Model B40i4

Maintenance Manual

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Chapter 1

Introduction, Safety and Inspection

Before You Begin (Please Read)

Introduction

This manual is intended for the service technician who is seeking information on product maintenance and service replacement parts. It contains planned maintenance, troubleshooting tips, as well as information on repair which will help the technician resolve problems that may occur.

Operating Instructions

This manual does not contain operating instructions. Operating instructions are sent with each forklift. If the operators manual is missing on your Bendi B40i4 forklift, call Landoll Corporation to order a replacement.

Service Training

Service Training is available for the forklift technician from Landoll Corporation. This includes operation, repair, maintenance, hydraulic system, electrical system and wire guidance. Contact Landoll Corporation at www.Landoll.com for more information.

Tools Needed

The tools needed will be the same tools that are often found in well-equipped service centers, in both SAE and metric sizes. For example, an assortment of open-end and box-end wrenches, sockets, as well as Allen and adjustable wrenches, assorted screwdrivers and non-marring mallets should be available.

Replacement Parts

When ordering parts that will be used for the repair and maintenance of your Landoll IC forklift, the model and serial number of the forklift being repaired will be required. This information is located on the serial number and capacity plate located to the left of the seat. **See Figure 1-1.** Only Landoll parts are to be used for all repairs.

Figure 1-1: Serial Number and Capacity Plate

The below notices are used throughout this manual for your reference and protection. Attention required.

NOTICE

Special notice - read and thoroughly understand.

CAUTION

Proceed with caution. Failure to heed caution 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 extreme caution. Failure to heed notice will cause injury or death to person and/or damage product.

General Maintenance Instructions

⚠ CAUTION

- **Steel toe shoes and eye protection are required when maintaining or repairing a lift forklift.**
- **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 planned maintenance, lubrication, and inspection system should be followed. A daily check before each shift is an OSHA requirement.
2. Only qualified and authorized personnel shall be permitted to inspect, maintain and service the forklift.
3. Before **leaving** the forklift for maintenance:
   - Stop the forklift and turn the ignition switch “OFF”.
   - Completely lower the mast. Place directional controls in neutral.
   - Apply the parking brake.
   - Remove the key.
   - Block the wheels, especially if the forklift is on an incline.
4. Before **working** on the forklift:
   - Raise the drive wheels off the floor.
   - Use chocks or other positive positioning devices.
   - Block load engaging means, inner masts or chassis, before working under them.
   - Performance operation checks of forklift and attachments shall be conducted in a well ventilated, authorized and safe clearance area.
5. Before **starting** to operate the forklift:
   - Be in operating position.
   - Place directional control in neutral.
   - Check functions of lift systems, directional control, speed control, steering, warning devices, brakes and any attachments if applicable.
6. To manage fire hazards have fire retardant equipment present. DO NOT use an open flame to check fluid levels, electrolyte or oil leakage.
7. DO NOT use open pans of fuel or flammable cleaning fluids to cleaning parts.
8. Keep shop well ventilated, clean and dry.
9. Brakes, steering mechanisms, control mechanisms, lift overload devices, guards, and safety devices shall be inspected regularly and maintained in safe operating condition.
10. Capacity, operation and maintenance instruction plates or decals shall be maintained in legible condition. **See Figure 1-1.**
11. All parts of lift mechanisms shall be inspected and maintained in safe operating condition.
12. All hydraulic systems shall be regularly inspected and maintained in conformance with good practice. Cylinders, valves and other similar parts shall be checked to assure that “drift” has not developed to an extent that it would create a hazard.
13. Batteries, motors, controllers, limit switches, protective devices, electrical conductors and connections shall be maintained in conformance with good practice. Special attention shall be paid to the condition of electrical insulation.
14. Forklifts shall be kept in a clean condition to minimize fire hazards and facilitate detection of loose or defective parts.
15. Modifications and additions which affect capacity and safe forklift operation shall not be performed by the customer or user without manufacturers prior written approval. Capacity, operation and maintenance plates or decals shall not be changed accordingly.
16. Care must be taken to assure that all replacement parts are interchangeable with the original parts and are of equal quality parts, that were originally installed on the forklift at the factory. Landoll Replacement Parts Manual is part number F-579.
17. Be sure that any optional equipment added to the forklift is positioned so that it does not block the vision of the operator or interfere with safe and efficient operation of the forklift.

For your Safety

NOTICE

In the interest of operator safety and in compliance with OSHA regulations, guidelines have been developed for performing service and maintenance on the forklift. Before performing service and maintenance on the forklift, review the following sections in this manual for additional procedures to be followed.

IMPORTANT

Anytime you are doing maintenance or repair on the Landoll B40i4 AC forklift, unless the forklift must be on for investigative testing, remove the key from the key switch console. Remove the main power fuse or connector and install a commercially available Lock Out/Tag Out device at the battery connectors, because it's possible to have a duplicate key, remove the main power fuse and install a commercially available Lock Out/Tag Out device on the battery connectors. Also, install a lockout warning reminder on the steering wheel warning that the forklift is not available for use.

Battery Safety Rules:

CAUTION

- **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.**

Hydraulic System

WARNING

- **HIGH PRESSURE FLUIDS ARE DANGEROUS!**
- **High pressure hydraulic oil 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 normal appearance of the skin. Medical attention by a doctor should be administered immediately.**

IMPORTANT

When maintenance is to be performed on the hydraulic system, make sure the system hydraulic pressure is relieved by:

- **Moving the forklift to a level area.**
- **Have no load on the forks.**
- **Completely lower the mast, or if the mast is the object of repair, have blocks under the mast.**
- **Relieve all system pressure by moving the hydraulic levers in each direction several times.**

Towing the Forklift

NOTE

The Bendi B40i4 forklift should be towed in the reverse direction. It is important to obey the following instructions:

1. With ignition off and stop pedal released, locate the brake release pump/valve assembly under the Left Engine Access Door Panel - notice the red manual control knob. **See Figure 1-2.** Close the manual valve by pulling up on the handle, rotate the handle 90° and allow the cross pin to fall into place.
2. Push and release the manual hand pump 5 to 7 times to build pressure that releases the park brake.
3. The Bendi B40i4 may now be towed a maximum of 200 yards, at a maximum speed of 2 MPH.
4. To reset park brakes, open manual valve by pulling up on the handle and rotate 90°, then locking the cross pin into the up (open) position.

WARNING

Failure to reset park brakes will result in an unsafe condition. The Bendi B40i4 forklift has no mechanical brakes and stopping is done by hydraulics.

Figure 1-2 Manual Tow Valve

WARNING

- **Have the park brake applied when hooking up the tow chain.**
- **Release the park brake only when ready to tow the forklift.**
- **Tow the forklift using a speed of 2 mph or less.**
- **DO NOT make sharp turns when towing the forklift. The towed forklift 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.**
- **The forklift can roll easily - USE EXTREME CARE!**
- **Brakes on a towed forklift will not operate.**

Towing Vehicle Requirements

- Towing vehicle must have a pull and braking capacity greater than 8000 lbs.
- Maximum towing speed should not exceed 2mph.

Towing a Forklift in the Reverse Direction

- Key must be in the “OFF” position.
- When attaching towing vehicle to forklift to be towed, a removable pin has been provided on the rear bottom side of the counter weight. **See Figure 1-3.** Firmly attach tow device to this pin.
- Towed vehicle’s forks should be empty and no higher than 12 in. off the ground.
- Be careful. With brakes released, vehicle will roll and steering will be difficult.
- Keep towing speed below 2 mph. Remember that the person on the towed lift has to turn his head to observe operations.

Figure 1-3: Tow Pin

Figure 1-4: Blocking Positions

Lifting and Blocking the Forklift

- Move forklift to a level area designated for repair.
- Keep forks empty and low to the ground.
- Remove the key.
- Unhook the battery.
- Use a jack or hoist with a 8000 lb. minimum lift.
- Set the lift on designated hardwood blocks. For block(s) placement - **See Figure 1-4.**
- Keep the height of the lifted forklift to a minimum.

Prior to Tilt Cylinder Repair

⚠ WARNING

DO NOT place feet or hands in any area through the mast or in forklift 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 of 8,000 lb. or greater. DO NOT work under or around a forklift that is not properly secured.

- Forklift repair must be in a level, designated area.
- Lower the mast completely to the floor.
- Turn the forklift “OFF”, pull the key and observe Lockout/Tagout procedures.
- Chock wheels so that the forklift cannot move.
- Attach a sling and hoist to all the top cross braces so the mast sections cannot move.

Mast Removal

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 upon 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 forklift. (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.**
- **Lower mast until it sits firmly on wooden blocks.**
- **For mast inspection, use only an approved safety platform or step ladder.**
- **NEVER repair chains, they are to be replaced.**
- **NEVER replace chain sets with only one chain. All chains are to be replaced in pairs.**

1. Move the forklift to a level, designated area.
2. Turn the key off and remove it from the ignition switch.
3. Remove the forks.
4. Move all levers back and forth several times to relieve internal hydraulic pressure.
5. Slowly and carefully remove the lift cylinder lines. Use a container to catch oil and an oil absorbent product to absorb any spills.
6. Disconnect all wiring (if used) between the mast and the forklift body.
7. Support the mast using the sling and an overhead hoist.
8. 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.
9. Remove all pins holding the tilt cylinders to the mast.

IMPORTANT

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. Make sure the blocks you will lay the mast on can hold the weight. Also, be SURE that no one and nothing is in the path the mast is taking to reach the blocks.

Cleaning & Inspecting the Forklift

Landoll Corporation recommends that their forklifts NOT be cleaned with a power washer. Electrical boards, circuitry and wiring can be damaged by high pressure water and soap. Moisture and soap left on components can rust, corrode or leave a residue that can damage everything that it comes in contact with. The preferred method of removing dust is compressed air. For localized cleaning, use a non-flammable solvent parts washer and compressed air after the part or area is cleaned.

- Always clean all metal parts with a de-greasing type cleaner solvent and wipe dry with a clean shop 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 quicker corrosion.

IMPORTANT

Cleaning solvents can be TOXIC and FLAMMABLE. Pay particular attention to all WARNING labels provided by the solvent manufacturer, such as, protection during use, personal health precautions and ventilation to avoid breathing vapors.

- 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.*
- Take care to properly identify and tag each part and its order of removal. If necessary, keep notes and put markings on all parts using a non-destructive marker, such as a felt-tipped pen.

Maintenance Introduction

Preventative maintenance & inspections are an essential part of all industrial equipment. A well planned inspection program is essential to keeping the working environment safe for the operator and for the longevity of the truck.

The inspection program designed by Landoll Corporation periodically checks the integrity of Bendi forklift systems such as:

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

Regular and planned 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 1-8 through 1-14.

These checklists include:

- *Operator's Daily Checklist*
- *1st 50 Hour Inspection Checklist*
- *1st 300 Hour Inspection Checklist*
- *300 Hour Inspection Checklist*
- *600 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 shorter intervals.

Inspection Sheets

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 Bendi Internal Combustion lift. The pre-shift inspection on your IC forklift is an OSHA requirement. 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. It's important that these inspections are documented.

Operators Daily Checklist	Status	Landoll / Bendi IC
SAFETY & OPERATIONAL CHECKS Have a **qualified** technician correct all problems.	OK - Yes,No	Maintenance Note if Applicable
If Fuel Odor is detected - **DO NOT START TRUCK - REPORT IMMEDIATELY!**		
Forks, Top Clip Retaining Pin and Heel - Condition.		
Load Backrest Extension - Attached.		
Lift and Lowering Control - Functioning smoothly.		
Tilt Control - Forward/Reverse Functioning smoothly.		
Side Shift Control Functioning smoothly.		
Hang-on Attachment functioning smoothly, securely attached, fittings attached.		
Steering Operation functioning smoothly.		
Drive & Stop Pedal functioning smoothly.		
Controls (Turn Power On) Investigate Unusual noises.		
Dash Display (Hour Meter, Oil Temp, Voltmeter, etc Functioning properly.)		
Horn, Lights, Seat Switch functioning properly.		
Service and Parking Brake functioning properly.		
Drive Control- Forward/Reverse functioning smooth.		
Engine Air Cleaner - Squeeze rubber dirt trap; Clean and check.		
Engine Belt - Check for wear.		
Battery. (Check for cracks and electrolyte level.)		
Hood and seat latch functioning properly.		
Operator's Compartment Capacity Plate Attached Info matches Model, Serial No. and attachments - Operator's Manual in protective case.		
Seat Belt, Buckle, and Retractors functioning properly.		
Overhead Guard properly mounted & attached.		
Radiator - Check Level in Overflow Tank.		
LPG Hoses - Check for damage, kinks, correct fittings.		
LPG Tank - Securely attached; free of rust, corrosion. Look for damage of any kind.		
Engine Oil, Hydraulic Oil, Brake Fluid - Check levels.		
Water Pump - Inspect		
Tires-Check for debris, Torque lug nuts - 225ft-lb(300Nm).		
Finger Guards attached.		
Major Structural Points (Front Rotation, Mast Braces, Overhead Guard) - Check for cracks.		
Hydraulic Cylinders, Pump, Valve-Check for leaks, noise.		
Safety Warnings Attached (See Manual for location).		

Date Inspector:	Truck No.	Model No.	Location	Serial No.	Shift	Hr Meter	Battery Fluid	Hydraulic Oil

To be performed after 1st 50 hours of truck operation <u>in addition</u> to the required pre-shift daily inspection

Technicians 1st 50 Hour Inspection	Status	Landoll / Bendi IC
SAFETY & OPERATIONAL CHECKS Have a **qualified** technician correct all problems.	OK - Yes,No	Maintenance Note if Applicable
Mast chains-Inspect, clean and lubricate.		
Power Steering - Check Operation, Inspect and Fill		
Drive wheels, Re-Torque lug nuts to 225 ft-lbs (300Nm).		
Vacuum Hoses - Check for cracks and leaks.		
Rotation Bearings - Retorque to 30 ft-lbs (40.7 Nm)		

Date Inspector:	Truck No.	Model No.	Location	Serial No.	Shift	Hr Meter	Battery Fluid	Hydraulic Oil

To be performed after 1st 300 hrs of truck operation <u>in addition</u> to the required pre-shift daily inspection.

Technicians 1st 300 Hour Inspection	Status	Landoll / Bendi IC
SAFETY & OPERATIONAL CHECKS Have a **qualified** technician correct all problems.	OK - Yes,No	Maintenance Note if Applicable
Mast - Inspect all friction surfaces.		
Check lift chain tension, inspect, clean and lubricate.		
Lift and Tilt cylinder - Check to be sure they work together and in unison.		
Power Steering - Check operation, inspect and fill.		
Parking Brakes - Check for effectivity.		
Engine Oil and Filter - Change.		
LPG Filter - Change.		
Hydraulic Oil Pump - Check Operation.		
Drive wheels, Re-Torque lug nuts to (225 ft-lbs(300 Nm).		
Vacuum Hoses - Check for cracks and leaks.		
Switches (interlock, direction, parking/seat, key, pressure/temperature) - Check operation.		
Wires, Connections, Bolts and Nuts - Check.		

Date Inspector:	Truck No.	Model No.	Location	Serial No.	Shift	Hr Meter	Battery Fluid	Hydraulic Oil

To be performed each 300 hrs of truck operation <u>in addition</u> to the required pre-shift daily inspection

Technicians 300 Hour Inspection	Status	Landoll / Bendi IC
SAFETY & OPERATIONAL CHECKS Have a **qualified** technician correct all problems.	OK - Yes,No	Maintenance Note if Applicable
Mast, carriage, or attachment friction surfaces - Clean, inspect for wear or damage, and lubricate.		
Lift chains - Clean and lubricate.		
Extend mast - Check for excessive wear.		
Attachment control - Operational.		
Rotation Bearings - Retorque to 30 ft-lbs (40.7 Nm)		
Front Wheel Bearings - Clean and fill with grease.		
Accelerator - Functioning smoothly.		
Controls (turn power on); Investigate unusual noises immediately.		
Instrument monitors - Functioning.		
Air Cleaner Element - Clean.		
Hydraulic fluid level - Check and fill.		
Vacuum Hoses - Check for cracks and leaks.		
Exterior of hydraulic Tank and Oil Tank Breather - Clean.		
Engine Compartment - Clean.		
Engine Oil and Filter - Replace.		
Alternator and Starter - Clean with compressed air; Check brushes and springs, check power terminals.		
Battery - Thoroughly clean case and connectors.		
Muffler and Exhaust System - Check for leaks.		
LPG System - Check pressure hoses and fitting seals.		
Radiator - Use air to clean fins; correct cap and tighten; check hoses and clamps for leaks.		
Seat belt, buckle, and retractors - Functioning smoothly.		
Tire - Check for debris,torque lug nuts to 225 ft-lbs (300 Nm).		
Load wheel bearings - Clean and fill with grease.		
Leaks - Hydraulic oil, Battery, Engine Oil, Engine Coolant.		
Hydraulic hoses and connections - Check for wear.		
Switches (interlock, direction, parking/seat, key, pressure, and temperature) - Check.		
Wire connections and sending units - Check.		
Grease fittings - Service.		
Tighten Overhead Guard Bolts - 170 fT-lbs(230 Nm).		

Date Inspector:	Truck No.	Model No.	Location	Serial No.	Shift	Hr Meter	Battery Fluid	Hydraulic Oil

To be performed each 600 hrs of truck operation <u>in addition</u> to the required pre-shift daily inspection

Technicians 600 Hour Inspection	Status	Landoll / Bendi IC
SAFETY & OPERATIONAL CHECKS Have a **qualified** technician correct all problems.	OK - Yes,No	Maintenance Note if Applicable
Tires - Check for debris; drive tire lug nuts - Torque to 225 ft-lbs (300 Nm).		
Wheel bearings - Clean and fill with grease.		
Check for Leaks - Hydraulic oil, battery, brake fluid, Complete gear box.		
Hydraulic hoses and connections - Check for wear.		
Switches (interlock, direction, parking/seat, key, pressure, and temperature) - Check.		
Wire connections and sending units - Check.		
Grease fittings - Service.		
Forks, top clip retaining pin and heel - Condition.		
Load rollers - No greater clearance than 1/16”.		
Mast chains - Lube with SAE 40W oil or Bowman Heavy Load Red grease - Check for wear and stretch.		
Steering operation - Functioning smoothly; Lubricate steering knob.		
Hydraulic oil filter - Change element and check for proper level - Check pressures.		
Air Cleaner Element - Clean and Inspect.		
LPG Vaporizer - Drain.		
Fan Drive Belt - Inspect.		
Control panel - Clean surface.		
Operator’s compartment capacity Plate Attached - Information matches model, serial no., and attachments.		
Check all connections for proper torque.		

Date Inspector:	Truck No.	Model No.	Location	Serial No.	Shift	Hr Meter	Battery Fluid	Hydraulic Oil

To be performed each 1000 hrs of truck operation <u>in addition</u> to the required pre-shift daily inspection

Technicians 1000 Hour Inspection	Status	Landoll / Bendi IC
SAFETY & OPERATIONAL CHECKS Have a **qualified** technician correct all problems.	OK - Yes,No	Maintenance Note if Applicable
Spark Plugs & Wires - Replace.		
Fuel Filter - Replace.		
Timing Belt - Inspect.		

Date Inspector:	Truck No.	Model No.	Location	Serial No.	Shift	Hr Meter	Battery Fluid	Hydraulic Oil

To be performed each 2000 hrs of truck operation <u>in addition</u> to the required pre-shift daily inspection.
Continued onto page 1-13 for clarity.

Technicians 2000 Hour Inspection	Status	Landoll / Bendi IC
SAFETY & OPERATIONAL CHECKS Have a **qualified** technician correct all problems.	OK (X)	Maintenance Note if Applicable
Mast, carriage, or attachment friction surfaces - Clean, inspect for wear or damage and lubricate.		
Mast chains - Lube with SAE 40W oil or Bowman Heavy Load Red grease - Check for wear and stretch.		
Lift chains - Clean and lubricate with SAE 40W oil or Bowman Heavy Load Red grease - Check for wear and stretch.		
Extend mast - Check for excessive wear.		
Attachment control - Operational.		
Accelerator - Functioning smoothly.		
Controls (pwr on); Investigate unusual noises immediately.		
Instrument monitors - Functioning.		
Parking Brake- Functioning.		
Exterior hydraulic tank and oil tank breather - Clean.		
Hydraulic oil and power steering - Clean dust from motors.		
Leaks - Hydraulic oil, battery, brake fluid, transmission.		
Hydraulic hoses and connections - Check for wear.		
Hydraulic oil filter - Change element and oil. Check for proper level - Check pressures.		
Hydraulic reservoir suction screens - Clean with solvent.		
Battery - Thoroughly clean.		
Battery - Check water/electrolyte level.		
Battery - Check structure and electrical conditions.		
Seat belt, buckle, and retractors - Functioning smoothly.		
Tires Check for debris, torque lug nuts to 225 ft-lbs (300Nm).		
Wheel bearings - Clean and fill with grease.		
Vacuum Hoses - Check for cracks and leaks.		
Switches (interlock, direction, parking/seat, key, pressure, and temperature) - Check.		
Wire connections and sending units - Check.		
Grease fittings - Service.		
Forks, top clip retaining pin and heel - Condition.		
Load rollers - No greater than 1/16” play.		
Steering operation - Functioning smoothly; Lube knob.		
Micro Switches - Check operation.		
Operator’s compartment capacity plate attached - Information matches model, serial no., and attachments.		
Check all connections for proper torque.		
LPG System - Check pressure hoses and fitting seals.		

Technicians 2000 Hour Inspection	Status	Landoll / Bendi IC
LPG Filter - Change.		
Air Cleaner Element - Clean.		
Timing Belt - Replace.		
Muffler and Exhaust System - Check for leaks and cracks.		
Alternator and Starter - Clean with compressed air: Check brushes and springs, check power terminals.		
Radiator - Use compressed air to clean fins; check for correct cap and tighten; check hoses and clamps, drain, flush & fill.		

Date Inspector:	Truck No.	Model No.	Location	Serial No.	Shift	Hr. Meter	Battery Fluid	Hydraulic Oil

To be performed each 4500 hrs of truck operation <u>in addition</u> to the required pre-shift daily inspection.

Technicians 4500 Hour Inspection	Status	Landoll / Bendi IC
SAFETY & OPERATIONAL CHECKS Have a **qualified** technician correct all problems.	OK (X)	Maintenance Note if Applicable
Hydraulic Oil - Change		

Date Inspector:	Truck No.	Model No.	Location	Serial No.	Shift	Hr. Meter	Battery Fluid	Hydraulic Oil

Lubrication Specifications

Name	Lubrication	Notes
Mast Chain	SAE 40W oil or Bowman Heavy Load Red Grease	Clean and re-oil
Mast Rail	Chassis Lube or Kendall SR-12X.	Lube inner side of upright rail.
Rotation Bearings	Texaco Ref. C&C #880	Use standard lubrication gun
Steering Knob	Light weight oil	Lightly oil
Reservoir Cap	SAE 30W oil	Clean in solvent and re-oil
Hydraulic Reservoir	Conoco Power flow HE (ISO Grade 46) Filtered to ISO 4406 cleanliness code 15/13/11 or equivalent Grade oil filtered to 15/13/11	Drain, flush, and refill
Carriage Rollers	Texaco Ref. C & C #880	Use standard lubrication gun
Engine Oil	10W 30 API “SL”	
Engine Coolant	GM6277M “Dexcool”	
*Failure to refill with oil that meets ISO 4406 cleanliness code 15/13/11 may void the warranty. Typical “NEW” oil DOES NOT meet this specification. Contact Landoll Corporation or your lubricant supplier for recommendation.		

Torque Specifications

Component	Torque
Drive motor with vehicle frame	130 ft. lbs. (176 Nm.)
Wheel Lug Nuts	225 ft. lbs. (300Nm)
Hydrostatic Steering Control Unit:	
Plug and o-ring assy #8 SAE fitting	Refer to Torque Chart on page 1-18.
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.)
Carriage roller capscrews	70-80 ft. lbs. (95-108 Nm.)
Chain and hose sheave screws	26-30 ft. lb. (35-41 Nm.)
Lift chain adjusting nuts	50-70 ft. lbs. (68-90 Nm.)
Backrest screws	145 ft. lbs. (197 Nm.)
Side shift mounting hooks	115-125 ft. lbs. (156-170 Nm.)

Fluid Capacities

Item	Capacity -Quarts (Liters)
Hydraulic Tank	14 gallons (44 liters)
Engine Oil	5 quarts (4.73 liters)
Engine Coolant	2.66 Gallon (10.1 Lietrs)

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 (in 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

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

Chapter 2

Planned Maintenance

Planned Maintenance Requirements

This section describes the planned maintenance requirements, adjustments and lubrication necessary to keep your Bendi Model B40i4 forklift forklift operating safely and efficiently. Planned maintenance procedures are designed to extend the service life of the forklift and prevent service repairs. This section must be thoroughly understood before you inspect or perform maintenance on the forklift.

Safety precautions and inspection schedules are provided in Chapter 1 of this manual including a Daily Operators Checklist (also found in the Operator's Manual provided with the forklift). Also provided are a 1st 50-100 Hour Inspection Checklist, a 1st 300 Hour Inspection Checklist, a 300 Hour Inspection Checklist, a 600 Hour Inspection Checklist and a 2000 Hour Inspection Checklist.

Recommended lubricants and torque values are found in Chapter 1, page 1-17.

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 13 gallons (50 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 forklift. See the Safety Chapter 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 with clean rags 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 1-17.*
- *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.*
- *It is recommended to use only Landoll authorized replacement parts.*

DANGER

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

- **NEVER perform any maintenance or service procedures unless specifically indicated in this manual or requested by your supervisor. All other service and maintenance on your Bendi B40i4 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 Bendi B40i4 forklift can cause lifting equipment failure.**
- **Removing the counterweights or uprights will change the center of gravity of the forklift and can cause the forklift to tip. The engine is considered part of the forklift's counterweight.**

To help avoid fire hazards:

- **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 forklift all must completely understand the general maintenance instructions and cautions described on page 1-2:

- Inspect the forklift in an area that has sufficient clearance to check all operator functions.
- Lower forks to the ground and tilt mast forward.
- If you will not be operating the forklift to check operator functions, block the wheels with chocks and/or other positive forklift-positioning devices.
- If you will be operating the forklift to perform operator functions, raise the drive wheels so they clear the floor.
- Block the mast to prevent it from engaging.
- If you need to hoist the forklift make sure the hoisting equipment has adequate size and capacity to move the equipment.
- 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 you are in the operator's seat:

1. Make sure your right foot is on the floor of the operator's compartment and not on a pedal.
2. Set the direction lever in the neutral position. **See Figure 2-1.**
3. Turn the key switch. Start engine and allow the switch to return. **See Figure 2-2.**
4. Release parking brake. **See Figure 2-3.**
5. Set the direction lever in the forward position. **See Figure 2-1.**
6. Check functions described in the Operator's Daily Checklist or other Checklists starting on page 1-7.

Figure 2-1: Direction Lever

Figure 2-2: Ignition Key Switch

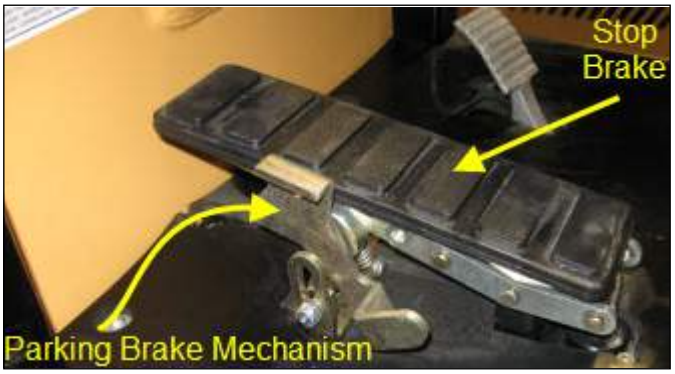

Figure 2-3: Parking Brake Lever

Completing Performance Testing

NOTE

Make sure all accessories are off (lights, etc.) before you turn the key switch to the "OFF" position.

1. Set the direction lever to "NEUTRAL".
2. Tilt the mast forward, lower the forks to the ground.
3. Turn the key switch to the "OFF" position, remove key.

IMPORTANT

Before you leave the forklift make sure that:

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

Daily Inspection

NOTE

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

The daily inspection includes:

- *Visual inspection of the entire forklift for any defect.*
- *Visual check for any engine oil or hydraulic fluid leaks.*
- *Radiator overflow level check.*
- *Check that all controls and gauges work properly.*

A complete Daily Checklist is included on page 1-8 of this maintenance manual as well as in Appendix A of the Bendi B40i4 Operator's Manual F-581.

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

Fuel System Check

WARNING

- **All fuels are very flammable and can burn or cause an explosion.**
- **DO NOT use an open flame to check the fuel level or to check for leaks in the fuel system.**
- **If a leak in the fuel system is detected, extreme care must be used during the repair.**
- **DO NOT operate the lift forklift until all leaks are repaired.**

Check the fuel system for leaks and the general condition of parts. When fuel is added to the forklift, follow the procedure for filling the LPG tank as described in the Bendi B40i4 Operator's Manual (F-581-R_).

Power Steering Check

1. Sit in the driver's seat and start the engine.

2. Disengage the park brake.
3. Verify that the forklift turns left and right with a relatively smooth, easy motion.
4. Turn the steering wheel completely to the right (a full right-hand turn).
5. Turn the steering wheel completely to the left (counterclockwise) while counting the number of full revolutions.
6. Next, turn the steering wheel completely to the right (clockwise) while counting the number of revolutions.
7. The number of turns clockwise and counterclockwise should be nearly equal (approximately 7-9 turns each direction.)

Checking the Battery

The battery used on the Bendi B40i4 Series forklift is maintenance free. Keep in mind all safety issues, as explained on page 1-3, when checking or replacing the battery.

Check Hydraulic Functions

1. Start the forklift.
2. Pull any one of the levers, to see if hydraulics are working. **Figure 3-22 on page 3-32**.
3. Visually check cylinders, valves, and hoses for leaks or other signs of wear.
4. Check hydraulic fluid level.
5. Check all levers.

Check Driver's Seat Switch

This procedure checks the physical mechanics (actuation) of the driver's seat switch only.
The switch is part of the seat. See figure below.

Figure 2-4: Seat Switch

1. Start the forklift and release the parking brake.
2. The seat switch and actuator are internal to the seat cushion, located on the underside of the seat cushion between the cushion and the bottom plate. See **Figure 2-4** above.
3. Set the direction control in either FORWARD or REVERSE direction and slowly apply acceleration. As the forklift begins to slowly move in either direction, lift yourself from the driver's seat just enough to release the switch in the seat cushion.
4. **The forklift must come to an immediate STOP after 3 seconds (to avoid false faults)**.
5. If the forklift continues the seat switch will need to be replaced.

Check Hydraulic Oil Level

1. Lower the mast to within a few inches of the ground, then tilt it back completely.
2. Side shift the mast to the center (normal carry position).
3. With the key switch "OFF", turn the steering wheel left and right until it becomes difficult to turn.
4. Open the engine compartment by releasing the latch just under the driver in the front of the compartment. **See Figure 2-5.**
5. Open the right side engine door.

Figure 2-5: Seat Release

6. Check the fluid level gauge on the right hand side of the tank. **See Figure 2-6.**

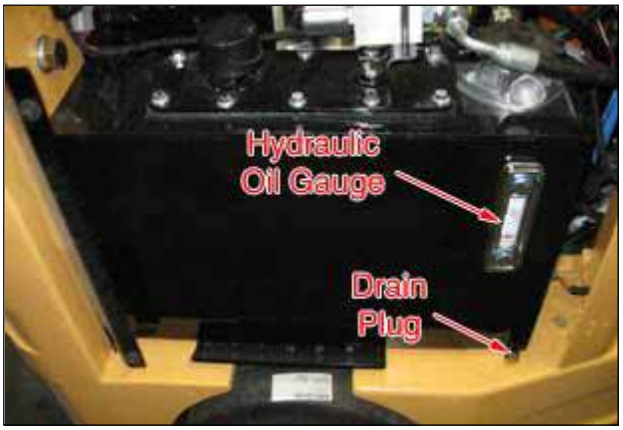

Figure 2-6 Oil Gauge

7. Clean the area around the hydraulic fill cap, then open the cap (turn counterclockwise). **See Figure 2-7.**

IMPORTANT

DO NOT add Hydraulic oil into the Hydraulic Breather cap.

IMPORTANT

- **It is important that the proper level of oil be maintained at all times. Failure to check the oil level as recommended could cause serious mast function operating problems.**

8. Add hydraulic oil as needed. See page 1-17 for recommended lubricants.
9. **DO NOT OVERFILL.** With the level above the FULL line, the oil does not have enough area for expansion when it heats up during normal operation.
10. If the fluid appears dirty or dark in color, check the forklift's maintenance log for the last fluid and filter change and then change accordingly.
11. Install the fill cap, making sure it is tight.
12. Close and latch the access assembly and doors.

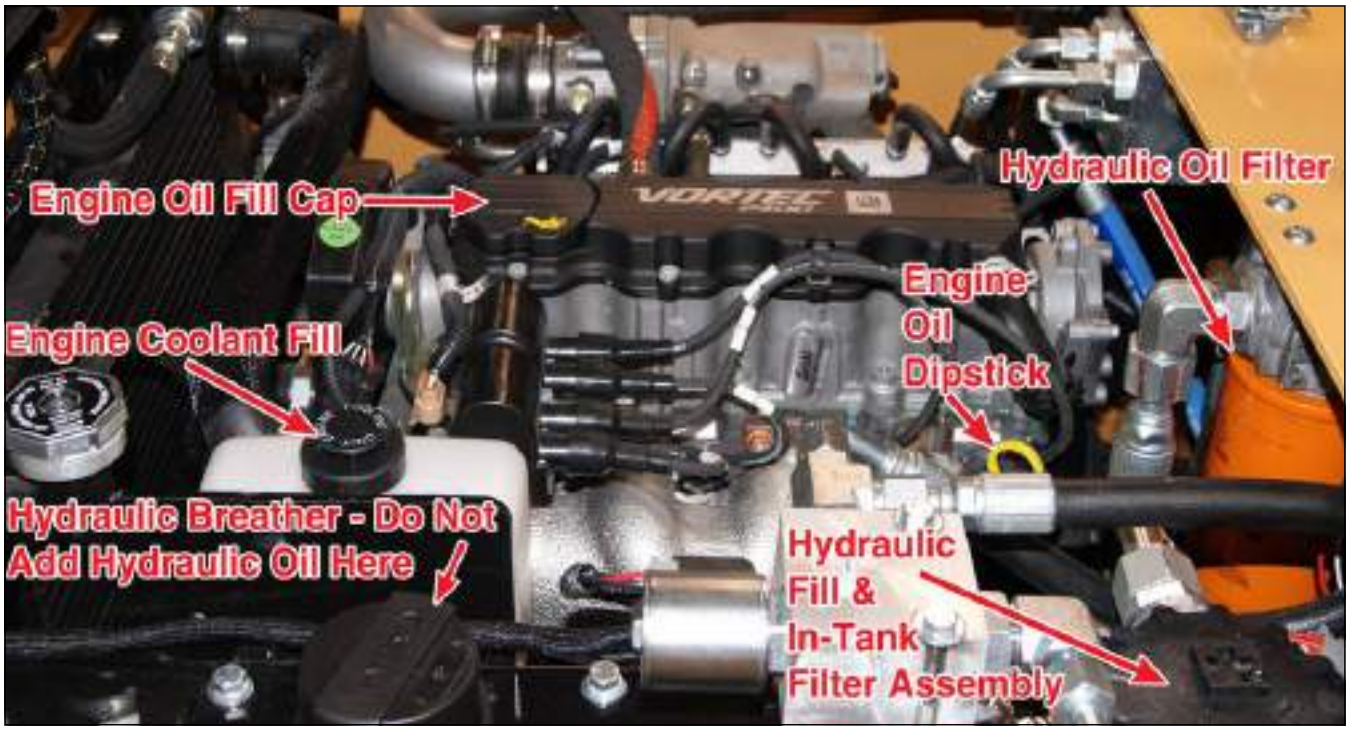

Figure 2-7: Engine Compartment Fluid Checks

Check Engine Oil Level

1. Lower the mast to within a few inches of the ground, then tilt it back completely.
2. Open the engine compartment by releasing the latch just under the driver in the front of the compartment. **See Figure 2-5.**
3. Remove engine oil dipstick and wipe end with a clean rag.
4. Insert dipstick and remove observing the oil level.
5. Ensure the oil level is at the proper level as indicated by the marks on the dipstick.
6. Clean the area around the engine fill cap, then open the cap (turn counterclockwise). **See Figure 2-7.**

IMPORTANT

- **It is important that the proper level of oil be maintained at all times. Failure to check the oil level as recommended could cause serious malfunction problems.**

7. Add engine oil as needed. See page 1-17 for recommended lubricants.
8. **DO NOT OVERFILL.** With the level above the FULL line, the oil does not have enough area for expansion when it heats up during normal operation.
9. If the fluid appears dirty or dark in color, check the forklift's maintenance log for the last fluid and filter change and then change accordingly.
10. Install the fill cap, making sure it is tight.
11. Close and latch the access assembly and doors.

Check Primary Lift Chain

This adjustment procedure is for both Triplex and Quad mast assemblies:

1. Park the forklift on a flat, level surface, with the parking brake engaged.
2. Set the mast in the center of the forklift, facing straight ahead, lowered to the floor and empty (unloaded). Check the fork level gauge on either side of the mast **See Figure 2-8.**
3. Set the key switch to “OFF” and remove the key.
4. Measure the distance from the floor to the bottom heel of each fork tine. **See Figure 2-9.** This measurement must be 1/8” (3.175 mm) minimum to 1/4” (6.35 mm) maximum.
5. If it is not within 1/8” to 1/4” (3.175 mm to 6.35 mm), adjust the primary lift chain accordingly.

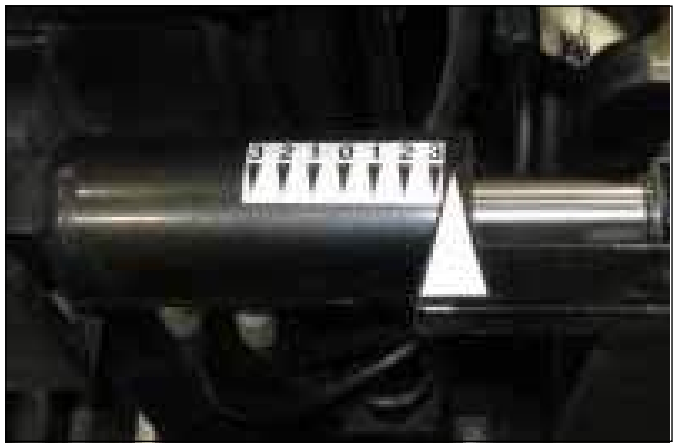

Figure 2-8: Fork Level Gauge

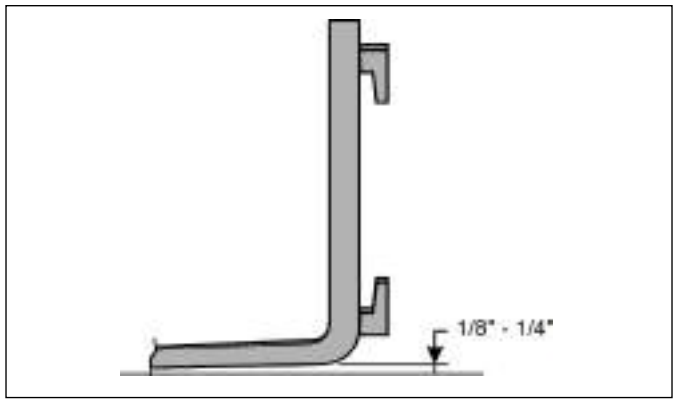

Figure 2-9: Fork Heel to Floor

Inspect Tires

WARNING

- **The forklift 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, you must always replace tires with the type originally supplied, consult your Landoll dealer for ordering information.**
- **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.**
- **Check all wheel lug nuts after 2 to 5 hours of operation: when new forklifts begin operation and on all forklifts when the drive wheels have been removed and installed. Tighten the nuts in a cross pattern to the correct torque value shown on page 1-17. When the nuts stay tight for eight hours, the interval for checking the torque can be extended to 300 hours.**

1. Inspect the tires for chunking (or chipping), embedded foreign material (wire, rocks, glass, metal, etc.), cuts, gouges, undercutting or uneven wear.
2. Remove any object that will cause damage. See **Figure 2-10 on page 2-7**.
3. Check for loose or missing hardware.
4. Remove any wire strapping or other material that is wrapped around the axle.
5. Make sure drive wheel nuts are tight. Tighten the wheel nuts in a cross pattern to a correct torque value of 225 ft.-lbs (300 Nm).
6. Squeaking or friction noises coming from the tires during operation may be caused by separation of the tire layers.
7. Separation is sometimes visible as a crack around the sidewall of the tire.
8. Both tires must be replaced.
9. Excessive wear may be an operator problem. Too much throttle when starting a sharp turn causes the inside tire to spin quicker, producing abnormal wear. More careful driving habits can add additional miles to tire life.

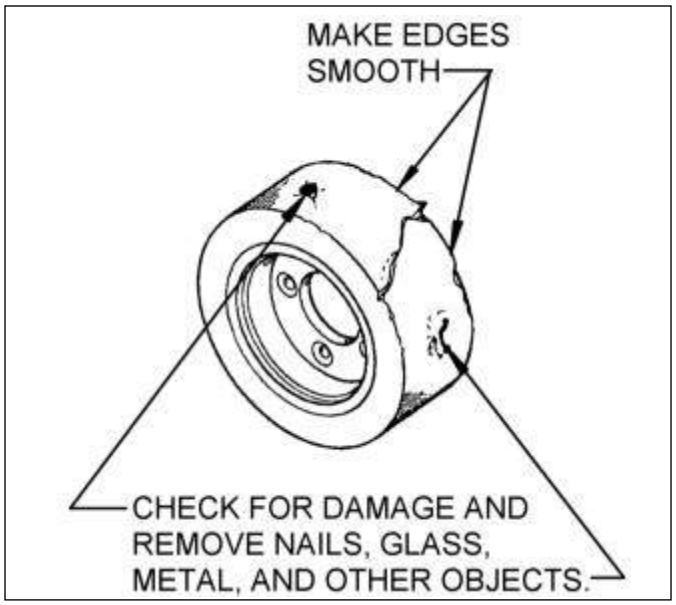

Figure 2-10: Tire Damage Types

Chunking (Chipping) or Embedded Objects

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 forklift 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 same kind of damage. **See Figure 2-10.**

1. Remove any embedded foreign material from the tire as soon as it is noticed. Also remove torn pieces of tread.
2. To avoid overloading, always center the payload on the forklift to equalize the load on all tires. DO NOT dangle the load on the ends of the forks. Also avoid fast cornering, which can cause an overload affect.
3. If the tires are chunked bad enough to produce a bouncy ride, replace them.

Undercutting and Uneven Wear

Undercutting is caused by continuous overloads, rapid, sharp turns, operating on slopes, a faulty steer axle, transporting loads with a high center of gravity, or transporting off-center loads.

Uneven tire wear is usually the result of mechanical defects misaligned wheels (misaligned steer axle) or a faulty drive axle.

Undercutting causes the rubber to bulge out over the edge of the steel band, cutting the rubber just above the base band. Check that the tires remain centered on the wheels to prevent splitting of the base band and tread separation. Correct such defects as soon as possible.

Flat-spotting

Flat-spotting occurs when:

- *The forklift has been sitting idle for some time after heavy use and is usually caused by overheated tires.*
- *The forklift has standing loads (loads left on the forks overnight).*
- *Locking the brakes while traveling in either direction on grades (slopes), with or without a load, causing excessive skidding. Polyurethane tires are extremely susceptible to this type of abuse.*

1. Avoid excessive heat. Where possible, avoid contact with hot metal or operation for long periods in hot oven rooms. Excessive heating will break-down the tire structure. Shields, which prevent heat from striking tires directly, will often prolong life.
2. Avoid standing loads. Solid tires will flat-spot when loads are left standing on the forklift overnight. In extreme cases, a flat spot develops and the tire bounces with every revolution.
3. If the tires are flat-spotted bad enough to produce a bouncy ride, replace them.
4. DO NOT indulge in stunt driving or horseplay particularly on grades (slopes).

To Extend Tire Life

A few simple measures can help increase tire life and reduce maintenance (downtime) and cost of operation:

1. Inspect tires regularly and remove embedded objects immediately.
2. Check that the tires remain centered on the wheels.
3. Lubricate the forklift according to the schedules provided on page 1-8 through page 1-14, however, avoid over lubricating.
4. Keep runways clean and maintain floors in good repair, free from breaks, ruts, cracks and debris.
5. Avoid excessive heat, overloading and standing loads.
6. Regularly check axle alignment and steering.
7. Avoid sharp turns and quick starts and stops.
8. Avoid oil, grease, gasoline and acid. Wipe these compounds off as soon as possible.
9. DO NOT allow hydraulic oil to drip onto the tires.

50 Hours Inspection

Check:

1. Mast Chains - Inspect, Clean and Lubricate.
2. Power Steering - Check Operation, Inspect and Fill.
3. Drive Wheels - Torque lug nuts - 225 ft.-lbs(300 Nm).
4. Vacuum Hoses - Check for cracks and leaks.
5. Actuator - Tighten Coupling bolts 30 ft.-lbs (40.7 Nm).

300 Hours Inspection

NOTE

The following 300 Hour Inspection information is provided for authorized service facilities ONLY.

Check Nuts, Bolts, and Screws

All major mechanical and major electrical connections (nuts, bolts, screws, etc.) must be checked and tightened periodically. Under severe operating conditions, checking and tightening inspection must be performed more frequently. See General Torque, Hydraulic Fitting Torque specifications starting on page 1-18.

Check and tighten the following:

1. Drive wheel lug nuts.
2. Drive unit gear boxes and motor mounting bolts (rear wheels).
3. To inspect the drive gear motor mounting bolts you must remove the tires. Jack (lift) the forklift and place it on safety blocks.

DANGER

When working under the forklift, always use safety blocks together with a lifting apparatus. DO NOT rely only on the lifting apparatus. The lift could leak fluid or be accidentally released, allowing the forklift to drop.

4. Load wheel / axle assembly front end mounting bolts.
5. Mast tilt cylinder pin locking bolts.
6. Mast mounting pin locking bolts.
7. Master cylinder clevis and mounting bolts.
8. All hydraulic pump and motor mounting bolts.
9. Hydraulic cylinder clevises.
10. Overhead guard mounting bolts.

Check Lift Operation

Check the lift cylinders to ensure proper sequencing.

1. Check to see that an unloaded mast will completely lift to full lift height (the relief valve opens). If it will not, check the hydraulic oil level in the reservoir; add oil if necessary.
2. Load the mast and raise it approximately 5’ (1.524m).
3. Quickly lower the mast until it is about 6” (152.4 mm) above the floor and stop the mast abruptly.
4. Make sure the elevating channel rollers maintain proper contact with the mast channel. **See Figure 2-11.**

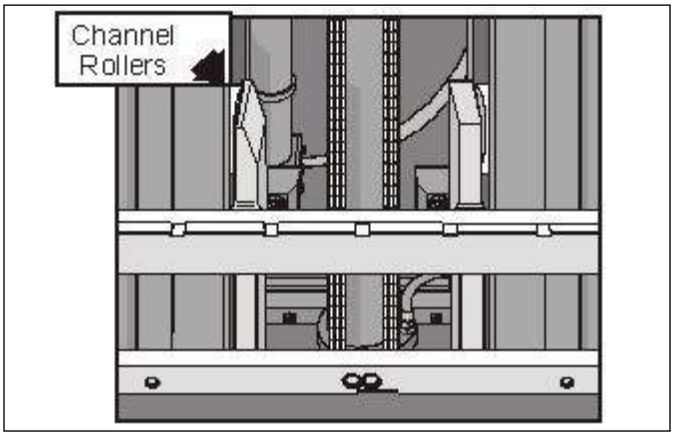

Figure 2-11: Channel Roller Contact

5. Look for signs of galling where the rollers contact the rail. **See Figure 2-12.**
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.

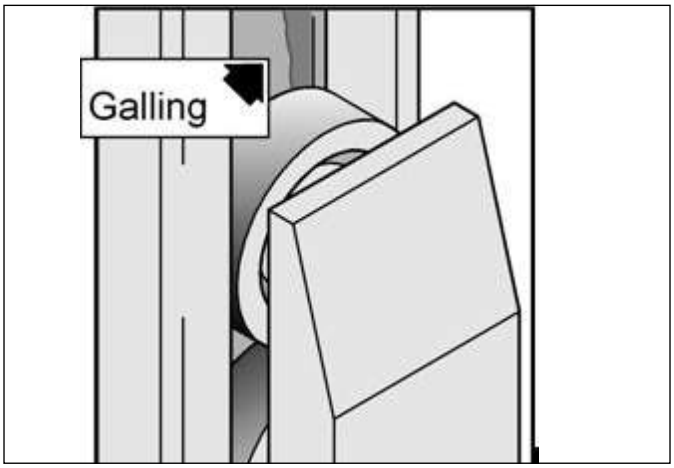

Figure 2-12: Channel Galling

Drive Wheel Lug Nuts

Re-torque the drive wheel lug nuts to 225ft-lbs (300Nm) once during the first 50 to 100 hours of operation, then once every 300 hours thereafter.

Hydraulic System Maintenance

Maintain the hydraulic system, and associated components, as required by the various inspection checklists.

CAUTION

- **DO NOT allow hydraulic fluid level to drop significantly or allow the reservoir to run dry. This will induce air into the system and cause damage to hydraulic system components.**
- **Prevent dirt or other foreign matter from entering the hydraulic system; clean filler caps before checking oil level.**

Cylinders and Valves:

Check these components for drift and leakage. Refer to Landoll Corporation and other vendor service information for specifications.

Hoses and Tube Lines:

Check for cracks, hardening, or other signs of wear. Reroute any usable hoses that are kinked, severely bent, or rest against hot parts. Look for leaks, especially at couplings and fittings. Replace any hoses or tube lines that do not meet system flow and pressure ratings.

Hydraulic Fluid:

Check fluid level and look for air bubbles.
Check the filter.
Check the hydraulic oil level when the oil is at operating temperature, the carriage is lowered and the engine is stopped. Add hydraulic oil only as needed. If more hydraulic oil is added over the “FULL” level, the hydraulic oil will leak from the breather during operation. The oil level indicated by the sight gauge is most accurate when the oil temperature is 130º to 200º F (53º to 93º C). See page 1-17 for recommended lubricants.

Other Hydraulic System Components:

Visually check other components to see if they are loosely mounted, show signs of leaks, damage or wear.

Side Shift Circuit Maintenance

DANGER

- **Before you remove any hoses or tubes, relieve hydraulic system pressure. With the forklift “OFF”, open the forklift auxiliary control valve(s) several times in both directions.**
- **Check for hydraulic fluid leaks using a piece of cardboard or wood. DO NOT use your bare hands.**
- **Remember to wear safety glasses.**
- **Hydraulic oil can be under very high pressure. A pinhole leak is not easily seen and if it pierces your skin, can possibly cause death. Seek medical attention immediately.**

To check side shift circuit performance:

1. Side shift completely to the left and hold the control handle in this position for 5 seconds.
2. Check for external leaks at the cylinder, fittings, and hoses.
3. Side shift completely to the right and hold the control handle in this position for 5 seconds. Check for external leaks at the cylinder, fittings, and hoses.

Identification Plate and Safety Warnings

DANGER

Make sure that the identification plate and safety warnings (decals) located on the forklift are legible and the information provided match the characteristics of the forklift. Failure to follow these guidelines can result in serious injury or death.

Contact Landoll Corporation if any accessories that modify the capacity and forklift operation are planned. After the factory reviews your request, new identification tags will be issued to update the rated capacity and other operation characteristics.

Check Tilt Cylinder Racking

WARNING

- **When checking any of the mast functions keep everyone away from the forklift. Movement of the mast or other components may injure unaware bystanders.**
- **Review the Safety chapter at the beginning of this manual.**
- **The following adjustment procedures are critical and must be maintained for optimum forklift performance.**

Tilt Cylinder Racking and Tilt Degree Settings

Racking occurs when the tilt cylinder strokes are uneven, (one cylinder bottoms before the other). The mast rails then twist, eventually causing them to crack and separate.

Proper tilt degree adjustment is 3° forward and 3° to 3.1° backward maximum for masts less than 240".

For masts above 240", tilt no more than 2° forward and 1° backward.

Racking

To check for racking:

1. Locate a reasonably level floor area to park the forklift.
2. Set the key switch to “ON” and shift the mast to the center of the forklift, as viewed from inside the driver’s cab.
3. Raise the forks about 36” (914 mm) from the floor and tilt the mast fully forward.
4. Tilt the mast forward and rearward a few times. Carefully watch as the mast completes the forward and backward stroke, checking for twisting (racking).
5. If there is any twisting motion (racking) of the mast rails when the cylinders “dead-head,” both tilt cylinder rods must be re-adjusted. See following Step 10 “To adjust for racking.”

CAUTION

If this is left unattended, serious damage to the mast assembly or the tilt cylinders can occur, causing extensive repair and downtime.

6. Trial and error is the most effective way to check this adjustment.
7. Repeat steps 4 and 5 a few times to be sure what type of adjustment is needed.
8. One cylinder may need tightening while the other needs loosening, or one cylinder may need a minor adjustment.
9. To check degree of tilt, be certain the forklift is on a smooth, level surface.
10. Tilt the mast back its full stroke.
11. Place a tilt gauge against the rear outer mast rail on the right side of the forklift. **See Figure 2-13.**
12. The gauge must read between 3.0° and 3.1° maximum for masts less than 240" (1° for masts with MFH greater than 240"). See Step 2 on page 2-11 “Tilt Degree Adjustment” if adjustment is needed.
13. To adjust for racking, tilt the mast fully backward.
14. Set the key switch to “OFF” and remove from key switch.

Figure 2-13: Tilt Gauge Placement

WARNING

DO NOT service the tilt cylinders while the key switch is “ON”. If steering wheel or drive pedal is accidentally moved, someone could be caught between the mast and the forklift, causing serious injury.

15. Loosen tilt cylinder jam nut using a 1-3/4” open end wrench. **See Figure 2-14.**
16. Adjust each tilt cylinder rod accordingly, using a 1-1/8” (28.6 mm) open end wrench, by turning clockwise to shorten the stroke or counterclockwise to increase the stroke.
17. Turn the rod only a 1/4 turn at a time until the correct setting is achieved.
18. You may have to tilt the mast a number of times (repeating Steps 10 through 13) until the adjustment is correct.

19. Remember, both cylinders must dead-head evenly and at the same time. Racking will eventually render the mast assembly and/or the tilt cylinders defective.

Figure 2-14 Tilt Cylinder Adjustment Jam Nut

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

Tilt Degree Adjustment

1. Park forklift on a level surface.
2. To adjust tilt degree, tilt the mast fully backward.

WARNING

- **For masts less than 294", NEVER exceed 3.0° to 3.1° rear tilt.**
- **NEVER exceed 2° forward or 1° backward tilt for masts greater than 294". Exceeding the tilt limitations will cause damage to the mast, tilt cylinders and could ultimately cause serious damage to the forklift and injury to those nearby.**
- **DO NOT service the tilt cylinders while the key switch is "ON". If a joystick, steering wheel or drive pedal is accidentally moved, you could be caught between the mast and the forklift, causing serious injury.**

3. Set the key "OFF" and remove it from the key switch.
4. Loosen the tilt cylinder jam nut. **See Figure 2-14.**
5. Place the tilt gauge against the rear outer mast rail on the right side of the forklift, about 6" (152 mm) above the pivot arm. The gauge must read between 3.0° and 3.1° maximum for masts less than 240" (1° rear tilt for masts with MFH greater than 240").
6. Adjust each tilt cylinder rod accordingly, using a 1-1/8" open end wrench, by turning clockwise to shorten the stroke or counterclockwise to increase the stroke.
7. Turn the rod only a 1/4 turn at a time.
8. You may have to tilt the mast a number of times (repeating Steps 16 through 20) until the adjustment is correct. **Remember**, both cylinders must dead-head evenly and at the same time or racking will occur.
9. When the adjustment is complete, tighten and torque both cylinder jam nuts.

Lubricating the Forklift

1. Before lubricating the forklift, lower the forks, set the key switch to the "OFF" position and set the parking brake.
2. Certain grease fittings may include protective plastic caps, remove them before applying grease. Remember to replace the caps when you are finished.
3. In the following illustrations, the location of grease fittings or surfaces to be greased may be marked by either a grease-gun or brush icon. **See Figure 2-15.**

Figure 2-15: Icons

4. Make sure all grease fittings are wiped clean before lubricating. If any of the fittings are corroded or blocked, replace them.
5. 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.
6. After high-pressure washing (not recommended), lubricate all unprotected grease fittings and metal-to-metal surfaces, located outside the forklift.
7. Interval frequency can be recorded from the running hours read on the hour meter in the driver's compartment.
8. See page 1-17 for recommended lubricants.

Tilt Cylinder Ends

WARNING

- **DO NOT service the forklift and/or mast area while the engine is running.**
- **If steering wheel or drive pedal is accidentally moved serious injury could occur.**

1. Start the forklift and tilt the mast straight forward to the normal carry position.

2. Set the key switch to “OFF” and remove the key.
3. Grease bearing fittings at both ends of each tilt cylinder and on each side of the forklift until fresh grease is squeezed from the bearings. **See Figure 2-16.**
4. The rod end is maintenance free and does not have a grease fitting
5. Wipe off excess grease.

Figure 2-16: Grease Zerk Locations

Lubricate Front Steer Wheel Bearings

1. Position the forklift on a flat surface, set the parking brake and block the wheels not being serviced to prevent movement.
2. Raise the mast about five feet (1.5m) to expose the inner wheel frame area and the wheel bearing grease fittings.
3. Block the mast.

DANGER

- **Getting under a forklift when it is lifted or jacked is dangerous and could cause serious injury or death. NEVER go under a forklift that is supported only by a jack.**
- **Make sure all lifting devices and supports, such as a jack or support stand, blocks of wood, are capable of handling the weight of the load.**

4. Set the key switch to “OFF” and remove the key.
5. Make sure the other wheels are securely blocked so that the forklift cannot move.
6. Remove the wheel hub cap - pry off using flat blade screwdriver. See **Figure 2-17 on page 2-12**
7. Clean out all excess grease from the spindle/wheel hub area.
8. Using a grease gun, lubricate the steer axle fitting, located on the inside of the front axle weldment plate until fresh grease is seen.
9. Wipe off excess grease and replace the hub cap using a rubber mallet.

NOTE

Make sure the breather hole is clear of grease and dirt, otherwise the hub cap could fall off.

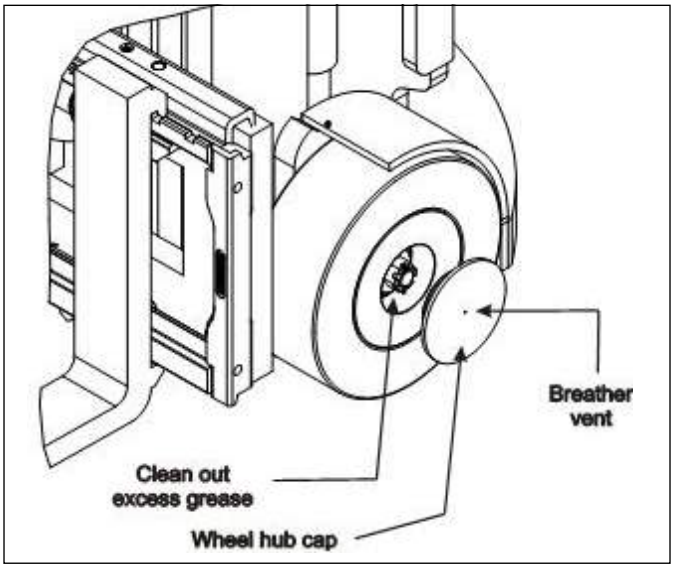

Figure 2-17: Front Steer Wheel Bearings

Grease/Inspect Bearings, Race & Inner Seal

If inspection of the bearing cones, cups (race), and inner seal is deemed necessary, proceed as follows: **See Figure 2-18.**

1. Bend back the tangs of the cotter pin and remove the pin from the wheel spindle.
2. Remove the spindle nut and bearing washer, then carefully pull out on the wheel to loosen the bearing.
3. As the wheel is removed, remove the outer wheel bearing cone, which pops free as the wheel is pulled away.
4. Be careful not to damage the inner seal as the wheel is removed.
5. If the inner seal is damaged, use a screwdriver to pry the seal from the wheel. Note how the seal is installed.
6. Remove the inner bearing cone.

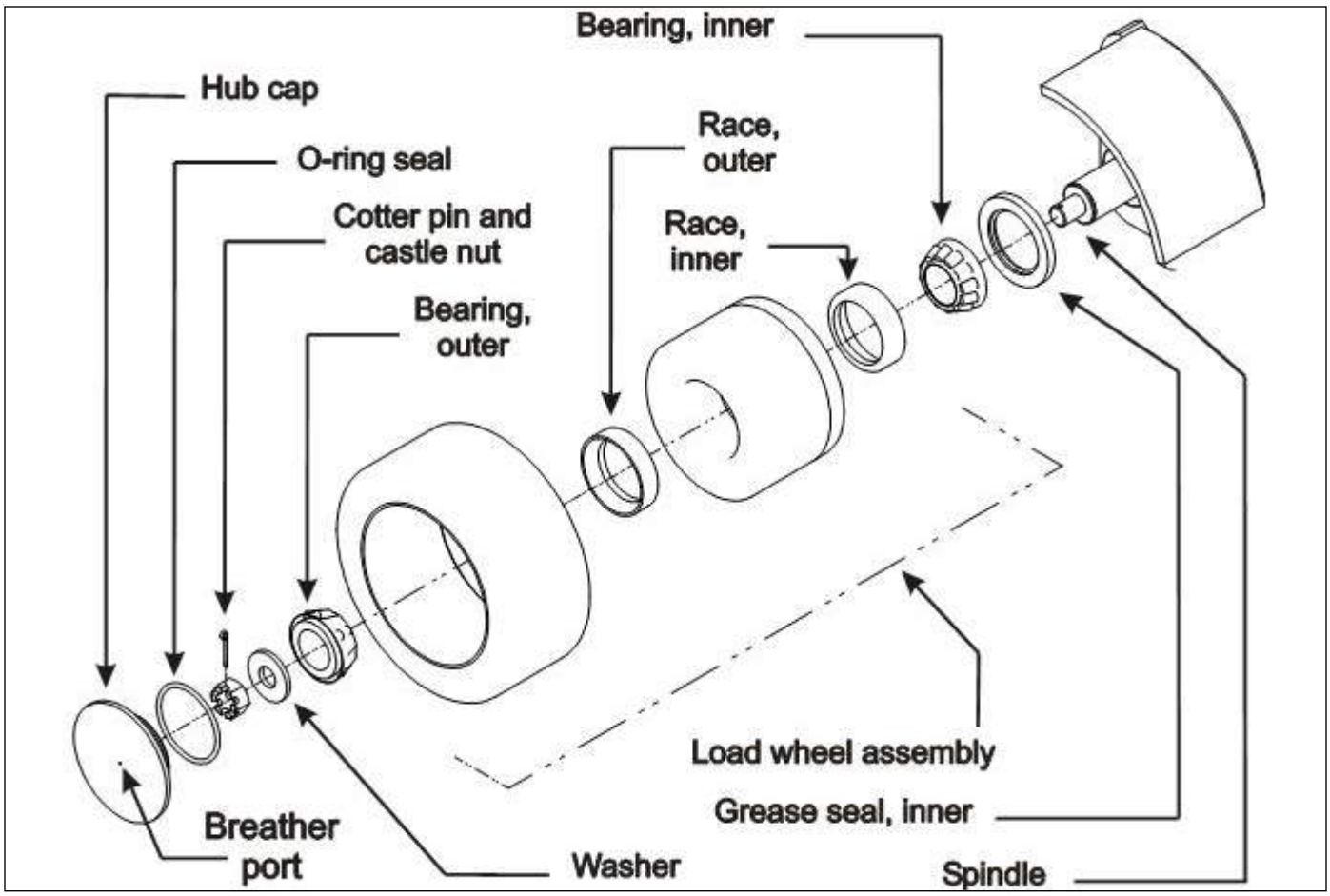

Figure 2-18: Bearings, Race and Inner Seal

NOTE

If the bearings must be replaced, use a standard puller to remove the inner and outer bearing cup (race) from the wheel rim.

7. Wash the bearing in a solvent. Examine it for damage or wear. Allow the parts to air dry.
8. Spin the bearings and check for unusual sounds indicating rough surfaces (Brinelling) or non-rotating rollers.
9. Replace bearings if they are noisy or appear rough.
10. Pack the bearings with high-temperature bearing grease making sure the grease penetrates the rollers, cone and cage from the back side. See page 1-17 for recommended lubricants.
11. Clean the spindle and examine it for wear or scoring damage.
12. Install new bearing cup (race) by pressing into wheel rim. Apply an even force to prevent cracking the cup (race) during installation. Be sure that each bearing cup (race) is fully seated (bottomed out) against the shoulder in the rim bore.
13. Install the inner bearing cone into the wheel rim.
14. Carefully set the wheel over the grease seal and spindle. Install the outer bearing cone, steel washer and the spindle nut.
15. While turning the wheel or rim counterclockwise, apply 240 to 260 in. lbs. (27 to 29 Nm) of torque to the spindle nut.
16. Spin the wheel to make sure it turns free, then back off the wheel nut 1/2 turn.
17. While turning the wheel, apply 20 to 25 in. lbs. (2.26 to 2.82 Nm) of torque to the nut. Again, check to make sure the wheel turns freely.
18. Back-off the nut slightly as necessary to align it with the nearest hole. Insert and bend back the legs of the new cotter pin.
19. Pump grease into the zerk on the inside of the spindle until grease comes out of the bearing cone.
20. Install the hub cap.

Actuator Seal Lubrication

1. Start the forklift and turn the mast fully to the right.
2. Locate the two grease-fill ports on the front side of the actuator (where mast is when in normal carry position). **See Figure 2-19.**

3. Apply 2-3 pumps of the recommended grease to the top and bottom ports. (See “Lubrication Specifications” on page 1-17.)
4. Turn the mast fully to the left and apply 2-3 more pumps.
5. Repeat as necessary until the grease begins to escape from the relief fittings on the top and bottom (top area shown).

DANGER

Be cautious when turning the mast back and forth. Make sure that all personnel and obstructions are out of the way. Something may become trapped between the mast and the body of the forklift, resulting in damage, injury or death.

Figure 2-19: Actuator Ports

Mast Mounting Pins

1. **See Figure 2-20.**
2. Start the forklift and turn the mast straight forward, to the normal carry position.
3. Tilt fully forward.
4. Set the key switch to “OFF” and remove the key.
5. Slide a rag or piece of cardboard under the mast in the area of the mounting pins to prevent oil from dripping onto the floor.
6. Reach in between that mast and the front end plate and apply grease to the two grease fittings in the lower mast mount. An extension to the grease gun may be required.
7. Wipe off any excess grease.

Figure 2-20: Mast Mounting Pin Grease Point

Forks and Side Shifter

1. **See Figure 2-21.**
2. Start the forklift and position the mast straight ahead.
3. Set the key switch to “OFF” and remove the key.
4. Before lubricating the rails, wipe off any excess lubricant and dirt buildup from within the rail channels.
5. Grease the two rail fittings across the top of the carriage rail until fresh grease is seen.
6. Wipe off any excess grease.

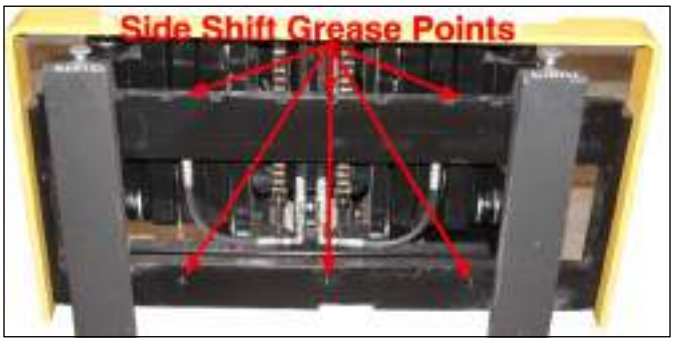

Figure 2-21: Side Shifter Grease Points

Fork Positioner Lubrication, Non-Side Shifting

1. **See Figure 2-22.**
2. Start the forklift and position the mast straight ahead.
3. Set the key switch to “OFF” and remove the key from the ignition switch.

4. 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.
5. Using a brush, lubricate the shaded areas on the fork rails, including a thin film on the front face of both rails. Wipe off excess grease.
6. Check for hose line routing damage and loose fittings.

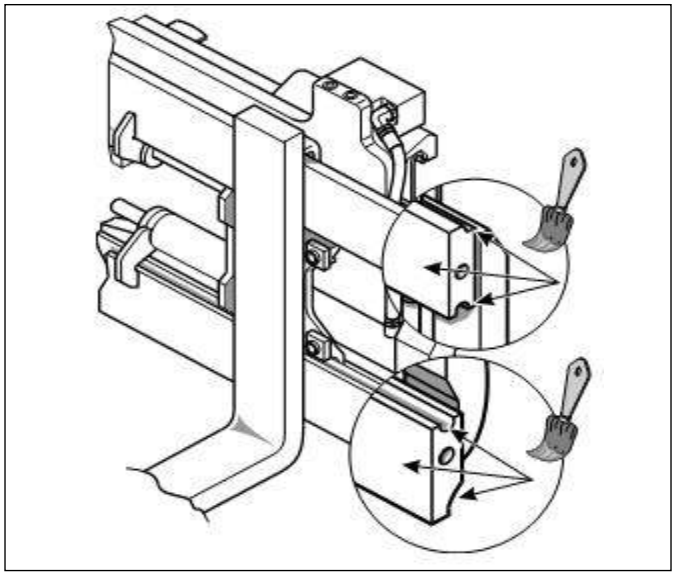

Figure 2-22: Fork Positioner Lube Points

Check Radial Piston Hydraulic Motor

These units are internally lubricated by fluid in the hydraulic system. No lubrication or checks are necessary.

Cooling System

Make a visual check of the coolant level.

WARNING

DO NOT remove the radiator cap from the radiator when the engine is hot. When the radiator cap is removed, the pressure is released from the system. If the system is hot, the steam and boiling coolant can cause burns.

Make sure the coolant level is between the “ADD COOLANT” and “HOT” marks on the overflow reservoir. The coolant will expand as it is heated and the level in the auxiliary coolant reservoir will increase. If coolant is added, use a 50% mixture of Dexcool and water.

Check the radiator fins.

Clean the radiator with compressed air/water as needed.

Air Filter

Check the air filter every 300 hours of operation. Very dirty conditions will require a daily inspection and cleaning or installation of a new filter element:

1. Use compressed air to clean the filter element. Air pressure must be less than 30 psi (210 kPa).
2. Apply the air from the inside to the outside of the filter element.
3. Inspect the filter element. **See Figure 2-23.** Put a bright light inside the filter element and look for holes or other damage.
4. If the filter needs replacing, light will show through the element paper.

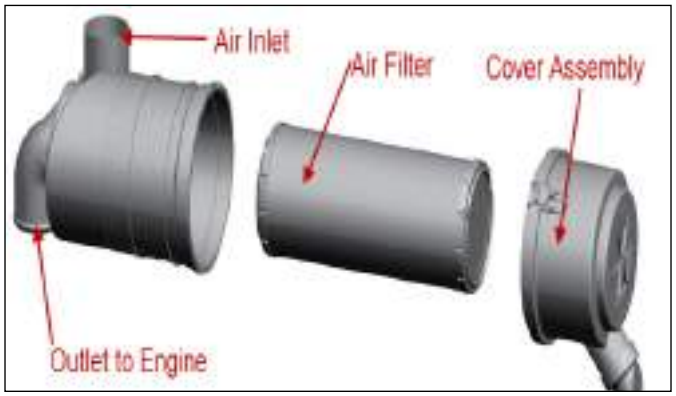

Figure 2-23: Air Filter Assembly

5. If the filter element is damaged, install a new filter element.
6. Use a cloth with solvent to clean the inside of the canister when the filter element is installed.

Figure 2-24: Oil Filter Location

Figure 2-25: Engine Drain Plug Location

Change Engine Oil and Filter

1. See **Figure 2-25**.
2. The mast must be fully lowered.
3. Set the parking brake and block both of the rear wheels.
4. Set the key switch to “OFF” and remove the key.
5. Slide a container, with a capacity of 2 gallons (10 liters) minimum under the drain plug, then remove the plug.
6. Drain engine oil.
7. Remove and replace engine oil filter.
8. Replace drain plug. **See Figure 2-25.**
9. Fill engine with oil. See page 1-17 for recommended lubricants and fluid capacities.
10. Check fluid level using engine dipstick. **See Figure 2-7.**
11. Operate the engine and observe the engine filter for oil leaks.
12. After operating, recheck engine oil level with dipstick and fill as necessary.

NOTES

DO NOT overfill. Having the level above the FULL mark on the engine dipstick does not allow enough area for expansion when the oil heats during normal operation.

600 Hour Inspection

Change Hydraulic Oil, Hydraulic Oil Filter and Tank Filter

1. Position the forklift on a flat surface, set the parking brake and block the wheels to prevent movement.
2. Set the key switch to “OFF” and remove the key.
3. Open right hand door and engine compartment cover.
4. Before removing either filter assembly, clean the area to avoid contamination.
5. Reach in and spin off the hydrostat charge hydraulic oil filter assembly. **Figure 2-7 on page 2-5**
6. Remove the filter canister and take the filter element from inside.
7. Coat the top O-ring seal on the new filter element with a thin film of hydraulic oil.
8. Insert the filter assembly into the filter mount and spin on to seat the O-ring seal.
9. Unscrew and remove cap in top of in-tank filter assembly.
10. Replace filter element.
11. Replace cap and tighten screw.
12. Operate the hydraulic system by running the mast functions and observe the filter for oil leaks.
13. Add hydraulic oil as needed to reach “FULL” on the fluid level gauge. **See Figure 2-6.**
14. Close engine compartment and right hand door.

Floor Plate Removal

The floor plates provide access to the drive module assembly which is mounted to the top of the RH floor plate. **See Figure 2-26.** The SAHR brake valve and service stop pedal and linkage are mounted under middle floor plate:

1. Thoroughly clean the floor area using brush and dustpan or vacuum.
2. Remove hardware and floor plates from the forklift frame.

NOTE

The drive module electrical harness will restrict how far the plate can be lifted. To fully remove the plate you must disconnect the electrical harness.

3. Install all screws when the floor plates are reinstalled and make certain the drive harness is reconnected to the drive.

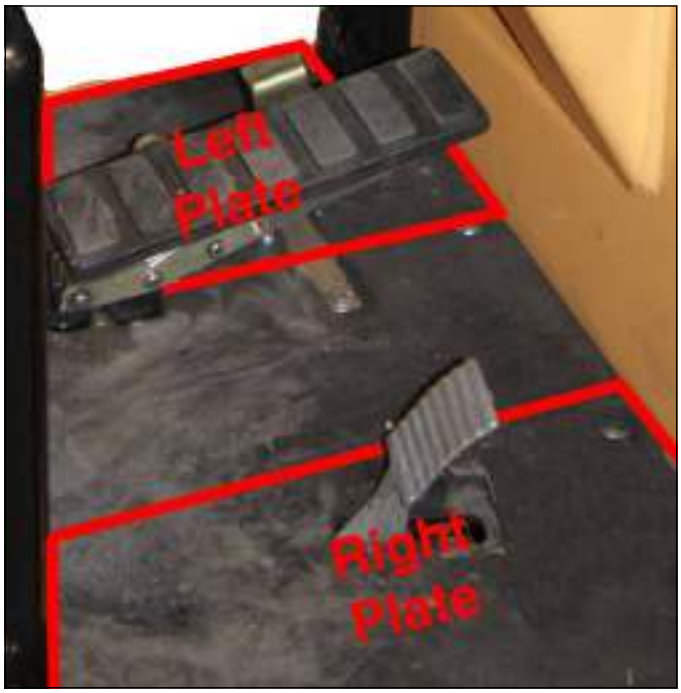

Figure 2-26: Floor Plate Removal

Mast Maintenance

IMPORTANT

The following information is provided for authorized service facilities ONLY.

To inspect and adjust the mast assembly, reference page 3-18.

For mast parts list manuals, see:
45D Quad Mast Parts List F-387
55D Triple Mast Parts List F-389

WARNING

- **NEVER work on the mast with a load on the forks or attachment in the raised position without supports... or while anyone is near the forklift control handles per ASME B56.1-2000.**
- **Mast adjustment procedures can produce unexpected movement of the upright rails and other parts.**
- **Be careful and alert.**
- **The forks must be empty. NEVER perform adjustments or inspections with loaded masts.**
- **NEVER walk or stand under raised forks.**

WARNING

- **NEVER stand on top of or climb on any part of the mast rails.**
- **NEVER reach through upright open areas.**
- **Wood blocks used for clamping must be square on the ends and not tapered or rounded. Use only hardwood blocks which are free from cracks and other visual damage. Tuck blocks into the channel under the roller where specified.**
- **For inspection, use only an approved safety platform or step ladder.**
- **NEVER attempt to repair a chain. If any problem is found in a chain, it must be replaced and chains must be replaced in sets.**
- **All mast rail rollers, carriage rollers, chain sheaves and cylinder head guide rollers (where applicable) are self-lubricating and sealed.**
- **Roller bearing life depends on the application and conditions of operation.**

NOTE

Any warranty repair must be pre-approved by the mast manufacturer.

Inspection Check List

- Load Roller.
- Chain Inspection.
- Chain Adjustment.
- Measure Chain Stretch.

Load Roller Maintenance

Check for proper load roller shimming as required by the 600 and 2000 Hour Inspection for Bendi Forklifts (pages 1-12 and 1-14):

1. The maximum side-to-side clearance, between load rollers, and the outer, or inner intermediate upright assemblies, is 1/16 in. (1.5 mm).
2. To check the clearance, insert a pry bar between the upright and roller, and measure the clearance at the “XXX”. **See Figure 2-27.**
3. If additional shims are required, refer to the appropriate manufacturer’s mast service manual.

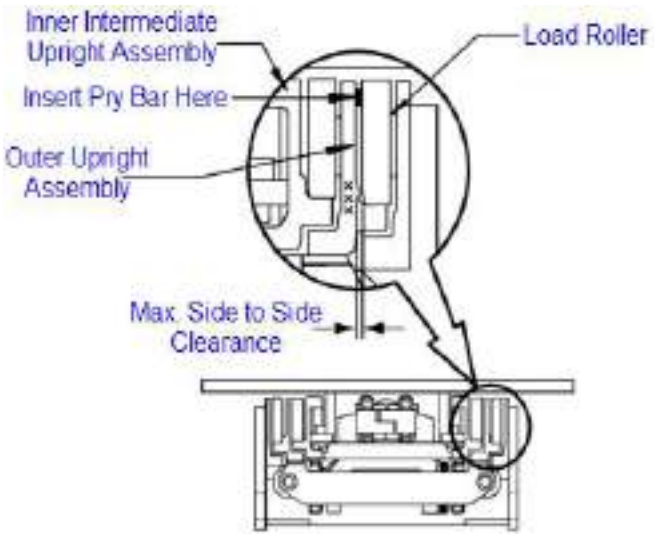

Figure 2-27: Load Roller Maintenance, Top View

Chain Maintenance

Regular inspection and lubrication of the chains will increase their service life and reduce downtime. When you perform chain maintenance, make sure you follow the guidelines in “Chain Inspection”, “Chain Lubrication”, “Chain Adjustment”, and “Measuring Chain Stretch”, as shown in the next several pages.

Chain Inspection

Inspect the chains and check for the following:

1. Chain wear - If one chain appears to be worn replace both chains of the pair.
2. Rust and corrosion - If chain joints become tight from rust and corrosion, loosen them with SAE 40W oil or penetrating oil. If they cannot be loosened, or if the tight joints are caused by bent pins, plates, or peened plate edges, replace both chains.
3. Cracked side plates - Replace both chains.
4. Protruding or turned pins - Replace both chains.
5. Side wear - If pins and outside plates show signs of wear, check for misalignment of sheaves, anchors or other components. Correct the misalignment. If wear is excessive, replace both chains.
6. Worn, broken or misaligned chain anchors - Replace or adjust as required.

Chain Lubrication

⚠ CAUTION

The chains must be coated with a film of lubricant at all times.

Lubricate the chains as listed on the Lubrication Chart located on page 1-17.
Each pair of chains has been factory-lubricated using heat and pressure to force the lubricant thoroughly into the chain links:

1. Avoid removal or contamination of this factory applied lubricant.
2. DO NOT wash, sand blast, etch, steam clean, or paint the chains.

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 the forks.
2. Extend 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.

Measuring Chain Stretch

If the chains have stretched beyond the recommended amount, they should be replaced in pairs.
Chain stretch can be measured with a Landoll provided chain wear scale - P/N 162280. See Figure 2-28.
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.

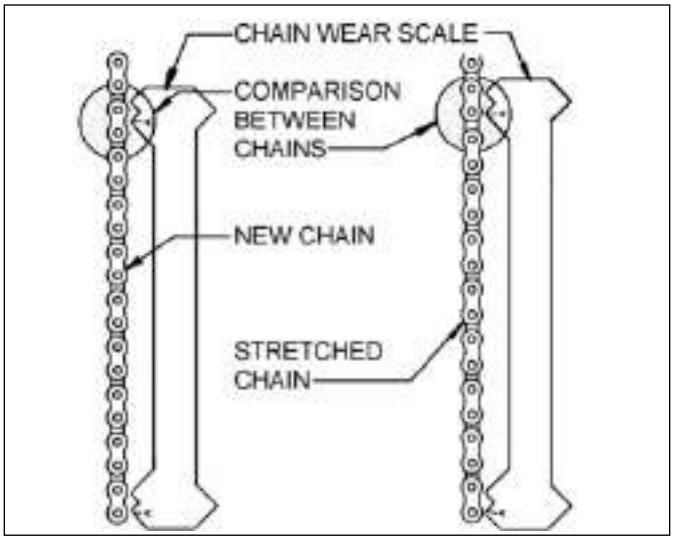

Figure 2-28: Chain Stretch Gauge

Fork Inspection

DANGER

- **NEVEROperate your Bendi B40i4 forklift if you suspect the forks are damaged. Report fork damage to your supervisor immediately.**
- **It is recommended to use only Landoll Corporation replacement parts.**
- **NEVER use forks repaired by welding.**
- **Always replace both forks. Switching forks from one forklift to another can be dangerous if the capacity of the forks is not known.**
- **If you find any defect in the forks or mounting components, take the forklift out of service until the fork is repaired or replaced.**
- **Failure to follow these recommendations can cause the load to fall resulting in serious injury or death.**

Check the top clip retaining pin and fork heel for signs of cracks and wear. Report any signs of cracks and wear to your supervisor immediately.
The following provides detailed procedures necessary to provide a complete fork and associated components inspection.

Rated Capacity and Load Center

1. The rated capacity of each fork must be at least half of the rated capacity stated on the identification plate.
2. The load center of each fork must match the load center stated on the identification plate.
3. If the values do not match, replace the fork with one that has the correct characteristics.

Cracks

Visually examine the forks for cracks and, if considered necessary, perform a non-destructive crack detection test. Pay special attention to:

1. Fork heel
2. Welds that attach mounting components to the fork blank
3. Top clip retaining pin

Straightness of Blade and Shank

Check the straightness of the upper face of each blade and the front face of each shank. If the deviation from straightness exceeds 0.5% of the length of the blade and/or the height of the shank, respectively, repair or replace the fork set.

Fork Angle

Check the angle between the upper face of each fork blade and the load face of each shank. If the deviation exceeds 3º from the original specification, repair or replace the fork.

Difference in Height Between Fork Tips

Check the difference in height between each fork blade, measured at the tip with the fork mounted on the fork carrier. If the difference in tip heights exceeds 3% of the length of the blade, repair or replace the fork.

Positioning Lock

Check the positioning lock on each fork to make sure it functions properly. If any problems are noted, repair or replace the fork.

Wear

Two different areas of the fork and fork attachment should be checked for wear: Blade and Hooks.

Fork Blade and Shank

Check each fork blade and shank for wear, pay special attention to the area surrounding the heel of the fork. If the thickness is reduced to 90% of the original thickness, repair or replace the fork.

Fork Hooks

Check the support face of the top hook and the retaining faces of both hooks for wear, crushing, and other local deformations. If any of these deficiencies cause excessive clearance between the fork and the fork carrier, repair or replace the fork.

Fork Marking

If the fork marking is not clearly legible, it should be remarked by the fork manufacturer, or their representative, in accordance with paragraph 7.25.2 (ASME B56.1-2000).

Measuring Fork Thickness and Distortion

1. Position the forklift on a flat surface, set the parking brake and block the wheels to prevent movement.
2. Set the key switch to “OFF” and remove the key from the ignition switch.
3. Measure fork thickness. **See Figure 2-29.**
4. Compare your fork measurement to the original thickness. 0.0625” (1.59 mm) is the maximum acceptable wear for a standard fork size of 1-1/2” x 4” (38.1 mm x 101.6 mm). If the fork is worn by more than 0.0625” (1.59 mm), the acceptable limit, replace both forks.

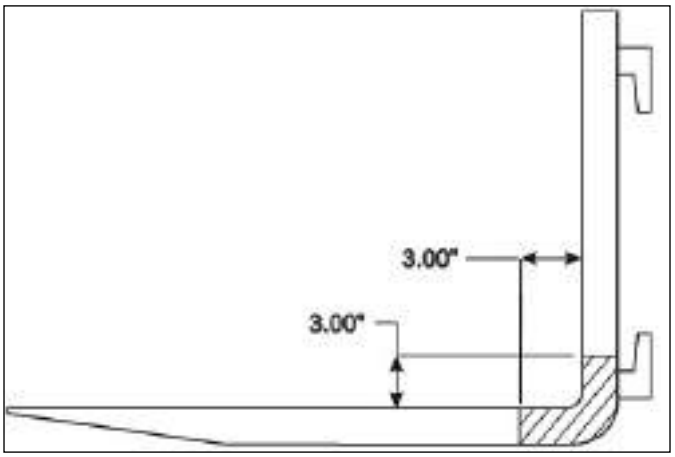

Figure 2-29: Fork Thickness

5. Measure the distortion distance (Y) of your forks. **See Figure 2-30.**
6. For this measurement, use a flat bar 4” x 24” (101.6 mm by 609.6 mm), that is 2” (50.8 mm) thick. Also use a 24” (609.6 mm) carpenter’s square. **See Figure 2-30.**
7. See table below which shows the acceptable Y distances. If the forks exceed the distance in the chart, replace them.

Blade	Length	Maximum	“Y” Value
32”	812.8 mm	3/4”	19 mm
36”	914.4 mm	31/32”	25 mm
40”	1016 mm	1 7/32”	31 mm
48”	1219 mm	1 1/2”	38 mm

Table 2-1: Acceptable Distortion Distance

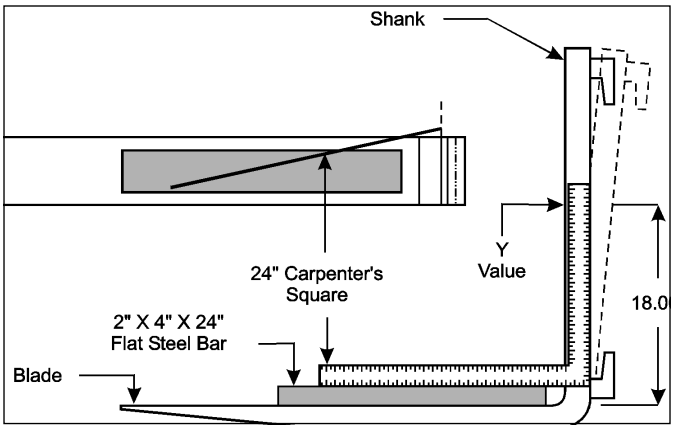

Figure 2-30: Fork Tip Elevation

8. Next, measure the elevation of each fork tip. If the difference is more than 3/4” (19.1 mm), replace the forks. **See Figure 2-30.**
9. Check the forks for cracks, paying close attention to the heel portion of the forks. If any cracks are found, replace the fork.
10. Every 2,400 hours, inspect the forks with magnetic particle or a dye penetrant inspection. If no test equipment is available in-house, send the forks to a qualified materials testing laboratory.

Lubricate Steer Wheel Knob

While the forklift is stationary and with the key switch “OFF”, apply a drop or two of light machine oil where the knob meets the steering wheel.

Spin the knob a few times and wipe off excess oil.

4500 Hours Inspection

Change Hydraulic Oil

1. The mast must be set to the normal carry position.
2. Set the parking brake and block both of the rear wheels.
3. Set the key switch to “OFF” and remove the key from the ignition switch.
4. Open right hand door and engine compartment cover.
5. Clean area around the fill cap to avoid contamination.
6. Open the fill cap. **See Figure 2-7.**
7. Jack (or raise) the left side of the forklift (as viewed from the driver’s compartment) a few inches/centimeters to force oil to the opposite side of the forklift. Also see Troubleshooting and Corrective Maintenance in Chapter 3.

8. Always place an appropriate support stand (or wood blocks) under the forklift, then lower the forklift to the stand, having the lifting device and stand both support the weight of the forklift.

DANGER

- **Getting under a forklift when it is lifted or jacked is dangerous and could cause serious injury or death.**
- **NEVER go under a forklift that it is supported only by a jack.**
- **Make sure all lifting devices and supports, such as a jack or support stand, blocks of wood, are capable of handling the weight of the load.**

9. The hydraulic oil tank drain plug is located on the front lower right side of the hydraulic tank. **See Figure 2-6.**
10. Slide a container, having a capacity of 15 gallons (57 liters) minimum under the drain plug, then remove the plug.
11. Reinstall the drain plug.
12. Change the hydraulic oil filters. See “Change Hydraulic Oil Filter” on page 2-16.
13. Before lowering the forklift, make sure the drain plug is tight enough to prevent oil leaks, but do not over tighten.
14. Remove jack stand or lift blocks and lower forklift back to level surface.
15. Add hydraulic oil. See page 1-17 for recommended lubricants and fluid capacities.
16. Also see “Check Hydraulic Oil Level,”page 2-4.

NOTE

DO NOT overfill. Having the level above the FULL marker on the sight gauge does not allow enough area for expansion when the oil heats during normal operation.

17. Replace the fill cap and make sure it is tightened securely.
18. Operate the hydraulic system by running the mast functions and observe the filter for oil leaks.
19. Add hydraulic oil as needed to reach “FULL” on the fluid level gauge.

Chapter 3

Troubleshooting and Corrective Maintenance

Troubleshooting

This chapter contains troubleshooting procedures to help diagnose and resolve problems.
Once the problem is located you must refer to the Corrective Maintenance Section starting onpage 3-16, for repair instructions.

Troubleshooting Chart procedures are arranged as:

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

Problem	Cause	Suggested Repair
ENGINE PROBLEMS		
Does not start.	No fuel.	• Make sure fuel lock off is working. • Check fuel pressure and fuel relay. • Check tank.
	No Spark.	• Check spark plugs, wires & coil.
No acceleration.	Drive pedal out of calibration.	• See Throttle Pot Setup on page 4-17 and recalibrate.
Runs Rough and/or Sluggish.	Refer to Chapter 5 for engine and fuel system service manuals.	
HYDRAULIC PROBLEMS		
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 Bendi IC Operator's Manual F-580 for additional information. • See "Understanding Stability," in the Bendi IC Operator's Manual, F-500.
	Insufficient pump or relief valve pressure.	• See "Mast does not lift load," on page 3-4.
	Mechanical damage of the mast.	• See "Mast does not lift load," on page 3-4.
	Hydraulic cylinders leaking or binding.	• See "Mast does not lift load," on page 3-4.

Problem	Cause	Suggested Repair
Mast does not tilt.	Inoperative tilt directional control valve.	• Repair or replace. • See “Tilt Cylinders” page 3-20.
	Insufficient pump or relief valve pressure.	See section “Insufficient pump or relief valve pressure,” beginning on page 3-4.
	Hydraulic cylinders leaking or binding.	• Tilt cylinder is leaking or binding - rebuild or replace. • Seal kits are available for most cylinders - see Mast Parts List(s) F-387 or F-389 for replacement items. • See “Tilt Cylinders,” on page 3-20.
Truck turns too slowly.		See “Steering drifts/wanders or is erratic,” on page 3-6.
Mast drifts downward.	Excessive load - attempting to lift loads beyond the capacity of the truck.	• See “Mast does not lift load,” on page 3-4.
	Lift hydraulic cylinders leaking or binding.	• Determine which cylinder is leaking or binding - rebuild or replace. • See “Mast does not lift load,” on page 3-4. • Seal kits are available for most cylinders - see Mast Parts List F-387 or F-389.
	Air in cylinder.	• Run mast to full extent three times to remove all air.
	Faulty lift control valve.	• Oil may be bypassing between the spool and body or the spool is not centering properly or is broken - repair or replace directional control valve.
Carriage does not shift or side shifts too slowly.	Inoperative shift cylinder.	• Repair or replace.
	Insufficient pump or relief valve pressure.	• See section “Insufficient pump or relief valve pressure,” beginning on page 3-4.
	Worn sideshift bearings.	• Replace sideshift bearings.
	Kinked or leaking supply hoses.	• Locate kink and straighten. • Repair or replace defective hose. • Tighten fittings to seal any leaks.

Problem	Cause	Suggested Repair
Mast does not lift load. **NOTE** **All mast warranty is managed by LIft-Tek. Please call 1-888-lifttek.**	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 Bendi IC Operator's Manual F-500 for additional information. • See "Understanding Stability," in the Bendi IC Operator's Manual F-500.
	Low hydraulic oil.	• Low levels can cause the pump to "cavitate" and not permit full lift of the mast. See "Check Lift Operation," in Chapter 2- Planned Maintenance, page 2-8. • Check reservoir oil level. Replenish as needed. See "Check Hydraulic Oil Level," in the Bendi IC Planned Maintenance, page 2-4.
	Faulty hydraulic control valve.	• Bent or damaged spool, worn internal seals - repair or replace as needed.
	Faulty pump.	• The hydraulic pump sections 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 Mast Parts List F-387 or F-389.
	Mechanical damage of the mast.	• Check mast for damage and signs of misadjustment. See "Check Lift Operation," in Chapter 2- Planned Maintenance, page 2-8.
	Insufficient system pressure.	• Check hydraulic pressure of system relief valves. For an overview of the system, see "Hydraulic System," in the Bendi IC Operator's Manual F-500. • Try re-adjusting the pressure relief valves. Maximum system pressure must not exceed 2,800 psi. • See "To Check and/or Adjust Pressure," on page 3-38. • Check valves for seal leaks, sticking or misadjustment. **Continued On Next Page...**

Problem	Cause	Suggested Repair
Cont'd	Insufficient system pressure.	• Repair or replace and/or re-adjust accordingly. • If problem persists, replace the relief valve cartridge.
Hard steering effort in one or both directions.	Improperly sized tires.	• Check tire specs described in the Bendi IC Operator's Manual F-500. • See "Inspect Tires" in Chapter 2, Planned Maintenance. page 2-6.
	Vehicle overloaded	• NEVER exceed capacity of the truck. Check capacity nameplate for tire specs. • Also see "Understanding Stability" in the Bendi IC Operator's Manual F-500.
	Low hydraulic fluid.	• See "Check Hydraulic Oil Level," on page 2-4, Planned Maintenance.
	Low flow rate or fluid pressure, load sense line restricted.	• Restriction in fluid return line. Remove line, clean and/or replace line. • Check pump. See "Auxiliary Pump, Steer and Lift Circuit," page 3-25. • Check hydraulic pressure. Eliminate restriction in load sense line. Line may be damaged/kinked, if so, replace line.
	Components in steering linkage, binding or making noise.	• Find source of problem and repair, such as - Steering column - See "Steering Column," on page 3-29. Orbital steering unit - See "Orbital Steer Unit," on page 3-30. Front rotation neck upper and/or lower bearings - See "Rotation Seals, Bearings, or Spur Gear," on page 3-23.
Lost motion at the steering wheel.	Steering wheel loose on column or stripped.	• Check and re-torque the steering wheel locking nut. • Replace steering wheel
	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.

Problem	Cause	Suggested Repair
Steering drifts/wanders, is erratic or turns too slowly.	Improperly sized tires.	• Check tire specs described in the Bendi B40i4 Operator's Manual F-580-R_. • See “Inspect Tires” in Chapter 2, Planned Maintenance, page 2-6.
	Low fluid or leaks in power steering system.	• Check hydraulic fluid level - replenish as necessary. • See “Check Hydraulic Oil Level,” on page 2-4, Planned Maintenance. • Check all related components for seal or fitting leaks - repair or replace.
	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 “Wheel Bearings, Seals, and Races,” page 3-21.
	Worn or out-of-adjustment steer assembly.	• Check motion control valve cartridges for foreign material (these are replaceable cartridges and will wear out over time). • See “Steering Column (Console),” on page 3-29. • Failed orbitrol - replace accordingly. • Loose actuator coupling - service accordingly. • Actuator leakage - check actuator for internal leakage. • Check appropriate “Appendix” index tab for vendor service information, where applicable. • Check hydraulic pressure of steering relief valve. • See “Auxiliary Pump (Steer and Lift Circuit,” on page 3-25.
	Insufficient hydraulic pressure at the pump.	

Continued on next page

Problem	Cause	Suggested Repair
Cont'd	Insufficient hydraulic pressure at the pump.	• Check steering motor for seal leaks, sticking or misadjustment - repair or replace.
No hydraulic pressure.	Coupling or shaft sheared or disengaged.	• Disassemble the pump and check the shaft and cartridge for damage.
	Oil intake line is restricted.	• Check for restrictions in reservoir ports. • See "Change Hydraulic Oil Filter," on page 2-4, Planned Maintenance.
	Fluid viscosity too heavy to pick up prime.	• Completely drain the system. • Add new filtered oil of the proper viscosity. • See page 1-17 for recommended lubricants. • See "Change Hydraulic Oil Filter," on page 2-4, Planned Maintenance.
Leaking fluid.	Cracked or cut hoses, where applicable.	• Replace the defective hose. NEVER attempt to patch or splice a hose.
	Loose or faulty hydraulic fittings.	• Tighten and/or replace. Be careful not to strip the threads, rendering the fitting defective.
	Oil seals deteriorated.	• Disassemble the unit and replace the oil seals.
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 page 1-17 for recommended lubricants.
	Excessive heat source.	• Locate excessive heat source, usually a restriction, in the system and correct the condition.
	High internal motor leakage.	Disassemble unit and replace worn rotor set.
	Severely worn or damaged internal splines.	• Disassemble unit and replace worn rotor set, drive link and coupling shaft.

Problem	Cause	Suggested Repair
ELECTRICAL PROBLEMS		
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. • See "Inspect Electrical Connections," in Chapter 2, Planned Maintenance, page 2-17. • 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.	Frayed or broken wires, blown fuse, faulty switch or electronics.	• Check related wire harnesses and connectors for contact problems, broken wires, check fuse, etc. • Continuity check on/off switches - replace as needed. • See "Intermittent Electrical Problems," below.
Intermittent electrical problems.	Loose electrical connections. Faulty Light or Accessory.	• Check for excessive vibration or poor maintenance records. • 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. • Use Plus1 diagnostic program with interface tools to identify problem. Replace faulty light or accessory.

Problem	Cause	Suggested Repair
AUDIBLE PROBLEMS		
Back up alarm does not sound.	Faulty alarm module. Frayed or broken wires, faulty direction control switch or electronics.	• Continuity check alarm module - replace as needed. • See “Back Up Alarms,” on page 3-51. • See “Inspect Electrical Connections,” in Chapter 2, Planned Maintenance. • 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. • Check wiring to relay. • See “Intermittent electrical problems,” on page 3-8.
Unusual noise when truck is in motion.	Faulty Hydraulic Wheel motor assembly.	• If unit is suspected, it must be removed from the truck and replaced. • See “Hydrostatic Drive Motor - Rear,” on page 3-37.
Singing noise.	Insufficient fluid level or charge oil flowing past cold start relief. Faulty motor bearing.	• Check fluid level. • Drive at reduced speed until oil/truck reaches operating temperature. • Faulty cold start relief valve. Replace with valve set at 460PSI (32 bar). • Repair or replace motor. See “Hydrostatic Drive Motor - Rear,” on page 3-37.

Problem	Cause	Suggested Repair
Muffled grinding noise.	Faulty wheel bearings - could be insufficient fluid or high pre-stress or excessive play on bearings.	• Determine if noise is in the front or rear. • For front - See “Wheel Bearings, Seals, and Races,” on page 3-21. • For rear - See “Hydrostatic Drive Motor - Rear,” on page 3-37. • See “Hydrostatic Pump,” on page 3-35.
	Damaged gearing - could be insufficient fluid, excessive play in bearings.	• Dismount gear box and examine for damage. • See “Replace Hydrostatic Drive Motor,” on page 3-37.
	Pump cavitation.	• Inlet to pump blocked. Check tank outlets for blockage.
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 Appendix B in the Bendi IC Operator's Manual F-500.
Pump making noise.	Pump intake partially blocked.	• Check the fluid condition and, if needed drain and flush the hydraulic system. Refill with clean oil. • See “Change Hydraulic Oil,” on page 2-16, Planned Maintenance.
	Air leaks at the intake or shaft seal. (Oil in reservoir could possibly look foamy).	• Check intake lines (hoses and fittings) and seals for leaks. Repair all leaks.
	Damaged pump/motor mounting.	• Repair and/or replace.
Horn does not work.	Faulty horn assembly or push button.	• Disconnect horn wires and push button - continuity test horn with 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 3-8.
	Blown horn fuse.	**Continued on next page**

Problem	Cause	Suggested Repair
Cont'd	Blown horn fuse.	•Check for electrical short - in horn or electrical connections.
Rubbing noise from the front wheels.	Faulty wheel bearing or damaged wheel shaft.	• Dismount suspected wheel and examine bearings and shaft. • See "Wheel Bearings, Seals, and Races," on page 3-21. • Check for foreign material lodged inside wheel hub - remove and repair and/or replace as needed.
Scraping noise when the mast is operated **NOTE** *All mast warranty is done by Lift-tek if applicable. Please call 888-liftek.*	Out of alignment. Faulty hydraulic cylinder - lift, tilt and/or shift. Needs lubrication.	• Realign and shim mast rails accordingly. • Determine which cylinder is bad - rebuild or replace. • Seal kits are available for most cylinders - see Mast Parts List(s) F-387 or F-389 for replacement items. • Lubricate mast as described in Chapter 2, Planned Maintenance.

Problem	Cause	Suggested Repair
VISIBLE PROBLEMS		
Leaking fluid.	Cracked, split, or cut hoses.	• Replace. NEVER attempt to patch a hose.
	Loose or faulty hydraulic fittings.	• Tighten and/or replace. Be careful not to strip the threads, rendering the fitting defective. • Replace seals in bad unit or replace unit.
	Pump or motor oil seals, rings, gaskets, etc. deteriorated by excessive heat or corrosion.	• Check appropriate vendor service information, where applicable.
****Cont'd on next page for clarity****		

Problem	Cause	Suggested Repair
Cracked or exceptionally worn forks. **DANGER!** **• 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.	• ***When replacing forks -*** Forks must be replaced in pairs. • 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 3-17.
	Excessive wear or defective hooks. **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 reset, 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.**	• Check each fork, especially at the heal area. If thickness is reduced to 90% of original thickness, replace the forks. • Check support face of the top hook and the retaining faces of both hooks for wear, crushing or other deformations. Excessive clearance between fork and carriage requires fork replacement.

Problem	Cause	Suggested Repair
Puddles/leakage in area of rear drive wheels.	Loose or faulty hydraulic fittings.	• Locate source of leak. Tighten and/or replace fittings. • Be careful not to strip the threads, rendering the fitting defective.
	Loose brake line fittings.	• Locate source of leak. Tighten and/or replace fittings.
	Faulty seal/gasket in drive motor.	• Locate source of leak - drive motor. • Replace unit. • See “Hydrostatic Drive - Rear,” on page 3-37.
	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 “To Replace the Hydrostatic Pump,” page 3-35. • Also see “Pump Problems,” on page 3-9. • Check appropriate vendor service information, where applicable.
Grease blotches around front 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 “Wheel Bearings, Seals, and Races,” on page 3-21.
Puddles/leakage near center area (neck) of the truck.	Loose hose or hydraulic fitting.	• Locate source of leak, example, pump or cylinder, oil tank drain line fitting, etc. Tighten and/or replace fittings. • Be careful not to strip the threads, rendering the fitting defective.
	Faulty oil seal/gasket in power steering motor.	• Rebuild or replace the power steering pump. • See “Steering Column (Console),” on page 3-29.
	Internal shaft seal worn or damaged.	
	Worn coupling shaft and internal seal.	

Problem	Cause	Suggested Repair
Puddles/leakage near mast.	Loose hose or hydraulic fitting. Leaking cylinder - lift, tilt and/or side shift.	• Locate source of leak, cylinder, manifold hose, cylinder hoses, etc. Tighten and/or replace fittings. • Be careful not to strip the threads, rendering the fitting defective. • Determine bad cylinder - rebuild and/or replace. • Seal kits are available for most cylinders - see Bendi IC Parts List F-501 and Mast Parts List(s) F-387 or F-389 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. • See “Inspect Electrical Connections,” in Chapter 2, Planned Maintenance. • 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 “Hydraulic Problems,” beginning on page 3-2.
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.
Lights do not work.	Faulty LED headlights. Blown fuse. Electrical problem - frayed or broken wires, faulty switch or electronics.	• Replace light assembly. • Replace fuse #2, 10 amps. • Check related wire harnesses and connectors for contact problems, broken wires, etc. • Continuity check on/off switches - replace as needed. • See “Intermittent Electrical Problems,” on page 3-8.

Problem	Cause	Suggested Repair
Excessive tire wear.	Hard starting and stopping.	• Examine operator's driving habits and train operator accordingly. • Excessive "hard" stops and starts contribute to abnormal brake and tire wear. • See "Inspect Tires," in Chapter 2, Planned Maintenance.
	Excessive overloading or improper weight distribution.	• NEVER lift loads in excess of what is recorded on the capacity nameplate in the Bendi IC Operator's Manual F-500. • Excessive overloading or improper weight distribution placed on the drive train will eventually render the gear box defective and could cause wheel traction problems; in turn, premature tire wear. • Also see "Understanding Stability," in the Bendi IC Operator's Manual F-500.
	Faulty drive motor bearings causing alignment problems.	• Replace complete motor.
	Worn steer wheel bearings.	• Replace. See "Wheel Bearings, Seals, and Races," on page 3-21.
	Improper tire durometer.	• Replace tire with Landoll recommended spare 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 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

- **You could be injured and the truck could be damaged if you try to do service work without qualified experience.**
- **If you use the wrong grade replacement parts, in time, they can break or loosen and serious injury could occur.**
- **It is recommended to use Landoll replacement parts before you attempt 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 key switch 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. If you are 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.

- Starting on page 1-2 refer to general maintenance, safety and battery safety instructions.
- 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.

Lifting the Truck

1. Always place an appropriate support stand or blocks of wood (8" square; 204 mm square minimum) under the truck if it is being lifted, then lower the truck to the support, having the lifting device and support both support the weight of the truck. **See Figure 1-4.**

DANGER

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

2. Make sure all lifting devices and supports, such as a jack or support stand, blocks of wood, are capable of handling the weight of the load.
3. Remove the truck cover doors for easy access.

Floor Plate(s) Removal

The right floor plate provides access to the accelerator module assembly which is mounted to the top of the floor plate. The stop/parking brake pedal and linkage are mounted to the stationary middle floor plate.

1. Thoroughly clean the floor area using brush and dustpan or vacuum.
2. Remove hardware and the floor plate from the truck frame.

NOTE

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

3. Install all screws when the floor plate is reinstalled and make certain the accelerator harness is reconnected to the accelerator.

Figure 3-1: Floor Plate Removal

Removing Forks

1. First, review "Before You Begin," page 1-1.
2. Slide the fork so the hook on the fork lines up with the notch on the bottom of the carriage.
3. Pull the fork tine upward until the hook is free of the carriage. **See Figure 3-2**.

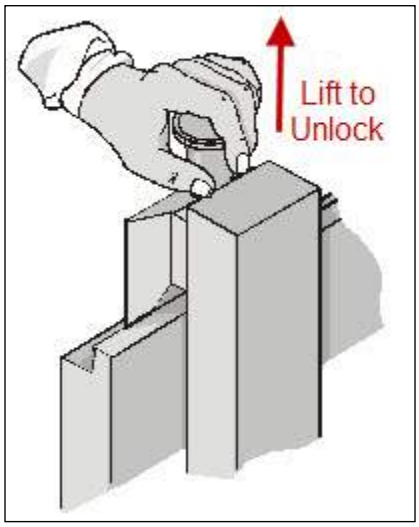

Figure 3-2: Fork Removal

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 carraige.

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 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 must be load tested before it is returned to service, unless only the positioning lock or marking was altered. 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.

Side Shifter

1. First, review "Before You Begin," page 1-1.
2. Park the truck on a clean, flat, level surface with enough room to work in the area safely.
3. Apply the parking brake and block all wheels.
4. Set the key switch to "OFF" and remove the key from the ignition switch**.**
5. Relieve hydraulic pressure in the system by turning the steering wheel two times to the left, then two times to the right, and move all control levers in both directions.
6. Disconnect the battery.
7. Disconnect the two hydraulic hoses (**Left** and **Right**) at the side shift cylinder. **See Figure 3-3**. The hoses feed back to the hydraulic control valve should they require replacement. **See Figure 3-4**.

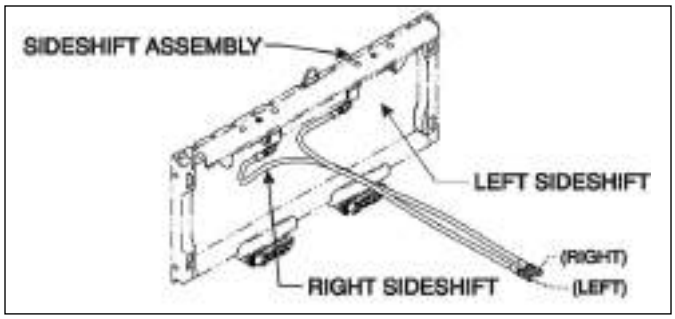

Figure 3-3: Side Shifter

8. Cap and plug the hoses and cylinder ports. Also tag the hoses for identification. Have rags handy for spills.
9. Remove side shift assembly and replace in reverse order.

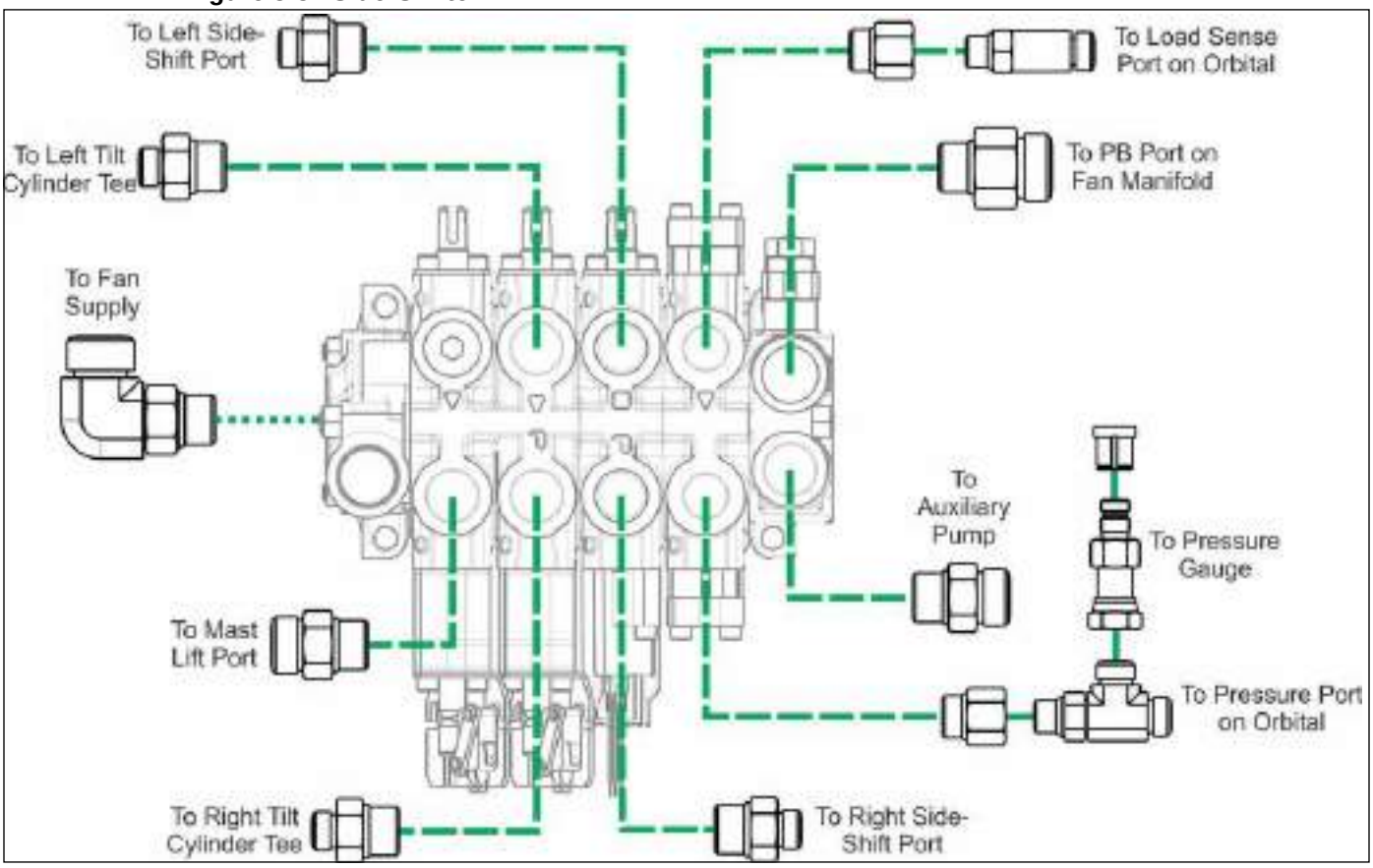

Figure 3-4: Hydraulic Control Valve Assembly

Mast Assembly Service

WARNING

- **Only trained and experienced technicians or your Landoll service representative must be allowed to service the mast assembly.**
- **NEVER place any part of your body into the working area of the mast.**
- **NEVER work on the mast while it is loaded, remove the load first.**
- **Be cautious and follow all safety precautions.**

Removing the Mast From the Truck

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

1. Thoroughly steam clean the mast, removing all dirt, debris and grease.
2. Record the roller clearances and chain adjustments before removing the carriage or rails. See “Mast Maintenance” on page 2-17, Planned Maintenance.
3. Review “Before you Begin,” on page 1-1.
4. Remove the forks. Review “Removing Forks,” on page 3-17.

5. 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 help.
6. At the mast, disconnect the lift cylinder hose and both side shift hoses from the hydraulic control valve.
7. Oil will drain from the cylinder lines and the hoses. Have shop rags handy to manage spills. Plug and/or cap the cylinder ports and hoses to prevent further oil drainage.
8. Tag each hose for identification.
9. Attach an overhead crane and strap, rated to 3 tons, and apply slight lift to the mast. See See Figure 3-5.
10. Disconnect the two tilt cylinders from the mast - see "Tilt Cylinders," beginning on page 3-20. **See Figure 3-6**.
11. With the tilt cylinders disconnected from the mast, move the overhead crane forward slightly to provide a gap between the mast and the front mounting plate. **See Figure 3-6**.

CAUTION

Wedge a block of wood between the mast and the front mounting plate to insure that the mast cannot be accidentally move backwards while you are disconnecting the pivot pin assemblies.

12. Remove the trunnion pin bolts (5/8"-11) and hardware. **See Figure 3-6**.
13. Remove the wedged block of wood between the mast and front mounting plate. Slowly slide the mast backwards.
14. Raise the mast enough to release the trunnion pins from their supports.

WARNING

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

15. 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 the 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. Secure the carriage to the mast if possible.

16. Dismantle, clean and inspect the mast assemblies and subassemblies as instructed in the Mast Service Manual.
17. Reassemble the mast in reverse order, using your notes as necessary and the enclosed Mast Service Manuals.
18. Before returning the mast to service, perform all adjustment procedures listed in enclosed supplier provided information in Chapter 7.

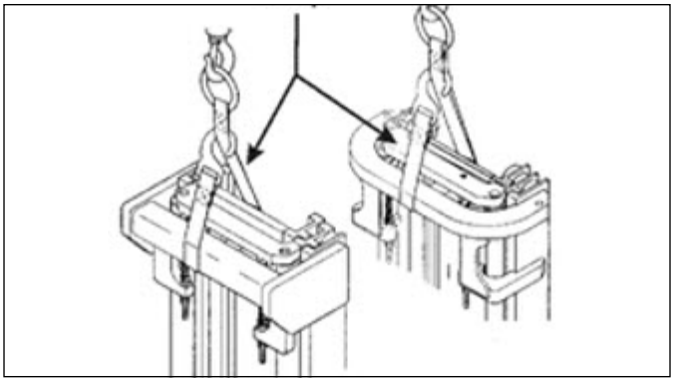

Figure 3-5: Overhead Strap

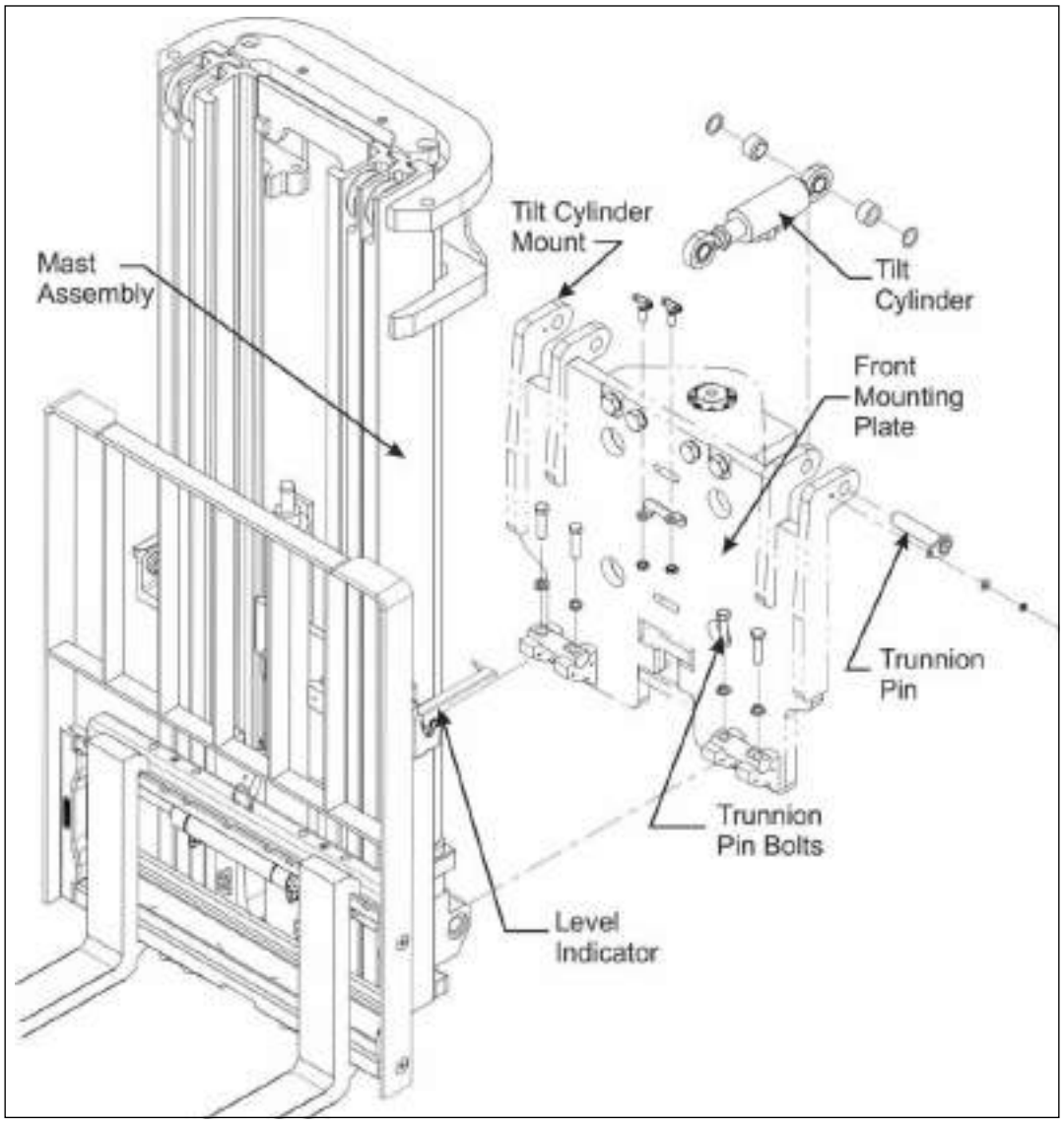

Figure 3-6: Tilt, Trunnion and Mast Assemblies

Tilt Cylinders

Review “Before you Begin...,” on page 1-1.

1. See Figure 3-6 Follow instructions shown here: If the cylinder is being removed, disconnect the two hoses from the bulkhead fitting prior to removal from the cylinder. The hose is fitted directly into the cylinder. Cap and plug the hoses and cylinder ports. Also tag the hoses for identification. Have rags handy for spills.
2. Mark the location of the cylinder locknut for reassembly to the new cylinder.
3. On the mast end of the cylinder, remove the bolt and hardware from the keeper pin assembly, remove pin and lift cylinder from clevis on mast. Pin is fitted with threaded hole (3/8-16) to allow for the use of a slide hammer for pin removal.
4. **DO NOT** lose the cylinder spacers and note how many spacers are on each side of the cylinder end.
5. If the cylinder is being serviced, remove the retaining bolt from the cylinder end, then remove the tilt cylinder pin.
6. Lift the cylinder from the front plate mount and remove the tube spacers from each side of the cylinder hub.
7. If the cylinder is being replaced, mark the location of the cylinder lock nut on the shaft.
8. Loosen the cylinder shaft lock nut and thread the cylinder rod end bearing from the cylinder rod.
9. To repair the tilt cylinder, replace seals, wiper, O-rings, etc. See Landoll LSC Parts Manual P/N F-575.
10. Install the lock nut, lock bracket and cylinder end(hub) to the new cylinder shaft.

11. Set the lock nut, insuring that the lock nut is in the same location to maintain the tilt angle on the new cylinder shaft and the same position as on the old cylinder.
12. Reconnect cylinder to mast assembly in reverse order.
13. Install tilt cylinder hoses into cylinder.
14. Reconnect cylinder rod end to mast, center the cylinder using spacers and shims.
15. When tilt cylinder installation is complete (cylinder is connected to the mast and front plate), remove the strap securing the mast to the overhead guard.
16. Readjust tilt cylinder/mast racking. See "Check Tilt Cylinder Racking," in Chapter 2, page 2-10, Planned Maintenance.

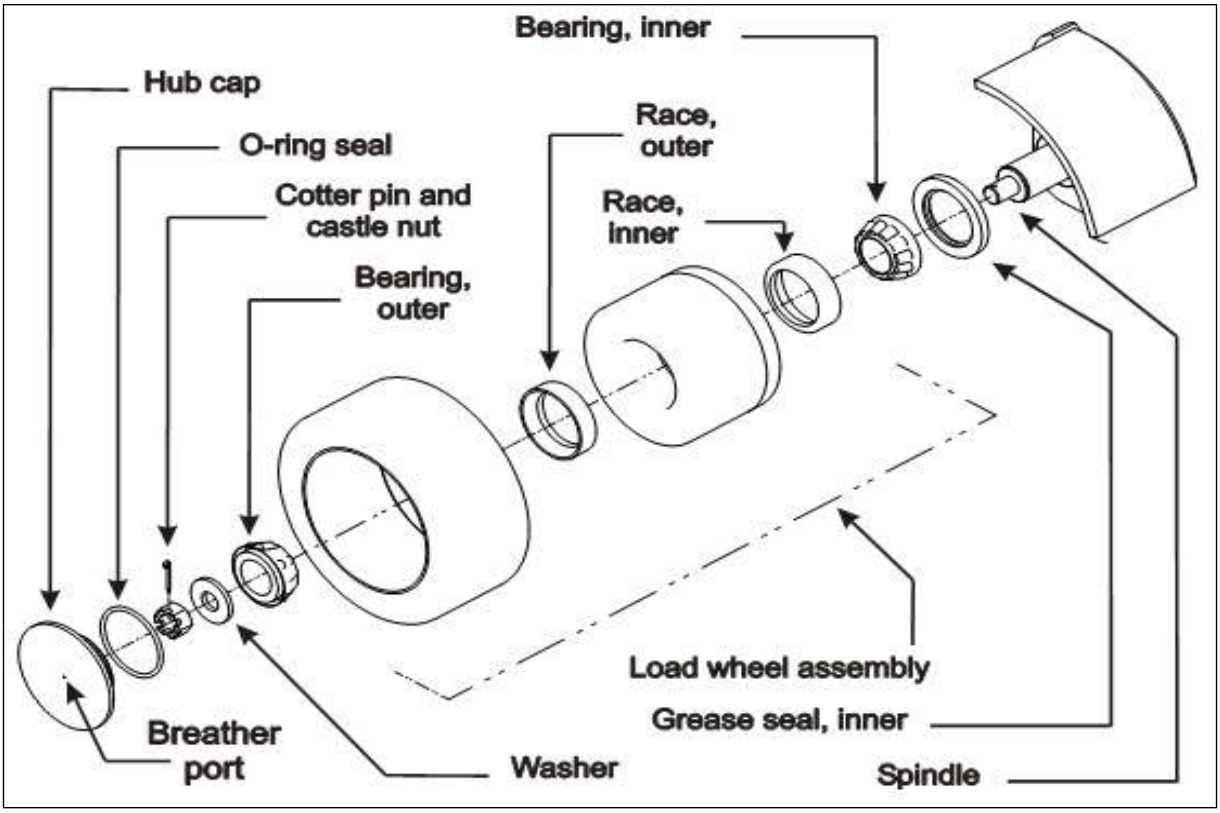

Figure 3-7: Wheel Bearings, Seals and Race

Wheel Bearings, Seals and Race

1. First, review "Before You Begin," page 1-1.
2. **See Figure 3-7**.
3. Set the key switch to "OFF" and remove the key from the ignition switch.
4. Apply the parking brake and disconnect the battery.
5. Make sure all the wheels are securely blocked so that the truck cannot move.
6. Lift and support the truck so that the wheel being serviced is clear of the floor by no more than 1" (25.4 mm). Review "Lifting the Truck," on page 1-5.
7. Remove the wheel rim cover (hub cap) and clean excess grease from around the spindle.
8. Remove the cotter pin.
9. Unscrew the hex slot nut (use open-end wrench) and remove the nut and spindle washer.
10. Pull the wheel rim out slightly to release the outer bearing cone.
11. Remove the outer bearing cone. Then, pull the wheel from the spindle.
12. Turn the tire over, face down, to remove the inner bearing cone and inner grease seal. Pry the old grease seal from the wheel. Note how the seal is installed.
13. Remove the inner bearing cone.
14. Use a punch to tap out the front inner bearing cup (race).
15. Turn the wheel over and remove the outer bearing cup (race).

NOTE

The bearing cone and bearing cup (race) are a matched set and must always be replaced as a set.

16. Use an approved solvent to remove all traces of old grease from the bearings, wheel rim and spindle. Allow the parts to air dry. Also see “Cleaning and Inspection,” on page 1-6.
17. Inspect the bearing for cracks, heat discoloration, worn rollers, etc. Check the bearing race for wear and/or damage.
18. Install a new inner and outer bearing cup (race) (one each) in the wheel rim. A seal and race tool is recommended to press in the race.

NOTE

Take care to apply an even force to the bearing cup (race) to prevent cracking during installation. Be sure that each bearing cup (race) is fully seated (bottomed out) against the shoulder in the bore.

19. Pack the bearings with high-temperature bearing grease making sure the grease penetrates the rollers, cone and cage from the back side. See page 1-17 for recommended lubricants.
20. Also apply a thin coat of grease to the spindle at the outer bearing seat and to the inner surfaces of the race.
21. Place the grease-packed inner bearing cone into the rear of the wheel and apply a little grease around the outer edge of the bearing.
22. Place the new grease seal over the inner bearing cone and tap the seal *evenly* into place using the seal and race tool. The seal must be flush with the wheel rim.
23. Carefully install the wheel rim to the spindle, push the outer bearing cone into position, and install the spindle washer and hex slot nut.
24. Support the wheel rim to avoid dragging the inner grease seal across the threads on the spindle.
25. Tighten the nut only slightly. Spin the wheel in a forward direction to seat the bearings and remove any excess grease.
26. While spinning the wheel, tighten the hex slot nut to the specified torque (22 ft. lbs./30 Nm.). See page 1-17 through page 1-19 for recommended torque specifications.
27. Loosen the nut 1/2 turn - no more, then tighten the nut again and torque as needed.
28. Insert a new cotter pin. Back-off the nut slightly as needed to align the notches to the hole in the spindle.
29. Install the hub cap and road test the truck before placing it back into operation.

Front Axle Assembly

To Check Load Wheels

1. First, review “Lifting the Truck,” beginning on page 1-5.
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 noticeablemovement, the bearings should be checked and then repacked with greaseand/or replaced.

WARNING

- **The truck is equipped with tires of a size and hardness that provide the necessary traction and maintain proper shape to prevent tipping.**
- **To maintain stability and maximum reliability, you must always replace tires with the type originally supplied, Landoll P/N 130741(Load Wheels) and refer to Sales Order for Drive Wheels Part Number.**
- **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.**

Removing the Front Axle

NOTE

It is recommended that in using an overhead crane and another forklift:

1. Review “Before You Begin,” page 1-1.
2. Review “Lifting the Truck,” page 1-5.
3. Park the truck on a clean, flat, level surface with enough room to work in the area safely. Keep in mind that another forklift will be used from the front.
4. Connect a strap from overhead crane to the top center cross member of the mast. See Strap Figure on page 3-18.
5. Remove the forks.
6. Using the overhead crane, raise the front of the truck off the ground to get the mounting block bolts loosened, but do not remove them yet.
7. Put the forks of another forklift underneath the front axle assembly.
8. Using the overhead crane, raise the front axle assembly off the ground approximately 6-8 inches. The lower the front axle assembly is raised off the ground, the easier it is to remove.

9. Slowly lower the front axle assembly onto the forks of the extra forklift.
10. Using a “C” clamp, clamp the axle to the forks.
11. Remove the 1-8 x 5 hex head cap screws. **See Figure 3-8.** Lift the mast up enough to remove the front axle assembly out from underneath the forklift.
12. After servicing, reassemble front axle assembly to truck by reversing instructions.

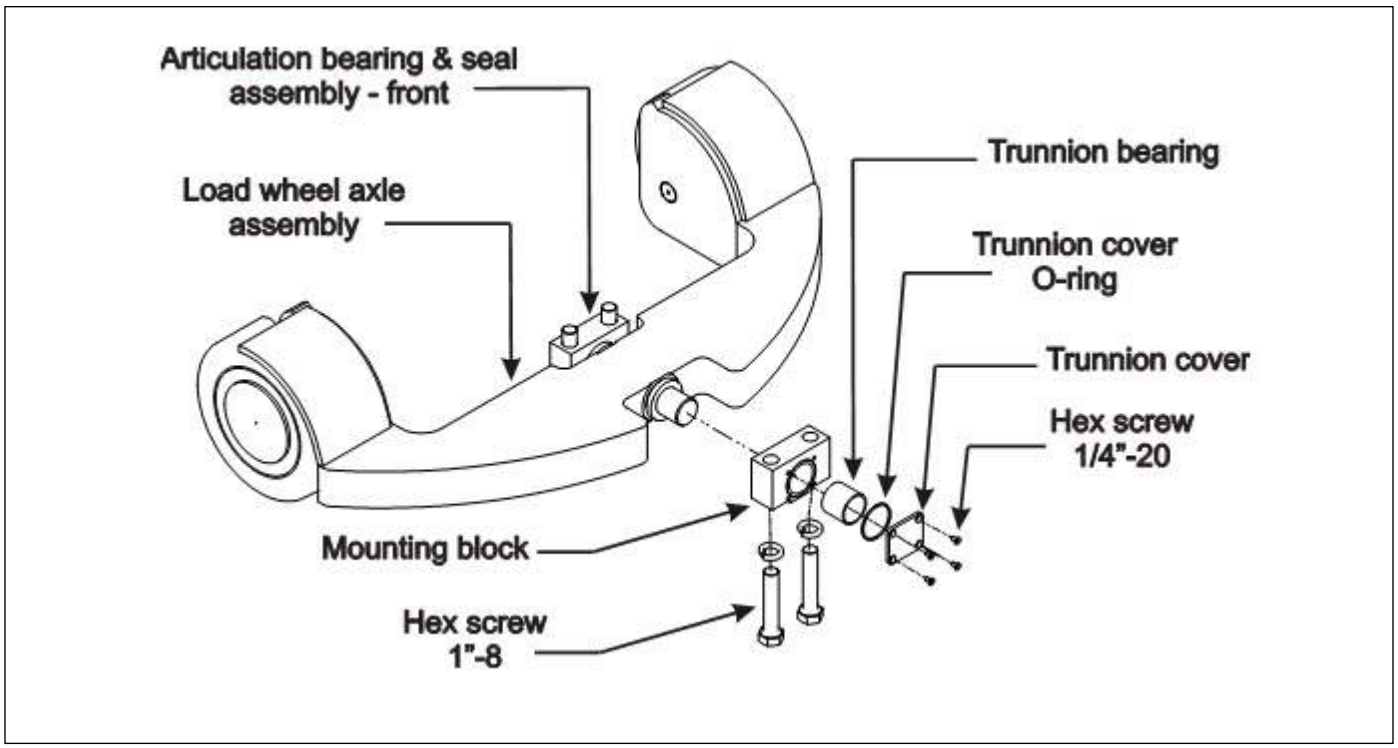

Figure 3-8: Front Axle

Articulation Bearing and Seal

1. Review “Before You Begin,”page 1-1.
2. Remove front axle assembly. See “Removing Front Axle” above.
3. Support the truck and the mast assembly.
4. Place the front axle assembly on work stands capable of supporting the load.
5. Remove the O-ring seal and clean off all grease. Examine seal for damage - replace accordingly.
6. Remove the from the front axle. **See Figure 3-8**.
7. At your work bench, remove the bearing from the block.
8. When reassembling, this bearing is a maintenance free dry bearing. No grease is needed during assembly, be certain the O-ring seals are properly installed.

Front Rotation Assembly

This section explains servicing the:

~ **Steering Actuator**.

~ **Stop blocks**.

~ **Steer potentiometer**

You will need a 2 to 3 ton (1,814-2,722 kg.) overhead crane to support the mast and/or the front end weldment, when you separate it from the truck front rotation arm. You will also need hydraulic jacks or large block of wood and a portable hydraulic press.

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

Removing the Steering Actuator

NOTES

Before any assembly or disasembly of components, clean actuator shaft ends and coupling pockets in mount plates using brake parts cleaner

DO NOT use anything containing molybdenum disulphide.

1. First, review “Before You Begin,” page 1-1.
2. Park the truck on a clean, flat, level surface with enough room to work in the area safely.

3. Apply the parking brake and block all wheels.
4. Relieve hydraulic pressure in the system by turning the steering wheel two times to the left, then two times to the right and move both joysticks in both directions.
5. Set the key switch to “OFF” and remove the key.
6. Support the front end of the truck (between the front rotation arm and the truck frame) using support stands or blocks of wood capable of handling the weight.
7. Connect a strap from the overhead crane around the top center cross member of the mast and apply slight tension only. See Strap Figure on page 3-18. Also see “Removing the Mast From the Truck,” on page 3-18.
8. Remove the steering potentiometer, potentiometer bracketand potentiometer rod.
9. Remove all screws in the top Ringfeder bearing. Screw these into thier adjacent threaded holes to push-off the outer ring.
10. Remove the bearing and set aside on a clean surface.
11. Remove the upper bearing spacer and pry bearing upwards.
12. Remove the four hex head screws holding the Upper actuator mount in place and remove mount.
13. Repeat step 9, 10 and 11 for the bottom Ringfeder bearing.
14. Remove hoses and cap to prevent spills.
15. Replace or repair the actuator and reassemble in reverse order.

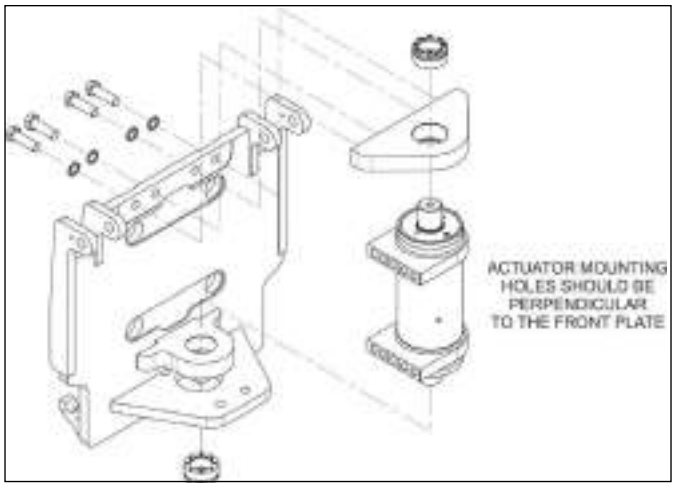

Figure 3-9: Rotation Assembly

Hints for Reassembly

1. To install the actuator, you must align all parts. The overhead crane may have to be adjusted a fraction of an inch to allow the actuator to slide in place.
2. Remember to install the bottom spacer before you move the front end weldment back into place.
3. Starting at the top of the assembly, carefully install the steer actuator. Align the shaft bottom through hole to the hole in the front plate weldment yoke. **See Figure 3-9**
4. Port P2 should be above port P1.
5. The Ringfeder bearings should be completely bottomed out in their respective pockets. If they aren’t, reposition as necessary.
6. Tighten all ringfeder locking screws alternating sides (like a car’s lug nuts) and torque to 30 ft lb (40.7 Nm).
7. Loosen plugs in P1 and P2 and slowly rotate the actuator 90°, until the ports face directly forward (towards the mast) and retighten P1 and P2.
8. Install the 3/4-16 hex head screw and hardware. Tighten and torque accordingly, see page 1-19.
9. Install the top portion of the assembly. Tighten and torque accordingly, see page 1-19.
10. Apply additional grease at the two grease fittings. See page 1-16 for recommended lubrication.

Stop Block

The rotation stops act as a cushion when the front end is turned the full 180° in either direction, See Figure 3-10 The rotation stop is replaced by simply removing the hex socket screw (3/8”-16).

Figure 3-10: Stop Block

Steer (Front Rotation) Pot

The steer (front rotation) sensor potentiometer is replaced as a complete unit and is electrically checked, **See Figure 3-11**.

For any troubleshooting and calibration information, see Chapter 4**.**

Figure 3-11: Front Rotation Potentiometer

To Center the Steer Pot

1. Loosen 10-32 x 3/4 hex head cap screws connecting steer pot bracket to rotation switch bracket.
2. Adjust steer pot bracket until centered over the potentiometer drive rod, located in the top of the front rotation shaft. **See Figure 3-11**.

NOTE

Once centered you must calibrate the pot, see Dash Display Operation and Calibration in Chapter 4 on page 4-16.

3. Tighten down the set screw.

To Adjust and/or Replace the Steer Pot

1. First, review "Before You Begin," page 1-1.
2. Position the forks (mast) straight ahead.
3. Set the key switch to "OFF" and remove the key.
4. Disconnect the battery.
5. Remove the plastic front rotation cover to expose the internal gearing and steer rotation pot assembly.
6. Loosen the two #10-32 X 3/4 hex head cap screws and "evenly" position the steer rotation pot assembly until rotation pot is centered over the potentiometer drive rod, located in the top of the rotation shaft. **See Figure 3-11**.
7. If the pot is being replaced, disconnect the electrical connector and remove the #8-32 x 1-1/2 round head bolts and hardware.
8. Install the new pot assembly in reverse order.
9. Tighten and torque the screws accordingly, refer to torque specification charts beginning on page 1-17.

Auxiliary Pump - Steer and Lift Circuit

The auxiliary pump is located at the end of the hydrostatic pump (toward the front of the forklift).

The pump supplies fluid to the load sense/fan control valve. This valve controls the flow to the steering circuit based on demand, and the cooling fan according to a signal from the vehicle controller. Excess flow is sent to the mast hydraulic valve for use on mast functions. **See Figures 3-12** and **3-14**.

Replacing the Auxiliary Pump - Steer and Lift Circuit

1. First, review "Before You Begin," page 1-1.
2. Set the key switch to "OFF" and remove the key from the ignition switch.
3. Apply the parking brake, disconnect the battery and block the wheels.
4. Relieve pressure in the system by turning the steering wheel two times to the left, then two times to the right and move the controls in both directions.
5. Remove the floor plate cover. See "Floor Plate Removal," page 3-16.

IMPORTANT

If the pump requires servicing, disconnecting the suction line hose will cause excessive oil drainage from the hydraulic tank.

To limit the amount of drainage:

- You can empty the hydraulic tank, particularly when an oil and oil filter change is due or if dirty oil is suspect with a pump failure.
- You can remove the oil filler cap located on the truck. Then have a helper hold an shop vacuum over the filler opening to create a "partial" vacuum in the tank. It is not necessary to seal the opening tight. Wrapping your hand around the opening is sufficient.

6. Remove hose assemblies.
7. Remove the 2 mounting bolts of the pump. **See Figures 3-12** and **3-14**.

NOTE

Immediately plug and cap all tube ends and pump ports and tag each for identification. Have shop rags ready to manage spills.

8. Remove top bolt and slide out the pump.
9. Remove and replace fittings in the new pump.
10. Reinstall in reverse order.

Figure 3-12: Auxiliary Pump Mounting Bolts

Figure 3-13:

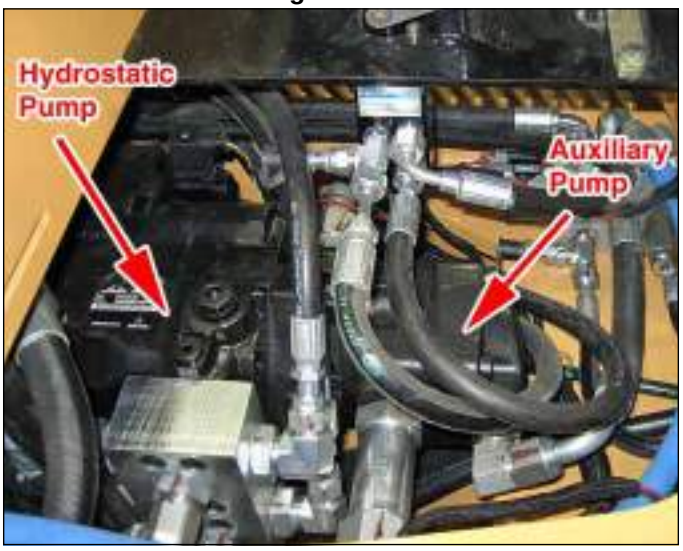

Figure 3-14: Pump Locations

Drive and Brake Pedals

Replacing the Drive (Accelerator) Pedal Assembly

1. First, review “Before You Begin,” page 1-1 and **See Figure 3-15**.
2. Set the key switch to “OFF” and remove the key.
3. Apply the parking brake, disconnect the battery and block all wheels.
4. Remove the driver’s compartment floor plate. See “Floor Plate Removal” on page 3-16.
5. Raise the floor panel as far as possible and disconnect the accelerator cable connector from the main harness.
6. Remove the nuts holding the throttle (accelerator) assembly.
7. Recalibrate using the Dash Display. See Chapter 4 for throttle pot calibration.

Figure 3-15: Drive Pedal

Stop Pedal/Park Brake Assembly

Spring Applied Hydraulically Released Brakes

The SAHR brakes are inherently self-adjusting. No adjustments are necessary or provided.

Stop Pedal

The stop pedal has about 1" maximum free-play before the pressure is removed from the brake system causing the brakes to lock-up.

The pedal also has a maximum travel range of up to only 2” (50.8 mm). Depressing the pedal the full distance allows the operator to set the park brake using the latch that is mounted on the pedal. **See Figure 3-16** Setting the park brake releases the fluid from the circuit to open the normally closed brake pressure switch. Brake lights are controlled through the vehicle controller based on operator inputs.

Figure 3-16: E-Brake/Stop Pedal

Checking the Park Brake efficiency

1. Move the truck to a level location and turn the key switch “OFF” shutting off the truck.
2. Disconnect the brake release line from the release pump located near the battery.
3. Cap the fitting on the release pump with a #6 ORS cap.
4. Start the truck.
5. Attempt to drive the truck forward.
6. The truck must not move. If the truck does move the brakes need service.

Steering Column and Console Assembly

Satisfactory performance of any hydraulic steering system requires a well-engineered installation.
The hydraulics must meet the design features of the vehicle and contribute to the operation for which the vehicle was built.
Make no changes to the steering system without first consulting qualified Landoll factory service personnel.
The section below explains the procedures to replace the steering wheel and the steering column, pump and motor:

1. Before disassembling or disconnecting any part of the system, thoroughly clean off all outside dirt, especially from around fittings and tube connections.
2. First, review “Before You Begin,” page 1-1.
3. Set the key switch to “OFF” and remove the key from the ignition switch.
4. Apply the parking brake and disconnect the battery.
5. Make sure the other wheels are securely blocked so that the truck cannot move.

The console assembly includes the following:

- LCD Dash Display which shows;
    1. Engine Temp
    2. Fuel Level
    3. Truck hours
    4. Warning Lights
- Headlights rocker switch (where fitted).
- 1 Option rocker switche (where fitted).
- 1 rocker switch saved for future use.
- Tilt steering lever
- Key switch.

6. The above parts are accessed by removing the right side steering assembly cover (black) - seven (7) screws and hardware.

Steering Wheel

1. Pry the plastic cover from the steering wheel using your finger tips. If you cannot grab the cover, using a medium sized flat blade screw driver carefully and gently prying upwards. **DO NOT** force, it may 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, use an automotive-type puller. 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, remember the tighter the nut, the more difficult it will be to remove later.

Figure 3-17: Steering and Column Assembly

Remove Right Side Cover

1. First, review "Before You Begin," page 1-1.
2. Set the key switch to "OFF" and remove the key from the ignition switch.
3. Apply the parking brake and disconnect the battery.
4. Make sure the other wheels are securely blocked so that the truck cannot move.
5. Loosen the Allen set screw in the tilt steering lever and remove the lever from the stem. **See Figure 3-17**.
6. Remove the four large screws and hardware marked (**A**). **See Figure 3-17**.
7. Remove the three right side top cover screws and hardware marked (**B**). **See Figure 3-17**.
8. Pry the bellows (rubber boot) free of the steering column cover.
9. Remove the right side cover to expose the internal components of the steering column.

Display

1. Repeat preceding section "Remove Right Side Cover".
2. Remove the four screws securing the dash panel to the steering console.
3. Reach inside the steering column and disconnect the appropriate display wire connectors from the main wire harness, then lift the panel out.
4. Install the new display by reversing the above steps.
5. Connect the wire connector to the wire harness and close the steering column by reversing the steps outlined in section "Remove Right Side Cover".

Key Switch

1. Repeat preceding section "Remove Right Side Cover" on page 3-28.
2. Reach inside the steering column and disconnect the appropriate switch connector from the main wire harness.
3. Unscrew the knurled switch collar ring to separate the switch from the base plate. **See Figure 3-18**.
4. Disconnect the wires from the switch terminals noting how they are connected to ensure proper orientation when connecting the new switch.

NOTE

If you are replacing the wire harness, disconnect the two leads on the steering column, again noting orientation and disconnect the cable connector.

5. Install the key switch and/or wire harness by reversing the preceding steps.

6. Close the steering column by reversing the steps outlined in section “Remove Right Side Cover,” on this page.

Figure 3-18: Key Switch

Option Rocker (On/Off) Switches

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

1. Repeat preceding section “Remove Right Side Cover,” beginning on this page.
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 knurled 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 3-19**.

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 installing the new rocker switch.
5. Insert the replacement switch in the slot and hold the wings 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 Right Side Cover”.

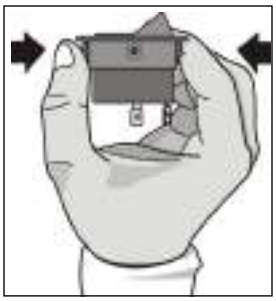

Figure 3-19: Rocker Switch

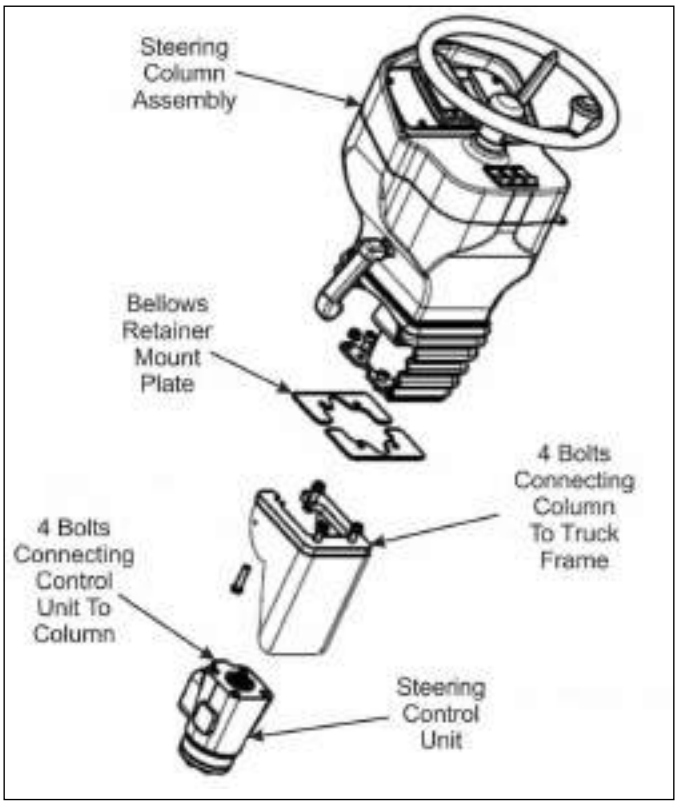

Figure 3-20: Steering Column

Steering Column (Console)

NOTE

This is a two man operation, due to weight of steering column (approximately 30 pounds/66 Kgs.). If an overhead crane is available, the crane could be strapped to the steering wheel for support.

1. Remove the driver’s compartment floor plate. See "Floor Plate Removal," on page 3-16.
2. Disconnect the two plugs that connect the dash harness to the main harness and any optional lighting harnesses.
3. Relieve hydraulic pressure in the system by turning the steering wheel a few times to the left and right.

4. 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 4**.

IMPORTANT

Four bolts secure the assembly to the orbital steering mount bracket for stability. Once removed the unit is supported by the hydraulic tubing only. Exercise care not to apply excessive force and bend the tubing.

5. Remove the plastic front rotation cover to expose the orbital control unit.
6. Remove the four bolts and hardware securing the orbital control unit to the steering column.
7. Remove the four bolts and hardware securing the steering column (console) to the bellows retainer plate. Two bolts are accessed through the cutout in the main frame (access opening).
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, you must turn the steering shaft 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 General Torque, page 1-17.

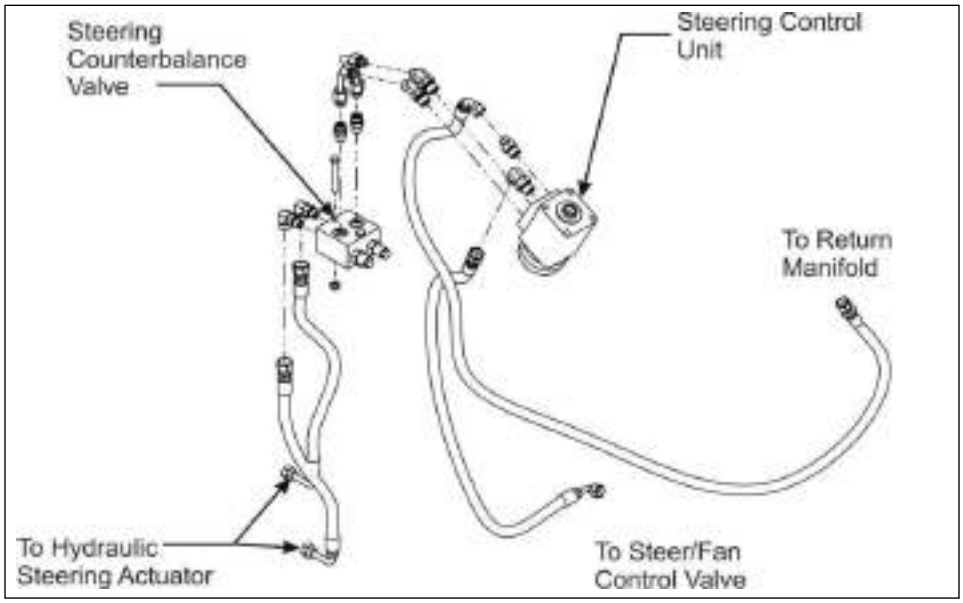

Figure 3-21: Steering Hydaulic Lines

Orbital Steer Unit

1. Repeat Steps 1 through 5 of preceding section “Steering Column (Console)”, beginning on page 3-27.
2. Tag the port locations of each hydraulic line and fitting, then disconnect the four lines from the unit. **See Figure 3-21**.
3. If the unit is being replaced, or the fittings are defective, notice the placement (angle) of the hose fittings then remove them. Thread them into the new steering control unit (or replace).
4. Immediately cap the ports in the control unit to prevent oil spills.
5. Install the new steering control unit to the steering column by following the preceding steps in reverse order.
6. Check oil level in the hydraulic tank and fill as needed. See "Hydraulic System Maintenance," in Chapter 2 Planned Maintenance, page 2-9.

Load Sense Steering System

The Bendi Lift truck uses a load sense priority flow control to meter hydraulic oil flow to the steering system. As the operator turns the wheel, a fluid signal from the steering control unit(orbital), shifts a load sense valve in the hydraulic circuit prior to the truck main control valve. This valve meters fluid from the main circuit to the steering orbital as needed. This system provides fluid to the steering system as needed and allows the fluid to flow back to the tank at low pressure when the steering is not needed, reducing power consumption.

Steering Counterbalance Valve

The steering counterbalance valve manifold is located under the front plastic gear cover.

The following procedure explains how to replace the steering counterbalance valve manifold should a sluggish or sticking valve cartridge be suspect.

IMPORTANT

If you remove the manifold from the truck for servicing (hex head screws and hardware), when reinstalling the manifold be certain to tighten the mounting screws in a staggered fashion while applying *equal* pressure to all screws. If the screws are not tightened and torqued evenly, you could create a stress crack, thus internal oil leaks, rendering the manifold defective.

1. First, review "Before You Begin," page 1-1.
2. Set the key switch to "OFF" and remove the key from the ignItion switch.
3. Apply the parking brake, disconnect the battery and block the wheels.
4. Relieve pressure in the system by turning the steering wheel two times to the left, then two times to the right and move the control levers in both directions.
5. Remove the plastic gear cover.
6. Disconnect tubing at the adapters and immediately plug/cap all lines. Have shop rags handy to manage spills.
7. Remove the adapters from the defective manifold and note their alignment, then remove the mounting hardware (5/16-18) and replace the manifold.
8. Clean the mating surfaces of the valve spools and make sure the O-ring seal is properly seated before sealing the parts together.
9. When installing fittings, apply a light film of oil to the O-ring seal and do not overtighten. Excessive pressure could damage the seals.
10. Install manifold - see "**IMPORTANT NOTE**," on previous page.
11. Reassemble in reverse order.
12. Before placing the truck back into operation, test it to make sure all functions are operating properly and that there are no oil leaks.

Hydraulic Control Valve Assembly

General

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 in front of the drivers arm rest, under the control levers. **See Figure 3-22**.

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

IMPORTANT

If you remove the valve from the truck for servicing (hex head screws and hardware), when reinstalling the valve be certain to tighten the mounting screws in a staggered fashion while applying *equal* pressure to all screws. If the screws are not tightened and torqued evenly, you could create a stress crack, thus internal oil leaks, rendering the valve defective.

The main hydraulic pump for lift, tilt and shift (mast functions) is a single cavity pump (5 gpm). System pressure varies from 2,650 psi, ±65 psi (18 MPa, ±0.45 MPa) minimum, up to 3,000 psi, ±65 psi (21 MPa, ±0.45 MPa) maximum. Actual pressure is determined by mast size, load requirements and lift speed.

- Check with your Landoll service representative for actual settings.
- The main pump pressure relief valve is located in the hydraulic control valve, which is located beneath the control valve cover, in front of the driver's arm rest. **See Figure 3-22**.
- A pressure gauge port is provided, with a "quick-coupler," Pressure Service Kit, Landoll p/n: 0018152, for reading the main pump pressure. **See Figure 3-4**.

NOTE

Before you service 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 hydraulic oil should be at warm operating temperature.

Also see "Mast Systems," in the Bendi B40i4 Operator's Manual F-580 for additional circuit information.

To Check and/or Adjust Control Valve Pressure

1. First, review "Before You Begin," page 1-1.
2. Set the key switch to "OFF", remove the key from the ignition switch 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 (21 MPa) pressure gauge, hose and quick-coupler.
4. If you are using your own system, have shop rags and a small container handy to collect oil spills.

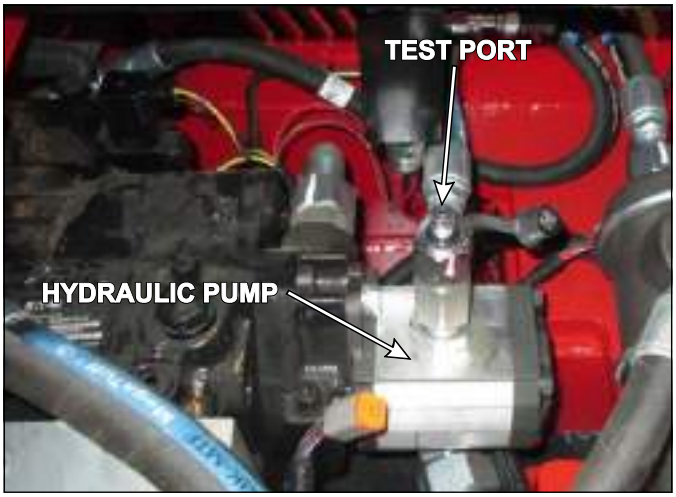

Figure 3-22: Test Port

5. Operate each function of the control valve briefly to relieve system pressure - allow oil to drain. Connect the pressure check kit quick-coupler (female end) to the coupler (male end) on the test port on the auxiliary pump.
6. If you are not using the pressure check kit, remove the quick-coupler and install an appropriate fitting to accept your pressure gauge arrangement.
7. Have rags handy to manage oil leakage.
8. Install your 3,000 psi (21 MPa) pressure gauge arrangement to the tee fitting.

⚠ CAUTION

- **All parts connected to the gauge port must be capable of handling up to 3,000 psi (21 Mpa).**
- **To adjust pressure, the truck (pump) must be running to create hydraulic pressure.**
- **Always pay attention and use caution when servicing the truck while it is running.**

9. Start the truck.
10. To check and/or set pressure, you must pull the tilt lever to bottom out (dead head) the cylinders and build pressure, then set the relief valve.

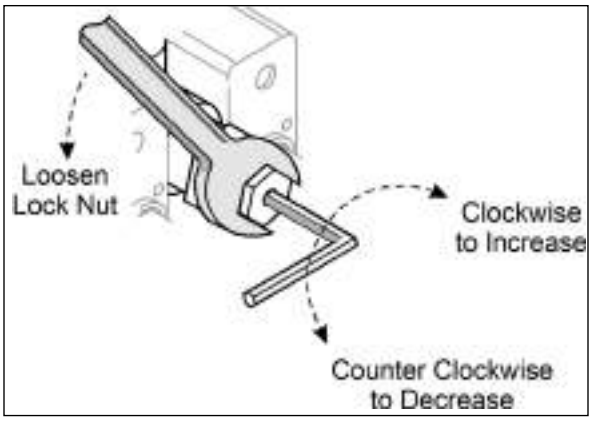

Figure 3-23: Relief Valve

11. Loosen the relief valve jam nut. **See Figure 3-23**
12. Adjust the valve stem by turning clockwise to increase pressure, counterclockwise to decrease pressure. **See Figure 3-23**.
13. Release the control lever immediately once the pressure is set (2,600 psi, + 65 psi, - 0 psi; 18 MPa, + 0.45, - 0 MPa minimum, up to 3,000 psi; 21 MPa, + 0.45, - 0 MPa).

IMPORTANT

DO NOT hold the control lever (bottomed out) for long periods of time. Excessive pressure is applied to the circuit which can, over long periods of time, damage internal components, overheating the hydraulic oil.

14. 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.
15. If the pressure is too high and cannot be adjusted to the proper value, replace the relief valve.
16. Tighten the relief valve jam nut.
17. Set the key switch to "OFF", remove the key from the ignition switch and disconnect the battery.
18. Operate the function control levers briefly to relieve system pressure - allows oil to drain.
19. Remove the pressure gauge quick- coupler, or remove your gauge arrangement and install the quick- coupler.
20. Start the truck.
21. Lift and lower the mast from a few feet a few times to check the hydraulic system for leaks.
22. Set the key switch to OFF and disconnect the battery.
23. Reassemble all items previously removed.

Hydraulic Control Valve

1. First, review “Before You Begin,” page 1-1.
2. Set the key switch to “OFF” and remove the key from the ignition switch.
3. Apply the parking brake, disconnect the battery and block the wheels.
4. Relieve pressure in the system by turning the steering wheel two times to the left, then two times to the right and move the control levers in both directions.
5. Remove the control valve cover to expose the hydraulic control valve. **See Figure 3-22**.
6. Determine the suspect valve spool and remove it from the hydraulic control valve and locate where the leak is occurring and/or determine which valve spool is defective. **See Figure 3-4**.

NOTE

All valves include external O-ring seals which are serviceable. However on pressure valves the internal mechanism is not serviceable and must be replaced as a complete unit.

7. Disconnect the control levers (three) from the valves and tag the levers for identification.
8. Disconnect hoses at fittings and immediately plug or cap all lines. Tag the lines for identification during reassembly.
9. Remove the two hex nuts and hardware holding the valve assembly to the truck base. Lift the valve from the truck and place it on your workbench. It is heavy so be prepared.
10. If a valve is being replaced, remove the hydraulic fittings from the defective valve and note how the fittings are arranged.
11. Before placing the truck back into operation, test it to make sure all functions are operating properly and that there are no oil leaks.
12. If the hydraulic control valve manifold is being replaced:

- Clean the mating surfaces of the valve spools and make sure the O-ring seal is properly seated before sealing the parts together.
- Disconnect hoses at the fittings and immediately plug/cap all lines. Have shop rags handy to manage spills.
- Remove the fittings from the defective valve and note their alignment, then remove the mounting hardware and replace the valve.
- Install the fittings in the replacement valve maintaining proper alignment.

IMPORTANT

When reinstalling the valve be certain to tighten the mounting screws in a staggered fashion while applying *equal* pressure to all screws. If the screws are not tightened and torqued evenly, you could create a stress crack, thus internal oil leaks, rendering the valve defective.

- When installing fittings, apply a light film of oil to the O-ring seal and do not overtighten. Excessive pressure could damage the seals.
- If the pressure relief valve is being replaced, you must readjust the pressure setting before operating the truck. See "To Check and/or Adjust Pressure," below.
- Reassemble in reverse order.

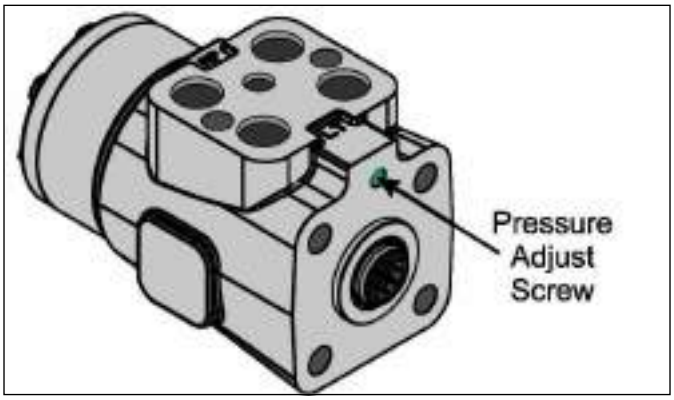

Figure 3-24: Pressure Adjustment Screw

Steer System Relief Valve

The Bendi B40i4 is equipped with a load sense power steering system. This system only uses the fluid that is required by the steering system. The relief valve for the steering system is found in the steering orbital (See Figure 3-24) where the orbital connects to the steering column. The hole that the screw is recessed into comes filled with easy to remove plastic which must be removed to access the pressure adjust screw. Power steering pressure is set at 1900 psi ±65 psi (18 MPa, ±0.3 MPa). A pressure gauge port is provided, with a “quick-coupler,” (pressure service kit, Landoll p/n: 0018152) for reading the steer pump pressure.

NOTE

Before you service 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.

To Check and/or Adjust Steer Pump Pressure

1. First, review “Before You Begin,” page 1-1.
2. Set the key switch to “OFF” and remove the key from the ignition switch.
3. For ease in checking pressure Landoll Service offers a Pressure Check Kit (p/n: 0018152) which includes a 3,000 psi (21 MPa) pressure gauge, hose and quick-coupler).
4. If you are using your own system, have shop rags and a small container to manage spills.
5. Turn the steering wheel briefly from one side to the other to relieve system pressure - allow oil to drain.
6. Connect the pressure check kit quick-coupler (female end) to the coupler (male end) on the control valve.
7. Start the truck.

⚠ CAUTION

To adjust pressure, the truck (pump) must be running to create hydraulic pressure. Always pay attention and use caution when servicing the truck while it is running.

8. Turn the steering wheel fully to the right and hold the wheel to allow pressure buildup. The pressure reading must be 1900 psi, 65 psi (18 MPa, ±0.3 MPa) maximum.
9. Release the steering wheel.

IMPORTANT

DO NOT hold the steering wheel (bottomed out) for long periods of time because excessive pressure is applied to the circuit which can, over long periods of time, damage internal components.

10. Remove the cap from the hex adjusting screw, turning the screw clockwise increases pressure or counterclockwise to decrease pressure.
11. Tighten locknut after adjustment.
12. 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.
13. If the pressure is too high and cannot be adjusted to the proper value, replace the steering orbital.
14. Turn the steering wheel from one side to check the hydraulic connections for leaks.
15. With pressure set at 1900 psi, +/- 65 psi (18 MPa, ±0.3 MPa) maximum, set the key switch to “OFF”.

Hydrostatic Pump

Charge Pressure Check

NOTE

- *A 600 psi gauge must be used for an accurate reading (Landoll p/n 133929). Internal repairs cannot be done to the hydrostatic drive. The entire unit must be replaced. If the Bendi B40i4 is exhibiting diminished gradibility or reduced top speed, then one must examine the hydrostatic drive system.*

The hydrostatic transmission is a system consisting of a pump and two wheel motors. If conditions exist that indicate wear within any single component, Landoll Corporation recommends that all components be replaced. This practice will ensure that repairs made to the lift truck will result in a productive machine.

1. Connect gauge to test ports at the brake valve. **See Figure 3-25**.
2. Start the engine and allow the B40i4 truck to run for approximately 15 minutes to warm the hydraulic oil to 150 degrees, by viewing the thermometer found in oil level sight glass on side of tank.
3. Monitor the charge pressure. If pressure is below 250 psi (17 bar), replace drive filter (p/n:146356).
4. Monitor charge pressure after a filter change. If pressure is still below 250 psi (17 bar) problems exist within the drive system. To further verify that the drive system needs repair/replacement, place the forklift against an immovable object. Monitor charge pressure while slowly depressing the accelerator pedal. If charge pressure decreases with increased load, the drive system must be replaced.

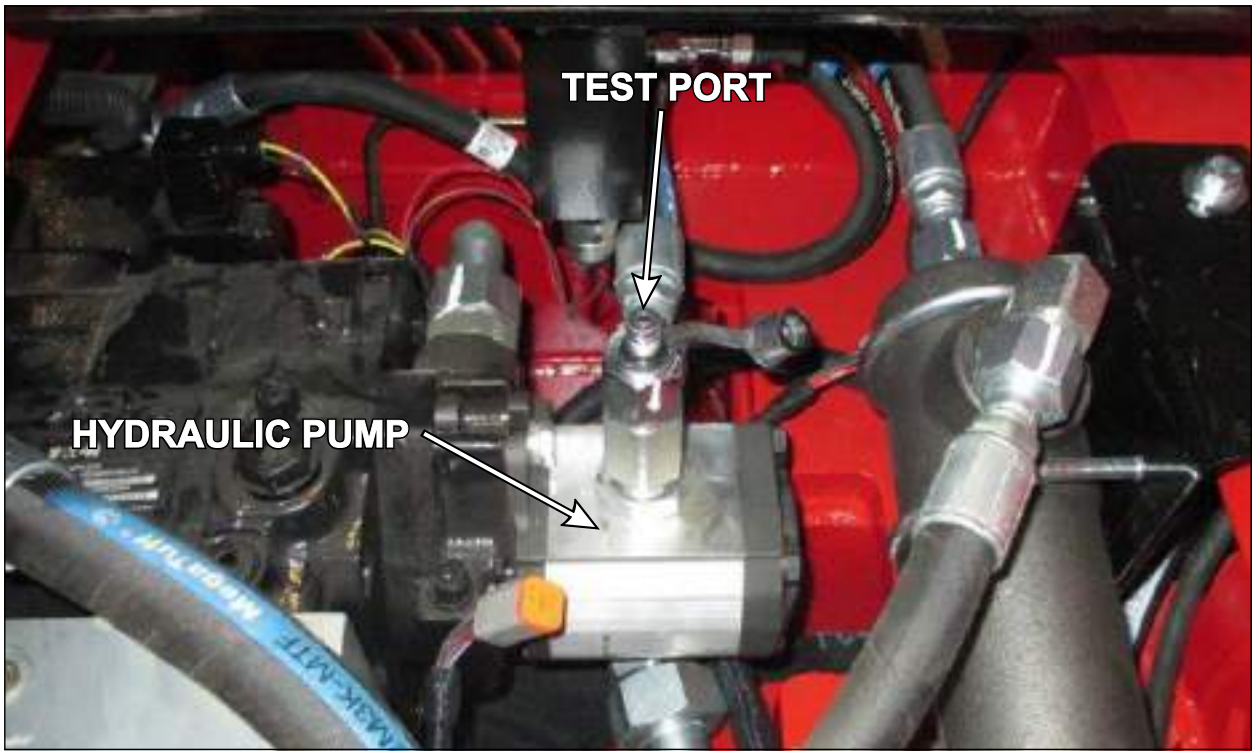

Figure 3-25: Charge Pressure Test Port

To Remove and Replace the Hydrostatic Pump

1. First, review “Before You Begin,” page 1-1.
2. Set the key switch to “OFF” and remove key from the ignition switch.
3. Apply the parking brake, disconnect the battery and block the wheels.
4. Remove the 3 floor plate covers. See “Floor Plate Removal,” page 2-16.
5. Before removing the hydrostatic pump, clean the area to avoid contamination.

   Any contamination of the pump or hose assemblies could result in failure of new or replaced pump.
6. Remove the auxiliary (steer and lift) pump. See "To Replace the Auxiliary Pump (Steer and Lift Circuit)", page 3-25.
7. Remove the high pressure drive manifold. **See Figure 3-25**.

NOTE

Immediately plug and cap all tube ends and pump ports and tag each for identification. Have shop rags ready to manage spills.

8. Remove case drain, check port and suction line hose assembly.
9. Place hand winch between overhead guard and center of pump. Put slight tension on pump.
10. Remove mounting hardware from pump to bell housing.
11. Start to raise winch while prying shaft away from bell housing coupler.
12. Once separated from engine, raise slightly to access and remove charge pressure, pilot and oil shuttle wiring.

NOTE

Be sure to mark all connections.

13. Remove hydrostatic pump.
14. Remove and replace all fittings.
15. Reinstall in reverse order.
16. Be sure to use an anti-seize lubricant on the shaft to the engine.

To Prime the Hydrostatic Pump

CAUTION

This procedure must be done EXACTLY as stated or immediate pump failure will occur. Consult the factory if there is any doubt or questions.

1. Fill both case drain ports with recommended oil that is filtered 10 microns or better. See page 1-17 for recommended lubricants.

2. Connect 600 psi gauge, Landoll p/n 133929, to the **front (right)** pump test port.

   Make sure everything is connected before proceeding as you will be energizing the hydraulic system.

3. **Start engine and let run for no longer than 1 second.**

   It is important to only let the engine fire and to shut it off immediately to remove all captured air in the system.

4. Continue this process until the pressure gauge reads 300 psi. +/- 50 psi. Once reached, your pump is primed and ready for continued running.

NOTE

Newer pumps will be closer to 400 psi when primed, but no less than 275 psi.

To Remove and Replace Hydrostatic Pump Manifold

1. First, review “Before You Begin (Please Read)” on page 1-1.
2. Set the key switch to “OFF” and remove key from the switch.
3. Apply the parking brake, disconnect the battery and block the wheels.
4. Remove the 3 floor plate covers. “Floor Plate(s) Removal” on page 3-16.
5. Clean the area around all hose connections and mounting surfaces.
6. Remove all hoses and fittings from the manifold.
7. Remove the 8 mounting bolts.
8. Remove the manifold, ensuring the 2 O-rings are also removed.
9. Clean the mounting surfaces of the hydrostat and the manifold.
10. Install new Landoll P/N 168279 O-rings lubricated with new, clean hydraulic oil.
11. Re-install manifold to the hydrostat and start all 8 bolts.
12. Snug all bolts in a criss cross pattern working from the center out.
13. Torque all bolts to 100ft./lbs (136 N.m) in the same pattern.
14. Re-install all fitting and hoses torqued to the specifications on ““Torque Specifications” on page 1-17

Hydrostatic Drive Motor Assembly

To Remove Drive Wheels

WARNING

- **The truck is equipped with tires of a size and hardness that provide the necessary traction and maintain a proper shape to prevent tipping.**
- **To maintain stability and maximum reliability, you must always replace tires with the type originally supplied, as listed on the specification sheet.**
- **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.**

1. First, review “Before You Begin,” page 1-1.
2. Set the key switch to “OFF” and remove key from the ignition switch.
3. Apply the parking brake and disconnect the battery**.**
4. Make sure the other wheels are securely blocked so that the truck cannot move.
5. 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 the Truck,” on page 1-5.
6. Remove the 10 hex nuts and hardware. **Figure 3-26 on page 3-36**.

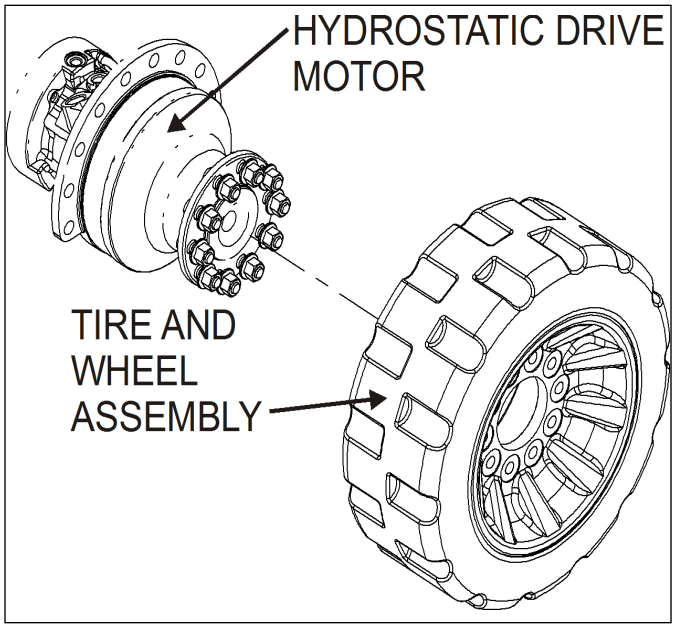

Figure 3-26: Removing Drive Wheel

7. Using an overhead crane and adequate lifting apparatus, remove the wheel. The wheel and tire weigh approximately 100 lbs(45.4 kg.).
8. When installing the new wheel, tighten and torque the ten hex nuts and hardware in a staggered fashion, following the numbering pattern. **See Figure 3-27**.
9. Tighten to 225 ft. lbs. (305 Nm). See Torque Specifications starting on page 1-17.

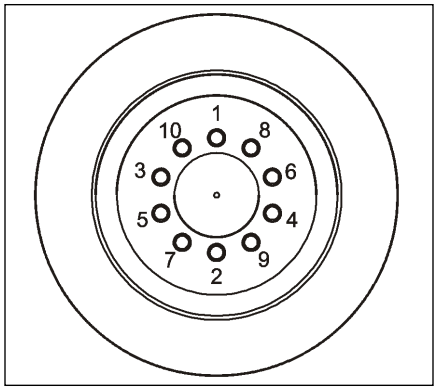

Figure 3-27: Tire Tightening Sequence

Hydrostatic Drive Motors - Rear

This section explains servicing the hydrostatic drive unit.

1. First, review “Before You Begin,” page 1-1.
2. Set the key switch to “OFF” and remove the key from the ignition switch.
3. Apply the parking brake.
4. Make sure all wheels are securely blocked so that the truck cannot move.
5. Raise the side of the truck being serviced 6” to 8” (15 - 20 cm) off the floor surface and support the truck while in this postion. Review previous section “Lifting the Truck,” on page 1-5.
6. Remove the drive wheel assembly on the side being serviced. **See Figure 3-28**.

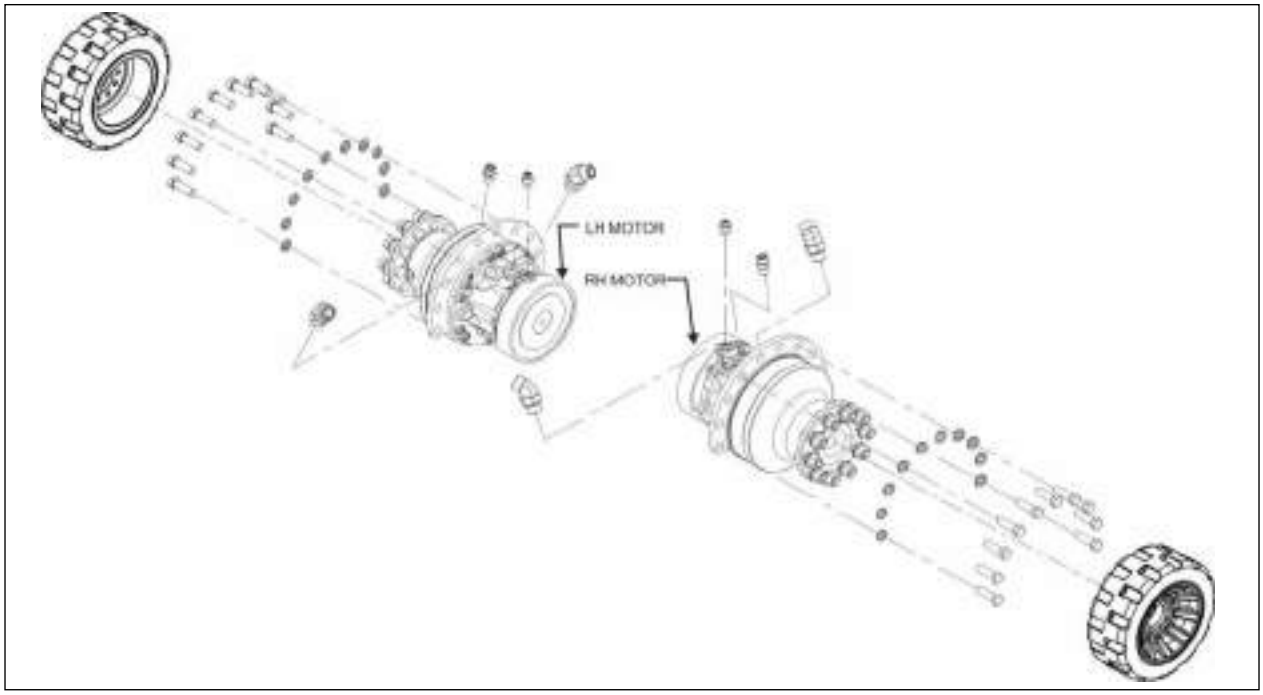

Figure 3-28: Hydrostatic Drive Motor Assembly

To Replace Hydrostatic Drive Motor Assembly

The hydrostatic drive motor assembly is very heavy and awkward to handle. It must be supported using an overhead crane as it is being removed from the truck. **See Figure 3-28**.

1. First, review “Before You Begin,” page 1-1.
2. Connect an overhead crane and strap around the drive motor and apply slight tension to stabilize the unit as the mounting bolts are removed.
3. Remove all external dirt and debris from the area.

NOTE

Immediately plug and cap all tube ends and pump ports and tag each for identification. Have shop rags ready to manage spills.

4. Remove the hose assemblies and fittings.
5. Remove the ten 9/16-18 x 2 hex head cap screws and hardware holding the drive motor to the truck frame. **See Figure 3-28**.
6. Place the drive motor on a sturdy work bench. Use wood planks to balance and support the assembly while on the workbench.

NOTE

When the drive motor must be exchanged, see Bendi B40i4 Model Parts Manual P/N F-579, for an overview and replacement parts.

7. Reassemble the drive motor to the truck by following the preceding steps in reverse order.
8. Tighten and torque the screws. See Torque Specifications starting on page 1-17.

Brake Service and Repair

NOTE

A cover will be required. It is destroyed in the removal process. The Landoll P/N of the cover and seal is 154199.

1. Remove the motor. The hydrostatic drive motor assembly is very heavy and awkward to handle. It must be supported using an overhead crane as it is being removed from the truck. See “To Replace Hydrostatic Drive Motor Assembly” on page 3-37.
2. Place the motor on the bearing support.

NOTE

Protect the studs by re-installing the nuts.

3. Remove and discard the brake cover, item 141. **See Figure 3-29**.

Figure 3-29: Remove Brake Cover

Figure 3-30: Extract O-Ring

4. Extract and discard the O-ring, item 143. **See Figure 3-30**.
5. Compress the spring washer, service kit P/N 157495, item 108. **See Figure 3-31**. Compress the spring using mandrel P/N 157492, with brake service insert P/N 156198.

Mark the mounting direction of the snap ring.

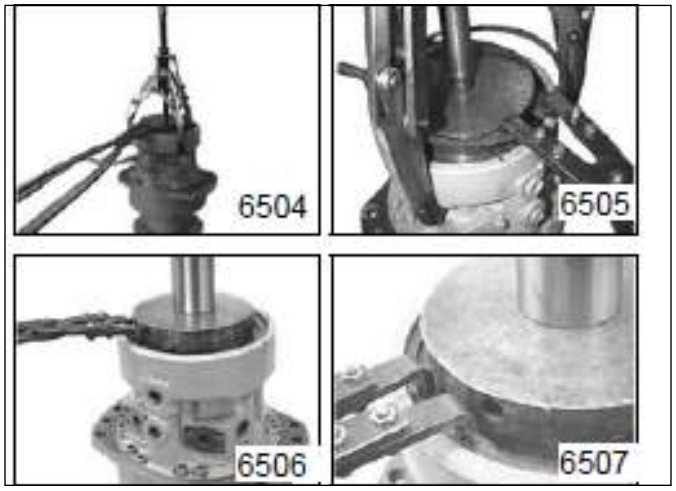

Figure 3-31: Compress Spring Washer

6. Remove the snap ring using internal snap ring pliers.
7. Extractor and pliers. **See Figures 6504** and **6505**.

8. Press and pliers. **See Figures 6506** and **6507.**

NOTE

If you use a bearing press do not place the bearing support on the studs.

9. Extract the spring washer, item 108. **See Figure 3-32.**
10. Extract the brake piston, item 107. **See Figure 3-33**.
11. Discard the O-ring, item 106. **See Figure 3-34**.
12. Remove and discard the bolts item(s)102. **See Figure 3-35**.
13. Remove the brake housing, item 101. **See Figure 3-36**.

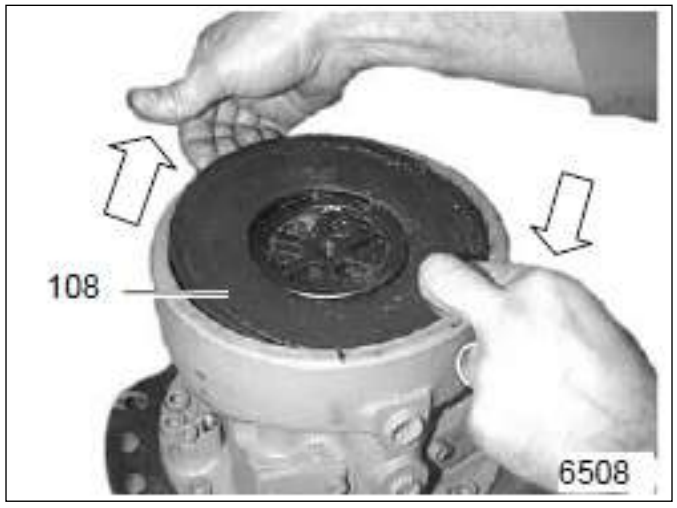

Figure 3-32: Remove Spring Washer

Figure 3-33: Remove Brake Piston

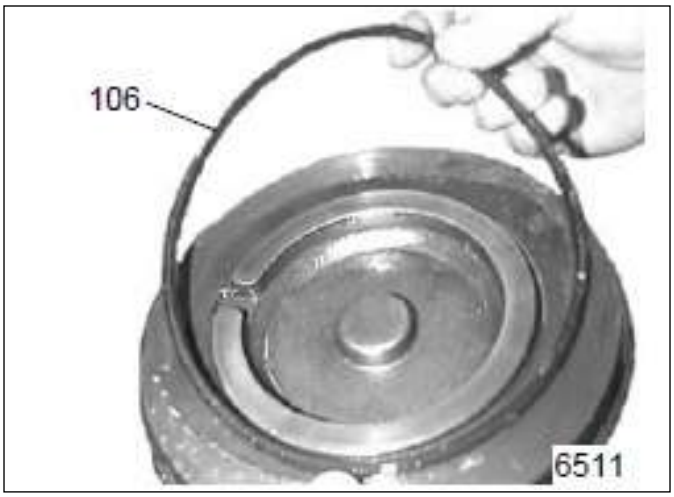

Figure 3-34: Remove O-Ring

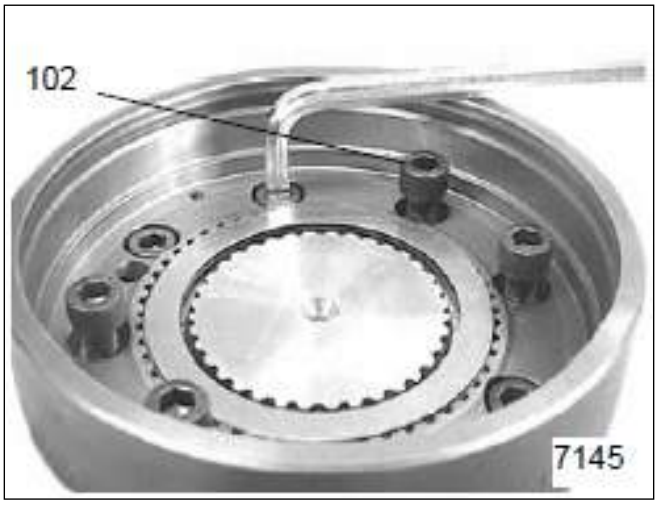

Figure 3-35: Remove Bolts

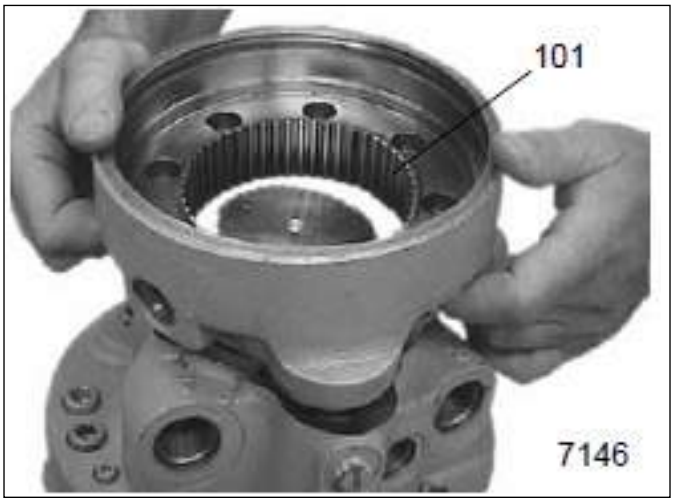

Figure 3-36: Remove Brake Housing

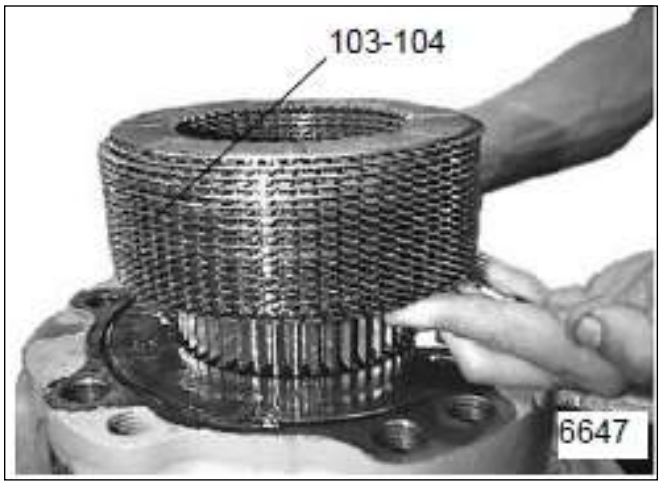

Figure 3-37: Remove Shims and Brake Discs

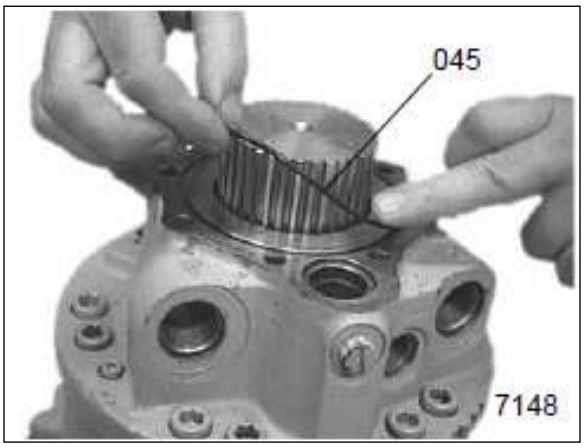

Figure 3-38: Remove O-Ring

14. Extract the shims. Extract the brake discs, items 103 and 104. **See Figure 3-37.**
15. Discard the O-ring, item 045. **See Figure 3-38.**

Reassembly

Before reassembling, it is necessary to ensure that all parts, including the surface conditions of the piston seal and the grooves are clean.

NOTE

All traces of rust, mud and water must be removed.

Ensure the brake housing has proper chamfers around the mounting screw holes. **See Figure 3-39**.

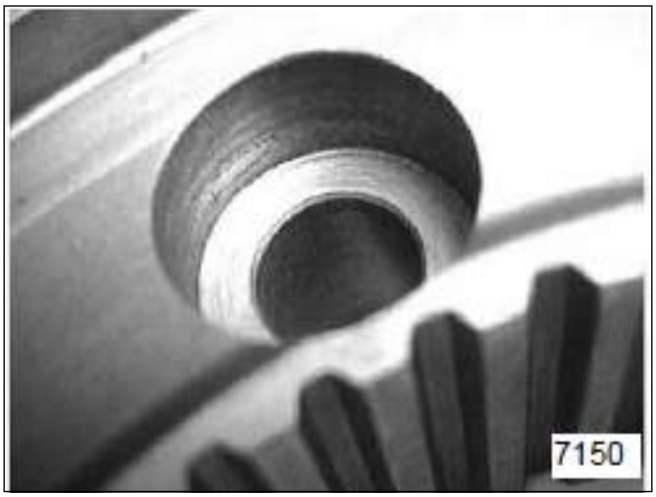

Figure 3-39: Correct Chamfering

1. Coat with anti-oxidizing grease, Mobil XHP222 or equivalent, the grooves, the top of the piston, the spring washer, the snap ring and the piston seal contact surface in the brake housing.
2. Remove residual, dried glue on the mating face of the valving cover. Scrape off all glue residues with a blade.

NOTE

DO NOT file or emery the mating surface. The finish must be maintained.

3. Wipe the mating face with a lint free moist cloth, rubbing the valve cover from inside to outside. **See Figure 3-40**.

Figure 3-40: Wipe Faces with Moist Cloth, Inside to Outside

4. Degrease the mating face using isopropyl alcohol.
5. Check again that there is no dried glue on the mating face of the brake housing. Scrape off all glue residues of the brake housing.

NOTE

DO NOT file or emery the mating surface. The finish must be maintained.

6. Wipe the mating face with a lint free moist cloth, rubbing the valve cover from inside to outside. **See Figure 3-41.**
7. Degrease the mating face using isopropyl alcohol.

NOTE

8. *After degreasing, do not touch the mating surfaces with hands or fingers.*
9. Using a clean brush apply a film of Loctite 7471 activator on the valve cover surface which should be in contact with the brake housing. Wait 2 minutes. **See Figure 3-42**.

IMPORTANT

DO NOT apply any activator on the shaft.

10. Install the new O-ring, item 045, and if the motor is dual displacement, install the new O-ring, item 057. **See Figure 3-43**.

Figure 3-41: Wipe Brake Housing with Moist Cloth, Inside to Outside

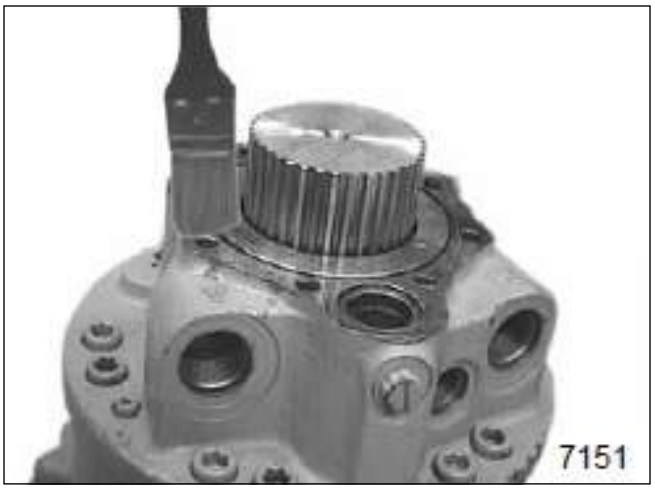

Figure 3-42: Brush Loctite on Valve Cover Surface

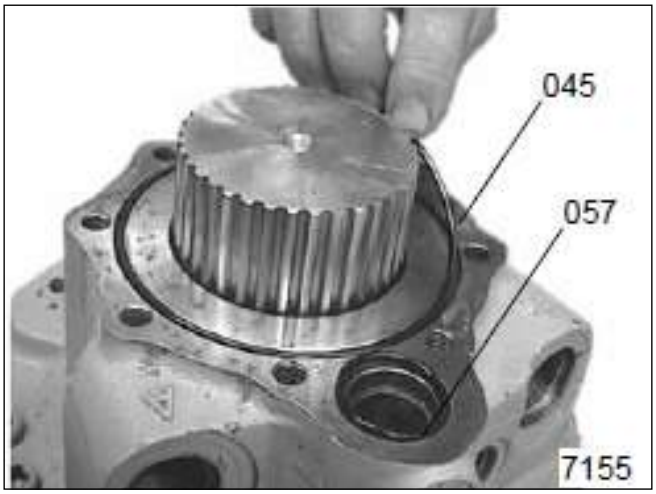

Figure 3-43: Install New O-Ring

NOTE

DO NOT touch the mating surface after coating it with the activator.

11. Place a continuous bead of Loctite 638 glue on the brake housing, following the median line of the mounting bolt hole centers. **See Figures 3-44** and **3-45**.
12. Make sure the bead of glue is continuous, with no gaps.

NOTE

NEVER apply the activator on the same surface as the bead of glue.

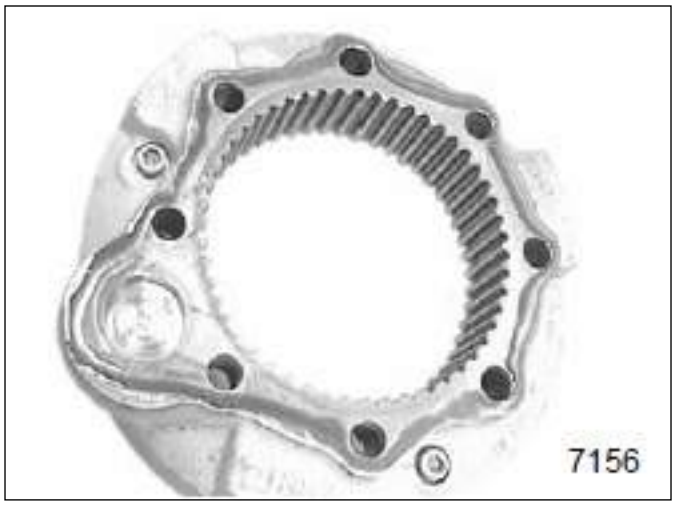

Figure 3-44: Apply Loctite to Brake Housing Face

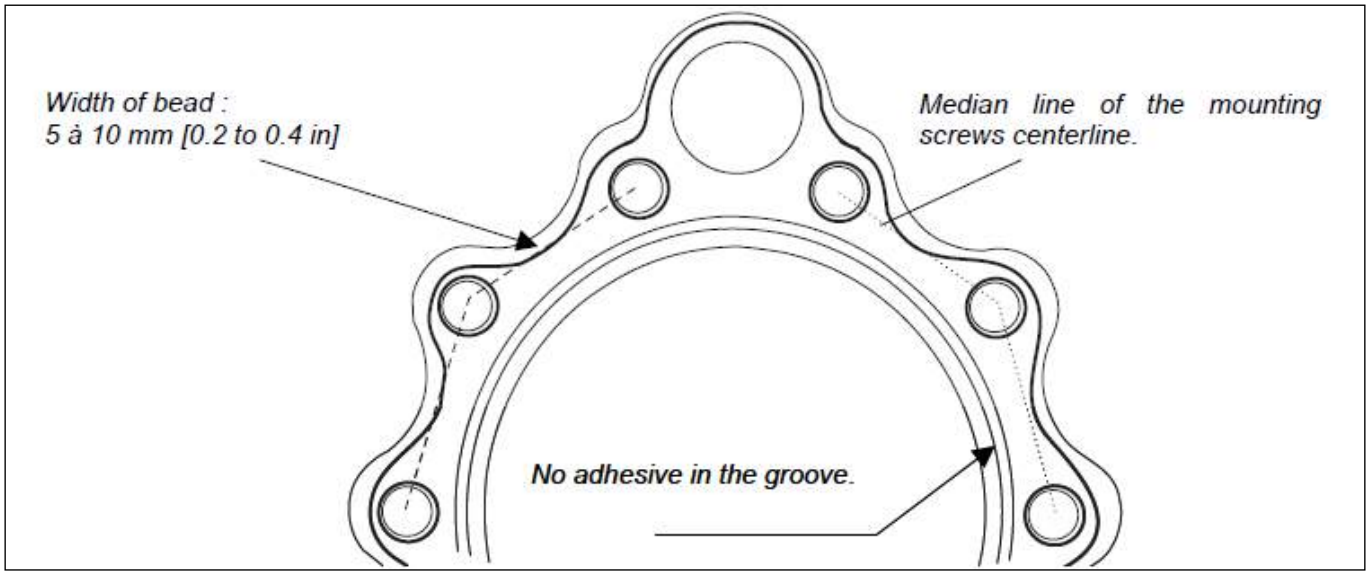

Figure 3-45: Loctite Only on the Median Line

IMPORTANT

The following steps must be acheived in 10 minutes maximum, after the glue is applied.

13. Position the parts to be assembled by installing some new bolts. **See Figure 3-46.**
14. Install and torque, 63 ft lbs (85 Nm), all new bolts, item 102. **See Figure 3-35.**

IMPORTANT

- **The glued connections remain fragile 6 hours after being glued.**
- **Avoid and shock to the glued parts.**
- **DO NOT use or test the brake nor the motor.**

15. Install the 6 balls on the cover, item 041. **See Figure 3-47**.

Figure 3-46: Position by Hand Tightening Bolts

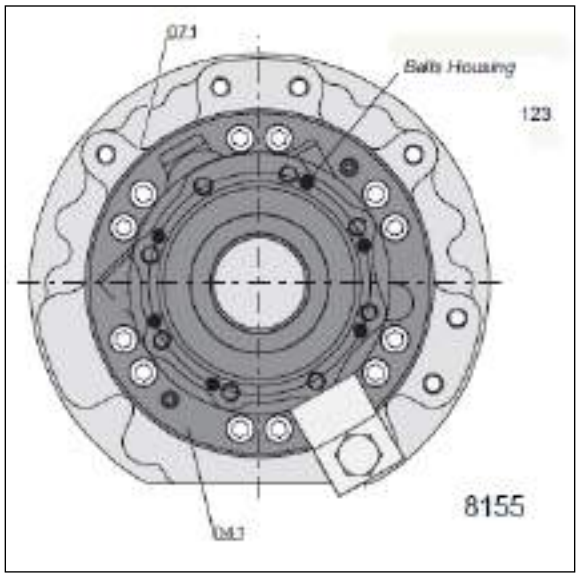

Figure 3-47: Install 6 Bearings on Cover

16. Install a new O-ring, item 045, in the cover, item 041. **See Figure 3-48**.
17. Install the brake housing, item 101, on the cover, item 041. Take care to place the housings in front of the balls, item 123. **See Figure 3-49.**
18. Install the torque reduction shims, item 115, according to the version. **See Figure 3-50**.
19. Oil the new discs with hydraulic fluid.

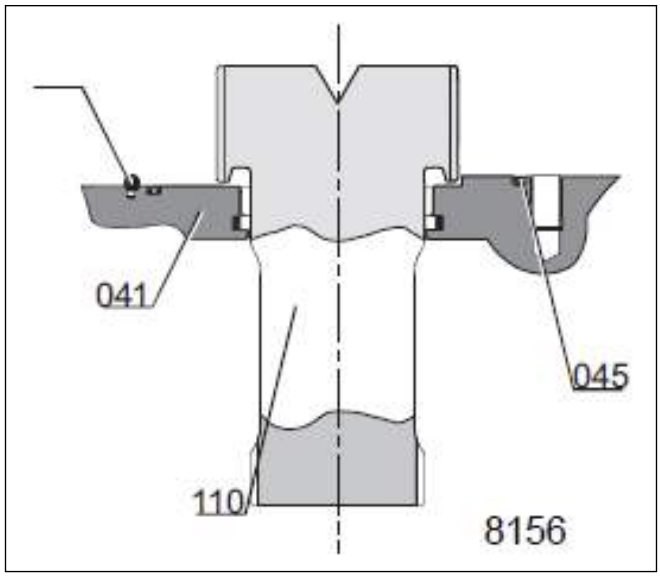

Figure 3-48: Install New O-Ring

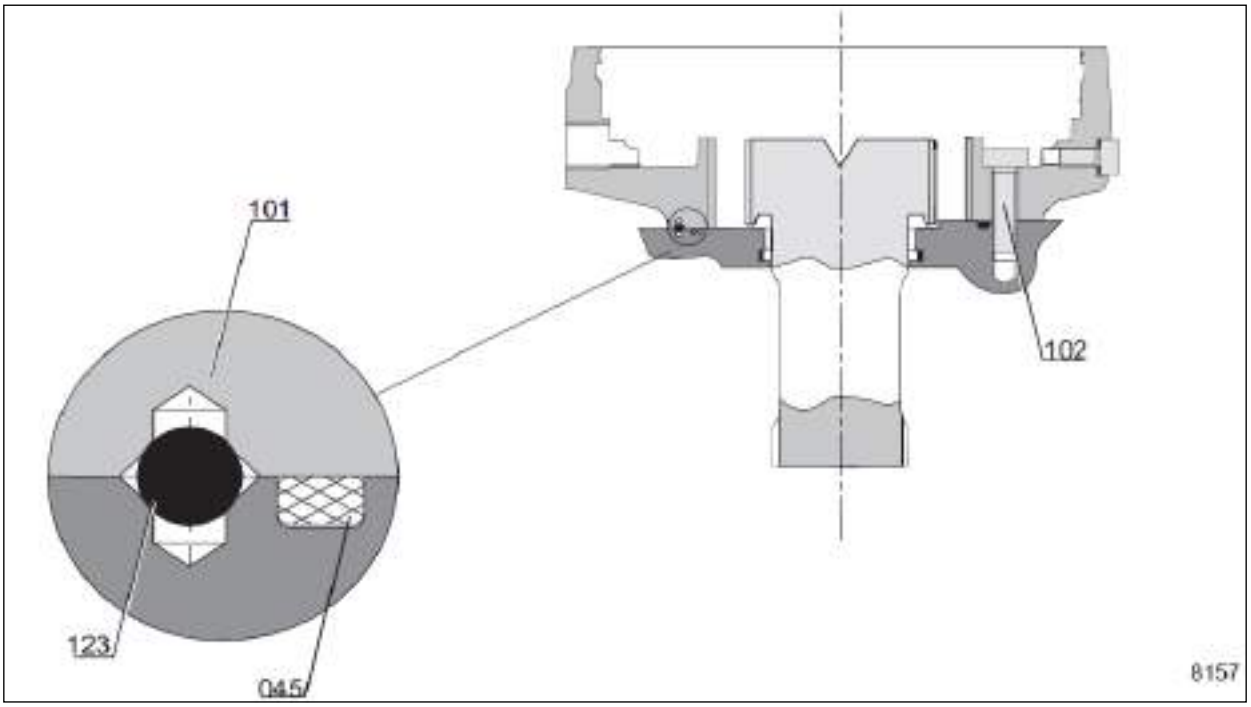

Figure 3-49: Allign Brake Housing and Cover Carefully

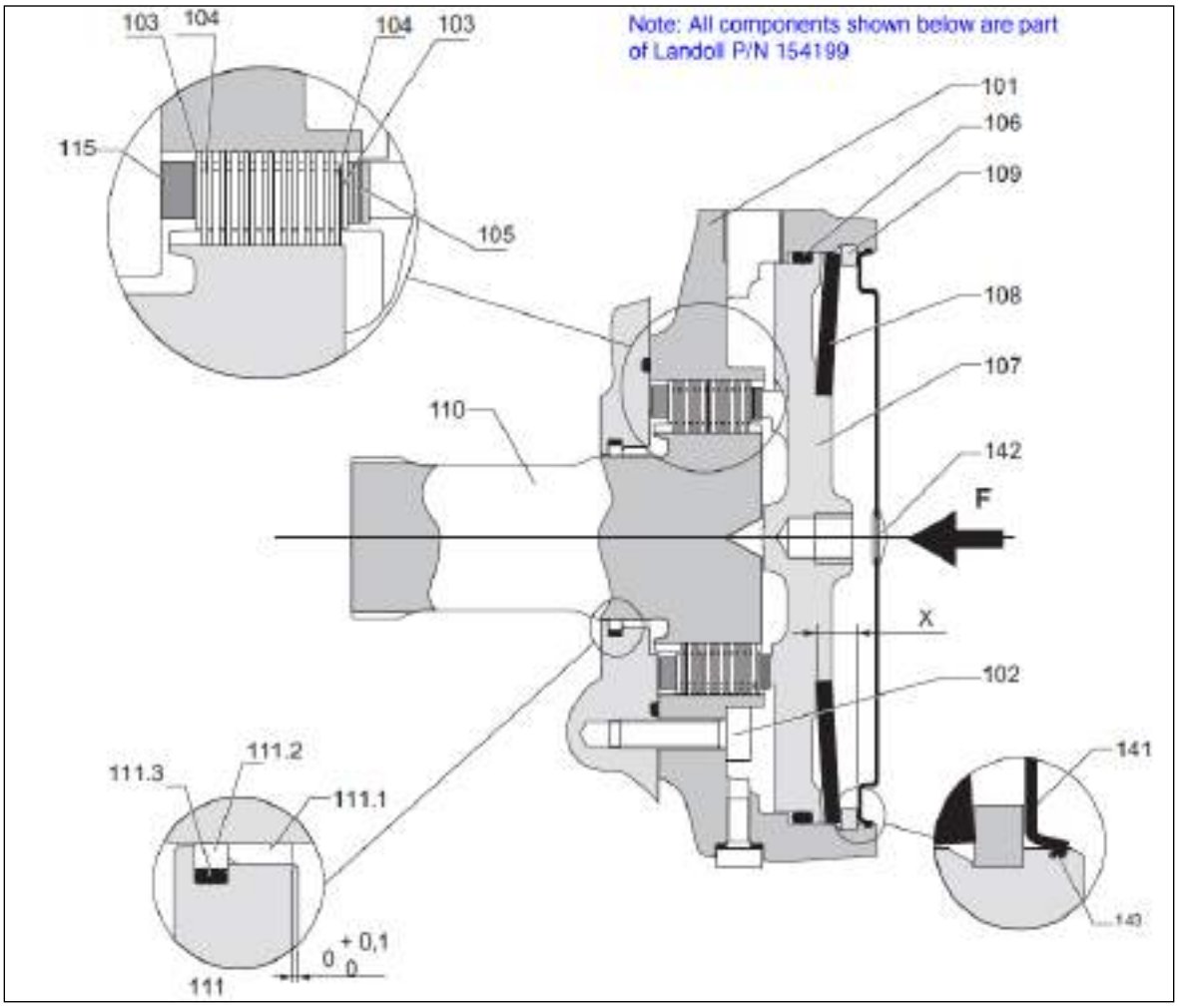

Figure 3-50: Install New Shims

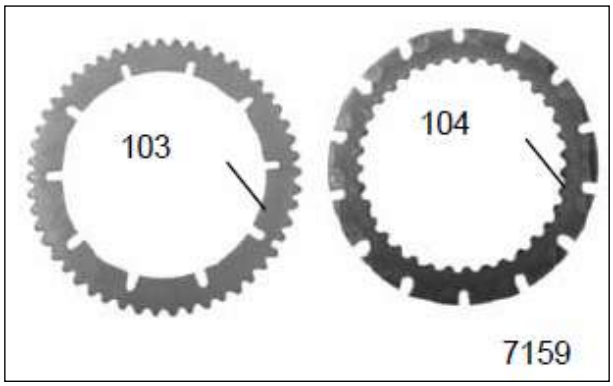

Figure 3-51: Install Brake Discs External then Internal Alternately

20. Start by installing one external brake disc, item 103, then one internal brake disc, item 104, then alternately 103 and 104 etc.

21. The last brake disc must be an external disc, item 103.

Table 3-1: Component Descriptions

Rep. Item	Description
101	Brake housing
102	Mounting screw
103	External brake disc
104	Internal brake disc
105	Shims

Table 3-1: Component Descriptions

Rep. Item	Description
106	Brake piston O-ring
107	Brake piston
108	Spring washer
109	Snap ring
115	Tourque reduction shim
141	Brake cover
142	Plug
143	O-ring

22. Coat the piston seal contact surface in the brake housing with anti-oxidizing grease - Mobil XHP222 or equivalent.
23. Install a new O-ring, item 106, on the piston, item 107. **See Figure 3-52**.

NOTE

The ring should be tight on the piston and not twisted.

24. Install the brake piston, item 107, in the brake body, item 101. **See Figure 3-53**.

NOTE

Be careful when passing the seal over the snap ring groove.

25. Install the spring washer, item 108, on the brake piston, item 107. **See Figure 3-54**.
26. Using a press or an extractor, apply 15740 lbs (70000N) of compressive force to install the snap ring. **See Figure 3-55**.

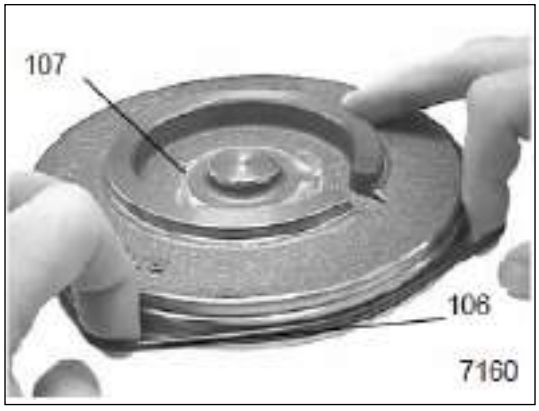

Figure 3-52: Install New O-Ring

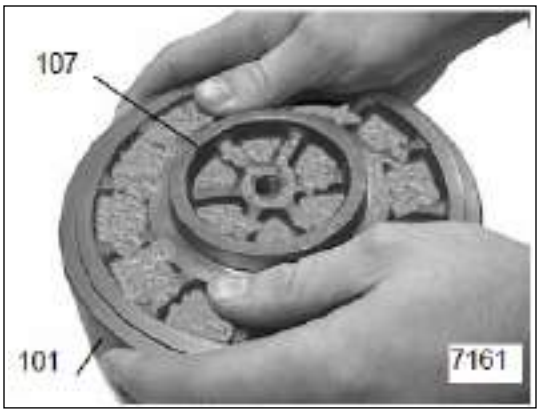

Figure 3-53: Install Brake Piston

Figure 3-54: Install Spring Washer

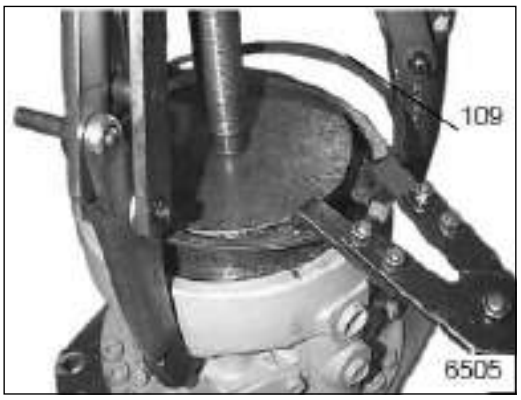

Figure 3-55: Apply 15,740 lbs to Snap Ring

27. Supply the pressure to the brake and measure the brake piston stroke using a dial gauge. **See Figure 3-56**.
28. Calculate the shimming, item 105, value(measured travel) in order to control the stroke of .034" (.87mm). **See Figure 3-50**.
29. Reapply the compressive force to remove the snap ring, item 109.
30. Remove the spring washer. **See Figure 3-57**.
31. Remove the brake piston. **See Figure 3-58**.

32. Install the proper shimming, item 105, on the last disc, **the thickest shim towards the brake piston. See Figure 3-59**.

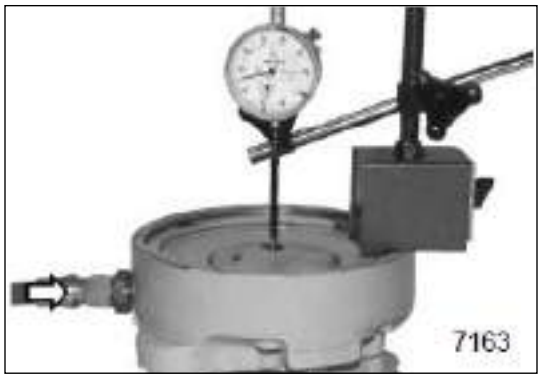

Figure 3-56: Measure PBrake Piston Stroke with Dial Gauge

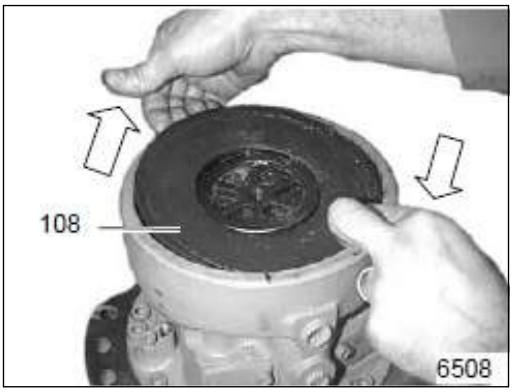

Figure 3-57: Remove Spring Washer

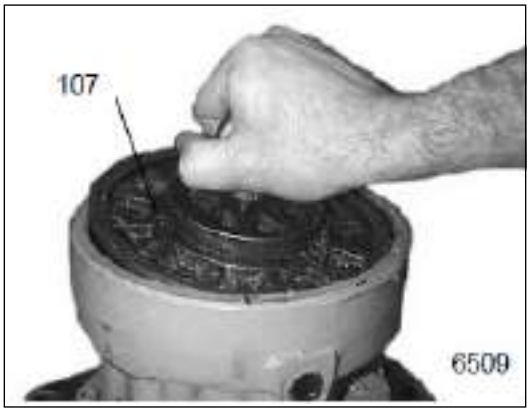

Figure 3-58: Remove Brake Piston

Figure 3-59: Install Shims on Last Disc, Thickest First

NOTE

Minimize the number of shims of thickness .0079" (.2mm).

33. Reinstall the brake piston, item 107, and the spring washer, item 108. **See Figure 3-60**.
34. Apply the compressive force of 15740 lbs (70000N) to install the snap ring, item 109 and release the compressive force. **See Figure 3-61**.
35. Supply the pressure to the brake piston again to check the piston stroke. **See Figure 3-56**.
36. Install a new O-ring, item 143, coated with antioxidizing grease (Mobil KHP 222 or equivalent) in it's grove. **See Figure 3-62**.
37. Install a new cover, item 141, on the entry chamfer. **See Figure 3-63**.
38. Click it into place using the corresponding mandrel, P/N 155304. **See Figure 3-64**.

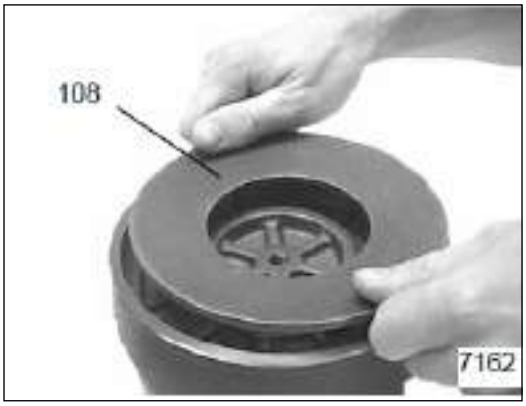

Figure 3-60: Reinstall Brake Piston and Spring Washer

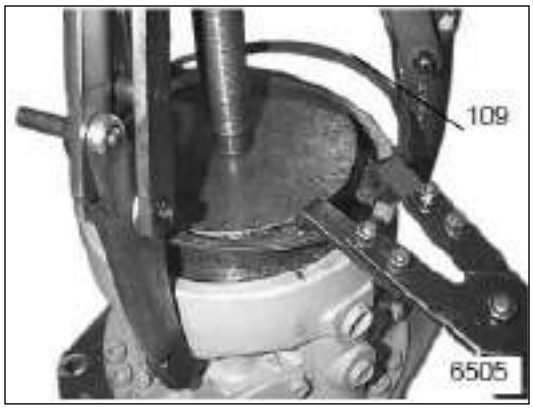

Figure 3-61: Apply 15,740 lbs to Install Snap Ring

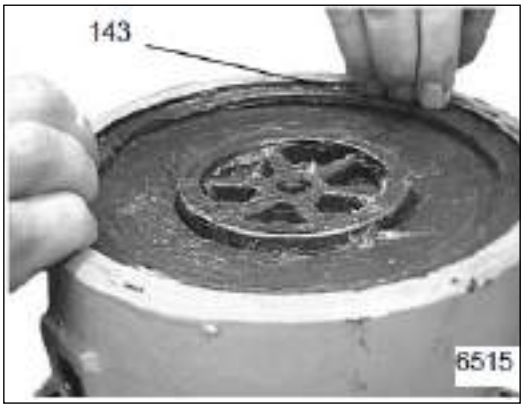

Figure 3-62: Install new O-Ring with Grease

Figure 3-63: Install New Cover

Figure 3-64: Click Into Place

NOTE

Make sure that the outer edge of the brake cover is engaged in the groove.

39. Install a new plug, item 142.
40. Install the motor.

IMPORTANT

Wait six hours after gluing before using the brake or engaging the power functions of the motor.

41. Check brake effectiveness.

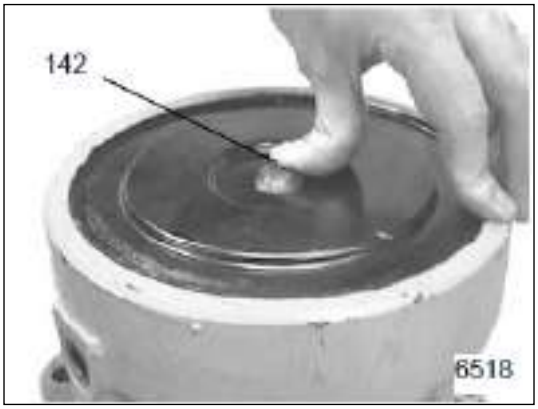

Figure 3-65: Install New Plug

Seat Assembly/Horn

Seat Switch

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

Replace the Switch and Cable

1. Set the key switch to "OFF" and remove from the ignition switch.
2. Apply the parking brake, disconnect the battery and block all wheels.
3. Release the battery/seat cover latch and raise the cover to expose the underside.
4. Make sure the cover is secured in the fully raised position.
5. Remove the hardware securing the front portion of the seat slide rails to the cover.
6. Loosen the back two sets of hardware. **See Figure 3-66**.
7. Lower the battery/seat cover, then raise the front of the seat up to expose the switch and cable mounting.
8. Have a helper disconnect the switch cable from the main harness, then unscrew the switch assembly.
9. Install the new switch and cable by performing the preceding steps in reverse order.
10. Before placing the truck back into operation, test it to be sure the switch functions properly. See "Check Driver's Seat Switch," on page 2-4.

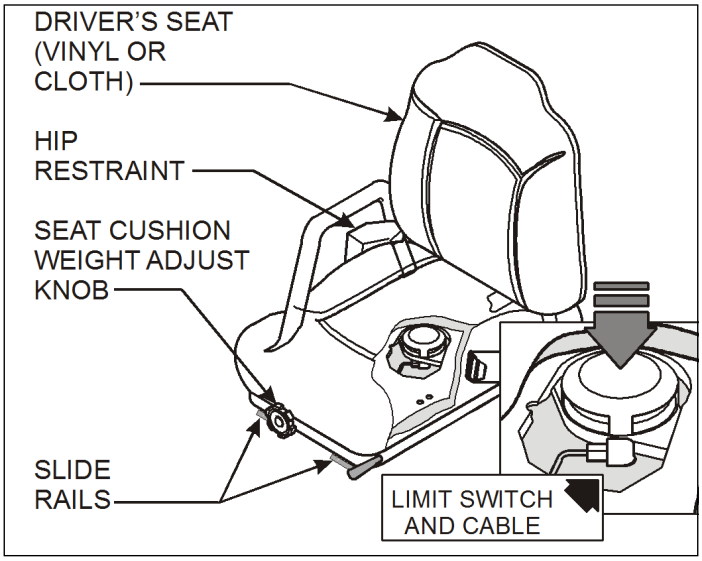

Figure 3-66: Seat Switch

Horn and Direction Control

- The horn push button and directional control switch (forward-neutral-reverse) are located on the driver's arm rest panel. Each assembly is available as a complete unit only. **See Figure 3-67**.
- The horn is located under the Steering Rotation Cover between the driver and the mast.

Horn Pushbutton

1. Set the key switch to "OFF" and remove key from the ignition switch.
2. Disconnect the battery.
3. The horn push button is removed by:
   - Remove the mushroom cap (setscrew). **See Figure 3-67.**
   - Remove the locknut.
   - Open the top cover to its full opened and locked position.
   - Note wire color and connection terminals and tag for identification.
   - Disconnect electrical leads to the pushbutton.
   - Install the new horn pushbutton by reversing the preceding steps.
   - Connect the battery and test the horn.

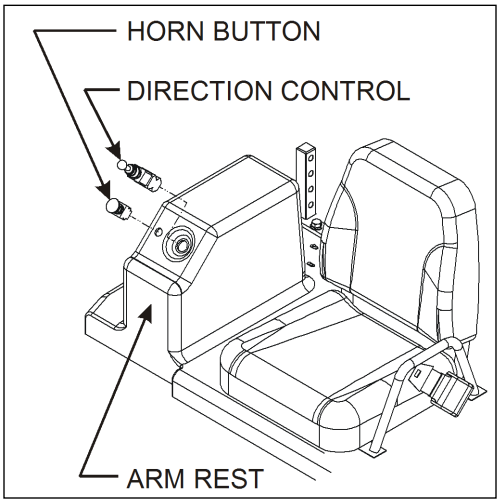

Figure 3-67: Horn Button/Direction Switch

Direction Control Switch

1. Set the key switch to “OFF” and remove key.
2. Remove the switch locknut cap. **See Figure 3-67**.
3. Open the top cover to the locked position.
4. Note wire color and connection terminals and tag for identification.
5. Disconnect electrical leads to the switch.
6. Install the new switch by reversing the preceding steps. The switch and arm rest casing are notched to insure proper installation.
7. Connect the battery and test the switch for forward and reverse travel.

Figure 3-68: Horn Location

Horn Removal

The horn (12VDC) is removed by:

1. Set the key switch to “OFF” and remove key from the ignition switch.
2. Disconnect the battery.
3. Remove front rotation cover to expose the horn. **See Figure 3-68**.
4. Disconnect the electrical wires.
5. Remove the hex screws and hardware to separate the horn from the frame.
6. Install the new horn by reversing the preceding steps.
7. Connect the battery and test the horn.

Fuses

The Bendi i4 fuses are located on the left side of the engine compartment. Replace only with the same size and specification.

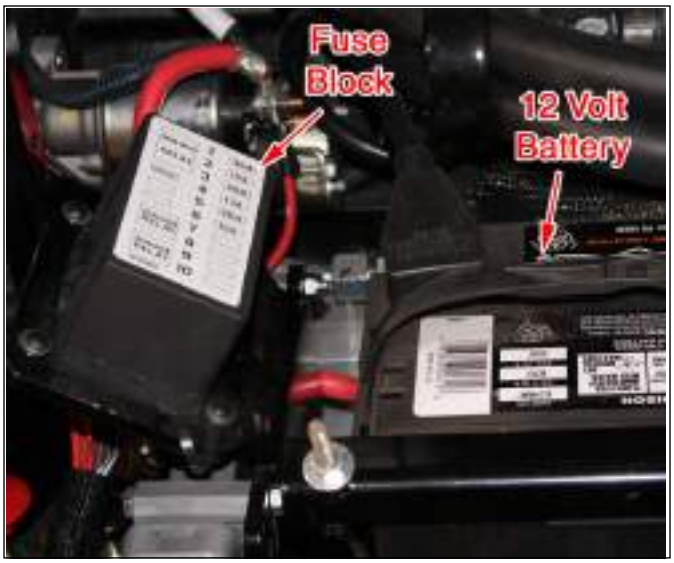

Figure 3-69: Fuse Block

Engine Assembly

Engine

Refer to the end of Chapter 6 for supplier maintenance information on the engine.

Fuel System

Refer to Chapter 5 for corrective maintenance on the fuel system.

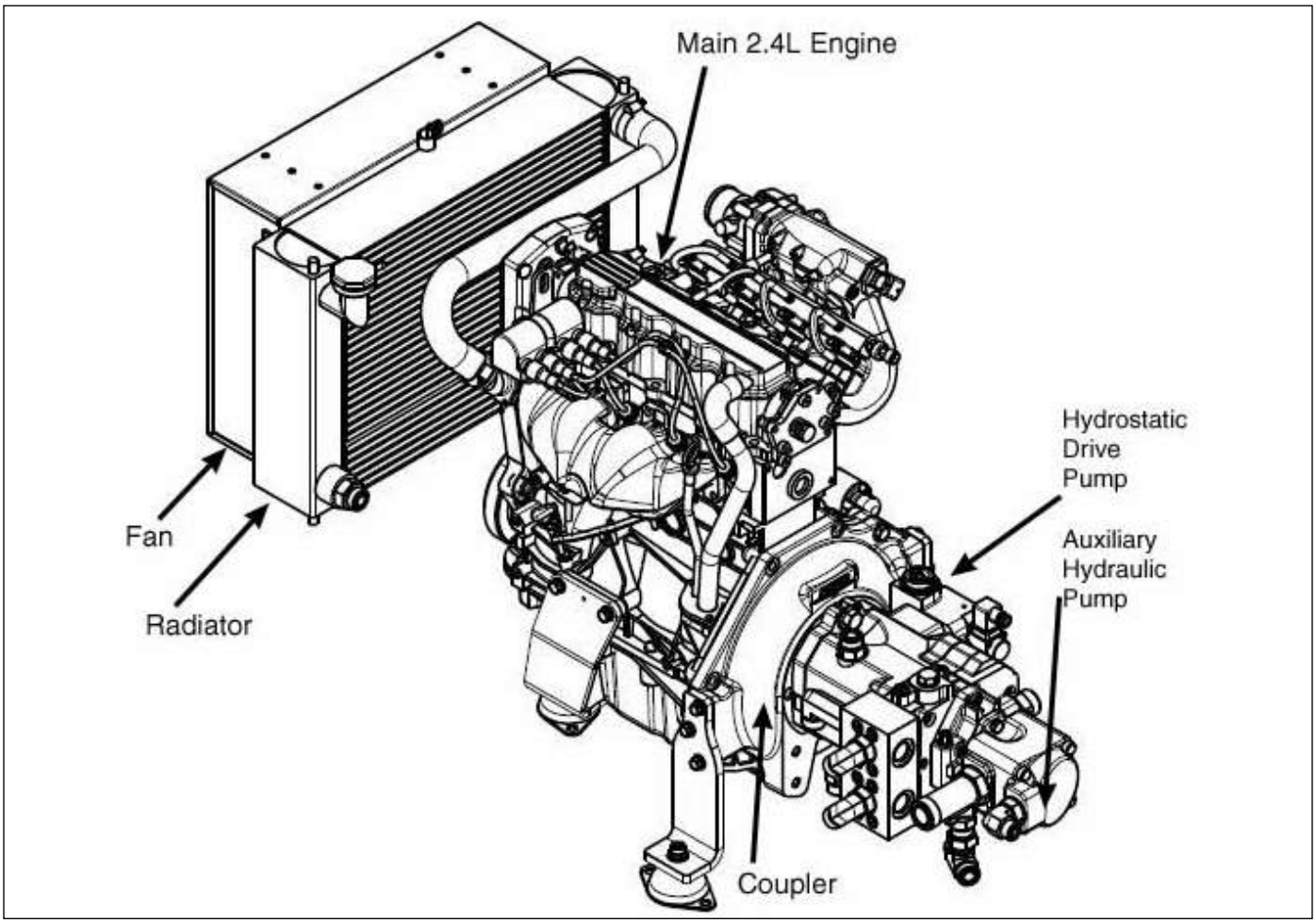

Figure 3-70: Powertrain Assembly

Radiator/Oil Cooler

NOTE

You may notice that when you turn the truck "OFF" the fan momentarily runs at full speed. This is completely normal.

1. First, review "Before You Begin," page 1-1.
2. Set the key switch to "OFF" and remove key from the ignition switch.
3. Apply the parking brake, disconnect the battery and block the wheels.
4. Remove back cover.
5. Remove muffler.
6. Drain anti-freeze from radiator.
7. Remove hose assemblies.

NOTE

Immediately plug hose assemblies. Have shop rags ready to manage spills.

8. Remove mounting hardware and radiator.
9. Replace radiator and reinstall in reverse order.

Figure 3-71: Radiator & Cooling Fan

Overhead Guard/Lighting/Alarms

Trucks equipped with optional flood / headlights, tail and stop lights, flashing or spot lights (strobe lights), etc. contain non-replaceable bulbs. The truck is equipped with LED bulbs and replacement varies according to manufacturer, but usually the unit gets replaced as a one assembly. **See Figure 3-72**.

Additional options can include backup alarms.

Figure 3-72: Overhead Guard Assembly

Back Up Alarms

Two types of back up alarm are offered - audible and voice.

1. First, review “Before You Begin,” page 1-1.
2. Set the key switch to “OFF” and remove key from the ignition switch**.**
3. Apply the parking brake and disconnect the battery.
4. To replace the alarm assembly disconnect the wire connector and remove the mounting hardware holding the alarm to its mounting bracket.

Chapter 4

Calibration and Programming

Vehicle Controller “Plus 1” Calibration and Programming

NOTE

Not all rear panel orientations are the same, but the pin connections used are the same.

Getting Started Using Plus 1 Software

NOTE

Landoll recommends steps 1 thru 3 be completed at the dealership and not at the customer location. If problems arise when loading the Plus 1 software, you may need to consult the factory.

1. Install the Plus 1 program by following the software installation instructions provided at Landoll.com.
2. Attach cable to the available USB computer port (Part number 150713) and the Kvaser cable (Part number 151159) to the Steer Column Cable before starting software.
3. Start Plus 1 software only.
4. If steps 1 thru 3 are OK proceed to hook up the computer interface cable to the forklift with the cable marked “Vehicle Controller”. **See Figures 4-1** and **4-2**.

Figure 4-1: Steering Column Connector

Figure 4-2: Computer Interface Cables

5. You are now ready to begin monitoring and operating the forklift functions and parameters.
6. Follow the screens shots provided below to navigate through the Plus 1 capabilities and forklift forklift performance checks.

IMPORTANT

The status is provided at the bottom of the computer screen See Figure 4-3.

Figure 4-3: Connected Status

Figure 4-4: Communication Problem

NOTES

If there's any communication problems between the forklift and your computer, you will see a message like ***Figure 4-4.***

ECU Downloading and Type

ECU screens are shown here in the next 2 illustrations to check the revisions of software and application along with downloading the appropriate software. **See Figures 4-5** and **4-6**.

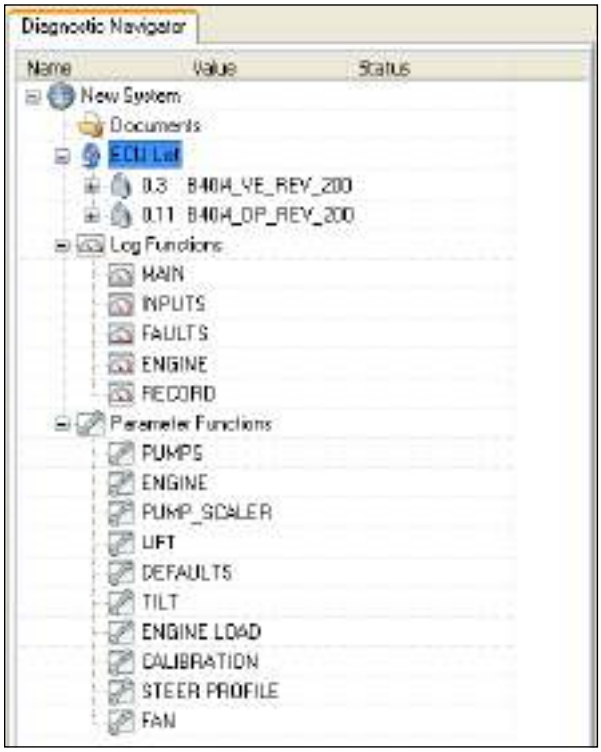

Figure 4-5: To Check Revision

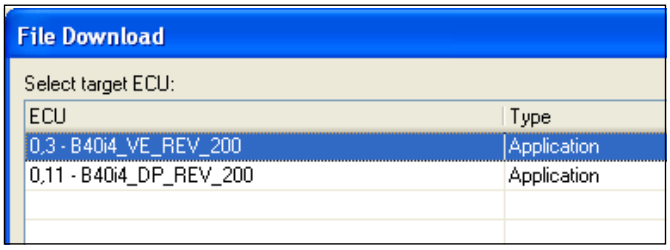

Figure 4-6 Download Software Screen

The Plus 1 software package is segregated into two basic operational sections. See Figure 4-5.

- **The first section of the software is a monitoring "Log Function", which allows the user to monitor vital performance settings in the B40i4 forklift.**
- **The second section, the "Parameter Functions" within the software is where parameters can be manipulated as applicable.**
- **Follow the screens shots of the Plus 1 provided in the upcoming pages.**
- **Also shown below you will notice in the right side column the REV control number that may become important as improvements are made in the software, by the factory.**

Format

In the following pages the sections title that the variables are in follow a format, i.e. **0,3-CP_RPM_PERCENT.**

0,3 - Defines the node's "specific controller"

CP - Stands for Check Point

After CP is the part of the string that specifies a specific variable to monitor, i.e. RPM PERCENT

In the screenshots on the following pages, you'll see a blue number outlined in black,eg~> which is to easily reference the definitions with the location of the variable on the screen. You will not see the black outlined numbers on the screen

Log Functions

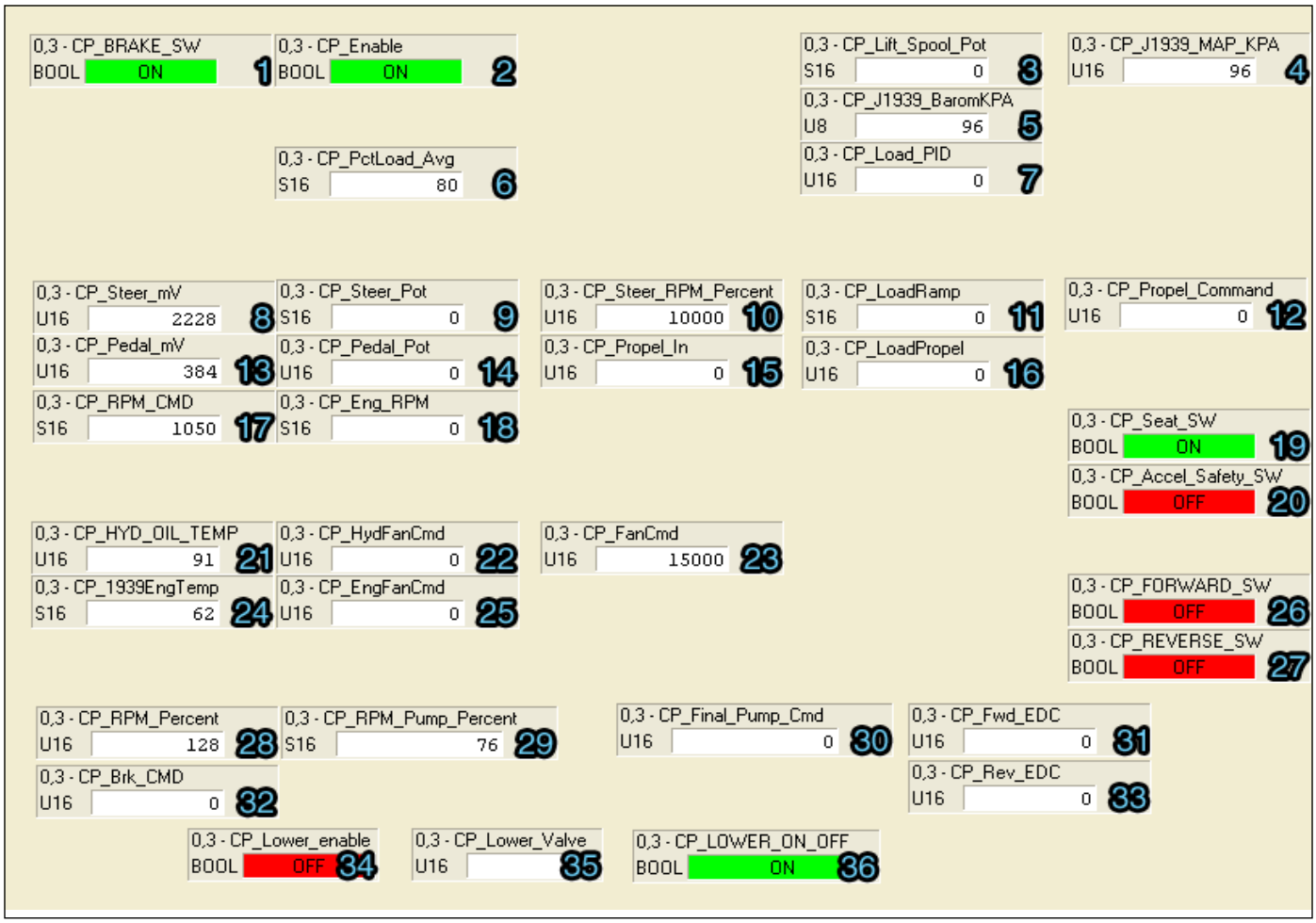

Figure 4-7: Main Inputs Screen

Main Inputs

The "**MAIN INPUTS**" screen shot provides monitored parameters for the Plus 1 functions. **See Figure 4-7.**

Below is provided a definitions list for forklift parameters: See Figure 4-7.

ECU checks the status of the following;

A. Drive Pedal within acceptable range.

B. Fan coil.

C. Drive Pedal position.

D. Steer Calibration within tolerance.

E. Steer pot within acceptable range.

F. FWD EDC coil.

G. REV EDC coil.

H. Forward direction switch.

I. Reverse direction switch.

J. Drive pedal switch.

1. **0,3-CP_BRAKE_SW** – **On** when stop pedal is depressed, **Off** when stop pedal is in neutral position. This signal is provided by a pressure transducer.
2. **0,3-CP_Enable** – **On** once ECM completes pre start checks successfully, **Off** when fault is present.
3. **0,3-CP_Lift_Spool_Pot** – Displays pot wiper voltage.
4. **0,3-CP_J1939_MAP_KPA** – Not used "for naturally aspirated".
5. **0,3-CP_J1939_BaromKPA** - Not used "for naturally aspirated".
6. **0,3-CP_PctLoad_Avg** – Displays an average of the percent load transmitted from the GFI Engine controller.
7. **0,3-CP_Load_PID** – Displays the output of the PID loop, Max load vs. Engine load.
8. **0,3-CP_Steer_mV** – Pot wiper voltage.
9. **0,3-CP_Steer_Pot** - Pot setting.

10. **0,3-CP_Steer_RPM_Percent** – Displays the mapped steer angle as a percent of RPM.
11. **0,3-CP_LoadRamp** - unused.
12. **0,3-CP_Propel_Command** – Displays commanded propel based on propel input from steer and pedal vs. mapped propel modified by PID loop.
13. **0,3-CP_Pedal_mV** – Pot wiper voltage.
14. **0,3-CP_Pedal_Pot** - unused.
15. **0,3-CP_Propel_In** – Displays the mapped Accel pedal input.
16. **0,3-CP_LoadPropel** – Shows the propel modified by the PID loop.
17. **0,3-CP_RPM_CMD** – Displays the RPM command based on propel, lift, shift, and tilt commands.
18. **0,3-CP_Eng_RPM** – Displays actual Engine RPM “Transmitted from the GFI ECM”.
19. **0,3-CP_Seat_SW** – **On** when operator is present, **Off** when operator is not present.
20. **0,3-CP_Accel_Safety_SW** – Displays the state of the accel pedal “**On** when pedal is depressed, **Off** when pedal is in the neutral position
21. **0,3-CP_HYD_OIL_TEMP** – Displays the Hydraulic oil temp “Thermistor-type sensor in hydraulic tank”.
22. **0,3-CP_HydFanCmd** – Displays Fan command based on min/max temperature scaled from 0 to 100%.
23. **0,3-CP_FanCmd** – Displays the current supplied to the coil on the fan valve.
24. **0,3-CP_1939EngTemp** – Displays the Actual engine temperature “Transmitted from the GFI ECM”.
25. **0,3-CP_EngFanCmd** - Displays Fan command based on min/max temperature scaled from 0 to 100%.
26. **0,3-CP_FORWARD_SW** – Displays the state of the direction Switch, **On** when forward is selected, **Off** when forward is not selected.
27. **0,3-CP_REVERSE_SW** - Displays the state of the direction Switch, **On** when reverse is selected, **Off** when reverse is not selected.
28. **0,3-CP_RPM_Percent** – Displays the result of Propel in added to load ramp, multiplied by 100 and divided by the actual RPM commanded.
29. **0,3-CP_RPM_Pump_Percent** – Displays the RPM percent after it is mapped “Profile & time ramp”.
30. **0,3-CP_Final_Pump_Cmd** – Displays the final pump command based on actual command vs. limited command based in temperature of hydraulic oil.
31. **0,3-CP_Fwd_EDC** – Displays current supplied to coil on the forward proportional valve.
32. **0,3-CP_Brk_CMD** – Displays amount of Brake command “driven by direction and amount commanded is said direction.
33. **0,3-CP_Rev_EDC** - Displays current supplied to coil on the reverse proportional valve.
34. **0,3-CP_Lower_enable** - Enables control of secondary lowering valve that bypasses the lift lower spool valve.
35. **0,3-CP_Lower_Valve** - Shows the value being sent to the secondary lowering valve for feedback.
36. **0,3-CP_LOWER_ON_OFF** - Turns on secondary lowering valve that bypasses the lift lower spool valve.

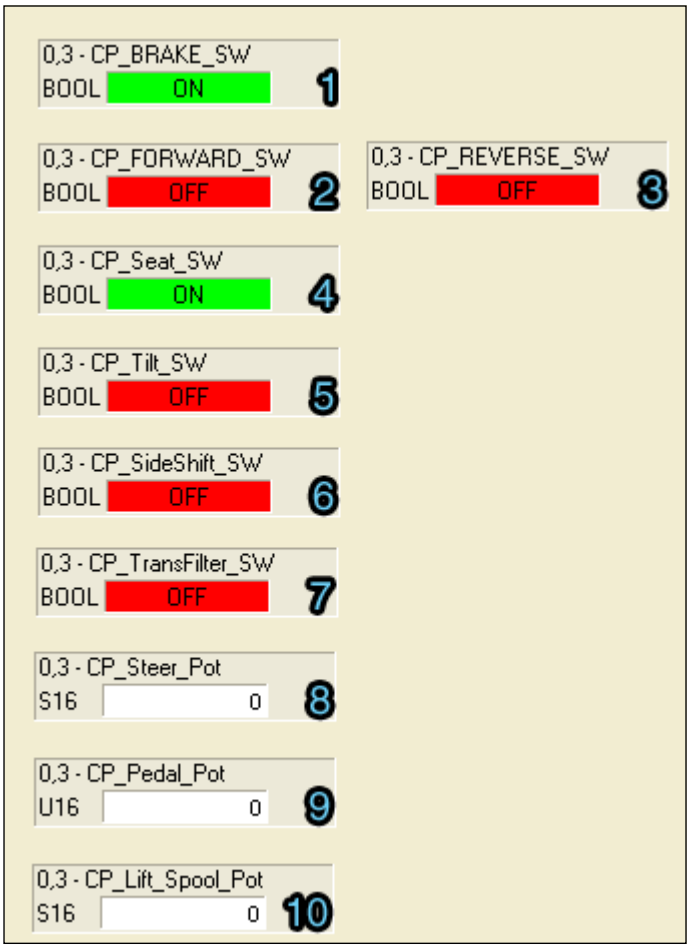

Figure 4-8: Input Screen

Input Screen

"**INPUTS SCREEN**" showing added functions monitored.

Below is provided a definitions list for forklift parameters: See Figure 4-8.

1. **0,3-CP_BRAKE_SW** – **On** when stop pedal is depressed, **Off** when stop pedal is in neutral position. Signal provided from a pressure transducer,
2. **0,3-CP_FORWARD_SW** - Displays the state of the direction Switch, **On** when forward is selected, **Off** when forward is not selected.
3. **0,3-CP_REVERSE_SW** - Displays the state of the direction Switch, **On** when reverse is selected, **Off** when reverse is not selected.
4. **0,3-CP_Seat_SW** - **On** when operator is present, **Off** when operator is not present.
5. **0,3-CP_Tilt_SW** – Displays status of tilt command, **On** when tilt lever is manipulated in either direction, **Off** when lever is in the neutral position.
6. **0,3-CP_SideShift_SW** – Displays status of Shift command, **On** when Shift lever is manipulated in either direction, **Off** when lever is in the neutral position.
7. **0,3-CP_TransFilter_SW** - If trans filter is plugged/clogged TrnasFilter_switch icon will be true/on.
8. **0,3-CP_Steer_Pot** - Represents steer angle scaled from -100% to +100% with straight being 0%.
9. **0,3-CP_Pedal_Pot** - Represents pedal position in .01%, 10000 being 100%.
10. **3-CP_Lift_Spool_pot** – Represents lift position scaled from -100% to +100% with neutral being 0%.

Figure 4-9: Faults Screen

"**FAULTS SCREEN**" showing added functions monitored

Below is provided a definitions list for forklift parameters: See Figure 4-9.

1. **0,3-CP_J1939_OFFLINE** – Displays CAN status, **Off** = communicating, **On** = Lost communication.
2. **0,3-CP_LiftSpool_Flt** – Displays status of lift pot, **Off** = systems ok, **On** = Pot shorted, open, or faulty.
3. **0,3-CP_LiftSpool_mV** – Displays pot wiper voltage.
4. **0,3-CP_LiftSpool_NoCal** – Displays calibration status, **Off** = calibration ok, **On** = no calibration.
5. **0,3-CP_Pedal_Flt** – Displays status of accel pot, **Off** = systems ok, **On** = Pot shorted, open, or faulty.
6. **0,3-CP_PumpFwdRevFlt** - If forward and reverse are at the same time PumpFwdRevFlt will be active.
7. **0,3-CP_Pedal_mV** – Displays pot wiper voltage.
8. **0,3-CP_REV_EDC_FLT** - Displays status of valve coil, **Off** = systems ok, **On** = coil, shorted, open, or faulty.
9. **0,3-CP_FWD_EDC_FLT** - Displays status of valve coil, **Off** = systems ok, **On** = coil, shorted, open, or faulty.
10. **0,3-CP_Steer_Flt** – Displays status of accel pot, **Off** = systems ok, **On** = Pot shorted, open, or faulty.
11. **0,3-CP_Steer_mV** – Displays pot wiper voltage.
12. **0,3-CP_SeatTimeOut** – Displays status of seat switch with delay, **Off** = seat switch is made and satisfied, **On** = seat switch not made due to short or open.
13. **0,3-HydTemp_FLT** – Displays status of Temperature sensor, **Off** = systems ok, **On** = Short high, short low, or open.
14. **0,3-CP_Fan_Fault** - Displays status of fan valve coil, **Off** = systems ok, **On** = coil, shorted, open, or faulty.
15. **0,3-C1p27.Ohm** – Displays resistance of Hydraulic temp sensor.
16. **0,3-CP_Lower_FLT** - Displays status of lift secondary bypass lift valve, **Off** = systems okay, **On** = coil shorted, open, or faulty

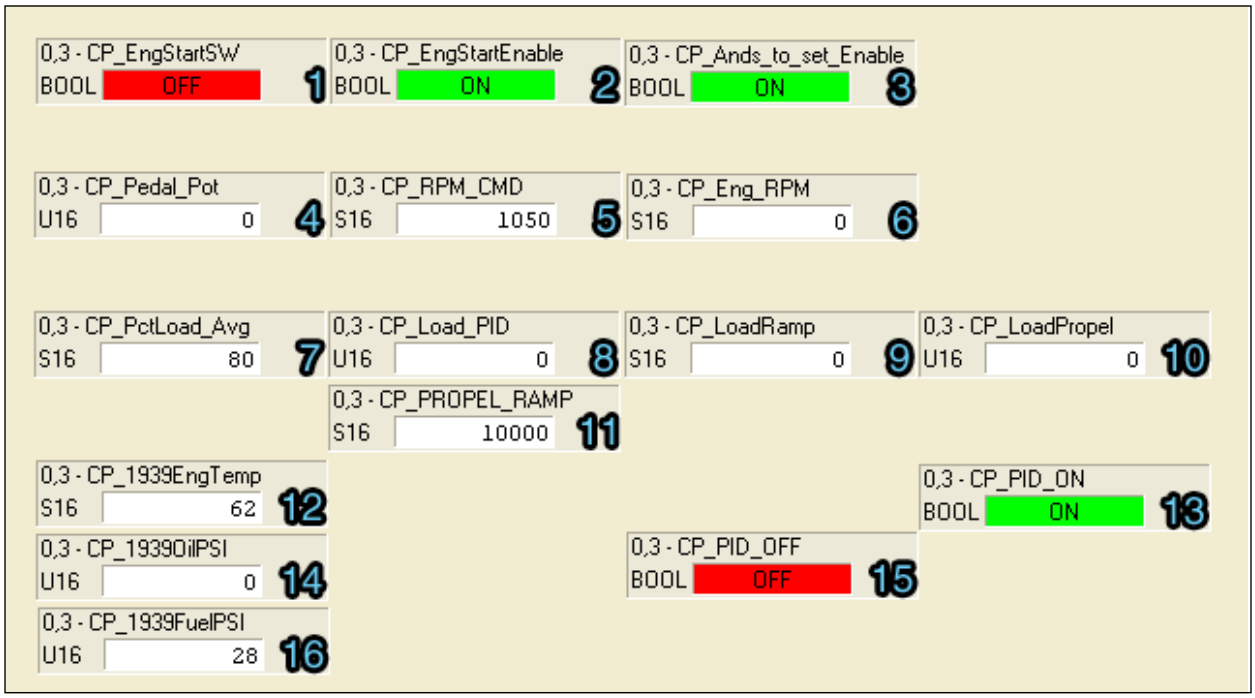

Figure 4-10: Engine Screen

Engine Screen

The "**ENGINE**" screen shot provides featured parameters for the Plus 1 functions. See Figure 4-10.

Below is provided a definitions list for forklift parameters: See Figure 4-10.

1. **0,3-CP_ EngStartSW** – Not Used.
2. **0,3-CP_EngStartEnable** – Monitors direction switch, seat switch, and engine RPM. For this input to be true (**On**) direction switch must be in neutral, seat switch must be satisfied and engine RPM must be below 500 RPM. **Off** means one of the switches is a no start state.
3. **0,3-CP_Ands_to_set_Enable** - Monitors direction switch, seat switch, and engine RPM. For this input to be true (**On**) direction switch must be in neutral, seat switch must be satisfied and engine RPM must be below 500 RPM. **Off** means one of the switches is a no start state.
4. **0,3-CP_Pedal_Pot** – Displays accel pot wiper voltage.
5. **0,3-CP_RPM_CMD** – Displays the combined RPM command i.e. Lift RPM, Tilt RPM, shift RPM, and throttle command. This will be the actual commanded RPM to the Engine.
6. **0,3-CP_Eng_RPM** – Displays the actual engine RPM in real time.
7. **0,3-CP_PctLoad_Avg** – Displays the Average Load Percent of the engine.
8. **0,3-CP_Load_PID** - Displays the Average Load Percent of the engine
9. **0,3-CP_LoadRamp** - Filtered Load PID
10. **0,3-CP_LoadPropel** - Final result of propel command (filtered using time ramps and PID for load percentage)
11. **0,3-CP_PROPEL_RAMP** - Filtered Propel command
12. **0,3-CP_1939EngTemp** - Displays Actual Engine temperature
13. **0,3-CP_PID_ON** - Displays status of the Load PID in the engine controller
14. **0,3-CP_1939OilPSI** - Displays actual Engine oil pressure
15. **0,3-CP_PID_OFF** - Displays status of the Load PID in the engine controller
16. **0,3-CP_1939FuelPSI** - Displays Engine fuel pressure in kPa

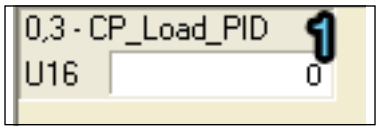

Figure 4-11: Record Screen

Record Screen

The "**RECORD**" screen shot provides featured parameters for the Plus 1 functions. See Figure 4-11.

Below is provided a definitions list for forklift parameters: See Figure 4-11.

1. **0,3-CP_ Load_PID** - Monitors the Load PID via Oscilloscope used for tuning Load percentage

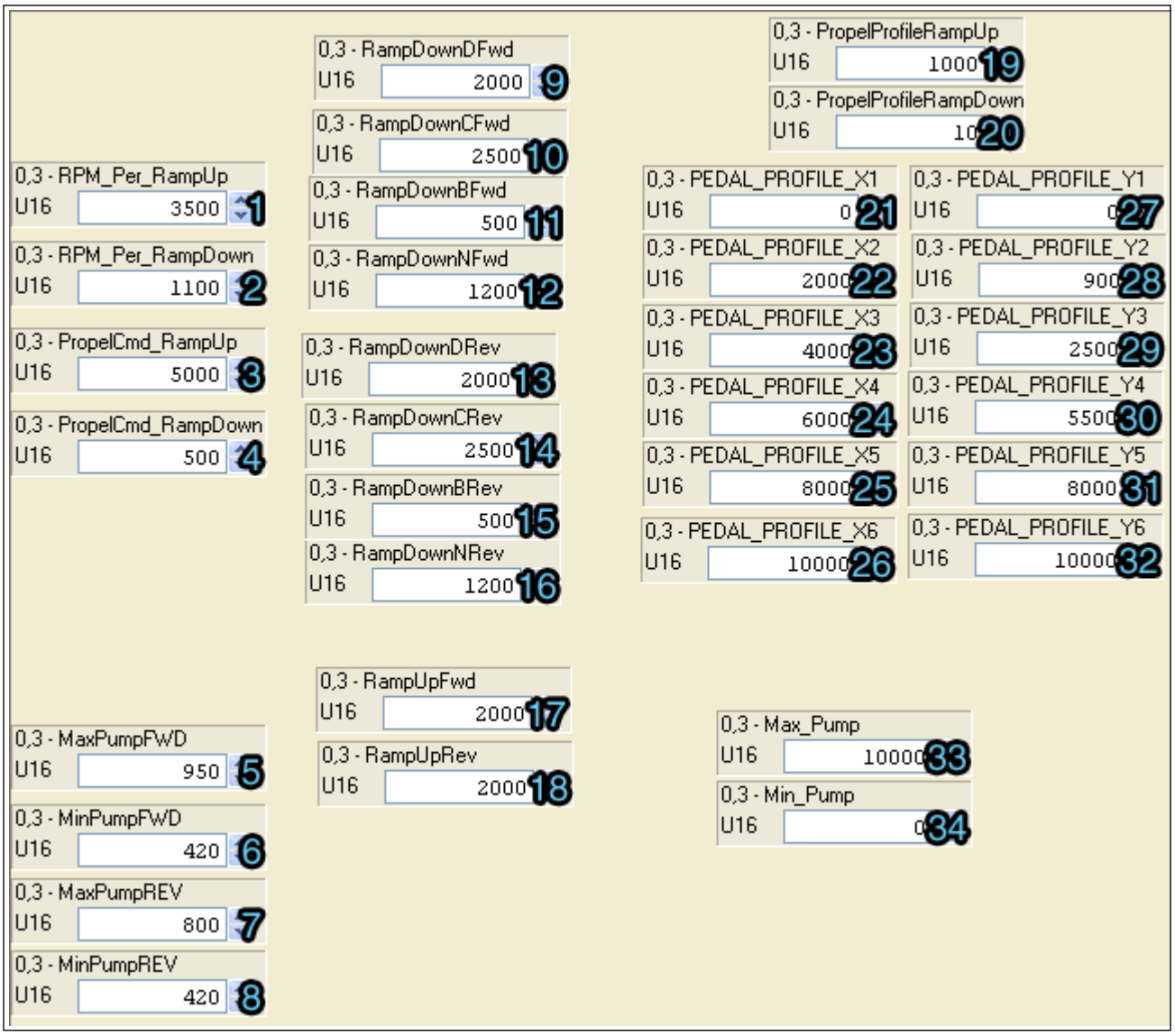

Figure 4-12: Pumps Screen

Pumps Screen

The "**PUMPS**" screen shot provides featured parameters for the Plus 1 functions. **See Figure 4-12.**

Below is provided a definitions list for forklift parameters: See Figure 4-12.

1. **0,3-RPM_Per_RampUp** - Time delay between actual and commanded RPM
2. **0,3-RPM_Per_RampDown** - Time delay between actual and commanded RPM
3. **0,3-PropelCmd_RampUp** - Time delay between actual and commanded Propel command
4. **0,3-PropelCmd_RampDown** - Time delay between actual and commanded Propel command
5. **0,3-MaxPumpFWD** – Defines the max current supplied to the forward direction coil.
6. **0,3-MinPumpFWD** – Defines the min current supplied to the forward direction coil.
7. **0,3-MaxPumpREV** – Defines the max current supplied to the reverse direction coil.
8. **0,3-MinPumpREV** – Defines the min current supplied to the reverse direction coil.
9. **0,3-RampDownDFWD** – Sets the decel rate when changing direction. "Forward to reverse". The lower the value the more aggressive.
10. **0,3-RampDownCFWD** – Sets the decel rate when letting up on the drive pedal. The lower the value the more aggressive.
11. **0,3-RampDownBFWD** – Sets the decel rate when applying the brake. The lower the value the more aggressive.

12. **0,3-RampDownNFWD** - Sets the decel rate when selecting neutral. The lower the value the more aggressive.
13. **0,3-RampDownDRev** – Sets the decel rate when changing direction. “Reverse to forward”. The lower the value the more aggressive.
14. **0,3-RampDownCRev** - Sets the decel rate when letting up on the drive pedal. The lower the value the more aggressive.
15. **0,3-RampDownBRev** - Sets the decel rate when applying the brake. The lower the value the more aggressive.
16. **0,3-RampDownNRev** - Sets the decel rate when selecting neutral. The lower the value the more aggressive.
17. **0,3-RampUpFwd** – Sets the accel rate in the forward direction.
18. **0,3-RampUpRev** – Sets the accel rate in the reverse direction.
19. **0,3-PropelProfileRampUp** – Sets the period for the six point profile to execute, sets timing for smooth operation
20. **0,3-PropelProfileRampDown** - Sets the period for the six point profile to execute, sets timing for smooth operation.
21. **0,3-Pedal_Profile_X**1 – Pre defined in software, for reference only.
22. **0,3-Pedal_Profile_X2** – Pre defined in software, for reference only.
23. **0,3-Pedal_Profile_X3** – Pre defined in software, for reference only.
24. **0,3-Pedal_Profile_X4** – Pre defined in software, for reference only.
25. **0,3-Pedal_Profile_X5** – Pre defined in software, for reference only.
26. **0,3-Pedal_Profile_X6** – Pre defined in software, for reference only.
27. **0,3-Pedal_Profile_Y1** – Pre defined in software, for reference only.
28. **0,3-Pedal_Profile_Y2** – Value sets the scaling of pedal input at 20%.
29. **0,3-Pedal_Profile_Y3** – Value sets the scaling of pedal input at 40%.
30. **0,3-Pedal_Profile_Y4** – Value sets the scaling of pedal input at 60%.
31. **0,3-Pedal_Profile_Y5** – Value sets the scaling of pedal input at 80%.
32. **0,3-Pedal_Profile_Y6** – Value sets the scaling of pedal input at 100%.
33. **0,3-Max_Pump** – Pre defined in software, for reference only.
34. **0,3-Min_Pump** – Pre defined in software, for reference only.

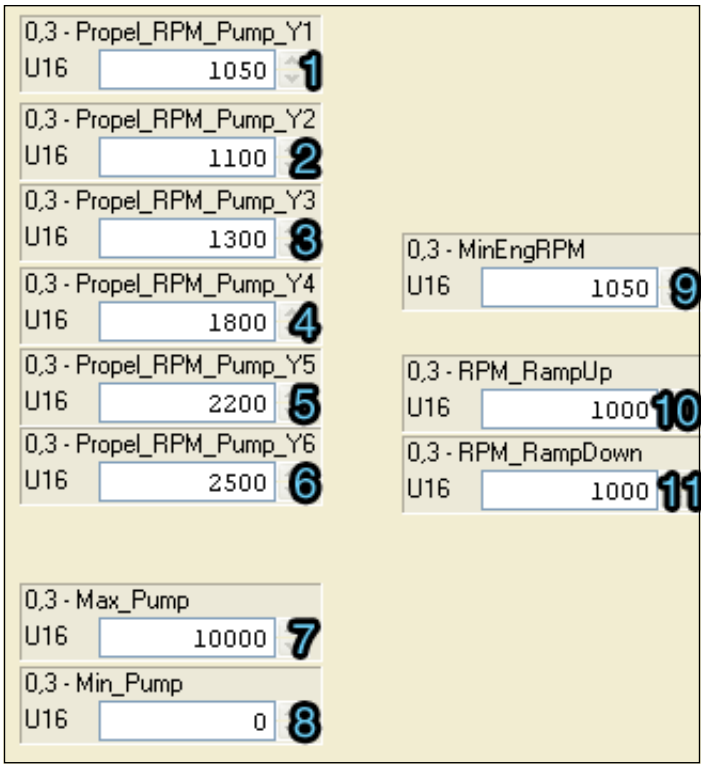

Figure 4-13: Engine Screen

Engine Screen (Parameters)

The “**ENGINE**” screen shot provides featured parameters for the Plus 1 functions. **See Figure 4-13.**

Below is provided a definitions list for forklift parameters: See Figure 4-13.

1. **0,3-Propel_RPM_Pump_Y1** - Pre defined in software, for reference only
2. **0,3-Propel_RPM_Pump_Y2** - Pre defined in software, for reference only
3. **0,3-Propel_RPM_Pump_Y3** - Pre defined in software, for reference only
4. **0,3-Propel_RPM_Pump_Y4** - Pre defined in software, for reference only
5. **0,3-Propel_RPM_Pump_Y5** - Pre defined in software, for reference only
6. **0,3-Propel_RPM_Pump_Y6** - Pre defined in software, for reference only
7. **0,3-Max_Pump** - Predefined in software, for reference only
8. **0,3-Min_Pump** - Pre defined in software, for reference only
9. **0,3-MinEngRPM** - Pre defined in software, for reference only

10. **0,3-RPM_RampUp** - Pre defined in software, for reference only
11. **0,3-RPM_RampDown** - Pre defined in software, for reference only.

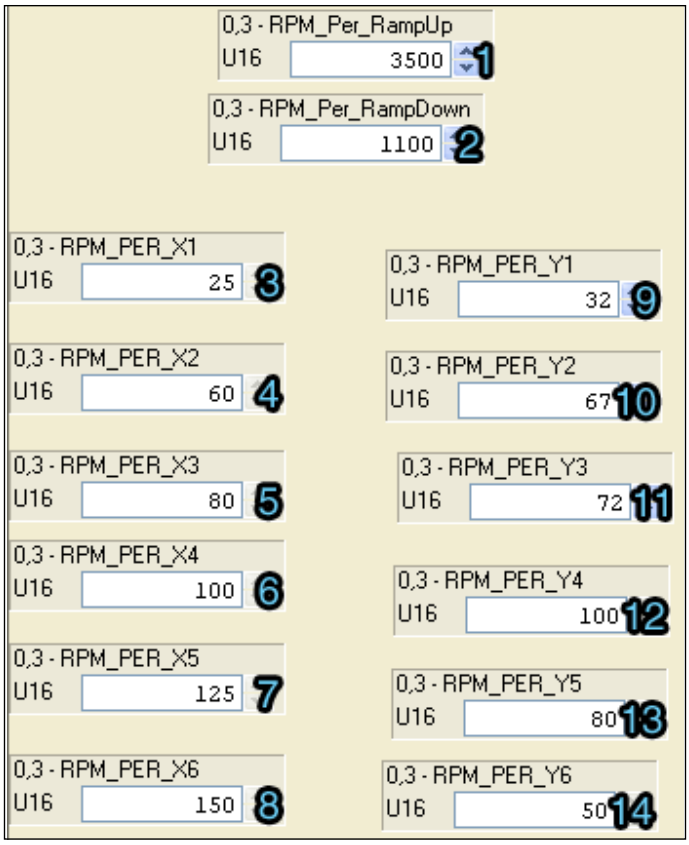

Figure 4-14: Pump Scaler Screen

Pump Scaler Screen

The "**PUMP SCALER**" screen shot provides featured parameters for the Plus 1 functions. **See Figure 4-14.**

Below is provided a definitions list for forklift parameters: See Figure 4-14.

1. **0,3-RPM_Per_RampUp** – Sets period for lift command to execute.
2. **0,3-RPM_Per_RampDown** – Sets period for lift command to execute.
3. **0,3-RPM_PER_X1** – Pre defined in software, for reference only.
4. **0,3-RPM_PER_X2** – Pre defined in software, for reference only.
5. **0,3-RPM_PER_X3** – Pre defined in software, for reference only.
6. **0,3-RPM_PER_X4** – Pre defined in software, for reference only.
7. **0,3-RPM_PER_X5** – Pre defined in software, for reference only.
8. **0,3-RPM_PER_X6** – Pre defined in software, for reference only.
9. **0,3-RPM_PER_Y1** – Value sets the added percent of change required for lift while in motion.
10. **0,3-RPM_PER_Y2** – Value sets the added percent of change required for lift while in motion.
11. **0,3-RPM_PER_Y3** – Value sets the added percent of change required for lift while in motion.
12. **0,3-RPM_PER_Y4** – Pre defined in software, for reference only.
13. **0,3-RPM_PER_Y5** – Pre defined in software, for reference only.
14. **0,3-RPM_PER_Y6** – Pre defined in software, for reference only.

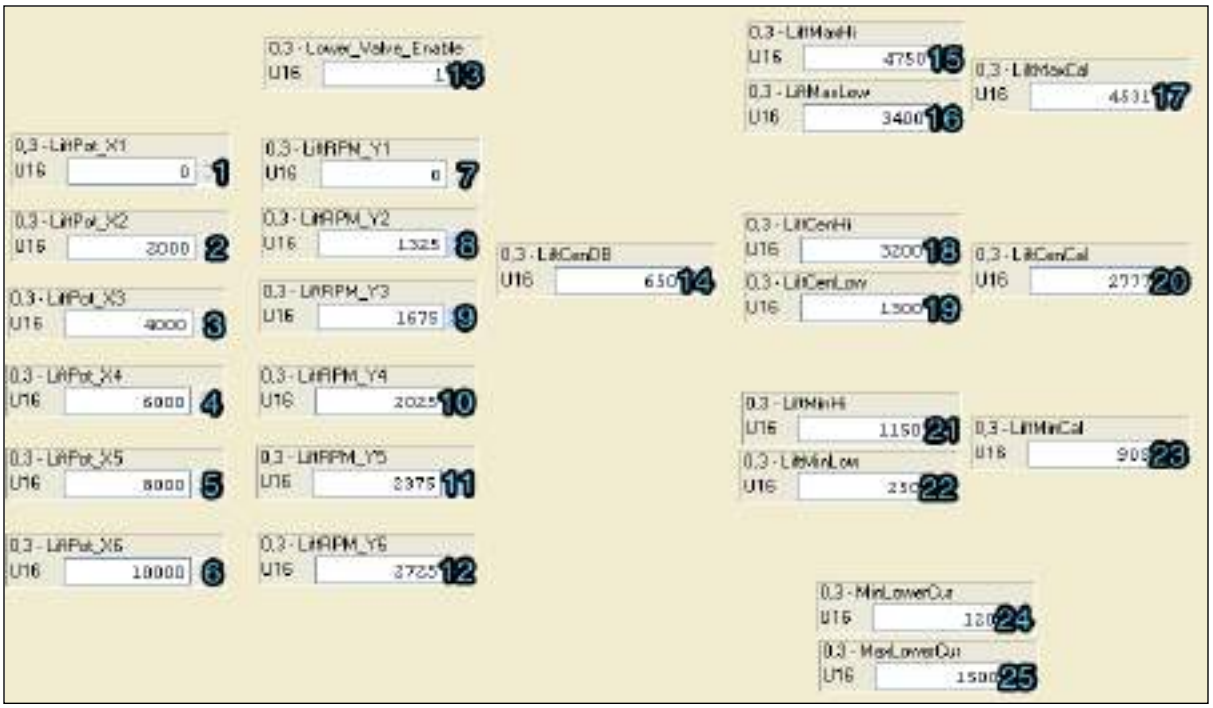

Figure 4-15: Lift Screen

Lift Screen

The "**LIFT**" screen shot provides featured parameters for the Plus 1 functions. See Figure 4-15.

Below is provided a definitions list for forklift parameters: See Figure 4-15.

1. **0,3-LiftPot_X1** – Pre defined in software, for reference only.
2. **0,3-LiftPot_X2** – Pre defined in software, for reference only.
3. **0,3-LiftPot_X3** – Pre defined in software, for reference only.
4. **0,3-LiftPot_X4** – Pre defined in software, for reference only.
5. **0,3-LiftPot_X5** – Pre defined in software, for reference only.
6. **0,3-LiftPot_X6** – Pre defined in software, for reference only.
7. **0,3-LiftPot_Y1** – Pre defined in software, for reference only.
8. **0,3-LiftPot_Y2** – Value sets RPM commanded to engine, Higher value = faster lift.
9. **0,3-LiftPot_Y3** – Value sets RPM commanded to engine, Higher value = faster lift.
10. **0,3-LiftPot_Y4** – Value sets RPM commanded to engine, Higher value = faster lift.
11. **0,3-LiftPot_Y5** – Value sets RPM commanded to engine, Higher value = faster lift.
12. **0,3-LiftPot_Y6** – Value sets RPM commanded to engine, Higher value = faster lift.
13. **0,3-Lower_Valve_Enable** - Enables control of secondary lowering valve that bypasses the lift lower spool valve.
14. **0,3-LiftCenDB** – Value sets the amount of Deadband between lift and lower command.
15. **0,3-LiftMaxHi** – Pre defined in software, for reference only.
16. **0,3-LiftMaxLow** – Pre defined in software, for reference only.
17. **0,3-LiftMaxCal** – Value can be manually entered for lift lever fully back.
18. **0,3-LiftCenHi** – Pre defined in software, for reference only.
19. **0,3-LiftCenLow** – Pre defined in software, for reference only.
20. **0,3-LiftCenCal** – Value can be manually entered for lift lever in neutral position.
21. **0,3-LiftMinHi** – Pre defined in software, for reference only.
22. **0,3-LiftMinLow** – Pre defined in software, for reference only.
23. **0,3-LiftMinCal** – Value can be manually entered for lift lever fully forward.
24. **0,3-MinLowerCur** – Pre defined in software, for reference only.
25. **0,3-MaxLowerCur** – Pre defined in software, for reference only.

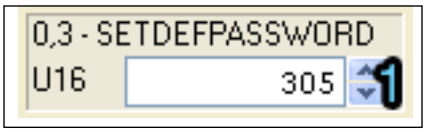

Figure 4-16: Defaults Screen

Defaults Screen

The "**Defaults**" screen shot provides featured parameters for the Plus 1 functions. **See Figure 4-16.**

Below is provided a definitions list for forklift parameters: See Figure 4-16.

1. **0,3-SETDEFPASSWORD** – Resets controller to factory defaults, Enter '2008' in the text box and download to controller.

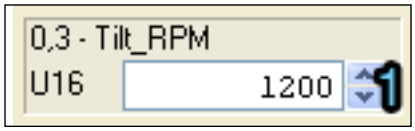

Figure 4-17: Tilt Screen

Tilt Screen

The "**Tilt**" screen shot provides featured parameters for the Plus 1 functions. **See Figure 4-17.**

Below is provided a definitions list for forklift parameters: See Figure 4-17.

1. **0,3-Tilt_RPM** – Value sets the engine RPM commanded when the tilt lever is manipulated ~ Default value is 1200

Figure 4-18: Engine Load Screen

Engine Load Screen

The "**ENGINE LOAD**" screen shot provides featured parameters for the Plus 1 functions. See Figure 4-18.

Below is provided a definitions list for forklift parameters: See Figure 4-18.

1. **0,3-Load_DB** – Pre defined in software, for reference only
2. **0,3-Load_PGAIN** – Pre defined in software, for reference only
3. **0,3-Load_IGAIN** – Pre defined in software, for reference only
4. **0,3-Load_DGAIN** – Pre defined in software, for reference only
5. **0,3-Load_T1** – Pre defined in software, for reference only
6. **0,3-LOAD_RPM_X1** – Pre defined in software, for reference only
7. **0,3-LOAD_RPM_X2** – Pre defined in software, for reference only
8. **0,3-LOAD_RPM_X3** – Pre defined in software, for reference only
9. **0,3-LOAD_RPM_X4** – Pre defined in software, for reference only
10. **0,3-LOAD_RPM_X5** – Pre defined in software, for reference only
11. **0,3-LOAD_RPM_X6** – Pre defined in software, for reference only
12. **0,3-MAP_VALUE** – Pre defined in software, for reference only
13. **0,3-MaxEngLoad** – Pre defined in software, for reference only
14. **0,3-LoadPID_RampDown** – Pre defined in software, for reference only
15. **0,3-LoadPID_RampUp** – Pre defined in software, for reference only
16. **0,3-Propel_RPM_Pump_Y1** – Pre defined in software, for reference only.
17. **0,3-Propel_RPM_Pump_Y2** – Pre defined in software, for reference only.
18. **0,3-Propel_RPM_Pump_Y3** – Pre defined in software, for reference only.
19. **0,3-Propel_RPM_Pump_Y4** – Pre defined in software, for reference only.
20. **0,3-Propel_RPM_Pump_Y5** – Pre defined in software, for reference only.
21. **0,3-Propel_RPM_Pump_Y6** – Pre defined in software, for reference only.
22. **0,3-PID_On_Value** – Pre defined in software, for reference only.

23. **0,3-PID_Off_Value** – Pre defined in software, for reference only.

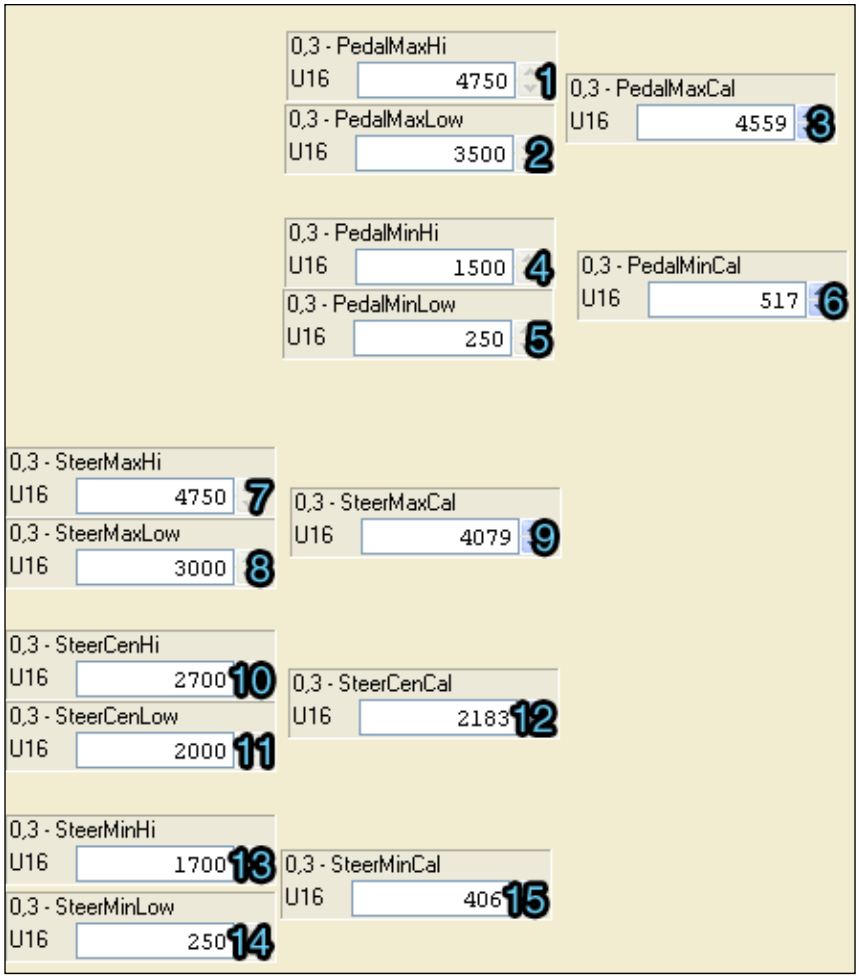

Figure 4-19: Calibration Screen

Calibration Screen

The "**CALIBRATION**" screen shot provides featured parameters for the Plus 1 functions. **See Figure 4-19.**

Below is provided a definitions list for forklift parameters: See Figure 4-19.

1. **0,3-PedalMaxHi** – This value is for fault detection during calibration. Default value = 4750, If the pot returns a voltage higher than this value during calibration, calibration will be unsuccessful. Pedal fully depressed.
2. **0,3-PedalMaxLow** – This value is for fault detection during calibration. Default value = 3500, If the pot returns a voltage below this value during calibration, calibration will be unsuccessful. Pedal fully depressed.
3. **0,3-PedalMaxCal** – This is the actual value of the accel pot "fully depressed" based on last calibration. Pedal fully depressed.
4. **0,3-PedalMinHi** - This value is for fault detection during calibration. Default value = 1500, If the pot returns a voltage higher than this value during calibration, calibration will be unsuccessful. Pedal in neutral position.
5. **0,3-PedalMinLow** - This value is for fault detection during calibration. Default value = 250, If the pot returns a voltage below this value during calibration, calibration will be unsuccessful. Pedal in neutral position.
6. **0,3-PedalMinCal** - This is the actual value of the accel pot "in neutral position" based on last calibration. Pedal in neutral position.
7. **0,3-SteerMaxHi** – This value is for fault detection during calibration. Default value = 4750, If the pot returns a voltage higher than this value during calibration, calibration will be unsuccessful. Steer full left.

8. **0,3-SteerMaxLow** – This value is for fault detection during calibration. Default value = 3000, If the pot returns a voltage below this value during calibration, calibration will be unsuccessful. Steer full left.
9. **0,3-SteerMaxCal** - This is the actual value of the steer pot “steer full left” based on last calibration. Steer full left.
10. **0,3-SteerCenHi** - This value is for fault detection during calibration. Default value = 2700, If the pot returns a voltage higher than this value during calibration, calibration will be unsuccessful. Steer center.
11. **0,3-SteerCenLow** - This value is for fault detection during calibration. Default value = 2000, If the pot returns a voltage below this value during calibration, calibration will be unsuccessful. Steer center.
12. **0,3-SteerCenCal** - This is the actual value of the steer pot “steer center” based on last calibration. Steer center.
13. **0,3-SteerMinHi** – This value is for fault detection during calibration. Default value = 1700, If the pot returns a voltage higher than this value during calibration, calibration will be unsuccessful. Steer full right.
14. **0,3-SteerMinLow** - This value is for fault detection during calibration. Default value = 250, If the pot returns a voltage below this value during calibration, calibration will be unsuccessful. Steer full right.
15. **0,3-SteerMinCal** - This is the actual value of the steer pot “steer full right” based on last calibration. Steer full right.

Figure 4-20: Steer Profile Screen

Steer Profile Screen

The “**STEER PROFILE**” screen shot provides featured parameters for the Plus 1 functions. **See Figure 4-20.**

Below is provided a definitions list for forklift parameters: See Figure 4-20.

1. **0,3-STEER_RPM_X1** – Pre defined in software, for reference only.
2. **0,3-STEER_RPM_X2** – Pre defined in software, for reference only.
3. **0,3-STEER_RPM_X3** – Pre defined in software, for reference only.
4. **0,3-STEER_RPM_X4** – Pre defined in software, for reference only.
5. **0,3-STEER_RPM_X5** – Pre defined in software, for reference only.
6. **0,3-STEER_RPM_X6** – Pre defined in software, for reference only.
7. **0,3-STEER_RPM_Y1** – Pre defined in software, for reference only.
8. **0,3-STEER_RPM_Y2** – Pre defined in software, for reference only.
9. **0,3-STEER_RPM_Y3** – Pre defined in software, for reference only.
10. **0,3-STEER_RPM_Y4** – Value set max RPM for percent of steer angle.
11. **0,3-STEER_RPM_Y5** – Value set max RPM for percent of steer angle.
12. **0,3-STEER_RPM_Y6** – Value set max RPM for percent of steer angle.

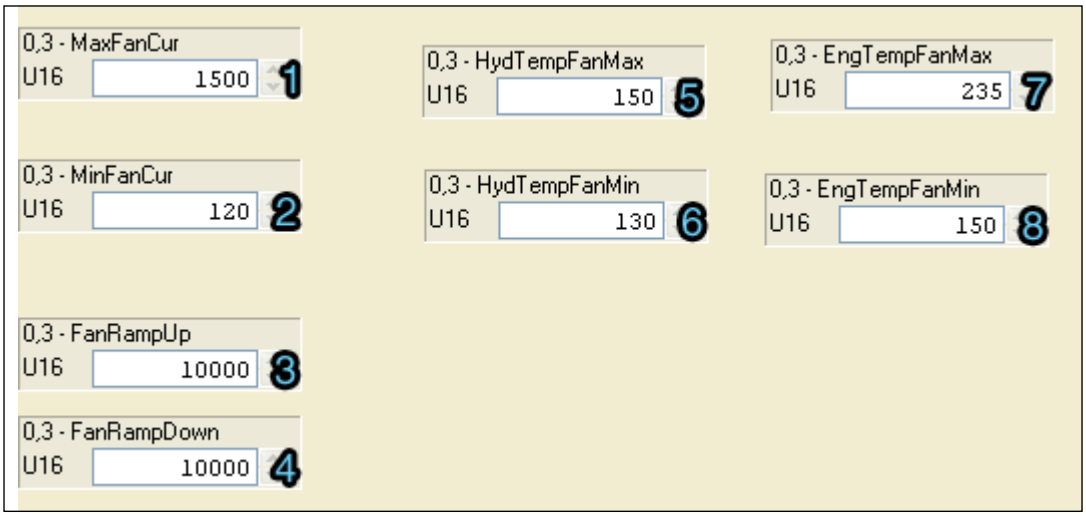

Figure 4-21: Fan Screen

Fan Screen

The "**FAN**" screen shot provides featured parameters for the Plus 1 functions. **See Figure 4-21.**

Below is provided a definitions list for forklift parameters: See Figure 4-21.

1. **0,3-MaxFanCur** – Pre defined in software, for reference only.
2. **0,3-MinFanCur** – Pre defined in software, for reference only.
3. **0,3-FanRampUp** – Pre defined in software, for reference only.
4. **0,3-FanRampDown** – Pre defined in software, for reference only.
5. **0,3-HydTempFanMax** – Pre defined in software, for reference only.
6. **0,3-HydTempFanMin** – Pre defined in software, for reference only.
7. **0,3-EngTempFanMax** – Pre defined in software, for reference only.
8. **0,3-EngTempFanMin** – Pre defined in software, for reference only.

Dash Display Calibration and Operation

CAUTION

While Calibration you will be operating many functions of the forklift and it is imperative that you position the forklift in an area without obstructions or personnel, that may be injured or product damaged.

Before **starting** to operate the forklift, for safe forklift operation, monitoring and performance testing:

- Be in a safe operating position.
- Apply parking brake.
- Place directional control in neutral.

To operate the forklift and begin Dash Display Calibration:

1. The ignition switch must be on, but the engine does not need to be running at this point. Later in step #6 you will need to then start the engine.
2. The display shown below will be shown with the ignition on, before the forklift is started. **See Figure 4-22.**

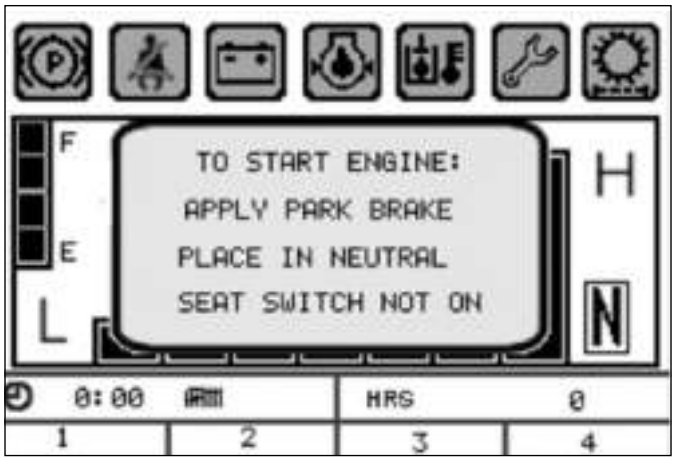

Figure 4-22: Display When Ignition On, Forklift Not Started

3. After the forklift is running and when the forklift and system are functioning correctly the row of "**Icons**" across the top of the "System Active" screen will not be seen. Each warning icon is described for your future reference. **See Figure 4-23.**

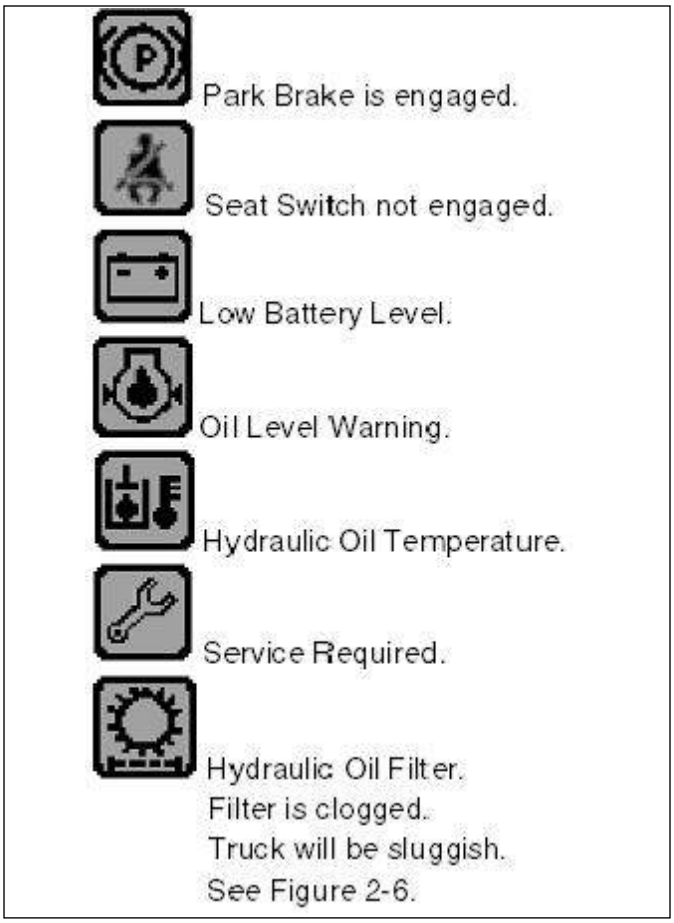

Figure 4-23: Warning Icons

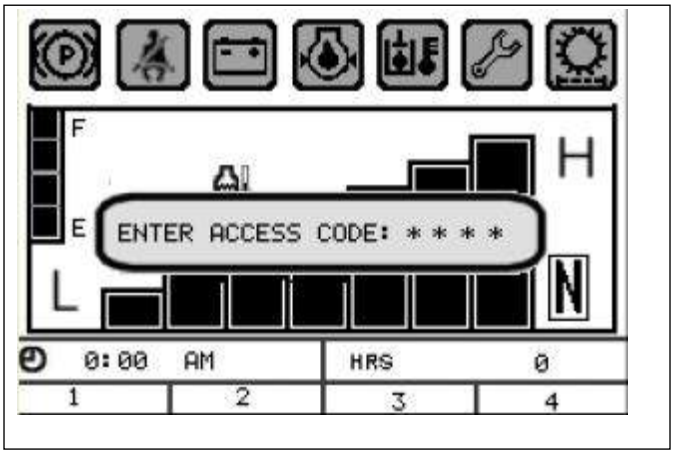

Figure 4-24: Access Code Screen

4. To view vehicle fault codes, engine fault codes and to access the service screen press and hold buttons 1 and 2 for four seconds.
5. When prompted for the access code enter 4 2 3 1. **See Figure 4-24.**
6. Turn ignition “ON” and start the forklift. The display shown below will be displayed. **See Figure 4-25.**

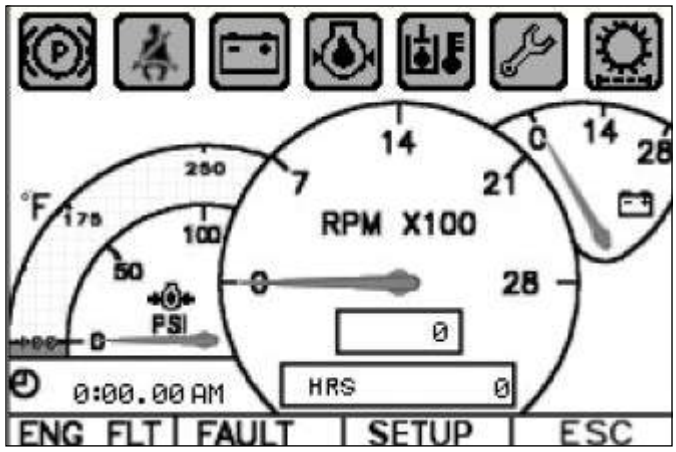

Figure 4-25: Sub Menu Screen

When a “Service Required”warning indication is given press the “ENG FLT” button located at the bottom of the display, **See Figure 4-25.** Obtain the SPN# fault information from the display as shown, which can be used in correlation with the Diagnostic Trouble Charts provided on starting on page 5-12. **See Figure 4-26.** Press the left button to change between “Active” and “Inactive” engine faults.

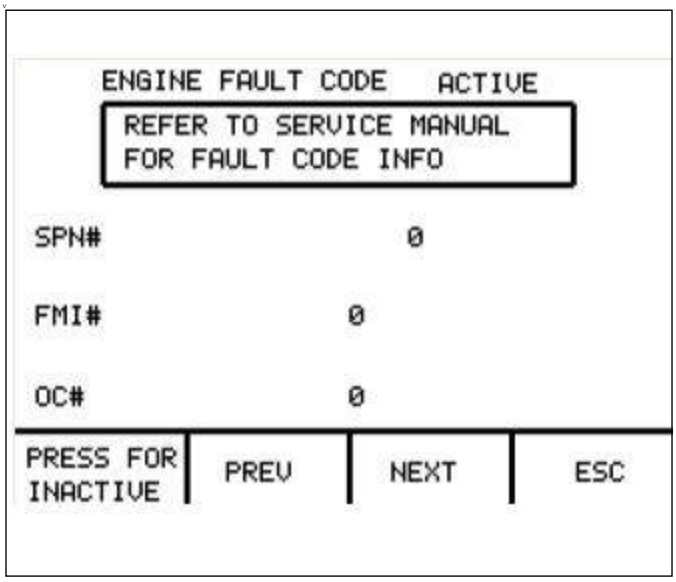

Figure 4-26: Engine Fault Code Screen

All other vehicle faults require you to press the “FAULT” button at the bottom of the display for description of the problem. **See Figure 4-27** for vehicle faults.

Figure 4-27: Vehicle Fault Screen

7. For Calibration of forklift functions first press the "SETUP" button located at the bottom of the display. **See Figure 4-25.**

NOTE

Read and understand through page 4-16 before continuing.

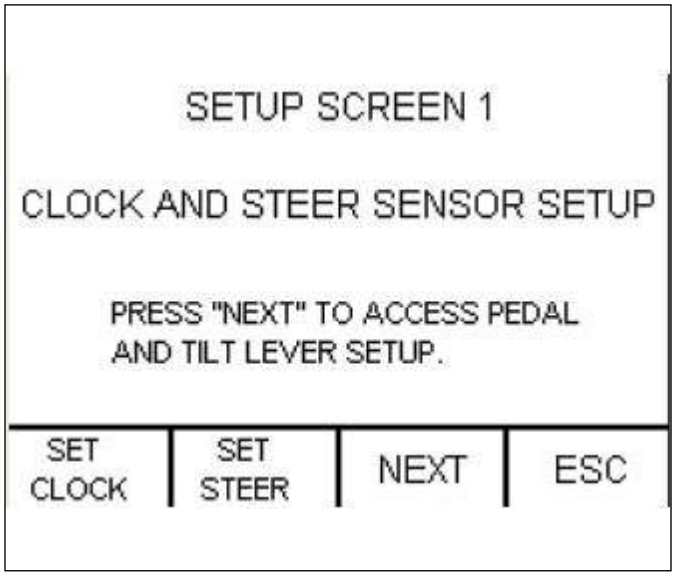

Figure 4-28: Setup Screen One

Setup screen 1 will allow you to set the clock and calibrate the steering settings. When completed with setup screen 1 and the steering is calibrated, press "NEXT" to proceed to "SETUP SCREEN 2" which will allow you to calibrate the drive pedal and tilt lever functions. **See Figure 4-28.**

IMPORTANT

At any time, with any of the three "SET STEER", "SET PEDAL" and/or "SET LIFT" settings if you require direction or assistance, select the "HELP" button and the steps required to complete that section of calibration will appear on the screen. See Figure 4-29. See Figure 4-30, showing the "SET STEER" function.

NOTE

In order to set the steer sensor, the engine must be running and the parking brake disengaged.

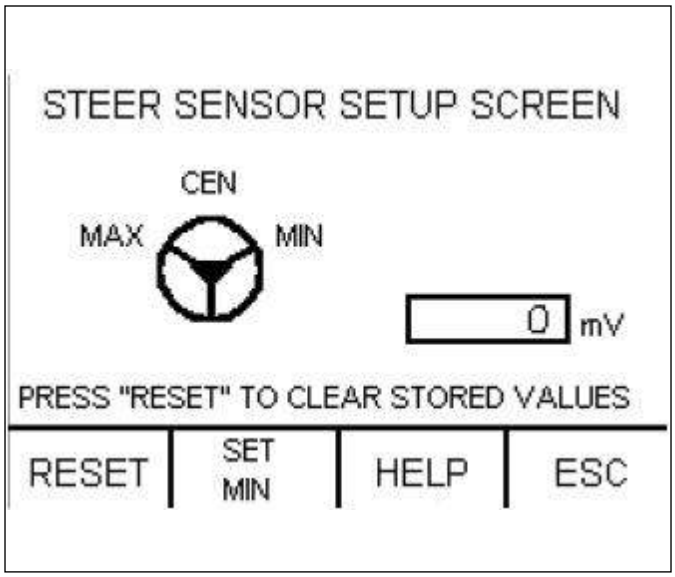

Figure 4-29: Set Steer Sensor Screen

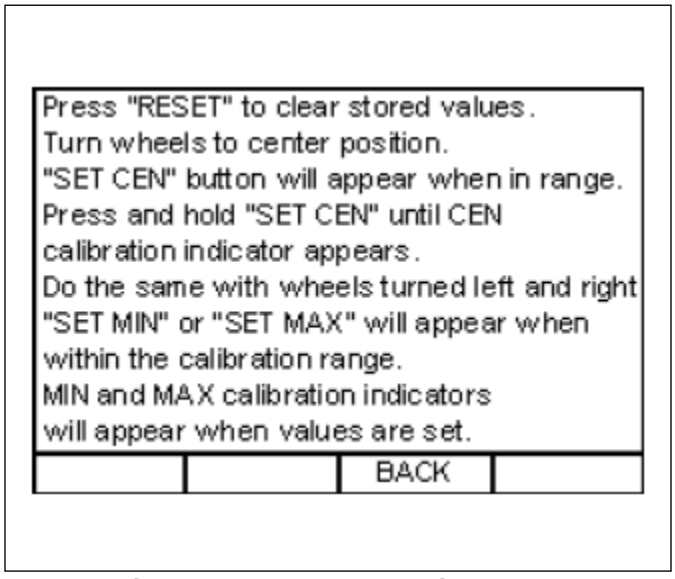

Figure 4-30: Set Steer Help Screen

Press “NEXT”” to proceed to “SETUP SCREEN 2” which will allow you to calibrate the drive pedal and Tilt Lever functions. **See Figures 4-31**, **4-32** and **4-33**.

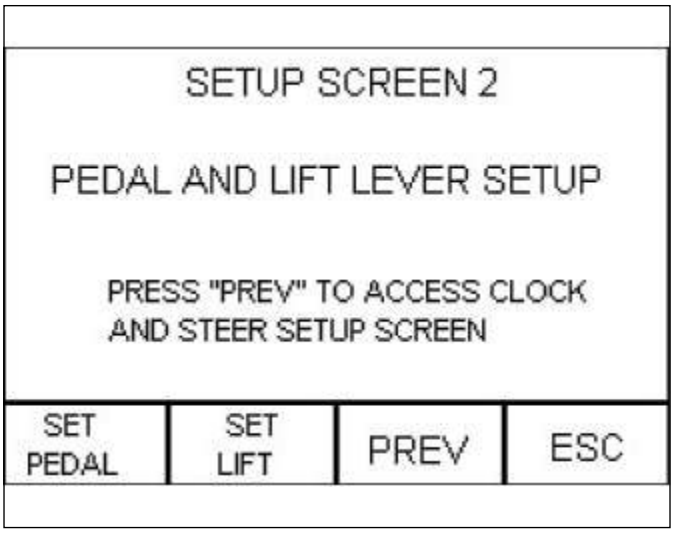

Figure 4-31: Setup Screen Two

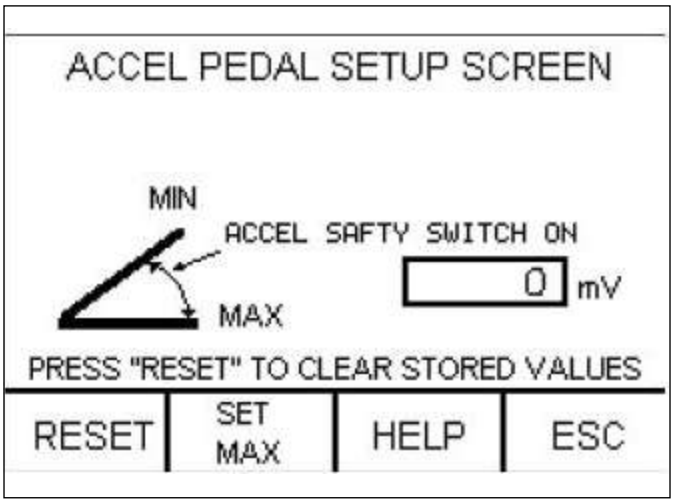

Figure 4-32: Acceleration Pedal Setup Screen

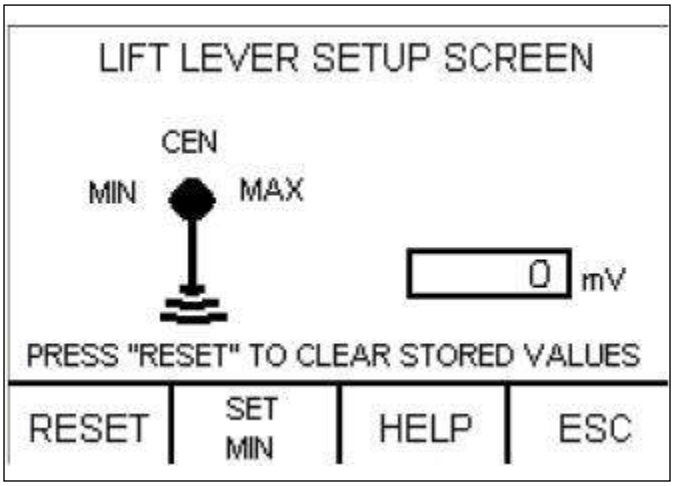

Figure 4-33: Lift Lever Setup Screen

Chapter 5

Engine with Fuel System

2.4 Liter GM 4 Cylinder Engine with GFI LPG Fuel Injection

2.4L LPG ENGINE DESCRIPTION	Specification
ENGINE CONFIGURATION	2.4L L4
Displacement	2,405 cc (147 cid)
Bore spacing (mm)	93.0
Bore x Stroke (mm)	87.5 x 100
Firing Order	1-3-4-2
Fuel Type	LPG
Engine Rotation (from the front / fan side)	Clockwise
Compression Ratio	9.6:1
Main bearing caps	2 bolt
Cam Drive	20 mm Toothed Belt
Valve train Configuration	SOHC / 2V
Valve Rocker	End pivot rocker / radiused cam follower
Valve Lifter / Lash Adjuster	Hydraulic lash adjusters in head
Crankcase Ventilation	Foul Air System with PCV
Oil Pan Capacity (excludes filter volume)	4.3L
LPG fuel system pressure	0.88 bar
Balancer/Pulley	Yes with 6 groove Poly V
Oil Level Indicator (Dipstick)	Yes
Oil Filter - screw into / location	Oil pump Assy/frnt of eng
Ventilation / PCV system	“Foul Air” System
- cam housing to intake plumbing	Yes (includes PCV)
- crankcase to cam housing plumbing	Yes
Water pump	Yes
Cooling - t/stat (start to open/full open)	82/97oC
Intake Manifold	Aluminum PFI Style
Exhaust Manifold	Cast iron with heat shield Dual channel

2.4L LPG ENGINE DESCRIPTION	Specification
IGNITION	
Spark Plugs	Conventional J-gap (.035")
DIS Coil pack	Mounted Side of Head
Plug Wires & retainers	Yes
PERFORMANCE	
Idle/Max Speed	1000 / 2700 rpm
Peak Torque	180 Nm (133 ft.-lbs)
Power	50 kW (67 hp)

2.4L LPG Engine GM Service Notes

Component	P/N	OEM Application	Notes
Spark Plug	151443	1000 hrs	Standard “J-gap” plug, no precious metal, gap: 0.9mm Torque: 25-30 N-m (18-22 lb.-ft.)
Spark Plug Wires	153465	1000 hr / 30 mo	
Oil Filter	149394	Every Oil Change	
Oil		300 hrs	ILSAC GF-3 is basically an API “SL” quality oil. 5W30 or 10W30 is acceptable.
Timing Belt	151439	1200 hrs	
GM Recommended Coolant		5,000 hr / 5 years	Coolant meeting GM6277M Spec - Dexcool recommended - this is a non silicate coolant, orange in color. 50/50 mix with distilled water.
Positive Crankcase Ventilation (PCV)		1600 hr	Replace any worn, plugged or collapsed hoses.

2.4L LPG Engine System Operation Overview

Based on the various inputs, the ECU determines the appropriate amount of air, fuel and spark advance to supply the requested engine speed. The calculations are based on a speed/ density calculation that uses MAP, MAT, engine speed, and volumetric efficiency to determine the airflow into the engine, and therefore, the optimum fueling for the engine. Engine RPM is determined from the crankshaft position sensor. The crank sensor is a reluctor sensor. The sensor generates 60 -2 pulses per engine revolution. The ECU translates the 60 -2 pulses into engine RPM and crankshaft rotational position. The ECU then commands the appropriate throttle angle from the electronic throttle and the appropriate injector pulse width.

Injector phasing is based on the camshaft sensor. The camshaft sensor is a Hall Effect sensor that sends a signal one per camshaft revolution, or once every 2 engine revolutions. The ECU then monitors the Oxygen sensor to make corrections for minor errors in the fueling. The ECU has the capability of both long term and short term fueling corrections. Long term is stored in memory and is not lost at key “OFF.”

2.4L LPG Engine System Operation

The manufacturer of record for the 2.4L engine, fuel and emissions system is GFI. The key components of the 2.4L engine system are the propane vaporizer, the electronic throttle, the engine control unit (ECU), the injector driver module, the fuel rail, the propane injectors, the oxygen sensor and the catalytic converter. The system operation, which operates on a torque based control strategy, is summarized as follows:

Propane

LPG is stored in the fuel storage cylinder in liquid form at pressures ranging from 25 to 300 psig (depending on the ambient temperature). When liquid propane changes from a liquid to a vapor, it expands 270 times. Heat and a drop in pressure, supplied by the engine coolant and the fuel vaporizer, are required to change the propane from the liquid form to a vapor. The fuel storage cylinders used for this application are designed to deliver liquid fuel, unlike a cooking cylinder that is designed to deliver vapor.

LPG Tank Valve

The valve opens and liquid propane flows from the fuel storage cylinder to the vaporizer through an integral liquid fuel filter.

Fuel Shutoff Solenoid

This solenoid is a normally closed valve on the vaporizer, controlled by the engine ECU, allows the fuel to flow into the vaporizer when the ignition key is turned on and the engine is running. The fuel shutoff solenoid is also opened momentarily (for 2 seconds) when the ignition is first turned on to allow the system to pressurize even if the engine is not started.

Vaporizer

When the fuel shutoff solenoid (1) on the vaporizer is open, liquid propane flows into the vaporizer (B) where the pressure is reduced to approximately 88 kPa (12.6 psi) and heat from the engine coolant (D) are used to convert the liquid fuel to gas (A). The regulator mechanism in the vaporizer provides the gaseous propane at a consistent operating pressure of 88 kPa (12.6 psi), referenced to the manifold pressure, to the fuel rail and gaseous fuel injectors. By referencing the outlet fuel pressure to manifold pressure, the injectors can have a longer pulse widths at idle (low MAP, hence low fuel pressure) which results in a more stable idle and also supply the required maximum flow at full load (high MAP, hence high fuel pressure).

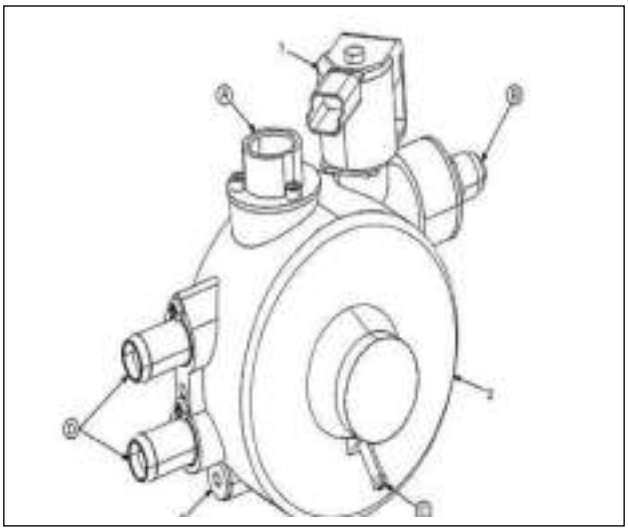

Figure 5-1: Vaporizer

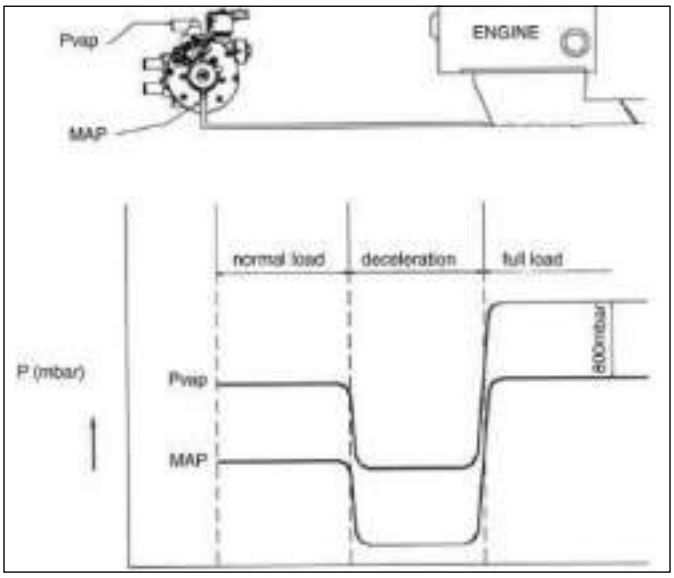

Figure 5-2: Vaporizer Pressure Regulation

Electronic Throttle

The electronic throttle plate is commanded to open by the ECU. A servo motor on the throttle opens the throttle plate and a throttle position sensor sends a signal back to the ECU to confirm the commanded opening is achieved. The electronic throttle performs the tasks of idle and over-speed governing. If there is a sensor failure in the throttle the power to the motor is shut off and the plate assumes a limp home position (just slightly open to allow a high idle of the forklift).

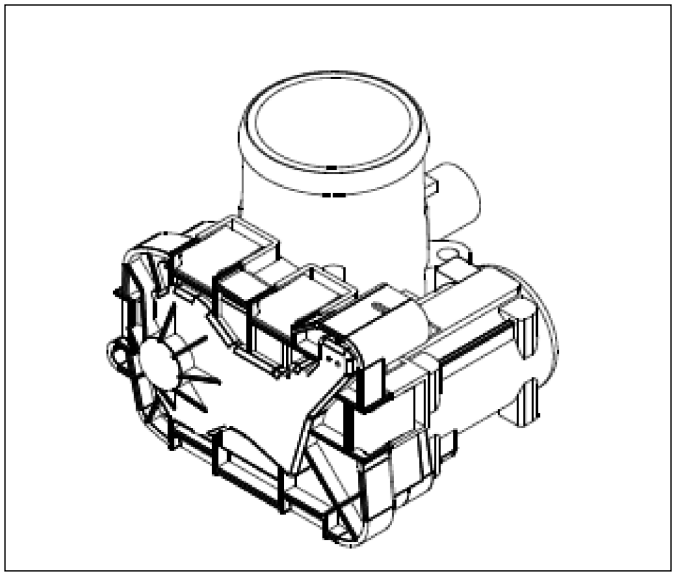

Figure 5-3: Throttle Body

As mentioned previously, if there is a throttle related failure, the electronic throttle will go into a “LIMP HOME” mode of operation. This mode of operation has the symptom of no engine response to the pedal. Check for any throttle body codes and remedy the situation. Then clear the codes and key off the vehicle and let sit for at least 30 seconds. This resets the ECU and removes the “LIMP HOME” throttle mode and should return pedal response. The “LIMP HOME” mode can be triggered by simply disconnecting the throttle body connector while the vehicle power is on. If the throttle body of an engine has to be replaced, the range of travel of the new throttle has to be learned by the ECU. It is important to open the S3000 monitor software, see page 5-15 through page 5-18, to clear the EEPROM in the diagnostics tab.

The key switch must then be turned off for 30 seconds.

When the key is switched back on the ECU will cycle the throttle body through the full range of motion to re-learn the throttle body end stops.

S3000 Engine Control Unit (S3000)

The S3000 ECU is the command and control unit for the 2.4 liter LPG engine. The ECU monitors inputs, performs engine management calculations and controls outputs to achieve the desired engine performance. The ECU also monitors the various input and output components, as well as it’s own internal functioning, for failures and then alerts the operation if any failures occur. The ECU also supplies the forklift controller with various engine operating parameters to allow for proper forklift operation. The S3000 ECU along with the S3000 Monitor software allows monitoring and recording of engine operating parameters as well as reading and clearing engine Diagnostic Trouble Codes (DTCs). The S3000 Monitor software is run in a Windows XP operating system on a laptop or desktop PC. The connection from the PC to the S3000 is through a Kvaser or iFak cable which connects to the USB port of the PC and to the CAN BUSS lines of the S3000 ECU (pin 2 of the 9 pin connector is CAN L and pin 7 is CAN H). The corresponding CAN wires can be found on the engine harness 8 pin Duetch connector CRP83 pins 7 (CAN H)and 8 (CAN L). See Figure 4-2.

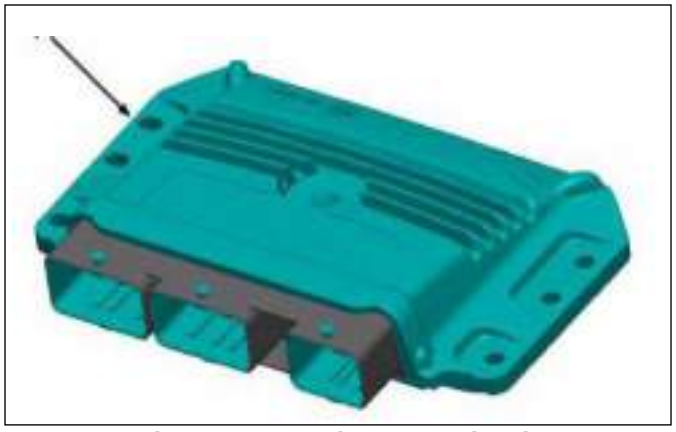

Figure 5-4: Engine Control Unit

The ECU (S3000) opens the throttle to the required opening to obtain the commanded speed. It then calculates the airflow into the engine based on MAP, speed, air and coolant temperature. The correct amount of fuel for the this airflow is calculated and injection signals, compensated for the actual measured fuel pressure, are sent to the injector driver unit which drives the peak and hold current injectors to deliver fuel to each intake manifold runner in sequence. The spark timing is set for optimum drivability and emissions. The resulting fuel air mixture is burned in the cylinder supplying torque to the crankshaft. The heated exhaust gas oxygen (HEGO) sensor is used to determine if the fueling was rich or lean of mixture and the injector pulse widths are then trimmed to provide fueling, which cycles the air to fuel ratio around the optimum 15.7 : 1 air to fuel ratio, to achieve maximum catalyst reduction of pollutants.

MAP Sensor and MAT Sensor

The MAP/MAT sensors are combined into one unit that is fitted into a port in the intake manifold to allow it to read MAT and MAP. The MAT portion of the sensor is a negative coefficient thermistor. This means that as the temperature goes up, the resistance drops. 5 volts is supplied across the sensor The voltage drop, which varies by temperature, is used to determine the manifold air temp. The MAP sensor is a 5 volt pressure transducer. When the pressure changes, the signal voltage varies from .5 to 4.5 volts.

Figure 5-5: Map/Mat Sensor Location

CAM Sensor

The camshaft sensor is mounted towards the end of the cylinder head. It is a Hall Effect sensor that is triggered by a hole on the end of the cam shaft. The signal is one pulse for every 2 engine revolutions, and is used to phase the fuel injection with the proper engine stroke. The engine will run without this signal but will have throttle tip hesitation problems.

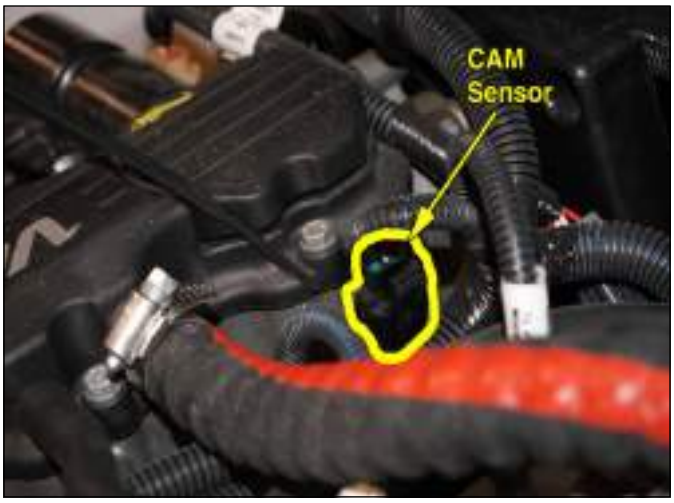

Figure 5-6: CAM Sensor Location

Crank Sensor

The crank position sensor is a reluctor sensor that is triggered by a 60 -2 toothed wheel on the crankshaft. The 2 missing teeth are used to determine engines rotational position. The crank sensor is the source of all other ECU functions so if this sensor is not functioning the ECU will not see an engine speed and will not provide fuel or spark to the engine.

Figure 5-7: Crank Shaft Sensor Location

Fuel Rail, Fuel Pressure & LPG Injectors

The now gaseous LPG flows into the fuel rail where it is distributed to the four LPG injectors. At the opposite end of the fuel rail to the inlet port (5) there is a Fuel Absolute Pressure (FAP) sensor, this sensor allows the ECU to lengthen or shorten the fuel injector pulse width to compensate for variations in the absolute fuel pressure supplied to the injectors. The fuel injectors are held in place in the fuel adapters (3) and the fuel injector brackets (2). The fuel rail does not hold the injectors in

place and should not be touching the top of the injectors as this can affect their performance. The propane injectors are a pulse width modulated injector. The greater the on time, or duty cycle, the more fuel will flow. The operation of the injectors is based on a diaphragm instead of a plunger principle. Two conditions are possible: The injector opens electrically by pulling the steel core on the diaphragm, by means of a magnetic field that is generated in the injector coil, during the opening period. As soon as the magnetic field in the injector coil drops, by the ECU opening the injector circuit, the injector closes under the influence of the LPG pressure across the diaphragm, which is delivered by the vaporizer.

Figure 5-8: Fuel Rail

Figure 5-9: Fuel Pressure Sensor Location

Heated Oxygen Sensor

The heated oxygen sensor in the exhaust just downstream of the exhaust manifold measures the oxygen content of the exhaust and feeds this information in the form of a voltage to the ECU. A high voltage (above 0.45) signals a fuel rich exhaust mixture while a low voltage (under 0.45) indicates a fuel lean mixture. The ECU uses this information to swing the fuel rich and lean at 2 to 10 times a second to supply the catalyst with the optimum mixture for emissions reduction.

The O2 sensor

The O2 sensors used in this engine are “planar” type sensors and require a small pumping current, supplied by the ECU, to function correctly. Normally the voltage from these sensors swings between 0.2 and 0.8 volts. However, if the pumping current is missing, or the sensor heater has malfunctioned, or if the sensor circuit is open, the O2 sensor voltage will rise to above 2.0 volts.

Three-Way Catalytic Converter

The 3-way converter uses a catalyst to convert HC (in the form of unburned gasoline), CO, and NOx (created when the heat in the engine forces nitrogen in the air to combine with oxygen) into harmless compounds. The converter is often called a three-way catalytic converter because it helps in reducing these three regulated emissions. In the converter, the catalyst (in the form of platinum and palladium) is coated onto a ceramic honeycomb that is housed in a muffler-like package attached to the exhaust pipe. The catalyst helps to convert carbon monoxide into carbon dioxide. It converts the hydrocarbons into carbon dioxide and water. It also converts the nitrogen oxides back into nitrogen and oxygen.

Fuel Gauge Quick Troubleshooting Guide

Shown below are common fuel gauge7 faults and possible related causes as well as helpful remedies:

Fault	Cause	Remedy
No Operation / Display Possible: (e.g. Display is Showing “Empty”)	Sonatic® FLT not properly connected. Cylinder with content < 50% installed or reset performed with cylinder content <50% contact area soiled / frozen. Wrong washers between Sonatic® FLT and hinged flap. Heavy deposits / soiling on LPG cylinder.	> Switch ignition on, check fuse and cabling. > Install cylinder with content > 50%. > Carefully clean / de-ice contact area. > Use correct washers. > Problem is cylinder related, fill level of this LPG cylinder cannot be displayed.
Incorrect display value:	LPG cylinder with similar filing level to previous one has been installed. Maximum forklift tilt limit exceeded when ignition switch is on. LPG cylinder placed into bracket incorrectly. Bracket not horizontal. Incorrect calibration value, e.g. caused by: - LPG cylinder with different diameter or abnormal liquid gas mixture. - Incorrect calibration.	> Perform reset or place full LPG cylinder into bracket. > Move forklift to level location and switch ignition off and back on. > Check LPG cylinder stop adjustment, place LPG cylinder into bracket correctly and secure. > Fit bracket in a horizontal position and calibrate.
Display continuously indicating “Empty” and remaining time indicator flashing continuously: (Between 0.5V and 0.8V, without load, in 0.25Hz)	Reset connection open.	> Close connection.
		Chart continued on next page for clarity.

Fault	Cause	Remedy
Pointer in gauge fluctuates continuously in first quarter: (Between 0.5V and 1.5V in 0.25Hz)	No LPG cylinder fitted. Maximum forklift limit exceeded. Contact area soiled / frozen. Wrong washers between Sonatica® FLT and hinged flap. Heavy deposits / soiling in LPG cylinder.	> Re-couple Sonatic® FLT to cylinder, switch ignition on again. > Place full LPG cylinder into bracket. > Move forklift to level location and switch ignition off and back on. > Carefully clear /de-ice contact area. > Use correct washers. > Problem is cylinder related, fill level of this cylinder cannot be displayed correctly.
Display value fluctuating continuously in first half immediately after ignition is switched on (Between 0.5V and 2.5V in 0.25Hz).	Sensor defective.	
Display value fluctuating continuously over entire range (Between 0.5V and 4.5V in 0.25Hz).	Calibration connection is open.	Close connection and re-calibrate.
Forklift stops even though gauge is indicating a fill level.	LPG cylinder installed in wrong position. Valve or dip tube has been installed in the LPG cylinder, in a twisted position. Heavy deposits / soiling in the LPG cylinder.	> Align LPG cylinder and secure. > Problem is cylinder related, fill level of this LPG cylinder and cannot be correctly displayed. > Problem is cylinder related, fill level of this LPG cylinder and cannot be correctly displayed.
Reset procedure unsuccessful.	No supply voltage, erroneous cabling.	> Restore supply voltage. > Cable correctly.
Calibration unsuccessful.	Exact order not followed. LPG cylinder not placed into bracket correctly. Full cylinder not installed. Contact area soiled / frozen. Heavy deposits / soiling in the LPG cylinder.	> Re-calibrate. > Fit LPG cylinder correctly and secure, switch ignition on again. > Place full LPG cylinder into bracket. Carefully clean / de-ice contact surface. Problem is cylinder related, Calibration cannot be performed on this LPG cylinder. ***Right reserved to make technical changes.***

Fuel Gauge Troubleshooting Flow Chart

Shown on the next page 5-9, is a useful fuel system troubleshooting flow chart that will assist in detecting faulty Sonatic® FLT devices. See Figure 5-10.

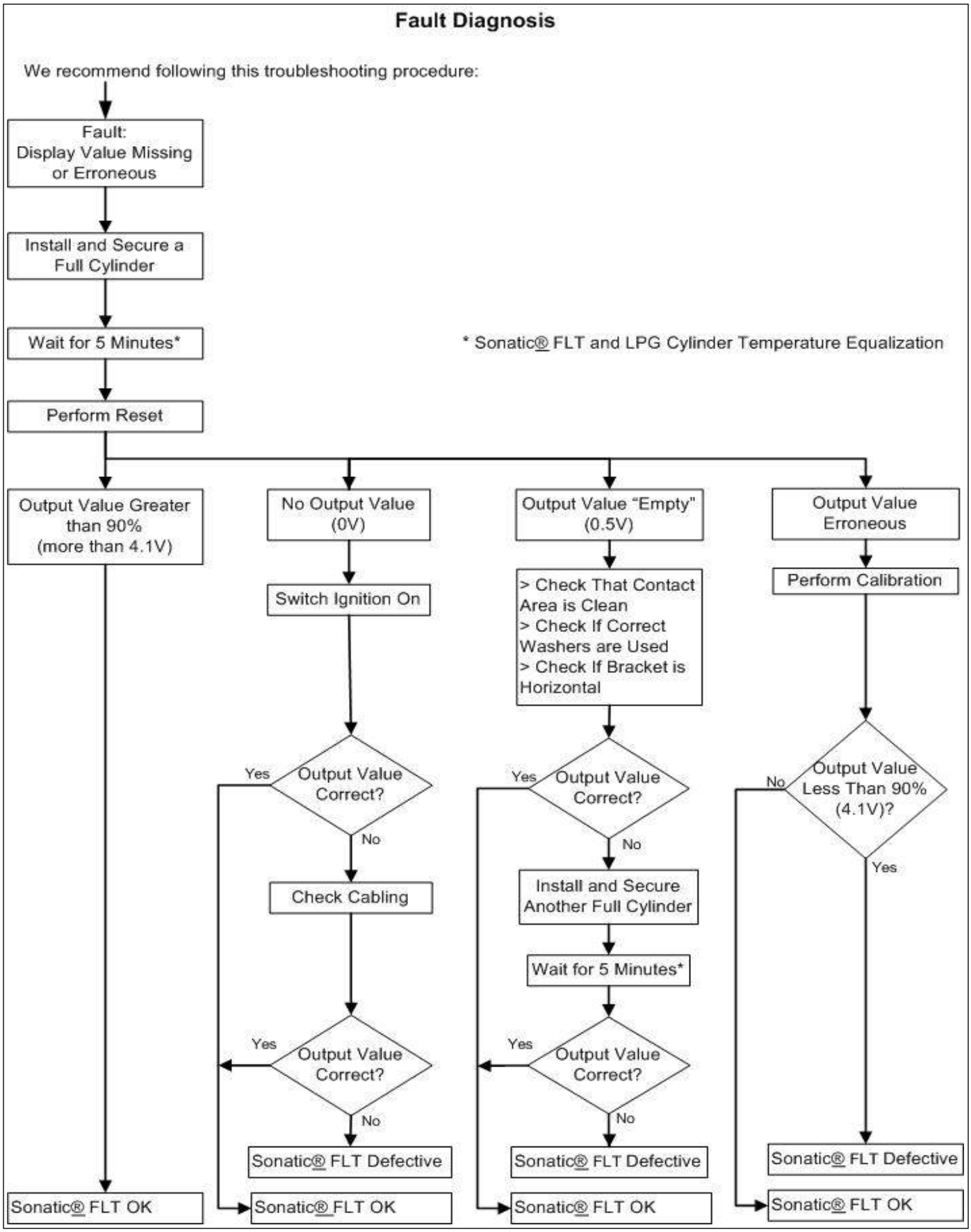

Figure 5-10: Fuel System Troubleshooting

2.4L LPG Engine Quick Trouble Shooting Guide

First Check For DTC Faults

1. Connect the S3000 Monitor and establish communications.
2. Check and note if there are any Diagnostic Trouble Codes (DTC's). Check both "Active" and "Historic". Press the "Save" button in the diagnostic window of the S3000 Monitor.
   - This will create a file (an HTML file with the default name "diagnostics.html". You can rename this file to whatever you like, but DO NOT change the html extension).
   - This HTML file, when double clicked, will open in your Internet Browser and show you what codes were present, when the check was done and what the ECU serial number, code and calibration are.
3. If there are any active DTC's use "**DIAGNOSTIC TROUBLES CODES"** to trouble shoot and repair the cause of the active DTC. There is an enclosed list of the S3000 ECU's Diagnostic Trouble Codes for reference at the end of this Chapter 5.

If ECU Can Not Communicate With The S3000 Monitor:

- You may not be getting power to the ECU.

1. With the key "ON" but the engine "OFF" put your ear down close to the Electronic Throttle Body (ETB). You should hear a high pitched buzz or whine from the ETB. If you do then the ECU has power and you should check you S3000 cable connections.
2. If there is no buzz then:
   - Back-probe the Power Latch Relay connector CPS206 with key in the "OFF" position
   - - pins E, F and D should have battery voltage
   - - pin A should be zero (or very low voltage)
3. Turn Key "ON"
   - - pin A should rise to battery voltage
   - - pin D should drop to zero (or very low voltage)
4. If with key "OFF" you do not see voltage on pins E and F then check forklift voltage supply and fuses.
5. If you do not see voltage on pin D then the coil may be bad in the relay (replace) or the power-latch relay circuit may be shorted to ground or the ECU is already on.
6. If when key is turned "ON" pin D drops but pin A does not rise the relay is faulty (replace).
7. If when the key is turned "ON" pin D does not drop, check that the key circuit is functioning by monitoring pin A of the alternator connector CPS214. This pin should go to battery voltage with key "ON" and to ground with key "OFF".
8. If key circuit is working correctly and still no drop on pin D of CPS206, then disconnect S3000 ECU, check for debris or a bent pin on the ECU's small connector pin D1 and check continuity between CPS203 pin D1 & CRP160 pin 3.
9. Disconnect CRP160 and assure there is a good ground from CPS160 pin 4 to battery ground.

Is The Throttle In Limp Home Mode?

If a fault occurs in any of the pedal, throttle or 5 volt power supply circuits the Electronic Throttle Body (ETB) will go into "Limp Home" mode. Power to the ETB will be removed and the throttle will stop buzzing. The throttle plate will take a neutral position of approximately 18% and will not move.

IMPORTANT

Any of the following Diagnostic Trouble Codes (DTC's) will cause the throttle to go into Limp Home mode:

SPN	FMI	Description
51	2	Throttle Sensor 1 vs. Throttle Sensor 2 Coherence
522711	4	Throttle Position Sensor 2 Open Circuit
522711	3	Throttle Position Sensor 2 Short Circuit
522710	4	Throttle Position Sensor 1 Open Circuit
522710	3	Throttle Position Sensor 1 Short Circuit
524286	31	Electronic Throttle Motor Wires Shorted or Watchdog Fail
524266	31	Electronic Throttle Motor Wires Shorted
522614	7	Throttle failed to enter Limp Home Zone
522616	8	Throttle actual versus commanded position error
522700	2	Redundant µ SDF Time-out
522696	2	Redundant µ pedal a/d conversion failure

SPN	FMI	Description
522695	2	Redundant µ throttle a/d conversion failure
522692	2	Redundant µ general a/d conversion failure
522699	2	Redundant µWatchdog failure
522690	2	Redundant µ SPI Bus failure
522698	2	Redundant µ Clock failure
522691	2	Redundant µ Sanity check failure
168	1	Battery voltage Low
524260	11	5 Volt Power Supply 2 Out of Spec
524261	11	5 Volt Power Supply 1 Out of Spec
522691	12	ECU Checksum Error

If the ETB goes into Limp Home mode the cause of the DTC must remedied, the DTC must be cleared and then the forklift keyed "OFF" for at least 20 seconds.

If the Engine cranks but will not start or runs poorly, with no DTC'S

- Is there the proper fuel in the tank and is the fuel tank open?
- Is there engine rpm showing on the S3000 monitor while cranking?
- Is there Spark at each spark plug?
- Are the injectors firing?
- Is there fuel pressure at fuel rail?
- Is LPG vaporizer Lock-Off opening?
- Do you have No or Low Cylinder compression?

Is the fuel tank open?

Make sure the tank valve is open and that the excess flow valve has not been tripped shut. The excess flow valve is in the LPG tank and will shut off the flow of LPG if there is a sudden surge or high flow of LPG. This valve can be tripped by a rapid opening of the manual tank valve (you may hear a click if it is tripped). To reset the excess flow valve close the manual valve completely and then slowly (especially at the beginning) re-open it to fully open.

Is there engine rpm showing on the S3000 monitor while cranking?

If there is no rpm showing on the S3000 Monitor and the monitor is communicating properly with the S3000 then the cranking rpm is too low or the engine crank sensor is not functioning. Is there sufficient battery voltage during cranking? The minimum cranking speed which can be detected by the ECU is 60 rpm. Disconnect CPS225 and put a voltmeter across pins 1 and 2 and set the voltmeter to AC low voltage then crank the engine. You should see some voltage, if zero replace the crank position sensor.

Is there Spark at each spark plug?

The spark should show up at the spark plug - if you remove a plug and hold the ground electrode against the engine block and crank the engine (or other suitable ground) you should see a spark between the spark plug tip and the ground electrode. Be sure there is no petrol or LPG about when you do this test. A preferred method is to have an in-line spark tester which fits between the high tension line and the spark plug. - If you see no spark at the plug or at the in-line spark tester: 1> The signals to trigger the coil to fire are on CPS217 pins A (cyl 2 & 3) and pin B (cyl 1 & 4) - if you disconnect CPS217 from the coil and put a voltmeter across pin A and ground and crank the engine you should see the voltage going up and down between 5 volts and 0 volts. 2> The 5 volts you should see intermittently on pins A and B of CPS217 is supplied through the resistors from pin F of CPS241. 3> check with a voltmeter that 5 volts appears on pin F of CPS241 when the engine is being cranked. 4> The ignition signals are supplied by the ECU which is powered by the power latch relay when the key is turned on. 5> The coil is powered with battery voltage along the chain of connections CPS217 pin D, CPS241 pin C, CRP55 pin 2 check to see this is present (note the battery voltage will only be present for 2 seconds after key on [after a 20 second key off] or when the engine is cranking) 6> The ground circuit for the ignition coil is CPS217 pin C, CPS241 pin D, CRP55 pin 7. Check to see this is present and continuous. It has been seen on some engines that the spark was bypassing the spark electrode by running inside the plug wire boot then to the

heat shield and then through the spring to ground. It has also been noticed that it is very difficult to determine if the clip at the end of the plug wire is truly snapped on the spark plug. It seems with some of the wires the spark wire can slide up and down inside the boot so when you go to push the wire onto the plug it is just the boot which is being pushed down and you feel no “snap” of connection. To eliminate all these issue take the metal heat shield and wire spring right off the plug wire. Then attempt to push the end clip out the end of the boot so you can see it. Then by holding the plug wire firmly at the entrance to the boot push the plug wire clip onto the spark plug tip. You should feel a noticeable snap as it clips on the plug. Try running the engine with all the plug wires having the heat shields and springs removed and securely fastened to the plugs and check operation.

Are the injectors firing?

The best and most thorough way to check the injector circuit is to insert a “noid” light in place of the injectors one by one and cranking the engine to see that the light flashes. A noid light can be approximated by using a 12 volt flashlight or tail-light bulb with wires soldered to the positive and negative contacts of the bulb. To see if the injectors are mechanically stuck, replacement with known good injectors is the best test. To find if there is one bad injector in the bunch take the engine rpm up to approximately 1200 rpm and using the S3000 monitor’s “Injector” tab disable one injector at a time and see if there is a drop in rpm as each injector in turn is disabled (the rpm needs to be above idle since if the forklift is on idle the idle governor will try to keep the rpm constant by opening the throttle when you disconnect an injector). If disabling an injector has no effect on the rpm it is likely that cylinder is not firing.

Is there fuel pressure at fuel rail?

Fuel pressure can be read via the S3000 monitor. The fuel pressure should be approximately 180 to 210 kPa when the engine is not running and 88 kPa above manifold pressure when it is running (this is approximately 125 to 140 kPa at idle). If the engine will start and run look at the “Feedback” window on the S3000 Monitor, if the values are hitting -25% or +25% this may indicate the fuel pressure is too high or too low. Check that the vacuum line that supplies the manifold pressure, from the manifold to the vaporizer, is connected and not leaking or plugged.

Is LPG vaporizer Lock-Off opening?

The LPG lock-off can be checked for activation with a iron bar (or other metal which is attracted to a magnet), by holding it close but not touching the solenoid tower of the vaporizer and then turning the key “ON”. Since the vaporizer solenoid is a high side control it can also be checked by watching for the appearance of battery voltage at CPS207 pin 1 at key on (for 2 seconds as mentioned above).

Do you have No or Low Cylinder compression?

Check compression in each cylinder using a compression gauge. Typically a cylinder will have 140 to 160 PSI of cranking compression. Low compression could be caused by burnt exhaust valves, a bad head gasket, worn rings and cylinder or a broken timing belt.

DTC codes

Shown on the next page are the DTC codes with descriptive details:

DIAGNOSTIC TROUBLE CODES

= Will cause Throttle "Limp Home" mode.

Description	SPN	FMI	Monitored Variable	Other Conditions
Throttle Sensor 1 vs Throttle Sensor 2 Coherance	51	2	Tps_coh_filt_abs_error	Key On
Pedal 1 to Pedal 2 sensor coherence failure	91	2	Aps_coh_filt_abs_error	Raw Pedal Position
Pedal vs Throttle Coherance Failure	91	11		Key On
Oil Pressure Sensor Voltage High	100	3	Oil_pressure_conv_result	Key On
Oil Pressure Sensor Voltage High at Stall	100	2	Oil_pressure_conv_result	Engine not running but key on
Oil Pressure Sensor Voltage Low	100	4	Oil_pressure_conv_result	Key On
Manifold Air Temp Short Circuit to Grnd	105	4	Temperature_air_brute	Key On
Manifold Air Temp Short Circuit to High	105	3	Temperature_air_brute	Key On
Manifold Air Temp Open Circuit	105	5	Temperature_air_brute	Key On
Manifold Pressure Short Circuit to High	106	3	Pres_admission_result_ad_conv	Key On
Manifold Pressure Open Circuit	106	4	Pres_admission_result_ad_conv	Key On
Manifold Pressure will Cranking Not Diff from Atm	106	14	Diag_pressure_in_stall - Diag_min_pressure_in_crank	(Engine cranking or just started) AND ECT>-10C AND Throttle Closed
Manifold Pressure Too Low at Open Throttle	106	1	Io_map_manifold_pressure	AND if the throttle position is below the values in the table (as a function of speed)
Manifold Pressure Incorrect at Stall	106	2	Io_map_manifold_pressure	rpm =0
Manifold Pressure Too High at Closed Throttle	106	0	Io_map_manifold_pressure	AND if the throttle position is above the values in the table (as a function of speed)
Coolant Temp Short to Grnd	110	4	Temperature_eau_result_ad_conv	Key On
Coolant Temp Short to High	110	3	Temperature_eau_result_ad_conv	Key On
Coolant Temp Open Circuit	110	5	Temperature_eau_result_ad_conv	Key On
Coolant Temperature Failing to Rise	110	10	Temperature_eau	Engine running, while warming up from cold to 65 degrees C ECT does not drop in temp.
Coolant temperature after warmup too low	110	2	Temperature_eau	Engine running, engine revolutions > 12032 (1/2 revolutions) (approx 5 minutes at 1200 rpm)
FAP minus MAP Too High	135	16		
FAP minus MAP Too Low	135	18		
LPG Pres Voltage Short to Grnd	135	4	Gfi_lpg_pressure_result_ad_conv (shifted << and & with 256)	Key On
LPG Pres Voltage Short to B+ or Open Circuit	135	3	Gfi_lpg_pressure_result_ad_conv (shifted << and & with 256)	Key On
LPG Pres Voltage Open Circuit NOT FUNCTIONAL	135	2		NOT FUNCTIONAL
Battery voltage Low	168	1	Tension_batterie_brute	Engine RPM must be greater then 608 rpm
Battery voltage High	168	0	Tension_batterie_brute	Key On
Code Checksum Error	628	12		Key On
Calibration Checksum Error	630	12		Key On
ECU Injector 1 Short to grnd	651	6	Internal TLE6220-1 Diagnostic	Engine Running
ECU Injector 1 Short to B+	651	3	Internal TLE6220-1 Diagnostic	Engine Running
ECU Injector 1 Open Circuit	651	5	Internal TLE6220-1 Diagnostic	Engine Running
ECU Injector 2 Short to grnd	652	6	Internal TLE6220-1 Diagnostic	Engine Running
ECU Injector 2 Short to B+	652	3	Internal TLE6220-1 Diagnostic	Engine Running
ECU Injector 2 Open Circuit	652	5	Internal TLE6220-1 Diagnostic	Engine Running
ECU Injector 3 Short to grnd	653	6	Internal TLE6220-1 Diagnostic	Engine Running
ECU Injector 3 Short to B+	653	3	Internal TLE6220-1 Diagnostic	Engine Running
ECU Injector 3 Open Circuit	653	5	Internal TLE6220-1 Diagnostic	Engine Running
ECU Injector 4 Short to grnd	654	6	Internal TLE6220-1 Diagnostic	Engine Running
ECU Injector 4 Short to B+	654	3	Internal TLE6220-1 Diagnostic	Engine Running
ECU Injector 4 Open Circuit	654	5	Internal TLE6220-1 Diagnostic	Engine Running
Code vs. Cal Version Mismatch	1635	13		Key On
MIL Short to B+	522545	6		
MIL Open Circuit	522545	5		
Downstream O2 Heater Short to Gnd	522608	4		
Downstream O2 Heater Short to High	522608	6		
Downstream O2 Heater Open Circuit	522608	5		
Rear O2 Short Short High	522609	6		
Throttle failed to enter Limp Home Zone	522614	7	Tpac_1_filt_filt_position	Key On then key off wait for powerlatch then key on
Throttle actual versus commanded position error	522616	8	Tpac_filtered_position_error	Throttle control in closed loop (i.e. not during thrust learns at key off)
Throttle failed to enter Fully Closed or Fully Open Zone	522617	5	Tpac_1_min_measured_position	Key On then key off wait for powerlatch then key on
O2 Sensor Failure to Switch Lean Bank 1	522630	2	Diag_trim_1	Lfbk_min_throttle_c changed from 5.08 to 3.17 %
O2 Sensor Failure to Switch Rich Bank 1	522631	2	Diag_trim_1	Lfbk_min_throttle_c changed from 5.08 to 3.17 %
Short Term Fuel Cor Railed lean Bank 1	522635	3	Lambda_feedback_1	Lfbk_min_throttle_c changed from 5.08 to 3.17 %
Short Term Fuel Cor Railed rich Bank 1	522636	4	Lambda_feedback_1	Lfbk_min_throttle_c changed from 5.08 to 3.17 %
SPI Bus Error	522690	12		Key On
Redundant µ SPI Bus failure	522690	2		Key On
ECU Checksum Error	522691	12		Key On
Redundant µ Sanity check failure	522691	2		Key On
Redundant µ general a/d conversion failure	522692	2		Key On
Memory Checksum Error	522694	12		Key On
Redundant µ throttle a/d conversion failure	522695	2		Key On
Redundant µ pedal a/d conversion failure	522696	2	Abs(Aps_2_raw_position_mcp_mcp - Aps_2_raw_position_mcw_mcp)	Key On
Redundant µ Clock failure	522698	2		Key On

Redundant µ Watchdog failure	522699	2		Key On
Redundant µ SDF Timeout	522700	2		Key On
Throttle Position Sensor 1 Short Circuit	522710	3	Tps_1_raw_filt_position	Key On
Throttle Position Sensor 1 Open Circuit	522710	4	Tps_1_raw_filt_position	Key On
Throttle Position Sensor 2 Short Circuit	522711	3	Tps_2_raw_filt_position	Key On
Throttle Position Sensor 2 Open Circuit	522711	4	Tps_2_raw_filt_position	Key On
Pedal 1 Sensor Short to Grnd	522712	4	Aps_1_raw_filt_position	Allowable % Difference between two pedal sensor readings
Pedal 1 Sensor Short to High Source	522712	3	Aps_1_raw_filt_position	Key On
Pedal 2 Short to grnd	522713	4	Aps_2_raw_filt_position	Key On
Pedal 2 Short to High Source	522713	3	Aps_2_raw_filt_position	Key On
O2 Short to Ground Bank 1	522735	4	Tension_sonde_amont_pour_diag	Engine is in Closed Loop Feedback mode.
O2 Short High Bank 1	522735	6	Tension_sonde_amont_pour_diag	
O2 Open Circuit Bank 1	522735	5	Lshd_voltage_upstr_sens_filtered	Engine running not at full load, coolant temp above -7.5
Upstream O2 Heater Short to Gnd Bank 1	522739	6	Driver Chip Monitored & Triggered tle_6220_3	Engine Running for more then 30 seconds
Upstream O2 Heater Short to High Bank 1	522739	3	Driver Chip Monitored & Triggered tle_6220_3	Engine Running for more then 30 seconds
Upstream O2 Heater Open Circuit Bank 1	522739	5	Driver Chip Monitored & Triggered tle_6220_3	Engine Running for more then 30 seconds
Failure to Detect or Incorrect CAM Shaft signal	522752	9	Gfi_cam_diag_pmh_counter	rpm > 500
Failure to Start due to Lack of Cam signal	522752	8	Atu_tcnt10d	
Oil Lamp Short to B+	523821	6		
Oil Lamp Open Circuit	523821	5		
5 Volt Power Supply 2 Out of Spec	524260	2	Tension_alimentation_1_brute	Key On
5 Volt Power Supply 2 Out of Spec	524260	11	Tension_alimentation_2_mesuree	was 4.8 to 5.2
5 Volt Power Supply 1 Out of Spec	524261	2	Tension_alimentation_1_brute	Key On
5 Volt Power Supply 1 Out of Spec	524261	11	Tension_alimentation_1_mesuree	Key On
Electronic Throttle Motor Wires Shorted	524266	31	Internal MC33186 ETC H Bridge Driver Chip Diagnostic	Key On
Electronic Throttle Motor Wires Shorted or Watchdog Fail	524286	31	Internal MC33186 ETC H Bridge Driver Chip Diagnostic	Key On

Getting Started Using Kvaser(S3000) Engine Diagnostics Software

IMPORTANT

It is important to remember that before operating the Kvaser software, you must connect the software EACH TIME by clicking on the "Connect Logo" shown below See Figure 5-11.

Figure 5-11: Connect Button

NOTE

Steps 1 thru 3 are recommended be done at the dealership and not at the customer location.

If problems occur when loading the Kvaser software, you may need to consult the factory.

1. Install the Kvaser program by following the software installation instructions with the CD.
2. Start Kvaser software only.
3. Attach cable to the available USB computer port.

If steps 1 thru 3 are ok, proceed to hook up the computer interface cable to the forklift with the cable marked "Engine J1939". **See Figures 4-1** and **4-2**.

4. Go to Settings, Connection Settings
5. Select the "Kvaser" device and "Channel 0", as shown below.

NOTE

After you connect the Kvaser cable to the laptop from the forklift, if it does not connect simply try a different USB port.

Figure 5-12: Connecting to Engine

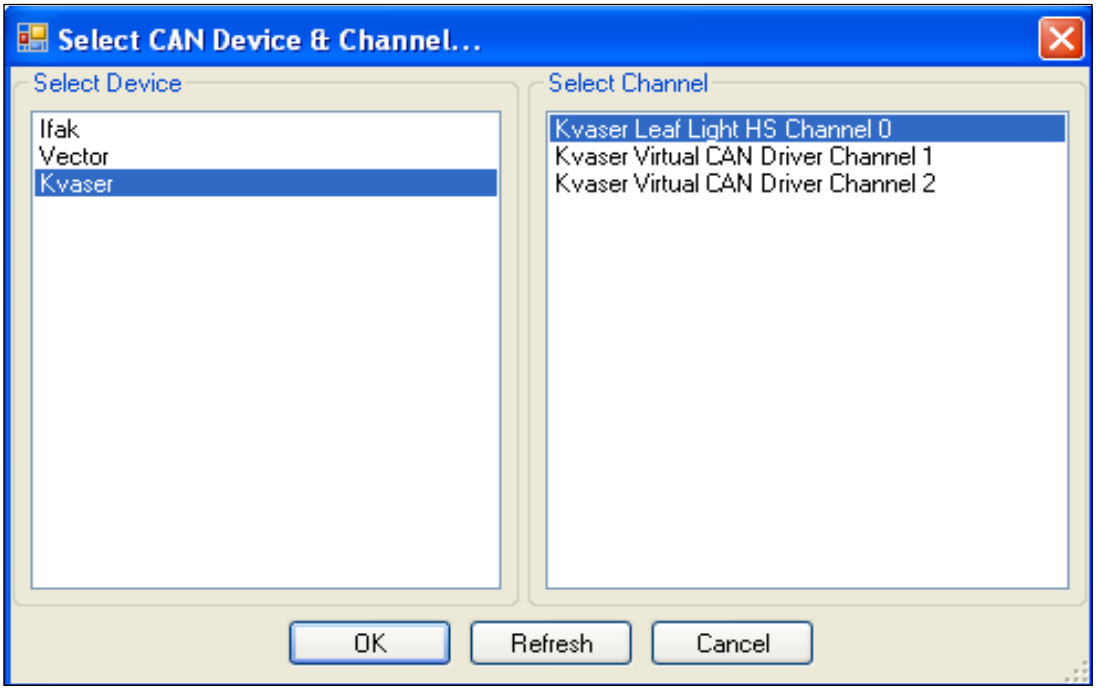

Figure 5-13: Device and Channel Selection Screen

⚠ CAUTION

While Testing you will be operating many functions of the forklift and it is imperative that you position the forklift in an area without obstructions or personnel, that may be injured or product damaged.

- Place the forklift in a safe operating position and location.
- Apply parking brake.
- Place directional control in neutral.
- Then turn ignition on.
- Should show screen like Figure 5-14, “Main Monitor Screen

Before **starting** to operate the forklift and for safe forklift operation, monitoring and performance testing:

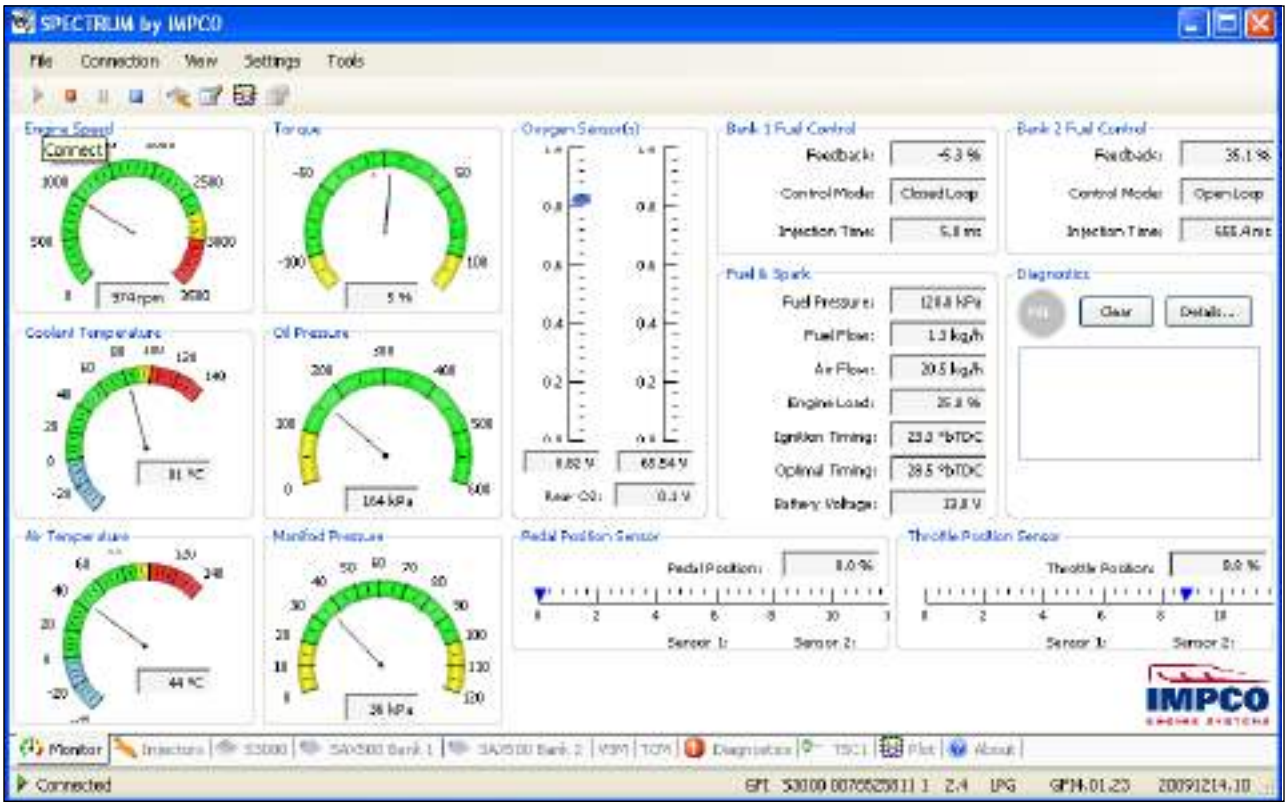

Figure 5-14: Main Monitor Screen

Injectors Function Tab

As marked, at the bottom left hand corner of the “Main Monitor” screen you will find the “Injectors Tab”. After you select this tab you will see a list of all injectors. **See Figure 5-15.** By selecting any number of “Disable Injectors” you will notice diminished performance in the engine as you remove those injectors from service. This capability is useful in locating faulty cylinder performance.

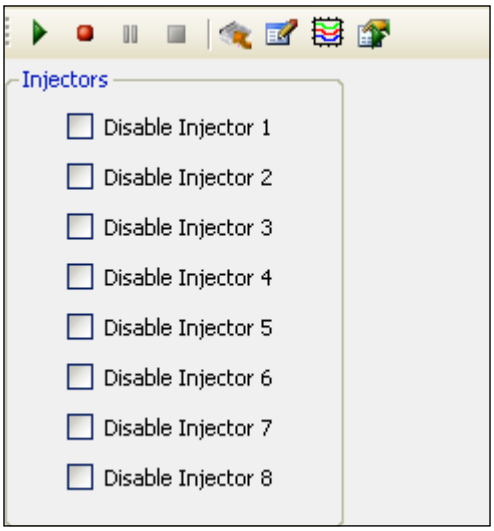

Figure 5-15: Injectors Tab

The provided **S3000, SAX500** tabs, along with the **VSM** and **TCM** tabs are provided to display all function settings within the software. The settings shown are for reference only, you will not need to alter or manipulate any options within those tabs.

Diagnostics Function Tab

Within this function “Active” or “Historic” engine faults will be recorded with SPN fault codes and descriptions. See Figure 5-16 on page 5-17. Both faults can be cleared although if corrections have not been made “Active” faults will return. All faults may be saved to a Tab Limited Excel file for future use. Faults can also be cleared here.

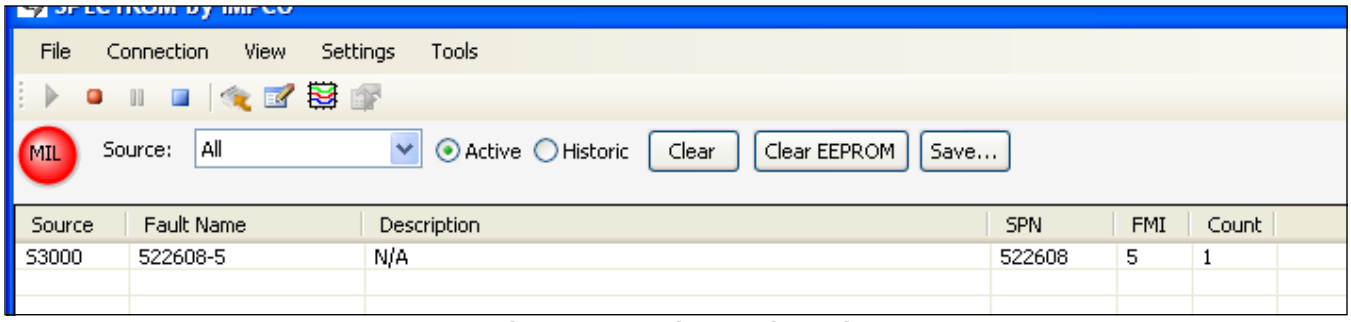

Figure 5-16: Diagnostics Tab

TSC1 Function Tab

The “TSCI Tab” (Testing System Components) allows you to operate the engine from your computer. See Figure 5-17. You are able to change RPM and torque of the engine as you monitor the performance.

Changing the controls you will notice the engine operations changing. Changes made in this screen overrides any actual pedal movement until computer is unplugged or control is switched to off.

NOTE

Priority Setting must be set on “0: Highest”.

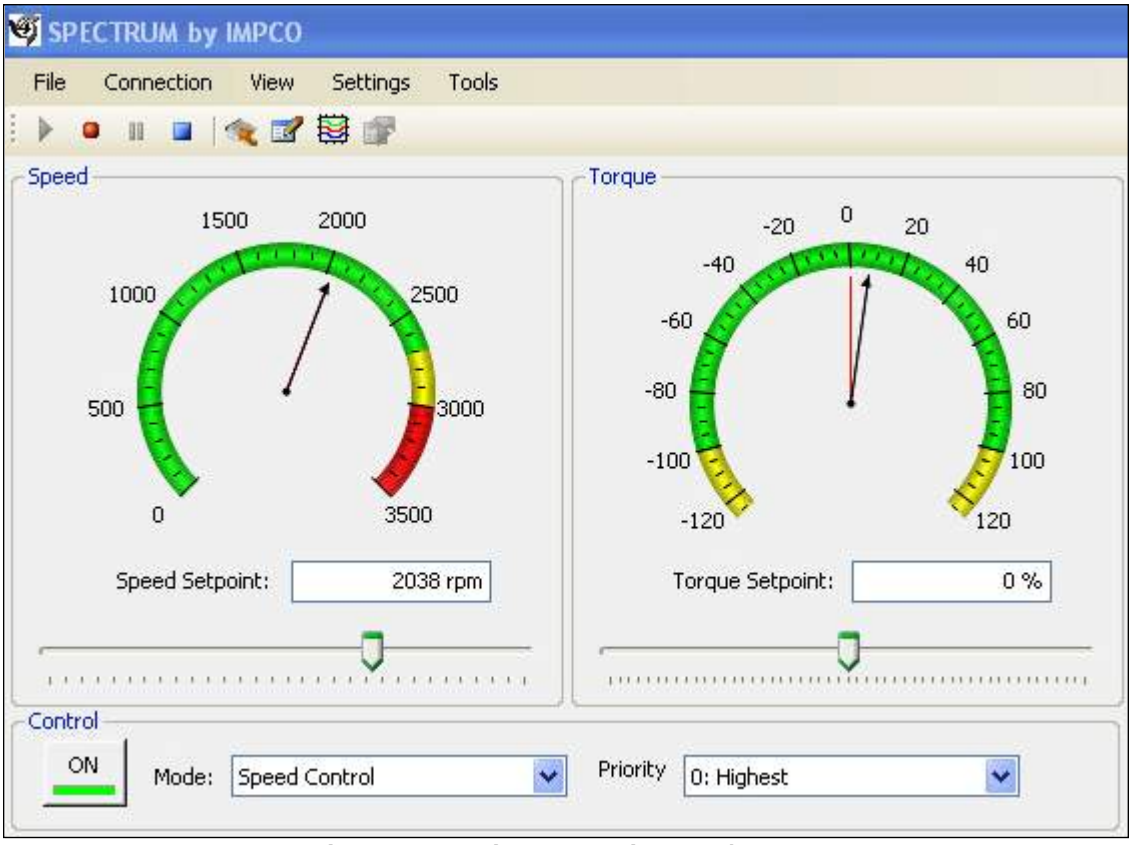

Figure 5-17: Plot Type Odometer/Torque

Plot/Plot Choices Function Tab

The “Plot”, Figure 5-18, allows you to monitor and graph a plot of engine performance. Figure 5-19 is provided to show options available within this functionality, that can be plotted on the graph in any combination required.

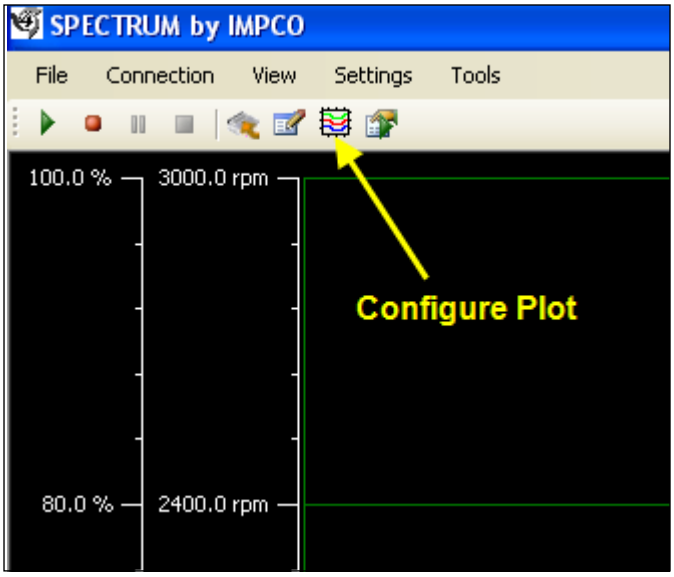

Figure 5-18: Plot Screen

Pedal position and engine speed have been selected as an example. The record function is also available to record graphs created, in a tab limited format.

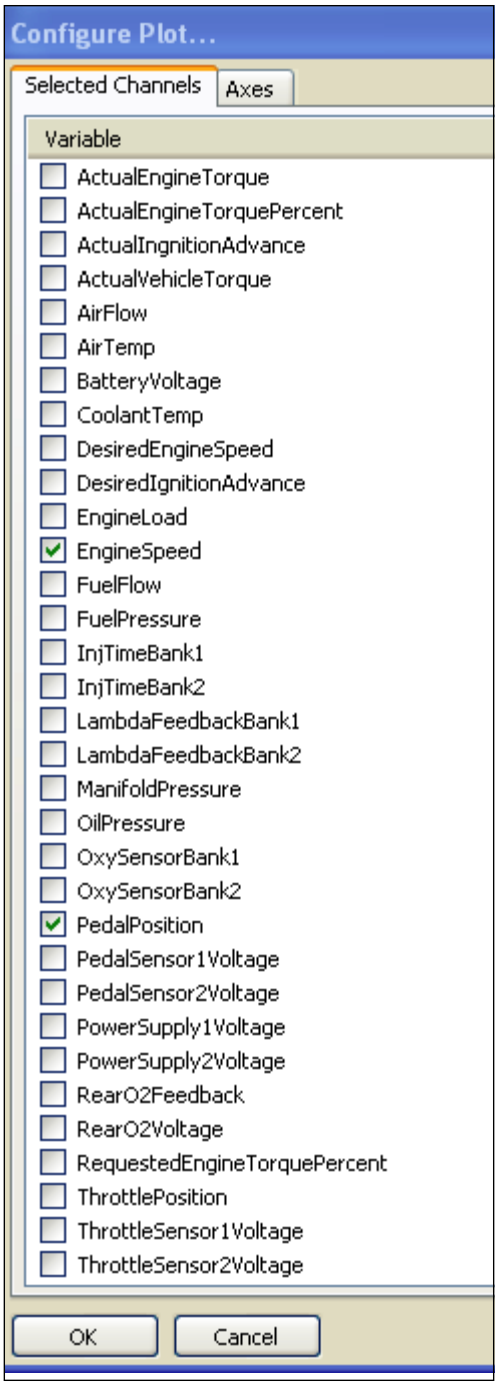

Figure 5-19: Configure Plot Screen

Chapter 6

GM Engine Supplier Provided Documentation

Disclaimer:

The documentation provided here within Chapter 6, "Supplier Provided Documentation", has been appended to this Landoll Maintenance Manual for reference only.

The specific contents of this information is not the responsibility of Landoll Corporation or any of it's affiliates.

2.4 Liter GM 4 Cylinder Engine with GFI LPG Fuel Injection

Table of Contents - page 3

- *Proceed to the above "Table of Contents" starting on next page to access the Engine Service instructions as required.*

Document Control Revision Log:

Date	Revision	Improvement(s) Description and Comments
01/26/11	F-581-R1	Initial Release
11/01/16	F-581-R1	Hydraulic fluid change - Joshua
nn/nn/nn	F-	

Equipment from Landoll Corporation is built to exacting standards ensured by ISO 9001 registration at all Landoll manufacturing facilities.

Model B40i4

Maintenance Manual

Re-Order Part Number F-581-R1

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