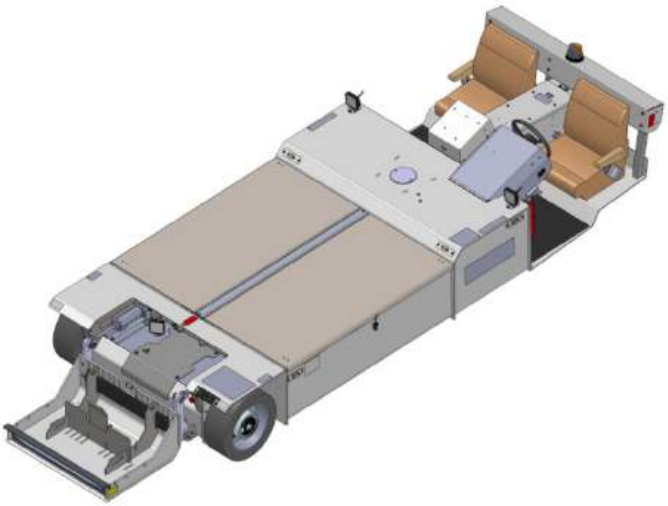
OPERATION & SERVICE MANUAL



Models: eJP-10
eJP-10SP
Electric Towbarless Tug

CE

04/2024 – Rev. 05

For Spare Parts, Operations & Service Manuals or Service Needs
Scan the QR code or visit Tronair.com/aftermarket

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REVISION	DATE	TEXT AFFECTED
01	02/2017	Original Release
02	05/2020	Modified Parts List
03	11/2021	Major revision
04	12/2023	Modified Parts List
05	04/2024	Modified9.2 Recommend Spare Parts Lists

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This product can not be modified without the written approval of Tronair, Inc. Any modifications done without written approval voids all warranties and releases Tronair, Inc., its suppliers, distributors, employees, or financial institutions from any liability from consequences that may occur. Only Tronair OEM replacement parts shall be used.

1.0 PRODUCT INFORMATION

1.1 DESCRIPTION

Electric towbarless tug with towing capacity up to 100,000 lbs

1.2 MODEL & SERIAL NUMBER

Reference nameplate on unit

1.3 MANUFACTURER

TRONAIR, Inc.
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Swanton, Ohio 43558 USA

Telephone: (419) 866-6301 or 800-426-6301
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1.4 DIMENSIONS

Weight	6,600 lbs (2,994 kg)
Length	209 in (530.9 cm)
Height	39 in (99 cm)
Width	70 in (177.8 cm)
Ground Clearance	4.25 in (10.8 cm) between drive tires
Deck Height	24 1/4 (61.6 cm)
Cradle Depth	29 in (73.7 cm)
Cradle Width	38 in (96.52 cm)
Cradle Lift Height	12 in at front edge (30.5 cm)
Cradle Capacity	10,000 lbs (4,536 kg)
Steering Axle Tire Size	(2) 4.88 x 8” (16” OD)
Drive Tire Size	(2) 21 x 8 x 15 (21” OD)

1.5 DRIVE SYSTEM

Traction Motor	Two 13HP A.C. electric motors
Motor Controller	Two 72 Volt motor controllers
Gear Reduction	Two 37.5:1 heavy duty gear reduction torque hubs
Empty Speed	7 mph (11 kph)
Full Load Speed	4 mph (6 kph)
Throttle type	Hall-Effect foot throttle
Battery Type	RCI Group 903
Battery Voltage	12, 6 Volt batteries (72 Volt)
Battery Capacity	430 Ah (20 HR) 340 Ah (5 HR)
Charge Time	Dependent on Charger Selection

1.6 STEERING SYSTEM

Dual Drive	Proportional Steering using Curtis Dual Drive Operation
Power steering	Utilizes steering valve and rotary actuator to provide 5th wheel type steering with leaf spring suspension. Steers 87º in each direction

1.7 BRAKE SYSTEM

Regenerative	Soft electric programmed regenerative braking is provided as the accelerator pedal is released.
Foot Brake	The brake pedal provides stronger electric regenerative braking.
Parking Brake	The parking brake consists of two multiple disc, enclosed type brakes. Maximum holding torque on the parking brake is 1600 in-lbs per side at the motors. Pressing the throttle releases the parking brake.

1.8 OPTIONAL EQUIPMENT AVAILABLE

Custom Colors and Graphics
Fully Automatic Battery Charger (External)
- Type ..... Eco Charge
- Rating..... 78 Amp at 72VDC

1.9 STANDARD EQUIPMENT

- Operator Panel Display with Battery Charge Indicator, Hourmeter, Speedometer, Steering Position Indicator, Diagnostic Functions
- Power Winch (Hydraulic Ram) with Reduced Force on Contact
- Front and Rear Facing LED Headlights
- LED Cradle Work Light
- Strobe Light
- Side Marker Lights
- Fire Extinguisher
- Two Nylon Strut Straps, 1.5” x 36”
- Nylon Winch Strap
- Nylon Safety Strap
- Rear Pintle Hitch

1.7 ADD ON KITS

K-4052.....Westwind Adapter
K-4177.....Sabreliner Adapter
K-4235.....Dash 8 400
K-4236.....Dash 8 100, 200, 300
K-5387.....Lear 40/45 Adapter (Required)
K-5388 .....Falcon 50/900/2000 Adapter (Required)
K-5389 .....Falcon 7X/8X Adapter
K-5391 .....Lear 45 Cradle Plates (Hold Down)
Z-9292.....Dash 8 Stand-Off Plate

2.0 SAFETY INFORMATION

2.1 USAGE AND SAFETY INFORMATION

To insure safe operations please read the following statements and understand their meaning. Also refer to your equipment manufacturer's manual for other important safety information. This manual contains safety precautions which are explained below. Please read carefully.

WARNING! — Warning is used to indicate the presence of a hazard that ***can cause severe personal injury, death, or substantial property damage*** if the warning notice is ignored.

CAUTION! — Caution is used to indicate the presence of a hazard that ***will or can cause minor personal injury or property damage*** if the caution notice is ignored.

2.2 SAFETY SWITCHES

1. The Emergency-Stop switch (ES1 or ES2) shuts off the main vehicle contactor and cuts all power from the battery. **WARNING! Do not press the Emergency-Stop switch while in motion unless an emergency truly exists. The Emergency-Stop switch will turn off all electric braking systems and rely on the parking brake to stop the vehicle.**
2. The Seat Switch (SW3) controls the controller input that limits the eJP-10 to creep speed. If the seat switch is not pressed, the eJP-10 will be limited to the programmed creep speed.
3. The solid state switch in the top of the accelerator pedal controls the Interlock (deadman) switch. The same switch also controls the release of the parking brake.
4. The "Start" function of the Key Switch (KS1) turns on relays K1, K2, and K3 to start the eJP-10. If the Key Switch is turned 'OFF" while in motion, the effect will be the same as pressing the Emergency-Stop. **WARNING! Do not turn the Key Switch to OFF while in motion. The Key Switch will turn off all electric braking systems and rely on the parking brake to stop the vehicle.**

2.3 DRIVING SAFETY

1. EJP-10, like any piece of machinery, should be operated by responsible personnel who are alert, attentive and aware of the potential for serious injury or death. Operators should not be under the influence of intoxicants, drugs or any substance that would alter or impair their actions or ability to make responsible and prudent judgments. No person should be allowed to operate the eJP-10 without reading and understanding this operator manual.
2. Operators are expected to know and observe all normal safety procedures for working around aircraft. The operator's knowledge of these general aviation safety procedures is a basic assumption for this manual. The omission of general aircraft safety procedures from the eJP-10 Operator's Manual is no excuse for the operator's failure to apply them.
3. Proper attire should be worn while operating eJP-10. Loose fitting clothing should be avoided. Appropriate outdoor work shoes should be worn at all times.
4. Do not leave the eJP-10 until the parking brake is set.
5. Do not leave the eJP-10 unattended when children are present.
6. The eJP-10 is normally stopped by slowly releasing the accelerator pedal. When stopping on an incline, release the accelerator pedal slowly to reduce roll-back. Use the foot brake if a stronger stop is needed. The parking brake will set when the eJP-10 comes to a complete stop and the accelerator pedal is not pressed.
7. For the smoothest transition while towing an aircraft, the tug should be brought to a stop before changing direction on the F-N-R switch.
8. Always accelerate and brake as smoothly as possible to prevent possible aircraft damage.
9. For moving aircraft up or down inclines/slopes, a qualified operator should be in the aircraft cockpit to utilize the aircraft's brakes for safety/backup.
10. When moving in reverse direction, look both ways and clear the area of other traffic and obstacles.

WARNING!

Do not allow anyone to sit or ride on the diamond plate or front fenders of the *eJP-10* while in motion.

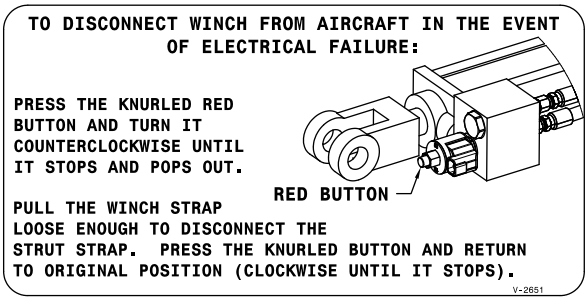
2.4 BATTERY SAFETY

1. The diamond plate over the batteries should always be open when charging the batteries indoors. During the charging cycle, explosive hydrogen gas is expelled. Open flame or sparks must be avoided. Do not smoke near the batteries while charging.
2. **Important**! All switches need to be turned off before plugging in the eJP-10 for charging.
3. Eye protection and rubber gloves should be worn when adding water or working with the batteries. Remember that the current capability of the batteries is extremely high.
4. Read Appendix III and Appendix IV understand safety procedures for working around batteries.

2.5 MOVING DISABLED TUG

2.5.1 Disconnect Winch

1. Chock the main landing gear of the aircraft involved.
2. Carefully lift the battery cover on the driver's side of the eJP-10.



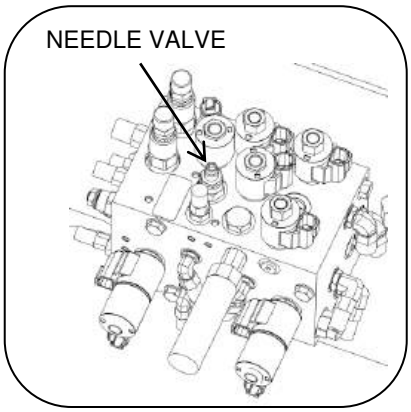
CAUTION!

The cover is equipped with gas springs. Do not allow the batter cover to hit the aircraft.

3. In the center of the tug, locate the valve with the red knurled button at the rod end of the winch cylinder. Press the knurled button and turn it counter-clockwise until it stops and pops out.
4. The winch strap can now be pulled loose enough to disconnect the strut strap from the aircraft.

2.5.2 Lower Cradle

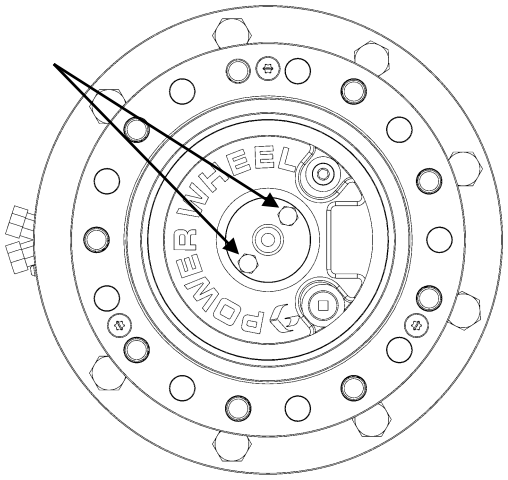
A ¼ inch hex key wrench will be required



1. Find the needle valve (NV1) located on the top of the valve block. The valve is referenced by the label Emergency Cradle Lowering Valve.
2. Open the needle valve very slightly (counter clockwise) to allow the cradle to lower. Tighten the valve (clockwise) to stop the cradle. It is best if the cradle can be stopped with the front edge still approximately ½ to ¾ inch off the ground.

2.5.3 Brakes and Steering on Disabled Tug

1. The eJP-10 is equipped with a mechanical parking brake that is set when there is no hydraulic power. If the eJP-10 needs to be towed, the torque hubs must be unlocked. Unlocking the hubs allows the drive wheels to turn without turning the brake or motor. To unlock, use a 7/16 wrench or socket and remove the two bolts from the round disc in the center of the hub. Flip the disc over and re-install so that the button presses on the center pin. To re-engage hubs put the center disc back to its original position.
2. If the hydraulic pump does not run, the tug can still be maneuvered with the steering wheel. Move the steering wheel slowly (it will be hard to turn) as the tug is rolling.



WARNING!

When the torque hubs are unlocked, the eJP-10 does not have brakes. Move the eJP-10 slowly. Wheel chocks must be used for stopping.

3.0 TRAINING

3.1 TRAINING REQUIREMENTS

The employer of the operator is responsible for providing a training program sufficient for the safe operation of the unit.

3.2 OPERATOR TRAINING

The operator training should provide the required training for safe operation of the unit.

NOTE: Maintenance and Trouble Shooting are to be performed by a skilled and trained technician.

4.0 OPERATING INSTRUCTIONS

WARNING!

Do not make sharp turns while moving rapidly. Always look behind you before backing up.

4.1 GENERAL INSTRUCTIONS

1. To start the eJP-10, the Emergency-Stop (E-Stop) switch on the driver's console must be in the released position and the E-Stop switch on the left front fender must be in the released position. To release E-stops, turn clockwise and release.
2. Sit down in the operator's seat. Turn the Forward/Neutral/ Reverse (F/N/R) switch to Neutral.
3. Turn the "Off- On-Start" switch to "Start" and hold for one second. The Operator display screen will come on at this time.
4. The hydraulic pump will start when:
a. The F/N/R switch is moved out of Neutral
b. Or the Cradle or Winch functions are used
5. Make sure the cradle is off the ground before moving. This is accomplished by pressing the "UP" side of the cradle toggle switch.
6. This tug is NOT designed to coast. Accelerating, braking, and maintaining a constant speed, are all very dependent on foot pedal position. This results in a tug that is very easy to drive and extremely easy to control on inclines. Push the throttle pedal to accelerate, slowly release the throttle to brake. Hold the throttle steady for a steady speed.
7. The switch located under the driver's seat must make contact before the eJP-10 will drive at "sitting speeds". If the driver is in the standing position, the eJP-10 will be limited to "Creep Speed" (approximately 1 mph). All towing positions on the Aircraft Selection switch are limited to 4 mph (6.4 kph). The return to Gate position is limited to 7 mph (11 kph)
8. If the eJP-10 is to be left On when the driver exits the driving position place the F/N/R switch in Neutral. This will prevent the hydraulic system from cycling on and off (charging the accumulator) while the tug is not in motion.
9. The parking brake will set automatically when the eJP-10 comes to a complete stop. The parking brake will also set when the key is turned off or when either Emergency-Stop switch is pressed. (Either of the latter two actions will cause the hydraulic accumulator to discharge.)

Warning

Turning the "Off-ON-Start" switch to "Off" while driving will result in a complete loss of electric braking and stopping will rely on the parking brake. Pressing either Emergency-Stop switch while driving will result in a complete loss of electric braking and stopping will rely on the parking brake.

10. The eJP-10 steers very easily. Turning the steering wheel 3-1/4 turns from center will result in turning the steering tires approximately 87º. During a sharp turn, the inside motor will slow to a stop then reverse direction. The eJP-10 is designed to be very maneuverable at slow speeds in tight places, NEVER enter into a turn at high speed. Loss of control will cause personal injury and property damage. Do not move your eJP-10 any faster than is necessary.
11. The steering console can be fully raised to allow the driver to stand while positioning the eJP-10 at the aircraft nose wheel. While the driver is in the standing position, the eJP-10 will be limited to "Creep Speed". This provides better throttle control for capture. While standing, do not apply any sudden throttle or brake that may cause loss of balance. Never drive while standing except for very slow final positioning. Do not allow anyone in the passenger compartment to stand while the tug is in motion. The steering console is raised by pulling the lever on the left hand side of the console and lifting upward.

WARNING!

The standing position on the eJP-10 is intended for approaching the aircraft for capture only. Release the aircraft from the sitting position.

WARNING!

Do not make sharp turns while moving rapidly. Always look behind you before backing up.

WARNING!

When moving tug under or out from under the nose of a Gulfstream, Global, or other aircraft with a slanted strut, make sure the winch strap is loosened before swinging. Angle of nose strut can cause winch strap to over tighten causing damage to the nose gear.

4.2 LOADING AIRCRAFT

1. On the driver's control panel, choose between Over Steer Protection (OSP) On or Off. Choosing OSP On adds over-steer protection (some restrictions will apply; refer to section 5.3 Over-steer Protection and 5.4.2 Using The Nose Gear Offset Plate). The OSP Off selection bypasses the over-steer protection.
2. Choose the Max Push/Pull force that best matches the aircraft manufactures limits.
3. Make sure the aircraft nose wheel steering system, hydraulic system, and/or mechanical linkages are either bypassed or disconnected so the wheel is free to turn within the aircraft's prescribed limits. Always check with the aircraft operator to determine the acceptable methods for moving their aircraft.
4. Insure that the winch and strut strap are not twisted or positioned in such a way that it may damage any part of the aircraft assembly to which it is attached for winching or towing.
5. Make sure the strap is narrow enough and positioned properly so it does not interfere with sensors, lines, cams, linkages or other fittings on the aircraft wheel strut. Use of the 1.5 inch-wide strap is recommended. Heavier straps can be requested.

WARNING!

Do not install the strut strap around the wheel strut so that it could damage any part of the wheel assembly, tires, hydraulic lines, up-locks or sensors during winching or towing operation.

CAUTION!

Do not contact the shiny oleo surface with any metal strap components.

WARNING!

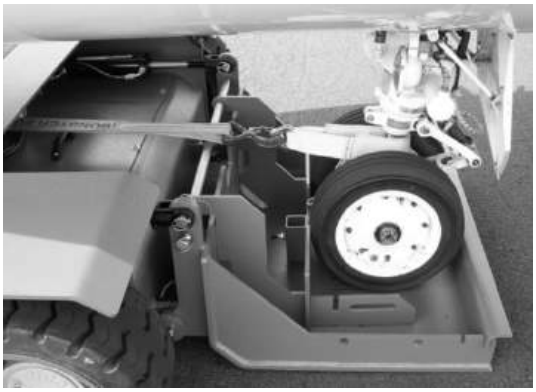
Some aircraft are authorized by their manufacturers to be moved by towbarless tugs using only approved adapters in lieu of the nylon strut strap. Verify with the aircraft operator the approved method for towing a particular aircraft.

4.3 OVER-STEER PROTECTION

The over-steer protection system is for dual nose wheel aircraft. When pulling the aircraft onto the cradle, both tires should make contact with the mat switch. The operation is simple; when the amount of torque applied to the NLG is sufficient to cause one tire to pull away from the mat switch, the winch will release to relieve the torque. If both wheels leave the mat switch, the winch will hold tight. For the best protection, the cradle needs to remain low with the front edge approximately 3 inches off the ground. Also, there needs to be space in the cradle for the wheels to pivot if an over-steer event takes place. For over-steer protection, leave the side plates spread as wide as possible or remove them. On larger diameter tires, the rear safety gate will also limit the degree of over-steer protection. If the wheels are allowed to firmly contact the rear safety gate and the cradle mat at the same time, the NLG will no longer be protected by the over-steer system. The addition of the cradle safety strap will not cause sufficient force to adversely affect the over-steer protection.

4.4 LOADING AIRCRAFT PROCEDURE

4.4.1 Normal Loading



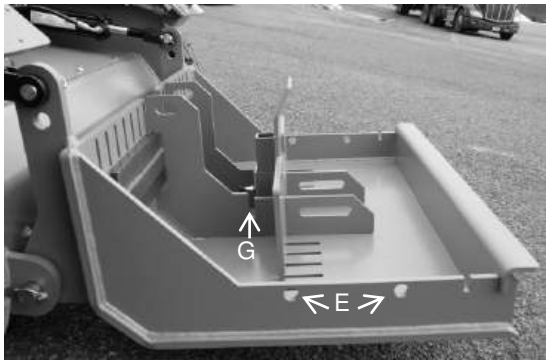
Position the eJP-10 in front of the aircraft nose wheel then lower the lift cradle to the ground. Attach the strut strap (or appropriate towing adapter) to the aircraft nose strut in such a way as to not damage the strut, switches or other components that may be part of the nose landing gear. Center the protective sleeve of the strut strap to insure only the sleeve is in contact with the aircraft. Using the winch controls mounted on the left front fender, extend the winch strap out far enough so it can be attached to the strut strap. Make sure the chocks have been removed and the aircraft brakes are not set. Using the front controls so you can monitor the aircraft nose gear, winch the aircraft onto the lift cradle until the nose wheel touches the cradle mat located on the front wall of the cradle. For dual nose wheels, both tires should touch the cradle mat. When the tire touches the cradle mat, a relief valve will reduce the pulling strength of the winch system to 400 lbs. This is to help prevent any inadvertent excess stress on the nose gear. Use the "Cradle Up" button to raise the front edge of the cradle approximately 3 inches off the ground. Re-tighten the winch strap after lifting the cradle.

4.4.2 Alternative Loading (Pulling the Cradle Under the Aircraft)

There are times when it is not desirable to allow forward movement of the aircraft while loading. This is especially true in tight hangar conditions. For these situations, the eJP-10 cradle can be pulled under the aircraft.

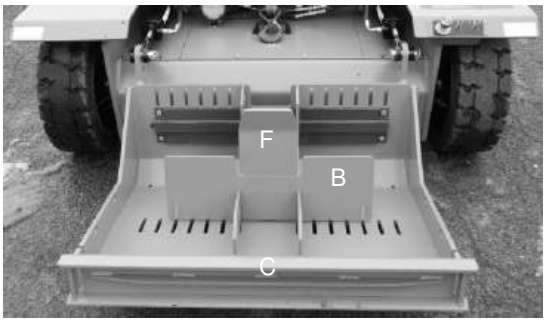
Set the Forward/ Neutral/ Reverse switch to Forward (this is necessary for eJP-10 parking brake release). The green LED lamp on the fender panel will indicate that the parking brakes have sufficient hydraulic pressure for brake release. Note: if the green light does not come on, check the position of the Forward/ Neutral/ Reverse switch.

Position the eJP-10 in front of the aircraft and connect to the aircraft as in “Normal Loading”. Leave the main gear wheel chocks in place and/or aircraft brakes set. Lift the cradle approximately ½ inch off the ground or floor. Use the Winch In command at the front fender while pressing the Brake Release button. When the NLG tires reach the back of the cradle, raise the cradle to 3 inches above the ground and re-tighten the winch strap as in “Normal Loading”.



4.4.3 Using The Nose Gear Offset Plate

Aircraft having forward facing torque links or gear doors (like Jetstream, Gulfstream G200, Westwind, MU2) will require you to use the offset plate (B) to keep the torque links or gear doors from contacting the cradle front wall. The default position for this plate is the closest slot (G) to the cradle wall. Set the movable side plates (A) to the proper width so the offset plate can slide into place. The offset plate has two possible positions for the moveable side plates. The inner two slots in the offset plate are for single nose wheel aircraft and the two slots closest to the outside of the offset plate are for dual nose wheel aircraft.



NOTE: When using the offset plate for a dual nose wheel aircraft, over-steer protection is limited to the wheel movement between:

- **The side plates. If the wheels are allowed to contact the side plates, the NLG will no longer be protected by the over-steer system.**
- **The offset plate and the rear safety gate. If the wheels are allowed to firmly contact the rear safety gate and the offset plate at the same time, the NLG will no longer be protected by the over-steer system.**

Some aircraft are required to use adapters in order to be towed by towbarless tugs (like Falcon 50, Lear 45). Under these circumstances the offset plate should be used to allow the aircraft to be loaded safely without the towbar head contacting the forward wall of the cradle. If a single nose wheel aircraft were being loaded using an adapter it would be easiest to not have the single nose wheel adapter (F) in place on the offset plate yet. Pull the aircraft in with the winch first until the nose wheel is in close proximity to the offset plate. Then slide the single nose wheel adapter (F) into its receiver and make sure it is locked in place by the spring plunger. Then snug up the nose wheel to the offset plate with the winch.

Depending on the size of the towbar head adapter, it may be necessary to use the second offset plate slot (G) to provide enough space for the adapter to fit in front of the cradle wall.

A. Movable Side Arms
B. Nose Gear Offset Plate
C. Rear Safety Gate
D. Cradle Mat
E. Safety Strap Holes
F. Single Nose Wheel Adapter
G. Offset Plate Slots

WARNING!

When using the offset plate for a dual nose wheel aircraft, over-steer protection is limited to the wheel movement between the side plates. If the wheels are allowed to contact the side plates, the NLG will no longer be protected by the over-steer system.

WARNING!

When using the offset plate for a dual nose wheel aircraft, over-steer protection is limited to the wheel movement between the offset plate and the rear safety gate. If the wheels are allowed to firmly contact the rear safety gate and the offset plate at the same time, the NLG will no longer be protected by the over-steer system.

WARNING!

Be extra careful when moving aircraft on inclines as aircraft or tug may move unexpectedly. Make sure no personnel are in the direct path of the aircraft or tug.

4.4.4 Safety Ratchet Strap

Secure the aircraft nose wheel with the safety ratchet strap. Position the strap so as not to damage any aircraft component and tighten with the ratchet to be just snug. The strap attaches through one of the two sets of rings (E) in the cradle side arm and runs across the top of the tire in front of the nose wheel strut and down to the corresponding ring in the other cradle side arm. In most cases it is preferable to run the safety strap over the top of the strut strap.

Drop the rear safety gate into the slots in the cradle side arms.

WARNING!

Pay close attention to where disconnected scissors rest. With the change in angle of the cradle moving up and down, a nose strut scissor could fall down and become pinched against the rear gate, causing significant damage.

4.5 PREPARING TO MOVE THE AIRCRAFT

Raise the lift cradle enough to safely clear obstacles on the ground and to provide necessary clearance between the aircraft and top of tug to avoid damage if the oleo strut compresses. For over-steer protection applications, limit the cradle lift to approximately 3 inches measured from the ground to the edge of the cradle. After raising the cradle, the winch strap will loosen due to the rotation of the cradle. Push the “winch in” button and snug up the winch strap prior to moving the aircraft.

WARNING!

Do not raise the cradle fully unless it is necessary to drop the tail of the aircraft to clear an obstacle. Lifting the nose wheel too high will cause a shift in the aircraft’s center of gravity and this could cause the aircraft to tip onto its tail.

4.6 MOVING THE AIRCRAFT

Move the aircraft slowly by choosing the direction of desired travel and slowly pressing the foot throttle.

4.7 UNLOADING THE AIRCRAFT

1. Loosen the winch strap and lower the lift cradle to a position 1/2” above the ground. Chock the aircraft and remove rear safety gate, strut strap and safety strap.
2. Back the eJP-10 away from aircraft, allowing the nose wheel of aircraft to roll off the lift cradle onto the ground.

5.0 QUICK NOTES ON BATTERY CARE

This section provides very general instructions for battery care. The battery in this vehicle represents a large investment and proper care of the battery is vital to the performance of this vehicle. Refer to Appendix III in this manual for the full Crown Battery Service Manual.

5.1 SAFETY

1. Always wear eye protection and rubber gloves when working with batteries.
2. Never wear jewelry, watches or rings while working around batteries.
3. When working on eJP-10, always UNPLUG the battery from the tug. The battery pack is capable of extremely high currents and could cause serious damage or injury if short-circuited.
4. If battery acid is accidentally spilled on the skin, immediately flush the area with large amounts of water. **Electrolyte splashed in the eyes is extremely dangerous!** If this should happen, force the eye open and flood it with cool, clean water for approximately fifteen minutes. A doctor should be called immediately when the accident occurs.
5. If you have any doubts or questions, contact Tronair, Inc.
6. The tug charging location should have good ventilation to the outside air. Signs should be posted for “Explosive Gases”, “No Smoking”, “No Sparks”, “No Open Flames”, and “No Electric Motors”. Check for additional local ordinances concerning battery-charging safety.

5.2 WATERING

1. Add approved water only to a fully charged battery. If the water in your area is not suitable (due to chemicals and impurities) used distilled or de-ionized water.
2. Keep battery cells filled to proper level. Low water can cause permanent damage to batteries.
3. Check water level once a week. Replace water lost to evaporation. Never add water to a discharged battery. If upon inspection water is below the battery plate separators before charging, add just enough water to cover the separators.
4. Never add sulfuric acid to a battery.
5. Do not transfer acid from one cell to another. Never allow the batteries to stand in an uncharged state. Plate damage will occur.

5.3 CHARGING

1. **Keep** battery **compartment open during charging to ensure proper ventilation.**
2. The batteries should be recharged when the state of charge indicator has declined to 30-40% (all green lights off).
3. Keep flame and metal away from the battery tops to prevent battery gasses from exploding.
4. Cool before charging or operating, if battery is above 115º F.
5. Press the emergency stop switch to shut off all electronics prior to charging. In the event that the emergency stop switch is not pressed, the limit switch at the charging plug will shut the tug off.

5.4 PRECAUTIONS

1. Read Appendix III and “Safety Precautions”
2. Keep battery tops clean and dry.
3. Be sure battery caps are on and secure for spark protection.
4. Check specific gravity levels weekly, after charging, but not directly after service watering. Refer to Appendix III.
5. Do not overcharge batteries. Allow several hours use between charges.

6.0 UNDERSTANDING SYSTEM FUNCTIONS FOR TROUBLE SHOOTING

6.1 EJP-10 DRIVE TRAIN SYSTEM

The eJP-10 is powered by two 13HP AC motors. The motors are connected directly in-line with the brakes and torque hubs for maximum mechanical efficiency. Motor input to Hub output ratio is 37.5:1. The maximum programmed draw-bar pull is 7000 lbs. (horizontal pulling value).

The motors are driven by two separate motor controllers; each is rated at 450 amps for 2 minutes and 185 amps continuous (1 hour). The controllers work in a Master/Slave configuration. Proportional steering is accomplished with Curtis Dual Drive Operation.

The maximum empty driving speed is 7 MPH. Acceleration and deceleration rates are programmed for smooth starts and stops thereby limiting the load applied to the NLG.

6.2 OVER-LOAD SYSTEM

The output torque, and thereby drawbar-pull, is controlled by programming maximum amperage limits for a given input. The input signal is provided by a six position selector switch. The present limits are set for draw-bar pulls of 3700 lbs., 4500 lbs., 5400, 6400 lbs., and 7000 lbs. If a situation is encountered that requires higher amperage than the pre-set limit, the EJP-10 will come to a stall. The winch is limited to a value just slightly below the draw-bar pull for each setting. When the winch reaches its maximum pull strength for the chosen input setting, the relief system will begin to cycle.

6.3 BRAKE DESCRIPTION

The eJP-10 has electric dynamic braking and two hydraulically opened parking brakes. The dynamic braking system is regenerative electric braking from the motors and is provided in two forms. First, as the operator reduces pressure on the accelerator pedal, either partially or fully, the motors begin braking. This is a soft regenerative braking and typically is sufficient for stopping the aircraft. If additional stopping power is needed, the foot brake can be used to provide stronger regenerative braking. This tug is designed to NOT coast when the accelerator pedal is released. Holding the throttle steady will result in a steady speed. Releasing the throttle will apply programmed regenerative braking.

The parking brakes consists of two “multiple disc type” brakes, one on each drive motor. These are located at the end of each motor. The brakes are spring set and are hydraulically opened when the accelerator pedal is used. When the tug comes to a stop, the parking brakes will set automatically. If stopping on an incline, release the accelerator pedal slowly. This will allow the Hill-Hold feature to take effect and limit roll-back as the parking brakes set.

In some tight hangars it is desired to pull the eJP-10 cradle under the aircraft tires. Some models starting mid 2021 will have a Brake Release button near the Winch In button on the fender panel. The Forward/ Neutral/ Reverse switch must be set to Forward. This allows the hydraulic pump to run and maintain enough pressure for brake release. The green LED on the fender panel indicates that there is sufficient hydraulic pressure for brake release. When the Brake Release button is pressed along with the Winch In button, the winch will pull the eJP-10 forward.

6.4 OVER-STEER/ OVER-TORQUE PROTECTION SYSTEM FUNCTION

The over-steer/over-torque protection allows enough travel in the winch strap to relieve the torque on the NLG. Initially there is a small amount of stretch in the winch strap and flex in the tires. When sufficient torque is applied to the NLG to cause one of the tires to pull away from cradle may, the winch strap will travel outward to relieve the torque. If the second tire pulls away from the cradle mat, the winch strap will lock again. To apply over-steer protection, set the OPS switch to the On position.

6.5 HYDRAULIC SYSTEM

The hydraulic system is used for parking brake release, steering, cradle motion, and winch motion. The hydraulic system uses an accumulator to store power for steering and brake release. A pressure switch turns the system on at 1350 PSI and off at 1850 PSI for accumulator charging. The hydraulic pump has an internal 2500 PSI relief valve. See INS-2387 hydraulic schematic.

6.6 RELAY FUNCTION and CONTACTOR FUNCTION (ELECTRICAL TROUBLE SHOOTING)

- In series, the Key On switch and driver's panel Emergency-Stop switches control 72VDC power to the coil of Contactor 1. When energized, Contactor 1 turns on the 72V-24V DC/DC converter.
- 24 V power is available to the Key Switch (KS1) when the converter is ON. Turning the Key Switch to the Start Position (KS2), Turns on Relays K1, K2, and K3.
- K1 is simply the Key Switch memory circuit.
- K2 applies 24VDC to the remainder of the 24V circuit.
- K3 applies power to the 12V lighting circuits.
- K4 turns the pump throttle signal on. On models having the Brake Release button on the fender panel, the pump throttle is controlled by VCL on the CAN bus and the K4 relay is not used.
- K5 is a brake light relay and only used with a Brake Light /Turn signal option.
- K6 is used to close the SV5 brake valve when the eJP-10 is turned on..
- Contactor 2 is the main vehicle contactor and is pulled in when K2 relay closes. This contactor remains energized throughout operation.
- Contactor 3 and 4 are the motor controller contactors and are pulled in by the Master and Slave controllers. Both of these contactors remain energized throughout operation.
- Contactor 5 is turned on by the Pump Motor controller when the Key Switch is turned to start. This contactor remains energized throughout operation.
- All drive speed, current limit, and winch limit functions are programmed into the Curtis 1238 motor controllers.

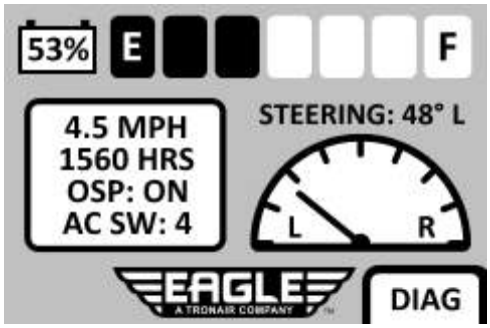
6.7 PRELIMINARY TROUBLE SHOOTING

TROUBLE	PROBABLE CAUSE	ACTION
Won't Start	Is the E-stop at the driver's panel pressed?	E-stop must be released. Turn clockwise to release
	Is the charger plugged in?	Vehicle must be off charge and have the battery plugged into the vehicle.
	Was the On switch held in the Start position?	May have to hold in Start position 1-2 seconds
	Is the battery dead?	Check battery charge
	Has the battery been unplugged from the vehicle?	Check under the front cover on the driver's side to see that the battery is plugged into the vehicle
	Is the E-stop on the front left fender pressed?	E-stop must be released. Turn clockwise to release
Won't Move	Is the driver sitting in the seat?	Switch in seat must make contact for driving at normal speed or towing at any speed.
Won't Move While Standing	Seat switch must make contact after initial start.	If the vehicle was started with the driver standing, driver must sit to initiate seat switch before continuing.
Slow Speed Only	Is the driver sitting in the seat?	Switch in seat must make contact for driving at normal speed or towing at any speed.
Winch makes cycling noise and fails to move aircraft	Is the Aircraft Selector switch in the correct setting for the aircraft? Are the brakes on the aircraft set?	The winch will only pull as hard as the value selected on the Aircraft Selector switch.

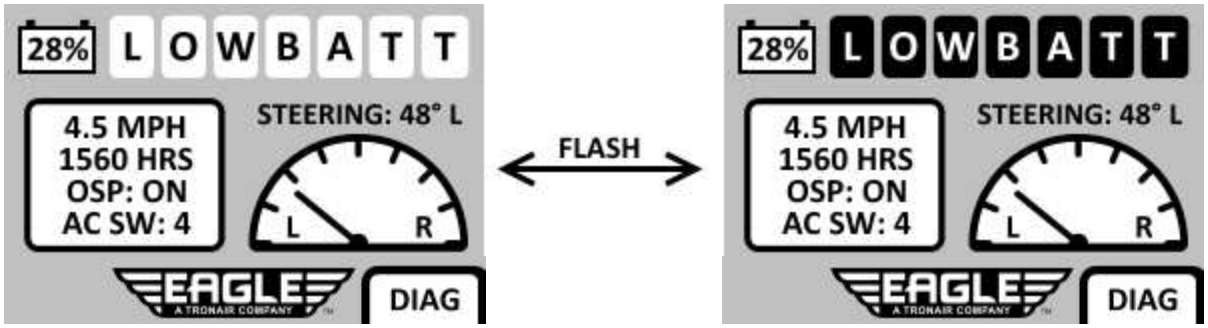
6.8 DASH DISPLAY

6.8.1 Main Run Page

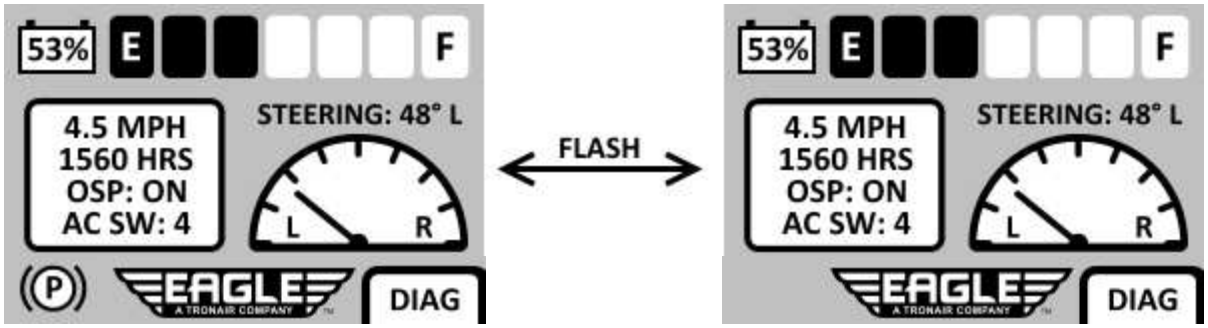
This screen will be displayed at vehicle start-up.



- Visual Steering Angle indicator will show steering tire position.
- Textual Steering Angle display shows steering tire position in degrees right (R) or left (L)
- Visual Battery State of Charge display is shown. Each bar equals approximately 10% of battery capacity.
- Textual Battery State of Charge shows percentage of remaining charge.
- A LOWBATT indication will flash along with red LED lights when battery state of charge is equal to or below 30% (1 second on, 1 second off).



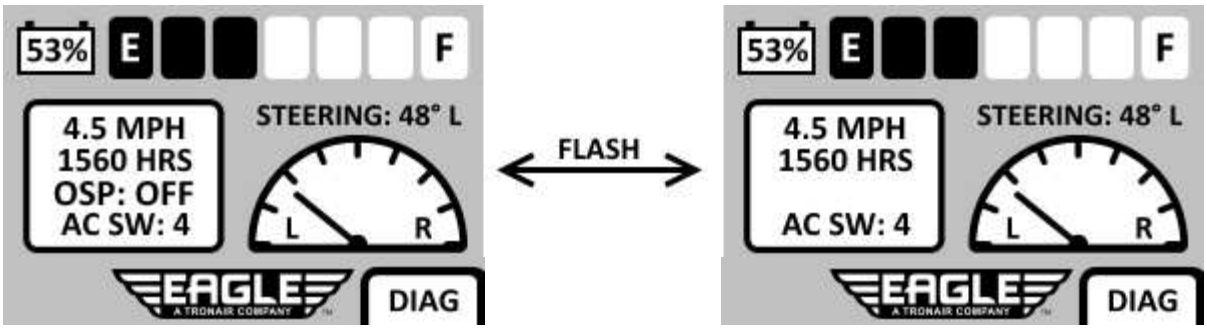
- Speed is shown in MPH. (Based on speed of left hand motor.)
- The Hour Counter is shown below the speedometer.
- Oversteer Protection status, ON or OFF is shown below the Hour Counter.
- Aircraft Switch position is shown as AC SW: (1-6).
- A ((P)) will flash when the Parking Brake is engaged (1 second on, 1 second off).



6.8.2 Error Messages

- An Over-Steer Fault will cause the red LED's to flash (1 second on / 1 second off) and will show a warning message "OVERSTEER FAULT" similar to below.
- When a Controls Error is active, the red LED's will flash (1 second on, 1 second off) and the warning message "CONTROLS FAULT" will be displayed.

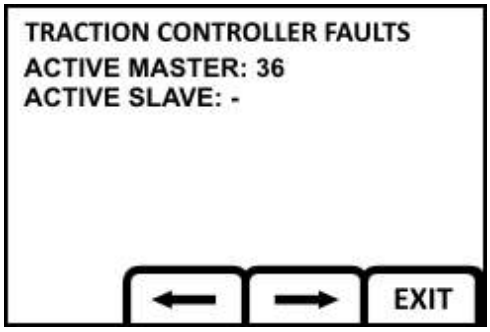
- When Over-Steer Protection is turned OFF, the "OSP: OFF" text will flash (1 second on, 1 second off).



6.8.3 Diagnostic Screens

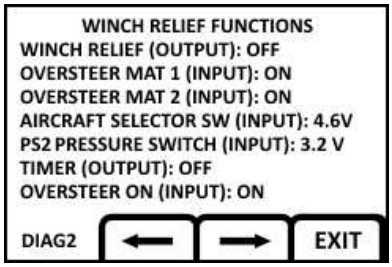
Pressing the “D” button will enter the diagnostic screens. Diagnostics are broken into “pages” for viewing. Arrow buttons will toggle between pages, with “EXIT” returning to the main menu.

Curtis Controller Error Display:
The screen displays 2-digit numeric codes from the Master or Slave controller. All active codes in a display loop.

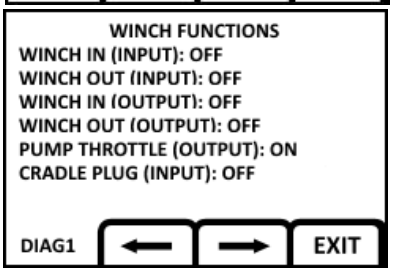


The remaining screens are used for diagnostic and trouble-shooting purposes. The next 5 screens show the On/Off status of inputs and outputs that are programmed into the Master and Slave motor controllers.

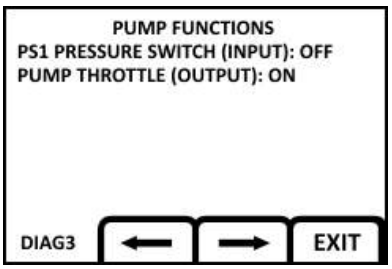
Winch Functions:
Winch In input (S-J1-11) ON/OFF
Winch Out input (S-J1-12) ON/OFF
Winch In output (M-J1-4) ON/OFF
Winch Out output (M-J1-3) ON/OFF
Pump Throttle output (M-J1-20) ON/OFF
Cradle Plug input (M-J1-14) ON/OFF



Winch Relief Functions:
Winch Relief output (S-J1-3) ON/OFF
Oversteer Mat 1 input (S-J1-22) ON/OFF
Oversteer Mat 2 input (S-J1-33) ON/OFF
Aircraft Selector value input (M-J1-24) 0-10 VDC
PS2 input (S-J1-24) 0-10 VDC
Timer output (M-J1-19) ON/OFF
Oversteer ON input (S-J1-14) ON/OFF

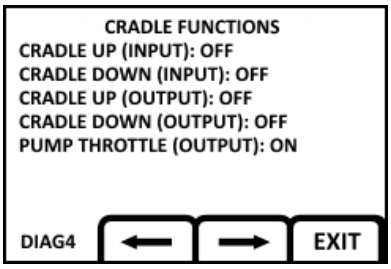


Pump Functions:
PS1 input (M-J1-11) ON/OFF
Pump Throttle output (M-J1-20) ON/OFF

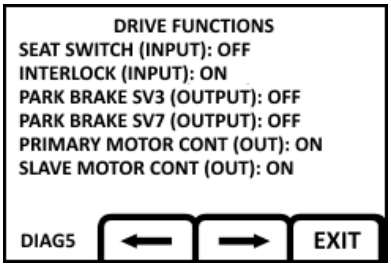


6.8.3 Diagnostic Screens *(continued)*

Cradle Functions:
Cradle UP input from RS1 (S-J1-9)
Cradle DOWN input from RS2 (S-J1-10)
Cradle UP output to SV1A (S-J1-2)
Cradle DOWN output to SV1B (S-J1-4)
Pump Throttle output (M-J1-20) ON/OFF

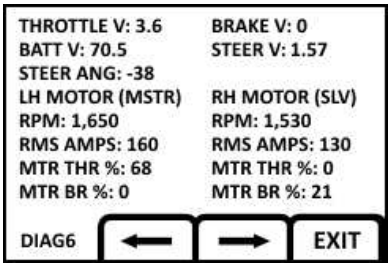


Drive Functions:
Seat Switch input (M-J1-10) ON/OFF
Interlock input (M-J1-9) ON/OFF
Park Brake release output SV3 (M-J1-5) ON/OFF
Park Brake release output SV7 (S-J1-5) ON/OFF
Slave motor contactor output (S-J1-6) ON/OFF
Master motor contactor output (M-J1-6) ON/OFF

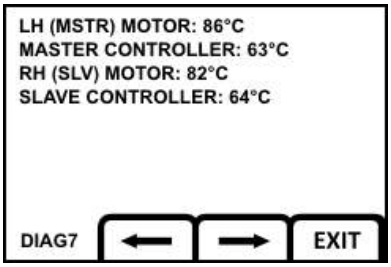


The next 2 screens show information used to trouble-shoot Throttle, Brake, Motor, or heat issues.

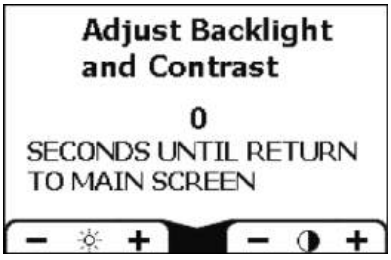
Primary and Secondary Drive Monitor:
System Throttle Voltage
System Brake Voltage
Battery Voltage
Steering Sensor Voltage (2 decimal places required)
Calculated Steering Angle
RPM (x2)
Motor RMS Current (x2)
Motor Throttle Percent (x2)
Motor Brake Percent (x2)



Motor and Controller Temperatures:
LH Master Motor Temperature
Master Drive Temperature
LH Master Motor Temperature
Master Drive Temperature



Backlight and Contrast:
Pressing the “A” button during normal run operation launches the backlight and contrast adjust screen with built-in timeout to return to the main menu.



Units:
Pressing the “B” and “C” buttons simultaneously while on the main Run page will switch speed units from MPH to KPH or vice-versa.

7.0 MAINTENANCE

WARNING!

All work on the eJP-10 tug should be performed by competent repair personnel. Before performing maintenance, review all safety procedures.

7.1 GENERAL MAINTENANCE

WARNING!

Be certain the eJP-10 is turned off and the battery is unplugged before performing any maintenance. The hydraulic accumulator can hold pressures up to 2500 PSI while the power is turned on. The accumulator will dump system pressure through valve SV4 when the power is turned off. This release of pressurized fluid into the reservoir can be heard every time the EJP-10 is turned off may take as long as 15 seconds.

1. Check battery water level weekly.
2. Periodically check the electrical and battery connections for looseness and tighten if necessary.
3. Check all bolts and hydraulic fittings for looseness. Tighten if necessary.
4. If battery acid should spill into the battery box or on metal parts, flush with water and baking soda. Sprinkle baking soda in bottom of battery box to prevent corrosion.

WARNING!

Battery acid is corrosive. Wear gloves and eye protection when servicing batteries.

5. Keep eJP-10 in a clean condition. Check for any unusual conditions, such as bent metal or broken parts.
6. Electric vehicles, such as eJP-10, should never be steam cleaned.
7. Tire Replacement. Replace worn tires with equal or greater capacity tires only. Do not change tire dimensions when replacing tires.

7.2 LUBRICATION

LUBRICATION CHART

Lube Point	Interval	Lube Spec	Remarks
Hydraulic Pump	Daily	MIL-PRF-5606)	Check level
Torque Hubs	First 50 hrs Semi-Annual or 200hrs	80/90 Wt. Gear lube Oil	Change
Lift Cradle Pivots	Monthly	SAE 50	
Hydraulic Cylinder Pivots	Monthly	SAE 50	Lube both ends
Steering Axle Hubs	Annually	Lithium Bearing Grease	Re-pack bearings

CAUTION!

To avoid potential injury or equipment damage, use proper support and block front tires when either end of tug is raised.

1. Repack both steering axle hubs with wheel bearing grease on an annual basis. Clean bearings and remove all old grease using solvent. Do not mix greases having different bases.
2. Check the oil level in the hydraulic pump reservoir every day during preoperational check. Add hydraulic oil, if necessary. Use MIL-PRF-5606 hydraulic fluid. Make sure the cradle and winch cylinders are fully retracted and power is off prior to adding fluid. Fluid level should be at least one and one half inches down from the top.
3. Torque Hub Lubrication. Rotate torque hub so that the two filler holes in the face of the hub are at the 12 and 3 o'clock positions. Remove the level screw at the 3 o'clock position of the axle. If oil is not at the level of the threads, add SAE 90W at the filler plug on top.

7.3 NYLON STRAPS

1. **Pre-shift Inspection Of Straps:** Winch, strut and safety straps should be inspected during the daily pre-shift inspection process.

WARNING!

These straps are the primary means of securing the aircraft to the eJP-10. Failure of these components could result in death or serious injury and/or significant damage to the aircraft.

2. **Worn/Damaged Straps:** Discontinue use of any strap that shows signs of wear or damage such as torn or frayed edges, damaged “D” rings or hooks, loose or broken stitching, signs of chemical damage or holes in webbing of strap.
3. **Periodic Strap Inspection:** Strut and winch straps are degraded in tension capacity by normal wear, age and exposure to the elements. Operators should inspect straps daily during normal pre-shift inspection.
4. **Routine Strap Replacement:** Strut and winch straps should be associated with a specific tug and tracked for age. Straps should be routinely replaced annually or after 150 hours of use, whichever occurs first. Replacement is mandatory if inspection shows any wear or damage that would lower maximum capacity of the straps or fittings.
5. **Non-Routine Strap Replacement:** Appendix VI is provided as a guideline for inspecting straps. **Straps provide the primary securing device for your aircraft and as such should be of primary importance in the maintenance cycle.**

7.4 COMPONENT WEAR

Tires should be replaced when the tread depth is less than ¼ in.

7.5 REPAIRS

1. Repairs needed on your eJP-10 should be performed by competent repair personnel.
2. The batteries in your eJP-10 must be replaced with like batteries. The charger has been designed to operate with this size battery. Do not substitute a higher or lower Amp/hour rated battery. All batteries should be replaced at the same time.
3. **Do not attempt to repair the electronic controller.** Contact Tronair for proper repair procedures.
4. Contact Tronair before making substitutions of any parts.

8.0 PRE-SHIFT CHECKLIST

Perform this check every day prior to the first shift. Place X if ok.
Do NOT operate any EJP-10 unit until all discrepancies have been corrected

	Week Of: _____							
	Date							
Function	**Inspected By**							
Check Fluid Levels								
Hydraulic Reservoir								
Battery Water Level								
Condition Check								
Hydraulic Hose								
Parking Brake Lines								
Winch Hydraulic Lines								
Lift Cradle Hydraulic Lines								
Nylon Winch Strap								
Nylon Attachment Straps								
Tires								
Lights								
Operational Check								
Foot Service Brake								
Dead Man Switch (in accelerator)								
Regenerative Electric Braking								
Steering								
Winch Cylinder								
Lift Cradle								
Cradle Mat								
Leak Check								
Hydraulic Pump Bay								
All Hydraulic Lines								
Battery Cases								
Torque Hubs								
Monthly Torque Specs								
Drive Wheel Lug Nuts – 160 ft lbs								
Rear Wheel Lug Nuts – 90 ft lbs								

Make copies of this page for continued use.

9.0 PROVISION OF SPARES

9.1 SOURCE OF SPARE PARTS

Spare parts may be obtained from the manufacturer:

TRONAIR, Inc.
1 Air Cargo Pkwy East
Swanton, Ohio 43558 USA

Telephone: (419) 866-6301 or 800-426-6301
Fax: (419) 867-0634
E-mail: sales@tronair.com
Website: www.tronair.com

For Spare Parts, Operations & Service Manuals or Service Needs:
Scan the QR code or visit Tronair.com/aftermarket

9.2 RECOMMENDED SPARE PARTS LISTS

Reference the following page(s) for Replacement Parts and Kits available.

K-4225..... Filter Element Kit
K-5250..... Battery Watering Kit
JP-233..... Winch Strap
H-3930 ..... Strut Strap
H-3931 ..... Safety Strap
H-3933 ..... Protective Cover
EC-1619-04..... Low Voltage Limiter Fuse
EC-1619-18..... Low Voltage Limiter Fuse
EC-2113-2.00..... 2 amp Fast Acting Fuse
EC-2113-7.00..... 7 amp Fast Acting Fuse
NVSP-34-007-CA..... LED Headlight

10.0 IN SERVICE SUPPORT

Contact Tronair, Inc. for technical services and information. See Section 1.3 – Manufacturer.

11.0 GUARANTEES/LIMITATION OF LIABILITY

Tronair products are warranted to be free of manufacturing or material defects for a period of one year after shipment to the original customer. This is solely limited to the repair or replacement of defective components. This warranty does not cover the following items:

a) Parts required for normal maintenance
b) Parts covered by a component manufacturers warranty
c) Replacement parts have a 90-day warranty from date of shipment

If you have a problem that may require service, contact Tronair immediately. Do not attempt to repair or disassemble a product without first contacting Tronair, any action may affect warranty coverage. When you contact Tronair be prepared to provide the following information:

a) Product Model Number
b) Product Serial Number
c) Description of the problem

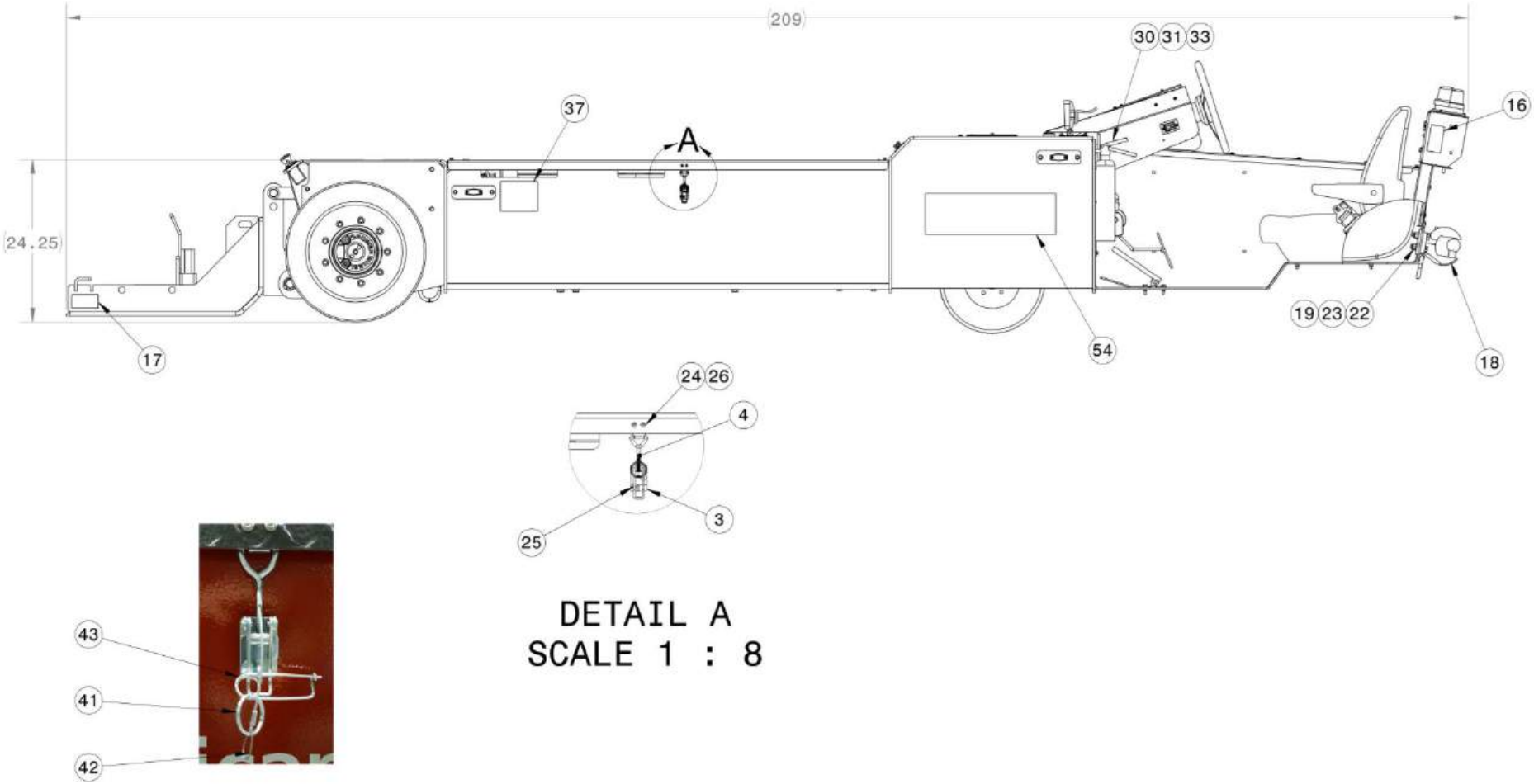
If warranty coverage is approved, either replacement parts will be sent or the product will have to be returned to Tronair for repairs. If the product is to be returned, a Return Material Authorization (RMA) number will be issued for reference purposes on any shipping documents. Failure to obtain a RMA in advance of returning an item will result in a service fee. A decision on the extent of warranty coverage on returned products is reserved pending inspection at Tronair. Any shipments to Tronair must be shipped freight prepaid. Freight costs on shipments to customers will be paid by Tronair on any warranty claims only. Any unauthorized modification of the Tronair products or use of the Tronair products in violation of cautions and warnings in any manual (including updates) or safety bulletins published or delivered by Tronair will immediately void any warranty, express or implied.

The obligations of Tronair expressly stated herein are in lieu of all other warranties or conditions expressed or implied. **Any unauthorized modification of the Tronair products or use of the Tronair products in violations of cautions and warnings in any manual (including updates) or safety bulletins published or delivered by Tronair will immediately *void any warranty, express or implied* and Tronair *disclaims any and all liability for injury (WITHOUT LIMITATION and including DEATH), loss or damage arising from or relating to such misuse*.**

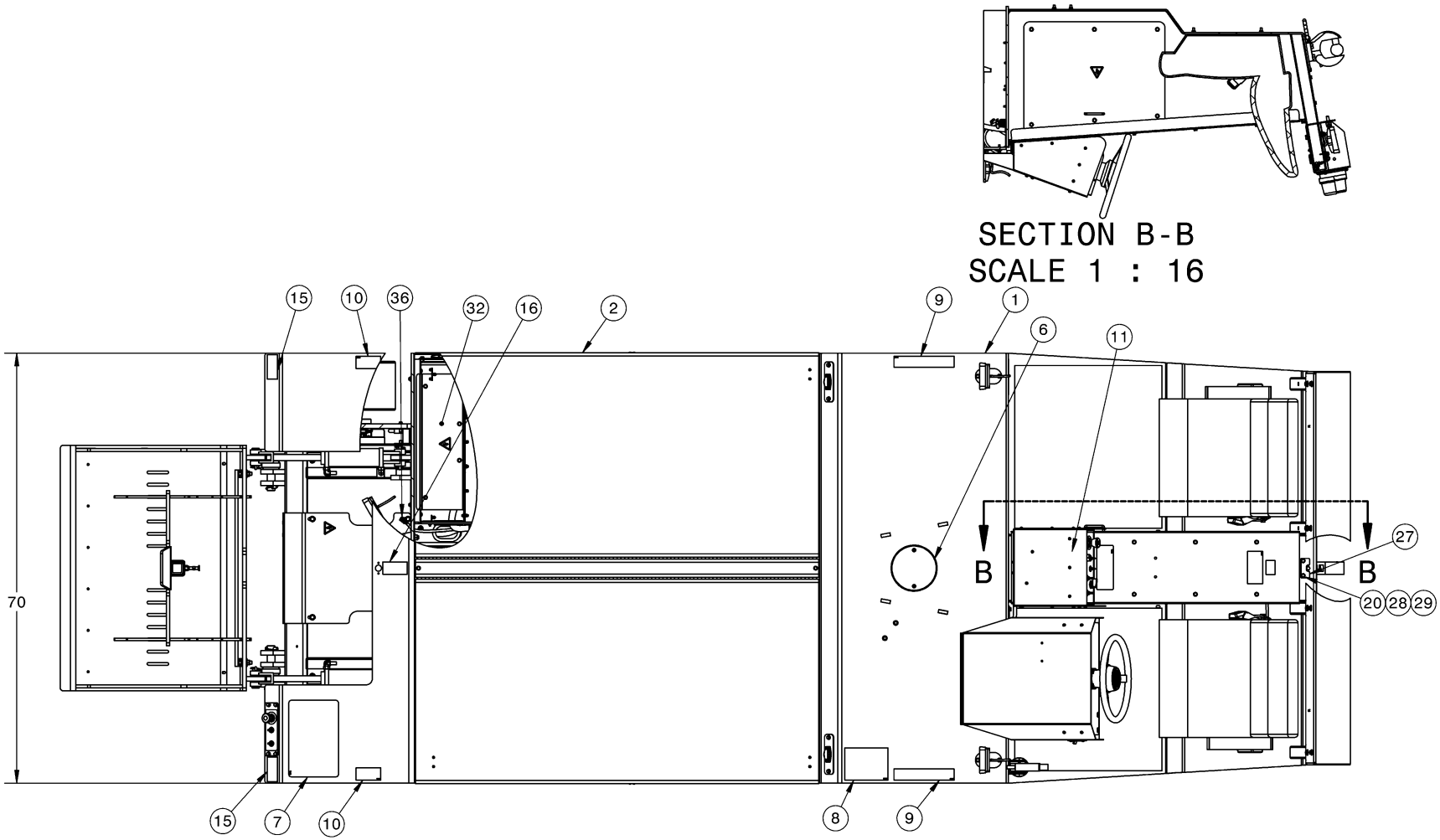
12.0 APPENDICES

APPENDIX I	Wiring Diagram INS-2441
APPENDIX II	Hydraulic Schematic INS-2387
APPENDIX III	Deep Cycle Battery Handling Maintenance and Test Procedures
APPENDIX IV	Lead Acid Batteries Safety Data Sheet (SDS)
APPENDIX V	Curtis Diagnostics and Troubleshooting
APPENDIX VI	Batter Charger Operator/Installer Manual
APPENDIX VII	Flat Sling Inspection
APPENDIX VIII	Royco 756 (MIL-PRF-5606) Safety Data Sheet (SDS)
APPENDIX IX	Declaration of Conformity

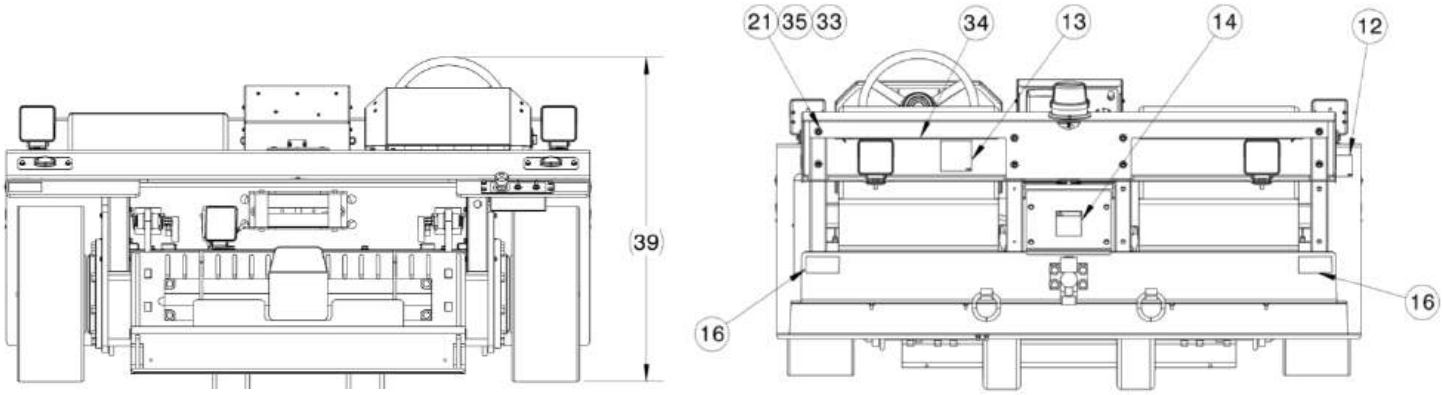
Parts List Illustration



Parts List Illustration



Parts List Illustration



Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
1	Z-9250	ASSEMBLY, HYDRAULIC	1
2	Z-9262	ASSEMBLY, BATTERY COVER	1
3	J-5354	SPACER, LATCH	2
4	H-3627	LATCH, DRAW ADJUSTABLE	2
5	Z-9267	ASSEMBLY, SIDE COVER	1
6	Z-8927	ASSEMBLY, COVER	1
7	V-2859	LABEL, LOADING INSTRUCTION	1
8	V-2187	LABEL, BATTERY INSTRUCTIONS	1
9	V-1814	LABEL, WARNING KEEP 5 FT	2
10	V-2194	LABEL, SIT DOWN	2
11	V-2191	LABEL, CAUTION HANDS/FEET	1
12	V-2249	LABEL, FASTEN SEAT BELT	1
13	V-2118	LABEL, SERIAL NO. (CE)	1
14	Z-9291	ASSEMBLY, HITCH COVER	1
15	H-2899	TAPE, REFLECTIVE WHITE	2
16	H-2807	REFLECTOR, RED	5
17	H-2806	REFLECTOR, YELLOW	2
18	JP-241	COMBO PINTLE HITCH	1
19	G-1503-1090N	FLATWASHER. 1/2 SST NARROW	8
20	G-1503-1050N	FLATWASHER. 1/4 SST NARROW	2
21	G-1503-1070N	FLATWASHER. 3/8 SST NARROW	6
22	G-1202-1090	STOPNUT, 1/2-13 ELASTIC	4
23	G-1112-109522	BOLT, 1/2-20 X 2-1/4" SST HEX HD	4
24	G-1476-103106	SCREW, #10-32 X 3/4" LG. SST SOC BUTT. HD CAP	4
25	G-1152-103710	SCREW, #10-32 X 1.0" LG SOCKET FLAT HD CAP	6
26	G-1202-1035	STOPNUT, #10-32 ELASTIC	4
27	S-3051-01	PLATE, COVER (P)	1
28	G-1502-1050R	LOCKWASHER, 1/4 SST REGULAR	2
29	G-1112-105006	BOLT, 1/4-20 X 3/4" LG SST HEX HD	2
30	H-3075	FIRE, EXTINGUISHER	1
31	G-1476-105010	SCREW, 1/4-20 X 1.0" LG. SST SOC BUTT. HD CAP	2
32	Z-9293	ASSEMBLY, CONTROLLER COVER	1

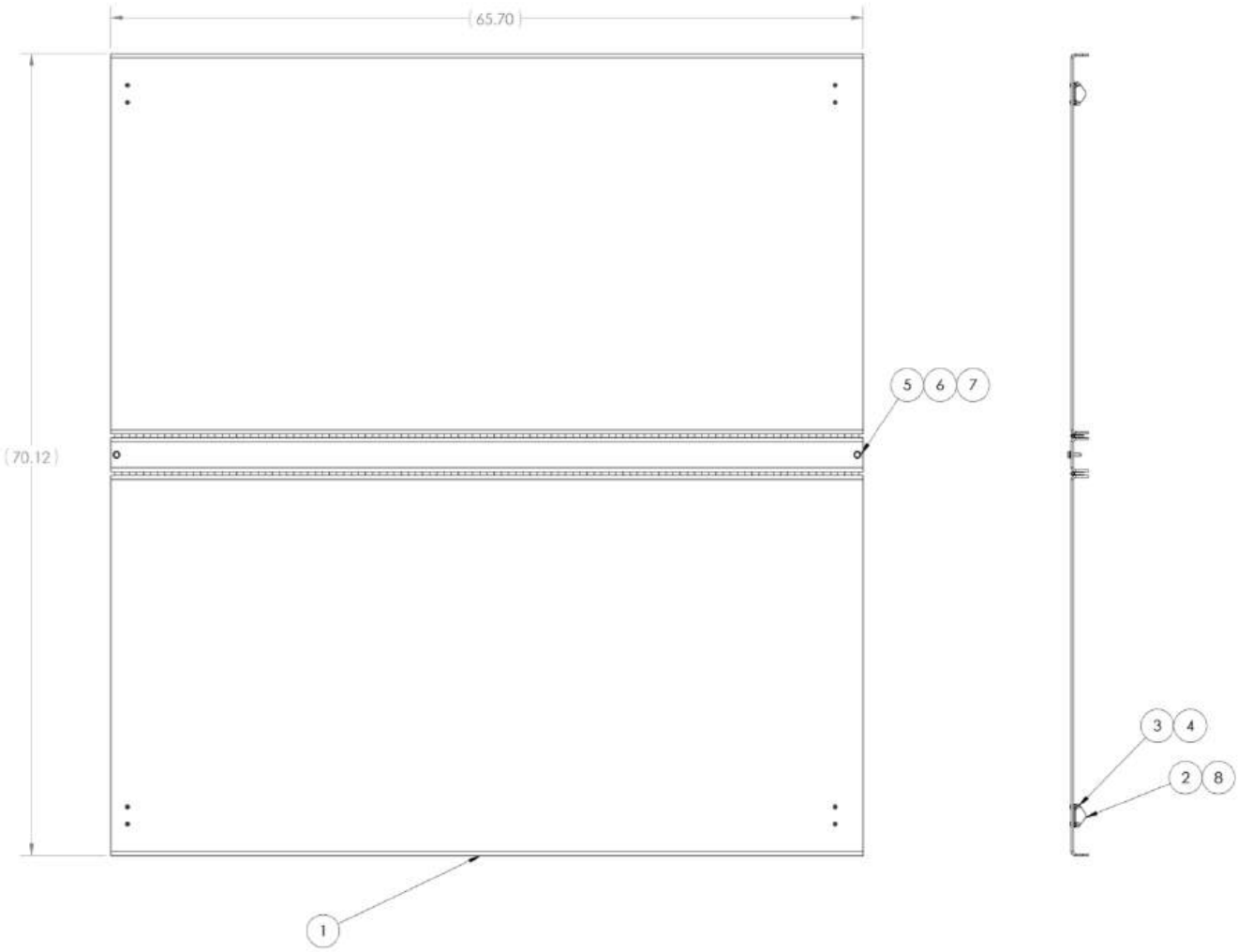
Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
33	H-4035	MOUNT, PUSH UMBRELLA	50
34	S-3076-01	PANEL, BACKREST (P)	1
35	G-1202-1070	STOPNUT, 3/8-16 ELASTIC	6
36	N/A	N/A	--
37	V-2696	LABEL, CHARGER PLUG	1
38	JP-079	FILLER, BATTERY	1
39	H-3931	STRAP, SAFETY	1
40	H-3930	STRAP, STRUT 36 IN	2
41	H-1025	RING, SPLIT RETAINER	2
42	H-2769	ASSEMBLY, LANYARD	2
43	H-3711	RETAINER, LOCKING PIN	2
44	Z-9270-01	FRAME, PACKAGE eJP10	1
45	Z-8053-01	CRADLE, PACKAGE JP100S	1
46	H-3933	COVER, PROTECTIVE	2
47	INS-2441	SCHEMATIC eJP10 ELECTRICAL	1
48	INS-2387	SCHEMATIC, HYDRAULIC	1
49	N/A	N/A	---
50	Z-9771	ASSEMBLY, MANUAL CRADLE PUMP	1
51	G-1100-105540	BOLT, 1/4-28 X 4.0" LG HEX HD GR 5	2
52	G-1250-1050W	FLATWASHER. #8 WIDE	4
53	G-1202-1055	STOPNUT, 1/4-28 ELASTIC	2
54	V-2727	LABEL, eJP-10	2

Parts List

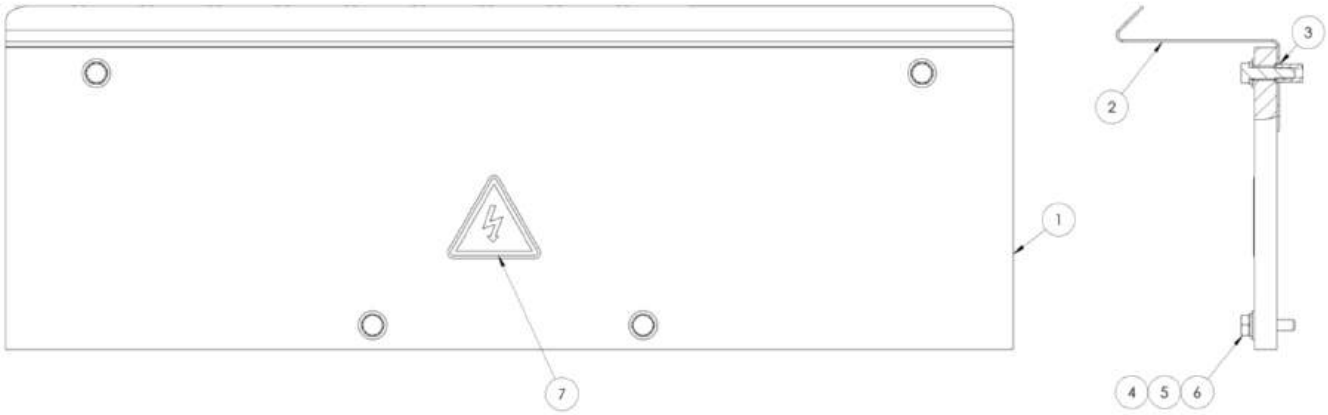
When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	Z-9246	ASSEMBLY BATTERY COVERS JP100 AC	1
2	JP-236	BRACKET	4
3	G-1476-103106	SCREW, #10-32 X 3/4" LG. SST SOC BUTT. HD CAP	8
4	G-1202-1035	STOPNUT, #10-32 ELASTIC	8
5	G-1503-1050N	FLATWASHER. 1/4 SST NARROW	2
6	G-1502-1050R	LOCKWASHER, 1/4 SST REGULAR	2
7	G-1112-105010	BOLT, 1/4-20 X 1.0" LG SST HEX HD	2
8	JP-235	GAS, STRUT	4

Parts List

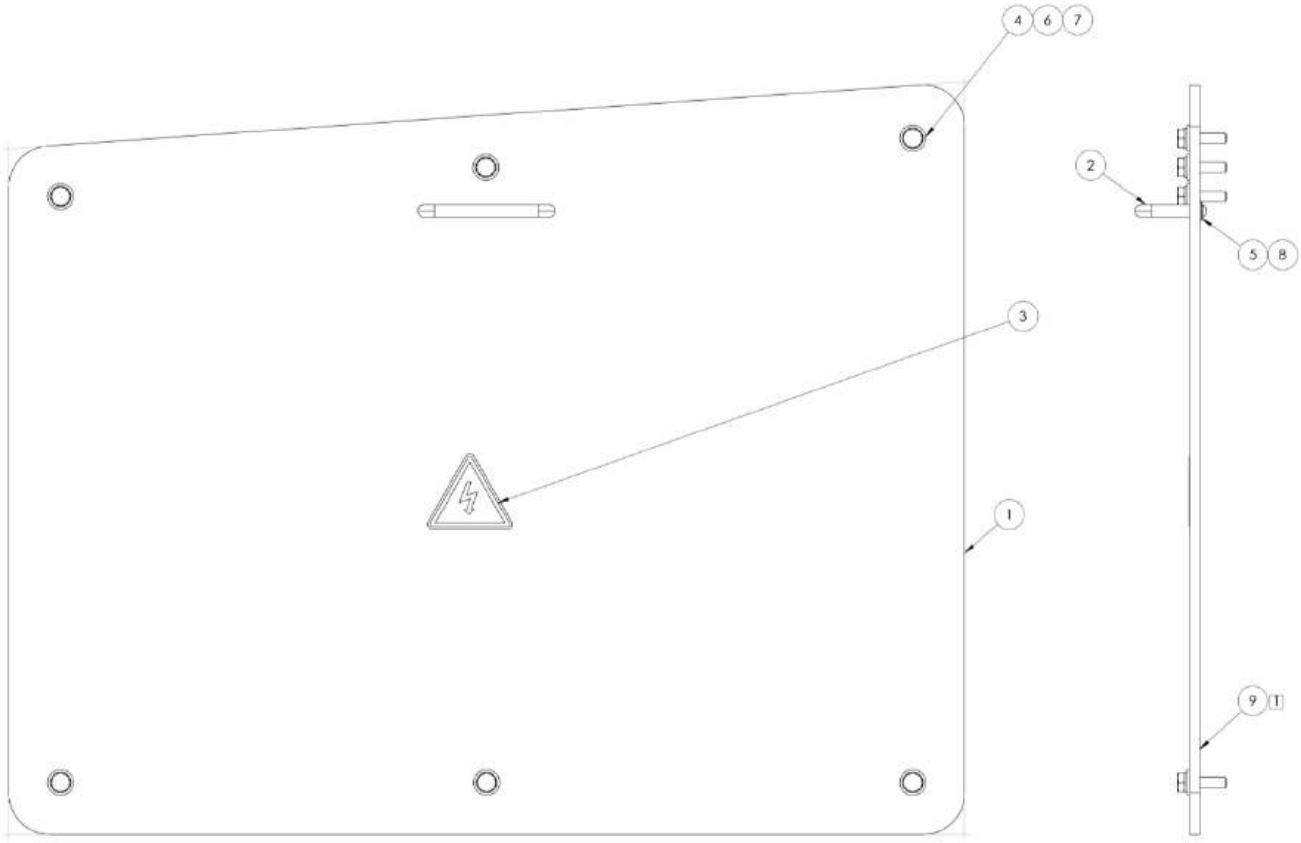
When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	J-6400	COVER, CONTROLLER	1
2	S-3059-01	BRACKET, COVER	1
3	G-1440-1050-S	NUTSERT, 1/4-20 OPEN END	2
4	G-1503-1050N	FLATWASHER. 1/4 SST NARROW	4
5	G-1502-1050R	LOCKWASHER, 1/4 SST REGULAR	4
6	G-1112-105010	BOLT, 1/4-20 X 1.0" LG SST HEX HD	4
7	V-1050	LABEL, ISO ELECTRICAL SHOCK	1

Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

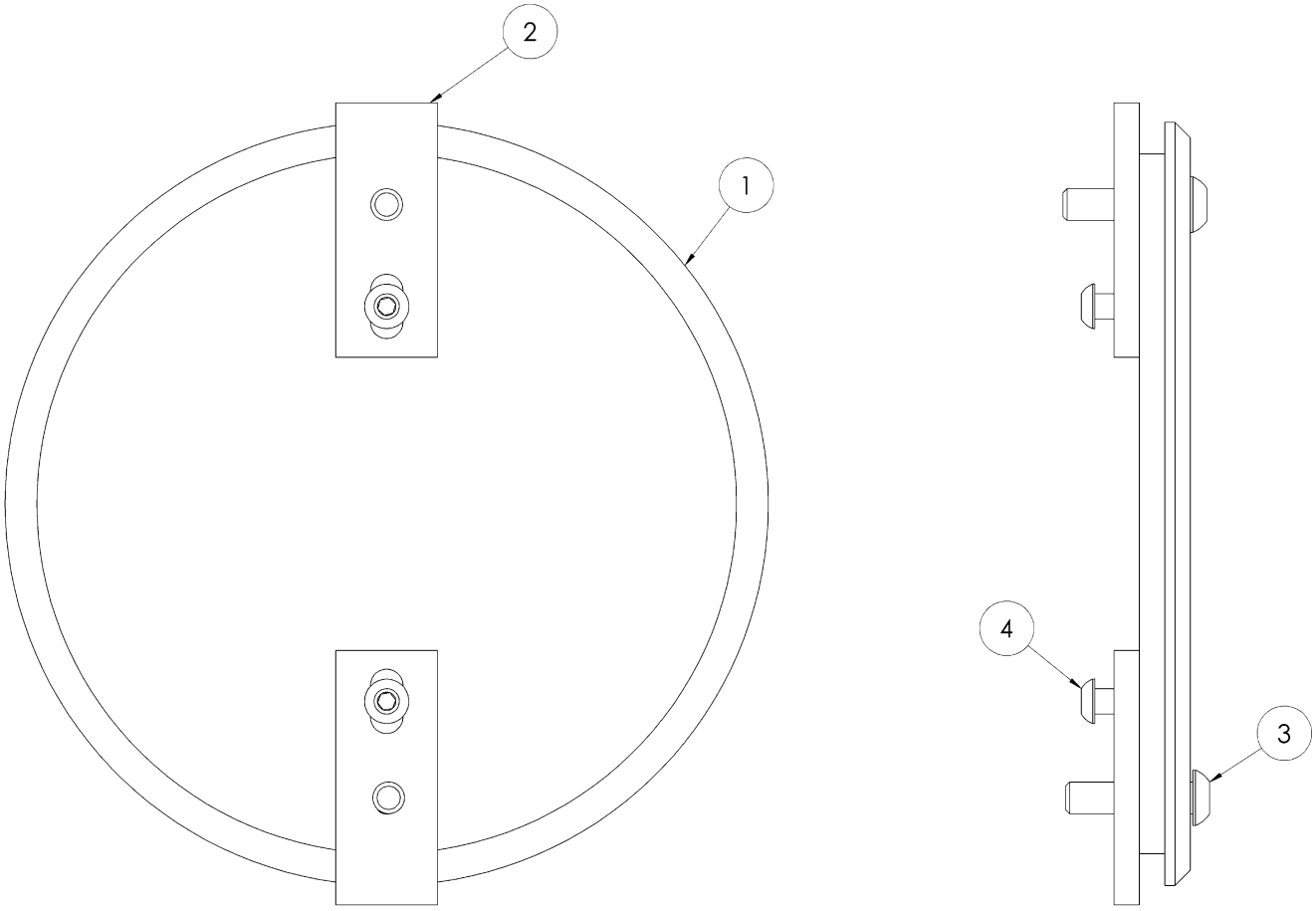


[1] NOTE: Place Item 9 (H-1204-06-81.0) outer edge of panel to seal panel to console wall of unit

Item	Part Number	Description	Qty
1	J-6379	PANEL, CONSOLE SIDE	-1
2	14074	HANDLE, DRAWER	1
3	V-1050	LABEL, ISO ELECTRICAL SHOCK	1
4	G-1503-1050N	FLATWASHER. 1/4 SST NARROW	6
5	G-1503-1020N	FLATWASHER. #8 SST NARROW	2
6	G-1502-1050R	LOCKWASHER, 1/4 SST REGULAR	6
7	G-1112-105010	BOLT, 1/4-20 X 1.0" LG SST HEX HD	6
8	G-1159-102004	SCREW, #8-32 X 1/2" LG. RD HEAD CROSS RECESS MACHINE	2
9	H-1204-06-81.0	TAPE, NEOPRENE FOAM SEAL	1

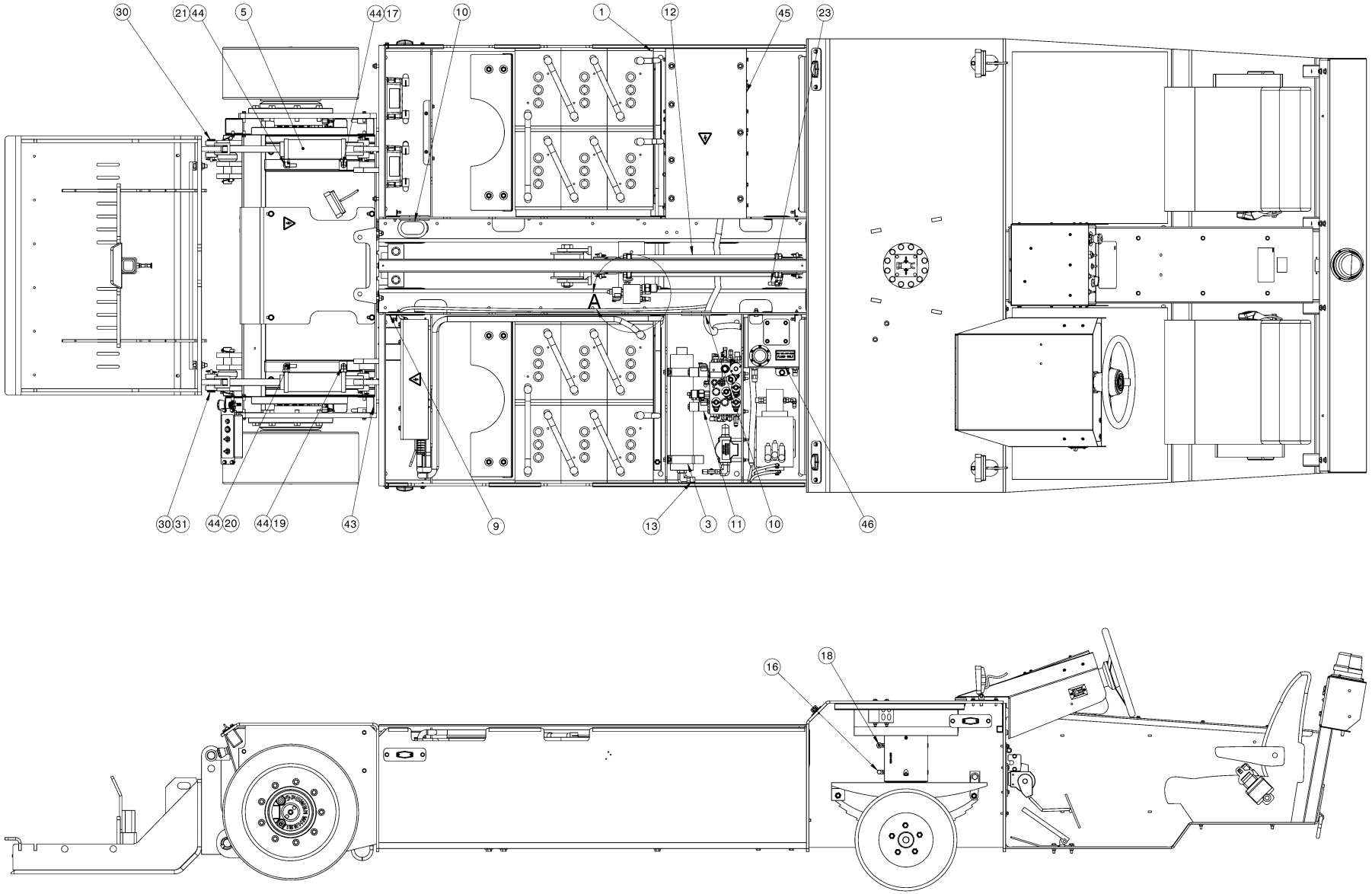
Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

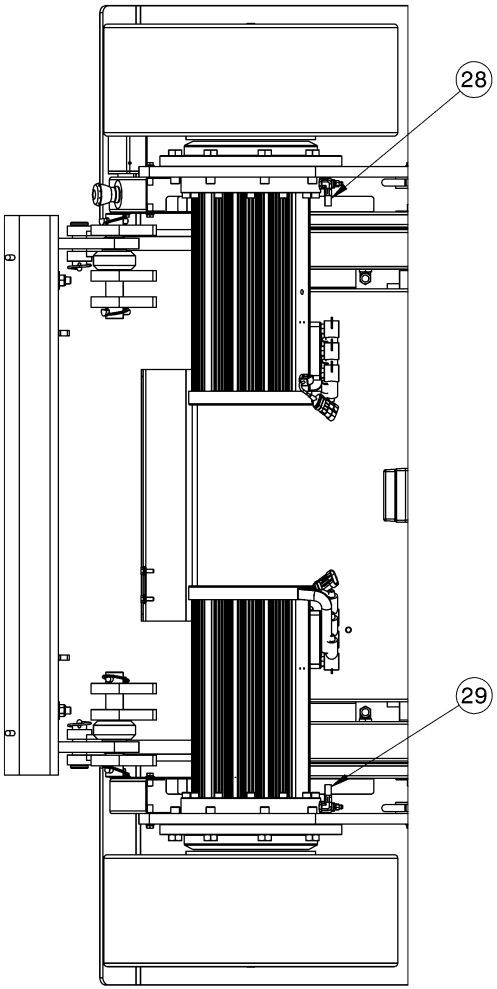


Item	Part Number	Description	Qty
1	J-6089-01	PLATE, COVER	REF
2	J-6077	PLATE, HOLD DOWN ARM	2
3	G-1476-106012	SCREW, 5/16-18 X 1-1/4" LG. SST SOC BUTT. HD CAP	2
4	G-1476-105006	SCREW, 1/4-20 X 3/4" LG. SST SOC BUTT. HD CAP	2

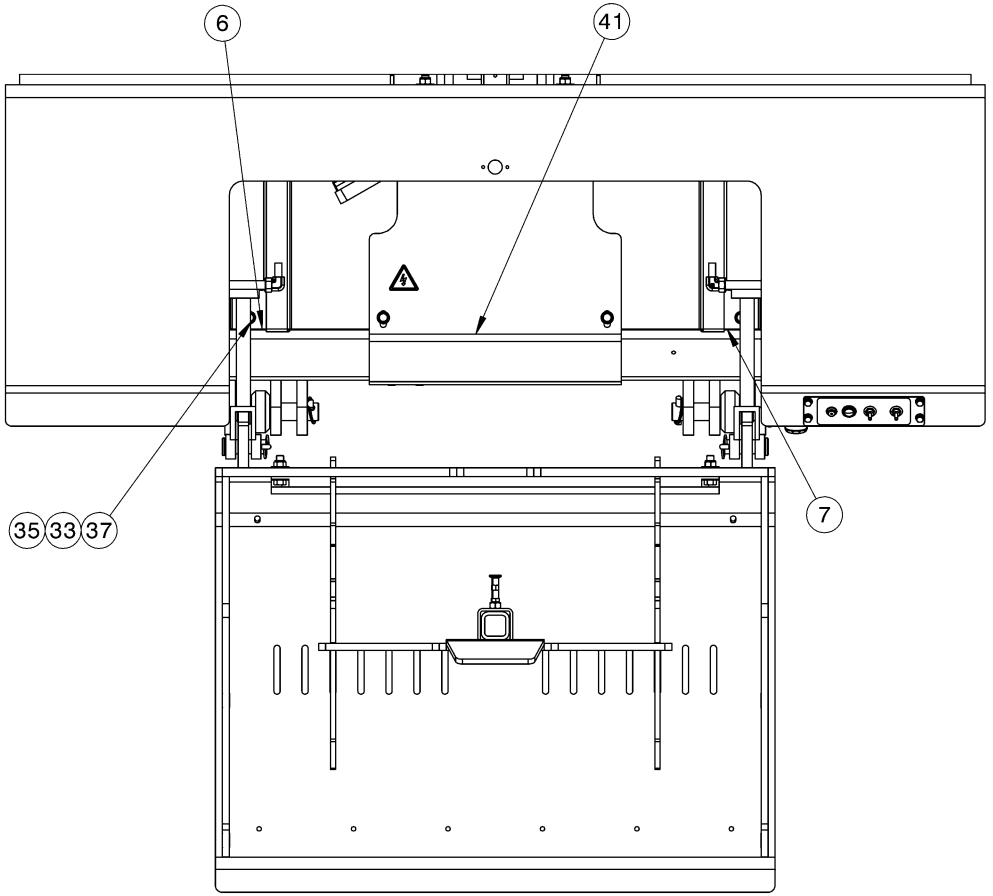
Parts List Illustration



Parts List Illustration

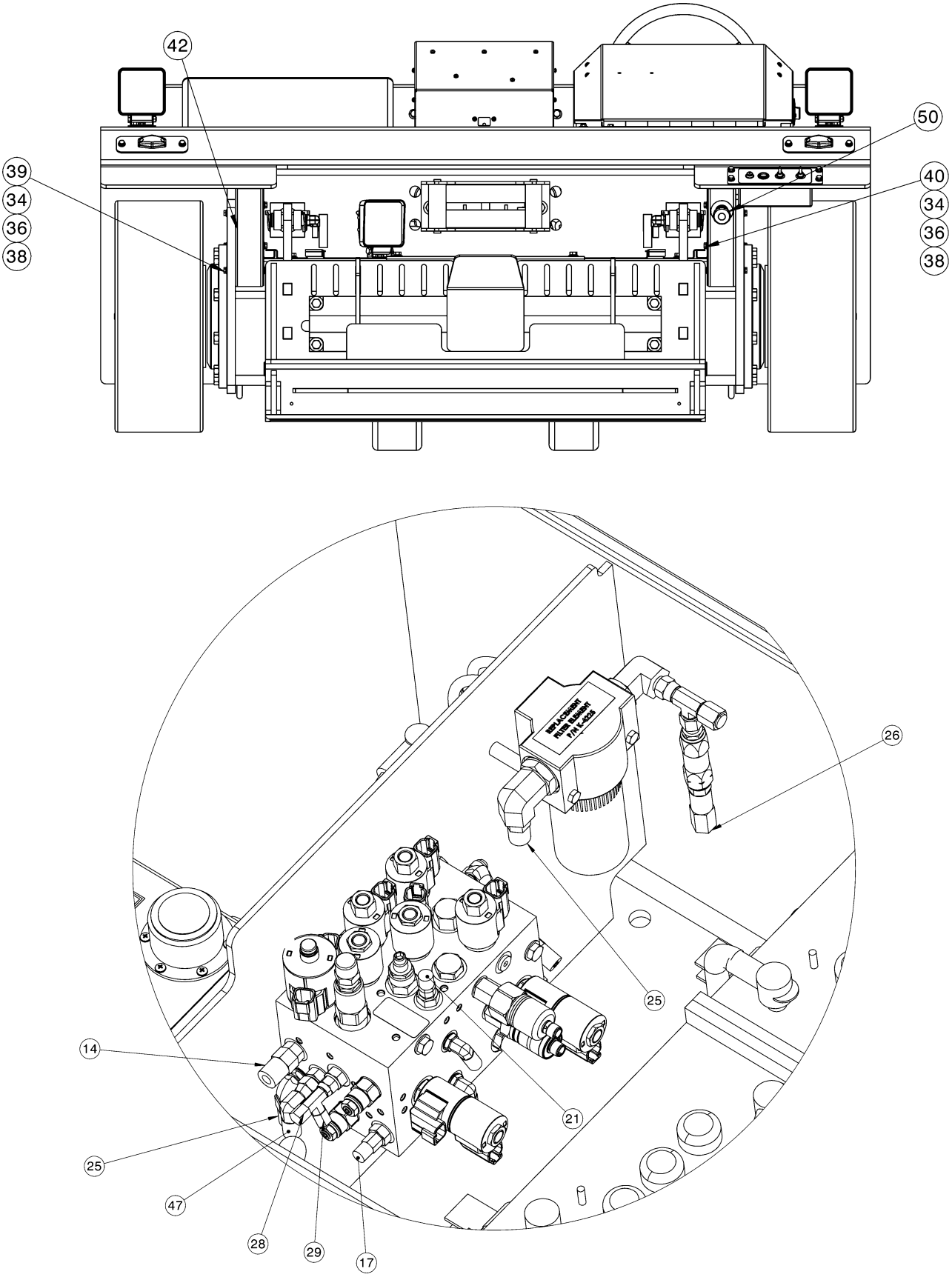


BOTTOM VIEW

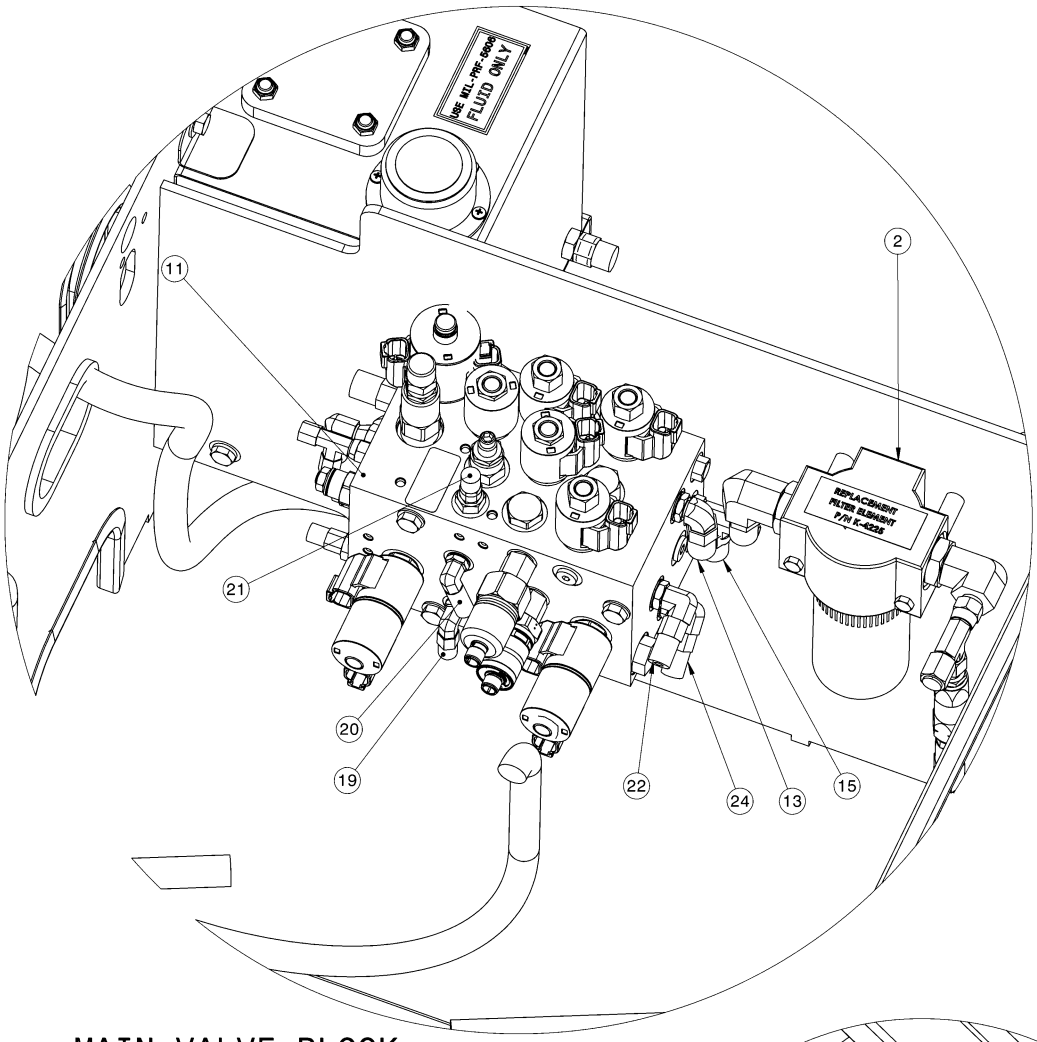


FRONT FENDER AREA

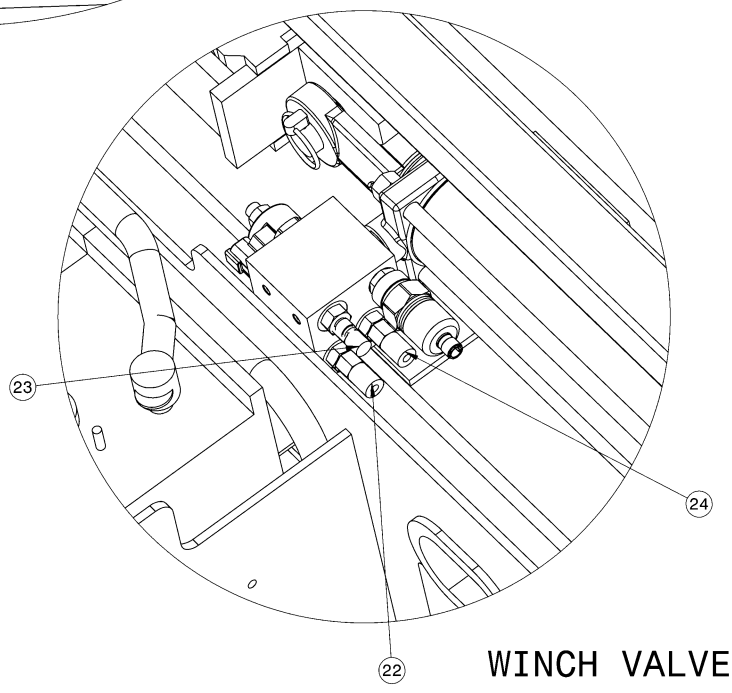
Parts List Illustration



Parts List Illustration

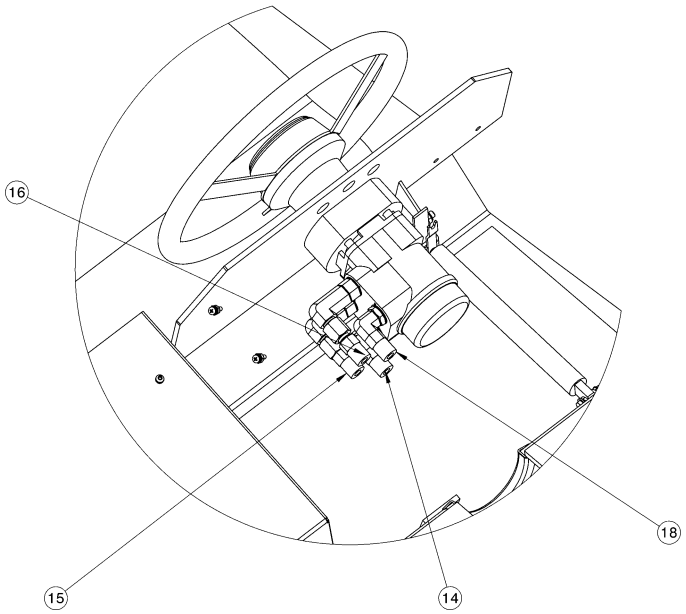


MAIN VALVE BLOCK

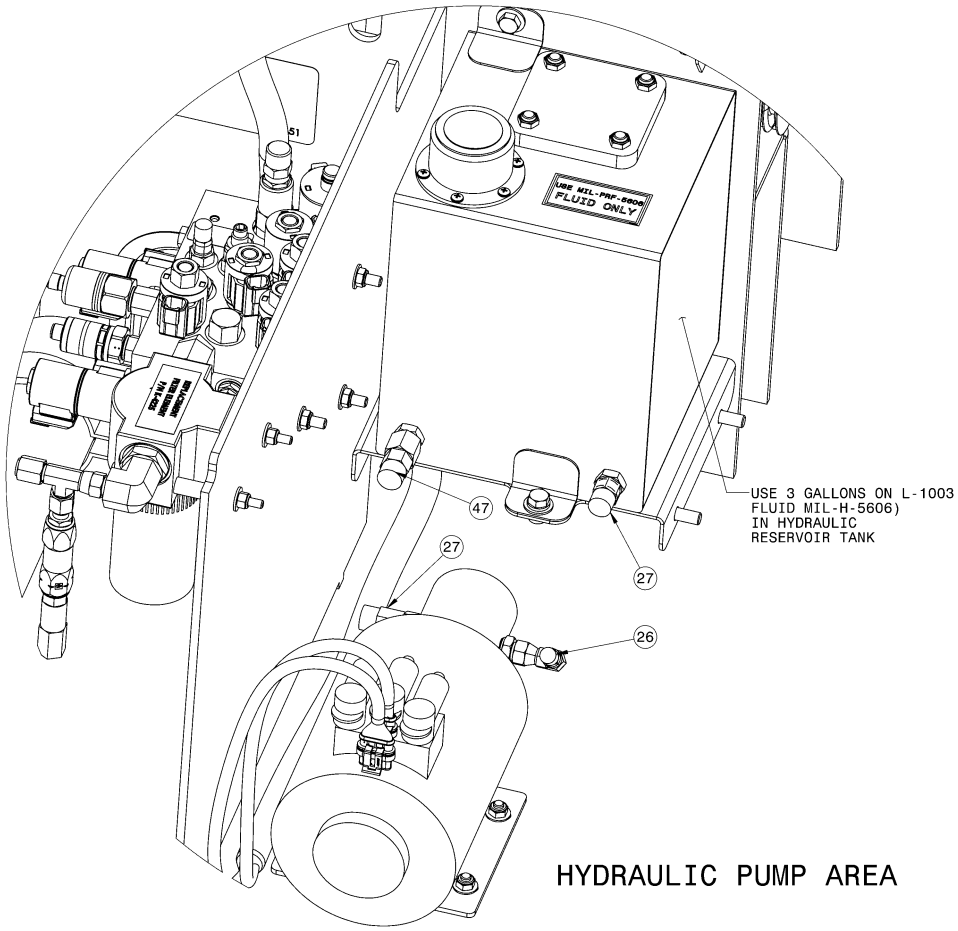


WINCH VALVE

Parts List Illustration



STEERING VALVE



HYDRAULIC PUMP AREA

Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
1	Z-9248	ASSEMBLY, INTERNAL	1
2	Z-9251	ASSEMBLY, FILTER	1
3	Z-9252	ASSEMBLY, ACCUMULATOR	1
4	S-3037-00	PANEL, MOTOR SIDE RT	1
5	HC-2746	CYLINDER, HYDRAULIC	2
6	S-3042-01	COVER, FRONT RIGHT SIDE (P)	1
7	S-3047-01	COVER, FRONT LEFT SIDE (P)	1
8	S-3039-00	PANEL, MOTOR SIDE LT	1
9	H-4040-02	GROMMET, 1.5 IN. I.D.G3061	1
10	H-4040-01	GROMMET, 3.0 IN. I.D.G3319 (65 DURO,SBR)	3
11	Z-9285	ASSEMBLY, MAIN VALVE	1
12	Z-9284	ASSEMBLY, WINCH ROLLER	1
13	Z-9290-01-1	FROM ACCUMULATOR PORT TO MAIN VALVE BLOCK P8	1
14	Z-9290-05	FROM MAIN VALVE BLOCK P9 TO STEERING VALVE PRESSURE	1
15	Z-9290-04	FROM MAIN VALVE BLOCK P11 TO STEERING VALVE TANK	1
16	Z-9290-03-1	FROM STEERING VALVE LEFT TO ROTARY ACTUATOR BOTTOM PORT	1
17	Z-9290-09	FROM MAIN VALVE BLOCK P3 TO CRADLE CYLINDER, PASSENGER'S SIDE, BLIND END	1
18	Z-9290-03-2	FROM STEERING VALVE RIGHT TO ROTARY ACTUATOR TOP PORT	1
19	Z-9290-14	FROM MAIN VALVE BLOCK P3-1 TO CRADLE CYLINDER, DRIVER'S SIDE, BLIND END	1
20	Z-9290-15	FROM MAIN VALVE BLOCK P4-1 TO CRADLE CYLINDER, DRIVER'S SIDE, ROD END	1
21	Z-9290-10	FROM MAIN VALVE BLOCK P4 TO CRADLE CYLINDER, PASSENGER'S SIDE, ROD END	1
22	Z-9290-07-1	FROM MAIN VALVE BLOCK P5 TO WINCH VALVE BLOCK P5	1
23	Z-9290-08	FROM WINCH VALVE BLOCK P2 TO WINCH CYLINDER BLIND END PORT	1
24	Z-9290-07-2	FROM MAIN VALVE BLOCK P6 TO WINCH VALVE BLOCK P1	1
25	Z-9290-01-2	FROM FILTER OUTLET PORT TO MAIN VALVE BLOCK P	1
26	Z-9290-02	FROM PUMP PRESSURE PORT TO FILTER INLET PORT	1
27	Z-9290-12	FROM TANK SUPPLY (RIGHT SIDE) TO PUMP SUPPLY	1
28	Z-9290-06	FROM MAIN BLOCK P10 TO PARKING BRAKE MASTER SIDE	1
29	Z-9290-11	FROM MAIN BLOCK P10 TO PARKING BRAKE SLAVE SIDE	1
30	R-3098	PIN, CYLINDER	2
31	G-1320-01	PIN, LYNCH	6
32	CYL PIN	CYL. PIN SUPPLY WITH CYL	2
33	G-1502-1070R	LOCKWASHER, 3/8 SST REGULAR	2
34	G-1502-1050R	LOCKWASHER, 1/4 SST REGULAR	16
35	G-1503-1070N	FLATWASHER. 3/8 SST NARROW	2
36	G-1503-1050N	FLATWASHER. 1/4 SST NARROW	16
37	G-1112-107010	BOLT, 38-16 X 1.0" SST HEX HD	2
38	G-1439-1050-S	NUTSERT, 1/4-20 OPEN END	12
39	G-1112-105012	BOLT, 1/4-20 X 1-1/4" LG SST HEX HD	8
40	G-1112-105006	BOLT, 1/4-20 X 3/4" LG SST HEX HD	8
41	Z-9304	ASSEMBLY, FRONT PANEL, LIGHT	1
42	S-3033-01	BRACKET, RIGHT (P)	1
43	S-3034-01	BRACKET, REAR (P) (R)	2
44	N-2001-06-S-B	ELBOW, STRAIGHT THREAD	4
45	Z-9577	ASSEMBLY, TERMINAL COVER	1
46	Z-9520	ASSEMBLY, HYDRAULIC RESERVOIR	1
47	Z-9290-13	FROM TANK RETURN (LEFT SIDE) TO MAIN VALVE BLOCK PORT T	REF
48	H-3461-02	FLEXABLE, SLEEVE COVER	110
49	G-1151-107205	SCREW, 3/8-16 X 5/8 HEX HD CAP GR 8	2
50	Z-10969	ASSEMBLY, FENDER E-STOP	1

Parts List

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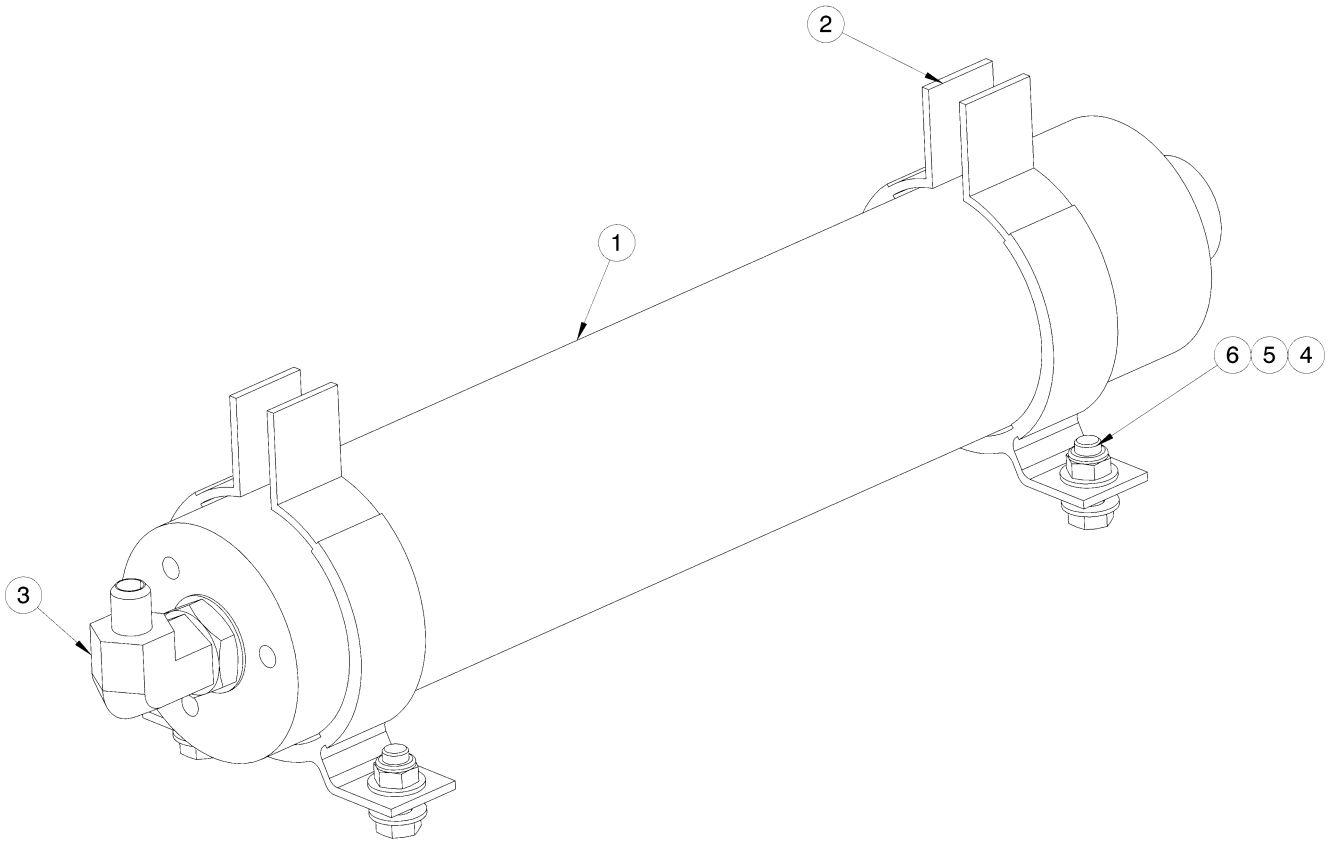

Item	Part Number	Description	Qty
1	HC-2747	ACCUMULATOR	1
2	H-3074-04	BRACKET, CLAMP	2
3	N-2001-39-S B	ELBOW, STR THD	1
4	G-1250-1070N	FLATWASHER. 3/8 NARROW	8
5	G-1202-1070	STOPNUT, 3/8-16 ELASTIC	4
6	G-1100-107010	BOLT, 3/8-16 X 1.0" HEX HD GR 5	4

Parts List

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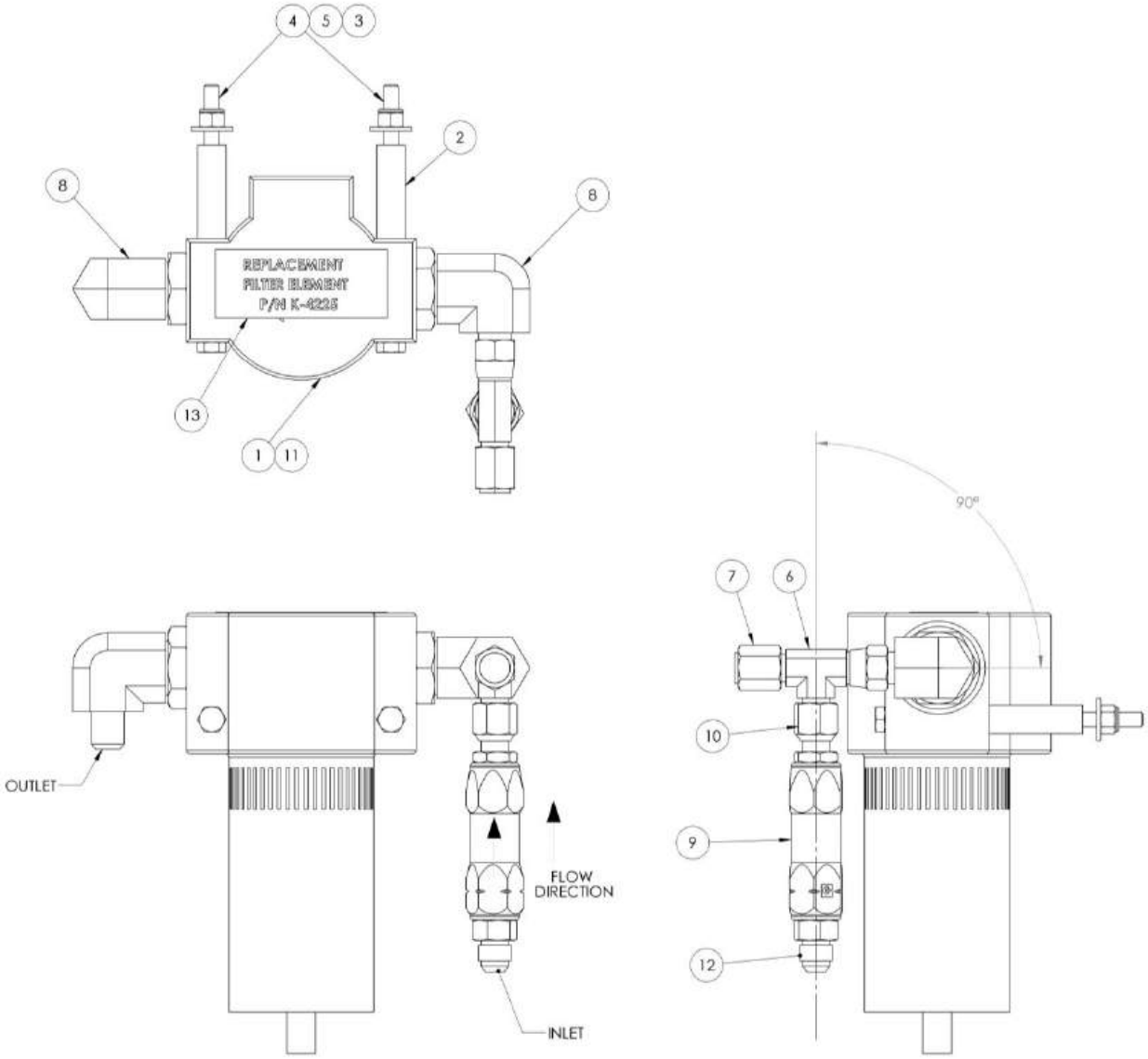
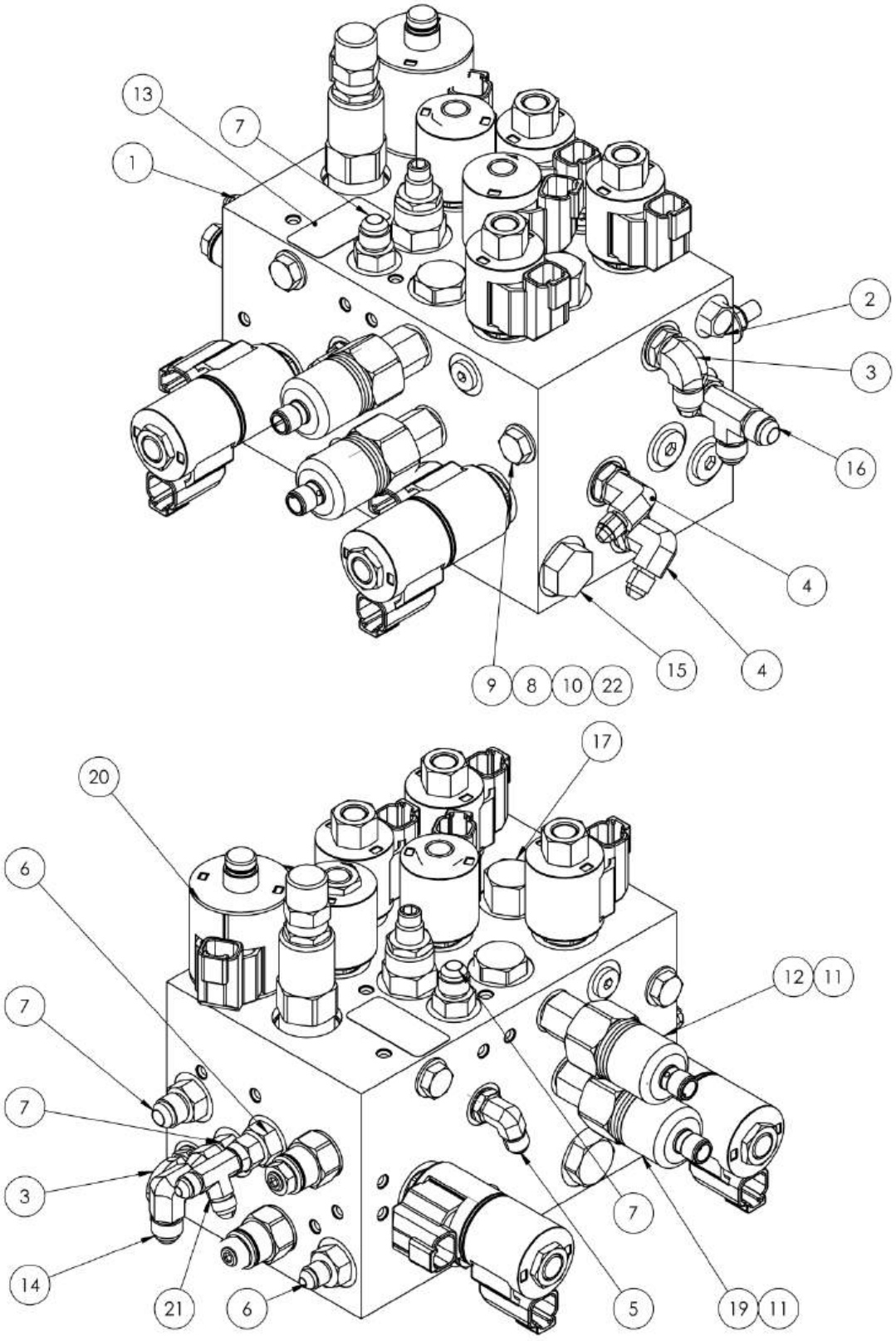


Item	Part Number	Description	Qty
1	HC-1244	BODY, FILTER-4	1
2	TR377-03-001.63	TBG, SST .50OD-.049W	2
3	G-1250-1050W	FLATWASHER. #8 WIDE	2
4	G-1100-105544	BOLT, 1/4-28 X 4-1/2" LG HEX HD GR 5	2
5	G-1202-1055	STOPNUT, 1/4-28 ELASTIC	2
6	N-2016-05-S	TEE, RUN SWIVEL NUT	1
7	N-2008-05-S	CAP, 3/8	1
8	N-2001-39-S-B	ELBOW, STR THD (MB)	2
9	HC-1731-04-005	VALVE, CHECK (INLINE)	1
10	N-2036-03-S-B	SWIVEL, 37 DEG FEMALE	1
11	HC-1322	ELEMENT, FILTER	1
12	N-2007-08-S-B	CONNECTOR, STR THD	1
13	V-2231	LABEL, FILTER ELEMENT REPLACEMENT	1

Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



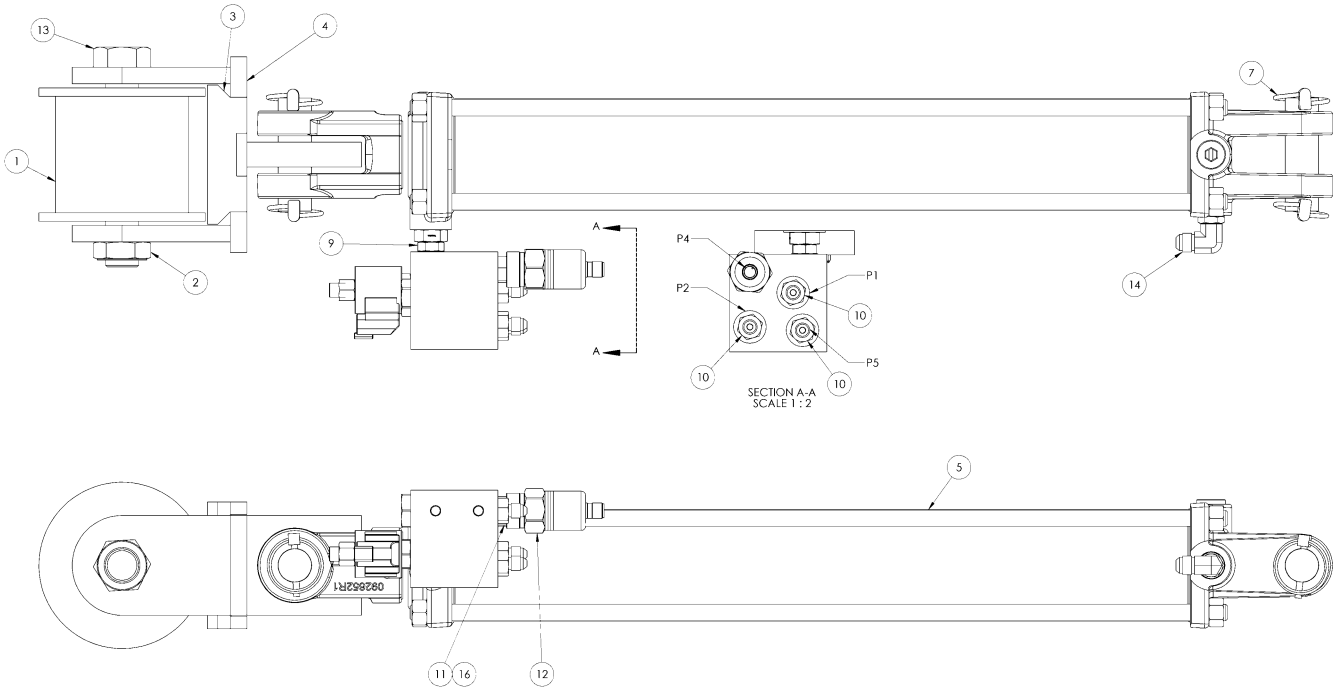
Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
1	HC-2742	ASSEMBLY, VALVE MANIFOLD	1
2	N-2053-03-S-B	PLUG, HEX HD W/O-RING	1
3	N-2001-08-S-B	ELBOW, STRAIGHT THREAD	2
4	N-2001-05-S-B	ELBOW, STRAIGHT THREAD	2
5	N-2001-03-S-B	ELBOW, STRAIGHT THREAD	2
6	N-2007-05-S-B	CONNECTOR, STR THD	2
7	N-2007-08-S-B	ADAPTER, -06 JIC M X -06 ORB M	3
8	G-1503-1060N	FLATWAHER, 5/16 NARROW S.S.	6
9	G-1112-106060	BOLT, 5/16-18 X 6.0" LG. SST HEX HD	3
10	G-1202-1060	STOPNUT, 5/16-18 ELASTIC	3
11	N-2846-02	FITTING, ADAPTOR	2
12	EC-2204-PGM-4	PRESSURE SENSOR, PROGRAMMED	1
13	V-2710	LABEL, LOWERING CRADLE	1
14	N-2002-05-S	ELBOW, -06 M JIC X -06 F JIC	1
15	N-2053-06-S-B	PLUG, HEX HD W/O-RING	1
16	N-2015-08-S-B	TEE, RUN STR THD	1
17	HC-2742-10_	FLOW, CONTROL PRESSURE COMP	1
18	N-2008-05-S-E	CAP, 3/8	1
19	EC-2204-PGM-5	PRESSURE SENSOR, PROGRAMMED	1
20	EC-3307	VAKVE, PROPORTIONAL	1
21	N-2016-03-S	TEE, RUN SWIVEL NUT	1
22	G-1513-1060N	FLATWASHER, THRU HARD N	3

Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	JP-240	ROLLER, UHMW WINCH	1
2	G-1203-1120	JAMNUT, 1-14 ELASTIC	1
3	Z-7750	ASSEMBLY, SPACER WINCH STRIP	1
4	Z-6343-01	WELDMENT, RETRACT SPOOL	1
5	HC-2741	CYLINDER, 3" BORE 20" STROKE	1
6	JP-233	WINCH, STRAP (NOT SHOWN)	1
7	G-1320-01	PIN, LYNCH	4
8	HC-2743	ASSEMBLY, CYLINDER VALVES	1
9	N-2464-16-S-B	UNION STRAIGHT THREAD	1
10	N-2007-05-S-B	CONNECTOR, STR THD	3
11	N-2987	BSPP#4 SAE/ORB X 1/4 MALE	1
12	HC-2690	PRESURE, SENSOR	1
13	G-1100-112560	BOLT, 1-14 X 6" LG. HEXHD GR 5	1
14	N-2001-06-S-B	ELBOW, STRAIGHT THREAD	1
15	HC-2714	SEAL, BONDED	1

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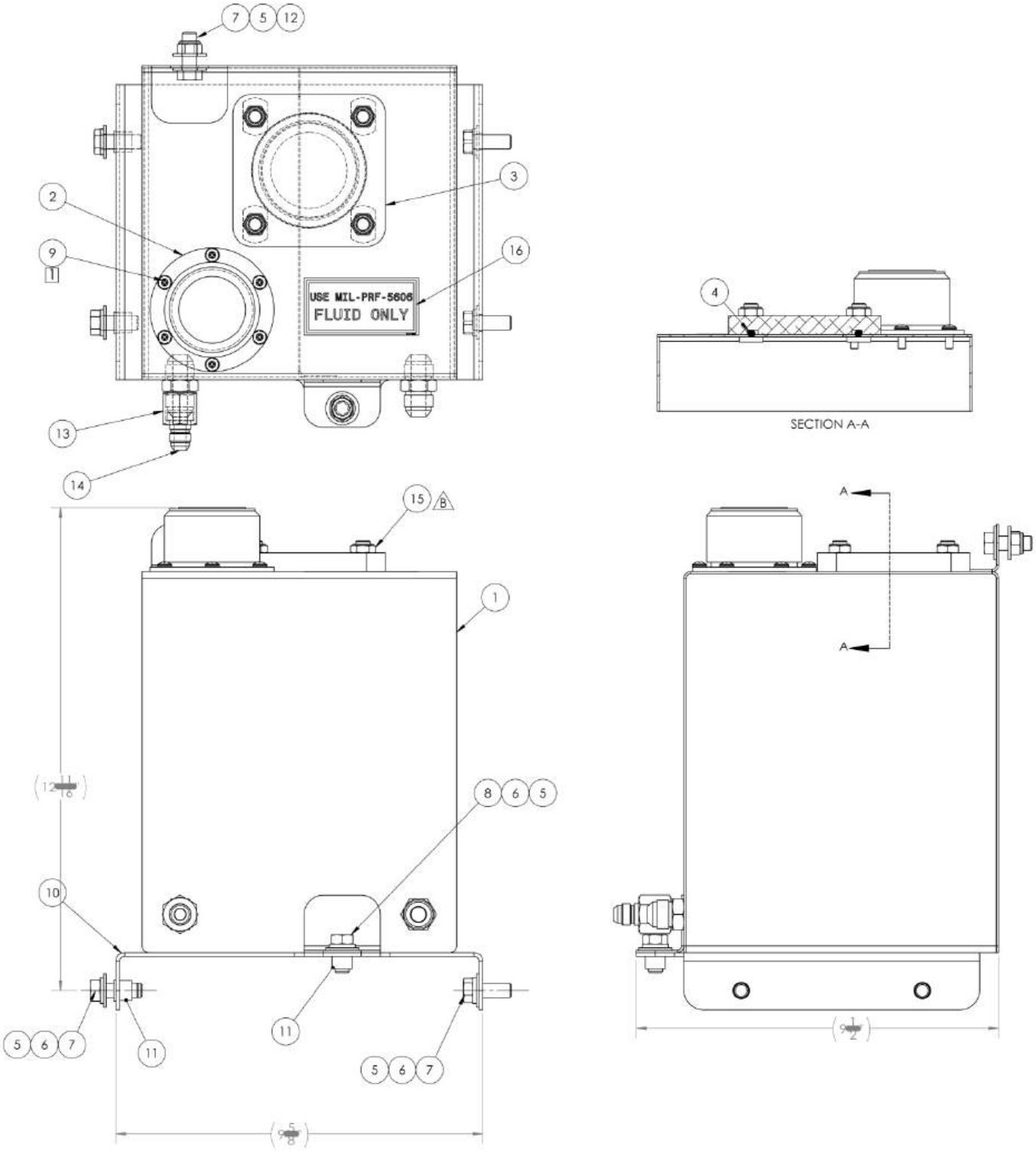
Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



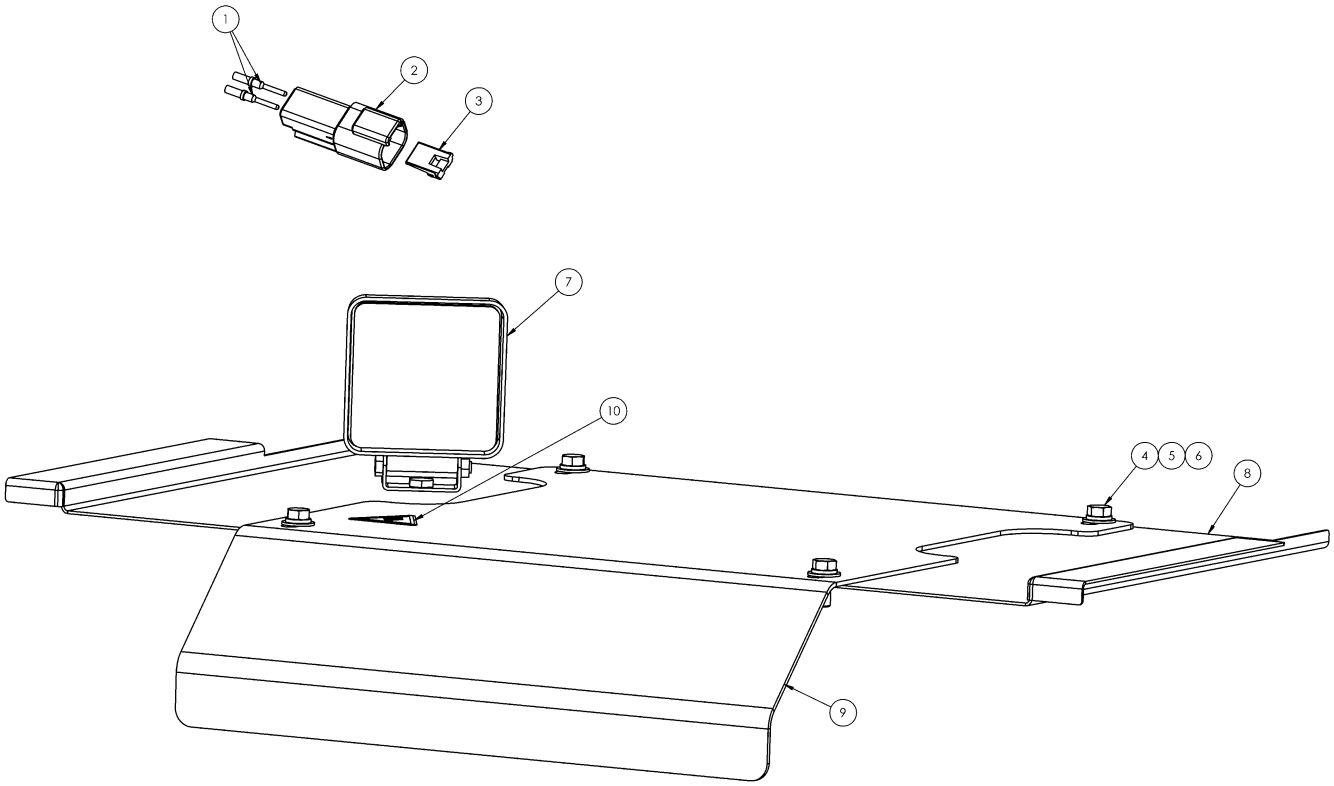
Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
1	Z-9517	WELDMENT, CONTAINER 2 GAL	1
2	HC-1030-01	FILTER, BREATHER	1
3	J-6543	CAP, CLEAN OUT	1
4	HC-2006-334	O-RING SERIES 2	1
5	G-1503-1070N	FLATWASHER. 3/8 SST NARROW	7
6	G-1502-1070R	LOCKWASHER, 3/8 SST REGULAR	5
7	G-1112-107010	BOLT, 38-16 X 1.0" SST HEX HD	5
8	G-1112-107006	BOLT, 38-16 X 3/4" SST HEX HD	1
9	G-1157-103504	SCREW, #10-32 X 1/2" LG PAN HD CROSS RECESS	6
10	S-3199-00	BRACKET, ANGLE (P)	1
11	G-1439-1070-S	NUTSERT, 3/8-16 OPEN END	3
12	G-1202-1070	STOPNUT, 3/8-16 ELASTIC	1
13	N-2000-06-S	NUT, #8 JIC X 37 DEG	1
14	N-2020-03-S	REDUCER, TUBE END	1
15	G-1203-1070	JAMNUT, 3/8-16 ELASTIC	4
16	V-1102	LABEL, MIL-PRF-5606	1

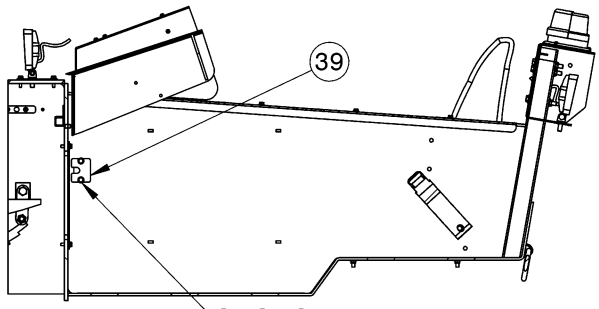
Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

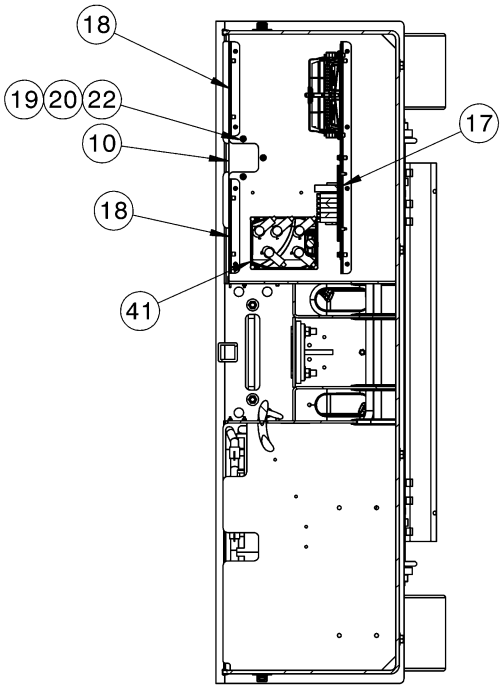


Item	Part Number	Description	Qty
1	4002-31	CONTACT, PIN (16AWG)	2
2	EC-2098	RECEPTACLE, 2 PIN	1
3	EC-2099	WEDGELOCK, 2 PIN	1
4	G-1112-107010	BOLT, 38-16 X 1.0" SST HEX HD	4
5	G-1502-1070R	LOCKWASHER, 3/8 SST REGULAR	4
6	G-1503-1070N	FLATWASHER. 3/8 SST NARROW	4
7	NVSP-34-007-CA	HEADLIGHT, LED SQ 500 LUMEN	1
8	S-3041-00	PANEL, MOTOR COVER	1
9	S-3832	WINCH, GUARD eJP-10	1
10	V-1050	LABEL, ISO ELECTRICAL SHOCK	1

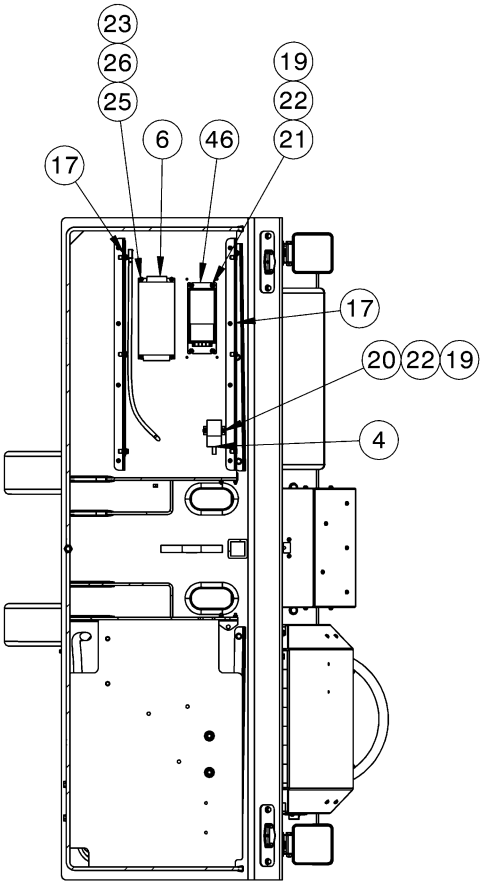
Parts List Illustration



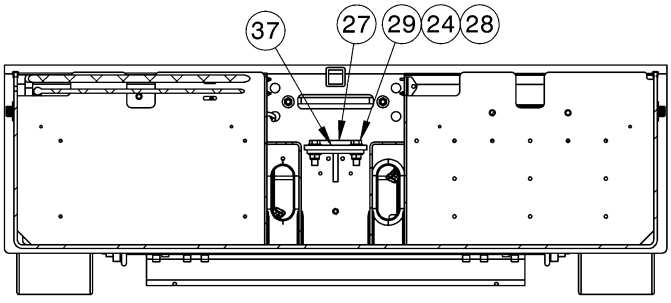
SECTION A-A



SECTION C-C

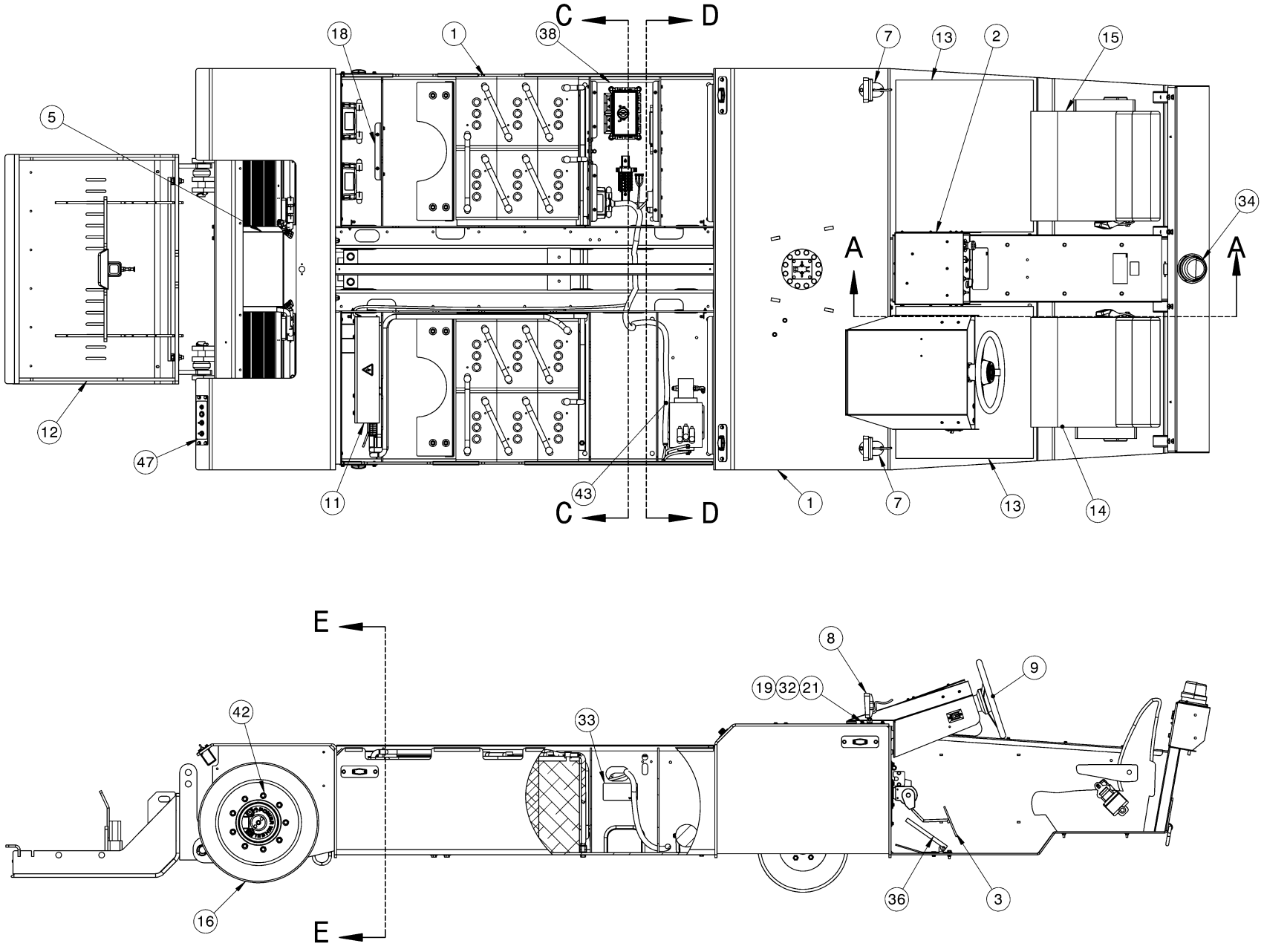


SECTION D-D

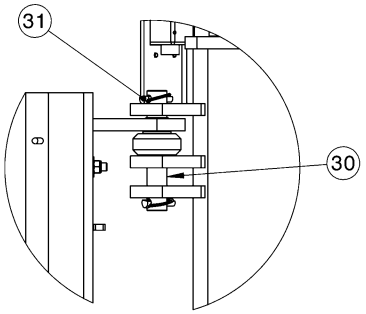


SECTION E-E

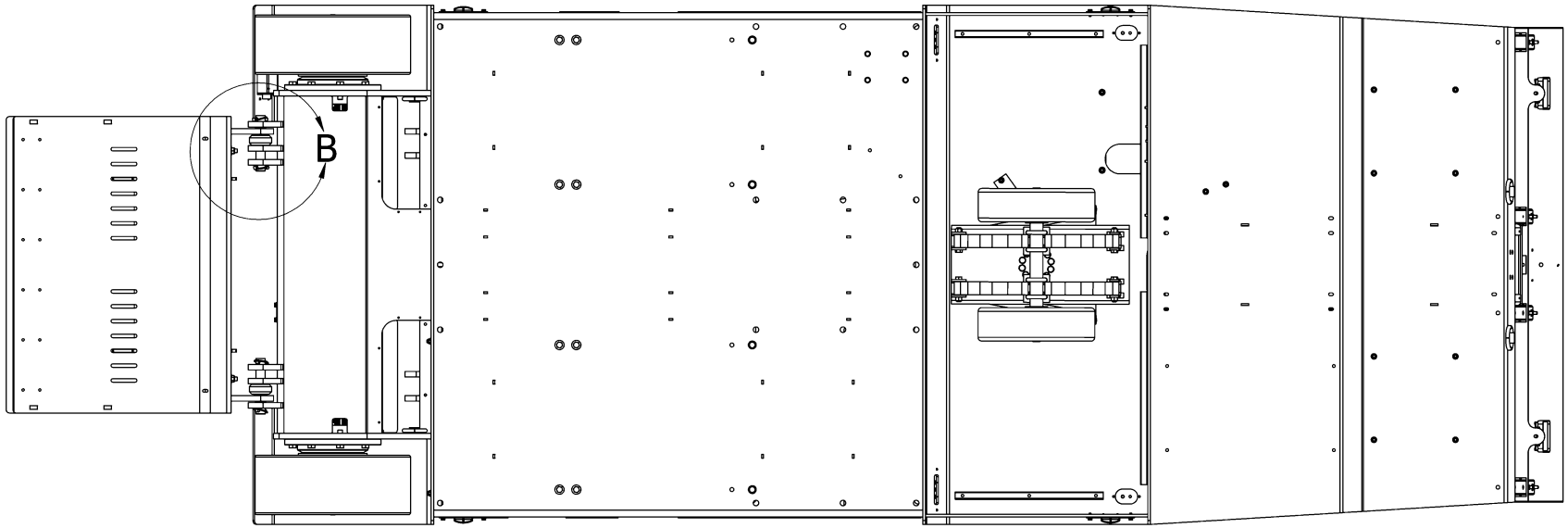
Parts List Illustration



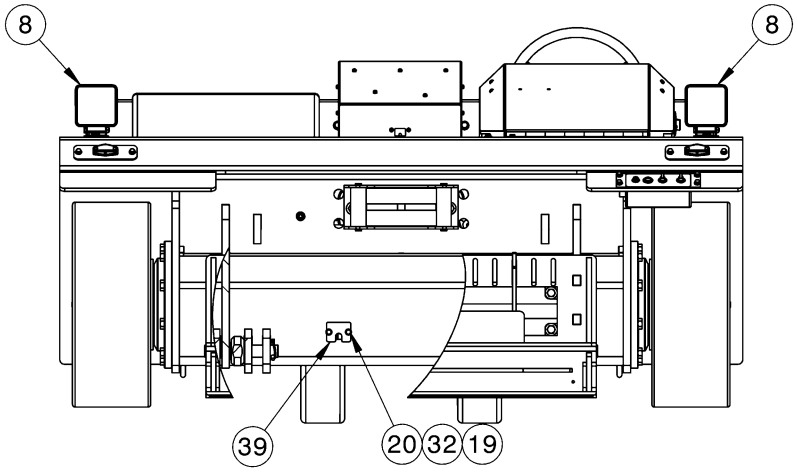
Parts List Illustration

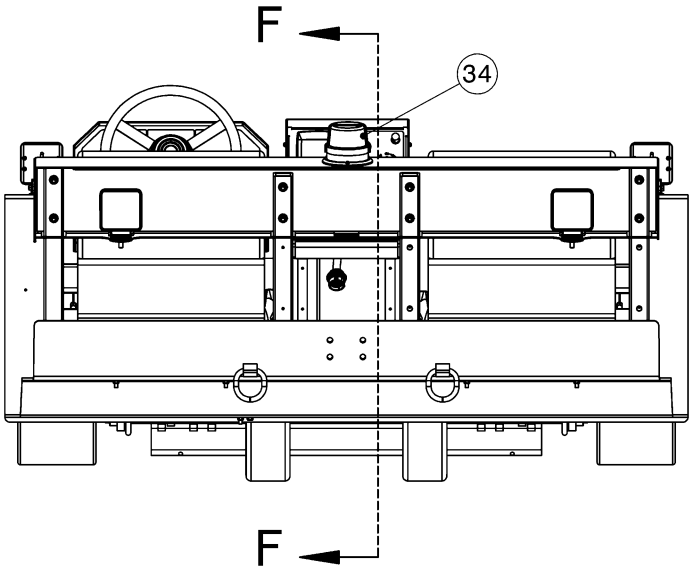


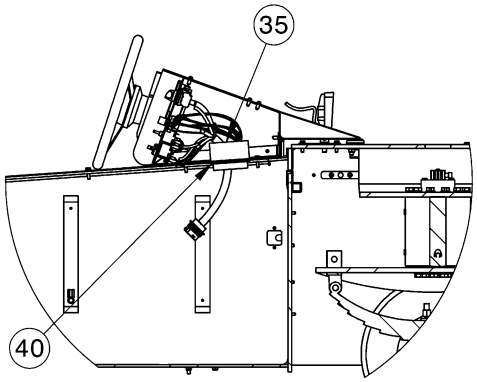
DETAIL B



Parts List Illustration







SECTION F-F
INSIDE CENTER CONSOLE

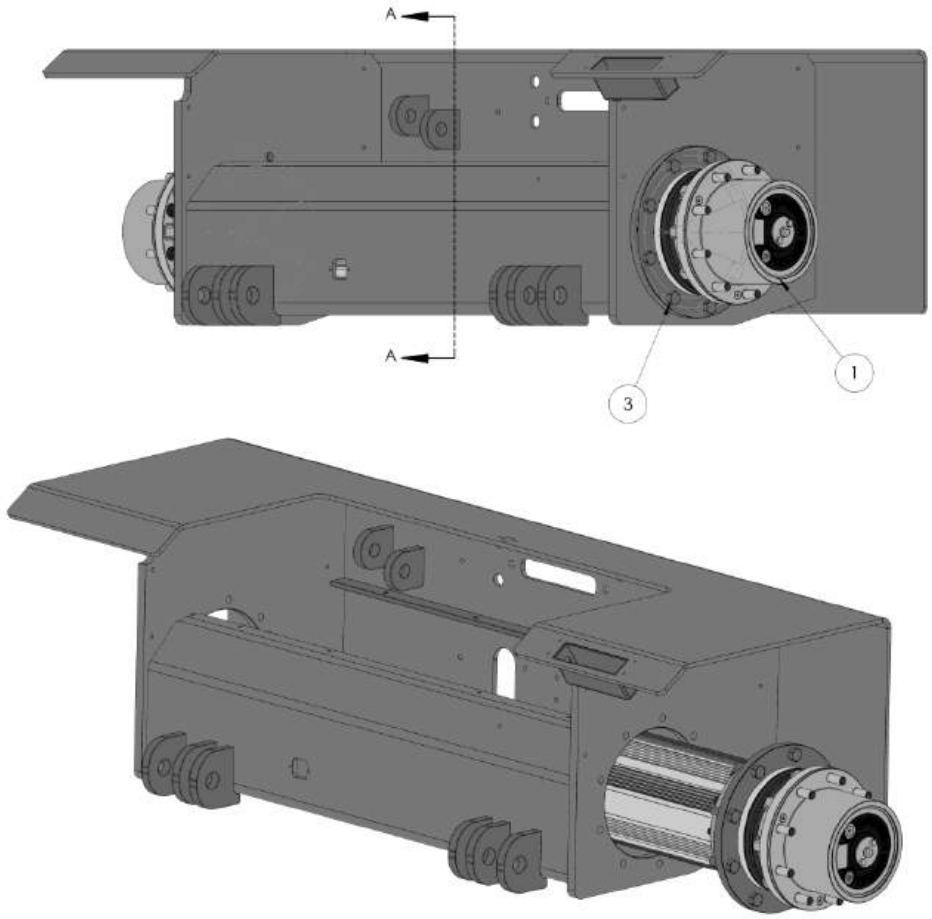
Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
1	Z-9240	ASSEMBLY, BATTERY BOX	1
2	Z-9247	ASSEMBLY, CENTER CONTROL PANEL	1
3	Z-9294	ASSEMBLY, BRAKE PEDAL	1
4	EC-2965	CONTACTOR	1
5	Z-9258	ASSEMBLY, MOTOR	1
6	EC-2991	DC-DC CONVERTER 72/12 VDC	1
7	S-2598-01	PLATE, BASE LIGHT 11 GA	2
8	NVSP-34-007-CA	HEADLIGHT, LED, SQUARE 500 LUMEN, ECCO E92007	4
9	Z-9249	ASSEMBLY, STEERING	1
10	S-3054-00	PLATE, COVER	1
11	Z-9266	ASSEMBLY, CONTACTOR PANEL	1
12	Z-8073	CRADLE, ASSEMBLY	1
13	H-3616	MAT, PLATFORM	2
14	Z-9283-01	ASSEMBLY, SEAT DRIVERS SIDE	1
15	Z-9283-02	ASSEMBLY, SEAT DRIVERS SIDE	1
16	U-1186	WHEEL, TIRE ASSEMBLY	2
17	Z-9286	ASSEMBLY, SUPPORT BRACKET	3
18	Z-9287	ASSY, SUPPORT BRACKET SHORT	3
19	G-1503-1050N	FLATWASHER. 1/4 SST NARROW	20
20	G-1112-105006	BOLT, 1/4-20 X 3/4" LG SST HEX HD	9
21	G-1112-105010	BOLT, 1/4-20 X 1.0" LG SST HEX HD	8
22	G-1202-1050	STOPNUT, 1/4-20 ELASTIC	10
23	G-1250-1020N	FLATWASHER, #8 NARROW	4
24	G-1250-1100N	FLATWASHER, 5/8 NARROW	4
25	G-1159-102006	SCREW, #8-32 X 3/4" LG. RD HEAD CROSS RECESS MACHINE	4
26	G-1202-1020	STOPNUT, #8-32 ELASTIC	4
27	R-2407	ROD, WINCH STRAP	1
28	G-1202-1105	STOPNUT, 5/8-18 ELASTIC	2
29	G-1420-110522	BOLT, 5/8-18 X 2-1/4" HEX HD GR 8	2
30	R-2740	ROD, CRADLE	2
31	JP-114	LINCH PIN	4
32	G-1502-1050R	LOCKWASHER, 1/4 SST REGULAR	8
33	V-2651	LABEL, ELECTRICAL FAILURE WINCH	1
34	Z-9289	ASSEMBLY, STROBE LIGHT	1
35	EC-2993-09	ADAPTER, CONDUIT	1
36	Z-9288	ASSEMBLY, FOOT PEDAL	1
37	J-3881-01	PLATE, WINCH STRAP CLAMP	1
38	Z-9295	ASSEMBLY, ELECTRICAL	1
39	S-2597-00	PLATE, COVER	2
40	EC-1176-09	LOCKNUT, CONDUIT	1
41	Z-9502	ASSEMBLY, PUMP CONTROLLER	1
42	G-1550	NUT, 5/8-18 TAPERED LUG	18
43	EC-3056	PUMP MOTOR WIRING HARNESS	1
44	EC-3055	HARNESS LAYOUT, EJP-12	1
45	EC-3012	HARNESS, EJP10 DASH	1
46	EC-3286	CONVERTER 72/24 VDC	1
47	Z-10961	ASSEMBLY, FENDER CONTROLS	1
48	EC-3304	CAN WIRE HARNESS	1

Parts List

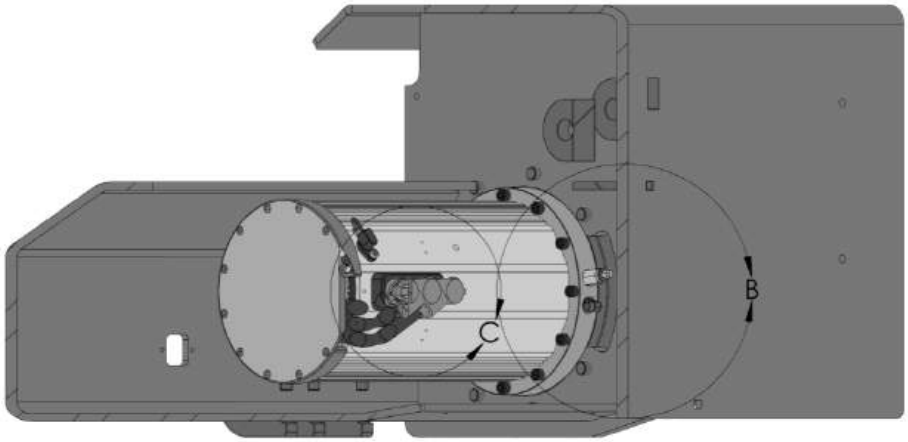
When ordering replacement parts/kits, please specify model, serial number and color of your unit.



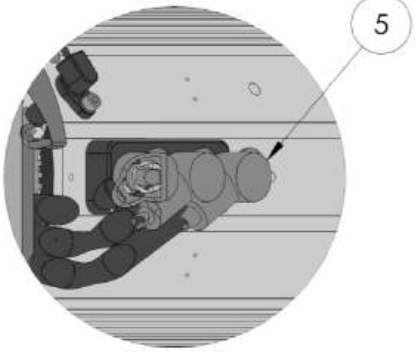
Item	Part Number	Description	Qty
1	EC-2992	MOTOR, HUB BRAKE ASSEMBLY	2
3	G-1420-110520	BOLT, 5/8-18 X 2" HEX HD GR 8	16

Parts List

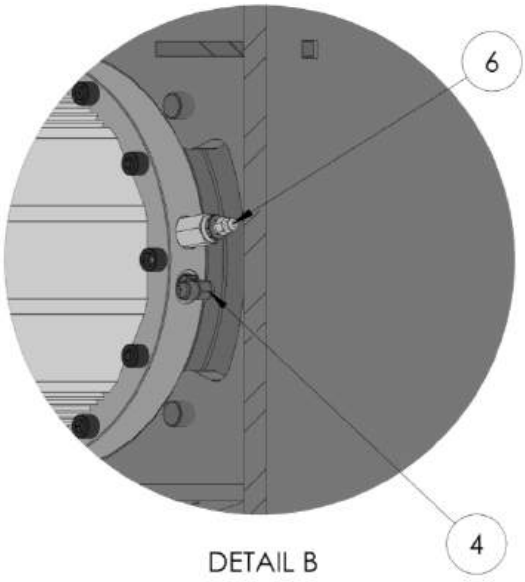
When ordering replacement parts/kits, please specify model, serial number and color of your unit.



SECTION A-A



DETAIL C

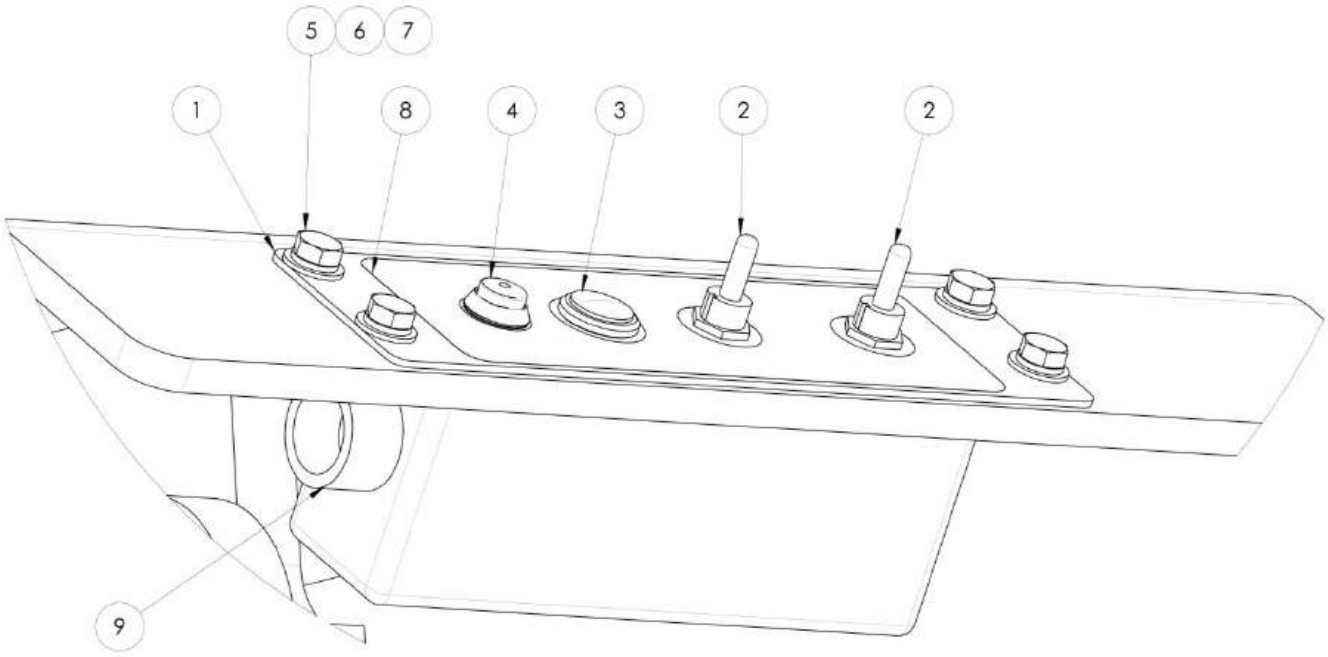


DETAIL B

Item	Part Number	Description	Qty
4	N-2001-03-S-B	ELBOW, STR THD	2
5	EC-2110	BATTERY, TERMINAL INSULATOR BLK	6
6	N-3027	PORT BLEED ADAPTER	1

Parts List

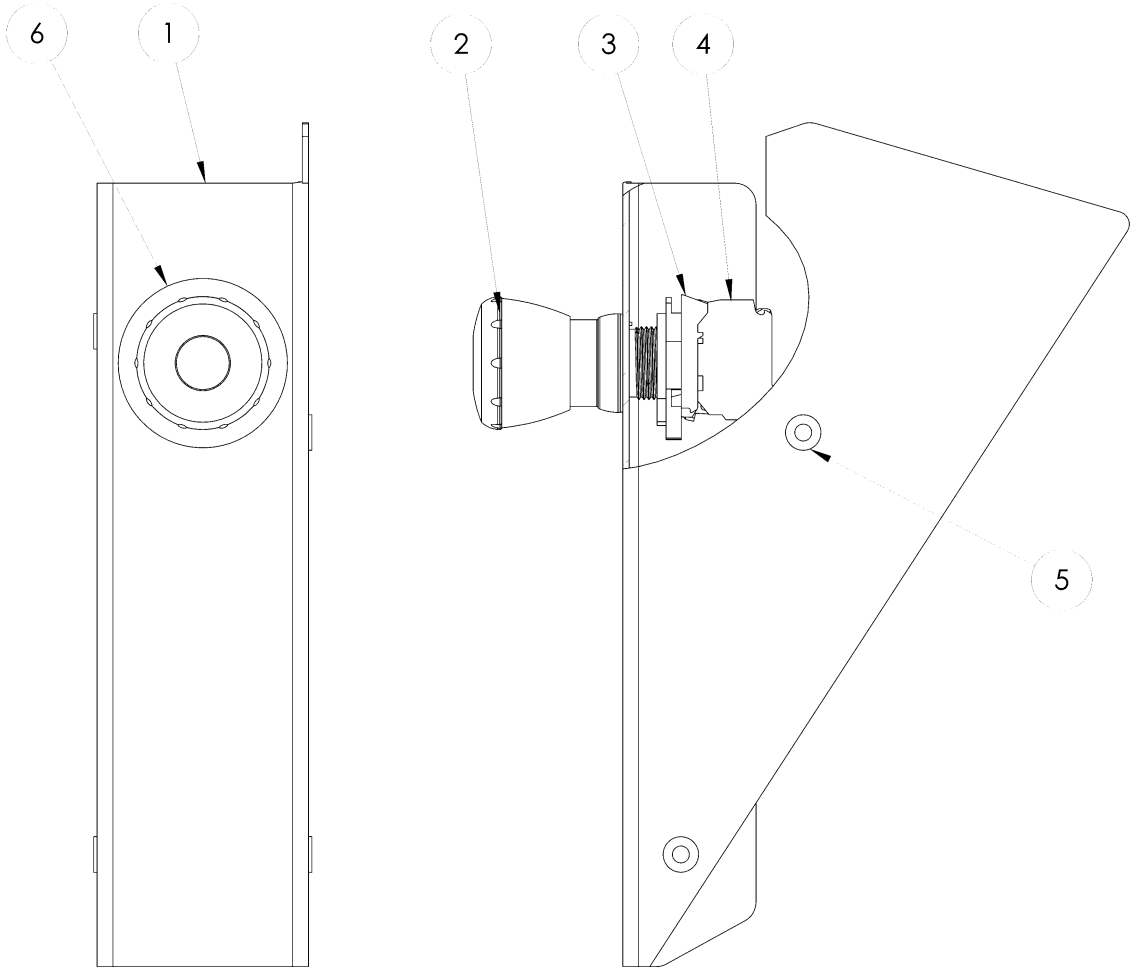
When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	S-3913-00	PLATE, FENDER SWITCHES (P)	1
2	EC-2745	SWITCH, TOGGLE 3 POS (DPDT)	2
3	EC-2826	LED, PANEL LAMP (GREEN)	1
4	EC-2947	PUSH BUTTON, MOMENTARY	1
5	G-1112-105006	BOLT, 1/4-20 X 3/4" LG SST HEX HD	4
6	G-1502-1050R	LOCKWASHER, 1/4 SST REGULAR	4
7	G-1503-1050N	FLATWASHER. 1/4 SST NARROW	4
8	V-2858	LABEL, FENDER SWITCH	1
9	EC-2993-01	ADAPTER, CONDUIT	1
10	S-3913-00	PLATE, FENDER SWITCHES (P)	1
11	EC-2745	SWITCH, TOGGLE 3 POS (DPDT)	2

Parts List

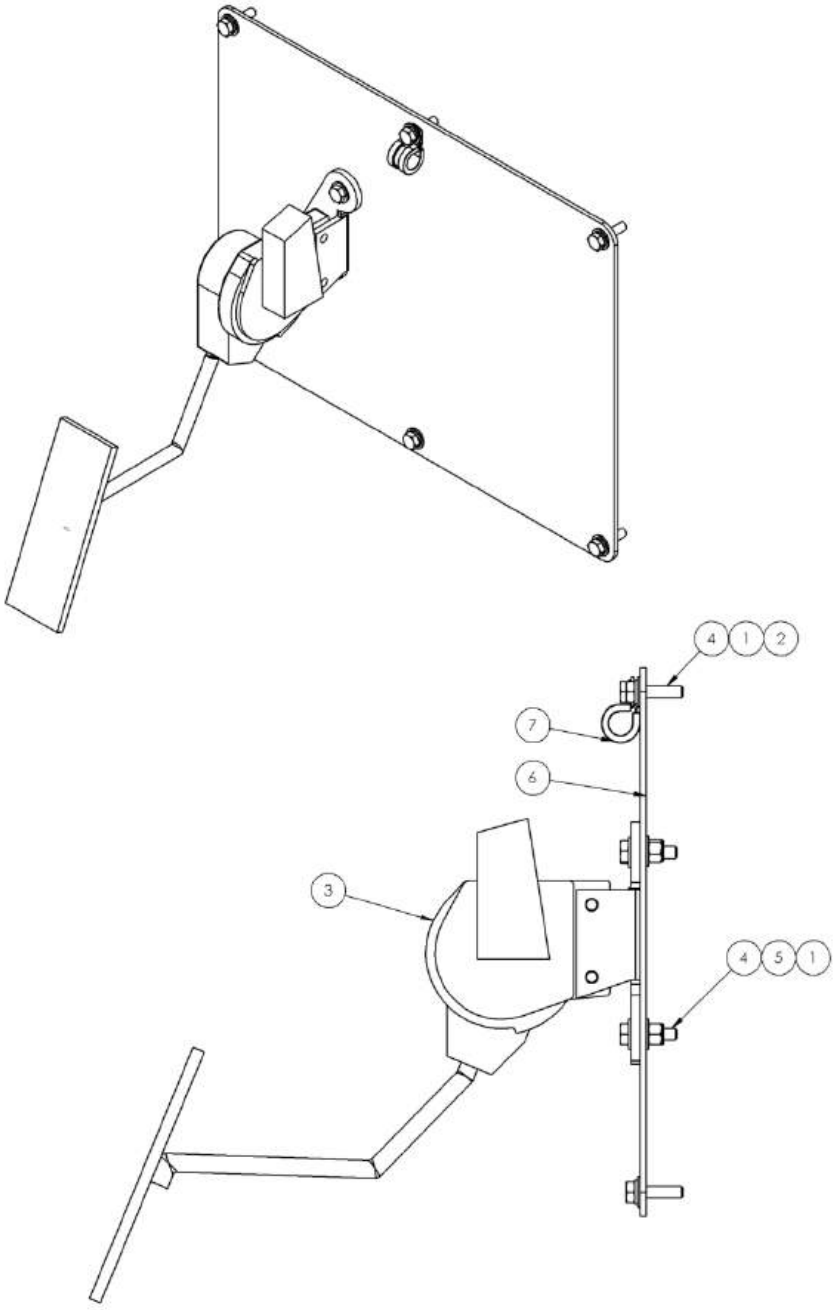
When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	S-3040-00	BRACKET, RIGHT	1
2	14132	SWITCH, E-STOP	1
3	14142	FLANGE, LATCH	1
4	14144	BLOCK, CONTACT (RED)	1
5	G-1439-1050-S	NUTSERT, 1/4-20 OPEN END	4
6	EC-1950-01	LEGEND PLATE, E-STOP	1

Parts List

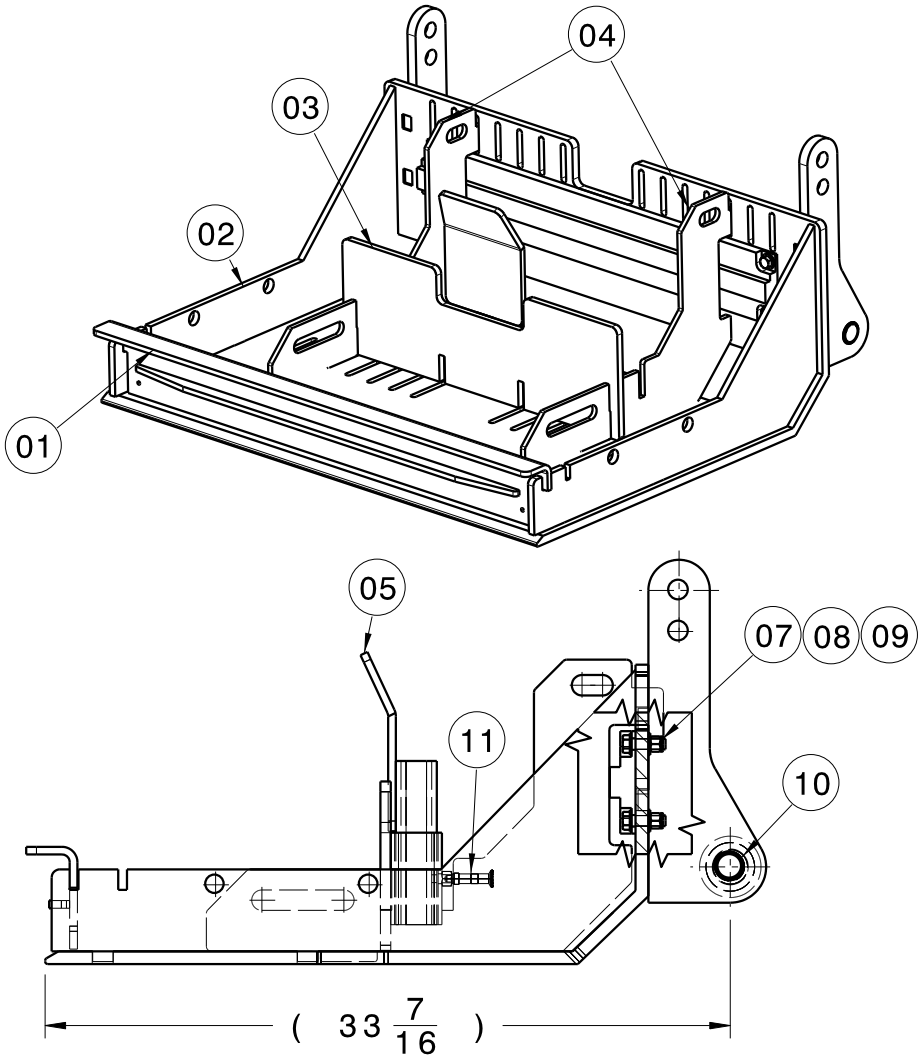
When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	G-1503-1050N	FLATWASHER. 1/4 SST NARROW	11
2	G-1502-1050R	LOCKWASHER, 1/4 SST REGULAR	6
3	EC-2985	MODIFIED, PEDAL FOOT EC-2961	1
4	G-1112-105010	BOLT, 1/4-20 X 1.0" LG SST HEX HD	8
5	g-1202-1050	STOPNUT, 1/4-20 ELASTIC	2
6	J-6184-01	PANEL, BRAKE	1
7	H-1721-01	CLAMP, ELECTRICAL	1

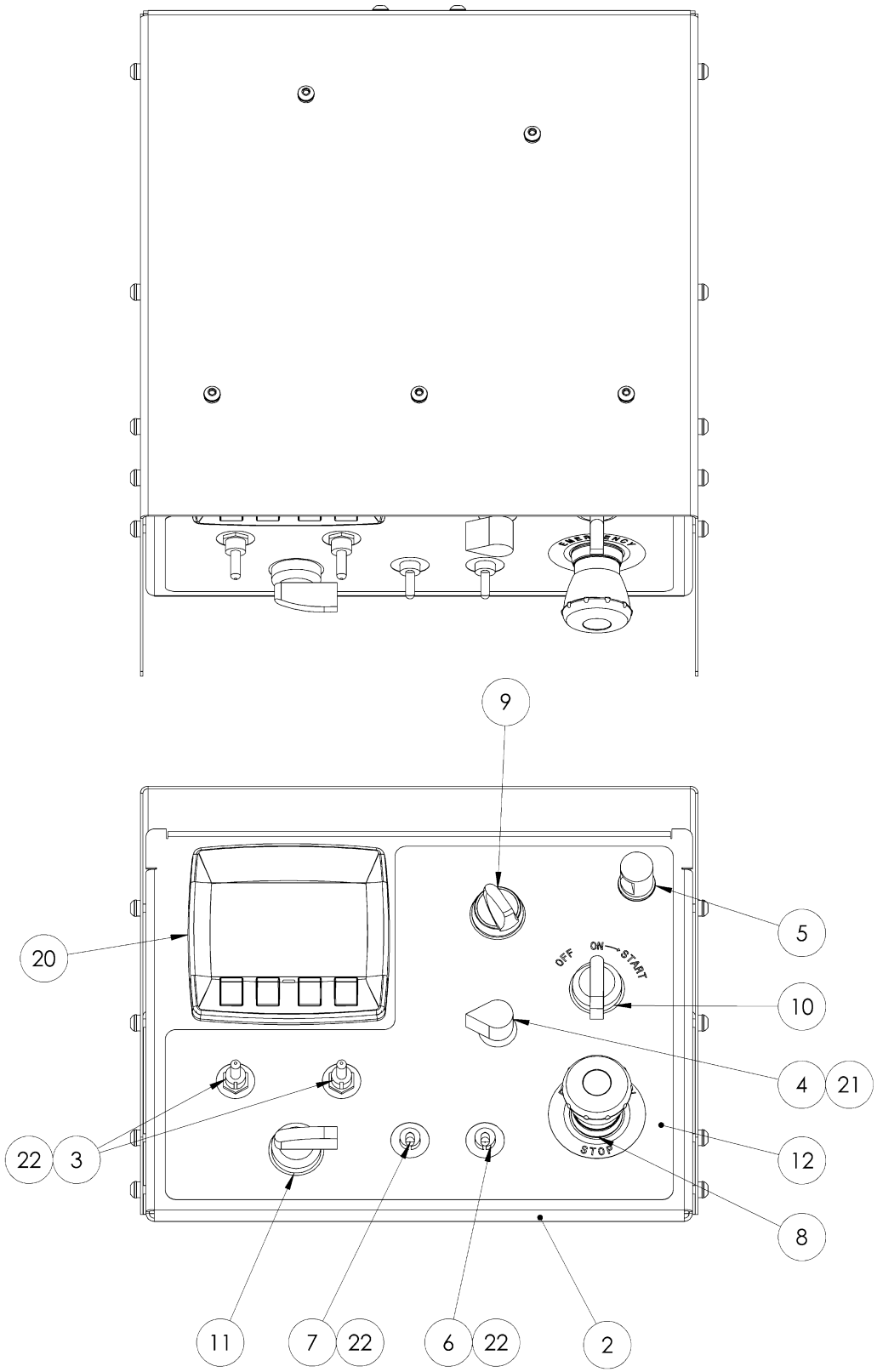
Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

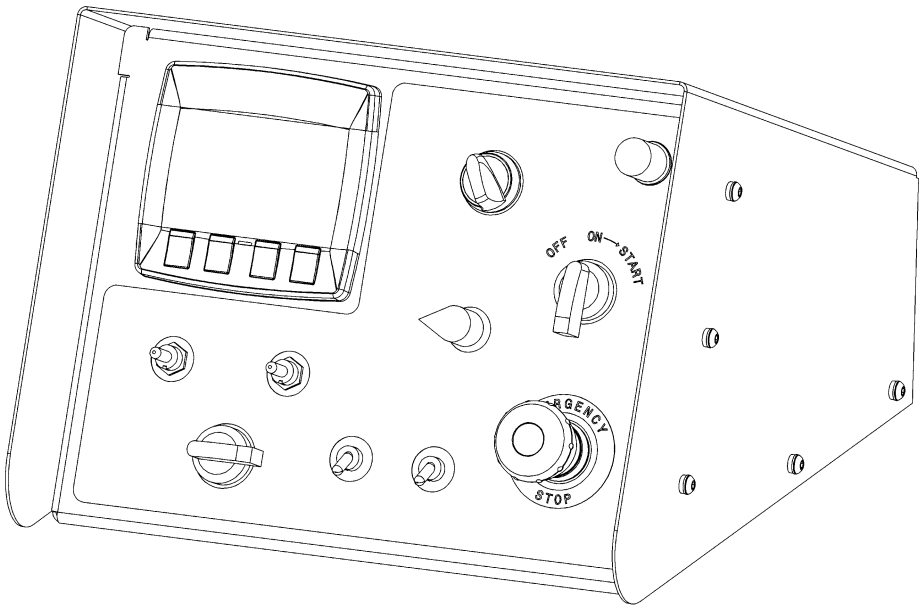


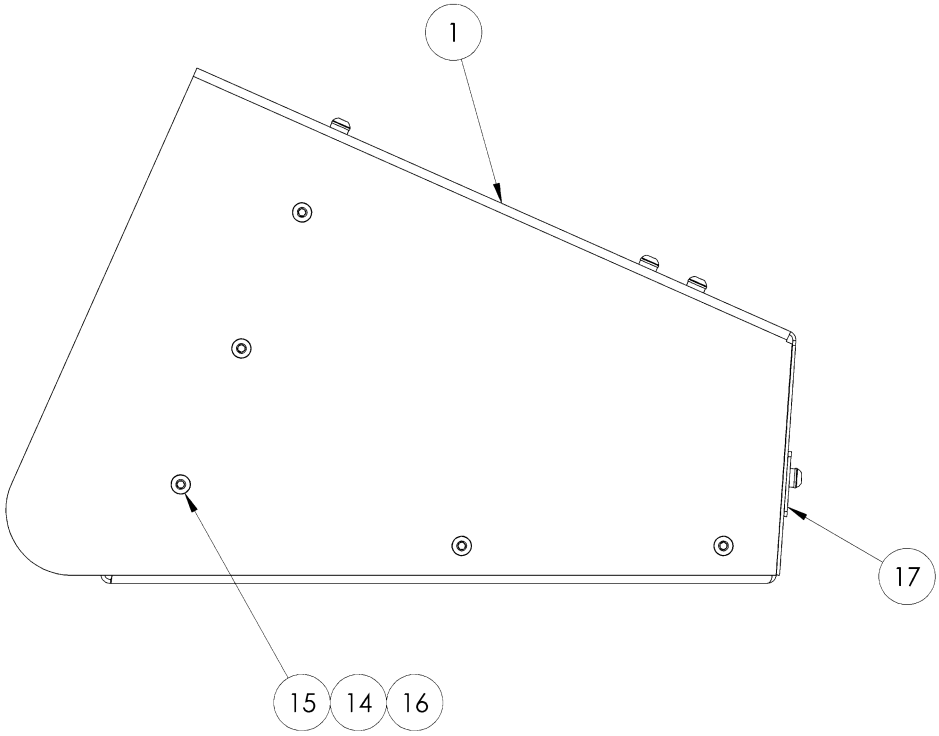
Item	Part Number	Description	Qty
1	Z-6322-01	WELDMENT, CRADLE ASSEMBLY STOP	Ref
2	Z-6336	WELDMENT, CRADLE ASSEMBLY	Ref
3	Z-6508	WELDMENT, CRADLE PLATE	Ref
4	J-3867	PLATE, MOVABLE SIDE	Ref
5	Z-6509	WELDMENT, NOSE SHOE	Ref
7	G-1112-109016	BOLT, ½ - 13 HH SS	4
8	G-1250-1090N	FLATWASHER, ½ NARROW	8
9	G-1202-1090	ESN, ½ - 13	4
10	H-3689	BEARING, FLANGE 1 ¼ ID 1 ½ OD X 1	2
11	JP-115	PLUNGER, INDEXING	1

Parts List Illustration



Parts List Illustration





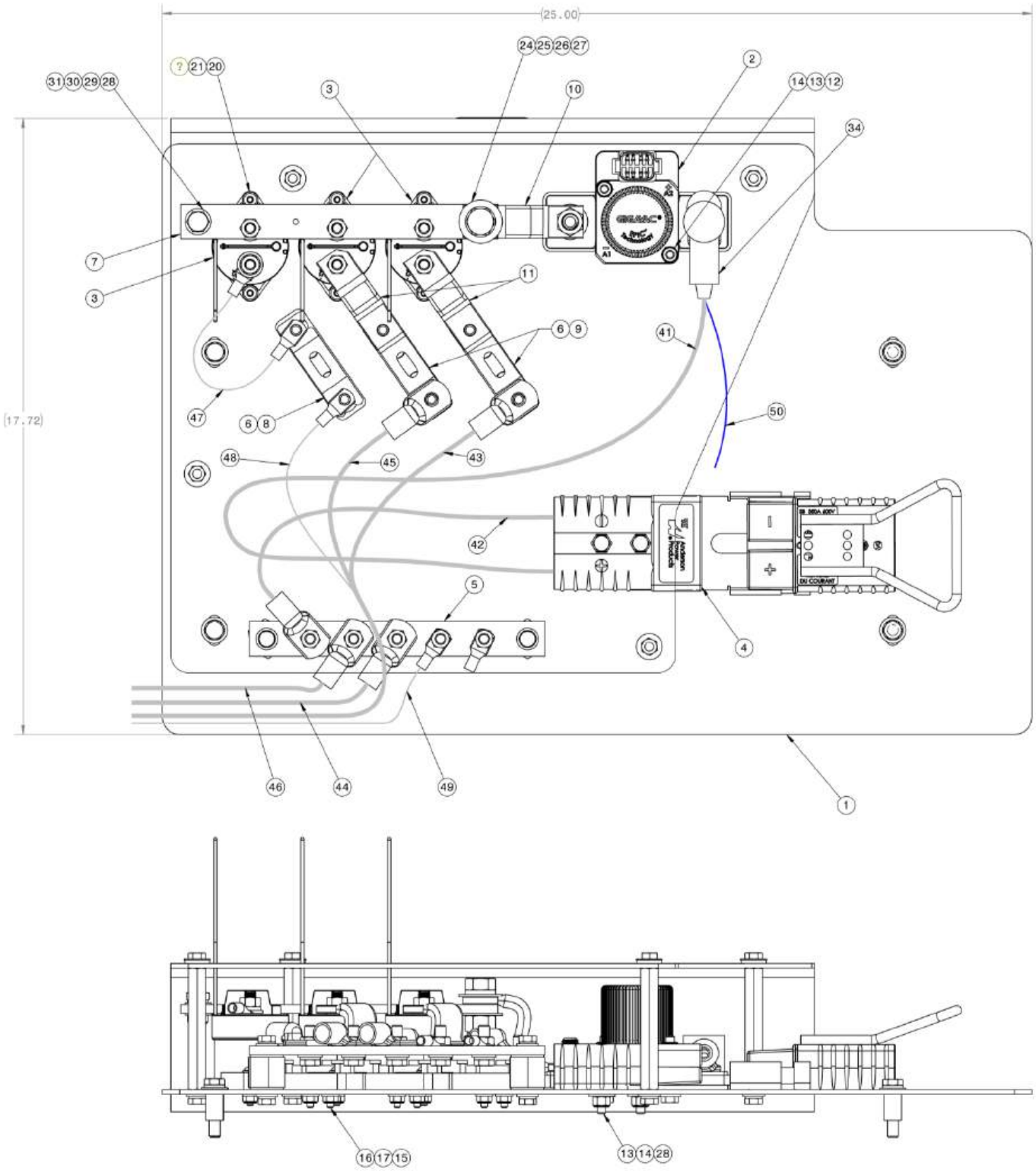
Parts List Illustration

Parts List

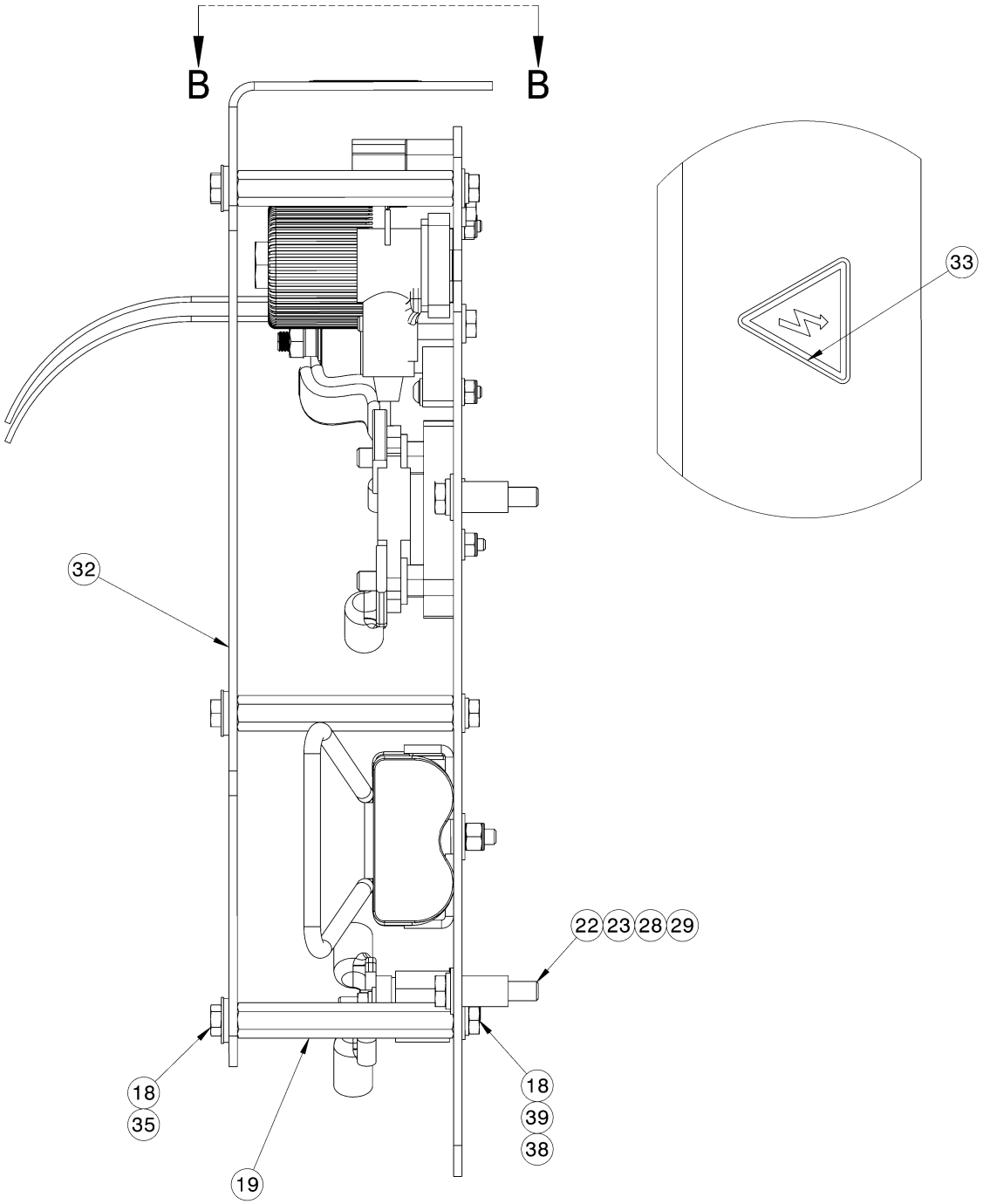
When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
1	S-3025-01	CONSOLE, CENTER TOP	1
2	S-3024-01	CONSOLE CENTER BASE	1
3	EC-2745	SWITCH, TOGGLE 3 POS (DPDT)	2
4	EC-2931	SWITCH, 6 POSTION	1
5	EC-2693	LAMP, PANEL LED	1
6	EC-2746	SWITCH, TOGGLE 2 POS (SPST)	1
7	EC-2747	SWITCH, TOGGLE 2 POS (DPST)	1
8	14132	SWITCH, E-STOP	1
9	14133	SWITCH, IDLR/RUN	1
10	EC-2740	SWITCH, 3 POSTIVE SPRING R/L	1
11	EC-2741	SWITCH, 3 POS MAINT W/LEVE	1
12	V-2668	LABEL, CONTROL PANEL	1
13	14143	BLOCK, CONTACT (GREEN)	3
14	G-1658-04	WASHER W NEOPRENE #10	17
15	G-1476-103106	SCREW, #10-32 X 3/4" LG. SST SOC BUTT. HD CAP	17
16	G-1439-1035-S	NUTSERT, 1/4-20 OPEN END	17
17	S-3055-01	PLATE, COVER	1
18	14144	BLOCK, CONTACT (RED)	5
19	14142	FLANGE, LATCH	4
20	XL00-10-001-CAP	STATUS, DISPLAY	1
21	EC-2932	KNOB	1
22	EC-2744	SEAL, TOGGLE SWITCH	4

Parts List Illustration



Parts List Illustration



Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

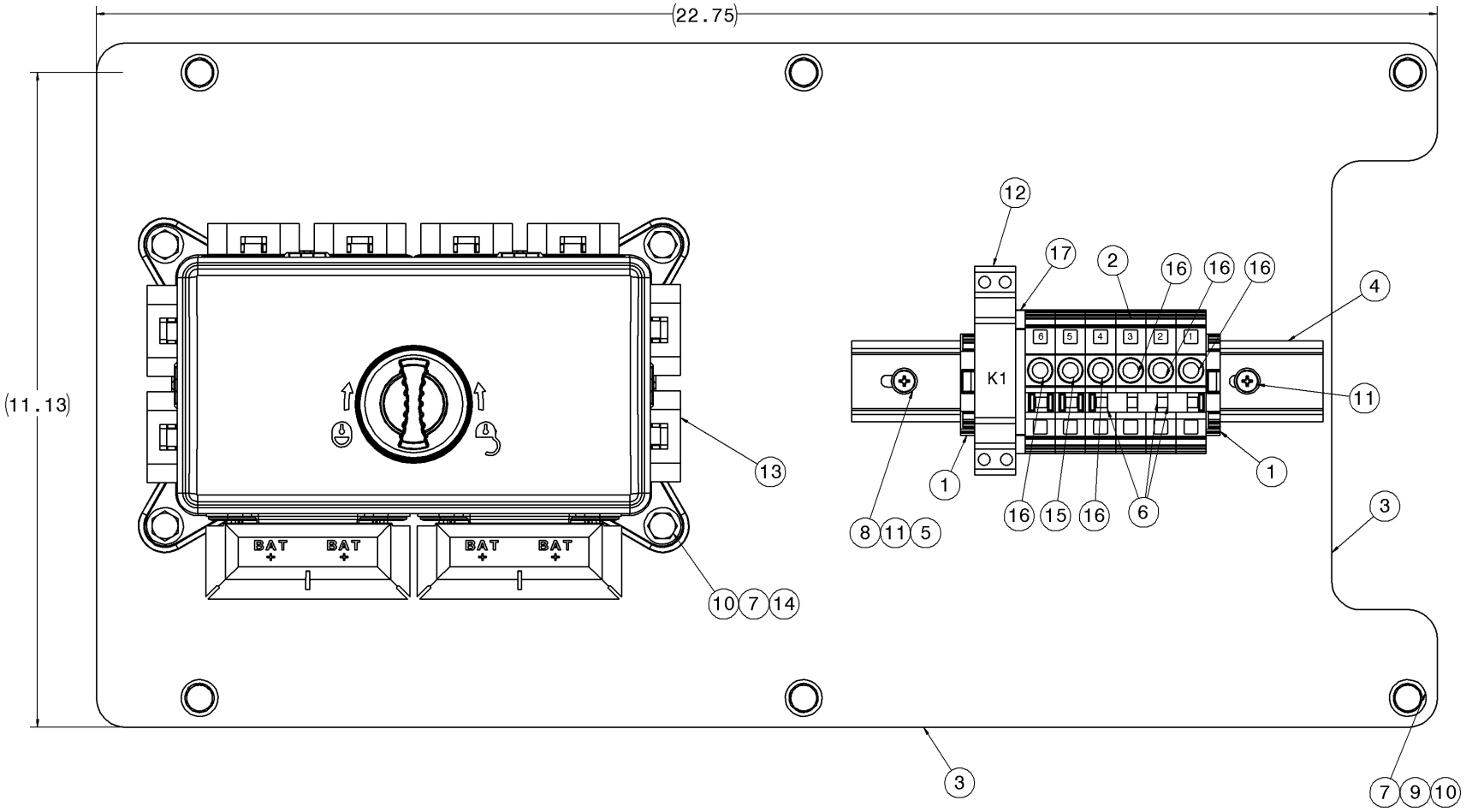
Item	Part Number	Description	Qty
1	J-6388-00	DIVIDER, BOLT-IN CONTACTOR	1
2	EC-2987	CONNECTOR 600 AMP 12-800 VDC	1
3	EC-2988	48V CONTACTOR	3
4	EC-3005	350A DUAL POLE SPRING & HOUSING	2
5	Z-9002	ASSEMBLY, BUSS BAR 5 PLCS	1
6	EC-1618	FUSE BLOCK, ANL LIMITERS	3
7	EC-2999	COPPER BUSBAR	1
8	EC-1619-04	FUSE, LOW VOLATAGE LIMITER (60 AMP)	1
9	EC-1619-18	FUSE, LOW VOLTAGE LIMITER (400 AMP)	2
10	EC-2997	CABLE, FLEX BRAIDED	1
11	EC-2998	FLEXIBLE BRAIDED CABLE	2
12	G-1250-1050N	FLATWASHER. 1/4 NARROW	2
13	G-1100-105016	BOLT, 1/4-20 X 1-3/4" LG HEX HD GR 5	4
14	G-1202-1050	STOPNUT, 1/4-20 ELASTIC	4
15	G-1250-1030N	FLATWASHER. #10 NARROW	6
16	G-1152-103710	SCREW, #10-32 X 1.0" LG SOCKET FLAT HD CAP	6
17	G-1202-1035	STOPNUT, #10-32 ELASTIC	6
18	G-1100-105004	BOLT, 1/4-20 X 1/2" LG. HEX HD GR 5	8
19	H-3875	STANDOFF FEMALE 1/4-20 X 3.5 LG	4
20	G-1503-1030N	FLATWASHER. #10 SST NARROW	12
21	G-1476-103110	SCREW, #10-32 X 1.0" LG. SST SOC BUTT. HD CAP	6
22	G-1501-1031	STOPNUT, #10-32 SST ELASTIC	6
23	G-1100-106014	BOLT, 5/16-18 X 1-1/2" LG. HEX HD GR 5	4
24	TR377-03-000.75	TBG, SST .50OD -.49W	4
25	G-1503-1090N	FLATWASHER. 1/2 SST NARROW	2
26	G-1502-1090R	LOCKWASHER, 1/2 SST REGULAR	1
27	G-1112-109014	BOLT, 1/2-13 X .1-1/2" SST HEX HD	1
28	G-1202-1090	STOPNUT, 1/2-13 ELASTIC	1
29	G-1503-1060N	FLATWASHER. 5/16 SST NARROW	8
30	G-1502-1060R	LOCKWASHER, 5/16 SST REGULAR	5
31	G-1112-106010	BOLT, 5/16-18 X 1.0" LG. SST HEX HD	1
32	G-1202-1060	STOPNUT, 5/16-18 ELASTIC	1
33	S-3067	COVER, ELECTRICAL	1
34	V-1050	LABEL, ISO ELECTRICAL SHOCK	1
35	EC-2110	BATTERY, TERMINAL INSULATOR BLK	1
36	G-1658-13	WASHER W NEOPRENE 1/4"	4
37	H-3698	CONNECTOR, HANDLE	1
38	H-3712	CONNECTOR, MAUNAL RELEASED	1
39	G-1503-1050N	FLATWASHER. 1/4 SST NARROW	4
40	G-1502-1050R	LOCKWASHER, 1/4 SST REGULAR	4
41	EC-3000-01	POWER CABLE - SIZE 2/0	REF
42	EC-3000-02	POWER CABLE - SIZE 2/0	REF
43	EC-3000-03	POWER CABLE - SIZE 2/0	REF

Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
44	EC-3000-04	POWER CABLE - SIZE 2/0	REF
45	EC-3000-05	POWER CABLE - SIZE 2/0	REF
46	EC-3000-06	POWER CABLE - SIZE 2/0	REF
47	EC-3000-13	POWER CABLE - SIZE 6	REF
48	EC-3000-14	POWER CABLE - SIZE 6	REF
49	EC-3000-16	POWER CABLE - SIZE 6	REF
50	EC-3000-18	POWER CABLE - SIZE 6	REF

Parts List Illustration



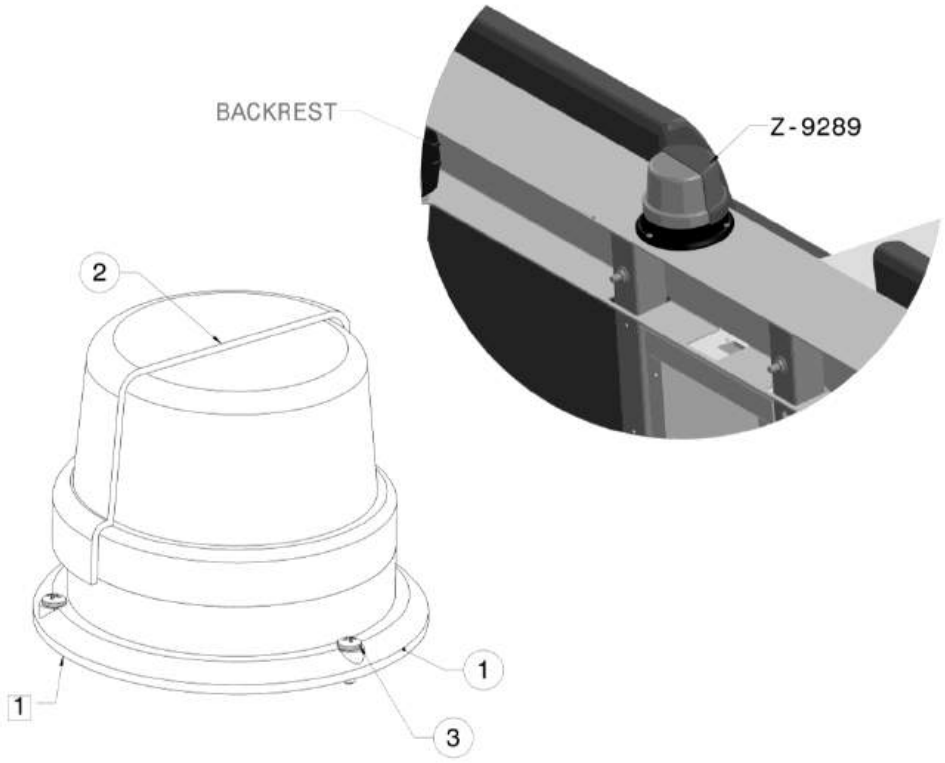
Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
1	13070	ANCHOR DINRAIL END	2
2	EC-2555	TERMINAL, BLOCK FUSE	6
3	S-3073-01	SHELF	1
4	EC-1895-008.00	RAIL, DIN	1
5	G-1439-1035-S	NUTSERT, #10-32 OPEN END	2
6	EC-2948	JUMPER, ADJACENT NOMINAL	3
7	G-1503-1050N	FLATWASHER. 1/4 SST NARROW	14
8	G-1503-1030N	FLATWASHER. #10 SST NARROW	2
9	G-1502-1050R	LOCKWASHER, 1/4 SST REGULAR	6
10	G-1112-105006	BOLT, 1/4-20 X 3/4" LG SST HEX HD	10
11	G-1497-103106	SCREW, #10-24 X 3/4" LG. SST PAN HD CROSS RECESS	2
12	EC-2690	RELAY, TIME DELAY ON	1
13	EC-3073	FUSE, RELAY BOX	1
14	G-1202-1050	STOPNUT, 1/4-20 ELASTIC	4
15	EC-2113-2.00	FUSE, 2 AMP FAST ACTING	1
16	EC-2113-7.00	FUSE, 7 AMP FAST ACTING	5
17	EC-2685	PLATE, END FUSE HOLDER	1

Parts List

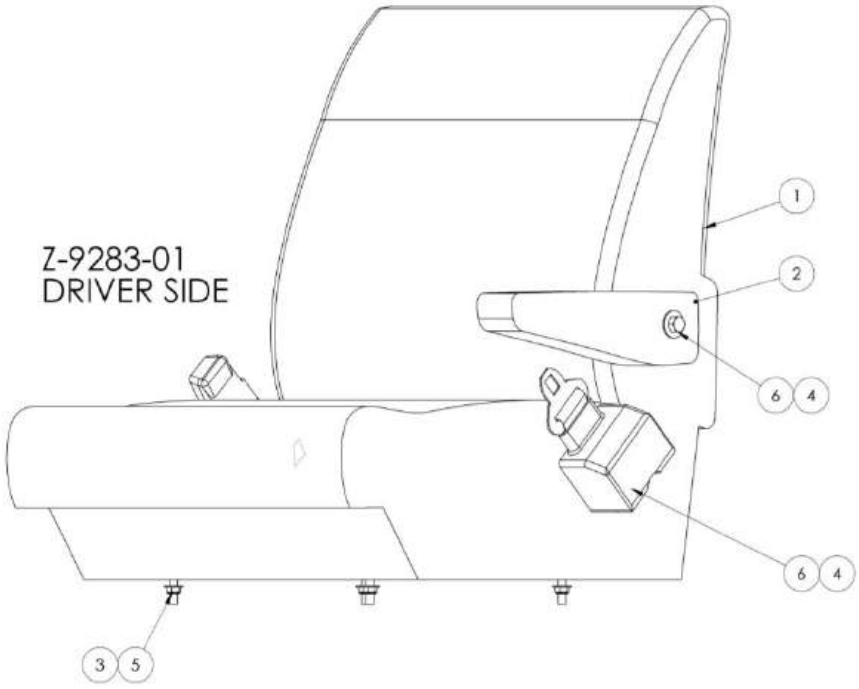
When ordering replacement parts/kits, please specify model, serial number and color of your unit.

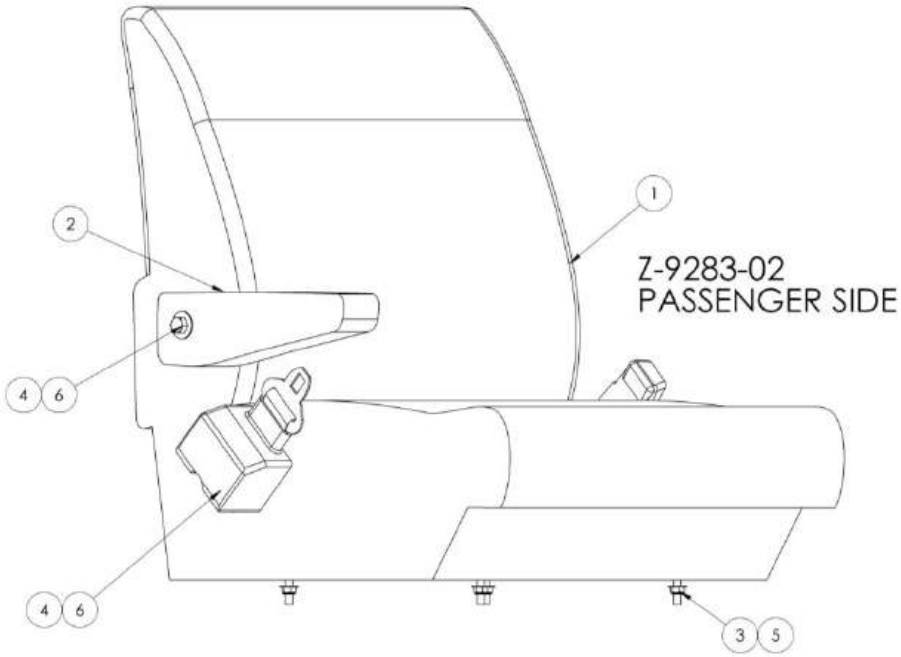


Item	Part Number	Description	Qty
1	JP-118	STOBE, LIGHT	1
2	JP-166	COVER, STROBE LIGHT	1
3	G-1497-102004	SCREW, #8-32 X 1/2" LG SST RD PH	3

Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

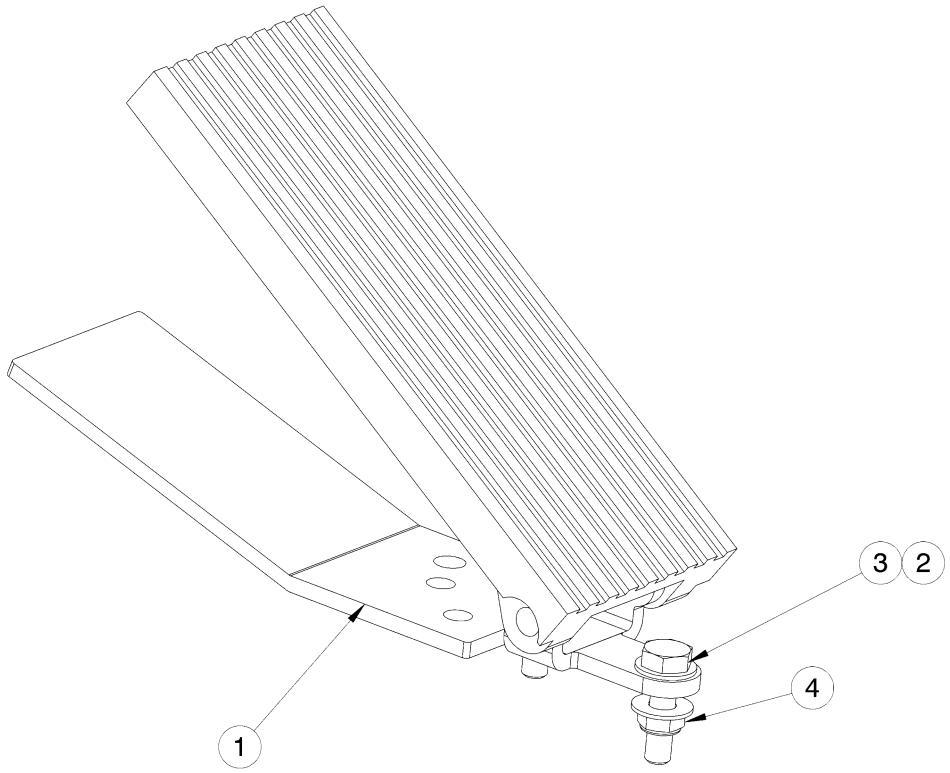




Item	Part Number	Description	Qty
1	JP-227	SEAT	1
2	JP-228	ARM REST	1
3	G-1503-1060N	FLATWASHER. 5/16 SST NARROW	4
4	G-1503-1080N	FLATWASHER. 7/16 SST NARROW	3
5	G-1501-1060	STOPNUT, 5/16-18 SST ELASTIC	4
6	G-1100-108510	BOLT, 7/16-20 X 1.0" HEX HD GR 5	3
7	JP-229	REEL, SEAT BELT	1

Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	EC-2766	FOOT, PEDAL	1
2	G-1503-1060N	FLATWASHER. 5/16 SST NARROW	4
3	G-1112-106012	BOLT, 5/16-18 X 1-1/4" LG. SST HEX HD	2
4	G-1202-1060	STOPNUT, 5/16-18 ELASTIC	4

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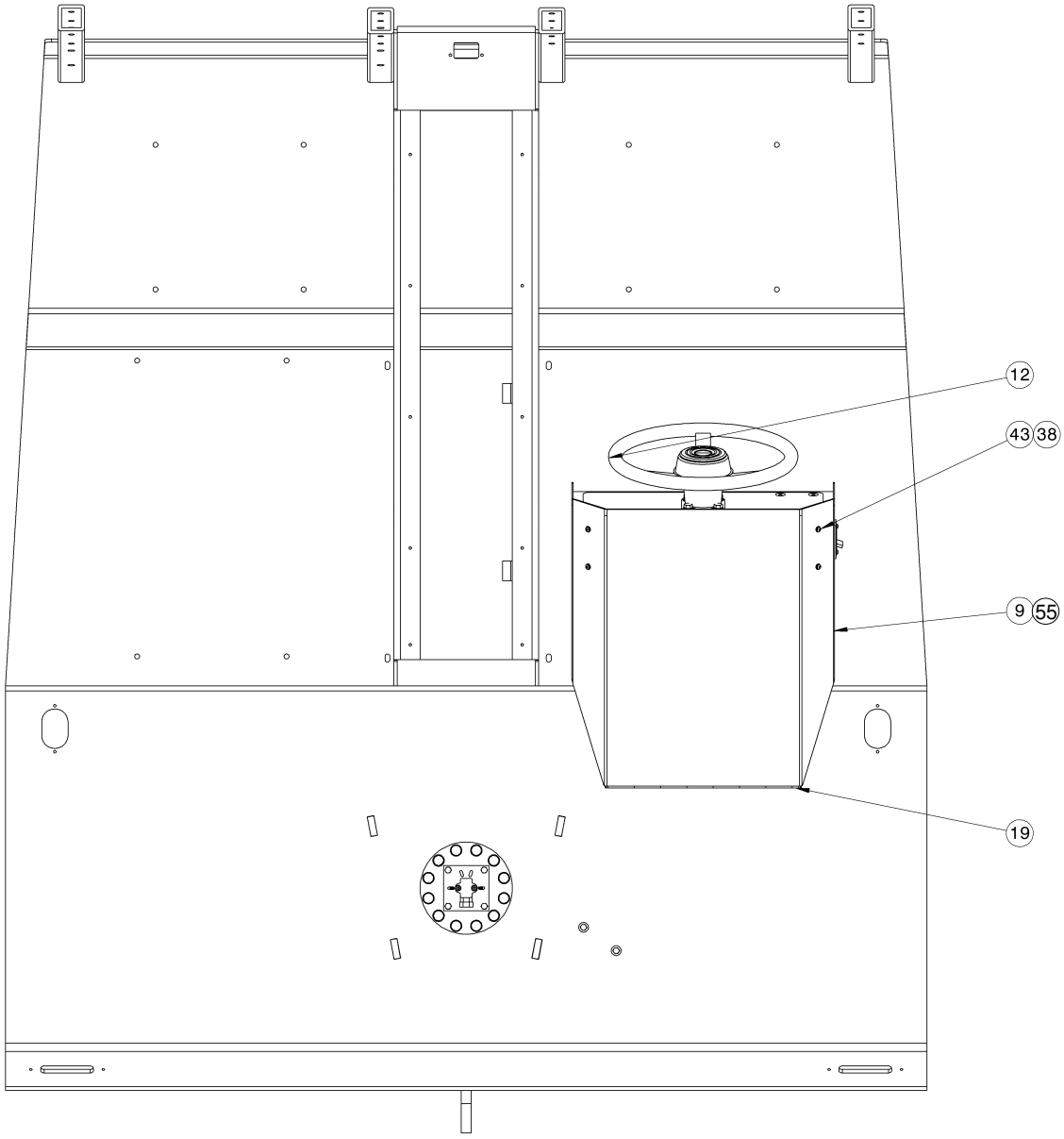
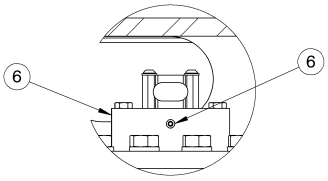
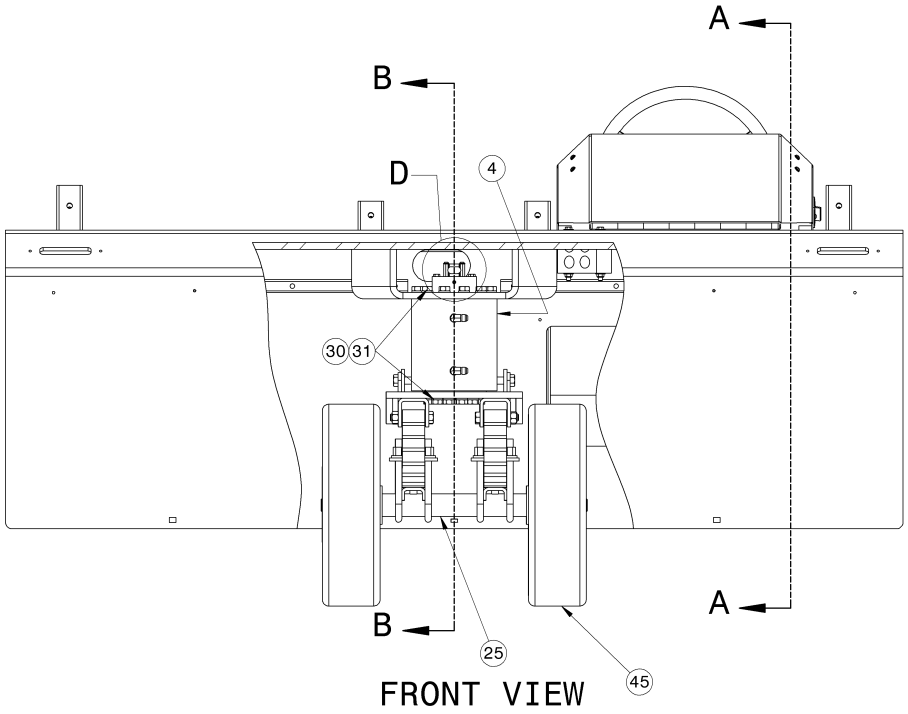
Parts List Illustration



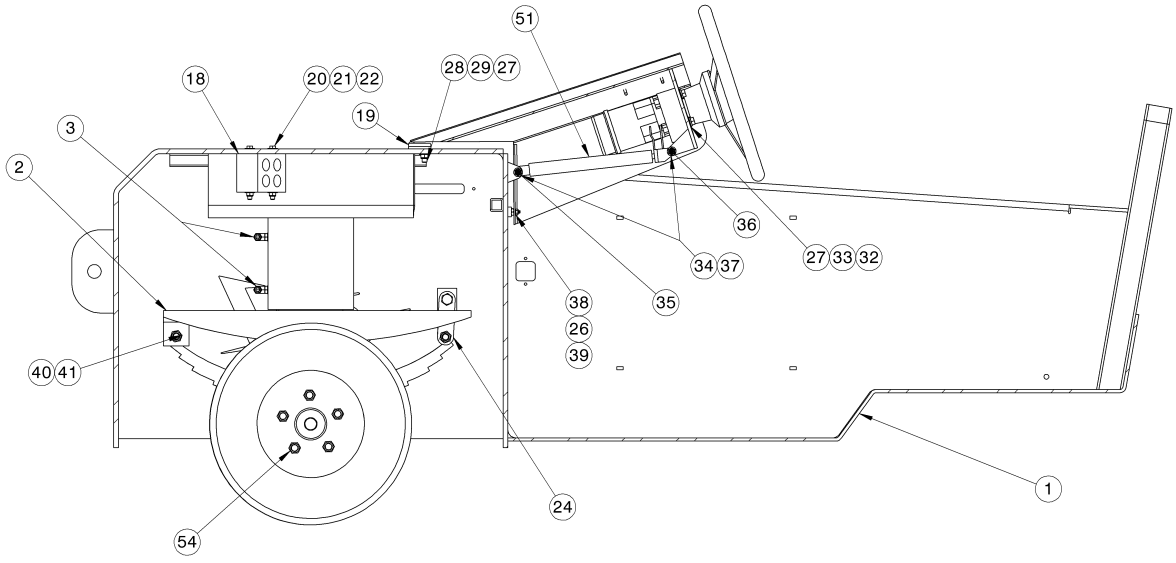
Parts List Illustration



DETAIL D
SCALE 1 : 3

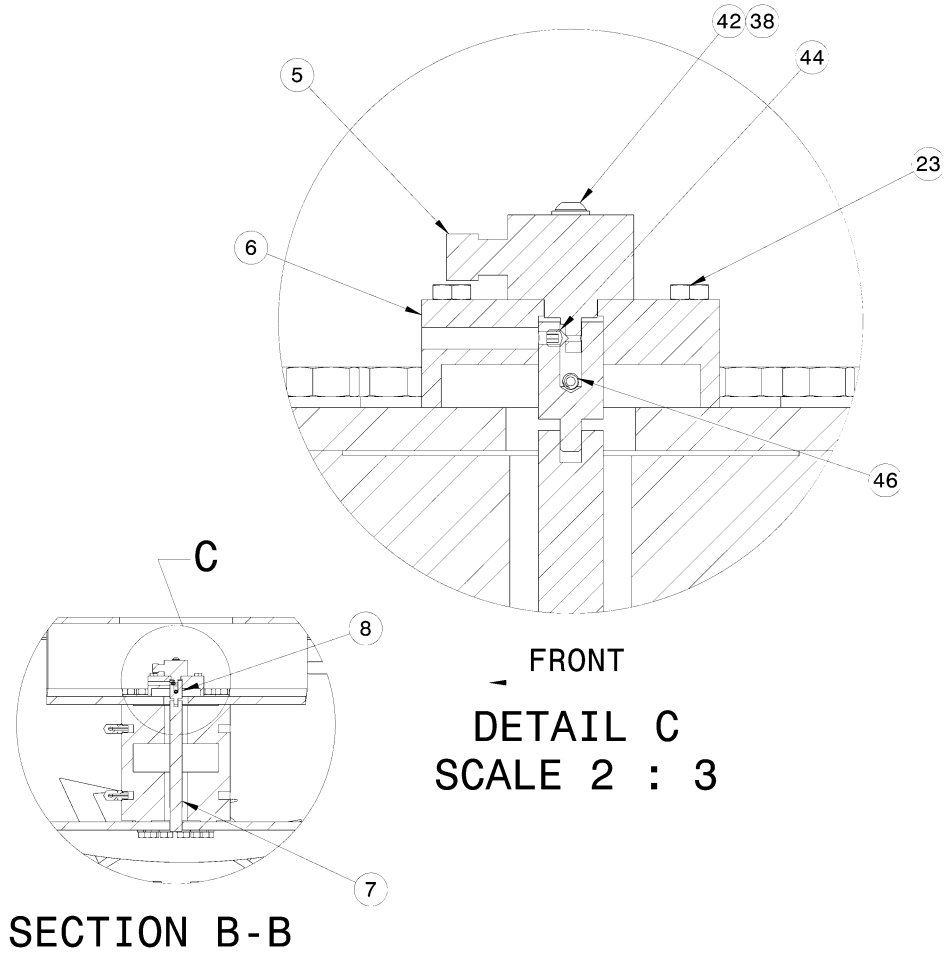


FRONT VIEW

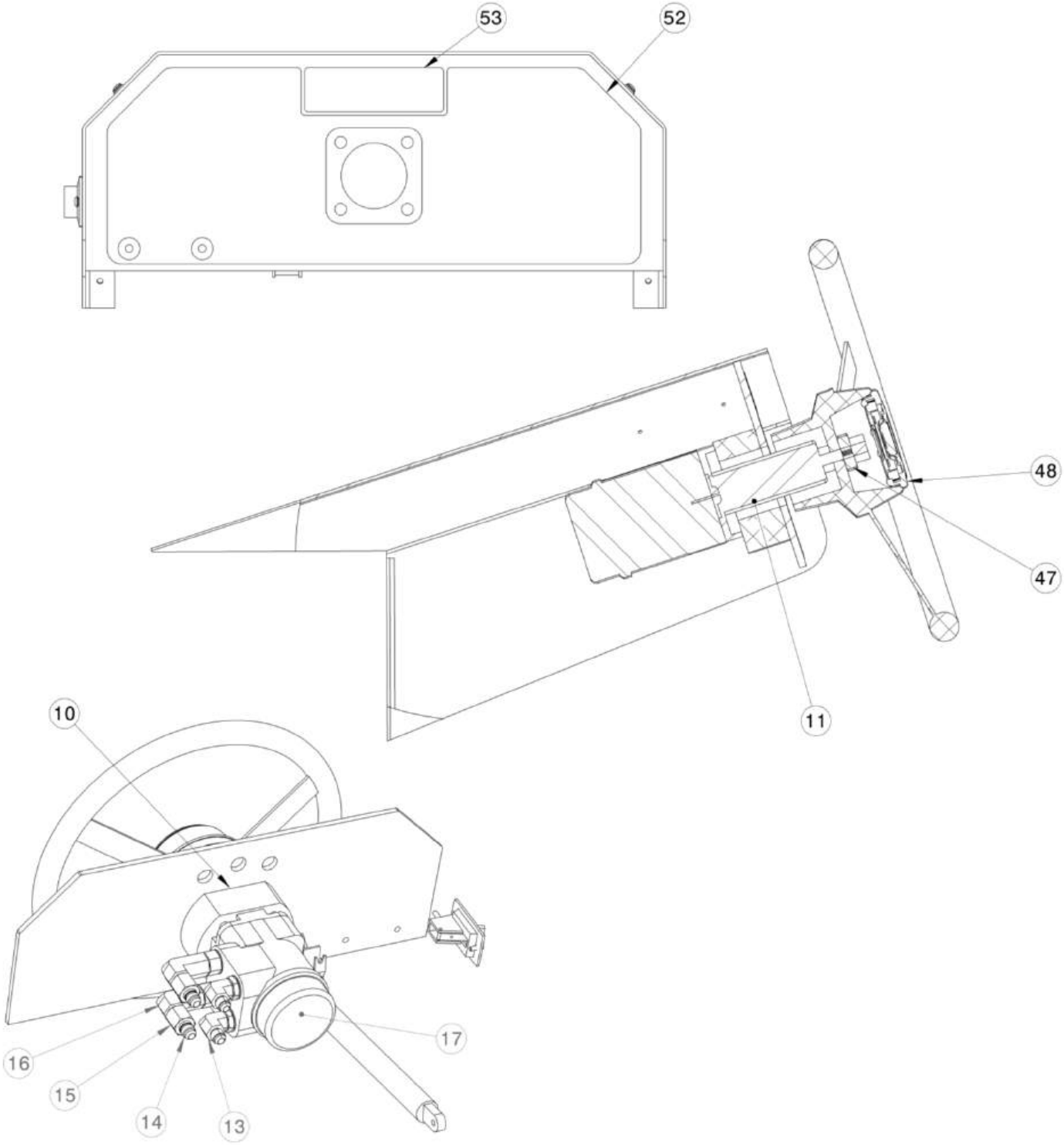


SECTION A-A

Parts List Illustration



Parts List Illustration



Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
1	Z-9238 P3	WELDMENT, STEERING SUBFRAME	REF
2	Z-6716-00	WELDMENT, BOTTOM STEERING PLATE	REF
3	N-2001-35-S-B	ELBOW, STR. THD. (6-4)	2
4	HC-2372	ACTUATOR, ROTARY	1
5	EC-2996	SENSOR, ROTARY HALL-EFFECT	1
6	J-6536	PLATE, SENSOR ARM	1
7	R-3142	EXTENSION, ROD	1
8	R-3141	ADAPTOR, ROD	1
9	Z-9272-00	WELDMENT, STEERING COWL	REF
10	R-2319	SPACER, STEERING	1
11	H-3067	STEERING, COLUMN	1
12	H-3068	STEERING, WHEEL	1
13	N-2001-09-S-B	ELBOW, STR. THD. (6-8)	2
14	N-2020-03-S	REDUCER, TUBE, END	2
15	N-2000-06-S	NUT, 37 DEG FLARE	2
16	N-2706-03-S-B	ELBOW, LONG STR. THD.	2
17	HC-2371	STEERING, VALVE	1
18	J-6387	BLOCK, HOSE ROUTING	1
19	S-2695-01	HINGE, SPACER	1
20	G-1420-106040	BOLT, 5/16-18 X 4" LG. HEX HD GR 8	2
21	G-1503-1060N	FLATWASHER. 5/16 SST NARROW	4
22	G-1202-1060	STOPNUT, 5/16-18 ELASTIC	2
23	G-1100-105014	BOLT, 1/4-20 X 1-1/2" LG HEX HD GR 5	4
24	J-4185-01	LINK, REAR	4
25	Z-9058	ASSEMBLY, SUSPENSION	1
26	JP-242	BUMPER, GUARDS, STEER COWL	2
27	G-1250-1070N	FLATWASHER. 3/8 NARROW	8
28	G-1100-107012	BOLT, 3/8-16 X 1-1/4" HEX HD GR 5	2
29	G-1202-1070	STOPNUT, 3/8-16 ELASTIC	2
30	G-1251-1090R	LOCKWASHER, 1/2 REGULAR	24
31	G-1100-109012	BOLT, 1/2-13 X 1-1/4" HEX HD GR 5	24
32	G-1251-1070R	LOCKWASHER, 3/8 REGULAR	4
33	G-1100-107030	BOLT, 3/8-16 X 3.0" HEX HD GR 5	4
34	G-1250-1060N	FLATWASHER. 5/16 NARROW	4
35	G-1100-106514	BOLT, 5/16-24 X 1-1/2" LG. HEX HD GR 5	1
36	G-1100-106520	BOLT, 5/16-24 X 2" LG. HEX HD GR 5	1
37	G-1202-1065	STOPNUT, 5/16-24 ELASTIC	2
38	G-1503-1030N	FLATWASHER. #10 SST NARROW	8
39	G-1202-1035	STOPNUT, #10-32 ELASTIC	2
40	G-1129	BOLT, SHACKLE	6
41	G-1240	NUT, SHACKLE	6
42	G-1476-103116	SCREW, #10-32 X 1-3/4" LG. SST SOC BUTT. HD CAP	2
43	G-1497-103106	SCREW, #10-24 X 3/4" LG. SST PAN HD CROSS RECESS	4

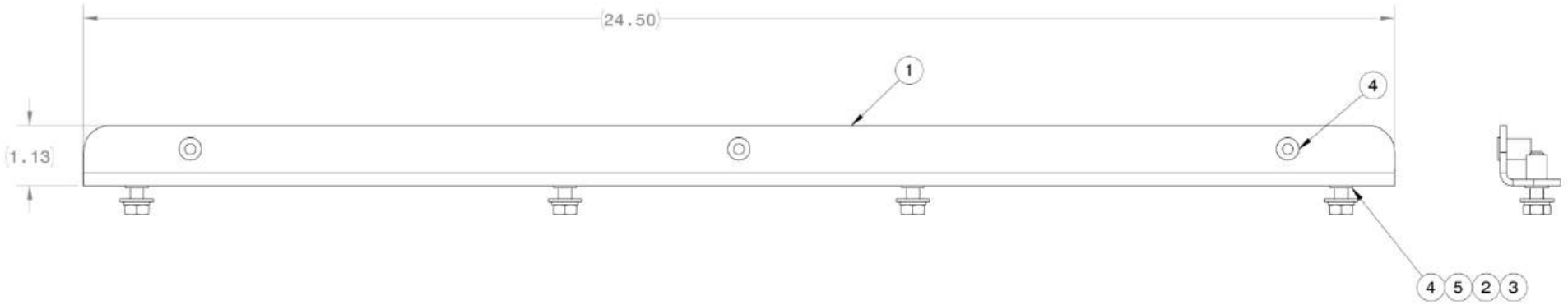
Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
44	G-1698	10-24 x 1/4" HEX DRIVE CONE PT. GRD 18-8 SS	1
45	U-1128	WHEEL, SOLID	2
46	H-4116	SET SCREW, CUP POINT	2
47	H-3069	NUT, STEERING WHEEL	1
48	EC-2040	BUTTON, HORN	1
49	JP-271	LEVER, STEERING COWL LIFT	1
50	G-1476-103104	SCREW, #10-32 X 1/2" LG. SST SOC BUTT. HD CAP	2
51	H-3665	CYLINDER, GAS	1
52	V-2247	LABEL, DRIVING OPERATION	1
53	V-2674	LABEL, DASH PANEL TRONAIR	1
54	JP-126	FRONT WHEEL HUB NUTS	10
55	G-1152-103703	Screw, 10 – 32 x 3/8 LG	4

Parts List

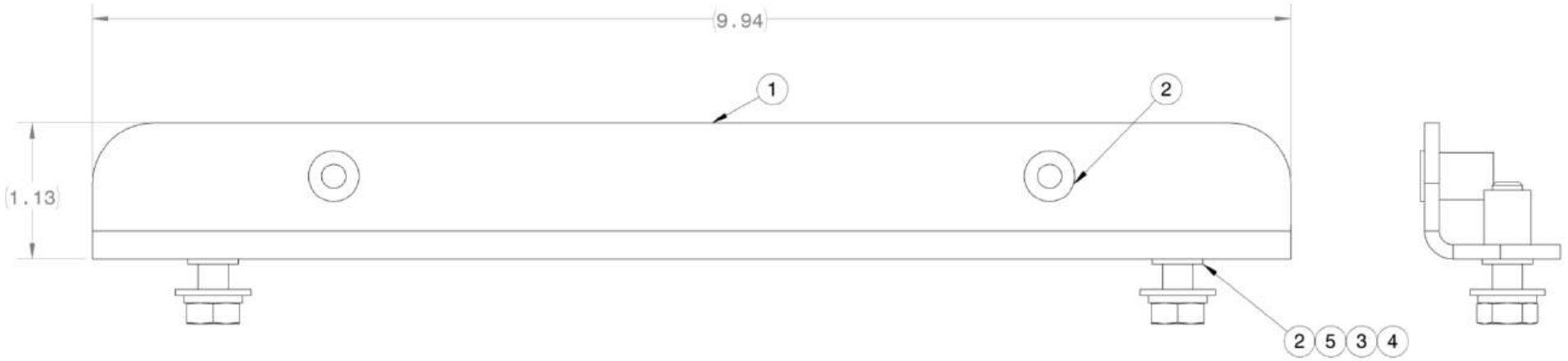
When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	S-3043-01	BRACKET, LONG	1
2	G-1503-1050N	FLATWASHER. 1/4 SST NARROW	4
3	G-1502-1050R	LOCKWASHER, 1/4 SST REGULAR	4
4	G-1440-1050-S	NUTSERT, 1/4-20 OPEN END	7
5	G-1112-105010	BOLT, 1/4-20 X 1.0" LG SST HEX HD	4

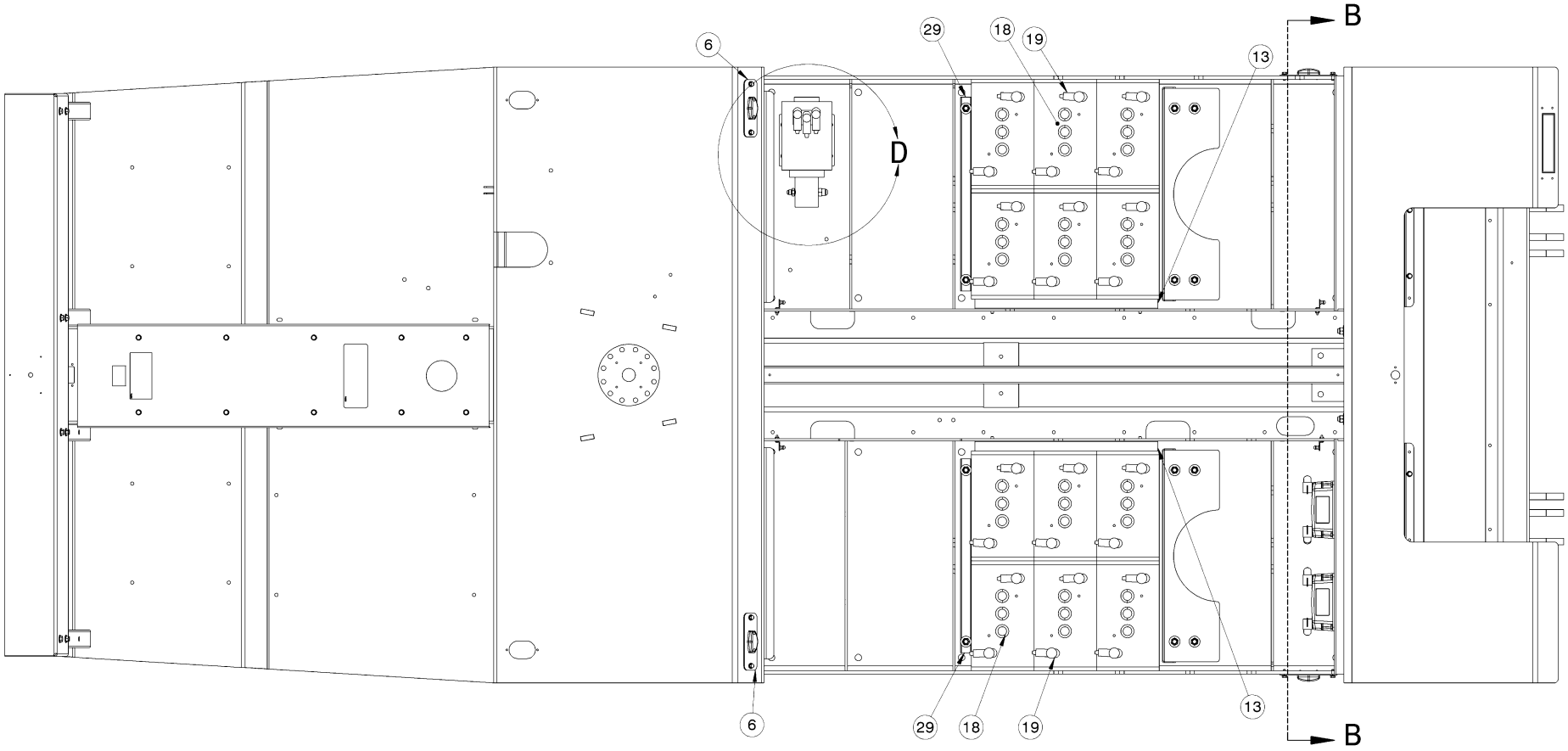
Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

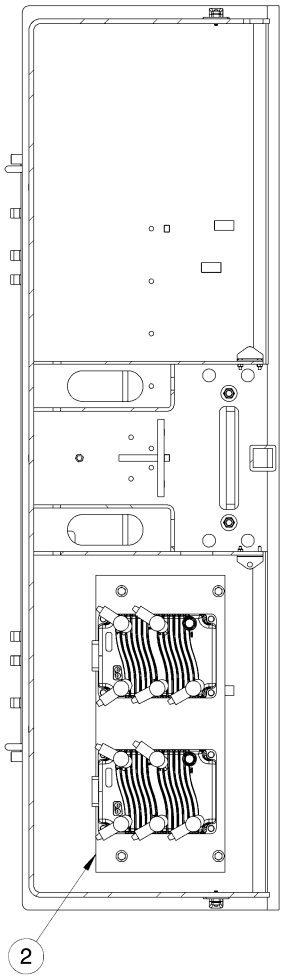


Item	Part Number	Description	Qty
1	S-3044-01	BRACKET, LONG	1
2	G-1440-1050-S	NUTSERT, 1/4-20 OPEN END	4
3	G-1503-1050N	FLATWASHER. 1/4 SST NARROW	2
4	G-1502-1050R	LOCKWASHER, 1/4 SST REGULAR	2
5	G-1112-105010	BOLT, 1/4-20 X 1.0" LG SST HEX HD	2

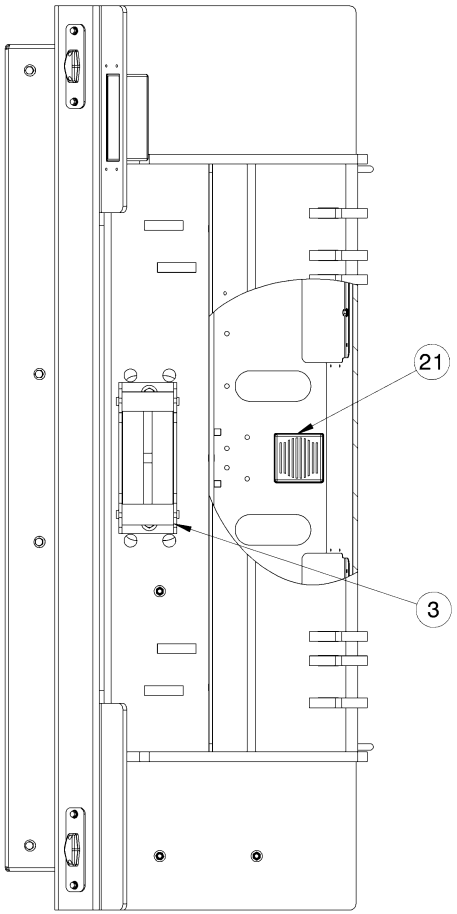
Parts List Illustration

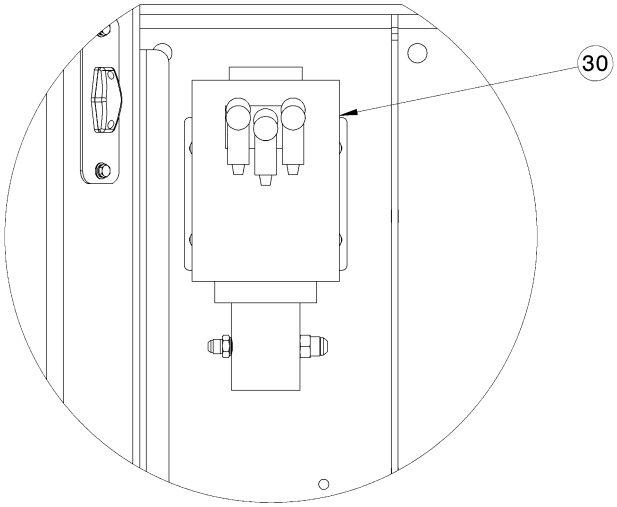


Parts List Illustration



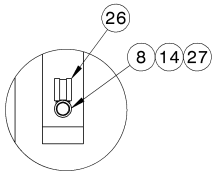
SECTION B-B
SCALE 3 : 32



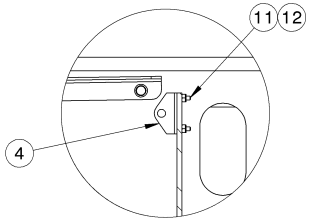


DETAIL D
SCALE 6 : 32

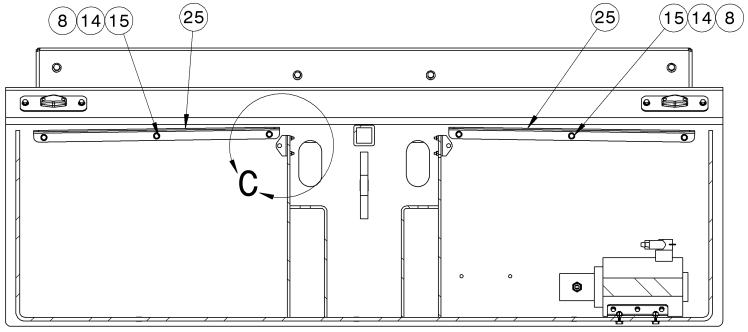
Parts List Illustration



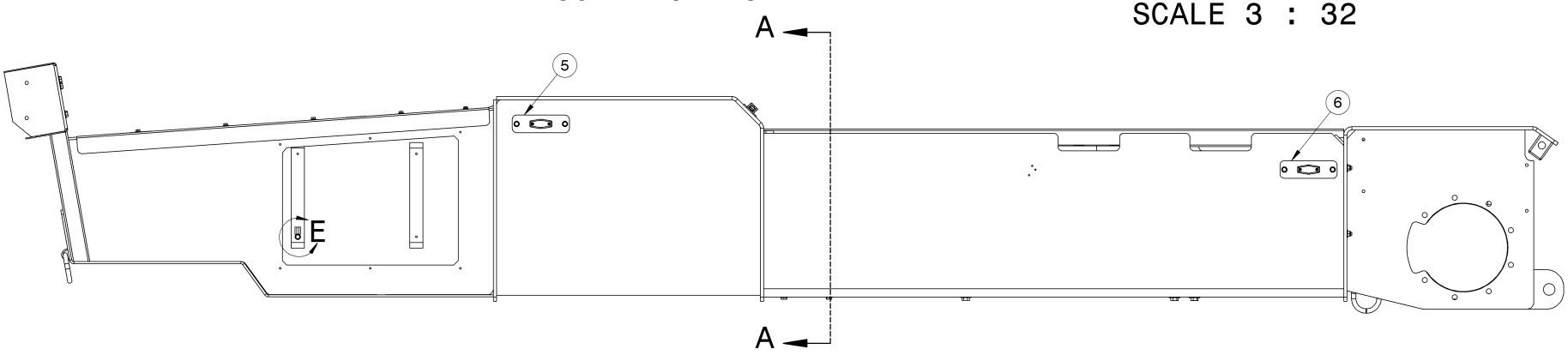
DETAIL E
SCALE 1 : 4

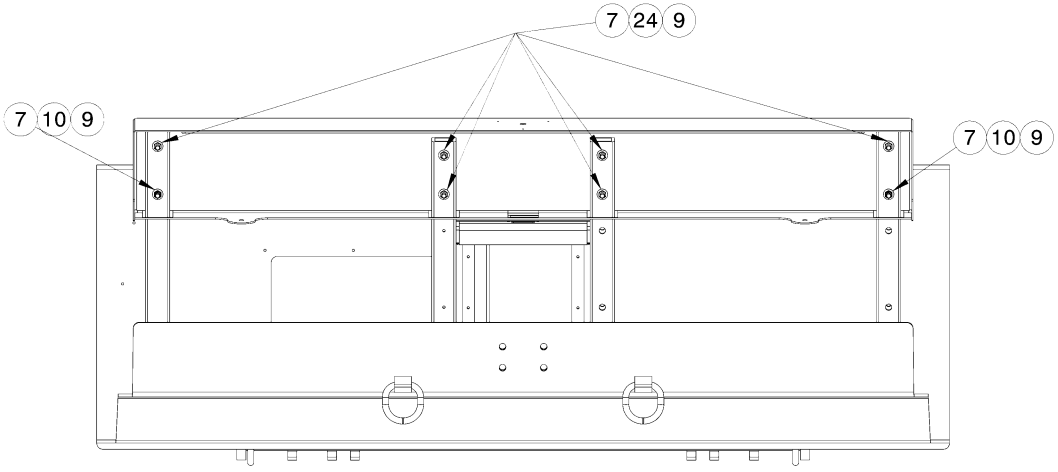


DETAIL C
SCALE 6 : 32



SECTION A-A
SCALE 3 : 32





REAR VIEW

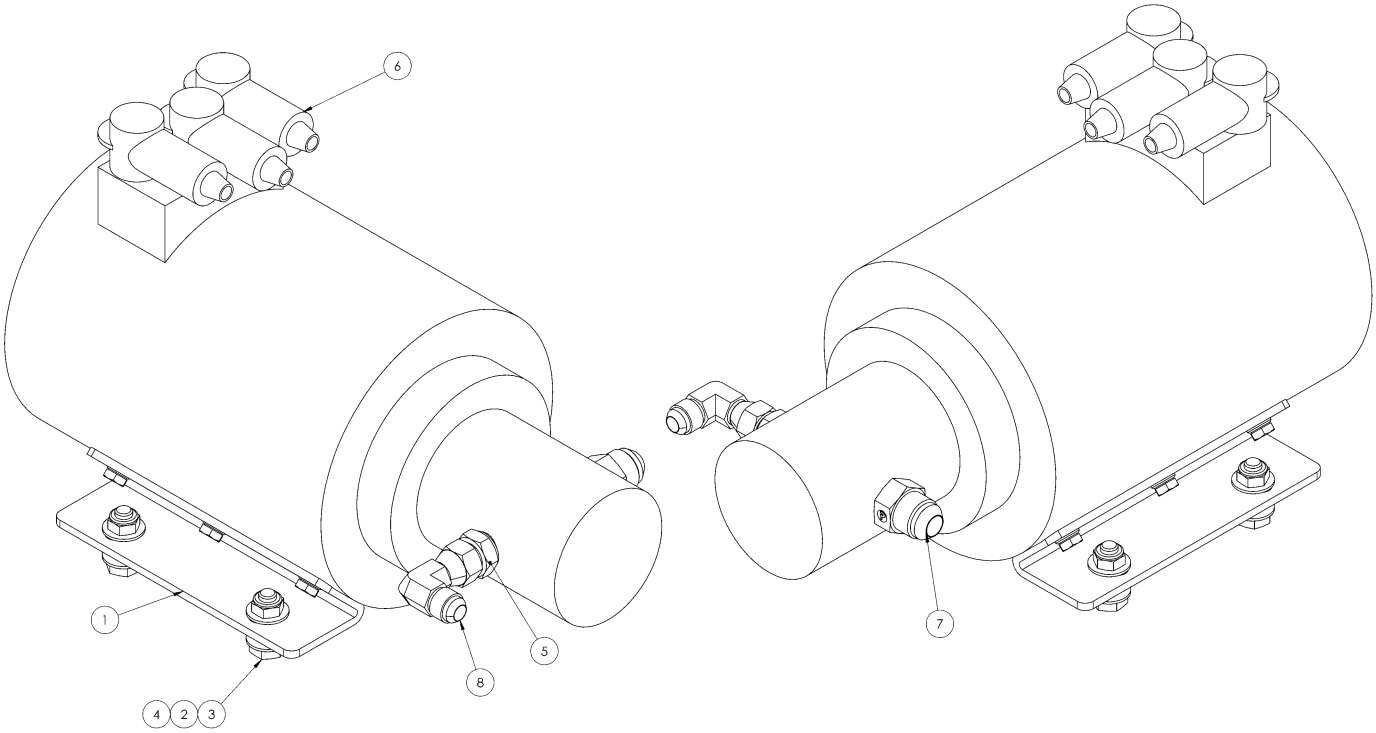
Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
1	Z-9238-01	WELDMENT, eJP-10	-1
2	Z-9239	ASSEMBLY, CONTROLLER	1
3	Z-9282	ASSY, WINCH ROLLER 4 IN WIDE	1
4	JP-236 BRACKET	BRACKET	4
5	Z-9264	ASSEMBLY, LED RED MARKER	2
6	Z-9265	ASSEMBLY, LED AMBER MARKER	4
7	G-1503-1070N	FLATWASHER. 3/8 SST NARROW	16
8	G-1503-1050N	FLATWASHER. 1/4 SST NARROW	11
9	G-1112-107030	BOLT, 38-16 X 3.0" SST HEX HD	8
10	G-1202-1070	STOPNUT, 3/8-16 ELASTIC	2
11	G-1476-103106	SCREW, #10-32 X 3/4" LG. SST SOC BUTT. HD CAP	8
12	G-1202-1035	STOPNUT, #10-32 ELASTIC	8
13	Z-9277	ASSEMBLY, BATTERY STOP	2
14	G-1502-1050R	LOCKWASHER, 1/4 SST REGULAR	11
15	G-1112-105006	BOLT, 1/4-20 X 3/4" LG SST HEX HD	6
16	Z-9280	ASSEMBLY, BATTERY BRACKET	2
17	Z-9281	ASSEMBLY, CONSOLE COVER	1
18	JP-213	BATTERY	12
19	EC-2110	BATTERY, TERMINAL INSULATOR	24
20	Z-9297-00	WELDMENT, BACKREST (P)	1
21	A-RTT12-00052	ELECTRICAL HORN	1
22	EC-3000	KIT, POWER CABLES	1
23	EC-3009	KIT, BATTERY CABELS	1
24	G-1207-1070	NUT, 3/8-16 JAM	6
25	J-6380-01	SUPPORT, COVER GUARD (P)	2
26	H-1721-02	CLAMP, ELECTRICAL	1
27	G-1112-105004	BOLT, 1/4-20 X 1/2" LG. SST HEX HD	5
28	S-3221-00	GUARD, WEATHER (P)	2
29	Z-9576	ASSEMBLY, BATTERIES STOP	2
30	Z-9820	ASSEMBLY, HYD PUMP	1

Parts List

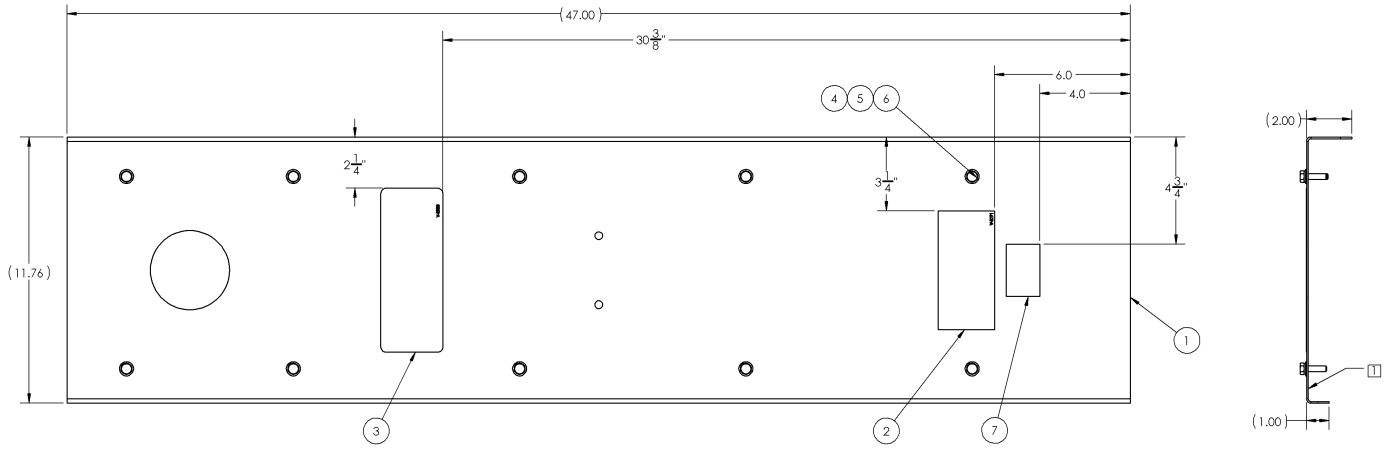
When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	EC-3108	ASSEMBLY, PUMP MOTOR	1
2	G-1503-1060N	FLATWASHER. 5/16 SST NARROW	8
3	G-1112-106010	BOLT, 5/16-18 X 1.0" LG. SST HEX HD	4
4	G-1202-1060	STOPNUT, 5/16-18 ELASTIC	4
5	N-3054-06M14-SB	37 FLARE ADAPTOR, METER M14X1.5	1
6	EC-2865	BATTERY, TERMINAL INSULATOR	3
7	N-3054-08M18-SB	CONNECTOR, STR THD	1
8	N-2002-05-S	ELBOW, SWIVEL NUT	1

Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	J-6374-01	PANEL, CONSOLE TOP (P)	1
2	V-2191	LABEL, CAUTION HAND/FEET	1
3	V-2553	LABEL, E-STOP	1
4	G-1503-1050N	FLATWASHER. 1/4 SST NARROW	10
5	G-1502-1050R	LOCKWASHER, 1/4 SST REGULAR	10
6	G-1112-105010	BOLT, 1/4-20 X 1.0" LG SST HEX HD	10
7	V-1001	LABEL, MADE IN USA	1

Parts List

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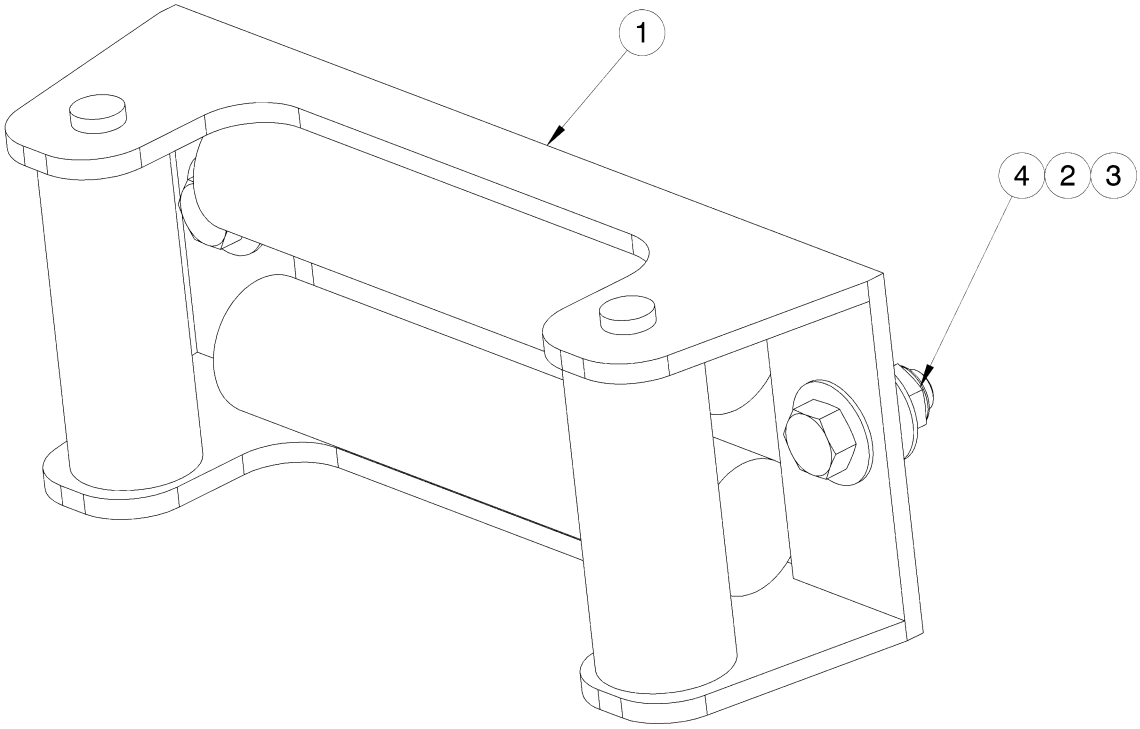

Item	Part Number	Description	Qty
1	JP-234	FAIRLEAD, ROLLER	1
2	G-1503-1090N	FLATWASHER. 1/2 SST NARROW	4
3	G-1420-109513	BOLT, 1/2-20 X 1-3/8" HEX HD GR 5	2
4	G-1202-1095	STOPNUT, 1/2-20 ELASTIC	2

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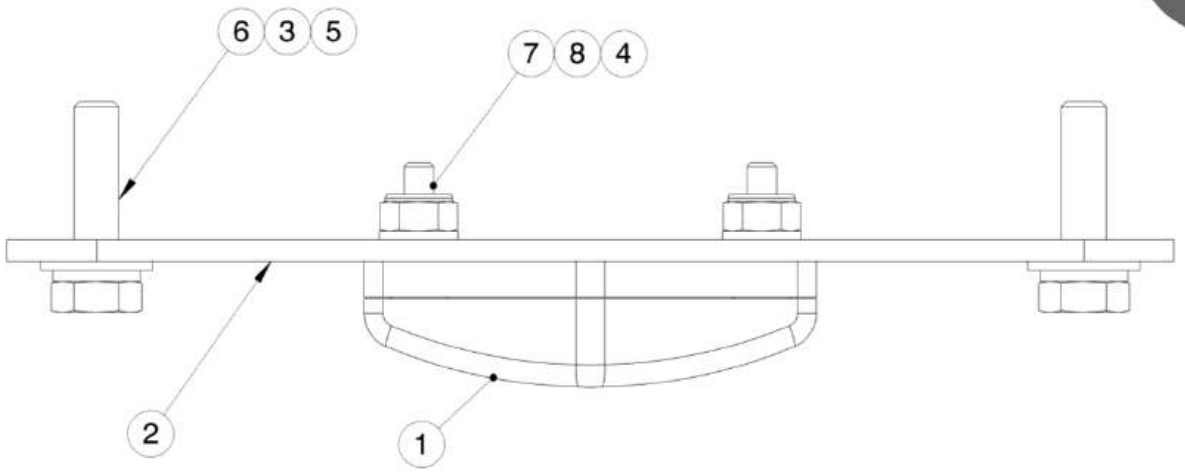
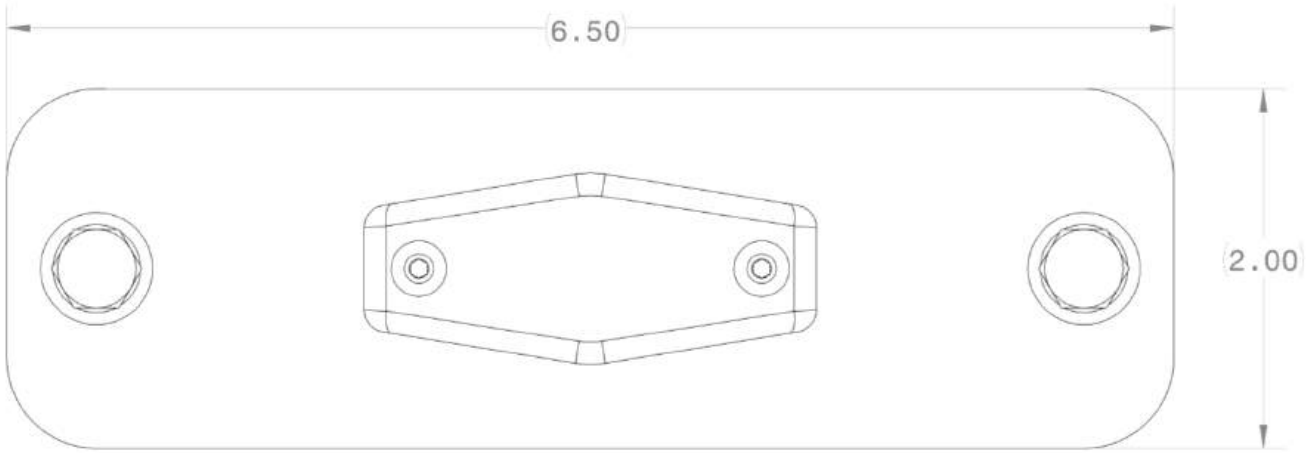
Parts List Illustration



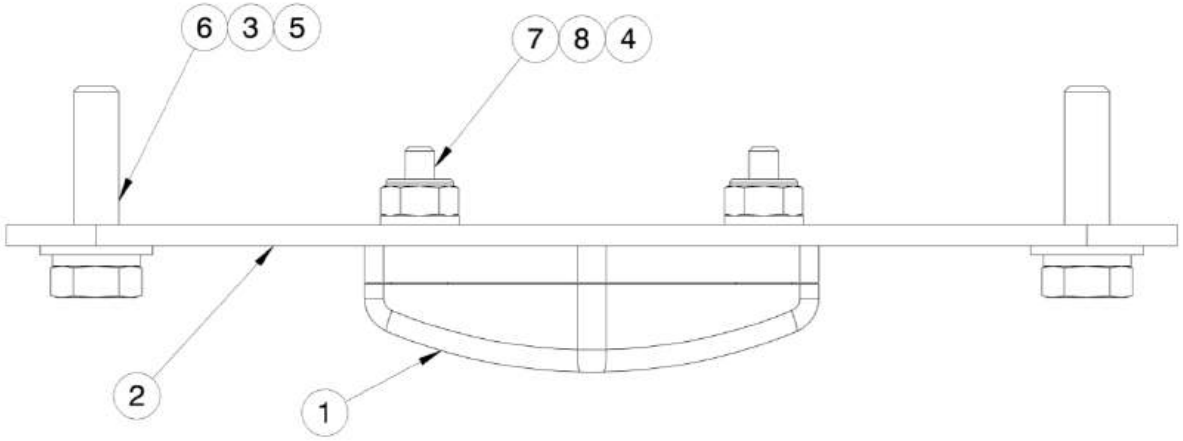


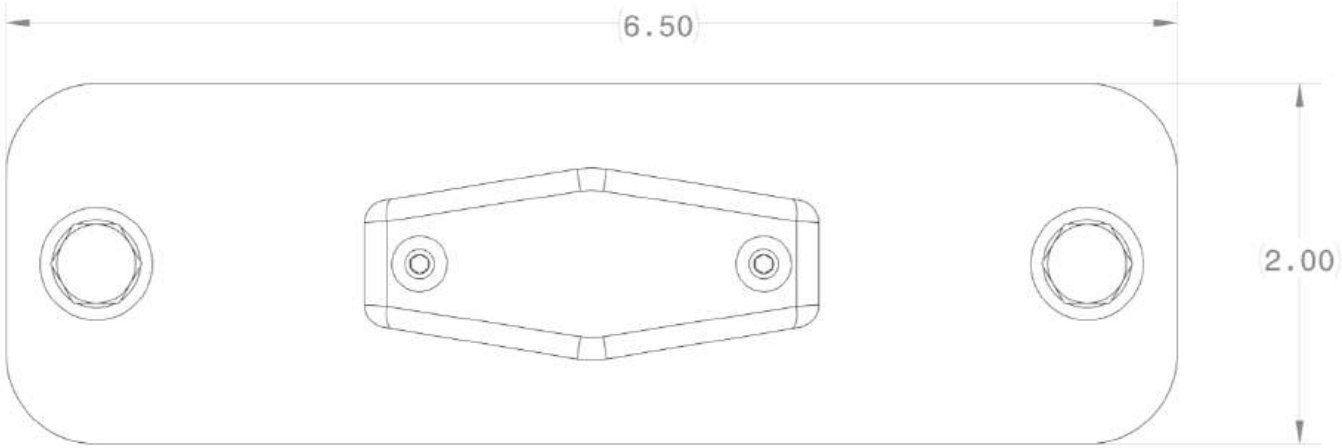
Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
1	NVSP-34-001-CA	SIDE INDICATOR LIGHT, RED	1
2	S-3052-00	PANEL, MARKER	1
3	G-1503-1050N	FLATWASHER. 1/4 SST NARROW	2
4	G-1503-1020N	FLATWASHER. #8 SST NARROW	2
5	G-1502-1050R	LOCKWASHER, 1/4 SST REGULAR	2
6	G-1112-105010	BOLT, 1/4-20 X 1.0" LG SST HEX HD	2
7	G-1476-102006	SCREW, #8-32 X 3/4" LG. SST SOC BUTT. HD CAP	2
8	G-1202-1020	STOPNUT, #8-32 ELASTIC	2

Parts List Illustration





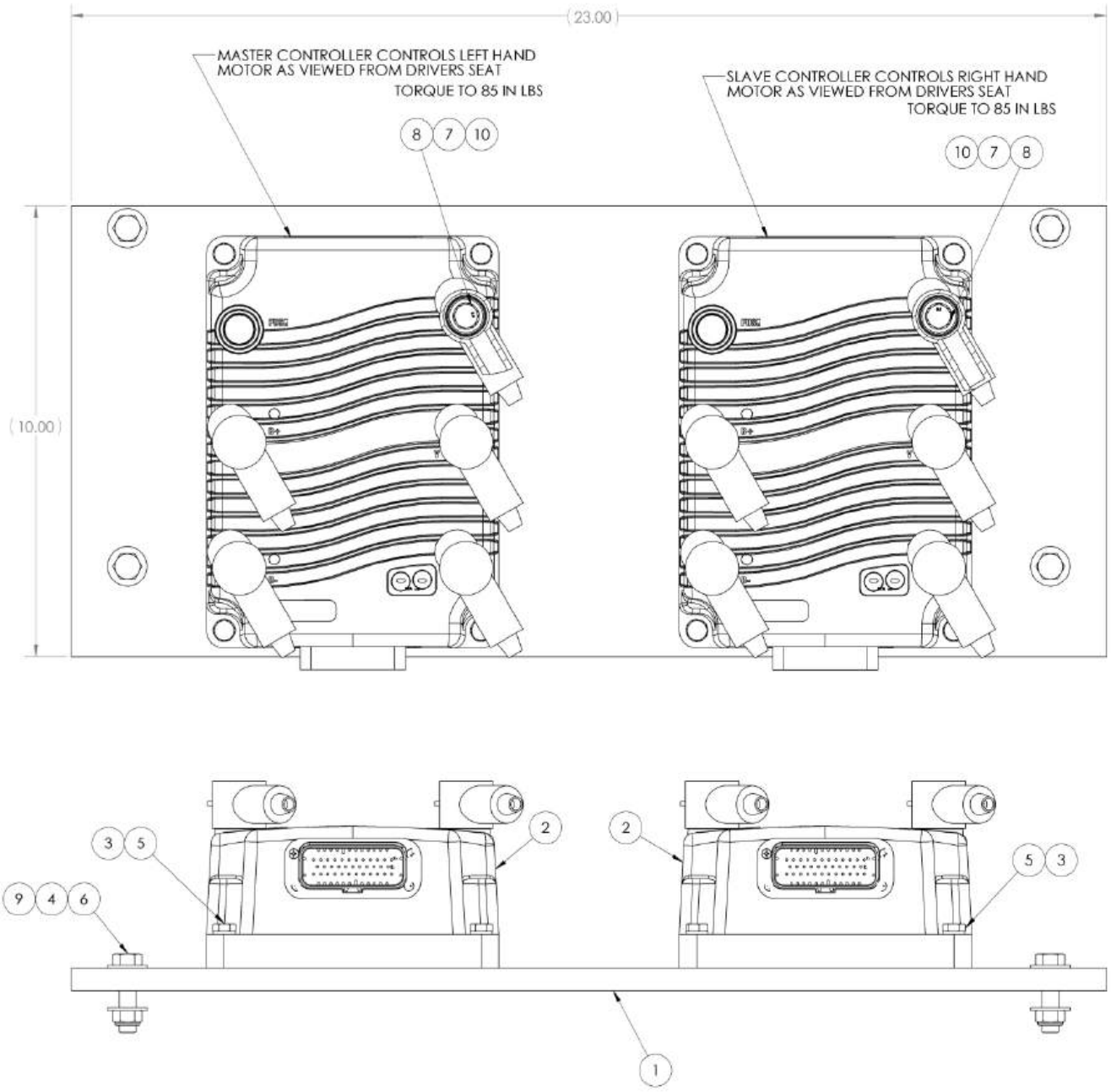
Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
1	A-EXL16-0490-1	SIDE INDICATOR LIGHT, AMBER	1
2	S-3052-00	PANEL, MARKER	1
3	G-1503-1050N	FLATWASHER. 1/4 SST NARROW	2
4	G-1503-1020N	FLATWASHER. #8 SST NARROW	2
5	G-1502-1050R	LOCKWASHER, 1/4 SST REGULAR	2
6	G-1112-105010	BOLT, 1/4-20 X 1.0" LG SST HEX HD	2
7	G-1476-102006	SCREW, #8-32 X 3/4" LG. SST SOC BUTT. HD CAP	2
8	G-1202-1020	STOPNUT, #8-32 ELASTIC	2

Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	J-6367	PANEL, HEAT SINK	1
2	EC-2986	CONTROLLER	2
3	G-1502-1050R	LOCKWASHER, 1/4 SST REGULAR	8
4	G-1503-1070N	FLATWASHER. 3/8 SST NARROW	8
5	G-1420-105012	BOLT, 1/4-20 X 1-1/4" LG HEX HD GR 8	8
6	G-1112-107014	BOLT, 38-16 X 1-1/2" SST HEX HD	4
7	G-1502-1060R	LOCKWASHER, 5/16 SST REGULAR	10
8	G-1114-080016	BOLT M8-1.25 X 16mm LG. CLASS 8.8	10
9	G-1202-1070	STOPNUT, 3/8-16 ELASTIC	4
10	EC-2110	BATTERY, TERMINAL INSULATOR BLK	10

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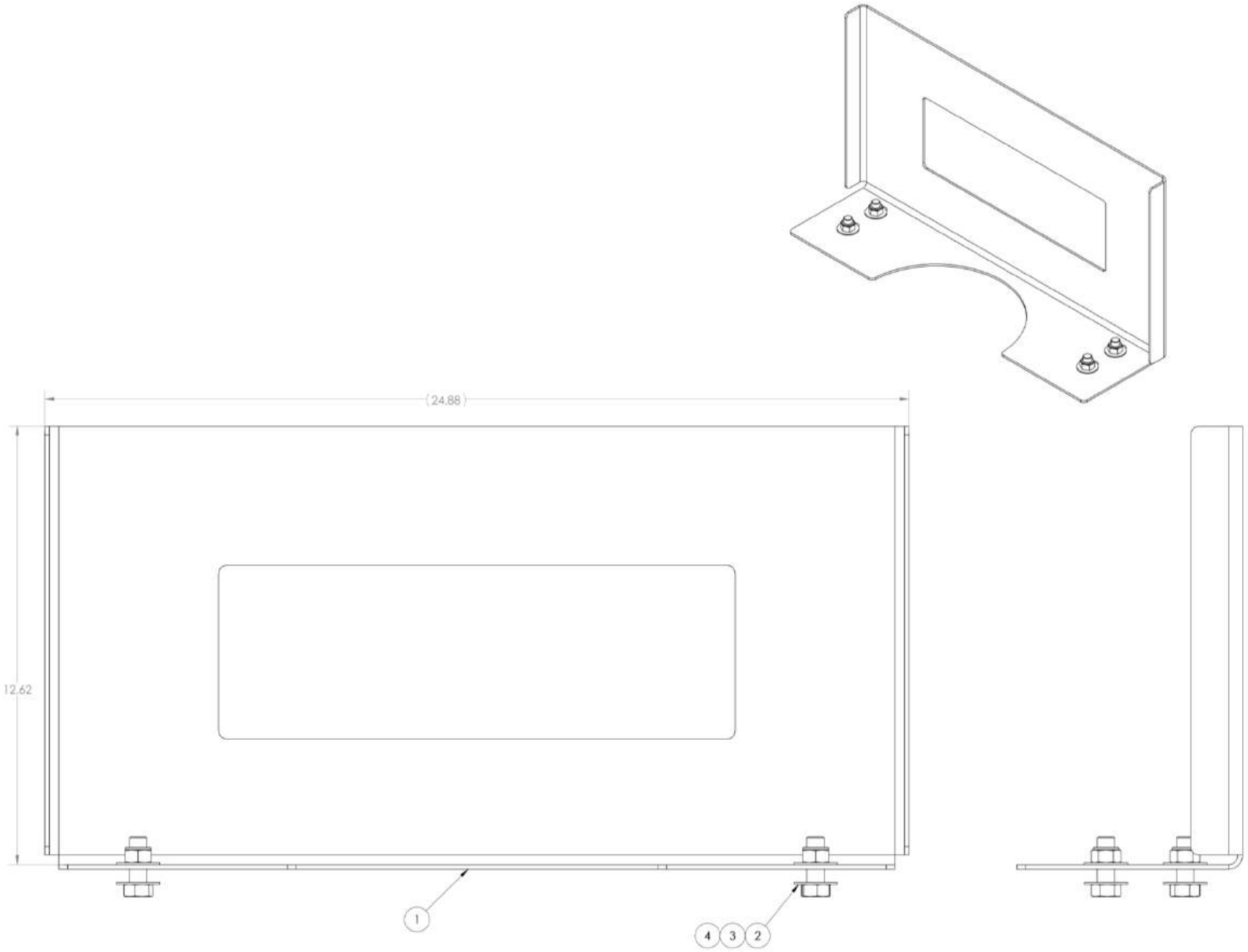
Parts List Illustration



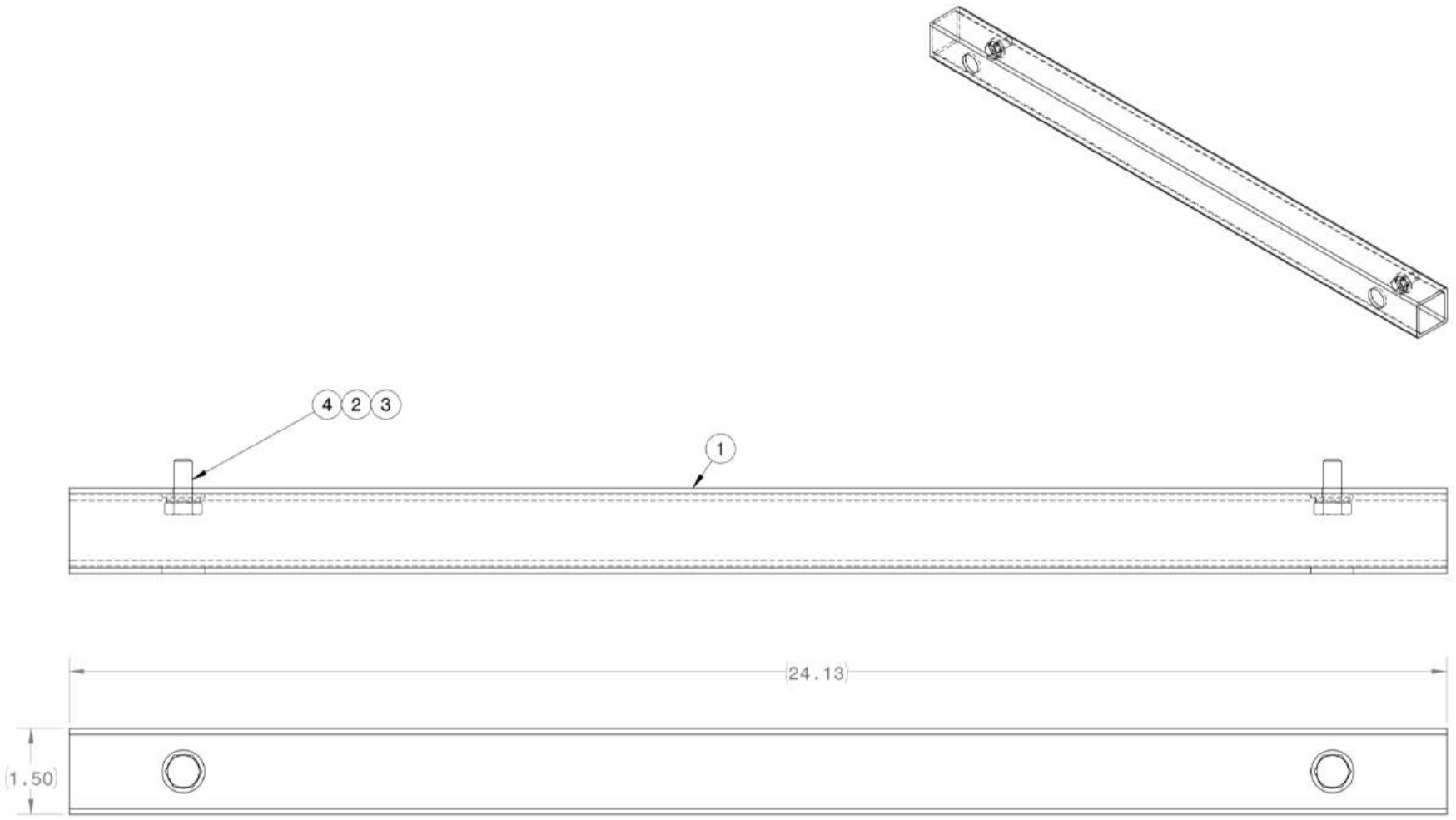
Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
1	S-3058-01	BRACKET, BATTERY STOP	1
2	G-1503-1090N	FLATWASHER. 1/2 SST NARROW	8
3	G-1112-109013	BOLT, 1/2-13 X 1-3/8" SST HEX HD	4
4	G-1202-1090	STOPNUT, 1/2-13 ELASTIC	4

Parts List

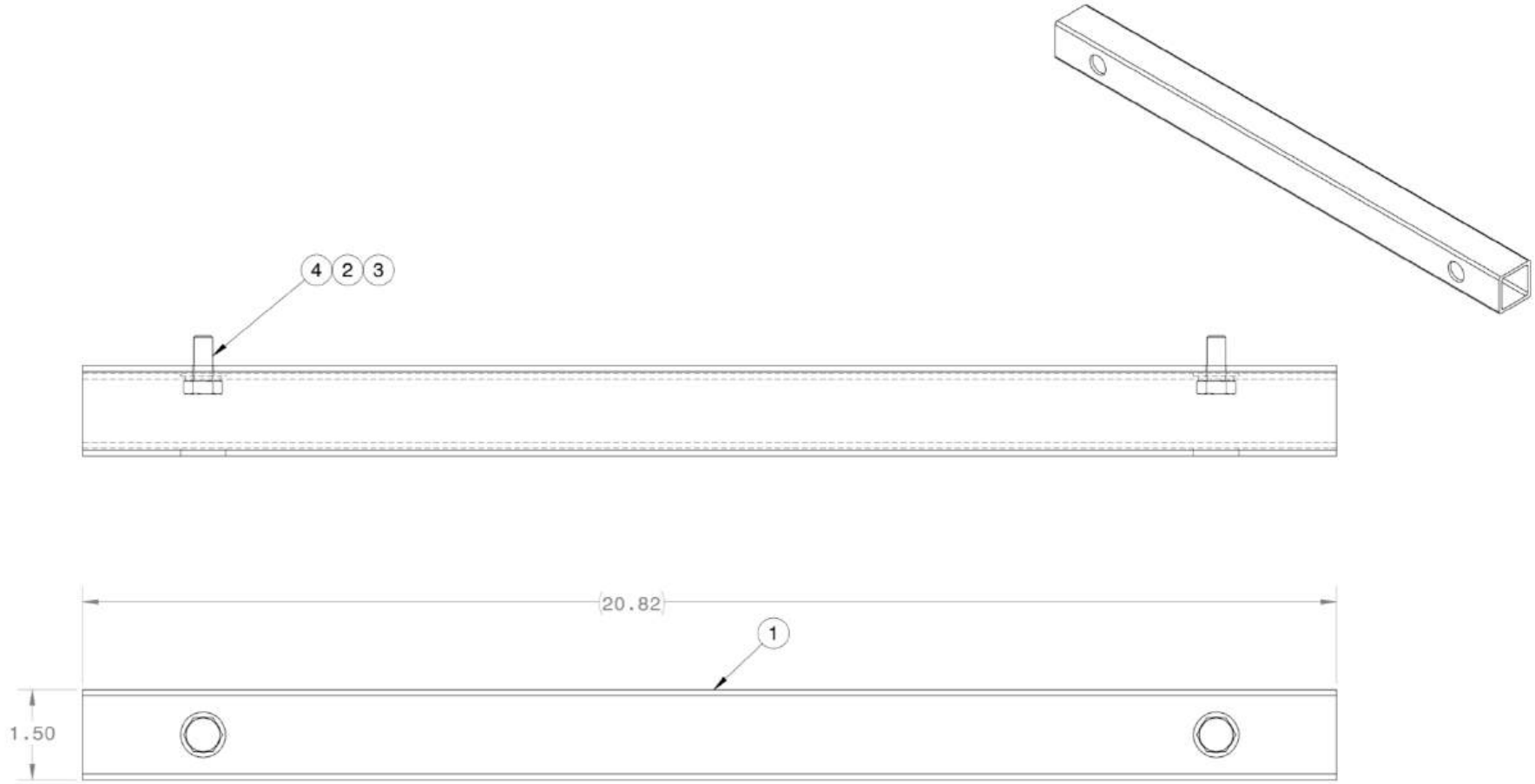
When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	TS-2678	TUBE, BATTERY STOP	1
2	G-1503-1060N	FLATWASHER. 5/16 SST NARROW	2
3	G-1502-1060R	LOCKWASHER, 5/16 SST REGULAR	2
4	G-1112-106006	BOLT, 5/16 X 3/4 H.H. S.S.	2

Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Item	Part Number	Description	Qty
1	TS-2679	TUBE, BATTERY STOP	1
2	G-1503-1060N	FLATWASHER. 5/16 SST NARROW	2
3	G-1502-1060R	LOCKWASHER, 5/16 SST REGULAR	2
4	G-1112-106006	BOLT, 5/16 X 3/4 H.H. S.S.	2

TRONAIR®

APPENDIX I

Wiring Diagram
INS-2441

LINE 0

72VDC INPUT BUS FROM B+

+ 72VDC UNSWITCHED LOCATION C23

LOCATION C85 (eJP-12 ONLY) LS1 21 22

FOR eJP-10, CONNECT WIRE C22-5B TO C10-27

FUSE BLOCK LOCATION C22 FU5 7.5 AMP

C22-5A (YEL 18 GA) C22-5B (PNK 18 GA) C10-27 (BRN 18 GA)

LOCATION C10-27/D1-27D17 D1-27 (PNK 18 GA)

LOCATION D17 (KS3, 72V CONTACT) (1B) (2B) KEY OFF/ON

D17-72 (RED 18 GA)

LOCATION D16 (ES1, 72V CONTACT) (1B) (2B) E-STOP DRIVER

LOCATION D1-28/C10-28 C18-CP (GRN 18 GA) C18-CP (GRN 18 GA)

LOCATION C18 CON1 C+ C- C17-2 (WHT 18 GA) S86O 72V SUPPLY

NEG. BUS B-

LOCATION C84 CONNECTOR 3D (BLACK)

LINE 1

LINE 2

CON 1 LOCATION C18 A(+) B #6 CABLE 72VDC SUPPLY CONTACTOR (SW60)

C22-6A (YEL 18 GA) FU6 10 AMP

24V DC-DC LOCATION C16 72V/24V DC/DC CONVERTER 12.5 AMPS OUT AT 24VDC

C22-6B (RED 18 GA) C16-GB (BLK 18 GA) C16-1 (BLU 14 GA) C16-GC (BLK 14 GA) C16-GA (BLK 14 GA)

LOCATION C84 STUD 8S

LOCATION C84 CONNECTOR 3E (BLACK)

B1

LINE 3

FLEX STRAP OR 2/0 CABLE FLEX STRAP 72VDC MAIN CONTACTOR CON2 (24VDC COIL) LOCATION C21

72VDC SWITCHED BUS LOCATION C24

LINE 4

FUSE BLOCK LOCATION C22 C22-1A (RED 12 GA) FU4 10 AMP C1-1 (PNK 18 GA)

LOCATION C1-1 CURTIS 1238E MASTER KSI (M-J1-1) DIRECT

LINE 5

FUSE JUMPERS 72VDC

FUSE JUMPER FU3 7.5 AMP C2-1 (PNK 18 GA)

LOCATION C2-1 CURTIS 1238E SLAVE KSI (S-J1-1) DIRECT

LINE 6

FUSE JUMPER FU2 7.5 AMP C22-2B (PNK 18 GA)

LOCATION C50-1 / P5-1 P1- (PNK 18 GA)

CURTIS 1232E PUMP CONTROLLER (P-J1-1)

LINE 7

FUSE JUMPER FU1 7.5 AMP C22-1B (PNK 18 GA)

12V DC-DC LOCATION C25 72V/12V DC/DC CONVERTER 25 AMPS OUT AT 12VDC

C25-1 (RED 12 GA) LOCATION C84 STUD 6S

C25-GC (BLK 12 GA) C25-GB (BLK 18 GA) C25-GA (BLK 12 GA)

LINE 8

LOCATION C84 CONNECTOR 11D (GREEN)

LINE 9

LOCATION C1-13 KSI COIL RETURN (M-J1-13) C1-13 (GRN 18 GA)

LOCATION C5 CON3 X1 +(RED) X2- (BLACK) C1-6 (YEL 18 GA) MASTER CONTACTOR (48VDC COIL)

DRIVER 1 (M-J1-6) (66%) LOCATION C1-6

LINE 10

LOCATION C2-13 KSI COIL RETURN (S-J1-13) C2-13 (LGR 18 GA)

LOCATION C78 CON4 X1 +(RED) X2- (BLACK) C2-6 (TAN 18 GA) SLAVE CONTACTOR (48VDC COIL)

DRIVER 1 (S-J1-6) (66%) LOCATION C2-6

LOCATION P1-13 KSI COIL RETURN (P-J1-13) P1-13 (LGR 18 GA)

LOCATION C51 CON5 X1 +(RED) X2- (BLACK) P1-6 (TAN 18 GA) PUMP CONTACTOR (48VDC COIL)

DRIVER 1 (P-J1-6) (66%) LOCATION P1-6

B2

LINE 11

LOCATION C84 INTERNAL 24V BUS

LINE 12

LOCATION C84 CONNECTOR 9F (BLUE) 24F2 2 AMP C15-1 (BLU 18 GA)

LOCATION C15 E-STOP FENDER ES2 C15-2 (BLU 18 GA) C87-L C87-K C10-17 (LBL 18 GA)

LOCATION C10-17/D1-17 D1-17 (LBL 18 GA)

LOCATION D16 E-STOP DRIVER ES1 (24V CONTACT) D16-2 (GRY 18 GA)

LOCATION D17 KS1 KEY OFF/ON D1-18B (BRN 18 GA)

LOCATION C10-18/D1-18 D1-18A (BRN 18 GA) C10-18 (BRN 18 GA)

LOCATION C84 CONNECTOR 9E (BLUE)

K1 87 30 86 85 K1 KEY SWITCH MEMORY CIRCUIT

LOCATION C84 B- COMMON BUS INTERNAL CONNECTION

LINE 13

LOCATION D17 KS2 KEY MOMENTARY ON D1-18C (BRN 18 GA)

LOCATION C10-19/D1-19 D1-19 (YEL 18 GA) C10-19 (YEL 18 GA)

LOCATION C84 CONNECTOR 9B (BLUE)

K2 86 85 K2 24V CONTROL CIRCUIT RELAY CONTACT ON LINE 15

LINE 14

LOCATION C20 K3 86 85 12V LIGHTING CIRCUIT RELAY CONTACT ON LINE 63

LINE 15

24F1 10 AMP K2 30 87

LOCATION C84 INTERNAL CONNECTION TO +24VDC FUSE BUS

LINE 16

LOCATION D1-1 (FUSED AT 2F08) D1-1 (PINK 18 GA)

LOCATION D12 P6 (RED 18 GA)

LOCATION D2 FORWARD D1-3 (BLU 18 GA)

LOCATION D1-3/C10-3 C1-22 (BLU 18 GA)

LOCATION C1-22 FORWARD TO MASTER SWITCH 7 (M-J1-22)

LINE 17

LOCATION D3 REV REVERSE P2 (RED 18 GA) D1-4 (GRN 18 GA)

LOCATION D1-4/C10-4 C1-33 (GRN 18 GA)

LOCATION C1-33 REVERSE TO MASTER SWITCH 8 (M-J1-33)

JUMPER (RED 18 GA) ADD FOR OPTION

LINE 18

LOCATION D23 BACKUP ALARM D1-12 (BRN 18 GA)

LOCATION D1-12/C10-12 C10-12-A (BRN 18 GA) C10-12-B (BRN 18 GA)

LOCATION C86-1 BACKUP ALARM (OPTION)

C10-12-C (BRN 18 GA) LOCATION C87-J

LINE 19

LOCATION D5 RS3 PANEL (WINCH IN) D1-7 (LBL 18 GA)

LOCATION D1-7/C10-7 C2-11B (LBL 18 GA) C2-11A (LBL 18 GA)

LOCATION C2-11 SLAVE INPUT SWITCH 5 (S-J1-11)

(C2-11C LBL 18 GA)

LOCATION D12-4 (FUSED AT 2F08) P4 (RED 18 GA)

LINE 20

RS4 PANEL (WINCH OUT) D1-8 (BRN 18 GA)

LOCATION D1-8/C10-8 C2-12B (BRN 18 GA) C2-12A (BRN 18 GA)

LOCATION C2-12 SLAVE INPUT SWITCH 6 (S-J1-12)

(C2-12C BRN 18 GA)

LINE 21

LOCATION D4 RS1 PANEL (CRADLE UP) D1-5 (LGR 18 GA)

LOCATION D1-5/C10-5 C2-9B (LGR 18 GA) C2-9A (LGR 18 GA)

LOCATION C2-9 SLAVE INPUT SWITCH 3 (S-J1-9)

(C2-9C LGR 18 GA)

LOCATION D12-3 (FUSED AT 2F08) P3 (RED 18 GA)

LINE 22

RS2 PANEL (CRADLE DOWN) D1-6 (PUR 18 GA)

LOCATION D1-6/C10-6 C2-10B (PUR 18 GA) SP4 C2-10A (PUR 18 GA)

LOCATION C2-10 SLAVE INPUT SWITCH 4 (S-J1-10)

TO C76 DIODE (C2-10E PUR 18 GA)

RESISTOR ASSEMMBLY

LINE 23

POSITION 1 R1 R7 LOCATION D6-3 G4 (BLK 18 GA) LOCATION D11-4

LINE 24

POSITION 2 R2 AC1

LOCATION D12-5 (FUSED AT 2F08) P5 (RED 18 GA)

POSITION 3 R3

LOCATION D61

POSITION 4 R4

LINE 25

POSITION 5 R5 D1 LOCATION D6-2 D1-9 (YEL 18 GA)

LOCATION D1-9/C10-9 C1-24 (YEL 18 GA) LOCATION C1-24

MASTER SWITCH 1(M-J1-24) (TRACTION MOTOR AMPERAGE LIMITS)

POSITION 6 R6

LINE 26

LINE 27

LOCATION D12-7 (FUSED AT 2F08) P7 (RED 18 GA)

LOCATION D8 SW6 DUAL WHEEL D1-10 (TAN 18 GA)

LOCATION D1-10/C10-10 C2-14 (TAN 18 GA)

LOCATION C2-14 SLAVE INPUT SWITCH 16 (S-J1-14)

R6

LINE 28

LOCATION C84 CONNECTOR 10C (YELLOW) 2F11 2 AMP C81-1 (RED 18 GA)

LOCATION C81 SW3 SEAT SWITCH C1-10 (WHT 18 GA)

LOCATION C1-10 MASTER SWITCH 4 (M-J1-10) LIMITS SPEED WHEN SW3 IS OPEN

LINE 29

LOCATION C77 C67-2D (RED 18 GA) C1-12 (BLK 18 GA)

LOCATION C1-12 MASTER INPUT SWITCH 6 (M-J1-12)

PARKING BRAKE RELEASE FOR WINCHING TUG UNDER AIRCRAFT

B3

LINE 30

LOCATION C68 RS3 FENDER (WINCH IN) C2-11C (LBL 18 GA) C2-11A (LBL 18 GA)

LOCATION C2-11 SLAVE INPUT SWITCH 5 (S-J1-11)

(C2-11B LBL 18 GA)

LOCATION C84 CONNECTOR 9H (BLUE) 2F06 2 AMP C67-2A (RED 18 GA) C67-2C (RED 18 GA)

LINE 31

RS4 FENDER (WINCH OUT) C2-12C (BRN 18 GA) C2-12A (BRN 18 GA)

LOCATION C2-12 SLAVE INPUT SWITCH 6 (S-J1-12)

(C2-12B BRN 18 GA)

LINE 32

LOCATION C67 RS1 FENDER (CRADLE UP) C2-9C (LGR 18 GA) C2-9A (LGR 18 GA)

LOCATION C2-9 SLAVE INPUT SWITCH 3 (S-J1-9)

(C2-9B LGR 18 GA)

C67-2B (RED 18 GA)

LINE 33

RS2 FENDER (CRADLE DOWN) C2-10E (PUR 18 GA) SP4 C2-10A (PUR 18 GA)

LOCATION C2-10 SLAVE INPUT SWITCH 4 (S-J1-10)

LINE 34

SP35 LOCATION C76 LOCATION C75 C2-10D (PUR 18 GA)

SV1 C54-3 (WHT 18 GA) LOCATION C54 (B-)

WAS SV7 (WINCH CHECK VALVE BY-PASS TO RV1) CLOSED WHEN OFF

LINE 35

LOCATION C84 CONNECTOR 9C (BLUE) 2F02 2 AMP C12-1A (RED 18 GA) C12-1B (RED 18 GA) C12-1C (RED 18 GA)

LOCATION C12 A1 18 15 OUTPUT (POS) A2 SV1 ON DELAY TIMER C2-10C (PUR 18 GA)

C1-19 (TAN 18 GA) LOCATION C1-19 MASTER OUTPUT DRIVER 6 (M-J1-19) AT 0 VDC

LINE 36

LOCATION C21 PIN 2 CON2 PIN 1 BUILT IN ECONOMIZER C21-1 (WHT 18 GA) LOCATION C84 CONNECTOR 10B (YELLOW)

24VDC COIL FOR 72V MAIN CONTACTOR

LINE 37

LOCATION C84 CONNECTOR 10D (YELLOW) 2F09 2 AMP C21-2 (RED 18 GA)

LOCATION C84 CONNECTOR 11H (GREEN) 2F08 2 AMP C10-1 (PNK 18 GA)

LOCATION C10-1/D1-1 D1-1 (PNK 18 GA)

LOCATION D12-1 FOR 24VDC DASH LOGIC

LINE 38

LOCATION C84 CONNECTOR 10E (YELLOW) 2F07 2 AMP C8-1C (RED 18 GA) (SP20) C8-1A (RED 18 GA)

PS1 LOCATION C8 SYSTEM PRESSURE SWITCH (PROGAMMABLE) PIN 1 PIN 3 C8-3B (BLK 18 GA)

PIN 4 C1-11 (ORG 18 GA) LOCATION C1-11 PRESSURE SWITCH 24VDC OUT TO MASTER SWITCH 5 (M-J1-11)

LINE 39

PS2 LOCATION C9 PRESSURE SENSOR FOR WINCH (PROGAMMABLE) C8-1B (RED 18 GA) PIN 1 PIN 3 C8-3C (BLK 18 GA) C8-3A (BLK 18 GA) LOCATION C84 CONNECTOR 10G (YELLOW)

PIN 2 C2-24 (WHT 18 GA) LOCATION C2-24 PRESSURE SENSOR 10VDC VARIABLE OUTPUT TO SLAVE SWITCH 1 (S-J1-24)

LINE 40

LINE 41

NOTE:
CIRCUITS INTERNAL TO THE FUSE BLOCK ARE GREEN.
CONNECTIONS TO THE FUSE BLOCK ARE RED TEXT.

CONTINUED ON PAGE 2

LET	REVISION	EC	DWN	CHK	DATE
A	ORIGINAL RELEASE	21568	GAM	KJY	07-30-2020
B	SEE SHEET 3 FOR CHANGES		-	-	8-26-2019

MAKE FROM: N/A
MATERIAL: N/A TYPE: N/A
FINISH: N/A
THIRD ANGLE PROJECTION
SCALE: N.T.S. DO NOT SCALE DRAWING
SIZE D

BREAK ALL SHARP EDGES AND CORNERS
() INDICATES REFERENCE DIMENSIONS
ITEM NUMBER ABOVE, QUANTITY BELOW
TOLERANCES UNLESS OTHERWISE SPECIFIED
DECIMAL INCH[mm]:
.X[X] ± .100[3]
.XX[.X] ± .030[0.8]
.XXX[.XX] ± .010[0.25]
.XXXX[.XXX] ± .003[0.076]
FRACTION INCH[mm]: ± 1/16[1.6]
ANGLES DEGREE[RADIANS] ± .5[0.01]

TRONAIR AIRCRAFT GROUND SUPPORT EQUIPMENT

DWN BY GAM CKD BY XXX 08-26-19

SCHEMATIC,eJP-10/ eJP12 ELECTRICAL

JP INS-2441 REV B

TRONAIR CODE

LET	REVISION	EC	DWN	CHK	DATE
A	ORIGINAL RELEASE		-	-	06-26-2019
B	SEE SHEET 3 FOR CHANGES	21568	GAM	KJY	07-30-2020

MAKE FROM: N/A
MATERIAL: N/A TYPE: N/A
FINISH: N/A
THIRD ANGLE PROJECTION
SCALE: N.T.S. DO NOT SCALE DRAWING
SIZE D

BREAK ALL SHARP EDGES AND CORNERS
() INDICATES REFERENCE DIMENSIONS
ITEM NUMBER ABOVE, QUANTITY BELOW
TOLERANCES UNLESS OTHERWISE SPECIFIED
DECIMAL INCH[mm]:
.X[X] ± .100[3]
.XX[.X] ± .030[0.8]
.XXX[.XX] ± .010[0.25]
.XXXX[.XXX] ± .003[0.076]
FRACTION INCH[mm]:
1/XX[1/X] ± 1/16[1.6]
ANGLES DEGREE[RADIANS]
X[XX] ± .5[0.01]

TRONAIR AIRCRAFT GROUND SUPPORT EQUIPMENT

DWN BY GAM | CKD BY XXX | 08-26-19

SCHEMATIC, eJP-10/eJP-12 ELECTRICAL

JP | INS-2441 | REV B

DIRECT TO CONTROLLER CONNECTIONS

MASTER

LOCATION C4

MOTOR TEMP SENSOR MASTER
PIN 1 — RED — C1-8 (PUR 18 GA) — ANALOG INPUT M-J1-8)
PIN 2 — BLK — C1-7C (LGR 18 GA) — MASTER I/O GROUND BUS C93-5

LOCATION C73

PROGRAMMING MOLEX MASTER
PIN 1 — C1-29 (ORG 18 GA) — RX (M-J1-29)
PIN 2 — C1-7F (LGR 18 GA) — MASTER I/O GROUND BUS C93-7
PIN 3 — C1-28 (GRY 18 GA) — TX (M-J1-28)
PIN 4 — C1-25D (BRN 18 GA) — +12V (M-J1-25)

LOCATION C3 — PLUG CONNECTION

POSITION ENCODER MASTER
PIN 1 — RED — C1-25E (BRN 18 GA) — +12V (M-J1-26)
PIN 2 — BLK — C1-7B (LGR 18 GA) — MASTER I/O GROUND BUS C93-6
PIN 3 — BLU — C1-32 (LBL 18 GA) — PHASE B (M-J1-32)
PIN 4 — WHT — C1-31 (TAN 18 GA) — PHASE A (M-J1-31)

LOCATION C6

.5 TO 4.5 VDC OUT

FOOT BRAKE
A — C1-17 (BLU 18 GA) — TO MASTER THROTTLE POT WIPER (M-J1-17)
B — C1-7D (LGR 18 GA) — MASTER I/O GROUND BUS C93-3
C — C1-26C (PUR 18 GA) — TO 1238E MASTER 5VDC SUPPLY (M-J1-26)
D
E — C1-9B (LBL 18 GA) — TO MASTER SWITCH 3 (M-J1-9)
C1-25B (BRN 18 GA) — TO 1238E MASTER 12VDC SUPPLY (M-J1-25)

LOCATION C1

LOCATION C7

.5 TO 4.5 VDC OUT

FOOT THROTTLE
5 — C1-26D (PUR 18 GA) — TO 1238E MASTER 5VDC SUPPLY (M-J1-26)
2 — C1-25C (BRN 18 GA) — TO 1238E MASTER 12VDC SUPPLY (M-J1-25)
1 — C1-9C (LBL 18 GA) — TO MASTER SWITCH 3 (M-J1-9)
4
6 — C1-7E (LGR 18 GA) — MASTER I/O GROUND BUS C93-4
C1-16 (GRY 18 GA) — TO MASTER THROTTLE POT WIPER (M-J1-16)

SLAVE

LOCATION C70

MOTOR TEMP SENSOR SLAVE
PIN 1 — RED — C2-8 (ORG 18 GA) — ANALOG INPUT S-J1-8)
PIN 2 — BLK — C2-7B (WHT 18 GA) — SLAVE I/O GROUND BUS C94-7

LOCATION C72

PROGRAMMING MOLEX SLAVE
PIN 1 — C2-29 (GRY 18 GA) — RX (S-J1-29)
PIN 2 — C2-7D (WHT 18 GA) — SLAVE I/O GROUND BUS C94-5
PIN 3 — C2-28 (LGR 18 GA) — TX (S-J1-28)
PIN 4 — C2-25C (YEL 18 GA) — +12V (S-J1-25)

LOCATION C71 — PLUG CONNECTION

POSITION ENCODER SLAVE
PIN 1 — RED — C2-25B (YEL 18 GA) — +12V (S-J1-25)
PIN 2 — BLK — C2-7C (WHT 18 GA) — SLAVE I/O GROUND BUS C94-6
PIN 3 — BLU — C2-32 (TAN 18 GA) — PHASE B (S-J1-32)
PIN 4 — WHT — C2-31 (BRN 18 GA) — PHASE A (S-J1-31)

LOCATION C69

STEERING SENSOR (5K)
PIN 1 — C2-26 (ORG 18 GA) — +5V (S-J1-26)
PIN 2 — C2-7E (WHT 18 GA) — SLAVE I/O GROUND BUS C94-8
PIN 3 — C2-17 (BLU 18 GA) — TO 1238E SLAVE POT2 WIPER (S-J1-17)

I/O GROUND (S-J1-7)

PUMP

LOCATION P2

MOTOR TEMP SENSOR PUMP
PIN 1 — RED — P1-8 (PUR 18 GA) — ANALOG INPUT P-J1-8)
PIN 2 — BLK — P10-1 (WHT 18 GA) — SLAVE I/O GROUND BUS P10-1

LOCATION P4

PROGRAMMING MOLEX PUMP
PIN 1 — P1-29 (ORG 18 GA) — RX (P-J1-29)
PIN 2 — P10-7 (WHT 18 GA) — SLAVE I/O GROUND BUS P10-7
PIN 3 — P1-28 (GRY 18 GA) — TX (P-J1-28)
PIN 4 — P1-25C (BRN 18 GA) — +12V (P-J1-25)

LOCATION P3 — PLUG CONNECTION

POSITION ENCODER PUMP
PIN 1 — RED — P1-25B (BRN 18 GA) — +12V (P-J1-25)
PIN 2 — BLK — P10-8 (WHT 18 GA) — SLAVE I/O GROUND BUS P10-8
PIN 3 — BLU — P1-32 (LBL 18 GA) — PHASE B (P-J1-32)
PIN 4 — WHT — P1-31 (TAN 18 GA) — PHASE A (P-J1-31)

CONNECTION NOTES:
S-J1-21 (CAN TERM H) IS CONNECTED TO S-J1-34 (CAN TERM L) WITHIN THE EC-3055 WIRE HARNESS.
THIS CONNECTION UTILIZES THE 120 OHM RESISTOR IN THE SLAVE CONTROLLER.
THE REMAINDER OF THE CAN CONNECTIONS ARE MADE USING EC-3304 CAN HARNESS.
THE CAN HARNESS CONTAINS THE SECOND 120 OHM RESISTOR.

LET	REVISION	EC	DWN	CHK	DATE
A	ORIGINAL RELEASE		-	-	08-26-2019
B	SHEET 1 B1 CHANGED C16 CONNECTIONS. B2 MOVED C51 LOC. ON DRAWING. B3 ADD PARK BRK RELEASE BUTTON. SHEET 2 B4 ADD P33 AND INDICATOR LIGHT. B5 ADD RV1 PROP VALVE. B6 K4 NOT USED. B7 DELETED C74 RESISTOR. SHEET 3 B8 I/O GND CONNECTIONS ARE NOW I/O GND BUS CONNECTIONS.	21568	GAM	KJY	07-30-2020

MAKE FROM: N/A
MATERIAL: N/A — TYPE: N/A
FINISH: N/A
THIRD ANGLE PROJECTION
SCALE: N.T.S. — DO NOT SCALE DRAWING — SIZE D

BREAK ALL SHARP EDGES AND CORNERS
() INDICATES REFERENCE DIMENSIONS
ITEM NUMBER ABOVE, QUANTITY BELOW

TOLERANCES UNLESS OTHERWISE SPECIFIED
DECIMAL INCH[mm]:
.X[X] ± .100[3]
.XX[.X] ± .030[0.8]
.XXX[.XX] ± .010[0.25]
.XXXX[.XXX] ± .003[0.076]
FRACTION INCH[mm]:
1/XX[1/X] ± 1/16[1.6]
ANGLES DEGREE[RADIANS]
X[XX] ± .5[0.01]

TRONAIR — AIRCRAFT GROUND SUPPORT EQUIPMENT

DWN BY GAM | CKD BY XXX | 08-26-19

SCHEMATIC, eJP10/eJP-12 ELECTRICAL

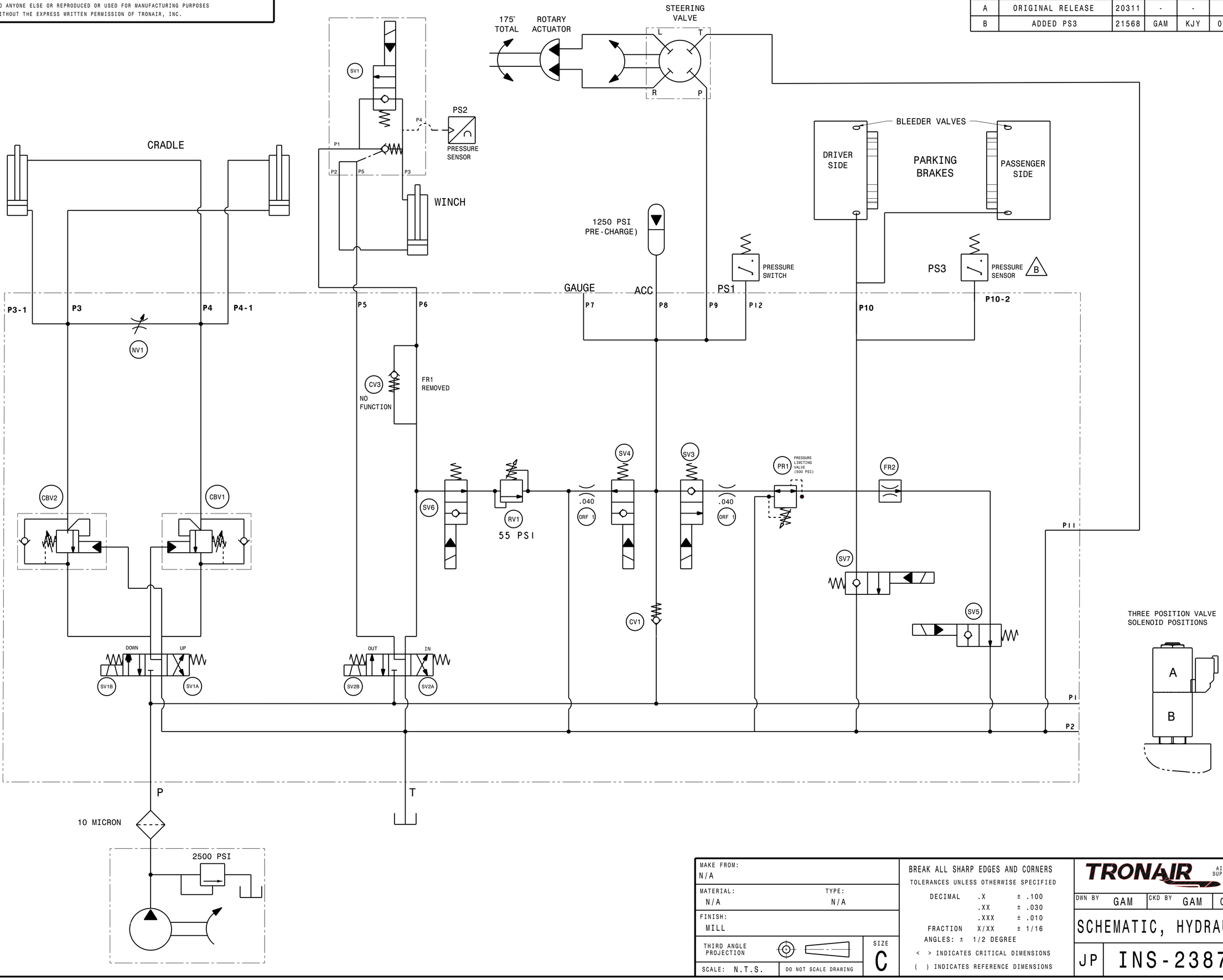
JP | INS-2441 | REV B

TRONAIR®

APPENDIX II

Hydraulic Schematic
INS-2387

LET	REVISION	ECN	DWN	CHK	DATE
A	ORIGINAL RELEASE	20311	-	-	06-20-17
B	ADDED PS3	21568	GAM	KJY	07-29-2020



MAKE FROM: N/A			
MATERIAL: N/A	TYPE: N/A		
FINISH: MILL			
THIRD ANGLE PROJECTION		SIZE	C
SCALE: N.T.S.	DO NOT SCALE DRAWING		

BREAK ALL SHARP EDGES AND CORNERS

TOLERANCES UNLESS OTHERWISE SPECIFIED

DECIMAL	.X	± .100
	.XX	± .030
	.XXX	± .010
FRACTION	X/XX	± 1/16
ANGLES: ±	1/2 DEGREE	

< > INDICATES CRITICAL DIMENSIONS

( ) INDICATES REFERENCE DIMENSIONS

TRONAIR AIRCRAFT GROUND SUPPORT EQUIPMENT

DWN BY	CKD BY	
GAM	GAM	06-20-17

SCHEMATIC, HYDRAULIC

JP	INS-2387	REV B

TRONAIR®

APPENDIX III

Deep Cycle Battery
Handling, Maintenance and Test Procedures

Safety. First.

Deep Cycle Battery Handling, Maintenance & Test Procedures

Crown Deep Cycle Batteries

The chemistry and plate design of deep cycle batteries are totally different than that of automotive starting batteries. The grid metal used in the deep cycle battery plate is specifically formulated to increase the adhesion of high-density active paste material. This provides the best available running time, cycle life and charge acceptance.

Crown Battery's heavy-duty plate design also protects against the stress of challenging Electric Vehicle (EV), motive power and RE (RE) applications – which includes vibration, heat and overcharge.

Crown deep cycle batteries employ a low-maintenance design. They do require periodic maintenance and effective charging service to ensure dependable service life. The purpose of this service guide is to help you understand the characteristics, operation and care of the batteries in your equipment so that all of their advantages may be fully realized.

The Power Behind Performance

CROWN®
DEEP CYCLE
BATTERIES

Inspection & Handling

1. Do not allow batteries in your equipment to tip or operate at a severe angle in any direction. This would allow the battery electrolyte to push through the battery vent assembly.
2. Charge the batteries in your equipment in a well-ventilated area.
3. Upon receipt of your equipment, examine the batteries for signs of wetness or impact (which may indicate damage in shipment or that the batteries were tipped beyond a 45° angle during transit).
4. If there is evidence of damage – notify Crown Battery or the OEM supplier to make a damage report.
5. Charge the batteries before placing the batteries in service. Simply connect the battery charger to your machine's charging port and allow it to run until it automatically shuts off.

Operating Guidelines

Deep cycle batteries supply all the power used in EV, motive power or RE system applications. One full cycle represents a full battery recharge followed by a complete battery discharge (as specified by the OEM). Battery life is usually measured in cycles – but in practical terms, your batteries should work well for three years from the beginning date of service.

However, battery maintenance and charging procedures will either prolong or shorten battery life, depending upon how well recommended practices are followed.

Other Factors That Affect Battery Life and Performance:

- Batteries are rated in ampere-hours (Ah) and are designed to perform a specific workload within an established period of time. Increasing either and/or both of these will over-discharge the batteries and result in shortened life.
- Limit discharging the batteries beyond 1.75 volts per cell – or 1.125 specific gravity per cell. 1.75 volts per cell corresponds to end-point voltages of 5.25 volts for 6-volt batteries, 7 volts for 8-volt batteries and 10.5 volts for 2-volt batteries.
- Batteries should always be recharged immediately following a complete discharge period. Never allow batteries to remain in a fully discharged condition, otherwise permanent damage will result.
- If daily or routine equipment operation results in only partial discharges (40% or less) and specific gravities are 1.225 or higher, recharging may be deferred to the next day, providing the workload is not expected to increase. Generally, user experience will determine the frequency of charging service under these circumstances.
- Under normal circumstance the temperature of the battery electrolyte must not exceed 110° F (43° C). If the battery is continuously operated at or above this point the service life of the battery will be severely diminished. Under normal conditions, battery electrolyte condition should range from 60° to 100° F (15° to 38° C). After charging, the battery should be allowed to cool-down or rest from 6 to 8 hours before the next discharge cycle begins.
- If a battery is ever hot to the touch, allow it to cool to ambient temperature before charging or discharging.
- Keep battery connectors and cabling in good condition. When disconnecting the battery connector from the equipment, pull on the connector – not the cable. Damage to the connectors and/or cables will result in poor battery performance.

Renewable Energy Charging Systems

To maximize performance and life batteries should be recharged fully after each discharge period. To verify full recharging, regularly monitor individual battery voltage and specific gravity. As a general rule, the total input amperes from your RE charging source should be between 10% and 20% of the total ampere-hours (20 Hour Rating) of the battery system capacity. Many RE charge controllers have adjustable equalization settings that ensure batteries are regularly restored to full capacity. Batteries used in RE systems should be equalized every thirty days at a minimum – with more frequent equalization occurring for battery systems routinely discharged below 50% of their rated capacity. Please refer to the following chart for additional charge control setting information:

	System Voltage				
Voltage Setting	6 V	12 V	24 V	36 V	48 V
Daily Charge (Absorption)	7.5	15	30	45	59.5
Equalize	7.8	15.6	31.2	46.8	62.4
Float	6.8	13.5	27	40.5	54

Contact Crown Battery's technical support department for additional charging application information.

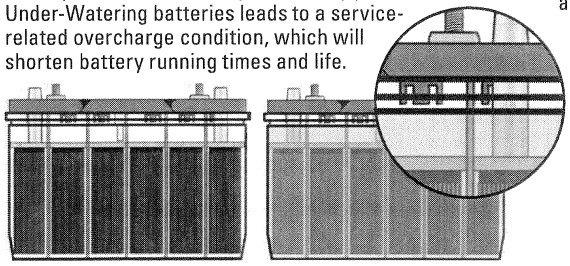
Watering Service

Deep cycle batteries begin service consuming relatively low amounts of water. In electric vehicle, motive power or RE service, the real need to add water to batteries may vary from weekly service to monthly service depending upon the operating environment and other external factors. As batteries age they will use more water, and in warmer climates batteries will require more frequent service. Equipment owners and users must be vigilant in performing regular watering service to ensure premium performance and life.

There are two conditions when watering can be harmful to your batteries:

☑ Over-Watering ☑ Under-Watering

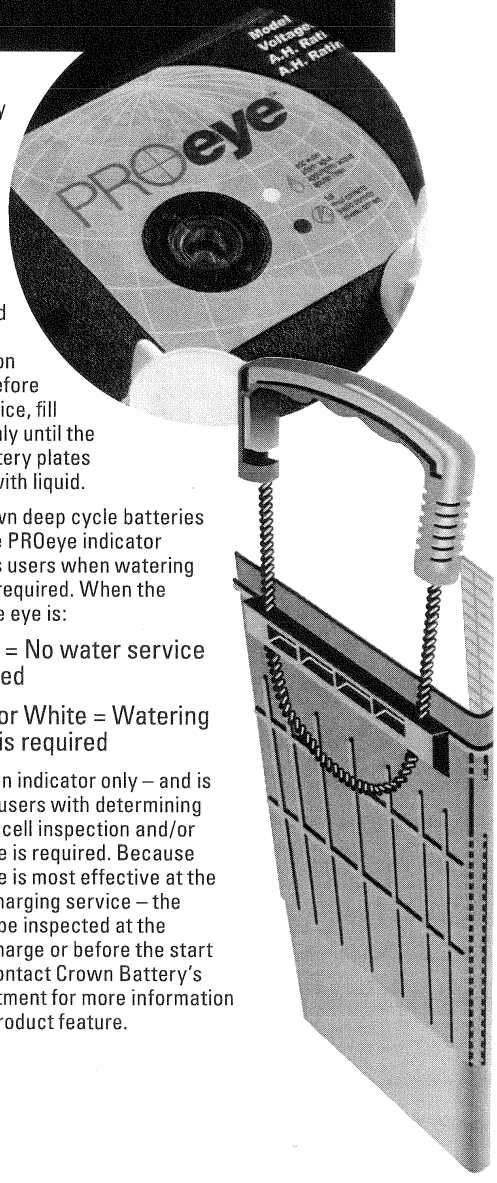
Over-Watering dilutes the sulfuric acid levels inside the battery – which results in poor battery performance. Under-Watering batteries leads to a service-related overcharge condition, which will shorten battery running times and life.



You can prevent watering-service related problems by using the illustration shown above as a reference point. Maintain battery liquid levels above the top of the battery plates – but no higher than the battery cover vent well. Never fill batteries to the brim of the cell or to a point where they overflow.

Several other rules apply when watering:

- USE ONLY DISTILLED or DE-MINERALIZED WATER.
- Never add battery acid, commercial additives or other foreign material to the batteries.
- Watering service should occur only after charging service is completed. Watering before charging service will result in overflow of the battery's electrolyte – causing a dangerous chemical spill condition and loss of battery capacity.
- Never charge batteries if the battery plates are found to be uncovered/ un-submerged in electrolyte. If this condition is detected before charging service, fill the battery only until the top of the battery plates are covered with liquid.



Many Crown deep cycle batteries feature the PROeye indicator that shows users when watering service is required. When the color of the eye is:

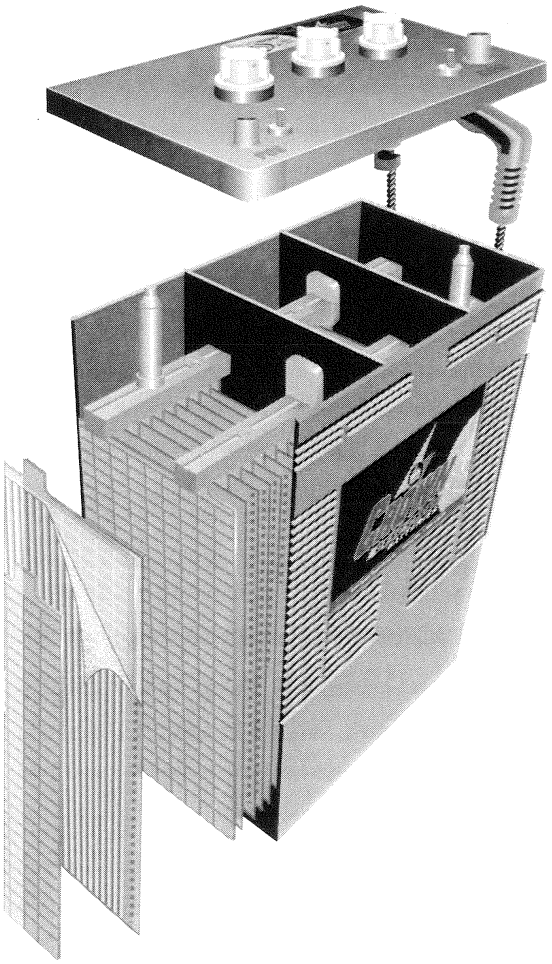
☑ Green = No water service is required

☑ Clear or White = Watering service is required

The PROeye is an indicator only – and is designed to aid users with determining when individual cell inspection and/or watering service is required. Because watering service is most effective at the completion of charging service – the PROeye should be inspected at the completion of charge or before the start of duty cycle. Contact Crown Battery's technical department for more information regarding this product feature.

SAFETY PRECAUTIONS:

1. ***CAUTION:*** *All lead-acid batteries generate highly flammable hydrogen gas. If ignited, the gas may explode violently. When working near batteries, always wear safety glasses, do not smoke or use open flame near the batteries, remove watches and jewelry, and avoid causing sparks with tools.*
2. *Battery electrolyte is corrosive and can cause blindness or severe burns. If exposed to battery electrolyte, immediately flush with water and seek medical attention.*
3. *The batteries in your equipment are electrically live at all times. Keep the top of the batteries clean and dry to prevent ground shorts and corrosion.*
4. *Do not tip a battery beyond a 45° angle in any direction. This would allow battery electrolyte to push through the battery vent assembly.*



Preventative Maintenance

- Battery covers and terminals should be kept clean, dry and free of corrosion. Battery vent caps must be secured to the batteries during use and charging period. Remove vent caps only to inspect electrolyte levels or specific gravities.
- When batteries or terminals require cleaning, use only biodegradable cleaner-neutralizer solutions that can be safely applied and disposed of through a common sanitary sewer. Other chemical-based solutions are often dangerous, ineffective and cannot be disposed of in an environmentally safe manner.
- If electrolyte is spilled onto batteries or the battery compartment area, neutralize it with a cloth moistened with a solution of baking soda and water mixed in the proportion of one pound of baking soda to one gallon of water. When the electrolyte is neutralized, wipe the affected area with a water-moistened cloth to remove all traces of soda.
- Inspect cable-to-terminal connections to ensure connections are tight and free of corrosion. Battery cables must be intact with no exposed wires.
- Preventative maintenance practices should include periodic inspection of battery specific gravity and open circuit voltage. An imbalance of specific gravity and open circuit voltage is usually a sign of improper charging, service infrequency, or a bad cell condition.

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CROWN®
DEEP CYCLE BATTERIES

Charging Guidelines

EV or Motive Power Service

Original equipment systems usually include an automatic charging system for battery charging. To maximize battery life and performance, batteries should be charged as outlined in the operating instructions included with the charging equipment. In the event of a charging-related battery performance problem, consult the OEM or Crown Battery service department to seek technical support. Extra care spent in proper charging will ensure battery performance.

Battery charging equipment varies in terms of output and overall charging performance. For new or replacement chargers used in EV or motive power service, Crown Battery recommends electronically controlled automatic chargers that are programmed to deliver a high constant current rate of 12 to 18 amperes per 100 ampere-hours (20 Hour Rating) of battery capacity. The constant voltage phase begins after the gassing point is achieved (2.42 volts per cell). This stage of charge will last approximately 5 hours for a fully discharged battery. During the constant voltage phase the charger voltage is limited to the gassing level (2.42 volts per cell), and the input current is allowed to gradually diminish. When the input current falls to the finish rate setting of 3 to 4 amperes per 100 ampere-hours (20 Hour Rating) of battery capacity, the charge phase will change from constant voltage to constant current at 3 to 4 amperes per 100 ampere-hours (20 Hour Rating) of battery capacity – with a maximum charging voltage of 2.65 volts per cell. The charge will be terminated approximately 3.5 hours from the gassing point by an approved charge termination method such as DV/DT. Please note that fixed ferro-resonant chargers using this profile must have finish voltages set at 2.58 volts per cell or higher.

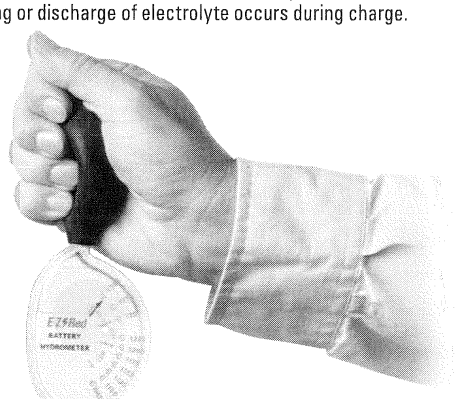
Batteries should always be recharged immediately following a complete discharge period. A weekly equalization charge – with the finish rate charge time extended 3 hours for a total of 6 hours from the gassing point – will ensure reliable discharge time and battery life. The charge factor of the standard recharge cycle should be equal to or greater than 1.08 (108%), while the charge factor of the equalization cycle should be equal to or greater than 1.15 (115%). To ensure optimum battery performance, total recharge time should in all cases be limited to 10 hours.

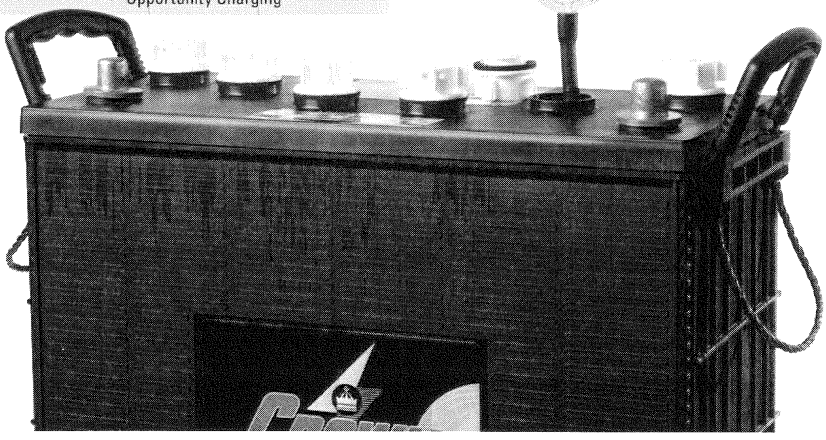
Power off the charger before connection to the battery to avoid sparking. To avoid battery explosion, never charge a frozen battery – warming the battery to room temperature before charging service begins. Charging service should be terminated if batteries become excessively hot or if violent gassing or discharge of electrolyte occurs during charge.

Troubleshooting

When properly maintained and charged, Crown deep cycle batteries will provide many years of trouble-free service. However, failure to follow the operating and maintenance guidelines listed above may result in poor performance or premature failure. The following addresses some of the typical errors in operation and maintenance:

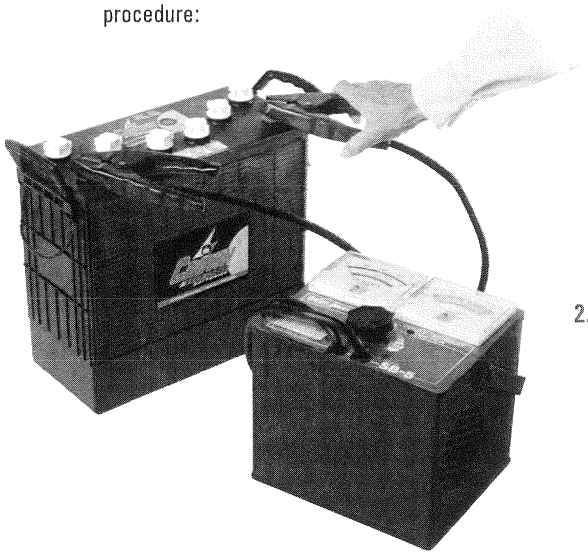
Condition	Check For
Poor Battery Performance	• Undercharged Battery • Sulfated Battery • Cold Operating Environment *(Less than 32°F / 0°C Temperature Reduces Useable Battery Capacity)* • Defective Connectors or Cables • Low Electrolyte • Old Batteries • Defective Charge-Level Gauge
Unequal/Low Specific Gravities	• Over-filling • Undercharging
Excessive Water Service	• Overcharging • Container Leak • Old Batteries
Odor During Charging	• Low Electrolyte • Overcharging
High Temperature	• Overcharging • Battery Overworked • Opportunity Charging



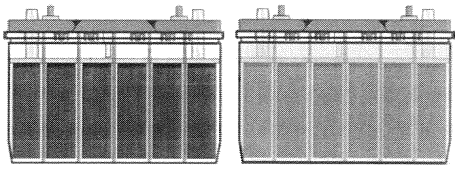


Troubleshooting

A common procedure for troubleshooting battery performance involves a three-point procedure:



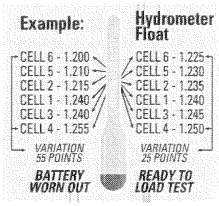
1. Visual Inspection: Check battery age or length of service if available. Inspect battery for damage - when physical damage to the battery container or terminals is present, replace the battery. If none, check the battery's cell electrolyte levels. Fluid levels should be above the top of plates in all cells, and no higher than the top of the fluid level indicator:



If the battery is sufficiently filled with electrolyte – proceed to step 2. If the top of the battery's plates are not covered with liquid, add water, replace vent caps and place the battery on charge. Be sure no open flame or spark is near while the battery's vent caps are removed from the battery.

2. Specific Gravity Inspection: Hydrometer reading of all cells should be at least 1.235 and show less than 50 points difference between high and low.

More than 50 points difference: replace the battery. Less than 50 points, but some cells read less than 1.235: recharge the battery. Replace the vent caps during recharge. Charge the battery using a properly matched automatic charger until all cells measure a specific gravity of 1.275 to 1.280. If charging won't bring up specific gravity, replace the battery.



State of Charge Level	Specific Gravity
100%	1.280 or Greater
75%	1.235 - 1.240
50%	1.190 - 1.195
25%	1.150 - 1.175
Discharged	1.125 or Less

3. Open Circuit Voltage and Electrical Load Test: Battery open circuit voltage is an effective indication of battery state of charge. Determine the approximate state of charge from the following chart.

Electrical load testing is an effective troubleshooting technique for identifying batteries with internal defects – but it is not an approved method for measuring deep cycle battery capacity. For this reason Crown Battery recognizes load test results as useful only for identifying batteries having bad cell conditions.

Batteries with less than 75% state of charge should be charged before an electrical load test is applied to the battery. When load testing batteries, remove all battery cables, disconnecting the negative cables first. Make sure the battery terminals are free of corrosion and dirt.

For batteries having stainless threaded stud terminals, attach a lead charging post to the threaded stud terminal before testing. Using a carbon pile load tester, apply a 50 to 75 ampere load for 15 seconds; remove the load. Refer to the chart at the left to determine the minimum passing voltage.

State of Charge Level	12 Volt Battery Open Circuit Voltage	6 Volt Battery Open Circuit Voltage
100%	12.6 or Greater	6.3 or Greater
75% - 100%	12.4 - 12.6	6.2 - 6.3
50% - 75%	12.2 - 12.4	6.1 - 6.2
25% - 50%	12.0 - 12.2	6.0 - 6.1
0 - 25%	11.7 - 12.0	5.95 - 6.0
0%	11.7 or Less	5.95 or Less

Chart Assumes a Fully Charged Gravity of 1.280.

	Battery Voltage Under 15 Second Load		
State of Charge	12 Volt	6 Volt	Specific Gravity
100%	12.66	6.33	1.280
75%	12.00	6.00	1.235

If the test voltage is above the minimum, return the battery to service. If test voltage is below the minimum, replace the battery.

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CROWN® BATTERY
SINCE 1926

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sales@crownbattery.com

Printed in U.S.A.

Form No. _____

Battery Care...Maintenance

Battery Inventory Management

Batteries should be stored in a cool, dry area in an upright position. Store batteries on a solid surface that can safely accommodate their weight. Batteries can be safely stacked two or three layers high by using a secure stacking surface (wafer-board, plywood, etc.) placed between each layer. When stacking batteries in layers, take care to secure battery terminals against short-circuit and to block-and-brace batteries to prevent any movement of the battery group.

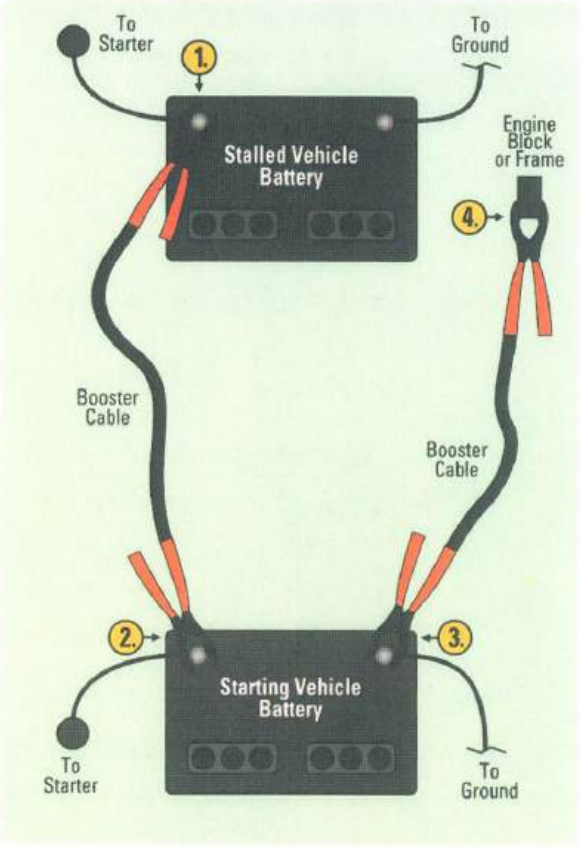
Use or sell oldest battery inventory first *(First In, First Out)*. Batteries require periodic stock rotation and service charging to ensure peak performance. Batteries marked with Shipping Date Codes older than 6 months from the current date should be service charged before sale or use. Shipping Date Codes follow a universal code standard. For example, **L5** = Battery shipped in December 2005:

Month		***Year***	
A – January	G – July	1 – 2001	6 – 2006
B – February	H – August	2 – 2002	7 – 2007
C – March	I – September	3 – 2003	8 – 2008
D – April	J – October	4 – 2004	9 – 2009
E – May	K – November	5 – 2005	0 – 2010
F – June	L – December		

Recommended Charging Practices

- Before charging service, refer to the charger manufacturer's instructions for correct charger-to-battery connection and equipment operation.
- Power off the charger before connection to the battery to avoid sparking.
- For batteries fitted with threaded stud terminals or GM-type side terminals, use only lead charging posts that ensure a flush lead-to-lead terminal surface contact. Verify that charging posts are securely tightened to the terminal, which will enable safe and effective charging service.
- To avoid battery explosion, never charge a frozen battery. Frozen batteries should be warmed to room temperature before charging service begins.
- Check battery cell electrolyte levels to ensure that liquid levels are above the top of the plates in all cells. If plates are not covered, add only enough water to cover plates, replace vent caps and place on charge. Be sure no open flame or spark is near while the battery's vent caps are exposed. After charging, fill with water and replace vent caps on the battery.
- Charging service should be terminated if batteries become excessively hot or if violent gassing or discharge of electrolyte occurs during charge.
- Avoid "quick" or "fast" charging batteries in all cases. Limit charger input current to 25% of the battery's reserve capacity minutes rating. Lower current input charges the battery more uniformly and creates less heat, which reduces the possibility of overcharge. Remember, overcharging ruins batteries.
- Monitor battery state-of-charge throughout the charging period, continuing the charge until a three-hour period shows no additional voltage or tapering of charge current. Refer to page 1 for full-charge voltage and specific gravity points.

Recommended Jump-Starting Practices



Refer to the vehicle owner's manual for manufacturer's recommended procedure.

Make it a point to wear personal protective equipment whenever jump-starting batteries – shield your eyes and face at all times, wear heavy-duty protective gloves before touching batteries or jumper cables.

Make certain that battery vent caps are tight and level. Place a heavy cloth over both batteries' vent caps. Keep a safe distance between vehicles involved in jump-starting, making sure vehicles don't come into contact while jump-starting occurs.

1. Connect one end of the booster cable to the positive terminal of the discharged battery.
2. Connect the other end of the positive booster cable to the positive terminal of the assisting battery.
3. Connect one end of the negative booster cable to the negative terminal of the assisting battery.
4. Complete the jump-start connection by securing the other end of the negative booster cable to the engine block of the vehicle having the discharged battery – as far away from the discharged battery as possible. Be aware of safety risks while completing this connection, such as moving fan blades, belts and fuel lines.

Printed in the U.S.A.

Form No. 20-TRD-B1105

TRONAIR®

APPENDIX IV

Lead Acid Batteries
Safety Data Sheet (SDS)

The Power Behind Performance

CROWN BATTERY SINCE 1926

EFFECTIVE DATE: 12/9/15

SAFETY DATA SHEET

SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: LEAD ACID BATTERIES: DEEP CYCLE & INDUSTRIAL
UN NUMBER: 2794
MANUFACTURER: CROWN BATTERY MANUFACTURING COMPANY
ADDRESS: P.O. Box 990, 1445 Majestic Drive, Fremont Ohio, 43420
CHEMTREC: 800.424.9300 (Domestic), 703.527.3887 (International)
CANUTEC: 613.996.6666 (Canada)
OTHER CALLS: 419.334.7181
FAX PHONE: 419.334.7416
COMPANY WEBSITE: www.crownbattery.com

SYNONYMS: Industrial Battery, Traction Battery, Stationary Battery, Deep Cycle Battery
CHEMICAL FORMULA: $PbO2 + Pb + 2H2SO4 = 2PbSO4 + 2H2O$
PRODUCT USE: Batteries, wet, filled with acid
PREPARED BY: Jim Anderson

SECTION 2: GHS HAZARDS IDENTIFICATION

HEALTH		ENVIRONMENTAL	PHYSICAL
Acute Toxicity (Oral/Dermal/Inhalation)	**Category 4**	Aquatic **Chronic 1** Aquatic **Acute 1**	Explosive Chemical, Division 1.3
Skin Corrosion/Irritation	**Category 1A**		
Eye Damage	**Category 1**		
Reproductive	**Category 1A**		
Carcinogenicity (lead compounds)	**Category 1B**		
Carcinogenicity (arsenic)	**Category 1A**		
Carcinogenicity (acid mist)	**Category 1A**		
Specific Target Organ Toxicity (repeated exposure)	**Category 2**		

Hazard Statements – DANGER!

Harmful if swallowed, inhaled, or in contact with skin.
Acid causes severe skin burns and eye damage.
May damage fertility or the unborn child if ingested or inhaled.
May cause harm to breast-fed children.
May cause cancer if ingested or inhaled.
Causes skin irritation, serious eye damage.
Contact with internal components may cause irritation or severe burns.
Causes damage to central nervous system, blood and kidneys through prolonged or repeated exposure if ingested or inhaled.
Irritating to eyes, respiratory system, and skin.
May form explosive air/gas mixture during charging.
Extremely flammable gas (hydrogen).
Explosive, fire, blast or projection hazard

Precautionary Statements

Obtain special instructions before use.
Do not handle until all safety precautions have been read and understood.
Wash thoroughly after handling.
Do not eat drink or smoke when using this product.
Avoid contact during pregnancy/while nursing.
Wear protective gloves/protective clothing, eye protection/face protection.
Use only outdoors or in a well-ventilated area.
Avoid contact with internal acid.
Do not breathe dust/fume/gas/mist/vapors/spray.
Keep away from heat/sparks/open flames/hot surfaces. No smoking
IF SWALLOWED OR CONSUMED: rinse mouth.
Do NOT induce vomiting. Call a poison center/doctor if you feel unwell.
IF ON CLOTHING OR SKIN (or hair): Remove/Take off immediately all contaminated clothing and wash it before reuse. Rinse skin with water/shower.
IF INHALED: Remove person to fresh air and keep comfortable for breathing.
Immediately call a POISON CENTER or doctor/physician.
IF IN EYES: Rinse cautiously with water for several minutes.
Remove contact lenses, if present and easy to do. Continue rinsing.
If exposed/concerned, or if you feel unwell seek medical attention/advice.
Store locked up, in a well-ventilated area, in accordance with local and national regulation.
Dispose of contents/container in accordance with local and national regulation.
Keep out of reach of children.

SAFETY DATA SHEET *(continued)*

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CROWN BATTERY SINCE 1926

SECTION 3: COMPOSITION / INFORMATION ON INGREDIENTS

INGREDIENTS (CHEMICAL/COMMON NAMES):	CAS NO.:	% BY WT:
Lead and Lead Compounds	7439-92-1	50 to 70
Antimony	7440-36-0	0.1 to .99
Sulfuric Acid	7664-93-9	3 to 5
Inert Components (Separator Material)	N.A.	1 to 2
Water	7732-18-5	23 to 25

SECTION 4: FIRST AID MEASURES

INHALATION:

Sulfuric Acid: Remove to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Consult a physician.

Lead: Remove from exposure, gargle, wash nose and lips; consult physician.

INGESTION:

Sulfuric Acid: Give large quantities of water; Do NOT induce vomiting or aspiration into the lungs may occur and can cause permanent injury or death; consult physician.

Lead: Consult physician immediately.

SKIN:

Sulfuric Acid: Flush with large amounts of water for at least 15 minutes; remove contaminated clothing completely, including shoes. If symptoms persist, seek medical attention. Wash contaminated clothing before reuse. Discard contaminated shoes.

Lead: Wash immediately with soap and water.

EYES:

Sulfuric Acid and Lead: Flush immediately with large amounts of water for at least 15 minutes while lifting lids; Seek immediate medical attention if eyes have been exposed directly to acid.

SECTION 5: FIRE-FIGHTING MEASURES

FLASH POINT: Not Applicable

FLAMMABLE LIMITS: LEL = 4.1% (Hydrogen Gas in air); UEL = 74.2%

EXTINGUISHING MEDIA: CO_2; foam; dry chemical. Do not use carbon dioxide directly on cells. Avoid breathing vapors. Use appropriate media for surrounding fire

FIRE FIGHTING PROCEDURES: Use positive pressure, self-contained breathing apparatus. Beware of acid splatter during water application and wear acid-resistant clothing, gloves, face and eye protection. If batteries are on charge, shut off power to the charging equipment, but note that strings of series connected batteries may still pose risk of electric shock even when charging equipment is shut down.

HAZARDOUS COMBUSTION PRODUCTS: Highly flammable hydrogen gas is generated during charging and operation of batteries. If ignited by burning cigarette, naked flame or spark, may cause battery explosion with dispersion of casing fragments and corrosive liquid electrolyte. Carefully follow manufacturer's instructions for installation and service. Keep away all sources of gas ignition and do not allow metallic articles to simultaneously contact the negative and positive terminals of a battery. Follow manufacturer's instructions for installation and service.

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CROWN BATTERY SINCE 1926

SECTION 6: ACCIDENTAL RELEASE MEASURES

Stop flow of material, contain/absorb small spills with dry sand, earth or vermiculite. Do not use combustible materials. If possible, carefully neutralize spilled electrolyte with soda ash, sodium bicarbonate, lime, etc. Wear acid-resistant clothing, boots, gloves, and face shield. Do not allow discharge of un-neutralized acid to sewer. Acid must be managed in accordance with approved local, state, and federal requirements. Consult state environmental agency and/or federal EPA.

SECTION 7: HANDLING AND STORAGE

HANDLING: Unless involved in recycling operations, do not breach the casing or empty the contents of the battery. Handle carefully and avoid tipping, which may allow electrolyte leakage. There may be increasing risk of electric shock from strings of connected batteries. Keep containers tightly closed when not in use. If battery case is broken, avoid contact with internal components. Keep vent caps on and cover terminals to prevent short circuits. Place cardboard between layers of stacked automotive batteries to avoid damage and short circuits. Keep away from combustible materials, organic chemicals, reducing substances, metals, strong oxidizers and water. Use banding or stretch wrap to secure items for shipping.

STORAGE: Store batteries under roof in cool, dry, well-ventilated areas separated from incompatible materials and from activities that may create flames, spark, or heat. Store on smooth, impervious surfaces provided with measures for liquid containment in the event of electrolyte spills. Keep away from metallic objects that could bridge the terminals on a battery and create a dangerous short-circuit.

CHARGING: There is a possible risk of electric shock from charging equipment and from strings of series connected batteries, whether or not being charged. Shut-off power to chargers whenever not in use and before detachment of any circuit connections. Batteries being charged will generate and release flammable hydrogen gas. Charging space should be ventilated. Keep battery vent caps in position. Prohibit smoking and avoid creation of flames and sparks nearby. Wear face and eye protection when near batteries being charged.

SECTION 8: EXPOSURE CONTROLS / PERSONAL PROTECTION

EXPOSURE LIMITS (mg/m³)						
Chemical & Common Name	**OSHA PEL**	**ACGIH**	**US NIOSH**	**Quebec PEV**	**Ontario OEL**	**EU OEL**
Lead and Lead Compounds (inorganic)	0.05	0.05	0.05	0.05	0.05	0.15 (b)
Electrolyte (H_2SO_4/H_2O)	1	0.2	1	1	0.2	0.05 (c)
Antimony	0.5	0.5	0.5	0.5	0.5	0.5 (b,e)

(a) As inhalable aerosol **(b)** Thoracic fraction

(c) Based on OEL's of Austria, Belgium, Denmark, France, Netherlands, Switzerland, & U.K.

N.E. = Not Established

ENGINEERING CONTROLS (VENTILATION): Store and handle in well-ventilated area. If mechanical ventilation is used, components must be acid-resistant. Handle batteries cautiously, do not tip to avoid spills. Make certain vent caps are on securely. If battery case is damaged, avoid bodily contact with internal components. Wear protective clothing, eye and face protection, when filling, charging or handling batteries. Do not allow metallic materials to simultaneously contact both the positive and negative terminals of the batteries. Charge batteries in areas with adequate ventilation. General dilution ventilation is acceptable.

RESPIRATORY PROTECTION (NIOSH/MSHA APPROVED): None required under normal conditions.
When concentrations of sulfuric acid mist are known to exceed PEL, use NIOSH or MSHA-approved respiratory protection.

SAFETY DATA SHEET *(continued)*

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CROWN BATTERY SINCE 1926

SKIN PROTECTION: If battery case is damaged, use rubber or plastic acid-resistant gloves with elbow-length gauntlet, acid-resistant apron, clothing and boots.

EYE PROTECTION: If battery case is damaged, use chemical goggles or face shield.

OTHER PROTECTION: In areas where water and sulfuric acid solutions are handled in concentrations greater than 1%, emergency eyewash stations and showers should be provided, with unlimited water supply. Chemically impervious apron and face shield recommended when adding water or electrolyte to batteries. Wash Hands after handling.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

PROPERTIES LISTED BELOW ARE FOR ELECTROLYTE:			
Boiling Point:	203 - 240° F	**Specific Gravity (H2O = 1):**	1.215 to 1.350
Melting Point:	N/A	**Vapor Pressure (mm Hg):**	10
Solubility in Water:	100%	**Vapor Density (AIR = 1):**	Greater than 1
Evaporation Rate: (Butyl Acetate = 1)	Less than 1	**% Volatile by Weight:**	N/A
pH:	~1 to 2	**Flash Point:**	Below room temperature (as hydrogen gas)
LEL (Lower Explosive Limit)	4.1% (Hydrogen)	**UEL (Upper Explosive Limit)**	74.2% (Hydrogen)
Appearance and Odor:	Manufactured article; no apparent odor. Electrolyte is a clear liquid with a sharp, penetrating, pungent odor.		

SECTION 10: STABILITY AND REACTIVITY

STABILITY: Stable _X_ Unstable ___

This product is stable under normal conditions at ambient temperature.

CONDITIONS TO AVOID: Prolonged overcharge at high current; sources of ignition.

INCOMPATIBILITIES: (MATERIALS TO AVOID)

Electrolyte: Contact with combustibles and organic materials may cause fire and explosion. Also reacts violently with strong reducing agents, metals, sulfur trioxide gas, strong oxidizers, and water. Contact with metals may produce toxic sulfur dioxide fumes and may release flammable hydrogen gas.

Lead Compounds: Avoid contact with strong acids, bases, halides, halogenates, potassium nitrate, permanganate, peroxides, nascent hydrogen, and reducing agents.

Arsenic Compounds: Strong oxidizers; bromine azide.
NOTE: hydrogen gas can react with inorganic arsenic to form the highly toxic gas – arsine

HAZARDOUS DECOMPOSITION PRODUCTS:

Electrolyte: Sulfur trioxide, carbon monoxide, sulfuric acid mist, sulfur dioxide, hydrogen sulfide.

Lead Compounds: Temperatures above the melting point are likely to produce toxic metal fume, vapor, or dust; contact with strong acid or base or presence of nascent hydrogen may generate highly toxic arsine gas.

HAZARDOUS POLYMERIZATION:

Will not occur.

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SECTION 11: TOXICOLOGICAL INFORMATION

ROUTES OF ENTRY:

Sulfuric Acid: Harmful by all routes of entry.

Lead Compounds: Hazardous exposure can occur only when product is heated, oxidized or otherwise processed or damaged to create dust, vapor or fume. The presence of nascent hydrogen may generate highly toxic arsine gas.

INHALATION:

Sulfuric Acid: Breathing of sulfuric acid vapors or mists may cause severe respiratory irritation.

Lead Compounds: Inhalation of lead dust or fumes may cause irritation of upper respiratory tract and lungs.

INGESTION:

Sulfuric Acid: May cause severe irritation of mouth, throat, esophagus and stomach.

Lead Compounds: Acute ingestion may cause abdominal pain, nausea, vomiting, diarrhea and severe cramping. This may lead rapidly to systemic toxicity and must be treated by a physician.

SKIN CONTACT:

Sulfuric Acid: Severe irritation, burns and ulceration.

Lead Compounds: Not absorbed through the skin.

Arsenic compounds: Contact may cause dermatitis and skin hyperpigmentation

EYE CONTACT:

Sulfuric Acid: Severe irritation, burns, cornea damage, and blindness.

Lead Compounds: May cause eye irritation.

EFFECTS OF OVEREXPOSURE – ACUTE:

Sulfuric Acid: Severe skin irritation, damage to cornea, upper respiratory irritation.

Lead Compounds: Symptoms of toxicity include headache, fatigue, abdominal pain, loss of appetite, muscular aches and weakness, sleep disturbances and irritability.

EFFECTS OF OVEREXPOSURE - CHRONIC:

Sulfuric Acid: Possible erosion of tooth enamel, inflammation of nose, throat & bronchial tubes.

Lead Compounds: Anemia; neuropathy, particularly of the motor nerves, with wrist drop; kidney damage; reproductive changes in males and females. Repeated exposure to lead and lead compounds in the workplace may result in nervous system toxicity. Some toxicologists report abnormal conduction velocities in persons with blood lead levels of 50 µg/100 ml or higher. Heavy lead exposure may result in central nervous system damage, encephalopathy and damage to the blood-forming (hematopoietic) tissues.

CARCINOGENICITY:

Sulfuric Acid: The International Agency for Research on Cancer (IARC) has classified "strong inorganic acid mist containing sulfuric acid" as a Group I carcinogen, a substance that is carcinogenic to humans. Per the guidance found in OSHA 29 CFR 1910.1200 Appendix F, this is approximately equivalent to GHS Category 1A. This classification does not apply to liquid forms of sulfuric acid or sulfuric acid solutions contained within a battery. Inorganic acid mist (sulfuric acid mist) is not generated under normal use of this product. Misuse of the product, such as overcharging, may result in the generation of sulfuric acid mist.

Lead Compounds: Lead is listed by IARC as a Group 2A - likely in animals at extreme doses. Per the guidance found in OSHA 29 CFR 1910.1200 Appendix F, this is approximately equivalent to GHS Category 1B. Proof of carcinogenicity in humans is lacking at present.

Arsenic: Arsenic is listed by IARC as a Group 1 - carcinogenic to humans. Per the guidance found in OSHA 29 CFR 1910.1200 Appendix F, this is approximately equivalent to GHS Category 1A.

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE: Overexposure to sulfuric acid mist may cause lung damage and aggravate pulmonary conditions. Contact of sulfuric acid with skin may aggravate diseases such as eczema and contact dermatitis. Lead and its compounds can aggravate some forms of kidney, liver and neurologic diseases.

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ACUTE TOXICITY:

Inhalation LD50:

Electrolyte:	LC50 rat: 375 mg/m3; LC50: guinea pig: 510 mg/m3
Elemental Lead:	Acute Toxicity Point Estimate = 4500 ppmV (based on lead bullion)
Elemental arsenic:	No data

Oral LD50:

Electrolyte:	rat: 2140 mg/kg
Elemental lead:	Acute Toxicity Estimate (ATE) = 500 mg/kg body weight (based on lead bullion)
Elemental arsenic:	LD50 mouse: 145 mg/kg
Elemental Antimony:	LD50 rat: 100 mg/kg

ADDITIONAL HEALTH DATA: All heavy metals, including the hazardous ingredients in this product, are taken into the body primarily by inhalation and ingestion. Most inhalation problems can be avoided by adequate precautions such as ventilation and respiratory protection covered in Section 8. Follow good personal hygiene to avoid inhalation and ingestion: wash hands, face, neck and arms thoroughly before eating, smoking or leaving the work site. Keep contaminated clothing out of non-contaminated areas, or wear cover clothing when in such areas. Restrict the use and presence of food, tobacco and cosmetics to non-contaminated areas. Work clothes and work equipment used in contaminated areas must remain in designated areas and never taken home or laundered with personal non-contaminated clothing. This product is intended for industrial use only and should be isolated from children and their environment.

The 19th Amendment to EC Directive 67/548/EEC classified lead compounds, but not lead in metal form, as possibly toxic to reproduction. Risk phrase 61: May cause harm to the unborn child, applies to lead compounds, especially soluble forms.

SECTION 12: ECOLOGICAL INFORMATION

ENVIRONMENTAL FATE: Lead is very persistent in soil and sediments. No data on environmental degradation. Mobility of metallic lead between ecological compartments is slow. Bioaccumulation of lead occurs in aquatic and terrestrial animals and plants but little bioaccumulation occurs through the food chain. Most studies include lead compounds and not elemental lead.

ENVIRONMENTAL TOXICITY: Aquatic Toxicity:

Sulfuric acid:	24-hr LC50, freshwater fish (Brachydanio rerio): 82 mg/L 96 hr- LOEC, freshwater fish (Cyprinus carpio): 22 mg/L
Lead:	48 hr LC50 (modeled for aquatic invertebrates): <1 mg/L, based on lead bullion
Arsenic:	24 hr LC50, freshwater fish (Carrassisus auratus) >5000 g/L.

ADDITIONAL INFORMATION:

- No known effects on stratospheric ozone depletion
- Volatile organic compounds: 0% (by Volume)
- Water Endangering Class (WGK): NA

SECTION 13: DISPOSAL CONSIDERATIONS (UNITED STATES)

SPENT BATTERIES: Send to secondary lead smelter for recycling. Spent lead-acid batteries are not regulated as hazardous waste when the requirements of 40 CFR Section 266.80 are met. Spilled sulfuric acid is a characteristic hazardous waste; EPA hazardous waste number D002 (corrosivity) and D008 (lead).

ELECTROLYTE: Place neutralized slurry into sealed acid resistant containers and dispose of as hazardous waste, as applicable. Large water diluted spills, after neutralization and testing, should be managed in accordance with approved local, state, and federal requirements. Consult state environmental agency and/or federal EPA.

Following local, State / Provincial, and Federal / National regulations applicable to end-of-life characteristics will be the responsibility of the end-user.

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SECTION 14: TRANSPORT INFORMATION

UNITED STATES:

The U.S. Department of Transportation (DOT) hazardous materials regulations (49 CFR) applicable to lead acid batteries are specified in 49 CFR 173.159.

Proper Shipping Name: Batteries, wet, filled with acid
Hazard Class: 8
ID Number: UN2794
Packing Group: N/A
Labels: Corrosive

49 CFR 173.159(e) specifies that when transported by highway or rail, electric storage batteries containing electrolyte or corrosive battery fluid are not subject to any other requirements of this subchapter, if all of the following are met:

(1) No other hazardous materials may be transported in the same vehicle;

(2) The batteries must be loaded or braced so as to prevent damage and short circuits in transit;

(3) Any other material loaded in the same vehicle must be blocked, braced, or otherwise secured to prevent contact with or damage to the batteries; and

(4) The transport vehicle may not carry material shipped by any person other than the shipper of the batteries.

If any of the above-referenced requirements are not met, the batteries must be shipped as fully-regulated Class 8 Corrosive hazardous materials.

IATA Dangerous Goods Regulations (DGR):

The shipping information is as follows:

Proper Shipping Name: Batteries, wet, filled with acid
Packing Group: N/A
Hazardous Class: 8
Label/Placard Required: Corrosive
UN Identification: UN2794
Reference: IATA Packing Instruction 870 (IATA DGR 56th Edition)

IMDG Code:

The shipping information is as follows:

Proper Shipping Name: Batteries, wet, filled with acid
Packing Group: N/A
Hazardous Class: 8
Label/Placard Required: Corrosive
UN Identification: UN2794
Reference: IMDG Code Packing Instruction P801

SECTION 15: REGULATORY INFORMATION

UNITED STATES: EPCRA Sections 302, 304, 311 & 312

Industrial lead-acid batteries, such as those used in forklifts, do **NOT** meet the OSHA definition of an "article" (US EPA, Oct. 1998). Therefore, the lead and acid that compose these batteries must be included when determining the various thresholds for these EPCRA section regulations. The acid in lead-acid batteries is **Sulfuric Acid**, which is an Extremely Hazardous Substance (EHS). The following table outlines the applicable EPCRA Sections and their respective thresholds for **Sulfuric Acid**:

EPCRA SECTIONS – SULFURIC ACID	THRESHOLDS
302 - Emergency Planning Notification	TPQ ≥ 1,000 lbs.
304 - Emergency Release Notification	RQ ≥ 1,000 lbs.
311 - MSDS Reporting	*TPQ ≥ 500 lbs.
312 - Chemical Inventory Reporting (i.e. Tier II)	*TPQ ≥ 500 lbs.

The reporting threshold for Sulfuric Acid is ≥ the designated TPQ or 500 lbs, whichever is less.

The lead used in lead-acid batteries does not qualify for any OSHA or EPCRA exemptions. Lead is **NOT** an EHS, and the following table outlines the applicable EPCRA Sections and their respective thresholds for **lead**:

EPCRA SECTIONS - LEAD	THRESHOLDS
311 - MSDS Reporting	≥ 10,000 lbs.
312 - Chemical Inventory Reporting (i.e. Tier II)	≥ 10,000 lbs.

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EPCRA Section 313

The reporting of lead and sulfuric acid (and their releases) in lead-acid batteries used in cars, trucks, most cranes, forklifts, locomotive engines, and aircraft for the purposes of EPCRA Section 313 is not required. Lead-acid batteries used for these purposes are exempt for Section 313 reporting per the "Motor Vehicle Exemption." See page B-22 of the **U.S. EPA Guidance Document for Lead and Lead Compound Reporting under EPCRA Section 313** for additional information of this exemption.

Supplier Notification: This product contains toxic chemicals that may be reportable under EPCRA Section 313 Toxic Chemical Release Inventory (Form R) requirements. For a manufacturing facility under SIC codes 20 through 39, the following information is provided to enable you to complete the required reports:

TOXIC CHEMICAL	CAS NUMBER	APPROXIMATE % BY WEIGHT
Lead	7439-92-1	50 to 70
Sulfuric Acid/Water Solution	7664-93-9	3 to 5
Antimony	7440-36-0	0.1 to 0.99
Arsenic	7440-38-2	<0.1

TSCA: TSCA Section 8b – Inventory Status: All chemicals comprising this product are either exempt or listed on the TSCA Inventory.

TSCA Section 12b (40 CFR Part 707.60(b)) No notice of export will be required for articles, except PCB articles, unless the Agency so requires in the context of individual section 5, 6, or 7 actions.

TSCA Section 13 (40 CFR Part 707.20): No import certification required (EPA 305-B-99-001, June 1999, Introduction to the Chemical Import Requirements of the Toxic Substances Control Act, Section IV.A)

RCRA: Spent Lead Acid Batteries are subject to streamlined handling requirements when managed in compliance with 40 CFR section 266.80 or 40 CFR part 273. Waste sulfuric acid is a characteristic hazardous waste; EPA hazardous waste number D002 (corrosivity) and D008 (lead).

STATE REGULATIONS (US):

Proposition 65 Warning: Battery posts, terminals and related accessories contain lead and lead compounds, chemicals known to the state of California to cause cancer and reproductive harm. Wash hands after handling.

INTERNATIONAL REGULATIONS:

Distribution into Quebec to follow Canadian Controlled Product Regulations (CPR) 24(1) and 24(2).

Distribution into the EU to follow applicable Directives to the Use, Import/Export of the product as-sold.

SECTION 16: OTHER INFORMATION

NFPA Hazard Rating for sulfuric acid:

Flammability (Red) = 0

Health (Blue) = 3

Reactivity (Yellow) = 2

Sulfuric acid is water-reactive if concentrated.

PREPARATION INFORMATION:

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The information contained herein is based upon data considered true and accurate. However, Crown Battery makes no warranties, express or implied, as to the accuracy or adequacy of the information contained herein or the results to be obtained from the use thereof. This information is offered solely for the user's consideration, investigation and verification. Since the use and conditions of use of this information and the material described herein are not within the control of Crown Battery, Crown Battery assumes no responsibility for injury to user or to third persons. The material described herein is sold only pursuant to Crown Battery's Terms and Conditions of Sale, including those limiting warranties and remedies contained therein. It is the responsibility of the user to determine whether any of this data and information is in accordance with applicable federal state or local laws and regulations.

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APPENDIX V

Curtis
Diagnostics and Trouble Shooting

9 DIAGNOSTICS AND TROUBLESHOOTING

These controllers detect a wide variety of faults or error conditions. Faults can be detected by the operating system or by the VCL code. This section describes the faults detected by the operating system.

Faults detected by VCL code (faults 51–67 in Table 6) cannot be defined here as they will vary from application to application. Refer to the appropriate OEM documentation for information on these faults.

DIAGNOSTICS

Diagnostics information can be obtained in either of two ways: (1) by reading the display on a 1313 handheld or 1314 PC programmer or (2) by observing the fault codes issued by the Status LEDs. See Table 5 for a summary of LED display formats.

The 1313/1314 programmer will display all faults that are currently set as well as a history of the faults that have been set since the history log was last cleared. The programmer displays the faults by name.

The pair of LEDs built into the controller (one red, one yellow) produce flash codes displaying all the currently set faults in a repeating cycle. Each code consists of two digits. The red LED flashes once to indicate that the first digit of the code will follow; the yellow LED then flashes the appropriate number of times for the first digit. The red LED flashes twice to indicate that the second digit of the code will follow; the yellow LED flashes the appropriate number of times for the second digit.

Example: Battery Undervoltage (code 23).

In the Fault menu of the 1313/1314 programmer, the words **Undervoltage Cutback** will be displayed; the real-time battery voltage is displayed in the Monitor menu ("Keyswitch Voltage").

The controller's two LEDs will display this repeating pattern:

RED	YELLOW	RED	YELLOW
*	* *	* *	* * *
(first digit)	(2)	(second digit)	(3)

The numerical codes used by the yellow LED are listed in the troubleshooting chart (Table 6), which also lists possible fault causes and describes the conditions that set and clear each fault.

Summary of LED display formats

The two LEDs have four different display modes, indicating the type of information they are providing.

Table 5 TYPES OF LED DISPLAY

DISPLAY	STATUS
Neither LED illuminated	Controller is not powered on; or vehicle has dead battery; or severe damage.
Yellow LED flashing	Controller is operating normally.
Yellow and red LEDs both on solid	Controller is in Flash program mode.
Red LED on solid	Internal hardware fault detected by the Supervisor or Primary microprocessor. Missing or corrupt software. Interrupting a software download may cause corruption of the software. Cycle KSI to clear. Reload software or replace controller if necessary.
Red LED and yellow LED flashing alternately	Controller has detected a fault. 2-digit code flashed by yellow LED identifies the specific fault; one or two flashes by red LED indicate whether first or second code digit will follow.

TROUBLESHOOTING

The troubleshooting chart, Table 6, provides the following information on all the controller faults:

- fault code
- fault name as displayed on the programmer's LCD
- the effect of the fault
- possible causes of the fault
- fault *set* conditions
- fault *clear* conditions.

Whenever a fault is encountered and no wiring or vehicle fault can be found, shut off KSI and turn it back on to see if the fault clears. If it does not, shut off KSI and remove the 35-pin connector. Check the connector for corrosion or damage, clean it if necessary, and re-insert it.

Table 6 TROUBLESHOOTING CHART

CODE	PROGRAMMER LCD DISPLAY / *EFFECT OF FAULT*	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
12	**Controller Overcurrent** *ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake.*	1. External short of phase U,V, or W motor connections. 2. Motor parameters are mis-tuned. 3. Controller defective. 4. Speed encoder noise problems.	*Set:* Phase current exceeded the current measurement limit. *Clear:* Cycle KSI.
13	**Current Sensor Fault** *ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake.*	1. Leakage to vehicle frame from phase U, V, or W (short in motor stator). 2. Controller defective.	*Set:* Controller current sensors have invalid offset reading. *Clear:* Cycle KSI.
14	**Precharge Failed** *ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake.*	1. See Monitor menu » Battery: Capacitor Voltage. 2. External load on capacitor bank (B+ connection terminal) that prevents the capacitor bank from charging.	*Set:* Precharge failed to charge the capacitor bank to the KSI voltage. *Clear:* Cycle Interlock input or use VCL function *Enable_Precharge()*.
15	**Controller Severe Undertemp** *ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake.*	1. See Monitor menu » Controller: Temperature. 2. Controller is operating in an extreme environment.	*Set:* Heatsink temperature below -40°C. *Clear:* Bring heatsink temperature above -40°C, and cycle interlock or KSI.
16	**Controller Severe Overtemp** *ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake.*	1. See Monitor menu » Controller: Temperature. 2. Controller is operating in an extreme environment. 3. Excessive load on vehicle.	*Set:* Heatsink temperature above +95°C. *Clear:* Bring heatsink temperature below +95°C, and cycle interlock or KSI.
17	**Severe B+ Undervoltage** *Reduced drive torque.*	1. See Monitor menu » Battery: Keyswitch Voltage. 2. Non-controller system drain on battery/KSI circuit wiring. 3. KSI disconnected while driving. 4. Blown KSI fuse.	*Set:* When below Brownout Voltage for 2 seconds (see Table D-1). *Clear:* Bring KSI voltage above Brownout Voltage.
17	**Severe KSI Undervoltage** *No Action.*	1. See Monitor menu » Battery: Keyswitch Voltage. 2. Non-controller system drain on battery/KSI circuit wiring. 3. KSI disconnected while driving. 4. Blown KSI fuse.	*Set:* When below Brownout Voltage for 2 seconds (see Table D-1). *Clear:* Bring KSI voltage above Brownout Voltage.

Table 6 TROUBLESHOOTING CHART, cont'd

CODE	PROGRAMMER LCD DISPLAY / *EFFECT OF FAULT*	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
18	**Severe B+ Overvoltage** *ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake.*	1. See Monitor menu » Battery: Capacitor Voltage. 2. Battery menu parameters are misadjusted. 3. Battery resistance too high for given regen current. 4. Battery disconnected while regen braking.	*Set:* Capacitor bank voltage exceeded the Severe Overvoltage limit (see page 58) with FET bridge enabled. *Clear:* Bring capacitor voltage below Severe Overvoltage limit, and then cycle KSI.
22	**Controller Overtemp Cutback** *Reduced drive and brake torque.*	1. See Monitor menu » Controller: Temperature. 2. Controller is performance-limited at this temperature. 3. Controller is operating in an extreme environment. 4. Excessive load on vehicle. 5. Improper mounting of controller.	*Set:* Heatsink temperature exceeded 85°C. *Clear:* Bring heatsink temperature below 85°C.
23	**B+ Undervoltage Cutback** *Reduced drive torque.*	1. Normal operation. Fault shows that the batteries need recharging. Controller is performance limited at this voltage. 2. Battery parameters are misadjusted. 3. Non-controller system drain on battery. 4. Battery resistance too high. 5. Battery disconnected while driving. 6. See Monitor menu » Battery: Capacitor Voltage. 7. Blown B+ fuse or main contactor did not close.	*Set:* Capacitor bank voltage dropped below the Undervoltage limit (see page 58) with the FET bridge enabled. *Clear:* Bring capacitor voltage above the Undervoltage limit.
24	**B+ Overvoltage Cutback** *Reduced brake torque.* *Note: This fault is declared only when the controller is running in regen.*	1. Normal operation. Fault shows that regen braking currents elevated the battery voltage during regen braking. Controller is performance limited at this voltage. 2. Battery parameters are misadjusted. 3. Battery resistance too high for given regen current. 4. Battery disconnected while regen braking. 5. See Monitor menu » Battery: Capacitor Voltage.	*Set:* Capacitor bank voltage exceeded the Overvoltage limit (see page 58) with the FET bridge enabled. *Clear:* Bring capacitor voltage below the Overvoltage limit.
25	**+5V Supply Failure** *None, unless a fault action is programmed in VCL.*	1. External load impedance on the +5V supply (pin 26) is too low. 2. See Monitor menu » outputs: 5 Volts and Ext Supply Current.	*Set:* +5V supply (pin 26) outside the +5V±10% range. *Clear:* Bring voltage within range.
26	**Digital Out 6 Open/Short** *Digital Output 6 driver will not turn on.*	1. External load impedance on Digital Output 6 driver (pin 19) is too low.	*Set:* Digital Output 6 (pin 19) current exceeded 1 Amp. *Clear:* Remedy the overcurrent cause and use the VCL function *Set_DigOut()* to turn the driver on again.

Table 6 TROUBLESHOOTING CHART, cont'd

CODE	PROGRAMMER LCD DISPLAY / *EFFECT OF FAULT*	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
27	**Digital Out 7 Open/Short** *Digital Output 7 driver will not turn on.*	1. External load impedance on Digital Output 7 driver (pin 20) is too low.	*Set:* Digital Output 7 (pin 20) current exceeded 1 Amp. *Clear:* Remedy the overcurrent cause and use the VCL function *Set_DigOut()* to turn the driver on again.
28	**Motor Temp Hot Cutback** *Reduced drive torque.*	1. Motor temperature is at or above the programmed Temperature Hot setting, and the current is being cut back. 2. Motor Temperature Control Menu parameters are mis-tuned. 3. See Monitor menu » Motor: Temperature and » Inputs: Analog2. 4. If the application doesn't use a motor thermistor, Temp Compensation and Temp Cutback should be programmed Off.	*Set:* Motor temperature is at or above the Temperature Hot parameter setting. *Clear:* Bring the motor temperature within range.
29	**Motor Temp Sensor Fault** *MaxSpeed reduced (LOS, Limited Operating Strategy), and motor temperature cutback disabled.*	1. Motor thermistor is not connected properly. 2. If the application doesn't use a motor thermistor, Motor Temp Sensor Enable should be programmed Off. 3. See Monitor menu » Motor: Temperature and » Inputs: Analog2.	*Set:* Motor thermistor input (pin 8) is at the voltage rail (0 or 10V). *Clear:* Bring the motor thermistor input voltage within range.
31	**Coil1 Driver Open/Short** *ShutdownDriver1.*	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set:* Driver 1 (pin 6) is either open or shorted. This fault can be set only when Main Enable = Off. *Clear:* Correct open or short, and cycle driver.
31	**Main Open/Short** *ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake.*	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set:* Main contactor driver (pin 6) is either open or shorted. This fault can be set only when Main Enable = On. *Clear:* Correct open or short, and cycle driver
32	**Coil2 Driver Open/Short** *ShutdownDriver2.*	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set:* Driver 2 (pin 5) is either open or shorted. This fault can be set only when EM Brake Type = 0. *Clear:* Correct open or short, and cycle driver.
32	**EMBrake Open/Short** *ShutdownEMBrake; ShutdownThrottle; FullBrake.*	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set:* Electromagnetic brake driver (pin 5) is either open or shorted. This fault can be set only when EM Brake Type >0. *Clear:* Correct open or short, and cycle driver.
33	**Coil3 Driver Open/Short** *ShutdownDriver3.*	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set:* Driver 3 (pin 4) is either open or shorted. *Clear:* Correct open or short, and cycle driver.
34	**Coil4 Driver Open/Short** *ShutdownDriver4.*	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set:* Driver 4 (pin 3) is either open or shorted. *Clear:* Correct open or short, and cycle driver.

Table 6 TROUBLESHOOTING CHART, cont'd

CODE	PROGRAMMER LCD DISPLAY / *EFFECT OF FAULT*	POSSIBLE CAUSE	SET/CLEAR CONDITION
35	**PD Open/Short** *ShutdownPD.*	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	*Set:* Proportional driver (pin 2) is either open or shorted. *Clear:* Correct open or short, and cycle driver.
36	**Encoder Fault** *ShutdownEMBrake;* *Throttle_Command* *is not processed*	1. Motor encoder failure. 2. Bad crimps or faulty wiring. 3. See Monitor menu » Motor: Motor RPM.	*Set:* Motor encoder phase failure detected. *Clear:* Cycle KSI.
37	**Motor Open** *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrottle;* *FullBrake.*	1. Motor phase is open. 2. Bad crimps or faulty wiring.	*Set:* Motor phase U, V, or W detected open. *Clear:* Cycle KSI.
38	**Main Contactor Welded** *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrottle;* *FullBrake.*	1. Main contactor tips are welded closed. 2. Motor phase U or V is disconnected or open. 3. An alternate voltage path (such as an external precharge resistor) is providing a current to the capacitor bank (B+ connection terminal).	*Set:* Just prior to the main contactor closing, the capacitor bank voltage (B+ connection terminal) was loaded for a short time and the voltage did not discharge. *Clear:* Cycle KSI
39	**Main Contactor Did Not Close** *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrottle;* *FullBrake.*	1. Main contactor did not close. 2. Main contactor tips are oxidized, burned, or not making good contact. 3. External load on capacitor bank (B+ connection terminal) that prevents capacitor bank from charging. 4. Blown B+ fuse.	*Set:* With the main contactor commanded closed, the capacitor bank voltage (B+ connection terminal) did not charge to B+. *Clear:* Cycle KSI.
41	**Throttle Wiper High** *ShutdownThrottle.*	1. See Monitor menu » Inputs: Throttle Pot. 2. Throttle pot wiper voltage too high.	*Set:* Throttle pot wiper (pin 16) voltage is higher than the high fault threshold (can be changed with the VCL function *Setup_Pot_Faults()*). *Clear:* Bring throttle pot wiper voltage below the fault threshold.
42	**Throttle Wiper Low** *ShutdownThrottle.*	1. See Monitor menu » Inputs: Throttle Pot. 2. Throttle pot wiper voltage too low.	*Set:* Throttle pot wiper (pin 16) voltage is lower than the low fault threshold (can be changed with the VCL function *Setup_Pot_Faults()*). *Clear:* Bring throttle pot wiper voltage above the fault threshold.
43	**Pot2 Wiper High** *FullBrake.*	1. See Monitor menu » Inputs: Pot2 Raw. 2. Pot2 wiper voltage too high.	*Set:* Pot2 wiper (pin 17) voltage is higher than the high fault threshold (can be changed with the VCL function *Setup_Pot_Faults()*). *Clear:* Bring Pot2 wiper voltage below the fault threshold.

Table 6 TROUBLESHOOTING CHART, cont'd

CODE	PROGRAMMER LCD DISPLAY / *EFFECT OF FAULT*	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
44	**Pot2 Wiper Low** *FullBrake.*	1. See Monitor menu » Inputs: Pot2 Raw. 2. Pot2 wiper voltage too low.	*Set:* Pot2 wiper (pin 17) voltage is lower than the low fault threshold (can be changed with the VCL function *Setup_Pot_Faults()*). *Clear:* Bring Pot2 wiper voltage above the fault threshold.
45	**Pot Low OverCurrent** *ShutdownThrottle;* *FullBrake.*	1. See Monitor menu » Outputs: Pot Low. 2. Combined pot resistance connected to pot low is too low.	*Set:* Pot low (pin 18) current exceeds 10mA. *Clear:* Clear pot low overcurrent condition and cycle KSI.
46	**EEPROM Failure** *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrottle;* *ShutdownInterlock;* *ShutdownDriver1;* *ShutdownDriver2;* *ShutdownDriver3;* *ShutdownDriver4;* *ShutdownPD;* *FullBrake.*	1. Failure to write to EEPROM memory. This can be caused by EEPROM memory writes initiated by VCL, by the CANbus, by adjusting parameters with the programmer, or by loading new software into the controller.	*Set:* Controller operating system tried to write to EEPROM memory and failed. *Clear:* Download the correct software (OS) and matching parameter default settings into the controller and cycle KSI.
47	**HPD/Sequencing Fault** *ShutdownThrottle.*	1. KSI, interlock, direction, and throttle inputs applied in incorrect sequence. 2. Faulty wiring, crimps, or switches at KSI, interlock, direction, or throttle inputs. 3. See Monitor menu » Inputs.	*Set:* HPD (High Pedal Disable) or sequencing fault caused by incorrect sequence of KSI, interlock, direction, and throttle inputs. *Clear:* Reapply inputs in correct sequence.
47	**Emer Rev HPD** *ShutdownThrottle;* *ShutdownEMBrake.*	1. Emergency Reverse operation has concluded, but the throttle, forward and reverse inputs, and interlock have not been returned to neutral.	*Set:* At the conclusion of Emergency Reverse, the fault was set because various inputs were not returned to neutral. *Clear:* If EMR_Interlock = On, clear the interlock, throttle, and direction inputs. If EMR_Interlock = Off, clear the throttle and direction inputs.
49	**Parameter Change Fault** *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrottle;* *FullBrake.*	1. This is a safety fault caused by a change in certain parameter settings so that the vehicle will not operate until KSI is cycled. For example, if a user changes the Throttle Type this fault will appear and require cycling KSI before the vehicle can operate.	*Set:* Adjustment of a parameter setting that requires cycling of KSI. *Clear:* Cycle KSI.
51–67	**OEM Faults** *(See OEM documentation.)*	1. These faults can be defined by the OEM and are implemented in the application-specific VCL code. See OEM documentation.	*Set:* See OEM documentation. *Clear:* See OEM documentation.

Table 6 TROUBLESHOOTING CHART, cont'd

CODE	PROGRAMMER LCD DISPLAY / *EFFECT OF FAULT*	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
68	**VCL Run Time Error** *ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; ShutdownInterlock; ShutdownDriver1; ShutdownDriver2; ShutdownDriver3; ShutdownDriver4; ShutdownPD; FullBrake.*	1. VCL code encountered a runtime VCL error. 2. See Monitor menu » Controller: VCL Error Module and VCL Error. This error can then be compared to the runtime VCL module ID and error code definitions found in the specific OS system information file.	*Set:* Runtime VCL code error condition. *Clear:* Edit VCL application software to fix this error condition; flash the new compiled software and matching parameter defaults; cycle KSI.
69	**External Supply Out of Range** *None, unless a fault action is programmed in VCL.*	1. External load on the 5V and 12V supplies draws either too much or too little current. 2. Fault Checking Menu parameters Ext Supply Max and Ext Supply Min are mis-tuned. 3. See Monitor menu » Outputs: Ext Supply Current.	*Set:* The external supply current (combined current used by the 5V supply [pin 26] and 12V supply [pin 25]) is either greater than the upper current threshold or lower than the lower current threshold. The two thresholds are defined by the External Supply Max and External Supply Min parameter settings (page 53). *Clear:* Bring the external supply current within range.
71	**OS General** *ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; ShutdownInterlock; ShutdownDriver1; ShutdownDriver2; ShutdownDriver3; ShutdownDriver4; ShutdownPD; FullBrake.*	1. Internal controller fault.	*Set:* Internal controller fault detected. *Clear:* Cycle KSI.
72	**PDO Timeout** *ShutdownThrottle; CAN NMT State set to Pre-operational.*	1. Time between CAN PDO messages received exceeded the PDO Timeout Period.	*Set:* Time between CAN PDO messages received exceeded the PDO Timeout Period. *Clear:* Cycle KSI or receive CAN NMT message.
73	**Stall Detected** *ShutdownEMBrake; Throttle_Command is not processed; Control Mode changed to LOS (Limited Operating Strategy).*	1. Stalled motor. 2. Motor encoder failure. 3. Bad crimps or faulty wiring. 4. Problems with power supply for the motor encoder. 5. See Monitor menu » Motor: Motor RPM.	*Set:* No motor encoder movement detected. *Clear:* Either cycle KSI, or detect valid motor encoder signals while operating in LOS mode and return Throttle Command = 0 and Motor RPM = 0.

Table 6 TROUBLESHOOTING CHART, cont'd

CODE	PROGRAMMER LCD DISPLAY / *EFFECT OF FAULT*	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
74	**Fault On Other Traction Controller**	Dual Drive fault: see Dual Drive manual.	
75	**Dual Severe Fault**	Dual Drive fault: see Dual Drive manual.	
77	**Supervisor Fault** *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrottle;* *ShutdownInterlock;* *ShutdownDriver1;* *ShutdownDriver2;* *ShutdownDriver3;* *ShutdownDriver4;* *ShutdownPD;* *FullBrake.*	1. The Supervisor has detected a mismatch in redundant readings. 2. Internal damage to Supervisor microprocessor. 3. Switch inputs allowed to be within upper and lower thresholds for over 100 milliseconds.	*Set:* Mismatched redundant readings; damaged Supervisor; illegal switch inputs. *Clear:* Check for noise or voltage drift in all switch inputs; check connections; cycle KSI.
78	**Supervisor Incompatible** *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrottle;* *ShutdownInterlock;* *ShutdownDriver1;* *ShutdownDriver2;* *ShutdownDriver3;* *ShutdownDriver4;* *ShutdownPD;* *FullBrake.*	1. The main OS is not compatible with the Supervisor OS.	*Set:* Incompatible software. *Clear:* Load properly matched OS code or update the Supervisor code; cycle KSI.
82	**Bad Calibrations** *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrottle;* *FullBrake.*	1. Internal controller fault.	*Set:* Internal controller fault detection. *Clear:* Cycle KSI.
83	**Driver Supply** *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrottle;* *FullBrake.*	1. Internal controller fault in the voltage supply for the driver circuits.	*Set:* Internal controller fault detection. *Clear:* Cycle KSI.

Table 6 TROUBLESHOOTING CHART, cont'd

CODE	PROGRAMMER LCD DISPLAY / *EFFECT OF FAULT*	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
87	**Motor Characterization Fault** *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrottle;* *FullBrake.*	1. Motor characterization failed during characterization process. See Monitor menu » Controller: Motor Characterization Error for cause: 0=none 1=encoder signal seen, but step size not determined; set Encoder Step Size manually 2=motor temp sensor fault 3=motor temp hot cutback fault 4= controller overtemp cutback fault 5=controller undertemp cutback fault 6=undervoltage cutback fault 7=severe overvoltage fault 8=encoder signal not seen, or one or both channels missing 9=motor parameters out of characterization range.	*Set:* Motor characterization failed during the motor characterization process. *Clear:* Correct fault; cycle KSI.
88	**Encoder Pulse Count Fault** *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrottle;* *ShutdownInterlock;* *ShutdownDriver1;* *ShutdownDriver2;* *ShutdownDriver3;* *ShutdownDriver4;* *ShutdownPD;* *FullBrake.*	1. Encoder Steps parameter does not match the actual motor encoder.	*Set:* Motor lost IFO control and accelerated without throttle command. *Clear:* Ensure the Encoder Steps parameter matches the actual encoder; cycle KSI.
89	**Motor Type Fault** *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrottle;* *FullBrake.*	1. The Motor_Type parameter value is out of range.	*Set:* Motor_Type parameter is set to an illegal value. *Clear:* Set Motor_Type to correct value and cycle KSI.
91	**VCL/OS Mismatch** *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrottle;* *ShutdownInterlock;* *ShutdownDriver1;* *ShutdownDriver2;* *ShutdownDriver3;* *ShutdownDriver4;* *ShutdownPD;* *FullBrake.*	1. The VCL software in the controller does not match the OS software in the controller.	*Set:* VCL and OS software do not match; when KSI cycles, a check is made to verify that they match and a fault is issued when they do not. *Clear:* Download the correct VCL and OS software into the controller.

Table 6 TROUBLESHOOTING CHART, cont'd

CODE	PROGRAMMER LCD DISPLAY / *EFFECT OF FAULT*	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
92	**EM Brake Failed to Set** *ShutdownEMBrake;* *ShutdownThrottle.* *Position Hold is engaged when Interlock=On.*	1. Vehicle movement sensed after the EM Brake has been commanded to set. 2. EM Brake will not hold the motor from rotating.	*Set:* After the EM Brake was commanded to set and time has elapsed to allow the brake to fully engage, vehicle movement has been sensed. *Clear:* Activate the throttle.
93	**Encoder LOS (Limited Operating Strategy)** *Enter LOS control mode.*	1. Limited Operating Strategy (LOS) control mode has been activated, as a result of either an Encoder Fault (Code 36) or a Stall Detect Fault (Code 73). 2. Motor encoder failure. 3. Bad crimps or faulty wiring. 4. Vehicle is stalled.	*Set:* Encoder Fault (Code 36) or Stall Detect Fault (Code 73) was activated, and Brake or Interlock has been applied to activate LOS control mode, allowing limited motor control. *Clear:* Cycle KSI or, if LOS mode was activated by the Stall Fault, clear by ensuring encoder senses proper operation, Motor RPM = 0, and Throttle Command = 0.
94	**EMR Rev Timeout** *ShutdownEMBrake;* *ShutdownThrottle.*	1. Emergency Reverse was activated and concluded because the EMR Timeout timer has expired. 2. The emergency reverse input is stuck On.	*Set:* Emergency Reverse was activated and ran until the EMR Timeout timer expired. *Clear:* Turn the emergency reverse input Off.
98	**Illegal Model Number** *ShutdownMotor;* *ShutdownMainContactor;* *ShutdownEMBrake;* *ShutdownThrottle;* *FullBrake;*	1. Model_Number variable contains illegal value. 2. Software and hardware do not match. 3. Controller defective.	*Set:* Illegal Model_Number variable; when KSI cycles, a check is made to confirm a legal Model_Number, and a fault is issued if one is not found. *Clear:* Download appropriate software for your controller model.
99	**Dualmotor Parameter Mismatch**	Dual Drive fault: see Dual Drive manual.	

TRONAIR®

APPENDIX VI

Battery Charger
Operator/Installer Manual

WARNING
Consult local, state or national electric codes for battery charger installation in an aircraft hangar.

DC POWER TECHNOLOGIES

TOMORROW'S TECHNOLOGY FOR TODAY'S APPLICATION

OPERATOR / INSTALLER MANUAL

MODULAR CHARGER

FS3

XHF SERIES

eco CHARGE

⚠ WARNINGS

Keep open flames away from batteries on charge.

Risk of battery explosion.

Be aware of battery fumes and electrolyte.

Do not dispose of batteries in the garbage.

Electrical hazard exists inside the charger, do not remove the side cover.

Always recycle lead acid batteries.

Battery electrolyte is highly corrosive.

Wear eye protection when working near batteries.

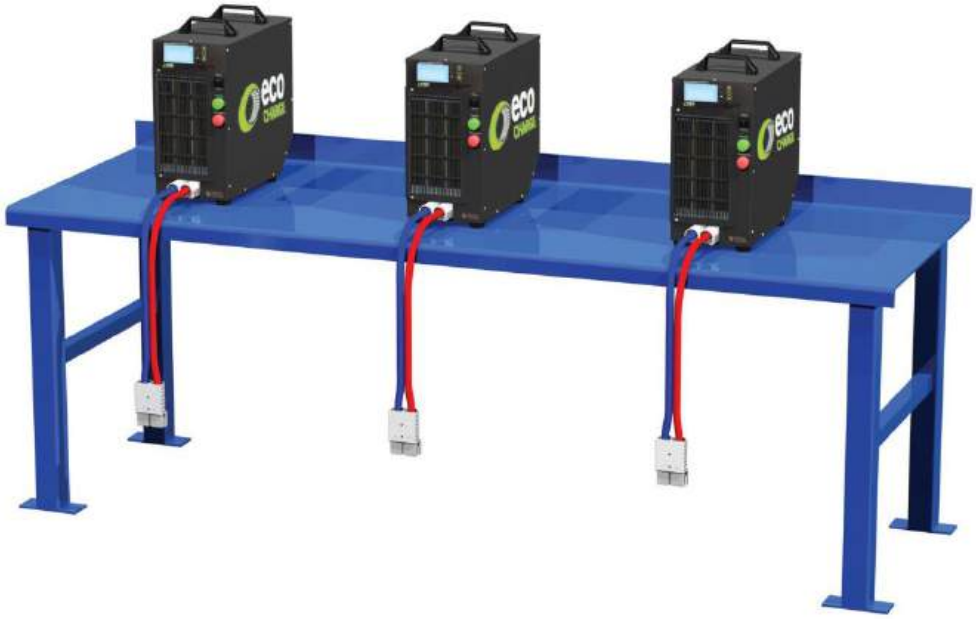
2. Warnings

Contents

Charger Serial Number	
Charger Part Number	
Date Supplied	
Vehicle Model	
Purchaser	
Purchase Invoice Number	
Fleet Number	

Location

The preferred installation is where the charger(s) can be located on a shelf, protected against accidental contact with the lift truck or its forks.



With the charger on a shelf the risk of damage to the charger or battery cables is greatly reduced.

Avoid just placing the charger on the floor next to the lift truck.

Mounting Bracket Options

Base Mount

1. Fix the mounting bracket to a bench using a type of fastener that suits the bench material.
2. Remove the 2x front case feet.
3. Slide the base of the FS3 onto the mounting bracket.
4. With 2x M5x8 hex bolts (included with the mounting bracket) secure the front of the mounting bracket to the FS3.
5. When fitting the battery cable ensure the locking screw is installed.

Side Mount

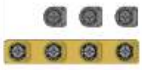
1. Fix the mounting bracket to the wall using a type of fastener that suits the wall material.
2. Slide the side of the FS3 onto the mounting bracket.
3. With 2x M5x8 hex bolts (included with the mounting bracket) secure the front of the mounting bracket to the FS3.
4. When fitting the battery cable ensure the locking screw is installed.

Rear Mount

1. Fix the mounting bracket to the wall using a type of fastener that suits the wall material.
2. Slide the rear of the FS3 onto the mounting bracket.
3. With 2x M5x8 hex bolts (included with the mounting bracket) secure the front of the mounting bracket to the FS3.
4. When fitting the battery cable ensure the locking screw is installed.

Installation

AC Input & Busbar Connection

Charger Model Number	Charger Modules	Supply Phase	DC Output	Supply Voltage	AC Supply in Max. Amps. Per Phase	Aux. Plug	Busbar Selection	Config. Number
FS3LUE-512	2x MP130	Single Phase	24/36/48V	208-240	28-30*	J5		1/2
FS3LUE-522	2x MP130	Three Phase	24/36/48V	208-240	15.5-23.2**	J5		3
FS3LUE-513	3x MP130	Single Phase	24/36/48V	208-240	28-30*	J5		1/2
FS3LUE-523	3x MP130	Three Phase	24/36/48V	208-240	13.3-27**	J5		3
FS3LUE-532	2x MP330	Three Phase	24/36/48V	380-480	8-10	J6		4
FS3LUE-533	3x MP330	Three Phase	24/36/48V	380-480	12-15	J6		4

* in single phase mode the output power will reduce to maintain maximum AC current draw.
** in three phase mode the adding of the third charger module reduces the AC current draw to achieve the same DC output as for two modules.

Charger Model Number

FS3LUE-5xy

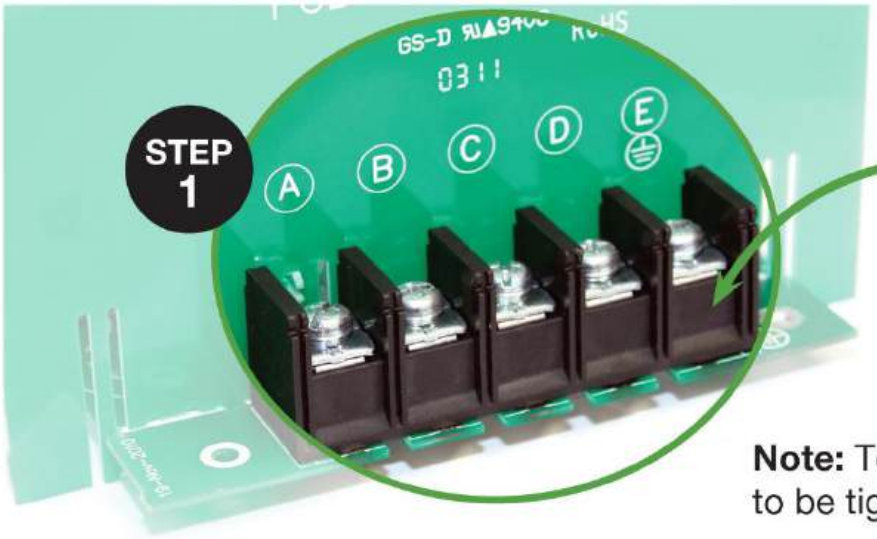
FS3 = Frame size.

MPx30 = 1 for MP130 or 3 for MP330.

y = 2 or 3 modules installed.

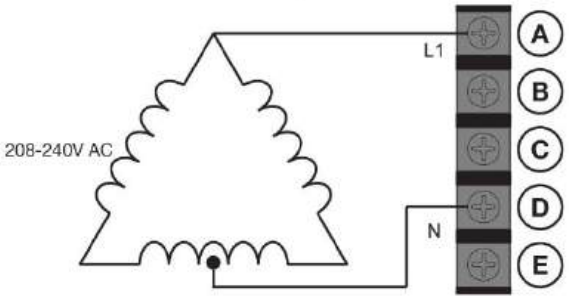
6. Installation

AC Filter Board Configuration - Step 1 of 3

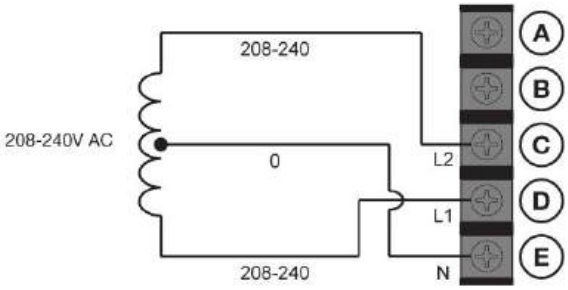


Note: Terminal connections to be tightened to 21 in.lbs

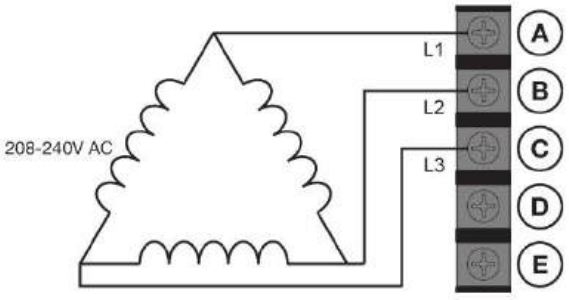
Configuration 1 - MP130
208-240V AC Single Phase.



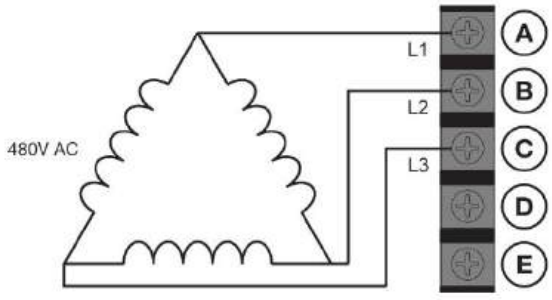
Configuration 2 - MP130
208-240V AC Single Phase Split Leg.



Configuration 3 - MP130
208-240V AC Three Phase.



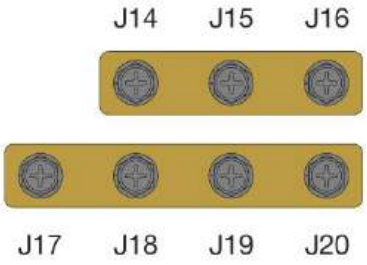
Configuration 4 - MP330
480V AC Three Phase.



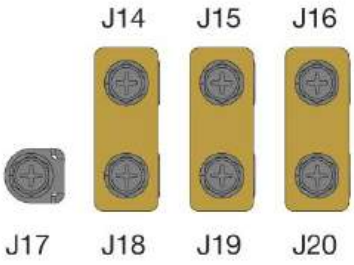
Note: It is common in the US that a fourth wire (neutral) be used in a triple phase circuit. If present, it should be attached to the "E" terminal.

AC Filter Board Configuration - Step 2 of 3

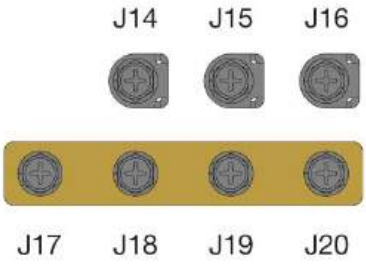
208-240V single phase configuration.



208-240V three phase configuration.



480V three phase configuration.

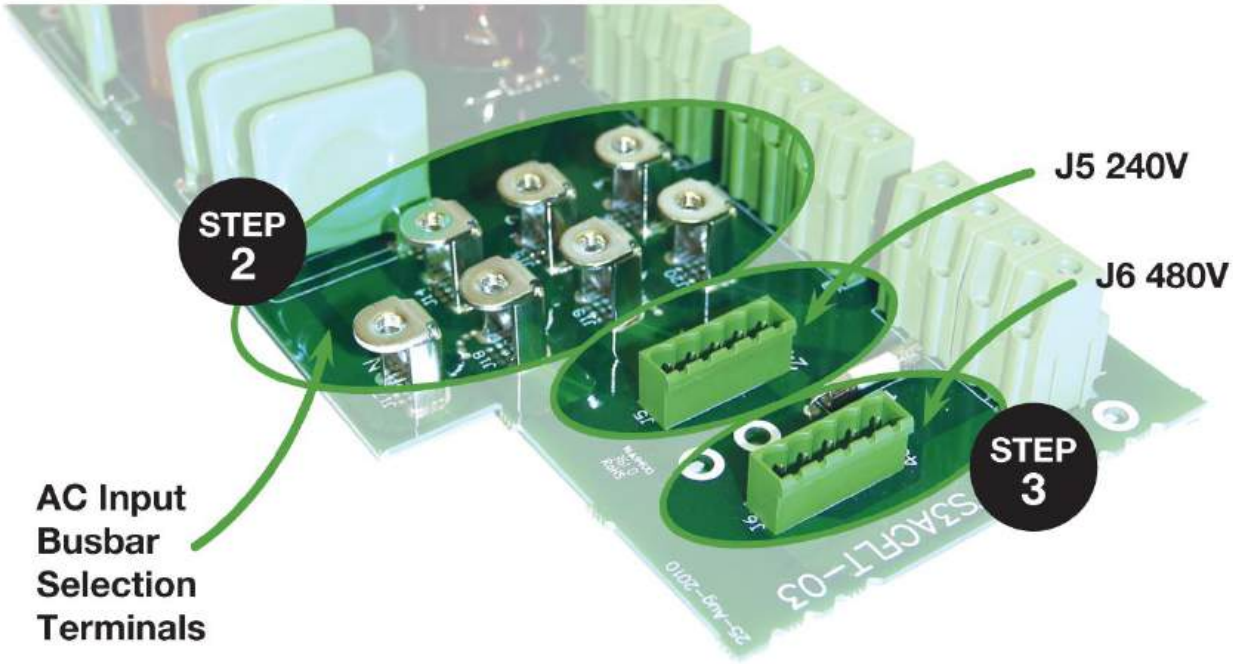


Use an 8mm socket on the M5 hex head bolts to secure the busbars in place. Unused busbar connections are bolted to the internal rear of the FS3 cabinet.

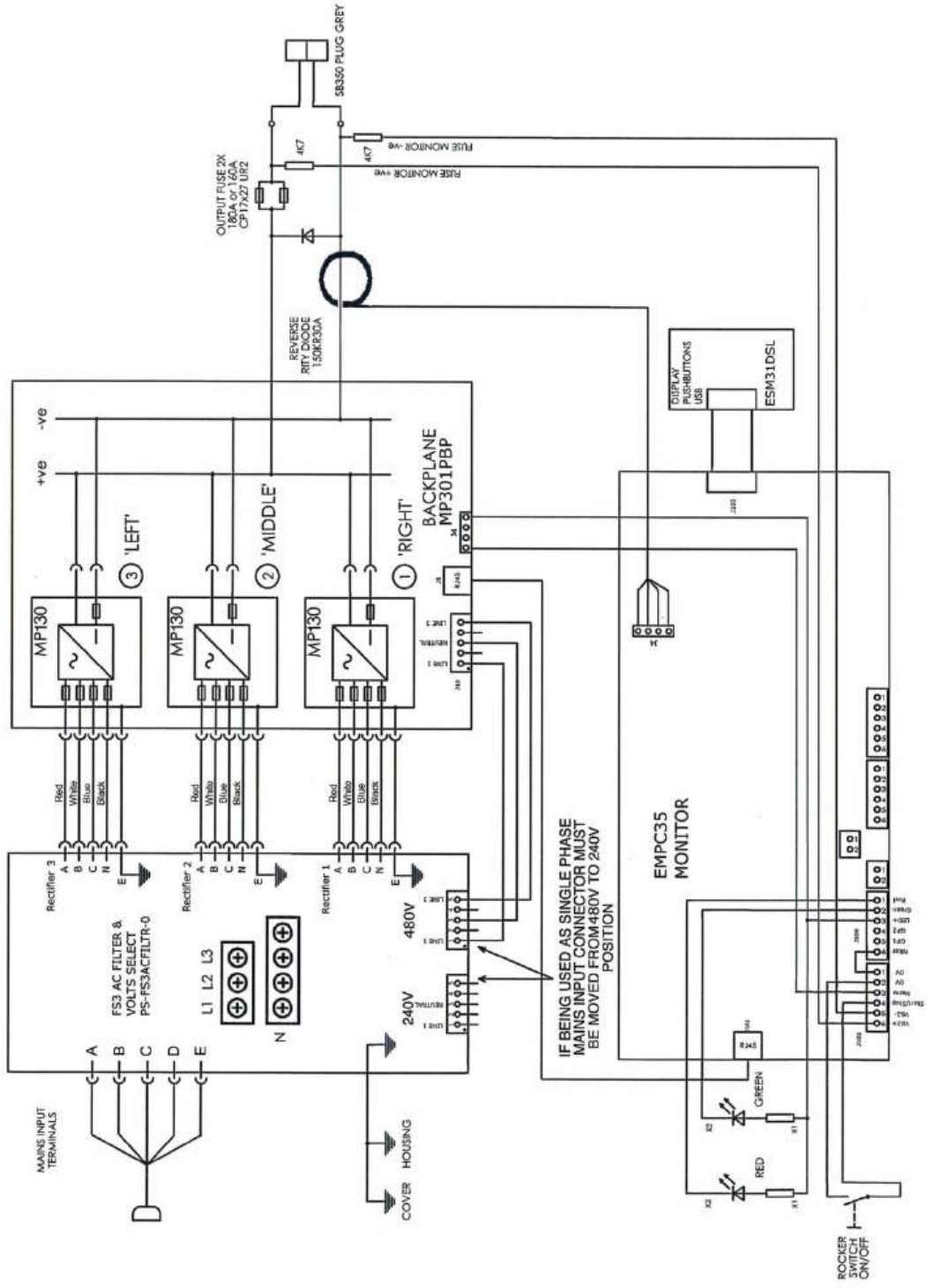
AC Filter Board Configuration - Step 3 of 3

AUX power supply connection to 208-240V outlet J5.

AUX power supply connection to 480V outlet J6.



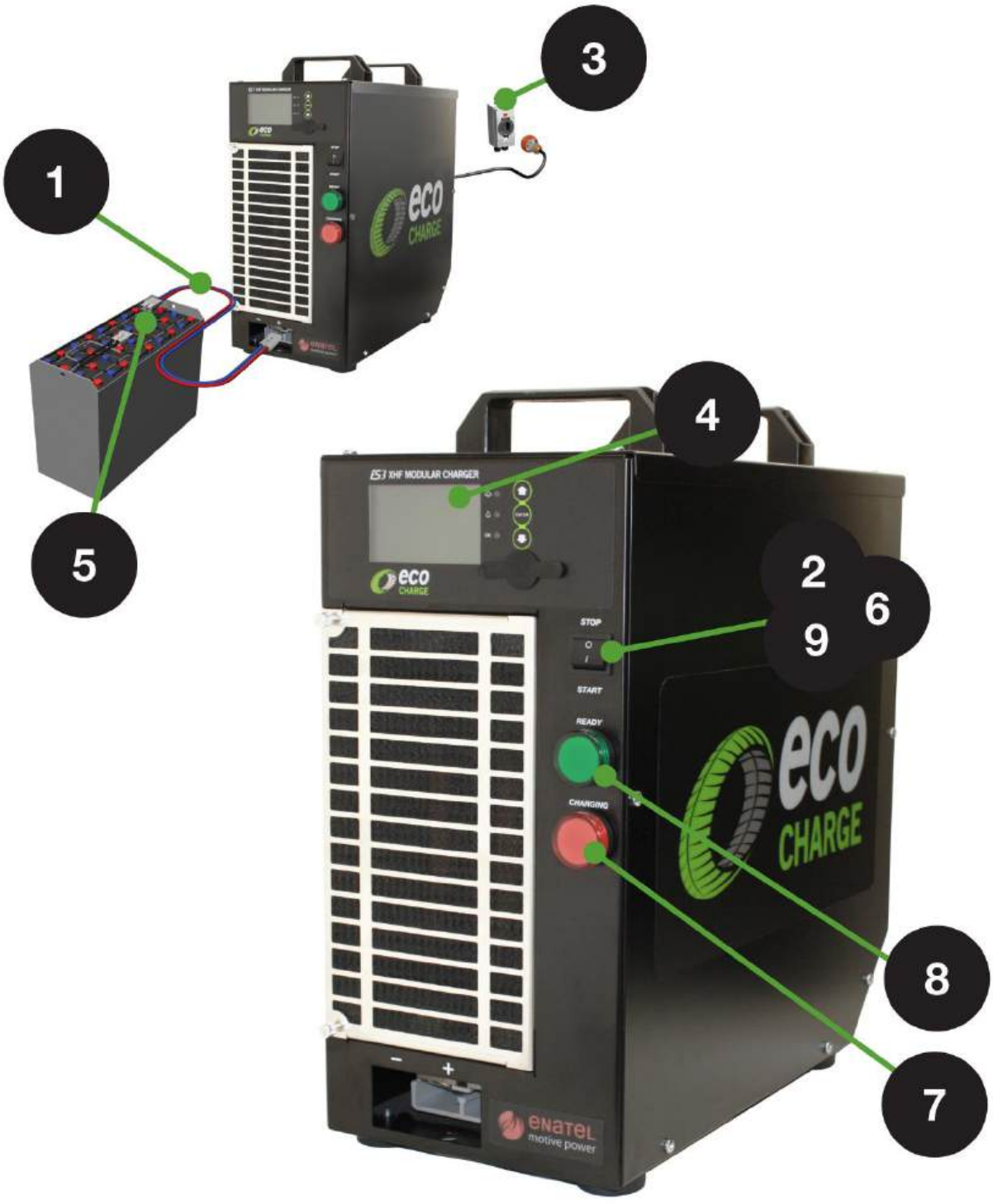
FS3 Block Diagram



Operating Instructions

1. Check the battery leads are in good condition before proceeding.
2. Set the rocker switch to ***STOP***.
3. Plug the charger in and turn on the AC supply.
4. Check the voltage, amphr and battery type indicated on the charger's display matches the battery to be charged.
5. Connect the battery to the charger using the correct cable.
6. Set the rocker switch to ***START***.
7. The red ***CHARGING*** light will illuminate to indicate charging has commenced.
8. When the green ***READY*** light illuminates, charging is complete.
9. Set the rocker switch to ***STOP*** and then disconnect the battery from the charger.

10. Operating Instructions


3
1
4
5
2
6
9
8
7
XHF MODULAR CHARGER
STOP
START
READY
CHARGING
eco CHARGE
enatel motive power

Front Panel

1 **Controller display.**
Displays information depending on the status of the charger.

2 **Controller push buttons (Set Equalize Charge).**
To enable equalize next cycle, plug in the battery
but before setting the rocker switch to ***START***:
- Press ▲ button to set equalize next cycle.
- Press ENTER to allow changing.
- Press ▲ to select “Enable”.
- Press ENTER to accept change.
- Press ▼ to select “Store”.
- Press ENTER to accept.
- Press ▼ to return to “Connect Battery”.
- Set the rocker switch to ***START***.

3 **Mini USB port.**

4 ***START/STOP* rocker switch.**
0 = Stop charge.
I = Start charge.

5 ***READY/CHARGING* indicator lights.**
RED steady on, GREEN off = Charging.
RED off, GREEN steady on = Charge complete.
RED flashing, GREEN off = Non-Urgent Alarm.
RED flashing, GREEN flashing = Urgent Alarm.

When a Non-Urgent Alarm is indicated the charge cycle has still completed and in most cases can be disregarded.

When an Urgent Alarm is indicated, the charge cycle has not been completed and the occurrence must be reported to a Supervisor, your servicing battery dealer or DC Power Technologies at 844-ECO-CHRG.

12. Front Panel

RED LED same as RED indicator.

AMBER LED same as GREEN indicator.

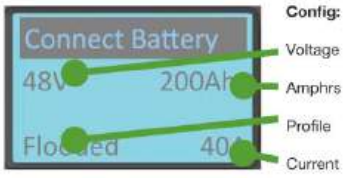
GREEN LED illuminates when charger is powered up.

UP button.

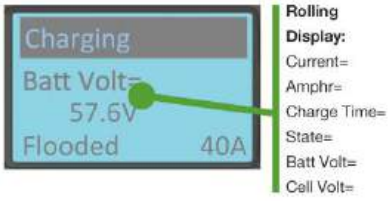
ENTER button.

DOWN button.

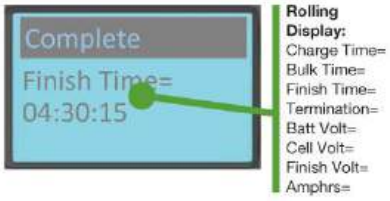
Display when no battery connected or rocker switch set to *STOP*.



Display when charging.



Display when charge complete.



Charger Configuration Settings

Charge Profiles Available
Conventional IUIa/IEI.
Opportunity charge.

Amp Hr Ranges
Conventional profile:
24V (300-1200 amp hr).
36V (300-1200 amp hr).
48V (300-950 amp hr).

Opportunity profile:
24V (300-750 amp hr).
36V (300-750 amp hr).
48V (300-600 amp hr).

Battery Types
Flooded.
Sealed.
Gel.
AGM.

Environments
Standard.
Freeze/cold condition.

Cable Length
Adjustable to any length.

Equalize Charge Settings
Cycle count:
Adjustable to any number.
Default setting is to equalize charge after every 5 complete charge cycles.

Day/time:
Select day and time of the week to trigger an equalize charge on the next charge cycle. Can also select to have it equalize charge every other week.

Manual equalize:
Select to have an equalize charge run from the display panel.

Contact DC Power Technologies for assistance with the adjustment of these settings.

Phone : 1-844-ECO-CHRG

www.DCPowerTechnologies.com

14. Charge Configuration Settings

Charger Alarms

Main Switch	Non-Urgent Module Fail	Configuration Error	APC Communications Fail
Inlet Filter	Urgent Module Fail	Output Fuse	APC Incorrect Voltage
Low Mains	Module Fan Fail	No Output Current	APC Unknown Charger
Mains Fail	Module Over Temperature	Monitor ADC Fail	

Charger Alarms

Main Switch. Urgent Alarm, shows the status of the front panel ***START/STOP*** rocker switch.

Inlet Filter. Non-Urgent Alarm, can give warning as to when the inlet filter needs servicing but is not enabled by default.

Low Mains. Non-Urgent Alarm, gives a indication of variation in the input mains voltage without actually affecting the ability of the charger to provide rated output. Can also indicate a charger module being overloaded.

Non-Urgent Module Fail. Non-Urgent Alarm, there is a charger module that is not providing output but the charger is still operating, but redundancy has been lost.

Urgent Alarms. When an urgent alarm is triggered, please note the charger will terminate its change cycle prematurely.

Mains Fail. Urgent Alarm, a mains loss situation and the charge cannot proceed.

Urgent Module Fail. Urgent Alarm, if the number of charger modules not providing output equals or exceeds the setting for urgent module count in the monitor tab then the charger will stop. If urgent module count is set to one then the charger is configured without redundancy and a single fault will stop the charge.

Module Fan Fail. Non-Urgent Alarm, in the event of a complete fail of the cooling fans the effected module will back off the maximum output current available to level where natural convection of heat will allow the module to continue operating.

Charger Alarms

Module Over Temperature. Urgent Alarm, normally related to a blocked filter or restricted exhaust air or installation in an inappropriate location.

Configuration Error. Urgent Alarm, the charger cannot meet the target current required by the controller even with all fitted charger modules operating or the configuration does not meet the limits set for a 10A mains input hardware limited charger.

Output Fuse. Urgent Alarm, a blown fuse in nearly all cases is caused by connecting a reverse polarity battery to the charger. When a fuse is blown, check all batteries for reverse cable connection. A common problem is with first charge of shift batteries that have not been previously tested in a lift truck. After replacing a battery or charger cable always closely check the polarity before plugging the battery onto the charger.

No Output Current. Urgent Alarm, the charger is not providing the expected output current. Generally related to a premature disconnection of the battery, but also could be an incorrectly inserted charger module.

Monitor ADC Fail. Urgent Alarm, internal watchdog of the controllers micro-controller indicating a major fault and potential unpredictable behaviour if the charger is left running.

APC Communications Fail. Urgent Alarm, the APC module has failed to communicate with the charger.

APC Incorrect Voltage. Urgent Alarm, the charger cannot produce the voltage required by the battery.

APC Unknown Charger. Urgent Alarm, the charger cannot find the required profile.

Battery Alarms

Over Discharged Battery	Bulk Charge Timeout	Minimum dV/dt	+dI/dt
Deeply Discharged Battery	Finishing Charge Timeout	Maximum Cell Voltage	Minimum Current
Sulphated Battery	Battery Disconnected	Batt Over Temp - Start	EQ/Refresh Timeout
Incorrect Battery	Reversed Battery	Batt Over Temp - Charge	

Battery Alarms

Over Discharged Battery. Urgent Alarm, the battery is still under 1.9Vpc after 30 seconds of charge which indicates a faulty battery that needs investigation.

Deeply Discharge Battery. Non-Urgent Alarm, the battery at start is under 1.9Vpc but recovers within 30 secs of charge, normally comes up when the battery is quickly unplugged from the lift truck and plugged into the charger.

Sulphated Battery. Urgent Alarm, deactivated by default.

Incorrect Battery. Urgent Alarm, the battery voltage is inappropriate for the configuration of the charger and cannot be charged without reconfiguring the charger to suit the battery.

Bulk Charge Timeout. Urgent Alarm, the battery has exceeded the maximum time allowed for the initial constant current bulk charge phase. Could indicate a faulty battery or the charger configuration is not correct for the size of battery to be charged. May need additional charger modules added to the charger.

Battery Alarms

Finishing Charge Timeout. Non-Urgent Alarm, the battery has exceeded the maximum time allowed for the finishing part of the charge cycle. Generally not a major problem and indicates the battery did not quite perform as expected. Not uncommon with new batteries that are still cycling up to full capacity (allow 10 cycles) however if the alarm is a regular occurrence it needs investigation and possible adjustment of the charger or service of the battery.

Battery Disconnected. Urgent Alarm, the battery has been unplugged before charge cycle has complete. This can damage the battery connector and increase risks of battery explosions as sparks around batteries at their top of charge whilst gassing can be very dangerous. If the battery needs to be disconnected mid cycle, the toggle switch must be first set to STOP. This will stop the charge and log a partial cycle in the charge log but allows safe disconnection of the battery.

Reversed Battery. Urgent Alarm, a battery with it plus and minus cables reversed has been connected to the charger. Generally this will also cause an output fuse alarm and the need to replace the chargers DC output fuse(s). Such a situation is not covered by warranty as new batteries should always first be checked for correct polarity BEFORE plugging onto the lift truck or a charger.

Minimum dV/dt. Non-Urgent Alarm, details the change in battery voltage over time. The alarm occurs when the change in voltage exceeds the value set in profile settings. This alarm also indicates the termination of a successful charge.

18. Battery Alarms

Maximum Cell Voltage. Non-Urgent Alarm, occurs when the voltage per cell exceeds the value set in the profile settings. Typically 2.7V per cell for lead acid batteries.

Batt Over Temp - Start. Urgent Alarm, occurs when the battery temperature measured before a charge profile starts exceeds the value set in the controller settings. This alarm will not allow the charge profile to continue.

Batt Over Temp - Charge. Non-Urgent Alarm, occurs when the battery temperature measured during a charge profile exceeds the value set in the controller settings. This alarm will allow the charge profile to complete.

+dI/dt. Urgent Alarm, occurs when the measured current in the constant voltage stage is rising instead of falling. This alarm will terminate the charge profile.

Minimum Current. Non-Urgent Alarm, occurs when using a IU profile and the current in the constant voltage stage falls below the value set in the profile settings. This alarm will not stop a profile and is considered normal for some types of batteries.

EQ/Refresh Timeout. Non-Urgent Alarm, occurs when the time in a given stage of the equalize profile has exceeded the value set for that stage of the profile. This alarm will terminate the equalize charge but is not considered an Urgent Alarm.

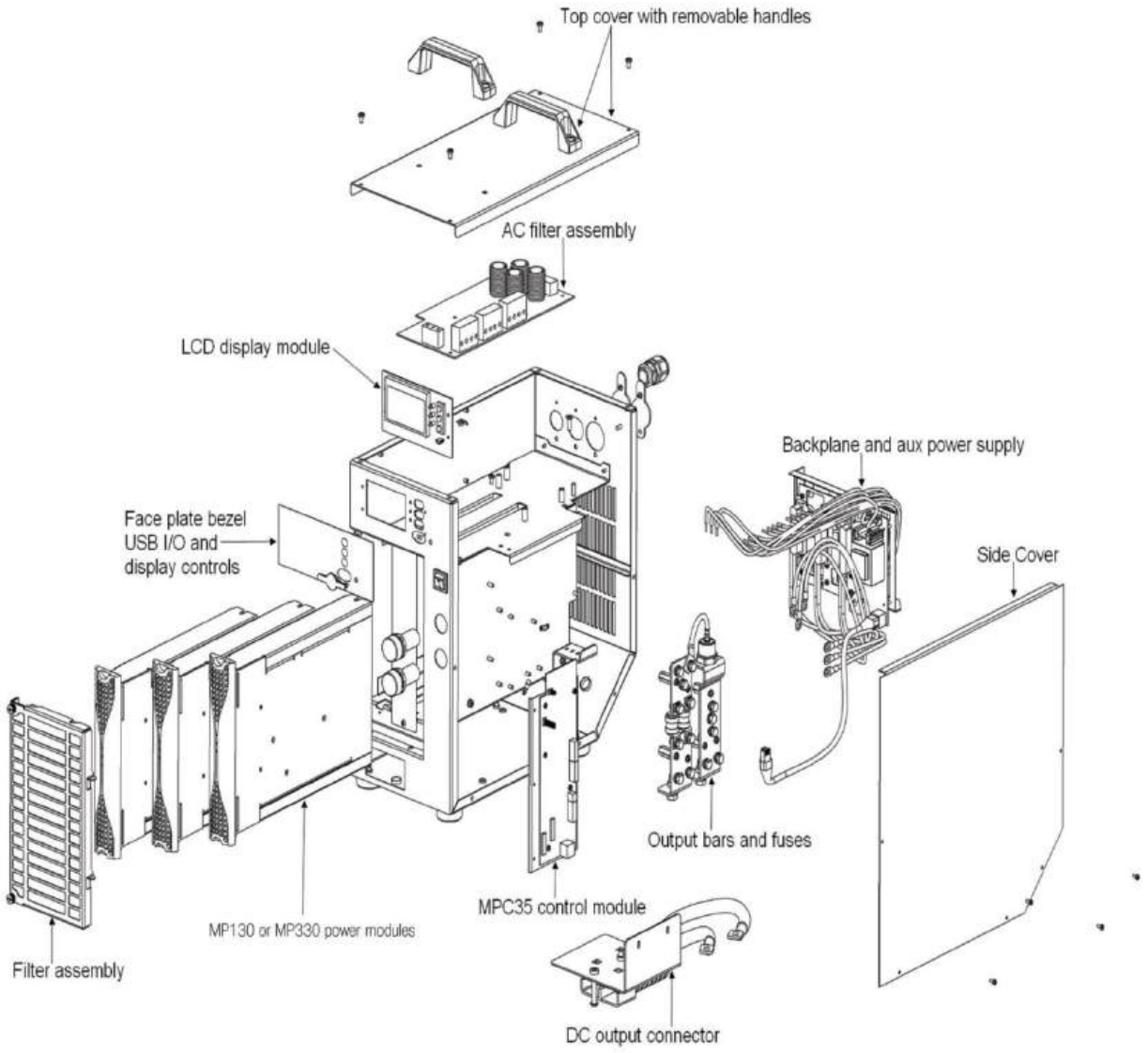
Troubleshooting

Problem	Possible Cause	Remedy
Main Switch Alarm.	Front panel switch in the STOP position.	Charge will start when the switch is set to START.
Inlet Filter Alarm.	Air inlet filter blocked.	Clean the filter.
Low Mains Alarm.	AC mains supply is low or charger modules may be overloaded.	Check configuration of the charger suits the application.
Non-Urgent Module Fail Alarm.	Charger module not providing output, there is capacity to charge at a reduced rate.	Replace the faulty charger module(s).
Urgent Module Fail Alarm.	Faulty charger modules are affecting the ability of the charger to charge the battery.	Replace the faulty charger module(s).
Module Fan Fail.	Faulty charger module fan.	Replace charger module.
Module Over Temperature.	Charger module is overheating.	Check air inlet filter is not blocked, check the charger is installed without any obstructions to air inlet and outlet.
Configuration Error.	Charger cannot provide the target output current.	Check the controller configuration matches the quantity of power modules installed, add charger modules if necessary.
Output Fuse.	Blown output fuse.	Check battery polarity. Replace blown fuse.
No Output Current.	Charger failing to provide the required current.	Check operator has not been unplugging battery mid charge cycle or the charge profile has allowed the battery current to fall below 0.7A.
Monitor ADC Fail.	Faulty MPC31 controller module.	Replace the MPC35 controller module ensuring the replacement is correctly configured.

20. Troubleshooting

Problem	Possible Cause	Remedy
Over Discharged Battery.	Battery is <1.9Vpc at connection but recovers within 30 seconds of charge.	Typically due to the battery being quickly unplugged from the truck and plugged onto the charger without allowing the battery to recover. Regular occurrences might need investigation of work practices.
Deeply Discharged Battery.	Battery is still <1.9Vpc after 30 seconds of charge.	Check battery for faults.
Incorrect Battery.	Battery is not the correct voltage for the charger.	Check the configuration matches the battery, check the operator is not trying to plug an incorrect battery type onto the charger.
Bulk Charge Timeout.	The bulk charge part of the cycle is longer than expected.	Check the charger configuration matches the battery, check the battery for problems.
Finishing Charge Timeout.	The finishing charge part of the cycle is longer than expected.	Check that the configuration matches the battery, regular timeouts may indicate a problem with the battery.
Battery Disconnected.	Battery has been disconnected mid charge cycle.	Remind the operator if there is a need to disconnect the battery mid charge cycle they must first set the front panel toggle switch to STOP.
Reversed Battery.	A reverse polarity battery has been connected to the charger.	Correct the incorrect battery wiring and replace the blown charger output fuse(s).
Inability to set a 36V configuration to greater than 46A or a 48V config greater than 35A.	Charger only has a 10A AC input lead.	Upgrade the AC input circuit and remove the hardware AC current limit function.

Exploded View



Spare Parts

Image	Description
	MP130 Module
	MP330 Module
	3 Across Backplane Assembly
	SM31 Large Display Assembly
	Voltage Sensor
	MPC35 Main Board Assembly
	FS3 AC Filter and Voltage Selection Assembly
	Stud Diode 150A 300V
	Fuse HRC180A 150VDC 240VAC
	Front Control Panel Membrane
	USB Hole Plug
	Carry Handle

Spare Parts

Image	Description
	Mounting Bracket
	Case Foot
	FS3 Cabinet
	FS3 Lid
	FS3 Side Panel
	DC Output Loom
	Blanking Plate Oval
	Blanking Plate Conduit
	Welded Filter Assembly
	Front Panel Green Indicator
	Front Panel Red Indicator
	Front Panel Rocker Switch

24. Spare Parts

Maintenance

Provided it is correctly installed in an appropriate location and is not abused, the charger will require little maintenance. The only requirement is to monitor the air inlet filter at the front of the charger for dirt accumulation. The charger modules internal to the charger housing require a good supply of cooling air during the charge cycle and a blocked filter will affect the cooling. A blocked filter could lead to the charger turning down its maximum output to prevent overheating of the charger modules. An extremely blocked filter could cause longer charge times, inability to charge the battery correctly or premature wear of the charger modules.

Service Interval

The recommended service interval is 6 months but this will vary depending on the location of the charger and the number of charge cycles performed. The fans in the charger modules only run during charging and are speed controlled. If the charger output is small the fans will only be turning slowly. At full power there is a considerable requirement for cooling air and the fans will be working hard with considerable hot air being exhausted from the rear of the charger. The exhaust air from the rear of the charger should never be restricted. The intermittent nature of the fans results in a long fan service with no scheduled replacement of fans being required.

Intake Filter

The filter material is an electrostatic polypropylene type that is easy to clean with compressed air to blow out any accumulated dirt and dust. Before attempting to clean the filter it is necessary to remove it from the housing by unscrewing the two captive screws and unhinging the filter from the housing. The electrostatic filters provide a good compromise between filtering and clogging, but a small quantity of dust will enter the charger modules during normal operation. A small quantity of dust in the charger modules will generally not cause problems, however excessive accumulation or where the material ingested is corrosive, conductive or wet will cause issues, resulting in premature wear of the charger modules.

Removing the filter from the housing.

1. Unscrew the 2x captive screws and unhinge the filter from the housing.

2. Blow out any dirt & dust buildup with compressed air to clean the filter.

Service & Warranty

Service
If both the RED and GREEN indicators are flashing there has been an Urgent Alarm that has prevented the charge cycle from completing. Take note of the error displayed on the display and contact your servicing battery dealer or call DC Power Technolgoies (DCPT) at 1-844-ECO-CHRG for assistance.

If the RED indicator is flashing, but the GREEN indicator is on steadily, the charge has completed satisfactorily but with a Non-Urgent Alarm. Contact DCPT only if this is occurring on a regular basis.

Warranty
DCPT warrants that the product is free from defects in material and workmanship and agrees to remedy any defect (or at its option replace the product) for a period of one year from the date of purchase. This warranty covers both parts and labour. Parts may be replaced under this warranty with new or remanufactured parts.

This warranty will not apply to any product that has been improperly installed, misused, abused, used in ways the product was not designed, altered or repaired in any way which may affect the performance or reliability of operation, sustained damage by power surges or electrical storms, or sustained shipping damage, or repaired by any unauthorised repair centre.

Please contact DCPT Customer Service to obtain a Returned Materials Authorisation (RMA) prior to shipping any products for repair. All shipments must be shipped prepaid and include proof of the date of your original purchase. Please include your name, address, phone number, email address and a brief description of the problem.

DCPT makes no other warranties, express or implied, including any warranty of fitness for a particular purpose. In no event shall DCPT be responsible for indirect or consequential damages or lost profits even if DCPT has been advised of the possibility of such damages. DCPT s sole obligation shall be the repair or replacement of a nonconforming product.

Warranty Certificate

ECO Charger FS3, FS5, FS9

DC Power Technologies Inc. warrants that this product is free from defects in the material and workmanship and agrees to remedy any defect (or at its option replace the product).

This warranty will not apply to any product that has been improperly installed (as described in the installation manual), misused, abused, used in the ways the product was not designed, altered or repaired in any way which may affect the performance of reliability of operation, sustained damage by power surges or electrical storms, or sustained shipping damage, or repaired by any unauthorized repair center.

This warranty covers both parts and labor. Parts may be replaced under this warranty with new or remanufactured parts.

1. **Products and Parts Warranted.** Subject to the exceptions listed below each Industrial Battery Charger is warranted for a specific period of time commencing from the date of sale by DC Power Technologies Inc. provided the charger is used in accordance with Enatel's Installation manual and instruction booklet. Exceptions to this warranty are as follows :

A. Terms and Conditions

Full Coverage, labor, travel, mileage & part replacement	**2 years**
Electronic parts only (fuses not included)	**4 years**

B. Warranty Expense Limitation : The maximum warranty expense DCPT will incur for any battery charger will be limited to the original purchase price of the battery charger.

C. AC Fuses, DC Fuses are not warranted unless found to be defective from the factory shipment.

2. **Commencement of Warranty Time Period.** The warranty periods indicated in the warranty schedule shall commence on the date of the sale from DC Power Technologies Inc.

3. **Persons Covered By Warranty.** DC Power Technologies Inc. extends this warranty only to the purchaser of the new equipment from DCPT or one of its authorized distributors. The products purchased under this agreement shall be used exclusively by the buyer and its employees and by no other persons: and therefore there shall be no third party beneficiary to this warranty.

4. **Altered Equipment.** Exception as authorized in writing, the warranty specified does not cover any equipment that has been altered by any party other than DCPT or its authorized dealer.

DC Power Technologies Inc. or Enatel Motive Power Ltd. Make no other warranties, express or implied, including any warranty of fitness for a particular purpose. In no event shall Enatel Motive Power or DCPT be responsible for indirect or consequential damages or lost profits even if Enatel Motive3 Power Ltd. Or DCPT have been advised of the possibility of such damages. Enatel Motive Power Ltd's / DCPT sole obligation to you shall be the repair or replacement of a non-conforming product.

WARNING : At all times safety must be considered an important factor in the installation, serving and operation of the product and skilled, qualified technical assistance should be utilized.

12432 Highway 99 Suite 72
Everett, WA 98204

Phone : 844-ECO-CHRG

www.DCPowerTechnologies.com

eco CHARGE HF SERIES

DC POWER TECHNOLOGIES
TOMORROW'S TECHNOLOGY FOR TODAY'S APPLICATION

Specifications

FS3 Cabinet

Dimensions (in):	7.75W x 15.25D x 15.25H
Weight:	46 pounds (with 3 modules)

MP130 & MP330 Modules

AC Input	MP130	MP330
	Single phase 208/240V Three phase 208/240V	Three phase 480V
Nominal Input Voltage:	208-278V AC	380-480V AC
Operating Voltage Range:	90-300V AC	340-580V AC
Frequency Range:	45-65Hz >0.99PF	45-65Hz >0.92PF
Typical Efficiency:	Max. 93% @ 48V	Max. 93% @ 48V

DC Output

Range:	25-65V DC 60A DC output up to 50V 52A DC output to 57.6V
Ripple:	<2mV
Broadband Noise:	2mV (<100hz) 200mV p-p (0-22Mhz)

Environmental Requirements

Ambient Temp. Range:	-50°F to 104°F (max. output power is derated above 122°F)
Storage Temperature:	-68°F to 158°F
Humidity:	5-95% RH (non-condensing)

Compliances

UL Listed:	E333392 - UL 1564
Safety:	EN60950
EMC:	EN61000-6-2, EN61000-6-4
AC Harmonics & Flicker:	EN61000-3-2, EN61000-3-3
California Appliance Efficiency Program:	Large Battery Charger Systems

Contact your local dealer :

DC POWER TECHNOLOGIES

TOMORROW'S TECHNOLOGY FOR TODAY'S APPLICATION

12432 Highway 99 Everett, WA 98204

Phone : 1-844-ECO-CHRG

Fax : 206-745-6077

www.DCPowerTechnologies.com

XHF SERIES eco CHARGE

Manufacturered by :

enatel motive power

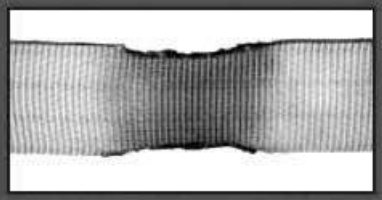
TRONAIR®

APPENDIX VII

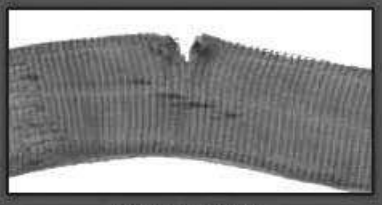
Flat Sling Inspection

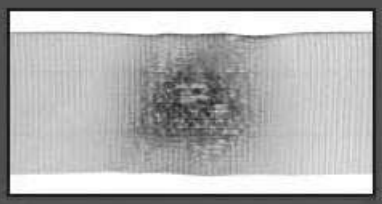
WARNING

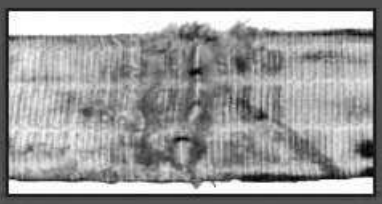
IF ANY DAMAGE SUCH AS THE FOLLOWING IS VISIBLE, THE SLING SHALL BE REMOVED FROM SERVICE IMMEDIATELY.

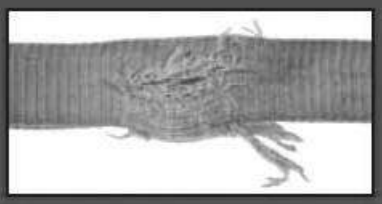

ACID OR CAUSTIC BURNS


CUTS

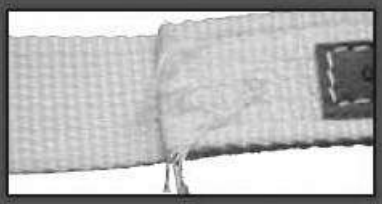

EDGE CUT


MELTING OR CHARRING

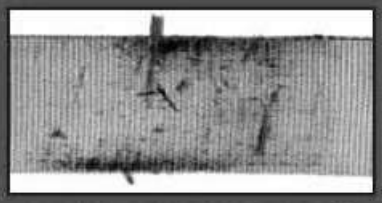

ABRASIONS


PUNCTURES


WELD SPATTER


BROKEN OR WORN STITCHES

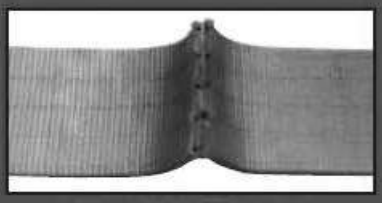

DAMAGED EYE


EMBEDDED MATERIALS

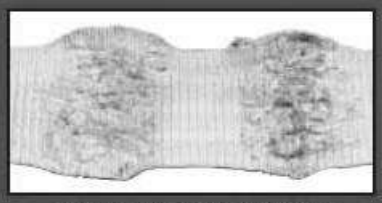

TENSILE BREAK


MISSING OR ILLEGIBLE TAGS


UV DEGRADATION


RED CORE YARNS


KNOTS


CRUSHED WEBBING


SNAGS


DISTORTED HARDWARE

TRONAIR®

APPENDIX VIII

Royco 756 (MIL-PRF-5606)
Safety Data Sheet (SDS)

SAFETY DATA SHEET

Royco 756

Version: 1.0 | Revision Date: 12/05/2014 | Print Date: 05/05/2015

SECTION 1. PRODUCT AND COMPANY IDENTIFICATION

Product name : Royco 756

Product Use Description: Lubricant

Company: Manufacturer
Anderol Specialty Lubricants, a division of Chemtura Corporation
215 Merry Lane
East Hanover, NJ
07936
United States of America

Telephone: +1 203-573-4596, Toll Free: +1 888-263-3765

Emergency telephone number: CHEMTREC: (24 hours) 800-424-9300
:
: 703-527-3887

For additional emergency telephone numbers see section 16 of the Safety Data Sheet.

Prepared by Product Safety Department
(US) +1 866-430-2775

MSDSRequest@chemtura.com

Additional advice: SYNTHETIC GEAR AND BEARING OIL, EP (ISO 680)

Recommended use of the chemical and restrictions on use

Recommended use : Lubricant

Restrictions on use : For industrial use only.

SECTION 2. HAZARDS IDENTIFICATION

Form	liquid
Colour	red
Odour	aromatic

GHS Classification

Aspiration hazard : Category 1
Acute aquatic toxicity : Category 3
Chronic aquatic toxicity : Category 3

GHS Label element

Signal word : **Danger**

Hazard pictograms :

Hazard statements : H304 May be fatal if swallowed and enters airways.
H412 Harmful to aquatic life with long lasting effects.

Other hazards : None

Precautionary statements : **Prevention:**
P273 Avoid release to the environment.
Response:
P301 + P310 IF SWALLOWED: Immediately call a POISON CENTER or doctor/ physician.
P331 Do NOT induce vomiting.
Storage:
P405 Store locked up.
Disposal:
P501 Dispose of contents/ container to an approved waste disposal plant.

Carcinogenicity:

IARC

No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

Group 3: Not classifiable as to its carcinogenicity to humans

Distillates (petroleum), hydrotreated middle	64742-46-7
Distillates (petroleum), hydrotreated light	64742-47-8
2,6-di-tert-butyl-p-cresol	128-37-0

OSHA

No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.
No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

NTP

No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

Hazardous components

Chemical Name	CAS-No.	Concentration (%)
Distillates (petroleum), hydrotreated light naphthenic	64742-53-6	>= 50 - < 70 %
Distillates (petroleum), hydrotreated middle	64742-46-7	>= 20 - < 30 %
Distillates (petroleum), hydrotreated light	64742-47-8	>= 5 - < 10 %
NJTS# 136411-5778P Polyolefins		>= 1 - < 5 %
Phenol, isobutylenated, phosphate (3:1)	68937-40-6	>= 0.1 - < 1 %
2,6-di-tert-butyl-p-cresol	128-37-0	>= 0.1 - < 1 %

SECTION 4. FIRST AID MEASURES

If inhaled : If inhaled
Move to fresh air.
If not breathing, give artificial respiration.
If breathing is difficult, give oxygen.
In case of bluish discolouration (lips, ear lobes, fingernails), give oxygen as quickly as possible.
Call a physician or poison control centre immediately.

In case of skin contact : In case of skin contact
Wash off with soap and water.
Remove contaminated clothing and shoes.
Wash contaminated clothing before re-use.
Get medical attention if irritation develops and persists.

In case of eye contact : In case of eye contact
Flush with plenty of water.
If eye irritation persists, consult a specialist.

If swallowed : If swallowed, DO NOT induce vomiting.
Call a physician or poison control centre immediately.

Most important symptoms and effects, both acute and delayed : Aspiration may cause pulmonary oedema and pneumonitis.

Notes to physician : For specialist advice physicians should contact the Poisons Information Service.

SECTION 5. FIREFIGHTING MEASURES

Suitable extinguishing media : Carbon dioxide (CO2)
Dry powder
Foam
Alcohol-resistant foam
Water mist

Unsuitable extinguishing media : Water

Specific hazards during firefighting	:	Burning produces noxious and toxic fumes.
Specific extinguishing methods	:	Use extinguishing measures that are appropriate to local circumstances and the surrounding environment. Use a water spray to cool fully closed containers.
Special protective equipment for firefighters	:	In the event of fire, wear self-contained breathing apparatus. Use personal protective equipment.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures	:	Use personal protective equipment. Ensure adequate ventilation.
Environmental precautions	:	Do not contaminate water. Do not flush into surface water or sanitary sewer system. Discharge into the environment must be avoided.
Methods and materials for containment and cleaning up	:	Contain spillage, soak up with non-combustible absorbent material, (e.g. sand, earth, diatomaceous earth, vermiculite) and transfer to a container for disposal according to local / national regulations (see section 13).

SECTION 7. HANDLING AND STORAGE

Advice on safe handling	:	Keep container closed when not in use.
Conditions for safe storage	:	Keep container tightly closed in a dry and well-ventilated place.
Materials to avoid	:	Strong acids and strong bases, Oxidizing agents

SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Components with workplace control parameters

Components	CAS-No.	Form of exposure	Permissible concentration	Basis
Distillates (petroleum), hydrotreated light naphthenic	64742-53-6	TWA (Mist)	5 mg/m3	OSHA Z-1
		TWA (Inhalable fraction)	5 mg/m3	ACGIH
		TWA (Mist)	5 mg/m3	NIOSH REL

		ST (Mist)	10 mg/m3	NIOSH REL
		TWA (Mist)	5 mg/m3	OSHA P0
Distillates (petroleum), hydrotreated middle	64742-46-7	TWA	500 ppm 2,000 mg/m3	OSHA Z-1
		TWA (Mist)	5 mg/m3	OSHA Z-1
		TWA	400 ppm 1,600 mg/m3	OSHA P0
		TWA (Mist)	5 mg/m3	NIOSH REL
		ST (Mist)	10 mg/m3	NIOSH REL
		TWA (Mist)	5 mg/m3	OSHA P0
Distillates (petroleum), hydrotreated light	64742-47-8	TWA	500 ppm 2,000 mg/m3	OSHA Z-1
		TWA	200 mg/m3	ACGIH
		TWA	400 ppm 1,600 mg/m3	OSHA P0
NJTS# 136411-5778P Polyolefins		TWA (Mist)	5 mg/m3	OSHA Z-1
		TWA (Mist)	5 mg/m3	NIOSH REL
		ST (Mist)	10 mg/m3	NIOSH REL
		TWA (Mist)	5 mg/m3	OSHA P0
2,6-di-tert-butyl-p-cresol	128-37-0	TWA	10 mg/m3	OSHA P0
		TWA (Inhalable fraction and vapor)	2 mg/m3	ACGIH
		TWA (Inhalable fraction and vapor)	2 mg/m3	ACGIH
		TWA	10 mg/m3	NIOSH REL

Engineering measures : Ensure that eyewash stations and safety showers are close to the workstation location.
Effective exhaust ventilation system

Personal protective equipment

Respiratory protection : not required under normal use
When workers are facing concentrations above the exposure limit they must use appropriate certified respirators.

Hand protection
Remarks : Neoprene gloves

Eye protection : Safety glasses with side-shields
or
Tightly fitting safety goggles

Skin and body protection : impervious clothing

Hygiene measures : Avoid contact with skin, eyes and clothing.
Handle in accordance with good industrial hygiene and safety practice.

Wash hands before breaks and at the end of workday.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	:	liquid
Color	:	red
Odor	:	aromatic
pH	:	Not applicable
pour point	:	< -60 °C
Boiling point/boiling range	:	No data available
Flash point	:	> 93.3 °C Method: ASTM D 93
Upper explosion limit	:	No data available
Lower explosion limit	:	No data available
Vapour pressure	:	No data available
Relative density	:	ca. 0.86
Solubility(ies)		
Water solubility	:	No data available
Partition coefficient: n-octanol/water	:	No data available
Auto-ignition temperature	:	No data available
Viscosity		
Viscosity, kinematic	:	13.9 mm2/s (40 °C)

SECTION 10. STABILITY AND REACTIVITY

Reactivity	:	No dangerous reaction known under conditions of normal use.
Chemical stability	:	No decomposition if stored and applied as directed.
Possibility of hazardous reactions	:	Hazardous polymerisation does not occur. Stable under normal conditions.
Conditions to avoid	:	Heat, flames and sparks. Contamination
Incompatible materials	:	Strong acids and strong bases

		Oxidizing agents
Hazardous decomposition products	:	Carbon oxides

SECTION 11. TOXICOLOGICAL INFORMATION

Acute oral toxicity		
2,6-di-tert-butyl-p-cresol (Component)	:	LD50: > 2,930 mg/kg Species: Rat Method: OECD Test Guideline 401
Acute dermal toxicity		
2,6-di-tert-butyl-p-cresol (Component)	:	LD50: > 2,000 mg/kg Species: Rat Method: OECD Test Guideline 402
Skin irritation		
NJTS# 136411-5778P Polyolefins (Component)	:	Result: No skin irritation
2,6-di-tert-butyl-p-cresol (Component)	:	Species: Rabbit Result: No skin irritation
Eye irritation		
NJTS# 136411-5778P Polyolefins (Component)	:	Result: No eye irritation
2,6-di-tert-butyl-p-cresol (Component)	:	Species: Rabbit Result: No eye irritation
Sensitisation		
2,6-di-tert-butyl-p-cresol (Component)	:	Species: Guinea pig Classification: Did not cause sensitisation on laboratory animals.
CMR effects		
NJTS# 136411-5778P Polyolefins (Component)	:	Carcinogenicity: Animal testing did not show any carcinogenic effects. Mutagenicity: Animal testing did not show any mutagenic effects. Teratogenicity: No effects on or via lactation, Did not show teratogenic effects in animal experiments. Reproductive toxicity: No toxicity to reproduction
2,6-di-tert-butyl-p-cresol (Component)	:	Mutagenicity: Animal testing did not show any mutagenic effects. Teratogenicity: No effects on or via lactation Reproductive toxicity: No toxicity to reproduction
Further information (Product)	:	No data is available on the product itself.

SECTION 12. ECOLOGICAL INFORMATION

Ecotoxicity effects

Toxicity to fish (Product) : Remarks:
No data available

Toxicity to daphnia and other aquatic invertebrates

NJTS# 136411-5778P : EC50: 190 mg/l
Polyolefins (Component) Exposure time: 48 h
Species: Daphnia magna (Water flea)

Phenol, isobutylenated, phosphate (3:1) (Component) : EC50: 0.202 mg/l
Exposure time: 48 h
Species: Daphnia magna (Water flea)

Toxicity to fish (Chronic toxicity)
Phenol, isobutylenated, phosphate (3:1) (Component) : NOEC: 0.093 mg/l
Exposure time: 90 d

Toxicity to daphnia and other aquatic invertebrates (Chronic toxicity)
Phenol, isobutylenated, phosphate (3:1) (Component) : NOEC: 0.0399 mg/l
Exposure time: 21 d

Elimination information (persistence and degradability)

Bioaccumulation (Product) : Remarks:
No data available

Mobility (Product) : Remarks:
No data available

Biodegradability (Product) : Result: No data available

Further information on ecology

Ecotoxicology Assessment

Results of PBT assessment (Product)
This mixture contains no substance considered to be persistent, bioaccumulating and toxic (PBT).

Additional ecological information (Product) : The product itself has not been tested.

SECTION 13. DISPOSAL CONSIDERATIONS

Disposal methods

Waste from residues : Dispose of waste material in compliance with all federal, state, and local regulations.

Contaminated packaging : Do not burn, or use a cutting torch on, the empty drum.

SECTION 14. TRANSPORT INFORMATION

ADR
Not dangerous goods

RID
Not dangerous goods

MERCOSUR
Not dangerous goods

DOT
Not dangerous goods

IATA
Not dangerous goods

IMDG
Not dangerous goods

SECTION 15. REGULATORY INFORMATION

EPCRA - Emergency Planning and Community Right-to-Know Act

CERCLA Reportable Quantity

Components	CAS-No.	Component RQ (lbs)	Calculated product RQ (lbs)
xylene	1330-20-7	100	*

*: Calculated RQ exceeds reasonably attainable upper limit.

SARA304 Reportable Quantity

This material does not contain any components with a section 304 EHS RQ.

SARA 311/312 Hazards : Acute Health Hazard

SARA 302 : No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 : This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

US State Regulations

California Prop 65 WARNING! This product contains a chemical known to the State of California to cause cancer.

formaldehyde 50-00-0

The components of this product are reported in the following inventories:

US.TSCA	On TSCA Inventory
DSL	All components of this product are on the Canadian DSL.
AICS	On the inventory, or in compliance with the inventory
NZIoC	Not in compliance with the inventory
ENCS	On the inventory, or in compliance with the inventory
KECI	On the inventory, or in compliance with the inventory
PICCS	On the inventory, or in compliance with the inventory
IECSC	On the inventory, or in compliance with the inventory

SECTION 16. OTHER INFORMATION

Further information

Other Emergency Phone Number

Latin America:	Brazil	+55 113 711 9144
	All other countries	+44 (0) 1235 239 670
Mexico:		+52 555 004 8763

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

APPENDIX IX

Declaration of Conformity

DECLARATION of CONFORMITY

The design, development and manufacture is in accordance with European Community guidelines

Towbarless Tug
eJP-10
eJP-10SP

Relevant provisions complied with by the machinery:
2006/42/EC
EN 1915-1
EN 12312-7

Relevant standards complied with by the machinery:
EN ISO 12100-1

Identification of person empowered to sign on behalf of the Manufacturer:

Patrick Finch

Quality Assurance Representative

Tronair, Inc.
1 Air Cargo Pkwy East
Swanton, OH 43558

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