OPERATOR'S MANUAL

Earth Pressure Balance Machine

EPB S/N: FA11400F

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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.

110V/240V/480V Electrical System Maintenance Shutdown Procedure

DANGER

Failure to lockout/tagout power before servicing will cause severe injury or death from electrocution or contact with moving parts.

BEFORE servicing the 110V/240V/480V electrical components of the EPB, perform the following procedure:

1. **Push E-Stop button and lockout/tagout ALL power.**
2. **Remove fuses to electrical device(s) to prevent accidental start up. Person performing maintenance must keep fuses in his possession until maintenance is complete.**
3. **Close door to electrical box if it must be re-energized.**
4. **Turn on main power (if needed) for lights, etc.**
5. **Perform maintenance to electrical device.**
6. **Once maintenance/service is complete, shut down, lockout/tagout ALL power.**
7. **Reinstall device fuses.**
8. **Close and secure electrical box cover.**
9. **Turn on main power.**

4160V Electrical System Maintenance Shutdown Procedure

DANGER

Failure to lockout/tagout power before servicing will cause severe injury or death from electrocution or contact with moving parts.

BEFORE servicing the 4160V electrical components of the EPB, perform the following procedure:

1. Push E-Stop button.

2. Once the E-Stop button is pushed in, the EPB 4160V Power Disconnect Output Line will automatically open (closed is power). The lights on the Output Line monitor will go off.

3. On Auxiliary Power, use crank to move auxiliary line to open position. The lights in the Auxiliary Line Monitor will go off.

4. Open auxiliary grounding switch cover and use crank in disconnect to turn it to ground. This will ground the power line. The Auxiliary Line Monitor will move to ground symbol. The Safe To Unplug 4160V Power Cable OFF (green light) indicator will illuminate.

5. Turn the 480V Main Disconnect to OFF and lockout/tagout all power.

6. Perform maintenance.

7. Once maintenance/service is complete, perform the following steps.

7a. Turn on power to Power Container.

7b. Move Auxiliary Ground switch to open position.

7c. Move Auxiliary Line to close position.

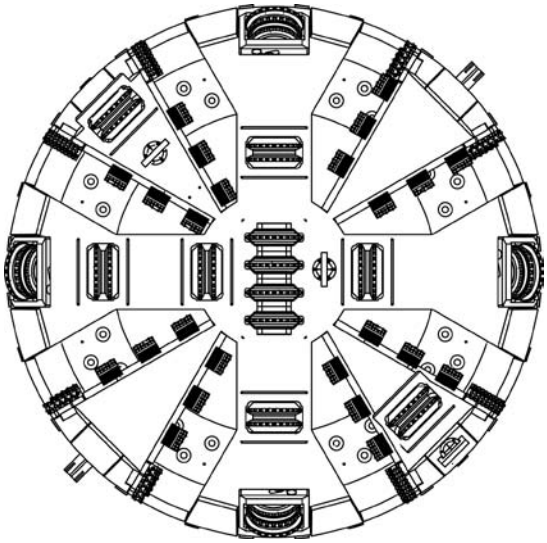
7d. Pull out E-Stop.

7e. Press the 4160V Power ON button on Power Container.

NOTICE **The High Voltage light should illuminate. If the light does not illuminate, contact a certified electrician to resolve the problem with the 4160V electrical system.**

⚠ DANGER

Any one in the area between the cutter head and the EPB bulkhead while the cutter head is rotating WILL BE KILLED.



BEFORE entering this area, you must perform lockout tag out, and remove cutter head fuses in switch gear car.

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.

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 spoils in the plenum chamber. This foam/bentonite slurry is then augered through a screw conveyor system then onto a belt conveyor to the muck cars. Once the muck cars are full, they are removed from the pipeline via a haul unit to the unloading area where the muck bucket is hoisted out of the shaft and unloaded. The tunnel is constructed as the EPBM bores through the ground with a segment erector. The segment erector places six concrete segments to build a complete ring within the jacking can of the EPBM. Once the complete ring is built, the EPBM hydraulic jacking cylinders are used to advance the EPBM by applying pressure to the concrete segments which applies pressure to the thrust block or other support structure pushing the EPBM forward. When the jacking cylinders are fully extended, the cylinders are retracted and the tunnel construction continues.

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.

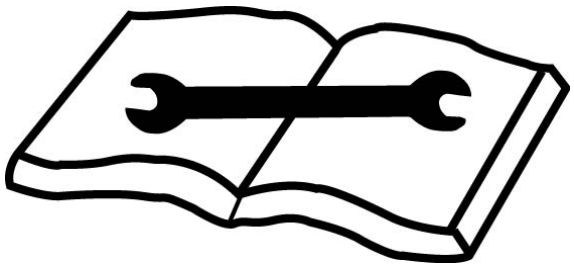
ATTENTION!
BECOME ALERT!
YOUR SAFETY IS INVOLVED!

READ OPERATOR'S MANUAL

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

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

Any unauthorized modifications will void the warranty.



WEAR PROTECTIVE CLOTHING

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

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

LOCKOUT/TAGOUT POWER BEFORE SERVICING

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

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

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.

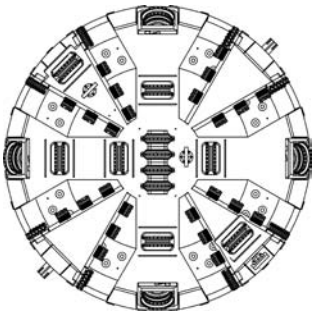
BEWARE OF SUSPENDED LOADS

⚠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.

CUTTERHEAD MAINTENANCE



⚠DANGER Anyone in the area between the cutterhead and the EPB bulkhead while the cutterhead is rotating WILL BE KILLED.

BEFORE entering this area, you MUST perform lockout/tagout, and remove cutterhead fuses in switch gear car (480V Box 1 and 480V Box 2).

KEEP PERSONNEL AWAY FROM MOVING PARTS

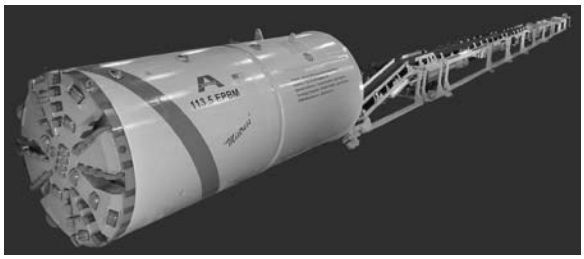
⚠WARNING Crushing hazard.
Keep personnel away from jacking cylinders. Failure to do so could result in serious personal injury or death.

UNAUTHORIZED WELDING

⚠WARNING Unauthorized welding can cause structural and/or electrical component failure resulting in possible injury or death.

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

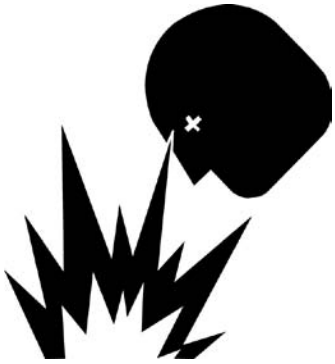
REGULARLY CLEAN AND INSPECT EQUIPMENT



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/TAGOUT power before performing any maintenance.

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

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

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

Do not service the machine while it is in motion.

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

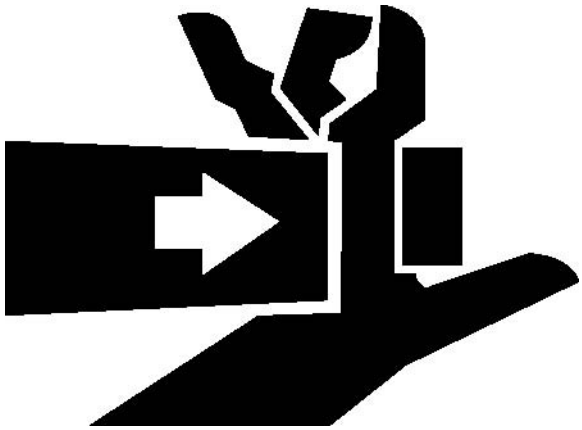
AVOID PINCH POINTS

⚠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

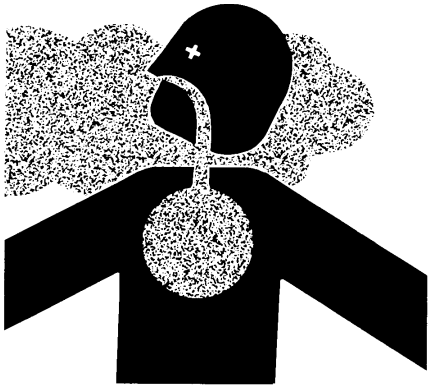
⚠DANGER Stay away from operating crane. If close to power lines, the crane, load, and ground may become electrified resulting in serious injury or death.

HIGH PRESSURE HYDRAULICS

⚠WARNING The earth pressure balance system contains high pressure hydraulics.

Keep all guards in place.

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.

REAR GATE ACCUMULATOR MAINTENANCE

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

The rear gate accumulator stores high pressure fluid.

BEFORE performing maintenance or repairs on rear gate, discharge accumulator.

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.

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.

KEEP AWAY FROM SCREW CONVEYOR 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/tagout power before servicing.

KEEP AWAY FROM BELT CONVEYOR

⚠DANGER Contact with rotating conveyor belt or idler rollers will cause severe injury or death.

Keep hands, body, and objects clear of rotating conveyor.

Do not operate without covers and guards in place.

Lockout/tagout power before servicing belt conveyor.

WATCH FOR CONVEYOR

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

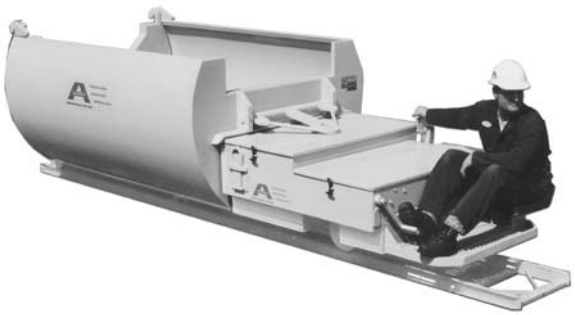
While moving haul unit into tunnel, avoid hitting the conveyor.

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.

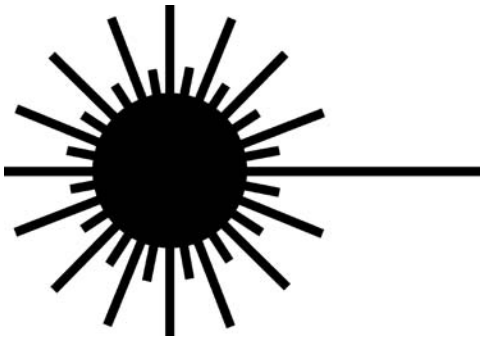


LOCKOUT/TAGOUT POWER BEFORE SERVICING HAUL UNIT

⚠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/TAGOUT power before performing any maintenance.

AVOID LASER LIGHT EXPOSURE

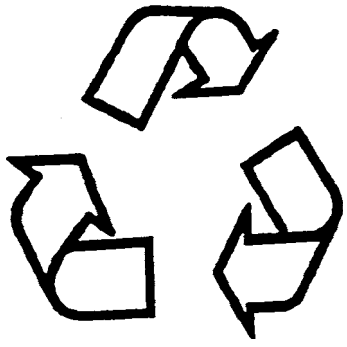


⚠DANGER Staring into laser light will cause severe injury.

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

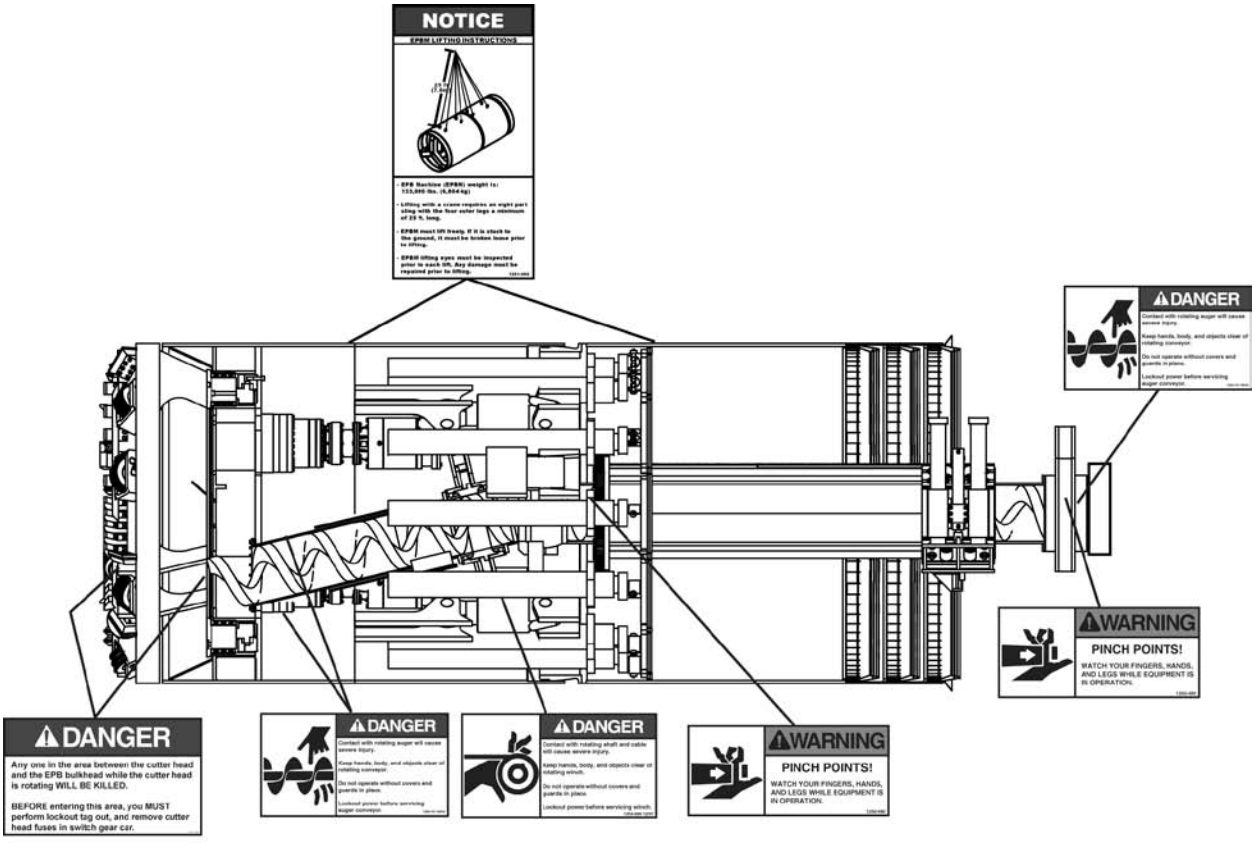
Keep all safety decals clean and readable. Use soft cloth, water, and a mild soap to clean the decals if they are too dirty to read. DO NOT clean safety decals with solvent. Solvent can damage them. Replace safety decals immediately if they are damaged, missing, or hard to read.

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

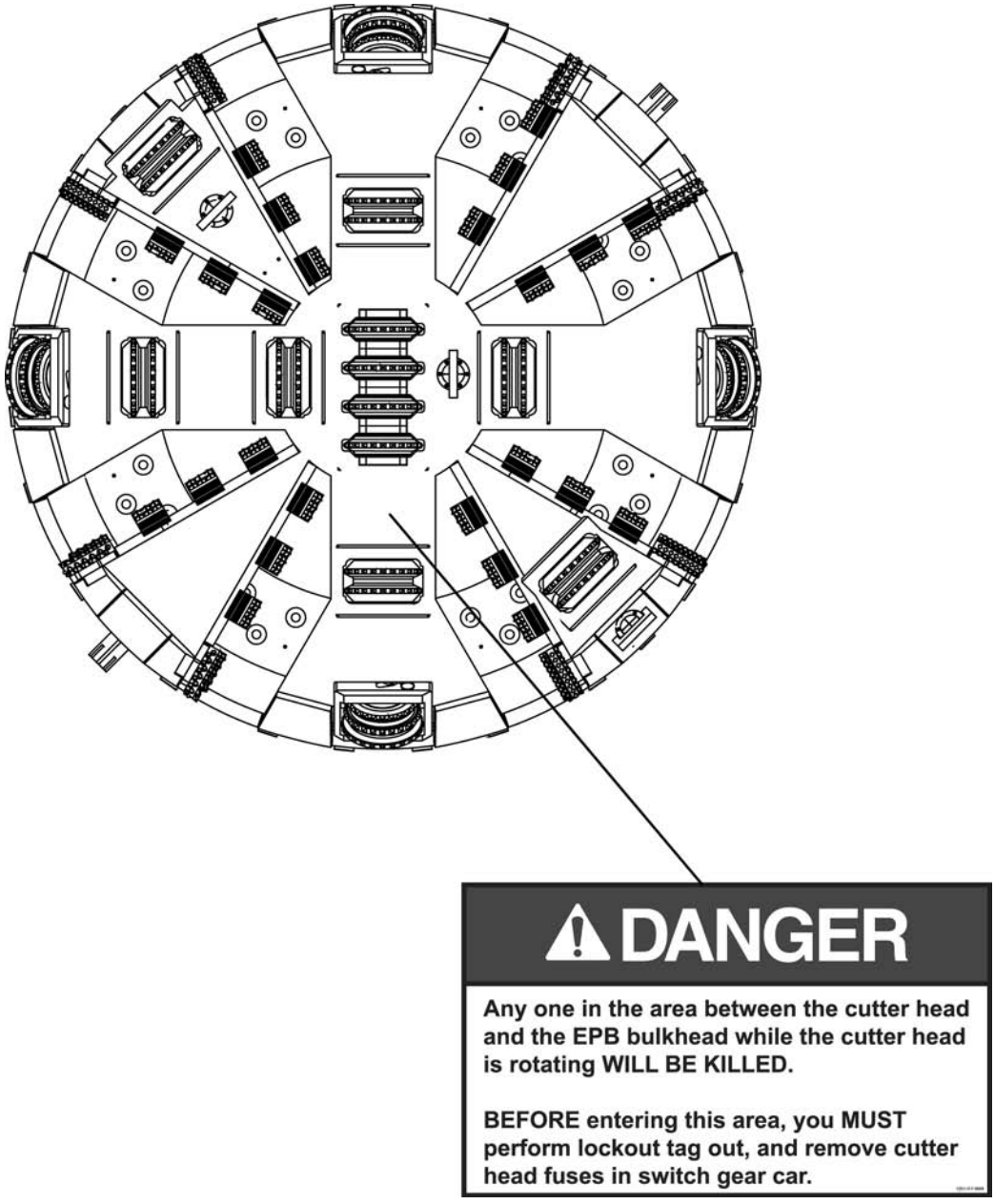
If a part is replaced that has any decal on it, apply the new decal to the replacement part. Before applying a new decal, be sure the surface is clean and dry.

This section illustrates all decals used on the EPB system; the safety, operation and informational decals.

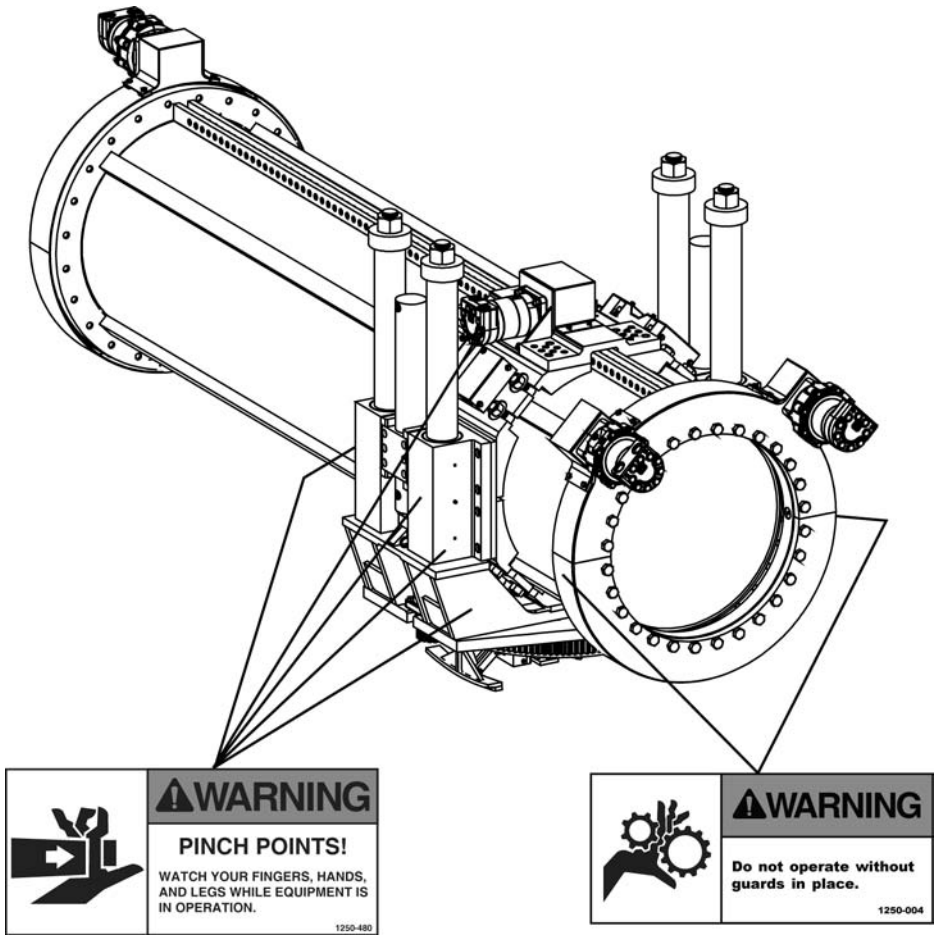
EPBM & SCREW CONVEYORS



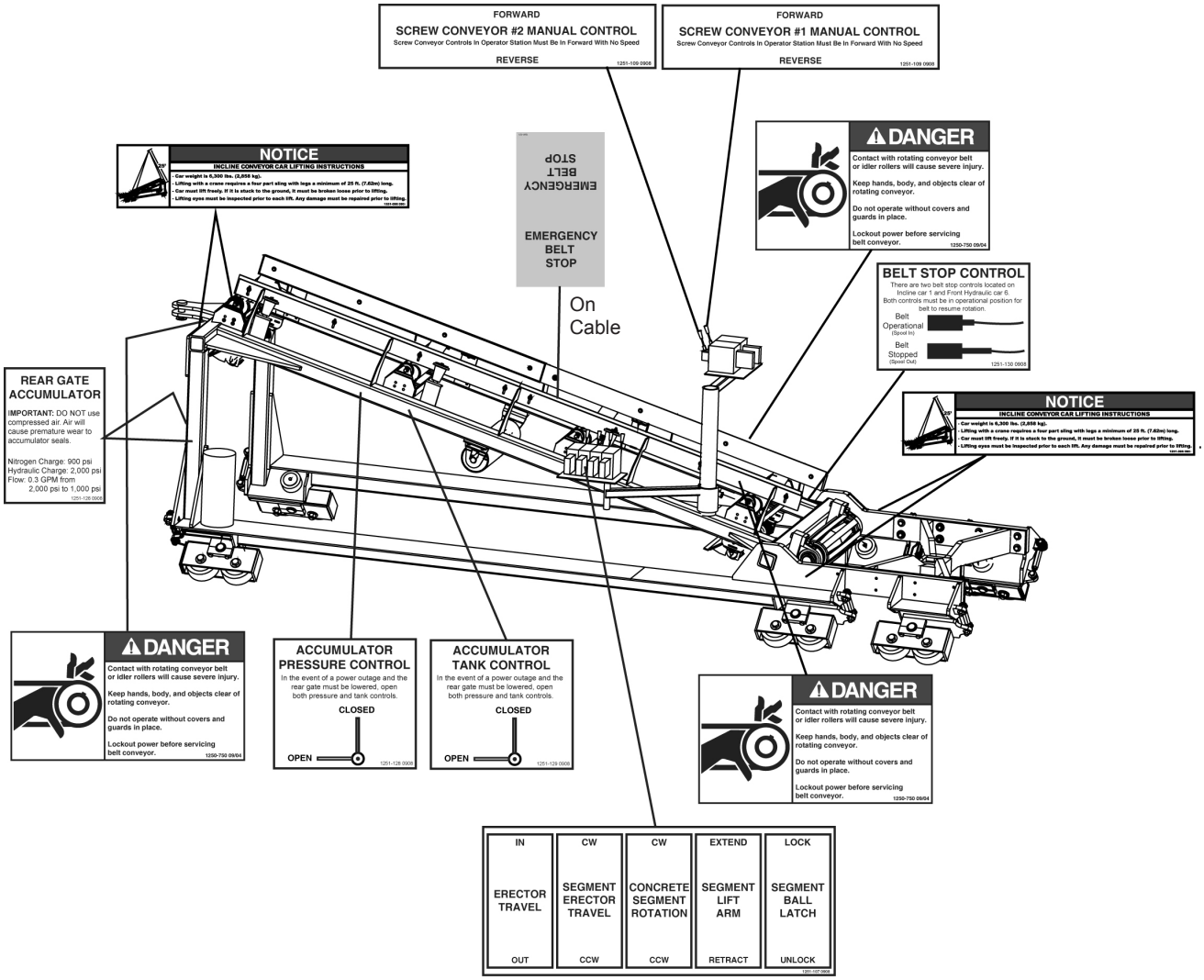
CUTTERHEAD


DANGER
Any one in the area between the cutter head and the EPB bulkhead while the cutter head is rotating WILL BE KILLED.
BEFORE entering this area, you MUST perform lockout tag out, and remove cutter head fuses in switch gear car.

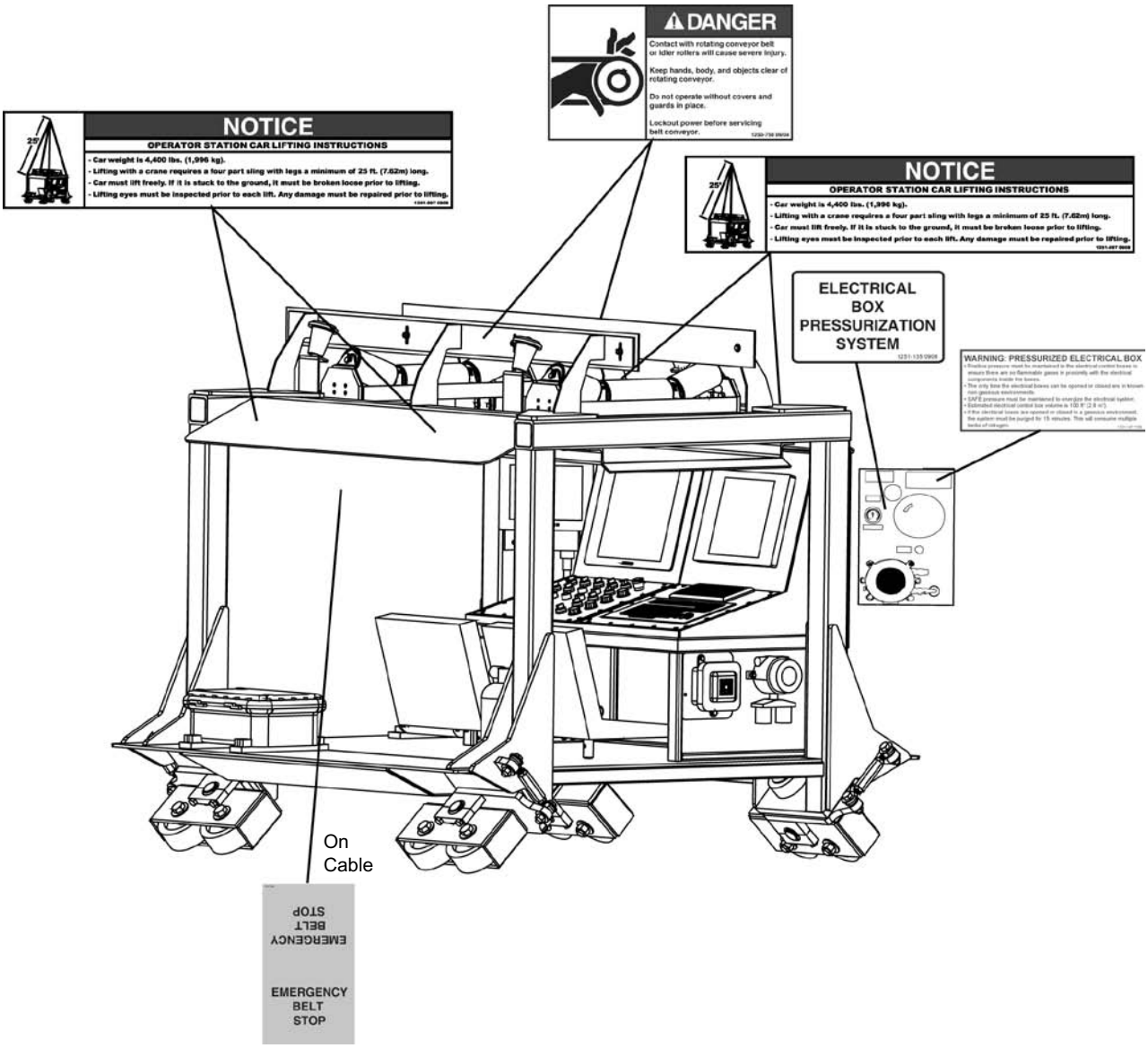
SEGMENT ERECTOR



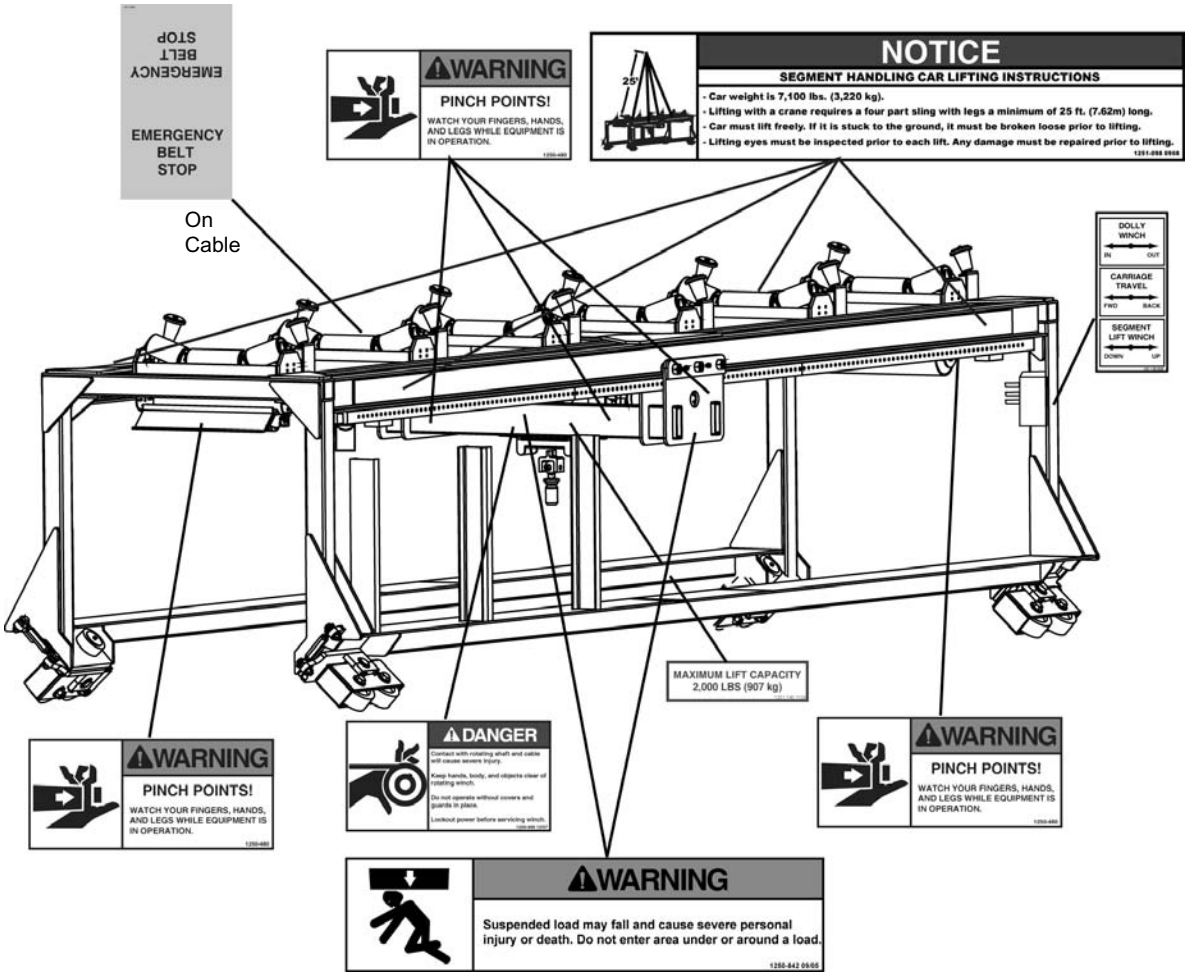
CAR #1 INCLINED CONVEYOR



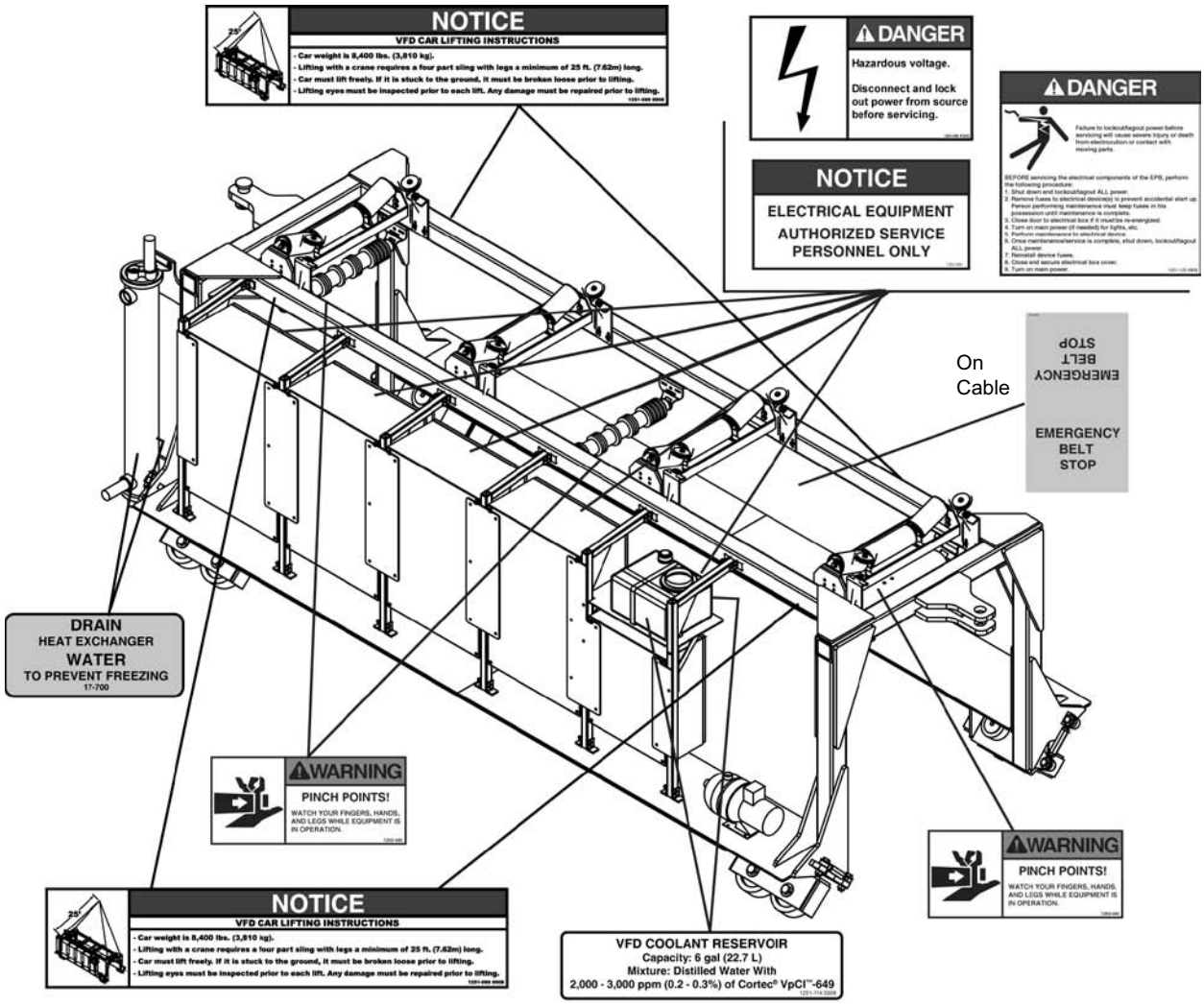
CAR #2 OPERATOR STATION



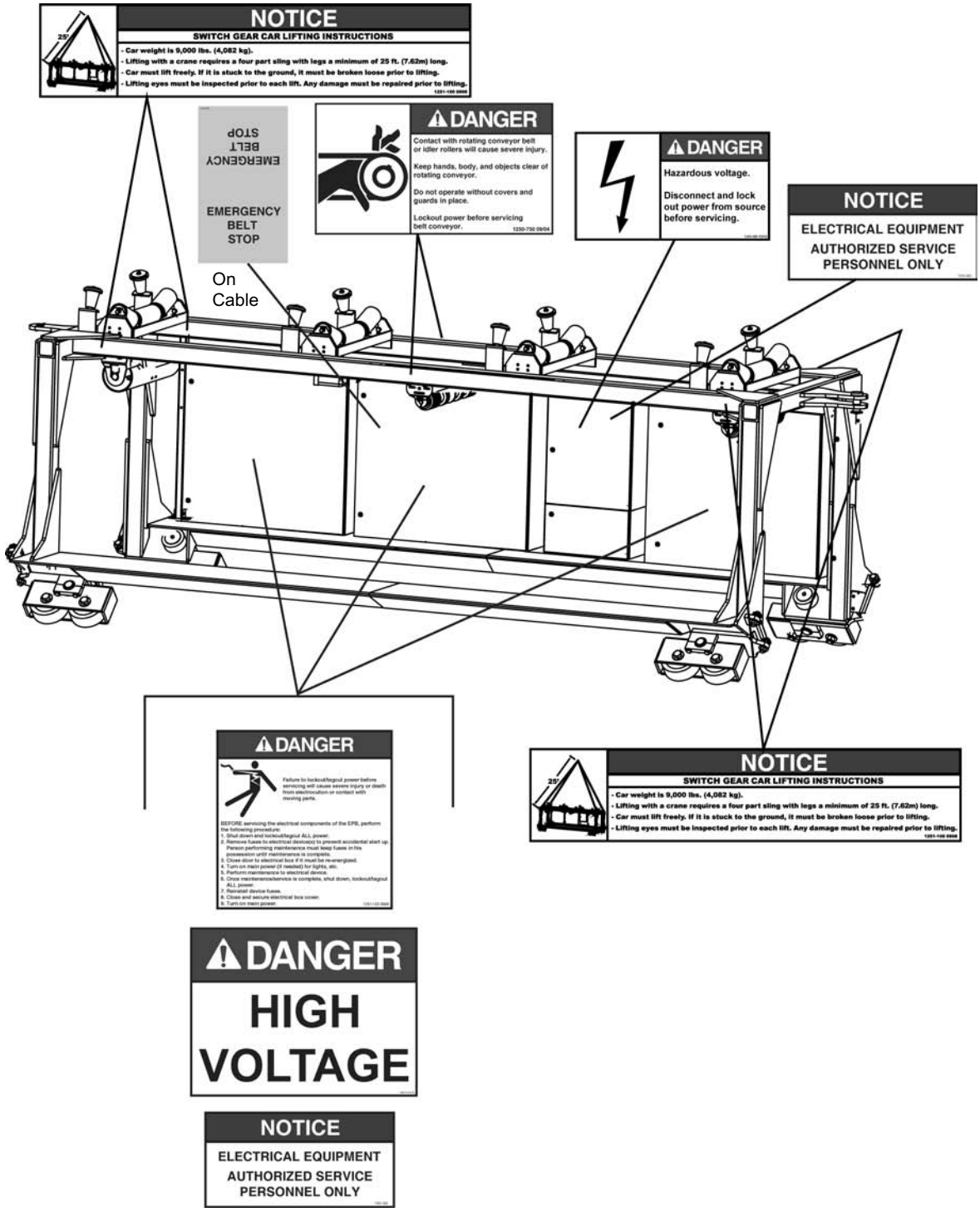
CAR #3 SEGMENT HANDLING



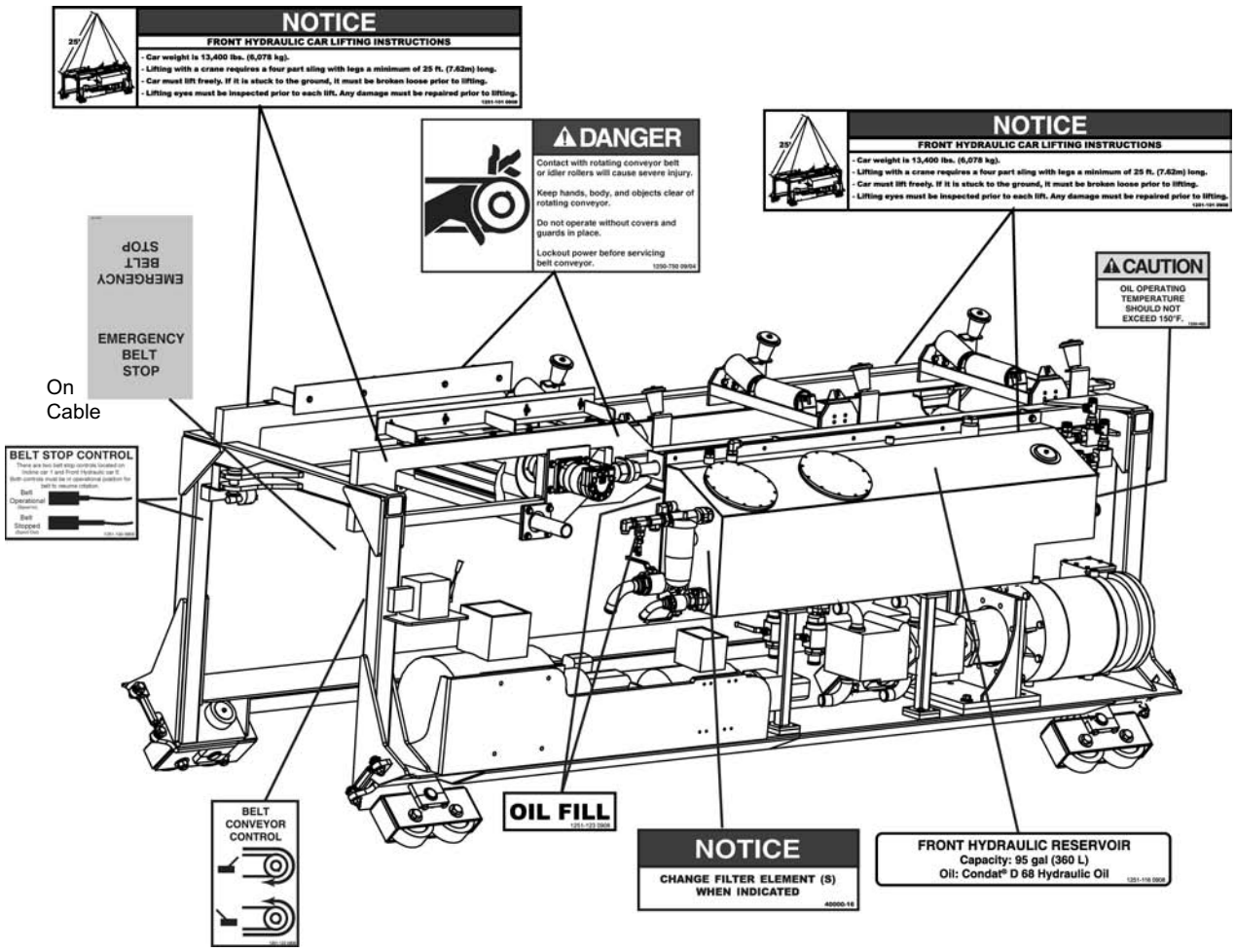
CAR #4 VFD


NOTICE
VFD CAR LIFTING INSTRUCTIONS
- Car weight is 8,400 lbs. (3,810 kg).
- Lifting with a crane requires a four part sling with legs a minimum of 25 ft. (7.62m) 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.
DANGER
Hazardous voltage.
Disconnect and lock out power from source before servicing.
DANGER
NOTICE
ELECTRICAL EQUIPMENT
AUTHORIZED SERVICE PERSONNEL ONLY
On Cable
EMERGENCY BELT STOP
EMERGENCY BELT STOP
DRAIN
HEAT EXCHANGER
WATER
TO PREVENT FREEZING
17-700
WARNING
PINCH POINTS!
WATCH YOUR FINGERS, HANDS, AND LEGS WHILE EQUIPMENT IS IN OPERATION.
WARNING
PINCH POINTS!
WATCH YOUR FINGERS, HANDS, AND LEGS WHILE EQUIPMENT IS IN OPERATION.
NOTICE
VFD CAR LIFTING INSTRUCTIONS
- Car weight is 8,400 lbs. (3,810 kg).
- Lifting with a crane requires a four part sling with legs a minimum of 25 ft. (7.62m) 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.
VFD COOLANT RESERVOIR
Capacity: 6 gal (22.7 L)
Mixture: Distilled Water With
2,000 - 3,000 ppm (0.2 - 0.3%) of Cortec® VpCI™-649

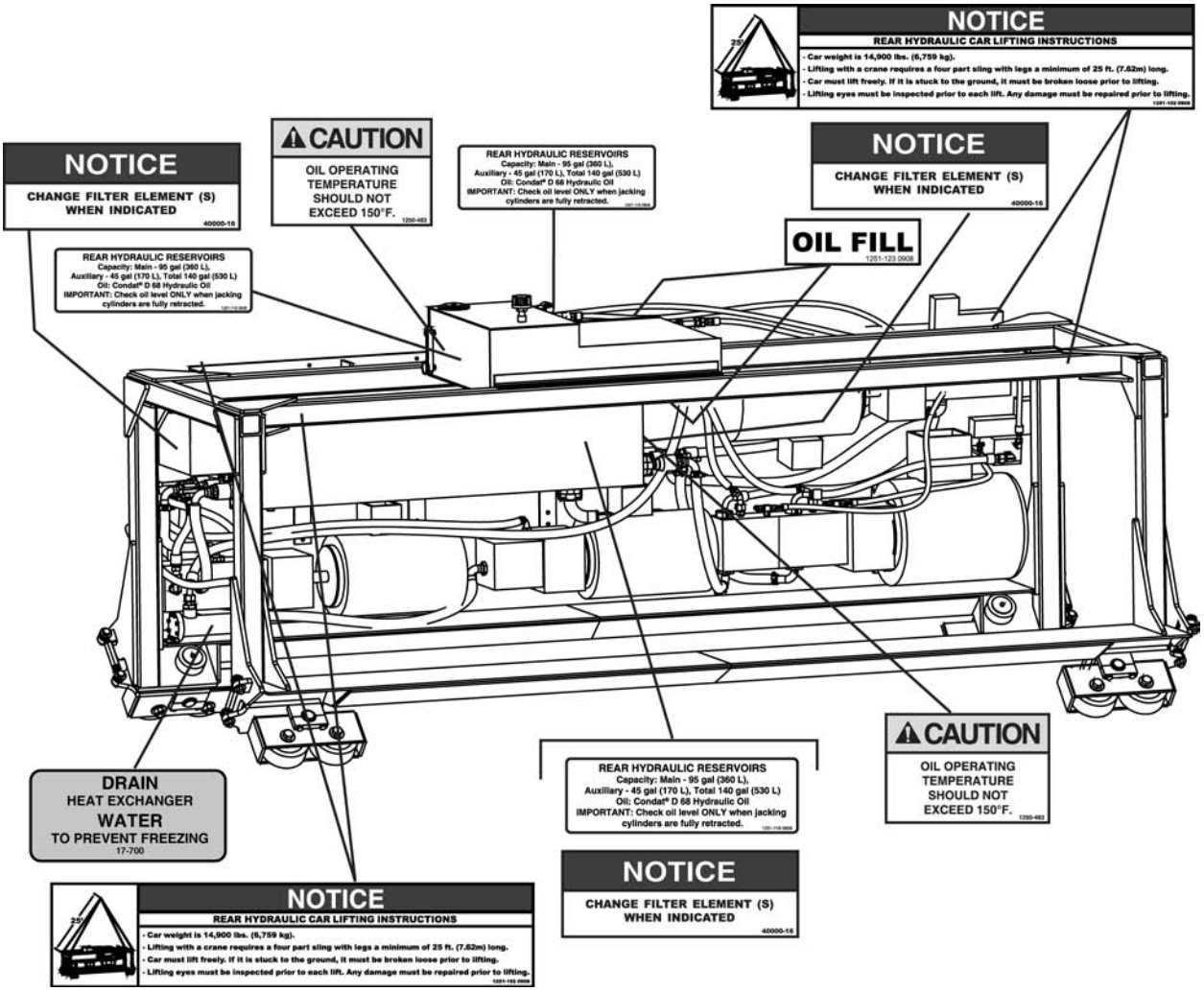
CAR #5 SWITCH GEAR



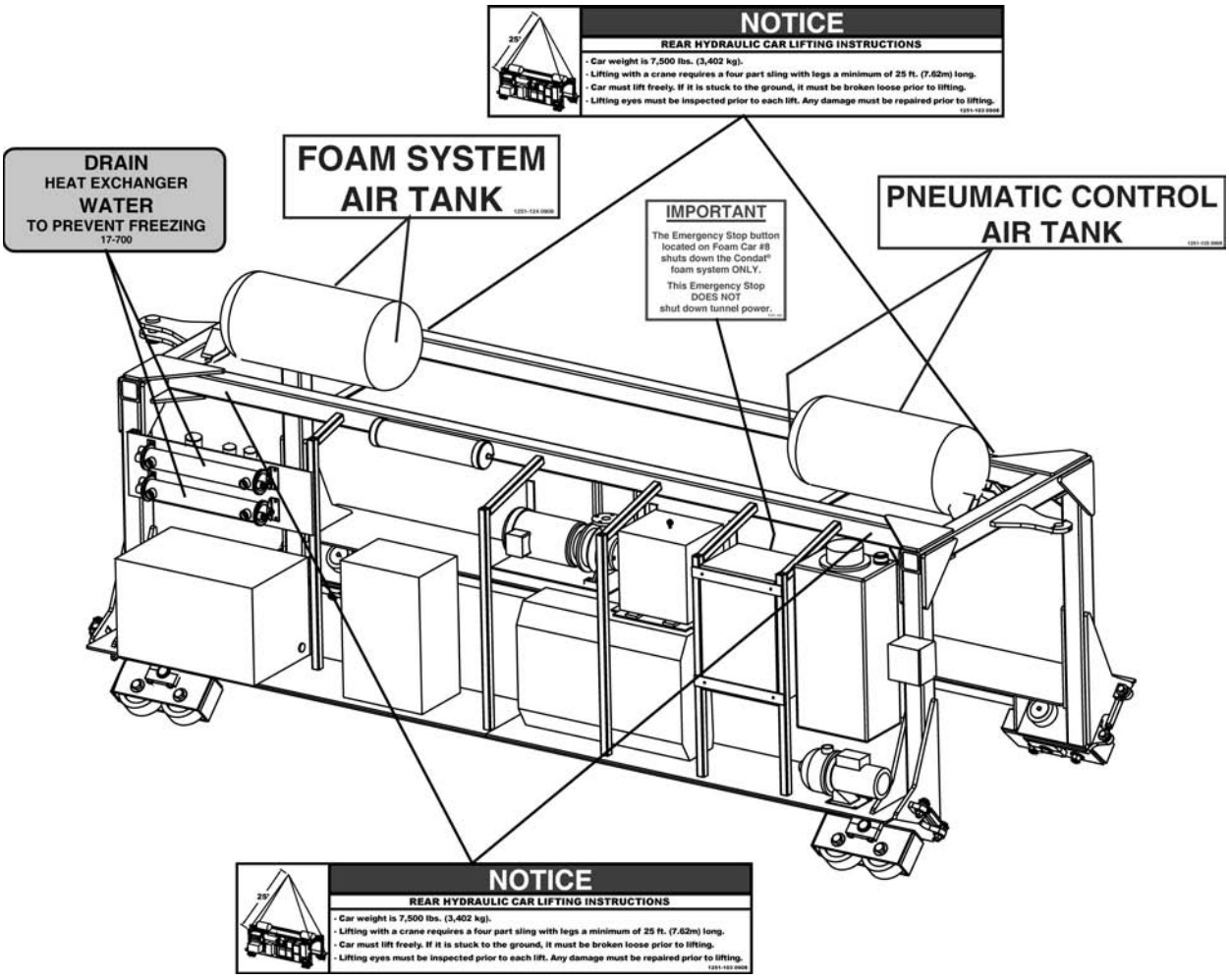
CAR #6 FRONT HYDRAULIC



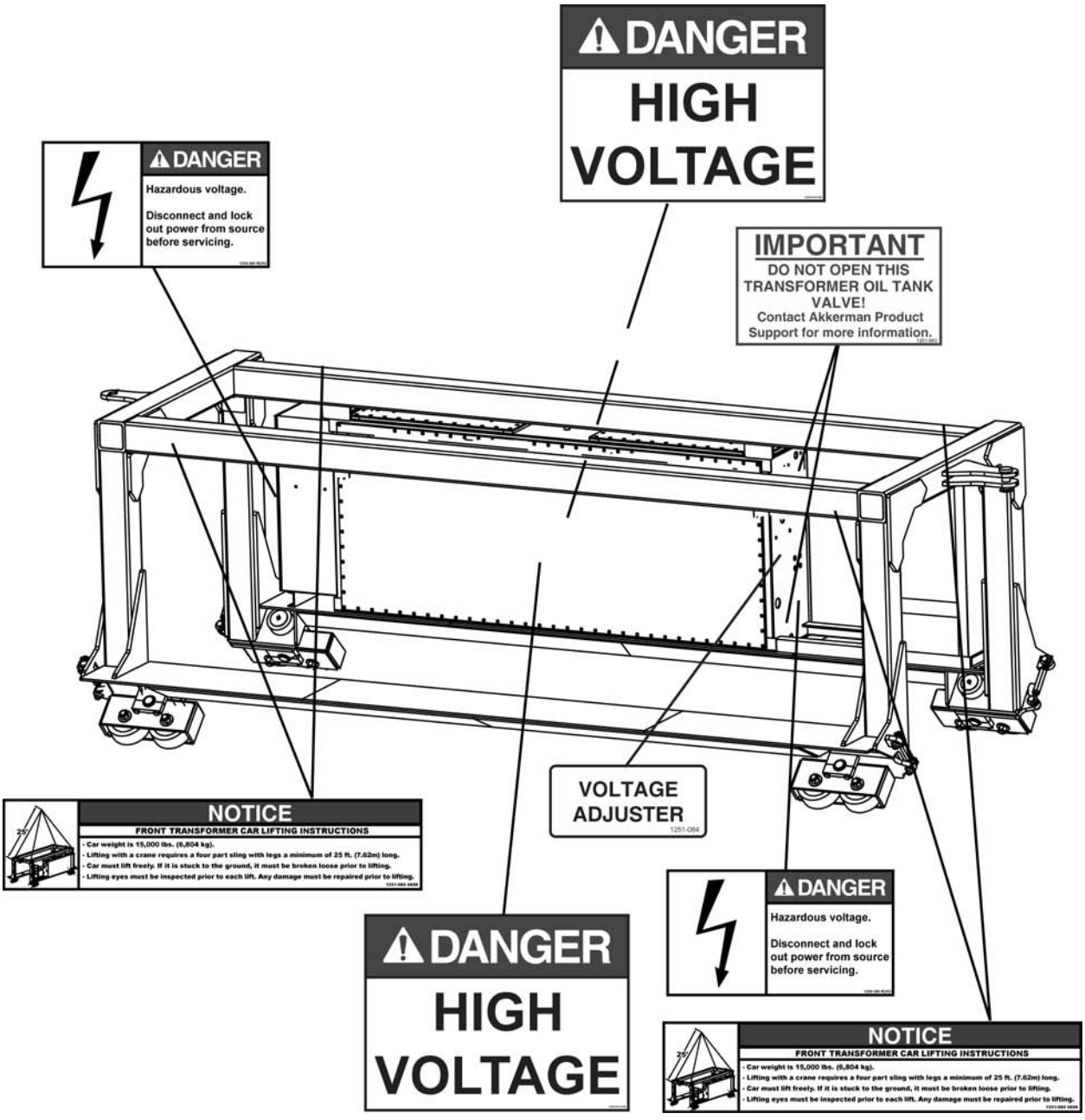
CAR #7 REAR HYDRAULIC



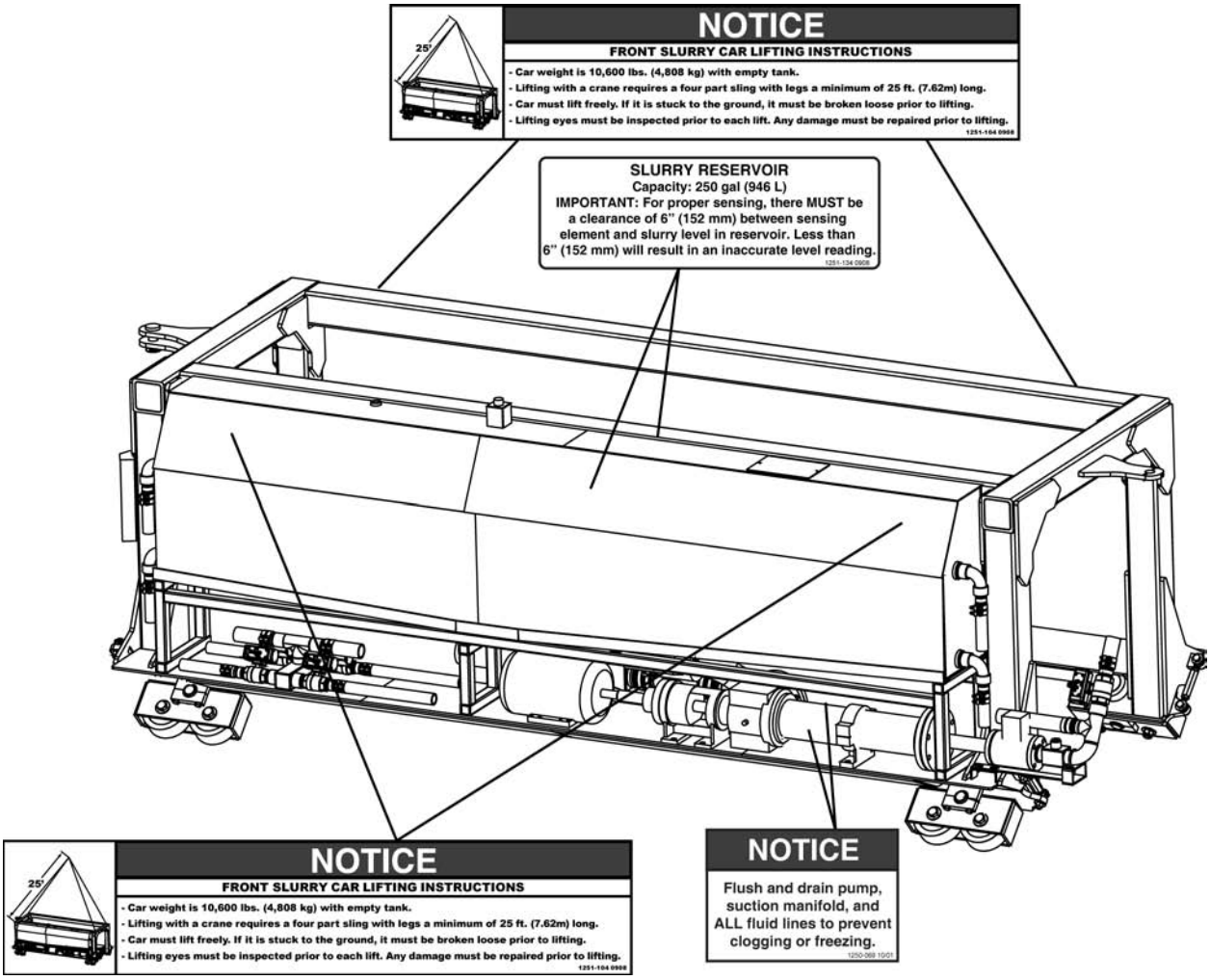
CAR #8 FOAM


NOTICE
REAR HYDRAULIC CAR LIFTING INSTRUCTIONS
- Car weight is 7,500 lbs. (3,402 kg).
- Lifting with a crane requires a four part sling with legs a minimum of 25 ft. (7.62m) 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.
DRAIN
HEAT EXCHANGER
WATER
TO PREVENT FREEZING
17-700
FOAM SYSTEM
AIR TANK
IMPORTANT
The Emergency Stop button located on Foam Car #8 shuts down the Condat® foam system ONLY.
This Emergency Stop DOES NOT shut down tunnel power.
PNEUMATIC CONTROL
AIR TANK
NOTICE
REAR HYDRAULIC CAR LIFTING INSTRUCTIONS
- Car weight is 7,500 lbs. (3,402 kg).
- Lifting with a crane requires a four part sling with legs a minimum of 25 ft. (7.62m) 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.

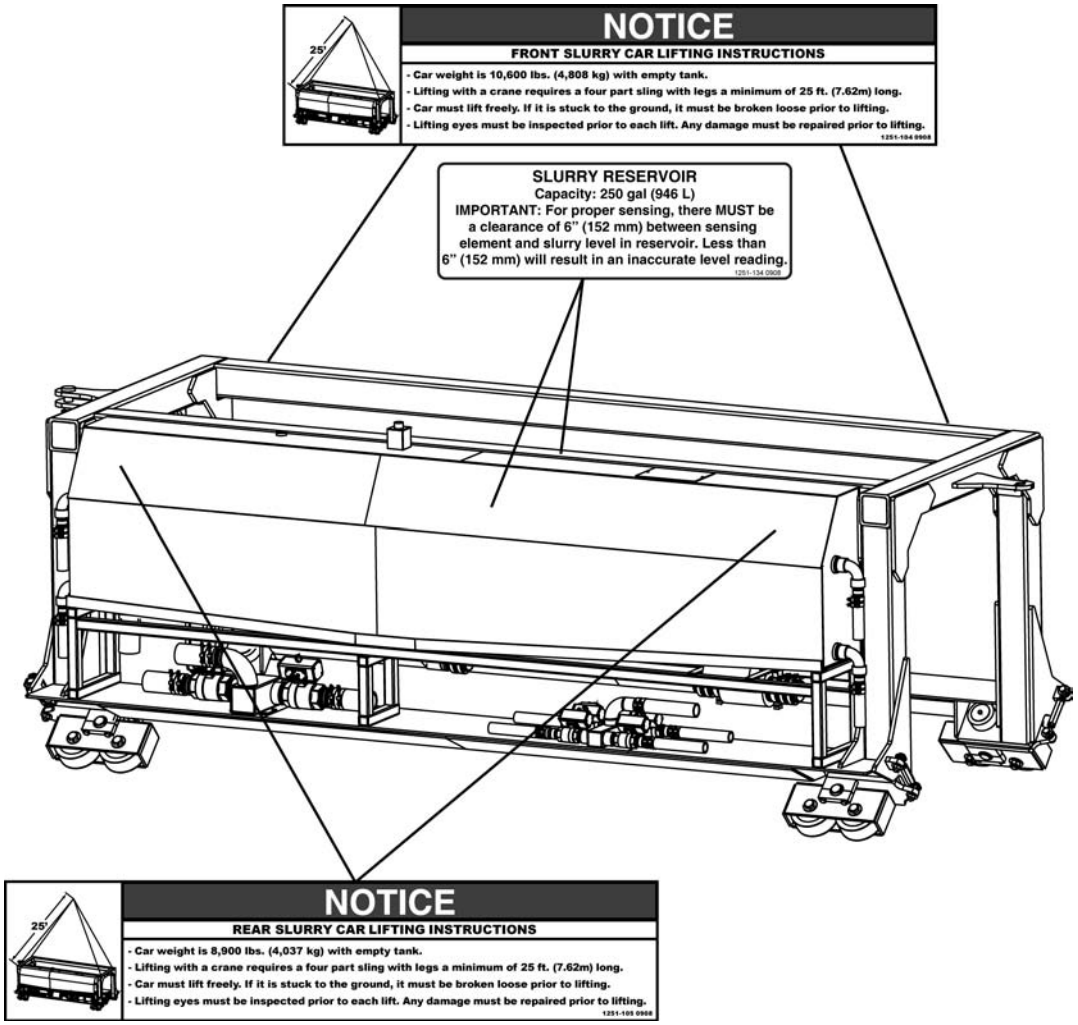
CAR #9 & 10 FRONT & REAR TRANSFORMER



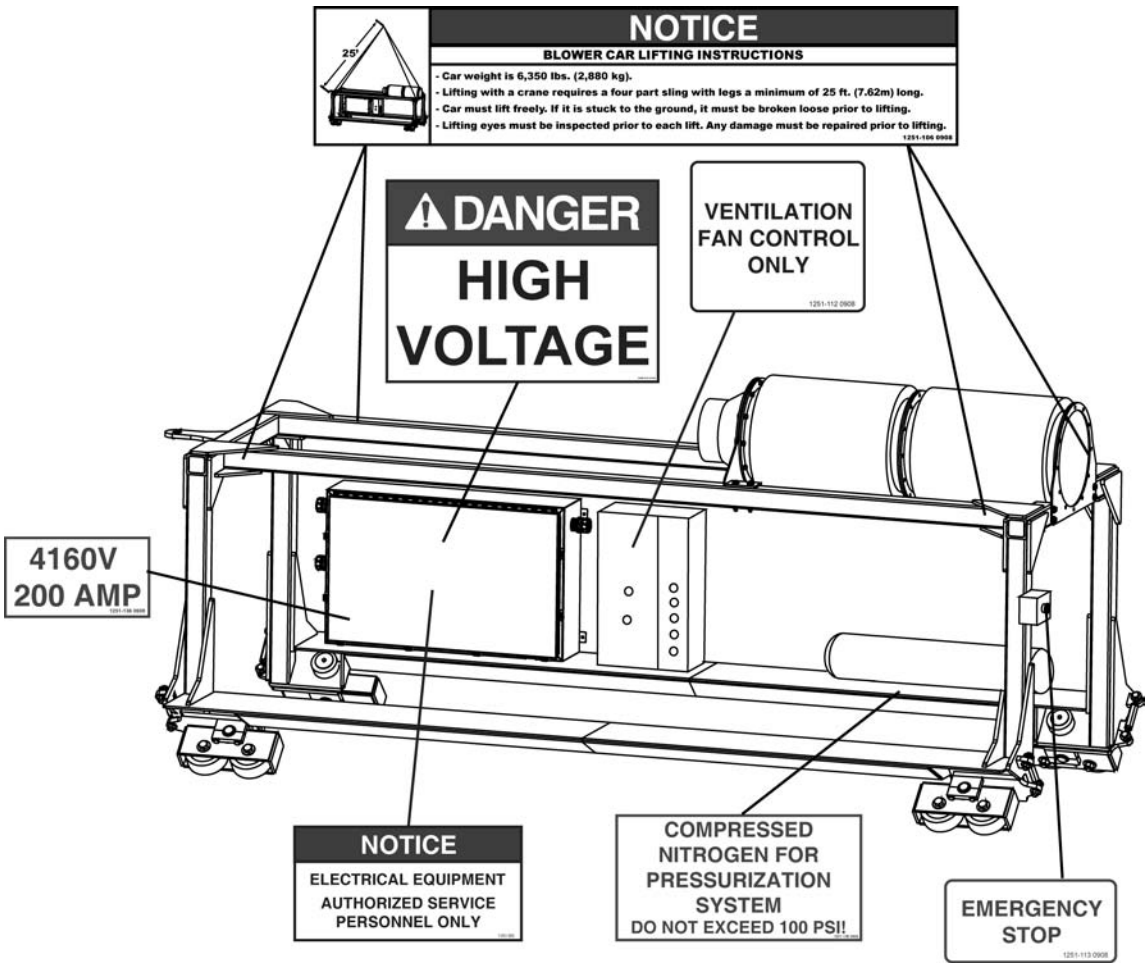
CAR #11 FRONT SLURRY



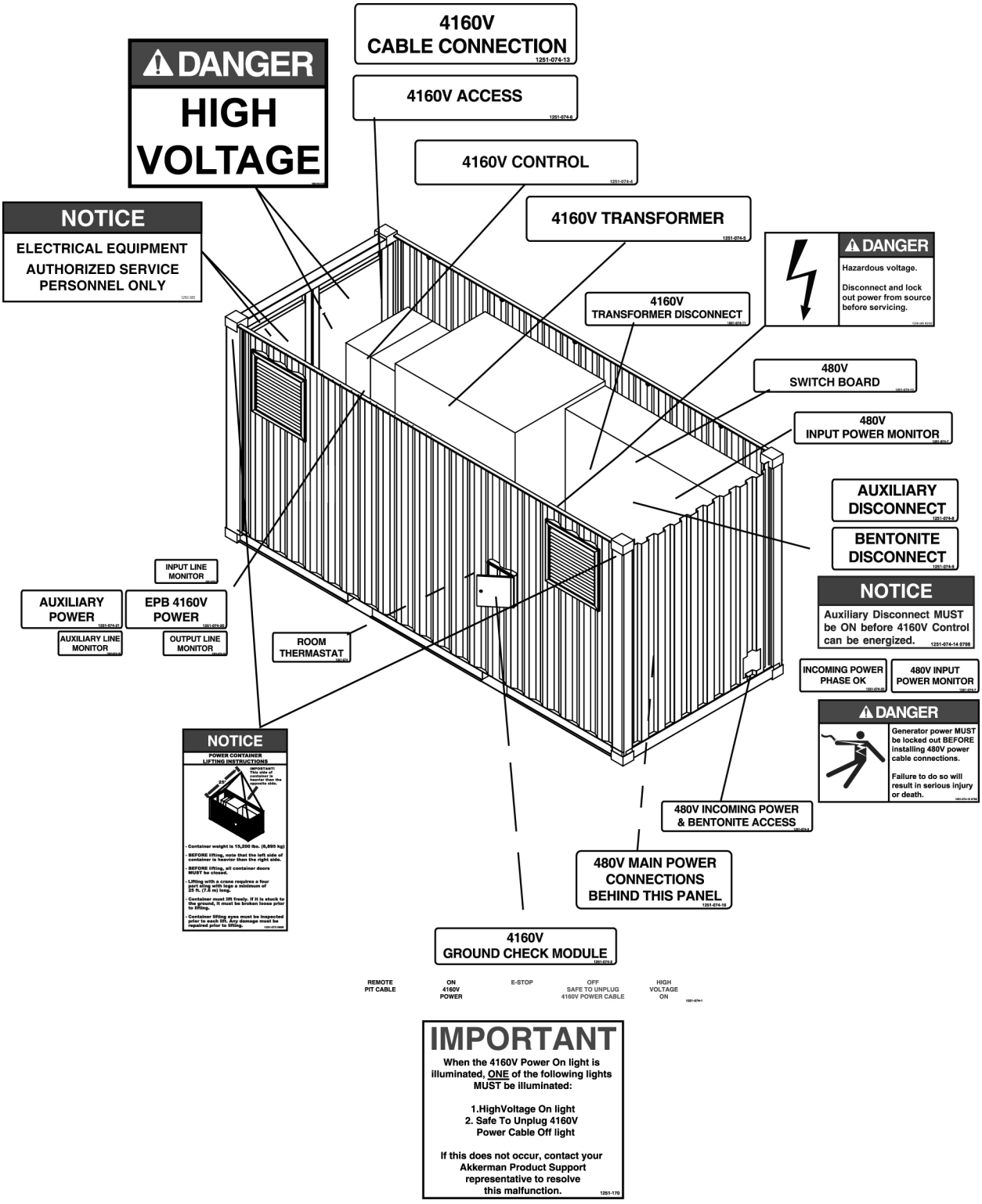
CAR #12 REAR SLURRY



CAR #13 BLOWER

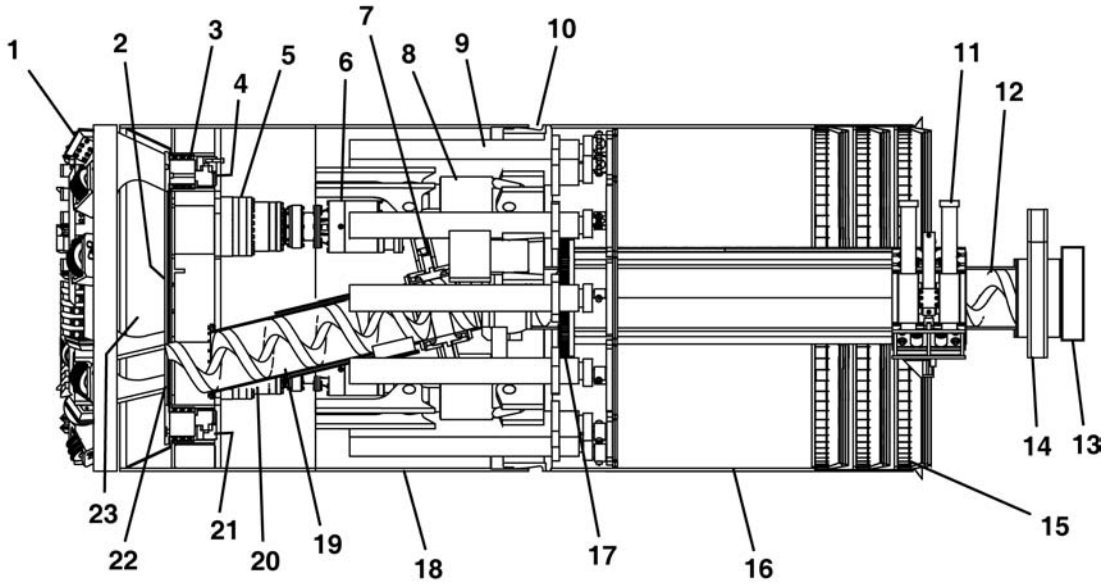


POWER CONTAINER



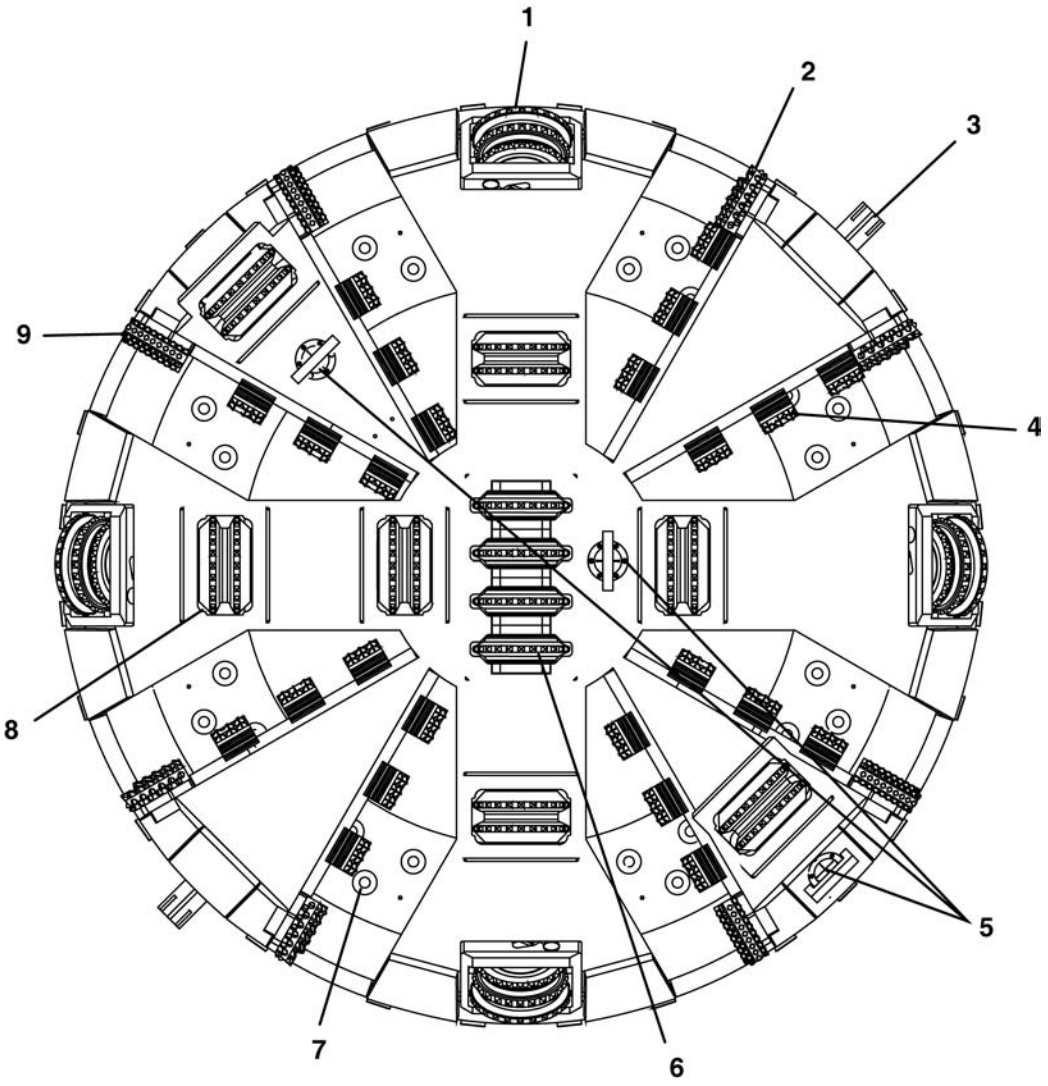
Terminology

EARTH PRESSURE BALANCE MACHINE (EPBM)



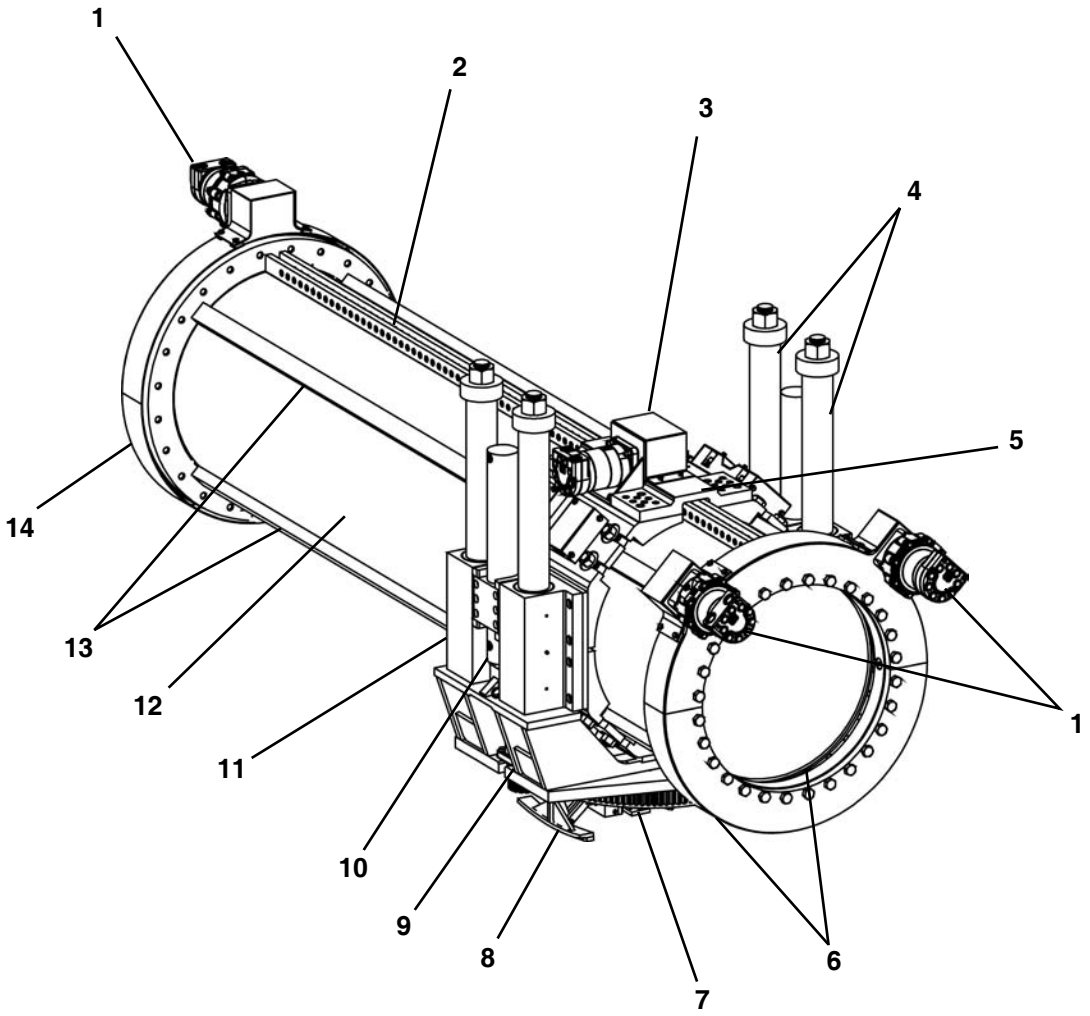
1. Cutterhead
2. Access Door
3. Main Bearing
4. Inspection Port
5. Cutter Drive Planetary (4)
6. Cutter Drive Motor (4)
7. Screw Conveyor #1 Drive
8. Steering Cylinder (4)
9. Jacking Cylinder (12)
10. Steering Joint
11. Segment Erector
12. Screw Conveyor #2
13. Rear Gate
14. Screw Conveyor #2 Drive
15. Tail Seal
16. Jacking Can
17. Segment Erector Drive Ring
18. Boring Head
19. Screw Conveyor #1
20. Intermediate Gate
21. Grease Drain Port
22. Front Gate
23. Plenum (Mixing) Chamber

CUTTERHEAD



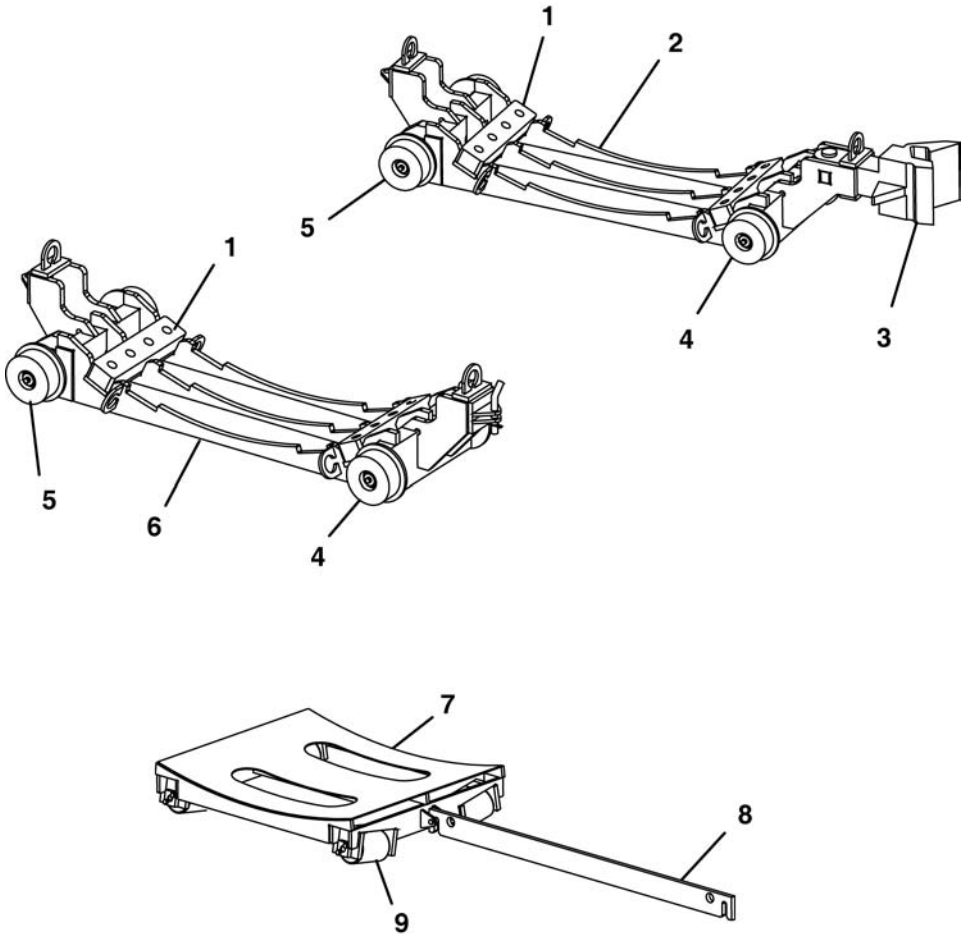
1. Triple Disc Cutter
2. Bucket Scraper - Tip
3. Copy Cutter
4. Face Scraper
5. Foam/Slurry Ports
6. Single Disc Cutter
7. Cutterhead Mount
8. Double Disc Cutter
9. Bucket Scraper - Bullet

SEGMENT ERECTOR



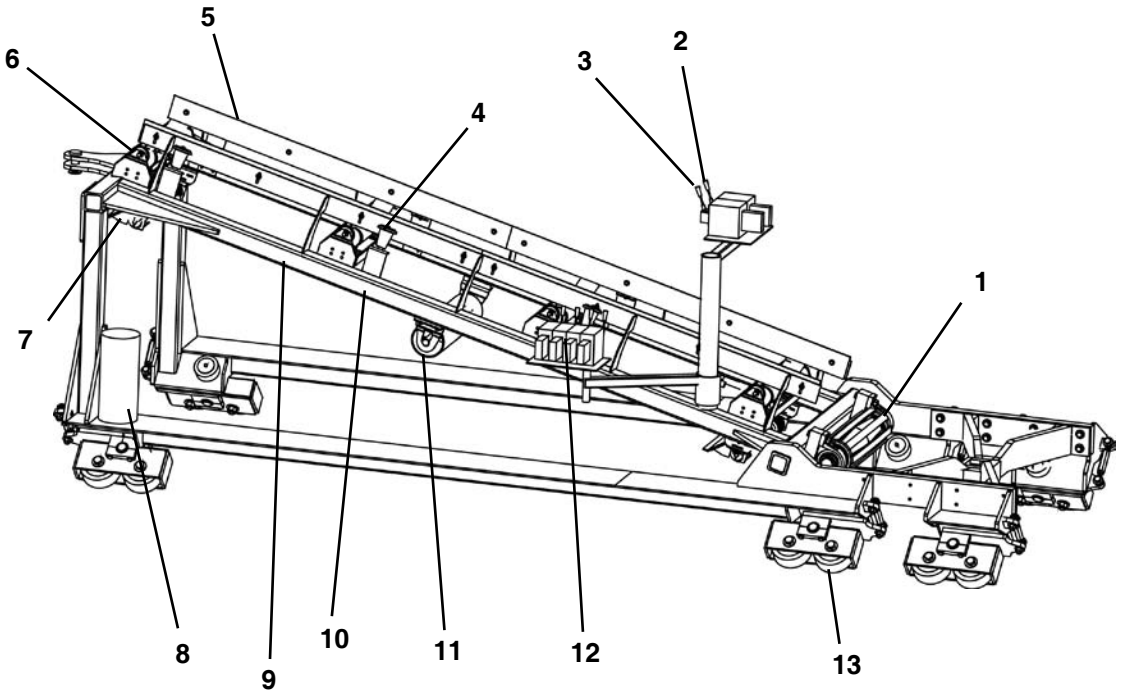
1. Segment Swing Drive
2. Rack Drive
3. Pinion Linear Drive
4. Torque Stabilizers
5. Carriage Assembly
6. Bearing and Drive Guard
7. Segment Ball Latch
8. Segment Stabilizer
9. Erector Arm Assembly
10. Segment Lift Cylinder
11. Slide Block Assembly
12. Erector Casing
13. Carriage Guides
14. Drive Guard

SEGMENT HANDLING CARS



1. Rubber Bumpers
2. Rear Segment Handler Car
3. Coupler To Locomotive
4. Axle Assembly
5. Idler Assembly
6. Front Segment Handler Car
7. Segment Conveyor Dolly
8. Segment Linkage
9. Roller Caster

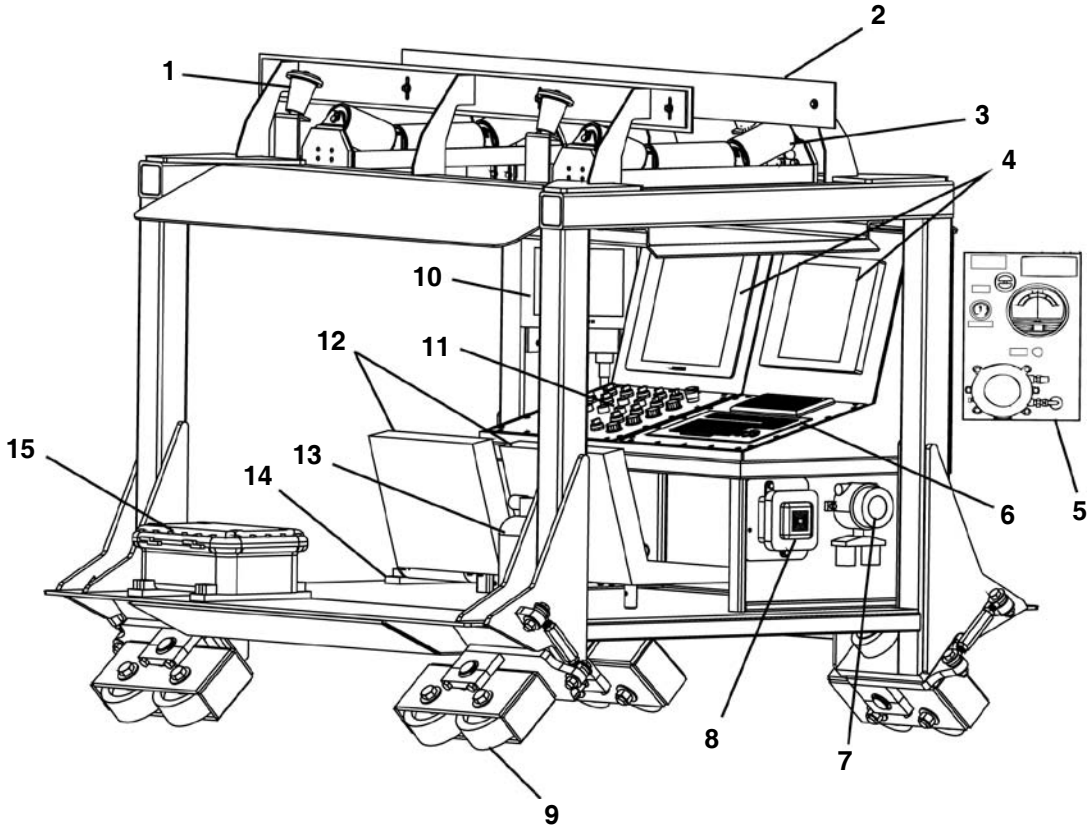
INCLINED CONVEYOR (CAR #1)



1. Front Roller Assembly
2. Screw Conveyor #1 Manual Control
3. Screw Conveyor #2 Manual Control
4. Conveyor Guide Roller
5. Belt Guide
6. Belt Roller Assembly
7. Return Roller
8. Rear Gate Accumulator Tank
9. Rear Gate Accumulator Pressure Control
10. Rear Gate Accumulator Tank Control
11. Return Roller Assembly
12. Erector Controls
13. Car Wheel Assembly

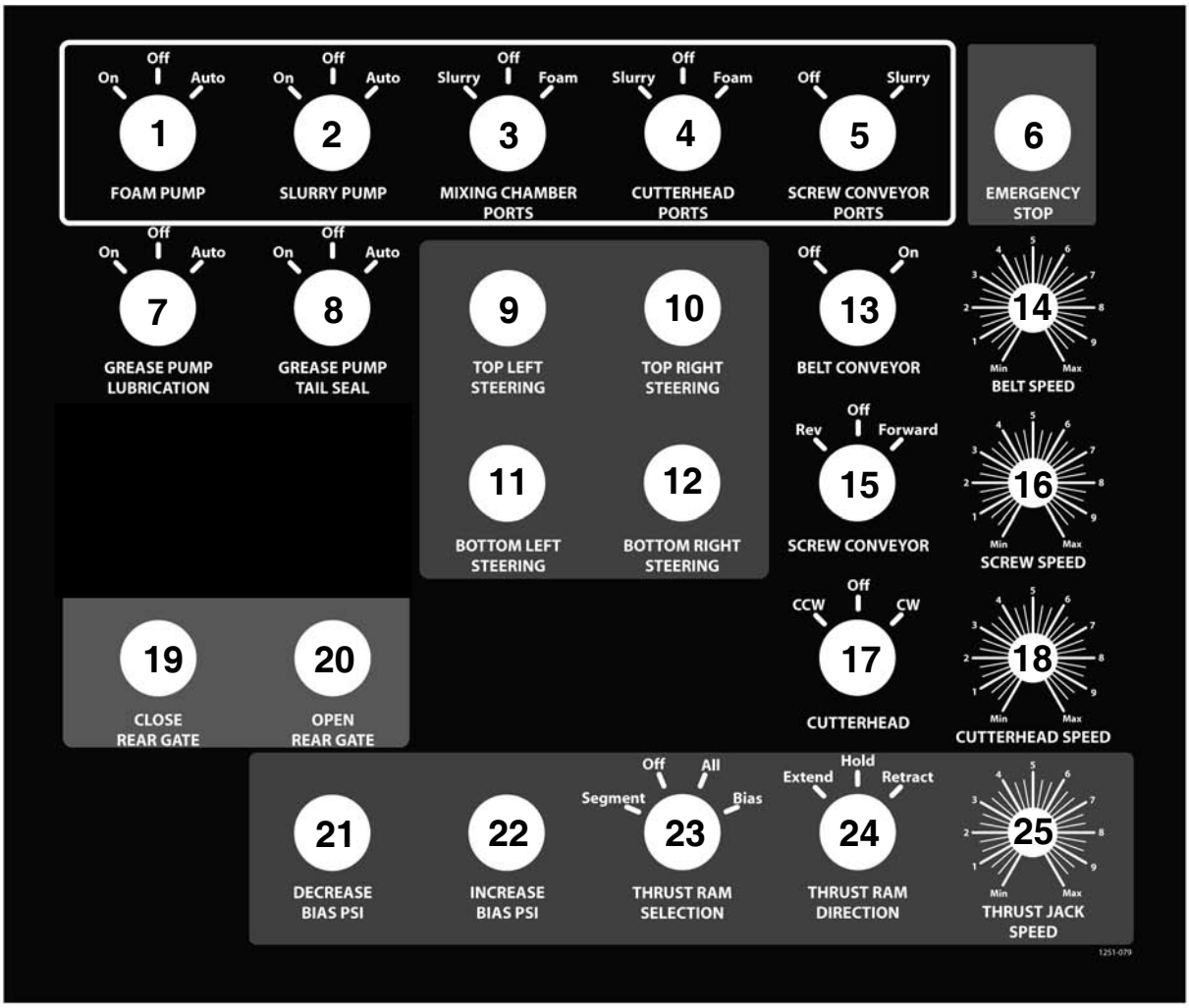
Not Shown: Tail Seal Grease Barrel

OPERATOR STATION (CAR #2)



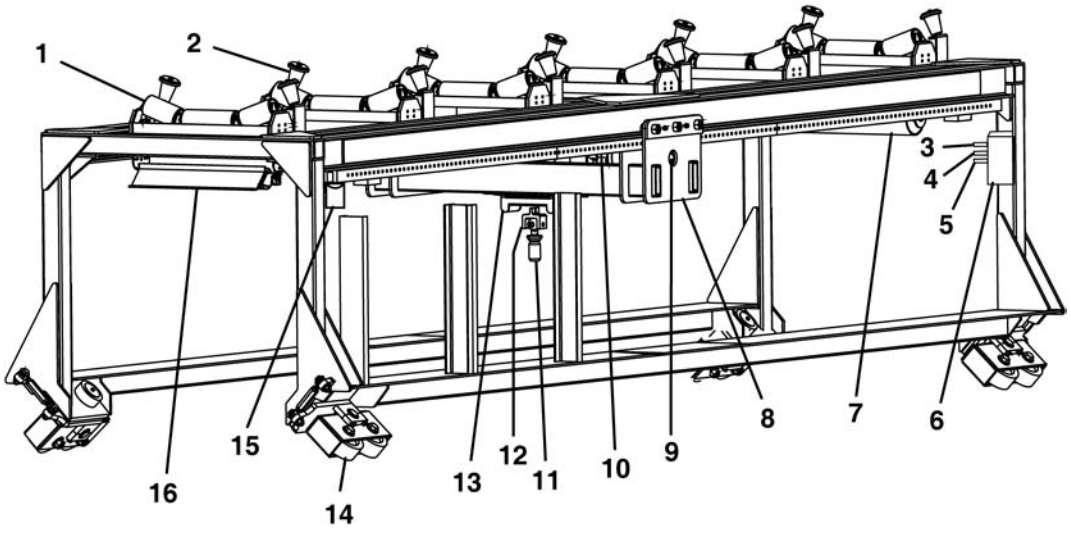
1. Conveyor Guide Roller
2. Belt Guide
3. Belt Roller Assembly
4. Computer Monitors
5. Pressurization System Control
6. Keyboards for Console & Guidance System
7. Gas Detector
8. Emergency Horn
9. Car Wheel Assembly
10. TACS Monitor
11. Control Console
12. Seat Assembly
13. Fire Extinguisher
14. TACS Switching Box 2
15. TACS Switching Box 1

OPERATOR'S STATION CONSOLE (CAR #2)



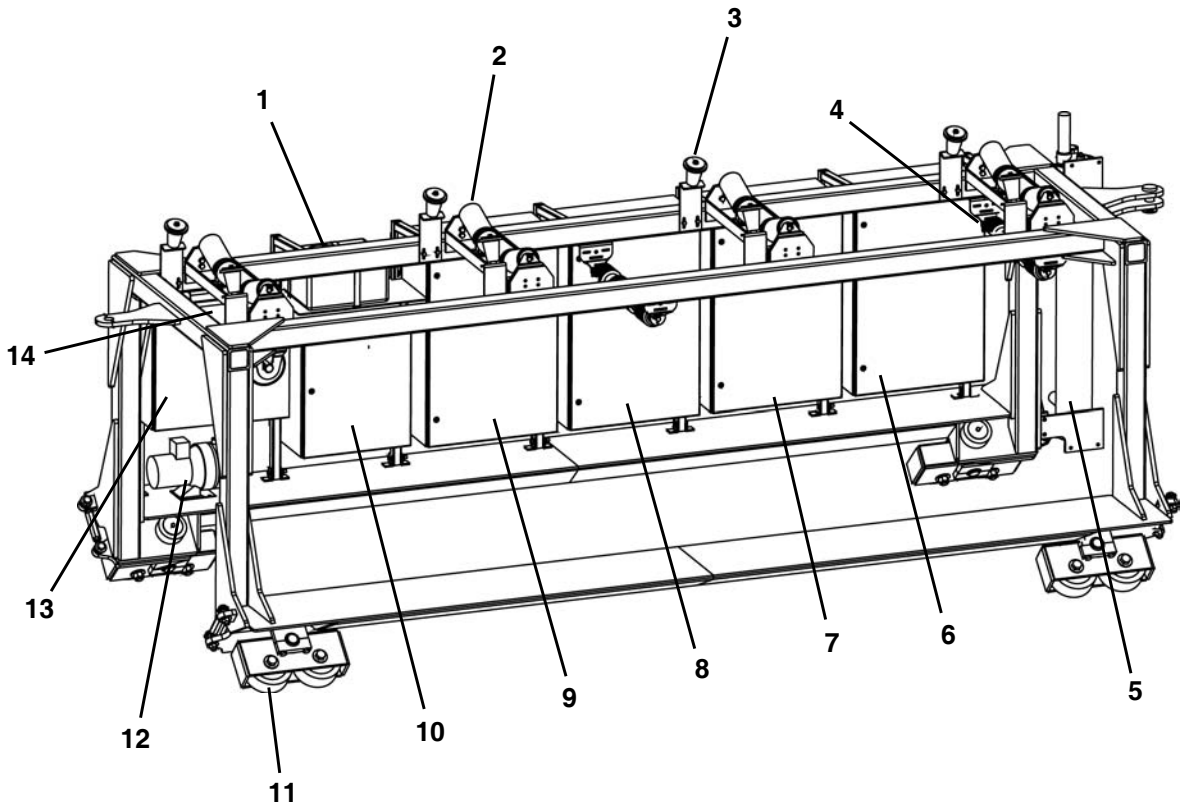
1. Foam Pump Control
2. Slurry Pump Control
3. Mixing Chamber Port Control
4. Cutterhead Port Control
5. Screw Conveyor Port Control
6. Emergency Stop
7. Grease Pump Lubrication Control
8. Grease Pump Tail Seal
9. Top Left Steering Control
10. Top Right Steering Control
11. Bottom Left Steering Control
12. Bottom Right Steering Control
13. Belt Conveyor Control
14. Belt Speed Control
15. Screw Conveyor Control
16. Screw Speed Control
17. Cutterhead Rotation Control
18. Cutterhead Speed Control
19. Rear Gate Close Control
20. Rear Gate Open Control
21. Bias Pressure Decrease
22. Bias Pressure Increase
23. Thrust Ram Selection
24. Thrust Ram Direction
25. Thrust Jack Speed

SEGMENT HANDLING (CAR #3)



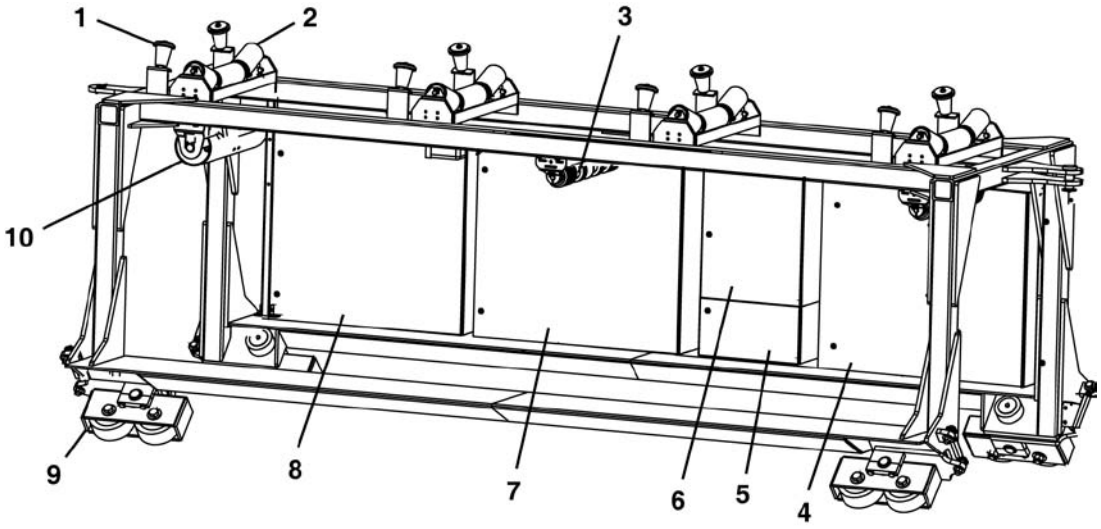
1. Belt Roller Assembly
2. Conveyor Guide Roller
3. Dolly Winch Control
4. Carriage Travel Control
5. Segment Lift Winch Control
6. Segment Handling Controls
7. Return Roller
8. Segment Handling Lift Carriage Assembly
9. Sprocket Linear Drive
10. Hydraulic Drive Motor
11. Segment Ball
12. Segment Lift Tool
13. Winch Assembly
14. Car Wheel Assembly
15. Red Visual Alarm
16. Return Roller

VFD (CAR #4)



1. VFD Coolant 6 Gallon Reservoir
2. Belt Roller Assembly
3. Conveyor Guide Roller
4. Return Roller
5. VFD Heat Exchanger
6. CutterHead 100 HP Motor VFD - Slave 3 - TR
7. CutterHead 100 HP Motor VFD - Slave 2 - BR
8. CutterHead 100 HP Motor VFD - Slave 1 - TL
9. CutterHead 100 HP Motor VFD - Master - BL
10. Slurry Drive 10 HP Motor VFD
11. Car Wheel Assembly
12. VFD Cooling Motor/Pump
13. VFD Line Reactor
14. Return Roller

SWITCH GEAR (CAR #5)



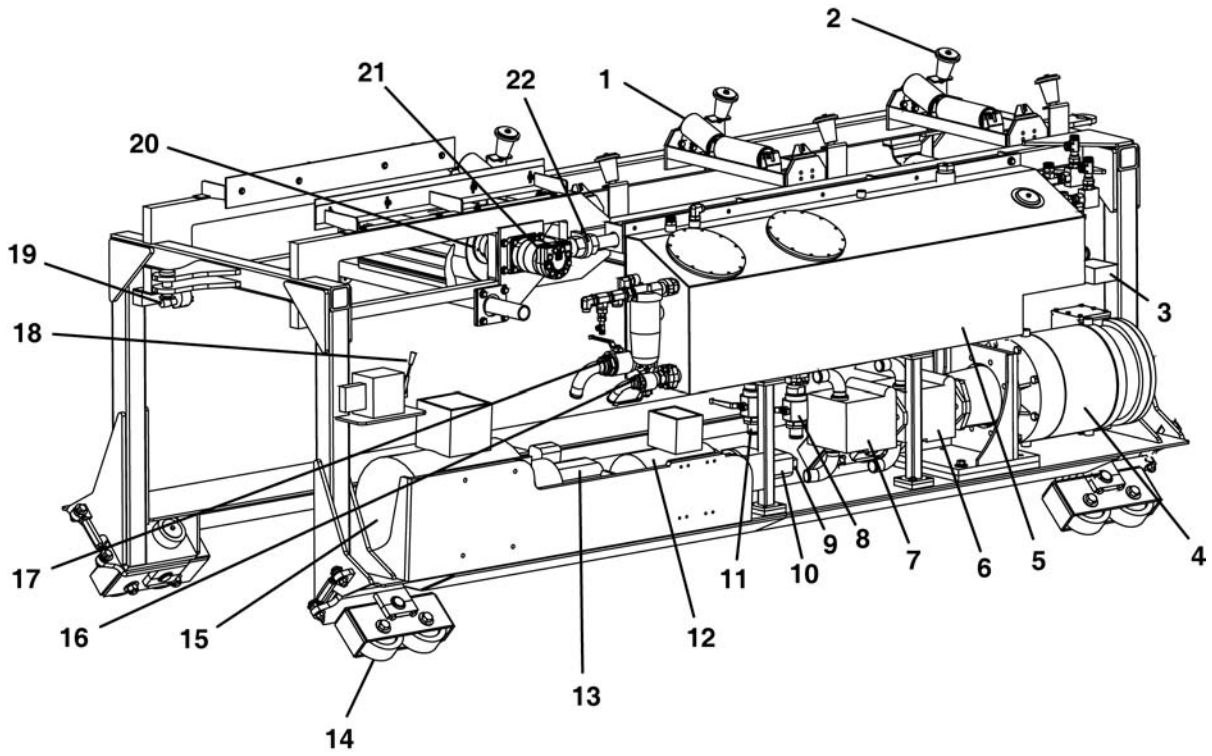
1. Conveyor Guide Roller
2. Belt Roller Assembly
3. Return Roller
4. 240VAC Box 3
5. *Service Panel
6. Transformer 480V To 240V/120V
7. **480VAC Box 2
8. ***480VAC Box 1
9. Car Wheel Assembly
10. Return Roller

* Service panel includes:
- 480V 3 Phase 40 amp
- 480V 3 Phase 20 amp
- 240V 3 Phase 30 amp
- GFCI 120V (2)

** 480VAC Box 2 includes:
- Drive Motor TR Contactor
- Drive Motor BR Contactor
- Belt Conveyor Starter
- Screw Conveyor Starter
- Foam Pumps Starter
- Cooling/Grease Pump Starter
- Belt Spray Bar Pump Starter

*** 480VAC Box 2 includes:
- Drive Motor TL Contactor
- Drive Motor BL Contactor
- Segment Handling Starter
- Steering/CC Starter
- Power to 240V Transformer Starter
- Jacking Starter
- Blower Contactor
- Slurry VFD Contactor
- Auxiliary 3 Phase Fuses

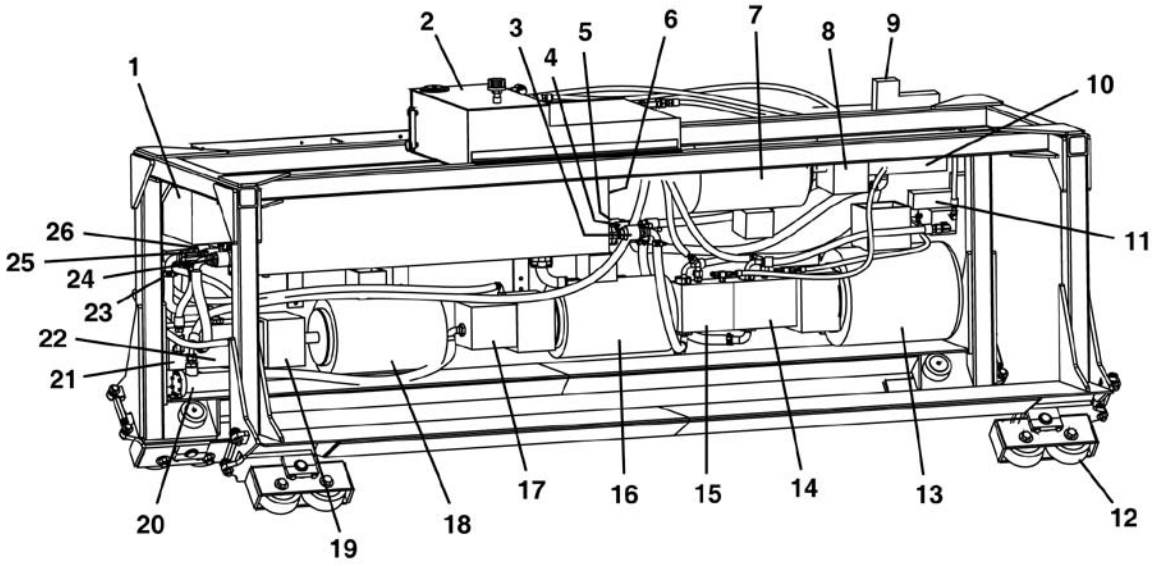
FRONT HYDRAULIC (CAR #6)



1. Return Roller
2. Belt Roller Assembly
3. Grease Control Manifold
4. Screw Conveyor Motor
5. Hydraulic Reservoir, 95 gal. (360 L)
6. Screw Conveyor 1 Feed Pump
7. Screw Conveyor 2 Feed Pump
8. Screw Conveyor Feed 1 Shutoff Valve
9. Main Drive Bearing Grease Pump
10. Oil Cooling Pump
11. Screw Conveyor Feed 2 Shutoff Valve
12. Cooling and Grease Drive Motor
13. Belt Conveyor Pump
14. Car Wheel Assembly
15. Belt Conveyor Drive Motor
16. Cooling Pump Shutoff Valve
17. Belt Conveyor Pump Shutoff Valve
18. Belt Conveyor Control
19. Belt Stop Control
20. Belt Conveyor Drive Roller
21. Belt Conveyor Drive Motor
22. Belt Screw Adjustment

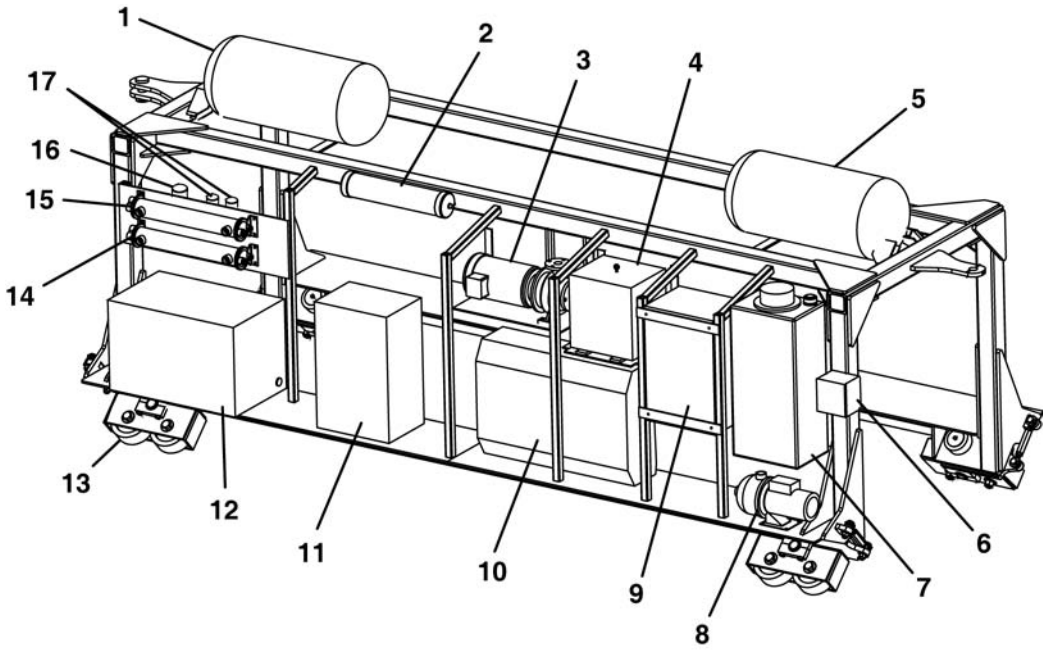
Not Shown: Main Bearing Grease Barrel

REAR HYDRAULIC (CAR #7)



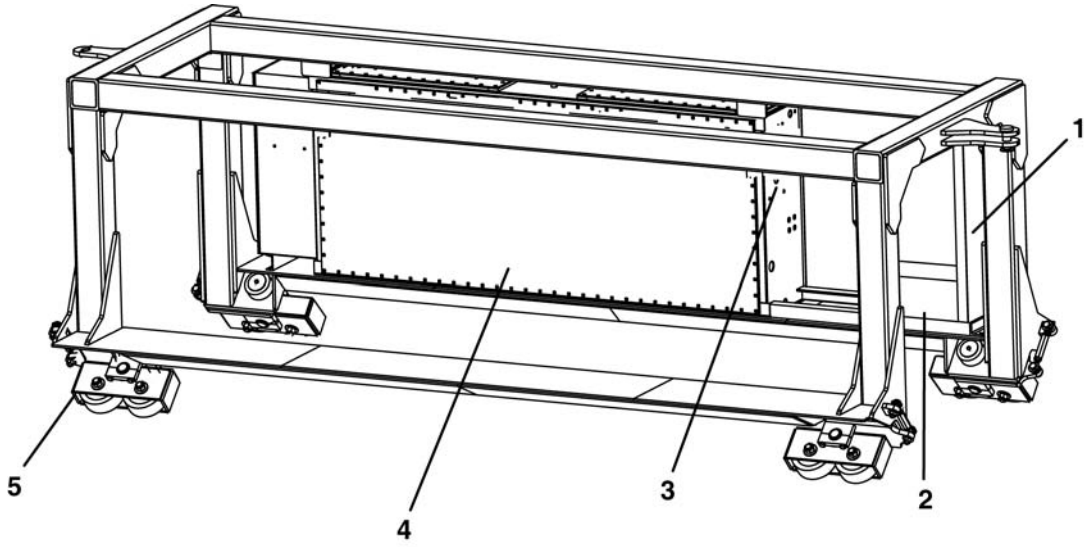
1. Hydraulic Reservoir, 98 gal. (360 L)
2. Overflow Reservoir, 45 gal. (170) L)
3. Jacking/Erector Pump B Shutoff Valve
4. Jacking Pump A Shutoff Valve
5. Steering Pump Shutoff Valve
6. Cooling Return Filter
7. Steering/Copy Cutter 30 HP Motor
8. Steering Pump
9. Jacking/Erector Control Manifold B
10. Copy Cutter Pump
11. Jacking Pump Control Manifold A
12. Car Wheel Assembly
13. Jacking 40 HP Motor
14. Jacking Pump A
15. Jacking/Erector Pump B
16. Foam Car 30 HP Air Compressor Drive Motor
17. Foam Car Air Compressor Drive Pump
18. Segment/Cooling/Tail Seal Grease 30 HP Motor
19. Segment Handling Pump
20. Heat Exchanger
21. Tail Seal Grease Pump
22. Oil Cooling Pump
23. Grease Control Manifold
24. Cooling Circuit Shutoff Valve
25. Segment Handling/Grease Pump
26. Air Compressor Shutoff Valve

FOAM (CAR #8)



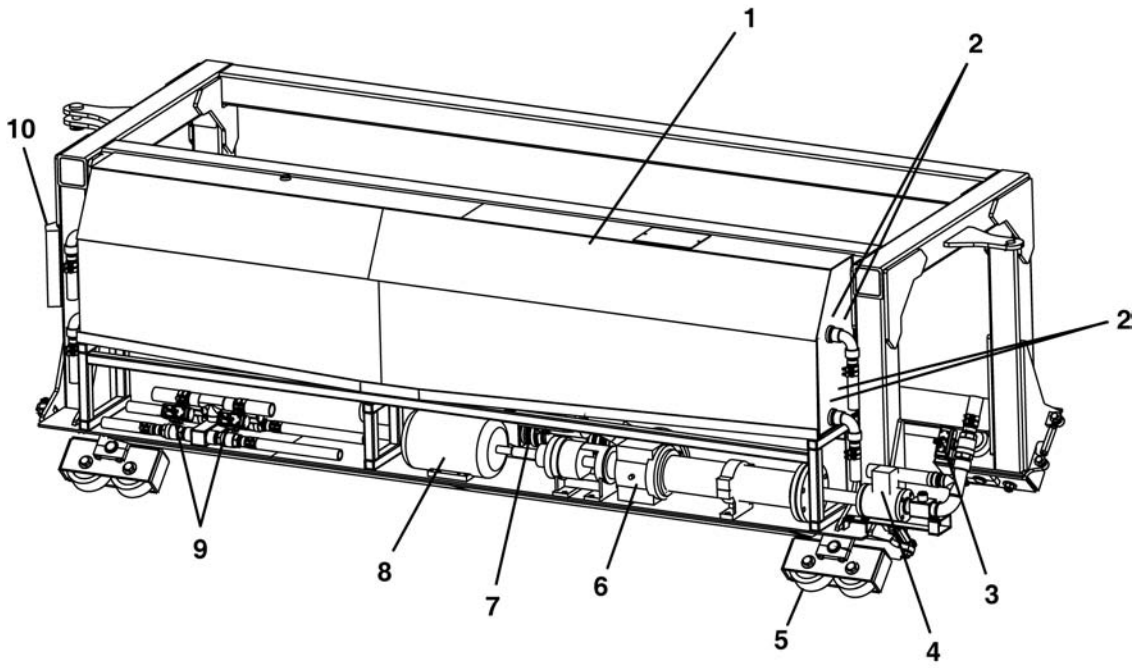
1. Foam System Air Tank
2. Pneumatic Control Valve Air Dryer
3. Cooling Return Booster Motor/Pump
4. Transformer 480V To 400V For Foam Generator
5. Pneumatic Control Air Tank
6. Foam Electrical Control Box
7. Spare Reservoir
8. Belt Spray Bar Pump
9. Foam Control System
10. Foam Generator
11. Foaming Agent
12. Foam & Pneumatic Control Air Compressor
13. Car Wheel Assembly
14. Hydraulic Oil Cooler
15. Foam & Pneumatic Control Air Cooler
16. Air System Filter
17. Pneumatic Control Filters

FRONT & REAR TRANSFORMERS (CARS #9 & 10)



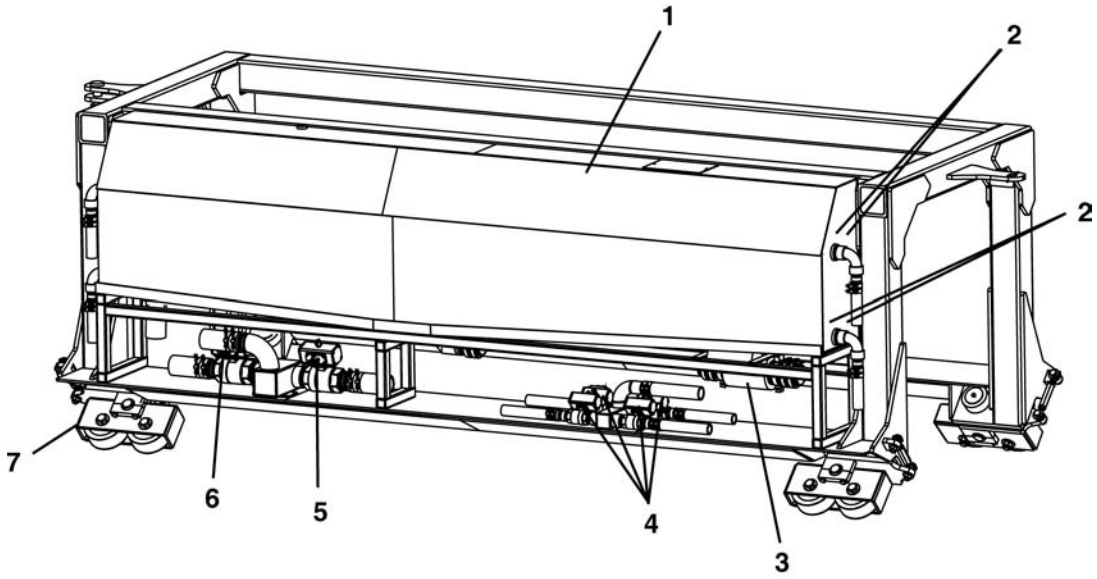
1. Oil Cooler
2. Water Pump
3. Voltage Adjuster
4. Transformer 4160VAC To 480VAC
5. Car Wheel Assembly

SLURRY FRONT (CAR #11)



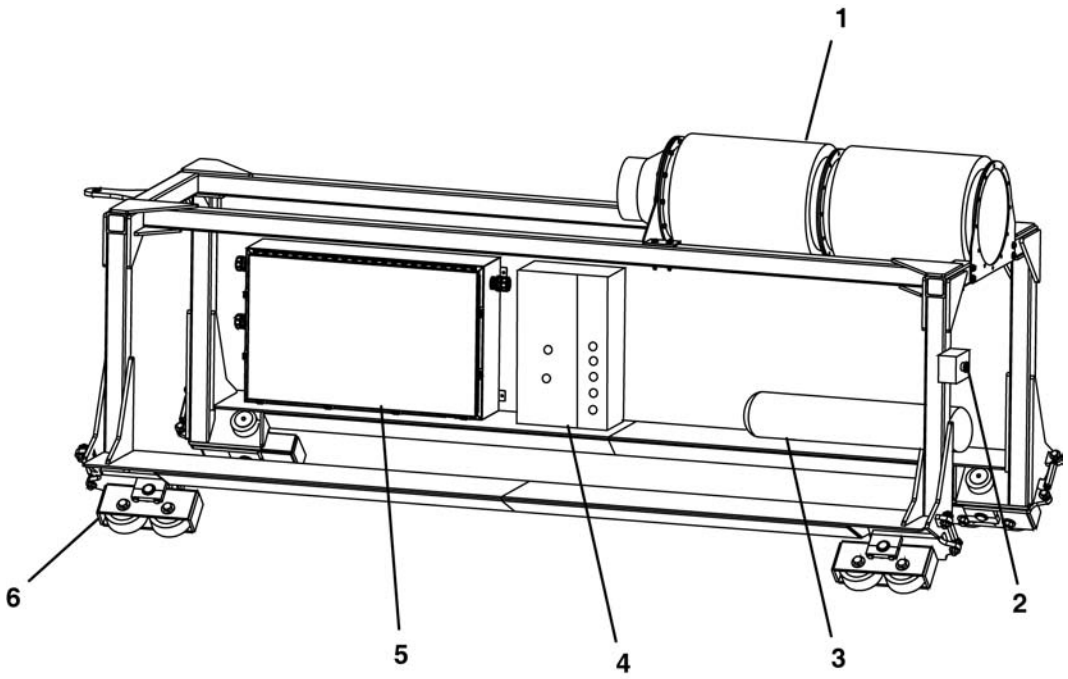
1. Slurry 250 Gallon (946 L)
2. Tank Level Sensors
3. Slurry Head Feed Pneumatic Control Valve
4. Flowmeter
5. Car Wheel Assembly
6. Slurry Pump
7. Slurry Pump Feed Pneumatic Control Valve
8. Slurry Motor 10 HP, 240VAC
9. Recirculation Pneumatic Control Valves
10. Slurry Control Box

SLURRY REAR (CAR #12)



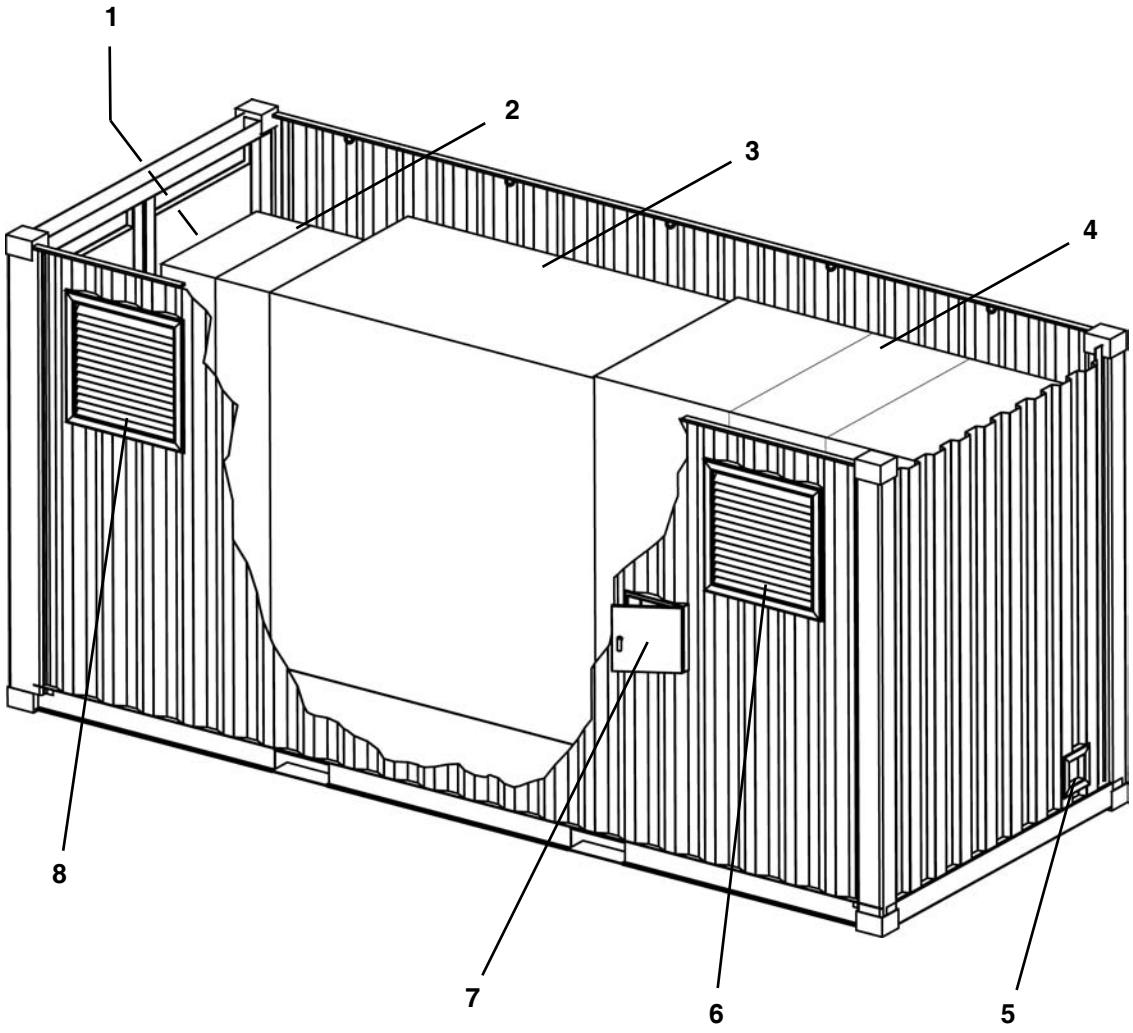
1. Slurry 250 Gallon (946 L)
2. Tank Level Sensors
3. Slurry Pump Feed Pneumatic Control Valve
4. Recirculation Pneumatic Control Valves
5. Front Tank Feed Pneumatic Control Valve
6. Rear Tank Feed Pneumatic Control Valve
7. Car Wheel Assembly

BLOWER (CAR #13)



1. Ventilation Fans
2. Emergency Stop
3. Compressed Nitrogen Tank For Pressurization System
4. Ventilation Fan Control
5. Main Power Junction Box
6. Car Wheel Assembly

POWER CONTAINER



1. 4160V Access
2. 4160V Control
3. 4160V Transformer
4. 480V Switch Board
   (Includes 4160V Transformer Disconnect and 480V Input Power Monitor)
5. 480V Input Power Monitor
6. Ventilation Fan
7. E-Stop, 4160V Power Control, and 4160V Ground Check Module
8. Ventilation Louvers

Controls & Instruments

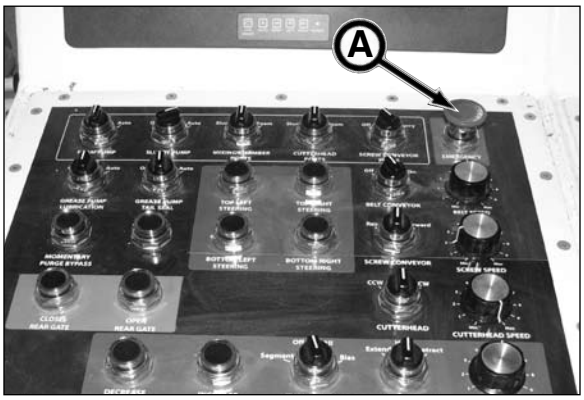
EMERGENCY STOP

⚠WARNING ALL Emergency Stop switches MUST be operating properly BEFORE operating EPB system. Failure to do so may cause severe injury or death.

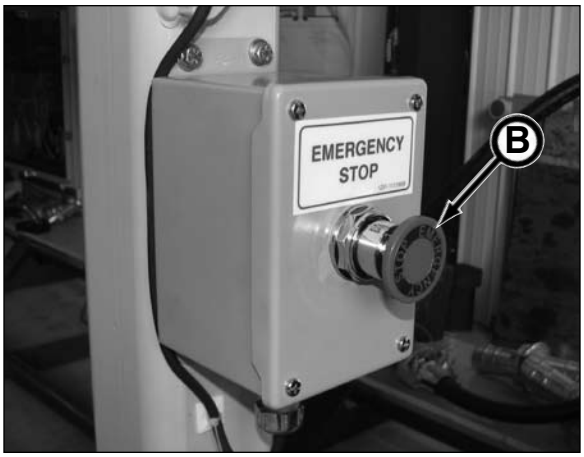
Push IN Emergency Stop button (A, B, C, or D) to stop ALL power, which includes power to the EPB operation lights. The lights include a battery backup which allows the lights to stay on for approximately 30 minutes after the power is shut down.

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

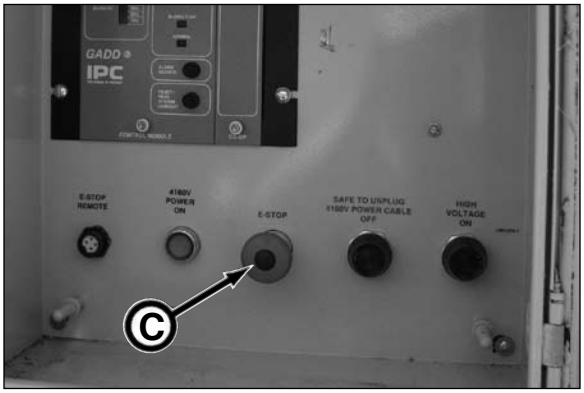
NOTICE The Emergency Stop button located on Foam car #8 shuts down the Condat® foam system power ONLY. This emergency stop **DOES NOT** shut down tunnel power.



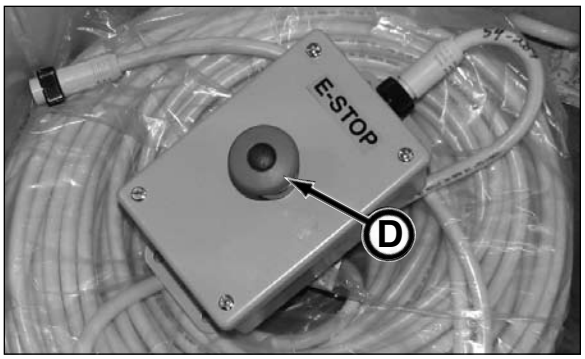
Console E-Stop (A) on Operator Station Car 2



E-Stop (B) on Blower Car 13



E-Stop (C) on EPB Power Container



Remote E-Stop (D) on EPB Power Container

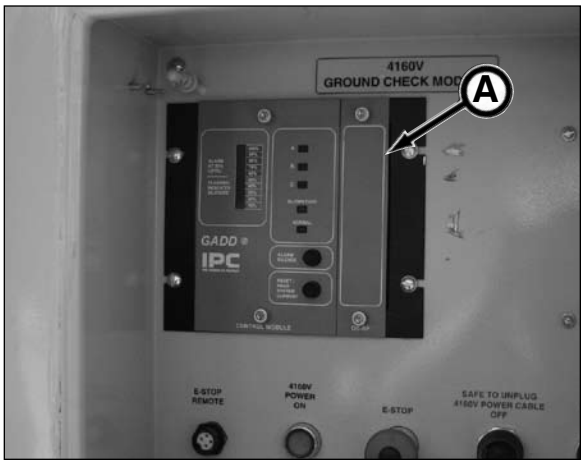
4160 VOLT GROUND CHECK MODULE (POWER CONTAINER)

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

After every segment ring installation, the 4160 Volt Ground Check Module (A) must be checked.

If illuminated bars (B) on module display are at 50% or over, shut down the system and have a certified electrician check all cable connections. This indicates the severity of the electrical leakage in percent.

The 4160 Volt contactor will automatically shut down if certain ground conditions are exceeded. Refer to your module manual.



Check Module Located On Power Container

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

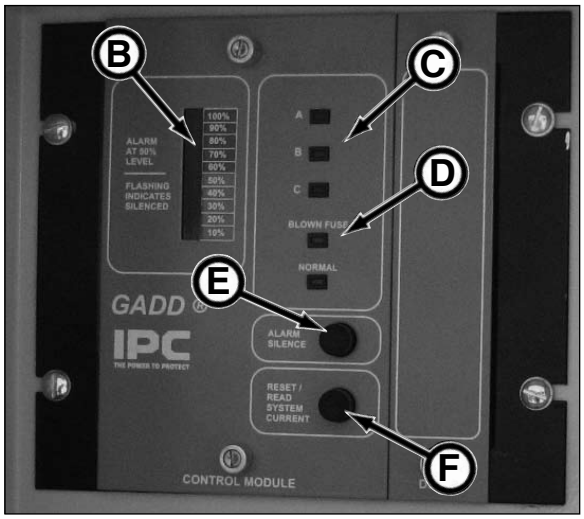
Disconnect and lock out power from source before servicing.

The electrical leakage indicators (C) flash if there is an electrical leakage.

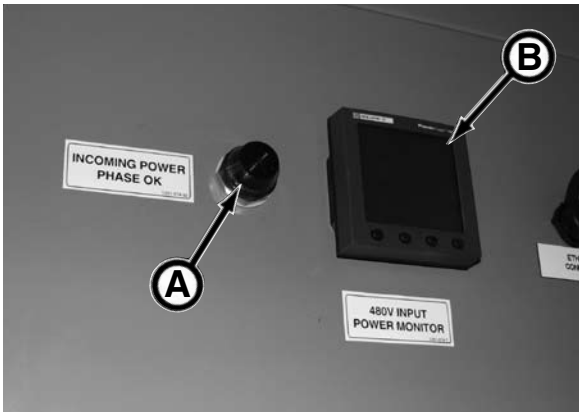
The Blown Fuse (D) indicator shows that no power is coming into the 4160V unit.

The Alarm button (E) sets off an alarm and opens the contactors, thus shutting down the system power.

The Reset button (F) resets the leakage indicators (C).



480V BENTONITE DISCONNECT (POWER CONTAINER)



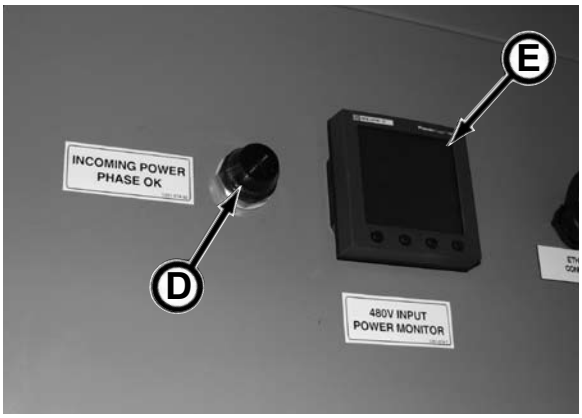
⚠DANGER Hazardous voltage. Disconnect and lock out power from source before servicing.

With the 480V incoming power connected to the 480V bus bars in the power container (refer to Connecting Power Leads in Operation section), the green Incoming Power Phase OK light (A) is on and the 480V Input Power Monitor (B) is monitoring close to 480V, flip the Bentonite Disconnect switch (C) to the ON position to provide power to the bentonite pump.

DO NOT flip the disconnect ON if the green Incoming Power Phase OK light is not on. This indicates that the external power source phase power is installed incorrectly. Disconnect and lock out ALL power before attempting to reverse the two generator power leads.

NOTICE This is a 480V, 100 AMP disconnect/breaker.

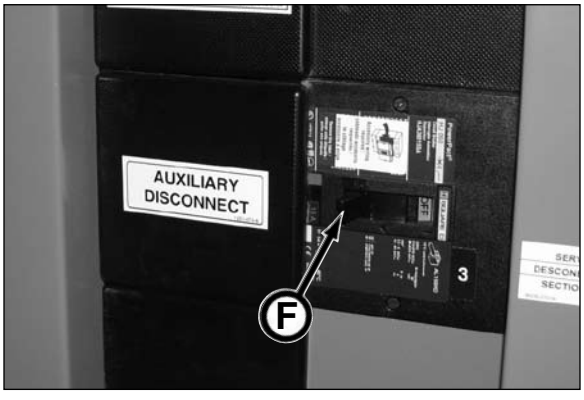
480V AUXILIARY DISCONNECT (POWER CONTAINER)



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

With the 480V incoming power connected to the 480V bus bars in the power container (refer to Connecting Power Leads in Operation section), the green Incoming Power Phase OK light (D) is on and the 480V Input Power Monitor (E) is monitoring close to 480V, flip the Auxiliary Disconnect switch (F) to ON to provide power to 480V devices on the job site.

DO NOT flip the disconnect ON if the green Incoming Power Phase OK light is not on. This indicates that the external power source phase power is installed incorrectly. Disconnect and lock out ALL power before attempting to reverse the two generator power leads.



NOTICE This is a 480V, 15 AMP disconnect/breaker.

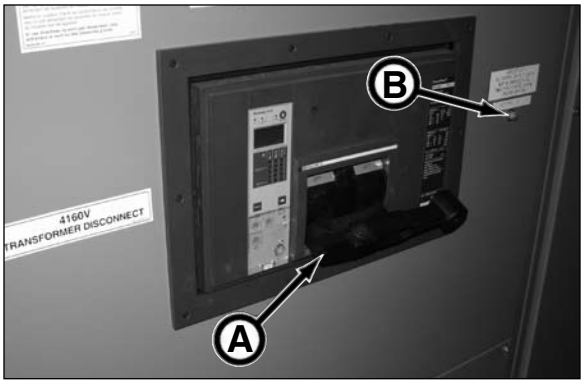
4160V TRANSFORMER DISCONNECT (POWER CONTAINER)

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

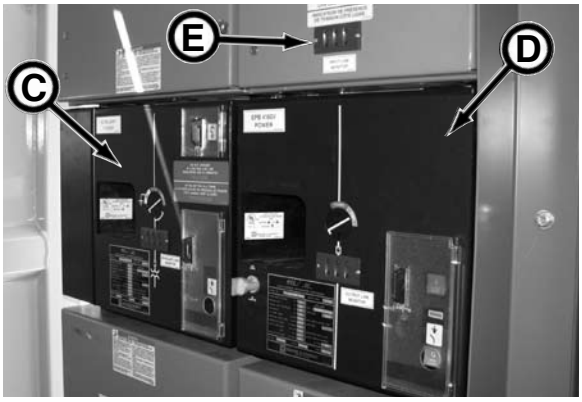
Once the 480V power is operational, the 4160V system can be activated.

Flip the 4160V Transformer Disconnect (A) to the ON position to provide power to the 4160V transformer.

Once this disconnect is ON, the “Control On” light (B) must be on. If not, the control system must be serviced.



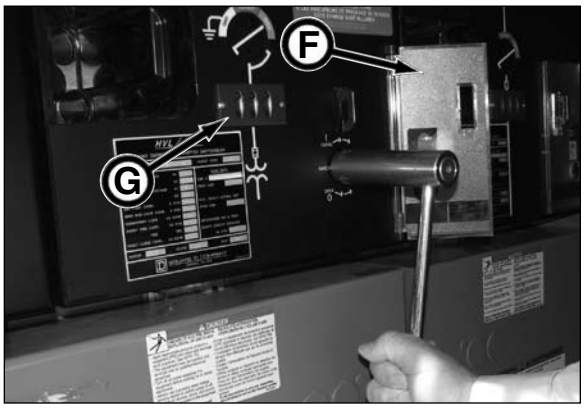
4160V AUXILIARY POWER (POWER CONTAINER)



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

The 4160V Auxiliary Power module (C) is a monitoring device to assure that there is proper power from the 4160V transformer. If there is a problem, this module will not allow the EPB Power module (D) to be turned on.

When there is power to the 4160V system (4160V Transformer Disconnect is ON) the Input Line Monitor (E) will illuminate indicating there is power to the 4160V input line.



To activate power to the Auxiliary Power module (C):
1. Open auxiliary grounding switch cover (F) to access the auxiliary disconnect.
2. Insert crank into disconnect and turn the crank until the circuit is CLOSED.
3. Once the circuit is CLOSED, the lights on the Auxiliary Line Monitor (G) will illuminate.

EPB 4160V POWER (POWER CONTAINER)

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

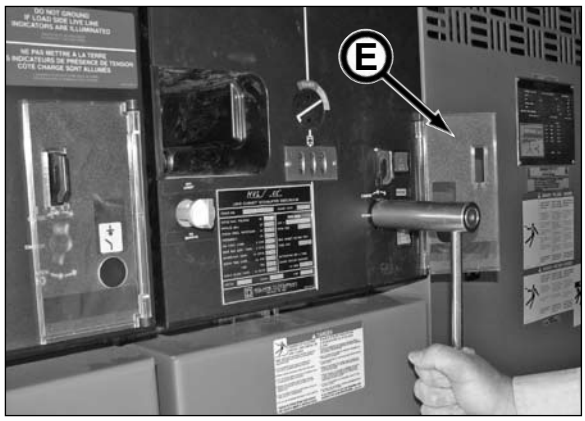
The EPB 4160V Power module (A) provides power to the EPB tunneling system.

When there is power to the 4160V Auxiliary Power module (B) [indicated by the illuminated Auxiliary Line Monitor (C)], power can now be activated to the EPB 4160V Power module.

To activate power to the EPB 4160V Power module (A):

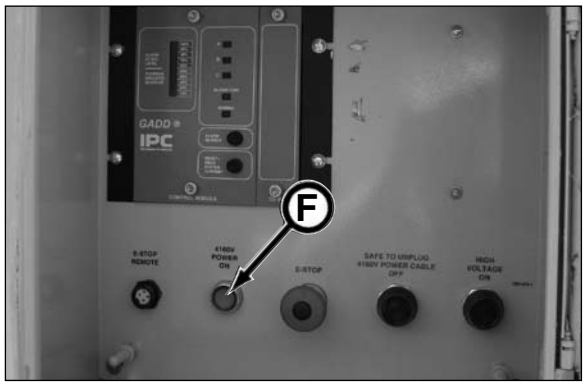
1. Check to see if spring icon (D) is elongated (yellow/black) or compressed (white/red).

2. If spring icon is elongated, the disconnect must be charged. Open door (E) and charge disconnect by inserting crank into disconnect and turning crank until the compressed spring icon is visible. Continue to step 3.
   If spring is compressed, continue to step 3.



NOTICE The car electrical boxes must be properly pressurized, otherwise the tunnel power will not energize.

3. On the power container, press 4160V Power On button (F). This will automatically close the contacts [shown on circuit indicator (G)] and power up the 4160V system.

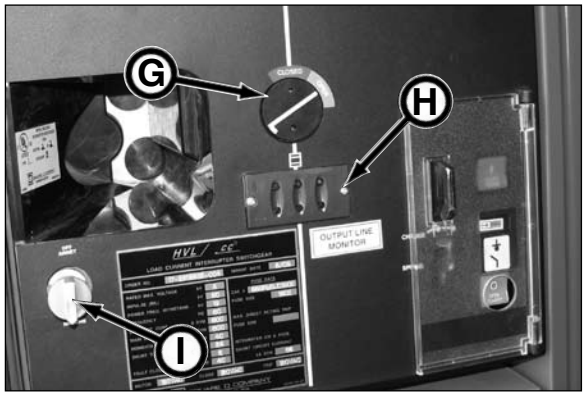


4. The Output Line Monitor (H) will illuminate once the 4160V power is on.

Use the Auto/Manual Charge Disconnect switch (I) as follows:

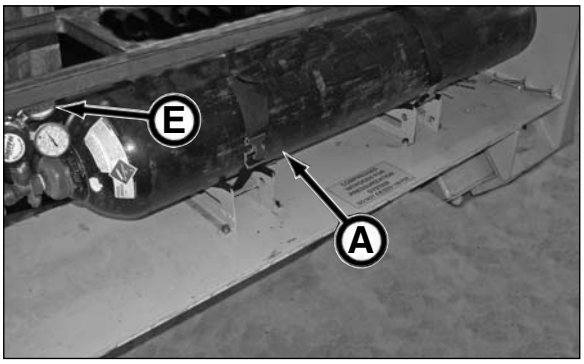
OFF - When power is turned off, the disconnect will have to be charged before start up.

ON - When power is turned off, the disconnect will automatically charge at start up.

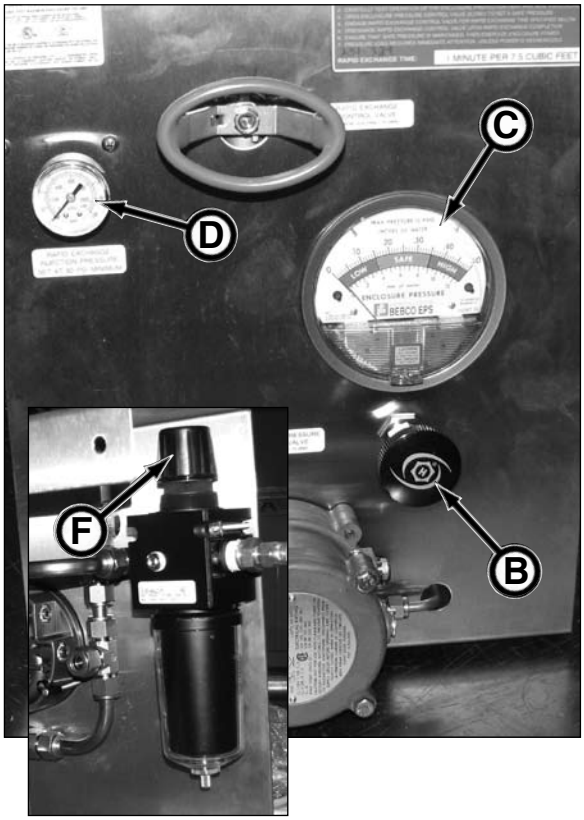


PRESSURIZATION SYSTEM

The pressurization system is designed to regulate and monitor pressure within the electrical control boxes on the switch gear car #5 and blower car #13 to prevent flammable vapor accumulation inside the electrical boxes. If positive pressure (at least .15 inches of water column pressure) cannot be maintained in the electrical boxes, the tunnel power will shut down.



There are various components of the pressurization system: nitrogen tank, enclosure pressure control valve, enclosure pressure gauge, rapid exchange pressure gauge, enclosure vent valve, and backside regulator.



Nitrogen Tank (A): This tank provides the compressed nitrogen to pressurize the electrical control boxes.

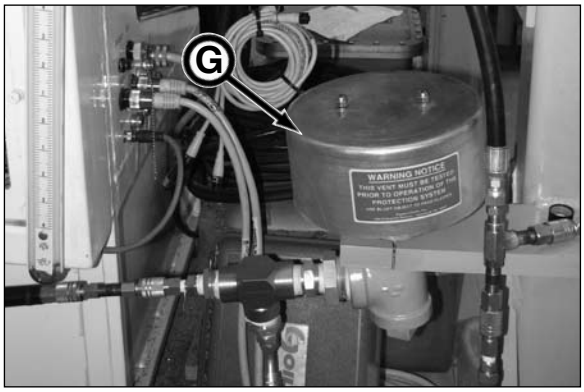
Enclosure Pressure Control Valve (B): This valve regulates the amount of nitrogen pressure in the electrical control boxes.

Enclosure Pressure Gauge (C): This gauge registers the pressure of the electrical boxes.

Rapid Exchange Pressure Gauge (D): This gauge must register the same as the nitrogen tank regulator output pressure (E).

Backside Regulator (F): Use this regulator to adjust pressure on the rapid exchange pressure gauge to match the nitrogen tank output pressure (E).

Enclosure Vent (G): In the event over pressurization occurs in the system, this vent will allow excess enclosure pressure to release.



MOMENTARY PURGE BYPASS

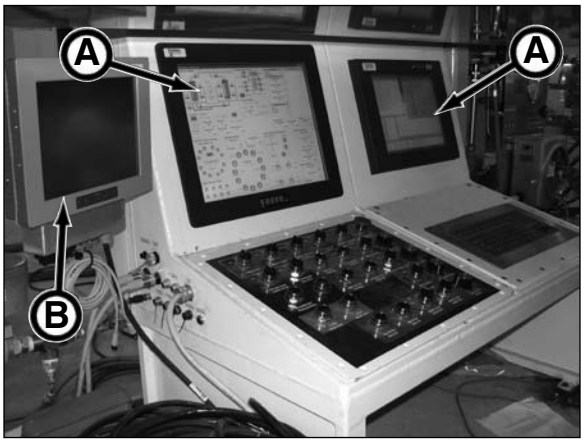
When the pressurization system detects that the electrical boxes are not holding pressure and once the enclosure pressure reaches the LOW zone on the enclosure pressure gauge, the tunnel power will shut down.

To start up the tunnel power without resolving the low enclosure pressure, press and hold the Momentary Purge Bypass button (A) and communicate to the personnel at the power container to restart the electrical system (refer to Daily Electrical System Startup in the Operation section).

Once the button is released, the tunnel power will shut down.

OPERATOR STATION CONTROLS

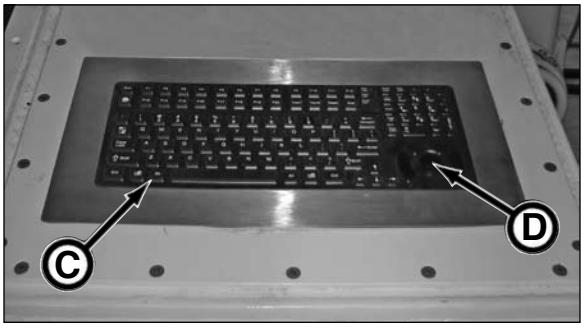
The operator station car #2 contains the jacking, steering, cutterhead, conveyor and lubrication controls of the EPB system. The two EPB control computer monitors (A) are touch screens.



NOTICE Periodically clean monitor screens (refer to Cleaning Computer Monitor Screens in the Operation section).

The operator station also includes the guidance system (B).

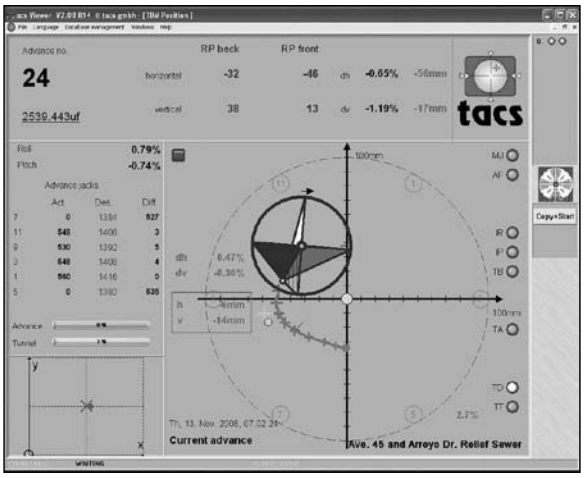
Use the keyboard (C) to select and enter data such as information for the report generator or for changing meter settings on the control screen.



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

GUIDANCE SYSTEM

The laser-based guidance system gives the operator information about the position and direction of the EPBM at all times, allowing the operator to pilot a path back to the designed tunnel axis without overstressing the tunnel lining. In addition, the segmental rings are pre-calculated to allow smooth EPBM advance. All the entered values and the results of the calculations are recorded and clearly displayed.



For operation and additional information on the guidance system, refer to your Tacs guidance system manual.

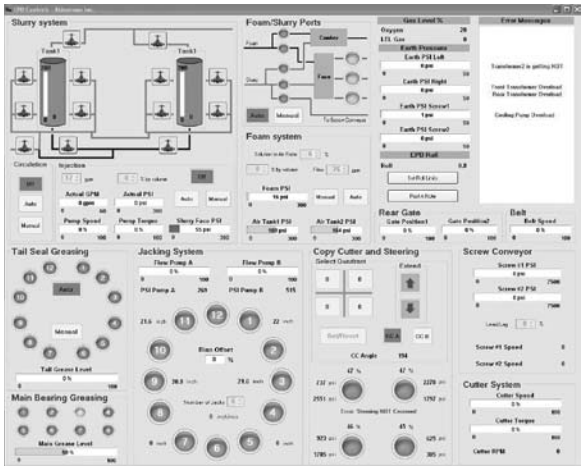
COMPUTER CONTROL SCREENS

NOTICE The computer control screens are touch screens. The controls can be activated by your finger or by using the mouse.

Once the computer is on, double click the EPB2008 program icon on the desktop to boot up the EPB systems program.

NOTICE Before the EPB systems program (EPB2008) is booted up or cycled, the console switches MUST be turned to the OFF position for the control program to function properly.

The left monitor (19”) displays the operational controls.



NOTICE On all bar meters and numeric meters on the operational control screen, a visual alarm limit can be changed as follows:

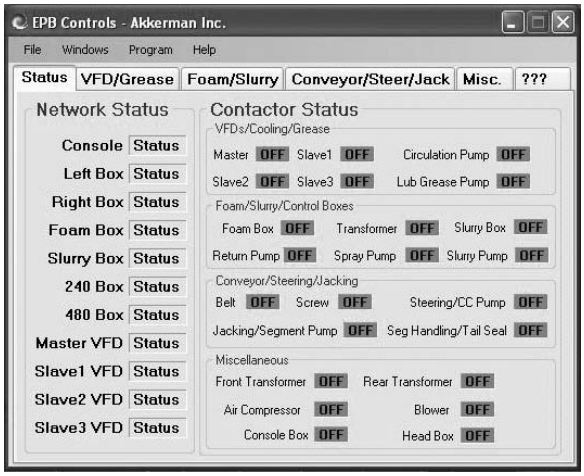
- click on the meter and pull down the menu.
- change the limit on the visual alarm as needed and click OK.

NOTICE If the operator control window is displayed on the right monitor (15”), drag the window to the left monitor (19”).

The right monitor (15”) displays the monitoring controls.

Click/touch the tabs to control the various components:

1. Status (Network and Contactor Status) Tab



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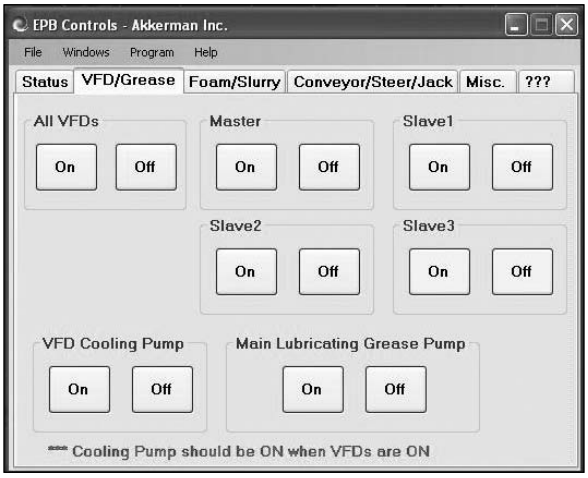
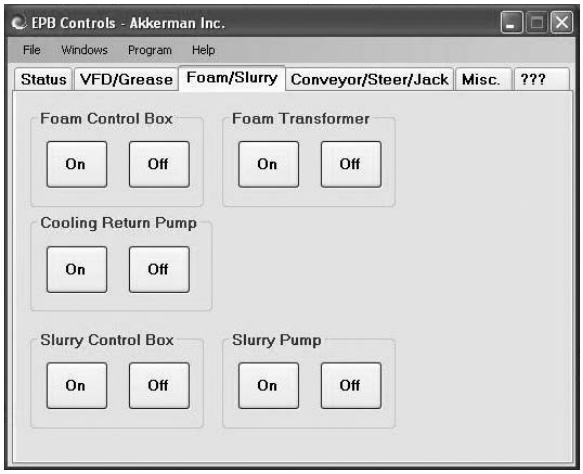
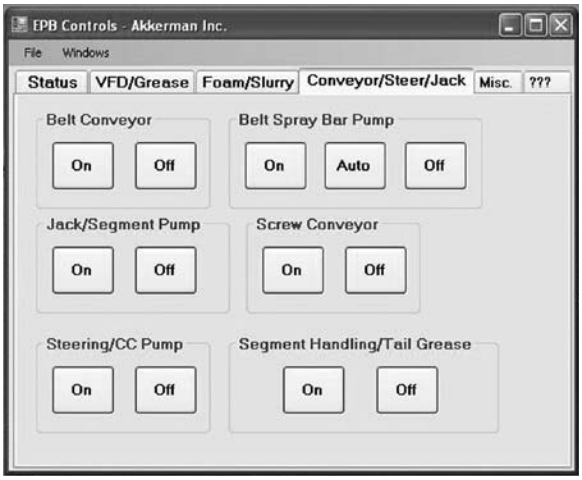
2. VFD/Grease Tab Controls



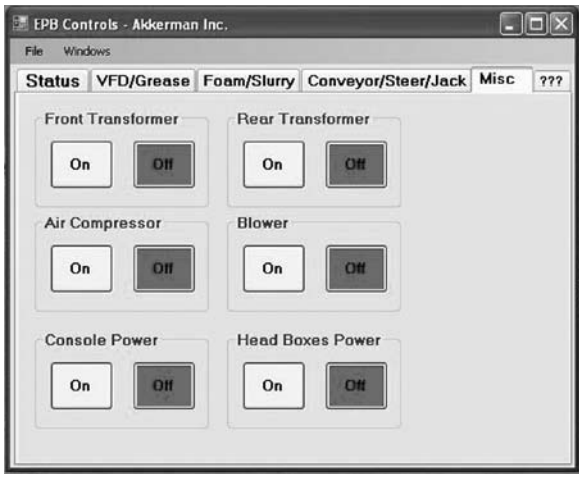
3. Foam/Slurry Tab Controls



4. Conveyor/Steer/Jack Tab Controls



5. Misc Tab Controls



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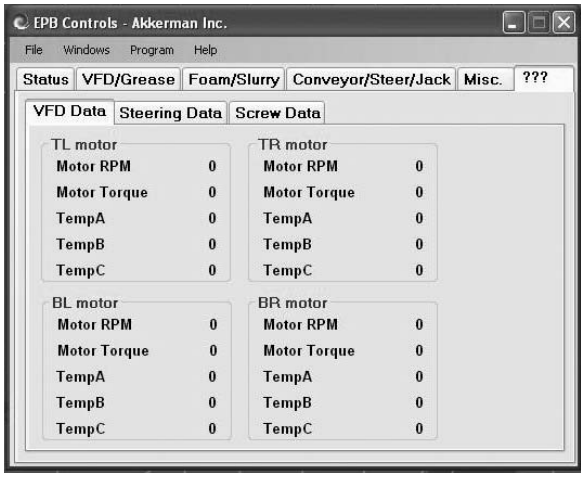
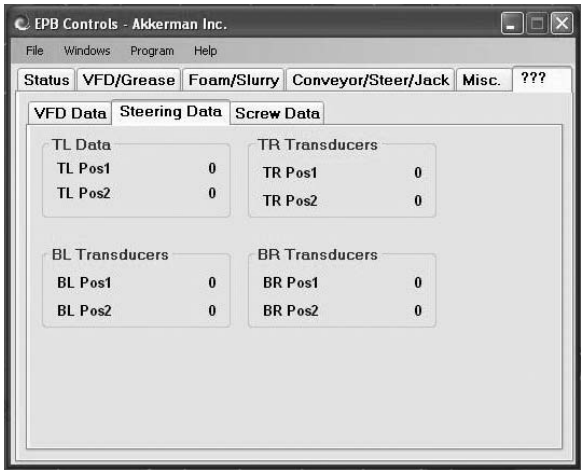
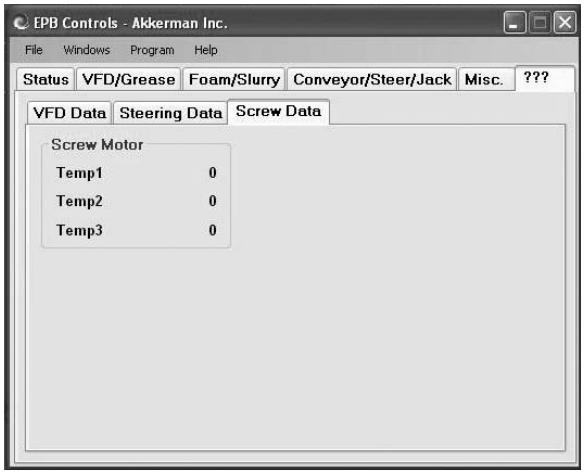
6a. ??? Tab Controls with VFD Data (cutterhead) Tab



6b. ??? Tab Controls with Steering Data Tab



6c. ??? Tab Controls with Screw Data Tab



CUTTERHEAD CONTROLS

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

NOTICE Abrupt operation may cause the machine to roll. Gradually adjust the cutterhead drive speed rotation.

CUTTERHEAD CONTROLS

To provide power for the cutterhead, press the All VFDs (or in the following order the Master, Slave 1, Slave 2, Slave 3), VFD Cooling Pump, and Main Lubricating Grease Pump by pressing the ON buttons under the VFD/Grease tab on the control screen (A).

NOTICE Anytime the cutterhead is rotating, the Main Lubricating Grease pump, the Tail Seal Grease pump and VFD Cooling Pump MUST be operating. Failure to do so will cause machine damage.

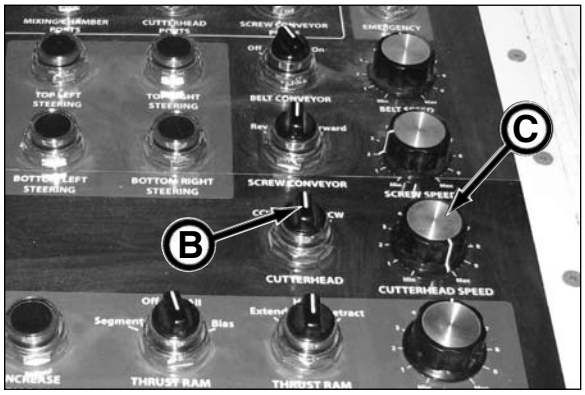
Cutterhead VFD Controls On Control Screen

The Cutterhead control (B) on the control console controls the cutter head rotation direction, clockwise (CW) or counterclockwise (CCW) as viewed looking forward into tunnel. This control also activates the Cutterhead Speed flow control (C).

The Cutterhead Speed control regulates the speed of the drive motors from 0 to 100%. Move the control as follows:

CW - increase cutterhead rotation speed
CCW - decrease cutterhead rotation speed

NOTICE To adjust the dial movement of the flow control, refer to Speed Control Sensitivity Adjustment in this section.



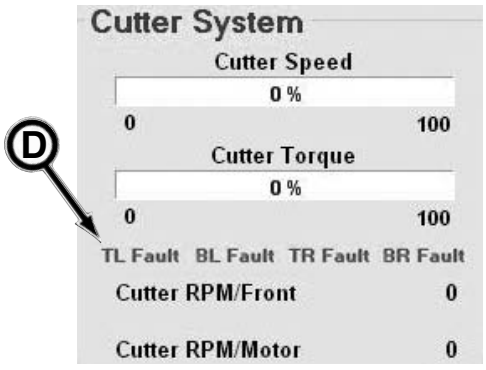
Cutterhead Controls On Control Console

NOTICE If power is shut down or there is a power outage, once the power is restored and the cutterhead motor/pump is restarted, the flow control is automatically reset at MIN (0) speed. To avoid confusion when power is restored, turn the flow control to MIN (0) before restarting.

The cutterhead speed and torque (clockwise & counterclockwise), and cutter system RPM Front (encoder on cutter) and motor can be monitored from the EPB Control screen on car #2. It is recommended to operate the cutterhead drive torque at a maximum of 80% (see Cutterhead Operation Guidelines in the Operation section).

The maximum cutterhead speed is 3.5 rpm.
The maximum cutterhead torque to 550,000 ft. lbs
The maximum motor RPM is 1,750.

NOTICE If a cutterhead motor stops, an error message (D) (TL Fault, BL Fault, TR Fault, BR Fault) will appear indicating which motor has faulted. Check VFD status on car #4 to clear fault.

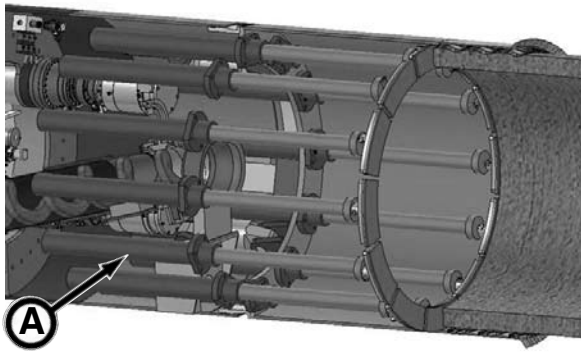


Cutter System Meters On EPB Control Screen

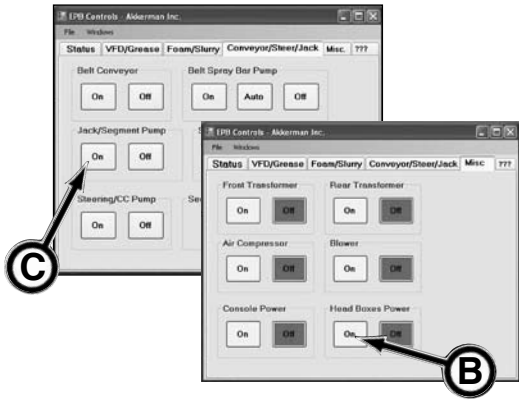
⚠DANGER Contact with electrical terminals in VFD boxes with power on WILL cause severe injury or death. Do not touch electrical terminals. Keep guards in place.

JACKING CONTROLS

The jacking controls regulate the jacking cylinders (A) during thrust, steering (with jacking cylinders) and concrete segment installation.



To activate the jacking controls, from the EPB Control screen, press the Head Boxes Power ON button (B) under the tab, Misc, and press the Jack/Segment Pump ON button (C) under the tab Conveyor/Steer/Jack.



JACKING CONTROLS

Thrust Ram Selection Control (D)

On the control console, move the Thrust Ram Selection control (D) as follows:

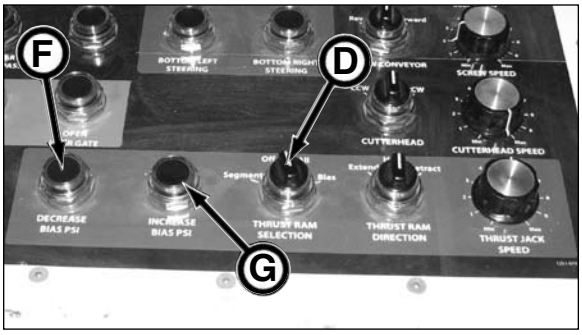
OFF
Prevents jacking cylinders from moving.

ALL
Allows all twelve jacking cylinders to extend or retract (selected with Thrust Ram Direction switch) the same distance.

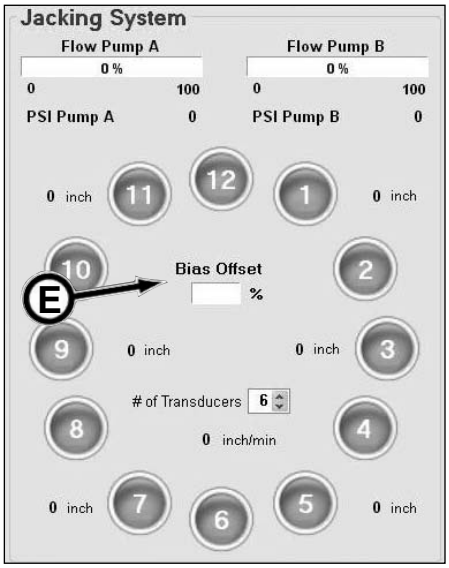
BIAS
Allows the operator to select which set of six cylinders will have high pressure (Pump A) and low pressure (Pump B).
The operator will depress the cylinder number based on the direction to be steered. For example, if downward steering is desired, depress cylinder 6 to activate cylinders 3 through 8 to low pressure. The six cylinders are selected to low pressure by pressing the desired cylinder and then the two buttons CW and the three buttons in CCW are automatically selected as low pressure. The other six cylinders are in high pressure mode.

On the control screen, Bias Offset (E), the % of thrust difference between Pump A (high pressure) and Pump B (low pressure), can be adjusted by pressing the Decrease Bias PSI (F) and Increase Bias PSI (G) buttons. For example, if the Bias Offset is 0%, all cylinders will have the same thrust pressure; if Bias Offset is 5%, the six low pressure cylinders have 5% less pressure than the high pressure cylinders.

(continued on next page)



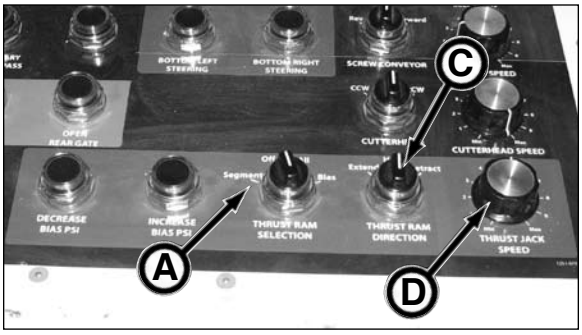
Jacking Controls
On Control Console



JACKING CONTROLS
Thrust Ram Selection Control (continued)

SEGMENT (A)
Allows the operator to select an individual cylinder or up to a maximum of four cylinders to stabilize the concrete segments during installation. This selection also provides power to the segment erector.

Select the desired cylinders by touching the cylinder number (B) on the control screen



Thrust Ram Direction Control (C)
FUNCTIONS:
HOLD
Stops flow to the jacking cylinders.

EXTEND
Extends the jacking cylinders.

RETRACT
Retracts the jacking cylinders.

Thrust Jack Speed Control (D)
The Thrust Jack Speed control (D) regulates the speed of the EPBM jacking cylinders from 0 to 100%. Move the control as follows:

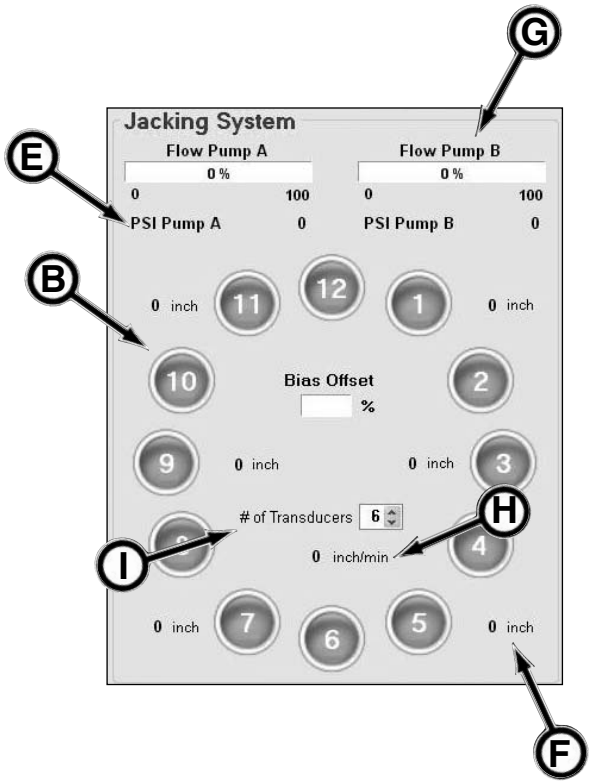
CW - increase jack speed
CCW - decrease jack speed

NOTICE To adjust the dial movement of the flow control, refer to Speed Control Sensitivity Adjustment in this section.

NOTICE If power is shut down or there is a power outage, once the power is restored and the Jack/Segment Motor/Pump is restarted, the flow control is automatically reset at 0 speed. To avoid confusion when power is restored, turn the flow control to MIN before restarting.

The jacking system pump pressure (E), cylinder extension (F), pump flow (G), and speed (H) [inches per minute] can be monitored from the control screen.

The # of Transducers field (I) corrects the jacking speed when not all twelve cylinders or 6 transducers are used, for example, during launch. This function is inactive but is available. Contact your Akkerman product support representative for more information.



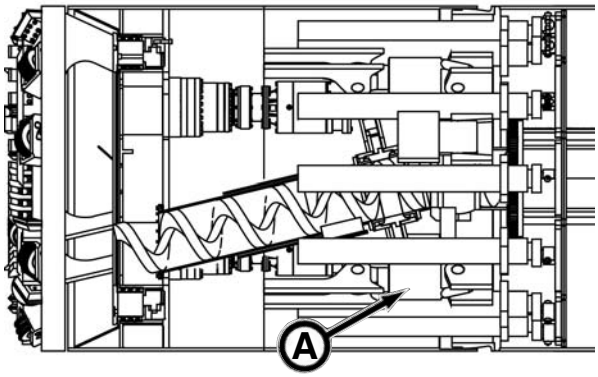
Jacking Specifications

Total Thrust Capacity ..... 960 tons
Jacking Pressure (Maximum) ..... 4,825 psi
Jacking Flow (Maximum) ..... 11.5 gpm each pump
- Extension for All or Bias Cylinders
  - Extension Rate..... 11” per minute
  - Stroke (Maximum)..... 62 in.
  - EPBM Advance Rate ..... 4 in. per minute
- Segment Cylinders (Only Pump A is controlling jacks)
  - Extension Flow Rate ..... 11.5 gpm max.
  - Extending One Cylinder ..... 80” per minute
- Retraction Flow (Maximum)
  - One Cyl. ..... 2.5 gpm
  - Two Cyl. ..... 5 gpm
  - Three Cyl. ..... 7.5 gpm
  - Four Cyl. ..... 10 gpm
  - Five - Twelve Cyl. ..... 11.5 gpm

STEERING CONTROLS

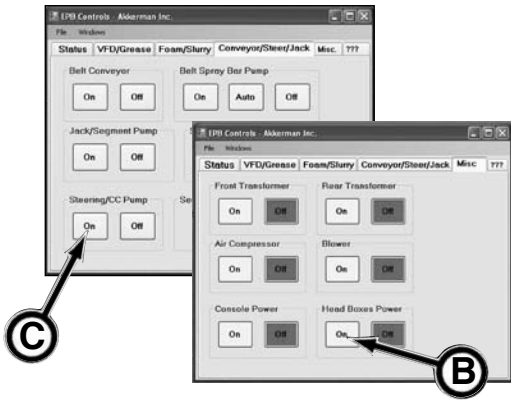
NOTICE For the proper steering procedure, refer to Steering Guidelines and Operation in the Operation section.

NOTICE Steering corrections should be carefully executed with small adjustments made over many feet. Making more extreme steering adjustments will increase the jacking forces due to the front and trailing sections not in parallel.



The steering controls regulate the four EPBM steering cylinders (A).

To activate the steering controls, from the EPB Control screen, press the Head Boxes Power ON button (B) under the Misc tab, and press the Steering/CC Pump ON button (C) under the Conveyor/Steer/Jack tab.



NOTICE When shutting down steering system, press Steering/CC Pump to OFF button. If steering pump is not shut off before system is shut down, the steering cylinders will move from the 50% position.

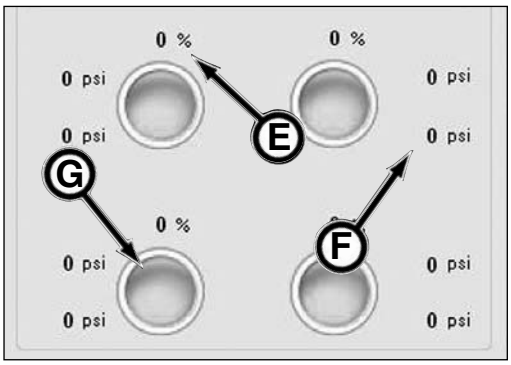
STEERING CONTROLS
The steering system is designed for two cylinders to operate simultaneously. Steer the EPBM by depressing the steering control buttons (D) [maximum of two cylinders can be selected at one time] to extend/retract the steering cylinders.

Depress the button(s) to extend/retract as desired:
100% is fully extended
50% is centered position
0% is fully retracted

Monitor the average cylinder position (E) in percent (two transducers per cylinder), and the extend/retract pressure (F) of the steering cylinders on the control screen.

At initial start up, the steering cylinders are centered represented by the 50% cylinder position. When steering is activated, the corresponding cylinders move as needed to retain a 100% position.

The maximum steering cylinder extension is 5.7" (shown as %).
The maximum pressure is 5,000 psi. The extend and retract cylinder pressure is monitored.
The maximum ton capacity per cylinder is 240 tons, or a maximum ton capacity of 960 tons.

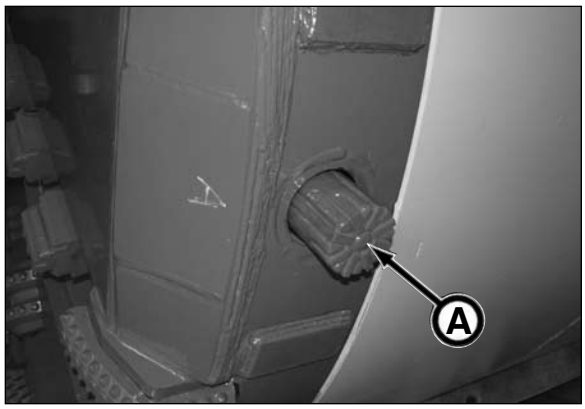


Steering Cylinder Status On EPB Control Screen

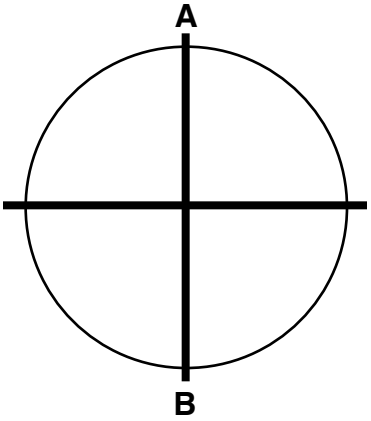
The steering cylinder status indicators (G) on the EPB Control screen represent the status of the individual steering cylinders:
dark blue - static light blue - activated

COPY CUTTER

The copy cutter (A) aids in steering by over-cutting particularly for curvatures of a tunnel.



The EPB is equipped with two copy cutters which cannot be used simultaneously. Copy Cutter A is located at the 0° position and the Copy Cutter B is located at the 180° position.



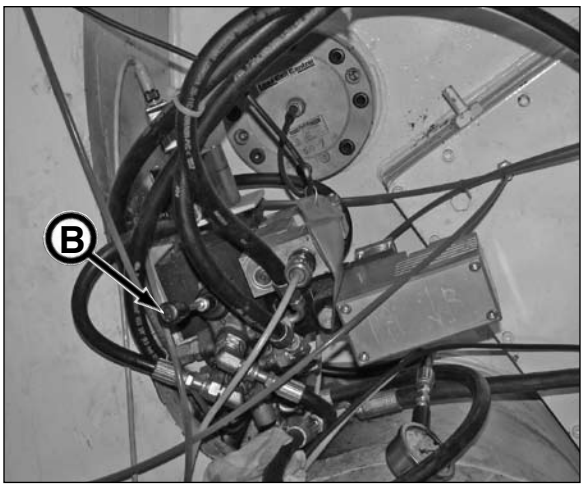
Cutterhead as viewed looking forward

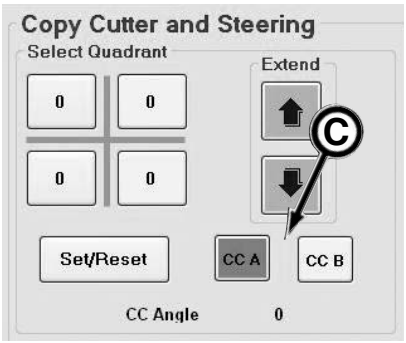
When using the copy cutter be sure the manual copy cutter controller (B) in the EPB is in the proper position:

Lever Up - Copy Cutter A
Lever Down - Copy Cutter B

The position of the controller must match the control CC A or CC B on the control screen (C), otherwise the copy selection range becomes opposite by 180°, and over-cutting will be opposite of intended direction.

Use copy cutter A until it is worn, then switch to B.

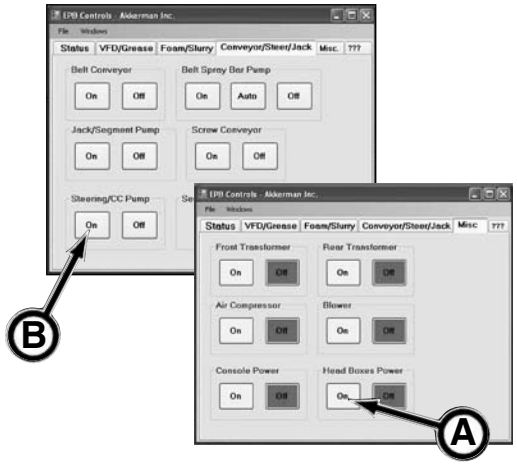




(continued on next page)

CONTROLS

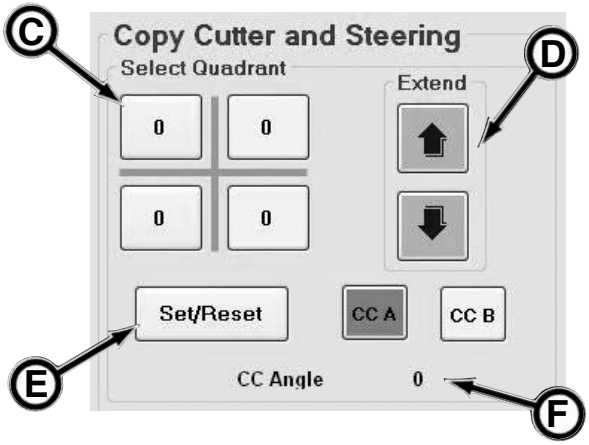
To activate the copy cutter controls, from the EPB control screen, press the Head Boxes Power ON button (A) under the tab, Misc, and press the Steering/CC Pump button ON (B) under the tab Conveyor/Steer/Jack.



Select the desired quadrant(s) (C) to extend the copy cutter. Push the Extend up or down arrows (D) to desired extension of copy cutter in inches. Then press Set/Reset button (E).

NOTICE Extend or retract the copy cutters in .25” (6mm) increments to a maximum extension of 5.5” (140 mm).

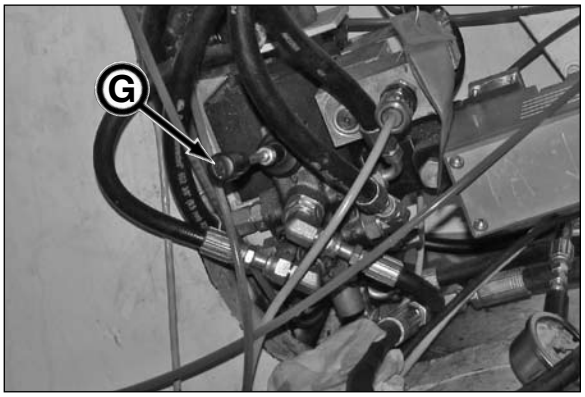
The CC Angle (F) displays the location of the selected copy cutter (in degrees) on the cutterhead.



Select copy cutter by moving controller (G) as follows.

Lever Up - Copy Cutter A
Lever Down - Copy Cutter B

NOTICE The same copy cutter must be selected on control screen and controller. Otherwise the copy cutter selection range becomes opposite by 180°, resulting in the over-cut will be opposite of intended direction.

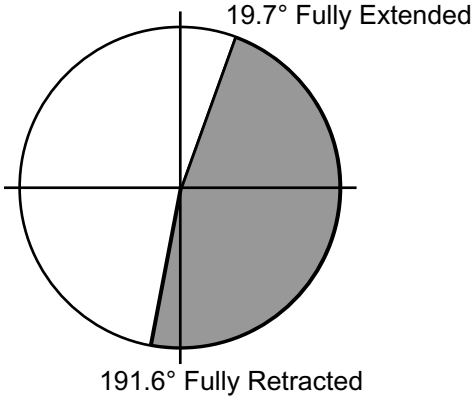


COPY CUTTER RANGE

When determining the overcut, keep in mind that the copy cutter extension will start at the beginning of the desired quadrant and will start to retract at the end of the quadrant.

As a general rule, the copy cutter extend and retract range is determined by cutterhead speed and extension of copy cutter:

- the cutterhead speed decreases the angles at the beginning and ending of the desired quadrant will be closer; cutterhead speed increase the angles will be farther from the beginning and ending of the desired quadrant.
- the copy cutter extension decreases the angles at the beginning and ending of the desired quadrant will be closer; copy cutter extension increase the angles will be farther from the beginning and ending of the desired quadrant.

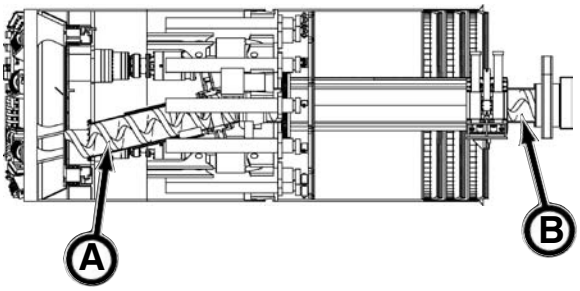


Copy Cutter Range Example
With Desired Overcut from 0° to 180° With 2.25”
Cutter Extension & Cutterhead At Full Speed

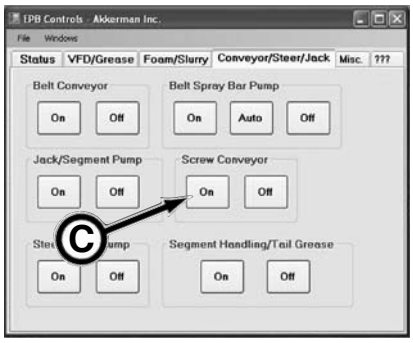
SCREW CONVEYOR

The screw conveyors help maintain the earth pressure balance while moving spoils to the belt conveyor.

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



CONTROLS
To activate the screw conveyor hydraulic motor/ pump from the control screen, press the Screw Conveyor ON button (C) under the tab, Conveyor/ Steer/Jack.

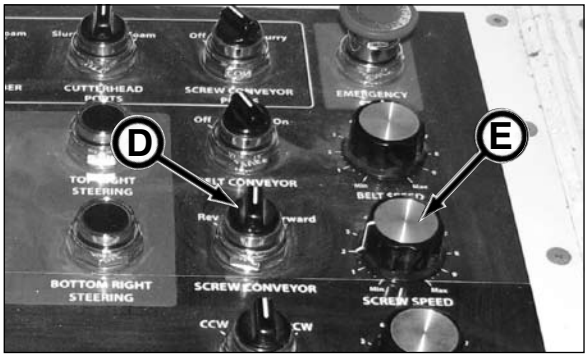


On the control console, turn the Screw Conveyor switch (D) to Forward or Rev to activate the Screw Speed flow control (E). Move switch as follows:

Forward - spoils towards launch shaft
Rev - spoils towards reception shaft

The Screw Speed flow control regulates the speed of the screw conveyor from 0 to 100%. Move the control as follows:

CW - increase screw speed
CCW - decrease screw speed



Screw Conveyor Controls On Control Console

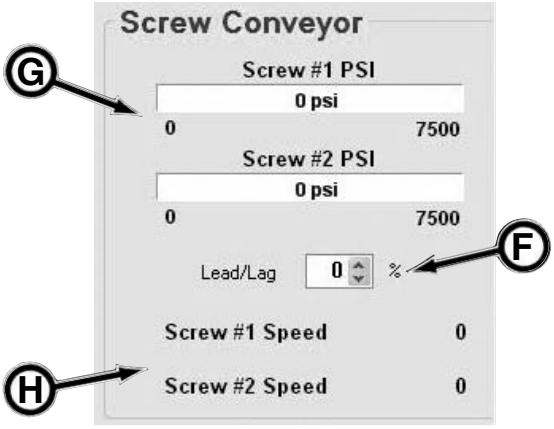
Adjust operation of #1 screw conveyor to compensate for the earth pressure balance. As a guideline, operate #2 screw conveyor speed at approximately 5% faster than the #1 screw conveyor.

NOTICE To adjust the dial movement of the flow control, refer to Speed Control Sensitivity Adjustment in this section.

NOTICE If power is shut down or there is a power outage, once the power is restored and the screw conveyor motor/pump is restarted, the flow control is automatically reset at 0 speed. To avoid confusion when power is restored, turn the flow control to MIN before restarting.

Adjust the Lead/Lag field (F) on the control screen to regulate the speed of the screw conveyor 2 to the speed of the screw conveyor 1:

Lead: % of screw conveyor 2 that is faster than screw conveyor 1 (positive %)
Lag: % of screw conveyor 2 that is slower than screw conveyor 1 (negative %)



The #1 and #2 conveyor pressure (G) and speed (H) are displayed on the control screen. The motor pressure is displayed in psi. The speed of the conveyor motor is displayed in RPM.

Maximum screw conveyor speed is 15 rpm.
Maximum screw conveyor pressure is 3,500 psi.

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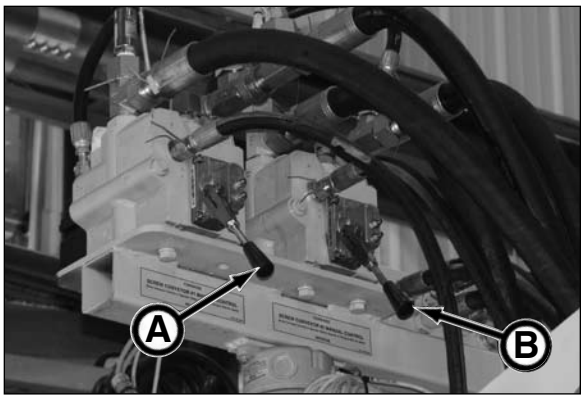
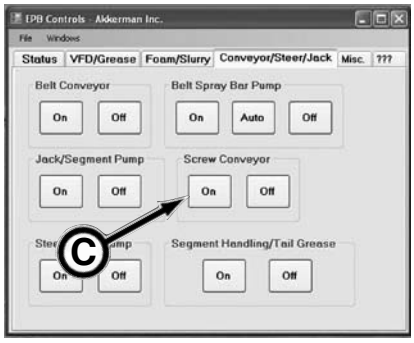
There are manually operated controls for the screw conveyor #1 (A) and screw conveyor #2 (B) located on the Incline car #1. Before using the manual controls, turn screw conveyor console control to OFF.



To activate the screw conveyor manual controls, on the EPB Control screen, turn on the Screw Conveyor hydraulic motor/pump control (C) under the tab, Conveyor/Steer/Jack.



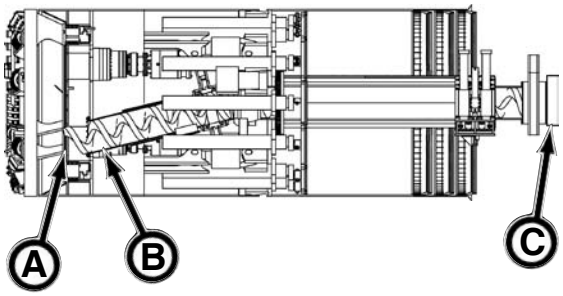
Move the levers as follows:

UP - Forward, spoils towards launch shaft
Neutral - Off
DOWN - Reverse, spoils towards reception shaft

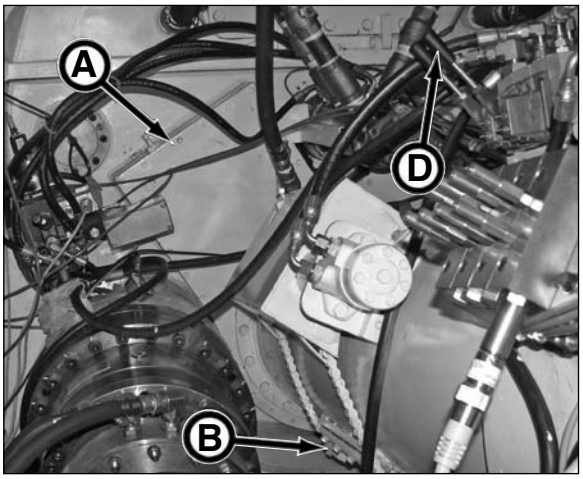
The speed of the screw conveyors are proportional to the movement of the control levers.

CONVEYOR GATE CONTROLS

The conveyor gates help regulate the flow of spoils through the screw conveyors. There are three conveyor gates; front (A) intermediate (B) and rear (C).



Front Gate (A)
The front gate is used when the screw conveyors must be removed for maintenance. Closing the front gate will seal spoils in the EPB chamber. Before closing the front gate, the screw conveyors and erector casing must be moved back to allow the front gate to close. Refer to Closing/Opening Front Gate in the Operation section.

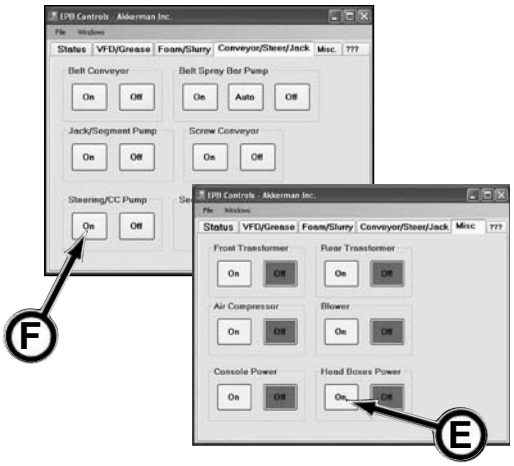


Intermediate Gate (B)
Typically the intermediate gate should never be used unless there is a need to remove larger material that will not pass through the screw conveyors.

The hydraulic gate control (D) regulates the position of the intermediate gate. BEFORE using hydraulic gate control, remove all gate hardware. Once gate is moved back to the closed position, secure all gate hardware to seal gate to screw conveyor.

Rear Gate (C)
The rear gate is used to stop spoils flow out of the screw conveyors.

To activate the rear gate controls, from the EPB Control screen, press the Head Boxes Power ON button (E) under the tab, Misc, and press the Steering/CC Pump ON button (F) under the tab, Conveyor/Steer/Jack.



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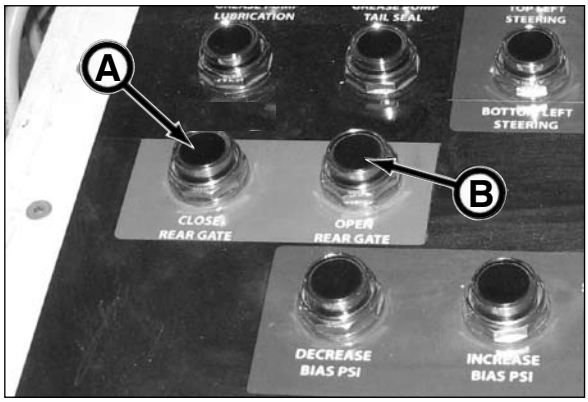
CONVEYOR GATE CONTROLS (continued)



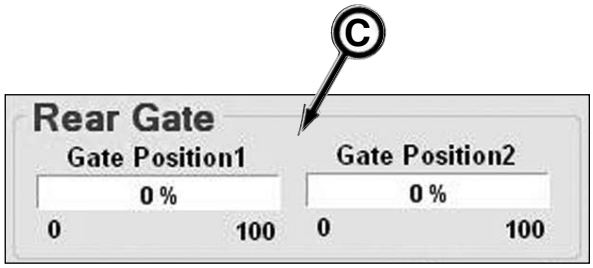
Rear Gate Conveyor Controls On Control Console

The conveyor gate controls on the control console operate the rear conveyor gate closing (A) and opening (B) by regulating the oil flow to the gate cylinders.

NOTICE To ensure sealing for a prolonged period of time, after closing gate tighten eight bolts on the gate frame.

There are two linear transducers that monitor the rear gate opening. The opening % is displayed on rear gate meters (C).

- 0% is fully closed
- 100% is fully open



Rear Gate Position Meter On Control Screen

Keep in mind, for the rear gate to be closed, BOTH gate position 1 and gate position 2 meters **MUST** be at 0%. For example, if one meter is at 0% and the other is at 10%, the gate is not completely closed.

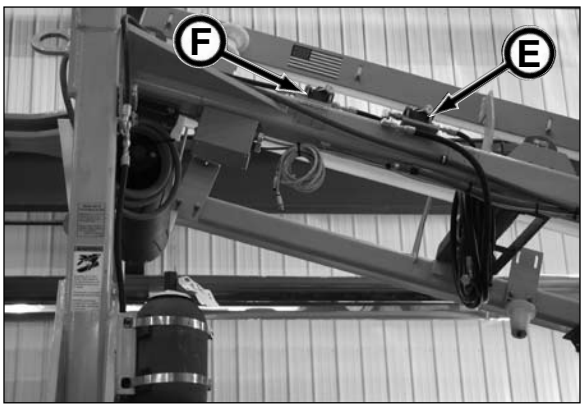
Rear Gate Accumulator (D)
In the event of a power outage or malfunction and the rear gate must be lowered without power, an accumulator is equipped on Incline car #1 of the EPB.

⚠WARNING Escaping oil or other fluids under pressure can penetrate your skin causing serious injury or death. The rear gate accumulator stores high pressure fluid. BEFORE performing maintenance or repairs on rear gate, discharge accumulator.

1. Open tank valve (E) slightly before opening pressure valve (F).

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

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



NOTICE The accumulator charge is for one use. If the accumulator is used, it must be recharged. To recharge the accumulator, refer to Charging The Rear Gate Accumulator in the Operation section.

BELT CONVEYOR

⚠DANGER Contact with rotating conveyor belt or idler rollers will cause severe injury or death. Keep hands, body, and objects clear of rotating conveyor.
Do not operate without covers and guards in place. Lockout/tagout power before servicing belt conveyor.

The belt conveyor will move the spoils from the screw conveyor to the muck cars (dirt bucket).

Control the speed of the conveyor so when the spoils drop on the belt conveyor, they do not pile up on the belt. A change in the EPB advancement rate, screw conveyor speed or ground conditions will require an adjustment in the conveyor speed.

⚠WARNING Running the conveyor too fast can cause severe injury from flying debris and cause possible machine damage. Slow the conveyor speed so there is continual controlled movement of the spoils into the muck car.

BELT CONVEYOR CONTROLS
To activate the belt conveyor hydraulic motor/pump press the Belt Conveyor ON button (A) on the control screen under the Conveyor/Steer/Jack tab.

NOTICE Before the conveyor belt rotates, there will be a three second audible and visual alarm. The audible alarm (horn) is located on Operator Station car #2. The two red visual alarms (B) are located on Segment Handling car #3 and the Rear Hydraulic car #7.

On the control console, turn the Belt Conveyor ON/OFF switch (C) to ON to activate the Belt Speed flow control. The Belt Speed (E) flow control regulates the speed of the belt conveyor from 0 to 100%. Move the control as follows:

CW - increase belt speed
CCW - decrease belt speed

NOTICE To adjust the dial movement of the flow control, refer to Speed Control Sensitivity Adjustment in this section.

The maximum belt speed is 90 rpm. The belt speed (D) can be monitored from the EPB Control screen on Operator Station car 2. The belt will move forward, moving spoils to the muck cars.

NOTICE If power is shut down or there is a power outage, once the power is restored and the belt conveyor motor/pump is restarted, the flow control is automatically reset at 0 speed. To avoid confusion when power is restored, turn the flow control to MIN before restarting.

The Belt Spray Bar Pump control (F) powers the belt conveyor spray bar pump on car #8 which regulates the spray bar on car #6.

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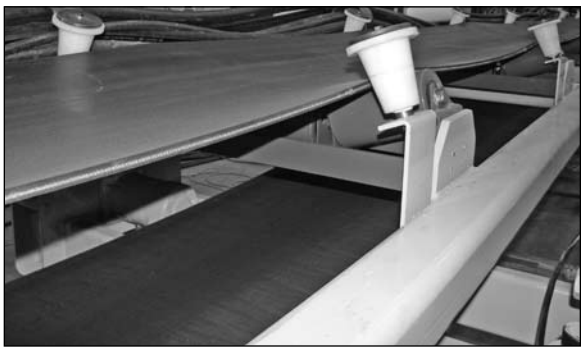
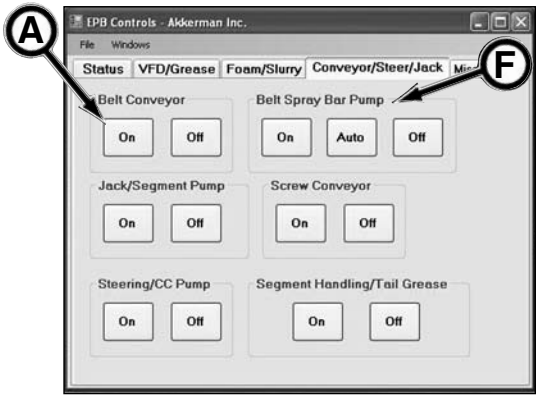
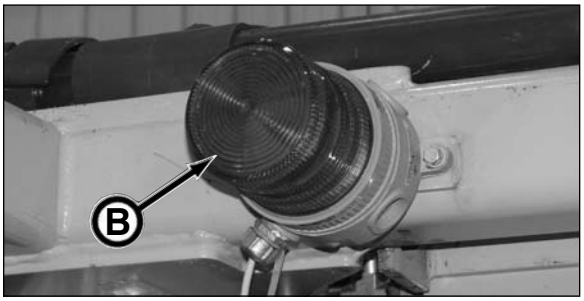
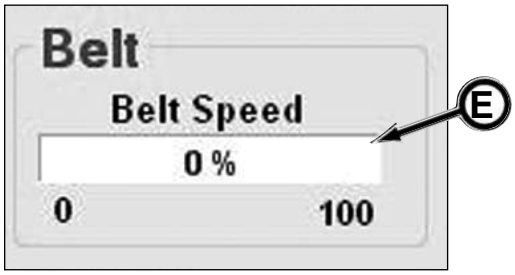






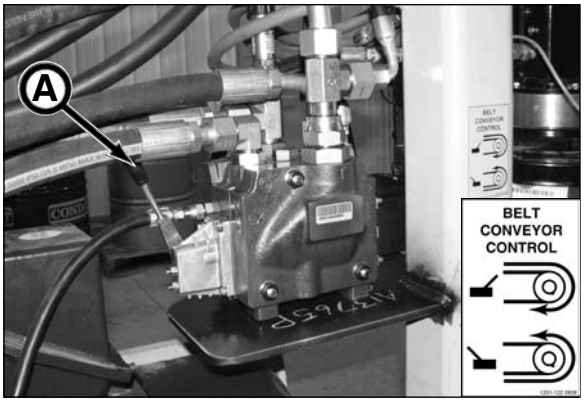
Red Visual Alarm Strobe on Rear Hydraulic Car 7

Belt Conveyor Controls On Control Console



BELT CONVEYOR CONTROLS (continued)

The Belt Conveyor Control (A) is located on Front Hydraulic car 6. This control overrides the console belt conveyor control and speed.



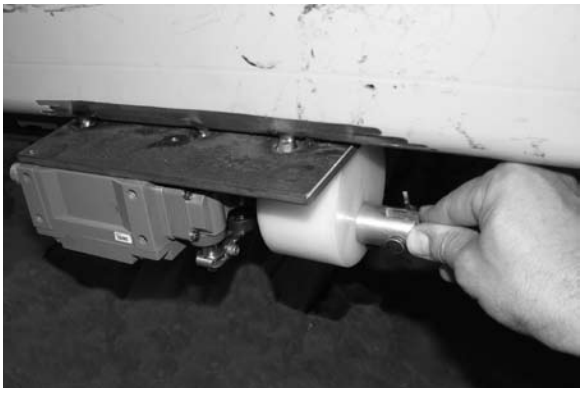
Move lever as follows:

Towards launch shaft - forward (towards launch shaft), typical belt rotation while mining

Towards reception shaft - reverse (towards reception shaft), use only during maintenance

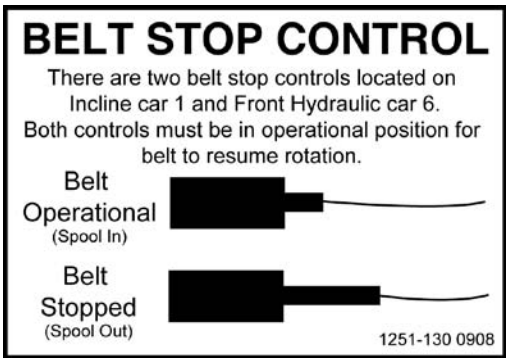
The speed of the belt is proportional to the movement of the control lever.

A Belt Stop Control is installed on Incline Belt car 1 and Front Hydraulic car 6 in the event the belt rotation must be stopped. The controls are equipped with an Emergency Belt Stop cable (B) as a means to stop the belt conveyor rotation. The belt will continue to rotate until the belt momentum stops.

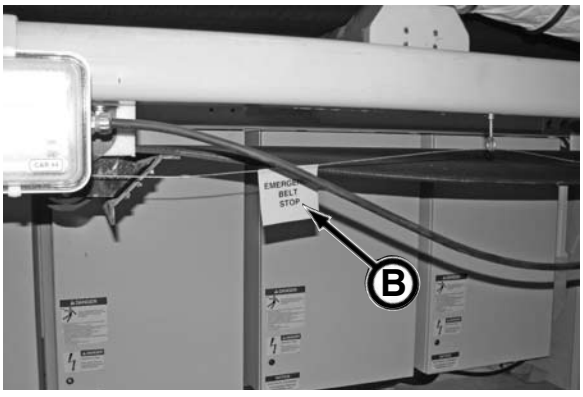


Pushing In Spool Of Belt Stop Control On Incline Belt Car 1

Once the belt is stopped with the cable, the spools of both stop controls must be pushed back into the control before the belt will be operational.

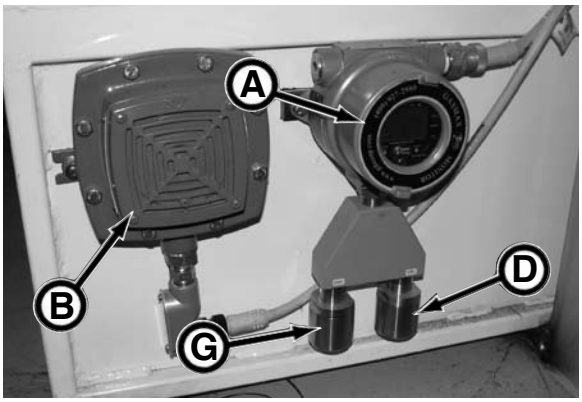


Belt Stop Control On Front Hydraulic Car 6



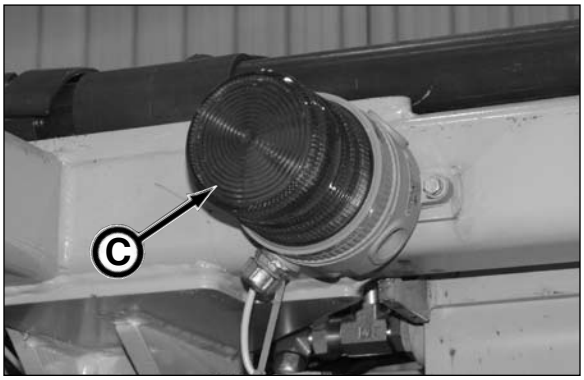
GAS & OXYGEN DETECTOR

For more information, refer to your GDS GasMax Gas Detection Manual.



⚠DANGER The gas detection system (A), that is installed in the EPB system, monitors only combustible gas levels and oxygen level. **Monitoring of all 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 at all times.

The gas detection system installed on operator station car #2 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.



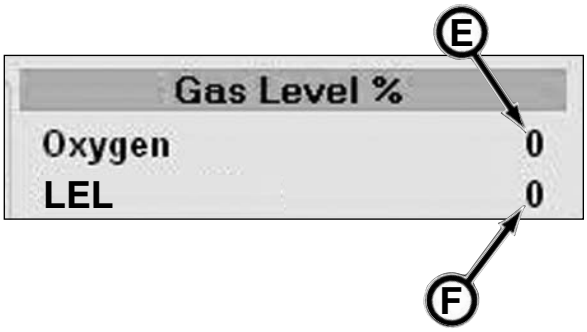
Red Visual Alarm Strobe on Rear Hydraulic Car 7

The gas detector system monitors gas levels as follows:

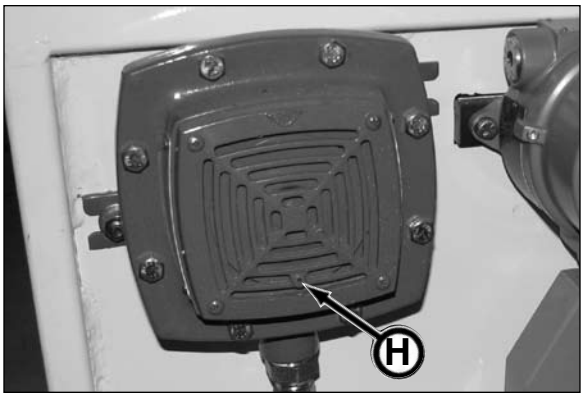
1. When the system detects a gas level reading of 5% LEL but less than 10% LEL, the audible alarm (horn) (B) on the operator station car 2 will sound repeatedly and the visual alarm strobes (C) will flash. There are two visual alarms located on segment handling car 3 and rear hydraulic car 7.

2. When the gas detector system detects a gas level of 10% LEL or higher at the LEL sensor (D), the tunnel power will automatically shut down.

3. The gas level % readings of oxygen (E) and LEL (F) at the gas detector is displayed on the control screen.



4. The oxygen sensor (G) of this system simply measures the oxygen level at the sensor location on car #2. There is no alarm with the oxygen level system.



NOTICE The alarm horn volume is adjustable. The horn must be adjusted so it can be easily heard over the ambient noises of operation. Adjust the volume by using an allen wrench in the set screw (H) on the horn face. Turn the set screw clockwise to reduce the volume. Turn the set screw counterclockwise to increase the volume.

GREASE PUMP LUBRICATION

Use the Grease Pump Lubrication control (A) to lubricate the following components:
- EPBM main bearings (B)
- main bearing seals (C)
- bearing gear ring and drive pinions (D)
- steering joint (E)
- cutterhead fluid swivel (F)
- screw conveyor bearings (G)
- screw conveyor #1 and #2 articulation joint (H)
- screw conveyor #1 front gate (I)
- copy cutters (J)

Grease Pump Lubrication Control On Control Console

MAIN GREASE PUMP CONTROLS

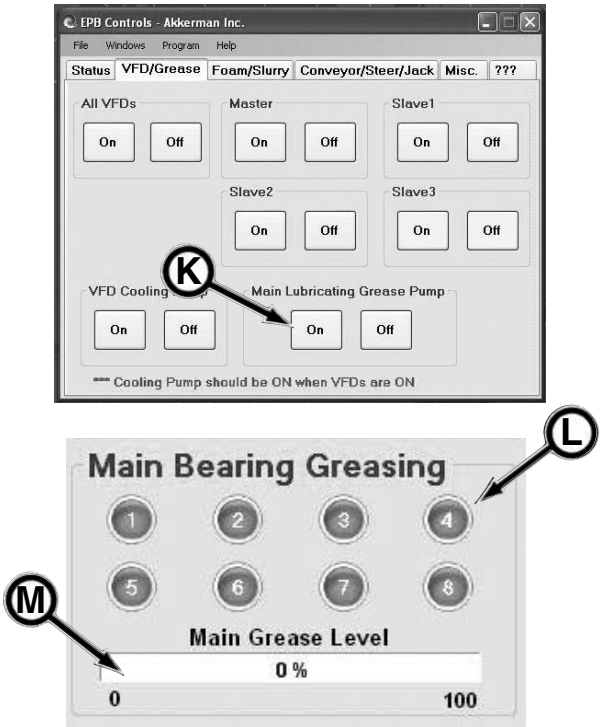
To provide power to the main grease pump, turn the Main Lubricating Grease Pump ON by pressing the ON button on the VFD/Grease tab of the control screen (K).

Turn Grease Pump Lubrication switch (A) to ON for constant greasing of components.

Turn Grease Pump Lubrication switch (A) to AUTO for greasing of the components only while the cutterhead is rotating.

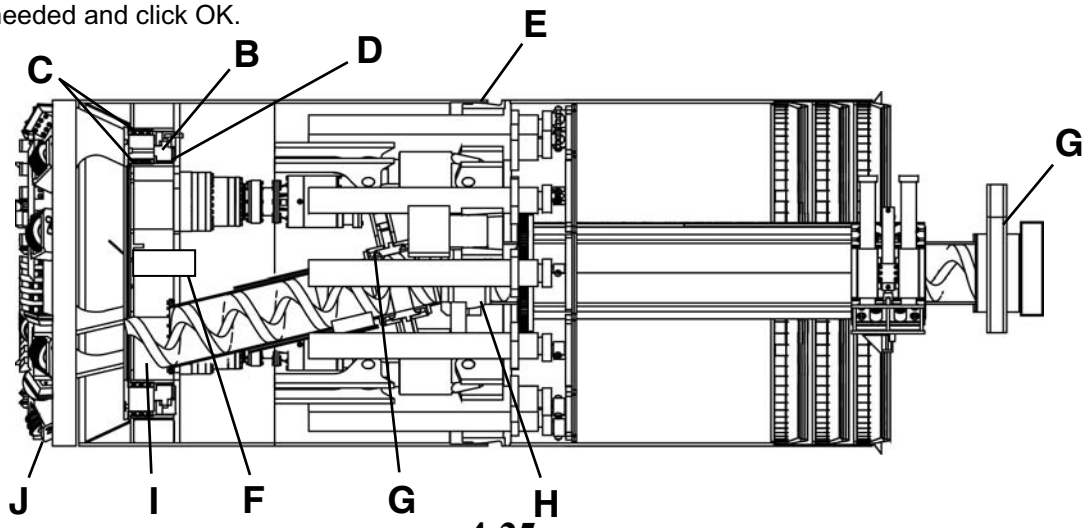
The Main Bearing Greasing on the control screen displays eight indicators (L) which will periodically flash between gray (no greasing) to blue (greasing). If a red marker appears around an indicator, this means that the block is not greasing the specific component, therefore shutdown immediately and troubleshoot the problem before resuming mining operation. For the specific EPBM greasing block location, refer to Grease Distribution Block Locations in this section.

A grease level scale meter (M) is added to the Main Bearing Greasing control screen. A red visual alarm will be visible once the grease barrel reaches the specified limit on the meter.



Lube Grease Pump Greasing Indicators & Grease Level On Control Screen

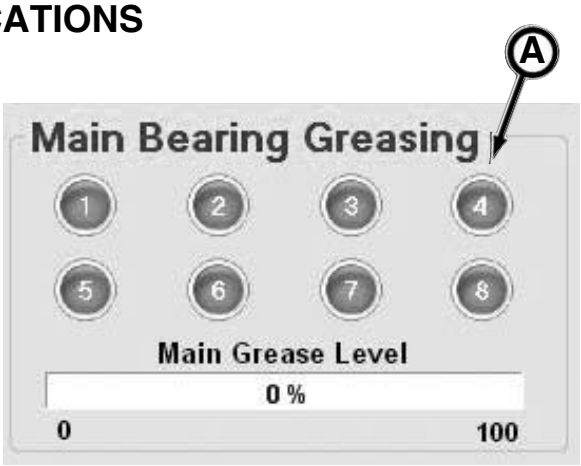
NOTICE The grease level meter alarm limit can be changed by clicking on the meter and pull down the menu. Change the limit on the visual alarm as needed and click OK.



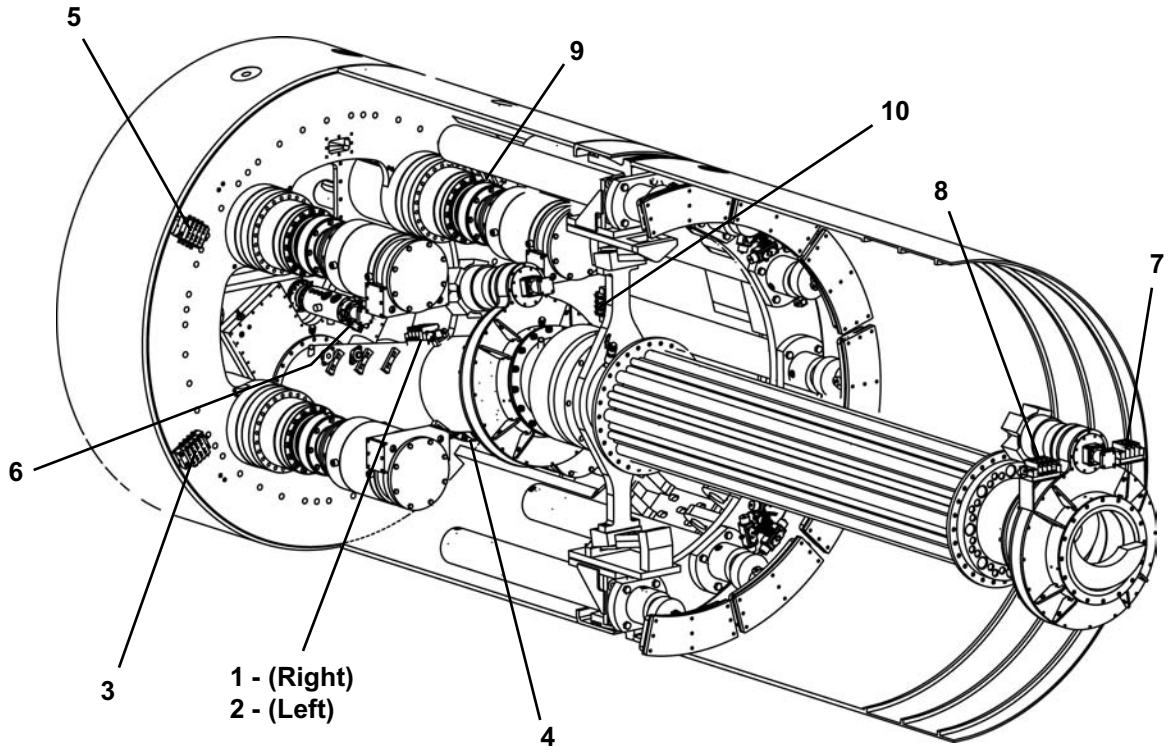
GREASE DISTRIBUTION BLOCK LOCATIONS

The Main Bearing Greasing control on the control screen displays eight indicators (A) which will periodically flash between gray (no greasing) to blue (greasing). If a red marker appears around an indicator, this means that the block is not greasing the specific component, therefore shutdown immediately and troubleshoot the problem before resuming mining operation.

To assist in troubleshooting, the illustration displays the location in the EPBM the corresponding block numbers on the control screen.



Lube Grease Pump Greasing Indicators On Control Screen



Block #1: Secondary Divider Distribution Block (feeds blocks 2, 3, 4, 5, 6, 9 and 10)

Block #2: Screw Conveyor #1 Drive and Bearing Greasing

Block #3: Main Bearing and Main Seal Greasing

Block #4: Main Bearing and Main Seal Greasing

Block #5: Main Bearing and Main Seal Greasing

Block #6: Copy Cutter and Front Gate Greasing

Block #7: Main Divider Distribution Block (feeds blocks 1 and 8)

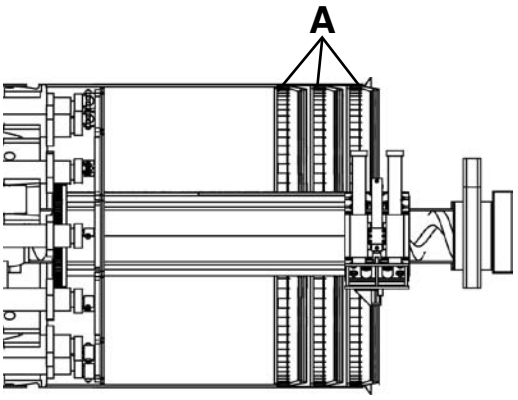
Block #8: Screw Conveyor #2 Drive and Bearing Greasing

Block #9: Main Bearing and Main Seal Greasing

Block #10: Steering Joint and Screw Joint Greasing

TAIL SEAL GREASE PUMP

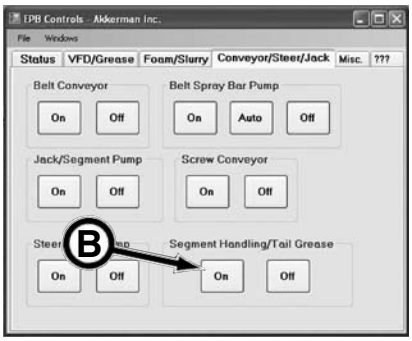
The tail seals (A) must be well lubricated to prevent any contamination from entering the seal area. Failure to do so will result in leakage of water/spoils into the machine and tunnel.



TAIL SEAL GREASE PUMP CONTROLS

To provide power to the tail seal grease pump, press the Segment Handling/Tail Grease power ON button (B) under the Conveyor/Steer/Jack tab.

When mining, be sure to turn the tail seal grease pump switch (C) on the control console to ON or AUTO as follows:



ON (Console)

When turning the tail seal grease pump switch (C) to the ON position, there are two control options:

1. AUTO (E) ; this is the default setting [see AUTO (E) (Console) below].
2. Manual (D) setting on the control screen [see Manual (D) below].

Manual (D): Press manual until button is highlighted in blue and then press the desired ports that require greasing. The selected ports will continue to be greased until they are shut off by pressing the button until it is gray. In the Manual setting, keep in mind that one port will always be greased.

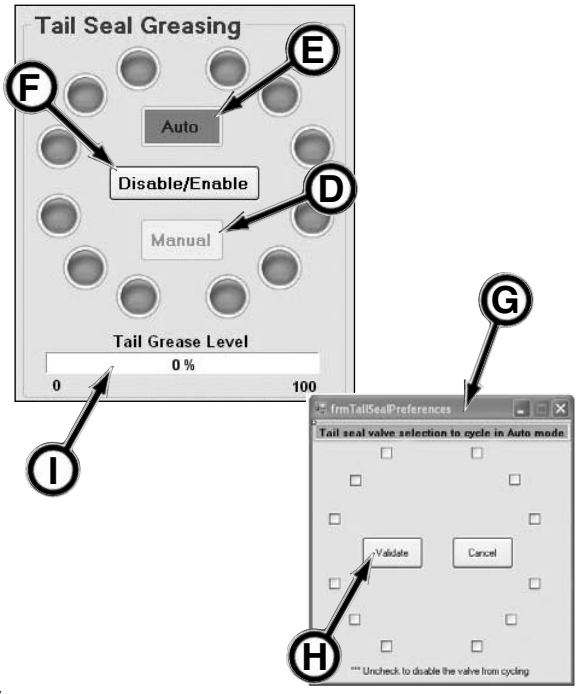
AUTO (E) (Console)

Select AUTO position to automatically grease the tail seal ports when the cutterhead is rotating. There will be no greasing if the cutterhead is not rotating.

The greasing duration at each port will be 15 seconds and will be visible with the specific port button highlighted in blue on the Tail Seal Greasing monitor. A gray button indicates that there is no grease being cycled on that port.

Another option within the AUTO position, is the Disable/Enable setting on the control screen to bypass the grease port(s) in the event the component is plugged or damaged:

Disable/Enable: Press disable/enable button (F) to access validate window (frmTailSealPreferences [G]) Uncheck the desired ports from cycling grease. Then press Validate button (H). The selected ports will no longer be greased until they are enabled (rechecked and validated). IMPORTANT: You must enable these grease ports to reactivate the grease cycling to the ports.



A grease level scale meter (I) is added to the Tail Seal Grease Pump control screen. A red visual alarm will be visible once the grease barrel reaches the specified limit on the meter.

NOTICE The grease level meter alarm limit can be changed by clicking on the meter and pulling down the menu. Change the limit on the visual alarm as needed and click OK.

Tail Seal Consumption

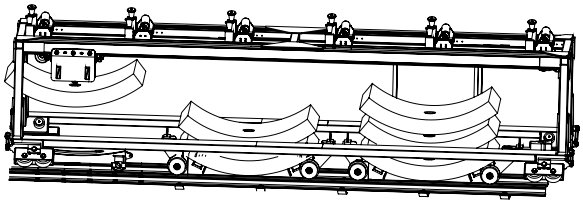
The recommended consumption rate is 1 kg/sq meter or 0.2 gal/min (2 lb/min) at 4 in/min advance rate. The recommended dosage of tail seal grease is 20 lb per meter advanced.

SEGMENT HANDLING CONTROLS (CAR #3)

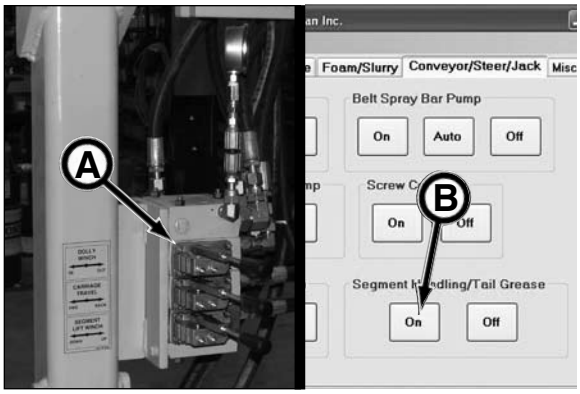
⚠WARNING Suspended loads may fall and cause severe personal injury or death.

Concrete segments are VERY HEAVY! Each segment weighs between 800 to 1500 lbs. (363 to 680 kg).

Do not enter area under or around a load.

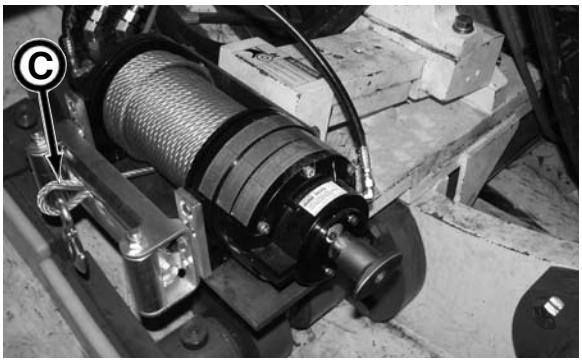


The segment handling car removes the concrete segments from the segment handler cars and off loads the segments onto the segment conveyor dolly. The dolly winch then moves the dollies into the erector zone in the EPBM.



NOTICE DO NOT lift more than one segment at a time. The hoist lift capacity is designed to lift only one segment at a time.

To activate the segment handling controls (A), press the Segment Handling/Tail Grease ON button (B) from the EPB Control screen under the tab, Conveyor/Steer/Jack.

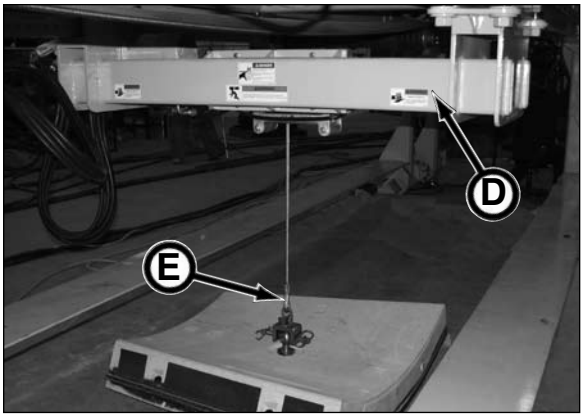


Move the control levers as follows:

- Dolly Winch:
  Left - IN: Winch cable (C) into EPBM
  Right - OUT: Winch cable out to Segment Car

- Carriage Travel:
  Left - FWD: Carriage (D) forward to EPBM
  Right - BACK: Carriage back towards launch shaft.

- Segment Lift Winch:
  Left - DOWN: Lift cable (E) lowers
  Right - UP: Lift cable raises



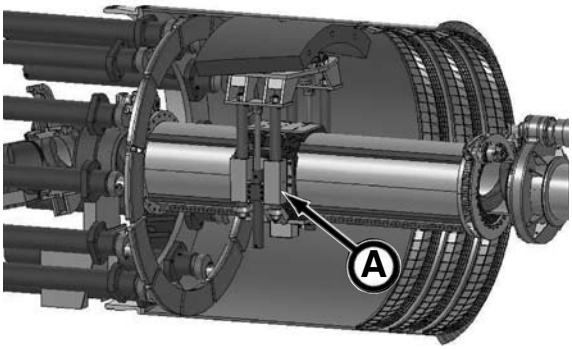
Maximum pressure for the segment handling system is 2,000 psi.

SEGMENT ERECTOR CONTROLS (CAR #1)

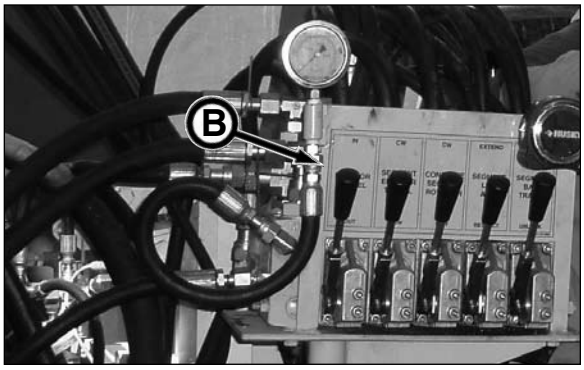
⚠WARNING Suspended loads may fall and cause severe personal injury or death.

Concrete segments are VERY HEAVY! Each segment weighs between 800 to 1500 lbs. (363 to 680 kg).

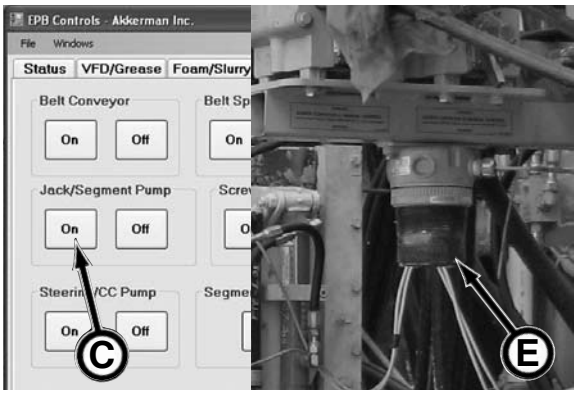
Do not enter area under or around a load.



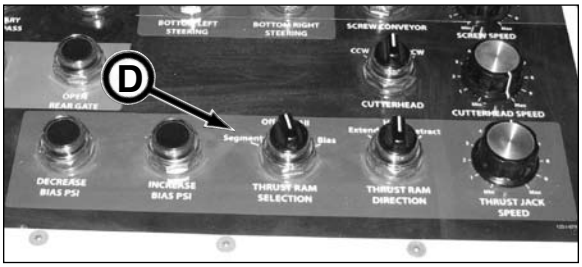
The segment erector (A) maneuvers the concrete segments as needed to form a complete tunnel ring as indicated by the guidance system.



To activate the segment erector controls (B), press the Jacking/Segment Pump ON button (C) from the EPB Control screen under the tab, Conveyor/Steer/ Jack.



NOTICE Once the segment erector pump (C) is powered on and the Thrust Ram Selection (D) control is positioned to Segment, the blue strobe light (E) on Incline Car #1 will illuminate indicating the erector is currently operating or will be operating shortly.

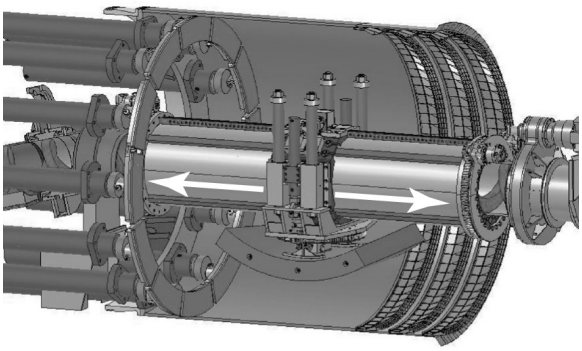


NOTICE When using segment erector controls, be sure to select Segment on the Thrust Ram Selection control (D) on the control console so the operator can select individual cylinders to stabilize the concrete segments during segment installation.

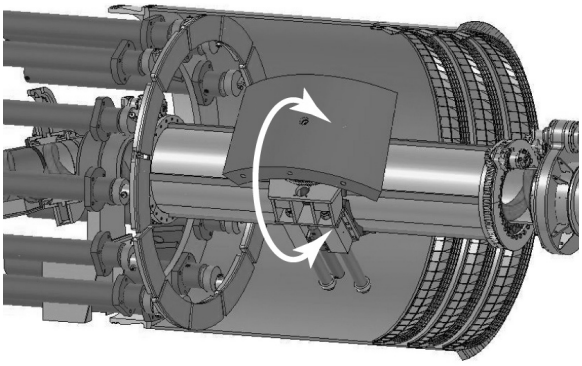
(continued on next page)

Segment Erector Controls (continued)

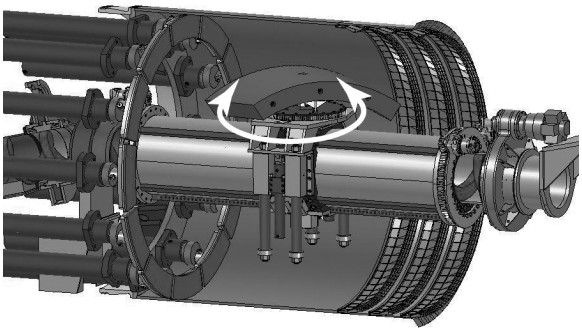
Move the control levers as follows:



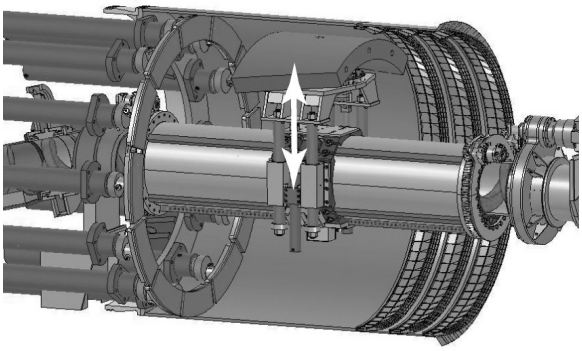
- Erector Travel:
  Up - IN: Erector moves horizontally along erector casing towards EPBM
  Down - OUT: Erector moves horizontally along erector casing away from EPBM



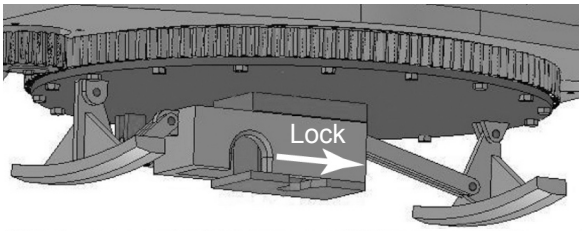
- Segment Erector Travel:
  Up - CW: Erector rotates CW around erector casing
  Down - CCW: Erector rotates CCW around erector casing



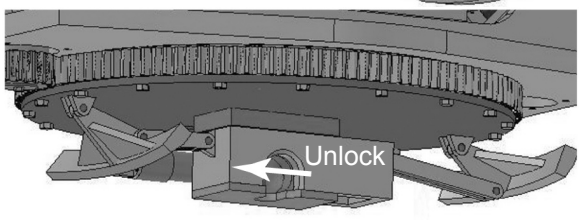
- Concrete Segment Rotation:
  Up - CW: Rotates segment CW
  Down - CCW: Rotates segment CCW



- Segment Lift Arm:
  Up - EXTEND: Lift cylinder extends
  Down - RETRACT: Lift cylinder retracts



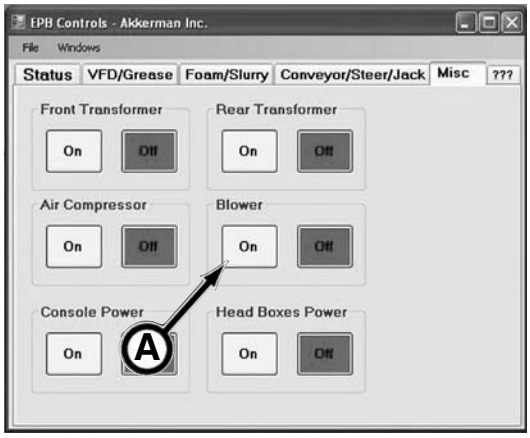
- Segment Ball Latch:
  Up - LOCK: Ball latch locks
  Down - UNLOCK: Ball latch unlocks



Maximum Pressures:
Erector Travel ..... 6.6 gpm @ 2,250 psi
Segment Erector Travel..... 17 gpm @ 2,250 psi
Concrete Segment Rotation ... 26 gpm @ 2,250 psi
Segment Lift Arm ..... 10.6 gpm @ 1,600 psi
Segment Ball Latch ..... 1.3 gpm @ 2,000 psi

BLOWER VENTILATION CONTROLS (CAR #13)

The Blower car #13 provides ventilation for the tunnel.



To activate power to the ventilation system, press the Blower ON button (A) from the EPB Control screen under the tab, Misc.

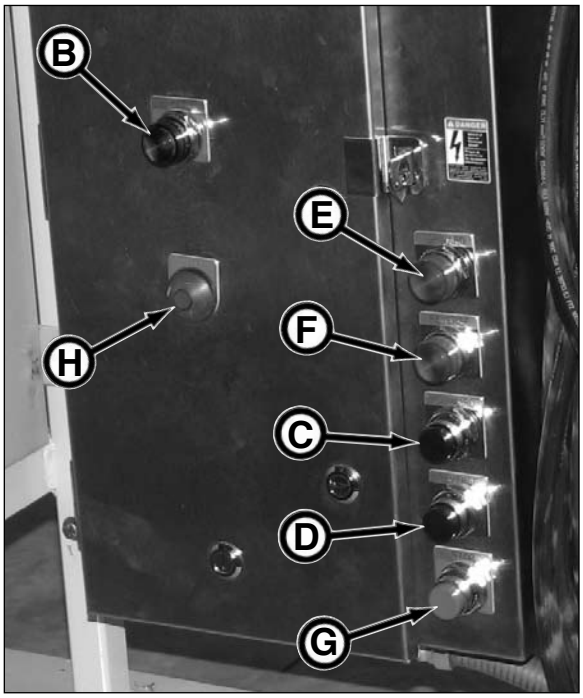
⚠DANGER ROTATING SPINNERS (blades). To prevent serious injury or death from rotating spinners: DO NOT service or make adjustments to the blower system without first performing the lock out and tag out power source procedure.

Once the ventilation system is energized, the green OFF light (B) will illuminate.

Press the desired Forward (C) or Reverse (D) buttons. The corresponding Forward (E) or Reverse (F) red light will illuminate.

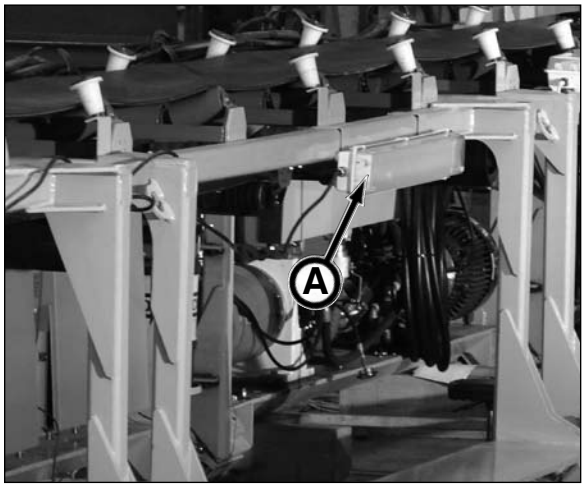
To stop the ventilation blower fan, press Stop button (G).

If an overload occurs and the Forward or Reverse controls do not function, press the reset (H).



LIGHTS

Each car is equipped with tunnel lights (A). The light control (B) is located on Blower car #13.



Turn the lights ON for full power lights while in the tunnel.

When the light control is turned OFF, the lights will dim and illuminate until the battery ballast power is drained.

Switch control to TEMP for lighting at full power for 30 minutes, then the lights will dim and illuminate until the battery ballast power is drained.

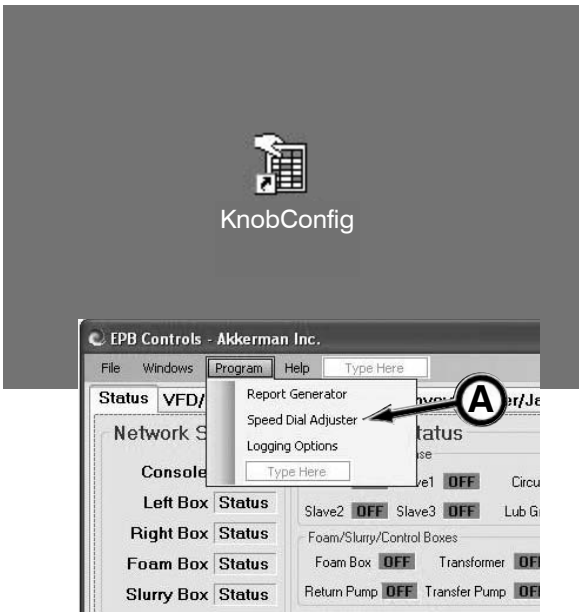
When tunnel power is shut off, such as, when adding a new electrical power cable or when shutting down for the day, switch control to TEMP position for 30 minutes of full light power before the lights dim.

NOTICE If starting the power for the day and the control is set to TEMP, there will be no tunnel lights since the battery ballast power has been drained. Turn on the lights by turning the control to ON. Besides illuminating the tunnel lights, the battery ballast will recharge.

SPEED CONTROL SENSITIVITY ADJUSTMENT

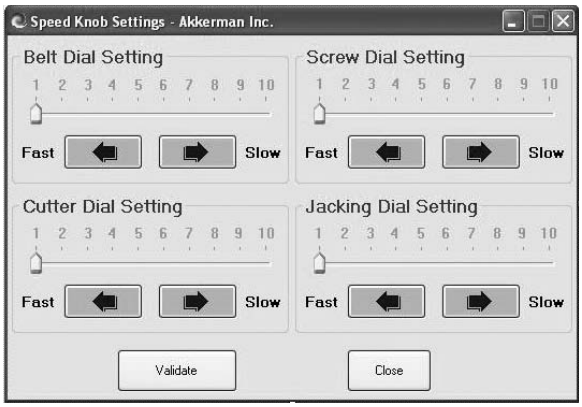
There is a program on the computer that allows the operator to fine tune the sensitivity of any of the speed controls (Belt, Screw, Cutterhead, and Thrust Jack Speeds).

1. Double click the Knob Config icon on the desktop or go to the EPB Controls window on the console screen, select the Program pulldown menu and select Speed Dial Adjuster.



2. In the Speed Knob Settings window, change the speed control sensitivity by:

a. select the desired dial setting control
b. click/touch on the arrow buttons to Fast or Slow or move the slider on the scale as needed.
c. click/touch Validate button
d. click/touch Close button once the speed control sensitivity is adjusted to operator preference.

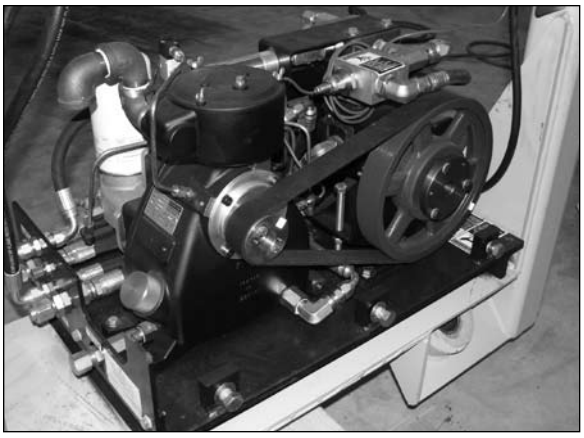


AIR COMPRESSOR (FOAM CAR #8)

⚠WARNING Do not remove caps, plugs or other components when compressor is running or pressurized. Do not use air from this compressor for breathing purposes or processing consumables.

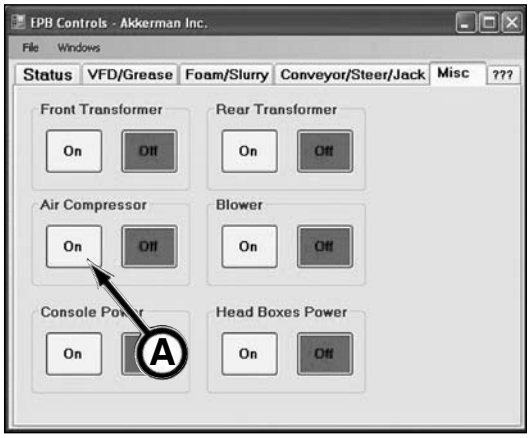
The air compressor, located on foam car #8, provides air for the pneumatic control valves and the foam system.

NOTICE The air compressor housing was removed for photographic purposes only. Never operate the air compressor without housing bolted in place.



Before starting the compressor:
1. check compressor oil level
   minimum level: bottom of fill port threads
   full level: top of fill port threads
2. check for any leaks or loose bolts
3. check drive for tightness.

To activate the air compressor, press the Air Compressor ON button (A) from the EPB Control screen under the tab, Misc.

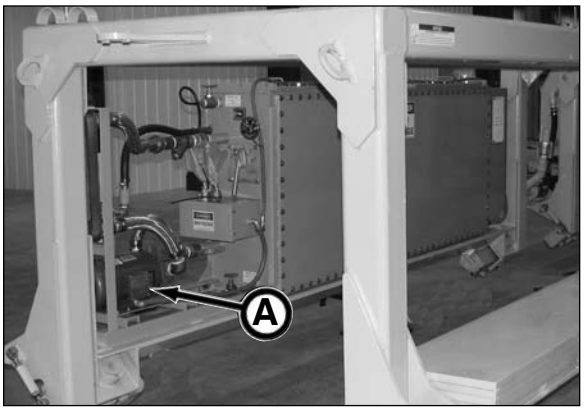


After starting, check for leaks and check operating pressure and temperature.

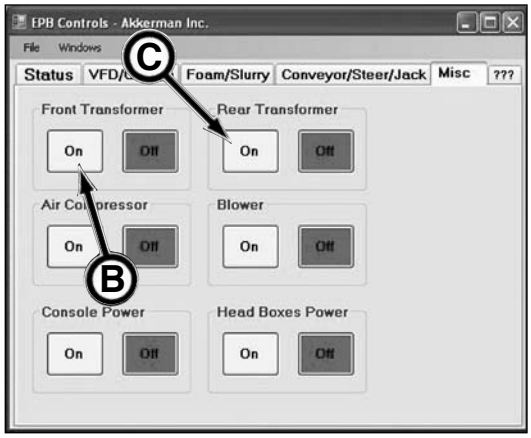
Specifications:
Operating pressure: ..... 150 to 175 psi
Operating temperature: ..... 190° F
Motor Speed @ full load:
.....2200 rpm @ 17.5 gpm @ 2600 psi
Compressor @ full load: ..... 8,800 rpm
CFM 50
Oil Capacity ..... 2.5 qts (2.4 L)
Oil ..... Vanguard High Performance Rotary Screw Compressor Oil

TRANSFORMER COOLING CONTROLS (TRANSFORMER CARS 9 & 10)

Once the 4160V is powered in the tunnel, the transformers will automatically turn on. When this occurs, turn on the transformer cooling pumps (A) on Transformer cars 9 and 10 to keep the transformers from overheating.



To power up the transformer cooling pumps, press the Front Transformer ON button (B) AND the Rear Transformer ON button (C) under the Misc tab of the control screen.



EARTH PRESSURE SENSORS

To retain the earth pressure as shown on the Geotechnical report while mining, the operational screen on the computer displays the earth pressure meters of the front bulkhead, the front of screw conveyor #1, and the rear gate on screw conveyor #2 pressure transducers. The face pressure must be maintained to prevent over and under mining.

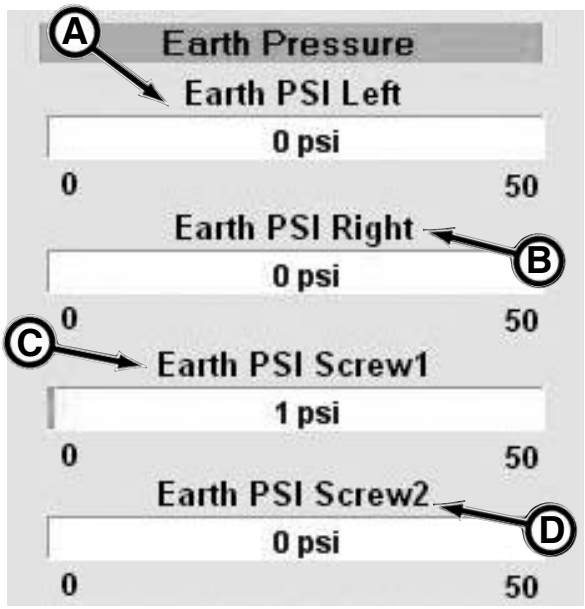
The Earth PSI Left (A) and Earth PSI Right (B) displays the left and right bulkhead earth pressure sensor meter readings of the pressure transducers.

The Earth PSI Screw1 (C) and Earth PSI Screw2 (D) meters display the readings of the screw conveyor pressure transducers.

The maximum pressure on the pressure transducers is 50 psi.

NOTICE The earth pressure meter alarm limits can be changed by clicking on the meter and pulling down the menu. Change the limit on the visual alarm as needed and click OK.

Earth Pressure Balance Right Sensor



EPB ROLL

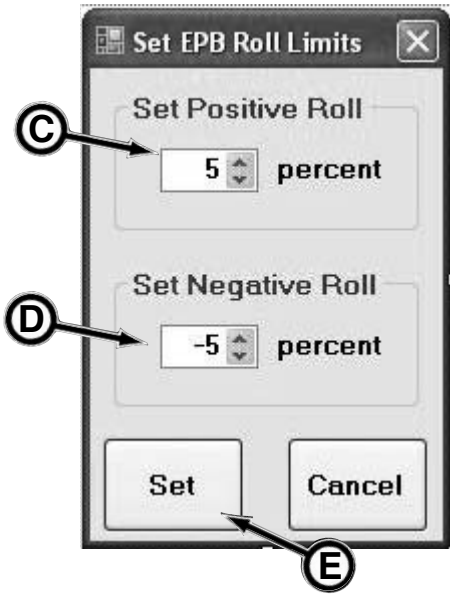
The current EPB roll (A) is shown on the control screen display as a percent. An EPB roll limit cutterhead shut down is equipped on your EPB (refer to Set Roll Limits below).

SET ROLL LIMITS (B)
The positive and negative roll parameters communicate to the system if the positive or negative roll exceed these percent parameters, the cutterhead rotation will shut down.

Five percent positive and negative roll is the default roll limit.

Adjust the Set Positive Roll (C) and Set Negative Roll (D) fields by clicking the Set Roll Limits button and then pressing the up and down arrows as needed or by simply typing the number in the number field. Then press the Set (E) button.

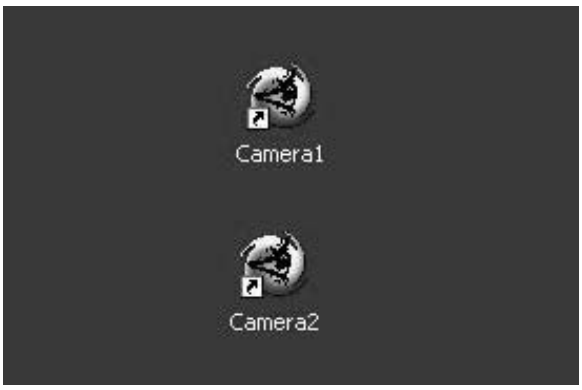
POST A NOTE (F)
Click this button to type a short note (255 character limit), Click POST button to save this note on the database. This note will be generated on a report providing the note was posted within the date and time parameters of the report.



CAMERAS

There are two cameras in the EPB for viewing operations. The camera windows will be displayed in the right monitor.

Double click Camera1 and Camera2 program icons on the desktop to display the camera windows.



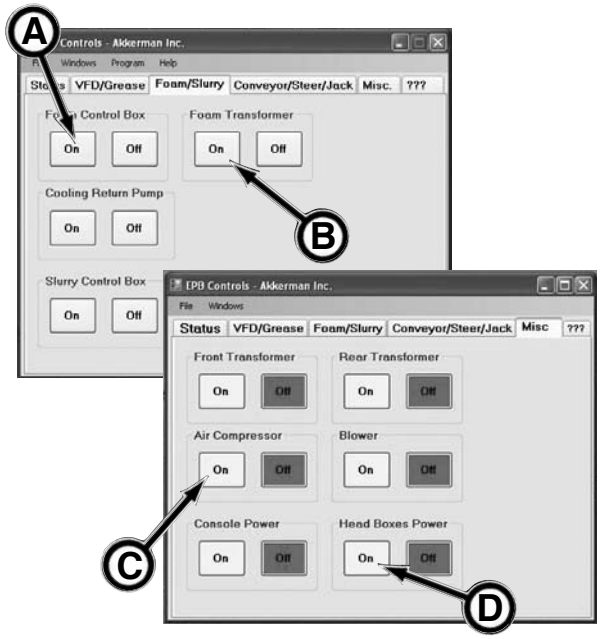
The camera windows can be moved on the computer monitor by touching the window or with the mouse and dragging it to the desired location.

There is a magnetic mount on the camera base to allow the camera(s) to be moved to a desired area within the length of ethernet cable.

FOAM CONTROLS

The foam system allows the EPB to condition the ground with foam to help increase cutting efficiency and reduce cutting torque. There are three foam/ slurry ports on the cutterhead and three in the plenum chamber. Typically the cutter injection ports are used, while the chamber ports are rarely used.

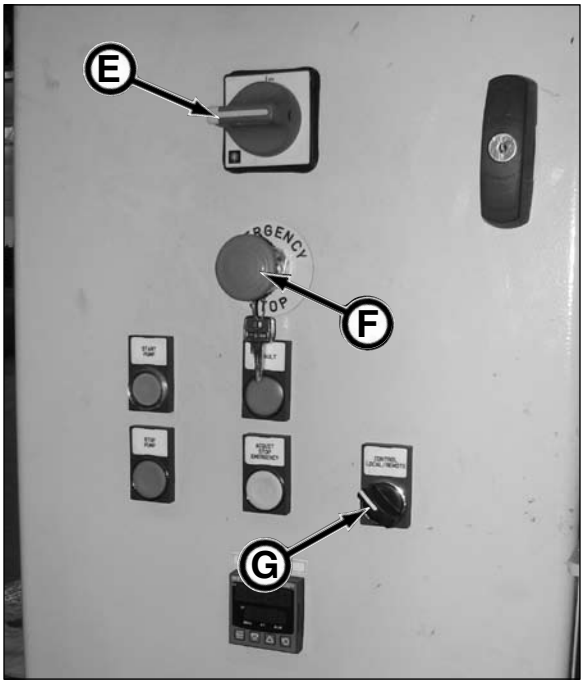
CONTROLS
The foam system components must be activated before foam can be generated.



1. On the control screen, press the Foam Control Box ON button (A), and the Foam Transformer ON button (B) under the Foam/Slurry tab.

2. On the control screen, press the Air Compressor ON button (C) under the Misc tab. The air compressor minimum output must be 90 psi.

3. Press the Head Boxes Power ON button (D) under the Misc tab. This will provide power to the foam control modules.



4. Turn foam control panel breaker switch (E) to the ON position.

5. Pull out Emergency Stop (F) on foam control panel.

IMPORTANT: This emergency stop shuts down foam system power ONLY. This emergency stop DOES NOT shut down tunnel power.

6. Turn control (G) to Remote position.

7. Turn on fresh water supply with a minimum of 45 psi @ 26 gpm.

8. Control the foam system as needed using the following foam console controls, control screen controls and foam control panel controls.

(continued on next page)

FOAM CONSOLE CONTROLS

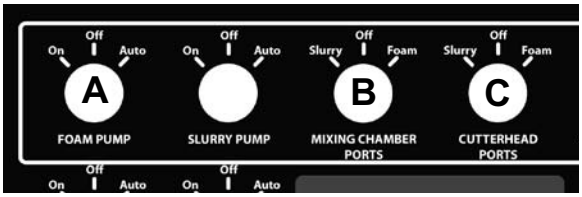
Foam Pump switch (A):

ON - foam will be pumped to the appropriate port(s) once Foam is selected on the Mixing Chamber Ports and/or Cutterhead Ports switches.

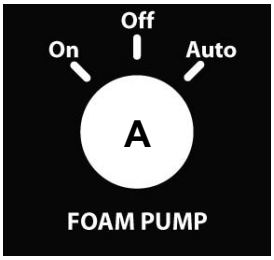
AUTO - foam will be pumped to the appropriate port(s) only while the cutterhead and screw conveyors are rotating once Foam is selected on the Mixing Chamber Ports and/or Cutterhead Ports switches.

NOTICE If foam system on control screen is on AUTO, the foam will not pump until the cutterhead and the screw conveyors are rotating AND the jacking cylinders are extending.

OFF - no foam flow



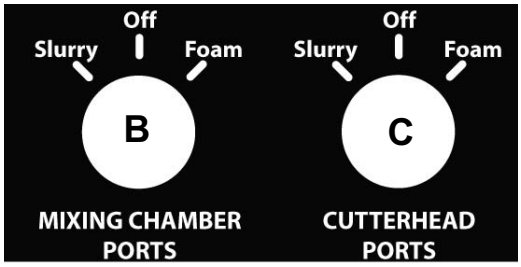
Control Console Foam Controls



Mixing Chamber Ports switch (B):

Foam - opens one valve to distribute foam to three ports in chamber

OFF - no foam flow



Cutterhead Ports switch (C):

Foam - opens three valve ports on cutterhead

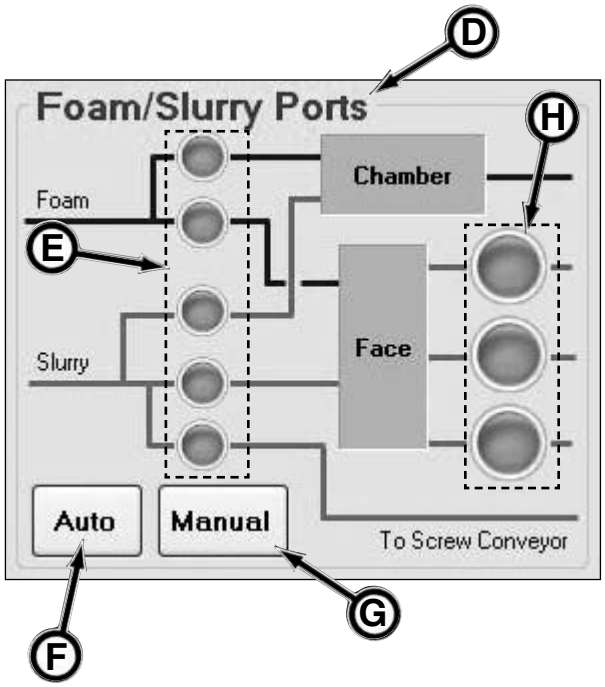
OFF - no foam flow

CONTROL SCREEN CONTROLS

Foam/Slurry Ports (D):

This control allows the operator to control individual ports on the cutterhead face (manual mode only). This control window is also a visual display of the foam/slurry pneumatic control valves that are open and closed on the cutterhead face and the plenum chamber.

The port indicator lights (E) will illuminate based on the selection made with the mixing chamber port switch, cutterhead port switch and the screw conveyor port switch (slurry only) on the control console.



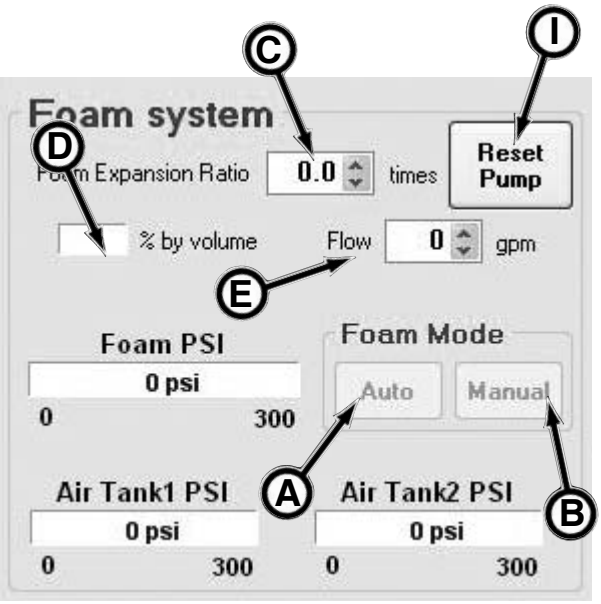
AUTO: Click Auto (F) to cycle foam or slurry to all three cutterhead ports, one at a time for 30 seconds.

MANUAL: Click Manual (G) to select all or individual cutterhead port buttons (H) for foam or slurry. Foam will pump continuously to the selected ports. The dark blue button will indicate the valve port is activated and open for foam or slurry.

NOTICE The cutterhead port buttons (H) are functional only in manual mode.

(continued on next page)

CONTROL SCREEN CONTROLS (continued)



Foam System:
The operator controls the foaming ratio and the flow of foam mixture, while the system regulates the % of foam mixed with soil removal.

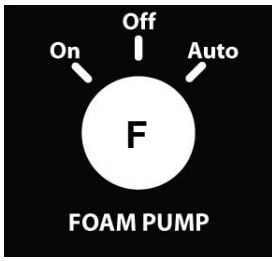
Foam Mode:

AUTO (A): For display only. Auto is highlighted when the Foam Pump switch (F) on the control console is turned to the AUTO position.

- Foam will be pumped to the selected port(s) only while the cutterhead and screw conveyors are rotating once Foam is selected on the Mixing Chamber Ports (G) and/or Cutterhead Ports (H) switches.

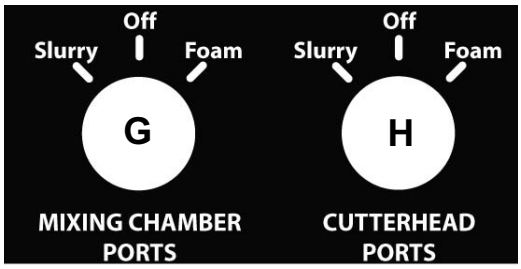
MANUAL (B): For display only. Manual is highlighted when the Foam Pump switch (F) on the control console is turned to the ON position.

- Foam will be pumped to the selected port(s) once Foam is selected on the Mixing Chamber Ports (G) and/or Cutterhead Ports (H) switches. The foam mixture will pump until the pump is shut off.



Foam Expansion Ratio (C): this field controls the foaming ratio. That is, how much more air than solution will be in the foam mixture. Input numbers are from 1 to 10. The higher the ratio or more air, the foam mixture will be less dense. The lower the ratio or less air, the foam mixture will be more soupy.

- Use 5 as a starting point. This means, there is 5 times more air than water in the foam solution and should be adjusted accordingly.



% By Volume (D): this field displays the approximate % of foam mixed with soil removal. This is calculated by the system and is a display field only.

Flow GPM (E): this field controls the flow of foam solution. The maximum gpm is 300 gpm.

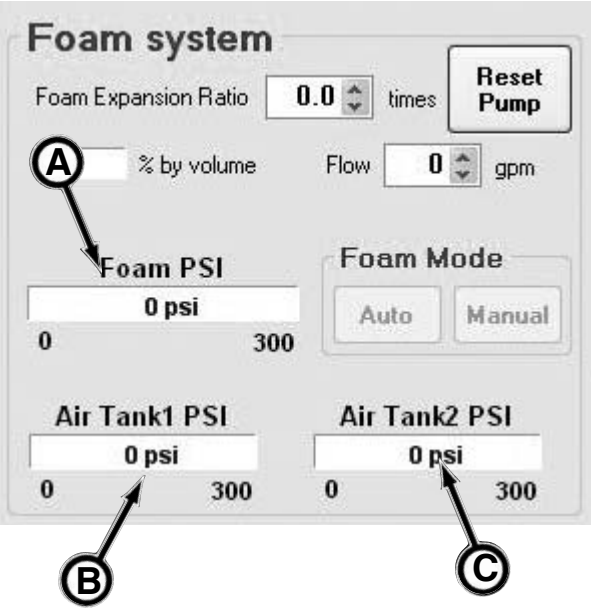
- Determining flow gpm: Every inch of soil mined per minute is equivalent to approximately 45 gpm (for EPB 113.5). If advancing 3 inches per minute (3 x 45 = 135 gpm of soil) with 30% mixed volume of foam, approximately 40 gpm of foam is required (135 x 30% = 40.5 gpm).

Reset Pump (I): this button will illuminate when a fault occurs. Press this button to reset the foam system pump in the event of a low air or water pressure fault. This button performs the same function as the Acquit Stop Emergency button on foam control panel.

(continued on next page)

CONTROL SCREEN CONTROLS (continued)

Foam System (continued):

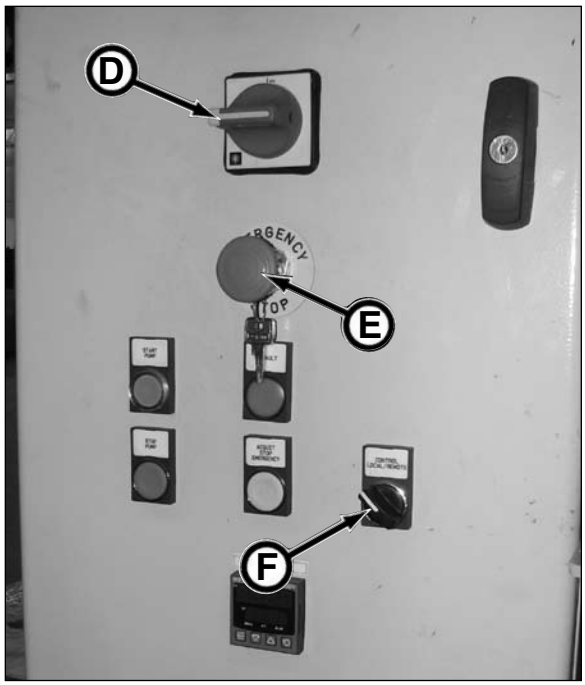


Foam PSI (A): this meter displays the foam pressure at outlet of foam gun in EPB. The maximum pressure is 75 psi. A high pressure on this meter indicates that a port(s) is plugged in cutterhead or chamber.

NOTICE If Foam PSI meter is displaying a high pressure, select the Manual button on the Foam/Slurry Ports window. Then select individual cutterhead port buttons while injecting foam to determine which port is plugged.

Air Tank1 PSI (B) / Air Tank2 PSI (C): Displays the air tank pressure for the pneumatic control valves and foam system. The maximum pressure for each tank is 175 psi. During mining operation, the pressure is typically at 150 psi.

FOAM CONTROL PANEL CONTROLS ON CAR #8



BREAKER (D): ON/OFF for foam system.

EMERGENCY STOP (E): Push IN to stop Condat® foam system. Pull OUT to restart power to foam system.
IMPORTANT: This emergency stop shuts down foam system power ONLY. This emergency stop DOES NOT shut down tunnel power.

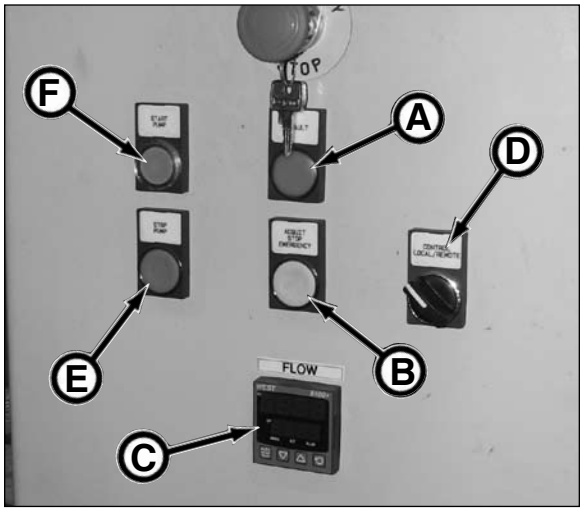
CONTROL LOCAL/REMOTE (F):
LOCAL: **(use only for testing purposes only)** Select Local for foam operation at this foam control panel. The foam pump switch on the control console and the foam controls on the control screen (on operator car #2) will be inactive. The port switches on the control console will be active.

NOTICE If using LOCAL control, the mixing chamber port switch and the cutterhead port switch on the control console on Operator car #2 MUST be turned to FOAM position (open valves). Failure to do so WILL cause damage to foam system.

REMOTE: Select Remote for foam operation from the Operator Car #2 control console and control screen. The Start Pump switch, Stop Pump switch, and the Flow control on the foam control panel will be inactive.

(continued on next page)

FOAM CONTROL PANEL CONTROLS ON CAR #8 (continued)



DEFAULT (A): The default light will illuminate a fault; air or water pressure is low.

ACQUIT STOP EMERGENCY (B): This is the default reset button. Press this button after the air or water pressure fault is corrected.

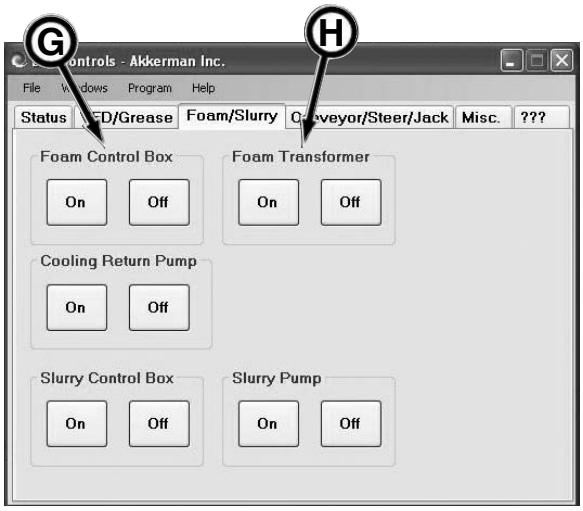
FLOW (C): Refer to Condat manual (active only when control (D) is set to local).

STOP PUMP (E): Press this button to stop the Condat® foam generator pump (active only when control (D) is set to local).

START PUMP (F): Press this button to start the Condat® foam generator pump (active only when control (D) is set to local).

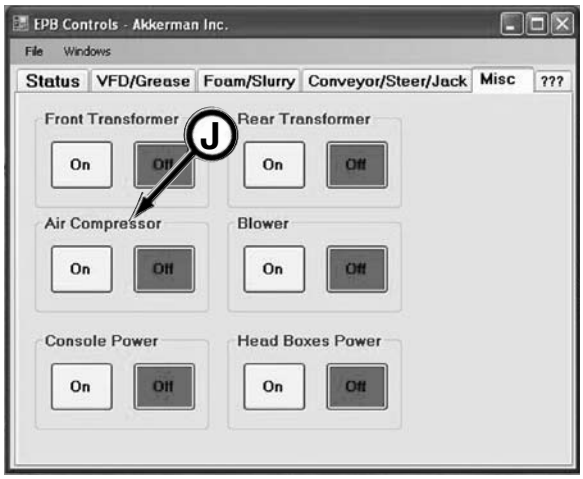
NOTICE If using LOCAL control, the mixing chamber port switch and the cutterhead port switch on the control console on Operator car #2 MUST be turned to FOAM position (open valves). Failure to do so WILL cause damage to foam system.

POWER CONTROLS ON EPB CONTROL SCREEN
Foam/Slurry Tab



Foam Control Box (G): Provides power to foam electrical control box.

Foam Transformer (H): Powers transformer in Foam Car #8 to lower power from 480VAC to 400VAC for the foam generator system.



Misc Tab
Air Compressor (J): Powers the air compressor on Foam Car #8 for air in foam system.

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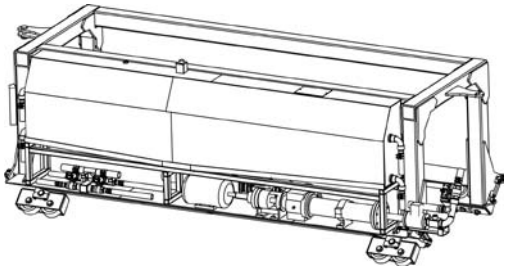
SLURRY CONTROLS

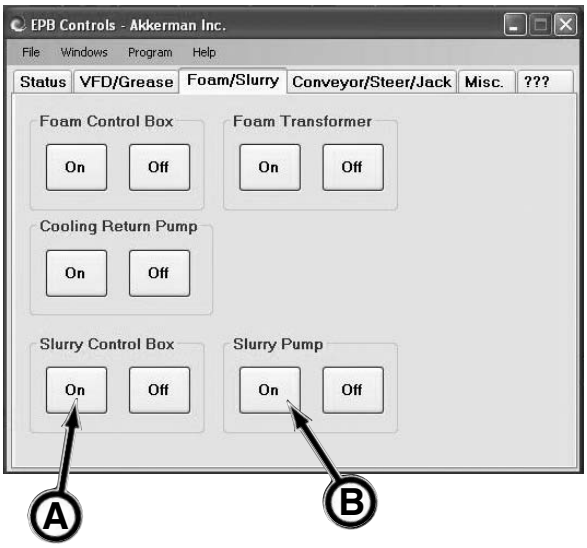
The slurry system allows the EPB to condition the ground with slurry to help increase cutting efficiency and reduce cutting torque. There are three foam/slurry ports on the cutterhead, three in the plenum chamber, and three in the screw conveyor. Typically the cutter injection ports are used, while the chamber ports are rarely used. The conveyor ports are used only if material is stuck in the conveyor.



Front Slurry Car #11

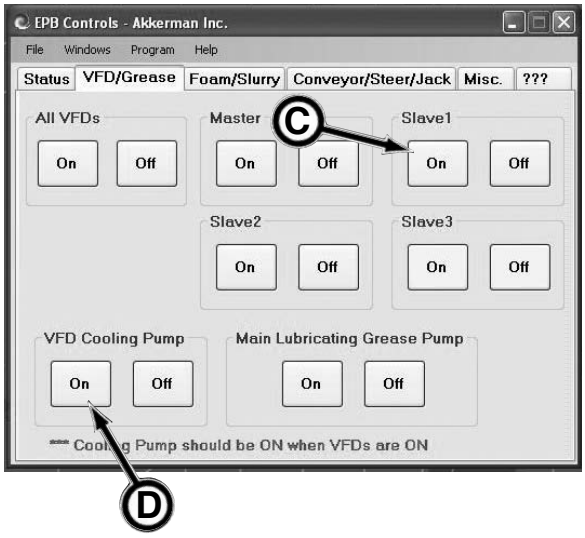
CONTROLS
The slurry system components must be activated before slurry can be utilized.

1. On the control screen, press the Slurry Control Box ON button (A) and the Slurry Pump ON button (B) under the Foam/Slurry tab.

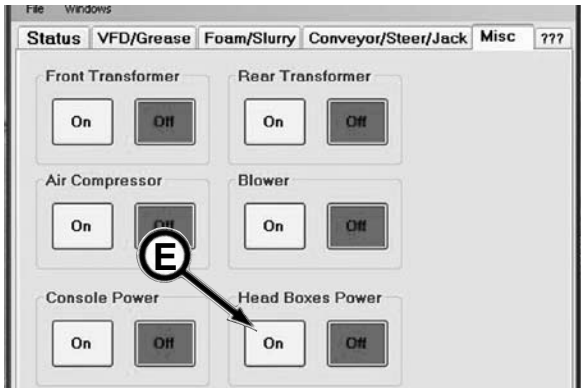


2. On the control screen, press the Slave1 ON button (C) under the VFD/Grease tab. This will provide power to the VFD communication module.

NOTICE Be sure to press the VFD Cooling Pump ON button (D) whenever VFD controls are on to prevent component damage.



3. On the control screen, press the Head Boxes Power ON button (E) under the Misc tab to provide power to the slurry control modules.



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SLURRY CONSOLE CONTROLS

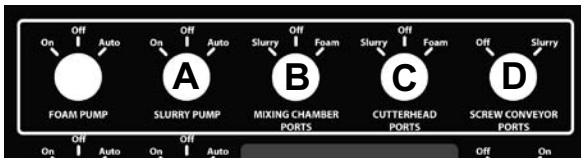
Slurry Pump switch (A):

ON - slurry will be pumped to the appropriate port(s) once Slurry is selected on the Mixing Chamber Ports, Cutterhead Ports switch and/or Screw Conveyor Ports switches.

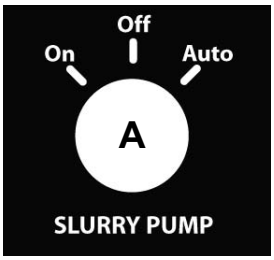
AUTO - slurry will be pumped to the appropriate port(s) only while the cutterhead and screw conveyors are rotating once Slurry is selected on the Mixing Chamber Ports, Cutterhead Ports and/or Screw Conveyor Ports switches.

NOTICE If slurry system on control screen is on AUTO, the slurry will not pump until the cutterhead and the screw conveyors are rotating AND the jacking cylinders are extending.

OFF - no slurry flow



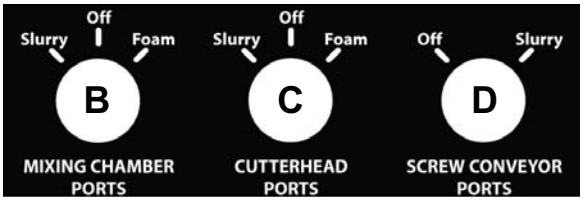
Control Console Slurry Controls



Mixing Chamber Ports switch (B):

SLURRY - opens one valve to distribute slurry to three ports in chamber

OFF - no slurry flow



Cutterhead Ports switch (C):

SLURRY - opens three valve ports on cutterhead

OFF - no slurry flow

Screw Conveyor Ports switch (D):

SLURRY - opens one valve to distribute slurry to three ports in screw conveyor

OFF - no slurry flow

CONTROL SCREEN CONTROLS

Foam/Slurry Ports (E):

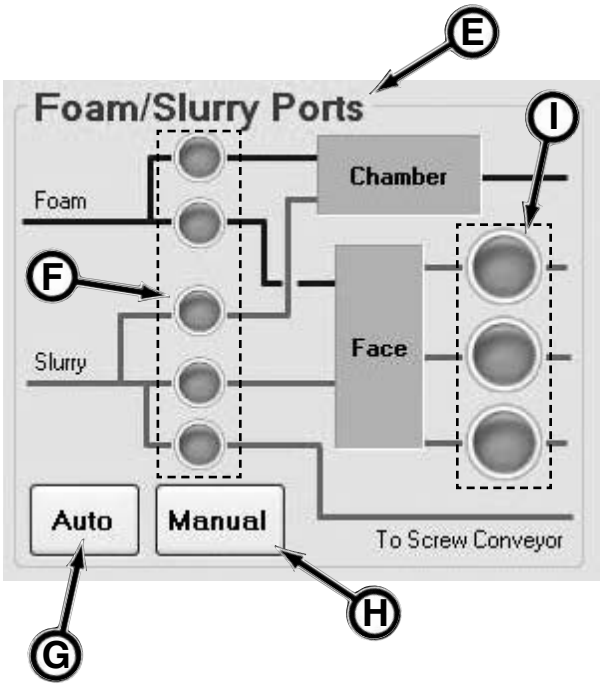
This control allows the operator to control individual ports on the cutterhead face (manual mode only). This control window is also a visual display of the foam/slurry pneumatic control valves that are open and closed on the cutterhead face and the plenum chamber.

The port indicator lights (F) will illuminate based on the selection made with the mixing chamber port switch, cutterhead port switch and the screw conveyor port switch (slurry only) on the control console.

AUTO: Click Auto (G) to cycle foam or slurry to all three cutterhead ports, one at a time for 30 seconds.

MANUAL: Click Manual (H) to select all or individual cutterhead port buttons (I) for foam or slurry. Slurry will pump continuously to the selected ports. The dark blue button will indicate the valve port is activated and open for foam or slurry.

NOTICE The cutterhead port buttons (I) are functional only in manual mode.



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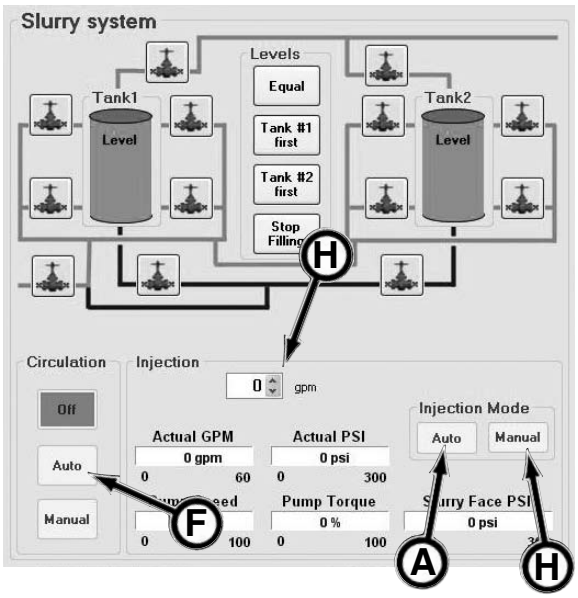
CONTROL SCREEN CONTROLS (continued)

Slurry System:
The slurry system consists of the injection, circulation and fill system controls and meters. The injection and circulation controls cannot be used at the same time. If one system is activated, the other system will automatically shut off. The fill system can be used during the operation of the injection or circulation system.



INJECTION CONTROLS
The injection controls regulate the amount of slurry mixture and controls the flow of slurry mixture to the EPB from the slurry tanks.

NOTICE During injection, there is no slurry circulation in the tanks.

Injection Mode:

AUTO (A): For display only. Auto is highlighted when the Slurry Pump switch (B) on the control console is turned to the AUTO position.

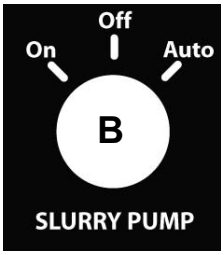
- Slurry will be pumped to the selected port(s) only while the cutterhead and screw conveyors are rotating once Slurry is selected on the Mixing Chamber Ports (C), Cutterhead Ports (D) and/or Screw Conveyor Ports (E) switches.

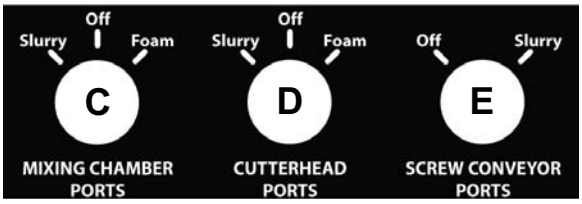
- Once the cutterhead and screw conveyors stop rotating, auto circulation cycles through each slurry tank. The Auto circulation button (F) will highlight when this occurs.

MANUAL (G): For display only. Manual is highlighted when the Slurry Pump switch (B) on the control console is turned to the ON position.

- Slurry will be pumped to the selected port(s) once Slurry is selected on the Mixing Chamber Ports (C), Cutterhead Ports (D) and/or Screw Conveyor Ports (E) switches. The slurry mixture will pump until the pump is shut off.

- Once the cutterhead and screw conveyors stop rotating, auto circulation does not occur. The operator must select a circulation mode.





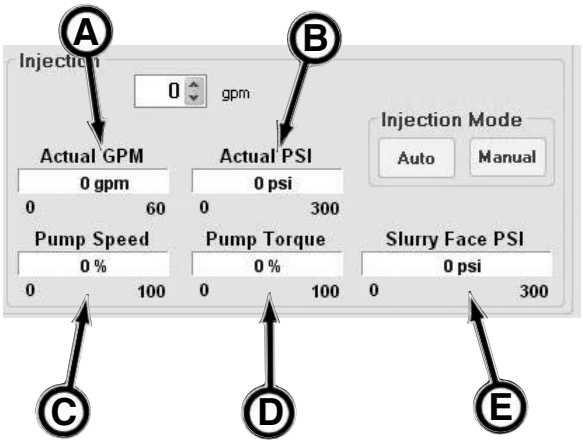
Port Switches

GPM (H): this field controls the flow of slurry solution. Default gpm is 30 gpm with a maximum of 60 gpm.

NOTICE Determining slurry gpm: Every inch of soil per minute is equivalent to approximately 45 gpm (for EPB 113.5). If advancing 4 inches per minute (4 x 45 = 180 gpm of soil) with 30% mixed volume of slurry, approximately 54 gpm of slurry is required (180 x 30% = 54 gpm).

(continued on next page)

CONTROL SCREEN CONTROLS (continued)
Slurry System - Injection Controls (continued)



ACTUAL GPM (A): this meter displays the slurry pump flow rate at the flowmeter on slurry car #11.

ACTUAL PSI (B): this meter displays the slurry pump pressure (injection mode) and mixing pressure (circulation mode). The maximum pressure is 75 psi.

PUMP SPEED (C): this meter displays the slurry pump speed in %.

PUMP TORQUE (D): this meter displays the slurry pump torque in %.

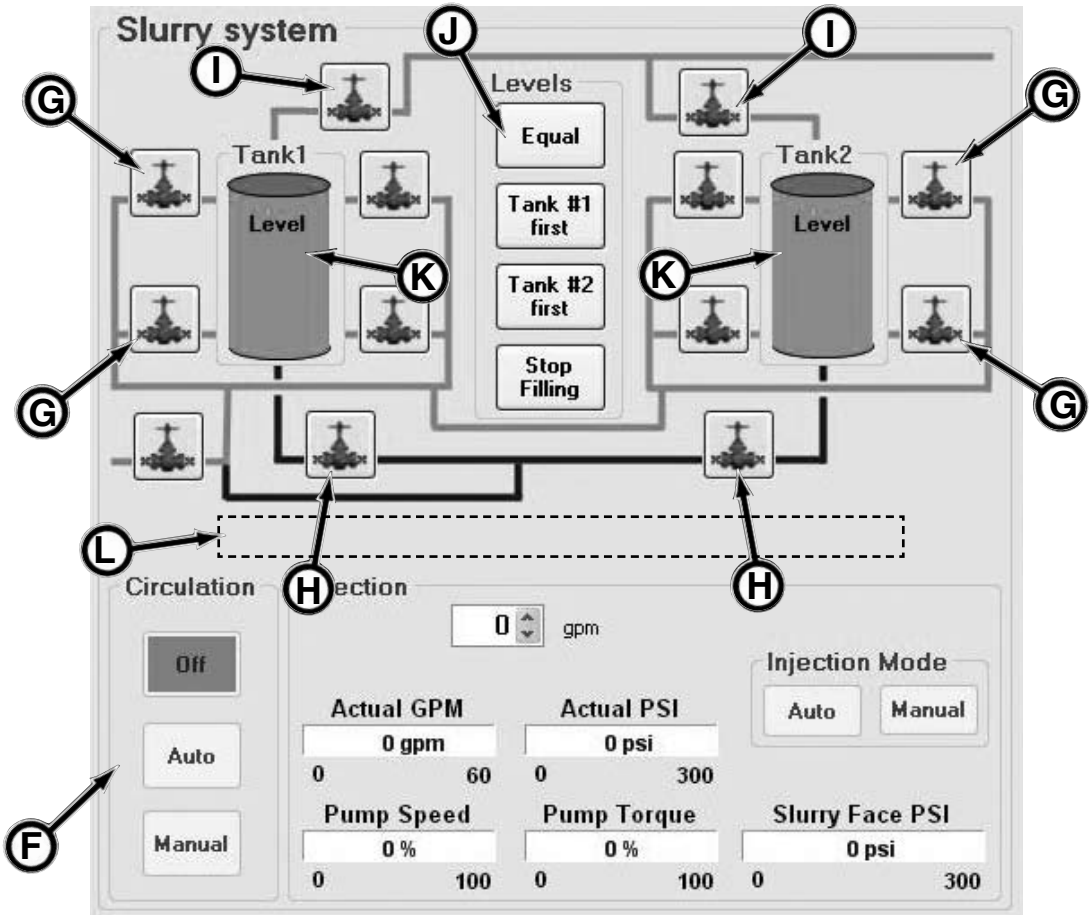
SLURRY FACE PSI (E): this meter displays the slurry face pressure at the EPB head. The maximum pressure is 75 psi.

CIRCULATION CONTROLS

The circulation controls on the slurry system regulates the slurry tank circulation on cars #11 and #12. The control screen controls consist of the Circulation Off, Auto, and Manual controls (F), the mixing port valves (four per tank) (G), the suction valves (one per tank) (H), fill valves (one per tank) (I), fill level controls (J), and the tank level indicator (K).

NOTICE During circulation, slurry injection is not allowed.

NOTICE If air pressure is low, the slurry system will shut down. If this occurs, the following warning message will appear in field area (L): “Air pressure is less than 90 psi. Slurry system will shut down.”



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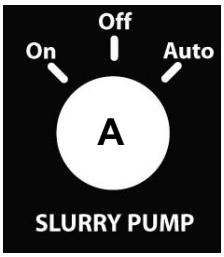
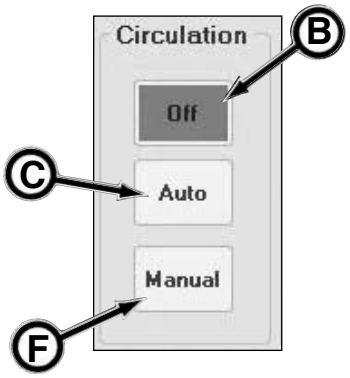
CONTROL SCREEN CONTROLS (continued)
Slurry System - Circulation Controls (continued)



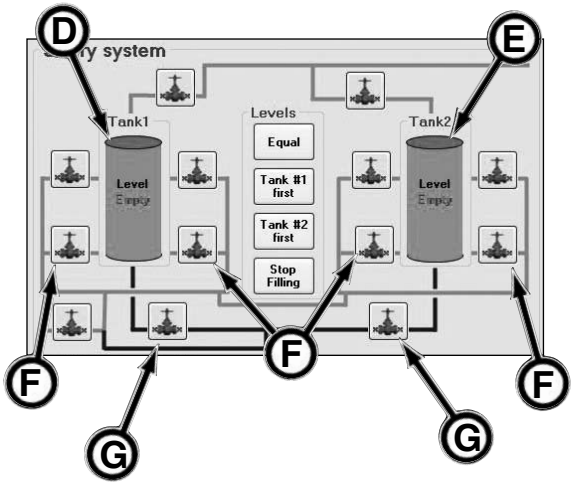
NOTICE The Slurry Pump control (A) on console must be to the ON or AUTO position for the circulation controls to function.

OFF (B): Shuts off circulation system.

AUTO (C): Slurry cycles through each tank mixing ports (four on each tank) and suction valve (one on each tank) for approximately 60 seconds each. This cycle will continue until it is shut off.



The circulation cycle in the AUTO mode is dependent on the tank level.
• If the level in both tank 1 (D) and 2 (E) are not empty, then the circulation alternates through the tanks by opening two mixing ports and suction valve on one tank and circulates through each mixing port for 60 seconds and then closes the valves. The cycle continues through the next tank until all mixing ports on both tanks have been cycled.
The total circulation cycle time is approximately 8 minutes. The circulation cycle continues until the operator shuts off the circulation.



• If the one tank is empty, the circulation will proceed through each of the four mixing ports and suction valve on the tank that is not empty for 60 seconds each. The total circulation cycle time is approximately 4 minutes. The circulation cycle continues until the operator shuts off the circulation.

MANUAL (F): Allows individual manual control of tank mixing ports and suction valves providing the tank is not empty. This control also allows the filling of one tank from the other tank. There is an interlock that prevents the operator from overfilling a tank.

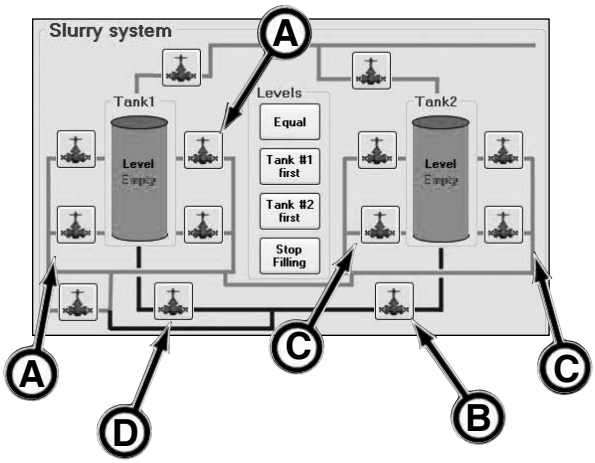
All suction valves and tank mixing port valves are closed, and the slurry pump is off in default mode.

Manual Circulation: Press one or more of the tank mixing ports (F) and suction valve(s) (G) to cycle slurry through the desired tank(s) providing the selected tank is not empty. The circulation continues until the operator shuts off the circulation.

NOTICE To energize the slurry pump during the manual circulation mode, a suction valve and a mixing port must be selected.

(continued on next page)

CONTROL SCREEN CONTROLS (continued)
Slurry System - Circulation Controls (continued)



Filling Tank 1 With Slurry From Tank 2 Using Circulation Mode: Open one or more mixing ports (A) on tank 1 and open suction valve (B) on tank 2. This will energize the slurry pump and pump slurry from tank 2 to tank 1 until tank 1 is full.

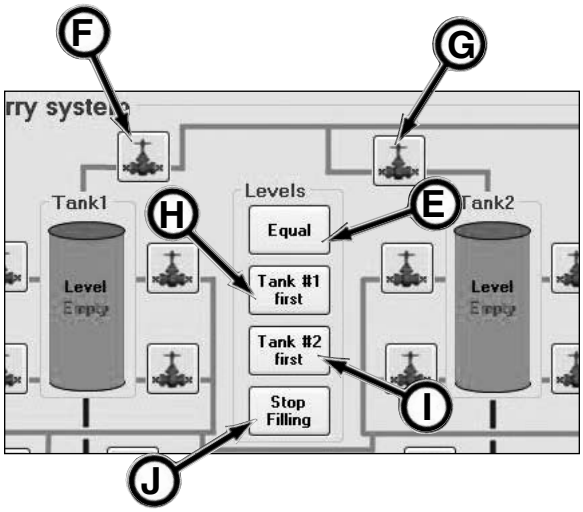
Filling Tank 2 With Slurry From Tank 1 Using Circulation Mode: Open one or more mixing ports (C) on tank 2 and open suction valve (D) on tank 1. This will energize the slurry pump and pump slurry from tank 1 to tank 2 until tank 2 is full.

NOTICE There is an interlock preventing an operator from overfilling a tank.

FILL LEVEL CONTROLS
The fill level controls on the slurry system are used to fill the tanks with inbound slurry from above ground.

NOTICE Once a fill button is pressed, the filling of the tanks will continue until the tanks are full or the stop filling button is pressed.

EQUAL (E): Tank 1 fill valve (F) and tank 2 fill valve (G) open and once filled, the tank valves close. If a tank is full, the appropriate tank fill valve will not open.

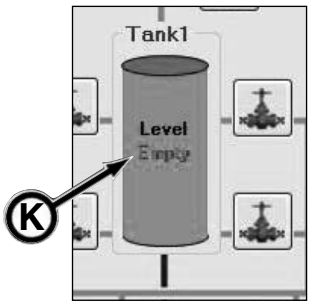


TANK #1 FIRST (H): Tank 1 fill valve opens (if tank is not full) and once filled, the fill valve closes. Then tank 2 fill valve opens and once filled, the fill valve closes.

TANK #2 FIRST (I): Tank 2 fill valve opens (if not full) and once filled, the fill valve closes. Then tank 1 fill valve opens and once filled, the fill valve closes.

STOP FILLING (J): Closes both tank fill valves if open.

TANK LEVEL SENSORS
There are four tank sensors for each tank; two full level redundant sensors and two empty level redundant sensors.
The control screen has a tank indicator (K) displaying a FULL, OK, or EMPTY reading on each tank depending on the slurry level. The approximate tank levels are:

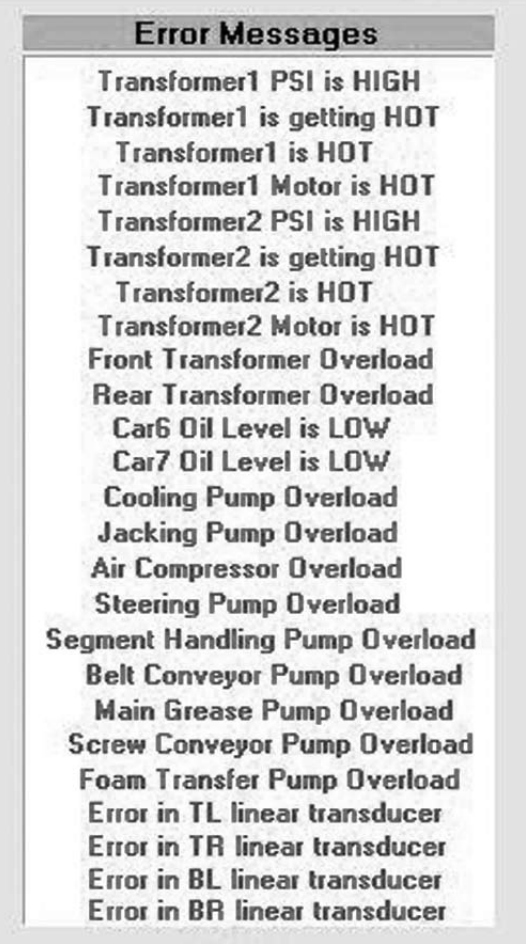


FULL - 250 gal. (946 L)
OK - level between full and empty
EMPTY - 30 gal. (114 L)

ERROR MESSAGES

The Error Messages monitor displays the messages as they occur. The messages are a visual indicator to make the operator aware of a potential problem.

It is recommended that the operator shut down the operation and resolve the problem before proceeding.



PRESSURE FILTER INDICATORS

To prevent under or over servicing of the hydraulic filter elements, a filter indicator has been installed on the Front Hydraulic #6 and Rear Hydraulic #7 cars.

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

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

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

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

Filter Indicator On Front Hydraulic Car #6

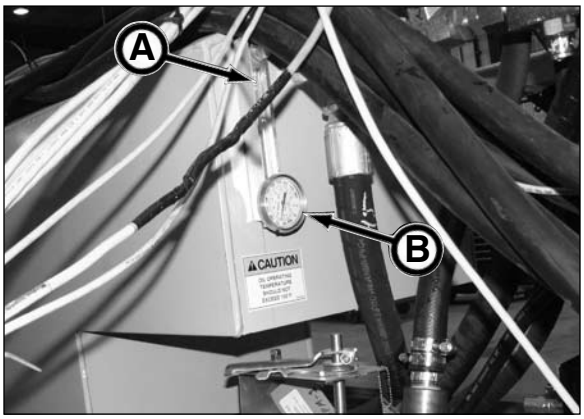
Filter Indicator On Rear Hydraulic Car #7

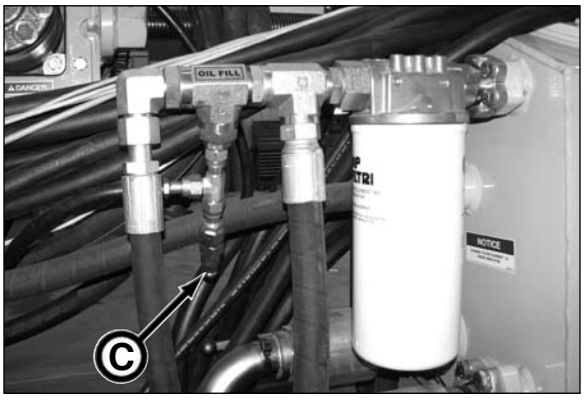
FRONT HYDRAULIC CAR #6 RESERVOIR

The hydraulic reservoir on car #6 provides hydraulic oil for the: screw conveyor pump, main bearing grease pump, reservoir cooling pump, and belt conveyor pump.

The reservoir includes an oil level sight gauge (A) and temperature gauge (B).

The hydraulic oil temperature should not exceed 150° F (66°C).





Refill reservoir, if needed, as follows:
1. Clean oil fill connection end (C).

2. Attach quick coupler hose to connection with other end of hose in oil supply container with Condat® D 68 hydraulic oil or equivalent.

NOTICE Do not mix oil manufacturers.

3. Pump oil until fluid reaches high mark on sight gauge.

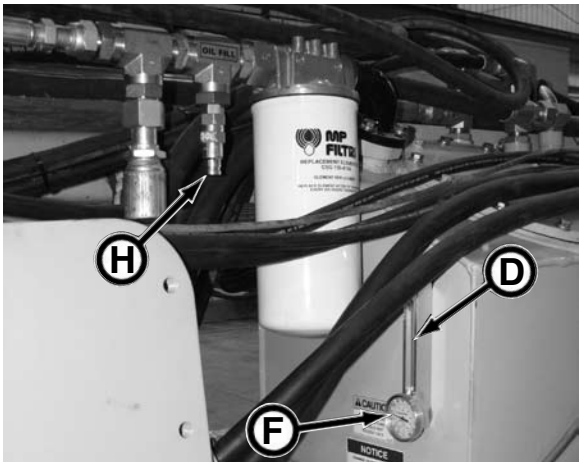
4. Remove oil supply quick coupler hose.

REAR HYDRAULIC CAR #7 RESERVOIR

The hydraulic reservoir on car #6 provides hydraulic oil for the: jacking/erector pump, steering pump, copy cutter pump, tail grease pump, reservoir cooling pump, air compressor pump and segment handling pump.

There are two reservoirs on car #7, the main and auxiliary reservoirs. Both reservoirs include an oil level sight gauge (D and E) and temperature gauge (F and G). The hydraulic oil temperature should not exceed 150° F (66°C).

⚠WARNING **Check oil level and refill ONLY when jacking cylinders are fully retracted.** Failure to do so could result in serious injury and machine damage from a ruptured hydraulic reservoir.



Main Reservoir on Rear Hydraulic Car #7

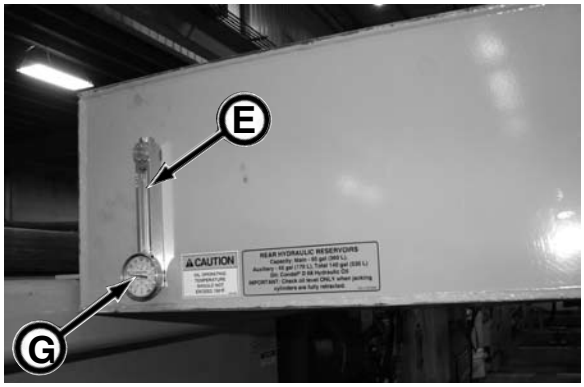
Refill reservoir, if needed, as follows:
1. Clean oil fill connection end (H).

2. Attach quick coupler hose to connection with other end of hose in oil supply container with Condat® D 68 hydraulic oil or equivalent.

NOTICE Do not mix oil manufacturers.

3. Pump oil until fluid reaches high mark on the auxiliary (top reservoir) sight gauge (E) reservoir.

4. Remove oil supply quick coupler hose.



Auxiliary Reservoir (top) on Rear Hydraulic Car #7

NOTES

Pre-Start Inspection

⚠WARNING Do not operate this equipment until you read, study, and understand this manual and your spoil removal system 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 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 buttons for proper operation at the start of each shift.
	8. Test air monitoring and ventilation detectors for proper operation.
	9. Thoroughly inspect all equipment for damage. Repair or replace before operating.
	10. Be sure all covers and guards are in place before operation.
	11. Check for loose or missing hardware. Replace damaged or missing hardware.
	12. Check for worn, loose, or damaged wire connections. Repair or replace wiring.
	13. Tighten loose clamps or fittings.
	14. Check electrical 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. Check oil level in hydraulic oil reservoirs. Add as needed.
	21. Lubricate screw conveyor gates. Refer to Periodic Maintenance section.
	22. Perform pre-start inspection on your spoils removal system. Refer to your system’s operation manual.
	23. Check that all switches are in the Off, Hold, and Stop position, and that all speed controls are at 0 (Min).
	24. Check power container for proper operation.

NOTES

Operation

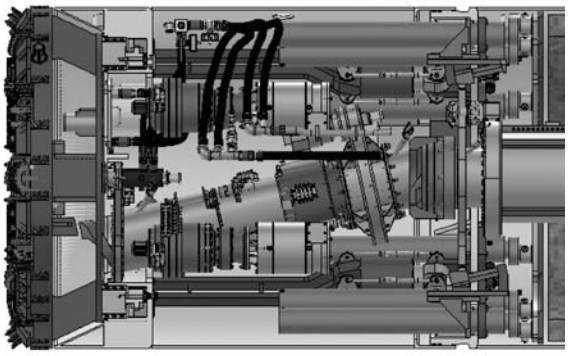
OPERATING GUIDELINES

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

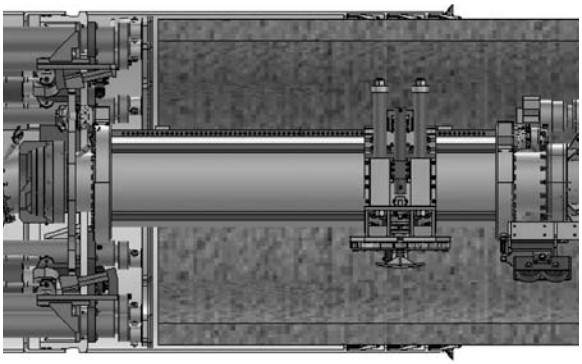
1. Before operating, read and understand the Safety, Pre-Start Inspection, Operation and Maintenance sections.
2. Do not operate this equipment while under the influence of alcohol, drugs, or medication.
3. Follow all Federal, State, and Local safety regulations and procedures.
4. Be sure OSHA prescribed safety protective equipment is being worn by all personnel.
5. Be sure the area is safe for operation. Keep worksite clean and orderly.
6. NEVER operate equipment if it has been engulfed with water. Contact your Akkerman Product Support representative for proper procedures on how to restore equipment for operation.
7. Have 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 power container (including the remote E-stop), operator station control console on car #2, and E-Stop on blower car #13.
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 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. Operate the #1 screw conveyor speed to retain the earth pressure balance.

SYSTEM OVERVIEW

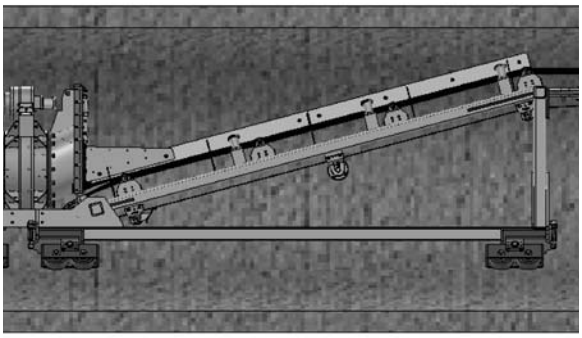
Earth Pressure Balance Machine (EPBM)
The purpose of the EPBM is to excavate material in a controlled manner by balancing the machine face pressure with the earth (soil) pressure. This control of material and pressure balance minimizes ground settlement and heaving. During excavation, a foam and/or slurry mixture is pumped 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 spoil removal system.



Segment Erector & Jacking Can
The segment erector places the concrete segments within the EPB jacking can to build a complete ring while the EPB jacking cylinders stabilize the segments during installation.

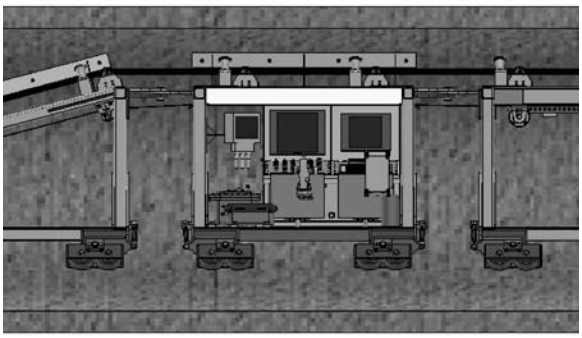


Car #1 Incline Car
This car transports spoils from the screw conveyor onto the belt conveyor to the muck cars. This car also contains the manual screw conveyor controls, the segment erector controls, and the rear gate accumulator controls.

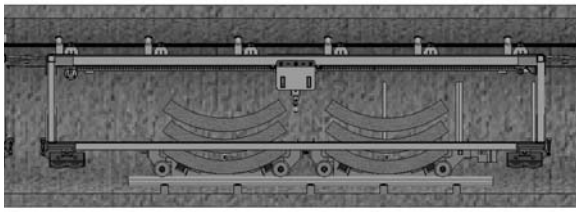


Car #2 Operator Station
This car contains the information and control system which monitors all inputs such as targeting data, pressures, positions, speeds, torques, and flows, and reports them to the operator.

This car also contains the pressurization system controls.

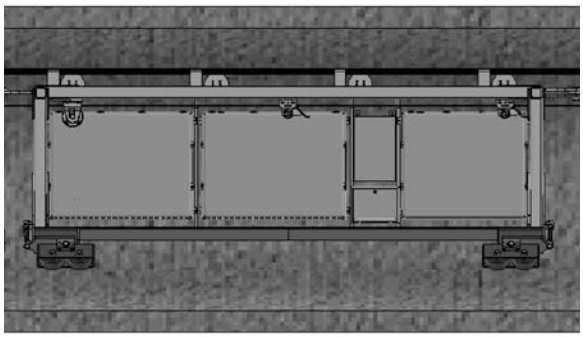


Car #3 Segment Handling
The lift carriage moves and unloads the concrete segments from the segment handling cars to the segment conveyor dollies for transport to the erector zone.

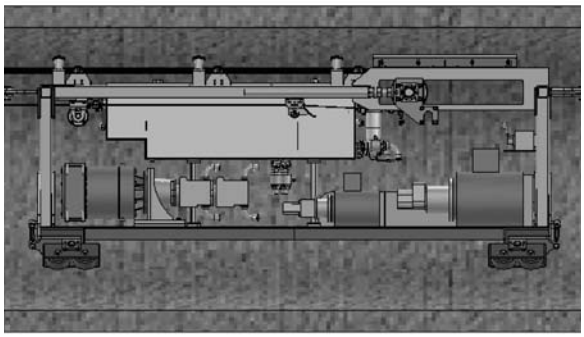


Car #4 VFD
This car contains the main cutter head drive control VFDs (Variable Frequency Drive) and VFD cooling system (cooling pump and heat exchanger).
This car also contains the slurry drive VFD which controls the slurry motor/pump on front slurry car #11.

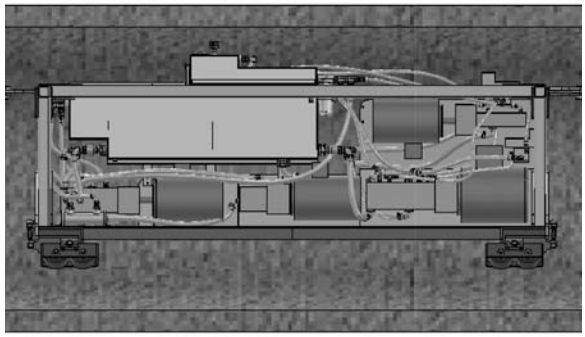
Car #5 Switch Gear
This car contains the electrical contactors and motor starters. The transformer cars provide power to the 480 VAC electrical boxes. The 480V to 240V/120V transformer in the car provides power to the 240VAC electrical box.



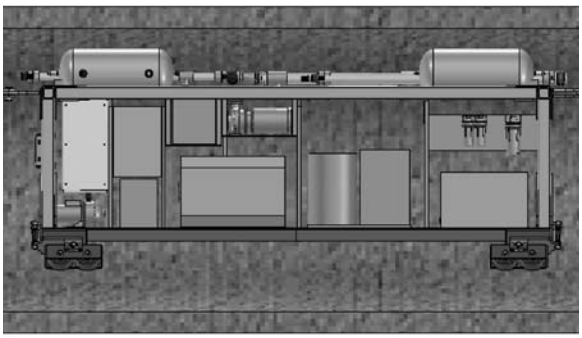
Car #6 Front Hydraulic
This car contains the hydraulics for the belt conveyor, screw conveyor, main drive grease and oil cooling system.



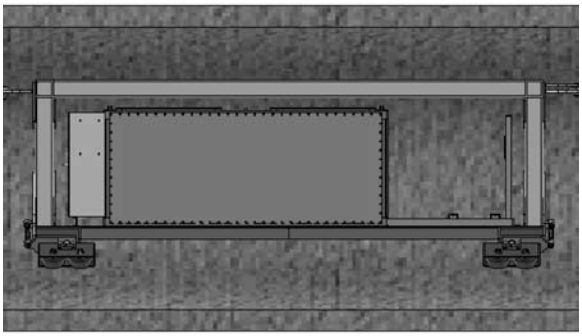
Car #7 Rear Hydraulic
This car contains the hydraulics for the jacking, steering, segment handling, segment erector, copy cutter, air compressor and oil cooling system.



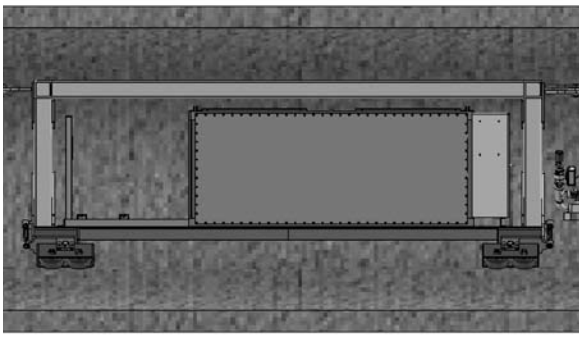
Car #8 Foam
This car contains the foam generator which transforms the foaming agent into a foam mixture and is pumped to the front of the EPBM. The foam is then mixed with the spoils to stabilize the face pressure. This car also contains the foam and pneumatic air tanks, 480V to 400V transformer for foam system power, cooling return booster pump, and cooling system for car components.



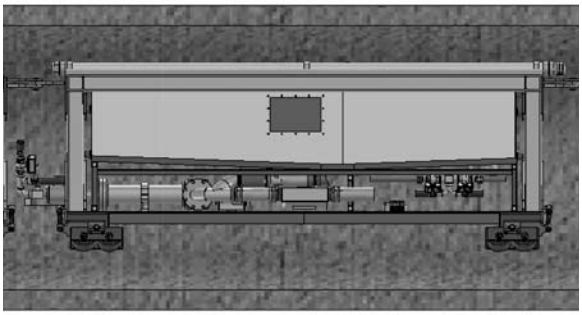
Car #9 Front Transformer
This car contains a powered transformer. The power is reduced from 4160V to 480V for the 480VAC Box 1 electrical box in switch gear car #5 for the jacking, segment erector, air compressor, steering, copy cutter and segment handling electrical contactors and starting motors.



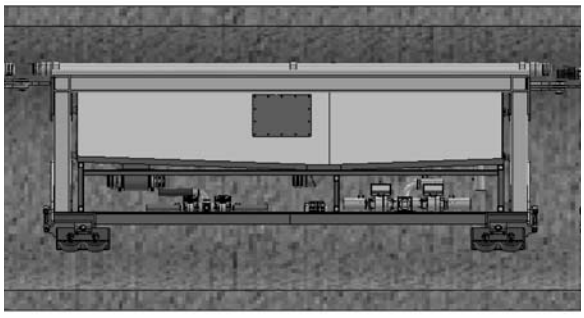
Car #10 Rear Transformer
This car contains a powered transformer. The power is reduced from 4160V to 480V for the 480VAC Box 2 electrical box in switch gear car #5 for the belt conveyor, cooling, grease, screw conveyor, foam pump, and foam transfer pump electrical contactors and starting motors.



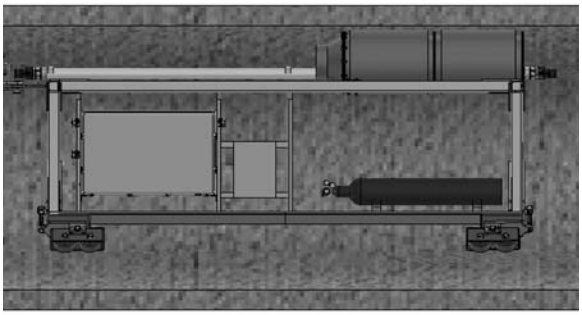
Car #11 Front Slurry
This car contains a 250 gal. slurry tank with flowmeter, slurry pump and 10 HP slurry motor. The slurry mixture in the tank is pumped to the front of the EPBM and is mixed with the spoils to stabilize the face pressure and/or to help reduce cutting torque.



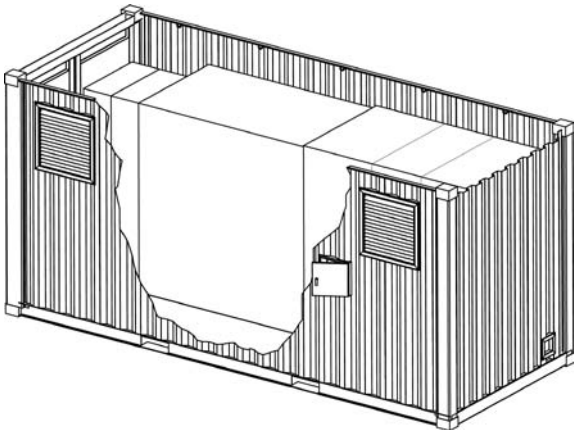
Car #12 Rear Slurry
This car contains a 250 gal. slurry tank with front and rear tank feed valves. The slurry mixture in the tank is pumped to the front of the EPBM and is mixed with the spoils to stabilize the face pressure and/or to help reduce cutting torque.



Car #13 Blower
This car contains the controls and fans for the tunnel ventilation system. It also contains the 4160V main power junction box, the compressed nitrogen tank for the pressurization system, Emergency Stop control, and tunnel lights control.



Power Container
The power container is the power distribution center for the 480 volt incoming power, 480V to 4160V transformer, and 4160 volt tunnel power. This container also includes two Emergency Stop controls; one is on the power container and one is a remote E-Stop.



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. Skid steer 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.

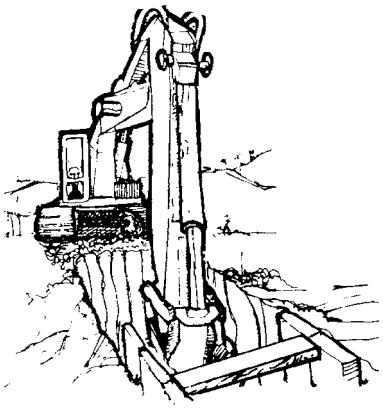
Equipment:

- EPBM
- Support Cars
- Screw Conveyors
- Power Container
- Concrete Segments
- Storage Container With Tools
- Crane
- Fork Lift
- Portable Welders
- Small Generator
- Generator Or Power Source
- Lubrication Pump
- Spoil Removal Truck
- Portable Toilet

Other site considerations:

- Spoil Removal Truck Access
- Launch Shaft Size
- Walkways
- Fresh Water Supply
- Hose Interconnections
- Segment Staging Area
- Electrical Interconnections
- 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, shaft layout design, and survey are complete, excavate the launch and reception shafts. Be sure the shafts will be well drained and use proper shoring or bracing in accordance with your local, state, and federal regulations.

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

4. Place steel plates on the shaft floor for supporting the base of the skid (rails), 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.

⚠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 skid 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 hydraulic hoses and electrical cables. Cover sharp corners to prevent damage to the cables and hoses.

9. Place the power container on a firm, level surface a safe distance from the launch shaft.

10. 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.

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

12. Test the EPBM jacking can, cycle the cylinders several times to purge air from the lines and check for leaks.

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, cars, and power source.

1. Connect power source 480V power cable to Power Container including ground (refer to Connect Power Leads in this section).

⚠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.

2. Connect 4160V power cable from Power Container to Blower Car #13.

3. Connect 4160V power cables (two cables) from Blower Car #13 to Front Transformer Car #9 and Rear Transformer Car #10.

4. Connect 480V power cable from Front Transformer Car #9 to 480V Box 1 on Switch Gear Car #5.

5. Connect 480V power cable from Rear Transformer Car #10 to 480V Box 2 on Switch Gear Car #5.

6. Connect EPB head power and all electrical devices to Switch Gear Car #5. Refer to the electrical schematics in section 11, Troubleshooting.

CONNECTING POWER LEADS

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

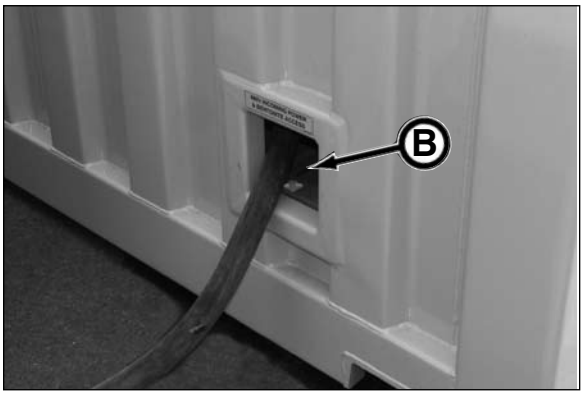
Failure to lockout power before connecting power leads or servicing will cause severe personal injury or death.

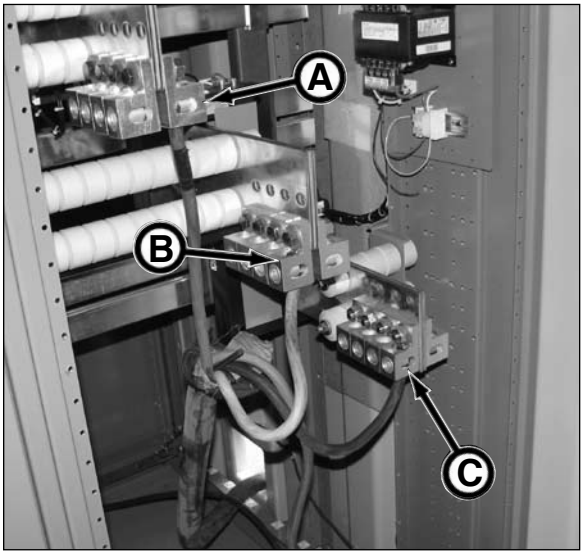
LOCKOUT TAGOUT main power supply before connecting power leads or servicing. ONLY a qualified and trained technician can operate this equipment. Electrical repairs must be performed only by a certified electrician.

NOTICE ONLY a certified electrician must connect the generator/power source power leads to the 480V power connections.

1. Open panels to gain access to the 480V terminal lugs.

2. Route generator/power source 480V power cord through container access (B).



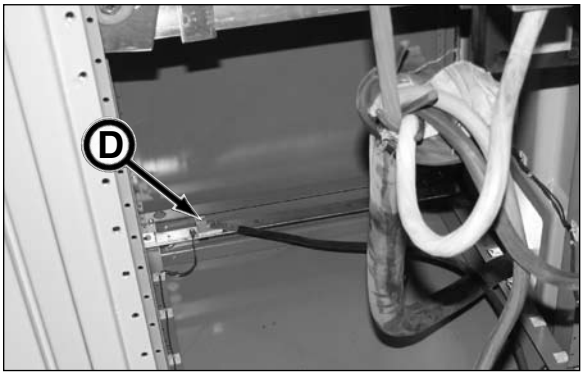


3. Secure power cord wires to appropriate 480V terminal lugs as follows:
   - Red wire to terminal (A)
   - White wire to terminal (B)
   - Black wire to terminal (C)
   - Green wire to ground terminal (D)

4. Replace panels in power container.

5. Do not power up system until you have performed the following procedures in this section:

- Install Hydraulic, Grease, Water & Air Connections
- Checkout Equipment Prior To Start-Up
- Prepare Hydraulic System For Start-Up
- System Start-Up



INSTALL HYDRAULIC, GREASE, WATER & AIR CONNECTIONS

⚠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.

1. Install ALL hydraulic hoses to components. Be sure all hydraulic supply, return, and load sense lines are connected to the proper hydraulic component. Refer to the Hydraulic Schematics in section 11, Troubleshooting.

Test all circuits independently for control and speed BEFORE operating entire system.

Be sure to keep hydraulic hoses separated from power cables during operation. The hoses will jump during operation and could damage air, grease, and/or water lines.

2. Install ALL grease lines from main lubrication grease barrel and tail seal grease barrel.

3. Install ALL air lines to each car for foam, slurry and pneumatic control systems.

4. Install ALL water line connections to each car for foam, slurry and cooling systems.

CHECKOUT EQUIPMENT PRIOR TO START-UP

1. Check the oil level in Front Hydraulic car #6 and Rear Hydraulic car #7 hydraulic reservoirs. Add oil if necessary.

⚠WARNING On Rear Hydraulic car #7, check oil level and refill ONLY when jacking cylinders are fully retracted. Failure to do so could result in serious injury and machine damage from a ruptured hydraulic reservoir.

2. Lubricate belt conveyor drive and idler end bearings.

3. Be sure ALL hydraulic hoses and electrical lines are properly installed.

4. Be sure ALL hydraulic pump supply shut off valves are open. Tie strap lever to valve to prevent accidental closure during operation.

5. Check air compressor oil level. Add oil if necessary.

6. Connect clean water supply hoses with 76.4 GPM @ 50 psi (minimum) for cooling and foam requirements.

7. Lubricate the steering cylinders, cutterhead swivel, segment erector and rear gate.

8. Check VFD coolant level on VFD car #4. Add coolant if necessary.

9. Check the main grease lubrication system (located between Switch Gear car #5 and Front Hydraulic Car #6) and tail seal grease (located on Incline car #1) barrels.

10. Be sure ventilation line is properly hooked up to ventilation system.

11. Check pressurization system compressed nitrogen tank pressure. Replace compressed nitrogen tank if necessary.

12. Check the rear gate accumulator pressure gauge. If gauge does not display 2,000 psi, the accumulator must be charged. Refer to Charging Rear Gate Accumulator in this section.

PREPARE HYDRAULIC SYSTEM FOR START-UP

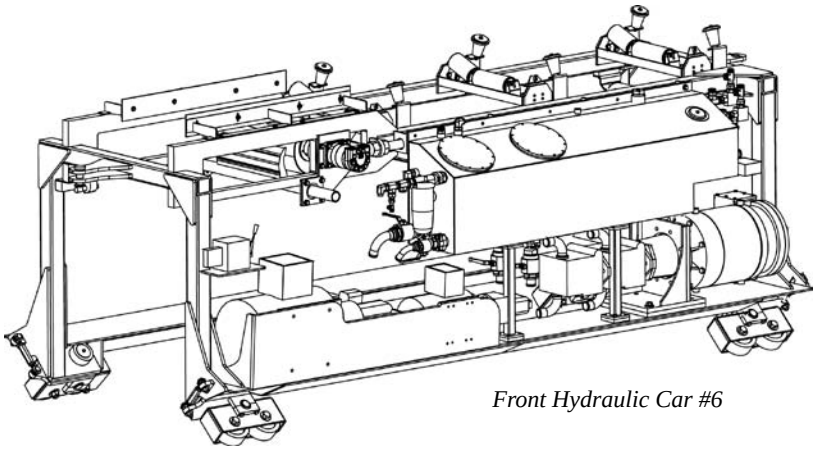
1. Connect hydraulic system. Refer to Install Hydraulic, Grease, Water & Air Connections in this section.

2. Check to be sure pump supply shut off valves are open and tie strapped to prevent accidental closure during operation.

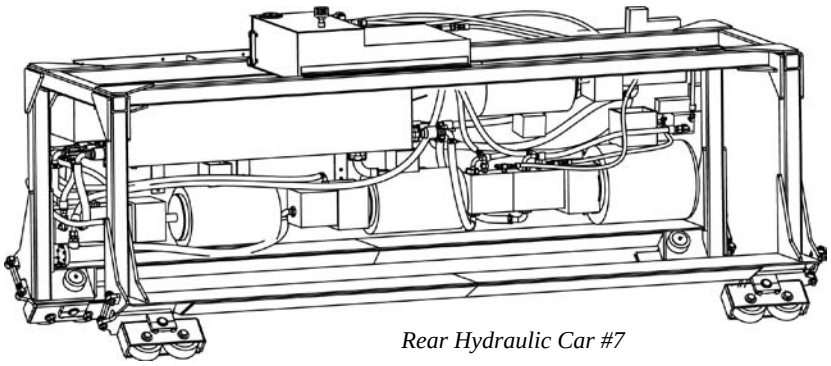
3. Check hydraulic oil level in Front Hydraulic car #6 and Rear Hydraulic car #7. Fill if needed. Check the reservoir levels often during operation. An error message (Car6 Oil Level is LOW, Car7 Oil Level is LOW) on the control screen will display if the oil level in one of the reservoirs is low.

⚠WARNING On rear hydraulic car #7, check oil level and refill ONLY when jacking cylinders are fully retracted. Failure to do so could result in serious injury and machine damage from a ruptured hydraulic reservoir.

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

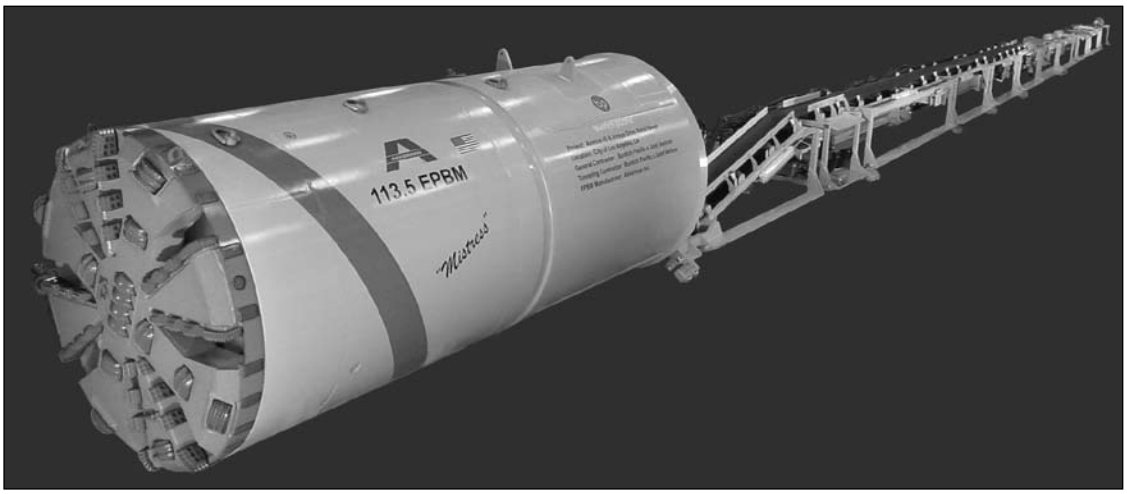


Front Hydraulic Car #6



Rear Hydraulic Car #7

SYSTEM START-UP



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

1. Refer to Install Hydraulic, Grease, Water & Air Connections in this section.

2. Connect all electrical component connections to the EPBM, Power Container, cars and power source. Refer to Install Electrical Connections in this section.

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

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

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

6. 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 should be closed and locked during operation to prevent unauthorized personnel from entering power container.

NOTICE Before the EPB systems program (EPB2008) is booted up or cycled, the console switches MUST be turned to the OFF position for the control program to function properly.

7. Perform daily electrical system startup. Refer to Daily Electrical System Startup in this section.

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

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

10. Test all Emergency Stop buttons for proper operation.

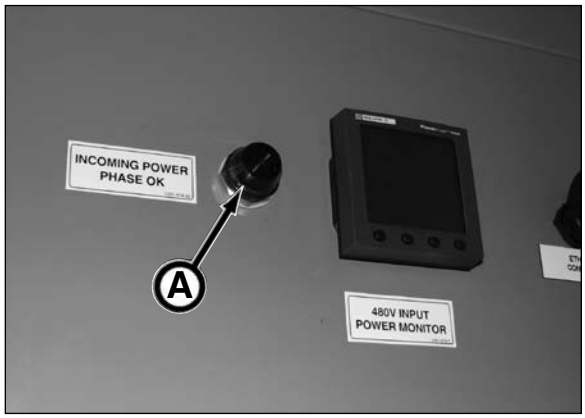
11. Refer to Check Hydraulics After Start-Up in this section.

DAILY ELECTRICAL SYSTEM START-UP

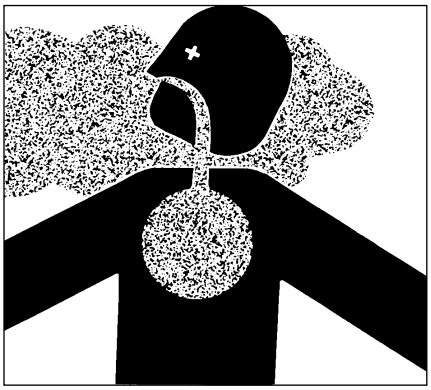
⚠DANGER Hazardous voltage.
This machine is powered by high voltage electricity.

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.



1. With power source connected to the 480V terminal connections in the power container (refer to Connecting Power Leads in this section), turn on power source and check phase relay (A). If phase power is incorrect, a certified electrician must lock out all power and then reverse the two generator power leads.



2. Check the gas level in the shaft and tunnel. The technician MUST be equipped with a personal gas detector to check the gas levels. NEVER enter a tunnel without checking the gas levels with a gas detector. Gases MUST be removed before entering shaft or tunnel.

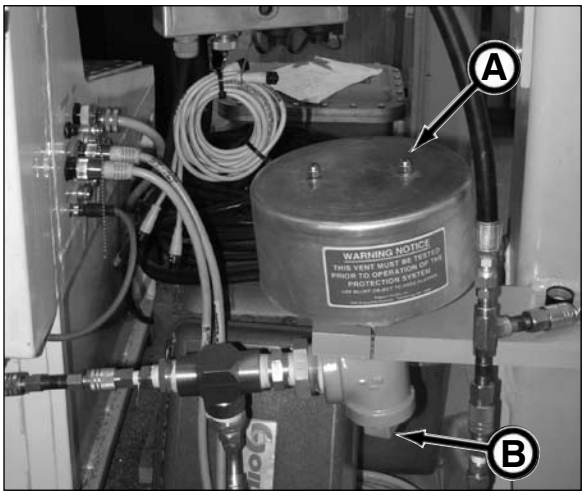
3. Check that ALL E-Stop buttons (power container, remote E-Stop from power container [not shown], blower car #13, and operator station car #2) are reset to the pulled out position.

(continued on next page)

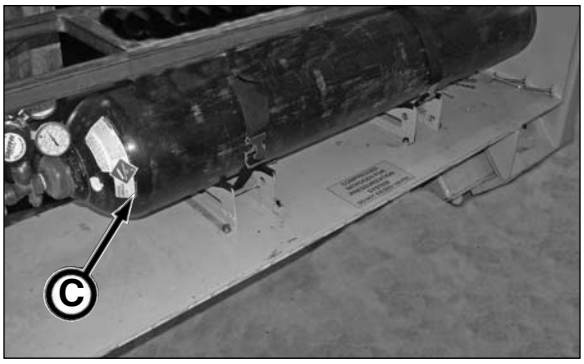
4. Be sure electrical boxes on all cars are sealed properly to minimize seal leakage.

NOTICE The only time the electrical boxes can be opened or closed are in known non-gaseous environments.

5. Test the pressurization system enclosure vent (A) for proper operation. Remove pipe plug (B) from vent and gently prod the vent flapper open with a small pointed object (ex: eraser end of a pencil) ensuring that the vent valve works freely. Replace plug.

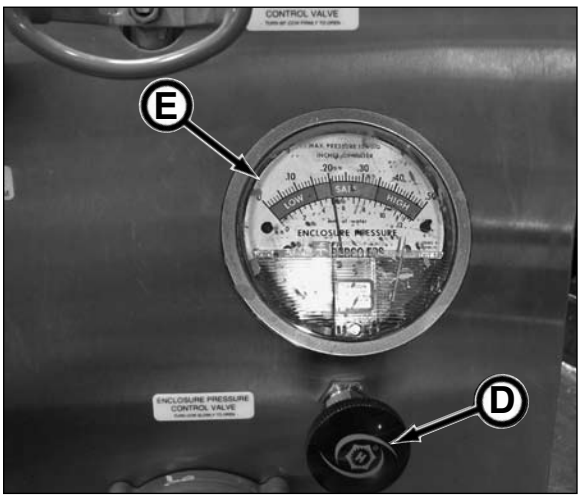


6. Turn on nitrogen tank (C) pressure valve on Blower Car #13 and then open regulator to 80 - 120 psi.



NOTICE After opening tank pressure, observe the amount of pressure to determine the life of the tank. Keep in mind that once there is not enough tank pressure, the electrical system will shut down.

7. On the pressurization system, slowly rotate the enclosure pressure control valve (D) counterclockwise (CCW) to set the enclosure pressure gauge (E) in the green “SAFE” pressure zone.



NOTICE The term “SAFE” zone for the pressurization system is between .15 and .35 inches of water column pressure.

8. Check that the Enclosure Pressure gauge maintains the “SAFE” pressure zone.

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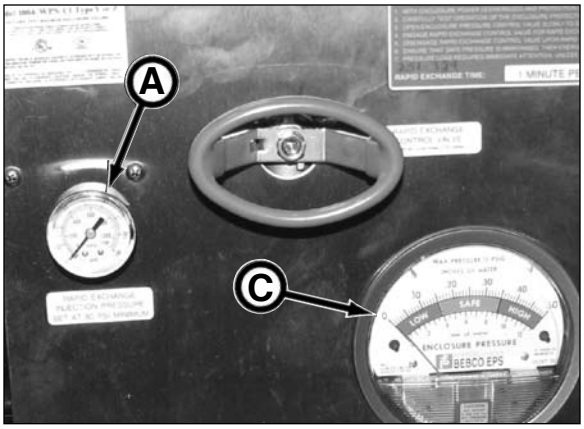
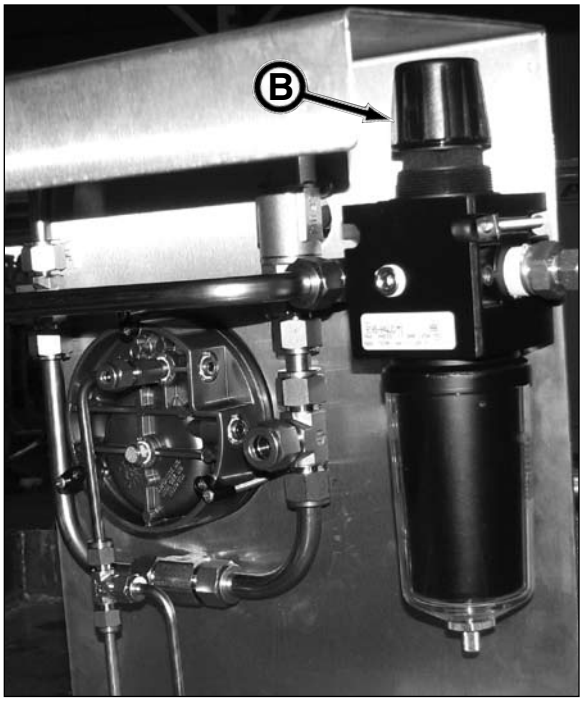
9. If the rapid exchange pressure gauge (A) is not registering 80 - 120 psi, confirm that the nitrogen tank regulator is registering 80 - 120 psi, then if necessary, open the regulator (B) on the backside of the pressurization system to achieve this pressure.

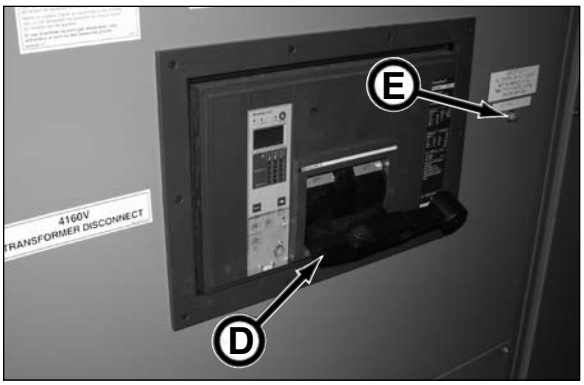


NOTICE If the enclosure pressure gauge (C) lowers to the LOW zone, the electrical system will shut down.



10. With incoming power connected and the green Incoming Power Phase OK light is illuminated, flip the 4160V Transformer Disconnect (D) to the ON position to provide power to the 4160V transformer.

    Once this disconnect is ON, the “Control On” light (E) must be on. If not, the control system must be serviced.



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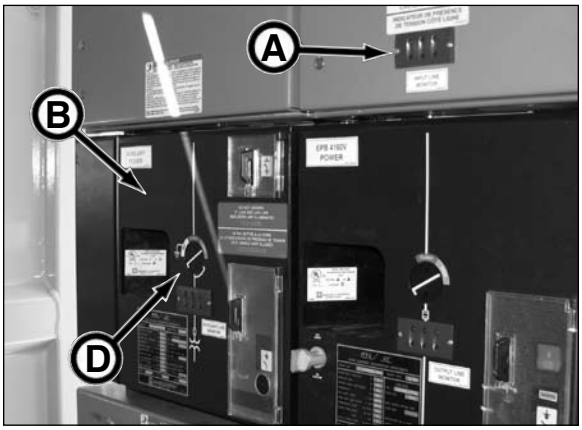
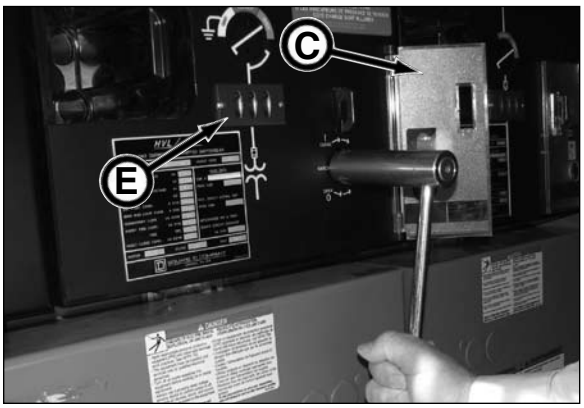


11. When there is power to the 4160V system (4160V Transformer Disconnect is ON) the Input Line Monitor (A) will illuminate indicating there is power to the 4160V input line.

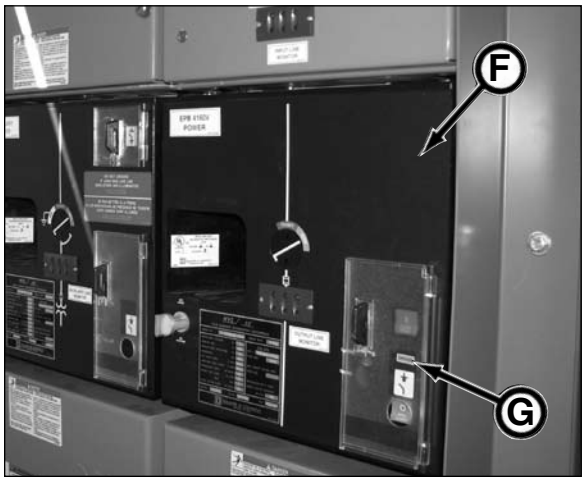
12. On the 4160V Auxiliary Power module (B), open door (C) to auxiliary disconnect.

NOTICE If the auxiliary power circuit is already closed [shown on circuit indicator (D)], skip step 13 and proceed to step 14.

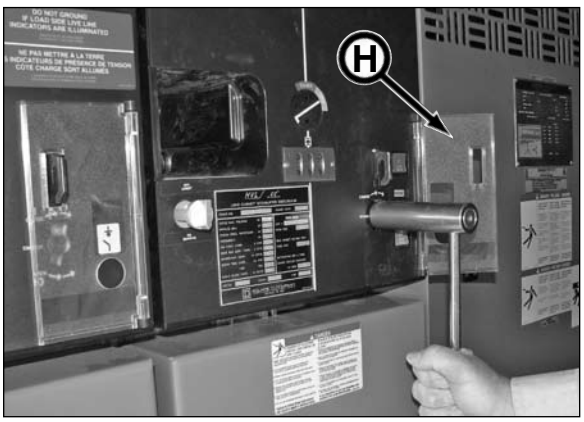


13. Insert crank into disconnect and turn the crank until the circuit is CLOSED.

14. Once the circuit is CLOSED, the lights on the Auxiliary Line Monitor (E) will illuminate indicating that there is power to the 4160V auxiliary power module. Close auxiliary disconnect door.



15. On the EPB 4160V Power module (F), check to see if spring icon (G) is elongated (yellow/black) or compressed (white/red).



If spring icon is elongated, the disconnect must be charged. Open door (H) and charge disconnect by inserting crank into disconnect and turning crank until the compressed spring icon is visible. Continue to step 16.

If spring is compressed, continue to step 16.

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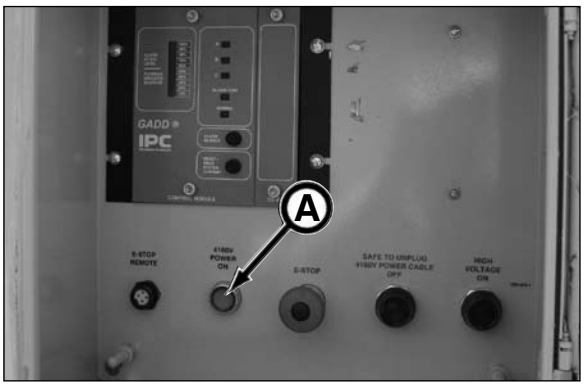
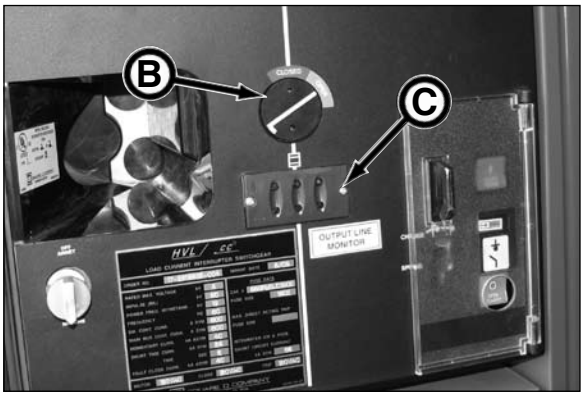
16. On the power container, press the 4160V Power On button (A). This will automatically close the contacts [shown on circuit indicator (B)] and power up the 4160V system.

17. The Output Line Monitor (C) will illuminate once the 4160V power is on.





18. Once 4160V power is on to the tunnel, the 240V box will energize and power up the gas detector. The gas detector will then monitor the gas levels. If gas levels are within the acceptable limits, power will then be available to the computer console in the operator station car #2 (the computer will automatically boot up), tunnel lights, and the 480V box. Power is available to the guidance system.

    If the gas detector senses excessive gas levels, all tunnel power will be shut down.

CHECK HYDRAULICS AFTER START-UP

⚠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.

1. Check return filter indicators on the Front Hydraulic #6 and Rear Hydraulic #7 cars. Once operating temperature reaches at least 100°F (38°C) and the filter indicator needle is in the red CHANGE zone, replace filter.

2. Check the oil level in Front Hydraulic car #6 and Rear Hydraulic car #7 hydraulic reservoirs. Add oil if necessary.

⚠WARNING On Rear Hydraulic car #7, check oil level and refill ONLY when jacking cylinders are fully retracted. Failure to do so could result in serious injury and machine damage from a ruptured hydraulic reservoir.

3. Check hydraulic components and hoses for leaks. Repair or replace as needed.

DAILY SHUTDOWN

1. At control console, turn all controls to OFF position.

2. On computer control screen, press all component control buttons to OFF.

3. Record target settings on target screen. The position and angle settings will help determine if the laser is bumped.

4. On Blower car 13, turn light switch to OFF (lights dim and illuminate until battery ballast power is drained) or TEMP (lighting at full power for 30 minutes then the lights will dim and illuminate until battery ballast power is drained).

5. Once all personnel have left the tunnel, proceed to the Power Container and push in E-Stop.

6. Shut down incoming 480V supply power and perform lockout/tagout procedure.

7. Shut down generator and perform lockout/tagout procedure.

ELECTRICAL SYSTEM MAINTENANCE SHUTDOWN FOR THE 110V/240V/480V SYSTEMS (EPB HEAD, CARS 1 THROUGH 8, 11 AND 12)

IMPORTANT: If performing maintenance on the 4160V system, refer to Electrical System Maintenance Shutdown For The 4160V System (Power Container, Cars 9, 10 and 13).

⚠DANGER Failure to lockout/tagout power before servicing will cause severe injury or death from electrocution or contact with moving parts.

BEFORE servicing the 110V/240V/480V electrical components of the EPB, perform the following procedure:

1. Push E-Stop button and lockout/tagout ALL power.
2. Remove fuses from electrical device(s) to prevent accidental start up. Person performing maintenance must keep fuses in his possession until maintenance is complete.
3. Close door to electrical box if it must be re-energized.
4. Turn on main power (if needed) for lights, etc.
5. Perform maintenance to electrical device.
6. Once maintenance/service is complete, shut down, lockout/tagout ALL power.
7. Reinstall device fuses.
8. Close and secure electrical box cover.
9. Turn on main power.

ELECTRICAL SYSTEM MAINTENANCE SHUTDOWN FOR THE 4160V SYSTEM (POWER CONTAINER, CARS 9, 10 AND 13)

IMPORTANT: If performing maintenance on the 110V, 240V, or 480V systems, refer to Electrical System Maintenance Shutdown For The 110V/240V/480V Systems (EPB Head, Cars 1 through 8, 11 and 12).

⚠DANGER Failure to lockout/tagout power before servicing will cause severe injury or death from electrocution or contact with moving parts.

BEFORE servicing the 4160V electrical components of the EPB, perform the following procedure:

1. Push E-Stop button.

2. Once the E-Stop button is pushed in, the EPB 4160V Power Disconnect Output Line will automatically open (closed is power). The lights on the Output Line Monitor will go off.

3. On Auxiliary Power, use crank to move auxiliary line to open position. The lights in the Auxiliary Line Monitor will go off.

4. Open auxiliary grounding switch cover and use crank in disconnect to turn it to ground. This will ground the power line. The Auxiliary Line Monitor will move to ground symbol.

NOTICE The Safe To Unplug 4160V Power Cable OFF (green light) indicator will illuminate.

5. Turn the 480V Main Disconnect to OFF and lockout/tagout ALL power.

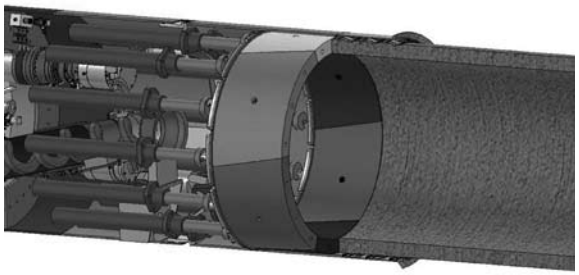
6. Perform maintenance.

7. Once maintenance is complete, perform the following steps:

7a. Turn on power to Power Container.
7b. Move Auxiliary Ground switch to open position.
7c. Move Auxiliary Line to close position.
7d. Pull out E-Stop.
7e. Press the 4160V Power ON button on Power Container.

NOTICE The High Voltage light should illuminate. If the light does not illuminate, contact a certified electrician to resolve the problem with the 4160V electrical system.

ADVANCING THE EPBM



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

2. Power on all control systems.

3. Press the Open Rear Gate button to be sure rear gate is fully open.

4. Turn Grease Pump Lubrication and Grease Pump Tail Seal switches to ON or AUTO position. (For more information, refer to Grease Pump Lubrication and Tail Seal Grease Pump in the Controls & Instruments section.)

5. Turn the Belt Conveyor switch to ON position and adjust speed accordingly.

6. Turn the Screw Conveyor switch to the FORWARD position and adjust speed accordingly.

7. Turn the Thrust Ram Selection switch to the ALL position.

8. Start EPBM jacking as follows:
   Select cutterhead rotation direction (CW, or CCW) and set the cutterhead drive speed at 50%, for a starting point. Select Extend on the Thrust Ram Direction switch and adjust the thrust jack 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.

9. Operator powers ON the foam and slurry system and sets it in AUTO mode at 30% - 50% ratio. If the jacking speed is reduced or increased, the operator must change the percentage ratio to match the jacking speed.

10. The screw conveyor speed must be adjusted as needed to retain the earth pressure balance.

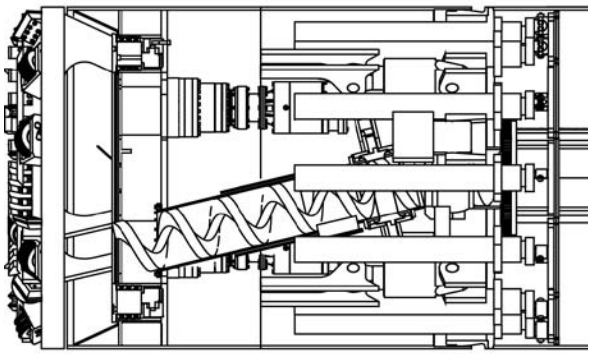
    - Reduce screw conveyor speed to increase soil pressure.
    - Increase screw conveyor speed to reduce soil pressure.

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 (adjust with Lead/Lag on the Screw Conveyor control screen).

11. After EPBM is fully advanced, power off the jacking, foam, slurry, screw conveyor, belt conveyor and cutterhead rotation (power off cutterhead rotation last to prevent stalling when mining resumes) systems.

12. Continue to build the tunnel rings (refer to Using Segment Erector and Jacking Cylinder Sequence For Segment Installation in this section.

CUTTERHEAD OPERATION GUIDELINES



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).

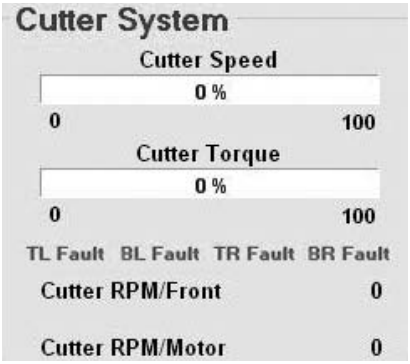
3. The cutterhead works equally well in both directions.

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 EPB Control Screen

JACKING OPERATION GUIDELINES

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

2. Use lower jacking pressures and lowest cutting head torque possible (below 80%), while maintaining high production rates.

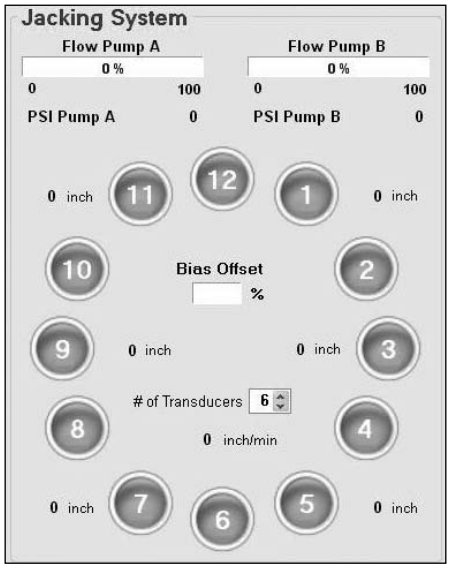
3. Maintaining proper grade and alignment of the tunnel to ensure low jacking pressure.

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

5. Do not allow steering pressures to rise above 5,800 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.



Jacking System Meters
On EPB Control Screen

STEERING OPERATING GUIDELINES

NOTICE Steering should be carefully executed with small corrections made over many feet while closely observing your EPB direction on the guidance system.

NOTICE When shutting down steering system, press Steering/CC Pump to OFF button. If steering pump is not shut off before system is shut down, the steering cylinders will move from the 50% position.

There are two methods to steer the EPBM:

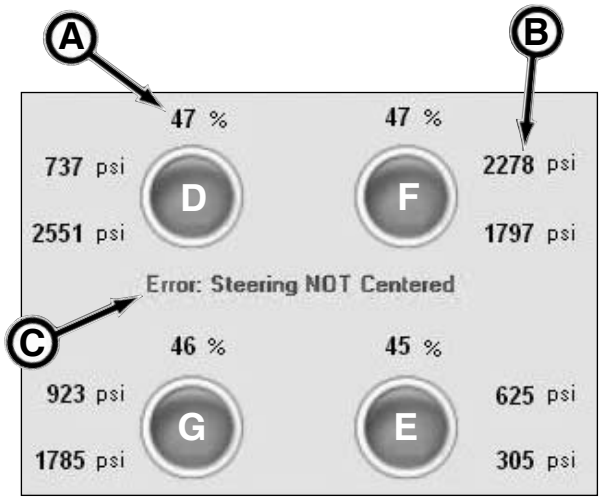
I. Steering cylinders

II. Jacking cylinders using BIAS mode

NOTICE Use the copy cutter to aid in steering, refer to Copy Cutter in Controls & Instruments section.

I. Steering Cylinders

The steering window on the computer screen displays the average cylinder positions in percent (A), the extend/retract pressure (B) of the cylinders, and an error statement (C). The error statement displays if the corresponding steering cylinders (D and E, F and G) are both registering less than 50% or both are registering more than 50%, thus the cylinders are not centered.



NOTICE If the “Error: Steering NOT Centered” message appears, refer to Using Manual Steer in this section.

1. Before making any steering adjustments, ALL four steering cylinders must be at 50% position.

2. When steering adjustments are necessary, be sure to make ONLY minor adjustments. Making more extreme steering adjustments will increase the jacking forces.

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

4. To steer, press the steering control buttons on the control console as follows:

To steer up, press both the bottom left and bottom right steering buttons. This will extend the bottom cylinders and retract the top cylinders.

To steer down, press both the top left and top right steering buttons. This will extend the top cylinders and retract the bottom cylinders.

To steer right, press both the top left and bottom left steering buttons. This will extend the left cylinders and retract the right cylinders.

To steer left, press both the top right and bottom right steering buttons. This will extend the right cylinders and retract the left cylinders.

To top left, press the bottom right steering button. This will extend the bottom right cylinder and retract the top left cylinder.

To top right, press the bottom left steering button. This will extend the bottom left cylinder and retract the top right cylinder.

To bottom right, press the top left steering button. This will extend the top left cylinder and retract the bottom right cylinder.

To bottom left, press the top right steering button. This will extend the top right cylinder and retract the bottom left cylinder.

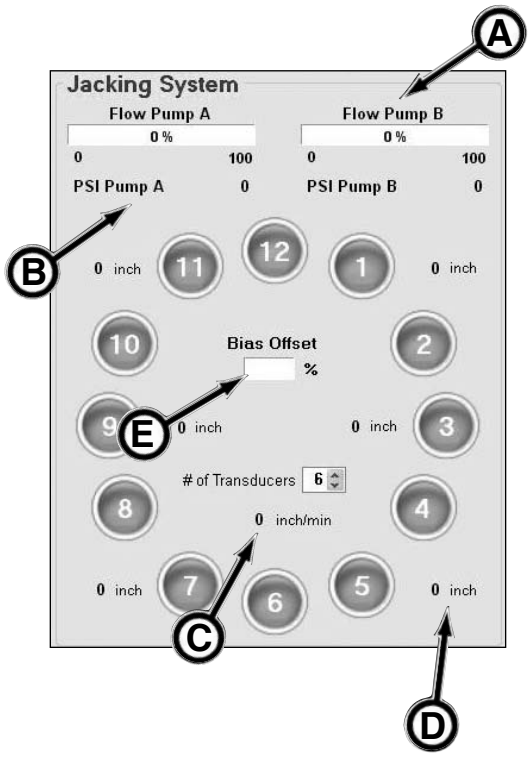
(continued on next page)

Steering Operating Guidelines (continued)

II. Jacking Cylinders Using BIAS Mode

NOTICE For additional information on the jacking controls, refer to Jacking Controls in section 4, Controls & Instruments.

The jacking system window on the computer screen displays the pump flow (A), pump pressure (B), speed (C), cylinder extension (D), and bias offset (E).



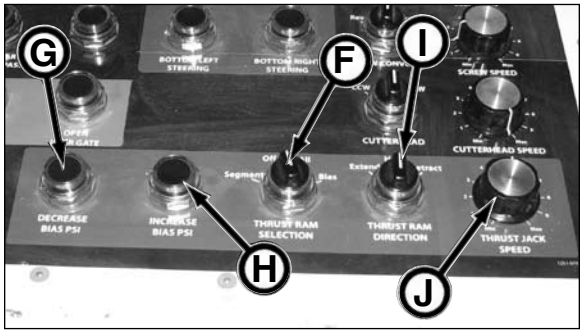
1. Before making any steering adjustments, check and record the position of all jacking cylinders.

2. When steering adjustments are necessary, be sure to make ONLY minor adjustments. Making more extreme steering adjustments will increase the jacking forces.

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

4. On the control console, turn Thrust Ram Selection switch (F) to the BIAS position. This selection allows the operator to select which set of six cylinders will have high pressure (Pump A) and low pressure (Pump B).

5. Set the Bias Offset. Bias Offset is the % of thrust difference between Pump A (high pressure) and Pump B (low pressure). This % is adjusted by pressing the Decrease Bias PSI (G) and Increase Bias PSI (H) buttons on the control console.



NOTICE If the Bias Offset is at 0%, all cylinders will have the same thrust pressure; or straight thrust. If the Bias Offset is 50%, there is a 50% difference in the six high and six low pressure cylinders. A good starting point for the Bias Offset is 30% and is recommended that the % should not exceed 80%.

5. On the control screen, depress the cylinder number based on the direction to be steered. For example, if downward steering is desired, depress cylinder 6 to activate cylinders 3 through 8 to low pressure.

6. Turn the Thrust Ram Direction switch (I) to Extend position to extend the jacking cylinders and slowly adjust speed with Thrust Jack Speed control (J). Once steering is complete, turn direction switch to Hold position.

USING MANUAL STEER

If the “Error: Steering NOT Centered” message (A) appears, you must use the Manual Steer program.

⚠WARNING USE Manual Steer ONLY when the steering cylinders are not centered and ONLY to move the corresponding cylinders to their proper 100% position. Using manual steer to perform normal steering will cause machine damage.

To use Manual Steer:

1. Double click ManualSteer program icon (B) on desktop.

2. Click Start Manual Steer button (C).

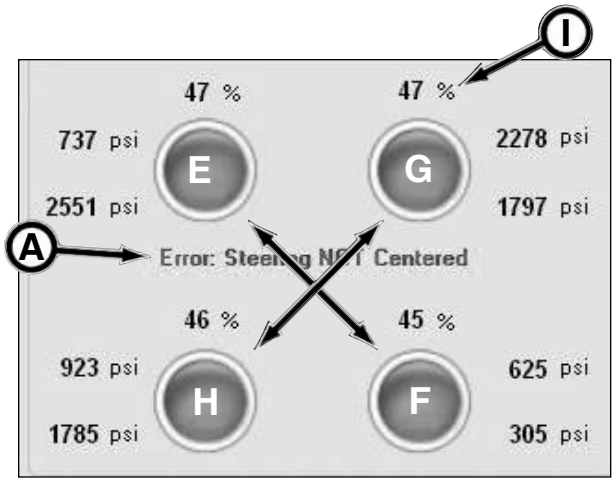
3. Extend or retract desired cylinder buttons (D) as needed for cylinders (E and F) % to equal 100% and cylinders (G and H) % to equal 100%. As the extend/retract buttons are being pressed, the corresponding cylinder % (I) will change as noted on steering control screen.

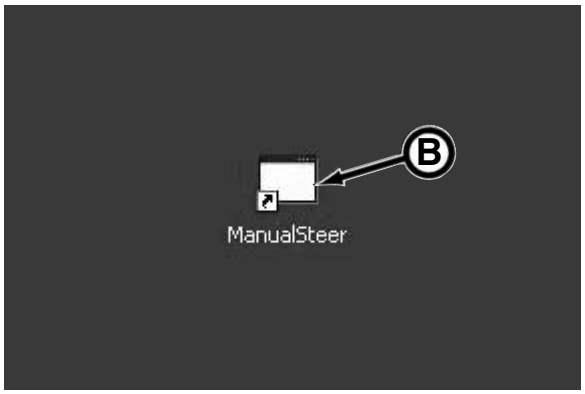
NOTICE Using ManualSteer will disable the steering cylinder control buttons (J) on the control console.

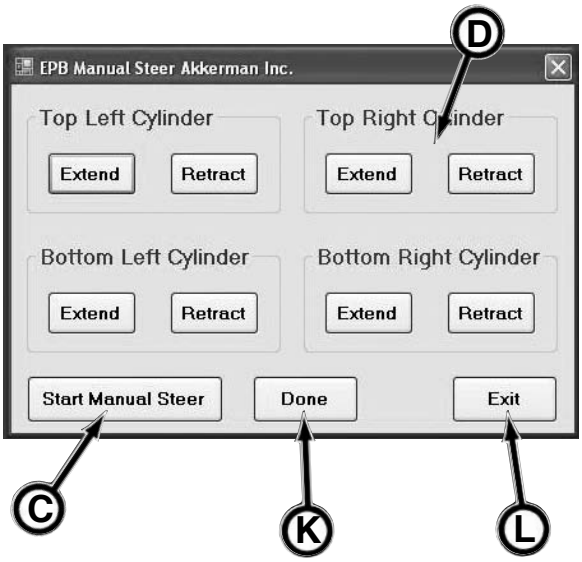
4. Once cylinders are in the proper position, click Done (K).

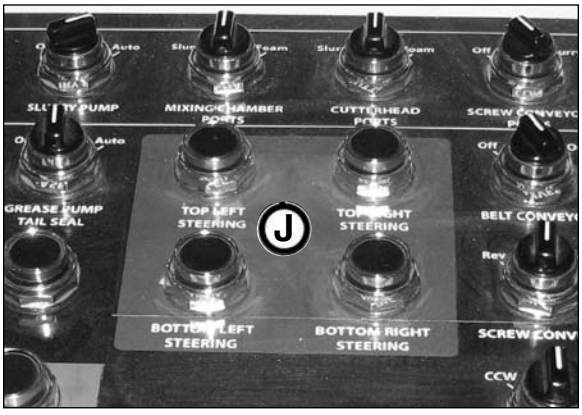
5. Click Exit (L) to exit the manual steer program.

6. Resume steering with steering cylinder console controls as needed based on guidance system data.









OPERATING THE SCREW CONVEYOR

The screw conveyor helps maintain the earth pressure balance while moving spoils to the belt conveyor.

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

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

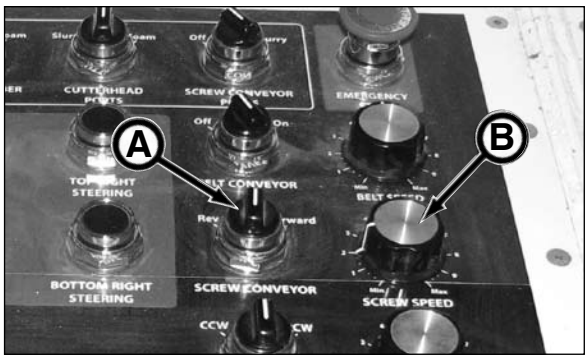
Do not operate without covers and guards in place.

Lockout/tagout power before servicing.

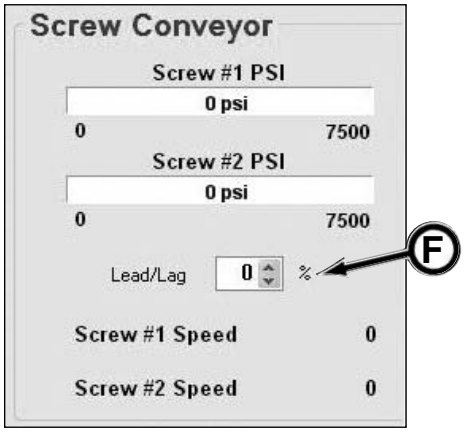
1. With the screw conveyor pump on, turn the Screw Conveyor control (A) to ON position to activate the control valve.

2. Turn Screw Speed control (B) slowly clockwise to increase screw conveyor speed and counterclockwise to decrease screw conveyor speed. To adjust the dial movement of the speed control, refer to Speed Control Sensitivity Adjustment in the Controls & Instruments section.

NOTICE A change in EPB advancement rate or ground conditions will require periodic adjustments to the conveyor speed. Operate the screw conveyor at a slower speed to help prevent plugging and will reduce premature wear to the screw conveyors and components.



3. Adjust operation of #1 screw conveyor to compensate for the earth pressure balance. As a guideline, operate #2 screw conveyor speed at approximately 5% faster than the #1 screw conveyor using the Lead/Lag field (C). This will help regulate the flow of spoils through the screw conveyors thus controlling earth pressure.



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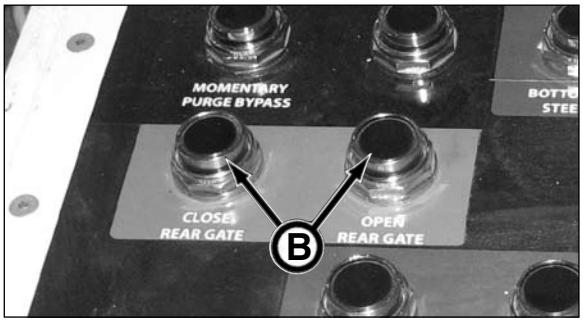
4. Use the rear conveyor gate (A) to stop spoils flow out of the screw conveyors.

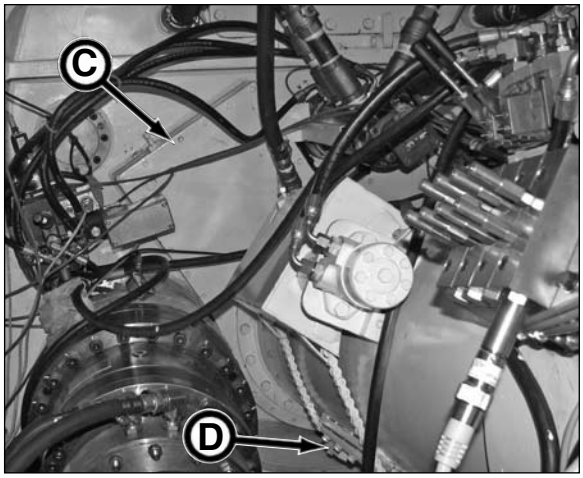
• Regulate the rear gate opening using the controls (B) on the control console.

NOTICE In the event of a power outage or malfunction and the rear gate must be lowered without power, refer to Operating Screw Conveyor Rear Gate With No Power in this section.



The front gate (C) is used when the screw conveyors must be removed for maintenance. Closing the front gate will seal spoils in the EPB chamber.

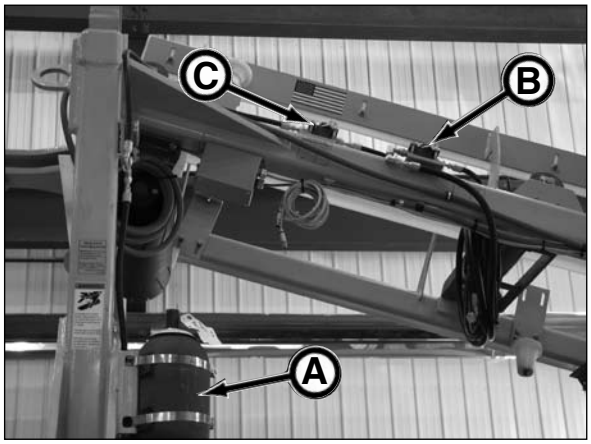
The intermediate gate (D) should never be used unless there is a need to remove larger material that will not pass through the screw conveyors.



OPERATING SCREW CONVEYOR REAR GATE WITH NO POWER

⚠WARNING Escaping oil or other fluids under pressure can penetrate your skin causing serious injury or death. The rear gate accumulator stores high pressure fluid. BEFORE performing maintenance or repairs on rear gate, discharge accumulator.

If the screw conveyor rear gate must be closed with the EPBM power off (in the event of a power outage or malfunction), the gate can be closed with pressurized oil stored in the rear gate accumulator (A).



1. Open tank valve (B) slightly before opening pressure valve (C).

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

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

NOTICE The accumulator charge is for one use. After using the accumulator to close rear gate, the hydraulic oil in the accumulator must be recharged. To recharge the accumulator, refer to Charging The Rear Gate Accumulator in this section.

CHARGING REAR GATE ACCUMULATOR

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

BEFORE performing maintenance or repairs on rear gate, discharge accumulator.

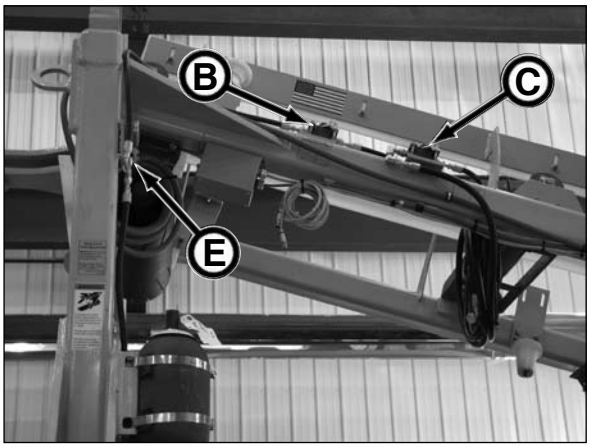
⚠DANGER If the accumulator requires repair, ONLY a certified service technician can check and fill the accumulator with dry nitrogen. Refer to the accumulator manufacturer for more information. **NEVER FILL AN ACCUMULATOR WITH OXYGEN!** An explosion will occur if oil and oxygen mix under pressure, resulting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

To charge the accumulator (A) with hydraulic oil:

1. Open BOTH accumulator pressure (B) and tank (C) valves.

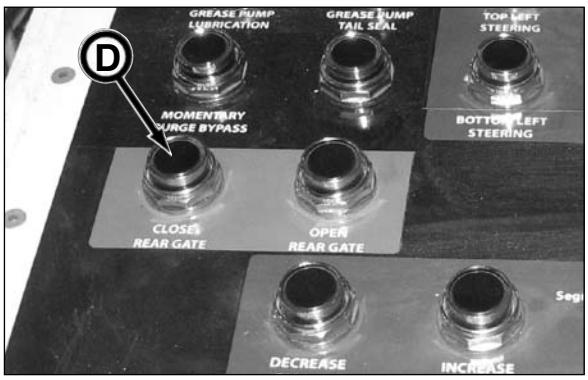
2. Close rear gate by pressing Rear Gate Close button (D) on control console of Operator Station car #2 until the system builds up to 2,000 psi as shown on pressure gauge (E).

3. Once system maintains 2,000 psi, release Rear Gate Close button and close both accumulator pressure and tank valves.

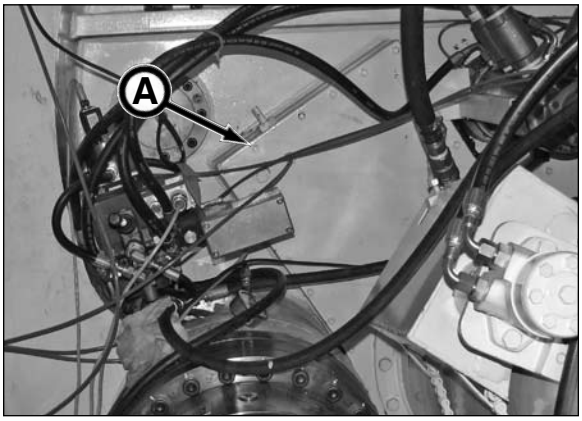


NOTICE If gate is not performing to 2,000 psi, check the nitrogen with charging kit (provided). Normally, nitrogen will not require recharging.

Rear Gate Accumulator:
Nitrogen Charge: 900 psi
Hydraulic Charge: 2,000 psi
Flow 0.3 GPM from 2,000 to 1,000 psi



CLOSING/OPENING FRONT GATE



The front gate is used when the screw conveyors must be removed for maintenance. Closing the front gate will seal spoils in the EPB chamber. Use the following procedure when closing or opening the front gate. **BE VERY CAREFUL** and take your time during this procedure, otherwise injury may result.

⚠DANGER Contact with severed electrical cables will cause serious injury or death.

Constantly monitor electrical cables during the opening and closing of the front gate procedure to prevent cutting or stretching of any electrical cables.

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

Do not enter area under the screw conveyor and erector system.

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

Constantly monitor hydraulic hoses and components during the opening and closing of the front gate procedure to prevent the puncturing of hoses.

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.

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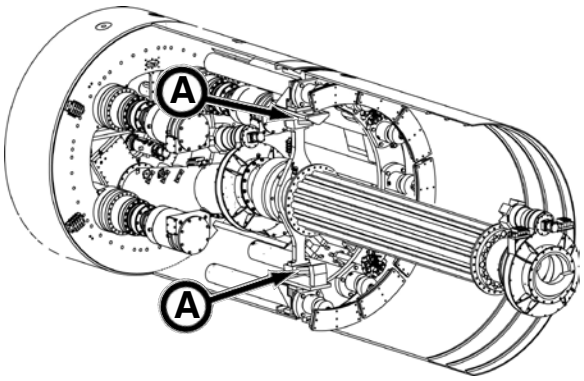
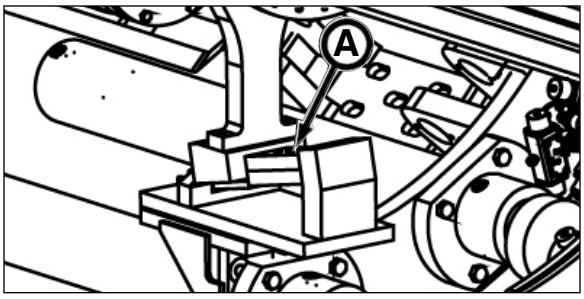
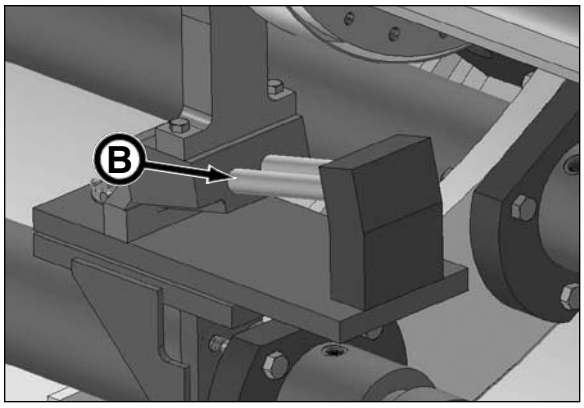
IMPORTANT: All hydraulic hoses, grease lines and electrical cables and components MUST be monitored VERY CLOSELY while closing or opening the front conveyor gate to prevent damage.

1. Remove lock blocks (A) (2 locations) by removing bolts.





2. Clean guide rods (B) (2 locations).

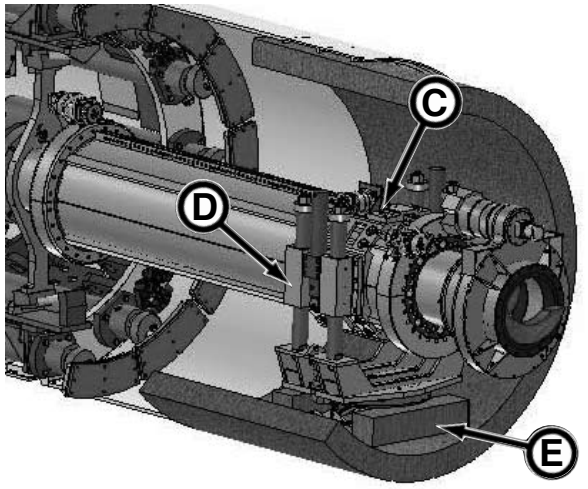


3. Move erector carriage (C) to most rearward position.

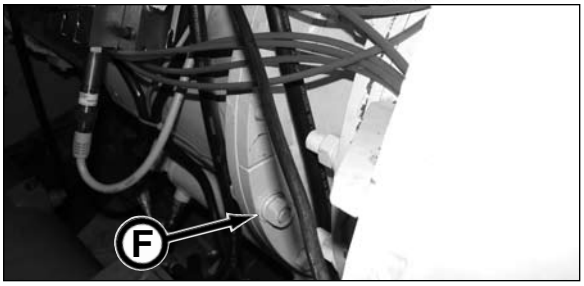
4. Rotate erector arm (D) so arm faces the 6 o'clock position.

5. Place cushioning material (E) between erector arm and concrete tunnel segment ID.

6. Extend erector arm until it comes into full contact with cushioning material. Do not over pressurize the erector arm cylinders, otherwise concrete segment damage may occur. The erector arm acts as a rear support of the conveyor/erector assembly.



7. Unbolt trombone joint from flange (F).



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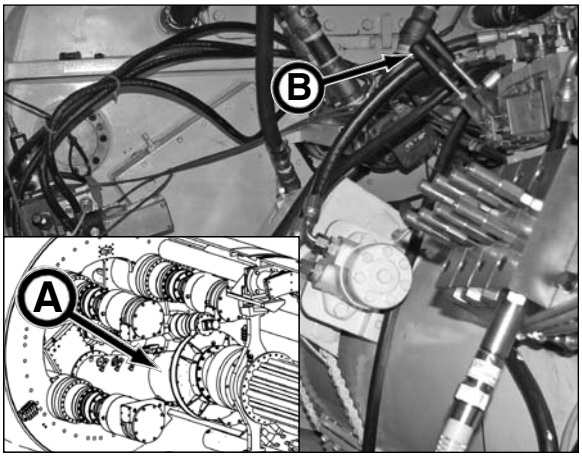
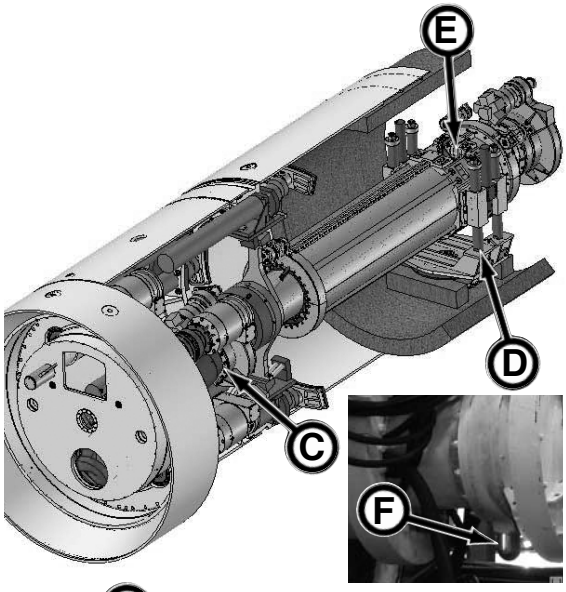


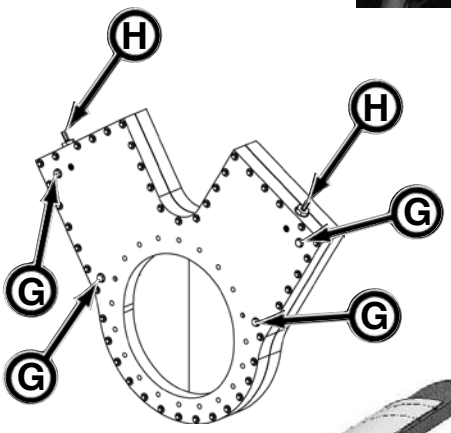
8. Slightly extend trombone joint (A) cylinders using control valve (B).



9. While SLOWLY extending trombone joint (C) cylinders, <u>simultaneously</u> extend segment arm (D) and travel erector carriage (E) forward (towards cutterhead) until the trombone cylinder extends 10”. During this procedure, the segment erector latch (F) MUST be freed from inclined conveyor car #1 support before continuing to extend joint.

NOTICE If binding occurs while extending trombone joint, stop immediately and check to be sure there are no obstructions on the upper and lower guide rods and that the segment erector is in the horizontal or parallel position. Also, be sure segment erector latch is freed from inclined conveyor car #1.

IMPORTANT: The segment erector MUST remain horizontal otherwise damage may occur.



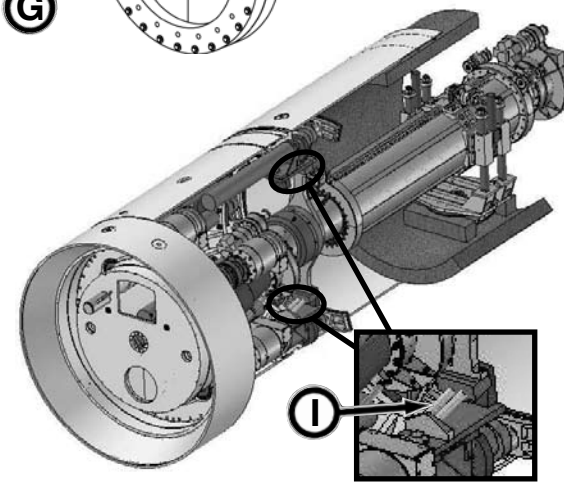
10. On the front gate assembly, remove plugs (G) and remove the socket head cap screws from all plugs.

11. Access gate actuator (H) and rotate CCW to close gate until gate passes plug holes, then reinsert the socket head cap screws and then the plugs. This locks gate in closed position. If the socket head cap screws cannot be reinserted, the gate is not completely closed.

12. Replace lock blocks on upper and lower guide rods (I).

13. This gate is only a temporary seal. If a longer extended period of time is required, cover the gate opening with a seal and plate.

14. Reverse procedure to open the front gate and reinstall the screw conveyor/erector system assembly.



OPERATING THE BELT CONVEYOR

⚠DANGER Contact with rotating conveyor belt or idler rollers will cause severe injury or death.

Keep hands, body, and objects clear of rotating conveyor.

Do not operate without covers and guards in place.

Lockout power before servicing belt conveyor.

Conveyor Operation Guidelines:

1. Check conveyor for damage or wear before operating. Repair or replace damaged or worn components before operating.
2. Avoid contact with conveyor.
3. Keep hands, body and objects clear of operating conveyor.
4. Do not operate without covers and guards in place.
5. Lockout power before performing maintenance or repairs on conveyor.
6. NEVER perform maintenance to conveyor while the conveyor is running.
7. While conveyor is running, DO NOT try to dislodge material from pulleys.
8. NEVER use a shovel or other hand tool to clean material buildup while the conveyor is running.
9. Before operating conveyor, check to be sure the belt is properly tensioned.

1. With conveyor properly installed and all guards in place, inform all personnel in tunnel that the conveyor is going to start up and to stay clear of the conveyor.

2. Move the muck car(s) into position to catch spoils from conveyor.

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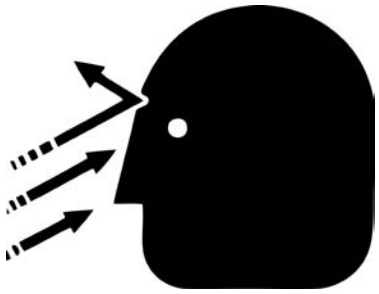
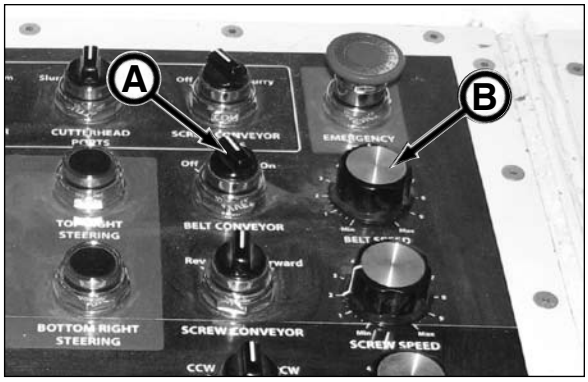


⚠WARNING Running the conveyor too fast can cause severe injury from flying debris and cause possible machine damage. Slow the conveyor speed so there is continual controlled movement of the spoils into the muck cars.

3. With the belt conveyor pump on, turn the Belt Conveyor control (A) to ON position to activate the control valve.



NOTICE When the Belt Speed control (B) is turned to rotate the belt conveyor, there will be a three second delay with audible and red visual alarms (two; located on car #3 and #7) and then the belt will rotate.

4. Turn Belt Speed control (B) slowly clockwise to increase belt speed and counterclockwise to decrease belt speed. To adjust the dial movement of the speed control, refer to Speed Control Sensitivity Adjustment in the Controls & Instruments section.

NOTICE Control the speed of the conveyor so when the spoils drop on the conveyor, they do not pile up on the belt. A change in EPB advancement rate, screw conveyor speed or ground conditions will require periodic adjustments to the conveyor speed.

6. Operate conveyor control and adjust speed with conveyor speed control to desired speed.

7. Periodically check the belt tension, belt guides, and belt tracking. Adjust as needed..

ADJUSTING THE BELT CONVEYOR

⚠DANGER Contact with rotating conveyor belt or idler rollers will cause severe injury or death.

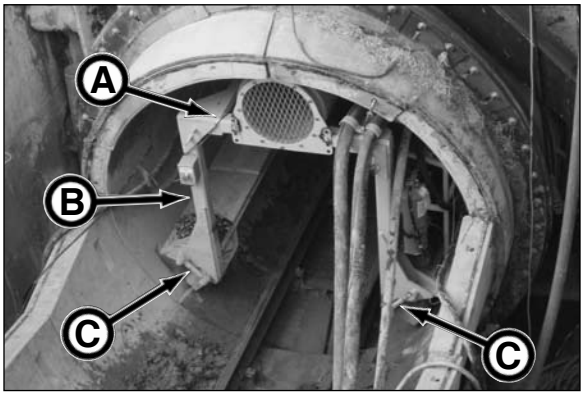
Keep hands, body, and objects clear of rotating conveyor.

Do not operate without covers and guards in place.

Lockout/tagout power before servicing belt conveyor.

The belt conveyor will require frequent adjustment during the mining operation:

A. Before making any belt adjustments, ALL cars MUST be level.

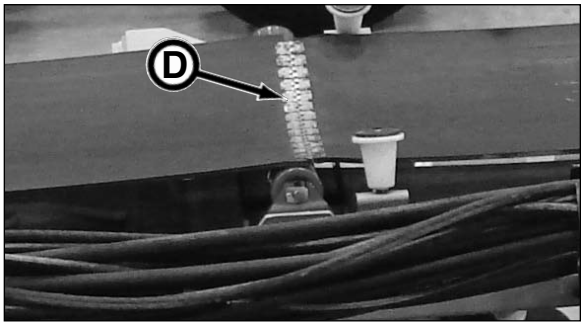


1. Place level on top of horizontal cross bar (A) or vertical support (B) of car.

2. Adjust wheel assembly adjuster (C) in small increments to steer car wheels until car is level.

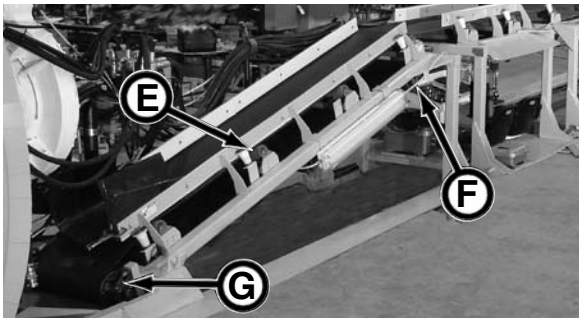
3. Repeat steps 1 and 2 for other rear cross bar or support of car and all other cars.

B. Check belt splices.



1. Check that belt splices (D) are in good condition and have no raised edges to prevent damage to conveyor components.

C. Check that all idler rollers are rotating.



1. ALL belt rollers (E), return rollers (F), and front roller (G) must rotate otherwise premature wear will occur to belt. Replace if roller does not rotate.

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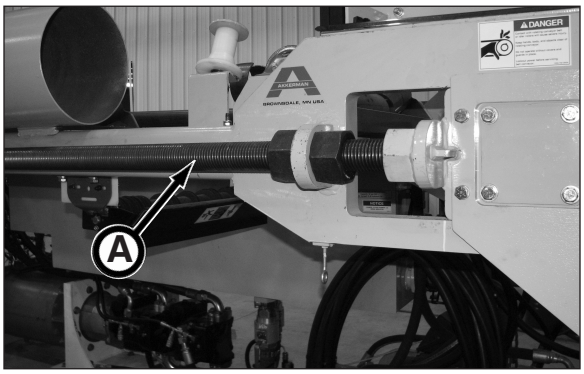
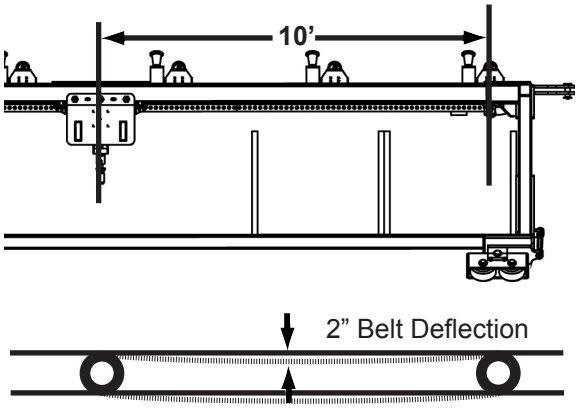
D. Check belt tension.

1. If tension requires adjustment, adjust the two adjustment screws (A) on the front hydraulic car #6.



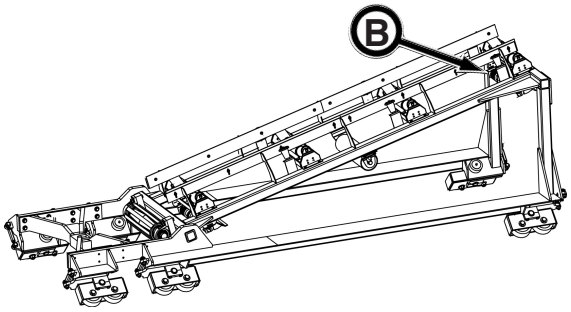
NOTICE Both adjustment screws must be adjusted at the same rate or distance. Failure to do so will cause premature wear in the belt due to the tension being different on each side of the belt.

2. On Segment Handling car #3, the optimum belt tension is a 2” belt deflection between the two return rollers (distance between return rollers is approximately 10’). Adjust as needed to achieve this deflection.



3. With the correct belt tension, the belt should be able to be lifted off the return rollers by hand with some resistance.

4. On Incline Conveyor car #1, it may be difficult to lift belt off of top return roller (B). This is the tightest belt tension on the conveyor.



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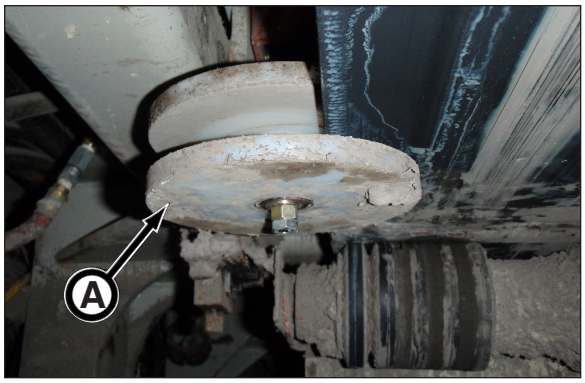
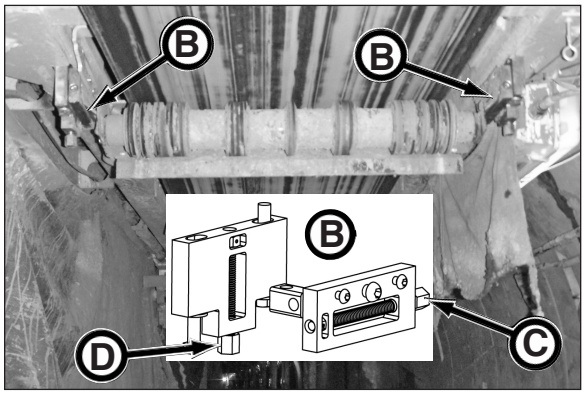
E. Check belt tracking.

1. Spring loaded belt guides (A) are equipped to restrain the belt to assist in keeping the belt properly trained during operation.

   Inspect the polyethylene guide rollers for excessive wear. Replace as needed. Also, periodically check the springs and hardware for stretching or damage. Replace as needed.



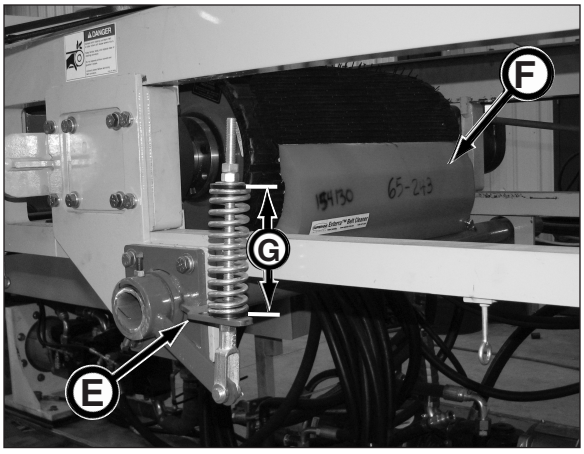
2. To adjust the belt tracking, use the adjustable return roller brackets (B) to regulate the belt tracking left or right [using horizontal adjust screw (C)] and up or down [using vertical adjust screw (D)] positioning as needed. Make only minor adjustments at a time and adjust the roller brackets ahead of the misalignment starting from the drive roller end working forward.



F. Adjust primary belt scraper.

1. The tensioner (E) on the primary belt scraper (F) located on Front Hydraulic car #6 must be adjusted according to the table below:

Scraper Blade Wear	Adjustment Dimension (G)
New	3.5”
25%	3.75”
50%	4”
75%	4.25”



2. The scraper must be adjusted properly otherwise the belt tracking and overall performance of the belt conveyor will be affected due to the buildup of material on the belt and rollers.

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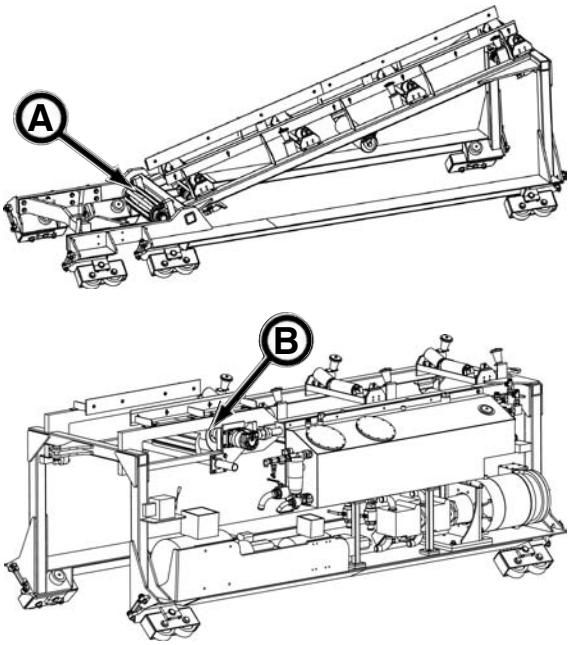
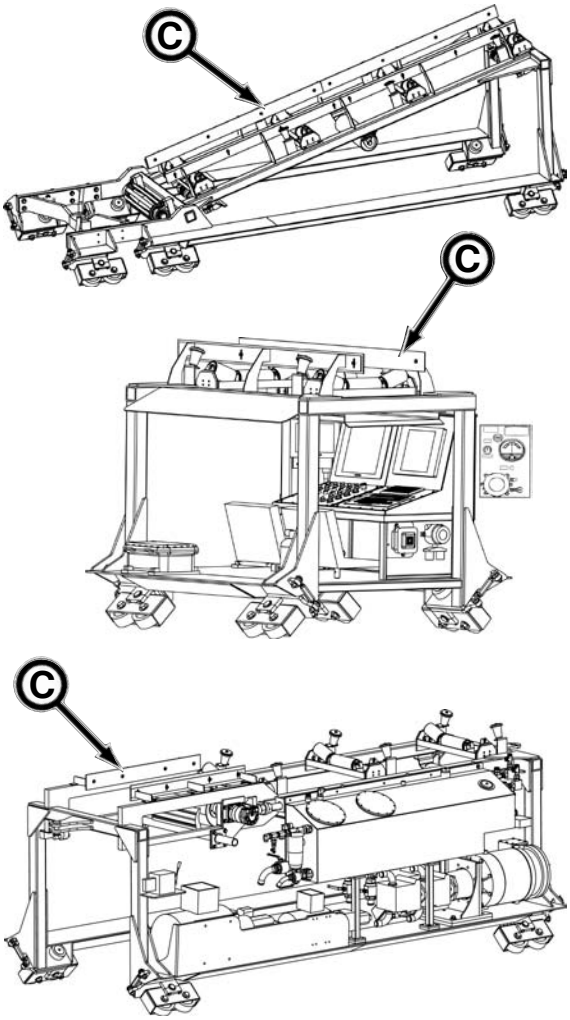
G. Clean spoils/debris from front roller assembly (A) on Inclined Conveyor car #1 and drive roller assembly (B) on Front Hydraulic car #6.

1. Removing spoils/debris from roller and drive assemblies will help prevent premature wear/damage to the rollers and belt.



H. Inspect side boards.

1. The side boards (C) are used to contain material on the belt conveyor at the Incline Car #1, Operator Car #2 and Front Hydraulic Car #6 areas. If side boards become worn, replace with new.



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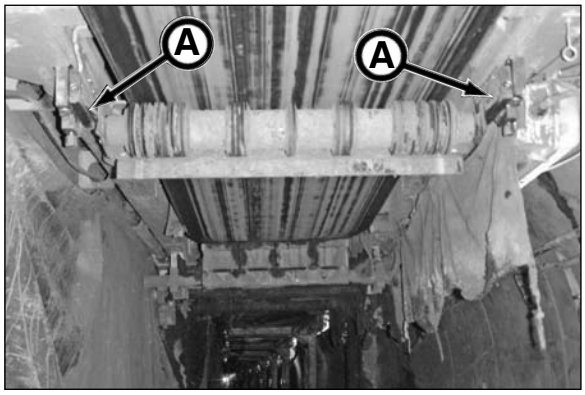
I. Belt adjustments for curve.

1. Preparations for a curve should be minimal providing all belt adjustments are properly made: belt tracking, belt tension, car alignment, track alignment and scraper adjustments.

   • You may need to readjust the adjustable return roller brackets (A) during the mining of the curve.



MINING IN A CURVE

IMPORTANT: In a tight curve, a curve radius of 463 ft (141 m), the clearance between the tunnel wall and the gantry cars will be approximately 3/4” (19 mm). Constantly monitor clearances while mining in a curve.

1. Refer to Adjusting Belt Conveyor in this section.

2. All cars must be level. This may require continual steering adjustments in the curve.

3. The track must be centered in tunnel floor, otherwise muck cars may interfere with gantry cars.

4. In a tight curve, check for clearances while mining:
   a. tunnel wall clearance.
   b. clearance with muck bucket cars and train to the inside frame structure of gantry cars.
   c. slowly mine in a tight curve while monitoring all clearances to prevent interference with car structures or tunnel wall.

CONTROLLING FOAM & SLURRY

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 three ports for slurry on the screw conveyor:
- The ball valves on the screw conveyor control the slurry flow to the three injection ports on the screw conveyor.

There are also four external ports on the EPBM for external lubrication (if needed).

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 control screen.

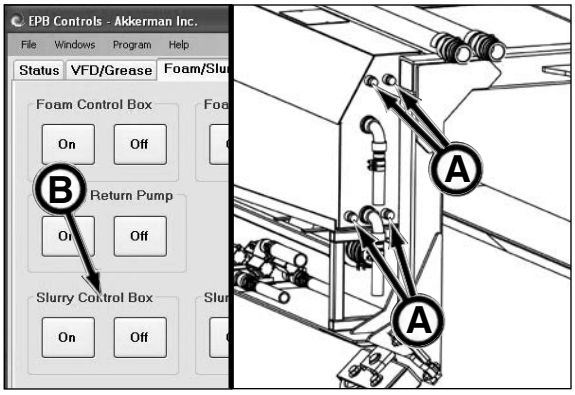
Set the Foam Pump control and Slurry Pump control to AUTO. The foam and slurry is started automatically when cutterhead and screw conveyors are rotating. The flow rate of the foam and slurry are controlled on control screen.

NOTICE If the slurry level sensor operation becomes erratic, clean the slurry tank level sensors (refer to Cleaning Slurry Tank Level Sensors in this section.

CLEANING SLURRY TANK LEVEL SENSORS

If slurry tank level sensor operation becomes erratic, the level sensors (A) must be cleaned.

1. Be sure slurry tank level is lower than the sensors.
2. On the control screen, press OFF on the Slurry Control Box button (B) under the Foam/Slurry tab.
3. Remove electrical control cables from sensors.
4. Remove level sensors.
5. Clean debris from sensor(s).
6. Replace sensors securely so the arrow on the sensor fitting is pointing up.
7. Replace electrical control cable into sensors.
8. Press Slurry Control Box ON button to resume slurry tank sensing.



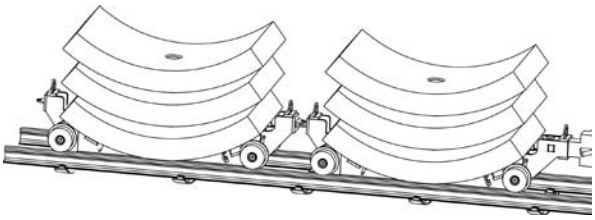
USING SEGMENT ERECTOR

The segment erector constructs the tunnel with six precast concrete segments to form the tunnel wall in the jacking can of the EPBM.

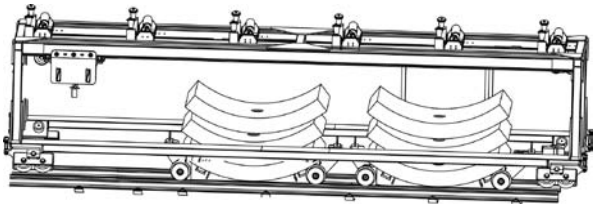
⚠WARNING Concrete segment(s) may fall causing serious injury or death. DO NOT enter area or around the lifted segments.
Concrete segments are VERY HEAVY. Each segment weighs between 800 to 1,500 lbs. (363 to 680 kg). Be sure segments are properly fastened to segment ball and segment lift tool before lifting and moving segments with lift carriage.

⚠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. **Keep out of erector area while it is in operation.**

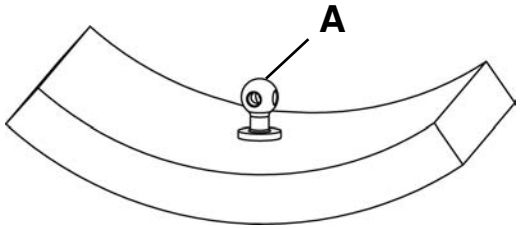
1. Load the front and rear segment handler cars with concrete segments in the order according to the tunnel segment arrangement information from the guidance system, and then move them into segment handling car #3.



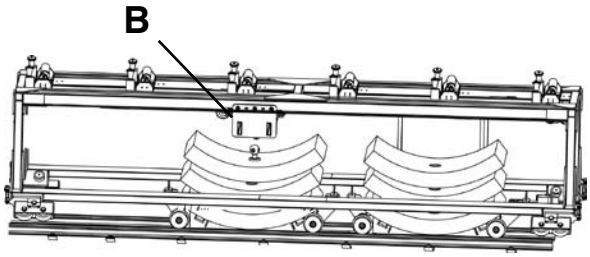
2. Position the front and rear segment handler cars as shown so that there is enough carriage travel (at least one meter) to lift the segments from the rear segment handler car.



3. Thread the segment ball (A) completely into the concrete segment.



4. Move the lift carriage (B), with the carriage travel control, over the concrete segment on the front segment handler car.

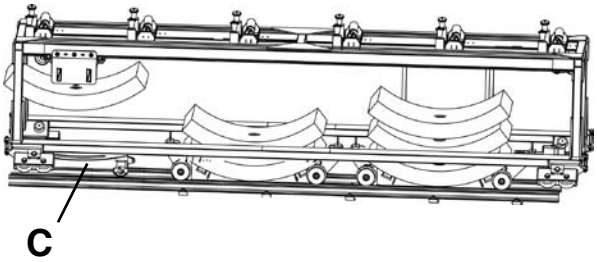


NOTICE Off load the “starter key” segment first. Then remove segments in the proper order according to the tunnel alignment from the guidance system.

5. Lower the segment lift tool onto the segment ball and secure with pin.

6. Place segment conveyor dolly (C) on the rails in the segment handling car #3.

7. With the concrete segment secured with carriage, move the segment over the dolly and lower segment onto dolly.



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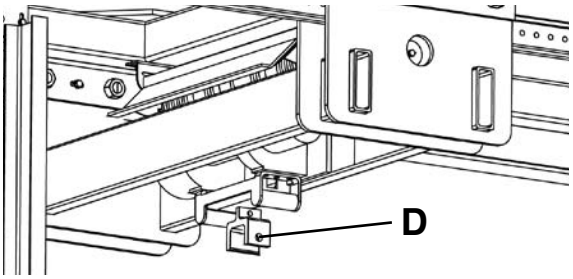
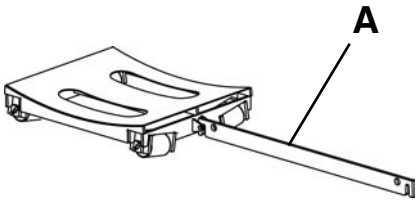
8. Unpin the lift tool (D) from the segment ball, then move lift carriage in-line with another segment.

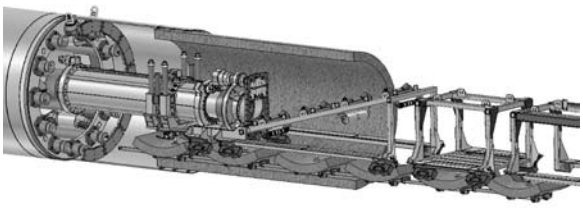
9. Connect cable from dolly winch in head to the dolly. Pull the dolly ahead to make room for another dolly.



10. Add segment linkage bar (A) between the segment dollies.



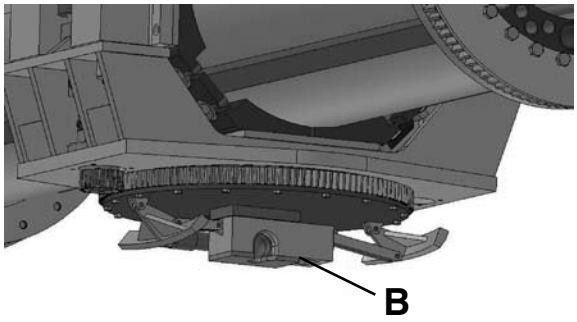
11. Repeat steps 3 through 10 until all concrete segments have been removed from the handler cars and onto the segment dollies. Then move the first dolly/segment into the erector zone.



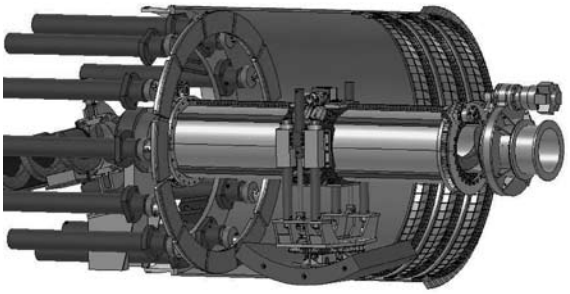
12. Unlock segment erector ball latch (B) (latch cylinder extended) with segment latch control.

NOTICE For segment erector control information, refer to Segment Erector Controls (Car #1) in the Control & Instruments section.

NOTICE Once the segment erector pump is powered on and the Thrust Ram Selection control on console is positioned to Segment, the blue strobe light on Incline Car #1 will illuminate indicating the erector is currently operating or will be operating shortly. All personnel should be clear of the erector area.

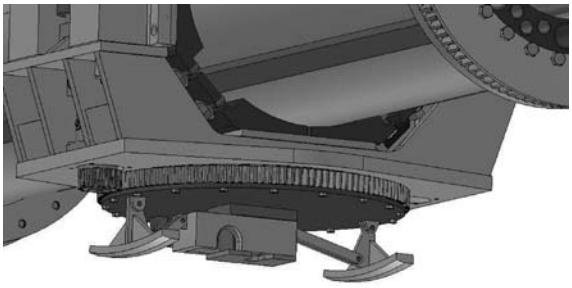


13. Lower erector arm with segment lift arm control and align segment ball into ball latch. You may need to also use the erector travel control to align ball into latch.



14. Lock latch on segment ball (latch cylinder retracted) with segment latch control. Be sure stabilizers are seated against segment.

NOTICE Concrete segment is removed for illustrative purposes only.



15. Once segment is properly latched, fully lift the segment arm/concrete segment with segment lift arm control.

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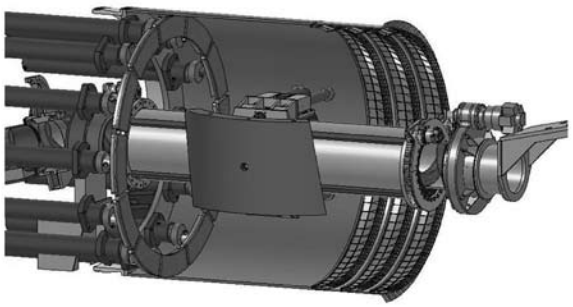
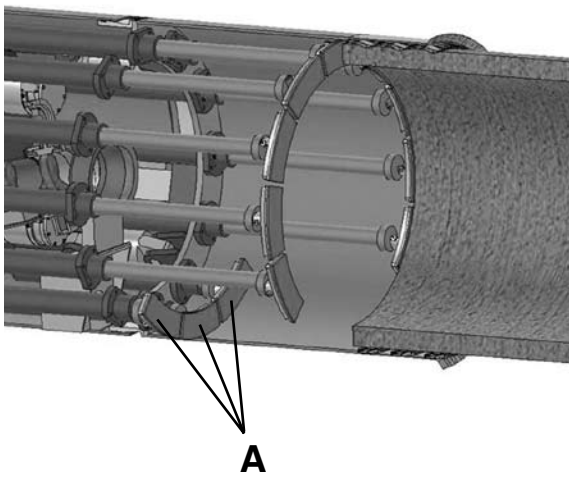
16. Rotate segment 90 degrees with segment rotation control.

17. Using the erector travel control, travel to the location where the segment is to be placed.



18. Retract thrust cylinders to provide clearance for segment. For example, as shown, cylinders in the 5, 6, and 7 o'clock positions (A) have been retracted.

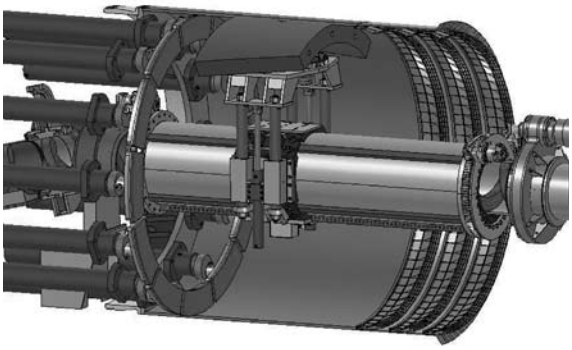
NOTICE For cylinder arrangement guideline, refer to Jacking Cylinder Sequence For Segment Installation in this section.



19. Rotate segment with the erector assembly rotation control and extend erector arm with segment lift arm control to properly position segment in tunnel.

NOTICE When rotating erector, be sure the rotation does not turn farther than 180 degrees. Doing so will damage the hydraulic hoses.

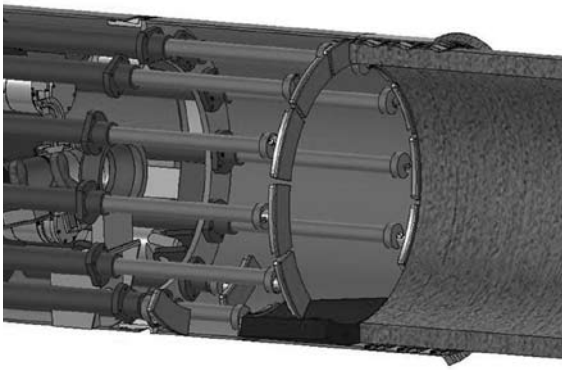
20. Set segment into position. Drive in line up dowels into segments.



21. With the segment into its proper position, extend appropriate jacking cylinders to secure and hold segment into position.

22. Remove empty dolly and set it on the storage area of the incline conveyor car.

23. With dolly winch, pull linkage forward until the segment is in position. Remove linkage and place into incline conveyor car.



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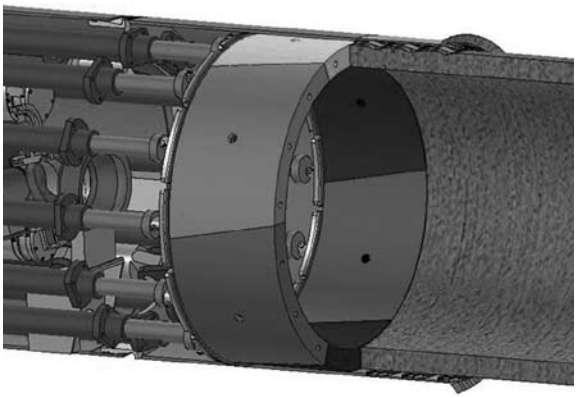


24. Repeat segment installation process until the tunnel ring is complete.

25. Once the tunnel ring is built, install radial bolts (three per seam).

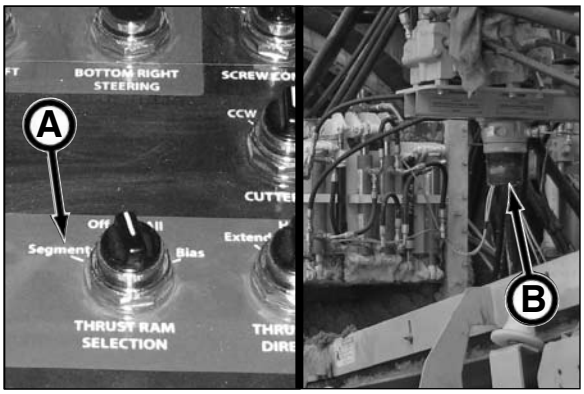
26. Grout segments per project requirements.

JACKING CYLINDER SEQUENCE FOR SEGMENT INSTALLATION

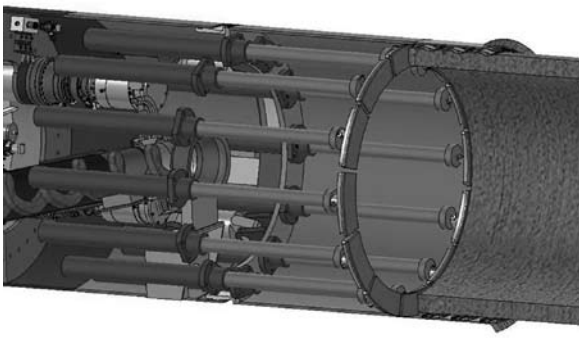
Use this sequence as a guideline for arranging the jacking cylinders when installing the concrete segments with the segment erector. The actual method will vary depending upon the guidance system tunnel segment arrangement information.

NOTICE To properly operate segment erector controls, refer to Segment Erector Controls (Car #1) in Controls & Instruments section.

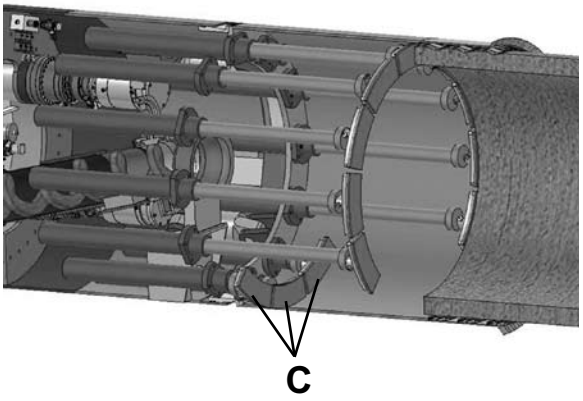
1. With the segment erector pump ON, turn the Thrust Ram switch to the SEGMENT position (A). The blue strobe light (B) on Incline Car #1 will illuminate indicating the erector is currently operating or will be operating shortly. **All personnel MUST be removed from erector area before operating segment erector.**



⚠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. **Keep out of erector area while it is in operation.**

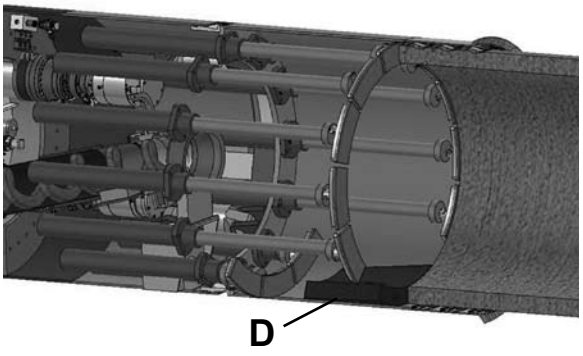


2. With the jacking cylinders extended against tunnel ring, retract jacking cylinders 5, 6 and 7 (C)



NOTICE Before installing concrete segments, all sealing surfaces should be cleaned and lubricated per the segment manufacturer's recommendation.

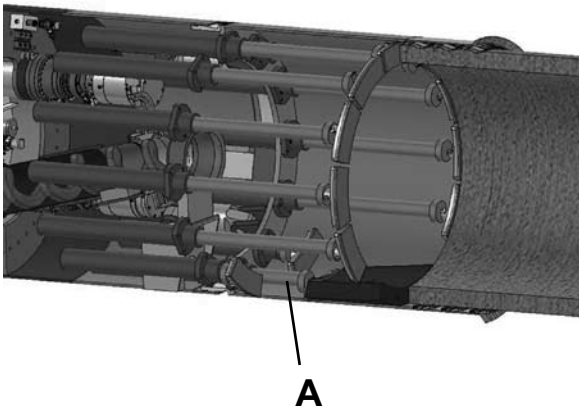
3. Install segment one (D) as indicated by guidance system information.



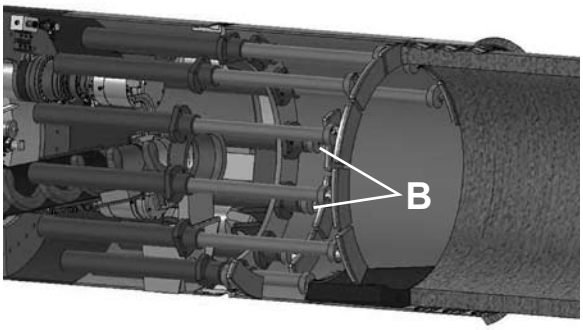
NOTICE Once each segment is set into position, drive line up dowels into segment.

(continued on next page)

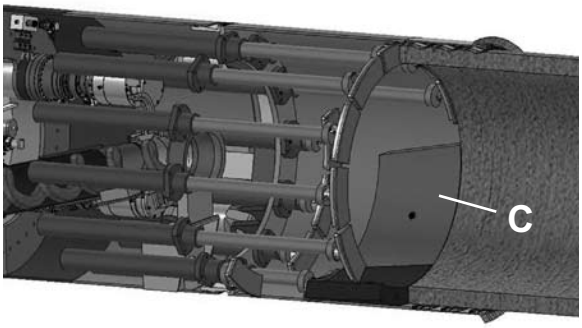
4. Extend jacking cylinder 6 (A) to hold segment one in place.



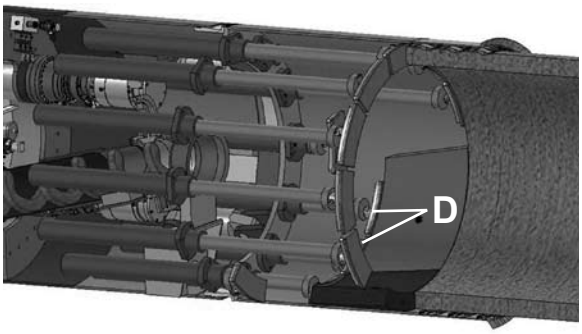
5. Retract jacking cylinders 3 and 4 (B).



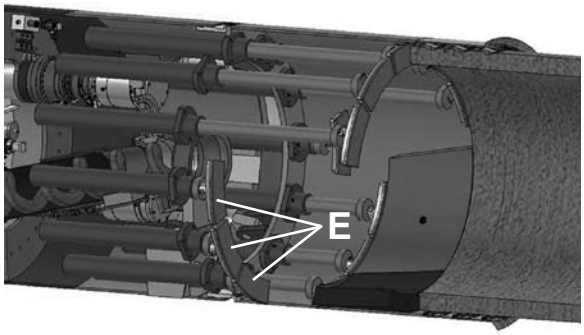
6. Install segment two (C) as indicated by guidance system information.



7. Extend jacking cylinders 4 and 5 (D) to hold segment two in place.



8. Retract jacking cylinders 7, 8 and 9 (E).



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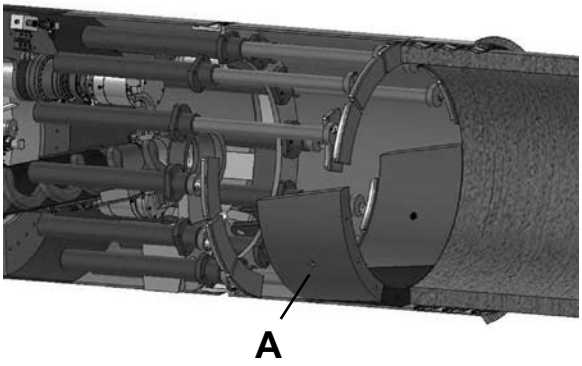
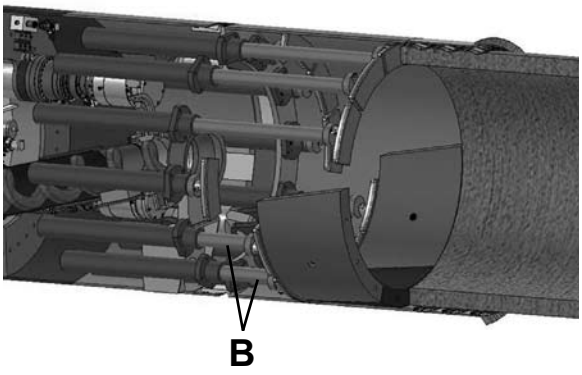
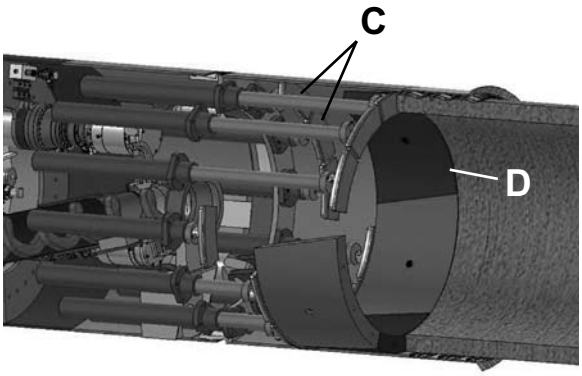
9. Install segment three (A) as indicated by guidance system information.



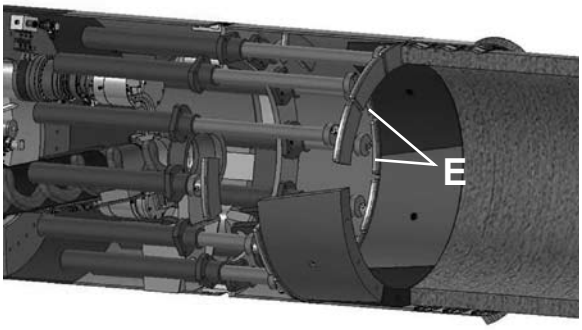
10. Extend jacking cylinders 7 and 8 (B) to hold segment three in place.



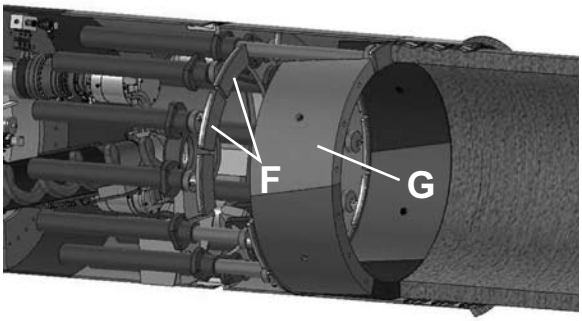
11. Retract jacking cylinders 1 and 2 (C) and install segment four (D) as indicated by guidance system information.



12. Extend jacking cylinders 2 and 3 (E) to hold segment four in place.



13. Retract jacking cylinders 10 and 11 (F) and install segment five (G).



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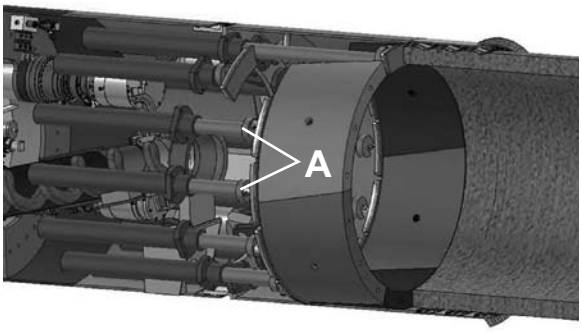
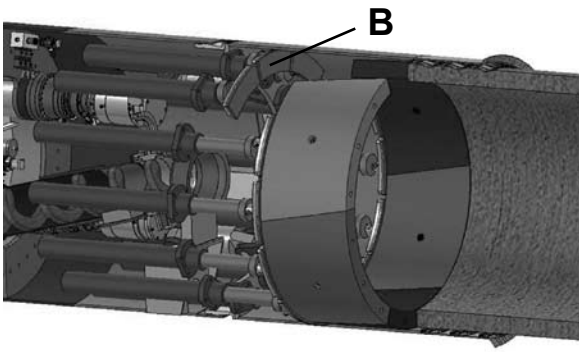
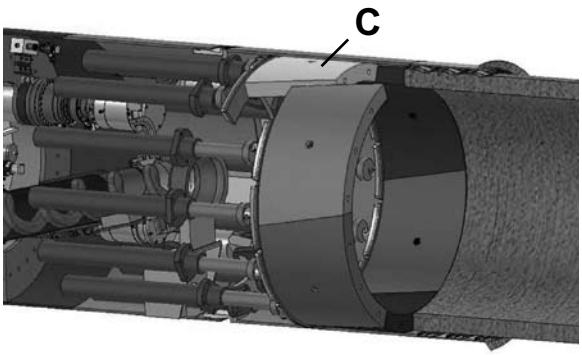
14. Extend jacking cylinders 9 and 10 (A) to hold segment five in place.



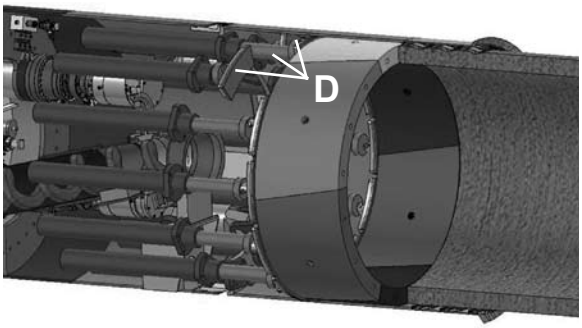
15. Retract jacking cylinder 12 (B).



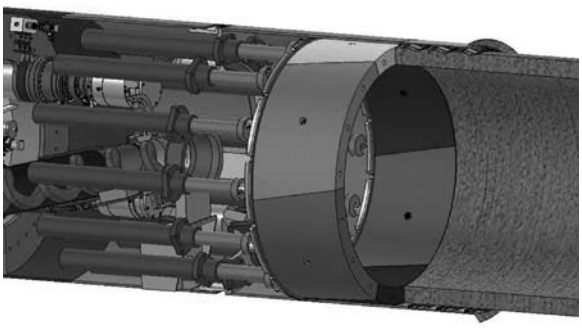
16. Install segment six (C) as indicated by guidance system information.



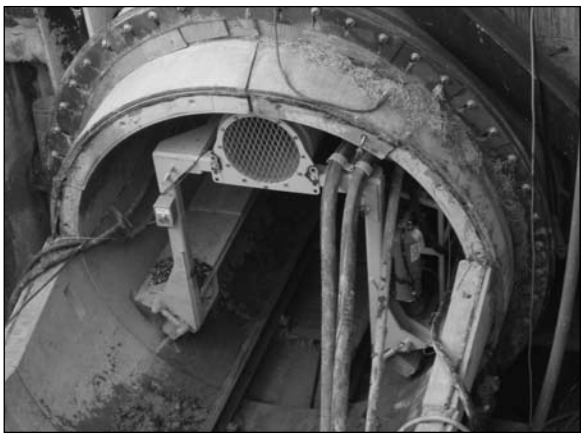
17. Extend jacking cylinder 1, 11 and 12 (D) to hold segment six in place.



18. Once the runnel ring is built, install radial bolts (three per seam) and grout segments per project requirements.



ADDING TUNNEL UTILITIES



Once the EPBM is advanced far enough, additional utilities (4160V power cable, ethernet cable, supply and return water hoses, bentonite hoses (if used) and any other utilities) must be added to the existing tunnel cables and hoses.

⚠DANGER Failure to lockout/tagout power before servicing will cause severe injury or death from electrocution or contact with moving parts.

1. Record target readings before electrical system shutdown.
2. Perform electrical system shutdown as follows in steps 3 through 6.
3. Push E-Stop button.
4. Once the E-Stop button is pushed in, the EPB 4160V Power Disconnect Output Line will automatically open (closed is power). The lights on the Output Line Monitor will go off.
5. On Auxiliary Power, use crank to move auxiliary line to open position. The lights in the Auxiliary Line Monitor will go off.
6. Open auxiliary grounding switch cover and use crank to turn it to ground. This will ground the power line. The Auxiliary Line Monitor will move to ground symbol.

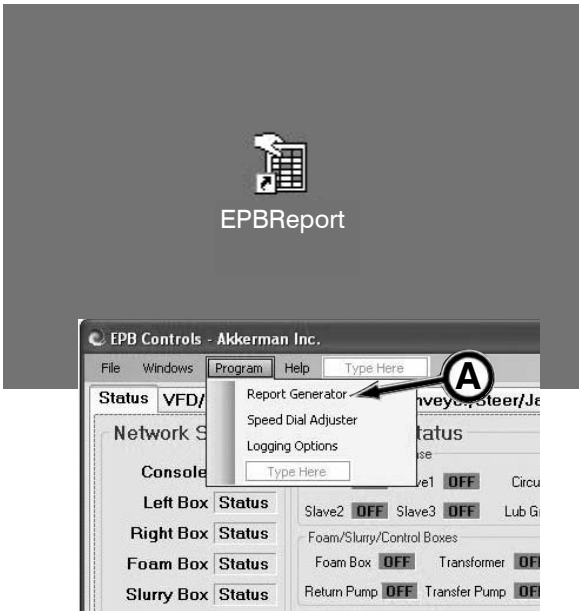
NOTICE The Safe To Unplug 4160V Power Cable OFF (green light) indicator will illuminate. If this indicator is not illuminated, DO NOT unplug cable. Contact a certified electrician to troubleshoot the problem.

7. With power locked out, disconnect the 4160 volt line, ethernet cable, supply and return water hoses, bentonite hoses (if used), and any other utilities. Make sure all of the 4160 volt electrical lines, hose connections and cables are in a clean, dry location.
8. 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.
9. Install new track as needed.
10. Install new 4160V power cable, ethernet cable, supply and return water hoses, bentonite hoses (if used), and any other utilities to the existing tunnel cables, hoses, etc.
11. Clean electrical and hose connections before installing.
12. Be sure all connections are properly secured.
13. Start-up electrical power as follows:
    a. Turn on power to Power Container.
    b. Move Auxiliary Ground switch to open position.
    c. Move Auxiliary Line to close position.
    d. Pull out E-Stop.
    e. Press the 4160V Power ON button on Power Container.

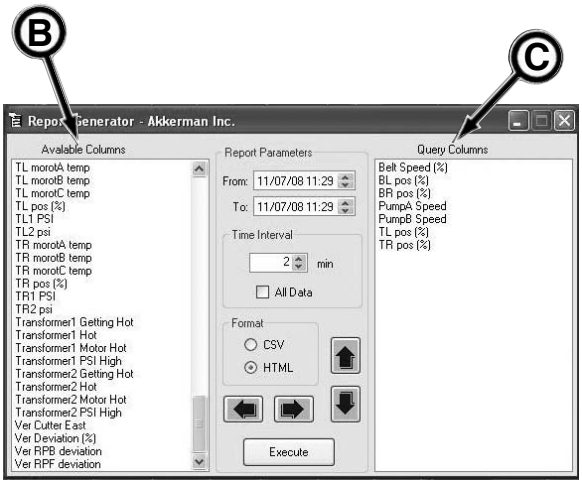
NOTICE The High Voltage light should illuminate. If the light does not illuminate, contact a certified electrician to resolve the problem with the 4160V electrical system.

14. After start-up, check target readings to be sure the laser was not bumped.
15. Continue to add utilities as needed.

USING THE REPORT GENERATOR



1. Double click the Report Generator icon, EPBReport, on desktop or go to the EPB Controls window on the console screen, select the Program pulldown menu and select Report Generator (A).



2. In the report generator window, the left column “Available Columns” (B) is a list of all the data variables (over 100) available for your report. The right column “Query Columns” (C) is a list of the data variables you selected for your report.

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

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

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

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

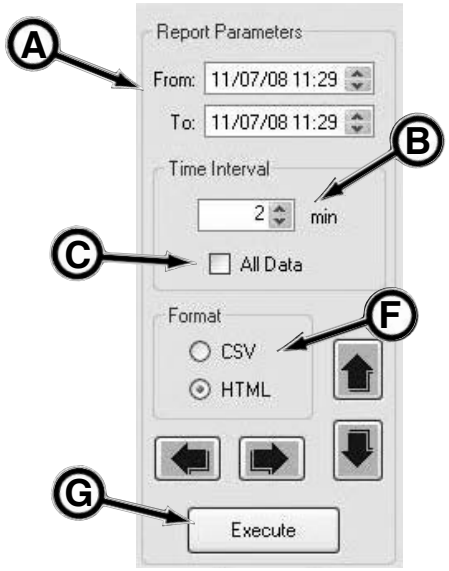
4. If necessary, reprioritize the variables in the Report Column, by selecting a variable and clicking the up or down Priority arrows. The top variable will appear on the left hand column of the report.

(continued on next page)

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

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

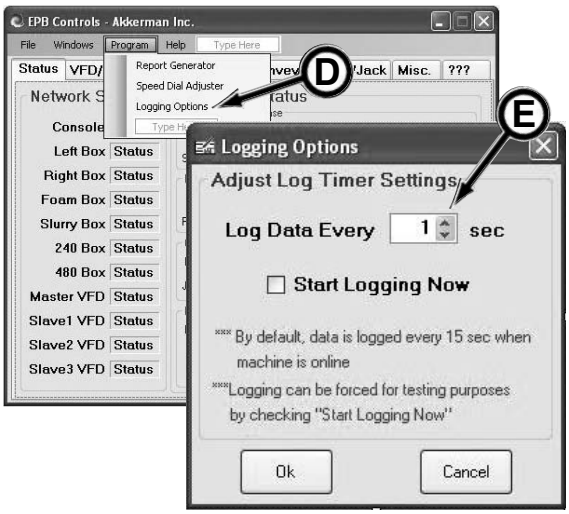
If you click the All Data box (C), the report will ignore the time interval and print the report for all logged data within your selected date and time parameters.



NOTICE Data is logged every 15 seconds. If desired, the logging timer can be changed by:

a. On the EPB Controls window of the console screen, select the Program pulldown menu and select Logging Options (D).

b. In the Logging Options window, change the timer in the Log Data Every field (E) and click OK.



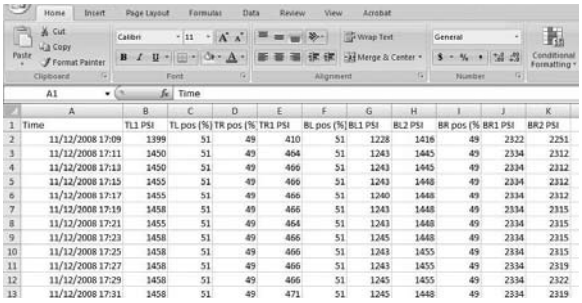
7. Select your desired report format (F).

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

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

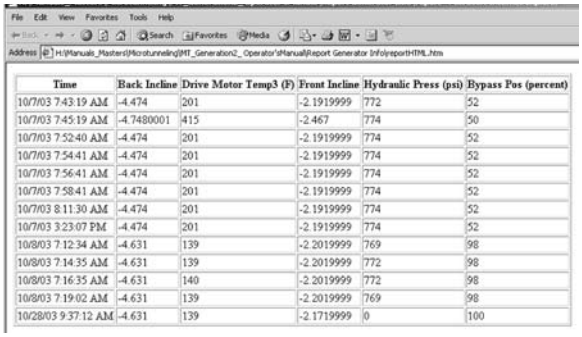
8. Click Execute button (G). The report is generated and will automatically open your CSV or HTML program on the computer screen.

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



Time	TL1 PSI	TL pos (%)	TR pos (%	TR1 PSI	BL pos (%)	BL1 PSI	BL2 PSI	BR pos (%	BR1 PSI	BR2 PSI
11/12/2008 17:09	1399	51	49	410	51	1228	1416	49	2322	2251
11/12/2008 17:11	1450	51	49	464	51	1243	1445	49	2334	2312
11/12/2008 17:13	1450	51	49	466	51	1243	1445	49	2334	2312
11/12/2008 17:15	1455	51	49	466	51	1243	1448	49	2334	2312
11/12/2008 17:17	1455	51	49	466	51	1240	1448	49	2334	2312
11/12/2008 17:19	1458	51	49	466	51	1243	1448	49	2334	2315
11/12/2008 17:21	1455	51	49	464	51	1243	1448	49	2334	2315
11/12/2008 17:23	1458	51	49	466	51	1245	1448	49	2334	2315
11/12/2008 17:25	1458	51	49	466	51	1243	1455	49	2334	2315
11/12/2008 17:27	1458	51	49	466	51	1243	1455	49	2334	2319
11/12/2008 17:29	1458	51	49	466	51	1245	1455	49	2334	2322
11/12/2008 17:31	1458	51	49	471	51	1245	1448	49	2334	2319

CSV Format In Excel



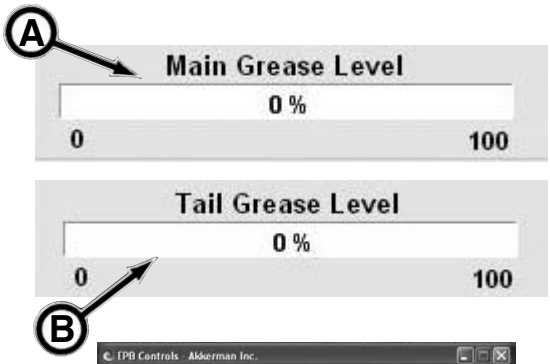
Time	Back Incline	Drive Motor Temp3 (F)	Front Incline	Hydraulic Press (psi)	Bypass Pos (percent)
10/7/03 7:43:19 AM	-4.474	201	-2.1919999	772	52
10/7/03 7:45:19 AM	-4.7480001	415	-2.467	774	50
10/7/03 7:52:40 AM	-4.474	201	-2.1919999	774	52
10/7/03 7:54:41 AM	-4.474	201	-2.1919999	774	52
10/7/03 7:56:41 AM	-4.474	201	-2.1919999	774	52
10/7/03 7:58:41 AM	-4.474	201	-2.1919999	774	52
10/7/03 8:11:30 AM	-4.474	201	-2.1919999	774	52
10/7/03 3:23:07 PM	-4.474	201	-2.1919999	774	52
10/8/03 7:12:34 AM	-4.631	139	-2.2019999	769	98
10/8/03 7:14:35 AM	-4.631	139	-2.2019999	772	98
10/8/03 7:16:35 AM	-4.631	140	-2.2019999	772	98
10/8/03 7:19:02 AM	-4.631	139	-2.2019999	769	98
10/28/03 9:37:12 AM	-4.631	139	-2.1719999	0	100

HTML Format In Internet Explorer

REPLACING GREASE BARREL

NOTICE NEVER operate EPB without greasing the main or tail greasing systems. Operating without proper greasing WILL cause machine damage.

If the Main Grease Level (A) or Tail Grease Level (B) meters on the operational screen display a low grease level, replace the specific grease barrel.

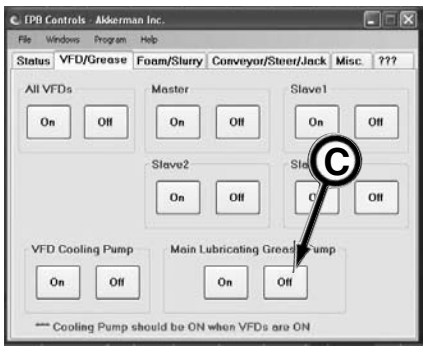


NOTICE If meter level is different than the actual volume in the grease barrel, the sensor must be calibrated. Refer to Calibrating Grease Barrel Sensor in this section.

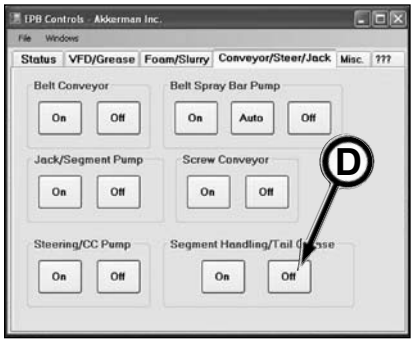
The following procedure is the same whether the main bearing grease barrel or tail seal grease barrel is being replaced.

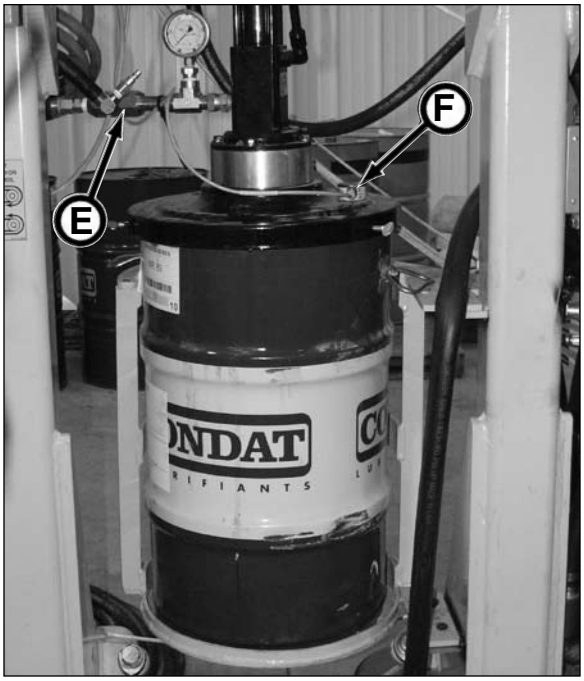
1. Turn off the grease pump on the EPB monitoring screen.

Main Bearing Grease: Press the Main Grease Pump OFF button (C) under the VFD/Grease tab.



Tail Seal Grease: Press the Segment Handling/Tail Grease OFF button (D) under the Conveyor/Steer/ Jack tab.

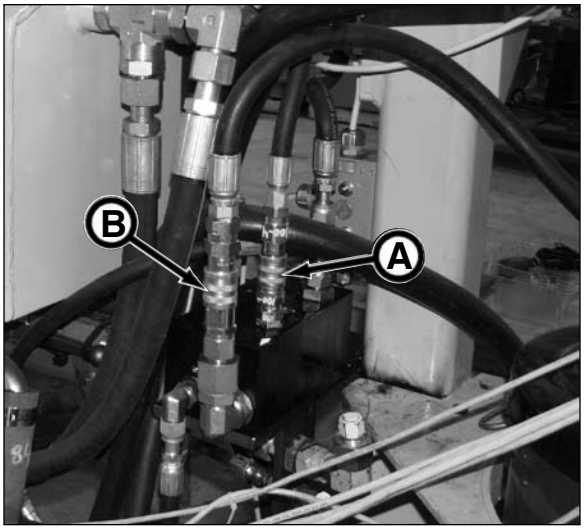




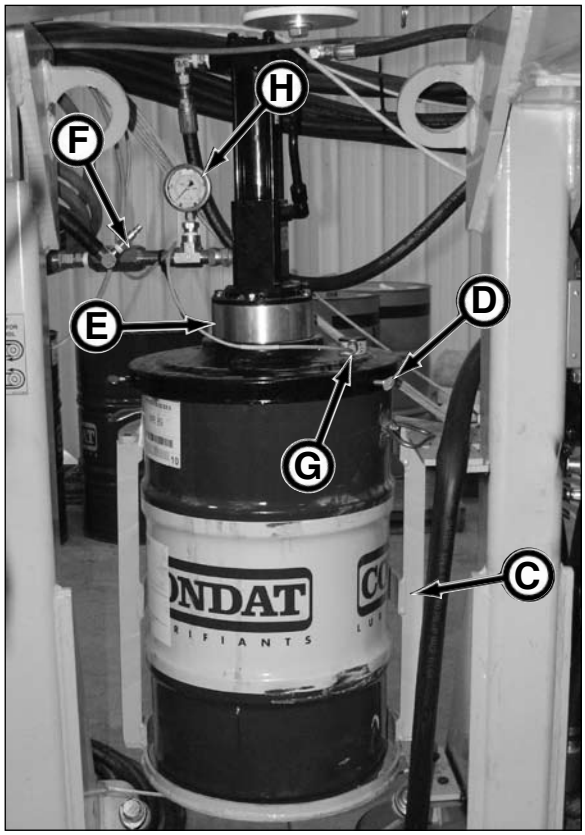
2. Remove the grease line connection (E).

3. Remove electrical connection (F) to level sensor.

(continued on next page)



4. Remove the feed hydraulic disconnect (A) and the return hydraulic disconnect (B) on hydraulic block.

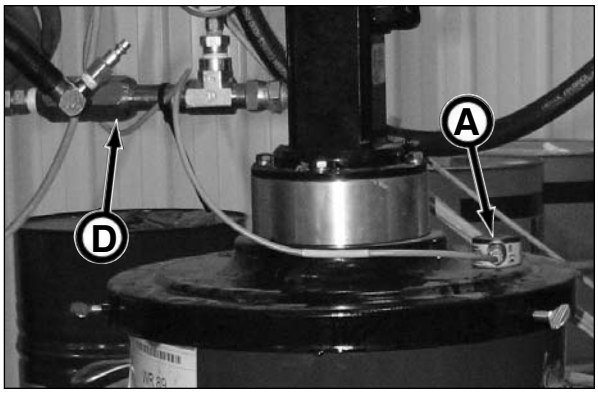


5. Unhook chain (not shown) securing barrel to basket (C).
6. Remove barrel and pump assembly/lid from basket by pulling out bottom of barrel first and making sure top of pump does not catch any wiring or hoses.
7. Loosen lid clamp screws (D).
8. Pull out pump assembly/lid (E) from grease barrel.
9. Remove plunger from empty barrel and place into new grease barrel. Be sure cone of plunger is on top.
10. Replace pump assembly/lid on top of new barrel making sure the lid to seated completely onto barrel.
11. Replace barrel in basket.
12. Install chain (not shown) to secure barrel to basket.
13. Install grease line connection (F); hand tighten only.
14. Install electrical connection (G) to level sensor.
15. Install the hydraulic feed (A) and return (B) disconnects.
16. Once the pump is restarted, the pressure gauge (H) will register 2,200 to 2,700 psi while cycling, though the gauge will read lower until air has been purged.

CALIBRATING GREASE BARREL SENSOR

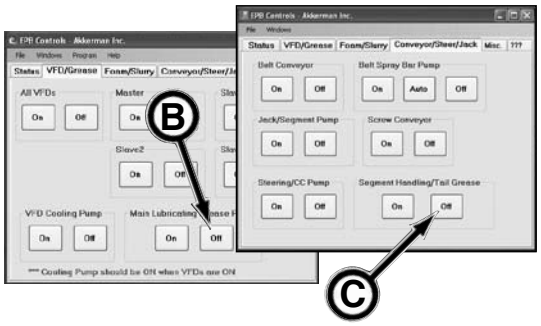
The grease barrel sensor must be recalibrated if the meter level is different than the actual volume in the grease barrel. Refer to Calibrating Grease Barrel Sensor in this section.

The grease barrel sensor calibration is the same procedure for the main bearing grease and tail seal grease. Perform the sensor calibration when replacing empty grease barrel.



NOTICE The level sensor (A) must be plugged in throughout the calibration procedure, otherwise the sensor will revert to the last saved program.

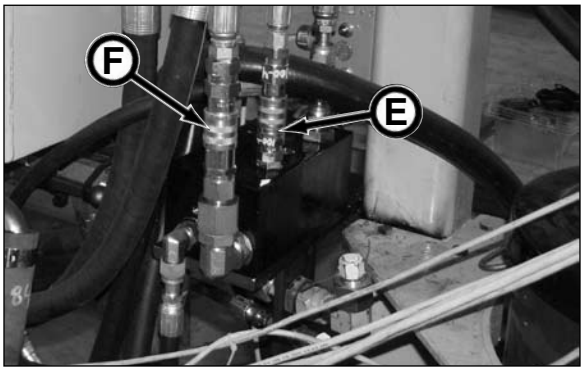
NOTICE Before performing calibration, the grease barrel must be empty.



1. Turn off the grease pump on the EPB monitoring screen:
   Main Bearing Grease: Press the Main Grease Pump OFF button (B) under the VFD/Grease tab.
   Tail Seal Grease: Press the Segment Handling/ Tail Grease OFF button (C) under the Conveyor/ Steer/Jack tab.

2. Remove the grease line connection (D).

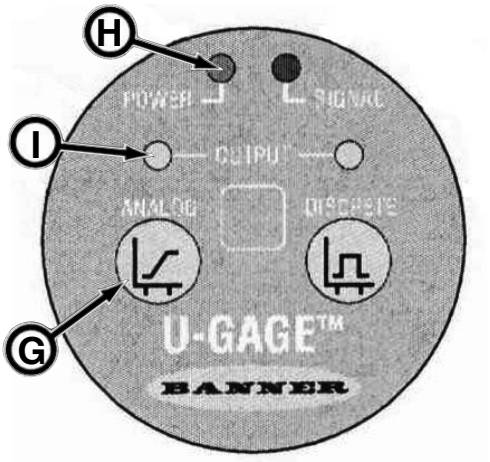
3. Remove the feed hydraulic disconnect (E) and the return hydraulic disconnect (F) on hydraulic block.



4. Unhook chain from basket.

5. Be sure grease sensor is plugged in throughout the calibration process.

6. On the grease barrel sensor, push and hold Analog button (G) until the green Power LED (H) goes off and the yellow Output LED (I) turns to solid yellow. This indicates that the sensor is waiting for the first limit or low level position.



7. In the empty barrel, be sure the plunger (cone up) is in the low level position of the barrel and with the pump assembly/lid properly seated on barrel, briefly click the Analog button (G). This will set the low level position in sensor. The yellow Output LED (I) will flash to acknowledge receiving the low level position; and is now waiting for the second limit or full level position.

8. Remove the pump assembly/lid and plunger from the empty barrel to the full barrel (cone up) and position the plunger to the full level position.

(continued on next page)

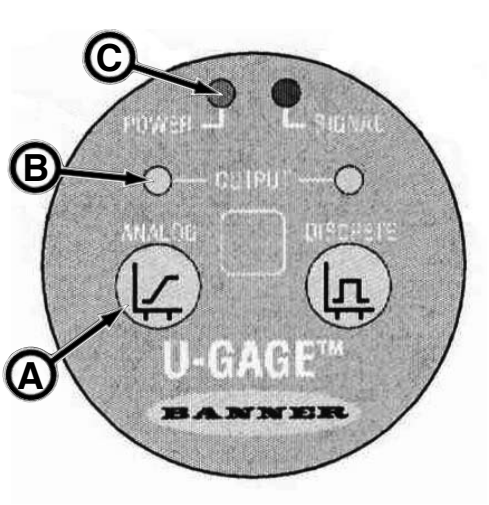
9. Secure pump assembly/lid onto full barrel. Be sure it is properly seated on barrel.

10. Click the Analog button (A). This will set the full level position in sensor. The yellow Output LED (B) turns off and the green Power LED (C) comes on.

11. The sensor is now calibrated for normal run mode.

12. Replace chain around full barrel to basket.

13. Replace grease line connection (hand tighten only), and feed and return hydraulic disconnects.



CLEANING COMPUTER MONITOR SCREENS

Periodically clean the computer monitor screens as follows:

NOTICE There is a method to disable the touch screen for cleaning. But when re-enabling the touch screen, the screen must be recalibrated and there is a potential to lose some of the parameters during the recalibration process. Therefore this method is not recommended.

NOTICE DO NOT shut down the computer via the Start menu. Doing so will require the tunnel power to be shut down and then restarted to boot up the computer. There is no power switch on the computer to prevent any spark from creating an explosion in a gaseous environment.

NOTICE DO NOT clean the monitor screens while the computer is on, otherwise a program, menu, etc might be unintentionally selected causing computer issues.

ONLY clean the monitor when the computer is shutdown such as at the beginning of a shift, while setting utilities, or at the end of the shift.

Use a non-residue cleaner such as a mild window cleaning solution or CRT screen cleaner. Do not scratch the screen face.

Below is a list of known cleaning agents that are compatible with the monitor screens:

Jet Dry®	Ariel®	Downey®	Domestos®
Fantastic®	Persil®	Vim®	Lenor®
Wisk®	Windex®	Vortex®	Formula 409®

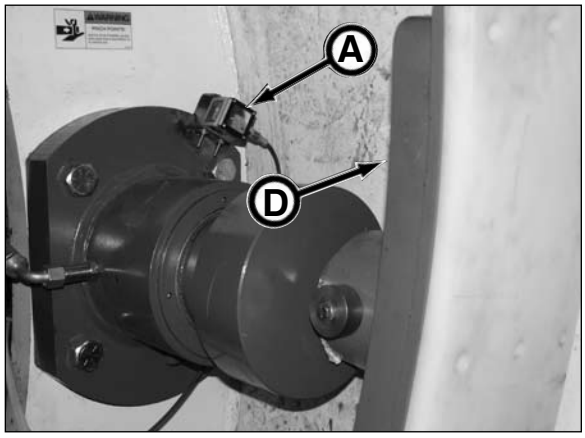
PROGRAMMING THRUST CYLINDER LASER TRANSDUCERS

⚠WARNING Contact with moving parts may cause severe injury or death. Keep hands, legs and feet away from moving parts

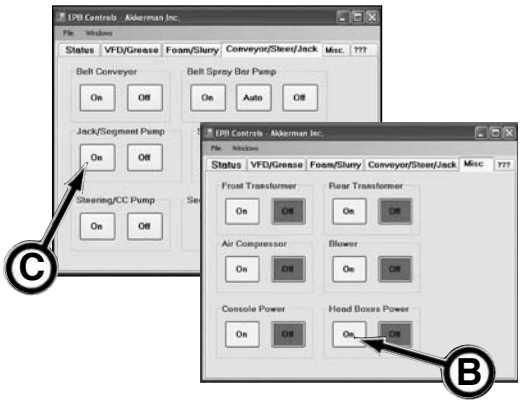
If the displayed value on the thrust cylinder laser transducer (A) (total of six transducers) does not match the physical measurement of the cylinder extension/retraction, or when replacing a cylinder, you must reprogram the laser transducer(s).

Use the following procedure for programming the thrust cylinder laser transducers.

NOTICE A ball point pen is required for pressing the programming buttons on the transducers.



1. The transducers must be powered on for at least 15 minutes before re-programming:
   a. from the EPB control screen, press the Head Boxes Power ON button (B) under the tab, Misc,
   b. and press the Jack/Segment Pump ON button (C) under the tab Conveyor/Steer/Jack.

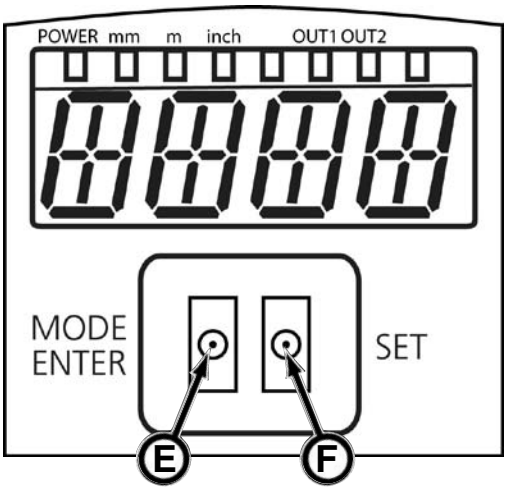


2. Clean transducer lens.

3. Be sure laser is positioned on target (cylinder pad [D]) and there are no objects obstructing the laser.

4. Fully retract cylinders and record value displayed on transducer noting cylinder number.

5. Fully extend cylinders and record value displayed on transducer noting cylinder number.



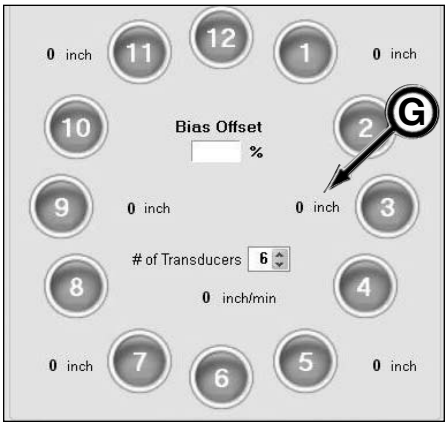
6. Press the ‘Mode/Enter’ button (E) (approx 9 times) until ‘ASP’ is displayed.

7. Press the ‘Set’ button (F) and keep it pressed. The current parameter flashes for 5 seconds, and then begins to increase. Continue holding or pressing briefly to increment the numbers until the fully retracted cylinder value is displayed. (Note: If the current parameter is higher than the desired value, continue holding ‘Set’, the value will eventually max out and restart at 0.)

8. Briefly press ‘Mode/Enter’ which will make this new value set point effective.

9. Press the ‘Mode/Enter’ button (approx 10 times) until ‘AEP’ is displayed.

10. Press the ‘Set’ button and keep it pressed. The current parameter flashes for 5 seconds, and then begins to increase. Continue holding or pressing briefly to increment the number until the fully extended cylinder value is displayed. (Note: If the current parameter is higher than the desired value, continue holding ‘Set’, the value will eventually max out and restart at 0.)



11. Briefly press ‘Mode/Enter’ which will make this new value set point effective.

12. Confirm that the value displayed on the control screen matches the stroke of the cylinder.

ABOVE GROUND MONITOR COMMUNICATIONS

Above ground monitors are provided to view the operator station car #2 control screens via ethernet cable.

Since ethernet cable has a limited distance to transfer data, two ethernet extenders are equipped (located in the 240V Box of the Switch Gear car #5 and typically in the above ground office trailer), to make longer distance communications possible.

It will be necessary to reconfigure the DIP (dual in-line package) switch settings on your ethernet extenders depending on the distance of the ethernet cable.

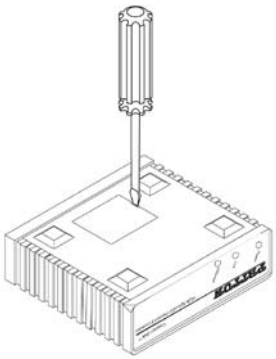
Before reconfiguring the DIP switches, be sure to check that all ethernet connections are secure and the ethernet extender is powered.

Normally:
• If the data is transferring slow, change the DIP switch settings to a shorter distance.

• If data is garbled, change the DIP switch settings to a longer distance.

To change the DIP switch settings:

1. To access the DIP switches, remove protective cover from bottom of extender as shown.



2. Change the DIP switch settings* on BOTH ethernet extenders as shown based on the length of the ethernet cable used. The DIP switch settings **MUST** be the same on both ethernet extenders otherwise data will not transfer.

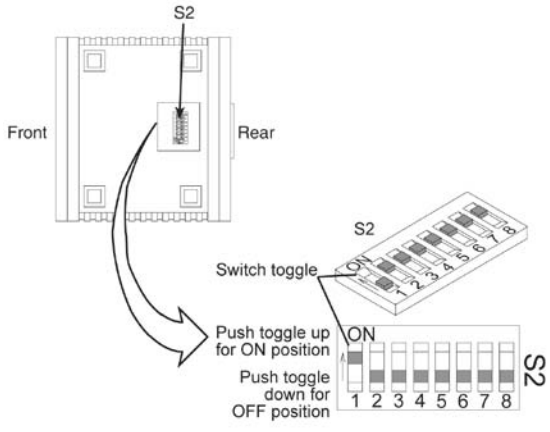
   • Push toggle up for ON position.
   • Push toggle down for OFF position.

3. Replace protective cover.

DIP SWITCH

Cable Length	1	2	3	4	5	6	7	8
800 ft	ON	ON	ON	ON	ON	ON	ON	OFF
2000 ft	ON	ON	OFF	ON	ON	ON	ON	OFF
4000 ft	ON	OFF	OFF	ON	ON	ON	ON	OFF
6000 ft	OFF	OFF	OFF	ON	ON	ON	ON	OFF

* This chart is the DIP switch settings for the Patton CopperLink™ Model 2172 Ethernet Extender.



VOLTAGE LOSS IN TUNNEL

When the 4160 voltage drops below an acceptable power level, the tunnel lights may flicker and/or unusual equipment malfunctions may occur.

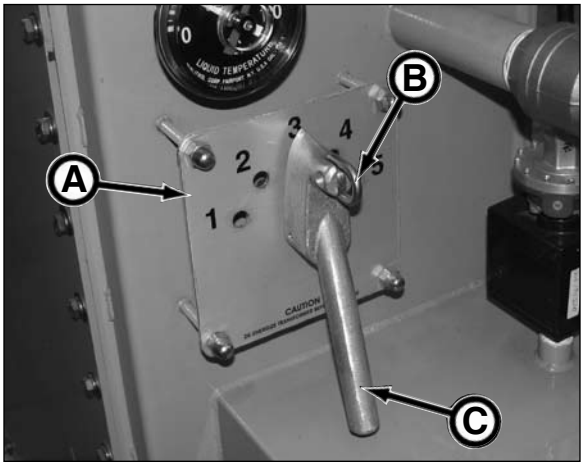
This voltage drop occurs once the transfer of electricity from the Power Container to the Blower Car #13 becomes too far to transmit the full power efficiently, resulting in a voltage line loss. Therefore, the voltage must be adjusted to compensate for this voltage line loss.

BEFORE making any voltage adjustment, contact your Akkerman product Support representative regarding this voltage loss. There may be other factors causing this voltage loss.

⚠DANGER Failure to lockout/tagout power before adjusting voltage may cause machine damage resulting in severe injury or death.

1. Shut down tunnel power and perform lockout/tagout procedure.

2. Access the voltage adjuster (A) on the Front Transformer Car #9.



3. Pull out adjustment lock (B) and move adjuster handle (C) to desired tab position, based on the distance from Power Container to Blower Car #13, as shown in the table below:

Distance	Voltage Adjustment Tab Position	Secondary Voltage Output
0 - 2,499 ft	3	480
2,500 ft - 4,999 ft	4	492
5,000 ft - 7,499 ft	5	504

4. Lock new adjustment position by releasing adjustment lock into tab position. Be sure to check adjustment lock by making sure adjustment handle does not move from new position.

5. Access voltage adjuster on Rear Transformer Car #10.

6. Follow steps 3 and 4 to adjust the voltage for Rear Transformer Car #10.

IMPORTANT: BOTH transformer car voltage adjusters **MUST** be set to the same setting. Failure to do so will cause components to be unsynchronized, resulting in reduced power efficiency.

7. Power can now be reenergized by following the Daily Electrical System Start-Up procedure in this section.

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

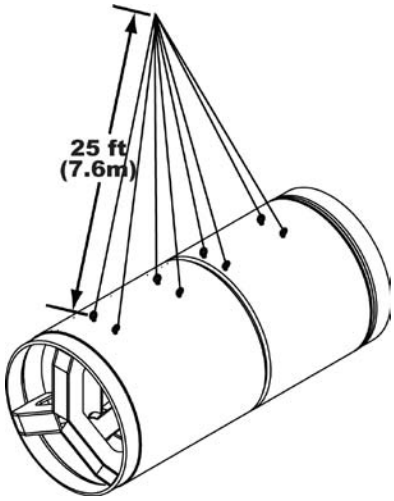
1. Earth Pressure Balance Machine

- EPB Machine (EPBM) weight is 133,000 lbs. (60,328 kg).

- Lifting with a crane requires an eight 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.



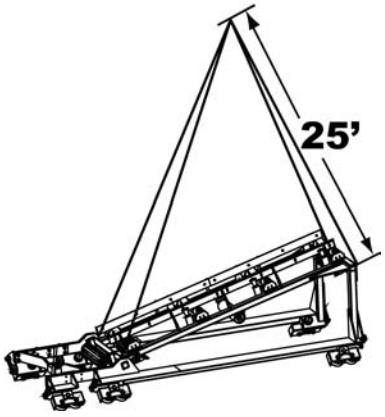
2. Inclined Conveyor Car #1

- Car weight is 6,300 lbs. (2,858 kg).

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



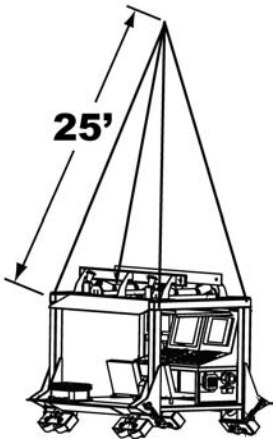
3. Operator Station Car #2

- Car weight is 4,400 lbs. (1,996 kg).

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



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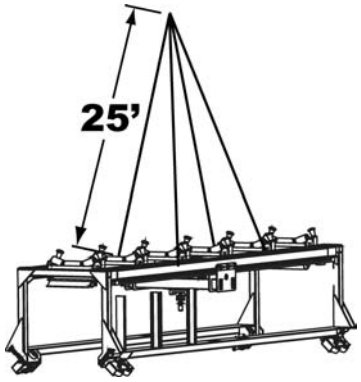
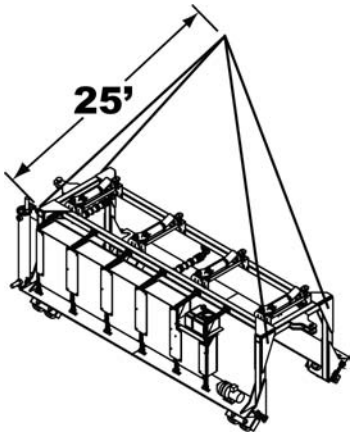
4. Segment Handling Car #3



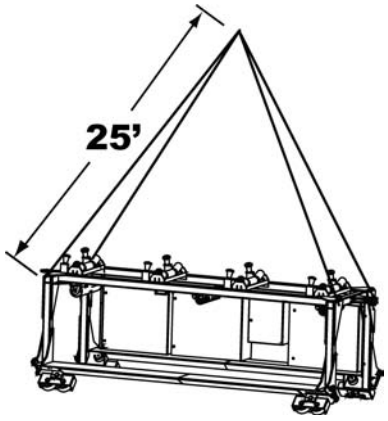
- Car weight is 7,100 lbs. (1,996 kg).
- Lifting with a crane requires a four part sling with legs a minimum of 25 ft. (7.62m) long.
- Car must lift freely. If it is stuck to the ground, it must be broken loose prior to lifting.
- Lifting eyes must be inspected prior to each lift. Any damage must be repaired prior to lifting.

5. VFD Car #4



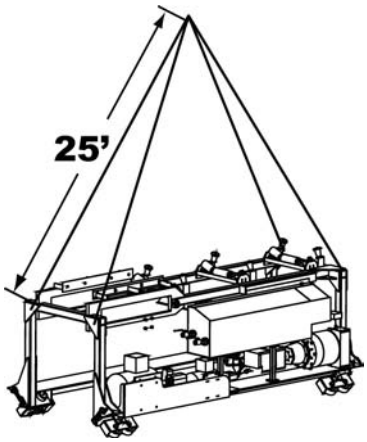
- Car weight is 8,400 lbs. (3,810 kg).
- Lifting with a crane requires a four part sling with legs a minimum of 25 ft. (7.62m) long.
- Car must lift freely. If it is stuck to the ground, it must be broken loose prior to lifting.
- Lifting eyes must be inspected prior to each lift. Any damage must be repaired prior to lifting.

6. Switch Gear Car #5



- Car weight is 9,000 lbs. (4,082 kg).
- Lifting with a crane requires a four part sling with legs a minimum of 25 ft. (7.62m) 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.

7. Front Hydraulic Car #6

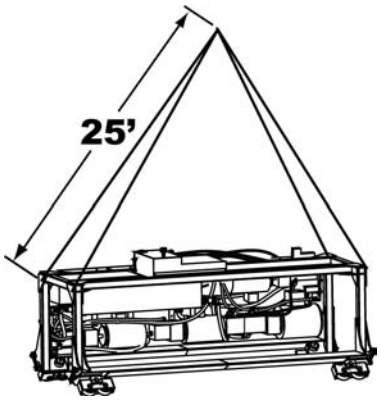


- Car weight is 13,400 lbs. (6,078 kg).
- Lifting with a crane requires a four part sling with legs a minimum of 25 ft. (7.62m) long.
- Car must lift freely. If it is stuck to the ground, it must be broken loose prior to lifting.
- Lifting eyes must be inspected prior to each lift. Any damage must be repaired prior to lifting.

(continued on next page)

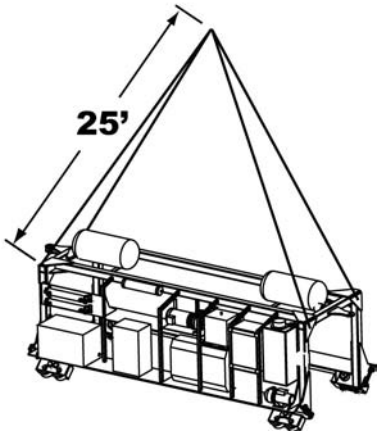
8. Rear Hydraulic Car #7

- Car weight is 14,900 lbs. (6,759 kg).
- Lifting with a crane requires a four part sling with legs a minimum of 25 ft. (7.62m) 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.



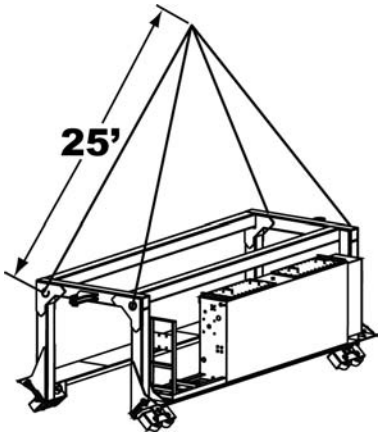
9. Foam Car #8

- Car weight is 7,500 lbs. (3,402 kg).
- Lifting with a crane requires a four part sling with legs a minimum of 25 ft. (7.62m) 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.



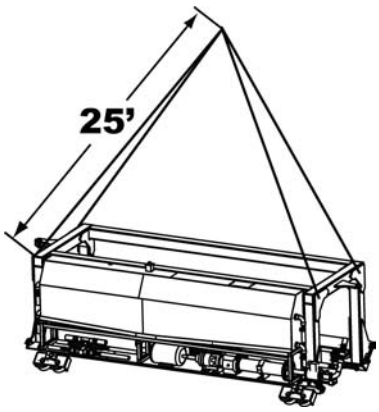
10. Front & Rear Transformer Cars #9 & #10

- Car weight is 15,000 lbs. (6,804 kg).
- Lifting with a crane requires a four part sling with legs a minimum of 25 ft. (7.62m) 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.



11. Front Slurry Car #11

- Car weight is 10,600 lbs. (4,808 kg).
- Lifting with a crane requires a four part sling with legs a minimum of 25 ft. (7.62m) 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.



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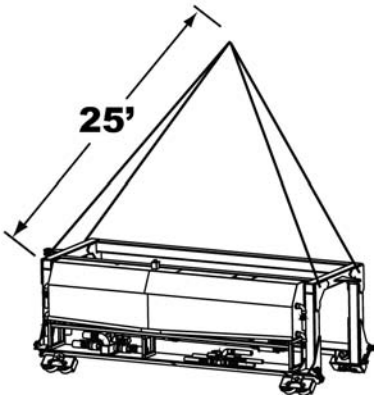
12. Rear Slurry Car #12

- Car weight is 8,900 lbs. (4,037 kg).

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



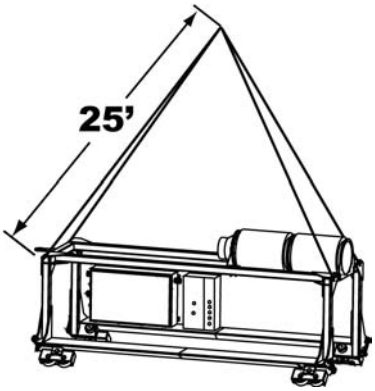
13. Blower Car #13

- Car weight is 6,350 lbs. (2,880 kg).

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



14. Power Container

- Container weight is 15,200 lbs. (6,895 kg).

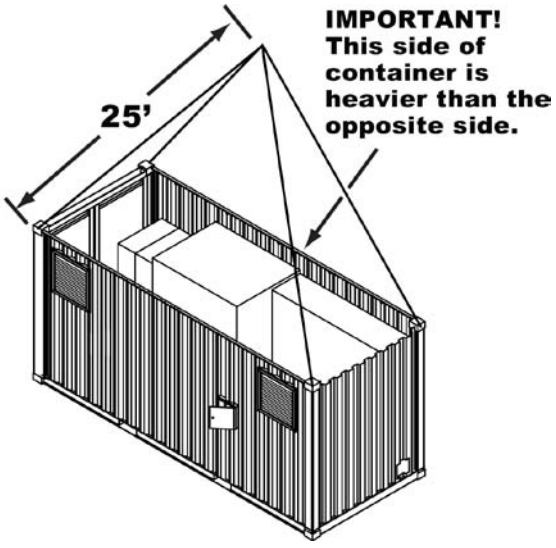
- BEFORE lifting, note that the left side of container is heavier than the right side.

- BEFORE lifting, all container doors MUST be closed.

- Lifting with a crane requires a four part sling with legs a minimum of 25 ft. (7.6m) long.

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

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



NOTES

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 on cars #6 and #7 are filled with Condat® D 68. This hydraulic oil is a fire resistant, biodegradable, non-toxic, synthetic hydraulic fluid.

Use Condat® D 68 hydraulic oil or equivalent when adding or changing lubricant.

NOTICE Do not mix oil manufacturers or grades.

Front Hydraulic car #6 oil reservoir capacity is 95 gal. (360L).

Rear Hydraulic car #7 oil reservoir capacity is
- Main: 95 gal. (360L)
- Auxiliary: 45 gal. (170L)

⚠WARNING On rear hydraulic car #7, check oil level and refill ONLY when jacking cylinders are fully retracted. Failure to do so could result in serious injury and machine damage from a ruptured hydraulic reservoir.

Recommended hydraulic oil:

Ambient Temp.	Hydraulic Oil
-25°F to 80°F	ISO 32
-10°F to 95°F	ISO 46
0°F to 105°F	ISO 68

NOTICE If a significant drop in operating efficiency is noticed and the hydraulic reservoir temperature is above 150°F, either increase cooling capacity, reduce load or increase oil viscosity.

Front Hydraulic Car #6 Hydraulic Fill & Reservoir

Rear Hydraulic Car #7 Hydraulic Fill & Main Reservoir

Rear Hydraulic Car #7 Auxiliary Reservoir

VFD COOLANT

The VFD coolant reservoir (located on VFD car #4) is filled with a mixture of distilled water and Cortec® VpCI™ -649. The VpCI™ -649 is a concentrated, multimetal water-soluble inhibitor recommended for closed loop systems.

Use a Cortec® VpCI™ -649 mixture or equivalent when adding or changing the liquid.

NOTICE Do not mix oil manufacturers or grades.

The VFD coolant reservoir capacity is 6 gal. (22.7L) filled with a mixture of distilled water with 2,000 - 3,000 ppm (0.2 - 0.3%) of Cortec® VpCI™ -649.

MAIN GREASE LUBRICATION SYSTEM GREASE

The main grease lubrication system grease barrel (located between Switch Gear Car #5 and Front Hydraulic Car #6) is Condat® GR 217 EP1. This grease is a biodegradable multipurpose grease designed for mechanical components working under heavy loads and in the presence of water.

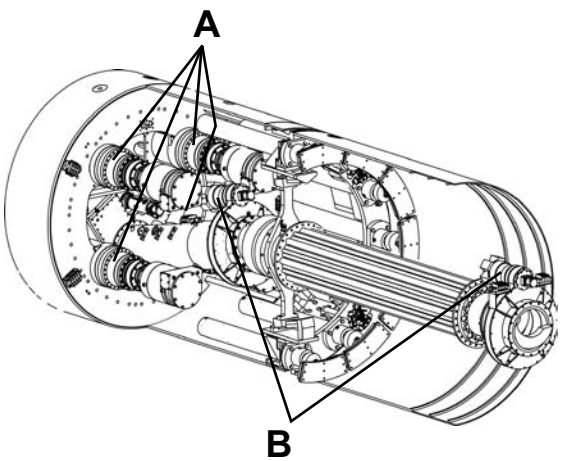
Use Condat® GR 217 EP1 grease or equivalent when replacing the main grease lubrication system grease barrel.

The main grease lubrication system lubricates the following components:

- EPBM main bearings
- main bearing seals
- bearing gear ring and drive pinions
- steering joint
- cutterhead fluid swivel
- screw conveyor bearings
- screw conveyor #1 and #2 articulation joint
- screw conveyor #1 front gate
- copy cutters

PLANETARY DRIVE LUBRICANT

The EPB main planetary drive (A) (4 places) and the screw conveyor planetary drive (B) (2 places) are filled with Mobil® SHC 630 Synthetic Bearing and Gear Oil.



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

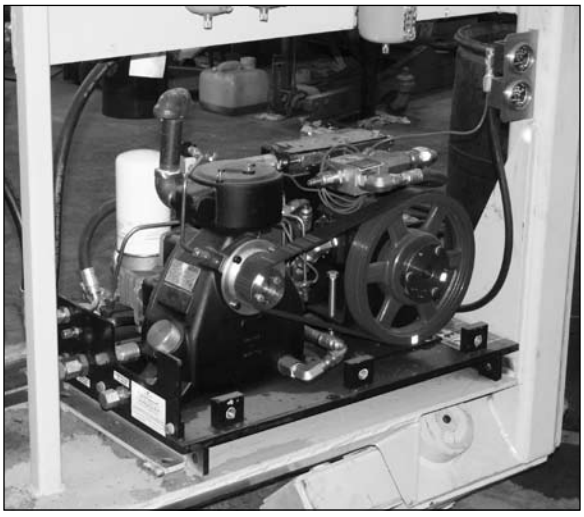
NOTICE The Mobil® SHC 630 Synthetic Bearing and Gear oil is a synthetic oil specifically designed for this application. If you change to a different oil, use a reputable oil supplier to meet or exceed the Mobil SHC 630 oil specification. Do not mix oil manufacturers or grades.

TAIL SEAL GREASE

The tail seal grease barrel (located on Inclined Conveyor Car #1) is Condat® WR 89 Tail Seal Grease. This grease is for tunneling machine tail seals and has been specially designed to provide static and dynamic seal against water, mucking, slurry and all grouts. WR 89 is a biodegradable and non-toxic grease.

Use Condat® WR 89 grease or equivalent when replacing the tail seal grease barrel.

AIR COMPRESSOR LUBRICANT



The air compressor oil sump (located on Foam car #8) is filled with Vanguard™ High Performance Rotary Screw Compressor Oil. This is a synthetic blend oil designed to provide exceptional lubrication during hot or severe service and controls fluid oxidation.

Use Vanguard™ High Performance Rotary Screw Compressor Oil or equivalent when adding or replacing the air compressor oil.

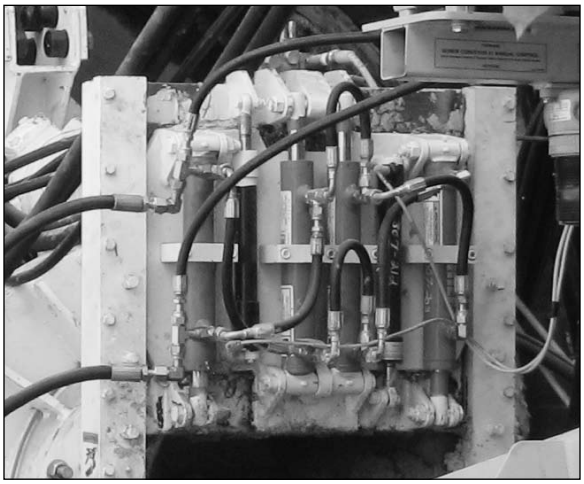
NOTICE Do not mix oil manufacturers or grades.

The oil sump capacity is 2.5 qts. (2.4 L).

Check oil level first thing in the morning before starting air compressor. The correct oil level is minimum to bottom threads on oil fill port up until oil runs out of port.

NOTICE The air compressor housing was removed for photographic purposes only. Never operate the air compressor without housing bolted in place.

CONVEYOR GATE LUBRICANT



The conveyor gate is lubricated with Mobilgrease® XHP222 Premium Lubricating Grease.

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

EPBM CUTTERHEAD SWIVEL LUBRICANT

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

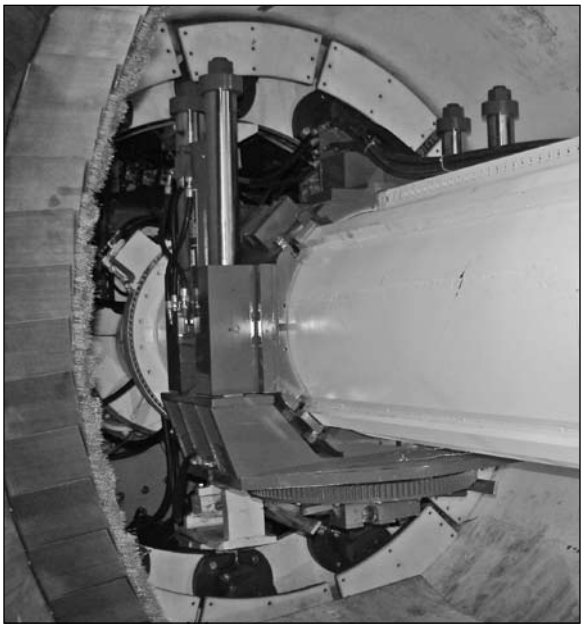
Use Mobilgrease® XHP222 Premium Lubricating Grease or equivalent when lubricating the swivel.

STEERING CYLINDER LUBRICANT

The steering cylinders (A) are lubricated with Mobilgrease® XHP222 Premium Lubricating Grease.

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

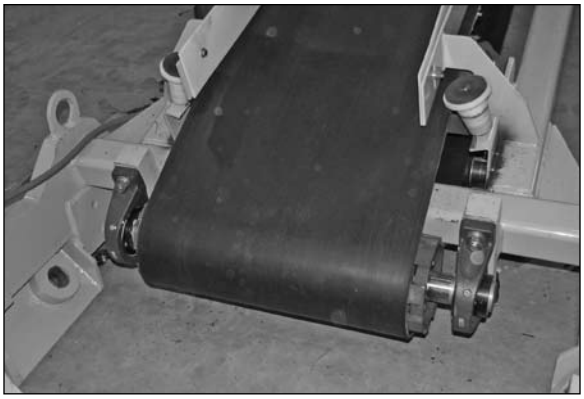
SEGMENT ERECTOR LUBRICANT



The segment erector is lubricated with Mobilgrease® XHP222 Premium Lubricating Grease.

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

BELT CONVEYOR LUBRICANT



The belt conveyor is lubricated with Mobilgrease® XHP222 Premium Lubricating Grease.

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

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.

All lubricants must be stored at least 100 ft (30.5 m) from the portal, or entrance to the tunnel.

NOTES

Periodic Maintenance

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

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

LUBRICATION & MAINTENANCE INTERVALS

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

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

BEFORE PERFORMING MAINTENANCE

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

2. Relieve hydraulic pressure.

3. Perform appropriate electrical system maintenance shutdown procedure. Refer to Electrical System Maintenance Shutdown for the 110V/240V/480V or 4160 Systems in the Operation section.

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/TAGOUT POWER BEFORE SERVICING

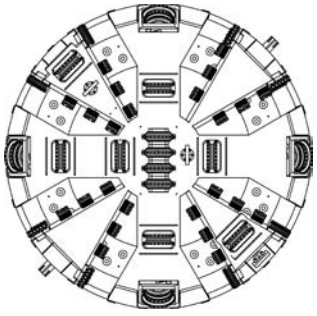
⚠WARNING Severe personal injury or death can result from unexpected pump unit start-up or machine movement.

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

CUTTERHEAD MAINTENANCE

⚠DANGER Anyone in the area between the cutterhead and the EPB bulkhead while the cutterhead is rotating WILL BE KILLED.

BEFORE entering this area, you MUST perform lockout/tagout, and remove cutterhead fuses in switch gear car (480V Box 1 and 480V Box 2).



HYDRAULIC OIL/FLUIDS UNDER PRESSURE

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

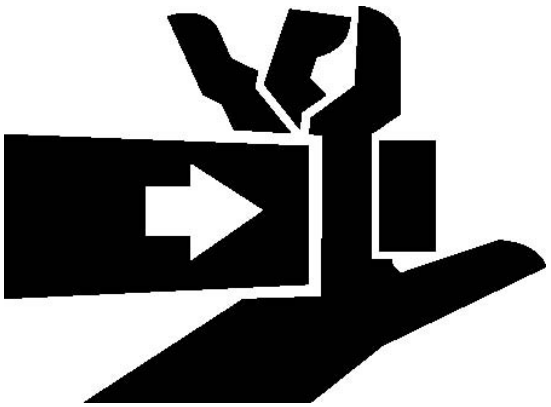
Release all pressure before performing maintenance or repairs. Never weld near pressurized fluid lines.

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 and/or electrical component failure resulting in possible injury or death.

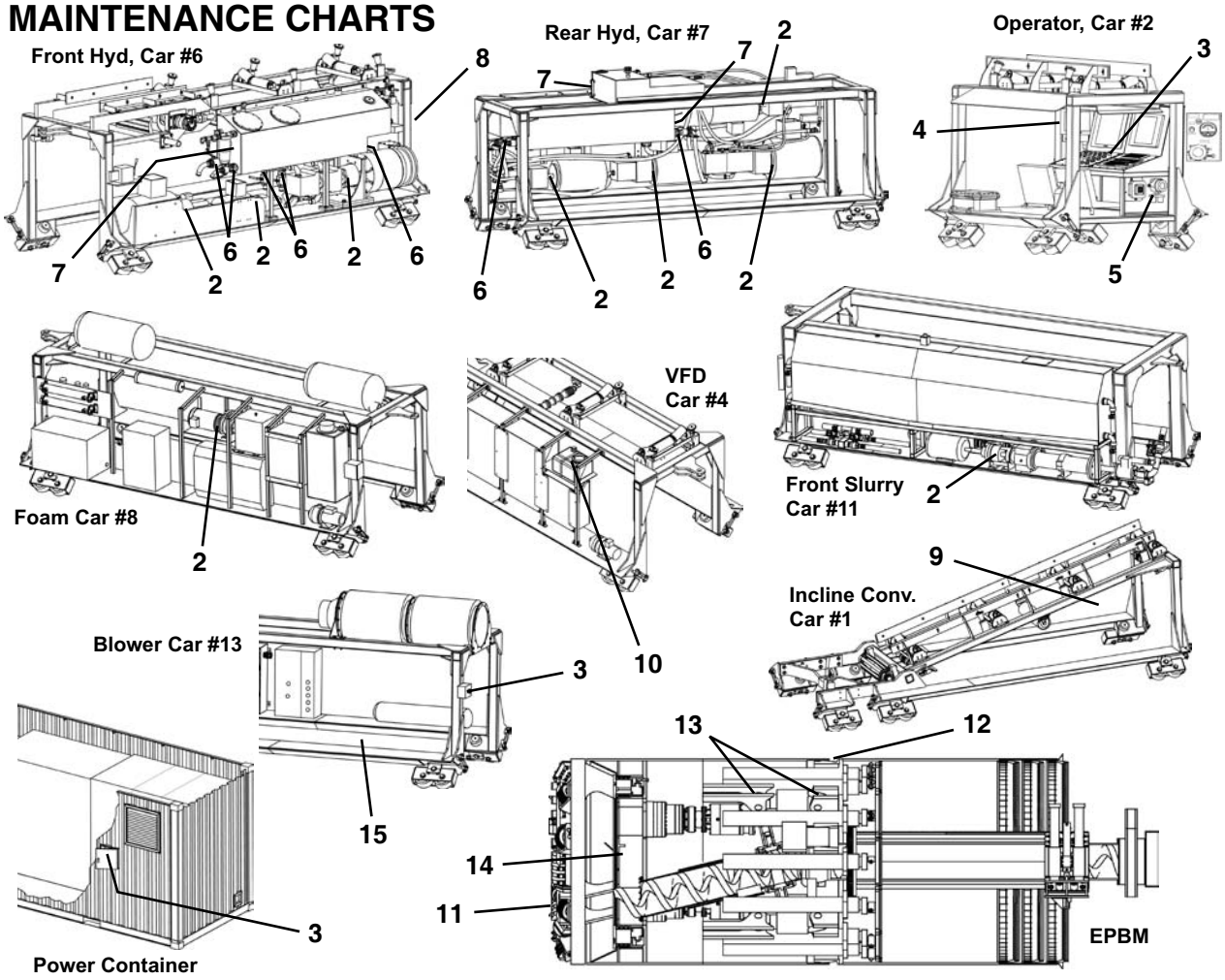
Do not weld on any structural member. Unauthorized welding or repair will void the warranty.

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



PRIOR TO EACH DRIVE LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
*1.	Pre-Start	Perform Pre-Start Inspection	Refer to section 5.	
2.	Control System	Verify Motor Rotation & Phase Monitor	All electric motors.	
3.	E-Stop Operation	Check All E-Stop Controls		
4.	Target	Refer to TACS manual		
5.	Gas Detector	Test Operation	See Gas Detection Manual	
6.	Hyd Reservoir Pump Screens	Clean		
**7.	Hydraulic Reservoirs	Check Oil Level	Fill as necessary. **	Condat® D 68
8.	Main Bearing Grease System	Check Barrel Level & Cycle System		Condat® GR 217 EP1
9.	Tail Seal Grease System	Check Barrel Level & Cycle System		Condat® WR 89
10.	VFD Coolant Res.	Check Reservoir Level	Fill as necessary.	Cortec® VpCI-64
11.	EPBM	Inspect Cutter Teeth & Surfaces	Repair or replace as necessary.	
12.	Steering Joint	Clean/Lubricate	Check for leaks and seal wear.	
13.	Steering Cylinders	Lubricate (8 places)	1-2 shots	Mobil® XHP222
14.	Swivel Grease Block #6	Lubricate (1 place)	10 shots	Mobil® XHP222
15.	Lights	Test Lamp Operation		

Use ONLY Condat® GR 217 EP1

* Not Shown ** **On Car 7 reservoir, check and fill ONLY when jacking cylinders are fully retracted.**

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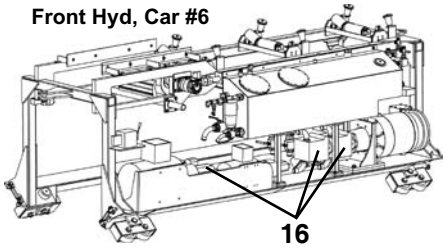

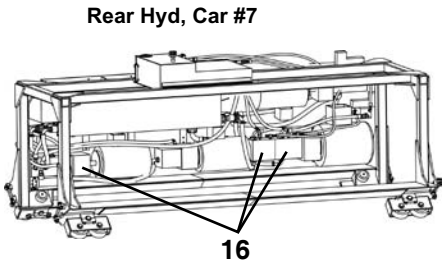

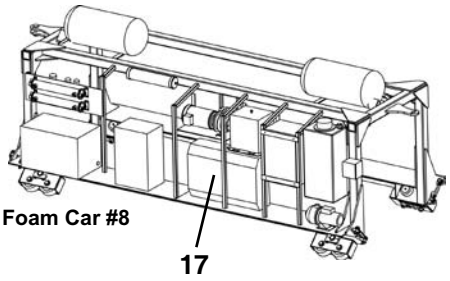

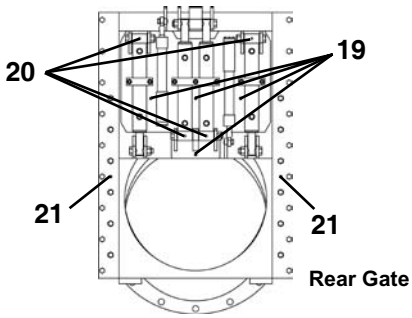

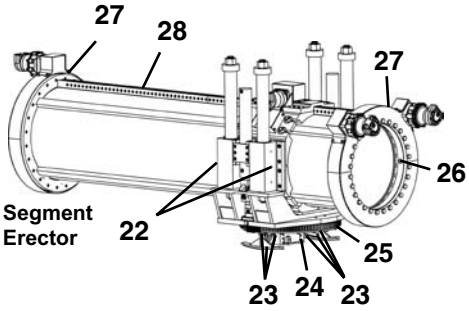

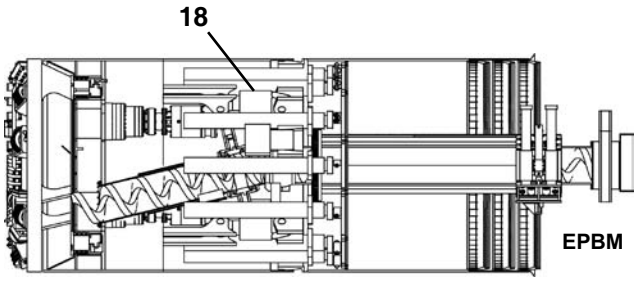

PRIOR TO EACH DRIVE LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
16.	Hydraulic Pump	Check Relief Settings	High and standby pressure.	See section 12.
17.	Foam Generator Equipment	Inspect Strainers/Filters	Refer to Condat® manual.	
18.	Steering Cylinders	Check Operation	Extend & retract-Verify on screen values agree with cyl position.	
19.	Rear Gate	Lubricate (4 places)	2 Shots each	Mobil® XHP222
20.	Gate Cylinder	Lubricate (4 places)	2 Shots each	Mobil® XHP222
21.	Gate Slide	Lubricate (2 places)	2 Shots each	Mobil® XHP222
22.	Arm Stabilizer	Lubricate (4 places)	2 Shots each	Mobil® XHP222
23.	Segment Stabilizer	Lubricate (6 places)		Lube Spray
24.	Segment Ball Latch	Lubricate (1 place)	Spot Grease	Mobil® XHP222
25.	Segment Rotator Gear Ring	Lubricate (1 place)		Lube Grease Graphite Spray
26.	Erector Bearing	Lubricate (2 places)	2 Shots	Mobil® XHP222
27.	Swing Gear Ring	Lubricate (2 places)		Lube Grease Graphite Spray
28.	Rack & Pinion	Lubricate		Lube Grease Graphite Spray
*29.	Hydraulic Hoses	Inspect	Replace if cracks/wear visible.	
*30.	Cables	Inspect Pin/Socket Prior To Mating	Clean & Dry As Necessary	

* Not Shown

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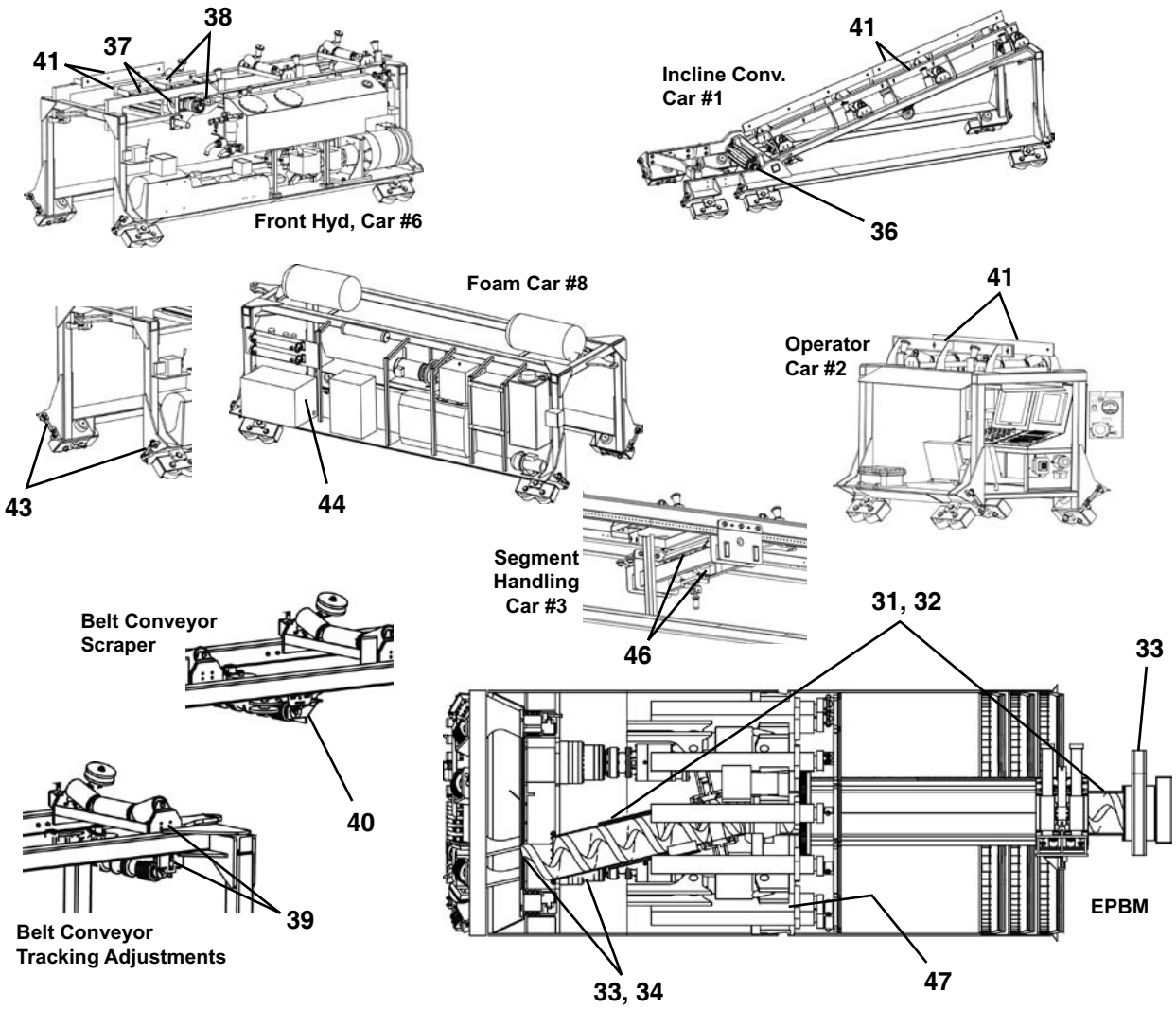
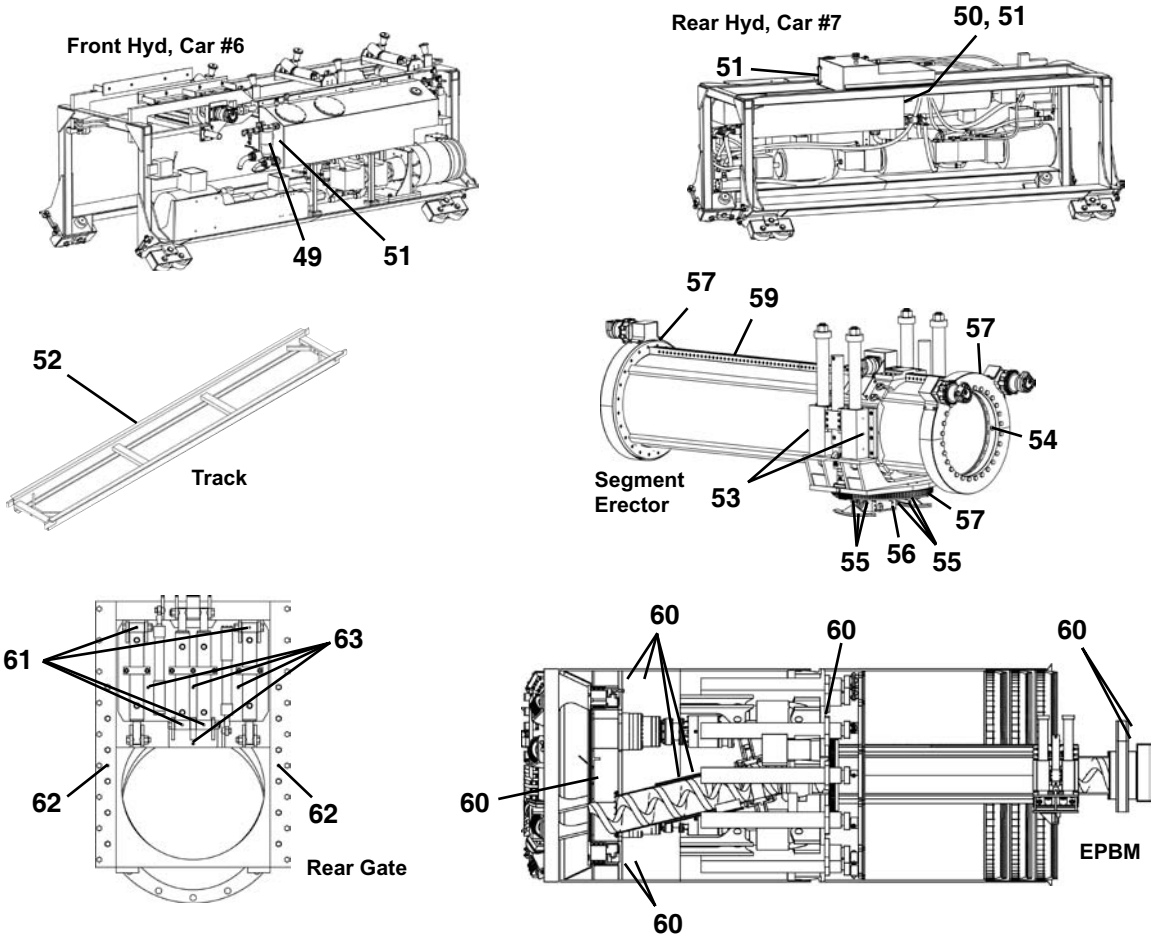


PRIOR TO EACH DRIVE LAUNCH

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
31.	S Conveyor Flighting	Inspect	If damaged, repair or replace.	
32.	S Conveyor Casing	Inspect	If damaged, repair or replace.	
33.	S Conveyor Gates	Inspect	If damaged, repair or replace.	
34.	S Conveyor Covers	Inspect	If damaged, repair or replace.	
*35.	Belt Conveyor	Inspect & Clean	If damaged, repair or replace.	
36.	B Conv. Frnt Bearing	Lubricate (2 places)		Mobil® XHP222
37.	B Conv. Drive Assy.	Lubricate (2 places)		Mobil® XHP222
38.	Belt Tension	Check & Adjust If Needed		
39.	Belt Tracking	Check & Adjust If Needed		
40.	Belt Scrapers	Check & Adjust If Needed		
41.	Belt Guides	Check & Adjust If Needed		
*42.	Belt Splice	Check & Adjust If Needed		
43.	Cars	Check Alignment	ALL cars must be level.	
44.	Air Compressor	Check Oil Sump Level	Add if necessary.	Vanguard High Performance Rotary Screw Compress. Oil
*45.	Haul System and Other Support	Perform Maintenance	Refer to your machine's maintenance manual.	
46.	Segment Lift Winch	Inspect Cable & Mtg Bolts	If damaged, replace with new.	
47.	Transport Winch	Inspect Cable & Mtg Bolts	If damaged, replace with new.	

* Not Shown



DAILY OR EVERY 10 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
*48.	Hydraulic Hoses	Inspect	If damaged or worn, replace.	
49.	Car #6 Cooling Return Filter	Check Indicator	Replace filter per indicator.	
50.	Car #7 Cooling Return Filter	Check Indicator	Replace filter per indicator.	
**51.	Hyd. Reservoirs (Cars 6 & 7)	Check Oil Level & Temp.	Add if necessary. **	Condat® D 68
52.	Track	Inspect	If damaged, repair or replace.	
53.	Arm Stabilizer	Lubricate (4 places)	2 shots each	Mobil® XHP222
54.	Erector Bearing	Lubricate (2 places)	2 shots each	Mobil® XHP222
55.	Segment Stabilizer	Lubricate (6 places)		Lube Spray
56.	Segment Ball Latch	Lubricate (1 place)	Spot grease.	
57.	Segment Rotator Gear Ring	Lubricate		Grease Graphite Spray
58.	Segment Swing Gear Ring	Lubricate		Grease Graphite Spray
59.	Rack & Pinion	Lubricate		
60.	Grease Pump Systems	Inspect For Oil Cycling	Inspect distribution lines/fittings for leaks or damage.	
61.	Gate Cylinder	Lubricate (4 places)	2 shots	Mobil® XHP222
62.	Gate Slide	Lubricate (2 places)	2 shots	Mobil® XHP222
63.	Rear Gate	Lubricate (4 places)	2 shots	Mobil® XHP222

* Not Shown ** **On Car 7 reservoir, check and fill ONLY when jacking cylinders are fully retracted.**

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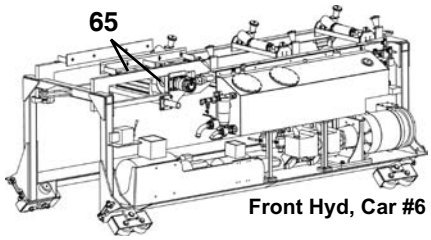
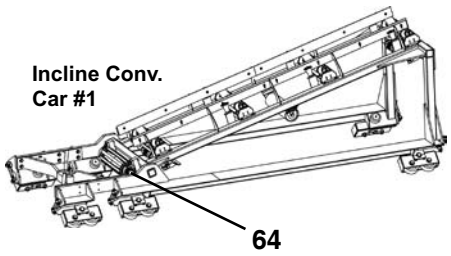
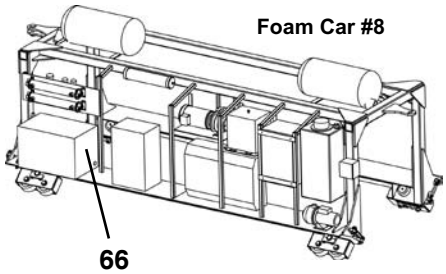


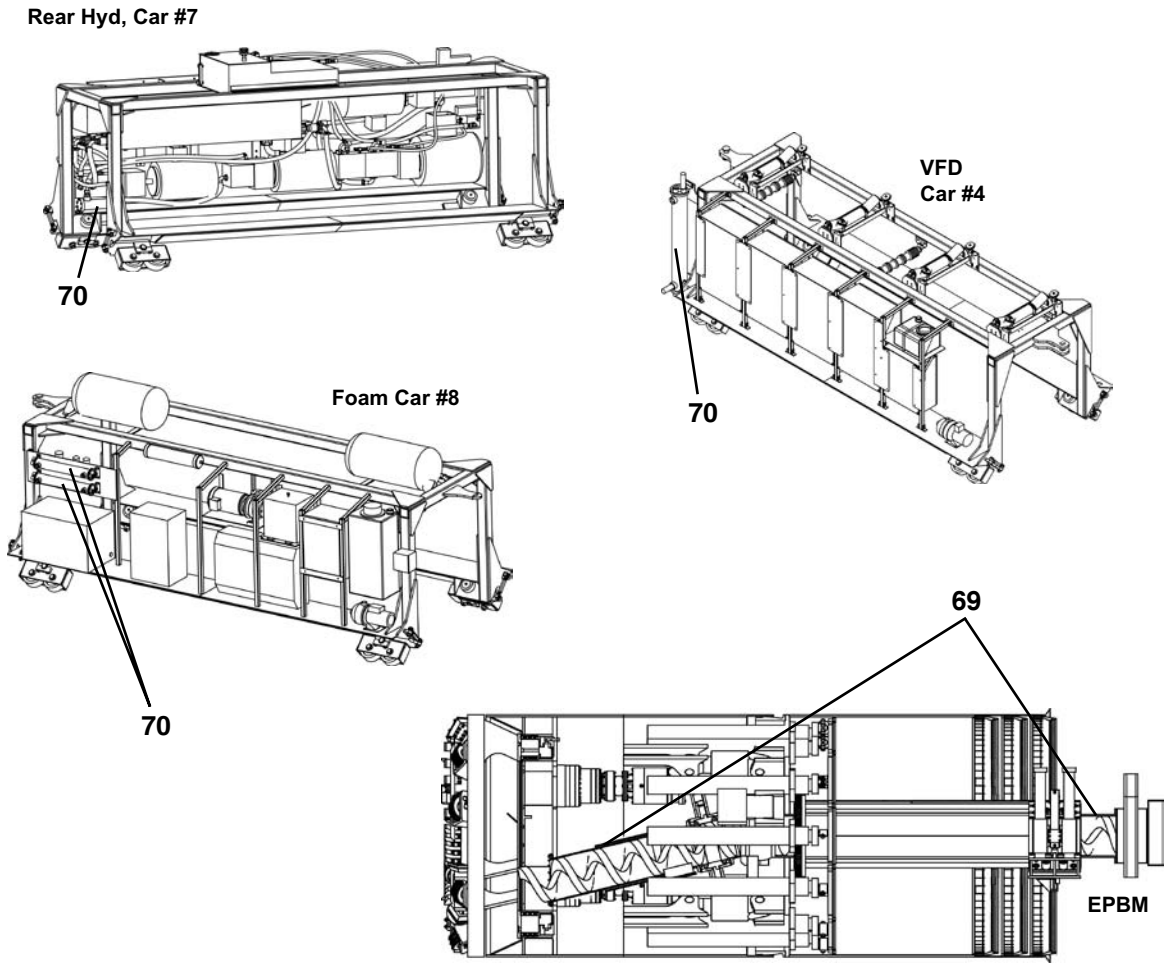




DAILY OR EVERY 10 HOURS OF OPERATION

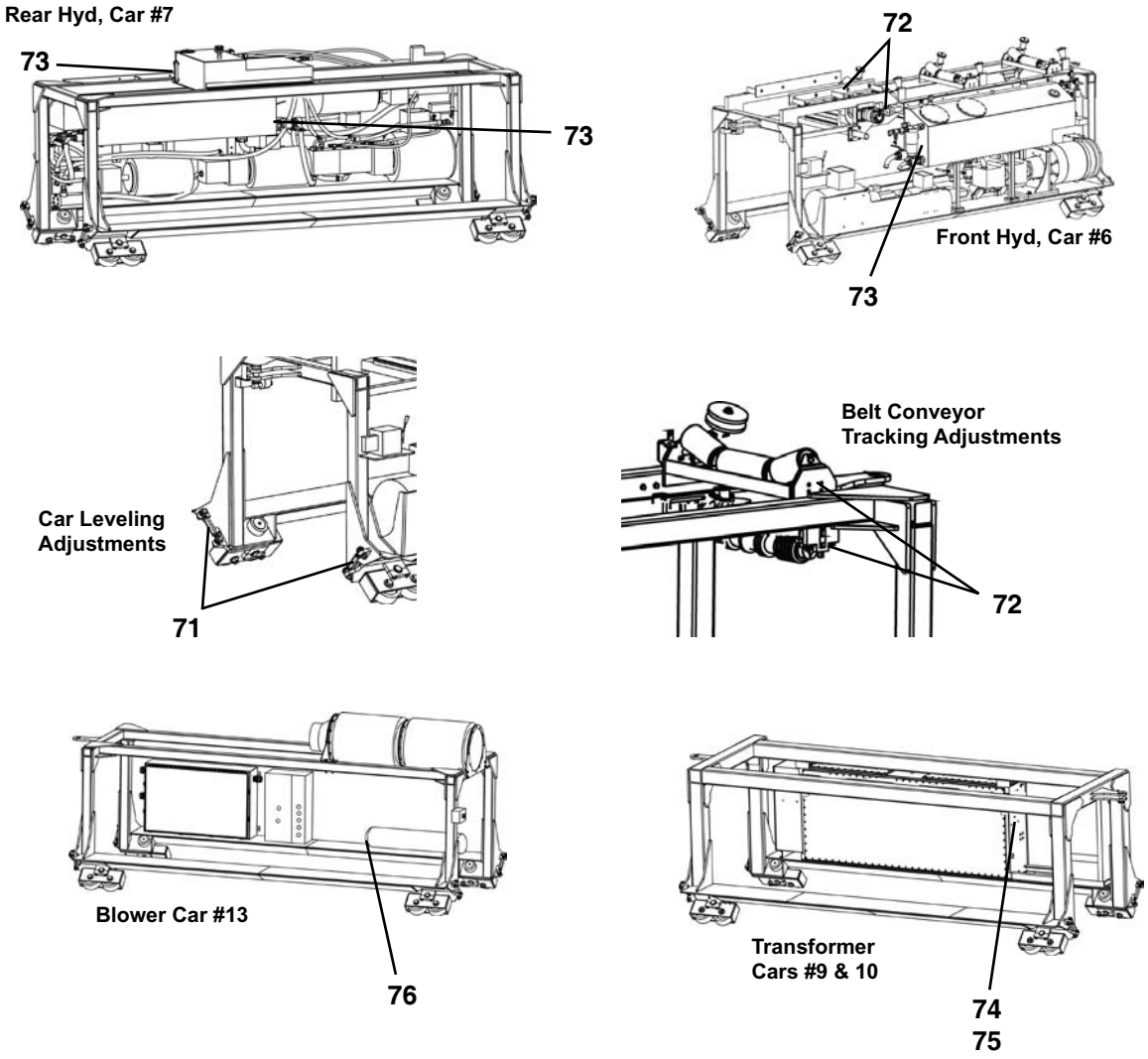
ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
64.	Belt Conveyor Block Bearing	Lubricate (2 places)	Lubricate until grease is forced out.	Mobil® XHP222
65.	Belt Conveyor Drive Pulley Brg.	Lubricate (2 places)	Lubricate until grease is forced out.	Mobil® XHP222
66.	Air Compressor Oil Sump	Check Level	Add if necessary.	Vanguard Compress. Oil
67.	Air Compressor Drive Belt	Check Tension		
68.	Air Compressor Pressure Gauge	Check Pressure	Approx. 150 psi.	

Periodically check Main Bearing Grease System and Tail Seal Grease System barrel levels. Replace barrels as needed.



END OF EACH DAY

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
69.	Screw Conveyor	Clean & Wash Conveyor		
70.	Heat Exchanger (Cooling System)	Drain	In freezing weather.	



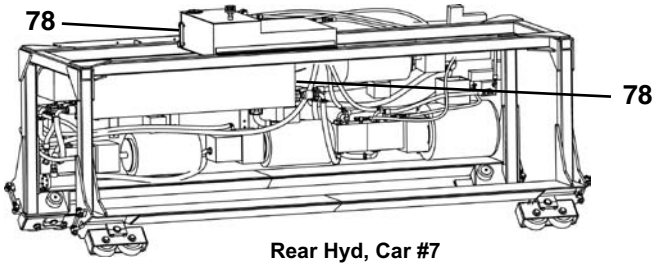
AFTER COMPLETION OF EVERY SEGMENT RING

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
71.	Cars	Check Alignment	ALL cars must be level.	
72.	Belt Conveyor	Check Tracking & Tension	Adjust as necessary.	
* 73.	Hydraulic Reservoirs	Check Oil Level & Temp.	Fill as necessary.	
** 74.	Transformer	Check Temperature Gauge	Max temp.: 100°C (212°F)**	
75.	Transformer	Check Oil Level	If LOW, shut down & troubleshoot.	
76.	Nitrogen Tank	Check Pressure	Replace as necessary.	

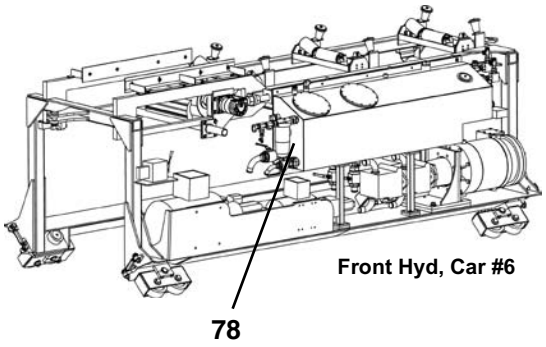
*** On Car 7 reservoir, check and fill ONLY when jacking cylinders are fully retracted.**

** The error messages Transformer1 is getting HOT, Transformer1 is HOT, Transformer2 is getting HOT, Transformer2 is HOT will display on the control screen when the transformer temperature reaches 60°C (140°F). When this occurs, monitor the transformer temperature gauge to make sure it does not exceed 100°C (212°F). Shut down the transformers at 100°C (212°F) and troubleshoot before restarting transformers.

- The white pointer on the gauge is the actual transformer temperature indicator. The red pointer on the gauge is the maximum indicating pointer which can be reset to determine the maximum temperature occurred between resets.



Rear Hyd, Car #7



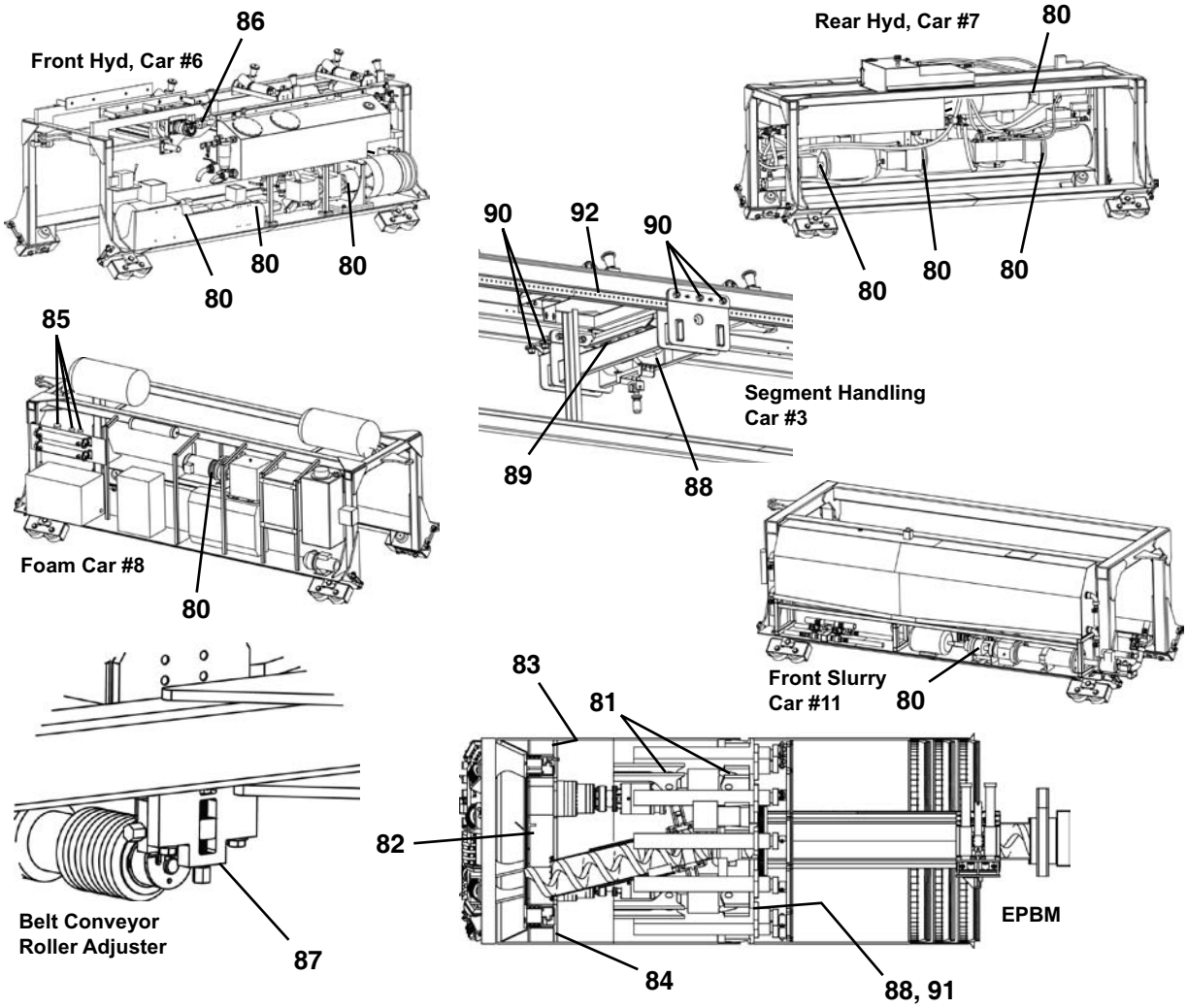
Front Hyd, Car #6

AFTER EVERY TUNNEL UTILITY INSTALLATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
*77.	Cables	Inspect Pin/Socket Prior To Mating		
**78.	Hydraulic Reservoirs	Check Oil Level & Temp	Add if necessary.**	Mobil® XHP222
*79.	Hydraulic Hoses	Inspect	If damaged or worn, replace.	

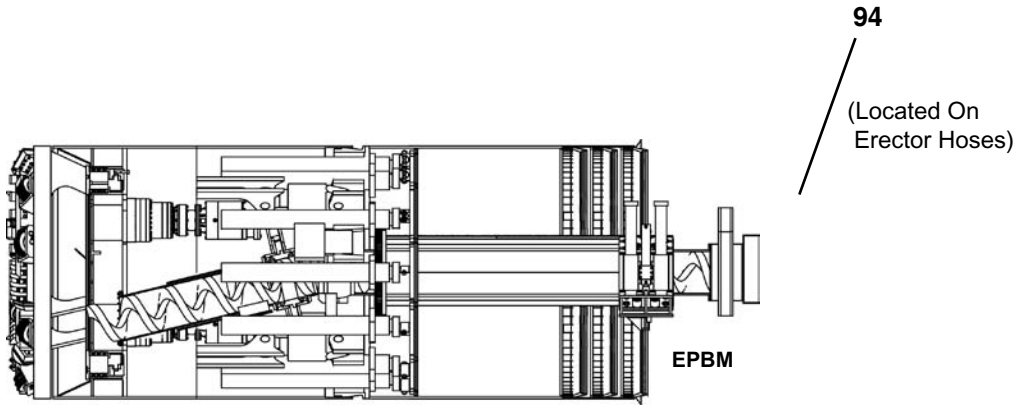
* Not Shown

** **On Car 7 reservoir, check and fill ONLY when jacking cylinders are fully retracted.**



WEEKLY OR EVERY 50 HOURS OF OPERATION

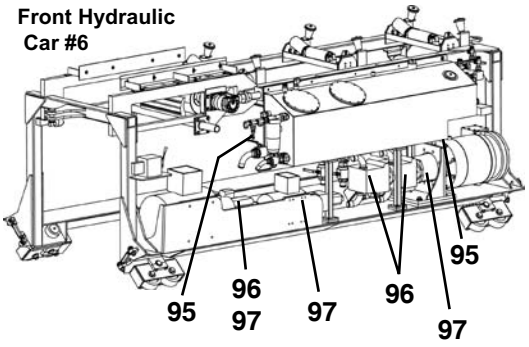
ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
80.	Electric Motors	Check	Ventilate openings clean & drain hole openings.	
81.	Steering Cylinders	Lubricate (8 places)	2 shots	Mobil® XHP222
82.	Swivel Grease Block #6	Lubricate (1 place)	10 shots	Mobil® XHP222
83.	Main Bearing Grease Cover	Inspect For Contamination		
84.	Main Bearing Grease Drain	Purge Grease		
85.	Air System Filters (3)	Inspect Indicator (Car 8)	Replace filter per indicator.	
86.	B. Conv. Tension Adjustment	Clean Threads & Lubricate		Lube Grease Graphite Spray
87.	Belt Conveyor Roller Adjuster	Clean & Lubricate		Lube Grease Graphite Spray
88.	Winch	Tighten Mounting Bolts	Tighten bolts to 75 ft-lb torque.	
89.	Segment Lift Winch	Inspect Cable	Min. of 5 safety wraps. If frayed or damaged, replace.	
90.	Track Rollers (16)	Tighten	Tighten until snug.	
91.	Segment Transport Winch	Inspect Cable	Min. of 5 safety wraps. If frayed or damaged, replace.	
92.	Rack	Clean & Lubricate		Lube Grease Graphite Spray

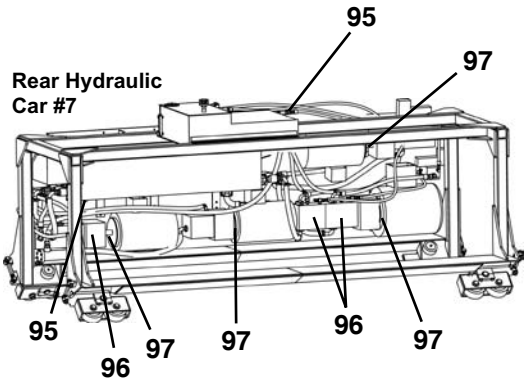


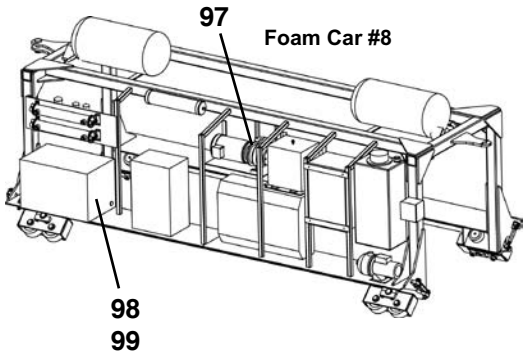
MONTHLY OR EVERY 250 HOURS OF OPERATION

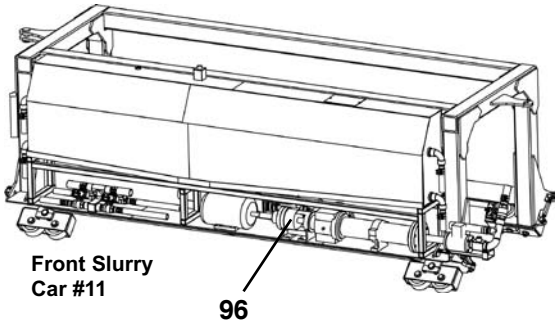
ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
*93.	Oil Analysis	Perform Analysis	Oil Sample	
94.	Erector In-Line Swivels (10)	Inspect Swivels	If worn, excessive play or leaking, replace.	

* Not Shown





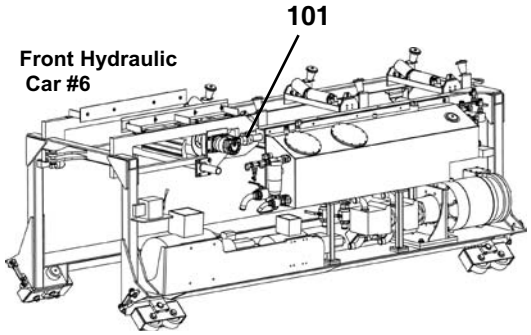


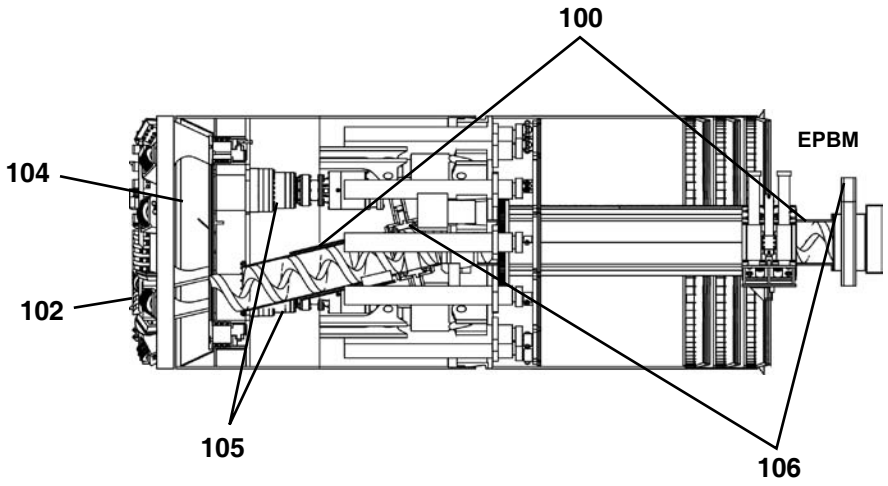


EVERY 500 HOURS OF OPERATION

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
* 95.	Hyd. Oil Reservoir Cars 6 & 7	Drain & Fill	Car 6 - 95 gal capacity Car 7* - main - 95 gal capacity aux - 45 gal capacity	Condat® D 68
96.	Load Sense Filters	Replace	Replace with new.	LS Filters
97.	Pump Drive Couplings	Inspect Dampener On Each Motor Drive	If worn or damaged, replace.	
98.	Air Compressor Oil Sump	Drain/New Filter/Fill		Vanguard Compress. Oil
99.	Air Compressor Cooler Core	Clean	Compressed air.	

*** On Car 7 reservoir, check and fill ONLY when jacking cylinders are fully retracted.**

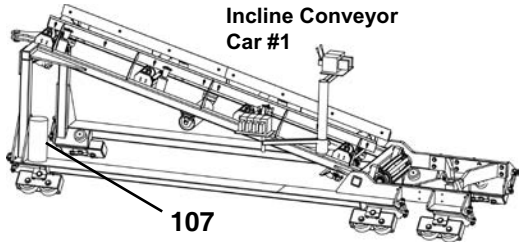


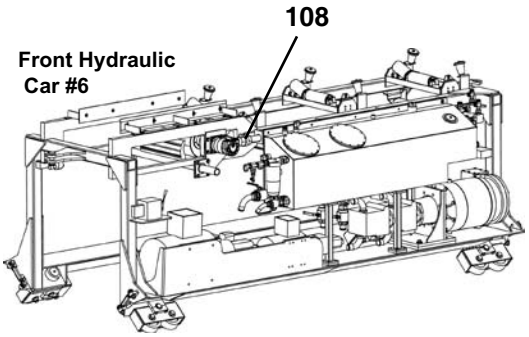


COMPLETION OF EACH DRIVE

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
100.	Conveyors	Clean/Empty		
101.	Belt Conveyor	Loosen Belt Tension		
102.	Cutters	Inspect For Wear/Damage	If damaged, repair or replace.	
*103.	Cables	Inspect For Wear/Cracks	If damaged, repair or replace.	
104.	Mixer Bar	Inspect For Damage	If damaged, repair or replace.	
105.	EPB Main Planetary Drive (4 places)	Drain & Fill	Once all planetaries are drained and filled, operate system to lubricate internal parts.	Mobil SHC 630
106.	Screw Conveyor Planetary Drive (2)	Drain & Fill	Once all planetaries are drained and filled, operate system to lubricate internal parts.	Mobil SHC 630

* Not Shown





AS REQUIRED

ITEM	COMPONENT	SERVICE	REQUIREMENT	MATERIAL
107. 108.	Accumulator Belt Conveyor	Recharge Hydraulic Oil Adjust Belt Tension	Hydraulic Charge: 2,000 psi	Condat® D 68

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.
12. Loosen belt on belt conveyor.
13. Refer to your Condat manual for foam system storage and your VanAir NK40 compressor manual for air compressor storage and other support equipment manuals for storage instructions.

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. Tighten belt tension on belt conveyor.
10. Review this Operator's Manual and all other equipment manuals before activating equipment from storage.

NOTES

Troubleshooting

EPBM

Problem	Cause	Solution
The jacking cylinders do not operate.	Pump motor not ON.	Turn on pump.
	Pump failure.	Repair or replace pump.
	Worn or damaged cylinder seals.	Replace seals.
	Relief valve leakage.	Repair or replace.
Operation of the jacking cylinder is not smooth.	Faulty operation valve.	Repair or replace.
	Decrease in pump output.	Repair or replace pump.
	Low hydraulic oil level.	Add oil.

HYDRAULIC PUMP

Problem	Cause	Solution
Electric motor overload.	Pressure setting is too high.	Reset pressure.
	Bearing of each section is damaged, & pump efficiency considerably lowered.	Replace bearing.
Decrease in the pump output.	Low standby pressure.	Adjust to proper setting.
Cannot obtain pump delivery pressure.	Low hydraulic oil level.	Add oil.
	Supply ball valve closed.	Open ball valve.
	Check load sense filter.	Change filter.
	Check load sense line.	Repair or replace.
	Standby pressure is low.	Adjust pressure.
	Relief valve failure.	Replace or reset the relief valve.
		Check oil leakage of all equipment.
	Drive coupling out of position.	Reposition coupling components.
Decrease in the pump output.	Damage of piston & connecting rod.	Replace piston sub-group.
Pump delivery pressure is not achieved.	Regulator failure.	Repair regulator.
	Worn or damaged pump.	Replace pump.

(continued on next page)

HYDRAULIC PUMP (Continued)

Problem	Cause	Solution
Oil leakage from oil seal.	Internal pressure in the casing is too high.	Lower pressure.
		Check if drain is clogged.
	Oil seal is damaged.	Replace seal.
	Shaft is damaged.	Replace shaft and seals.
Noisy pump.	Cavitation occurred.	Fully open supply ball valve.
		Inspect and repair pump.
	Worn drive coupling dampener.	Replace dampener.
	Damage to piston and connecting rod.	Replace piston & rod.
	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.
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.
	Low oil level.	Add oil.
Increase in oil temperature.	Lack of oil in tank.	Refill oil in tank.
	Excessive pressure.	Adjust to set pressure.
	No or low water pressure in cooling circuit.	Adjust flow and pressure.
	Low pressure.	Adjust to correct 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.
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.
	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.

(continued on next page)

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.

SCREW CONVEYOR

Problem	Cause	Solution
No spoils at discharge.	Check auger for rotation.	Correct operation.
	One auger stalled.	Check for rocks or obstructions.
	Operating pressure too low.	Adjust to proper setting.
	Cutterhead not advancing.	Advance cutterhead.
	Pump not on.	Turn on pump.
Auger in low speed operation.	Speed set too low.	Adjust console control for high speed.
	Rotational pressure too high.	Empty auger until pressure is reduced.
	Low standby pressure.	Adjust to 200-300 psi.
	Low relief pump setting.	Adjust relief to proper psi.

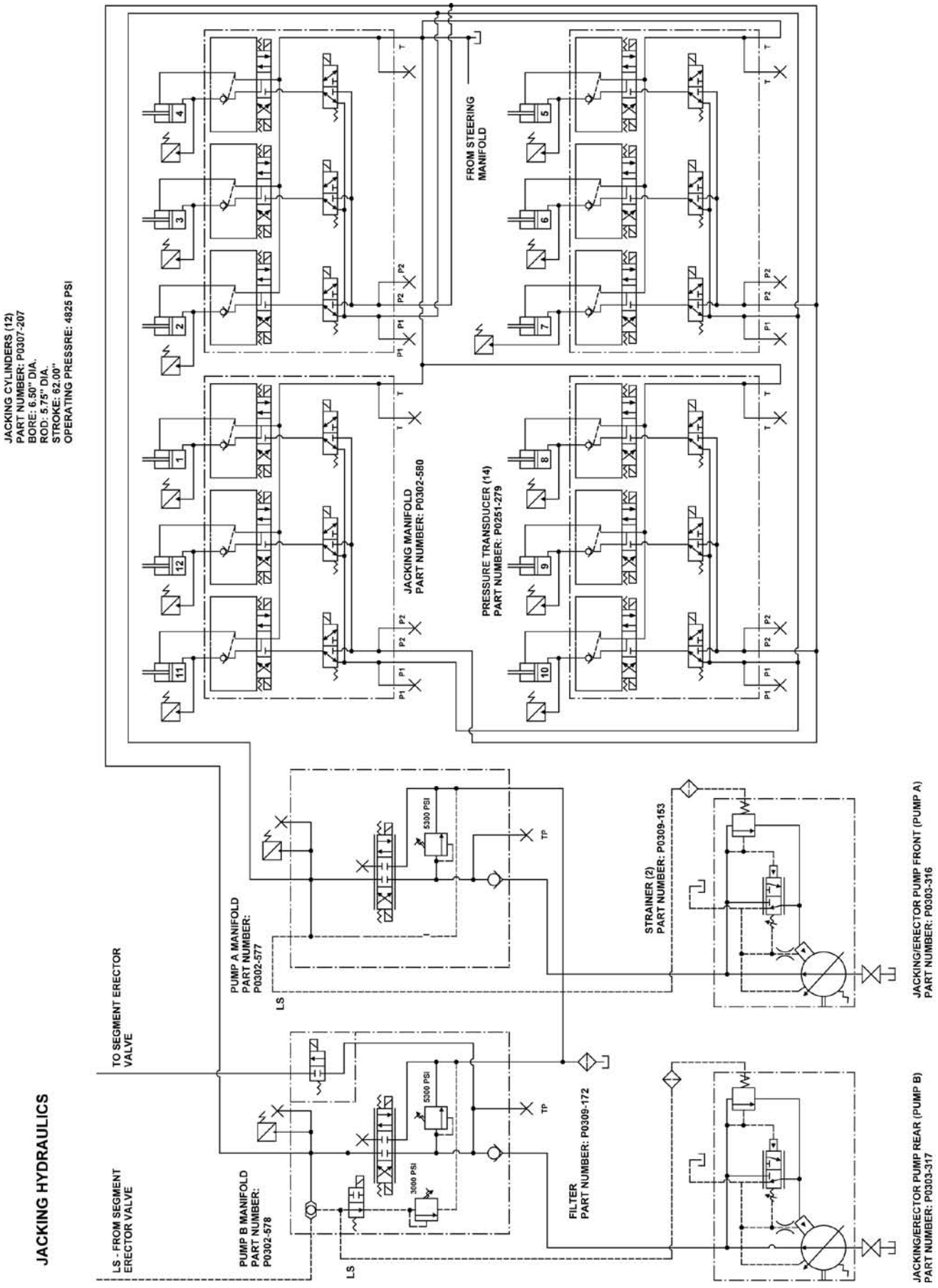
BELT CONVEYOR

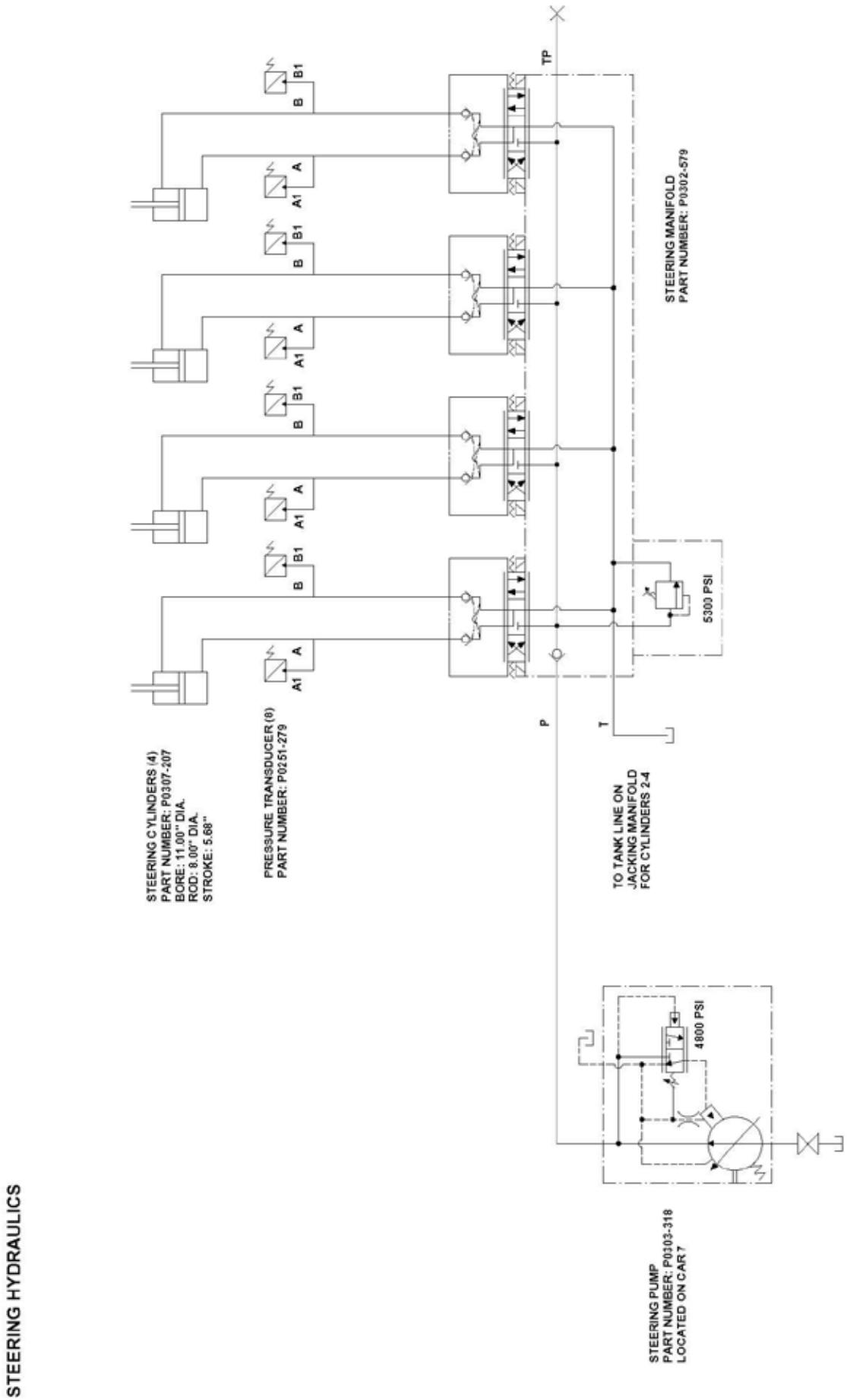
Problem	Cause	Solution
Belt conveyor will not operate.	Check belt stop control.	Reset.
	Damaged control cable.	Check control cable.
	Operating pressure too low.	Adjust to proper setting.
	Belt too tight.	Adjust to proper tension.
	Pump not on.	Turn on pump.
	Low standby pressure.	Reset.
Belt operates too slow.	Speed set too low.	Adjust console control for high speed.
	Low standby pressure.	Adjust to 200-300 psi.
	Low relief pump setting.	Adjust relief to proper psi.
	Low oil level.	Add oil.
Belt operates in reverse.	Connection switch wired incorrectly.	Rewire switch.

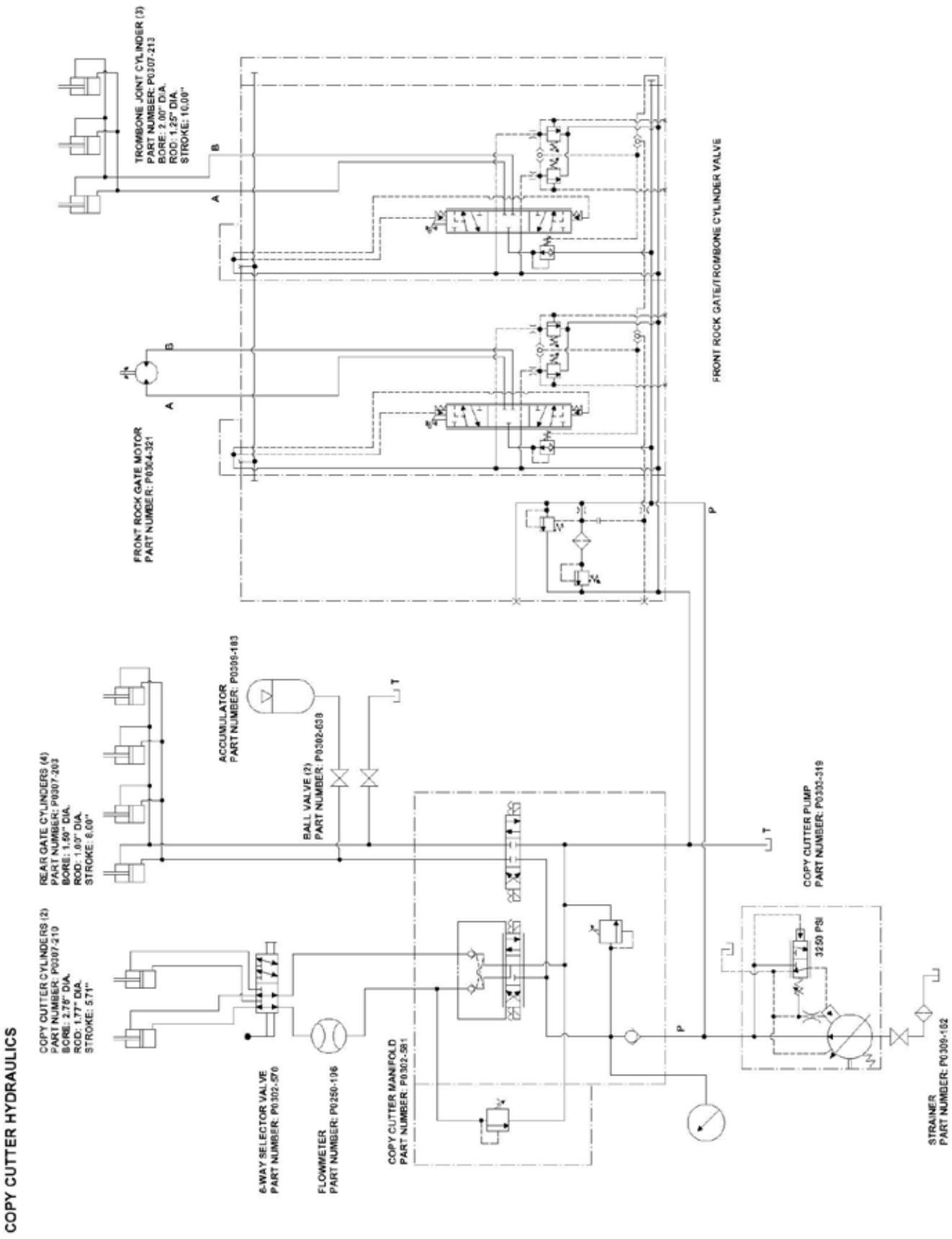
PRESSURIZATION SYSTEM

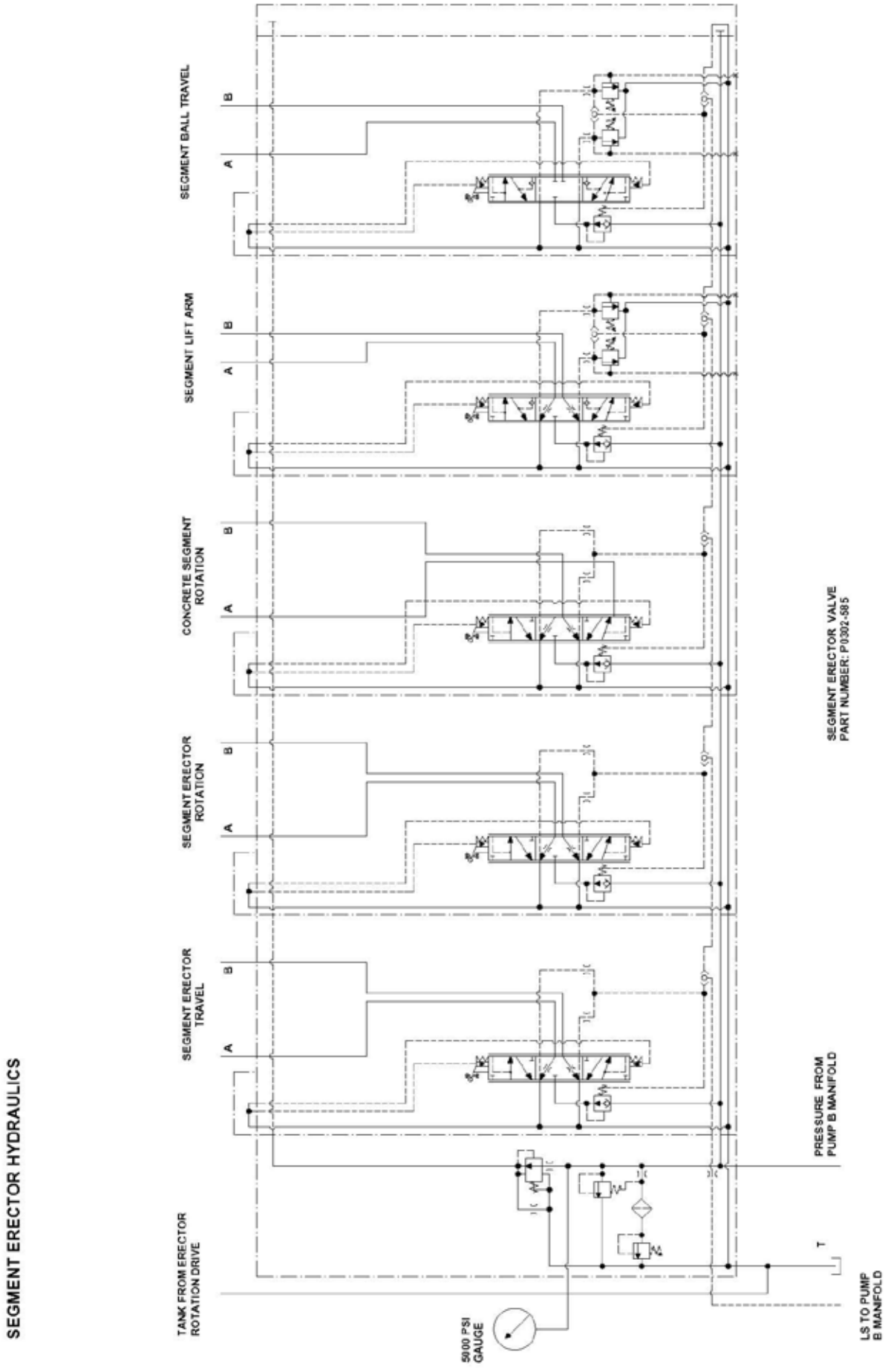
Problem	Cause	Solution
Enclosure pressure control valve will not hold a “Safe” .25 inch pressure.	Leakage around gasketing, covers, seams, piping and tubing connections, conduit connections and electrical conduit seals of the enclosure.	Tighten enclosure latches; Apply silicone sealant from inside the protected enclosure.
Enclosure pressure gauge reading is difficult to stabilize.	Insufficient enclosure leakage or opening of the venturi orifice is crimped too small.	Remove the orifice, cut off crimped end and ream the tube, then recrimped and reinstall the tube to note effect.
Enclosure pressure loss alarm switch does not appear to be operating.	Pressure switch is out of calibration.	Calibrate by slowly adjusting CCW to decrease setpoint & CW to raise the setpoint.
	Pressure switch has not been energized.	Verify the power supply has been applied to power contacts of WPSA.
Problems persists, or if the system does not appear to be operating properly.	Persisting problems.	Contact Pepperl+Fuchs applications customer service at 330-486-0002.

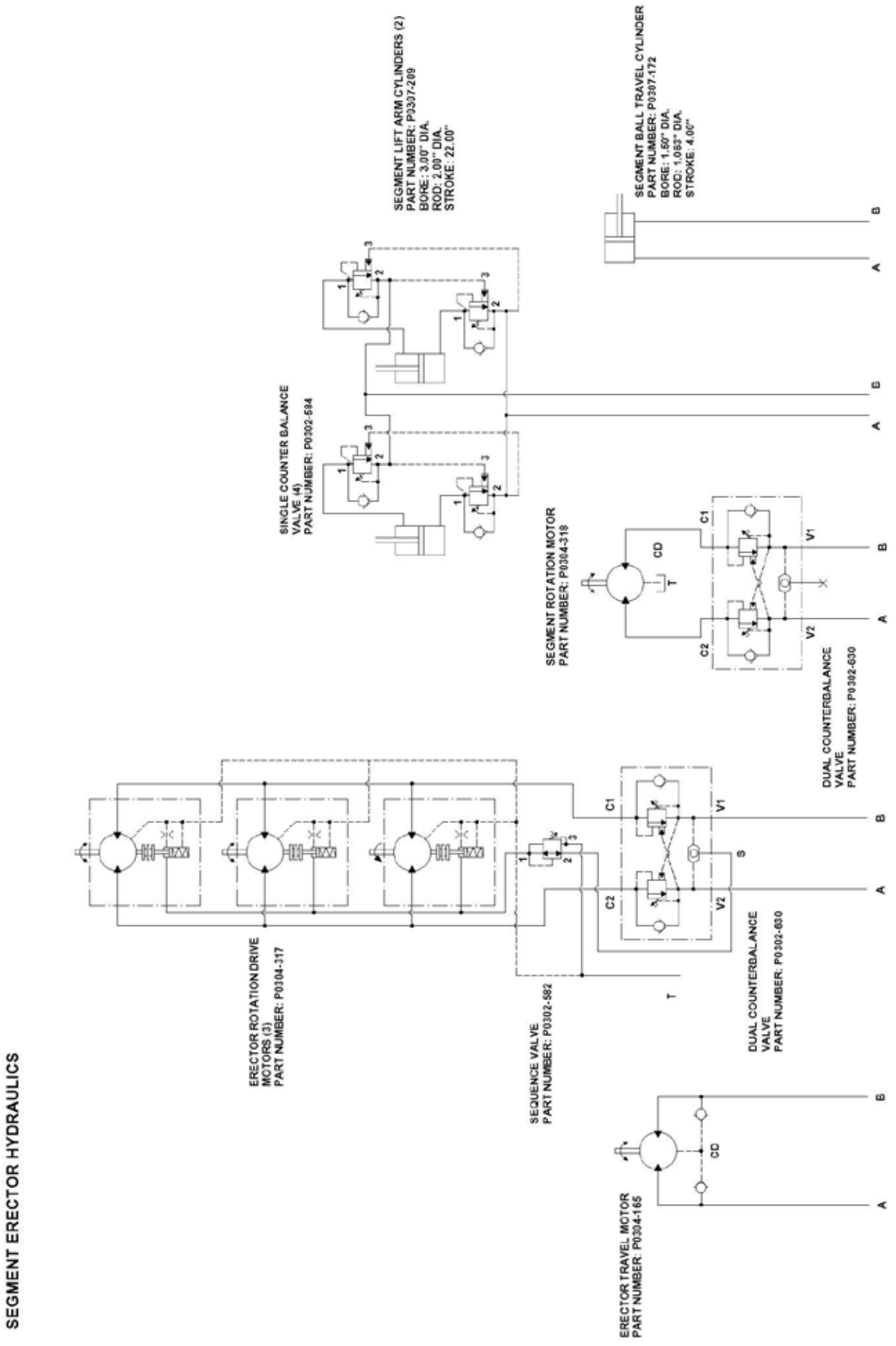
HYDRAULIC SCHEMATICS

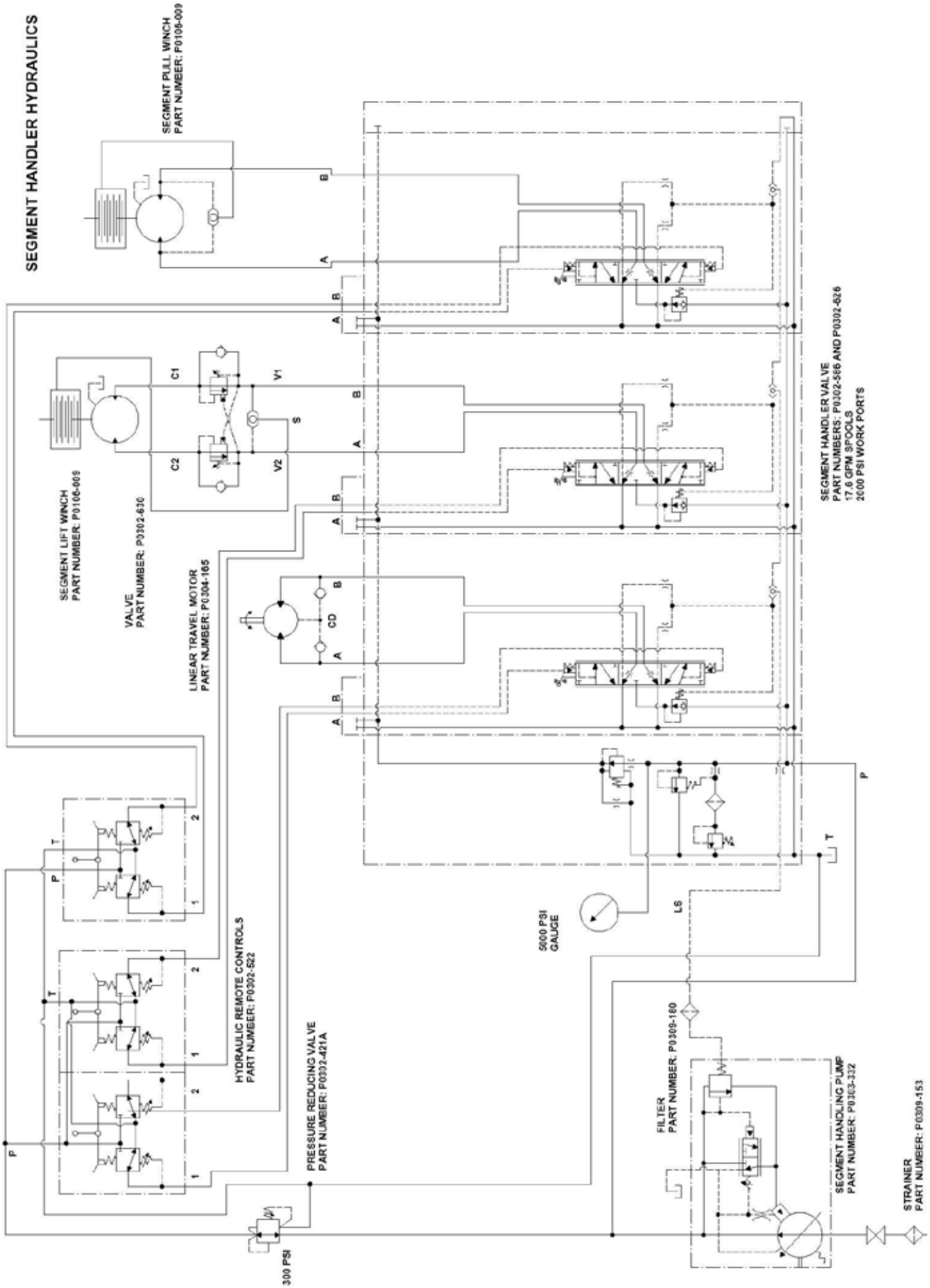


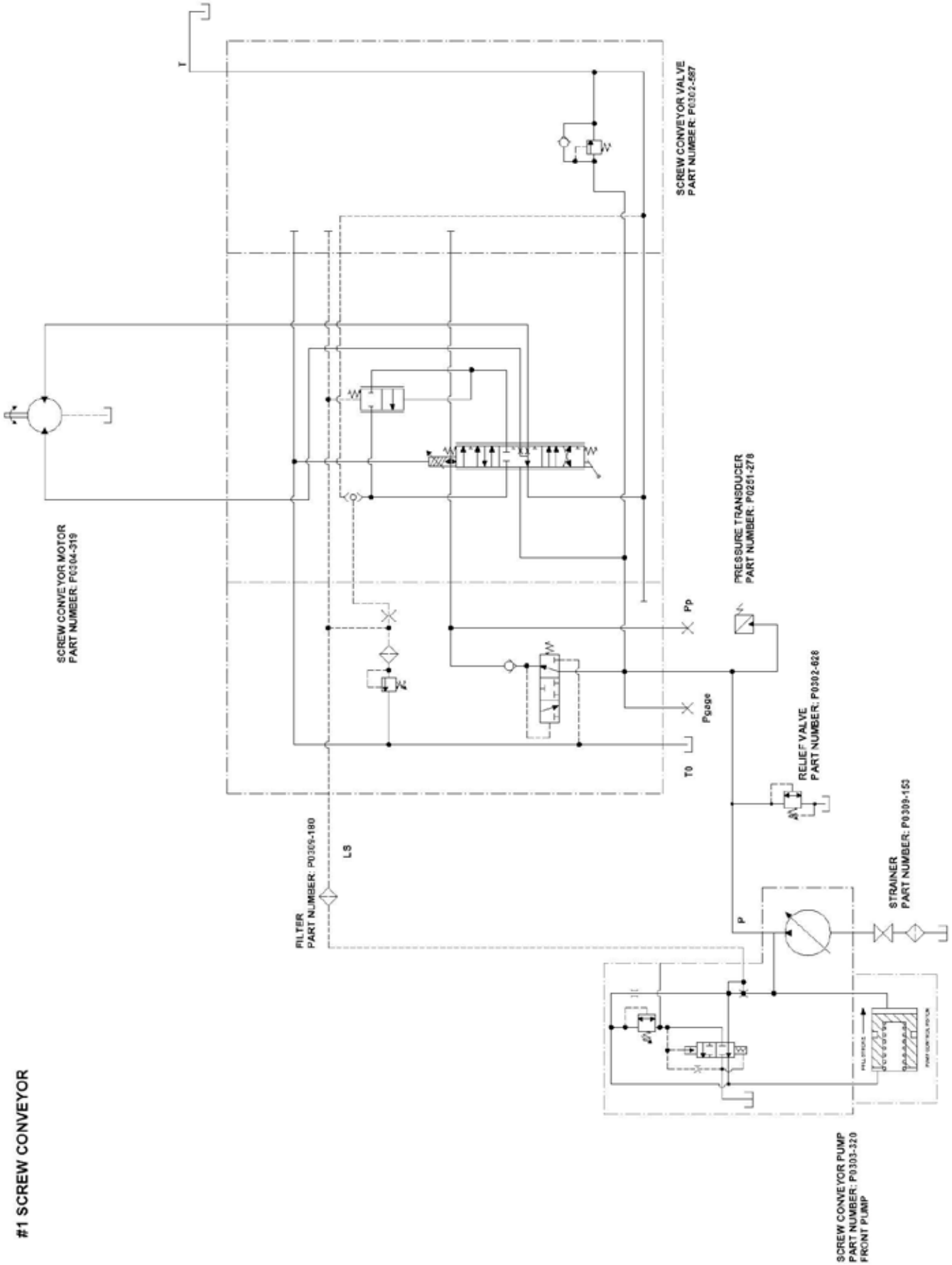

STEERING HYDRAULICS
STEERING CYLINDERS (4)
PART NUMBER: P0307-207
BORE: 11.00" DIA.
ROD: 8.00" DIA.
STROKE: 5.68"
PRESSURE TRANSDUCER (6)
PART NUMBER: P0251-279
TO TANK LINE ON
JACKING MANIFOLD
FOR CYLINDERS 2-4
STEERING MANIFOLD
PART NUMBER: P0302-579
5300 PSI
4800 PSI
STEERING PUMP
PART NUMBER: P0303-318
LOCATED ON CAR 7
TP
P
T
A
A1
B
B1

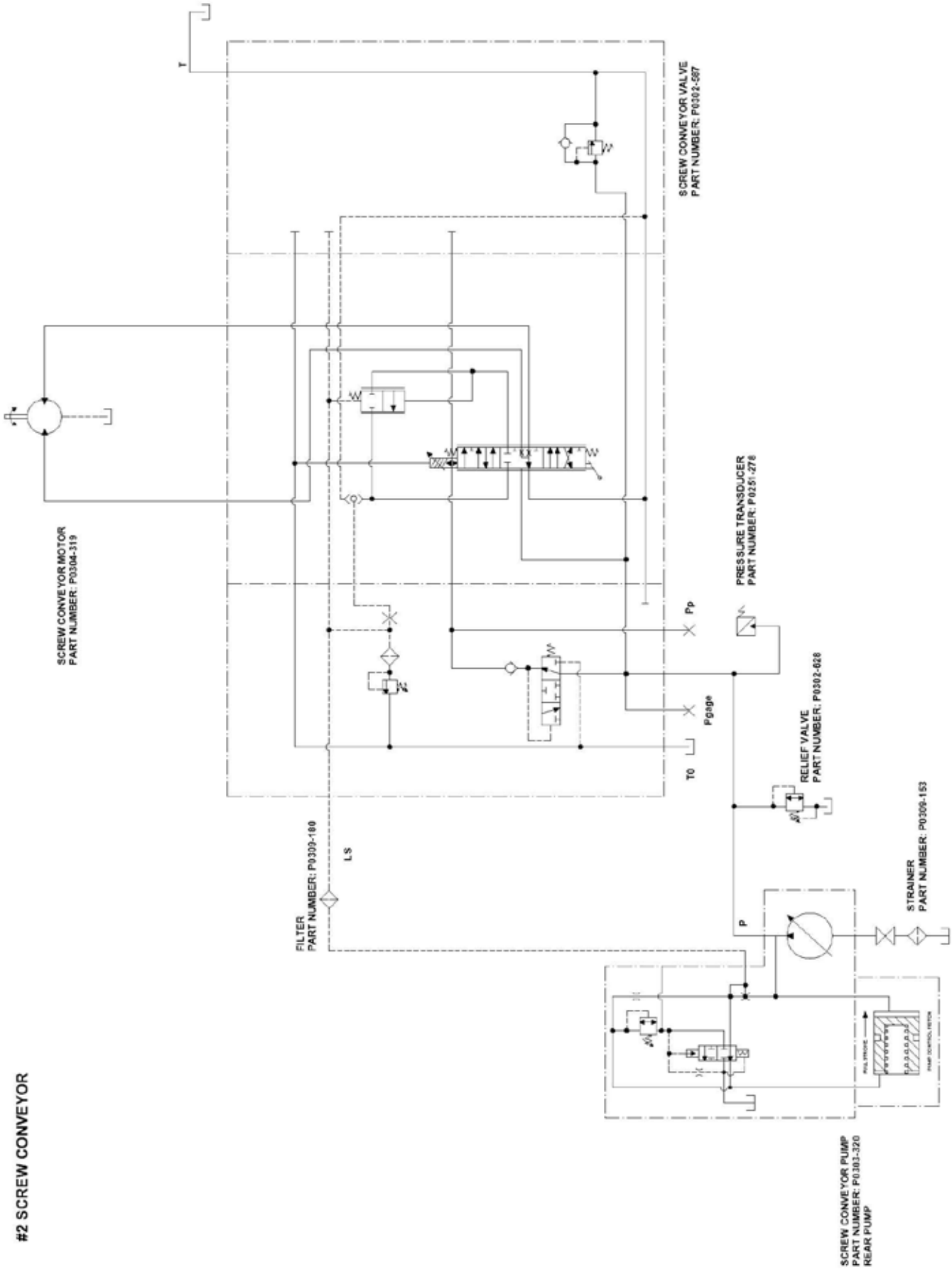

COPY CUTTER HYDRAULICS
TROMBONE JOINT CYLINDER (3)
PART NUMBER: P0307-213
BORE: 2.00" DIA.
ROD: 1.25" DIA.
STROKE: 16.00"
FRONT ROCK GATE MOTOR
PART NUMBER: P0364-321
FRONT ROCK GATE/TROMBONE CYLINDER VALVE
ACCUMULATOR
PART NUMBER: P0309-183
BALL VALVE (2)
PART NUMBER: P0302-639
REAR GATE CYLINDERS (4)
PART NUMBER: P0307-203
BORE: 1.59" DIA.
ROD: 1.00" DIA.
STROKE: 8.00"
COPY CUTTER CYLINDERS (2)
PART NUMBER: P0307-219
BORE: 2.76" DIA.
ROD: 1.77" DIA.
STROKE: 5.71"
COPY CUTTER PUMP
PART NUMBER: P0333-319
3250 PSI
6-WAY SELECTOR VALVE
PART NUMBER: P0302-976
FLOWMETER
PART NUMBER: P0250-106
COPY CUTTER MANIFOLD
PART NUMBER: P0302-581
STRAINER
PART NUMBER: P0309-162
A
B
P
T

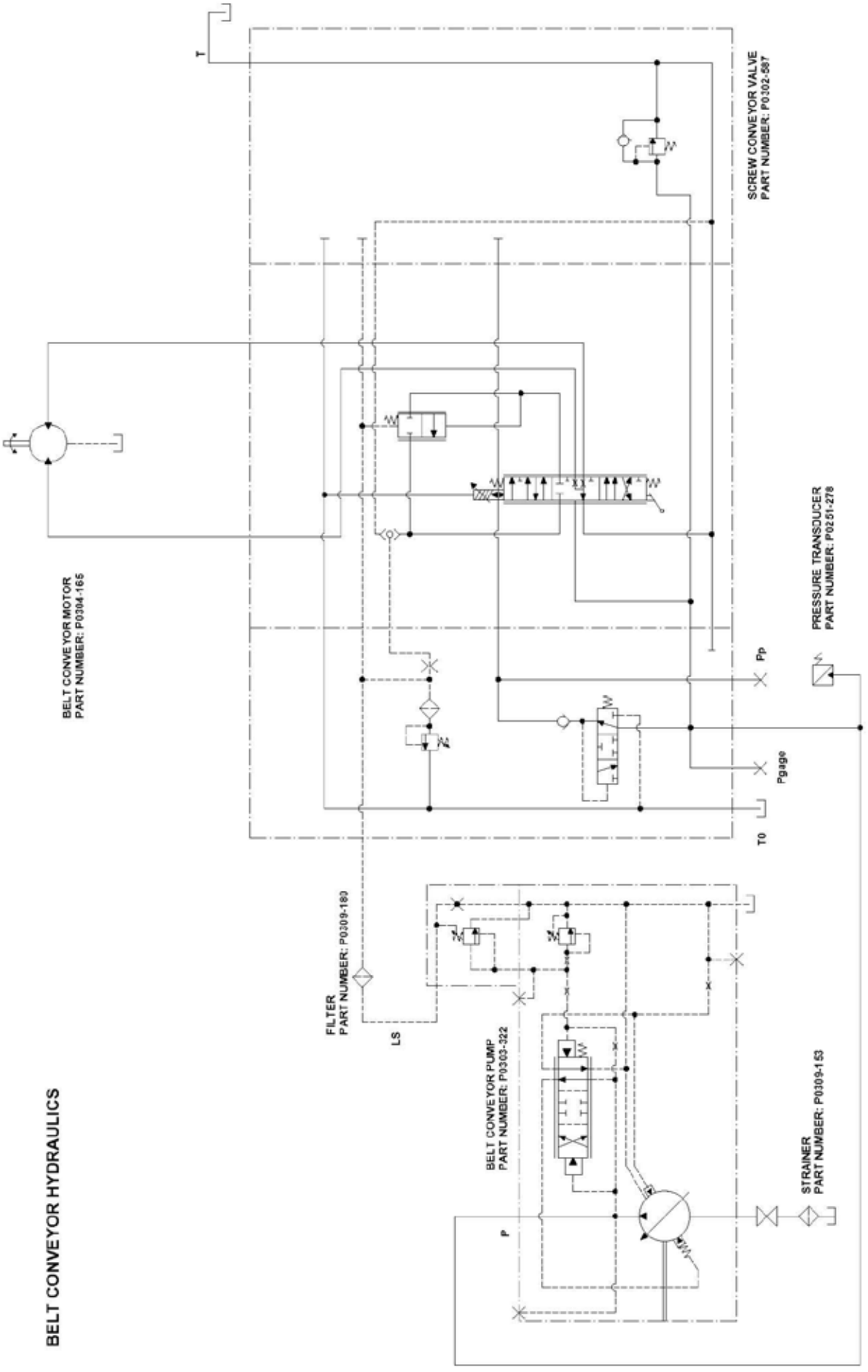

SEGMENT ERECTOR HYDRAULICS
SEGMENT BALL TRAVEL
SEGMENT LIFT ARM
CONCRETE SEGMENT ROTATION
SEGMENT ERECTOR ROTATION
SEGMENT ERECTOR TRAVEL
A
B
SEGMENT ERECTOR VALVE PART NUMBER: P0302-585
PRESSURE FROM PUMP B MANIFOLD
T
LS TO PUMP B MANIFOLD
TANK FROM ERECTOR ROTATION DRIVE
5000 PSI GAUGE


SEGMENT ERECTOR HYDRAULICS
SEGMENT LIFT ARM CYLINDERS (2)
PART NUMBER: P3307-209
BORE: 3.00" DIA.
ROD: 2.00" DIA.
STROKE: 22.00"
SEGMENT BALL TRAVEL CYLINDER
PART NUMBER: P0307-172
BORE: 1.50" DIA.
ROD: 1.063" DIA.
STROKE: 4.00"
SINGLE COUNTER BALANCE
VALVE (4)
PART NUMBER: P0302-594
SEGMENT ROTATION MOTOR
PART NUMBER: P0304-318
DUAL COUNTERBALANCE
VALVE
PART NUMBER: P0302-630
ERECTOR ROTATION DRIVE
MOTORS (3)
PART NUMBER: P0304-317
SEQUENCE VALVE
PART NUMBER: P0302-582
DUAL COUNTERBALANCE
VALVE
PART NUMBER: P0302-630
ERECTOR TRAVEL MOTOR
PART NUMBER: P0304-165
A
B
C1
C2
V1
V2
CD
T
S

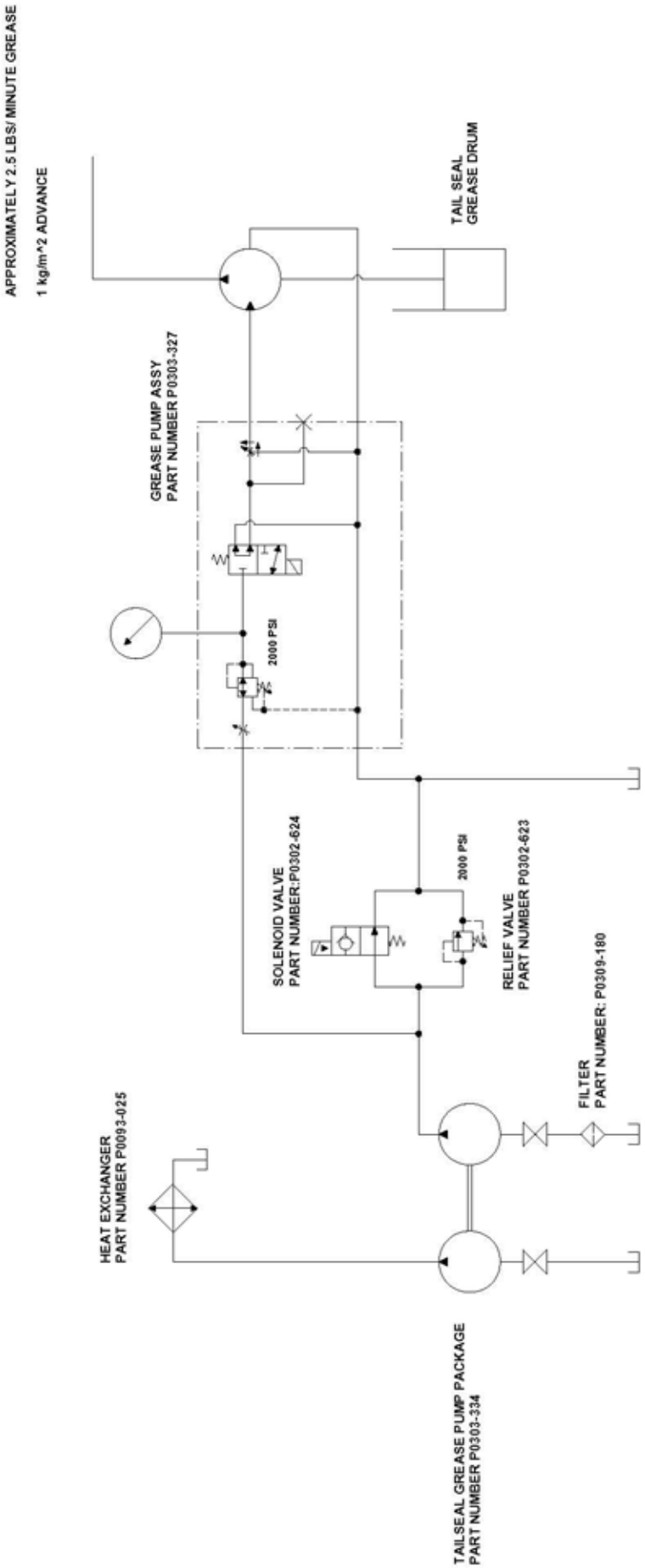

SEGMENT HANDLER HYDRAULICS
SEGMENT PULL WINCH
PART NUMBER: P0106-009
SEGMENT LIFT WINCH
PART NUMBER: P0106-009
VALVE
PART NUMBER: P0302-630
LINEAR TRAVEL MOTOR
PART NUMBER: P0304-165
SEGMENT HANDLER VALVE
PART NUMBERS: P0302-586 AND P0302-626
17.6 GPM SPOOLS
2000 PSI WORK PORTS
HYDRAULIC REMOTE CONTROLS
PART NUMBER: P0302-522
PRESSURE REDUCING VALVE
PART NUMBER: P0302-421A
300 PSI
5000 PSI
GAUGE
FILTER
PART NUMBER: P0309-160
SEGMENT HANDLING PUMP
PART NUMBER: P0303-332
STRAINER
PART NUMBER: P0309-153
C1
C2
V1
V2
S
CD
A
B
P
T
LS
1
2

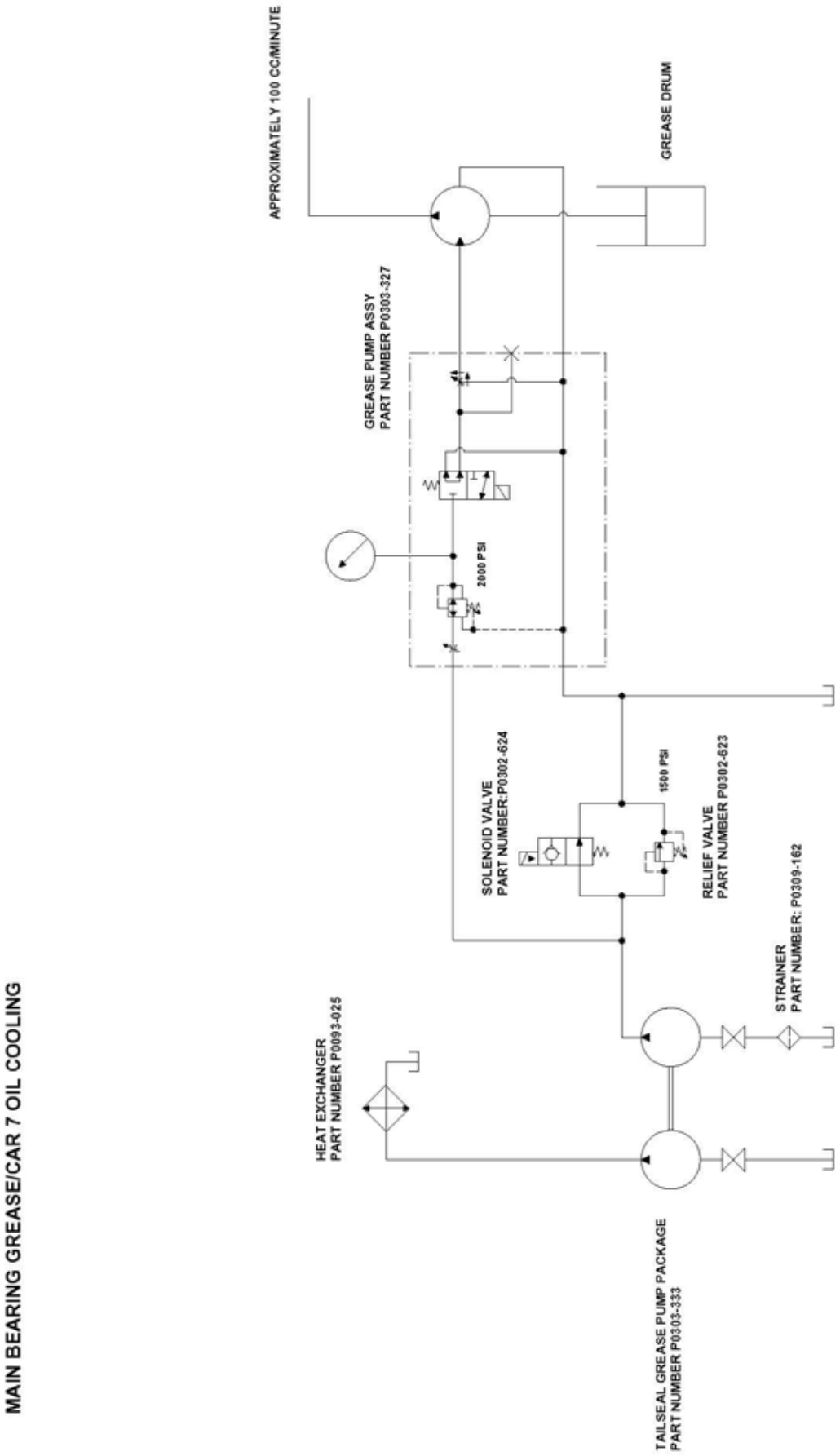

#1 SCREW CONVEYOR
T
SCREW CONVEYOR VALVE
PART NUMBER: P0302-587
SCREW CONVEYOR MOTOR
PART NUMBER: P0304-319
PRESSURE TRANSDUCER
PART NUMBER: P0251-278
Pp
Pgage
T0
RELIEF VALVE
PART NUMBER: P0302-628
FILTER
PART NUMBER: P0309-180
LS
STRAINER
PART NUMBER: P0309-153
P
SCREW CONVEYOR PUMP
PART NUMBER: P0303-320
FRONT PUMP


#2 SCREW CONVEYOR
SCREW CONVEYOR MOTOR
PART NUMBER: P0304-319
SCREW CONVEYOR VALVE
PART NUMBER: P0302-597
PRESSURE TRANSDUCER
PART NUMBER: P0251-278
RELIEF VALVE
PART NUMBER: P0302-628
STRAINER
PART NUMBER: P0309-153
FILTER
PART NUMBER: P0309-180
SCREW CONVEYOR PUMP
PART NUMBER: P0303-320
REAR PUMP
T
Pp
Pgage
TO
LS
P

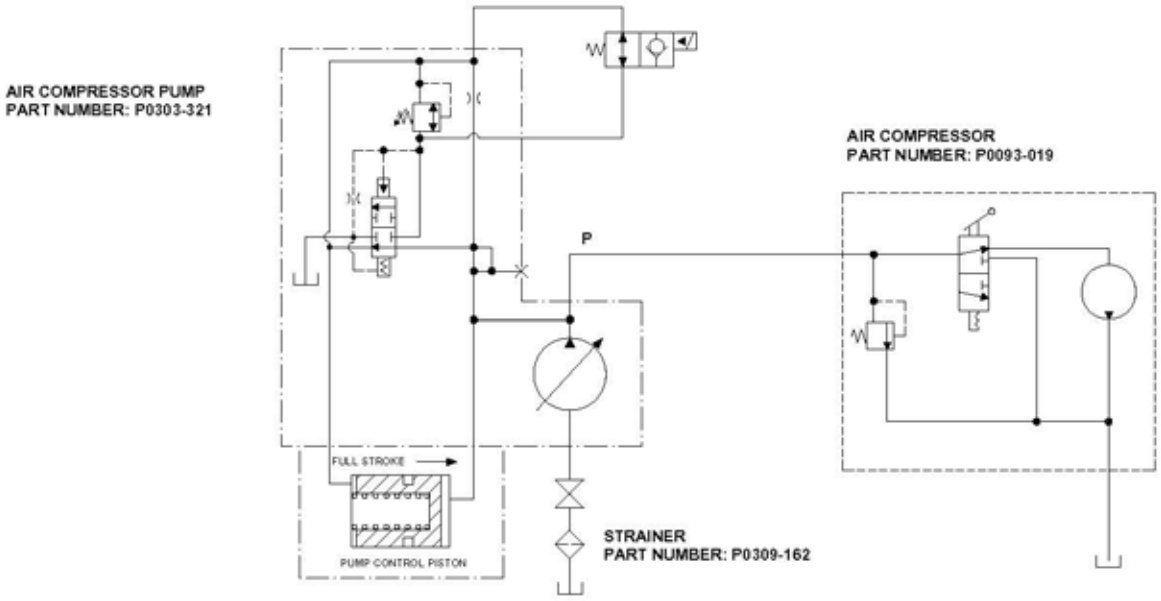

T
SCREW CONVEYOR VALVE
PART NUMBER: P0302-587
BELT CONVEYOR MOTOR
PART NUMBER: P0304-165
PRESSURE TRANSDUCER
PART NUMBER: P0251-278
Pp
Pgage
T0
FILTER
PART NUMBER: P0309-180
LS
BELT CONVEYOR PUMP
PART NUMBER: P0303-322
STRAINER
PART NUMBER: P0309-153
P
BELT CONVEYOR HYDRAULICS

TAIL SEAL GREASE/CAR 6 OIL COOLING

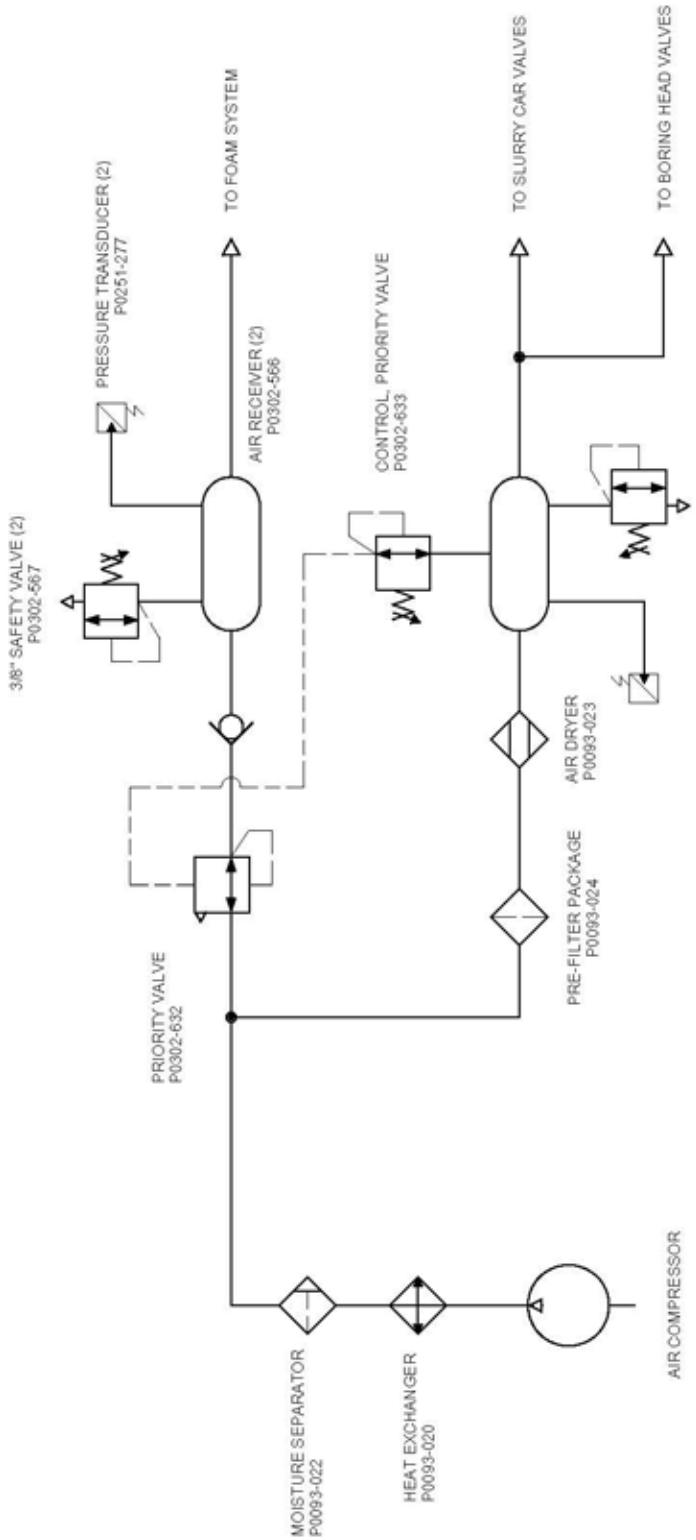



MAIN BEARING GREASE/CAR 7 OIL COOLING
APPROXIMATELY 100 CC/MINUTE
GREASE DRUM
GREASE PUMP ASSY
PART NUMBER P0303-327
2000 PSI
SOLENOID VALVE
PART NUMBER:P0302-624
1500 PSI
RELIEF VALVE
PART NUMBER P0302-623
STRAINER
PART NUMBER: P0309-162
HEAT EXCHANGER
PART NUMBER P0093-025
TAILSEAL GREASE PUMP PACKAGE
PART NUMBER P0303-333

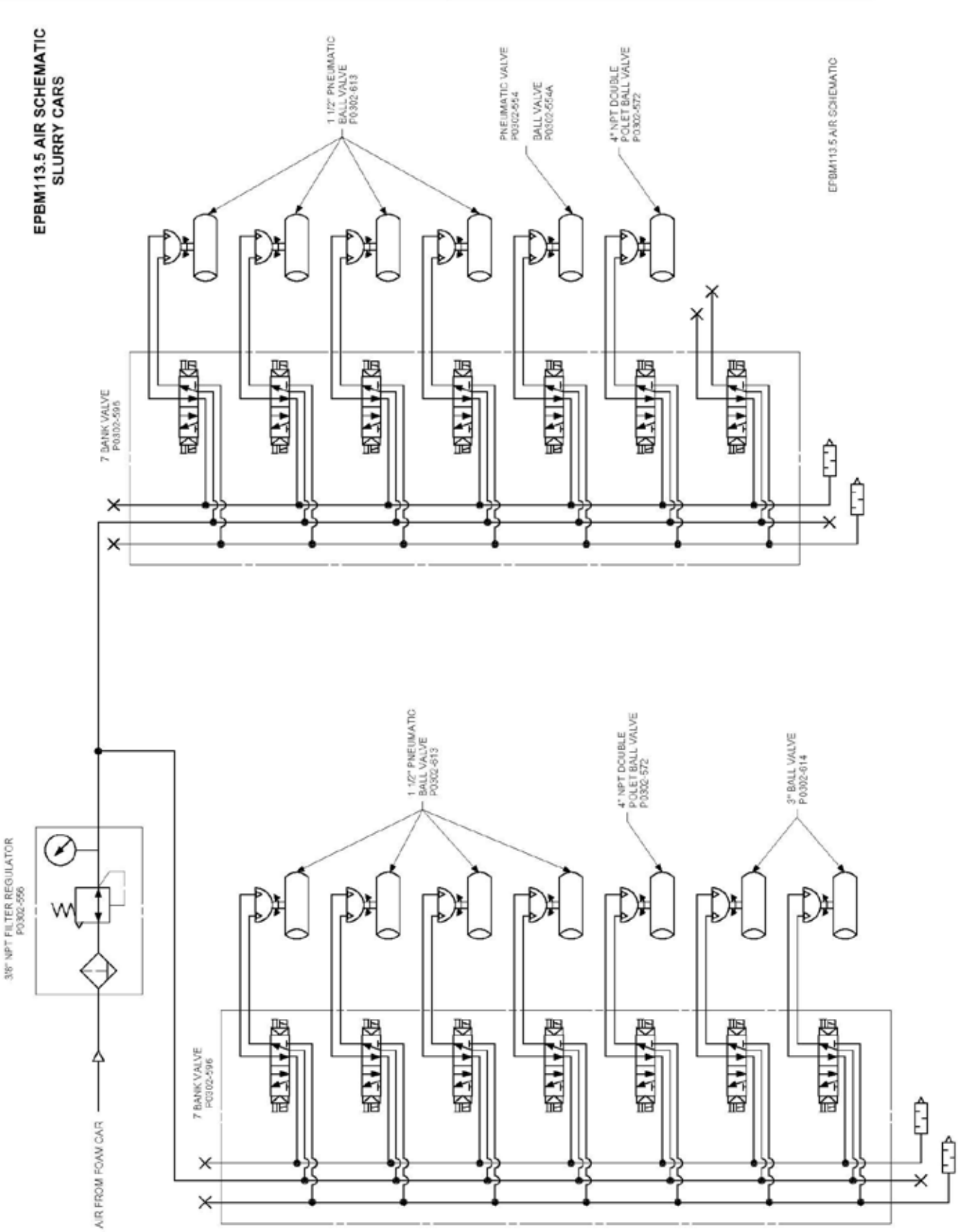
AIR COMPRESSOR HYDRAULICS

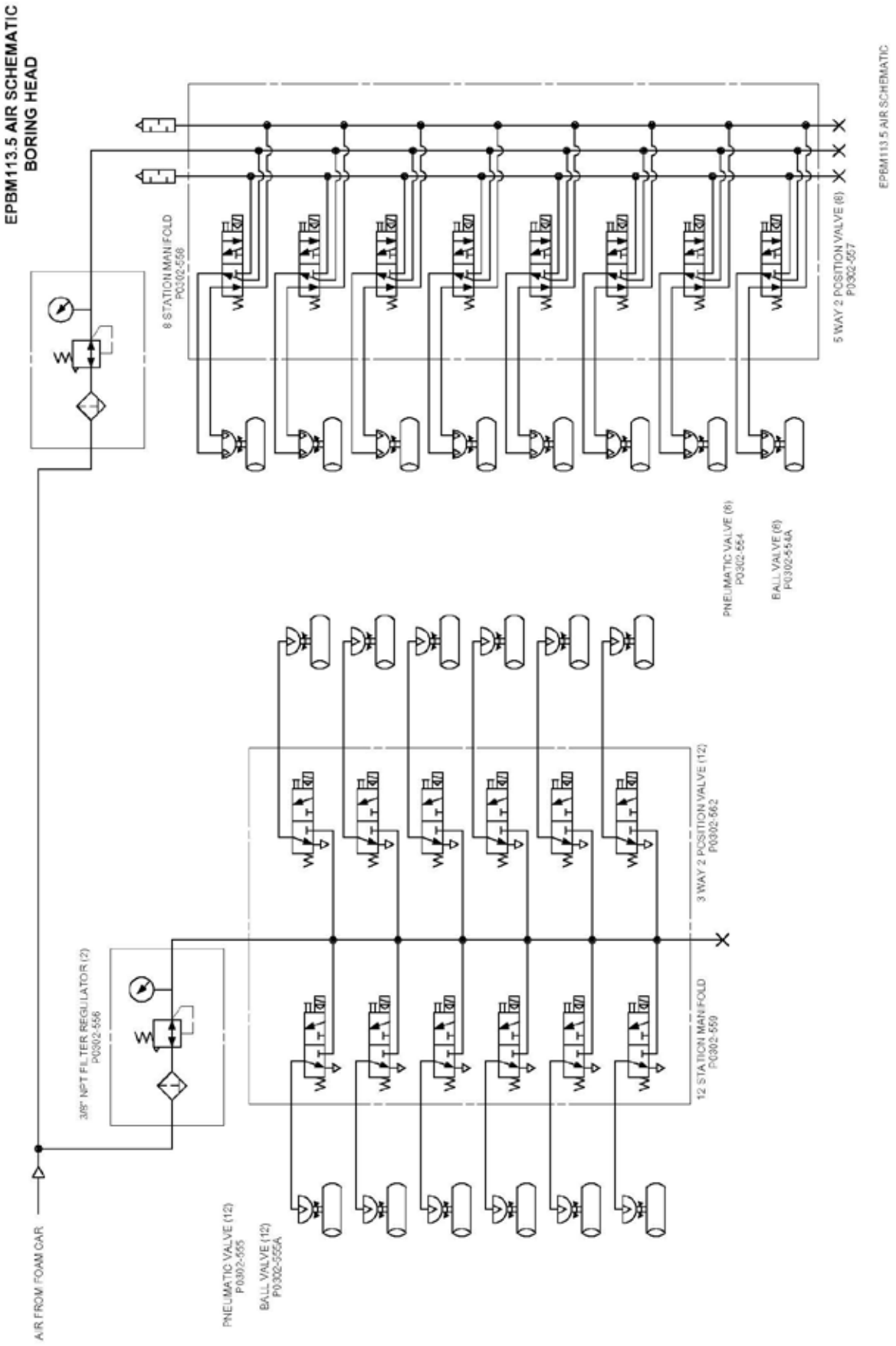


AIR SCHEMATICS

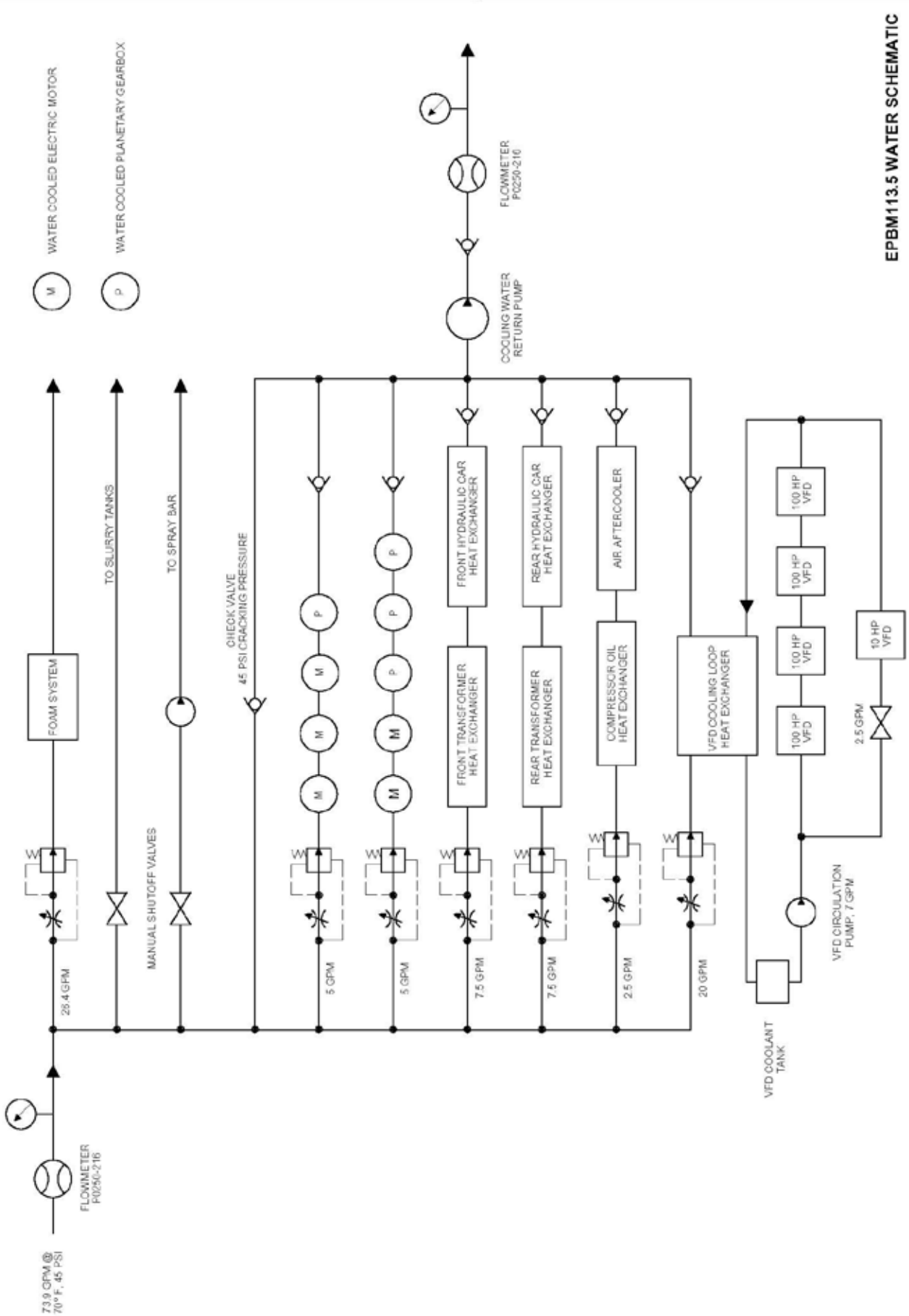


EPBM113.5 AIR SCHEMATIC
FOAM CAR


EPBM113.5 AIR SCHEMATIC
SLURRY CARS
1 1/2" PNEUMATIC BALL VALVE P0302-613
PNEUMATIC VALVE P0302-554
BALL VALVE P0302-554A
4" NPT DOUBLE POLET BALL VALVE P0302-572
EPBM113.5 AIR SCHEMATIC
7 BANK VALVE P0302-596
1 1/2" PNEUMATIC BALL VALVE P0302-613
4" NPT DOUBLE POLET BALL VALVE P0302-572
3" BALL VALVE P0302-614
3/8" NPT FILTER REGULATOR P0302-556
7 BANK VALVE P0302-596
AIR FROM FOAM CAR

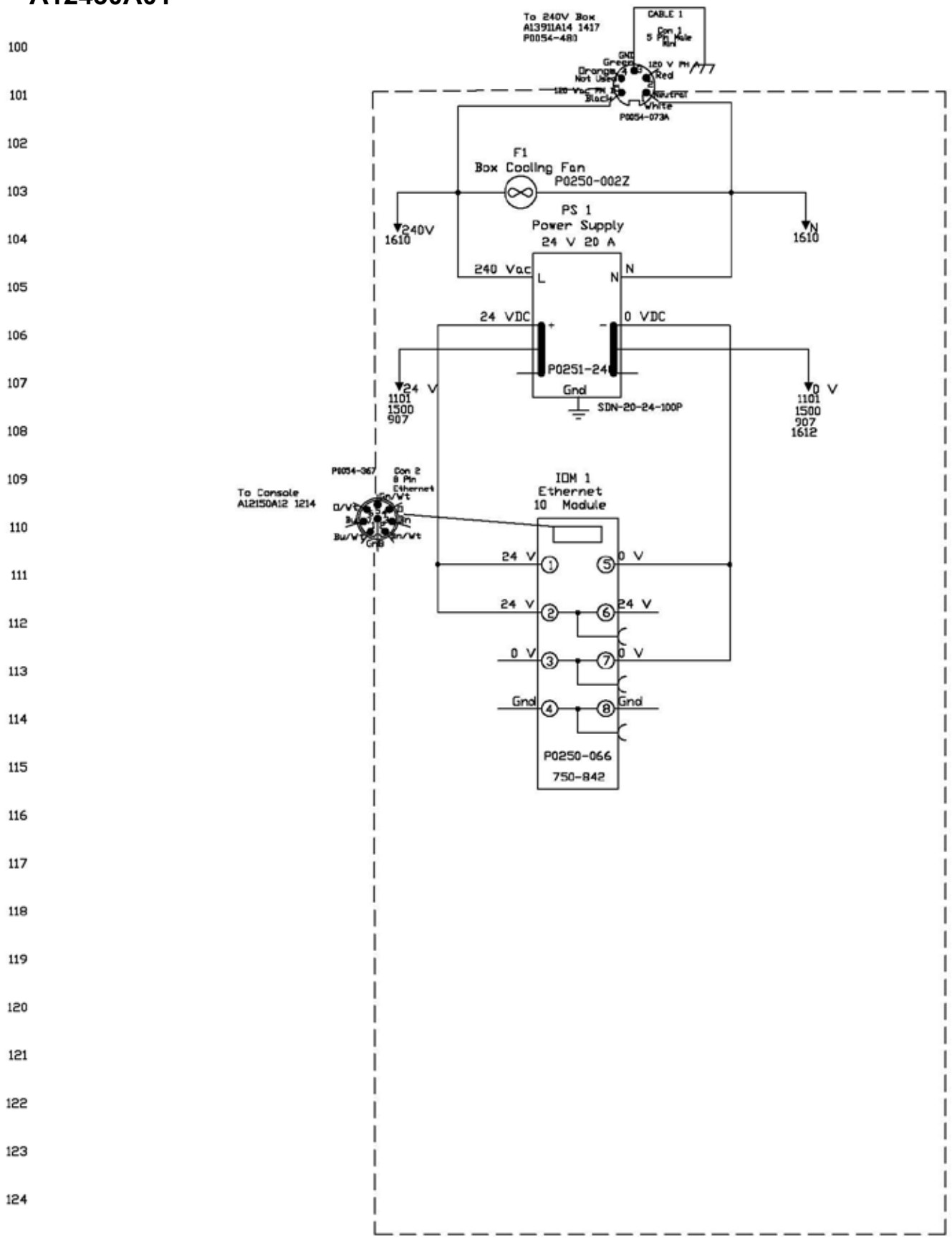

EPBM113.5 AIR SCHEMATIC
BORING HEAD
8 STATION MANIFOLD
P0302-558
5 WAY 2 POSITION VALVE (8)
P0302-557
PNEUMATIC VALVE (8)
P0302-554
BALL VALVE (8)
P0302-554A
3 WAY 2 POSITION VALVE (12)
P0302-562
12 STATION MANIFOLD
P0302-559
3/8" NPT FILTER REGULATOR (2)
P0302-556
PNEUMATIC VALVE (12)
P0302-555
BALL VALVE (12)
P0302-555A
AIR FROM FOAM CAR
EPBM113.5 AIR SCHEMATIC

WATER SCHEMATIC



ELECTRICAL SCHEMATICS - HEAD LEFT CONTROL BOX

A12430A01



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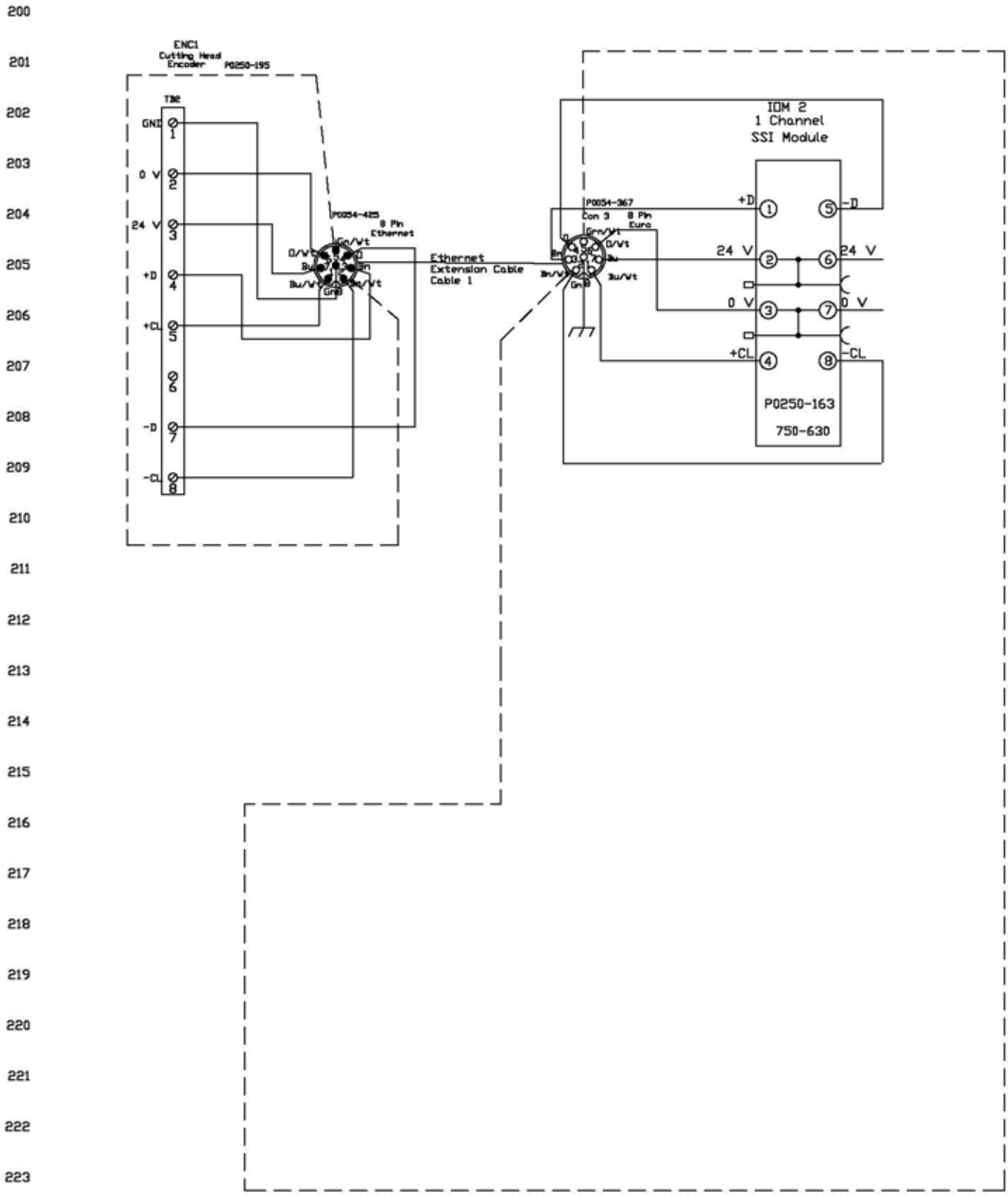
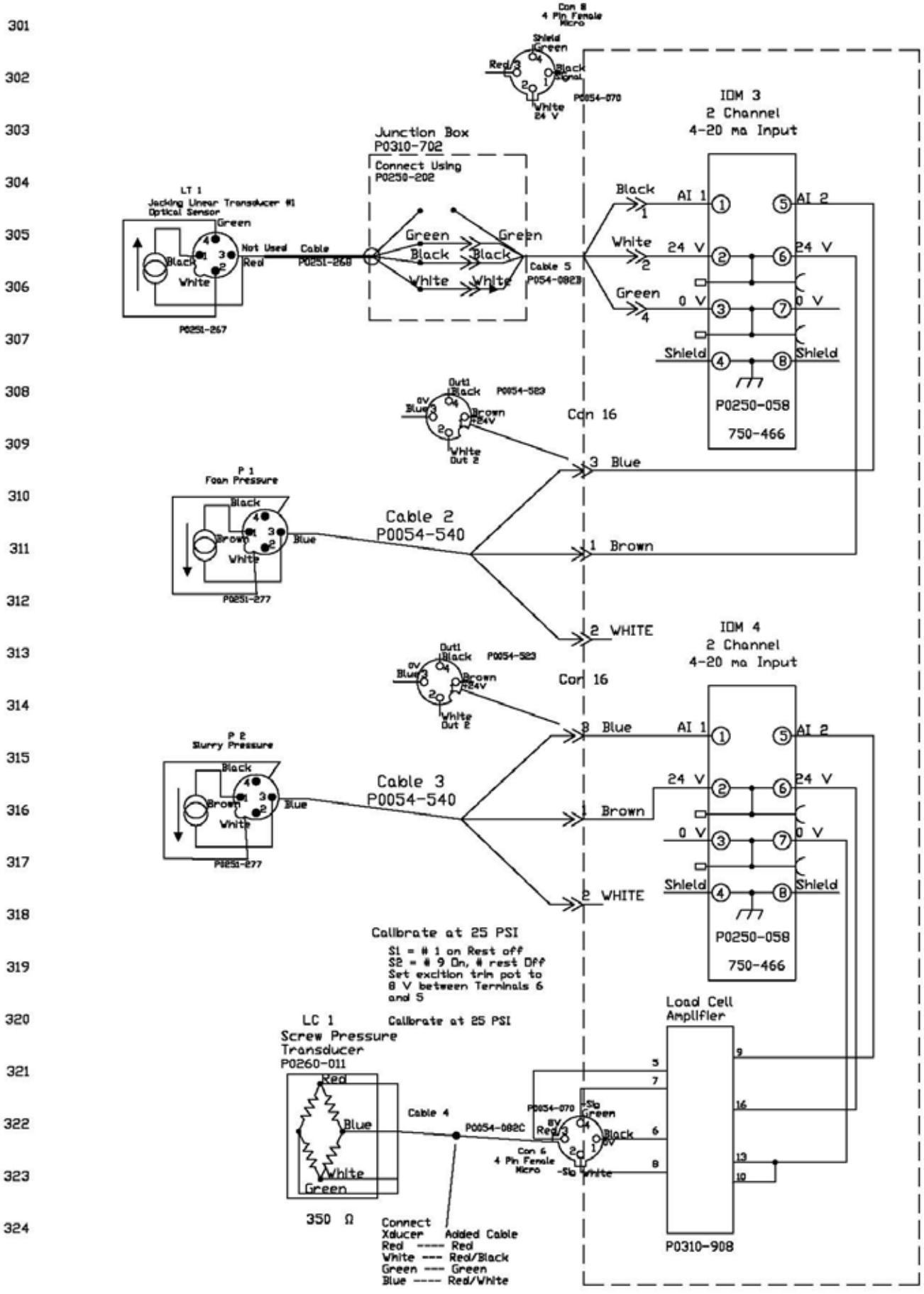
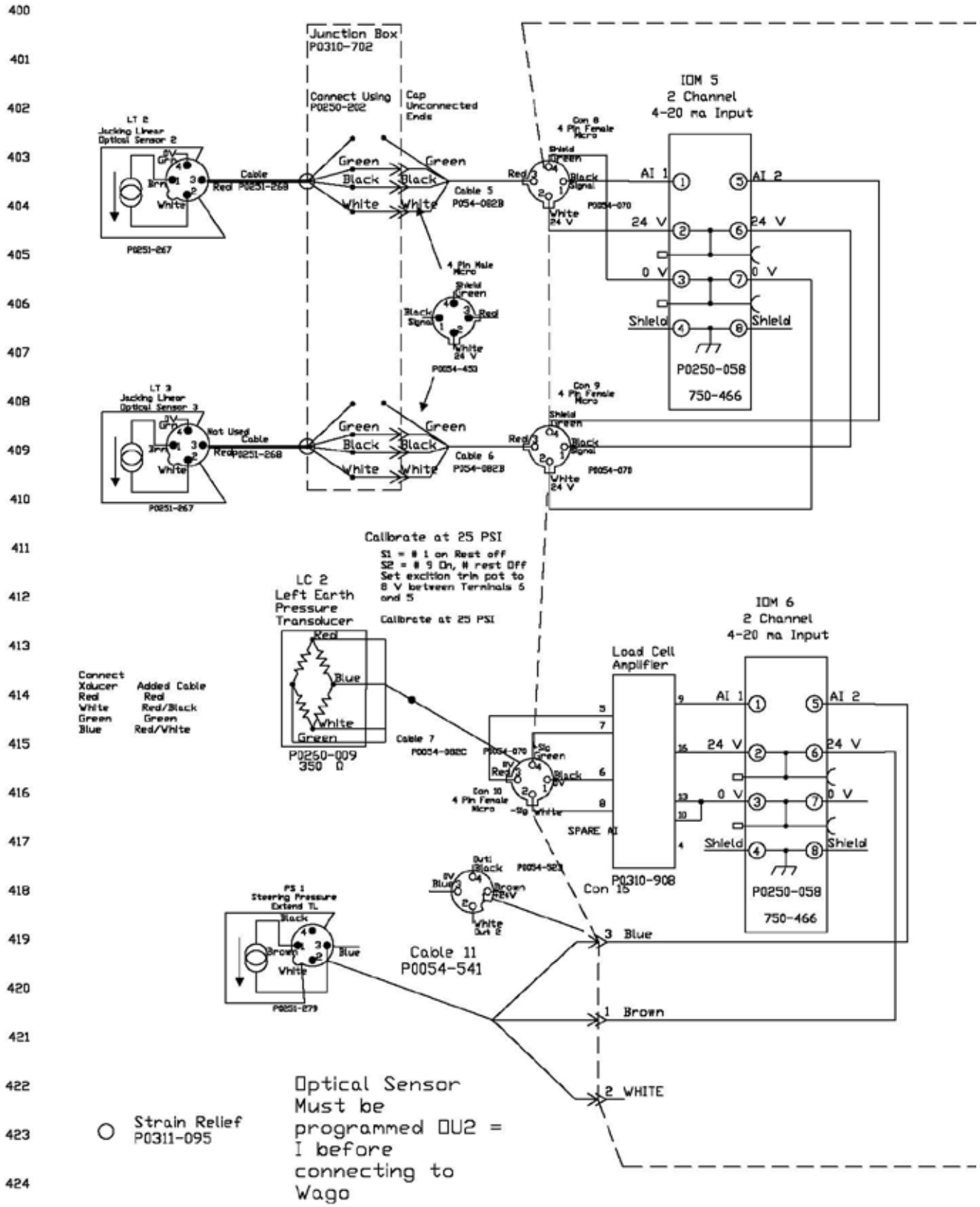

ENC1
Cutting Head
Encoder
P0250-195
TB2
GND
0 V
24 V
+D
+CL
-D
-CL
P0254-425
8 Pin
Ethernet
Ethernet
Extension Cable
Cable 1
P0254-367
Con 3
8 Pin
Euro
IOM 2
1 Channel
SSI Module
+D
-D
24 V
24 V
0 V
0 V
+CL
-CL
P0250-163
750-630

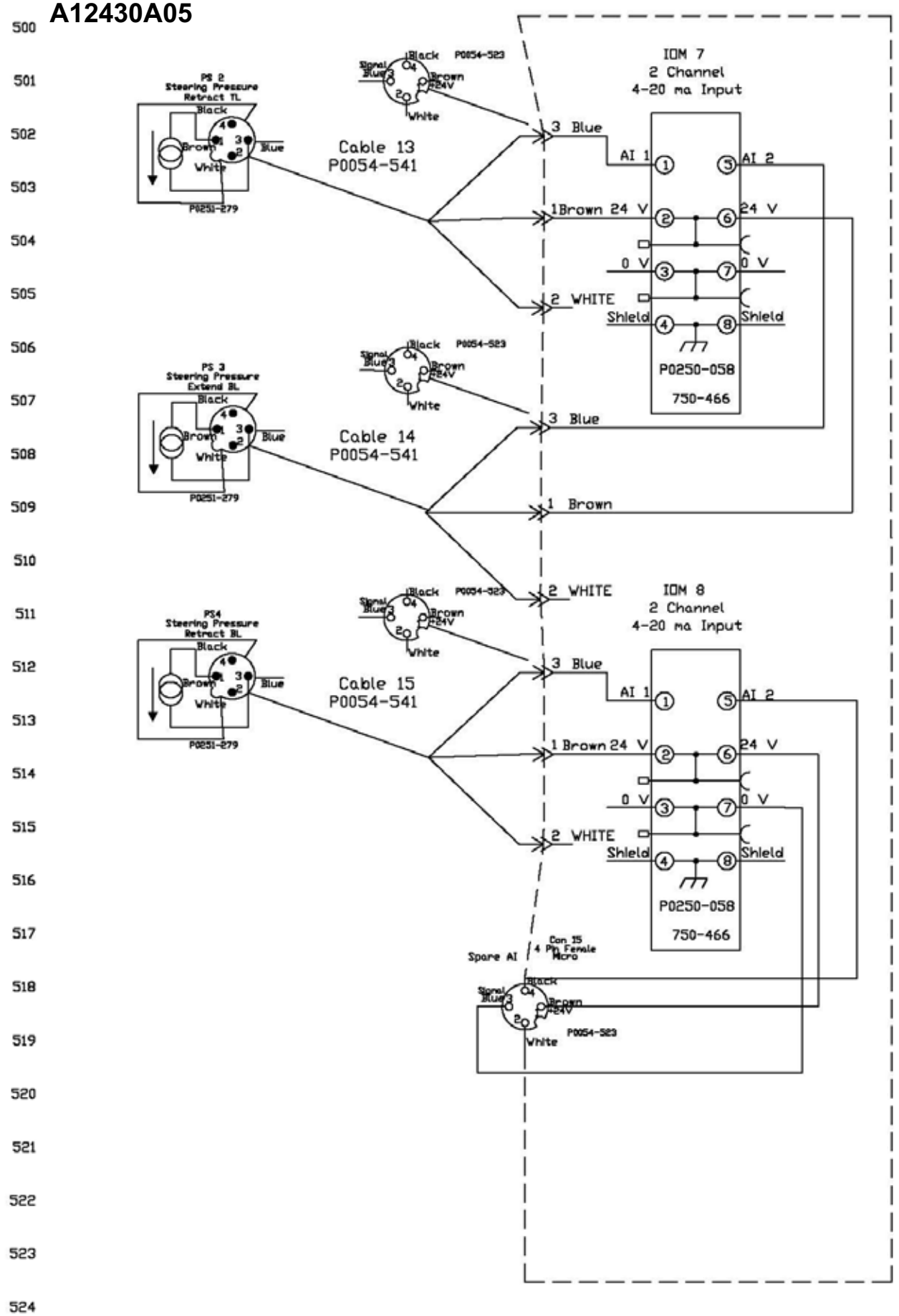
A12430A03


Con 8
4 Pin Female
Micro
Shield
Green
Red
Black
White
24 V
P0054-070
IDM 3
2 Channel
4-20 ma Input
Junction Box
P0310-702
Connect Using
P0250-202
LT 1
Jacking Linear Transducer #1
Optical Sensor
Green
Black
White
Red
Not Used
Cable
P0251-268
P0251-267
Green
Black
White
Cable 5
P0054-082B
Black
White
Green
Shield
AI 1
AI 2
24 V
0 V
P0250-058
750-466
Out1
Black
P0054-523
0V
Blue
Brown
+24V
White
Out 2
Con 16
3 Blue
1 Brown
2 WHITE
P 1
Foam Pressure
Cable 2
P0054-540
P0251-277
IDM 4
2 Channel
4-20 ma Input
P 2
Slurry Pressure
Cable 3
P0054-540
Calibrate at 25 PSI
S1 = # 1 on Rest off
S2 = # 9 On, # rest Off
Set excition trim pot to
8 V between Terminals 6
and 5
LC 1
Screw Pressure
Transducer
P0260-011
Red
Blue
White
Green
350 Ω
Calibrate at 25 PSI
Cable 4
P0054-082C
P0054-070
Con 6
4 Pin Female
Micro
Load Cell
Amplifier
P0310-908
Connect
Xducer
Red ---- Red
White --- Red/Black
Green --- Green
Blue ---- Red/White
Added Cable

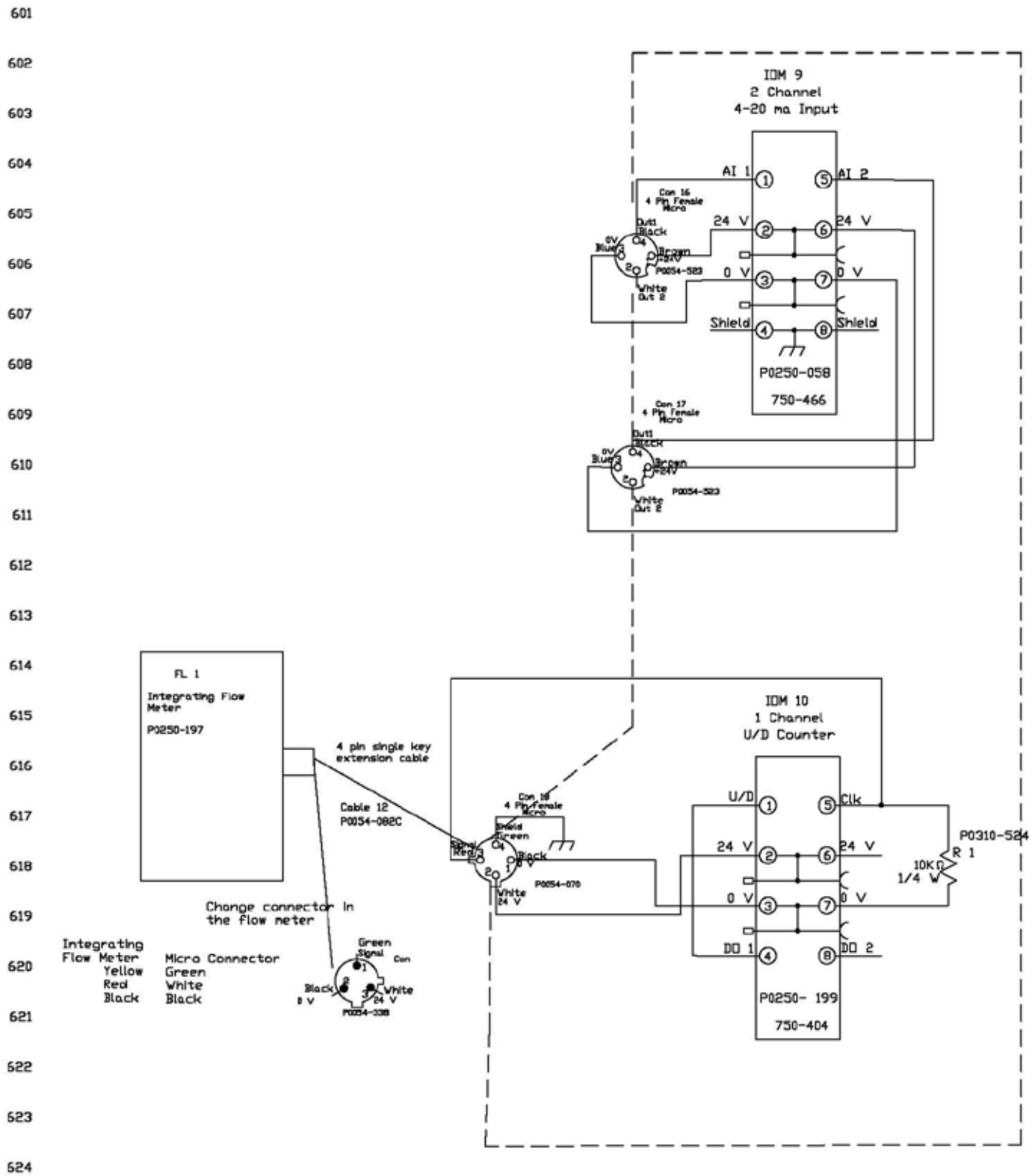
A12430A04


Junction Box
P0310-702
Connect Using
P0250-202
Cap
Unconnected
Ends
IOM 5
2 Channel
4-20 ma Input
LT 2
Jacking Linear
Optical Sensor 2
Cable
Red P0251-268
Green
Black
White
Cable 5
P0054-082B
Con 8
4 Pin Female
Micro
Shield
Green
Red
Black
Signal
White
24 V
P0054-070
AI 1
AI 2
24 V
0 V
Shield
P0250-058
750-466
4 Pin Male
Micro
P0054-453
LT 3
Jacking Linear
Optical Sensor 3
Not Used
Cable
Red P0251-268
Cable 6
P0054-082B
Con 9
4 Pin Female
Micro
P0054-078
P0251-267
Calibrate at 25 PSI
S1 = # 1 on Rest off
S2 = # 3 On, # rest Off
Set excition trim pot to
8 V between Terminals 6
and 5
Calibrate at 25 PSI
LC 2
Left Earth
Pressure
Transducer
Red
Blue
White
Green
P0250-009
350 Ω
Connect
Xducer Added Cable
Red Red
White Red/Black
Green Green
Blue Red/White
Cable 7
P0054-082C
Con 10
4 Pin Female
Micro
Load Cell
Amplifier
SPARE AI
P0310-908
Con 15
IOM 6
2 Channel
4-20 ma Input
P0250-058
750-466
PS 1
Steering Pressure
Extend TL
Black
Brown
Blue
White
P0251-279
Cable 11
P0054-541
3 Blue
1 Brown
2 WHITE
Optical Sensor
Must be
programmed OU2 =
I before
connecting to
Wago
Strain Relief
P0311-095

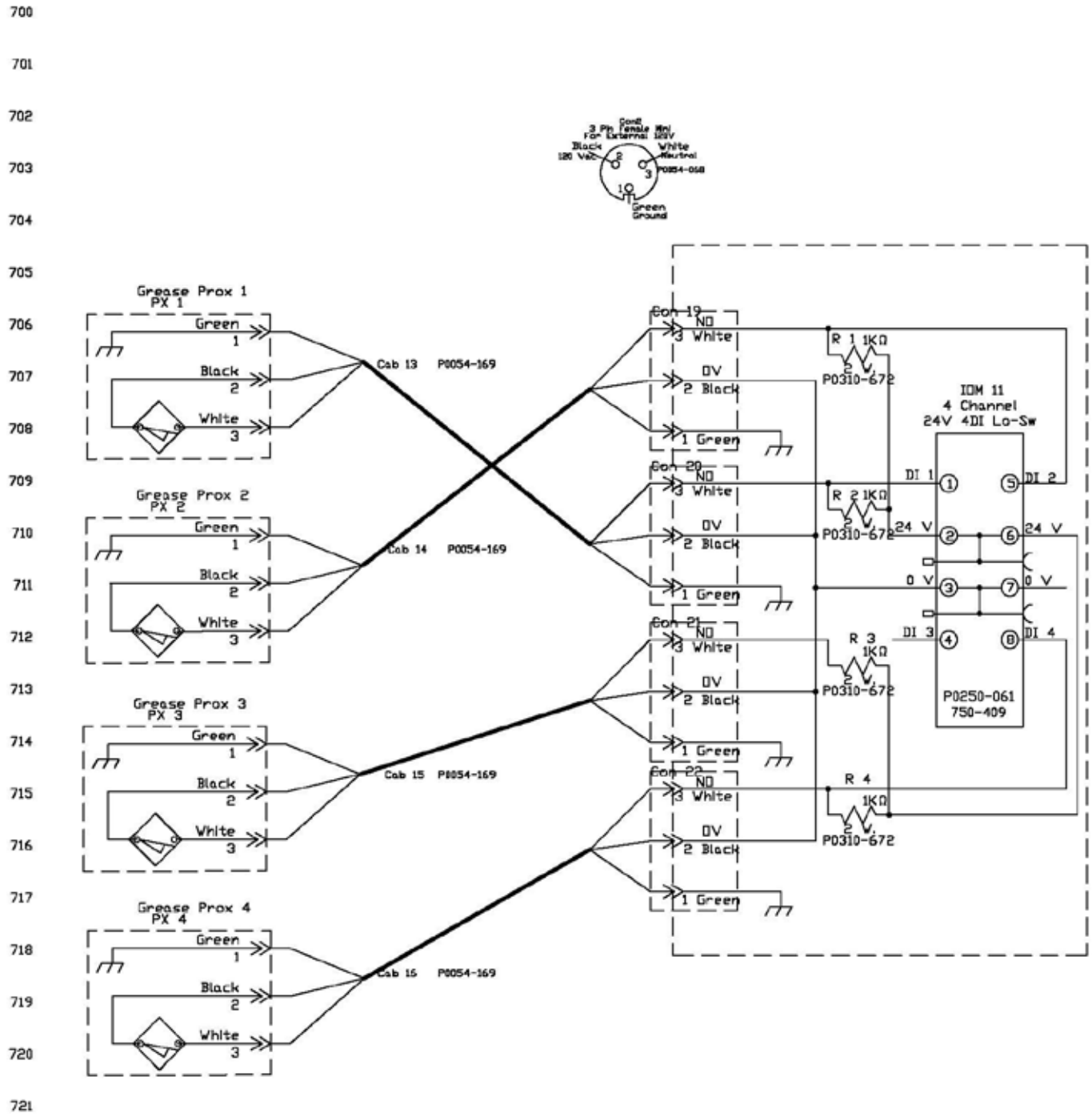
A12430A05


PS 2
Steering Pressure
Retract TL
Black
Brown
Blue
White
P0251-279
Cable 13
P0054-541
Black
Brown
+24V
White
P0054-523
IOM 7
2 Channel
4-20 ma Input
3 Blue
AI 1
AI 2
1 Brown 24 V
24 V
0 V
0 V
2 WHITE
Shield
Shield
P0250-058
750-466
PS 3
Steering Pressure
Extend BL
Cable 14
P0054-541
1 Brown
PS4
Steering Pressure
Retract BL
Cable 15
P0054-541
IOM 8
2 Channel
4-20 ma Input
Spare AI
Con 15
4 Pin Female
Micro

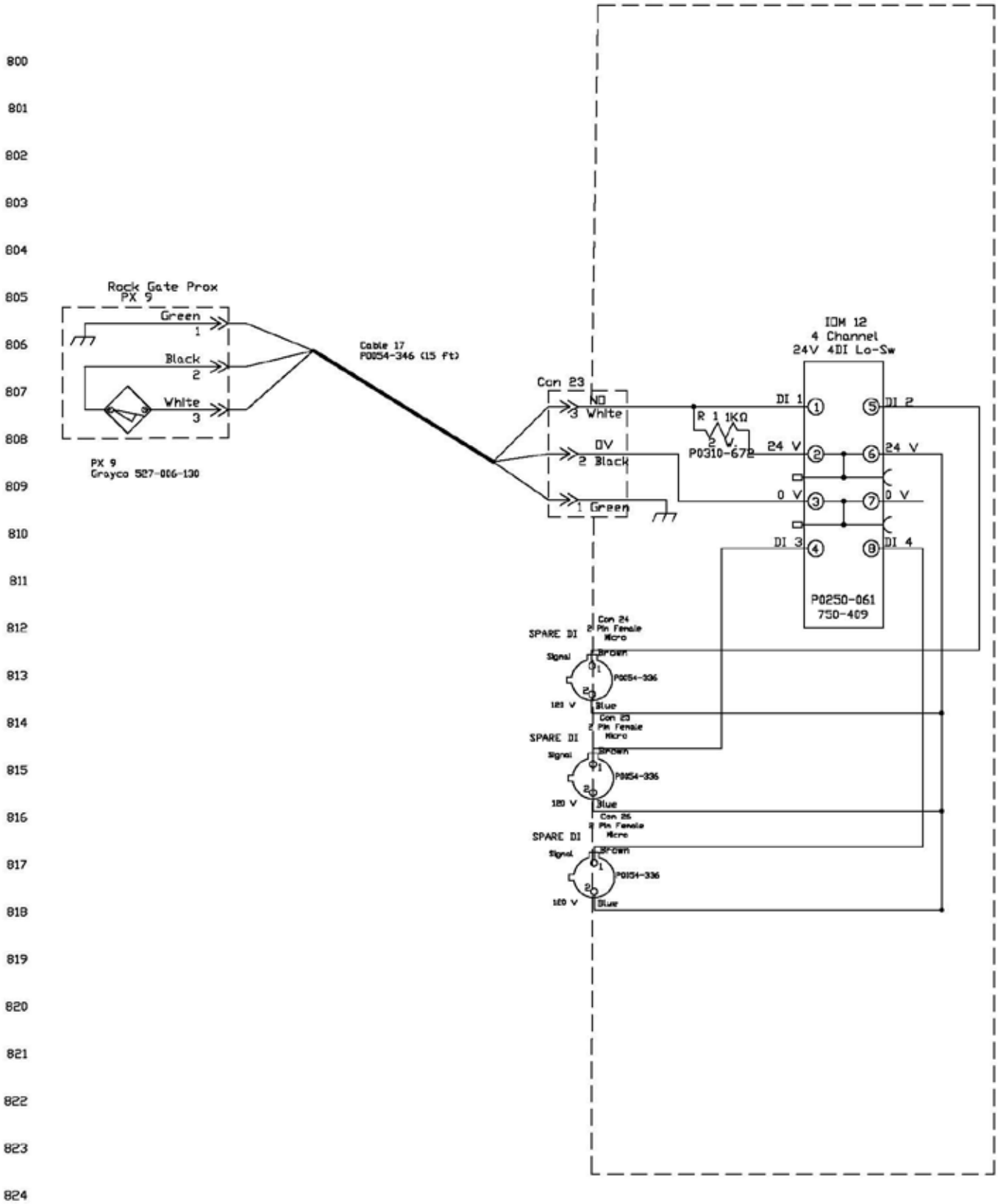
A12430A06


IOM 9
2 Channel
4-20 ma Input
AI 1
AI 2
24 V
0 V
Shield
P0250-058
750-466
IOM 10
1 Channel
U/D Counter
U/D
Clk
DO 1
DO 2
P0250- 199
750-404
FL 1
Integrating Flow Meter
P0250-197
4 pin single key extension cable
Cable 12
P0054-082C
Change connector in the flow meter
Integrating Flow Meter
Yellow
Red
Black
Micro Connector
Green
White
Black
P0310-524
R 1
10KΩ
1/4 W

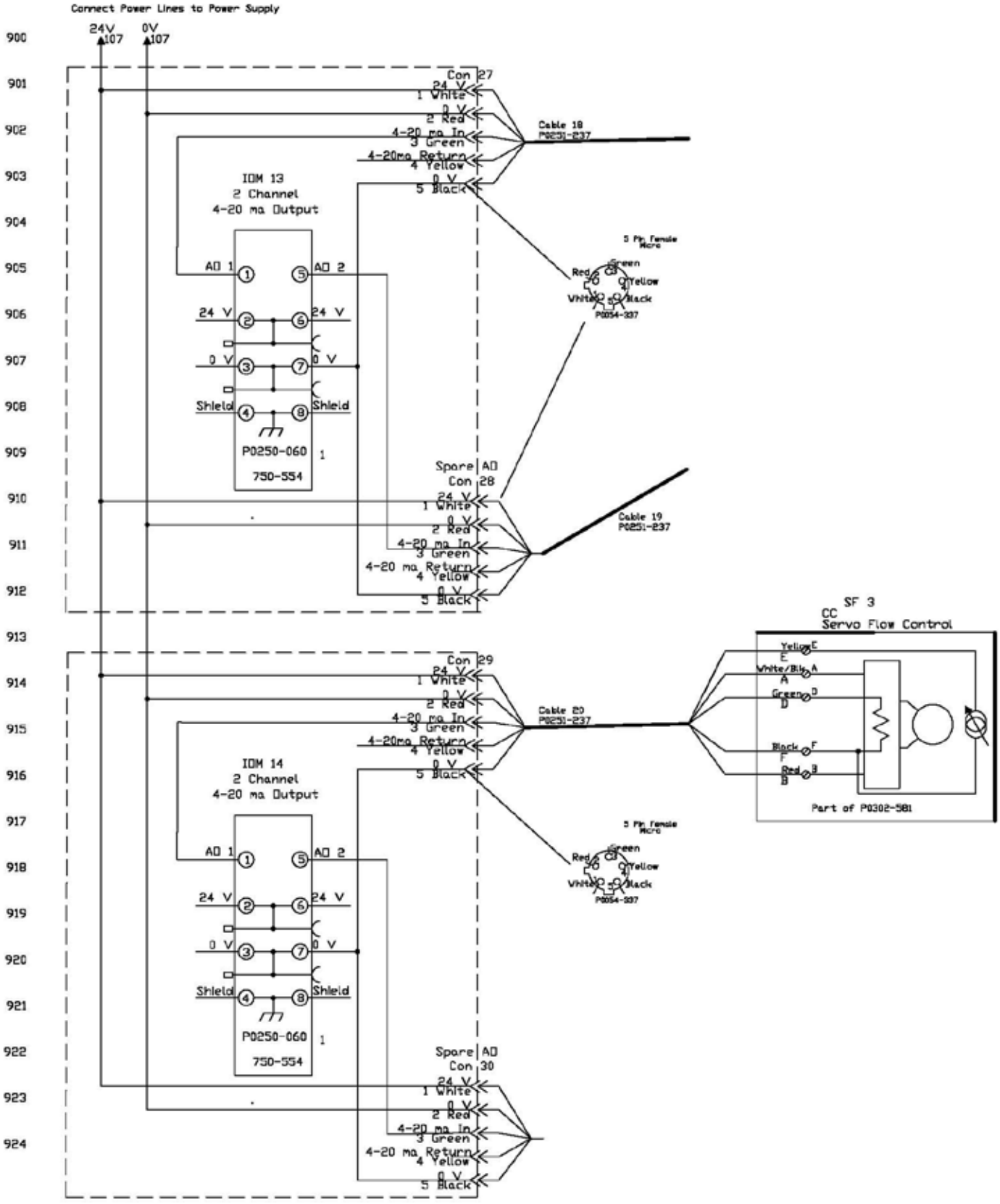
A12430A07


Grease Prox 1
PX 1
Green
1
Black
2
White
3
Cab 13 P0054-169
Grease Prox 2
PX 2
Cab 14 P0054-169
Grease Prox 3
PX 3
Cab 15 P0054-169
Grease Prox 4
PX 4
Cab 16 P0054-169
Con 19
Con 20
Con 21
Con 22
ND
DV
2 Black
1 Green
R 1 1KΩ
R 2 1KΩ
R 3 1KΩ
R 4 1KΩ
P0310-672
IOM 11
4 Channel
24V 4DI Lo-Sw
DI 1
DI 2
DI 3
DI 4
24 V
0 V
P0250-061
750-409

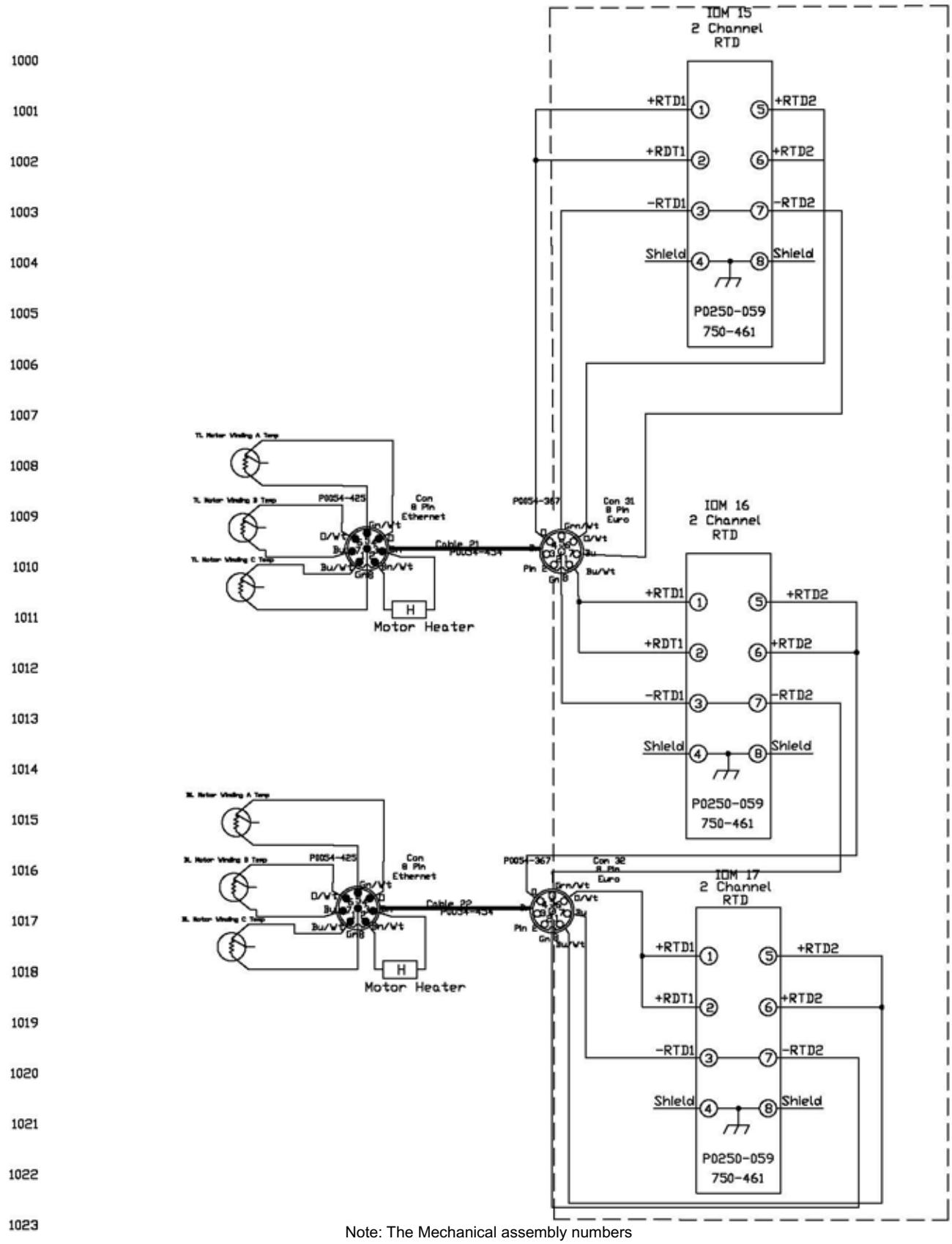
A12430A08


Rock Gate Prox
PX 9
Green
1
Black
2
White
3
PX 9
Grayco 527-006-130
Cable 17
P0154-346 (15 ft)
Con 23
NO
3 White
0V
2 Black
1 Green
R 1 1KΩ
P0310-672
IOM 12
4 Channel
24V 4DI Lo-Sw
DI 1
DI 2
24 V
24 V
0 V
0 V
DI 3
DI 4
P0250-061
750-409
Con 24
2 Pin Female
Micro
SPARE DI
Signal
Brown
P0154-336
123 V
Blue
Con 25
2 Pin Female
Micro
SPARE DI
Signal
Brown
P0154-336
120 V
Blue
Con 26
2 Pin Female
Micro
SPARE DI
Signal
Brown
P0154-336
109 V
Blue

A12430A09

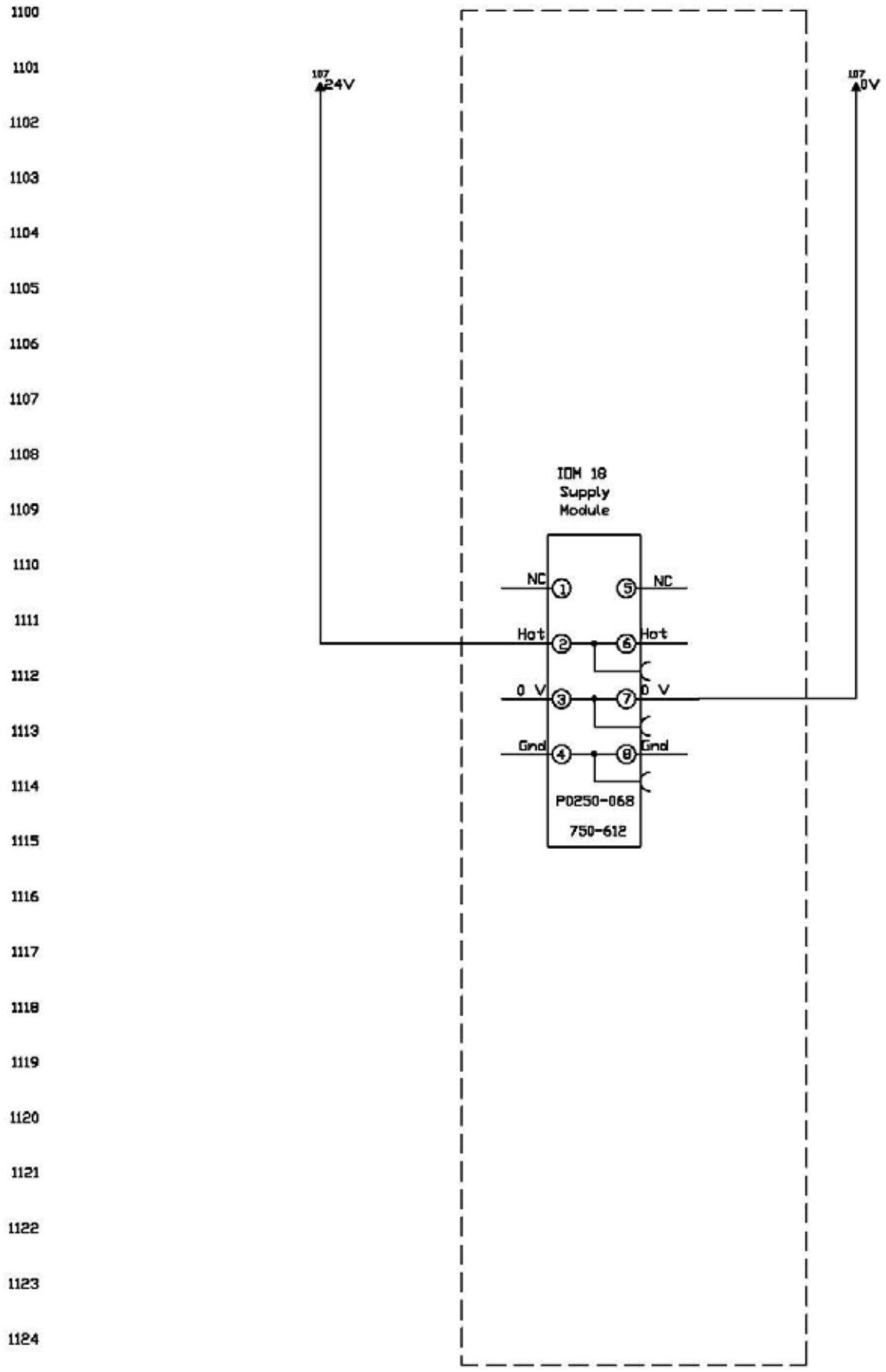

Connect Power Lines to Power Supply
24V
107
0V
107
Con 27
24 V
1 White
0 V
2 Red
4-20 ma In
3 Green
4-20ma Return
4 Yellow
0 V
5 Black
Cable 18
P0251-237
IOM 13
2 Channel
4-20 ma Output
AO 1
AO 2
24 V
0 V
Shield
P0250-060
750-554
5 Pin Female Micro
Red
Green
Yellow
White
Black
P0054-337
Spare AO
Con 28
Cable 19
P0251-237
SF 3
CC
Servo Flow Control
Yellow
White/Blk
Green
Black
Red
Part of P0302-581
Con 29
Cable 20
P0251-237
IOM 14
2 Channel
4-20 ma Output
Spare AO
Con 30

A12430A10

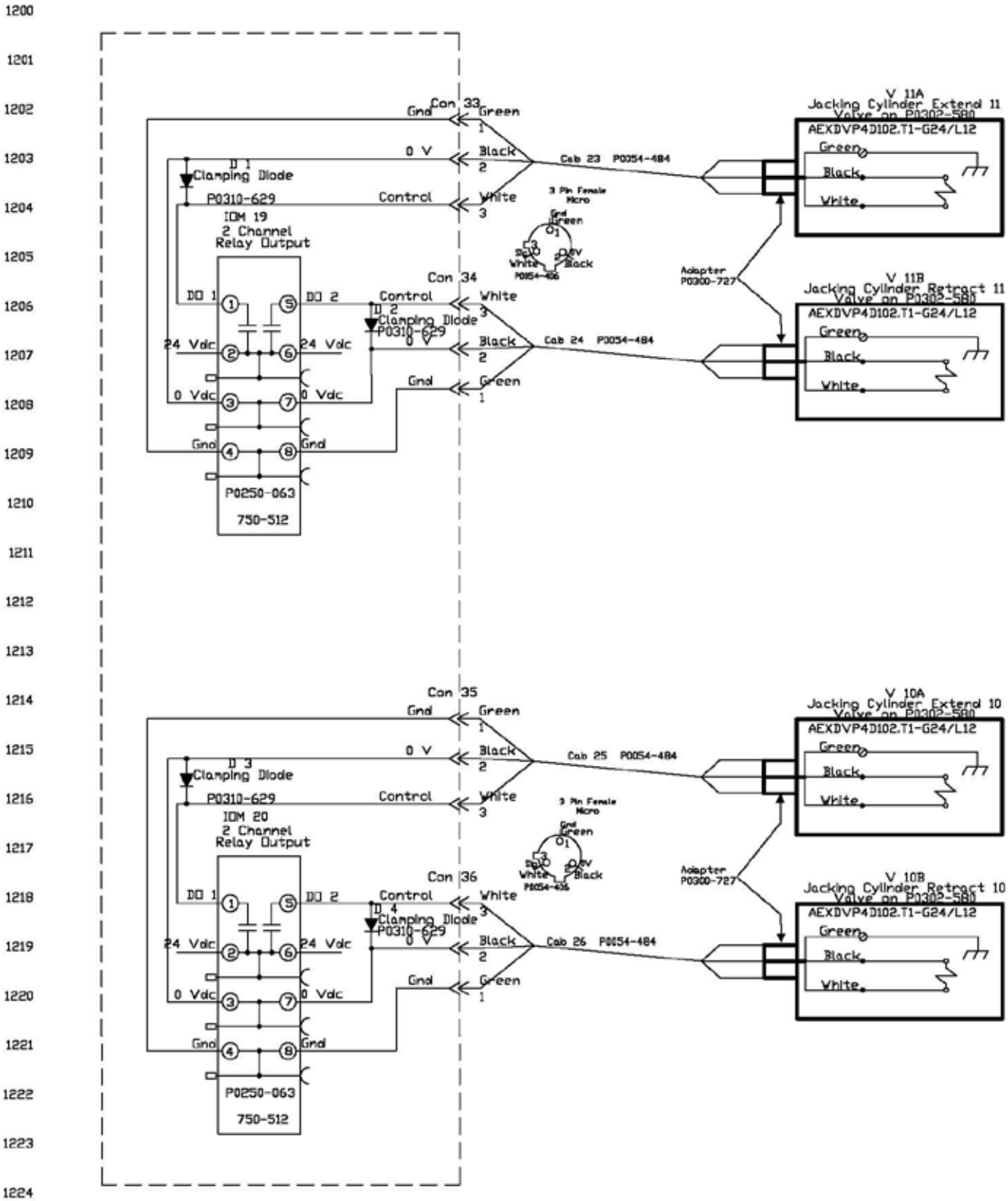


Note: The Mechanical assembly numbers are A22413A for the Panel and A22410A for the Box and connectors.

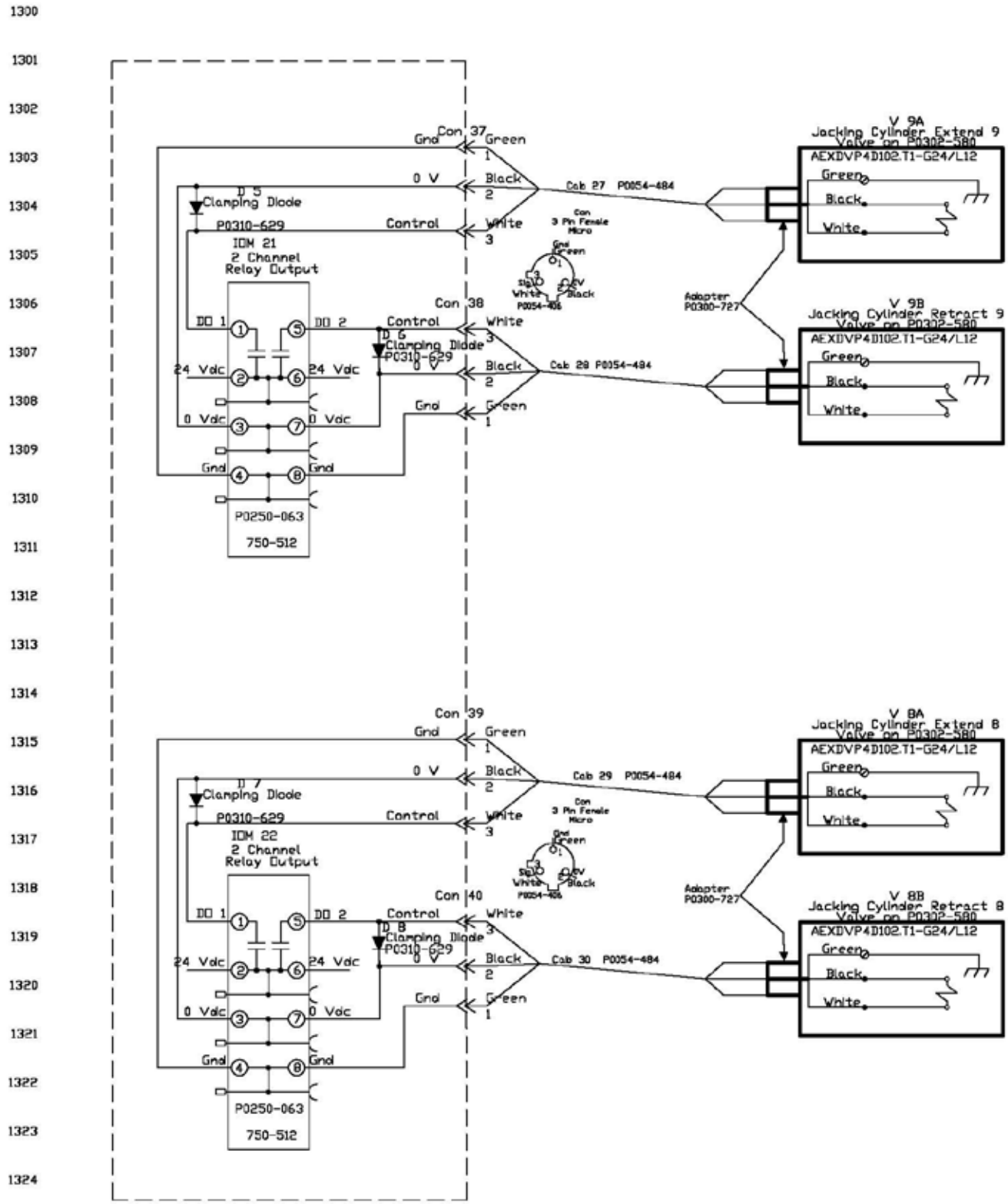
A12430A11


1100
1101
1102
1103
1104
1105
1106
1107
1108
1109
1110
1111
1112
1113
1114
1115
1116
1117
1118
1119
1120
1121
1122
1123
1124
107
24V
107
0V
IDM 18
Supply
Module
NC
1
5
NC
Hot
2
6
Hot
0 V
3
7
0 V
Gnd
4
8
Gnd
P0250-068
750-612

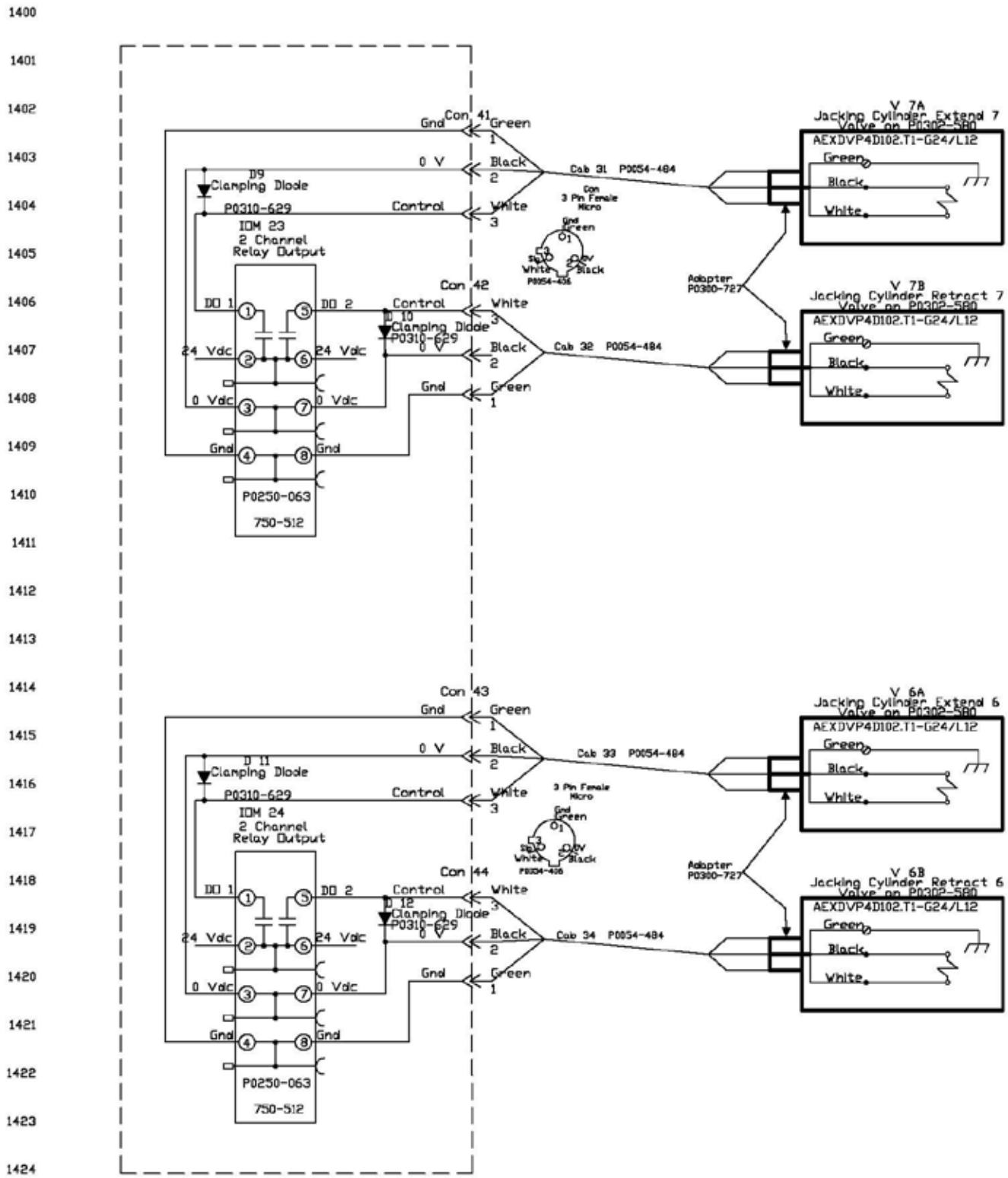
A12430A12


Con 33
Gnd
Green
1
0 V
Black
2
D 1
Clamping Diode
P0310-629
Control
White
3
IOM 19
2 Channel
Relay Output
Cab 23 P0054-484
3 Pin Female
Micro
Gnd
Green
O1
5V
Black
White
P0054-436
V 11A
Jacking Cylinder Extend 11
Valve on P0302-580
AEXDVP4D102.T1-G24/L12
Green
Black
White
Adapter
P0300-727
Con 34
DO 1
DO 2
D 2
Clamping Diode
P0310-629
24 Vdc
0 Vdc
Cab 24 P0054-484
V 11B
Jacking Cylinder Retract 11
Valve on P0302-580
AEXDVP4D102.T1-G24/L12
P0250-063
750-512
Con 35
D 3
Clamping Diode
P0310-629
IOM 20
2 Channel
Relay Output
Cab 25 P0054-484
V 10A
Jacking Cylinder Extend 10
Valve on P0302-580
AEXDVP4D102.T1-G24/L12
Con 36
D 4
Clamping Diode
P0310-629
Cab 26 P0054-484
V 10B
Jacking Cylinder Retract 10
Valve on P0302-580
AEXDVP4D102.T1-G24/L12
P0250-063
750-512

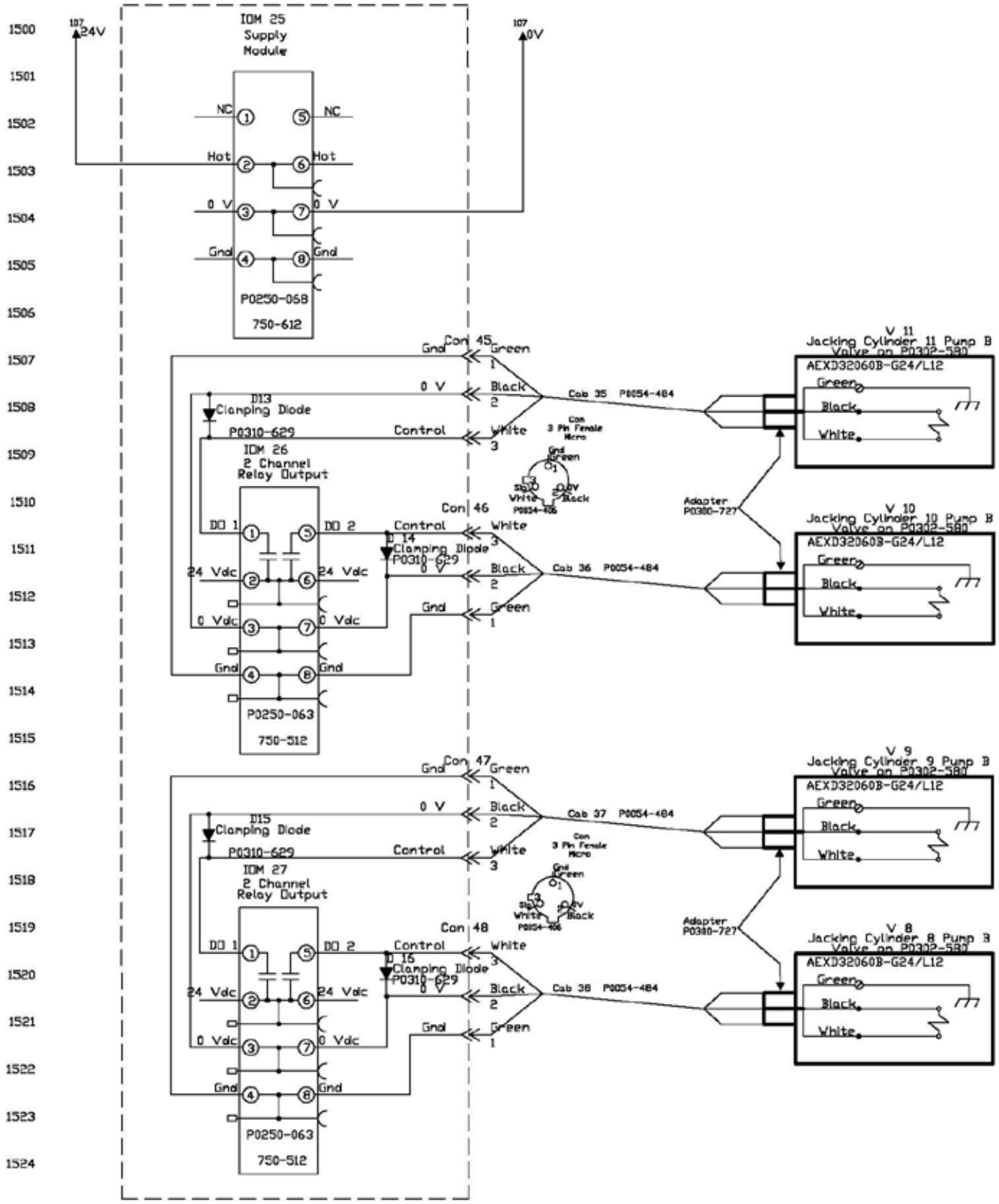
A12430A13


Con 37
Gnd
Green
1
0 V
Black
2
Control
White
3
D 5
Clamping Diode
P0310-629
IDM 21
2 Channel
Relay Output
DO 1
DO 2
24 Vdc
24 Vdc
0 Vdc
0 Vdc
Gnd
Gnd
P0250-063
750-512
Con 38
D 6
Clamping Diode
P0310-629
Cab 27 P0054-484
Con
3 Pin Female
Micro
Adapter
P0300-727
V 9A
Jacking Cylinder Extend 9
Valve on P0302-580
AEXDVP4D102.T1-G24/L12
V 9B
Jacking Cylinder Retract 9
Valve on P0302-580
AEXDVP4D102.T1-G24/L12
Cab 28 P0054-484
Con 39
D 7
Clamping Diode
P0310-629
IDM 22
2 Channel
Relay Output
Con 40
D 8
Clamping Diode
P0310-629
Cab 29 P0054-484
Cab 30 P0054-484
V 8A
Jacking Cylinder Extend 8
Valve on P0302-580
AEXDVP4D102.T1-G24/L12
V 8B
Jacking Cylinder Retract 8
Valve on P0302-580
AEXDVP4D102.T1-G24/L12

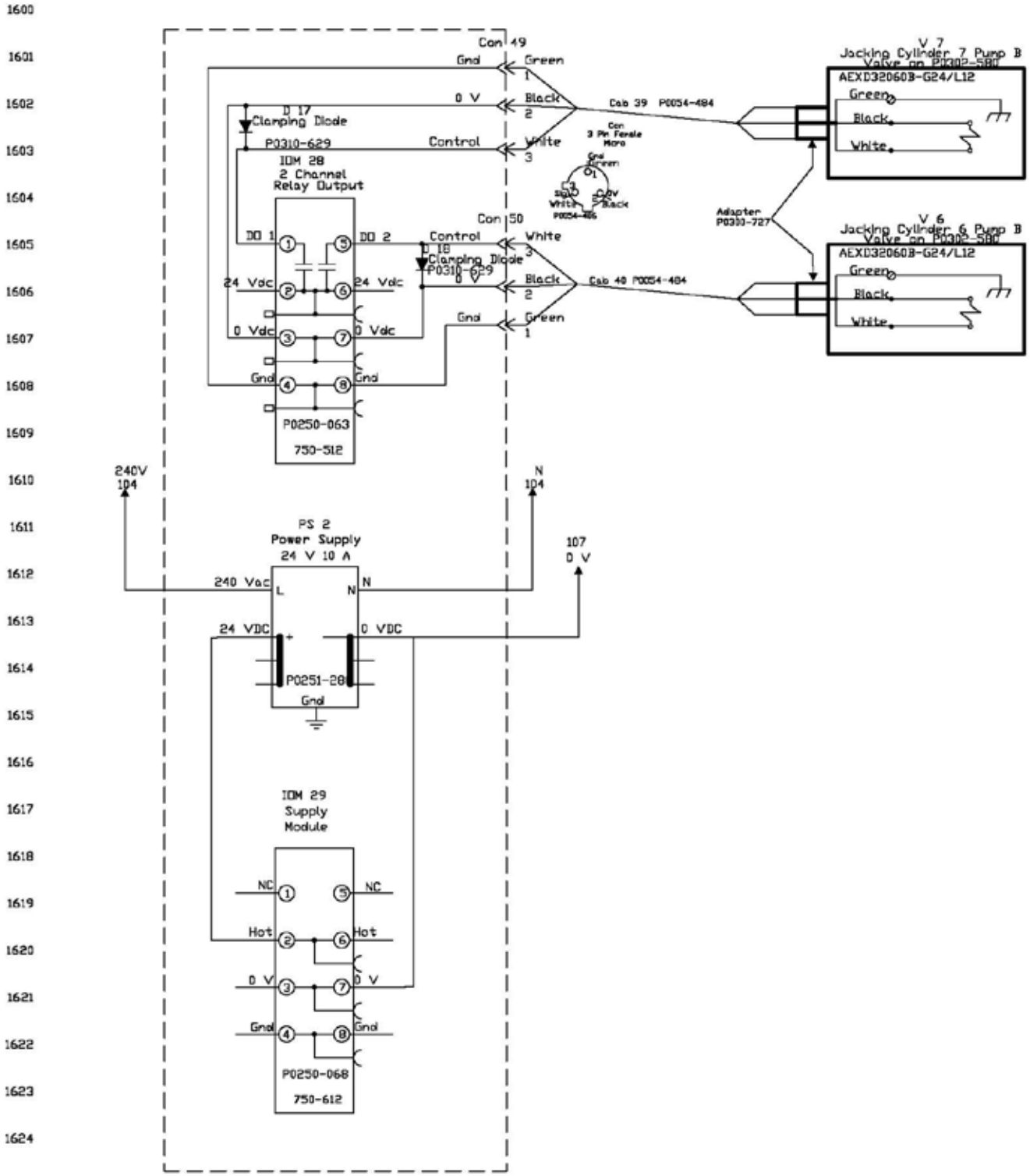
A12430A14


Con 41
Gnd
Green
1
0 V
Black
2
D9
Clamping Diode
P0310-629
Control
White
3
IOM 23
2 Channel
Relay Output
Cab 31 P0054-484
Con
3 Pin Female
Micro
Gnd
Green
O1
+24V
Black
White
P0054-436
V 7A
Jacking Cylinder Extend 7
Valve on P0302-580
AEXDVP4D102.T1-G24/L12
Green
Black
White
Adapter
P0300-727
V 7B
Jacking Cylinder Retract 7
Valve on P0302-580
AEXDVP4D102.T1-G24/L12
Green
Black
White
Con 42
DO 1
DO 2
Control
White
D 10
Clamping Diode
P0310-629
0 V
Black
2
Cab 32 P0054-484
24 Vdc
24 Vdc
0 Vdc
0 Vdc
Gnd
Green
1
Gnd
Gnd
P0250-063
750-512
Con 43
Gnd
Green
1
0 V
Black
2
D 11
Clamping Diode
P0310-629
Control
White
3
IOM 24
2 Channel
Relay Output
Cab 33 P0054-484
3 Pin Female
Micro
Gnd
Green
O1
+24V
Black
White
P0054-436
V 6A
Jacking Cylinder Extend 6
Valve on P0302-580
AEXDVP4D102.T1-G24/L12
Green
Black
White
Adapter
P0300-727
V 6B
Jacking Cylinder Retract 6
Valve on P0302-580
AEXDVP4D102.T1-G24/L12
Green
Black
White
Con 44
DO 1
DO 2
Control
White
D 12
Clamping Diode
P0310-629
0 V
Black
2
Cab 34 P0054-484
24 Vdc
24 Vdc
0 Vdc
0 Vdc
Gnd
Green
1
Gnd
Gnd
P0250-063
750-512

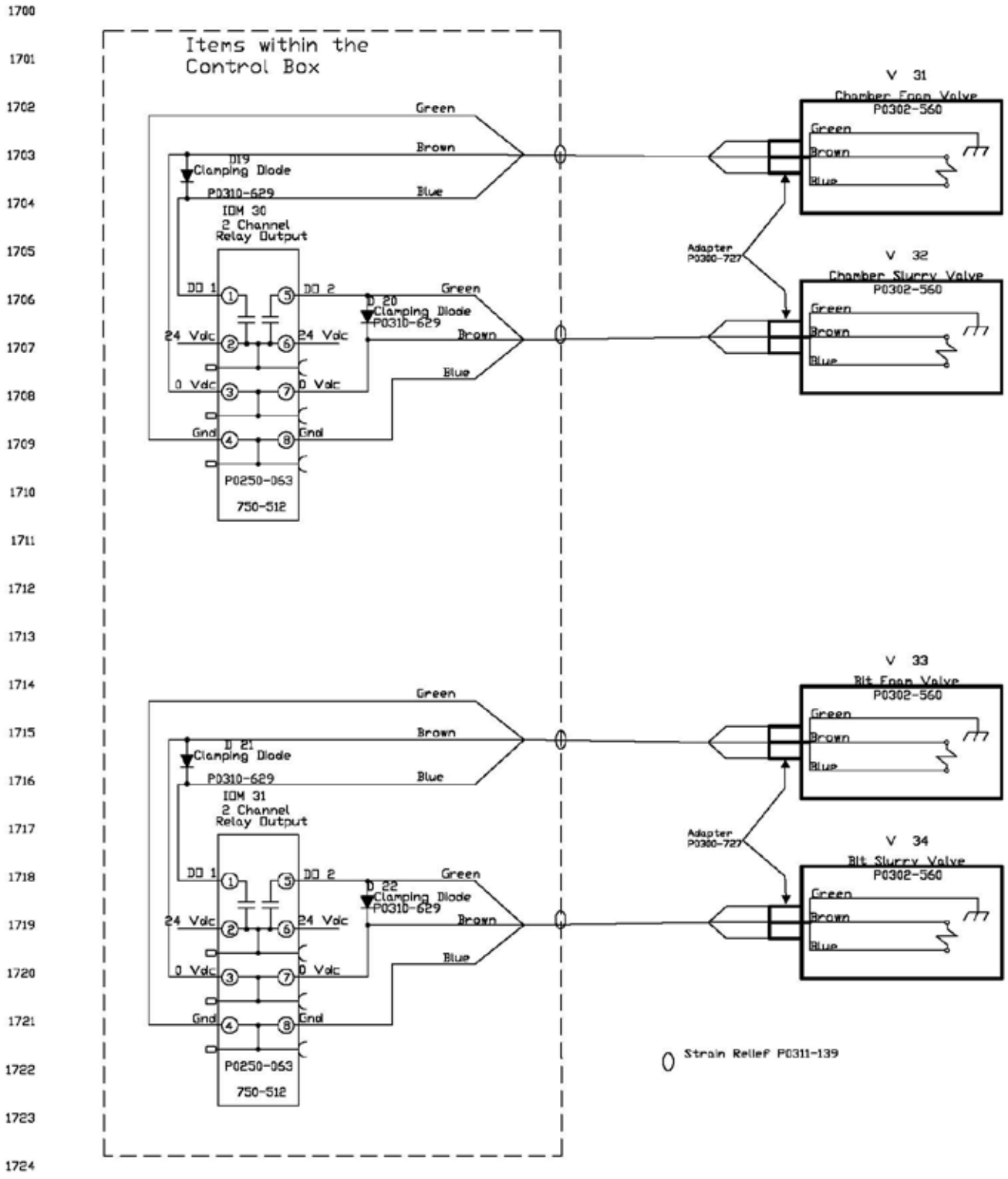
A12430A15


IOM 25
Supply
Module
107
24V
107
0V
NC
Hot
0 V
Gnd
P0250-068
750-612
Con 45
Gnd
Green
0 V
Black
Control
White
D13
Clamping Diode
P0310-629
IOM 26
2 Channel
Relay Output
DO 1
DO 2
24 Vdc
0 Vdc
P0250-063
750-512
Con 46
D14
Clamping Diode
Cab 35 P0054-484
Cab 36 P0054-484
Adapter
P0380-727
V 11
Jacking Cylinder 11 Pump B
Valve on P0302-580
AEXD32060B-G24/L12
V 10
Jacking Cylinder 10 Pump B
Valve on P0302-580
Con 47
D15
IOM 27
Con 48
D16
Cab 37 P0054-484
Cab 38 P0054-484
V 9
Jacking Cylinder 9 Pump B
Valve on P0302-580
V 8
Jacking Cylinder 8 Pump B
Valve on P0302-580

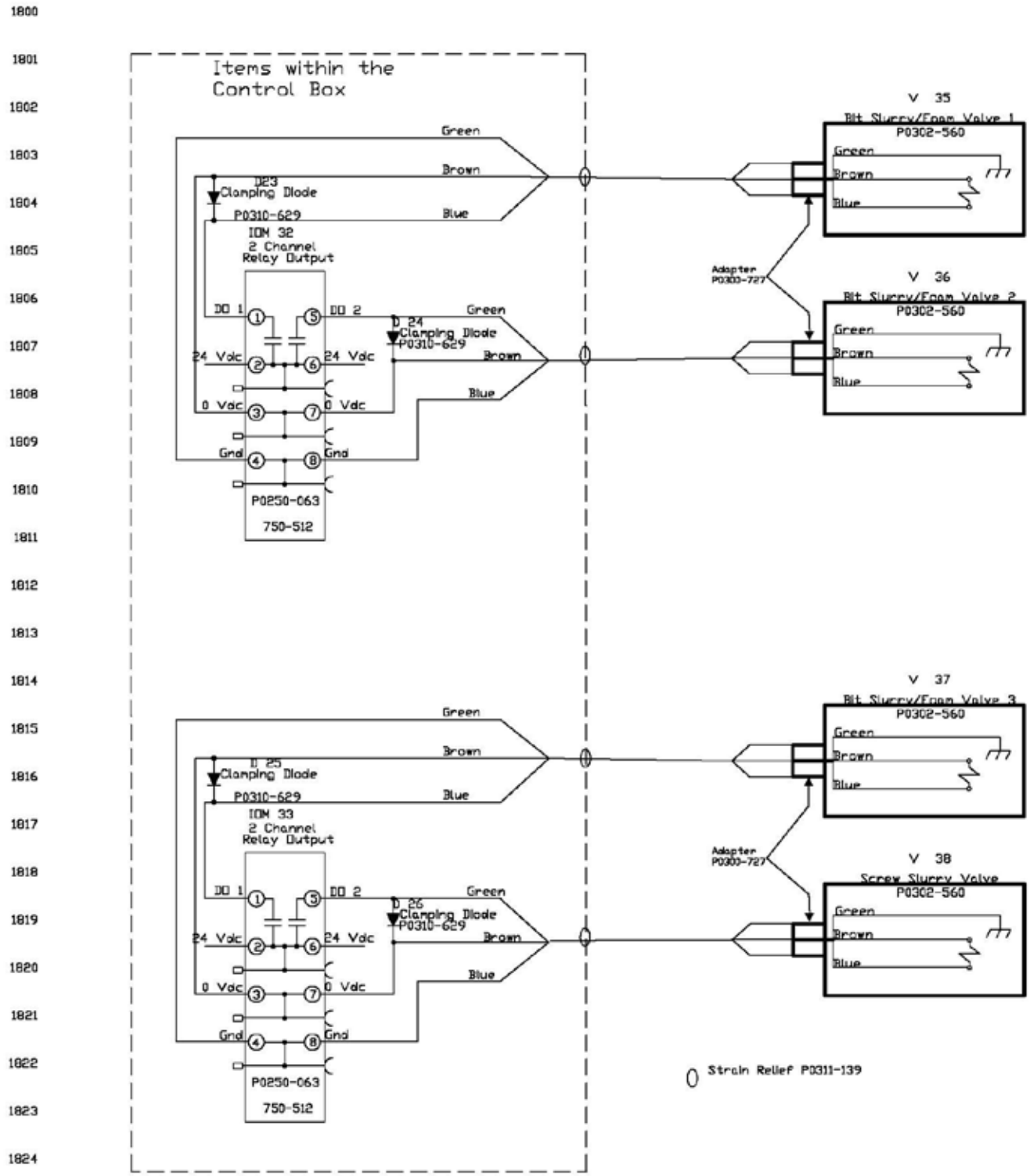
A12430A16


Con 49
Gnd
Green
1
0 V
Black
2
D 17
Clamping Diode
P0310-629
Control
White
3
IDM 28
2 Channel
Relay Output
DO 1
DO 2
24 Vdc
24 Vdc
0 Vdc
0 Vdc
Gnd
Gnd
P0250-063
750-512
Con 50
Control
White
3
D 18
Clamping Diode
P0310-629
Black
2
Gnd
Green
1
Cab 39 P0054-484
Cab 40 P0054-484
Con
3 Pin Female
Micro
Adapter
P0310-727
V 7
Jacking Cylinder 7 Pump B
Valve on P0302-580
AEXD32060B-G24/L12
Green
Black
White
V 6
Jacking Cylinder 6 Pump B
Valve on P0302-580
AEXD32060B-G24/L12
Green
Black
White
240V
104
N
104
PS 2
Power Supply
24 V 10 A
240 Vac
L
N
N
107
0 V
24 VDC
+
0 VDC
P0251-28
Gnd
IDM 29
Supply
Module
NC
NC
Hot
Hot
0 V
0 V
Gnd
Gnd
P0250-068
750-612

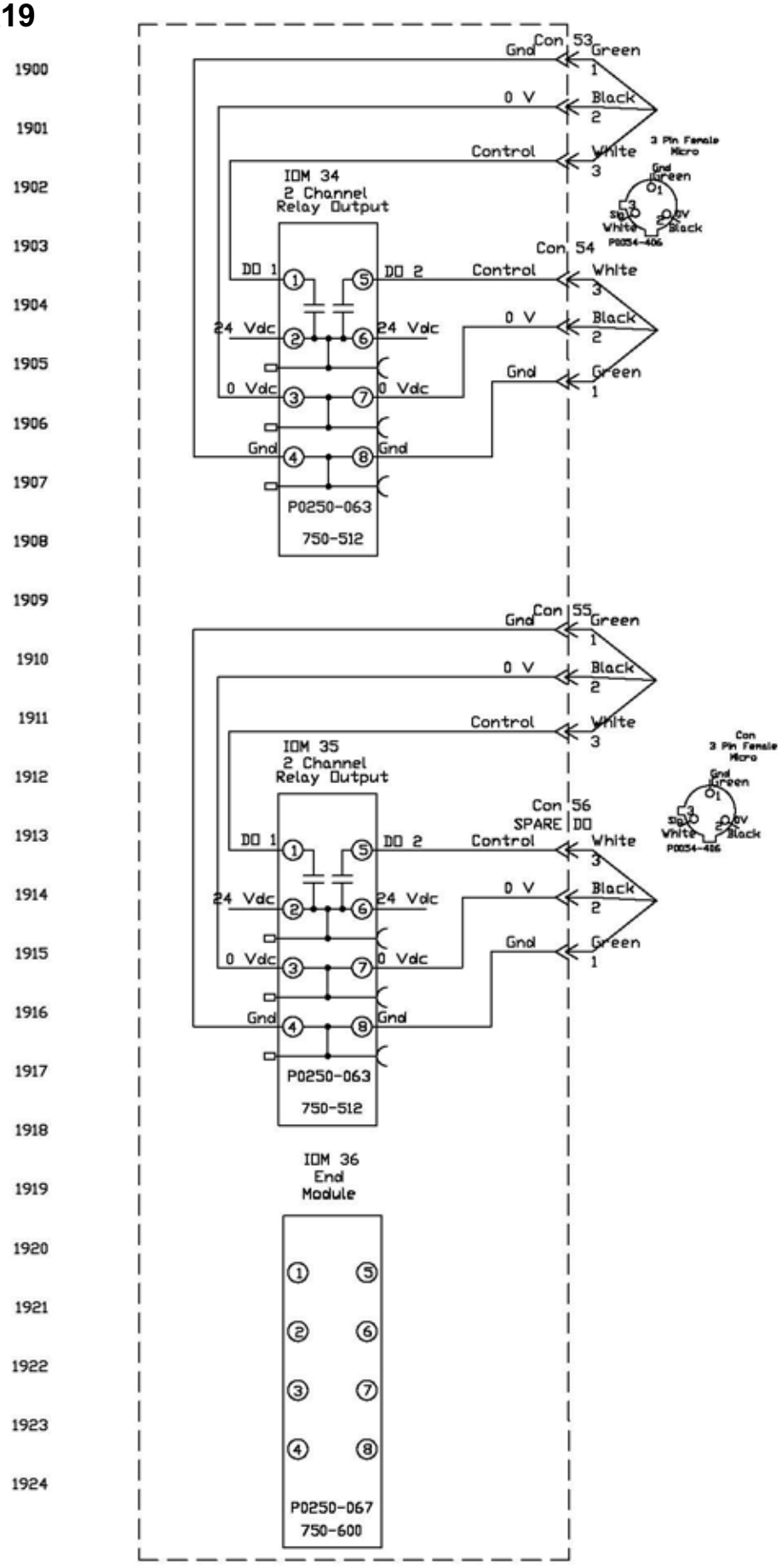
A12430A17


Items within the Control Box
V 31
Chamber Foam Valve
P0302-560
Green
Brown
Blue
Adapter P0380-727
V 32
Chamber Slurry Valve
P0302-560
D19 Clamping Diode P0310-629
IOM 30
2 Channel Relay Output
DO 1
DO 2
24 Vdc
0 Vdc
Gnd
D 20 Clamping Diode P0310-629
P0250-063
750-512
V 33
Bit Foam Valve
P0302-560
D 21 Clamping Diode P0310-629
IOM 31
2 Channel Relay Output
V 34
Bit Slurry Valve
P0302-560
D 22 Clamping Diode P0310-629
Strain Relief P0311-139

A12430A18

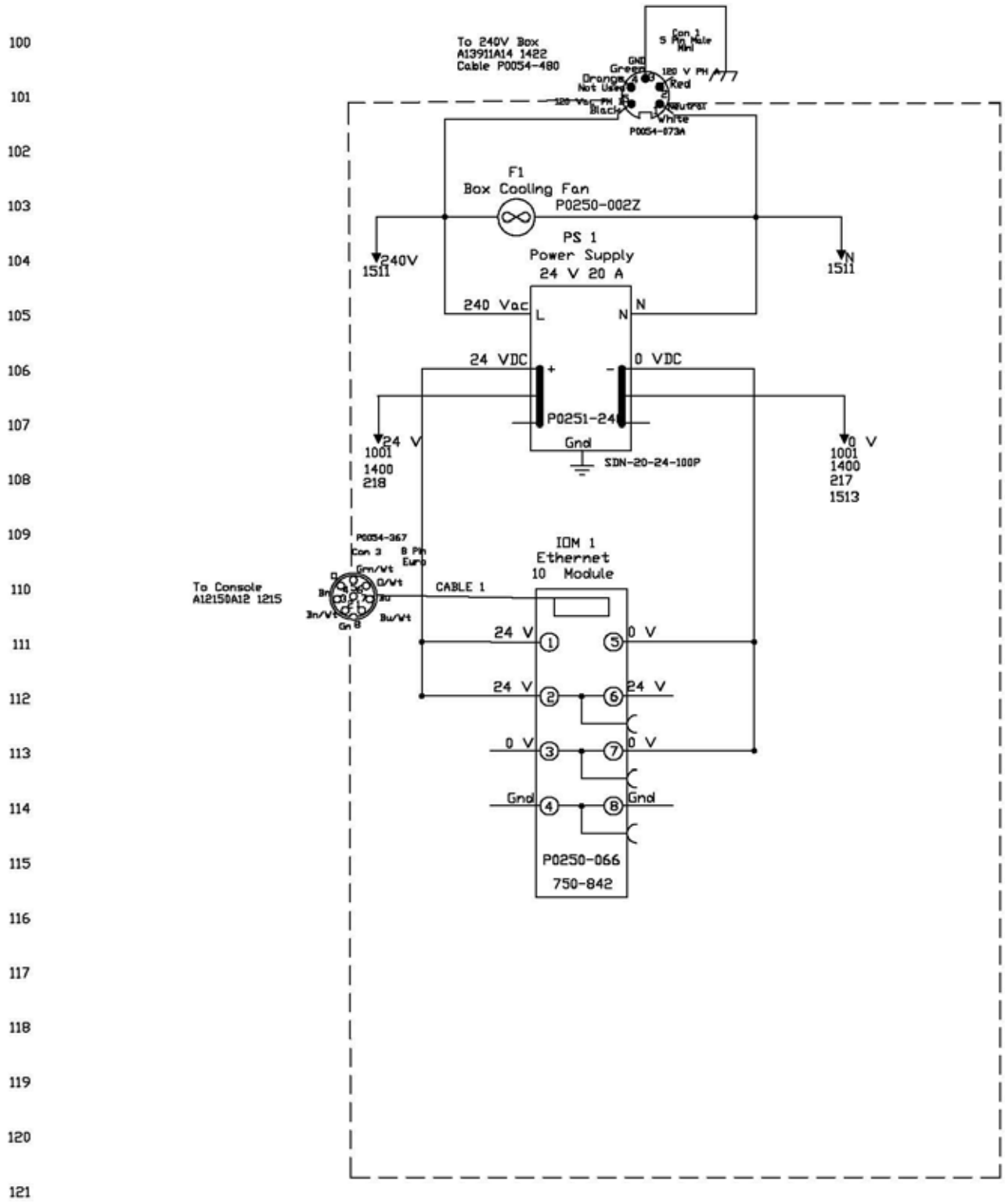

Items within the Control Box
V 35
Bit Slurry/Foam Valve 1
P0302-560
Green
Brown
Blue
Adapter P0300-727
V 36
Bit Slurry/Foam Valve 2
P0302-560
D23 Clamping Diode P0310-629
IDM 32
2 Channel Relay Output
DO 1
DO 2
24 Vdc
0 Vdc
Gnd
D 24 Clamping Diode P0310-629
P0250-063
750-512
V 37
Bit Slurry/Foam Valve 3
P0302-560
D 25 Clamping Diode P0310-629
IDM 33
2 Channel Relay Output
D 26 Clamping Diode P0310-629
V 38
Screw Slurry Valve
P0302-560
Strain Relief P0311-139

A12430A19

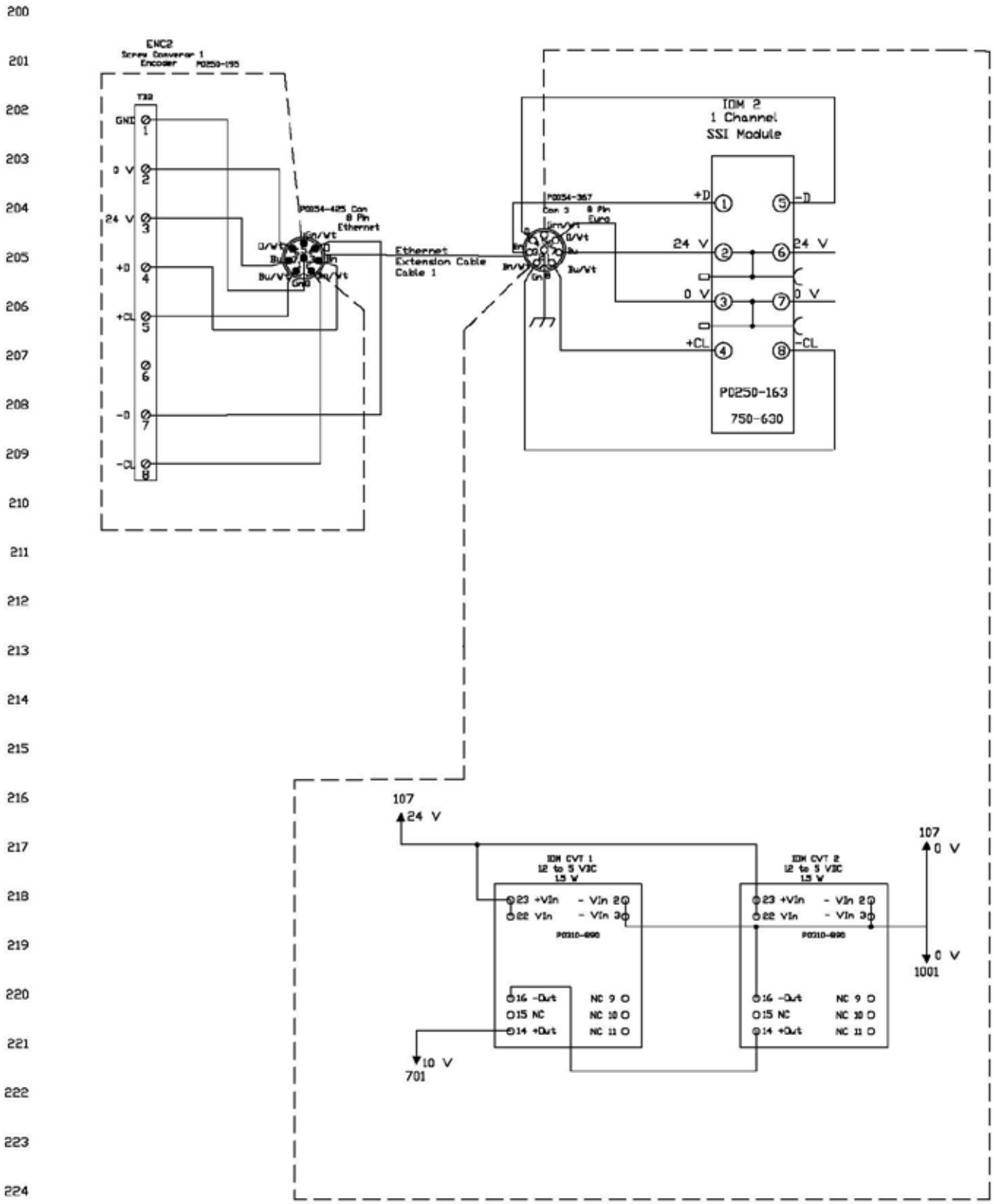

1900
1901
1902
1903
1904
1905
1906
1907
1908
1909
1910
1911
1912
1913
1914
1915
1916
1917
1918
1919
1920
1921
1922
1923
1924
Con 53
Gnd
Green
1
0 V
Black
2
Control
White
3
3 Pin Female Micro
IOM 34
2 Channel
Relay Output
DO 1
DO 2
24 Vdc
24 Vdc
0 Vdc
0 Vdc
Gnd
Gnd
P0250-063
750-512
Con 54
Control
White
3
0 V
Black
2
Gnd
Green
1
Con 55
Con 56
SPARE DO
IOM 35
2 Channel
Relay Output
IOM 36
End
Module
P0250-067
750-600

ELECTRICAL SCHEMATICS - HEAD RIGHT CONTROL BOX

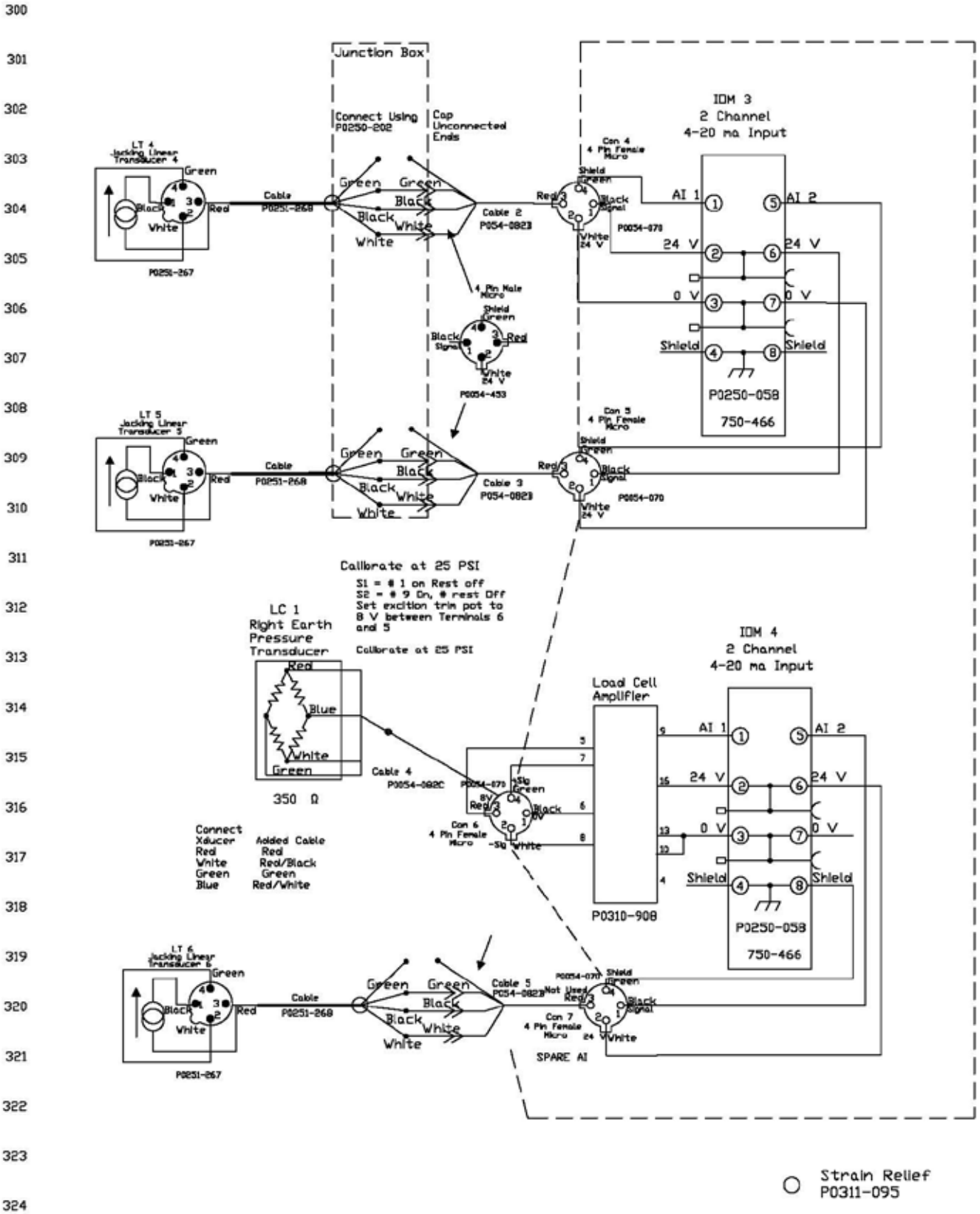
A12431A01



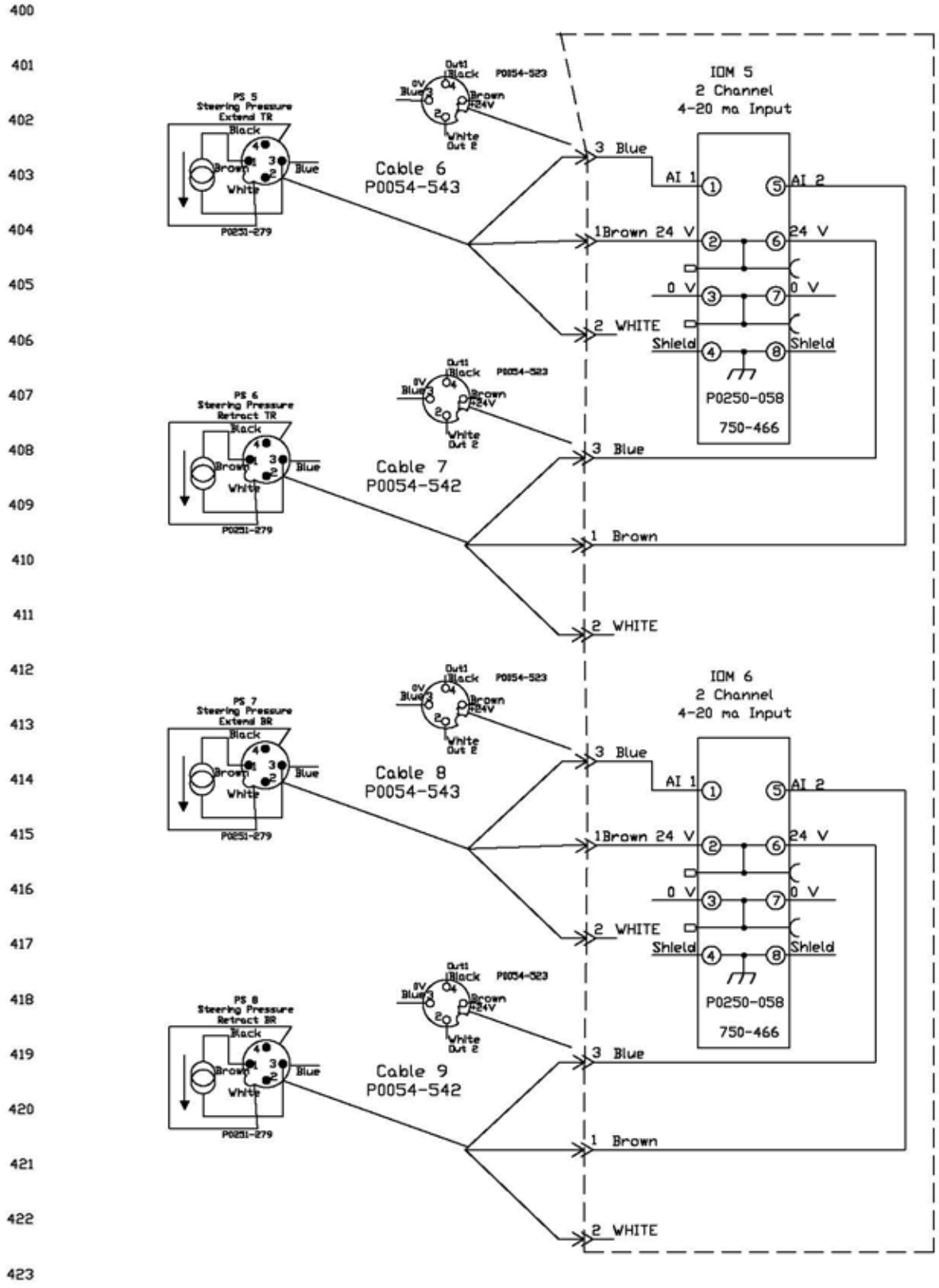
A12431A02


ENC2
Screw Conveyor 1
Encoder
P0250-195
T32
GND
0 V
24 V
+D
+CL
-D
-CL
P0354-425 Con
8 Pin
Ethernet
Ethernet
Extension Cable
Cable 1
IDM 2
1 Channel
SSI Module
P0354-367
Con 3
8 Pin
Fuco
+D
-D
24 V
0 V
+CL
-CL
P0250-163
750-630
107
24 V
IDM CVT 1
12 to 5 VDC
1.5 W
IDM CVT 2
12 to 5 VDC
1.5 W
23 +Vin
22 Vin
- Vin 2
- Vin 3
P0310-000
16 -Out
15 NC
14 +Out
NC 9
NC 10
NC 11
10 V
701
1001

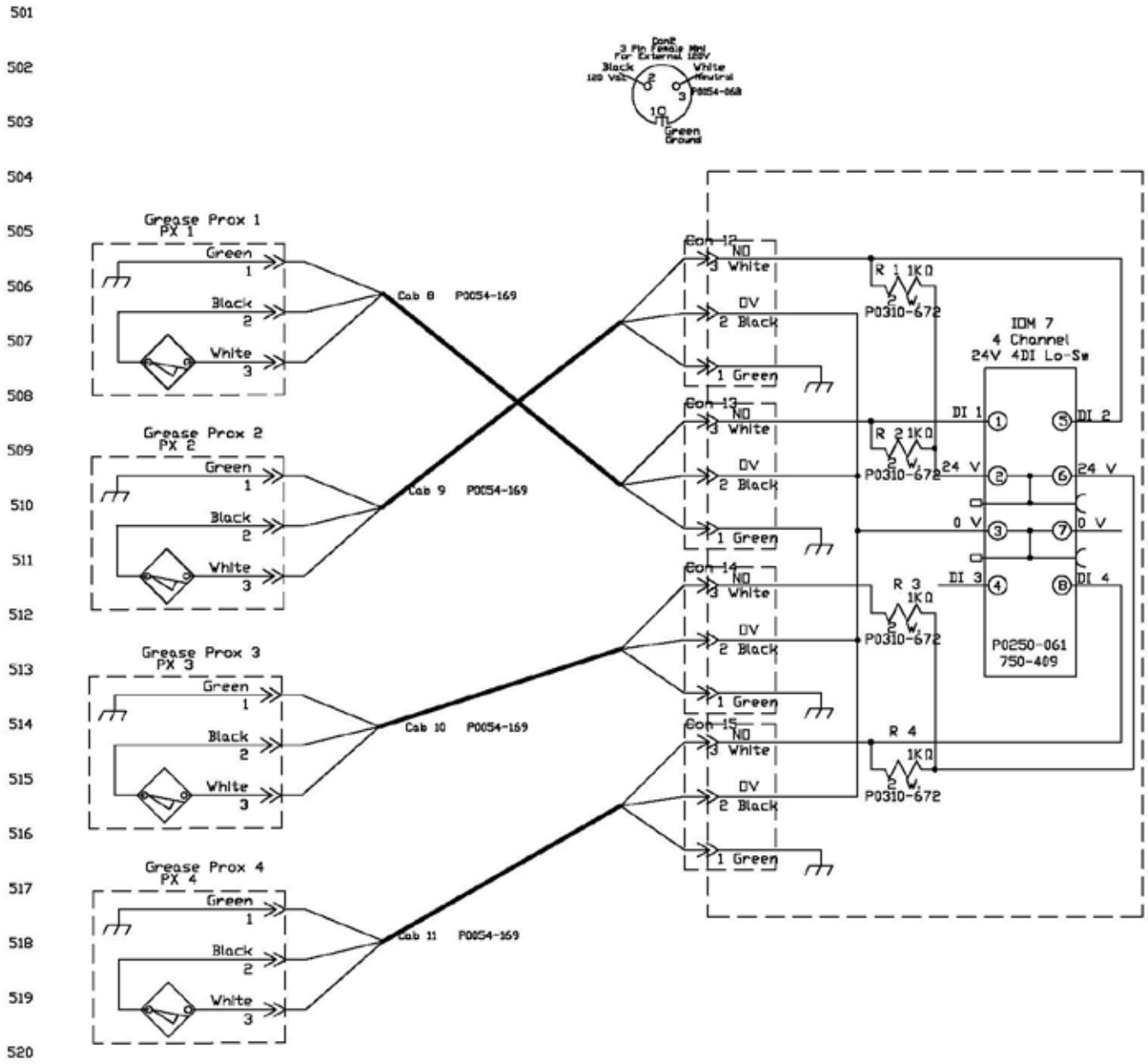
A12431A03


Junction Box
Connect Using P0250-202
Cap Unconnected Ends
IDM 3
2 Channel
4-20 ma Input
P0250-058
750-466
LT 4
Jacking Linear Transducer 4
LT 5
Jacking Linear Transducer 5
LT 6
Jacking Linear Transducer 6
Cable P0251-268
Cable 2 P0054-0823
Cable 3 P0054-0823
Cable 5 P0054-0823
P0054-453
P0054-070
P0054-071
P0251-267
Calibrate at 25 PSI
S1 = # 1 on Rest off
S2 = # 9 On, # rest Off
Set excition trim pot to 8 V between Terminals 6 and 5
Calibrate at 25 PSI
LC 1
Right Earth Pressure Transducer
350 Ω
Cable 4 P0054-082C
P0054-072
Load Cell Amplifier
P0310-908
IDM 4
2 Channel
4-20 ma Input
Connect Xducer
Red
White
Green
Blue
Added Cable
Red
Red/Black
Green
Red/White
SPARE AI
Strain Relief P0311-095

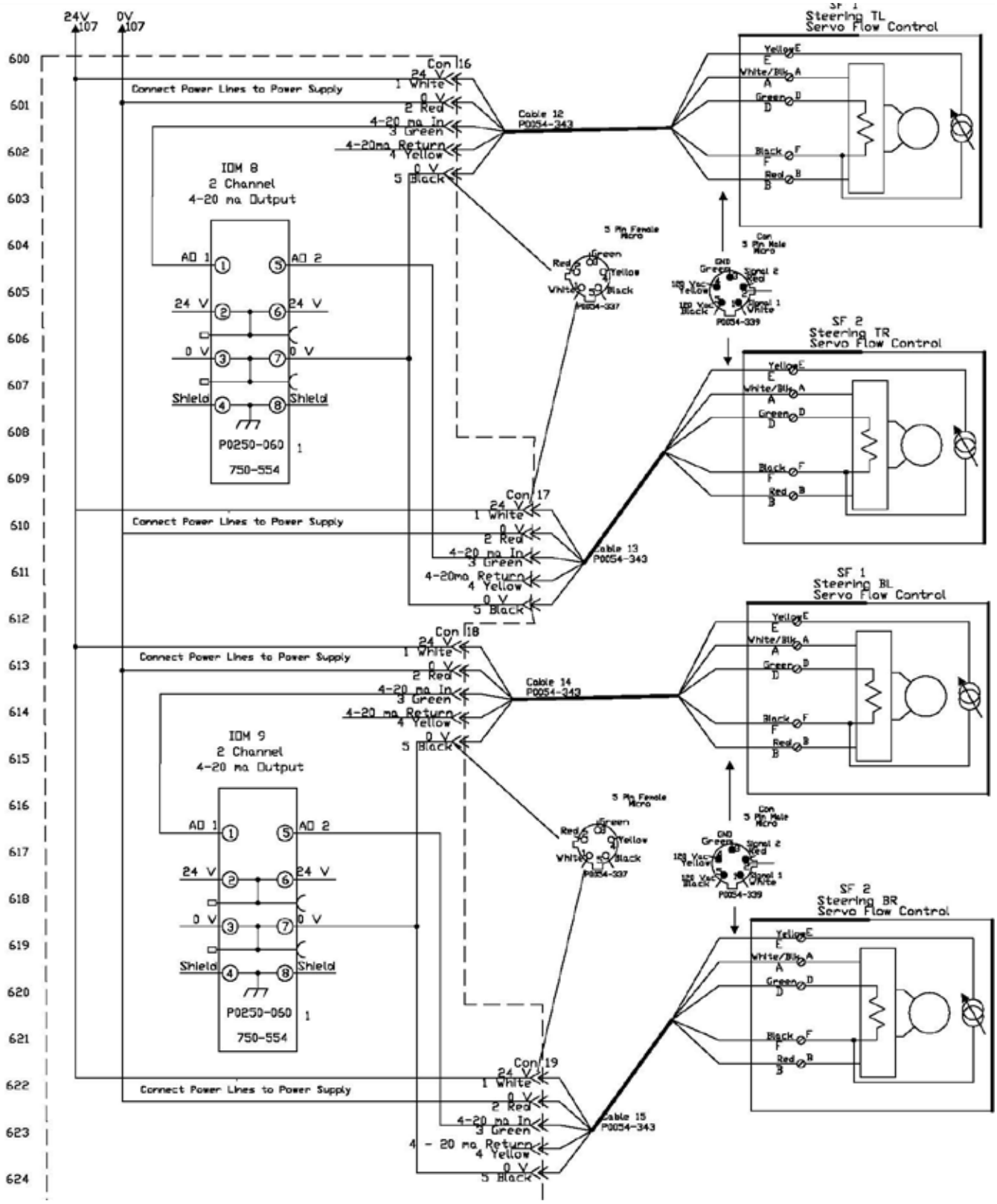
A12431A04


400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
PS 5
Steering Pressure
Extend TR
Black
Brown
Blue
White
P0231-279
Out1
Black
P0054-523
0V
Blue
Brown
+24V
White
Out 2
Cable 6
P0054-543
IOM 5
2 Channel
4-20 ma Input
3 Blue
AI 1
AI 2
1Brown 24 V
24 V
0 V
0 V
2 WHITE
Shield
Shield
P0250-058
750-466
PS 6
Steering Pressure
Retract TR
Cable 7
P0054-542
1 Brown
PS 7
Steering Pressure
Extend BR
Cable 8
P0054-543
IOM 6
2 Channel
4-20 ma Input
PS 8
Steering Pressure
Retract BR
Cable 9
P0054-542

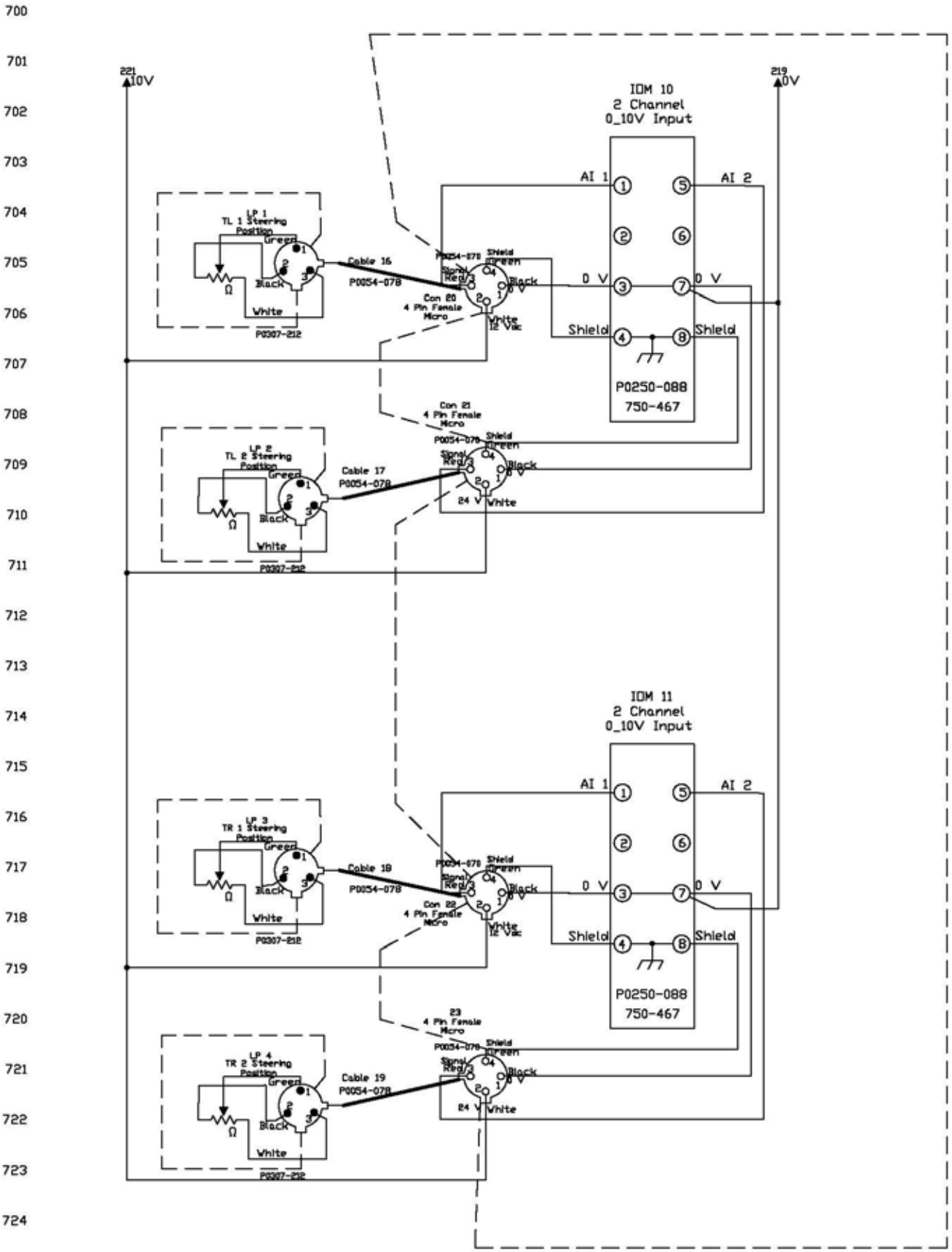
A12431A05


Grease Prox 1
PX 1
Green
1
Black
2
White
3
Cab 8 P0054-169
Grease Prox 2
PX 2
Cab 9 P0054-169
Grease Prox 3
PX 3
Cab 10 P0054-169
Grease Prox 4
PX 4
Cab 11 P0054-169
Conn 12
NO
3 White
0V
2 Black
1 Green
Conn 13
Conn 14
Conn 15
R 1 1KΩ
P0310-672
R 2 1KΩ
R 3 1KΩ
R 4 1KΩ
IOM 7
4 Channel
24V 4DI Lo-Sw
DI 1
DI 2
DI 3
DI 4
24 V
0 V
P0250-061
750-409

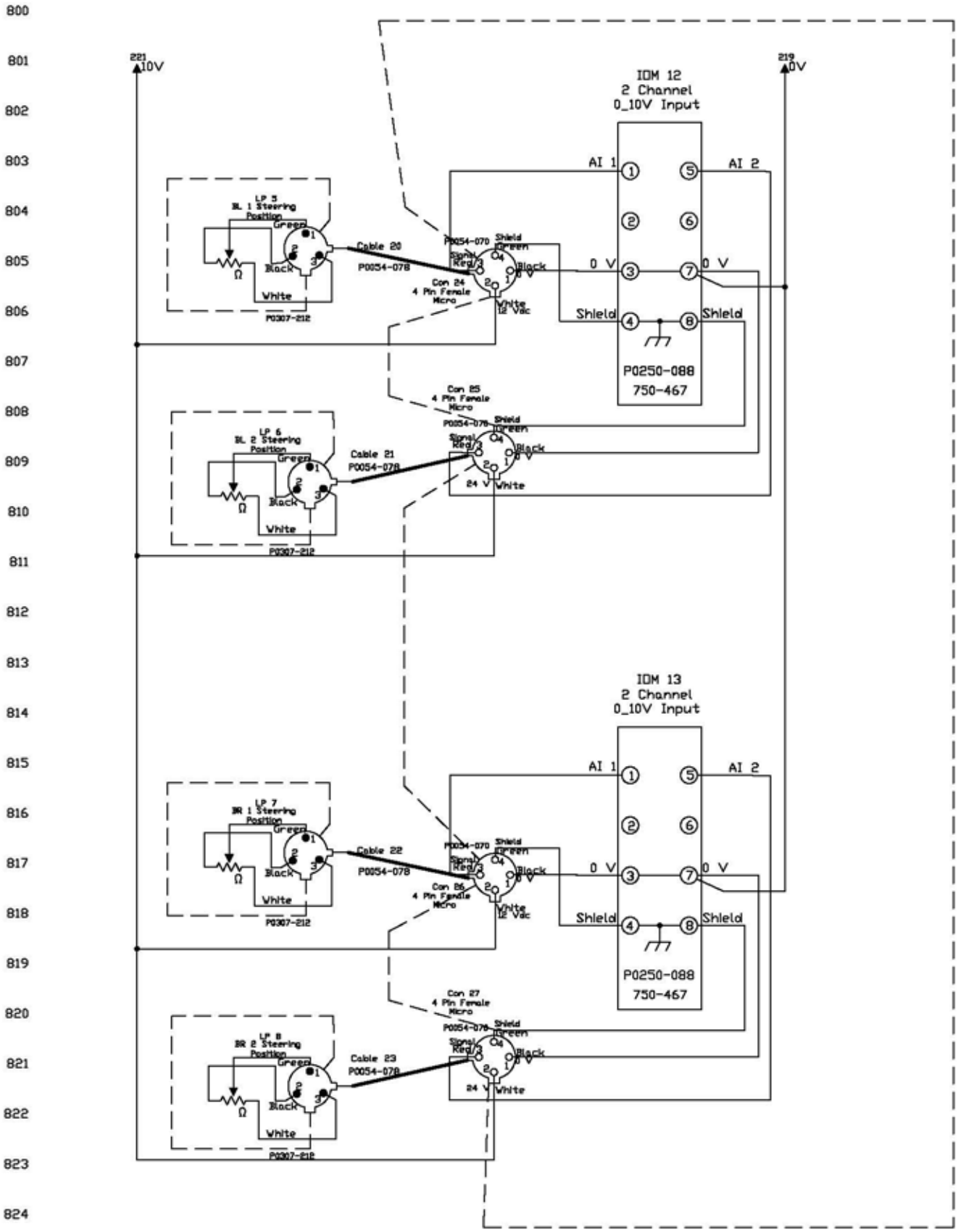
A12431A06


24V 107
0V 107
Connect Power Lines to Power Supply
Con 16
1 White 24 V
2 Red 0 V
3 Green 4-20 ma In
4 Yellow 4-20ma Return
5 Black 0 V
Cable 12 P0054-343
IOM 8
2 Channel
4-20 ma Output
AO 1
AO 2
24 V
0 V
Shield
P0250-060
750-554
SF 1
Steering TL
Servo Flow Control
SF 2
Steering TR
Servo Flow Control
Con 17
Cable 13 P0054-343
SF 1
Steering BL
Servo Flow Control
Con 18
Cable 14 P0054-343
IOM 9
2 Channel
4-20 ma Output
SF 2
Steering BR
Servo Flow Control
Con 19
Cable 15 P0054-343
5 Pin Female Micro
5 Pin Male Micro
P0054-337
P0054-339

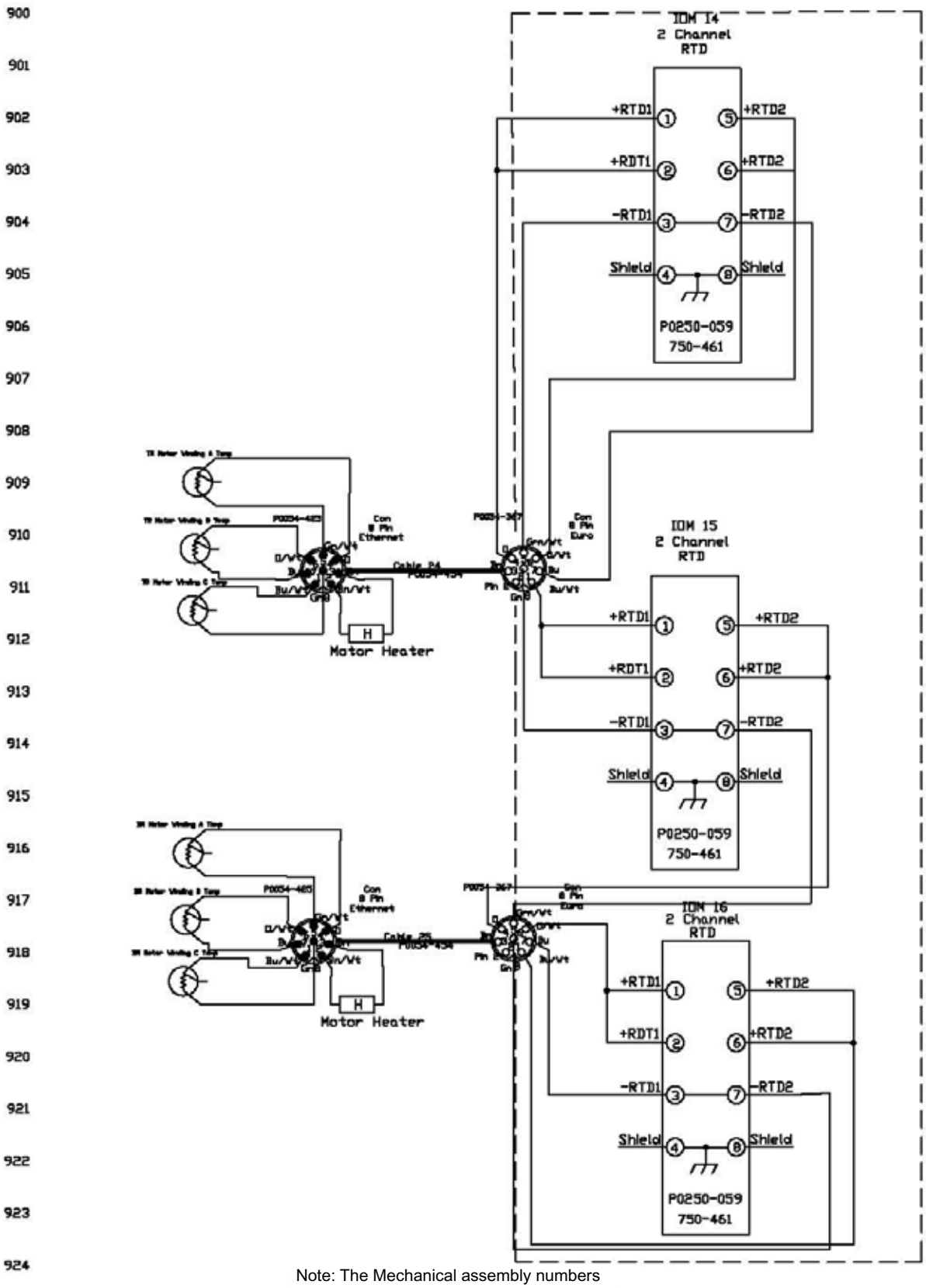
A12431A07


700
701
702
703
704
705
706
707
708
709
710
711
712
713
714
715
716
717
718
719
720
721
722
723
724
221
10V
219
0V
IOM 10
2 Channel
0_10V Input
AI 1
AI 2
0 V
0 V
Shield
Shield
P0250-088
750-467
LP 1
TL 1 Steering
Position
Green
Black
White
P0307-212
Cable 16
P0054-078
Con 20
4 Pin Female
Micro
Shield
Green
Signal
Red
Black
White
12 Vac
Con 21
4 Pin Female
Micro
LP 2
TL 2 Steering
Position
Cable 17
P0054-078
24 V
IOM 11
2 Channel
0_10V Input
LP 3
TR 1 Steering
Position
Cable 18
P0054-078
Con 22
4 Pin Female
Micro
23
4 Pin Female
Micro
LP 4
TR 2 Steering
Position
Cable 19
P0054-078

A12431A08

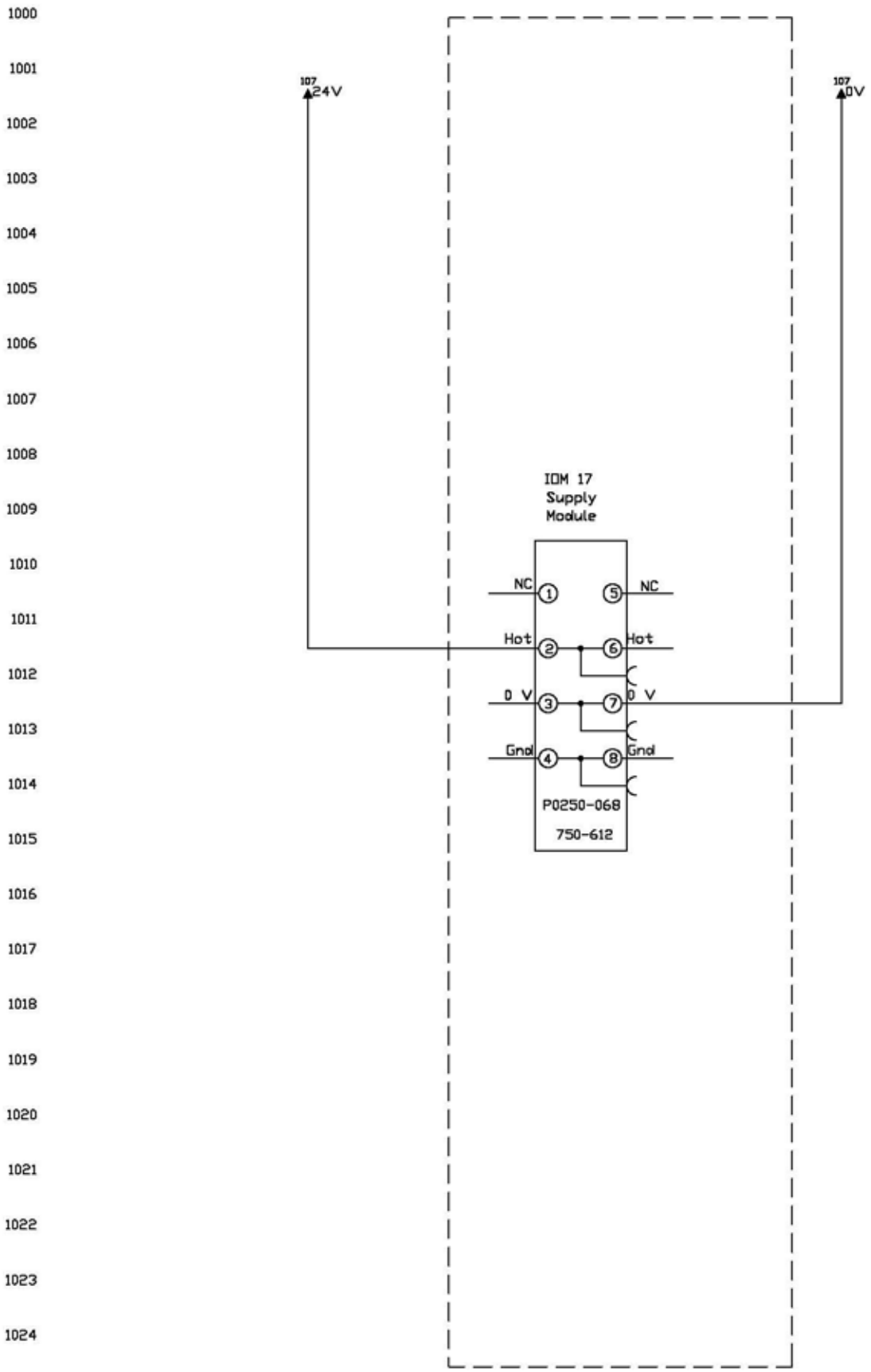

800
801
802
803
804
805
806
807
808
809
810
811
812
813
814
815
816
817
818
819
820
821
822
823
824
221
10V
219
0V
IOM 12
2 Channel
0_10V Input
AI 1
AI 2
0 V
0 V
Shield
Shield
P0250-088
750-467
LP 5
BL 1 Steering
Position
Green
Black
White
P0307-212
Cable 20
P0054-078
P0054-070
Shield
Green
Signal
Red
Black
White
12 Vdc
Con 24
4 Pin Female
Micro
Con 25
4 Pin Female
Micro
LP 6
BL 2 Steering
Position
Cable 21
24 V
IOM 13
2 Channel
0_10V Input
LP 7
BR 1 Steering
Position
Cable 22
Con 26
4 Pin Female
Micro
LP 8
BR 2 Steering
Position
Cable 23
Con 27
4 Pin Female
Micro

A12431A09

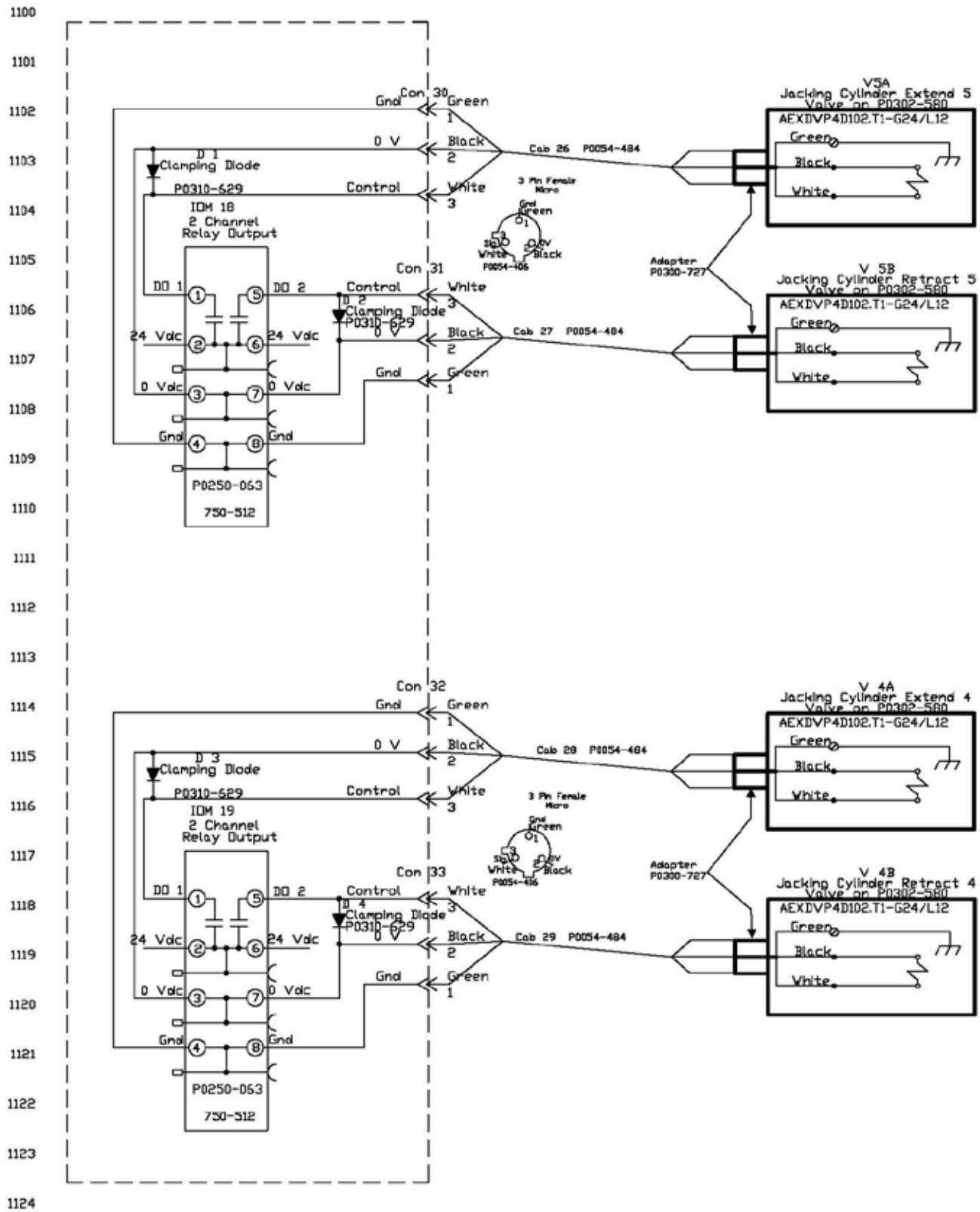


Note: The Mechanical assembly numbers are A22413A for the Panel and A22410A for the Box and connectors.

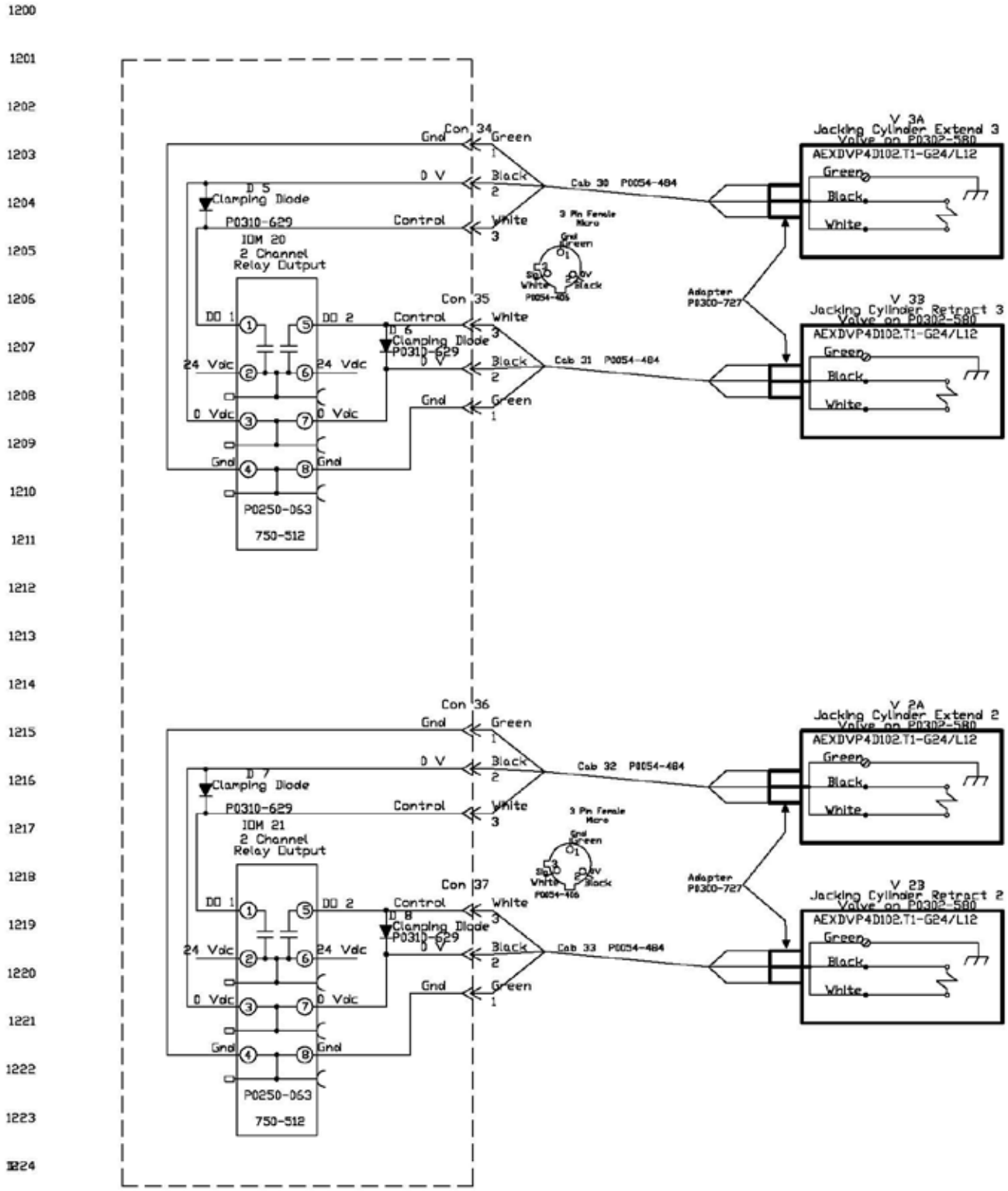
A12431A10


1000
1001
1002
1003
1004
1005
1006
1007
1008
1009
1010
1011
1012
1013
1014
1015
1016
1017
1018
1019
1020
1021
1022
1023
1024
107
24V
107
0V
IOM 17
Supply
Module
NC
1
5
NC
Hot
2
6
Hot
0 V
3
7
0 V
Gnd
4
8
Gnd
P0250-068
750-612

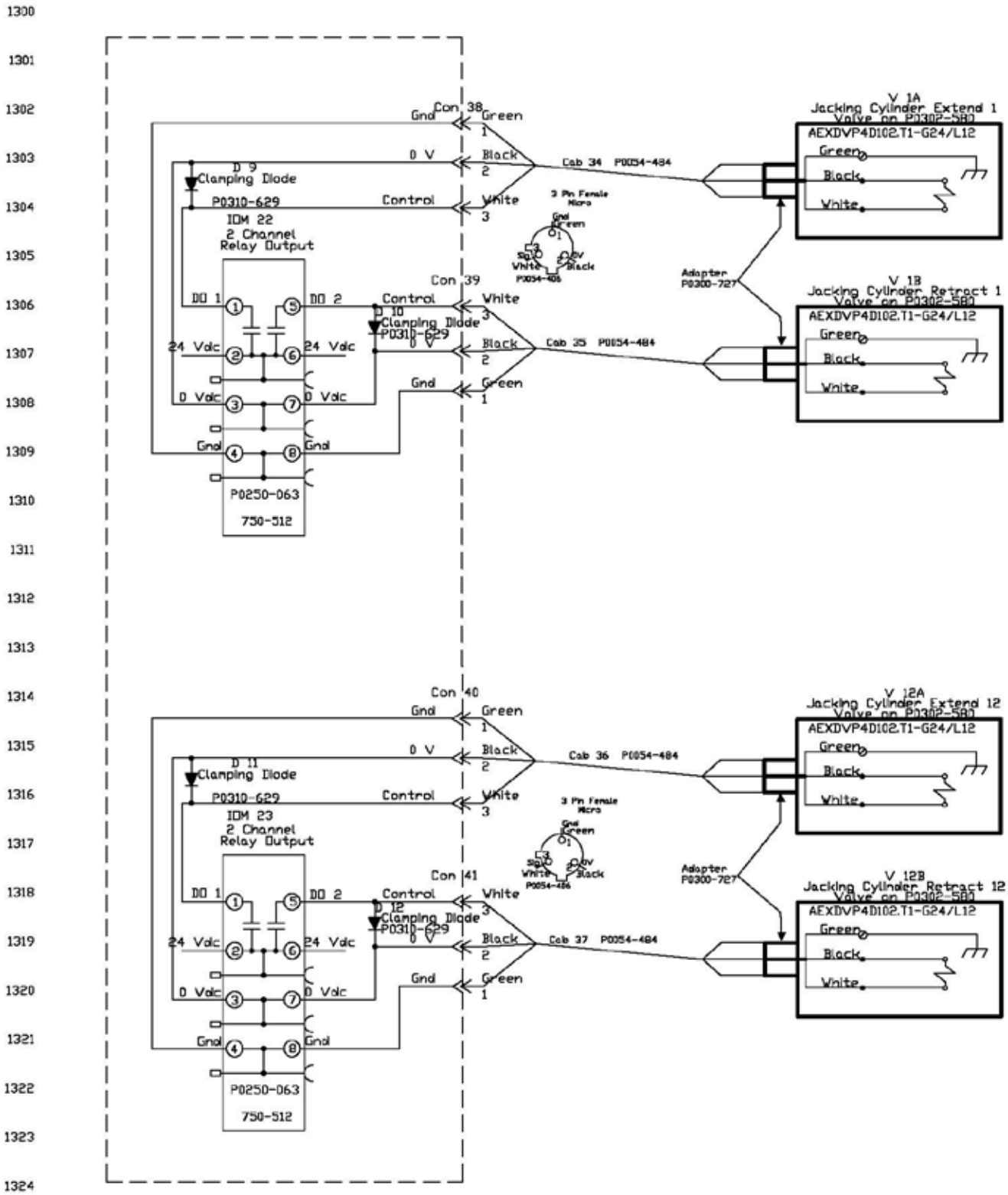
A12431A11


Con 30
Gnd
Green
1
0 V
Black
2
D 1
Clamping Diode
P0310-629
Control
White
3
IDM 18
2 Channel
Relay Output
Cab 26 P0054-484
3 Pin Female Micro
Gnd
Green
0V
Black
Sig
White
P0054-406
V5A
Jacking Cylinder Extend 5
Valve on P0302-580
AEXDVP4D102.T1-G24/L12
Green
Black
White
Adapter
P0300-727
V 5B
Jacking Cylinder Retract 5
Valve on P0302-580
AEXDVP4D102.T1-G24/L12
Green
Black
White
Con 31
DO 1
DO 2
Control
White
3
D 2
Clamping Diode
P0310-629
0 V
Black
2
Cab 27 P0054-484
24 Vdc
24 Vdc
0 Vdc
0 Vdc
Gnd
Green
1
Gnd
Gnd
P0250-063
750-512
Con 32
Gnd
Green
1
0 V
Black
2
D 3
Clamping Diode
P0310-629
Control
White
3
IDM 19
2 Channel
Relay Output
Cab 28 P0054-484
3 Pin Female Micro
Gnd
Green
0V
Black
Sig
White
P0054-406
V 4A
Jacking Cylinder Extend 4
Valve on P0302-580
AEXDVP4D102.T1-G24/L12
Green
Black
White
Adapter
P0300-727
V 4B
Jacking Cylinder Retract 4
Valve on P0302-580
AEXDVP4D102.T1-G24/L12
Green
Black
White
Con 33
DO 1
DO 2
Control
White
3
D 4
Clamping Diode
P0310-629
0 V
Black
2
Cab 29 P0054-484
24 Vdc
24 Vdc
0 Vdc
0 Vdc
Gnd
Green
1
Gnd
Gnd
P0250-063
750-512

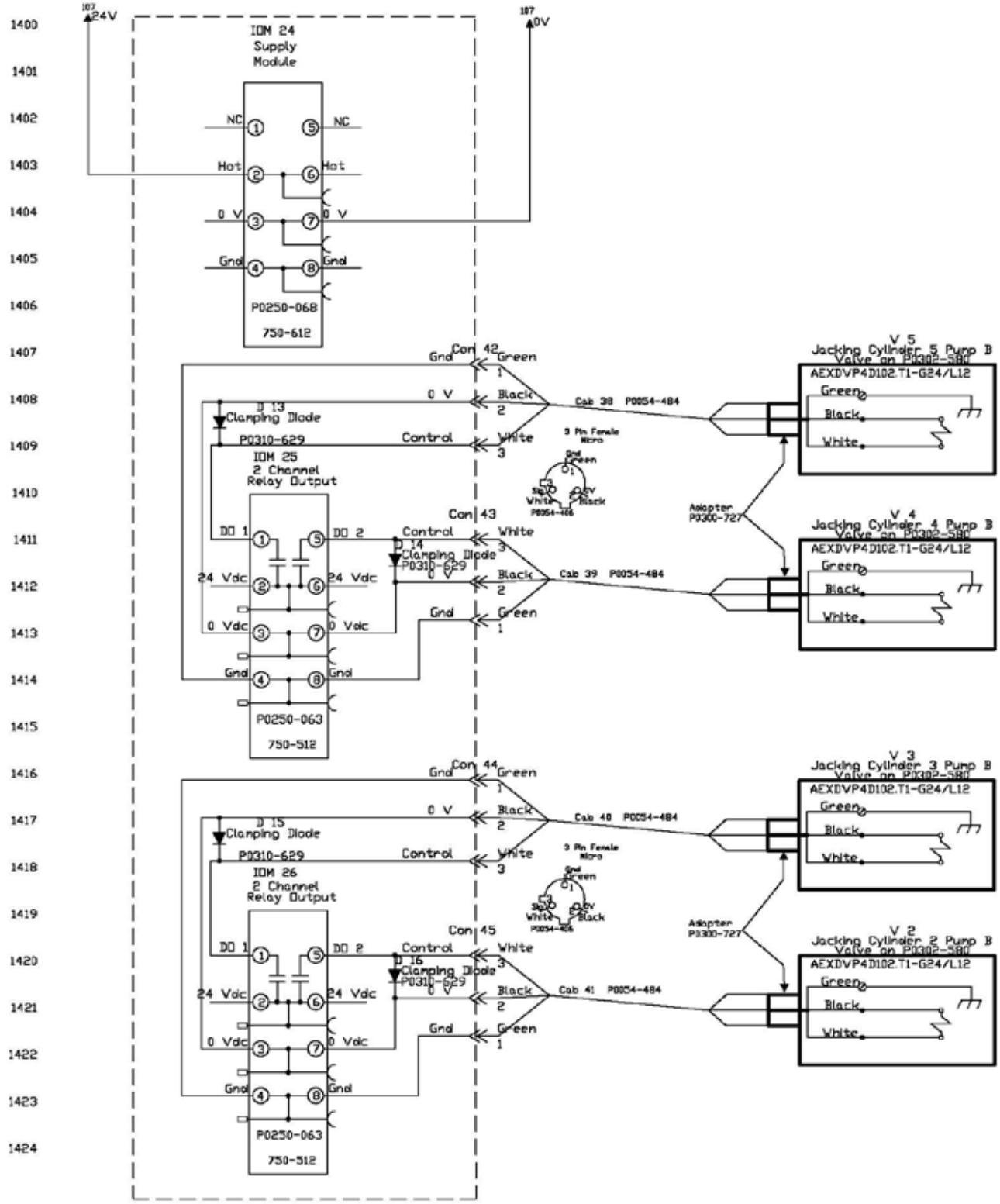
A12431A12


Con 34
Gnd
Green
1
0 V
Black
2
Control
White
3
D 5
Clamping Diode
P0310-629
IOM 20
2 Channel
Relay Output
DO 1
DO 2
24 Vdc
0 Vdc
Gnd
P0250-063
750-512
Cab 30 P0054-484
3 Pin Female
Micro
P0054-406
Adapter
P8300-727
V 3A
Jacking Cylinder Extend 3
Valve on P0302-580
AEXDVP4D102.T1-G24/L12
Green
Black
White
Con 35
D 6
Clamping Diode
P0310-629
Cab 31 P0054-484
V 3B
Jacking Cylinder Retract 3
Valve on P0302-580
Con 36
D 7
Clamping Diode
P0310-629
IOM 21
Cab 32 P0054-484
V 2A
Jacking Cylinder Extend 2
Valve on P0302-580
Con 37
D 8
Clamping Diode
P0310-629
Cab 33 P0054-484
V 2B
Jacking Cylinder Retract 2
Valve on P0302-580

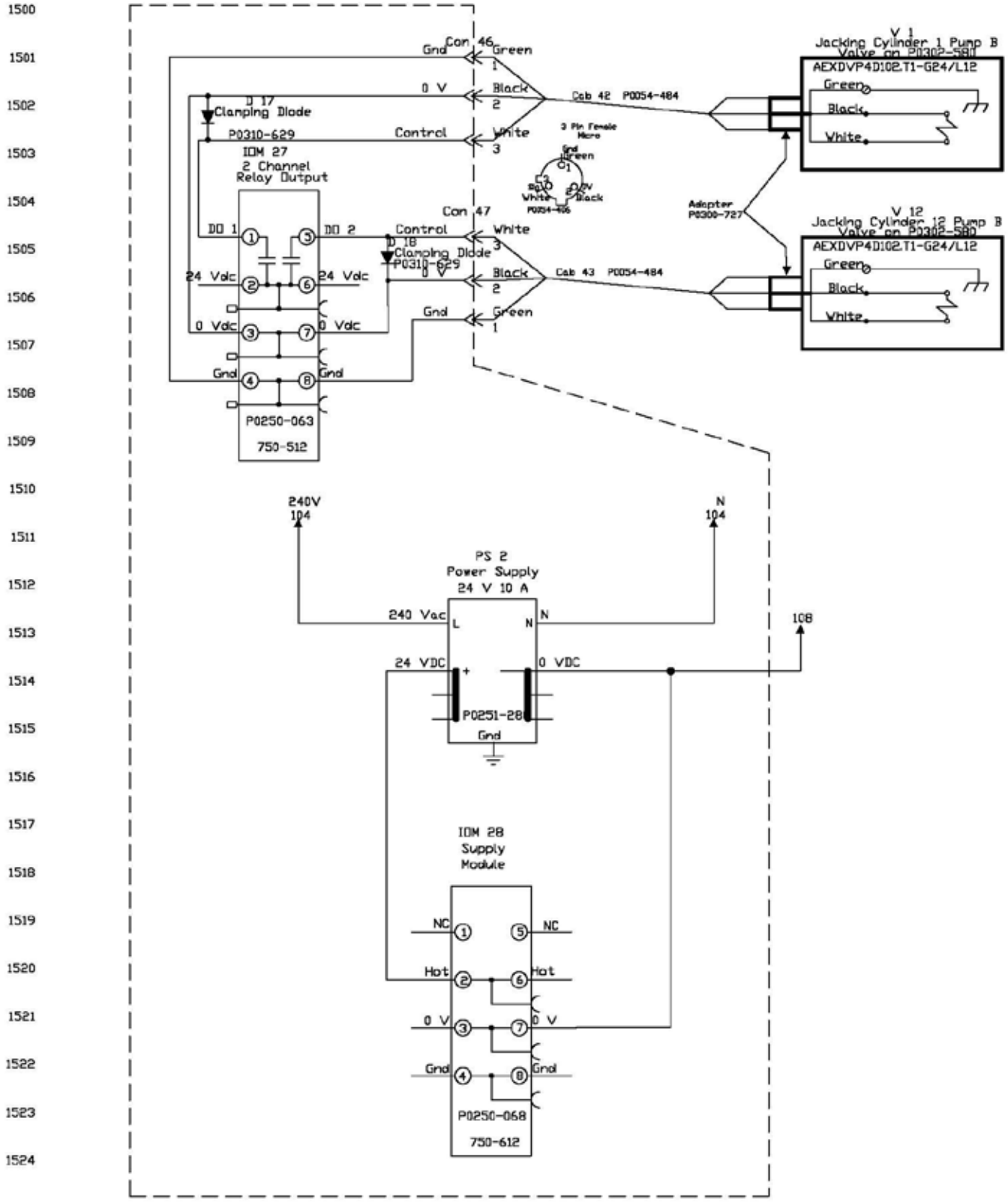
A12431A13


Con 38
Gnd
Green
1
0 V
Black
2
D 9
Clamping Diode
P0310-629
Control
White
3
IDM 22
2 Channel
Relay Output
DO 1
DO 2
24 Vdc
24 Vdc
0 Vdc
0 Vdc
Gnd
Gnd
P0250-063
750-512
Con 39
Control
White
3
D 10
Clamping Diode
P0310-629
0 V
Black
2
Gnd
Green
1
Cab 34 P0054-484
Cab 35 P0054-484
3 Pin Female
Micro
Adapter
P0300-727
V 1A
Jacking Cylinder Extend 1
Valve on P0302-580
AEXDVP4D102.T1-G24/L12
Green
Black
White
V 1B
Jacking Cylinder Retract 1
Valve on P0302-580
AEXDVP4D102.T1-G24/L12
Green
Black
White
Con 40
Gnd
Green
1
0 V
Black
2
D 11
Clamping Diode
P0310-629
Control
White
3
IDM 23
2 Channel
Relay Output
DO 1
DO 2
24 Vdc
24 Vdc
0 Vdc
0 Vdc
Gnd
Gnd
P0250-063
750-512
Con 41
Control
White
3
D 12
Clamping Diode
P0310-629
0 V
Black
2
Gnd
Green
1
Cab 36 P0054-484
Cab 37 P0054-484
3 Pin Female
Micro
Adapter
P0300-727
V 12A
Jacking Cylinder Extend 12
Valve on P0302-580
AEXDVP4D102.T1-G24/L12
Green
Black
White
V 12B
Jacking Cylinder Retract 12
Valve on P0302-580
AEXDVP4D102.T1-G24/L12
Green
Black
White

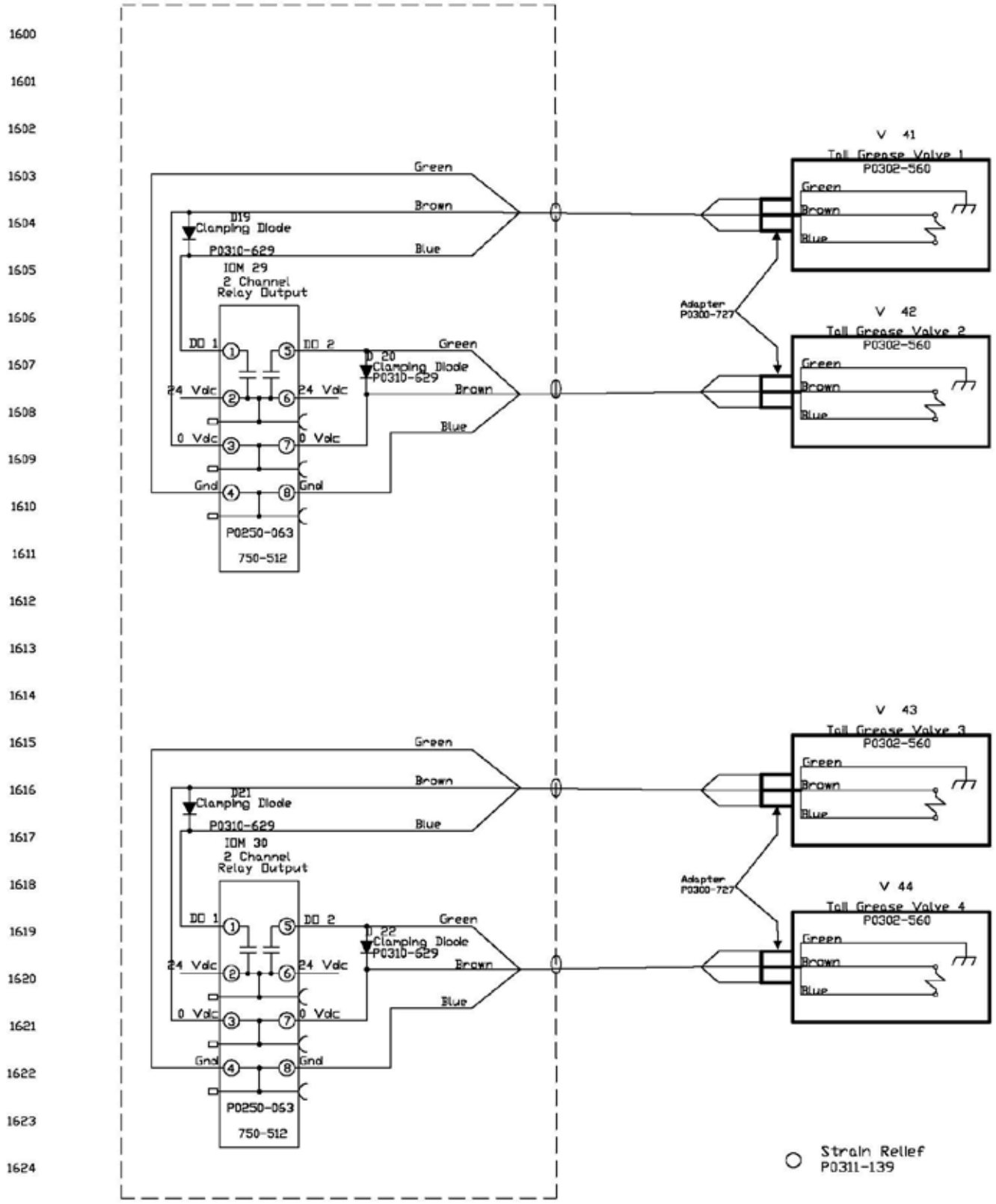
A12431A14


107
24V
187
0V
IOM 24
Supply
Module
NC
Hot
0 V
Gnd
P0250-068
750-612
Con 42
Green
Black
White
Gnd
0 V
Control
D 13
Clamping Diode
P0310-629
IOM 25
2 Channel
Relay Output
DO 1
DO 2
24 Vdc
0 Vdc
D 14
Clamping Diode
P0310-629
Con 43
Cab 38 P0054-484
Cab 39 P0054-484
3 Pin Female Micro
Adapter P0300-727
V 5
Jacking Cylinder 5 Pump B
Valve on P0302-580
AEXDVP4D102.T1-G24/L12
V 4
Jacking Cylinder 4 Pump B
Valve on P0302-580
AEXDVP4D102.T1-G24/L12
P0250-063
750-512
Con 44
D 15
Clamping Diode
P0310-629
IOM 26
2 Channel
Relay Output
Con 45
D 16
Clamping Diode
P0310-629
Cab 40 P0054-484
Cab 41 P0054-484
V 3
Jacking Cylinder 3 Pump B
Valve on P0302-580
AEXDVP4D102.T1-G24/L12
V 2
Jacking Cylinder 2 Pump B
Valve on P0302-580
AEXDVP4D102.T1-G24/L12

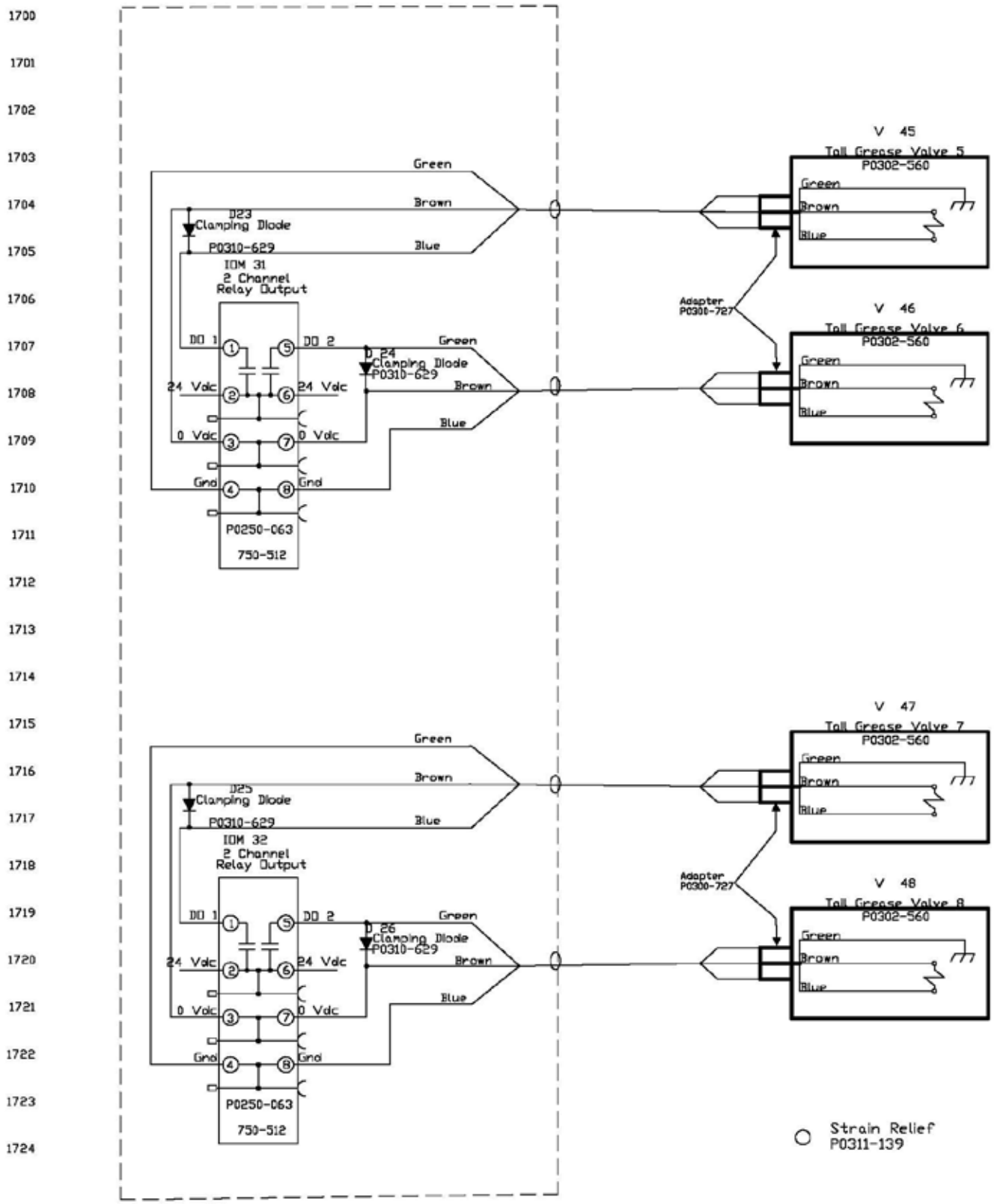
A12431A15


Con 46
Gnd
Green
1
0 V
Black
2
Control
White
3
D 17
Clamping Diode
P0310-629
IDM 27
2 Channel
Relay Output
DO 1
DO 2
24 Vdc
24 Vdc
0 Vdc
0 Vdc
Gnd
Gnd
P0250-063
750-512
Cab 42 P0054-484
3 Pin Female
Micro
Adapter
P0300-727
V 1
Jacking Cylinder 1 Pump B
Valve on P0302-580
AEXDVP4D102.T1-G24/L12
Green
Black
White
Con 47
D 18
Clamping Diode
P0310-629
Cab 43 P0054-484
V 12
Jacking Cylinder 12 Pump B
Valve on P0302-580
AEXDVP4D102.T1-G24/L12
240V
104
N
104
PS 2
Power Supply
24 V 10 A
240 Vac
L
N
108
24 VDC
+
0 VDC
P0251-28
Gnd
IDM 28
Supply
Module
NC
NC
Hot
Hot
0 V
0 V
Gnd
Gnd
P0250-068
750-612

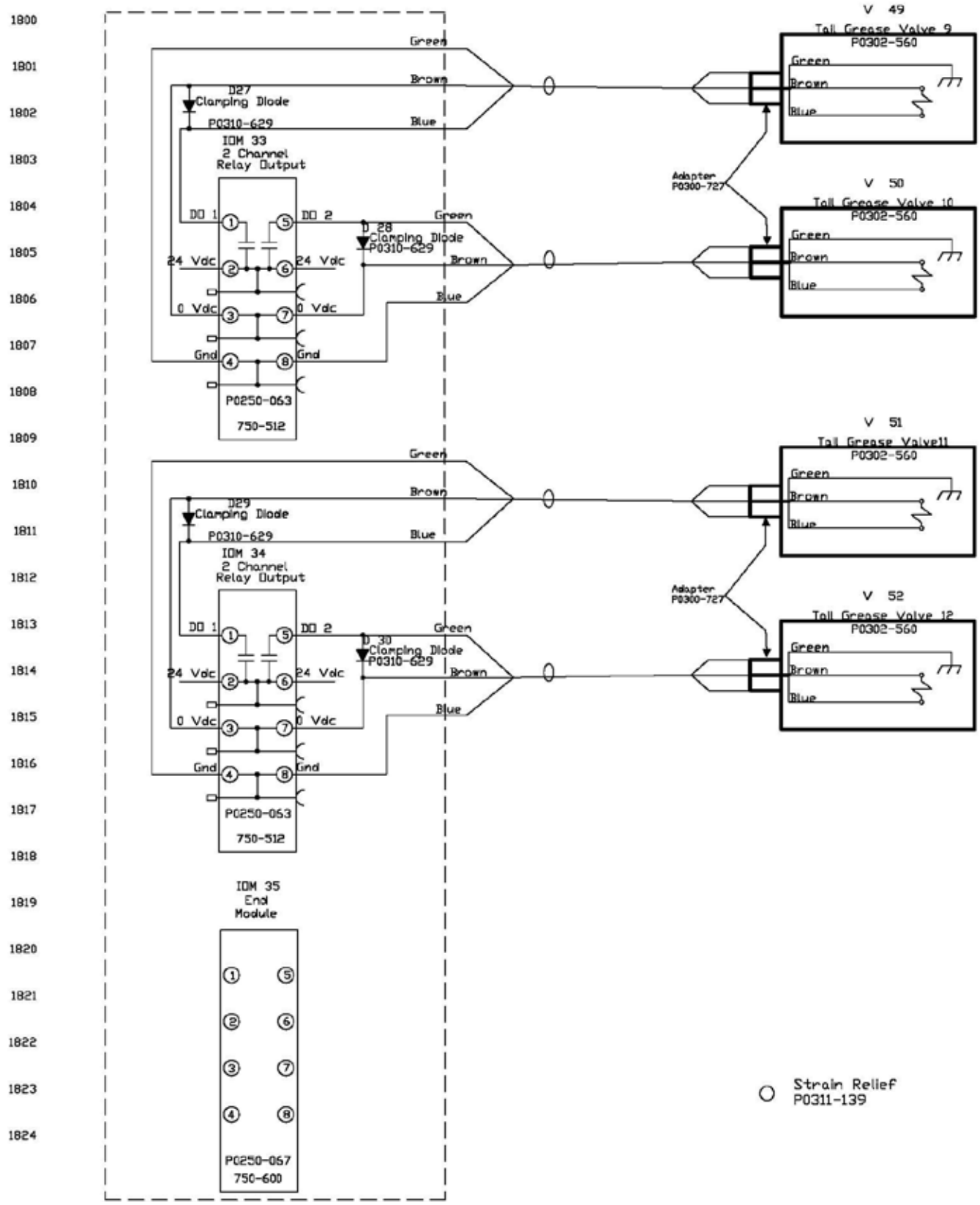
A12431A16


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
V 41
Tall Grease Valve 1
P0302-560
Green
Brown
Blue
D19
Clamping Diode
P0310-629
IOM 29
2 Channel
Relay Output
DO 1
DO 2
24 Vdc
0 Vdc
Gnd
P0250-063
750-512
Adapter
P0300-727
V 42
Tall Grease Valve 2
P0302-560
D 20
Clamping Diode
P0310-629
V 43
Tall Grease Valve 3
P0302-560
D21
Clamping Diode
P0310-629
IOM 30
2 Channel
Relay Output
V 44
Tall Grease Valve 4
P0302-560
D 22
Clamping Diode
P0310-629
Strain Relief
P0311-139

A12431A17

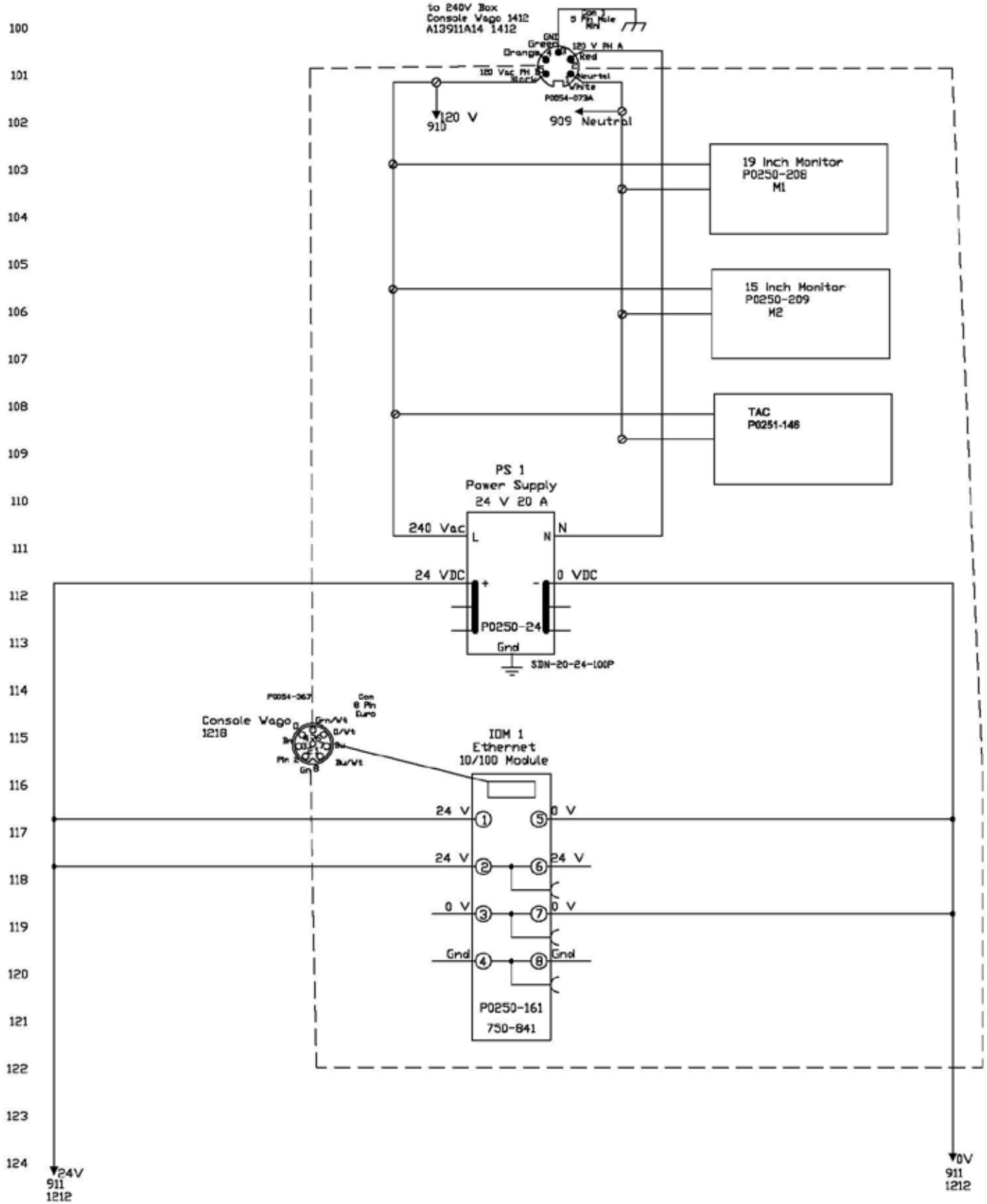

1700
1701
1702
1703
1704
1705
1706
1707
1708
1709
1710
1711
1712
1713
1714
1715
1716
1717
1718
1719
1720
1721
1722
1723
1724
V 45
Tall Grease Valve 5
P0302-560
Green
Brown
Blue
D23
Clamping Diode
P0310-629
IOM 31
2 Channel
Relay Output
DO 1
DO 2
24 Vdc
0 Vdc
Gnd
P0250-063
750-512
Adapter
P0300-727
V 46
Tall Grease Valve 6
P0302-560
D 24
Clamping Diode
P0310-629
V 47
Tall Grease Valve 7
P0302-560
D25
Clamping Diode
P0310-629
IOM 32
2 Channel
Relay Output
V 48
Tall Grease Valve 8
P0302-560
D 26
Clamping Diode
P0310-629
Strain Relief
P0311-139

A12431A18

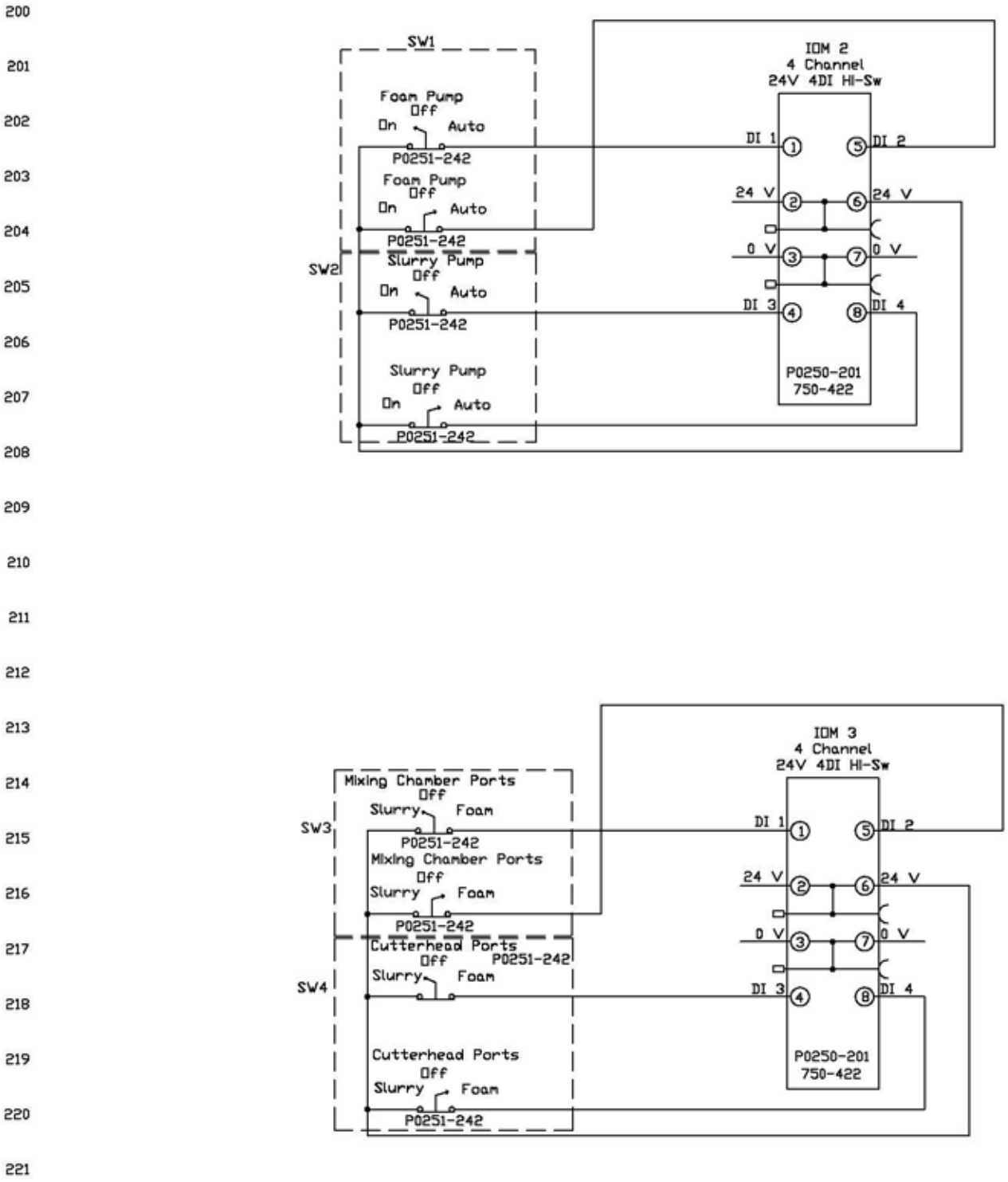

1800
1801
1802
1803
1804
1805
1806
1807
1808
1809
1810
1811
1812
1813
1814
1815
1816
1817
1818
1819
1820
1821
1822
1823
1824
Green
Brown
Blue
D27
Clamping Diode
P0310-629
IOM 33
2 Channel
Relay Output
DO 1
DO 2
24 Vdc
0 Vdc
Gnd
D 28
Clamping Diode
P0310-629
P0250-063
750-512
V 49
Tail Grease Valve 9
P0302-560
Adapter
P0300-727
V 50
Tail Grease Valve 10
P0302-560
D29
Clamping Diode
P0310-629
IOM 34
2 Channel
Relay Output
D 30
Clamping Diode
P0310-629
V 51
Tail Grease Valve11
P0302-560
V 52
Tail Grease Valve 12
P0302-560
IOM 35
End
Module
P0250-067
750-600
Strain Relief
P0311-139

ELECTRICAL SCHEMATICS - CONSOLE CONTROL

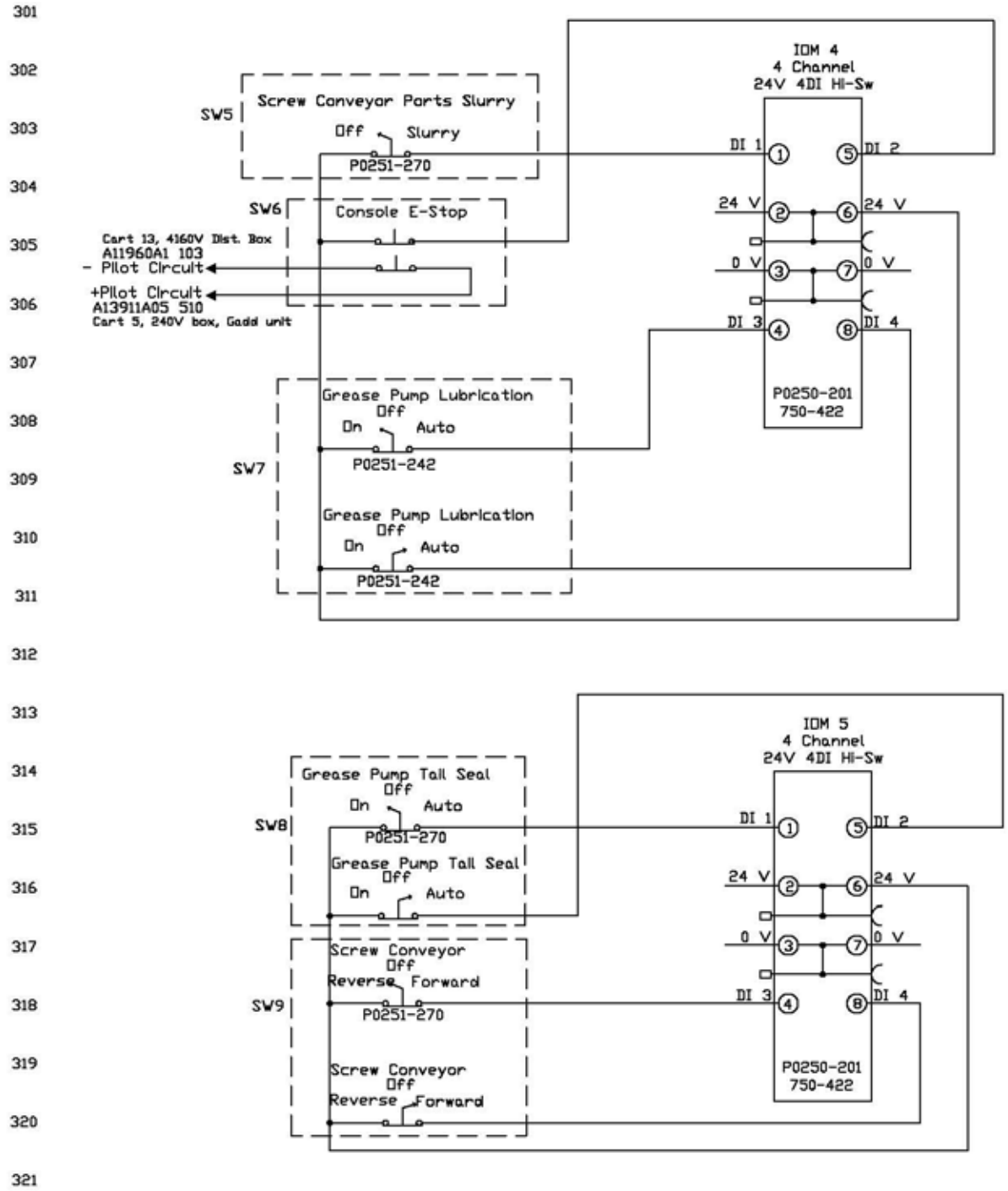
A12150A01



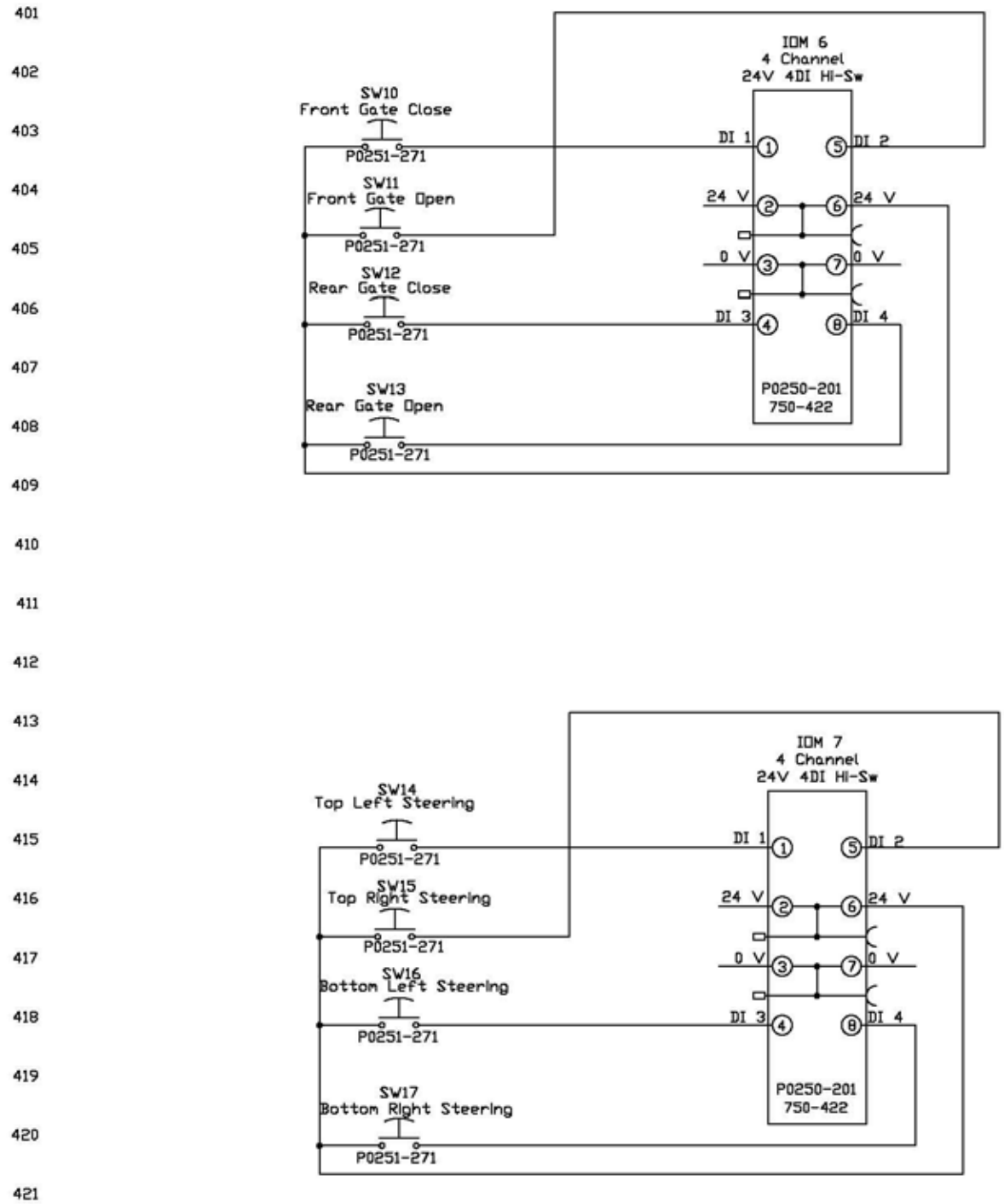
A12150A02


SW1
Foam Pump
Off
On
Auto
P0251-242
Foam Pump
Off
On
Auto
P0251-242
SW2
Slurry Pump
Off
On
Auto
P0251-242
Slurry Pump
Off
On
Auto
P0251-242
IOM 2
4 Channel
24V 4DI HI-Sw
DI 1
DI 2
24 V
24 V
0 V
0 V
DI 3
DI 4
P0250-201
750-422
SW3
Mixing Chamber Ports
Off
Slurry
Foam
P0251-242
Mixing Chamber Ports
Off
Slurry
Foam
P0251-242
SW4
Cutterhead Ports
Off
P0251-242
Slurry
Foam
Cutterhead Ports
Off
Slurry
Foam
P0251-242
IOM 3
4 Channel
24V 4DI HI-Sw
DI 1
DI 2
24 V
24 V
0 V
0 V
DI 3
DI 4
P0250-201
750-422

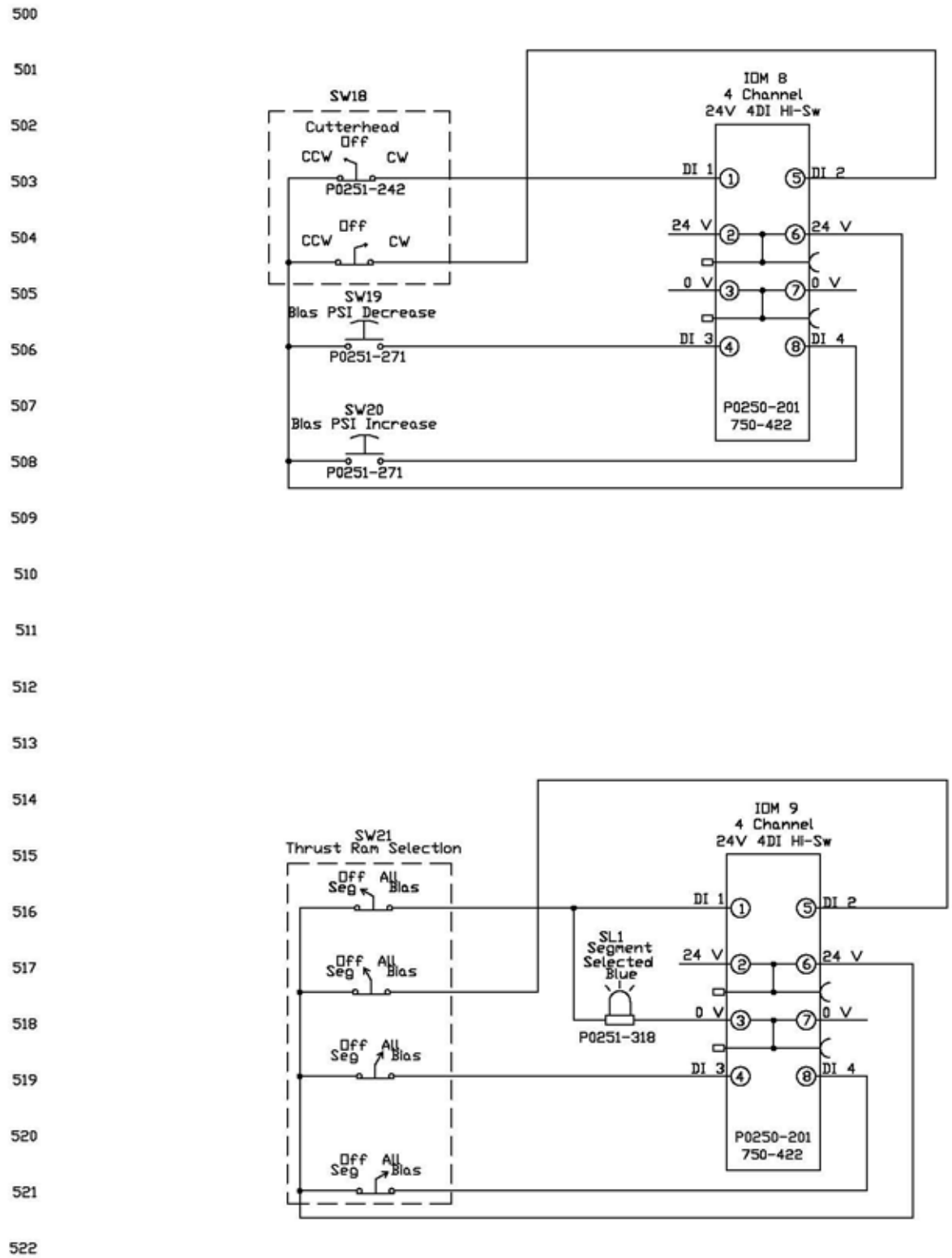
A12150A03


301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
IOM 4
4 Channel
24V 4DI Hi-Sw
SW5
Screw Conveyor Parts Slurry
Off
Slurry
P0251-270
SW6
Console E-Stop
Cart 13, 4160V Dist. Box
A11960A1 103
- Pilot Circuit
+Pilot Circuit
A13911A05 510
Cart 5, 240V box, Gadd unit
DI 1
DI 2
24 V
24 V
0 V
0 V
DI 3
DI 4
P0250-201
750-422
Grease Pump Lubrication
Off
On
Auto
P0251-242
SW7
Grease Pump Lubrication
Off
On
Auto
P0251-242
IOM 5
4 Channel
24V 4DI Hi-Sw
Grease Pump Tail Seal
Off
On
Auto
SW8
P0251-270
Grease Pump Tail Seal
Off
On
Auto
Screw Conveyor
Off
Reverse
Forward
SW9
P0251-270
Screw Conveyor
Off
Reverse
Forward
DI 1
DI 2
24 V
24 V
0 V
0 V
DI 3
DI 4
P0250-201
750-422

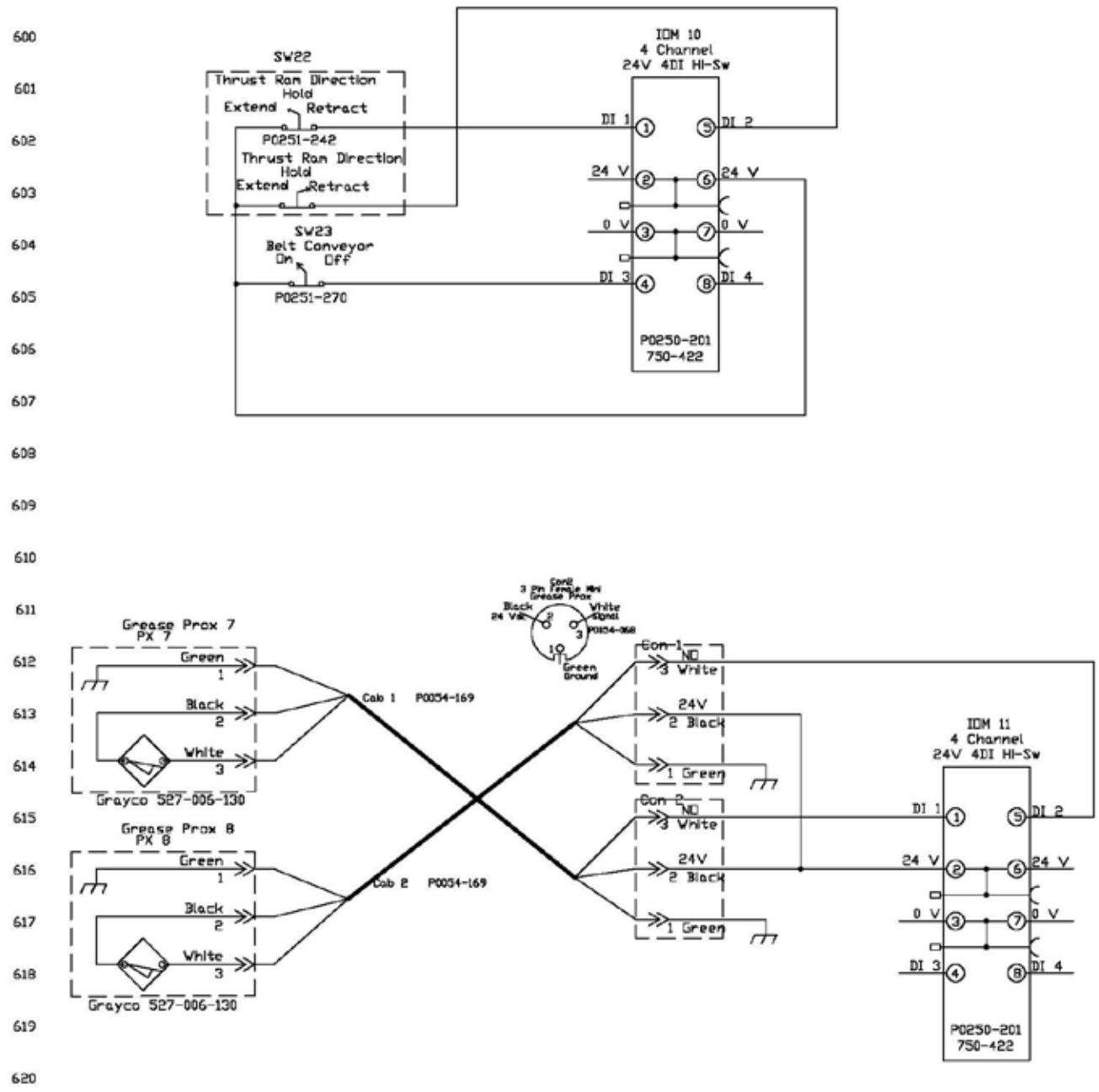
A12150A04


401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
IOM 6
4 Channel
24V 4DI Hi-Sw
SW10
Front Gate Close
P0251-271
SW11
Front Gate Open
P0251-271
SW12
Rear Gate Close
P0251-271
SW13
Rear Gate Open
P0251-271
DI 1
DI 2
24 V
24 V
0 V
0 V
DI 3
DI 4
P0250-201
750-422
IOM 7
4 Channel
24V 4DI Hi-Sw
SW14
Top Left Steering
P0251-271
SW15
Top Right Steering
P0251-271
SW16
Bottom Left Steering
P0251-271
SW17
Bottom Right Steering
P0251-271
DI 1
DI 2
24 V
24 V
0 V
0 V
DI 3
DI 4
P0250-201
750-422

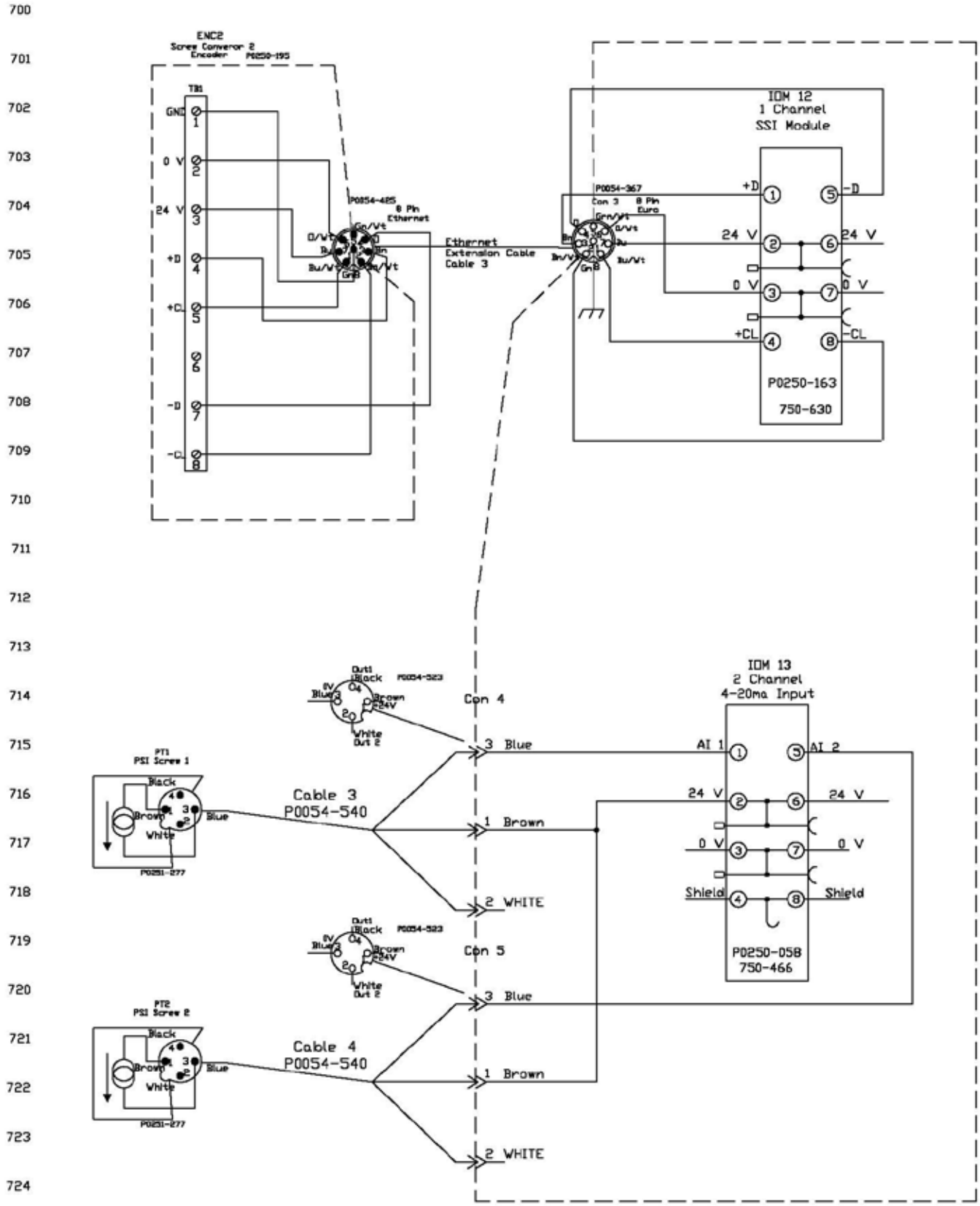
A12150A05


500
501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
518
519
520
521
522
SW18
Cutterhead
Off
CCW
CW
P0251-242
Off
CCW
CW
SW19
Bias PSI Decrease
P0251-271
SW20
Bias PSI Increase
P0251-271
IOM 8
4 Channel
24V 4DI Hi-Sw
DI 1
DI 2
24 V
24 V
0 V
0 V
DI 3
DI 4
P0250-201
750-422
SW21
Thrust Ram Selection
Off All
Seg Bias
Off All
Seg Bias
Off All
Seg Bias
Off All
Seg Bias
SL1
Segment
Selected
Blue
P0251-318
IOM 9
4 Channel
24V 4DI Hi-Sw
DI 1
DI 2
24 V
24 V
0 V
0 V
DI 3
DI 4
P0250-201
750-422

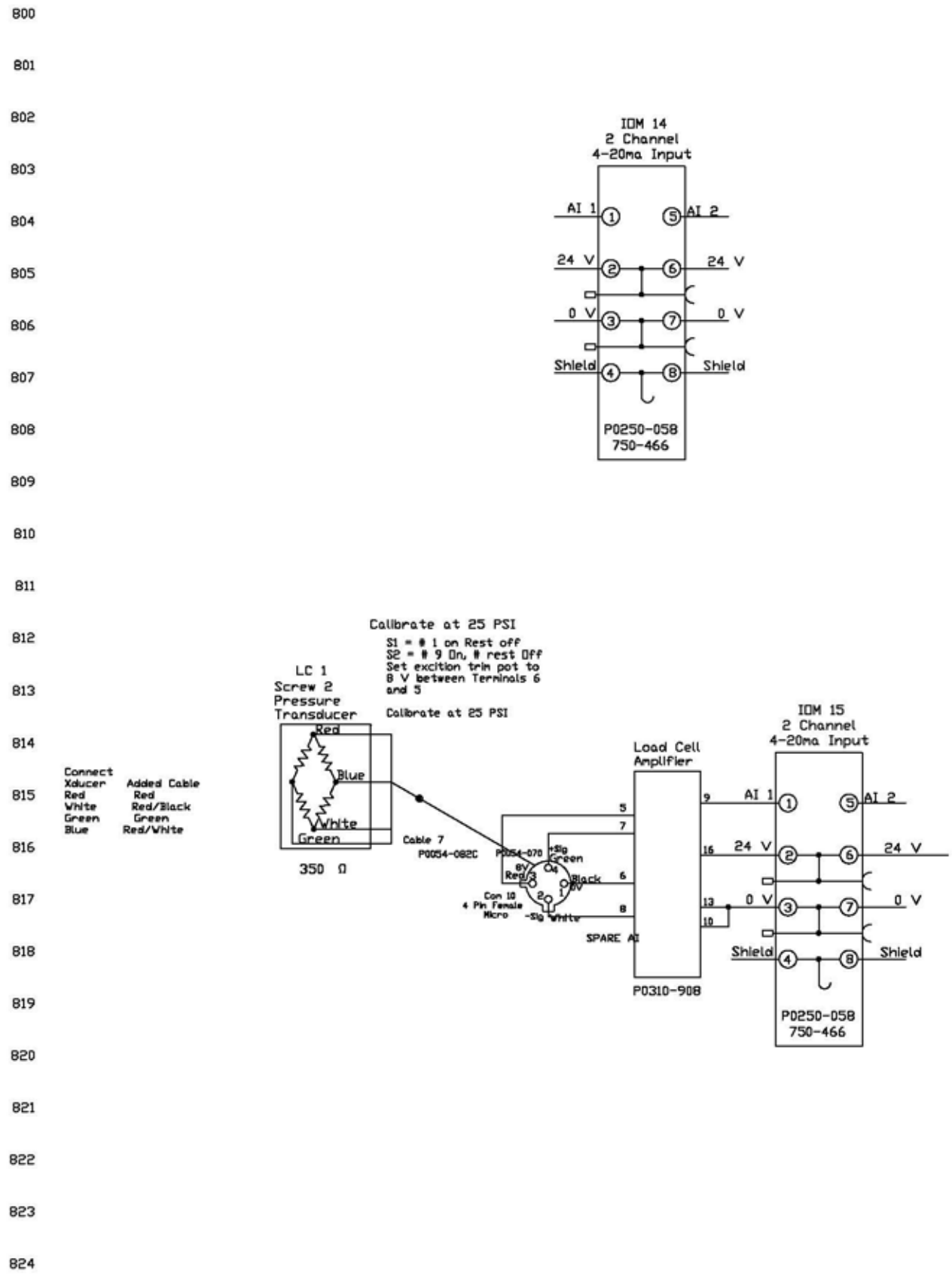
A12150A06


IDM 10
4 Channel
24V 4DI HI-Sw
SW22
Thrust Ram Direction
Hold
Extend
Retract
P0251-242
Thrust Ram Direction
Hold
Extend
Retract
SW23
Belt Conveyor
On
Off
P0251-270
DI 1
DI 2
24 V
24 V
0 V
0 V
DI 3
DI 4
P0250-201
750-422
Grease Prox 7
PX 7
Green
1
Black
2
White
3
Grayco 527-005-130
Grease Prox 8
PX 8
Green
1
Black
2
White
3
Grayco 527-006-130
Cab 1 P0054-169
Cab 2 P0054-169
Green
Ground
Con-1
NO
3 White
24V
2 Black
1 Green
Con-2
NO
3 White
24V
2 Black
1 Green
IDM 11
4 Channel
24V 4DI HI-Sw
DI 1
DI 2
24 V
24 V
0 V
0 V
DI 3
DI 4
P0250-201
750-422

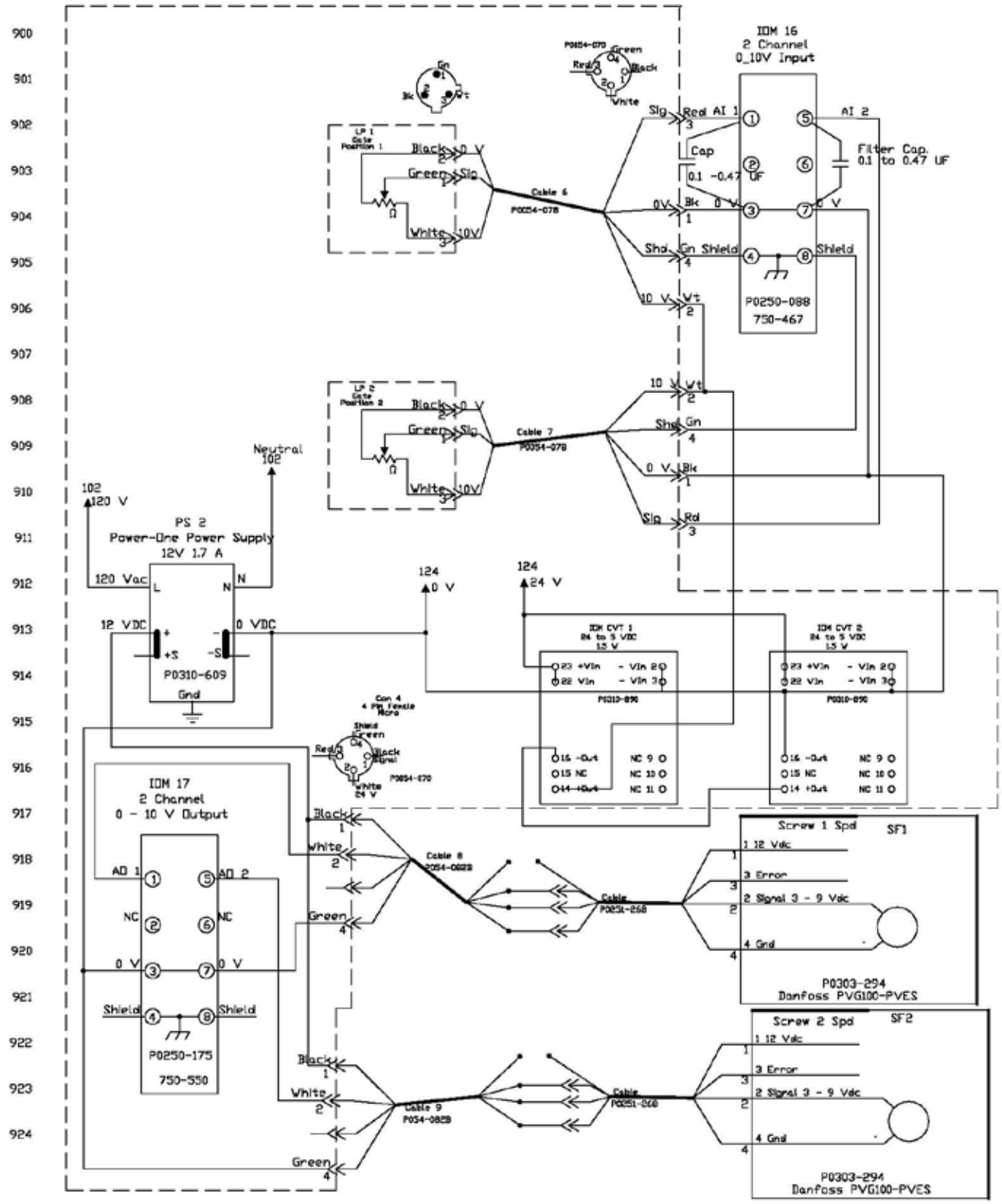
A12150A07


ENC2
Screw Conveyor 2
Encoder
P0250-195
TB1
GND
0 V
24 V
+D
+CL
-D
-CL
P0054-485
8 Pin
Ethernet
Ethernet
Extension Cable
Cable 3
P0054-367
Con 3
8 Pin
Euro
IOM 12
1 Channel
SSI Module
+D
-D
24 V
0 V
+CL
-CL
P0250-163
750-630
Out1
Black
Blue
Brown
+24V
White
Out 2
P0054-523
Con 4
3 Blue
1 Brown
2 WHITE
PT1
PSI Screw 1
Black
Brown
Blue
White
P0251-277
Cable 3
P0054-540
IOM 13
2 Channel
4-20ma Input
AI 1
AI 2
Shield
P0250-058
750-466
Con 5
PT2
PSI Screw 2
Cable 4
P0054-540

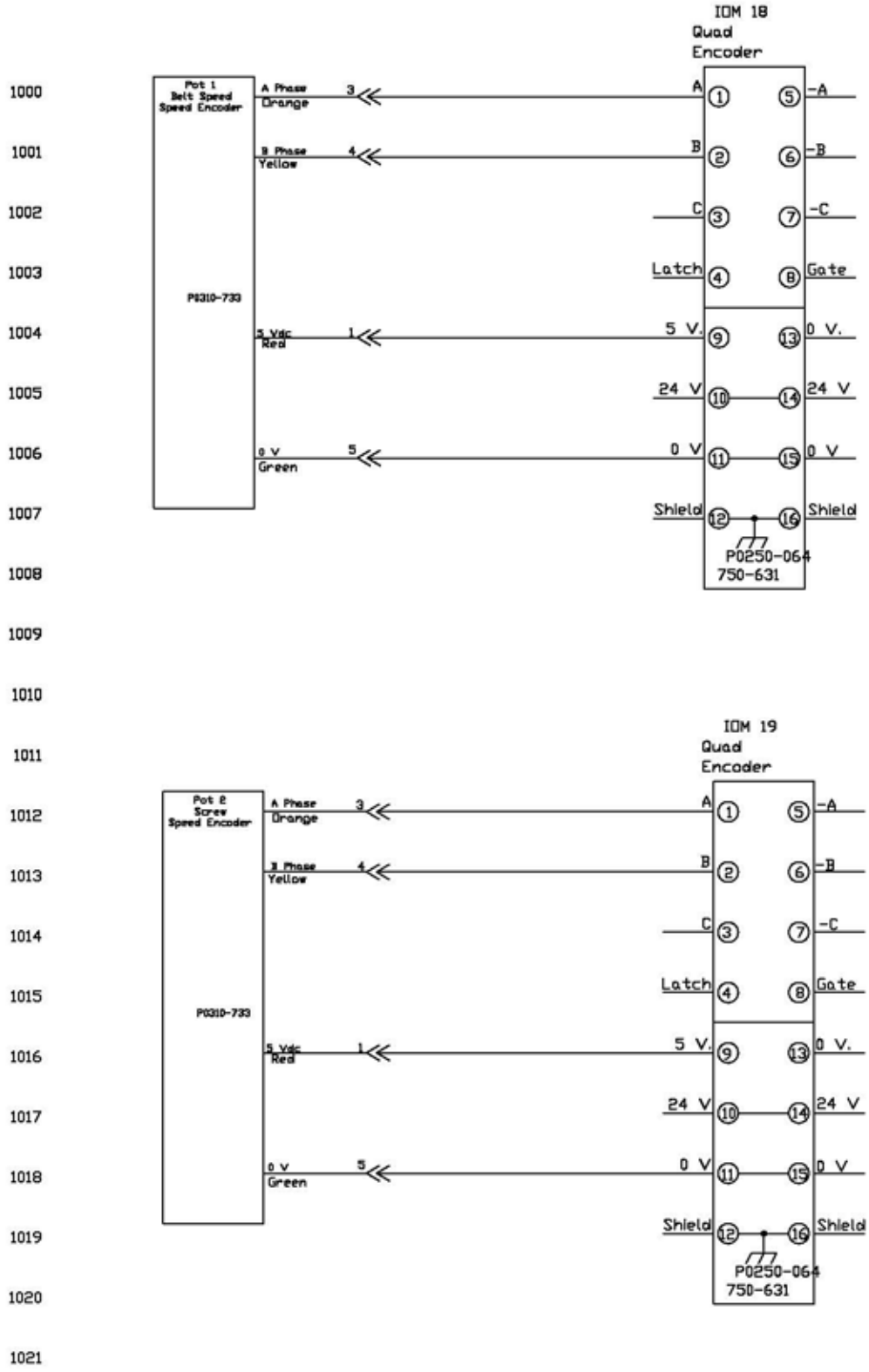
A12150A08


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
IDM 14
2 Channel
4-20ma Input
AI 1
AI 2
24 V
24 V
0 V
0 V
Shield
Shield
P0250-058
750-466
Calibrate at 25 PSI
S1 = # 1 on Rest off
S2 = # 9 On, # rest Off
Set excition trim pot to
8 V between Terminals 6
and 5
Calibrate at 25 PSI
LC 1
Screw 2
Pressure
Transducer
Red
Blue
White
Green
350 Ω
Connect
Xducer
Red
White
Green
Blue
Added Cable
Red
Red/Black
Green
Red/White
Cable 7
P0054-082C
P0054-070
+Sig
Green
6V
Red
Black
-Sig
White
Con 10
4 Pin Female
Micro
Load Cell
Amplifier
SPARE AI
P0310-908
IDM 15
2 Channel
4-20ma Input
AI 1
AI 2
24 V
24 V
0 V
0 V
Shield
Shield
P0250-058
750-466

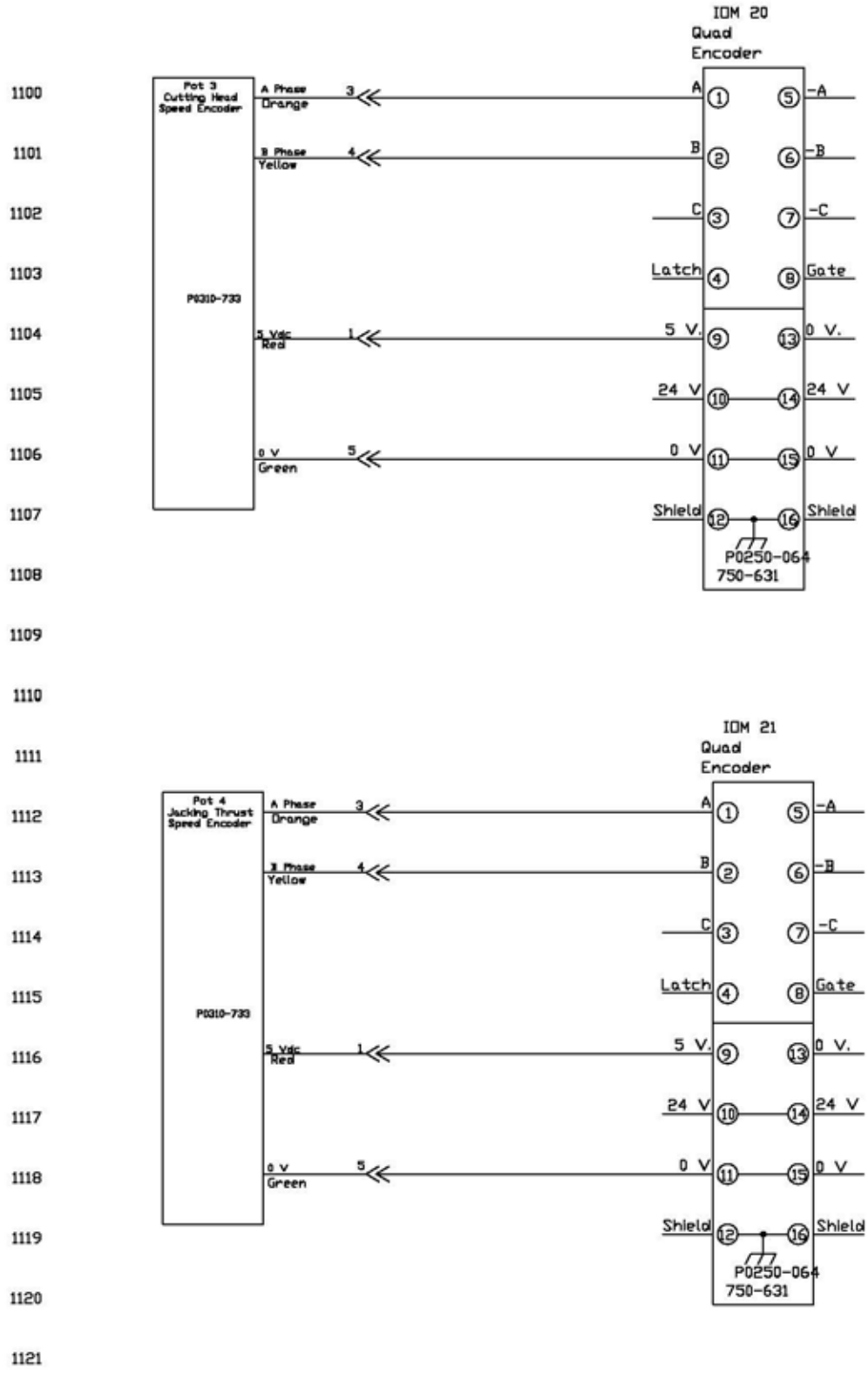
A12150A09


IDM 16
2 Channel
0_10V Input
P0250-088
750-467
PS 2
Power-One Power Supply
12V 1.7 A
120 Vac
12 VDC
0 VDC
P0310-609
Neutral
102
120 V
124
0 V
124
24 V
IDM 17
2 Channel
0 - 10 V Output
P0250-175
750-550
Screw 1 Spd
SF1
Screw 2 Spd
SF2
P0303-294
Danfoss PVG100-PVES
Cable 6
P0054-078
Cable 7
P0054-078
Cable 8
P0054-0828
Cable 9
P0054-0828
Filter Cap.
0.1 to 0.47 UF

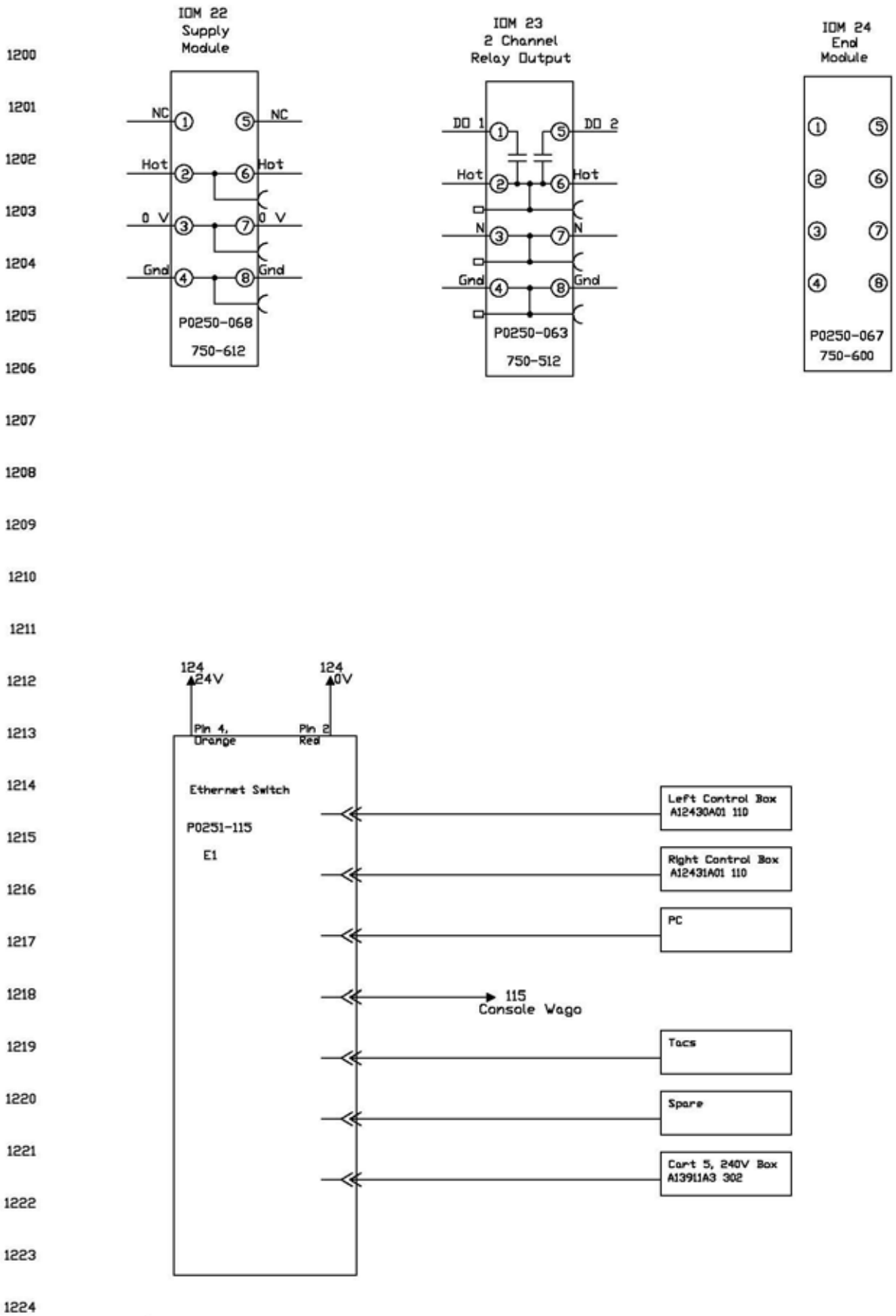
A12150A10


IOM 18
Quad
Encoder
Pot 1
Belt Speed
Speed Encoder
P0310-733
A Phase
Orange
B Phase
Yellow
5 Vdc
Red
0 V
Green
A
B
C
Latch
5 V.
24 V
0 V
Shield
-A
-B
-C
Gate
0 V.
24 V
0 V
Shield
P0250-064
750-631
IOM 19
Quad
Encoder
Pot 2
Screw
Speed Encoder
P0310-733
A Phase
Orange
B Phase
Yellow
5 Vdc
Red
0 V
Green
A
B
C
Latch
5 V.
24 V
0 V
Shield
-A
-B
-C
Gate
0 V.
24 V
0 V
Shield
P0250-064
750-631

A12150A11

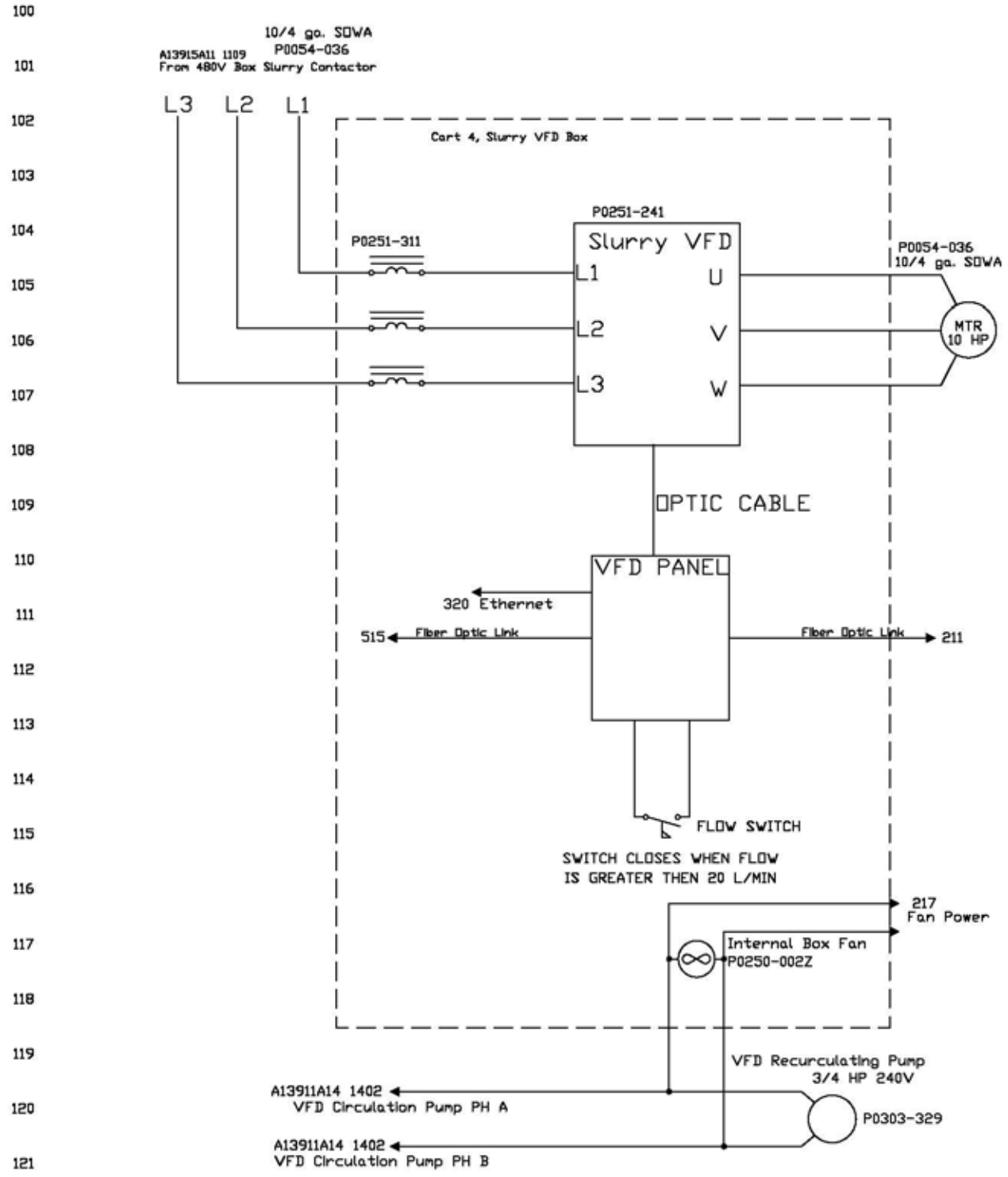

IOM 20
Quad
Encoder
Pot 3
Cutting Head
Speed Encoder
P0310-733
A Phase
Orange
B Phase
Yellow
5 Vdc
Red
0 V
Green
A
B
C
Latch
5 V.
24 V
0 V
Shield
-A
-B
-C
Gate
0 V.
24 V
0 V
Shield
P0250-064
750-631
IOM 21
Quad
Encoder
Pot 4
Jacking Thrust
Speed Encoder
P0310-733
A Phase
Orange
B Phase
Yellow
5 Vdc
Red
0 V
Green
A
B
C
Latch
5 V.
24 V
0 V
Shield
-A
-B
-C
Gate
0 V.
24 V
0 V
Shield
P0250-064
750-631

A12150A12

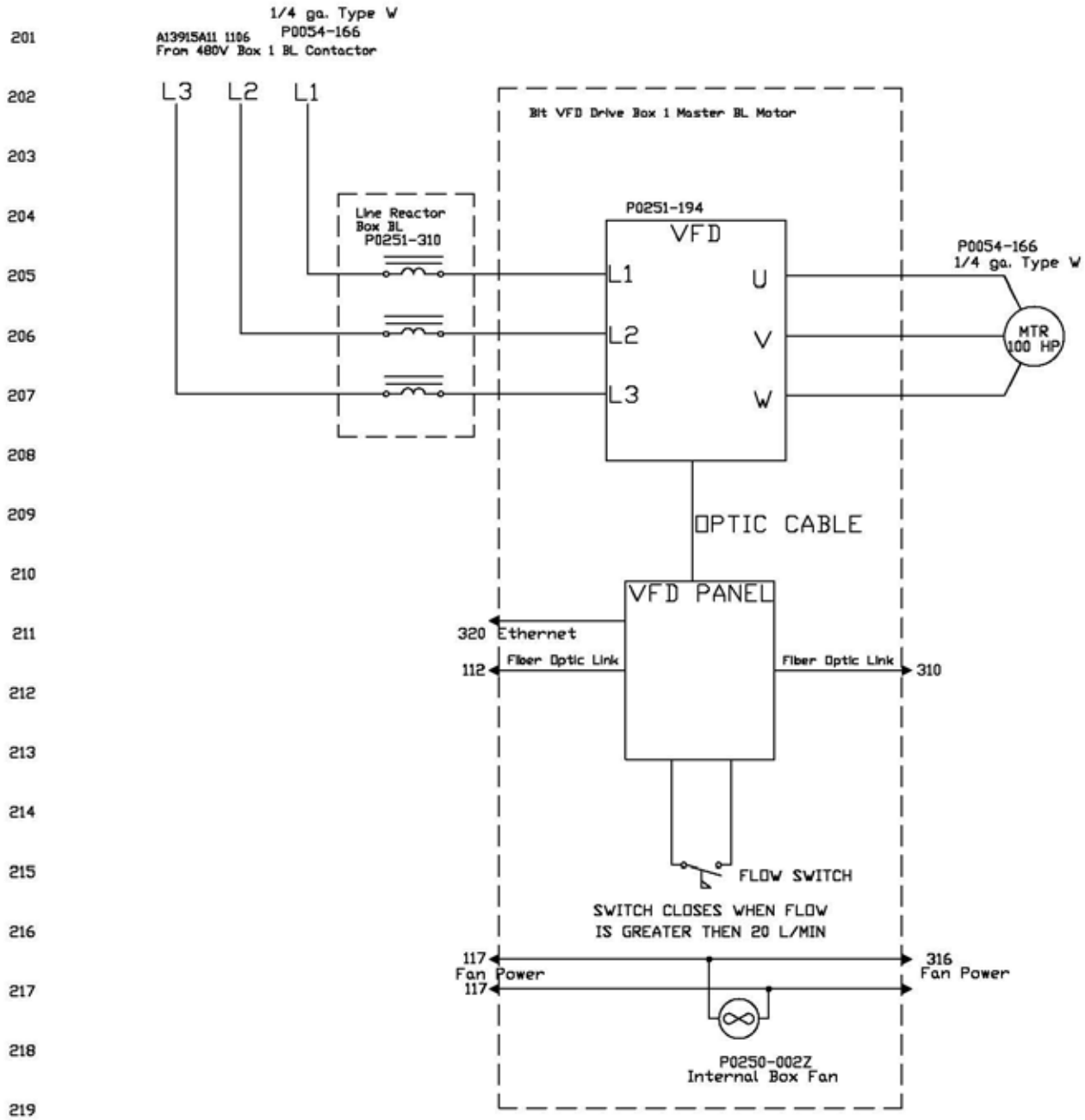

IOM 22
Supply
Module
NC
NC
Hot
Hot
0 V
0 V
Gnd
Gnd
P0250-068
750-612
IOM 23
2 Channel
Relay Output
DO 1
DO 2
Hot
Hot
N
N
Gnd
Gnd
P0250-063
750-512
IOM 24
End
Module
P0250-067
750-600
124
24V
124
0V
Pin 4,
Orange
Pin 2
Red
Ethernet Switch
P0251-115
E1
Left Control Box
A12430A01 110
Right Control Box
A12431A01 110
PC
115
Console Wago
Tacs
Spare
Cart 5, 240V Box
A13911A3 302

ELECTRICAL SCHEMATICS - VFD CONTROL

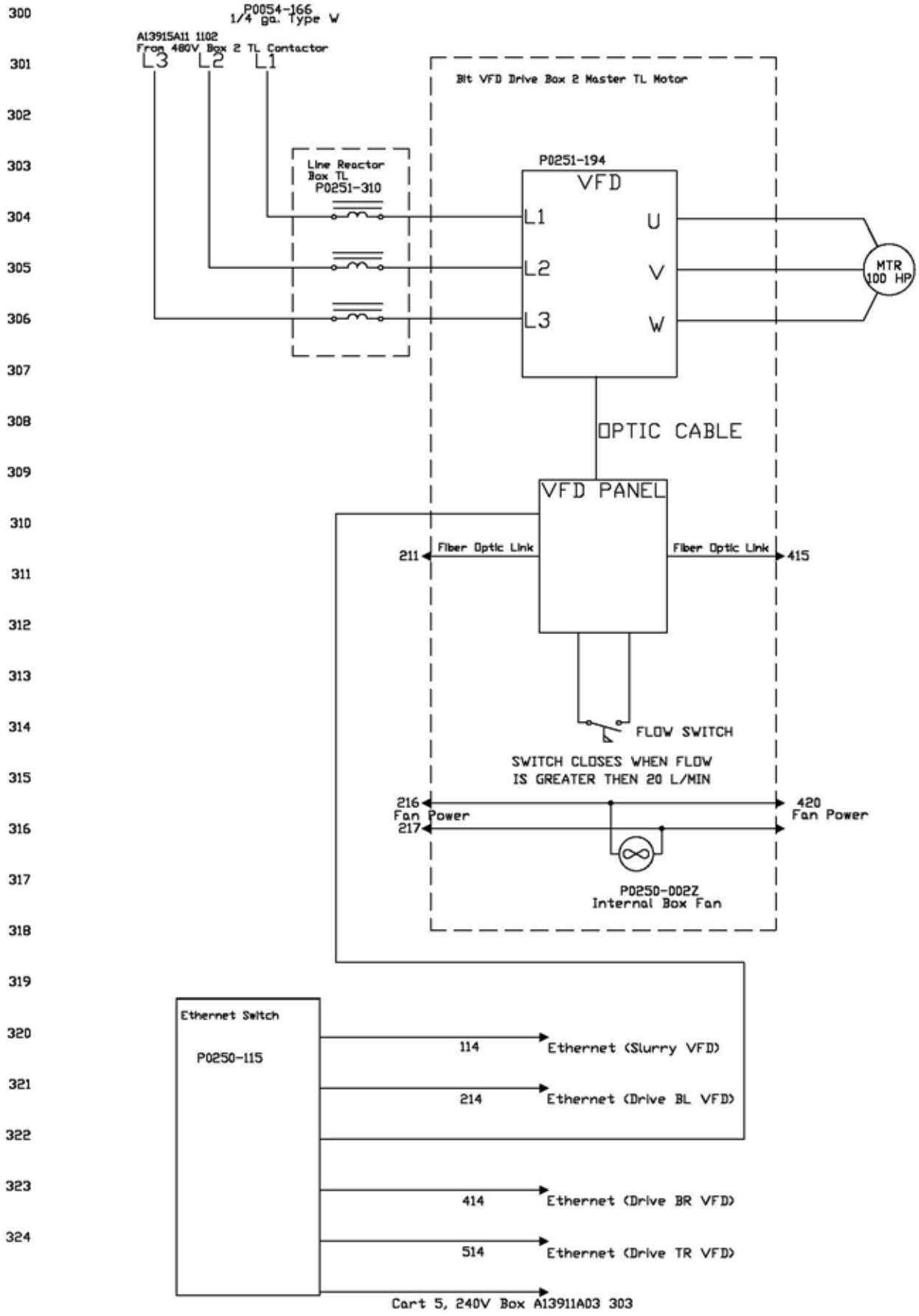
A13912A01



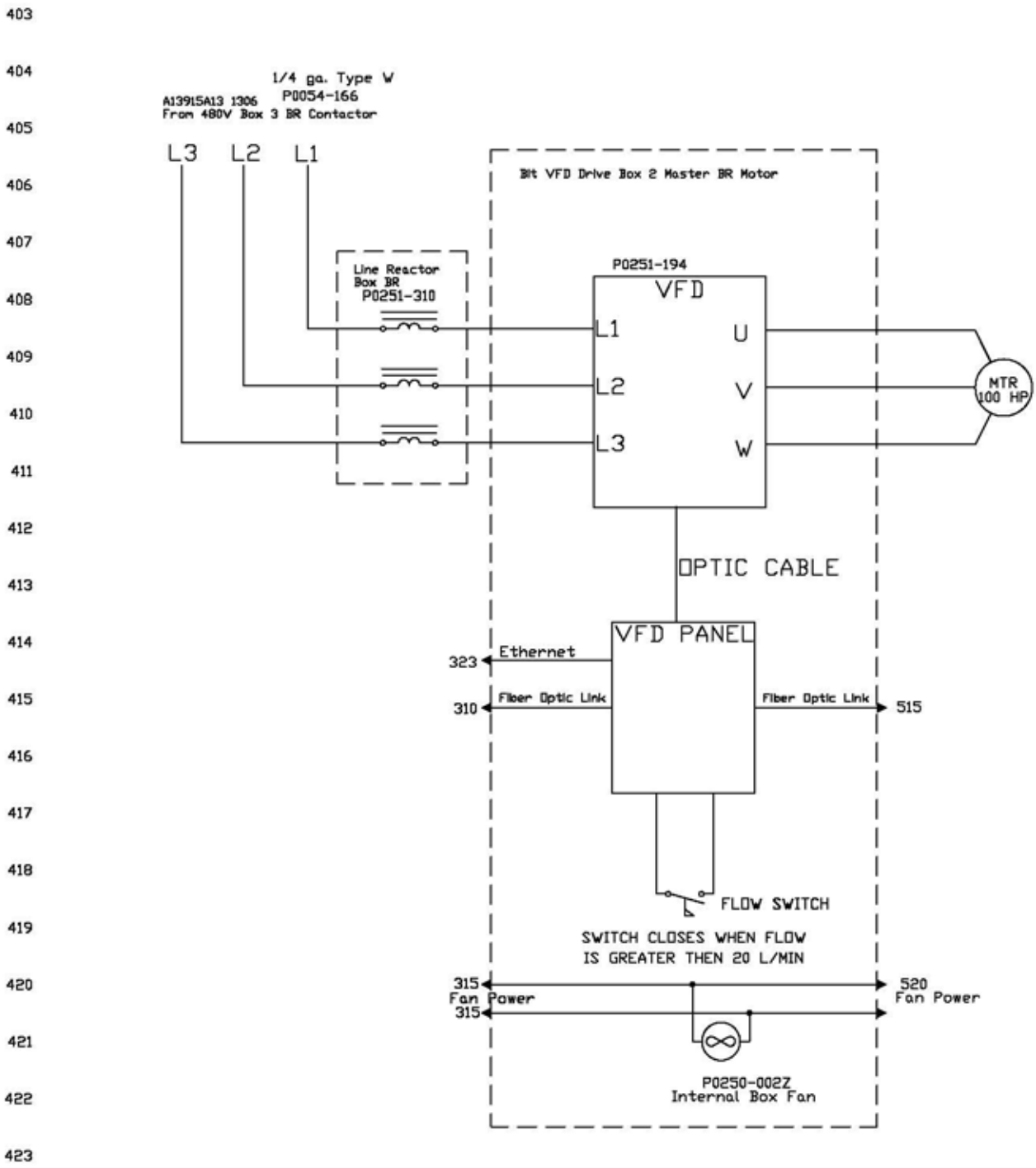
A13912A02


1/4 ga. Type W
P0054-166
A13915A11 1106
From 480V Box 1 BL Contactor
L3
L2
L1
Bit VFD Drive Box 1 Master BL Motor
Line Reactor
Box BL
P0251-310
P0251-194
VFD
L1
L2
L3
U
V
W
P0054-166
1/4 ga. Type W
MTR
100 HP
OPTIC CABLE
VFD PANEL
320 Ethernet
112
Fiber Optic Link
Fiber Optic Link
310
FLOW SWITCH
SWITCH CLOSES WHEN FLOW
IS GREATER THEN 20 L/MIN
117
Fan Power
117
316
Fan Power
P0250-002Z
Internal Box Fan

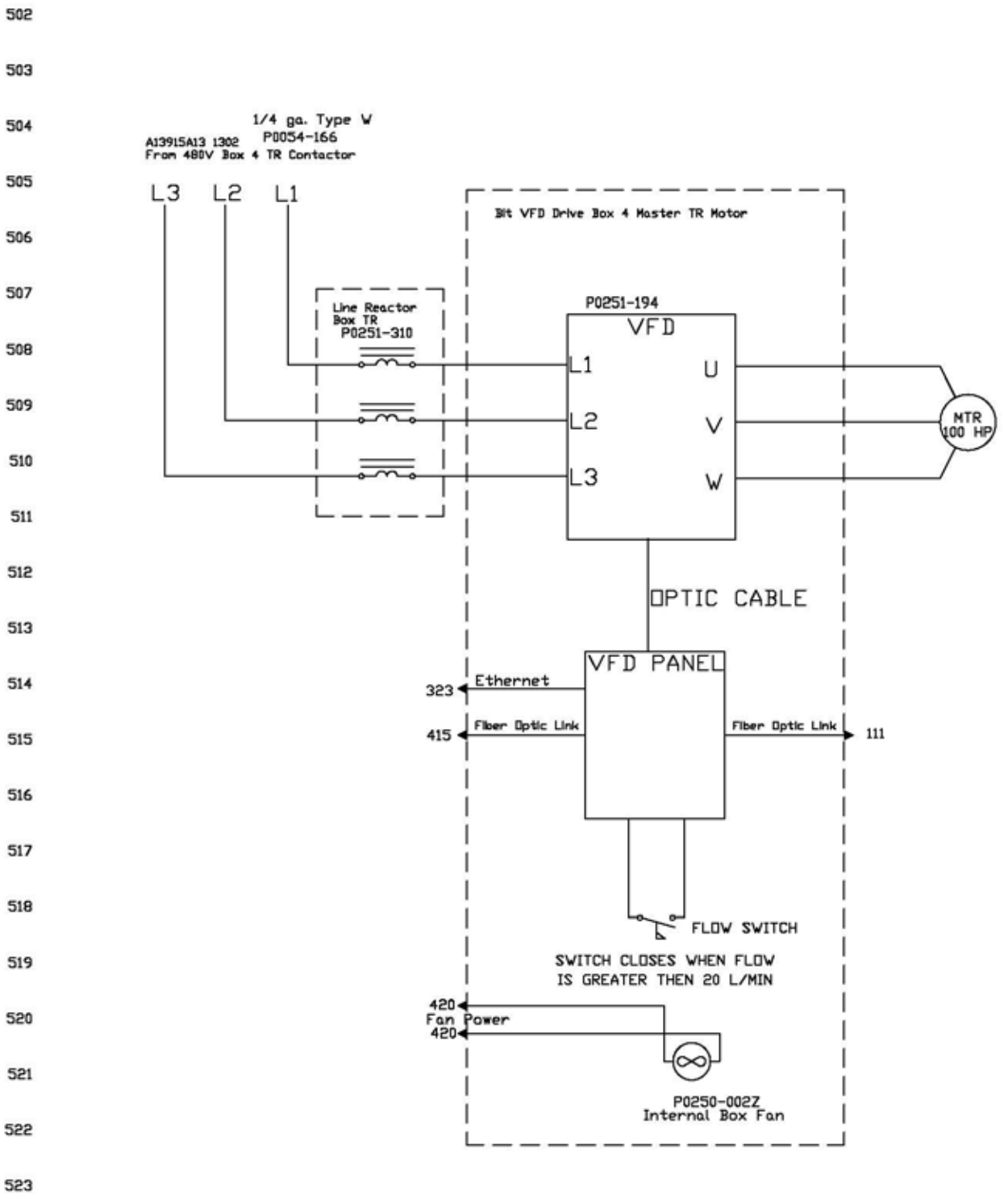
A13912A03


P0054-166
1/4 ga. Type W
A13915A11 1102
From 480V Box 2 TL Contactor
L3 L2 L1
Blt VFD Drive Box 2 Master TL Motor
Line Reactor
Box TL
P0251-310
P0251-194
VFD
L1
L2
L3
U
V
W
MTR
100 HP
OPTIC CABLE
VFD PANEL
211
Fiber Optic Link
Fiber Optic Link
415
FLOW SWITCH
SWITCH CLOSES WHEN FLOW
IS GREATER THEN 20 L/MIN
216
Fan Power
217
420
Fan Power
P0250-002Z
Internal Box Fan
Ethernet Switch
P0250-115
114
Ethernet (Slurry VFD)
214
Ethernet (Drive BL VFD)
414
Ethernet (Drive BR VFD)
514
Ethernet (Drive TR VFD)
Cart 5, 240V Box A13911A03 303

A13912A04

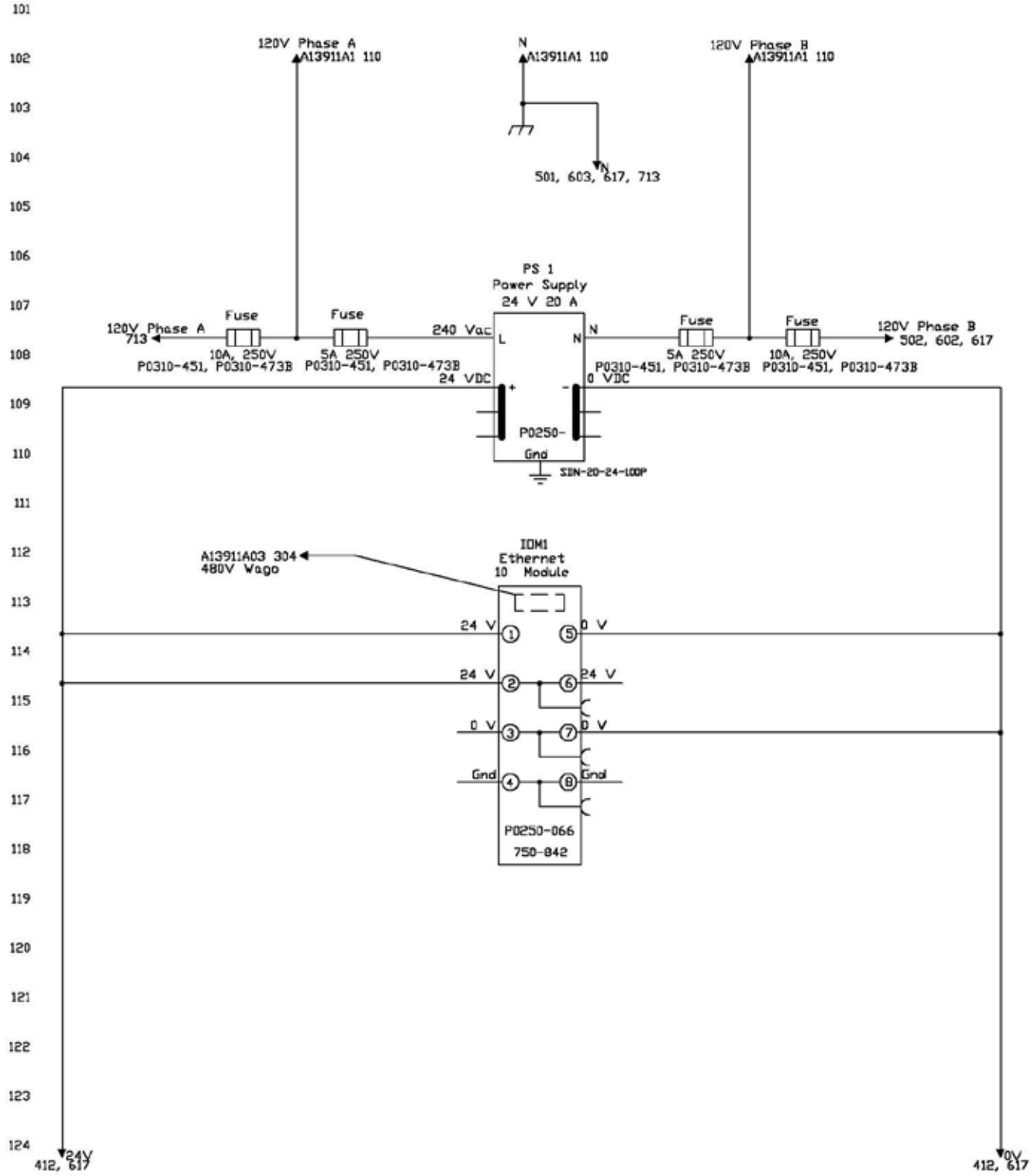

1/4 ga. Type W
P0054-166
A13915A13 1306
From 480V Box 3 BR Contactor
L3
L2
L1
Bit VFD Drive Box 2 Master BR Motor
Line Reactor
Box BR
P0251-310
P0251-194
VFD
L1
L2
L3
U
V
W
MTR
100 HP
OPTIC CABLE
VFD PANEL
323
Ethernet
310
Fiber Optic Link
Fiber Optic Link
515
FLOW SWITCH
SWITCH CLOSES WHEN FLOW
IS GREATER THEN 20 L/MIN
315
Fan Power
315
520
Fan Power
P0250-002Z
Internal Box Fan

A13912A05

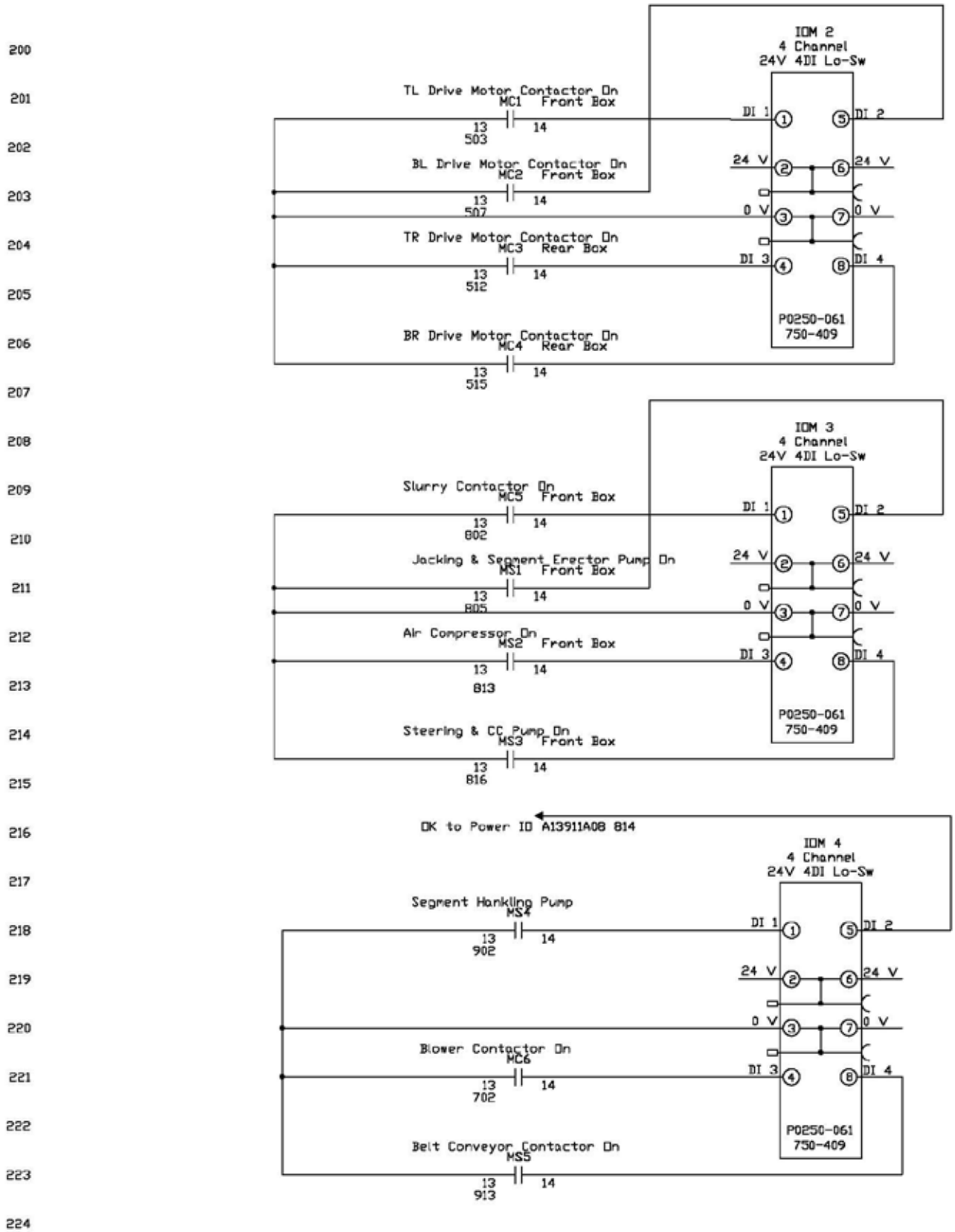

1/4 ga. Type W
P0054-166
A13915A13 1302
From 480V Box 4 TR Contactor
L3
L2
L1
Bit VFD Drive Box 4 Master TR Motor
Line Reactor
Box TR
P0251-310
P0251-194
VFD
L1
L2
L3
U
V
W
MTR
100 HP
OPTIC CABLE
VFD PANEL
323
Ethernet
415
Fiber Optic Link
Fiber Optic Link
111
FLOW SWITCH
SWITCH CLOSES WHEN FLOW
IS GREATER THEN 20 L/MIN
420
Fan Power
420
P0250-002Z
Internal Box Fan

ELECTRICAL SCHEMATICS - 480V CONTROL

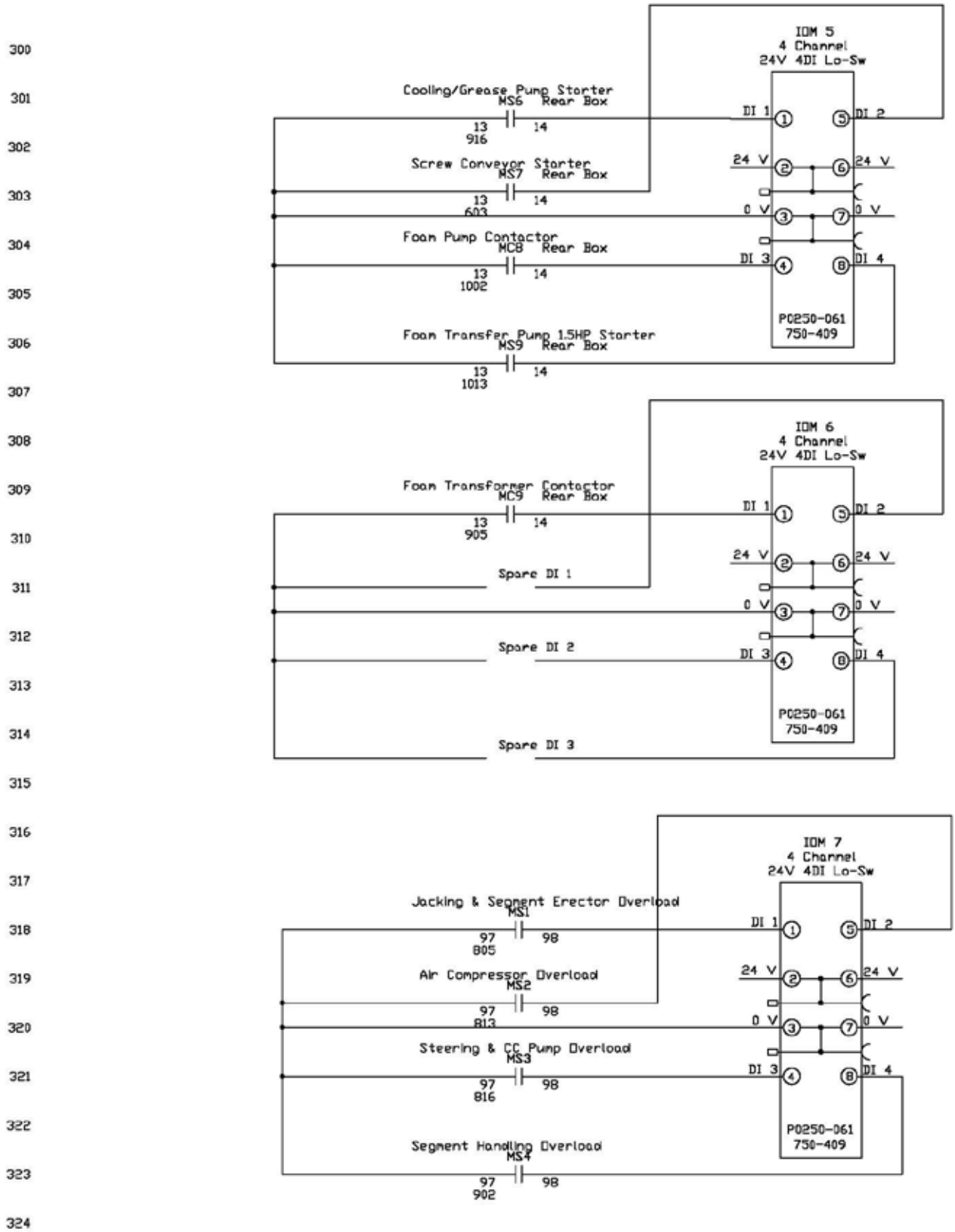
A13915A01



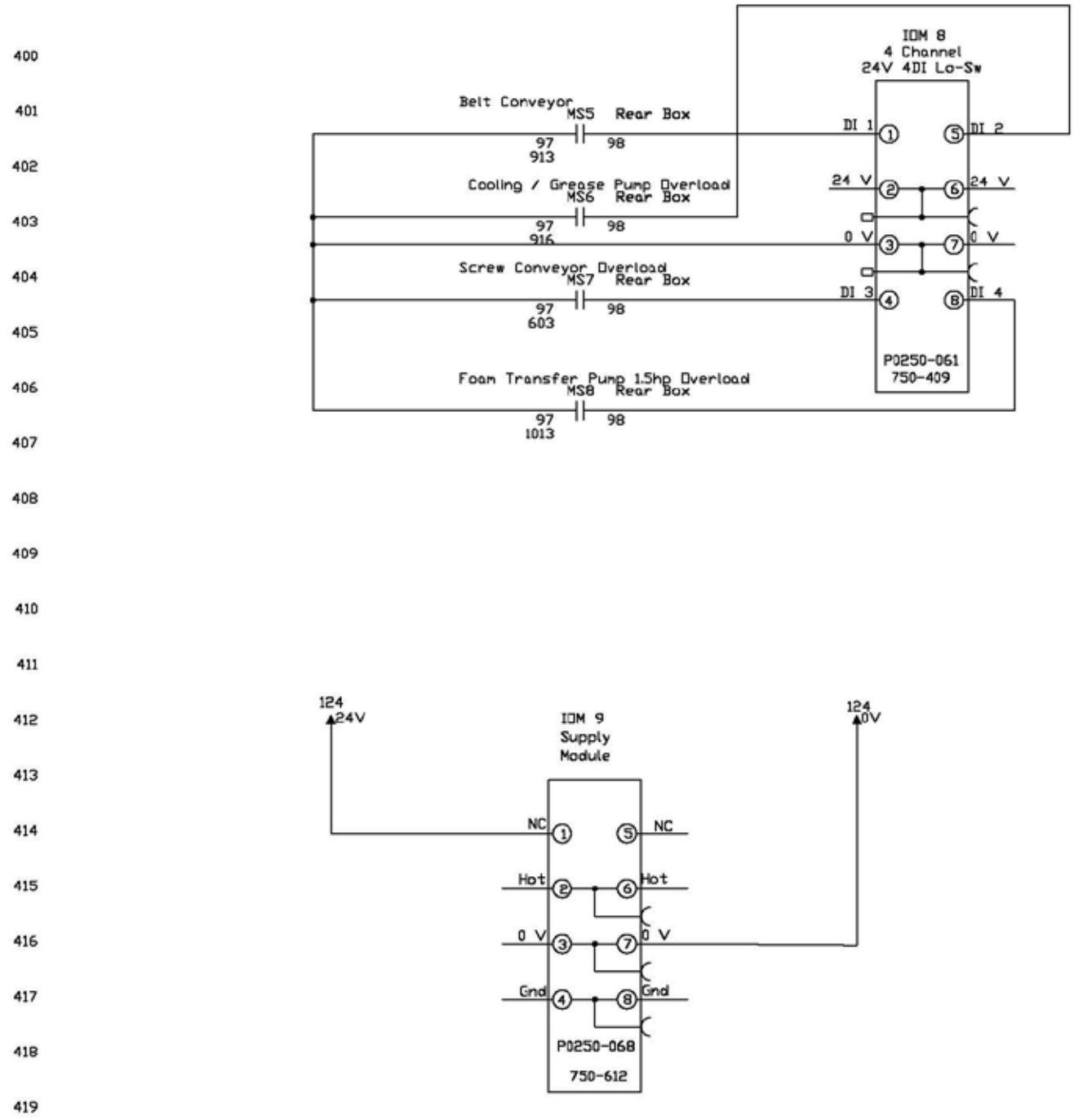
A13915A02


200
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
IOM 2
4 Channel
24V 4DI Lo-Sw
TL Drive Motor Contactor On
MC1 Front Box
13
503
14
BL Drive Motor Contactor On
MC2 Front Box
13
507
14
TR Drive Motor Contactor On
MC3 Rear Box
13
512
14
BR Drive Motor Contactor On
MC4 Rear Box
13
515
14
DI 1
DI 2
24 V
24 V
0 V
0 V
DI 3
DI 4
P0250-061
750-409
IOM 3
4 Channel
24V 4DI Lo-Sw
Slurry Contactor On
MC5 Front Box
13
802
14
Jacking & Segment Erector Pump On
MS1 Front Box
13
805
14
Air Compressor On
MS2 Front Box
13
813
14
Steering & CC Pump On
MS3 Front Box
13
816
14
DI 1
DI 2
24 V
24 V
0 V
0 V
DI 3
DI 4
P0250-061
750-409
OK to Power ID A13911A08 814
IOM 4
4 Channel
24V 4DI Lo-Sw
Segment Hankling Pump
MS4
13
902
14
Blower Contactor On
MC6
13
702
14
Belt Conveyor Contactor On
MS5
13
913
14
DI 1
DI 2
24 V
24 V
0 V
0 V
DI 3
DI 4
P0250-061
750-409

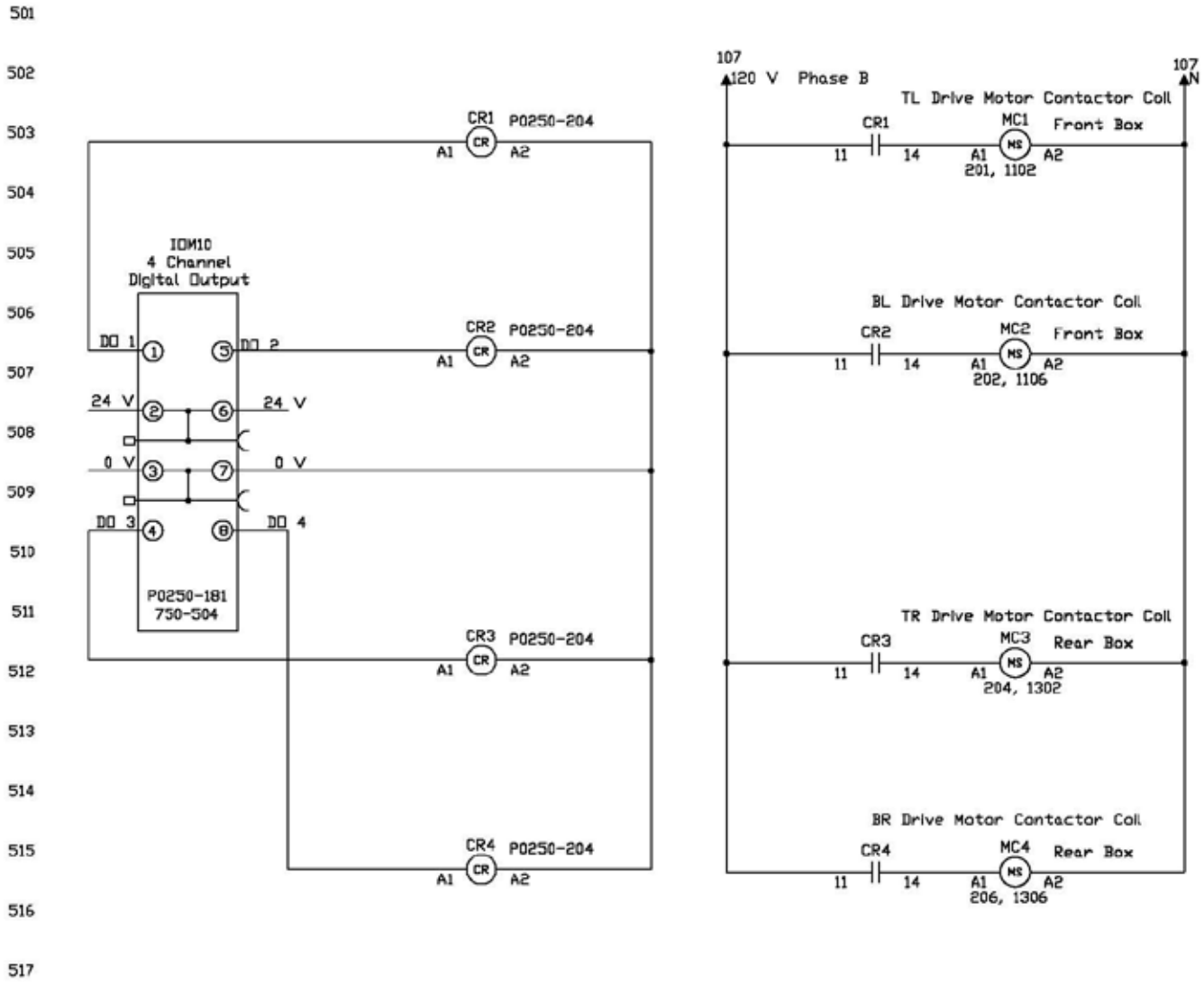
A13915A03


300
301
302
303
304
305
306
307
308
309
310
311
312
313
314
315
316
317
318
319
320
321
322
323
324
IOM 5
4 Channel
24V 4DI Lo-Sw
Cooling/Grease Pump Starter
MS6 Rear Box
13
916
14
Screw Conveyor Starter
MS7 Rear Box
13
603
14
Foam Pump Contactor
MC8 Rear Box
13
1002
14
Foam Transfer Pump 1.5HP Starter
MS9 Rear Box
13
1013
14
DI 1
DI 2
24 V
0 V
DI 3
DI 4
P0250-061
750-409
IOM 6
4 Channel
24V 4DI Lo-Sw
Foam Transformer Contactor
MC9 Rear Box
13
905
14
Spare DI 1
Spare DI 2
Spare DI 3
DI 1
DI 2
24 V
0 V
DI 3
DI 4
P0250-061
750-409
IOM 7
4 Channel
24V 4DI Lo-Sw
Jacking & Segment Erector Overload
MS1
97
805
98
Air Compressor Overload
MS2
97
813
98
Steering & CC Pump Overload
MS3
97
816
98
Segment Handling Overload
MS4
97
902
98
DI 1
DI 2
24 V
0 V
DI 3
DI 4
P0250-061
750-409

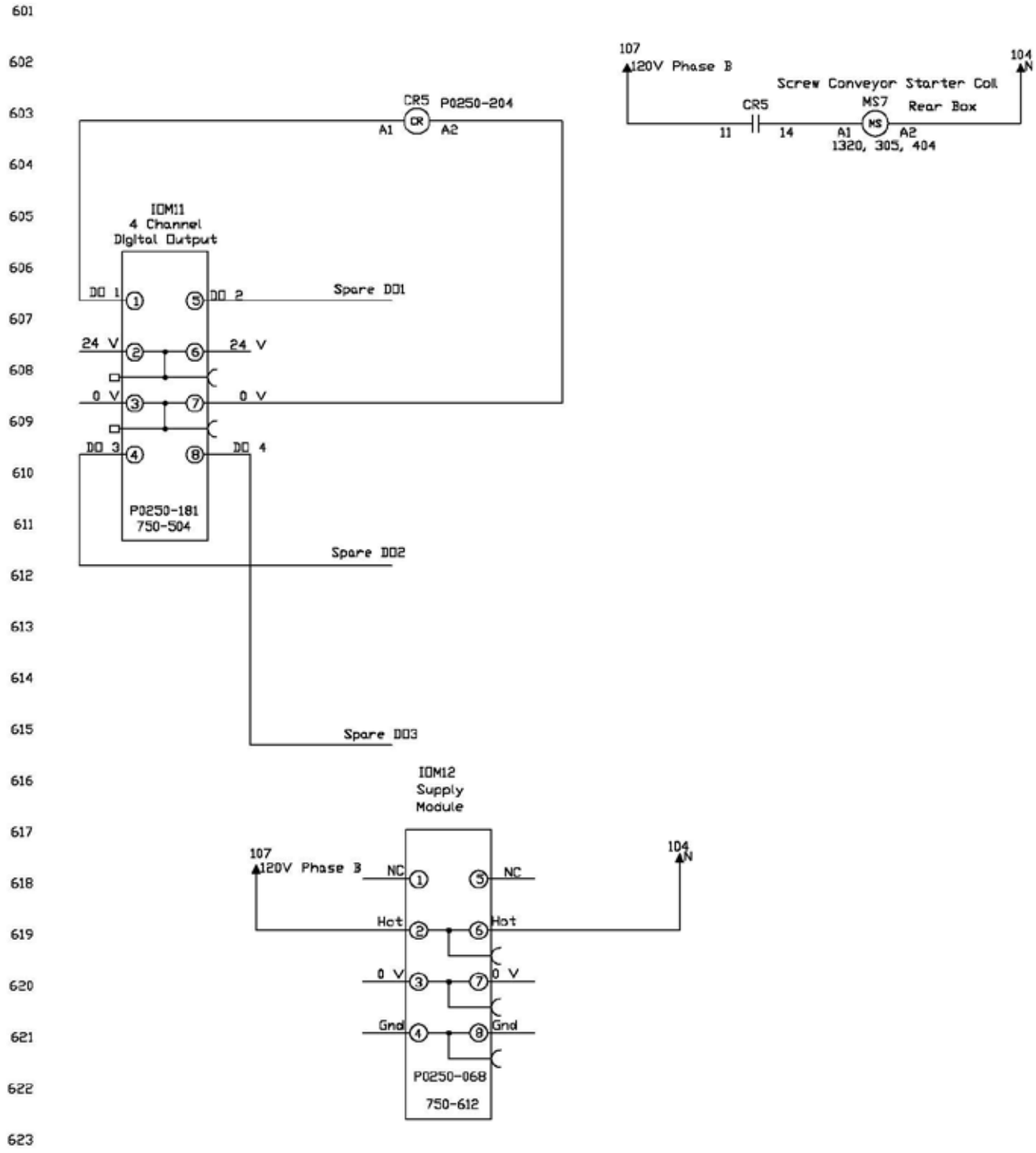
A13915A04


400
401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
IOM 8
4 Channel
24V 4DI Lo-Sw
Belt Conveyor
MS5 Rear Box
97
913
98
Cooling / Grease Pump Overload
MS6 Rear Box
97
916
98
Screw Conveyor Overload
MS7 Rear Box
97
603
98
Foam Transfer Pump 1.5hp Overload
MS8 Rear Box
97
1013
98
DI 1
DI 2
24 V
24 V
0 V
0 V
DI 3
DI 4
P0250-061
750-409
124
24V
IOM 9
Supply
Module
124
0V
NC
NC
Hot
Hot
0 V
0 V
Gnd
Gnd
P0250-068
750-612

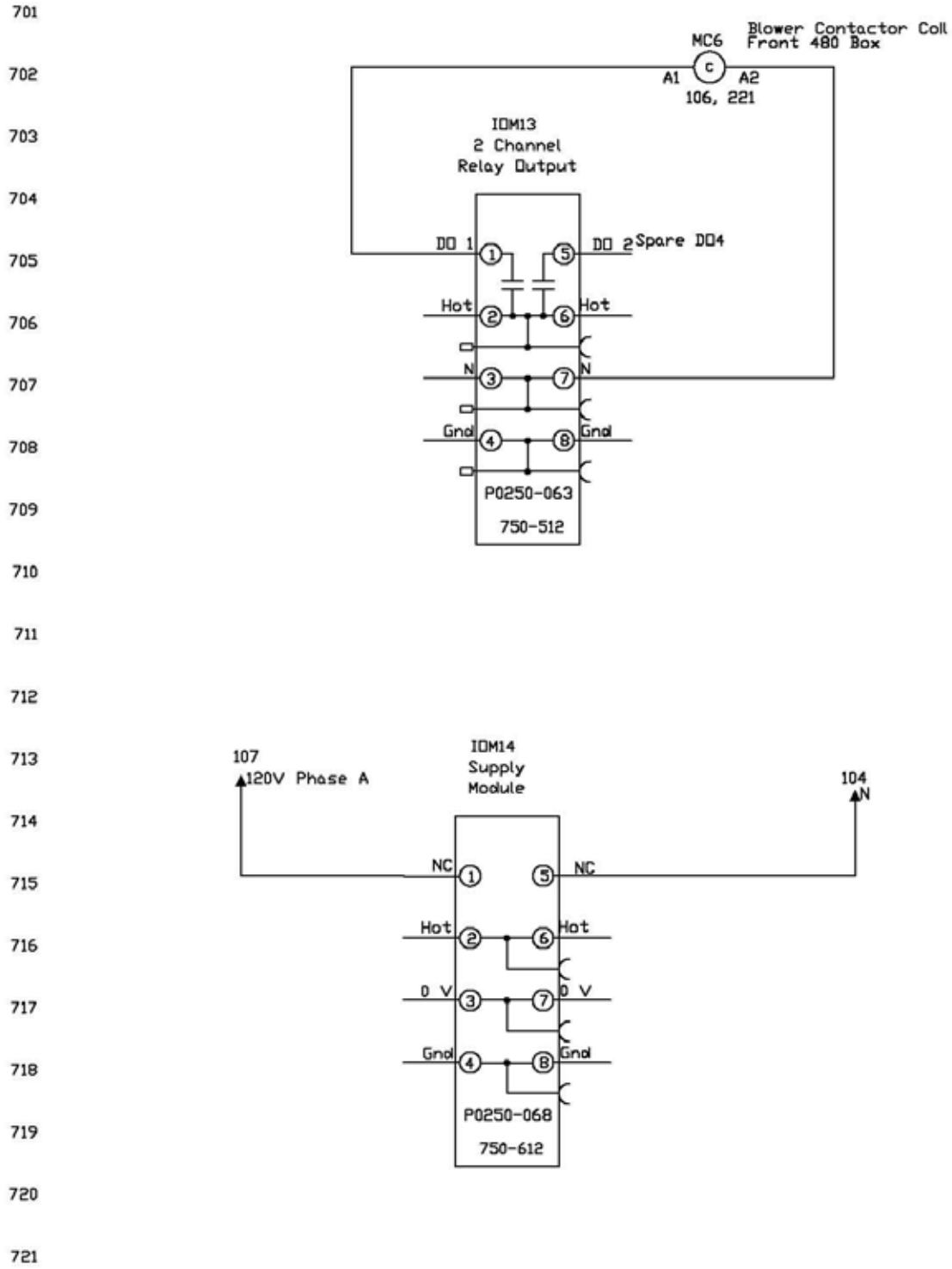
A13915A05


501
502
503
504
505
506
507
508
509
510
511
512
513
514
515
516
517
IOM10
4 Channel
Digital Output
DO 1
DO 2
DO 3
DO 4
24 V
24 V
0 V
0 V
P0250-181
750-504
CR1 P0250-204
CR2 P0250-204
CR3 P0250-204
CR4 P0250-204
A1
A2
107
120 V Phase B
107
N
TL Drive Motor Contactor Coil
CR1
MC1
Front Box
11
14
A1
A2
201, 1102
BL Drive Motor Contactor Coil
CR2
MC2
Front Box
202, 1106
TR Drive Motor Contactor Coil
CR3
MC3
Rear Box
204, 1302
BR Drive Motor Contactor Coil
CR4
MC4
Rear Box
206, 1306

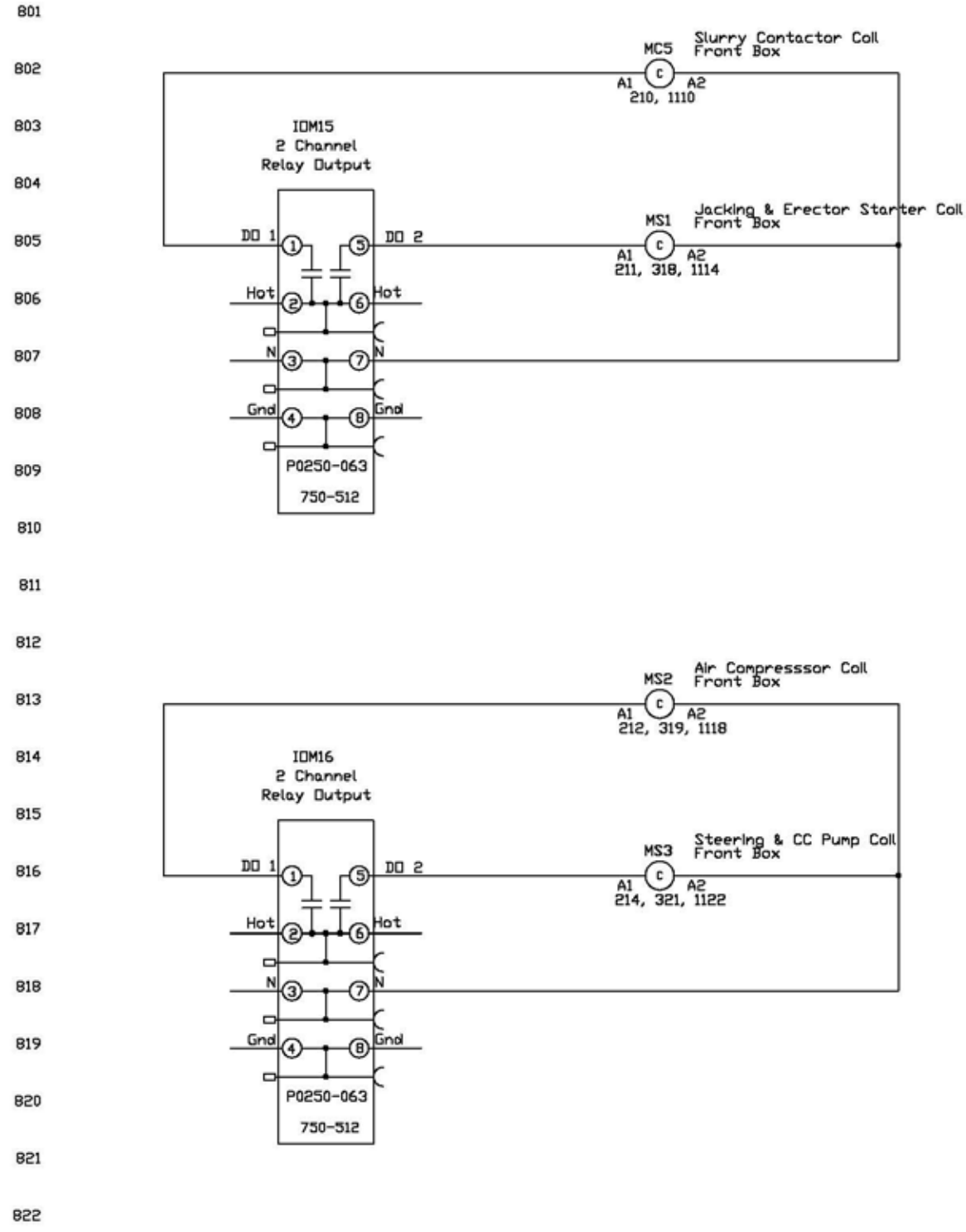
A13915A06


601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
617
618
619
620
621
622
623
107
120V Phase B
104
N
Screw Conveyor Starter Coil
Rear Box
CR5
MS7
11
14
A1
A2
1320, 305, 404
CR5 P0250-204
A1
A2
IOM11
4 Channel
Digital Output
DO 1
DO 2
Spare DO1
24 V
24 V
0 V
0 V
DO 3
DO 4
P0250-181
750-504
Spare DO2
Spare DO3
IOM12
Supply
Module
107
120V Phase B
104
N
NC
NC
Hot
Hot
0 V
0 V
Gnd
Gnd
P0250-068
750-612

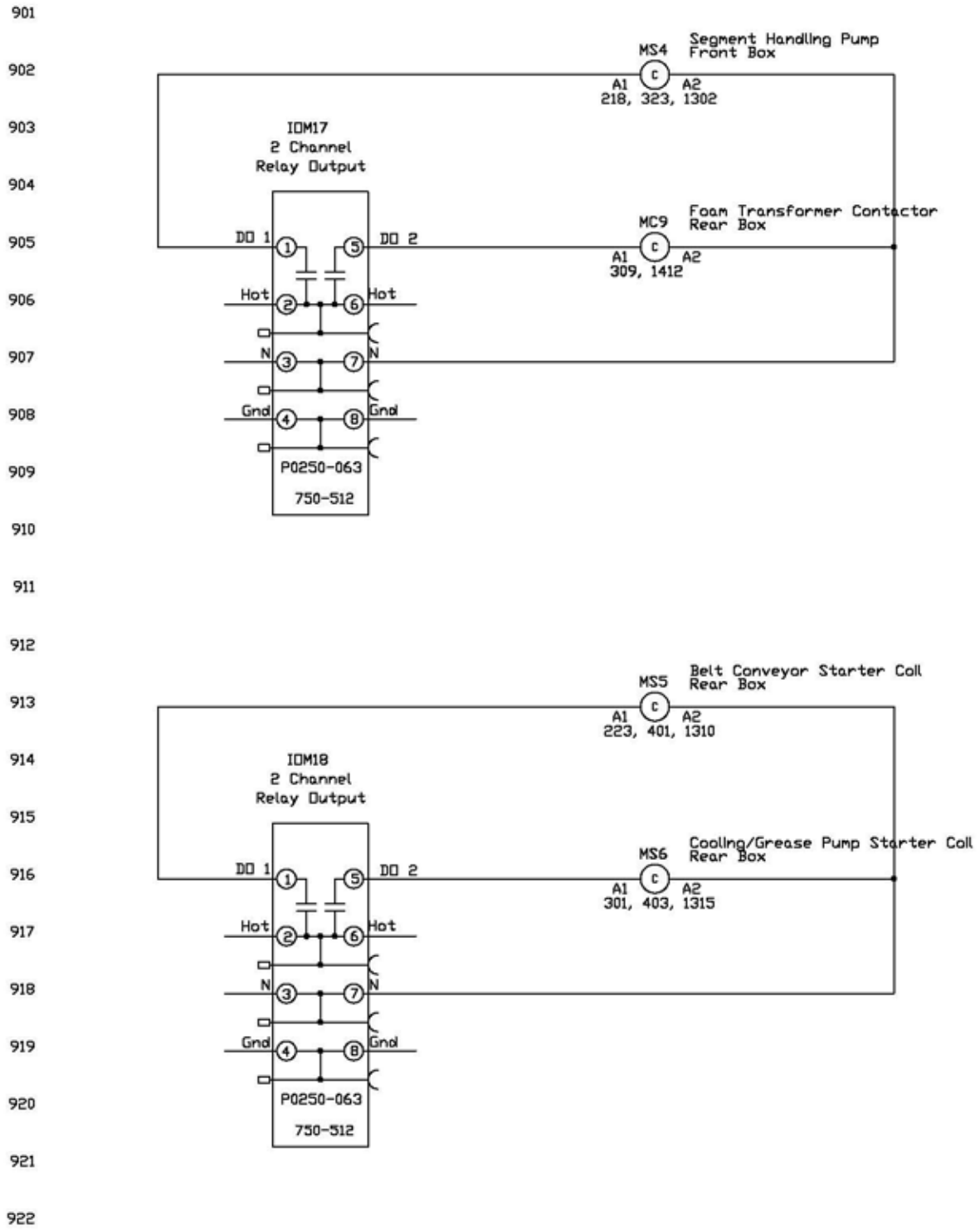
A13915A07


701
702
703
704
705
706
707
708
709
710
711
712
713
714
715
716
717
718
719
720
721
MC6
Blower Contactor Coil
Front 480 Box
A1
A2
106, 221
IDM13
2 Channel
Relay Output
DO 1
DO 2
Spare DO4
Hot
Hot
N
N
Gnd
Gnd
P0250-063
750-512
107
120V Phase A
IDM14
Supply
Module
104
N
NC
NC
Hot
Hot
0 V
0 V
Gnd
Gnd
P0250-068
750-612

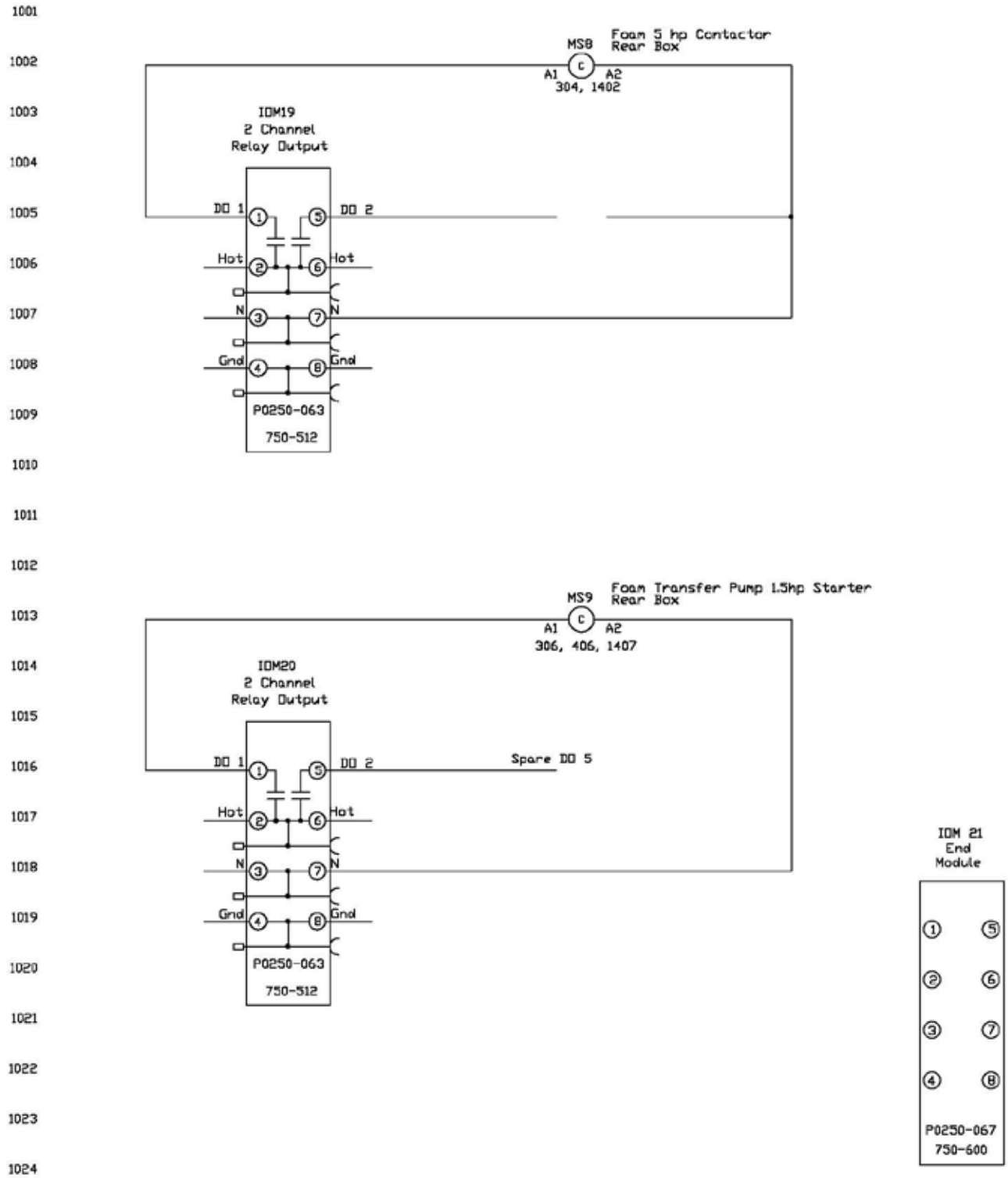
A13915A08


B01
B02
B03
B04
B05
B06
B07
B08
B09
B10
B11
B12
B13
B14
B15
B16
B17
B18
B19
B20
B21
B22
MC5
Slurry Contactor Coil
Front Box
A1
A2
210, 1110
IOM15
2 Channel
Relay Output
DO 1
DO 2
MS1
Jacking & Erector Starter Coil
Front Box
A1
A2
211, 318, 1114
Hot
Hot
N
N
Gnd
Gnd
P0250-063
750-512
MS2
Air Compresssor Coil
Front Box
A1
A2
212, 319, 1118
IOM16
2 Channel
Relay Output
DO 1
DO 2
MS3
Steering & CC Pump Coil
Front Box
A1
A2
214, 321, 1122
Hot
Hot
N
N
Gnd
Gnd
P0250-063
750-512

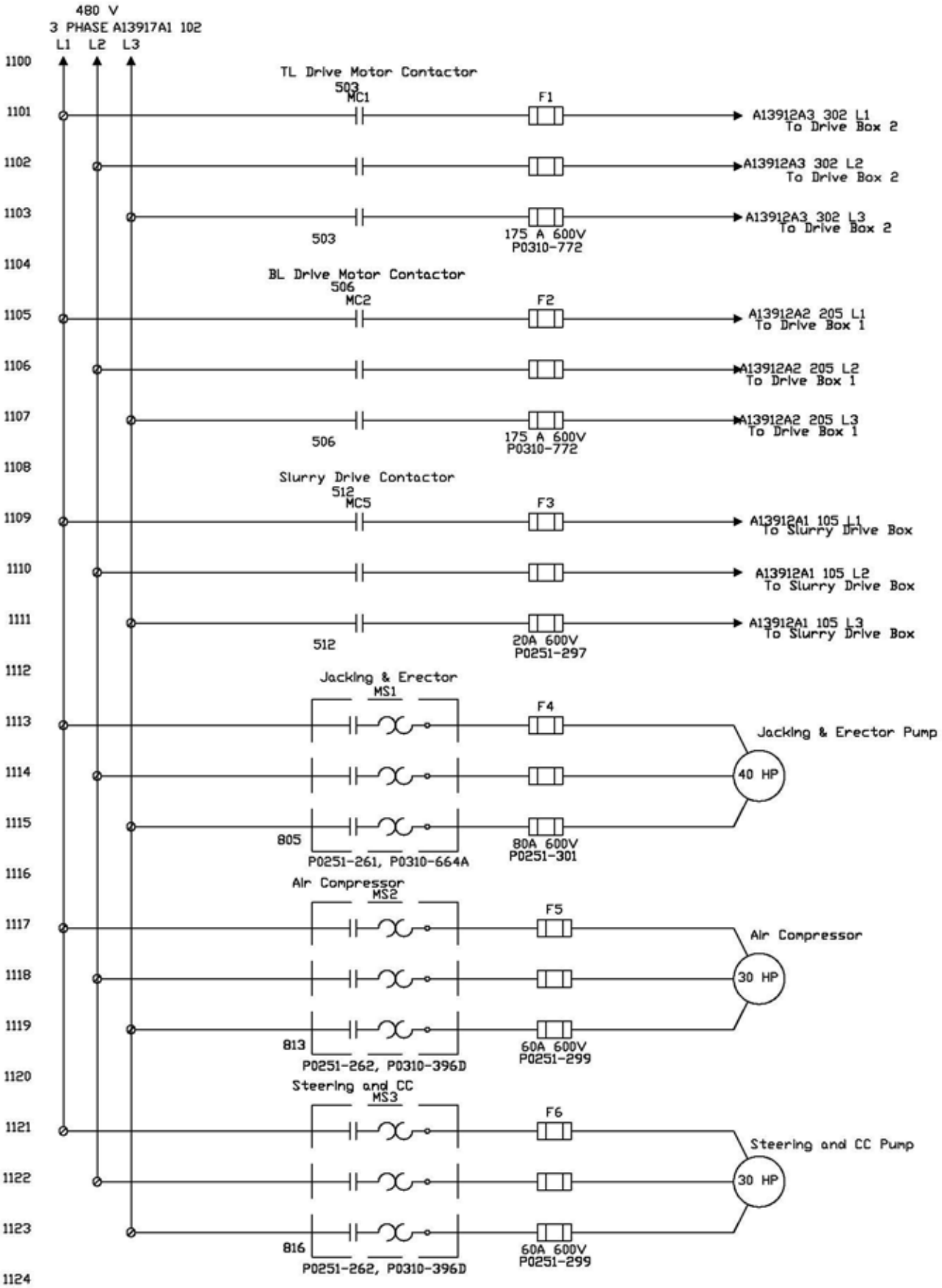
A13915A09


901
902
903
904
905
906
907
908
909
910
911
912
913
914
915
916
917
918
919
920
921
922
MS4
Segment Handling Pump
Front Box
A1
218, 323, 1302
A2
IOM17
2 Channel
Relay Output
MC9
Foam Transformer Contactor
Rear Box
DO 1
DO 2
A1
309, 1412
A2
Hot
Hot
N
N
Gnd
Gnd
P0250-063
750-512
MS5
Belt Conveyor Starter Coil
Rear Box
A1
223, 401, 1310
A2
IOM18
2 Channel
Relay Output
MS6
Cooling/Grease Pump Starter Coil
Rear Box
DO 1
DO 2
A1
301, 403, 1315
A2
Hot
Hot
N
N
Gnd
Gnd
P0250-063
750-512

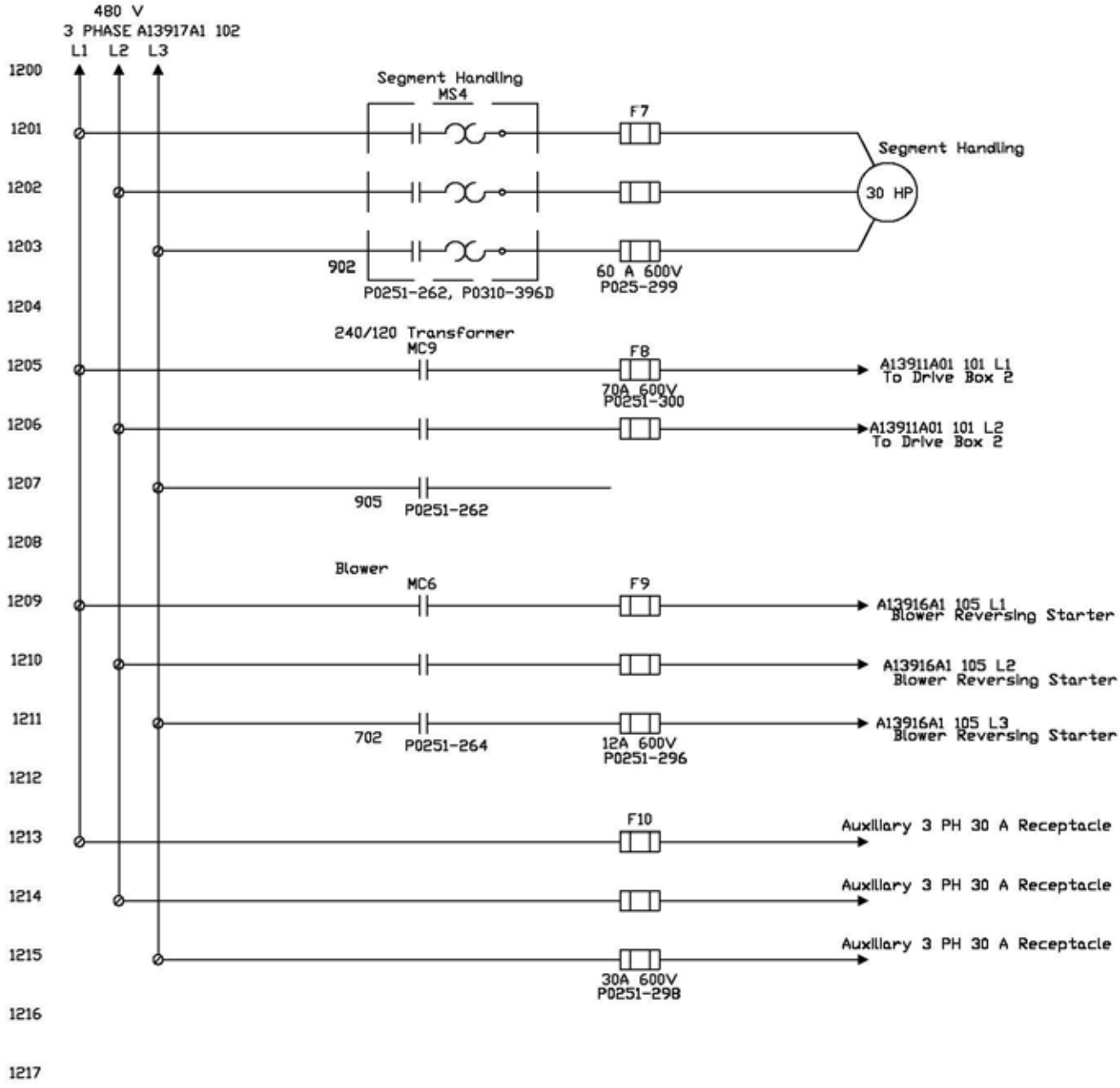
A13915A10


1001
1002
1003
1004
1005
1006
1007
1008
1009
1010
1011
1012
1013
1014
1015
1016
1017
1018
1019
1020
1021
1022
1023
1024
MS8
Foam 5 hp Contactor
Rear Box
A1
A2
304, 1402
IOM19
2 Channel
Relay Output
DO 1
DO 2
Hot
Hot
N
N
Gnd
Gnd
P0250-063
750-512
MS9
Foam Transfer Pump 1.5hp Starter
Rear Box
A1
A2
306, 406, 1407
IOM20
2 Channel
Relay Output
DO 1
DO 2
Spare DO 5
Hot
Hot
N
N
Gnd
Gnd
P0250-063
750-512
IOM 21
End
Module
P0250-067
750-600

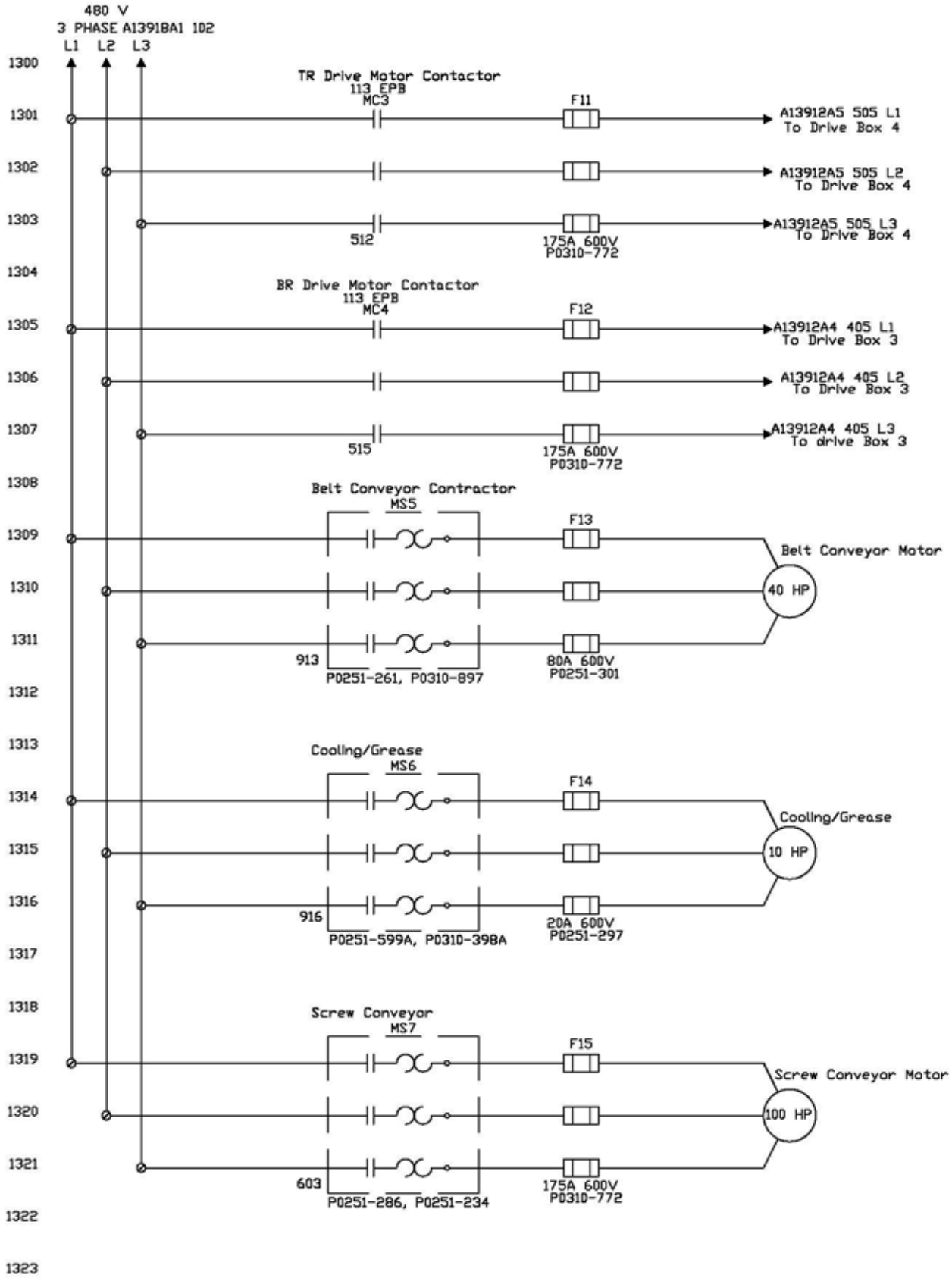
A13915A11


480 V
3 PHASE A13917A1 102
L1 L2 L3
1100
TL Drive Motor Contactor
503
MC1
F1
1101
A13912A3 302 L1
To Drive Box 2
1102
A13912A3 302 L2
To Drive Box 2
1103
A13912A3 302 L3
To Drive Box 2
503
175 A 600V
P0310-772
1104
BL Drive Motor Contactor
506
MC2
F2
1105
A13912A2 205 L1
To Drive Box 1
1106
A13912A2 205 L2
To Drive Box 1
1107
A13912A2 205 L3
To Drive Box 1
506
175 A 600V
P0310-772
1108
Slurry Drive Contactor
512
MC5
F3
1109
A13912A1 105 L1
To Slurry Drive Box
1110
A13912A1 105 L2
To Slurry Drive Box
1111
A13912A1 105 L3
To Slurry Drive Box
512
20A 600V
P0251-297
1112
Jacking & Erector
MS1
F4
1113
Jacking & Erector Pump
1114
40 HP
1115
805
80A 600V
P0251-301
P0251-261, P0310-664A
1116
Air Compressor
MS2
F5
1117
Air Compressor
1118
30 HP
1119
813
60A 600V
P0251-299
P0251-262, P0310-396D
1120
Steering and CC
MS3
F6
1121
Steering and CC Pump
1122
30 HP
1123
816
60A 600V
P0251-299
P0251-262, P0310-396D
1124

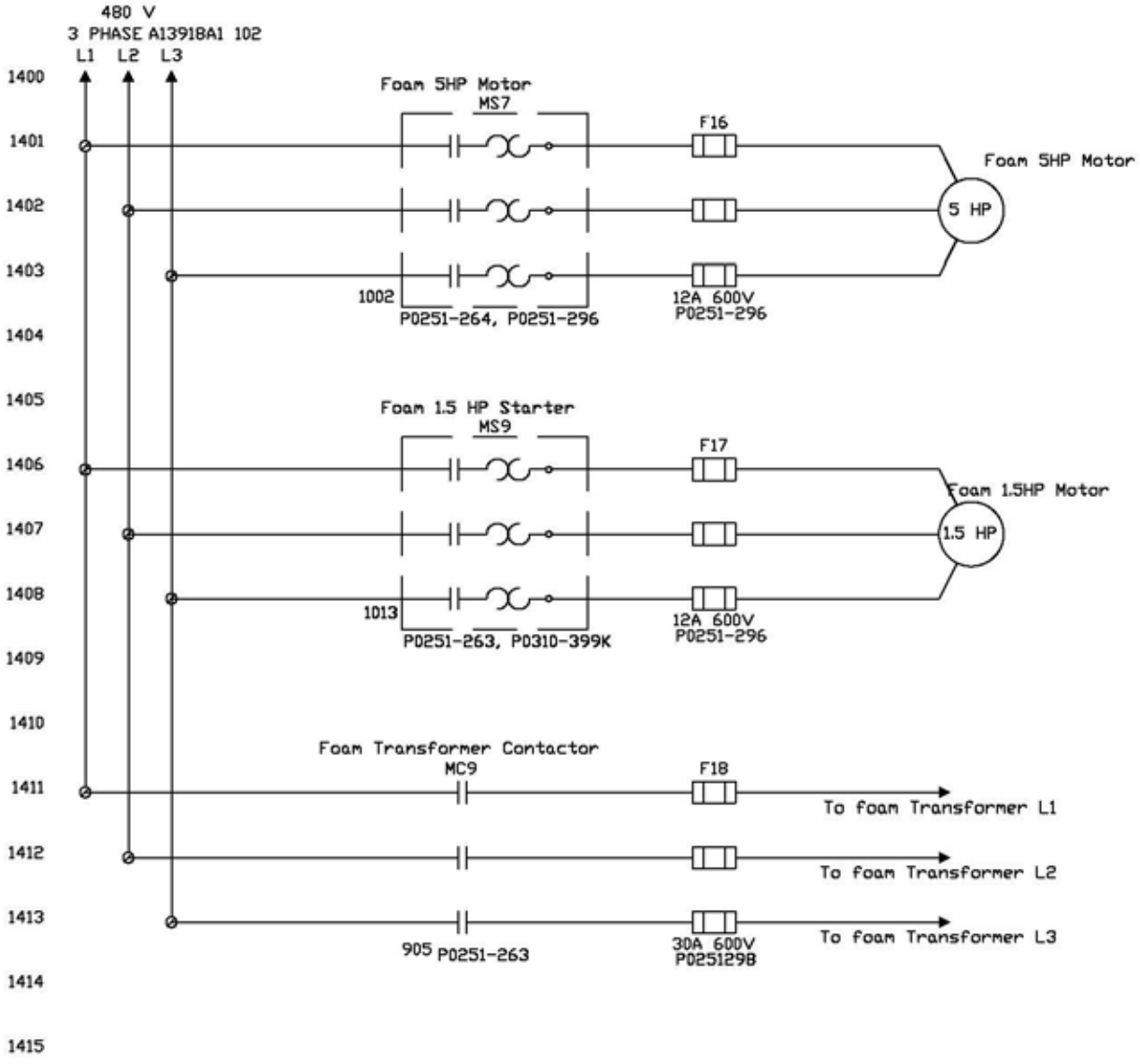
A13915A12


480 V
3 PHASE A13917A1 102
L1 L2 L3
1200
1201
1202
1203
1204
1205
1206
1207
1208
1209
1210
1211
1212
1213
1214
1215
1216
1217
Segment Handling
MS4
F7
Segment Handling
30 HP
902
P0251-262, P0310-396D
60 A 600V
P025-299
240/120 Transformer
MC9
F8
70A 600V
P0251-300
A13911A01 101 L1
To Drive Box 2
A13911A01 101 L2
To Drive Box 2
905
P0251-262
Blower
MC6
F9
A13916A1 105 L1
Blower Reversing Starter
A13916A1 105 L2
Blower Reversing Starter
702
P0251-264
12A 600V
P0251-296
A13916A1 105 L3
Blower Reversing Starter
F10
Auxiliary 3 PH 30 A Receptacle
Auxiliary 3 PH 30 A Receptacle
Auxiliary 3 PH 30 A Receptacle
30A 600V
P0251-298

A13915A13

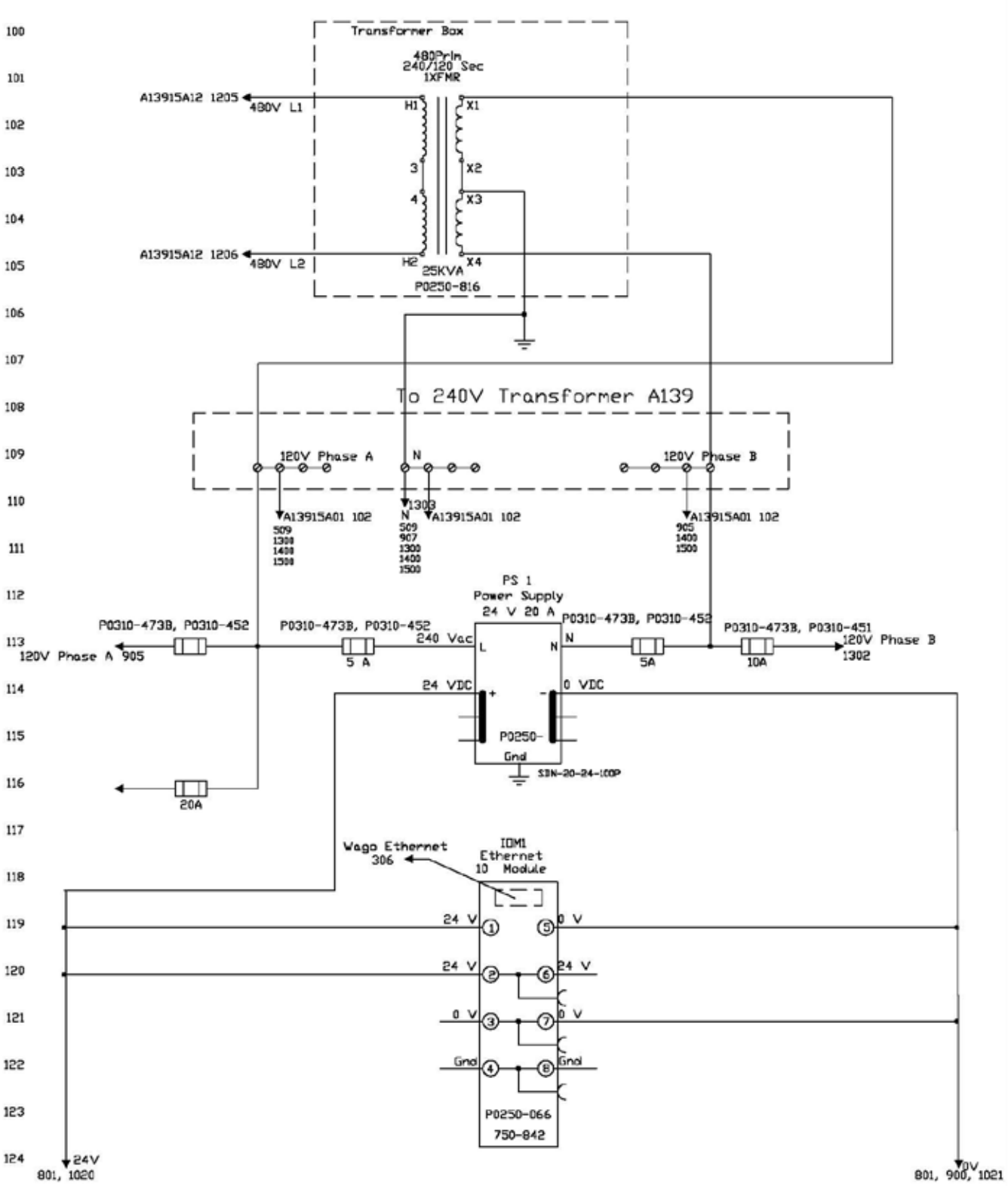

480 V
3 PHASE A13918A1 102
L1 L2 L3
1300
1301
1302
1303
1304
1305
1306
1307
1308
1309
1310
1311
1312
1313
1314
1315
1316
1317
1318
1319
1320
1321
1322
1323
TR Drive Motor Contactor
113 EPB
MC3
F11
A13912A5 505 L1
To Drive Box 4
A13912A5 505 L2
To Drive Box 4
A13912A5 505 L3
To Drive Box 4
512
175A 600V
P0310-772
BR Drive Motor Contactor
113 EPB
MC4
F12
A13912A4 405 L1
To Drive Box 3
A13912A4 405 L2
To Drive Box 3
A13912A4 405 L3
To drive Box 3
515
175A 600V
P0310-772
Belt Conveyor Contractor
MS5
F13
Belt Conveyor Motor
40 HP
913
P0251-261, P0310-897
80A 600V
P0251-301
Cooling/Grease
MS6
F14
Cooling/Grease
10 HP
916
P0251-599A, P0310-398A
20A 600V
P0251-297
Screw Conveyor
MS7
F15
Screw Conveyor Motor
100 HP
603
P0251-286, P0251-234
175A 600V
P0310-772

A13915A14

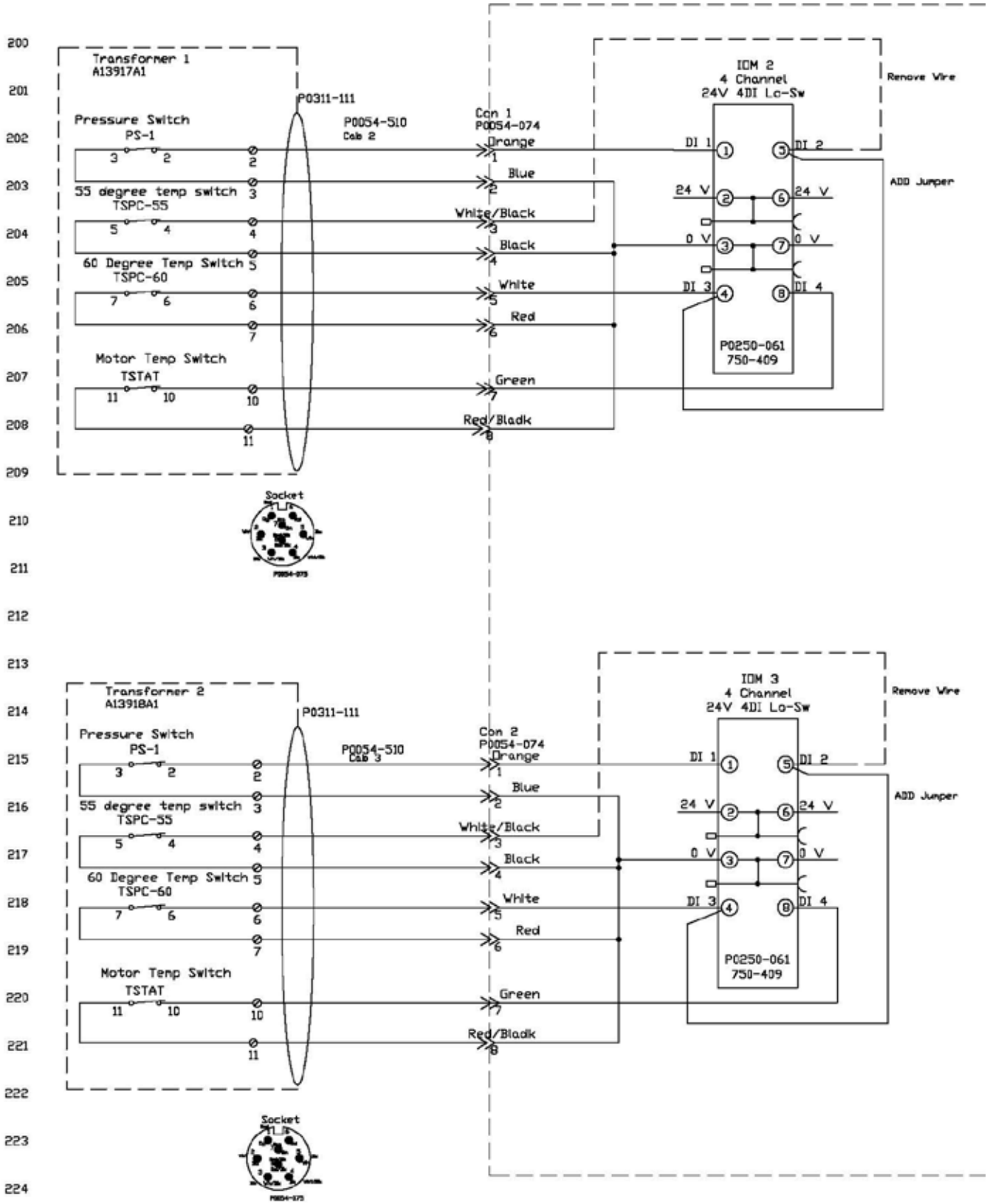

480 V
3 PHASE A13918A1 102
L1 L2 L3
1400
1401
1402
1403
1404
1405
1406
1407
1408
1409
1410
1411
1412
1413
1414
1415
Foam 5HP Motor
MS7
F16
Foam 5HP Motor
5 HP
1002
P0251-264, P0251-296
12A 600V
P0251-296
Foam 1.5 HP Starter
MS9
F17
Foam 1.5HP Motor
1.5 HP
1013
P0251-263, P0310-399K
12A 600V
P0251-296
Foam Transformer Contactor
MC9
F18
To foam Transformer L1
To foam Transformer L2
To foam Transformer L3
905 P0251-263
30A 600V
P025129B

ELECTRICAL SCHEMATICS - 240V CONTROL

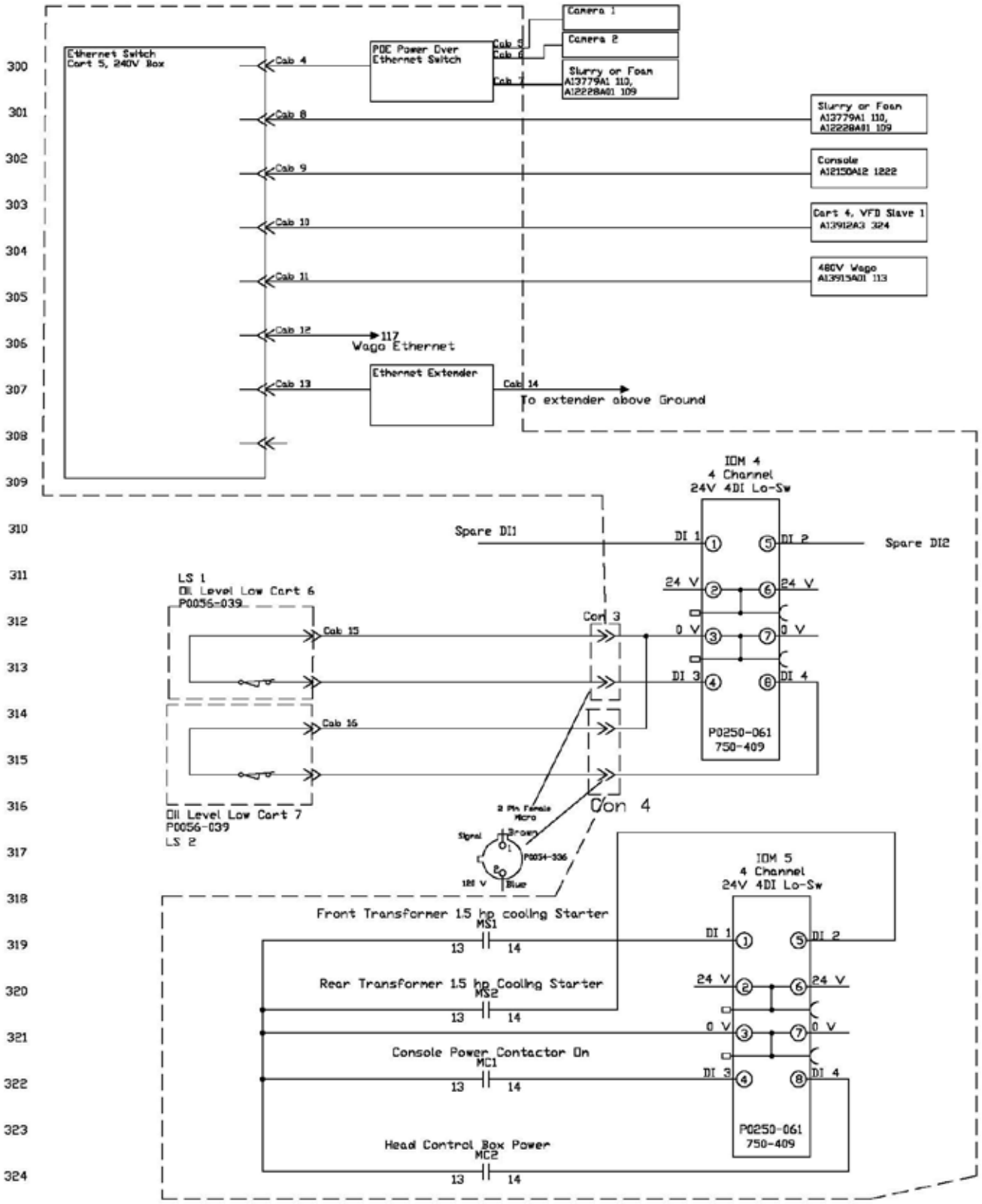
A13911A01



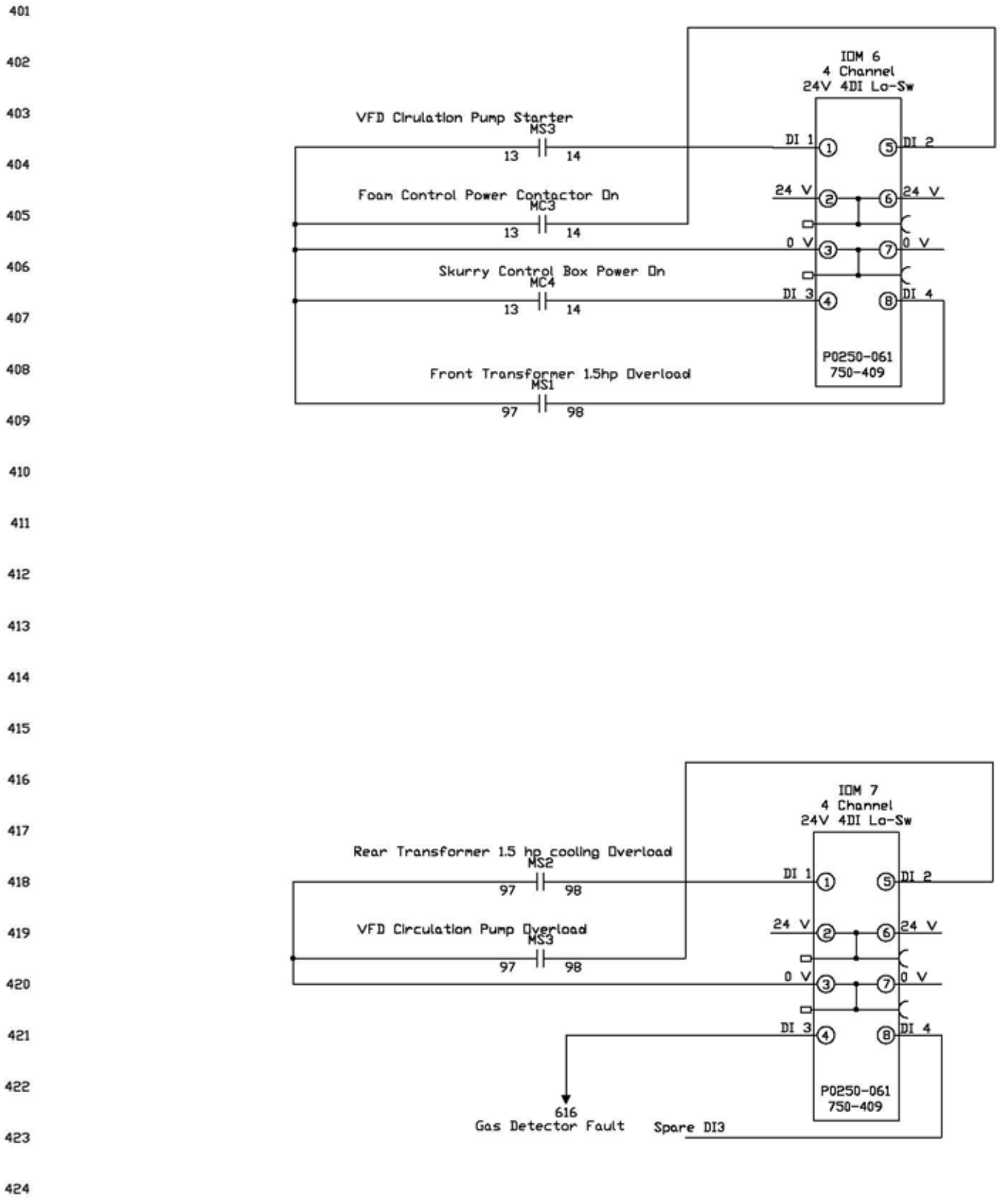
A13911A02


Transformer 1
A13917A1
P0311-111
Pressure Switch
PS-1
55 degree temp switch
TSPC-55
60 Degree Temp Switch
TSPC-60
Motor Temp Switch
TSTAT
P0054-510
Cab 2
Con 1
P0054-074
Orange
Blue
White/Black
Black
White
Red
Green
Red/Bladk
IOM 2
4 Channel
24V 4DI Lo-Sw
Remove Wire
ADD Jumper
DI 1
DI 2
DI 3
DI 4
24 V
0 V
P0250-061
750-409
Socket
Transformer 2
A13918A1
P0311-111
P0054-510
Cab 3
Con 2
P0054-074
IOM 3
4 Channel
24V 4DI Lo-Sw
Remove Wire
ADD Jumper
P0250-061
750-409
Socket

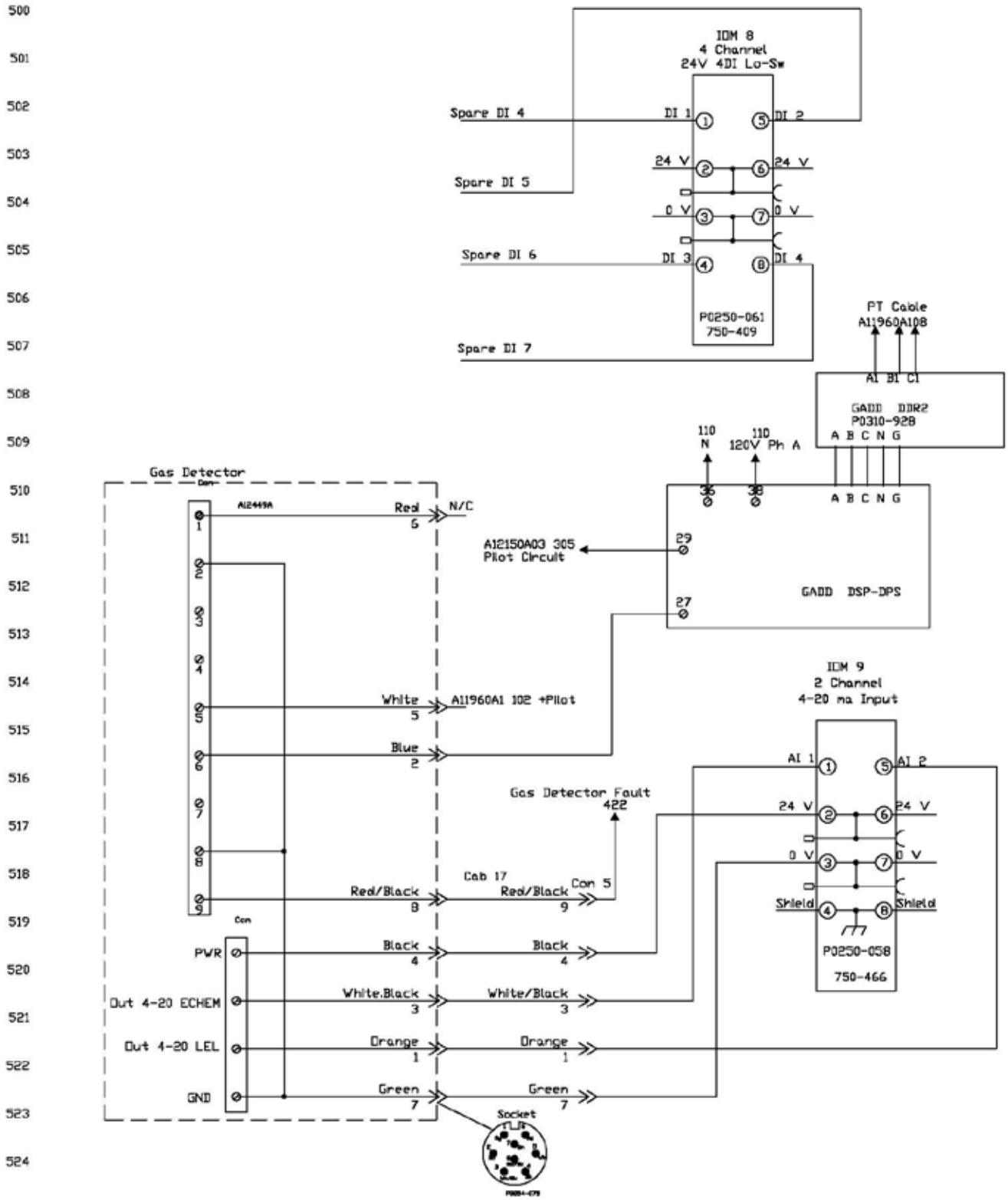
A13911A03


Ethernet Switch
Cart 5, 240V Box
Cab 4
PDE Power Over
Ethernet Switch
Cab 5
Cab 6
Cab 7
Camera 1
Camera 2
Slurry or Foam
A13779A1 110,
A12228A01 109
Cab 8
Slurry or Foam
A13779A1 110,
A12228A01 109
Cab 9
Console
A12150A12 1222
Cab 10
Cart 4, VFD Slave 1
A13912A3 324
Cab 11
480V Wago
A13915A01 113
Cab 12
117
Wago Ethernet
Cab 13
Ethernet Extender
Cab 14
To extender above Ground
IOM 4
4 Channel
24V 4DI Lo-Sw
Spare DI1
DI 1
DI 2
Spare DI2
24 V
0 V
DI 3
DI 4
P0250-061
750-409
LS 1
Oil Level Low Cart 6
P0056-039
Cab 15
Cab 16
Con 3
Con 4
Oil Level Low Cart 7
P0056-039
LS 2
2 Pin Female
Micro
Signal
Brown
Blue
P0034-336
IOM 5
4 Channel
24V 4DI Lo-Sw
Front Transformer 1.5 hp cooling Starter
MS1
13
14
Rear Transformer 1.5 hp Cooling Starter
MS2
Console Power Contactor On
MC1
Head Control Box Power
MC2

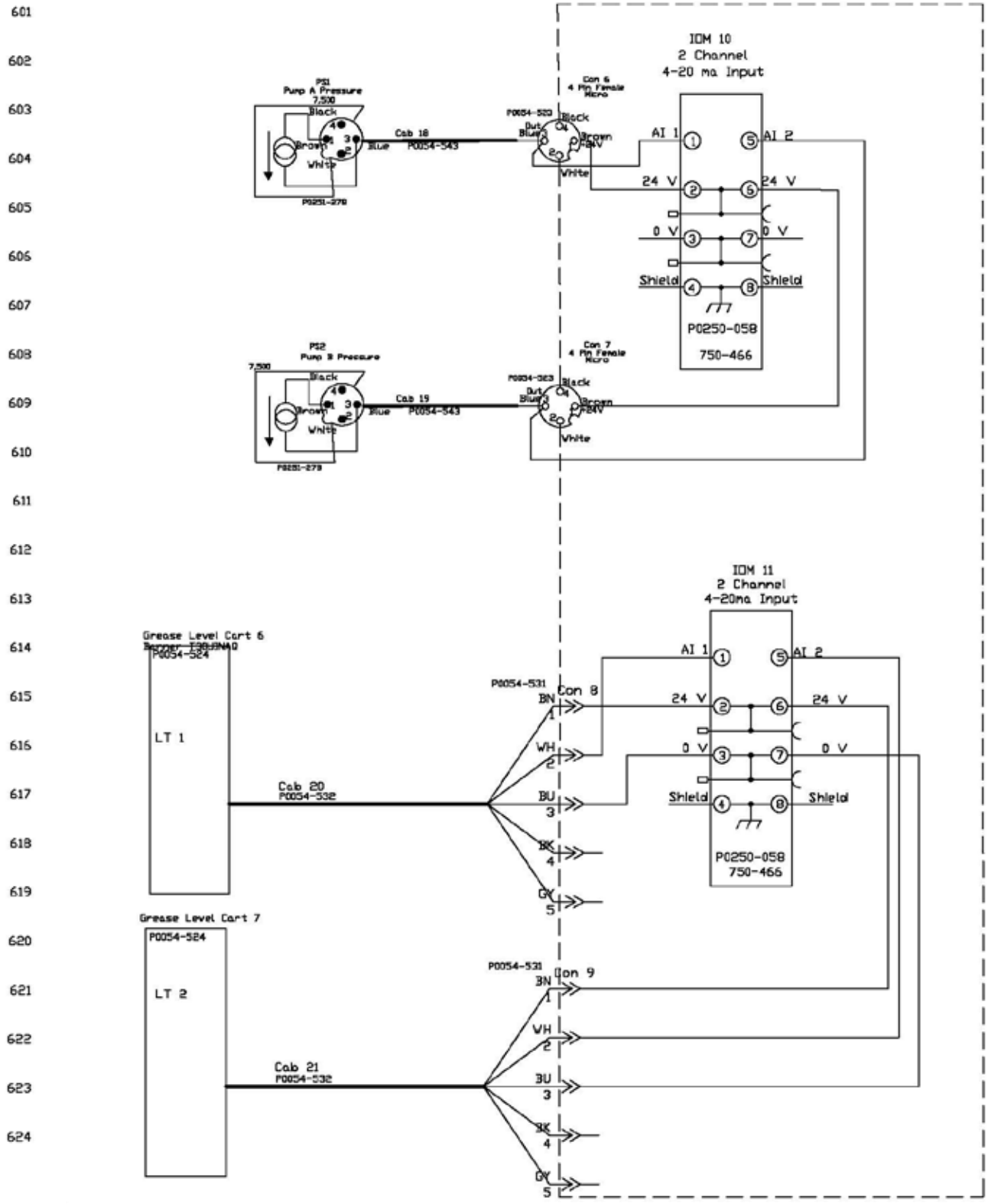
A13911A04


401
402
403
404
405
406
407
408
409
410
411
412
413
414
415
416
417
418
419
420
421
422
423
424
IOM 6
4 Channel
24V 4DI Lo-Sw
VFD Cirulation Pump Starter
MS3
13
14
Foam Control Power Contactor On
MC3
13
14
Skurry Control Box Power On
MC4
13
14
Front Transformer 1.5hp Overload
MS1
97
98
DI 1
DI 2
24 V
24 V
0 V
0 V
DI 3
DI 4
P0250-061
750-409
IOM 7
4 Channel
24V 4DI Lo-Sw
Rear Transformer 1.5 hp cooling Overload
MS2
97
98
VFD Circulation Pump Overload
MS3
97
98
DI 1
DI 2
24 V
24 V
0 V
0 V
DI 3
DI 4
P0250-061
750-409
616
Gas Detector Fault
Spare DI3

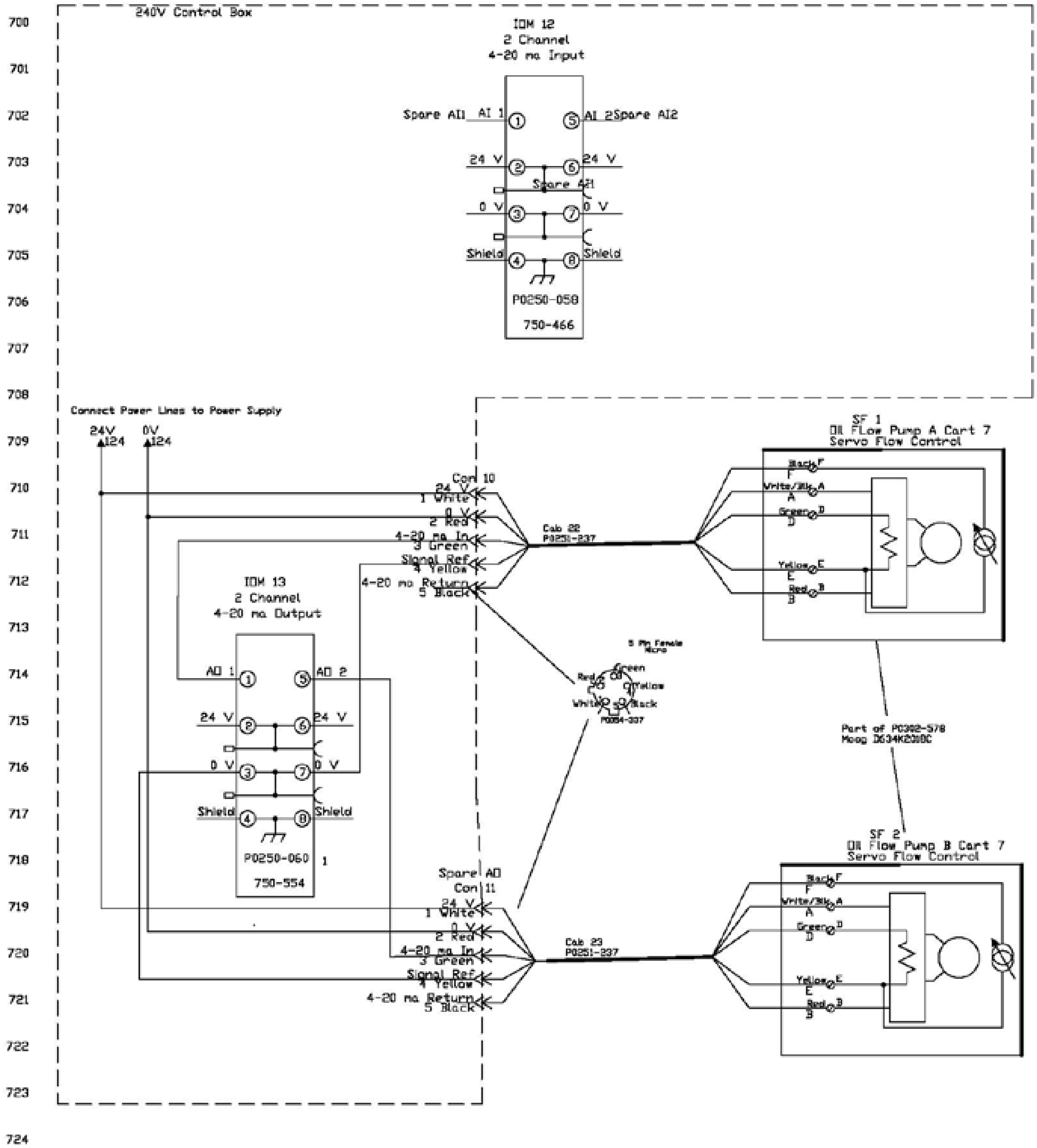
A13911A05


IDM 8
4 Channel
24V 4DI Lo-Sw
Spare DI 4
DI 1
DI 2
24 V
24 V
Spare DI 5
0 V
0 V
Spare DI 6
DI 3
DI 4
P0250-061
750-409
Spare DI 7
PT Cable
A11960A108
A1 B1 C1
GADD DDR2
P0310-928
A B C N G
110
N
110
120V Ph A
A B C N G
Gas Detector
A12150A03 305
Pilot Circuit
29
27
GADD DSP-DPS
A12449A
Red
5
N/C
White
5
A11960A1 102 +Pilot
Blue
2
IDM 9
2 Channel
4-20 ma Input
AI 1
AI 2
Gas Detector Fault
422
24 V
24 V
0 V
0 V
Shield
Shield
P0250-058
750-466
Cab 17
Red/Black
8
Red/Black
9
Con 5
Con
PWR
Black
4
Black
4
Out 4-20 ECHEM
White.Black
3
White/Black
3
Out 4-20 LEL
Orange
1
Orange
1
GND
Green
7
Green
7
Socket

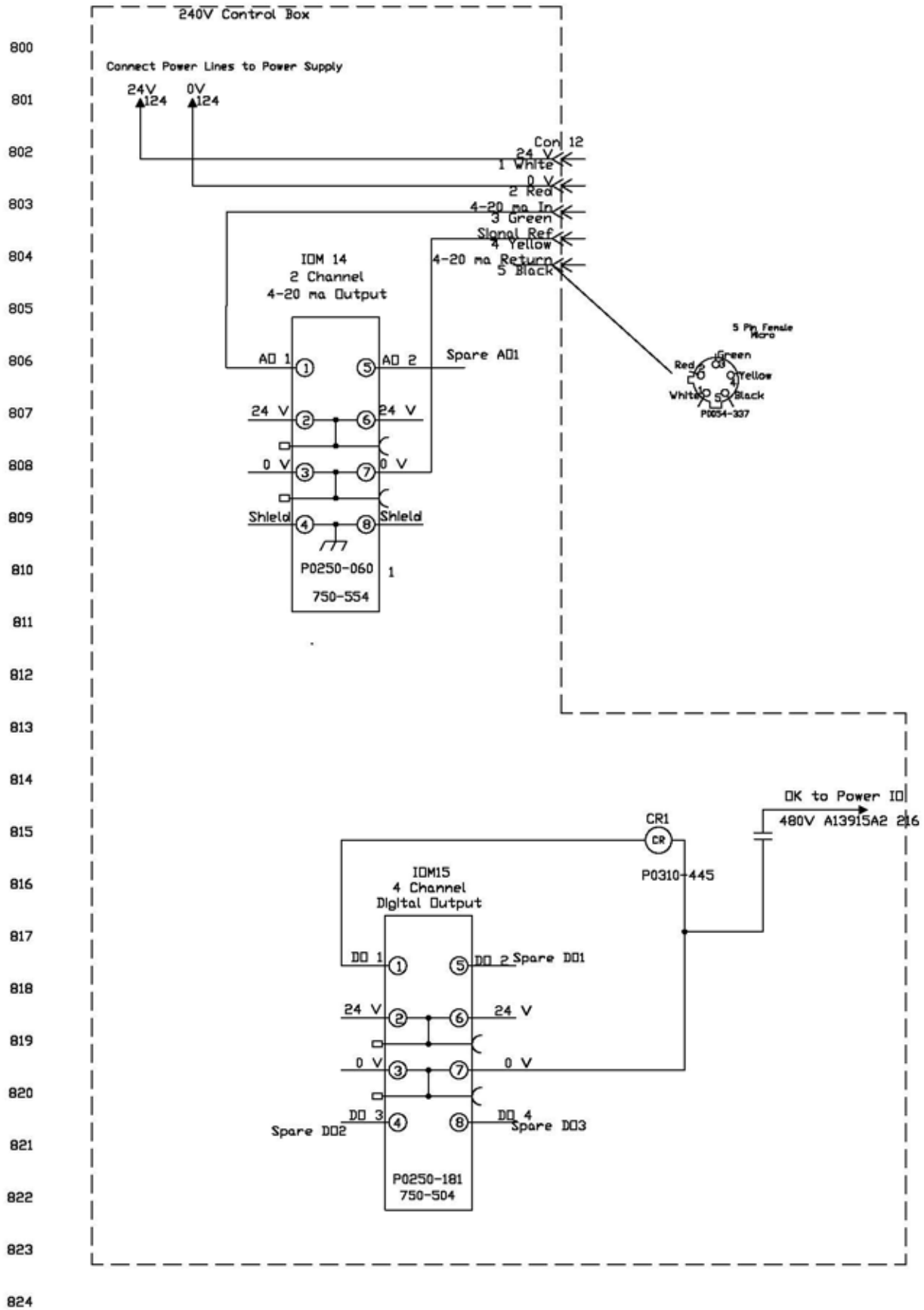
A13911A06


IOM 10
2 Channel
4-20 ma Input
PS1
Pump A Pressure
7,500
Black
Brown
White
Cab 18
P0054-543
Con 6
4 Pin Female
Micro
P0054-523
Black
Brown
White
AI 1
AI 2
24 V
0 V
Shield
P0250-058
750-466
PS2
Pump B Pressure
7,500
Cab 19
P0054-543
Con 7
4 Pin Female
Micro
P0054-523
IOM 11
2 Channel
4-20ma Input
Grease Level Cart 6
P0054-524
LT 1
Cab 20
P0054-532
P0054-531
Con 8
BN
WH
BU
BK
GY
Grease Level Cart 7
P0054-524
LT 2
Cab 21
P0054-532
P0054-531
Con 9

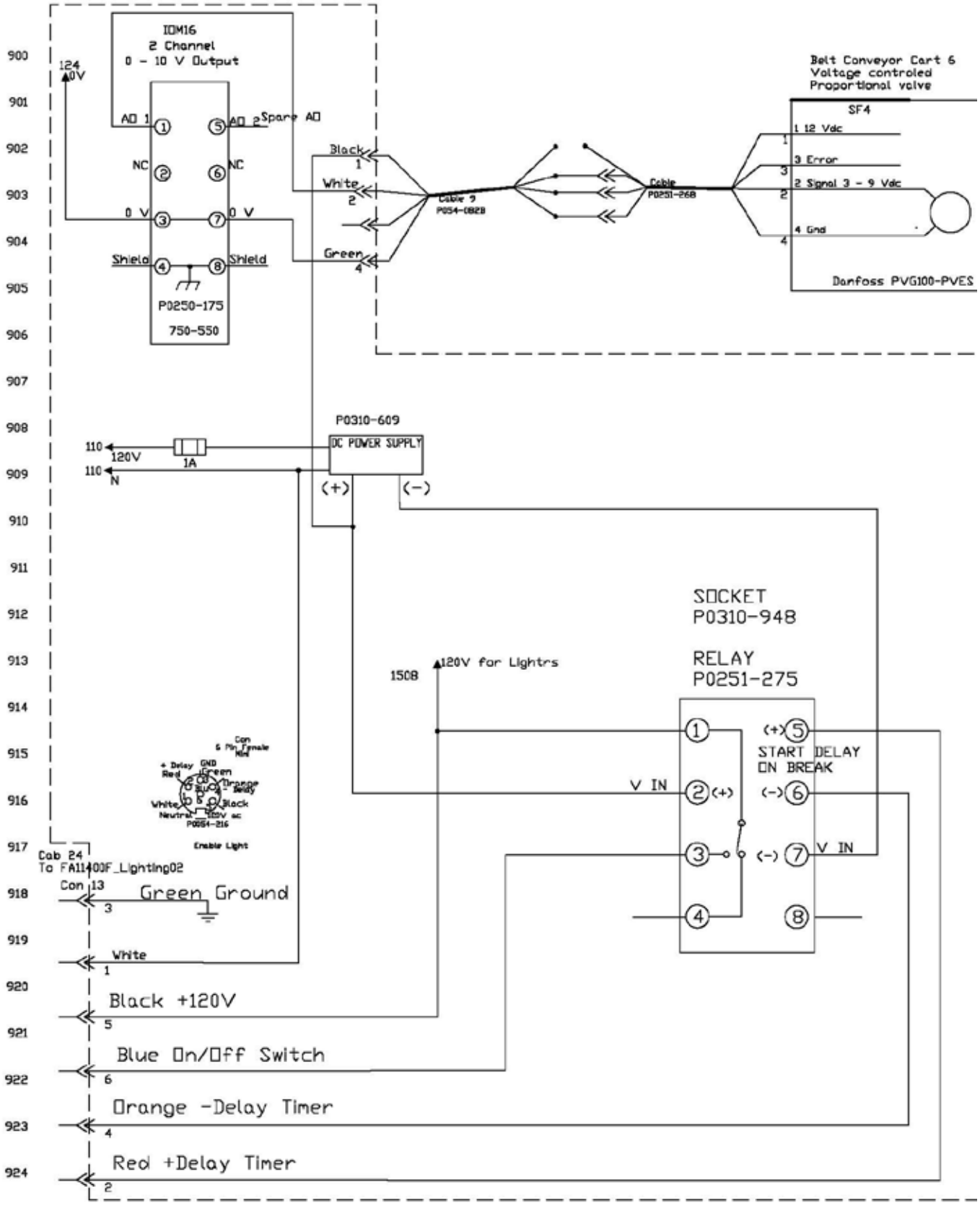
A13911A07


240V Control Box
IOM 12
2 Channel
4-20 ma Input
Spare AI1
AI 1
AI 2
Spare AI2
24 V
Spare AI1
0 V
Shield
P0250-058
750-466
Connect Power Lines to Power Supply
24V
0V
124
Con 10
24 V
1 White
0 V
2 Red
4-20 ma In
3 Green
Signal Ref
4 Yellow
4-20 ma Return
5 Black
Cab 22
P0251-237
SF 1
Oil Flow Pump A Cart 7
Servo Flow Control
Black
White/Blk
Green
Yellow
Red
IOM 13
2 Channel
4-20 ma Output
AO 1
AO 2
P0250-060
750-554
5 Pin Female
Micro
Part of P0302-578
Moog D634K2010C
SF 2
Oil Flow Pump B Cart 7
Servo Flow Control
Spare AO
Con 11
Cab 23
P0251-237

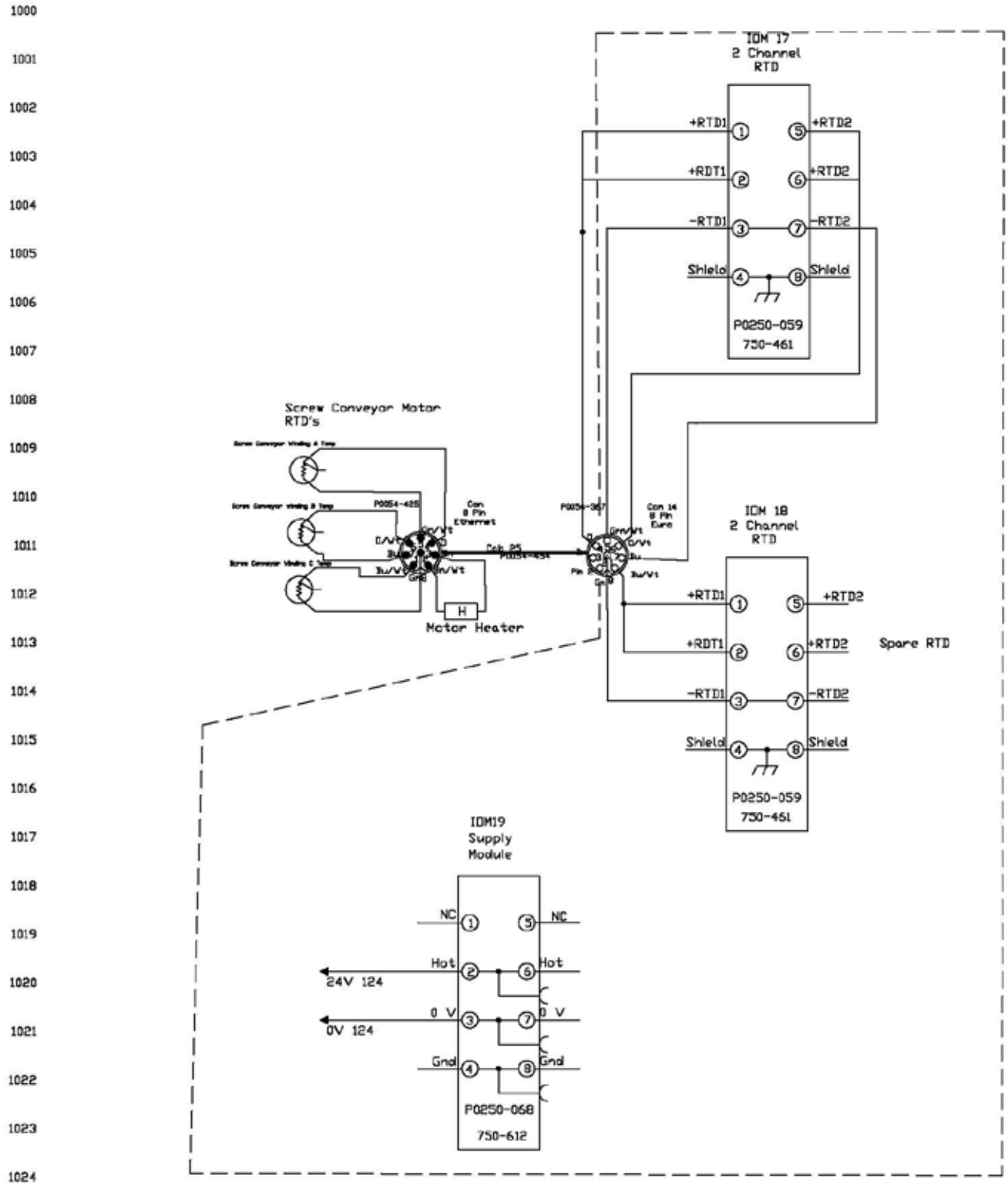
A13911A08


240V Control Box
Connect Power Lines to Power Supply
24V 124
0V 124
Con 12
24 V 1 White
0 V 2 Red
4-20 ma In 3 Green
Signal Ref 4 Yellow
4-20 ma Return 5 Black
IOM 14
2 Channel
4-20 ma Output
AO 1
AO 2
Spare AO1
24 V
0 V
Shield
P0250-060
750-554
5 Pin Female Micro
Red
Green
Yellow
White
Black
P0054-337
OK to Power IO
480V A13915A2 216
CR1
CR
P0310-445
IOM15
4 Channel
Digital Output
DO 1
DO 2 Spare DO1
DO 3 Spare DO2
DO 4 Spare DO3
P0250-181
750-504

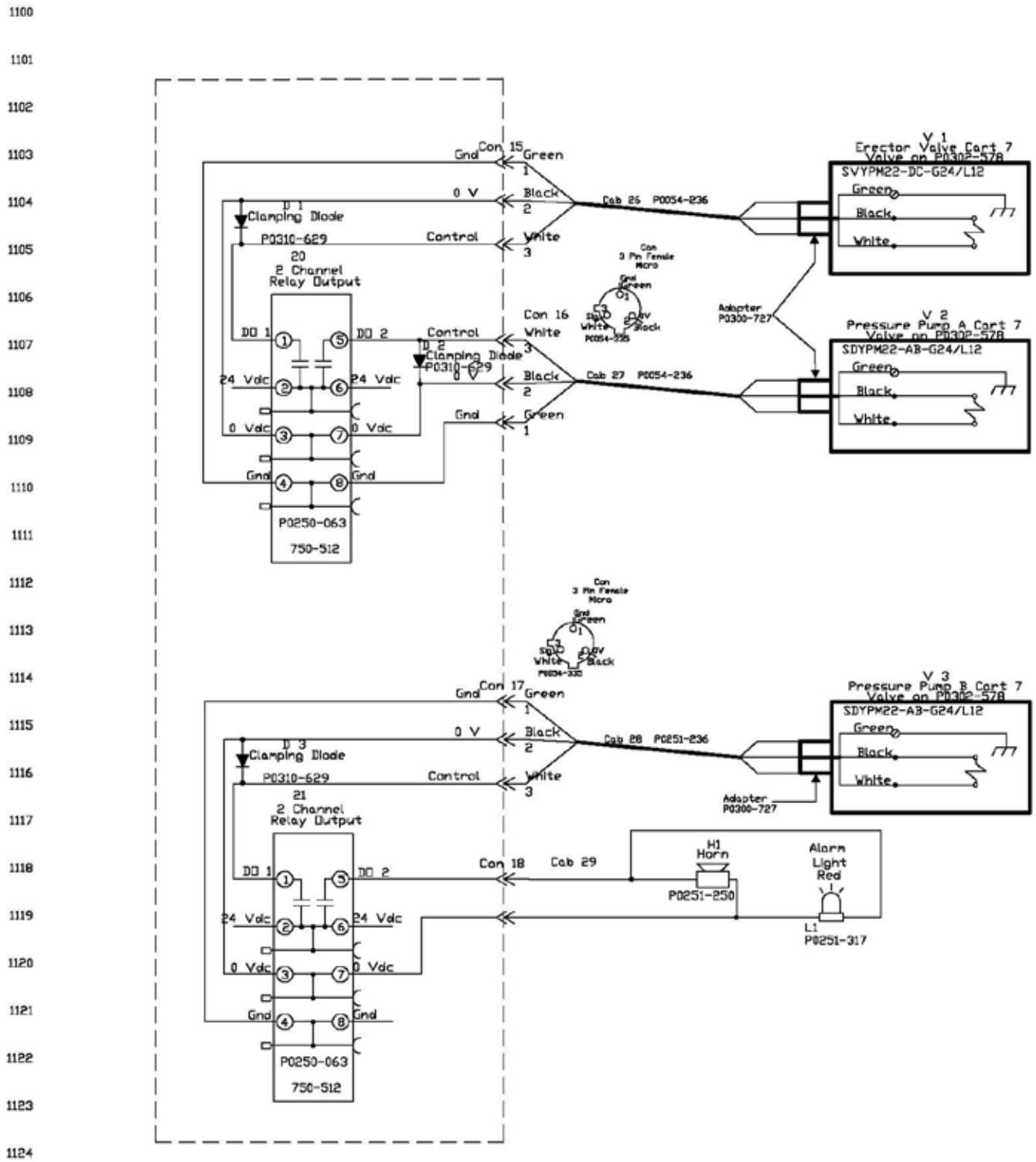
A13911A09


IOM16
2 Channel
0 - 10 V Output
124
0V
AO 1
AO 2
Spare AO
NC
NC
0 V
0 V
Shield
Shield
P0250-175
750-550
Black
White
Green
Cable 9
P054-0828
Cable
P0251-268
Belt Conveyor Cart 6
Voltage controled
Proportional valve
SF4
1 12 Vdc
3 Error
2 Signal 3 - 9 Vdc
4 Gnd
Danfoss PVG100-PVES
P0310-609
DC POWER SUPPLY
110
120V
1A
110
N
(+)
(-)
SOCKET
P0310-948
RELAY
P0251-275
120V for Lightrs
150B
START DELAY
ON BREAK
V IN
V IN
Cab 24
To FA11403F_Lighting02
Con 13
Green Ground
White
Black +120V
Blue On/Off Switch
Orange -Delay Timer
Red +Delay Timer

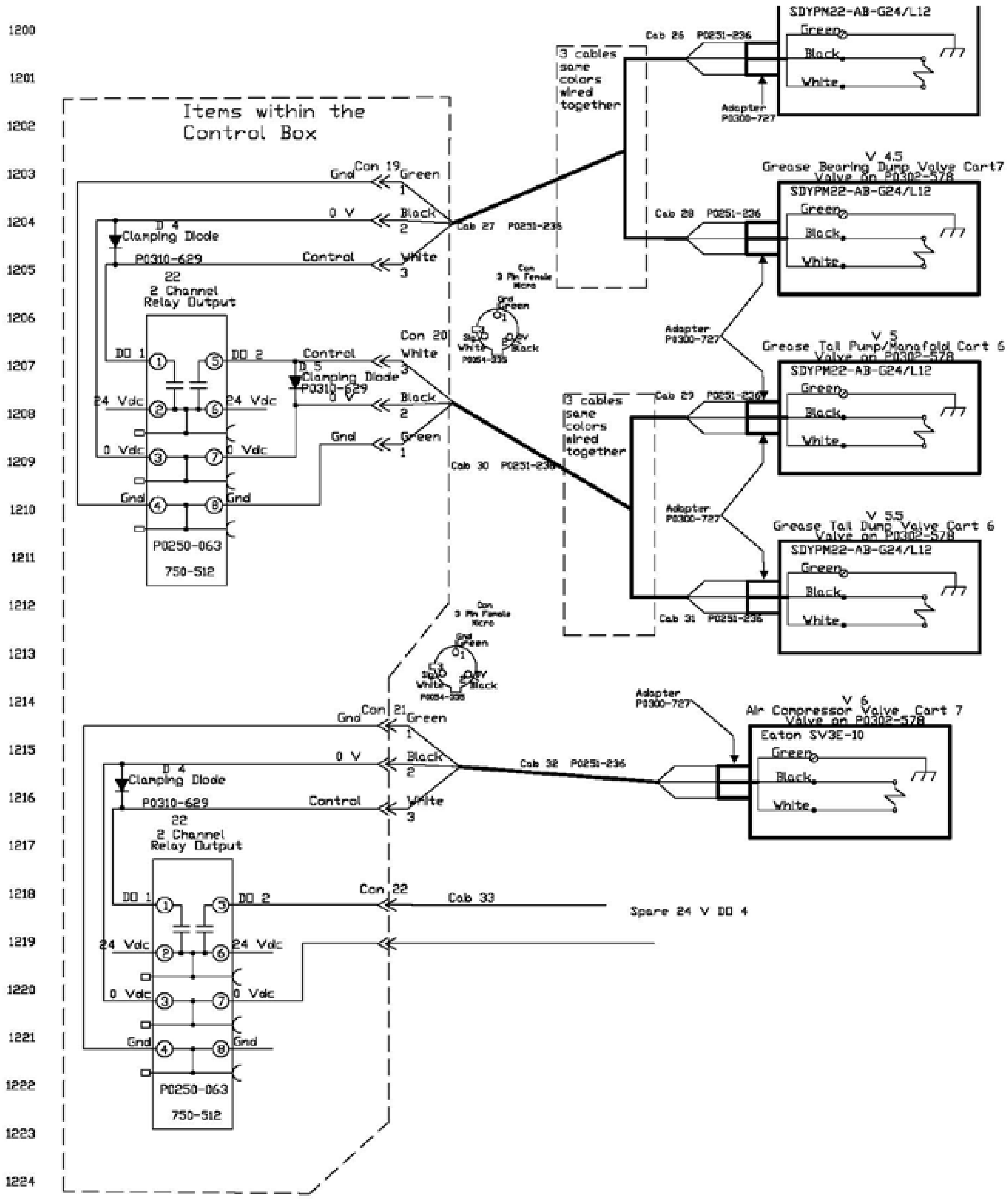
A13911A10


IDM 17
2 Channel
RTD
+RTD1
+RDT1
-RTD1
Shield
+RTD2
+RTD2
-RTD2
Shield
P0250-059
750-461
Screw Conveyor Motor
RTD's
Con
8 Pin
Ethernet
Con 14
8 Pin
Euro
H
Motor Heater
IDM 18
2 Channel
RTD
+RTD1
+RDT1
-RTD1
Shield
+RTD2
+RTD2
-RTD2
Shield
Spare RTD
P0250-059
750-461
IDM19
Supply
Module
NC
Hot
0 V
Gnd
NC
Hot
0 V
Gnd
24V 124
0V 124
P0250-068
750-612

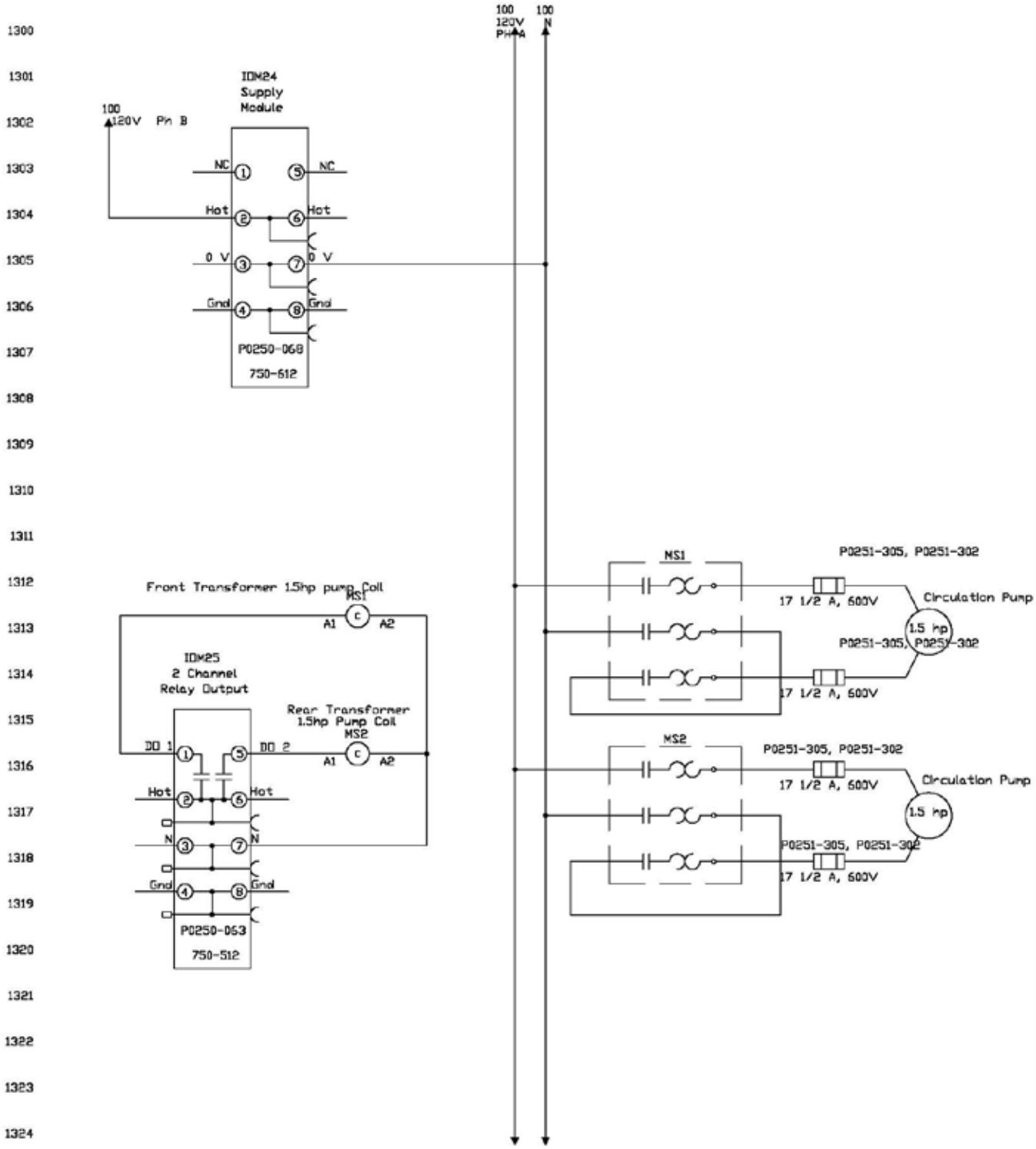
A13911A11


Con 15
Gnd
Green
1
0 V
Black
2
Control
White
3
D 1
Clamping Diode
P0310-629
20
2 Channel
Relay Output
DO 1
DO 2
24 Vdc
24 Vdc
0 Vdc
0 Vdc
Gnd
Gnd
P0250-063
750-512
Cab 25 P0054-236
V 1
Erector Valve Cart 7
Valve on P0302-578
SVYPM22-DC-G24/L12
Green
Black
White
Con
3 Pin Female
Micro
Gnd
Green
1
Sig
White
2
+24V
Black
3
P0054-335
Adapter
P0300-727
Con 16
Control
White
3
D 2
Clamping Diode
P0310-629
Black
2
Gnd
Green
1
Cab 27 P0054-236
V 2
Pressure Pump A Cart 7
Valve on P0302-578
SDYPM22-AB-G24/L12
Green
Black
White
Con 17
Gnd
Green
1
0 V
Black
2
Control
White
3
D 3
Clamping Diode
P0310-629
21
2 Channel
Relay Output
DO 1
DO 2
24 Vdc
24 Vdc
0 Vdc
0 Vdc
Gnd
Gnd
P0250-063
750-512
Cab 28 P0251-236
V 3
Pressure Pump B Cart 7
Valve on P0302-578
SDYPM22-AB-G24/L12
Green
Black
White
Adapter
P0300-727
Con 18
Cab 29
H1
Horn
P0251-250
Alarm
Light
Red
L1
P0251-317

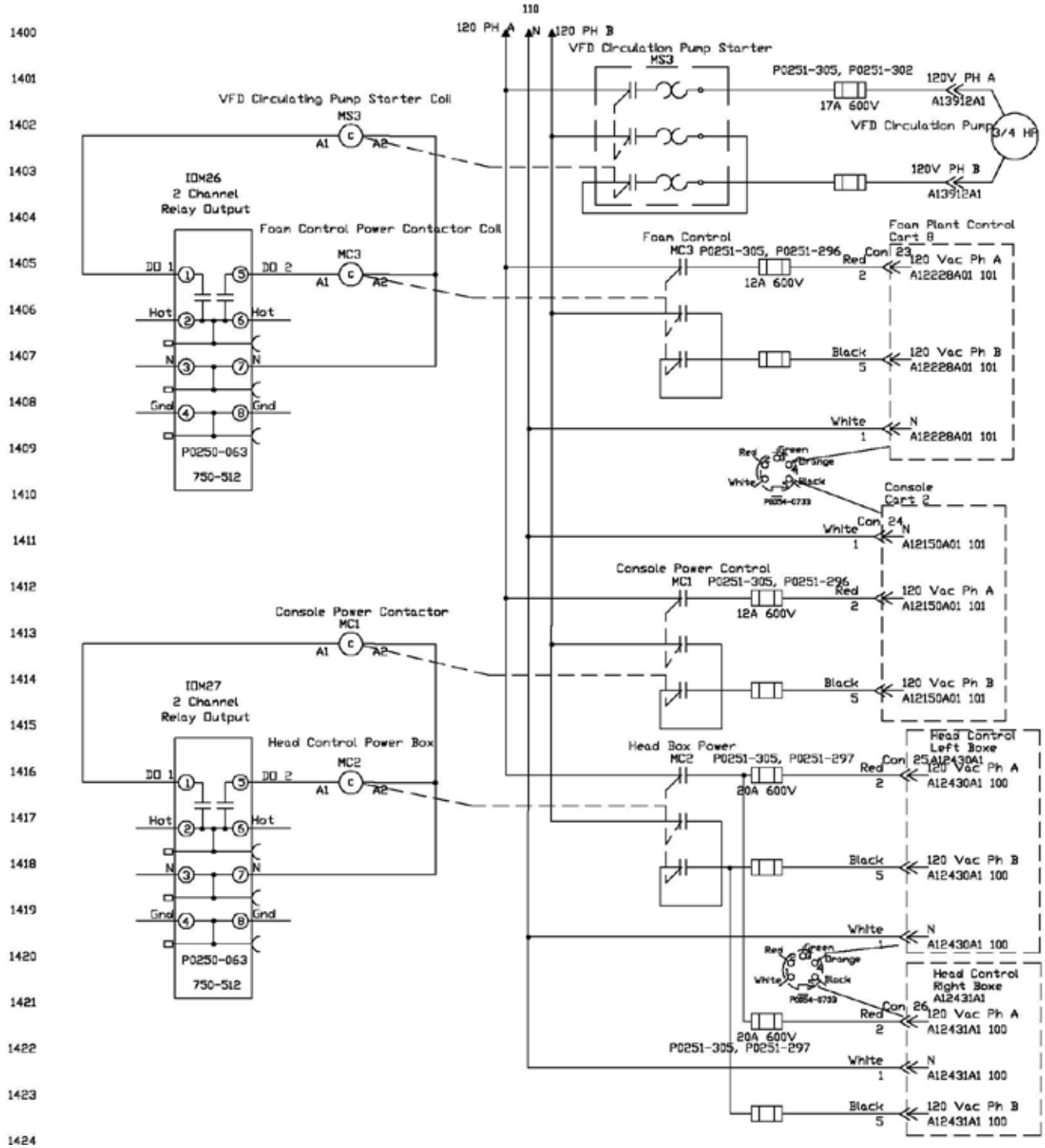
A13911A12


1200
1201
1202
1203
1204
1205
1206
1207
1208
1209
1210
1211
1212
1213
1214
1215
1216
1217
1218
1219
1220
1221
1222
1223
1224
Items within the Control Box
Con 19
Gnd
Green
1
0 V
Black
2
D 4
Clamping Diode
P0310-629
Control
White
3
22
2 Channel
Relay Output
DO 1
DO 2
24 Vdc
0 Vdc
Gnd
P0250-063
750-512
Con 20
D 5
Clamping Diode
P0310-629
Cab 27 P0251-236
Cab 30 P0251-236
3 cables same colors wired together
Cab 26 P0251-236
SDYPM22-AB-G24/L12
Adapter
P0300-727
V 4.5
Grease Bearing Dump Valve Cart7
Valve on P0302-578
Cab 28 P0251-236
Con
3 Pin Female
Micro
P0054-335
V 5
Grease Tail Pump/Manafold Cart 6
Valve on P0302-578
Cab 29 P0251-236
V 5.5
Grease Tail Dump Valve Cart 6
Valve on P0302-578
Cab 31 P0251-236
Con 21
Cab 32 P0251-236
V 6
Air Compressor Valve Cart 7
Valve on P0302-578
Eaton SV3E-10
Con 22
Cab 33
Spare 24 V DO 4

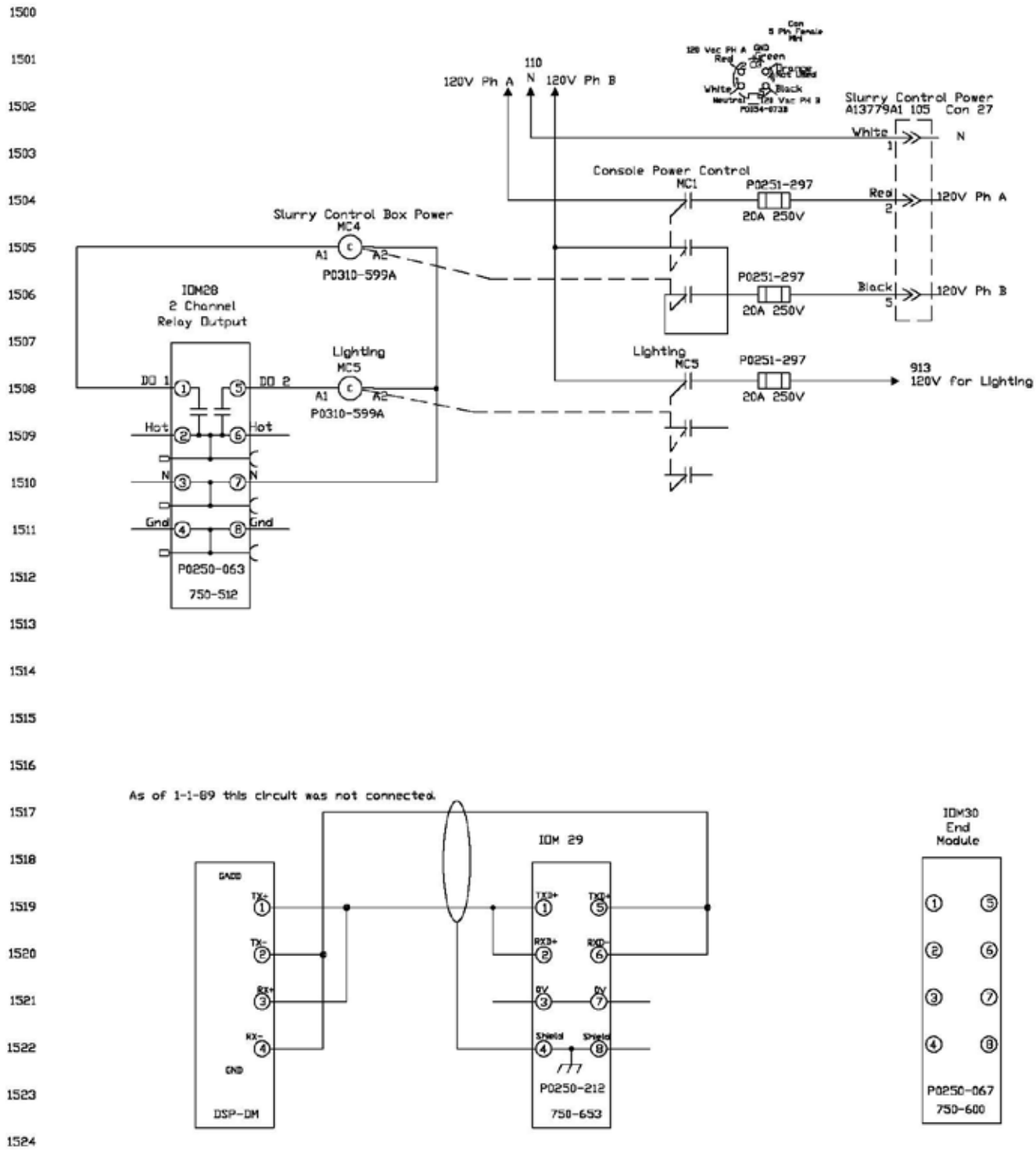
A13911A13


1300
1301
1302
1303
1304
1305
1306
1307
1308
1309
1310
1311
1312
1313
1314
1315
1316
1317
1318
1319
1320
1321
1322
1323
1324
100
120V
PH A
100
N
IDM24
Supply
Module
100
120V Ph B
NC
Hot
0 V
Gnd
P0250-068
750-612
Front Transformer 1.5hp pump Coil
MS1
A1
A2
IDM25
2 Channel
Relay Output
Rear Transformer
1.5hp Pump Coil
MS2
DO 1
DO 2
N
P0250-053
750-512
P0251-305, P0251-302
17 1/2 A, 600V
Circulation Pump
1.5 hp

A13911A14

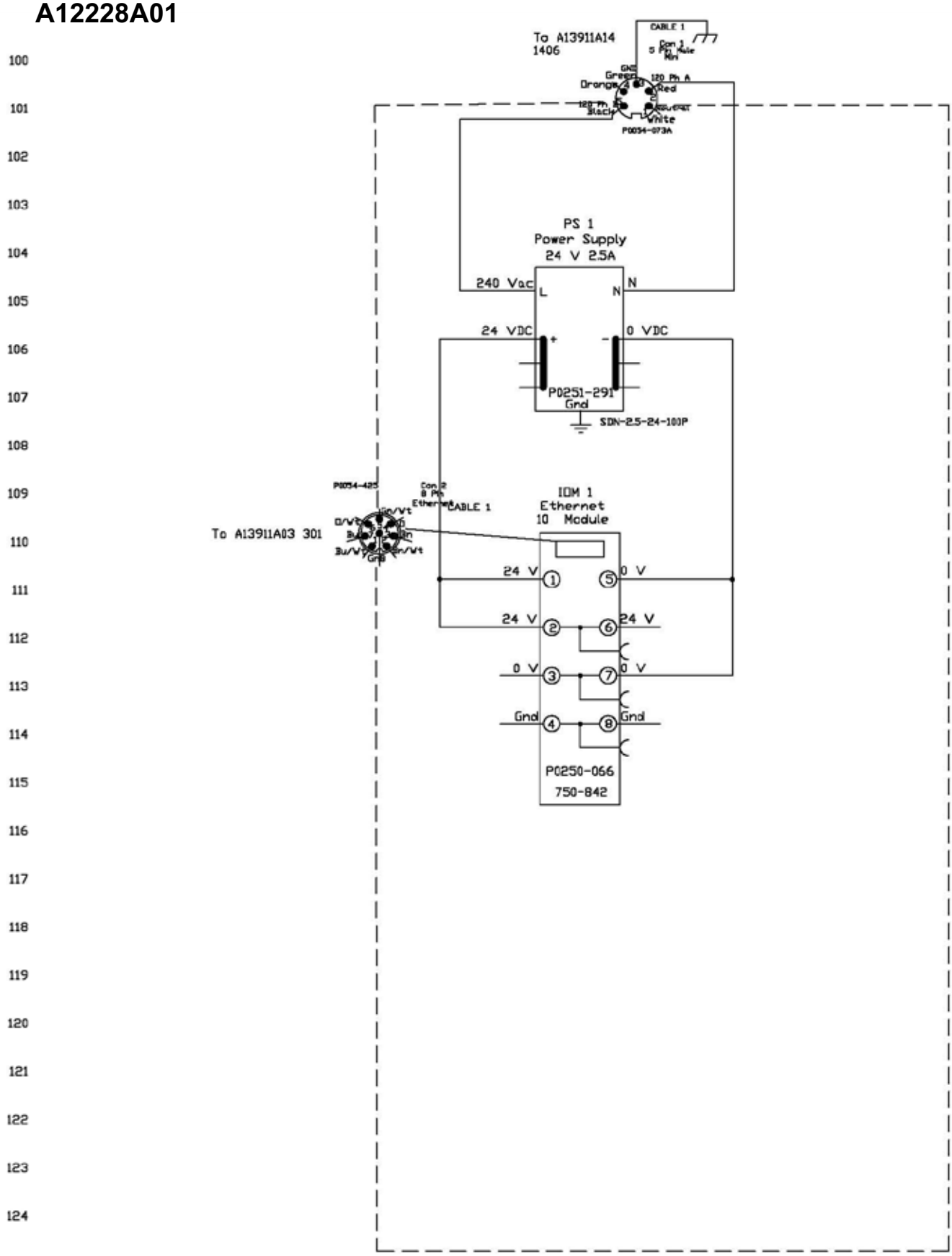

110
120 PH A
N
120 PH B
VFD Circulation Pump Starter
MS3
P0251-305, P0251-302
120V PH A
17A 600V
A13912A1
VFD Circulation Pump
3/4 HP
120V PH B
A13912A1
VFD Circulating Pump Starter Coil
MS3
A1
A2
IOM26
2 Channel
Relay Output
Foam Control Power Contactor Coil
MC3
DO 1
DO 2
Hot
N
Gnd
P0250-063
750-512
Foam Control
MC3 P0251-305, P0251-296
12A 600V
Foam Plant Control
Cart B
Con 23
Red
2
120 Vac Ph A
A12228A01 101
Black
5
120 Vac Ph B
A12228A01 101
White
1
N
A12228A01 101
Red
Green or Orange
White
Black
P0254-6733
Console
Cart 2
Con 24
White
1
N
A12150A01 101
Console Power Control
MC1 P0251-305, P0251-296
12A 600V
Red
2
120 Vac Ph A
A12150A01 101
Console Power Contactor
MC1
Black
5
120 Vac Ph B
A12150A01 101
IOM27
2 Channel
Relay Output
Head Control Power Box
MC2
Head Box Power
MC2 P0251-305, P0251-297
20A 600V
Head Control
Left Boxe
A12430A1
Con 25
Red
2
120 Vac Ph A
A12430A1 100
Black
5
120 Vac Ph B
A12430A1 100
White
1
N
A12430A1 100
Head Control
Right Boxe
A12431A1
Con 26
Red
2
120 Vac Ph A
A12431A1 100
20A 600V
P0251-305, P0251-297
White
1
N
A12431A1 100
Black
5
120 Vac Ph B
A12431A1 100

A13911A15

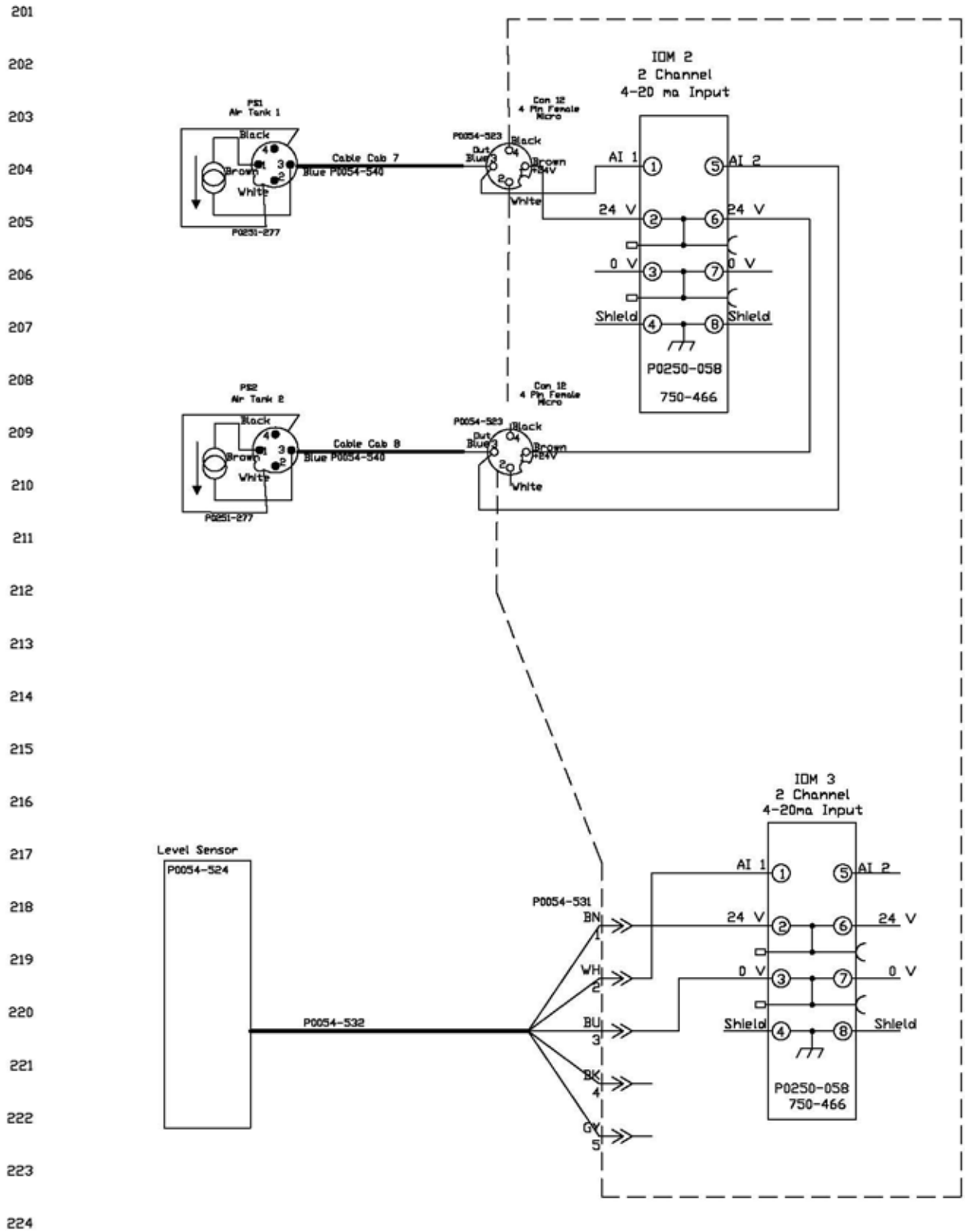

120V Ph A
110
N
120V Ph B
Slurry Control Power
A13779A1 105 Con 27
White
N
Console Power Control
MC1
P0251-297
20A 250V
Red
120V Ph A
Slurry Control Box Power
MC4
A1
A2
P0310-599A
P0251-297
20A 250V
Black
120V Ph B
IDM28
2 Channel
Relay Output
Lighting
MC5
Lighting
MC5
P0251-297
20A 250V
913
120V for Lighting
DO 1
DO 2
Hot
Hot
N
N
Gnd
Gnd
P0250-063
750-512
As of 1-1-89 this circuit was not connected.
IDM 29
IDM30
End
Module
DSP-DM
P0250-212
750-653
P0250-067
750-600

ELECTRICAL SCHEMATICS - FOAM PLANT CONTROL

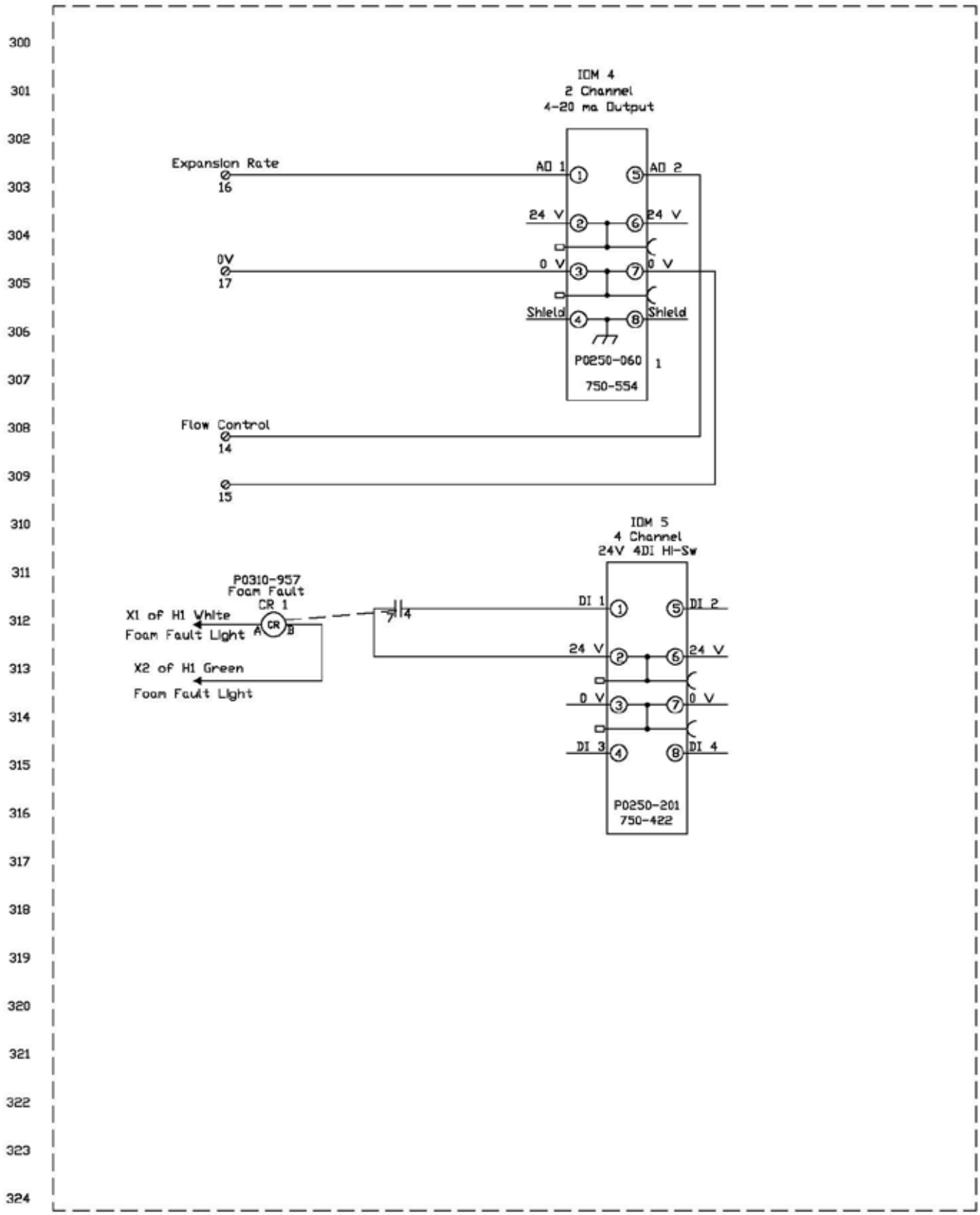
A12228A01



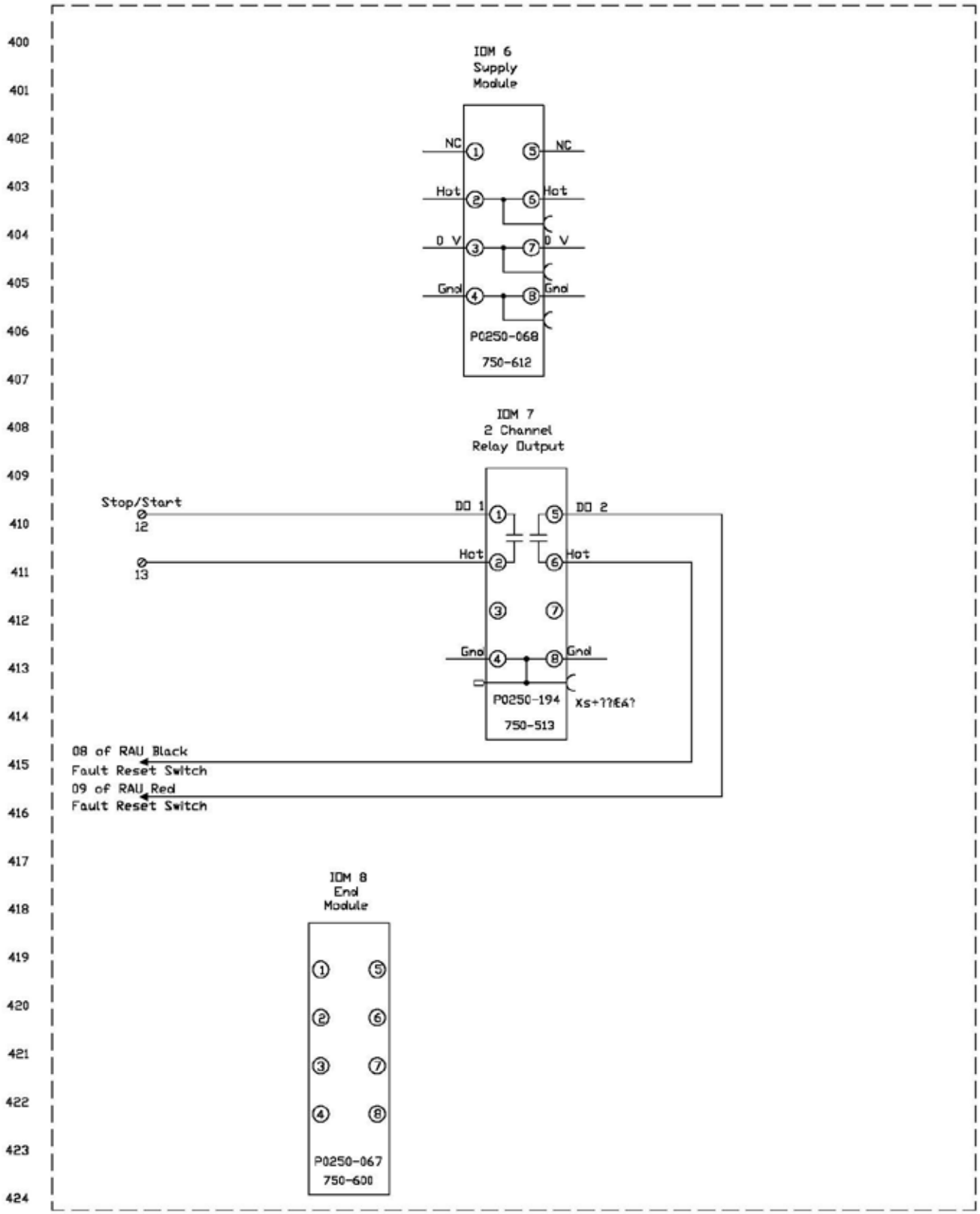
A12228A02


IDM 2
2 Channel
4-20 ma Input
PS1
Air Tank 1
Black
Brown
White
P0251-277
Cable Cab 7
Blue P0054-540
P0054-523
Con 12
4 Pin Female
Micro
Black
Brown +24V
White
AI 1
AI 2
24 V
0 V
Shield
P0250-058
750-466
PS2
Air Tank 2
Cable Cab 8
IDM 3
2 Channel
4-20ma Input
Level Sensor
P0054-524
P0054-532
P0054-531
BN
WH
BU
BK
GY

A12228A03

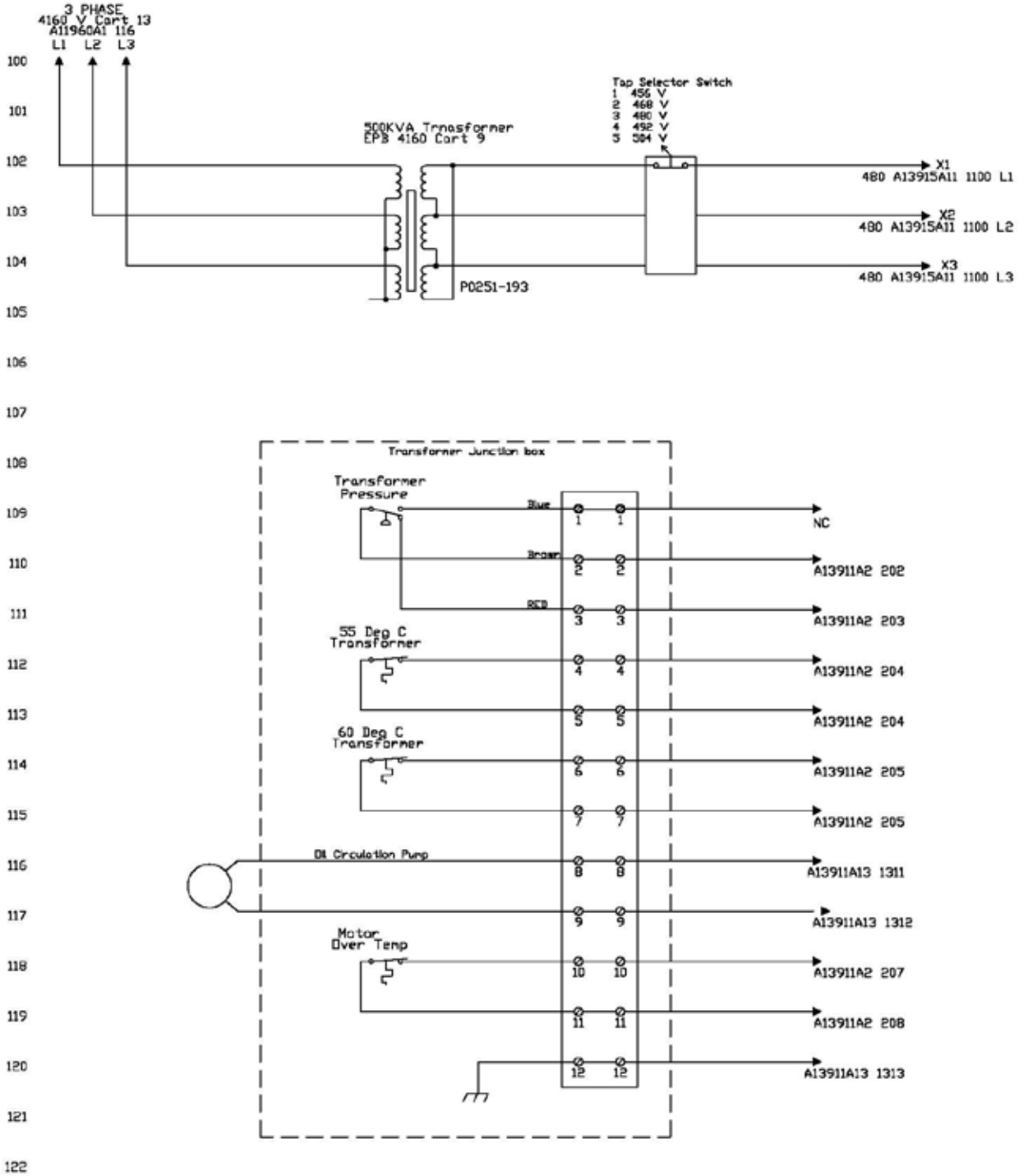

IOM 4
2 Channel
4-20 ma Output
Expansion Rate
16
AO 1
AO 2
24 V
24 V
0V
17
0 V
0 V
Shield
Shield
P0250-060
750-554
Flow Control
14
15
IOM 5
4 Channel
24V 4DI HI-Sw
P0310-957
Foam Fault
CR 1
X1 of H1 White
Foam Fault Light
X2 of H1 Green
Foam Fault Light
DI 1
DI 2
24 V
24 V
0 V
0 V
DI 3
DI 4
P0250-201
750-422

A12228A04


IDM 6
Supply
Module
NC
Hot
0 V
Gnd
P0250-068
750-612
IDM 7
2 Channel
Relay Output
Stop/Start
12
13
DO 1
DO 2
Hot
Gnd
P0250-194
750-513
08 of RAU Black
Fault Reset Switch
09 of RAU Red
Fault Reset Switch
IDM 8
End
Module
P0250-067
750-600

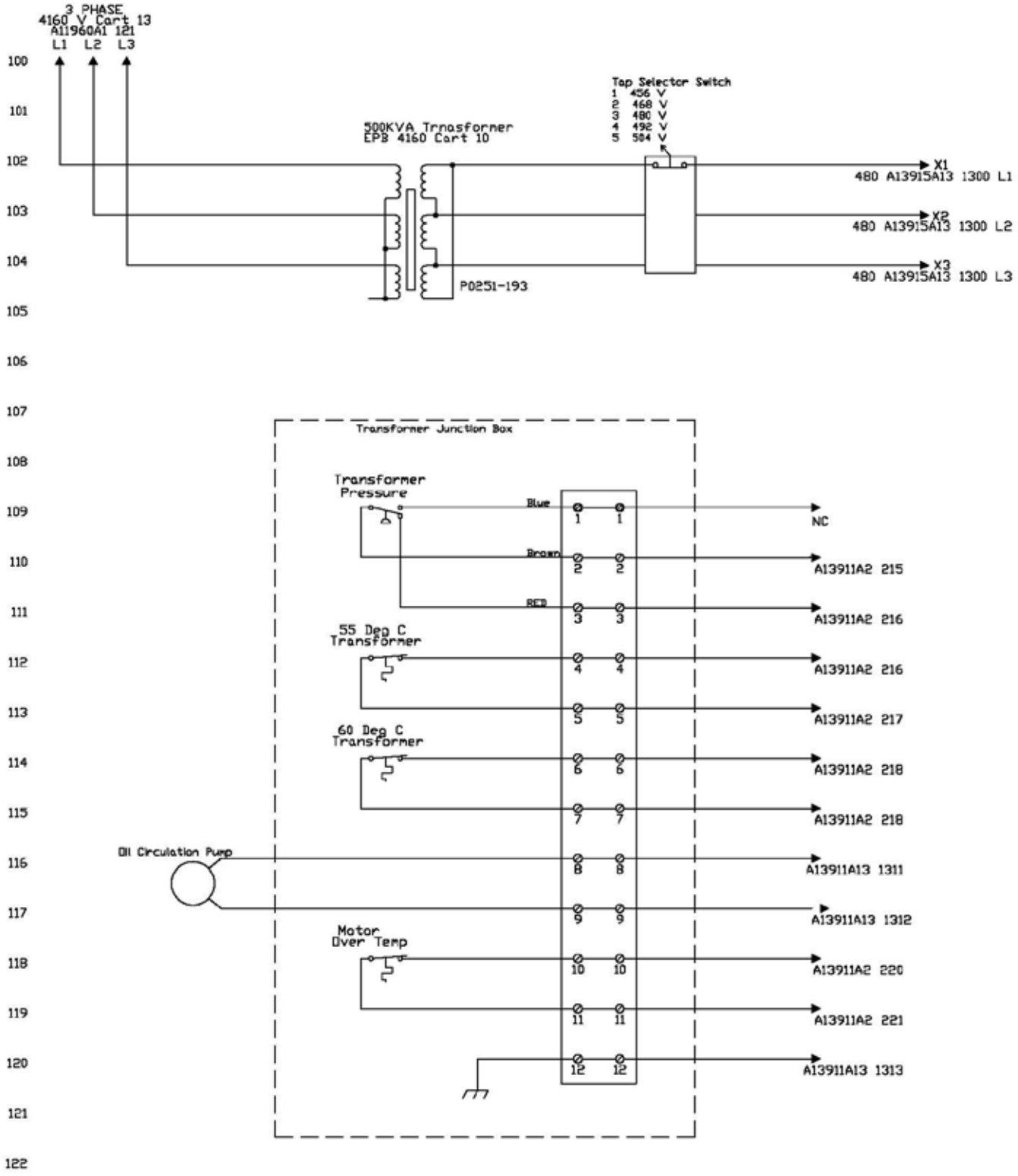
ELECTRICAL SCHEMATICS - FRONT 4160 TRANSFORMER

A13917A1



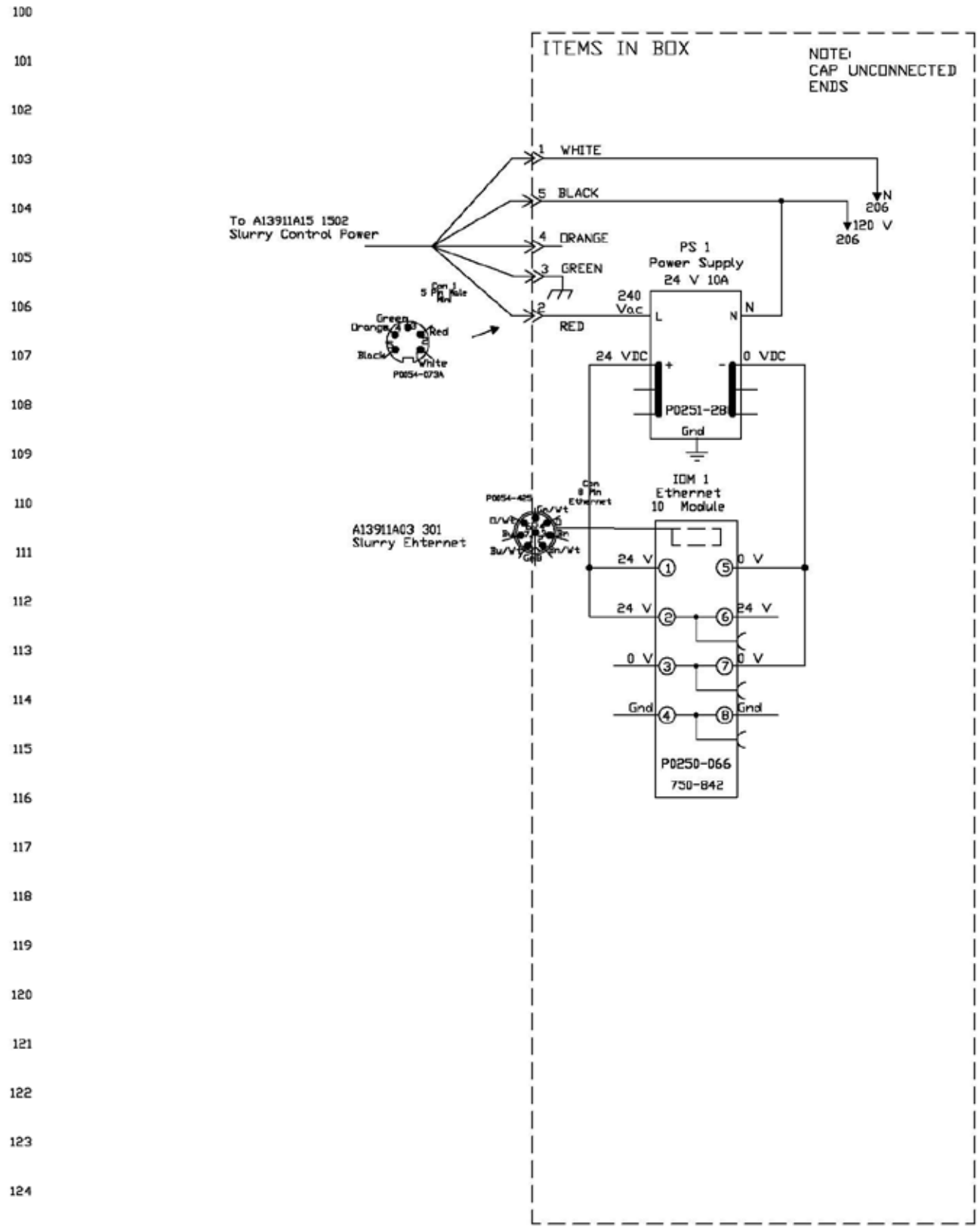
ELECTRICAL SCHEMATICS - REAR 4160 TRANSFORMER

A13918A1

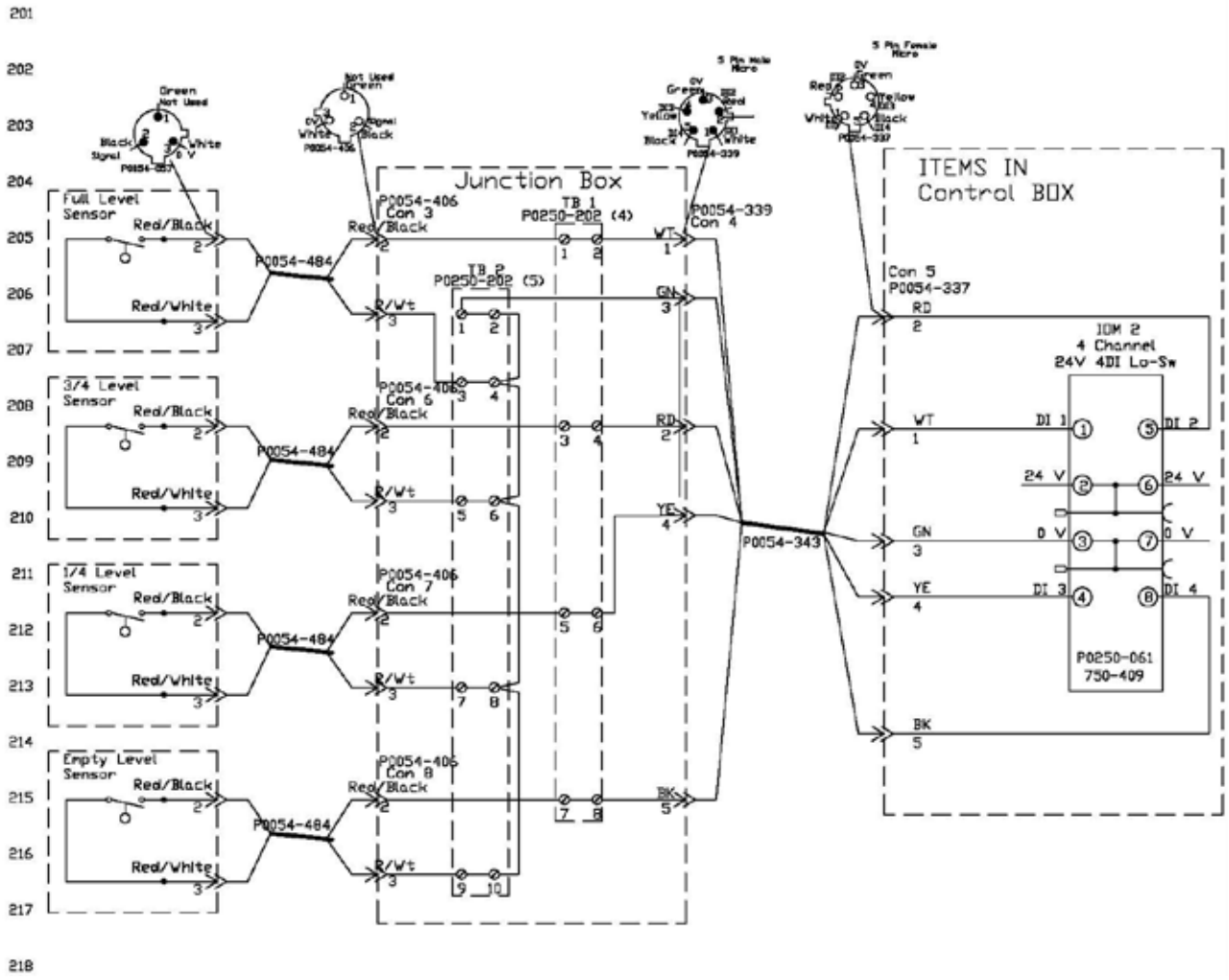


ELECTRICAL SCHEMATICS - SLURRY CONTROL

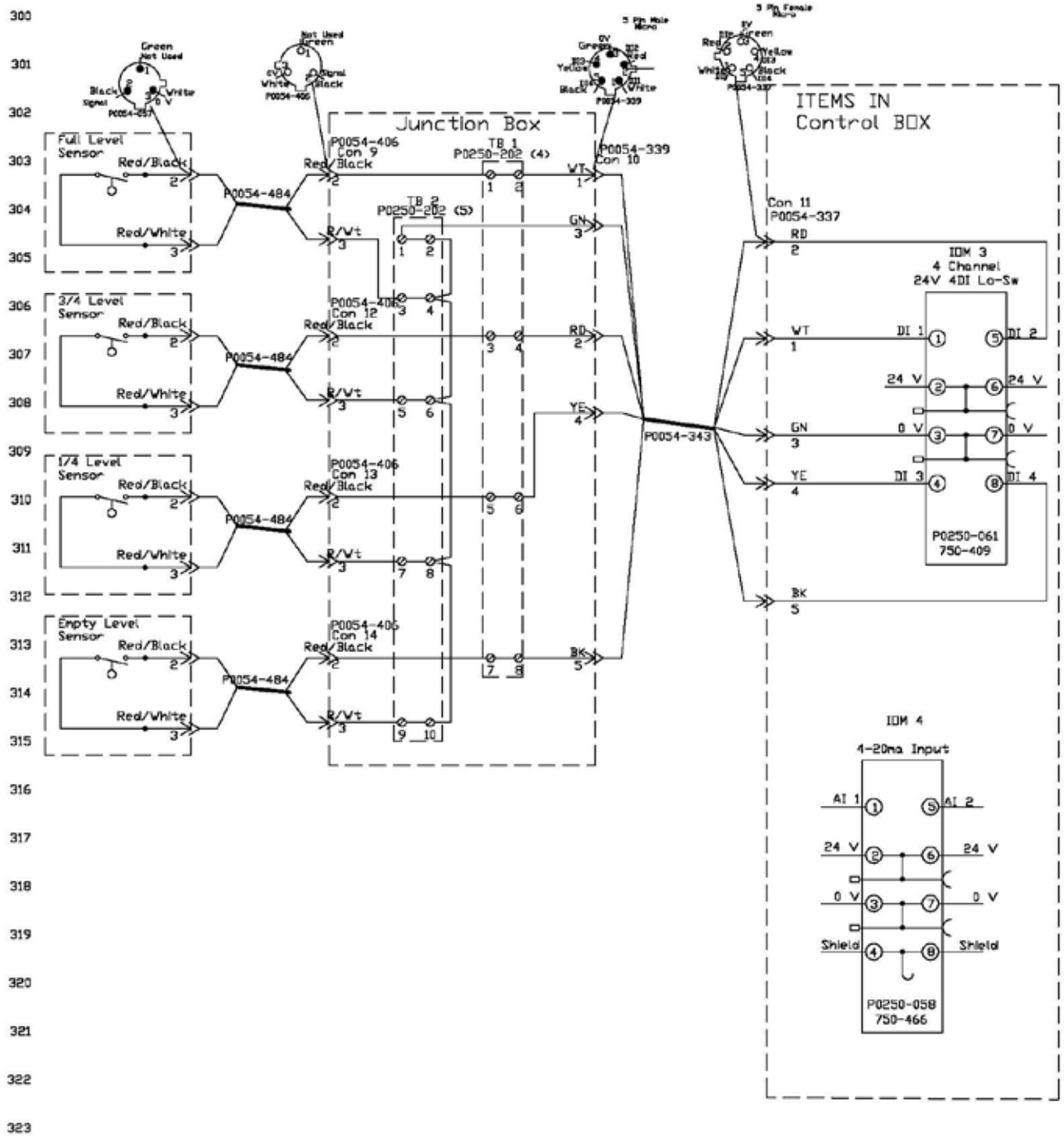
A13779A01



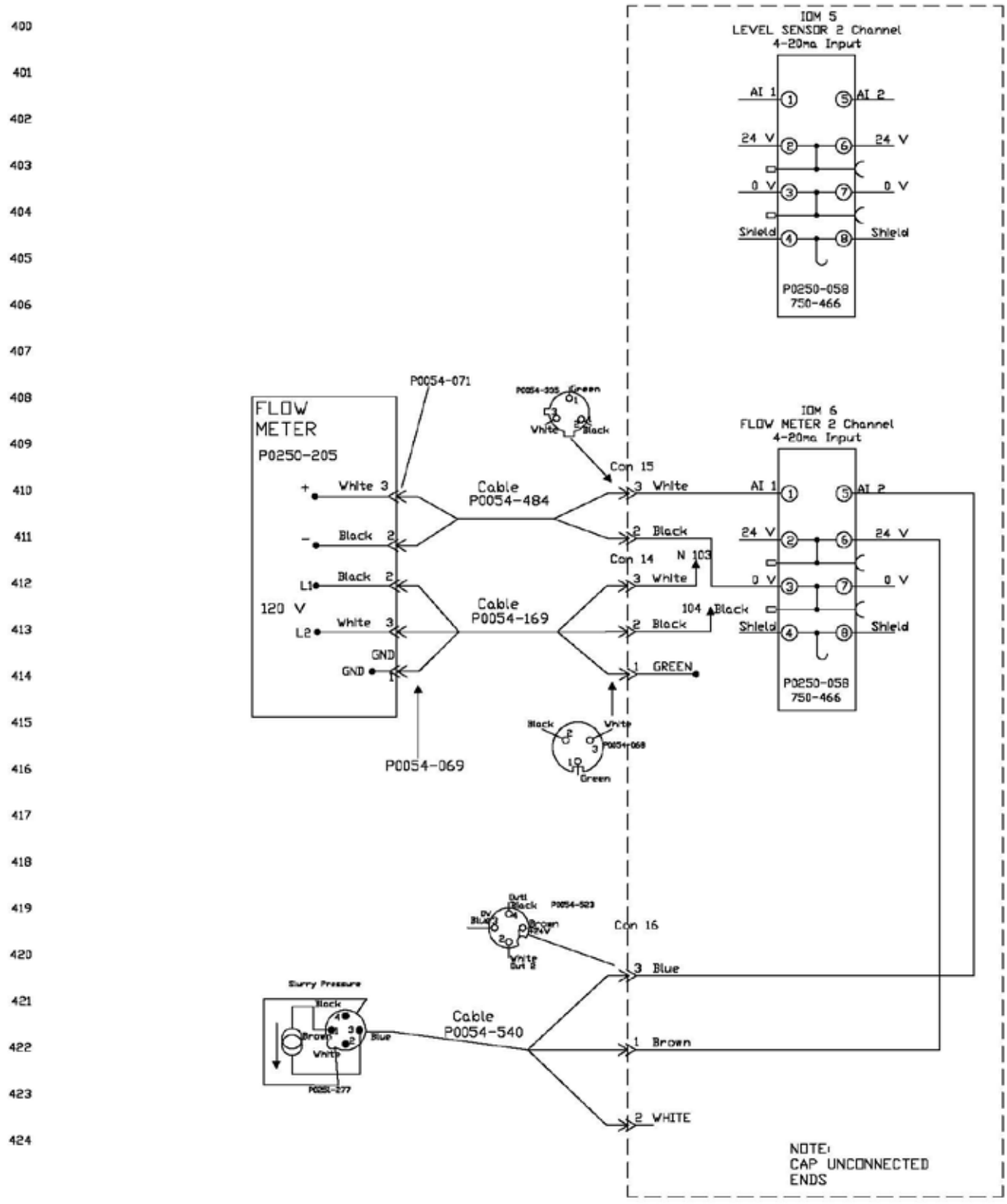
A13779A02


Junction Box
ITEMS IN
Control BOX
Full Level
Sensor
3/4 Level
Sensor
1/4 Level
Sensor
Empty Level
Sensor
Red/Black
Red/White
P0054-484
P0054-406
Con 3
Con 6
Con 7
Con 8
TB 1
P0250-202 (4)
TB 2
P0250-202 (5)
P0054-339
Con 4
P0054-343
Con 5
P0054-337
IDM 2
4 Channel
24V 4DI Lo-Sw
P0250-061
750-409
WT
RD
GN
YE
BK
DI 1
DI 2
DI 3
DI 4
24 V
0 V

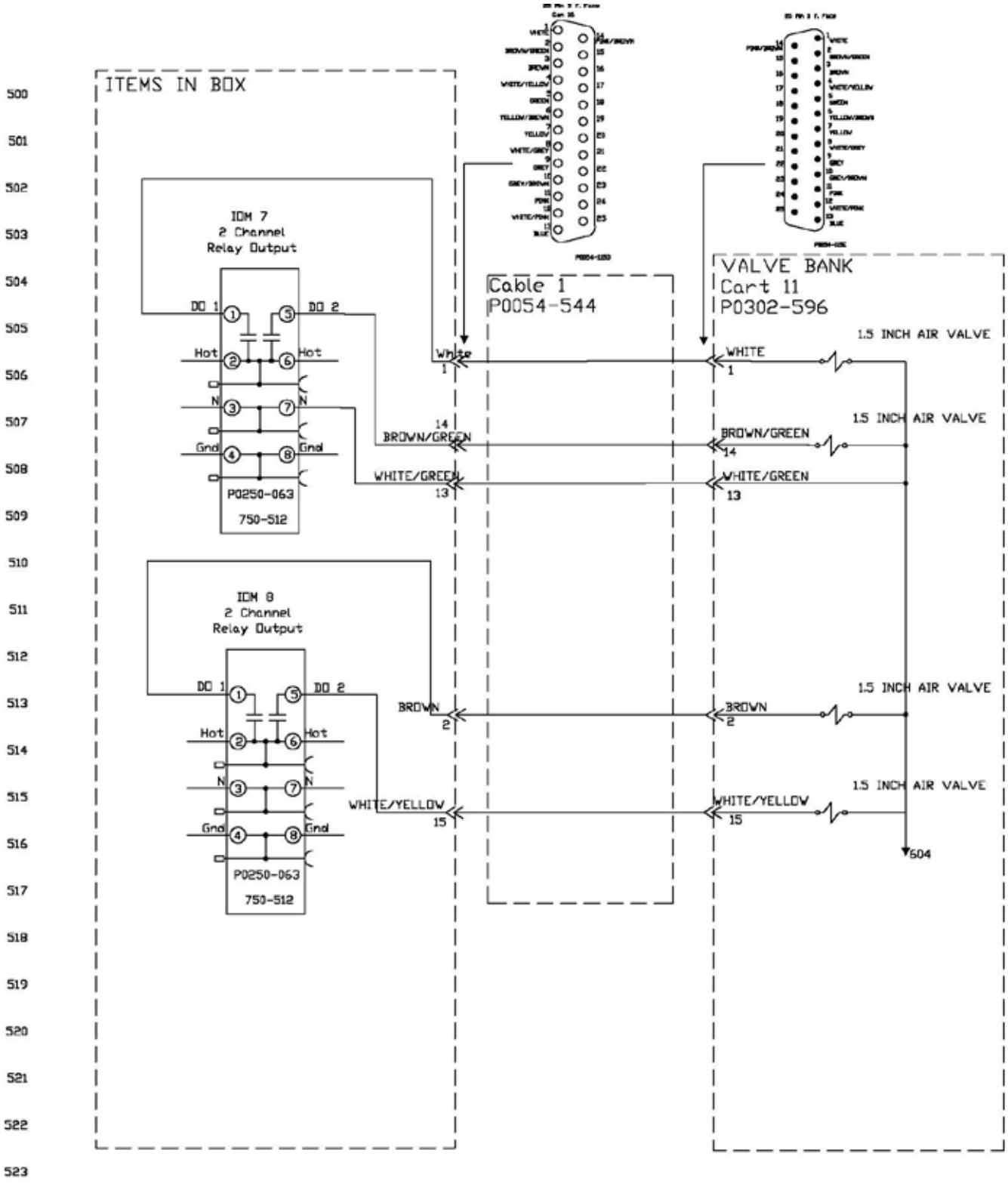
A13779A03


Junction Box
ITEMS IN
Control BOX
Full Level
Sensor
3/4 Level
Sensor
1/4 Level
Sensor
Empty Level
Sensor
Red/Black
Red/White
P0054-484
P0054-406
Con 9
Con 12
Con 13
Con 14
TB 1
P0250-202 (4)
TB 2
P0250-202 (5)
P0054-339
Con 10
P0054-343
Con 11
P0054-337
IOM 3
4 Channel
24V 4DI Lo-Sw
DI 1
DI 2
DI 3
DI 4
24 V
0 V
P0250-061
750-409
IOM 4
4-20ma Input
AI 1
AI 2
Shield
P0250-058
750-466

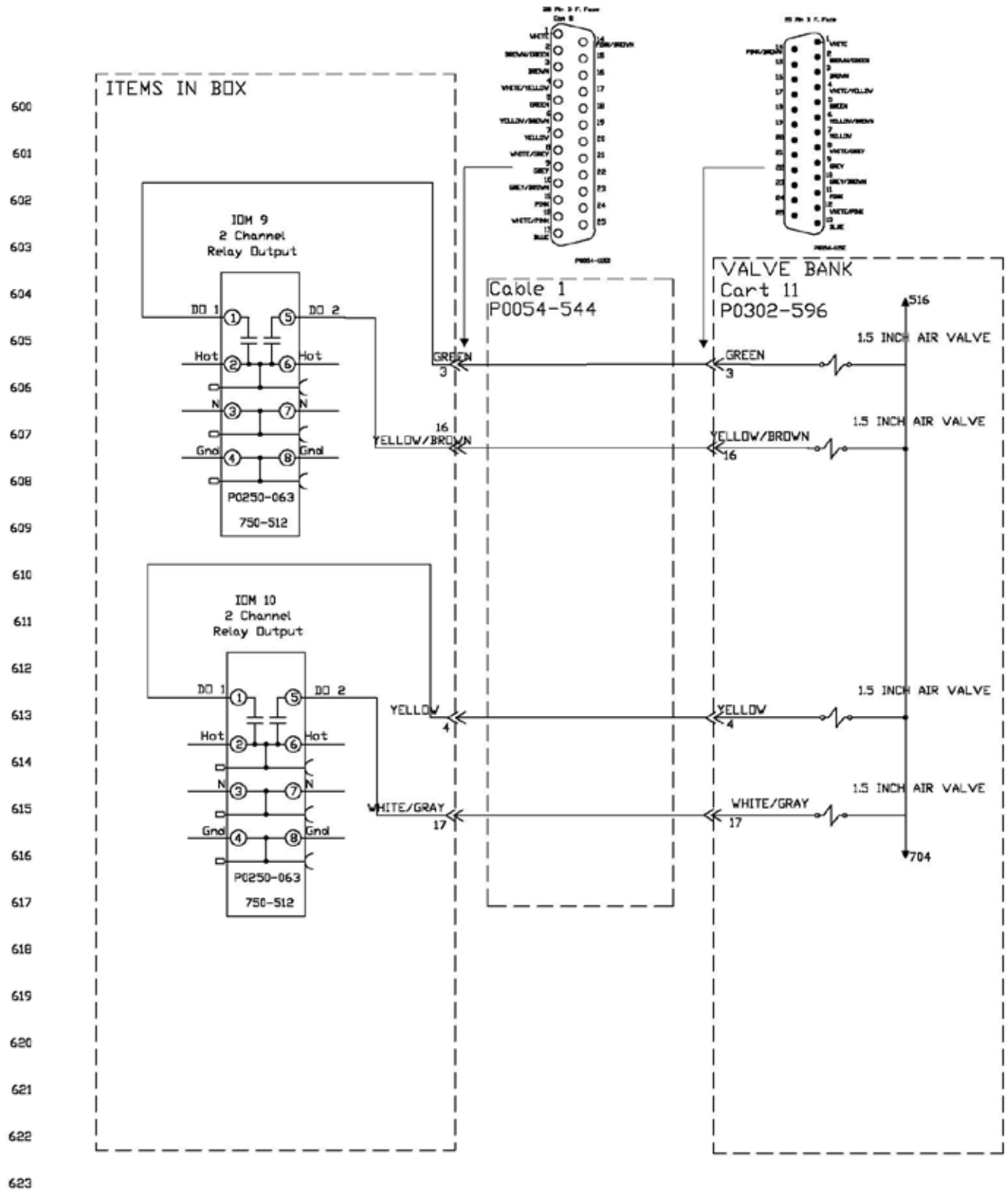
A13779A04


IOM 5
LEVEL SENSOR 2 Channel
4-20ma Input
AI 1
AI 2
24 V
24 V
0 V
0 V
Shield
Shield
P0250-058
750-466
P0054-071
FLOW
METER
P0250-205
+
White 3
–
Black 2
L1
Black 2
120 V
L2
White 3
GND
GND
Cable
P0054-484
Cable
P0054-169
P0054-069
P0054-335 Green
White
Black
Con 15
3 White
2 Black
Con 14
N 103
3 White
104 Black
2 Black
1 GREEN
IOM 6
FLOW METER 2 Channel
4-20ma Input
AI 1
AI 2
24 V
24 V
0 V
0 V
Shield
Shield
P0250-058
750-466
Black
White
P0054-068
Green
P0054-523
Con 16
3 Blue
1 Brown
2 WHITE
Slurry Pressure
Black
Brown
Blue
White
P0251-277
Cable
P0054-540
NOTE:
CAP UNCONNECTED
ENDS

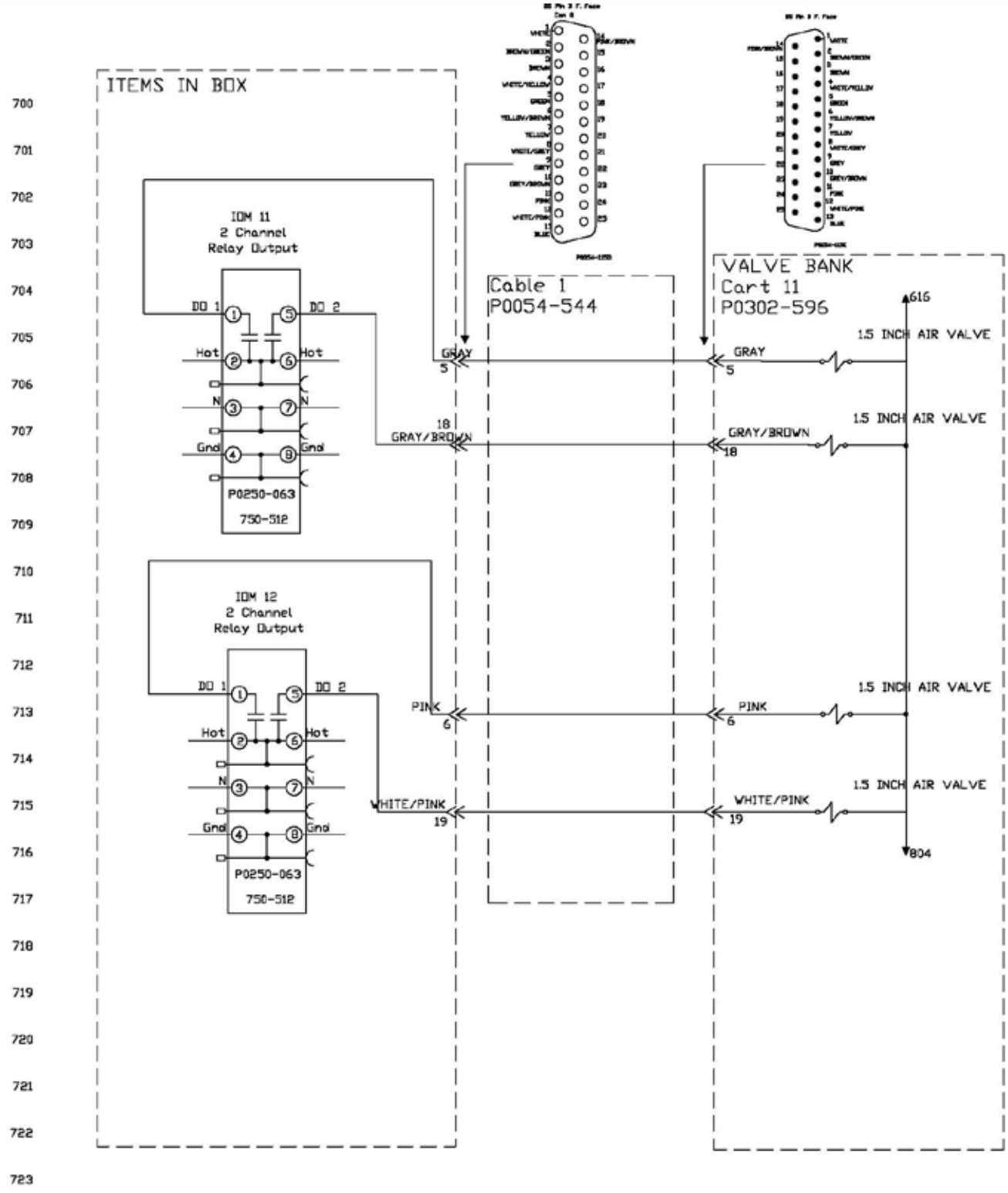
A13779A05


ITEMS IN BOX
IDM 7
2 Channel
Relay Output
DO 1
DO 2
Hot
Hot
N
N
Gnd
Gnd
P0250-063
750-512
IDM 8
2 Channel
Relay Output
DO 1
DO 2
Hot
Hot
N
N
Gnd
Gnd
P0250-063
750-512
Cable 1
P0054-544
VALVE BANK
Cart 11
P0302-596
White
1
14
BROWN/GREEN
WHITE/GREEN
13
BROWN
2
WHITE/YELLOW
15
WHITE
1
BROWN/GREEN
14
WHITE/GREEN
13
BROWN
2
WHITE/YELLOW
15
1.5 INCH AIR VALVE
1.5 INCH AIR VALVE
1.5 INCH AIR VALVE
1.5 INCH AIR VALVE
504

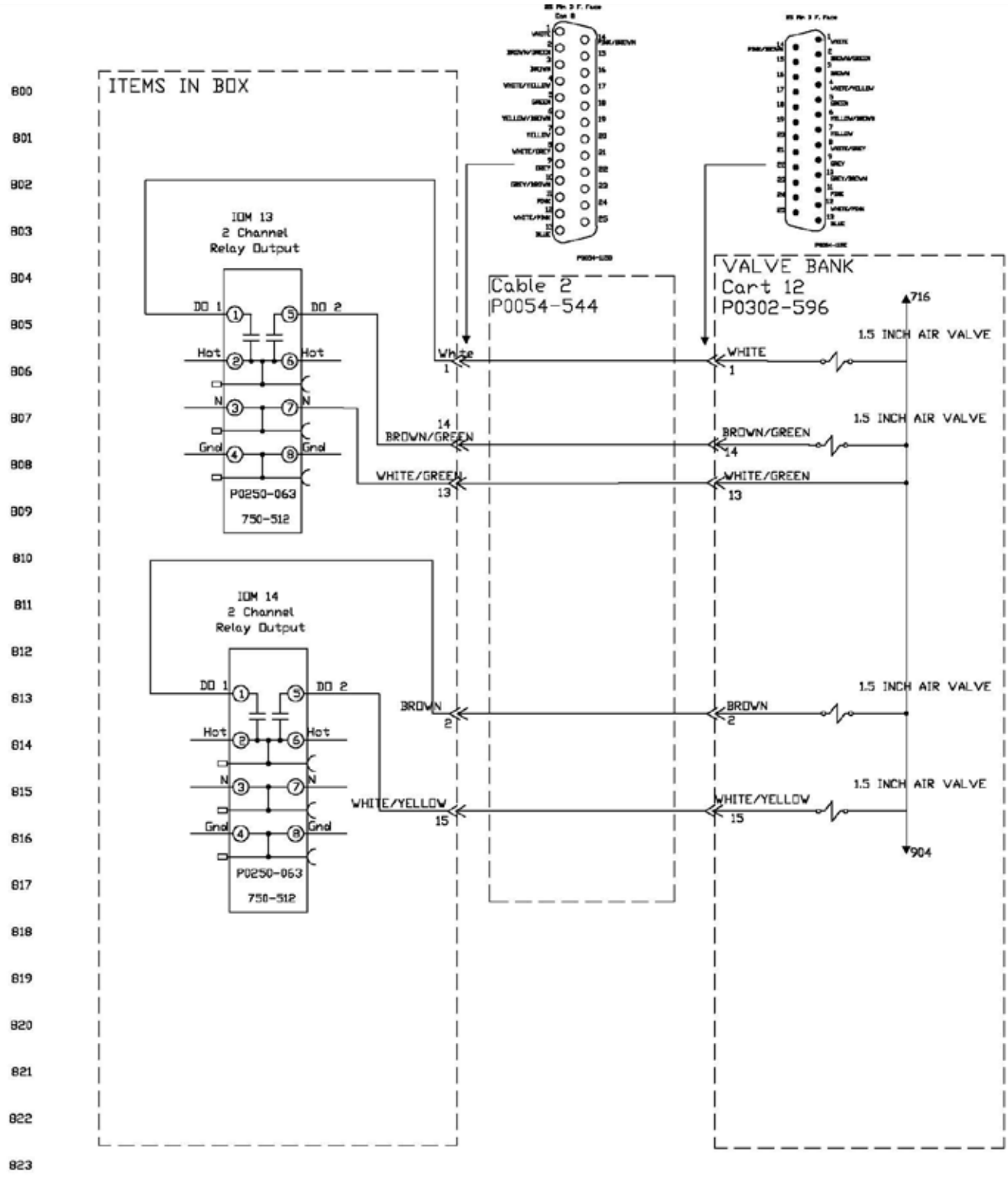
A13779A06


ITEMS IN BOX
IOM 9
2 Channel
Relay Output
DO 1
DO 2
Hot
Hot
N
N
Gnd
Gnd
P0250-063
750-512
IOM 10
2 Channel
Relay Output
DO 1
DO 2
Hot
Hot
N
N
Gnd
Gnd
P0250-063
750-512
Cable 1
P0054-544
VALVE BANK
Cart 11
P0302-596
516
704
GREEN
3
YELLOW/BROWN
16
YELLOW
4
WHITE/GRAY
17
1.5 INCH AIR VALVE
1.5 INCH AIR VALVE
1.5 INCH AIR VALVE
1.5 INCH AIR VALVE

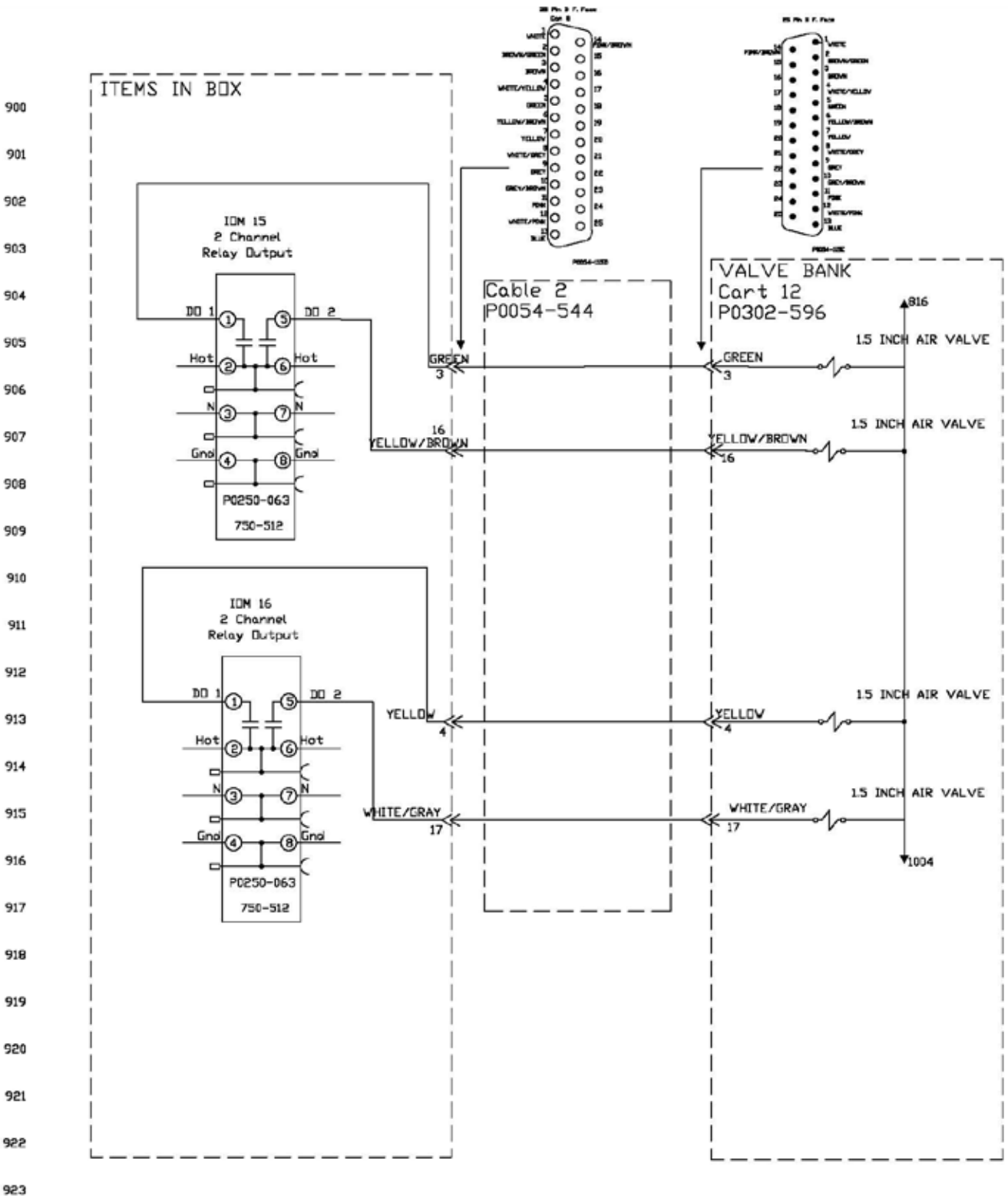
A13779A07


ITEMS IN BOX
IDM 11
2 Channel
Relay Output
DO 1
DO 2
Hot
Hot
N
N
Gnd
Gnd
P0250-063
750-512
IDM 12
2 Channel
Relay Output
DO 1
DO 2
Hot
Hot
N
N
Gnd
Gnd
P0250-063
750-512
Cable 1
P0054-544
VALVE BANK
Cart 11
P0302-596
GRAY
5
GRAY
5
1.5 INCH AIR VALVE
18
GRAY/BROWN
GRAY/BROWN
18
1.5 INCH AIR VALVE
PINK
6
PINK
6
1.5 INCH AIR VALVE
WHITE/PINK
19
WHITE/PINK
19
1.5 INCH AIR VALVE
616
804

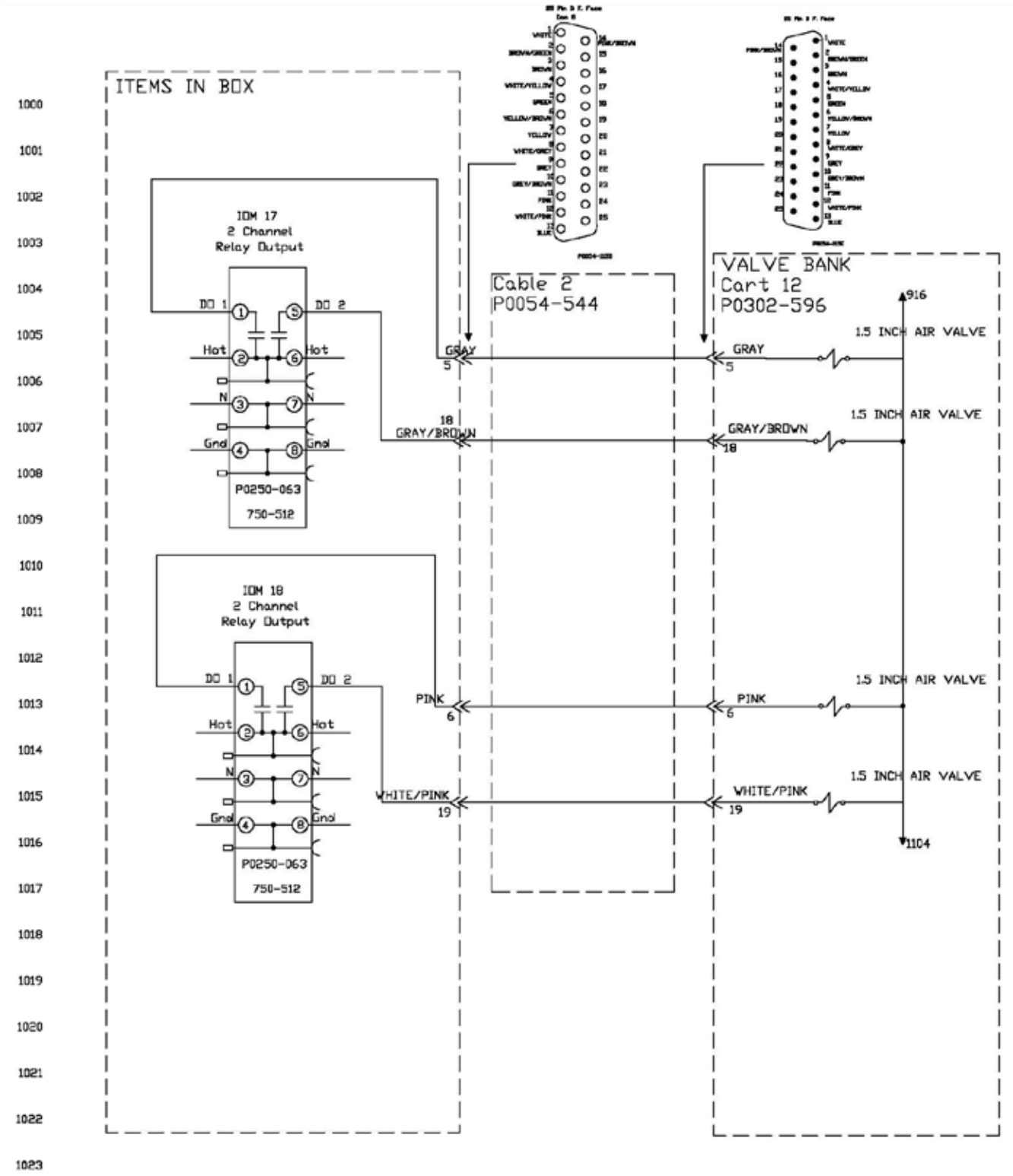
A13779A08


ITEMS IN BOX
IOM 13
2 Channel
Relay Output
DO 1
DO 2
Hot
Hot
N
N
Gnd
Gnd
P0250-063
750-512
IOM 14
2 Channel
Relay Output
DO 1
DO 2
Hot
Hot
N
N
Gnd
Gnd
P0250-063
750-512
Cable 2
P0054-544
VALVE BANK
Cart 12
P0302-596
716
904
WHITE
1
BROWN/GREEN
14
WHITE/GREEN
13
BROWN
2
WHITE/YELLOW
15
1.5 INCH AIR VALVE
1.5 INCH AIR VALVE
1.5 INCH AIR VALVE
1.5 INCH AIR VALVE

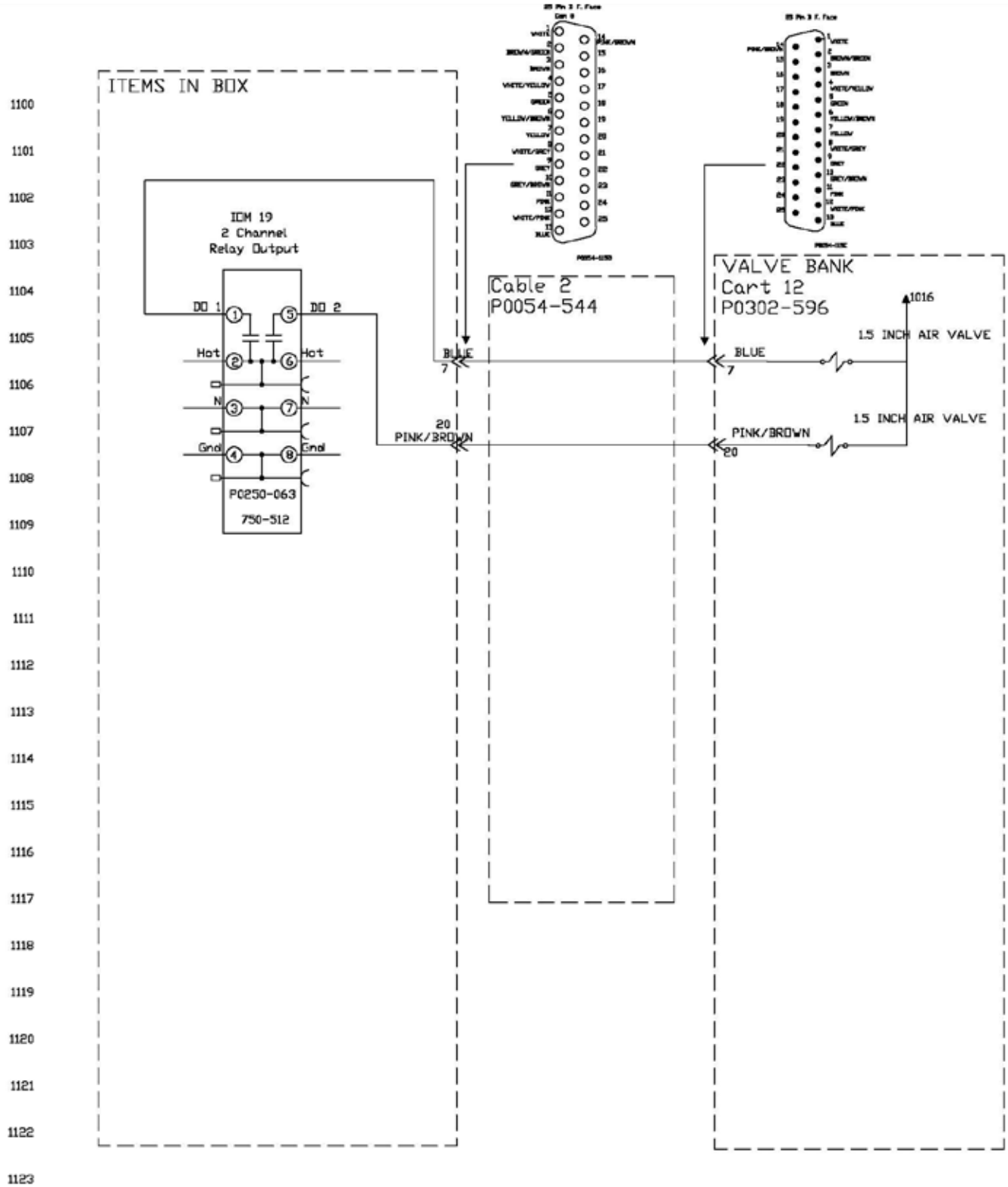
A13779A09


ITEMS IN BOX
IDM 15
2 Channel
Relay Output
DO 1
DO 2
Hot
Hot
N
N
Gnd
Gnd
P0250-063
750-512
IDM 16
2 Channel
Relay Output
DO 1
DO 2
Hot
Hot
N
N
Gnd
Gnd
P0250-063
750-512
Cable 2
P0054-544
VALVE BANK
Cart 12
P0302-596
816
1004
GREEN
3
YELLOW/BROWN
16
YELLOW
4
WHITE/GRAY
17
1.5 INCH AIR VALVE
1.5 INCH AIR VALVE
1.5 INCH AIR VALVE
1.5 INCH AIR VALVE

A13779A10

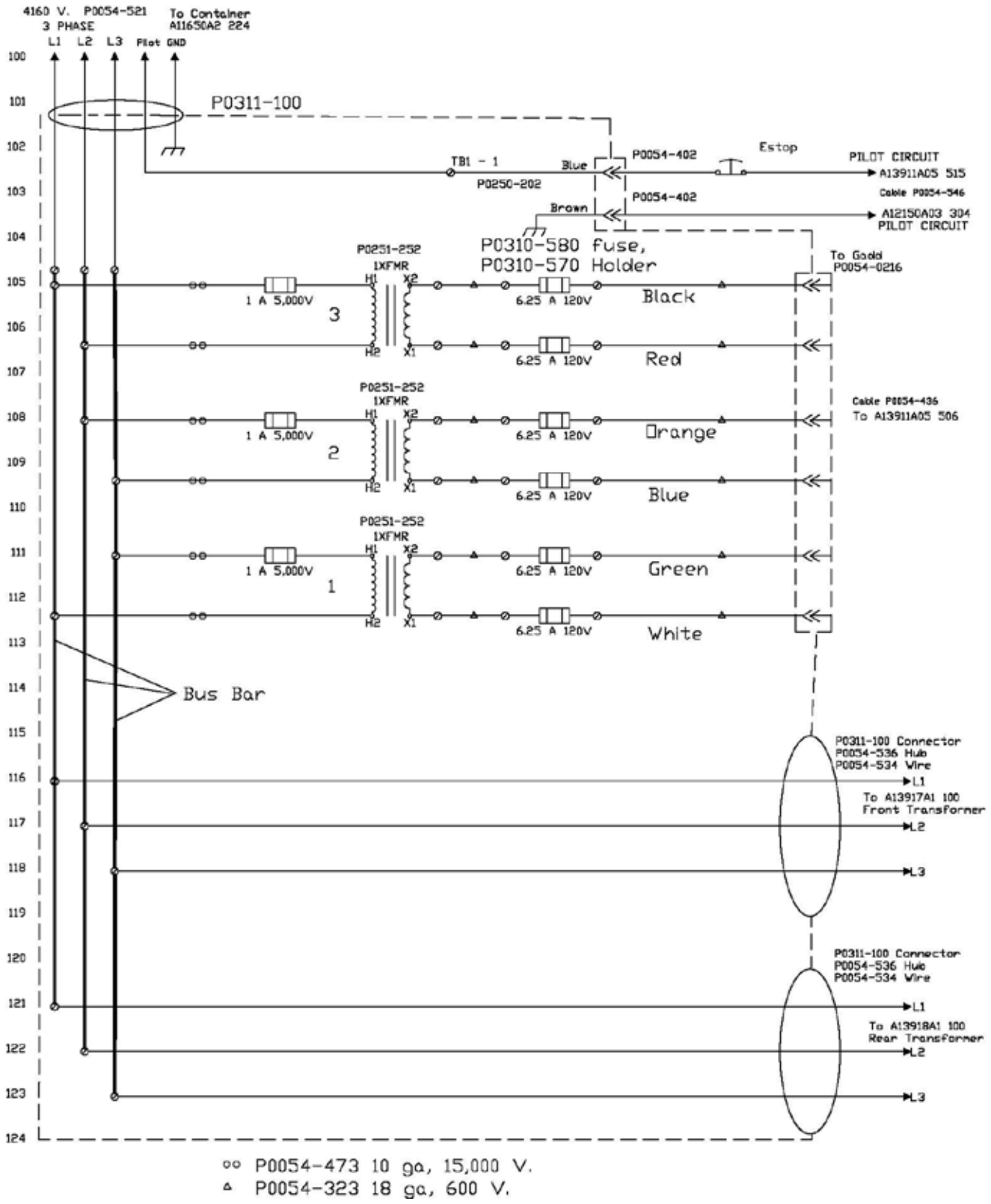

ITEMS IN BOX
IOM 17
2 Channel
Relay Output
DO 1
DO 2
Hot
Hot
N
N
Gnd
Gnd
P0250-063
750-512
IOM 18
2 Channel
Relay Output
DO 1
DO 2
Hot
Hot
N
N
Gnd
Gnd
P0250-063
750-512
Cable 2
P0054-544
VALVE BANK
Cart 12
P0302-596
916
1104
GRAY
5
GRAY
5
1.5 INCH AIR VALVE
18
GRAY/BROWN
GRAY/BROWN
18
1.5 INCH AIR VALVE
PINK
6
PINK
6
1.5 INCH AIR VALVE
WHITE/PINK
19
WHITE/PINK
19
1.5 INCH AIR VALVE

A13779A11


ITEMS IN BOX
ICM 19
2 Channel
Relay Output
DO 1
DO 2
Hot
Hot
N
N
Gnd
Gnd
P0250-063
750-512
Cable 2
P0054-544
VALVE BANK
Cart 12
P0302-596
1016
1.5 INCH AIR VALVE
1.5 INCH AIR VALVE
BLUE
7
BLUE
7
20
PINK/BROWN
PINK/BROWN
20

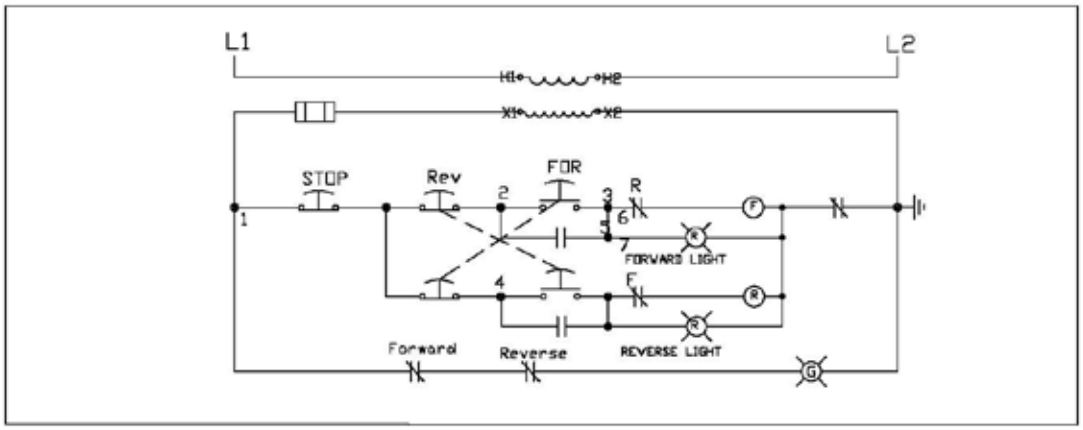
ELECTRICAL SCHEMATICS - 4160 POWER DISTRIBUTION

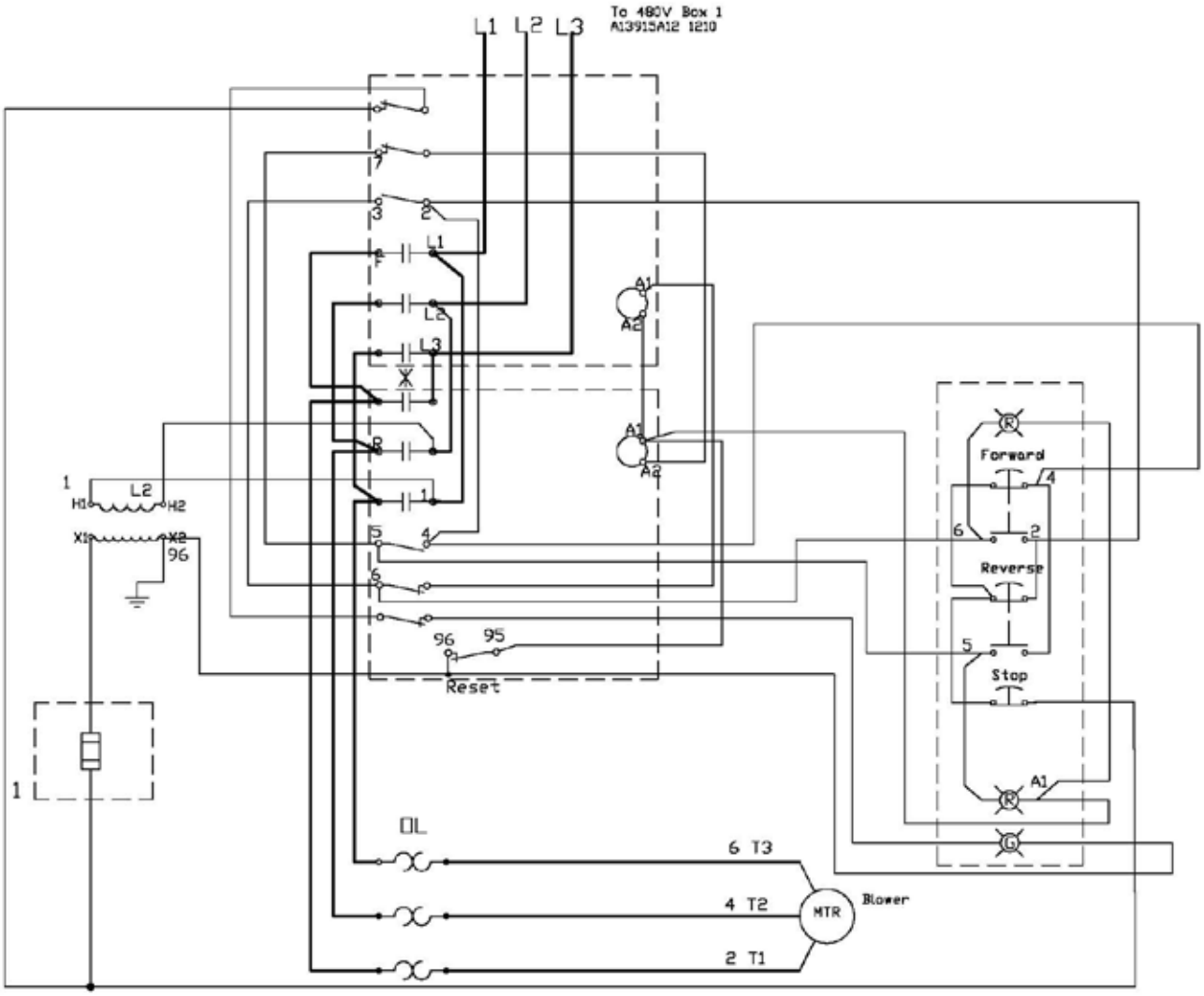
A11960A01



ELECTRICAL SCHEMATICS - BLOWER CAR 13 REVERSING STARTER

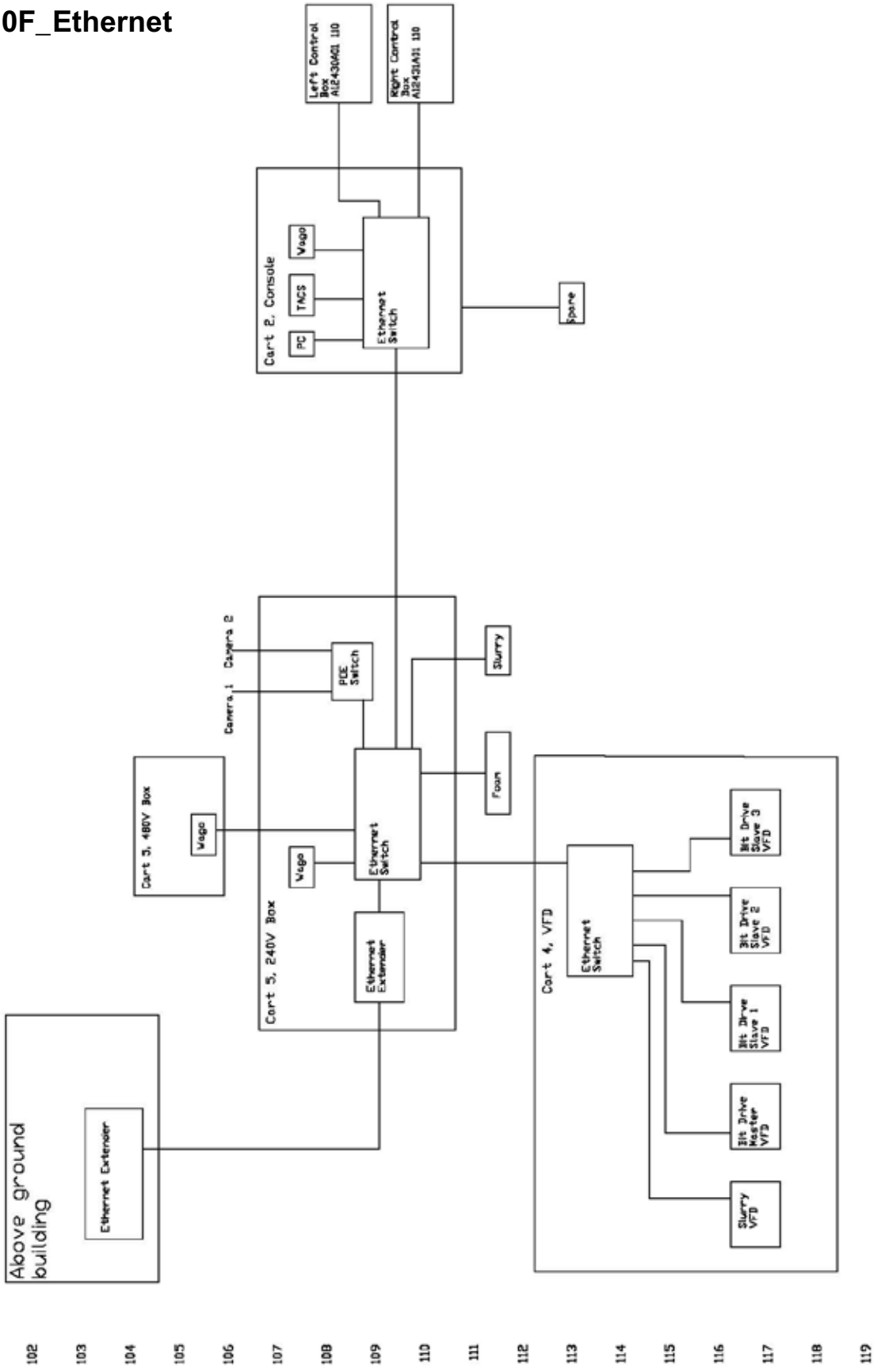
A13916A1





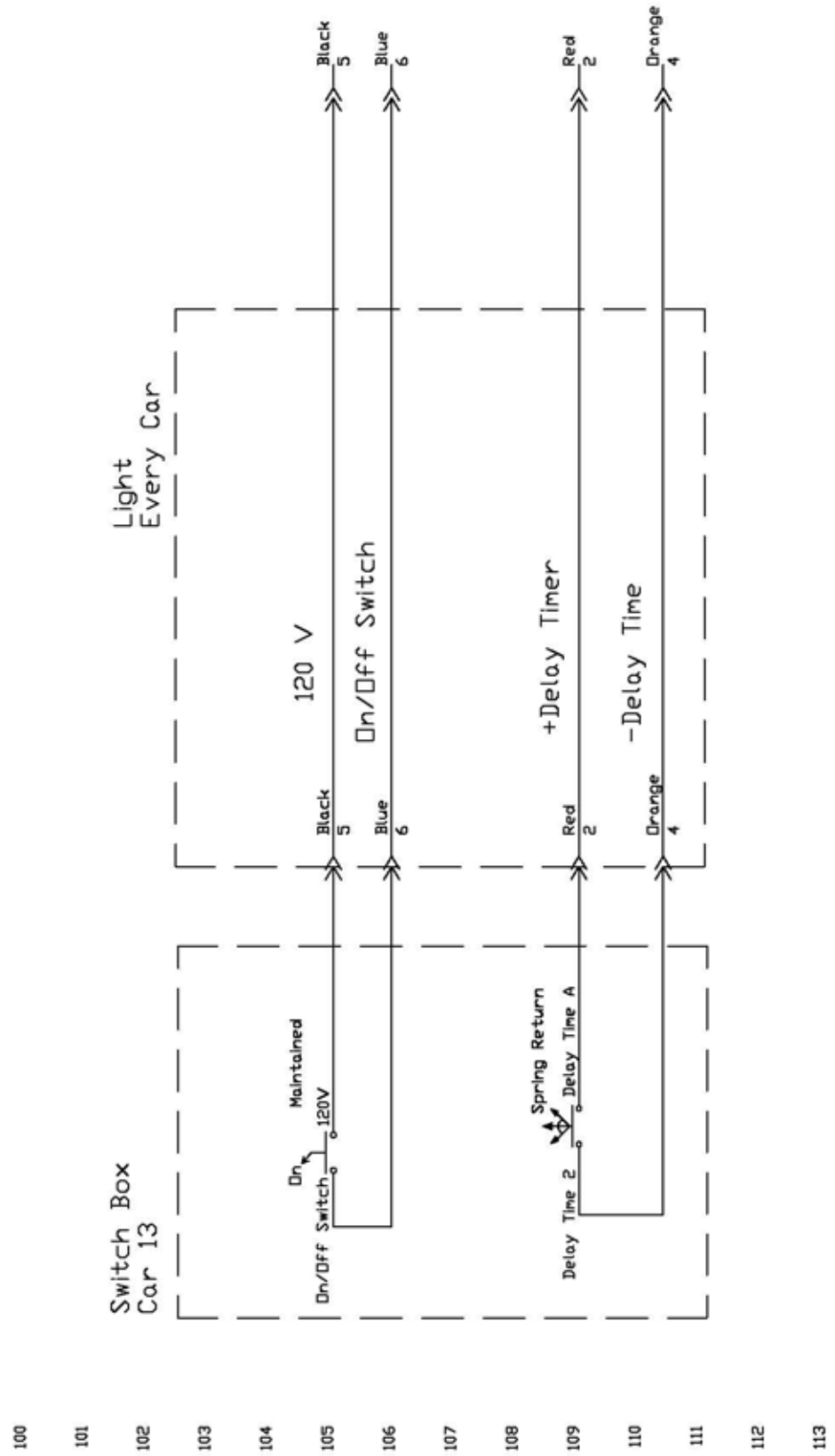
ELECTRICAL SCHEMATICS - ETHERNET CIRCUIT

FA11400F_Ethernet

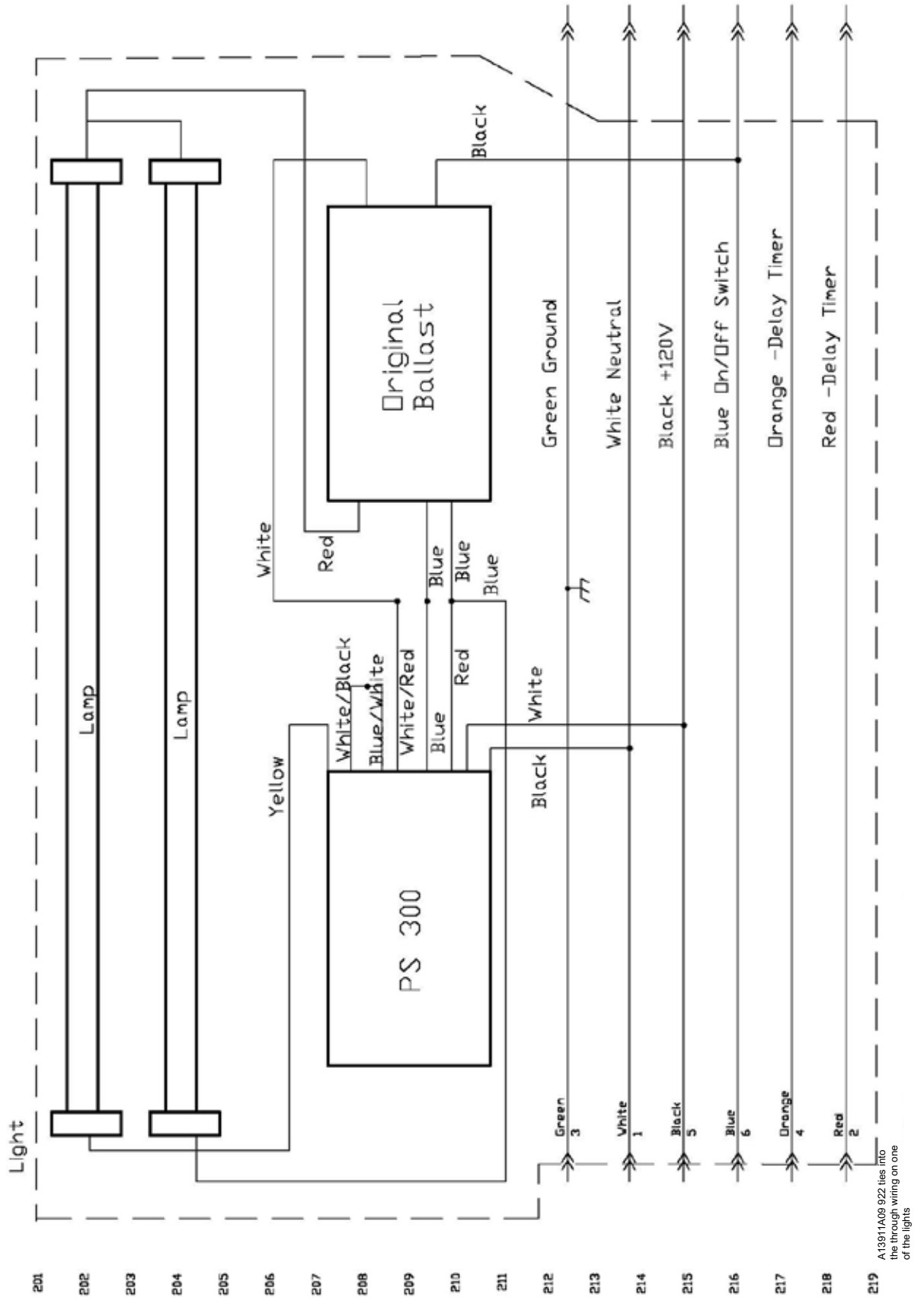


ELECTRICAL SCHEMATICS - LIGHTING

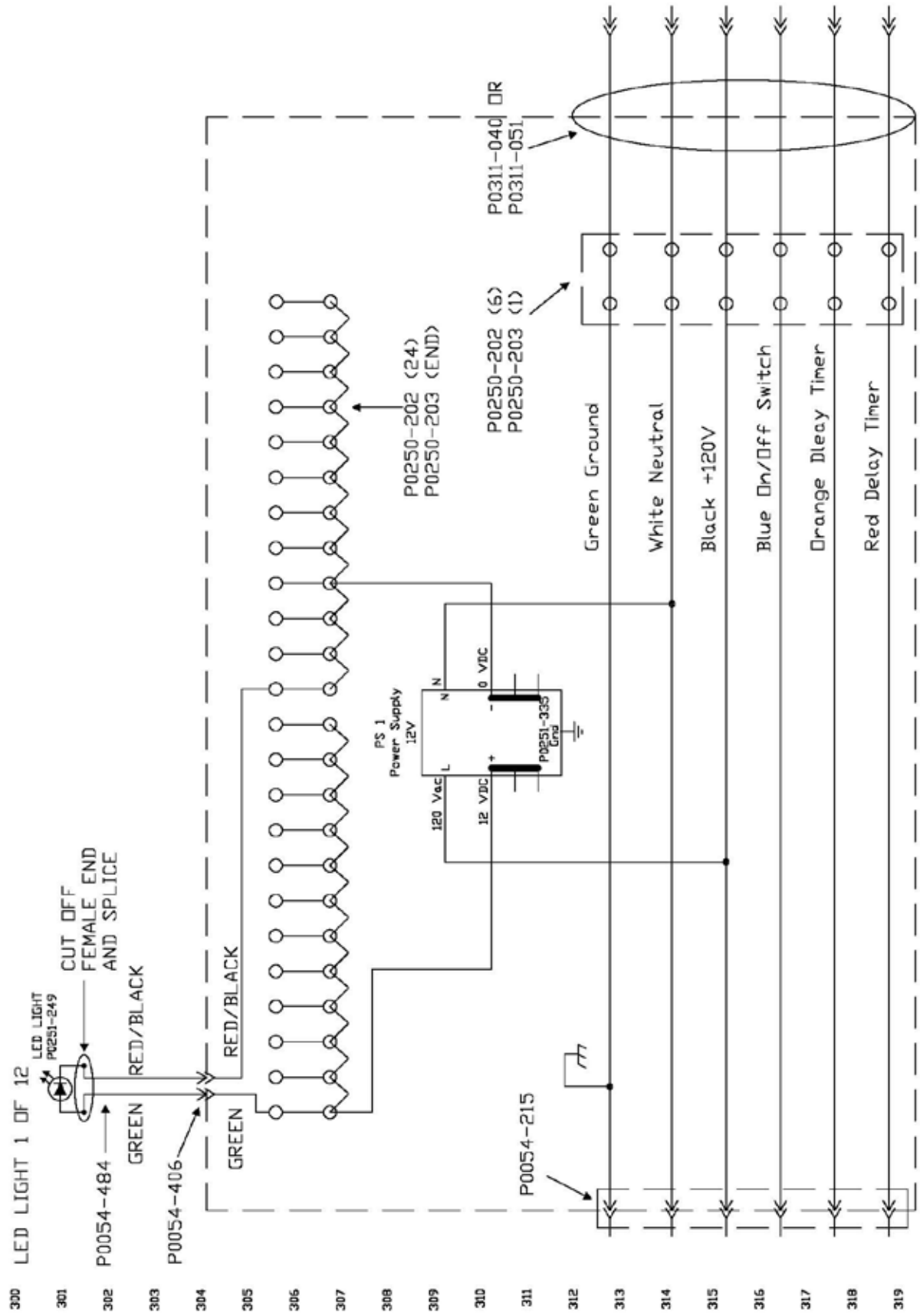
FA11400F_Lighting01



FA11400F_Lighting02

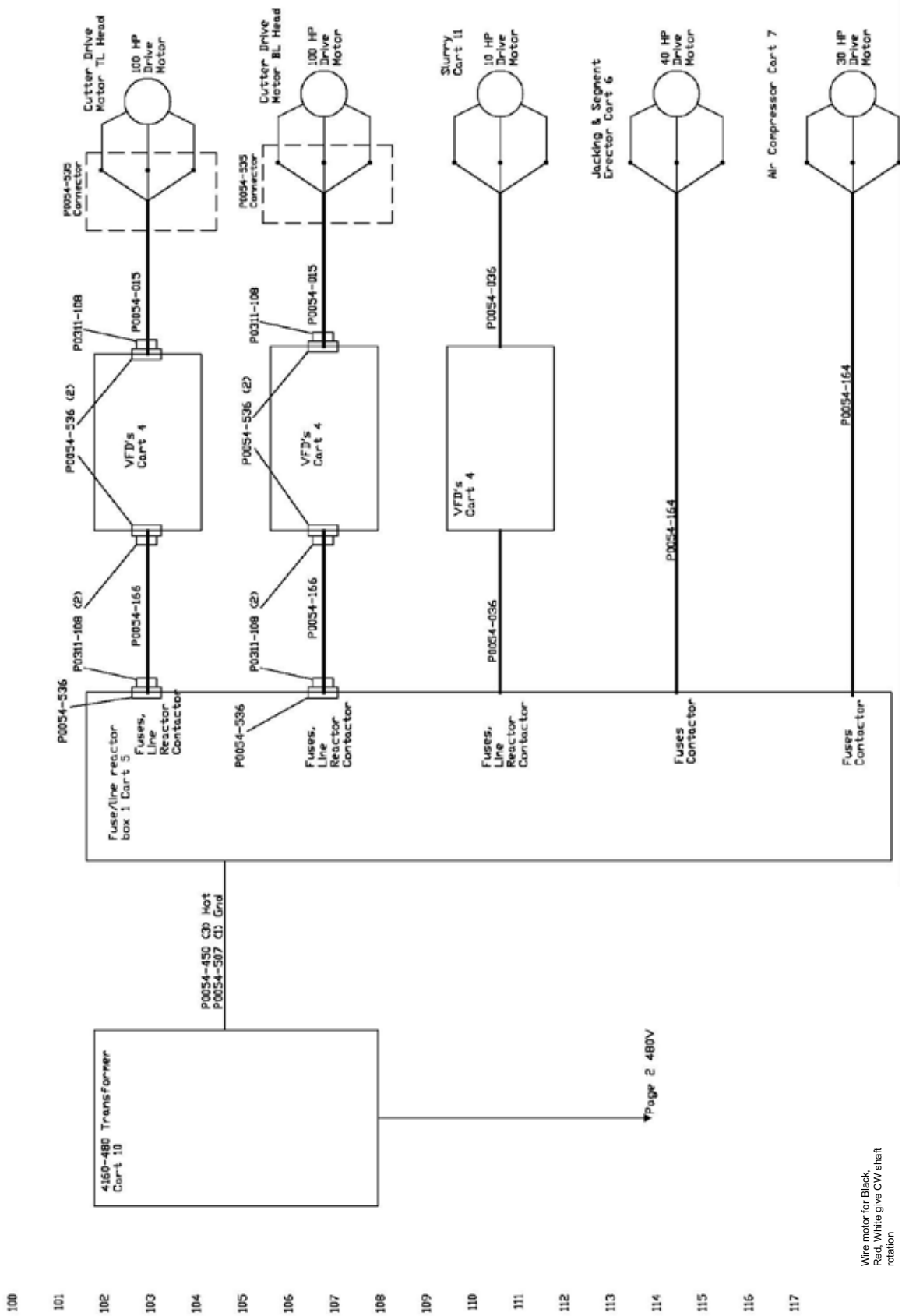


FA11400F_Lighting03

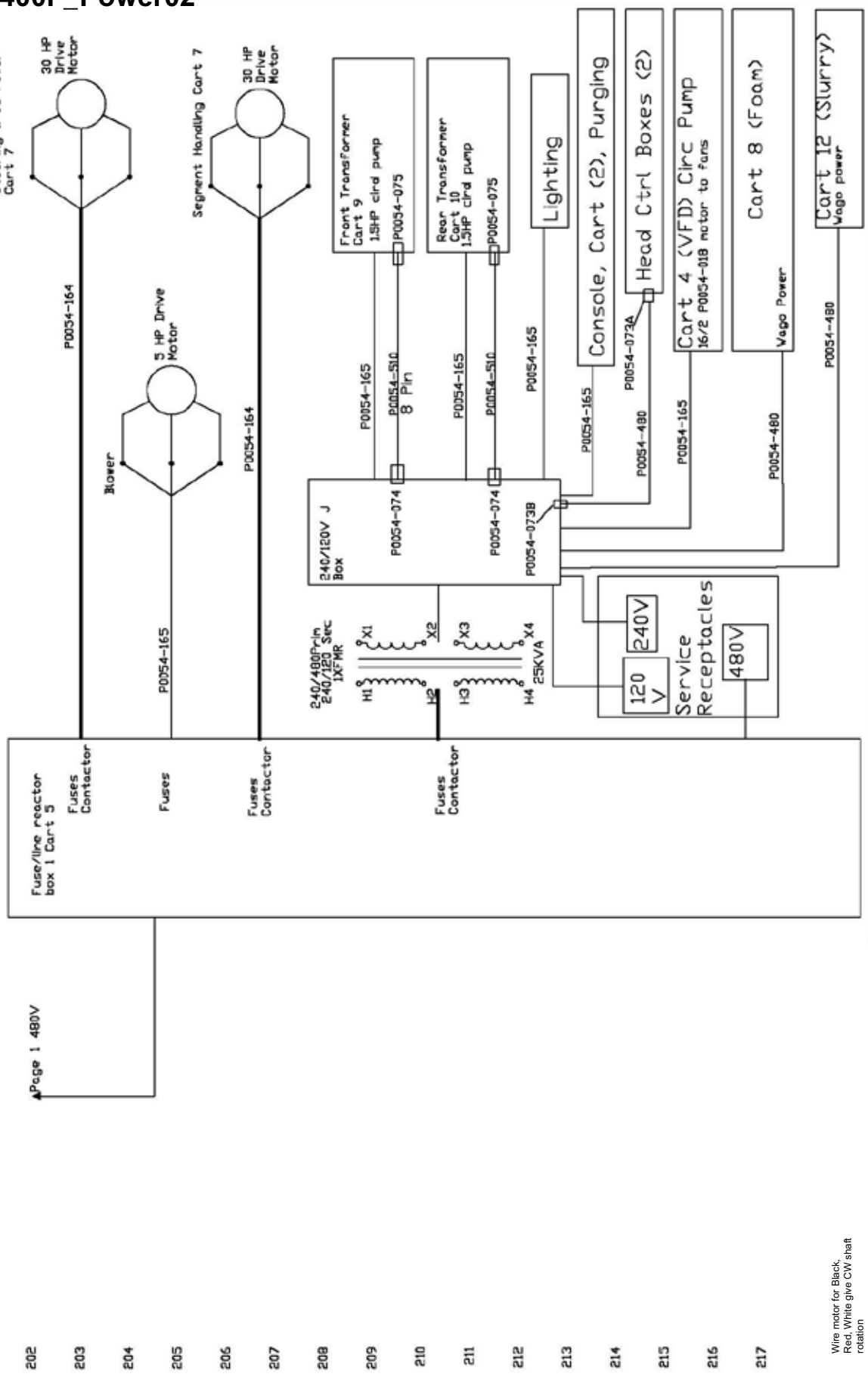


ELECTRICAL SCHEMATICS - HEAD POWER DISTRIBUTION

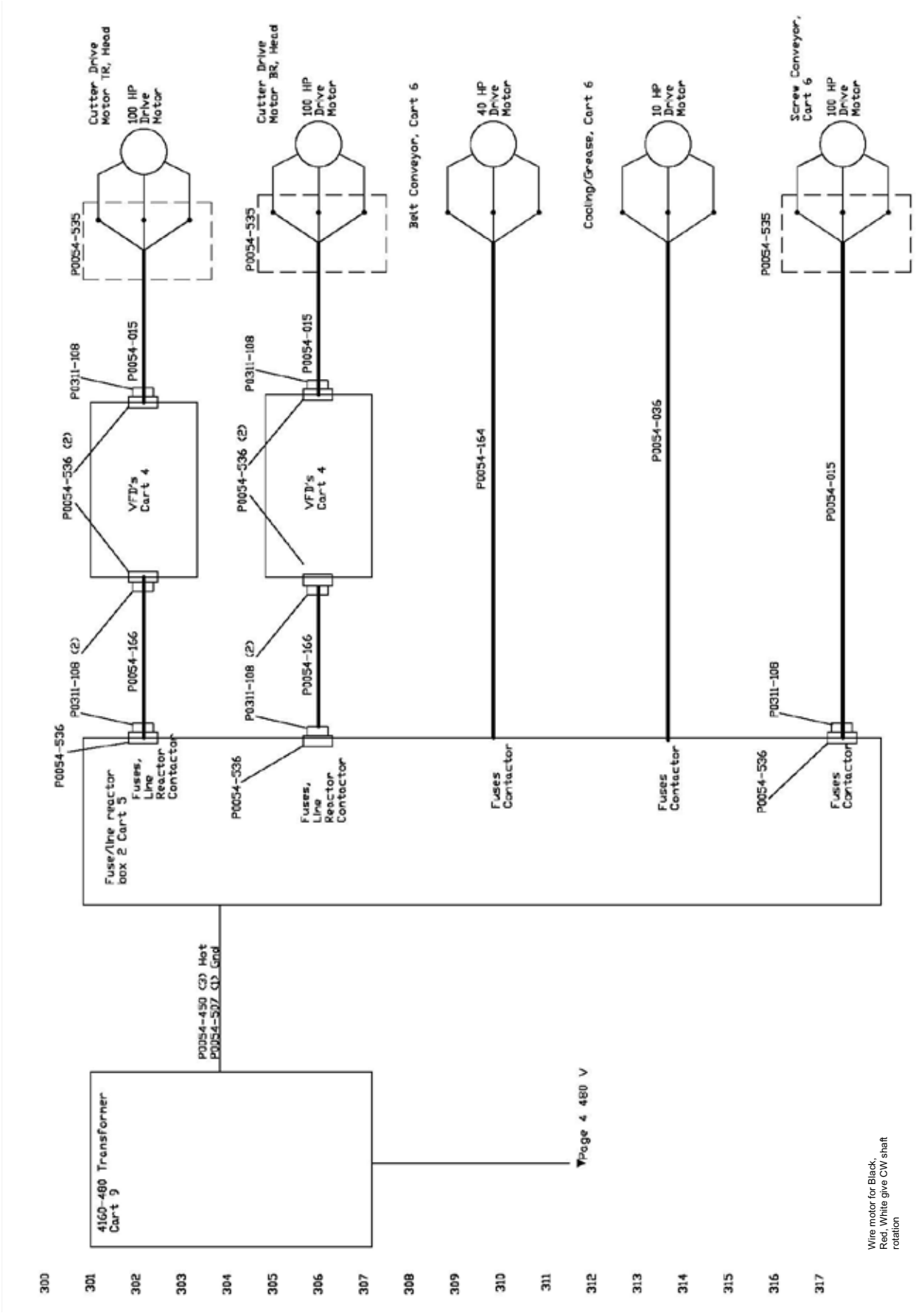
FA11400F_Power01



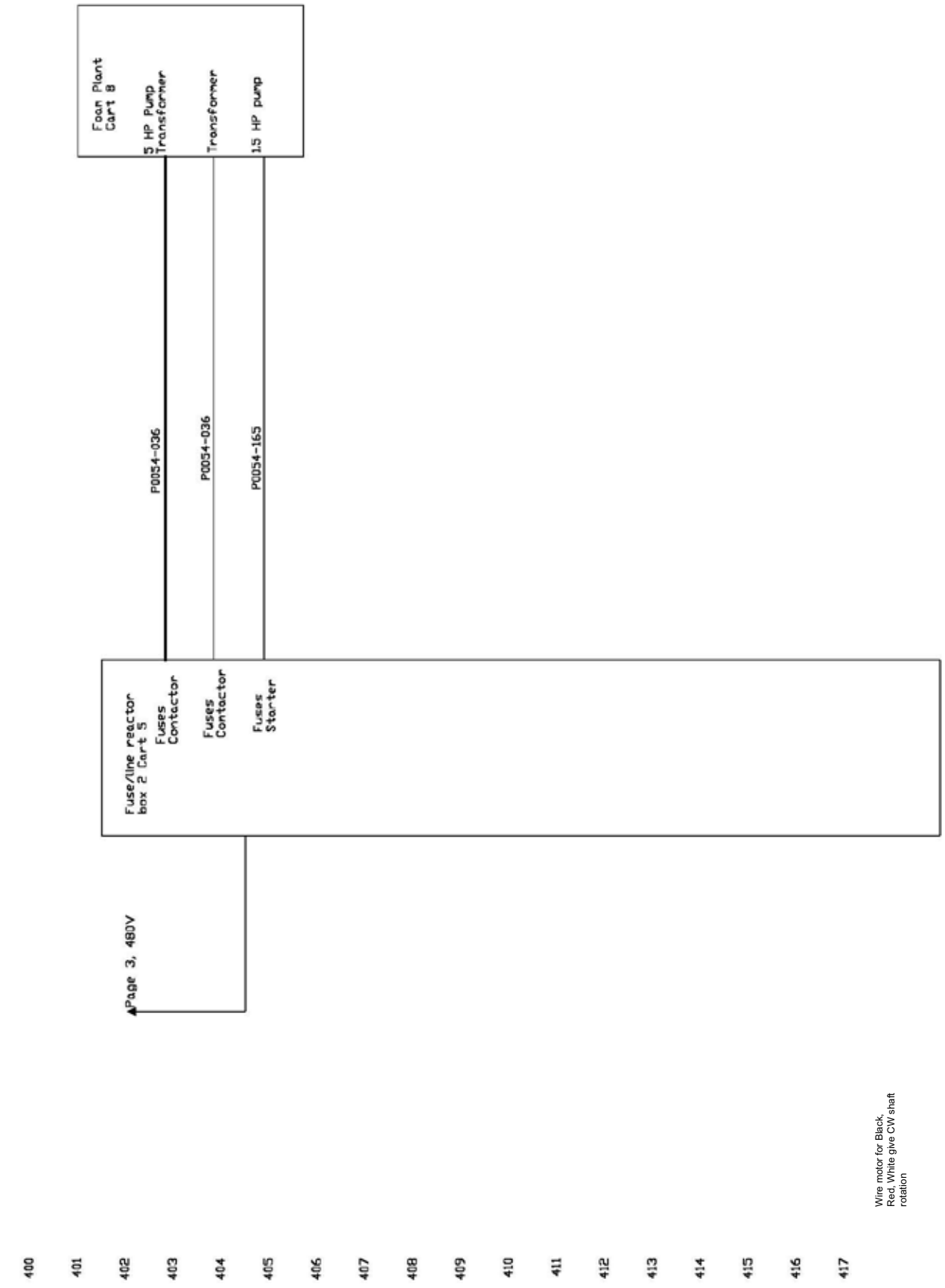
FA11400F_Power02



FA11400F_Power03

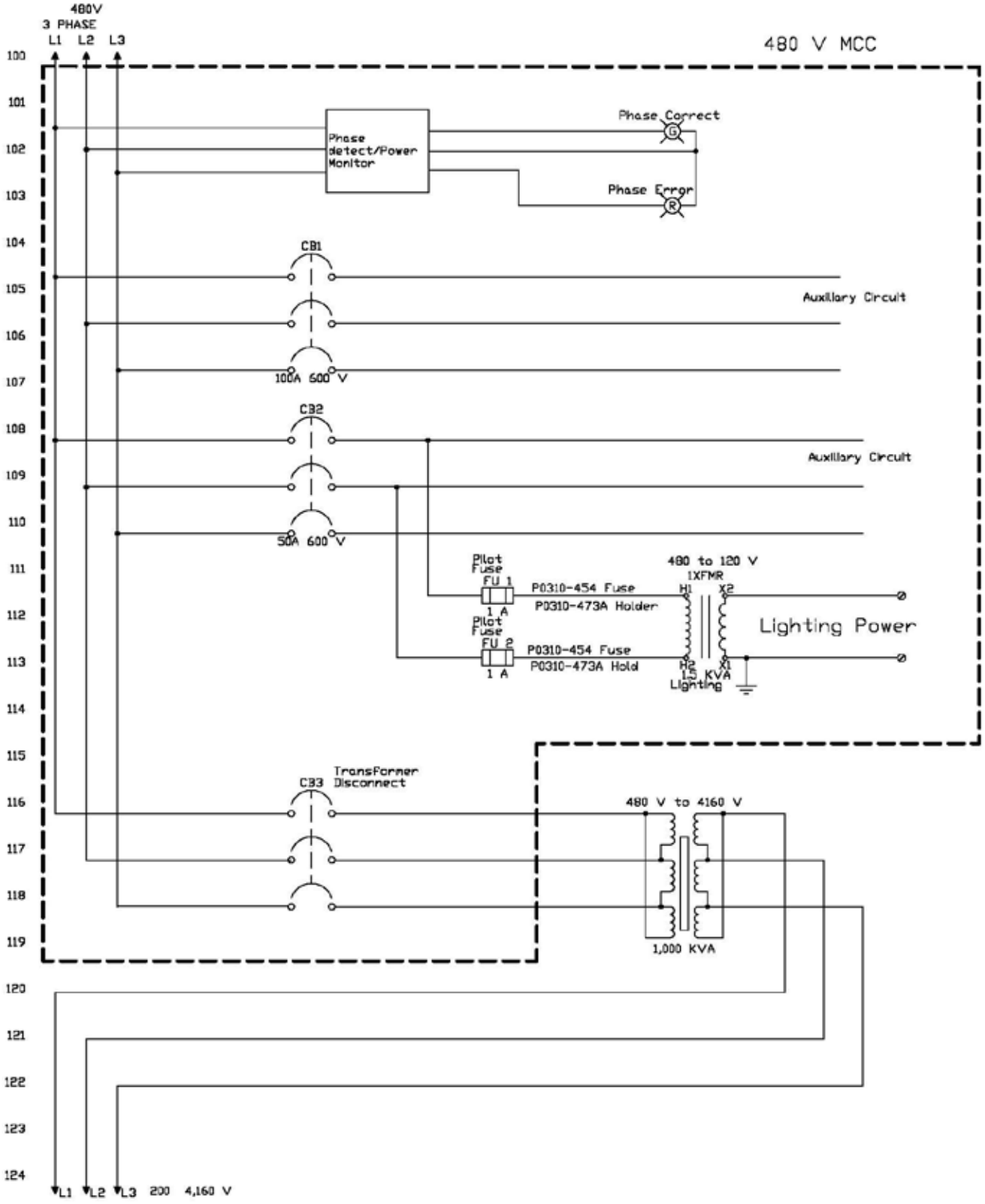


FA11400F_Power04

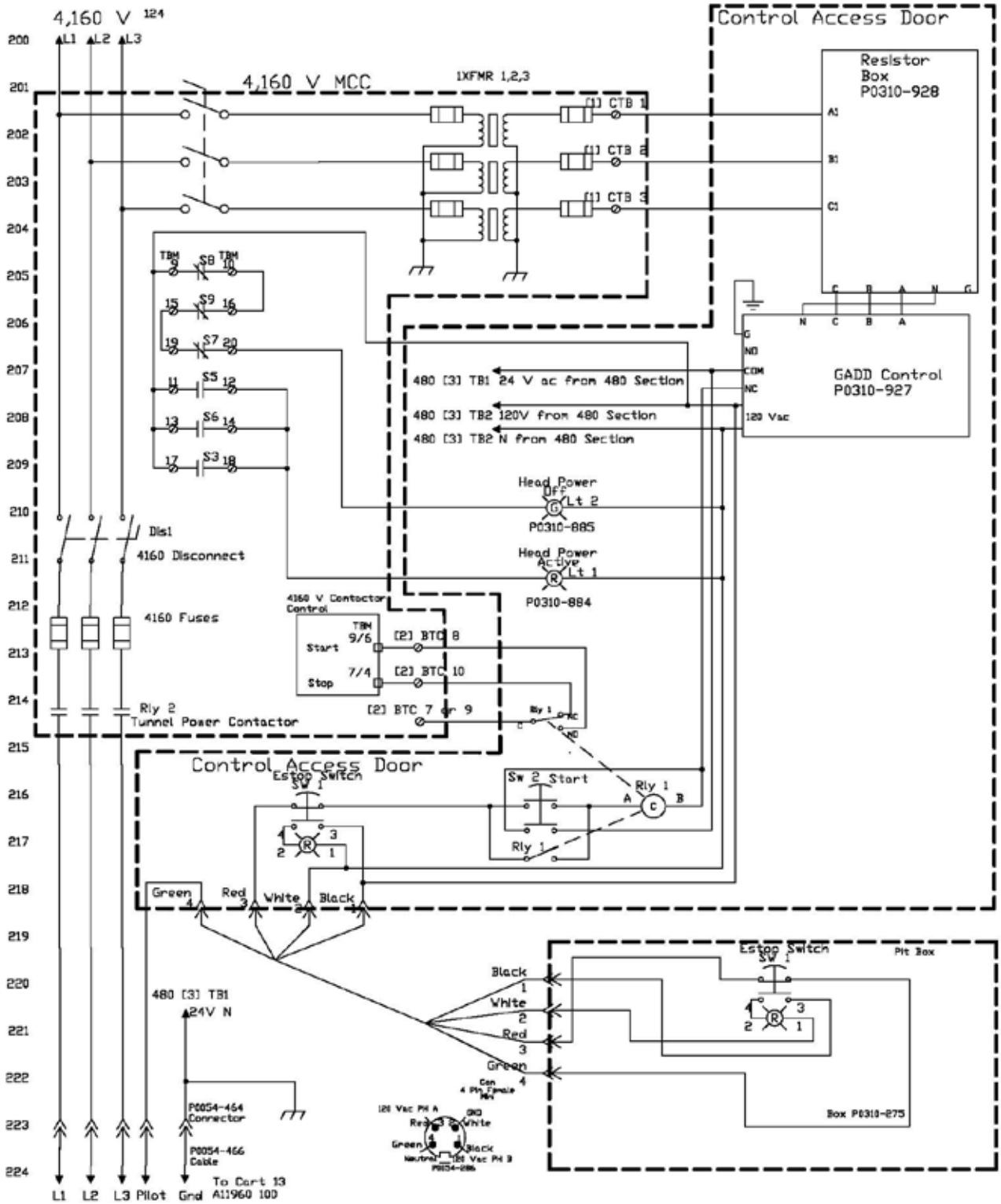


ELECTRICAL SCHEMATICS - POWER CONTAINER CIRCUIT

A11650A01

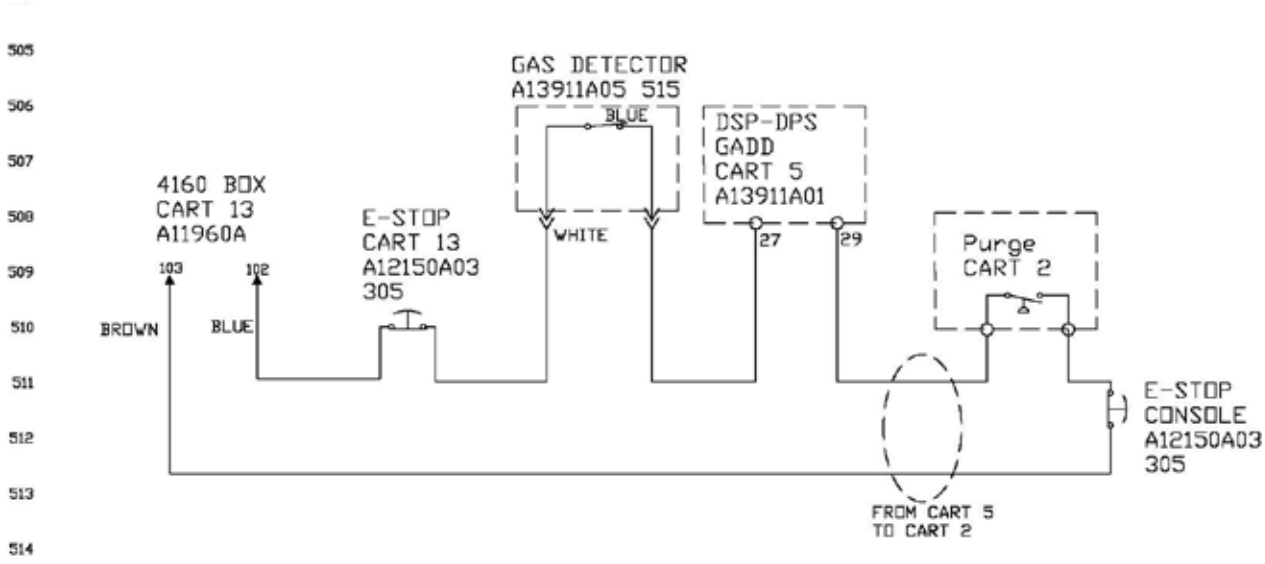


A11650A02


4,160 V
Control Access Door
4,160 V MCC
1XFMR 1,2,3
Resistor Box P0310-928
GADD Control P0310-927
480 [3] TB1 24 V ac from 480 Section
480 [3] TB2 120V from 480 Section
480 [3] TB2 N from 480 Section
Head Power Off Lt 2
P0310-885
Head Power Active Lt 1
P0310-884
Dis1
4160 Disconnect
4160 Fuses
Rly 2
Tunnel Power Contactor
4160 V Contactor Control
Start
Stop
Control Access Door
Estop Switch
SW 1
SW 2 Start
Rly 1
Green
Red
White
Black
480 [3] TB1
24V N
P0054-464
Connector
P0054-466
Cable
To Cart 13
A11960 100
Estop Switch
Pit Box
Box P0310-275
L1
L2
L3 Pilot
Gnd

ELECTRICAL SCHEMATICS - PILOT CIRCUIT

FA11400F-Pilot01



Specifications

General

Shield Diameter ..... 113.5 in. (2,883 mm)
Cutterhead Cutting Diameter
..... 115 in OD (2,921mm)
Concrete Segment Ring Outside Diameter
..... 108.5 in. (2,756 mm)
Concrete Segment Ring Inside Diameter
..... 94 in. (2,388 mm)

Cutterhead

Cutterhead Configuration ..... Mixed ground
.....configuration with combination of carbide
.....disc cutters & carbide stationary cutters
Maximum Material Size ..... 10 in. (254 mm)
..... diameter spherical
Disc Cutter Configuration
.....Four single discs in center
Seven double discs on face
Four triple discs around gauge
All disc cutters back loaded
Single Discs .... 12 in. dia with 11 ton cap.
Double Discs .. 12 in. dia with 17.6 ton cap
Triple Discs ..... 11 to 12 inch dia with 16.5 ton capacity
Stationary Carbide Cutters
..... Carbide embedded, high strength, bolt-on scrapers on face & gage
Over Cutter
.....Two over cutters extendible radially
..... 5.7 in. stroke each

Cutterhead Drive

Torque ..... 550,000 ft-lbs.
Rotational Speed ..... 0 to 3.5 rpm
Continuously variable in CW or CCW
Drive ..... Periphery drive electric motors with planetary reduction gearboxes
Drive Motors.... Four 100 hp motors at pinions
Motor Control .....One VFD for each motor
....Each water cooled VFD rated at 300 amps

Cutterhead Bearing & Sealing

Bearing Type ..... Tri-roller bearing with integral drive gear
Sealing System ..... Triple row lip seals on inside and outside of drive ring

Cutterhead Fluid Swivel

Configuration ..... Three ports for slurry & foam additive
.....Four hydraulic ports to support profile cutters

Steering System

Articulation ..... 3.5 degrees
Number of Cylinders ..... Four
Cylinder Dimensions..... 11 in diameter bore
.....8 in. diameter rod
..... 5.5 in. stroke
Rated Pressure ..... 5,050 psi
Total Thrust Capacity ..... 960 ton

Jacking System

Number of Cylinders .....Twelve
Cylinder Dimensions ... 6.5 in. diameter bore
.....5.75 in diameter rod
..... 62 in. stroke
Rated Pressure ..... 4,825 psi
Total Thrust Capacity ..... 960 ton
Rated Extension Speed ..... 4 in. per minute
Maximum Extension Speed.. 7 in. per minute

Jacking Can Sealing

Type of Sealing .. Three rings of brush seals
..... Front two rings of seals serviceable from inside of tunnel
.....Grout blocker on rear most ring of brush seals

Screw Conveyor

Conveyor Type ..... Open ribbon centerless
Conveyor Configuration ..... Dual conveyor configuration with one conveyor extending from the plenum chamber to the center of articulation
.....Second conveyor extends from this point to behind the segment erector
Conveyor Drive ..... Periphery drive motor on each conveyor
Outside Diameter ..... 18.5 in. (470 mm)
Maximum Material Size ..... 12 in. spherical

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

Guidance System

Description ... Laser based guidance system
.....with laser theodolite & video target
.....Integral data recording
..... Above ground display
..... Ring building software

Foam & Slurry Injection

Injection Ports On Cutterface:
..... Three 1.5 in diameter through fluid swivel
Injection Ports Through Bulkhead:
.....Three 2 in. diameter
Injection Ports In Screw Conveyor:
.....Three 2 in. diameter

Air Compressor

Configuration ... Hydraulic drive rotary screw
Rating ..... 50 icfm @ 175 psi

Earth Pressure Sensors

Quantity of Sensors .....Four Total
Locations:
..... Two in plenum at spring line
.....Two in screw conveyor, one at each end

Power Container

Required Power ... 480VAC, 3 Phase, 60 Hz
Main Circuit Breaker .....1,125 amp
Transformer ..... One 1,000 kVA
Tunnel Cable Voltage 4,160V

TBM Transformers

Quantity ..... Two
Rating ..... 500 kVA each

Gas Detectors

Gas Sensing ..... Oxygen & combustible gas

Miscellaneous

Cutterhead Access ...Entry door into plenum
.....chamber through bulkhead
Lighting ..... Fluorescent lighting on each car
Gassy Operation:
.. Rated for NEC Class 1 Division 2 Groups C & D

HYDRAULIC PRESSURE SETTINGS

HYDRAULIC COMPONENT	MAXIMUM OPERATING PRESSURE Load Sense (PSI)	Pressure Comp. (PSI)
Jacking Pump A	200	4,800
Jacking Pump B	200	4,800
Jacking Manifold B - Erector	500	3,000
Steering Pump	-	3,000
Steering Manifold Relief	-	5,300
Screw Conveyor #1	300	3,500
Screw Conveyor #2	300	3,500
Belt Conveyor	200	3,000
Segment Handling	500	3,000
Copy Cutter	-	3,000
Air Compressor	-	3,000
Erector - Rotation	-	2,250
Linear Travel	-	2,250
Segment Rotation	-	2,250
Segment Latch	-	2,000
Segment Lift	-	1,600
Jacking Manifold Relief (In EPBM)	-	6,000

FLUID CAPACITIES*

Hydraulic Reservoirs

Front Hydraulic Car #6 ..... 95 gal (360 L)

Rear Hydraulic Car #7

Main ..... 95 gal (360 L)

Auxiliary ..... 45 gal (170 L)

⚠WARNING On rear hydraulic car #7, check oil level and refill ONLY when jacking cylinders are fully retracted. Failure to do so could result in serious injury and machine damage from a ruptured hydraulic reservoir.

VFD Coolant Reservoir ..... 6 gal (22.7 L)

Air Compressor Oil Sump ..... 2.5 qts (2.4 L)

Slurry Tanks (2) ..... 250 gal (946 L)

Main Drive Planetary (4) ** ..... 2.67 gal (10.1 L)

Screw Conveyor Planetary Drive (2) ** ..... 1.16 qt (1.1 L)

* Fluid capacities are approximate values. Be sure to check levels are filling. DO NOT OVERFILL!

** Fill planetary drives to half full oil level plug. DO NOT OVERFILL!

NOTES

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.

NOTES

Warranty

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

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