AKKERMAN®

TRENCHLESS EQUIPMENT SPECIALISTS

OPERATOR'S MANUAL

Earth Pressure Balance Machine

EPB S/N: A10500A

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SERVICE • RELIABILITY • INNOVATION

⚠ DANGER

This machine is powered by high voltage electricity.

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

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

NOTES

Introduction

This operator's manual contains important safety, operation, and maintenance information for your Akkerman Earth Pressure Balance (EPB) machine. You must read and understand this manual before you operate and maintain this equipment. Keep this manual in your EPB 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 Earth Pressure Balance Machine. 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.

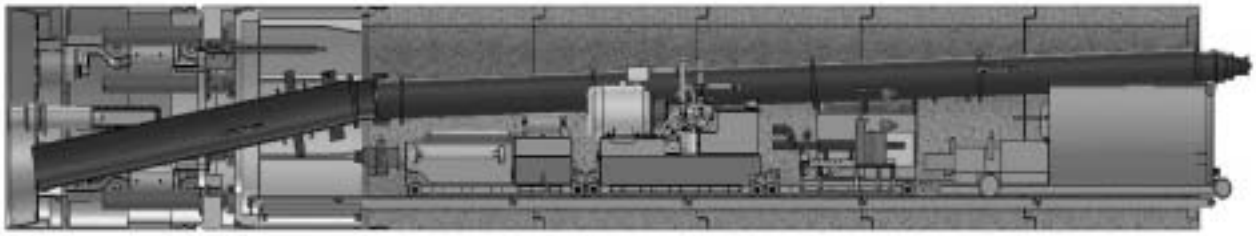
⚠ DANGER Indicates an extremely hazardous situation which, if not avoided, WILL result in death or serious injury.

⚠ 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
Earth Pressure Balance System

Earth pressure balance is a type of "trenchless technology." The Earth Pressure Balance Machine (EPBM) applies pressure to the material at the front of the cutter head and controls the amount of material excavated to prevent over and under mining. The basic operation of a earth pressure balance system consists of a earth pressure balance machine for piloting the course and excavating the ground. Simultaneously, a foam/bentonite slurry mixture is pumped to the EPBM, and mixed with the spoil. This foam/bentonite slurry is then augered through a screw conveyor system to the dirt bucket. Once the dirt bucket is full, the dirt bucket is removed from the pipeline via a haul unit to the unloading area where the dirt bucket is hoisted out of the shaft and unloaded. The EPBM hydraulic jacking cylinders are used to advance the EPBM. Then the launch shaft jacking frame with hydraulic cylinders are used to advance the jacking can and pipeline up to the EPBM.

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 or death.

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

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

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

BEWARE OF SUSPENDED LOADS

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

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

Do not enter area under or around a load.

KEEP PERSONNEL AWAY FROM MOVING PARTS

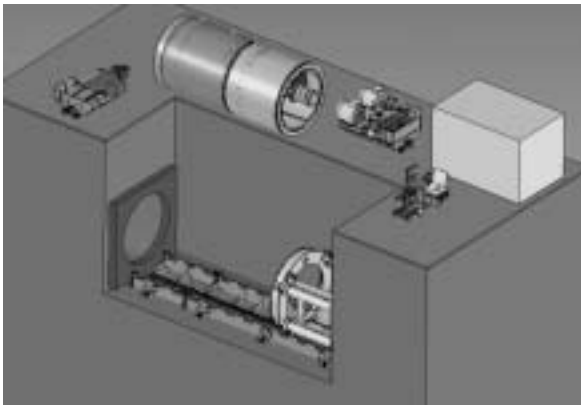
⚠WARNING Crushing hazard.
Keep personnel away from inside of jacking frame. Failure to do so could result in serious personal injury or death.

UNAUTHORIZED WELDING

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

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

REGULARLY CLEAN AND INSPECT EQUIPMENT



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

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

INSPECT ELECTRICAL CONNECTIONS

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

PRACTICE SAFE MAINTENANCE

⚠WARNING Unexpected equipment movement may cause serious personal injury.

LOCKOUT power before performing any maintenance.

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

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

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

Do not service the machine while it is in motion.

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

AVOID PINCH POINTS

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

Keep hands away from moving parts.

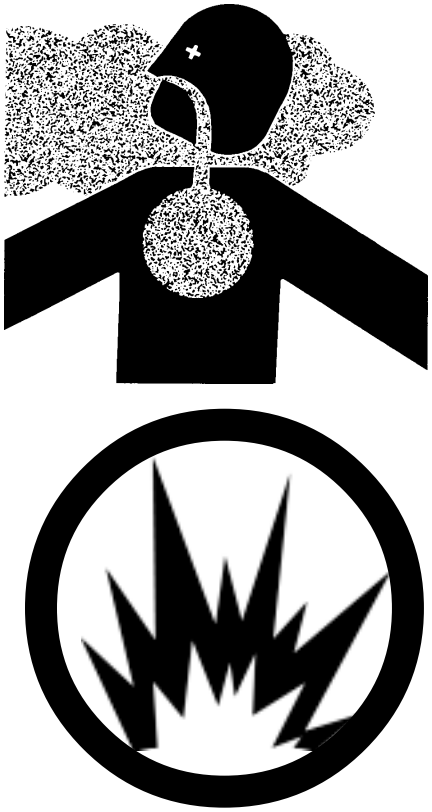
Watch your fingers, hands, and legs while equipment is in operation.

Handle parts carefully to avoid crushing and pinch point hazards.

STAY AWAY FROM CRANE

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

TEST TUNNEL VENTILATION



⚠WARNING Keep EPBM and tunnel well ventilated at all times.

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

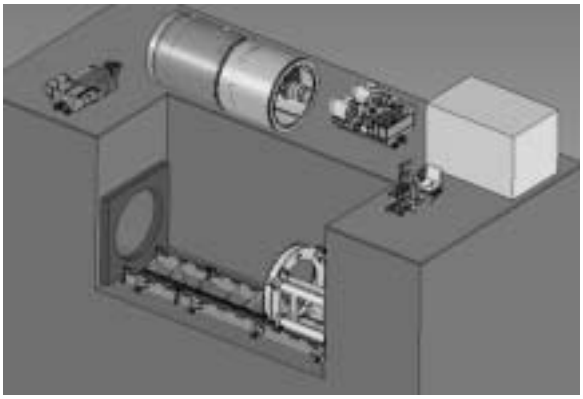
Before and during the shaft operation, test for combustible and toxic gases and oxygen deficiency.

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 earth pressure balance 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.

KEEP RIDERS OFF HAUL UNIT

Allow only operator on operating seat when moving haul unit. Keep riders off.

Riders on haul unit can be easily injured by being struck by objects or being thrown off of the equipment. Riders can also obstruct the operator's view resulting in the equipment being operated in an unsafe manner.

A rider may be allowed in an empty dirt bucket (with contractor approval only), to transport personnel from the tunnel opening to the boring head. If allowed, the rider MUST be fully inside dirt bucket, including head and all other body parts, to avoid contact with obstructions. Also, rider cannot obstruct the operator's view.

AVOID TUNNEL WALL CONTACT

⚠WARNING Contacting tunnel wall and other pipeline obstructions can cause severe personal injury or death.

Keep all body parts on haul unit while unit is moving.

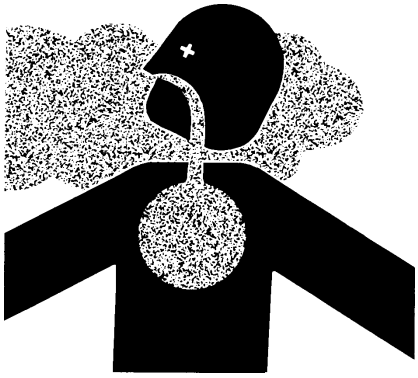
USING CONVEYOR LIFT

⚠WARNING Conveyor lift may tip resulting in serious injury or death.

Conveyor lift MUST be mounted securely to 1448 haul unit frame with five mounting plates, and ten 5/8-11 x 4 in. bolts, flat washers, and nuts.

Conveyor must be secured to conveyor lift with two straps.

FOAM & SLURRY PLANT PROTECTION



When adding materials into mixer and tanks, be sure protective equipment is worn including OSHA certified eye wear and dust mask to prevent personal injury.

WATCH FOR CONVEYOR

⚠WARNING Avoid contact with conveyor. Failure to do so could cause severe injury or death.

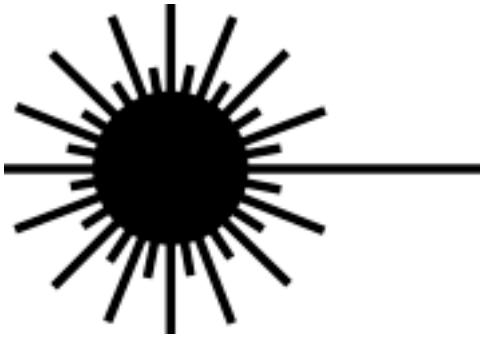
While moving haul unit into tunnel, avoid hitting the conveyor.

LOCKOUT POWER BEFORE SERVICING HAUL UNIT

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

Disconnect battery harness from contactor harness and remove battery pack from haul unit to LOCKOUT power before performing any maintenance.

AVOID LASER LIGHT EXPOSURE

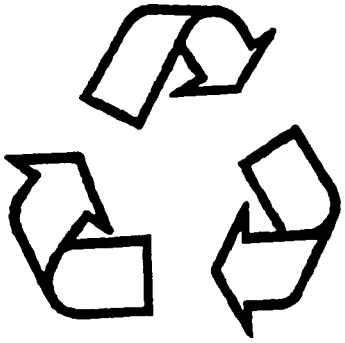


⚠DANGER Staring into laser light will cause severe injury.

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.

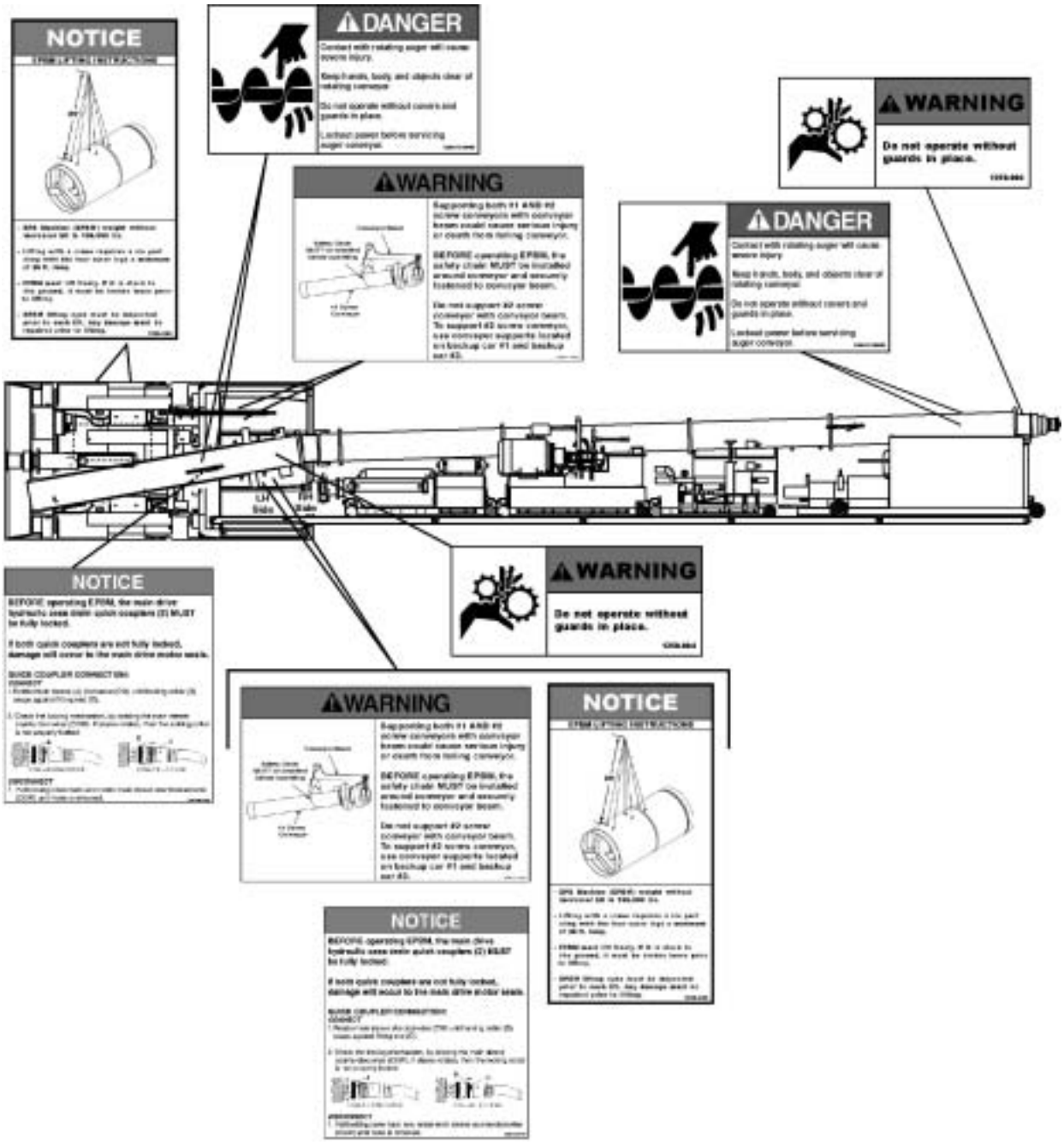
Safety Decals

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.

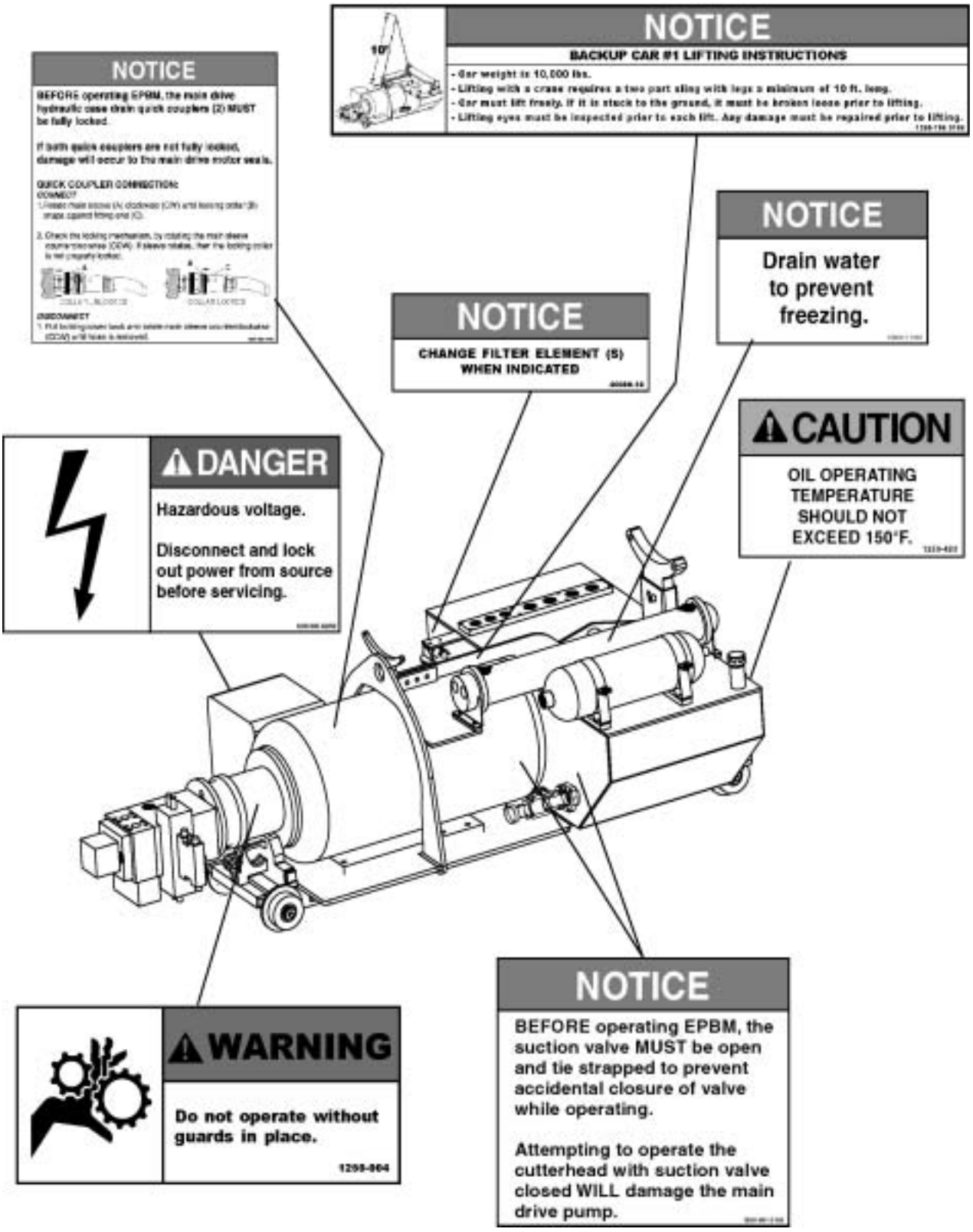
Serious injury or property damage can occur if safety instructions are not followed. Contact your Akkerman Product Support representative for free replacement safety decals.

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.

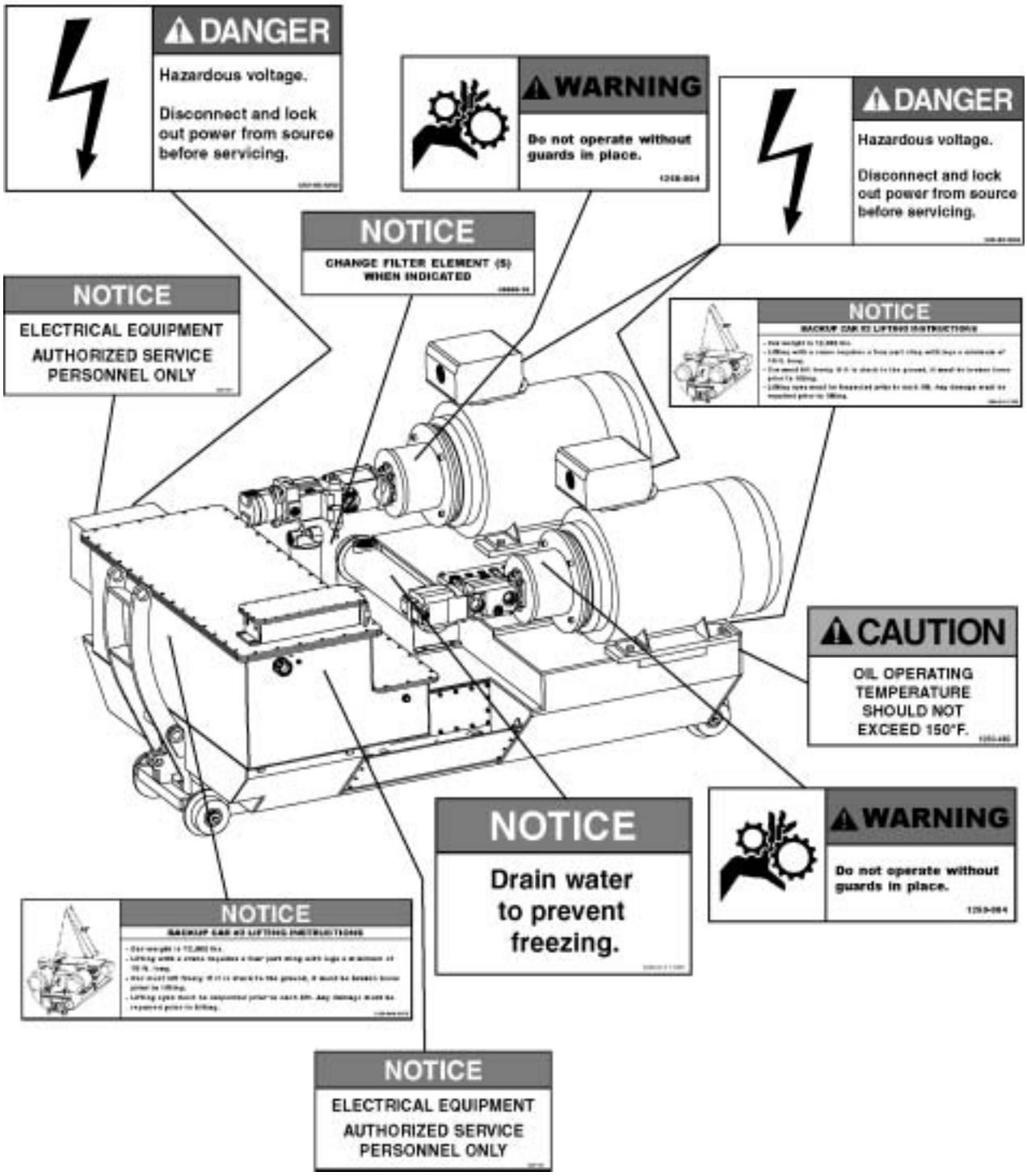
EPBM & CONVEYORS



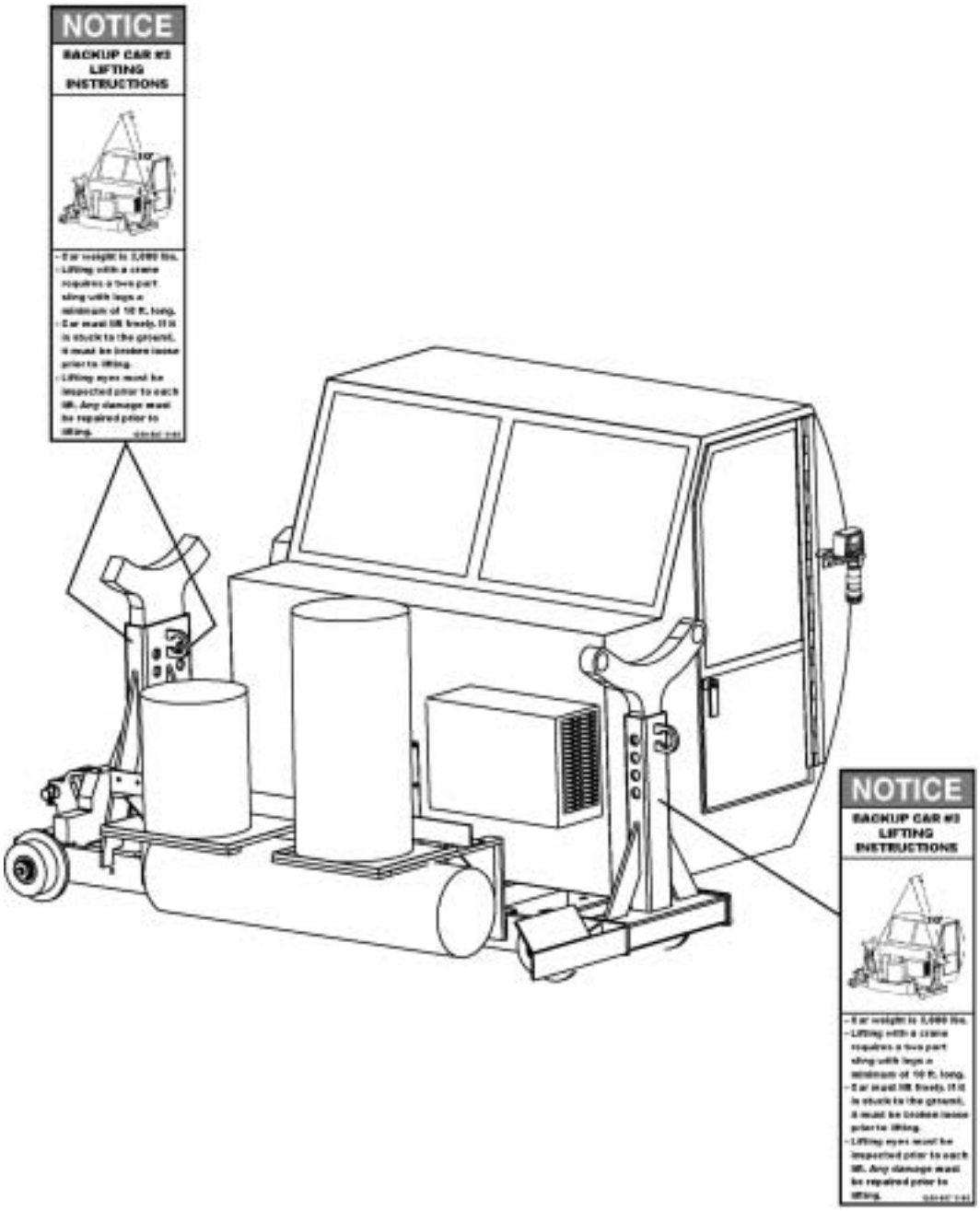
BACKUP CAR #1


NOTICE
BEFORE operating EPBM, the main drive hydraulic case drain quick couplers (2) MUST be fully locked.
If both quick couplers are not fully locked, damage will occur to the main drive motor seals.
QUICK COUPLER CONNECTION:
CONNECT:
DISCONNECT:
NOTICE
BACKUP CAR #1 LIFTING INSTRUCTIONS
- Car weight is 10,000 lbs.
- Lifting with a crane requires a two part sling with legs a minimum of 10 ft. long.
- Car must lift freely. If it is stuck to the ground, it must be broken loose prior to lifting.
- Lifting eyes must be inspected prior to each lift. Any damage must be repaired prior to lifting.
NOTICE
Drain water to prevent freezing.
NOTICE
CHANGE FILTER ELEMENT (S) WHEN INDICATED
CAUTION
OIL OPERATING TEMPERATURE SHOULD NOT EXCEED 150°F.
DANGER
Hazardous voltage.
Disconnect and lock out power from source before servicing.
WARNING
Do not operate without guards in place.
1298-864
NOTICE
BEFORE operating EPBM, the suction valve MUST be open and tie strapped to prevent accidental closure of valve while operating.
Attempting to operate the cutterhead with suction valve closed WILL damage the main drive pump.

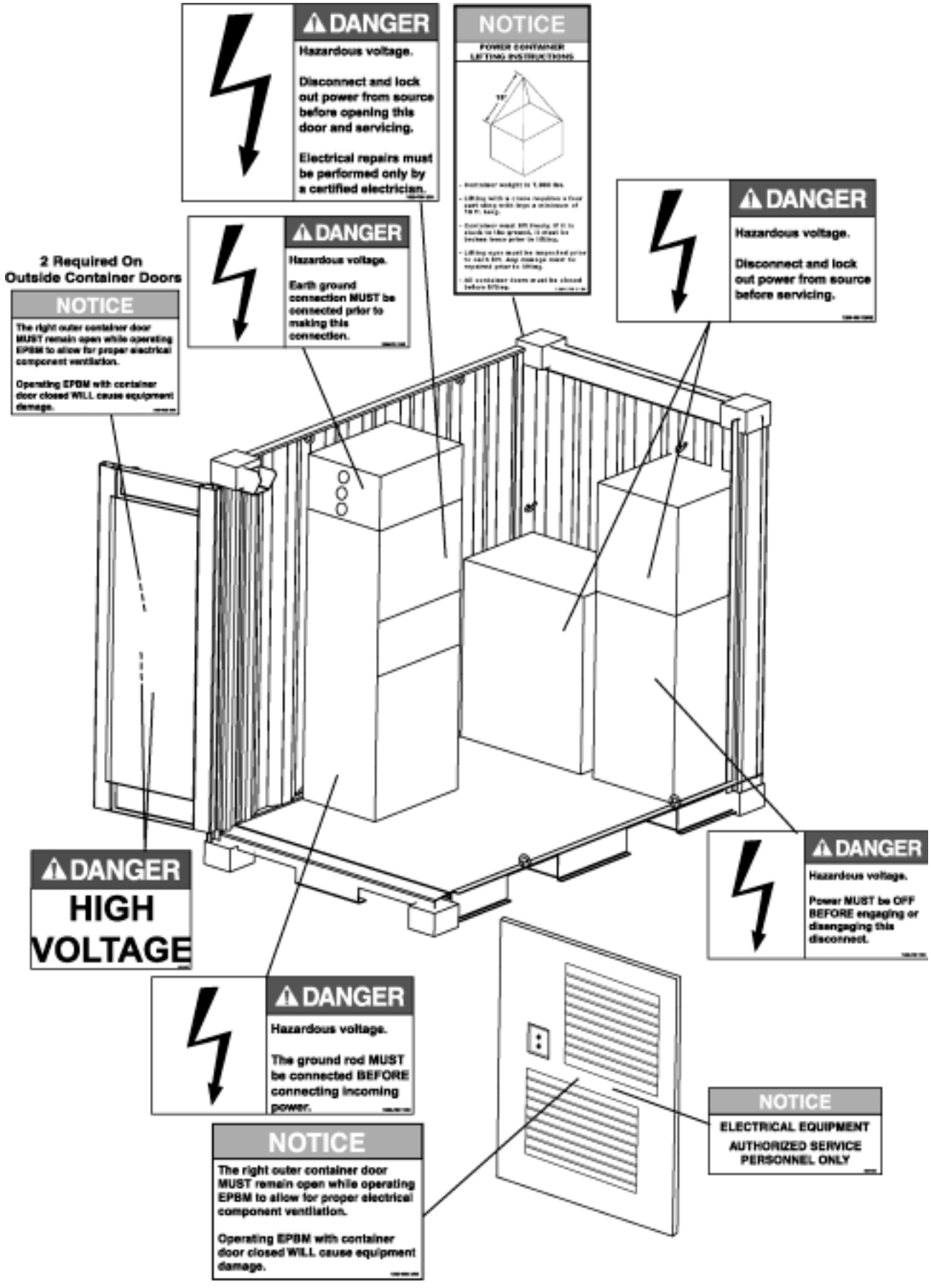
BACKUP CAR #2


DANGER
Hazardous voltage.
Disconnect and lock out power from source before servicing.
WARNING
Do not operate without guards in place.
DANGER
Hazardous voltage.
Disconnect and lock out power from source before servicing.
NOTICE
CHANGE FILTER ELEMENT (S) WHEN INDICATED
NOTICE
ELECTRICAL EQUIPMENT AUTHORIZED SERVICE PERSONNEL ONLY
NOTICE
NOTICE
CAUTION
OIL OPERATING TEMPERATURE SHOULD NOT EXCEED 150°F.
NOTICE
Drain water to prevent freezing.
WARNING
Do not operate without guards in place.
NOTICE
NOTICE
ELECTRICAL EQUIPMENT AUTHORIZED SERVICE PERSONNEL ONLY

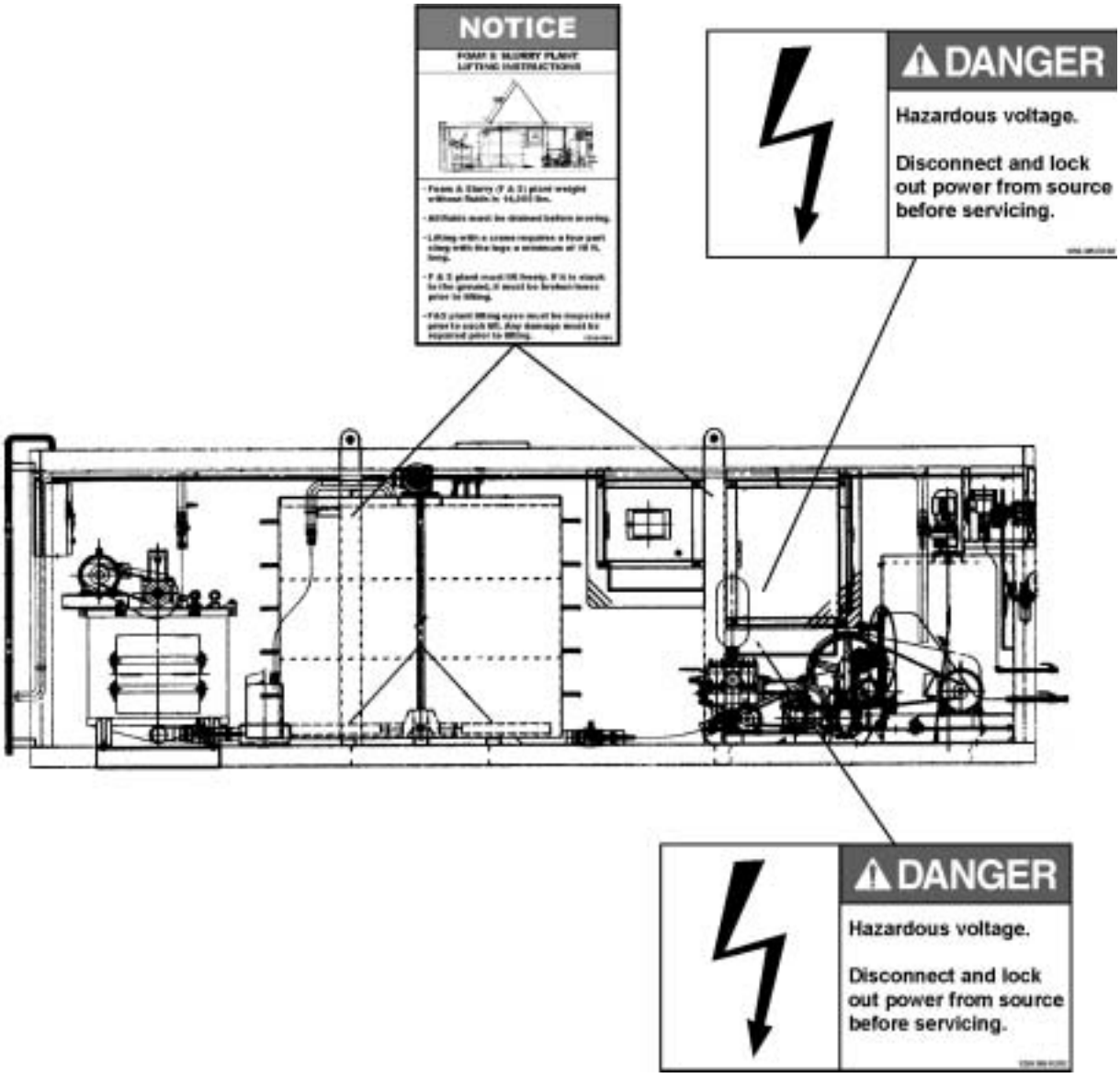
BACKUP CAR #3


NOTICE
BACKUP CAR #3
LIFTING
INSTRUCTIONS
NOTICE
BACKUP CAR #3
LIFTING
INSTRUCTIONS

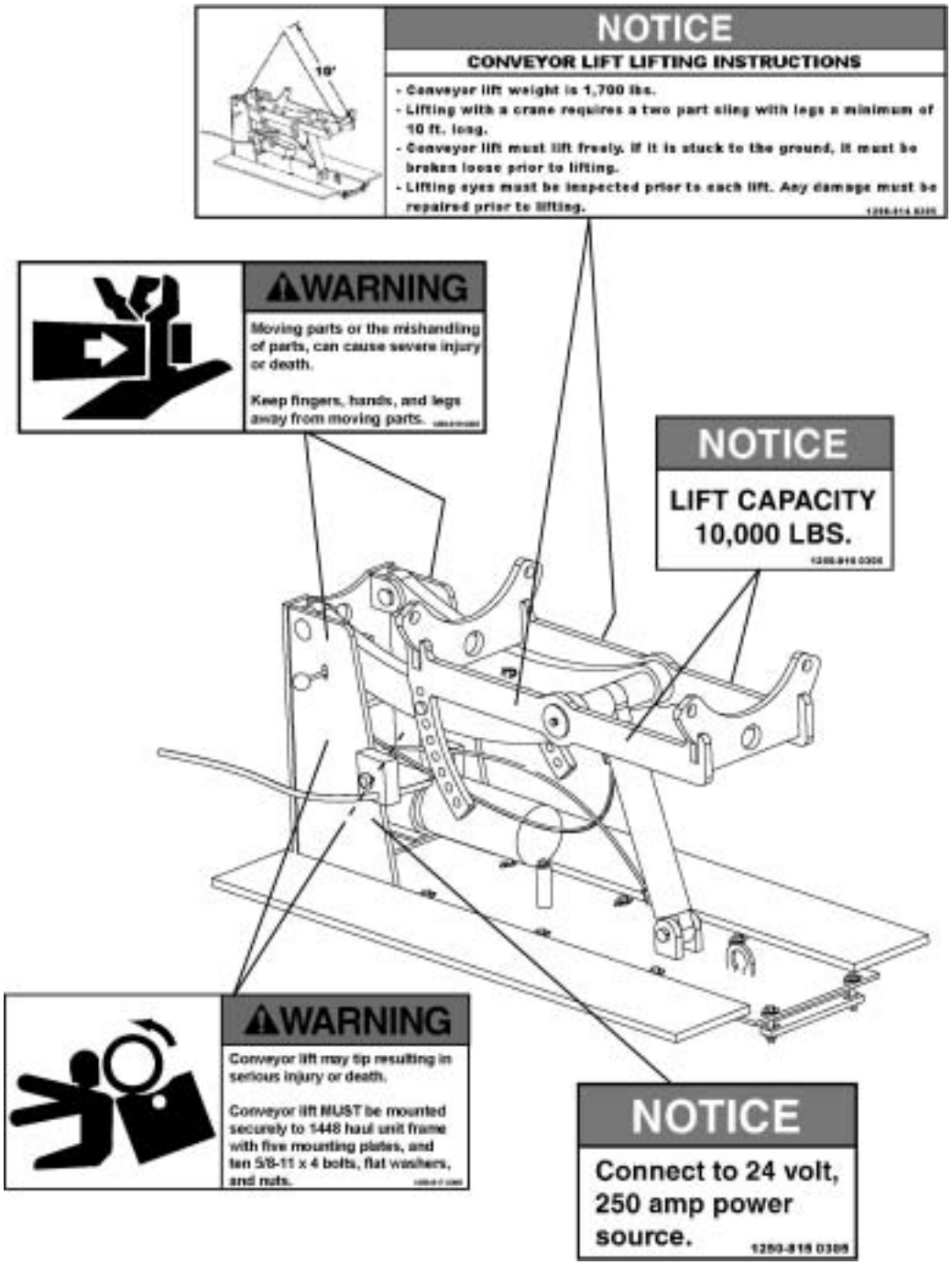
POWER CONTAINER



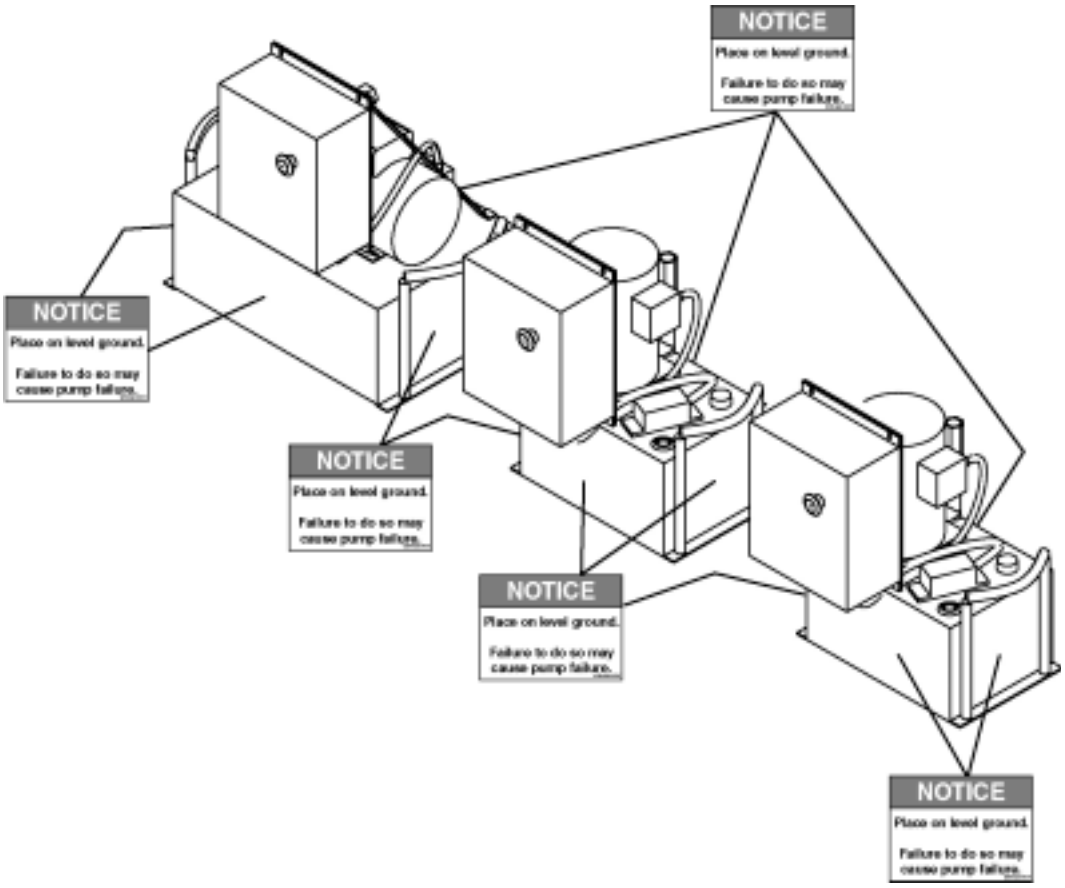
FOAM & SLURRY PLANT



CONVEYOR LIFT ASSEMBLY

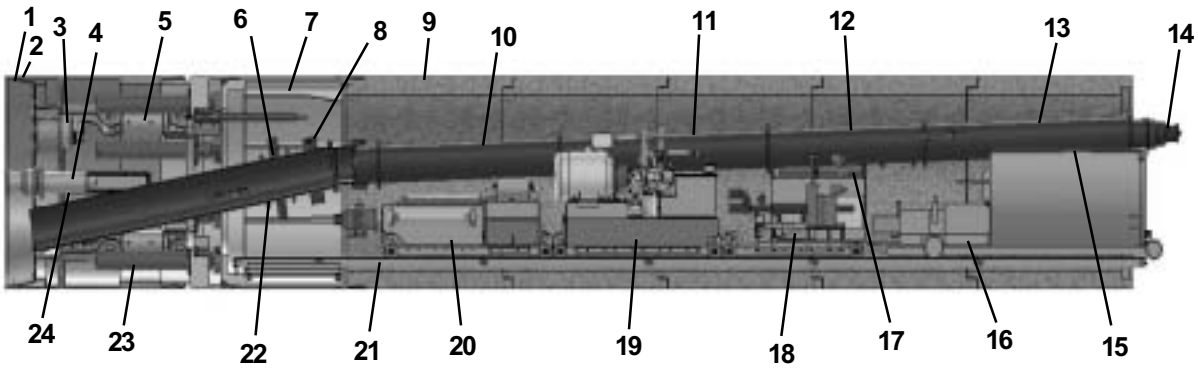


SCAVENGING PUMPS



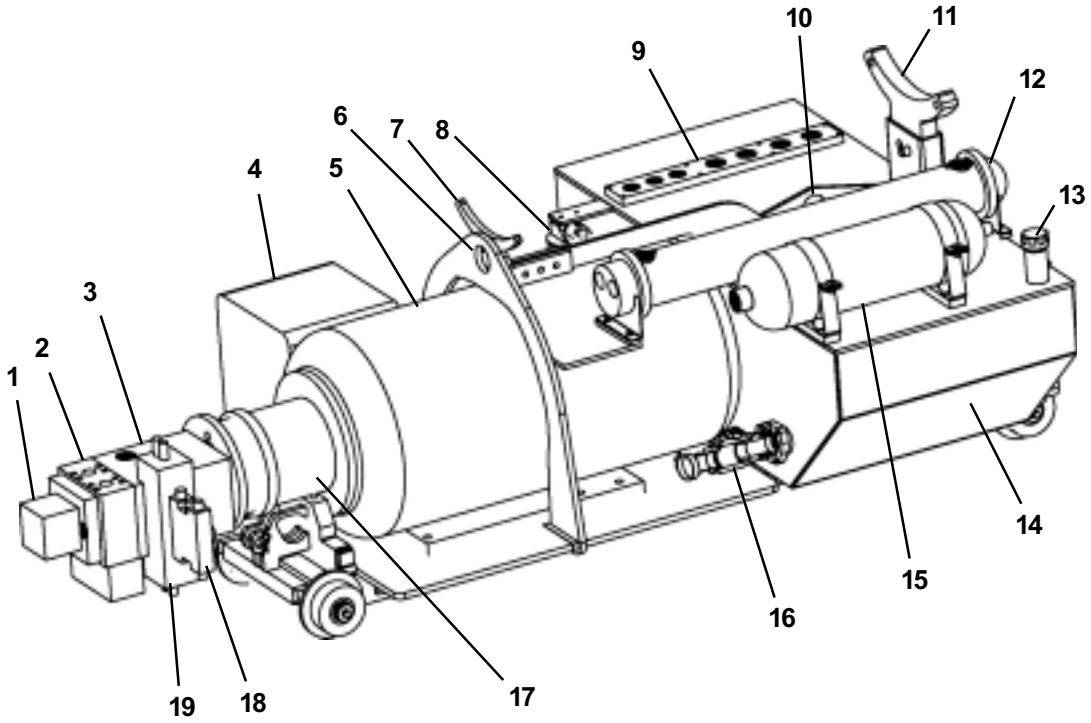
Terminology

EPBM SYSTEM



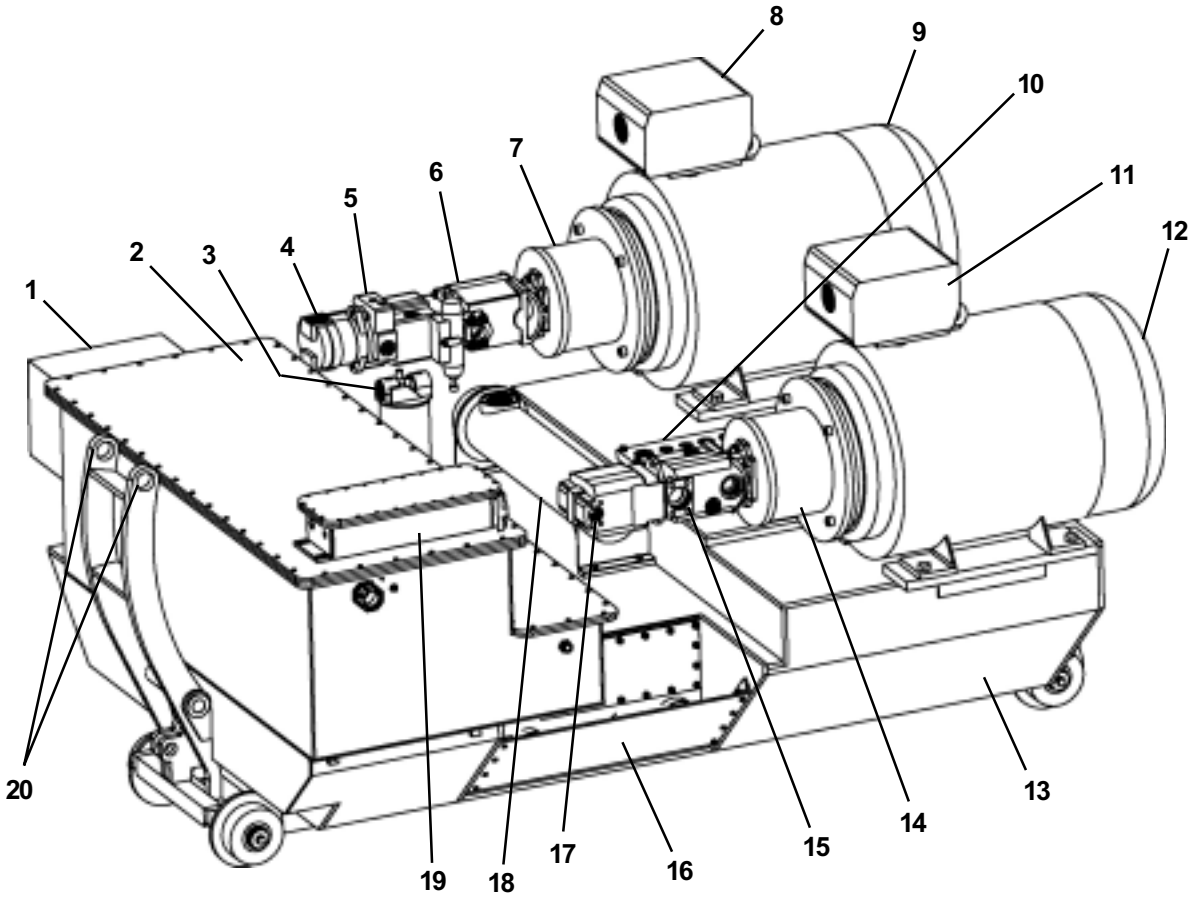
1. Cutterhead
2. Copy Cutter
3. Cutter Drive Motors
4. Swivel
5. Steering Cylinder
6. #1 Screw Conveyor Drive Motor
7. Jacking Can
8. #1 Intermediate Gate
9. Pipe
10. #2 Screw Conveyor Front Section
11. #2 Screw Conveyor Front- Mid Section
12. #2 Screw Conveyor Mid-Trailing Section
13. #2 Screw Conveyor Trailing Section
14. #2 Screw Conveyor Drive Motor
15. #2 Conveyor Gate
16. Haul Unit
17. Operator's Station
18. Backup Car #3
19. Backup Car #2
20. Backup Car #1
21. Track
22. #1 Conveyor Gate
23. Jacking Cylinders
24. Earth Pressure Sensors

BACKUP CAR #1



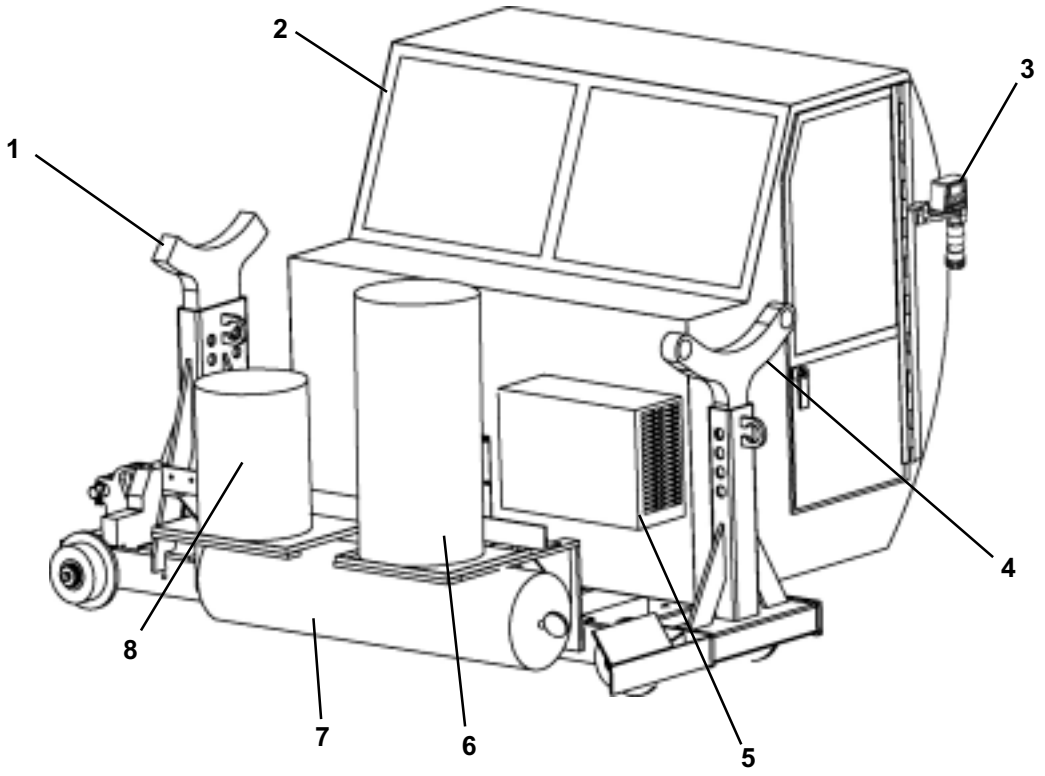
1. Charge Pump
2. Port Block
3. Main Drive Pump
4. Electrical Box
5. 300 HP Electric Motor - Main Drive
6. Lifting Eye - Front
7. Conveyor Support - Front
8. Return Filter With Filter Indicator
9. Return Manifold
10. Lifting Eye - Rear
11. Conveyor Support - Rear
12. Heat Exchanger
13. Hydraulic Oil Fill
14. Hydraulic Reservoir - 150 Gal.
15. Charge Pressure Accumulator
16. Suction Valve
17. Drive Coupling
18. Control Assembly
19. Pressure Limiter

BACKUP CAR #2



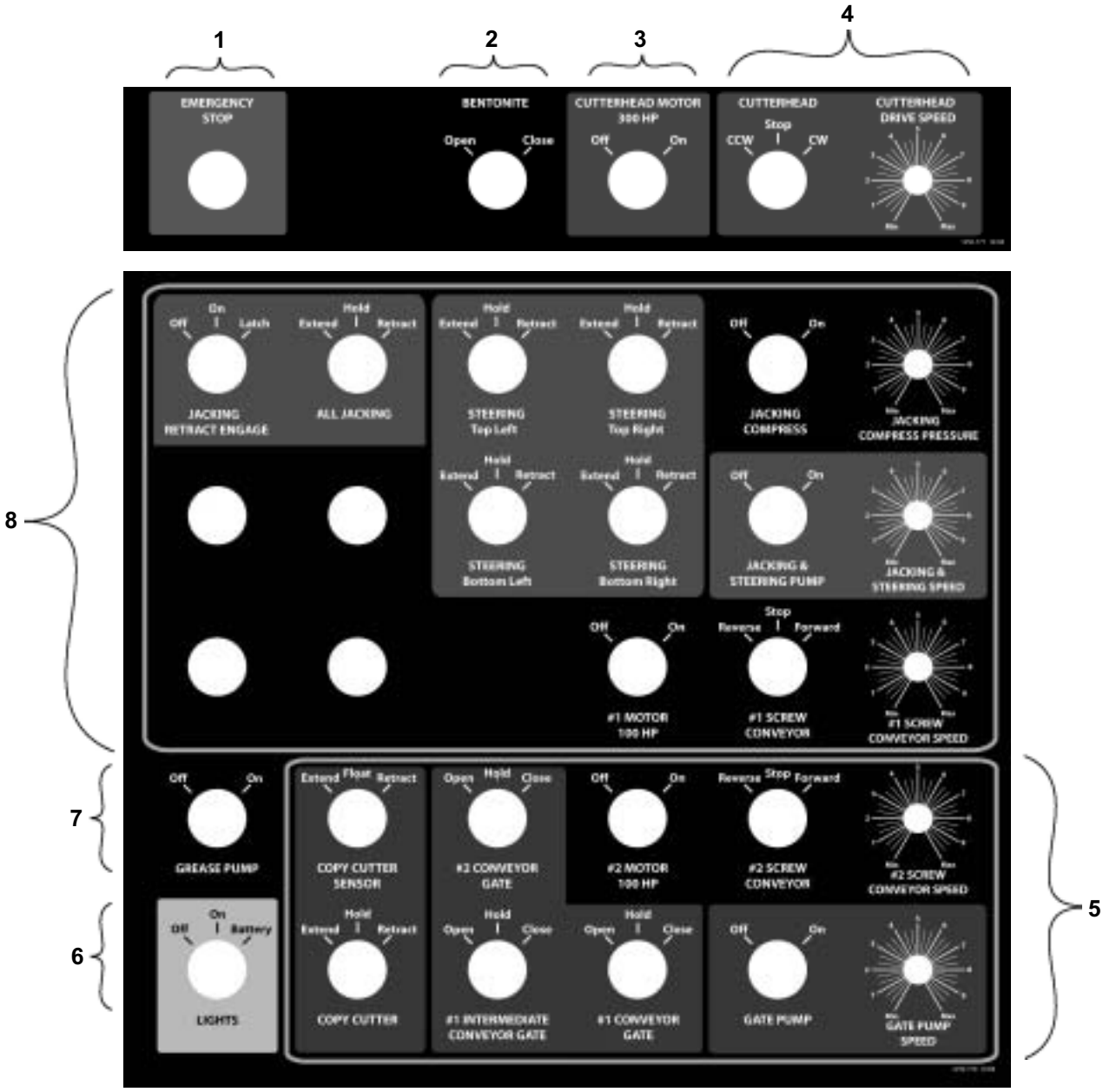
1. Transformer 120 V
2. Motor Fuse/Contactor Box
3. Cooling Filter With Filter Indicator
4. Cooling Pump
5. Conveyor Gate & Copy Cutter Pump
6. #2 Screw Conveyor Pump
7. Drive Coupling
8. Electrical Box
9. 100 HP Electrical Motor
10. Return Manifold
11. Electrical Box
12. 100 HP Electrical Motor
13. Hydraulic Tank - 300 Gal.
14. Drive Coupling
15. #1 Screw Conveyor Pump
16. Suction Manifold
17. Steering & Jacking Cylinder Pump
18. Heat Exchanger
19. Motor Control Box
20. Lifting Eyes - Rear

BACKUP CAR #3



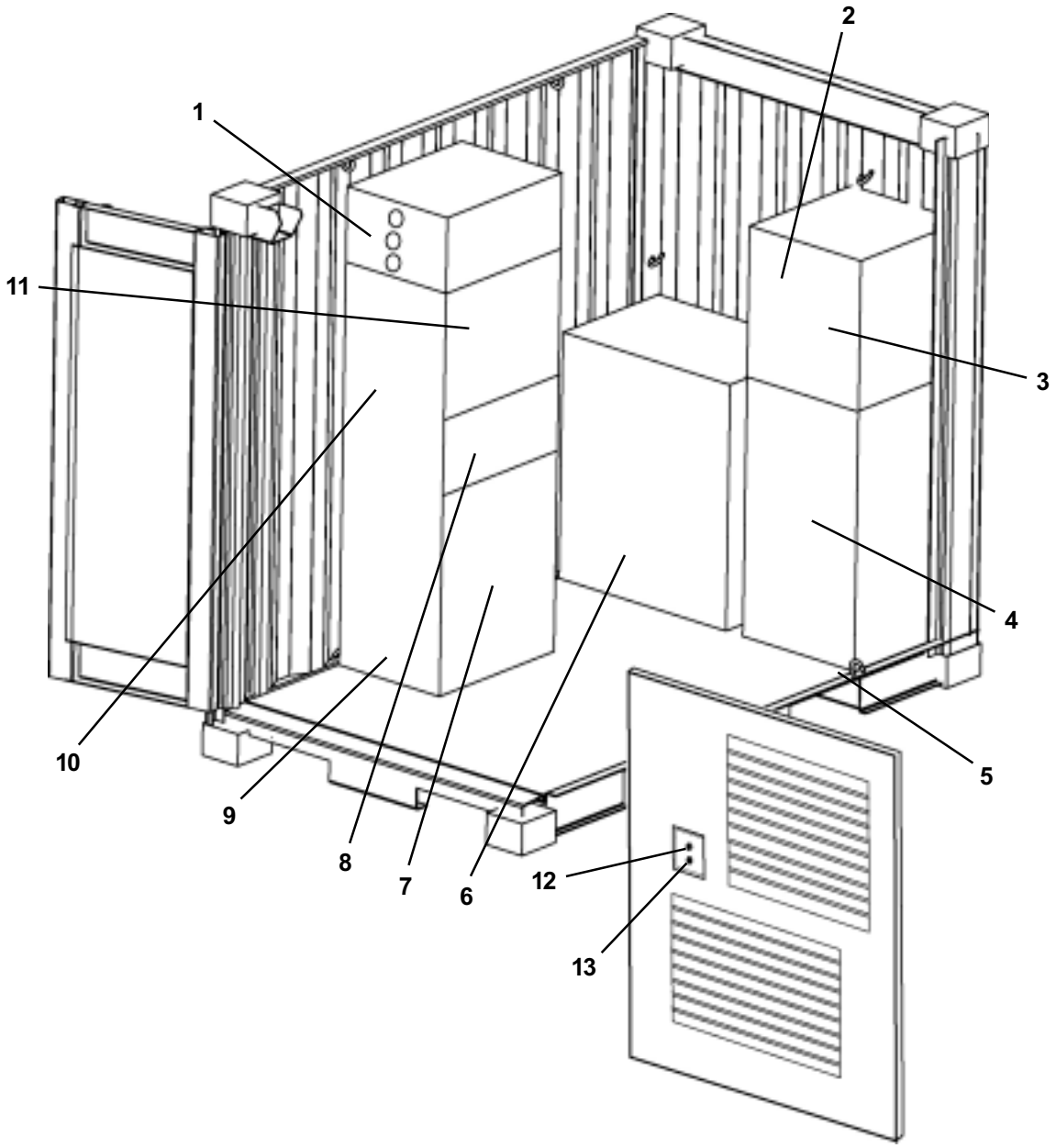
1. Conveyor Support - Front
2. Operator Station
3. Gas Detector
4. Conveyor Support - Rear
5. Air Conditioning Unit
6. Jacking Can Greasing System Reservoir
7. Screw Conveyor #2 Rear Gate Accumulator
8. Automated Grease System Reservoir

OPERATOR'S STATION CONSOLE (BACKUP CAR #3)



1. Emergency Stop
2. Bentonite (External Ports)
3. Cutter Head Motor
4. Cutterhead Rotation
5. Copy Cutter, Gate, & #2 Screw Conveyor Controls
6. Lights
7. Grease Pump
8. Jacking, Steering, & #1 Screw Conveyor Controls

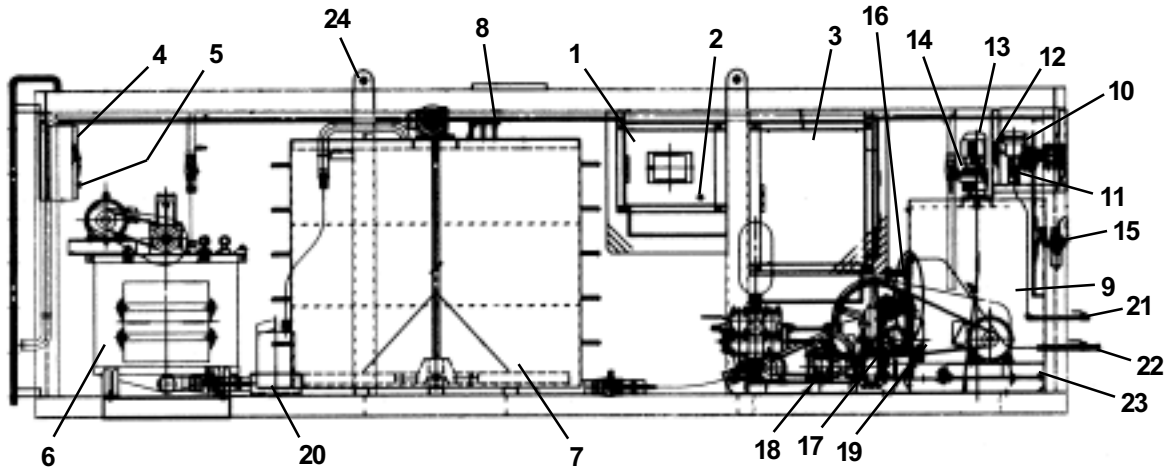
POWER CONTAINER



1. 480 Volt Incoming Power
2. 2400 Volt EPB Machine Power Lights
3. 2400 Volt Ground Check Module
4. 2400 Volt Main Disconnect
5. 2400 Volt Power Cord
6. Transformer
7. Head Power Transformer Disconnect
8. Foam & Slurry Main Disconnect
9. Earth Ground Connection
10. Foam & Slurry Power
11. Foam & Slurry Transformers
12. Emergency Stop / EPBM Power Off*
13. EPBM Power On*

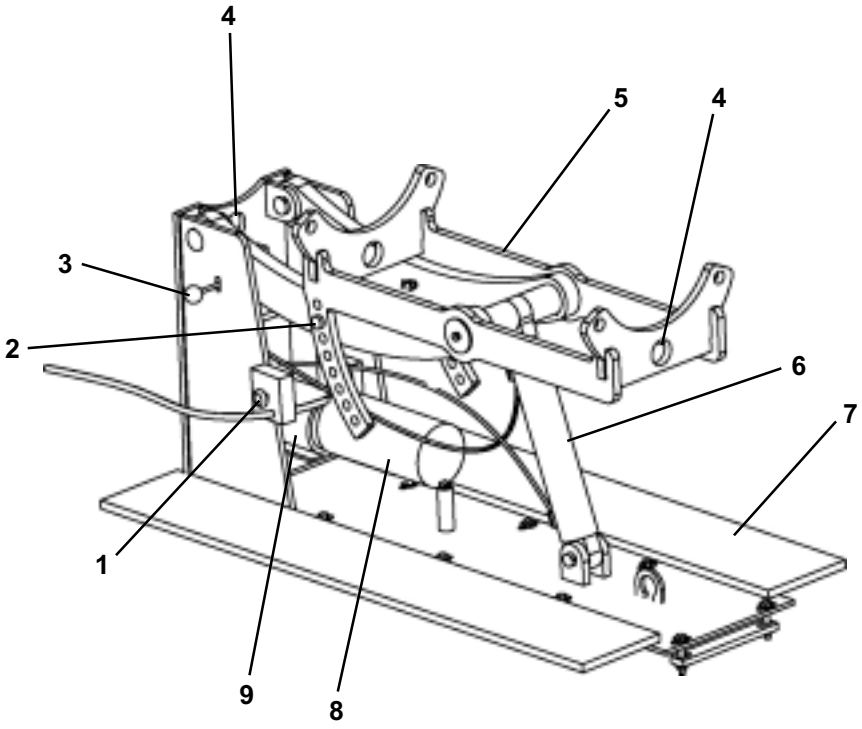
* Mounted on power door.

FOAM & SLURRY PLANT



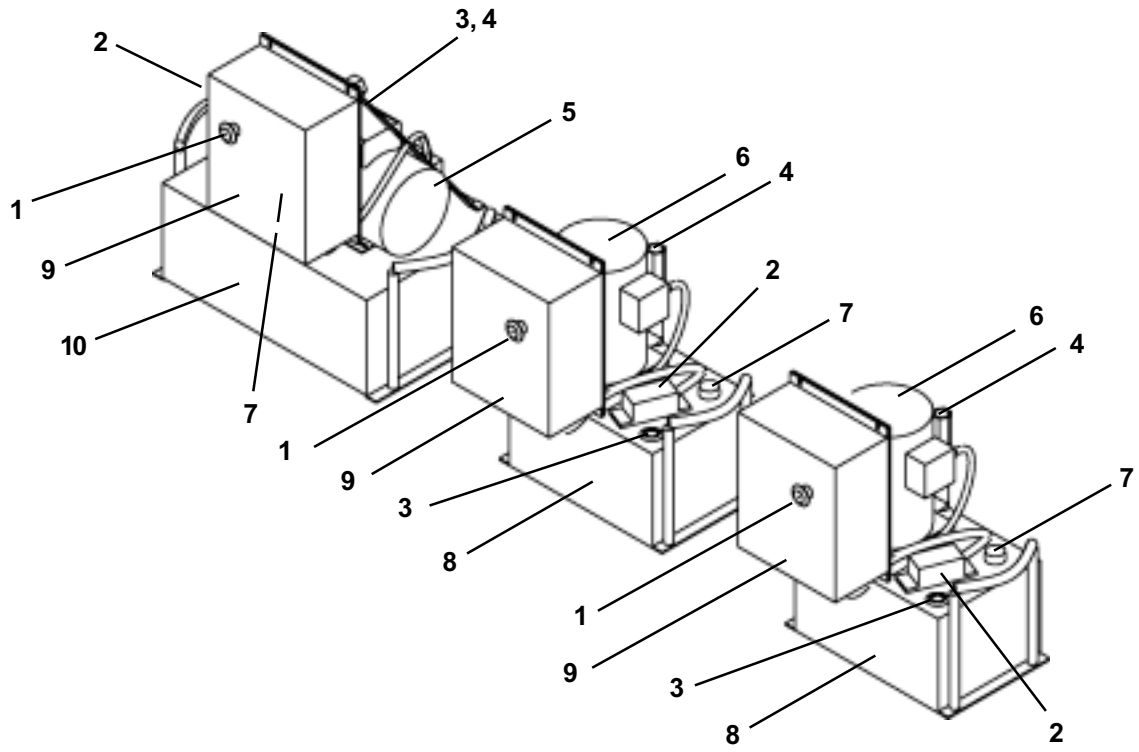
1. Operation Panel
2. Operation Panel - Emergency Stop
3. Pump Control Panel
4. Slurry Control Panel
5. Slurry Control Panel - Emergency Stop
6. Slurry Mixer
7. Slurry Tank
8. Slurry Tank Level Sensor
9. Solution Tank
10. Air Flow Meter
11. Air Pressure Sensor
12. Slurry Flow Meter
13. Slurry Pressure Sensor
14. Flow Control Valve
15. Regulator
16. Solution Pressure Sensor
17. Solution Flow Meter
18. Solution Pump
19. Slurry Pump
20. Slurry Transfer Pump
21. Air Delivery Pipe
22. Solution Delivery Pipe
23. Slurry Delivery Pipe
24. Lifting Eye

CONVEYOR LIFT ASSEMBLY



1. E-Stop Button
2. Cradle Arm Adjustment
3. Lift Control
4. Lifting Eye
5. Cradle Arm
6. Lift Cylinder
7. Floor Grate
8. Oil Reservoir
9. Electric Motor

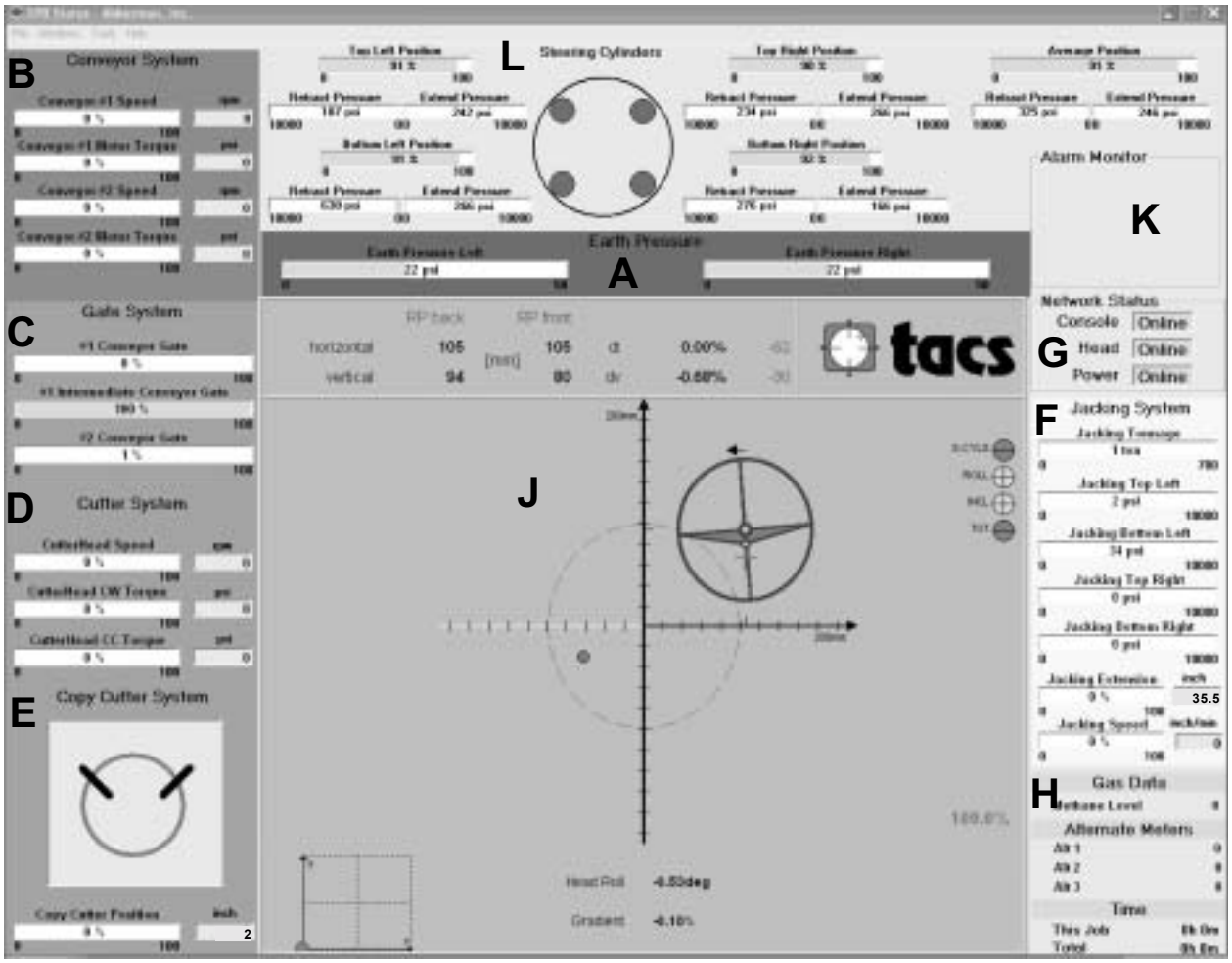
SCAVENGING PUMPS



1. E-Stop Button
2. Pump Float Box
3. Input To Pump Connection
4. Output Of Pump Connection
5. Motor - 1-1/2 HP
6. Motor - 1/2 HP
7. Breather
8. Reservoir - 5 Gallon
9. Power Box
10. Reservoir - 10 Gallon

Controls & Instruments

TARGET SCREEN



The target screen shows all critical tunneling data by means of graphical and numerical meter displays. The Earth Pressure (A), Conveyor System (B), Gate System (C), Cutter System (D), Copy Cutter System (E) (an animation showing the cutterhead rotation and copy cutter position is also displayed), and Jacking System (F) meter information is represented with bar graphs and numerical values. The Network Status (G) of the Console, Head, and Power (Backup Car #2) are displayed. The EPBM operational meter information (H); Gas Data, Alternate Meters, and Time, are represented with numerical 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 (J) shows a graphical representation of: the position of the EPBM cutterhead, target position, and projected cutterhead position. Other numerical information is displayed on the target screen: reference points, head roll, gradient, strength of steering. For more information, refer to your target user manual.

The Alert Monitor (K) displays the following problem messages as they occur: Cutter Motor Overload, #1 Motor Overload, #2 Motor Overload, Out Of Grease, and Grease Pump Problem.

The Steering Cylinder indicator (L) displays the EPBM steering cylinder stroke position in percent and retract and extend pressure in PSI for the top left, bottom left, top right and bottom right cylinders. The average position in percent, and retract and extend pressures are also displayed with bar graphs and numerical values.

(continued on next page)

GAS DATA
Methane Level displays the % of LEL (Lower Explosive Limit) gas concentration at backup car #3.

ALTERNATE METERS
This feature is not available at this time.

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

Total displays the total number of computer hours used.

Gas Data	
Methane Level	0
Alternate Meters	
Alt 1	0
Alt 2	0
Alt 3	0
Time	
This Job	0h 0m
Total	0h 0m

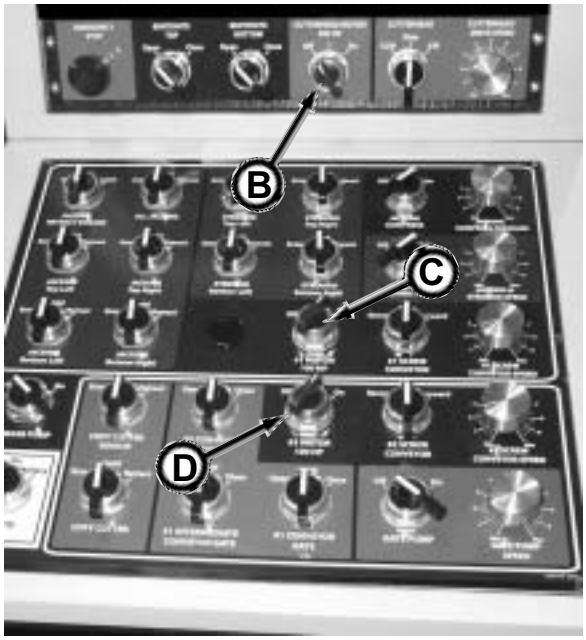
MOTOR CONTROLS

The motor controls power the EPBM functions.

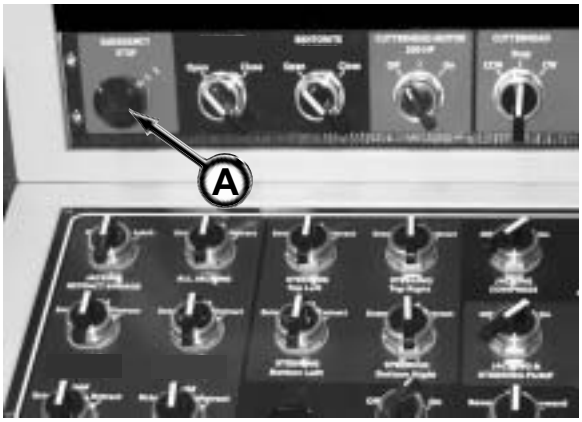
Switch Cutterhead Motor 300 HP control (B) to ON position to power the cutterhead rotation.

Switch #1 Motor 100 HP control (C) to ON position to power the Jacking & Steering, and #1 Screw Conveyor functions.

Switch #2 Motor 100 HP control (D) to ON position to power the Conveyor Gates, #2 Screw Conveyor, and copy cutter functions.



EMERGENCY STOP



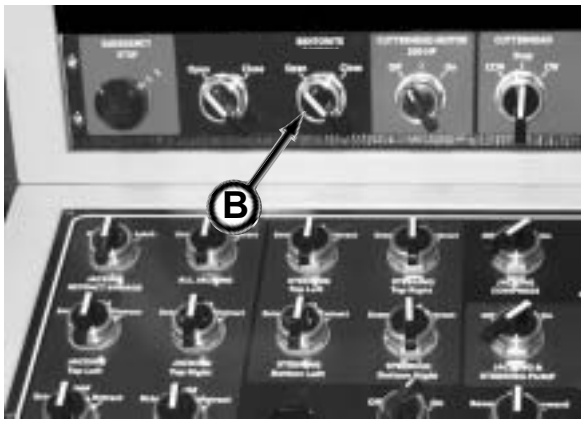
Push IN Emergency Stop button (A) to stop ALL power, which includes power to the operation lights.

This button must be pulled out to restart operation.

NOTICE There is a light control on the bottom left hand side of control panel. Turn switch to Battery when power is shut off.

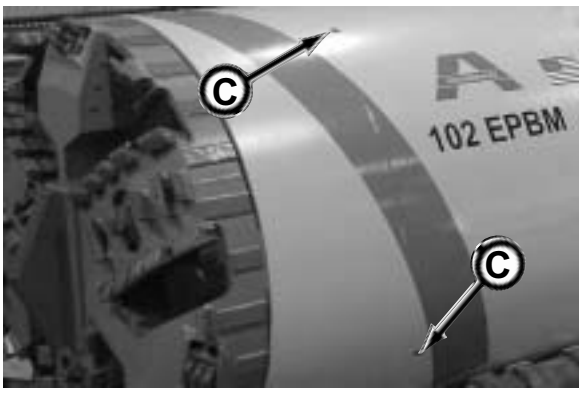
This Emergency Stop will not stop the foam and slurry plant function. The foam and slurry plant has a separate power source and emergency stop switches.

BENTONITE CONTROL



Turn Bentonite switch to Open position to open the bentonite valve to the four external ports (C) on the EPBM. The bentonite flow is controlled manually inside the EPBM with four individual ball valves.

Turn the Bentonite switch to Close position to stop bentonite flow to the four external ports on the EPBM.



CUTTERHEAD CONTROLS

The cutterhead controls the power, speed and direction of the cutterhead rotation (drive motor) on the EPBM.

NOTICE Abrupt operation may cause the machine to roll. Before starting, be sure cutterhead drive speed is at 0% before starting cutterhead rotation.

CUTTERHEAD MOTOR 300HP (A)
The Cutterhead Motor 300HP powers the four cutterhead motors ON and OFF.

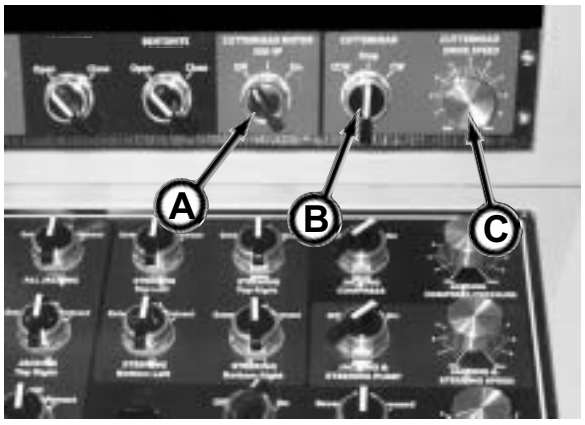
CUTTERHEAD (B)
The Cutterhead controls the direction of the cutterhead rotation as follows:

CCW
Turns the EPBM drive motors CCW (as viewed from operator seat).

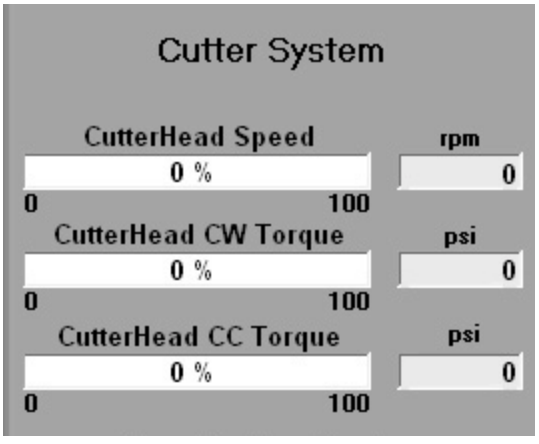
STOP
Stops the EPBM drive motor.

CW
Turns the EPBM drive motors CW (as viewed from operator seat).

CUTTERHEAD DRIVE SPEED (C)
The Cutterhead Drive Speed control regulates the speed of the EPBM drive motor from 0 to 100%.



The cutterhead speed and torque (clockwise & counterclockwise) can be monitored from the target screen.



Cutter System Meters
On Target Screen

JACKING CONTROLS

The jacking controls select the jacking function and regulate the oil flow to the EPBM jacking cylinders.

To use these controls, turn ON #1 Motor 100 HP (A) and the Jacking & Steering Pump (B).

NOTICE **NEVER RETRACT THE JACKING CYLINDERS WHILE MINING. DOING SO WILL CAUSE THE PIPE ADAPTER TO SEPARATE FROM PIPE.** Retract the jacking cylinders only in shop, pre-launch or completion of drive situations.

JACKING CONTROLS

Use the ALL JACKING switch (C) while mining to extend the jacking cylinders.

SWITCH FUNCTIONS:
HOLD
Stops flow to the jacking cylinders.

EXTEND
Extends the jacking cylinders.

RETRACT
Retracts the jacking cylinders. **Use the function only in shop, pre-launch, or completion of drive situations.**

JACKING & STEERING SPEED
The Jacking & Steering Speed control (D) regulates the speed of the EPBM jacking cylinders from 0 to 100%.

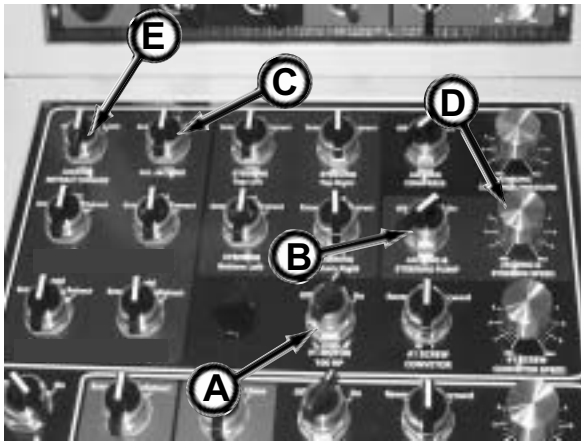
The jacking system tonnage, individual cylinder pressure, extension, and speed can be monitored from the target screen.

JACKING RETRACT ENGAGE

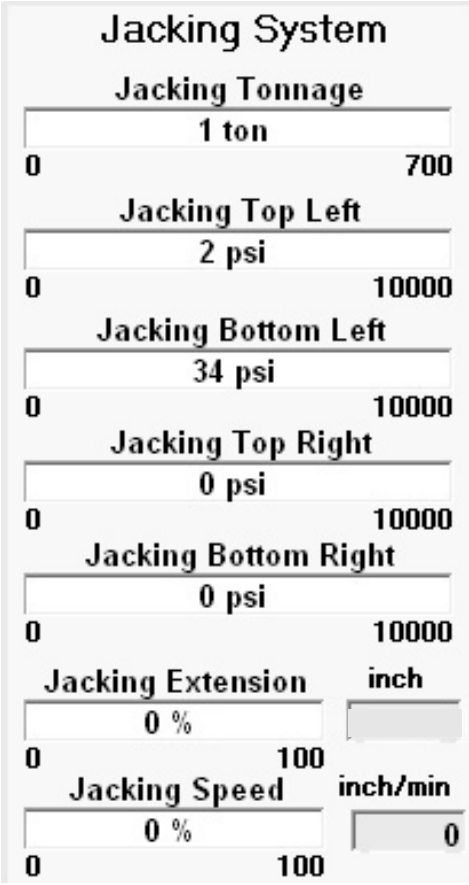
NOTICE **NEVER RETRACT THE JACKING CYLINDERS WHILE MINING. DOING SO WILL CAUSE THE PIPE ADAPTER TO SEPARATE FROM PIPE.** Retract the jacking cylinders only in shop, pre-launch or completion of drive situations.

The Jacking Retract Engage (E) control is used ONLY if jacking cylinder retraction is necessary.

Turn switch (E) to Latch position and release. You may now retract the jacking cylinders . When complete, IMMEDIATELY turn to OFF position.



A - #1 Motor 100 HP
B - Jacking & Steering Pump
C - All Jacking Control
D - Jacking & Steering Speed Flow Control
E - Jacking Retract Engage Control



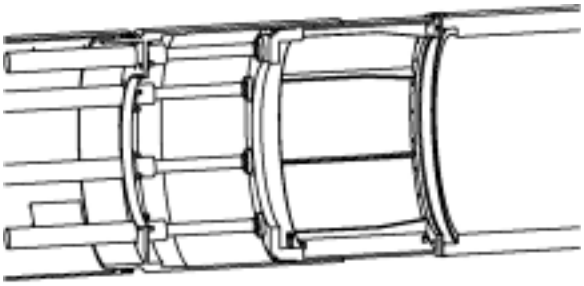
Jacking System On Target Screen

JACKING COMPRESS

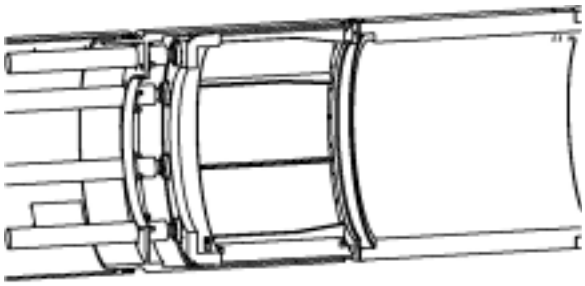
NOTICE **BEFORE** compressing jacking can, refer to Compressing Jacking Can in the Operation section for proper compressing procedure. Jacking can must be lubricated while being compressed.

Once the EPBM cylinders are fully extended, and the pipe is being jacked from the launch shaft, the EPBM jacking cylinders must be compressed.

NOTICE **NEVER RETRACT THE EPBM JACKING CYLINDERS WHILE MINING. DOING SO WILL CAUSE THE PIPE ADAPTER TO SEPARATE FROM PIPE. COMPRESS THE EPBM JACKING CYLINDERS USING THE LAUNCH SHAFT JACKING EQUIPMENT.** Retract the jacking cylinders only in shop, pre-launch or completion of drive situations.

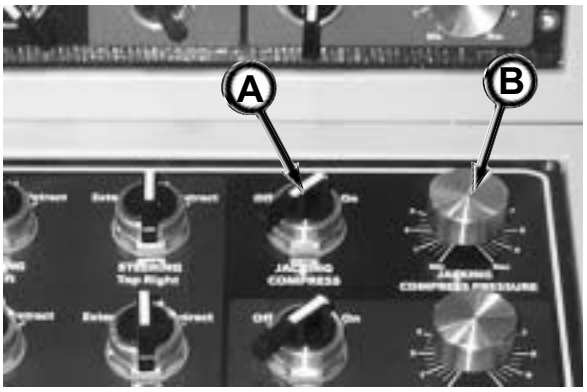


Jacking Can Extended



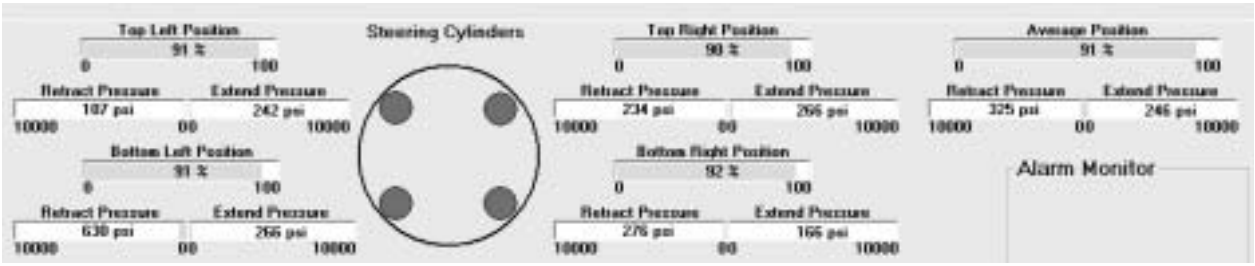
Jacking Can Retracted

Turn Jacking Compress switch (A) to ON position and regulate the speed of the EPBM jacking cylinders to retain the earth pressure balance, with the Jacking Compress Pressure flow control (B).

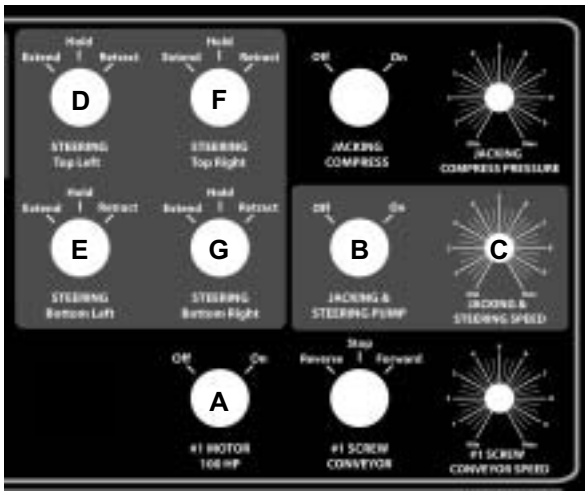


STEERING CONTROLS

NOTICE For the proper steering procedure, refer to Steering Guidelines and Operation in the Operation section.

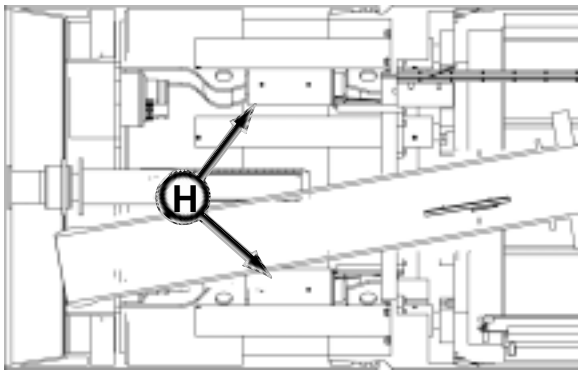


Monitor the cylinder position in percent, the extend and retract pressure of the steering cylinders, and the average position and extend and retract pressure on the target screen, as shown above.



Turn the #1 Motor (A) and the Jacking & Steering Pump (B) to ON position. To control the steering cylinders (H), switch cylinder controls to the extend, retract, or hold position. The speed of the cylinder is controlled by the Jacking and Steering Speed flow control (C).

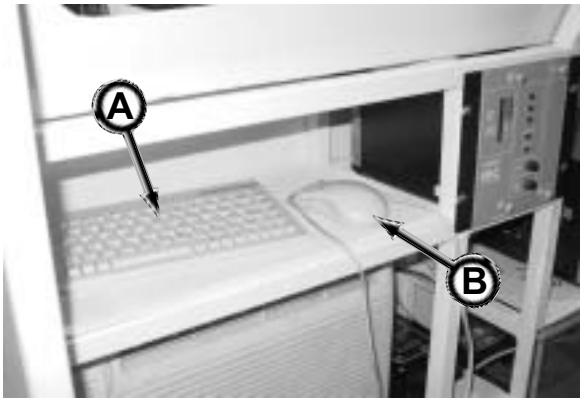
A - #1 Motor Control
B - Jacking & Steering Pump Control
C - Jacking & Steering Speed Flow Control
D - Top Left Cylinder Control
E - Top Right Cylinder Control
F - Bottom Left Cylinder Control
G - Bottom Right Cylinder Control
H - Steering Cylinders



NOTICE Before steering, ALL steering cylinders must be positioned to 20% prior to steering. Failure to do so could cause machine damage. Also, to assist in controlling the EPBM steering, an interlock is designed into the system so two cylinders must be operated simultaneously.

NOTICE Steer only when the jacking can is compressed. Doing so will cause the jacking can to misalign with the stationary can. This misalignment will prevent the jacking can from compressing.

KEYBOARD & MOUSE CONTROLS



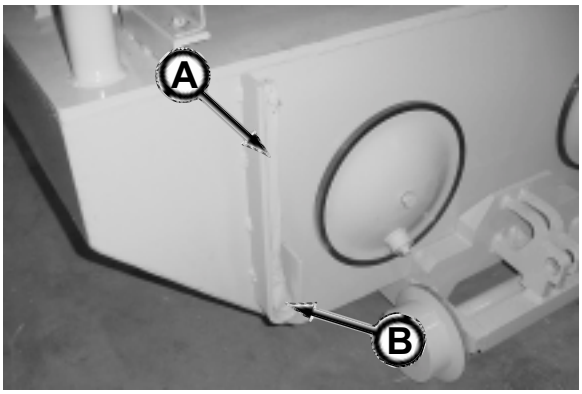
Use the keyboard (A) to select and enter information for the report generator or for changing your meter settings on the target screen.

MOUSE
The mouse (B) controls the computer screen pointer and select functions on the monitor.

BACKUP CAR #1 HYDRAULIC RESERVOIR

The hydraulic reservoir in backup car #1 includes an oil level sight gauge (A) and temperature gauge (B).

The hydraulic oil temperature should not exceed 125 degrees F.

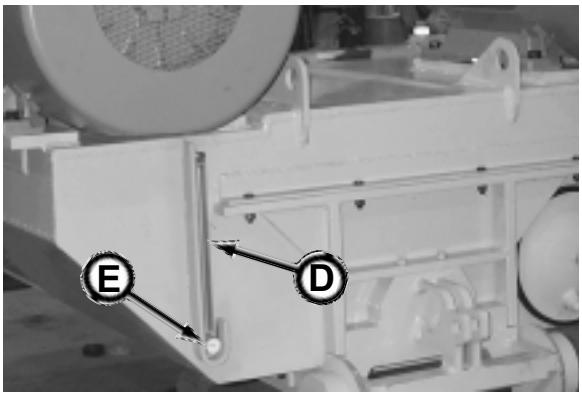


Remove the fill cap (C) to fill the hydraulic reservoir.

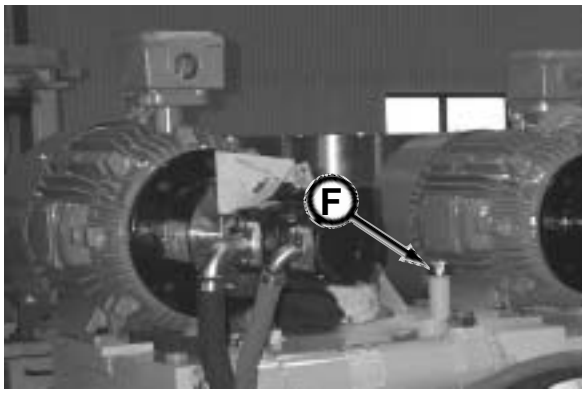
BACKUP CAR #2 HYDRAULIC RESERVOIR

The hydraulic reservoir in backup car #2 includes an oil level sight gauge (D) and temperature gauge (E).

The hydraulic oil temperature should not exceed 125 degrees F.



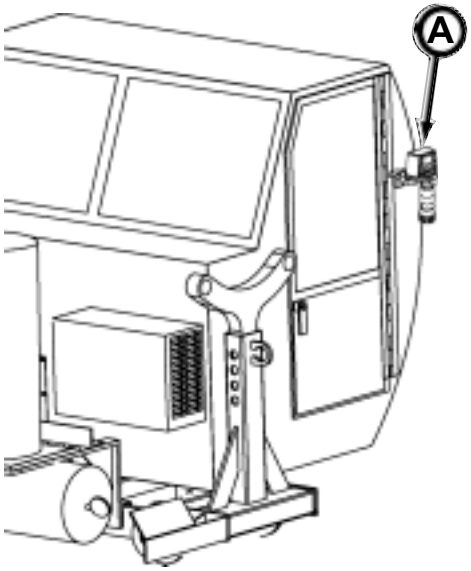
Remove the fill cap (F) to fill the hydraulic reservoir.



GAS DETECTOR

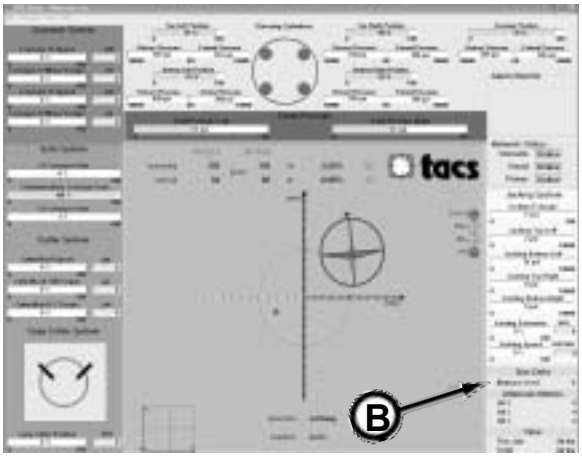
For more information, refer to your APEX Gas Detection manual.

⚠ DANGER The gas detection system installed in the EPBM system, 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 on backup car #3 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 system monitors gas levels as follows:



1. When the system detects a gas level reading of 5% LEL but less than 20% LEL, the horn in the pit will sound repeatedly.

2. When the system detects a gas level reading of 20% LEL or higher, the head power will automatically shut down.

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

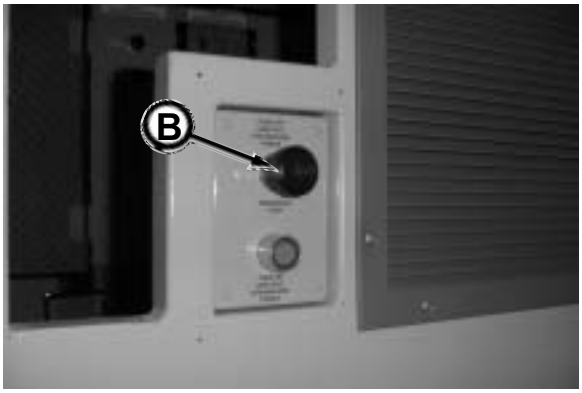
2400 VOLT MAIN DISCONNECT (POWER CONTAINER)

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

The 2400 Volt contactor must be disengaged by pressing in Emergency Stop button BEFORE engaging or disengaging this main disconnect (A). Refer to 2400 Volt EPB Machine Power below.

To energize power to the EPB cutterhead, flip the main disconnect switch up to the ON position. To de-energize power, flip the main disconnect switch down to the OFF position.

The 2400 Volt EPBM power (B) MUST be OFF before the 2400 Volt main disconnect can be turned OFF.

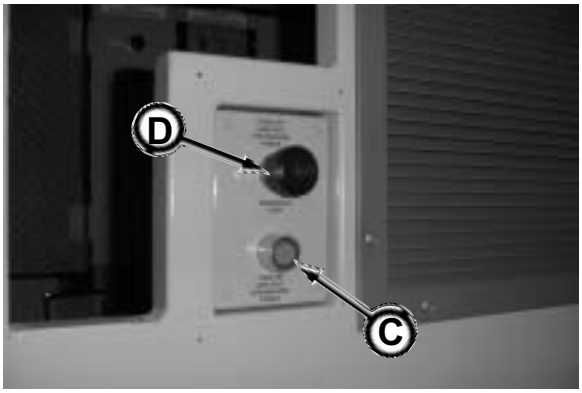


2400 VOLT EPB MACHINE POWER (POWER CONTAINER)

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

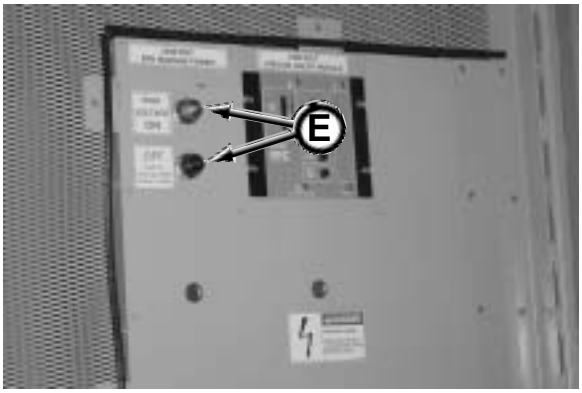
Depress ON button (C) to start the 2400 volt EPBM power. The OFF button (D) must be pulled out for the ON button to function. The 2400 Volt Main Disconnect must be to ON position to start the 2400 volt power (see above).

Depress OFF button (D) to stop all EPBM power.



EMERGENCY STOP
Button (D) is also used as an Emergency Stop. Depress button to stop all EPBM power.

POWER LIGHTS
The High Voltage ON (red light) and OFF Safe To Unplug 2400V Power Cable (green light) power lights (E) will illuminate when the corresponding power button is depressed.

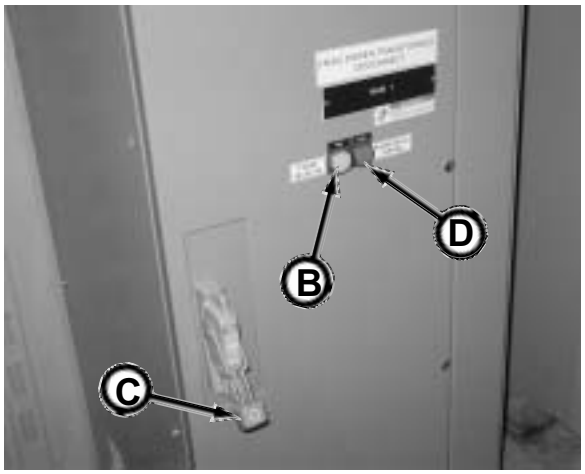


HEAD POWER TRANSFORMER DISCONNECT (POWER CONTAINER)

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

With generator power (or other power source) connected to the 480 Volt Incoming Power connections (A) (refer to Connecting Power Leads in Operation section), and the Green Phase Relay OK (B) light ON, flip the disconnect switch (C) up to the ON position.

DO NOT flip the disconnect on if the Red Phase Relay Tripped (D) 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.



FOAM & SLURRY MAIN DISCONNECT (POWER CONTAINER)

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

Connect foam & slurry power cord to the Foam & Slurry System Power connection (E) in power container.

Flip the Foam & Slurry Main Disconnect (F) up to power the Foam & Slurry Plant. Flip the main disconnect down to shut off power to the Foam & Slurry Plant.

Emergency Stop switches for the Foam & Slurry Plant are located on the operation panel and the slurry control panel (refer to your Foam & Slurry Manual for more information).

NOTICE Since the Foam & Slurry Plant has a separate power source, this disconnect is not affected by the 2400 Volt EPB Machine Power Stop Button/Emergency Stop.

2400 VOLT GROUND CHECK MODULE

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

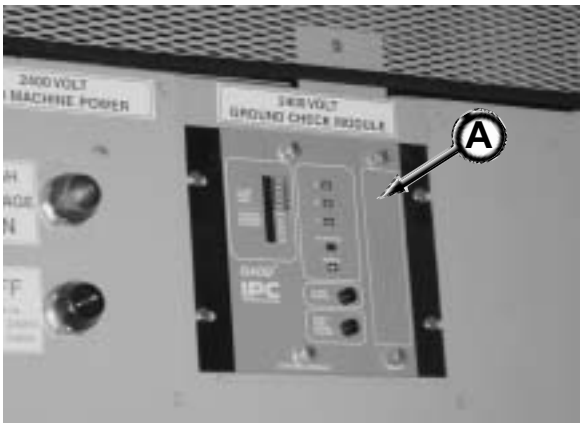
After every pipe change, the 2400 Volt Ground Check Module (A) must be checked.

If illuminated bars on module display are at 50% or over, shut down the system and have a certified electrician check all cable connections.

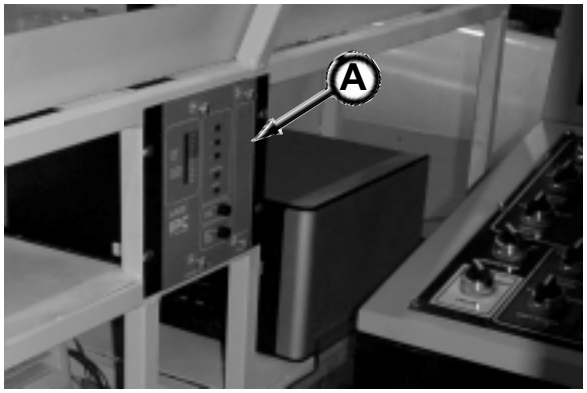
The 2400 Volt contactor will automatically shut down if certain ground conditions are exceeded. Refer to your module manual.

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

Disconnect and lock out power from source before servicing.



Check Module Located in Power Container



Check Module Located in Backup Car #3

GREASE PUMP

NOTICE This grease pump switch controls the EPBM automated greasing system. This switch does not control the jacking can greasing system.

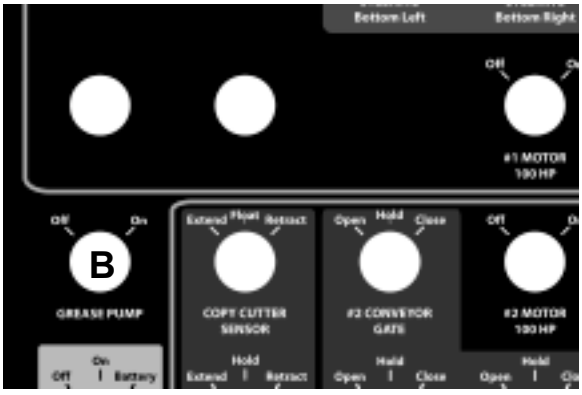
Turn Grease Pump switch (B) to ON position to pump grease to the EPBM cutterhead and conveyor bearings.

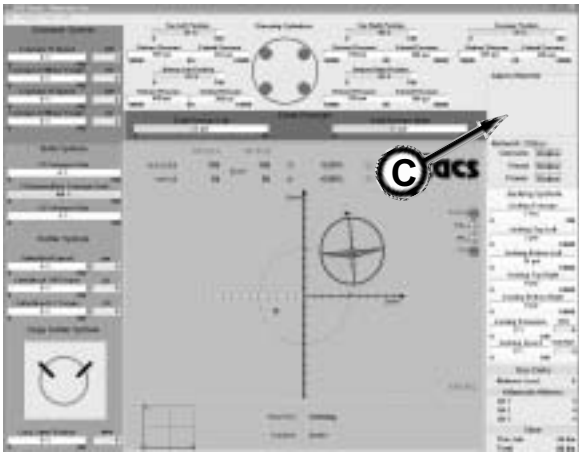
Turn grease pump switch OFF to stop grease flow.

This control does not grease the cutterhead swivel or the conveyor gates.

When the grease level for the automated greasing system is low, Out Of Grease will display on the target screen Alert Monitor (C).

Also, if grease is not being cycled through the automated greasing system grease pump, Grease Pump Problem will display on the target screen Alert Monitor (C).

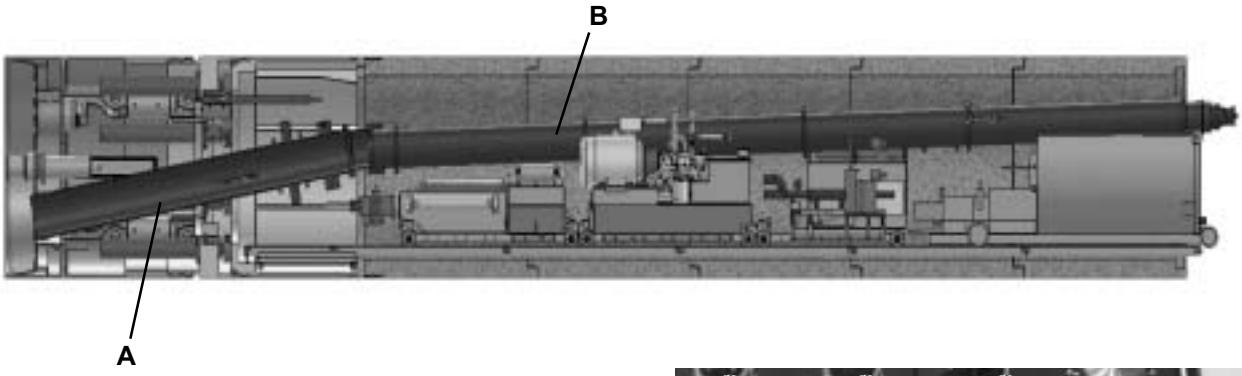




SCREW CONVEYOR CONTROLS

The screw conveyor controls operate the #1 screw conveyor (A) and #2 screw conveyor (B) power, conveyor rotation and speed.

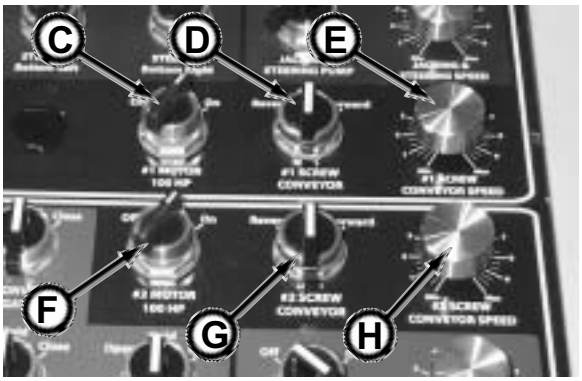
Adjust operation of #1 screw conveyor to compensate for the earth pressure balance. Operate #2 screw conveyor speed at approximately 5% faster than the #1 screw conveyor.



#1 SCREW CONVEYOR (A)
To power the #1 screw conveyor motor, turn #1 Motor (C) control to the ON position.

Rotation Control
To operate the #1 screw conveyor rotation, turn the #1 Screw Conveyor (D) control to the Reverse, Stop, or Forward position.

#1 Screw Conveyor Speed
The #1 Screw Conveyor Speed (E) control regulates the speed of the conveyor motor from 0 to 100%.

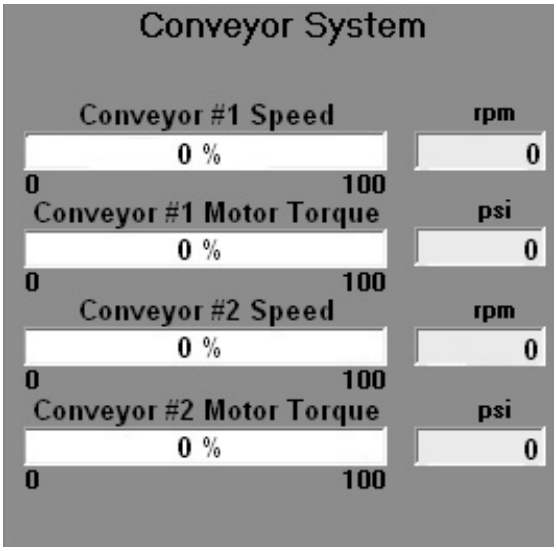


#2 SCREW CONVEYOR (B)
To power the #2 screw conveyor motor, turn #2 Motor (F) control to the ON position.

Rotation Control
To operate the #2 screw conveyor rotation, turn the #2 Screw Conveyor (G) control to the Reverse, Stop, or Forward position.

#2 Screw Conveyor Speed
The #2 Screw Conveyor Speed (H) control regulates the speed of the conveyor motor from 0 to 100%.

The #1 and #2 conveyor speed and motor torque are displayed on the target screen.



Conveyor System Meters On Target Screen

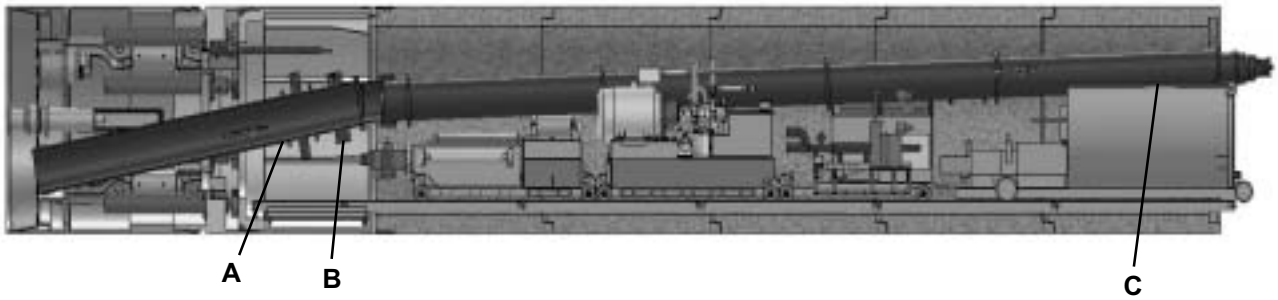
CONVEYOR GATE CONTROLS

The conveyor gate controls operate the conveyor gate function and regulates the oil flow to the gate cylinders for the desired gate opening:

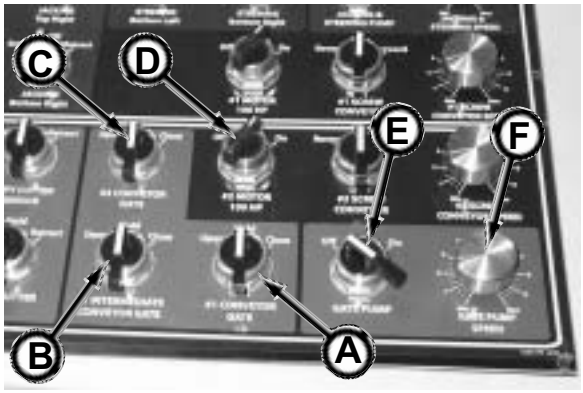
- #1 Conveyor Gate (A)
- #1 Intermediate Conveyor Gate (B)
- #2 Conveyor Gate (C)

The #1 intermediate conveyor gate should always be open except when removing #2 screw conveyor.

The #1 conveyor gate should never be used unless there is a need to remove larger material that will not pass through the #2 screw conveyor.



To power the gates, turn #2 Motor (D) and Gate Pump (E) controls to the ON position.



Turn the specified gate control to the Hold, Open or Close position. Continuing to hold the control in the open or close position will cause the gate to open or close further.

SWITCH FUNCTIONS

HOLD
Stops flow to the selected gate cylinder.

OPEN
Opens selected gate by retracting gate cylinder.

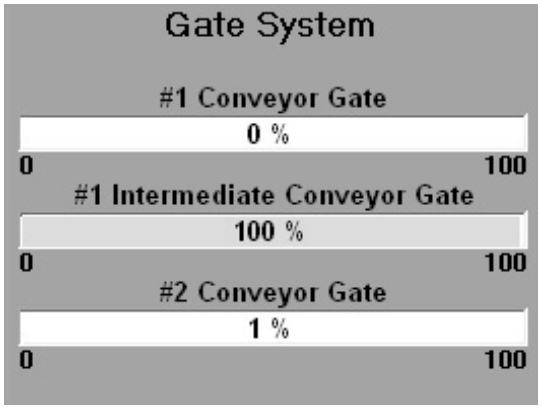
CLOSE
Closes selected gate by extending gate cylinder.

GATE PUMP SPEED (F)
The Gate Pump Speed control regulates the speed of the selected gate from 0 to 100%.

The position of the gates in percent, is displayed on the target screen Gate System.

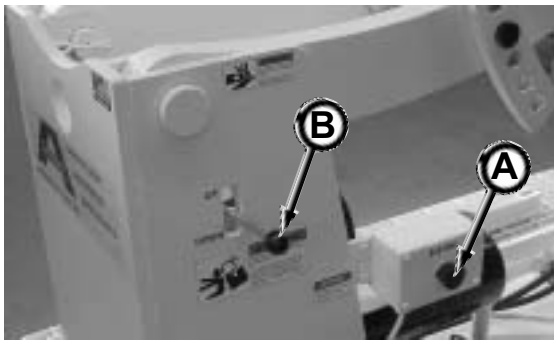
0% - Fully Closed
100% - Fully Open

NOTICE To operate the #2 Conveyor Gate with no power and hydraulically recharge the rear gate accumulator, refer to Operating #2 Screw Conveyor Rear Gate With No Power in Operation section.



Gate System Meters On Target Screen

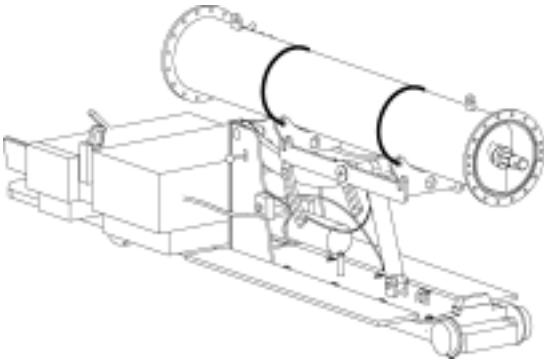
CONVEYOR LIFT



The conveyor lift is used to assist in mounting the #2 screw conveyor sections during the launch sequence and removal of the #2 screw conveyor at the completion of the drive.

With conveyor lift battery cables properly connected to the 1448 haul unit battery (refer to Installing Conveyor Lift in Operation section), pull out E-Stop button (A) to power the motor.

Flip the lift control (B) UP to raise the conveyor and DOWN to lower the conveyor.



Depress E-Stop button (A) to stop power to the conveyor lift.

EMERGENCY STOP
Button (A) is also used as an Emergency Stop. Depress button to stop power to the conveyor lift.

LIGHTS

⚠WARNING Do not switch light power if gas is present. Sparks caused by activating or deactivating any electrical or hydraulic devices could cause an explosion.

If the gas levels exceed OSHA prescribed levels, leave tunnel immediately. Once ALL personnel are out of tunnel, shut down power from power source.

Gases must be removed before reentering tunnel.

Switch EPBM, lights On or Off with light control (C).

When power is shut off in the EPBM, such as, when adding a new pipe, switch control to Battery position for battery power. The Battery light control will only illuminate the light in the backup car #3 operator's station.

When power is back on in the EPBM, switch control from Battery to On or Off position to prevent battery drainage.

Pre-Start Inspection

⚠WARNING Do not operate this equipment until you read, study, and understand this manual and your haul unit and foam & slurry plant operation manuals. A daily inspection of the equipment must be performed to prevent severe personal injury or death and equipment damage.

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

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

	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 electrical lines for frayed or worn insulation or wires. Replace damaged or worn electrical lines.
	15. Check for fluid leaks. Repair leak or replace components.
	16. Keep job site clean and organized.
	17. Perform all lubrication and maintenance procedures. Refer to Section 9, Periodic Maintenance.
	18. Test each function and control to ensure correct operation.
	19. Check hydraulic hoses and lines for leaks, wear and/or damage. Replace any defective hoses and/or lines.
	20. All hydraulic connections must be properly locked before operation. Failure to do so will cause equipment damage. Refer to Check Quick Coupler Connections in Operation section.

(continued on next page)

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

	21. Check main drive case drain, #1 and #2 screw conveyor return hydraulic quick coupler connections to be sure they are properly locked. If couplers are not locked, damage WILL occur to main drive motors/conveyor motors.
	22. Check oil level in hydraulic oil reservoirs. Add as needed.
	23. Lubricate #1 and #2 screw conveyor gates. Refer to Periodic Maintenance section.
	24. Lubricate conveyor #1/#2 swivel joint. Refer to Periodic Maintenance section.
	25. Filter main drive hydrostatic system. Refer to Filter Main Drive Hydrostatic System in Operation section. After filtering, tie strap both ball valves open to prevent accidental closure.
	26. Tie strap backup car #1 suction valve open to prevent accidental closure.
	27. Lubricate cutterhead swivel. Refer to Periodic Maintenance section.
	28. Perform pre-start inspection on your haul unit. Refer to your haul unit operator's manual.
	29. Check that all switches are in the Off, Hold, and Stop position, and that all speed controls are at 0 (Min).
	30. Turn on grease pump and test to be sure it is cycling through the clear valves located on EPBM, #1 screw conveyor, and backup car #3.
	31. Open power container doors before starting. Doors must be open to prevent electrical system from overheating.
	32. Check lexan covers/windows for damage: electrical control box in EPBM, electrical control boxes on backup car #2, and windows on backup car #3. Replace if damaged.

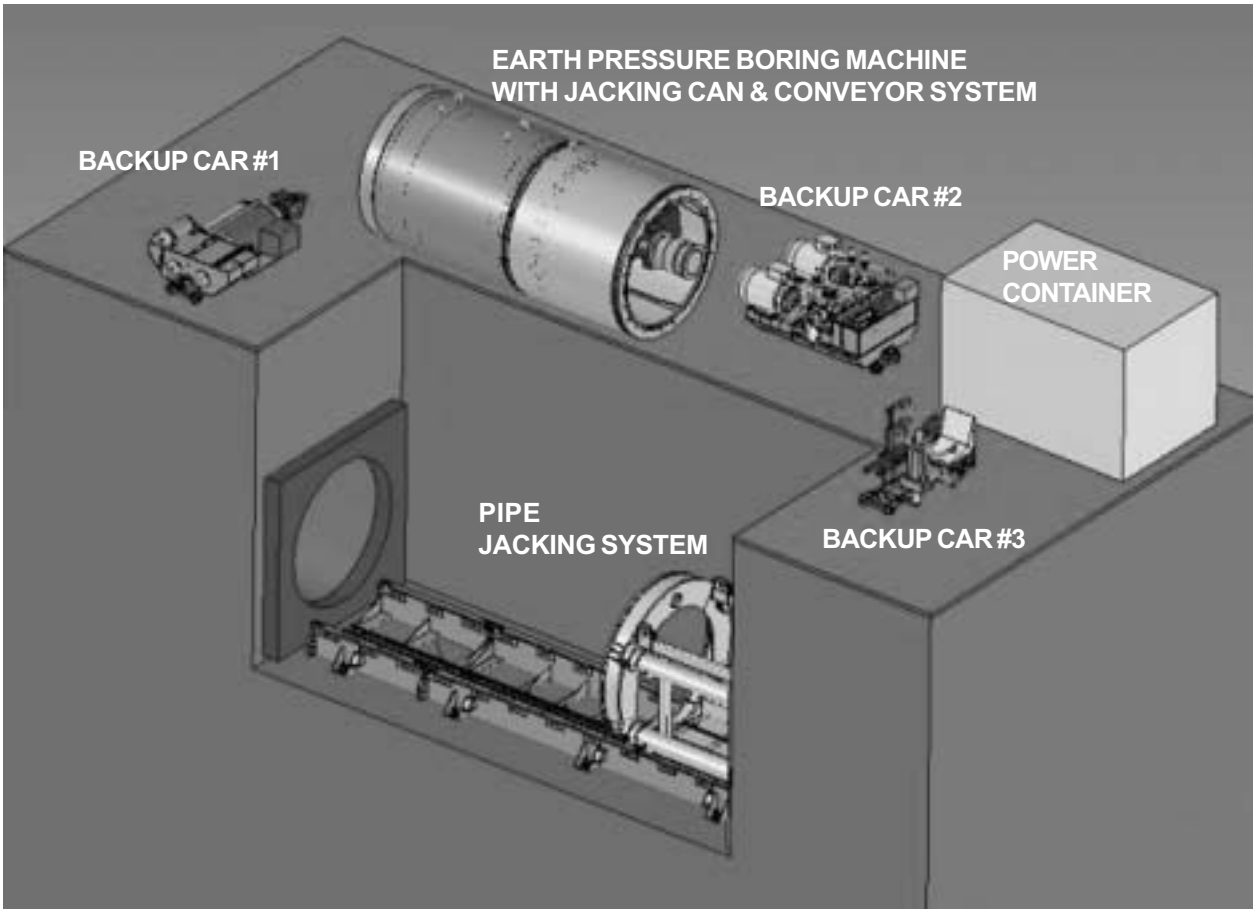
Operation

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 crane operator when lifting and lowering equipment into the launch or reception shafts.
12. Never walk or work under any part of the excavator or crane and suspended loads.
13. Test each function and control to make sure they work properly.
14. Lock out 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 by checking E-Stop controls in the operator station, power container, and remote pit control box.
18. Before starting equipment, walk completely around all machines and equipment. Let all job site personnel know that you are starting up the equipment. Do not start until all unauthorized personnel are clear of the equipment.
19. After start-up, observe all gauges, meters, controls and warning devices to assure they are functioning properly and their readings are within the operating range.
20. Never leave the operator's station without first releasing hydraulic pressure, performing daily system shutdown, and disconnecting the main power supply.
21. Lock out the main disconnect, shut off generator or other external power source, and attach a DO NOT OPERATE tag or similar warning tag to the main power disconnect before performing maintenance.
22. If adjustments must be made with the equipment running, always work as a 2-person team with one person in the operator's station while the other works on the machine.
23. Check cable for continuity and shorting before each use. Do not pull or strain cables; doing so will result in damage.
24. BEFORE operating, the suction valve on backup car #1 MUST be open and tie strapped to prevent accidental closing of valve.
25. The main drive case drain lines from backup car #1 to cutterhead motors MUST be properly locked.
26. Operate the #1 screw conveyor speed to retain the earth pressure balance.

SYSTEM OVERVIEW



Earth Pressure Balance Machine (EPBM)
The purpose of the EPBM is to excavate material in a controlled manner by balancing the machine face pressure with the earth (soil) pressure. This control of material and pressure balance minimizes ground settlement and heaving. During excavation, a foam and/or slurry mixture is pumped from the foam & slurry plant (not shown) to the EPBM cutterhead and mixes with the spoil in the cutterhead chamber, to create a soft non-sticky “toothpaste consistency” for removal through the conveyor system and haul unit system.

Backup Car #1
This car is equipped with the main hydraulic drive pump and 300 HP electric motor to run the four cutterhead motors.

Backup Car #2
This car is equipped with two 100 HP electric motors and pumps to run the jacking, steering, screw conveyor #1 and #2, and copy cutter functions. This car also holds the electrical boxes for the head power and target.

Backup Car #3
This car includes the operator station, gas detector, and grease pump for the automated greasing system and the jacking greasing system. The operator station contains the information and control system which monitors all inputs such as targeting data, pressures, positions, speeds, torques, and flows, and reports them to the operator. The control console is equipped with a computer that interfaces to the operator and controls the machine operations.

Jacking Can & Pipe Jacking System
The EPBM jacking cylinders are used to advance the EPBM through the ground by extending the EPBM jacking can against the pipeline. The pipe jacking system (jacking frame and optional intermediate jacking) provides the horizontal thrust to push the pipe and EPBM jacking can to the EPBM.

Power Container
The power container is the power distribution center for the 480 volt incoming power, transformer, and 2400 volt EPBM power.

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. Wash down 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 an EPB project.

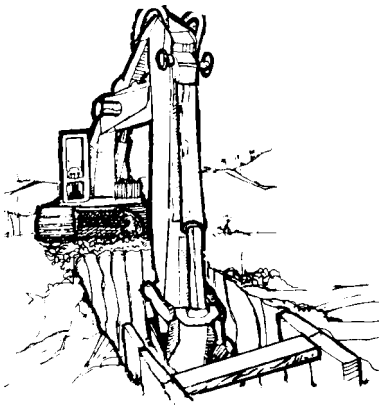
Equipment:

- EPBM
- Foam & Slurry Plant
- Screw Conveyors
- Above Ground Power Station
- Jacking Frame
- Storage Container With Tools
- Crane
- Fork Lift
- Portable Welders
- Small Generator
- Generator Or Power Source
- Pipe Lubrication Pump
- Spoil Removal Truck
- Portable Toilet

Other site considerations:

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

SITE PREPARATION



AEM is the original author and publisher of the above illustration

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

2. After the soil analysis, 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 skid, jacking frame, EPBM 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 skid (rails), jacking frame, EPBM, and pipe.

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

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

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

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

7. Lower the jacking frame onto skid. The frame elevation can be adjusted to grade by the jacks on the bottom of the frame.

8. Connect the jacking frame hydraulic hoses, electrical cables and pit box (if equipped). Cover sharp corners to prevent damage to the cables and hoses.

9. 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.

10. Place the power container and foam & slurry plant on a firm, level surface a safe distance from the launch shaft.

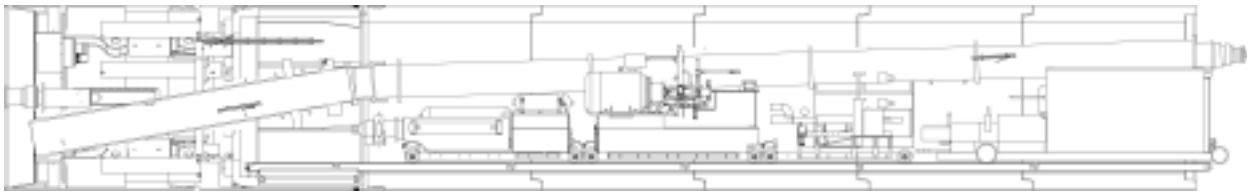
11. Place the generator or main power source as far away from the shaft as possible. This will reduce the noise to the operator and make it easier to communicate with the launch and reception personnel.

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

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

14. Perform launch sequence. Refer to Launch Sequence in this section.

CHECKOUT EQUIPMENT PRIOR TO START-UP



1. Fill automated greasing system and jacking can grease reservoirs in backup car #3.

2. Connect clean water supply hoses with 15 GPM minimum to heat exchangers on backup car #1 and #2.

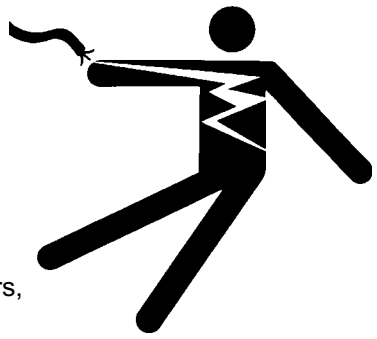
3. Check the oil level in backup cars #1 and #2 hydraulic reservoirs. Add oil if necessary.

4. Lubricate the cutterhead swivel, conveyor #1 to #2 swivel, and #1 and #2 screw conveyor gates.

5. Check to be sure the suction valve on backup car #1 is open and tie strapped to prevent accidental closing of valve.

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

INSTALL ELECTRICAL CONNECTIONS



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

Install all electrical connections to the EPBM, power container, backup cars, power source, and foam & slurry plant as follows:

I. Install electrical connections on backup car #1 to the EPBM head box

1. Clogged Filter
2. Clockwise (CW) Rotation (cutterhead)
3. Counterclockwise (CCW) Rotation (cutterhead)
4. Flow Control

II. Install electrical connections on backup car #2 to the EPBM head box

1. Power Cable (6 pin)
2. Ethernet

III. Install electrical connections on EPBM jacking control manifold to backup car #2

1. Jacking Compress

IV. Install electrical connections on EPBM head box to backup car #3

1. Target Cable

V. Install electrical connections on backup car #2 to backup car #3

1. Power Cable (6 pin)
2. Ethernet
3. Ethernet
4. Pilot
5. Phase Monitor
6. Grease Pump Power Cable (5 pin)

VI. Install Power Container electrical connections

1. 2400V power cable to backup car #3.
2. Power source cable to Foam & Slurry System Power
3. Pit box Emergency Stop power cable to Emergency Stop Power
4. Earth ground cable to Earth Ground Connection

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

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

5. Power source power cable to 480V Incoming Power (refer to Connecting Power Leads in this section)

VII. Install 2400 V power cable to backup cars

1. From backup car #3 to backup car #2
2. From backup car #2 to backup car #1

VII. For Launch Sequence Only: Install 110V power to scavenging pumps

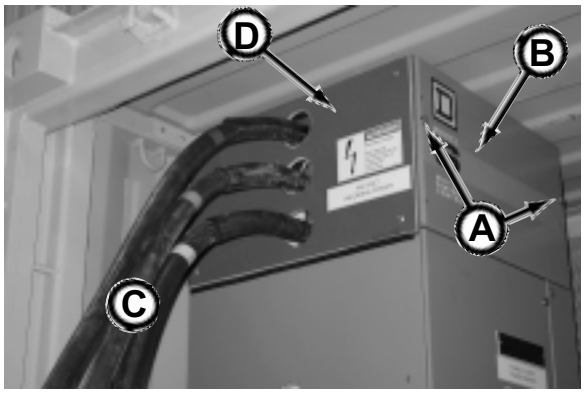
1. 110V power into main drive and conveyor scavenging pumps.

CONNECTING POWER LEADS

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

NOTICE Only a certified electrician must connect the generator power leads to the 480 Volt Incoming Power module connections.

1. Turn locking screws (A) one-quarter turn and remove cover (B).
2. Remove bolts and washers from power leads. Be careful not to drop bolt or washer into housing while removing.
3. Route generator power cords (C) (color coded) through panel (D) and secure onto power leads with bolts and washers removed in step 2.
4. Replace cover and secure locking screws.



INSTALL HYDRAULIC, GREASE, & AIR CONNECTIONS

Install all hydraulic connections to the EPBM, backup cars and screw conveyors #1 and #2. The quick coupler connections must be properly locked before operation (refer to Check Quick Coupler Connections in this section).

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

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

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

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

I. Install hydraulic connections from backup car #1 to EPBM

1. Two main hydrostatic drive lines (1-1/2" high pressure).

2. Two main drive case drain lines (1" low pressure).

NOTICE BEFORE operating EPBM, the main drive hydraulic case drain quick couplers (2) MUST be fully locked. If both quick couplers are not fully locked, damage will occur to the main drive motor seals.

NOTICE For launch sequence only, connect the main drive case drain lines to main drive scavenging pump. Once backup car #1 is relocated into pipeline, the scavenging pump must be removed. The case drain lines must then be connected from EPBM to backup car #1.

II. Install hydraulic connections between backup car #2 and EPBM

1. One supply line (1/2" high pressure) on backup car #2 flow control to jacking control manifold in EPBM.

2. One return line (3/4" low pressure) on backup car #2 return manifold to jacking control manifold in EPBM.

3. One supply line (1/2" low pressure) on backup car #2 flow control to conveyor manifold in EPBM.

4. One return line (1/2" low pressure) on EPBM conveyor manifold to backup car #2 return manifold.

III. Install hydraulic connections between backup car #3 and screw conveyor #2

1. One 3/4" line from backup car #3 accumulator to screw conveyor #2 rear section ball valve quick disconnect.

(continued on next page)

Install Hydraulic, Grease, & Air Connections (continued)

IV. Install hydraulic connections between backup car #2 and screw conveyor #2

1. One 1/2” line from backup car #2 return manifold to screw conveyor #2 rear section ball valve quick disconnect.

2. One 3/4” line (supply) from backup car #2 flow control to screw conveyor #2 rear section dynex valve.

3. One 1” line (return) from screw conveyor #2 rear section dynex valve to backup car #2 return manifold.

NOTICE BEFORE operating EPBM, the conveyor return line quick coupler MUST be fully locked. If quick coupler is not fully locked, damage will occur to the conveyor motor.

NOTICE For the launch sequence only, connect the #2 screw conveyor return line to conveyor drive scavenging pump. Once backup car #2 is relocated into pipeline behind backup car #1, remove the #2 conveyor scavenging pump. The #2 screw conveyor return line must then be reconnected from #2 screw conveyor rear section dynex valve to backup car #2 return manifold.

V. Install hydraulic connections between EPBM and screw conveyor #2

1. Two 3/4” lines from EPBM conveyor manifold to screw conveyor #2 gate cylinders.

VI. Install hydraulic connections between backup car #2 to screw conveyor #1

1. One 3/4” line (supply) from backup car #2 flow control to screw conveyor #1 dynex valve.

2. One 1” line (return) from screw conveyor #1 dynex valve to backup car #2 return manifold.

NOTICE BEFORE operating EPBM, the conveyor return line quick coupler MUST be fully locked. If quick coupler is not fully locked, damage will occur to the conveyor motor.

NOTICE For the launch sequence only, connect the #1 screw conveyor return line to conveyor drive scavenging pump. Once backup car #2 is relocated into pipeline behind backup car #1, remove the #1 conveyor scavenging pump. The #1 screw conveyor return line must then be reconnected from #1 screw conveyor dynex valve to backup car #2 return manifold.

VII. Install EPBM automated grease lines between backup car #3 and screw conveyors #1 and #2

1. Two lines from grease pump on backup car #3 to screw conveyor #1.

2. Two lines from grease pump on backup car #3 to screw conveyor #2.

VIII. Install jacking can grease lines between backup car #3 and jacking can

1. One grease line on jacking can grease pump to fitting on back end of jacking can.

IX. Install air supply line to jacking can grease pump

1. Install air supply line (from separate air compressor, not from foam & slurry plant) to jacking can grease pump.

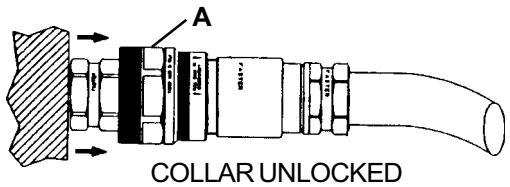
X. Install lines between EPBM and foam & slurry plant

1. Connect air (1/2”), water (2”), and slurry (1-1/4”) lines on EPBM to connections on foam & slurry plant.

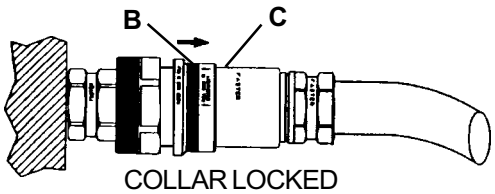
CHECK QUICK COUPLER CONNECTIONS

NOTICE There are three quick coupler styles on the EPB system which must be checked so they are properly locked before operation. Failure to do so could cause equipment damage.

I.



COLLAR UNLOCKED



COLLAR LOCKED

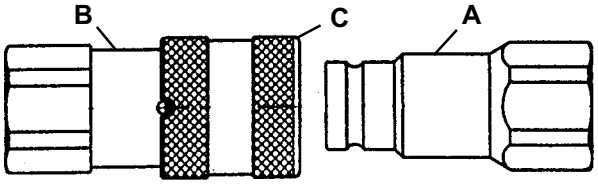
CONNECT

1. Rotate main sleeve (A) clockwise (CW) until locking collar (B) snaps against fitting end (C).
2. Check the locking mechanism, by rotating the main sleeve counterclockwise (CCW). If sleeve rotates, the locking collar is not properly locked.

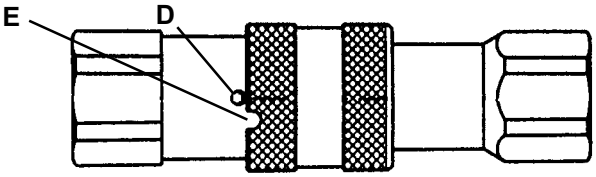
DISCONNECT

1. Pull locking cover back and rotate main sleeve counterclockwise (CCW) until hose is removed.

II.



COUPLER UNLOCKED



COUPLER LOCKED

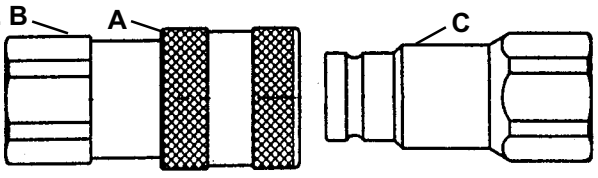
CONNECT

1. Install male fitting (A) completely into female fitting (B) until they snap together.
2. Rotate main sleeve (C) on female quick coupler to lock the connection.
3. Check the locking connection. The knob (D) and notch (E) must NOT be aligned.

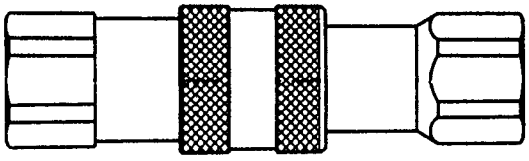
DISCONNECT

1. Rotate sleeve until notch in sleeve aligns with knob on female quick coupler.
2. Pull sleeve back and the connection will disconnect.

III.



COUPLER UNLOCKED



COUPLER LOCKED

CONNECT

1. Pull back sleeve (A) on female coupler (B), and insert male coupler end (C) until they snap together.

DISCONNECT

1. Pull back sleeve (A) on female coupler until male end disconnects.

PREPARE HYDRAULIC SYSTEM FOR START-UP

1. Connect hydraulic system. Refer to Install Hydraulic Connection in this section.

2. Check to be sure main drive case drain lines are fully locked. Refer to Lock Main Drive Case Drain Quick Couplers in this section.

3. Check hydraulic oil level in backup cars #1 and #2. Fill if needed. Check the reservoir level often during operation.

4. Open suction valve on backup car #1. Tie strap lever to valve to prevent accidental closure during operation.

5. Check hydraulic hoses and components for leaks, wear and/or damage. Replace any defective hoses or components before operation.

NOTICE After electrical system start-up and before operating EPBM, the main drive hydrostatic system must be filtered. Refer to Filter Main Drive Hydrostatic System in this section.

6. Proceed to system start-up.

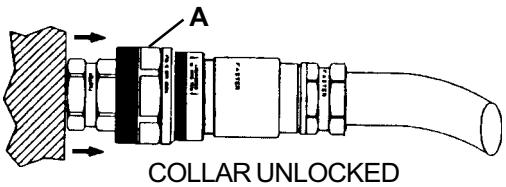
LOCK MAIN DRIVE CASE DRAIN QUICK COUPLERS

NOTICE BEFORE operating EPBM, the main drive hydraulic case drain quick couplers (2) MUST be fully locked. If both quick couplers are not fully locked, damage will occur to the main drive motor seals.

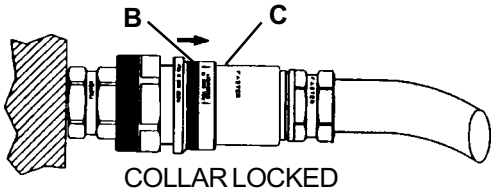
CONNECT

1. Rotate main sleeve (A) clockwise (CW) until locking collar (B) snaps against fitting end (C).

2. Check the locking mechanism, by rotating the main sleeve counterclockwise (CCW). If sleeve rotates, the locking collar is not properly locked.



COLLAR UNLOCKED



COLLAR LOCKED

DISCONNECT

1. Pull locking cover back and rotate main sleeve counterclockwise (CCW) until hose is removed.

FILTER MAIN DRIVE HYDROSTATIC SYSTEM

The hydrostatic oil must be filtered before operating cutterhead whenever backup car #1 is disconnected from the EPBM. This will be at start-up, after advancing EPBM far enough to add a pipe and relocate the backup car #1 to the EPBM in the shaft, or if the backup car #1 is disconnected to remove a large rock in #1 screw conveyor.

After connecting the main drive hydraulic pressure and case drain lines from backup car #1 to the quick disconnects in the EPBM, you MUST filter the oil through the closed loop system before operating the cutterhead to prevent damage from contamination.

1. Be sure suction valve on backup car #1 is open. Failure to do so will starve the main drive pump and cause damage.

1. Install main drive hydraulic pressure and case drain hoses from backup car #1 to the quick disconnects in the EPBM.

NOTICE BEFORE operating EPBM, the main drive hydraulic case drain quick couplers (@) MUST be fully locked. If both quick couplers are not fully locked, damage will occur to the main drive motor seals.

2. Turn BOTH ball valves in CLOSED position.

3. Rotate cutterhead clockwise at 25% speed for 5 minutes. Keep an eye on the filter indicators during filtration process. Replace filter (s) if indicator displays a red band.

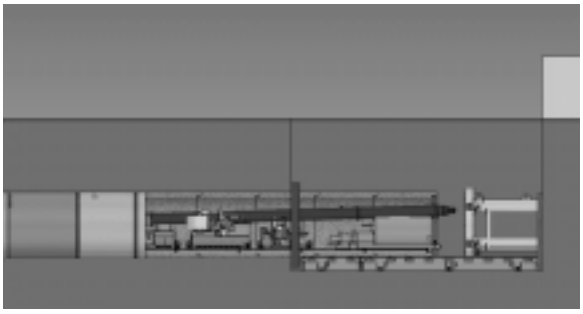
4. Rotate cutterhead counterclockwise at 25% speed for 5 minutes. Keep an eye on the filter indicators during filtration process. Replace filter (s) if indicator displays a red band.

NOTICE Once the ball valves are in the OPEN position, the filter indicators are inoperative since the oil only passes through the filters if the ball valves are in the CLOSED position.

5. After filtering oil, turn cutterhead rotation OFF.

6. Open BOTH ball valves and tie strap lever to valves to prevent accidental closure during operation.

SYSTEM START-UP



1. With hydraulic connections installed, prepare the hydraulic system for start-up. Refer to Prepare Hydraulic System For Start-Up in this section.

2. Connect electrical components. Refer to Install Electrical Connections in this section.

3. Turn off all disconnects in power container, switch all console controls to Stop, Hold, Float, or Off positions, turn all speed controls to 0 (Min), and push in all Emergency Stop buttons (power container, console, pit box, and foam & slurry plant).

4. Before start-up, walk completely around all 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.

NOTICE Power container doors must remain open during operation. Otherwise, the system will overheat.

5. Connect power source to 480 Volt Incoming Power in power container.

6. Turn on power source and check phase monitor.

7. With power source connected to the 480 Volt Incoming Power connections and the Green Phase Relay OK light ON, flip the Head Power Transformer Disconnect switch up to the ON position.

NOTICE Do not flip the disconnect to the ON position if the Red Phase Relay Tripped 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.

8. Flip the 2400 Volt Main Disconnect up to ON position.

9. Flip the Foam & Slurry Main Disconnect up to ON position.

10. Make sure the Emergency Stop button on console is pulled out.

11. Pull out Emergency Stop on power container and then press green start button.

12. Filter the main drive hydrostatic system. Refer to Filter Main Drive Hydrostatic System in this section.

13. After filtering main drive hydrostatic system, open both ball valves (in EPBM) and tie strap levers to valves to prevent accidental closure during operation.

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

15. Check hydraulic hoses and components for leaks, wear and/or damage. Replace any defective hoses or components before operation.

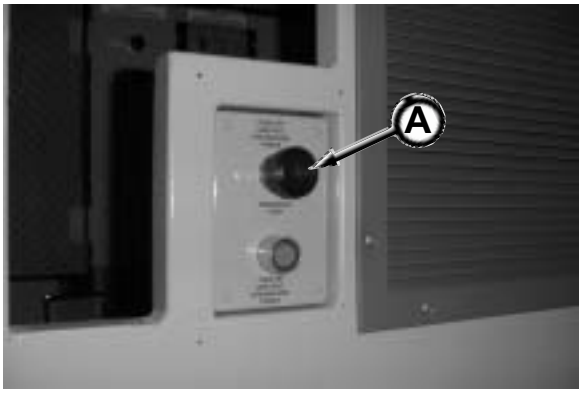
16. Test all Emergency Stop buttons for proper operation.

17. Once power is on, the computer in backup car #3 will automatically boot up to the target screen.

NOTICE It is not necessary to shut down the computer before shutting down the power, though the target readings on the target screen should be recorded before shut down, in the event the laser in launch shaft is bumped.

ELECTRICAL SYSTEM SHUTDOWN

1. Push in Emergency Stop button (A) on power container. This disengages power to the 2400 volt contactor.



2. Flip the Head Power Transformer Disconnect (B) down to the OFF position.

3. Flip the 2400 Volt Main Disconnect (C) down to the OFF position.

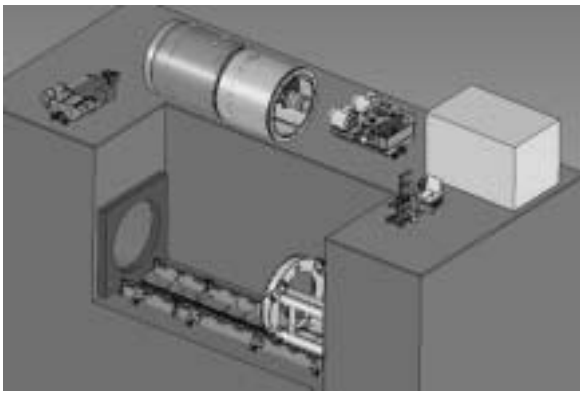
4. Flip the Foam & Slurry Main Disconnect (D) down to the OFF position.

EPBM LAUNCH SEQUENCE

There are various methods to launch the EPBM system. The contractor is responsible for the launch sequence for his specific project. Below describes one launch method.

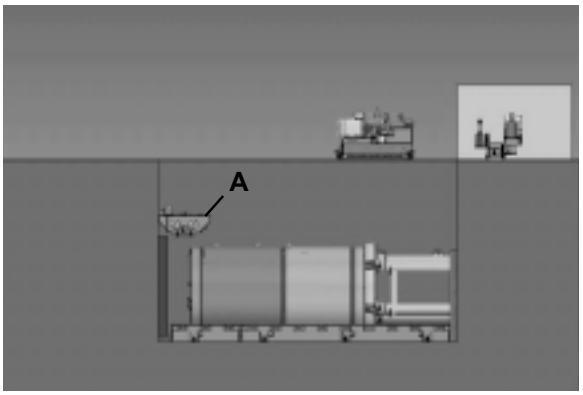
NOTICE The EPBM jacking system will not be used during the launch sequence. The EPBM will be advanced by the launch shaft jacking frame.

1. Prepare the launch and reception shafts. Refer to Site Preparation in this section. The minimum launch shaft length is one of the following; whichever is longer: 1) jacking frame plus one pipe or, 2) jacking frame with EPBM.



2. With pit seal installed and the skid and jacking frame lowered onto concrete shaft floor, lower the EPBM (with pipe adapter, screw conveyor #1 with screw conveyor #1 and #2 swivel) onto skid.

3. Mount backup car #1 (A) above pit seal or nearest EPBM as possible; 10’ maximum elevation above EPBM. The backup car #1 must be mounted near the same elevation as the EPBM to minimize case drain back pressure in closed loop hydraulic circuit.



NOTICE The power container and backup cars #2 and #3 remain on surface (close to each other for ease of routing electrical and hydraulic lines).

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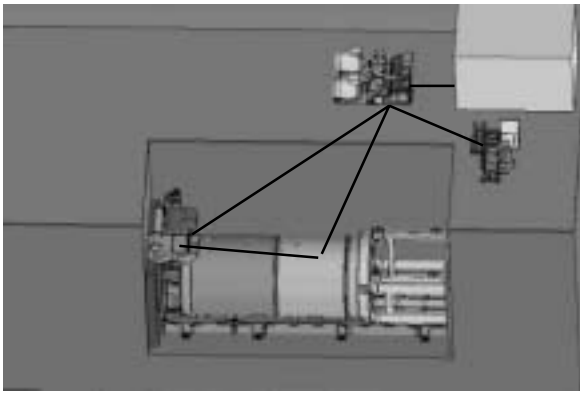


4. Install hydraulic connections. Refer to Install Hydraulic Connections in this section.

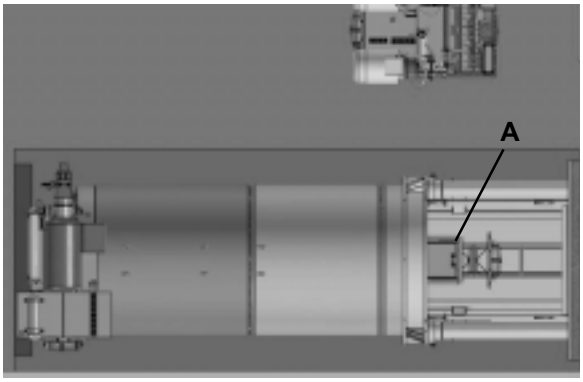
NOTICE Be sure to install scavenging pumps for the main drive, and #1 and #2 screw conveyor motors.

5. Install electrical connections. Refer to Install Electrical Connections in this section.

6. Perform system set-up. Refer to System Setup in this section.

7. Ensure alignment of the laser with the target (refer to your target manual).

8. Install track. Install track with each additional pipe during setup.



9. Lower haul unit onto track so the operator seat is opposite tunnel opening. Once the complete EPBM system is installed into the shaft, the haul unit can be relocated so the operator enters the tunnel first.

NOTICE Due to clearances, you may have to use a haul cart with the low profile dirt bucket until all backup cars and conveyors are installed into shaft.

10. Insert low profile dirt bucket (A) onto haul unit or haul cart and move so bucket is under intermediate gate opening.

11. Connect jacking frame hydraulic hoses and electrical cables and controls. Cycle jacking frame hydraulics several times to purge air from system and check for leaks.

12. Turn on cutterhead motor, and #1 and #2 motors. Turn on Grease Pump. Turn on Gate Pump.

13. Switch #1 conveyor gate and #2 conveyor gate to Close position. Open #1 intermediate conveyor gate.

14. Turn #1 Screw Conveyor switch to Forward position and regulate spoil flow as needed with speed control and #1 conveyor gate opening.

15. Position all steering cylinders at 20%.

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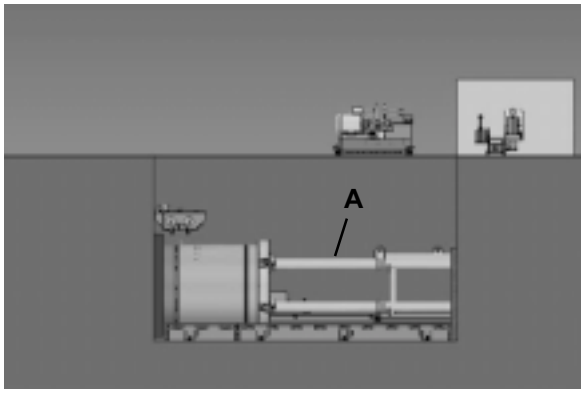
16. Slowly rotate the EPBM cutterhead and slowly push the EPBM cutter face through the launch shaft seal by extending the jacking frame cylinders (A) fully. Be careful not to damage the seal and to ensure proper equipment alignment.



17. Remove spoils as needed. Use foam or slurry as needed so spoils are of a soft, non-sticky "toothpaste consistency." The EPBM operator must communicate with the jacking frame operator and foam & slurry operator to ensure the earth pressure balance is being maintained.

18. Once jacking frame cylinders are fully extended, stop cutterhead rotation, conveyor, and foam/slurry (if used).

19. Retract jacking frame cylinders.

20. (If needed) Lower four foot spacer can onto skid.

21. Jack the spacer can by extending the jacking frame cylinders, EPBM cutterhead CW rotation, #1 screw conveyor in forward position, and foam & slurry (if needed).

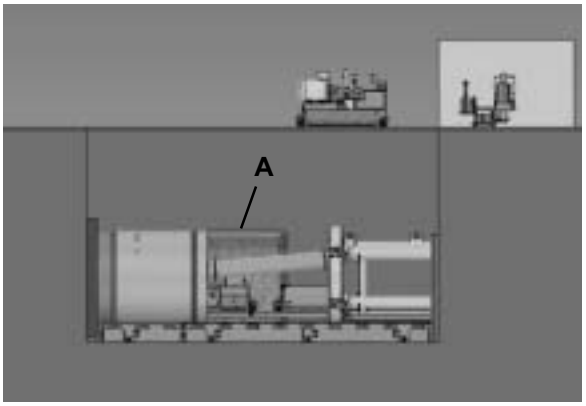
22. Once jacking frame cylinders are fully extended, stop cutterhead rotation, conveyor, and foam/slurry (if used).

23. Retract jacking frame cylinders and remove spacer can.

24. Insert pipe #1 (A) onto skid and set into EPBM pipe adapter.

25. Shutdown all power.

26. Disconnect electrical and hydraulic lines from backup car #1 and EPBM.

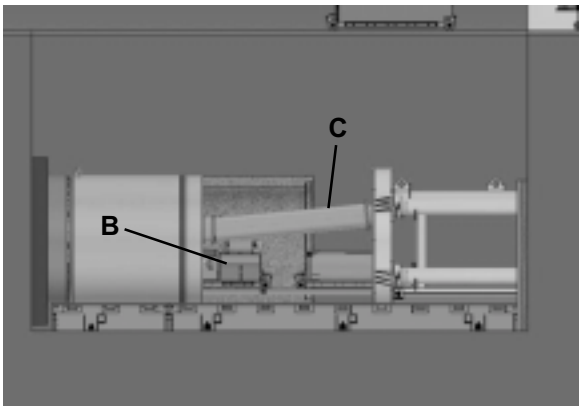


27. Install backup car #1 (B) onto track.

28. Install #2 screw conveyor rear section (C) (with motor drive) to conveyor swivel.

NOTICE For ease of installing #2 screw conveyor sections, refer to Installing Conveyor Lift in this section. Also, to operate conveyor lift, refer to Operating Conveyor Lift in this section.

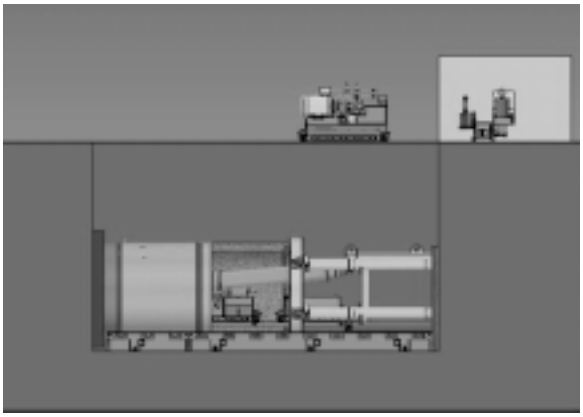
NOTICE Remove main drive scavenging pump and reconnect hydraulic lines (refer to Install Hydraulic, Grease, & Air Connections in this section).



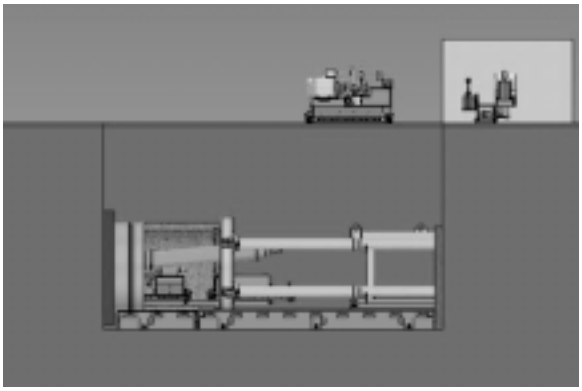
29. Reconnect all electrical and hydraulic lines.

30. Turn on power and filter the main drive hydrostatic system (refer to Filter Main Drive Hydrostatic System in this section).

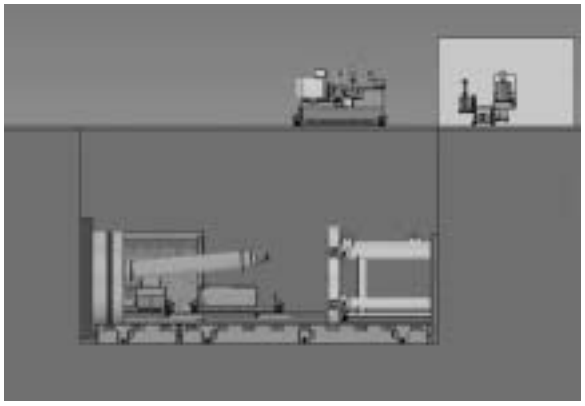
31. Jack pipe #1 by extending the jacking frame cylinders, EPBM cutterhead CW rotation, #1 and #2 screw conveyors in forward position, #1 intermediate gate closed, #1 conveyor gate open to assist in controlling earth pressure, #2 conveyor gate open, and foam & slurry (if needed).



32. Once jacking frame cylinders are fully extended, stop cutterhead rotation, conveyor, foam/slurry (if used), and close conveyor gates.



33. Retract jacking frame cylinders.



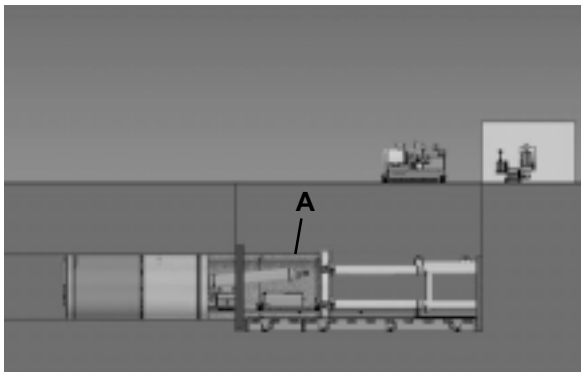
34. (If needed) Lower spacer can and use jacking frame with EPBM system fully operational to fully extend cylinders.

35. Retract jacking frame cylinders and remove spacer can.

NOTICE Add intermediate jacking stations (IJS) as needed per contractor requirements.

36. Set pipe #2 (A) and fully jack pipe.

NOTICE Be sure #2 screw conveyor is supported with conveyor support on backup car #1.

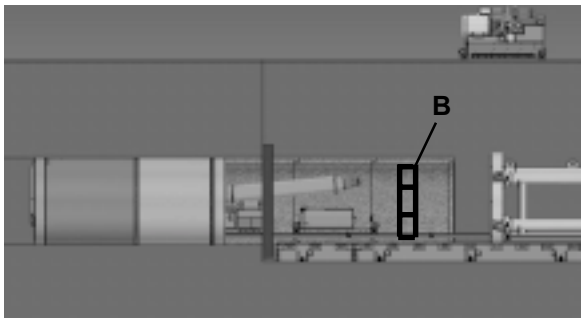


37. Install screw conveyor support (B) into pipe #3.

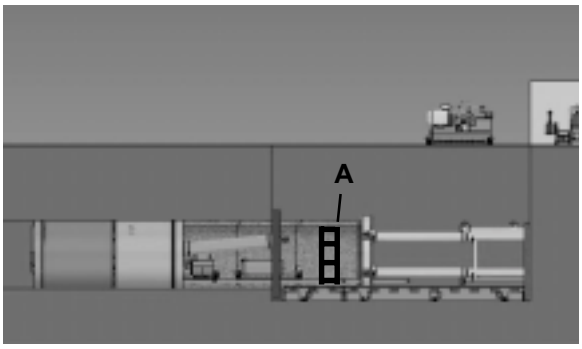
38. Set pipe #3 and install track.

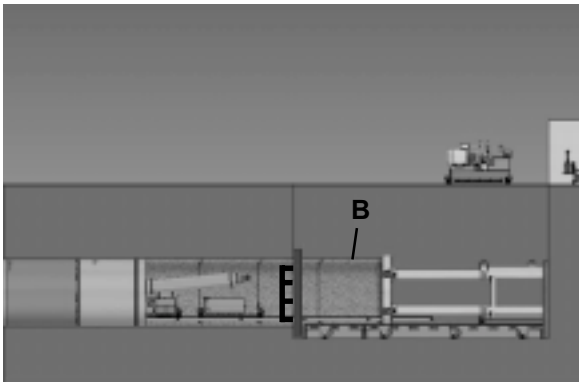
39. Adjust screw conveyor support turnbuckles so conveyor support is firmly against pipe.

NOTICE The screw conveyor support is to be used only for supporting #2 screw conveyor during emergency backup car removal. Do not use screw conveyor support to support conveyors during EPBM operation. Support the #2 screw conveyor with supports on backup cars #1 and #3.

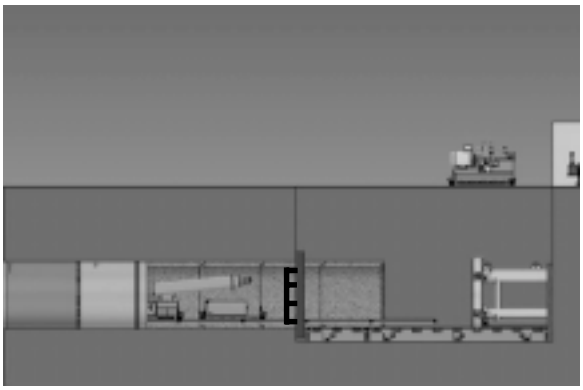


40. Jack pipe #3 (A) and pipe #4 (B).





41. Retract jacking cylinders.

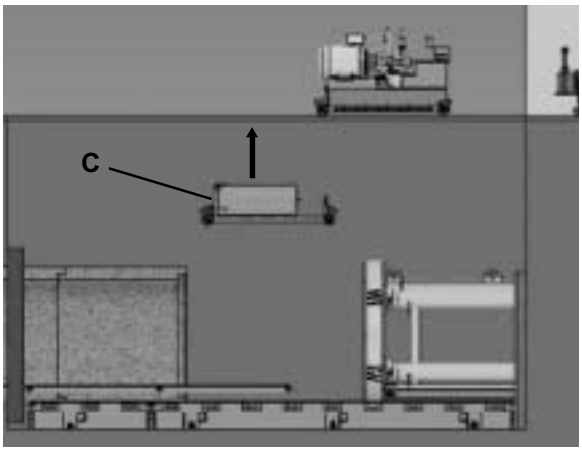


42. Fully jack pipe #5 to pit seal using spacer cans (if needed) to allow room for equipment installation.

43. Once the end of pipe #5 is near the pit seal, shut down and disconnect electrical and hydraulics lines.

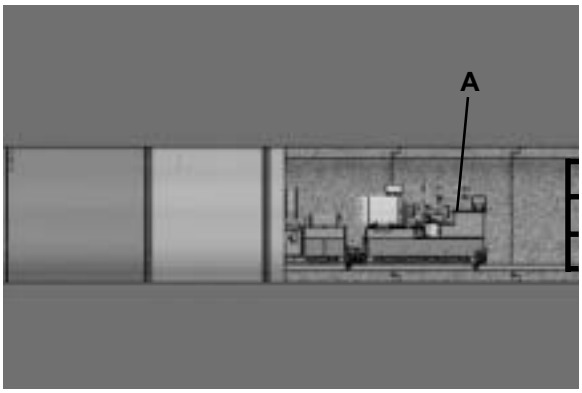
44. Remove #2 screw conveyor rear section.

45. Remove low profile dirt bucket and haul unit/haul cart (C).



46. Lower backup car #2 (A).

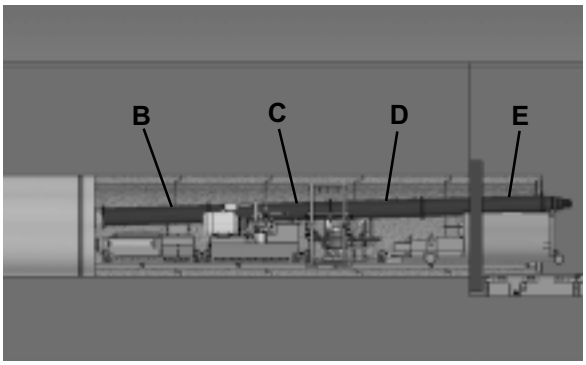
NOTICE Remove conveyor drive scavenging pumps and reconnect hydraulic lines (refer to Install Hydraulic, Grease, & Air Connections in this section).



47. Lower #2 screw conveyor sections one (B) and two (C).

48. Support screw conveyor on backup car #1 conveyor supports.

49. Mount backup car #2 to backup car #1 and attach screw conveyor to swivel.

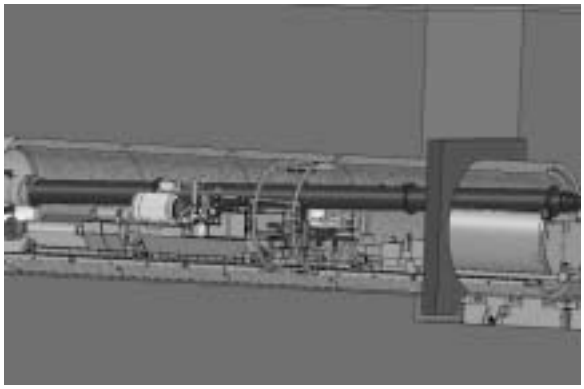


50. Remove 2400 volt connector from backup car #3. Lower backup car #3 into launch shaft.

51. Lower #2 screw conveyor sections three (D) and four (E) (rear).

52. Support #2 screw conveyor sections on backup car #3 conveyor supports.

53. Fasten #2 screw conveyor sections together.

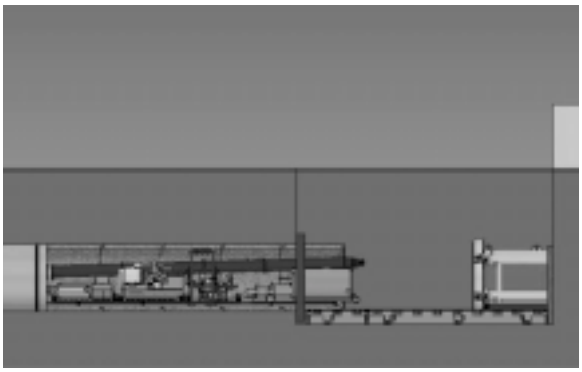


54. Reconnect all electrical and hydraulic connections.

55. Install haul unit with operator seat going into tunnel first. Install large dirt bucket.

56. Power up system.

57. The EPB equipment is now set. Proceed to Advancing The EPBM in this section.



USING SCAVENGING PUMPS

The scavenging pumps displace case drain oil from the main drive, and #1 and #2 screw conveyor motors back to tank during the launch sequence. The pumps protect the motor shaft seals by preventing case drain pressure buildup in the motors when backup car #1 and backup car #2 hydraulic reservoirs are not in line with the EPBM in launch shaft. Failure to use the scavenging pumps in the launch sequence, may cause motor failure.

INSTALLATION

1. Place pumps on level surface, close to specific motor (main drive, #1 and #2 screw conveyor). If pumps are not on a level surface, pump failure may result.

2. Connect motor case drain lines to Input To Pump connection (A) on pump

3. Connect screw conveyor hydraulic lines from Output of Pump connection (B) to tank connections on backup car #2. FAILURE TO CONNECT TO CORRECT BACKUP CAR WILL CAUSE BACKUP CAR RESERVOIR OVERFLOW AND/OR DRAINING PROBLEMS.

4. Connect main drive hydraulic line from Output Of Pump connection (C) to tank connections on backup car #1. FAILURE TO CONNECT TO CORRECT BACKUP CAR WILL CAUSE BACKUP CAR RESERVOIR OVERFLOW AND/OR DRAINING PROBLEMS.

5. Connect 110V power source to each pump.

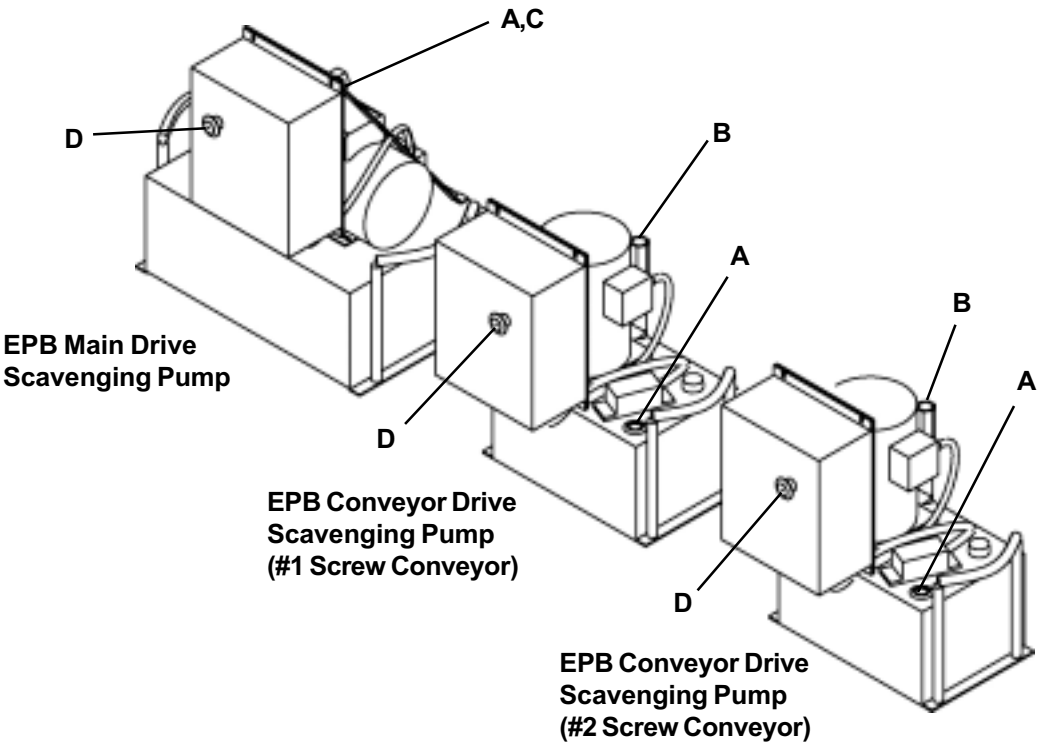
OPERATION

1. With scavenging pumps properly connected, turn E-Stop button (D) clockwise while pulling out to power desired pump. Pump will not operate unless E-Stop button is out.

2. To stop a pump, push E-Stop button in.

NOTICE Each pump has an individual E-Stop button. Pushing E-Stop button in on one pump will not stop all three scavenging pumps.

(continued on next page)



Using Scavenging Pumps (continued)

3. When pumps are no longer needed, disconnect power and hydraulics from pumps. Reconnect the main drive, conveyor #1 and conveyor #2 hydraulics as described in Installing Hydraulic, Grease, & Air Connections in this section.

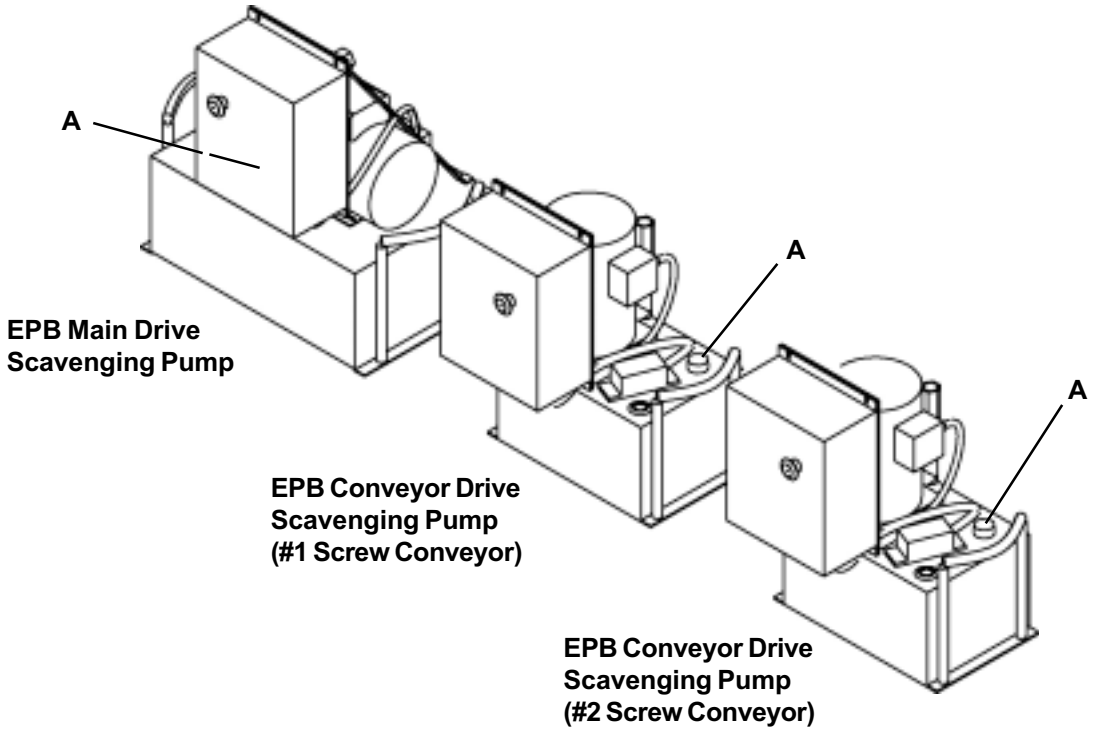
4. Drain pumps when not in use.

TROUBLESHOOTING
If a scavenging pump overflows out breather (A):

a) Pump is not connected to 110V power source.

b) E-Stop button is not pulled out.

c) Case drain flow from connected motor is excessive, indicating a malfunction of motor.



INSTALLING THE CONVEYOR LIFT ASSEMBLY

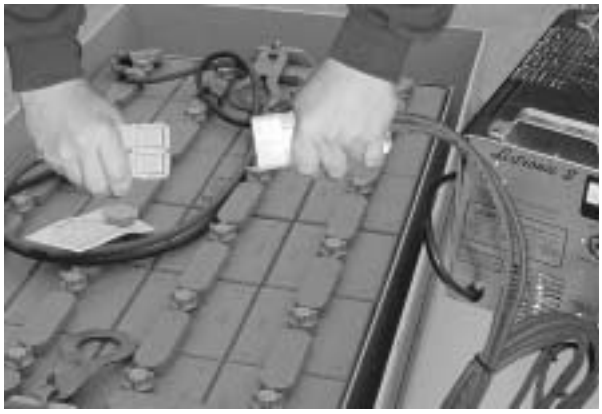
⚠WARNING Batteries produce explosive gases. Wear eye protection and protective clothing during battery service. Keep sparks, flames, and cigarettes away from batteries.

If acid enters eye, IMMEDIATELY flush eye with running cold water for at least 15 minutes and get medical attention.

If battery acid contacts skin and clothing, wash immediately with soap and water.

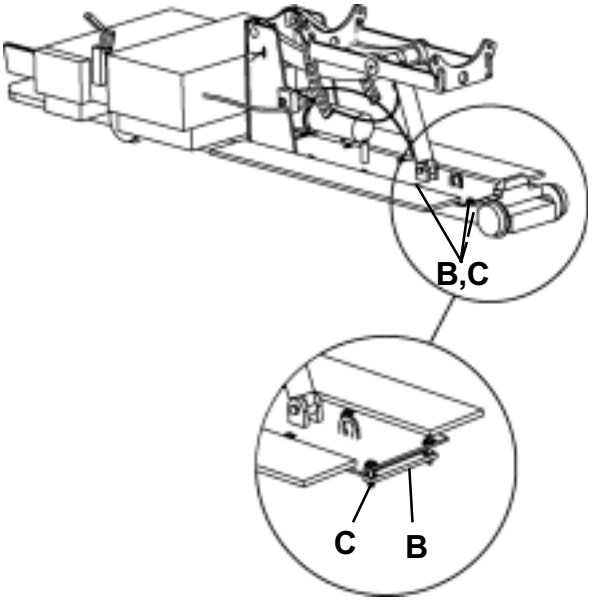
NOTICE Battery must be fully charged before installing conveyor lift. Failure to do so could result in dead battery while using conveyor lift.

1. Recharge 1448 battery pack (refer to your 1448 Operator's Manual for proper procedure.



2. Lower conveyor lift assembly onto 1448 haul unit.

3. Mount conveyor lift assembly (A) to 1448 haul unit frame with five mounting plates (B), ten 5/8-11 x 4 in. bolts, flat washers, and nuts (C). Fasten hardware securely.

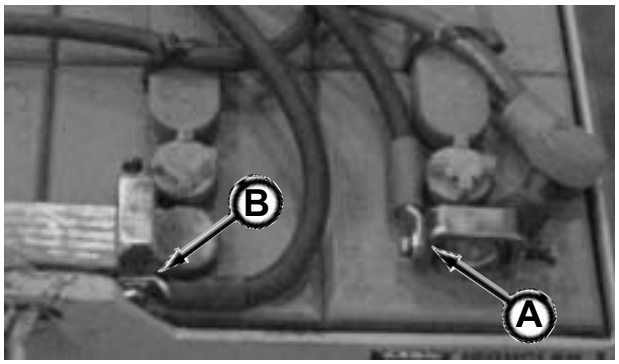


4. With 1448 haul unit battery cover removed, remove negative crossbar cover and positive post cover. Retain covers.

5. Install conveyor lift C clamp (A) with positive (red) cable to positive post.

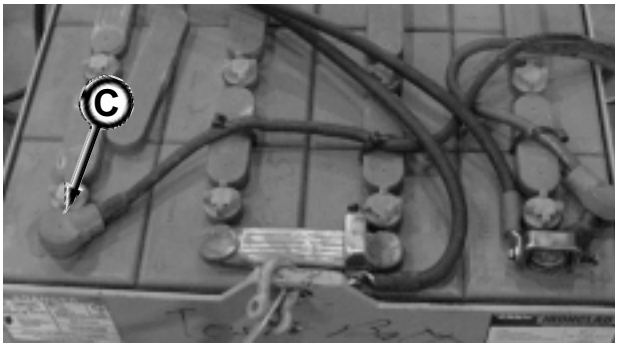
6. Install conveyor lift C clamp (B) with negative (black) cable to negative crossbar.

7. BEFORE operating haul unit and conveyor lift, inspect ALL electrical connections to prevent electrical shortages.



NOTICE DO NOT install conveyor lift cables to 48V negative post (C). Doing so will burn out the conveyor lift motor.

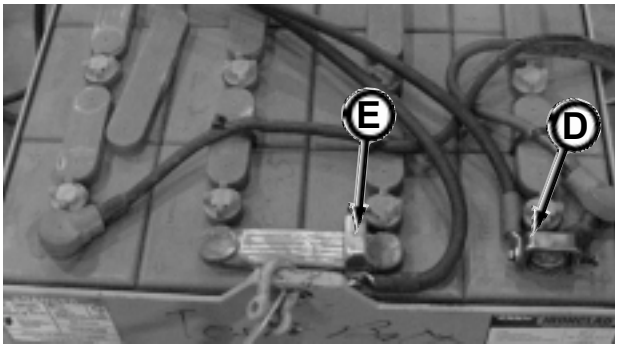
8. Replace battery cover. The 1448 battery box will require rework so when the battery cover is replaced, the conveyor lift cables are not pinched.



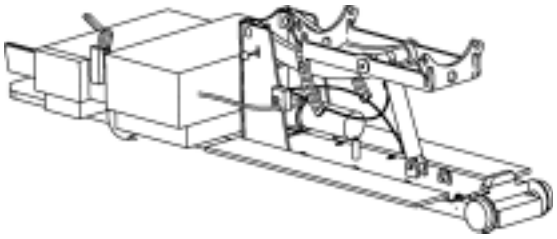
⚠WARNING The 1448 and conveyor lift cables must not be pinched. Doing so could cause electrical shortage resulting in serious injury or death.

9. After using conveyor lift, remove the conveyor lift battery cables by removing the negative cable C clamp (D) first and then the positive cable C clamp (E). Replace negative crossbar cover and positive post cover.

10. Remove conveyor lift from 1448 haul unit.



OPERATING THE CONVEYOR LIFT

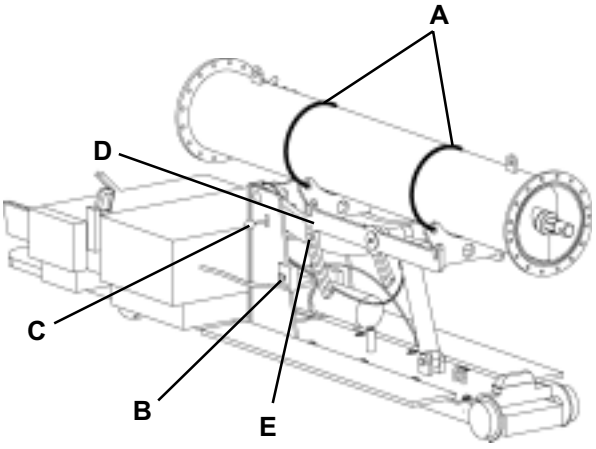


1. Install conveyor lift to 1448 haul unit (refer to Installing Conveyor Lift in this section).

⚠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.



2. Lower #2 screw conveyor section onto conveyor lift. Determine the center of gravity on each conveyor section (particularly the rear section) and lower onto conveyor lift accordingly to prevent conveyor from tipping.

3. Secure conveyor section to conveyor lift with two straps (A).

4. Slowly move the 1448 haul unit/conveyor lift into the tunnel.

5. Once conveyor is moved into the approximate installation location, stop haul unit.

6. Turn on conveyor lift motor by pulling button (B) out.

7. Raise the lift control (C) to lift the conveyor into position as needed.

NOTICE You will need to change the angle of the screw conveyor to align conveyor sections by adjusting the cradle arm (D). Once cradle arm angle is adjusted, secure with two pins (E) and two hitch pins.

8. Fasten conveyor sections.

9. Once conveyors are mounted together, remove straps and then lower conveyor lift.

10. Move haul unit to launch shaft and repeat steps 2 through 9 for other conveyor sections.

ADVANCING THE EPBM

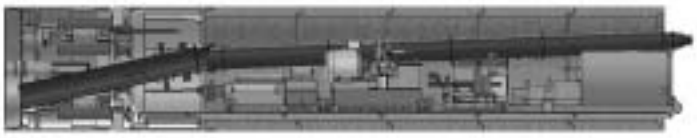
To begin tunnel excavation:

1. Perform Pre-Start Inspection checklists in the Pre-Start Inspection section, and the System Start-Up and EPBM Launch Sequence in this section.

2. Turn Grease Pump switch to ON position.

3. Turn Cutterhead Motor switch ON position.

4. Turn #1 Motor switch to ON position.



5. Turn Jacking & Steering Pump switch to ON position

6. Turn #2 Motor and Gate Pump switches to ON position.

7. Switch gates #1 Intermediate Conveyor Gate and #2 Conveyor Gate, to fully OPEN position.

8. Switch #2 Screw Conveyor to the Forward position and adjust speed as necessary.

9. Start EPBM jacking as follows:
   Select cutter rotation direction (CW, or CCW) and set the cutterhead drive speed at 50%, for a starting point. Select Extend on the All Jacking switch and run your jacking speed so the cutterhead torque is at a maximum of 30% for mixing and 50% for excavation. Use a maximum of 80% cutterhead rotation when jacking. If an obstruction is encountered, there is an additional 20% torque available. Reduce jacking speed to reduce torque. Watch forces.

   - The cutterhead works equally well in both directions.
   - Watch for machine roll. If it exceeds 1.5 to 2 degrees, reverse the cutting head rotation.
   - Operate cutterhead rotation at high speeds in stable ground, lower speeds in unstable ground.

10. Operator contacts the foam and slurry system operator to power ON the system and set in AUTO mode at 50% ratio. If the machine operator reduces or increases the jacking speed, the operator must inform the foam and slurry operator. The foam and slurry operator will then change the percentage ratio to match the jacking speed.

11. Switch #1 Screw Conveyor to the Forward position. Adjust conveyor speed as needed to retain the earth pressure balance.

    - Reduce screw conveyor speed to increase soil pressure.
    - Increase screw conveyor speed to reduce soil pressure.

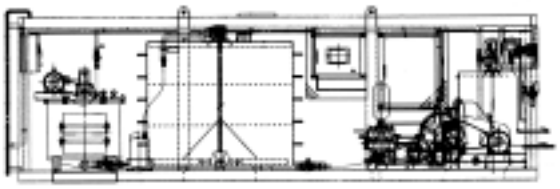
NOTICE Keep in mind while operating, the cutterhead rotation and jacking speeds are normally not readjusted during excavation. The #1 screw conveyor speed is readjusted to compensate for the earth pressure balance. Also, operate the #2 screw conveyor speed at approximately 5% higher than the #1 screw conveyor speed.

12. After EPBM is fully advanced, the EPBM operator will contact the jacking frame operator to advance the jacking frame. Before the jacking frame is advanced, the EPBM operator will switch off the cutterhead rotation, jacking, and #1 and #2 screw conveyors.

13. The EPBM operator will switch the Jacking Compress to the ON position.

14. While the jacking frame is being advanced, the EPBM operator will adjust the Jacking Compress Pressure to retain the earth pressure balance, AND pump grease into the jacking can cavity to prevent contamination from entering cavity while EPBM jacking cylinders are being compressed. Refer to Compressing Jacking Can in this section.

CONTROLLING FOAM & SLURRY



NOTICE Refer to your Foam and Slurry Plant manual (Additive Injection Equipment) for set-up, operation, and maintenance details.

Use foam and/or slurry mixture as follows to create spoils with a non-sticky “toothpaste consistency”:

Clay	Foam
Silty Clay	Slurry
Silt	Foam/Slurry Mixture
Sand	Slurry

There are six ports for foam and slurry on the EPBM:
- The ball valves on the cutterhead swivel control the flow of additive to the three specific injection ports on the cutterhead.
- The ball valves on the EPBM bulkhead control the flow of additive to the three specific injection ports in the chamber.

There are two ports for foam and slurry on the #1 screw conveyor:
- The ball valves on the #1 screw conveyor control the flow of additive to the two specific injection ports on the #1 screw conveyor.

There are also four external ports on the EPBM for external bentonite lubrication (if needed):
- The ball valves on the EPBM shell control the flow of bentonite lubrication to four specific injection ports on the EPBM.

Typically the cutter injection ports are used, while the chamber ports are rarely used. The conveyor ports are used only if material is stuck in the conveyor. The external port bentonite lubrication is used if jacking forces are too high.

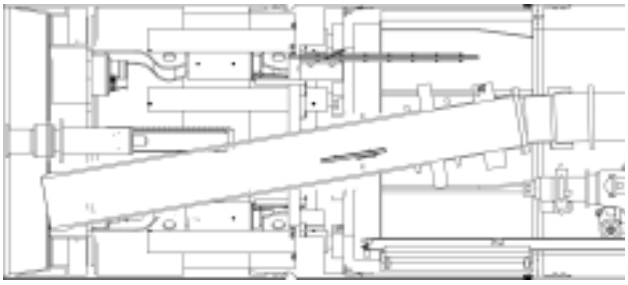
If the lubrication lines are plugged, use high pressure slurry to clean out lines.

All the injection operation information are set on the operation panel touch screen.

Set the Foaming Flow Control and Slurry Flow Control to AUTO. The pump speed is controlled automatically. The pump speed needed to keep the given injection rate is calculated based on the excavation area and the jacking speed of the EPBM cylinders, both of which are items the plant operator enters on the operation panel during setup.

The EPBM operator must inform the plant operator if the jacking speed is reduced or increased. The plant operator will then reset the jacking speed on the plant operation panel.

CUTTERHEAD OPERATION



1. Jacking flow rates can be increased to a maximum cutterhead drive torque of 80%. If an obstruction is encountered, there is an additional 20% torque available to break through the obstruction. Reduce jacking speed to reduce torque.

2. Abrupt operation may cause machine to roll. Before starting cutterhead rotation, be sure cutterhead drive speed control is at 0 (Min).

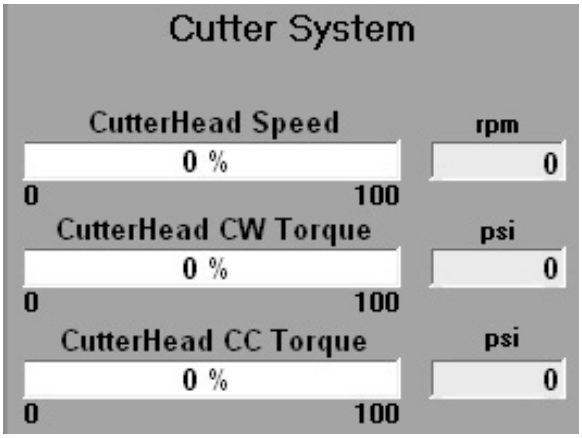
3. The cutterhead works equally well in both directions.

4. Watch for machine roll. If it exceeds 1.5 to 2 degrees, reverse the cutting head rotation.

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

6. Start cutter rotation and adjust speed to 1 to 3 rpm so torque is less than 30% for mixing. After cutter rotation is adjusted, extend the jacking cylinders. Watch the cutterhead torque so it does not exceed 80%.

7. If cutterhead torque is too high, reduce jacking speed.



Cutter System Meters
On Target Screen

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 80%), while maintaining high production rates.

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

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

5. Do not allow steering pressures to rise above 5800 PSI for soft ground. Reduce advancement rate, or increase cutter head rotation speed to reduce pressure.

6. Jacking speed is too fast if the conveyor cannot reduce the soil pressure at full speed.

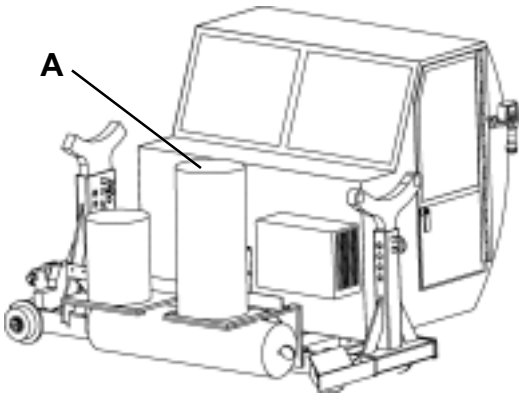
7. If cutterhead torque is too high, reduce jacking speed.

8. Before compressing the jacking can, be sure to start jacking can grease pump. Refer to Compressing Jacking Can in this section.

Jacking System Meters
On Target Screen

COMPRESSING JACKING CAN

While compressing the jacking can, it MUST be greased to prevent contaminates from entering the annular space between the stationary can and the moving can.

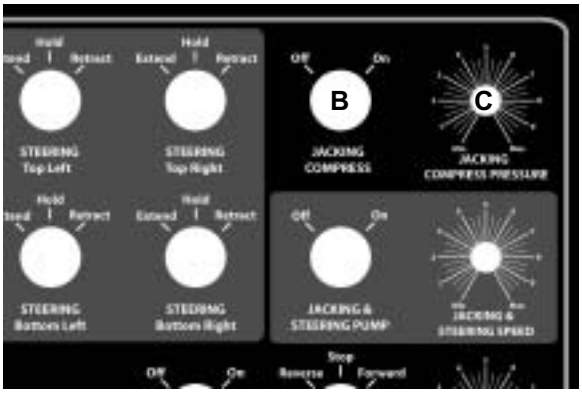


1. Be sure the jacking can grease reservoir (A) is full before compressing jacking can.

2. Turn Jacking Compress switch (B) to ON position.

3. Turn air on to the jacking can grease pump.

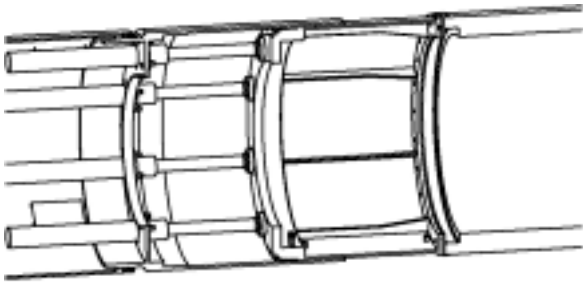
4. Open ball valve, located on backup car #3 jacking can reservoir, to start pumping grease to jacking can.



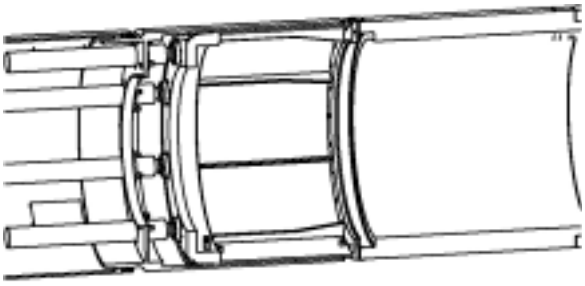
5. While extending the jacking cylinders from the launch shaft jacking frame, control the compressing pressure with the Jacking Compress Pressure flow control (C) to maintain the earth pressure balance. The EPBM operator and the jacking frame operator will need to be in communication during this process so pressures are not exceeded. BE SURE that grease is being pumped into annular space. Failure to lubricate the jacking can while compressing will cause damage to jacking can.

6. The jacking can must be completely compressed before mining can proceed. When jacking can is completely compressed, turn the Jacking Compress switch to OFF position and the Jacking Compress Pressure flow control to 0 (Min) position.

7. Turn off air and close ball valve on backup car #3 jacking can reservoir.



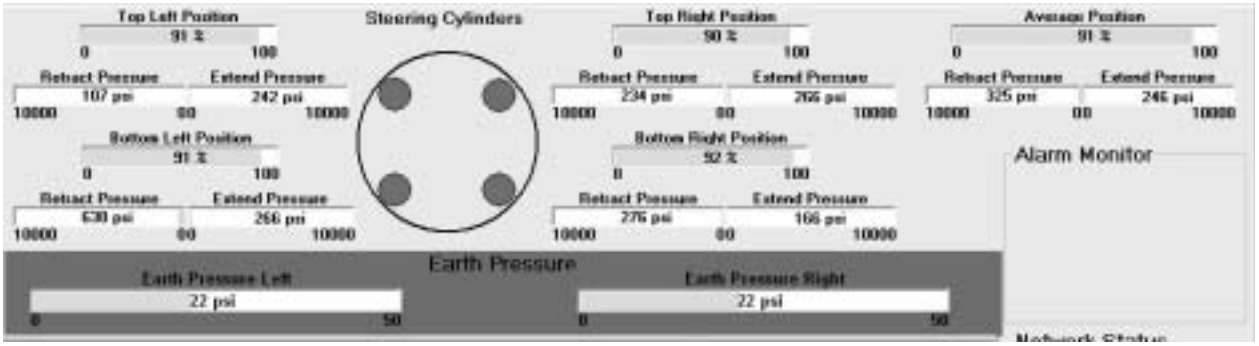
Jacking Can Extended



Jacking Can Retracted

STEERING GUIDELINES & OPERATION

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



The steering cylinder positions in percent, the extend/retract pressure of the cylinders, and the average cylinder position and extend/retract pressure is displayed on the target screen.

1. Before making any steering adjustments, ALL four steering cylinders must be at 20% position.

2. Turn all steering switches to the HOLD position.

3. Switch #1 Motor to ON position, switch ON Jacking & Steering Pump and adjust Jacking & Steering Speed accordingly.

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

NOTICE Steer only when the jacking can is compressed. Doing so will cause the jacking can to misalign with the stationary can. This misalignment will prevent the jacking can from compressing.

5. Steering:

To steer up, switch both the bottom left and bottom right steering controls to EXTEND position. Control the cylinder extend flow rate with the Jacking and Steering Speed flow control.

To steer down, switch both the top left and top right steering controls to EXTEND position. Control the cylinder extend flow rate with the Jacking and Steering Speed flow control.

To steer right, switch both the top left and bottom left steering controls to EXTEND position. Control the cylinder extend flow rate with the Jacking and Steering Speed flow control.

To steer left, switch both the top right and bottom right steering controls to EXTEND position. Control the cylinder extend flow rate with the Jacking and Steering Speed flow control.

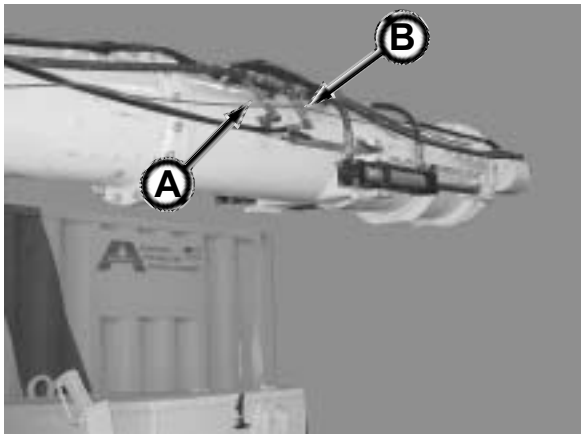
NOTICE There is a steering cylinder interlock that allows only two cylinders to work simultaneously. This is designed into the steering system to avoid steering control problems.

6. While steering, be sure to watch the earth pressure indicators on the target screen to retain the earth pressure balance.

OPERATING #2 SCREW CONVEYOR REAR GATE WITH NO POWER

If the #2 screw conveyor gate must be closed with the EPBM power off, the gate can be closed with pressurized oil stored in the #2 rear gate accumulator.

There are two ball valves on the #2 screw conveyor. Ball valve (A) controls the pressure line and ball valve (B) controls the return line.

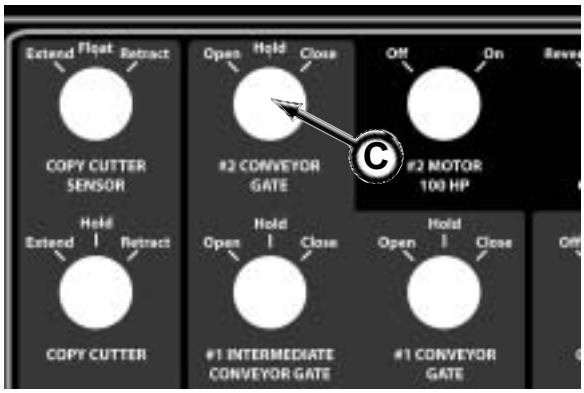


1. Open return valve (B) slightly before opening pressure valve (A).

2. Open pressure valve (A). Gate will close with the pressure from the accumulator.

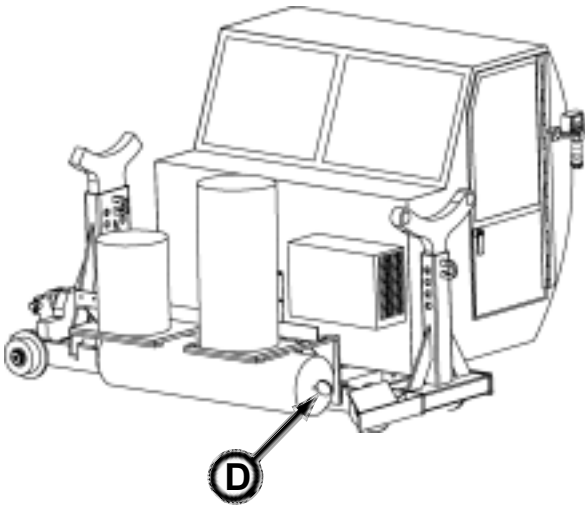
3. Once gate is closed, close both pressure and return ball valves.

CHARGING GATE ACCUMULATOR WITH HYDRAULIC OIL (NOT DRY NITROGEN)



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

After using the accumulator to close rear gate, the hydraulic oil in the accumulator must be recharged.



1. Close #2 Conveyor Gate (C). Once gate is closed, continue to hold the gate switch to Close position.

2. Open accumulator charge (pressure) valve (A) on #2 screw conveyor.

3. When accumulator is charged to 2,000 psi on pressure gauge (D), close accumulator charge valve (A).

4. Release #2 Conveyor Gate switch.

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. Retract jacking frame cylinders.
2. Turn Cutterhead switch to STOP position.
3. Turn Cutterhead Motor switch to OFF position.
4. Turn all other switches to Off, Stop, or Hold position.
5. Turn all flow controls to 0 (Min) position.
6. Record target settings on target screen.
7. Shut down Foam & Slurry Plant.
8. Perform electrical system shutdown. Refer to Electrical System Shutdown in this section.
9. With power locked out, disconnect the 2400 volt line, the foam, slurry and air hoses, ethernet cable (if backup car # 3 is above ground), heat exchanger water hoses, bentonite hoses (if used), jacking can grease pump air hose, vent supply, and audio cable. Make sure all of the 2400 volt electrical lines, hose connections and cables are in a clean, dry location and are out of the way of the next pipe.

10. Disconnect track extension.
11. Perform a visual machine inspection by checking the following items: all fluid levels, leaks, and machine damage. Make repairs before operating. Also check to be sure all connections are properly connected and secured.
12. Lower the next pipe into shaft and wipe off and lubricate the sealing ring to ensure proper sealing before setting pipe.
13. Slowly advance the new pipe with the launch shaft jacking frame until pipe is set.
14. Install new pipe track and reinstall track extension.
15. Clean electrical and hose connections before reinstalling.
16. Reconnect the 2400 volt electrical line, the foam, slurry and air hoses, ethernet cable (if backup car #3 is above ground), heat exchanger hoses, bentonite hoses (if used), jacking can grease pump air hose, vent supply, and audio cable. Be sure all connections are properly secured.
17. Perform system start-up. Refer to System Start-Up in this section.
18. After start-up, check target readings to be sure the laser was not bumped in the launch shaft.
19. Repeat installation for subsequent pipe.

DAILY SHUT DOWN

1. Turn all console switches to the Off, Stop, or Hold position.

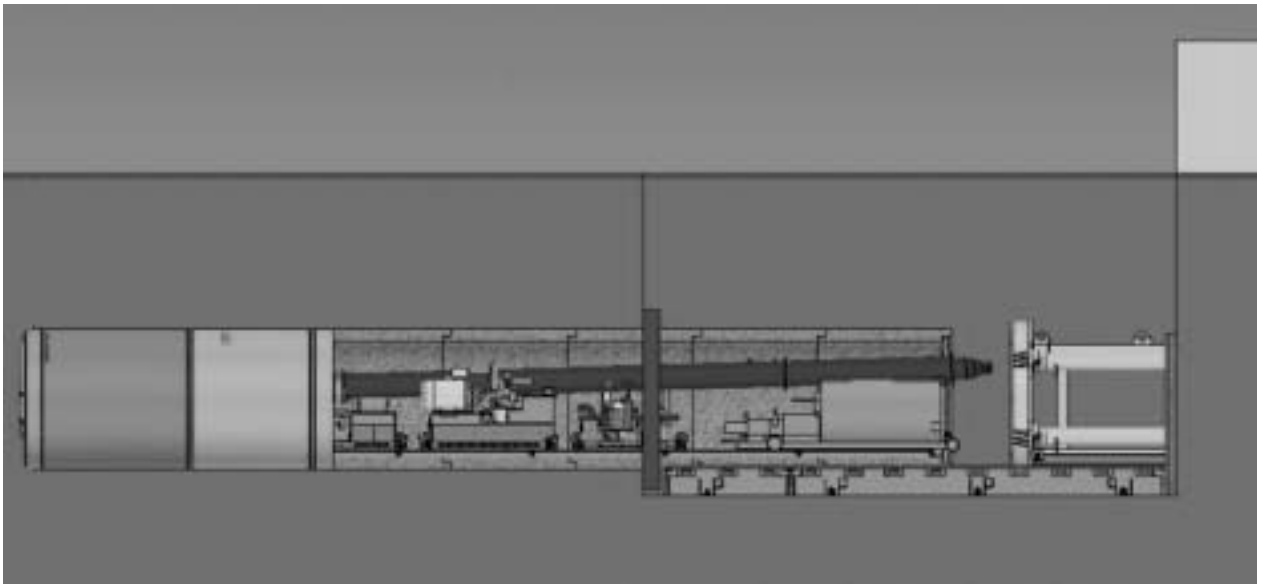
2. Turn all flow controls to the 0 (Min) position.

3. Shut down Foam & Slurry Plant.

4. Record target settings on target screen.

5. Perform electrical system shutdown. Refer to Electrical System Shutdown in this section.

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



Transporting

TRANSPORTING GUIDELINES

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

Do not enter area under or around a load.

1. Know the local, state, and federal transportation regulations.
2. Obtain required permits for transporting.
3. Remove any obstacles from the trailer floor.
4. Clean debris from equipment.
5. Load and unload on level ground.
6. If lifting equipment with a hoist or other lifting device, the equipment lifting eyes and sling must be inspected for damage before lifting. If damaged, replace.
7. Securely fasten equipment to trailer floor.
8. Secure all loose items in control container.
9. Observe the lifting instructions on the following pages.

LIFTING INSTRUCTIONS

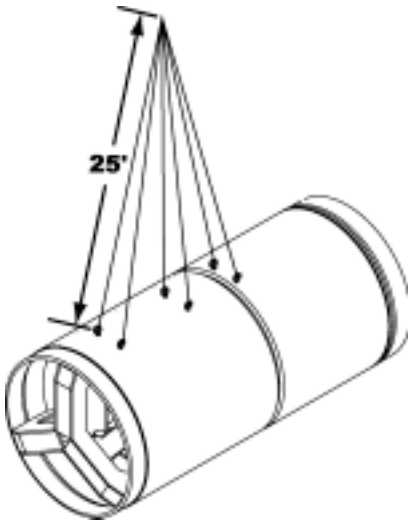
1. Earth Pressure Boring Machine

- EPB Machine (EPBM) weight without increaser kit is 105,000 lbs. (47,628 kg).

- Lifting with a crane requires a six part sling with the four outer legs a minimum of 25 ft. long.

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

- EPBM lifting eyes must be inspected prior to each lift. Any damage must be repaired prior to lifting.



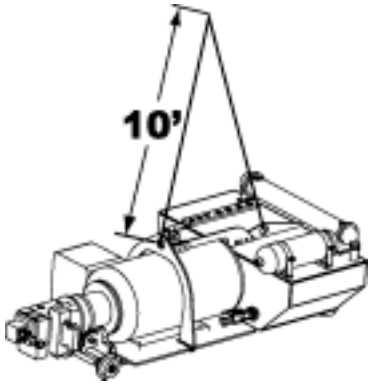
2. Backup Car #1

- Car weight is 10,000 lbs. (4,536 kg).

- Lifting with a crane requires a two part sling with legs a minimum of 10 ft. long.

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

- Lifting eyes must be inspected prior to each lift. Any damage must be repaired prior to lifting.



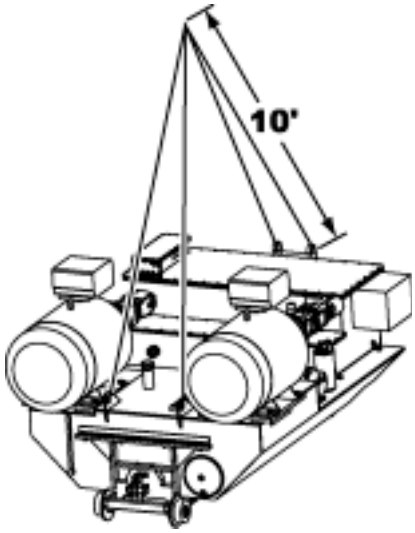
3. Backup Car #2

- Car weight is 12,000 lbs. (5,443 kg).

- Lifting with a crane requires a four part sling with legs a minimum of 10 ft. long.

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

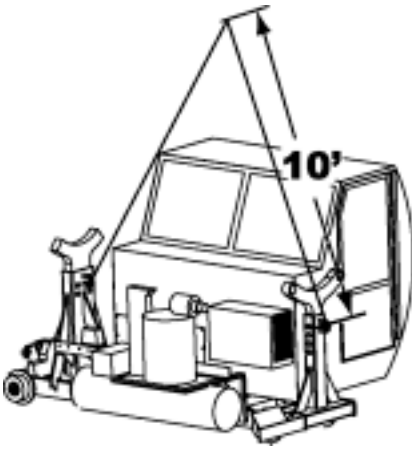
- Lifting eyes must be inspected prior to each lift. Any damage must be repaired prior to lifting.



(continued on next page)

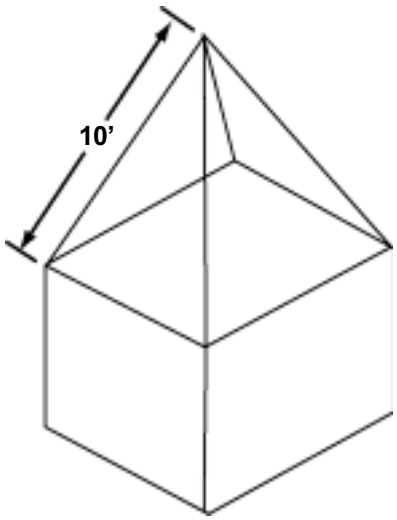
4. Backup Car #3

- Car weight is 3,000 lbs. (1,361 kg).
- Lifting with a crane requires a two part sling with legs a minimum of 10 ft. long.
- Car must lift freely. If it is stuck to the ground, it must be broken loose prior to lifting.
- Lifting eyes must be inspected prior to each lift. Any damage must be repaired prior to lifting.



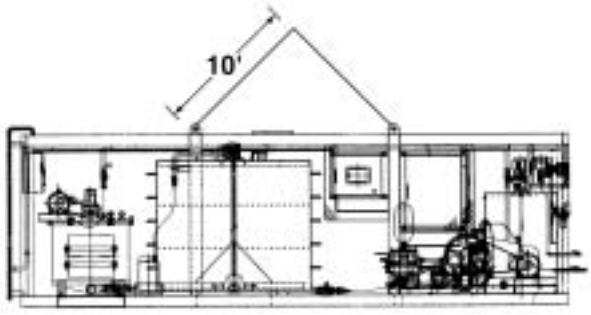
5. Power Container

- Container weight is 7,000 lbs. (3,175 kg).
- Lifting with a crane requires a four part sling with legs a minimum of 10 ft. long.
- Container must lift freely. If it is stuck to the ground, it must be broken loose prior to lifting.
- Lifting eyes must be inspected prior to each lift. Any damage must be repaired prior to lifting.
- All container doors must be closed before lifting.



6. Foam & Slurry Plant

- Foam & Slurry (F & S) plant weight without fluids is 14,000 lbs. (6,350 kg).
- Lifting with a crane requires a four part sling with legs a minimum of 10 ft. long.
- F & S must lift freely. If it is stuck to the ground, it must be broken loose prior to lifting.
- F & S plant lifting eyes must be inspected prior to each lift. Any damage must be repaired prior to lifting.



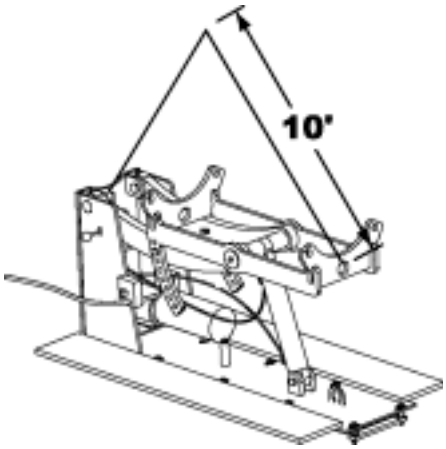
8. Conveyor Lift

- Conveyor lift weight is 1,700 lbs. (771 kg).

- Lifting with a crane requires a two part sling with legs a minimum of 10 ft. long.

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

- Lifting eyes must be inspected prior to each lift. Any damage must be repaired prior to lifting.



Lubricants

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

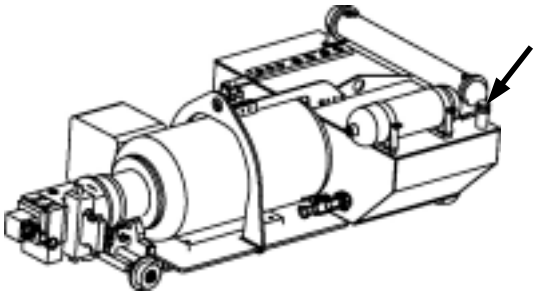
HYDRAULIC RESERVOIR LUBRICANT

The hydraulic reservoirs for backup cars #1 and #2 are filled with Quaker Quintolubric 822-300 hydraulic fluid. This hydraulic oil is a high performance, synthetic, and fire resistant, hydraulic fluid.

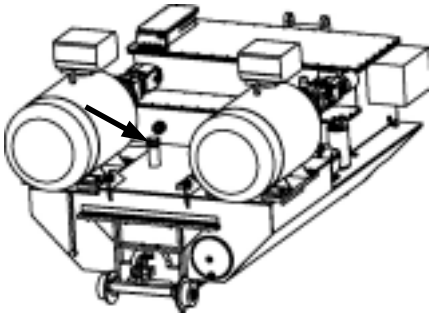
Use Quaker Quintolubric Series 822 (ISO-VG-68) hydraulic fluid or equivalent when adding or changing lubricant.

NOTICE Do not mix oil manufacturers or grades.

Backup car #1 oil reservoir capacity is 150 gallons.
Backup car #2 oil reservoir capacity is 300 gallons.



Backup Car #1 Hydraulic Reservoir



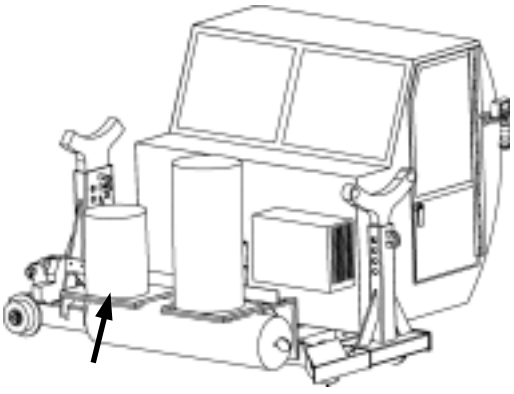
Backup Car # 2 Hydraulic Reservoir

EPBM AUTOMATED GREASING SYSTEM LUBRICANT

The EPBM automated greasing system is filled with Mobilux® EP1, a high performance, general-purpose, industrial grade, lithium grease.

Use Mobilux® EP1 or equivalent when adding or changing grease. Do not use biodegradable grease in this system.

The EPBM automated grease reservoir capacity is 5 gallons.



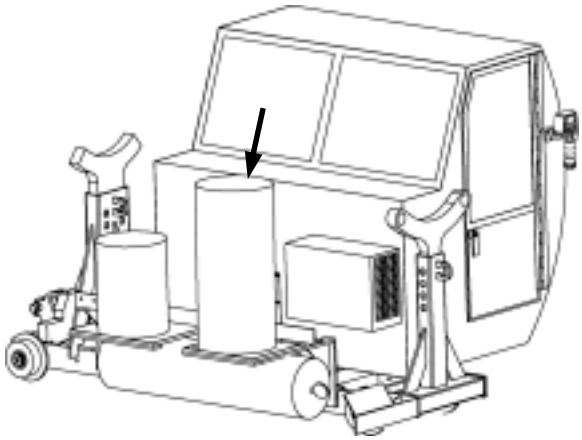
EPBM JACKING CAN GREASING SYSTEM LUBRICANT

The EPBM automated greasing system is filled with Mobilux® EP1, a high performance, general-purpose, industrial grade, lithium grease.

.Use Mobilux® EP1 or equivalent when adding or changing grease. This grease is not biodegradable.

If a biodegradable grease is required, use Mobilgrease® EAL 101 or 102 or equivalent.

The jacking can grease reservoir capacity is 16 gallons.

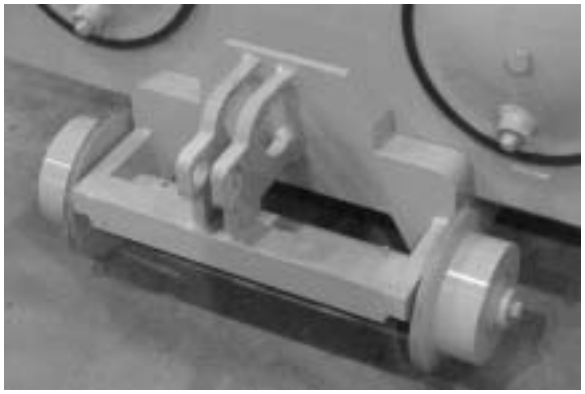


GREASE

The lubrication fittings 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.



Backup Car #1 Lubrication Points

EPBM CUTTERHEAD SWIVEL LUBRICANT

The EPBM cutterhead swivel (A) is filled with Mobilgrease® XHP222 Premium Lubricating Grease.

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

CONVEYOR GATE LUBRICANT

The #1 and #2 conveyor gates are lubricated with Mobilgrease® XHP222 Premium Lubricating Grease

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

#1 Screw Conveyor Gate

CONVEYOR LIFT HYDRAULIC RESERVOIR LUBRICANT

The conveyor lift hydraulic reservoir is filled with ISO-VG-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-20W or API GL-1/GL-2 oil specification. Do not mix oil manufacturers or grades.

The conveyor lift reservoir capacity is approximately 2 gallons.

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.

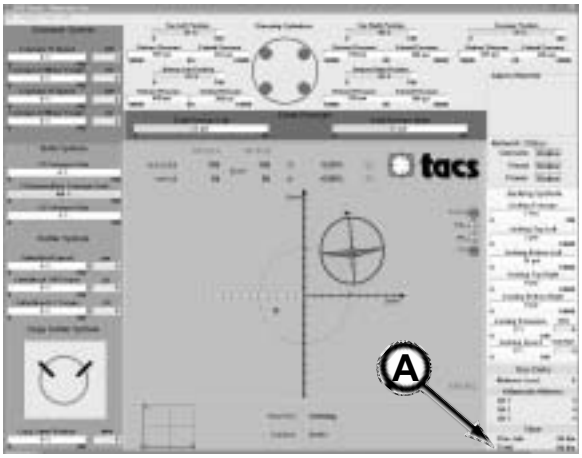
Maintenance and repairs must only be performed by a qualified service technician.

LUBRICATION & MAINTENANCE INTERVALS

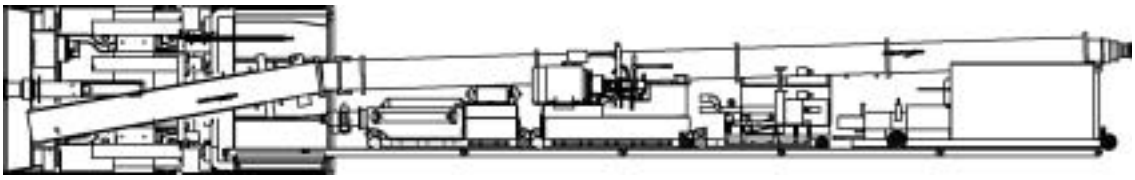
The requirements for lubrication and maintenance are shown on the maintenance charts in this section.

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.



BEFORE PERFORMING MAINTENANCE



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

2. Relieve hydraulic pressure.

3. Turn backup car #1 suction valve to the CLOSED position. Before operating equipment, be sure this valve is tie strapped to the OPEN position. Failure to do so will starve the pump resulting in pump damage.

4. Do not work on hydraulic system if oil temperature exceeds 125° F (51° C).

5. **Lockout all power. Perform lock out/tag out procedure.**

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.

HYDRAULIC OIL/FLUIDS UNDER PRESSURE

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

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

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

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

AVOID PINCH POINTS

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

Keep hands away from moving parts.

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

Handle parts carefully to avoid crushing and pinch point hazards.

UNAUTHORIZED WELDING

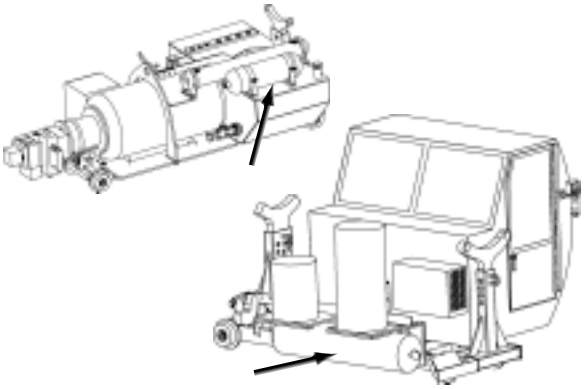
⚠WARNING Unauthorized welding can cause structural failure resulting in possible injury or death.

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

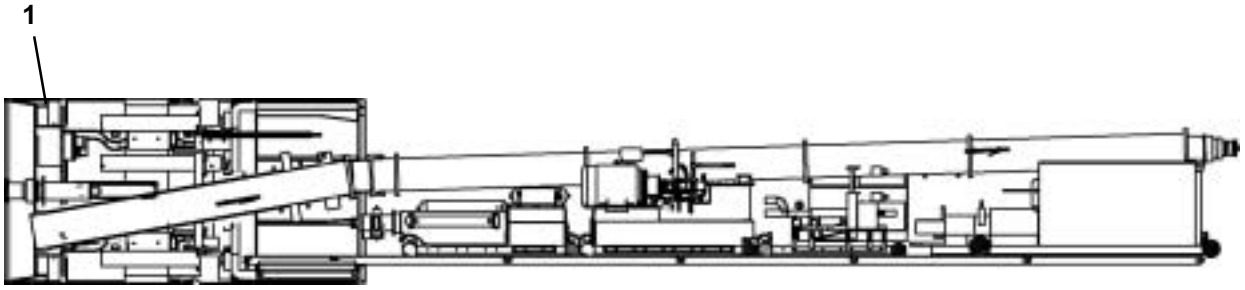
MAINTAINING ACCUMULATOR

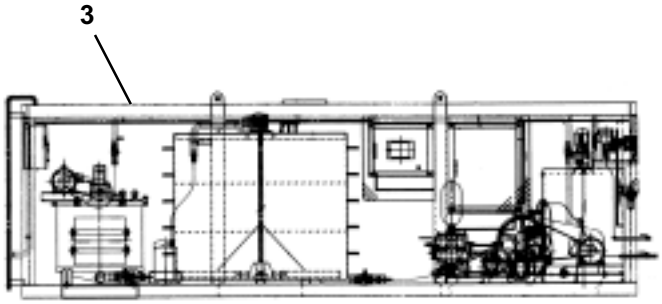
⚠WARNING Escaping oil or other fluids under pressure can penetrate your skin causing serious injury.

Release all pressure before performing maintenance or repairs. BEFORE servicing accumulator, do not disconnect hoses or fittings without first discharging it. Only a qualified service technician should service accumulator.



MAINTENANCE CHARTS

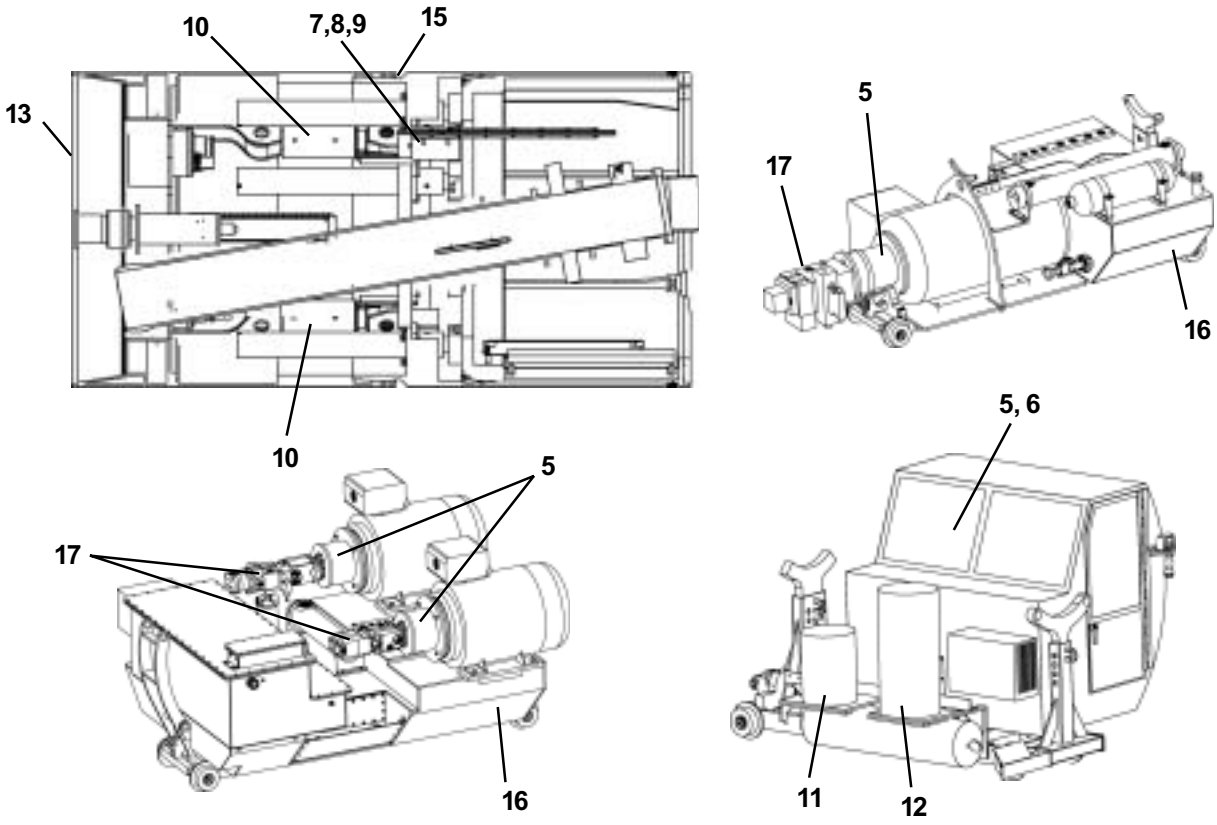




START OF TUNNELING PROJECT

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
1.	Drive Seals	Inspect Seal Mating Surface		
* 2.	Cables	Inspect Pin/Socket Prior To Mating	Clean & Dry As Necessary	
3.	Foam & Slurry Plant	Perform Maintenance	Refer to Foam & Slurry manual.	

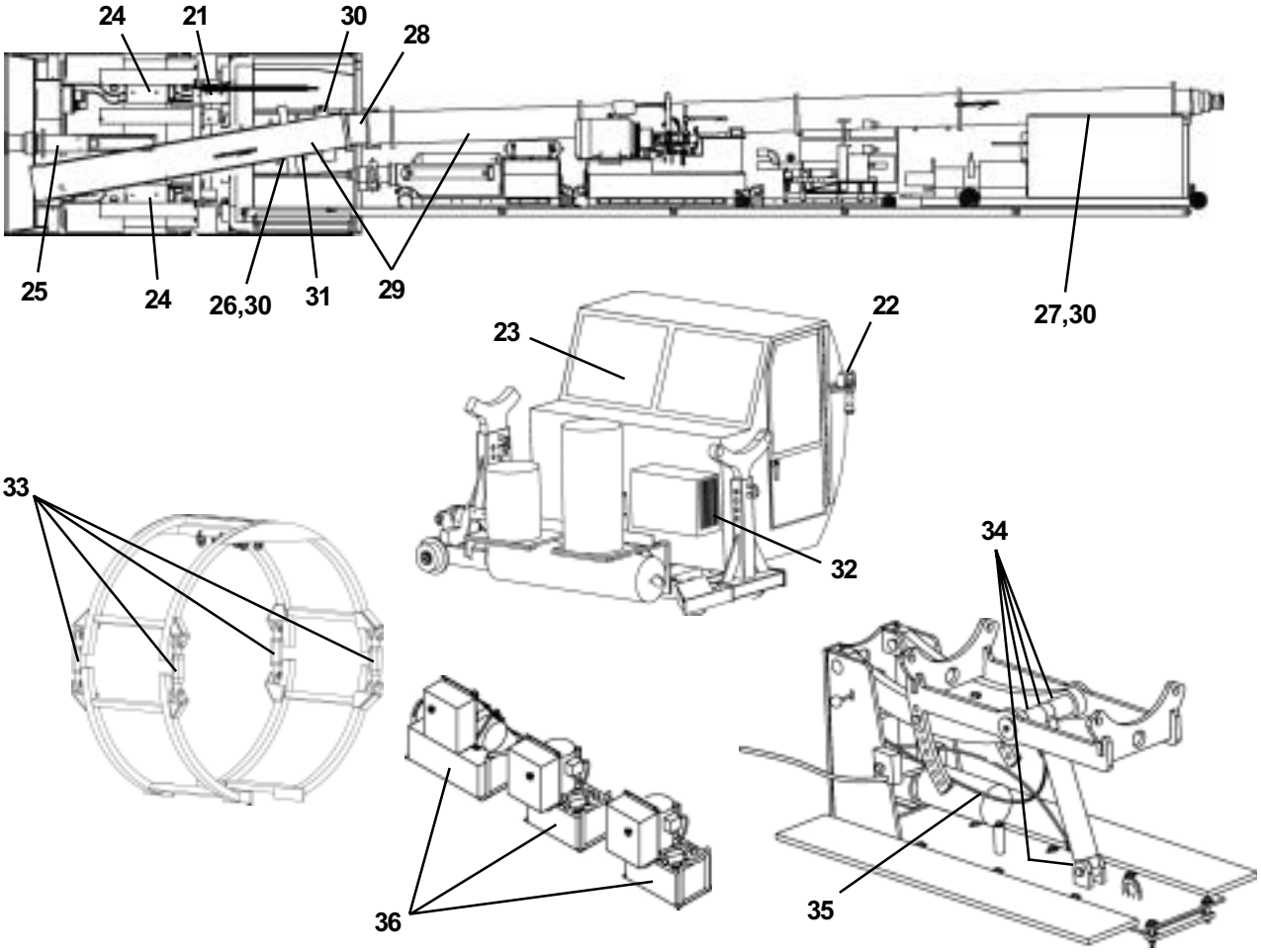
* Not Shown



PRIOR TO EACH DRIVE LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
* 4.	Pre-Start	Perform Pre-Start Inspection	Refer to section 5.	
5.	Control System	Verify Motor Rotation & Phase Monitor	All electric motors.	
6.	E-Stop Operation	Check All E-Stop Controls		
7.	Target	Clean	Use mild, abrasive-free cleaning solution and scratch free cloth.	
8.	Target	Check Configuration Parameters & Calibration		
9.	Target	Check Roll	Roll Right (+); Roll Left (-)	
10.	Steering Cylinders	Check Calibration Of Linear Transducers	Stroke reading: 0 to 100% each cyl.	
11.	Automated Grease System	Fill (5 gal.)	Fill with new grease.	Mobilux EP1
12.	Jacking Can Grease System	Fill (16 gal.)	Fill with new grease.	Mobilux EP1
13.	EPBM	Inspect Cutter Teeth & Surfaces	Repair or replace as necessary.	
* 14.	Hydraulic Hoses	Inspect	Replace if cracks/wear visible.	
15.	Steering Joint	Clean/Lubricate	Check for leaks and seal wear.	
16.	Hydraulic Reservoirs	Check Oil Level	Fill as necessary.	
17.	Hydraulic Pump	Check Relief Settings	High and low pressure	
* 18.	Skid Leveling Scrw	Lubricate	Lubricate generously.	
* 19.	Haul Unit, Pump Unit & Jacking Frame	Perform Maintenance	Refer to your machine's maintenance manual.	

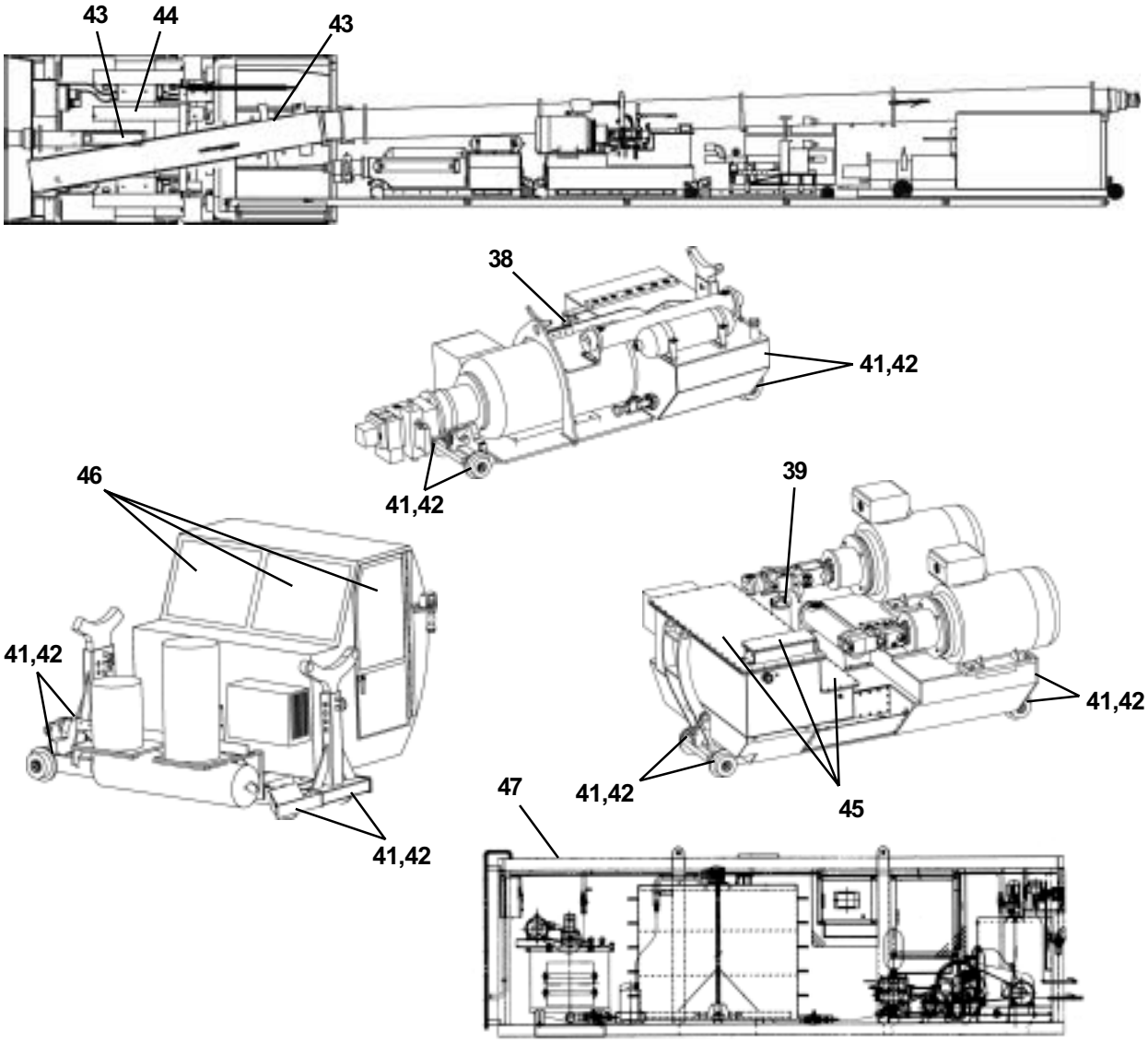
* Not Shown



PRIOR TO EACH DRIVE LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
* 20.	Audio Controls**	Test Operation & Control		
21.	Target Inclinometer	Verify	Use digital level & calibrate if necessary. See Tacs manual.	
22.	Gas Detector	Test Operation	See Gas Detection Manual	
23.	Lights	Test Lamp Operation		
24.	Steering Cylinders	Check Operation	Extend & retract-Verify on screen values agree with cyl position.	
25.	Cutterhead Swivel	Lubricate	Lubricate until grease is forced out.	Mobil XHP222
26.	#1 Conveyor Gate	Lubricate (4 places)	Lubricate until grease is forced out.	Mobil XHP222
27.	#2 Conveyor Gate	Lubricate (4 places)	Lubricate until grease is forced out.	Mobil XHP222
28.	#1/#2 Conveyor Joint Swivel	Lubricate (2 places)	Lubricate until grease is forced out.	Mobil XHP222
29.	Conveyor Flighting	Inspect	If damaged, repair or replace.	
30.	Conveyor Gates	Inspect	If damaged, repair or replace.	
31.	Conveyor Covers	Inspect		
32.	A/C Unit	Clean Fins		
33.	#2 Screw Conveyor Support	Lubricate (4 places)	Lubricate until grease is forced out.	Mobil XHP222
34.	Conveyor Lift	Lubricate (4 places)	Lubricate until grease is forced out.	Mobil XHP222
35.	Conveyor Lift	Check Oil Level	Refill as needed.	ISO-VG-46-20W
36.	Scavenging Pumps	Clean Screens (3)		

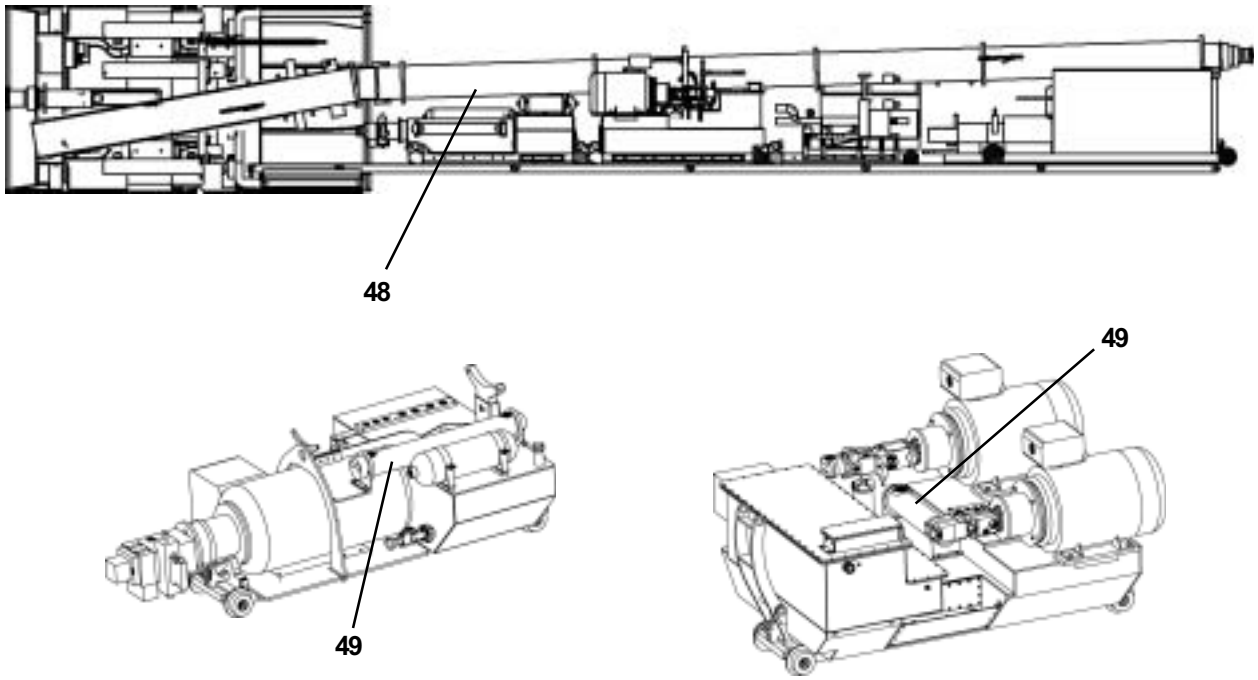
* Not Shown
** If equipped



DAILY OR EVERY 10 HOURS OF OPERATION

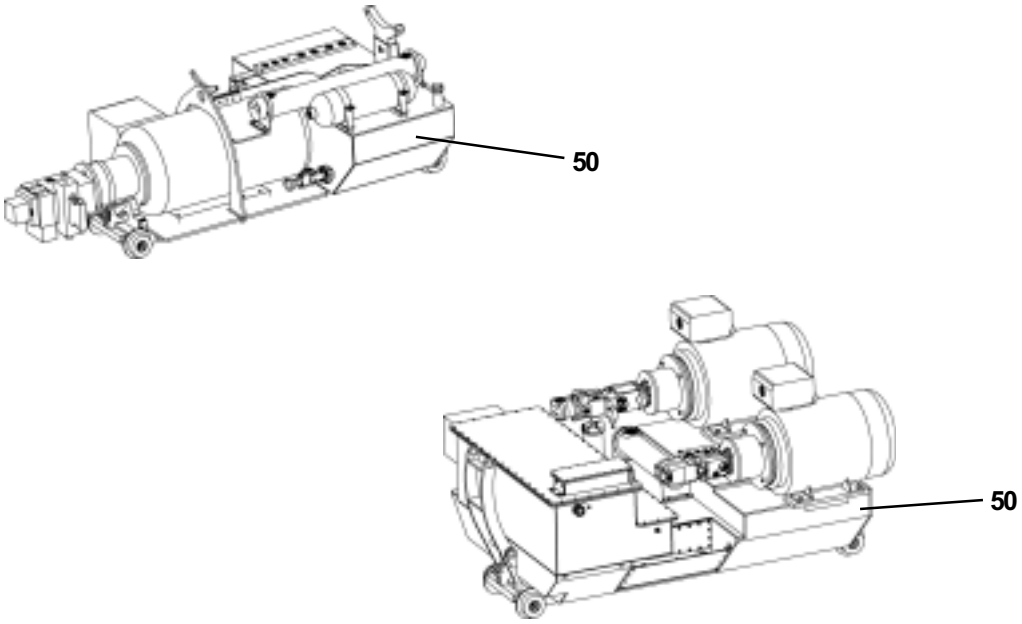
ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
* 37.	Hydraulic Hoses	Inspect	If damaged or worn, replace.	
38.	Backup Car #1 Return Filter	Check Indicator	Replace filter per indicator.	
39.	Backup Car #2 Return Filter	Check Indicator	Replace filter per indicator.	
* 40.	Track	Inspect	If damaged, repair or replace.	
41.	Backup Car Idler Assembly	Lubricate Wheel Bearings	Lubricate until grease is forced out.	
42.	Backup Car Idler Assembly	Inspect	If damaged, repair or replace.	
43.	Grease Recovery Reservoirs	Empty Reservoirs		
44.	Automated Grease Pump System	Inspect For Oil Cycling	Indicator must shift.	
45.	Lexan Covers	Check For Leaks Or Cracks.	Replace.	
46.	Lexan Window	Inspect For Cracks.	Replace.	
47.	Foam & Slurry Plt	Perform Maintenance	Refer to Foam & Slurry manual.	

* Not Shown



END OF EACH DAY

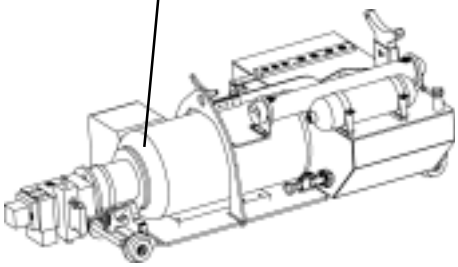
ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
48.	#2 Screw Conveyor	Clean & Wash Conveyor	Once empty, close all gates.	
49.	Heat Exchanger	Drain (2)	In freezing weather.	

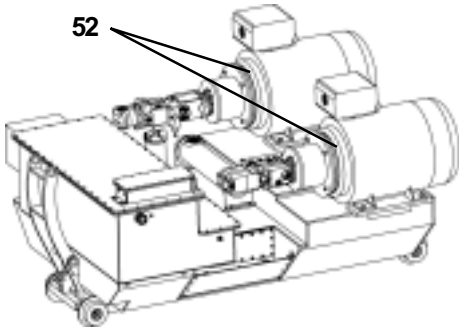


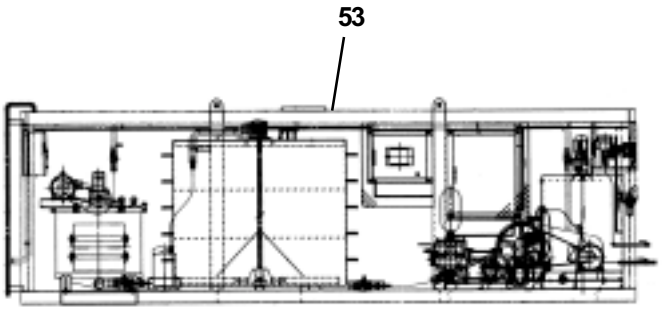
AFTER EVERY PIPE INSTALLATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
50.	Hydraulic Reservoirs	Check Oil Level & Temp	Add is necessary.	Quinto 822-300
* 51.	Cables	Inspect Pin/Socket Prior To Mating		

* Not Shown

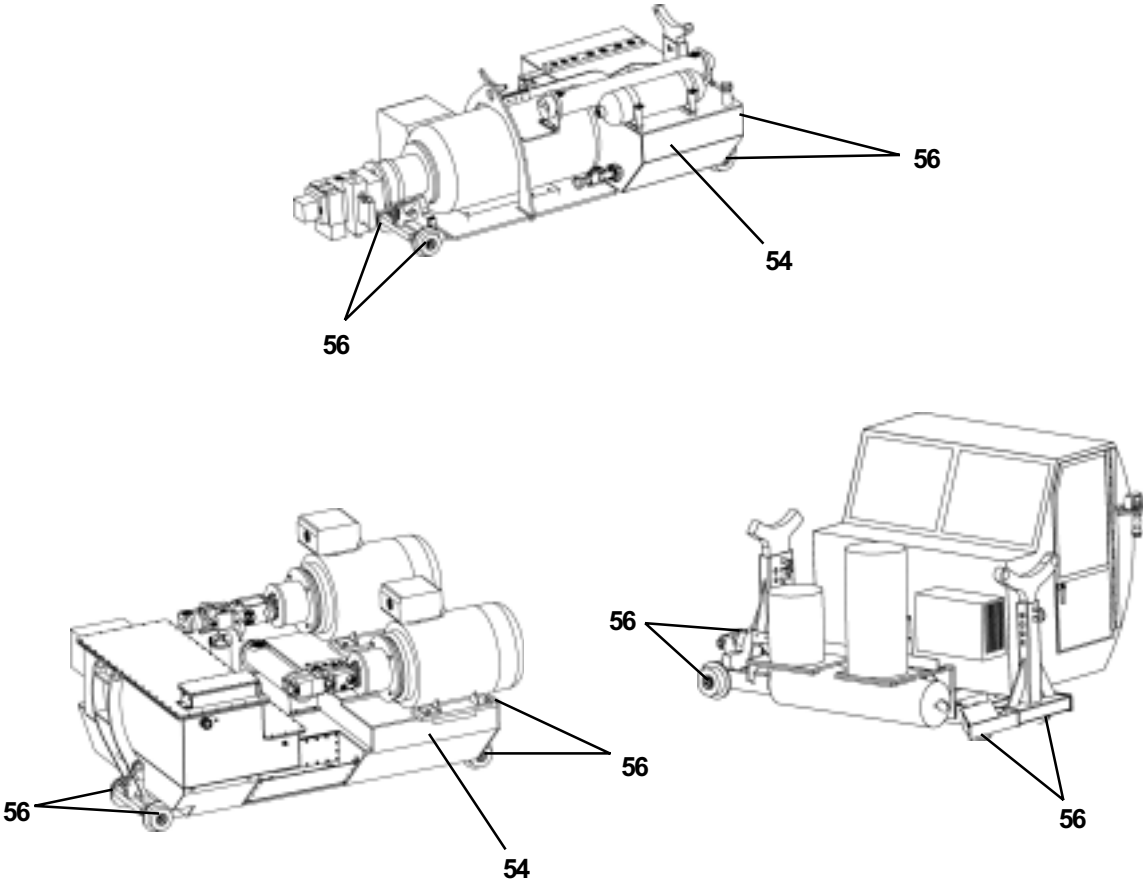






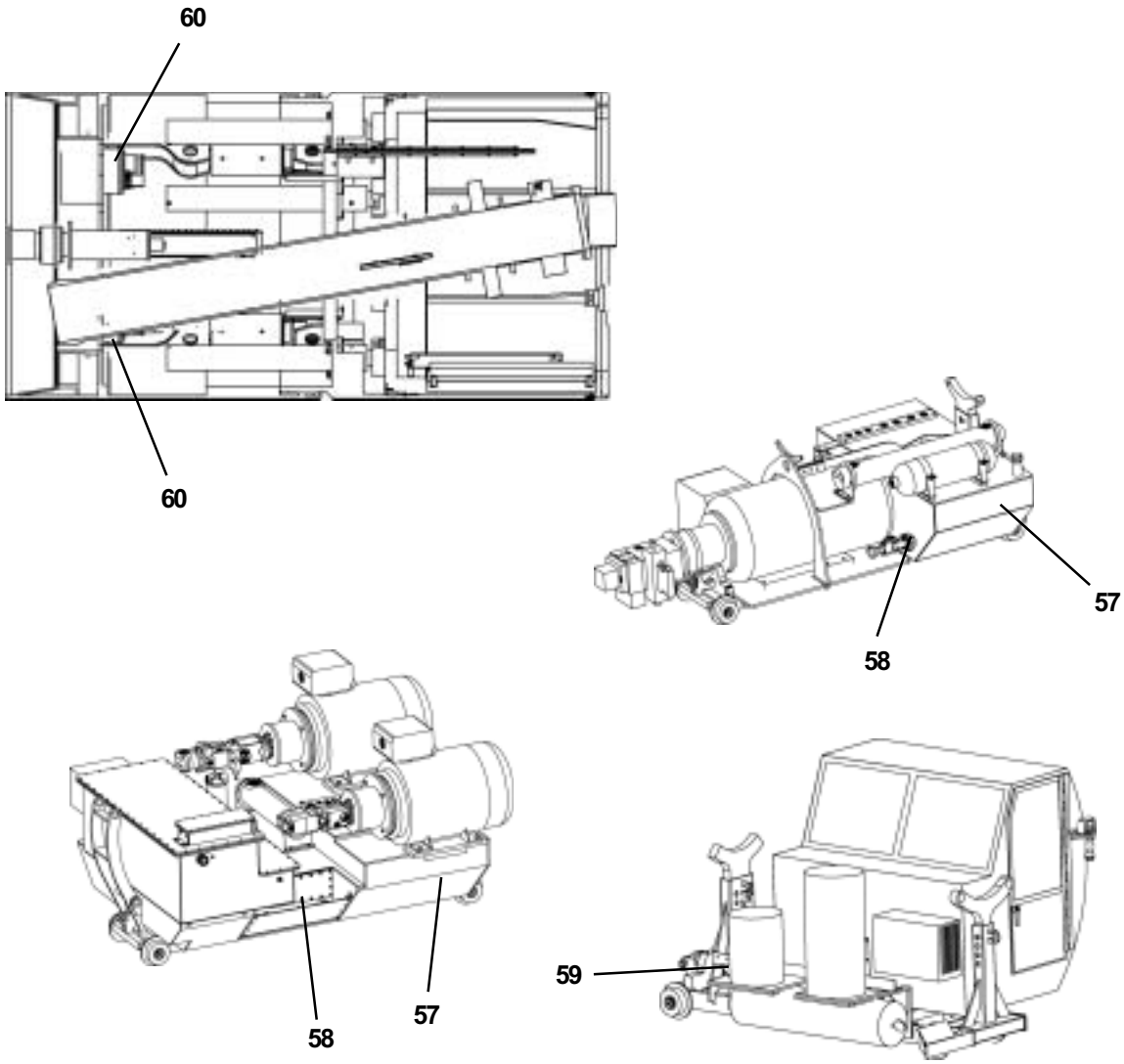
WEEKLY OR EVERY 50 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
52.	Electric Motors	Check	Ventilate openings clean & drain hole openings.	
53.	Foam & Slurry Plt	Perform Maintenance	Refer to Foam & Slurry manual.	



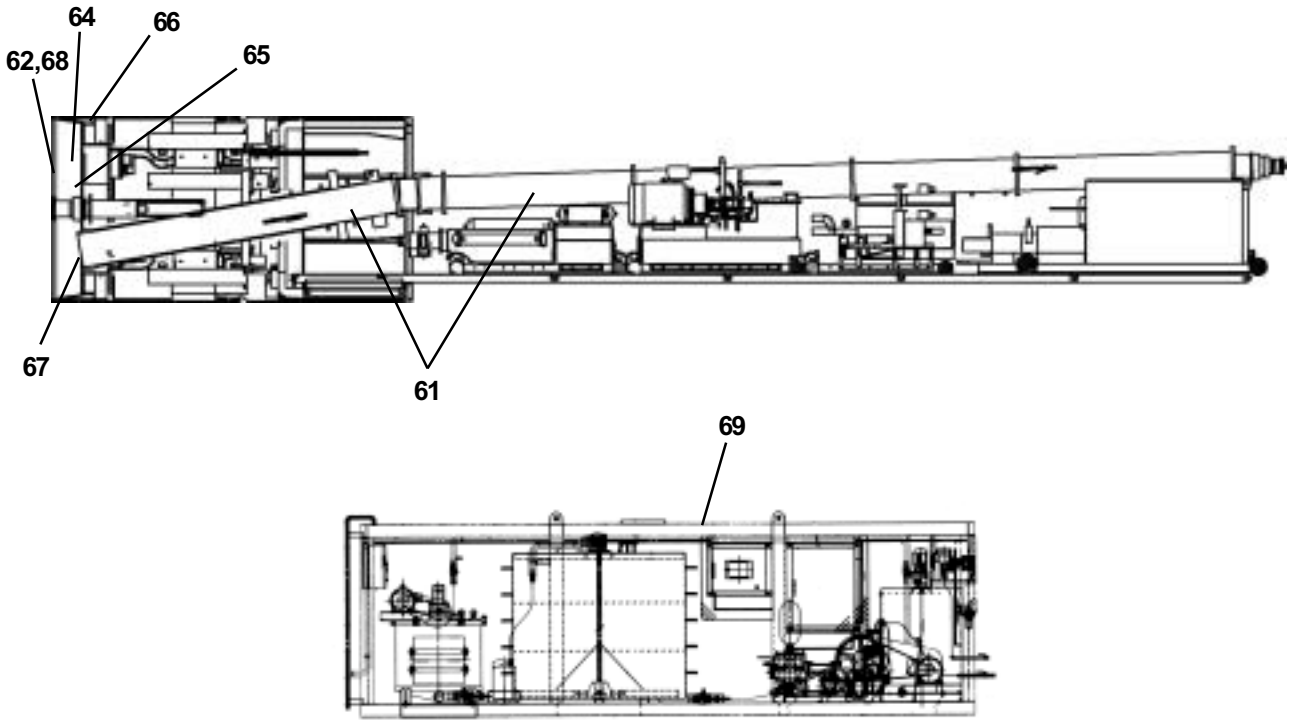
MONTHLY OR EVERY 250 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
54.	Hydraulic Oil Reser.	Drain water & check oil level.		
55.	Oil Analysis	Perform analysis.	Oil Sample	
56.	Backup Car Wheels	Lubricate wheel bearings.	Lubricate until grease is forced out.	



EVERY 500 HOURS OF OPERATION

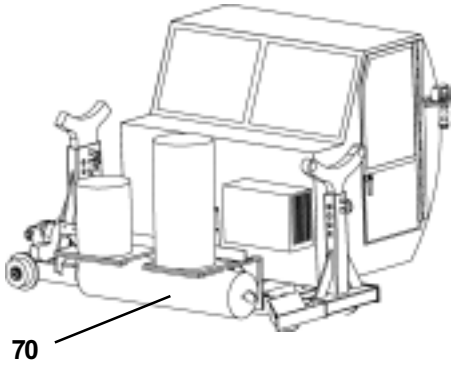
ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
57.	Hyd. Oil Reservoir Backup Cars 1 & 2	Drain & Fill	Backup Car #1 - 150 gal capacity Backup Car #2 - 300 gal capacity	
58.	Hyd. Oil Reservoir Backup Cars 1 & 2	Clean Screens	Clean	
59.	Greasing System	Clean Screens (2)	Clean	
60.	Drive Motor	Inspect Pinion Gears (4)	If damaged, replace.	



COMPLETION OF EACH DRIVE

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
61.	Conveyors	Clean/Empty		
62.	Cutters	Inspect For Wear/Damage	If damaged, repair or replace.	
* 63.	Cables	Inspect For Wear/Cracks	If damaged, repair or replace.	
64.	Crusher Bar	Inspect For Damage	If damaged, repair or replace.	
65.	Cutter Bit Fluid Lines	Inspect For Damage		
66.	Front Drive Seal	Lubricate	Lubricate until grease is forced out of front drive seal.	
67.	Helix	Inspect For Wear	If damaged, repair or replace.	
68.	Face Ripper Tools	Replace	See page 9-14.	
69.	Foam & Slurry Plt.	Perform Maintenance	Refer to Foam & Slurry manual.	

* Not Shown

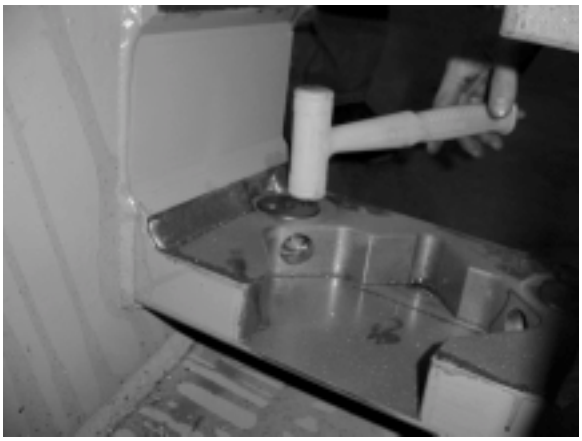


AS REQUIRED

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
70.	Accumulator	Recharge Hydraulic Oil		

INSTALLING FACE RIPPER TOOLS

1. Install barrel nuts so holes will be aligned for bolts installed in step 4 (shown in drawing).



2. Install ripper.

3. Install wedges with tapered edge away from cutter, as shown in drawing.

4. Install 19mm x 5.25 in. bolts and tighten securely.

5. Install additional rippers by following steps 1 through 4.

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. Retract all hydraulic cylinders if possible. If not, coat exposed cylinder rods with a corrosion preventive.
5. Repaint equipment where necessary.
6. Drain hydraulic oil, flush oil reservoirs, change hydraulic filters, and refill hydraulic reservoirs. Check for leaks.
7. Wipe up lube spills. Dispose of rags and trash properly. Store oily rags and other flammable material in protective containers.
8. If possible, store equipment under cover and out of the weather in a ventilated area.
9. Remove guidance target and place it in the storage box.
10. Do not smoke in areas where flammable materials are stored.
11. Store fuels and lubricants in properly marked containers.

REMOVING FROM STORAGE

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

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

Troubleshooting

EPBM

Problem	Cause	Solution
The jacking can does not operate.	Pump failure.	Repair or replace pump.
	Operation valve malfunction.	Check stroke of the spool when valve is in operation.
		Replace o-ring.
	Worn or damaged cylinder seals.	Replace seals.
	Relief valve leakage.	Repair or replace.
Operation of the jacking can is not smooth.	Faulty operation valve.	Repair or replace.
	Decrease in pump output.	Repair or replace pump.
	Worn or damaged cylinder seals.	Replace seals.
Oil pressure rises sharply.	Relief valve pressure set too high.	Reset relief valve.
Jacking can seal leaking.	Packing is damaged.	Replace packing.
	Bad seal surface and seal.	Repair seal surface & replace seal.

HYDRAULIC PUMP

Problem	Cause	Solution
Electric motor overload.	Pressure revolution is too high.	Reset pressure.
	If equipped with regulator, set pressure is too high due to adjustment failure.	Readjust regulator.
	Bearing of each section is damaged, & pump efficiency considerably lowered.	Replace bearing.
	Abrasion of rotating section.	Repair motor.
Decrease in the pump output.	Oil viscosity too high.	Refer to Lubricants section for proper oil.
Cannot obtain pump delivery pressure.	Accumulated air in the piping.	Bleed air.
	Filter in suction pipe is clogged.	Clean.
	Air is sucked in from suction pipe.	Repair or replace suction valve.
	Pump rotation is incorrect.	Correct pump rotation.
	Pump revolution is too high.	Correct to normal revolution.
	Boost pressure is too low.	Adjust boost pressure.

HYDRAULIC PUMP (Continued)

Problem	Cause	Solution
Cannot obtain pump delivery pressure (continued).	Oil leakage from valve and actuator in the piping.	Repair valve & actuator.
	Relief valve failure.	Replace or reset the relief valve.
		Check oil leakage of all equipment.
	Rattling of piston and connecting rod became loud.	Replace piston.
Decrease in the pump output.	Damage of piston & connecting rod.	Replace piston sub-group.
Pump delivery pressure is not achieved.	Failure in solenoid valve in circuit.	Replace solenoid valve.
	Regulator failure.	Repair regulator.
	Damage to head pin of cyl. casing.	Replace cylinder casing.
Oil leakage from oil seal.	Internal pressure in the casing is too high.	Lower pressure.
		Check if drain is clogged.
	Misalignment of centering of shaft.	Readjust shaft.
	Oil seal is damaged.	Replace seal.
	Shaft is damaged.	Replace shaft and seals.
Oil leakage from seat surface.	Internal pressure in the casing is too high.	Lower pressure.
	Seat surface failure.	Repair/replace seat surface.
	Packing is damaged.	Replace packing.
	Loose hardware.	Tighten hardware securely.
Oil leakage from plug and union.	Missing or damaged o-ring.	Install/replace o-ring.
	Loose hardware.	Tighten hardware securely.
	Seat surface failure.	Repair/replace seat surface.
	Union thread failure.	Replace union.
		Check if surge pressure & vibration are too large.

HYDRAULIC PUMP (Continued)

Problem	Cause	Solution
Noisy pump.	Cavitation occurred.	Inspect and repair pump.
	Damage to piston and connecting rod.	Replace piston & rod.
	Cylinder casing damage. High surge pressure occurred.	Replace casing.
	Shaft bearing damage.	Replace bearing.
	Chattering relief valve.	Replace relief valve.
	Pump vibration due to incorrect installation.	Correct installation.

HYDRAULIC MOTOR

Problem	Cause	Solution
No rotation.	Overload.	Reduce load.
	Wrong oil viscosity.	Replace oil with correct viscosity.
	Abrasion of internal parts due to dust, oil deterioration or cavitation.	Remove drain plug & check for metal shavings.
Oil leakage.	Damage or abrasion in the oil seal.	Replace oil seal. Inspect & repair seal contact face.
	Leaking o-ring due to loose hardware.	Replace o-ring and tighten hardware securely.
	Damaged o-ring.	Replace o-ring.
Abnormal noise.	Air in the circuit and motor.	Purge air completely.
	Cavitation	Operate so negative pressure is not generated.
Increase in oil temperature.	Lack of oil in tank.	Refill oil in tank.
	Excessive pressure.	Adjust to set pressure.

LUBRICATING SYSTEM

Problem	Cause	Solution
Pump does not start.	Power is off.	Turn on power switch & operating power switch.
		Inspect voltage of primary side with tester.
	Motor wiring is disconnected.	Inspect & repair wiring.
Pump fails to operate. Indicator on target screen.	Reservoir is empty.	Fill reservoir.
	Motor is overloaded.	Inspect & replace.
	Abrasion of plunger.	Replace cylinder & plunger.
	Plunger damage.	Replace cylinder, plunger, & connecting rod.
	Abrasion of reducer.	Replace reducer.
	Motor circuit is disconnected.	Inspect & repair the wiring.
Pump operates sporadically. (When turning off operating power and turning back on, the pump can be operated, pump stops again soon after.)	Reverse rotation of motor.	Change two of three phases.
	Air is in pump.	Close air plug.
		Purge air from tank.
	Grease too heavy.	Replace with lighter grease.
	Pipe failure.	Inspect & repair piping.
	Grease leaking from main piping and branch piping.	Inspect & repair piping.
	Main & branch piping contain air.	Disconnect several joints & purge air while operating pump.
	Failure in setting protective timer.	Set to lubricating time + 5 minutes.
	Limit switch malfunction.	Inspect & repair limit switch.
	Dirt in pressure relief valve.	Disassemble & clean.
	Hydraulic switch valve malfunction.	Disassembly & repair.
	Discharge capacity of pump is insufficient due to abrasion of cylinder and plunger.	Adjust cylinder & plunger with shims or replace.

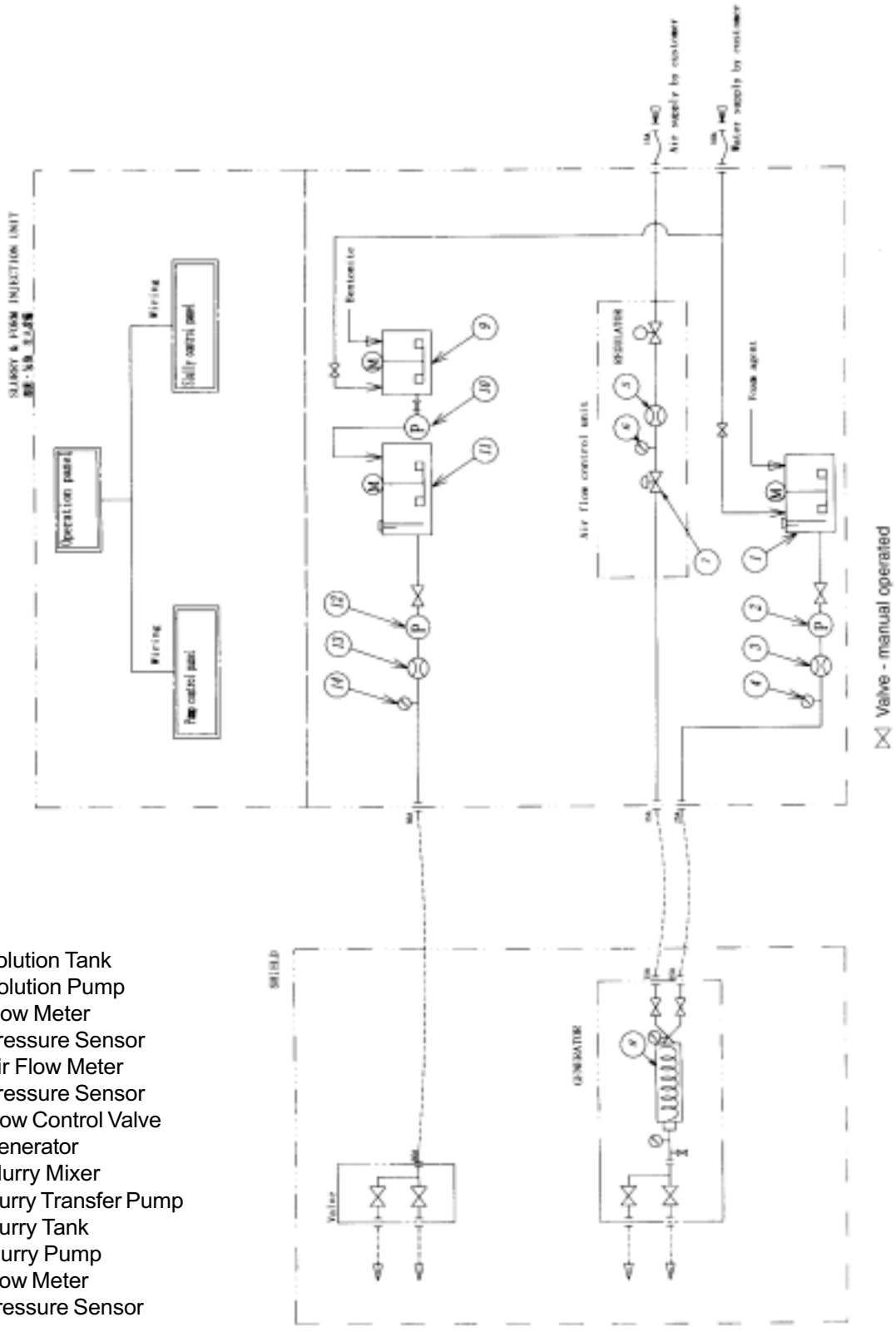
LUBRICATING SYSTEM (Continued)

Problem	Cause	Solution
Grease pump produces excessive operating noise or produces unusual noise.	Abrasion.	Replace reducer & lubricating pump unit.
	Shortage of lubricant.	Refill reservoir.
Pump pressure gauge fluctuates excessively.	Air is in main & branch piping.	Disconnect several joints pure air while operating pump.
Water in reservoir.	Poor quality grease.	Refer to Lubricants section for proper grease.
	Pump is splashed with water.	Install protecting cover.
	Check valve malfunction.	Disassemble & clean check valve or replace.
Some of the indicator rods attached to distributors fail to operate.	Bearing is blocked.	Check & repair.
	Sub-supply pipe is crushed.	Inspect & repair pipe.
	Reversing pressure of hydraulic operated reversing valve is too low.	Adjust reversing pressure.
	Dirt in distributor.	Disassemble & clean distributor or replace.

SCAVENGING PUMPS

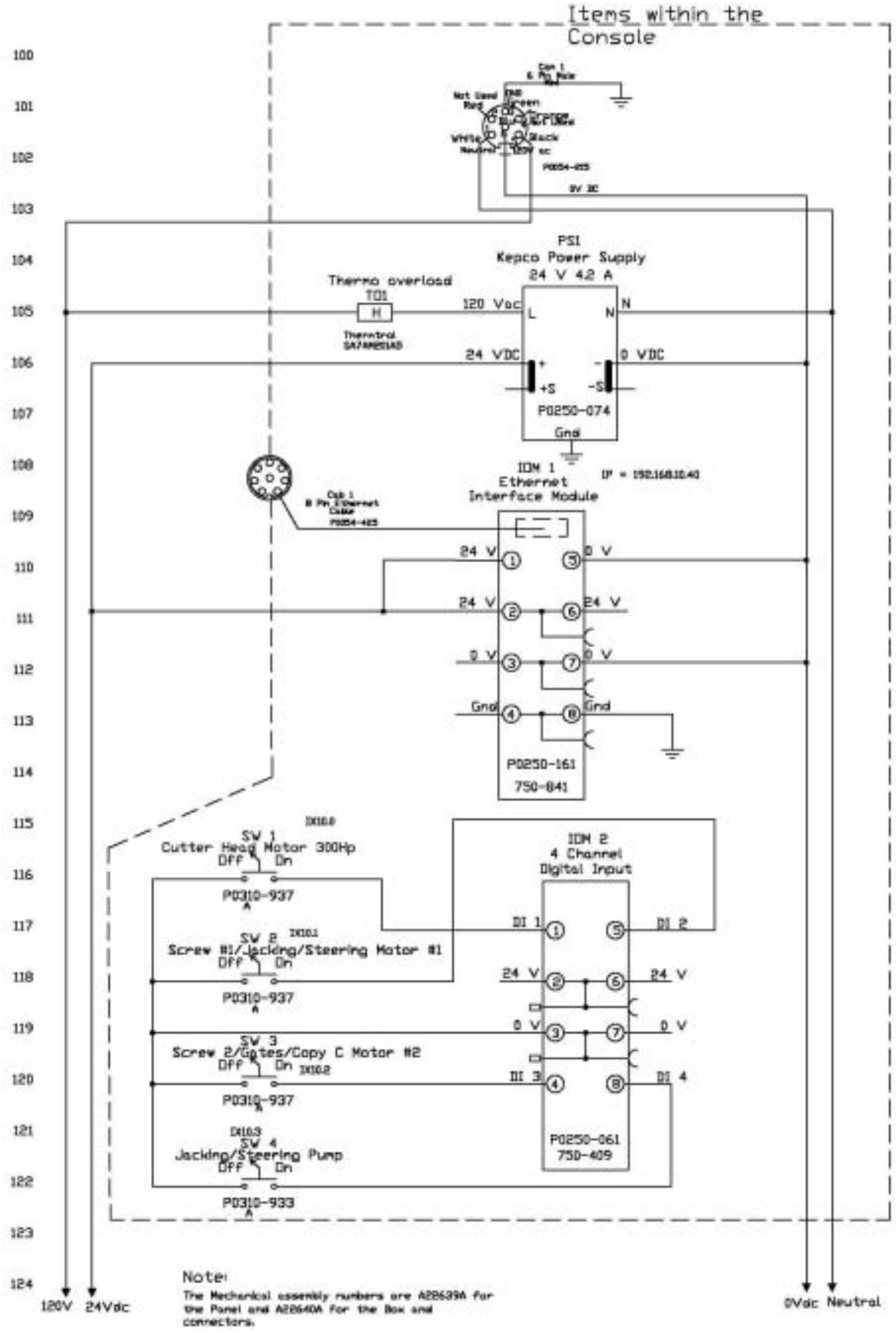
Problem	Cause	Solution
Hydraulic oil overflows out of breather.	Pump is not connected to 110V power source.	Connect to 110V power.
	E-Stop button not pulled out.	Twist E-Stop button clockwise while pulling out.
	Excessive case drain flow.	Motor malfunction, repair.

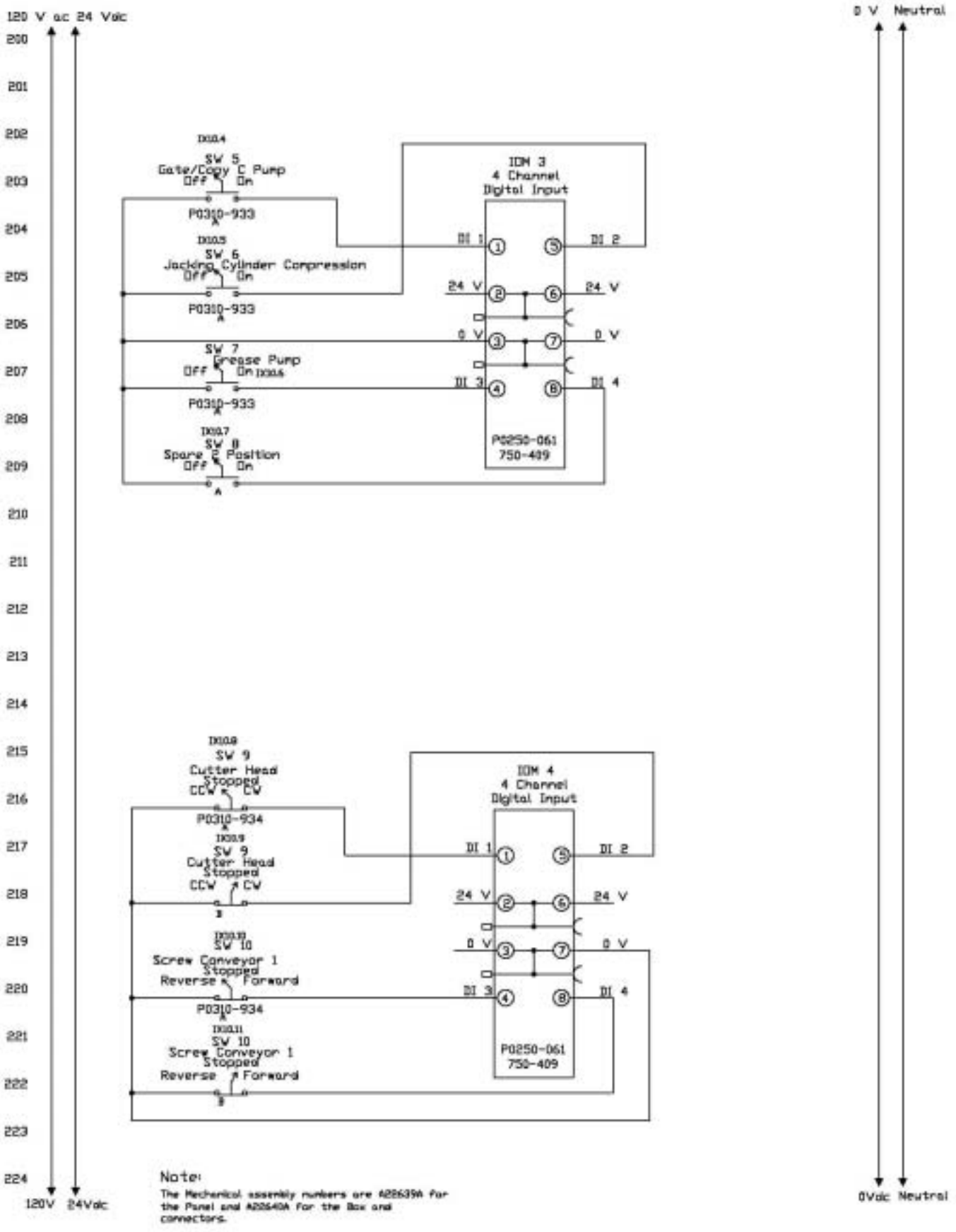
FOAM & SLURRY PLANT INJECTION SYSTEM FLOW DIAGRAM



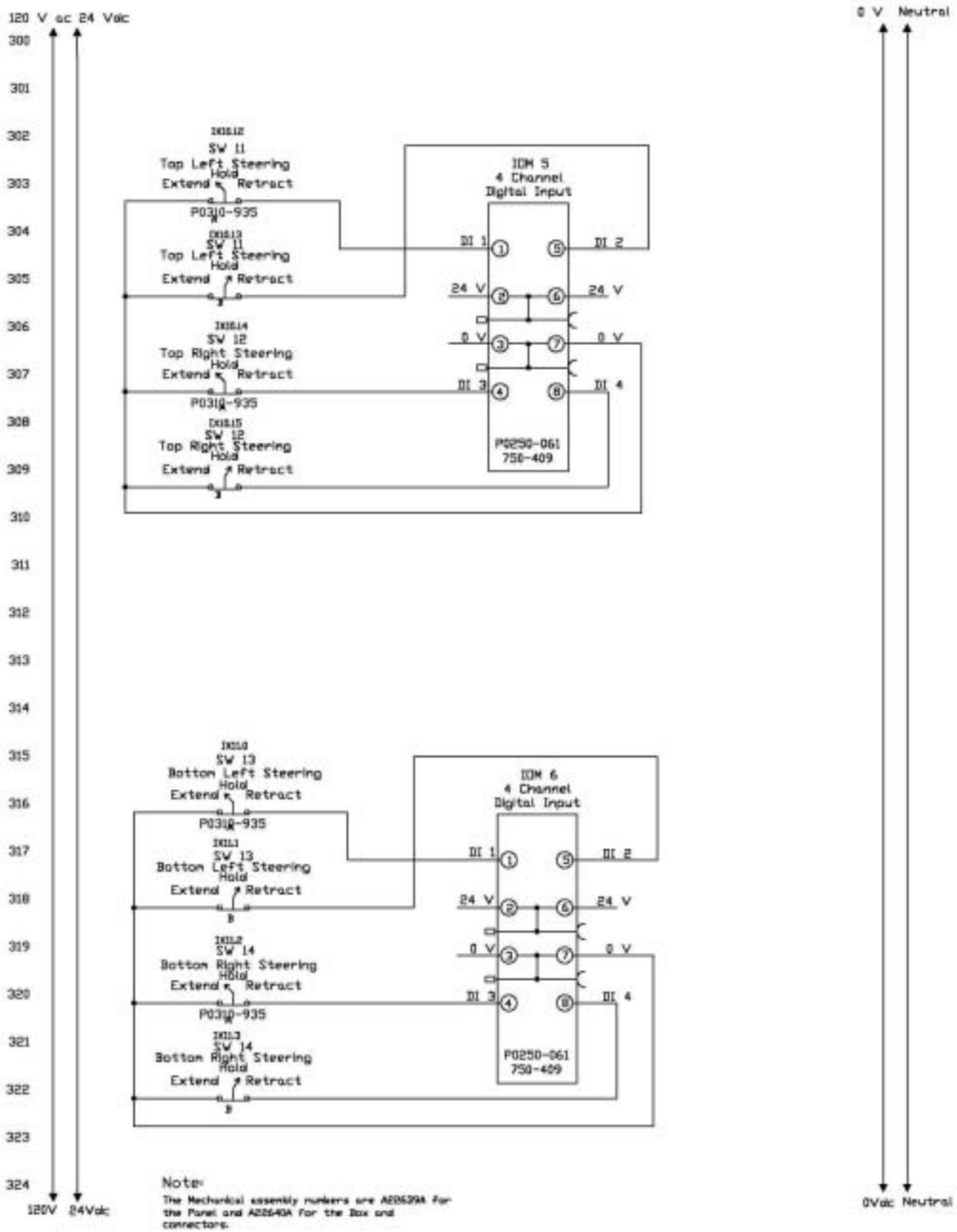
1 - Solution Tank
2 - Solution Pump
3 - Flow Meter
4 - Pressure Sensor
5 - Air Flow Meter
6 - Pressure Sensor
7 - Flow Control Valve
8 - Generator
9 - Slurry Mixer
10 - Slurry Transfer Pump
11 - Slurry Tank
12 - Slurry Pump
13 - Flow Meter
14 - Pressure Sensor

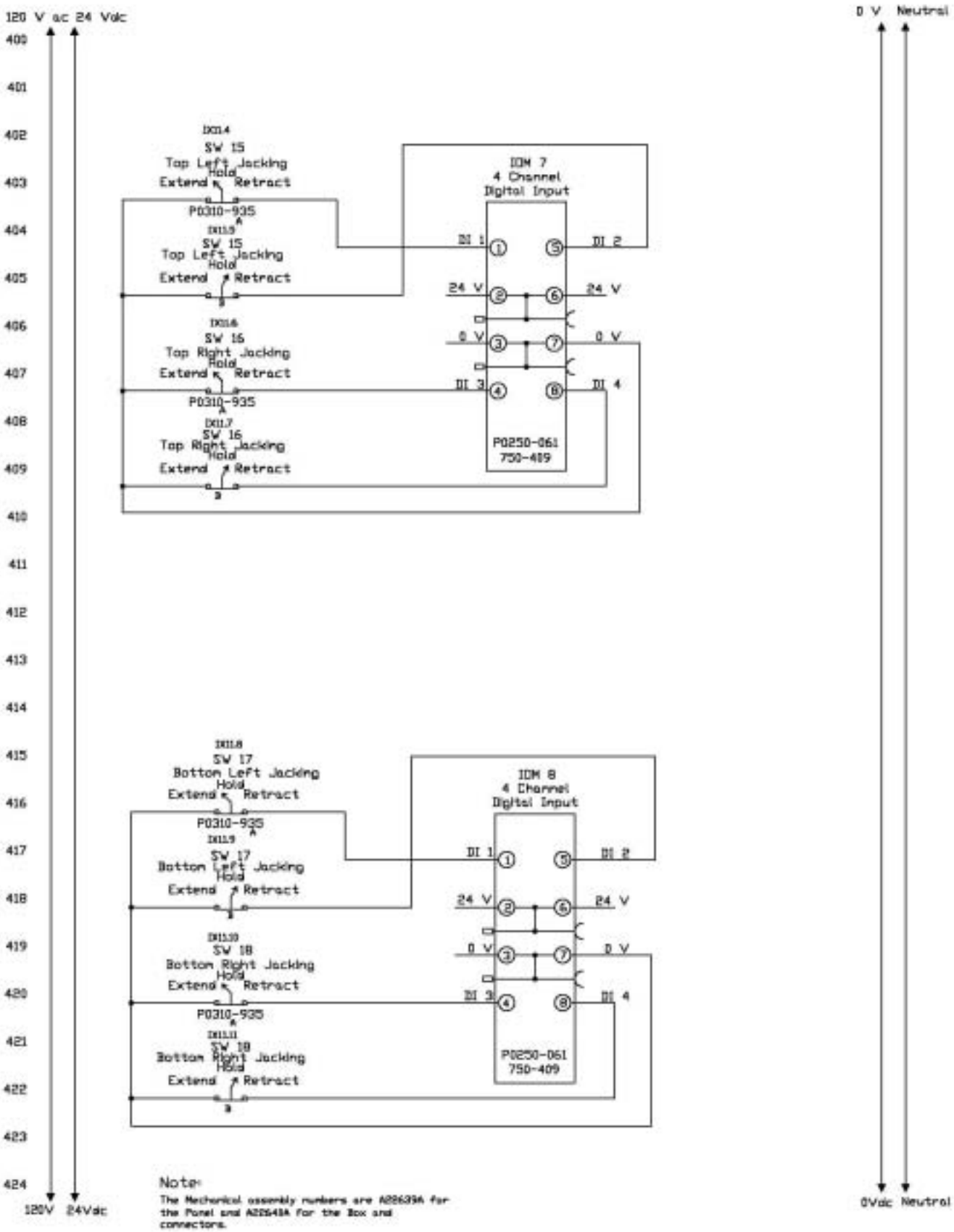
ELECTRICAL SCHEMATICS - CONSOLE

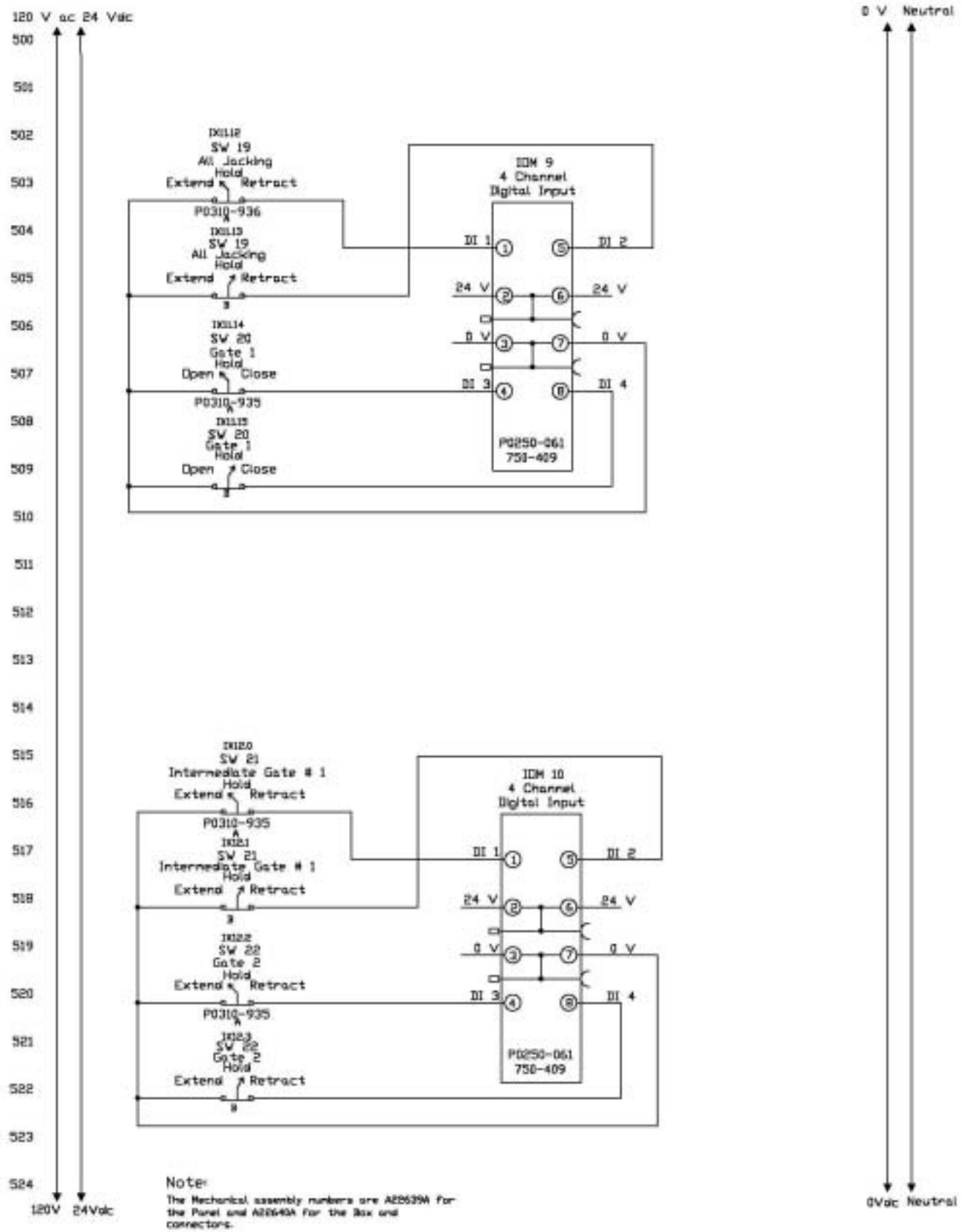




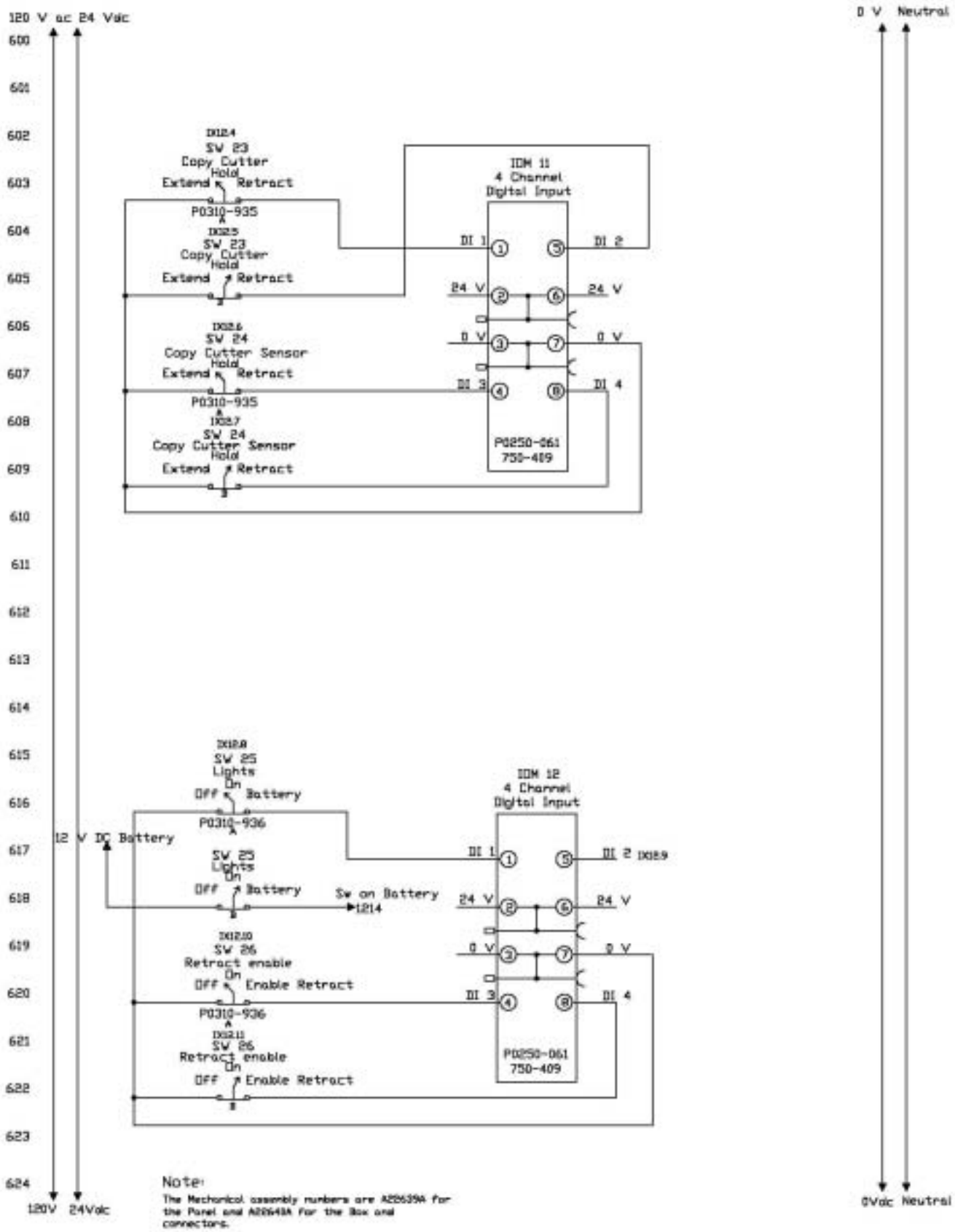
Note:
The Mechanical assembly numbers are 428639A for the Panel and 428640A for the Box and connectors.

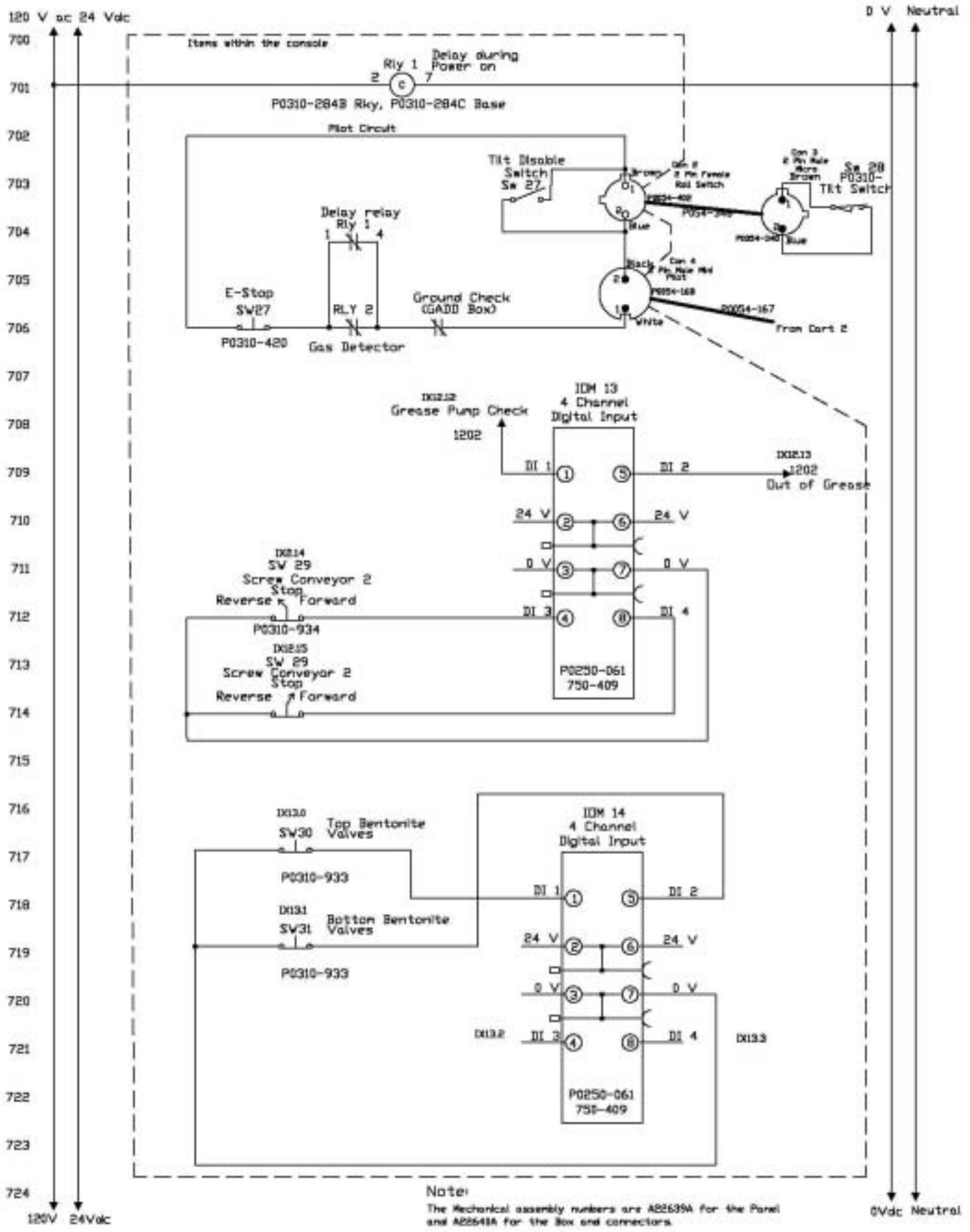

120 V ac 24 Vdc
0 V Neutral
IXI8.12
SW 11
Top Left Steering
Hold
Extend
Retract
P0310-935
IXI8.13
SW 11
Top Left Steering
Hold
Extend
Retract
IXI8.14
SW 12
Top Right Steering
Hold
Extend
Retract
P0310-935
IXI8.15
SW 12
Top Right Steering
Hold
Extend
Retract
IOM 5
4 Channel
Digital Input
DI 1
DI 2
24 V
24 V
0 V
0 V
DI 3
DI 4
P0250-061
750-409
IXI1.0
SW 13
Botton Left Steering
Hold
Extend
Retract
P0310-935
IXI1.1
SW 13
Botton Left Steering
Hold
Extend
Retract
IXI1.2
SW 14
Botton Right Steering
Hold
Extend
Retract
P0310-935
IXI1.3
SW 14
Botton Right Steering
Hold
Extend
Retract
IOM 6
4 Channel
Digital Input
DI 1
DI 2
24 V
24 V
0 V
0 V
DI 3
DI 4
P0250-061
750-409
Note:
The Mechanical assembly numbers are A226398A for the Panel and A226540A for the Box and connectors.
120V 24Vdc
0Vdc Neutral

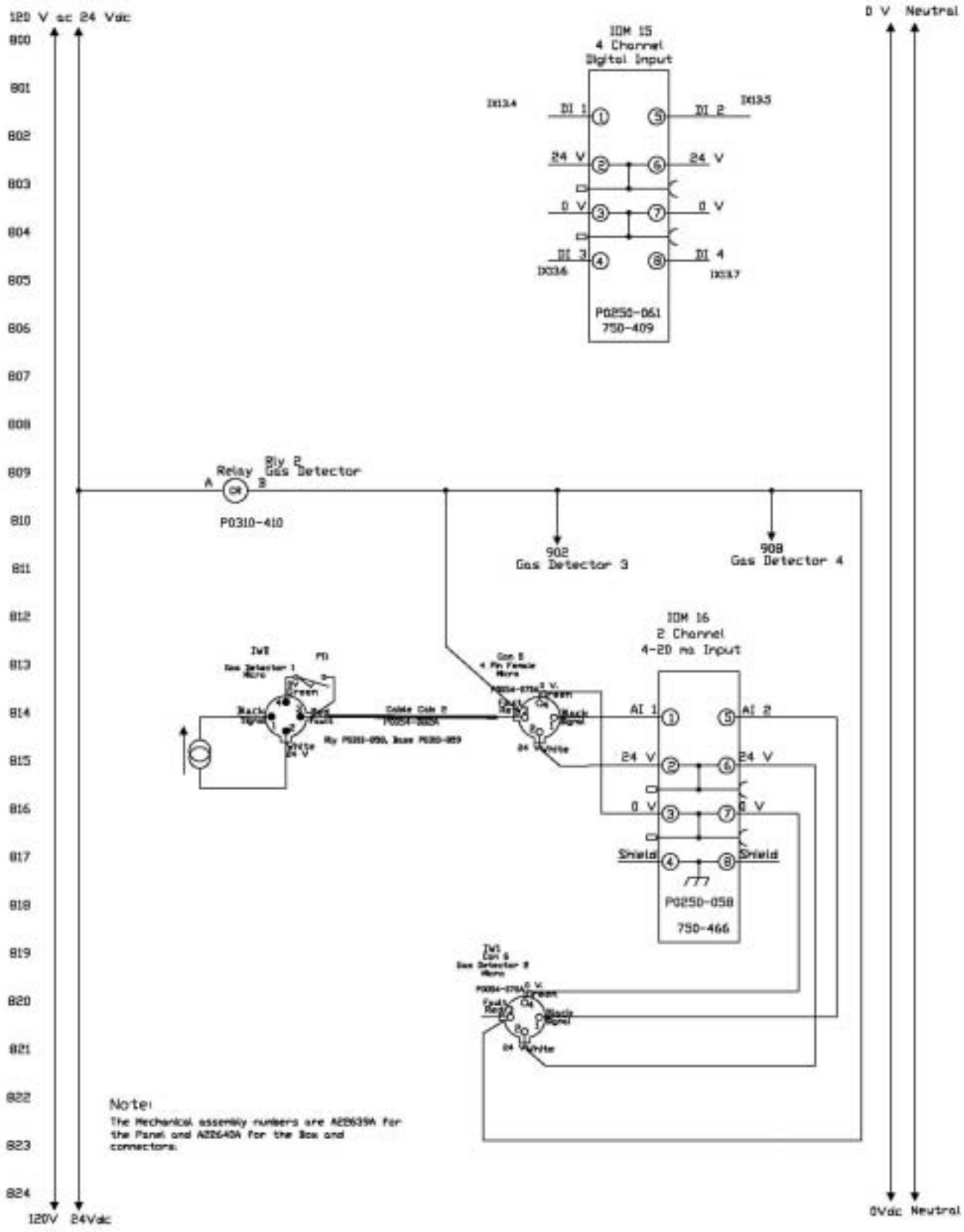

120 V ac 24 Vdc
0 V Neutral
IDM 7
4 Channel
Digital Input
SW 15
Top Left Jacking
Hold
Extend
Retract
P0310-935
SW 16
Top Right Jacking
P0250-061
750-409
IDM 8
SW 17
Botton Left Jacking
SW 18
Botton Right Jacking
DI 1
DI 2
DI 3
DI 4
24 V
0 V
120V 24Vdc
0Vdc Neutral
Note:
The Mechanical assembly numbers are A226394A for the Panel and A225418A for the Box and connectors.

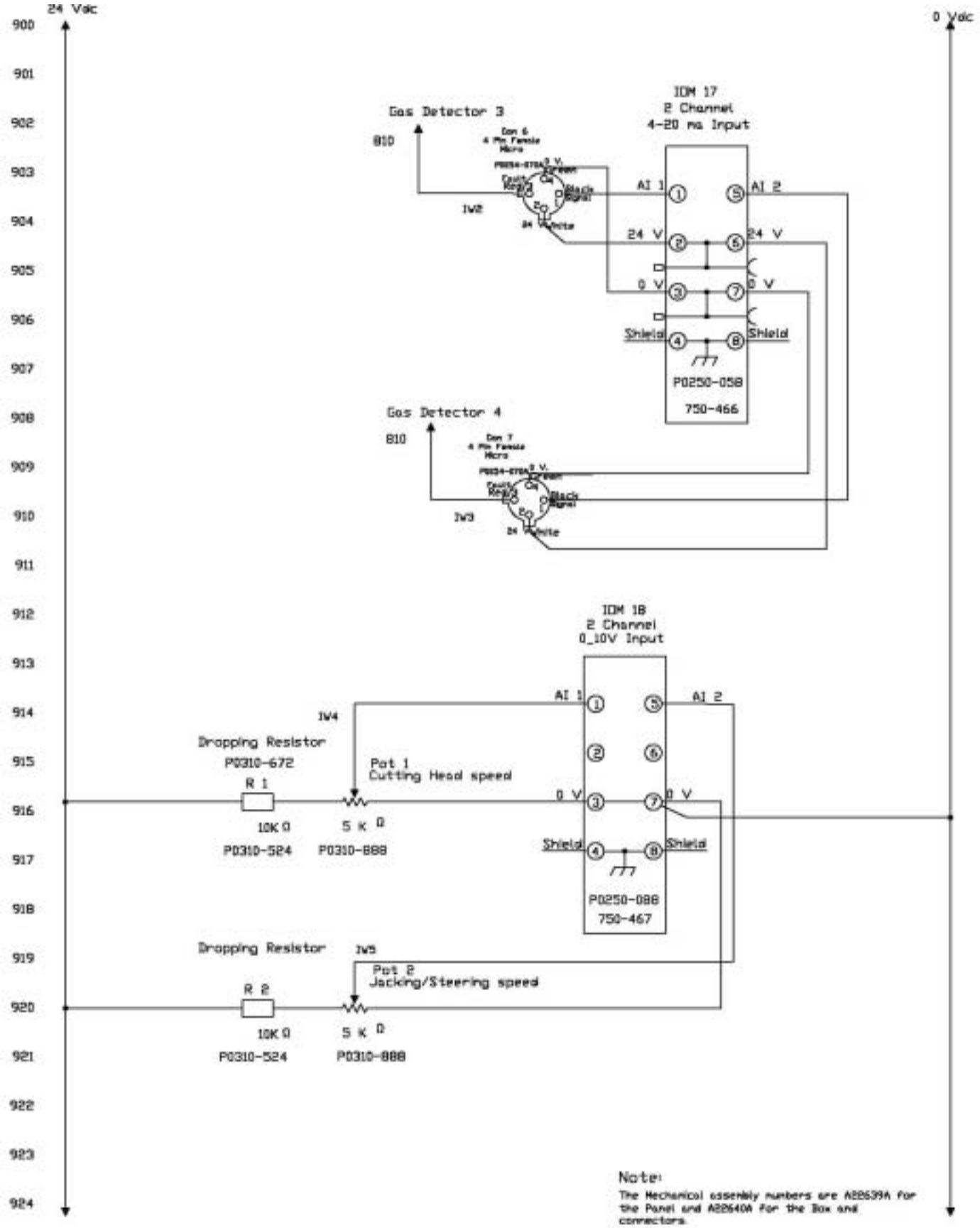


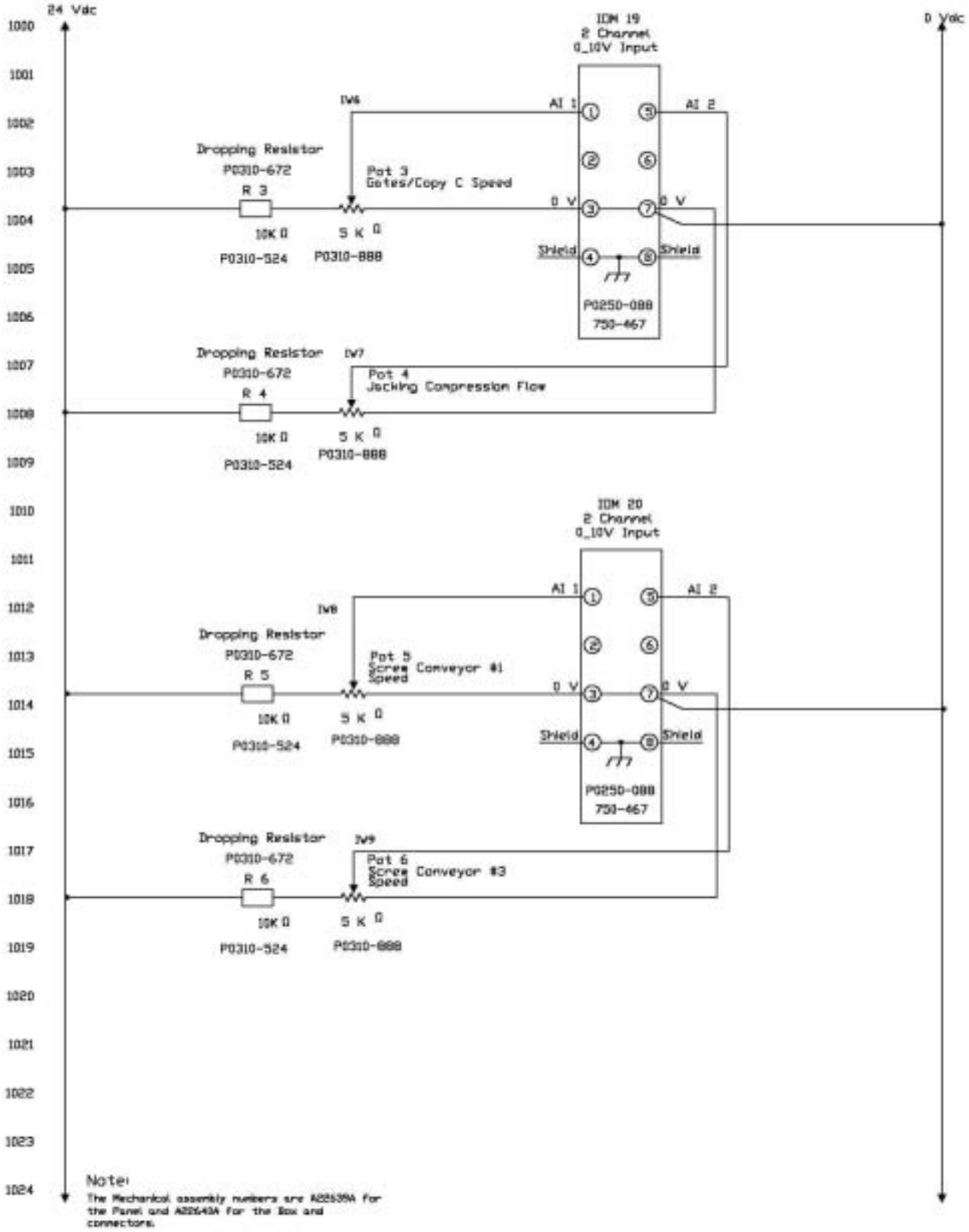
Note:
The Mechanical assembly numbers are A20639A for the Panel and A20640A for the Box and connectors.

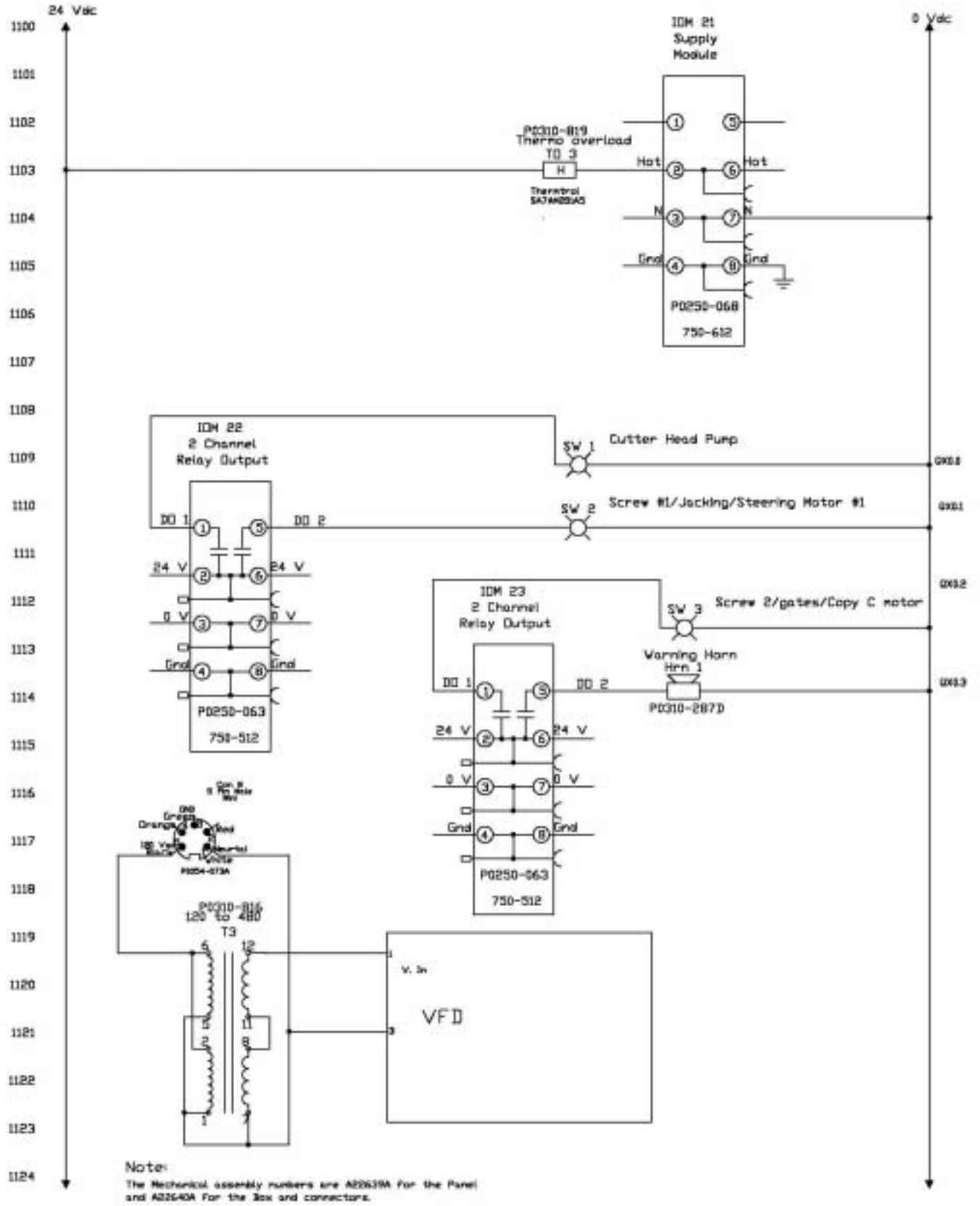

120 V ac 24 Vdc
0 V Neutral
600
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
621
622
623
624
IX12.4
SW 23
Copy Cutter
Hold
Extend
Retract
P0310-935
IX12.5
SW 23
Copy Cutter
Hold
Extend
Retract
IX12.6
SW 24
Copy Cutter Sensor
Hold
Extend
Retract
P0310-935
IX12.7
SW 24
Copy Cutter Sensor
Hold
Extend
Retract
IDM 11
4 Channel
Digital Input
DI 1
DI 2
24 V
24 V
0 V
0 V
DI 3
DI 4
P0250-061
750-409
IX12.8
SW 25
Lights
On
Off
Battery
P0310-936
12 V DC Battery
SW 25
Lights
On
Off
Battery
Sw on Battery
1214
IX12.10
SW 26
Retract enable
On
Off
Enable Retract
P0310-936
IX12.11
SW 26
Retract enable
On
Off
Enable Retract
IDM 12
4 Channel
Digital Input
DI 1
DI 2 IX12.9
24 V
24 V
0 V
0 V
DI 3
DI 4
P0250-061
750-409
120V 24Vdc
0Vdc Neutral
Note:
The Mechanical assembly numbers are A22639A for the Panel and A22640A for the Box and connectors.

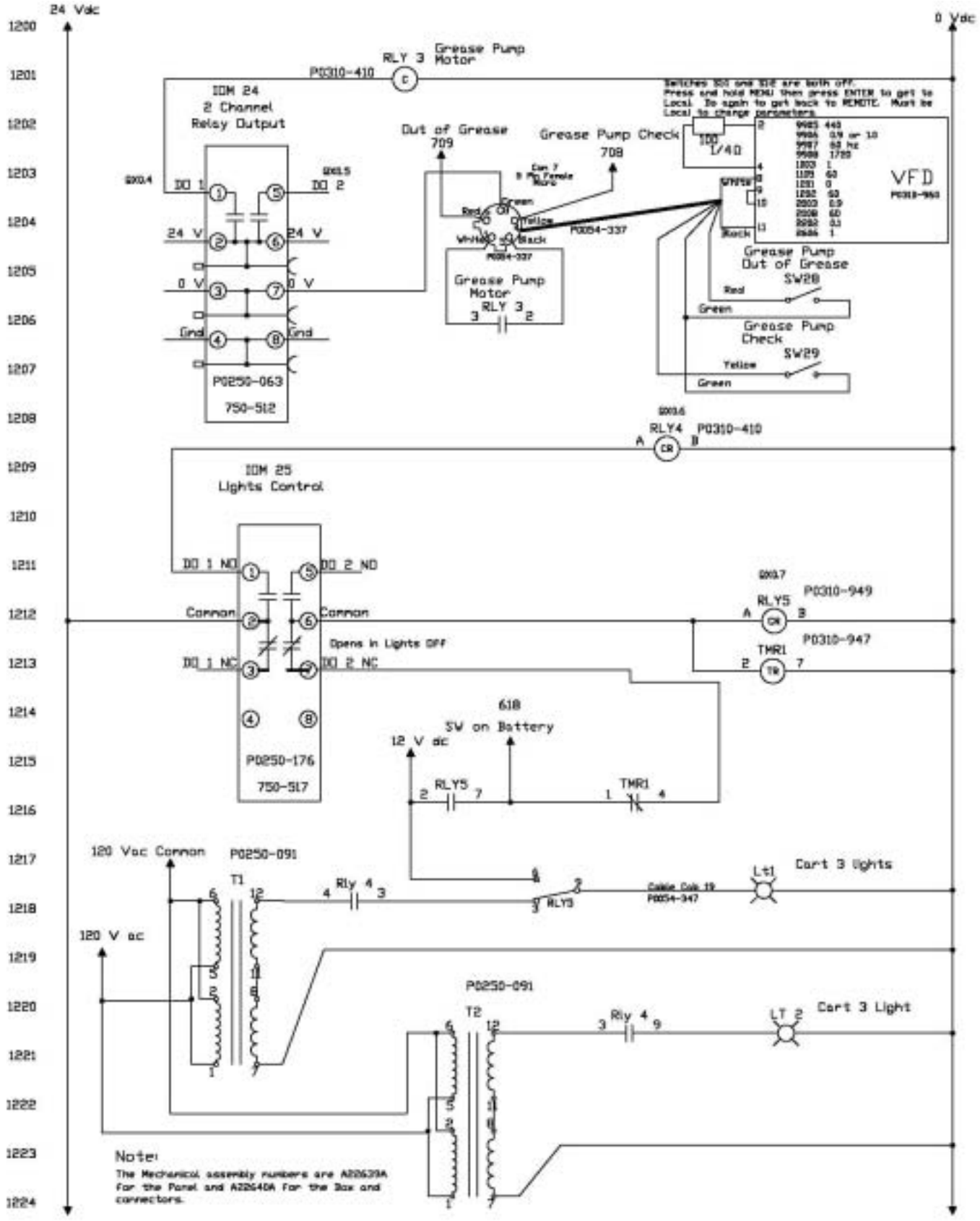

120 V ac 24 Vdc
0 V Neutral
Items within the console
Rly 1 Delay during Power on
P0310-284B Rly, P0310-284C Base
Pilot Circuit
Tilt Disable Switch Sw 27
Sw 28 P0310- Tilt Switch
Delay relay Rly 1
E-Stop SW27
RLY 2
Ground Check (GADD Box)
P0310-420
Gas Detector
From Cart 2
IDM 13 4 Channel Digital Input
Grease Pump Check 1202
Out of Grease 1202
SW 29 Screw Conveyor 2 Stop Reverse Forward
P0310-934
P0250-061 750-409
IDM 14 4 Channel Digital Input
SW30 Top Bentonite Valves
P0310-933
SW31 Bottom Bentonite Valves
P0310-933
Note:
The Mechanical assembly numbers are A82639A for the Panel and A82648A for the Box and connectors.
120V 24Vdc
0Vdc Neutral


120 V ac 24 Vdc
0 V Neutral
IDM 15
4 Channel
Digital Input
DI 1
DI 2
24 V
0 V
DI 3
DI 4
P0250-061
750-409
Rly 2
Relay Gas Detector
P0310-410
902
Gas Detector 3
908
Gas Detector 4
IDM 16
2 Channel
4-20 ma Input
AI 1
AI 2
Shield
P0250-058
750-466
Note:
The Mechanical assembly numbers are AE2639A for the Panel and AE2640A for the Box and connectors.
120V 24Vdc
0Vdc Neutral

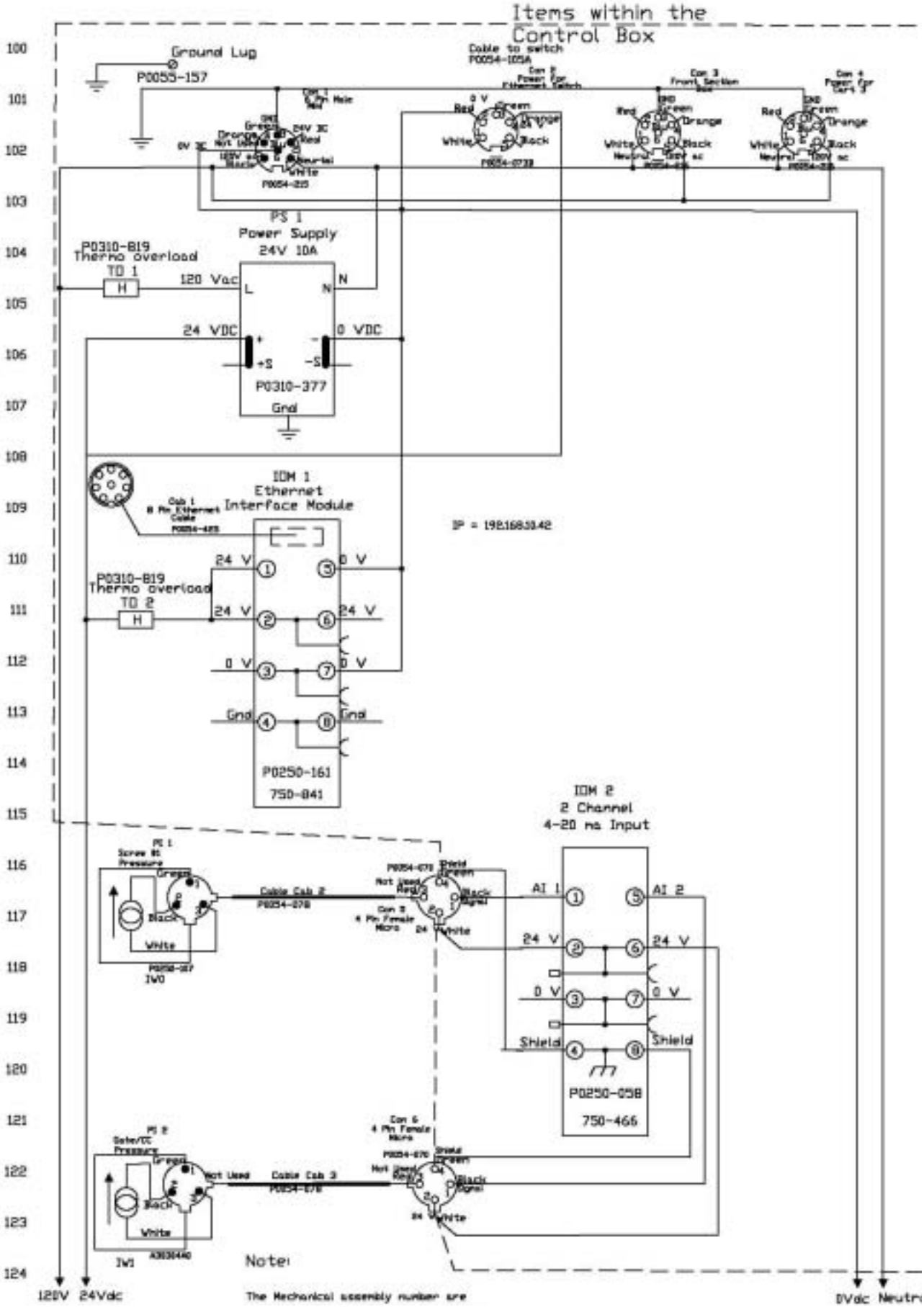

24 Vdc
0 Vdc
IDM 17
2 Channel
4-20 ma Input
Gas Detector 3
810
IW2
AI 1
AI 2
24 V
0 V
Shield
P0250-058
750-466
Gas Detector 4
810
IW3
IDM 18
2 Channel
0_10V Input
IW4
Dropping Resistor
P0310-672
R 1
10K Ω
P0310-524
Pot 1
Cutting Head speed
5 K Ω
P0310-888
P0250-088
750-467
Dropping Resistor
IW5
Pot 2
Jacking/Steering speed
R 2
10K Ω
P0310-524
5 K Ω
P0310-888
Note:
The Mechanical assembly numbers are A22639A for the Panel and A22640A for the Box and connectors.

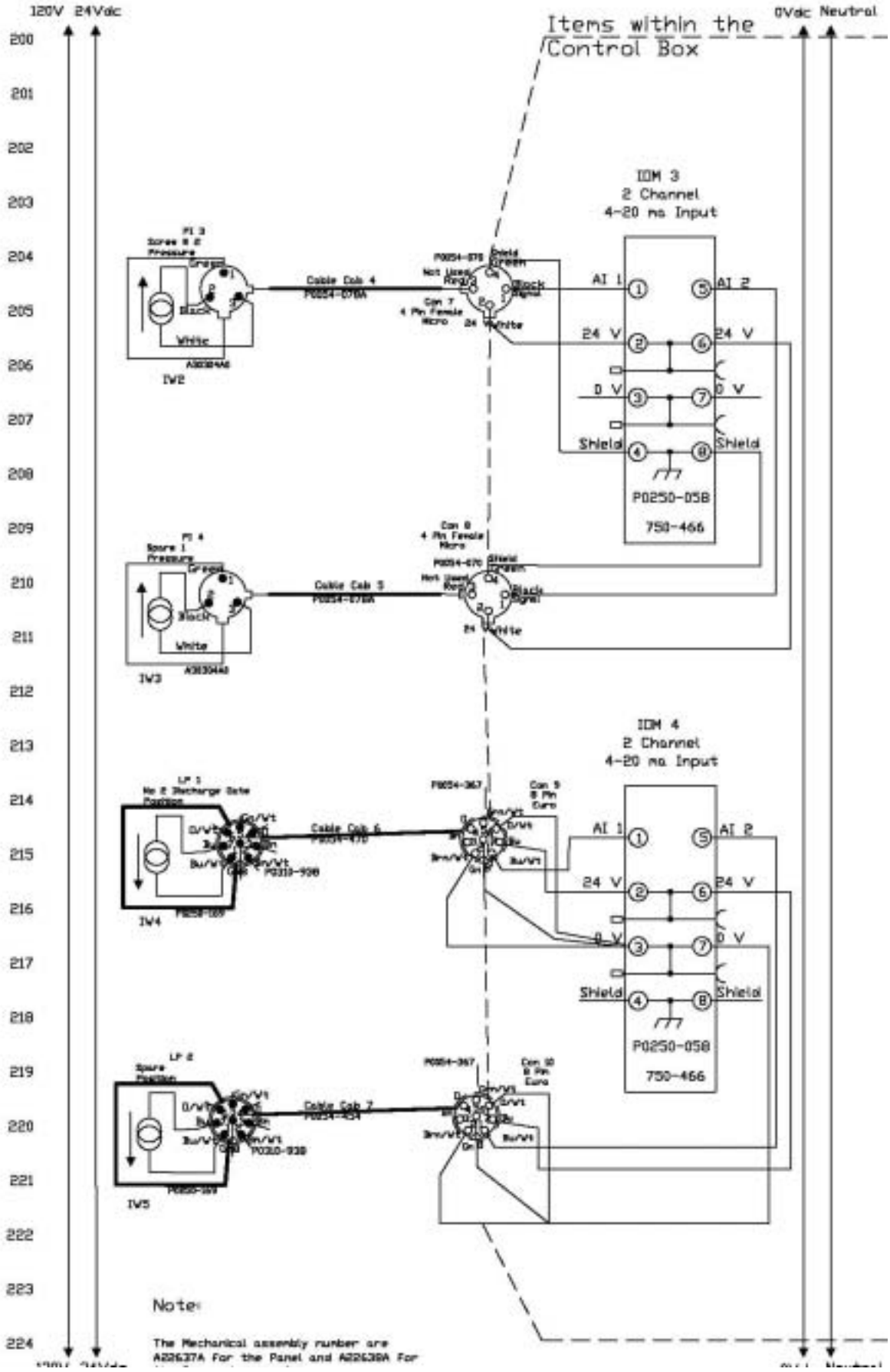

24 Vdc
0 Vdc
IDM 19
2 Channel
0_10V Input
AI 1
AI 2
IV6
Dropping Resistor
P0310-672
R 3
Pot 3
Gates/Copy C Speed
10K Ω
5 K Ω
P0310-524
P0310-888
0 V
Shield
P0250-088
750-467
Dropping Resistor
P0310-672
IV7
Pot 4
Jacking Compression Flow
R 4
10K Ω
5 K Ω
P0310-524
P0310-888
IDM 20
2 Channel
0_10V Input
AI 1
AI 2
IV8
Dropping Resistor
P0310-672
Pot 5
Screw Conveyor #1
Speed
R 5
10K Ω
5 K Ω
P0310-524
P0310-888
0 V
Shield
P0250-088
750-467
Dropping Resistor
P0310-672
IV9
Pot 6
Screw Conveyor #3
Speed
R 6
10K Ω
5 K Ω
P0310-524
P0310-888
Note:
The Mechanical assembly numbers are A22539A for the Panel and A22540A for the Box and connectors.

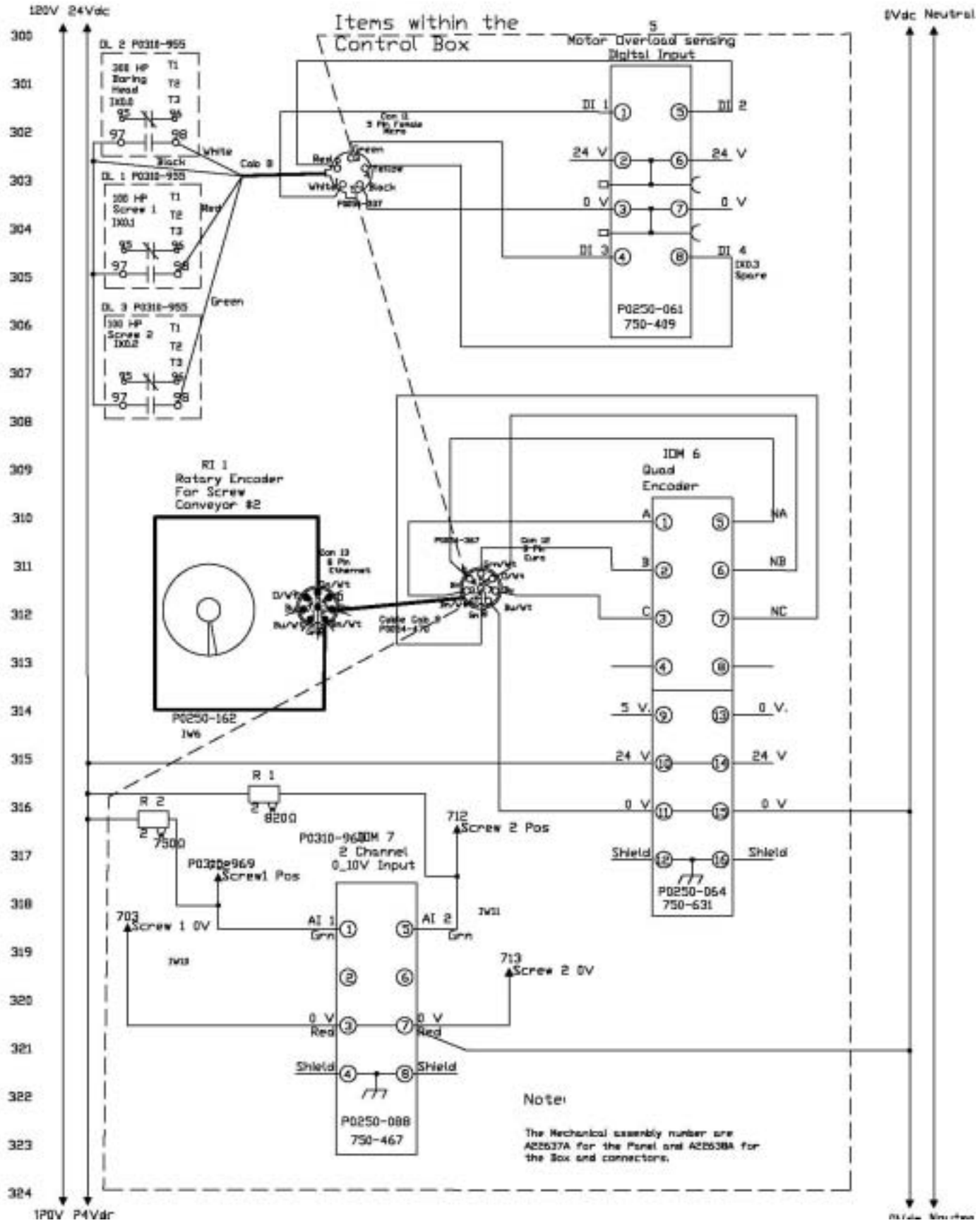

24 Vdc
0 Vdc
IDM 21
Supply
Module
P0310-819
Thermo overload
TD 3
Hot
N
Gnd
P0250-068
750-632
IDM 22
2 Channel
Relay Output
SW 1
Cutter Head Pump
SW 2
Screw #1/Jacking/Steering Motor #1
DO 1
DO 2
24 V
0 V
Gnd
P0250-063
750-512
IDM 23
2 Channel
Relay Output
SW 3
Screw 2/gates/Copy C motor
Warning Horn
Hrn 1
P0310-287D
P0310-816
120 to 480
T3
VFD
Note:
The Mechanical assembly numbers are A22639A for the Panel
and A22640A for the Box and connectors.

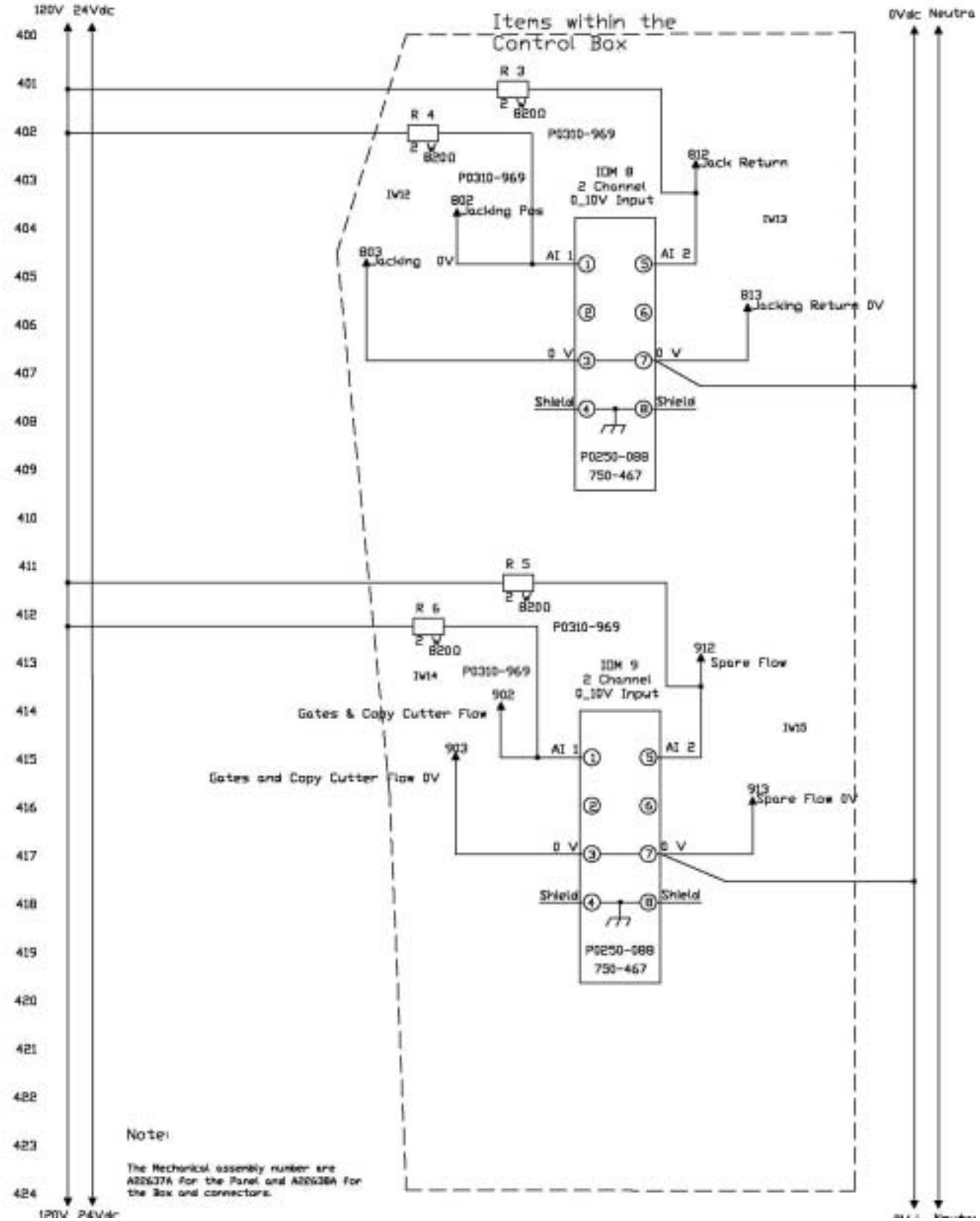

24 Vdc
0 Vdc
RLY 3 Grease Pump Motor
P0310-410
IOM 24
2 Channel
Relay Output
DO 1
DO 2
24 V
0 V
Gnd
P0250-063
750-512
Out of Grease
709
Grease Pump Check
708
P0054-337
Grease Pump Motor RLY 3
Grease Pump Out of Grease SW28
Grease Pump Check SW29
VFD
RLY4 P0310-410
IOM 25
Lights Control
DO 1 NO
DO 2 NO
Common
DO 1 NC
DO 2 NC
Opens in Lights OFF
P0250-176
750-517
RLY5 P0310-949
TMR1 P0310-947
618
SW on Battery
12 V ac
120 Vac Common
P0250-091
T1
T2
Rly 4
RLY3
Cable Cab 19
P0054-347
Lt1
Cart 3 Lights
LT 2
Cart 3 Light
120 V ac
Note:
The Mechanical assembly numbers are A22639A for the Panel and A22640A for the Box and connectors.

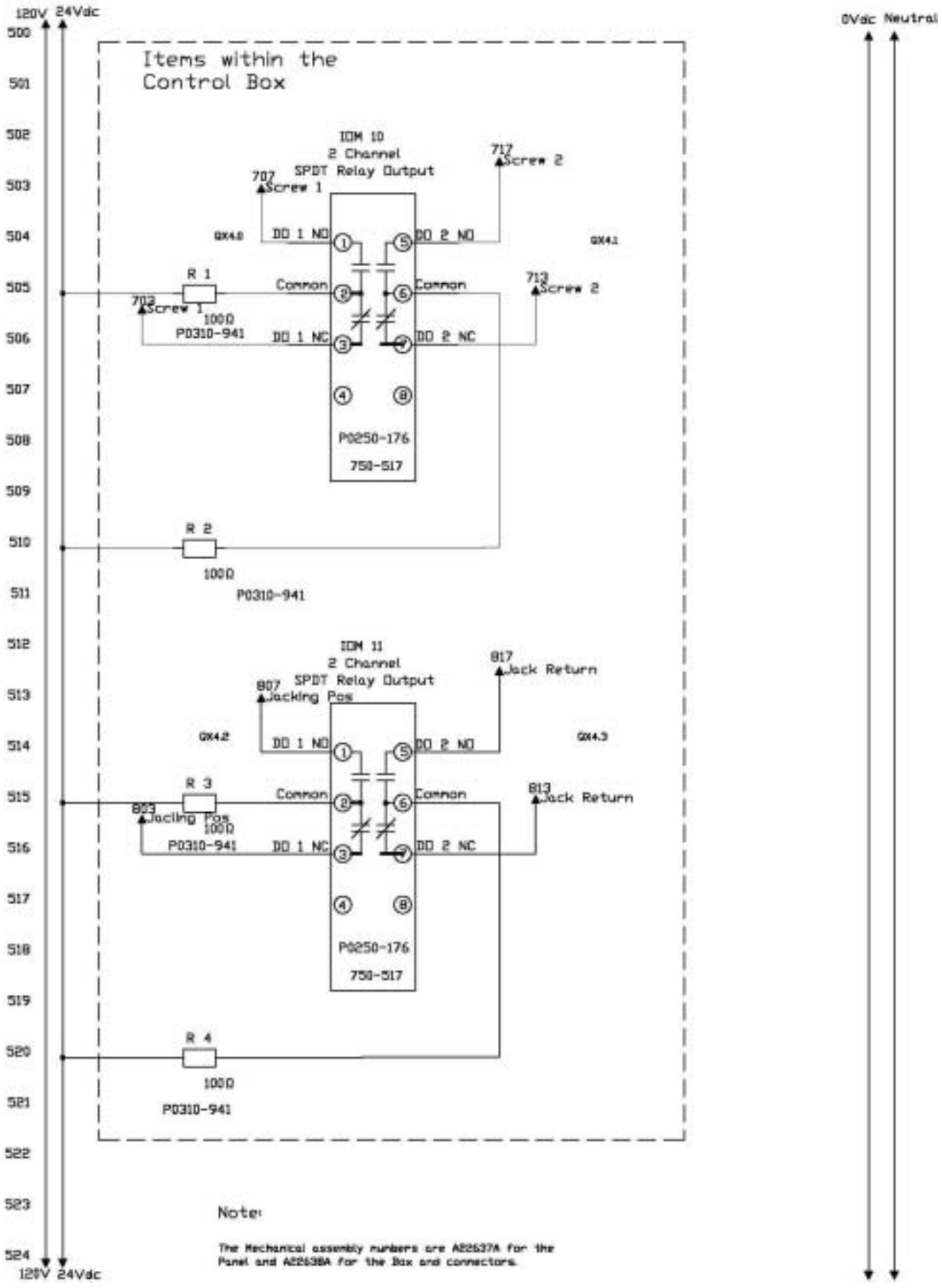
ELECTRICAL SCHEMATICS - BACKUP CAR #2

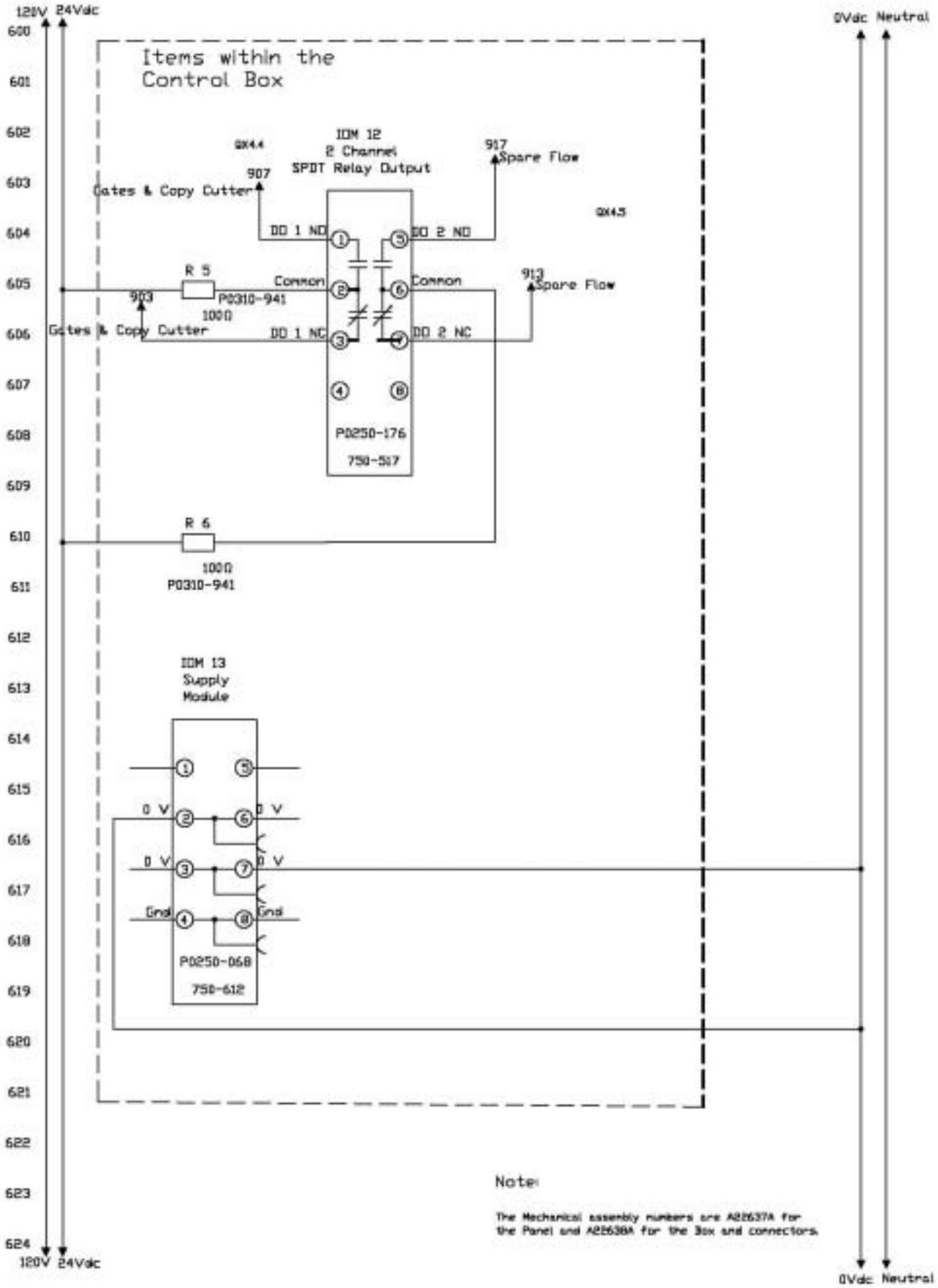


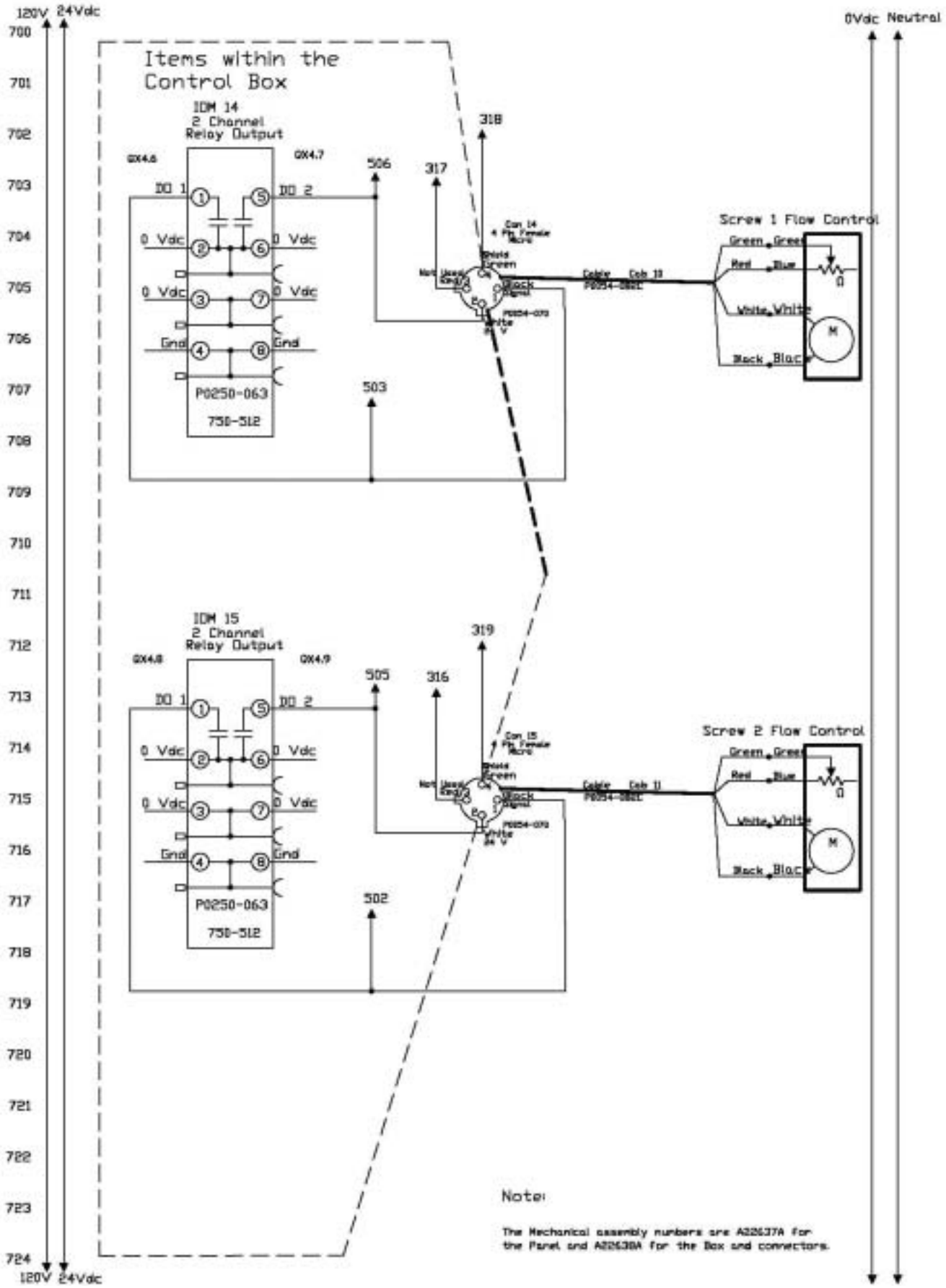

120V 24Vdc
0Vdc Neutral
Items within the Control Box
IOM 3
2 Channel
4-20 ma Input
AI 1
AI 2
24 V
0 V
Shield
P0250-058
750-466
IOM 4
2 Channel
4-20 ma Input
AI 1
AI 2
24 V
0 V
Shield
P0250-058
750-466
IW2
IW3
IW4
IW5
Cable Cab 4
Cable Cab 5
Cable Cab 6
Cable Cab 7
Black
White
Shield
Note:
The Mechanical assembly number are
A22637A For the Panel and A22638A For

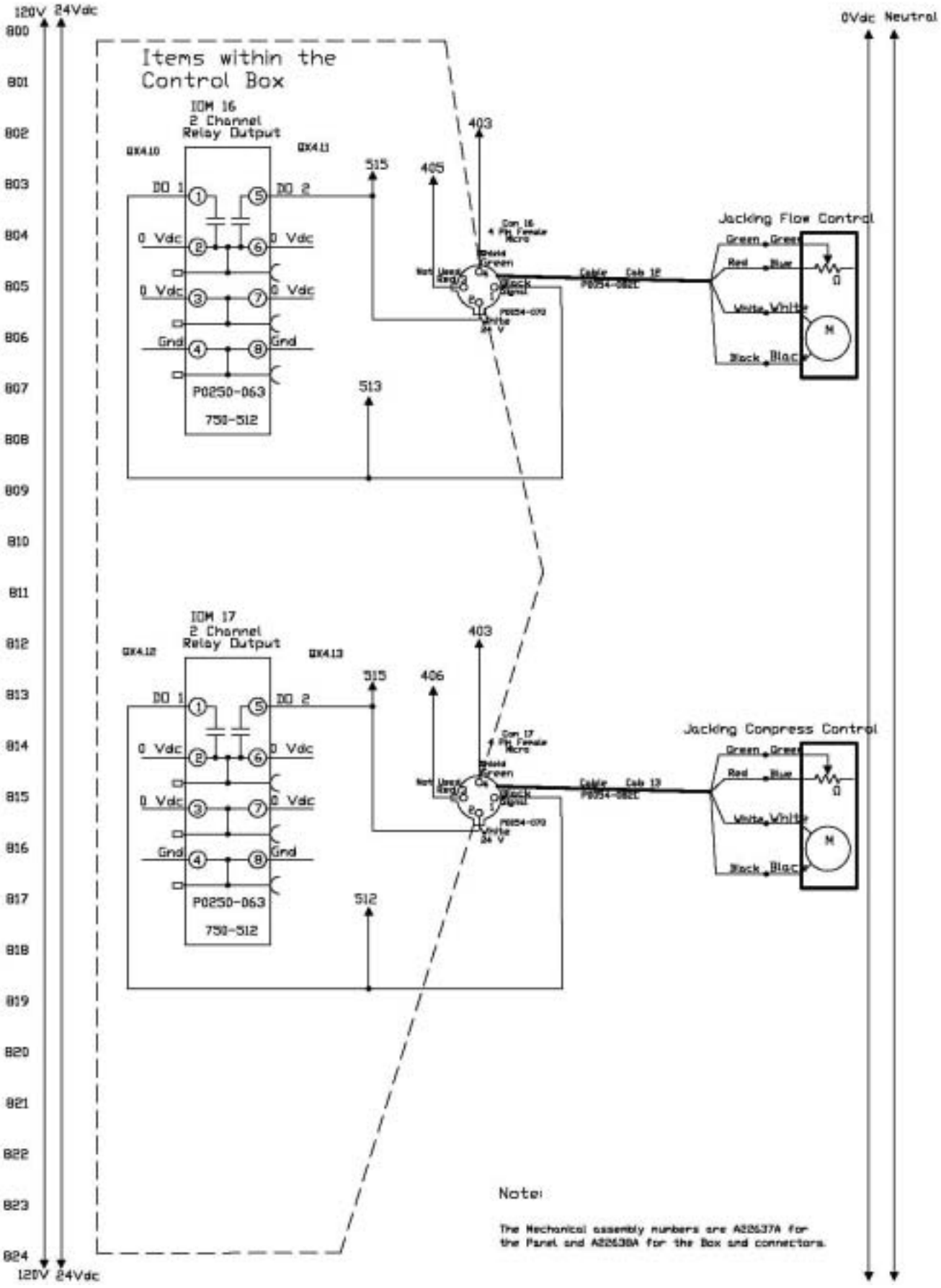

120V 24Vdc
Items within the Control Box
5
Motor Overload sensing Digital Input
DI 1
DI 2
24 V
0 V
DI 3
DI 4
P0250-061
750-409
DL 2 P0318-955
DL 1 P0318-955
DL 3 P0318-955
White
Black
Green
Red
RI 1
Rotary Encoder For Screw Conveyor #2
P0250-162
IDM 6
Quad Encoder
A
B
C
NA
NB
NC
5 V.
0 V.
Shield
P0250-064
750-631
R 1
8200
R 2
7500
712
Screw 2 Pos
P0310-969
IDM 7
2 Channel 0_10V Input
Screw1 Pos
703
Screw 1 0V
713
Screw 2 0V
AI 1
AI 2
Grn
P0250-088
750-467
Note:
The Mechanical assembly number are A25537A for the Panel and A25538A for the Box and connectors.
8Vdc Neutral
120V 24Vdc

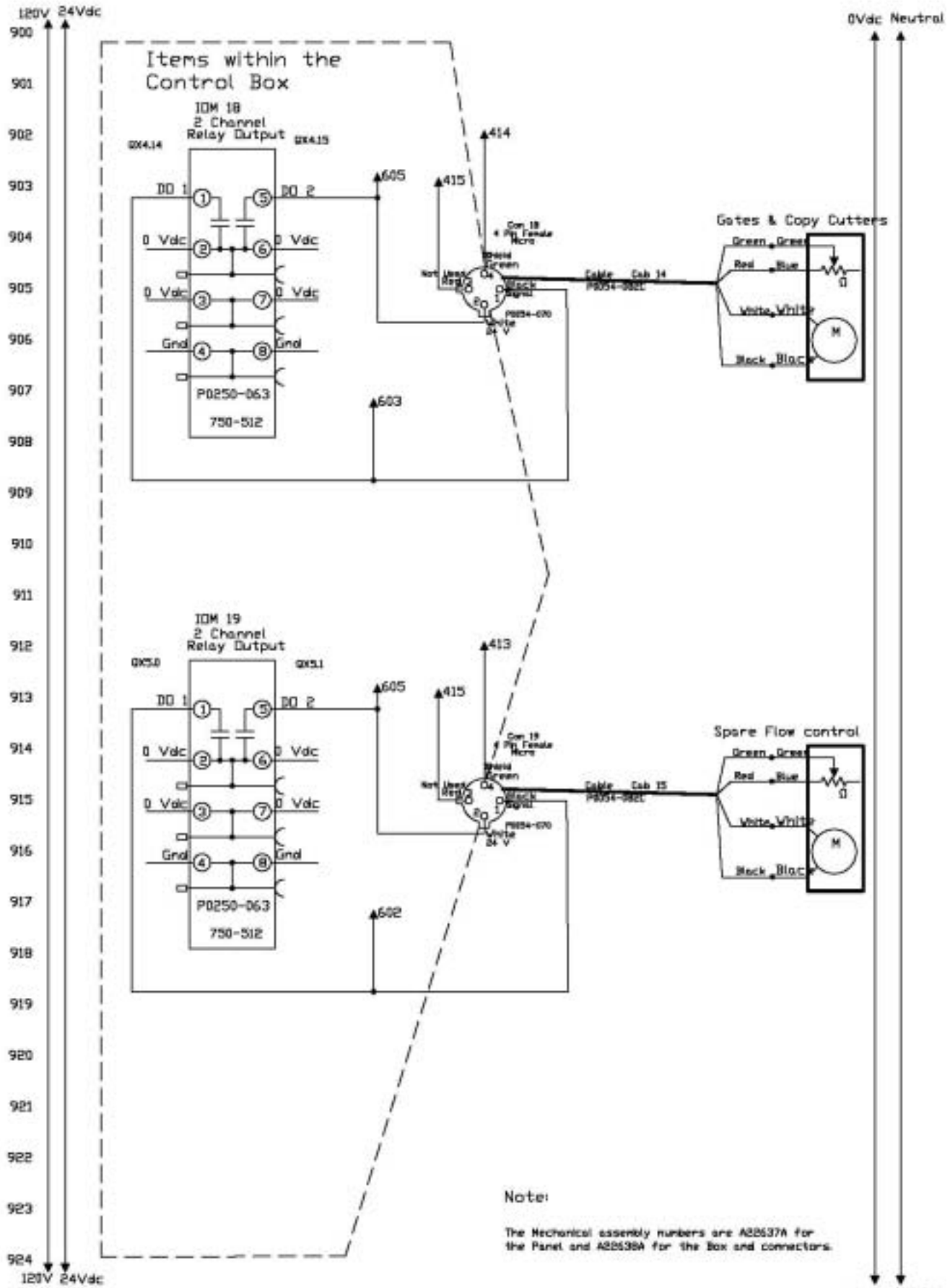

120V 24Vdc
0Vdc Neutro
Items within the Control Box
R 3
R 4
R 5
R 6
820Ω
P0310-969
IV12
IV13
IV14
IV15
IOM 8
2 Channel
0_10V Input
IOM 9
2 Channel
0_10V Input
802 Jacking Pos
803 Jacking 0V
812 Jack Return
813 Jacking Return 0V
902 Gates & Copy Cutter Flow
903 Gates and Copy Cutter Flow 0V
912 Spare Flow
913 Spare Flow 0V
AI 1
AI 2
0 V
Shield
P0250-088
750-467
Note:
The Mechanical assembly number are A22637A for the Panel and A22638A for the Box and connectors.

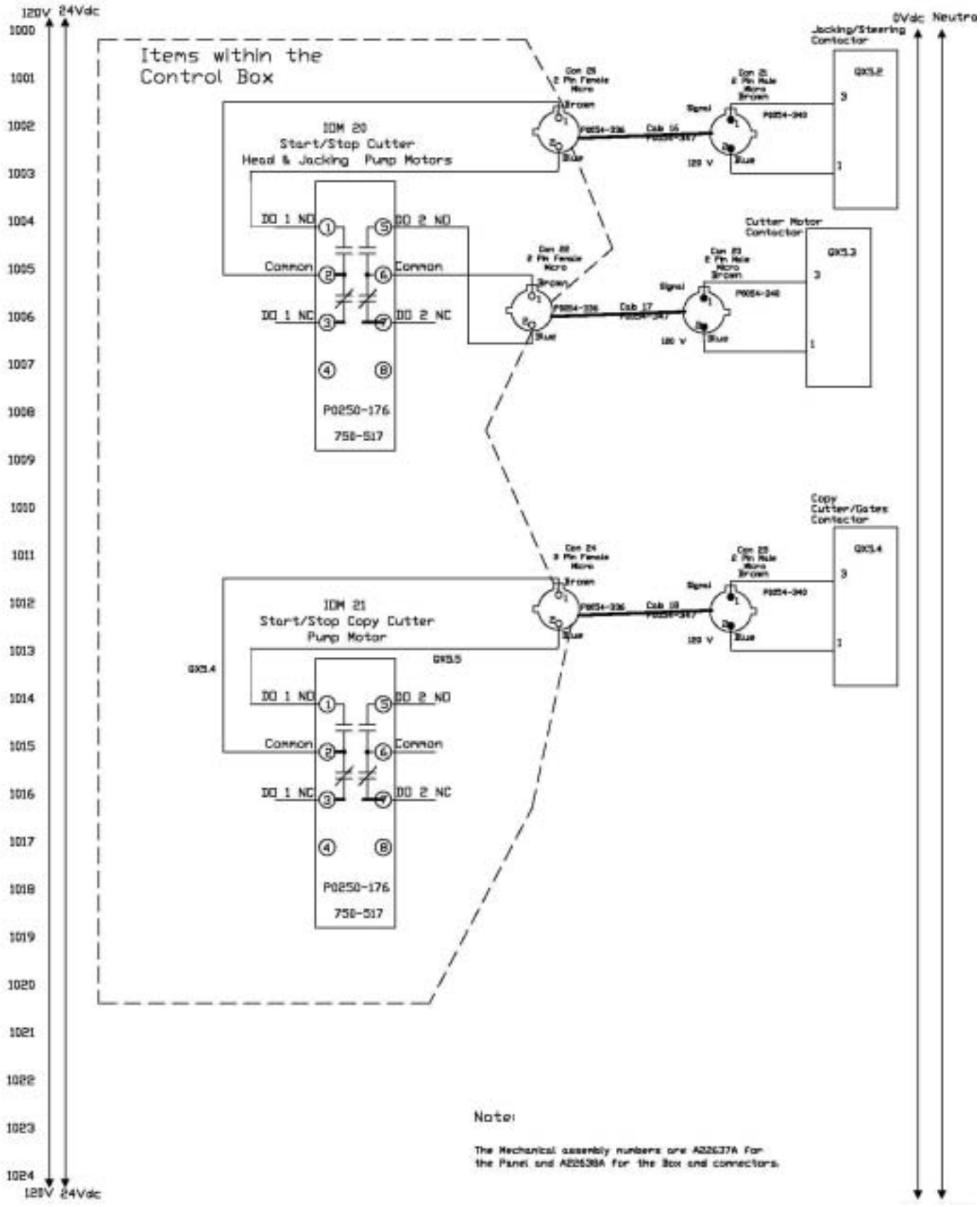

120V 24Vdc
0Vdc Neutral
Items within the Control Box
IOM 10
2 Channel
SPDT Relay Output
707 Screw 1
717 Screw 2
DO 1 NO
DO 2 NO
GX4.0
GX4.1
R 1
Common
Common
713 Screw 2
703 Screw 1
100Ω
P0310-941
DO 1 NC
DO 2 NC
P0250-176
750-517
R 2
100Ω
P0310-941
IOM 11
2 Channel
SPDT Relay Output
807 Jacking Pos
817 Jack Return
GX4.2
GX4.3
DO 1 NO
DO 2 NO
R 3
Common
Common
813 Jack Return
803 Jacking Pos
100Ω
P0310-941
DO 1 NC
DO 2 NC
P0250-176
750-517
R 4
100Ω
P0310-941
Note:
The Mechanical assembly numbers are A22637A for the Panel and A22638A for the Box and connectors.
120V 24Vdc

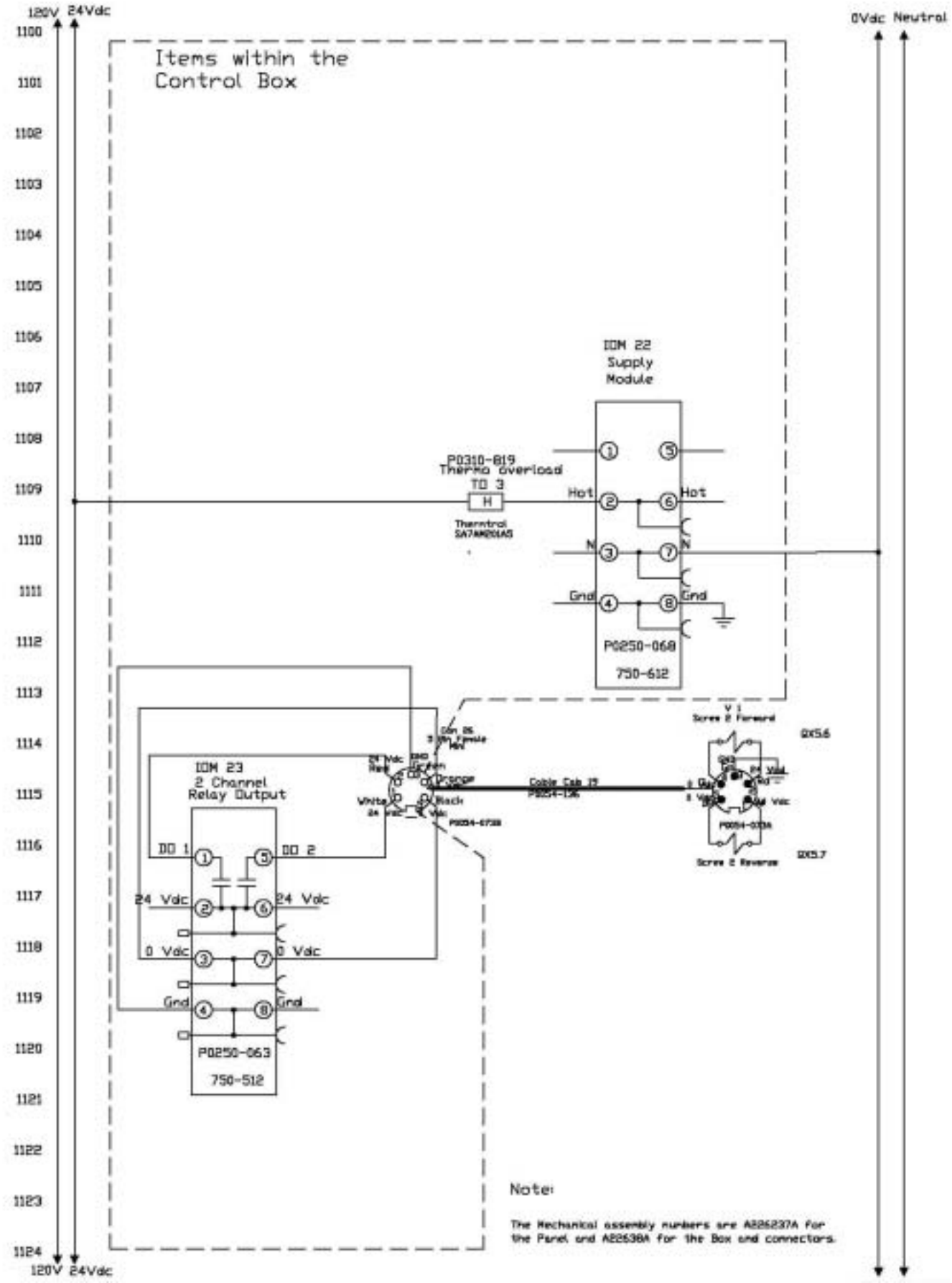

120V 24Vdc
0Vdc Neutral
Items within the Control Box
IOM 12
2 Channel
SPDT Relay Output
907
Gates & Copy Cutter
917
Spare Flow
DO 1 NO
DO 2 NO
R 5
Common
Common
913
Spare Flow
903
P0310-941
100Ω
Gates & Copy Cutter
DO 1 NC
DO 2 NC
P0250-176
750-517
R 6
100Ω
P0310-941
IOM 13
Supply
Module
0 V
0 V
0 V
0 V
Gnd
Gnd
P0250-068
750-612
Note:
The Mechanical assembly numbers are A22637A for the Panel and A22638A for the Box and connectors.
120V 24Vdc
0Vdc Neutral

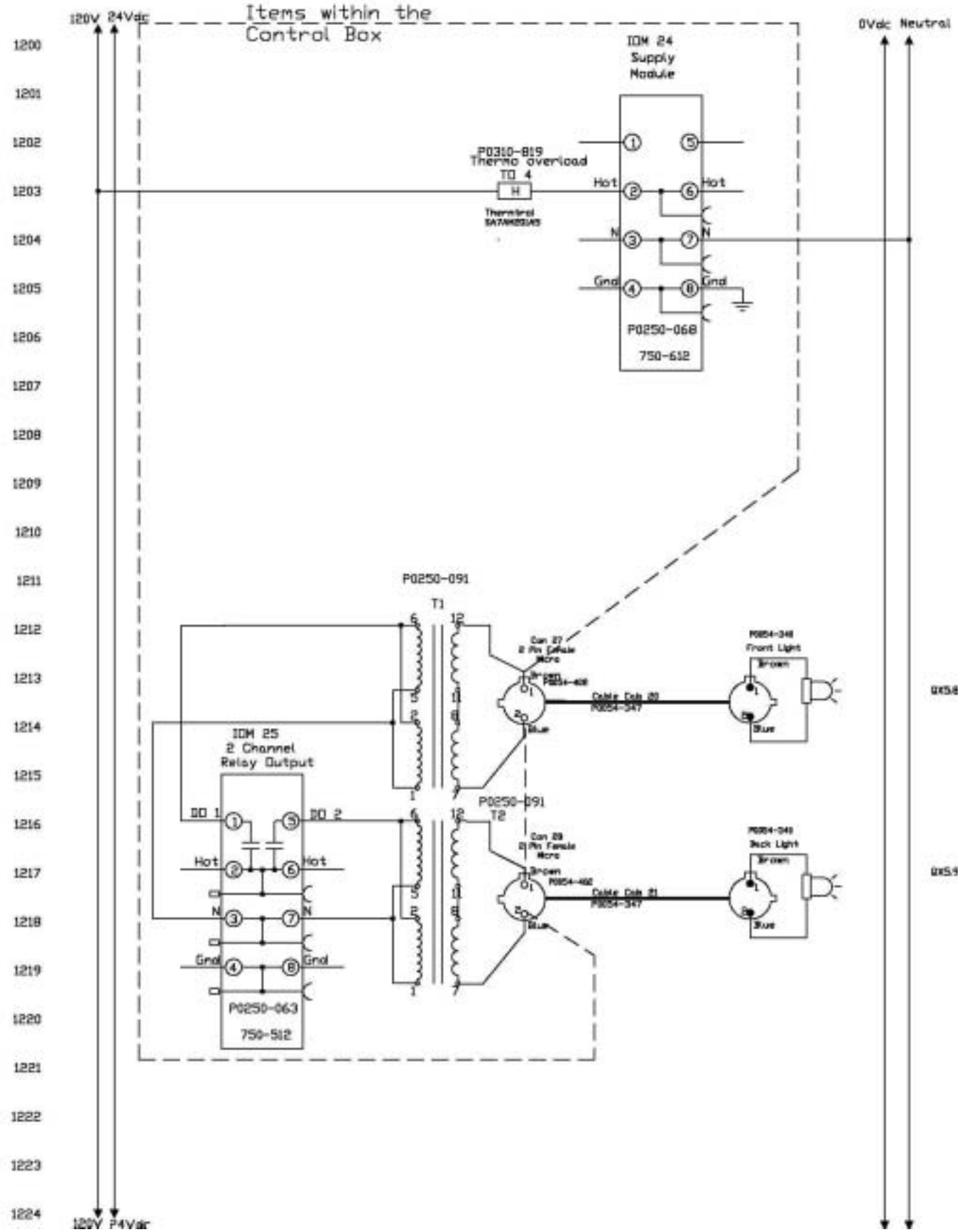

120V 24Vdc
0Vdc Neutral
Items within the Control Box
IDM 14
2 Channel
Relay Output
IDM 15
2 Channel
Relay Output
P0250-063
750-512
Screw 1 Flow Control
Screw 2 Flow Control
Note:
The Mechanical assembly numbers are A22637A for the Panel and A22638A for the Box and connectors.
120V 24Vdc


120V 24Vdc
0Vdc Neutral
Items within the Control Box
IOM 16
2 Channel
Relay Output
IOM 17
2 Channel
Relay Output
DO 1
DO 2
0 Vdc
Gnd
P0250-063
750-512
515
513
512
403
405
406
Jacking Flow Control
Jacking Compress Control
Green
Red
White
Black
Blue
M
Note:
The Mechanical assembly numbers are A22637A for the Panel and A22638A for the Box and connectors.
800
801
802
803
804
805
806
807
808
809
810
811
812
813
814
815
816
817
818
819
820
821
822
823
824

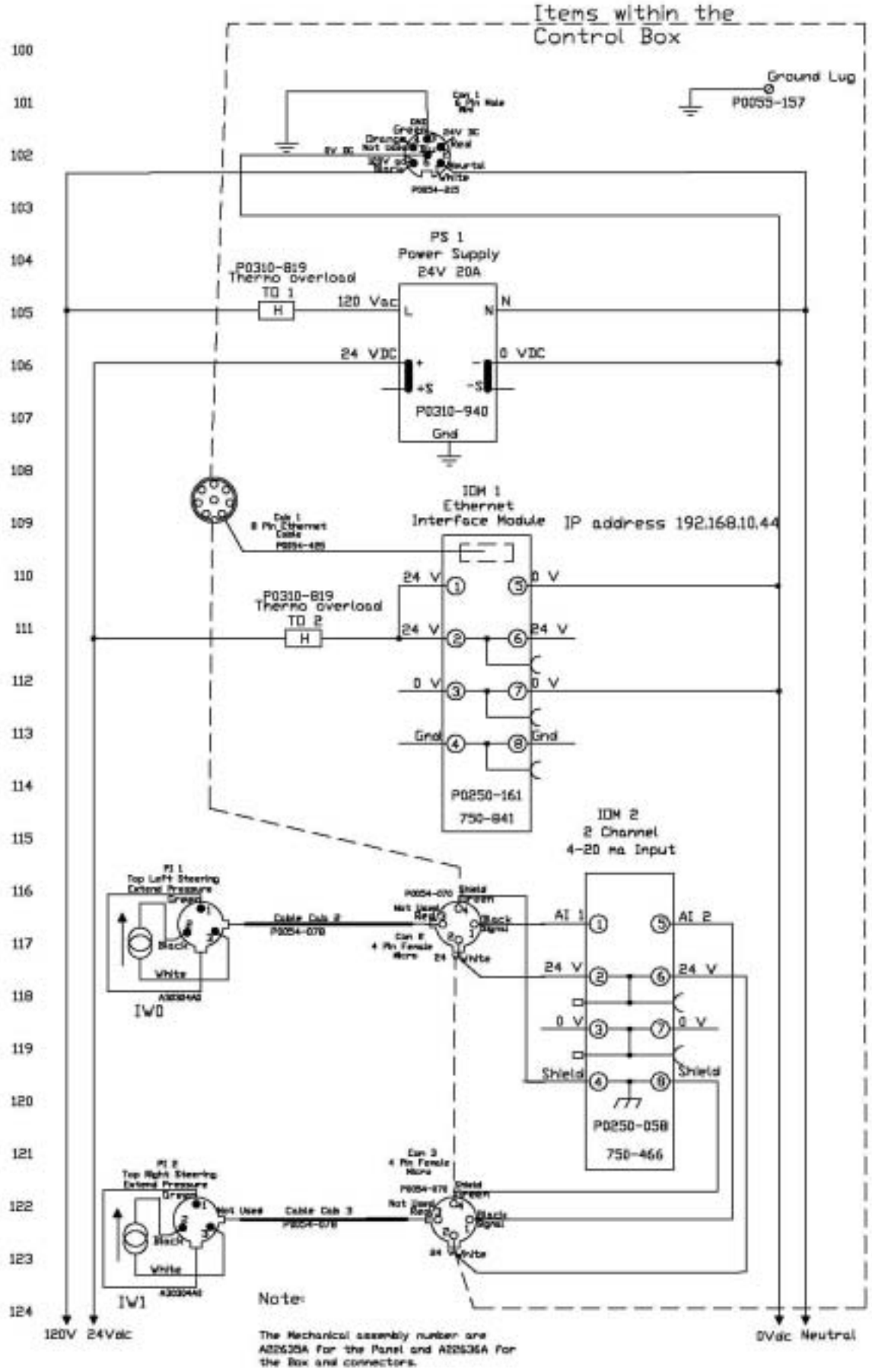

120V 24Vdc
0Vdc Neutral
Items within the Control Box
IOM 18
2 Channel
Relay Output
DO 1
DO 2
0 Vdc
Gnd
P0250-063
750-512
605
603
414
415
Gates & Copy Cutters
Green
Red
Blue
White
Black
M
IOM 19
2 Channel
Relay Output
413
415
605
602
Spare Flow control
Note:
The Mechanical assembly numbers are A20637A for the Panel and A20638A for the Box and connectors.
120V 24Vdc

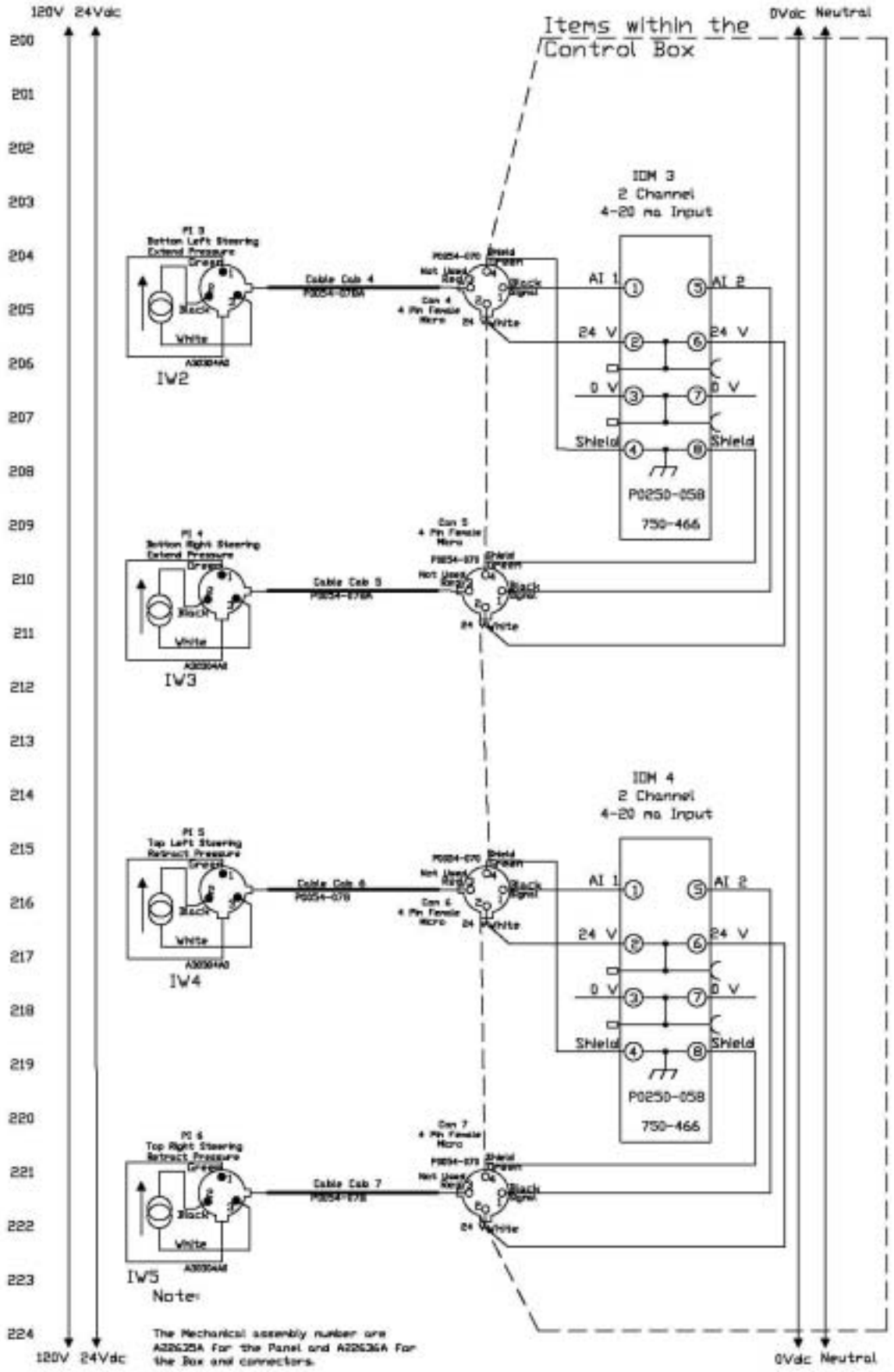

120V 24Vdc
0Vdc Neutro
Items within the Control Box
IOM 20
Start/Stop Cutter Head & Jacking Pump Motors
DO 1 NO
DO 2 NO
Common
Common
DO 1 NC
DO 2 NC
P0250-176
750-517
Jacking/Steering Contactor
GX5.2
Cutter Motor Contactor
GX5.3
IOM 21
Start/Stop Copy Cutter Pump Motor
GX5.4
GX5.5
Copy Cutter/Gates Contactor
GX5.4
Note:
The Mechanical assembly numbers are A22637A for the Panel and A22638A for the Box and connectors.
120V 24Vdc

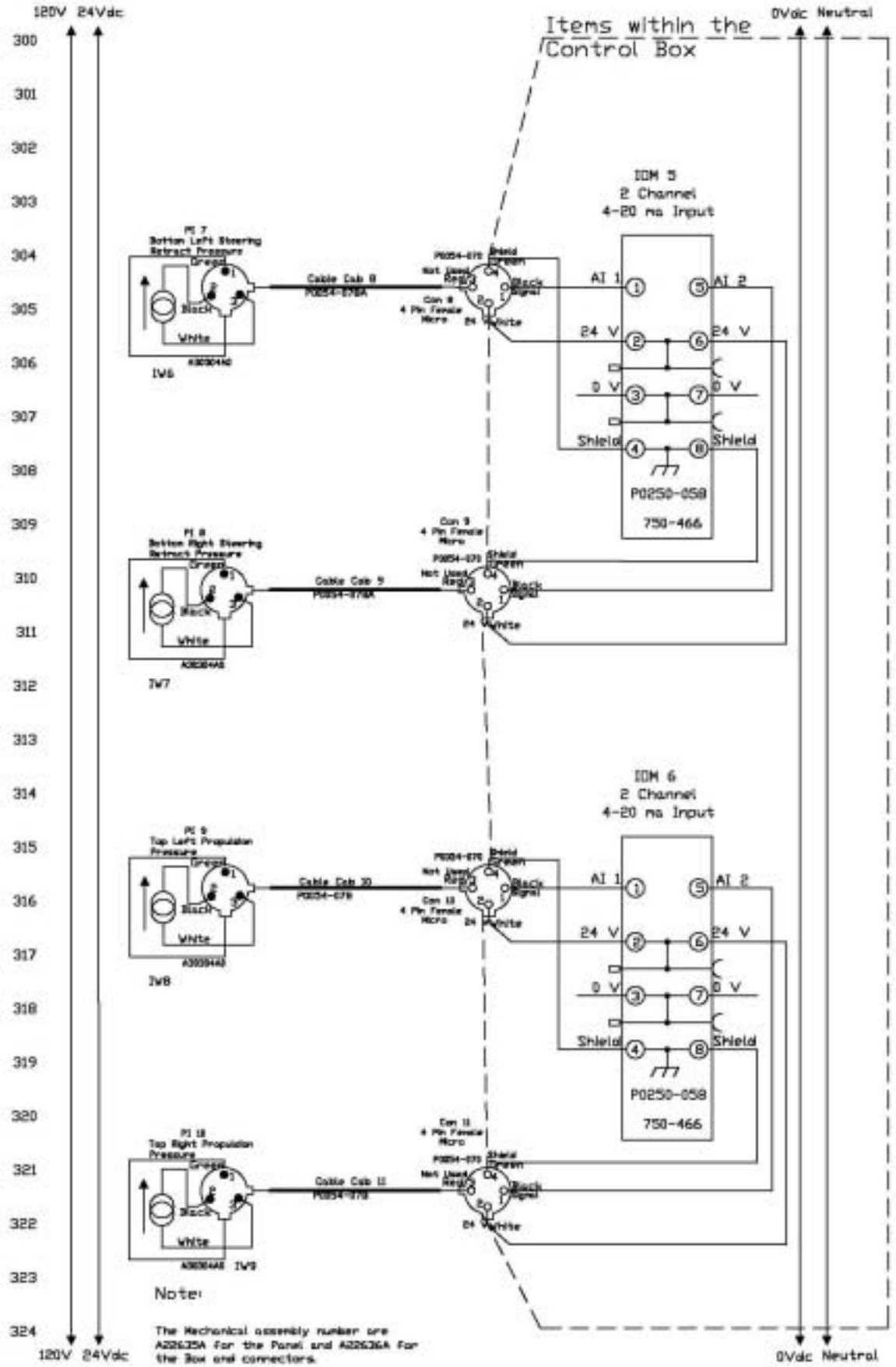

120V 24Vdc
0Vdc Neutral
Items within the Control Box
IOM 22 Supply Module
P0310-819
Thermo overload
TO 3
Hot
Hot
N
N
Gnd
Gnd
P0250-068
750-612
IOM 23
2 Channel
Relay Output
DO 1
DO 2
24 Vdc
24 Vdc
0 Vdc
0 Vdc
Gnd
Gnd
P0250-063
750-512
Note:
The Mechanical assembly numbers are A226237A for the Panel and A226238A for the Box and connectors.

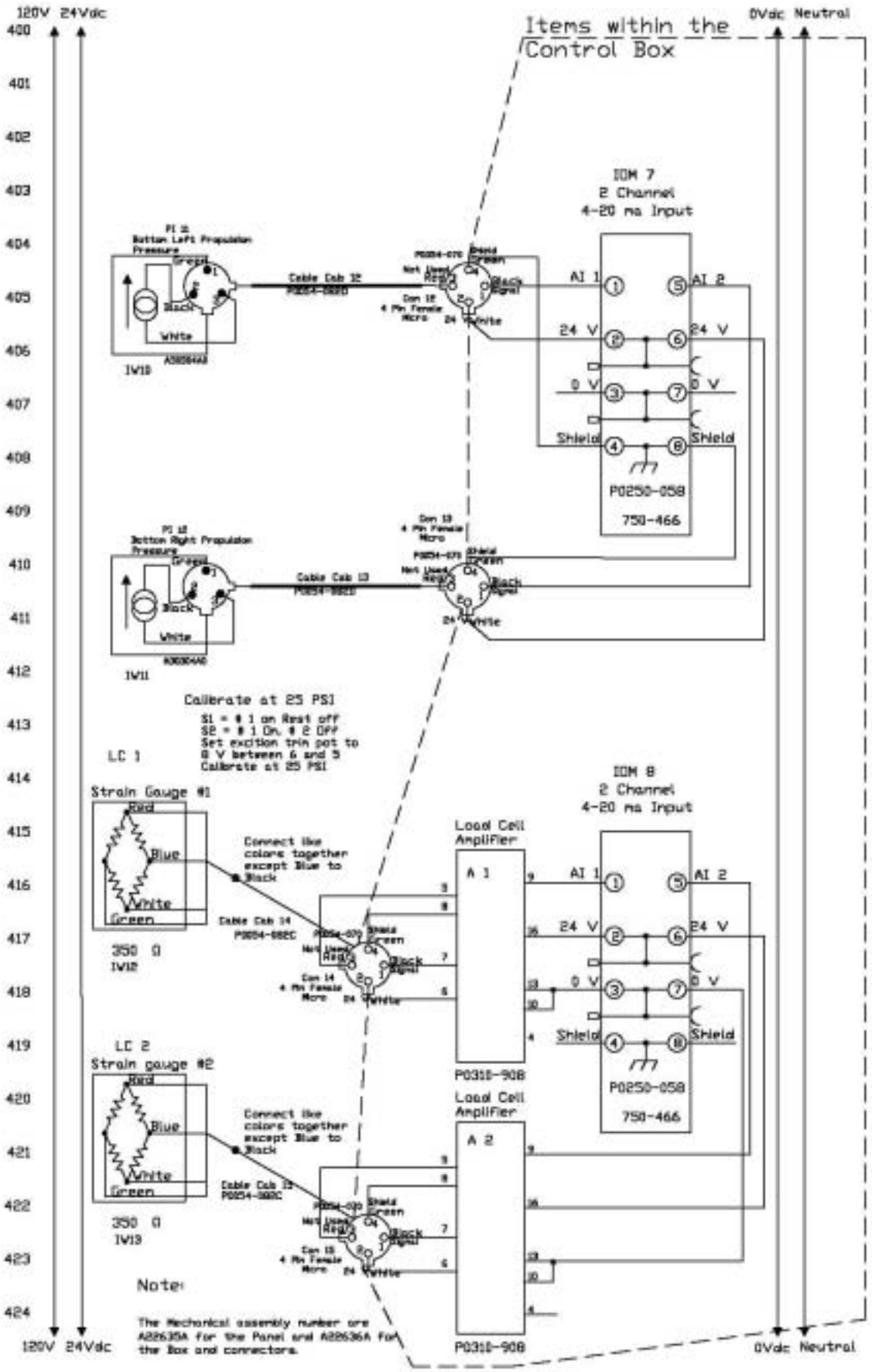

120V 24Vdc
Items within the Control Box
0Vdc Neutral
IDM 24 Supply Module
P0310-819 Thermo overload
TO 4
Hot
N
Gnd
P0250-068
750-612
P0250-091
T1
T2
IDM 25 2 Channel Relay Output
DO 1
DO 2
P0250-063
750-512
Front Light
Back Light
Brown
Blue
120V 24Vdc

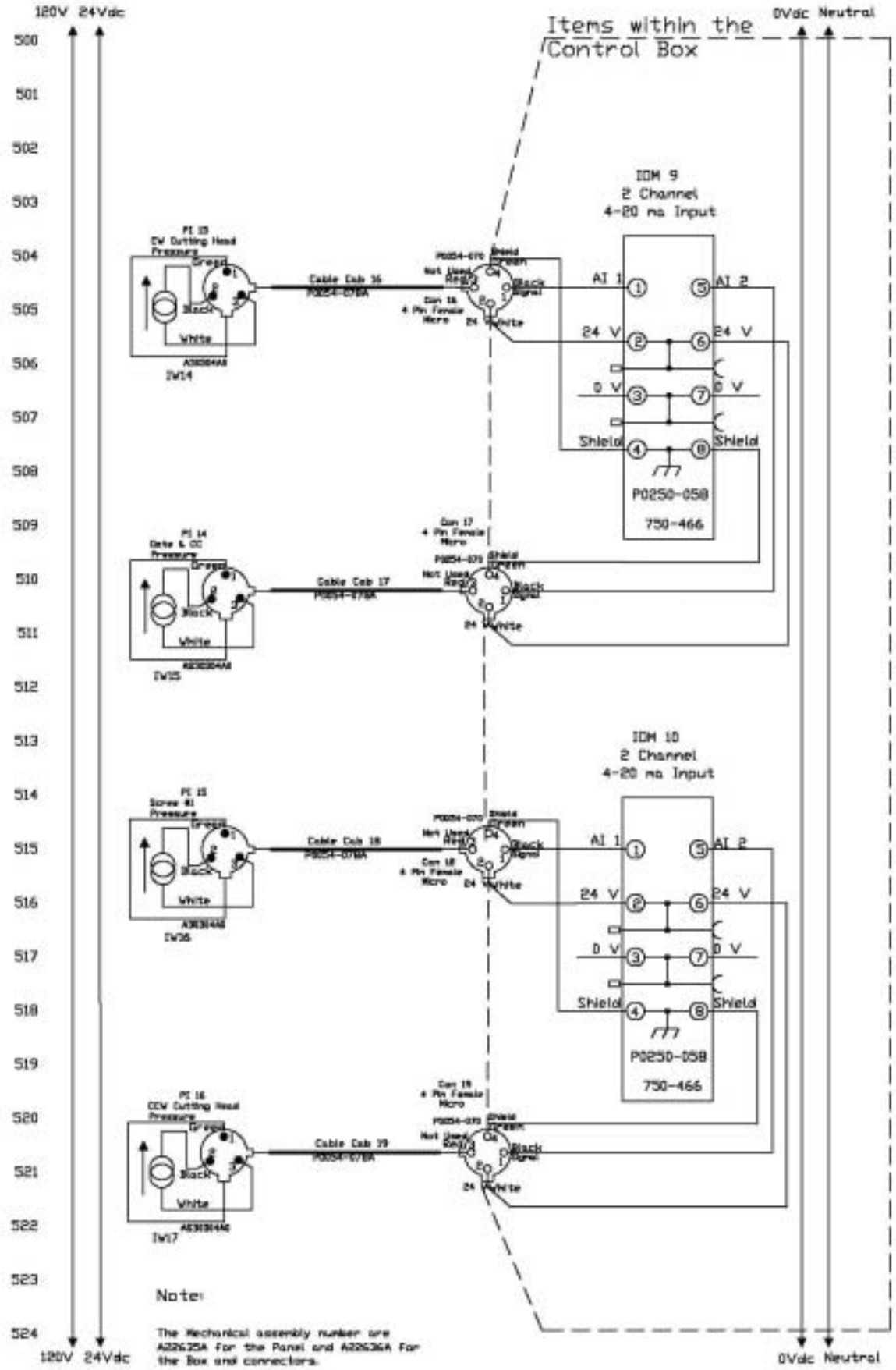
ELECTRICAL SCHEMATICS - HEAD FRONT SECTION BOX

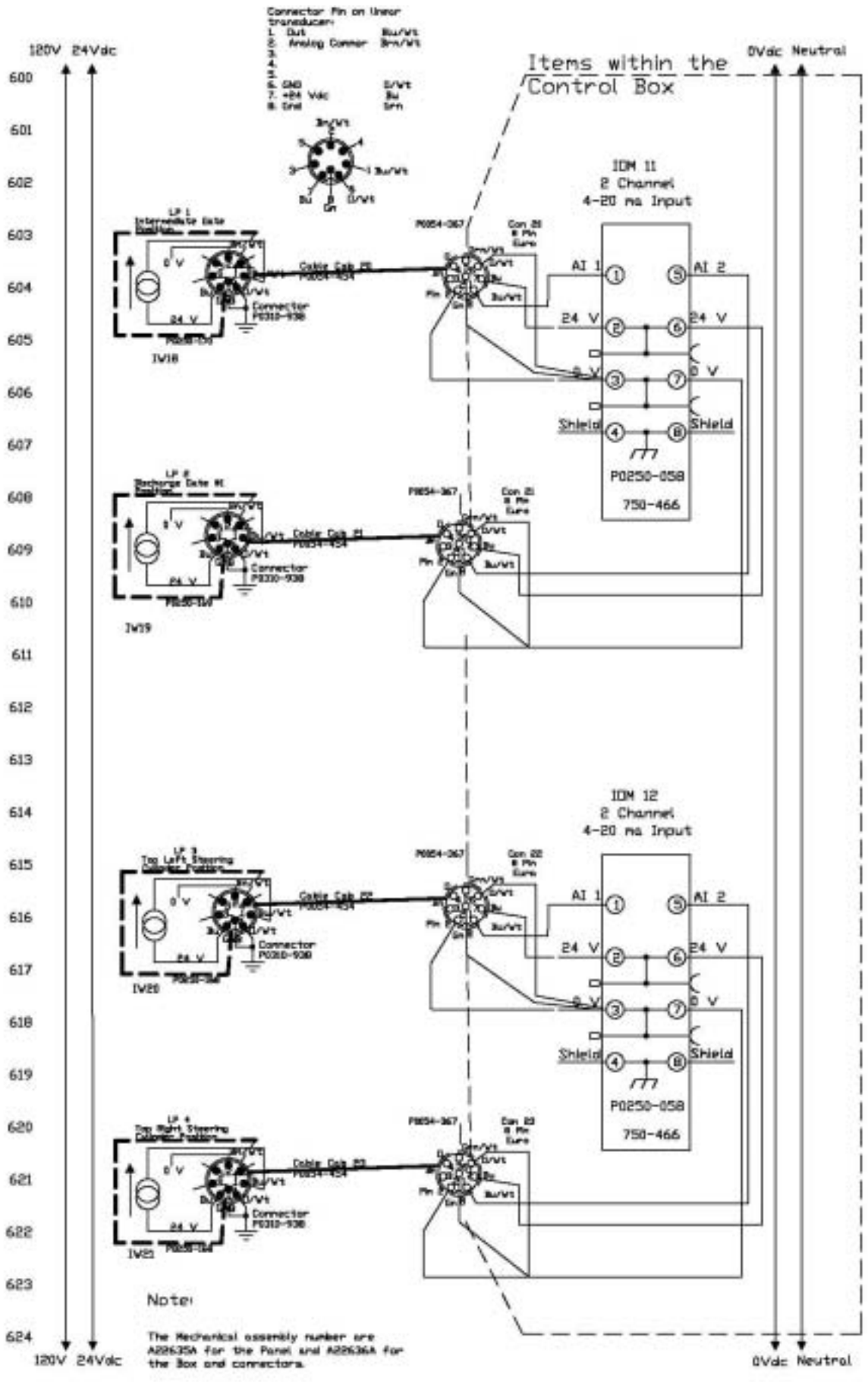


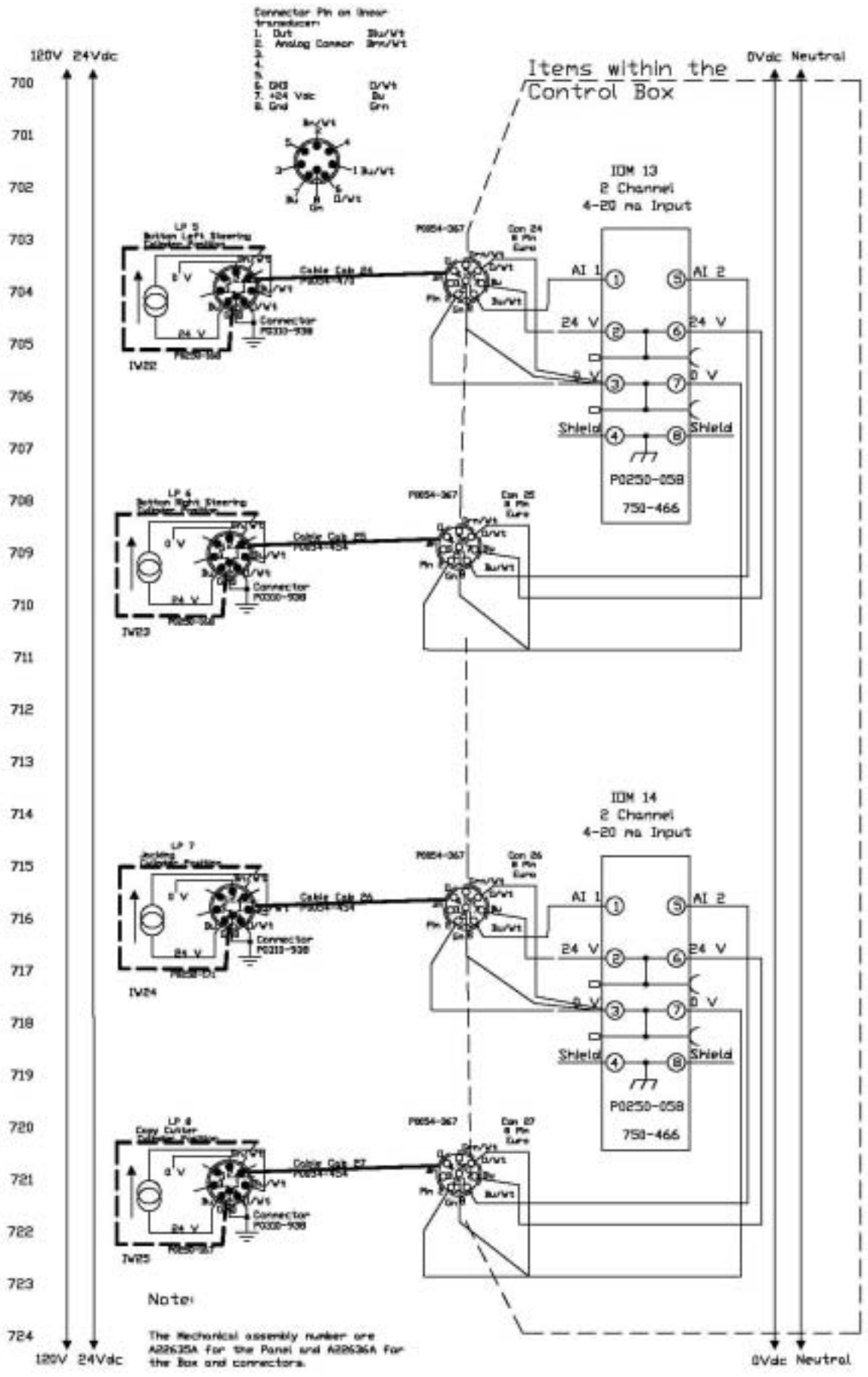

120V 24Vdc
0Vdc Neutral
Items within the Control Box
IDM 3
2 Channel
4-20 ma Input
IDM 4
2 Channel
4-20 ma Input
AI 1
AI 2
24 V
0 V
Shield
P0250-058
750-466
IW2
IW3
IW4
IW5
Note:
The Mechanical assembly number are A22623A for the Panel and A22626A for the Box and connectors.

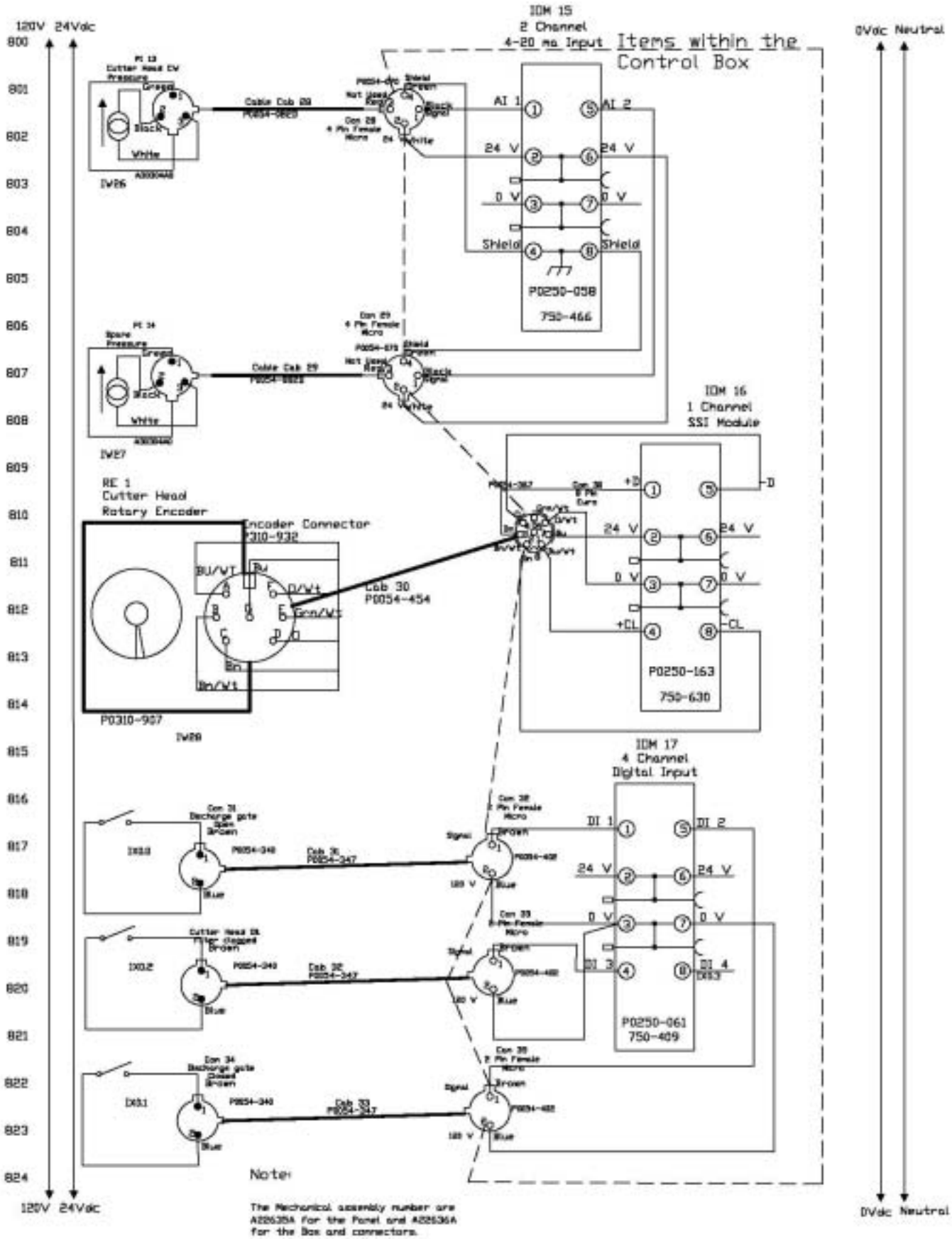

120V 24Vdc
0Vdc Neutral
Items within the Control Box
IDM 5
2 Channel
4-20 ma Input
IDM 6
2 Channel
4-20 ma Input
AI 1
AI 2
24 V
0 V
Shield
P0250-058
750-466
Cable Cab 8
Cable Cab 9
Cable Cab 10
Cable Cab 11
IW6
IW7
IW8
IW9
Note:
The Mechanical assembly number are A22635A for the Panel and A22636A For the Box and connectors.

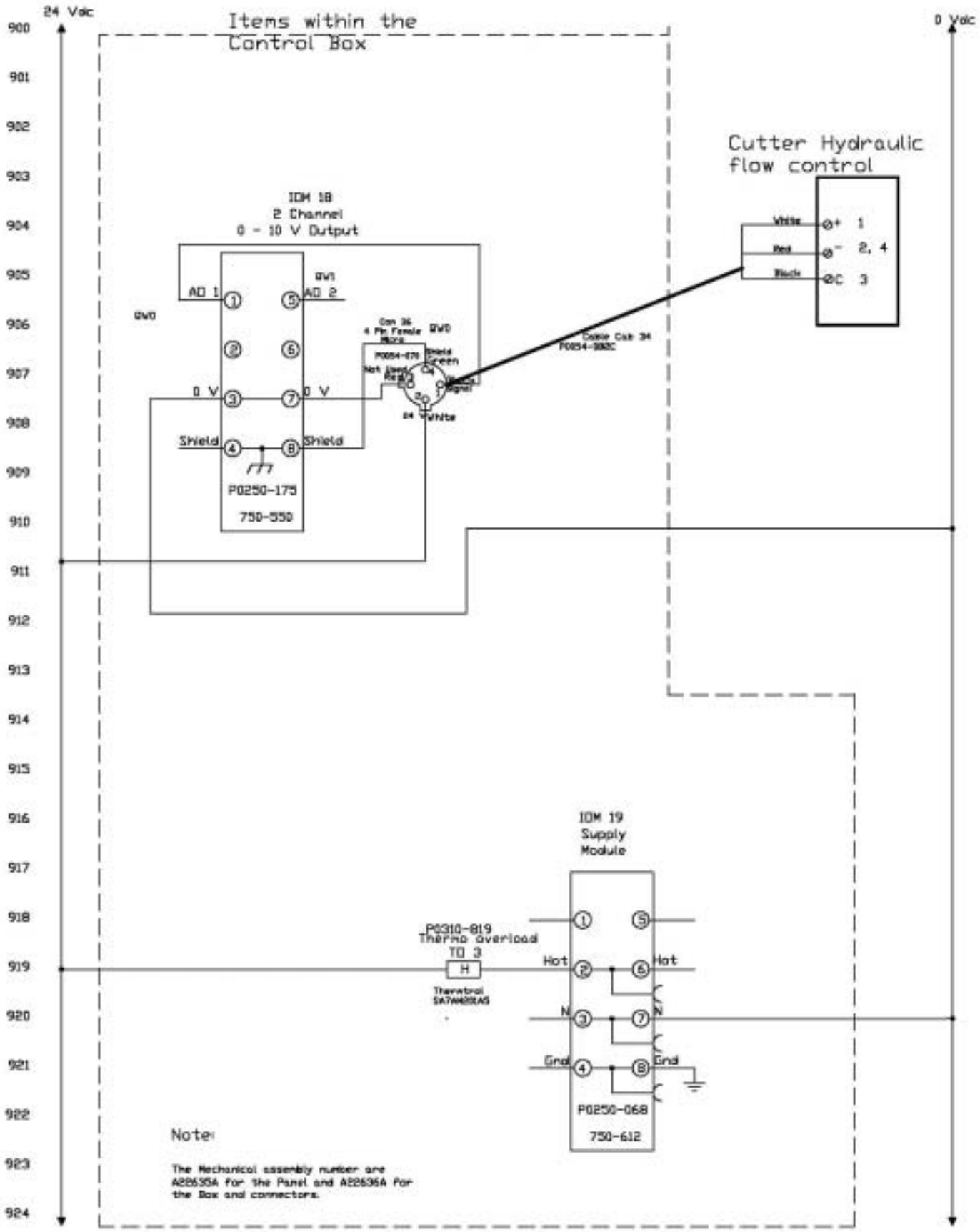

120V 24Vdc
0Vdc Neutral
Items within the Control Box
IOM 7
2 Channel
4-20 ma Input
AI 1
AI 2
24 V
0 V
Shield
P0250-058
750-466
Cable Cab 12
Cable Cab 13
Cable Cab 14
Cable Cab 15
IV10
IV11
IV12
IV13
Calibrate at 25 PSI
S1 = # 1 on Rest off
S2 = # 1 On, # 2 OFF
Set excition trim pot to
8 V between 6 and 5
Calibrate at 25 PSI
LC 1
LC 2
Strain Gauge #1
Strain gauge #2
Red
Blue
White
Green
350 Ω
Connect like colors together except Blue to Black
Load Cell Amplifier
A 1
A 2
P0310-908
IOM 8
2 Channel
4-20 ma Input
Note:
The Mechanical assembly number are A22635A for the Panel and A22636A for the Box and connectors.

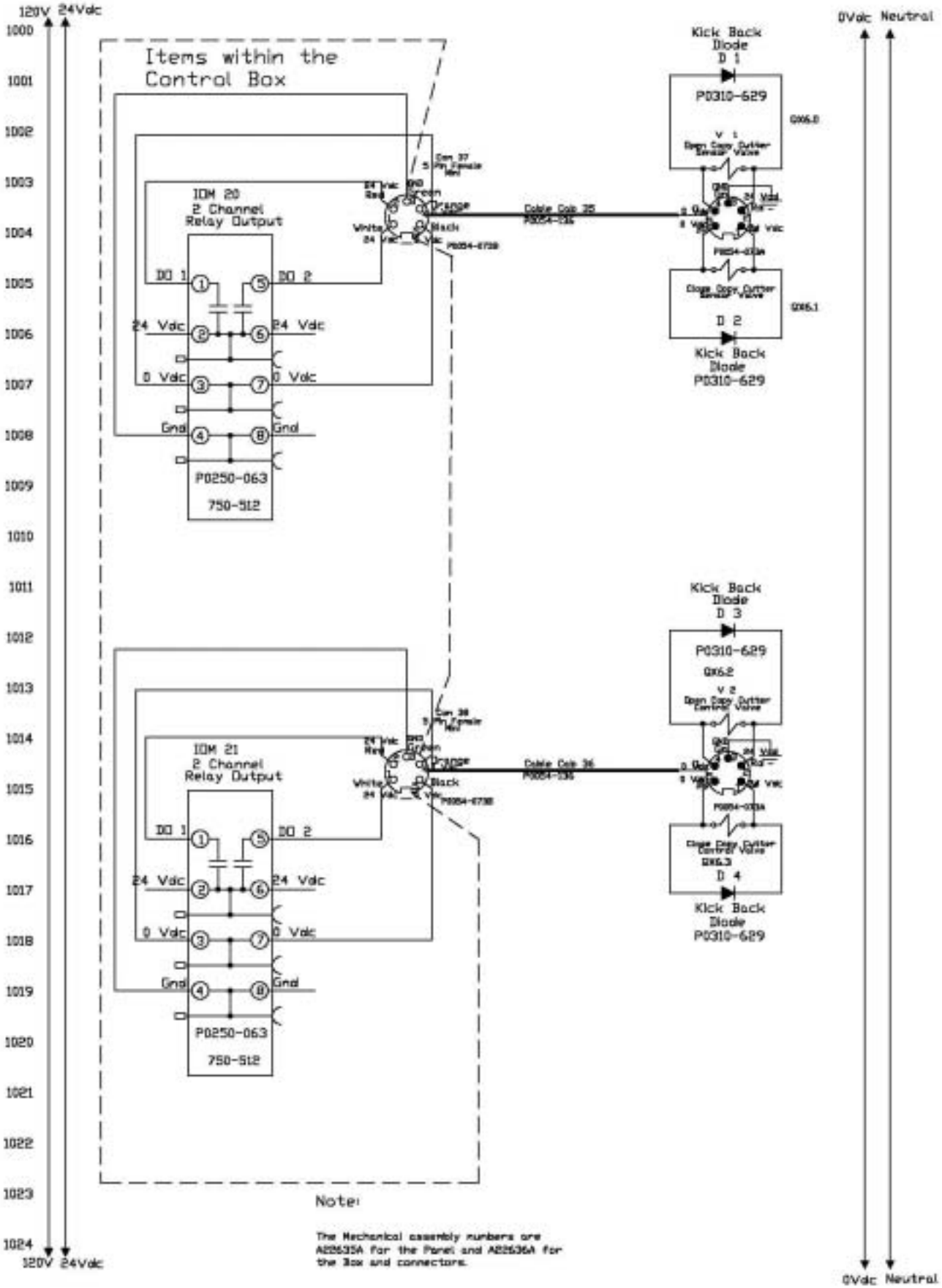

120V 24Vdc
0Vdc Neutral
Items within the Control Box
IOM 9
2 Channel
4-20 ma Input
AI 1
AI 2
24 V
0 V
Shield
P0250-058
750-466
IOM 10
2 Channel
4-20 ma Input
Note:
The Mechanical assembly number are A22625A for the Panel and A22626A for the Box and connectors.
120V 24Vdc
0Vdc Neutral

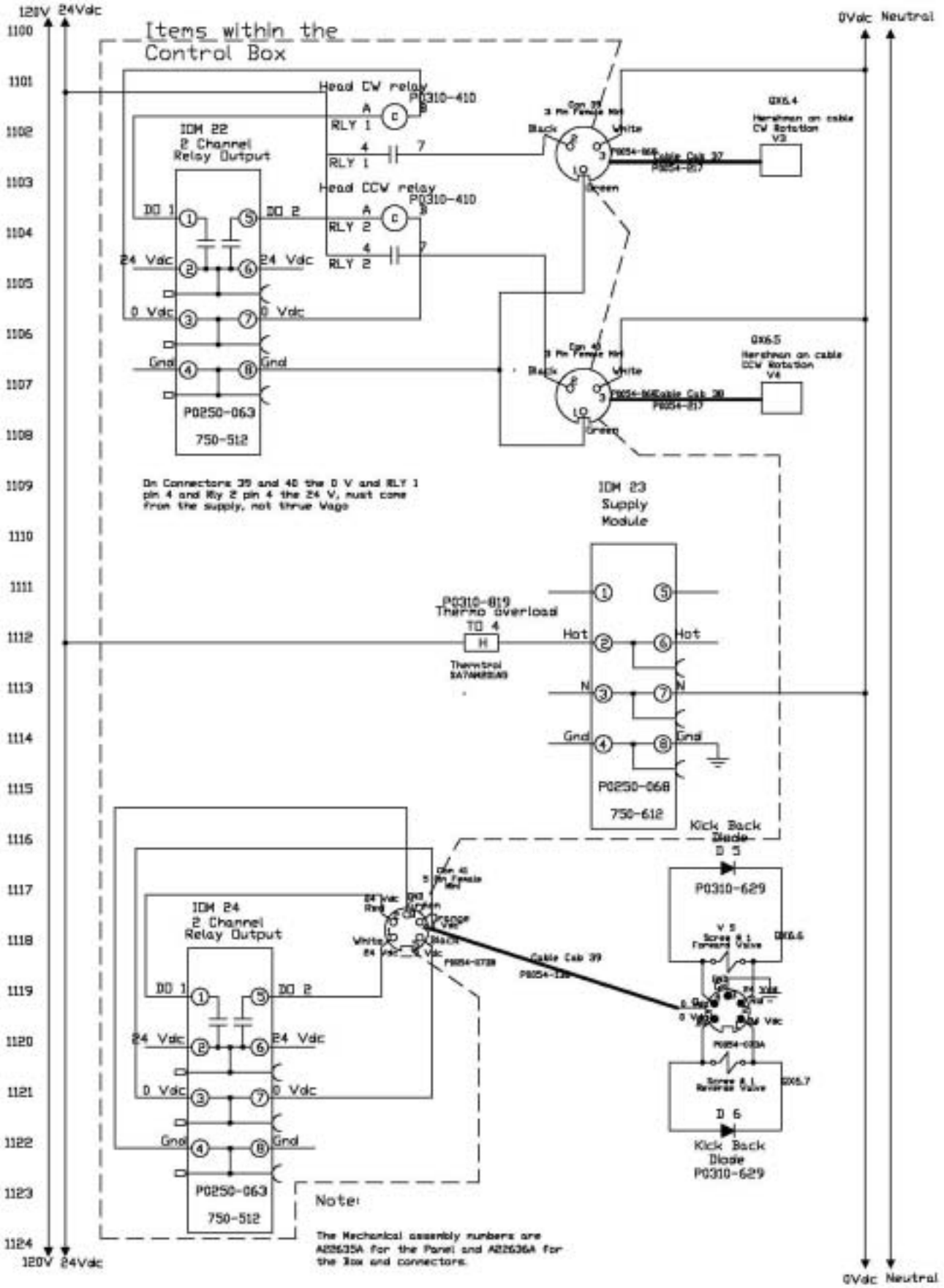

120V 24Vdc
0Vdc Neutral
Items within the Control Box
IDM 11
2 Channel
4-20 ma Input
IDM 12
2 Channel
4-20 ma Input
AI 1
AI 2
24 V
0 V
Shield
P0250-058
750-466
IV18
IV19
IV20
IV21
Note:
The Mechanical assembly number are A22635A for the Panel and A22636A for the Box and connectors.
120V 24Vdc
0Vdc Neutral

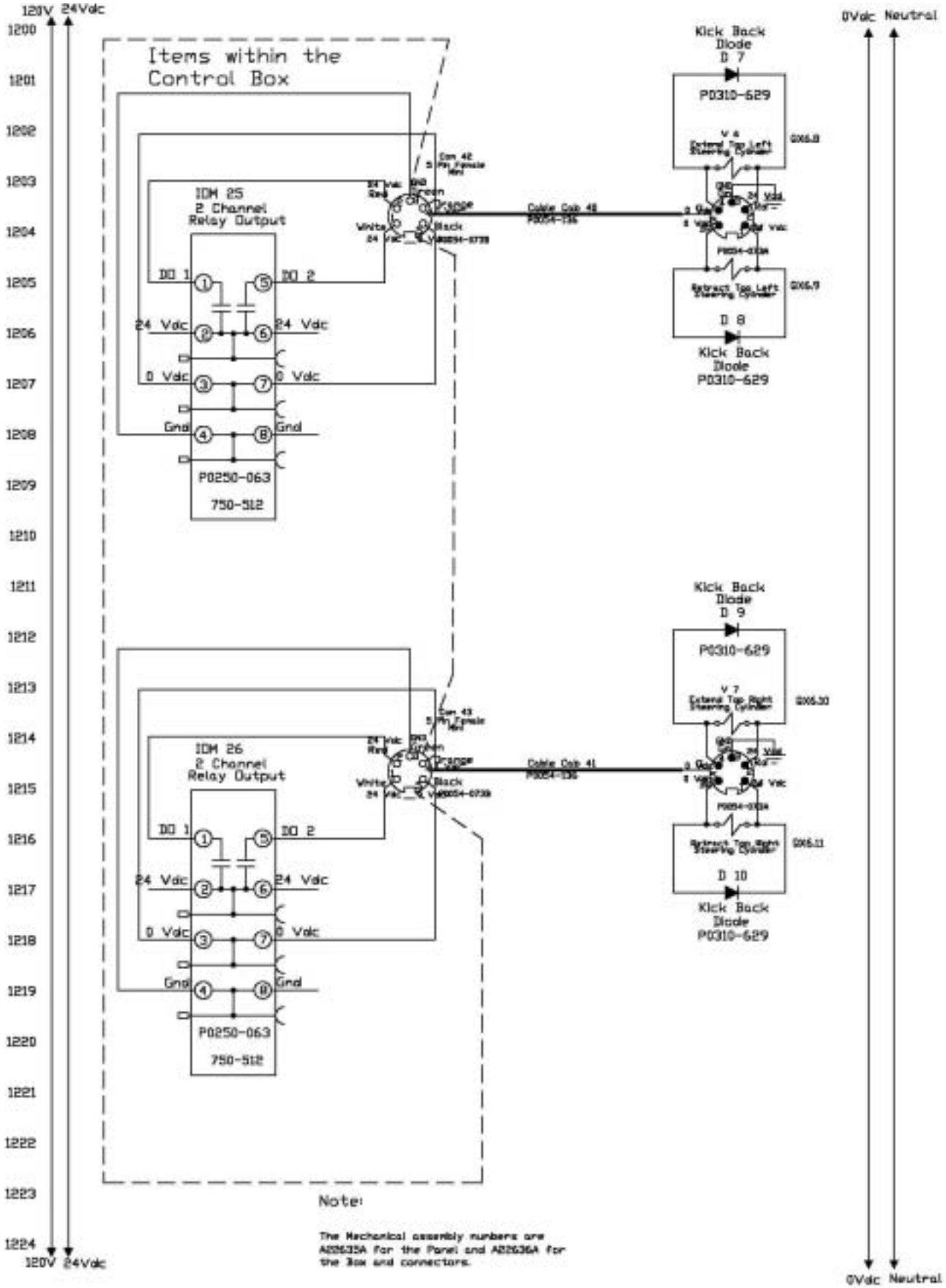

120V 24Vdc
0Vdc Neutral
Items within the Control Box
IDM 13
2 Channel
4-20 ma Input
IDM 14
2 Channel
4-20 ma Input
AI 1
AI 2
24 V
0 V
Shield
P0250-058
750-466
Note:
The Mechanical assembly number are A22635A for the Panel and A22636A for the Box and connectors.
120V 24Vdc
0Vdc Neutral

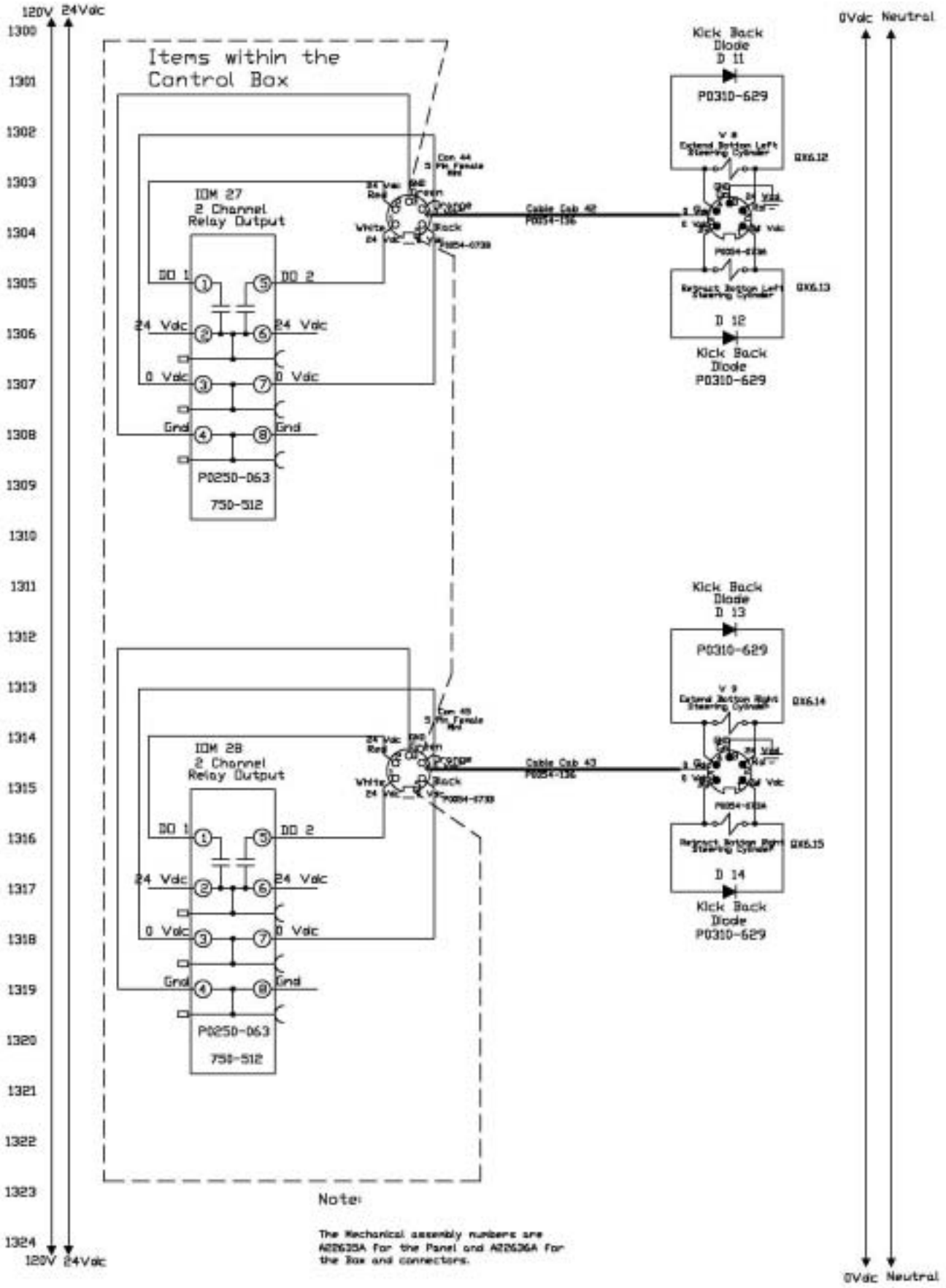

120V 24Vdc
0Vdc Neutral
IDM 15
2 Channel
4-20 ma Input
Items within the Control Box
AI 1
AI 2
24 V
0 V
Shield
P0250-058
750-466
IDM 16
1 Channel
SSI Module
RE 1
Cutter Head
Rotary Encoder
Encoder Connector
P310-932
Cab 30
P0054-454
P0310-907
IVR9
P0250-163
750-630
IDM 17
4 Channel
Digital Input
DI 1
DI 2
DI 3
DI 4
P0250-061
750-409
Note:
The Mechanical assembly number are A22635A for the Panel and A22636A for the Box and connectors.

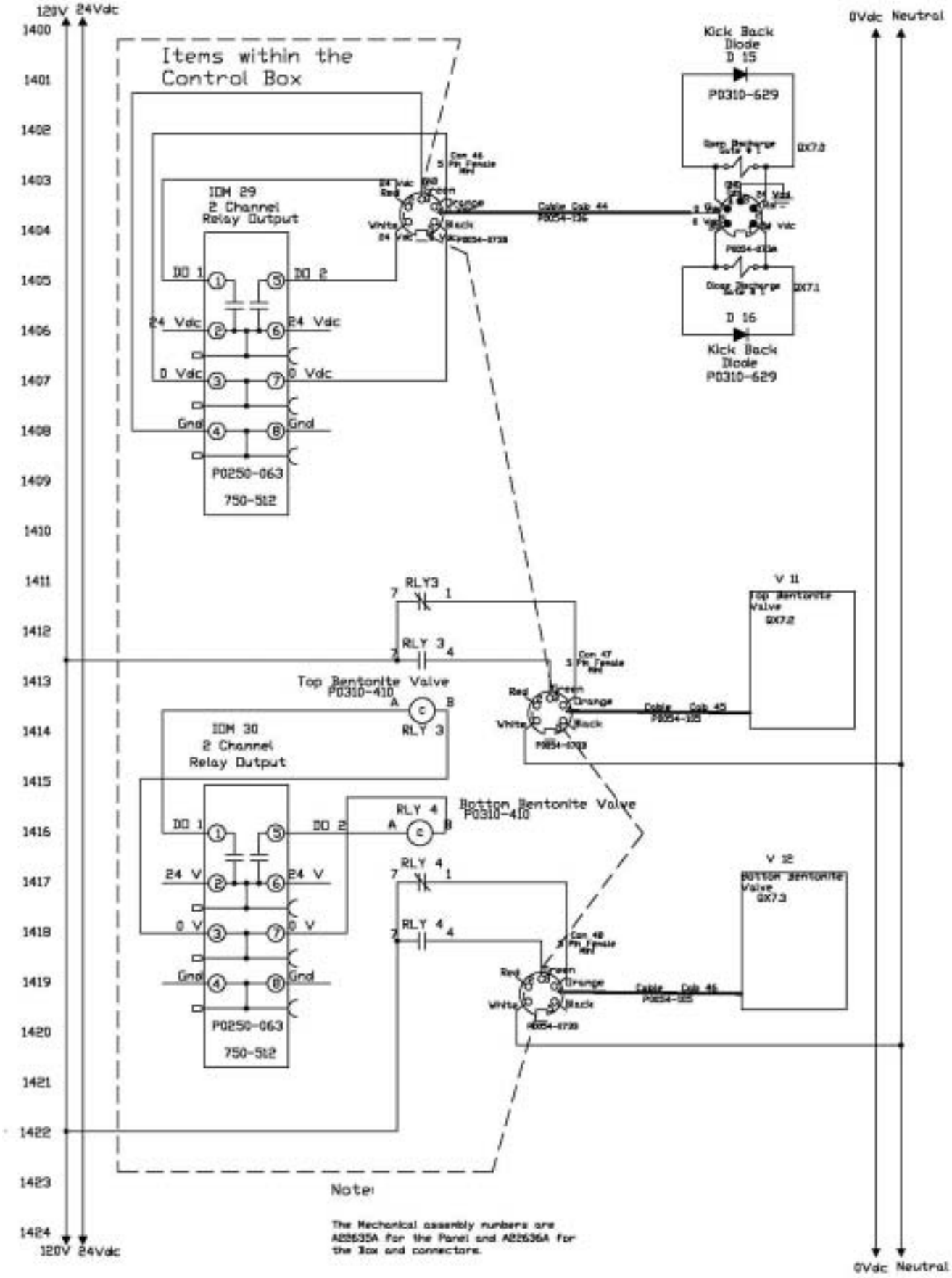

24 Vdc
0 Vdc
Items within the Control Box
Cutter Hydraulic flow control
IOM 18
2 Channel
0 - 10 V Output
AO 1
AO 2
0 V
0 V
Shield
Shield
P0250-175
750-550
White
Red
Black
+ 1
- 2, 4
C 3
IOM 19
Supply
Module
P0310-819
Thermo Overload
TO 3
H
Hot
Hot
N
N
Gnd
Gnd
P0250-068
750-612
Note:
The Mechanical assembly number are A28636A for the Panel and A28636A for the Box and connectors.

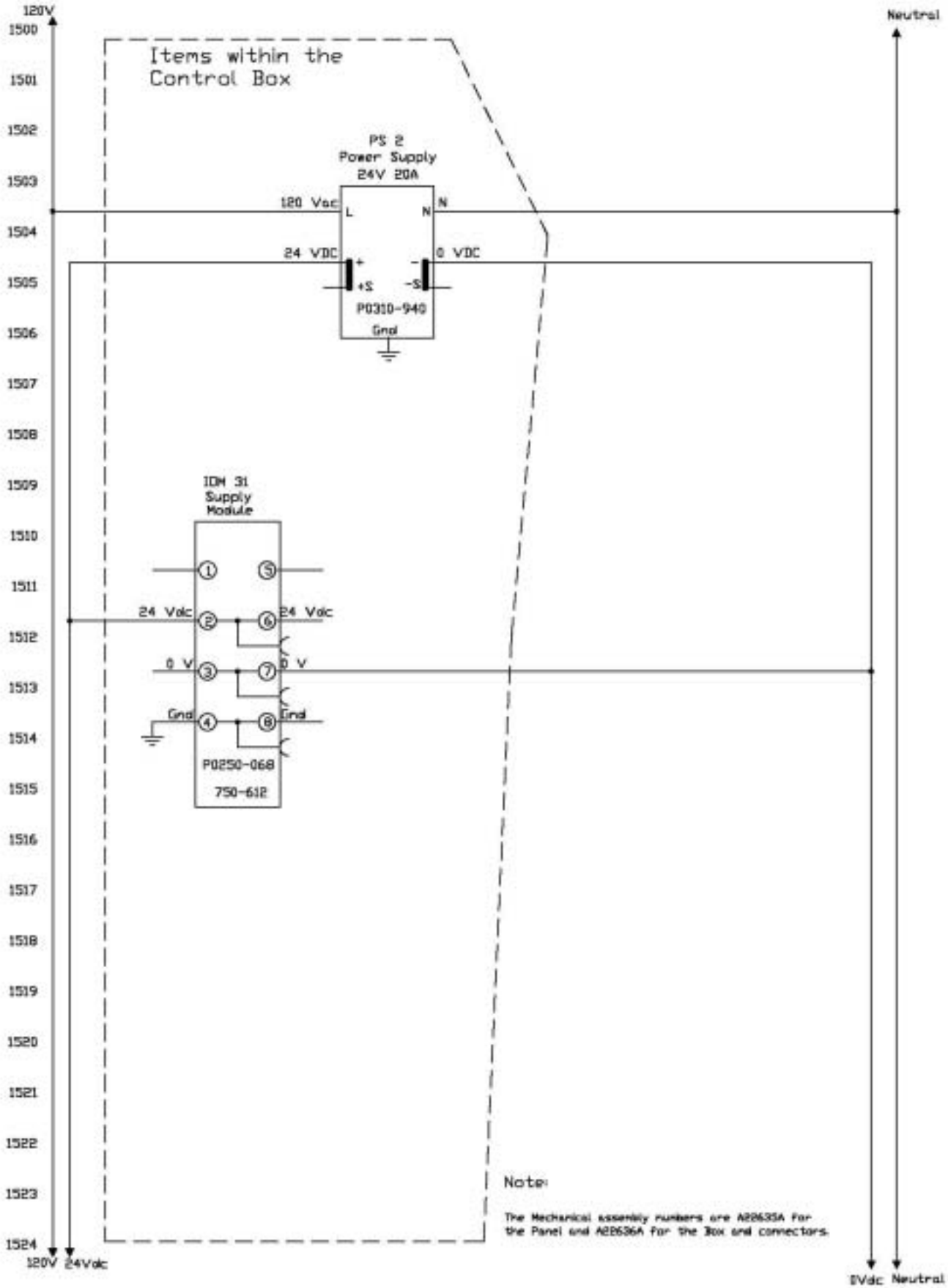

120V 24Vdc
0Vdc Neutral
Items within the Control Box
IOM 20
2 Channel
Relay Output
IOM 21
2 Channel
Relay Output
DO 1
DO 2
24 Vdc
0 Vdc
Gnd
P0250-063
750-512
Kick Back Diode D 1
P0310-629
Kick Back Diode D 2
P0310-629
Kick Back Diode D 3
P0310-629
Kick Back Diode D 4
P0310-629
Note:
The Mechanical assembly numbers are A22535A for the Panel and A22536A for the Box and connectors.
120V 24Vdc
0Vdc Neutral

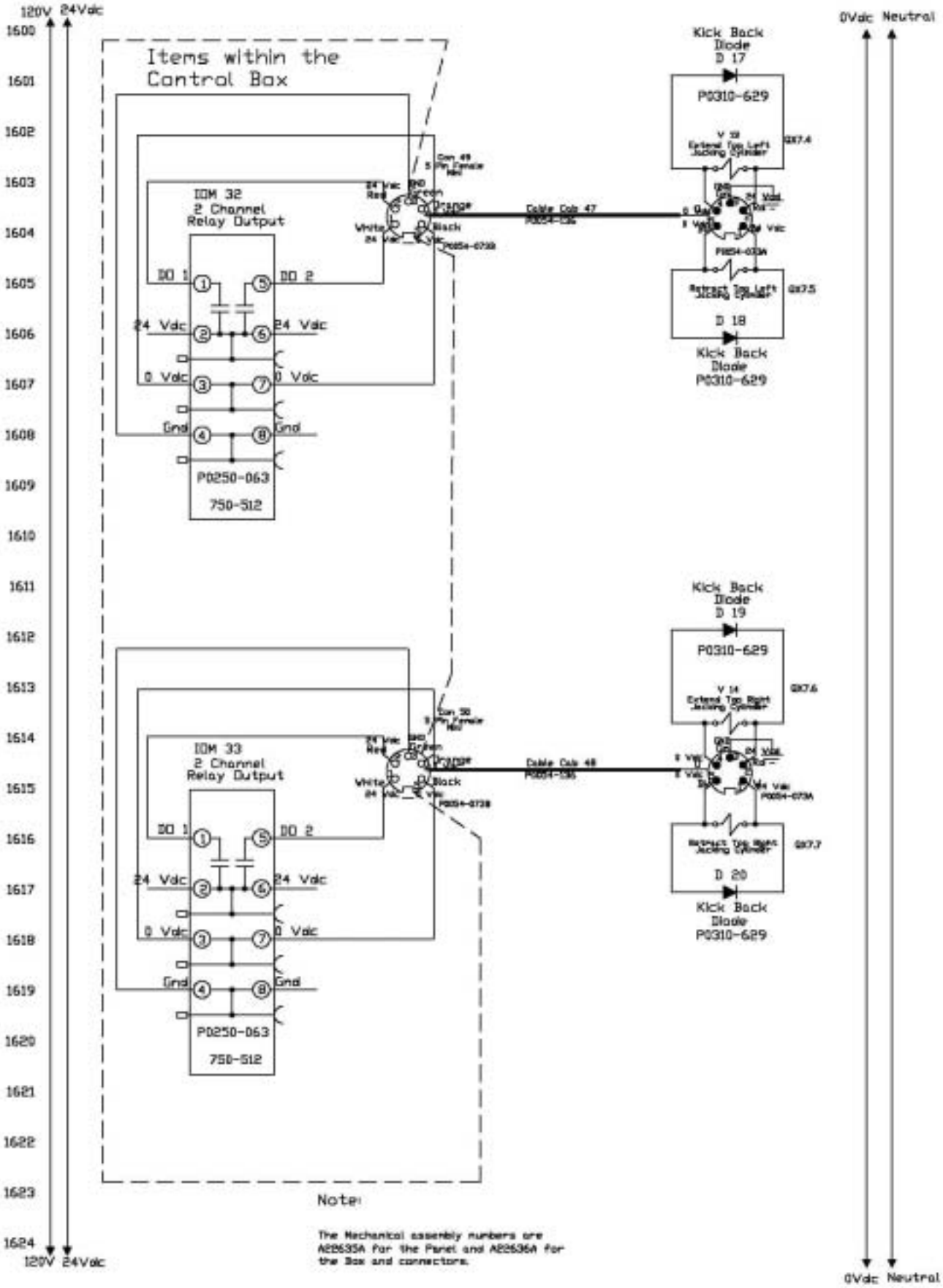

120V 24Vdc
Items within the Control Box
0Vdc Neutral
Head CW relay P0310-410
Head CCW relay P0310-410
IDM 22
2 Channel
Relay Output
DO 1
DO 2
24 Vdc
0 Vdc
Gnd
P0250-063
750-512
RLY 1
RLY 2
QX6.4
Hershman on cable CW Rotation V3
QX6.5
Hershman on cable CCW Rotation V4
On Connectors 39 and 40 the 0 V and RLY 1 pin 4 and Rly 2 pin 4 the 24 V, must come from the supply, not thrue Wago
IDM 23
Supply
Module
P0310-019
Thermo overload
TO 4
Hot
N
P0250-068
750-612
Kick Back Diode
D 5
P0310-629
IDM 24
2 Channel
Relay Output
Cable Cab 39
D 6
Kick Back Diode
P0310-629
Note:
The Mechanical assembly numbers are A22635A for the Panel and A22636A for the Box and connectors.
120V 24Vdc
0Vdc Neutral

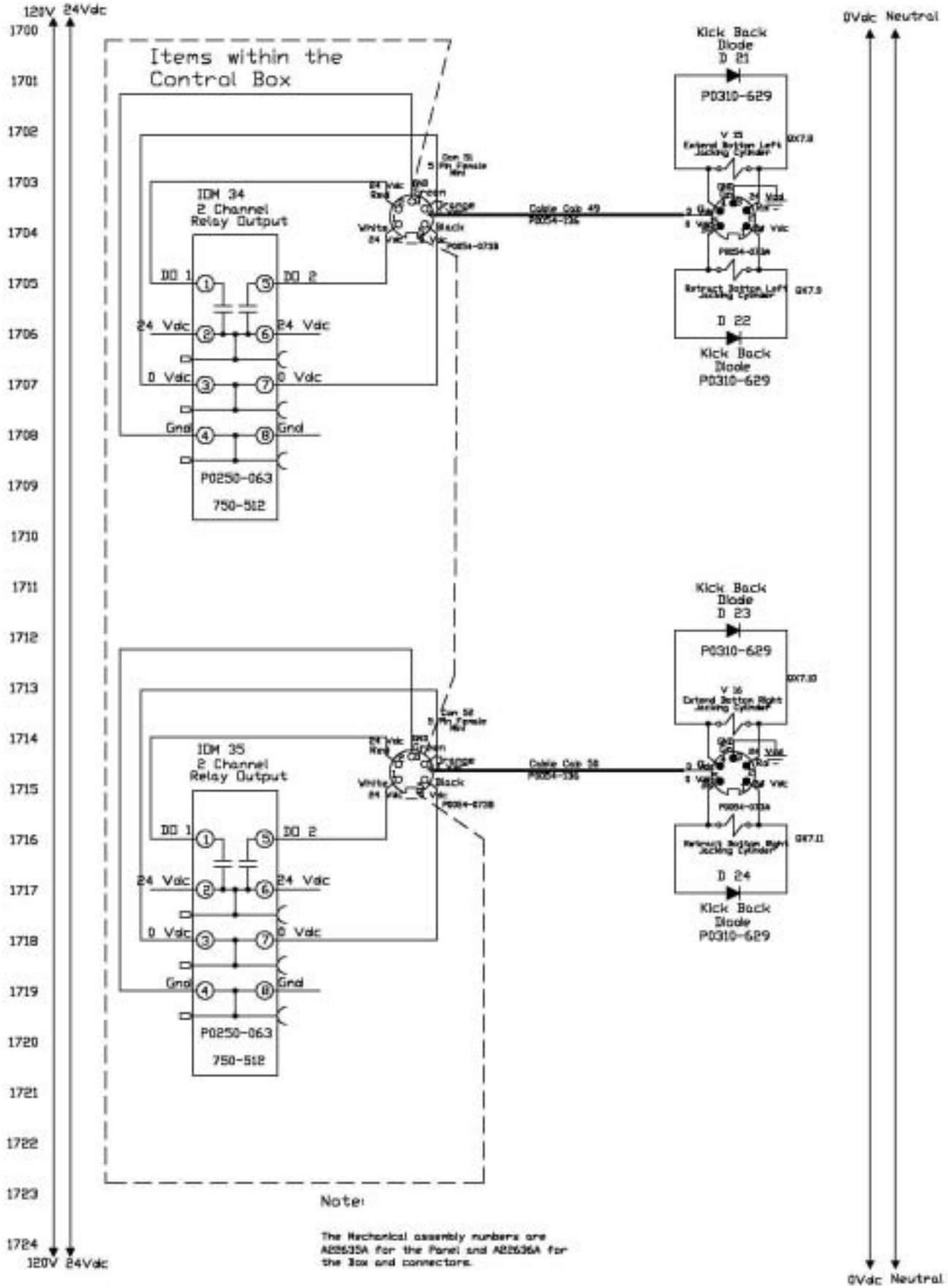

120V 24Vdc
Items within the Control Box
IDM 25
2 Channel
Relay Output
DO 1
DO 2
24 Vdc
0 Vdc
Gnd
P0250-063
750-512
IDM 26
2 Channel
Relay Output
Kick Back Diode D 7
P0310-629
Kick Back Diode D 8
P0310-629
Kick Back Diode D 9
P0310-629
Kick Back Diode D 10
P0310-629
0Vdc Neutral
Note:
The Mechanical assembly numbers are A22633A for the Panel and A22636A for the Box and connectors.

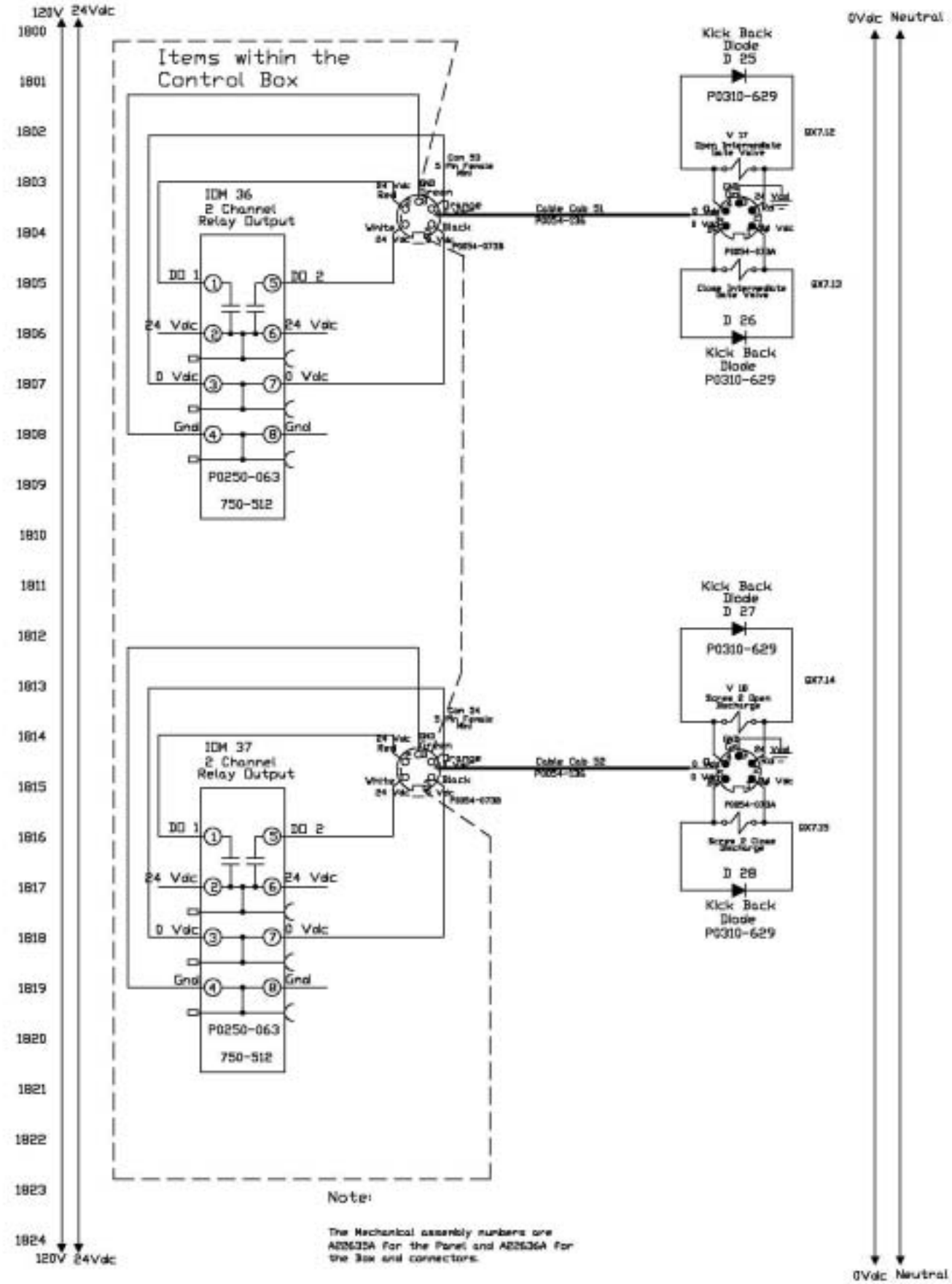

120V 24Vdc
0Vdc Neutral
Items within the Control Box
IOM 27
2 Channel
Relay Output
DO 1
DO 2
24 Vdc
0 Vdc
Gnd
P0250-063
750-512
IOM 28
2 Channel
Relay Output
Kick Back Diode D 11
P0310-629
Kick Back Diode D 12
P0310-629
Kick Back Diode D 13
P0310-629
Kick Back Diode D 14
P0310-629
Cable Cab 42
P0254-136
Cable Cab 43
P0254-136
Note:
The Mechanical assembly numbers are A22635A for the Panel and A22636A for the Box and connectors.
120V 24Vdc
0Vdc Neutral

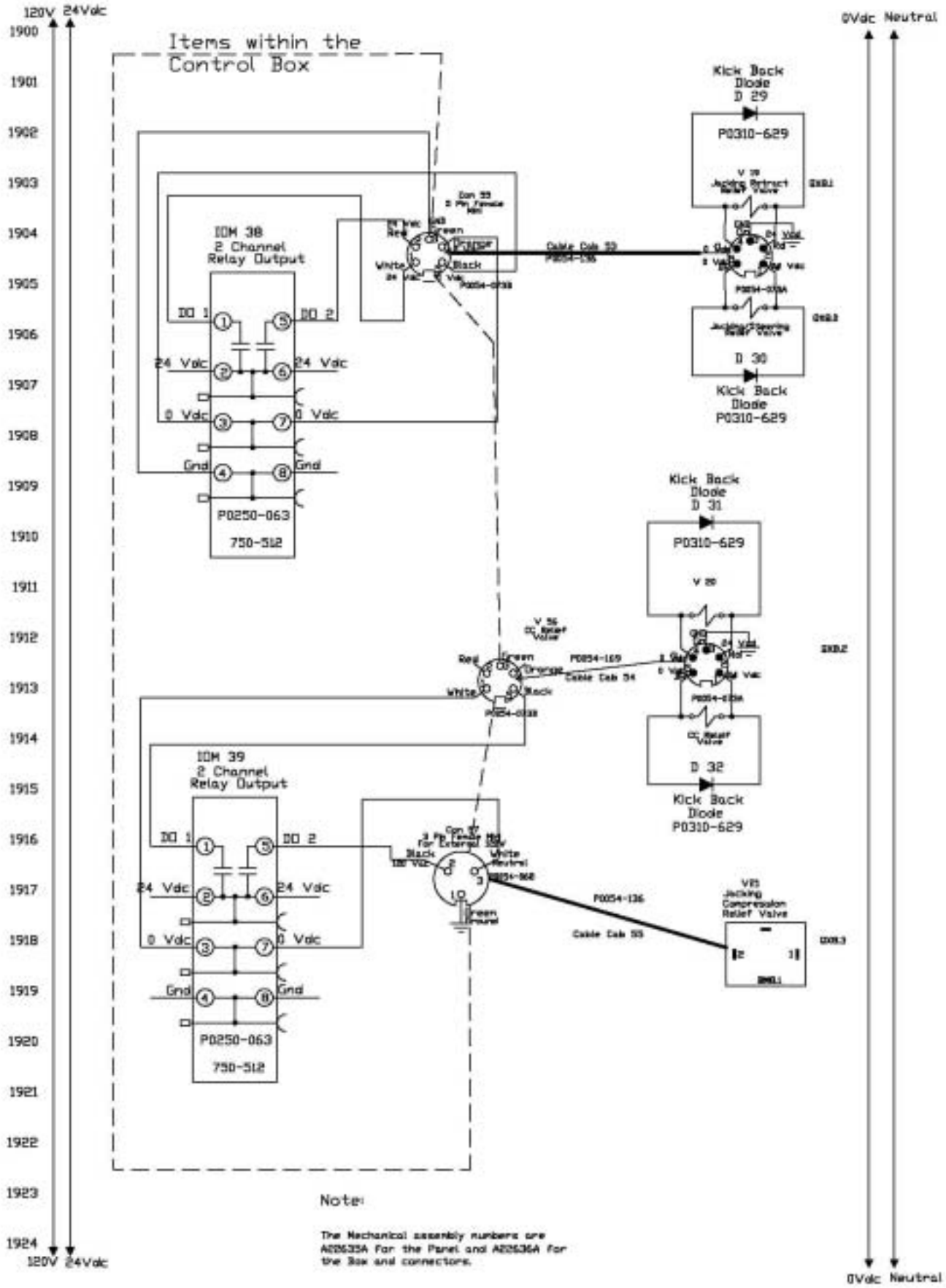

120V 24Vdc
0Vdc Neutral
Items within the Control Box
Kick Back Diode D 15
P0310-629
IDM 29
2 Channel
Relay Output
DO 1
DO 2
24 Vdc
0 Vdc
Gnd
P0250-063
750-512
Cable Cab 44
P0254-136
D 16
Kick Back Diode
P0310-629
RLY3
RLY 3
Top Bentonite Valve
P0310-410
V 11
IDM 30
2 Channel
Relay Output
RLY 4
Bottom Bentonite Valve
P0310-410
V 12
24 V
0 V
Cable Cab 45
P0254-135
Note:
The Mechanical assembly numbers are A22535A for the Panel and A22536A for the Box and connectors.

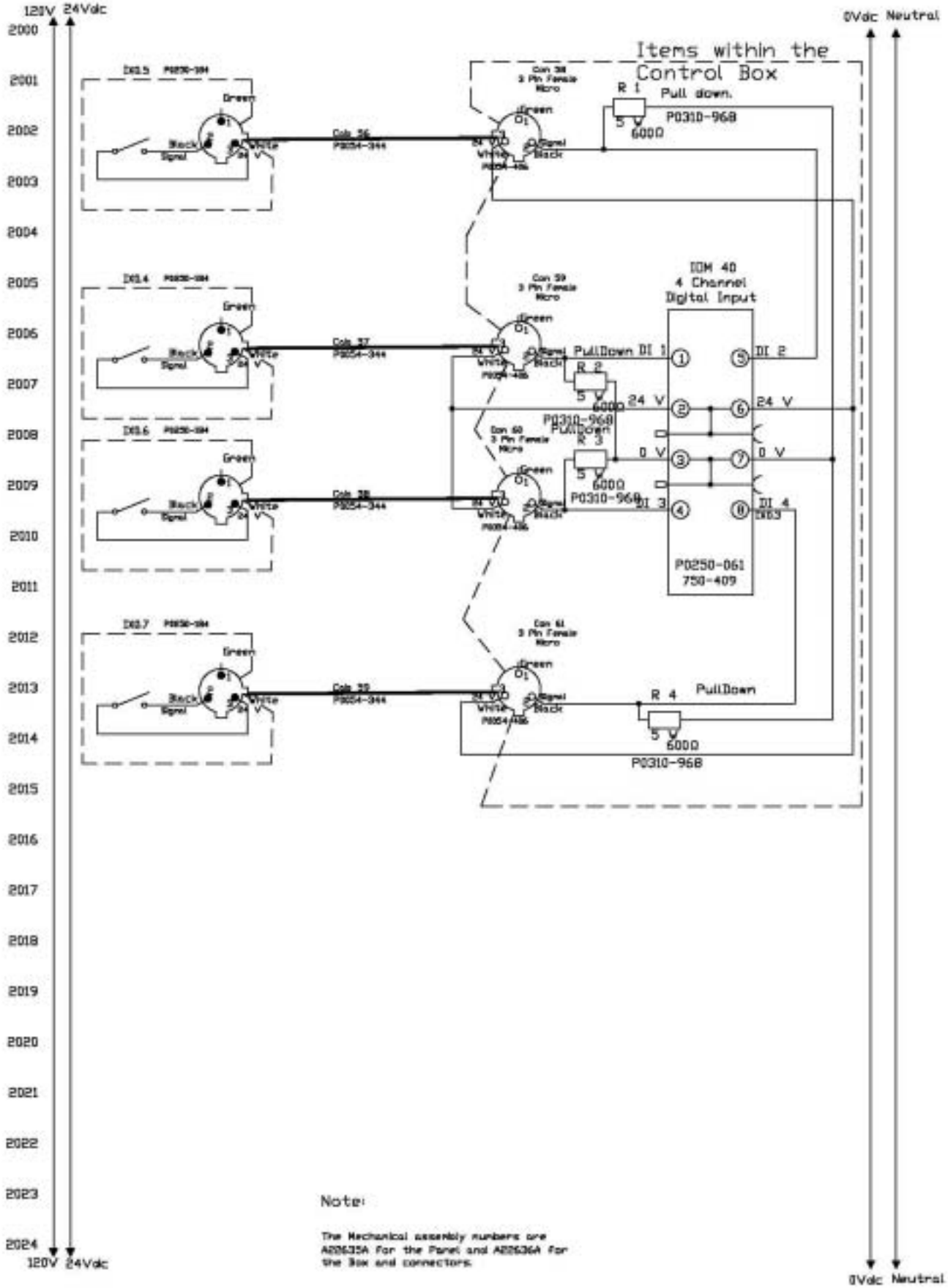

120V
Neutral
Items within the Control Box
PS 2
Power Supply
24V 20A
120 Vac
L
N
24 VDC
0 VDC
+S
-S
P0310-940
Gnd
IDM 31
Supply
Module
24 Vdc
24 Vdc
0 V
0 V
Gnd
Gnd
P0250-068
750-612
Note:
The Mechanical assembly numbers are A28635A for the Panel and A28636A for the Box and connectors.
120V
24Vdc
0Vdc
Neutral

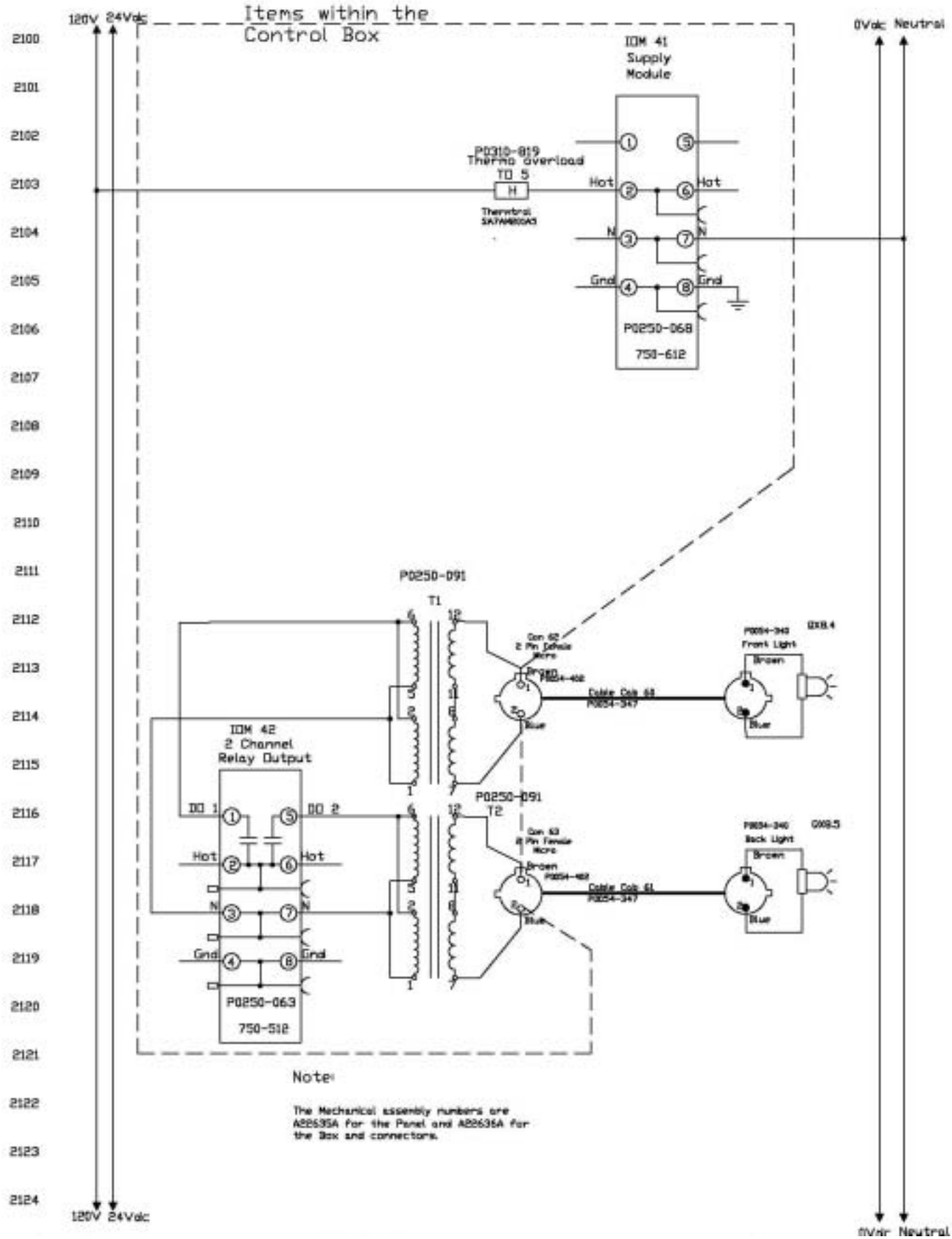

120V 24Vdc
1600
1601
1602
1603
1604
1605
1606
1607
1608
1609
1610
1611
1612
1613
1614
1615
1616
1617
1618
1619
1620
1621
1622
1623
1624
120V 24Vdc
Items within the Control Box
IOM 32
2 Channel
Relay Output
DO 1
DO 2
24 Vdc
24 Vdc
0 Vdc
0 Vdc
Gnd
Gnd
P0250-063
750-512
Con 49
5 Pin Female
Cable Cab 47
P0854-036
White
24 Vdc
Black
Vdc
P0854-0738
Kick Back
Diode
D 17
P0310-629
V 39
Extend Tpo Left
Jacking Cylinder
QX7.4
P0854-073A
Retract Tpo Left
Jacking Cylinder
QX7.5
D 18
Kick Back
Diode
P0310-629
IOM 33
2 Channel
Relay Output
DO 1
DO 2
24 Vdc
24 Vdc
0 Vdc
0 Vdc
Gnd
Gnd
P0250-063
750-512
Con 50
5 Pin Female
Cable Cab 48
P0854-035
White
24 Vdc
Black
Vdc
P0854-0738
Kick Back
Diode
D 19
P0310-629
V 14
Extend Tpo Right
Jacking Cylinder
QX7.6
P0854-073A
Retract Tpo Right
Jacking Cylinder
QX7.7
D 20
Kick Back
Diode
P0310-629
Note:
The Mechanical assembly numbers are
AE0535A for the Panel and AE0536A for
the Box and connectors.
0Vdc Neutral
0Vdc Neutral

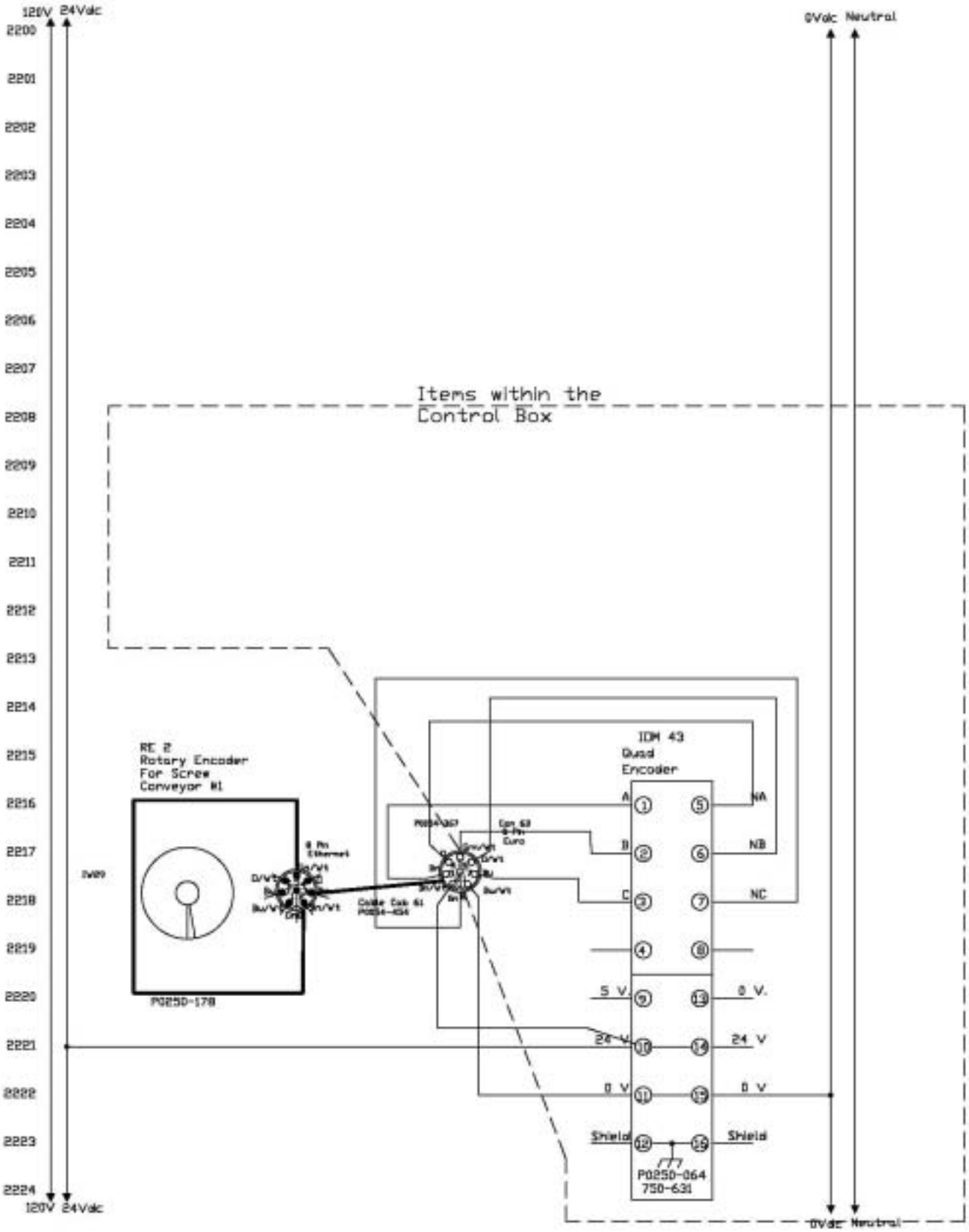

120V 24Vdc
1700
1701
1702
1703
1704
1705
1706
1707
1708
1709
1710
1711
1712
1713
1714
1715
1716
1717
1718
1719
1720
1721
1722
1723
1724
120V 24Vdc
Items within the Control Box
IDM 34
2 Channel
Relay Output
DO 1
DO 2
24 Vdc
24 Vdc
0 Vdc
0 Vdc
Gnd
Gnd
P0250-063
750-512
IDM 35
2 Channel
Relay Output
DO 1
DO 2
24 Vdc
24 Vdc
0 Vdc
0 Vdc
Gnd
Gnd
P0250-063
750-512
Kick Back Diode D 21
P0310-629
Kick Back Diode D 22
P0310-629
Kick Back Diode D 23
P0310-629
Kick Back Diode D 24
P0310-629
Cable Cab 49
Cable Cab 50
Note:
The Mechanical assembly numbers are A22535A for the Panel and A22536A for the Box and connectors.
0Vdc Neutral
0Vdc Neutral


120V 24Vdc
0Vdc Neutral
Items within the Control Box
IDM 36
2 Channel
Relay Output
DO 1
DO 2
24 Vdc
0 Vdc
Gnd
P0250-063
750-512
Kick Back Diode
D 25
P0310-629
D 26
Kick Back Diode
P0310-629
IDM 37
2 Channel
Relay Output
Kick Back Diode
D 27
P0310-629
D 28
Kick Back Diode
P0310-629
Note:
The Mechanical assembly numbers are A02635A for the Panel and A02636A for the Box and connectors.
120V 24Vdc
0Vdc Neutral

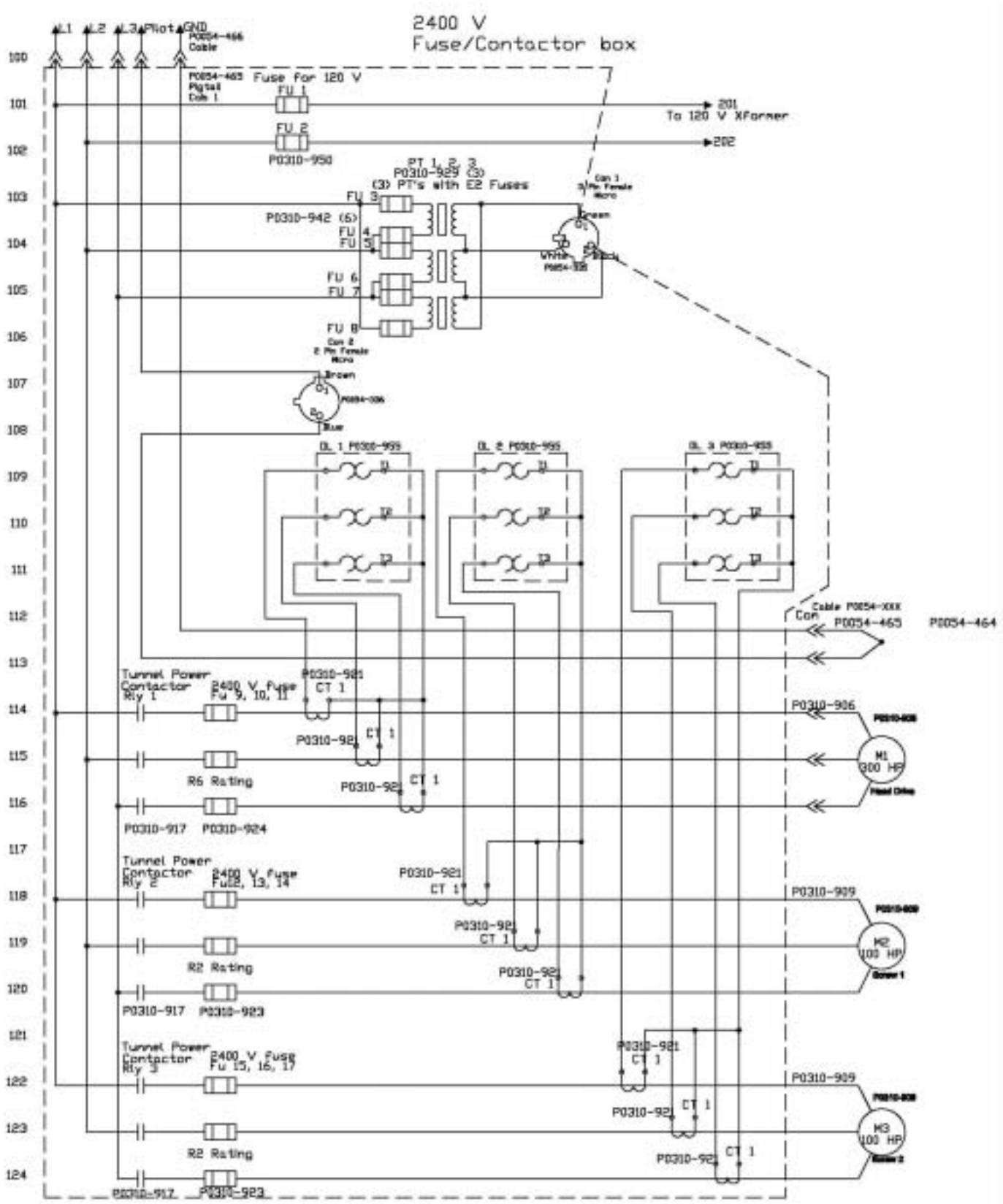

120V 24Vdc
0Vdc Neutral
Items within the Control Box
Kick Back Diode D 29
P0310-629
IOM 38 2 Channel Relay Output
DO 1
DO 2
24 Vdc
0 Vdc
Gnd
P0250-063
750-512
Cable Cab 32
P0054-136
D 30
Kick Back Diode P0310-629
Kick Back Diode D 31
P0310-629
V 55
P0054-169
Cable Cab 34
D 32
Kick Back Diode P0310-629
IOM 39 2 Channel Relay Output
Black
White
Green
Neutral
V85 Jacking Compression Relief Valve
Cable Cab 33
Note:
The Mechanical assembly numbers are A20533A for the Panel and A20536A for the Box and connectors.

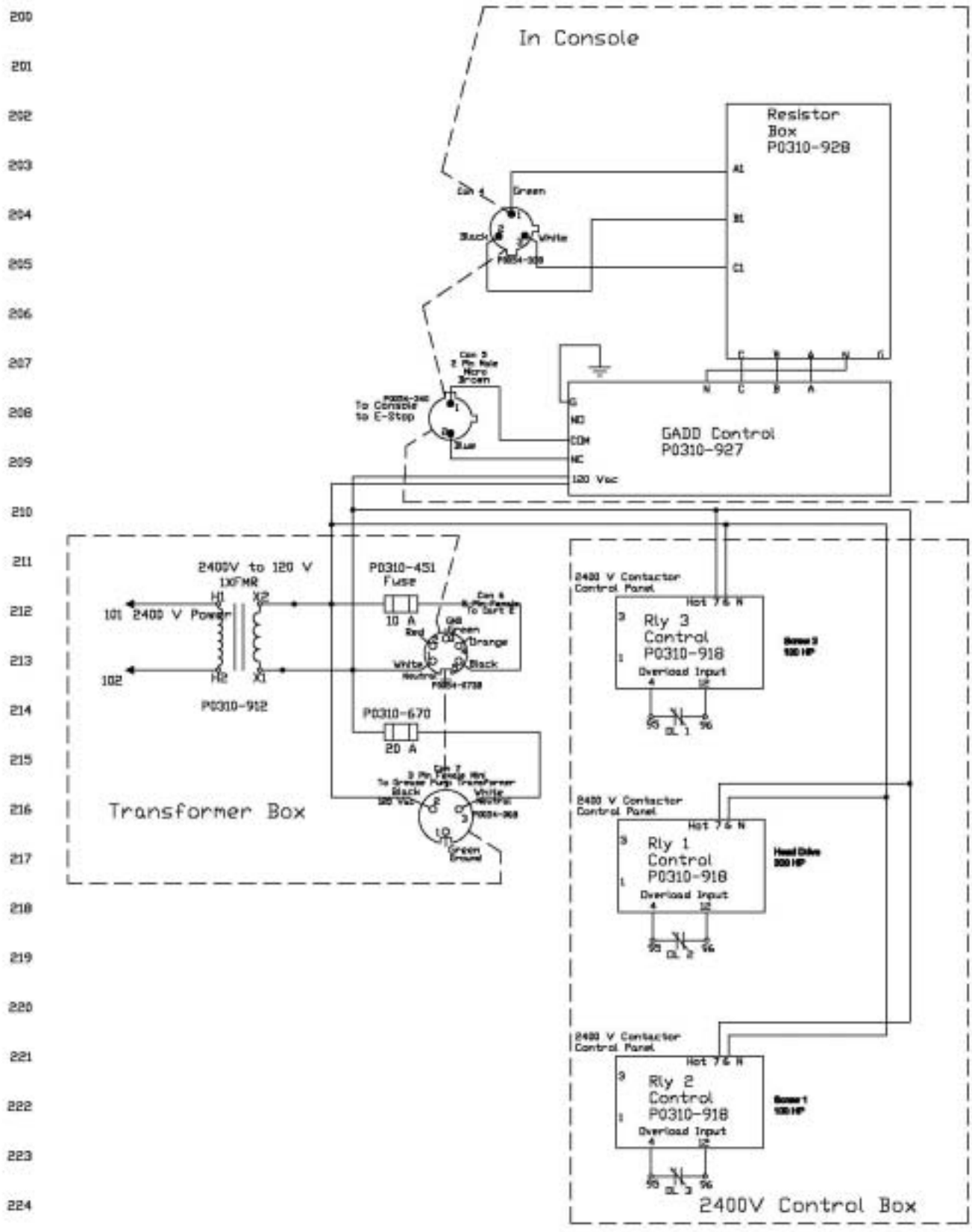

120V 24Vdc
0Vdc Neutral
Items within the Control Box
Con 38 3 Pin Female Micro
R 1
Pull down.
P0310-968
5 V
600Ω
Green
Black Signal
White
Cab 36 P0254-344
Con 59 3 Pin Female Micro
IOM 40 4 Channel Digital Input
PullDown DI 1
DI 2
R 2
24 V
Con 60 3 Pin Female Micro
R 3
0 V
DI 3
DI 4
P0250-061 750-409
Con 61 3 Pin Female Micro
R 4
PullDown
Note:
The Mechanical assembly numbers are A20635A for the Panel and A20636A for the Box and connectors.


Items within the Control Box
120V 24Vdc
0Vdc Neutral
IOM 41 Supply Module
P0310-819 Thermo overload TO 5
Hot
Hot
N
N
Gnd
Gnd
P0250-068
750-612
P0250-091
T1
T2
IOM 42 2 Channel Relay Output
DO 1
DO 2
P0250-063
750-512
Front Light
Back Light
Brown
Blue
Note:
The Mechanical assembly numbers are A26635A for the Panel and A26636A for the Box and connectors.
120V 24Vdc
0Vdc Neutral

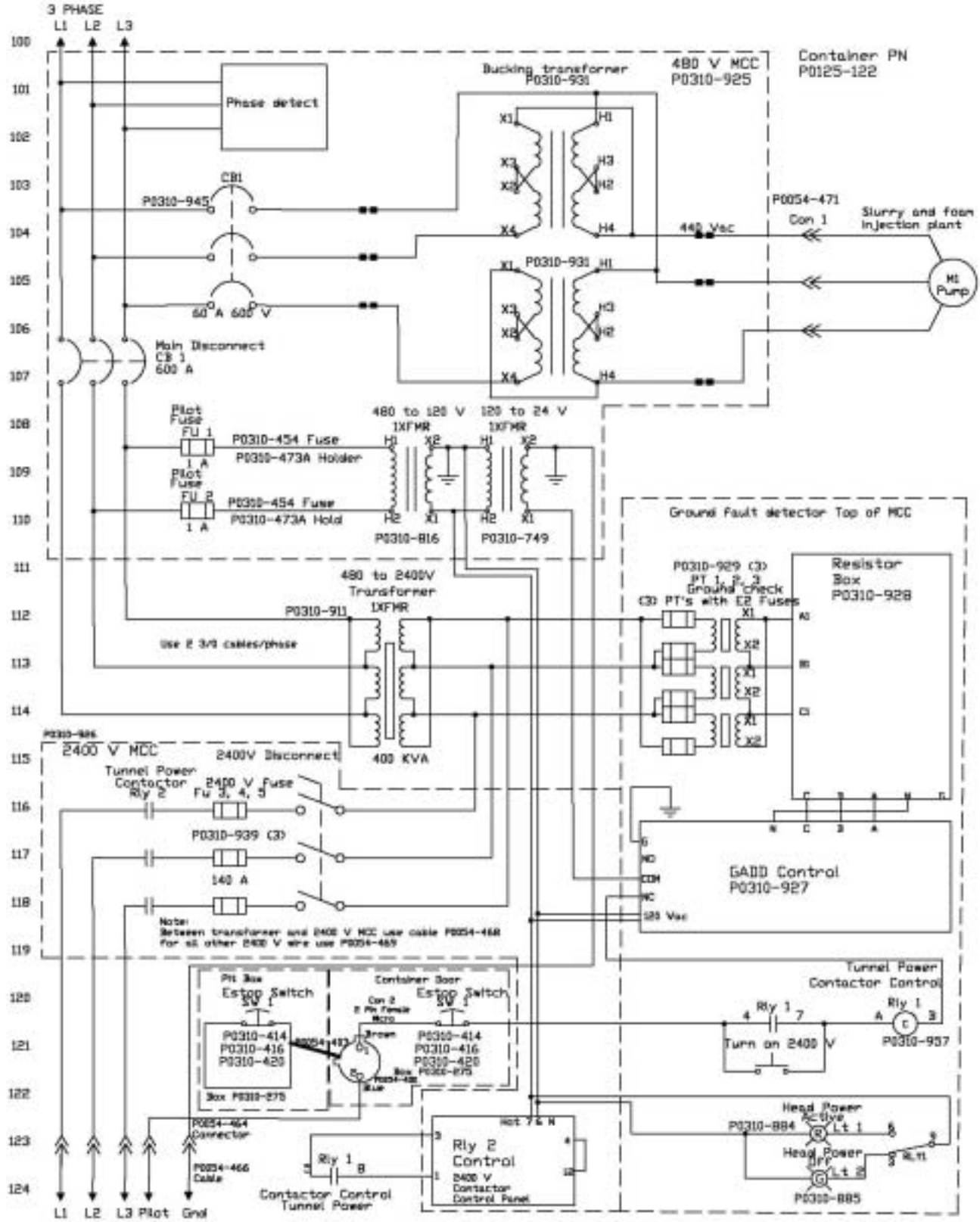

120V 24Vdc
0Vdc Neutral
Items within the Control Box
RE 2
Rotary Encoder
For Screw
Conveyor #1
P025D-178
IDM 43
Quad
Encoder
A
B
C
NA
NB
NC
5 V.
0 V.
24 V
0 V
Shield
Shield
P025D-064
750-631
120V 24Vdc
0Vdc Neutral

ELECTRICAL SCHEMATICS - HEAD POWER CIRCUIT




In Console
Resistor Box P0310-928
Green
Black
White
GADD Control P0310-927
To Console to E-Stop
Blue
Brown
NO
COM
NC
120 Vac
2400V to 120 V 1XFMR
P0310-451 Fuse
10 A
101 2400 V Power
102
P0310-912
P0310-670
20 A
Transformer Box
2400 V Contactor Control Panel
Rly 3 Control P0310-918
Rly 1 Control P0310-918
Rly 2 Control P0310-918
Overload Input
2400V Control Box

ELECTRICAL SCHEMATICS - POWER CONTAINER



Specifications

EPBM

Outside Diameter ..... 102 in.
Shield Length ..... 222 in (18' 6")
Shield Weight ..... 105,000 lbs.
Minimum Inside Pipe Diameter ..... 84 in.

Cutterhead

Torque ..... 433,000 ft-lbs.
Rotational Speed ..... 3.0 rpm
Drive ..... Electric-Hydraulic
Electric Motor ..... One 300 hp, 2300 VAC
Hydraulic Pump
..... One 22 cid close loop pump, 3200 psi
Hydraulic Motors ..... Four 305 cid
Oil Reservoir ..... 150 gal

Jacking Can

Stroke ..... 34 in.
Capacity ..... 675 ton
Cylinders ..... 8 cylinders: 6.5 in. bore, 5100 psi
Speed ..... 7 in. per minute

Steering Cylinders

Cylinders ... 4 cylinders: 9.25 in. bore, 5100 psi
Capacity ..... 685 ton
Steering Angles
Up/Down ..... 5 degrees
Left/Right ..... 3 degrees

Auxiliary Hydraulics

Electric Power ..Two 100 hp 2300 VAC motors
Oil Reservoir ..... 300 gal

Above Ground Power Container

Incoming Power
..... 480 VAC 60 Hz
..... 550kW Prime Generator Minimum
Tunnel Cable Power ..... 2300 VAC
Foam & Slurry Plant Power ... 400 VAC 60 Hz

#1 Screw Conveyor

Type ..... Open center ribbon screw
Diameter (Outside) ..... 18.5 in.
Rotational Speed ..... 0 to 15 rpm
Maximum Capacity ..... 72 cubic yards/hour
Maximum Spherical Object ..... 13 in. diameter

#2 Screw Conveyor

Type ..... Shaft drive screw
Diameter (Outside) ..... 16.5 in.
Rotational Speed ..... 0 to 26 rpm
Maximum Capacity ..... 72 cubic yards/hour
Maximum Spherical Object ..... 6 in. diameter

Additive System: Foam & Bentonite Slurry

Injection Ports On Cutterhead Face
..... Three 1.5 in. diameter
Injection Ports Through Front Bulkhead
..... Three 2 in. diameter
Maximum Slurry Injection Rate ..... 50 gpm
Maximum Foam Injection Rate ..... 42 gpm

Weights

EPBM Shield ..... 105,000 lbs (47,628 kg)
Backup Car #1 ..... 10,000 lbs. (4,536 kg)
Backup Car #2 ..... 12,000 lbs. (5,443 kg)
Backup Car #3 ..... 3,000 lbs. (1,361 kg)
Power Container ..... 7,000 lbs. (3,175 kg)
Foam & Slurry Plant .... 14,000 lbs. (6,350 kg)
Conveyor Lift ..... 1,700 lbs. (771 kg)

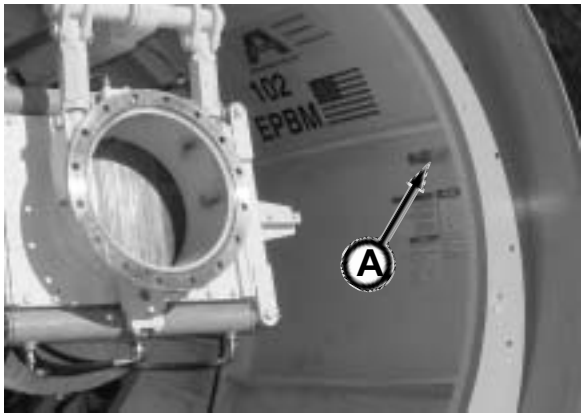
Identification Numbers

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

EARTH PRESSURE BALANCE MACHINE (A)

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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