG 1 OF 1 REV -

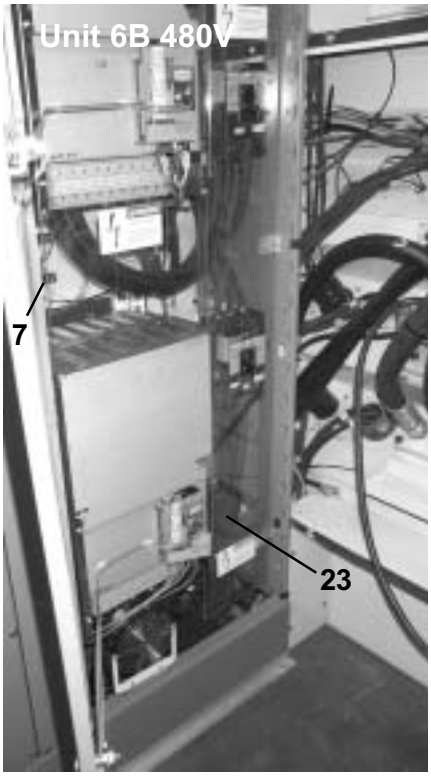

Unit 1A 480V
1

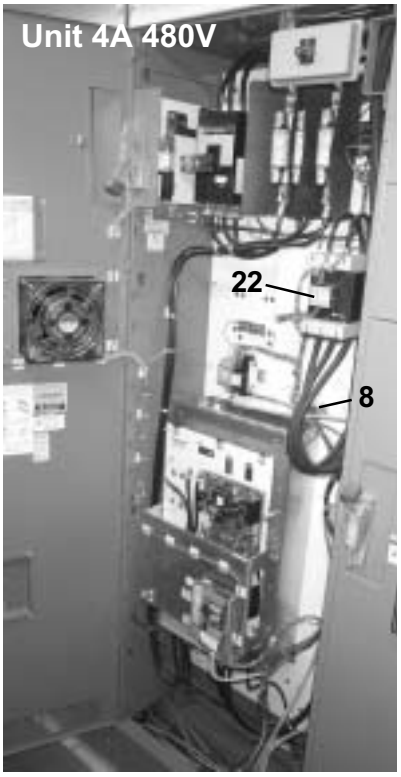

Unit 1A 240V XFMR
2

REV	DESCRIPTION	BY	DATE	REV	REV. UNIT LOCATION	WGM	8/15/02
A	REV. LAYOUT	SLM	8/16/02	C	REV. DAE TEXT	WGM	8/16/02

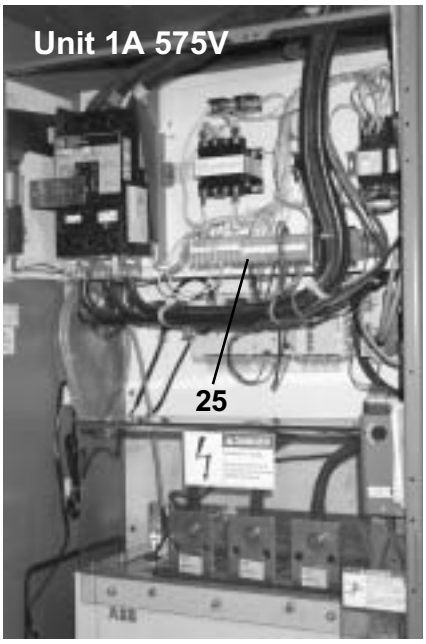


JOB NAME:	AKKERMAN INC.	EQUIPMENT DESIGNATION:	240V MCC FEEDER XFMR
JOB LOCATION:		EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL MCC
DRAWN BY:	SLM	DRAWING TYPE:	ELEMENTARY DIAGRAM
ENGR:	GARY MOSS		SQUARE D COMPANY
DATE:	JULY 15, 2002	DWG#	E15012042-004-03 PG 1 OF 1 REV C
DRAWING STATUS:	RECORD		


Unit 6B 480V
7
23

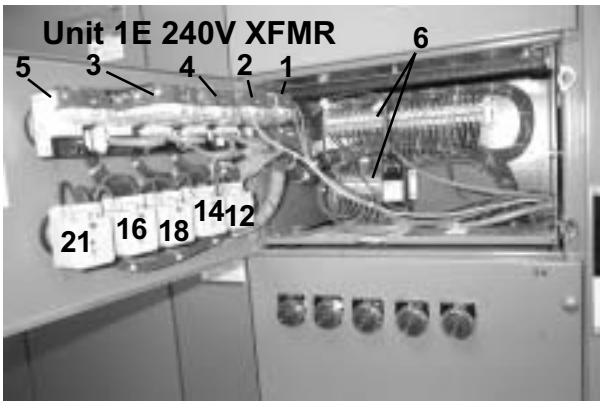

Unit 4A 480V
22
8


Unit 2O 480V
11
10

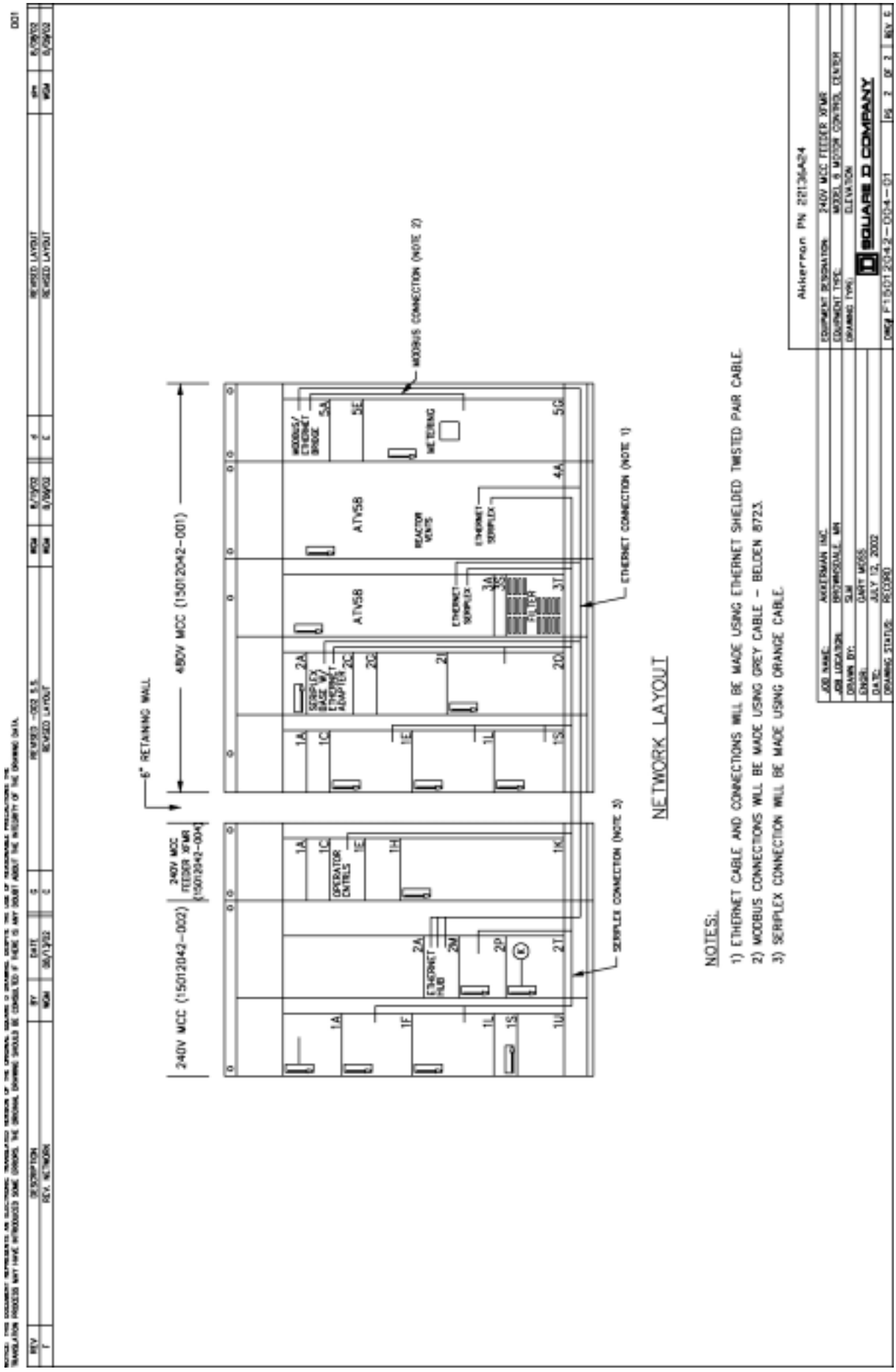

Unit 1A 575V
25


Unit 1B 575V
22


Unit 3A 480V
24
9

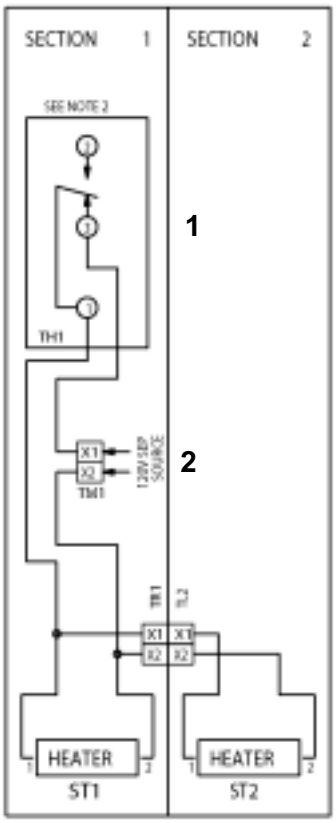

Unit 1E 240V XFMR
5
3
4
2
1
6
21
16
18
14
12


Unit 1H 240V XFMR
20
17
19
15
13


6" RETAINING WALL
240V MCC (15012042-002)
240V MCC FEEDER XFMR (15012042-004)
480V MCC (15012042-001)
MODBUS CONNECTION (NOTE 2)
ETHERNET CONNECTION (NOTE 1)
SERIPLEX CONNECTION (NOTE 3)
ATV58
OPERATOR CNTRLS
ETHERNET HUB
SERIPLEX BASE W/ ETHERNET ADAPTER
MODBUS/ ETHERNET BRIDGE
METERING
REACTOR VENTS
ETHERNET SERIPLEX
FILTER
NETWORK LAYOUT
NOTES:
1) ETHERNET CABLE AND CONNECTIONS WILL BE MADE USING ETHERNET SHIELDED TWISTED PAIR CABLE.
2) MODBUS CONNECTIONS WILL BE MADE USING GREY CABLE - BELDEN 8723.
3) SERIPLEX CONNECTION WILL BE MADE USING ORANGE CABLE.
Akkerman PN 22136424
JOB NAME: AKKERMAN INC.
EQUIPMENT DESIGNATION: 240V MCC FEEDER XFMR
JOB LOCATION: REHOBOTH, MA
ENCLOSURE TYPE: MODEL 6 MODBUS CONTROL CENTER
DRAWN BY: SLM
DRAWING TYPE: ELEVATION
ENGR: GARY MYERS
DATE: JULY 12, 2002
DRAWING STATUS: RELEASED
SQUARE D COMPANY
DWG # 15012042-004-01
PG 2 OF 2
REV E

NOTES

REV	DESCRIPTION	BY	DATE				



NOTE 1: STRIP HEATER (200W, 120V) HOTWATT #CS12 OR EQUIVALENT.
CUSTOMER MUST PROVIDE PROTECTIVE POWER SUPPLY.

NOTE 2: THERMOSTAT IS LOCATED IN VERTICAL WIRE TROUGH.
(30°F-110°F, 120V) PENN CONTROLS #A19BAC-1.
MOUNT PER REFERENCE DRAWING A80455-300.

Akkerman PN A22136A25

JOB NAME:	AKKERMAN INC.	EQUIPMENT DESIGNATION:	240V MCC
JOB LOCATION:	BROWNSDALE, MN	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL MCC
DRAWN BY:	SLM	DRAWING TYPE:	WIRING DIAGRAM
ENGR:	GARY MOSS	SQUARE D COMPANY	
DATE:	JULY 15, 2002		
DRAWING STATUS:	RECORD	DWG# C15012042-002-01	PG 1 OF 1 REV -


240V
MCC
Unit Located Between
Units 1A & 2A 240V
1
2

COMPONENT INFORMATION

MCC DESIGNATION: 240V MCC

ADDRESS SPX1	ADDRESS SPX2	UNIT LOC	NAMEPLATE DESIGNATION	UNIT TYPE	SIZE	HP	DISC AMPS	CONTROL or DISTRIBUTION TRANSFORMER VA	FUSE SIZE PRI	FUSE SIZE SEC	UNIT FEATURES	DRAWING NUMBER
		1A	Not Used									
A=40 B=41	A=42 B=43	1F	HEAD MOTOR COOLING PUMP	FVNR	1	1/2	15	50			[illegible]	[illegible]
											[illegible]	
		1L	Not Used									
											[illegible]	
		1S	240V DIST. XFMR FEEDER	[illegible]			30				[illegible]	[illegible]
		1B	240V PANEL DIST. XFMR	[illegible]				10K			[illegible]	[illegible]
		2A	240V DIST. PANEL	PANELBD			100				[illegible]	[illegible]
		2B	ETHERNET SWITCH	[illegible]							[illegible]	[illegible]
A=48 B=49		2P	OIL COOLER FAN	FVNR	1	1	15				[illegible]	[illegible]
		2T	240V INCOMING MAIN BREAKER	[illegible]			200				[illegible]	[illegible]

[illegible]

Akkerman PN A22136A30

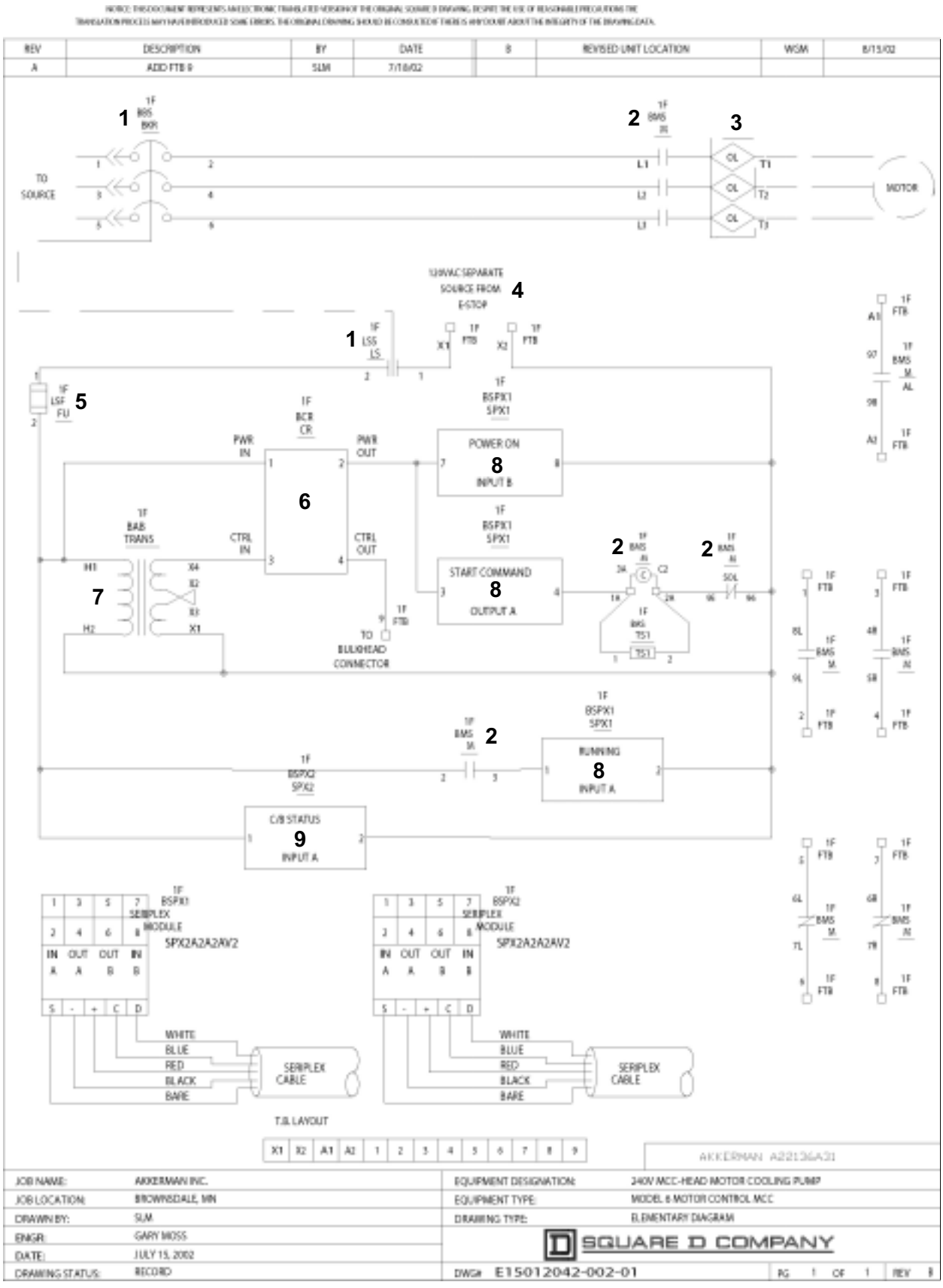
JOB NAME:	AKKERMAN INC
JOB LOCATION:	BROWNSDALE, MN
DRAWN BY:	SLM
ENGR:	GARY ROSS
DATE:	JULY 15, 2002
DRAWING STATUS:	RECORD

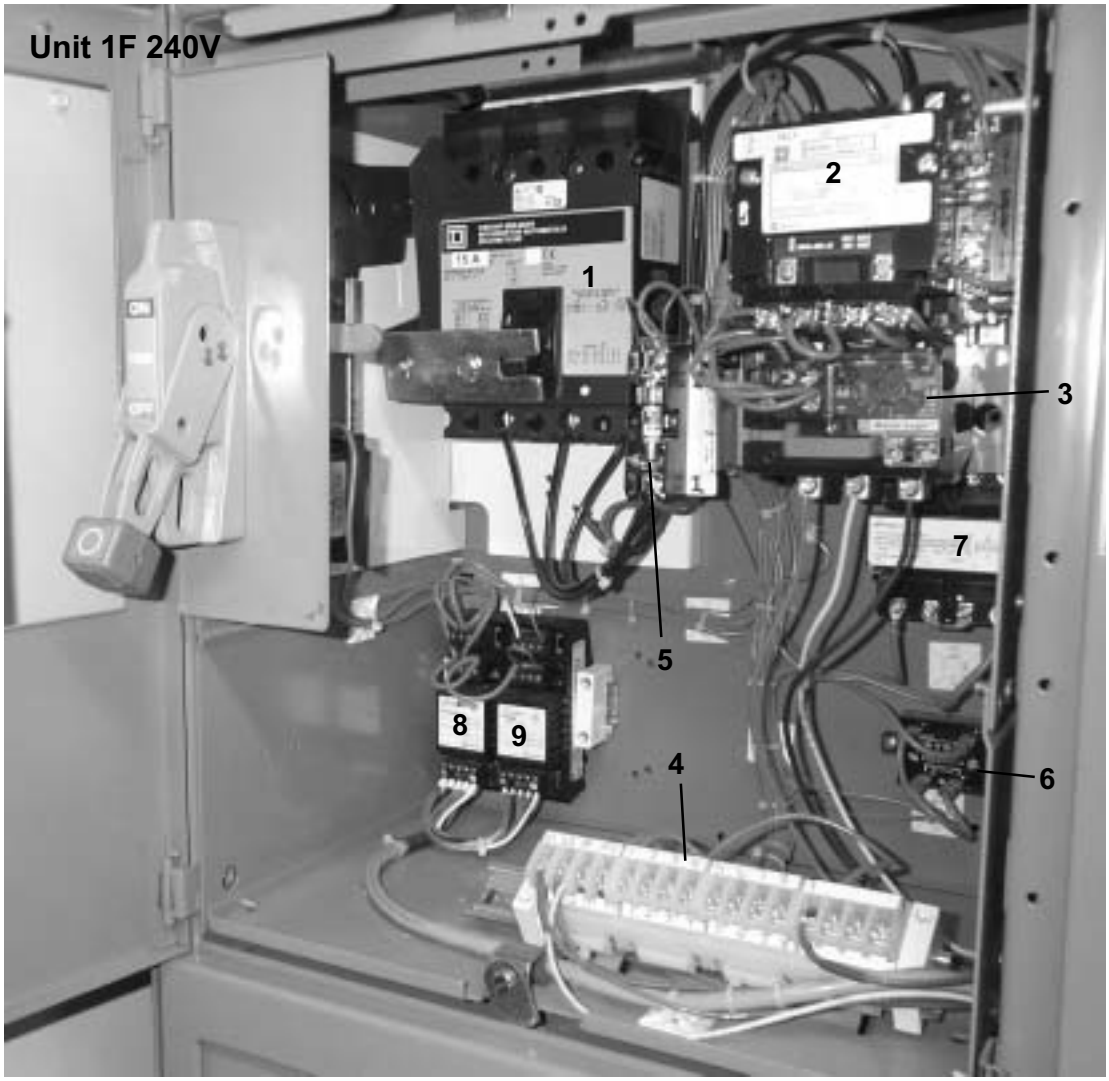
EQUIPMENT DESIGNATION:	240V MCC
EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL MCC
DRAWING TYPE:	COMPONENT INFORMATION

SQUARE D COMPANY

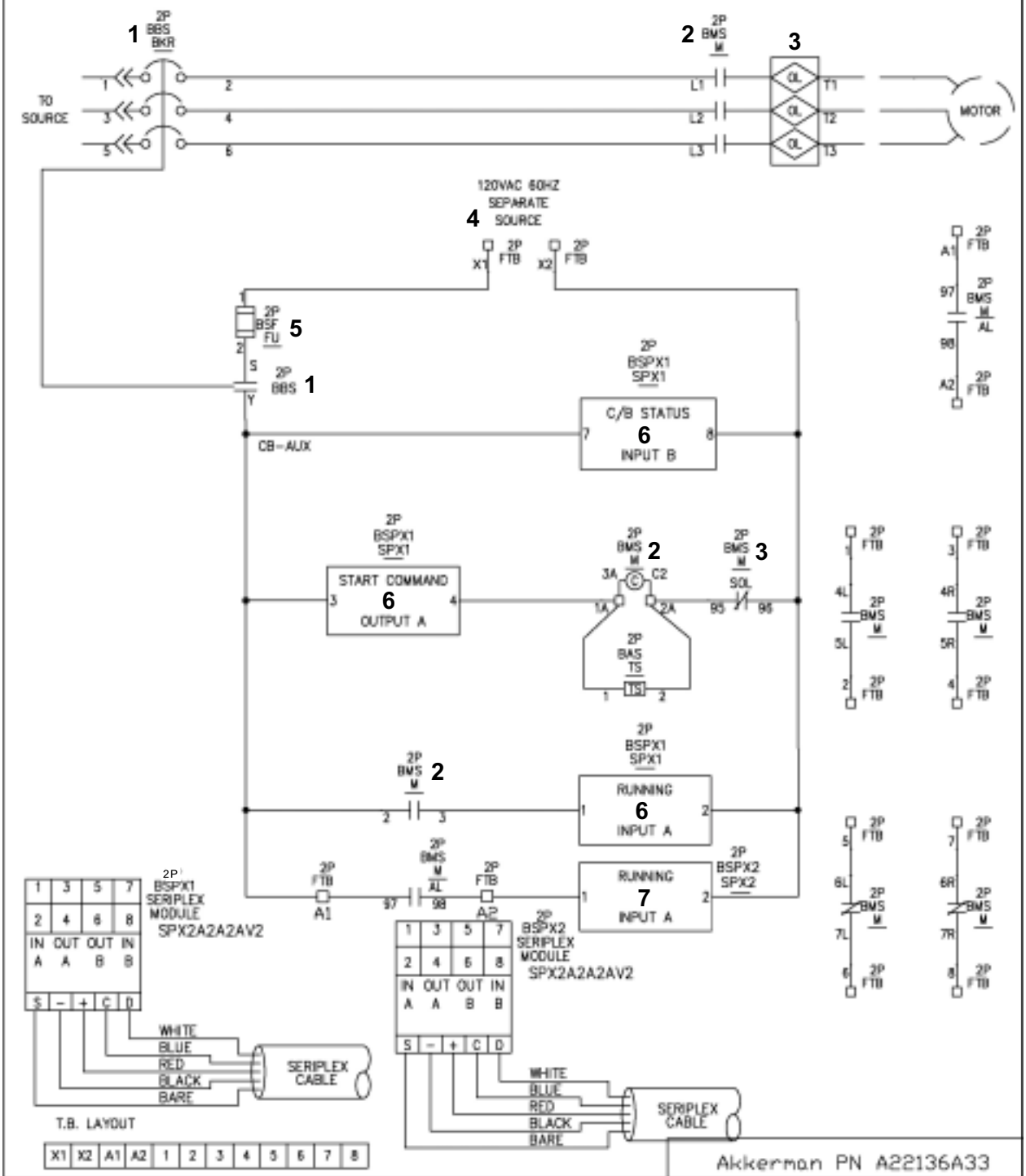
DWG# 11501-2042-002-01 PG 1 OF 1 REV D

NOTES

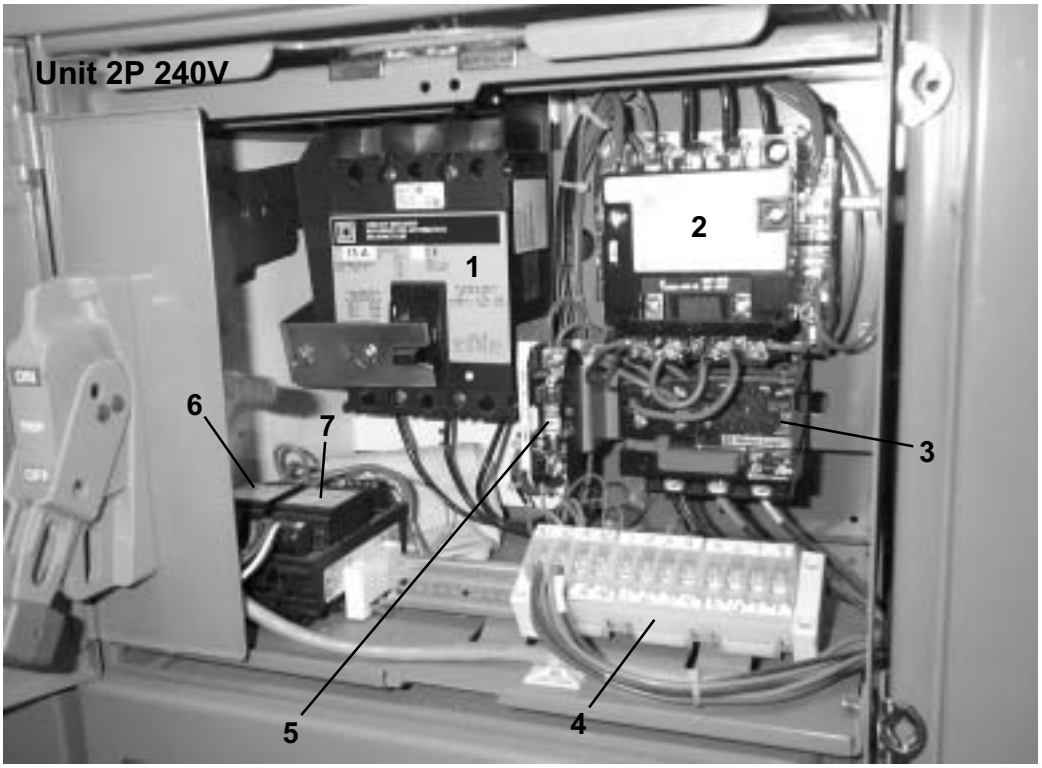

REV | DESCRIPTION | BY | DATE | REVISED UNIT LOCATION | WSM | 8/15/02
A | ADD FTB 9 | SLM | 7/18/02
TO SOURCE
MOTOR
120VAC SEPARATE SOURCE FROM E-STOP
POWER ON
INPUT B
START COMMAND
OUTPUT A
RUNNING
INPUT A
C/B STATUS
INPUT A
PWR IN
PWR OUT
CTRL IN
CTRL OUT
TO BULKHEAD CONNECTOR
SPX2A2A2AV2
SERIPLEX CABLE
WHITE
BLUE
RED
BLACK
BARE
T.B. LAYOUT
X1 X2 A1 A2 1 2 3 4 5 6 7 8 9
AKKERMAN A22136A31
JOB NAME: AKKERMAN INC.
JOB LOCATION: BROWNSDALE, MN
DRAWN BY: SLM
ENGR: GARY MOSS
DATE: JULY 15, 2002
DRAWING STATUS: RECORD
EQUIPMENT DESIGNATION: 240V MCC-HEAD MOTOR COOLING PUMP
EQUIPMENT TYPE: MODEL 6 MOTOR CONTROL MCC
DRAWING TYPE: ELEMENTARY DIAGRAM
SQUARE D COMPANY
DWG# E15012042-002-01
PG 1 OF 1 REV B


Unit 1F 240V
1
2
3
4
5
6
7
8
9

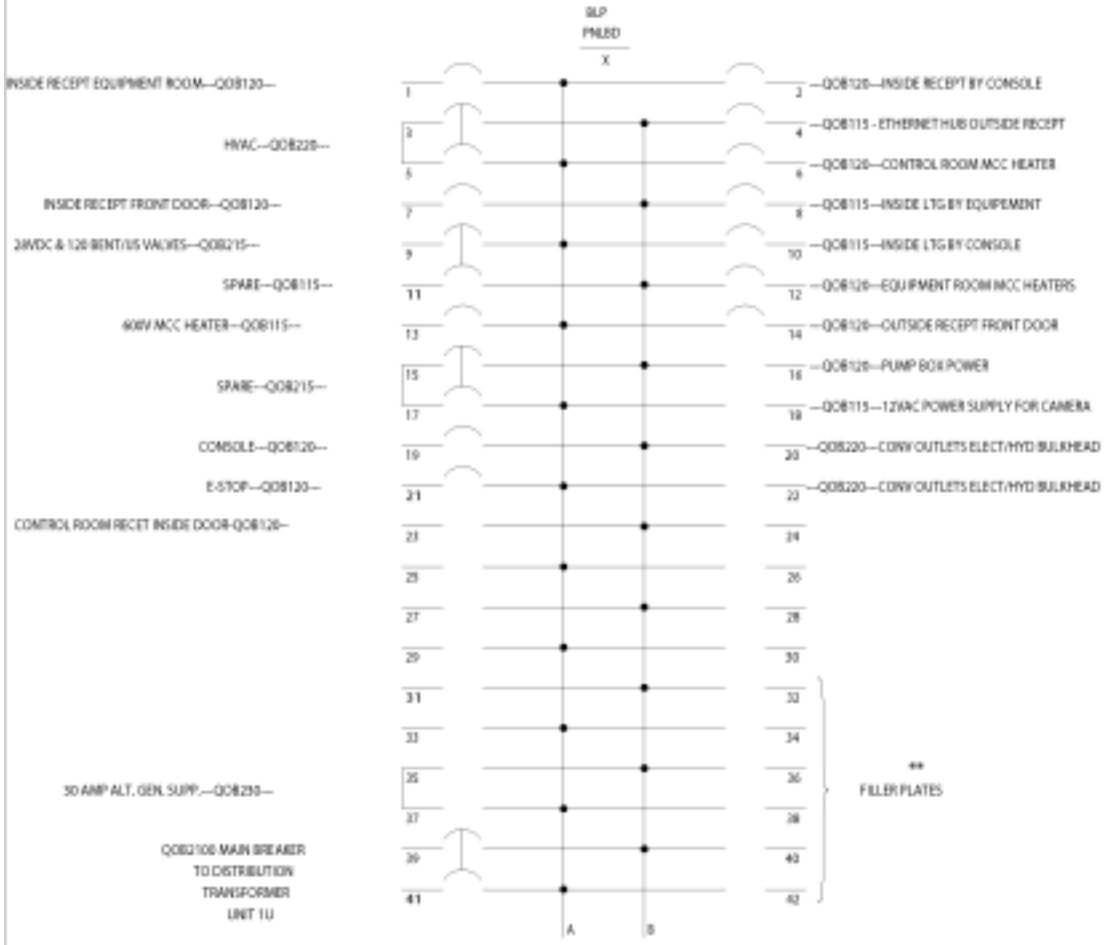
REV	DESCRIPTION	BY	DATE	B	REV. SERIPLEX MODULE OUTPUT	WGM	8/16/02
A	REV. SERIPLEX MODULE NO.	SLM	7/18/02				



JOB NAME:	AKKERMAN INC.	EQUIPMENT DESIGNATION:	240V MCC – OIL COOLING FAN
JOB LOCATION:	BROWNSDALE, MN	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL MCC
DRAWN BY:	SLM	DRAWING TYPE:	ELEMENTARY DIAGRAM
ENGR:	GARY MOSS		SQUARE D COMPANY
DATE:	JULY 15, 2002		
DRAWING STATUS:	RECORD	DWG# E15012042-002-03	PG 1 OF 1 REV B


Unit 2P 240V
1
2
3
4
5
6
7

REV	DESCRIPTION	BY	DATE	B	REV NEUTRAL LUG NOTE	SUM	07/18/02
D	REVISED XFMR LOCATION	RKSM	08/15/02	C	CHANGES TO SINGLE PHASE	RKSM	08/06/02



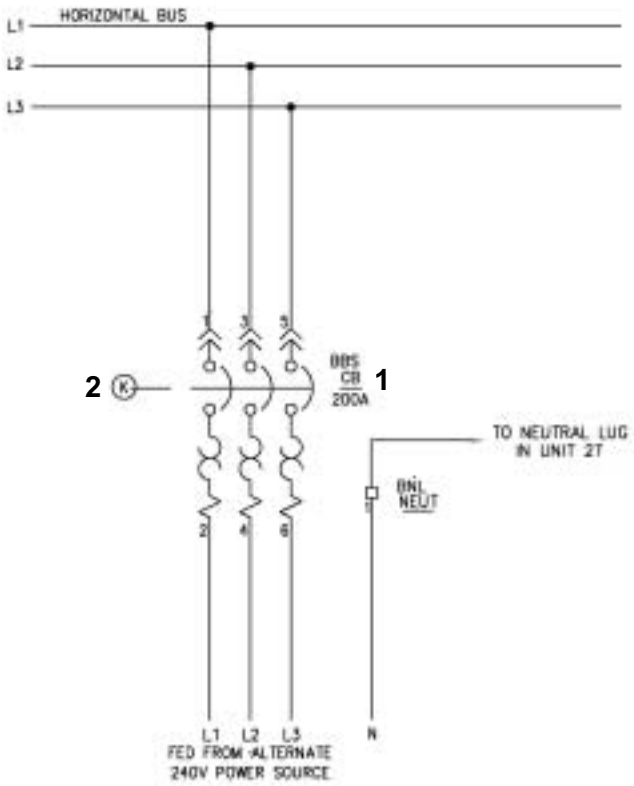
** NOTE: THESE SPACES CAN NOT BE USED DUE TO RATING OF MAIN BREAKER.

Akkerman PN A22136A34

JOB NAME:	AKKERMAN INC.	EQUIPMENT DESIGNATION:	240V MCC
JOB LOCATION:	BROWNSDALE, MN	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL MCC
DRAWN BY:	SUM	DRAWING TYPE:	ELEMENTARY DIAGRAM
ENGR:	GARY MOSS		SQUARE D COMPANY
DATE:	JULY 15, 2002		
DRAWING STATUS:	RECORD	DWG# E1S012042-002-04	PG 1 OF 1 REV D

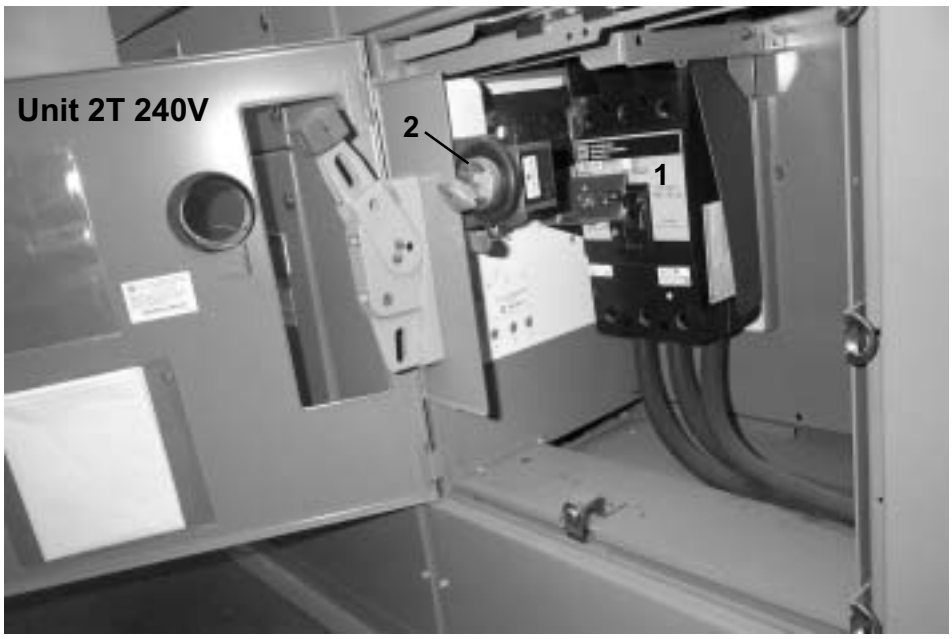

Unit 2P 240V

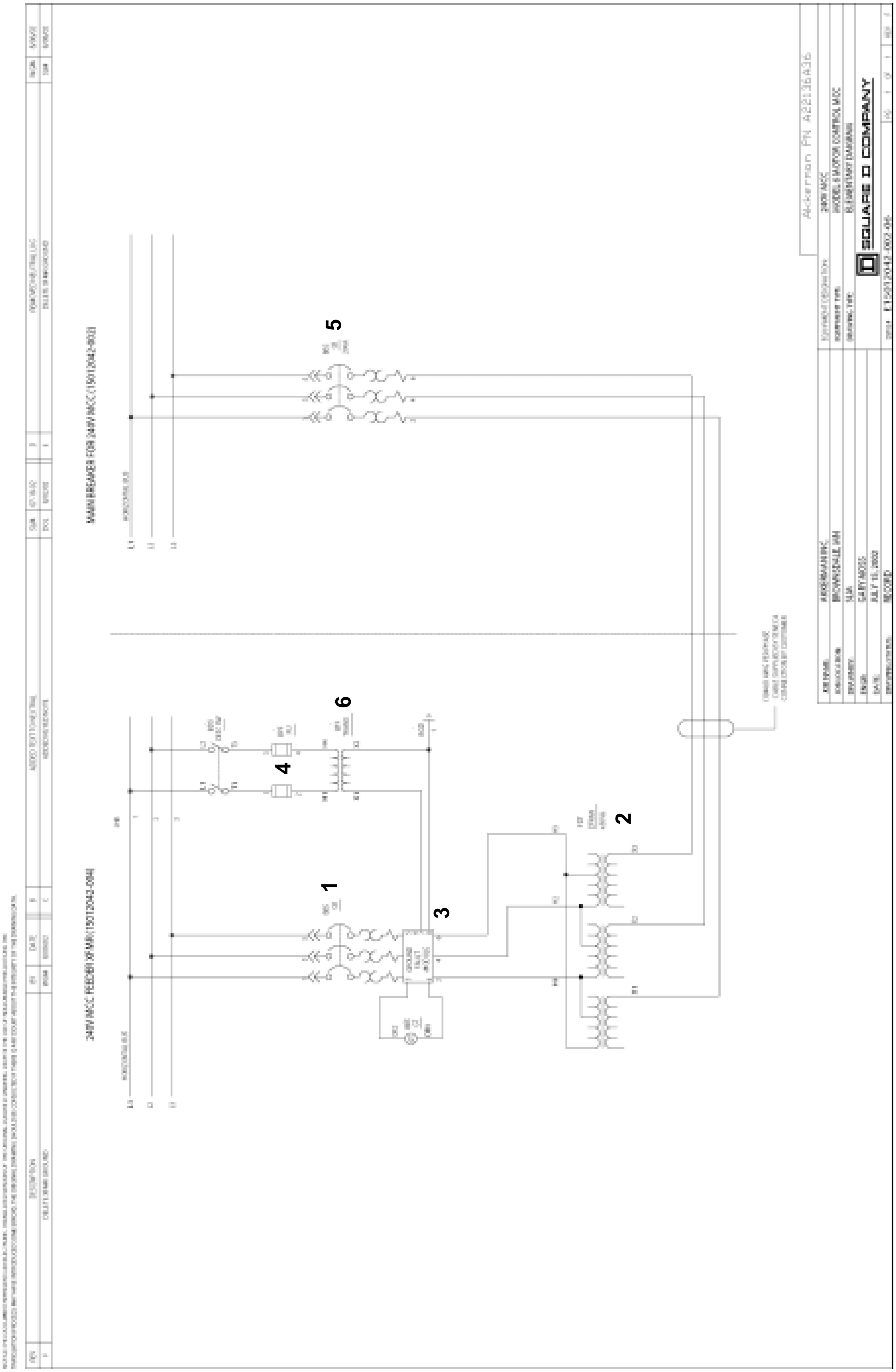
REV	DESCRIPTION	BY	DATE				
A	ADDED NEUTRAL	TR	07/16/02				

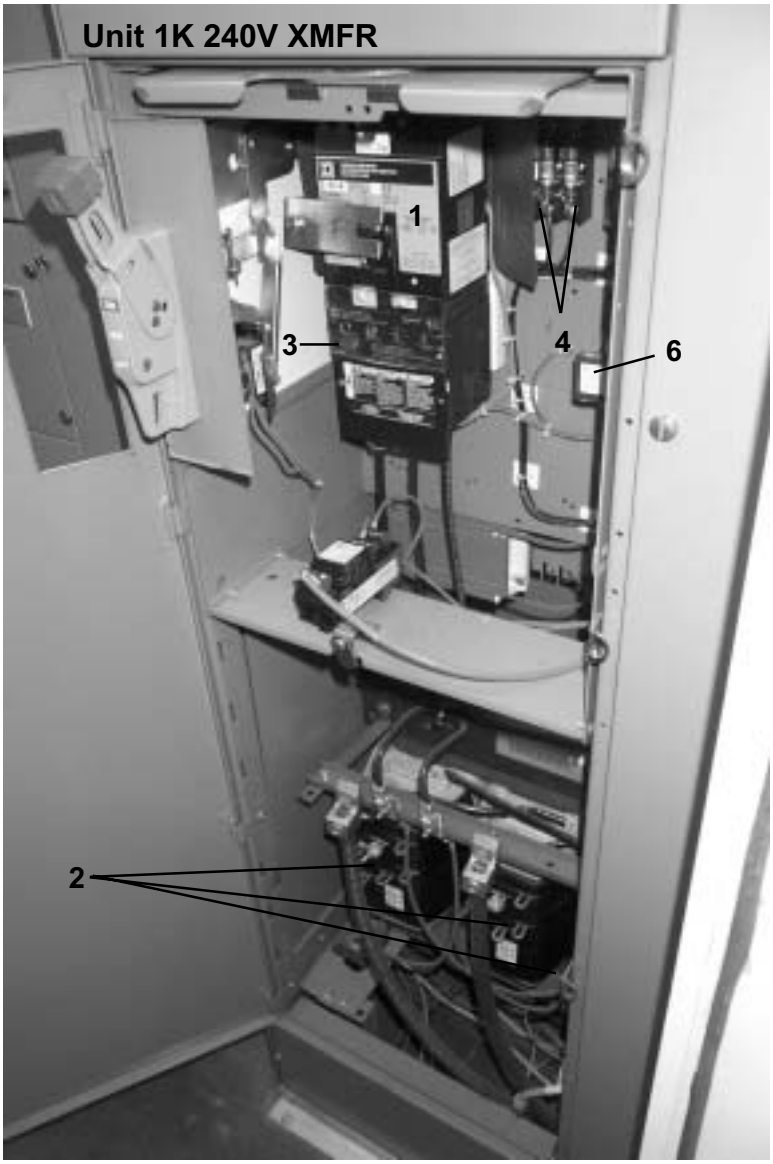


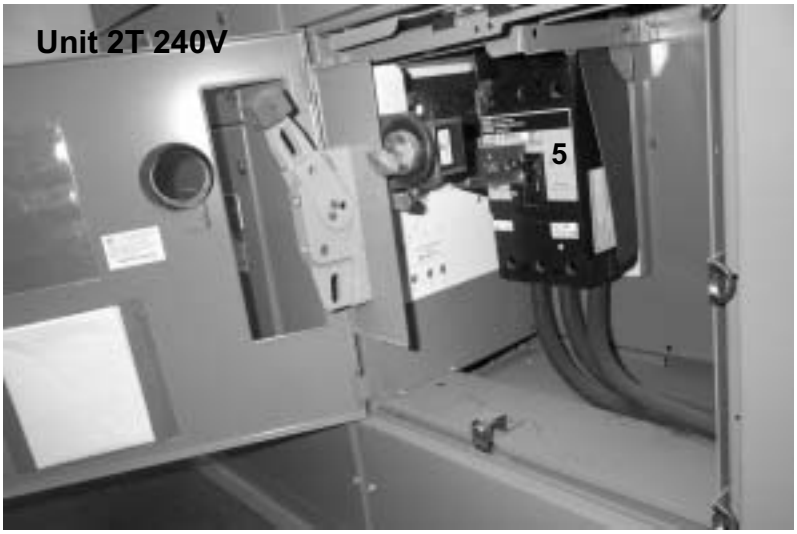
Akkerman PN A22136A35

JOB NAME:	AKKERMAN INC.	EQUIPMENT DESIGNATION:	240V MCC
JOB LOCATION:	BROWNSDALE, MN	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL MCC
DRAWN BY:	SLM	DRAWING TYPE:	ELEMENTARY DIAGRAM
ENGR:	GARY MOSS	SQUARE D COMPANY	
DATE:	JULY 15, 2002		
DRAWING STATUS:	RECORD	DWG# E15012042-002-05	PG 1 OF 1 REV A


Unit 2T 240V
2
1


5
6
4
2
1
3
SQUARE D COMPANY


Unit 1K 240V XMFR
1
3
4
6
2


Unit 2T 240V
5

NOTICE: THIS DOCUMENT REPRESENTS AN ELECTRONIC TRANSLATED VERSION OF THE ORIGINAL SQUARE D DRAWING. DESPITE THE USE OF REASONABLE PRECAUTIONS THE TRANSLATION PROCESS MAY HAVE INTRODUCED SOME ERRORS. THE ORIGINAL DRAWING SHOULD BE CONSULTED IF THERE IS ANY DOUBT ABOUT THE INTEGRITY OF THE DRAWING DATA.

REV	DESCRIPTION	BY	DATE	REV	REVISED UNIT LOCATION	WSM	8/8/02
D	REVISED PWR SUPPLY UNIT	WSM	8/15/02	C	REV. DWG. NO.	SLM	8/8/02

ETHERNET IP ADDRESSES

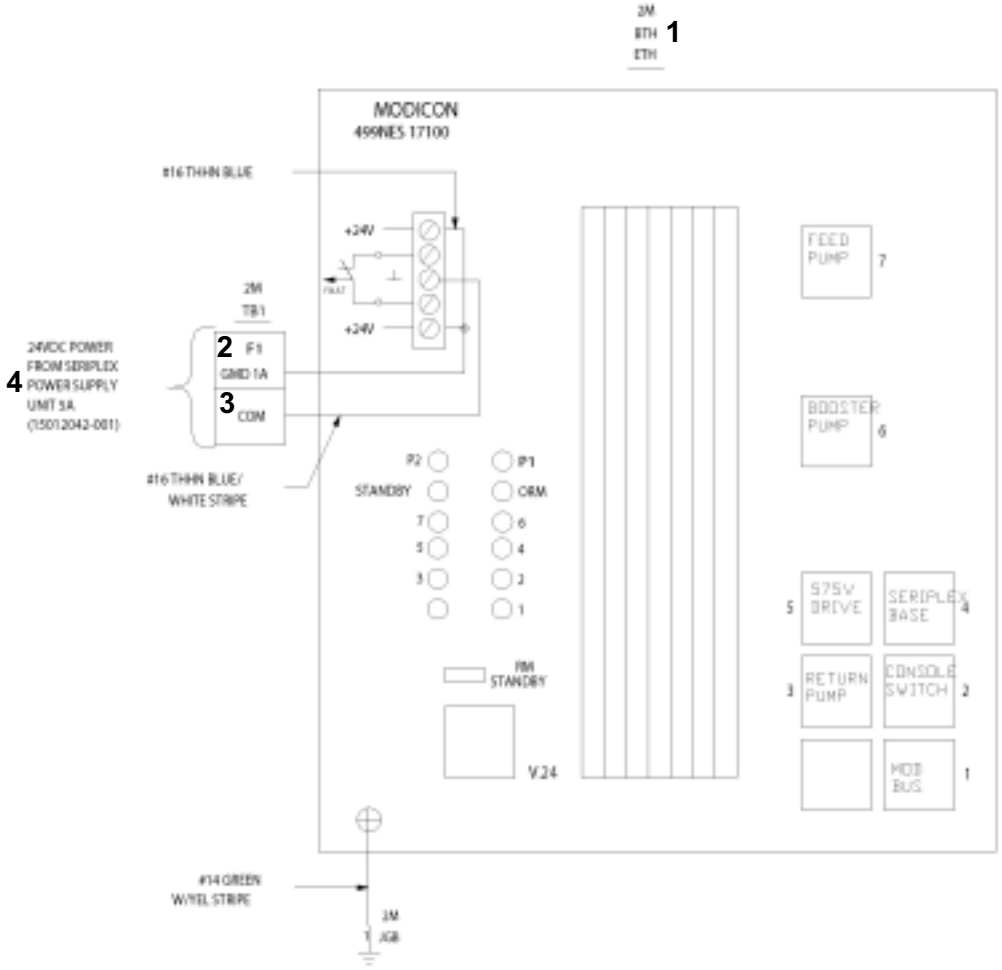
192.168.10.80 - MCC CONTROLS (ETHERNET TO SERIPLEX BRIDGE)

192.168.10.82 - POWER METER

192.168.10.84 - MAIN DRIVE VFD

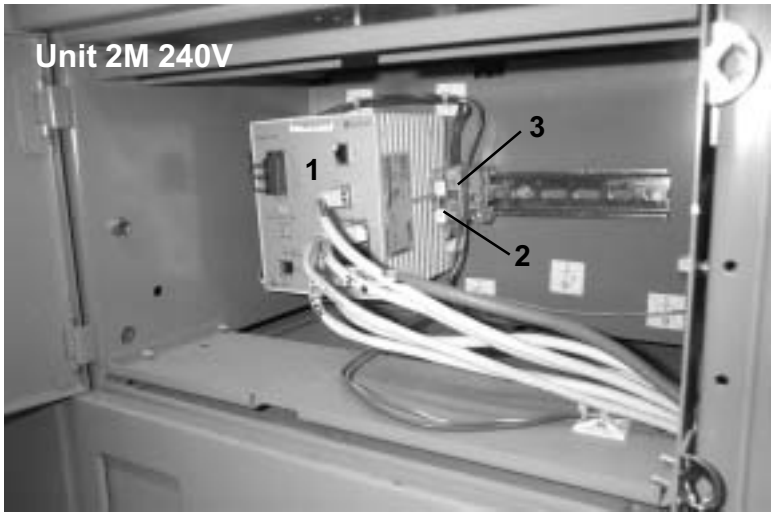
192.168.10.85 - BOOSTER VFD

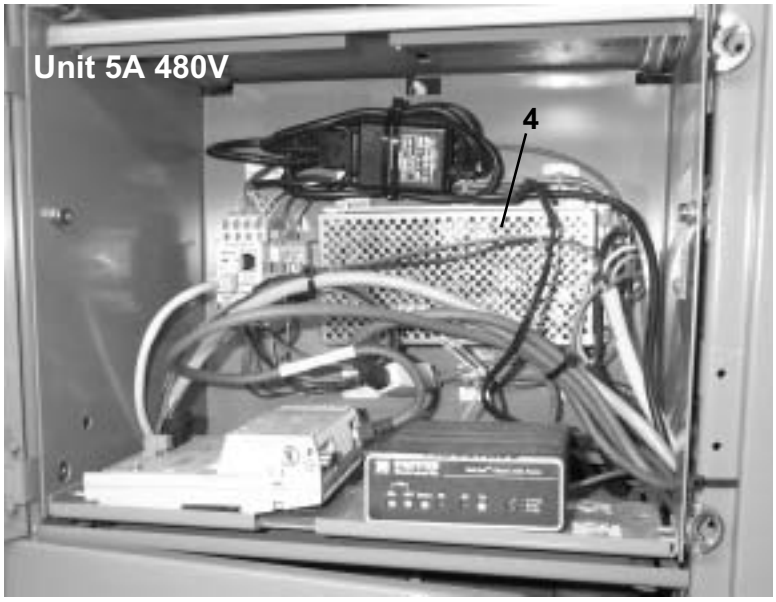
192.168.10.88 - RETURN PUMP VFD

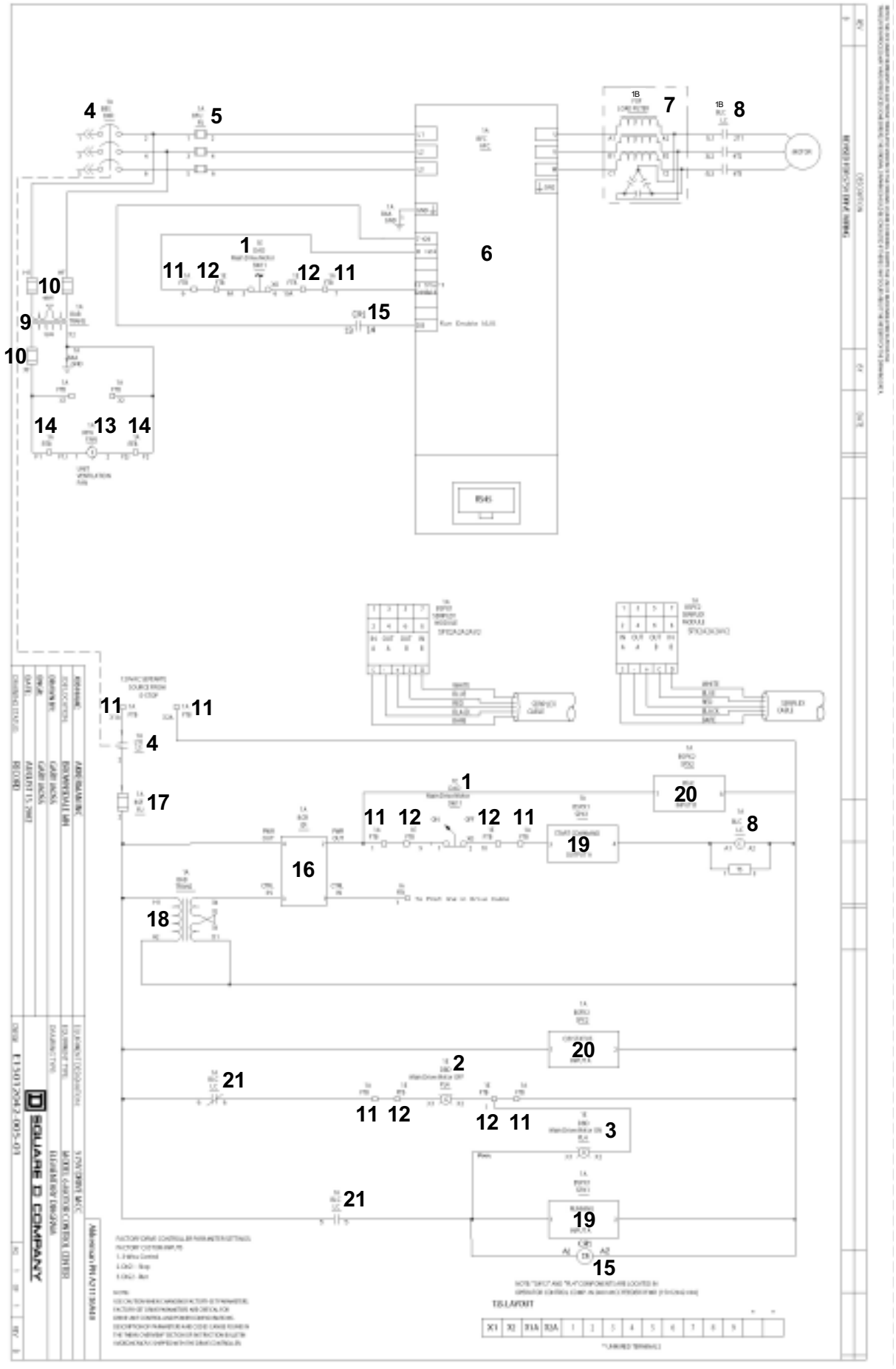


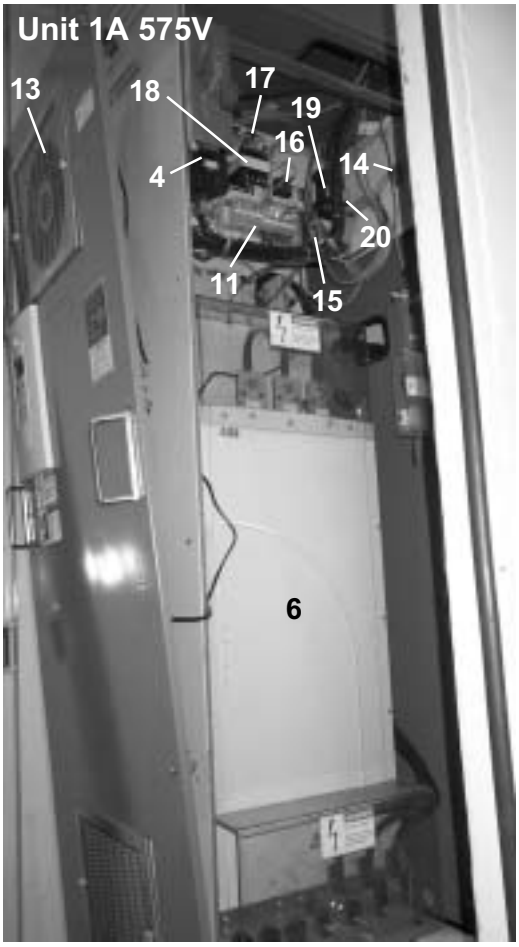
Akkerman PN A22136A37

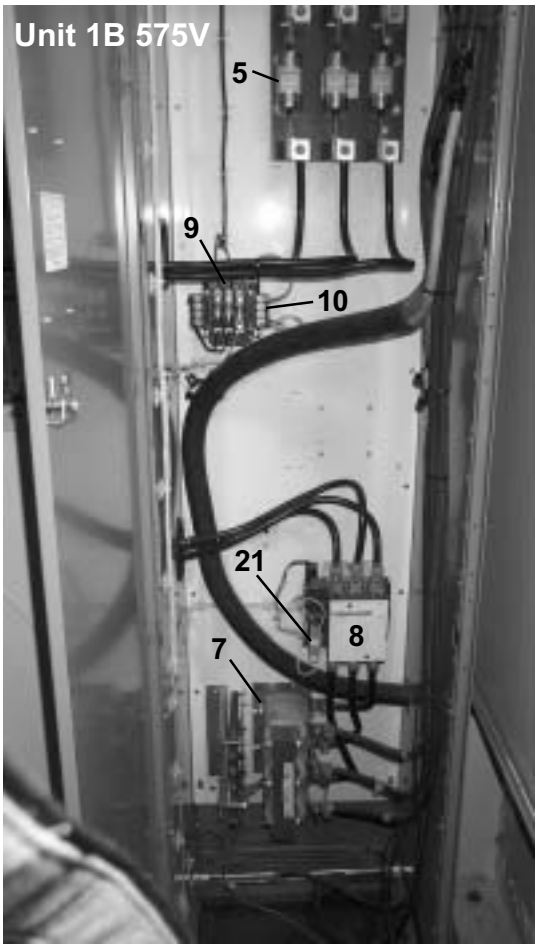
JOB NAME:	AKKERMAN INC.	EQUIPMENT DESIGNATION:	240V MCC
JOB LOCATION:	BROWNSDALE, MN	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL MCC
DRAWN BY:	SLM	DRAWING TYPE:	ELEMENTARY DIAGRAM
ENGR:	GARY MOSS		SQUARE D COMPANY
DATE:	JULY 15, 2002		
DRAWING STATUS:	RECORD	DWG# E15012042-002-07	PG 1 OF 1 REV D

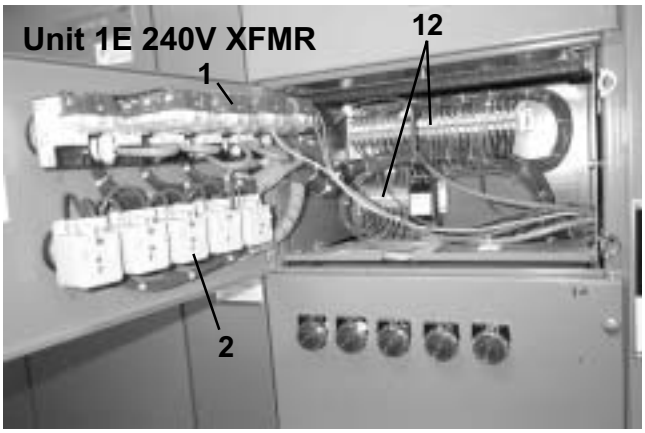

Unit 2M 240V
1
2
3

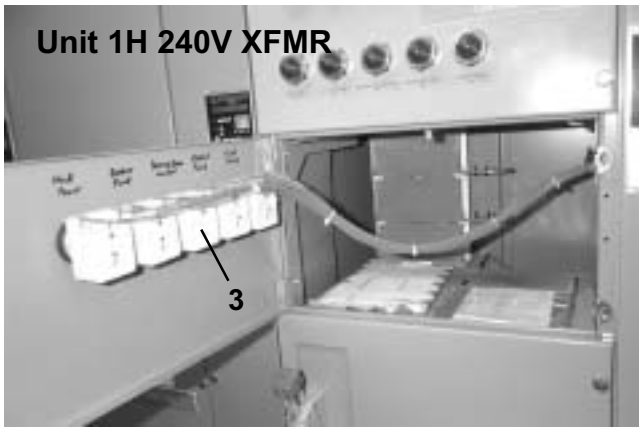

Unit 5A 480V
4


4
5
7
8
1
6
11
12
12
11
15
10
9
10
14
13
14
11
11
4
17
1
20
11
12
12
11
8
19
16
18
20
2
21
11
12
12
11
3
21
19
15

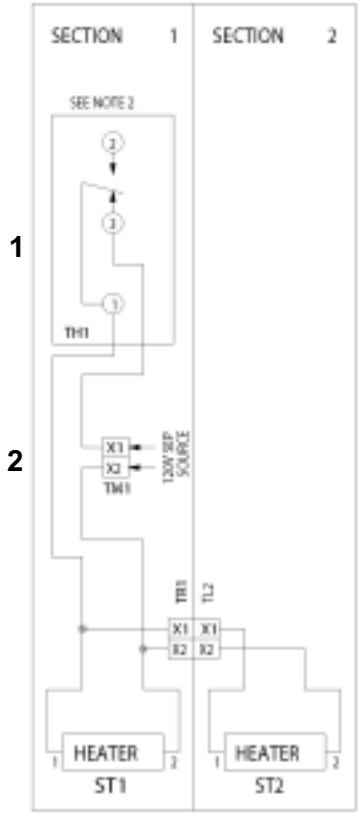

Unit 1A 575V
13
18
17
19
16
4
14
20
11
15
6


Unit 1B 575V
5
9
10
21
8
7


Unit 1E 240V XFMR
12
1
2


Unit 1H 240V XFMR
3

REV	DESCRIPTION	BY	DATE				
A	MOVE T'STAT TO SECT. 1	SLM	7/18/02				



NOTE 1: STRIP HEATER (200W, 120V) HOTWATT #CS12 OR EQUIVALENT.
CUSTOMER MUST PROVIDE PROTECTIVE POWER SUPPLY.

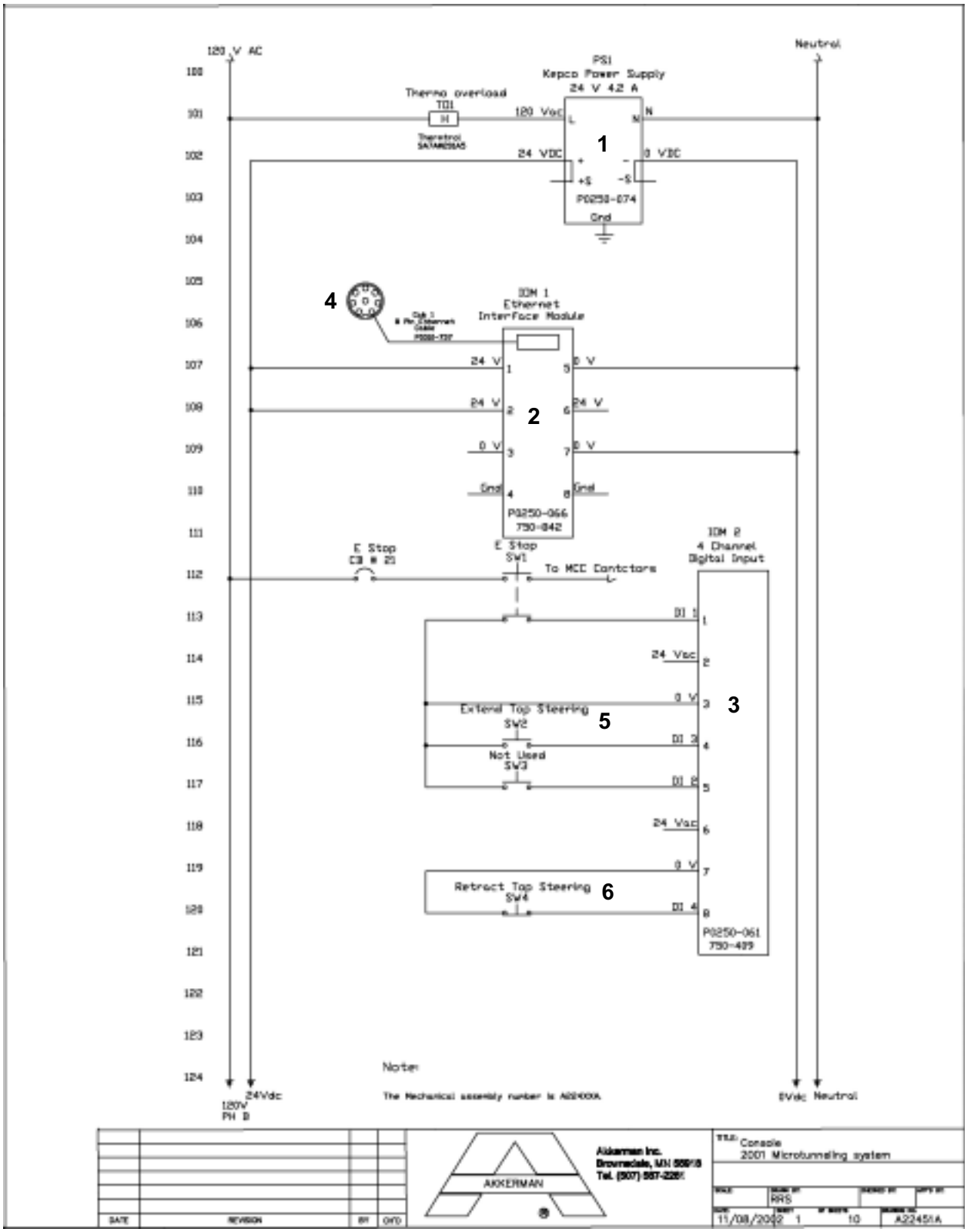
NOTE 2: THERMOSTAT IS LOCATED IN VERTICAL WIRE TROUGH.
(30°F-110°F, 120V) PENN CONTROLS #A19BAC-1.
MOUNT PER REFERENCE DRAWING A80455-300.

Akkerman PN A22136A41

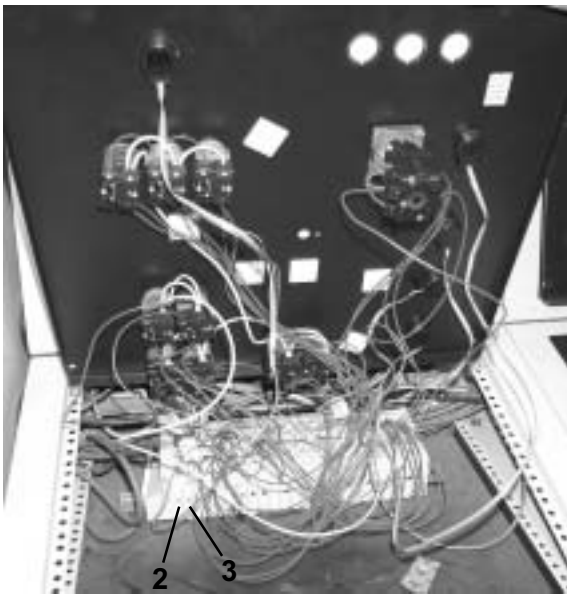
JOB NAME:	AKKERMAN INC	EQUIPMENT DESIGNATION:	TUNNELING VFD
JOB LOCATION:	BROWNSDALE MN	EQUIPMENT TYPE:	MODEL 6 MOTOR CONTROL CENTER
DRAWN BY:	CAD	DRAWING TYPE:	WIRING DIAGRAM
ENGR:	GARY MOSS	SQUARE D COMPANY	
DATE:	JUNE 21, 2002		
DRAWING STATUS:	RECORD	DWG# C15012042-005-01	PG 1 OF 1 REV A

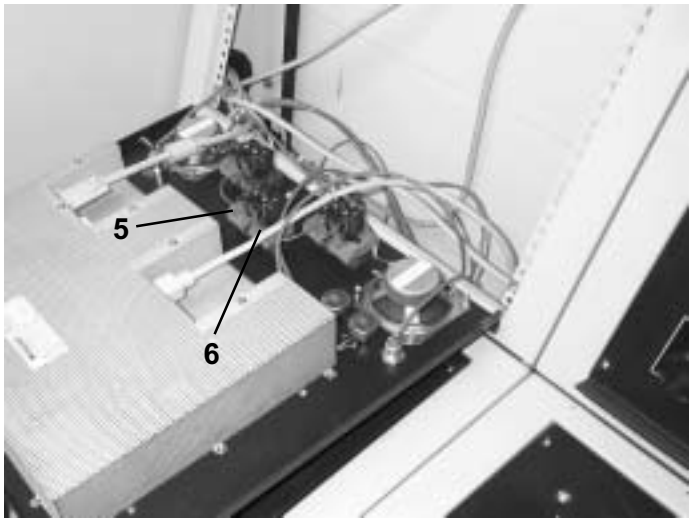

Unit 1A 575V
1
2

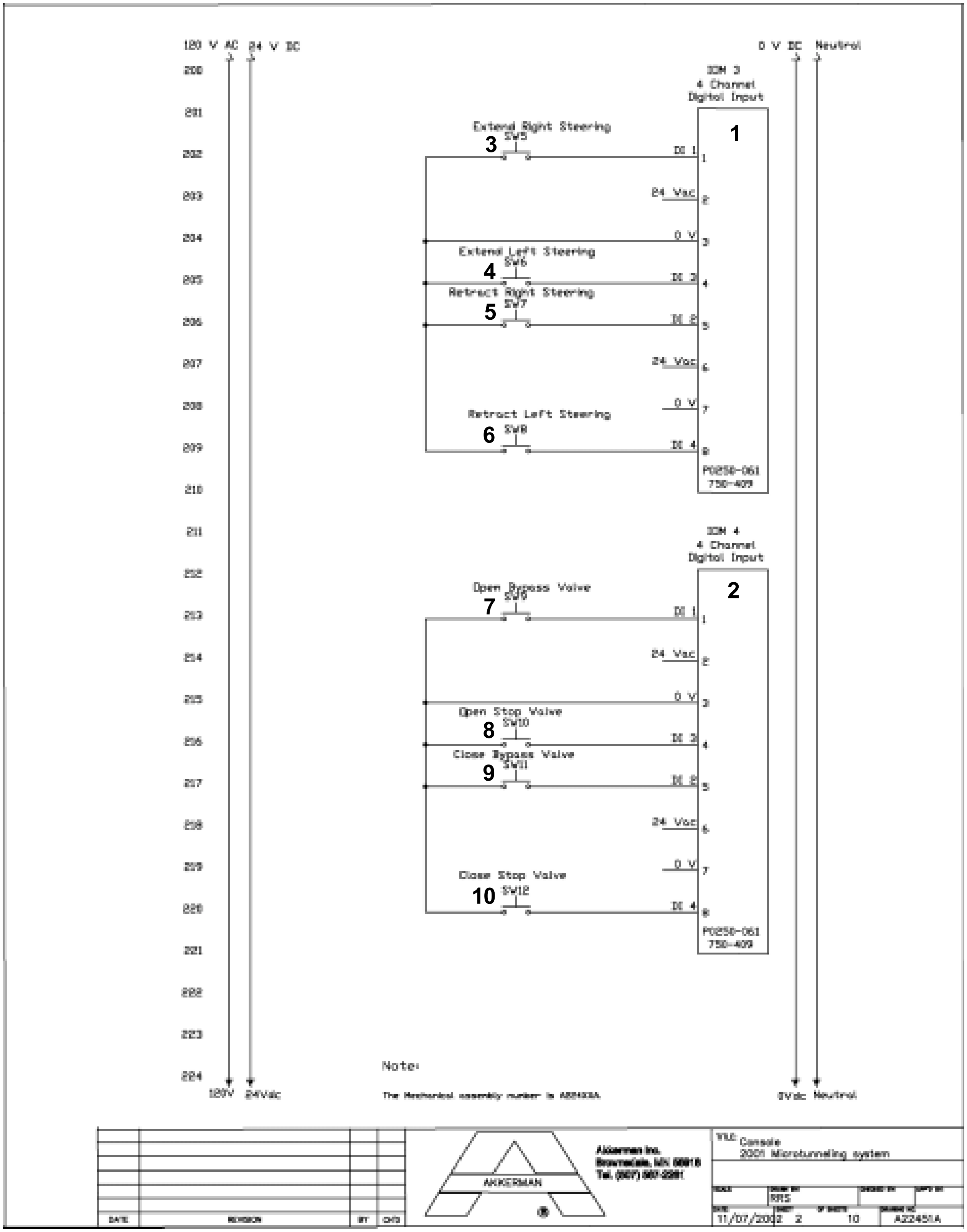
CONSOLE SCHEMATICS

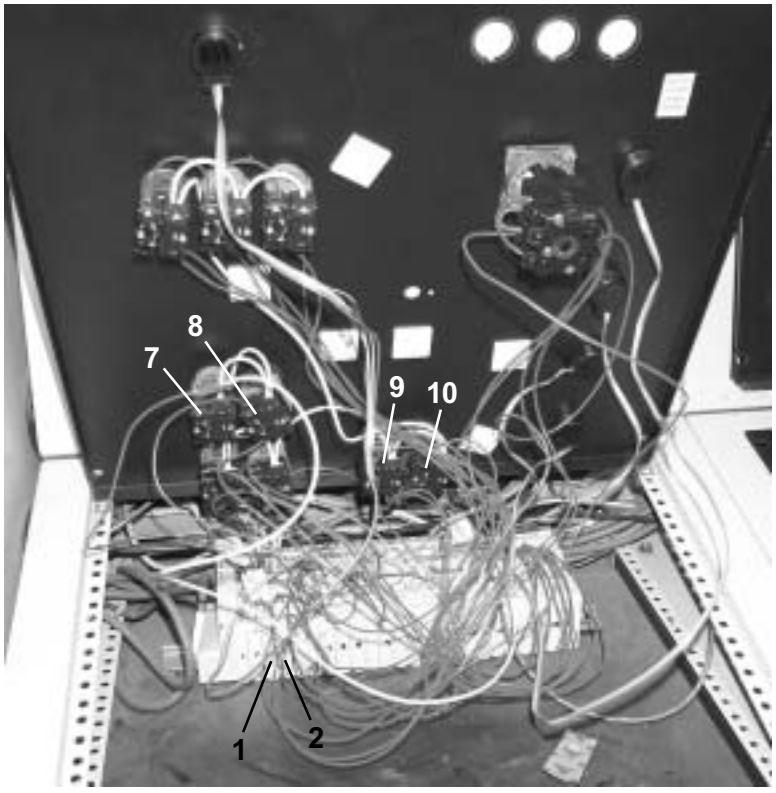


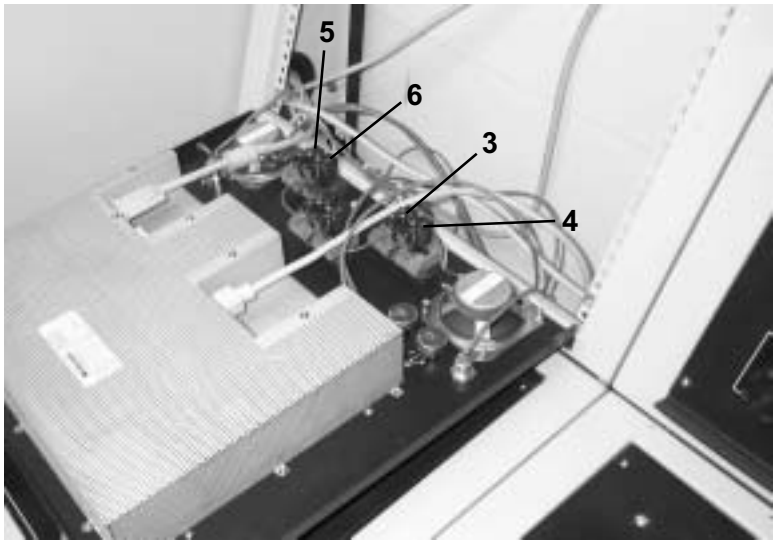

4
1

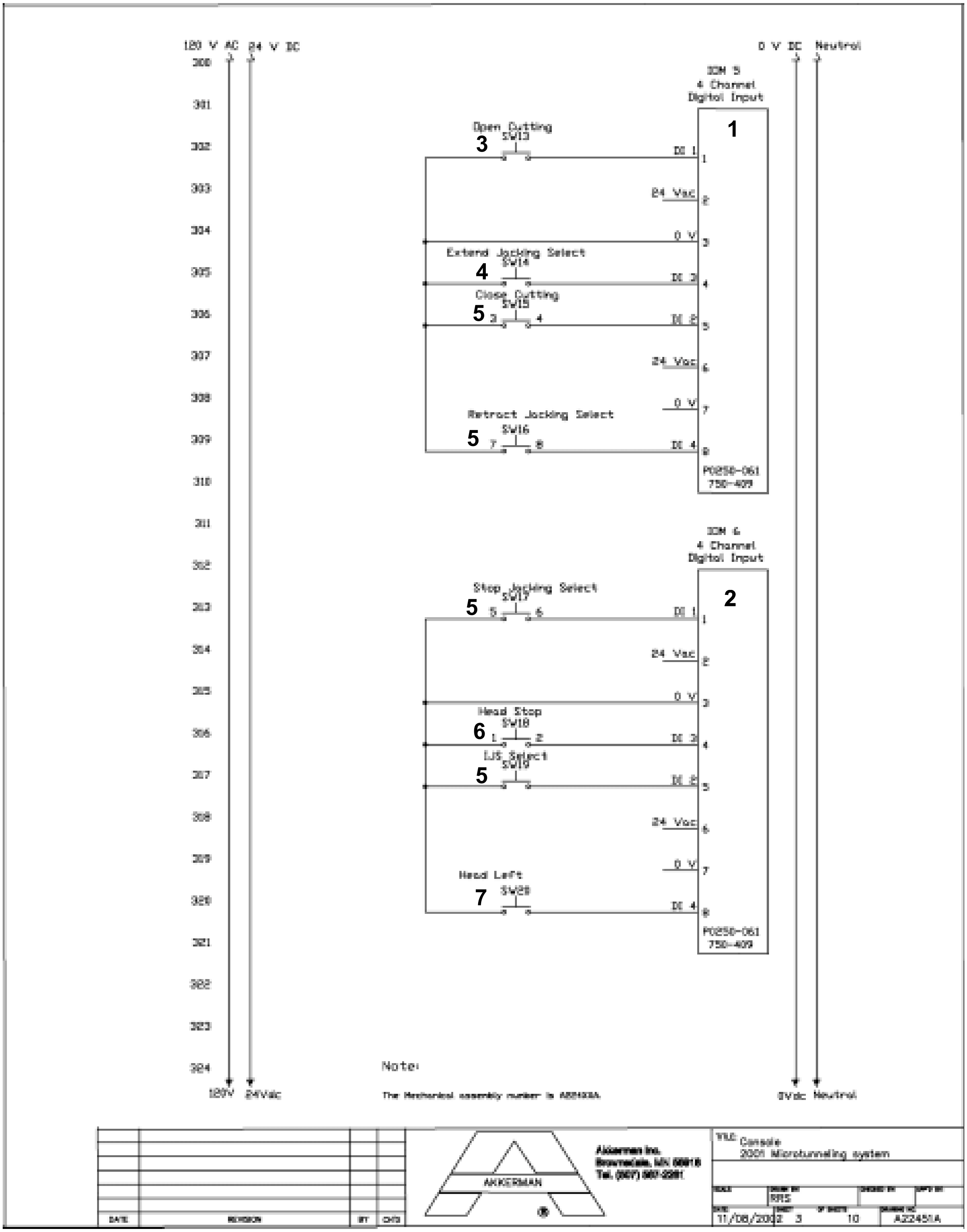

2
3


5
6

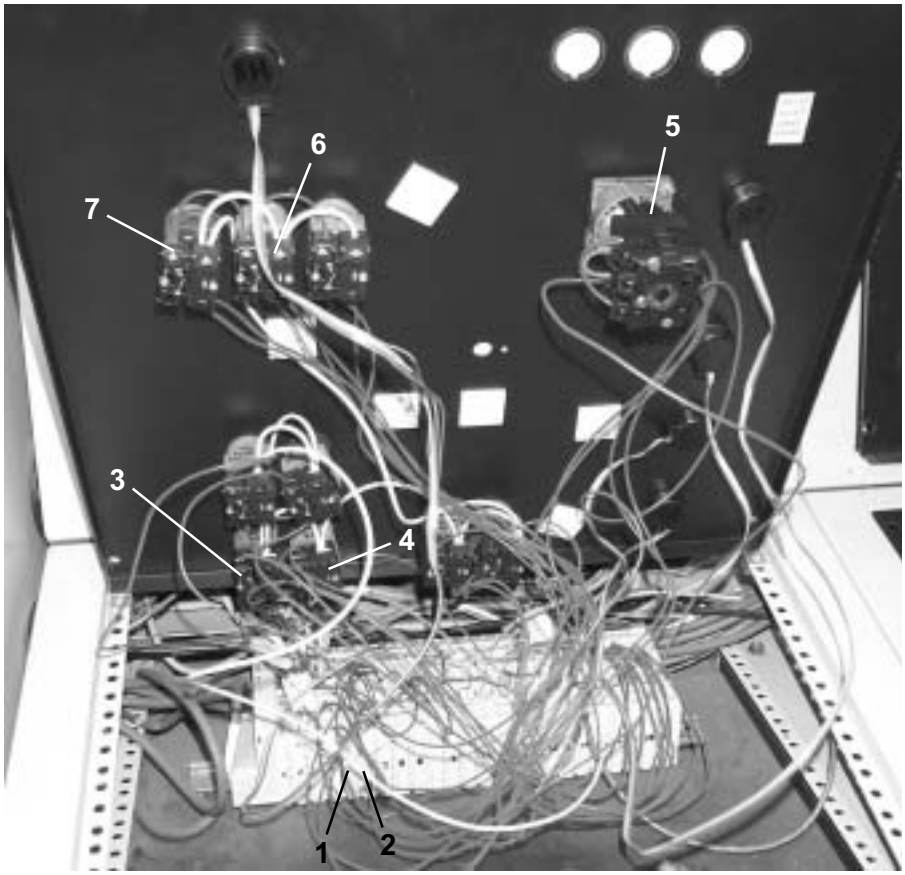

120 V AC
24 V DC
0 V DC
Neutral
IOM 3
4 Channel
Digital Input
1
Extend Right Steering
SW5
3
DI 1
24 Vac
0 V
Extend Left Steering
SW6
4
DI 3
Retract Right Steering
SW7
5
DI 2
24 Vac
0 V
Retract Left Steering
SW8
6
DI 4
P0250-061
750-409
IOM 4
4 Channel
Digital Input
2
Open Bypass Valve
SW9
7
DI 1
24 Vac
0 V
Open Stop Valve
SW10
8
DI 3
Close Bypass Valve
SW11
9
DI 2
24 Vac
0 V
Close Stop Valve
SW12
10
DI 4
P0250-061
750-409
Note:
120V
24Vdc
0Vdc
Neutral
AKKERMAN
Console
2001 Microtunneling system
RRS
11/07/2002
2
10
A22451A
DATE
REVISION
BY
CHK'D

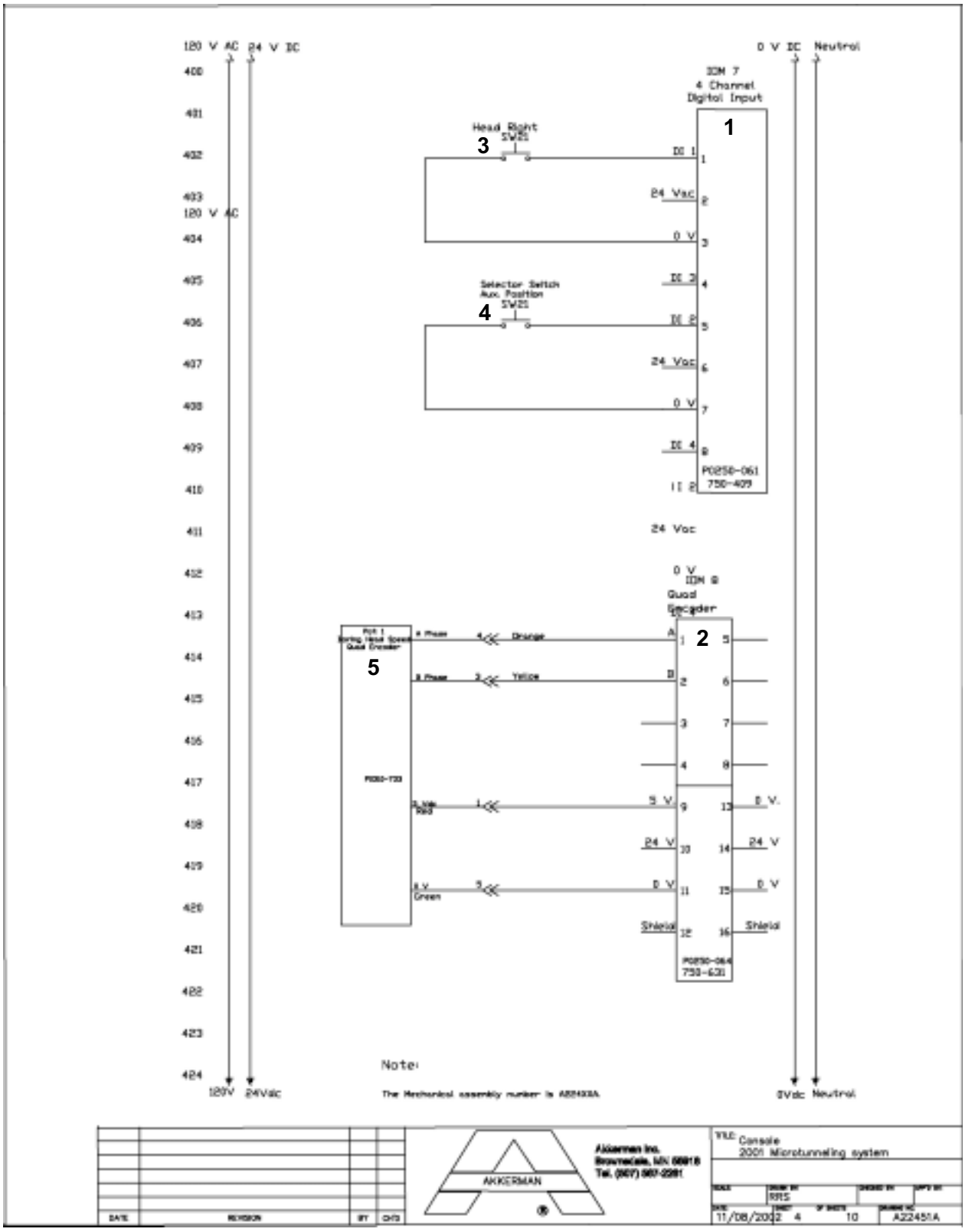

8
7
9
10
1
2

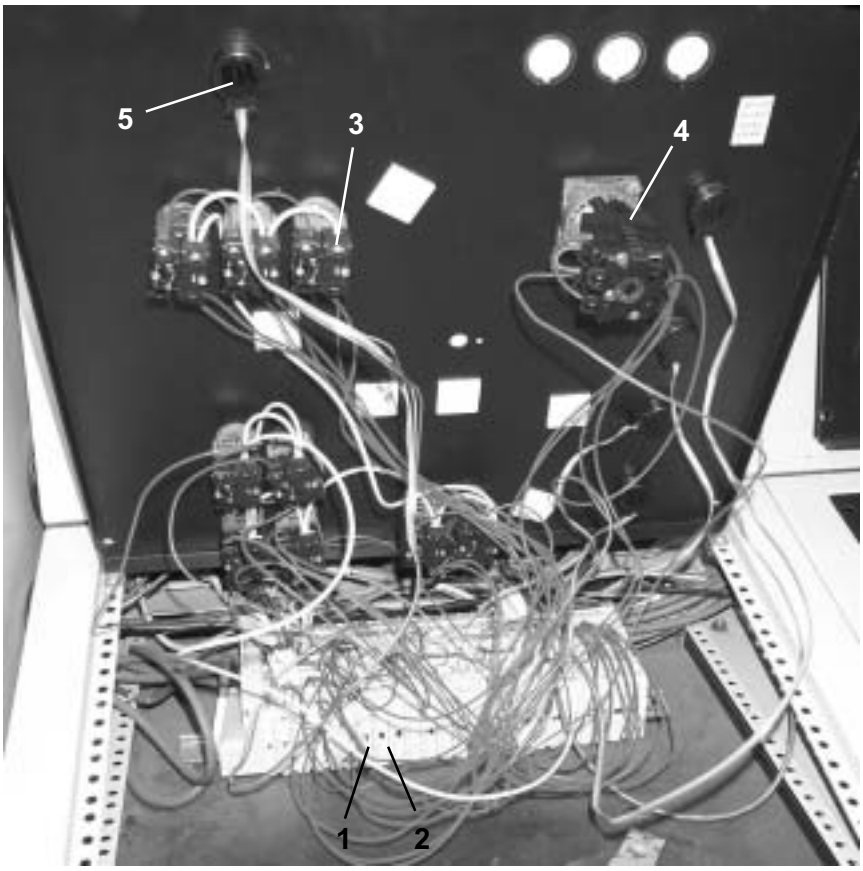

5
6
3
4

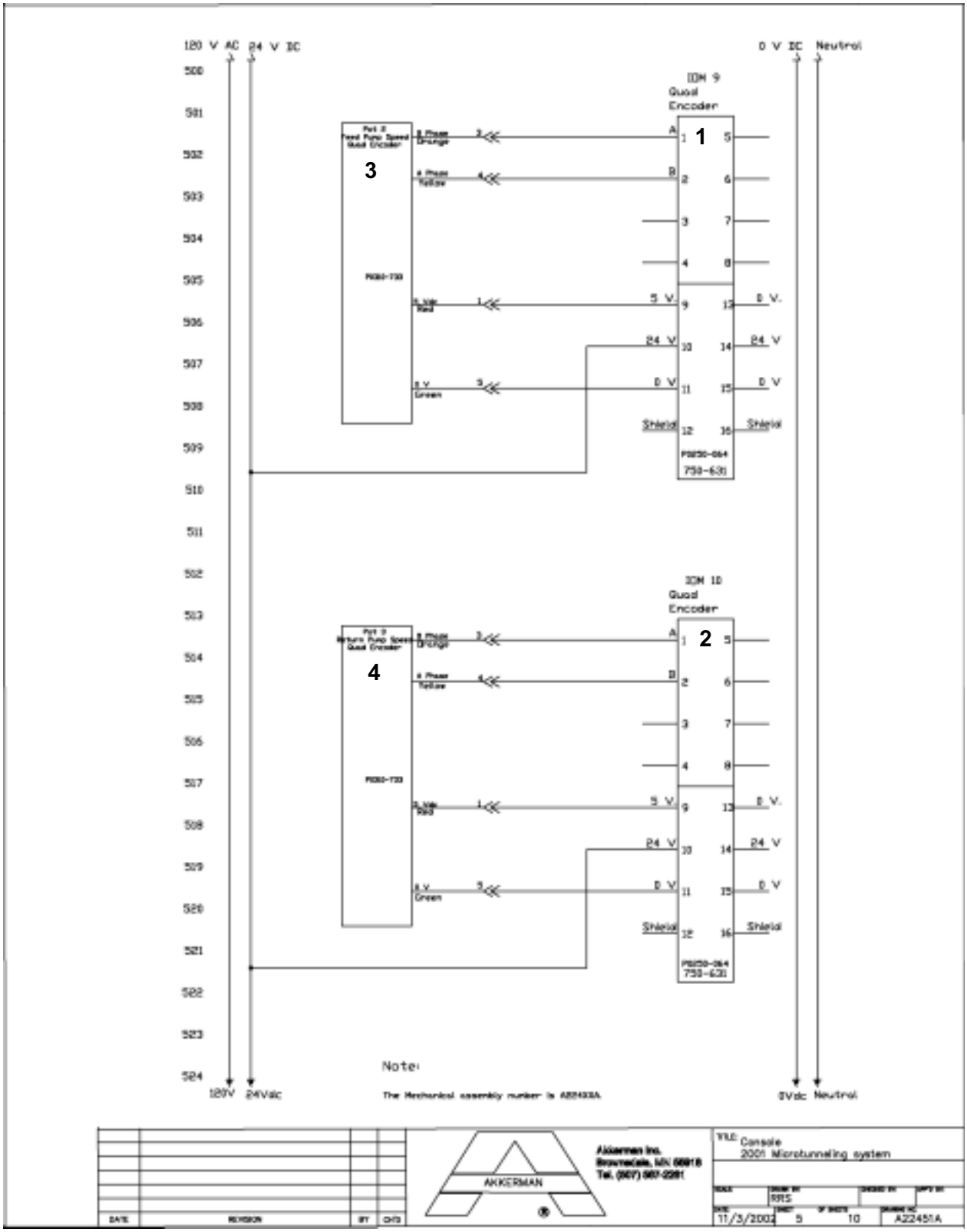


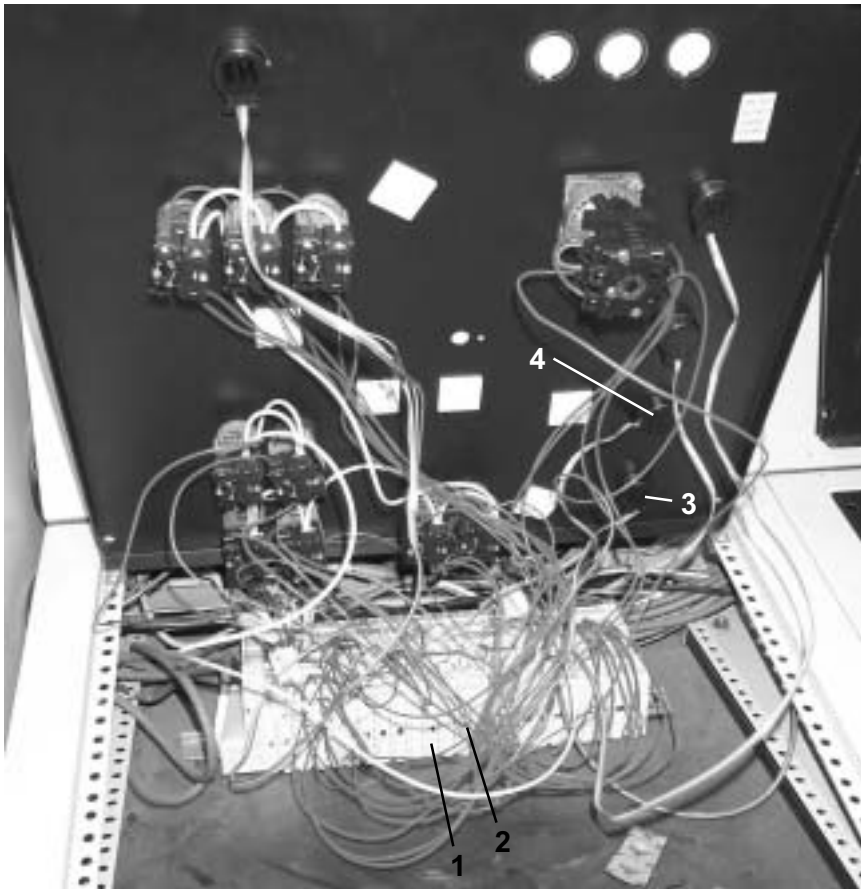
120 V AC
24 V DC
0 V DC
Neutral
IOM 5
4 Channel
Digital Input
Open Cutting
SW13
Extend Jacking Select
SW14
Close Cutting
SW15
Retract Jacking Select
SW16
P0250-061
750-409
IOM 6
4 Channel
Digital Input
Stop Jacking Select
SW17
Head Stop
SW18
IJS Select
SW19
Head Left
SW20
Note:
120V
24Vdc
0Vdc
Neutral
AKKERMAN
Console
2001 Microtunneling system
RRS
11/08/2002
A22451A

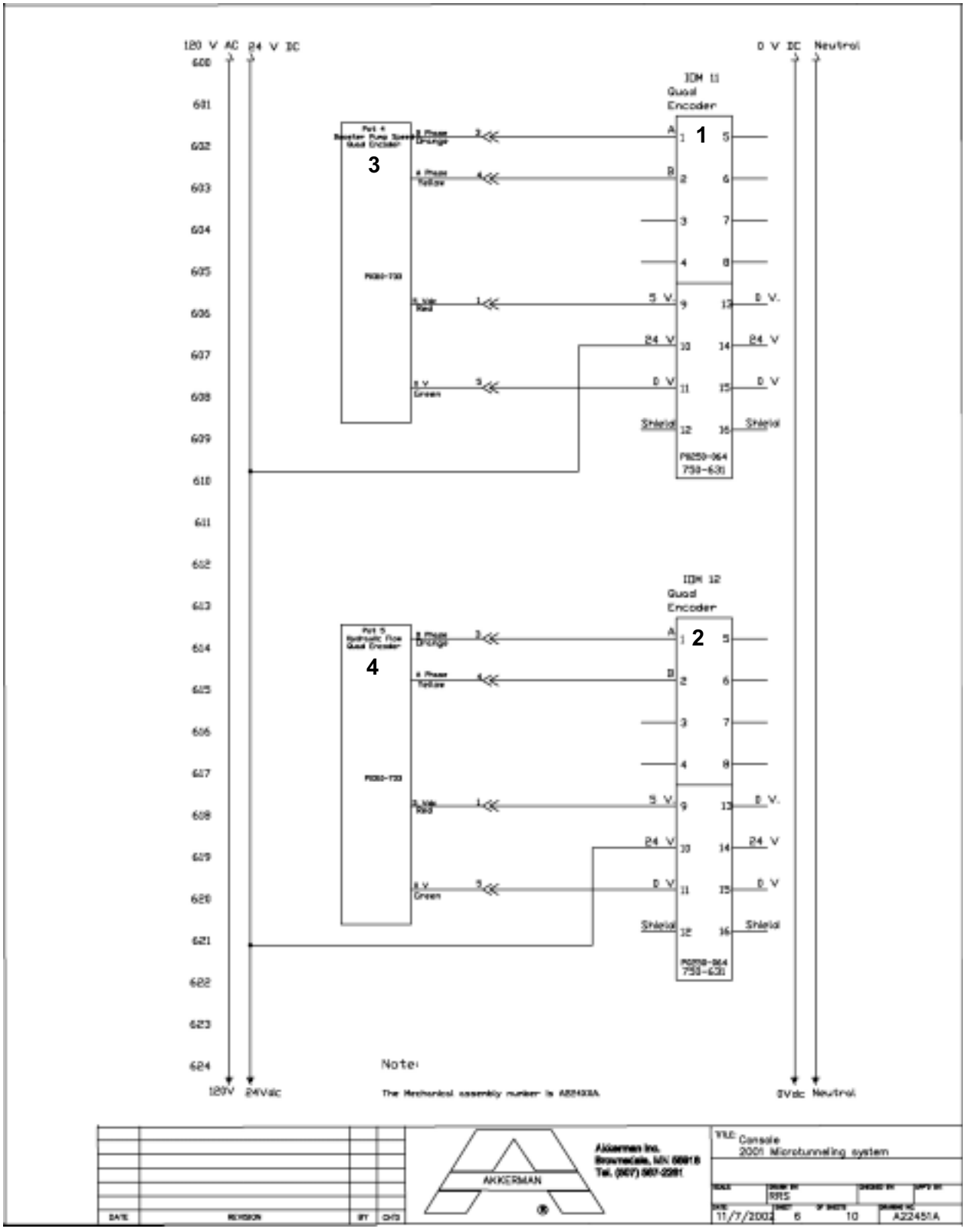

6
5
7
3
4
1
2

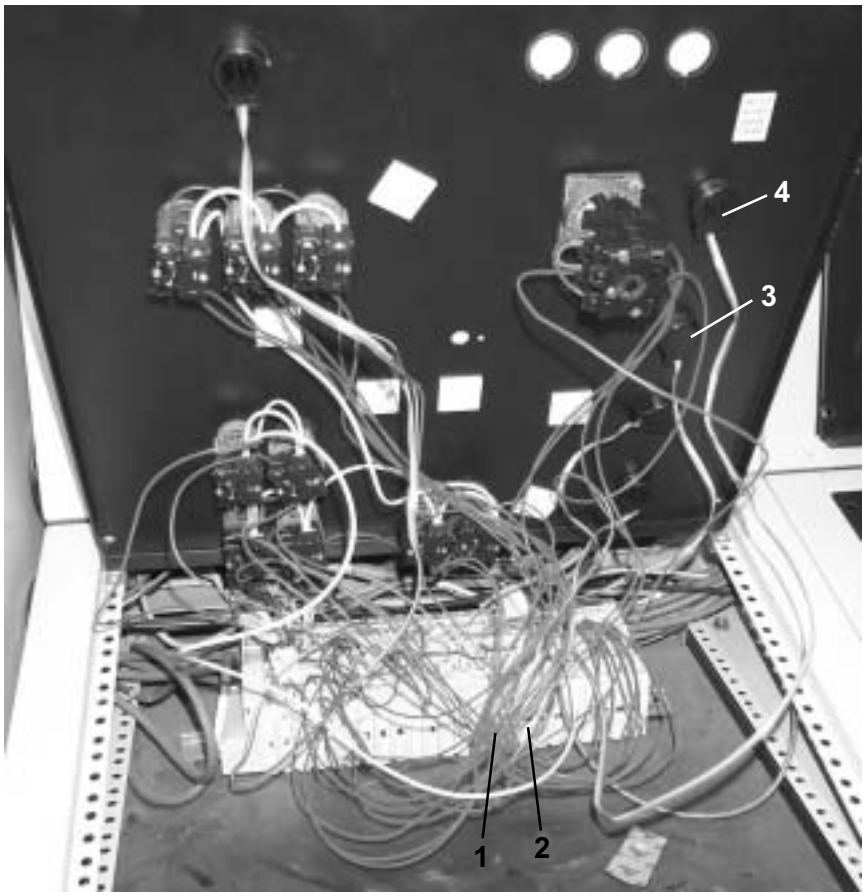

120 V AC
24 V DC
0 V DC
Neutrol
IDM 7
4 Channel
Digital Input
1
Head Right
SW31
3
DI 1
24 Vac
0 V
Selector Switch
Aux. Position
SW21
4
DI 3
DI 2
24 Vac
0 V
DI 4
P0250-061
750-409
24 Vac
0 V
IDM 8
Quad
Encoder
2
5
A Phase
Orange
B Phase
Yellow
5 V
0 V
24 V
0 V
Shield
P0250-064
750-631
Note:
The Mechanical assembly number is A22433A
120V
24Vdc
0Vdc
Neutrol
AKKERMAN
Akkerman Inc.
Brownsdale, MN 55918
Tel. (507) 567-2991
Console
2001 Microtunneling system
11/08/2002
4
10
A22451A

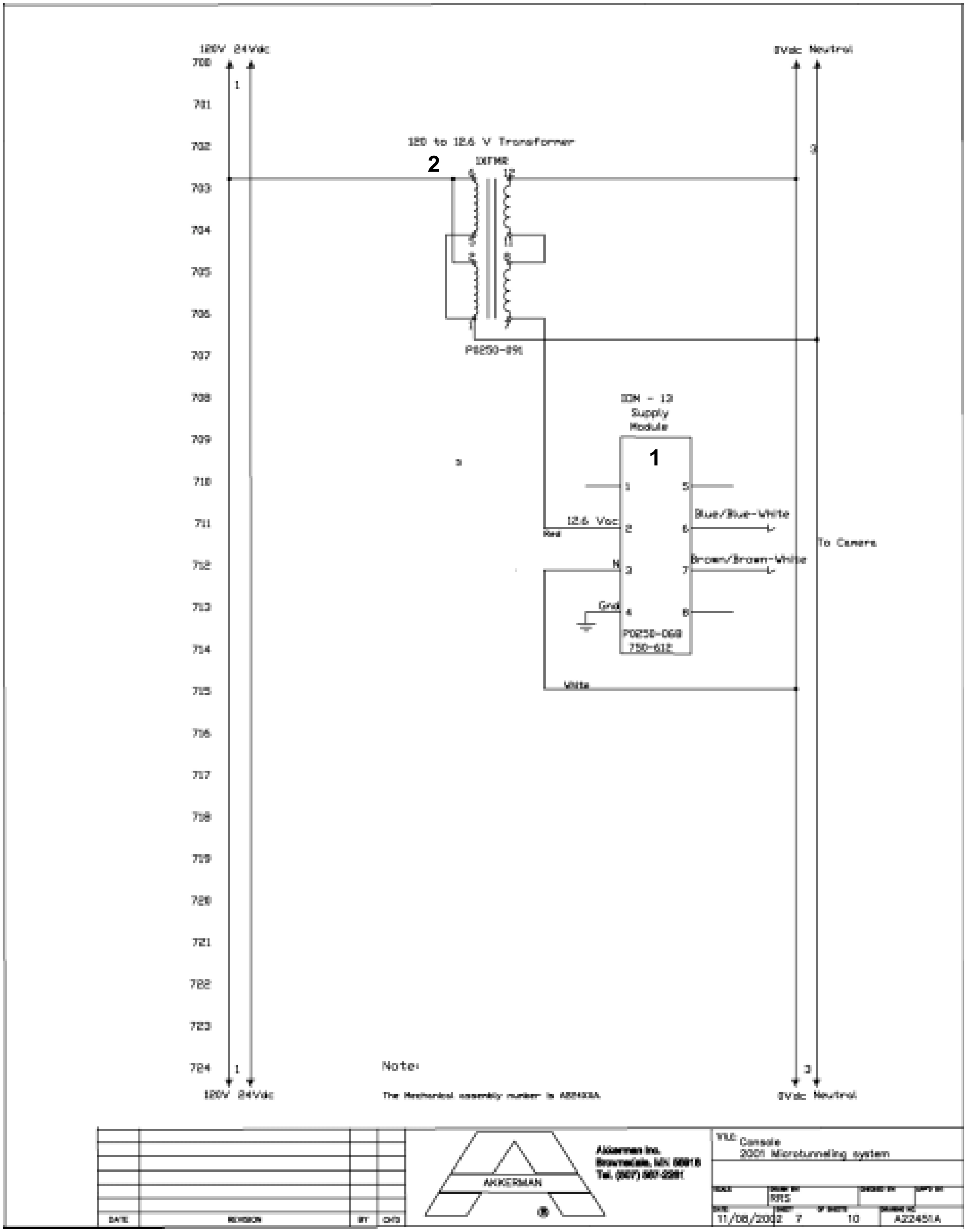

5
3
4
1
2

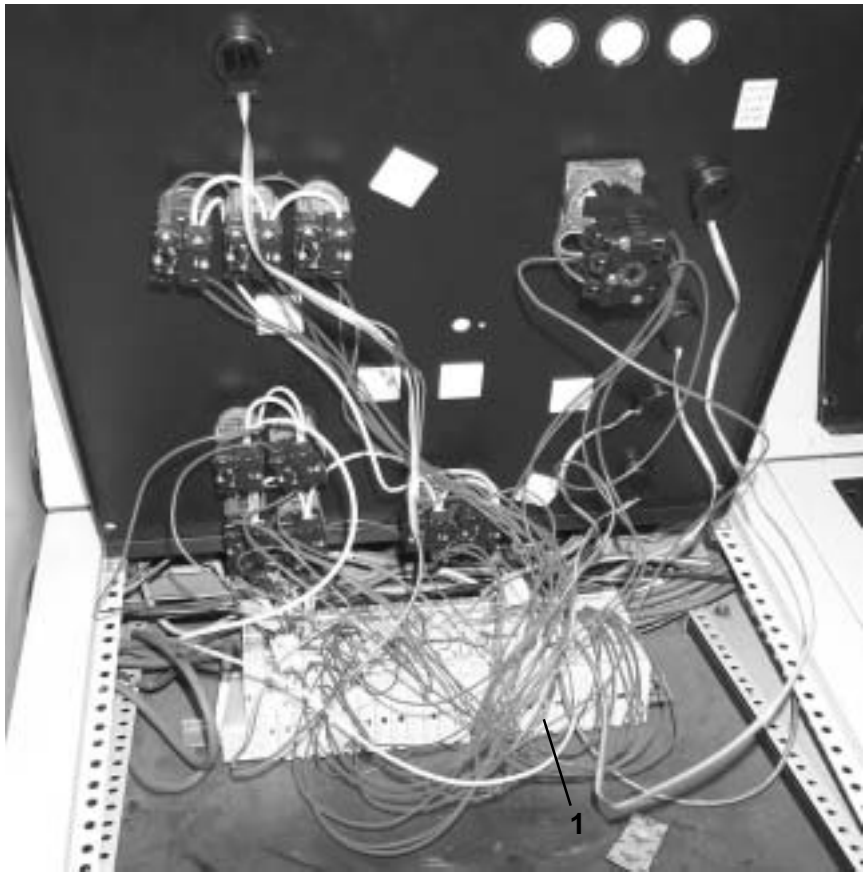

120 V AC
24 V DC
0 V DC
Neutral
IDM 9
Quad
Encoder
1
3
5 V
24 V
0 V
Shield
IDM 10
Quad
Encoder
2
4
Note:
120V
24Vdc
0Vdc
Neutral
AKKERMAN
Akkerman Inc.
Console
2001 Microtunneling system
RRS
11/3/2002
5
10
A22451A


4
3
2
1

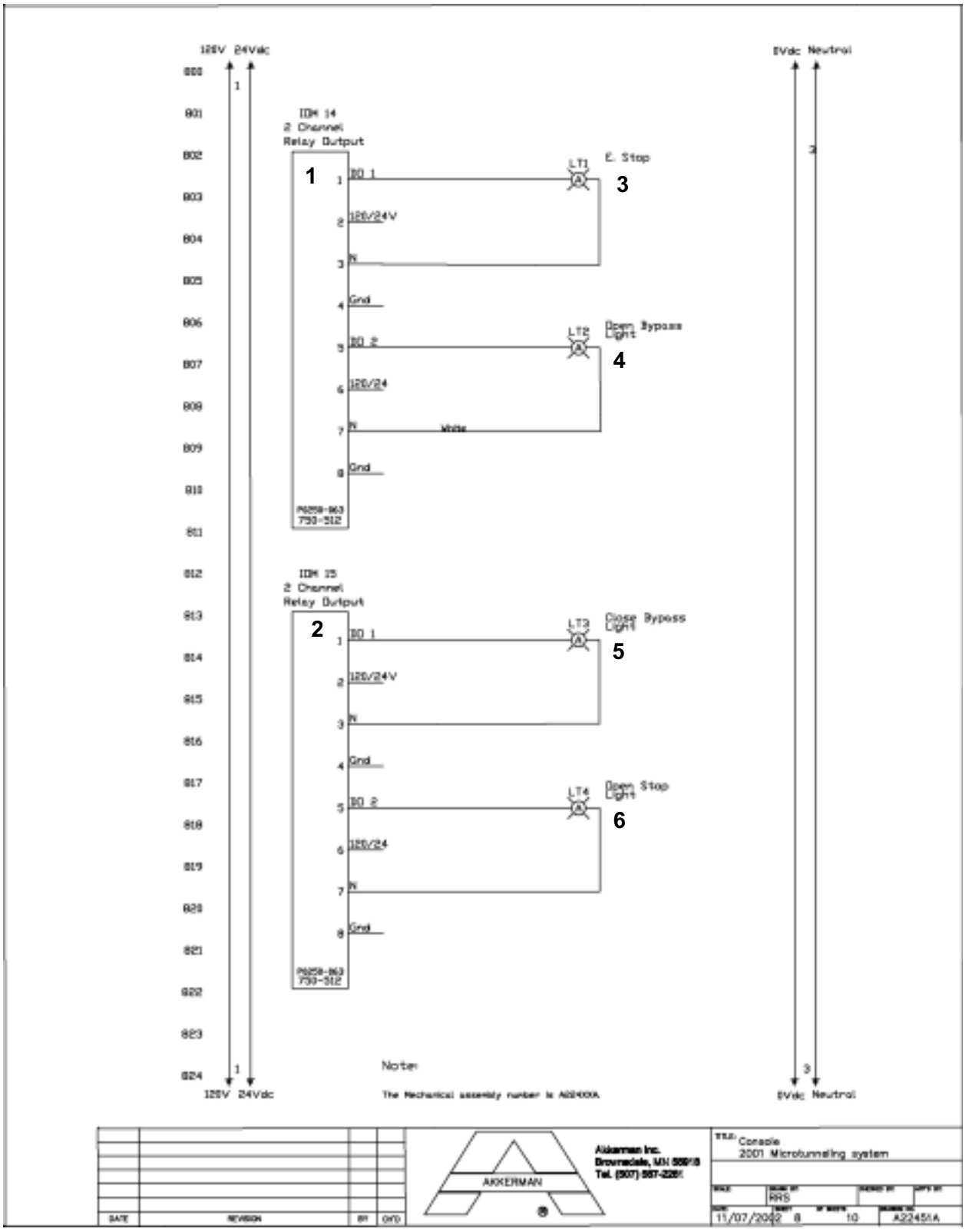

120 V AC
24 V DC
0 V DC
Neutral
IDM 11
Quad Encoder
1
3
IDM 12
Quad Encoder
2
4
5 V.
24 V
0 V
Shield
Note:
120V
24Vdc
0Vdc
Neutral
AKKERMAN
Akkerman Inc.
Console
2001 Microtunneling system
11/7/2002
A22451A

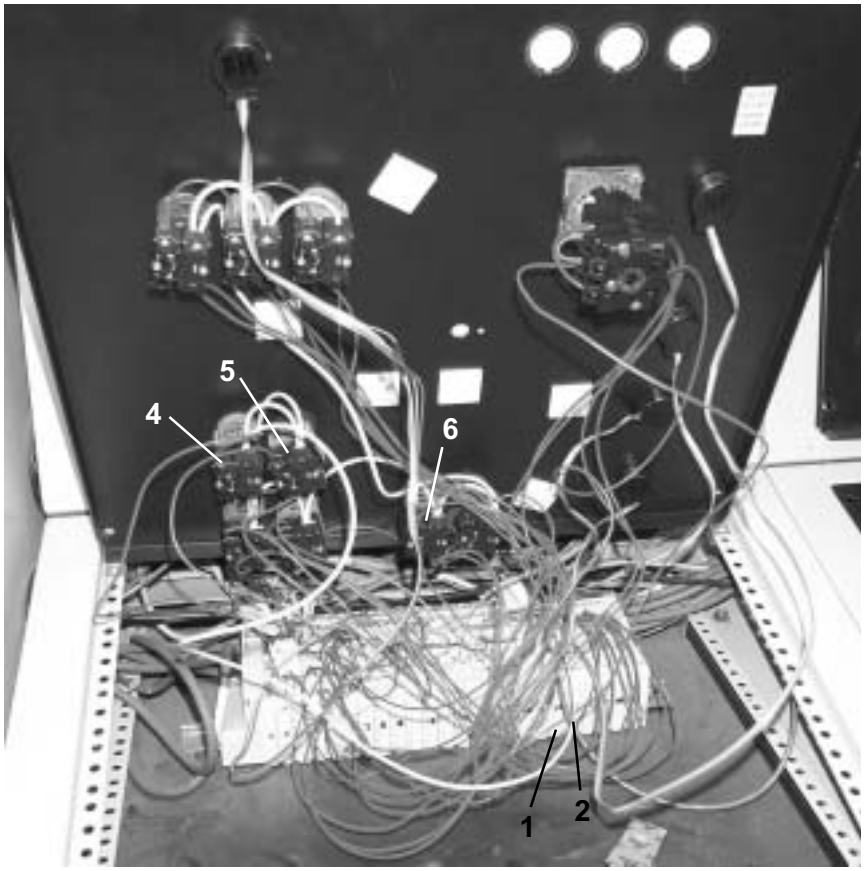

4
3
1
2

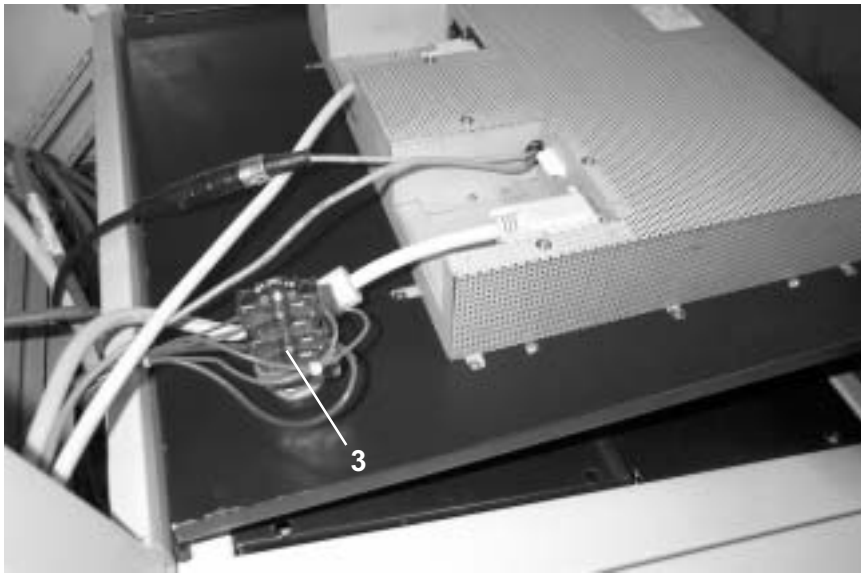

120V 24Vdc
0Vdc Neutral
120 to 12.6 V Transformer
1XFMR
P0250-091
ION - 13
Supply
Module
12.6 Vac
Red
Blue/Blue-White
Brown/Brown-White
To Camera
White
Gnd
P0250-068
750-612
Note:
AKKERMAN
Console
2001 Microtunneling system
RRS
11/08/2002
A22451A


1


2


120V 24Vdc
5Vdc Neutral
IDK 14
2 Channel
Relay Output
1
DO 1
120/24V
N
Gnd
DO 2
120/24
N
Gnd
LT1
E. Stop
3
LT2
Open Bypass
Light
4
White
IDK 15
2 Channel
Relay Output
2
DO 1
120/24V
N
Gnd
DO 2
120/24
N
Gnd
LT3
Close Bypass
Light
5
LT4
Open Stop
Light
6
Note:
The Mechanical assembly number is A224XXA
120V 24Vdc
5Vdc Neutral
AKKERMAN
Akkerman Inc.
Brownsdale, MN 55918
Tel. (507) 567-2281
Console
2001 Microtunneling system
RRS
11/07/2002
A2245IA


5
4
6
1
2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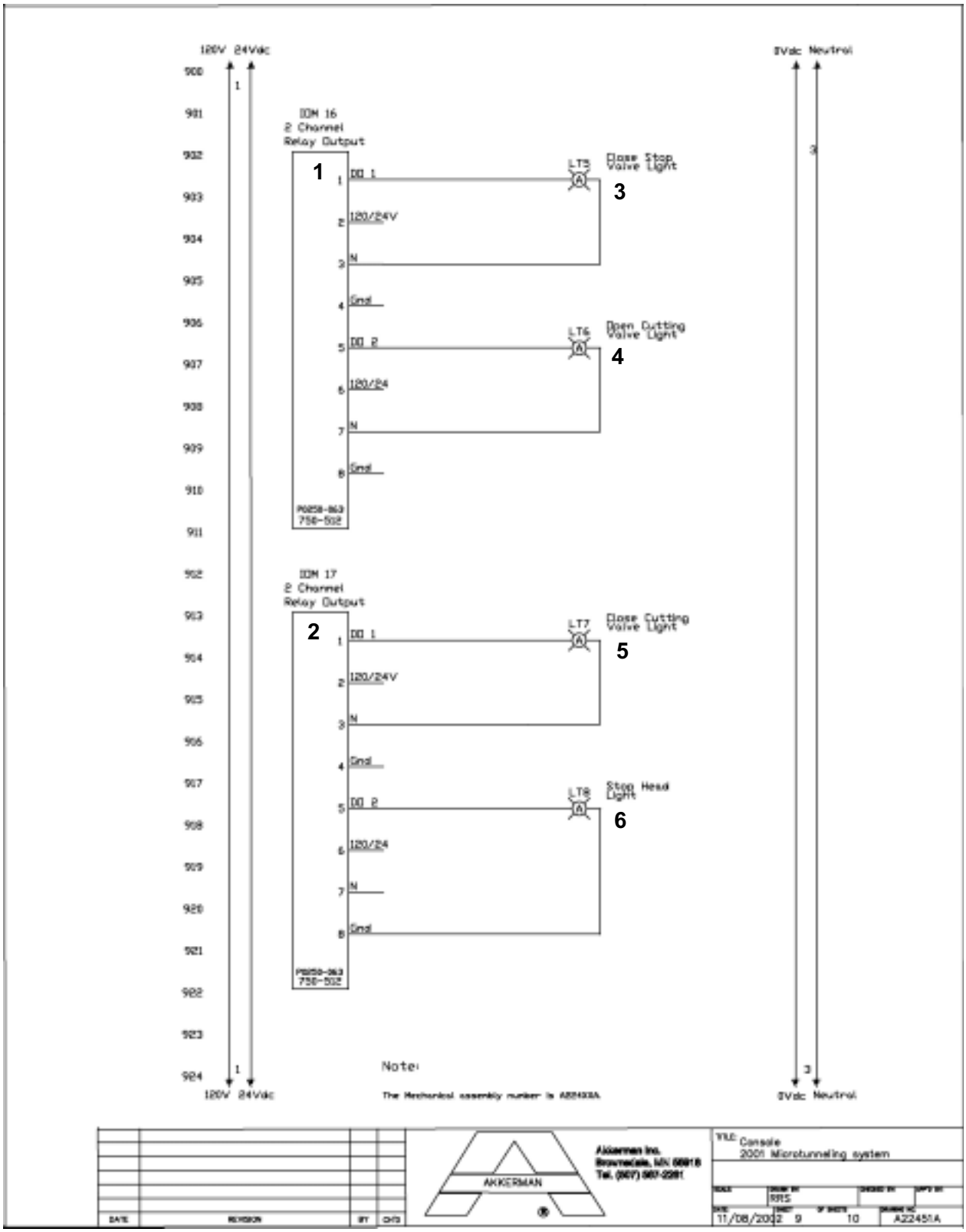
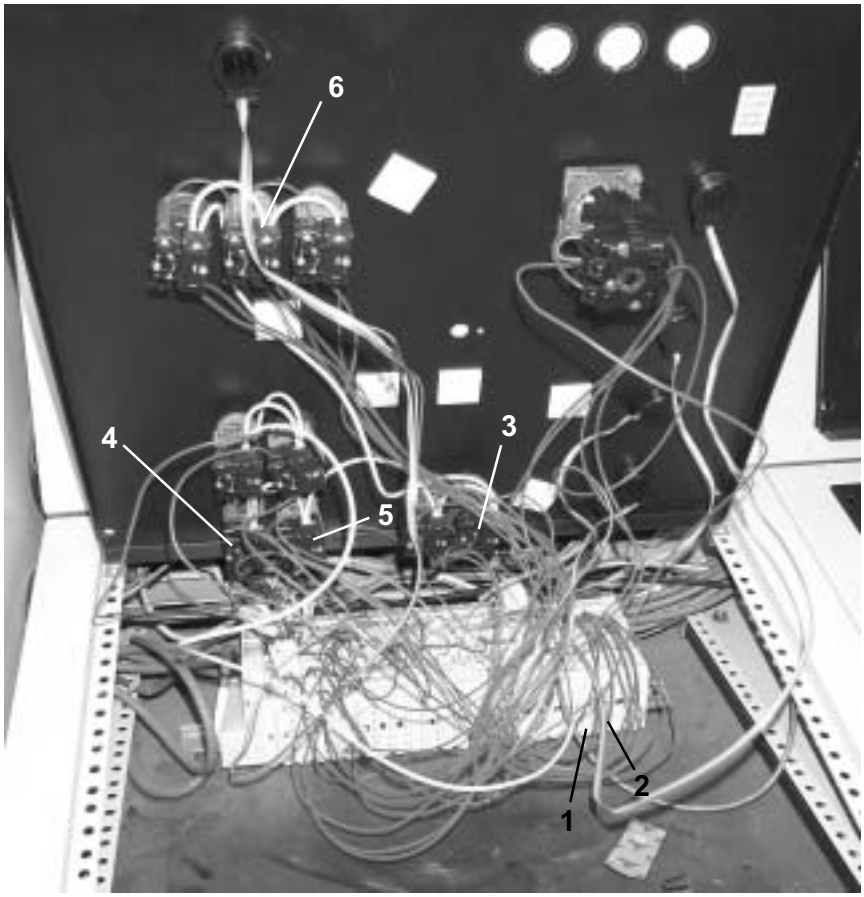
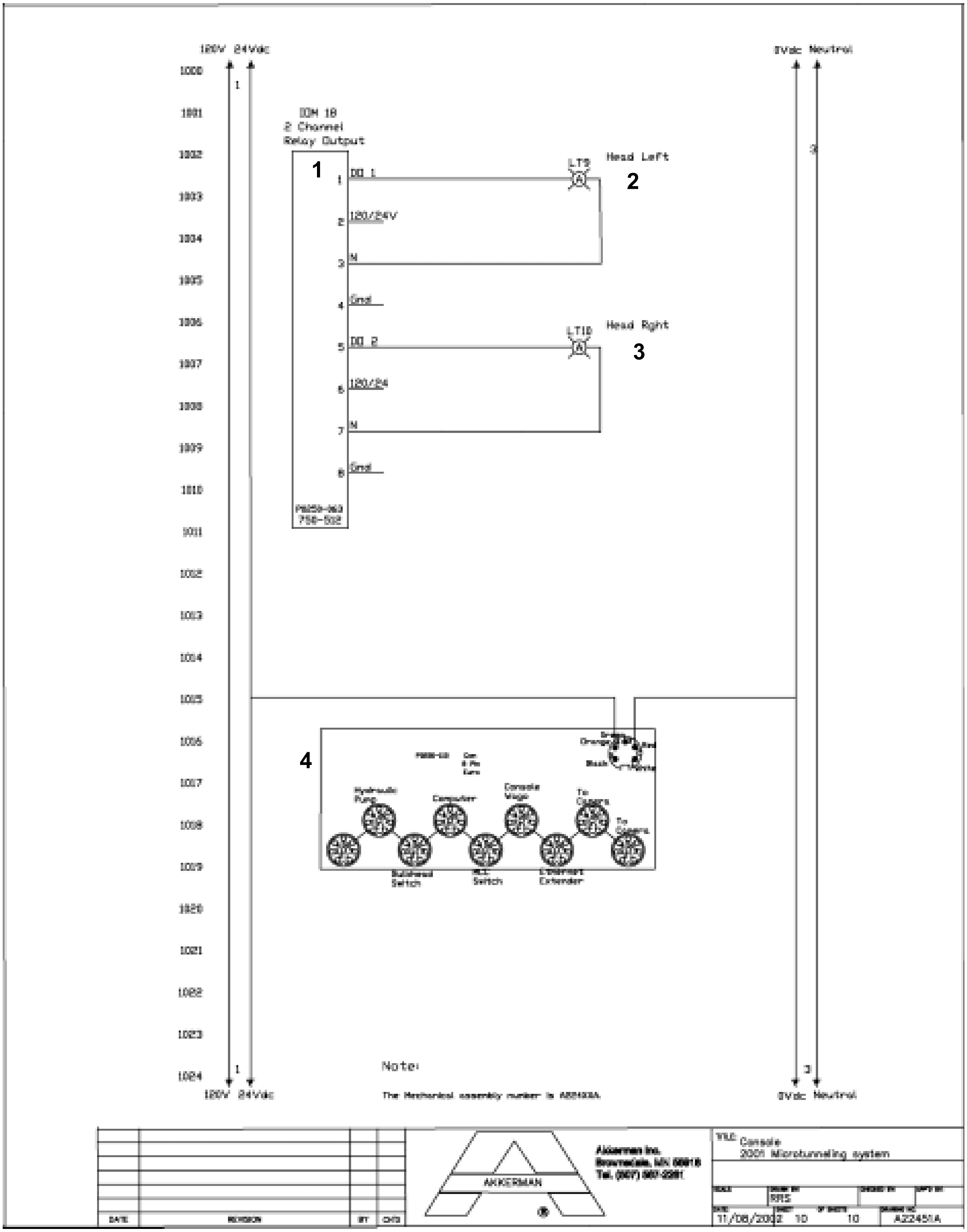
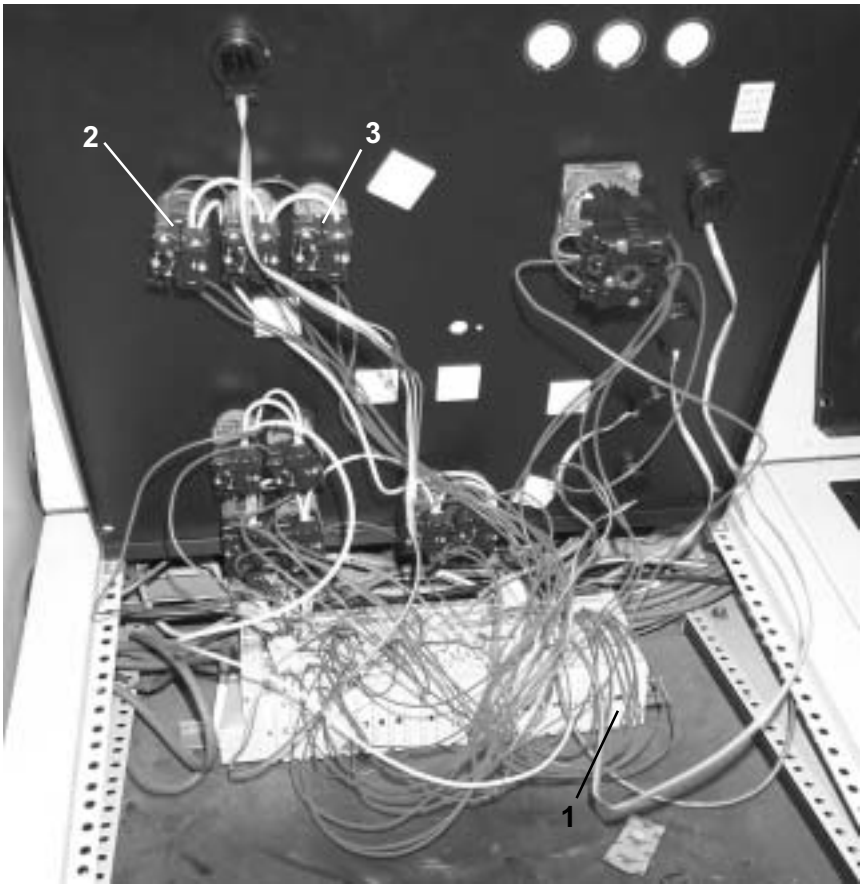

120V 24Vdc
0Vdc Neutral
IOM 16
2 Channel
Relay Output
1
DO 1
120/24V
N
Gnd
DO 2
120/24
N
Gnd
LT5
Close Stop
Valve Light
3
LT6
Open Cutting
Valve Light
4
IOM 17
2 Channel
Relay Output
2
DO 1
120/24V
N
Gnd
DO 2
120/24
N
Gnd
LT7
Close Cutting
Valve Light
5
LT8
Stop Head
Light
6
Note:
The Mechanical assembly number is A22493A
AKKERMAN
Akkerman Inc.
Console
2001 Microtunneling system
11/08/2002
A22451A

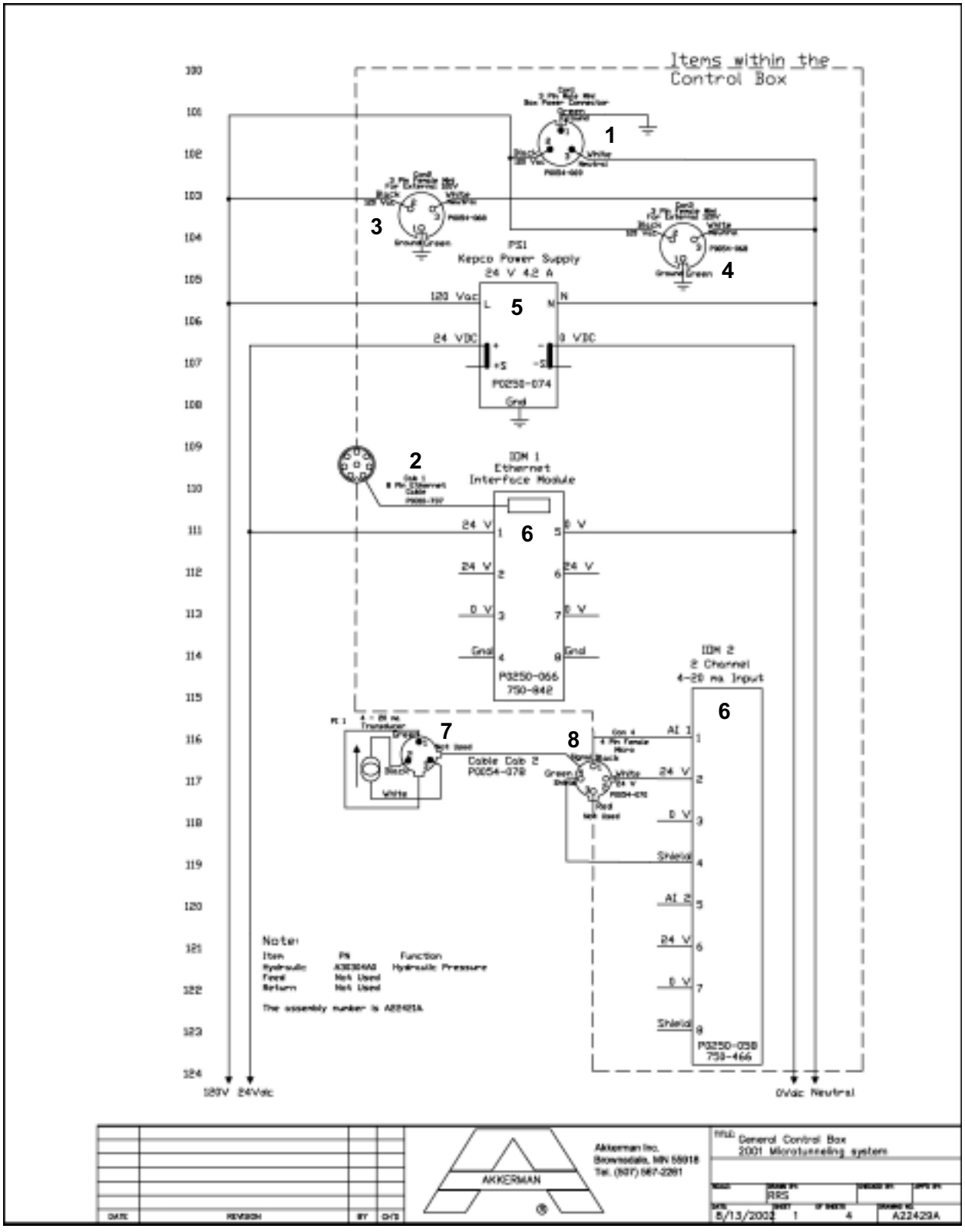

6
4
3
5
1
2

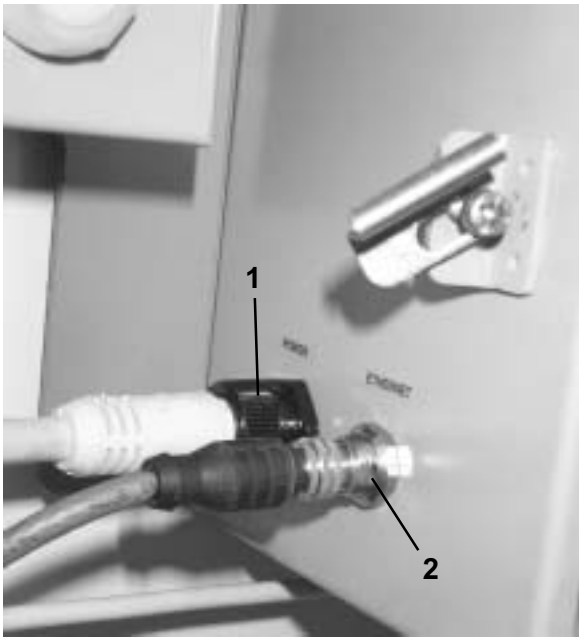

120V 24Vdc
0Vdc Neutral
IDM 10
2 Channel
Relay Output
1
DO 1
120/24V
N
Gnd
DO 2
120/24
N
Gnd
LT9
Head Left
2
LT10
Head Right
3
4
Hydraulic Pump
Computer
Console Wago
Bulkhead Switch
Switch
Ethernet Extender
Note:
The Mechanical assembly number is A22XXXA.
AKKERMAN
Console
2001 Microtunneling system
RRS
11/08/2002
10
10
A22451A

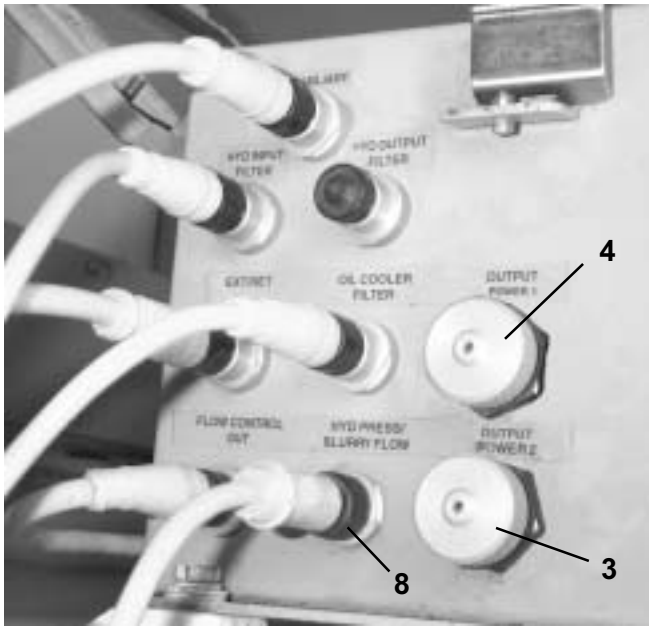

2
3
1


EMERGENCY
STOP
TRENCHLESS
EQUIPMENT
SPECIALISTS
4

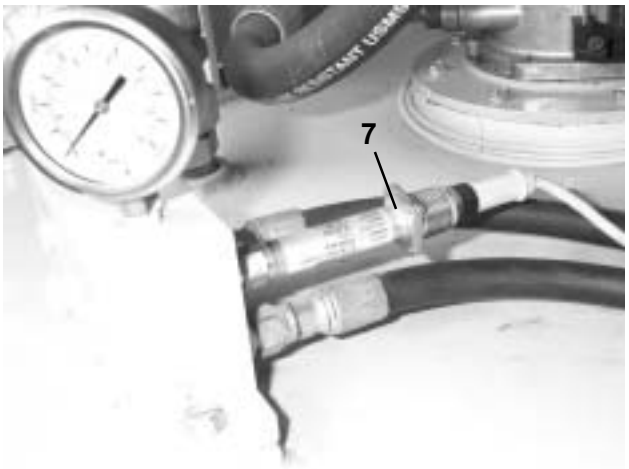
GENERAL CONTROL BOX SCHEMATICS




1
2


4
3
8


5
6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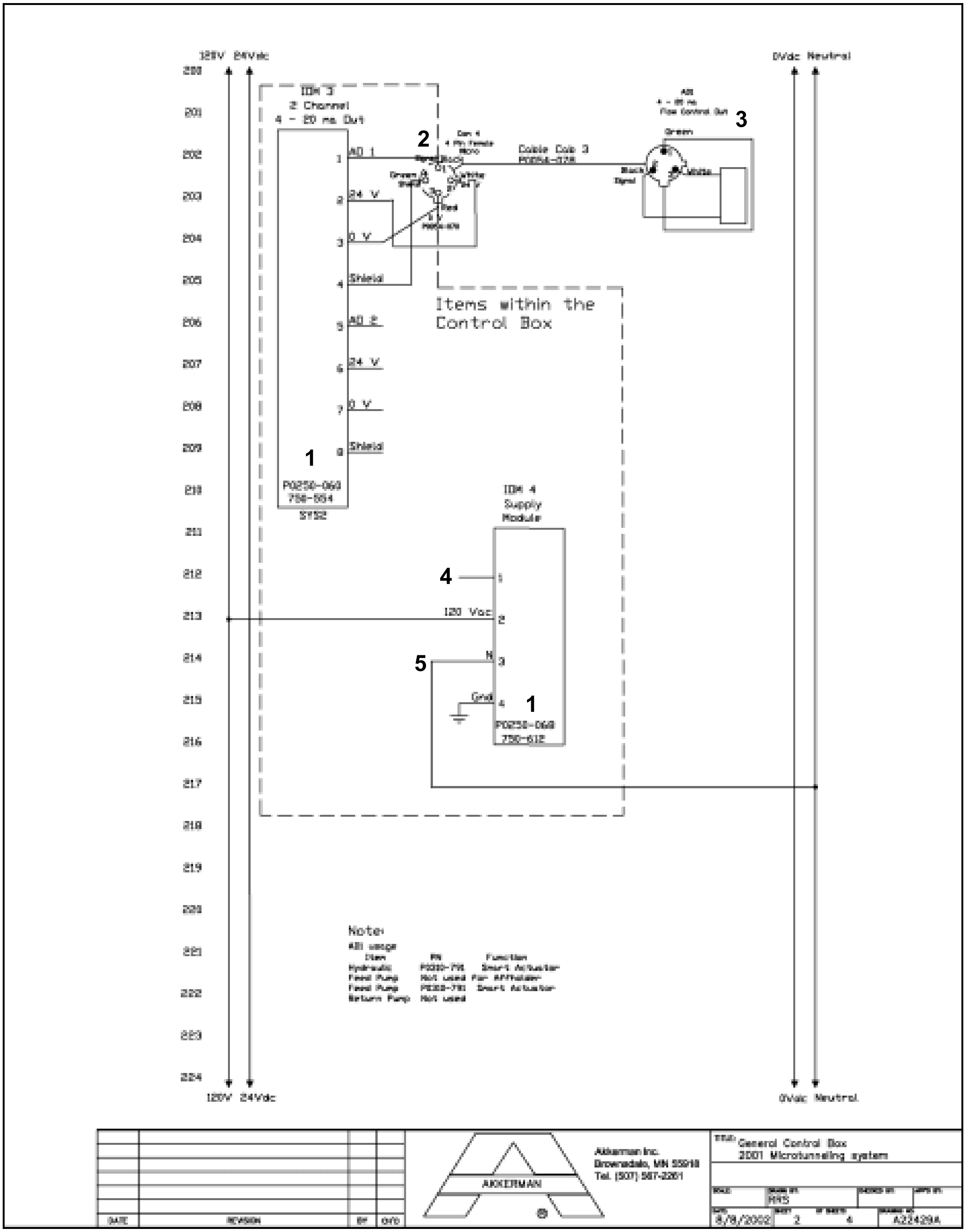
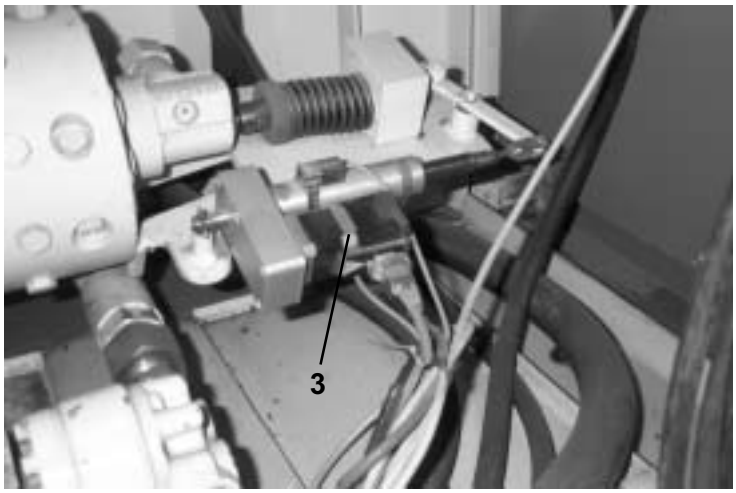

120V 24Vdc
0Vdc Neutral
IDM 3
2 Channel
4 - 20 ma Out
AD 1
24 V
0 V
Shield
AD 2
24 V
0 V
Shield
P0250-060
750-554
SYS2
Cable Cab 3
Items within the
Control Box
IDM 4
Supply
Module
120 Vac
N
Gnd
P0250-060
750-612
Note:
1
2
3
4
5
Akkerman Inc.
Brownsdale, MN 55918
Tel. (507) 567-2261
AKKERMAN
General Control Box
2001 Microtunneling system
MRS
8/8/2002
2
4
A22429A
DATE
REVISION


1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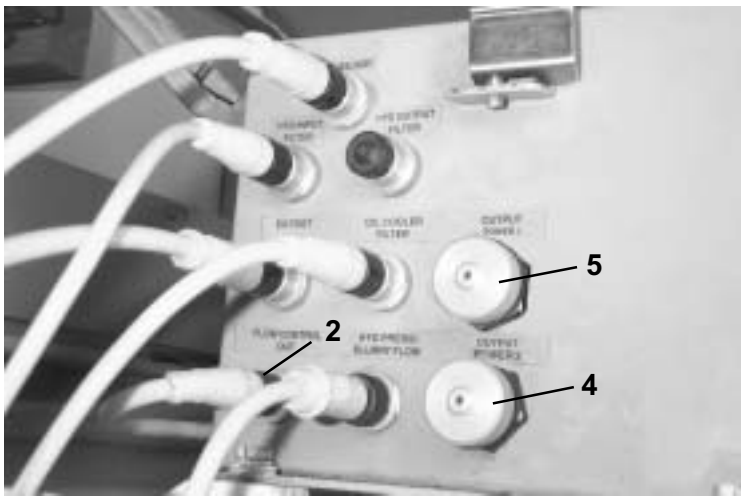
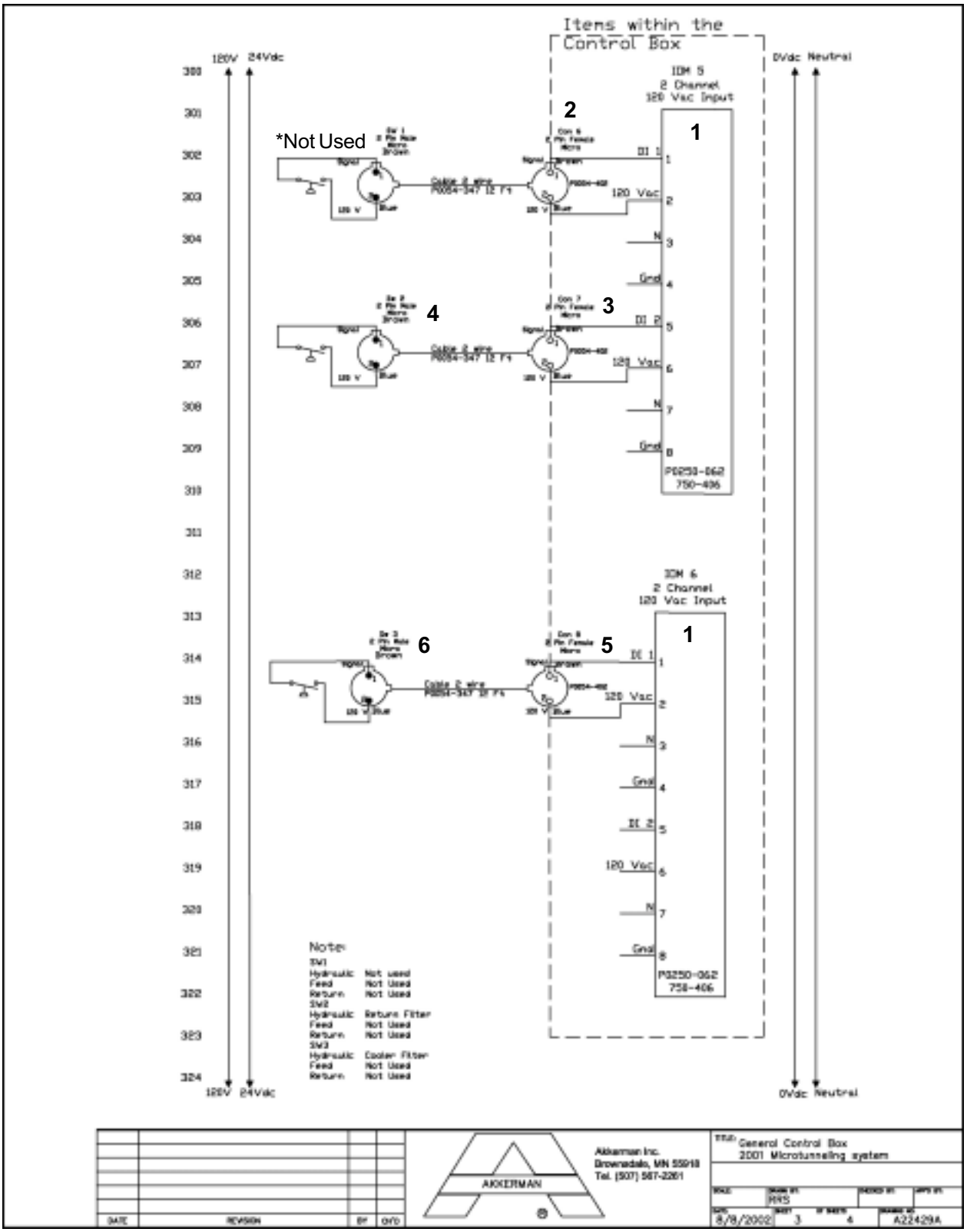
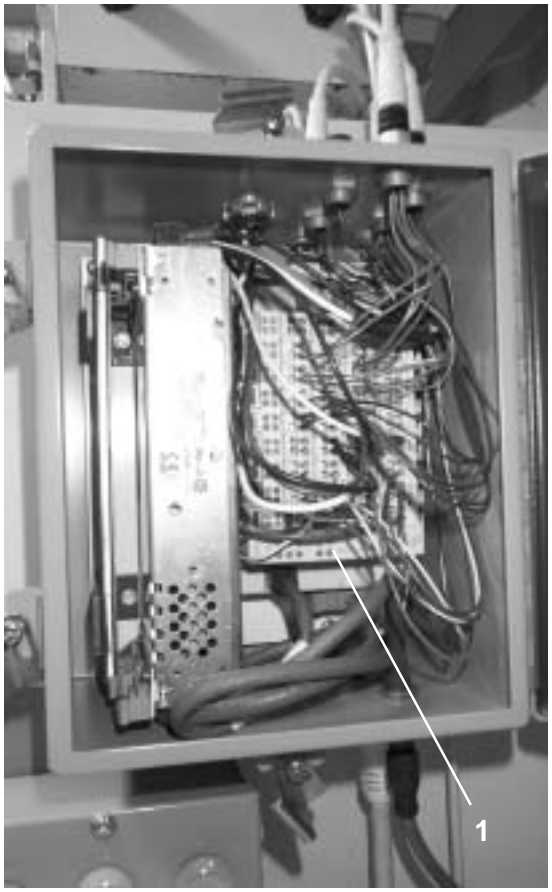
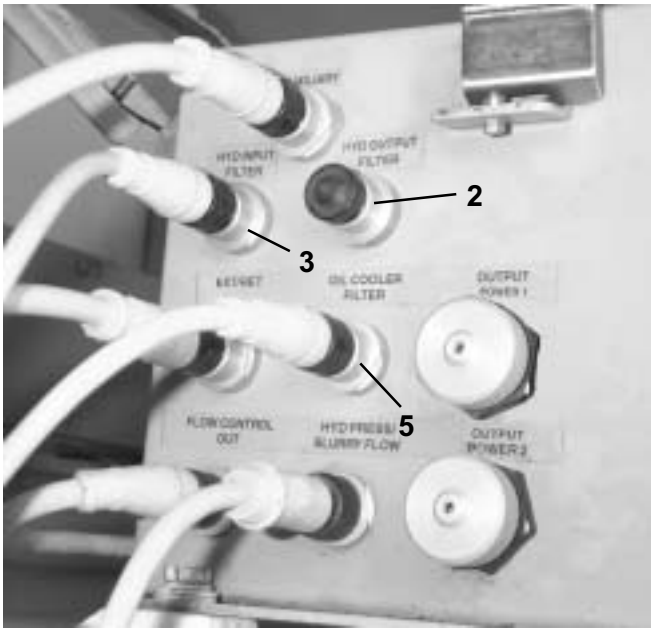
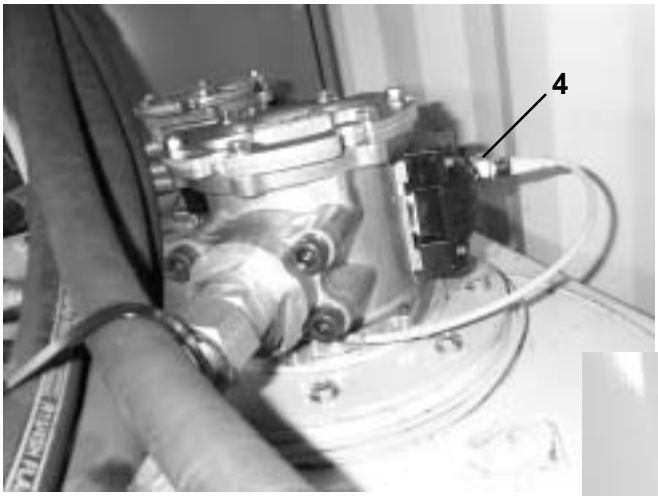
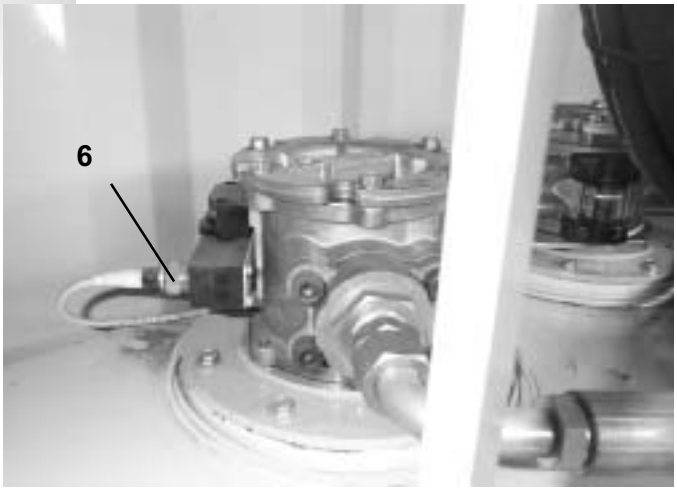

5
2
4


Items within the Control Box
120V 24Vdc
0Vdc Neutral
IDM 5
2 Channel
120 Vac Input
IDM 6
2 Channel
120 Vac Input
*Not Used
1
2
3
4
5
6
DI 1
DI 2
120 Vac
N
Gnd
P0250-062
750-406
Note:
SW1
Hydraulic Not used
Feed Not Used
Return Not Used
SW2
Hydraulic Return Filter
Feed Not Used
Return Not Used
SW3
Hydraulic Cooler Filter
Feed Not Used
Return Not Used
Akkerman Inc.
Brownsdale, MN 55918
Tel. (507) 567-2261
AKKERMAN
General Control Box
2001 Microtunneling system
8/8/2002
A22429A


1


2
3
5


4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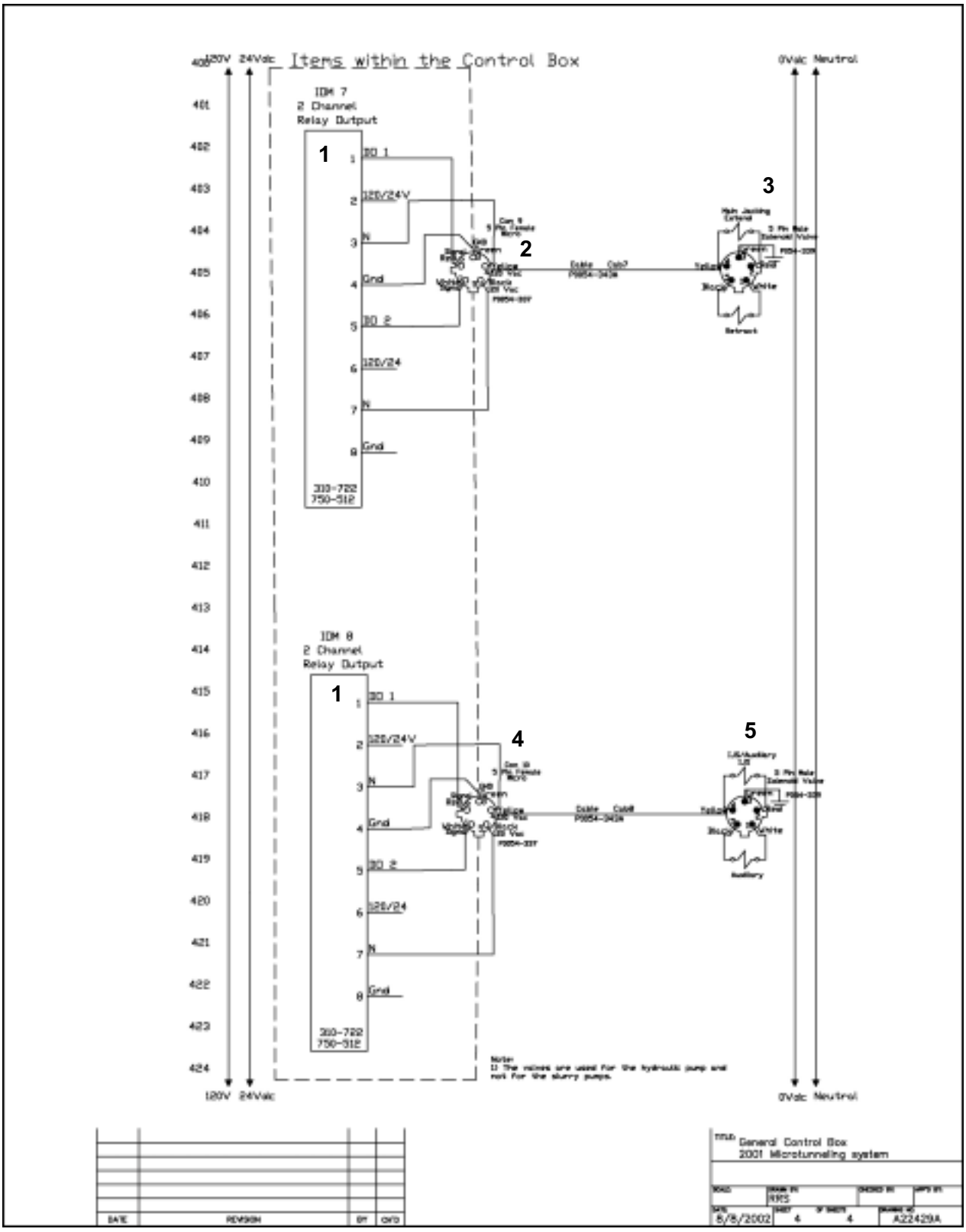
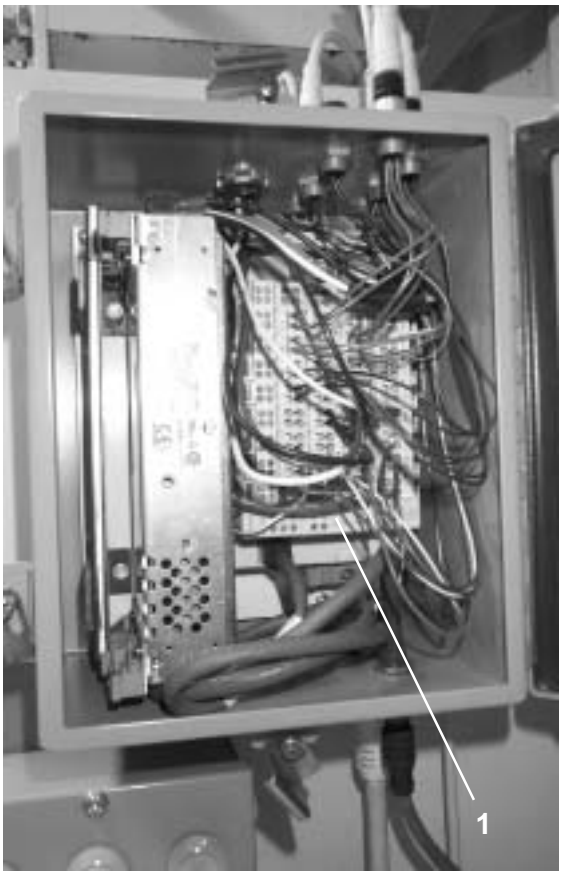
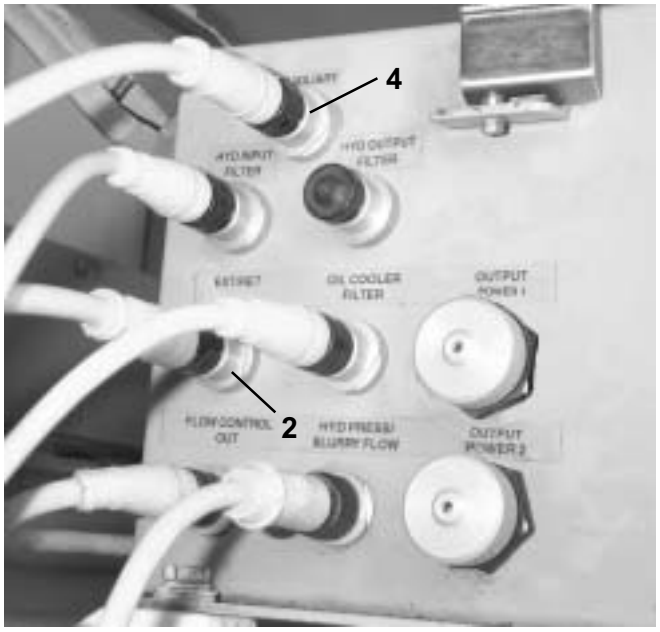
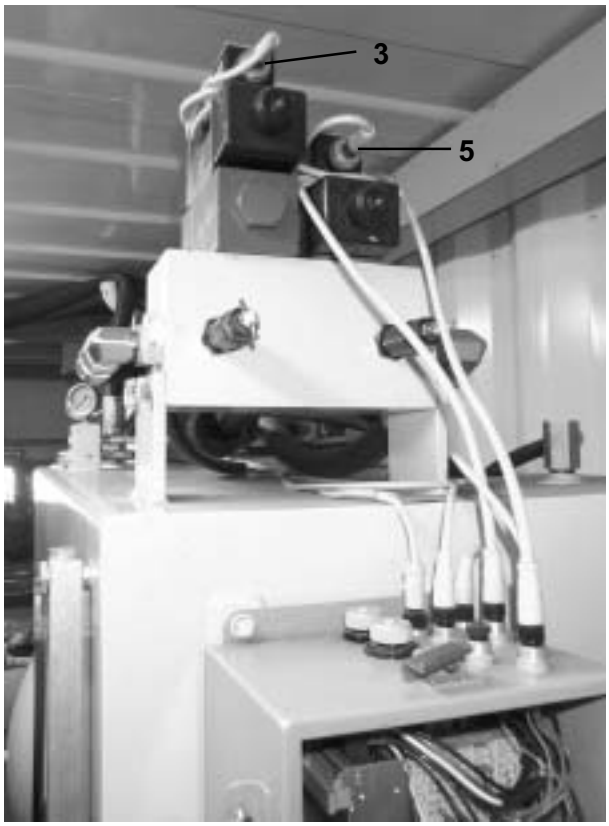
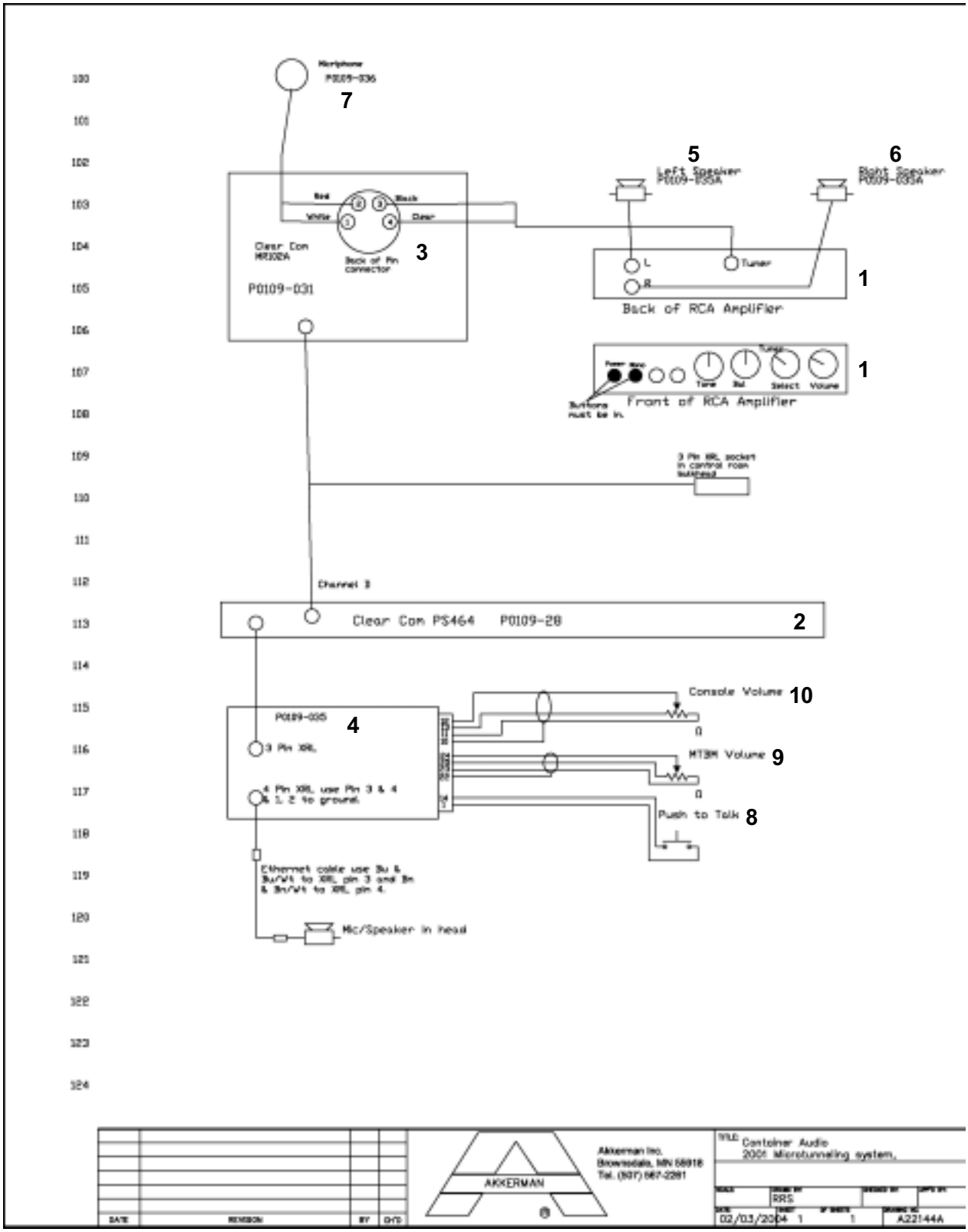

Items within the Control Box
120V 24Vac
0Vac Neutral
IDM 7
2 Channel
Relay Output
1
SO 1
120/24V
N
Gnd
SO 2
120/24
N
Gnd
330-722
750-512
2
3
IDM 8
2 Channel
Relay Output
1
SO 1
120/24V
N
Gnd
SO 2
120/24
N
Gnd
330-722
750-512
4
5
Notes:
1) The valves are used for the hydraulic jump and not for the slurry pumps.
General Control Box
2001 Microtunneling system
8/8/2002
A22429A

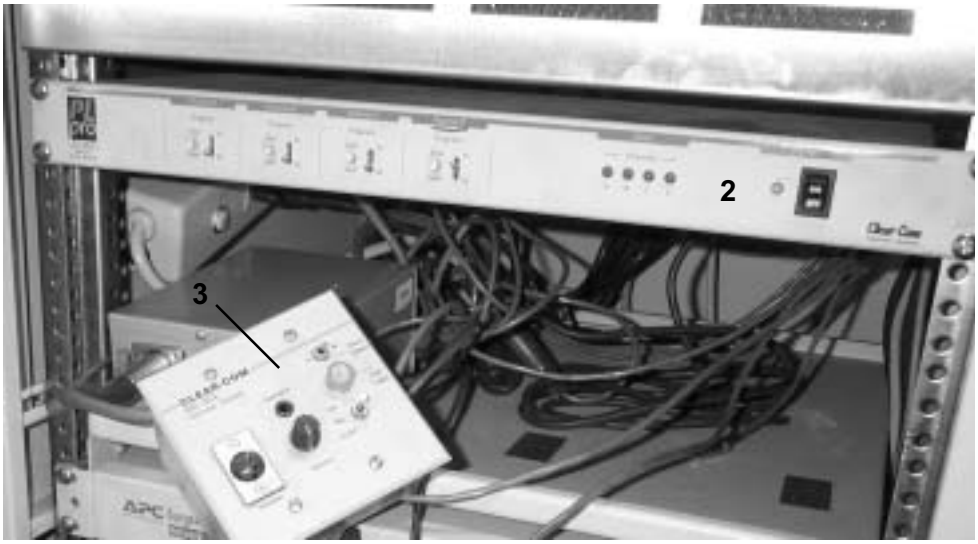

1


4
2


3
5

CONTAINER AUDIO SCHEMATICS

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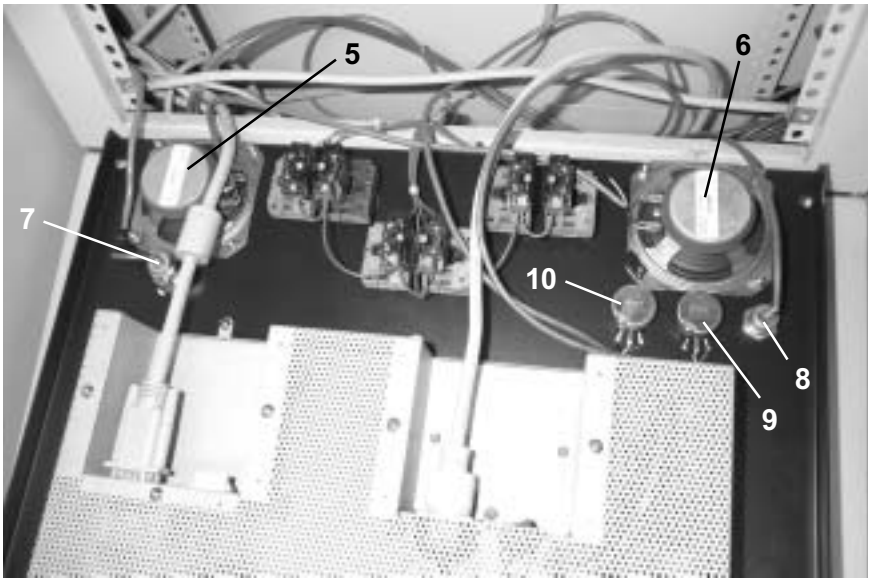
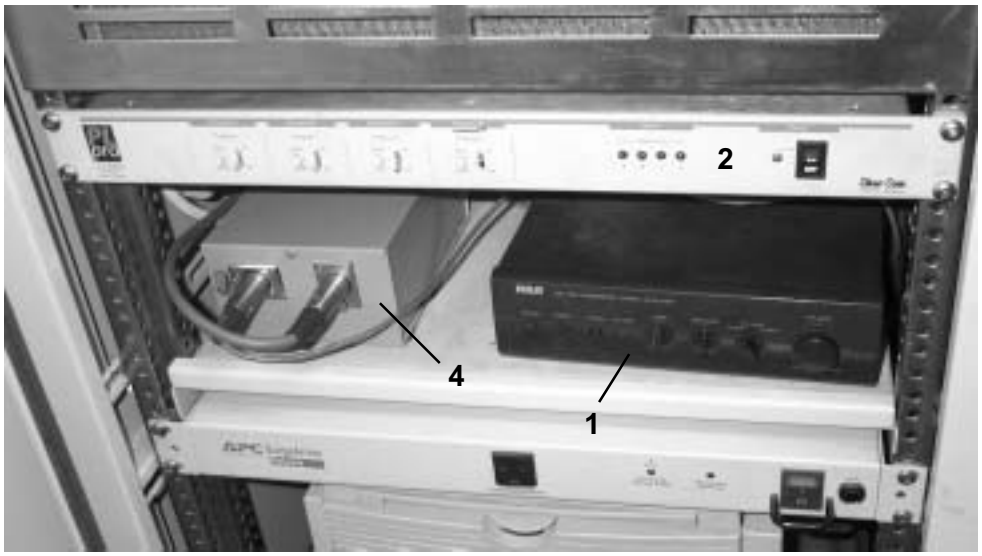
3

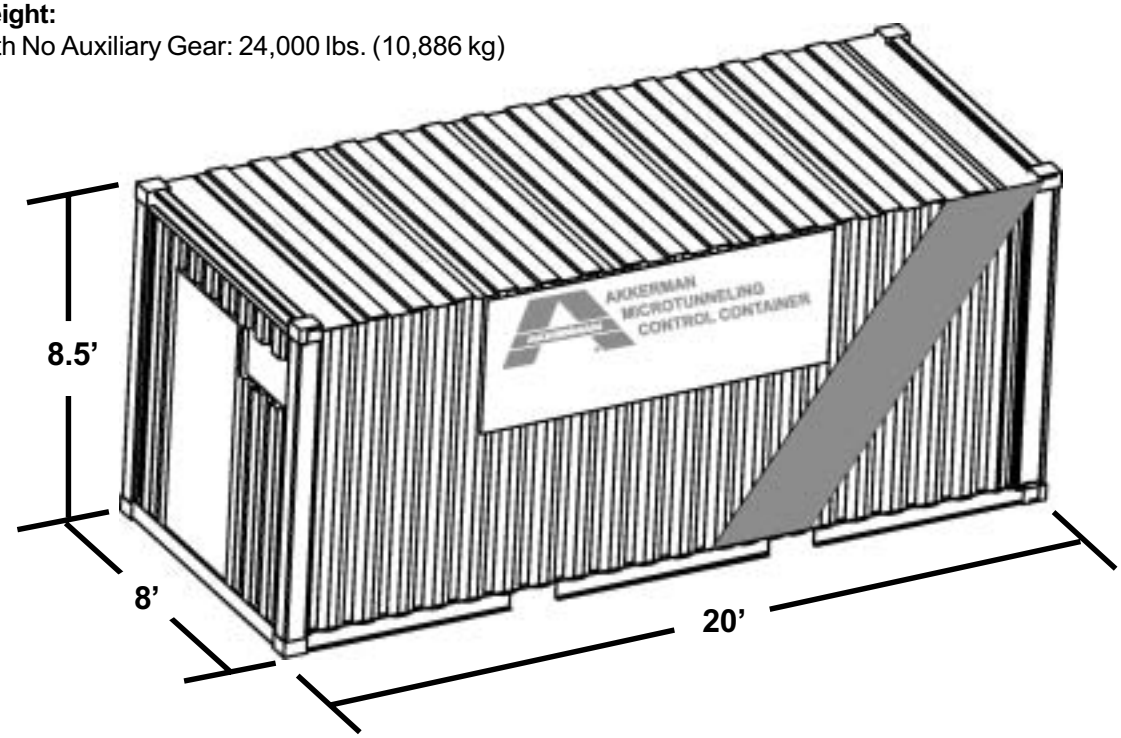

5
6
7
10
8
9


2
4
1

Specifications

CONTROL CONTAINER

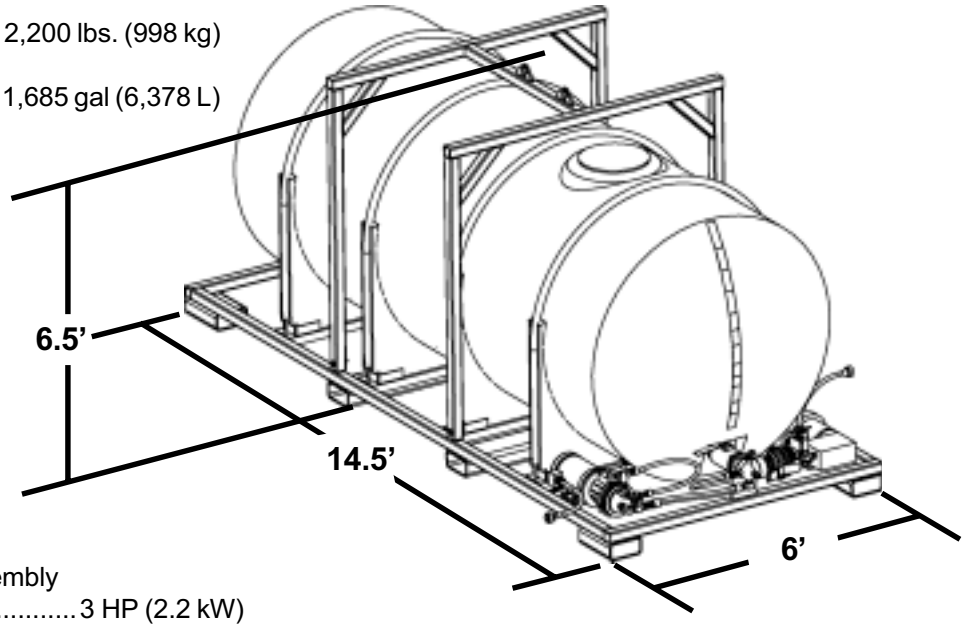
Weight:
With No Auxiliary Gear: 24,000 lbs. (10,886 kg)



WATER COOLING TANK

Weight (Empty) ..... 2,200 lbs. (998 kg)

Tank Capacity ..... 1,685 gal (6,378 L)



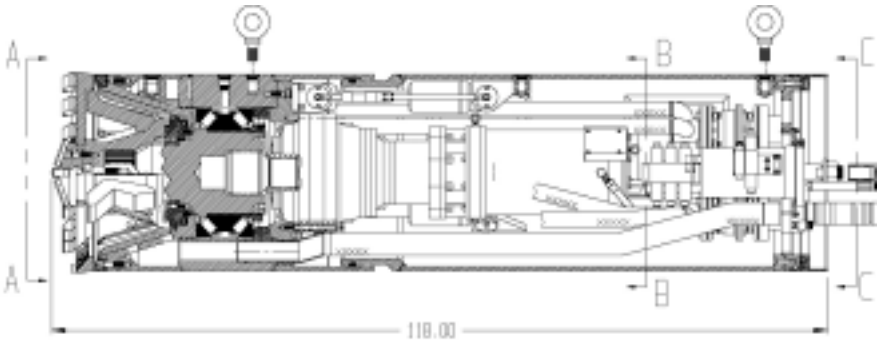
Larger Drive Motor Pump Assembly
Motor .....3 HP (2.2 kW)
RPM 1,740
Pump
Maximum GPM Capacity ..... 6 gpm (22.7 L/min)
Delivery @ Max. Pressure
..... 292 revs/gal (78 revs/L)
Max. Inlet Pressure ..... 250 psi (1,724 kPa)
Oil Capacity ..... 1.1 US qt (1.05 L)

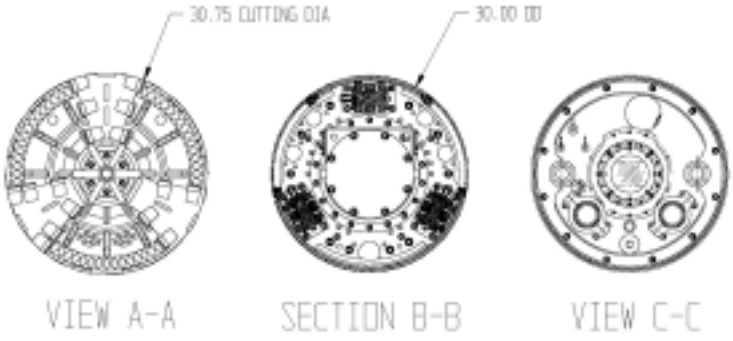
Smaller Drive Motor Pump Assembly
Motor ..... 1/2 HP (0.37 kW)
RPM 1,725
Pump
Maximum GPM Capacity ..... 1.8 gpm (6.8 L/min)
Delivery @ Max. Pressure
..... 972 revs/gal (258 revs/L)
Max. Inlet Pressure ..... 250 psi (1,724 kPa)
Oil Capacity ..... 1.0 US qt (0.95 L)

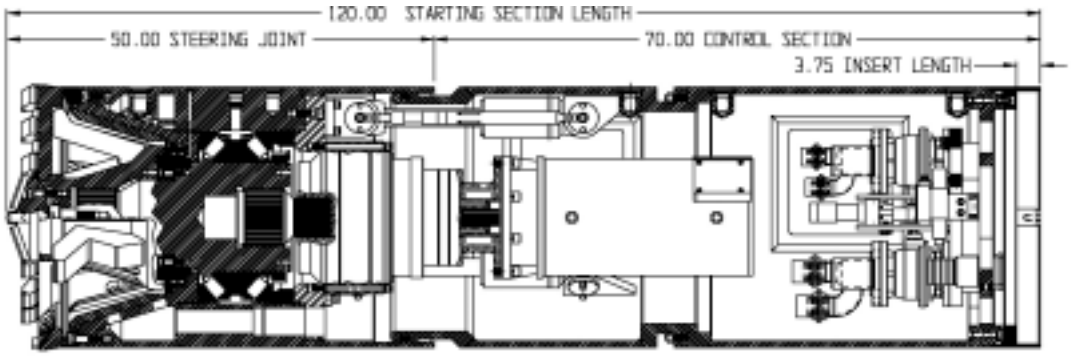
MTBM SL30

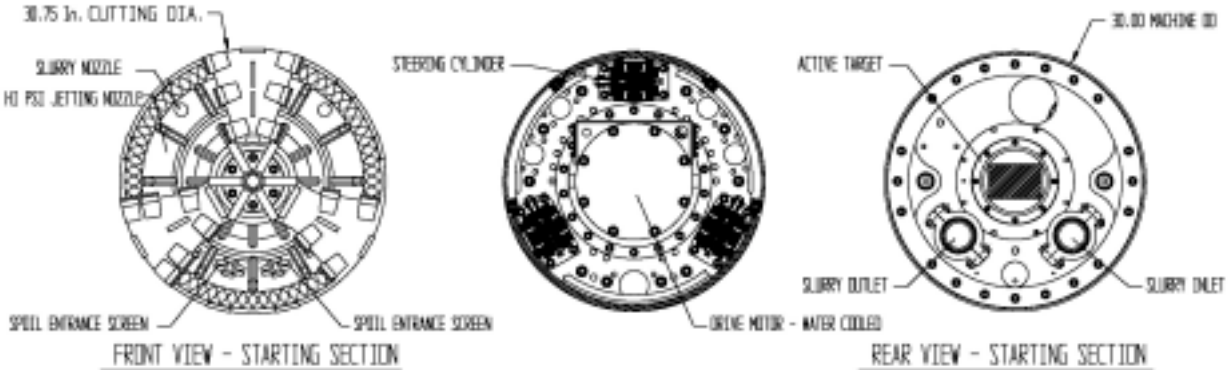
Weight:

Starting Section With Cutter Head & Coupling Sleeve: 9,000 lbs. (4,082 kg)







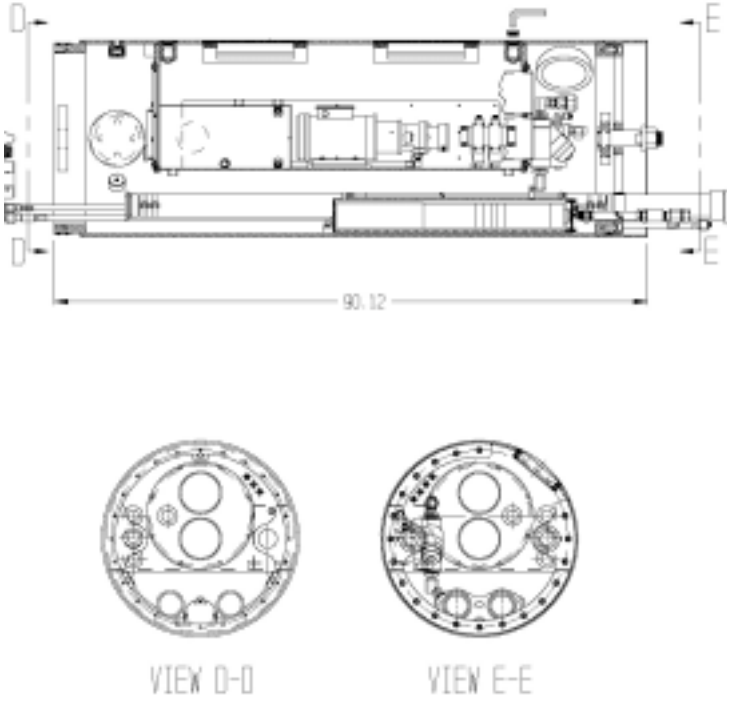


MICROTUNNELING BORING MACHINE - STARTING SECTION

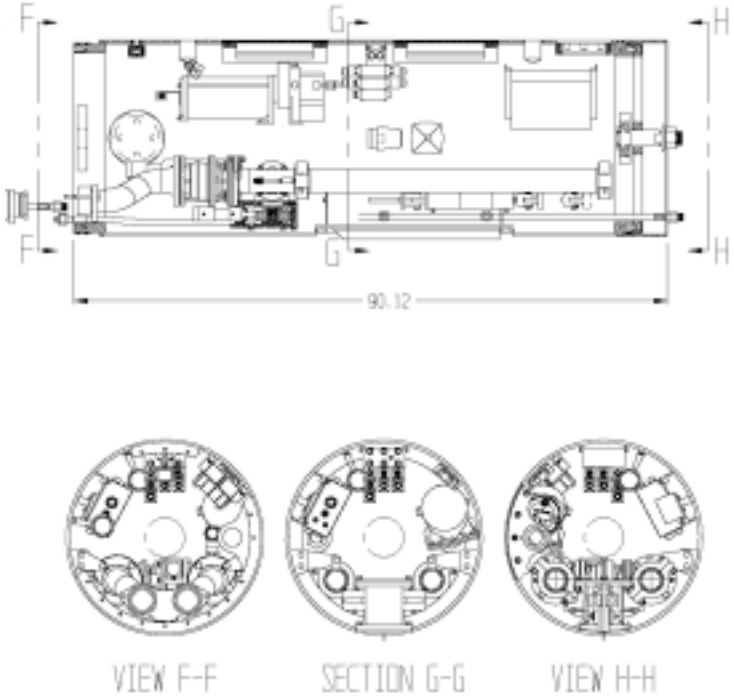
Model	Pipe O.D.	Min Pipe I.D.	MTBM-STARTING SECTION		MTBM DRIVE			Slurry Pipe Bore (Inches)	On-Brd Booster Pump
			Length (Inches)	Wt. (lbs)	H.P.	Peak Torque (Ft-Lbs)	Speed (Rpn)		
SL30	30.00	18.00	120.00	9,000	75	60,800	0 - 12	3.0 / 4.0	NO

(continued on next page)

Weight:
Middle Section With Coupling Sleeve: 3,000 lbs. (1,361 kg)



Weight:
Trailing Section With Pipe Adapter: 3,000 lbs. (1,361 kg)



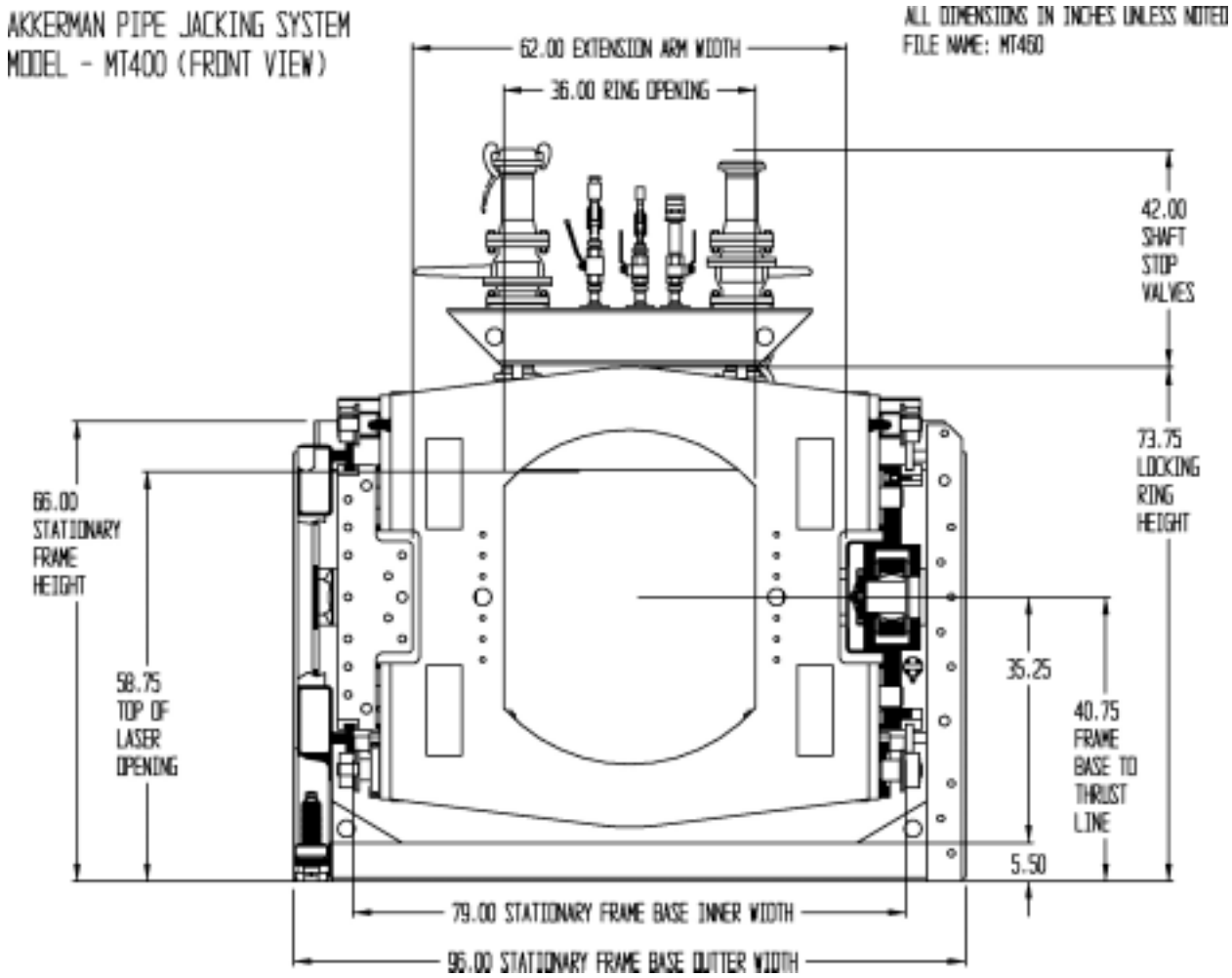
MT400 JACKING FRAME

Weight:
Jacking Frame With Locking Ring & Pipe Adapter;
Without Extension: ..... 27,260 lbs. (12,365 kg)

Total Thrust Capacity ..... 400 ton @ 9,000 psi

Maximum Pipe Diameter ..... 60 in. (1,524 mm)

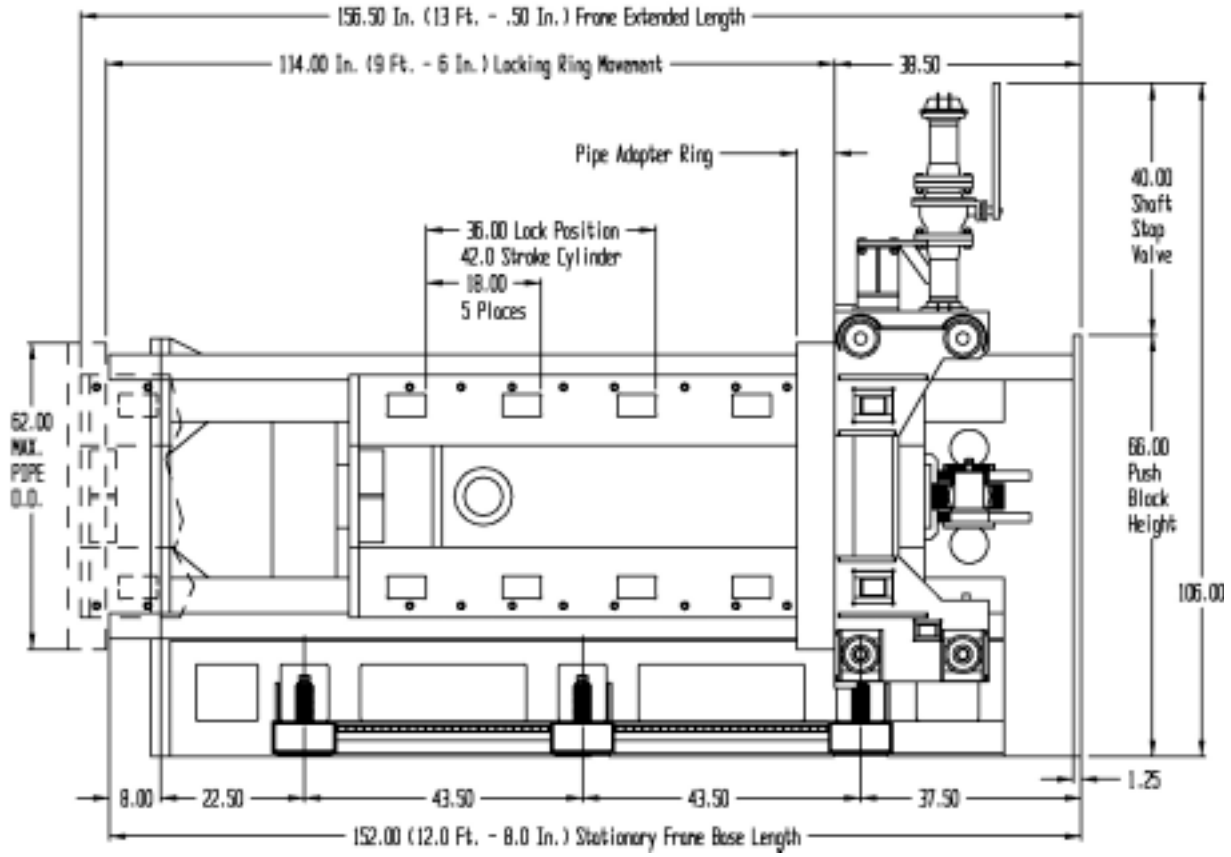
Distance Between Locking (dogs) ... 36 in. (76 mm)



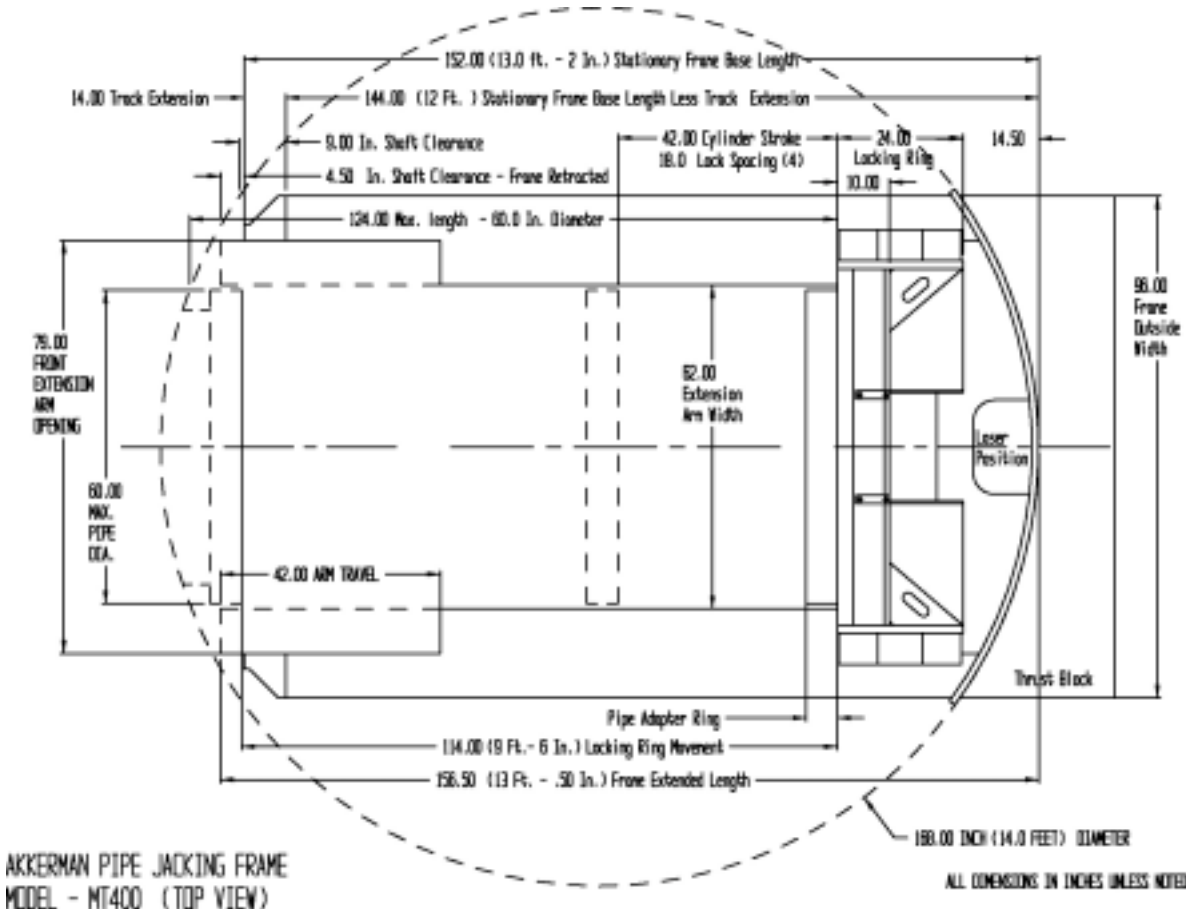
(continued on next page)

AKKERMAN PIPE JACKING FRAME
MODEL - MT400 (SIDE VIEW)

ALL DIMENSIONS IN INCHES UNLESS NOTED

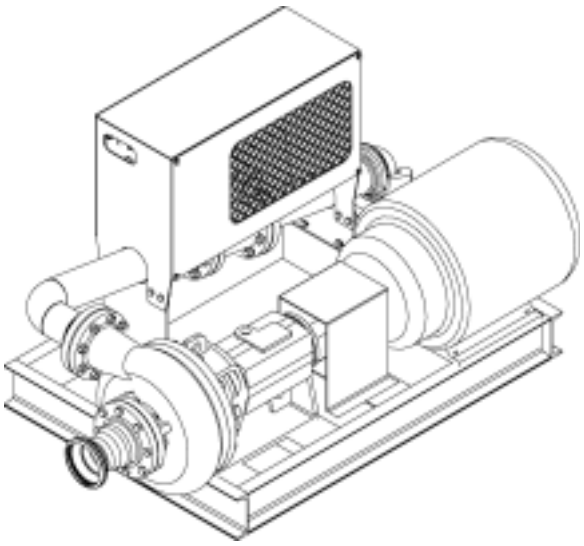


(continued on next page)



AKKERMAN PIPE JACKING FRAME
MODEL - MT400 (TOP VIEW)

SLURRY FEED PUMP



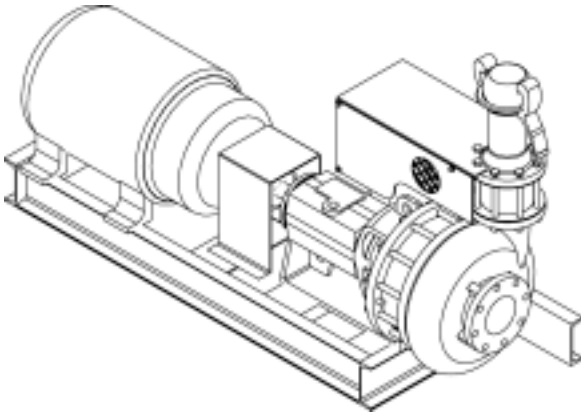
Weight ..... 2,000 lbs. (907 kg)

Size (width x length x depth) ..... 47 x 78 x 44.5 in.
(1,194 x 1,981 x 1,130 mm)

Motor ..... 75 HP (56 kW)

Maximum GPM (capacity limit does not consider suction line velocity):
4x3x13 ..... 750 gpm (2,839 L/min)
5x4x14 ..... 1100 gpm (4,163 L/min)

SLURRY RETURN PUMP



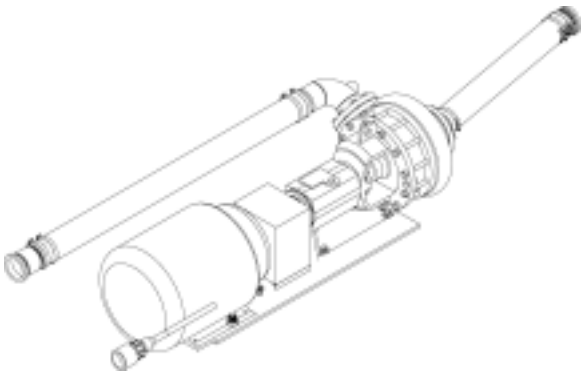
Weight ..... 2,000 lbs. (907 kg)

Size (width x length x depth) ..... 32 x 83 x 44.5 in.
(2,108 x 813 x 1,130 mm)

Motor ..... 60 HP (44.7 kW)

Maximum GPM (capacity limit does not consider suction line velocity):
4x3x13 ..... 750 gpm (2,839 L/min)
5x4x14 ..... 1100 gpm (4,163 L/min)

SLURRY BOOSTER PUMP



Weight ..... 2,000 lbs. (907 kg)

Size (width x length x depth) ..... 25 x 85 x 2.5 in.
(635 x 2,159 x 635 mm)

Motor ..... 60 HP (44.7 kW)

Maximum GPM (capacity limit does not consider suction line velocity):
4x3x13 ..... 750 gpm (2,839 L/min)
5x4x14 ..... 1100 gpm (4,163 L/min)

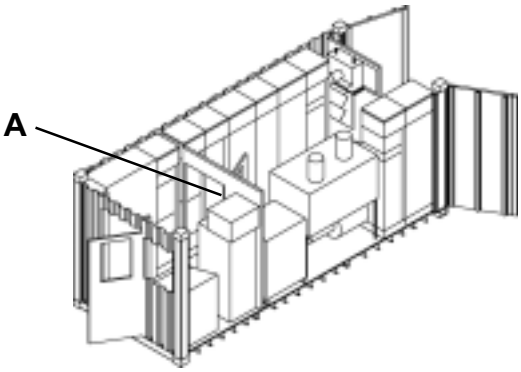
Identification Numbers

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

CONTROL CONTAINER (A)

Model Number _____

Serial Number _____



MTBM (B)

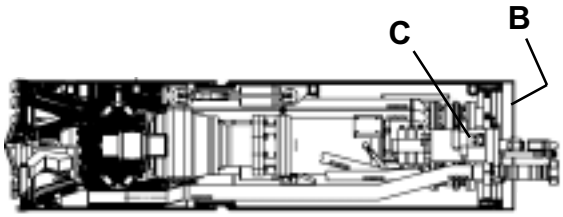
Model Number _____

Serial Number _____

TARGET (C)

Model Number _____

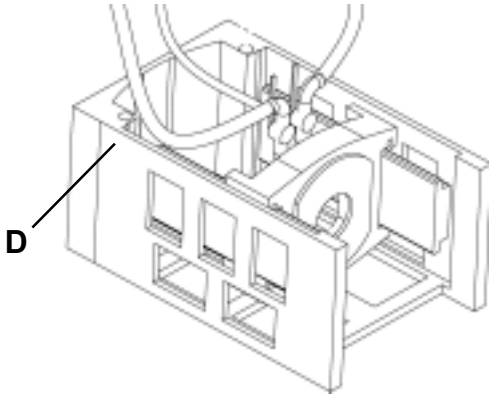
Serial Number _____



JACKING FRAME (D)

Model Number _____

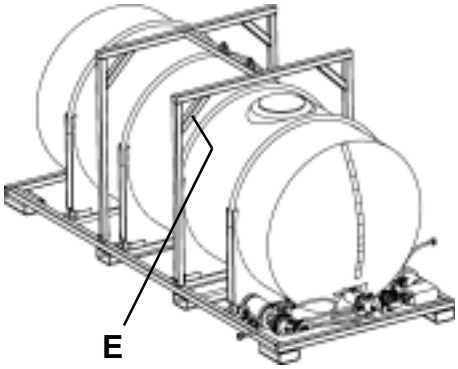
Serial Number _____



WATER COOLING TANK (E)

Model Number _____

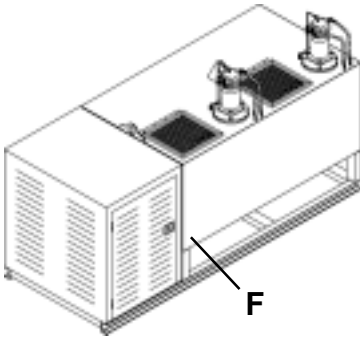
Serial Number _____



BENTONITE PUMP (F)

Model Number _____

Serial Number _____



Material Safety Data Sheets

The Federal Occupational, Safety, and Health Administration (OSHA) Standard 29 CFR 1910.1200, require that specific material safety data sheets (MSDS) 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, MSDS which apply to its product line. Simply contact your Akkerman Product Support representative for a copy.

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

Warranty

Akkerman Inc. warrants that all equipment manufactured by it be free from defects due to workmanship or material under normal use and service for a period of 90 days. This warranty does not apply to normal wear items such as cutter teeth, filters, etc. Akkerman Inc. does not warrant the fitness of its equipment for a particular purpose or application.

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