



Drexel SL 30/40/50 Series AC Lift Truck Maintenance Manual



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Introduction, Safety, and Specifications

Introduction

Operating Instructions

Service Training

Required Tools

Both SAE and metric tools needed should be found in well-equipped service centers. Assorted open-end and box-end wrenches, sockets, Allen and adjustable wrenches, assorted screwdrivers and non-marring mallets should be available to properly perform maintenance and repair.

Replacement Parts

Both the Model Number and Serial Number are required when ordering maintenance and repair parts for the Drexel SL truck. This information is located on the capacity plate located to the left of the steering wheel base. See Figure 1-1 for an example. Only Landoll parts are to be used for any repairs.

[illegible]

Figure 1-1: Serial and Capacity Plate

INTRODUCTION, SAFETY, AND SPECIFICATIONS

Below are the Notice, Caution, Warning and Danger safety notices and their descriptions used in this book appear as follows:

NOTICE

Special notices that include helpful maintenance hints. Read and thoroughly understand.



CAUTION

Proceed with caution. Failure to heed may cause injury to person or damage product.



WARNING

Proceed with caution. Failure to heed warning will cause injury to person or damage product.



DANGER

Proceed with caution. Failure to heed warning will cause injury to person or damage product.

General Maintenance Instructions



CAUTION

- Steel toe shoes and eye protection are required when maintaining or repairing a lift truck.
- Ear protection may also be required if the repair facilities are excessively noisy, per OSHA standards.
- Keep feet, hands and all other body parts away from all mast areas and pinch points.
- Power industrial trucks may become hazardous if scheduled maintenance is neglected. Therefore adequate maintenance facilities, as well as trained personnel and procedures, should be provided.

IMPORTANT

Maintenance and inspection shall be performed in conformance with the following practices:

1. A scheduled maintenance, lubrication and inspection system shall be followed. OSHA Standards require daily inspections before each shift.
2. Only qualified and authorized personnel shall be permitted to inspect, maintain or service the truck.
3. Before **leaving** the truck:
 - Stop the truck.
 - Lower the mast completely.
 - Place directional controls in neutral.
 - Turn keyswitch off.
 - Block the wheels, especially if the truck is on an incline.
4. Before **servicing** the truck:
 - Perform a Lock Out/Tag Out operation on the truck.
 - Raise drive wheels off the floor.
 - Use chocks or other positive positioning devices.
 - Block load engaging means, inner masts or chassis before working under them.
 - Locate and area with adequate clearance when evaluating performance of truck or attachments.
5. Before **operating** the truck:
 - Be in an operating position: faced forward, left hand on steering knob, right hand on control joystick, left foot firmly planted on the floorplate.
 - Place directional control in neutral.
 - Check functions of lift systems, directional control, speed control, steering, warning devices, brakes and any attachments if any are used.
6. Keep fire protection equipment present.
7. Do not use an open flame to check fluid levels.
8. Do not use an open flame to check for leakage of electrolyte, fluids or oil.
9. Do not use open pans of fuel or flammable cleaning fluids to clean parts.
10. Keep shop well ventilated, clean and dry.
11. Brakes, steering mechanisms, control mechanisms, lift overload devices, guards and safety devices shall be inspected regularly and maintained in safe operating condition.
12. Capacity, operation plates, maintenance instruction plates or decals shall be maintained in legible condition.
13. All lift mechanisms and components shall be regularly inspected to ensure safe operating conditions.

14. All hydraulic systems and related components shall be regularly inspected and properly maintained to ensure safe operating conditions.
 - **Cylinders and other similar parts shall be checked to assure that “drift” has not developed to an the extent that it would create a hazard.**
15. Batteries, motors, controllers, limit switches, protective devices, electrical conductors and connections shall be regularly inspected and properly maintained to ensure safe operating conditions.
 - **Special attention shall be paid to the condition of electrical insulation.**
16. Trucks shall be kept in clean condition to minimize fire hazards and facilitate detection of loose or defective parts.
17. Modifications and/or additions, which affect capacity and safe truck operation, shall not be performed by the customer or user without prior written approval of Landoll Corporation. In addition, capacity, operation and maintenance instruction plates or decals may not be removed or altered except by Landoll Corporation.
18. Only OEM parts and those of equivalent quality should be used for maintenance or repairs.
 - **Landoll Replacement Parts Manual is part number F-624.**
19. Optional equipment shall not restrict the operator's field of vision.
20. Optional equipment shall not interfere with safe and efficient operation of the truck or it's controls.

For your Safety

NOTICE

Lock Out/Tag Out

In the interest of operator safety and operator compliance with OSHA regulations, guidelines have been developed to perform service and maintenance on the truck.

Before performing service and maintenance on the truck, review the following sections in this manual for additional procedures to be followed.

IMPORTANT

Anytime you are doing maintenance or repair on the Landoll Drexel SL truck, unless it must be on for investigative testing, remove the key from the console. Disconnect the battery cable connector and install a commercially available LockOut/TagOut device at the battery connectors and remove the main power fuse, since it's possible to have a duplicate key.

- Remove key from console.
- Disconnect battery cable connectors.
- Install LockOut/TagOut device at the battery connectors.
- Remove the main power fuse.
- Place LockOut/TagOut warning reminder on the steering wheel.

INTRODUCTION, SAFETY, AND SPECIFICATIONS

Battery Safety Rules:



CAUTION

- Wear protective clothing, rubber apron, boots gloves and full-face shield when performing any maintenance on batteries.
- DO NOT allow electrolyte to come in contact with eyes, skin, clothing or floor. If electrolyte contacts eyes, flush immediately with clean water. OBTAIN MEDICAL ATTENTION IMMEDIATELY!
- Should electrolyte be spilled on skin, rinse promptly with clean water and soap. A baking soda solution (one pound to one gallon of water) will neutralize acid spilled on clothing, floor or other surfaces. Apply solution until bubbling stops and rinse with clean water.
- Keep battery vent plugs firmly in place at all times, except when adding water or taking hydrometer readings.
- DO NOT bring any type of flame or spark near the battery.
- DO NOT place any electrically conductive tool on the battery that could cause a spark. Gas formed while the battery is charging is highly explosive. This gas remains in the cells long after charging is complete.
- Keep the battery clean. Foreign matter in the electrolyte will result in poor battery performance.
- Follow the battery manufacturer's instructions concerning maintenance and repair.

Battery Care and Charging



CAUTION

- Only qualified and experienced personnel should perform maintenance and repair on batteries.
- Make certain the charger being used matches the voltage and amperage of the truck battery. This voltage is listed on the truck serial plate. See Figure 1-1
- Before connecting or disconnecting batteries to the charger, make sure the charger is OFF. Attempts made to do this while the charger is ON could result in serious injury to the operator and damage could occur to the charger with sparks or electrical spikes.
- Keep sparks or open flame away from the battery or the charging area.
BATTERY FUMES ARE EXPLOSIVE!
- NEVER smoke or have an open flame near the battery. Gas formed during charging is explosive and can cause injury. Consult the charger manufacturer's manual covering your charger for operation and maintenance.
- The battery must meet size, weight and voltage requirements of the truck.

Battery Removal and Installation



CAUTION

Battery Removal:

- When removing the battery move the truck to an area intended for battery care, on a level floor.
- Turn the keyswitch to the OFF position and remove the key.
- Disconnect battery and lock out the truck as described in the Lock Out/Tag Out section described on page 1-3.
- Never remove the battery partially from the truck without a roller stand in place.
- Lower load completely. If battery is removed with load raised, use hoist attached to mast to protect against tip over.
- DO NOT allow any metallic object to come in contact with the top of the battery. This may cause a short circuit when removing or transporting the battery. Use an insulator (such as plywood) to cover the top of the battery during removal.



CAUTION

Battery Installation:

- When installing the battery move truck to an area intended for battery care.
- The load forks must be all the way down to the floor.
- Turn keyswitch to OFF position and put the key in a secure place.

Good Battery Care Recommendations:

- Add approved water only - never add acid.
- Keep electrolyte levels proper.
- Keep battery top clean and dry.
- Keep flame and metal away from battery top.
- Keep vent caps tightened.
- Cool before charging/operating battery above 115°F.
- Use only approved, correct voltage/current, charger.
- Keep battery cover open while charging.
- If in doubt, call your local Landoll service technician.

Hydraulic System



WARNING

- High pressure fluids are dangerous and can puncture the skin and cause severe injury!
- Relieve all pressure from the hydraulic system before attempting to work on it.
- Make sure all hydraulic lines are tight before starting the system. Leaks in the hydraulic system can pierce the skin and cause severe injury. Any fluid injected into the skin under high pressure should be considered a medical emergency despite a normal appearance of the skin. Medical attention should be administered immediately.

IMPORTANT

Before performing maintenance on the hydraulic system, relieve system pressure by:

- Move the truck to a level area.
- Eliminate any load on the forks.
- Lower mast completely or place blocks under the mast if it is the part being repaired.
- Relieve any excess system pressure by moving the steering wheel in both directions.

INTRODUCTION, SAFETY, AND SPECIFICATIONS

Towing the Truck

General Safety Tips:



WARNING

- Have the service brake applied when hooking up the tow chain.
- Tow the truck at a speed of 2 mph or less.
- **DO NOT** make sharp turns when towing the truck. The towed truck will be difficult to steer. **USE EXTREME CAUTION** and keep the towed vehicle at a slow, manageable speed.
- Forks must be empty and preferably not more than 12" off the floor.
- With the park brake disabled, the truck can roll easily - **USE EXTREME CARE!**
- Failure to reset park brake will result in an unsafe condition.



Figure 1-2: Tow Pin

Towing Vehicle Requirements

- Towing vehicle must have a pull and braking capacity greater than 8000 lbs.
- Maximum towing speed should not exceed 2mph.
- Always tow the truck in the reverse direction.

IMPORTANT

Be careful, truck will roll easily and steering will be difficult.

Towing a Truck in the Reverse Direction

IMPORTANT

Brake function will not be equivalent to an operational truck.

1. Key must be in the OFF position.
2. There should be no load on the forks and no higher than 12 inches off the ground.
3. Firmly attach tow device from the towing vehicle to the lift truck tow pin provided on the lower rear side of the lift truck frame, as shown in Figure 1-2.
4. Keep the towing speed below 2 mph. The operators of the towing vehicle and the disabled lift truck should maintain communication and visual contact while observing the towing operation.



Figure 1-3: Truck Blocking

Lifting and Blocking the Truck

- Move truck to a level area designated for repair.
- Keep forks empty and low to the ground.
- Turn the key off and remove it from the console.
- Disconnect the battery cables.
- Attach Lock Out/Tag Out device to the truck.
- Use a jack or hoist with a 32,000 lb. (16 ton) minimum lift.
- Set the lift on designated hardwood blocks. See Figure 1-3 for placement of blocks. Blocks are required on each of the four corners of the truck to provide a safe, stable repair position.
- Keep the height of the lifted truck to a minimum.

Prior to Tilt Cylinder Repair



WARNING

Do not place feet or hands in any area through the mast or in truck pinch points. Servicing the tilt cylinders requires the use of an overhead hoist, hoist slings and wheel blocks. The overhead hoist and slings must have a rating appropriately greater for the weight of the mast being serviced. Do not work under or around a truck that is not properly secured.

- Truck repair must be in a level, designated area.
- Lower the mast completely to the floor.
- Turn the truck off and observe Lockout/Tagout procedures.
- Chock wheels so that the truck cannot move.
- Attach a sling and hoist to all the top cross braces so the mast sections cannot move.

INTRODUCTION, SAFETY, AND SPECIFICATIONS

Mast Service Precautions



WARNING

- When servicing the mast or sections of the mast, hardwood blocks (4"X4", 100 X 100mm minimum) should be used to keep individual sections of the mast from falling. In addition to the hardwood blocks, chains should be used to hold the mast sections from moving, in both the vertical and horizontal directions.
- Mast work to be done in a flat, designated area.
- NEVER walk under or stand on forks.
- Remove forks before starting mast repairs.
- NEVER reach through the upright open areas of the mast.
- NEVER maintain or repair the mast without supports or while anyone is near the truck. (ASME B56.1-2000)
- Raise mast and position blocks under the second stage mast.
- Using an appropriate set of C-clamps, secure wooden blocks to mast channel.
- For mast inspection, use only an approved safety platform or step ladder.
- NEVER repair mast chains, they are to be replaced.
- NEVER replace mast chain sets with only one chain. All chains are to be replaced in pairs.

Mast Removal

For mast information, refer to Chapter 5 and 6, "Supplier Provided Documentation" and "Removing the Mast From the Truck" on page 3-19.

1. Move the truck to a level, designated area.
2. Pivot the mast to the right.
3. Turn the key off and remove it from the column.
4. Remove the forks.
5. Turn the steering wheel left and right several times to relieve any excess hydraulic pressure.
6. Slowly and carefully remove the lift, tilt, pivot and sideshift hoses. Use a container to catch oil and an oil absorbent product to absorb any spills.
7. Remove the four 3/4" hex head cap screws and hardware that hold the mast to the top of the pivot arm.
8. Disconnect all wiring (if used) between the mast and the truck body.

9. Support the mast using the sling and an overhead hoist.
10. Chain the individual sections of mast together at the upper cross braces. Chain the lower mast carriage to the lower section of the mast, keeping the sections from moving when the mast is laid down on the floor as mast may swing.
 - The mast is **EXTREMELY** heavy. Extra care should be taken to minimize possible injury. Make sure the hoist is rated for the weight of the mast.

Cleaning & Inspecting the Truck

Landoll Corporation strongly discourages the use of power washers for cleaning forklift trucks. The high pressure water and soap can damage components such as electrical boards, circuitry and wiring. Water and other cleaning residue promotes the formation of rust and corrosion or may otherwise degrade some truck components. The recommended method for dust removal is compressed air. For localized cleaning, the preferred method of cleaning is use of a non-flammable solvent.

IMPORTANT

Carefully review manufacturer provided **WARNING** labels and **MSDS** information when using solvents or other chemicals. Follow the recommended precautions regarding use of personal protective equipment and adequate ventilation to avoid breathing toxic fumes. Adhere to manufacturer's instructions regarding safe use and proper disposal methods.

- Clean metal parts with a de-greasing type solvent cleaner and wipe dry with a clean rag.
- Allow parts to air dry.
- Do not allow cleaning solvent to come in contact with rubber parts or rubber insulation, such as electrical wiring, seals, etc. to avoid corrosion.
- For non-metal parts, clean using a mild soap solution, shop vacuum for dust and loose dirt or a dust pan and brush.
- Inspect all parts thoroughly for breaks, cracks, tears, burrs, scoring, warping or sharp edges, glazing, rust pitting, flat spots, etc. Notify your supervisor of all defects and record it in the truck log book.
- Inspect all screws and hardware for stress marks, breaks, cracks, thread defects, etc.
- *Replace all damaged or questionable parts with Landoll approved replacement parts.*
- Take care to properly identify and tag each part and its order of removal. If necessary, take photographs, keep notes and put markings on all parts using a non-destructive marker, such as a felt-tipped pen.

Lubrication Specifications

Name	Lubrication	Notes
Hydraulic System	Mobil DTE13 or similar ISO grade 32 hydraulic oil	Drain, flush and refill
Brake System	DOT 3 Brake Fluid	Fill
Steer Wheel Bearings	Alvania Grease No. 2	Clean and re-grease
Rotation Bearings	Mobil XHP222 or similar High Performance NLGI Grade 2 grease	Use standard lubrication gun
Steering Knob	Light weight oil	Lightly oil
Battery Rollers (optional)	SAE 30W oil	Clean and re-oil
Gear Case	Mobilube SHC-630 only	Drain, flush and refill
Gear Racks	Mobil 375 NC or similar Exposed Gear lube	Aerosol Spray
Carriage Rollers	Mobil XHP222 or similar High Performance NLGI Grade 2 grease	Use standard lubrication gun
Side Shift Chain/Slide Assembly	Molybdenum EP Chassis Grease	Clean and re-grease
Pivot Shaft Bearings	Molybdenum EP Chassis Grease	Clean and re-grease
Grease Fittings	Molybdenum EP Chassis Grease	Clean and re-grease
Mast Rails	Molybdenum EP Chassis Grease	Clean and re-grease
Mast Chains	SAE40W oil or Bowman Heavy Load Red Grease	Clean and re-oil
General Lubrication	SAE 20 Lubricating Oil	Clean and re-oil

Torque Specifications

Component	Torque
Load/Drive Wheel	450 ft. lbs. (610 Nm.)
Steer Wheel	200 ft. lbs. (271 Nm)
Fluid draining and filling plug	16 ft. lbs. (22 Nm.)
Drive motor with vehicle frame	130 ft. lbs. (176 Nm.)
Steering Control Unit	
Plug and o-ring assy #8 SAE fitting	44-48 ft. lbs. (60-65 Nm.)
Steer control unit assy bolt (M8 X1.0)	18-23 ft. lbs. (24-31 Nm.)
Mounting bolts	23-25 ft. lbs. (31-34 Nm.)
Mast and Side Shift Mechanism	
Chain guard capscrews	48-52 ft. lbs. (65-71 Nm.)
Main lift cyl. plunger retainer	95-125 ft. lbs. (129-169 Nm.)
Free lift cyl. plunger retainer	275-300 ft. lbs. (373-407 Nm.)
Chain and hose sheave screws	26-30 ft. lb. (35-41 Nm.)
Lift chain adjusting nuts	50-70 ft. lb. (77-95 Nm.)
Backrest screws	145 ft. lbs. (197 Nm.)
Side shift mounting hooks	115-125 ft. lbs. (156-169 Nm.)
Overhead Guard Bolts	170 ft. lbs. (230 Nm.)

Fluid Capacities

Item	Capacity - Quarts (Liters)
Hydraulic Tank	11 gallons (42 liters)
Brake Fluid	2 pints (1 liter)
Gear Box	16 oz.

INTRODUCTION, SAFETY, AND SPECIFICATIONS

General Torque Specifications (rev. 4/97)

This chart provides tightening torques for general purpose applications when special torques are not specified on process or drawing. Assembly torques apply to plated nuts and capscrews assembled without supplemental lubrication (as received condition). They do not apply if special graphite moly-disulfide or other extreme pressure lubricants are used. When fasteners are dry (solvent cleaned) add 33% to as received condition torque. Bolt head identification marks indicate grade and may vary from manufacturer to manufacturer. Thick nuts must be used on grade 8 capscrews. Use value in [] if using prevailing torque nuts

TORQUE SPECIFIED IN FOOT POUNDS

UNC SIZE	SAE Grade 2	SAE Grade 5	SAE Grade 8	UNF SIZE	SAE Grade 2	SAE Grade 5	SAE Grade 8
1/4-20	4 [5]	6 [7]	9 [11]	1/4-28	5 [6]	7 [9]	10 [12]
5/16-18	8 [10]	13 [13]	18 [22]	5/16-24	9 [11]	14 [17]	20 [25]
3/8-16	15 [19]	23 [29]	35 [42]	3/8-24	17 [21]	25 [31]	35 [44]
7/16-14	24 [30]	35 [43]	55 [62]	7/16-20	27 [34]	40 [50]	60 [75]
1/2-13	35 [43]	55 [62]	80 [100]	1/2-20	40 [50]	65 [81]	90 [112]
9/16-12	55 [62]	80 [100]	110 [137]	9/16-18	60 [75]	90 [112]	130 [162]
5/8-11	75 [94]	110 [137]	170 [212]	5/8-18	85 [106]	130 [162]	180 [225]
3/4-10	130 [162]	200 [250]	280 [350]	3/4-16	150 [188]	220 [275]	320 [400]
7/8-9	125 [156]	320 [400]	460 [575]	7/8-14	140 [175]	360 [450]	500 [625]
1-8	190 [237]	408 [506]	680 [850]	1-14	210 [263]	540 [675]	760 [950]
1-1/8-7	270 [337]	600 [750]	960 [1200]	1-1/8-12	300 [375]	660 [825]	1080 [1350]
1-1/4-7	380 [475]	840 [1050]	1426 [1782]	1-1/4-12	420 [525]	920 [1150]	1500 [1875]
1-3/8-6	490 [612]	1010 [1375]	1780 [2225]	1-3/8-12	560 [700]	1260 [1575]	2010 [2512]
1-1/2-6	650 [812]	1460 [1825]	2360 [2950]	1-1/2-12	730 [912]	1640 [2050]	2660 [3325]

METRIC:

Coarse thread metric class 10.9 fasteners and class 10.0 nuts and through hardened flat washers, phosphate coated, Rockwell "C" 38-45. Use value in [] if using prevailing torque nuts

Nominal thread diameter (mm)	Newton Meters (Standard Torque)	Foot Pounds (Standard Torque)	Nominal Thread Diameter (mm)	Newton Meters (Standard Torque)	Foot Pounds (Standard Torque)
6	10 [14]	7 [10]	20	385 [450]	290 [335]
7	16 [22]	12 [16]	24	670 [775]	500 [625]
8	23 [32]	17 [24]	27	980 [1105]	730 [825]
10	46 [60]	34 [47]	30	1330 [1470]	990 [1090]
12	80 [125]	60 [75]	33	1790 [1950]	1340 [1450]
14	125 [155]	90 [115]	36	2325 [2515]	1730 [1870]
16	200 [240]	150 [180]	39	3010 [3210]	2240 [2380]
18	275 [330]	205 [245]			

Hydraulic Fitting Torque Specifications

37 degree JIC, ORS, & ORB (REV. 10/97)

This chart provides tightening torques for general purpose applications when special torques are not specified on process or drawing. Assembly torques apply to plated nuts and capscrews assembled without supplemental lubrication (as received condition). They do not apply if special graphite moly-disulfide or other extreme pressure lubricants are used. When fasteners are dry (solvent cleaned) add 33% to as received condition torque. Bolt head identification marks indicate grade and may vary from manufacturer to manufacturer. Thick nuts must be used on grade 8 capscrews. Use value in [] if using prevailing torque nuts

TORQUE SPECIFIED IN FOOT POUNDS

PARKER® BRAND FITTINGS

Dash Size	37 Deg. JIC	O-ring (ORS)	O-ring boss
-4	11-13	15-17	13-15
-5	14-16	-----	21-23
-6	20-22	34-36	25-29
-8	43-47	58-62	40-44
-10	55-65	100-110	58-62
-12	80-90	134-146	75-85
-16	115-125	202-218	109-121
-20	160-180	248-272	213-237
-24	185-215	303-327	238-262
-32	250-290	-----	310-340

GATES® BRAND FITTINGS

Dash Size	37 Deg. JIC	O-ring (ORS)	O-ring boss
-4	10-11	10-12	14-16
-5	13-15	-----	-----
-6	17-19	18-20	24-26
-8	34-38	32-40	37-44
-10	50-56	46-56	50-60
-12	70-78	65-80	75-83
-14	-----	65-80	-----
-16	94-104	92-105	111-125
-20	124-138	125-140	133-152
-24	156-173	150-180	156-184
-32	219-243	-----	-----

AEROQUIP® BRAND FITTINGS

Dash Size	37 Deg. JIC	O-ring (ORS)	O-ring boss
-4	11-12	10-12	14-16
-5	15-16	-----	16-20
-6	18-20	18-20	24-26
-8	38-42	32-35	50-60
-10	57-62	46-50	75-80
-12	79-87	65-70	125-135
-14	-----	-----	160-180
-16	108-113	92-100	200-220
-20	127-133	125-140	210-280
-24	158-167	150-165	270-360

INTRODUCTION, SAFETY, AND SPECIFICATIONS

Table provided for general use.

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Chapter 2

Inspections and Preventative Maintenance

Inspection Introduction

Inspections and preventative maintenance are an essential part of maintaining all industrial equipment. A well planned inspection program is essential to operator safety and truck longevity.

The inspection program recommended by Landoll Corporation periodically checks the integrity of Drexel forklift systems including:

- *Checking performance of operator functions - lift, tilt, side shift, pivot, attachment and traction systems.*
- *Checking for leaks.*
- *Checking fluid levels.*
- *Making sure components are securely attached.*
- *Checking the tires.*

Preventative maintenance is the responsibility of **both** the daily operator and the forklift technician.

To make sure these and other systems are checked periodically, Landoll Corporation has developed a system of checklists. A blank copy of each checklist can be found on pages 2-2 through 2-8.

These checklists include:

- *Operator's Daily Checklist*
- *1st 50 Hour Inspection Checklist*
- *500 Hour Inspection Checklist*
- *1000 Hour Inspection Checklist*
- *2000 Hour Inspection Checklist*

Except for the Operator's Daily Checklist, these tasks are usually performed by a service and maintenance facility that is approved by Landoll Corporation. These inspection sheets should be copied, completed and maintained by the forklift technicians.

IMPORTANT

Recommended service inspections are based on normal operating conditions. If the truck is subjected to severe or above normal operating conditions, extreme temperatures, excessive dust or wet environments, or if the truck is around corrosive materials, service must be performed at more frequent intervals.

IMPORTANT

The performance of the Landoll/Drexel Swingmast is dependent on the condition of the battery installed in the truck. To ensure a long battery life and dependable lift truck performance, perform the daily inspection of battery electrolyte and follow the service recommendations of the battery's supplier.

Inspection Checklists

The following pages are OSHA (Occupational Safety and Health Administration) required check sheets. These sheets should be copied and the copies used for maintenance checks on your Drexel SL AC forklift. It is the operator's duty to inspect the lift before each shift and report all problems to the person in charge of forklift maintenance. Have a qualified mechanic correct all noted problems.

Daily pre-shift inspection is an OSHA requirement, regulation 1910.178(q)(7).

These inspections must be documented.

INSPECTIONS AND PREVENTATIVE MAINTENANCE

Have a **qualified** technician correct all problems.

SL AC

Date	Inspector	Truck No.	Model No.	Location	Serial No.	Shift	Hr. Meter	Batt Fluid Add	Hyd Oil Added

Operator's Daily Checklist		Status	Drexel Lift
SAFETY & OPERATIONAL CHECKS	Description	OK - Yes/No	Comments
Tires	Check for debris		
Static Straps	Check for presence		
Parking Brake	Check operation		
Service Brakes	Check operation and fluid fill level		
Forks, Top Clip Retaining Pin & Heel	Check condition		
Pivot Arm Racking	Check for proper pivot operation		
Mast Racking	Check for proper lift operation		
Hydraulic Oil	Check fluid level		
Hydraulic Cylinders	Check for leaks		
Controls (turn power on)	Investigate unusual noises		
Controls	Check Accelerator operation		
	Check Lift/Lower control operation		
	Check Tilt control operation		
	Check Side-shift control operation		
	Check Pivot control operation		
	Check Directional switch operation		
	Speed Select switch & operation		
	Check Return-to-Neutral operation		
	Check Seat Switch operation		
	Check Horn operation		
	Optional Attachment switch & operation		
Lights & Backup Alarm (if equipped)	Check switch & operation		
Steering	Check operation		
Dash Display	Check hourmeter/BDI		
	Check for fault codes		
Battery	Check water/electrolyte level and charge		
Battery Restraint System	Adjust and fasten		
Safety Warnings & Operator's Manual	Attached and legible		
Capacity Plate	Attached and legible		
Seat Adjustments	Lumbar, slide and pivot operation		
Seat Belt, Buckle and Retractors	Check operation		
Overhead Guard	Check for damage and cracks		

INSPECTIONS AND PREVENTATIVE MAINTENANCE

To be performed after the **first** 50 hrs or 2 weeks of truck operation, whichever comes first, in addition to the required pre-shift daily inspection. Have a **qualified** technician correct all problems.

SL AC

Date	Inspector	Truck No.	Model No.	Location	Serial No.	Shift	Hr. Meter	Batt Fluid Add	Hyd Oil Added

1st 50 Hour Inspection Checklist	Action Needed	Status	Drexel Lift
SAFETY & OPERATIONAL CHECKS	Description	OK - Yes/No	Comments
Mast Chains	Inspect, Clean & Check tension		
Carriage Friction Surfaces	Clean & Inspect		
Travel Stops	Check for wear and cracks		
	Retorque		
Load Backrest	Retorque bolts to 150 ft./lbs. (205 Nm)		
Steer Wheels	Retorque lug nuts to 180 ft./lbs. (225 Nm)		
Drive Wheels	Retorque lug nuts to 225 ft./lbs. (305 Nm)		
Hydraulic Oil	Check level		
Gear Box	Drain, flush and refill		
The gearbox drain/flush/fill occurring after the first 50 hours or 2 weeks of operation is CRITICAL to the life of your forlift.			

INSPECTIONS AND PREVENTATIVE MAINTENANCE

To be performed after **each** 500 hrs, or each month, of truck operation, whichever comes first, in addition to the required pre-shift daily inspection. Have a **qualified** technician correct all problems.

SL AC

Date	Inspector	Truck No.	Model No.	Location	Serial No.	Shift	Hr. Meter	Batt Fluid Add	Hyd Oil Added

Technicians 500 Hour Checklist	Action Needed	Status	Drexel Lift
SAFETY & OPERATIONAL CHECKS	Description	OK - Yes/No	Comments
Mast, Carriage and Attachment	Clean, inspect for wear and lube.		
Mast	Inspect, Clean & Lube rails & chains		
	Smooth operation		
	Check for wear		
	Lubricate attachment (if equipped)		
Forks, Top Clip Retaining Pin & Heel	Check condition		
Reeving Hoses	Check condition		
Tilt Cylinder	Check fwd/rwd tilt angles		
	Check operation		
	Jam nut tight		
	Grease pivots (3 total)		
Load Backrest	Retorque to 150 ft./lbs. (205 Nm)		
Traverse Gear Bearings	Grease (2 total)		
Rack & Traverse Gear	Lube with Mobil 375N		
Crosshead Rollers (upper and lower)	Grease (10 total)		
Travel Stops	Check for wear and cracks		
	Retorque		
Motors	Clean and torque studs and bolts		
	Clean cooling vents		
Steering	Check operation		
	Grease steer axle (8 total)		
	Check Steer Pot		
	Lube steering knob		
	Check pressure - 2600 PSI		
Load Wheel Bearings	Clean and fill with grease		
Controller	Check for faults		
	Clean surface		
	Check operation of contactor points		
Controls (turn power on)	Investigate unusual noises		
	Check electrical connections		
Dash Display	Check hourmeter BDI and fault codes		
Parking Brake	Check pad wear and switch		
Continued on next page			

Technicians 500 Hour Checklist	Action Needed	Status	Drexel Lift
Continued from previous page			
Controls	Check Accelerator operation		
	Check Lift/Lower control operation		
	Check Tilt control operation		
	Check Side-shift control operation		
	Check Pivot control operation		
	Check Directional switch operation		
	Speed Select switch operation		
	Check Return-to-Neutral operation		
	Check Seat Switch operation		
	Check Horn operation		
	Optional Attachment operation		
Service Brake	Check operation and pedal.		
	Check for leaks, pad wear		
	Check electrical connector and pot		
	Drain & refill brake fluid		
Exterior of Hydraulic Tank & Tank Breather	Clean		
Hydraulic Cylinders, Pump, Hoses and Connections	Check for leaks and wear		
Hydraulic Pump	Clean dust from motors		
	Check for leaks		
Front Rotation Shaft	Grease (2 total)		
Gearbox, Brakes, Hydraulic Oil and Battery	Check for leaks		
Hydraulic Hoses, Hardlines and Connections	Check for wear and leaks		
	Replace filter element		
Accelerator	Functioning smoothly		
Battery Cover	Lifts smoothly and easily		
Battery Rollout Tray (if equipped)	Check safety restraints & safety switch		
Battery Restraints	Adjust and fasten		
Switches (Direction, Park Brake, Key etc.)	Check and Tighten		
Lights & Backup Alarm	Check operation		
Wire Connections	Check		
Seat Adjustments	Check operation of slide, pivot and lumbar		
Seat Belt, Buckle, and Retractors	Functioning smoothly		
Fans	Check operation		
Wheels	Check tire condition, remove debris		
	Retorque steer axle wheel lug nuts to 180 ft./lbs. (225 Nm)		
	Retorque drive axle wheel lug nuts to 225 ft./lbs. (305 Nm)		
Data Plate	Intact and accurate		
Major Structural Points (Axle Mount, Overhead Guard, Rotation Pin, etc.)	Check for damage and cracks		

INSPECTIONS AND PREVENTATIVE MAINTENANCE

To be performed **each** 1000 hrs, or every 6 months, of truck operation, whichever comes first in addition to the required pre-shift daily inspection. Have a **qualified** technician correct all problems.

SL AC

Date	Inspector	Truck No.	Model No.	Location	Serial No.	Shift	Hr. Meter	Batt Fluid Add	Hyd Oil Added

Technicians 1000 Hour Inspection	Action Needed	Status	Drexel Lift
SAFETY & OPERATIONAL CHECKS	Description	OK - Yes/No	Comments
Mast	Inspect friction areas		
Battery	Clean and neutralize		
Battery Restraints	Adjust and fasten		

INSPECTIONS AND PREVENTATIVE MAINTENANCE

To be performed **each** 2000 hrs, or every year, of truck operation, whichever comes first in addition to the required pre-shift daily inspection. Have a **qualified** technician correct all problems.

SL AC

Date	Inspector	Truck No.	Model No.	Location	Serial No.	Shift	Hr. Meter	Batt Fluid Add	Hyd Oil Added

Technicians 2000 Hour Checklist	Action Needed	Status	Drexel IC
SAFETY & OPERATIONAL CHECKS	Description	OK - Yes/No	Comments
Mast Chains	Check tension		
Hydraulic Oil	Change		
Hydraulic Reservoir Suction Screen	Clean with solvent		
Gear Box	Drain, flush and refill		
Brake Fluid	Change		
Seat Belt, Buckle, & Retraction	Check operation		
Contactors Coils	Check resistance		

INSPECTIONS AND PREVENTATIVE MAINTENANCE

Planned Inspections and Maintenance Requirements

This section describes the planned maintenance requirements, adjustments and lubrication necessary to ensure safe and efficient operation of the Drexel SL forklift truck. Planned maintenance procedures are designed to extend the service life of the truck and prevent unnecessary repairs. Thoroughly review this section prior to inspecting or servicing the forklift truck.

Inspection schedules are provided on pages 2-2 through 2-8 of this manual and also in the Operator's manual provided with the truck.

Recommended lubricants and torque values are found on page 1-9.

Tools or Equipment Required

In addition to a good portable light source and various tightening tools, as explained on page 1-1, the following tools and equipment may be required:

- *Hydraulic jack, appropriate for the weight being raised.*
- *Safety stands, appropriate for the weight being supported.*
- *Overhead crane, appropriate for the weight being lifted and/or supported.*
- *Grease gun.*
- *Torque wrench - capable of measuring at least 500 ft. lbs. (678 Nm).*
- *Drain pan, capable of holding at least 6 gallons (22.7 liters) of hydraulic fluid.*

Special Tools Required

The following special tools may be required:

- *Angle wrenches*

IMPORTANT

Read and comply with all applicable SAFETY precautions when servicing this truck. See the "Getting Started (Please Read)" on page 1-1 at the beginning of this manual.

NOTE

*Common sense and standard precautions apply when servicing machinery and **must always be used.***

- Before using any solvent or cleaning solution, be sure that it will not damage the part you are cleaning. For example, gasoline should never be used to clean parts. Gasoline is highly flammable and may damage some types of rubber and plastic. Hydraulic brake fluid (standard, not silicone type) is often used to clean rubber parts. It also removes paint quickly, so care should be exercised when it is used.
- Tag all parts for identification and location before removal and mark all mating parts for accurate reassembly.
- Protect finished surfaces from damage caused by dropped wrenches, spilled solvent, etc.
- Use a penetrating oil to loosen difficult screws, nuts or bolts. A hand-held impact driver is a handy tool when removing tight fasteners.
- Certain bolts, screws, or nuts are secured with a non-permanent thread-locking compound at the factory, (i.e. Loctite Primer and Blue sealant #243 or equivalent Landoll p/n:115627). When these parts are replaced, a non-permanent thread-locking compound must be reapplied.
- No parts, except those press-fit assembled, require unusual force to disassemble. If you encounter trouble, determine the reason for the difficulty, before proceeding.
- Cover all openings caused by removing parts or sub-assemblies to keep objects from falling in where additional damage could result.
- When assembling two parts, start all of the fasteners first, then tighten them evenly and in a staggered manner. Be sure both mating surfaces are aligned, not cocked or off-center.
- Observe standard torque ratings for the size and type of fastener as listed starting on page 1-8.
- Be sure to use the proper nuts, bolts and other fasteners as rated; SAE Grade 5, SAE Grade 8, ISO Prop Class 8.8, etc.
- All fasteners must be replaced with the identical type.
- Use of Landoll authorized replacement parts is recommended.

**DANGER**

Failure to follow these guidelines can cause serious injury or death:

- Never perform maintenance or service procedures unless specifically indicated in this manual or at the specific request of supervisory personnel. All other service and maintenance on your SL AC forklift must be provided by a facility authorized by Landoll Corporation to perform these services.
- Wipe up any spills immediately to prevent slipping, fire, explosion, or contact with hazardous materials.
- Failure to use lifting equipment of adequate capacity to lift and move your SL forklift can cause lifting equipment failure.
- Removing the counterweights or uprights will change the center of gravity of the truck and can cause the truck to tip. The battery is considered part of the truck's counterweight.

To help avoid fire related injuries:

- Have fire extinguishing equipment present in the work area.
- Do not allow sparks or open flames while checking fluid level, leaking oil, or electrolyte.
- Do not use fuel or flammable cleaning fluids to clean parts.

Preparing for Inspection or Maintenance

Before inspecting or maintaining the truck, thoroughly read and understand the instructions and cautions described beginning on page 1-2:

- Inspect the truck in an area that has sufficient clearance to check all operator functions.
- Lower forks to the ground and tilt mast forward.
- Use wheel chocks or other positive truck-positioning devices if drive functions will not be checked.
- Raise the drive wheels so they are not in contact with the floor when checking operator functions while leaving the truck in a stationary position.
- Block the mast to prevent it from engaging.
- Use adequately rated hoisting equipment if the truck will be hoisted for service.
- Never remove counterweights or uprights. This will change the center of gravity and can cause an unstable condition.

Performance Testing

NOTE

Make sure all accessories are off before continuing.

Make sure:

1. The operator should be properly seated in the operator's seat before beginning testing procedures.
2. Turn the keyswitch on.
3. Set the direction switch to the forward position
4. Check functions described in the Operator's Daily Checklist or other Checklists starting on page 2-2.

IMPORTANT

Before leaving the truck make sure that:

- The parked truck will not cause an obstruction or safety hazard and is clear of the path of fire exits/equipment.
- The truck will not be left unattended on an incline.
- If the truck is inoperative and you must leave it parked on an incline, securely block all wheels and remove the key.

Daily Inspections

IMPORTANT

Daily inspection is an OSHA requirement. Report any defect immediately to your supervisor.

The daily inspection includes:

- *Visual inspection of the entire truck for any defect.*
- *Visual check for any hydraulic leaks.*
- *Check that all controls and gauges work properly.*

A complete Daily Checklist is included on page 2-2 of this manual as well as in the Drexel SL AC Operator's Manual F-625.

Some specific guidelines follow in the next several pages to aid in the daily forklift inspection.

Tires

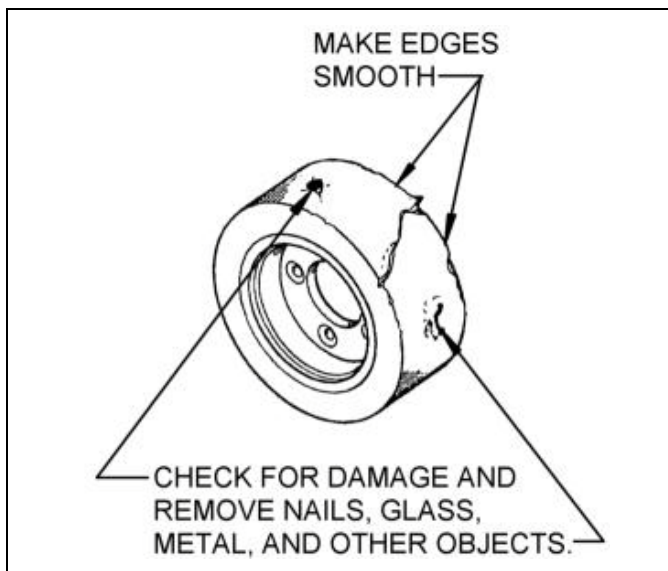


Figure 2-1: Tire Damage

Chunking or chipping is caused by repeatedly running over objects on a littered floor which can chip away or produce deep cuts to the rubber surface of the tire. Embedded objects, such as glass, metal chips, or nails left in a tire, and truck overloading cause the same effect. Sharp, rapid turns at quick speeds, jack-rabbit starts and stops and other such bad driving habits can cause the flat spots and similar damage.

Check all wheel lug nuts after 2 to 5 hours of operation, when new lift trucks begin operation and on all lift trucks when the drive wheels have been removed and re-installed. Tighten the nuts in a cross pattern to the correct torque value shown on page 1-9. When the nuts stay tight for eight hours, the interval for checking the torque can be extended to 300 hours.

Static Straps

Shown in Figure 2-2 is a ESD Strap, two of which is installed just behind the front axle. This strap will drain all static electricity build up that may occur on the SL AC forklift. ESD Straps should be in fair condition, bolted securely to the body and touching the ground.

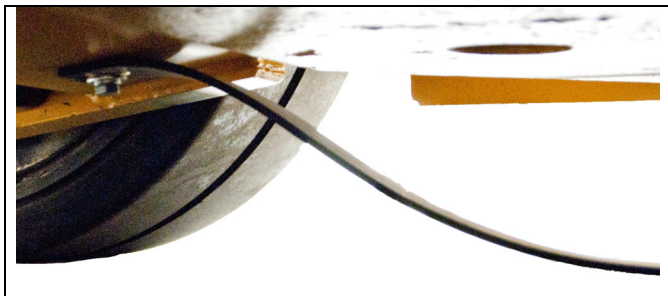


Figure 2-2: ESD Strap

Parking Brake

1. First, review "Getting Started (Please Read)" on page 1-1.
2. Set the key switch to OFF and place the key in a secured location.
3. Disconnect the battery.
4. Make sure all the other wheels are securely blocked so that the truck cannot move.
5. Remove floor plates (See "Floor Plate Removal" on page 3-55.).
6. Remove lower dash cover weldment (See Figure 3-41 on page 3-59).
7. Disconnect e-brake cutout switch connector.
8. Connect the ohmmeter leads to the switch wires.

NOTE

The meter should show less than 1 ohm.

9. Slowly pull upon the brake lever, the meter reading must be "OPEN," indicating the switch is released before the lever reaches its full locking position.

IMPORTANT

10. If the meter does not read "OPEN," the switch needs to be replaced. (See "Replacing Parking Brake Switch" on page 3-34.)
11. Disconnect the ohmmeter.
12. Reassemble in reverse order.

NOTICE

DO NOT release or operate the truck when in doubt about the effectiveness of the parking brake system. Contact your Landoll service representative for assistance.

Service Brakes

With the keyswitch set to ON, drive forward slowly and then steadily apply the brake pedal. The truck should stop smoothly without noticeable vibration. Any problems with the brake system must be repaired immediately. Do not use the truck until proper maintenance has been performed.

Check the Brake Fluid Level

The Master Cylinder reservoir is located under the floor plates just above attached to the brake pedal assembly. Remove the bolt on lid and check the levels as indicated. The reservoir is full when the oil level is at the fill line.

Lift Chains

Visually inspect the chain for cracks, stretched or stressed links and broken pins. When raising the mast listen for usual chain noise and watch the action of the chain for anything unusual. Watch for unusual pulley movement or pulley wobble that would indicate a worn mast bearing.

Forks



CAUTION

- Do not service carriage forks while the keyswitch is on. If a control lever is accidentally moved, serious injury could occur.
- It is recommended to use only Landoll Corporation replacement parts. Use only quality forks that are forged or have an up-set heel and that have the same capacity rating as the factory installed forks.
- Never use forks repaired by welding.
- Always replace both forks. Switching forks from one truck to another can be dangerous if the capacity of the forks is not known.
- Check the forks for cracks, closely at the heel portion of the forks. Replace the fork if cracks are found. Never attempt to repair, weld or alter a fork.

Load Backrest

Fasteners for the load backrest may loosen due to vibration or weather conditions. Torque the backrest fasteners to 145 ft. lb. (197 Nm).

Hydraulic Oil

Completely lower the mast. Unscrew and remove the access door to the right of the operator seat and pull out the dipstick to ensure the oil level reads between the marks. Add recommended oil if the level is low. See the Lubrications Chart on page 1-9.

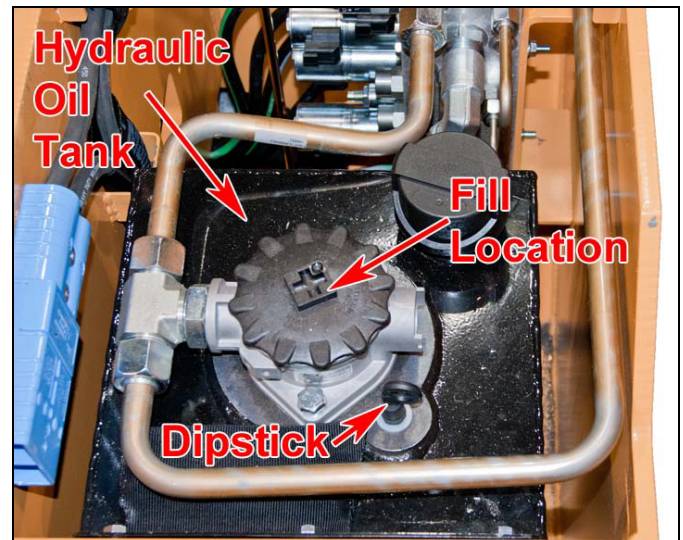


Figure 2-3: Reservoir Location

If the truck has been in operation, let the truck sit for several minutes before checking the oil level to allow time for the oil to return to the tank.

Hydraulic Cylinders

Check underneath the truck for evidence of fluid leaks. Look for hydraulic hose wear, damage and leaks. Make sure clamps and fittings are tight. In the event that leaks are detected, immediate corrective action must be taken. Leaks must be repaired and the hydraulic fluid level checked before operating the truck.

Hydraulic Hoses and Fittings

Check underneath the truck for evidence of fluid leaks. Look for hydraulic hose wear, damage and leaks. Make sure clamps and fittings are tight. If leaks are found, have service repair all leaks immediately and check the hydraulic fluid level. Do not drive the truck.

Slide Bearing Pads

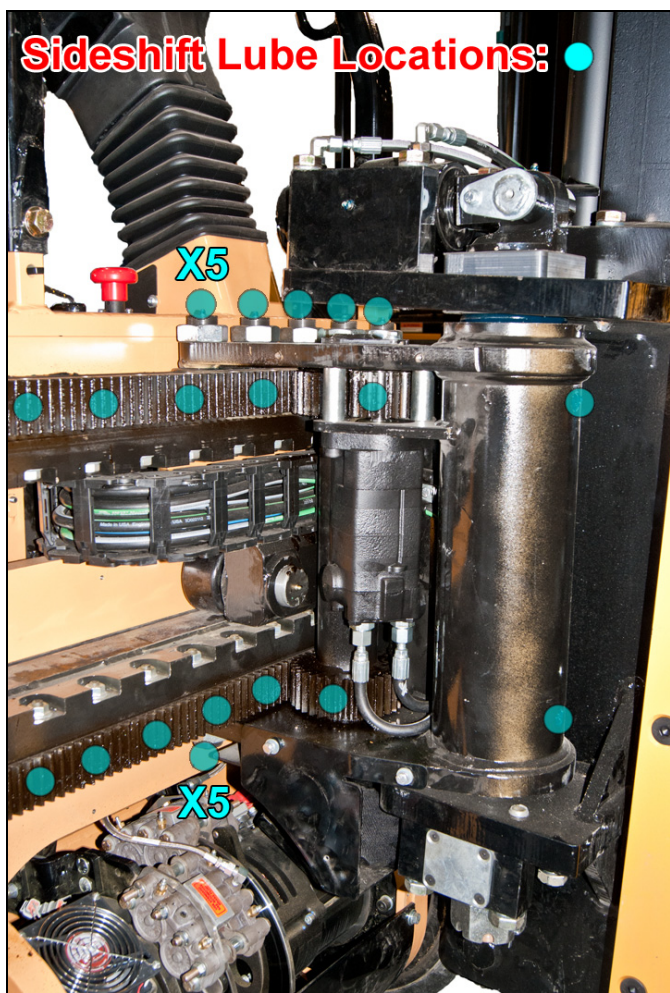


Figure 2-4: Sideshift Lubrication

Proper lubrication of the slide assembly and gear rack is important for proper operation of the side-shift function and to prevent corrosion. See Figure 2-4.

Refer to the Recommended Lubricants chart on page 1-9 in this manual for the correct grease for your truck. Also, See Figure 2-4.

Controls

With the keyswitch turned ON, raise the mast. The hydraulic motor should start running as soon as the control is moved out of the neutral position and stop as soon as the control returns to the neutral position. The motor should not run at all when lowering the mast.

Check that the primary mast cylinder extends fully and that the lift carriage rises to the top of the inner rails before the secondary cylinders begin to move.



WARNING

Make sure there is sufficient room above to raise the mast safely and keep all people clear.

When the lift carriage reaches the top of the inner rails the secondary cylinders and middle rails begin lifting. Check to make sure the rails travel smoothly and that there is no chatter or visible binding.

- With the mast fully extended, begin lowering the mast. The secondary cylinders and middle rails fully lower first, followed by the primary cylinder and the lift carriage. Check for smooth travel with no chattering or visible binding.
- If there is noticeable chatter or binding, immediately notify a supervisor or service personnel.

DO NOT attempt to operate the truck until the problem is corrected.

Tilt Control

Move the joystick left and right, tilting the mast to both extents. Movement should be smooth and steady, without any sticking.

Side-shift control

Actuate the side shift control by holding the trigger on the back of the joystick and moving it left and right several times back and forth to both extents. Listen for any abnormal noise that may be caused by binding in the side-shift mechanism. If any binding is detected apply grease to the bearing pads immediately.



WARNING

Do not service the side-shift assembly while the keyswitch is ON. If the control is accidentally moved serious injury could occur.

Horn

Press the horn button is the red button on the joystick control. Make certain the horn sounds when trigger is actuated.

Lights

Check the integrity and operation of all the lights and alarms on your SL forklift.

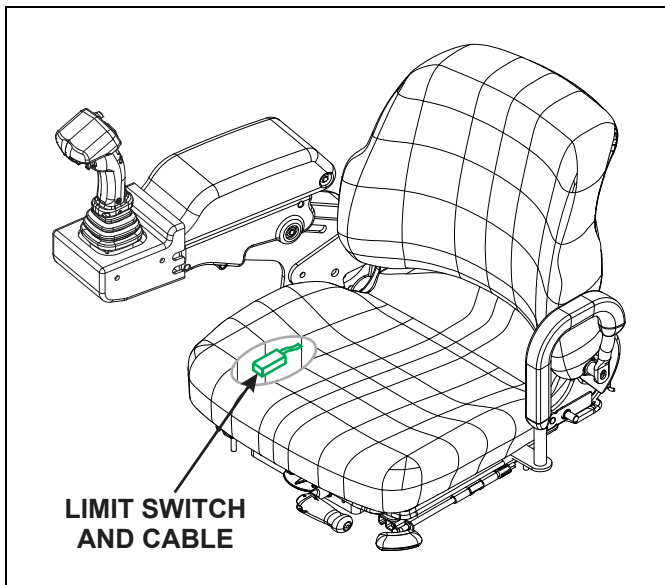


Figure 2-5: Seat Switch

Seat Switch

This procedure checks the physical mechanics (actuation) of the driver's seat switch only.

The switch is part of the seat as shown in Figure 2-5.

1. Start the truck and release the parking brake.
2. The seat switch and actuator are internal to the seat cushion, located on the under side of the seat cushion between the cushion and the bottom plate.
3. Set the direction control lever in either FORWARD or REVERSE and slowly apply acceleration. As the truck begins to slowly move in either direction, the operator should raise off of the seat just enough to disengage the switch located under the seat cushion.
4. **The truck will not come to an immediate STOP.** You should lose forward direction (or reverse). The truck may coast unless the brakes are applied.
5. If the truck continues, take truck out of service for repairs immediately.

Steering

Before operating the truck, check the steering system to make sure it operates correctly. To check the steering system:

1. Get in the operator's compartment and turn the keyswitch to the ON position.
2. Next, while moving forward or backwards slowly, turn the steering wheel clockwise. The rear steer wheels should turn clockwise. Repeat turning the steering wheel counterclockwise, and the rear steer wheels should turn counterclockwise.

While turning the steering wheel there should be a little resistance felt.

Dash Display

Ensure that the Battery Discharge Indicator, Speed and Direction Indicators, Hourmeter and other readouts are functioning properly.

Battery

It is important to properly maintain the battery to ensure long life and strong voltage potential.

The truck battery contains concentrated sulfuric acid which can cause severe chemical burns. When the battery is charging it releases hydrogen, a highly explosive gas.

Shorting the battery terminals releases enormous amounts of energy causing sparks and flames and it can heat nearby components to dangerous temperatures.

The battery is very heavy and if restraints are not replaced after maintenance the battery could slide out of the truck causing electrical shorts and/or spilling of acid and could cause the truck to tip.

Using a Hydrometer

As the battery discharges the specific gravity of the electrolyte lowers. A hydrometer allows you to check the specific gravity of the cells, thus the charge state of the battery.

To use a hydrometer:

- Remove a cap from one or two of the cells. Gently squeeze (compress) the bulb of the hydrometer.
- Insert the tube of the hydrometer into the cell electrolyte. Slowly release the bulb to allow fluid to draw into the hydrometer. Enough fluid must enter the hydrometer to allow the float to move freely.
- The specific gravity of the electrolyte is read off the scale of the float where it emerges from the fluid.

NOTE

It is good practice to select many different and multiple cells.

INSPECTIONS AND PREVENTATIVE MAINTENANCE

**WARNING**

- Always disconnect the battery before performing any truck maintenance.
- Wear protective clothing and safety glasses when working with battery acid or the battery in general.
- Neutralize acid spills immediately with Bicarbonate of Soda (common baking soda).
- If acid contacts the skin or eyes, wash with water immediately and seek medical attention at once.
- Use caution when changing the battery connectors to ensure that the polarity is not reversed.
- Keep vent plugs in place and clean at all times.
- When replacing the battery, use the same type battery as specified on the truck rating nameplate. Failure to comply could result in an unbalanced condition resulting in tipping the truck and possible injury.
- Close and/or tighten any battery restraints which have been installed on the truck.
- Always assume that the battery is emitting explosive hydrogen gas and practice proper safety precautions.
- Do not smoke, use open flame, create arcs or sparks near the battery.
- Consult the label on your battery for information on cell-type, ampere-hour capacity, charge rate and normal full-charge voltage. At the end of the charge, do not allow a charge current to exceed 1.5 amps per 100 amp-hours capacity.
- Packaged with every battery are specific instructions for battery care and a Material Safety Data Sheet (MSDS). Read these documents thoroughly before performing any service to the battery.
- Never place any tool or metal object on top of the battery where it could possibly touch battery terminals and cause a short or serious electrical shock.

NOTE

When returning the electrolyte to the battery, ensure that the fluid is returned to the cell from which it was taken.

Be careful not to splash the electrolyte.

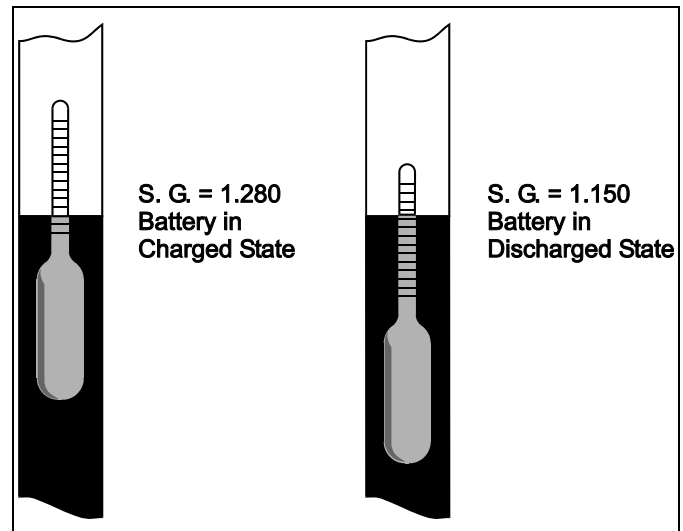


Figure 2-6: Hydrometer

Charging a Wet Cell Battery

1. Remove each vent cap and check electrolyte levels. Ambient temperature should be +77°F (+25°C) to get a proper reading. In cold weather the battery may look dry.
2. Do not add water until an accurate level is obtained; cold weather can affect the level. If water must be added, use only distilled water.
3. Make sure the electrolyte level is at the level indicator.
4. Replace the vent caps. They must be secured in place during charging. Ordinarily, the charge should take about 3 to 5 hours to complete.
5. Charge the battery using a constant current charger set to 5% of the six-hour battery capacity. For example, 55 amps for a 1,100 AH (ampere-hour) battery.

IMPORTANT

Do not charge the battery at a finish current which exceeds the rating on the battery nameplate. Consult the label on your battery for information on cell-type, ampere-hour capacity, charge rate and normal full charge voltage. At the end of the charge, do not allow a charge current to exceed 1.5 amp per 100 amp-hours capacity.

6. During the initial charge the volume of electrolyte decreases through electrolysis and evaporation. Water approved for use in lead-acid storage batteries should be added if the electrolyte levels falls below the level indicator.

7. If the cell temperature rises higher than +110°F (+61.2°C), either reduce the charging current to half the original value or stop charging until the temperature falls below +110°F (+61.2°C). Reducing the charging current will extend the charging time accordingly.
8. Refer to the table below for Specific Gravity correction factors dependent upon electrolyte temperature.
9. Continue charging until the cells out-gas freely and the specific gravity remains constant over a three-hour period. At the end of the charge period the cell voltages rise to about 2.55 volts and the specific gravity rises to about 1.280, corrected to 77°F.
10. When charging is complete, ensure the vented cell caps on the battery are secure.
11. Connect battery cables and install battery back into truck.

Temp °F	Correction	Temp °F	Correction
39-41	-0.012	101-103	+0.008
42-44	-0.011	104-106	+0.009
45-47	-0.010	107-109	+0.010
48-50	-0.009	110-112	+0.011
51-53	-0.008	113-115	+0.012
54-56	-0.007	116-118	+0.013
57-60	-0.006	119-121	+0.014
61-63	-0.005	122-124	+0.015
64-66	-0.004	125-127	+0.016
67-69	-0.003	128-130	+0.017
70-72	-0.002	131-133	+0.018
73-75	-0.001	134-136	+0.019
76-78	0	137-139	+0.020
79-81	+0.001	140-142	+0.021
82-84	+0.002	143-145	+0.022
85-87	+0.003	146-148	+0.023
88-91	+0.004	149-151	+0.024
92-94	+0.005	152-154	+0.025
95-97	+0.006	155-157	+0.026
98-100	+0.007	158-160	+0.027

Battery Restraints System (Rollout Option Only)

The battery restraint should be in place at all times when a battery is installed in the truck. A switch that detects the battery restraint will disable the truck if the restraint is not in place.

Safety Warnings

Check for damaged and missing decals. If the decals are not legible, they must be cleaned or replaced.

Seat Belt

Make sure the buckle and receptacle are in proper working condition and that the belt itself has no rips or frays.

Major Structural Points

Rust Or Corrosion

Check the truck frame, side panels, floor panels as well as mast assemblies for rust and corrosion. Clean rusty or corroded areas and repaint, if applicable. Apply a thin coat of oil to any bare metal surface.

NOTE

Immediately pull truck from service and repair if frame cracks are found.

Overhead Guard

Check the overhead guard, making sure that it is firmly attached to the truck and that all fasteners are secured. The overhead guard is adjustable to accommodate various drivers and operating restrictions (low ceilings, door openings, etc.).

1st 50 Hours

Mast Chains

This adjustment procedure is for Triplex & Quadplex mast assemblies:

1. Park the truck on a flat, level surface, with the parking brake engaged.
2. Lower the empty (unloaded) forks to the floor.
3. Set the keyswitch to OFF and remove the key.
4. Measure the distance from the floor to the bottom heel of each fork tine. See Figure 2-6 This measurement must be 1/8" (3.175 mm) minimum to 1/4" (6.35 mm) maximum. See Figure 2-7 for reference.
5. If it is not within 1/8" to 1/4" (3.175 mm to 6.35 mm), adjust the primary lift chain accordingly.

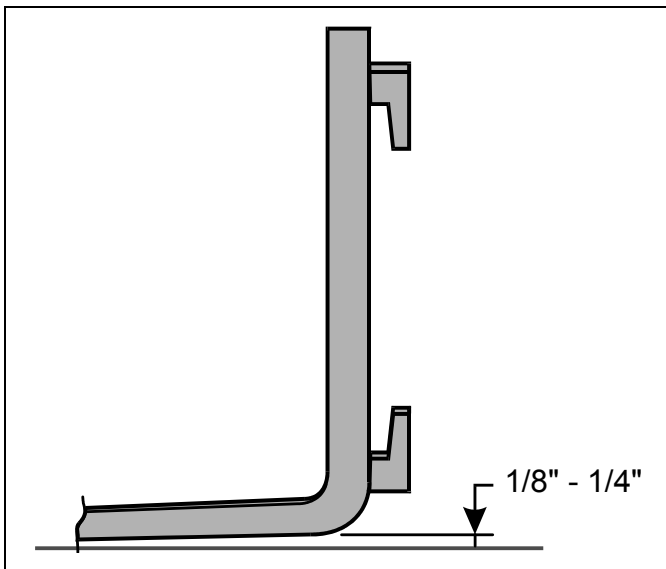


Figure 2-7: Fork Heel to Floor

Pivot Arm Racking

Examine the following pivot arm racking functions:

1. If the forks are not pointed straight forward, with the keyswitch turned to ON pivot the mast counterclockwise to the front loading position.
2. Ensure the pivot arm meets the crosshead stop when the pivot cylinder bottoms.
3. If the pivot arm pulls upward when the cylinder bottoms, this indicates racking. Adjust the pivot cylinder rod.
4. If clearance exists between the rear face of the pivot arm and the crosshead stop, adjust the pivot cylinder rod. Refer to "Removing the Pivot Cylinder" on page 3-21 for procedures.

Mast Racking

Perform the following general mast inspections:

1. With the keyswitch turned to ON, tilt the unloaded mast rearward. The mast should stop when the tilt cylinders bottom with no evidence of mast twist (racking).
2. If twisting occurs, adjust the tilt cylinder rods. Refer to "Tilt Cylinder" on page 2-18.

Gear Box

1. First, review "Getting Started (Please Read)" on page 1-1.
2. With the front tires raised and supported, spin the drive wheel and check for noise, rolling resistance and free play.

NOTE

There are no user serviceable parts for the gearbox assembly. The unit must be replaced as a complete assembly.



DANGER

Perform service only in a well-ventilated area.

Do not breathe vapors.

Wear protective goggles, aprons and gloves.

Avoid contact with skin, eyes and clothes.

Keep away from heat and flame.

Failure to observe these precautions may result in death or injury.

If you become dizzy, get fresh air and medical help immediately.

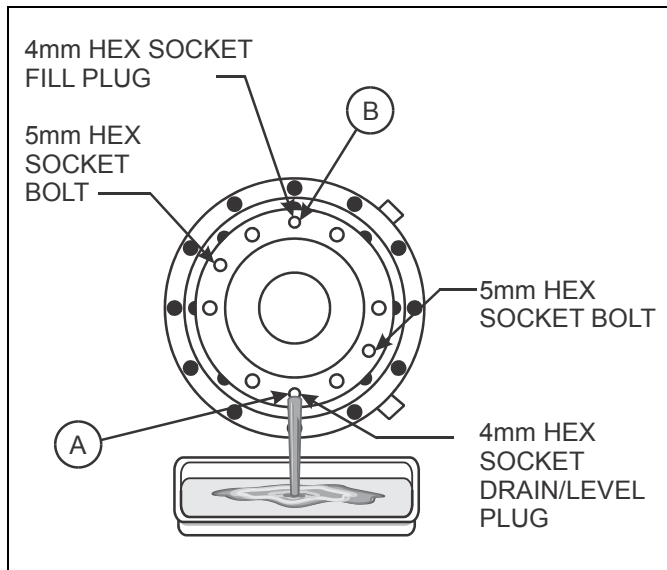
If solvent contacts your eyes, immediately treat in accordance with the recommendations on the container.

Do not mix different types of lubricants.

Always read the label affixed to the fluid container for all safety information before use.

Servicing the Gearbox

1. Position the truck on a flat surface, turn the steering completely to the left and block the front wheels to prevent movement.
2. Set the keyswitch to OFF, remove the key from the keyswitch and place in a secure area.
3. Disconnect the battery and install Lock Out/Tag Out.
4. Access the Gearbox area by removing the tire.
5. Thoroughly clean the area around the fill and drain/level plugs.

**Figure 2-8: Servicing the Gear Box****IMPORTANT**

Always place an appropriate support stand under the truck if it is being lifted. Lower the truck to the stand, having both the lifting device and stand supporting the weight of the truck.

**DANGER**

Getting under a truck when it is lifted or jacked is dangerous and could cause serious injury or death. NEVER go under a truck that is supported only by a jack

6. Place a drain pan capable of storing up to 32 ounces (1.0 liter) of fluid under the drain plug.
7. Using a 4 mm Allen key, unscrew the drain/level (position A) and fill (position B) plugs.

**CAUTION**

If truck has just been in operation for a period of time the oil could be very hot. Use special gloves and/or allow the truck to cool before changing the oil. It is best to drain fluid while the unit is warm, but not HOT!

Never drain oil into sewer lines.

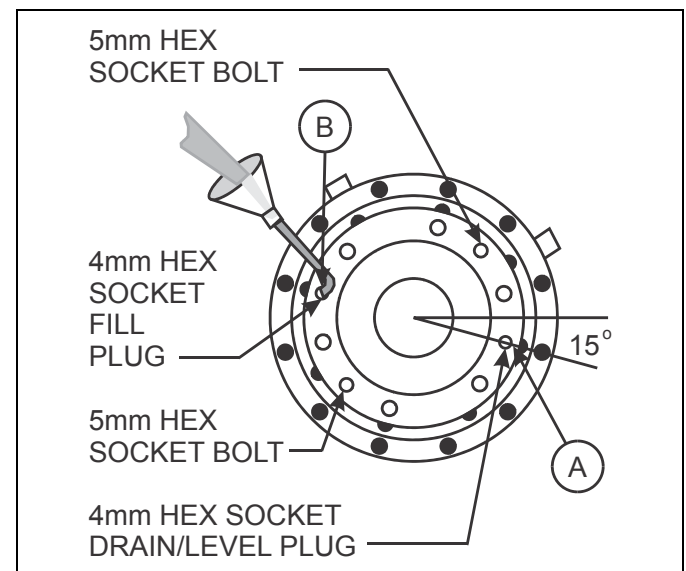
8. Drain the fluid completely into the drain pan.
 9. Once the fluid has been drained, replace the drain/level plug in position A.
 10. Wash the interior of the gear box with cleaning liquid as recommended by the lubricant manufacturer.
- Put liquid into the gear box through the fill plug and replace the fill plug.

- Run the gear box for a few minutes at a high speed.
 - Drain the cleaning liquid from the gear box in the same way as described for draining the oil.
 - Clean any contaminants from the magnetic trap and O-ring seal on the plugs.
11. To fill the gear box, turn until the drain/level hole in position A is about 15° below the horizontal center line of the gear box.
 12. Fill the gear box with synthetic gear lube through position B until fluid flows out from position A. Fluid capacity is approximately 1 pint(16 oz).

NOTE

DO NOT OVERFILL.

13. Install both plugs. Tighten to 25 ft. lbs. (34 Nm).
14. Wipe off any oil spillage on outside of the gear box.

**Figure 2-9: Refilling the Gearbox**

500 Hour Inspections

General Mast Inspection

Perform the following general mast inspections:

1. Check the hoist cylinder for proper sequencing.(See "Controls" on page 2-12.)
2. Check if the unloaded mast elevates to full lift (relief should open). If mast will not go to full lift, check the hydraulic fluid level in the reservoir and add fluid if required.
3. With load on forks in front carry position, elevate to approximately 5 feet (1.524 meters). Lower fast to within 6 inches (152.4 mm) of floor and stop abruptly. The mast should stop with a solid effect. if bouncy, bleed the hydraulic cylinder.

INSPECTIONS AND PREVENTATIVE MAINTENANCE

4. Check the carriage rollers and elevating channel rollers for proper contact with mating surface.
5. Look for signs of galling where the rollers contact the rail. See Figure 2-10.



Figure 2-10: Channel Galling

6. Galling is indicated by track marks in the rails that are 1/4" to 1/2" (6.35 mm to 12.7 mm) wide running up the rail. Normal track marks are no more than 1/4" (6.35 mm) wide.
7. If galling is detected, adjust the rollers for the proper clearance over the full length of the mast rails.
8. Check for proper lift chain adjustments.
9. Check for chain contact with retaining lip on sheaves.

Front Carry Position Setting

The proper front carry position is verified by competing the following:

1. Pivot the mast back to the frame (all the way counterclockwise).
2. A piece of paper should stay in place between the mast and the frame pad and shouldn't be able to be pulled out with mast pressure applied.
3. The mast will tend to "rise" or "jump" if adjusted too tight when it is brought back against the frame.

Tilt Cylinder

1. To check degree of tilt, be certain the truck is on a smooth, level surface.
2. Tilt the mast back its full stroke.
3. Place a tilt gauge against the rear outer mast rail on the right side of the truck.
4. The gauge must read between 3.0° and 4.1° maximum.
5. To adjust, tilt the mast fully backward.

6. Set the keyswitch to OFF and remove the key.
7. Loosen tilt cylinder jam nut using a 1-3/4" open end wrench. See Figure 2-11.
8. To shorten the stroke of the tilt cylinder, turn the jam nut clockwise until its flush against the unthreaded part of the cylinder rod, then continue turning the nut to rotate the cylinder rod further into the tilt cylinder. To lengthen the stroke, retract the cylinder all the way in and turn the jam nut counter-clockwise to rotate the cylinder rod further out of the cylinder.
9. Place the tilt gauge against the rear outer mast rail on the right side of the truck, about 6" (152 mm) above the pivot arm. The gauge must read between 3.0° and 4.1° maximum.
10. Turn the rod only a 1/4 turn at a time until the correct setting is achieved.
11. Steps 8 through 10 may have to be repeated a number of times until the adjustment is correct.

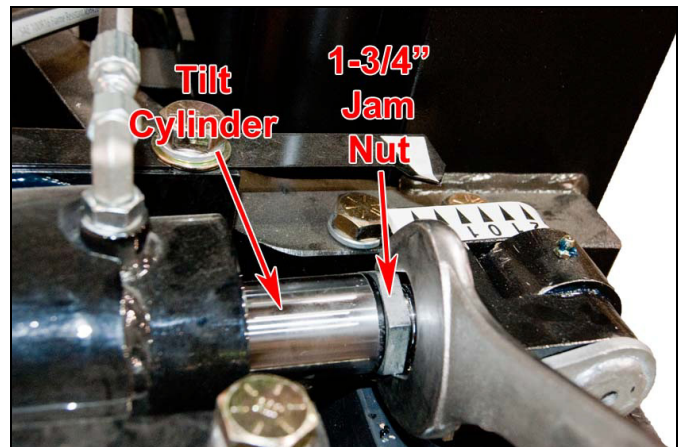


Figure 2-11: Tilt Cylinder Adjustment

12. When the adjustment is complete, tighten and torque the cylinder jam nut. Torque by tightening the jam nut an additional 1/10 to 1/8 turn after the nut contacts clevis.

Accelerator/Direction Control

Assure that the truck moves forward when the direction switch is pushed forward and the accelerator is pressed, reverse when switched backward and accelerator is pressed, and stops movement when the accelerator is released.

Service Disc Brakes

The service brakes are hydraulically-actuated, disc brakes, similar to an automotive disc brake system. They are installed to the gear box / motor assembly, on the two front drive wheels only.

The brakes should be checked every 200 hours of operation. Normal brake pad life is approximately 3,000 hours of operation, as determined by driving conditions. If the truck is near or beyond this time frame, the brakes must be inspected.

New brake pads are approximately 0.265" (6.7 mm) thick; replace them when the pad thickness is 0.0625" (1.588 mm) or less at the thinnest point.

A few indications of possible brake pad replacement are:

- excess travel of the service brake pedal,
- the truck pulling to one side when the brakes are applied,
- and squealing is heard when you apply the brakes.

Drive the truck at creep speed and apply brakes lightly, to determine if brakes pads are contacting the disk (rotor). You should feel a slight pulsating effect as the pads contact the disk.

Hydraulic

Dirt and other foreign materials may collect on the hydraulic pump. Any grease, dust and other grime will collect heat that the pump and motor are trying to dissipate, possibly leading to overheating issues.

Wheel Bearings

Clean and grease wheel bearings. See "Disassembling and Inspecting Wheel Bearings" on page 3-44 for wheel bearing details.

Switches

It is vitally important to check the condition of the operational and safety switches. Check the functionality of all switches, making sure they haven't failed open OR closed.

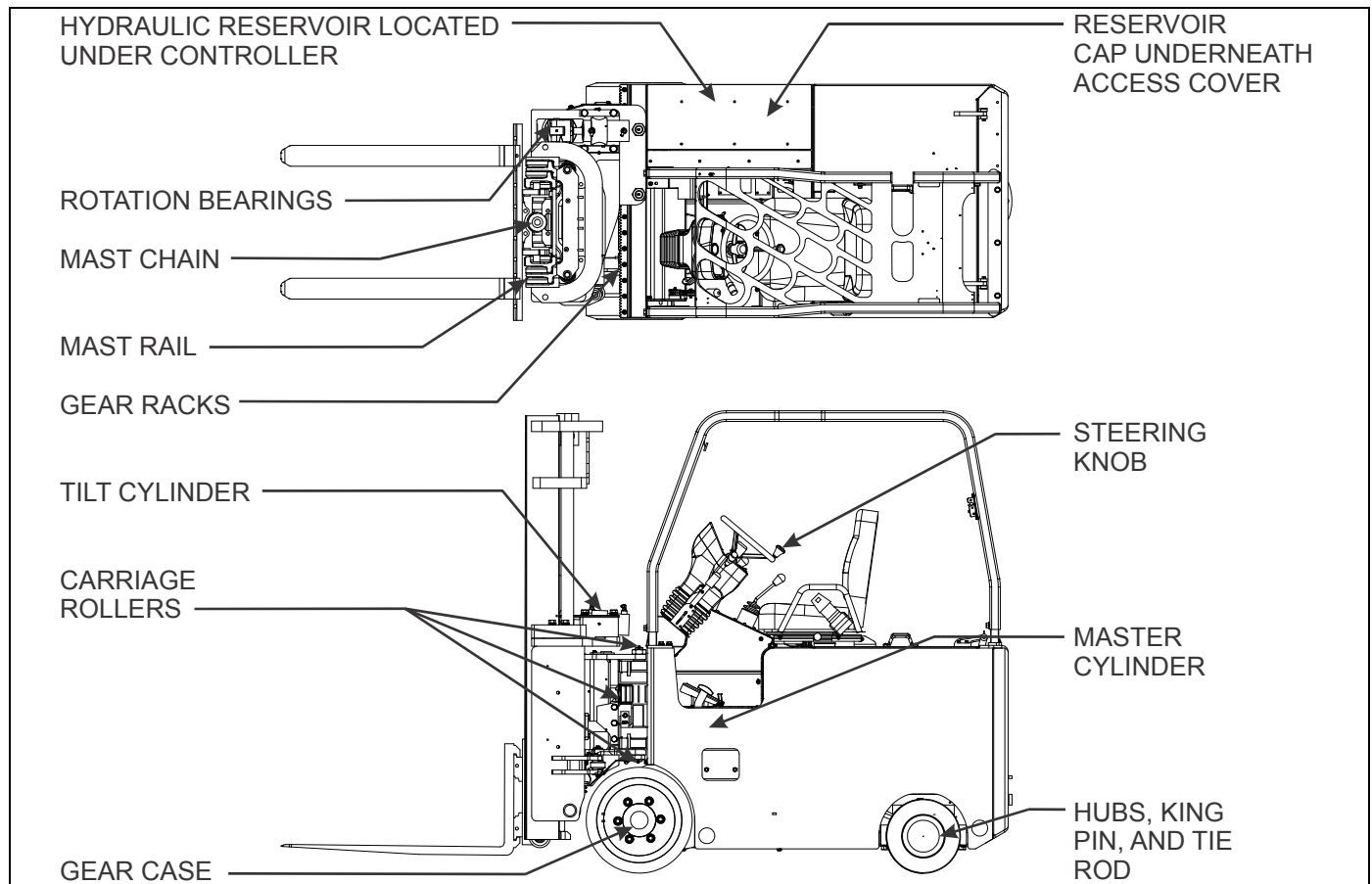


Figure 2-12: Lubrication Locations

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Truck Lubrication

1. Before lubricating the truck, lower the forks, set the keyswitch to the OFF position.
2. Certain grease fittings may include protective plastic caps. Remove them before applying grease. Remember to replace the caps when finished.

In the following procedures, the location of grease fittings or surfaces to be greased are by either a grease-gun or brush. Refer to Figure 2-12 on page 2-19

3. Make sure all grease fittings are wiped clean before lubricating. If any of the fittings are corroded or blocked, replace them.

NOTE

Before brush applying grease to bearing pad surfaces, wipe out the channel to remove any foreign matter that may have accumulated since your last lubrication.

4. After a truck cleaning, lubricate all unprotected grease fittings and metal-to-metal surfaces, located outside the truck.
5. Interval frequency can be recorded from the running hours read on the hour meter in the driver's compartment.
6. See "Lubrication Specifications" on page 1-9 for recommended lubricants.



WARNING

Do not service the truck and/or mast area while the keyswitch is ON. If a joystick, steering wheel or accelerator pedal is accidentally moved, serious injury could occur.

Tilt Cylinder Clevis

1. Start the truck and pivot the mast straight forward to the normal carry position.
2. Set the keyswitch to OFF, remove the key from the keyswitch and place in a secure area.
3. Perform a Lock Out/Tag Out procedure.
4. Grease clevis fitting on end of tilt cylinder until fresh grease is squeezed from the clevis. Wipe off excess grease.

Main Rotation Bearings

1. Start the truck and pivot the mast straight forward to the normal carry position.
2. Set the keyswitch to OFF, remove the key from the keyswitch and place in a secure area.
3. Perform a Lock Out/Tag Out procedure.

4. Grease the upper and lower front rotation bearing fittings until fresh grease is squeezed from the lower bearing.
5. Wipe off excess grease at the lower bearing.

Fork Positioner Lubrication (Option)

1. Start the truck and position the mast straight ahead.
2. Set the keyswitch to OFF, remove the key from the keyswitch and place in a secure area.
3. Before lubricating the positioner rails, wipe off excess lubricant and dirt buildup from within the rail channels and dirt from the top and bottom of the rail grooves.
4. Using a brush, lubricate the top areas on the fork rails, including a thin film on the front face of both rails. Using a grease gun apply grease to the lower fork rails.
5. Wipe off excess grease.

Chain Adjustment

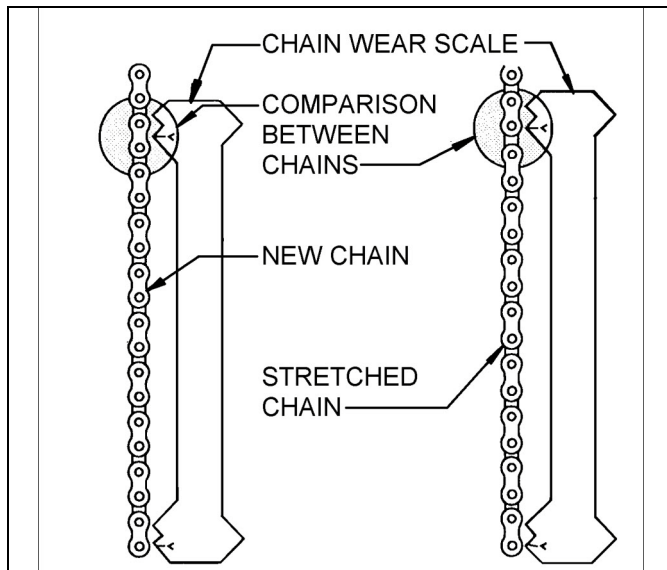
The chain must be adjusted so each strand is under equal tension for proper load distribution and mast operation. To determine whether the chains are properly adjusted:

1. Remove load from forks.
2. Raise the mast to put the chains under tension.
3. Press the center of a strand of chain with your thumb, then press at the same place on the other chain of the pair.
4. Each chain in a pair should have equal "give". If tension is not equal, adjust them as described in the manufacturer's mast service manual, starting on page 5-3 or 6-3.

Measuring Chain Stretch

If the chains stretch beyond the recommended amount, they should be replaced in pairs. Chain stretch can be measured with a chain wear scale, as shown in Figure 2-13. The scale indicates whether the distance between two chain links is within tolerance. The shaded area in the illustration compares a stretched chain to a new chain. Measure the chains according to the instructions printed on the chain wear scale, without load on the carriage.

- To check the free lift chains, raise the carriage 1 ft. (30 cm) off the ground to put tension on the chains.
- To check the main lift chains, raise the mast until the inner upright starts to extend putting tension on the chains.

**Figure 2-13: Measuring Chain Stretch****Check Primary Lift Chain**

1. Park the truck on a flat, level surface.
2. Set the mast in the center of the truck, facing straight ahead, level to the floor and empty (unloaded).
3. Set the keyswitch to OFF, remove the key and place the key in a secure area.
4. Measure the distance from the floor to the bottom heel of each fork tine. Measurement must be 1/8" (3.175 mm) minimum to 1/4" (6.35 mm) maximum. If it is not within 1/8" to 1/4" (3.175 mm to 6.35 mm), adjust the primary lift chain accordingly.

Check Lift Operation

1. Check the lift cylinders to ensure proper sequencing. If adjustment is needed, see "Lift Chains" on page 2-11 or supplier information in Chapter 5 or 6.
2. Check to see that an unloaded mast will completely lift to full lift height (the relief opens). If it will not, check the hydraulic oil level in the reservoir and add oil if necessary.
3. Load the mast and raise it approximately to 5' (1.524 m), then quickly lower the mast until it is about 6" (1.524 mm) above the floor and stop the mast abruptly.
4. Make sure the elevating channel rollers maintain proper contact with the mast channel.
5. Look for signs of galling where the rollers contact the rail. Galling is indicated by track marks in the rails that are 1/4" to 1/2" (6.35 mm to 12.7 mm) wide running up the rail. Normal track marks are no more than 1/4" (6.35 mm) wide.
6. If galling is detected, adjust the rollers for the proper clearance over the full length of the mast rails. See Chapters 5 & 6 for reference.

Steer Axle

Examine the following steer axle functions:

1. Check the steer axle trunnion mounting bolts; torque to 210-250 ft. lbs. (285-340 Nm).
2. Check the wheel bearing nuts. With the wheel off the floor, tighten the wheel nut to 50 ft. lbs. (68 Nm). Back it off 1/4 turn to no less than 20 ft. lbs. (27 Nm). Check for rotation of the wheel.
3. Check the cotter pins on the spindle tie rod end trunnions; replace if required.
4. Check the steer cylinder for leaks around the hose connection and the rod gland. Repair if required.
5. Raise the rear end of the truck, support it with safety stands, and check for wheel bearing play indicating loose or damaged bearings. Adjust the bearings as outlined in step 2 above. Rotate the wheel and check for bearing noise or roughness indicating damaged bearings. Replace if necessary. Refer to "Disassembling and Inspecting Wheel Bearings" on page 3-44 for procedures.
6. Check the steer cylinder ends for excessive play.
7. Check the tie rod bearing ends for excessive play.

2000 Hour Inspections**Check Planetary Gear Box****NOTE**

The planetary drive gear box (right and left side) assemblies (2) are filled with oil at the factory. An oil change is necessary after the first 50 hours maximum of operation in order to remove particles worn down during the running-in phase. Thereafter, an oil change is only required once every 2000 hours or yearly, whichever comes first. Also, if the truck has been in storage for one year or more, the oil should be changed before placing the truck into operation.

See "Servicing the Gear Box" on page 2-17.

**DANGER**

- Perform service only in a well-ventilated area.
- Wear protective goggles, aprons and gloves.
- Avoid contact with skin, eyes and clothes.
- In case of accidental eye contact, immediately treat in accordance with the manufacturer's recommendations.
- Do not mix different types of lubricants. Always read the label affixed to the fluid container for all safety information before use.

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Table provided for general use.

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Chapter 3

Troubleshooting and Corrective Maintenance

Preliminary Procedures

- **Thoroughly review the problem with the operator to obtain a complete description of what is wrong.**
- Observe the operator's driving practices and operating procedures to see if operator error could be the problem.

If you suspect operator error, review the operating procedures with the operator, or have the operator read the SL Series Operator's Manual (F-625) provided with each truck.

- If the problem is determined to be operator error, return the truck to service and see that the operator is properly retrained before being allowed to drive the truck.
- Check the planned maintenance log to make sure that the log is up-to-date and the problem is recorded. If it is not, or if there is no log, begin one and start by performing an planned maintenance inspection of the truck (See the SL Series Operator's Manual (F-625) or see "Inspection Checklists," on page 2-1.
- After the problem has been corrected, operate the truck again to verify the repair and to ensure there are no additional problems. If no other problems exist, return the truck to operation. If other problems are found, troubleshoot and repair them before returning the truck to operation.

Troubleshooting Charts

This chapter contains troubleshooting procedures to help diagnose and resolve problems. Once the problem is identified, refer to "Corrective Maintenance," on page 3-18, for repair instructions.

Troubleshooting Chart procedures are arranged as:

1. **Hydraulic Problems**
2. **Brake Problems**
3. **Electrical Problems**
4. **Audible Problems**
5. **Visible Problems**

TROUBLESHOOTING AND CORRECTIVE MAINTENANCE

Hydraulic Problems		
Problem	Cause	Suggested Repair
Mast does not lift load.	Attempting to lift a load in excess of the truck's capacity.	• NEVER attempt to lift a load heavier than the specified rating of the truck. • Also, see "Traveling and Load Handling," in the SL Series Operator's Manual (F-625) for additional information. • See "Understanding Stability," in the SL Series Operator's Manual (F-625).
	Low Hydraulic Oil	• Low levels can cause the pump to "cavitate" and not permit full lift of the mast. See "Mast Chains," on page 2-16. • Check reservoir oil level. Replenish as needed. See "Hydraulic Oil," on page 2-11.
	Faulty hydraulic control valve.	• Bent or damaged spool, worn internal seals - repair or replace as needed.
	Joystick malfunctioning.	• If no other cause is found to be at fault, refer to "Joystick Troubleshooting" section for more information.
	Faulty Pump.	• The hydraulic pump section may be damaged - replace the pump.
	Hydraulic Cylinders leaking or binding.	• Determine which cylinder is leaking or binding - rebuild or replace. • Seal kits are available for most cylinders - See "Lift Technologies Mast Service Manual," on page 5-1.
	Mechanical damage of the mast.	• Check mast for damage and signs of misadjustment. See "Mast Chains," on page 2-16
	Insufficient system pressure.	• Check hydraulic pressure of the system relief valves. For an overview of the system, see "Hydraulic System," in the SL Series Operator's Manual (F-625). • Try re-adjusting the pressure relief valves. Maximum system pressure must not exceed 2,800psi.

****Continued on next page****

Hydraulic Problems		
Problem	Cause	Suggested Repair
Mast does not lift load.	Insufficient system pressure.	**Continued from previous page** • See “Checking and/or Adjusting Pressure,” on page 3-38. • Check valves for seal leaks, sticking or misadjustment. • Repair or replace and/or re-adjust accordingly. • If problems persists, replace the relief valve cartridge.
	Faulty valve coil	• Lift coil is either open or shorted, preventing lift valve operation.
Mast lifts slowly - loss of lift speed.	Attempting to lift a load in excess of the truck's capacity	• NEVER attempt to lift a load heavier than the specified rating of the truck. • Also, see “Traveling and Load Handling,” in the SL Series Operator's Manual (F-625) for additional information • See “Understanding Stability,” In the SL Series Operator's Manual (F-625).
	Insufficient pump or relief valve pressure.	• See “Mast does not lift load,” problem in troubleshooting table.
	Mechanical damage of the mast.	• See “Mast does not lift load,” problem in troubleshooting table.
	Hydraulic cylinders leaking or binding.	• See “Mast does not lift load,” problem in troubleshooting table.
	Pump motor encoder faulty or not plugged in.	• Make sure the pump motor encoder is plugged into the truck harness. • Replace the pump motor encoder.

TROUBLESHOOTING AND CORRECTIVE MAINTENANCE

Hydraulic Problems		
Problem	Cause	Suggested Repair
Mast drifts downward.	Excessive load - attempting to lift loads beyond the capacity of the truck.	• NEVER attempt to lift a load heavier than the specified rating of the truck. • See "Mast does not lift load," problem in troubleshooting table.
	Lift hydraulic cylinders leaking or binding.	• Determine which cylinder is leaking or binding - rebuild or replace. • See "Mast does not lift load," problem in troubleshooting table. • Seal kits are available for most cylinders - See "Lift Technologies Mast Service Manual," on page 5-1.
	Air in cylinder.	• Run mast to full extent three times to remove all air.
	Joystick malfunctioning.	• Cycle forklift power. If problem is fixed, inspect joystick. If problem persists inspect joystick and control valve.
	Bad check valve.	• See "Lift Technologies Mast Service Manual," on page 5-1.
	Faulty lift control valve	• Oil may be bypassing the lowering cartridge. Disconnect wire harness from the coil. If the mast continues lowering - Replace cartridge. • If lowering stops with harness disconnected, troubleshoot the control system/joystick.
	Joystick malfunctioning.	• Turn the truck off. If the downward drift stops, see "Joystick Troubleshooting: section for more information. • If problem persists, inspect control valve.

Hydraulic Problems		
Problem	Cause	Suggested Repair
Mast does not tilt.	Inoperative tilt directional control valve.	• Repair or replace. • See “Removing the Tilt Cylinder,” on page 3-21.
	Insufficient pump or relief valve pressure.	• See “Insufficient system pressure,” on page 3-2.
	Joystick malfunctioning.	• If no other cause is found to be at fault, refer to “Joystick Troubleshooting” section for more information.
	Hydraulic cylinder leaking or binding.	• Tilt cylinder is leaking or binding - rebuild or replace. • See “Removing the Tilt Cylinder,” on page 3-21.
Carriage does not shift, or swing arm does not pivot.	Inoperative traverse drive motor.	• Repair or replace - “Removing the Traverse Drive Motor,” on page 3-21.
	Insufficient pump or relief valve pressure.	• See “Insufficient system pressure,” on page 3-2.
	Inadequate lubrication or worn bearings.	• See “Forks,” on page 3-18. • Replace bearings - See “Removing Main Rotation Pin Bearings,” on page 3-22 and “Removing Traverse Pin Weldment,” on page 3-22.
	Joystick malfunctioning.	• If no other cause is found to be at fault, refer to “Joystick Troubleshooting” section for more information.
	Kinked or leaking supply hoses.	• Locate kink and straighten. • Repair or replace defective hose. • Tighten fittings to seal any leaks. • See “Hydraulic Fittings and Hoses,” on page 3-47.

TROUBLESHOOTING AND CORRECTIVE MAINTENANCE

Hydraulic Problems		
Problem	Cause	Suggested Repair
Steering drifts/wanders or is erratic.	Improperly sized tires.	• Check tire part numbers found in the SL Series Parts Manual (F-624) • See "Tires," on page 2-10.
	Low fluid or leaks in hydraulic system.	• Check hydraulic fluid level - replenish as necessary. • See "Hydraulic Oil," on page 2-11. • Check all related components for seal or fitting leaks - repair or replace.
	Loose steering pump and motor assembly mounting.	• Check and tighten mounting brackets and mounting between motor and pump. • See "Hydraulic Motor and Pump," on page 3-37.
	Air in the hydraulic system.	• Check the inlet connections to determine where air is being drawn into the system. • Tighten loose connections. • Bleed hydraulic system.
	Worn or loose wheel bearings.	• Check wheel bearings - replace as needed. • See "Disassembling and Inspecting Wheel Bearings," on page 3-44.
Steering drifts/wanders or is erratic.	Worn or out-of-adjustment steer assembly.	• See "Steering Column (Console)," on page 3-59. • Failed or weak orbital centering spring will cause the steering to drift - replace accordingly.
	Insufficient hydraulic pressure at the hydraulic pump.	• Check hydraulic pressure of steering relief valve (2,600 psi). • See "Hydraulic Motor and Pump," on page 3-37. • Check steering motor for seal leaks, sticking or misadjustment - repair or replace.

Hydraulic Problems		
Problem	Cause	Suggested Repair
Hard steering effort in one or both directions.	Improperly sized tires.	• Check the specifications described in the SL Series Operator's Manual (F-625). • See "Tires," on page 2-10.
	Low hydraulic fluid.	• See "Hydraulic Oil," on page 2-11.
	Low flow rate or fluid pressure.	• Restriction in fluid return line or line is too small. Remove line, clean and/or replace line. • Check pump. See "Hydraulic Motor and Pump," on page 3-37. • Loadsense cartridge fault - Replace cartridge. • Check hydraulic pressure - 2,600 psi.
	Components in steering linkage binding or making noise.	• Find source of problem and repair, such as - Steering column - See "Steering Column (Console)," on page 3-59. Orbital steering unit - See "Steering Orbital Control Unit," on page 3-60.
	Inside drive wheel not dropping out.	• Check steer sensor settings - adjust or replace.
	Faulty loadsense valve.	• Remove, inspect, clean or replace loadsense cartridge.
Lost motion at the steering wheel.	Steering wheel loose on column or stripped.	• Check and retorque the steering wheel locking nut. • See "Steering Wheel," on page 3-58.
	Air in the hydraulic system.	• Check the inlet connections to determine where air is being drawn into the system. • Tighten loose connections. • Bleed the hydraulic system.
Truck turns too slowly.	See "Steering drifts/wanders or is erratic," problem in troubleshooting table.	

TROUBLESHOOTING AND CORRECTIVE MAINTENANCE

Hydraulic Problems		
Problem	Cause	Suggested Repair
No hydraulic pressure.	Pump driven in the wrong direction of rotation <i>after</i> servicing.	- Change the drive direction immediately to prevent seizure. - Correct the pump cartridge ring position for each direction of rotation.
	Coupling or shaft sheared or disengaged.	Disassemble the pump from motor and check the shaft and motor for damage.
	Oil intake line is restricted.	- Check all strainers and filters for dirt and sludge - clean or replace. - See "Change Hydraulic Oil Filter," on page 3-37.
	Fluid viscosity too heavy to pick up prime.	- Completely drain the system. - Add new filtered oil of the proper viscosity. See "Lubrication Specifications," on page 1-9. - See "Change Hydraulic Oil Filter," on page 3-37.
Leaking fluid.	Cracked or cut hoses, where applicable.	- Replace. NEVER attempt to patch a hose. - See "Hydraulic Fittings and Hoses," on page 3-47.
	Loose or faulty hose clamps, where applicable.	- Tighten and/or replace clamp. - Replace hose.
	Loose or faulty hydraulic fittings.	- Tighten and/or replace. Be careful not to strip the threads, rendering the fitting defective. - See "Hydraulic Fittings and Hoses," on page 3-47.
	Oil seals deteriorated.	Disassemble the unit and replace the oil seals.
Pump making noise.	Pump intake partially blocked.	- Service the hydraulic tank intake strainer. - Check the fluid condition and if necessary drain and flush the hydraulic system. Refill with clean oil. - See "Change Hydraulic Oil Filter," on page 3-37.
	Air leaks at the intake or shaft seal. (Oil in reservoir would possibly be foamy.)	Check intake lines (hoses and fittings) and seals for leaks. Repair all leaks.
	Damaged pump/motor mounting.	Repair or replace.

Hydraulic Problems		
Problem	Cause	Suggested Repair
Significant loss of speed under load.	Lack of sufficient oil supply.	• Check for faulty relief valve and adjust or replace as required. • Check for and repair worn pump. • See "Lubrication Specifications," on page 1-9.
	Excessive heat.	• Locate excessive heat source (usually a restriction) in the system and correct the condition.
	High internal pump leakage.	• Replace pump.
	Severely worn or damaged internal splines.	• Disassemble and repair motor or pump.

Brake Problems		
Problem	Cause	Suggested Repair
Service brakes do not stop the truck.	Low fluid level in master cylinder reservoir.	• See "Service Disc Brakes," on page 2-19. • If low, check for leaking fittings or lines - tighten or replace. • Brake line fittings are made of soft metal. Be careful not to strip the threads, rendering the fitting defective. • Also check the wheel cylinder for leaks - rebuild or replace. • See "Master Cylinder," on page 3-51.
	Worn brake pads.	• Check brake pads for wear or defects - always replace both sides. • See "Service Disc Brakes," on page 2-19. • See "Changing Brake Pads," on page 3-29.
	Brake pedal linkage adjustment.	• Check linkage for loose nuts, broken or stressed linkage, or misadjustment - repair and re-adjust. • See "Service Brake Pedal Assembly," on page 3-54.
	Brake pad contamination.	• If hydraulic oil, brake fluid or grease come in contact with the pads, they must be wiped clean and the pads must be sanded using a fine emery cloth. • If the pads are saturated, they must be replaced.

TROUBLESHOOTING AND CORRECTIVE MAINTENANCE

Brake Problems		
Problem	Cause	Suggested Repair
Spongy or soft service brake pedal.	Possible air in brake lines.	- Bleed air from brake lines - indicated by bubbles in fluid during fluid bleed or when checking the master fluid reservoir. - See "Bleeding Brakes," on page 3-53. - Check brake system for loose fittings and cross threaded fittings. - Also check master cylinder reservoir fluid level - low level can allow air into lines. - See "Service Disc Brakes," on page 2-19.
	Faulty seals in master cylinder or low fluid level.	- Examine the brake lines and master cylinder for leaks - repair immediately, then bleed the brakes. - Check brake calipers. - Check master cylinder piston for worn seals. - Remove the master cylinder filler cap and <i>slowly</i> press the brake pedal. A pulse of fluid should be seen in the cylinder reservoir. If not, replace the cylinder. - See "Master Cylinder," on page 3-51.
Parking brake does not hold the truck.	Brake cable system malfunction or out of adjustment.	- Check parking brake linkage for loose nuts, broken or stressed linkage, or misadjustment - repair and re-adjust. - See "Parking Brake Assembly," on page 3-33.
	Service brakes not working properly.	See "Service brakes do not stop the truck.," on page 3-9.

Electrical Problems		
Problem	Cause	Suggested Repair
Frayed or broken wires.	This may be caused by improperly secured wires or harnesses allowing pinching or excessive movement (vibration).	• Repair or replace wires and harness and secure properly. • See “Electrical,” on page 3-48. • Make sure wires do not come in contact with any moving parts or are not pinched in access doors or cover panels.
Lights do not work.	Blown fuse.	• Check fuse labeled “Lights.”
	Electrical problem - frayed or broken wires, faulty switch or electronics.	• Check related wire harnesses and connectors for contact problems, broken wires, etc. • Continuity check on/off switches - replace as needed.
Intermittent electrical problems.	Loose electrical connections.	• Check for excessive vibration or poor maintenance procedures. • Tighten contacts as needed. • Examine cable assemblies for tight connections. • Wire terminal crimps should be secure and wire stranding must not be frayed or corroded.

Audible Problems		
Problem	Cause	Suggested Repair
Back up alarm does not sound.	Faulty alarm module.	• Continuity check alarm module - replace as needed. • See “Back Up Alarms,” on page 3-63.
	Electrical problem - frayed or broken wires, faulty direction control lever or electronics.	• Check related wire harnesses and connectors for contract problems, broken wires, etc. • Examine cable assemblies for tight connections. • Wire terminal crimps should be secure and wire stranding must not be frayed or corroded. • Check wiring to relay. • See “Intermittent electrical problems,” on page 3-11. • Alarm contactor may be shorted or open. Check and replace as necessary.

TROUBLESHOOTING AND CORRECTIVE MAINTENANCE

Audible Problems		
Problem	Cause	Suggested Repair
Unusual noise when truck is in motion.	Rubbing or binding brake pads in front wheels.	• Try to isolate the cause of the noise. • Drive truck slowly having another operator check for the unusual noise. • Step on brakes lightly to see if brakes are binding or rubbing excessively - repair or replace. • See "Brake System Service," on page 3-29.
	Faulty drive motor assembly.	• If unit is suspected, it must be removed from the truck and replaced. • See "Gear Box and Traction Drive Motor," on page 3-40.
Singing noise.	Insufficient fluid level.	• Check fluid level. See "Gear Box," on page 2-16.
	Faulty motor bearing.	• Repair or replace motor. See "Gear Box and Traction Drive Motor," on page 3-40.
Muffled grinding noise.	Faulty wheel bearings - could be insufficient grease or high pre-stress or excessive play on bearings.	• Determine if noise is in the front or the rear. • For rear - See "Disassembling and Inspecting Wheel Bearings," on page 3-44. • For front - See "Gear Box and Traction Drive Motor," on page 3-40.
	Damaged gearing - could be insufficient fluid or excessive play in bearing.	• Dismount gear box and examine for damage. • See "Gear Box and Traction Drive Motor," on page 3-40.
Clicking noise during a turn.	Loose or shifting component.	• Try to isolate the area of the noise, then check for loose parts, misalignment, load shifting, etc. • Check that components are in place and properly torqued. See "Torque Specifications," on page 1-9.

Audible Problems		
Problem	Cause	Suggested Repair
Horn does not work.	Faulty horn assembly.	• Disconnect horn wires - continuity test horn leads connected to battery power. • Check related wire harnesses and connectors for contact problems, broken wires, etc. • Examine cable assemblies for tight connections. • Wire terminal crimps should be secure and wire stranding must not be frayed or corroded. • See "Intermittent electrical problems," on page 3-11. • Horn contactor may be shorted or open. Check and replace as necessary. • If problem occurs repeatedly, or if the forklift is used in an application with heavy horn use, consider upgrading the horn relay to the Heavy Duty Horn Kit (Landoll P/N 170700)
	Blown fuse.	• Check for a blown fuse on fuse panel. • Check for electrical short - in horn or electrical connections.
	Joystick malfunctioning.	• If no other cause is found to be at fault, refer to "Joystick Troubleshooting" section for more information.
Rubbing noise from the rear wheels.	Faulty wheel bearing or damaged wheel shaft.	• Dismount suspected wheel and examine bearings and shaft. • See "Disassembling and Inspecting Wheel Bearings," on page 3-44. • Check for foreign material lodged inside wheel hub - remove and repair or replace as needed.

TROUBLESHOOTING AND CORRECTIVE MAINTENANCE

Audible Problems		
Problem	Cause	Suggested Repair
Scraping noise when mast is operated.	Out of alignment.	• Realign and shim mast rails accordingly. • See "Mast and Front Plate Assemblies," on page 3-18.
	Faulty hydraulic cylinder - lift, tilt and/or shift.	• Determine which cylinder is bad - rebuild or replace. • Seal kits are available for most cylinders, see "Lift Technologies Mast Service Manual," on page 5-1 for replacement items. • See "Mast and Front Plate Assemblies," on page 3-18.
	Needs lubrication.	• Lubricate mast as described in "Lubrication Specifications," on page 1-9.

Visible Problems		
Problem	Cause	Suggested Repair
Cracked or exceptionally worn forks  WARNING If you find any defect in the forks or mounting components, take the forklift out of service until the forks are repaired. Failure to do so can cause the load to fall, resulting in serious injury or death.	Fatigue, age, excessive lifting of overweight loads, straightness of blade and shank, fork angle or height differences between fork tips.	• <i>When replacing forks - Forks must be replaced in pairs.</i> • Check straightness of the upper face of each blade and the front face of each shank. If deviation exceeds 0.5% of the length of the blade and/or height of shank respectively, replace forks. • Check angle between upper face of fork blade and load face of each shank. If deviation exceeds 3° from original specification, replace forks. • Check difference in height between each fork blade (measured at the tip with the fork mounted on the carriage. If difference in tip heights exceeds 3% of the length on the blade, replace the forks. • See "Removing Forks," on page 3-18.
	Excessive wear or defective hooks.	• Check each fork, especially at the heel area. If thickness is reduced to 90% of original thickness, replace the forks. • Check support face of the top hook and the retaining faces both hooks for wear, crushing or other deformations. Excessive clearance between fork and carriage requires fork replacement.
	 WARNING • Forks requiring repair must be returned to the original manufacturer. • Never try to repair surface cracks or wear by welding. If a fork is re-set, make sure it is heat treated before it is returned to service. • A fork that has undergone repairs must be load tested before it is returned to service. The test facility must test forks according to paragraph 7.25.3 (ASME B56.1-2000), except that the test load must be 2.5 times the rated capacity marked on the fork.	
Leaking fluid.	Cracked, split or cut hoses.	• Replace. NEVER attempt to patch a hose. See "Hydraulic Fittings and Hoses," on page 3-47. **Continued on next page**

TROUBLESHOOTING AND CORRECTIVE MAINTENANCE

Visible Problems		
Problem	Cause	Suggested Repair
Leaking fluid.	Loose or faulty hydraulic fittings.	**Continued from previous page** - Tighten or replace. Be careful not to strip the threads, rendering the fitting defective. - See "Hydraulic Fittings and Hoses," on page 3-47.
	Pump or motor oil seals, rings, gaskets, etc. deteriorated by excessive heat or corrosion.	Replace seals in bad unit or replace unit.
Puddles/leakage in area of front drive wheels.	Loose or faulty hydraulic fittings.	- Locate source of leak. Tighten or replace fittings. - Be careful not strip the threads, rendering the fitting defective. - See "Hydraulic Fittings and Hoses," on page 3-47.
	Loose brake line fittings.	- Locate source of leak. Tighten or replace fittings. - Brake line fittings are made of soft metal. Be careful not to strip the threads, rendering the fitting defective. - See "Brake System Service," on page 3-29.
	Faulty seal/gasket in drive motor.	- Locate source of leak - gear box. - Replace unit. - See "Gear Box and Traction Drive Motor," on page 3-40.
	Faulty seals/gaskets in main hydraulic pump.	- Check the hydraulic pump assembly for excessive wear, oil leaks, loose or defective fittings. - Replace seals or replace unit. - See "Hydraulic Motor and Pump," on page 3-37. - Also, see "Pump making noise," on page 3-8.
	Leaking brake caliper.	- Rebuild or replace caliper. - See "Master Cylinder," on page 3-51 and "Brake System Service," on page 3-29. - See "Bleeding Brakes," on page 3-53.
Grease blotches around rear steer wheels (especially on inside of wheel rim).	Faulty grease seal in steer wheel assembly.	- Check Seal rings and wheel shaft for damage in seal area. - Replace the inner grease seal. - See "Disassembling and Inspecting Wheel Bearings," on page 3-44.

Visible Problems		
Problem	Cause	Suggested Repair
Puddles/leakage near mast.	Loose hose or hydraulic fitting.	• Locate source of leak: cylinder, manifold hose, cylinder hoses, etc. Tighten or replace fittings. • Be careful not to strip the threads, rendering the fittings defective. • See "Hydraulic Fittings and Hoses," on page 3-47.
	Leaking cylinder - lift, tilt and/or sideshift.	• Determine bad cylinder - rebuild or replace. • See "Mast and Front Plate Assemblies," on page 3-18. • Seal kits are available for most cylinders - see "Lift Technologies Mast Service Manual," on page 5-1 for replacement items.
Frayed or broken wires.	This may be caused by improperly secured wires or harnesses allowing pinching or excessive movement (vibration).	• Repair or replace wires and harnesses and secure properly. • Make sure wires do not come in contact with any moving parts or are not pinched in access doors or cover panels.
Scraping marks on the mast.	Rail misalignment.	• Realign rails. See "Mast and Front Plate Assemblies," on page 3-18.
Excessive tire wear.	Hard starting and stopping.	• Examine operator's driving habits and train operator accordingly. • Excessive "hard" or sudden stops and starts contribute to abnormal brake and tire wear. • See "Service Disc Brakes," on page 2-19. • See "Tires," on page 2-10.
	Excessive overloading or improper weight distribution.	• NEVER lift loads in excess of what is recorded on the capacity nameplate, page 1-1. • Excessive overloading or improper weight distribution placed on the drive train will eventually render the gearbox defective and could cause wheel traction problems; in turn, premature tire wear. • Also, see "Understanding Stability," in the SL Series Operator's Manual (F-625).
	Faulty drive motor bearings causing alignment problems.	• Repair or replace.

****Continued on next page****

TROUBLESHOOTING AND CORRECTIVE MAINTENANCE

Visible Problems		
Problem	Cause	Suggested Repair
Excessive tire wear.	Worn steer wheel bearings.	**Continued from previous page** Replace. See "Disassembling and Inspecting Wheel Bearings," on page 3-44.
	Improper tire durometer	Repair only with Landoll recommended replacement parts.

Corrective Maintenance

This section is divided by features. For each feature, major adjustment and/or settings, mechanical repairs and electrical control system repairs are addressed. Features are listed in the Table of Contents, at the front of this book, along with page reference information.

As a Safety Reminder - Duplicate Safety Information and Precautions from Chapter 1 will be shown.

IMPORTANT

- It is important to always locate the section which pertains to your needs, then read the entire procedure before attempting to adjust, repair and/or replace parts.
- It is recommended to always use genuine Landoll replacement parts to maintain the overall high quality performance and to guarantee maximum truck stability and to minimize downtime.

When it becomes necessary to do an electrical or mechanical service repair or maintenance procedure, it is important to have the proper tools required, in both English and Metric sizes, and to review/practice the following safety suggestions.



WARNING

- Damage to personnel and the truck if service work is attempted without proper qualified experience.
- Use of the wrong grade of replacement parts will, in time, cause breakages or looseness, potentially causing serious injury.
- It is recommended to use Landoll replacement parts before attempting any truck maintenance.

- Be sure to use the proper nuts, bolts and other fasteners. Many are specifically rated; i.e. SAE Grade 5, SAE Grade 8, ISO Prop Class 8.8, etc., and must be replaced with the identical type.

- Whenever possible, return the truck to a service area having sufficient lighting, work space and an assortment of tools needed to complete the repair.
- Set the keyswitch to OFF and remove the key from the ignition switch.**
- Set the direction control lever to NEUTRAL and set the parking brake.



CAUTION

To be certain the truck will not move, place wedges (or blocks of wood) at the front and back of the tires. When servicing the brakes or tires, place the block at the front and rear of the tire farthest away from the one being serviced, that is, the tire on the opposite side of the truck and at the opposite end.

- Refer to general maintenance, safety and battery safety instructions, starting on page 1-1.

Disconnect the battery. Never place a tool or any metal object on top of the battery where it could possibly touch battery terminals causing a short or serious electrical shock.

Mast and Front Plate Assemblies

Forks

Removing Forks

- First, review "Getting Started (Please Read)," on page 1-1.
- Slide the fork so the hook on the fork lines up with the notch on the bottom of the carriage.
- Pull the fork tine upward until the hook is free of the carriage (See Figure 3-1).

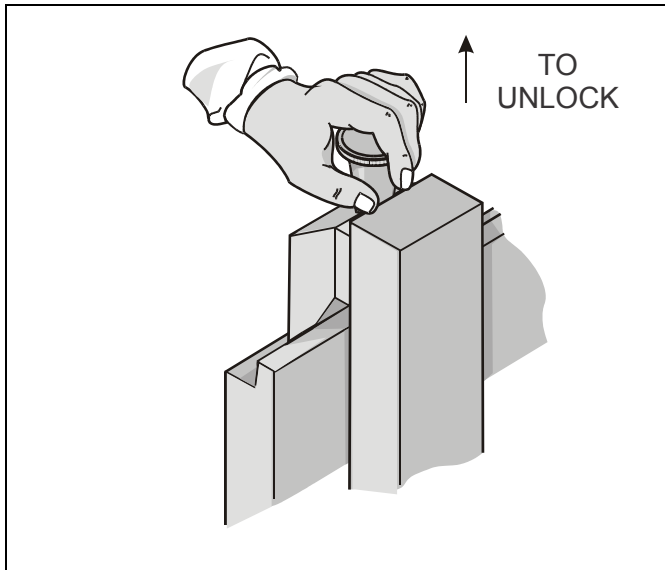


Figure 3-1: Changing Forks

NOTE

As an alternate method, raise the forks a few inches from the floor and place a block of wood under the fork. Slowly lower the forks. The block of wood lifts the fork to unhook it from the carriage.

4. Lift the fork off the carriage. Various forks can be heavy - use adequate lifting apparatus or ask for a helper as needed.
5. To replace the forks, perform steps 1 through 3 in reverse order.

Repairing Forks

The following information is provided for authorized service facilities ONLY. If you suspect that a fork needs to be repaired, return it to the manufacturer or other expert of equal competence, for repair. Never try to repair surface cracks or wear by welding the fork. If you need to reset a fork, make sure it is heat treated before it is returned to service.

Load Testing Forks

The following information is provided for authorized service facilities ONLY. A fork that has undergone repairs, other than repair or replacement of the positioning lock and/or marking, must be load tested before it is returned to service. The testing facility must test the forks according to paragraph 7.25.3 (ASME B56.1-2000) except that the test load must be 2.5 times the rated capacity marked on the fork.

Mast



WARNING

Only trained and experienced technicians or your Landoll service representative must be allowed to service the mast assembly. Never place any part of one's body into the working area of the mast. Never work on the mast while it is loaded; remove the load first. Observe all safety precautions while operating the overhead crane and lifting apparatus.

Removing the Mast From the Truck

To remove the mast, the work area must be clean and clear of obstacles, large enough to lay the mast horizontally, have a concrete floor and an overhead crane and frame rated to at least three (3) tons and three or four 6" x 6" x 48" (53 mm x 53 mm x 1,219 mm) solid planks of wood.

It is recommended to thoroughly steam clean the mast, removing all dirt, debris and grease.

Record the roller clearances and chain adjustments before removing the carriage or rails.

Make notes as you disassemble the mast while referring to "Supplier Provided Documentation (Duplex)," starting on page 5-1 or "Supplier Provided Documentation (Triplex)," starting on page 6-1. A separate manual is available for the quadplex masts.

1. First, review "Getting Started (Please Read)," on page 1-1.
2. Remove the forks. Review "Removing Forks," on page 3-5.
3. Remove the four bolts and hardware holding the backrest to the mast. Carefully remove the backrest; it can be heavy - use adequate lifting apparatus or ask for a helper.
4. Pivot mast to the right. Remove 1/2-20 x 3/4 hex socket set screw from mast hooks (See Figure 3-3 on page 3-23).
5. At the mast, disconnect the lift cylinder hose (1).
6. Oil will drain from the cylinder lines and the hoses. Have shop rags handy to clean oil spills. Plug and/or cap the cylinder ports and hoses to prevent further oil drainage. Tag each hose for identification.

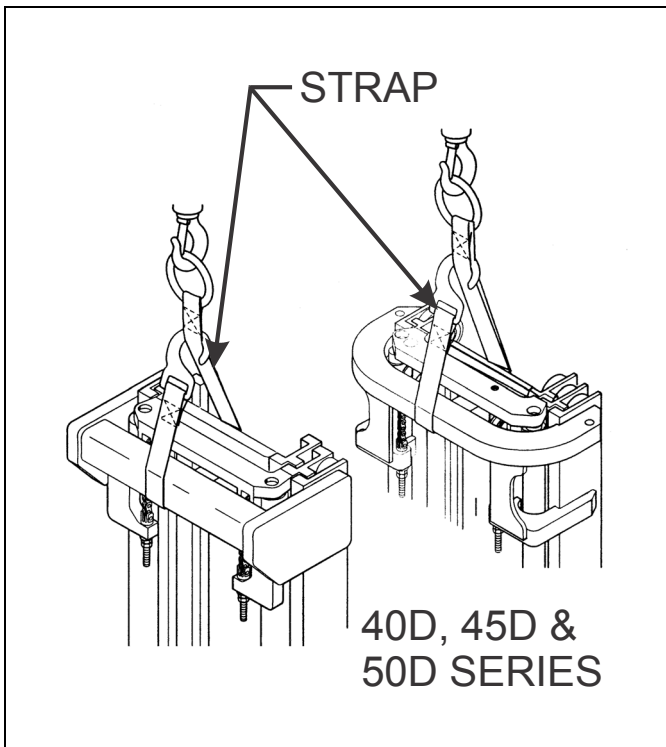


Figure 3-2: Supporting the Mast

7. Attach an overhead crane and strap, rated to 3 tons, and apply slight lift to the mast as shown in Figure 3-2.
8. Remove the four hex head cap screws (3/4-16 x 4") and hardware (See Figure 3-3 on page 3-23).
9. Raise the mast enough to release the mast hooks from their supports.



WARNING

The mast may swing from the lift truck, be alert and cautious!

10. Lay the mast horizontally, carriage side facing up, across three or four 6" x 6" x 48" (53 mm x 153 mm x 1,220 mm) planks of wood.

NOTE

Be careful! If top of mast is lower than the bottom of mast when laying flat, the carriage will slide to the top, causing damage to the mast or even injury. It is recommended to secure the carriage to the mast if possible.

11. Dismantle, clean and inspect the mast assemblies and subassemblies as instructed in "Supplier Provided Documentation (Duplex)," beginning on page 5-1 or "Supplier Provided Documentation (Triplex)," beginning on page 6-1.
12. Reassemble the mast in reverse order, using your notes as necessary.

13. Before returning the mast to service, perform all adjustment procedures listed in enclosed "Supplier Provided Documentation (Duplex)," beginning on page 5-1 or "Supplier Provided Documentation (Triplex)," beginning on page 6-1.

Mast Carriage Assembly

This section explains servicing the:

Pivot Cylinder - See Figure 3-6 on page 3-26.

Traverse Drive Motor - See Figure 3-7 on page 3-27.

Traverse Countershaft Weldment - See Figure 3-6 on page 3-26.

A 3 ton (6,000 lb/2,722 kg.) overhead crane is required to adequately support the mast and/or the front end weldment when separating it from the truck front rotation arm. Hydraulic jacks or a large block of wood and portable hydraulic press are also necessary.

This service is best performed at a service center as opposed to the customer facility.

Removing Carriage Weldment Assembly

1. First, review "Getting Started (Please Read)," on page 1-1.
2. Hook up a hoist to the mast and put slight tension on the strap.
3. Remove and mark the hoses to the tilt cylinder (Figure 3-4 on page 3-24).

NOTE

Cap and plug the hoses and cylinder to keep dirt out.

4. Remove tilt cylinder pin weldment (See Figure 3-4).

NOTE

Mast will be free and will be able to move back and forth.

5. Remove mounting hardware for tilt cylinder and remove cylinder.
6. Remove pivot cylinder pin weldment (See Figure 3-3).

NOTE

Mast will be free to swing back and forth.

7. Remove and mark hoses to pivot cylinder (See Figure 3-6).

NOTE

Cap and plug the hoses and cylinder to keep dirt out.

8. Remove carriage pivot cylinder pin (See Figure 3-6) and remove cylinder.
9. Swing out the mast and masthead weldment (See Figure 3-3).

10. Remove and mark the hoses at the bulkhead fittings on the masthead weldment.

NOTE

Cap and plug the hoses to keep the dirt out.

11. Remove the masthead hose strap (See Figure 3-2 on page 3-20).
12. Remove cotter pin and castle nut from main rotation pin weldment (See Figure 3-5).

NOTE

Make sure to note the order and number of spacers between the masthead weldment and the mast tilt trunnion.

13. Using the hoist lift up the mast and the masthead weldment until the main rotation pin weldment becomes free (See Figure 3-4).
14. Remove main rotation pin weldment.

NOTE

The mast and masthead weldment assembly should swing free from the carriage weldment assembly and needs to be set to the side out of the way in a safe manner.

15. Remove the hose guard weldment (See Figure 3-7).
16. Remove the traverse motor cover plate.
17. Remove all the hoses from the carriage weldment assembly so that they are just coming out of the hydraulic hose carrier (See Figure 3-8).
18. Remove the hydraulic hose carrier from the carriage weldment assembly.
19. Remove the left hand carriage stop weldment (See Figure 3-8).
20. Put a strap completely around the carriage weldment assembly and hook it to a hoist.
21. Using the hoist as support, push the carriage weldment assembly to the left side of the truck for removal.
22. Reassemble in reverse order.

Removing the Tilt Cylinder

1. First, review "Getting Started (Please Read)," on page 1-1.
2. If the cylinder is being removed, disconnect the two hydraulic hoses from the tilt cylinder, shown in See Figure 3-4. Cap and plug the hoses and cylinder ports. Also tag the hoses for identification. Have rags handy to soak up oil spills.
3. Mark the location of the cylinder jam nut for reassembly to the new cylinder.

NOTE

The jam nut is usually at the end of the threads closest to the barrel of the cylinder.

4. On the mast end of the cylinder, remove the bolt and hardware from the tilt cylinder pin weldment and remove the pin from the tilt cylinder clevis (See Figure 3-4).

NOTE

If mast has not been removed, the mast and masthead weldment will fall forward to main rotation pin placement.

5. Remove bolts (4) from tilt cylinder mounts and remove cylinder.

NOTE

To repair the tilt cylinder, replace seals, wiper, o-rings, etc., see SL Series Parts Manual (F-624).

6. Reconnect cylinder to mast assembly in reverse order.

Removing the Pivot Cylinder

1. Remove pivot cylinder pin weldment (See Figure 3-3).
2. Swing mast out by hand fully and block so it will not close during maintenance.

NOTE

The end of cylinder will fall down.

3. Mark and unhook hydraulic hoses (2). Cap and plug cylinder and hose lines.
4. Remove carriage pivot cylinder pin (See Figure 3-6).
5. To repair pivot cylinder, see SL Series Parts Manual (F-624).
6. Replace damaged parts and put back together in reverse order.

Removing the Traverse Drive Motor

1. Remove traverse motor cover plate (See Figure 3-7).
2. Mark and unhook hydraulic hoses (2). Cap and plug cylinder and hose lines.
3. Remove 1/2-20 x 4-1/2 hex head cap screws (See Figure 3-7).
4. Remove and replace traverse drive motor.
5. Reassemble in reverse order.

TROUBLESHOOTING AND CORRECTIVE MAINTENANCE

Removing Main Rotation Pin Bearings

1. Remove Carriage Weldment Assembly as described in steps 1 - 14 on page 3-20.
2. Remove front rotation seals (See Figures 3-4 and 3-5).
3. Remove and replace front rotation bearing cones.

NOTE

Pre-pack the bearings with grease before replacing. Bearing cups and cones should be replaced as a set.

4. Reassemble in reverse order.

Removing Traverse Pin Weldment

1. Remove Carriage Weldment Assembly as described in steps 1-14 in "Removing Carriage Weldment Assembly," on page 3-20.

NOTE

It is easier to realign the traverse pin weldment when putting the traverse weldment assembly back together on the traverse racks if the carriage weldment assembly is off.

2. Remove the mounting hardware for the traverse pin weldment (See Figure 3-6).
3. Remove the traverse weldment assembly (traverse pin weldment, bushings, traverse countershaft weldment, and spacers).
4. Reassemble in reverse order.

Removing Cam Followers

1. Remove Carriage Weldment Assembly as described in steps 1 - 14 on page 3-20.
2. Remove and replace failed cam follower (See Figure 3-6).

NOTE

There are two different sizes of cam followers on the carriage weldment assembly. Be sure to replace with the correct size.

3. Reassemble in reverse order.

Removing the Traverse Rack

1. Remove Carriage Weldment Assembly as described in steps 1-14 in "Removing Carriage Weldment Assembly," on page 3-20.
2. Remove mounting hardware holding traverse rack to the upper or lower rack weldment (See Figure 3-8).
3. Remove and replace traverse rack.
4. Reassemble in reverse order.

Removing Wear Strip Bar

NOTE

The following applies only to truck with hardened wear strips. If there are any questions, consult Landoll Corporation.

1. Remove Carriage Weldment Assembly as described in steps 1-14 in "Removing Carriage Weldment Assembly," on page 3-20.
2. Remove old wear strip (See Figure 3-8) that needs replaced.
3. Clean up welding area of all paint, etc.

NOTE

When rewelding the wear strips back on you must use stainless steel welding wire or the wear strip will not stay on after use.

4. Weld on new wear strip.
5. Reassemble in reverse order.

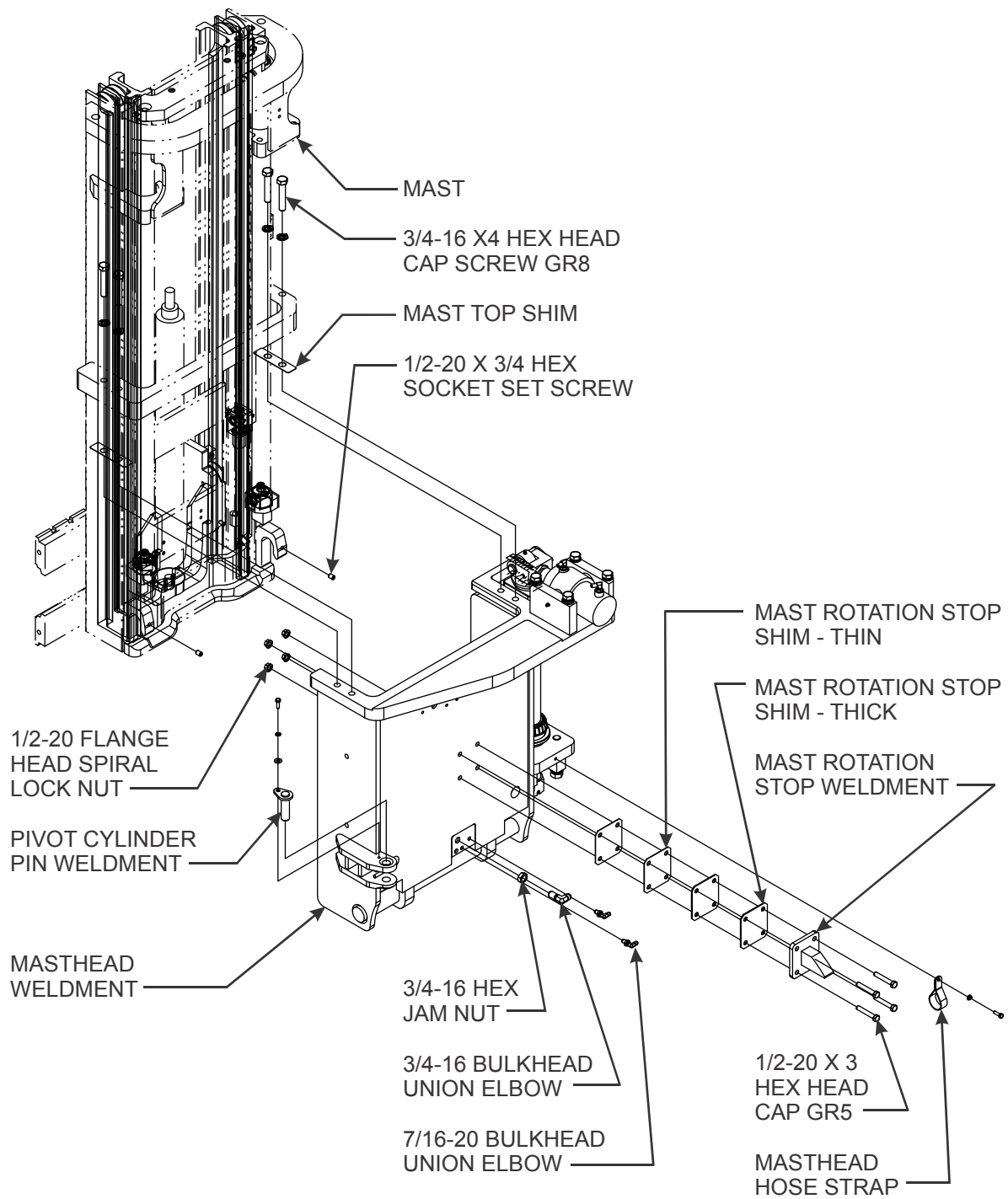


Figure 3-3: Masthead Assembly (1 of 3)

TROUBLESHOOTING AND CORRECTIVE MAINTENANCE

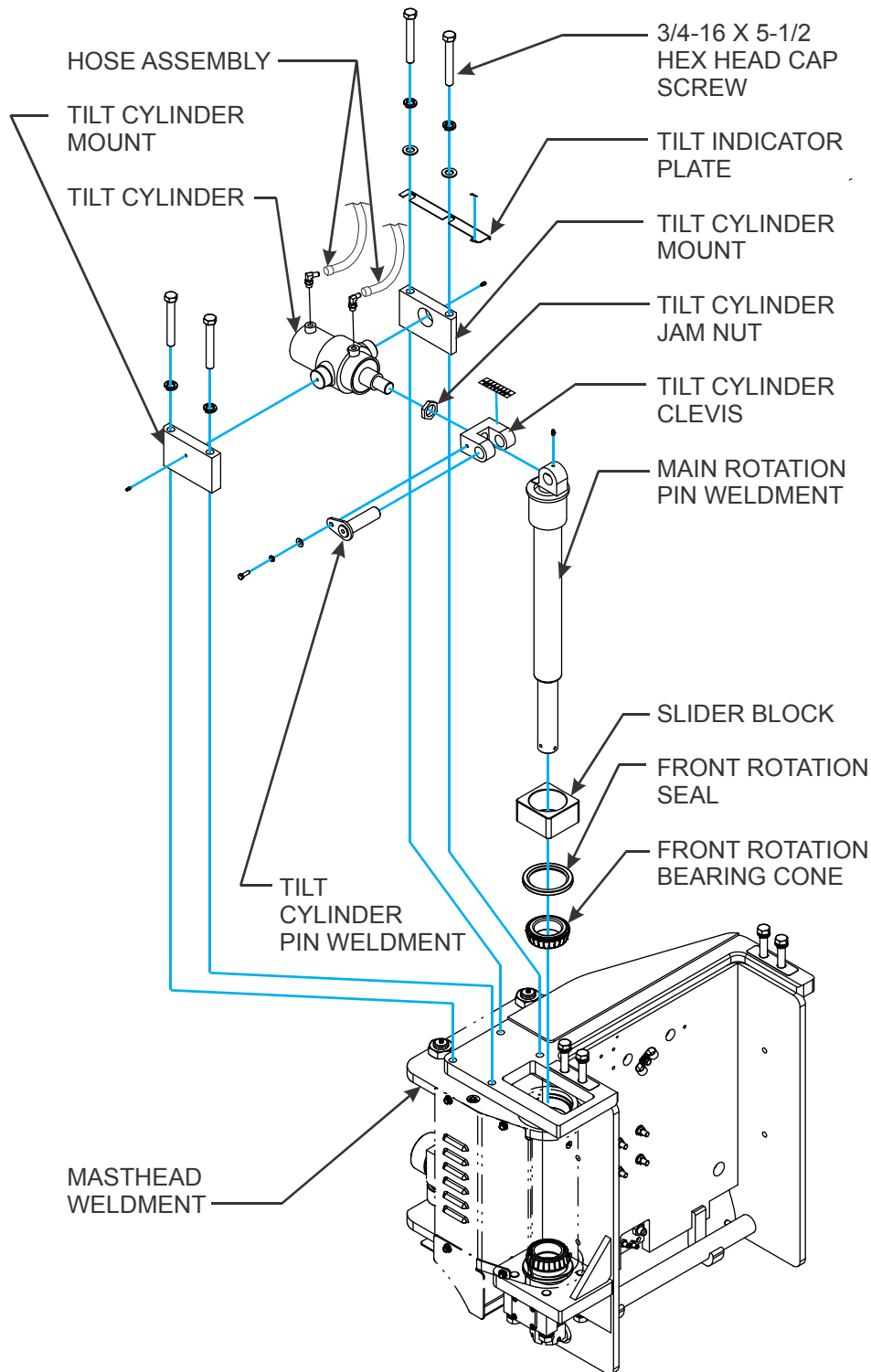


Figure 3-4: Masthead Assembly (2 of 3)

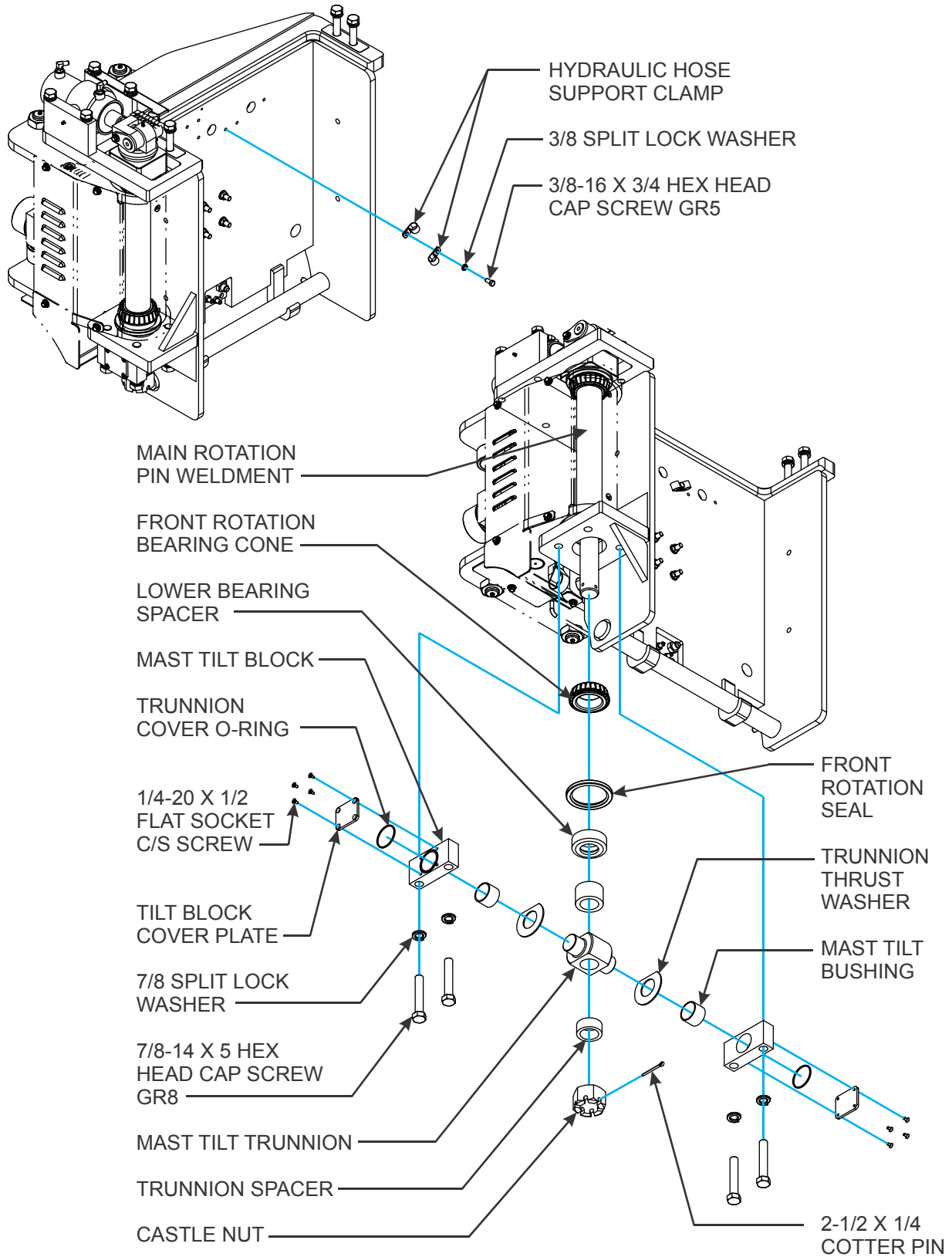


Figure 3-5: Masthead Assembly (3 of 3)

TROUBLESHOOTING AND CORRECTIVE MAINTENANCE

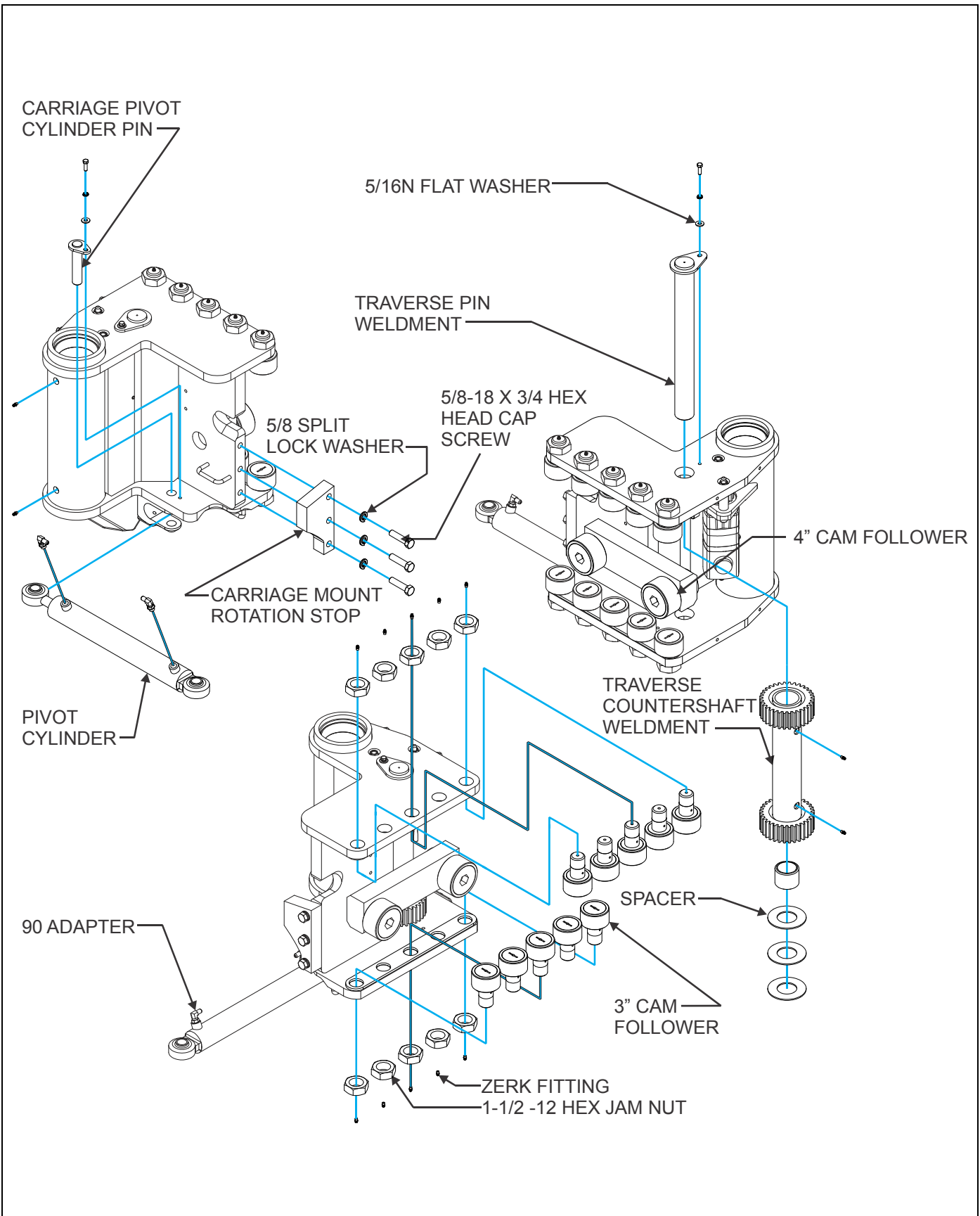


Figure 3-6: Carriage Assembly (1 of 2)

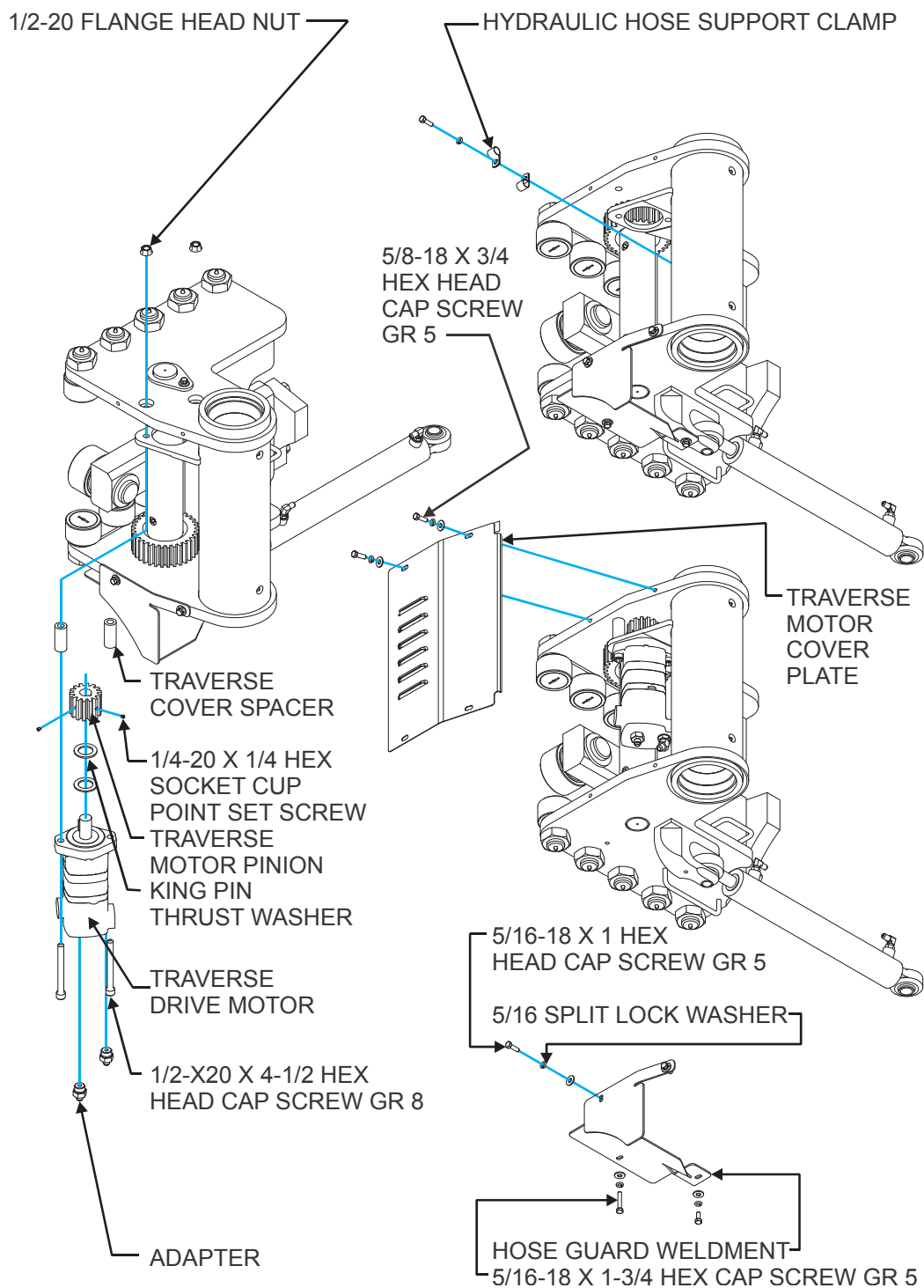


Figure 3-7: Carriage Assembly (2 of 2)

TROUBLESHOOTING AND CORRECTIVE MAINTENANCE

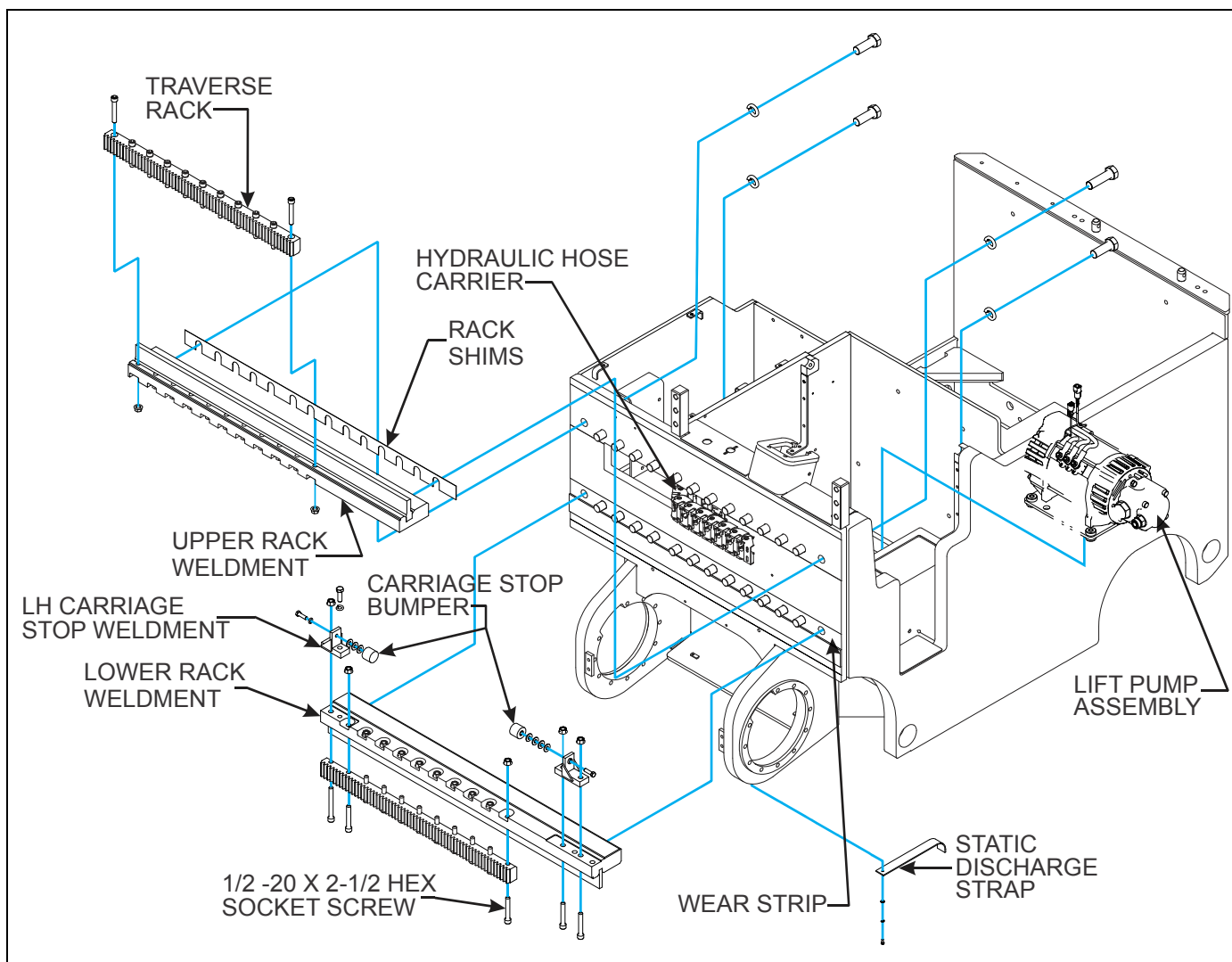


Figure 3-8: Hydraulic Hose Carrier and Rack Installation

Brake System Service



WARNING

Safety must always be paramount when working on brake system components.

Do not use parts that do not appear to be in perfect working condition. It is recommended to use only Landoll genuine replacement parts.

Whenever servicing a brake component, it is recommended to service both sides of the truck to prevent premature wear and uneven braking action.

If you are unsure about a procedure, seek professional help. Contact your Landoll service representative.

Wear eye protection. If brake fluid comes in contact with your eyes, immediately rinse them with water and seek medical attention.

Use only DOT #3 brake fluid.

Brake fluid will damage paint. Cover all body parts and be careful not to spill fluid during this procedure.

Brake Caliper Assembly



WARNING

Brake pads must be replaced on both wheels at the same time. NEVER replace the pads on only one wheel.

Do not, under any circumstances, use petroleum-based solvents to clean brake parts. Use only brake cleaner or denatured alcohol.

Do not use compressed air to blow dust particles from the brake assembly.

Make sure you strictly adhere to all clearances and torque specifications.

When you are finished working on the brakes, test them carefully under controlled conditions before releasing the truck for operation.

If the contact surfaces of the rotor show cracks, score marks, deep grooves, a raised lip on the outer edge, or signs of overheating or warping, the rotor must be replaced.

If a problem is suspected, do not release or drive the truck until the problem is corrected.

Changing Brake Pads

1. First, review "Getting Started (Please Read)," on page 1-1.
2. Set the keyswitch to OFF and place the key in a secured location away from the lift truck.
3. Apply the parking brake and disconnect the battery.
4. Make sure all the other wheels are securely blocked so that the truck cannot move.
5. Remove the brake rotor shield (See Figure 3-9).
6. Remove floor plates (See "Floor Plate Removal," on page 3-55)

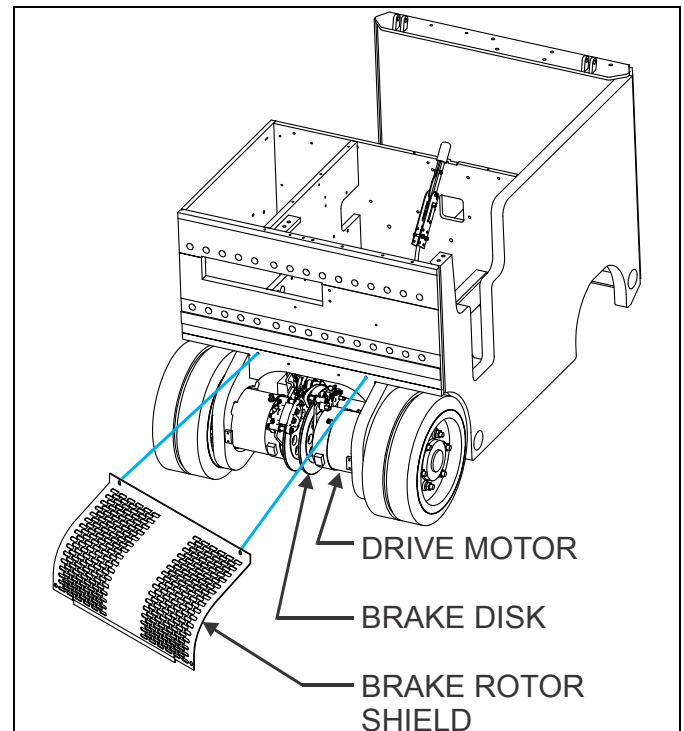


Figure 3-9: Removing Brake Rotor Shield

NOTE

It is recommended to do this to easily access the LH brake caliper assembly.

7. Remove the 3/8 X 24 X 1-1/2 hex headed cap screws securing the brake caliper assembly to its mounting plate (See Figure 3-10). Capture the spacers within the mounting holes and keep any shims separate for each side.
8. If preferred, although not necessary, disconnect the brake lines, using a flare-nut wrench. Plug or cap the ends to avoid fluid loss and contamination. Have a container and shop rags handy to soak up any spilled brake fluid.

TROUBLESHOOTING AND CORRECTIVE MAINTENANCE

IMPORTANT

DO NOT spill brake fluid over the caliper housing. Brake fluid will damage paint. Cover all body parts and be careful not to spill fluid during this procedure.

NOTE

Flare-nut wrenches should be used as they wrap around the nut to prevent rounding off the flats.

9. Remove the two outer hex head screws and hardware to allow pads to be removed from caliper assembly (See Figure 3-10).
10. Remove both old disk brake pads.
11. Push the piston into the caliper bore to provide clearance between the new brake pads and the rotor during assembly.
12. Check the contact surfaces of the rotor for cracks, score marks, deep grooves, a raised lip on the outer edge, signs of overheating or rotor run-out. If any of these are present, the rotor must be replaced (See "Disc Brake Rotors" on page 3-32).

Also look for surface glazing, grease or brake fluid on the brake pad contact surfaces. Grease and brake fluid can be removed using denatured alcohol or brake cleaner. However, the pads must be replaced if they are contaminated.

Surface glazing, which is a glossy, highly polished finish, can be removed with medium grit emery cloth (100-120 grit).

13. Check the brake lines for cracking or splits, any apparent weakness - replace as needed.
14. Check both brake caliper pistons for signs of fluid leakage, indicating a defective seal which must be repaired.

NOTE

If caliper assembly must be taken apart to repair leaks, all caliper seals and o-rings must be replaced.

15. Install the new brake pads and reassemble the caliper (two outer hex head screws and hardware). Torque the screws to the specifications shown on page 1-9.
16. Install the brake caliper assembly to its brake caliper mount (See Figure 3-10). Ensure correct number of shims are installed between caliper and mount. Pads should have the same clearance from the disk prior to actuation of brakes.
17. Bleed the brake if any brake lines have been disconnected (See "Bleeding Brakes" on page 3-53).
18. Top off the master cylinder with brake fluid (See "Check the Brake Fluid Level" on page 2-10). Pump the brakes several times to seat the new brake pads.

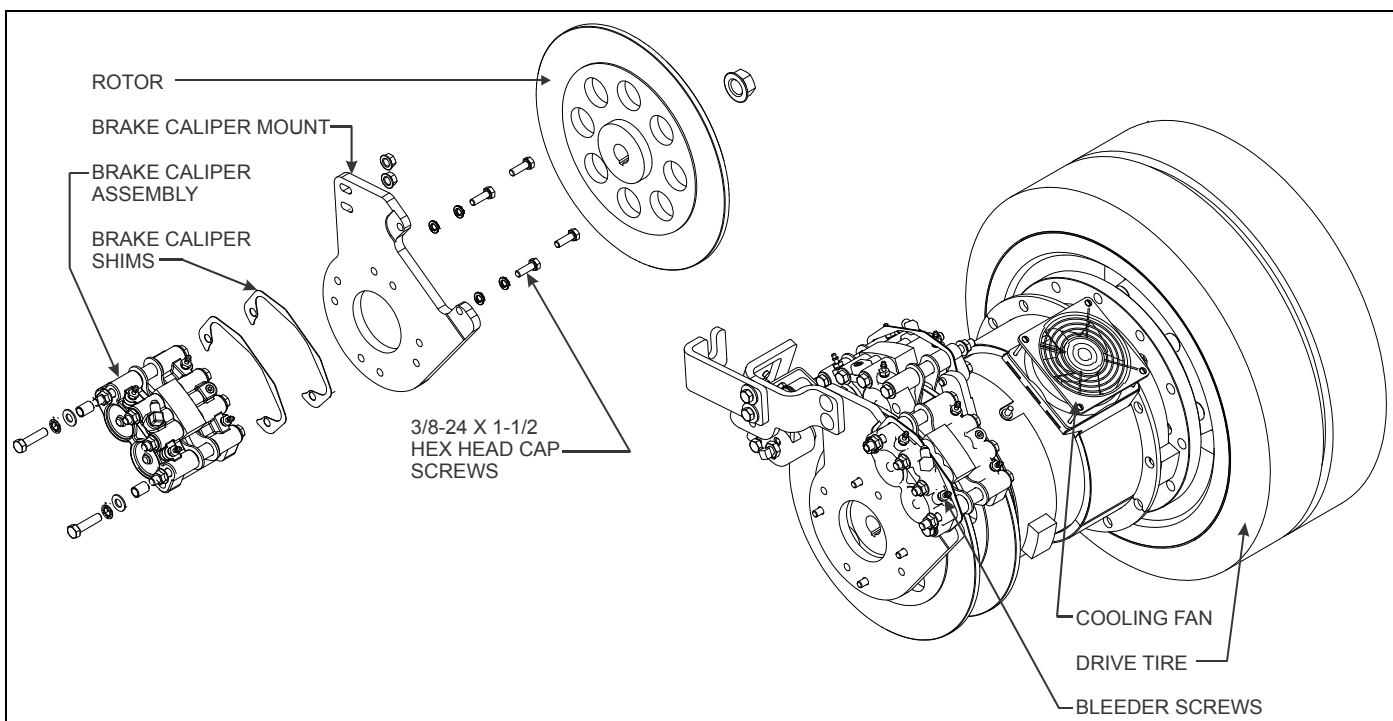


Figure 3-10: Disc Brake Assembly Overview

19. Reassemble and check the truck. Connect the battery and check for proper brake operation as follows:
 - Raise and block the truck off the ground.
 - Accelerate the forklift to full speed.
 - Apply the brakes to quickly STOP the wheels.
 - Release the brake pedal after the wheels stop, then accelerate again to full speed.
 - Release the accelerator pedal to allow the truck to coast to a stop.
 - Both wheels should stop very closely together (around the same time).
 - Repeat this procedure two times in forward and in reverse directions.
20. If the forklift does not perform as stated above, reinspect the brake calipers for wear (See "Service Brakes" on page 2-10).
21. Return the truck to the ground. Make a few normal stops in forward and reverse to allow the brakes to further seat themselves. DO NOT lock the brakes as this may cause flat spots.

Replacing the Brake Caliper Assembly

IMPORTANT

Whenever servicing or replacing a caliper assembly, it is recommended to service both sides of the truck to prevent premature wear and uneven braking action.

It is recommended when replacing a brake caliper assembly to purge the entire brake system of old, possibly contaminated fluid.

1. Repeat steps 1 through 8 of preceding section "Changing Brake Pads," on page 3-29 to remove the brake caliper assembly.
2. Install the new caliper assembly in reverse order making sure the brake pads are properly installed.
3. Bleed the brakes ("Bleeding Brakes," on page 3-53). It is recommended when replacing a brake caliper assembly to purge the entire brake system of old, possibly contaminated fluid.
4. Repeat Steps 19 through 21 of preceding section "Changing Brake Pads," on page 3-29.

Repairing Brake Caliper Pistons

If the brake caliper piston freezes-up or shows signs of leaking, it must be repaired or replaced before returning the truck to operation.



WARNING

Whenever servicing and/or replacing a caliper assembly or internal parts, you must service both sides of the truck to prevent premature wear and uneven braking action.

1. Repeat steps 1 through 8 of the preceding section "Changing Brake Pads," beginning on page 3-25.
2. Remove the brake caliper assembly from the truck and place on your workbench.
3. Stuff shop rags and a block of wood into the caliper to catch the piston, then lightly apply compressed air to the inlet port.

IMPORTANT

DO NOT apply too much air pressure to the bore, or the piston may jump out, causing damage to the piston and/or injury. Be absolutely sure to keep fingers away from the piston while air is being applied.

4. Once the piston pops free, remove the O-ring seals and discard. Be careful not to scratch metal surfaces. Do not use metal tools when removing the seal.
5. Remove both bleeder screws.
6. Inspect the piston and the caliper housing bore for corrosion, worn plating, scoring, nicks, etc. Crocus cloth can be used to polish out light corrosion only. Beyond that, the entire brake caliper assembly must be replaced.
7. Thoroughly wipe out the bore area and clean all parts, then lubricate the piston, caliper and O-ring seal with fresh, clean Dot #3 brake fluid ("Lubrication Specifications," on page 1-9).
8. Install the O-ring seal to the piston and slide the piston into the housing bore. Make sure the O-ring seals do not twist as the piston is inserted.
9. Bottom the piston into the bore, then install new brake pads.
10. Bleed the brakes (See "Bleeding Brakes," on page 3-53).
11. Repeat Steps 19 through 21 of preceding section, "Changing Brake Pads," on page 3-29.

Disc Brake Rotors



WARNING

Whenever servicing and/or replacing a rotor assembly, you must service both sides of the truck to prevent premature wear and uneven braking action.

Repeat steps 1 through 5 of preceding section "Changing Brake Pads," on page 3-29.

Check the rotors for scoring, cracks, deep grooves, a raised lip on the outer edge, signs of overheating, rotor run-out or other damage. Rotor run-out should be measured while the rotor is installed.

Rotor thickness measurements may be checked with the rotor installed or removed from the truck. Use a dial gauge to check run-out. Use a calibrated micrometer, calibrated in ten-thousandths of an inch, to check thickness.

Measure Thickness

Measure thickness, using a micrometer, at four or more points on the rotor and make sure all measurements are taken at the same distance in from the outer edge of the rotor.

Thickness variations of more than 0.0005" (0.013 mm) can cause pedal pulsation and/or vibration when applying the brakes. A rotor that does not meet these specifications, must be replaced.

Check Lateral Run-Out (Warping)

1. Raise, jack up, and block both sides of the truck to allow the drive wheel to rotate freely (See "Lifting and Blocking the Truck," on page 1-7).
2. Secure the dial indicator to the drive wheel electric motor casing so the indicator button contacts the rotor at about 0.50" (13 mm) from the outer edge of the rotor. Set the dial indicator to zero (See Figure 3-11).
3. Turn the rotor (wheel/tire) by hand one or two complete revolutions and observe the total indicated run-out.
4. If the run-out exceeds 0.0031" (0.08mm), replace the rotor. **Do not resurface the rotor** - see Replacing Brake Rotor Assemblies.

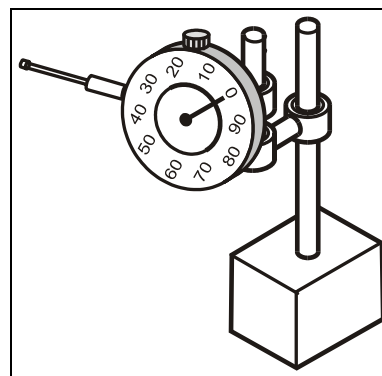


Figure 3-11: Dial Indicator

Replacing Brake Rotor Assemblies

1. Repeat Steps 1 through 8 of preceding section "Changing Brake Pads," on page 3-29.
2. Remove brake caliper assembly.

IMPORTANT

To remove the rotor, the use of a pry bar and a rubber mallet (dead-blow hammer) will be required. **DO NOT USE an unprotected hammer. Damage to the rotor will occur, rendering it unserviceable.**

3. Loosen the flanged hex nut (3/4-16, Grade 8) and hardware from the motor shaft (See Figure 3-12). **DO NOT** remove the nut from the assembly at this time.
4. Drive pry bar between non-machined surface of the rotor and the drive motor, where the brake caliper is mounted (See Figure 3-12).
5. Using the rubber mallet (dead-blow hammer), hit the rotor on the opposite side, driving it towards to loosened nut.
6. Repeatedly hit the rotor evenly in a circular motion until it pops free, then remove the nut.

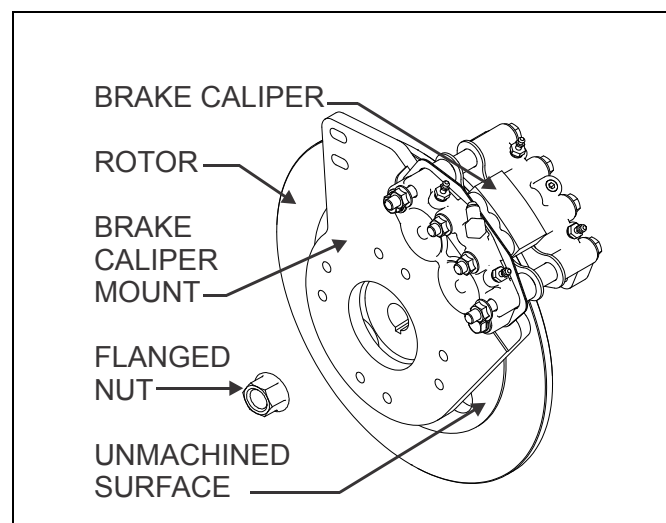


Figure 3-12: Rotor Assembly

- One of the drive motors must be removed before removing the rotor from the armature.

IMPORTANT

The removal of the drive motor can be done as a completed assembly. It needs only to be slid out just enough for the rotor to clear.

- Slide the rotor assembly from the keyed drive shaft and discard. **Do not** lose the woodruff key.

IMPORTANT

When handling the new rotor, protect the finish surfaces from damage, such as nicks, deep scratches, dents from dropping, corrosion, etc. Damage to the braking surfaces renders the rotor defective.

- Install the new rotor to the keyed drive shaft. Install, tighten and torque the flanged hex nut (See "Torque Specifications" on page 1-9).

NOTE

Make sure there is no grease on the shaft/nut area before installing and torquing the nut.

- Reassemble in reverse order.
- Bleed the brakes (See "Bleeding Brakes" on page 3-53).
- Repeat Steps 19 through 21 of preceding section "Changing Brake Pads," on page 3-29.

Parking Brake Assembly

The parking brake assembly includes:

- Parking Brake Lever
- Parking Brake Switch
- Parking Brake Cable
- Parking Brake Caliper Assembly

Parking Brake Lever

The amount of horizontal travel of the parking brake lever should allow the lever to move from the vertical position down to the horizontal position, having the brake fully applied in the horizontal position.

**CAUTION**

Adjusting the parking brake lever too tight will overheat brake rotors causing premature wear; or overheat the drive motors, causing premature failure.

Checking Parking Brake Adjustment

- First, review "Getting Started (Please Read)," on page 1-1.
- Set the keyswitch to OFF, then place the key in a secured location away from the lift truck and disconnect the battery.
- Block all wheels.
- Raise the right side of the truck until the front drive tire clears the floor by no more than 1" (25.4 mm) - see "Lifting and Blocking the Truck," on page 1-7.
- Pull back on the parking brake lever as far as possible using moderate force (See Figure 3-13). The amount of horizontal travel should allow the lever to snap into the near full horizontal position. The right front wheel should not turn when attempting to turn by hand.

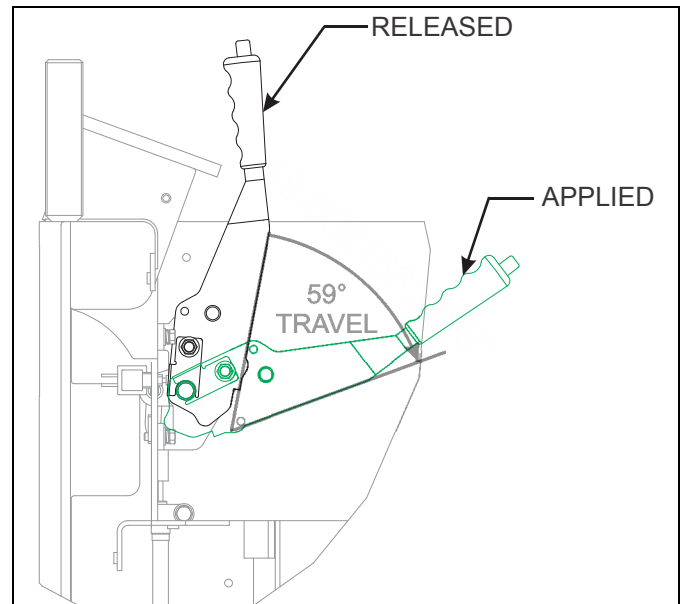


Figure 3-13: Parking Brake Travel

**WARNING**

Before reaching in to turn the wheel, make sure the truck has sat idle long enough to cool. Various parts can get extremely hot during operation. Also make sure you are wearing appropriate work gloves.

- Release the parking brake by pushing the button as the lever is pulled backward. Then allow the handle to move back into the upright position before releasing the button.
- Brake adjustments are done at the rotor. No adjustments are necessary at the lever.
- If this test fails to lock the wheels from movement, see "Adjusting Parking Brake Caliper," on page 3-35.

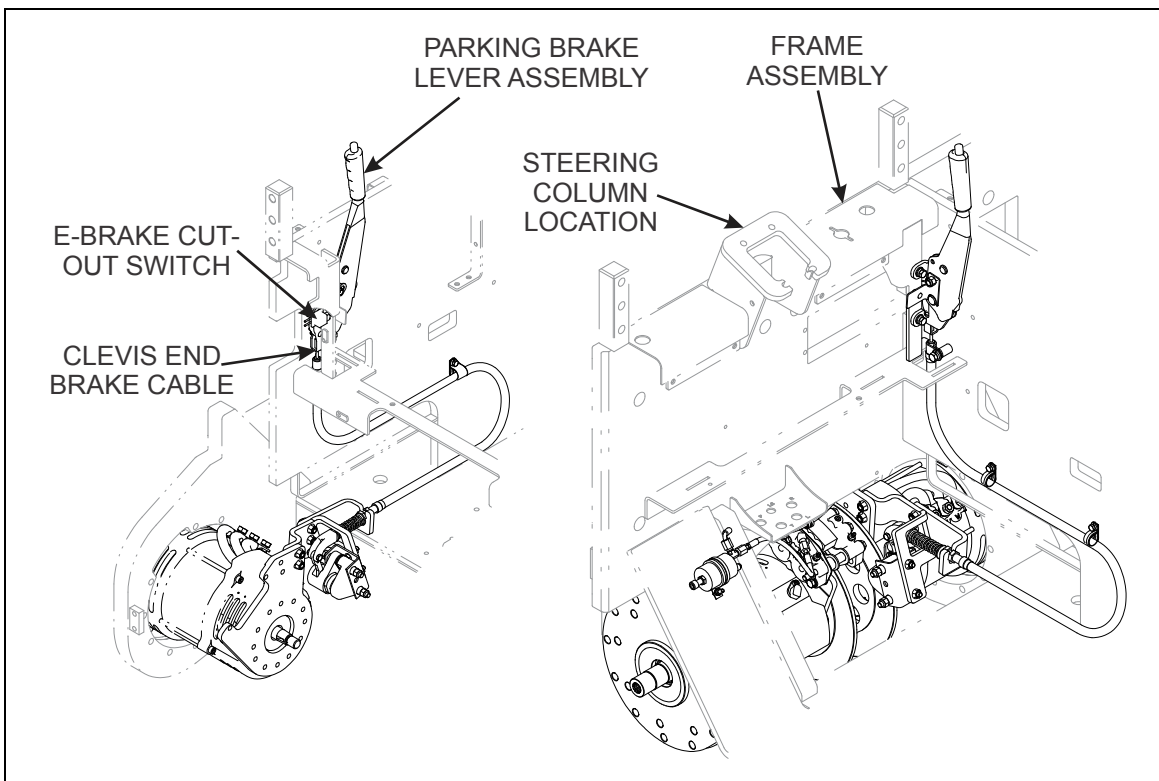


Figure 3-14: Parking Brake Handle

Parking Brake Switch

The parking brake switch electrically resets the controller to its neutral state.

Checking Parking Brake Switch

1. First, review "Getting Started (Please Read)," on page 1-1.
2. Set the keyswitch to OFF and place the key in a secured location away from the lift truck.
3. Disconnect the battery.
4. Make sure all the other wheels are securely blocked so that the truck cannot move.
5. Remove the lower dash cover weldment (See Figure 3-41 on page 3-59).
6. Disconnect e-brake cutout switch connector.
7. Connect the ohm meter leads to the switch wires.

NOTE

The meter should show less than 1 ohm.

8. Slowly pull up on the brake lever, the meter reading must be "OPEN", indicating the switch is released before the lever reaches its full locking position.

IMPORTANT

If the meter does not read "OPEN", the switch needs to be replaced (See "Replacing Parking Brake Switch" on page 3-34).

9. Disconnect the ohm meter.
10. Reassemble in reverse order.

Replacing Parking Brake Switch

1. First, review "Getting Started (Please Read)," on page 1-1.
2. Set the keyswitch to OFF and place the key in a secured location away from the lift truck.
3. Apply the parking brake and disconnect the battery.
4. Make sure all the other wheels are securely blocked so that the truck cannot move.
5. Remove the lower dash cover weldment to expose the parking brake mechanics.
6. Disconnect the switch at the wire connector and unscrew the switch from the dash.
7. Install the new switch in reverse order and tighten the jam nut.
8. Connect the switch at the connector.

IMPORTANT

The plunger is preset and has no adjustment. It is always activated in the resting position.

9. Reassemble in reverse order.
10. To check the operation of this switch:
 - Start the truck and release the parking brake.
 - Set the control lever to FORWARD and very slowly increase motor speed.
 - As the truck is moving forward at slow speed, slowly pull up on the brake lever.
 - The truck must immediately slow to a STOP.
 - If the truck continues moving forward, recheck the setting and operation of the switch.

**WARNING**

DO NOT release or operate the truck if you are in doubt about the effectiveness of the parking brake system. Contact a Landoll service representative for assistance.

Replacing the Parking Brake Cable

1. First, review "Getting Started (Please Read)," on page 1-1.
2. Set the keyswitch to OFF and place the key in a secured location away from the lift truck.
3. Disconnect the battery.
4. Make sure all the other wheels are securely blocked so that the truck cannot move.
5. Remove floor plates (See "Floor Plate Removal" on page 3-55) and lower dash cover weldment to expose the parking brake mechanism.
6. Remove the cable from the truck noting how the cable is positioned (See Figure 3-15).
7. Feed the new cable from the parking brake lever to the wheel motor in the same manner as the one removed, then connect both ends.
8. Adjust the parking brake cable - see "Adjusting Parking Brake Caliper," on page 3-35.
9. Reassemble in reverse order.

**WARNING**

DO NOT release or operate the truck if you are in doubt about the effectiveness of the parking brake system. Contact your Landoll service representative for assistance.

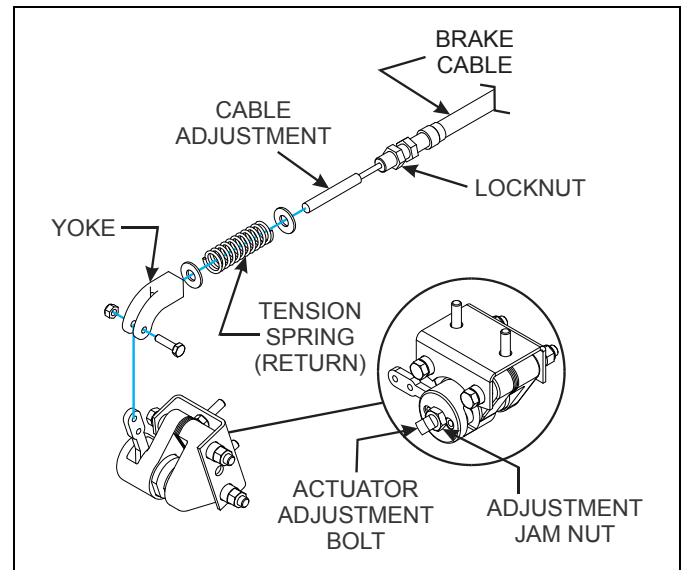


Figure 3-15: Parking Brake Cable - Caliper End

Parking Brake Caliper Assembly

The parking brake caliper assembly is used for holding the forklift in place while the driver is not there after it is activated by pulling the park brake lever.

Adjusting Parking Brake Caliper

1. First, review "Getting Started (Please Read)," on page 1-1.
2. Set the keyswitch to OFF, then place the key in a secured location away from the lift truck and disconnect the battery.
3. Make sure all the other wheels are securely blocked so that the truck cannot move.
4. Remove floor plates (See "Floor Plate Removal" on page 3-55).
5. Loosen adjustment bolt jam nut (See Figure 3-15).
6. Adjust actuator adjustment bolt to desired position (See Figure 3-15).
7. Tighten adjustment bolt jam nut.
8. Reassemble in reverse order.

Changing Parking Brake Pads or Replacing Parking Brake Caliper

1. First, review "Getting Started (Please Read)," on page 1-1.
2. Set the keyswitch to OFF, then place the key in a secured location away from the lift truck and disconnect the battery.
3. Make sure all the other wheels are securely blocked so that the truck cannot move.
4. Remove floor plates (See "Floor Plate Removal" on page 3-55)

TROUBLESHOOTING AND CORRECTIVE MAINTENANCE

5. Remove 3/8-16 x 1-1/4 round head square neck screws and nuts from park brake bracket (See Figure 3-21 on page 3-41).

IMPORTANT

The parking brake caliper and bracket will be loose when hardware is removed. Remove the parking brake caliper carefully so that the caliper pads, backing plate, and actuator pin do not fall out.

6. Either remove caliper for replacement or replace brake pads with new ones.
7. Reassemble in reverse order.
8. Adjust caliper (See "Adjusting Parking Brake Caliper" on page 3-35).

Replacing Any Other Hydraulic Brake Component

1. First, review "Getting Started (Please Read)," on page 1-1.
2. Set the keyswitch to OFF and place the key in a secured location away from the lift truck.
3. Apply the parking brake and disconnect the battery.
4. Make sure all the other wheels are securely blocked so that the truck cannot move.
5. Remove floor plates (See "Floor Plate Removal" on page 3-55).
6. Replace the damaged component.

IMPORTANT

Use flare-nut wrenches to remove these lines. Do not overtighten the fittings to avoid stripping the brass threads.

7. Bleed the brakes (See "Bleeding Brakes" on page 3-53).
8. Reassemble in reverse order.

Hydraulic

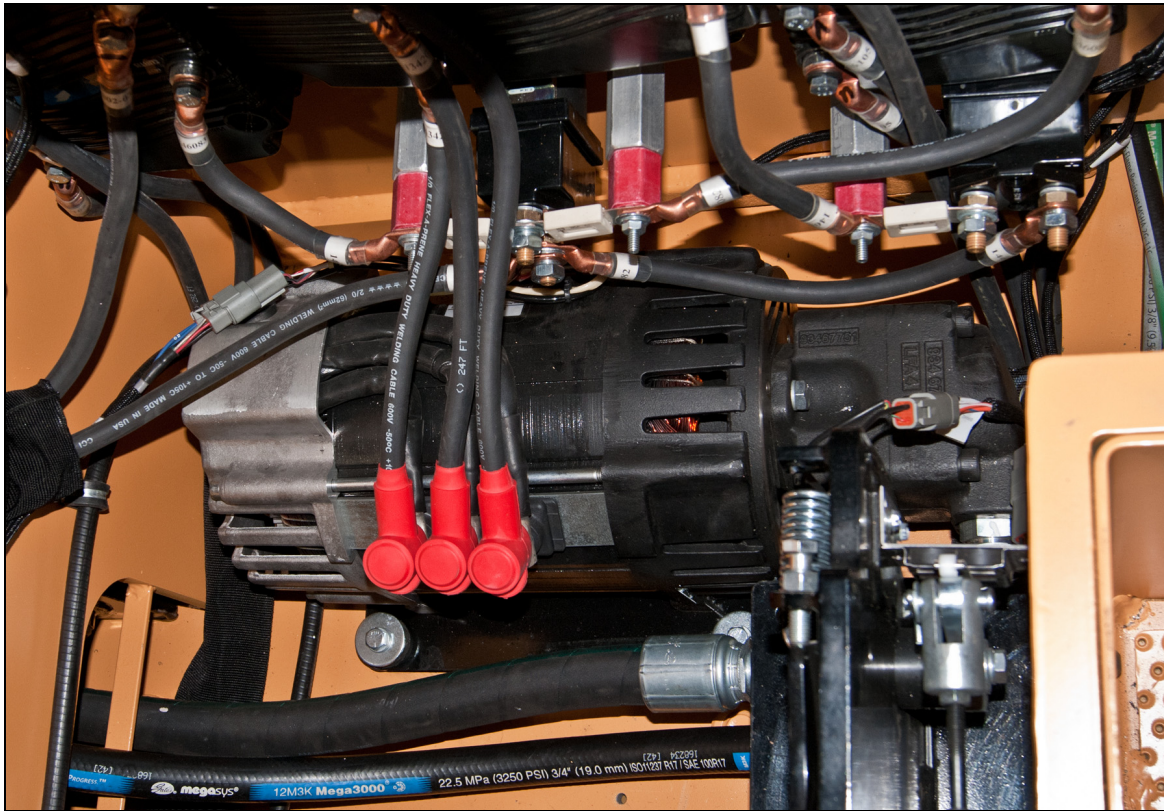


Figure 3-16: Motor Compartment

Hydraulic Motor and Pump

1. First, review "Getting Started (Please Read)," on page 1-1.
2. Set the keyswitch to OFF and place the key in a secured location away from the lift truck.
3. Apply the parking brake and disconnect the battery.
4. Make sure all the other wheels are securely blocked so that the truck cannot move.
5. Remove the floor plates (See "Floor Plate Removal" on page 3-55).
6. Remove the lower dash cover weldment (See Figure 3-35 on page 3-55).
7. Remove seat pedestal cover weldment (See Figure 3-35 on page 3-55).
8. Replace desired component (See Figure 3-16).

NOTE

Be sure to cap and plug in hydraulic ports and mark any cables that are removed in this process.

9. Reassemble component in reverse order.

Change Hydraulic Oil Filter

1. Position the truck on a flat surface, set the parking brake and block the wheels to prevent movement.
2. Set the keyswitch to OFF and place the key in a secured location away from the lift truck.
3. Disconnect the battery.
4. Remove the cover plate to the operator's right by removing the four 5/16 - 18 X 3/4 button head socket cap screws.
5. Using a clean, lint-free cloth, clean the area around filter and replacement element.
6. Unscrew and remove in-tank filter assembly from the top of the hydraulic tank.
7. Replace the filter element and replace in-tank filter assembly.
8. Operate the hydraulic system by running the mast functions and observe the filter for oil leaks.
9. Reinstall the cover plate.

TROUBLESHOOTING AND CORRECTIVE MAINTENANCE

Hydraulic Control Valve Assembly

Individual directional control, pressure valve assemblies and gauge ports (for psi readings) are located on the hydraulic control valve or the steering control valve manifolds. The hydraulic control valve manifold is located under the side cover plate.

The following procedure explains how to replace a specific valve should a sluggish or sticking valve spool be suspect.

IMPORTANT

When removing the valve from the truck for servicing (hex head screws and hardware), during reinstallation of the valve, be certain to tighten the mounting screws in a staggering fashion while applying *equal* pressure to all screws. If the screws are not tightened and torqued evenly, a stress crack may form, causing internal oil leaks and rendering the valve defective.

The main hydraulic pump for lift, tilt, pivot, and shift (mast functions) is a vane pump. System pressure varies from 2,650 psi, ± 65 psi (183 bar, ± 4 bar) minimum, up to 3,000 psi, ± 65 psi (207 bar, ± 4 bar) maximum. Actual pressure is determined by mast size, load requirements and lift speed.

Check with a Landoll service representative for actual setting. The main pump pressure relief valve is located on the hydraulic control valve (See Figure 3-17).

A pressure gauge port is provided, with a “quick-coupler,” (pressure service kit, Landoll p/n: 0018152) for reading the main pump pressure.

NOTE

Before servicing this valve for possible pressure problems, make sure there are no leaks in the hydraulic system and that there is sufficient oil in the tank. Both conditions can contribute to low pressure problems.

(Also see “Mast Systems,” in the SL Series Operator's Manual (F-625) for additional circuit information.)

Checking and/or Adjusting Pressure

NOTE

System pressure should be adjusted quickly to avoid overheating of components.

1. First, review “Getting Started (Please Read),” on page 1-1.
2. Set the keyswitch to OFF, place the key in a secured location away from the lift truck, and disconnect the battery.
3. For ease in checking pressure Landoll Service offers a Pressure Check Kit (p/n: 0018152) which includes a 3,000 psi (207 bar) pressure gauge, hose and quick-coupler.

4. If you are using your own system, have shop rags and a small container handy to collect any oil spills.
5. Remove the hydraulic compartment cover on the right side of the truck.
6. Operate the steering wheel briefly to relieve any residual system pressure.
7. Connect the pressure check kit quick-coupler (female end) to the coupler (male end) on the control valve (See Figure 3-17).
 - If you are not using the pressure check kit, remove the quick-coupler and install an appropriate fitting to accept your pressure gauge arrangement.
 - Have rags handy to collect the oil leakage.
 - Install your 3,000 psi (207 bar) pressure gauge arrangement to the relief valve (See Figure 3-17).

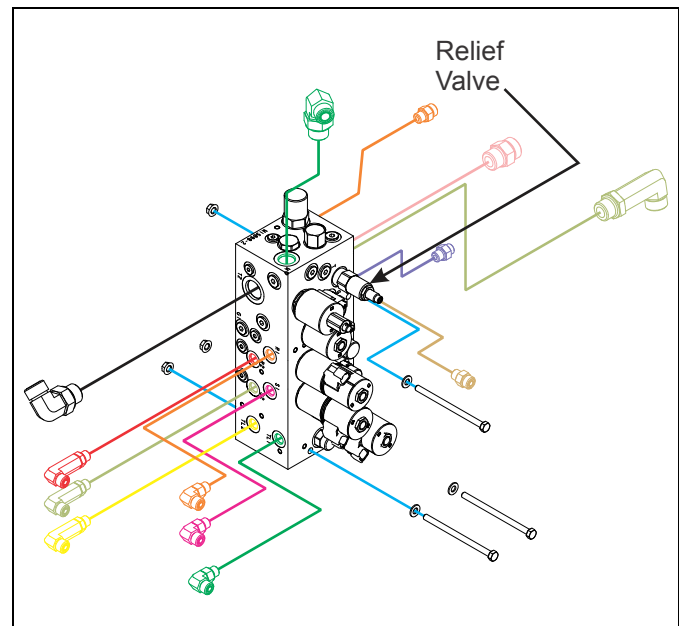


Figure 3-17: Connecting Pressure Gauge



CAUTION

All parts connected to the gauge port must be capable of handling up to 3,000 psi (207 bar). To adjust pressure, the truck (pump) must be running to create hydraulic pressure. Always pay attention to the surroundings when servicing the truck while it is running.

8. Start the truck.
9. Actuate the tilt level until the cylinder dead heads to build sufficient pressure to set the relief valve.

NOTE

The relief valve is located on the upper left of the surface facing the valve from the operator's seat. See Figure 3-17 on page 3-38.

10. Loosen the relief valve jam nut (See Figure 3-18).
11. Adjust the valve stem by turning clockwise to increase pressure, counterclockwise to decrease pressure (See Figure 3-18).
12. Release the joystick immediately once the pressure is set (2,600 psi, + 65 psi, - 0 psi; 179 bar, + 4 bar, - 0 bar minimum, up to 3,000 psi; 207 bar, + 4 bar, - 0 bar).

IMPORTANT

Do not hold the joystick (bottomed out) for long periods of time. Excessive pressure is applied to the circuit which can, over long periods of time, generate heat and damage internal components. This will also overheat the hydraulic oil.

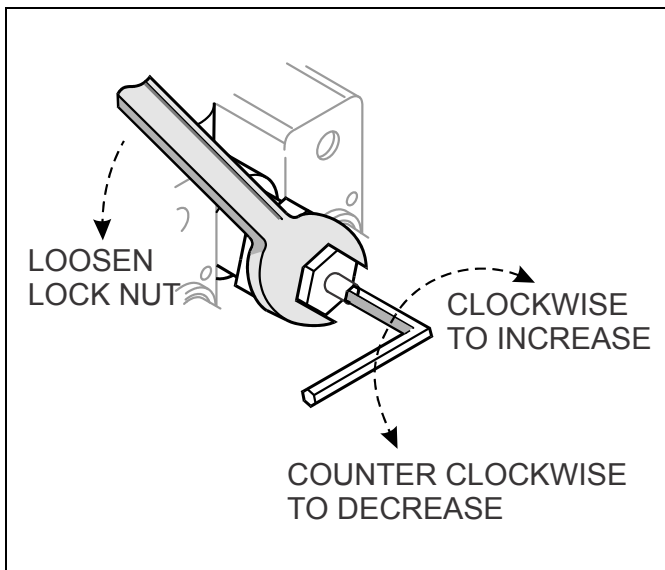


Figure 3-18: Relief Valve Setting

13. If the pressure is low and cannot be adjusted to the proper value, check the pump and make sure there are no leaks in the hydraulic system. If the pressure is too high and cannot be adjusted to the proper value, replace the relief valve.
14. Tighten the relief valve lock nut.
15. Set the keyswitch to OFF, place the key in a secured location away from the lift truck, and disconnect the battery.
16. Operate the steering wheel briefly to relieve any residual system pressure.
17. Remove the pressure gauge quick-coupler or remove the gauge arrangement.

18. Start the truck.
19. Lift and lower the mast from a few feet a few times to check the hydraulic system for leaks.
20. Set the keyswitch to OFF and disconnect the battery.
21. Reassemble all items previously removed.

Replacing Hydraulic Control Valve

1. First, review "Getting Started (Please Read)," on page 1-1.
2. Set the keyswitch to OFF and place the key in a secured location away from the lift truck.
3. Apply the parking brake, disconnect the battery and block the wheels.
4. Relieve pressure in the system by turning the steering wheel left and right slightly.
5. Remove the hydraulic compartment cover to expose the hydraulic control valve.
6. Disconnect hoses at fittings and immediately plug cap all lines. Tag the lines for identification during reassembly.
7. Disconnect the harness from each coil.
8. Remove the hardware holding the valve assembly to the truck base. Lift the valve from the truck and place it on your workbench. Be prepared for it to be heavy.
9. If a valve is being replaced, remove the hydraulic fittings from the defective valve and note how the fittings are arranged.
10. Before placing the truck back into operation, test it to make sure all functions are operating properly and that there are no oil leaks.
11. Reassemble in reverse order.

Drive System

Load Wheel Assembly

Removing Load Wheels



WARNING

The truck is equipped with tires of a size and hardness that provide the necessary traction and still maintain a proper shape to minimize tipping. To maintain stability always replace tires with the type originally supplied, as listed on the specification sheet at the beginning of this manual.

It is also recommended to replace worn tires in pairs. Treaded drive tires must be replaced when the groove is gone.

1. First, review "Getting Started (Please Read)," on page 1-1.
2. Set the keyswitch to OFF and place the key in a secured location away from the lift truck.
3. Disconnect the battery. Make sure the other wheels are securely blocked so that the truck cannot move.
4. Lift and support the truck so that the load wheel being serviced is clear of the floor by no more than 1" (25.4 mm). Also see "Lifting and Blocking the Truck," on page 1-7.
5. Remove the six lug nuts (See Figure 3-19 on page 3-40).

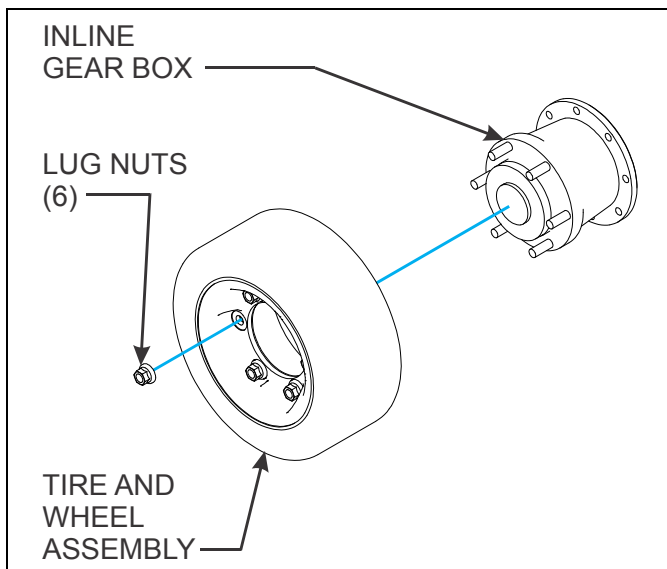


Figure 3-19: Removing Load Wheel

6. Using adequate support, remove the wheel.

NOTE

The wheel and tire weigh over 200 lbs. (90.7 kg.).

7. When installing the new wheel, tighten and torque the six lug nuts in a staggering fashion, following the numbering pattern (See Figure 3-20).
8. Tighten to 450 ft. lbs. (610 Nm) (See "Torque Specifications" on page 1-9).

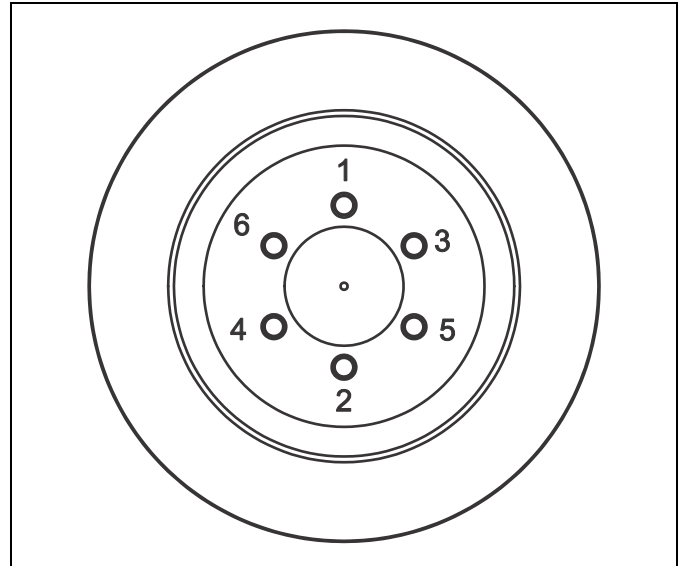


Figure 3-20: Tire Tightening Sequence

Gear Box and Traction Drive Motor

This section explains servicing the traction drive unit.

1. First, review "Getting Started (Please Read)," on page 1-1.
2. Set the keyswitch to OFF and place the key in a secured location away from the lift truck.
3. Apply the parking brake. Make sure all wheels are securely blocked so that the truck cannot move.
4. Raise the side of the truck being serviced 6" to 8" (15 - 20 cm) off the floor surface and support the truck in this position. Review previous section (See "Lifting and Blocking the Truck" on page 1-7).
5. Remove the load wheel assembly on the side being serviced (See Figure 3-19).

The traction drive assembly is very heavy and awkward to handle. It must be supported as it is being removed from the truck. See Figure 3-12 for a complete breakdown of the load wheel and traction drive assembly.

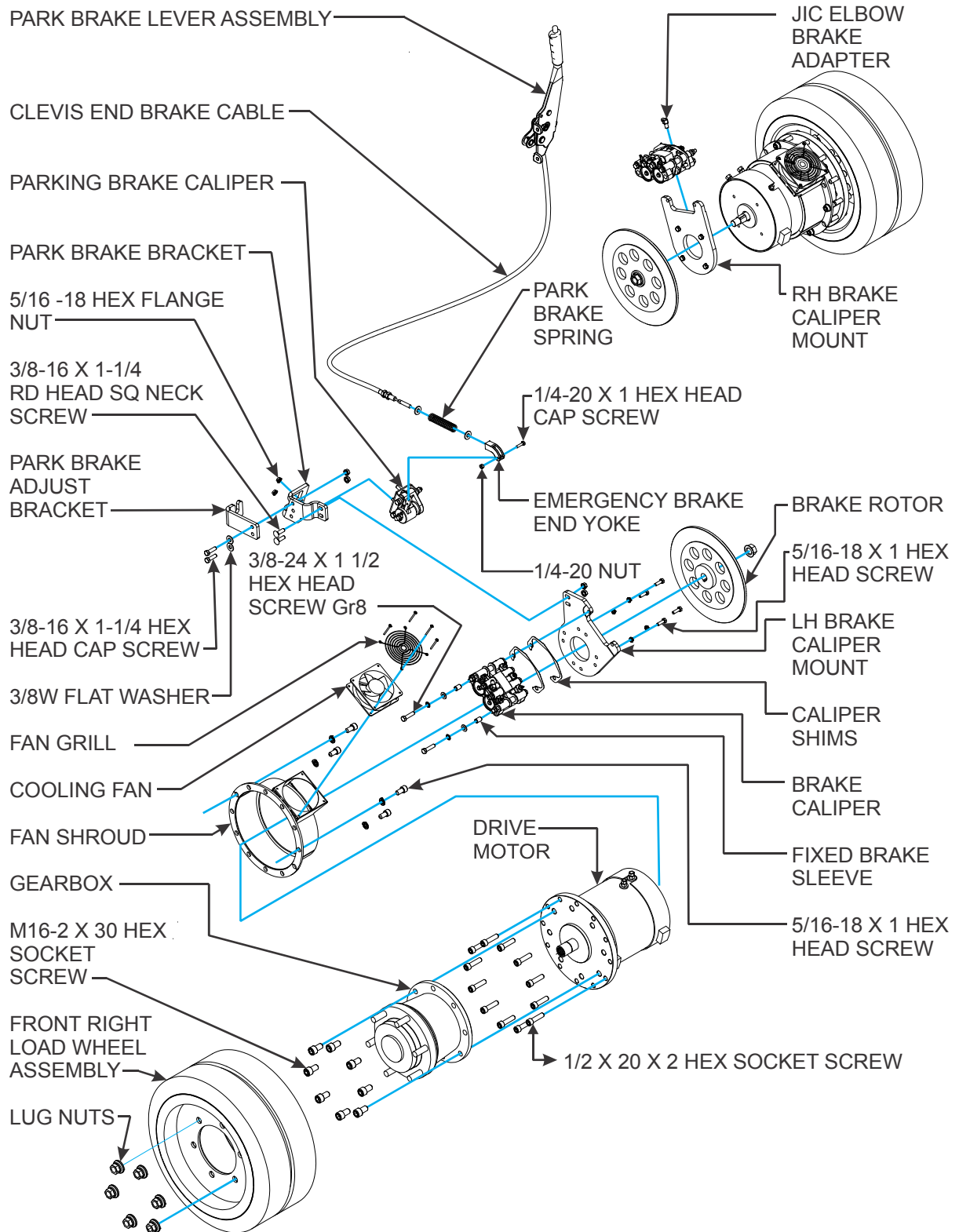


Figure 3-21: Load Wheel and Traction Drive Assembly

Replacing the Gear Box

1. First, review "Getting Started (Please Read)," on page 1-1.
2. Complete steps in "Removing Load Wheels," on page 3-40
3. Support the gear box as the mounting screws are removed.
4. Remove the eight M16-2 x 30 hex socket screws and hardware holding the gear box to the truck frame (See Figure 3-21).
5. Evenly support the gear box and allow the shaft to slide free of the motor.
6. Place the gear box on a sturdy work bench. Use wood planks to balance and support the assembly while on the workbench.
7. To service the gear box, see SL Series Parts List (p/n F-624) for an overview and replacement parts.
8. Reassemble the gear box to the truck by following the preceding steps in reverse order.
9. Tighten and torque the M16-2 x 30 screws (See "Torque Specifications" on page 1-9).



WARNING

When installing a new gear box unit, it is shipped from the factory *without oil*, therefore you must add oil before putting the unit into operation (See "Lubrication Specifications" on page 1-9).

For proper oil fill instructions, see "Servicing the Gearbox," on page 2-16.

Replacing the Traction Drive Motor

1. Repeat the process described in "Replacing the Gear Box," to remove the gear box.
2. Remove the Brake caliper - see "Replacing the Brake Caliper Assembly," on page 3-31 and "Disc Brake Rotors," on page 3-32
3. Support the unit as the mounting bolts are removed.
4. Remove the twelve 1/2-20 x 2 hex socket screws and hardware holding the motor to the truck frame (See Figure 3-21).

5. With the motor supported, rotate the motor to align the electrical connecting terminals to the slots machined in the truck frame side plate (See Figure 3-21).
6. Slide the motor out the side of the truck far enough to install a second strap around the motor. This strap is to support the motor from outside the truck frame.
7. Place the assembly on a sturdy work bench. Use wood planks to balance and support the assembly while on the workbench.
8. Assemble the new motor by following the preceding steps in reverse.
9. Tighten and torque the screws. See "Torque Specifications," on page 1-9
10. To service the traction drive motor, see SL Series Parts Manual (F-624) for an overview and replacement parts.

Steering Axle Assembly

Removing Rear Axle

1. Park truck with the rear wheels turned straight. Remove battery and battery tray.
2. Remove and cap/plug hydraulic lines to steering cylinder (See Figure 3-22).
3. Disconnect truck harness from steering sensor.
4. Center a jack at the rear of the truck to lift the truck off of the rear axle.
5. Remove 1-8 x 5-1/2 hex head cap screws that fasten rear axle mounting blocks to frame (See Figure 3-22).
6. Use proper lifting apparatus to lift frame until the rear axle assembly clears the frame when rolling axle back.
7. After sufficient clearance is achieved, support truck with blocks and remove jack.
8. Roll axle back to gain access.
9. Reassemble in reverse order.

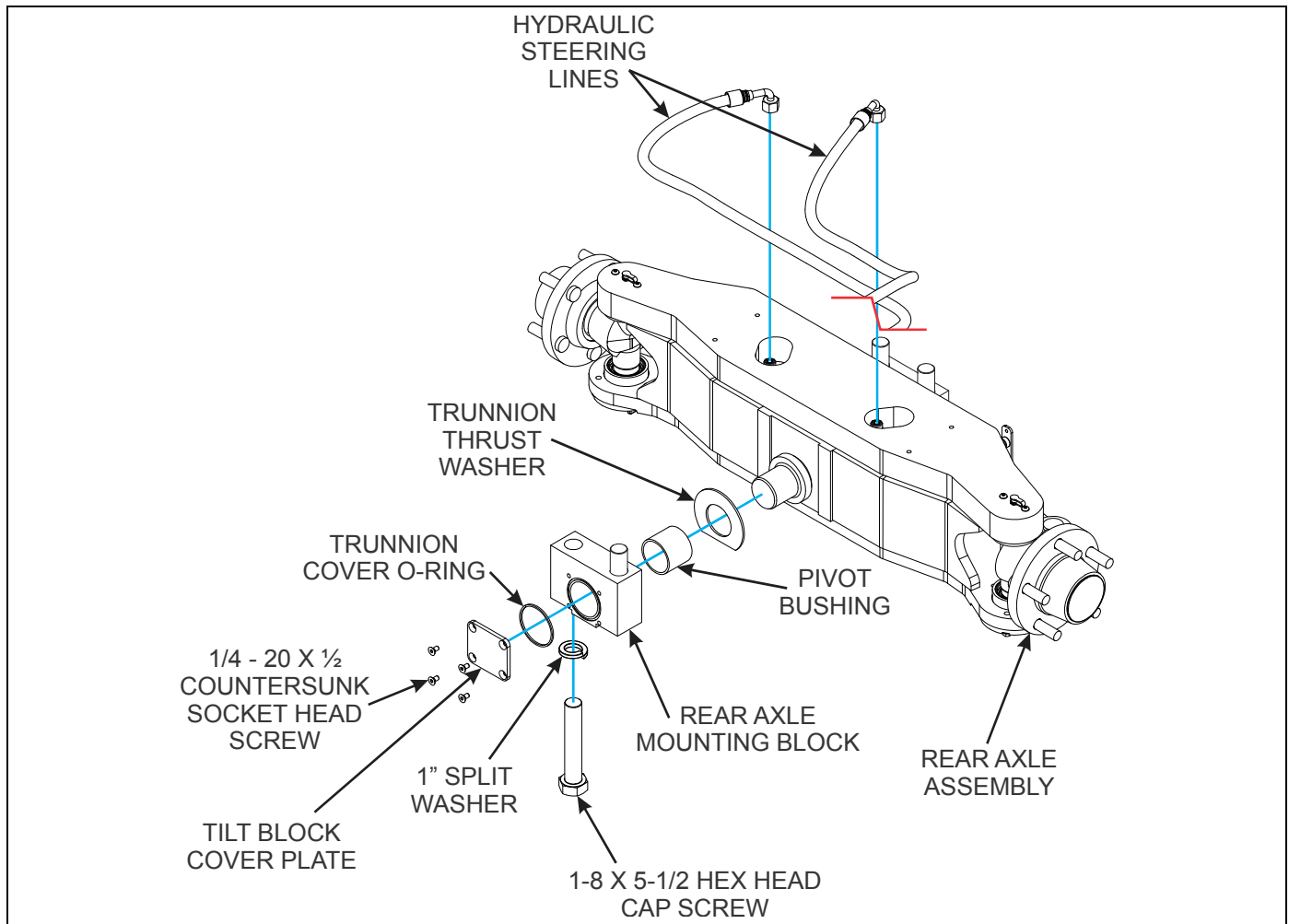


Figure 3-22: Rear Axle Removal

Disassembling and Inspecting Rear Axle Mounting Blocks

1. Slide rear axle mounting blocks from axle (See Figure 3-22).
2. Replace pivot bushings if excessive bushing wear is apparent. Pivot bushing inside diameter must be less than 2.060"
3. Pivot bushings can be replaced by removing tilt block cover plate and pressing used bushing from block. Bushing O.D. is 2.25".
4. Inspect trunnion thrust washers for wear and replace if parts are less than 0.080" thick.
5. Press new pivot bushings into block until flush with cover side.
6. Inspect trunnion cover o-ring and replace if damaged.
7. Insert trunnion cover o-ring into groove and replace tilt block cover plate.

Checking Steer Wheels

1. First, review "Lifting and Blocking the Truck," on page 1-7.
2. With the truck raised and supported, spin each wheel and check for noise, rolling resistance and free play.
3. Rock the wheel in and out on the spindle. If there is any noticeable movement, the bearings should be checked and then repacked with grease and/or replaced.

TROUBLESHOOTING AND CORRECTIVE MAINTENANCE

**WARNING**

The truck is equipped with tires of a size and hardness that provide the necessary traction and still maintain a proper shape to minimize tipping. To maintain stability and maximum reliability always replace tires with the type originally supplied, as listed on the specification sheet at the beginning of this manual.

It is also recommended to replace worn tires in pairs. Treaded drive tires must be replaced when the tread depth is less than 0.0625" (1.6mm) at the deepest point.

2. Measure the tire diameter. If the diameter of the tire is less than 13", Landoll recommends that the tire be replaced.
3. Remove hub cap, 5/32 x 1-1/2 cotter pin, 1-14 hex slot nut, spindle washer, and outer bearing cone. See Figure 3-23 for reference.
4. Slide hub/wheel assembly from spindle. Remove inner bearing cone and seal from hub.
5. Clean bearing cones and seal. Clean bearing cups inside hub.
6. Replace bearing if rollers are pitted, rusted, or cracked.
7. Replace bearing cones if cones are cracked or pitted.

NOTE

Pre-pack the bearings with grease before replacing. Bearing cups and cones should be replaced as a set.

8. Replace seal if worn or damaged.

Disassembling and Inspecting Wheel Bearings

1. Lift axle and support so that wheels are free to rotate.

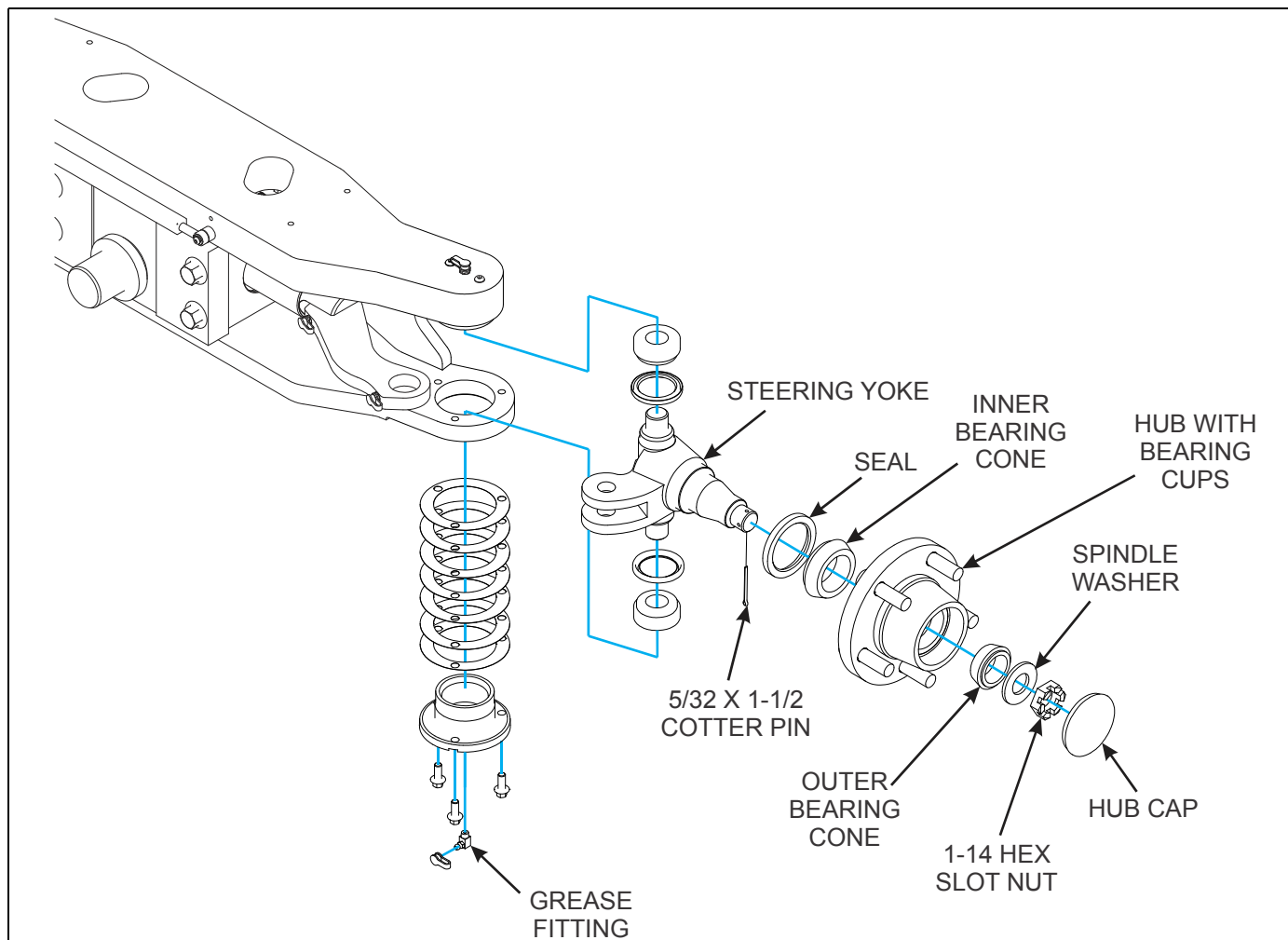


Figure 3-23: Wheel Bearing Assembly

Assembling Wheel Bearings

1. If bearing cups are replaced, clean hub and press new bearing cups into hub (See Figure 3-23).
2. Pack wheel bearings with grease.
3. Place outside face of wheel down on bench. Insert inner bearing and carefully drive seal in until flush with hub.
4. Carefully slide hub, bearing, and seal assembly onto spindle.

IMPORTANT

Be careful! Avoid damaging the grease seal. A damaged seal must be replaced.

5. Insert outer bearing cone and washer. Tighten hex slot nut against spindle washer.
6. Adjust bearing preload by slowly rotating hub while tightening hex slot nut until resistance is felt (approximately 75 ft/lbs). Back nut off 1/16 of a turn or until a notch aligns with the spindle cross-hole.
7. Readjust if the wheel does not rotate smoothly.
8. Ensure that the cavity between the two wheel bearings is filled with grease by injecting grease into the grease fitting at the top of the steering yoke until grease flows through outer bearing.
9. Apply a thin layer of grease to the hub cap o-ring and press hub cap into hub.

Disassembling and Inspecting Steering Axle

1. Remove the steering potentiometer and potentiometer bracket (See Figure 3-24).
2. Remove the 1-14 x 2-1/2 hex head cap screws from steering yoke and tie rod pin weldment from tie rod clevis.
3. Remove king pin cover plates and kingpin locking screw (3/8-16 x 2-1/2 hex head cap screw) (See Figure 3-24). Remove kingpin by pushing from the top down.
4. Slide the steering yoke from rear axle. Use care to catch the thrust bushing, thrust washer, and steel shim washers as steering yoke is removed from axle.
5. Replace the kingpin and bearings if pitted or if excessive wear is apparent.
6. Inspect tie rod pin weldment and tie rod bushing. Replace both if bushing I.D. is greater than 0.780" or if the pin diameter is less than 0.720"
7. Replace tie rod end if movement of ball in tie rod end is greater than 0.030".
8. Replace thrust bushing if thickness is less than 0.145."

TROUBLESHOOTING AND CORRECTIVE MAINTENANCE

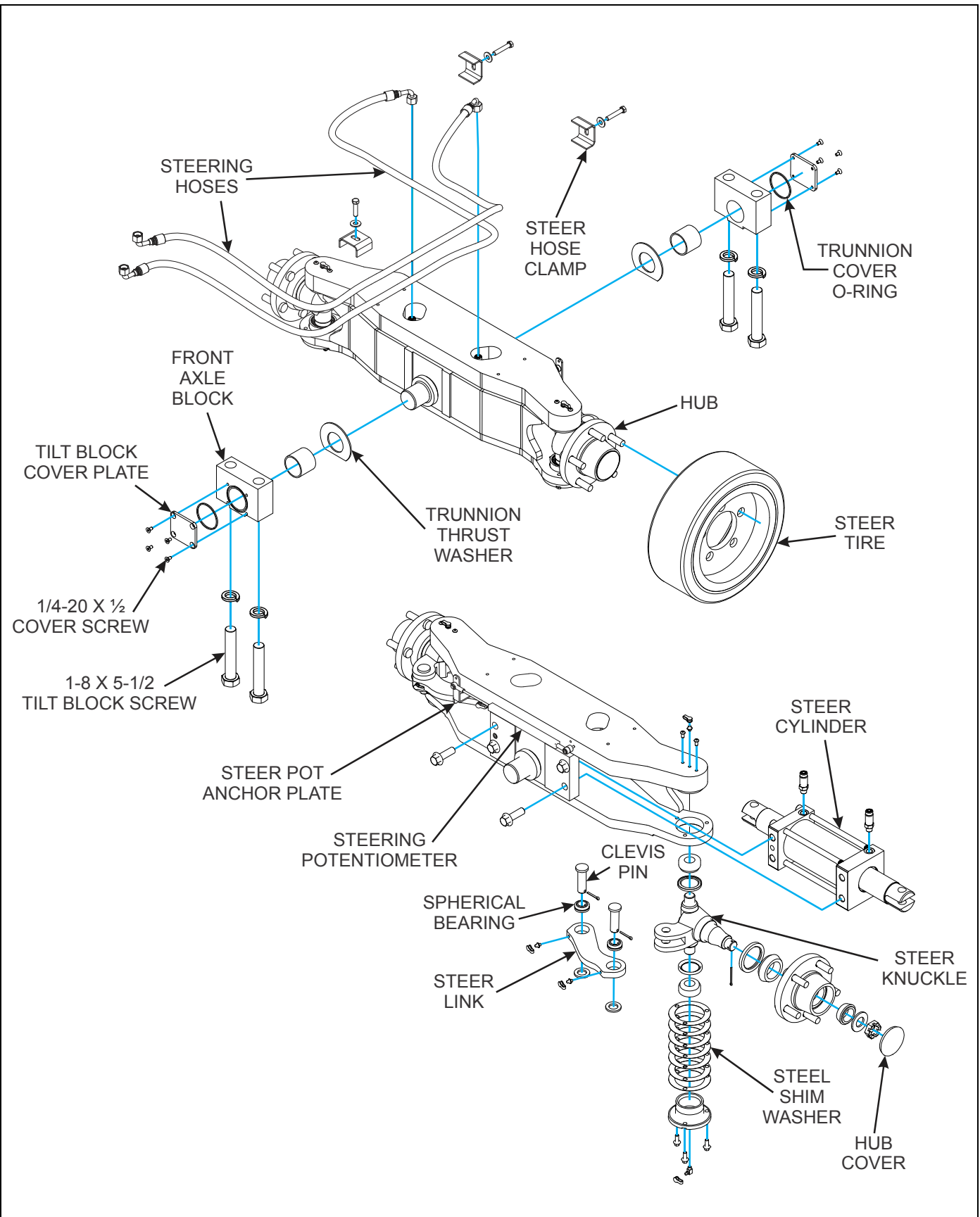


Figure 3-24: Steering Axle Assembly

Assembling Steering Axle

1. Clean the kingpin cover plates and cover pockets on steering yoke (See Figure 3-24). Clean the steering yoke and rear axle weldment.
2. Grease the shims and place them in shim cavity on the bottom of the axle. Grease will hold the shims in place.
3. Place the thrust washer inside the steering yoke and the thrust bushing on top of the washer. The king pin may be used to align the bushing and washer with the kingpin hole in yoke.
4. Slide the steering yoke over axle, align the kingpin notch with the kingpin locking bolt hole while inserting the kingpin up through the steering yoke and axle.
5. Insert the kingpin locking pin (3/8-16 x 2-1/2 hex head cap screw) and check for axial clearance. Add steel shim washers if axial clearance is greater than 0.030".
6. Tighten 3/8-16 hex lock nut on kingpin locking screw to 23 ft-lb.
7. Apply a small bead (1/8") of silicone sealant. (Permatex blue rty or equivalent) just inside the bolt circle on the bearing side of each kingpin covers. Install kingpin cover plates, apply thread-locking compound (Loctite 242 or equivalent) to each cover fastener (1/4-20 x 1/2 flat socket head screw and 1/4-20 x 3/4 hex head cap screw), and tighten to 72-96 in-lb (8-11 Nm).
8. Depending on the extent of disassembly necessary, the tie rods may need to be reassembled. A tie rod consists of items tie rod clevis, 1-16 hex jam nut, and tie rod end. Apply thread lock compound and tighten 1-14 x 2-1/2 hex head cap screws to 500 ft-lbs.
9. Adjust the tie rod ends so that the wheels are straight when the steering cylinder is centered. After the wheels are adjusted, install the steering pot cam, using tie rod pins. Tighten tie rod pin retainer bolts (1/4-20 x 3/4 hex head cap screws) to 72-96 in-lb (8-11 Nm).
10. Install the steering potentiometer and the potentiometer bracket (See Figure 3-24).

IMPORTANT

Care should be taken to rotate the fixed ball end of the potentiometer to align with the mounting hole of the wiring as it exits the pot housing. Failure to do so may cause the wiring of the potentiometer to come in contact with the truck frame and deteriorate the insulation of the harness.

11. Upon assembly, lubricate all the grease fittings before installing axle on truck.

Axle Installation

1. To install, reverse the order of removal (See "Removing Rear Axle" on page 3-42).
2. After lowering the frame onto rear axle mounting blocks, tighten the 1-8 x 5-1/2 hex head cap screws to 400 ft-lbs.
3. Connect the truck harness to the steering sensor.
4. Connect hydraulic hoses, making sure that the hoses are secure and free from abrasion.

Hydraulic Fittings and Hoses

1. Set the keyswitch to OFF and place the key in a secured location away from the lift truck.
2. Disconnect the battery and block the wheels.



WARNING

Before disconnecting any hydraulic fittings or hose assemblies, relieve the system pressure, down to zero (0) psi. This is accomplished by turning the steering wheel a few times in both directions, and moving the control levers in both directions after the keyswitch is turned OFF.

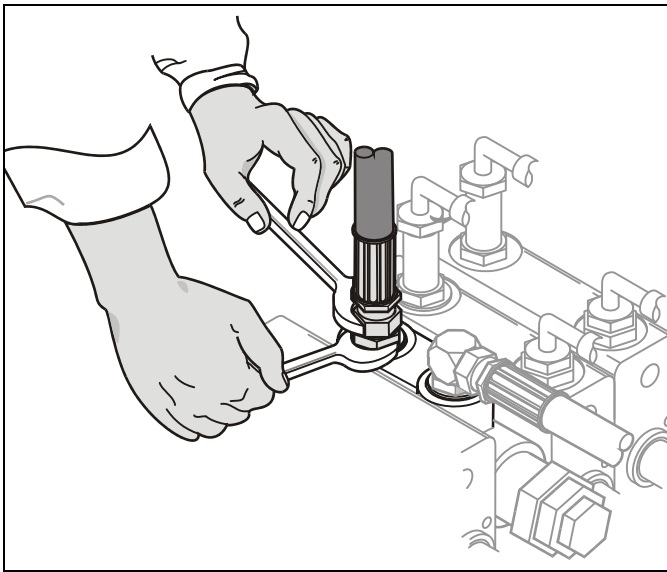
HIGH PRESSURE HYDRAULIC OIL LEAKS CAN PIERCE THE BODY AND CAUSE SEVERE INJURY TO PERSONNEL. ALWAYS REDUCE PRESSURE BEFORE OPENING ANY HYDRAULIC PRESSURE LINE.

Oil is slippery and can cause falls. To avoid injury, wipe up spilled oil with shop rags, or apply an oil-dry and clean up after it has soaked up the spill.

3. Remove the hose coupling from the defective fitting. Use two wrenches; one wrench to loosen the hose coupling, and one to prevent the fitting from turning (See Figure 3-25). Have rags handy to soak up any oil spillage.
4. Always tag the hoses and fittings for identification. If necessary, keep notes and put markings on parts using a non-destructive marker, such as a felt-tipped pen.
5. Remove the defective fitting and replace with a new fitting. Use two wrenches; one wrench to tighten the hose coupling, and one to prevent the fitting from turning (See Figure 3-25).

NOTE

SAE fittings do not need a thread sealant. They are straight thread and include an O-ring seal.

**Figure 3-25: Removing Hoses and Fittings**

Electrical

Replacing Complete Control Panel

1. First, review "Getting Started (Please Read)," on page 1-1.
2. Move the mast carriage completely to the left (if possible).
3. Set the keyswitch to OFF and place the key in a secured location away from the lift truck.
4. Apply the parking brake and disconnect the battery.
5. Make sure all the other wheels are securely blocked so that the truck cannot move.
6. Remove the floor plates. See "Floor Plate Removal," on page 3-55 for reference.
7. Remove all cables and disconnect the main harness.

NOTE

Make sure to mark all cables where they go.

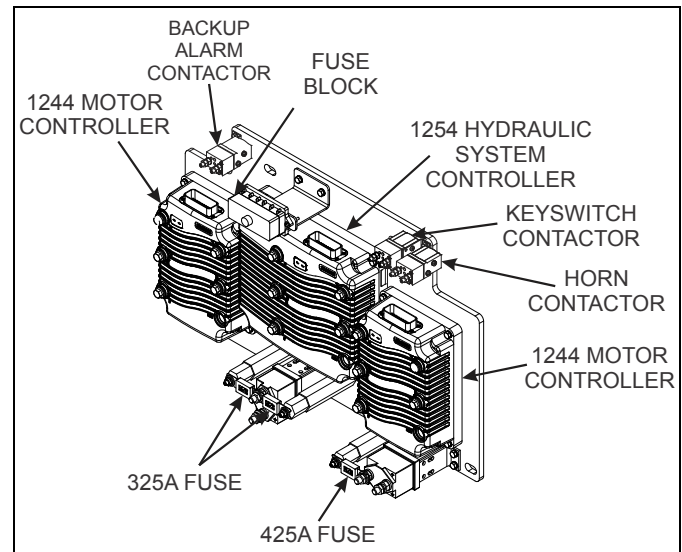
8. Remove mounting hardware.
9. Using a proper lifting apparatus remove the panel from the forklift.
10. Reassemble in reverse order.
11. Calibrate the control panel.

Replacing Single Controller Components

1. First, review "Getting Started (Please Read)," on page 1-1.
2. Set the keyswitch to OFF and place the key in a secured location away from the lift truck.
3. Apply the parking brake and disconnect the battery.
4. Make sure all the other wheels are securely blocked so that the truck cannot move.
5. Remove the floor plates. See "Floor Plate Removal," on page 3-55 for reference.
6. Replace component as needed (See Figure 3-26).
7. Reassemble in reverse order.

NOTE

If a controller is replaced, it must be reprogrammed.

**Figure 3-26: Electrical Control Panel**

Replacing EXM Controller Module

The EXM module controls the hydraulic control valve based on user inputs from the joystick.

1. Remove the two 5/16 X 3/4 button head screws holding the control panel cover in place and remove it.
2. The EXM module is to the left of the controller panel while facing them. Remove the harness by pressing on the plug latch and gently pulling on it.
3. Remove the two #10 X 1" hex head screws holding the module to the frame.
4. Reassemble in reverse order.
5. No calibration is necessary.

Steering and Pedals

Brake Pedal Assembly

Disc Brakes

The front disc brakes are inherently self-adjusting. NO adjustments are necessary or provided. Refer to "Changing Brake Pads," on page 3-29.

Brake Pedal

The pedal has a maximum range of travel of up to only 0.500" (12.7 mm) before it contacts the positive stop hex screw, and includes a brake light switch that energizes the brake STOP lights, where applicable, and has a switch for disengaging traction drive. The brake light/accelerator switch is factory set to trip just as the brake pedal begins its downward stroke.

Service Brake Linkage

1. First, review "Getting Started (Please Read)," on page 1-1.
2. Set the keyswitch to OFF, place the key in a secured location away from the lift truck, and disconnect the battery.
3. Before doing any adjustment, check for:
 - low fluid level in the master cylinder reservoir (See "Check the Brake Fluid Level" on page 2-10).
 - air or leaks in the system
 - worn brake pads (See "Changing Brake Pads" on page 3-29).

Any of these conditions can affect pedal free-play. Proceed to the appropriate heading for repairs.
4. Remove the left floor plate to expose the brake pedal linkage and master cylinder (See "Floor Plate Removal" on page 3-55).
5. Loosen 5/16" (7.94 mm) lock nut on the master cylinder push rod (See Figure 3-27).

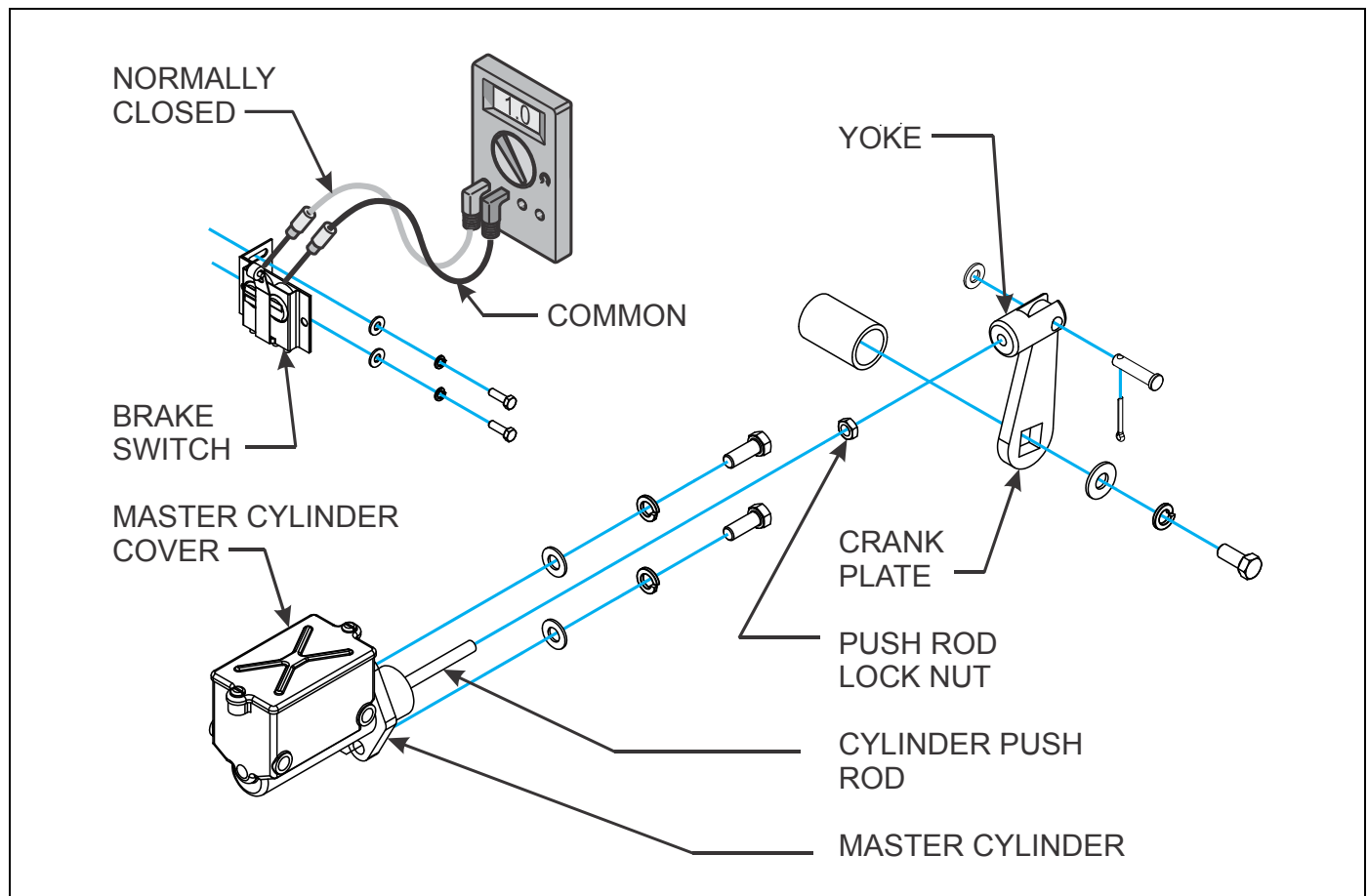


Figure 3-27: Master Cylinder and Brake Switch

6. Turn the rod clockwise to increase dimension on the pedal; turn counterclockwise to decrease dimension. See Figure 3-28 for free play adjustment dimension and note.

Tighten the adjustment lock nut against the brake pedal yoke.
7. Install the left floor plate.

TROUBLESHOOTING AND CORRECTIVE MAINTENANCE

8. Connect the battery and check for proper brake operation as follows:
 - Raise and block the truck off the ground.
 - Accelerate the forklift to full speed.
 - Apply the brakes to quickly STOP the wheels.
 - Release the brake pedal after the wheels stop, then accelerate again to full speed.
 - Release the accelerator pedal to allow the truck to coast to a stop.
 - Both wheels should stop very closely together (around the same time).
 - Repeat this procedure two times in forward and in reverse directions.
9. If the forklift does not perform as stated above, reinspect the brake calipers for wear. (See "Service Disc Brakes" on page 2-19).
6. Slowly push down on the brake pedal. Before the pedal reaches its first locking position the meter must read one of the following:
 - a. The meter must show a reading of open at the full upright pedal position for brake lights (2 black wires).
 - b. The meter must show a reading of closed (or less than 1 ohm) at the full upright pedal position (2 green wires).
7. Slide the brake switch forward or backward to locate the switch at this position - to just trip as the pedal begins its downward stroke (See Figure 3-27).
8. Carefully tighten and torque the screws (8 to 10 ft. lbs.; 11-14 Nm) to secure the switch without moving the setting, then release the brake pedal to verify the setting.
9. Disconnect the ohm meter.
10. Connect the battery and start the truck.
11. Apply the brakes while checking that the lights turn ON and/or the accelerator switch interrupts as pressure is applied to the master cylinder.

NOTE

Do not lock the brakes when stopping to avoid "flat-spotting."

Brake Light/Accelerator Switch Replacement

1. First, review "Getting Started (Please Read)," on page 1-1.
2. Set the keyswitch to OFF and place the key in a secured location away from the lift truck.
3. Disconnect the battery, block the wheels and release the parking brake.
4. Remove floor plates (See "Floor Plate Removal" on page 3-55)
5. Unscrew and remove the switch assembly from the brake pedal frame and install the new switch (See Figure 3-29 on page 3-51).
6. To set the switch refer to "Brake Light/Accelerator Switch Adjustment."

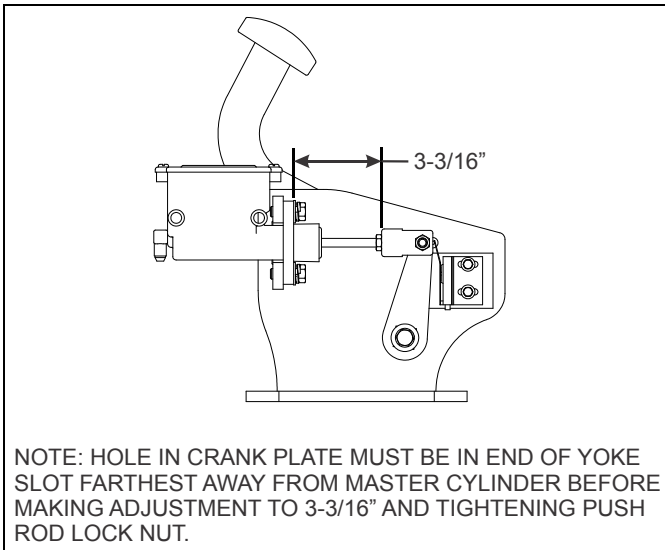
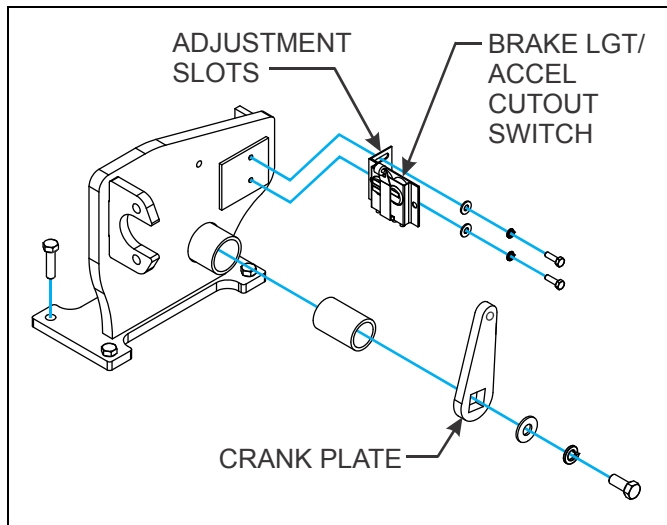


Figure 3-28: Free Play Brake Adjustment

Brake Light/Accelerator Switch Adjustment

1. First, review "Getting Started (Please Read)," on page 1-1.
2. Set the keyswitch to OFF, place the key in a secured location away from the lift truck, and disconnect the battery.
3. Remove the left floor plate to expose the brake pedal linkage and master cylinder (See "Floor Plate Removal" on page 3-55).
4. Slightly loosen both brake switch hex head screws (See Figure 3-27).
5. Connect the ohm meter leads to the wires of the switch to be checked.

**Figure 3-29: Brake Light Switch**

Master Cylinder

Replacing Master Cylinder

1. First, review "Getting Started (Please Read)," on page 1-1.
2. Set the keyswitch to OFF and place the key in a secured location away from the lift truck.
3. Apply the parking brake, disconnect the battery and block the wheels.
4. Remove floor plates (See "Floor Plate Removal" on page 3-55)
5. Remove the master cylinder fill cap and rubber diaphragm (two round head screws).

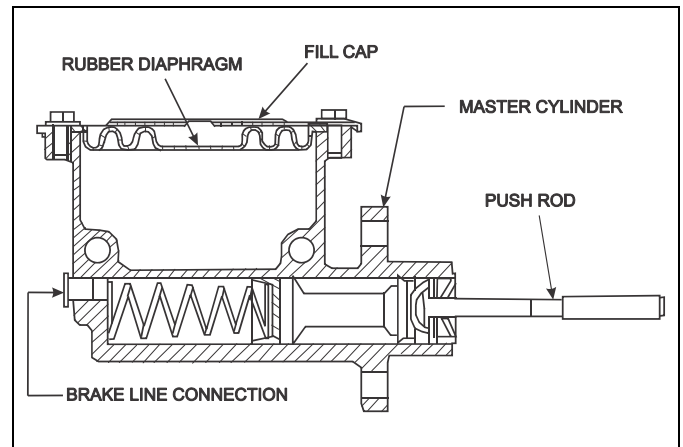
NOTE

Siphon out as much fluid as possible. Install and tighten the fill cap and diaphragm before removing the cylinder (See Figure 3-30).

6. Place rags under the brake line connections. Have a plastic cap or bag handy to cover the end of the line to limit fluid spillage.

IMPORTANT

Brake fluid will damage paint. Cover all body parts and be careful not to spill fluid during this procedure.

**Figure 3-30: Master Cylinder Assembly**

7. Using a flare-nut wrench, disconnect the brake fluid line at the rear of the cylinder (See Figure 3-31).

NOTE

Flare-nut wrenches should be used as they wrap around the nut to prevent rounding off the flats.

8. Carefully pull the brake line away from the cylinder. Seal or plug the brake line and master cylinder port to prevent fluid loss and/or contamination.
9. Disassemble the yoke from the master cylinder crank plate (one 5/16-18 screw and hardware) (See Figure 3-31).
10. Remove the two master cylinder mounting bolts (3/8-16) and remove the cylinder from the truck.

TROUBLESHOOTING AND CORRECTIVE MAINTENANCE

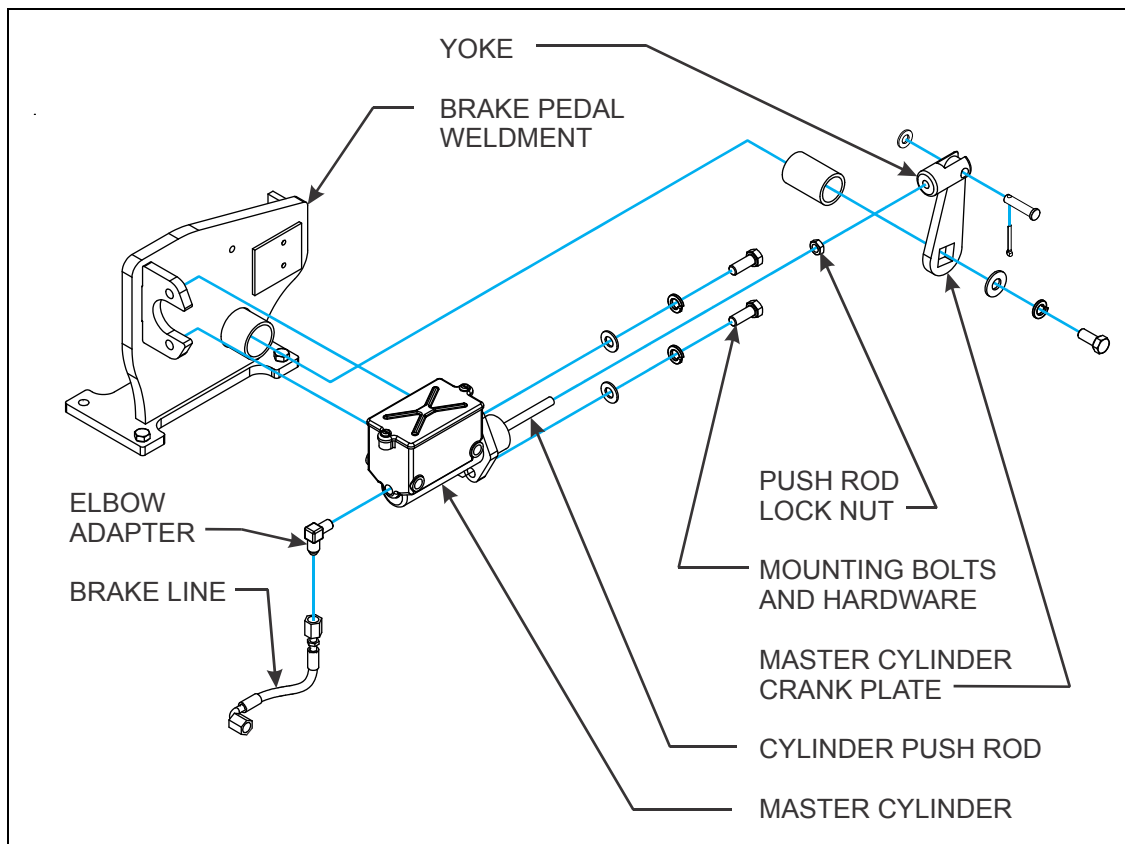


Figure 3-31: Cylinder Removal

11. Remove the reservoir cap and discard any fluid remaining in the reservoir.
12. Mark the push rod lock nut setting, then remove the yoke and lock nut from the old cylinder and install it to the new cylinder, maintaining the same lock nut setting.

NOTE

The push rod lock nut should be installed so that when the pedal is completely retracted, the yoke to the master cylinder crank plate hardware is loose, when it is completely assembled. Note: Whenever the master cylinder is removed and/or replaced, the hydraulic brake system must be bled. The time required to bleed the system can be reduced and made easier if the master cylinder is filled with brake fluid and bench-bled before installing the cylinder into the truck (See "Bench Bleed the Master Cylinder" on page 3-52).

13. Replace the new master cylinder in reverse order.
4. Press a finger tightly over the master cylinder outlet port to prevent air from being drawn back into the cylinder when the push rod is released, or feed a separate line (flexible tubing) from the cylinder port(s) and immerse the other end in the container of new brake fluid. See Figure 3-32 on page 3-53.
Wait several seconds to allow fluid to be drawn from the reservoir to the cylinder bore, then repeat this.

IMPORTANT

Brake fluid will damage paint. Cover all body parts and be careful not to spill fluid during this procedure. Wipe up any spilled fluid immediately, then flush the area with clean water.

Bench Bleed the Master Cylinder

Since high pressure is not involved in the bench bleed procedure, your finger can be used to plug the cylinder hole and prevent air intake.

1. Support the cylinder (in a vise) to prevent fluid spillage while allowing you to push the internal piston with the push rod (See Figure 3-32).
2. Remove the filler cap and fill the cylinder with DOT 3 brake fluid.
3. Slowly push in on the rubber boot and cylinder plunger (push rod) assembly to force air from the cylinder, then hold the push rod in (See Figure 3-32).
step. When the rod is pushed again, any trapped air will be expelled through the flexible tubing (or will move the finger used to block the master cylinder outlet port). See Figure 3-25.

Place rags under the brake line fitting to soak up any fluid loss.

5. When only brake fluid is expelled from the master cylinder outlet port, hold the push rod in and seal the master cylinder outlet port with an appropriate threaded plug or plastic cap, then release pressure on the push rod.
6. Fill the master cylinder reservoir and install the filler cap and gasket.

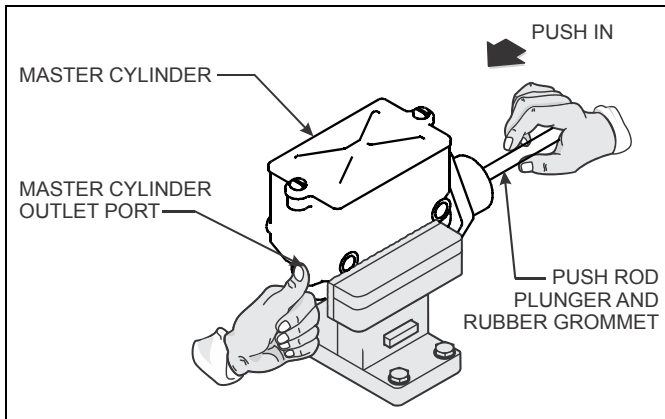


Figure 3-32: Support and Bench Bleed the Cylinder

Bleeding Brakes

Bleeding the brake system is necessary to remove any air that is trapped when replacing brake lines, brake calipers or the master cylinder. To avoid extensive damage to the system, use only DOT 3 brake fluid.



WARNING

Wear eye protection. In case of eye contact, immediately rinse them with water and seek medical attention.

Check the fluid level often during the bleeding operation and add fluid as needed to prevent the level from falling low enough to allow air bubbles into the master cylinder.

Use only fresh (new) DOT 3 brake fluid. NEVER use old or used brake fluid. It contains moisture which will deteriorate the brake system components.

It is necessary to bleed both wheels if air has entered the system due to low fluid level or if a brake line has been disconnected at the master cylinder or at the tee fitting. If the brake pedal feels spongy when pressed and goes almost to the mechanical stop but regains height when pumped, air has entered the system. The system must be bled. If no fittings were recently opened for service, check for leaks that would have allowed air into the system and repair leaks before attempting to bleed the system.

Have an assistant handy, as well as a supply of brake fluid, an empty container, a length of 3/16" (4.763 mm) clear plastic or vinyl tubing to fit over the cylinder bleeder fitting and a six point wrench to open and close the fitting.



WARNING

DO NOT allow fluid to run down the inside of the brake caliper and onto the brake pad. It will contaminate the brake lining material causing an unsafe brake condition and unnecessary repair.

1. First, review "Getting Started (Please Read)," on page 1-1.
2. Set the keyswitch to OFF and place the key in a secured location away from the lift truck.
3. Apply the parking brake and disconnect the battery.
4. Block and remove the front drive wheels.
5. Start with the right wheel as viewed from inside the driver's compartment (the wheel farthest from the master cylinder).
6. Loosen the bleeder fitting slightly, then tighten it to a point where it is snug but can be loosened quickly and easily.
7. Fit a length of tubing over the bleed screw and immerse the other end in the container of new brake fluid. Check that the tubing fits tightly over the bleeder fitting (See Figure 3-33).
8. Check fluid level in the master cylinder. Fill as needed before beginning.
9. Have someone slowly depress the brake pedal several times to build pressure in the system, then hold the pedal down.

IMPORTANT

Be careful when handling bleeder screws. Rust may cause the fitting to easily break off if forced. Installing a new bleeder screw may include overhaul. Spray the fitting with penetrating oil before attempting to loosen it to help prevent problems.

10. Loosen the cylinder bleed screw until fluid starts to flow. Watch for air bubbles at the immersed end of the tube.
11. When the brake pedal bottoms, tighten the bleed screw, then release the pedal. DO NOT release pressure on the pedal until the bleed screw is tightened.
12. Repeat Steps 8 through 11 as many times as needed until the fluid draining in the container is free of air bubbles.
13. Check the master cylinder fluid level and fill as needed before beginning the other side.

TROUBLESHOOTING AND CORRECTIVE MAINTENANCE

14. Check the operation of the brakes. The pedal should feel solid when depressed, with no sponginess. If necessary, repeat this procedure.

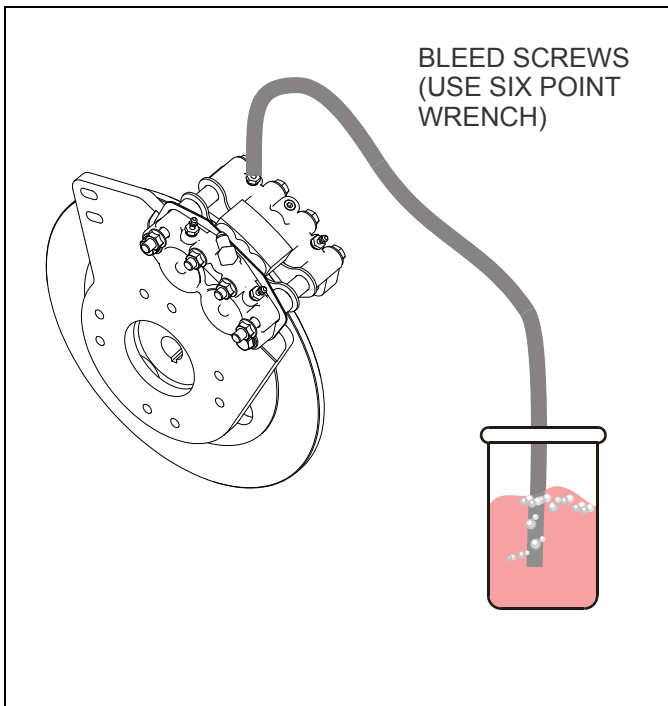


Figure 3-33: Bleeding Brakes

Service Brake Pedal Assembly

The service brake assembly (brake pedal) includes the mechanical brake pedal assembly, containing a pivot bushing. The only normal repair items are the switch, the pivot bushing, or the brake return spring (See Figure 3-34).

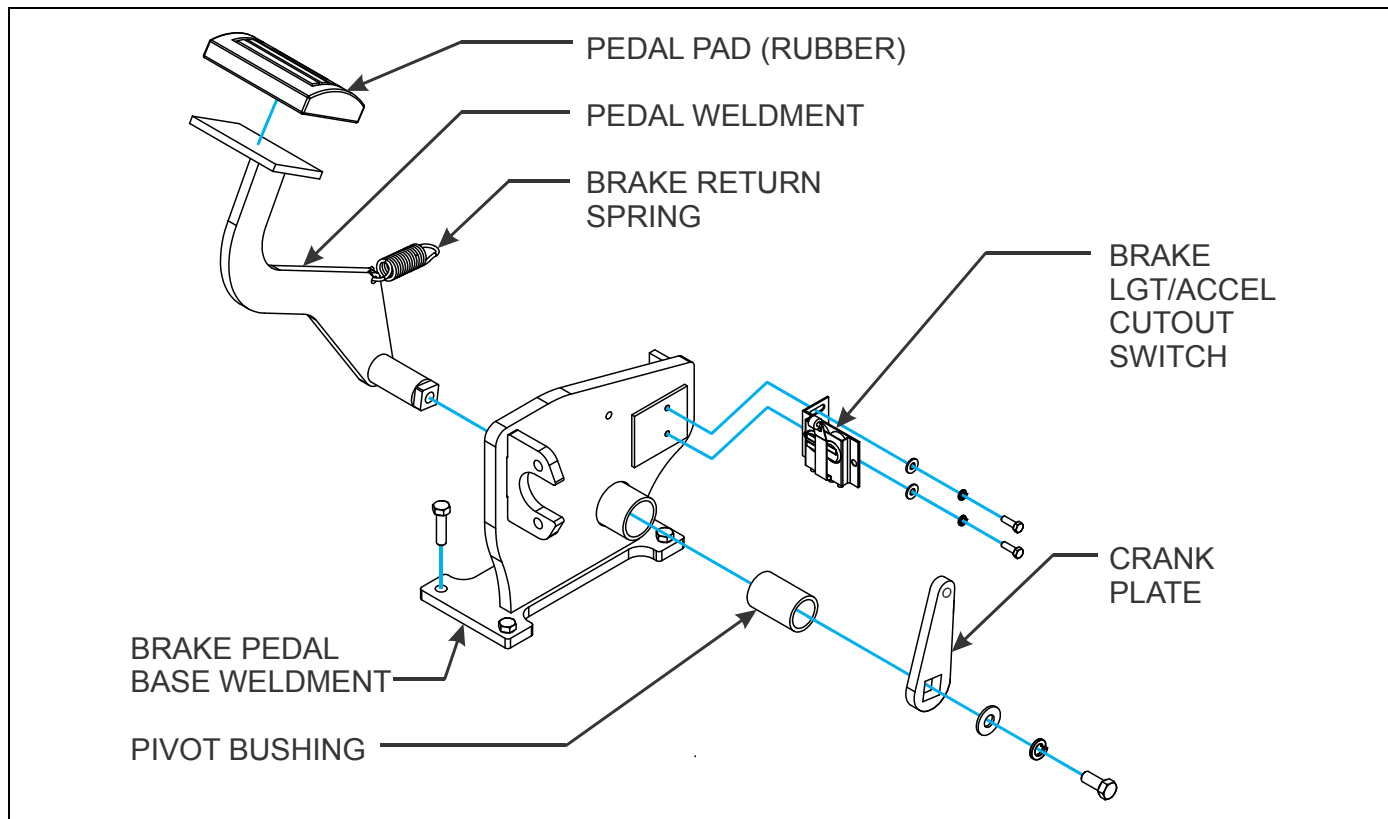


Figure 3-34: Brake (Service) Pedal Assembly

Accelerator Pedal Assembly

The accelerator assembly consists of the linear potentiometer, harness, and accelerator pedal (See Figure 3-36).

Floor Plate Removal

This panel provides access to the linear accelerator module assembly which is mounted to the underside of the floor plate. The master cylinder and service brake pedal and linkage are mounted within the frame well.

1. Thoroughly clean the floor area using brush and dustpan or vacuum.
2. Pull up the rubber floor mat. Be careful around the accelerator pedal to avoid tearing the mat (See Figure 3-35).
3. Remove the left floor plate from the truck frame.

NOTE

All planned maintenance checks can be done by removing only the left floor plate.

4. If more extensive maintenance is necessary, remove the hardware holding the lower dash cover weldment and remove.
5. Remove the hardware holding the right floor plate to the truck frame. Carefully lift the right floor plate. Note that the accelerator pedal assembly and linear accelerator assembly are still attached to the right floor plate.

NOTE

The linear accelerator module electrical harness will restrict how far the plate can be lifted. To fully remove the plate the electrical harness must be fully disconnected.

6. Reassemble in reverse order.

NOTE

It is recommended to leave all hardware loose when reinstalling for proper fit. After the floor plate hardware is installed, torque to recommended values (See "Torque Specifications" on page 1-9).

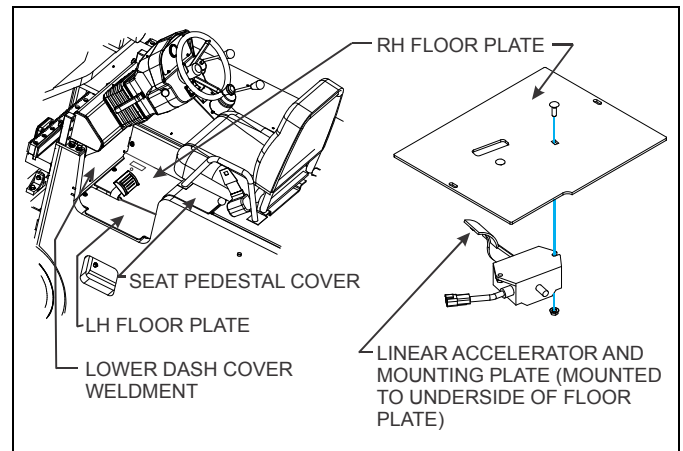


Figure 3-35: Floor Plate Removal and Linear Accelerator Module Assembly

Adjusting Accelerator Pedal

1. First, review "Getting Started (Please Read)," on page 1-1.
2. Set the keyswitch to OFF and place the key in a secured location away from the lift truck.
3. Block wheels.
4. Remove the floor plate (See Figure 3-35).

NOTE

It is recommended to hold the right hand floor plate in a vice while doing this procedure.

5. Loosen the allen head fastener on the pedal arm so that it can rotate freely. Rotate the pedal until the pedal touches the rear of the slot. Tighten the fastener.
6. Install floor plate assembly back on the forklift.
7. Install left hand floor plate.
8. Refer to Landoll Setup Procedure, located in "Truck Calibration," on page 4-1 to recalibrate the accelerator.

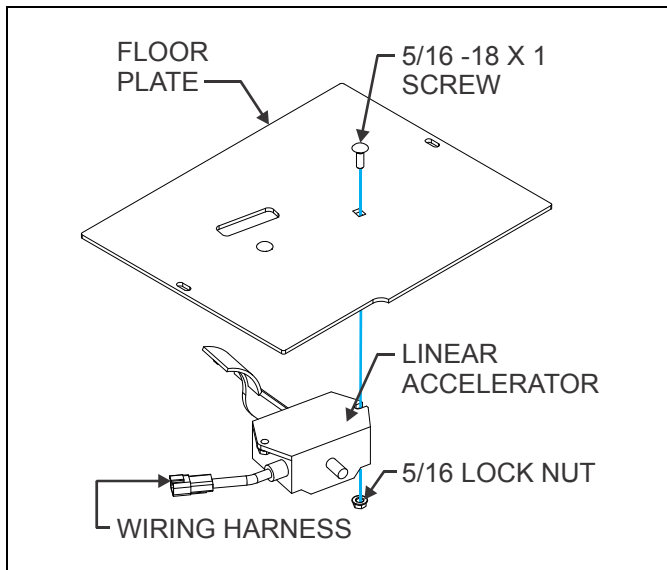


Figure 3-36: Linear Accelerator Module Assembly

Replacing Linear Accelerator Module

1. First, review "Getting Started (Please Read)," on page 1-1.
2. Set the keyswitch to OFF and place the key in a secured location away from the lift truck.
3. Apply the parking brake, disconnect the battery and block all wheels.
4. Remove the floor plates (See "Floor Plate Removal" on page 3-55).
5. Remove the two round head screws (5/16-18 x 1) and hardware securing the accelerator to the floor panel (See Figure 3-36).
6. Install the replacement accelerator onto the floor plate (See Figure 3-36).
7. Loosen the allen headed fastener on the pedal arm and orient the pedal 90° up. Insert the flat part of the arm through the slot, rotate and mate the accelerator mounting surface to the underside of the floor plate. Align with the 5/16" bolts and tighten to secure the accelerator.
8. Adjust the pedal (See "Adjusting Accelerator Pedal" on page 3-55).

Steering Column/Dash Assembly

This procedure replaces the steering wheel, steering column, and components.

The console assembly includes the following:

- Auxiliary power rocker switch (fan, scanner, etc.)
- Headlights (rocker switch, where fitted)
- Speed Mode (Fast & Slow)
- Tilt steering lever
- Keyswitch
- Dash Display

The above parts are accessed by removing the right side steering assembly cover (black) - ten (10) screws and hardware.

Remove the Display Panel

1. First, review "Getting Started (Please Read)," on page 1-1.
2. Set the keyswitch to OFF and remove the key from the keyswitch
3. Apply the parking brake, perform a Lock Out/Tag Out procedure and disconnect the battery. Make sure all the wheels are securely blocked so that the truck cannot move.
4. Remove the steering wheel by first removing the center boot covering the steering wheel locking nut and then loosen and remove the steering wheel.
5. Remove the four large screws and hardware marked (A), as shown in Figure 3-37.
6. Remove the screws and hardware marked (B).
7. Reach inside the steering column and disconnect the appropriate display wire connectors from the main wire harness.
8. Install the new display by reversing the above steps.
9. Connect the wire connector to the display and close the steering column by reversing the steps outlined in 4 through 6.

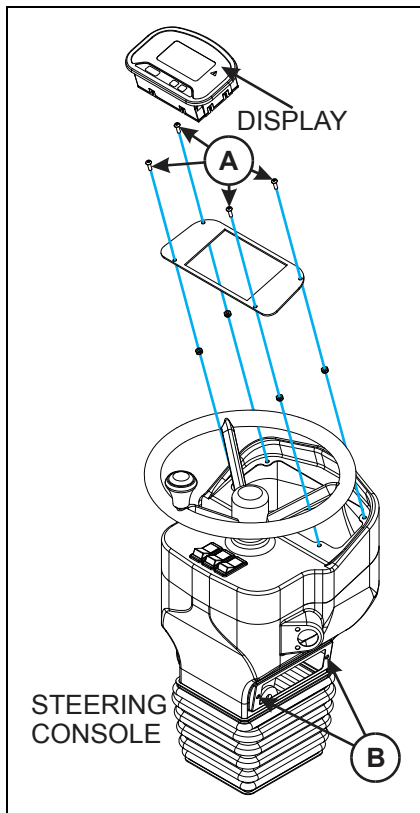


Figure 3-37: Steering Console and Display

Display

1. Repeat preceding section "Remove the Display Panel," on page 3-56.
2. Reach inside the steering column and disconnect the appropriate display wire connectors from the main wire harness (See Figure 3-38).
3. Remove the two knurled nuts and hardware holding the display to the panel.
4. Install the new display by reversing the above steps.
5. Connect the wire connector to the display and close the steering column by reversing the steps outlined in section "Remove the Display Panel," on page 3-56.

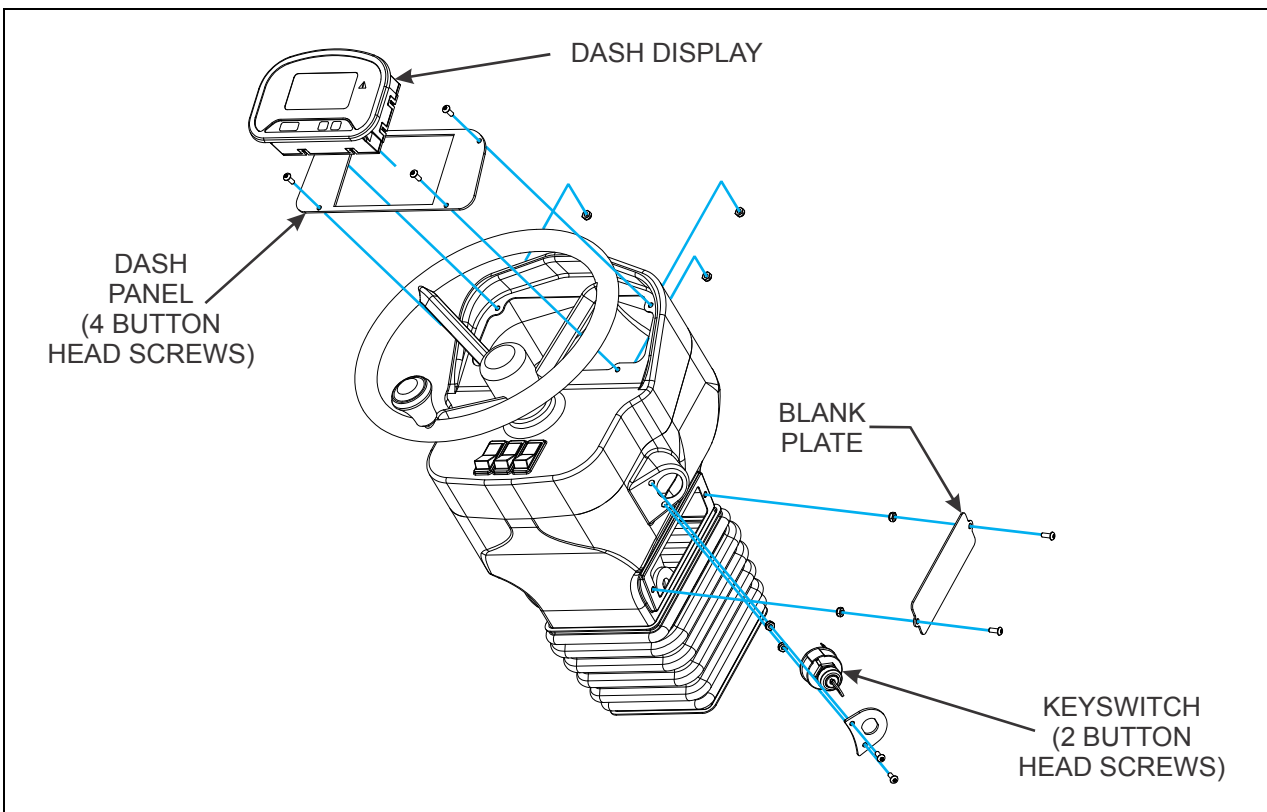


Figure 3-38: Console Dash Display Panel

Keyswitch

1. Remove the right side cover to expose the internal components of the steering column as described in "Remove the Display Panel," on page 3-56.
2. Unscrew the knurled switch collar ring to separate the switch from the base plate. See Figure 3-39.
3. Disconnect the wires from the switch terminals noting how they are connected to ensure proper orientation when connecting the new switch.
4. Install the keyswitch by reversing the preceding steps.

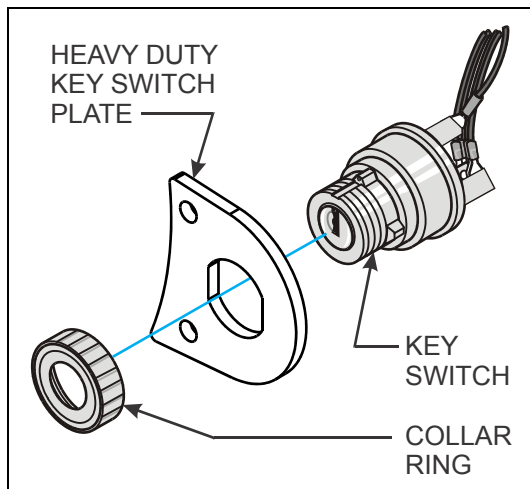


Figure 3-39: Keyswitch

Rocker (On/Off) Switches

Rocker switches are also used to control various light packages, speed control or other accessories. When an option is installed, the switch is activated.

1. Repeat the preceding section "Remove the Display Panel," on page 3-56.
2. Reach inside the steering column and disconnect the appropriate accessory switch connector from the main wire harness.
3. The accessory on/off rocker switches are held by plastic wings (or tabs). Compress the wings (or tabs) on one side at a time to release the switch body, then push it up and out of the slot (See Figure 3-40).

NOTE

Be careful when compressing and pushing the switch in or out. The wings (tabs) could break off if the procedure is not done evenly on all sides.

4. Detach the wires from the defective switch, noting the connection arrangement for when installing the new rocker switch.

5. Insert the replacement switch in the slot and compress the wings (or tabs) as necessary to allow it to pop into place.
6. Connect the cable connector to the wire harness and close the steering column by reversing the steps outlined in section "Remove the Display Panel," on page 3-56.

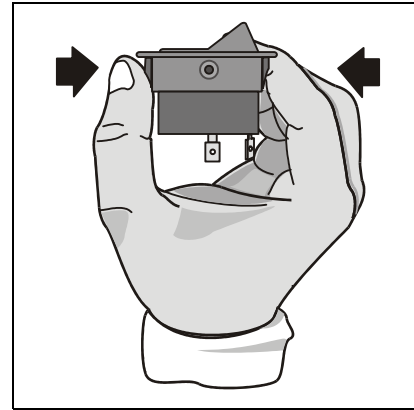


Figure 3-40: Option Rocker Switches

Steering Wheel

1. Pry the plastic cover from the steering wheel using finger tips. If the cover cannot be grabbed, carefully use a medium sized flat blade screw driver and gently pry upwards. DO NOT force it or the cover will crack.
2. Loosen the wheel nut.
3. Pry the steering wheel upwards by wiggling and pulling straight up. It is important to pull up evenly on both sides of the wheel.

NOTE

If the wheel is difficult to remove, tap the wheel nut using a dead-blow hammer a few times. The wheel should remove easily.

4. Install the steering wheel by placing it over the shaft, aligning the wheel and shaft splines and pushing downward evenly until the nut can be installed.
5. Tighten the nut, keeping in mind the tighter the nut the more difficult it will be to remove the steering wheel later on.

Steering Column (Console)

This is a two man operation, due to weight and awkward weight distribution of steering column (approximately 30 pounds/14 kgs.). If an overhead crane is available, the crane could be strapped to the steering wheel for support.

1. Remove floor plates (See "Floor Plate Removal" on page 3-55)
 2. Remove the lower dash cover weldment (See Figure 3-41).
 3. Disconnect the plugs that connect the dash harness to the main harness and any optional lighting harnesses.
 4. Relieve hydraulic pressure in the system by turning the steering wheel a few times to the left and right.
 5. Also pry (up) the bellows (rubber boot) free of the bellows retainer plate. This exposes the mounting plate for the steering column and the orbital control unit (See Figure 3-41).
- IMPORTANT**
- Four bolts secure the assembly to the orbital steering mount bracket for stability. Once removed, the unit is supported by the hydraulic tubes only.**
6. Remove the four bolts and hardware securing the orbital control unit to the steering column (See Figure 3-41).
 7. Remove the four bolts and hardware securing the steering column (console) to the bellows retainer plate.
 8. With help, lift the steering column upwards to disengage the shaft from the orbital unit, then remove the steer column from the truck.
 9. When installing the new steer column, the steering shaft must be turned until it aligns with the orbital unit and drops into place.
 10. Continue by reversing the preceding steps making sure to tighten and torque all mounting screws (See "Torque Specifications" on page 1-9).

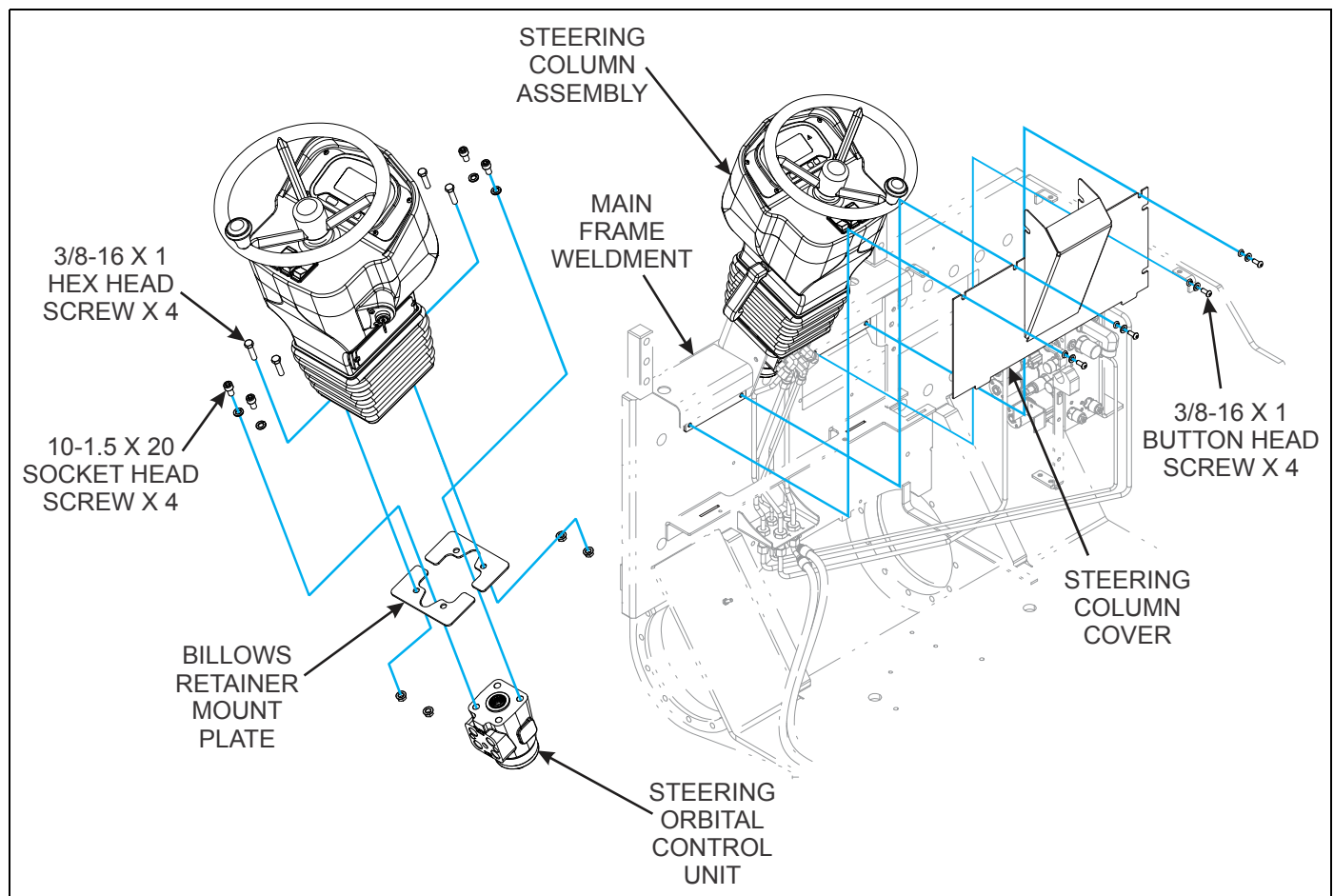


Figure 3-41: Steering Column Installation

TROUBLESHOOTING AND CORRECTIVE MAINTENANCE

Steering Orbital Control Unit

1. Remove floor plates (See "Floor Plate Removal" on page 3-55).
2. Remove the lower dash cover weldment (See Figure 3-41).
3. Relieve hydraulic pressure in the system by turning the steering wheel a few times to the left and right.
4. Tag the port locations of each hydraulic line and fitting, then disconnect the four lines from the unit (See Figure 3-42).

Review section "Hydraulic Fittings and Hoses," on page 3-47. Have shop rags handy to soak up any fluid spills.

NOTE

Immediately plug and cap all hose ends and tag each for identification. Have shop rags handy to soak up any oil spills.

5. If the unit is being replaced or the fittings are defective, notice the placement (angle) of the tube fittings then remove them.
6. Install the new steering orbital control unit to the steering column by following the preceding steps in reverse order (See Figure 3-42).
7. Check oil level in the hydraulic tank and fill as needed (See "Change Hydraulic Oil Filter" on page 3-37).

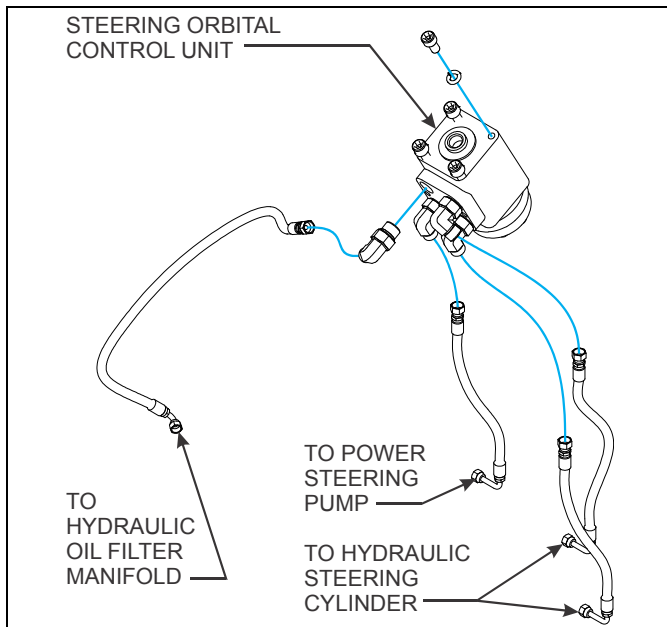


Figure 3-42: Steering Orbital Control Unit

Direction Control Switch

The directional control switch (forward-neutral-reverse) is located on the face of the control joystick. Each assembly is available as a complete unit only.

Horn

The horn button is part of the joystick.

Removing the Horn

1. Make sure the key switch is OFF, placed in a secured location away from the lift truck and that the battery is disconnected.
2. Remove hydraulic component cover plate.
3. Disconnect the electrical wires.
4. Remove the hex screws and hardware to separate the horn from the frame. See Figure 3-43 for reference.
5. Install the new horn by reversing the preceding steps.
6. Connect the battery and test the horn.

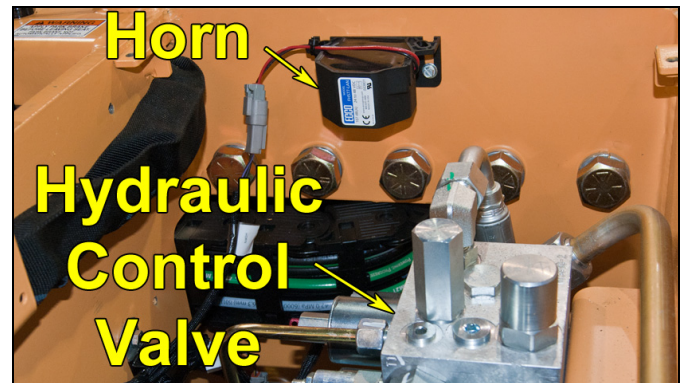


Figure 3-43: Horn Location

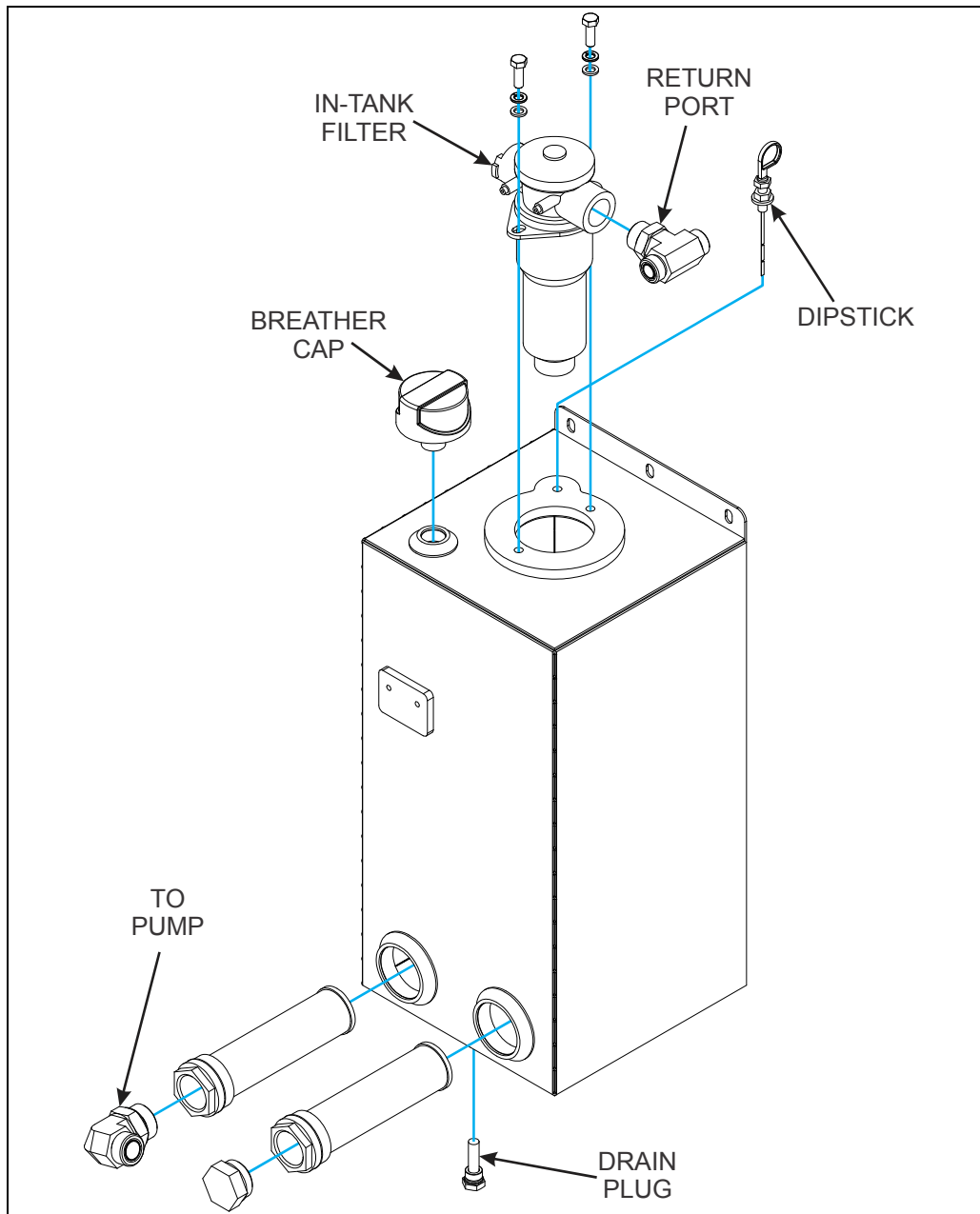


Figure 3-44: Replacing Hydraulic Tank

Replacing Hydraulic Tank

1. First, review "Getting Started (Please Read)," on page 1-1.
2. Move the mast carriage completely to the left (if possible).
3. Set the keyswitch to OFF and place the key in a secured location away from the lift truck.
4. Apply the parking brake and disconnect the battery.
5. Lift the right side of the forklift with a jack and overhead hoist.
6. Make sure all the other wheels are securely blocked so that the truck cannot move.
7. Remove the hydraulic compartment cover.
8. From underneath the forklift, unscrew the drain plug from the hydraulic tank.
9. Clean the drain plug. The end is magnetized to assist in keeping the hydraulic oil clean.
10. Drain the hydraulic tank (See Figure 3-44).

NOTE

A container or containers with sufficient capacity to contain approximately 10 gallons of oil are necessary to complete this task.

11. Disconnect the hydraulic suction and return lines going to the hydraulic tank.

TROUBLESHOOTING AND CORRECTIVE MAINTENANCE

12. Remove dipstick neck assembly.
13. Remove breather cap assembly.
14. Unbolt hydraulic tank from frame.
15. Remove hydraulic tank using proper lifting apparatus.
16. Replace in reverse order.

Seat Switch

The driver's seat micro switch and cable assembly are mounted to the bottom of the seat cushion.

Replacing the Switch and Cushion

1. First, review "Getting Started (Please Read)," on page 1-1.
2. Set the keyswitch to OFF and place the key in a secured location away from the lift truck.
3. Apply the parking brake, disconnect the battery and block all wheels.
4. Remove the two seat clips from the under the front of the seat cushion (See Figure 3-45).
5. Raise the front of the seat cushion approximately 1-1/2" and gently pull forward to disengage the cushion from the seat.
6. Follow the seat switch harness from the front of the cushion to the back corner, and unhook the harness from the main harness.
7. Remove the micro switch clip from the plastic seat insert.
8. Cut the wire tie holding the wire harness in place.
9. Remove the micro switch and disconnect the wire terminal ends, making note of their connection and orientation.
10. Pull out the wire harness through the back of the seat cushion.
11. Thread the new wire harness between the seat insert and the foam pad and pull the wire terminals through the micro switch opening.
12. Attach the wire terminals to the correct prongs on the new micro switch and push the switch back into place.
13. Reinstall the retaining clip.
14. Install a new wire tie to hold wire harness securely in place.
15. Make sure both sides of the rubber boot of the cushion are tucked inside, and install the seat cushion back into place.
16. Reinstall the seat clips through the two studs from the seat cushion.
17. Before placing the truck back into operation, test it to be sure the switch functions properly (See "Seat Switch" on page 2-13).

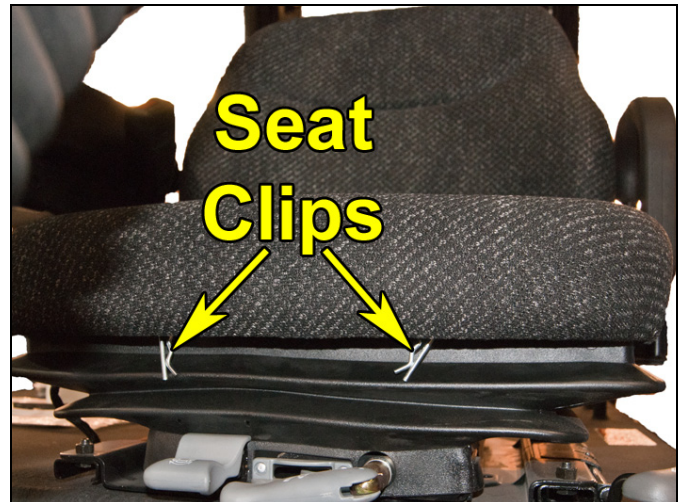


Figure 3-45: Seat Switch See Figure 3-45

Safety Features

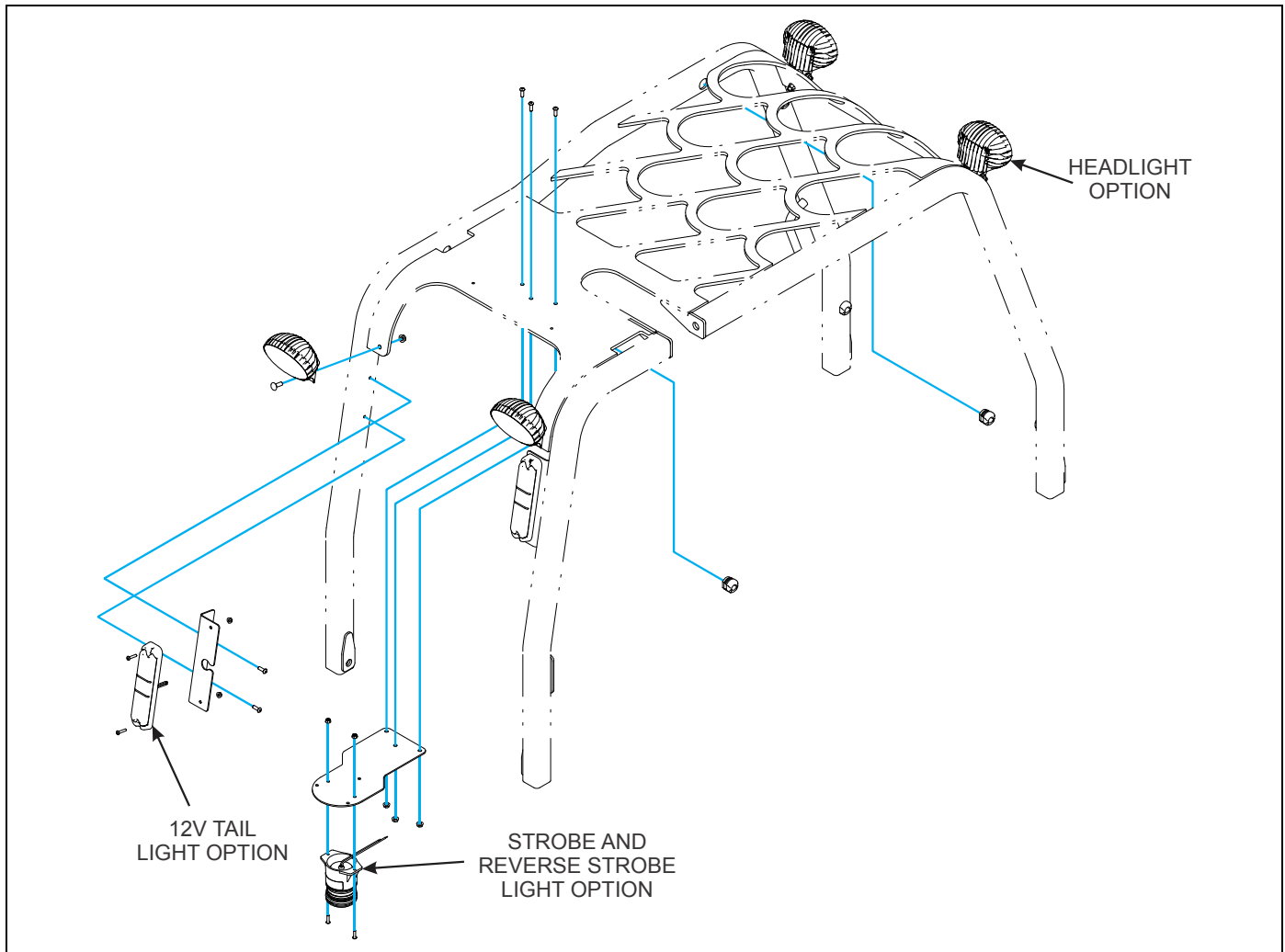


Figure 3-46: Overhead Guard Alarms and Lighting Options

Overhead Guard, Lighting, and Alarms

Trucks are equipped with optional flood / headlights, tail and stop lights, flashing or spot lights (strobe lights), etc. Refer to SL Series Parts Manual (F-624) for replacement parts.

Additional options can include backup alarms, etc (See Figure 3-46).

Back Up Alarms



WARNING

Make sure electrical power to the alarm is turned OFF and that the battery is disconnected. Wear eye protection.

1. First, review "Getting Started (Please Read)," on page 1-1.
2. Set the keyswitch to OFF and place the key in a secured location away from the lift truck.
3. Apply the parking brake and disconnect the battery.
4. To replace the alarm assembly, simply disconnect the wire connector and remove the mounting hardware holding the alarm to its mounting bracket (See Figure 3-46).
5. Reassemble in reverse order.

Table provided for general use.

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Chapter 4

Calibration and Programming

Controller Theory of Operation

The Drexel SL AC truck uses Curtis controllers that convert DC battery power to 3-phase AC power by precisely controlling the induction drive for high bandwidth, efficiency and low ripple torque generation. The Dual Drive feature of Curtis controllers allows 2 controllers to work in vehicles with dual fixed axle drive motors, a steered wheel or axle, and an analog steer-angle sensor. The 2 controllers should be the same size and model. Different models of controllers cannot be mixed. The 2 controllers control motor speed on the inner and outer wheels during turns, as well as vehicle speed and acceleration while turning. Current is automatically balanced between the 2 traction motors when driving straight, and a limited operating strategy (LOS) allows limp-home in case of a steer angle sensor, single motor or controller failure.

The Display is shown here for reference:

Button #1 **“Enter Key”** - Used to Enter the Calibration Mode and to make selections after they are located.

NOTE

You must hold the enter button down until the change has been accepted.

Button #2 **“Up Key”** - Used to move “Up” through the selections.

Button #3 **“Down Key”** - Used to move “Down” through the selections.



Figure 4-1: Dash Display

Dash Display Parameters

The following parameters can be adjusted through the dash display:

- Maintenance Monitor - Used to set the hour meter value at which the operator will be alerted that service is required, NXT SVC DUE. When the truck meets or exceeds the value entered in this section, “SERVICE DUE” will be shown on the display.
- Steer Potentiometer (Steer Pot) Setup - Used to calibrate the steering position potentiometer.
- Accelerator Potentiometer (Accelerator Pot) Setup - Used to calibrate the accelerator potentiometer.
- Brake Potentiometer (Brake Pot) Setup - Used to calibrate the brake potentiometer.
- Lift Lockout Setup - This parameter allows for adjustment of the battery capacity percentage where lift lockout is initiated.

IMPORTANT

When replacement of the steering, brake, or acceleration potentiometer has been performed, re-calibration of the Drexel SL AC is required.

Truck Calibration

NOTE

While in the display's calibration menus, the truck will not move forward, backward, or perform any mast functions other than lowering the forks.

Truck calibration is performed by activating the keyswitch and performing the following procedure:

Follow the flow chart in Figure 4-2 on page 4-3

1. At the Main Screen, press and hold the ENTER button for approximately 5 seconds. This will open the calibration menu. An asterisk (*) will show your selection. You can use the Up/Down arrows to toggle the selection. Hold down ENTER to select.

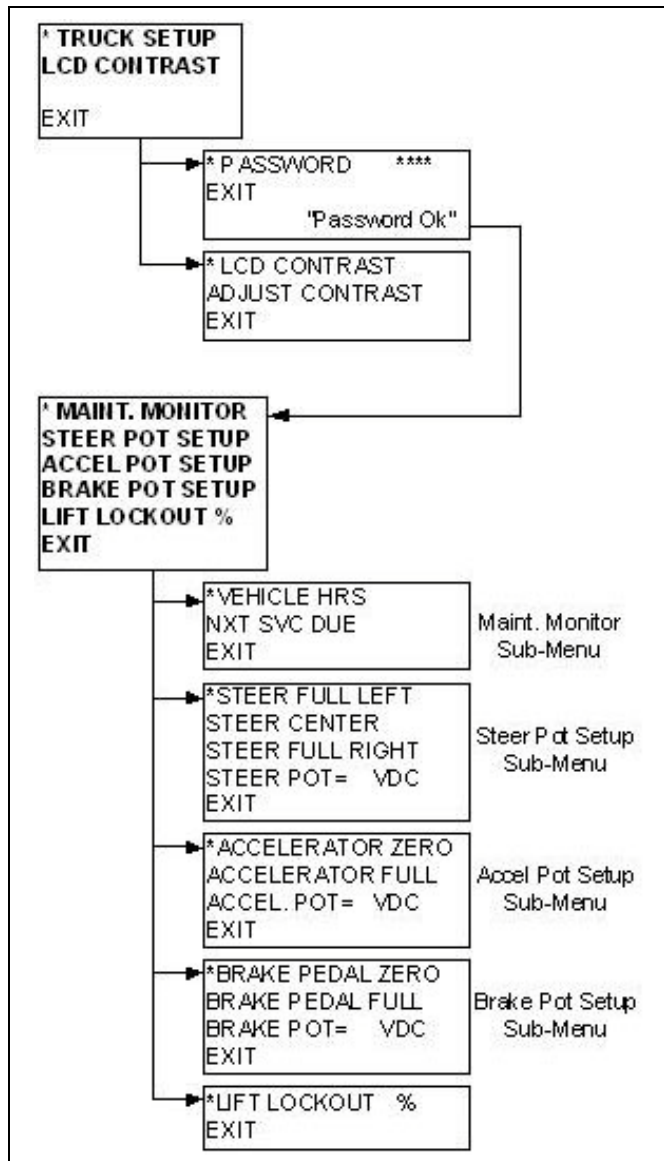
CALIBRATION AND PROGRAMMING

2. To adjust the screen's contrast level, select **LCD CONTRAST** and hold the enter key, then select **ADJUST CONTRAST** similarly. Press the UP and DOWN buttons to adjust the brightness to your preference. Press the ENTER key to finish.
3. To begin the Truck Setup, go back to the main first screen shown in Figure 4-2 on page 4-3, move the asterisk to **TRUCK SETUP** and hold the ENTER button.
4. The next screen will give you the option to enter a password or to exit. To enter the password, select **ENTER PSW** and hold enter, then use the UP/DOWN arrows to manipulate the value to the desired digit. Pressing the ENTER button accepts that digit and moves onto the next one. Repeat this process for each digit. After entering the correct password, the truck setup menu will be displayed.

NOTE

The default password is: 4 2 3 1.

5. If you would like a reminder for maintenance, navigate to **MAINT MONITOR** selection and adjust the Service Due Hour Meter value as you require. The digits shows the number of hours in 100's until the warning is shown. To disable this option, just enter 99900 hours into the field.
6. Next, to calibrate the steer potentiometer, press the DOWN arrow button until the asterisk is to the right of **STEER POT SETUP**, and press ENTER. The Directional switch must be switched to forward to be able to turn the steering wheel.
7. The next screen will show what operations you will need to perform to complete the calibration. Hold down ENTER to begin.
 - The asterisk moves to the right indicating the current step in the calibration you are currently in.
 - Steer truck fully left and press ENTER. Turn Steer to straight selection and hit ENTER. Steer the truck to the right position & press ENTER.
 - When the asterisk is beside the **EXIT**, the steer pot calibration is complete.
8. **ACCELERATOR POTENTIOMETER SETUP:** Navigate to **ACCEL POT SETUP** on the main menu and press ENTER. Press ENTER again to begin calibration.
 - **ACCEL ZERO** calibration - Ensure the foot pedal is in the up position and press ENTER.
 - **ACCEL FULL** - Press the pedal to the floor and press ENTER. Monitor the accelerator pot voltage on the screen; ensure this value is changing with movement of the pedal between 0.2VDC and 5.2VDC.
 - When the asterisk is beside the **EXIT**, the accelerator pot calibration is complete.
9. **BRAKE POTENTIOMETER SETUP:** Select **BRAKE POT SETUP** from the truck setup menu and press ENTER. Press ENTER again to begin calibration.
 - **BRAKE PEDAL ZERO** - Ensure the brake pedal is in the up position and press ENTER.
 - **BRAKE PEDAL FULL** - Press the brake pedal to the floor and press ENTER. Monitor the brake pot voltage on the screen; ensure this value is changing with movement of the pedal between 0.3VDC and 5.3VDC.
 - When the asterisk is beside the **EXIT**, the brake pot calibration is complete.
10. **LIFT/LOCKOUT SETUP:** Select **LIFT LOCKOUT** from the truck setup menu and press enter. Press ENTER again to begin editing.
 - Use the UP/DOWN arrows to manipulate the value to the desired percentage of battery charge before the "Limp Home" mode is activated and press enter to store the new value. This completes the LIFT/LOCKOUT.

**Figure 4-2: Truck Calibration Flow Chart**

1314 Drexel SL AC Controller Software Program Installation and Operation

The 1314 Controller Software is used to manipulate, monitor and diagnose the Drexel SL AC Forklift performance and functions.

The following sections will guide you through the installation of the 1314 Controller Programming Station and explain the software program functionality.

USB to Serial Port Adaptor Cable

Depending on the configuration of your laptop, an interface cable may be needed for the software transfer between the laptop and the Drexel controllers. A 9-pin Serial to USB port adapter is needed. See Figure 4-3.

**Figure 4-3: Serial to USB Adapter**

NOTE

The Belkin F5U509 is a recommended model, although other suppliers of this type of adapter are available at many computer cable suppliers. Refer to See Figure 4-3..

If your laptop is equipped with a serial port you may connect the Drexel controller directly to your laptop with the supplied 1314 Curtis interface cable. See Figure 4-4.

**Figure 4-4: Controller Dongle**

See Figure 4-5. Shown here is the Serial to USB adaptor cable connected to the Curtis 1314 interface cable that is to be connected between the forklift controller and your laptop computer. Reference Figure 4-6 on page 4-4 for truck cable connector(s) locations.

CALIBRATION AND PROGRAMMING

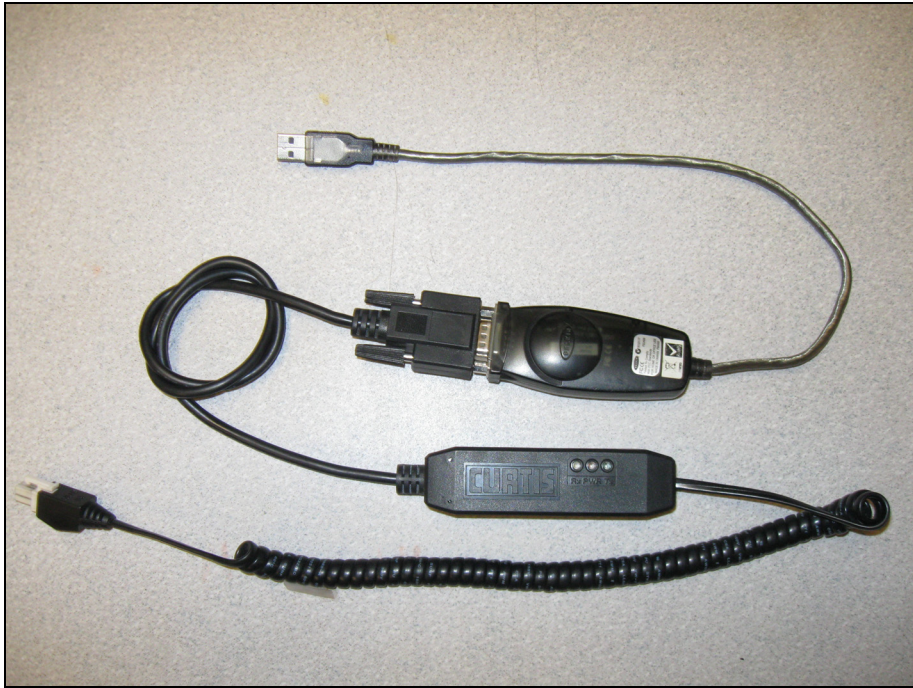


Figure 4-5: Serial Adaptor + 1314 Interface Cable



Figure 4-6: Cable Connections

1314 Installation Procedure

Follow the installation instructions below:

1. Insert Curtis 1314 PC Programming Station CD into your CD ROM drive.
2. If the screen in Figure 4-7 does not automatically appear, go to your computer directory, double click your CD ROM drive (usually D:\) and double click **setup.exe** as shown in Figure 4-8. Click **[Next]**.

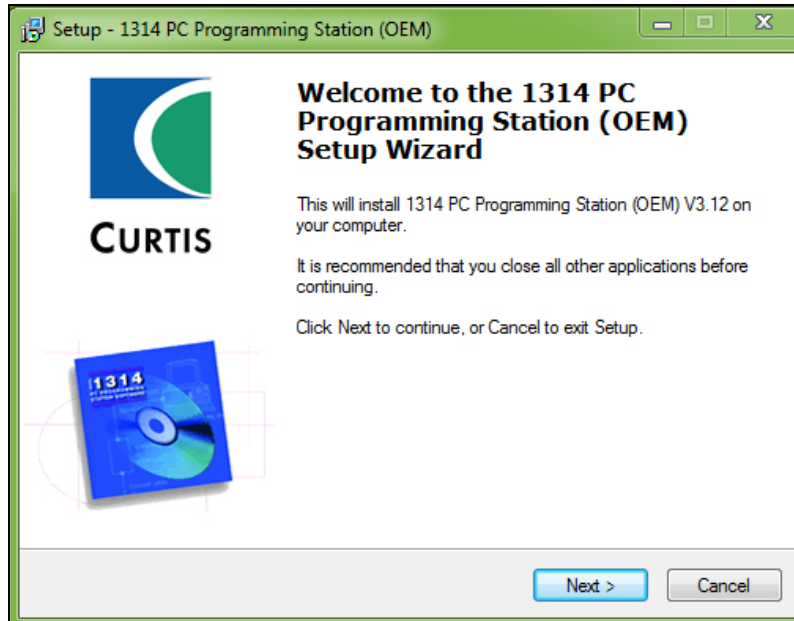


Figure 4-7: Start - Steps 1 & 2

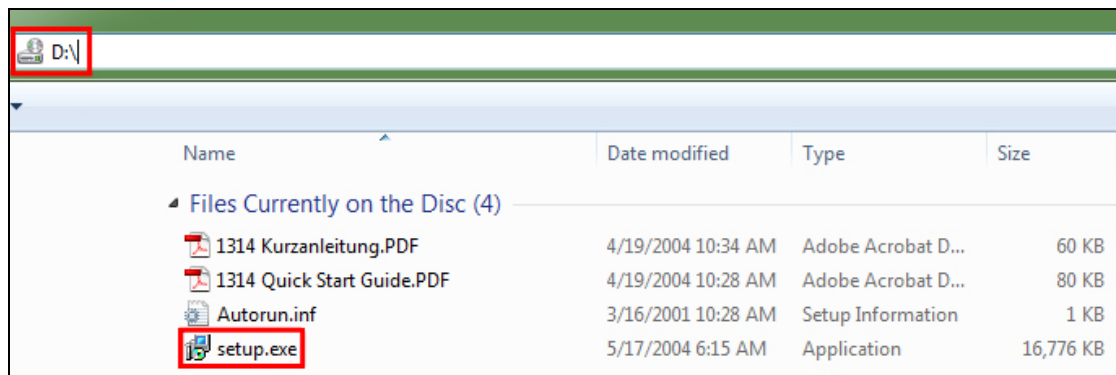


Figure 4-8: Starting Installation Program

CALIBRATION AND PROGRAMMING

3. Be sure to thoroughly read and understand the contents of the Software License Agreement.
4. Click the radial button beside “I accept the agreement” if you understand and agree and then click **[Next]**.

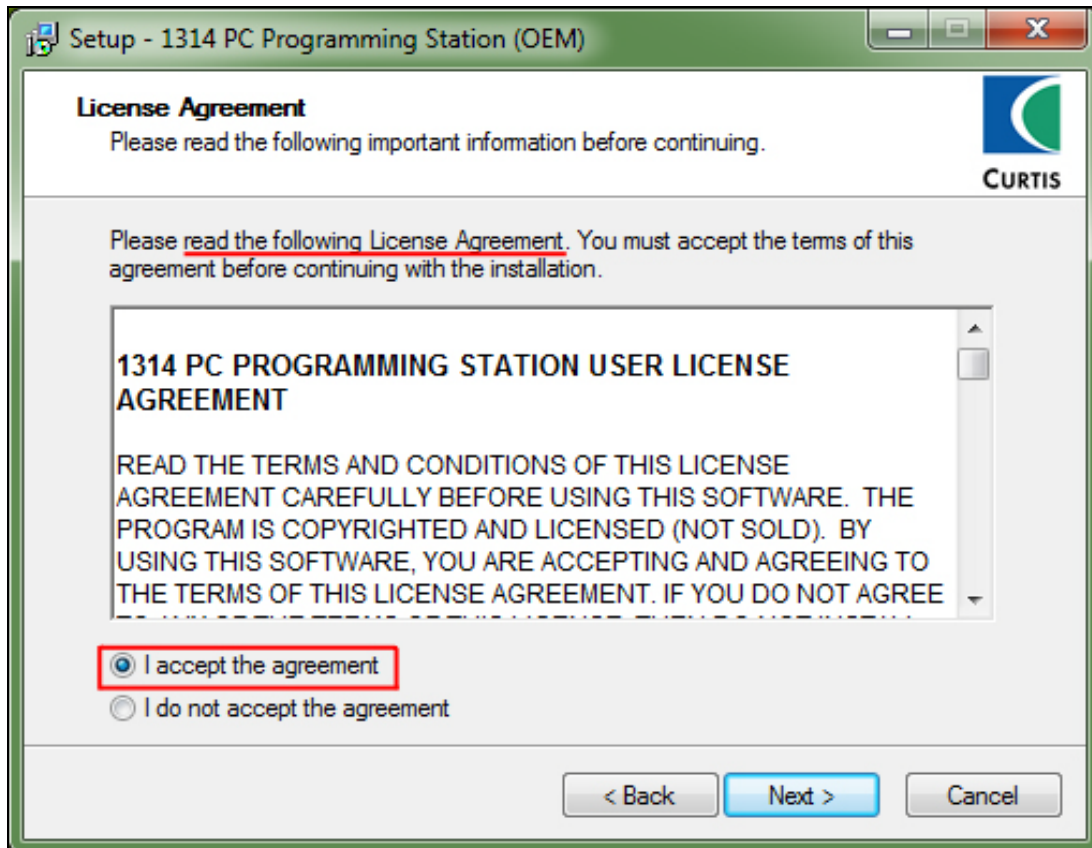


Figure 4-9: Steps 3 & 4

5. The next screen gives you the option to load the program in a specific location. In situations that multiple drives are used it may be advantageous to use this option. For most users, the location it auto-generates should be adequate. Click **[Next]**.

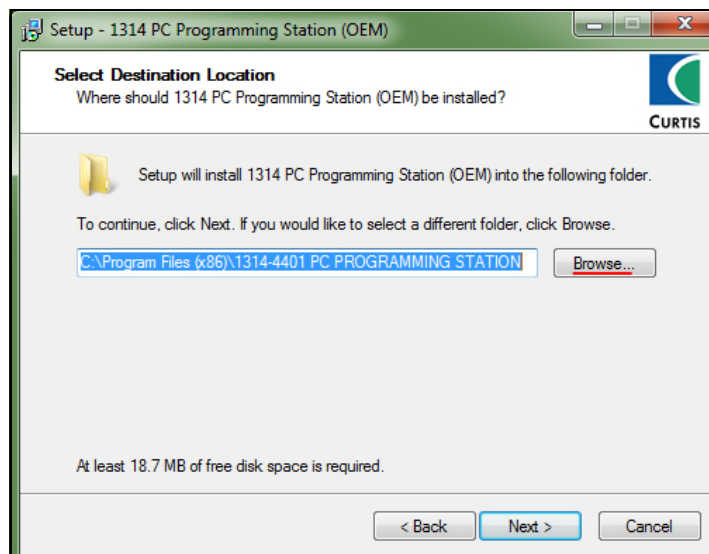


Figure 4-10: Destination Selection

6. Now hit **[Install]** to begin the process.

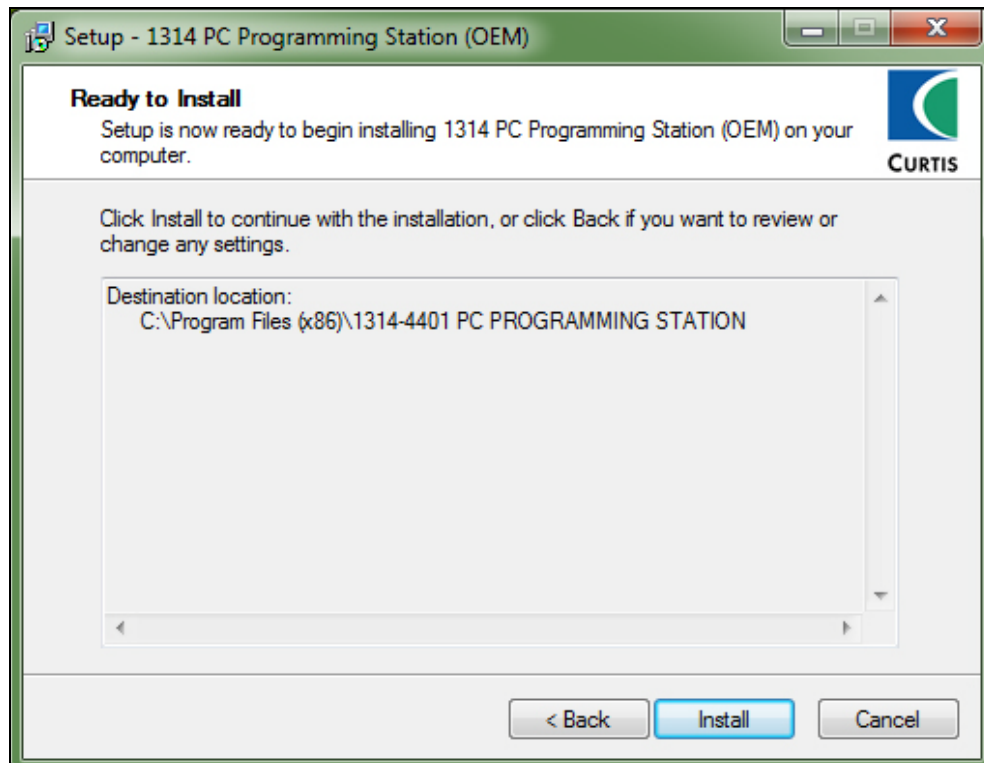


Figure 4-11: Ready to Install

7. If you see the screen in Figure 4-12, you have successfully installed the 1314 Curtis Program.

Click **[Finish]** to launch the program or uncheck the option beside "Run 1314 PC Programming Station" if you are not about to plug in and begin diagnosing.

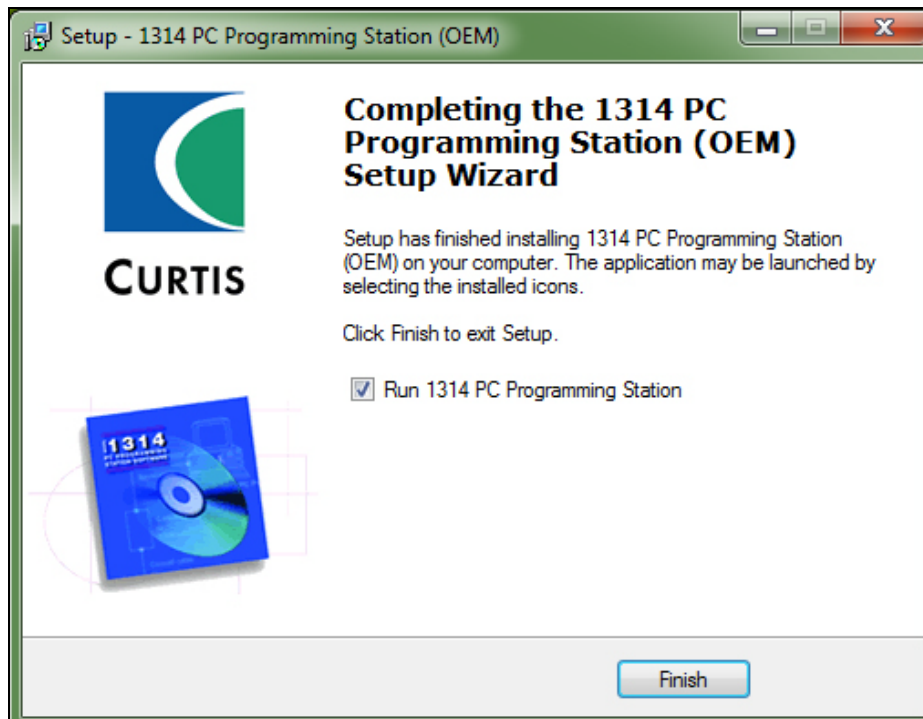


Figure 4-12: Successful Installation

CALIBRATION AND PROGRAMMING

1314 Update Procedure

NOTE

This procedure must be completed before using the software, on every installation of the software. See Figure 4-13.

1. Open the 1314 Software program and select “Help.”
2. Select the CHECK FOR UPDATES menu.

This will use the internet to ensure that you have the latest revision level.

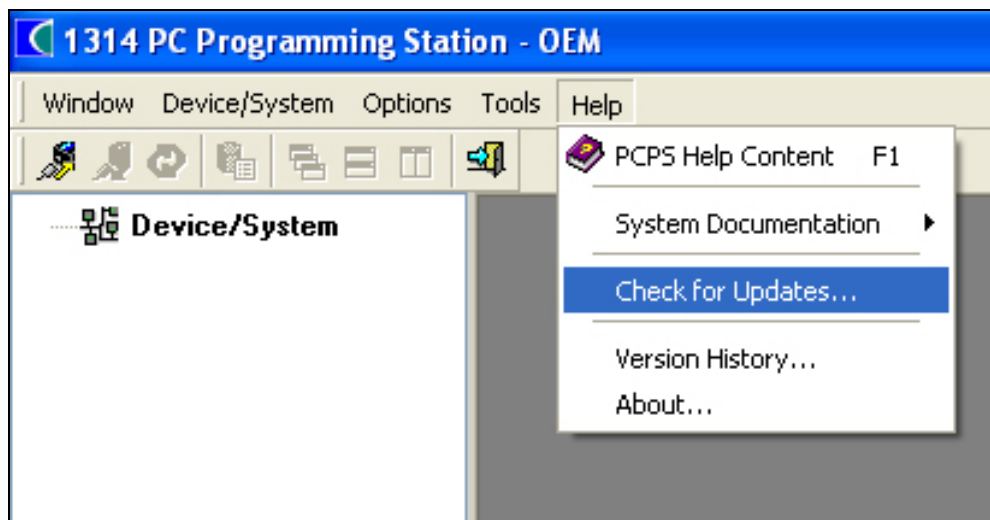


Figure 4-13: Update Procedure

Communicating with Drexel SL AC Controllers

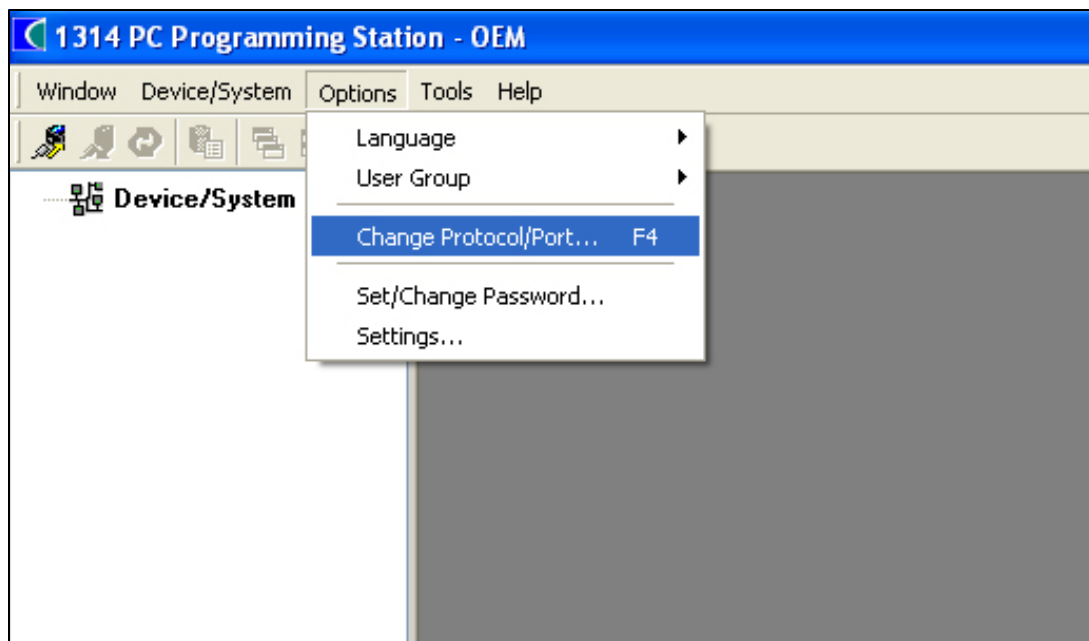


Figure 4-14: Communicating with the Controllers

To initiate communications with the Drexel Controllers, with the Curtis program open go to **Options**, then click **Change Protocol/Port**, as shown in Figure 4-14.

The computer should be connected to the trucks harness labeled “Master,” and the truck turned on.

Select ENHANCED SERIAL protocol and then press the CONNECT button. This is shown in Figure 4-15, though the communication port number may differ from computer to computer.

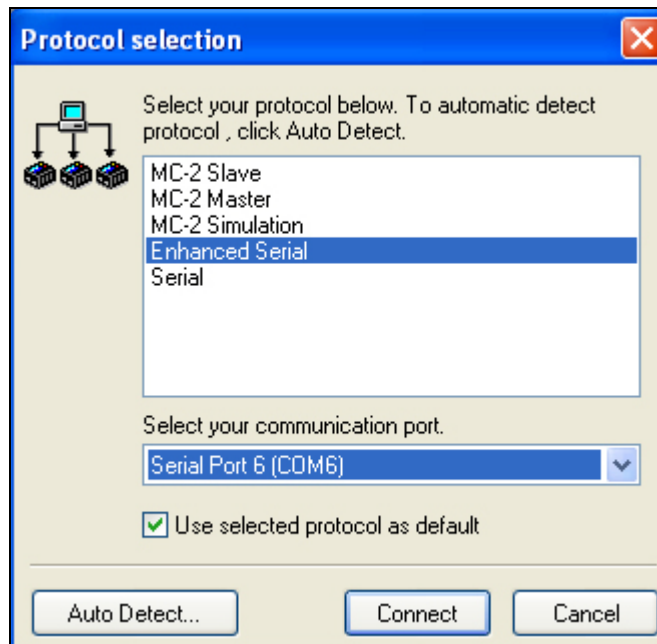


Figure 4-15: Selecting Protocol and Port

Highlight the connected controller and select the icon for Device Parameters, as shown in Figure 4-16. Once you've selected a parameter from the program tree you can adjust them in the active window.

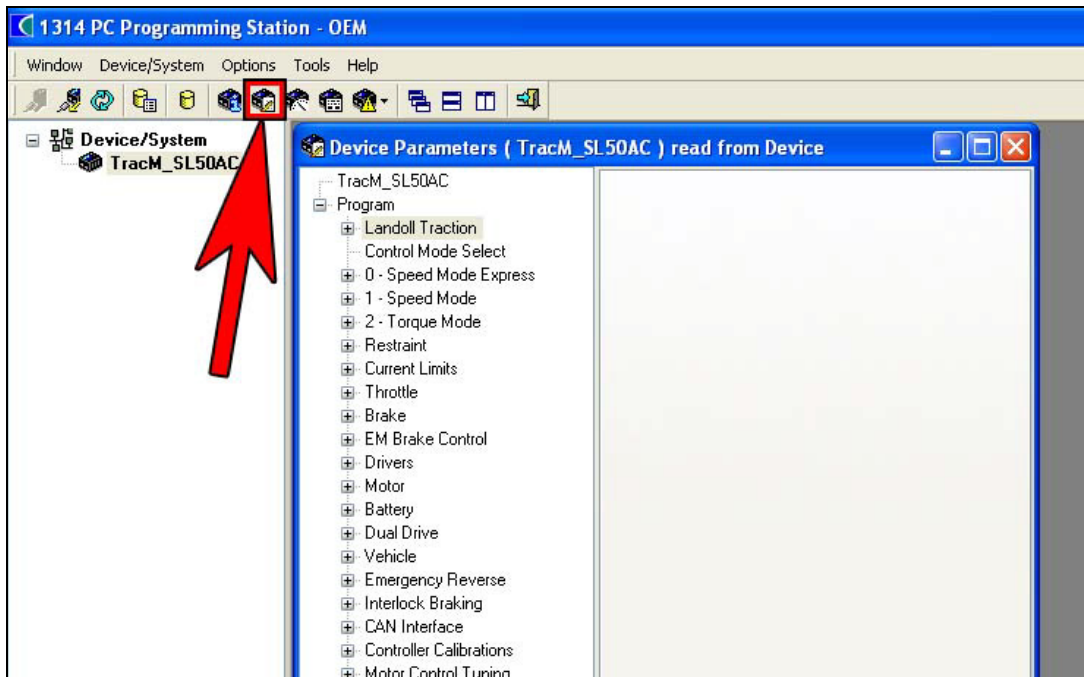
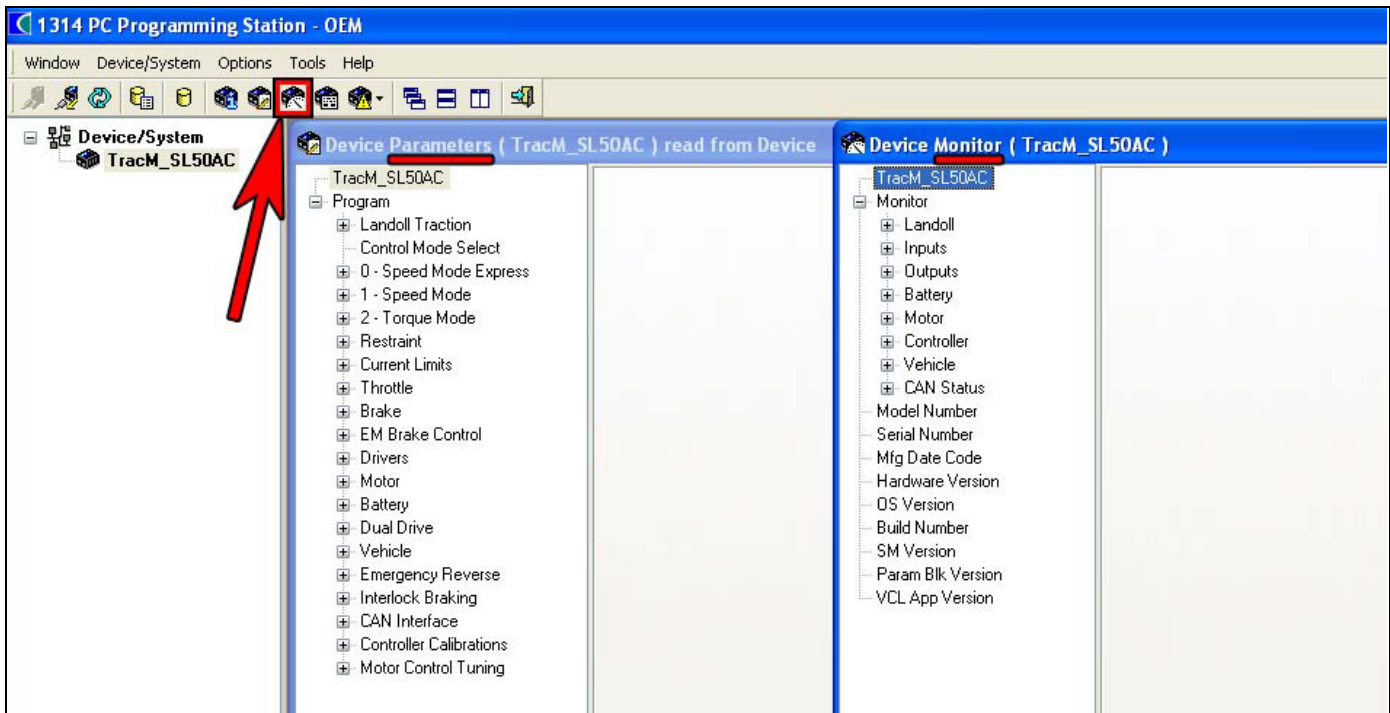


Figure 4-16: Accessing Parameters

The device may be monitored by clicking on the MONITOR button. The monitor function is useful to see

actual controller values during operation of the truck.

CALIBRATION AND PROGRAMMING**Figure 4-17: Accessing the Monitor**

Controller Fault History

The 1314 programmer can be used to access the controller's fault history file. The programmer will read out all the faults the controller has experienced since the last time the fault history file was cleared. Faults such as contactor faults may be the result of loose wires; contactor wiring should be carefully checked. Faults such as over temperature may be caused by operator habits or by overloading. After a problem has been diagnosed and corrected, it is a good idea to clear the fault history file. This allows the controller to accumulate a new file of faults. By checking the new fault history file at a later date you can readily determine whether the problem was indeed fixed.

You may now begin to manipulate, monitor and diagnose the forklift performance and functionality.

1314 Software has many built-in features to help in troubleshooting individual controllers. Click on the Exclamation point icon and select the desired option as shown in Figure 4-18.

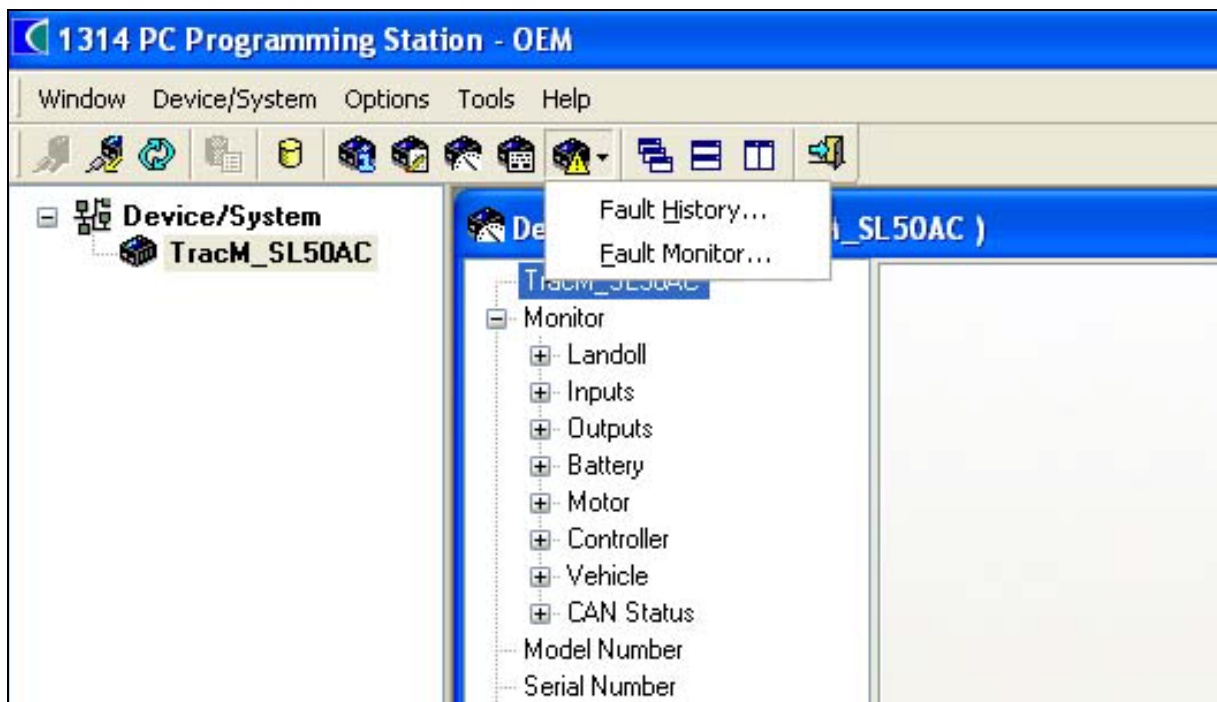


Figure 4-18: Fault Monitor

Individual faults in FAULT HISTORY are cleared by highlighting the fault and RIGHT clicking it. A drop down menu will give you the option to clear the fault as shown in the example in Figure 4-19.

IMPORTANT

After successfully re-flashing a controller, make sure to clear the fault history of all comments.

CALIBRATION AND PROGRAMMING

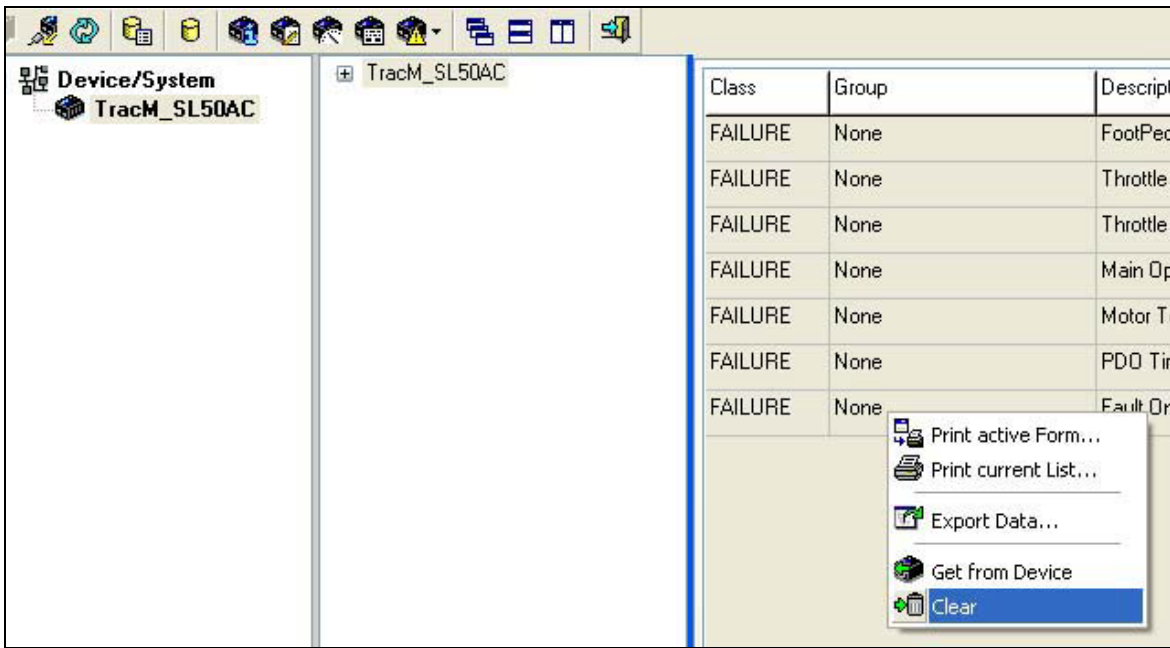


Figure 4-19: Fault History

Menu Overview

See Figure 4-20 for the following:

Number 1 in Figure 4-20 shows the Disconnect Icon.

Number 2 shows, from left to right, Device Info, Device Parameters, Device Monitor, Device Functions and Fault History.

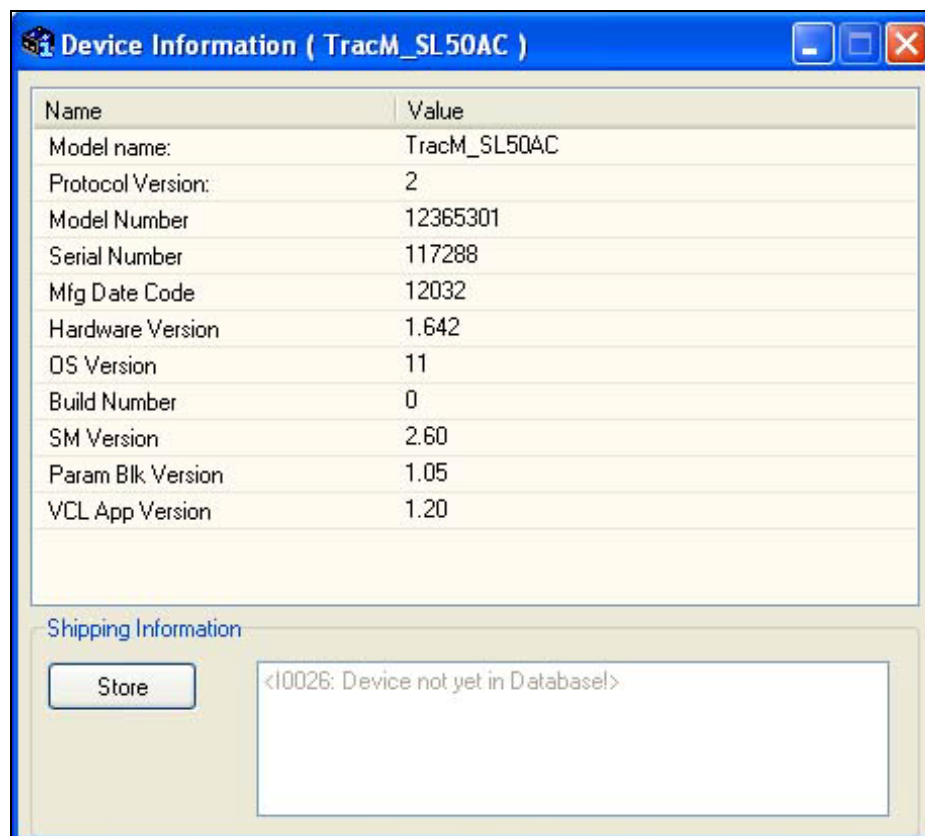
Number 3 shows the controller currently connected.

TracM_SL50AC is Master Controller, Lan_TS_SL50 is Slave Controller, and Pump_SL50AC is Pump Controller.

Program Menus

There are five menus, which in turn lead to nested submenus.

- **Information** — displays data about the host controller, model and serial numbers, date of manufacture, hardware and software revisions, and itemization of other devices that may be associated with the controller's operation.
- **Parameters** — provides access to the programmable parameters.
- **Monitor** — presents real-time values during vehicle operation; these include all inputs and outputs, as well as the mapped throttle values and conditioned throttle requests.
- **Functions** — provides access to the controller-cloning commands and to the "reset" command.
- **Faults** — presents diagnostic information and also a means to clear the fault history file.

**Figure 4-20: Devices Info****Figure 4-21: Software Revisions****IMPORTANT**

Contact Landoll for Current Software Revision. See Figure 4-21.

CALIBRATION AND PROGRAMMING

NOTE

After successfully connecting to the controller, proceed through the instructed menus and sub-menus to review all parameters.

For All Parameters:

To change actual value to a desired value, click in the white text field or use the slider just underneath. When complete, click OK to change value. All parameters are programmable from the Master Controller connection.

NOTE

Where available, descriptions for the following parameters are taken directly from Curtis Instruments, Inc.'s Integrated Traction & Hydraulic System Motor Controller Manual.

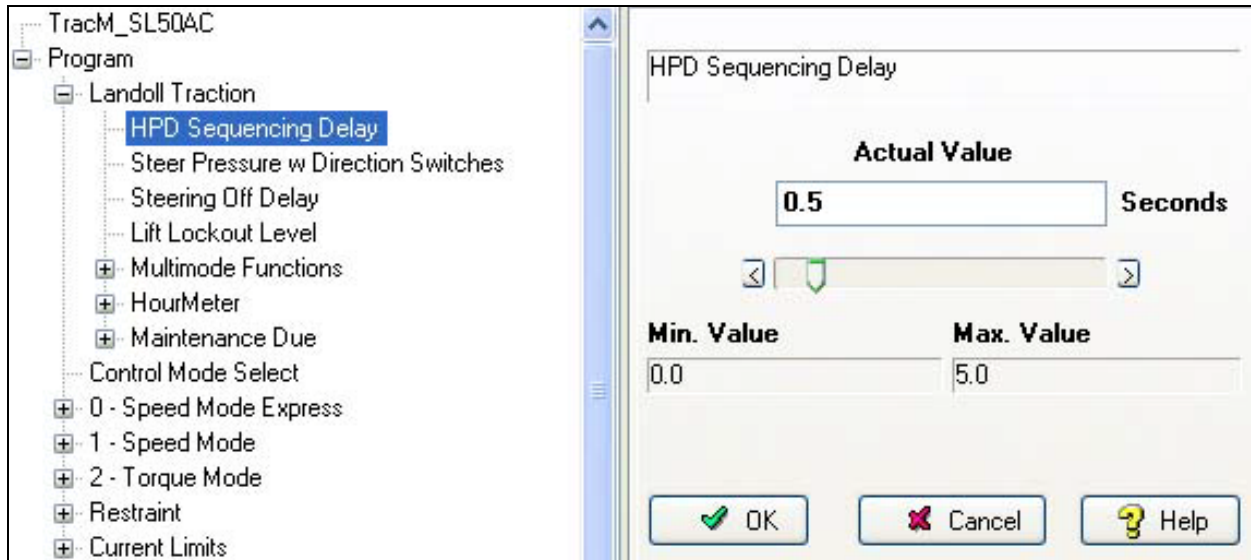


Figure 4-22: Landoll Traction, HPD Sequencing Delay - 1 of 2

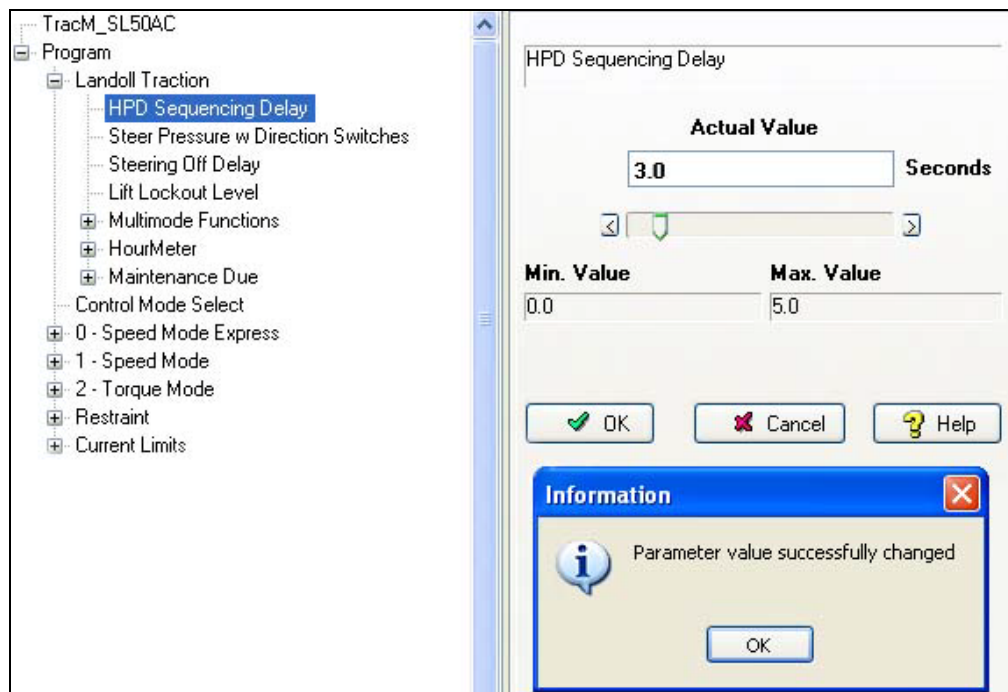


Figure 4-23: HPD Sequencing Delay - 2 of 2

****Parameters are programmable from the Master Controller Connection.**

Landoll Traction Menu		
Programmable Parameter	Definition	Range
High Pedal Disable Sequencing Delay	Actual Value shows current duration the seat switch can be false until SRO (return to neutral) occurs.	0.0 - 5.0 Seconds
Steer Pressure with Direction Switches	When set to "On" , allows steer pressure when the direction switch is set to forward or reverse.	Off - On
Steering Off Delay	Sets the amount of time that the pump will continue to run after the seat switch parameter is false.	0.0 - 30.0 Seconds
Lift Lockout Delay	Sets the percentage of battery discharge before lift lockout occurs. Note: Lift lockout protects the operator from taking the battery below safe levels.	0 - 99
Multimode Functions, Rabbit Forward Maximum Speed	Sets the forward vehicle max speed in Rabbit Mode. Note: The Rabbit and Turtle functions are determined by the position of the switch on the dash.	0 - 100 %
Multimode Functions, Turtle Forward Maximum Speed	Sets the forward vehicle max speed in Turtle Mode. See "Rabbit Forward Maximum Speed."	0 - 100 %
Multimode Functions, Rabbit Reverse Maximum Speed	Sets the reverse vehicle max speed in Rabbit Mode. See "Rabbit Forward Maximum Speed."	0 - 100 %
Multimode Functions, Turtle Reverse Maximum Speed	Sets the reverse vehicle max speed in Turtle Mode. See "Rabbit Forward Maximum Speed."	0 - 100 %
HourMeter, Set Total Hours and Minutes	When set to "On" , values entered in "10s of Hours" and "Remaining HRs in Mins" parameters are sent to the controller.	Off - On
HourMeter, 10's of Hours	Sets the value for number of hours in multiples of 10. Example: Value entered is 150 , then hourmeter would read 1500 (150 X 10 = 1500).	0 - 20,000
HourMeter, Remaining Hours in Minutes	Sets the value for number of hours less than 10, entered in minutes. Example: Value entered is 438 , then hourmeter would read 7.3 (438 ÷ 60 = 7.3).	0 - 600
Maintenance Due, Next Service Due	When hourmeter is equal to the value entered here, "SRVC DUE" will be displayed on the dash display. This is an optional parameter, and effective off is set to 99900 (factory default).	0 - 99900 Hours

CALIBRATION AND PROGRAMMING

****Parameters are programmable from the Master Controller Connection.**

1 - Speed Mode		
Programmable Parameter	Definition	Range
Response, Full Acceleration Rate High Speed	Sets the rate (in seconds) at which the speed command increases when full throttle is applied at high vehicle speeds. Larger values represent slower response.	0.1 - 30.0 Seconds
Response, Full Acceleration Rate Low Speed	Sets the rate (in seconds) at which the speed command increases when full throttle is applied at low vehicle speeds.	0.1 - 30.0 Seconds
Response, Low Acceleration Rate	Sets the rate (in seconds) at which the speed command increases when a small amount of throttle is applied. This rate is typically adjusted to affect low speed maneuverability.	0.1 - 30.0 Seconds
Response, Neutral Deceleration Rate High Speed	Sets the rate (in seconds) that is used to slow down the vehicle when the throttle is released to neutral at high vehicle speeds.	0.1 - 30.0 Seconds
Response, Neutral Deceleration Rate Low Speed	Sets the rate (in seconds) that is used to slow down the vehicle when the throttle is released to neutral at slow vehicle speeds.	0.1 - 30.0 Seconds
Response, Full Brake Rate High Speed	Sets the rate (in seconds) at which the vehicle slows down from high speeds when full brake is applied or when full throttle is applied in the opposite direction.	0.1 - 30.0 Seconds
Full Brake Rate Low Speed	Sets the rate (in seconds) at which the vehicle slows down from slow speeds when full brake is applied or when full throttle is applied in the opposite direction.	0.1 - 30.0 Seconds
Response, Low Brake Rate	Sets the rate (in seconds) at which the vehicle slows down at all speeds when a small amount of brake is applied or when a small amount of throttle is applied in the opposite direction.	0.1 - 30.0 Seconds
Response, Fine Tuning, Partial Deceleration Rate	Sets the rate (in seconds) that is used to slow down the vehicle when the throttle is reduced without being released to neutral. Larger values represent slower response.	0.1 - 30.0 Seconds
Response, Fine Tuning, High Speed	Sets the percentage of the Typical Max Speed above which the HS parameters will be used.	0 - 100 %
Response, Fine Tuning, Low Speed	Sets the percentage of the Typical Max Speed below which the LS parameters will be used.	0 - 100 %
Response, Fine Tuning, Reversal Soften	Larger values create a softer reversal from regen braking to drive when near zero speed. This helps soften the transition when the regen and drive current limits are set to different values.	0 - 100 %

1 - Speed Mode		
Programmable Parameter	Definition	Range
Response, Fine Tuning, Maximum Speed Acceleration	Controls the rate at which the maximum speed setpoint is allowed to change when the value of Max Speed is raised. The rate set by this parameter is the time to ramp from 0 rpm to Typical Max Speed rpm. For example, suppose Max Speed is raised from 1000 rpm to 4000 rpm. If Typical Max Speed is 5000 rpm, and the rate is 10.0 seconds, it will take $10.0 * (4000 - 1000) / 5000 = 6.0$ seconds to ramp from 1000 rpm to 4000 rpm.	0.1 - 30.0 Seconds
Response, Fine Tuning, Maximum Speed Deceleration	Controls the rate at which the maximum speed setpoint is allowed to change when the value of Max Speed is lowered. For example, suppose you change Max Speed from 4500 rpm to 2500 rpm. If Typical Max Speed is 5000 rpm, and the rate is 5.0 seconds, it will take $5.0 * (4500 - 2500) / 5000 = 2.0$ seconds to ramp from 4500 rpm to 2500 rpm.	0.1 - 30.0 Seconds

CALIBRATION AND PROGRAMMING

****Parameters are programmable from the Master Controller Connection.**

Throttle		
Programmable Parameters	Definition	Range
Throttle, Forward Deadband	Defines the accelerator potentiometer voltage at the deadband threshold when the direction switch is set to FWD. This value is set automatically when calibrating through the dash display. Note: Calibration should be completed through the display. To set the using 1314 software, use the monitor menu to view Inputs/Throttle Pot when the accelerator is not depressed. Add 0.10 to this value and then enter it into the Actual Value for Forward Deadband.	0.00 - 5.00 Volts
Forward Maximum	Defines the accelerator potentiometer voltage required to produce 100% controller output when the direction switch is set to FWD. This value is set automatically when calibrating through the dash display. Note: Calibration should be completed through the display. To set using the 1314 software, use the monitor menu to view Inputs/Throttle Pot with the accelerator fully depressed. Subtract 0.10 from this value and enter it into the Actual Value for Forward Max.	0.00 - 5.00 Volts
Reverse Deadband	Defines the accelerator potentiometer voltage at the deadband threshold when the direction switch is set to REV. This value is set automatically when calibrating through the dash display. Note: Calibration should be completed through the display. This value should be set to the same value as Throttle/Forward Deadband.	0.00 - 5.00 Volts
Reverse Maximum	Defines the accelerator potentiometer voltage required to produce 100% controller output when the direction switch is set to REV. This value is set automatically when calibrating through the dash display. Note: Calibration should be completed through the display. This value should be set to the same value as Throttle/Reverse Deadband.	0.00 - 5.00 Volts

****Parameters are programmable from the Master Controller Connection.**

Brake		
Programmable Parameter	Definition	Range
Brake Deadband	Defines the brake potentiometer voltage at the deadband threshold. This value is set automatically when calibrating through the dash display. Note: Calibration should be completed through the display. To set using the 1314 software, use the monitor menu to view Inputs/Brake Pot when the brake is not depressed. Add 2.0 to this value and then enter it into the Actual Value for Brake Deadband.	0.00 - 5.00 Volts
Brake Maximum	Defines the brake potentiometer voltage required to produce 100% controller output. This value is set automatically when calibrating through the dash display. Note: Calibration should be completed through the display. To set using the 1314 software, use the monitor menu to view Inputs/Brake Pot when the brake is fully depressed. Subtract 0.10 from this value and then enter it into the Actual Value for Brake Max.	0.00 - 5.00 Volts

CALIBRATION AND PROGRAMMING

****Parameters are programmable from the Master Controller Connection.**

Battery		
Programmable Parameter	Definition	Range
Reset Volts Per Cell	The reset voltage level is checked only once, when KSI is first turned on. Note that the BDI Reset Percent parameter also influences the algorithm that determines whether BDI Percentage is reset to 100%. Reset Volts Per Cell should always be set higher than Full Volts Per Cell. Reset Voltage Level = Reset Volts Per Cell × number of cells in the battery pack. Parameter changes not recommended - Landoll default settings.	0.900 - 3.000 Volts
Full Volts Per Cell	The full voltage level sets the keyswitch Voltage that is considered to be 100% state-of-charge; when a loaded battery drops below this voltage, it begins to lose charge. keyswitch Voltage is viewable in the 1314 menu Monitor » Battery. Full Voltage Level = Full Volts Per Cell × number of cells in the battery pack. Parameter changes not recommended - Landoll default settings.	0.900 - 3.000 Volts
Empty Volts Per Cell	The empty voltage level sets the keyswitch_Voltage that is considered to be 0% state-of-charge. Empty Voltage Level = Empty Volts Per Cell × number of cells in the battery pack. Parameter changes not recommended - Landoll default settings.	0.900 - 3.000 Volts
Discharge Time	Sets the minimum time for the BDI algorithm to count down the BDI Percentage from 100% to 0%. State of Charge Level = (Full Voltage Level - Empty Voltage Level) × BDI Percentage / 100) + Empty Voltage Level.	0 - 600 Minutes
Battery Discharge Indicator Reset Percent	When a battery has a high BDI percentage, its float voltage at KSI On can sometimes cause false resets. The BDI Reset Percent parameter addresses this problem by allowing the user to define a BDI Percentage value above which the BDI Percentage variable will not reset. When KSI is first powered on, the BDI Percentage variable will reset to 100% only if (keyswitch Voltage > Reset Voltage Level) and (BDI Percentage < BDI Reset Percent).	0 - 100 %

****Parameters are programmable from the Master Controller Connection.**

Dual Drive		
Programmable Parameter	Definition	Range
Master, Steer Potentiometer Minimum	Defines the steer potentiometer voltage when steering as far counterclockwise as possible. This value is set automatically when calibrating through the dash display. Note: Calibration should be completed through the display. To set using the 1314 software, use the monitor menu to view Inputs/Steer Pot when steering as far counterclockwise as possible and enter this value into the Actual Value for Steer Pot Min.	0.00 - 5.00 Volts
Master, Steer Potentiometer Zero	Defines the steer potentiometer voltage when the steering straight ahead. This value is set automatically when calibrating through the dash display. Note: Calibration should be completed through the display. To set using the 1314 software, use the monitor menu to view Inputs/Steer Pot when steering straight ahead and enter this value into the Actual Value for Steer Pot Zero.	0.00 - 5.00 Volts
Master, Steer Potentiometer Maximum	Defines the steer potentiometer voltage when steering as far clockwise as possible. This value is set automatically when calibrating through the dash display. Note: Calibration should be completed through the display. To set using the 1314 software, use the monitor menu to view Inputs/Steer Pot when steering as far clockwise as possible and enter this value into the Actual Value for Steer Pot Max.	0.00 - 5.00 Volts

CALIBRATION AND PROGRAMMING

Device Parameter Monitor

Make sure that you have the controller selected (1) and click the Monitor Icon (2).

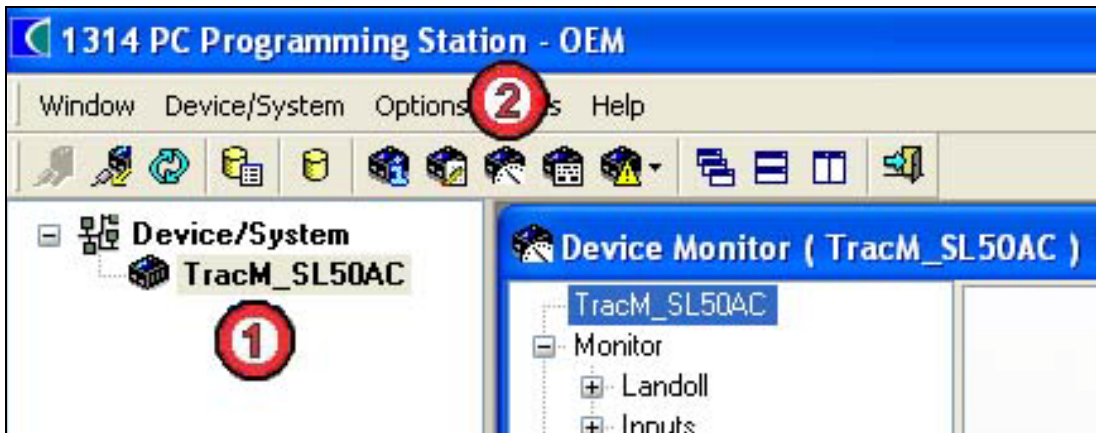


Figure 4-24: Monitor Menu

Landoll Parameter Details		
Monitor Value Name	Definition	Range
Lift Cutout Flag	On when in Lift Lock-Out.	On - Off
Steer Pump Speed Flag	On when in forward or reverse AND driver is on the seat.	On - Off
Seat Switch Flag		On - Off
Handbrake Switch		On - Off
Seat Switch	On when operator is in seat.	On - Off
Battery Roll Out Switch	(Optional) On when battery is correctly installed.	On - Off
Mode Switch	On when in Rabbit Mode, Off when in Turtle Mode.	On - Off
Throttle Switch	On when accelerator is depressed.	On - Off
Forward Switch	On when direction switch is engaged in the forward direction.	On - Off
Reverse Switch	On when direction switch is engaged in the reverse direction.	On - Off
Main Cont Driver PWM	100% setting to pull in contactor and 80% to hold contactor.	
Motor Temp Sensor Analog	Linear thermocouple reading.	

Inputs Parameter Details		
Monitor Value Name	Definition	Range
Throttle Command	Shows, in percentage, the amount of command being requested of the controller.	-100 - 100 %
Mapped Throttle	Shows, in percentage, the throttle being requested of the motors, factoring in speed setting, angle of steer pot, etc.	-100 - 100 %
Throttle Pot	Shows, in volts, the value of the throttle's potentiometer wiper.	0.0 - 5.5 Volts
Brake Command	Shows, in percentage, the amount of command being requested of the controller.	0 - 100 %
Mapped Brake	Shows, in percentage, the deceleration of the motors, factoring in speed setting, direction of travel, etc.	0 - 100 %
Brake Pot	Shows, in volts, the value of the second potentiometer's wiper.	0.0 - 5.5 Volts
Steer Pot	Shows, in volts, the value of the steering's potentiometer wiper.	0.0 - 5.5 Volts
Steer Angle (deg)	Shows, in degrees, the steer angle calculated by the controller.	-90 - 90 degrees
Interlock	Shows if the interlock is on or off.	On - Off

Outputs Parameter Details		
Monitor Value Name	Definition	Range
5 Volts	Shows, in volts, the value of the +5V supply for the left motor encoder.	0.00 - 6.25 Volts
Ext Supply Current	Shows, in milliAmps, the current of the +5V supply for the left motor encoder.	5 - 200 mA

Battery Parameter Details		
Monitor Value Name	Definition	Range
BDI	Shows, in percentage, the battery's state of charge.	0 - 100 %
Capacitor Voltage	Shows, in volts, the value of the controller's internal capacitor bank at the B+ terminal.	0 - 105 Volts
keyswitch Voltage	Shows, in volts, the value of the KSI.	0 - 105 Volts

CALIBRATION AND PROGRAMMING

Motor Parameter Details		
Monitor Value Name	Definition	Range
Motor RPM	Shows, in revolutions per minute, the speed of the motor.	-12000 - 12000 RPM
Temperature	Shows, in degrees Celsius, temperature at the sensor readout.	-100 - 300 °C
MotorSpeed A	Shows, in revolutions per minute, the speed of the motor encoder phase A. Should equal MotorSpeed B.	0 - 12000 RPM
MotorSpeed B	Shows, in revolutions per minute, the speed of the motor encoder phase B. Should equal MotorSpeed A.	0 - 12000 RPM

Controller Parameter Details		
Monitor Value Name	Definition	Range
Current (RMS)	Shows, in amps, the RMS current of the controller, all 3 phases taken into account.	0 - 1000 Amps
Temperature	Shows, in degrees Celsius, the controller's internal temperature.	-100 - 300 °C
Main State	Shows the state that the Main contactor is in. 0 means open 1 means precharge 2 means weldcheck 3 means closing delay 4 means missing check 5 means closed (when Main Enable is on) 6 means delay 7 means arccheck 8 means opendelay 9 means fault 10 means closed (when Main Enable is off)	0 - 10
Regen	Shows if the regen braking is taking place.	On - Off
VCL Error Module	Shows the value of the VCL Runtime Error.	0 - 65536
VCL Error	Shows the value of the cause of the VCL Runtime Error.	0 - 65536

Cutback Parameter Details		
Monitor Value Name	Definition	Range
Motor Temp Cutback	Displays the current available as a result of the motor temperature cutback function. A value of 100% indicates no cutback in current.	0 - 100 %
Controller Temp Cutback	Displays the current available as a result the controller temperature cutback function. A value of 100% indicates no cutback in current.	0- 100 %
Undervoltage Cutback	Displays the current available as a result the undervoltage cutback function. A value of 100% indicates no cutback in current.	0 - 100 %
Overvoltage Cutback	Displays the current available as a result the overvoltage cutback function. A value of 100% indicates no cutback in current.	0 - 100 %

Vehicle Parameter Details		
Monitor Value Name	Definition	Range
Base Speed Captured	Displays the value of the motor base speed captured in the most recent acceleration. This value is used to set the Base Speed parameter (Program » Motor Control Tuning » Field Weakening Control menu), using the Base Speed.	0 - 8000

CAN Status Parameter Details		
Monitor Value Name	Definition	Range
CAN NMT State	Shows the current Controller CAN NMT State. 0 means initialization 4 means stopped 5 means operational 127 means pre-operational.	0 - 127

After successfully re-flashing a controller, make sure to clear the fault history of all comments.

CALIBRATION AND PROGRAMMING

Curtis Controller Troubleshooting

IMPORTANT

The following troubleshooting chart provides information on the Curtis controller faults:

- Fault code
- Fault name displayed on the dash display.
- The effect of the fault
- Possible causes of the fault
- Fault *set* conditions
- Fault *clear* conditions

NOTE

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

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 LED's both on solid	Controller is in Flash program mode.
Red LED on solid	Watchdog failure or no software loaded. Cycle KSI to restart, and if necessary load software.
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.

See Figure 4-25. For illustration, see photo for the left, pump and right controllers, the interconnect cables and the LED lights.

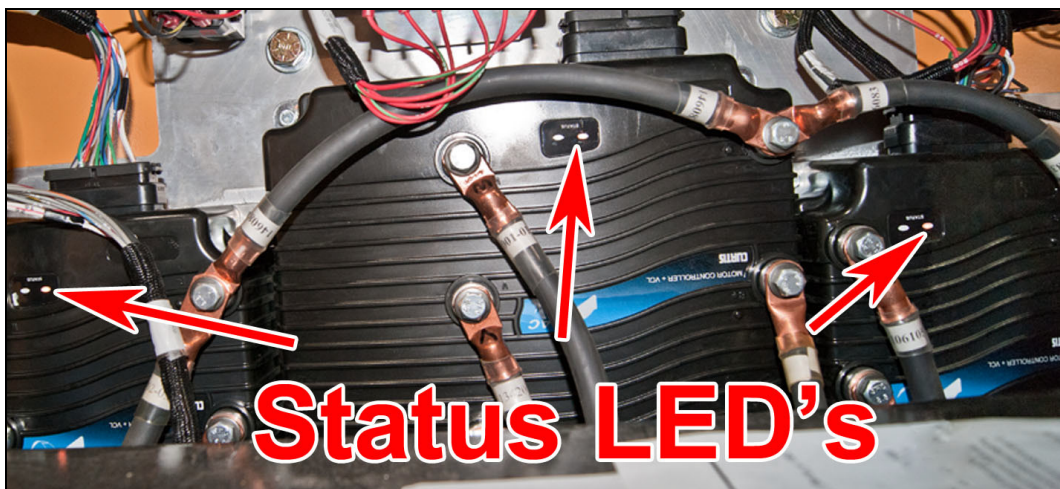


Figure 4-25: LED Status

Program Troubleshooting Chart

C O D E	PROGRAMMER LCD DISPLAY	T	P	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
12	Controller Overcurrent <i>ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; ShutdownPump.</i>	X	X	1. External short of phase U,V, or W motor connections. 2. Motor parameters are mis-tuned. 3. Controller defective.	<i>Set:</i> Phase current exceeded the current measurement limit. <i>Clear:</i> Cycle KSI.
13	Current Sensor Fault <i>ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; ShutdownPump.</i>	X	X	1. Leakage to vehicle frame from phase U, V, or W (short in motor stator). 2. Controller defective.	<i>Set:</i> Controller current sensors have invalid offset reading. <i>Clear:</i> Cycle KSI.
14	Precharge Failed <i>ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; Full Brake; ShutdownPump.</i>	X	X	1. See Monitor menu » Battery: Capacitor Voltage. 2. External load on capacitor bank (B+ connection terminal) that prevents the capacitor bank from charging.	<i>Set:</i> Precharge failed to charge the capacitor bank to the KSI voltage. <i>Clear:</i> Cycle Interlock input or use VCL function Precharge().
15	Controller Severe Undertemp <i>ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; ShutdownPump.</i>	X	X	1. See Monitor menu » Controller: Temperature. 2. Controller is operating in an extreme environment.	<i>Set:</i> Heatsink temperature below -40°C. <i>Clear:</i> Bring heatsink temperature above -40°C, and cycle interlock or KSI.
16	Controller Severe Overtemp <i>ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; ShutdownPump.</i>	X	X	1. See Monitor menu » Controller: Temperature. 2. Controller is operating in an extreme environment. 3. Excessive load on vehicle. 4. Improper mounting of controller.	<i>Set:</i> Heatsink temperature above +95°C. <i>Clear:</i> Bring heatsink temperature below +95°C, and cycle interlock or KSI.
17	Severe Undervoltage Reduced drive torque.	X	X	1. Battery Menu parameters are misadjusted. 2. Non-controller system drain on battery. 3. Battery resistance too high. 4. Battery disconnected while driving. 5. See Monitor menu » Battery: Capacitor Voltage. 6. Blown B+ fuse or main contactor did not close.	<i>Set:</i> Capacitor bank voltage dropped below the Severe Undervoltage limit (see page 55) with FET bridge enabled. <i>Clear:</i> Bring capacitor voltage above Severe Undervoltage limit.
18	Severe Overvoltage <i>ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; ShutdownPump.</i>	X	X	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.	<i>Set:</i> Capacitor bank voltage exceeded the Severe Overvoltage limit (see page 55) with FET bridge enabled. <i>Clear:</i> Bring capacitor voltage below Severe Overvoltage limit, and then cycle KSI.

CALIBRATION AND PROGRAMMING

C O D E	PROGRAMMER LCD DISPLAY	T	P	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
22	Controller Overtemp Cutback <i>Reduced drive and brake torque.</i>	X	X	1. See Monitor menu » Controller: Temperature. 2. Controller is performance-limited at this temperature. 3. Controller is operating in an extreme setting. 4. Excessive load on vehicle. 5. Improper mounting of controller	<i>Set:</i> Heat sink temperature exceeded 85°C. <i>Clear:</i> Bring heat sink temperature below 85°C.
23	Undervoltage Cutback <i>Reduced drive torque.</i>	X	X	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.	<i>Set:</i> Capacitor bank voltage dropped below the Undervoltage limit (see page 55) with the FET bridge enabled. <i>Clear:</i> Bring capacitor voltage above the undervoltage limit.
24	Overvoltage Cutback <i>Reduced brake torque.</i>	X	X	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.	<i>Set:</i> Capacitor bank voltage exceeded the Overvoltage limit (see page 55) with the FET bridge enabled. <i>Clear:</i> Bring capacitor voltage below the Overvoltage limit.
25	+5V Supply Failure <i>None, unless a fault action is programmed in VCL.</i>	X	X	1. External load impedance on the +5V supply (pin 26) is too low. 2. See Monitor menu » outputs: 5 Volts and Ext Supply Current.	<i>Set:</i> +5V supply (pin 26) outside the +5V±10% range. <i>Clear:</i> Bring voltage within range.
28	Motor Temp Hot Cutback <i>Reduced drive torque.</i>	X	X	1. Motor temperature is at or above the programmed Temperature Hot setting, and the requested current is being cut back. 2. Motor Temp 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.	<i>Set:</i> Motor temperature is at or above the Temperature Hot parameter setting. <i>Clear:</i> Bring the motor temperature within range.
29	Motor Temp Sensor Fault <i>MaxSpeed reduced (LOS, Limited Operating Strategy), and motor temperature cutback disabled.</i>	X	X	1. Motor thermistor is not connected properly. 2. If the application doesn't use a motor and motor thermistor, Motor Temp Sensor Enable should be programmed Off. 3. See Monitor menu » Motor: Temperature and » Inputs: Analog2.	<i>Set:</i> Motor thermistor input (pin 8) is at the voltage rail (0 or 10V). <i>Clear:</i> Bring the motor thermistor input voltage within range.
31	Coil1 Driver Open/Short ShutdownDriver1.	X	X	1. Open or short on driver load. 2. Dirty connector pins. 3. Bad crimps or faulty wiring.	<i>Set:</i> Main contactor driver (pin 6) is either open or shorted. This fault can be set only when Main Enable = Off. <i>Clear:</i> Correct open or short, and cycle driver.

C O D E	PROGRAMMER LCD DISPLAY	T	P	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
36	Encoder Fault <i>ShutdownEMBrake.</i>	X	X	1. MotorCoil3 Driver Open/Short ShutdownDriver3. encoder failure. 2. Bad crimps or faulty wiring. 3. See Monitor menu » Motor: Motor RPM.	<i>Set:</i> Motor encoder phase failure detected. <i>Clear:</i> Cycle KSI.
37	Motor Open <i>ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; ShutdownPump.</i>	X	X	1. Motor phase is open. 2. Bad crimps or faulty wiring.	<i>Set:</i> Motor phase U, V, or W detected open. <i>Clear:</i> Cycle KSI.
38	Main Contactor Welded <i>ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; ShutdownPump.</i>	X	X	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).	<i>Set:</i> 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. <i>Clear:</i> Cycle KSI
39	Main Contactor Didn't close <i>ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; ShutdownPump</i>	X	X	1. Maincontactor 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.	<i>Set:</i> With the main contactor commanded closed, the capacitor bank voltage (B+ connection terminal) did not charge to B+. <i>Clear:</i> Cycle KSI.
41	Throttle Wiper High <i>ShutdownThrottle.</i>	X	X	1. See Monitor menu >> Inputs: Throttle Pot. 2. Throttle pot wiper voltage too high.	<i>Set:</i> Throttle pot wiper (pin 16) voltage is higher than the high fault threshold (can be changed with the VCL function SETUP POT FAULTS) <i>Clear:</i> Bring throttle pot wiper voltage above the fault threshold.
42	Throttle Wiper Low <i>ShutdownThrottle;</i>	X	X	1. See Monitor menu >> Inputs: ThrottlePot. 2. Throttle pot wiper voltage too high.	<i>Set:</i> Throttle pot wiper (pin 16) voltage is higher than the high fault threshold (can be changed with the VCL function Setup_Pot_Faults). <i>Clear:</i> Bring throttle pot wiper voltage below the fault threshold.
43	Pot2 Wiper High <i>FullBrake.</i>	X		Refer to Curtis	Return Controller to Landoll Corporation for evaluation.
44	Pot2 Wiper Low <i>FullBrake.</i>	X		Refer to Curtis	Return Controller to Landoll Corporation for evaluation.
45	Pot Low Overcurrent <i>ShutdownThrottle. FullBrake ShutdownSteer</i>	X	X	1. See Monitor menu >> Outputs: Pot Low. 2. Combined pot resistance connected to pot low is too low.	<i>Set:</i> Pot low (pin 18) current exceeds 10mA. <i>Clear:</i> Clear pot low overcurrent condition and cycle KSI.

CALIBRATION AND PROGRAMMING

C O D E	PROGRAMMER LCD DISPLAY	T	P	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
46	EEPROM Failure <i>ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; ShutdownInterlock;Shutdown Driver1 ShutdownDriver2;Shutdowndr iver3; ShutdownDriver4;ShutdownP D; Fullbrake; ShutdownPump; TrimDisable;SevereDual; ShutdownSteer; LOSDual</i>	X	X	1. Failure to write to EEPROM memory. This can be caused by EEPROM memory writes initiated by VCL, by the CAN bus, by adjusting parameters with the programmer, or by loading new software into the controller.	<i>Set:</i> Controller operating system tried to write to EEPROM memory and failed. <i>Clear:</i> Download the correct software (OS) and matching parameter default settings into the controller and cycle KSI.
47	HPD/Sequencing Fault. <i>Shutdown Throttle</i>			1. KSI, interlock, direction, and throttle inputs applied in incorrect sequence. 2. Bad crimp, faulty wiring or KSI switch. See Monitor menu>>Inputs.	<i>Set:</i> HPD (High Pedal Disable) or sequencing fault caused by incorrect sequence if KSI, interlock, direction and throttle inputs. <i>Clear:</i> Reapply correct input sequence.
49	Parameter Change Fault <i>ShutdownMotor; ShutdownEMBrake; Shutdown Throttle; Fullbrake; ShutdownPump</i>	X	X	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.	<i>Set:</i> Adjustment of a parameter setting that requires cycling of KSI. <i>Clear:</i> Cycle KSI.
52	Battery Rollout Switch <i>Fault in Left traction controller.</i>				Return Controller to Landoll Corporation for evaluation.
68	VCL Run Time Error <i>ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; ShutdownInterlock; ShutdownDriver1; ShutdownDriver2; ShutdownDriver3; ShutdownDriver4; ShutdownPD; FullBrake; ShutdownPump. ShutdownPump: TrimDisable; SevereDual; ShutdownSteer; LOSDual.</i>	X	X	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.	<i>Set:</i> Runtime VCL code error condition. <i>Clear:</i> 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 <i>None, unless a fault action is programmed in VCL;</i>	X	X	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 mistuned. 3. See Monitor menu>>Outputs: Ext Supply Current.	<i>Set:</i> 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 low current threshold. The two thresholds are defined by the External Supply Max and External Supply Min parameter settings. <i>Clear:</i> Bring the external supply current within range.

C O D E	PROGRAMMER LCD DISPLAY	T	P	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
71	OS General <i>ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; ShutdownInterlock; ShutdownDriver1;ShutdownD river2; ShutdownDriver3;ShutdownD river4; ShutdownPD; FullBrake:Shutdown Pump; TrimDisable; SevereDual;Shutdown Steer; LOSDual</i>	X	X	1.Internal Controller fault.	<i>Set:</i> Internal controller fault detected. <i>Clear:</i> Cycle KSI.
72	PDO Timeout <i>Shutdown Interlock; CAN NMT State set to Pre-operational</i>	X	X	Time between CAN OPDO messages received exceeded the PDO Timeout Period.	<i>Set:</i> Time between CAN PDO messages received exceeded the PDO Timeout Period. <i>Clear:</i> Cycle KSI or receive CAN NMT message
73	Stall Detected <i>ShutdownMotor; SevereDual; ShutdownEMBrake; Control Mode changed to LOS (Limited Operating Strategy)</i>	X	X	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.	<i>Set:</i> No motor encoder movement detected. <i>Clear:</i> Either cycle KSI, or detect valid motor encoder signals while operating in LOS mode and return Throttle Command=) and Motor RPM=0.
74	Fault On other Traction Controller <i>For information on this fault, plug the programmer into the other controller.</i>	X	X	1. A fault is active on the other traction controller.	<i>Set:</i> In a Dual Drive traction system, any fault in the other traction controller will cause this fault to be set. <i>Clear:</i> Clear all the active faults in the other traction controller.

CALIBRATION AND PROGRAMMING

C O D E	PROGRAMMER LCD DISPLAY	T	P	POSSIBLE CAUSE	SET/CLEAR CONDITIONS
75	Dual Severe Fault <i>ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; Shutdown Pump Other controller: Same effects as this controller.</i>	X	X	1. Both traction controllers have active severe faults and therefore both will be disabled.	<i>Set:</i> A severe fault in each traction controller will cause this fault to be set. <i>Clear:</i> Correct the severe fault(s) in either controller to clear the Dual Severe Fault; of course, you will want to clear all faults on both controllers.
91	VCL/OS Mismatch <i>ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; ShutdownInterlock; ShutdownDriver1; ShutdownDriver2; ShutdownDriver3; ShutdownDriver4; ShutdownPD; FullBrake; ShutdownPump</i>			1. The VCL software in the controller does not match the OS software in the controller.	<i>Set:</i> 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 don't. <i>Clear:</i> Download the correct VCL and OS software into the computer.
91	VCL/OS Mismatch <i>ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; ShutdownInterlock; ShutdownDriver1; ShutdownDriver2; ShutdownDriver3; ShutdownDriver4; ShutdownPD; FullBrake; ShutdownPump</i>			1. The VCL software in the controller does not match the OS software in the controller.	<i>Set:</i> 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 don't. <i>Clear:</i> Download the correct VCL and OS software into the computer.
93	Encoder LOS <i>(LimitedOperatingStrategy). Enter LOS control mode.</i>			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.	<i>Set:</i> 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. <i>Clear:</i> 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.
98	Illegal Model Number <i>ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; ShutdownPump.</i>	X	X	1. Model_Number variable contains illegal value (not 1234, 1236, 1238, or 1298). 2. Software and hardware do not match. 3. Controller defective.	<i>Set:</i> 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. <i>Clear:</i> Download appropriate software for your controller model.
99	Dualmotor Parameter Mismatch <i>ShutdownMotor; ShutdownMainContactor; ShutdownEMBrake; ShutdownThrottle; FullBrake; ShutdownPump.</i>	X		1. Dual Motor Enable parameter set On and Control Mode Select parameter not set to 1 (Speed Mode Express) or 2 (Speed Mode).	<i>Set:</i> When the Dual Drive software is enabled, the controller must be set to either Speed Mode Express or Speed Mode; otherwise this fault is set. <i>Clear:</i> Adjust parameters to appropriate values for your application and cycle KSI.

Controller Maintenance

There are no user serviceable parts in the Curtis 1234/36/38 controllers. No attempt should be made to open, repair, or modify the controller. Modifying the controller will void the warranty. It is recommended that the controller and connection be kept clean and dry and that the controller's fault history file be checked and cleared during service.

Controller Cleaning

Periodically cleaning the controller exterior will help protect it against corrosion and possible electrical problems created by dirt that is part of the operating environment and that normally exists in battery powered systems. When working around any battery powered system, proper safety precautions should be taken. These include, but are not limited to: proper training, wearing eye protection, and avoiding loose clothing and jewelry.

IMPORTANT

Never use a pressure washer to clean the controller.

Use the following cleaning procedure for routine maintenance:

1. Remove power by disconnecting the battery.
2. Discharge the capacitors in the controller by connecting a load across the controller's **B+** and **B** terminals.
3. Remove any dirt or corrosion from the power and signal connector areas. The controller should be wiped clean with a moist rag. Dry it before reconnecting the battery.
4. Make sure the connections are tight.

CALIBRATION AND PROGRAMMING

Table provided for general use.

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Chapter 5

Supplier Provided Documentation (Duplex)

Disclaimer:

The documentation provided here within Chapter 5, “Supplier Provided Documentation”, has been appended to this Landoll Maintenance Manual for reference only.

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Lift Technologies Mast Service Manual

Models 30D-60D

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Proceed to the above “Table of Contents” starting on page 4, to the Mast Installation, Periodic Maintenance, Troubleshooting and Service instructions as required.

SUPPLIER PROVIDED DOCUMENTATION (DUPLEX)

Chapter 6

Supplier Provided Documentation (Triplex)

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Lift Technologies Mast Service Manual

Models 35D-55D

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Proceed to the above “Table of Contents” starting on page 4, to the Mast Installation, Periodic Maintenance, Troubleshooting and Service instructions as required.

SUPPLIER PROVIDED DOCUMENTATION (TRIPLEX)

Document Control Revision Log:

Date	Revision	Improvement(s) Description and Comments
10/10/12	F-626-R1	Initial Release
nn/nn/nn	F-	
nn/nn/nn	F-	



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