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TOYOTA
INDUSTRIAL EQUIPMENT

Service Manual

7BRU18, 7BRU23, 7BDRU15, 7BSU20, and 7BSU25

Serial Numbers
21,000 and up for 24 Volt
32,000 and up for 36 Volt

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TOYOTA

INDUSTRIAL EQUIPMENT

SERVICE MANUAL

Reach Lift Truck

Models: 7BRU18
7BRU23
7BDRU15
7BSU20
7BSU25

24 Volt Models - Serial No. 21,000 and Up
36 Volt Models - Serial No. 32,000 and Up

00700-CL220-01 **Issued: 6/1/04**

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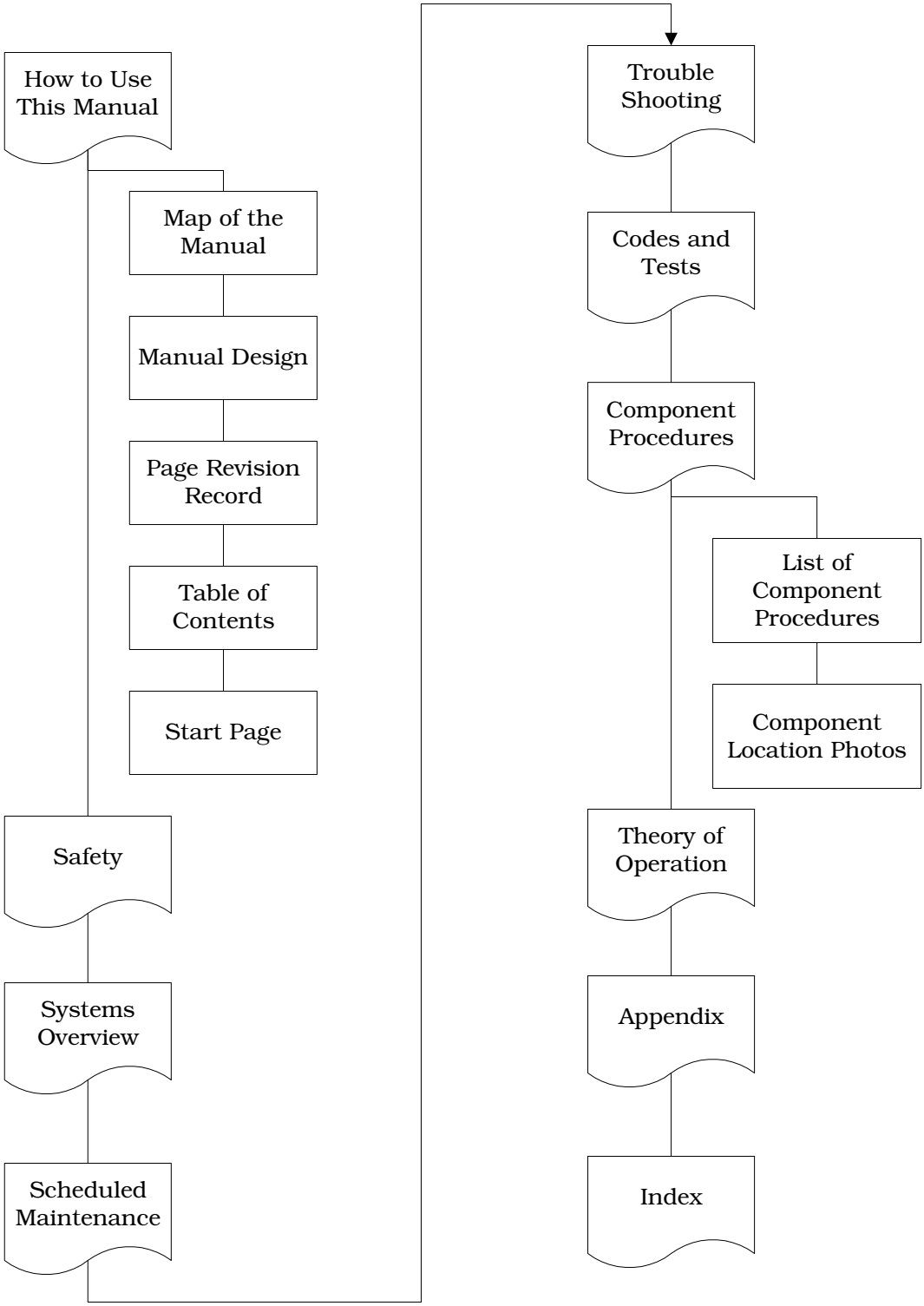
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How to Use This Manual

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Map of the Manual



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Manual Design

This manual is designed with the following objectives in mind:

- Provide technical coverage for expected levels of user expertise.
- Anticipate your needs and reduce your decisions regarding maintenance.
- Reduce page flipping through a "one-stop shopping" approach.

The two-line running page header at the top of each page tells you:

- the name of the manual (Toyota Reach Service Manual)
- the current Chapter Title (e.g., this page *How to Use This Manual*)
- the current topic (e.g., this page *Manual Design*)

We suggest you get in the habit of turning to the **START** page first when you use this manual.

The **START** page asks a few simple questions to guide you to the proper chapter.

- **How to Use This Manual** explains the manual format and design and contains the Table of Contents and START page.
- **Safety** explains warning and caution notes, general safety rules and safety rules for batteries, static, jacking, and welding.
- **Systems Overview** includes truck specifications and functional overview of the major systems.
- **Scheduled Maintenance** outlines the recommended schedule of preventive services to keep your truck working most efficiently.
- **Troubleshooting** is a set of "decision-tree" charts designed to take you from a symptom to a specific sequence of tests in order to isolate a failing component.
  - The **START TROUBLESHOOTING** chart (see page 5-19) will guide you to the individual troubleshooting symptom chart you need.
  - Once you're familiar with the symptoms listed, you may instead simply find the symptom chart from the **List of Troubleshooting Charts** (see page 5-17).
  - When you complete a troubleshooting procedure, be sure to follow the steps in **End of Troubleshooting Procedure** chart END-1 (see page 5-22).
- **Electrical Codes and Tests** contains detailed description of the software modes of operation and information about electrical error codes and diagnostic tests under the control of the system firmware.
- **Component Procedures** gives step-by-step procedures for testing, removal, installation, and adjustment of individual truck components. Components are listed in an order which considers:
  - Frequency of attention
  - Physical attachment (example: brake must be removed before drive motor)
  - Functional relation (example: carriage and mast components are grouped together)

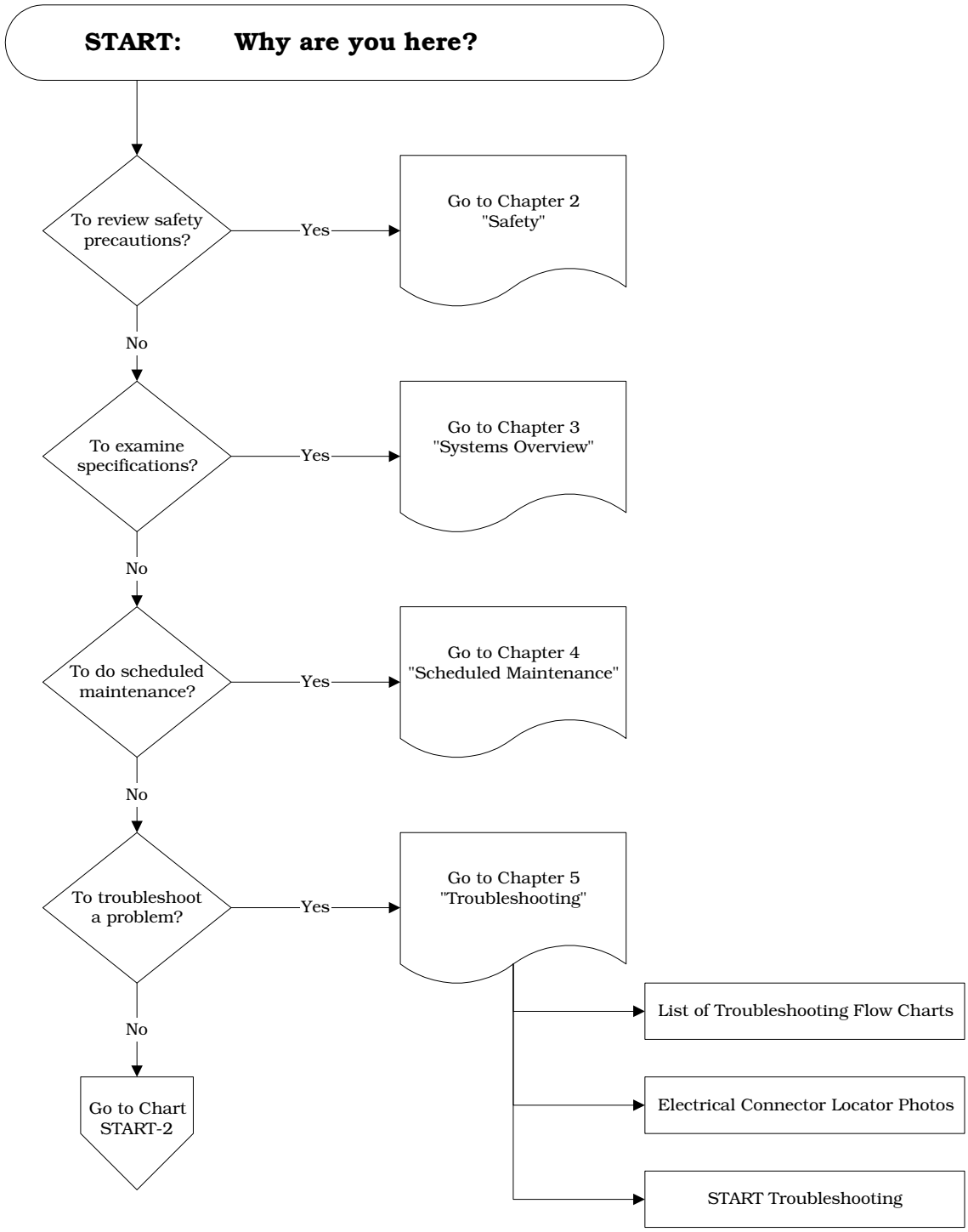
  To find a component procedure, you may use one of three methods:
  - Look up the component name in the **List of Component Procedures** (see page 7-2).
  - Find the component in the **Component Locators Photos** (see page 7-5).
  - Look up the component name in the maintenance manual **Index** (see page I-1).
- **Theory of Operation** gives detailed theory of operation information for all major systems.
- **Appendix** contains reference information such as torque values, lubricants, and schematics.
- **Index** lists subjects alphabetically.

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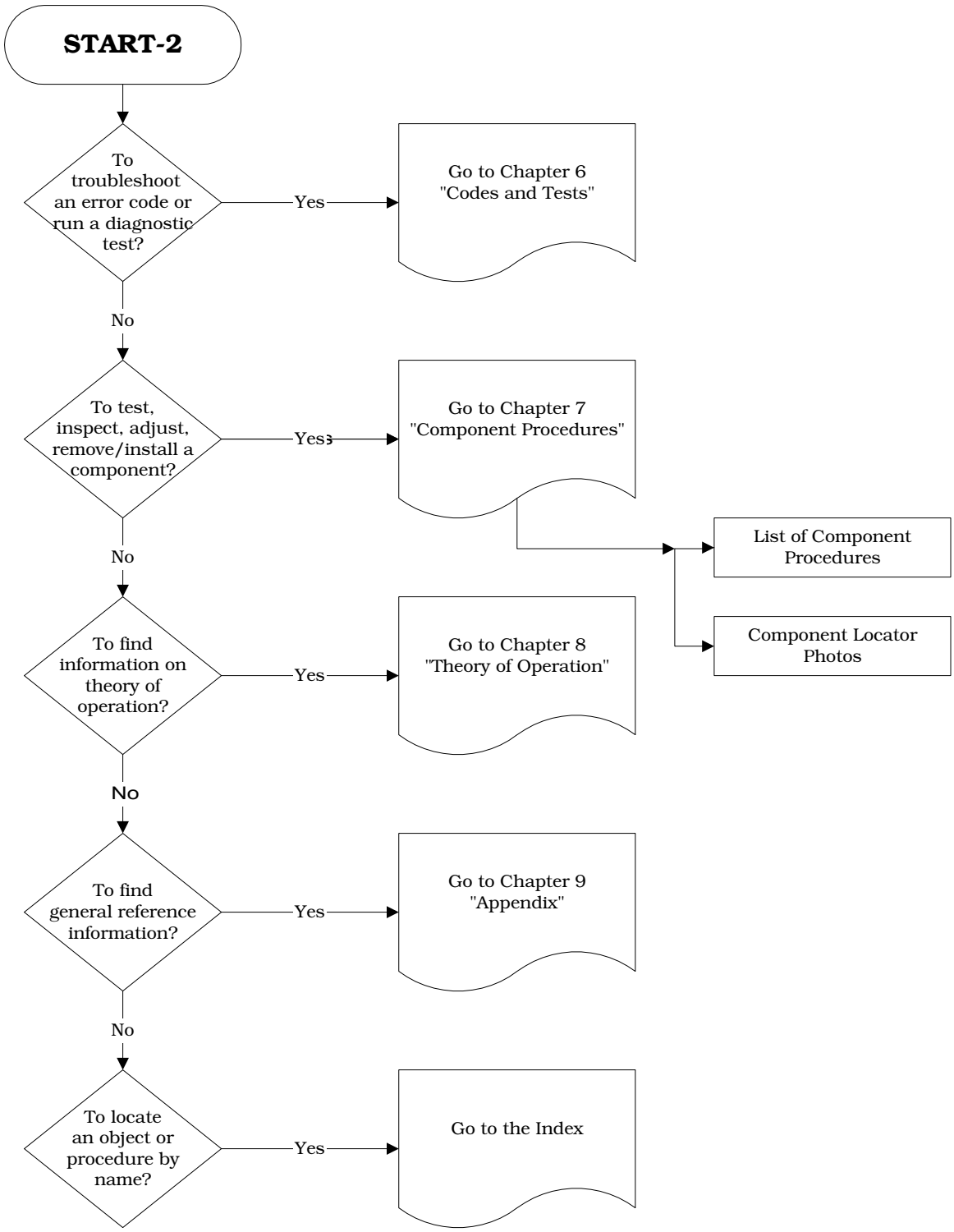
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START Page



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Safety

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Definitions

Throughout this manual, you will see two kinds of safety reminders:

⚠WARNING

Warning means a potentially hazardous situation exists which, if not avoided, could result in death or serious injury.

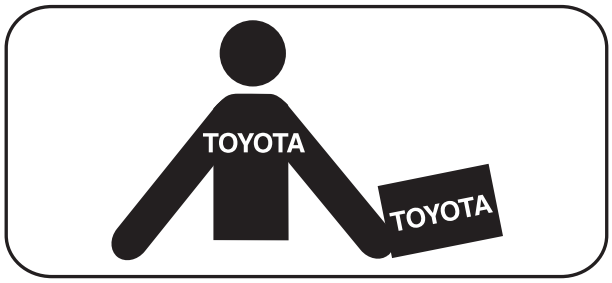
⚠ CAUTION

Caution means a potentially hazardous situation exists which, if not avoided, could result in minor or moderate injury or in damage to the lift truck or nearby objects.

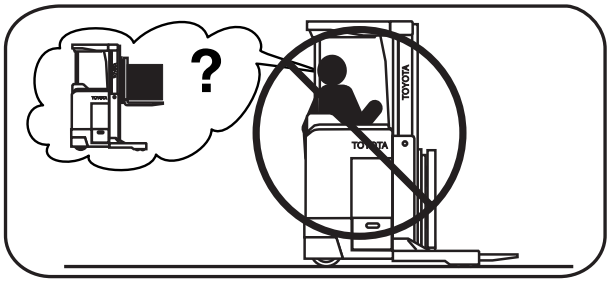
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General Safety

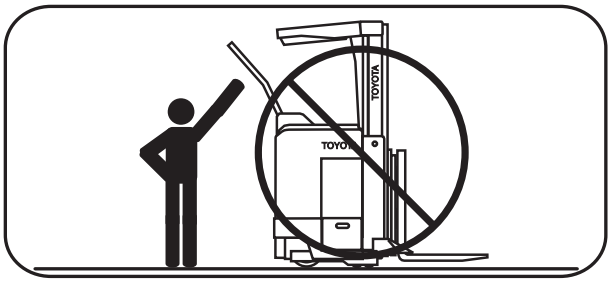
Do not operate or work on this lift truck unless you have read the operator's manual and are trained, qualified, and authorized to do so.



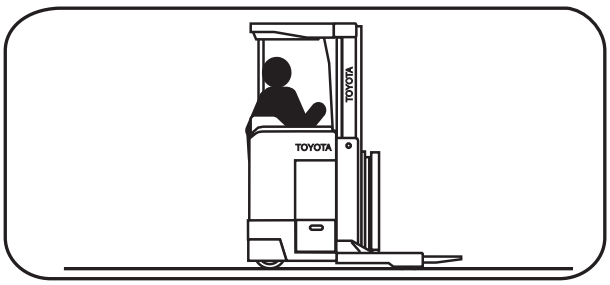
Know the lift truck's controls and what they do.



Do *NOT* operate this lift truck if it needs repair or if it is in any way unsafe.

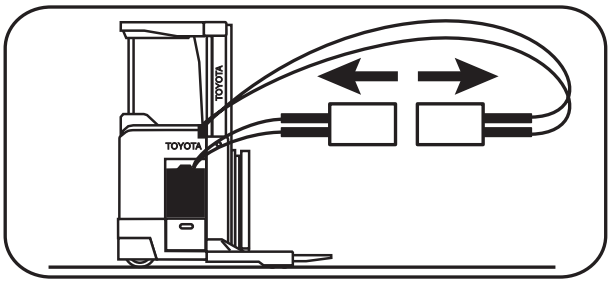


Operate this lift truck only from the operator's position.

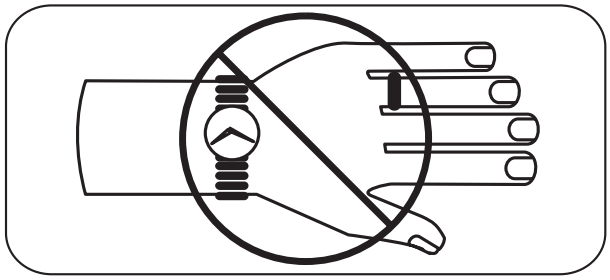


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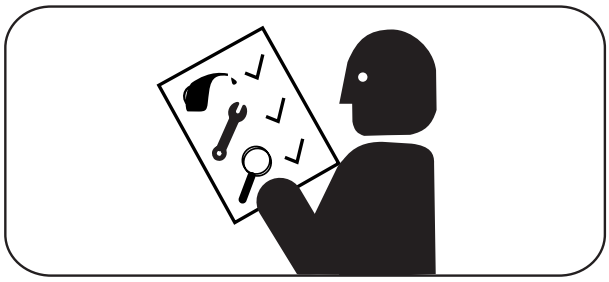
Before working on this lift truck, always turn the key switch to OFF and disconnect the lift truck's battery connector (unless this manual tells you otherwise).



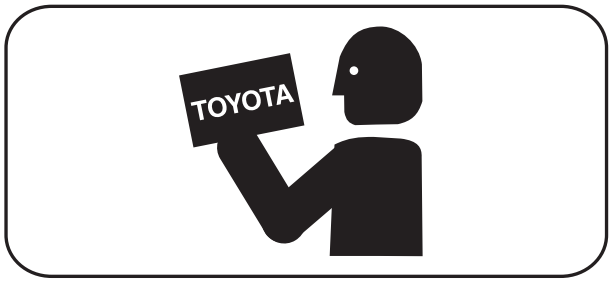
Do *NOT* wear watches, rings, or jewelry when working on this lift truck.



Follow the scheduled lubrication, maintenance and inspection steps.

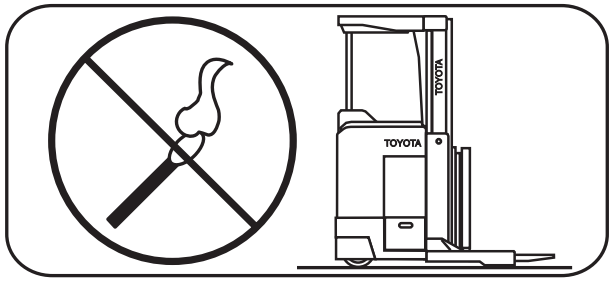


Follow exactly the safety and repair instructions in this manual. Do not take "shortcuts".

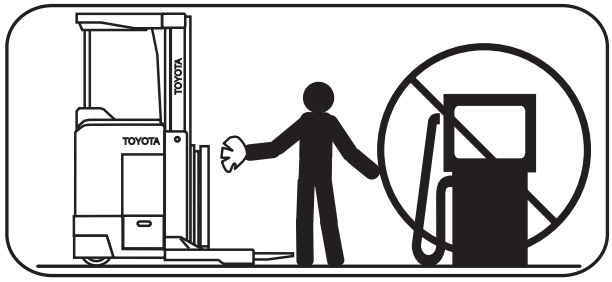


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Do *NOT* use an open flame near the lift truck.



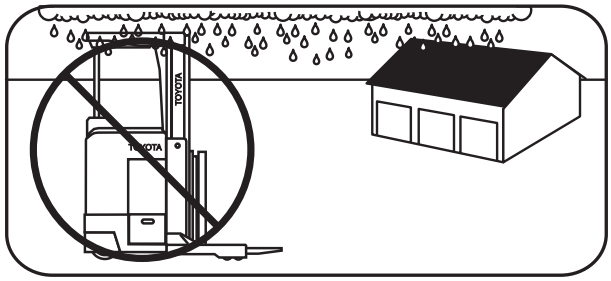
Do *NOT* use gasoline or other flammable liquids for cleaning parts.



Clean up any hydraulic fluid, oil or grease that has leaked or spilled on the floor.

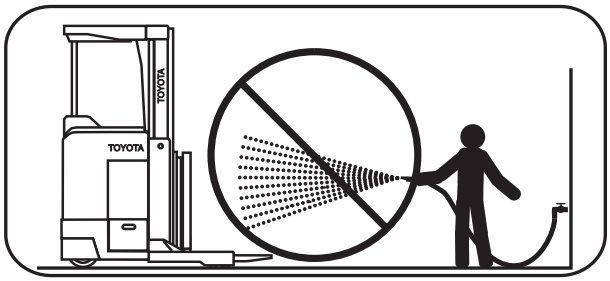


Always park this lift truck indoors.

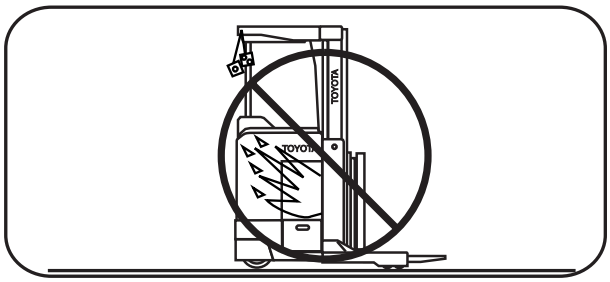


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Do *NOT* wash this lift truck with a hose.



Do *NOT* add to or modify this lift truck until you contact your local Dealer to receive written manufacturer approval.



Do *NOT* park this lift truck in a cold storage area overnight.

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Battery Safety

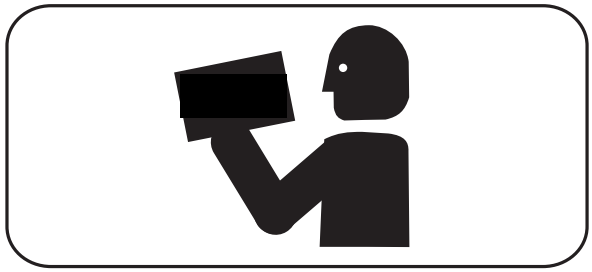
⚠WARNING

As a battery is being charged, an explosive gas mixture forms within and around each cell. If the area is not properly ventilated, this explosive gas can remain in or around the battery for several hours after charging. Be sure there are no open flames or sparks in the charging area. An open flame or spark can ignite this gas, resulting in serious damage or injury.

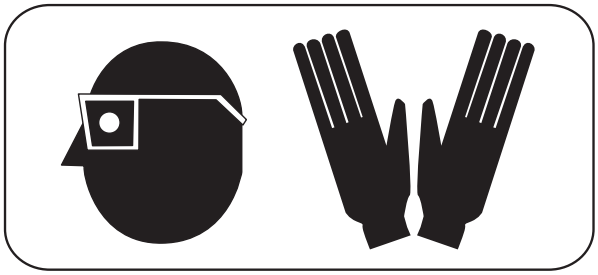
⚠WARNING

Battery electrolyte is a solution of sulfuric acid and water. Battery acid causes burns. Should any electrolyte come in contact with your clothing or skin, flush the area immediately with cold water. Should the solution get on your face or in your eyes, flush the area with cold water and get medical help immediately.

Read, understand and follow procedures, recommendations and specifications in the battery and battery charger manufacturer's manuals.

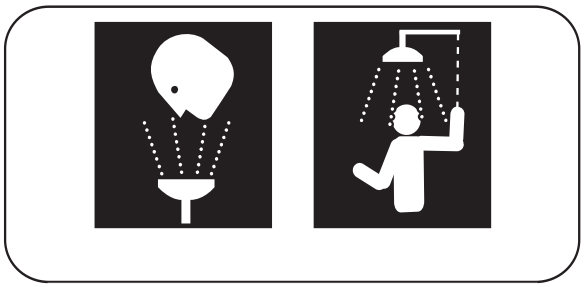


Wear personal protective equipment to protect eyes, face and skin when checking, handling or filling batteries. This equipment includes goggles or face shield, rubber gloves (with or without arm shields) and a rubber apron.

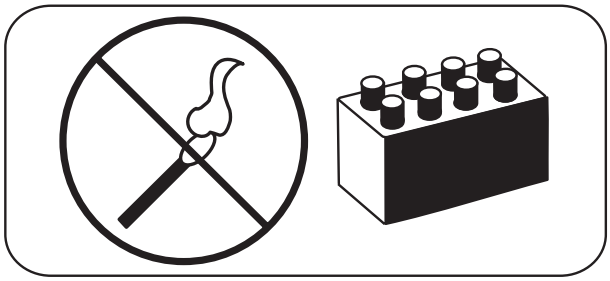


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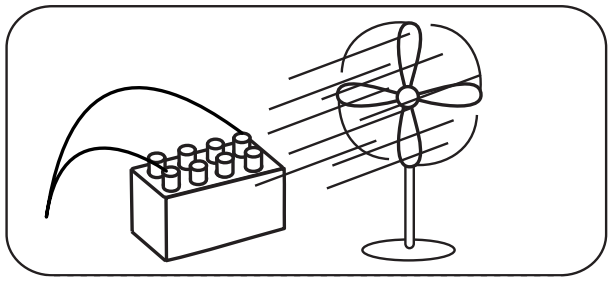
Make sure a shower and eyewash station are nearby in case there is an accident.



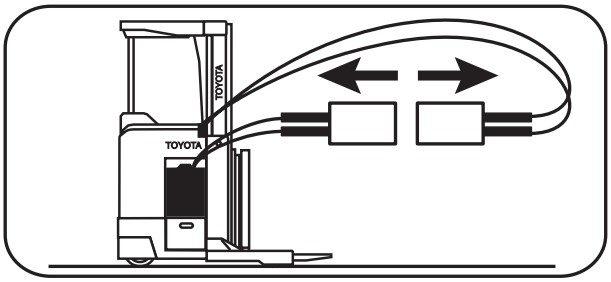
A battery gives off explosive gases. *NEVER* smoke, use an open flame, or use anything that gives off sparks near a battery.



Keep the charging area well-ventilated to avoid hydrogen gas concentration.

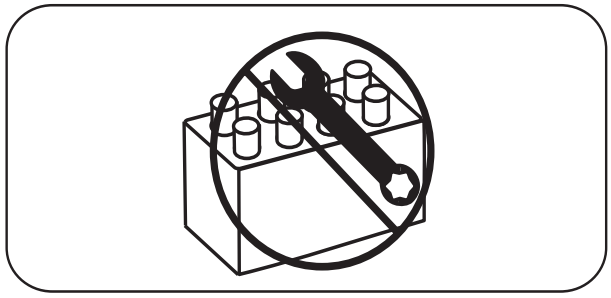


Turn the key switch OFF *before* disconnecting the battery from the lift truck at the battery connector. Do not break live circuits at the battery terminals. A spark often occurs at the point where a live circuit is broken.



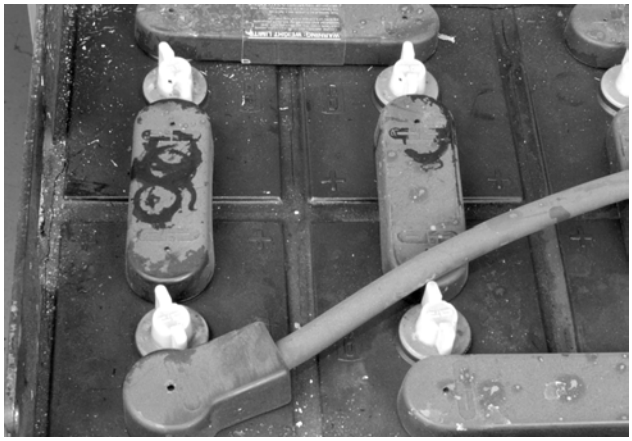
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Do not lay tools or metal objects on top of the battery. A short circuit or explosion could result.



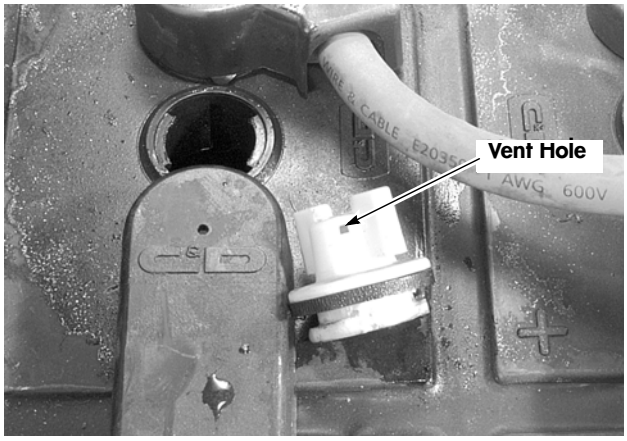
Keep batteries clean. Corrosion causes shorts to the frame and possibly sparks.

Keep plugs, terminals, cables and receptacles in good condition to avoid shorts and sparks.



Keep filler plugs firmly in place at all times *except* when the electrolyte level is checked, when water is added to the cells or when the specific gravity is checked.

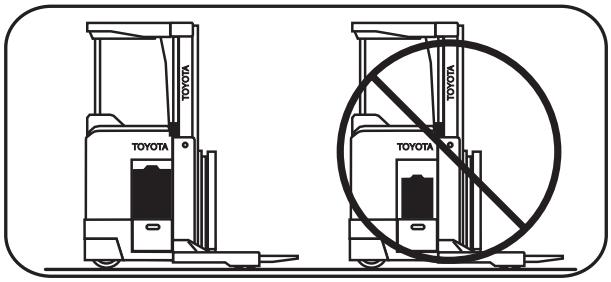
Make sure the vent holes in the filler plugs are open to allow the gas to escape from the cells.



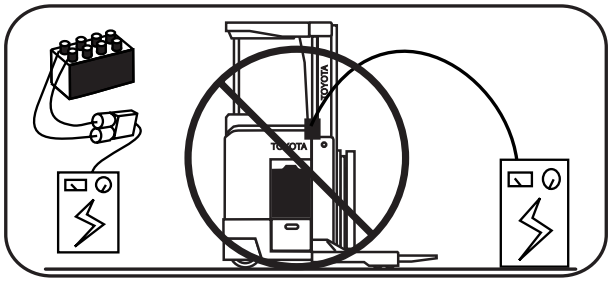
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Do not allow cleaning solution, dirt or any foreign matter to enter the cells.

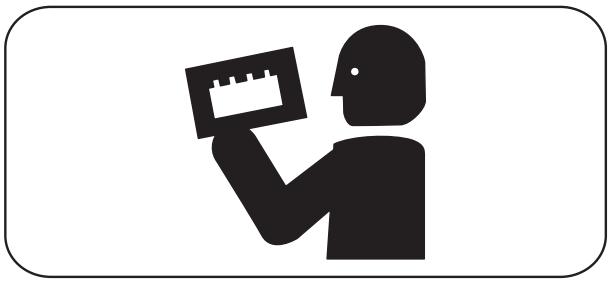
Make sure you install the correct size battery. A smaller or lighter weight battery could seriously affect lift truck stability. See the lift truck's specification plate for more information.



Never plug a battery charger into the lift truck's battery connector. Plug the battery charger only into the battery connector from the battery.



Follow the charging procedures in the Battery Instruction Manual and in the Battery Charger Instruction Manual.



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Static Safety

Electronic circuit boards and devices used on the Toyota lift truck can be damaged by the discharge of static electricity, called electrostatic discharge (ESD).

Static charges can accumulate from normal operation of the lift truck as well as movement or contact between non-conductive materials such as plastic bags, synthetic clothing, synthetic soles on shoes and styrofoam coffee cups.

Accumulated static can be discharged through human skin to a circuit board or component by touching the parts. Static discharge is also possible through the air when a charged object is placed close to another surface at a different electrical potential. *Static discharge can occur without seeing or feeling it.*

Whenever working on or near static-sensitive electronics, always follow these ESD precautions:

- Wear an ESD wrist strap.
- Connect the ground plug to the ESD ground jack on the lift truck. See Figure 2-1. If you cannot use the ground jack, connect the ground clamp to an unpainted, grounded surface on the lift truck frame.
- Handle circuit boards by the edges only. Avoid touching the edge connectors.
- If you will be removing or installing static-sensitive components, place them on a properly grounded antistatic mat.
- To transport static sensitive components, including failed components being returned, place the components in an antistatic bag or box (available from your local authorized Toyota Dealer).

The wrist strap and associated accessories should be tested monthly to verify they are working properly. A defective static discharge wrist band will not alert you that it is bad.



Figure 2-1: Ground Jack

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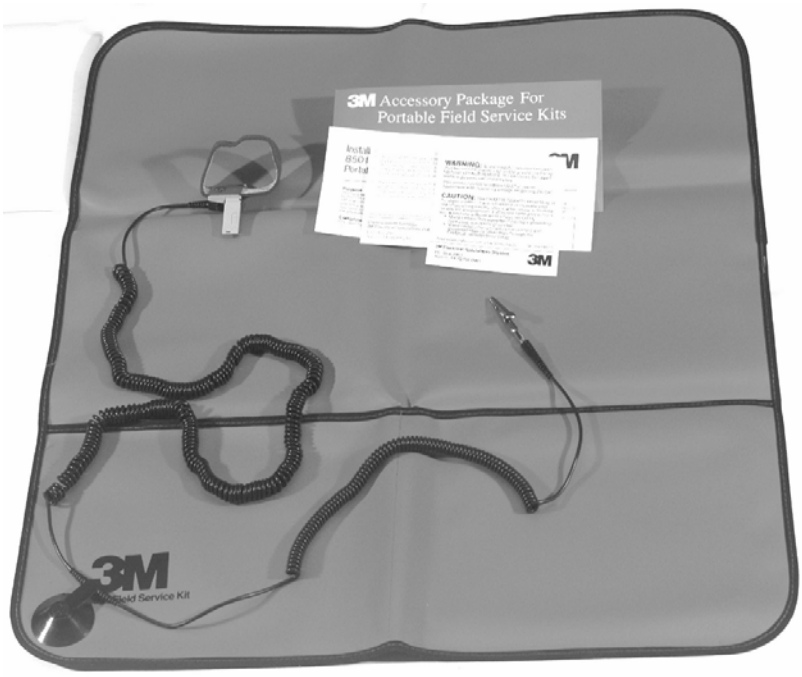


Figure 2-2: Anti-Static Kit with Wrist Strap and Mat

Figure 2-2 shows the components of the Toyota antistatic field service kit, Part Number (P/N) 00590-04849-71. The kit includes a wrist strap, ground cord and static-dissipative work surface (mat). Follow the instructions packaged with this kit.

Wrist straps are available in quantities of 25, as P/N 00590-04848-71.

A wrist strap tester is available as P/N 00590-04850-71.

Contact your local Dealer for information.

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Jacking Safety

It may be necessary to jack the lift truck off the floor to perform maintenance procedures. When doing so, observe the following safety precautions:

1. Make sure the floor surface is level or move the truck to a location where it is level.
2. Lower the forks completely. Remove any load.
3. Place all controls in neutral.
4. Block the wheels to prevent movement of the vehicle.
5. Disconnect the battery connector.
6. Place the jack under the designated jacking points. See Figure 2-3.

⚠WARNING

Use extreme care whenever the lift truck is jacked up. Keep hands and feet clear from vehicle while jacking the lift truck. After the lift truck is jacked, place solid blocks beneath it to support it. DO NOT rely on the jack alone to support the lift truck.

Tractor

1. Place the jack in the designated jacking position. See Figure 2-3.
2. Jack the rear of the lift truck so that the drive tire is off the floor no more than 2 in. (50 mm).
3. Block the lift truck in place.

Mast

1. Place the jack in the designated jacking position. See Figure 2-3.
2. Jack the side of the truck so that the load wheel is off the floor no more than 1/2 in. (13 mm).
3. Block the lift truck in place.

NOTE: After working on a vehicle, test all controls and functions to assure proper operation.

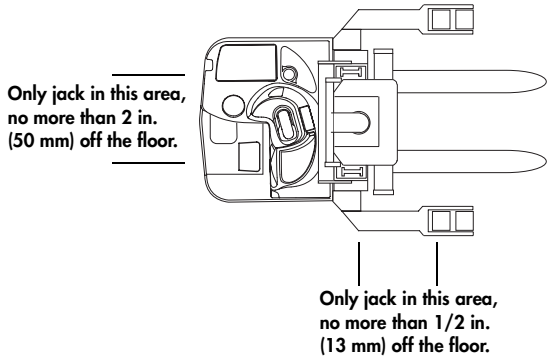


Figure 2-3: Correct Jacking Locations

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Tie-down for Transport

To transport your Toyota lift truck in an over-the-road vehicle or rail car, follow these steps:

1. Lower the forks and locate the lift truck in the center of the transport vehicle.
2. Using a suitable lifting device, remove the battery. See “Battery Safety” on page 2-7.
3. Position the adjustable chain over and through the battery compartment.
4. Position an additional adjustable chain over and through the battery compartment.
5. Position the chain ends of one chain toward the front of the vehicle bed and the chain ends of the other chain to the back of the vehicle bed and draw taut.

NOTE: This will secure the lift truck to the vehicle bed and prevent tip-over and forward or backward movement.

6. Secure the battery according to the battery manufacturer’s instructions.

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Welding Safety

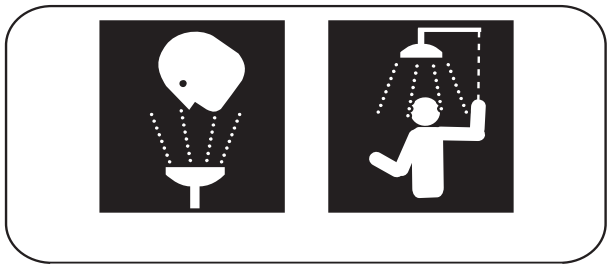
⚠WARNING

Flame cutting or welding on painted surfaces may produce potentially harmful fumes, smoke and vapors. Prior to performing flame cutting or welding operations, it is recommended that the coating be removed in the vicinity where the operation(s) will be performed.

Coating removal may be by mechanical methods, chemical methods or a combination of methods. Flame cutting and/or welding operations should be carried out only in well ventilated areas using local exhaust if necessary.

Before working on this lift truck, make sure that:

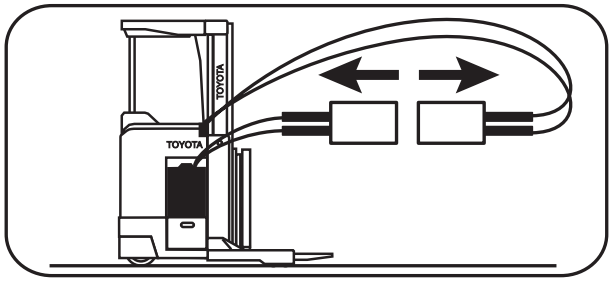
- Fire protection equipment is nearby.
- You know where the nearest eyewash station is.



⚠ CAUTION

Disconnect the battery before you attempt to inspect, service or repair the lift truck.

- Check for shorts to frame as described in "Shorts to Frame Test" on page 5-4. If any shorts are detected, remove them before you proceed with the welding operation.
- Clean the area to be welded.
- Protect all lift truck components from heat, weld spatter and debris.
- Attach the ground cable as close to the weld area as possible.



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Welding Safety

- Disconnect all electrical cards before any type of electric resistance welding is done.
- Do not perform any welding operations near the electrical components.
- If welding must be done near the battery compartment, remove the battery from the lift truck.
- When you are finished welding, perform all ground tests and electrical inspections before the vehicle is operated.

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Systems Overview

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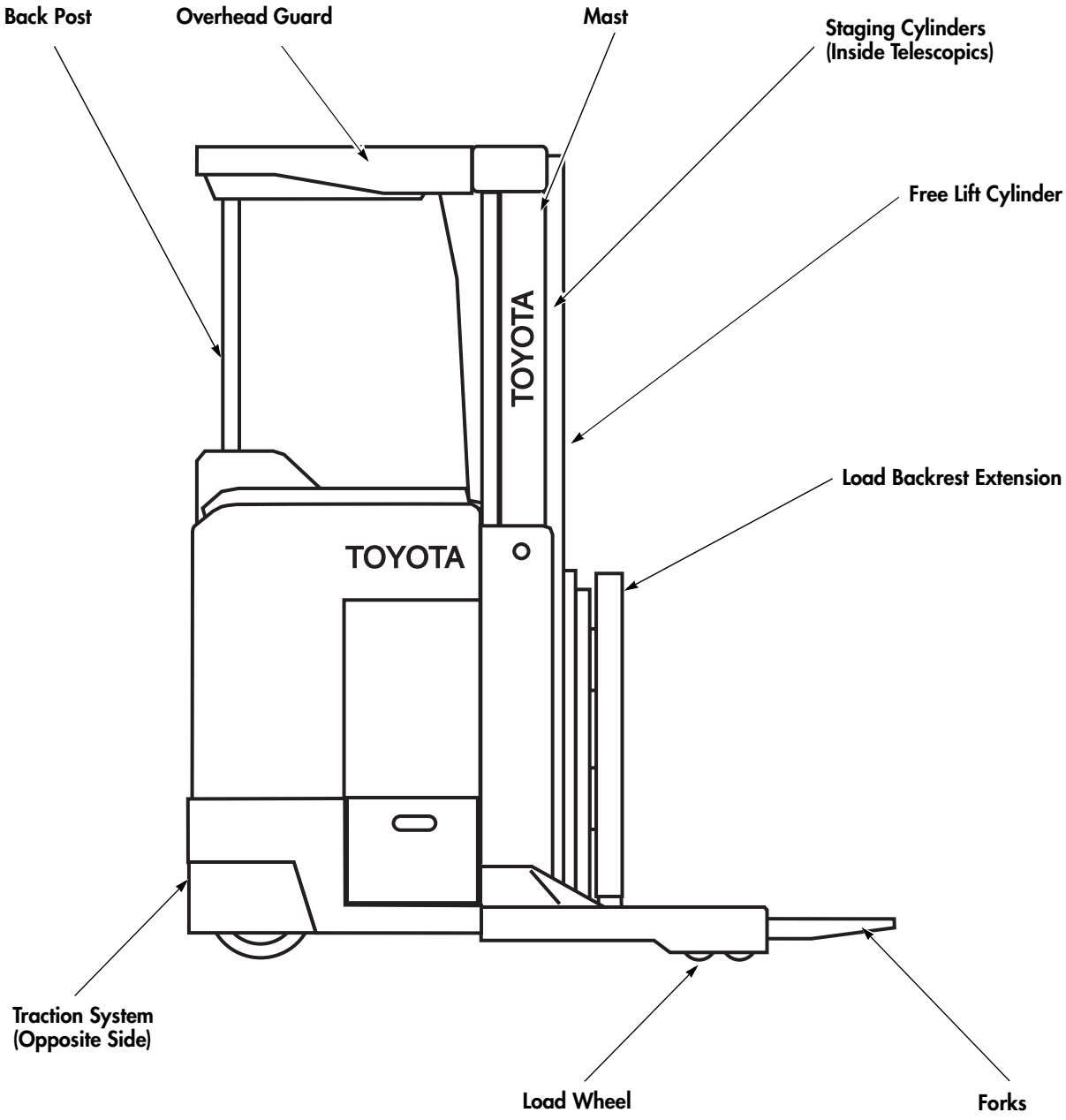
Vehicle Specifications

Category		Single Deep Reach			Double Deep Reach	Straddle		
Unless otherwise noted, all dimensions are in inches.								
Model Designation		7BRU18		7BRU23	7BDRU15	7BSU20		7BSU25
Max. Load Capacity (w/41 in. BLO)		3500 lb. to 270 in.		4500 lb. to 270 in. 3500 lb. to 330 in.	3000 lb. to 300 in. 2700 lb. to 330 in.	4000 lb. to 270 in.		5000 lb. to 270 in.
Lift Height, Max. (EH)		270 in.		330 in. (B) 360 in. (C)		270 in.		330 in. (B) 360 in. (C)
Lift Speed	Loaded	40 fpm	60 fpm	60 fpm		40 fpm	60 fpm	60 fpm
	Empty	60 fpm	80 fpm	95 fpm		60 fpm	80 fpm	95 fpm
Lowering Speed	Loaded	80 fpm	80 fpm	95 fpm		80 fpm		95 fpm
	Empty	80 fpm	80 fpm	90 fpm		80 fpm		90 fpm
Reach/Retract Speed (seconds)	Loaded	5.0	4.5	4.0	5.0	n/a		
	Empty	4.0	3.5	3.0	4.0	n/a		
Travel Speed (mph)	Loaded	5.5	6.0	6.8 <300 in. 6.0 >300 in.		5.5	6.0	6.8 <300 in. 6.0 >300 in.
	Empty	6.0	6.5	6.8 <300 in. 6.5 >300 in.		6.0	6.5	6.8 <300 in. 6.5 >300 in.
Acceleration, Empty (max. seconds)		5.5	5.3	5.0		5.5	5.3	5.0
Overall Length (without Forks)		70.5 (A) 72.5 (B)	72.5	75.0 (B) 79.5 (C)		72.5 (A) 74.5 (B)	74.5	77.0 (B) 81.5 (C)
Base Leg Opening (inside)		32 - 50 in.						
Reach Distance (in.)		23	23	22	39.7	n/a		
Battery Compartment (in.)		14.4 or 16.4	16.4	16.4 or 21		14.4 or 16.4	16.4	16.4 or 21
Battery Voltage		24	36			24	36	
Min. Battery Weight		1600 lb.	2000 lb.	2600 lb. ≥330 2400 lb. <330	2000 lb. (B) 2600 lb. (C)	1600 lb.	2000 lb.	2000 lb. (B) 2400 lb. (C)

***A = 14.4 in. Battery Compartment**
B = 16.4 in. Battery Compartment
C = 21 in. Battery Compartment

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General System Data



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Brake

The braking system meets all requirements of ASME B56.1 and is the recommended system for stopping the vehicle in an emergency. Plugging is the recommended procedure for stopping the lift truck under normal operating conditions. The brake assembly is mounted on top of the drive motor. The brake assembly consists of a rotor mounted on the drive motor armature shaft and a stationary friction disc. The brake is electrically applied and released.

Steering

The steering system consists of the following:

- steering wheel
- electric steer tach
- electric steer controller
- electric steer motor

The electric steer controller supplies electrical voltage for the steering system. The electric steering motor receives direction commands from the operator through steering wheel turns. The electric steer motor turns the drive unit. The steer tach monitors rotation of the steering wheel, sending + or – voltage to the steer controller.

Lift/Lower System

All inputs and outputs related to the lift/lower system are controlled by the Display card. The Display card determines what actions are required based on inputs from the operator and from system feedback.

As VR2 is moved by the operator, a voltage, proportional to the position of the control, is sent through the Tractor Interface card to the Display card where it is processed.

When the Lift/Lower control is moved to lift, voltage from VR2 increases; when it is moved to lower, the voltage from VR2 decreases. As the lift/lower control is moved, VR2 voltage is sensed by the Tractor Interface card. This data is then transmitted to the Display card, which determines whether to lift or lower. This is accomplished by the Display card comparing the present voltage to the learned voltage value.

Remember that the neutral value for VR2 is learned and stored for future reference by the Display card during Calibrate mode.

Unique Lift/Lower System Features

All coils used for the lift/lower system are 24V, even on 36V lift trucks. This is accomplished by the Display card pulsing the appropriate coil driver located on the Tractor Interface card. If a lift truck is 36V, the coil driver will be pulsed at a rate of 66% (66% x 36V = 24V).

The Display card monitors lift pump motor rotation (back EMF) at JP8-9. If the control is moved from lift to lower, the Display card will not allow the carriage to lower until the lift pump motor has stopped. This allows smooth, controlled movement of the carriage without a “bump”. The length of the delay will depend on the oil viscosity, pump/motor tightness, temperature, and the load on the carriage.

Auxiliary System

The auxiliary system consists of auxiliary controls and cylinder(s) for reach/retract, sideshift or tilt. The lift/lower and auxiliary systems share the same reservoir, motor and pump.

Reach/Retract

Reach extends the forks away from the mast assembly when the reach button on the multi-function control handle is depressed. Inputs for reach are received by the Tractor Interface card at JP10-1.

Retract moves the forks toward the mast assembly when the retract button on the multi-function control handle is depressed. Inputs for retract are received by the Tractor Interface card at JP10-2.

If the lift truck is configured for two speed reach and retract, the sequence in which the Reach/Retract buttons are depressed determines the

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speed and direction the reach mechanism travels.

- Depressing and holding the Reach button, then depressing the Retract button activates high speed reach.
- Depressing and holding the Retract button, then pressing the Reach button activates high speed retract.

Sideshift

Sideshift allows the operator to move the fork carriage to the left or right in relation to the mast. The amount of sideshift will be 2 or 4 in. (5 or 10 cm) in either direction depending on the Base Leg Opening (BLO). Inputs for sideshift right are received by the Tractor Interface card at JP10-3. Inputs for sideshift left are received by the Tractor Interface card at JP10-4.

Fork Tilt

Fork tilt allows the operator to raise or lower the tips of the forks. Standard fork tilt is 5° up and 2° down. Inputs for fork tilt up are received by the Tractor Interface card at JP10-5. Inputs for fork tilt down are received by the Tractor Interface card at JP10-6.

Traction System

All inputs and outputs related to the traction system are controlled by the Display card. The Display card determines what actions are required based on inputs from the operator and from system feedback.

As VR1 is moved by the operator, a voltage, proportional to the position of the control, is sent through the Tractor Interface card to the Display card where it is processed.

When the directional/speed control handle is moved in the forward direction (away from the operator), voltage from VR1 increases; when it is moved in the reverse direction (toward the operator), the voltage from VR1 decreases. As the directional/speed control handle is moved, VR1 voltage is sensed by the Tractor Interface card. This data is then transmitted to the Display card, which determines the desired direction of travel. This is accomplished by the Display card comparing the present voltage to the learned voltage value.

Remember that the neutral value for VR1 is learned and stored for future reference by the Display card during Calibrate mode.

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Modes of Operation

Self-diagnosis Mode

Self-diagnosis mode is the normal running mode. No passwords are required to enter self-diagnosis mode.

Analyzer (AnL) Mode

Analyzer mode is the error analysis mode. Both primary and secondary passwords are required to enter analyzer mode. Once the analyzer mode is activated, the display will show “Analyzer.”

Tuning (Tuning) Mode

Tuning mode is used to change settings. Both the primary and secondary passwords are required to enter tuning mode. Once the tuning mode is activated, the display will show “Tuning.”

Calibrate (Calibrte) Mode

Calibrate mode is used to set values that are checked upon power-up and used continuously after power-up. A unique secondary password, as well as the primary password, is required to enter calibrate mode. Any lift truck whose Display Card does not have stored calibrate values will be disabled until calibrate mode is run. The truck’s display will scroll “Run Calibrate Mode” until it is performed. Calibrate mode is used to learn (set) the values for the traction pot, the lift pot, the deadman pedal pot, and the pressure transducer (option).

Configure (Configur) Mode

Configure mode is used to set unique truck features. The primary and a unique secondary password are required to enter configure mode.

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Scheduled Maintenance

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Maintenance Guidelines

A regularly scheduled maintenance program is recommended to enable:

- maximum truck performance
- maximum truck life
- reduction of costly down time
- avoidance of unnecessary repairs

Scheduled maintenance includes:

- lubrication
- cleaning
- inspection
- service

Perform all of the scheduled checks and maintenance during the suggested intervals. The time intervals given in this guide are based on normal operating conditions. When operating under abnormal or severe conditions, perform these services more often as required to keep the unit in good operating condition.

See page A-2 in the Appendix for lubrication equivalents. Refer to the manufacturer's supplements for components not listed on the following pages.

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Daily or Every 8 Operating Hours

Item	Daily or Eight Hour Checklist
Battery	Check cleanliness. Check the electrolyte level and specific gravity following the battery manufacturer's instruction manual. Check the connector. Make sure all powered functions are shut down when disconnected. Check the battery gates. Be sure they are properly installed and locked securely in place. Check the "free play" of the battery. Be sure that it has no more than 0.50 in. (12.7 mm) of movement in any direction.
Brake	Check that the deadman pedal returns to up position when released. Check that travel is cut out and brake is applied when deadman pedal is in fully raised position.
Forks	Inspect for damage, bending, cracking, or signs of unauthorized modification. Check for minimum thickness. See page 7-227.
General Operation	Check that the horn operates when you press the horn button (battery must be connected and key switch ON). Check the speed and directional controls. Check the steering operation. Check the lift/lower, reach/retract, sideshift, and tilt functions. Check all other components and hardware, inspecting for looseness as necessary. Report any damage that may hinder truck operation. Note any unusual noise during operation, and report it to the supervisor or maintenance personnel. Replace any warning decals that have become unreadable or damaged.
Hydraulic System	Check hydraulic connections and hoses for leaks. Check for proper fluid level in hydraulic reservoir.
Mast	Inspect mast for damage or binding.
Switches	Check that each switch controls the assigned function. Check for intermittent switch operation.
Wheels	Inspect the condition of the drive and load wheels. Remove any steel chips and foreign material to prevent damage to the wheels. Check for gouging and chunking of tire surface.

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Monthly or Every 200 Operating Hours

Perform the daily check list plus the following.

Item	Monthly or 200 Hour Checklist
Brake	Check for satisfactory brake operation. Check the brake actuation and deadman switch adjustment. Inspect the brake pads and rotor for minimum thickness, gap, and signs of oil. Clean or adjust.
Caster Assembly	Check the caster assembly adjustment. Adjust if necessary using the procedure on page 7-35. Inspect the caster wheel axle and bearings for excessive wear. See page 7-47.
Contactor Tips	Check the contactor tips. Replace if worn. See page 7-80.
Drive Unit	Check the oil level of the drive housing. Check and clean the drive housing breather. Lubricate steering bearing via grease fittings.
Electrical System	Visually inspect all cables for damage. See page 7-75 and page 7-79. Check for shorts to frame. See “Head1 on page5-4.
Forks	Inspect thickness. See page 7-227.
General Operation	Check the condition of cables and hoses. Give special attention to cables and hoses which are not stationary. Check the tension of the over-the-mast pulley cables. Check for looseness of all mounting bolts and nuts.
Hydraulic System	Inspect hydraulic connections and mounting. Inspect hoses, tubes, and fittings for leaks. Clean the hydraulic fluid breather cap.
Motor Brushes	Check the condition of brushes, springs, and holders. Check that the brush length exceeds the minimum length. See page 7-103.
Mast	Grease mast. Inspect, lubricate, and adjust lift chains. Examine for wear. See page 7-186.
Overhead Guard	Check for physical damage to the guard. Replace the guard if it is structurally damaged. Check the torque of the overhead guard mounting bolts.
Sideshift Carriage	Check tightness of screws securing the lower mounting hooks to the carriage bar are tight. See “Sideshift Carriage” on page 7-221. Check for damaged hydraulic hoses or fittings.
Wheel	Check the tightness of the drive wheel mounting cap screws. Check and lubricate the load wheel bearings.

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Semi-annually or Every 1000 Operating Hours

Perform the monthly checklist, including the daily checklist, plus the following:

Item	Semi-Annual or 1000 Hour Checklist
Hydraulic System	Change the filter. See page 7-142. Change the hydraulic fluid. See page 7-140.
Pump and Motor	Separate the lift pump and motor. Lubricate the shaft with anti-seize lubricant.
Sideshift Carriage	Check thickness of upper pads. If less than 0.06 in. (1.5 mm), replace them. Check thickness of lower pads. If less than 0.2 in. (5 mm), replace them. See “Pad Replacement” on page 7-222. Grease the lower bar of forklift carriage in area where pads slide.

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Annually or Every 2000 Operating Hours

Perform the semi-annual checklist, including the monthly and daily checklist, plus the following:

Item	Semi-Annual or 1000 Hour Checklist
Drive Unit	Change the drive unit fluid. See page 7-60.
Sideshift Carriage	Replace pads. See “Pad Replacement” on page 7-222.

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Lubricants

Cold Storage Conditioning

If the lift truck is to be used in a cold storage application, it is equipped with Class I, Class II or Class III cold storage option components when delivered from the factory, *except* for the oil in the hydraulic reservoir and the drive unit.

⚠ CAUTION

At such time as the customer is ready to start using the truck in a cold storage environment, the oil in the hydraulic system and the drive unit must be changed in accordance with the following items.

Classes Of Cold Storage

There are three classes of cold storage application. Those classes are:

1. Class I: Applies to lift trucks operating in an:
   - environment where temperatures fluctuate from +20°F (–7°C) to +70°F (21°C) in a continuous duty cycle
   - application where the truck goes in and out of the freezer for short periods of time
2. Class II: Applies to lift trucks operating:
   - in and out of an environment where temperatures fluctuate from +40°F (4°C) to –40°F (–40°C).
   - continuously at –20°F (–29°C).
3. Class III: Applies to lift trucks operating directly in and out of an environment where temperatures fluctuate between –40°F (–40°C) and a warm humid area such as a dock rather than a cooler.

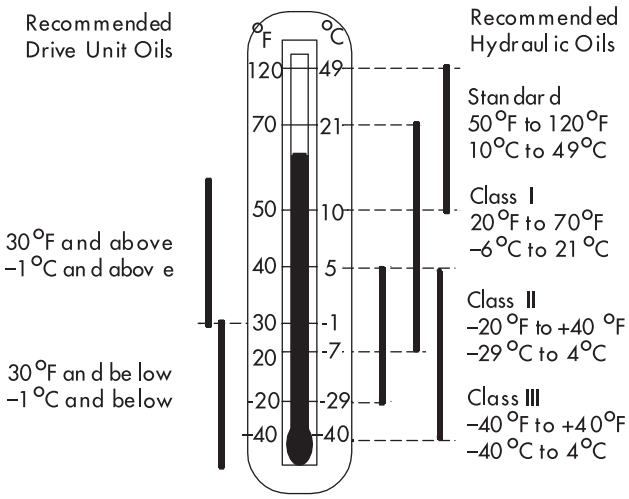


Figure 4-1: Recommended Oils by Temperature

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Lubricants

Refer to:

- Lubrication Equivalency Chart on page A-2.
- Figure 4-1 to ensure the proper oil selection for a particular temperature range.
- Follow the recommended procedure for changing the fluid in the hydraulic system. Refer to page 7-140.

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Lubrication and Inspection Points

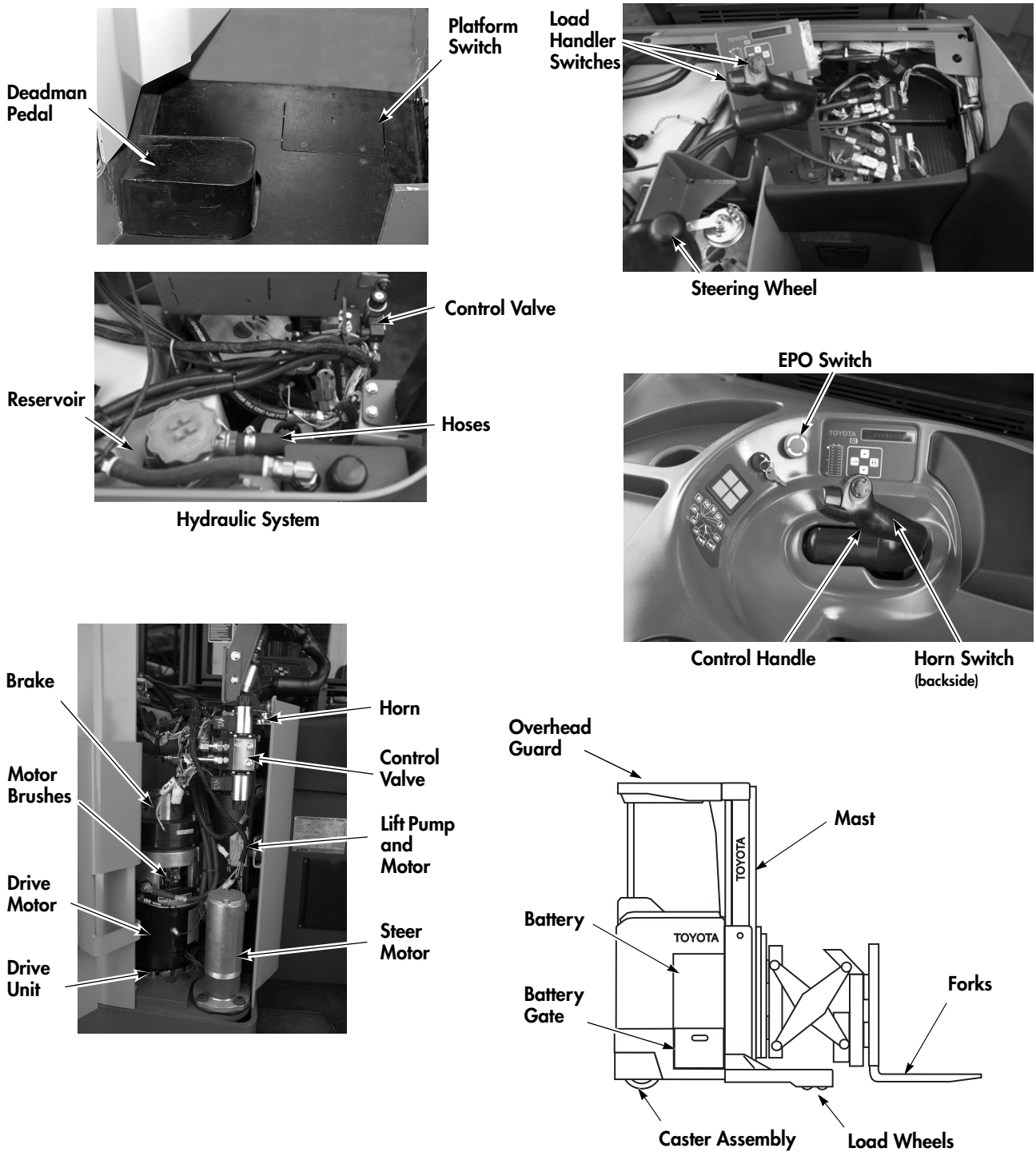


Figure 4-2: Lubrication and Inspection Points

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Troubleshooting

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How to Use This Chapter

This chapter uses a set of “decision-tree” charts designed to take you from a symptom to a specific sequence of tests in order to isolate a failing component.

- Use the **START TROUBLESHOOTING Chart TS-1** on page 5-19 to guide you to the individual symptom chart you need.
- Once you’re familiar with the symptoms listed, you may instead simply look up the symptom chart from the **List of Troubleshooting Charts** on page 5-17.

As you work with a troubleshooting symptom chart, you may be instructed to test various electrical connector pins. Use the **Electrical Connector Locator Photos** on page 5-12 or the **Electrical Connector Locator Chart** on page 5-10 to find a particular electrical connector.

Every time you complete a troubleshooting procedure, be sure to follow the steps in **End of Troubleshooting Chart END1** on page 5-22.

If the troubleshooting symptom charts do not isolate the problem, or if the symptoms are not consistent or repeatable, go to the **General Troubleshooting Chart GEN1** on page 5-20. This chart will help you approach the problem in a systematic and logical manner.

Each chart begins with a lozenge-shaped symbol containing the title and symptom. Charts are identified as H for Hydraulic, T for Travel, and W for Wiring. The logic generally flows top to bottom and left to right. A symbol shaped like a baseball home plate means the chart is continued on another page, either a continuation of the current chart, or a different chart. Continuation charts have a suffix number added. A continuation chart begins with a circle-shaped symbol containing the chart number, including suffix.

For example, look at Chart "H-14: Reach Works Slow" on page 5-46. One logic path is continued on Chart H-14-2, which is the next page. Another logic path from Chart H-14 goes to the End of Troubleshooting Chart END1, on page 5-22.

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Electrical Troubleshooting Guidelines

Many problems are caused by a faulty or dirty battery. Make sure the battery is clean. Check the electrolyte level and state of charge. See “Charging” on page 7-73.

⚠WARNING

Block the lift truck whenever a troubleshooting procedure requires turning key switch S1 ON. This will avoid accidents caused by unexpected lift truck travel.

⚠ CAUTION

Unless otherwise directed, disconnect the battery connector when you check electrical circuits or components with an ohmmeter. Electrical current can damage the ohmmeter.

Save time and trouble by looking for simple causes first.

Visually inspect all wiring and electrical components for:

- loose connections or connectors
- loose or broken terminals
- damaged terminals, blocks, or strips
- broken wiring and shorted conditions (especially those that are close to metal edges or surfaces)

Use an ohmmeter to check for wiring continuity.

For information on pin, connector, and harness connections, see Wiring Harness on page 7-76.

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Shorts to Frame Test

"Shorts to frame" is an industry term for unintentional current leakage paths between normally isolated electrical circuits and their metal enclosures.

Shorts to frame may be metallic connections, such as a wire conductor contacting metal through worn insulation. More often, shorts to frame are resistive "leakage" paths caused by contamination and/or moisture.

These leakage paths can result in unwanted electrical noise on the metallic truck structure, and may result in improper operation.

Shorts to frame can be caused by:

- accumulation of dirt
- battery electrolyte leakage
- motor brush dust
- motor brush leads touching the housing
- breakdown in insulation
- bare wires
- pinched wiring harness
- improper mounting of circuit cards

Shorts to frame can occur at numerous locations on a truck, including:

- batteries
- motors
- cables, wiring, and harnesses
- heat sinks
- bus bars
- solenoids
- contactors
- terminal strips
- switches
- power panel insulation
- circuit card mounts

To test for shorts to frame:

1. Turn the key switch OFF and disconnect the battery connector.
2. To test the battery for shorts to case, connect a 12V test light to the battery case from battery B+, and then to the battery case from battery B–. If the light lights at all, even momentarily, there is a *serious* problem with the battery, either external contamination or internal damage. *DO NOT continue until this condition is corrected.* Your meter may be damaged if you proceed before correcting this condition.

   Install another battery in the truck and repeat this procedure from step 1.

   If the test light does not light, continue to the next step.
3. With the battery disconnected from the truck, use a Digital Volt Meter (DVM) on the ampere function to measure the leakage current from the battery case to battery B+ and from the battery case to battery B–. Begin measuring at the highest Ampere scale and work toward the lowest. A reading of more than 0.001A (1mA) indicates a *serious* short. *DO NOT continue until this condition is corrected.* Your meter may be damaged if you proceed before correcting this condition.

   Install another battery in the truck and repeat this procedure from step 1.

   If the current is less than 0.0002A (0.2mA), go to step 4. If the current is greater than 0.0002A (0.2mA) and less than 0.001A (1mA), remove the battery from the truck, then continue with step 4. Make sure the battery case does not touch the truck frame during the remaining tests.

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4. With the battery disconnected (or removed and disconnected) from the truck, use a digital ohmmeter to measure the resistance from truck frame to truck B+, to truck B– (NOT battery B+ and B–), and to all fuses and motors. A reading of less than 1000 ohms indicates a *serious* short. *DO NOT continue until this condition is corrected.* Your meter may be damaged if you proceed before correcting this condition.
   a. To identify the cause of the short to frame, disconnect circuit components until the low resistance condition disappears. Do not reconnect components one at a time, but leave them disconnected until the low resistance reading disappears. Prevent disconnected terminals or connectors from touching truck frame or other conductive surfaces.
   b. The most likely areas to check are:
      - motors
      - heat sinks
      - power cables
      - power circuit components
      - control circuit components
   c. Repair or replace the component causing the low resistance condition, Then repeat Step 4.
   d. Reconnect all other components previously disconnected, one at a time, measuring resistance between steps. If a reading is less than 1000 ohms when reconnecting a component, that component or its wiring is defective; repair or replace as appropriate.
   e. When, after all components are reconnected, you get readings greater than 1000 ohms, continue with the next step.
5. Reconnect the battery connector to the truck and turn the key switch ON. If the battery was previously removed, ensure the battery case does not touch the truck frame.
6. Use a DVM on the current function meter to measure leakage current to the truck frame from B+, B–, and all fuses and motor terminals. Begin measuring at the highest ampere scale and work toward the lowest. If the current is less than 0.001A (1mA), go to step 7. If the current is more than 0.001A (1mA), continue this step below.
   a. To identify the cause of the short to frame, disconnect circuit components until the leakage current reads less than 0.001A (1mA). Do not reconnect components one at a time, but leave them disconnected until the leakage current reads less than 0.001A (1mA). Prevent disconnected terminals or connectors from touching truck frame or other conductive surfaces.
   b. The most likely areas to check are:
      - motors
      - heat sinks
      - power cables
      - power circuit components
      - control circuit components
   c. Repair or replace the component(s) causing the leakage current. Repeat step 6.
   d. Reconnect all other components previously disconnected, measuring current between steps. If a reading is more than 0.001A (1mA) when reconnecting a component, that component or its wiring is defective. Repair/replace as appropriate.
7. When, after all components are reconnected, you get a reading less than 0.001A (1mA) there is no short to frame condition with the truck or the battery. If you previously removed the battery from the truck, re-install the battery.

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To test for shorts to frame:

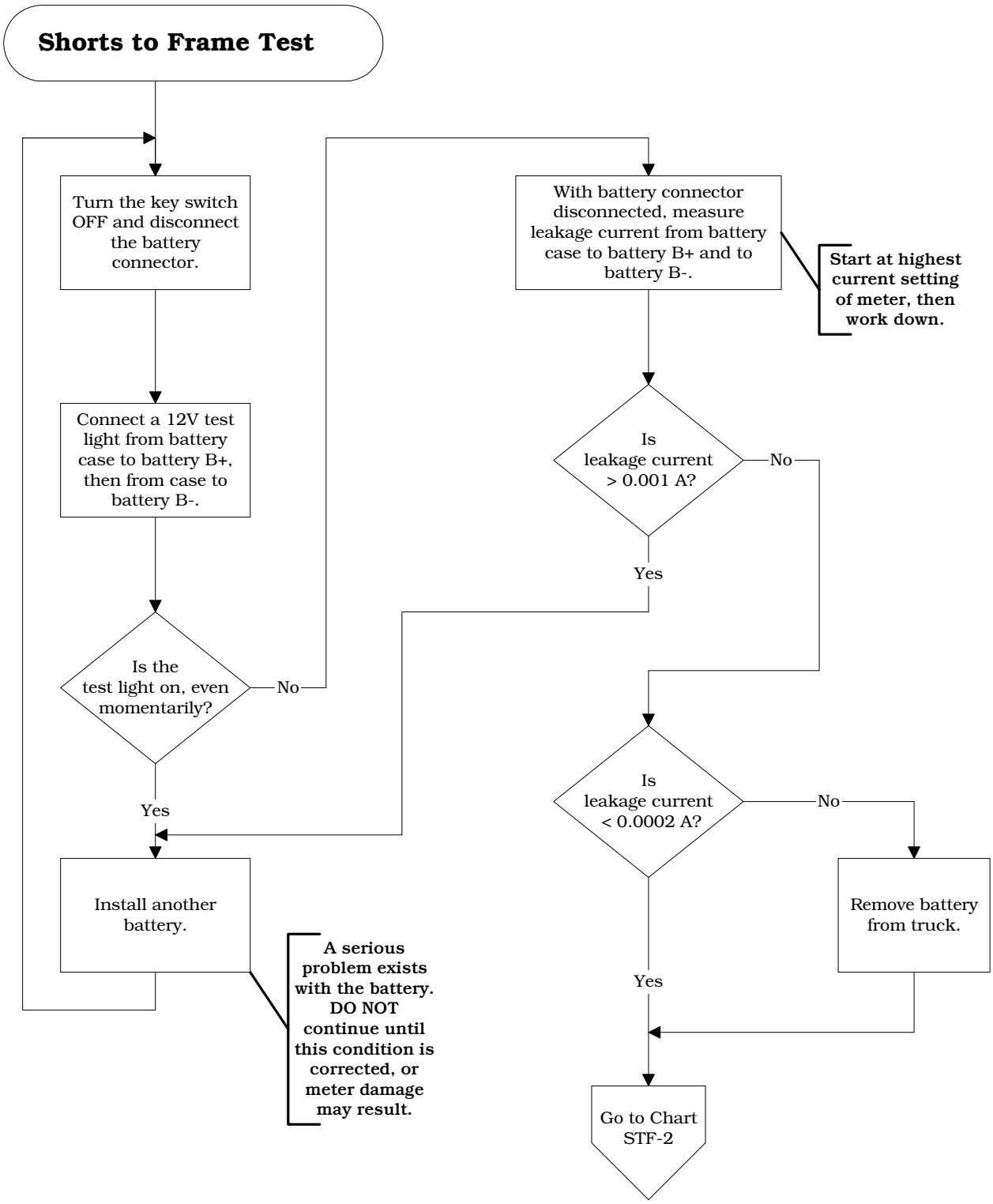
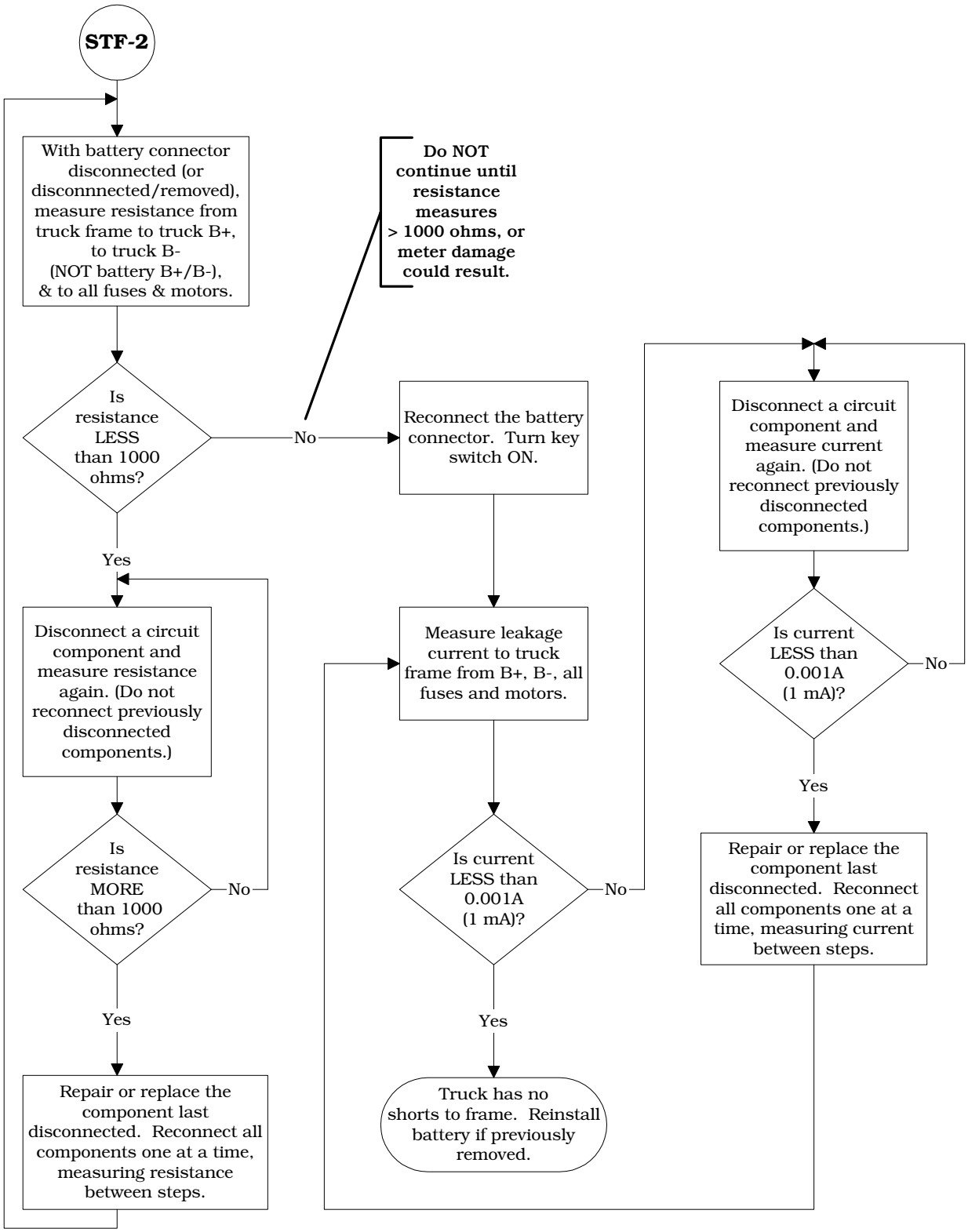


Figure 5-1: Shorts to Frame Test

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To test for shorts to frame:



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Hydraulic Troubleshooting Guidelines

⚠ CAUTION

After elevating or reaching the carriage for troubleshooting, be sure to use blocks to secure the carriage.

Use extreme care when blocking the mast for any reason. Never remove a block when it is supporting the mast.

Lower the carriage fully and retract the reach mechanism fully.

If the lift truck is equipped with tilt, set the forks level, not tilted either up or down.

If the lift truck is equipped with sideshift, center the forks horizontally.

When you check voltage at solenoids, make sure hydraulic lines and components are fully installed.

Whenever possible, keep the key switch OFF and the battery connector disconnected.

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Definitions

Auxiliary Function

A hydraulic function other than lift/lower. On the Toyota Reach lift truck, they include: reach/retract, tilt, and sideshift. Some auxiliary functions, or "aux" functions, are options not present on every lift truck.

Continuity

A continuous and uninterrupted path between two or more locations in an electrical circuit, typically having a resistance of less than 1 ohm.

Deadman Switch

The switch in the lift truck that must be closed to allow lift truck operation. It is activated by the operator stepping on the foot pedal thus engaging the deadman pedal.

High Speed Travel Limit

A reduced speed initiated when the lift truck is driven and the carriage is elevated above a certain mast height. This is a safety feature that limits the speed of travel with an elevated mast and helps prevent unstable load conditions.

Mast Assembly

The elevating section of the lift truck, which bolts to the tractor section adjacent to the battery. The mast assembly consists of telescopic sections, carriage assembly, lift cylinders, lift chains, etc.

Mast Switch

A switch on the mast that is actuated when the carriage is above a certain height on the mast. It is used to activate the speed limit feature to limit travel speed when the carriage is elevated.

Open Circuit

A lack of a continuous path between two or more electrical connections. Generally, when such a circuit is tested, it will have a resistance greater than ten megohms.

Overtemperature (Power Amplifiers)

Overtemperature of the motor power amplifier is from 185°F (85°C) and above. At overtemperature the drive current limit is linearly decreased from full set current down to zero. Plug current is *not* reduced to provide full vehicle braking under all thermal conditions.

Pulse Width Modulation

Pulse Width Modulation (PWM), also called "chopping," controls the speed of the motor by switching the battery voltage to the motor on and off very quickly.

Short Circuit or "Short"

A short circuit is an unspecified path in a circuit that provides unwanted full or partial continuity between two or more locations in an electrical circuit.

Example: Two insulated wires are physically next to each other and the insulation has been worn off each of the wires. Because the conductors inside each wire are now touching each other, there is a short circuit.

Example: A power cable from the battery to a junction post in the lift truck has had the insulation worn away. Because the wire conductors are touching the tractor frame, there is a short circuit of the battery cable.

Tractor

The body section of the lift truck that contains the battery, motors, drive unit, controls, and handle. The mast assembly bolts to the tractor, which is adjacent to the battery.

Undertemperature

When the power amplifier is operating at less than 13°F (–25°C), the current limit is cut back resulting in reduced travel speed.

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Electrical Connector Locator Chart

Refer also to the electrical connector locator photos which follow the table below.

Connector	Location	Function or Routing
40, 41	Steer Motor	Steer Motor to Steer Controller at SK2
BR	Brake	Brake Coil to Tractor Interface Card at JP8
HD1	Display Card	CAN Bus +/– to Traction Power Amplifier at JT2 and Lift Power Amplifier at JL2
HD2	Display Card	Overlay (Input SW1, 2 & 3, BDI LEDs 1 & 7-10, Brush Wear, Steer LEDs 2, 3 & 4)
HD3	Display Card	Sonalert
HD5	Display Card	Display card to SFA and SFB near the Speed Feedback Proximity Sensors
HD6	Display Card	Overlay (BDI LED's 2-6, Input SW4, Steer LEDs 1 & 5-8)
JL1	Lift Power Amplifier	Lift Power Amplifier to B+ Relay and Tractor Interface Card at JP8
JL2	Lift Power Amplifier	Lift Power Amplifier CAN Bus to Traction Power Amplifier at JT2 and Display Card at HD1
JP5	Tractor Interface Card	Tractor Interface Card to Back-Up Alarm (H2)
JP6	Tractor Interface Card	Tractor Interface Card to Solenoid Coils [DIRA (Y12), DIRB (Y13), Lift (Y10-2), Proportional Lower (Y10-3), and B+ Relay]
JP7	Tractor Interface Card	Tractor Interface Card to: • Key Switch (S1) • EPO Switch (S2) • Deadman Switch (S3) • Horn (H1) • Brake Potentiometer (VR3) • Traction Motor Temperature Sensor (DT) through JPM • Traction Brush Wear (TB) • Lift Motor Temperature Sensor (LT) through JPZ • Electrical Compartment Fan (FAN1) • Reach (Y14, Y15), Tilt (Y17) and S/S (Y16) Solenoid coils
JP8	Tractor Interface Card	Tractor Interface Card to: • Traction Power Amplifier at JT1 • Lift power amplifier at JL1 • Brake (BR) • Steer Controller safety relay and start/stop • MM Contactor • Lift Motor Sensor (M– on Lift Power Amplifier)
JP9	Tractor Interface Card	Tractor Interface Card to Mast Switches (S4, S5, S6), Platform (right foot) Switch (S7), and 180° steer sensor.

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Connector	Location	Function or Routing
JP10	Tractor Interface Card	Tractor Interface Card inputs from Control Handle potentiometers (VR1, VR2) and switches
JP11	Tractor Interface Card	Tractor Interface Card to Drive Wheel Position Sensor B (speed/direction sensor)
JP12	Tractor Interface Card	Tractor Interface Card to F4, F5, and F6
JP13	Tractor Interface Card	Tractor Interface Card to Drive Wheel Position Sensor A (speed/direction sensor)
JP14	Tractor Interface Card	Tractor Interface Card to Pressure Transducer (PRESS)
JP15	Tractor Interface Card	Tractor Interface Card to Spare Solenoid Driver and Staging Switch (S8)
JP16	Tractor Interface Card	Tractor Interface Card to Lift Brush Wear Sensor (LB)
JPD2	Tractor Interface Card	Tractor Interface Card to Display Card at JPS2
JPD3	Tractor Interface Card	Tractor Interface Card to Display Card at JPS3
JPM	Near Traction Motor	Traction Motor Temperature Sensor (DT) to Tractor Interface Card at JP7
JPS2	Display Card	Display Card Serial Communication to Tractor Interface Card at JPD2
JPS3	Display Card	Display Card Analog Input to Tractor Interface Card at JPD3
JPZ	Near Lift Motor	Lift Motor Temperature Sensor (LT) to Tractor Interface Card at JP7
JT1	Traction Power Amplifier	Traction Power Amplifier to B+ Relay and Tractor Interface Card at JP8
JT2	Traction Power Amplifier	Traction Power Amplifier CAN Bus to Display Card at HD1 and Lift Power Amplifier at JL2
SK1	Steer Controller	Steer Controller to JP8 and Steer Tachometer
SK2	Steer Controller	Steer Controller to F7 and Steer Motor
LB	Near Lift Motor	Lift Brush Wear to Tractor Interface Card at JP16
SFA and SFB	On top of Brake/Traction Motor Assembly	Speed Feedback Proximity Sensors to Display Card at HD5
TACH	Steer Tachometer	Steer Tachometer to Steer Controller at SK1
TB	Near Traction Motor	Traction Brush Wear to Tractor Interface Card at JP7

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Electrical Connector Locator Photos

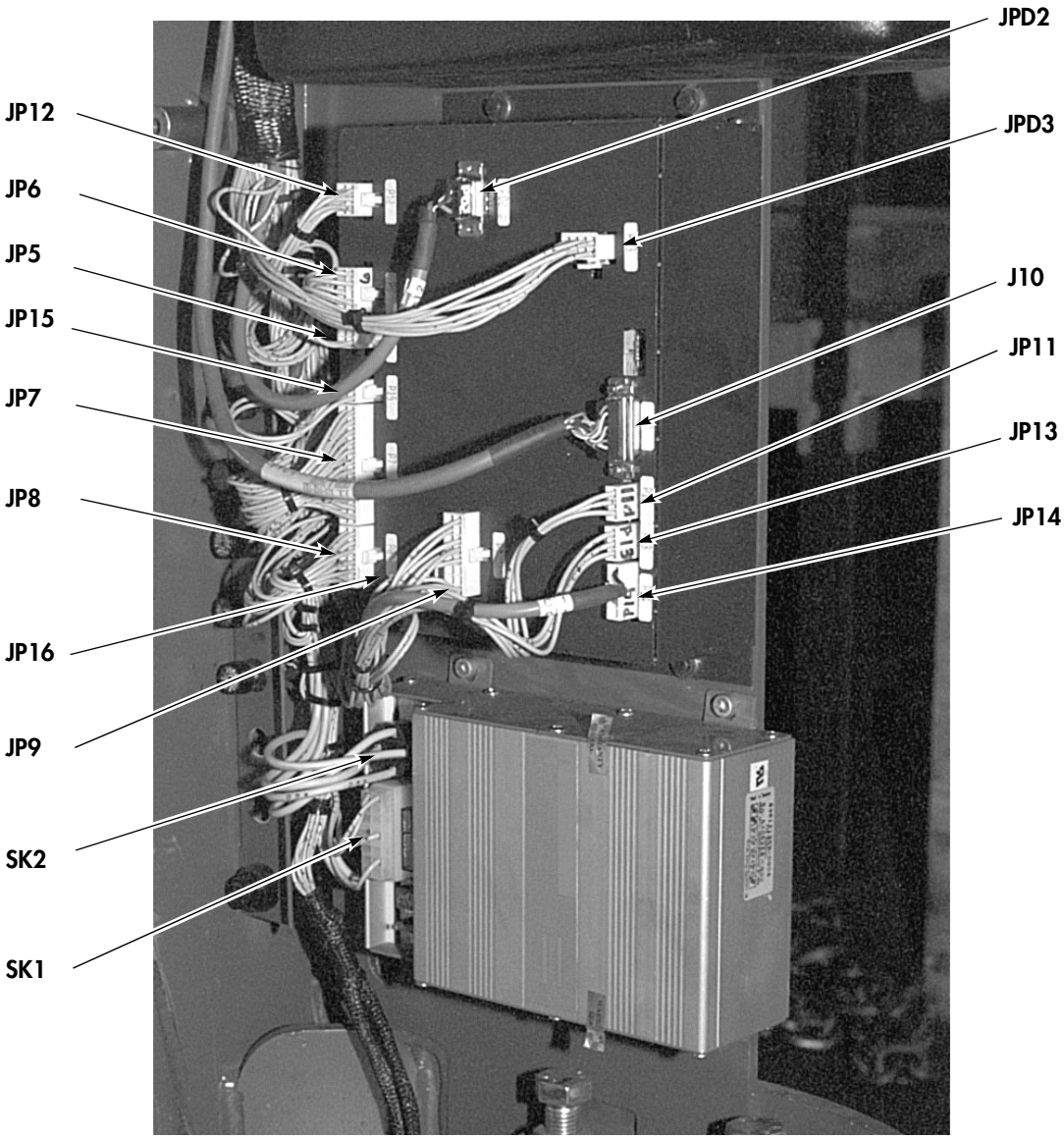


Figure 5-2: Electrical Connectors, Electrical Compartment (Operator Right Side)

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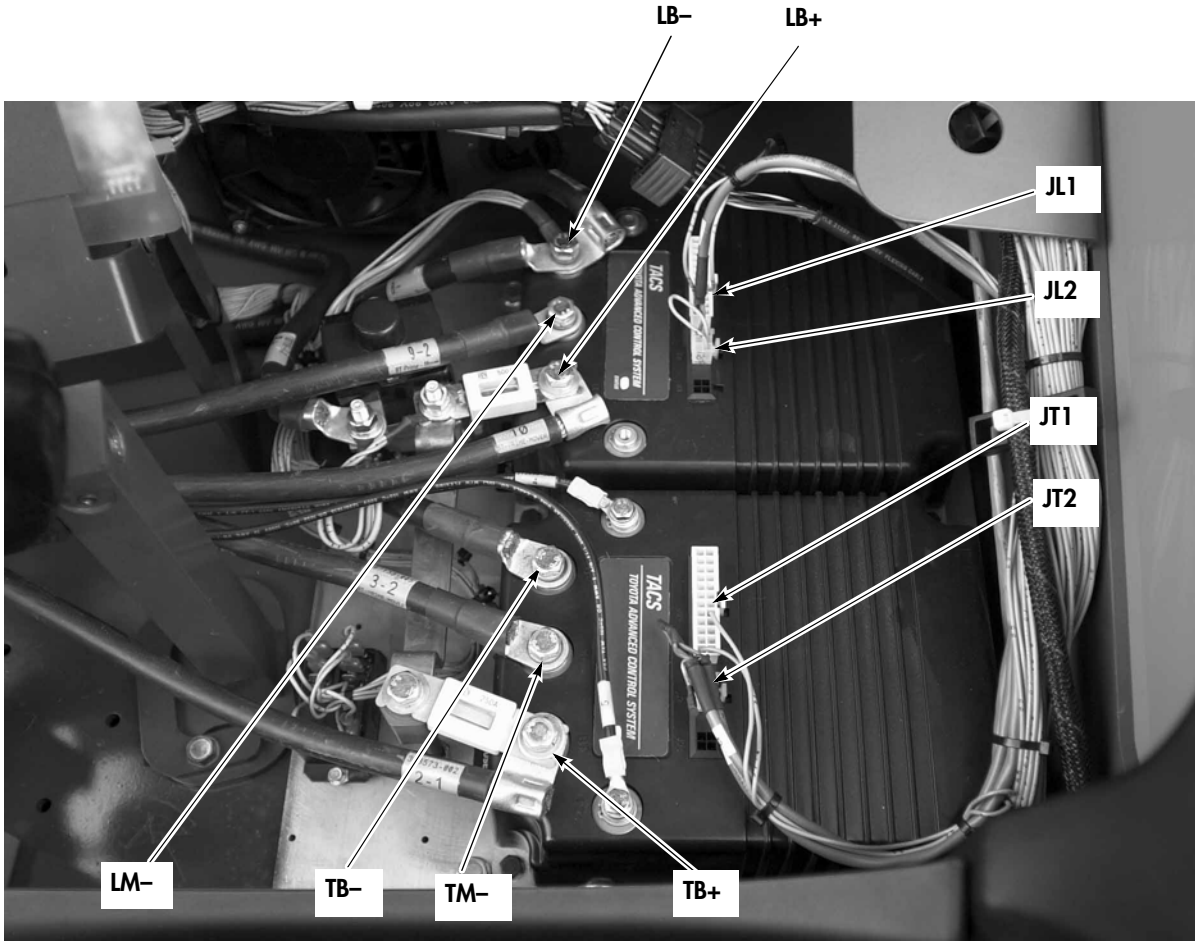


Figure 5-3: Power Amplifier Connections

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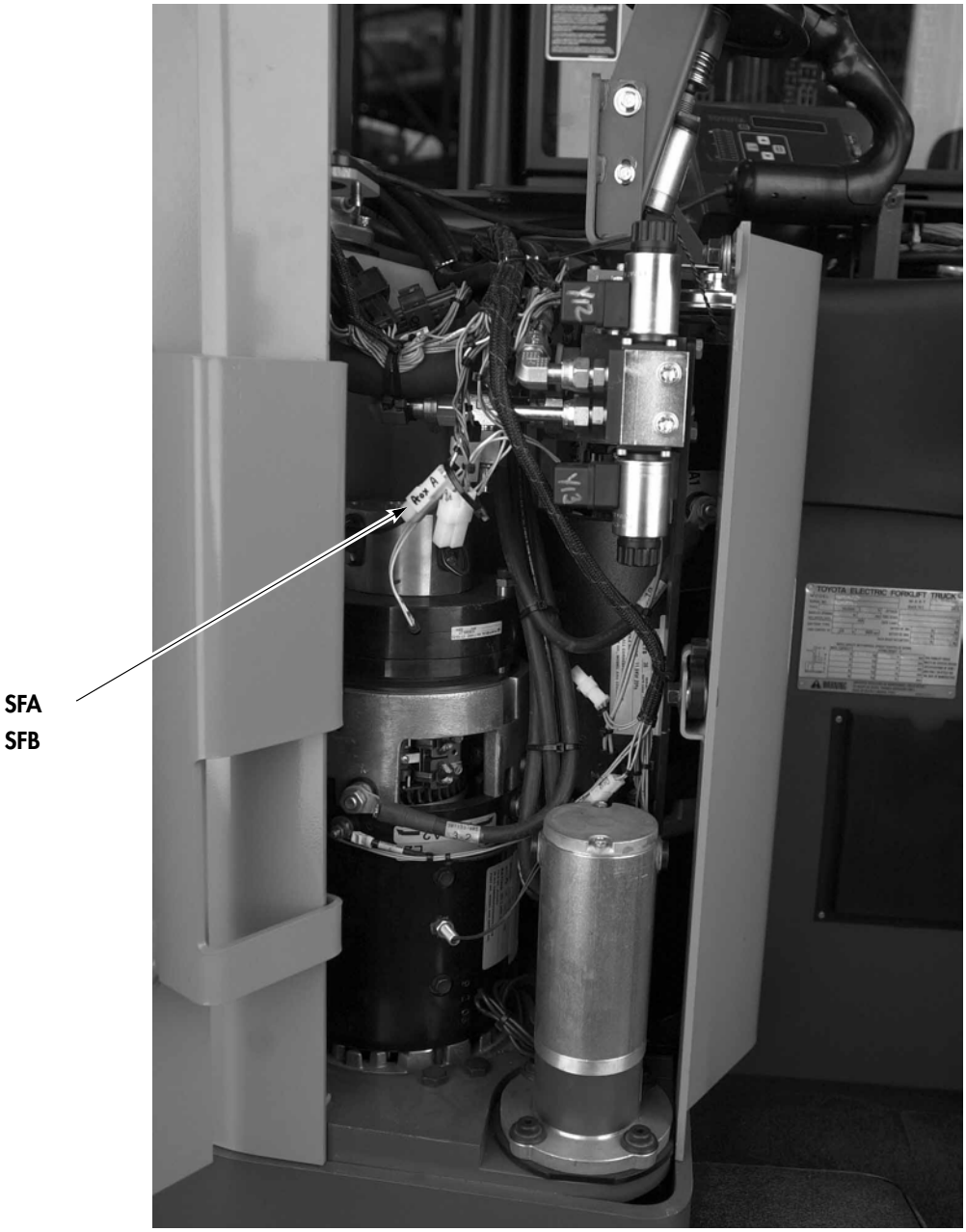


Figure 5-4: Electrical Connectors, Motor Compartment

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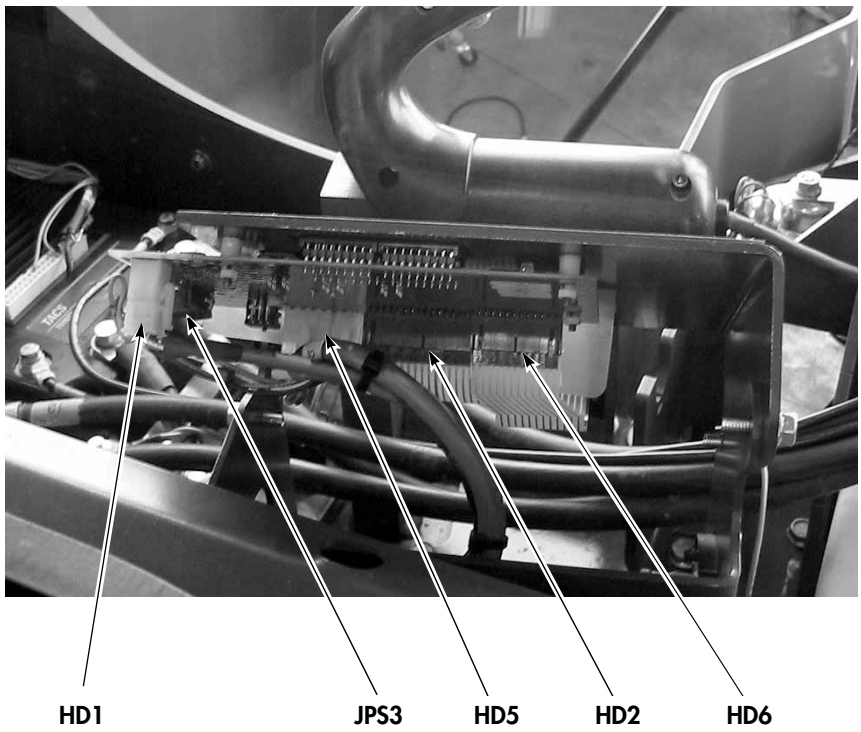


Figure 5-5: Electrical Connectors, Operator Display/Display Card

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List of Troubleshooting Flowcharts

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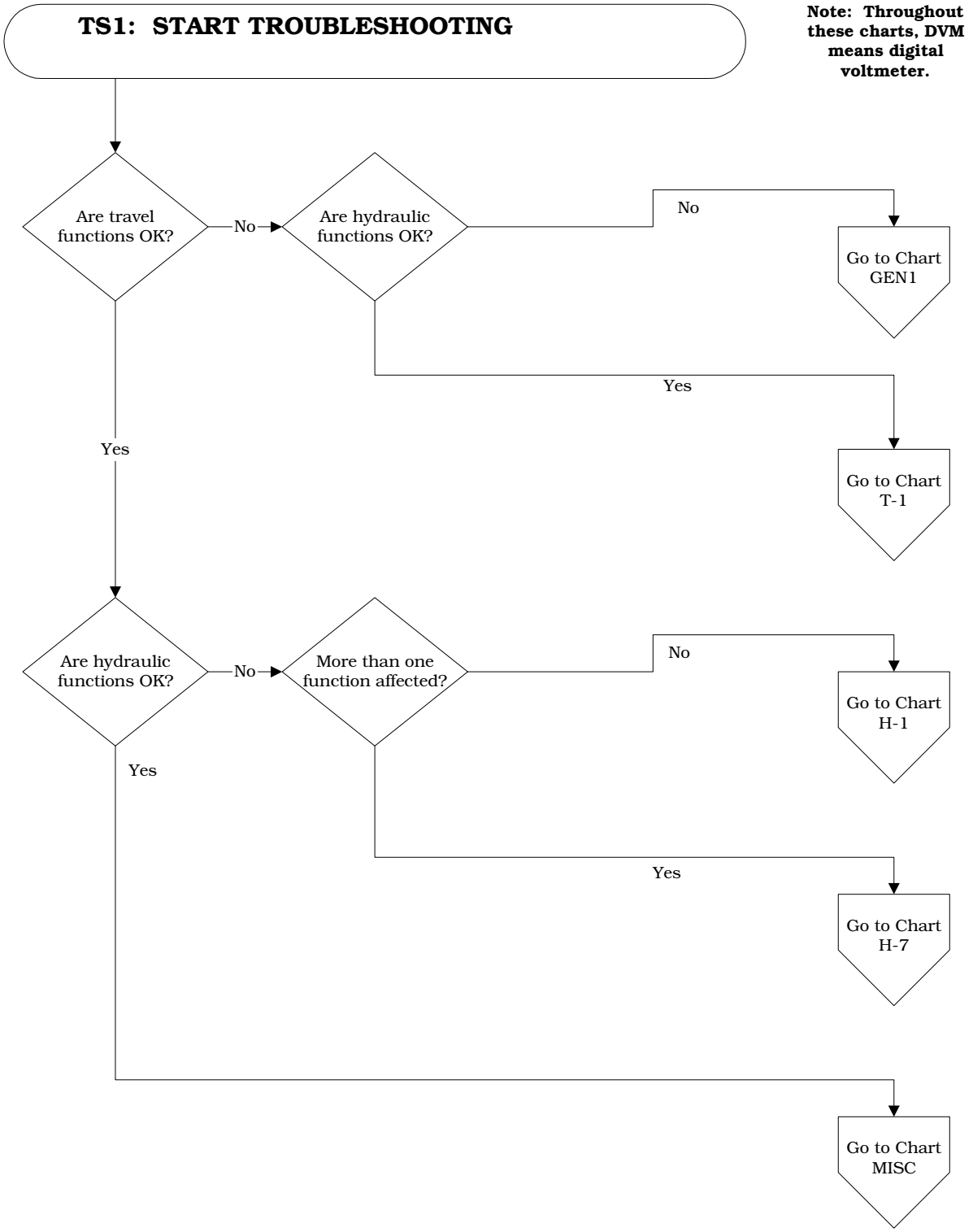
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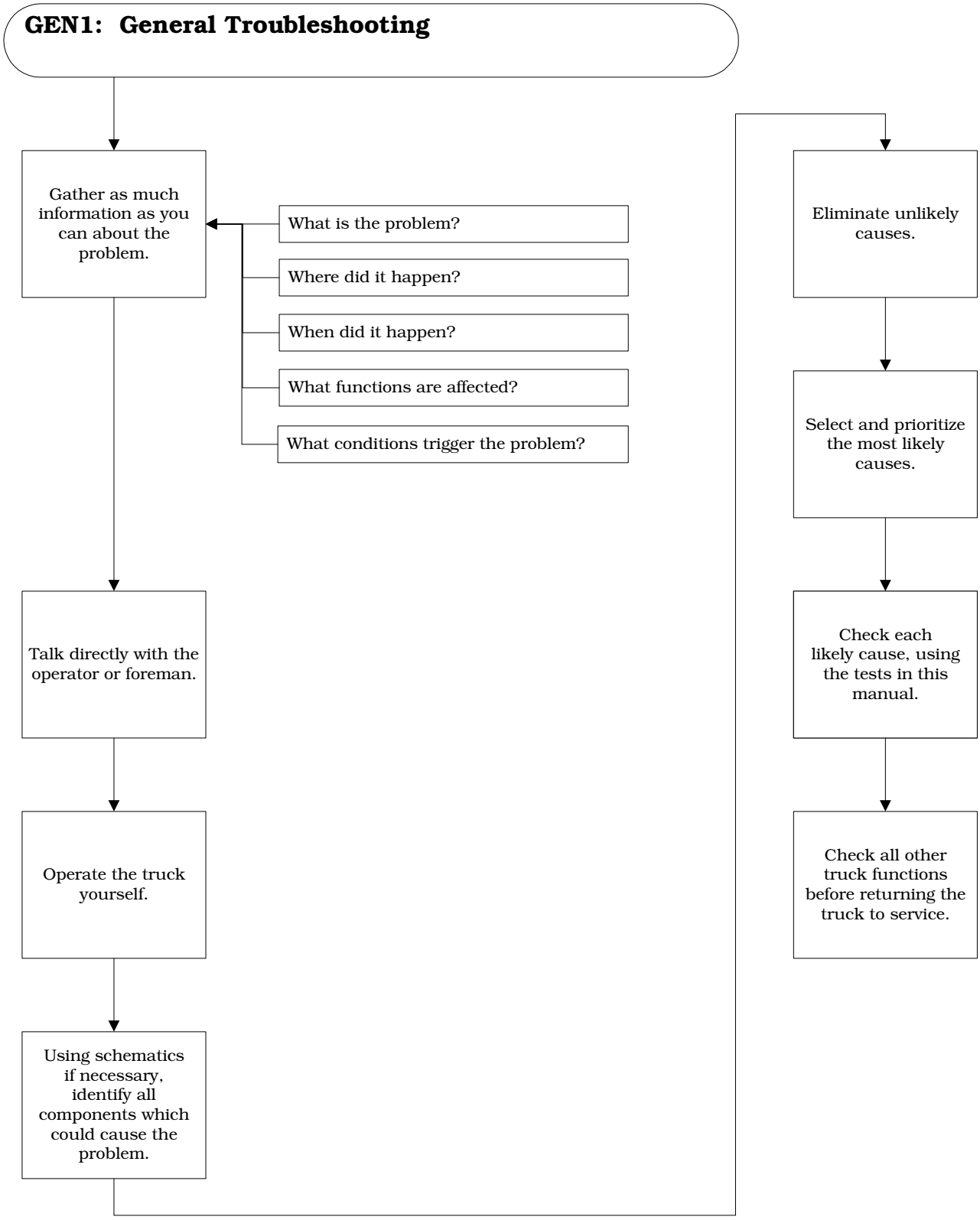
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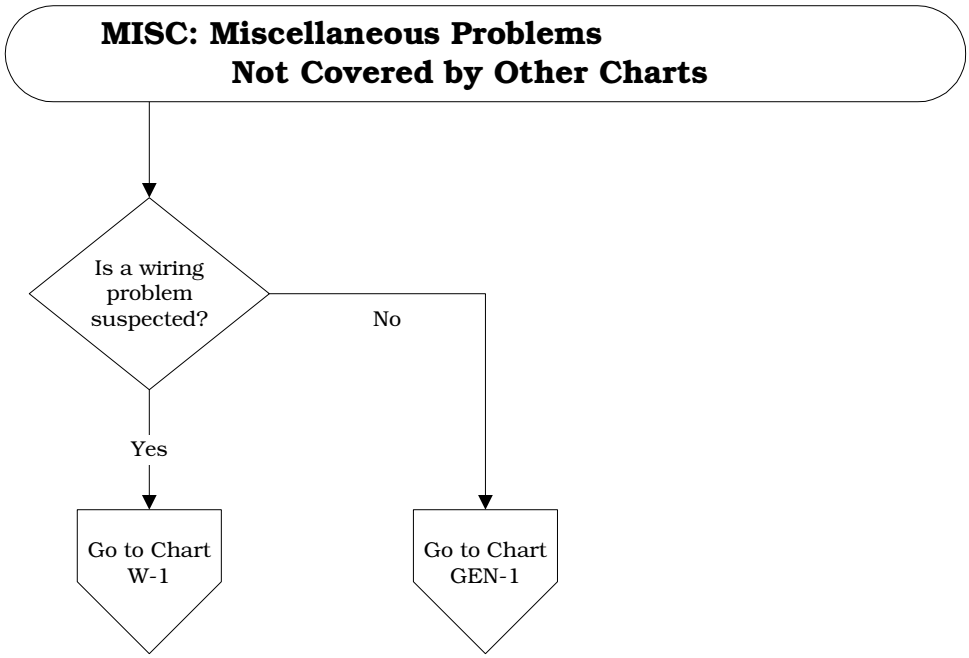
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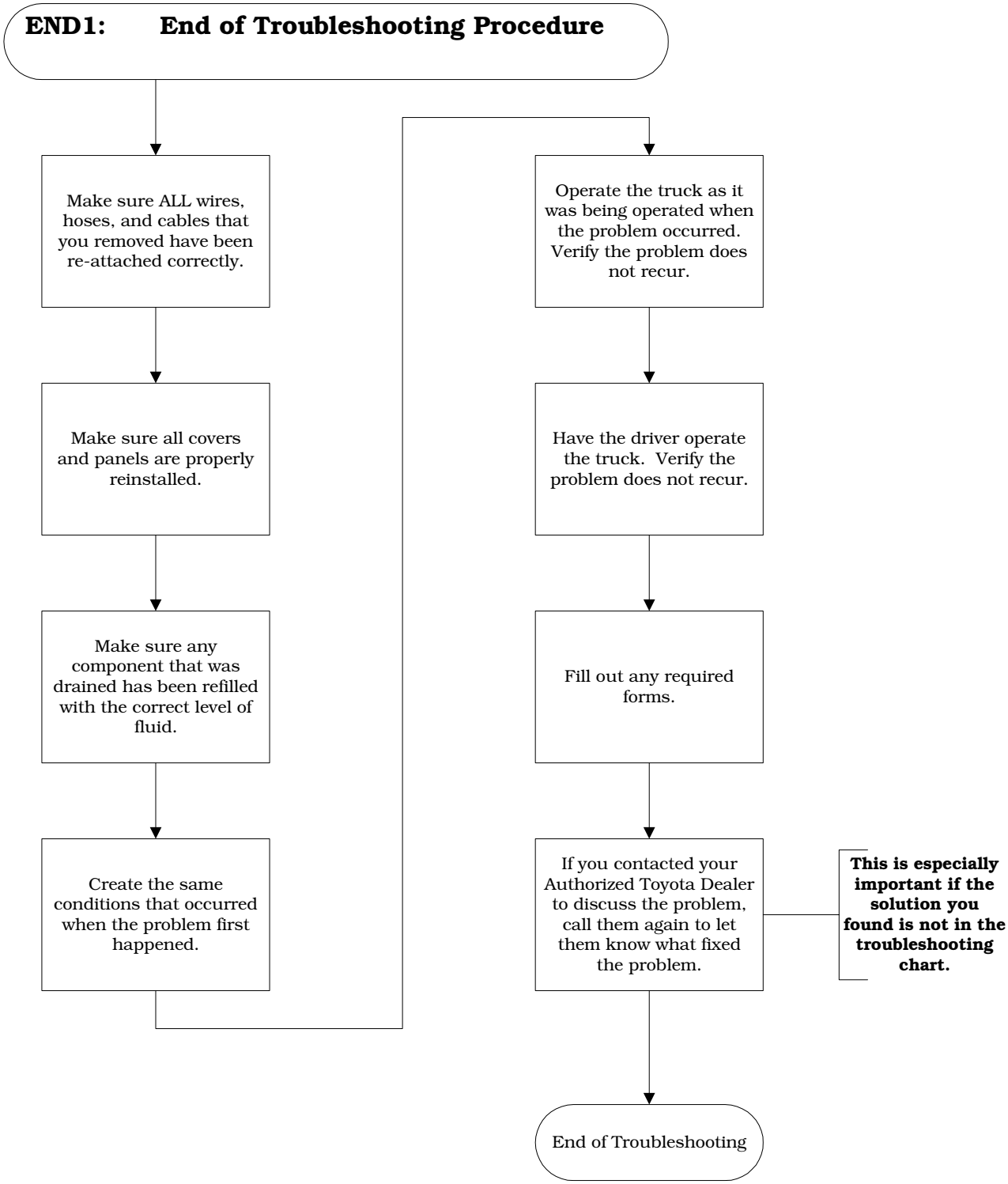
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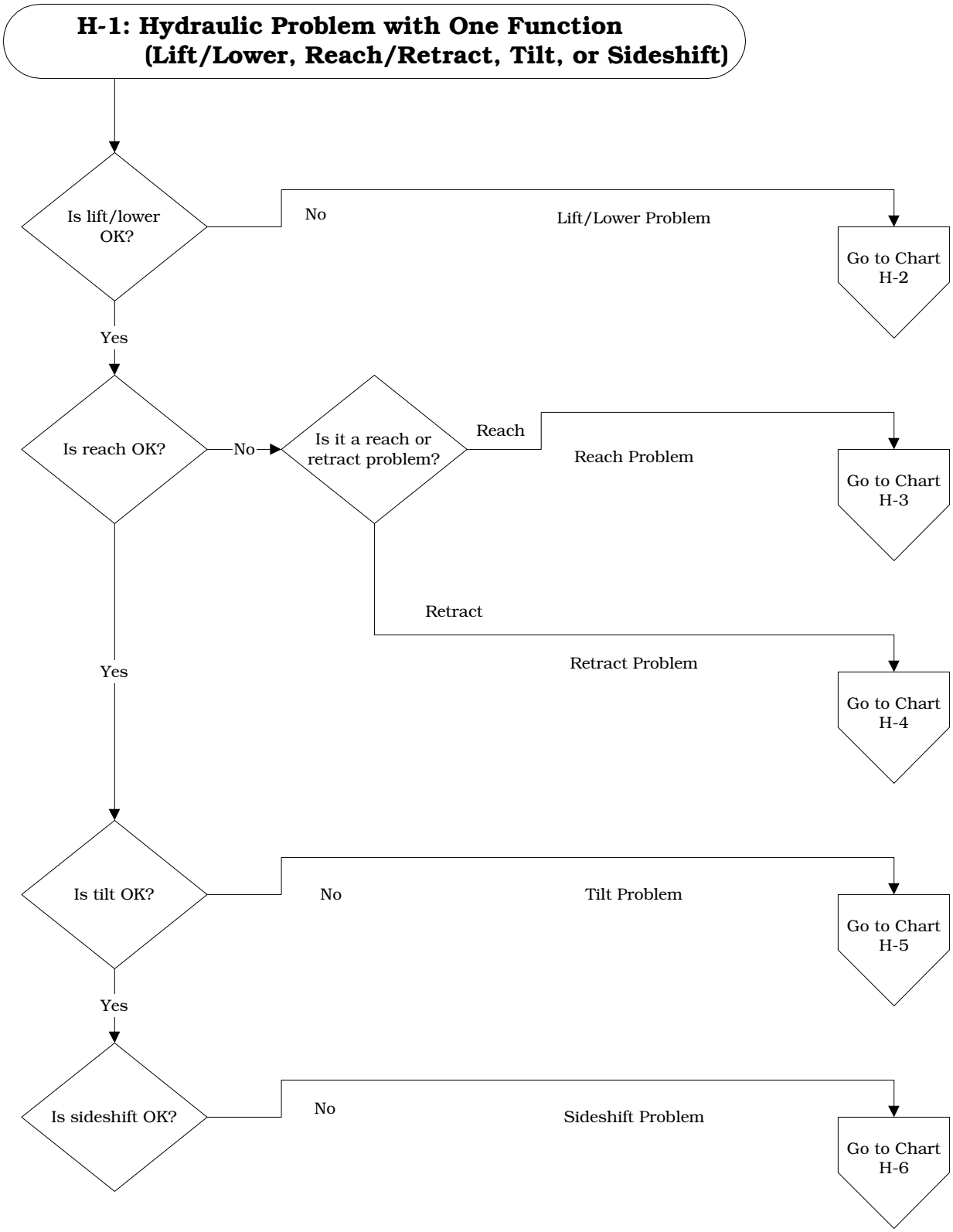
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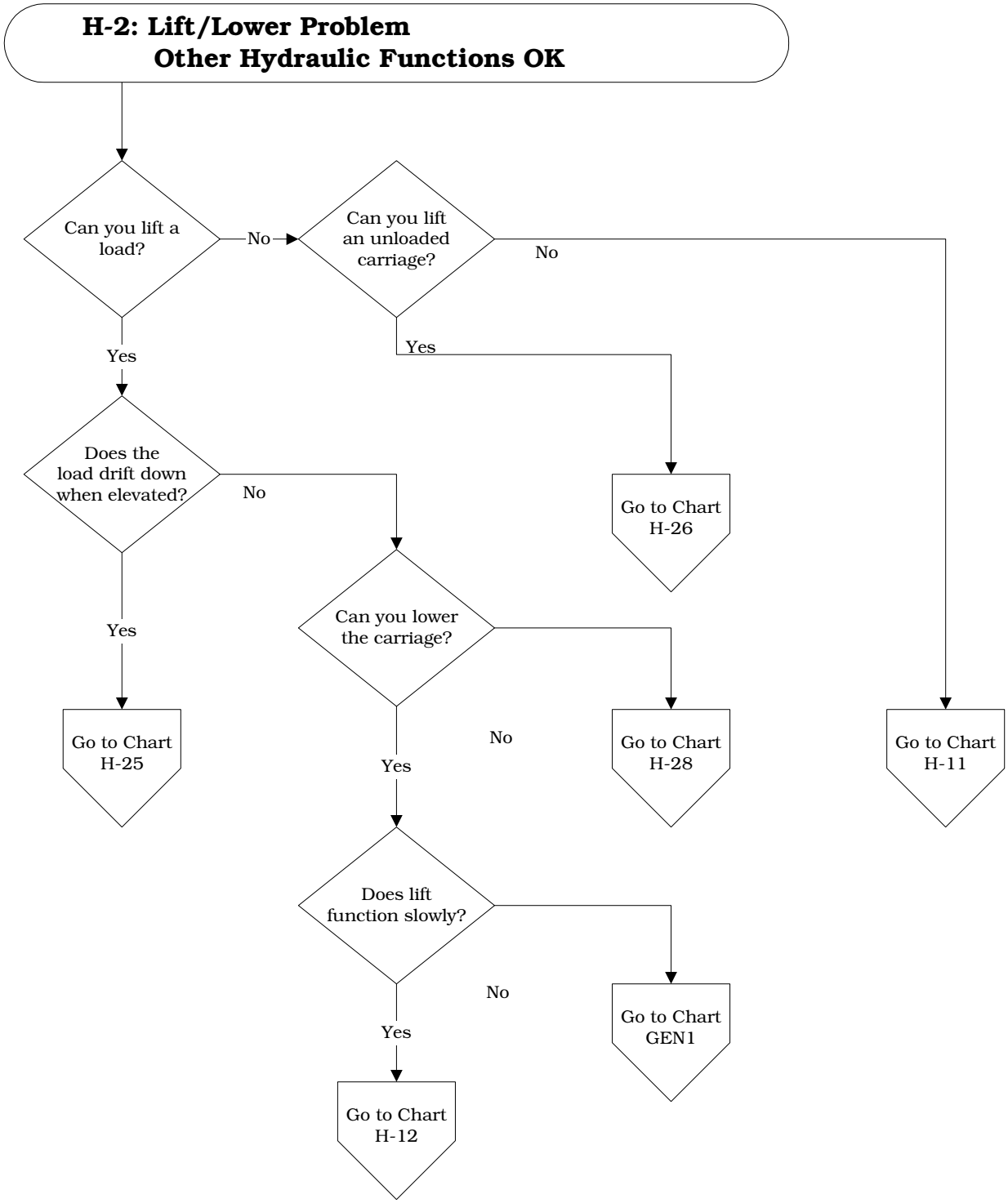
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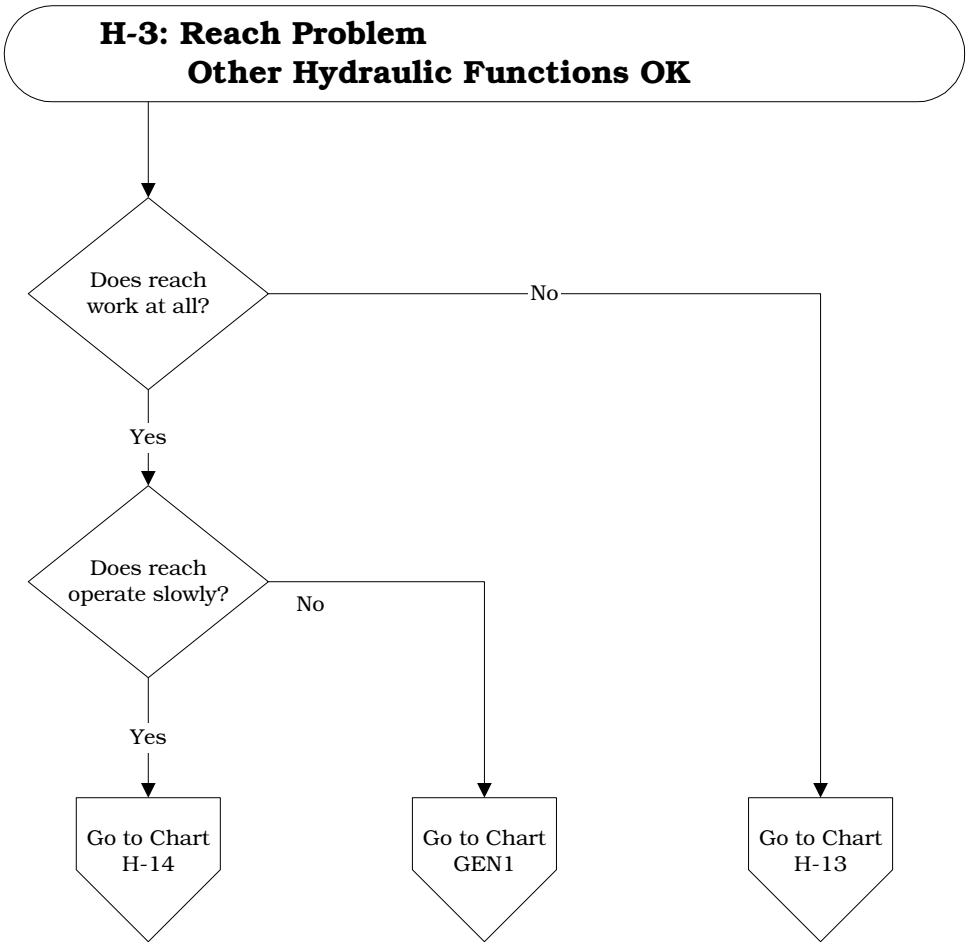
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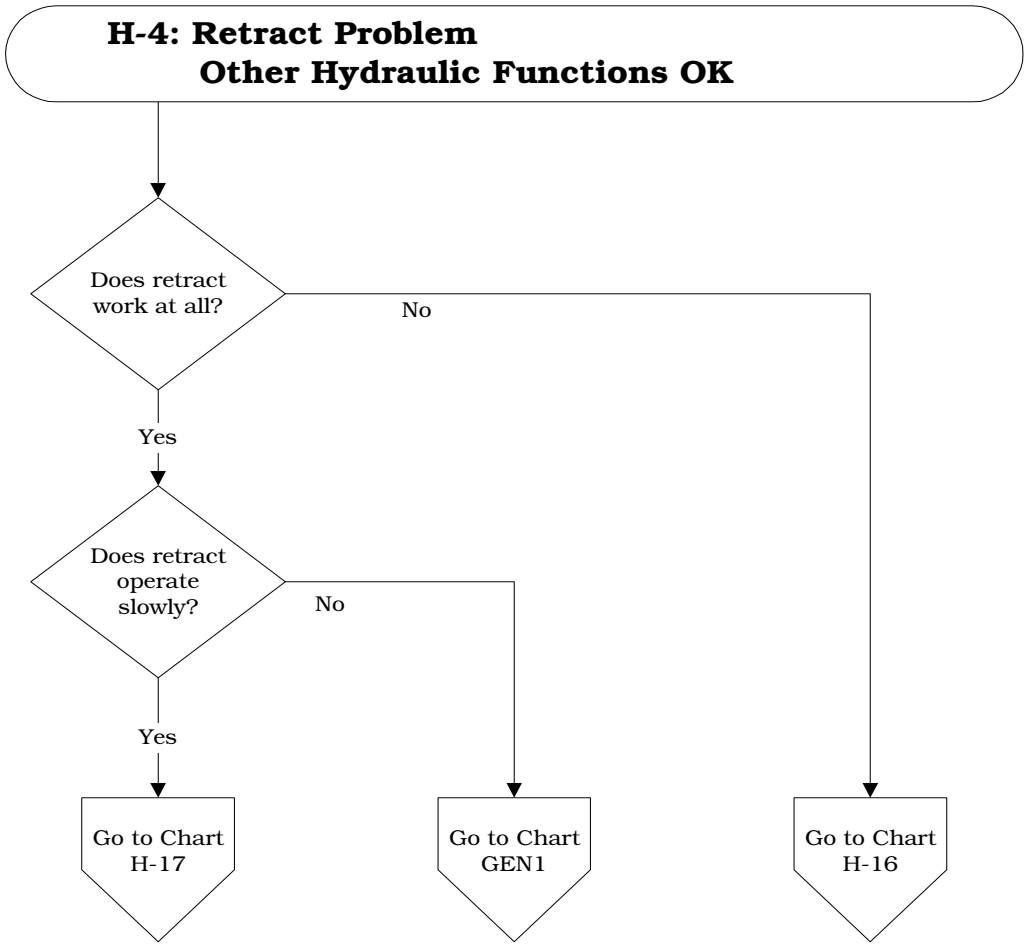
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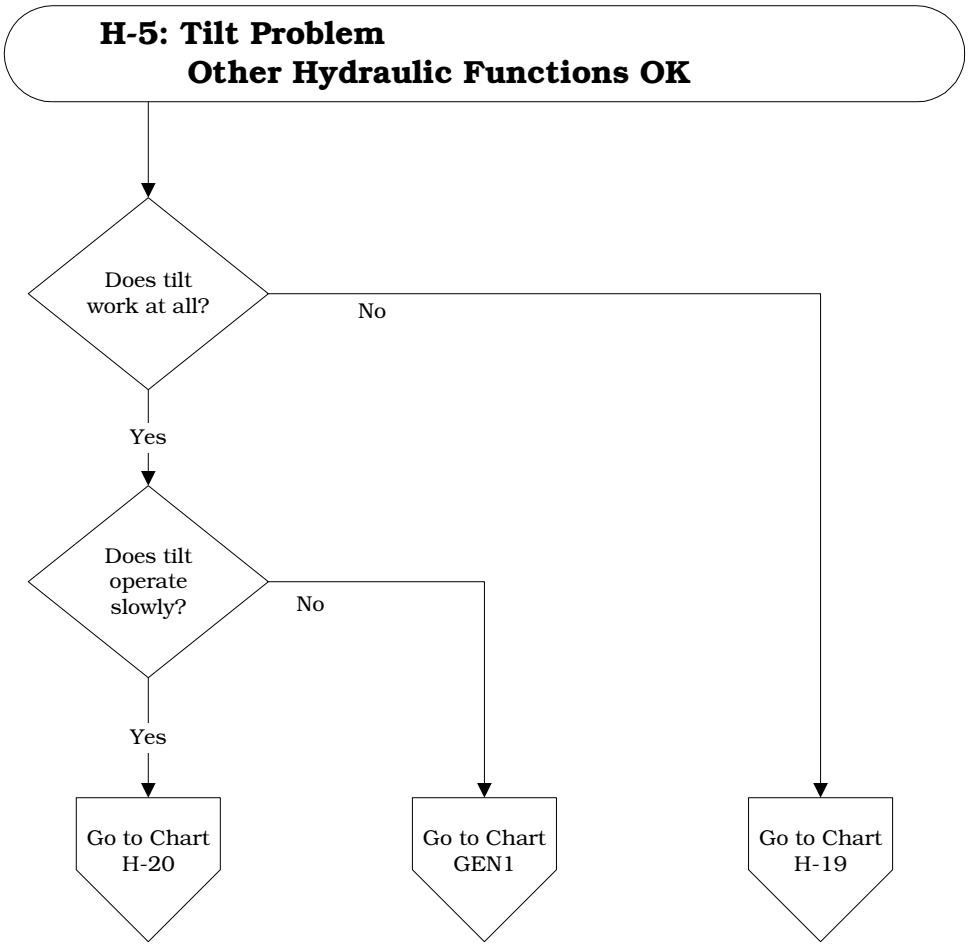
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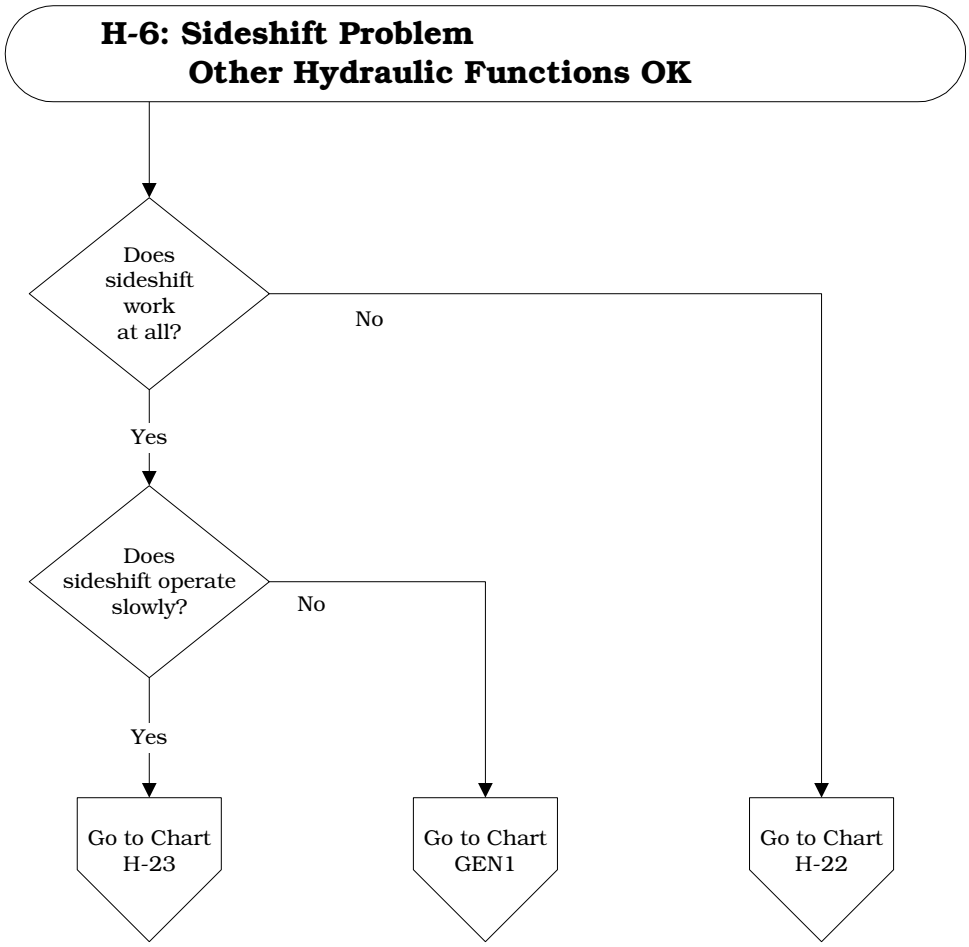
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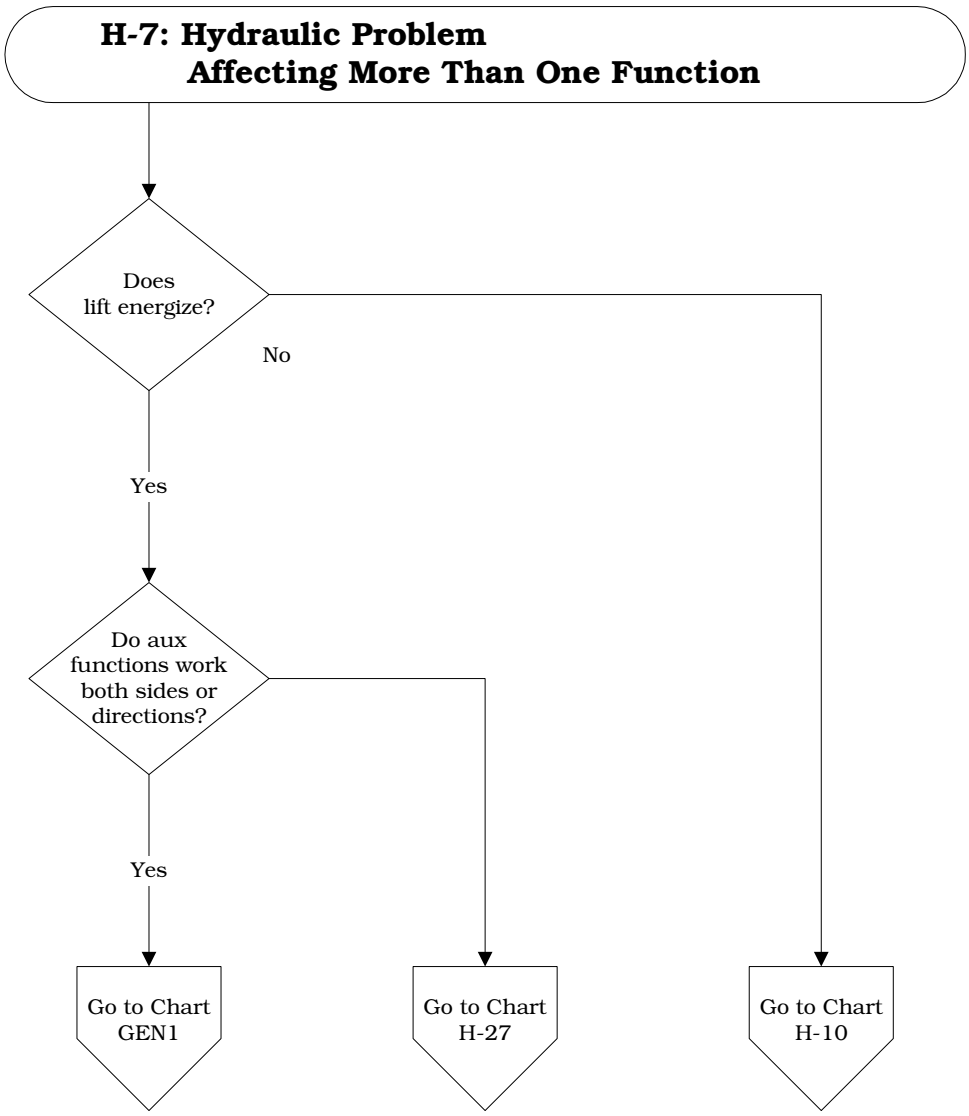
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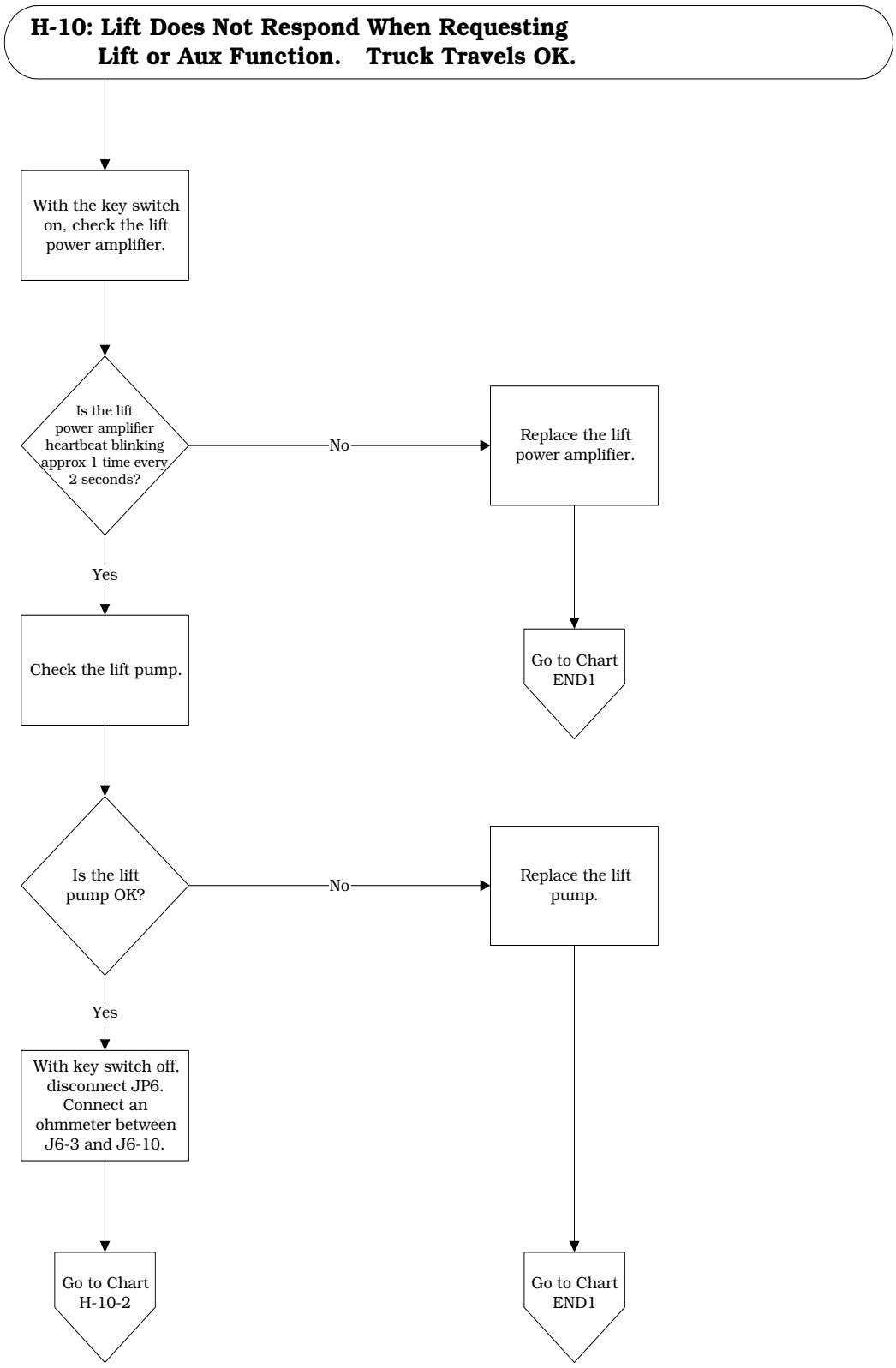
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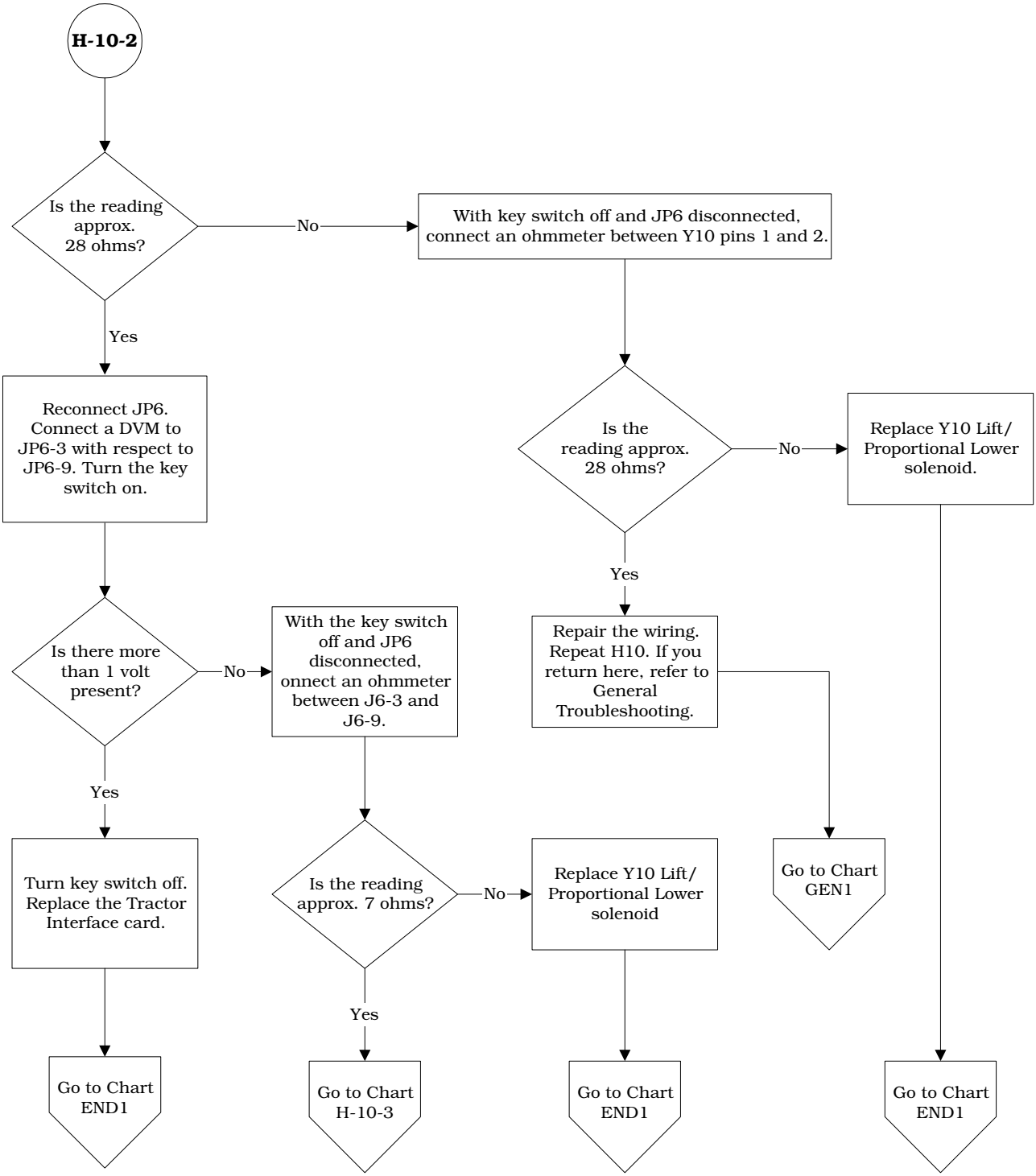
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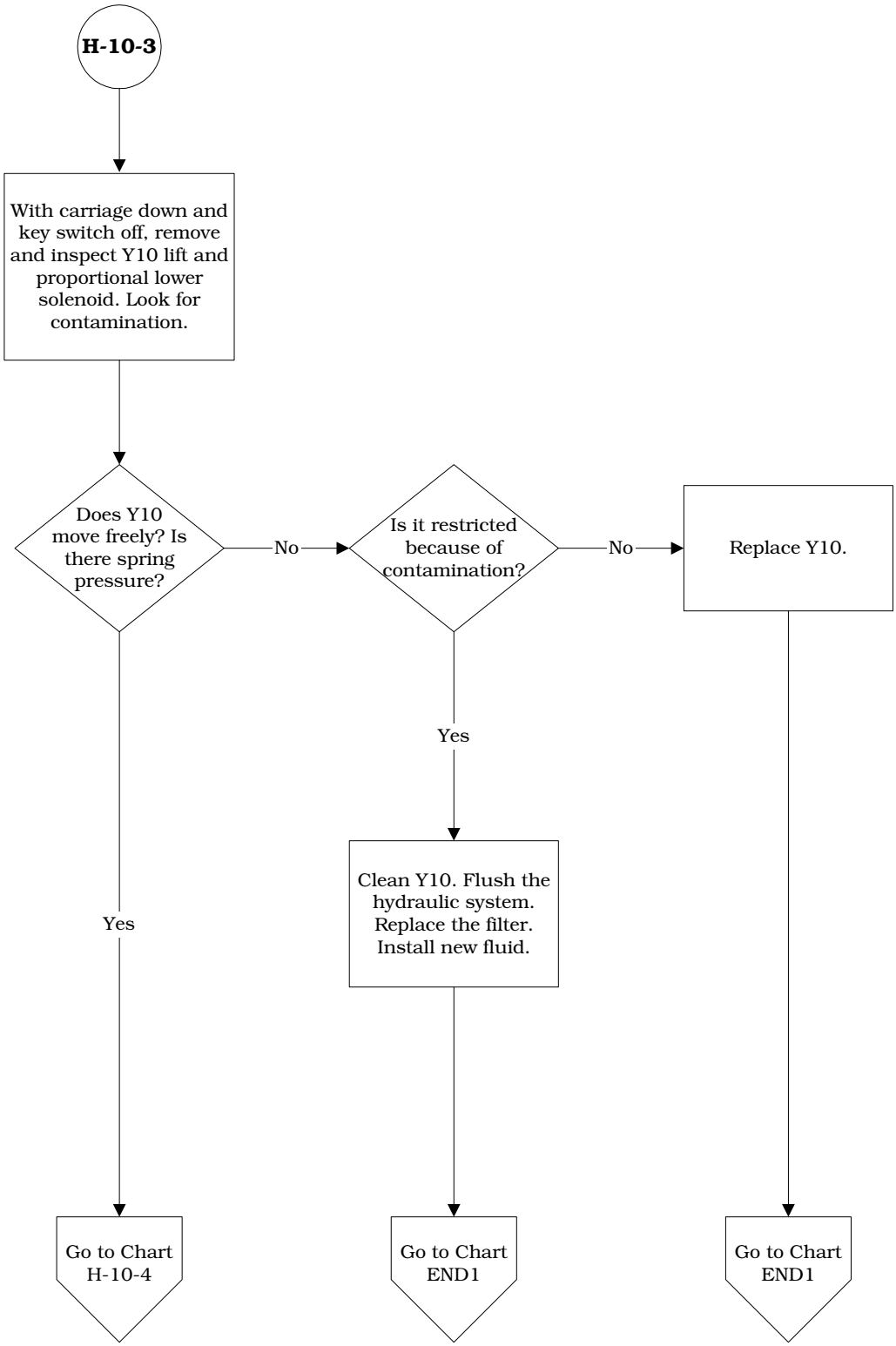


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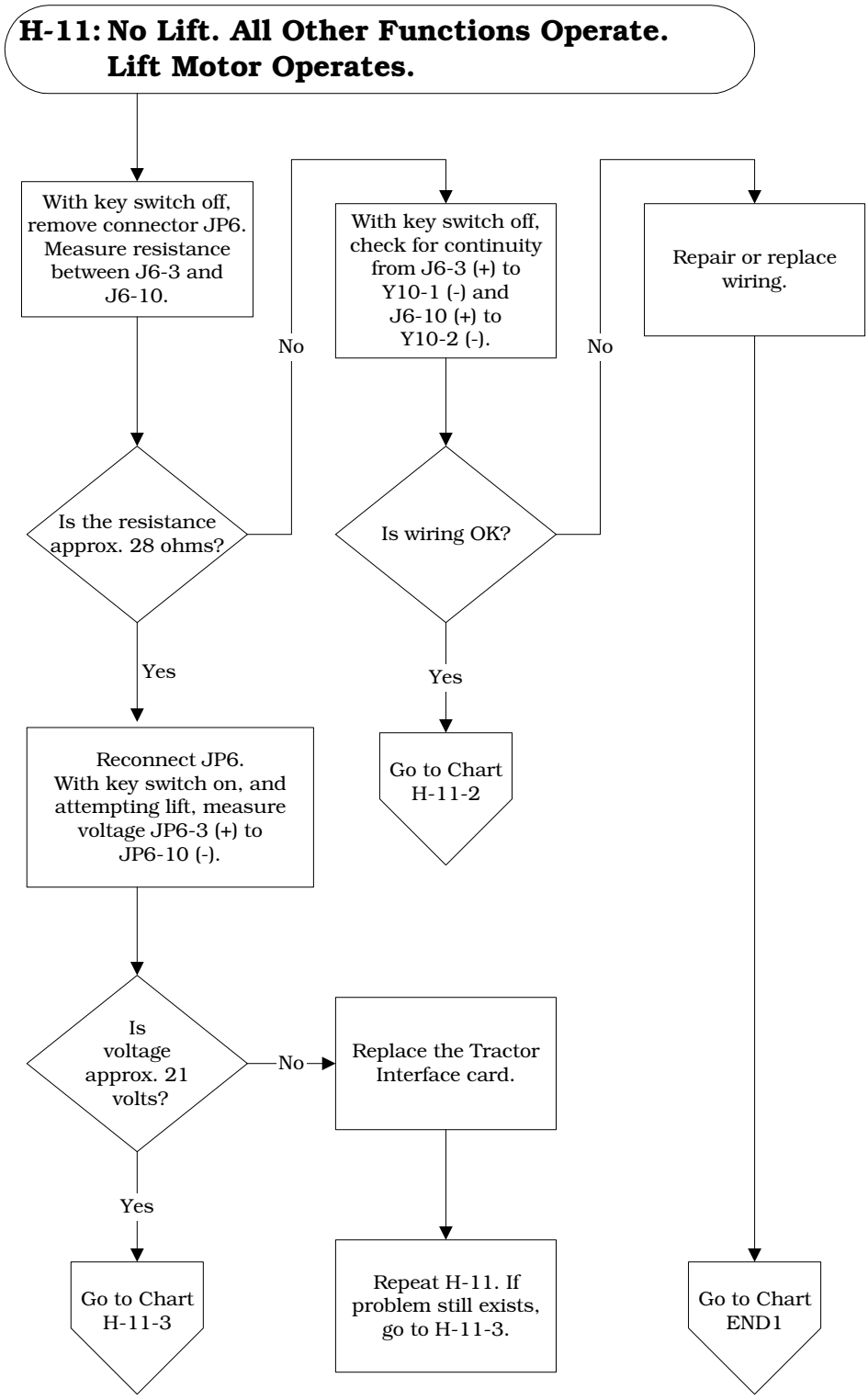


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H-10: Lift Does Not Respond for Lift or Aux. Function

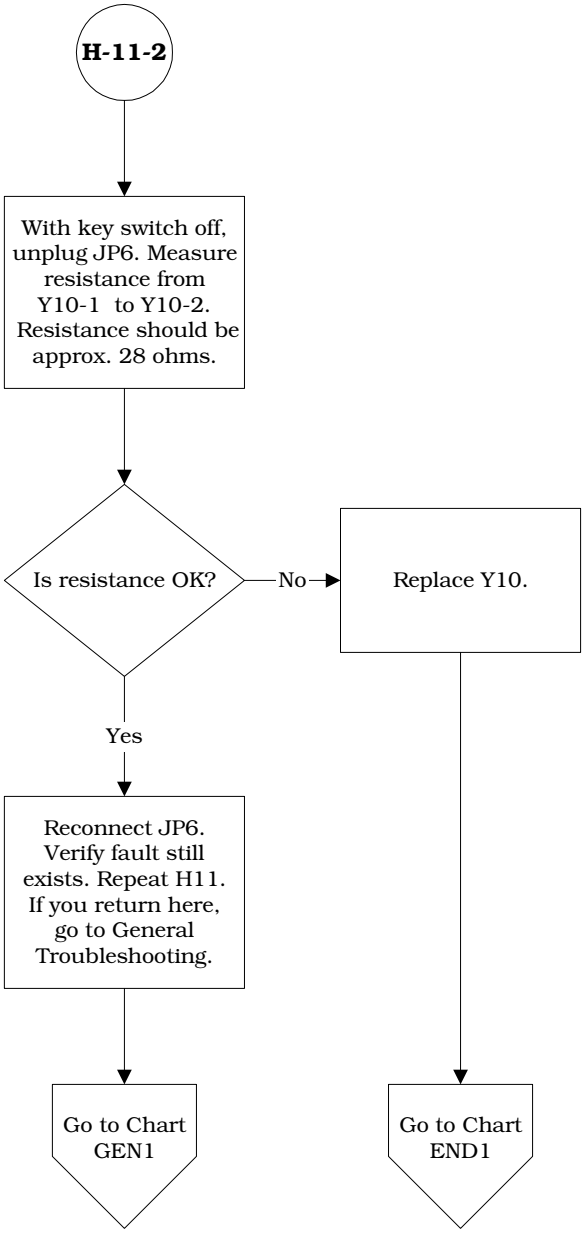


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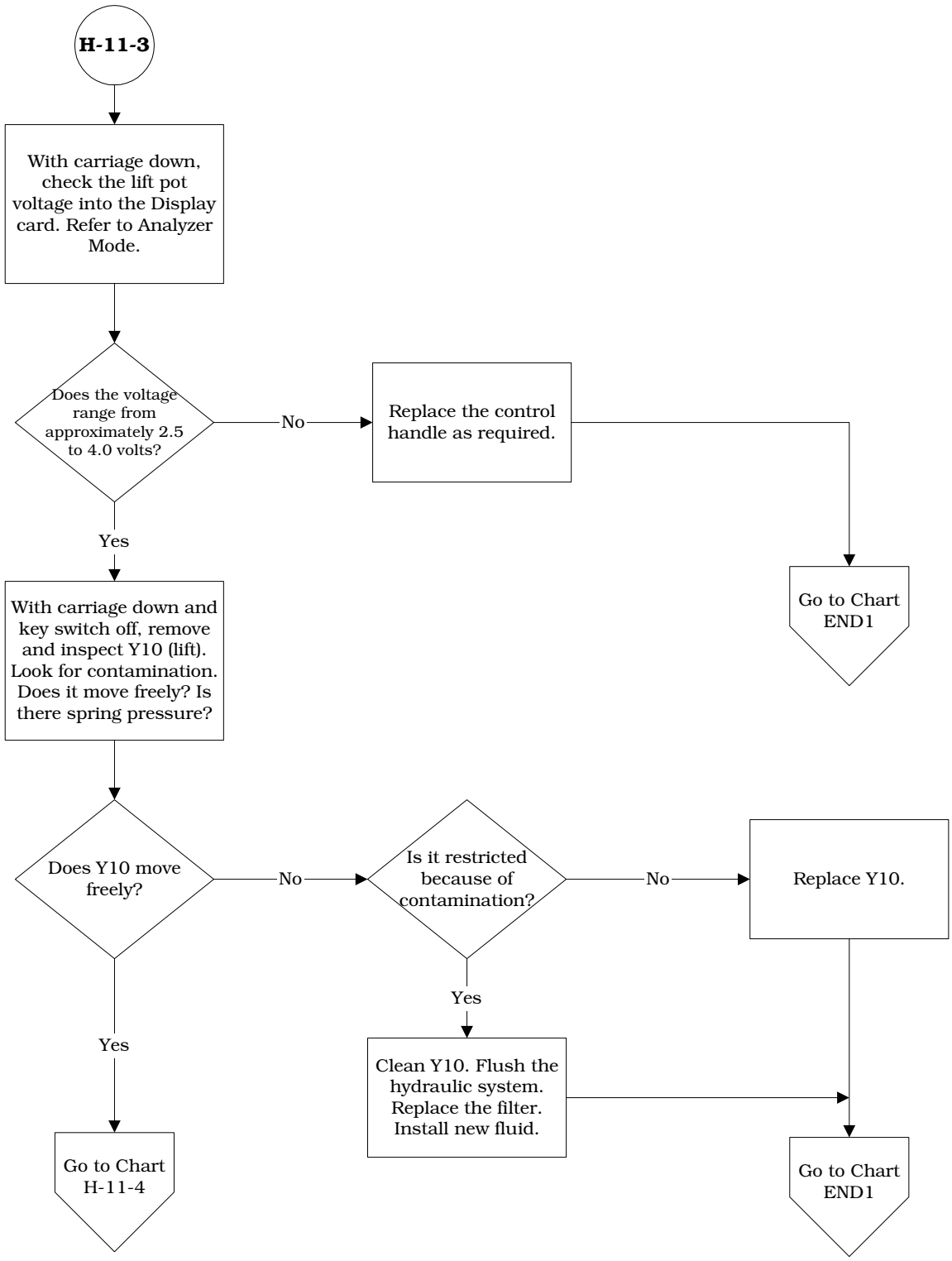


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H-11: No Lift, Lift Motor Operates

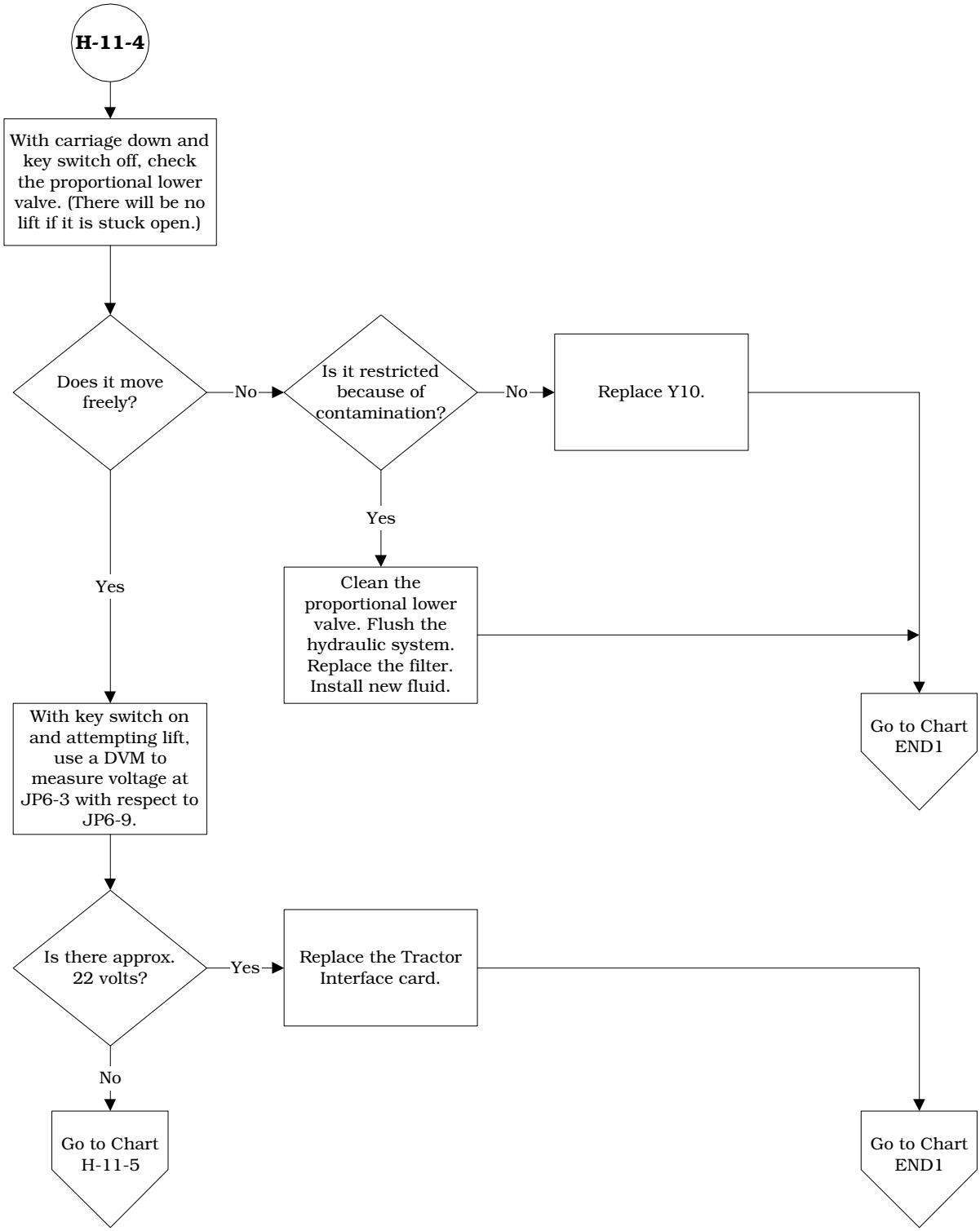


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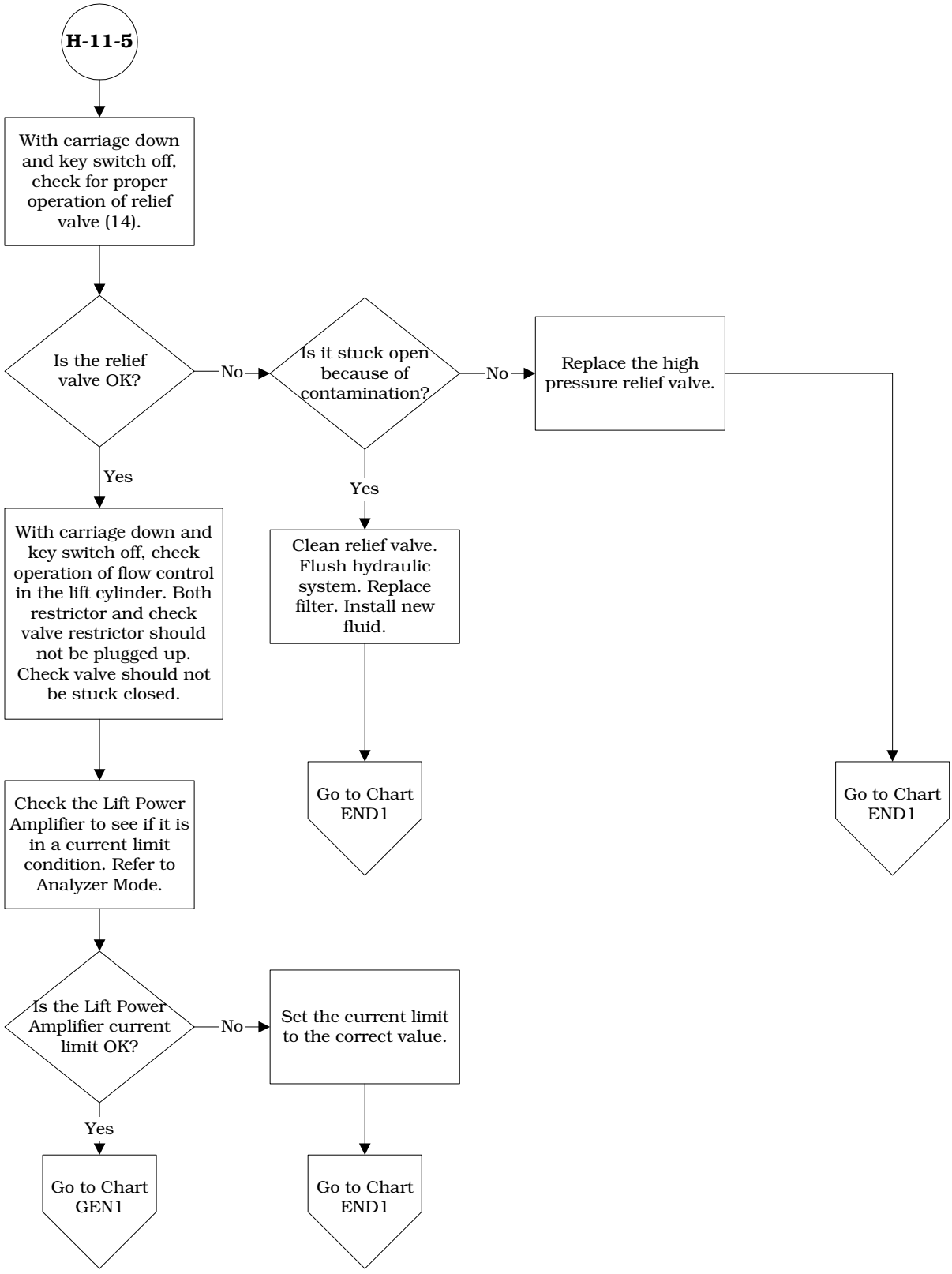


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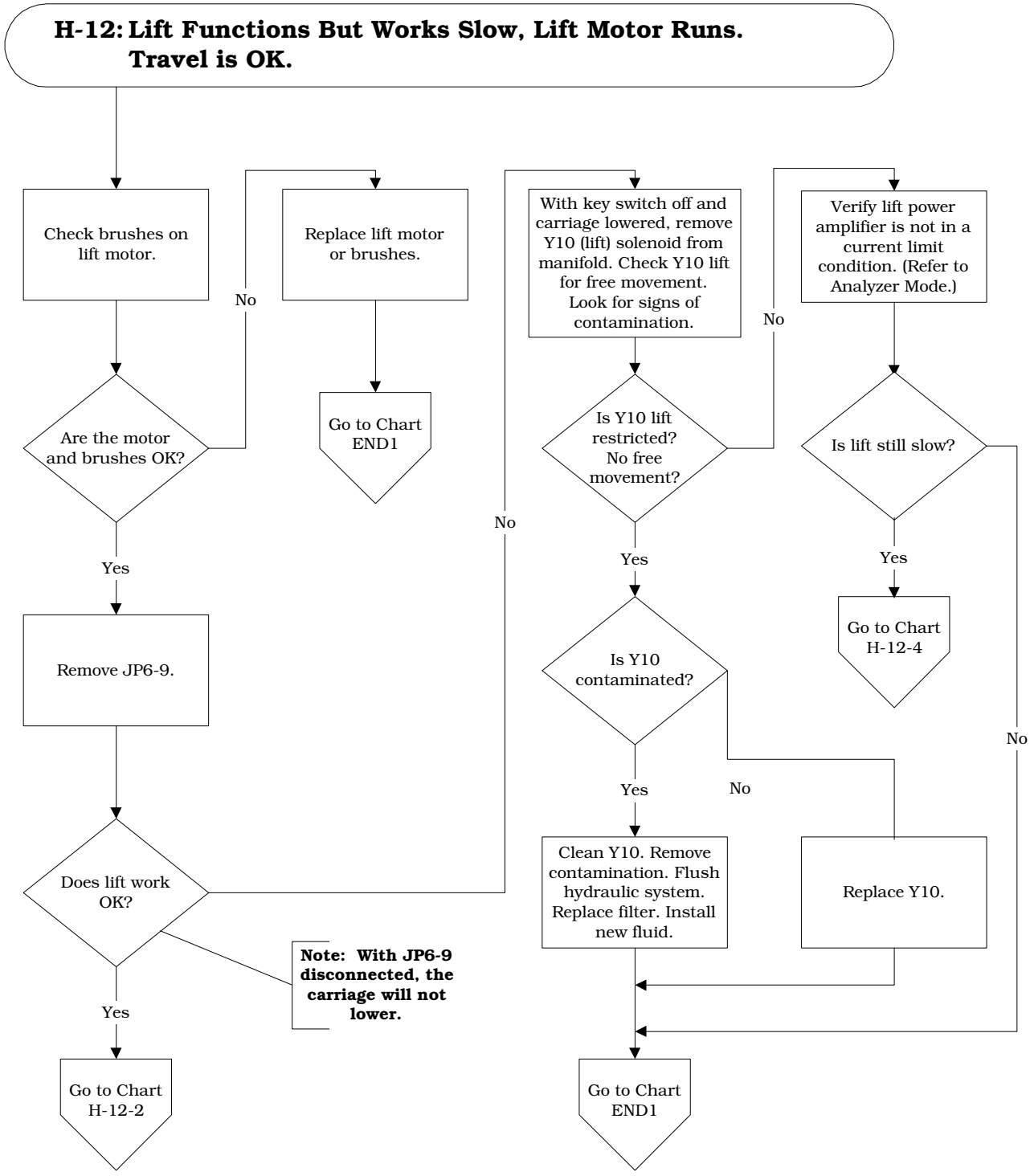
H-11: No Lift, Lift Motor Operates



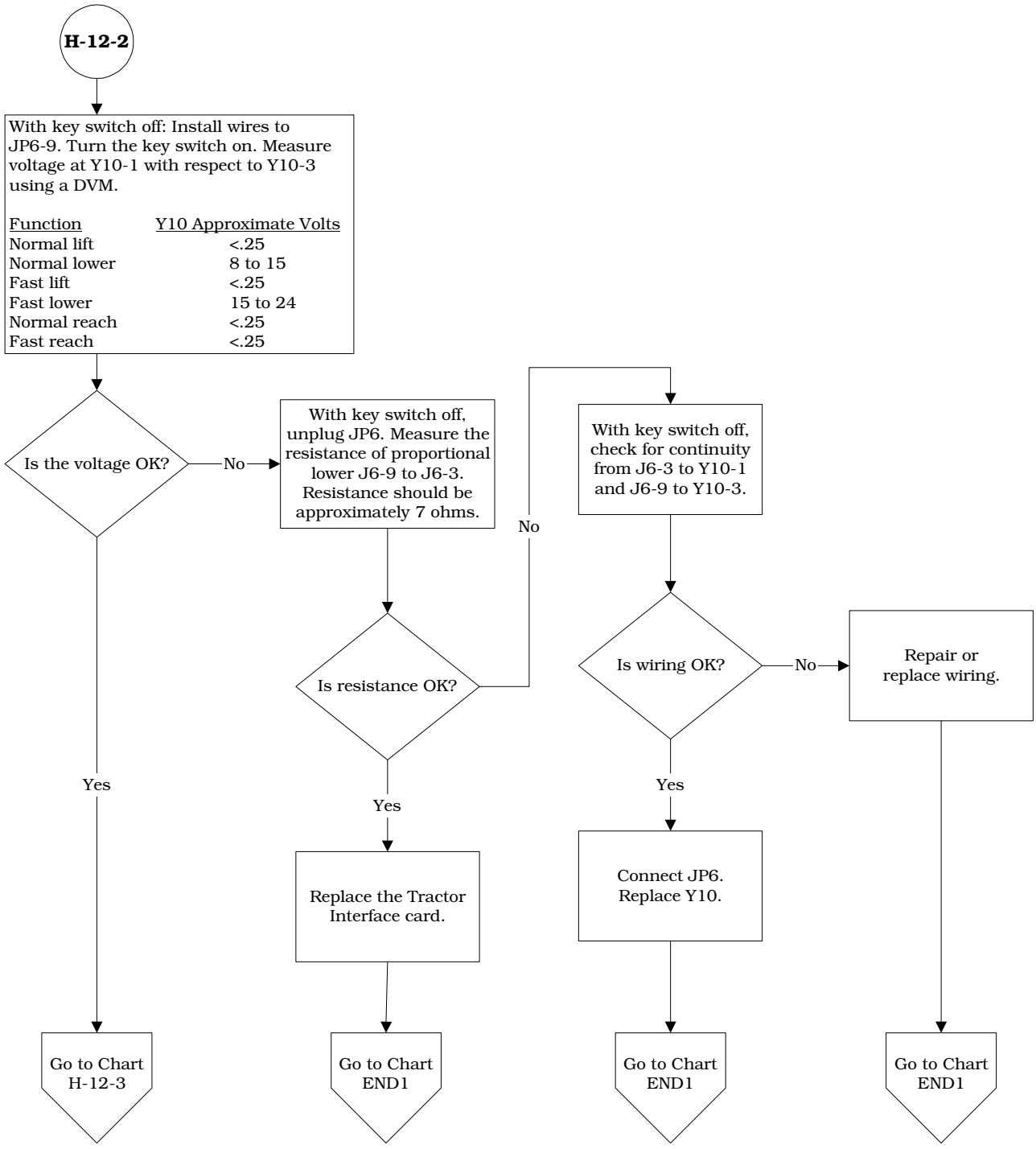
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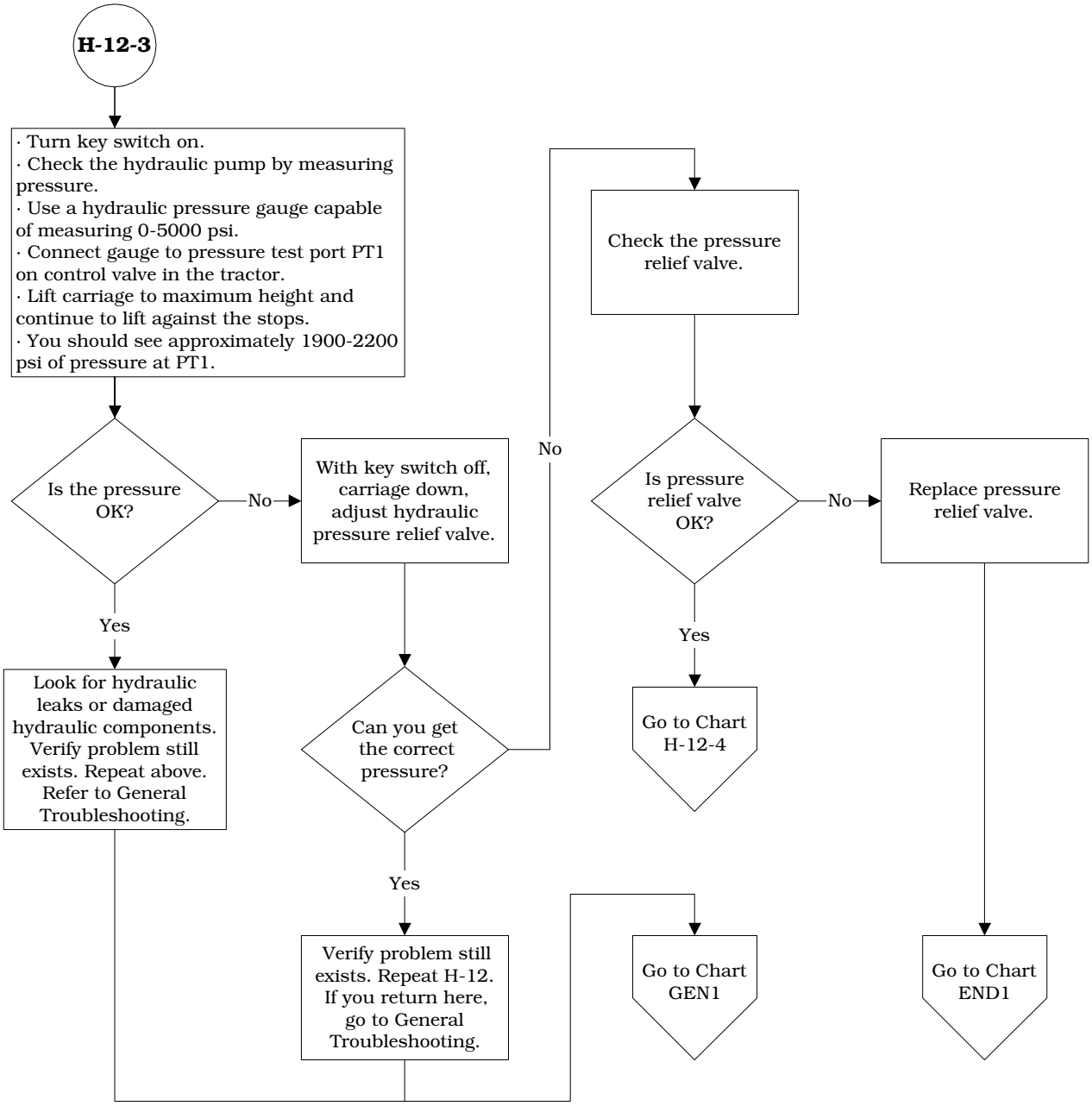


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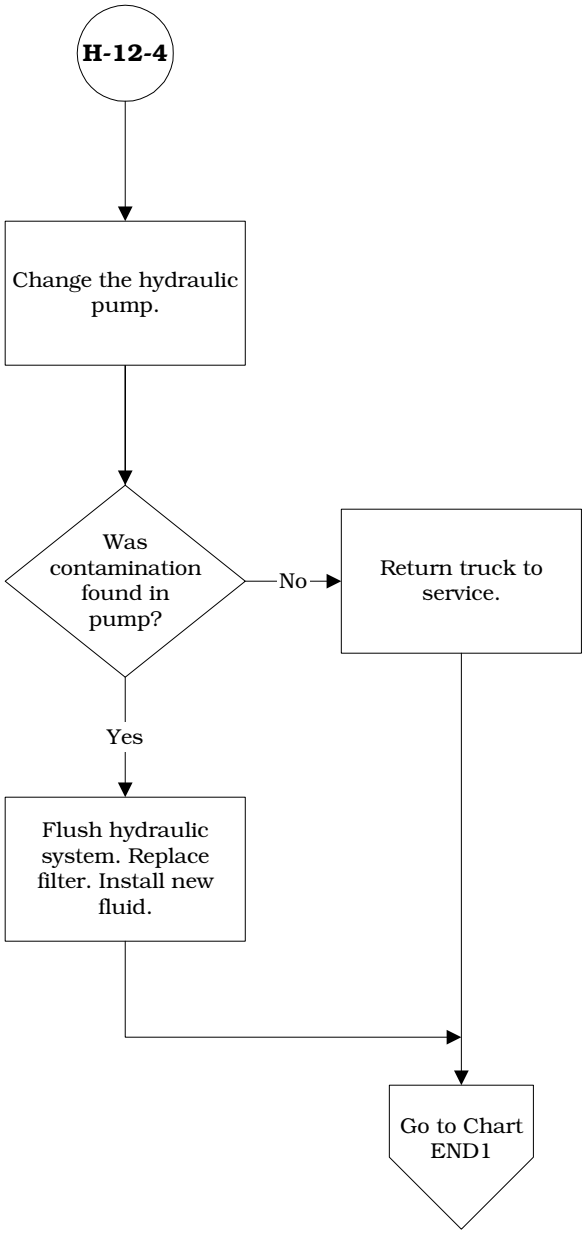


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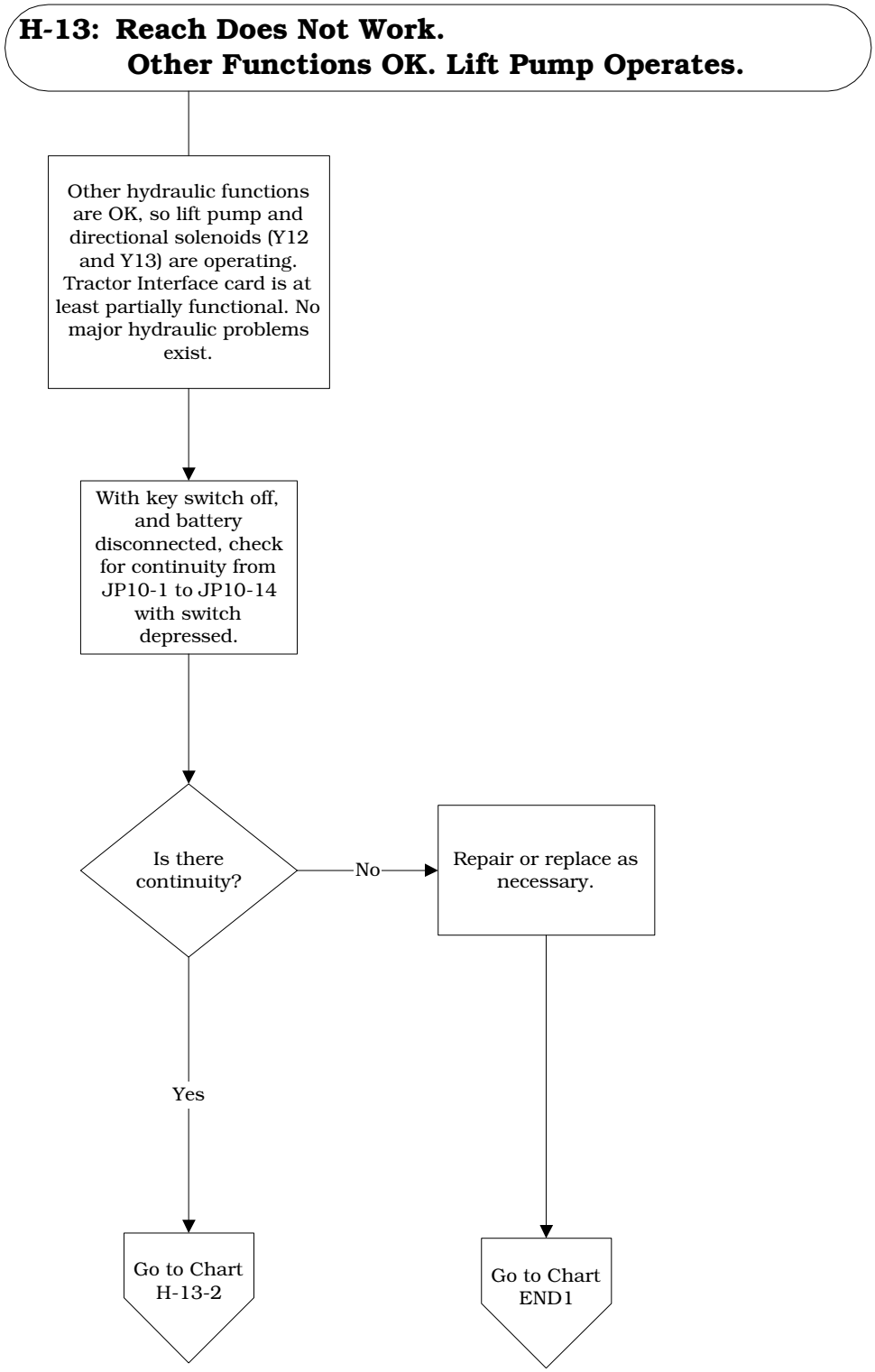
H-12: Lift Functions But Works Slow, Lift Motor Runs



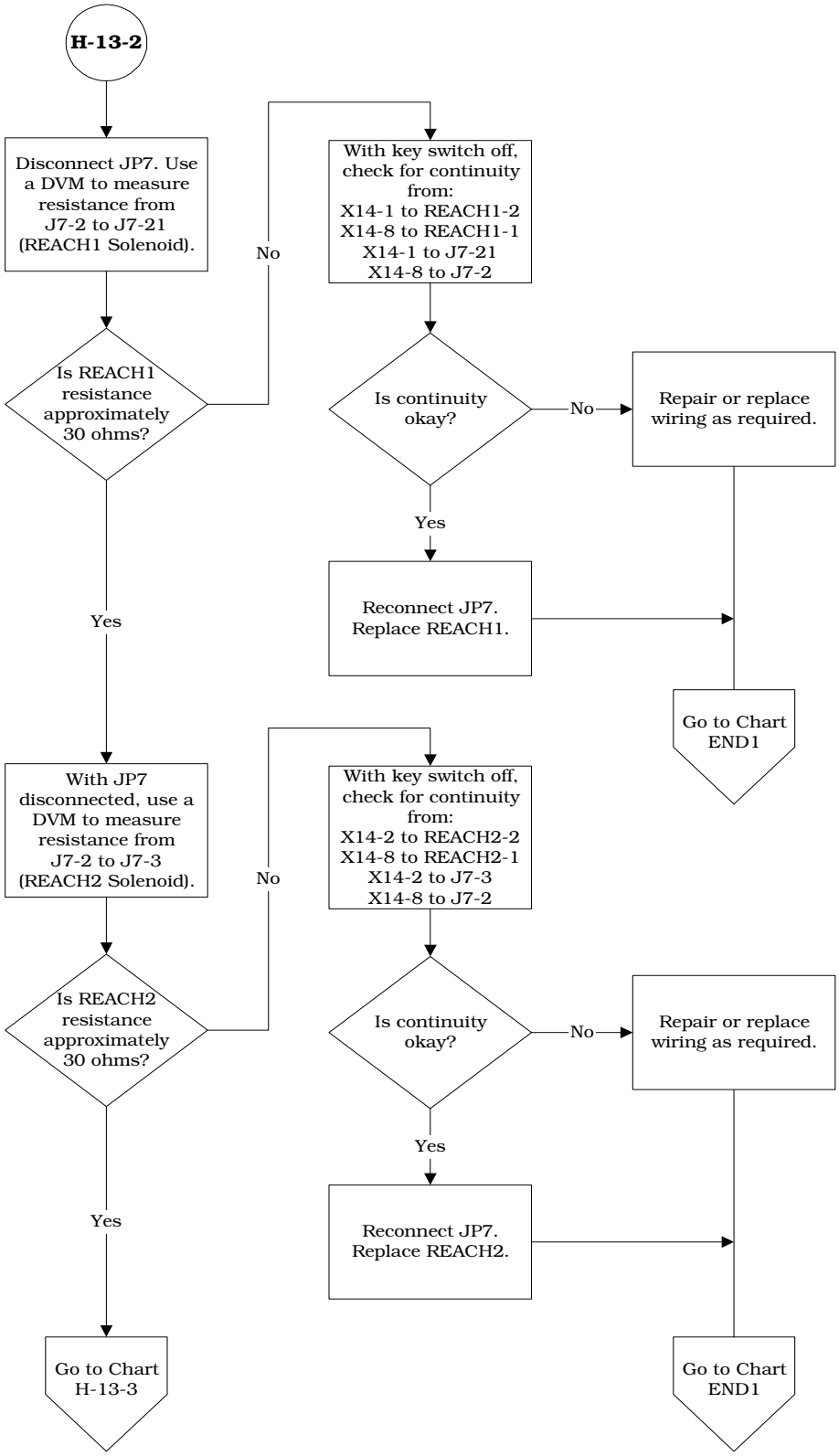
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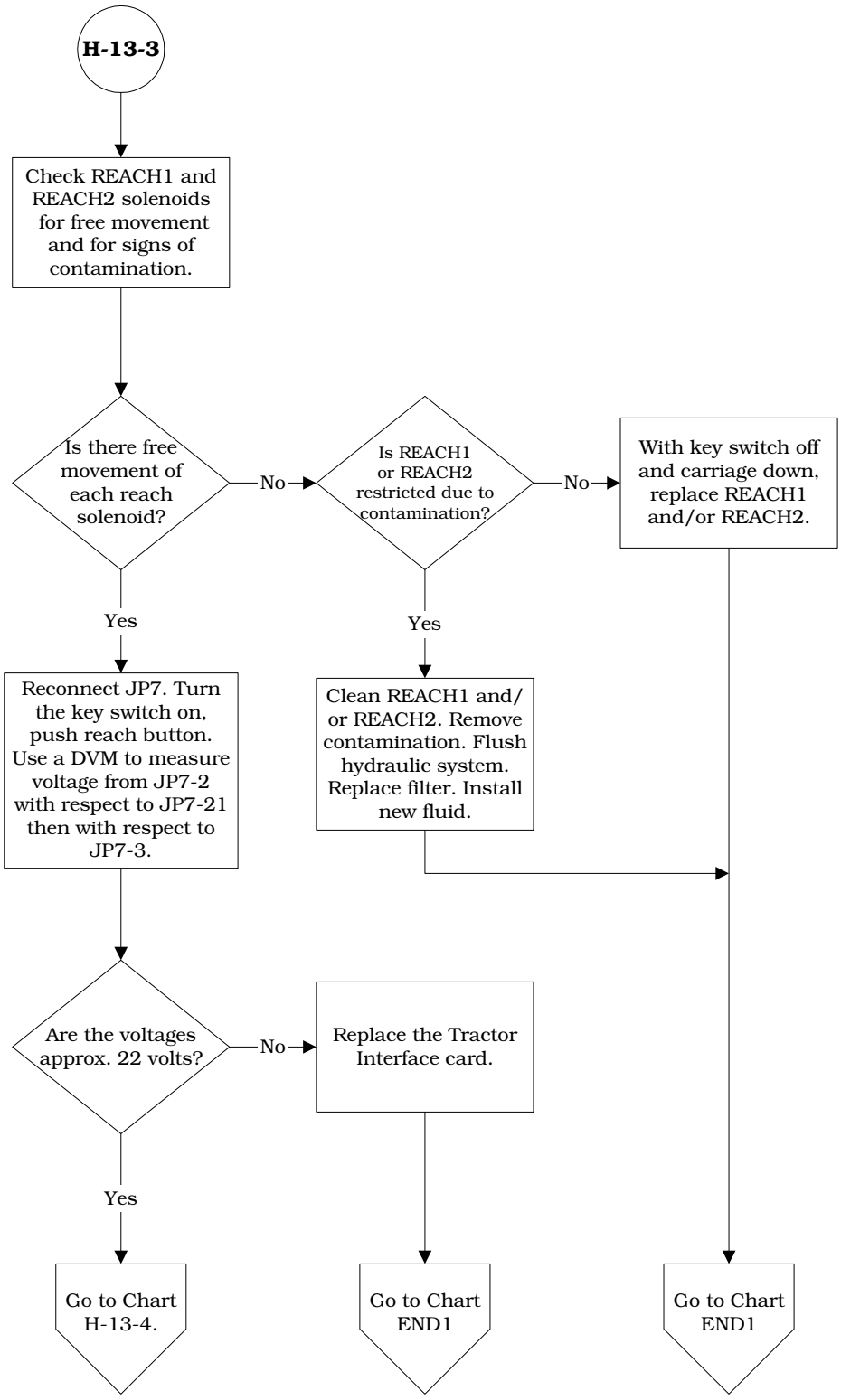
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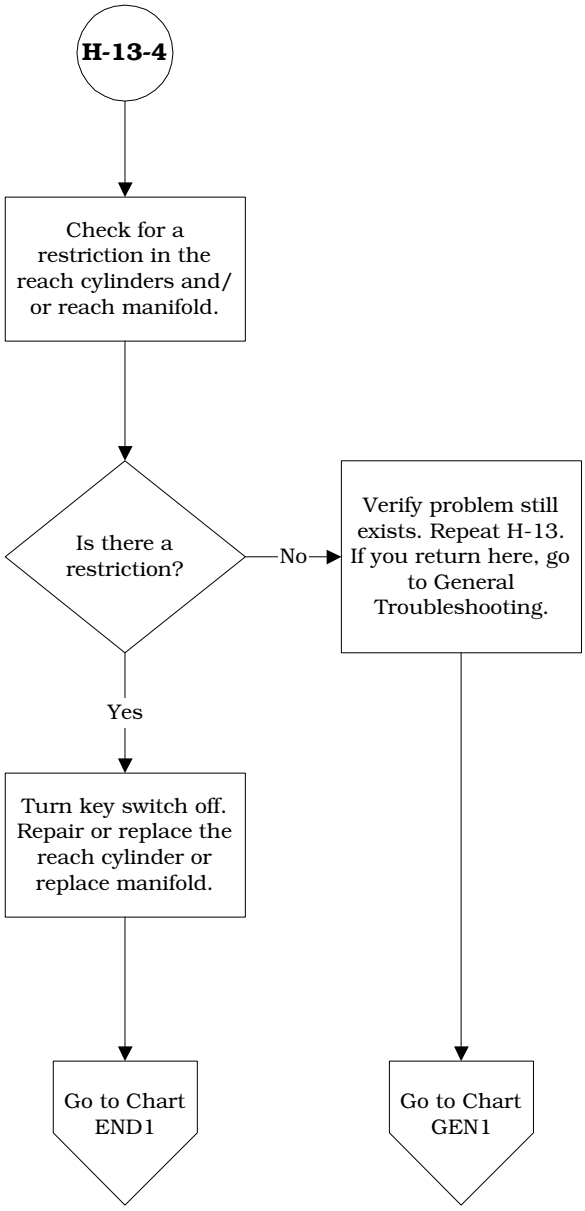
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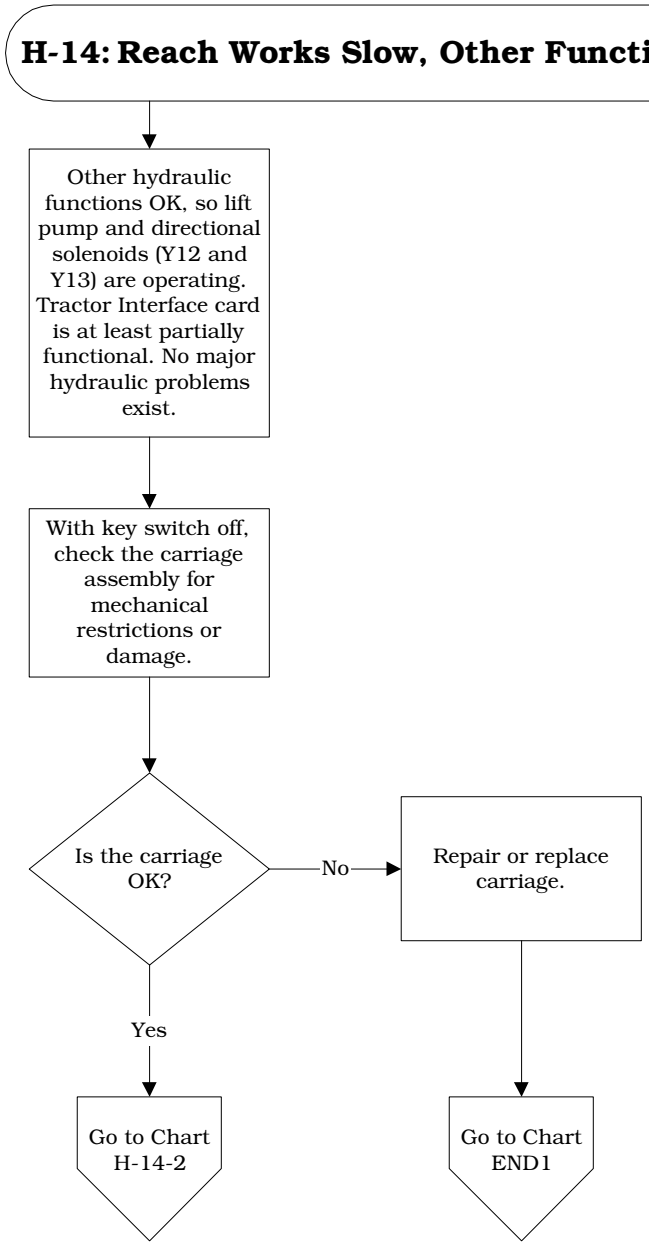
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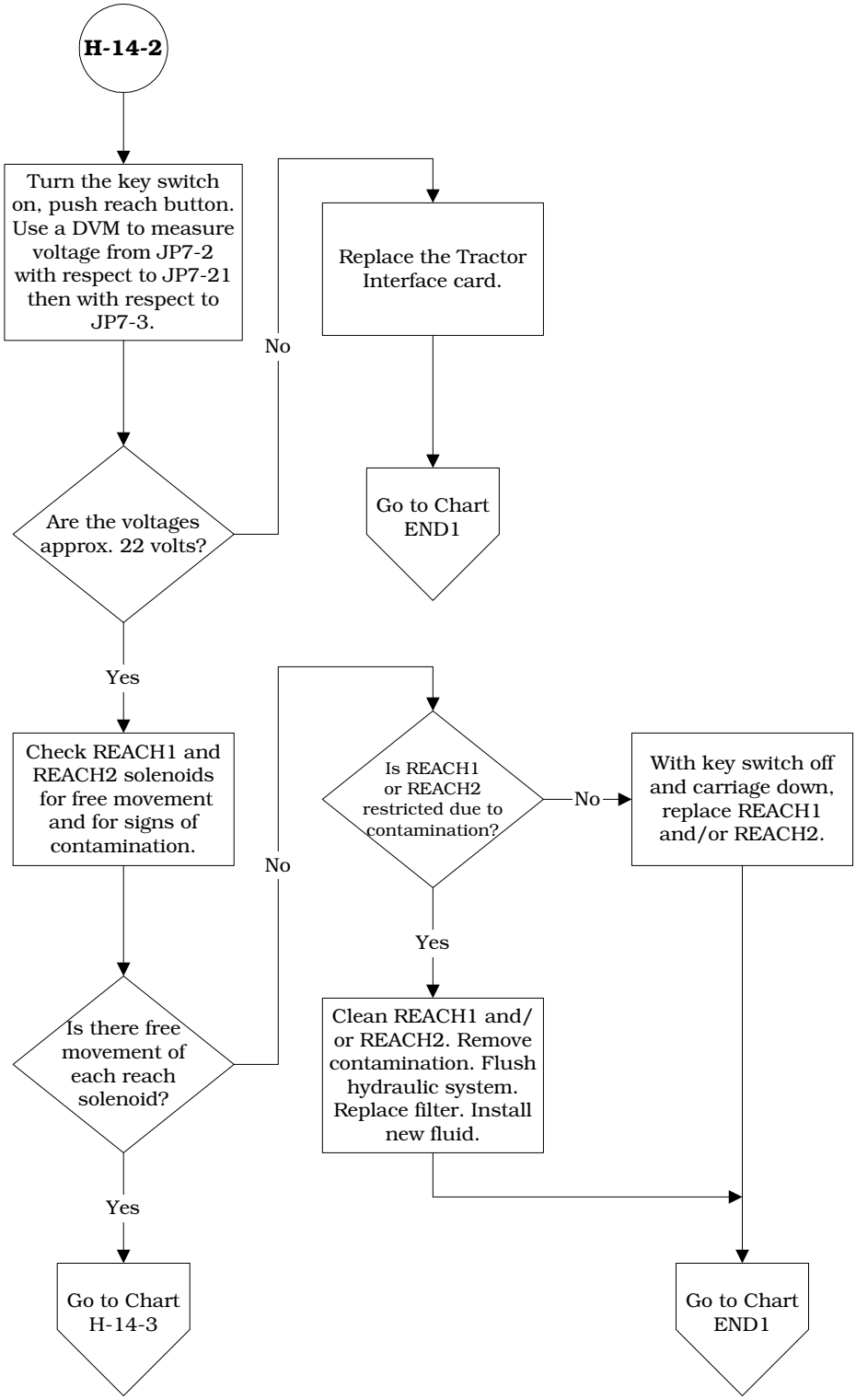
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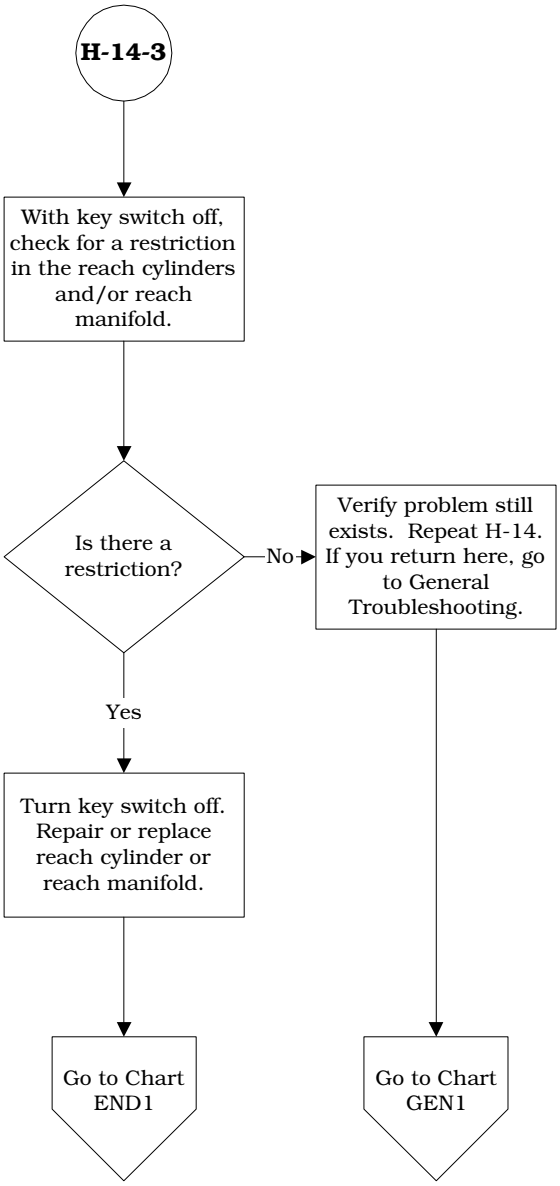


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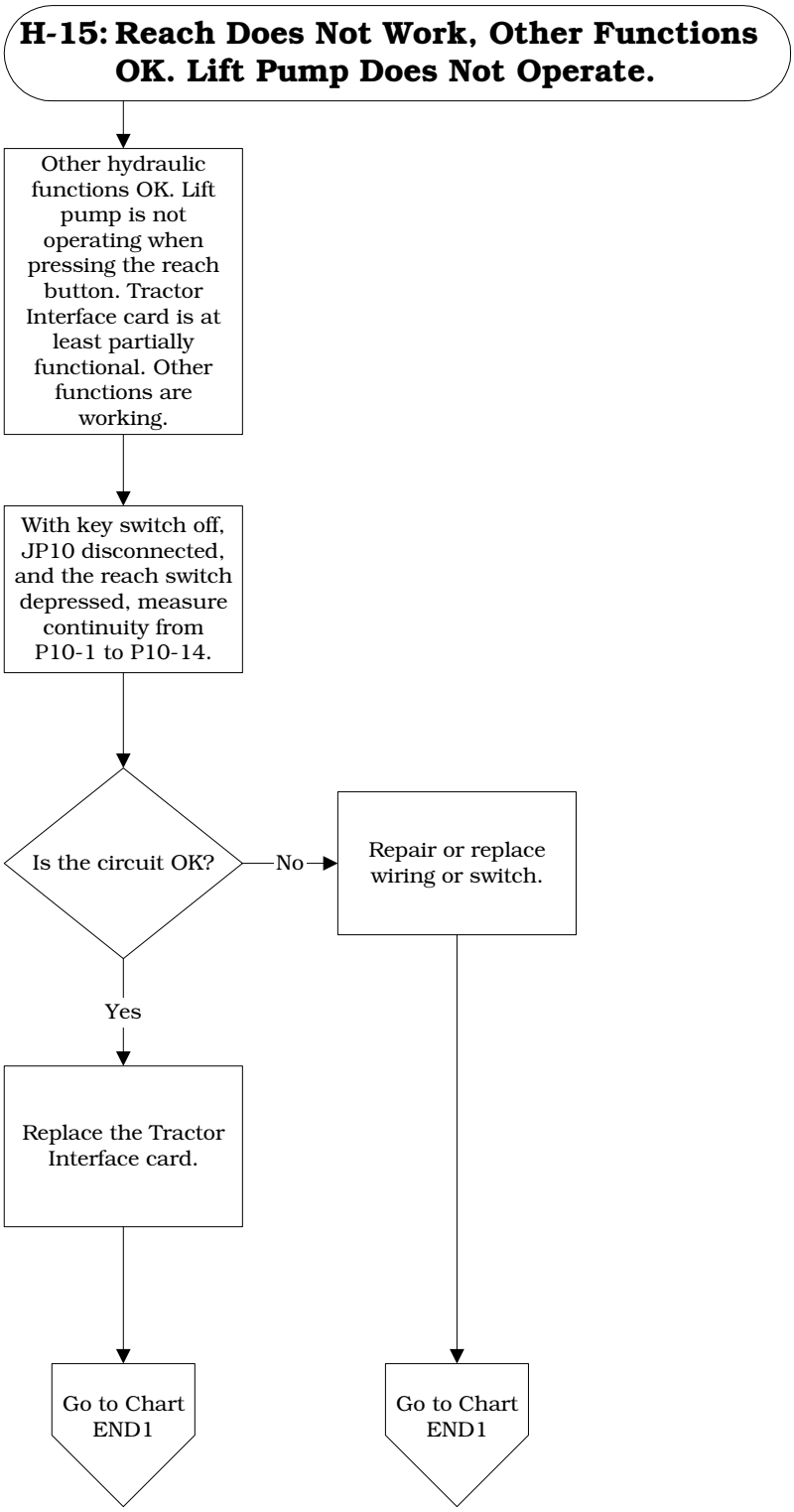


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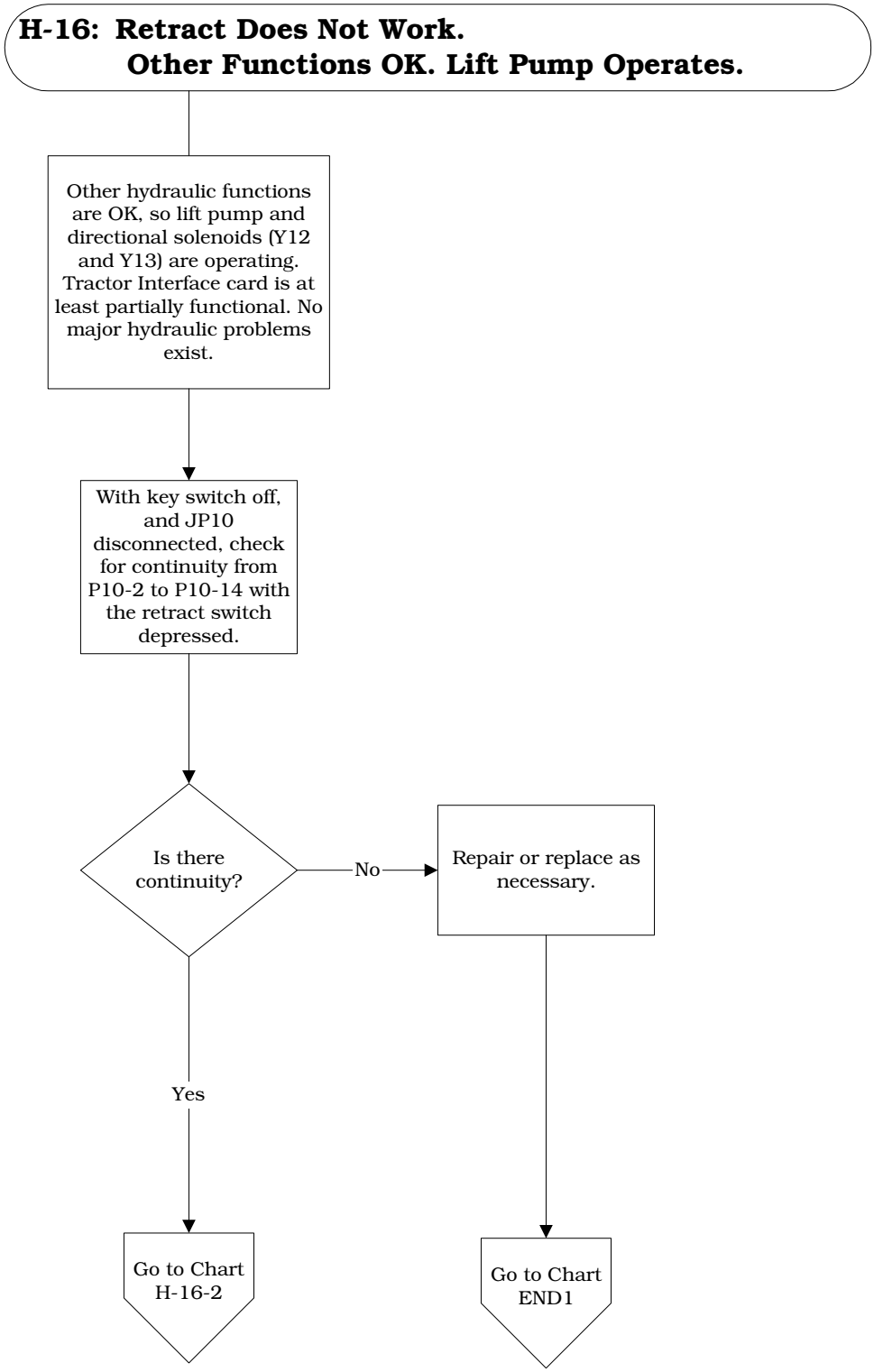
H-14: Reach Works Slow



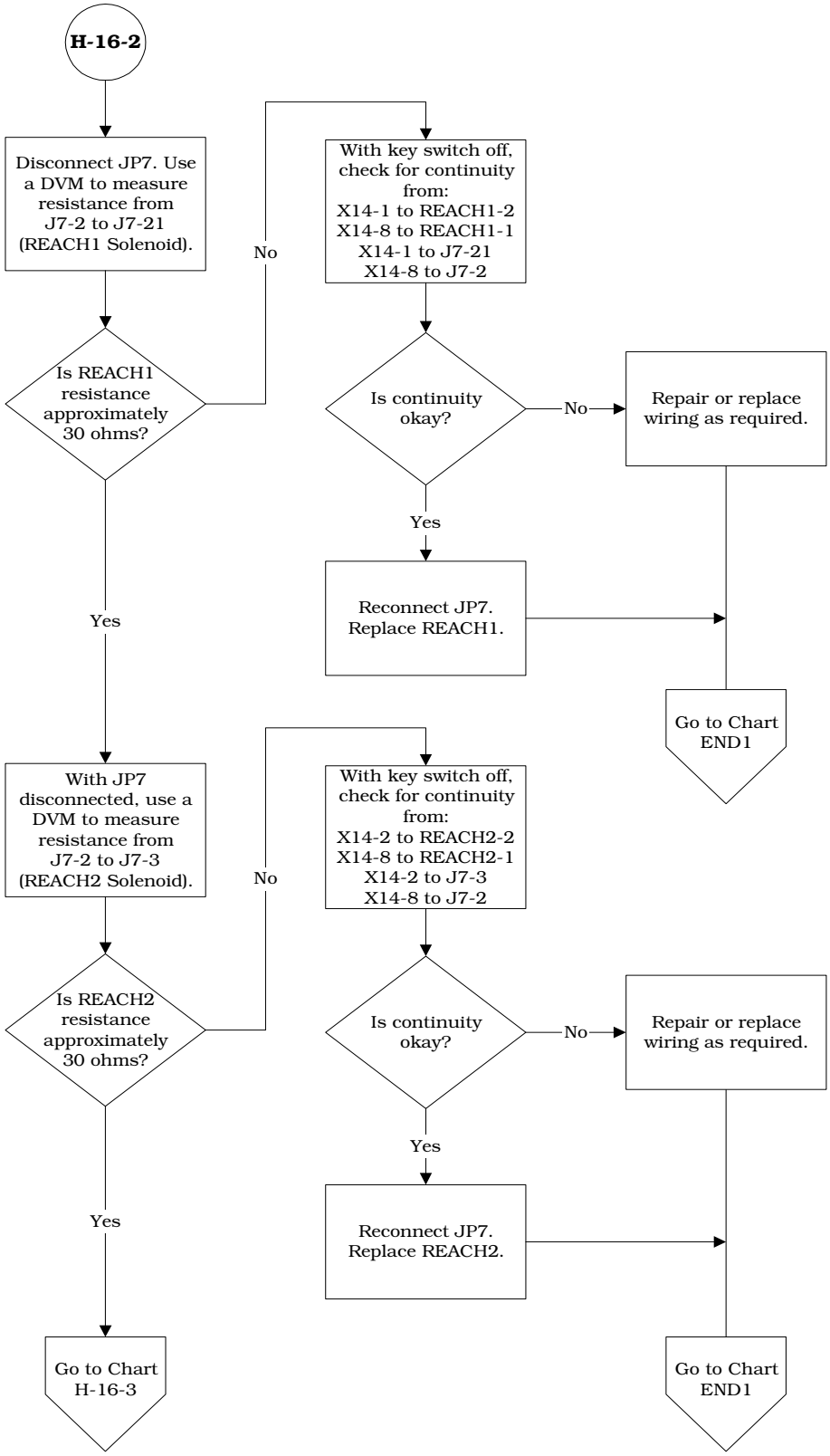
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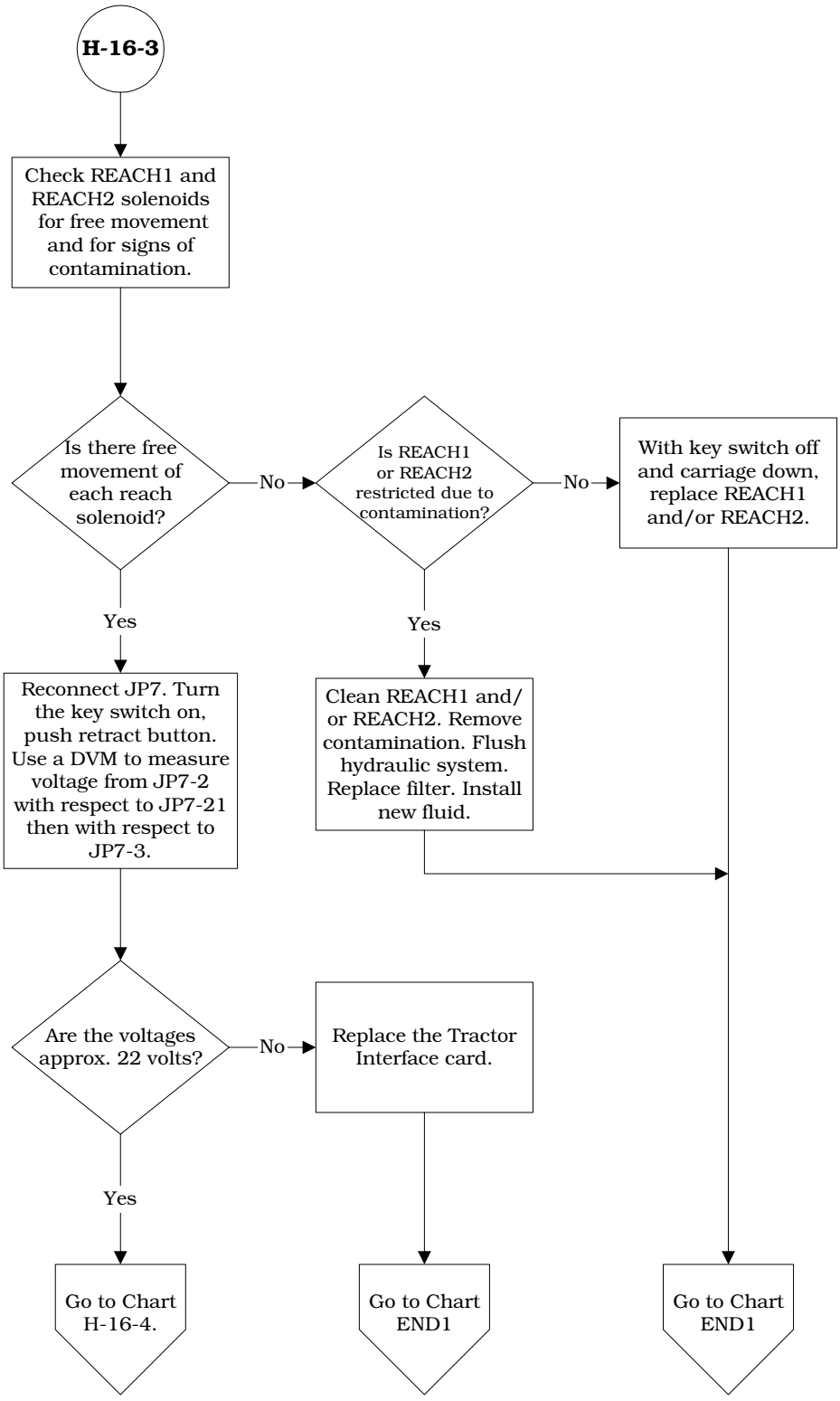


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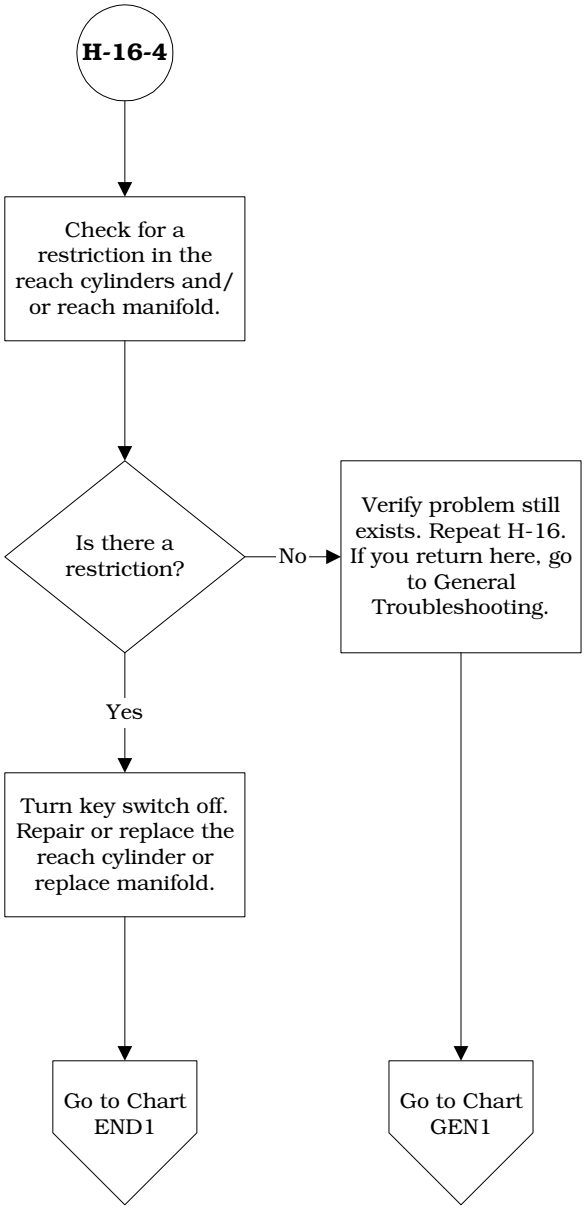


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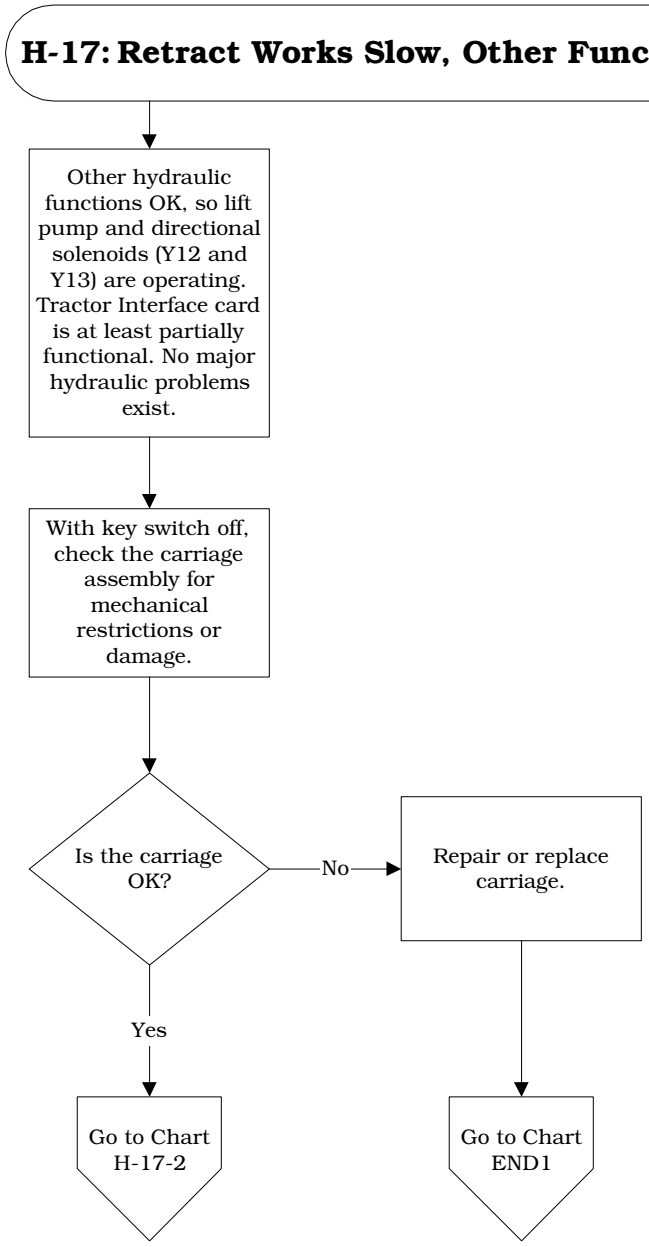
H-16: Retract Does Not Work



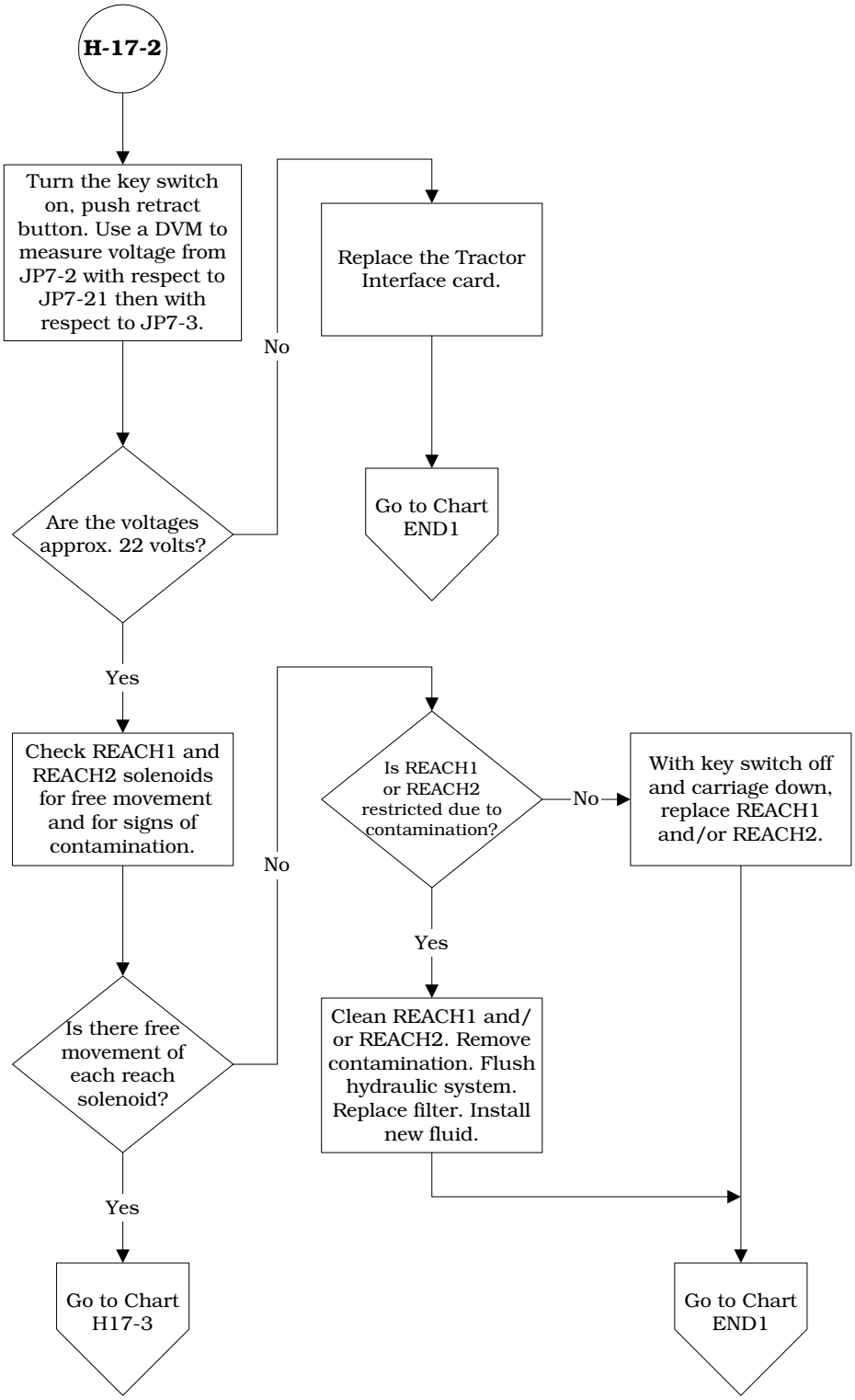
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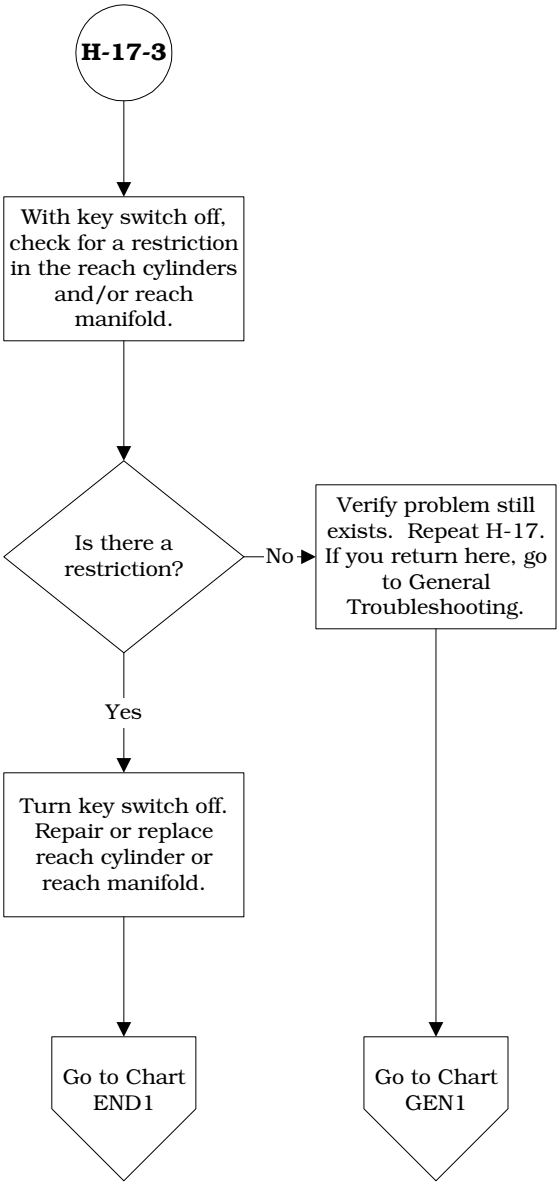


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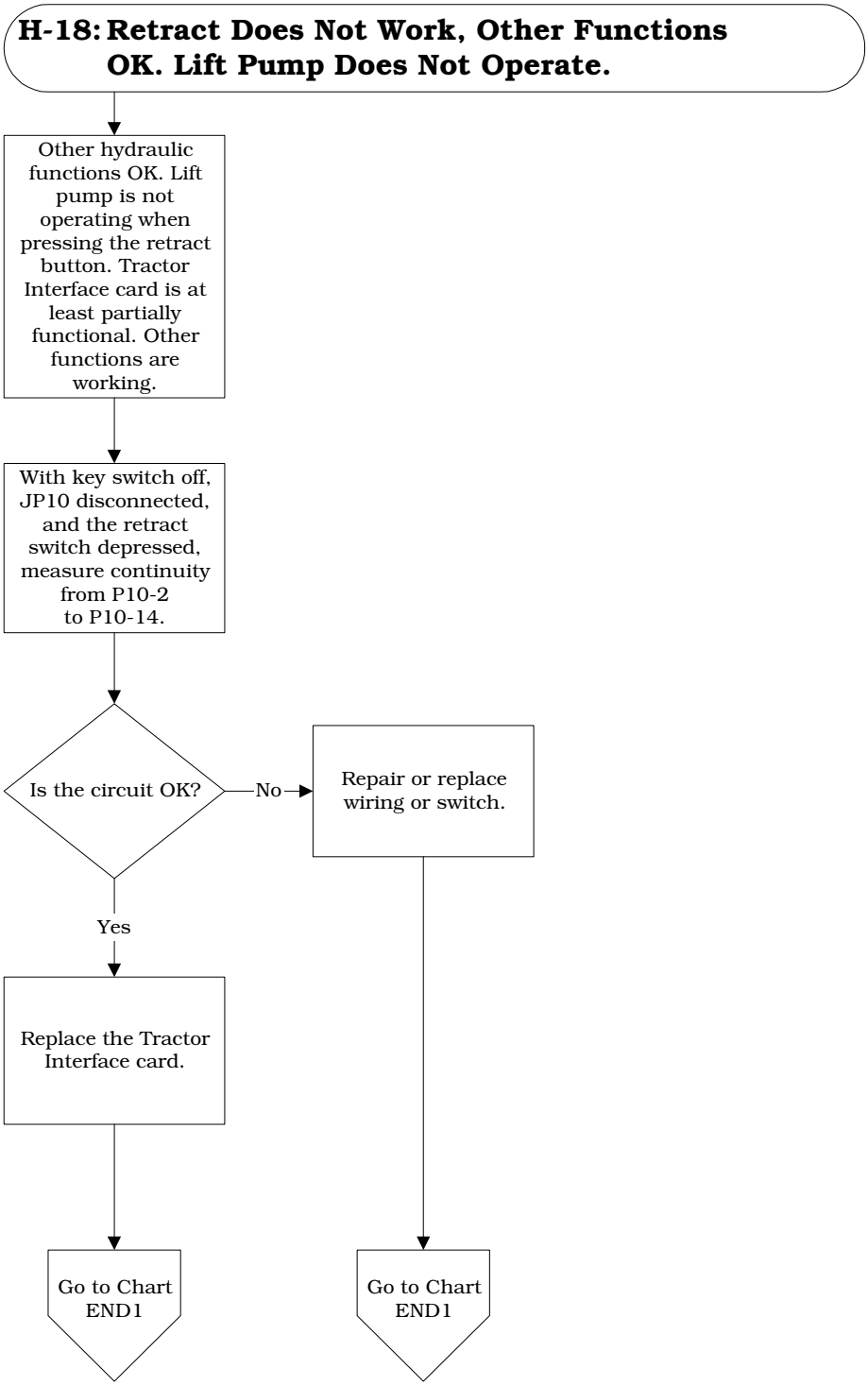


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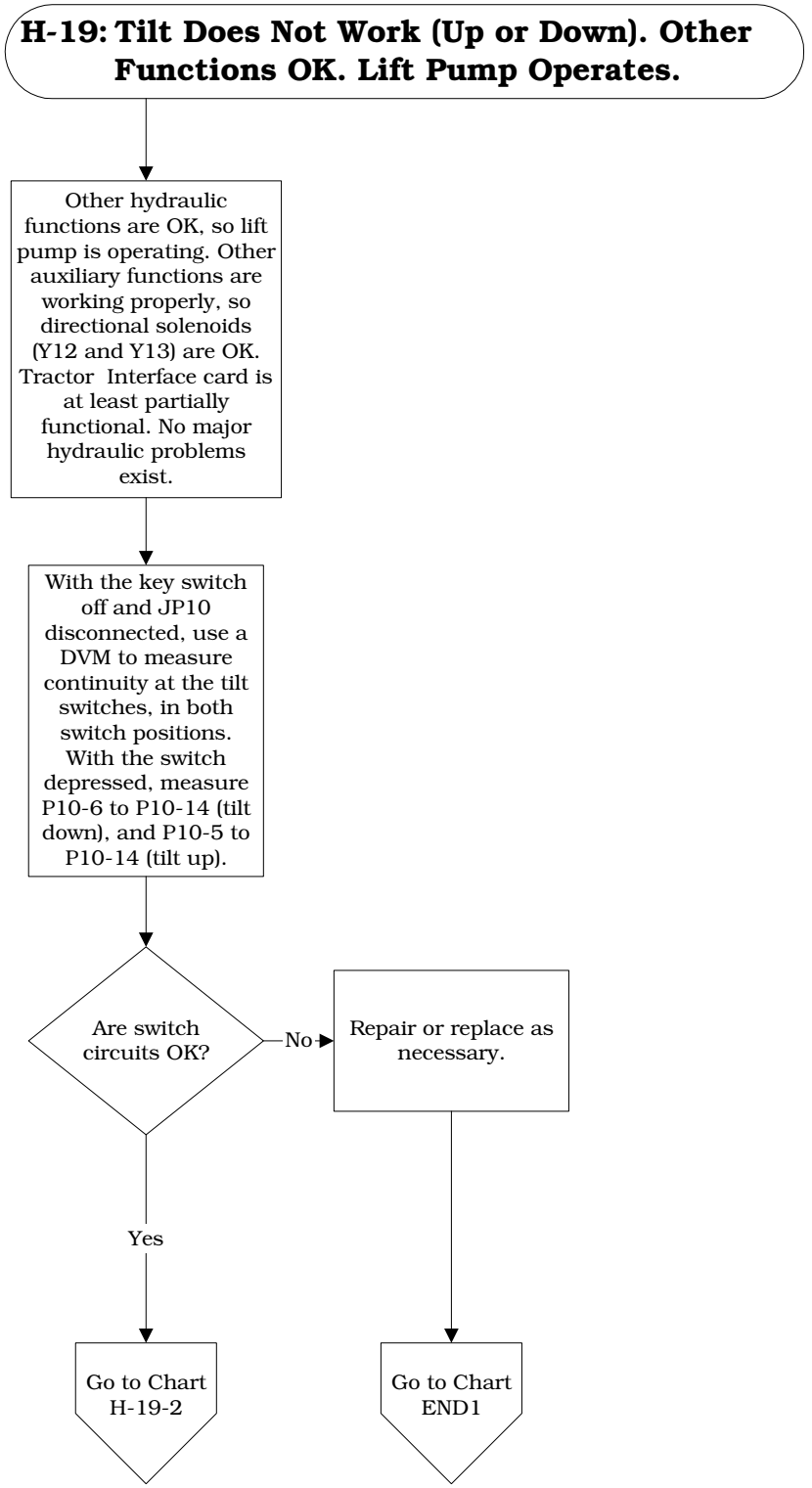
H-17: Retract Works Slow



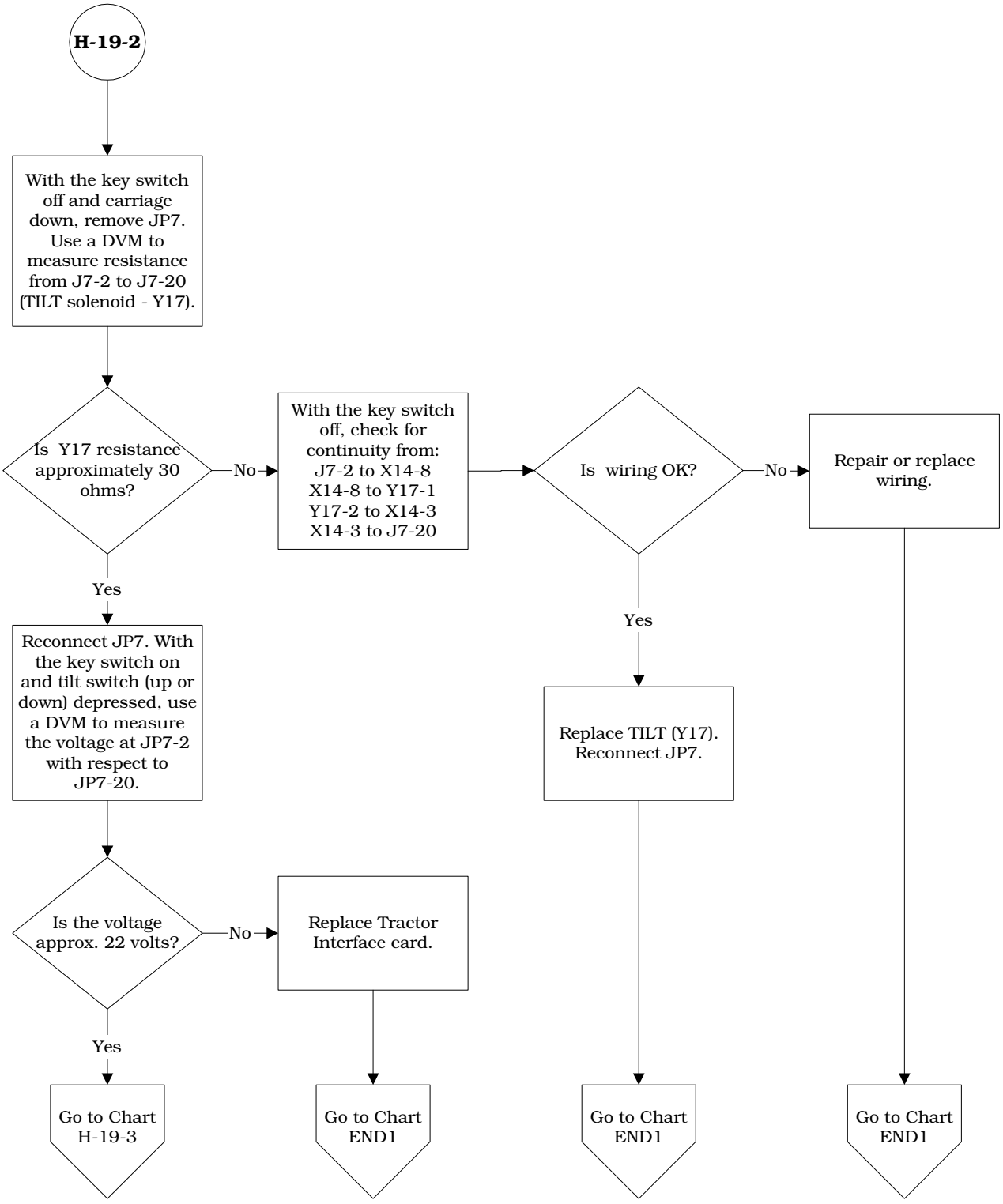
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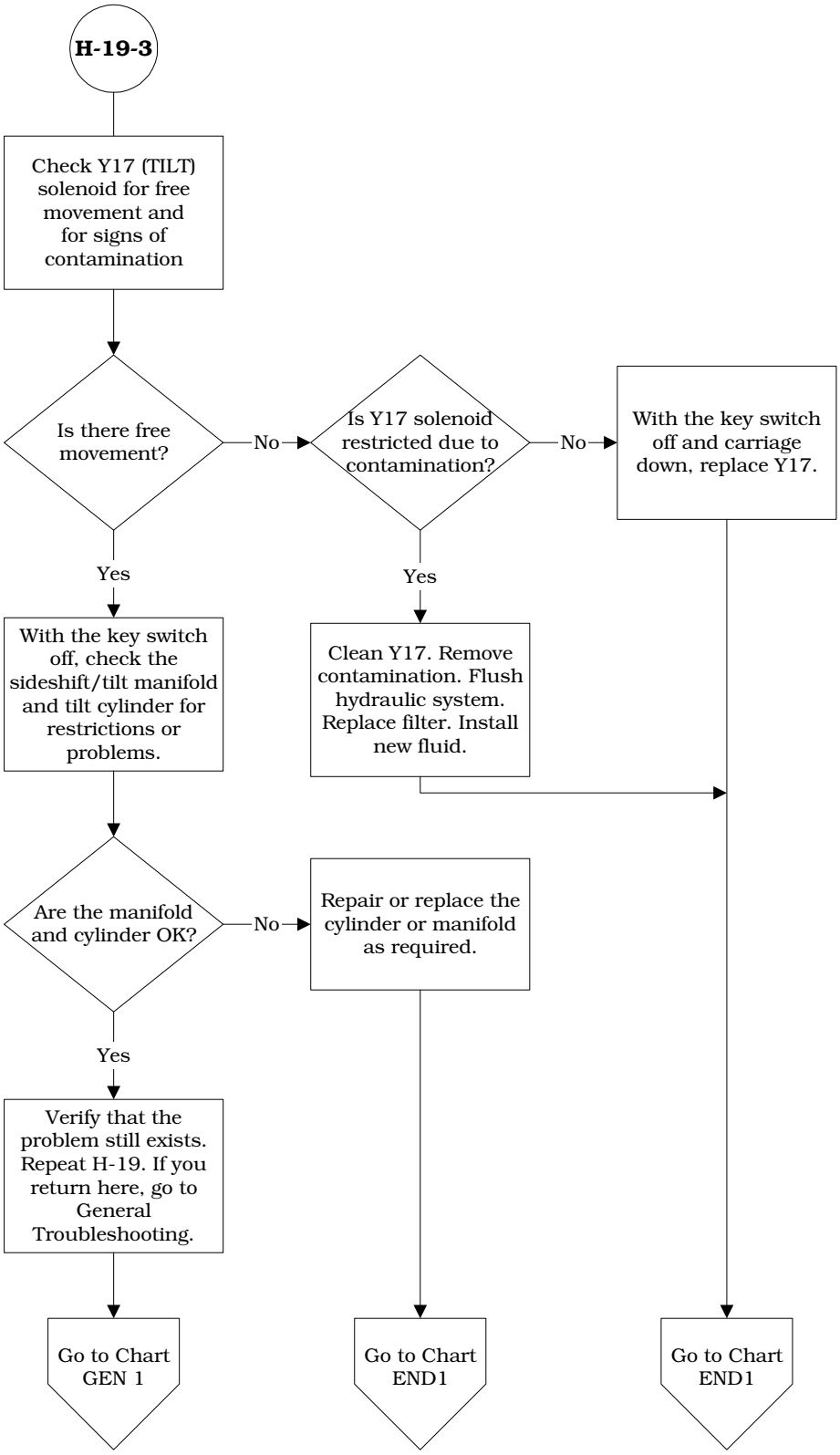


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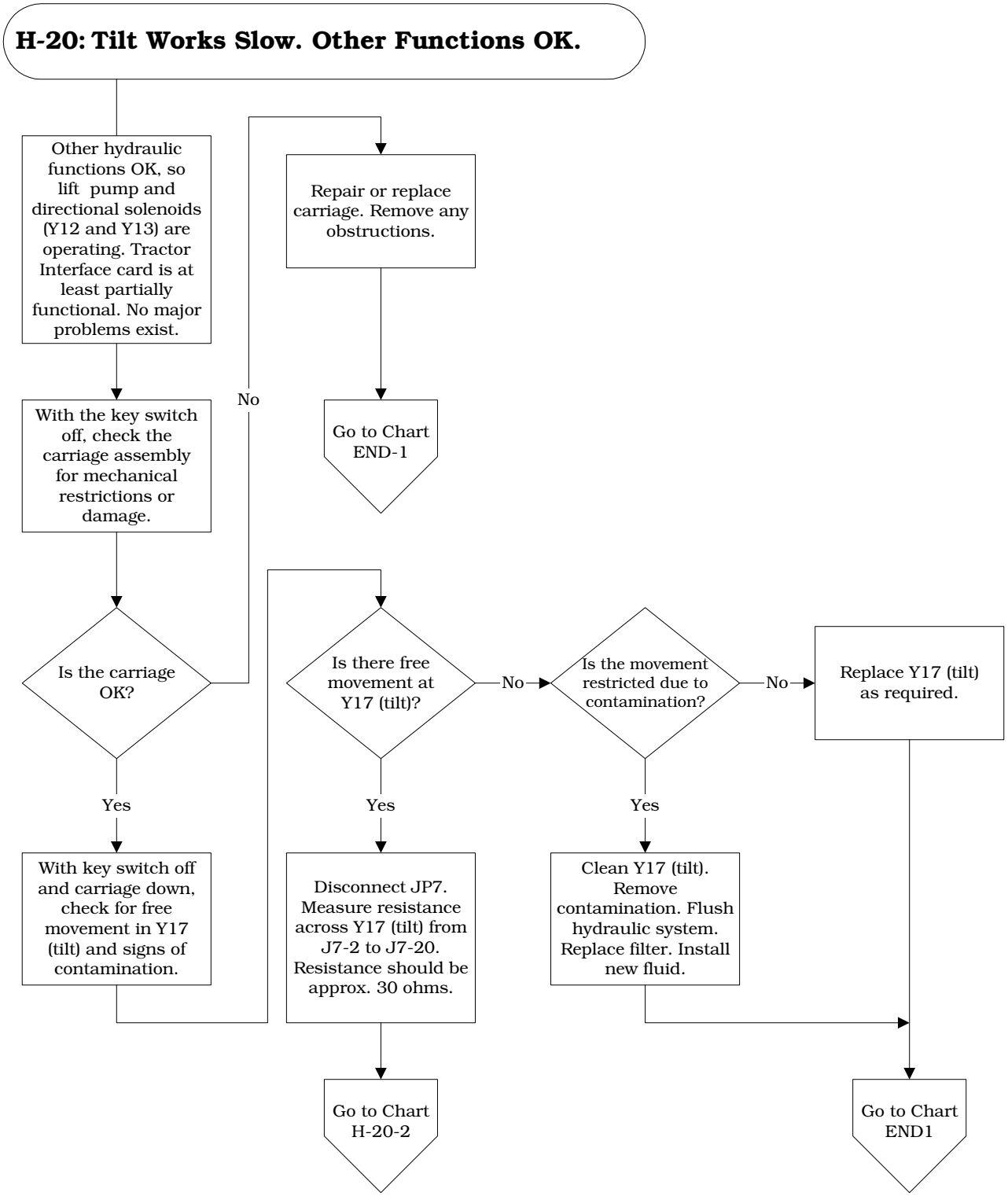


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H-19: Tilt Does Not Work (Up or Down)

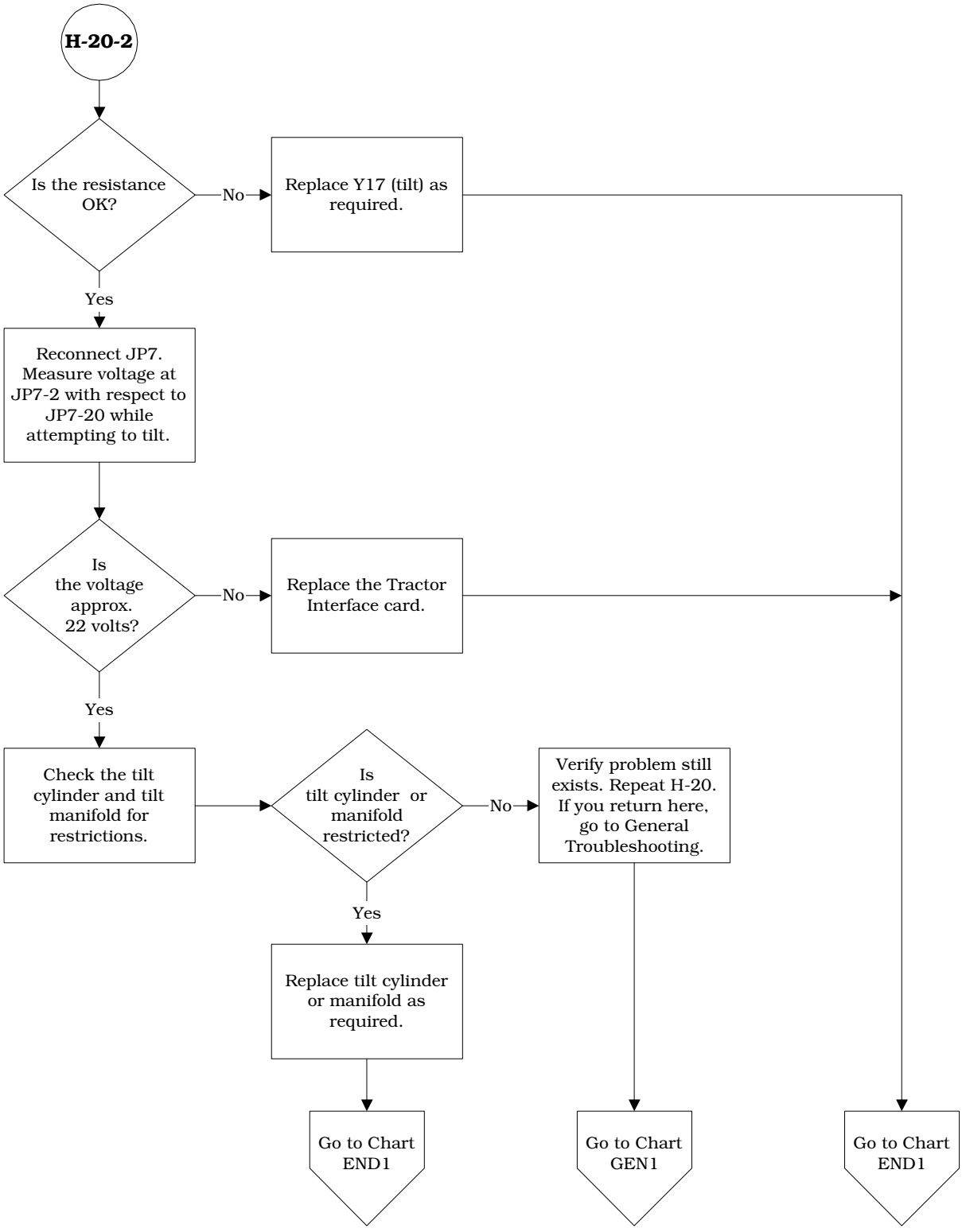


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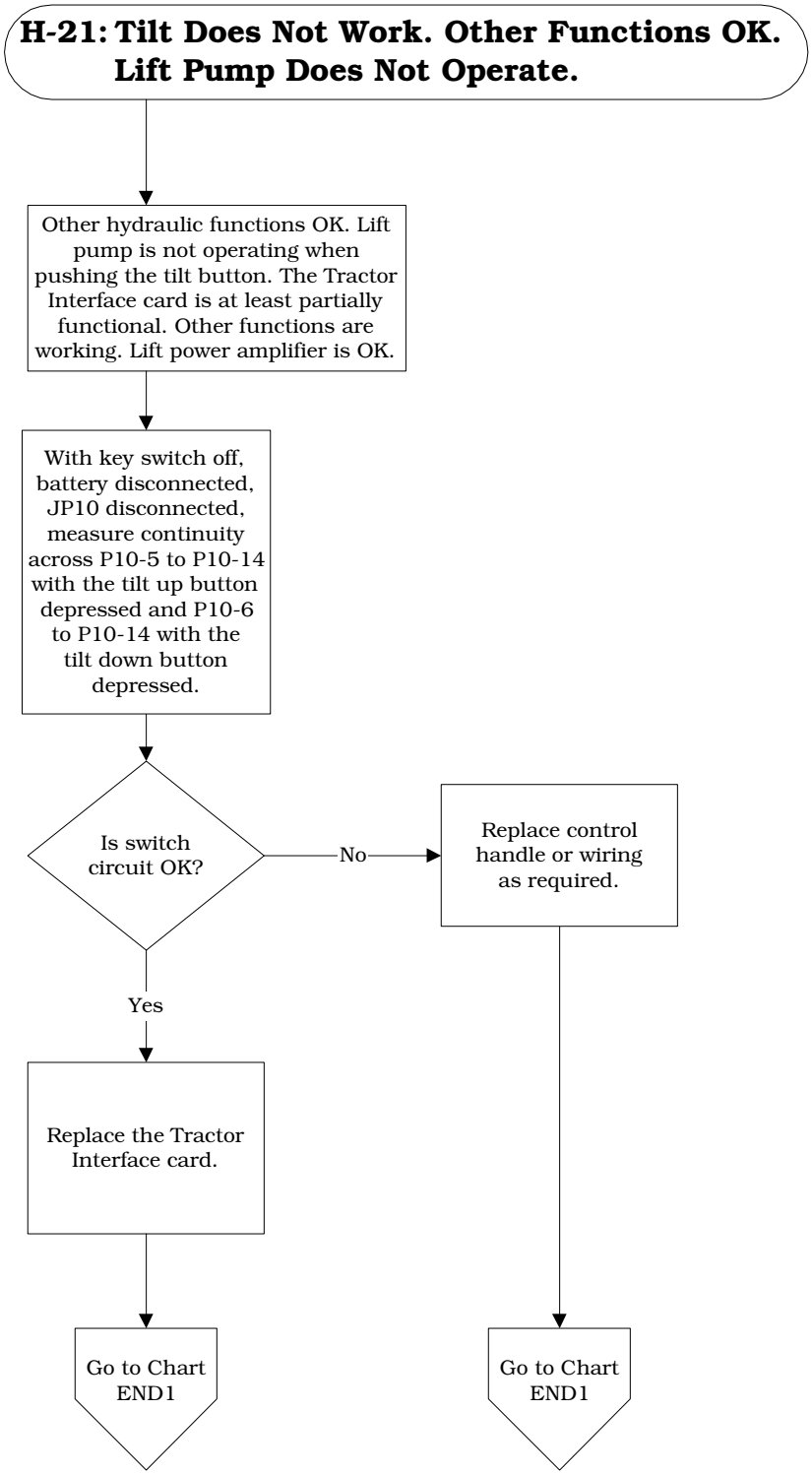


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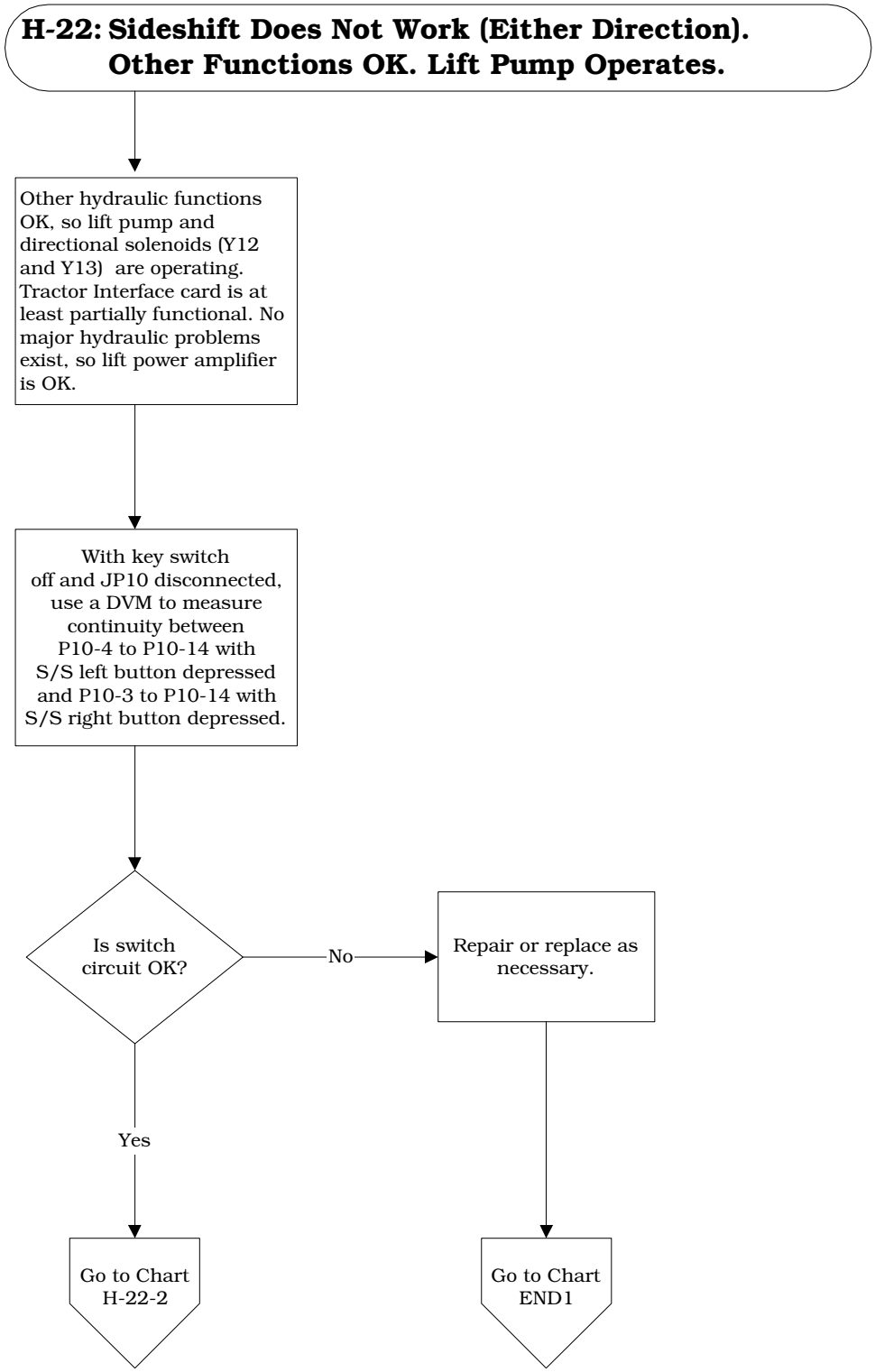
H-20: Tilt Works Slow



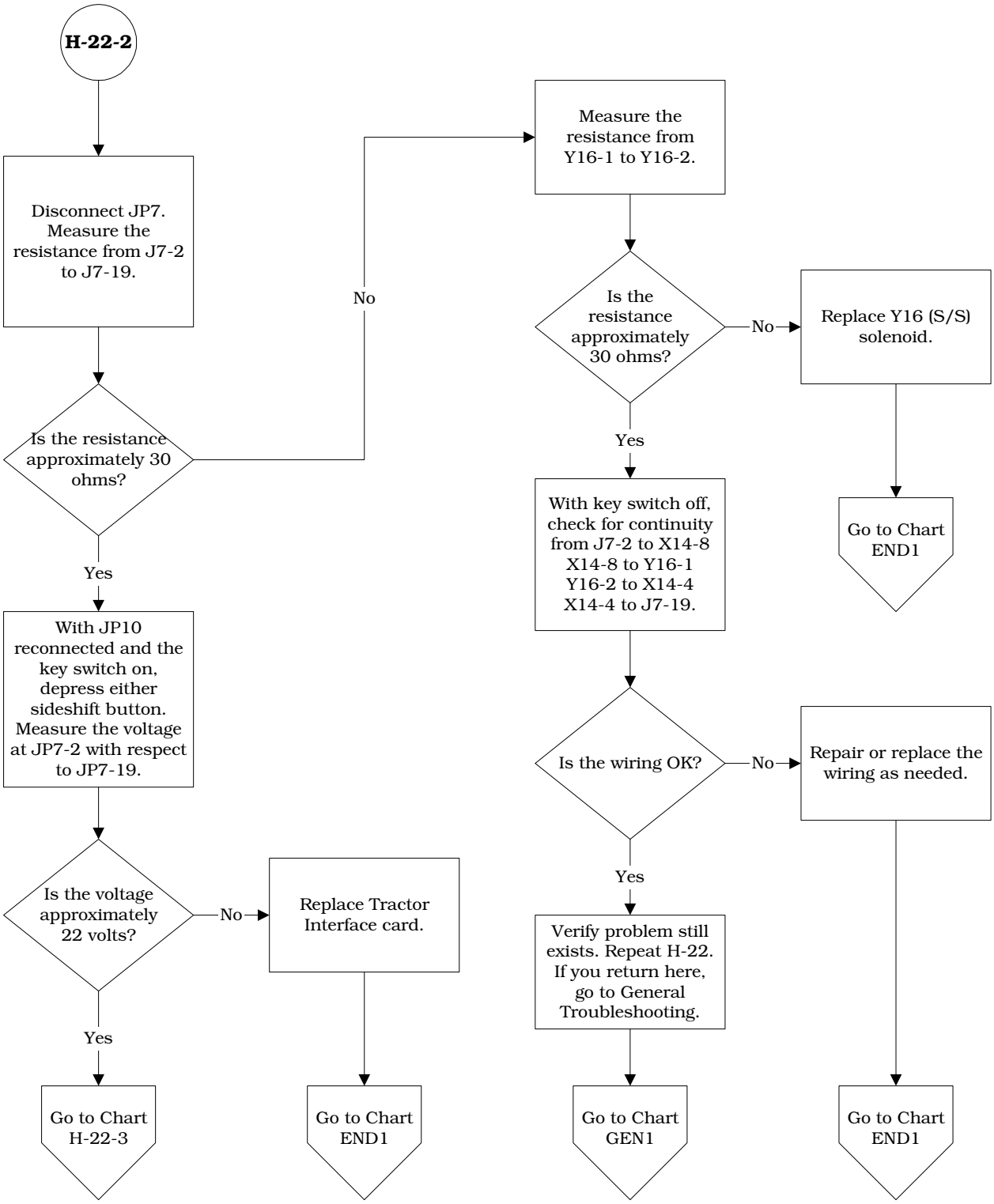
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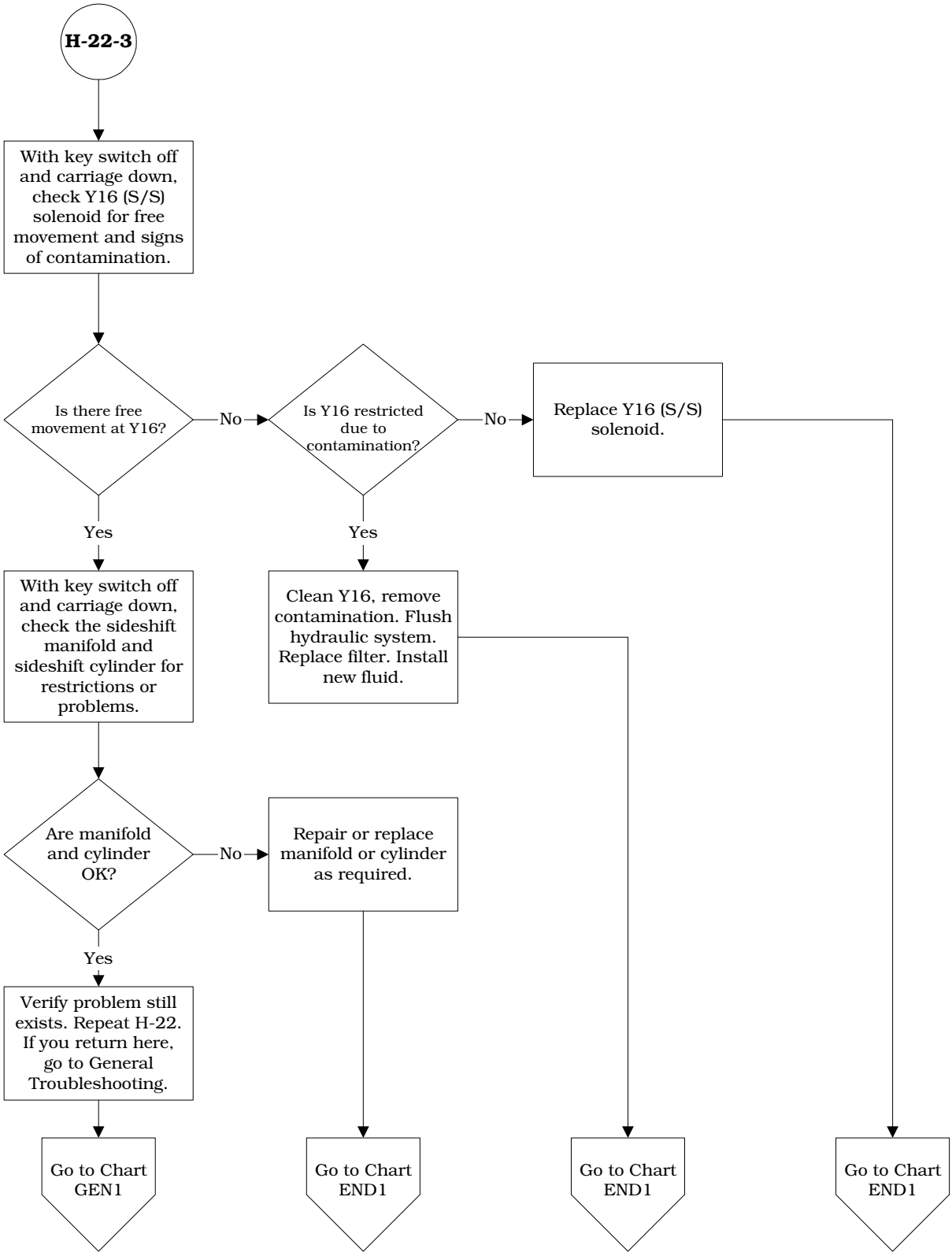


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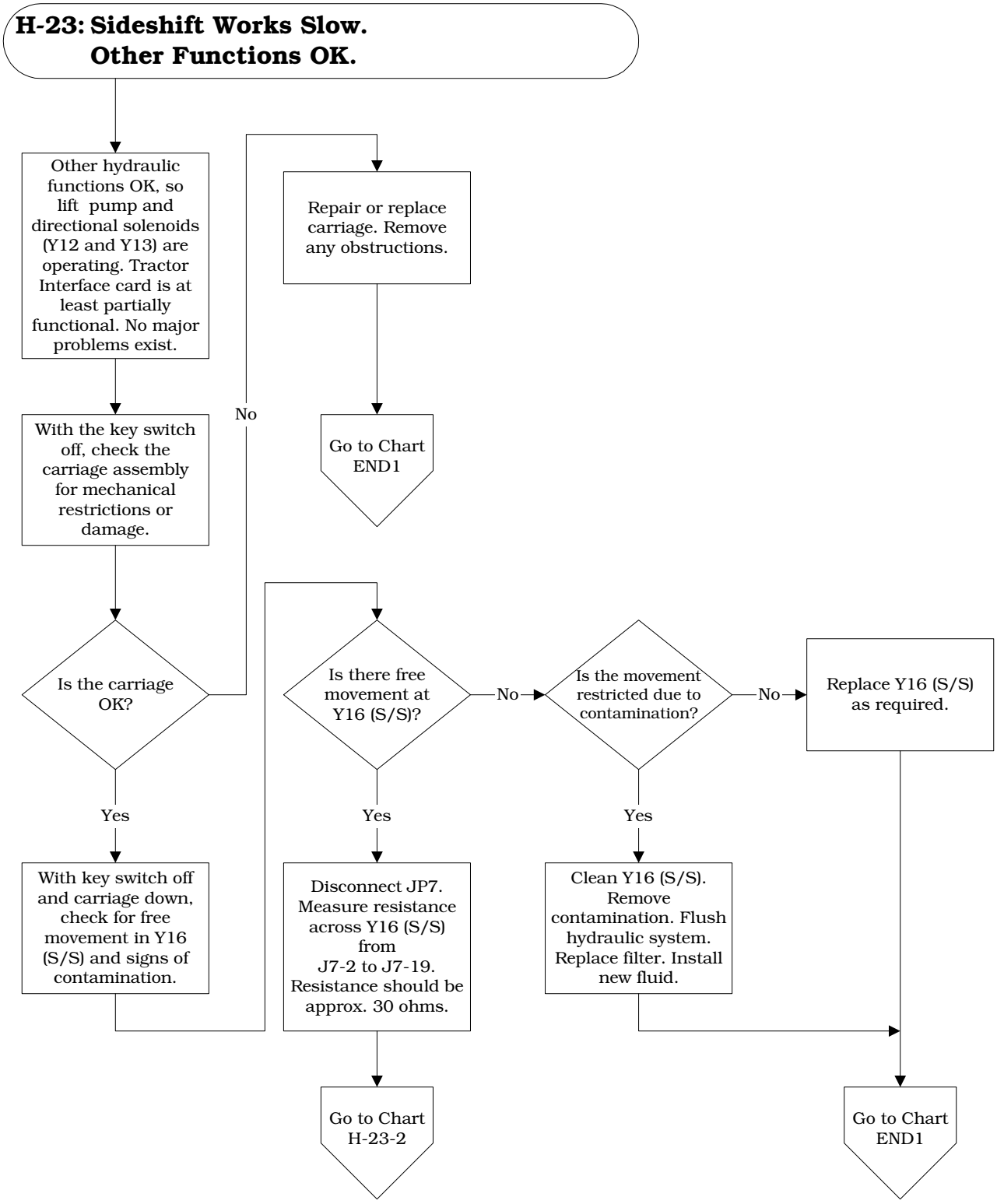


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H-22: Sideshift Does Not Work (Either Direction)

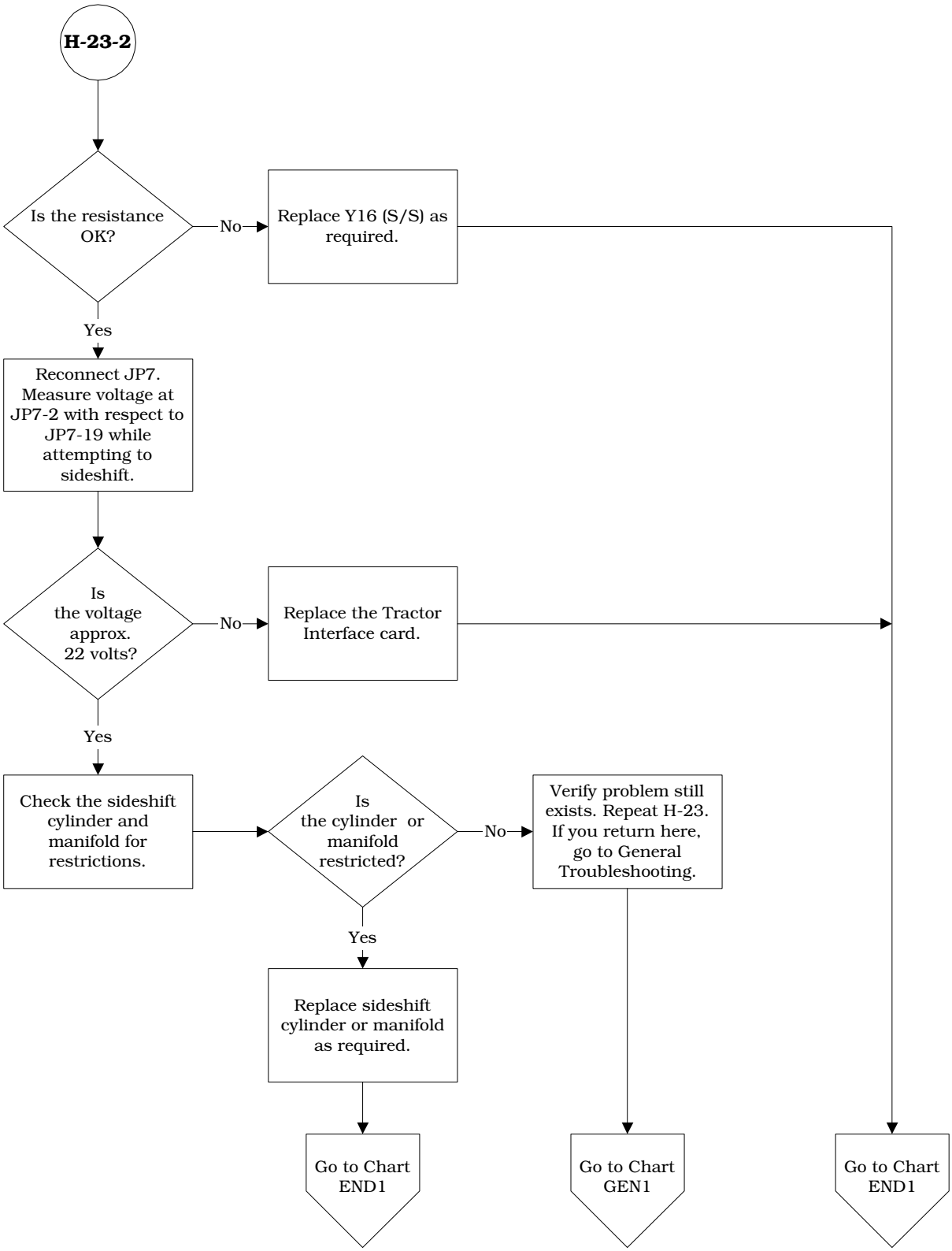


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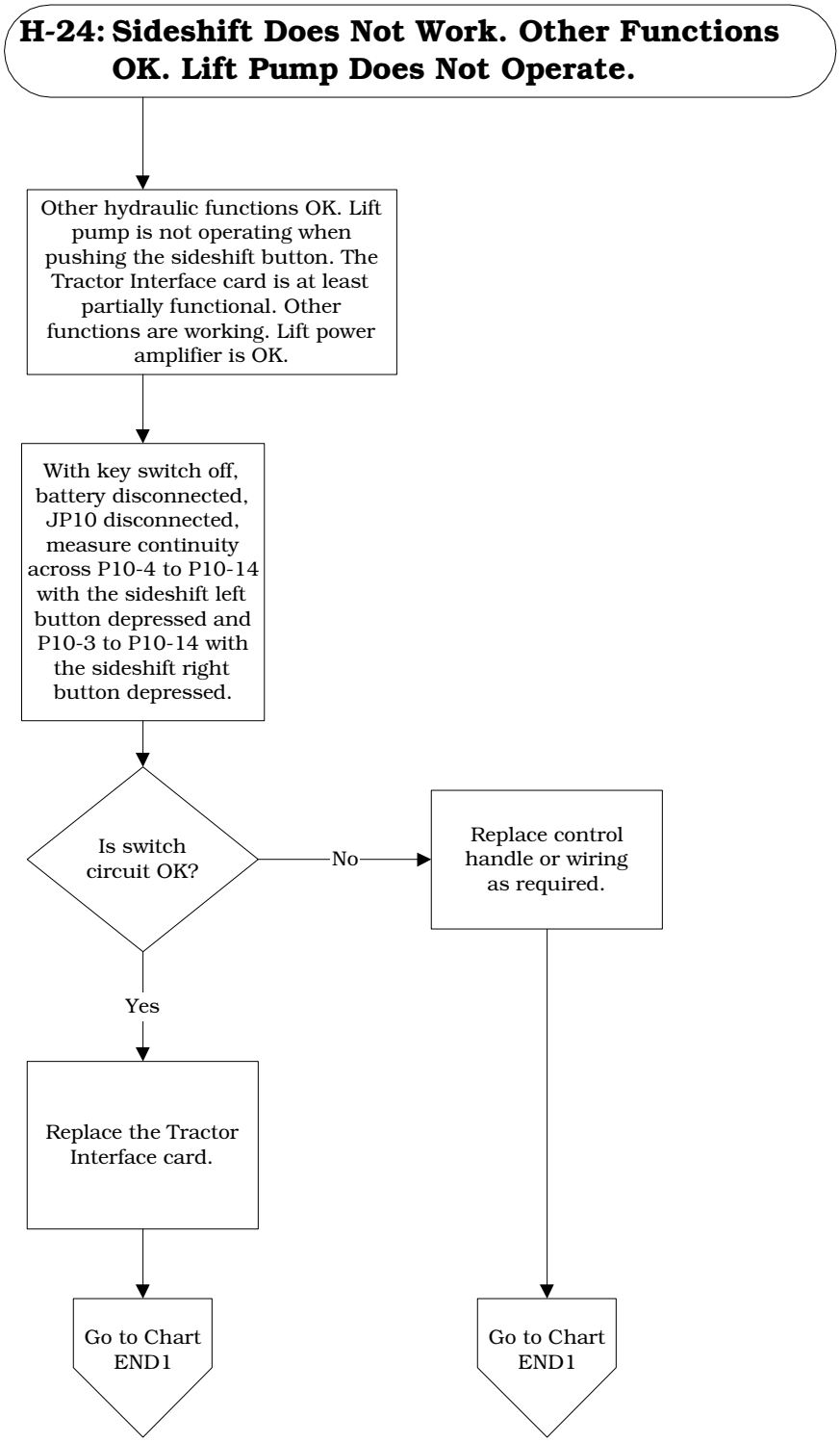


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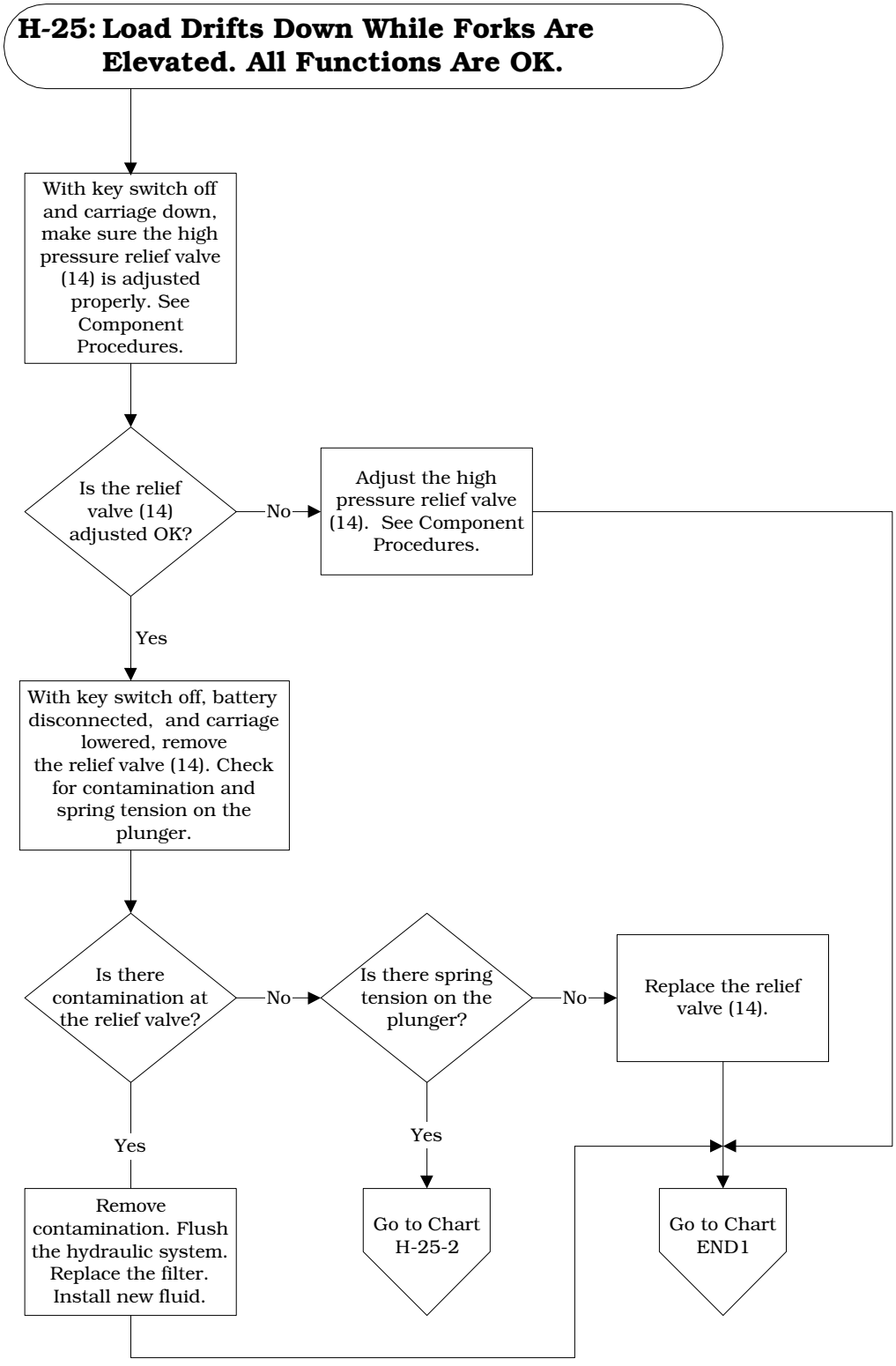
H-23: Sideshift Works Slow



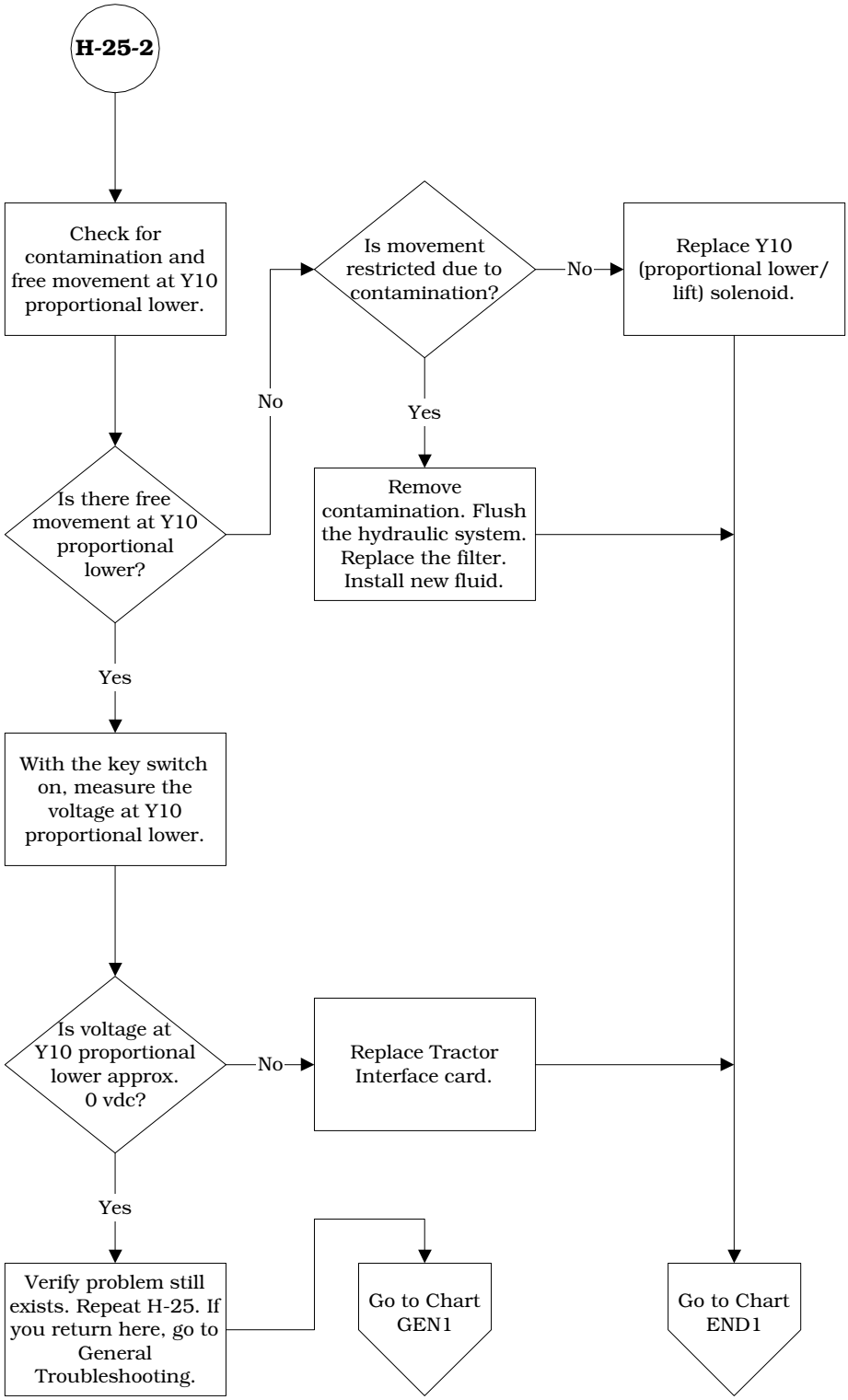
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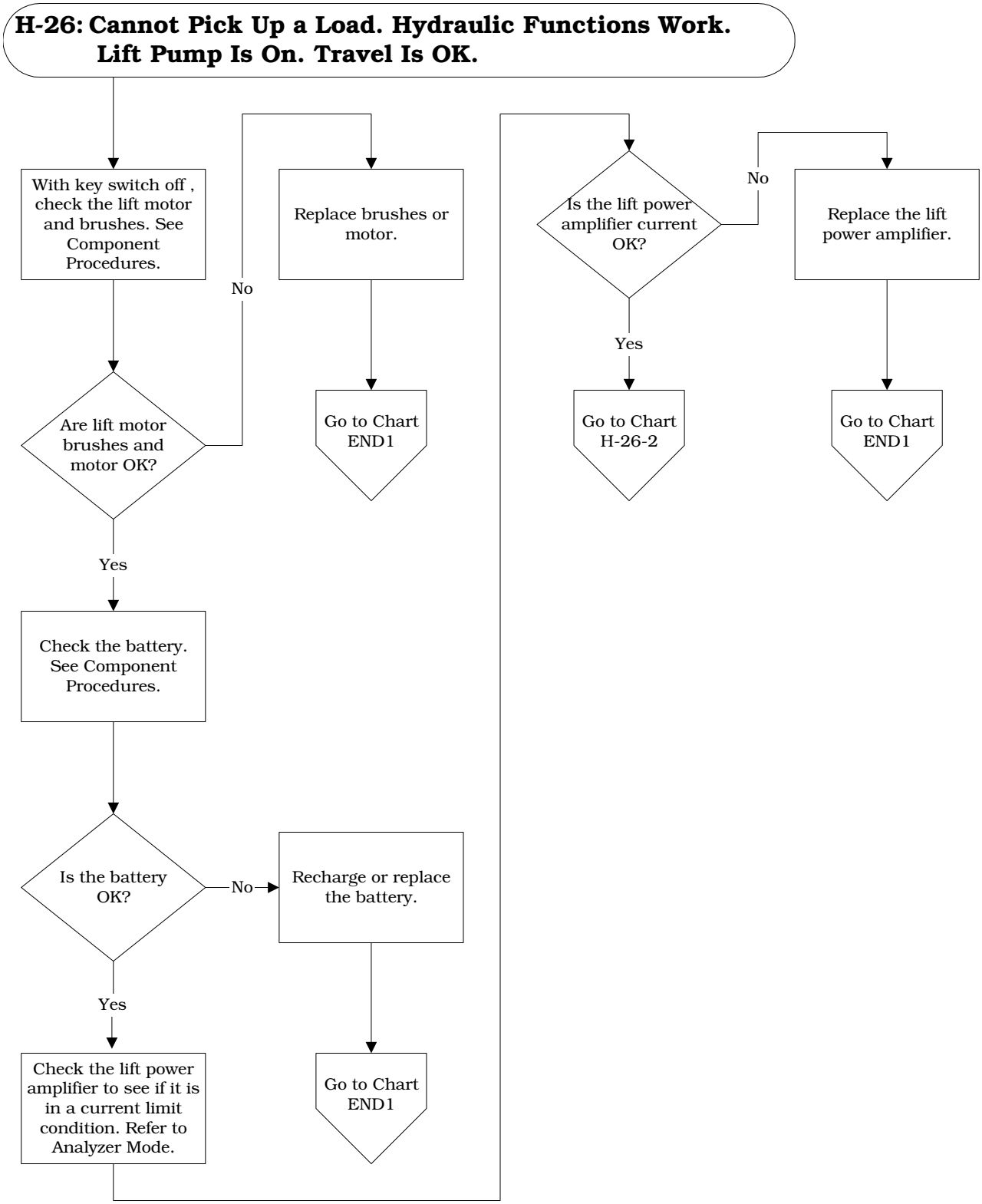
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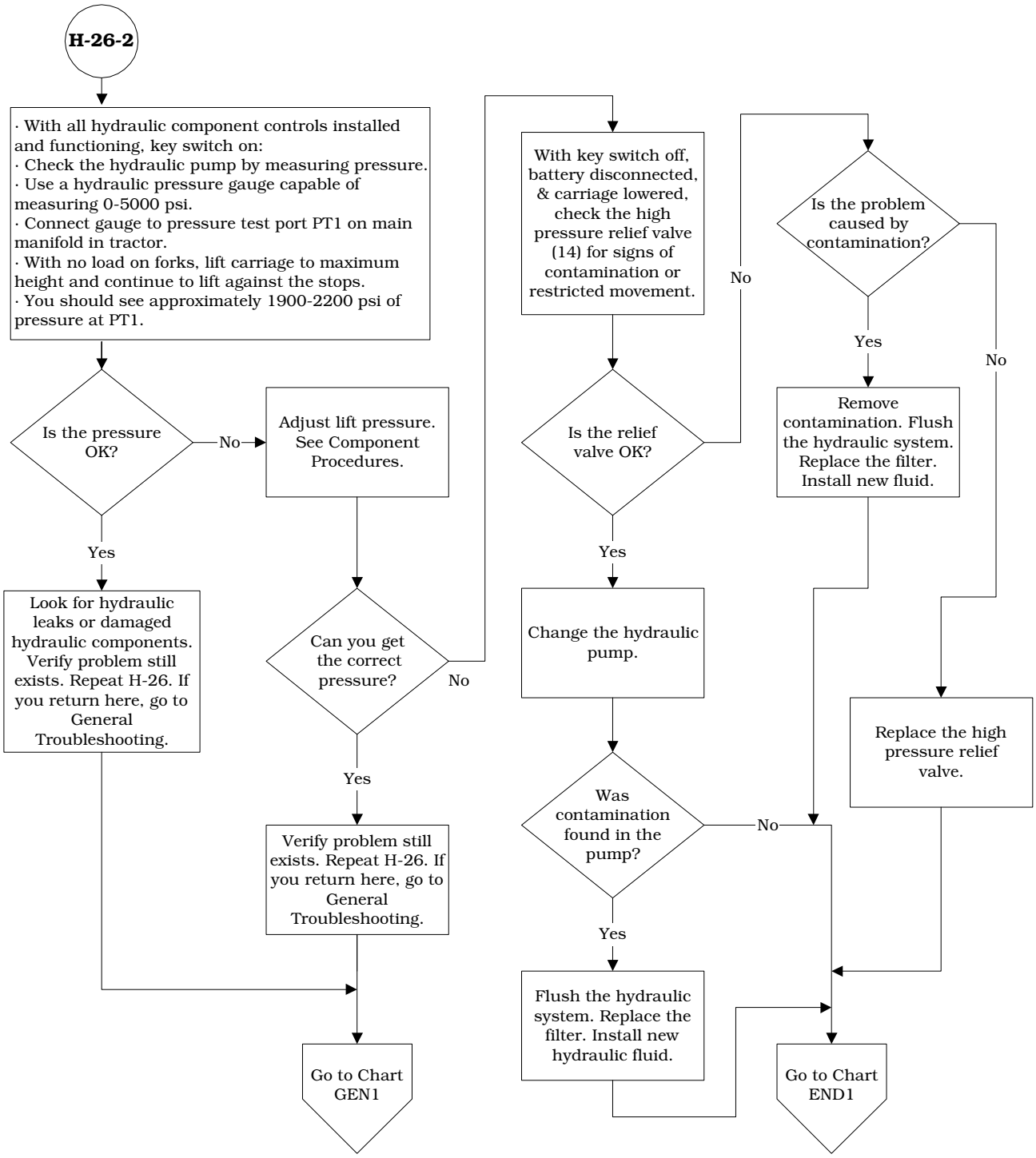
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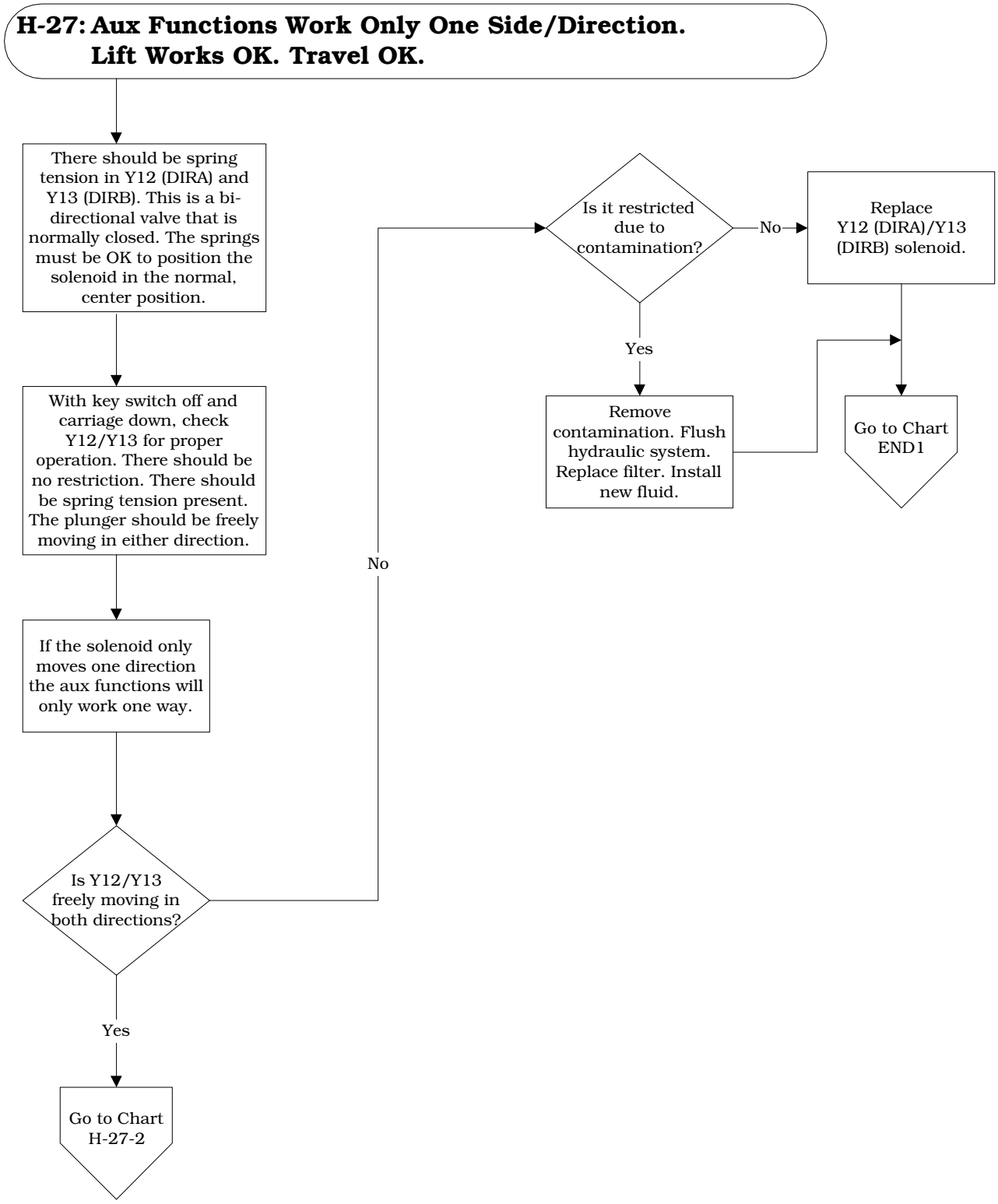
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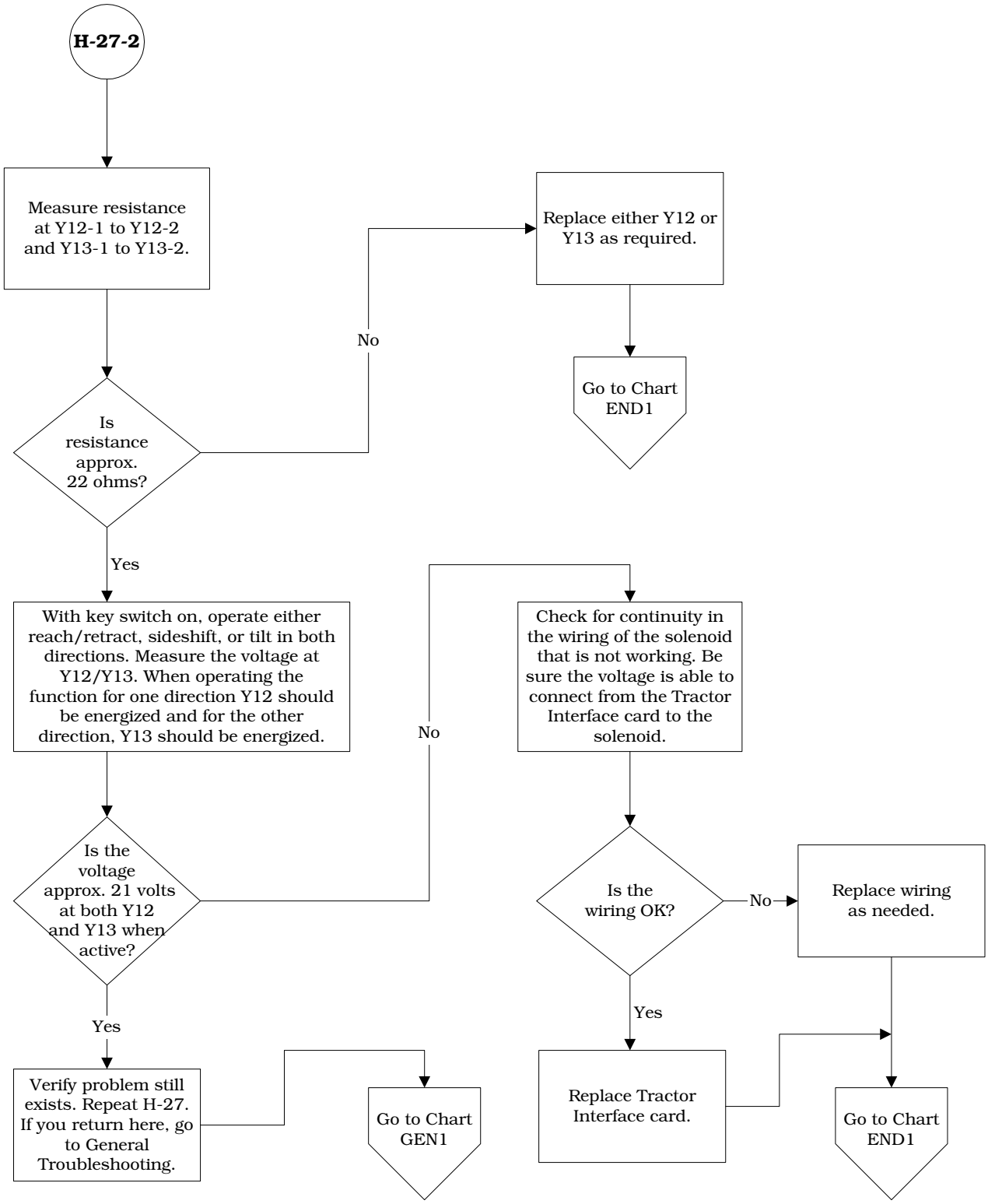
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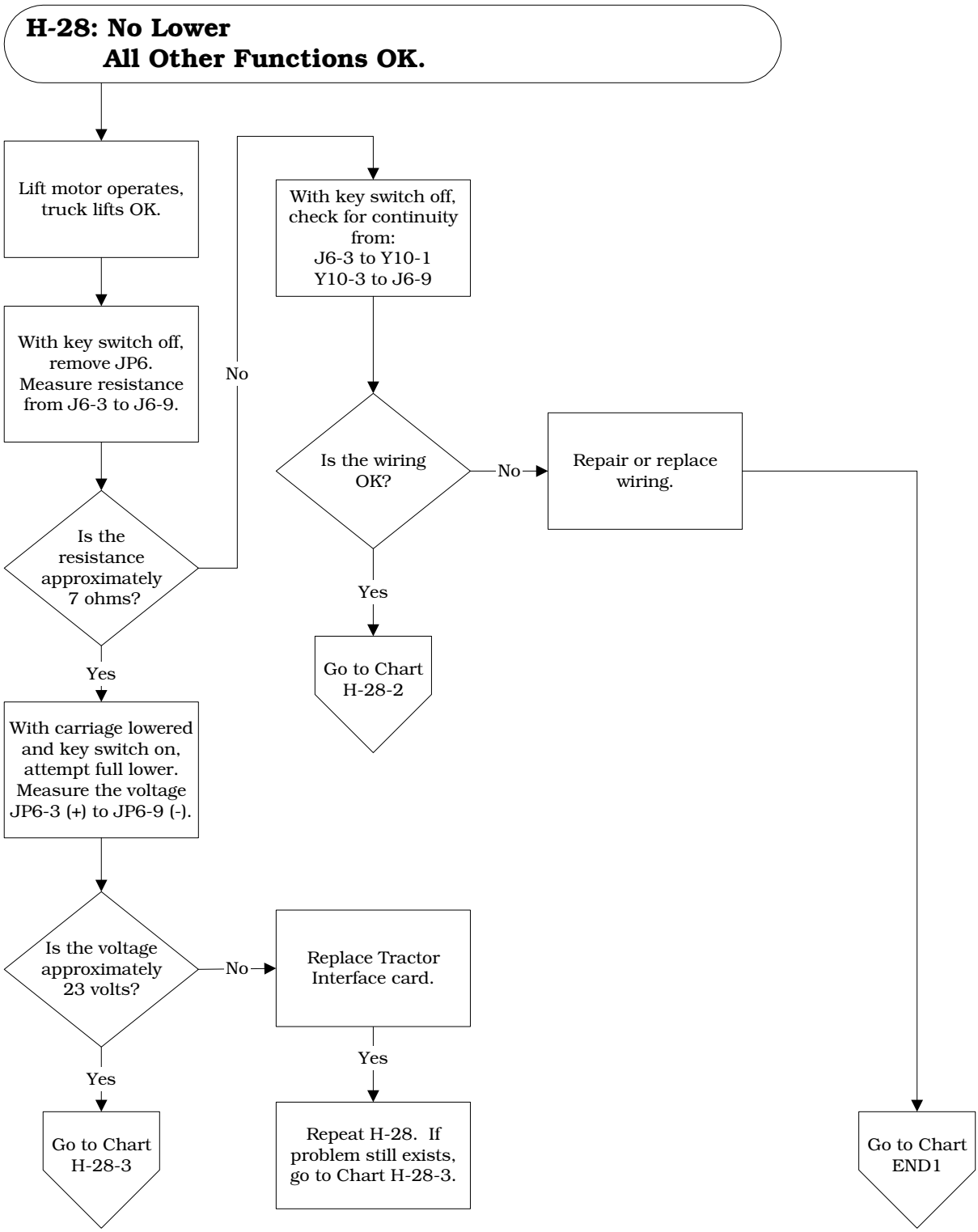
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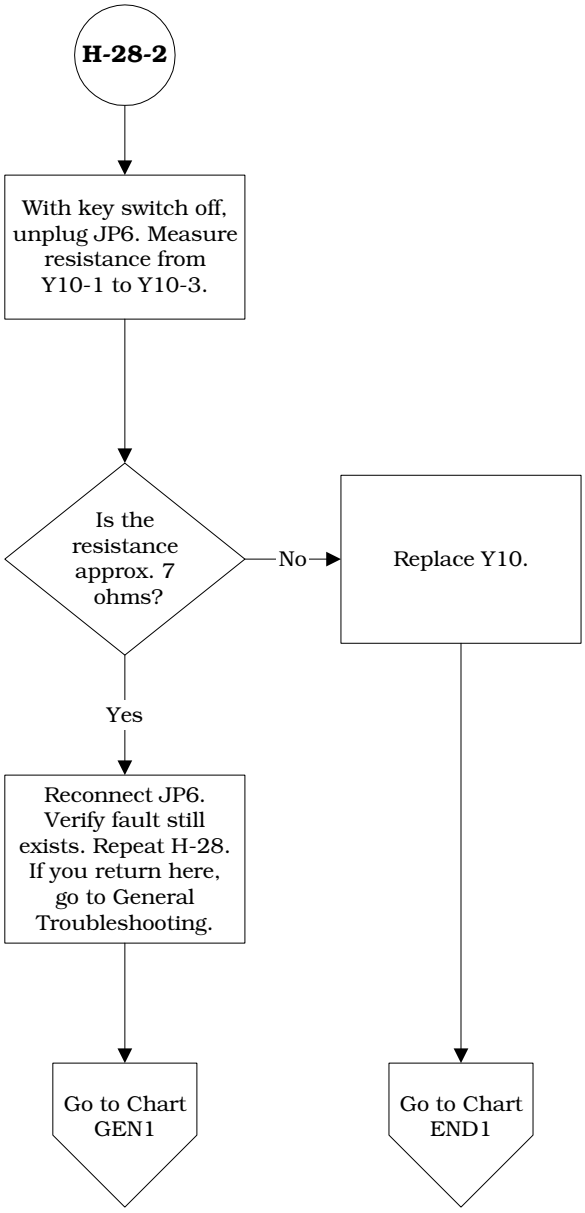
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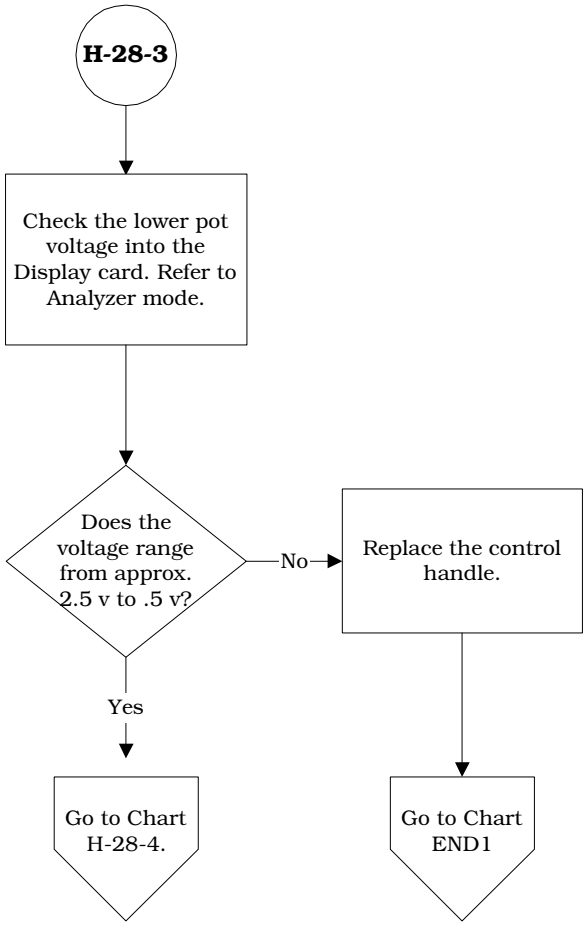


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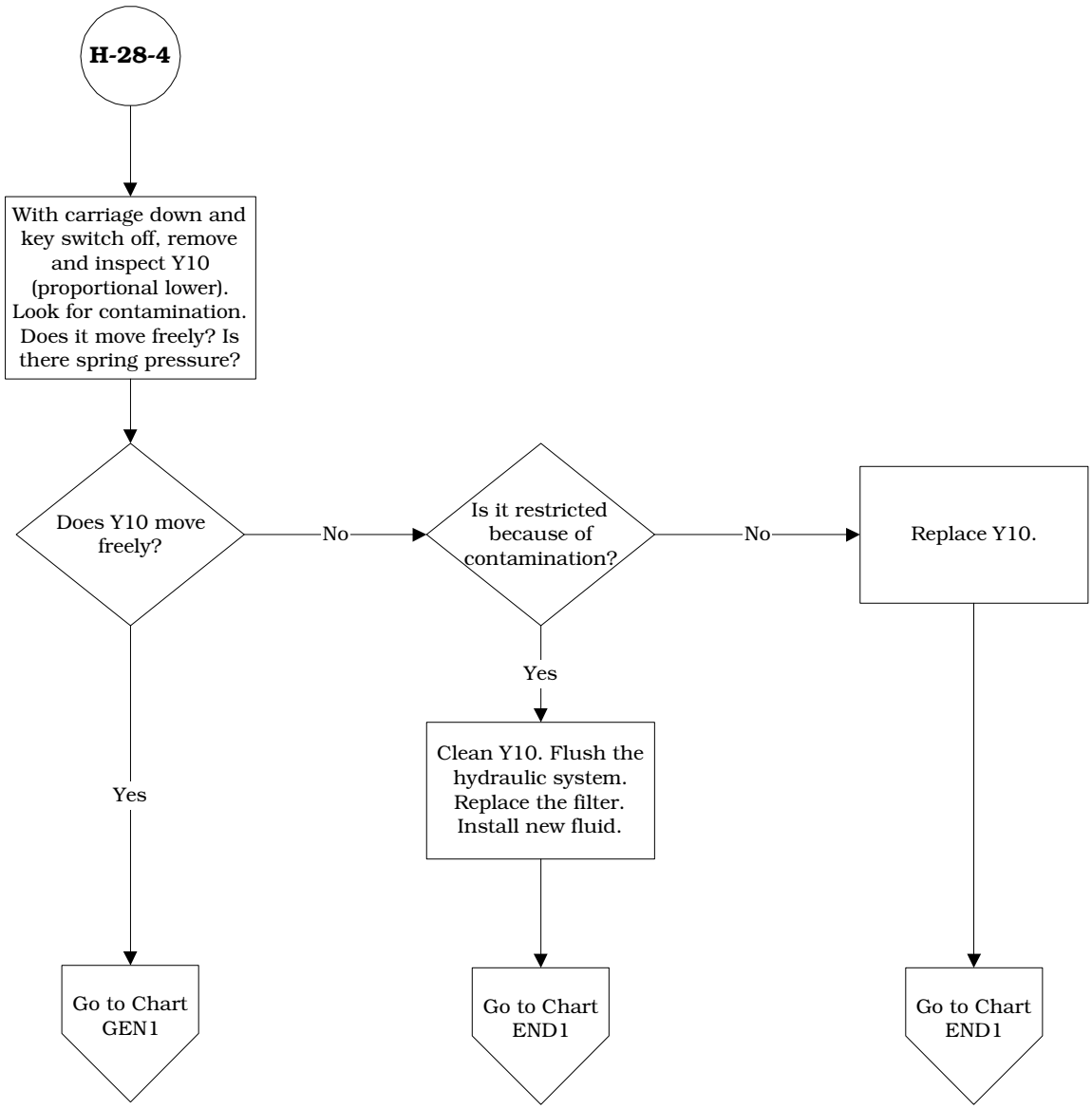


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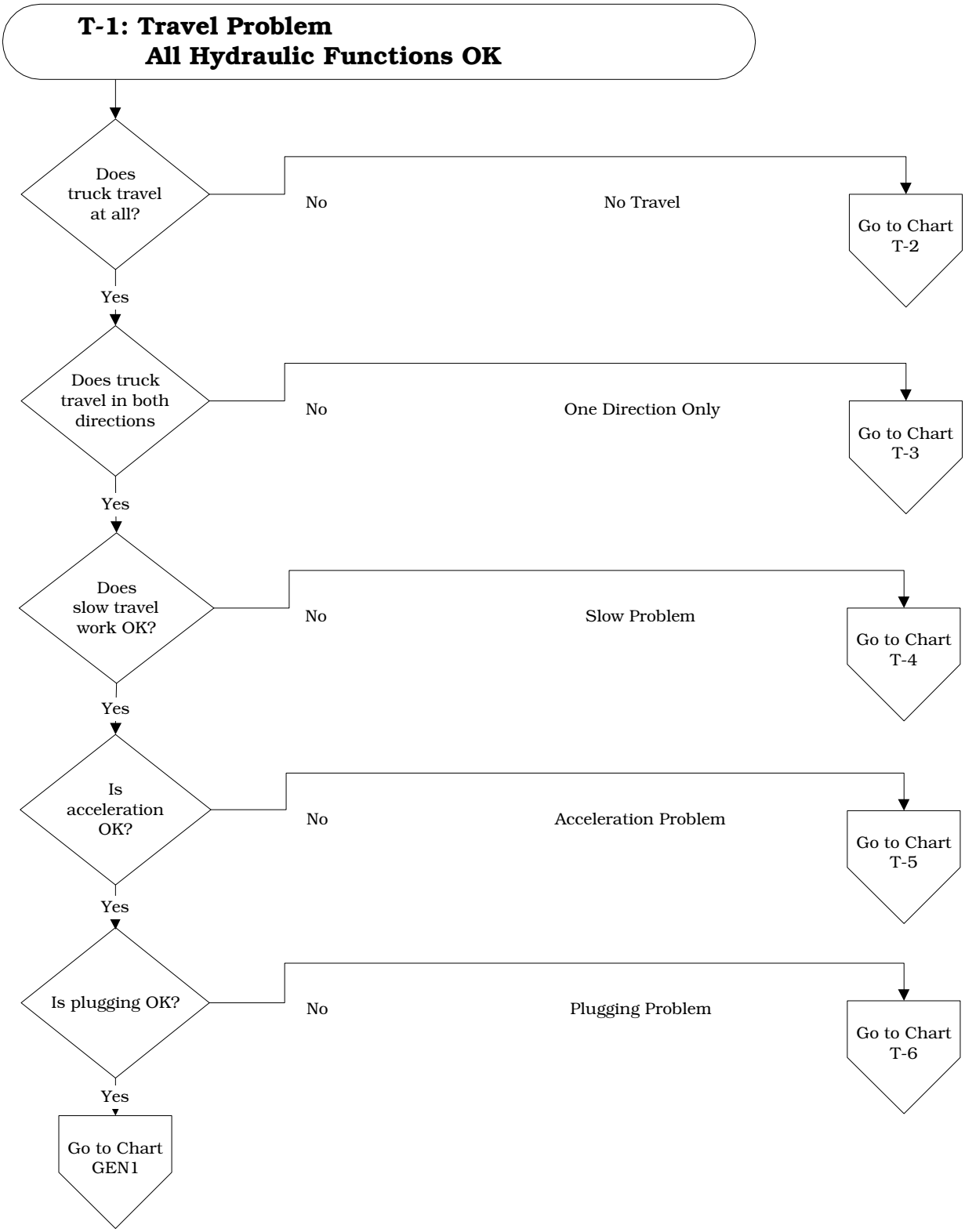
H-28: No Lower



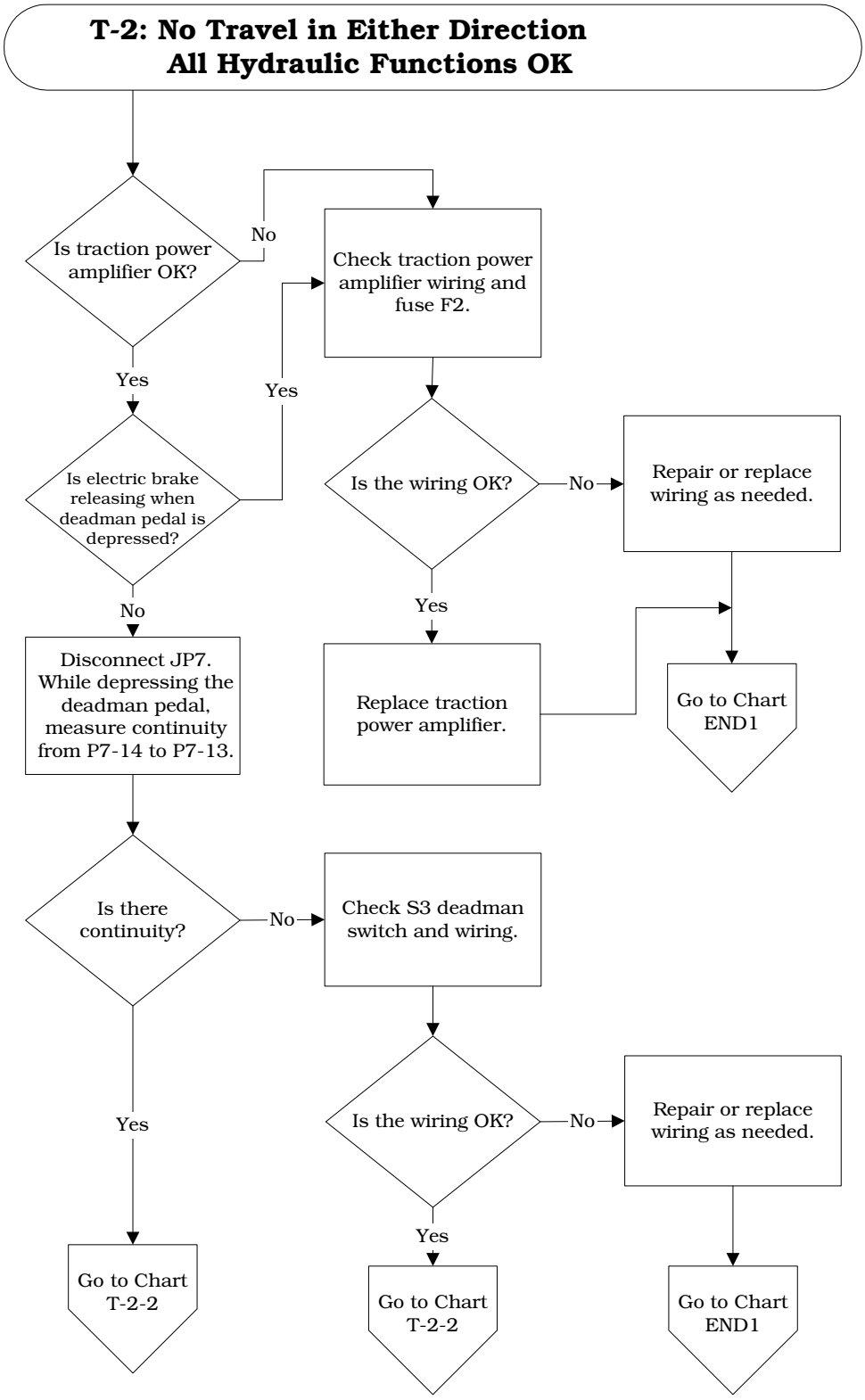
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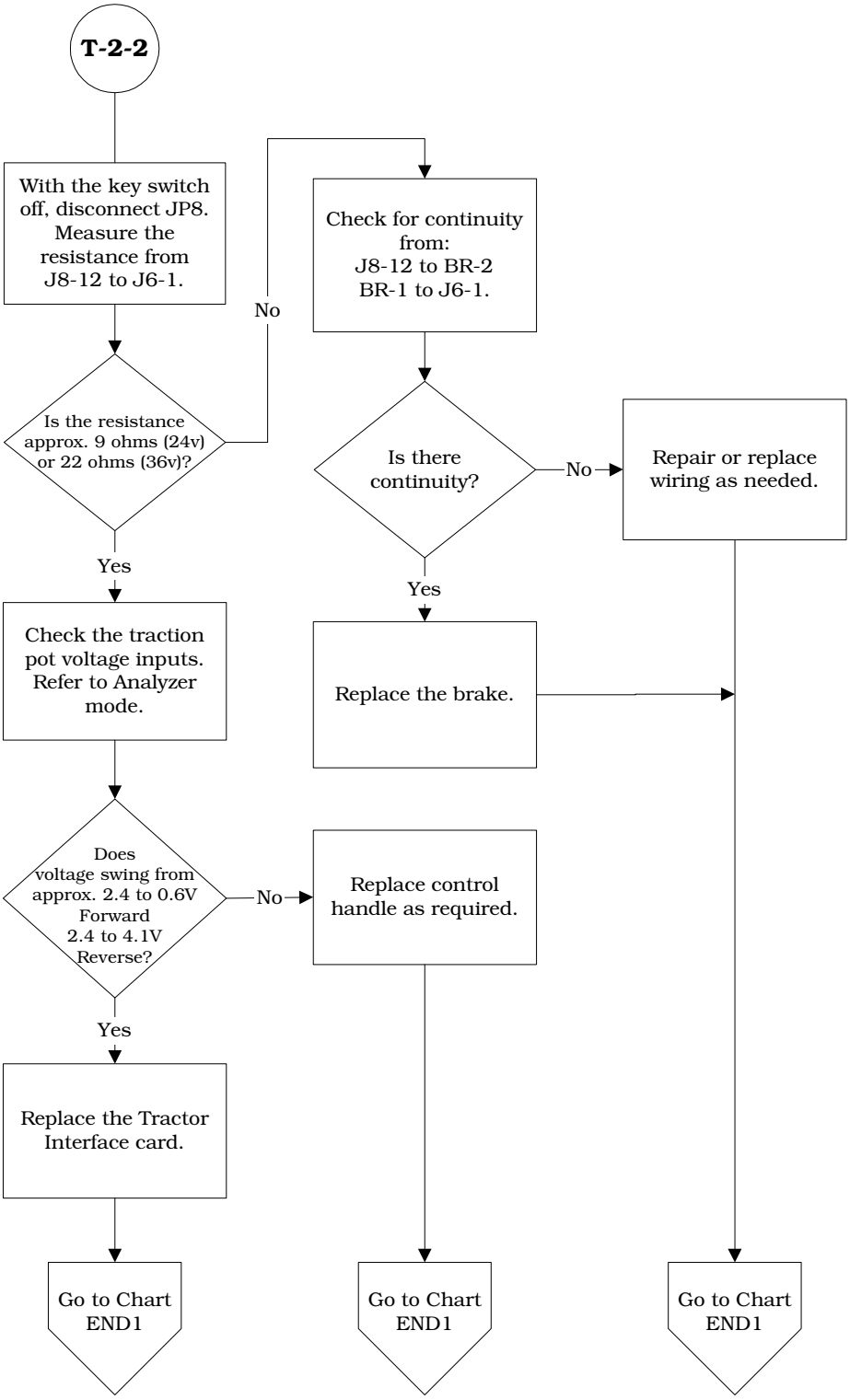


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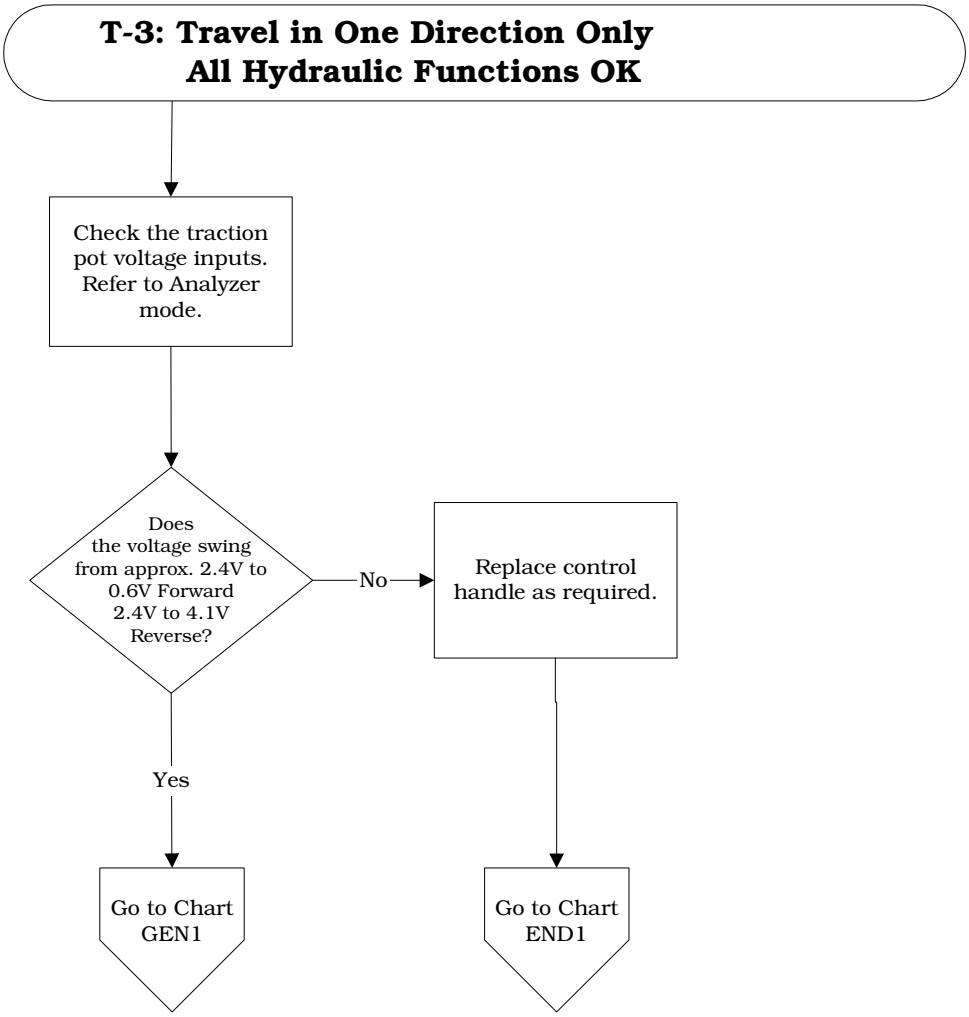


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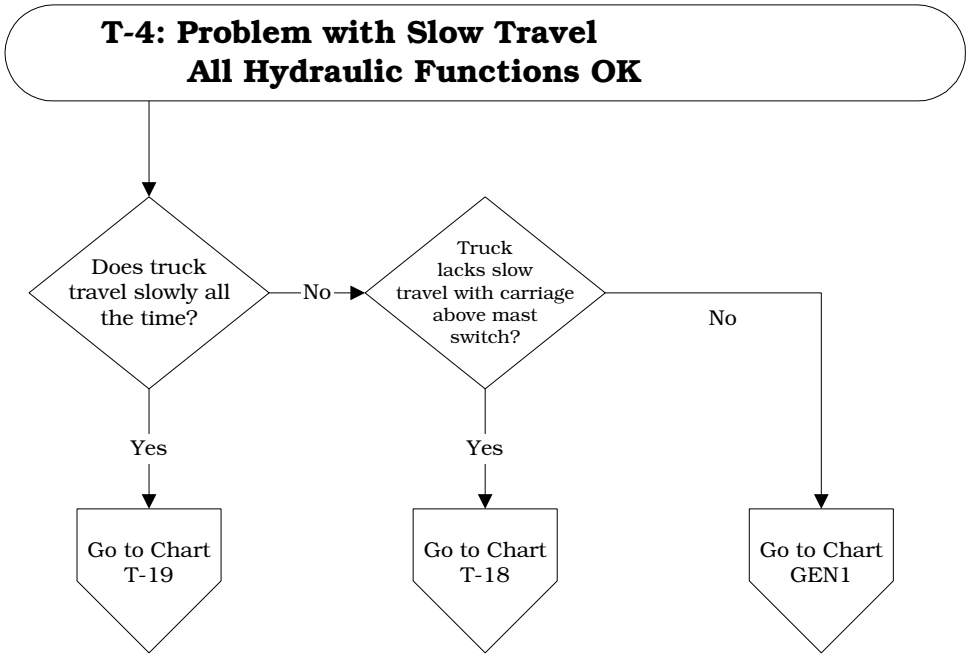
T-2: No Travel In Either Direction



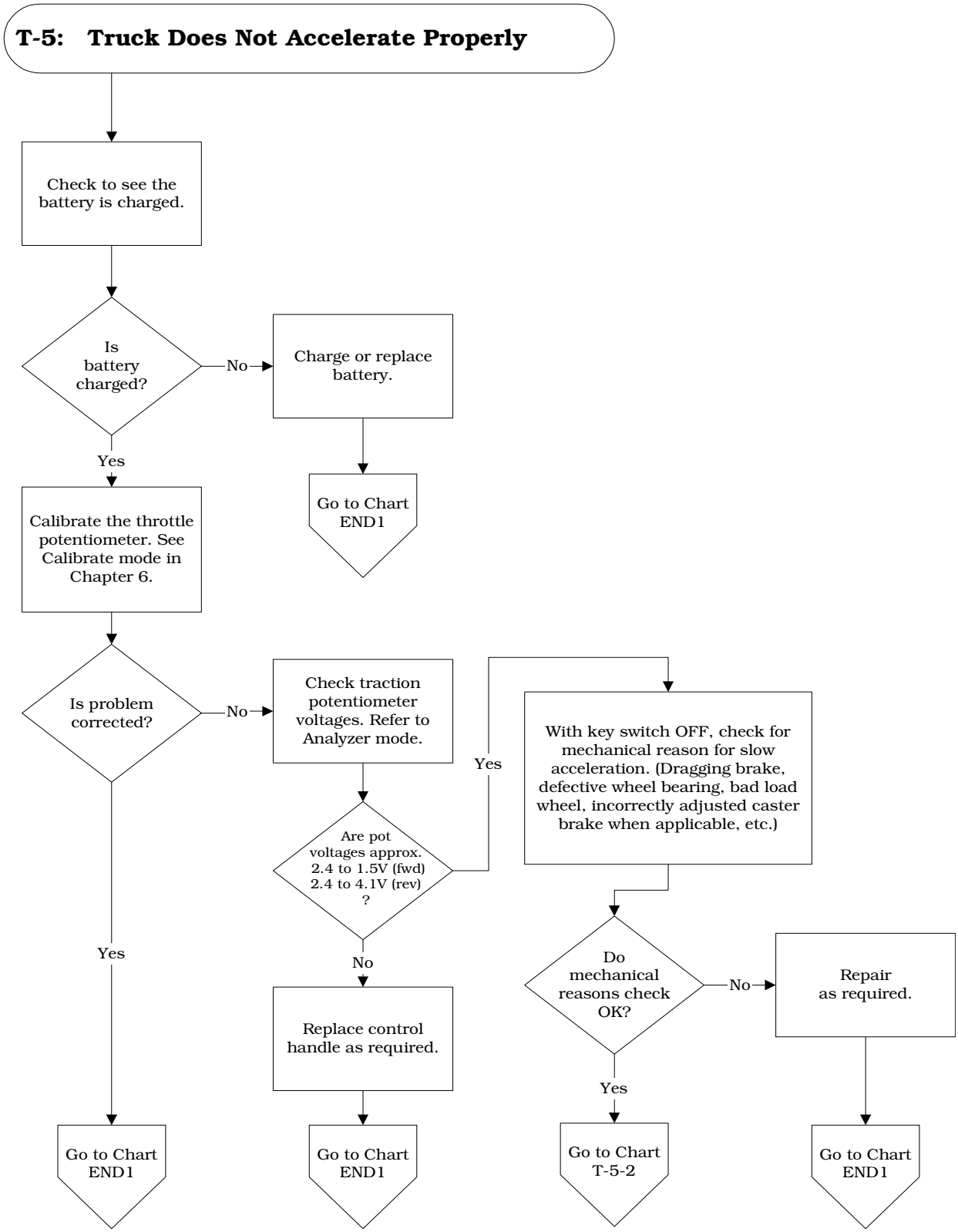
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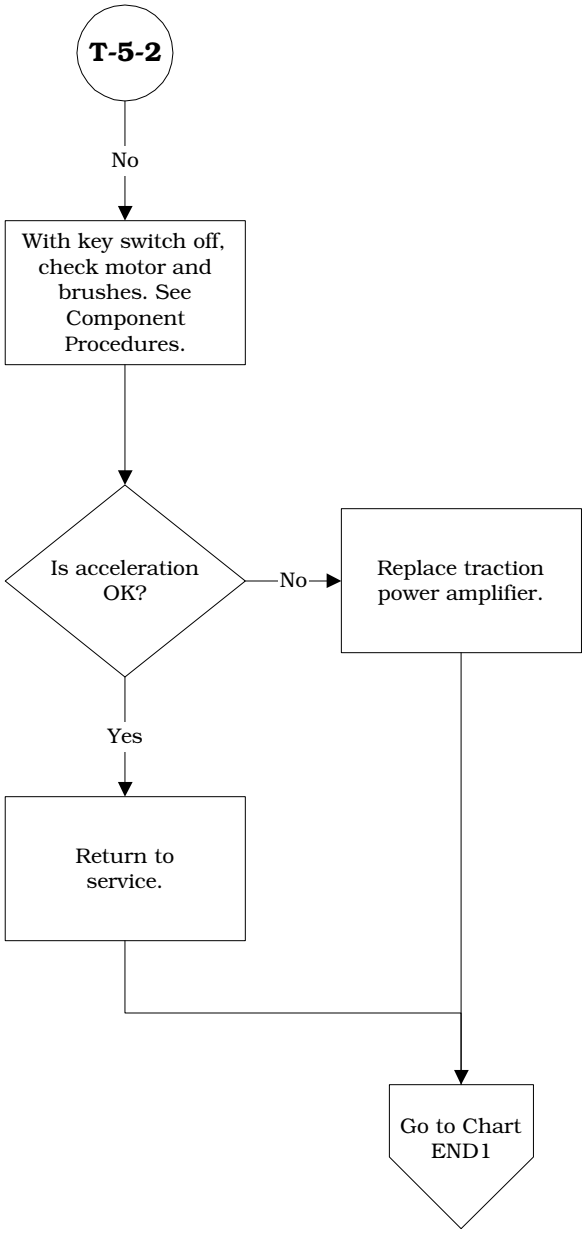


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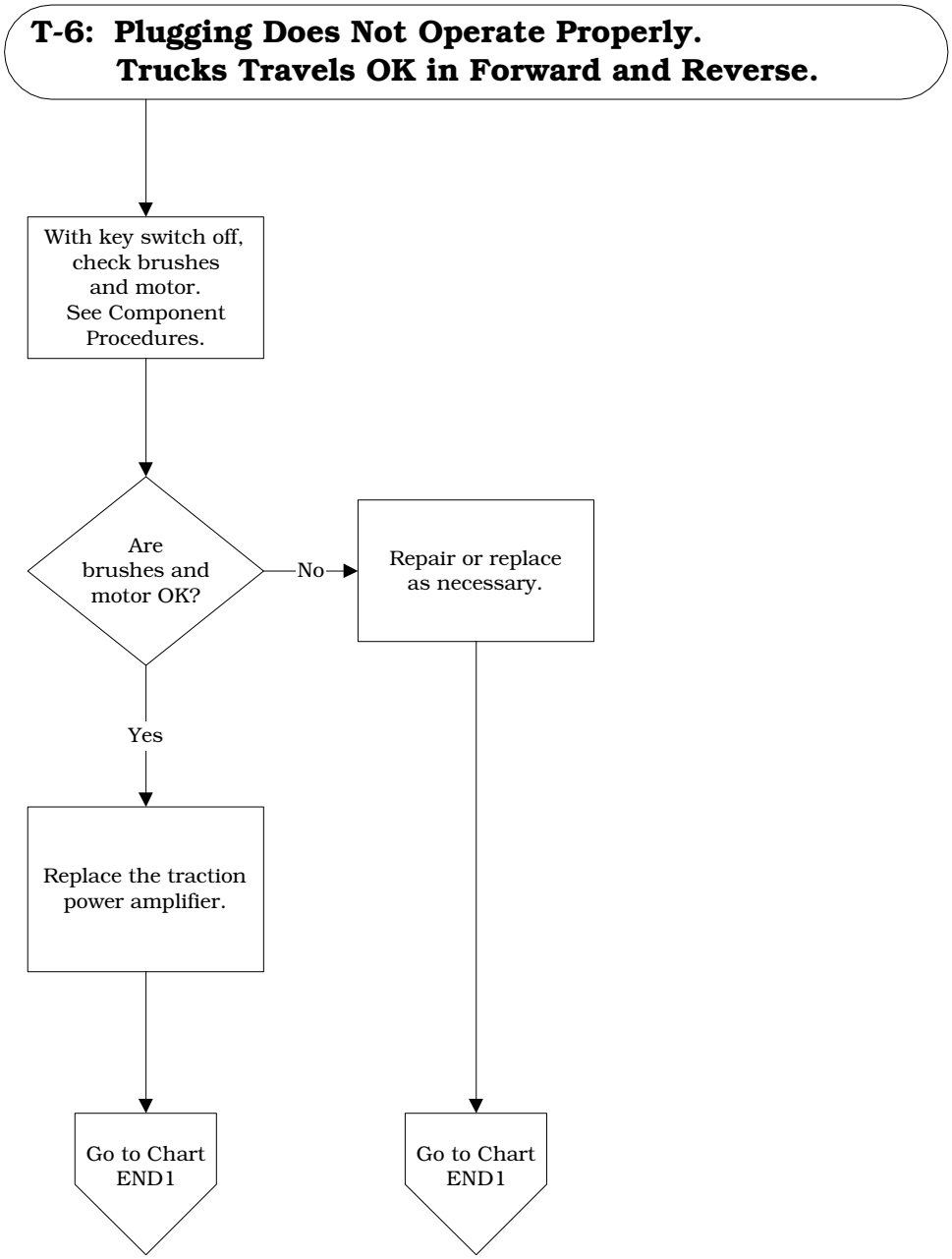


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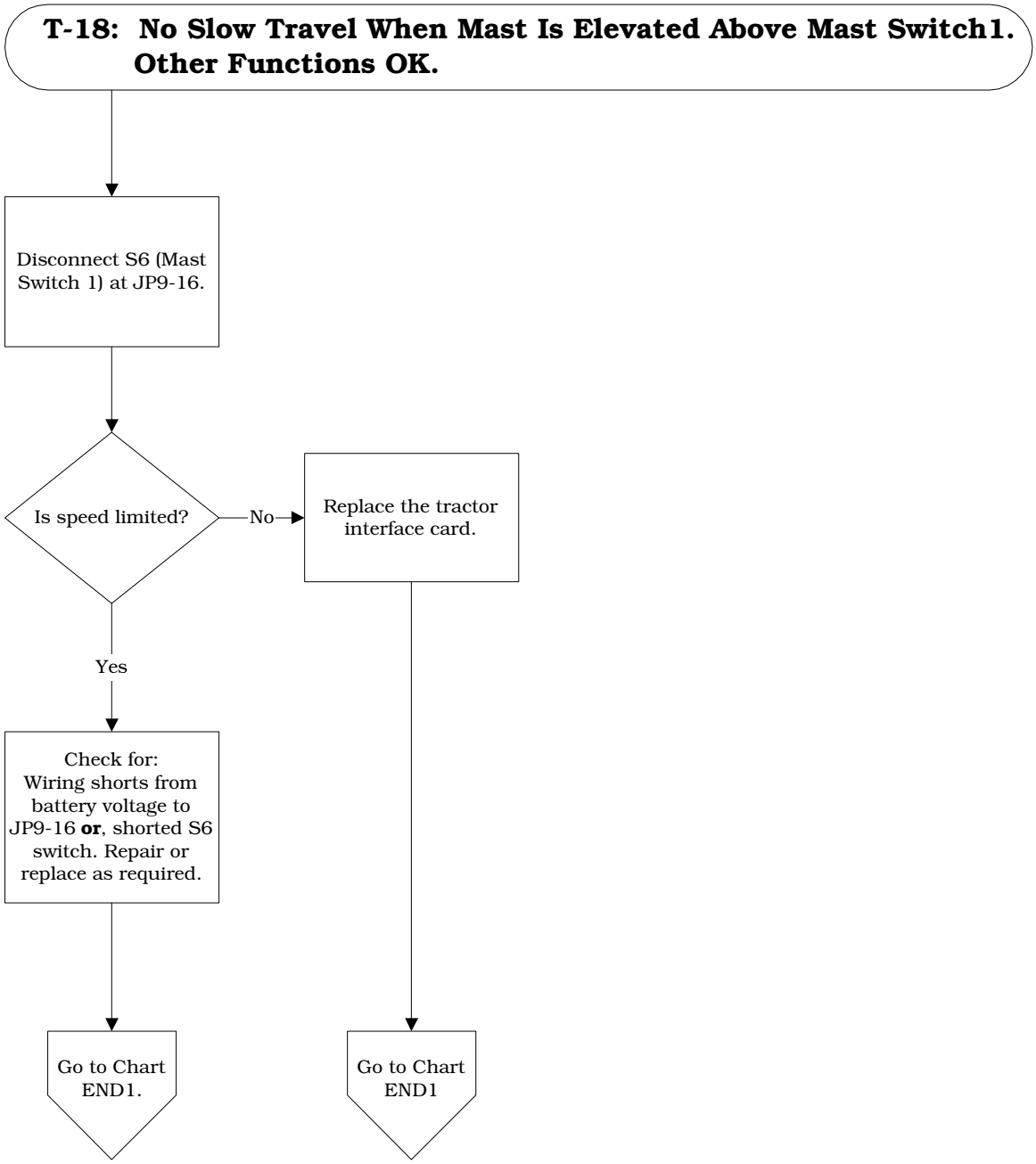
T-5: Truck Does Not Accelerate Properly



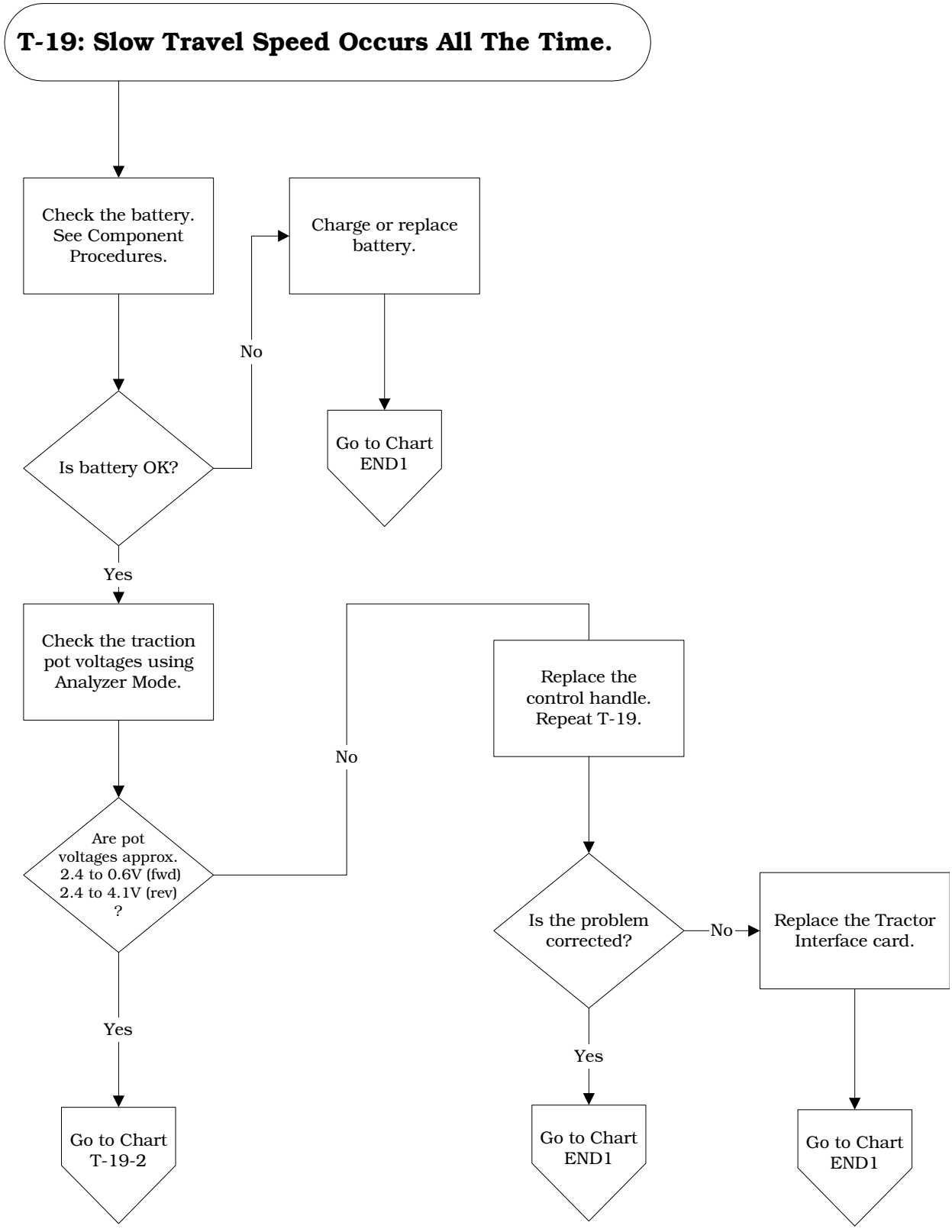
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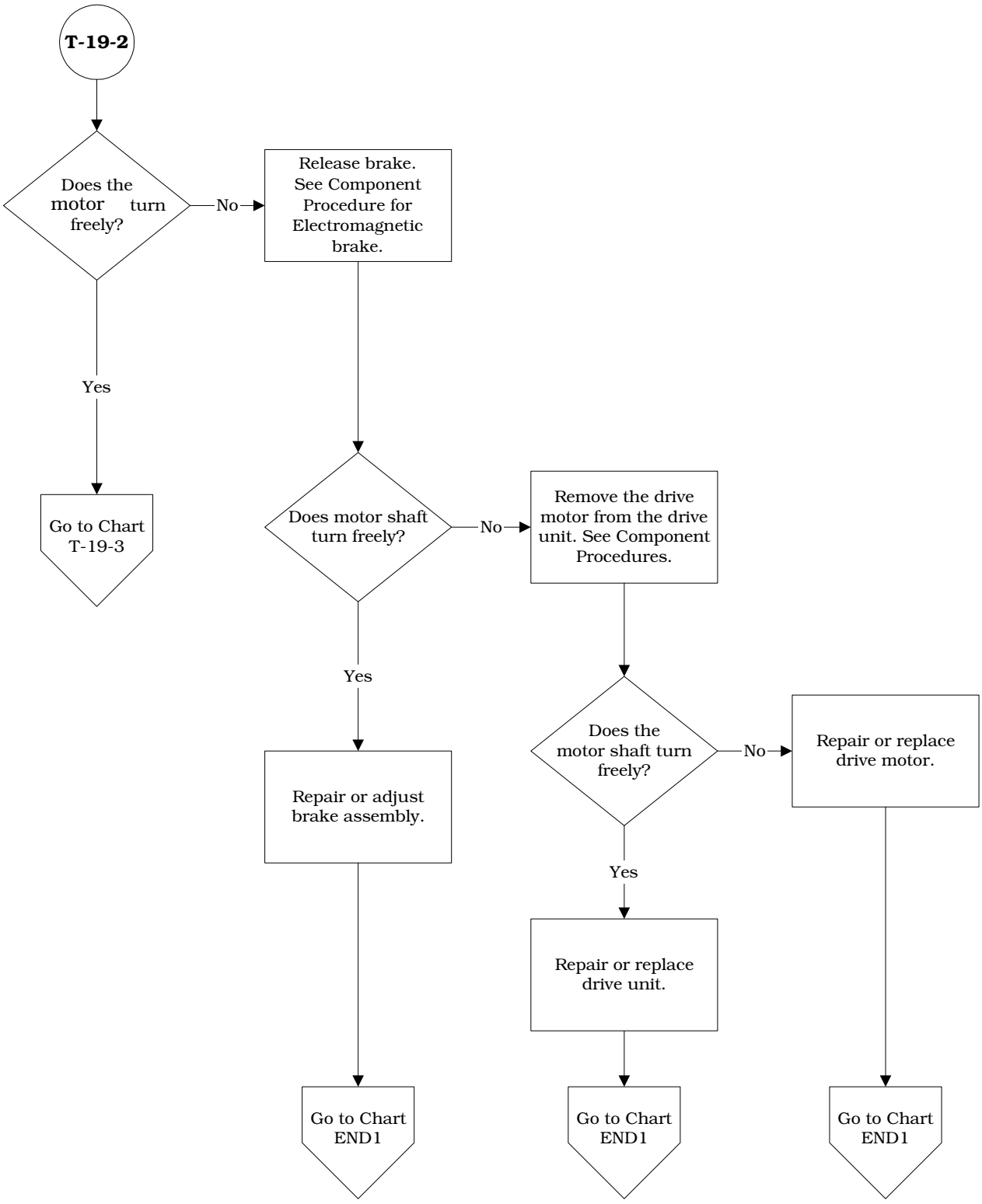


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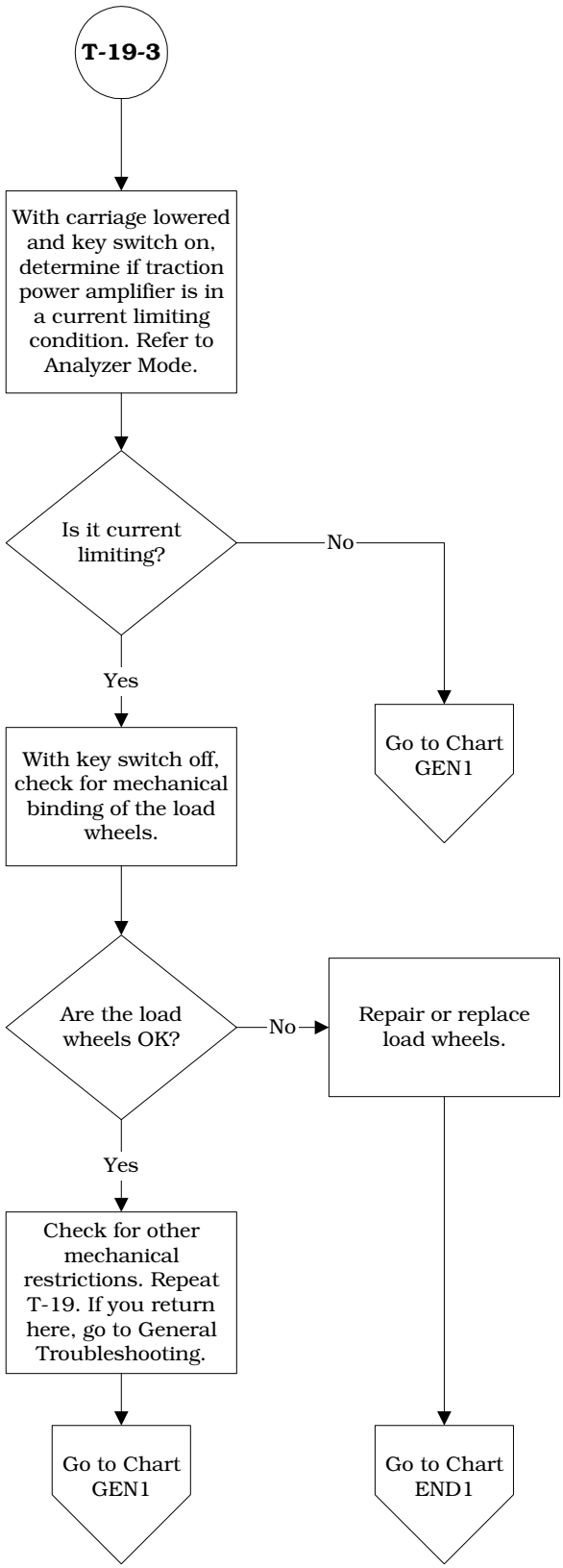


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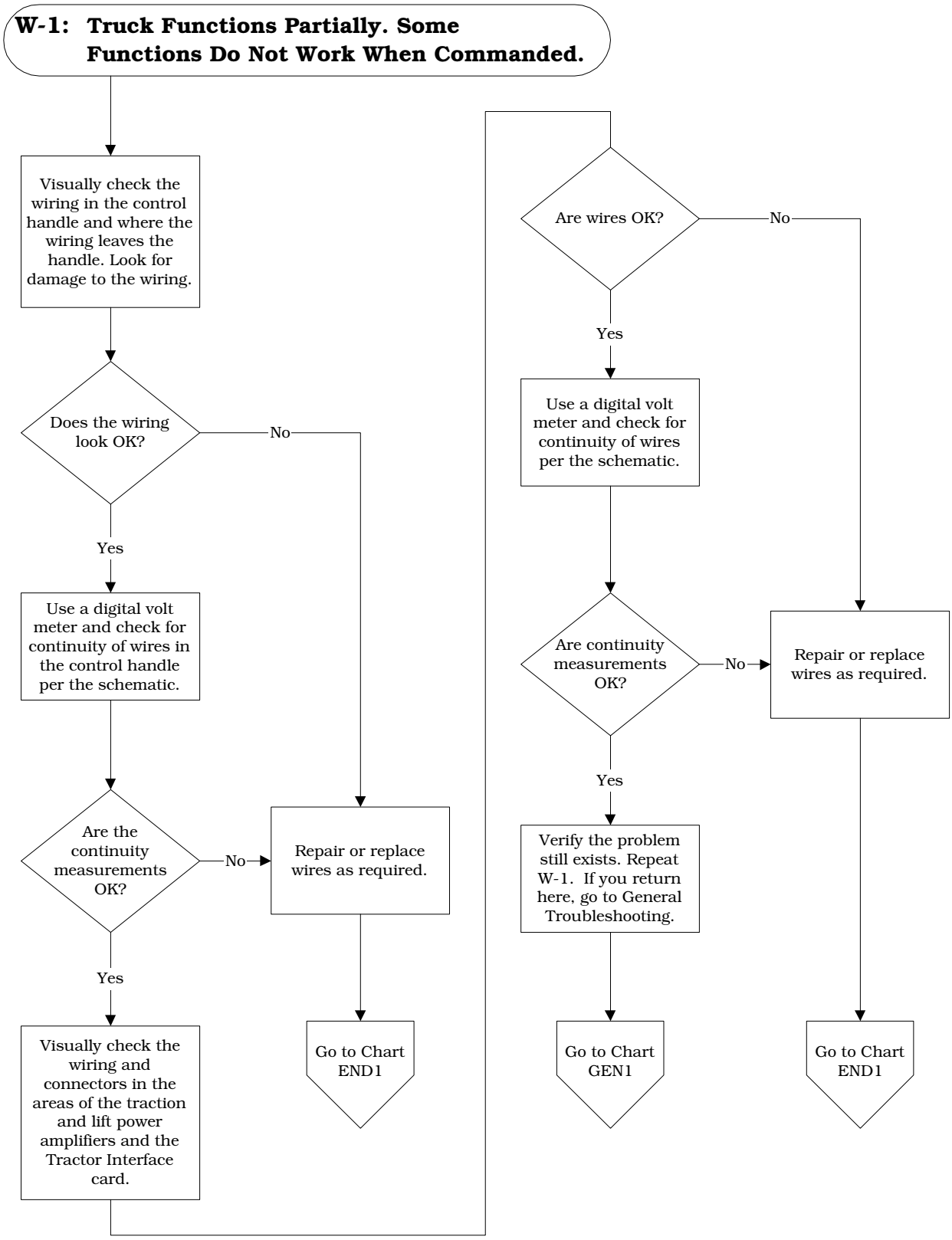
T-19: Slow Travel Speed At All Times



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Electrical Codes and Tests

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Modes of Operation

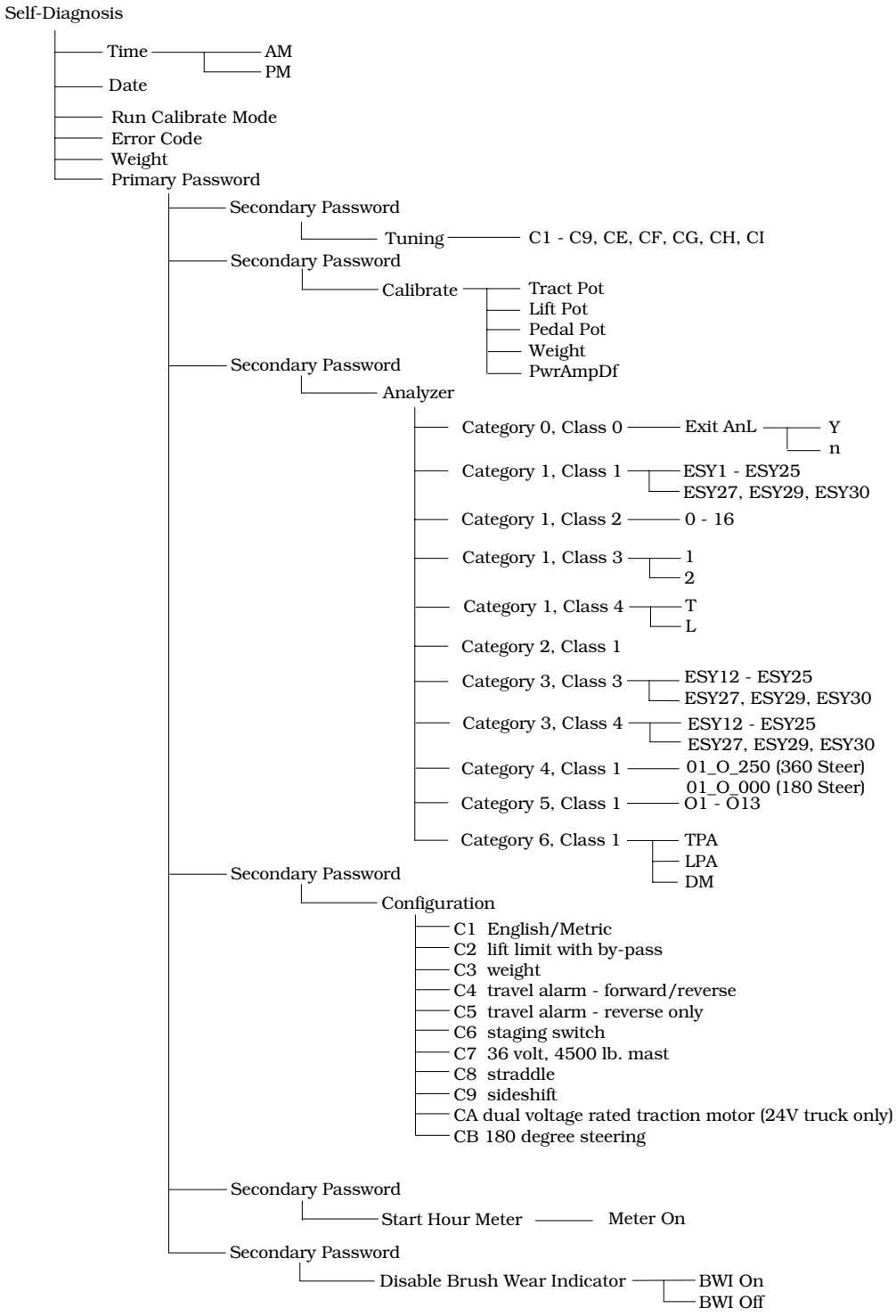


Figure 6-1: Menu Structure for Modes of Operation

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Passwords

The Toyota Reach lift truck uses two levels of passwords: primary and secondary.

The primary password is required for entrance into all modes except self-diagnosis.

A unique secondary password is required for disabling the brush wear warning, starting the hour meters, or activating Analyzer, Calibrate, Configure or Tuning Modes.

Entering the Primary Password

1. Press the power control select switch and hour meter select switch simultaneously (system should respond with a short beep).
2. Within 10 seconds, press the up arrow (system should respond with a short beep).
3. Within 10 seconds, press the down arrow (system should respond with a short beep).
4. Within 10 seconds, press the up and down arrows simultaneously and hold them for 2 seconds (system should respond with a short beep after 2 seconds).

Acceptance of the primary password will be indicated by the word “PRIMARY” appearing on the display. If a switch is not pressed within the 10 second limit, the system will default back to the self-diagnosis mode.

Disable the Brush Wear Warning

Entering the Secondary Password

1. Enter the primary password.
2. Within 10 seconds, press the up arrow switch (system should respond with a short beep).
3. Within 10 seconds, press the down arrow switch (system should respond with a short beep).

Acceptance of the secondary password will be indicated by the word “BWI ON” or “BWI OFF” appearing on the display. To return the system to self-diagnosis mode, press the hour meter select switch. To toggle from “BWI ON” to “BWI OFF” press either the UP or DOWN ARROW switch, then press the hour meter select switch to save and return to self-diagnosis mode. If the BWI icon located on the display is not on, “BWI ON” can not be toggled to “BWI OFF.” The BWI performance limit can be disabled only once between brush replacement. When OFF, it will remain off for 8 traction hours or 8 lift hours. After that time, the system will revert back to ON and limit top traction speed to 2.5 mph, top lift speed to 25%, or both.

Start the Hour Meter

The Toyota Reach lift truck is shipped from the factory in a Demo mode. The operator display will show “TOYOTA . . . TRUCK IN DEMO MODE” and the buzzer will sound once an hour until Demo mode is deactivated. The Demo mode is deactivated when 100 hours of operation is reached *or* when the secondary password is entered to start the hour meters.

Entering the Secondary Password

1. Enter the primary password.
2. Within 10 seconds, press the hour meter select switch and power control select switch simultaneously (system should respond with a short beep).
3. Within 10 seconds, press the up arrow switch (system should respond with a short beep).

Acceptance of the secondary password will be indicated by the word “Meter ON” appearing on the display for 1 second before the system returns to the self-diagnosis mode. Entering the secondary password automatically causes the resetting of the hour meters to 0 and clearing of all stored error codes.

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Self-diagnosis Mode

No passwords are required to enter self-diagnosis mode. Whenever the key switch is turned ON (|), self-diagnosis mode performs a system self-check prior to allowing lift truck operation. Time, date or weight displays are available after the self-check is complete.

Self-diagnosis mode is the normal running mode and will automatically detect errors in the traction and lift/lower systems. When errors are detected, a buzzer will sound and a corresponding error code will be displayed. All other modes are entered through self-diagnosis mode.

Maneuvering within Self-diagnosis Mode

During power-up the display will show "TOYOTA" for a minimum of two seconds then go to one of the following displays:

- Time or Date (whichever was last displayed)
- Run calibrate mode
- Weight (option)

An error code will be displayed if there is an error.

Use the DOWN ARROW switch to scroll through the time, date, and weight (if available). Both the time and date may be adjusted.

Adjusting the Date

Press the power control switch. The months will flash on and off at a 1 second rate. Use the UP or DOWN ARROW switches to change the month. Press the power control switch again. The months will stop flashing and the days will blink on and off. Use the UP or DOWN ARROW switches until the desired day is reached. Press the power control switch a third time to move to the year category. With the years blinking, press the UP or DOWN ARROW switches until the desired year is reached. Press the power control switch one more time to stop the year from blinking. This will end the adjustment of the date setting.

Date format example: 10/01/98.

Adjusting the Time

Press the power control switch. The hours will flash on and off at a 1 second rate. Use the UP or DOWN ARROW switches to change the hours. Press the power control switch again. The hours will stop flashing and the minutes will blink on and off. Use the UP or DOWN ARROW switches until the desired minute is reached. Press the power control switch a third time to stop the minutes from blinking. This will also end the adjustment of the time setting. (The PM will automatically switch to AM [or AM to PM] as the hours change from 11 to 12.) Time format example: 5:10 PM.

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Analyzer (AnL) Mode

Analyzer mode is the error analysis mode. Both primary and secondary passwords are required to enter Analyzer Mode.

Entering the Secondary Password

1. Enter the primary password.
2. Within 10 seconds, press the power control select switch (system should respond with a short beep).
3. Within 10 seconds, press the up and down arrow switches simultaneously (system should respond with a short beep).

"Analyzer" will appear on the display indicating acceptance of the secondary password.

Entering Analyzer Mode

To enter Analyzer Mode, press the power control switch. The 8 character display will display "AnL" in the left most segments and the right most segments will display "00." The left "0" will be flashing. The left number is the category number. The right number is the class number.

Maneuvering within Analyzer Mode

Category or class numbers may be changed using the UP or DOWN ARROW switches. Press the power control select switch to activate the class (right) number. The class number will be flashing on and off. Press the UP or DOWN ARROW switches until the desired class number is displayed. Once the class number is flashing, the "AnL" changes to "rUn." Once the desired number is displayed, press the power control select switch. The class number will stop flashing and the "rUn" will disappear and be replaced by a test result.

To end one test and start another, press the power control select switch to activate the class number. The display will return to "rUn." If the test is from the same category, press the UP or DOWN ARROW switches to change to the desired class number. Press the power control select switch to enable the test.

If the desired test is from a different category, set the class number to "0." Press the power control select switch activating the category (left) number. The category number will start flashing and "rUn" will change to "AnL." Use the UP or DOWN ARROW switches to select the desired category, then press the power control select switch. When the "AnL" changes to "rUn," select the class number as directed above.

To end "Analyzer" mode, set the class number to "0." Press the power control select switch to activate the category number and change "rUn" to "AnL." Set the category number to "0." With "00" displayed, press the power control select switch. The "00" will be replaced by "Yn" with the "n" flashing. The "AnL" will be replaced by "End." Press the UP ARROW switch to cause the "Y" to start flashing, then press the power control select switch to exit Analyzer Mode and return to Self-Diagnosis Mode.

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Calibrate (Calibrte) Mode

Calibrate mode is used to set values on components whose values would vary from one lift truck to the next. Any lift truck whose Display Card does not have stored calibrate values will be disabled until calibrate mode is run upon power-up. The truck's display will scroll "Run Calibrate Mode" until it is performed. Calibrate mode is used to learn (set) the values for the traction pot, the lift/lower pot, the deadman pedal pot, and the pressure transducer (weight option). Calibrate mode is also used to reset the power amplifier values to the default settings.

Entering the Secondary Password

1. Enter the primary password.
2. Within 10 seconds, press the down arrow switch (system should respond with a short beep).
3. Within 10 seconds, press the power control select switch and hour meter select switch simultaneously (system should respond with a short beep).

"Calibrte" will appear on the display indicating acceptance of the secondary password.

Entering Calibrate Mode

Press the power control select switch to get beyond the "Calibrte" display.

Maneuvering within Calibrate Mode

When the power control select switch is pressed to advance beyond the "Calibrte" display, the display changes to "TractPot." To skip from one item to another, press the UP or DOWN ARROW switches. Use the hour meter select switch to end calibrate mode and return to Self-diagnosis mode.

If the "TractPot" input is to be calibrated, press the power control select switch. This centers the scale and sets the end points for maximum forward and reverse at 2 times the deadband value. If a higher value is read as the truck is run in normal mode, the set value will change to the new value unless it is outside the maximum range value. Once the traction pot is learned, the display will flash "Done" for 1 second then display "LiftPot."

If the "LiftPot" is to be calibrated, press the power control select switch. This centers the scale and sets the end points for maximum speed up and down at 2 times the deadband value. If a higher value is read as the truck is run in normal mode, the set value will change to the new value unless it is outside the maximum range value. Once the lift pot is learned, the display will flash "Done" for 1 second then display "PedalPot."

If the "PedalPot" is to be calibrated, press the power control select switch. The following message will scroll across the display: "step on left pedal...Confirm pedal down by pressing DOWN ARROW button." After pressing the DOWN ARROW button the following message appears: "step off left pedal...Confirm pedal up by pressing UP ARROW button." Once the pedal pot is learned, the display will display "Weight" if the lift truck is equipped with that option. Otherwise the display will indicate "PwrAmpDf."

If the "Weight" option is available and needs to be calibrated, press the power control select switch when "Weight" appears on the display. The following message will scroll across the display: "Lower forks to floor, then lift 3 inches." When the lift message stops scrolling across the display, the following message appears: "Press the hour meter select switch when finished." While the Display Card is learning the lift system pressure, "calibrating weight" will scroll across the display. When learning is complete, the display will indicate "Done" for 1 second then display "PwrAmpDf."

Press the power control select switch twice to skip over calibrating weight.

At the "PwrAmpDf" display the power amplifiers may be reset to the original default values. Press the power control select switch. The display will change to "Reset? N." Press the UP or DOWN ARROW button to toggle between "Reset? N" and "Reset? Y." If "Reset? N" is displayed, the power amplifiers will not be reset, the current values will be retained when the power control select switch is pressed. If "Reset? Y" is displayed, the power amplifiers will reset to their default values when the power

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control select switch is pressed. “Setting!” is displayed until the until the resetting of the default values is complete. Then the display will return to “TractPot”.

Press the hour meter select switch to end calibrate mode.

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Configure (Configur) Mode

Configure mode is used to set unique truck features.

Entering the Secondary Password

1. Enter the primary password.
2. Within 10 seconds, press the hour meter select switch and the power control select switch simultaneously (system should respond with a short beep).
3. Within 10 seconds, press the down arrow switch (system should respond with a short beep).

“Configur” will appear on the display indicating acceptance of the secondary password.

Entering Configure Mode

Press the power control select switch to get beyond the “Configur” display.

Maneuvering within Configure Mode

Configure mode is used to enable lift truck features that are not available on all models. Enabling of the options is achieved by pressing the power control select switch to scroll through the list. The UP ARROW switch will activate the option, the DOWN ARROW switch will make the option inactive. Example: C3 YES (active), C8 NO (not active): or C1 Eng (English unit of measure active), C1 Met (metric unit of measure active).

Options that may be included on this lift truck include:

- C1 English?/Metric?
- C2 lift limit with bypass?
- C3 weight (pressure transducer)?
- C4 travel alarm, forward and reverse?
- C5 travel alarm, reverse only?
- C6 staging switch?
- C7 36V, 4500 lb. mast?
- C8 straddle? (no reach/retract or sideshift)
- C9 sideshift? (default is sideshift ON)
- CA dual voltage rated traction motor? (24V truck only)
- CB 180° steering?

Exiting Configure Mode

There are three methods to exit Configure mode, returning to self-diagnosis mode.

- Method 1 - press the hour meter select switch
- Method 2 - cycle the key switch
- Method 3 - no activity within 2 minutes (neither deadman pedal depressed nor operator display buttons pressed).

Only Method 1 allows the changed parameters to be permanently saved.

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Tuning (Tuning) Mode

Tuning mode is used to change settings. Both primary and secondary passwords are required to enter Tuning mode.

Entering the Secondary Password

1. Enter the primary password.
2. Within 10 seconds, press the hour meter select switch (system should respond with a short beep).
3. Within 10 seconds, press the hour meter select switch and the power control select switch simultaneously (system should respond with a short beep).

“Tuning” will appear on the display indicating acceptance of the secondary password.

Maneuvering within Tuning Mode

Use the power control select switch to increment through the tuning mode selections. The display will indicate first the tuning code, then the level setting for that code. The level setting uses all eight characters on the display. Each setting is individually saved. Settings that were changed are only saved when the hour meter select switch is pressed, exiting Tuning mode. The left most character represents weak or low-end setting. The right most character represents strong or high-end setting. Only one character is lit at the lowest setting. As settings increase, additional characters are lit until maximum setting has been reached.

Use care when working in tuning mode. Truck functions are still active to allow changing of parameters and testing of truck functions.

Fourteen tuning adjustments are possible.

Tuning Code	Action	Result	Adjustment
C1	Lift Power Amplifier soft start (acceleration rate)	Lift acceleration	The factory default will show as a strong setting (1-8) segments on. Moving down from the “8” will soften the lift acceleration.
C2	Lift Power Amplifier response time after activation (quick start)	Provides a faster acceleration in response to fast changes in throttle command	The factory default will show as a strong setting (1-8) segments on. Moving down from the “8” will change the initial lift quick start to a slower response.
C3	Battery charge meter correction	Changes the discharge profile	The factory default will show as a mid-setting (1-5) segments on. Moving up or down from the “5” will change the discharge profile by 5% per character. An “8” sets the fastest discharge profile.
C4	Maximum traveling speed limiter	Limiting the maximum travel speed	The factory default will show as the highest setting (1-8) segments on. Moving down from the “8” will change the maximum travel speed by 0.5 mph per character.
C5	Reach/retract	One or two speed	The factory default will be two speed, represented by all characters being lit. One speed reach/retract is represented by the left most character being on. The technician can set one speed reach/retract by setting from 1 to 4 characters on, or for two speed reach by setting from 5 to 8 characters on.

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Tuning Code	Action	Result	Adjustment
C6	Throttle Brake (coast)	Sets the amount of braking torque when the handle is returned to neutral	The factory default will show as a minimum setting of (1) segment on which means there is no neutral braking. Moving up from the “1” will increase the neutral braking.
C7	Maximum lifting speed limiter	Limiting the maximum lift speed	The factory default will show as a maximum setting of (1-8) segments on. Moving down from the “8” will decrease the maximum lifting speed allowed. 8 = maximum speed
C8	Traction acceleration	Adjusts the time it takes to get to full speed	The factory default will show a setting of (1-5) segments on. Moving up or down from the “5” will change the traction acceleration. 8 = most aggressive
C9	Lift interrupt set level	Sets the cutout level for the BDI or it disables the cutout	The factory default will show as a maximum setting of (1-5) segments on. Moving up to “8” disables lift interrupt. Moving down increases which LED lift cutout occurs. 7= 0 LEDs, 6= 1 LED, 5= 2 LEDs, 4= 3 LEDs 3= 4 LEDs, 2= 5 LEDs, 1= 6 LEDs
CE	Lower decel below Mast Switch 1	Adjusts the time it takes to decelerate to a stop	The factory default will show a setting of (1-3) segments on. Moving up from the “3” will cause a quicker stop. Moving down from the “3” will cause a slower stop.
CF	Lower decel above Mast Switch 1	Adjusts the time it takes to decelerate to a stop	The factory default will show a setting of (1-3) segments on. Moving up from the “3” will cause a quicker stop. Moving down from the “3” will cause a slower stop.
CG	Lower feathering	Adjusts the amount of feathering available during lowering	The factory default will show a setting of (1-6) segments on. Moving up from the “6” will decrease the feathering during lower. Moving down from the “6” will increase feathering during lowering.
CH	Staging area lowering speed slowdown	Adjusts the speed of mast lowering travel through the staging area	The factory default will show a setting of four (4) stars. Increasing the number of stars increases the lowering speed through the staging area. Decreasing the number of stars decreases the lowering speed through the staging area. 1 star = slowest; 8 stars = fastest
CI	Staging area lift speed slowdown	Adjusts the speed of mast lift travel through the staging area	The factory default will show a setting of four (4) stars. Increasing the number of stars increases the lifting speed through the staging area. Decreasing the number of stars decreases the lifting speed through the staging area. 1 star = slowest; 8 stars = fastest

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Exiting Tuning Mode

There are 3 methods to exit tuning mode, returning to self-diagnosis mode. Only method 1, however, allows the changed parameters to be permanently saved.

1. Press the hour meter select switch.
2. Cycle the key switch.
3. No activity within 2 minutes (neither deadman pedal depressed nor operator display buttons pressed).

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Code Summary Table

The following table summarizes informational, performance limiting, and fault codes.

"Effect" Designations The following "Effect" designations are used throughout the Code Summary Table:			
0	0 mph speed limit	N	Lift speed derating
1	1 mph speed limit	R	2.5 mph speed limit
D	Traction system derating	T	Traction system shutdown
I	Informational	W	Lowering system shutdown
L	Lift system shutdown	X	Total shutdown

Code	Condition	Effect	Related Tests
02	Limit Switches Do Not Agree	R	11:ESY21, 22
08	Lift Cutout Switch Does Not Agree With Staging Switch	1	11:ESY21, 22, 23
09	Traction Power Amplifier POST Failed or Watchdog Fault	X	none
10	Traction Power Section (M–) Fault	X	none
11	Traction Power Amplifier HPD Failure	X	none
12	Traction Power Amplifier SRO	T	none
13	Traction Power Amplifier Request Out-of-Range	T	none
15	Traction Power Amplifier Contactor Driver Overcurrent	T	none
16	Traction Power Amplifier MM Contactor Welded	T	none
17	Traction Power Amplifier Precharge Fault	X	none
18	Traction Power Amplifier MM Contactor Open	L, T	none
19	Traction Power Amplifier Battery Undervoltage	D	12:12
20	Traction Power Amplifier Battery Overvoltage	D	12:12
21	Traction Power Amplifier Thermal Cutback	D	12:4
23	Lift Power Amplifier POST Failed or Watchdog Fault	L, T	none
24	Lift Power Amplifier (M–) Fault	L, T	none
25	Lift Power Amplifier HPD Failure	X	none
26	Lift Power Amplifier SRO Failure	L	none
27	Lift Power Amplifier Request Out-of-Range	L, W	none
28	Lift Power Amplifier Contactor Driver Overcurrent	L	none
29	Lift Power Amplifier Main Contactor Welded	L	none
30	Lift Power Amplifier Precharge Fault	X	none
31	Lift Power Amplifier Main Contactor Open	L, T	none
32	Lift Power Amplifier Battery Undervoltage	L/N	12:12
33	Lift Power Amplifier Battery Overvoltage	N	12:12
34	Lift Power Amplifier Thermal Cutback	N	12:8
35	Traction Potentiometer Voltage Out-of-Range	T	12:2
36	Lift Potentiometer Voltage Out-of-Range or AUX Button Depressed During POST	L, W	11:ESY15 thru 20, 12:6
37	Lift Potentiometer Voltage Out-of-Neutral During POST	L, W	11:ESY15 thru 20, 12:6
39	Traction Motor Above Upper Limit	1/D	12:3
40	Lift Motor Above Upper Limit	N	12:7
41	No Traction Power Amplifier CAN Communication Received By Display Card	X	61:TPA

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Code	Condition	Effect	Related Tests
42	Parameter Setting Error In Traction Power Amplifier	X	61:TPA, LPA, DM
43	No Lift Power Amplifier CAN Communication Received By Display Card	X	61:LPA
44	Parameter Setting Error In Lift Power Amplifier	X	61:LPA, LPA, DM
45	Traction Motor Temperature Out-of-Range	1	12:3
46	Lift Motor Temperature Out-of-Range	N	12:7
49	Travel Requested With No Movement is Detected	X	13:1, 2
50	Lift Pump Motor Stalled	L	12:5
51	Traction Speed Proximity Sensor Failure	D	13:1, 2
57	Traction Potentiometer Voltage Out-of-Neutral During POST	T	12:2
58	Steer Limit Feedback Signal Error	D	none
59	CAN Transmission Failure Between the Display Card and Traction/Lift Power Amplifiers	X	61:TPA, LPA, DM
60	Battery Overvoltage	X	12:11
61	Steer Error	T	none
62	Brake Sense - Brake Will Not Engage	T	Test 21
63	Brake Sense - Brake Will Not Release	T	none
64	Brake Pedal Potentiometer Voltage Out-of-Range	0	12:16
65	Deadman Pedal Potentiometer and Deadman Switch Do Not Agree	0	11:ESY13
66	Steering Configuration Does Not Match Hardware	X	none
67	180° Steering Sensor Error	R	11:ESY29, 30, Test 41
68	Steer Limit Feedback Signal Error	R	none
69	Steer Limit Feedback Signal Error	R	none
70	Traction Speed Proximity Sensor Disconnected	D	13:1, 2
71	Mast Switch 1 Not Crossed	R	11:ESY22
72	Tractor Interface Clock Chip Inoperative	1	none
73	Traction Motor Field Circuit Open	X	none
74	Traction Power Amplifier Armature Sensor Failure	X	12:0
75	Traction Power Amplifier Field Sensor Failure	X	12:1
76	Traction Power Amplifier MM Contactor Missing	X	none
77	Traction Power Amplifier Armature Sensor Failure	X	none
78	Lift Power Amplifier MM Contactor Missing	X	none
C1	+12V Out-of-Range	X	12:13
EC	Display Card Operating System Error	X	none
E1	Mast Height Encoder Channel A or B Signal Failure	L	none
E2	Mast Height Encoder Failure	L	none
E3	Mast Height Indicator COP Time-Out	L	none
E4	Mast Height Indicator Invalid OP-Code	L	none
E5	Mast Height Indicator COP Not Enabled	L	none
E6	Mast Height Indicator Memory Check	L	none
FD	Communication Error	X	none
F1	Display Card COP Time-out	X	none
F2	Display Card Invalid OP-Code	X	none
F3	Display Card CAN or WSI Reset	X	none
F7	Display Card COP Not Enabled	X	none

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Code 02

Code Title	Code 02 - Limit Switches Do Not Agree
Reason	This code is displayed if Mast Switch 1 and the Staging Switch are activated out of order.
System Response	
Alarm Sounds	Yes
Operator Display	Code 02
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Limited to 2.5 mph
Lift/Lower System	Operational

General Information:

When lifting, the freelift cylinder raises the carriage up to full height. The staging switch will exit out of the top of the inner mast rail with the carriage. At this time the staging switch will remove the battery positive volt signal from the tractor interface at JP15-2, wire #106. As lifting continues, the staging cylinders begin to raise the mast rails, the bottom tie bar of the intermediate rail moves up and away from Mast Switch 1. Mast sw. 1, no longer sensing the metal surface of the tie bar, removes the battery positive volt signal from the tractor interface at JP9-16, wire #79.

The staging switch is located on the RH side of the carriage bar between the upper and middle rollers. This proximity switch, as seen on Analyzer Mode, Category 1, Class 1, ESY 21, should display “YES” until the carriage exits out the top of the inner mast rail, at which time it should change to “NO.”

Mast Switch 1 is located on the bottom tie bar of the outer mast rail. This proximity switch, as seen on Analyzer Mode, Category 1, Class 1, ESY 22, should display “YES” while the intermediate mast rail is fully lowered and the bottom tie bar is covering the switch. The display should change to “NO” when the tie bar is raised above the switch.

Error Code 02 will be displayed if the control detects that;

- While lifting, Mast Switch 1 changed from “YES” to “NO” before the Staging Switch
- While lowering, the Staging Switch changed from “NO” to “YES” before Mast Switch 1

Error Code 02 may not reset until the problem is corrected and the mast is raised and lowered with proper switch operation.

Possible Causes and Checks:

1. Check the operation of Mast Switch 1 and the Staging Switch in Analyzer Mode, Category 1, Class 1, ESY 21 (staging sw.) and ESY22 (mast sw. 1).
   a. If operation of both switches are as described above replace the Tractor Interface Card.
   b. If the one or both switches are not operating properly continue checking at step 2.

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2. Make sure both proximity switches are properly adjusted. The gap between the switch and the metal activating surface should be between 0.187 and 0.250 in. (4.75 and 6.35 mm). Adjust and check operation of switches as described in step 1.
3. Check switch voltages at Tractor Interface Card by carefully back probing the connector while still plugged in.
4. Check for damaged wires or poor connections at harness connectors.

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Code 08

Code Title	Code 08 - Lift Cutout Switch Does Not Agree With Staging Switch
Reason	This code is displayed if the optional Lift Limit switch turns OFF before the Staging switch.
System Response	
Alarm Sounds	Yes
Operator Display	Code 08
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Limited to 1.0 mph.
Lift/Lower System	Operational - no AUX functions

General Information:

The Optional Lift Limit Switch is also referred to as Lift Inhibit or Lift Cutout. All three descriptions are referring to the same switch.

If the truck is equipped with the Lift Cutout option, the Lift Cutout switch will always be higher than the Staging switch. Therefore it is impossible for the Lift Cutout switch to turn “Off” before the Staging switch unless due to a failure.

When lifting, the freelift cylinder raises the carriage up to full height. The staging switch will exit out the top of the inner mast channel with the carriage. At this time the staging switch will remove the battery positive volt signal from tractor interface JP15-2 (wire #106). As lifting continues, the staging cylinders lift the mast until the lift limit switch aligns with the cutout hole in the interrupt bar. The Lift Limit switch, no longer sensing the metal surface of the interrupt bar, removes the battery positive volt signal from JP9-15 (wire #98) of the Tractor Interface Card.

The staging switch is located on the RH side of the carriage bar between the upper and middle rollers. This proximity switch, as seen on Analyzer Mode, Category 1, Class 1, ESY 21, should display “YES” until the carriage exits out the top of the inner mast rail, at which time it should change to “NO”.

This proximity switch, as seen on Analyzer Mode, Category 1, Class 1, ESY 22, should display “YES” while the intermediate mast rail is fully lowered and the bottom tie bar is covering the switch. The display should change to “NO” when the tie bar is raised above the switch.

The Lift Limit Switch is mounted to the upper LH chain anchor mount on the outer mast channel. The interrupt bar is mounted on the intermediate mast channel and is equipped with several knockout plugs. When one of the knockouts is removed the switch will no longer sense the metal surface when the mast is raised and the switch is aligned with the knockout hole. At this time this proximity switch, as seen on Analyzer Mode, Category 1, Class 1, ESY 23, should display “NO” indicating that the switch is no longer sensing the metal interrupt bar.

The Error Code 08 may not reset until the problem is corrected and the mast is raised and lowered with proper switch operation.

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Possible Causes and Checks:

1. If C2 Configure Code is set to “YES” and the truck is not equipped with the Lift Limit Switch Option, this code will appear. Set the C2 Configure to “NO”.
2. Check the operation of the Staging Switch and the Lift Limit Switch in the Analyzer Mode, Category 1, Class 1, ESY 21 (staging sw) and ESY23 (lift limit sw).
   a. If operation of both switches are as described above replace the Tractor Interface Card.
   b. If the one or both switches are not operating properly, continue checking at step 3.
3. Make sure both proximity switches are properly adjusted. The gap between the switch and the metal activating surface should be between 0.187 and 0.250 in. (4.75 and 6.35 mm). Adjust and check operation of switches as described in step 2.
4. Check switch voltages at Tractor Interface Card by carefully back probing the connector while still plugged in.
5. Check for damaged wires or poor connections at harness connectors.

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Code 09

Code Title	Code 09 - Traction Power Amplifier POST Failed or Watchdog Fault
Reason	This code is displayed if the Traction Amp fails its Pre-Operation Start Test (POST) or detects a Watchdog Failure.
System Response	
Alarm Sounds	Yes
Operator Display	Code 09
Traction Power Amplifier	Energized (In) - LED = Code 1, 2
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Inoperative

General Information:

Code Appears During Startup - During the initial startup of the truck (key switch to “ON”) the Traction Power Amplifier reported to the Display Card that it had detected an internal POST failure. The Display Card did not detect this error; it is only reporting that the Traction Amp has shut down with an internal Error Code 1-2. The Display Card converts the Traction Amp Error Code 1-2 to the Error Code 09.

During the run mode the Traction Amp control system detects an internal control system failure. If this occurs, the Traction Amp will shut down and report the failure to the Display Card.

Possible Causes and Checks:

1. Verify the Traction Amp LED indicator agrees with the Code 09 by flashing a 1-2 Code.
2. Check all electrical connections to the Traction Amp for tight and proper connections. If all connections check OK, replace the Traction Amplifier if the error occurs after the key switch is cycled OFF/ON.

NOTE: There are no additional tests that can be performed to detect this error. This error is an internal failure of the Traction Amp. Since the amp is sealed and is not serviceable, replacing the amp is the only solution.

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Code 10

Code Title	Code 10 - Traction Power Amplifier (M–) Fault
Reason	This code is displayed when the Traction Power Amp reports to the Display Card that it has detected a short circuit between the M– and B– Traction Amp terminals.
System Response	
Alarm Sounds	Yes
Operator Display	Code 10
Traction Power Amplifier	Energized (In) - LED = Code 1, 3
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Inoperative

General Information:

During operation the Traction Amp detected a short circuit condition between the M– and B– terminals. This failure could be caused internally or possibly externally. All external reasons for the short should be checked before the amp is replaced. The Display Card did not detect this error; it is only reporting that the Traction Amp has shut down with an internal Error Code 1-3. The Display Card converts the Traction Amp Error Code 1-3 to Error Code 10.

Possible Causes and Checks:

1. Check for shorted A1 to A2 motor cables.
2. Check for A1 & A2 motor cables shorted to frame.
3. Check for signs of a shorted Armature (i.e. blackened or damaged commutator or brushes).

NOTE: Amp may have suffered permanent damage if short is found.

4. If all external checks are OK, failure is internal to amp. Remove and replace Traction Amp.

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Code 11

Code Title	Code 11 - Traction Power Amplifier HPD Failure (HPD= High Pedal Disable)
Reason	This code will be displayed if the Traction Power Amp detects greater than 25% throttle request at Start-Up.
System Response	
Alarm Sounds	Yes
Operator Display	Code 11
Traction Power Amplifier	Energized (In) - LED = Code 2, 3
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Inoperative

General Information:

The HPD feature prevents the traction power amp from driving the traction motor if greater than 25% throttle request is applied to the amp's throttle request input at start-up. Available in the amp for use in a different type of application, the HPD feature is not used on the Toyota reach truck since the throttle control, part of the multi-function control handle, is equipped with a return spring and automatically returns the control handle to neutral. Truck software checks are also provided to assure the control handle is in the correct position at key on. This code will only be displayed if a failure internal to the traction power amp occurs.

Possible Causes and Checks:

If an Error Code 11 is displayed, the only solution is to replace the Traction Amp. The amp is either defective, has been incorrectly programmed during manufacture or is the wrong amp for this truck.

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Code 12

Code Title	Code 12 - Traction Power Amplifier Static Return to Off (SRO)
Reason	This code will be displayed if the Traction Power Amp detects a directional (forward/backward) travel request on the amp's inputs at Start-Up.
System Response	
Alarm Sounds	Yes
Operator Display	Code 12
Traction Power Amplifier	Energized (In) - LED = Code 2, 2
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Operational

General Information:

The SRO feature is designed to detect if the truck is in a forward or reverse travel direction at start-up. Available in the amp for use in a different type of application, the SRO feature is not used on the Toyota reach truck since the directional travel control, part of the multi-function control handle, is equipped with a return spring and automatically returns the control handle to neutral (no direction selected). Truck software checks are also provided to assure the control handle is in the correct position at key on. This code will only be displayed if a failure internal to the traction power amp occurs

Possible Causes and Checks:

If Error Code 12 is displayed, the only solution is to replace the Traction Amp. The amp is either defective, has been incorrectly programmed during manufacture or is the wrong amp for this truck.

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Code 13

Code Title	Code 13 - Traction Power Amplifier Request Out-of-Range
Reason	This code is displayed when the Traction Power Amp receives an out-of-range speed command.
System Response	
Alarm Sounds	Yes
Operator Display	Code 13
Traction Power Amplifier	Energized (In) - LED = Code 2, 1
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Operational

General Information:

This code will be displayed if the Traction Amp does not accept the command for traction speed from the Display Card. This may be the fault of the amp or the other truck components. Error code history should be checked for the presence of additional codes that may be the root cause.

Possible Causes and Checks:

Check and record all 10 stored error codes in history. If code 35 appears at the same hour meter reading as the code 13, Trouble-shoot the code 35 first.

If Error Code 35 is not present along with the Code 13, remove and replace the Traction Amp if the error persists.

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Code 15

Code Title	Code 15 - Traction Power Amplifier Contactor Driver Overcurrent
Reason	This code is displayed when the Traction Power Amp detects a short in its MM contactor driver circuit.
System Response	
Alarm Sounds	Yes
Operator Display	Code 15
Traction Power Amplifier	Energized (In) - LED = Code 3, 1
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Operational

General Information:

On the Toyota reach truck, the Traction Amp contactor driver circuit is used to supply the Tractor Interface Card with a battery negative volt signal at JP8-11 (wire #36). This signal informs the Tractor Interface the Traction Amp is requesting the MM contactor to pull in. If at any time, the Traction Amp detects a fault, it will remove this signal voltage and the truck will shut down. The appropriate code will be displayed.

Possible Causes and Checks:

If Error Code 15 occurs, check wire #36 from Traction Amp connector JT1-17 to the Tractor Interface Card connector JP8-11 for shorts and/or grounds.

Remove wire #36 from Traction Amp connector JT1-17. Turn key switch ON. If code 15 re-appears, replace the Traction Amp. If another code appears such as code 41, recheck wire #36. If OK, possibly the Tractor Interface Card is bad.

NOTE: Normally, the Traction Amp contactor driver circuit directly operates a contactor that will draw between 2A to 4A. On the Toyota reach truck, this circuit is used as a signal voltage with only approx. 0.15A being drawn. This code should not appear unless the amp is bad or wire #36 is shorted to the frame or another wire.

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Code 16

Code Title	Code 16 - Traction Power Amplifier MM Contactor Welded
Reason	This code is displayed when the Traction Power Amp detects the MM contactor is closed when it should be open.
System Response	
Alarm Sounds	Yes
Operator Display	Code 16
Traction Power Amplifier	Energized (In) - LED = Code 3, 2
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Operational

General Information:

When the MM contactor opens due to the brake pedal being lifted, the Traction Amp performs a test to assure the contactor tips are open. The Traction Amp pulses the drive motor armature circuit and measures the amount of available voltage. If the MM contactor is open, the only available voltage is in the capacitor bank within the Traction Amp. When the drive motor armature circuit is pulsed, the capacitor bank is quickly discharged. The Traction Amp detects a loss of voltage and is satisfied the MM contactor has opened.

If the MM contactor is stuck (welded) closed, there will be an unlimited supply of voltage being supplied to the amp from the battery via the stuck closed MM contactor tips. The Traction Amp will detect that there is no voltage drop when it pulses the drive motor armature and will instruct the Display Card to display Code 16. In most cases, Code 29 will be logged into memory at the same time as the Code 16.

Possible Causes and Checks:

1. Check the contactor for welded or stuck closed tips.
   a. Remove and replace tips if welded. Contactor tips should not be sanded or filed, failure will occur shortly after.
   b. If stuck, disassemble and clean contactor for free movement. Replace contactor if free movement is not possible.
2. Check if contactor is remaining energized by measuring voltage across the contactor coil. If voltage is present, check for shorted wire #85 to frame, another wire or battery negative and repair as necessary.
3. Bad Tractor Interface Card

NOTE: Battery positive voltage is supplied to the contactor coil via wire #24 any time the key switch is ON and the ESTOP switch is closed. The Tractor Interface will supply a negative voltage to the coil via wire #85 to energize the coil at JP8-6. The Tractor Interface will energize the contactor coil only when both the Traction and Lift Amps request

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it. May also see Code 29 in memory, if so there is a high probability that the contactor is or was welded.

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Code 17

Code Title	Code 17 - Traction Power Amplifier Precharge Fault
Reason	This code is displayed if the Traction Power Amp capacitors do not properly charge during the start up procedure.
System Response	
Alarm Sounds	Yes
Operator Display	Code 17
Traction Power Amplifier	Energized (In) - LED = Code 3, 3
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Inoperative

General Information:

When the key switch is turned ON, battery positive voltage is applied to the Traction Amp connector JT1-1 via wire #37. This battery positive voltage charges the Traction Amp's internal capacitor bank via an internal 10kohm resistor. This charge circuit charges the capacitors in approx. 2 seconds. The 10kohm resistor allows the capacitors to charge but, if any other device tries to run off the pre-charge voltage, the resistor causes the voltage to drop to near zero. In that situation, the capacitors will not charge due to the very low voltage. The Traction Amp observes the capacitors have not charged and commands the Display Card to show Code 17.

Possible Causes and Checks:

1. If Code 30 is also present in the Error Code Memory, remove the F3 Lift Power Amp fuse and restart the truck.
   a. If only Error Code 17 is displayed, troubleshoot as described below.
   b. If only Error Code 30 is displayed, refer to Error Code 30 (Page 6-42).
2. With key switch ON and MM contactor open, check for battery voltage across Traction Amp power terminals B+ & B–.
   a. If near zero volts, check for battery voltage at Traction Amp connector JT1-1 wire #37.
   b. If wire #37 is battery voltage, check for any device that may have been connected to the traction B+ cable terminal (other than wire #12 to the Tractor Interface). Devices such as strobes, alarms or customer computer equipment will pull the charge voltage down if connected to this circuit.
3. Check for short circuit between the B+ & B– Traction Amp terminals.
4. If all above checks are OK, replace the Traction Amp.

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Code 18

Code Title	Code 18 - Traction Power Amplifier MM Contactor Open
Reason	This code is displayed if the Traction Power Amp detects the MM contactor is open when it should be closed.
System Response	
Alarm Sounds	Yes
Operator Display	Code 18
Traction Power Amplifier	Energized (In) - LED = Code 3, 4
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Lower Operational, Lift Inoperative

General Information:

When the MM contactor closes due to the brake pedal being depressed, the Traction Amp performs a test to ensure the contactor tips are closed. The Traction Amp pulses the drive motor armature circuit and measures the amount of available voltage. If the MM contactor is closed, there is an unlimited supply of voltage available to the Traction Amp from the battery via the closed MM contactor tips. The Traction Amp detects there is no voltage drop when it pulses the drive motor armature. At that time, the Traction Amp is satisfied the MM contactor tips are properly closed.

If the contactor tips are stuck open, the only available voltage is in the capacitor bank within the Traction Amp. When the drive motor armature circuit is pulsed, the capacitor bank is quickly discharged. The Traction Amp detects the loss of voltage and instructs the Display Card to show Code 18.

Possible Causes and Checks:

1. Check the contactor for burned tips or presence of foreign matter that may prevent the tips from making contact. Replace tips if damaged. Do not sand or file contactor tips or failure will soon occur.
2. Check for a physically stuck open contactor. Disassemble and clean the contactor for free movement. Replace contactor if free movement is not possible.
3. Check contactor coil circuit. With the key switch ON and ESTOP closed, check for battery positive voltage on wire #24 at the Tractor Interface plug JP8-6.
   a. If battery voltage is not present, check for battery voltage on Tractor Interface plug JP8-1.
   b. If battery voltage is present, check for open at wire #24 or #85 from Tractor Interface to the MM contactor coil.
4. Check for proper PC Control voltage from Traction and Lift Amps to the Tractor Interface Card when brake pedal is depressed. Should be less than 0.1V.

NOTE: Proper voltage may only be present for a few seconds. When code is displayed, the voltage will jump up due to traction control shutdown.

   a. Check Traction Amp PC Control voltage at Tractor Interface plug JP8-11 wire

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#36 when brake pedal is depressed. Should be <0.1V with contactor energized. If always >10.0V, check wire #36 for open circuit or poor connection at Traction Amp connector JT1-17.

b. Check Lift Amp PC Control voltage at Tractor Interface plug JP8-10 wire #75 when brake pedal is depressed. Should be <0.1 volt with contactor energized. If always >10.0V, refer to Error Code 31 (Page 6-43).

5. If error code is still being displayed and all previous checks do not correct the problem, replace the Traction Amp.

NOTE: This error code is similar and may be related to Error Code 31.

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Code 19

Code Title	Code 19 - Traction Power Amplifier Battery Undervoltage
Reason	This code is displayed if the Traction Power Amp detects the available battery voltage is too low.
System Response	
Alarm Sounds	Yes
Operator Display	Code 19
Traction Power Amplifier	Energized (In) - LED = Code 4, 1
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Traction System in current cutback if voltage drops below 70% of nominal battery voltage; 24V truck = 16.8V, 36V truck = 25.2V Traction System is inoperative if voltage drops below 70% - 4V of nominal voltage; 24V truck = 12.8V, 36V truck = 21.2V
Lift/Lower System	Operational

General Information:

The Traction Amp monitors battery voltage at the B+ & B– cable terminals. If, at any time after the MM contactor is closed, the battery voltage at those terminals drops below the specified level, Error Code 19 is displayed. Depending on how low the voltage drops, the control will either reduce the maximum current limit to the traction motor or shut down the traction system. The error code is displayed even if the low voltage briefly dropped below the specified level.

Possible Causes and Checks:

1. Check the battery voltage by accessing Analyzer Mode, Category 1, Class 2, Test 12.
2. Check the battery charge level.
   a. Check specific gravity on all cells. All specific gravity readings should be within 0.010 of each other. If below 1.175 charge battery and monitor for return of code.
   b. Check cell voltage on each cell. If below 1.9 volts per cell, charge battery and monitor for return of code.
   c. Check Lift Interrupt Set Level in the Tuning Mode, Code C9.
3. Check for voltage drop in the cables with the battery under load. Pick up a near capacity load, measure volts while accelerating to full speed or while driving up a ramp or grade.
   a. Connect positive meter lead to the battery's positive cable. Connect the negative meter lead to the B+ cable terminal of the Traction Amp. If voltage drop is greater than 0.250V, check for bad connection of the battery connector, power cables to the MM contactor, MM

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contactor tips or high resistance in the F2 (250A) fuse.

b. Connect negative meter lead to the battery's negative cable. Connect the positive meter lead to the B– cable terminal of the Traction Amp. If voltage drop is greater than 0.250V, check for bad connection of the battery connector or battery negative from the battery to the Lift Power Amp B– cable terminal and negative cable from the Lift Power Amp B– cable terminal to the Traction Power Amp B– cable terminal.

4. Inspect the battery cables for signs of heat or damage.
5. Check the battery connector for properly crimped contacts. If cable is frayed or the crimp has failed, replace the cable or properly crimp on a new connector.
6. If error code is still being displayed and all previous checks do not correct the problem, the Traction Amp may be incorrectly reading the battery voltage. Replace the Traction Amp.

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Code 20

Code Title	Code 20 - Traction Power Amplifier Battery Overvoltage
Reason	This code is displayed when the Traction Power Amp detects the available battery voltage is too high.
System Response	
Alarm Sounds	Yes
Operator Display	Code 20
Traction Power Amplifier	Energized (In) - LED = Code 4, 2
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Traction System in current cutback if voltage rises above 17% of nominal battery voltage; 24V truck = 28.08V, 36V truck = 42.12V Traction System is inoperative if voltage rises above 33% of nominal voltage; 24V truck = 31.92V, 36V truck = 47.88V)
Lift/Lower System	Operational

General Information:

The Traction Amp monitors the battery voltage at the B+ & B– cable terminals. If, at any time after the MM contactor is closed, the battery voltage at those terminals rises above the specified level, the Error Code 20 is displayed. Depending on how high the voltage raises, the control will either reduce the maximum current limit to the traction motor or shut down the traction system. The error code is displayed even if the voltage briefly rose above the specified level.

Possible Causes and Checks:

1. Check the battery voltage by accessing Analyzer Mode, Category 1, Class 2, Test 12.
2. Measure voltage on Traction Power Amp B+ to B– cable terminals.
   a. If voltage is above the specified level, check the battery charger for proper operation.
   b. If voltage is below the specified level, operate truck and check for re-occurrence of the error code.
      - If error code repeats with no other codes in memory, replace the Traction Power Amp.
      - If error code repeats with additional codes also being logged into memory, troubleshoot the other codes before replacing the Traction Amp.

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3. Check the battery charge level.
   a. Check specific gravity on all cells. All specific gravity readings should be within 0.010 of each other. If above 1.300, the battery may be over-charged. Check the battery charger for proper operation.
   b. Check cell voltage on each cell. If above 2.5V per cell, the battery may be over-charged. Check the battery charger for proper operation.
4. If error code is still being displayed and all previous checks do not correct the problem, the Traction Amp may be incorrectly reading the battery voltage. Replace the Traction Amp.

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Code 21

Code Title	Code 21 - Traction Power Amplifier Thermal Cutback
Reason	This code is displayed if the Traction Power Amp detects the temperature of the heat sink is higher than 185° F (85° C) or below 10.4° F (-12° C).
System Response	
Alarm Sounds	Yes
Operator Display	Code 21. Thermometer Icon illuminated.
Traction Power Amplifier	Energized (In) - LED = Code 4, 3
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Traction System in current cutback if temperature is between 185° and 203° F (85° and 95° C) or is below 10.4° F (-12° C)
Lift/Lower System	Operational

General Information:

The Traction Power Amp monitors the temperature of the heat sink next to the output transistors. The amp uses a thermal sensor mounted to the heat sink within the housing. The reported temperature of the Traction Amp can be viewed in the Analyzer Mode, Category 1, Class 2, Test 4. In order to check the true temperature of the amp, a thermal measuring device must be used. Many types of thermal measuring devices are available; some digital meters are equipped with a K type probe. Infrared thermal measuring devices are also available.

Possible Causes and Checks:

If in a Hot Environment;

1. Check the temperature by accessing Analyzer Mode, Category 1, Class 2, Test 4.

   If the error code is still present and the temperature of the Traction Amp heat sink is below the limits described above, replace the Traction Amp.

2. Excessive load on truck or extreme environment. If application is excessive, the truck must be parked until it cools before returning to service. The application should be evaluated and recommendations should be made that will resolve the issue.

   a. Is truck being used to push loads or travel up ramps?

   b. Is truck operated in an extremely hot environment?

3. While code is present, measure temperature of heat sink on the Traction Power Amp and compare to the displayed temperature by accessing Analyzer Mode, Category 1, Class 2, Test 4.

   a. If the temperature of the heat sink is below the limits described above and the display is above the limits the temperature sensor is defective, replace the Traction Amp.

   b. If both temperature readings are at or above the limits described above, measure temperature of the truck frame plate adjacent to the location where the heat sink temperature was measured. If

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frame plate temperature is greater than 10° cooler than the Traction Amp heat sink, the mounting of the amp is improper and is not allowing adequate heat transfer. Remove the amp, clean, inspect and correct the heat sink surfaces and re-install the amp properly.

If in a Cold Environment;

1. If the truck is parked in a freezer for a prolonged period of time, the Traction Amp may have cooled to below the described limits. At 10.4° F (-12° C), current limit begins to be linearly reduced to a maximum reduction of 50% when the temperature drops below -13° F (-25° C). The only solutions are to drive the truck until the Traction Amp warms or park in a warmer location.
2. If the truck is equipped for cold storage or freezer operation, verify the heater and associated thermostat are functioning. The thermostat closes at approx. 40° F (4° C) and opens at approx. 61° F (16° C).

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Code 23

Code Title	Code 23 - Lift Power Amplifier POST Failed or Watchdog Fault
Reason	This code is displayed when the Lift Amp fails its Pre-Operation Start Test (POST) or detects a Watchdog Failure.
System Response	
Alarm Sounds	Yes
Operator Display	Code 23
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Code 1, 2
Performance Limits	
Travel System	Inoperative, lift system dropped out main contactor.
Lift/Lower System	Lift Inoperative/Lower Operational

General Information:

Code appears during startup - during the initial startup of the truck (key switch to ON) the Lift Power Amplifier reports to the Display Card that it detected an internal POST failure. The Display Card did not detect this error; it is only reporting that the Lift Amp has shut down with an internal Error Code 1-2. The Display Card converts Lift Amp Error Code 1-2 to Error Code 23.

During run mode, the Lift Amp control system detects an internal control system failure. When this occurs, the Lift Amp shuts down and reports the failure to the Display Card.

Possible Causes and Checks:

1. Verify the Lift Amp LED indicator agrees with the Code 23 by flashing the 1-2 code.
2. Check all electrical connections to the Lift Amp for tight and proper connections. If all connections are OK, replace the Lift Amplifier if the error occurs after the key switch is cycled OFF/ON.

NOTE: There are no additional tests that can be performed to detect this error. This error is an internal failure of the Lift Amp. Since the amp is sealed and is not serviceable, replacing the amp is the only solution.

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Code 24

Code Title	Code 24 - Lift Power Amplifier (M–) Fault
Reason	This code is displayed when the Lift Power Amp reports to the Display Card that is has detected a short circuit between the M– and B– Lift Amp terminals.
System Response	
Alarm Sounds	Yes
Operator Display	Code 24
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Code 1, 3
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Lift Inoperative/Lower Operational

General Information:

During operation, the Lift Amp detected a short circuit condition between the M– and B– terminals. This failure could be caused internally or externally. All external reasons for the short should be checked before the amp is replaced. The Display Card did not detect this error - it is only reporting that the Lift Amp has shut down with an internal Error Code 1-3. The Display Card converts the Lift Amp Error Code 1-3 to Error Code 24.

Possible Causes and Checks:

1. Check for shorted B+ to M– motor cables.
2. Check for shorted M– to B– power cables.
3. Check for signs of a shorted armature, such as a blackened or damaged commutator or brushes.

NOTE: The amp may have suffered permanent damage if short is found.

4. If all external checks are OK, the failure is internal to the amp. Remove and replace Lift Power Amp.

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Code 25

Code Title	Code 25 - Lift Power Amplifier HPD Failure (HPD= High Pedal Disable)
Reason	This code will be displayed if the Lift Power Amp detects greater than 25% speed request at Start-Up.
System Response	
Alarm Sounds	Yes
Operator Display	Code 25
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Code 2, 3
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Inoperative

General Information:

The HPD feature prevents the lift power amp from driving the pump motor if greater than 25% speed request is applied to the amp's speed request input at start-up. Available in the amp for use in a different type of application, the HPD feature is not used on the Toyota reach truck since the lift/lower control, part of the multi-function control handle, is equipped with a return spring and automatically returns lift/lower knob to neutral. Truck software checks are also provided to assure the lit/lower knob is in the correct position at key on. This code will only be displayed if a failure internal to the lift power amp occurs.

Possible Causes and Checks:

If an Error Code 25 is displayed, the only solution is to replace the Lift Amp. The amp is either defective, has been incorrectly programmed during manufacture or is the wrong amp for this truck.

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Code 26

Code Title	Code 26 - Lift Power Amplifier SRO Failure (SRO = Static Return to OFF)
Reason	This code will be displayed if the Lift Power Amp detects a directional lift/lower request on the amp's inputs at Start-Up.
System Response	
Alarm Sounds	Yes
Operator Display	Code 26
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Code 2, 2
Performance Limits	
Travel System	Operational
Lift/Lower System	Lift Inoperative/Lower Operational

General Information:

The SRO feature is designed to detect if the truck is in a lift or lower function at start-up. Available in the amp for use in a different type of application, the SRO feature is not used on the Toyota reach truck since the lift/lower control, part of the multi-function control handle, is equipped with a return spring and automatically returns the lift/lower knob to neutral. Truck software checks are also provided to assure the lift/lower knob is in the correct position at key on. This code will only be displayed if a failure internal to the lift power amp occurs.

Possible Causes and Checks:

If Error Code 26 is displayed, replace the Lift Amp. The amp is either defective, has been incorrectly programmed during manufacture or is the wrong amp for this truck.

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Code 27

Code Title	Code 27 - Lift Power Amplifier Request Out-of-Range
Reason	This code is displayed when the Lift Power Amp receives a Lift or Lower command that is out-of-range.
System Response	
Alarm Sounds	Yes
Operator Display	Code 27
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Code 2, 1
Performance Limits	
Travel System	Operational
Lift/Lower System	Inoperative

General Information:

This code is displayed if the Lift Amp does not accept the command for lift or lower speed from the Display Card. This may be the fault of the amp or other truck components. Error code history should be checked for the presence of additional codes that may be the root cause.

Possible Causes and Checks:

Check and record all 10 stored error codes in history. If Code 36 appears at the same hour meter reading as the Code 27, troubleshoot Code 36 first.

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Code 28

Code Title	Code 28 - Lift Power Amplifier Contactor Driver Overcurrent
Reason	This code is displayed when the Lift Power Amp detects a short in its MM contactor driver circuit.
System Response	
Alarm Sounds	Yes
Operator Display	Code 28
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Code 3, 1
Performance Limits	
Travel System	Operational
Lift/Lower System	Lift Inoperative/Lower Operational

General Information:

On the Toyota reach truck, the Lift Amp contactor driver circuit is used to supply the Tractor Interface Card with a B– voltage signal at JP8-10 (wire #75). This signal informs the Tractor Interface the Lift Amp is requesting the MM contactor to pull in. If, at any time, the Lift Amp detects a fault, it will remove this signal voltage and the truck will shut down. The appropriate code will be displayed.

Possible Causes and Checks:

If Error Code 28 occurs, check wire #75 from Lift Amp connector JL1-17 to the Tractor Interface Card connector JP8-10 for shorts and/or grounds.

Remove wire #75 from Lift Amp connector JL1-17. Turn key switch ON. If Code 28 re-appears, replace the Lift Amp. If another code appears, such as Code 43, recheck wire #75. If OK, the Tractor Interface Card may be bad.

NOTE: Normally, the Lift Amp contactor driver circuit directly operates a contactor that draws between 2A to 4A. On this truck, this circuit is used as a signal voltage with approx. 0.15A being drawn. This code should not appear unless the amplifier is bad or wire #75 is shorted to the frame or another wire.

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Code 29

Code Title	Code 29 - Lift Power Amplifier Main Contactor Welded
Reason	This code is displayed when the Lift Power Amp detects the MM contactor is closed when it should be open.
System Response	
Alarm Sounds	Yes
Operator Display	Code 29
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Code 3, 2
Performance Limits	
Travel System	Operational
Lift/Lower System	Lift Inoperative/Lower Operational

General Information:

If the MM contactor is stuck (welded) closed, there will be an unlimited voltage supply to the amp from the battery via the closed MM contactor tips. The Lift Amp can detect the contactor is still closed and will instruct the Display Card to display Code 29. In most cases, Error Code 16 will be logged into memory at the same time as Code 29. Use both error code troubleshooting guides when debugging.

Possible Causes and Checks:

1. Check the contactor for welded or stuck closed tips;
   a. Remove and replace tips if welded. Contactor tips should not be sanded or filed, as failure will occur shortly after.
   b. If stuck, disassemble and clean contactor for free movement. Replace contactor if free movement is not possible.
2. Check if contactor is remaining energized by measuring voltage across the contactor coil. If voltage is present, check for shorted wire #85 to frame, another wire or battery negative and repair as necessary.
3. Tractor Interface Card may be bad.

NOTE: Battery positive voltage is supplied to the contactor coil via wire #24 any time the key switch is ON and the ESTOP switch is closed. The Tractor Interface supplies a negative voltage to the coil via wire #85 to energize the coil at JP8-6. The Tractor Interface will energize the contactor coil only when both the Traction and Lift Amps request it. A Code 16 may also be seen in memory. If so, the contactor was probably welded.

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Code 30

Code Title	Code 30 - Lift Power Amplifier Precharge Fault
Reason	This code is displayed when the Lift Power Amp capacitors do not properly charge during the Start Up procedure.
System Response	
Alarm Sounds	Yes
Operator Display	Code 30
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Code 3, 3
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Inoperative

General Information:

When the key switch is turned ON, B+ is applied to the Lift Amp connector JL1-1 via wire #75. This charges the Lift Amps' internal capacitor bank via an internal 10kohm resistor, charging the capacitors in approx. 2 seconds. The 10kohm resistor allows the capacitors to charge but, if any other device tries to run off the pre-charge voltage, the resistor causes the voltage to drop to near 0V. In that situation, the capacitors will not charge due to the very low voltage. The Lift Amp sees that the capacitors have not charged and commands the Display Card to show Code 30.

Possible Causes & Checks:

1. If Error Code 17 is also present in the Error Code Memory, remove the F2 Traction Power Amp fuse and restart the truck;
   a. If only Error Code 17 is displayed, refer to Code 17 (Page 6-26).
   b. If only Error Code 30 is displayed, troubleshoot as follows.
2. With key switch ON and MM contactor open, check for B+ across Lift Amp power terminals B+ & B–;
   a. If near 0V, check for B+ at Traction Amp connector JL1-1 wire #75.
   b. If wire #75 is B+, check for any device that may have been connected to the lift B+ cable terminal. Devices such as strobes, alarms or customer computer equipment will pull the charge voltage down if connected to this circuit.
3. Check for short circuit between the B+ & B– Lift Amp terminals.
4. If all checks are OK, replace the Lift Amp.

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Code 31

Code Title	Code 31 - Lift Power Amplifier Main Contactor Open
Reason	This code is displayed when the Lift Power Amp detects the MM contactor is open when it should be closed
System Response	
Alarm Sounds	Yes
Operator Display	Code 31
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Code 3, 4
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Lift Inoperative/Lower Operational

General Information:

When the MM contactor closes due to the brake pedal or right foot switch being depressed, full battery voltage is made available to the Lift Amp for hydraulic operation. If the contactor tips are stuck open, the only available voltage is in the capacitor bank within the Lift Amp. When a hydraulic function is operated, the Lift Amp begins pulsing the pump motor. If the MM contactor tips are not closed, the capacitor bank will be quickly discharged. The Lift Amp detects the loss of voltage and instructs the Display Card to show Error Code 31.

Possible Causes & Checks:

1. Check the contactor for burned tips or presence of foreign matter that may prevent the tips from making contact. Replace tips if damaged. Do not sand or file contactor tips or failure will soon occur.
2. Check for a physically stuck open contactor. Disassemble and clean the contactor for free movement. Replace contactor if free movement is not possible.
3. Check contactor coil circuit. With the key switch ON and ESTOP closed, check for B+ on wire #24 at the Tractor Interface plug JP8-6.
   a. If B+ is NOT present, check for B+ on Tractor Interface plug JP8-1.
   b. If B+ IS present, check for open wire #24 or #85 from Tractor Interface to the MM contactor coil.
4. Check for proper PC Control voltage from Traction & Lift Amps to the Tractor Interface Card when brake pedal or right foot switch is depressed. Should be less than 0.1V.

NOTE: Proper voltage may only be present for a few seconds. When code is displayed, the voltage will jump up due to lift control shutdown

   a. Check Lift Amp PC Control voltage at Tractor Interface plug JP8-10 wire #75 when brake pedal or right foot switch is depressed. Should be less than 0.1V with contactor energized. If always greater than 10.0V, check wire #75 for open circuit or poor connection at Lift Amp connector JL1-17.

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b. Check Traction Amp PC Control voltage at Tractor Interface plug JP8-11 wire #36 when brake pedal or right foot switch is depressed. Should be less than 0.1V with contactor energized. If always greater than 10.0V, refer to Code 18 (Page 6-27).

5. If error code is still displayed and all previous checks do not correct the problem, replace the Lift Amp.

NOTE: This Error Code is similar and may be related to Error Code 18.

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Code 32

Code Title	Code 32 - Lift Power Amplifier Battery Undervoltage
Reason	This code is displayed when the Lift Power Amp detects the available battery voltage is too low.
System Response	
Alarm Sounds	Yes
Operator Display	Code 32
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Code 4, 1
Performance Limits	
Travel System	Operational
Lift/Lower System	Lift System in current cutback if voltage drops below 70% of nominal battery voltage; 24V truck = 16.8V, 36V truck = 25.2V Lift System inoperative if voltage drops below 70% - 4V of nominal voltage; 24V truck = 12.8V, 36V truck = 21.2V

General Information:

The Lift Amp monitors the battery voltage at the B+ & B– cable terminals. If, at any time after the MM contactor is closed, the battery voltage seen at those terminals drops below the specified level, Error Code 32 is displayed. Depending on how low the voltage drops, the control will either reduce the maximum current limit to the lift motor or shut down the lift system. The error code is displayed even if the low voltage briefly dropped below the specified level.

Possible Causes & Checks:

1. Check the battery voltage by accessing Analyzer Mode, Category 1, Class 2, Test 12.
2. Check the battery charge level.
   a. Check specific gravity on all cells. All specific gravity readings should be within 0.010 of each other. If below 1.175, charge battery and monitor for return of code.
   b. Check cell voltage on each cell. If below 1.9V per cell, charge battery and monitor for return of code.
   c. Check Lift Interrupt Set Level in the Tuning Mode, Code C9.
3. Check for voltage drop in the cables with the battery under load. Lift the mast to full height and continue full lift, stalling the hydraulic system; measure voltage as described below.

NOTE: Only stall the hydraulic system for 10 seconds; let rest for 2 minutes before repeating test.

   a. Connect positive meter lead to the battery's positive cable. Connect the negative meter lead to the B+ cable terminal of the Lift Amp. If voltage drop measured is greater that 0.250V, check for bad connection of the battery connector, power cables to the MM

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contactor, MM contactor tips or high resistance in the F3 (250A) fuse.

b. Connect negative meter lead to the battery's negative cable. Connect the positive meter lead to the B– cable terminal of the Lift Amp. If voltage drop measured is greater that 0.25V, check for bad connection of the battery connector or battery negative from the battery to the Lift Power Amp B– cable terminal.

4. Inspect the battery cables for signs of heat or damage.
5. Check the battery connector for properly crimped contacts. If cable is frayed or the crimp has failed, replace the cable or properly crimp on a new connector.
6. If error code is still being displayed and all previous checks do not correct the problem, the Lift Amp may be incorrectly reading the battery voltage.

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Code 33

Code Title	Code 33 - Lift Power Amplifier Battery Overvoltage
Reason	This code is displayed when the Lift Power Amp detects the available battery voltage is too low.
System Response	
Alarm Sounds	Yes
Operator Display	Code 33
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Code 4, 2
Performance Limits	
Travel System	Operational
Lift/Lower System	Lift System in current cutback if voltage rises above 17% of nominal battery voltage 24V truck = 28.08V, 36V truck = 42.12V Lift System is inoperative if voltage rises above 33% of nominal voltage 24V truck = 31.92V, 36V truck = 47.88V

General Information:

The Lift Amp monitors battery voltage at the B+ & B– cable terminals. If, at any time after the MM contactor is closed, the battery voltage seen at those terminals rises above the specified level, Error Code 33 is displayed. Depending on how high the voltage raises, the control will either reduce the maximum current limit to the lift motor or shut down the lift system. The error code will be displayed even if the voltage briefly rose above the specified level.

Possible Causes & Checks:

1. Check the battery voltage by accessing Analyzer Mode, Category 1, Class 2, Test 12.
2. Measure voltage at Lift Power Amp B+ to B– cable terminals;
   a. If above specified level, check the battery charger for proper operation.
   b. If voltage is below the specified level, operate truck and check for re-occurrence of the error code.
      - If error code repeats with no other codes in memory, replace the Lift Power Amp.
      - If error code repeats with additional codes also logged in memory, troubleshoot the other codes first before replacing the Lift Power Amp.
3. Check the battery charge level;
   a. Check specific gravity on all cells. All specific gravity readings should be within 0.010 of each other. If above 1.300, the battery may be overcharged. Check the battery charger for proper operation.
   b. Check cell voltage on each cell. If above 2.5V per cell, the battery may be over-charged, check the battery charger for proper operation.

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4. If error code is still being displayed and all previous checks do not correct the problem, it is possible the Lift Amp is reading the battery voltage incorrectly. Replace the Lift Power Amp.

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Code 34

Code Title	Code 34 - Lift Power Amplifier Thermal Cutback
Reason	This code is displayed when the Lift Power Amp detects the temperature of the heat sink is higher than 185° F (85° C) or below 10.4° F (–12° C).
System Response	
Alarm Sounds	Yes
Operator Display	Code 34 - Thermometer Icon illuminated.
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Code 4, 3
Performance Limits	
Travel System	Operational
Lift/Lower System	Lift System in current cutback if temperature is between 185° and 203° F (85° and 95° C) or is below 10.4° F (–12° C). Lift System is inoperative if temperature rises above 203° F (95° C).

General Information:

The Lift Power Amp monitors the temperature of the heat sink next to the output transistors. The amp uses a thermal sensor mounted to the heat sink within the amp housing. The reported temperature of the Lift Amp can be viewed in the Analyzer Mode, Category 1, Class 2, Test 8. In order to check the true temperature of the amp, a thermal measuring device must be used. Many types of thermal measuring devices are available; some digital meters are equipped with a K type probe. Infrared thermal measuring devices are also available.

Possible Causes & Checks:

If in a Hot Environment;

1. Check the temperature by accessing Analyzer Mode, Category 1, Class 2, Test 8.

   If the error code is still present and the temperature of the Lift Amp heat sink is below the limits described above, replace the Lift Amp.

2. Excessive load on truck or extreme environment. If application is too excessive, the truck must be parked until it cools before returning to service. The application should be evaluated and recommendations should be made that will resolve the issue.

   a. Is lift function being used incorrectly?

   b. Is truck being operated in an extremely hot environment?

3. While code is present, measure temperature of heat sink on the Lift Power Amp and compare to the displayed temperature by accessing Analyzer Mode, Category 1, Class 2, Test 8.

   a. If the temperature of the heat sink is below the limits described above and the display is above the limits, the temperature sensor is bad. Replace the Lift Amp.

   b. If both temperature readings are at or above the limits described above, measure temperature of the truck frame plate adjacent to the location where the

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heat sink temperature was measured. If frame plate temperature is greater than 10° cooler than the Lift Amp heat sink, the mounting of the amp is improper and is not allowing adequate heat transfer. Remove the amp, clean and inspect and correct the heat sink surfaces. Properly re-install the amp.

If in a Cold Environment;

1. If the truck is parked in a freezer for a prolonged period of time, the Lift Amp may have cooled to below the described limits. At 10.4° F (–12° C) current limit begins to be linearly reduced to a maximum reduction of 50% when the temperature drops below –13° F (–25° C). The only solutions are to operate the hydraulic system until the Lift Amp warms or park in a warmer location.
2. If the truck is equipped for cold storage or freezer operation, verify the heater and associated thermostat are functioning. The thermostat closes at approx. 40° F (4° C) and opens at approx. 61° F (16° C).

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Code 35

Code Title	Code 35 - Traction Potentiometer Voltage Out-of-Range
Reason	This code is displayed when the Display Card detects the traction potentiometer voltage is out-of-range either at Start-Up or during Run Mode.
System Response	
Alarm Sounds	Yes
Operator Display	Code 35
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Operational

General Information:

When the key switch is first turned ON, the Display Card performs a Pre-Operational Start Test (POST). The POST test checks many different systems, settings and voltages for proper operation. One of the tests is to assure the traction pot voltage is within the operating range. The operating voltage range is 0.2V to 4.8V. A voltage above or below this range is considered out-of-range. Traction pot voltage can be seen in Analyzer Mode, Category 1, Class 2, Test 2.

If the traction pot voltage is not within the operating range at POST, Error Code 35 is displayed.

During Run Mode (anytime after a successful POST), if the Display Card detects the traction pot voltage above 4.8V or below 0.2V, Error Code 35 is displayed.

Possible Causes & Checks:

Error Code 35 during POST;

Check traction pot voltage in Analyzer Mode.

Is pot voltage 0.2V or lower or 4.8V or higher?

1. If YES, make sure the control handle is securely fastened to the mounting bracket. Make sure set screw is tight and retest.
2. Replace control handle.

Error Code 35 during Run Mode;

Check traction pot voltage in Analyzer Mode while moving handle to the full forward and full reverse positions.

Is pot voltage 0.2V or lower in full forward or 4.8V or higher in full reverse?

1. If YES, make sure the control handle is securely fastened to the mounting bracket. Make sure set screw is tight and retest.
2. Replace control handle.

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Code 36

Code Title	Code 36 - Lift Potentiometer Voltage Out-of-Range or AUX Button Depressed During POST
Reason	This code is displayed when the Display Card detects the lift pot voltage is out-of-range at Start-Up or during Run Mode or a voltage signal from one of the AUX buttons is present at POST.
System Response	
Alarm Sounds	Yes
Operator Display	Code 36
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Operational
Lift/Lower System	Inoperative

General Information:

When the key switch is first turned ON, the Display Card performs a Pre-Operational Start Test (POST). The POST test checks many different systems, settings and voltages for proper operation. One of the tests is to assure the lift pot voltage is within the operating range. The operating voltage range is 0.2V to 4.8V. A voltage above or below this range is considered out-of-range. Lift pot voltage can be seen in Analyzer Mode, Category 1, Class 2, Test 6.

If the lift pot voltage is not within the operating range at POST, Error Code 36 is displayed.

Error Code 36 is also displayed if one of the AUX (tilt, reach or sideshift) buttons is depressed during POST. Refer to Analyzer Mode, Category 1, Class 1, ESY15 thru 20 to view AUX button voltage input status.

During Run Mode (anytime after a successful POST), if the Display Card detects the lift pot voltage above 4.8V or below 0.2V, Error Code 36 is displayed.

Possible Causes & Checks:

Error Code 36 during POST;

Check lift pot voltage in Analyzer Mode.

Is pot voltage 0.2V or lower or 4.8V or higher?

1. If YES, make sure the knob is securely fastened to the pot shaft (are locking set screws loose?). Remove knob, adjust pot shaft for 2.5 neutral volts, tighten screws and retest.
2. Replace control handle.

Error Code 36 during Run Mode;

Check lift pot voltage in Analyzer Mode while moving knob to the full lift and full lower positions.

Is pot voltage 0.2V or less in full lower or 4.8V or higher in full lift?

1. If YES, make sure the knob is securely fastened to the pot shaft (are locking set screws loose?). Remove knob, adjust pot shaft for 2.5 neutral volts, tighten screws and retest.
2. Replace control handle.

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Code 37

Code Title	Code 37 - Lift Potentiometer Voltage Out-of-Neutral During POST
Reason	This code is displayed when the Display Card detects the Lift Pot Voltage is Out-of-Neutral at POST (Start-Up).
System Response	
Alarm Sounds	Yes
Operator Display	Code 37
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Operational
Lift/Lower System	Inoperative

General Information:

When the key switch is first turned ON, the dIsplay Card performs a Pre-Operational Start Test (POST). The POST test checks many different systems, settings and voltages for proper operation. One of the tests is to assure the lift pot neutral voltage is within the neutral dead band. The neutral dead band is a range the Display Card considers to be neutral (not lift or lower). The neutral dead band voltage range is 0.2V higher or lower than the calibrated neutral lift pot voltage. Lift pot voltage can be seen in Analyzer Mode, Category 1, Class 2, Test 6.

If the lift pot voltage is not within the calibrated neutral dead band at POST, Error Code 37 is displayed.

Example: If the lift pot voltage in neutral is 2.5V and the lift pot is calibrated at that voltage, the neutral dead band is 2.3 - 2.7V. During POST, the lift pot voltage must be within 2.3 - 2.7V, otherwise a Code 37 is displayed. The neutral dead band voltage will vary depending on the actual lift pot neutral voltage at the time of calibration.

After calibration, the truck cannot tell you what the calibrated voltage is. Therefore, there is no way to know if the traction pot voltage seen at the time of troubleshooting is the same as it was at calibration, unless it is recorded at the time of calibration. It is recommended that the calibration voltages be recorded each time after the handle is calibrated.

Error Code 37 is also displayed if a tilt, reach or side shift AUX button is depressed during POST. Refer to Analyzer Mode, Category 1, Class 1, ESY15 thru 20 to view AUX button voltage input status.

Possible Causes & Checks:

Error Code 37 during POST;

1. Make sure the operator is not moving the lift/lower knob out of neutral during POST. If the knob is moved to lift or lower during POST, the voltage seen by the display will be out-of-neutral.
2. Check neutral lift pot voltage in Analyzer Mode;
   a. If pot voltage is lower than 2.0V or greater than 3.0V, check for poor connection of handle harness to Tractor

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Interface or Module if equipped. If OK, replace control handle.

b. If pot voltage is between 2.0 and 3.0V, record actual neutral voltage and calibrate lift pot. Test run truck. Check if neutral voltage is varying from calibrated voltage. If yes, replace control handle. If voltage does not vary, return truck to service. If code reappears, check neutral voltage and compare to neutral voltage recorded at time of calibration. If neutral voltage has increased or decreased by more than 0.2V, replace the control handle.

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Code 39

Code Title	Code 39 - Traction Motor Above Upper Limit
Reason	This code is displayed when the Display Card detects the traction motor is above 265° F (129.4° C).
System Response	
Alarm Sounds	Yes
Operator Display	Code 39
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Traction speed is reduced by 1 mph if above 235° F (113° C) Traction speed is reduced by 1.5 mph if above 250° F (121° C) Traction speed is reduced to 1 mph if above 265° F (129.4° C)
Lift/Lower System	Operational

General Information:

The traction motor is equipped with a temperature sensor that is threaded into the side of the motor case. The temperature sensor continually sends a signal to the Display Card, via the Tractor Interface Card, that varies depending on the temperature of the motor. The display monitors the motor temperature and will display Error Code 39 if the signal from the temperature sensor indicates the motor is above 265° F (129.4° C). You can monitor the temperature of the motor by accessing the Analyzer Mode, Category 1, Class 2, Test 3. The display is updated with new temperature readings every 2 minutes. Therefore, there will be a delay in the temperature reading if the temperature signal quickly changes.

Possible Causes & Checks:

1. Check the displayed motor temperature by accessing the Analyzer Mode Category 1, Class 2, Test 3. Is displayed motor temperature 752° F (371° C)?

   If YES, traction motor sensor or circuit is open or shorted.

   - Check continuity of wires #38 & #39 from temp sensor harness plug to Tractor Interface.
   - Check temp sensor resistance; should be approx. 2kohm at 70° F. Replace if necessary.
   - If both previous checks are correct and have not solved the problem, replace the Tractor Interface Card.
   - If the previous checks are correct and have not solved the problem, replace the Display Card.

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2. Make sure the motor is really above upper limit. In order to check the true temperature of the motor a thermal measuring device must be used. Many types of thermal measuring devices are available; some digital meters are equipped with a K type probe. Infrared thermal measuring devices are also available. Measure motor temperature and compare with displayed temperature on Display Card.

   Is motor temperature within 10° of temperature on Display Card?

   a. If YES, the motor temperature sensor is reading correctly.

   b. If NO, check the temp sensor wires #38 & #39 for continuity. If OK, replace the temp sensor. When installing the new temp sensor, thread the sensor all the way in until it just bottoms out, then unscrew 1 turn. Temp sensor must not touch the bottom. If temp sensor does not correct the problem, replace the Tractor Interface.

3. If temp sensor is judged to be correctly measuring temperature, is the temperature above 265° F (129.4° C)?

   a. If YES, check application for a reason the motor is overheating. (ramps, pushing loads, very high cycle operation). If due to operator abuse, advise customer of proper use of truck. If not due to abuse, contact dealer for motor cooling information.

   b. If NO, replace the Display Card for improperly displaying Code 39 when temperature is below specified limits.

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Code 40

Code Title	Code 40 - Lift Motor Above Upper Limit
Reason	This code is displayed when the Display Card detects the lift motor is above 265° F (129.4° C).
System Response	
Alarm Sounds	Yes
Operator Display	Code 40
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Operational
Lift/Lower System	Limited to 25% of full speed lift.

General Information:

The lift motor is equipped with a temperature sensor that is threaded into the side of the motor case. The temperature sensor continually sends a signal to the Display Card, via the Tractor Interface Card, that varies depending on the temperature of the motor. The display monitors the motor temperature and will display Error Code 40 if the signal from the temperature sensor indicates the motor is above 265° F (129.4° C). You can monitor the temperature of the motor by accessing Analyzer Mode, Category 1, Class 2, Test 7. The display is updated with new temperature readings every 2 minutes. Therefore, there will be a delay in the temperature reading if the temperature signal quickly changes.

Possible Causes & Checks:

1. Check the displayed motor temperature by accessing the Analyzer Mode Category 1, Class 2, Test 7. Is displayed motor temperature 752° F (371° C)?

   If YES, lift motor sensor or circuit is open or shorted.

   a. Check continuity of wire #34 & #50 from temp sensor harness plug to Tractor Interface.

   b. Check temp sensor resistance. Should be approx. 2kohm at 70° F. Replace if necessary.

   c. If both previous checks are correct and have not solved the problem, replace the Tractor Interface Card.

   d. If the previous checks are correct and have not solved the problem, replace the Display Card.

2. Make sure the motor is really above upper limit. In order to check the true temperature of the motor, a thermal measuring device must be used. Many types of thermal measuring devices are available; some digital meters are equipped with a K type probe. Infrared thermal measuring devices are also available. Measure motor temperature and compare with displayed temperature on Display Card. Is motor temperature within 10° of temperature on Display Card?

   a. If YES, the motor temperature sensor is reading correctly.

   b. If NO, check the temp sensor wires #34 & #50 for continuity. If OK, replace the temp sensor. When installing the new temp sensor, thread the sensor all the way in until it just bottoms out, then

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unscrew 1 turn. Temp sensor must not touch the bottom. If temp sensor does not correct the problem, replace the Tractor Interface.

3. If temp sensor is judged to be correctly measuring temperature, is the temperature above 265° F (129.4° C)?
   a. If YES, check application for a reason the motor is overheating. (lift stalling, excessive loads, very high cycle operation). If due to operator abuse, advise customer of proper use of truck.
   b. If YES, check for excessive pressure when raising mast empty. If pressure is above 2000 psi with no load, check for hydraulic system restriction or mast hanging up.
   c. If NO, replace the Display Card for improperly displaying Code 40 when temperature is below specified limits.

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Code 41

Code Title	Code 41 - No Traction Power Amplifier CAN Communication Received By Display Card
Reason	This code is displayed if the Display Card is not receiving any communication messages from the Traction Amp. (CAN = Controller Area Network)
System Response	
Alarm Sounds	Yes
Operator Display	Code 41
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Inoperative

General Information:

During initial Start-Up (POST) the Display Card sends a communication message to the Traction Amp. If the Traction Amp fails to respond to the Display Card's message, Error Code 41 is displayed.

During Run Mode (anytime after successful Start-Up), the Display Card and Traction Amp continuously exchange messages. If the Display Card detects the Traction Amp has not sent a message for more than 100 ms, Error Code 41 is displayed.

The CAN communication messages are transmitted via the CAN bus harness that is connected to the Display Card at connector HD1, the Traction Amp at connector JT2 and the Lift Amp at JL2. All three controllers see all communication messages that are sent. The Traction Amp will only respond to messages that pertain to the Traction Amp.

The CAN communication messages cannot be measured with a meter. To determine if the Traction Amp is communicating with the Display Card, check for the Traction Amp (TPA) software version number in Analyzer Mode, Category 6, Class 1, TPA. If the TPA software number is present (example: TPA 11.02), the Traction Amp is communicating with the Display Card. If the TPA software number is not present (example: TPA 0.00), the Traction Amp and the Display Card are not communicating. There are several TPA software numbers that may be displayed depending on the version of the Traction Amp. For this test, it is only necessary to verify that the software number is not zeros.

Possible Causes & Checks:

1. Access Analyzer Mode, Category 6, Class 1, TPA. Is the TPA displaying a software number?

   If YES, check all connections at Display Card HD1 and Traction Amp JT2. If OK, replace the Display Card for not responding to the Traction Amp CAN communication.

   If NO, check for the yellow Traction Amp LED heartbeat;

   a. If no heartbeat, check for battery positive voltage at connector JT1, wire #37. If voltage is OK, replace the Traction Amp. If no voltage, check for poor connection of wire #37 between

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Traction Amp and Tractor Interface Card P8-1. Check K1 relay for proper operation.

b. If heartbeat is present, check for Lift Amp firmware software (LPA);

   i. If LPA is displaying a software number, swap the 6-pin JT2 and JL2 CAN communication harness connectors on the Traction and Lift Amps. If the TPA software number is now displayed, JT2 has an open connection. Repair or replace the harness. If TPA still is not displaying a software number, replace the Traction Amp.

   ii. If LPA is not displaying a software number, check for Display Card firmware version (DM).

   - If a DM software number is present, check for open connections between CAN harness connectors HD1, JT2 and JL2. Repair or replace harness as necessary.
   - If DM software number is not present, replace the Display Card.

2. Make sure the key switch has not been cycled ON to OFF then back ON in less than two seconds. Rapid key cycling can cause an Error Code 41 as well as Error Codes 43, 59 or 61 to appear.

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Code 42

Code Title	Code 42 - Parameter Setting Error In Traction Power Amplifier
Reason	This code is displayed if the Display Card is not receiving the Traction Amps parameter setting info or one or more of the parameter settings are out-of-range.
System Response	
Alarm Sounds	Yes
Operator Display	Code 42
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Inoperative

General Information:

At Start-Up, the Display Card and Traction Amp begin communication via the CAN harness at connectors HD1 & JT2. If the Display Card is not receiving the necessary Traction Amp parameter settings or if the settings are out of normal range, Error Code 42 is displayed.

Possible Causes & Checks:

1. Check for all three software versions (DM,TPA & LPA) being displayed in Analyzer Test 61.
   a. If all software versions are displayed, communication is OK.
   b. If software versions are not displayed (all zeros), check for poor connections at the CAN harness between connectors HD1, JT2 & JL2. Repair or replace harness as required. If connections are OK, replace the Display Card.
2. Go to Calibrate mode and reset the power amp default settings (PwrAmpDf).
   a. If Error Code 42 is still displayed after cycling the key switch, replace the Traction Amp.
   b. If truck is operating normally, check for static strap. Install if not equipped. Make sure strap is clean and making full contact with floor. The use of a static chain is recommended for durability.

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Code 43

Code Title	Code 43 - No Lift Power Amplifier CAN Communication Received By Display Card
Reason	This code is displayed if the Display Card is not receiving any communication messages from the Lift Amp. (CAN = Controller Area Network)
System Response	
Alarm Sounds	Yes
Operator Display	Code 43
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Inoperative

General Information:

During initial Start-Up (POST) the Display Card sends a communication message to the Lift Amp. If the Lift Amp fails to respond to the Display Card's message, Error Code 43 is displayed.

During Run Mode (anytime after successful Start-Up), the Display Card and Lift Amp continuously exchange messages. If the Display Card detects the Lift Amp has not sent a message for more than 100 ms, Error Code 43 is displayed.

The CAN communication messages are transmitted via the CAN bus harness that is connected to the Display Card at connector HD1, the Traction Amp at connector JT2 and the Lift Amp at JL2. All three controllers see all communication messages that are sent. The Lift Amp will only respond to messages that pertain to the Lift Amp.

The CAN communication messages cannot be measured with a meter. To determine if the Lift Amp is communicating with the Display Card, check for the Lift Amp (LPA) software version number in Analyzer Mode, Category 6, Class 1, LPA. If the LPA software number is present (example: LPA 11.02), the Lift Amp is communicating with the Display Card. If the LPA software number is not present (example: LPA 0.00), the Lift Amp and the Display Card are not communicating. There are several LPA software numbers that may be displayed depending on the version of the Lift Amp. For this test, it is only necessary to verify that the software number is not zeros.

Possible Causes & Checks:

1. Access Analyzer Mode, Category 6, Class 1, LPA. Is the LPA displaying a software number?

   If YES, check all connections at Display Card HD1 and Traction Amp JL2. If OK, replace the Display Card for not responding to the Lift Amp CAN communication.

   If NO, check for the yellow Lift Amp LED heartbeat;

   a. If no heartbeat, check for battery positive voltage at connector JL1, wire #37. If voltage is OK, replace the Lift Amp. If no voltage, check for poor connection of wire #37 between Lift Amp

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and Tractor Interface Card P8-1. Check K1 relay for proper operation.

b. If heartbeat is present, check for Traction Amp firmware software (TPA);

   i. If TPA is displaying a software number, swap the 6-pin JL2 and JT2 CAN communication harness connectors on the Lift and Traction Amps. If the LPA software number is now displayed, JL2 has an open connection. Repair or replace the harness. If LPA still is not displaying a software number, replace the Lift Amp.

   ii. If TPA is not displaying a software number, check for Display Card firmware version (DM).

   - If a DM software number is present, check for open connections between CAN harness connectors HD1, JT2 and JL2. Repair or replace harness as necessary.
   - If DM software number is not present, replace the Display Card.

2. Make sure the key switch has not been cycled ON to OFF then back ON in less than two seconds. Rapid key cycling can cause an Error Code 43 as well as Error Codes 41, 59 or 61 to appear.

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Code 44

Code Title	Code 44 - Parameter Setting Error In Lift Power Amplifier
Reason	This code is displayed if the Display Card is not receiving the Lift Amps parameter setting info or one or more of the parameter settings are out-of-range.
System Response	
Alarm Sounds	Yes
Operator Display	Code 44
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Inoperative

General Information:

At Start-Up, the Display Card and Lift Amp begin communication via the CAN harness at connectors HD1 & JL2. If the Display Card is not receiving the necessary Lift Amp parameter settings or if the settings are out of normal range, Error Code 44 is displayed.

Possible Causes & Checks:

1. Check for all three software versions (DM,TPA & LPA) being displayed in Analyzer Test 61.
   a. If all software versions are displayed, communication is OK.
   b. If software versions are not displayed (all zeros), check for poor connections at the CAN harness between connectors HD1, JT2 & JL2. Repair or replace harness as required. If connections are OK, replace the Display Card.
2. Go to Calibrate mode and reset the power amp default settings (PwrAmpDf).
   a. If Error Code 44 is still displayed after cycling the key switch, replace the Lift Amp.
   b. If truck is operating normally, check for static strap. Install if not equipped. Make sure strap is clean and making full contact with floor. The use of a static chain is recommended for durability.

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Code 45

Code Title	Code 45 - Traction Motor Temperature Out-of-Range
Reason	This code is displayed if the Display Card detects the traction motor temperature sensor circuit is either open or shorted.
System Response	
Alarm Sounds	Yes
Operator Display	Code 45
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Speed limited to 1.0 mph
Lift/Lower System	Operational

General Information:

Upon Start-Up and during RUN Mode, the Display Card is looking for the Tractor Interface to send traction motor temperature information. If within 1 minute after the key is turned ON a valid motor temperature signal is not sent, Error Code 45 is displayed.

View the traction motor temperature in Analyzer Mode, Category 1, Class 2, Test 3. If the temperature displayed is above 750° F, the temperature sensor circuit is either open of shorted.

Possible Causes & Checks:

1. Check traction and lift motor temperatures in Analyzer Mode. If lift motor temperature is OK, disconnect the lift motor temp sensor and connect it to the traction motor temp sensor harness plug.
   a. If a valid traction motor temperature is now being displayed, replace the traction motor temp sensor. Perform check 2 to assure sensor is defective.
   b. If traction motor temperature is above 750° F, the temp sensor circuit is bad. Go to check 2 for complete troubleshooting.
2. Disconnect the traction temperature sensor from the truck harness. The sensor should measure approx. 2000 ohms at 75° F. If resistance is above 10kohms or near 0 ohms, replace the temperature sensor.
3. If temperature sensor resistance is OK, reconnect temp sensor to harness. Disconnect Tractor Interface Card connector P7. Check resistance between pin 23 (wire #39) and pin 24 (wire #38). Resistance should be same as previous check.
   a. If resistance is above 10kohms or near 0 ohms, check harness for open or shorted wires #38 & #39 between temp sensor and Tractor Interface Card.
   b. If resistance is OK, replace Tractor Interface Card.
4. If these checks do not resolve the problem, replace the Display Card.

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Code 46

Code Title	Code 46 - Lift Motor Temperature Out-of-Range
Reason	This code is displayed if the Display Card detects the lift motor temperature sensor circuit is either open or shorted.
System Response	
Alarm Sounds	Yes
Operator Display	Code 46
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Operational
Lift/Lower System	Limited to 25% lift speed

General Information:

Upon Start-Up and during RUN Mode, the Display Card is looking for the Tractor Interface to send lift motor temperature information. If within 1 minute after the key is turned ON a valid motor temperature signal is not sent, Error Code 46 is displayed.

View the lift motor temperature in Analyzer Mode, Category 1, Class 2, Test 7. If the temperature displayed is above 750° F, the temperature sensor circuit is either open of shorted.

Possible Causes & Checks:

1. Check lift and traction motor temperatures in Analyzer Mode. If traction motor temperature is OK, disconnect the traction motor temp sensor and connect it to the lift motor temp sensor harness plug.
   a. If a valid lift motor temperature is now being displayed, replace the lift motor temp sensor. Perform check 2 to assure sensor is defective.
   b. If lift motor temperature is above 750° F, the temp sensor circuit is bad. Go to check 2 for complete troubleshooting.
2. Disconnect the lift temperature sensor from the truck harness. The sensor should measure approx. 2000 ohms at 75° F. If resistance is above 10kohms or near 0 ohms, replace the temperature sensor.
3. If temperature sensor resistance is OK, reconnect temp sensor to harness. Disconnect Tractor Interface Card connector P7. Check resistance between pin 11 (wire #50) and pin 12 (wire #34). Resistance should be same as previous check.
   a. If resistance is above 10kohms or near 0 ohms, check harness for open or shorted wires #34 & #50 between temp sensor and Tractor Interface Card.
   b. If resistance is OK, replace Tractor Interface Card.
4. If these checks do not resolve the problem, replace the Display Card.

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Code 49

Code Title	Code 49 - Travel Requested With No Movement Detected
Reason	This code is displayed if the Display Card detects the traction motor armature current is greater than 250A, the traction pot is requesting more than 80% travel speed, and no motor rotation is detected by the speed sensor for more than 7 seconds. This may indicate the drive motor is stalled.
System Response	
Alarm Sounds	Yes
Operator Display	Code 49
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Inoperative

General Information:

The Display Card monitors functions on the truck. The Display Card has been programmed to look for the possibility that the drive motor may be stalling or is stalled. The stalling of the drive motor may be due to the operator pushing loads, brake drag or any other force opposing travel.

For Error Code 49, the armature current must be over 250A (indicating the motor is under load), the traction pot is requesting more than 80% speed (indicating the operator wants to go near full speed) and the speed sensor on top of the drive motor is indicating the motor is not turning, thus the motor is stalled under high amp load. This condition must happen for more than 7 seconds for Error Code 49 to be displayed.

If all components are operating correctly, the error code can be prevented by not subjecting the truck to a stalled condition.

This code can also be generated if one of the monitored systems is not operating correctly. If the control is incorrectly reading the armature amps, the speed sensor, or the traction pot request, the code may be displayed based on incorrect information. These components should be evaluated for correct operation if a Code 49 is displayed.

Possible Causes & Checks:

1. Check speed sensor input by accessing Analyzer Mode, Category 1, Class 3, Test 1 for kph or Test 2 for mph. Drive truck forward and reverse. Is the display showing the speed of the truck?
   a. If YES, speed sensors operating correctly.
   b. If NO, speed sensors not operating correctly.
      i. Check for continuity of speed sensor wires between speed sensor harness connector and Display Card connector HD5. Repair or replace harness as necessary.

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ii. Check speed sensor voltage by measuring approx. 5V between the red and black wires at the speed sensor 3-pin connector. If voltage is incorrect, check continuity of red and black wires between connector and Display Card connector HD5. If wires are OK, replace Display Card.

iii. Check speed sensors for proper switching by removing sensor from housing. Measure voltage between black and white/black wires. Voltage should be approx. 5V if sensor is in mid-air. Voltage should be near 0V when sensor tip is put next to steel (not aluminum). If voltage is not correct, replace bad sensor. Be sure to reinstall sensor in same position as removed.

2. If speed sensors are operating correctly and code is being displayed when no stall condition exists, replace the Display Card.

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Code 50

Code Title	Code 50 - Lift Pump Motor Stalled
Reason	This code is displayed if the Display Card detects the Lift motor current is greater than 450A for more than 2 minutes or the pump motor has been running (lifting) for more than 2 minutes at greater than 80% lift pot speed request (the mast should have fully extended by this time). This may indicate the lift pump motor is stalled.
System Response	
Alarm Sounds	Yes
Operator Display	Code 50
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Operational
Lift/Lower System	Lift Inoperative/Lower Operational

General Information:

The Display Card monitors functions of the truck. The Display Card has been programmed to look for the possibility that the lift pump motor may be stalling or stalled. The stalling of the lift pump motor may be due to the operator lifting oversized loads, hydraulic restriction or any other force opposing lift.

Error Code 50 is displayed if either of the following two conditions are detected;

1. The pump motor current is over 450A (indicating the motor is under a heavy load) for more than 2 minutes. The tallest mast would have fully extended and hit the mechanical stops.
2. The lift pot is requesting more than 80% lift speed (indicating the operator wants to lift at near full speed) for more than 2 minutes. The tallest mast would have fully extended and hit the mechanical stops.

If all components are operating correctly, the error code can be prevented by not subjecting the truck to a stalled condition.

This code can also be generated if one of the monitored systems is not operating correctly. If the control is incorrectly reading the armature amps or lift pot request, the code may be displayed based on incorrect information. These components should be evaluated for correct operation if a Code 50 is displayed.

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Code 50

Possible Causes & Checks:

If Error Code 50 is displayed while the truck is not under a stalled condition, check the following:

1. Check lift pump motor amp draw by accessing Analyzer Mode, Category 1, Class 2, Test 5. Begin lifting the forks empty at full speed. Motor amps should be approx. 200A or less in free lift and approx. 250A or lower in staging.

   If amp draw is at or near 450A;

   a. Check for mechanical binding of mast.

   b. Check hydraulic pressure of lift hose. If at or above 2000 psi when forks are raised empty, check for hydraulic restriction in hoses, fittings or lift cylinder safety down valves. If pressure is under 1200 psi, go to check 2.

2. Check lift solenoid for proper operation by measuring voltage across wires #31 and #89 at Tractor Interface connector P6, pin 3 (#31) and pin 10 (#89). Voltage should be near 24V during a lift request.

   a. If voltage is OK, replace Y10 solenoid.

   b. If voltage is at or near 0V, check continuity of wires #31 & #89 between the Y10 lift solenoid and the Tractor Interface connector P6. If wires are OK and the lower function is operating normally, replace the Tractor Interface Card.

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Code 51

Code Title	Code 51 - Traction Speed Proximity Sensor Failure
Reason	This code is displayed if the Display Card detects a sudden, unexpected change in travel speed OR No travel speed is detected when the operator is requesting travel and drive motor armature current is below 250A (not stalled).
System Response	
Alarm Sounds	Yes
Operator Display	Code 51
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Limited to 20% of maximum speed with full plugging capability.
Lift/Lower System	Operational

General Information:

The Display Card monitors functions on the truck. The Display Card has been programmed to check that the drive motor is turning when power is applied. Error Code 51 will be displayed if a malfunction is detected due to the following conditions;

- If an unexpected change in travel speed occurs, the Display Card will begin looking at the armature current every 50 ms (usually only 300 ms) and determine if a high amp motor stall is occurring (Error Code 49) or if, at low amps, the traction speed proximity sensor may have failed.
- No travel speed is detected and the operator is requesting more than 80% speed (via traction pot) and drive motor armature current is below 250A. No travel speed indicates the motor is not turning and the armature current below 250A indicates the motor is not stalled. Due to the accelerator traction pot requesting greater than 80% speed, the drive motor should be turning and the speed proximity sensor should be sending a speed signal to the display. The Display Card will wait for approx. 7 seconds before displaying Error Code 51.
- No travel speed is detected and the operator is requesting more than 25% but less than 80% speed (via traction pot) and drive motor armature current is below 250A. No travel speed indicates the motor is not turning and the armature current below 250A indicates the motor is not stalled. Due to the accelerator traction pot requesting greater than 25% speed, the drive motor should be turning and the speed proximity sensor should be sending a speed signal to the display. The Display Card will wait for approx. 20 seconds before displaying Error Code 51.

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Code 51

Possible Causes & Checks:

1. Make sure the motor is actually turning when Error Code 51 is displayed.
   a. If not turning, check motor for slipping armature core on shaft or a stall condition.
   b. If turning, check for speed sensor cam wheel not turning with motor armature.
2. Check speed sensor input by accessing Analyzer Mode, Category 1, Class 3, Test 1 for kph or Test 2 for mph. Drive truck forward and reverse. Is display showing speed of the truck?
   a. If YES, speed sensors are operating correctly. Replace Display Card.
   b. If NO, check speed sensors not operating correctly.
      i. Check for continuity of speed sensor wires between speed sensor harness connector and Display Card connector HD5. Repair or replace harness.
      ii. Check speed sensor voltage by measuring approx. 5V between the red and black wires at the speed sensor 3-pin connector. If voltage is incorrect, check continuity of red and black wires between connector and Display Card connector HD5. If wires OK, replace Display Card.
      iii. Check speed sensors for proper switching by removing sensor from housing, measure voltage between black and white/black wires. Voltage should be approx. 5V if sensor is in mid-air. Voltage should be near 0V when sensor tip is put next to steel (not aluminum). If not correct, replace bad sensor. Be sure to reinstall sensor in same position as removed.

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Code 57

Code Title	Code 57 - Traction Potentiometer Voltage Out-of-Neutral During POST
Reason	This code is displayed if the Display Card detects the Traction Pot Voltage is Out-of-Neutral at POST (Start-Up).
System Response	
Alarm Sounds	Yes
Operator Display	Code 57
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Operational

General Information:

When the key switch is first turned ON, the Display Card performs a Pre-Operational Start Test (POST). The POST test checks many different systems, settings and voltages for proper operation. One of the tests is to assure the traction pot neutral voltage is within the neutral dead band. The neutral dead band is a voltage range the Display Card considers to be neutral (not forward or reverse). The neutral dead band voltage range is 0.2V higher or lower than the calibrated neutral traction pot voltage. Traction pot voltage can be seen in Analyzer Mode, Category 1, Class 2, Test 2.

If the traction pot voltage is not within the calibrated neutral dead band at POST, Error Code 57 is displayed.

Example: If the traction pot voltage in neutral is 2.5V and the traction pot is calibrated at that voltage, the neutral dead band is 2.3 - 2.7V. During POST, the traction pot voltage must be within 2.3 - 2.7V, otherwise a Code 57 is displayed. The neutral dead band voltage will vary depending on the actual traction pot neutral voltage at the time of calibration.

After calibration, the truck cannot tell you what the calibrated voltage is. Therefore, there is no way to know if the traction pot voltage seen at the time of troubleshooting is the same as it was at calibration, unless it is recorded at the time of calibration. It is recommended that the calibration voltages be recorded each time after the handle is calibrated.

Possible Causes & Checks:

Error Code 57 During POST;

1. Make sure the operator is not moving the handle out of neutral during POST. If the handle is moved forward or reverse during POST, the voltage seen by the display will be out-of-neutral.
2. Check neutral traction pot voltage in Analyzer Mode.
   a. If pot voltage is lower than 2.0V or greater than 3.0V, check for poor connection of handle harness to Tractor Interface or module if equipped. If OK, replace control handle.
   b. If pot voltage is between 2.0 and 3.0V, record actual neutral voltage and

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calibrate traction pot. Test run truck. Check if neutral voltage varies from calibrated voltage. If YES, replace control handle. If voltage does not vary, return truck to service. If code reappears, check neutral voltage and compare to neutral voltage recorded at time of calibration. If neutral voltage has increased or decreased by more than 0.2V, replace the control handle.

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Code 58

Code Title	**Code 58 - Steer Limit Feedback Signal Error** **NOTE:** This error code applies only to trucks with 180° steering.
Reason	This code appears if no steer limit command was sent to the steer controller but a steer limit command was detected on the feedback lines.
System Response	
Alarm Sounds	Yes
Operator Display	Code 58
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Limited to 2.5 mph
Lift/Lower System	Operational

General Information:

The Display Manager Card monitors the 180° and steer stop A and B sensors through the Tractor Interface Card. The Display Card processes the sensor signals to determine where the transmission is in the 180° arc. If the transmission is at either steer limit, the Display Card requests the Steer Controller, through the Tractor Interface Card and using the appropriate Steer Direction Limit signal, to disable steering in the direction being steered. If the transmission is not at an electrical steer limit, the Display Card requests the Steer Controller, through the Tractor Interface Card and using the Steer Direction Limit signals, to allow steering in both directions. Feedback signals from the Steer Controller's Steer Direction Limit inputs return to the Display Card, through the Tractor Card, showing the state of the Steer Direction Limit signals. The Display Card then determines if the returned signals agree with the requested signals. If the returned signals do not agree with the requested signals, Error Code 58 is displayed.

Possible Causes and Checks:

NOTE: The following checks may also be useful when the electrical stops are not working and the mechanical stops are being used, but no Code 58 displays.

1. Steer the drive wheel to the straight forks/tractor direction of travel. Cycle the key switch ON.

   Is Error Code 58 displayed?

   Looking at the Steer Controller, is either or both LEDs, LED 2 (Lim–) and LED 3 (Lim+) illuminated?

NOTE: A dimly lit LED is not considered illuminated.

NO to both questions, proceed to Check 2.

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YES to both questions. No code should appear and no LEDs should be illuminated. The Steer Controller is being requested to limit steering in one or both directions, but the steering is not at a limit. If LED 3 (Lim+) is illuminated, check wire #82 between the Steer Controller SK1-11 and the Tractor Interface Card JP15-4 and JP8-9 for shorts. If LED 2 (Lim–) is illuminated, check wire #83 between the Steer Controller SK1-5 and the Tractor Interface Card JP6-8 and JP8-7 for shorts. Repair or replace wiring as required. If no shorts are found, replace the Tractor Manager Card.

YES to the code 58 and NO to the illuminated LEDs. No code 58 should appear. Check wire #82 between the Steer Controller SK1-11 and the Tractor Interface Card JP8-9 for shorts. Check wire #83 between the Steer Controller SK1-5 and the Tractor Interface Card JP8-7 for shorts. Repair or replace wiring as required. If no shorts are found, replace the Tractor Manager Card.

NO to the code 58 and YES to the illuminated LEDs. No LEDs should be illuminated. The Steer Controller is being requested to limit steering in one or both directions, but the steering is not at a limit. If LED 3 (Lim+) is lighted check wire #82 between the Steer Controller SK1-11 and the Tractor Interface Card JP15-4 and JP8-9 for shorts. If LED 2 (Lim–) is illuminated, check wire #83 between the Steer Controller SK1-5 and the Tractor Interface Card JP6-8 and JP8-7 for shorts. Repair or replace wiring as required. If no shorts are found, replace the Tractor Interface Card.

2. Cycle the key switch ON. Steer the drive wheel CW to the electrical stop. Verify the drive wheel is at the electrical steer stop by observing both Steer Stop A and B sensors are illuminated.

   Is Error Code 58 displayed?

   Looking at the Steer Controller, is LED 3 (Lim+) illuminated?

NOTE: A dimly lit LED is not considered illuminated.

NO to code 58 and YES to the illuminated LED, proceed to Check 3.

YES to both questions. Code 58 should not be displayed if LED 3 (Lim+) is illuminated. At the CW steer limit, LED 3 (Lim+) should be illuminated. There is a problem with the feedback circuitry. Check wire #82 between the Steer Controller SK1-11 and the Tractor Interface Card JP8-9 for open. If no open is found, replace the Tractor Interface Card.

YES to the code 58 and NO to the illuminated LED. Code 58 should not be displayed and LED 3 (Lim+) should be illuminated. Check wire #82 between the Steer Controller SK1-11 and the Tractor Interface Card JP15-4 for open. If no open is found, replace the Tractor Interface Card.

NO to both questions. LED 3 (Lim+) should be illuminated. The electrical stops are not working and the mechanical stops are being used. Replace the Steer Controller.

3. Cycle the key switch ON. Steer the drive wheel CCW to the electrical stop. Verify the drive wheel is at the electrical steer stop by observing both Steer Stop A and B sensors are illuminated.

   Is Error Code 58 displayed?

   Looking at the Steer Controller, is LED 2 (Lim–) illuminated?

NOTE: A dimly lit LED is not considered illuminated.

NO to code 58 and YES to the illuminated LED, proceed to Check 4.

YES to both questions. Code 58 should not be displayed if LED 2 (Lim–) is illuminated. At the CCW steer limit, LED 2 (Lim–) should be illuminated. There is a problem with the feedback circuitry. Check wire #83 between the Steer Controller SK1-5 and the Tractor Interface Card JP8-7 for open. If no open is found, replace the Tractor Interface Card.

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YES to the code 58 and NO to the illuminated LED. Code 58 should not be displayed and LED 2 (Lim–) should be illuminated. Check wire #83 between the Steer Controller SK1-11 and the Tractor Interface Card JP6-8 for open. If no open is found, replace the Tractor Interface Card.

NO to both questions. LED 2 (Lim–) should be illuminated. The electrical stop may not be working and the mechanical stop is possibly being used. Replace the Steer Controller.

Check 4

Check wires #82 and #83 between the Tractor Interface Card and the Steer Controller for opens, shorts, and seating connections. Inspect Tractor Interface connector JP6-8, JP15-4, JP8 pins 7 & 9 for seating connections. Inspect Steer Controller connector SK1 pins 5 & 11 for seating connections. Replace the Tractor Interface Card. Replace the Steer Controller.

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Code 59

Code Title	Code 59 - CAN Communications Failure Between the Display Card and Traction/Lift Power Amplifiers
Reason	This code is displayed if the Display Card detects that it is unable to successfully transmit CAN communication messages to the power amps for more than 5ms.
System Response	
Alarm Sounds	Yes
Operator Display	Code 59
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Inoperative

General Information:

During initial Start-Up (POST) the Display Card begins transmitting communication messages to the Traction and Lift Amps. The Display Card is programmed to wait for the amps to power-up and accept the incoming messages. The amps will normally power-up in 100ms but the Display Card will wait up to 3000ms (3 seconds) for a message response before it displays Error Code 59.

During run mode (anytime after successful Start-Up) the Display Card constantly sends and receives communication messages to and from the Traction and Lift Amps. The messages are sent at 500,000 bits of information per second. The Display Card will retry to send a failed message until it is successfully sent. However, if a response to a sent message is not received within 5 ms, after 22 retries the Display Card will display Error Code 59.

Possible Causes & Checks:

1. If Error Code 59 is intermittent, the cause may be from static electricity. A static arc can cause the CAN network to momentarily stop functioning. Make sure the truck is equipped with a static strap or chain. It should be making good contact with the floor. Install a new strap or chain if missing.
2. Check for software revision numbers by accessing Analyzer Mode, Category 6, Class 1, Test DM, TPA & LPA. If all three software revisions display zeros (DM0.0, TPA 0.00, LPA 0.00) disconnect the CAN bus harness plugs (JT2 & JL2 - 6-pin connector) from the Traction and Lift Amps.
   a. If the DM software revision number changes from zeros to a valid revision number (example DM4.0) check the CAN bus harness for shorts between the Display Card connector HD1, JT2 & JL2. Repair or replace harness as necessary.
   b. If the DM software revision number remains at zero (example DM0.0) replace the Display Card.
3. Make sure the key switch has not been cycled ON to OFF then ON again quickly. This can cause an Error Code 59 as well as Error Codes 41, 43 or 61 to appear. When the key is cycled, the OFF time should be a minimum of two seconds.

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Code 60

Code Title	Code 60 - Battery Overvoltage
Reason	This code is displayed if the Display Card detects battery voltage exceeding 45V.
System Response	
Alarm Sounds	Yes
Operator Display	Code 60
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Inoperative

General Information:

The Traction Power Amp measures battery voltage. The Display Card reads battery voltage from the Traction Power Amp. If the Display Card detects battery voltage higher than 45V, Error Code 60 is displayed. The Display Card is sensitive to short spikes over 45V. If a short spike over 45V occurs, Error Code 60 is displayed and the Display Card will drop the MM contactor in an attempt to prevent damage to the control system.

The battery voltage read by the Display Card can be monitored by accessing Analyzer Mode, Category 1, Class 2, Test 11. If the voltage is at or greater than 45V (2.5V/cell), the battery may have been overcharged or is not the correct battery for the truck. Under normal conditions, the maximum battery voltage read should not exceed 40.5V (2.25V/cell).

Possible Causes & Checks:

1. If the code occurs after the battery has been charged, check that the battery voltage does not exceed 45V after charging.

   if YES;

   a. the battery charger may be overcharging the battery

   b. battery electrolyte may be low and battery has abnormally high surface voltage

   c. battery may not have been allowed to cool after charge and has high surface voltage

   If NO, the code may be caused by either static electricity or intermittent shut down. Go to Check 2.

2. If the code occurs intermittently, the cause may be static electricity. Make sure the truck is equipped with a static strap or chain. It should be making good contact with the floor. Install a new strap or chain if missing. Go to Check 3.

3. An intermittent code may also be caused by a sudden loss of battery power. If the battery plug or MM contactor is suddenly opened removing all battery power from the truck, a sudden voltage spike in excess of 45V from the motors or solenoid coils may occur

   a. Check for poor connections at the battery plug, MM contactor tips, fuses,

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key switch and associated wiring and power cables.

b. Check for other stored codes that may indicate the root cause.

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Code 61

Code Title	Code 61 - Steer Error
Reason	This code is displayed if the Display Card detects a steer brake request from the Steer Controller is at the Tractor Interface Card connector JP8-5.
System Response	
Alarm Sounds	Yes
Operator Display	Code 61
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Operational

General Information:

During Start-Up and Run Mode the Display Card monitors the steer brake request input at the Tractor Interface Card connector JP8-5 wire #52. This signal is sent to the Tractor Interface Card by the Steer Controller and, when at battery voltage, indicates the steer system is fully operational. If the Steer Controller detects a problem in the steer system, it will display an LED error code on the steer controller and remove the voltage on wire #52, alerting the Display Card that a steer error has occurred and to shut down the truck. To troubleshoot the steer error, the LED Error Code on the Steer Controller must be viewed and evaluated. See Table 6-1.

An open, shorted or improperly seated connection on wire #52 between the Steer Controller connector SK1-8 and Tractor Interface connector JP8-5 can also generate this code. Although the steer controller is not at fault, the loss of the signal voltage triggers the Display Card to display Error Code 61.

Error Code 61 is most commonly created when the truck is turned OFF and ON in less than two seconds. The steer controller requires the key switch is OFF at least 2 seconds before being turned ON. This error code is typically displayed when the truck has displayed another error code and the operator quickly cycles the key.

Possible Causes & Checks:

1. If Error Code 61 is not constant, instruct the operator the key switch must remain OFF at least 2 seconds before being turned ON.
2. Check error code memory for other codes recorded at the same hour meter reading. Troubleshoot other error codes first.
3. If Error Code 61 is currently displayed, check the LED error code on the Steer Controller before turning the key OFF.
   a. If the only LED illuminated is the green ON LED1, the Steer Controller is not faulted. Check for battery voltage at wire #52 at the Steer Controller connector SK1-8.

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i. If 0V, check for an open or shorted connection at Steer Controller connector. If OK, Steer Controller is bad. Replace the Steer Controller.

ii. If battery voltage is present, check for battery voltage at Tractor Interface connector JP8-5 wire #52. If battery voltage is present, check for open or shorted connection at JP8-5. If OK, replace the Tractor Interface Card. If 0V, wire #52 is open between the Tractor Interface and Steer Controller. Repair or replace wire #52 as necessary.

b. If the Green LED1 and one or more of the Red LEDs are illuminated, See Table 6-1.

c. If no LEDs are illuminated, check for battery voltage at the Steer Controller connector SK1-1.

i. If battery voltage is present, replace the Steer Controller.

ii. If 0V, check for battery voltage at Tractor Interface connector JP8-4. If battery voltage is present, wire #37 between Tractor Interface and Steer Controller is open. Repair or replace wire #37 as necessary.

iii. If 0V, check Traction & Lift Amp has a heartbeat. If YES, replace the Tractor Interface Card. If NO, check for a failed K1 relay.

Table 6-1: Steer Controller Codes

LED - State	Description
LED1 - ON	Steer Controller ON
LED2 - ON	Negative (CCW) Direction Limit
LED3 - ON	Positive (CW) Direction Limit
LED4 - ON LED5 - OFF	Error In Tachometer Circuit
LED4 - OFF LED5 - ON	Error In Controller Or Motor Circuit
LED4 - ON LED5 - ON	Error In Controller
LED1 - OFF LED4 - OFF LED5 - OFF	Supply Voltage Error

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Code 62

Code Title	Code 62 - Brake Sense - Brake Will Not Engage
Reason	This code is displayed if the Display Card detects the brake should be applied but is actually released.
System Response	
Alarm Sounds	Yes
Operator Display	Code 62
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Operational

General Information:

The brake is a spring applied, electrically released disc brake system. The brake assembly consists of a brake disc, springs and an electromagnet coil. The springs press the disc and lock the brake. To release the brake, the Display Card commands the Tractor Interface Card to apply power to the brake coil. The coil lifts the disc against the springs and the brake is released. When the brake is required, the Display Card commands the Tractor Interface Card to remove power from the brake coil allowing the springs to apply pressure to the disc and stop the truck.

The brake coil is connected to wires #37 & #64. Wire #37 supplies battery positive to the brake coil when the K1 relay is energized (key switch ON). When the brake is requested to be released, the Tractor Interface Card connects wire #64 to battery negative. The Display Card monitors the voltage on wire #64. If wire #64 is at battery negative, the brake is released. If wire #64 is at battery positive, the brake is applied.

Error Code 62 is displayed when the Display Card sees the brake is released (battery negative on wire #64) though it has commanded the brake to be applied (battery positive on wire #64).

Possible Causes & Checks:

1. Check error code history by accessing Analyzer Mode, Category 2, Class 1. Check the number of Error Code 62's logged in memory. An Error Code 62 may be followed by a Code 59; if so troubleshoot the Code 62 first. The Code 59 may have been caused by the K1 relay opening suddenly when the Code 62 error occurred.
2. Check wire #64 for open or shorts between the brake coil and the Tractor Interface Card connector JP8-12. Repair or replace the wire as necessary.
3. If all wiring checks are OK, replace the Tractor Interface Card.

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Code 63

Code Title	Code 63 - Brake Sense - Brake Will Not Release
Reason	This code is displayed if the Display Card detects the brake should be released but is actually applied.
System Response	
Alarm Sounds	Yes
Operator Display	Code 63
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Operational

General Information:

The brake is a spring applied, electrically released disc brake system. The brake assembly consists of a brake disc, springs and an electromagnet coil. The springs press the disc and lock the brake. To release the brake, the Display Card commands the Tractor Interface Card to apply power to the brake coil. The coil lifts the disc against the springs and the brake is released. When the brake is required, the Display Card commands the Tractor Interface Card to remove power from the brake coil, allowing the springs to apply pressure to the disc and stop the truck.

The brake coil is connected to wires #37 & #64. Wire #37 supplies battery positive to the brake coil when the K1 relay is energized (key switch ON). When the brake is requested to be released, the Tractor Interface Card connects wire #64 to battery negative. The Display Card monitors the voltage on wire #64. If wire #64 is at battery negative, the brake is released. If wire #64 is at battery positive, the brake is applied.

Error Code 63 is displayed when the Display Card sees the brake is applied (battery positive on wire #64) though it has commanded the brake to be released (battery negative on wire #64).

Possible Causes & Checks:

1. With the key switch ON, check voltage on wire #64 at the brake coil harness 2-pin connector. Do not step on the brake pedal or right foot pedal. Brake should be applied.
   a. If wire #64 is battery positive, go to Check 2.
   b. If wire #64 is less than battery positive, check voltage on wire #37 at the brake coil harness 2-pin connector;
      i. If wire #37 is battery positive, replace the brake coil.
      ii. If wire #37 is less than battery positive, check for poor connection or open wire between brake coil harness connector and K1 relay. Check K1 relay for proper operation. Check F4 fuse.
2. Check voltage on wire #64 at the brake coil harness 2-pin connector with key switch ON and the brake pedal depressed. The brake should be released.
   a. If wire #64 is battery positive and no other codes are present, replace the Tractor Interface Card.
   b. If wire #64 is at battery negative, the brake system is operating normally. If

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code #63 is still being displayed, the Tractor Interface Card may not be communicating properly with the Display Card or the Display Card may not be properly monitoring the brake coil. First replace the Tractor Interface Card. If not corrected, replace the Display Card.

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Code 64

Code Title	Code 64 - Brake Pedal Potentiometer Voltage Out-of-Range
Reason	This code is displayed if the Display Card detects the brake pedal potentiometer voltage is out of the acceptable range (less than 0.45V or above 3.37V).
System Response	
Alarm Sounds	Yes
Operator Display	Code 64
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative - brake applied
Lift/Lower System	Operational

General Information:

The Display Card monitors the Brake Pedal Pot voltage (listed as VR3 on schematic). If the drops below 0.45V or rises above 3.37V, the Display Card will display Error Code 64, shut down the traction system and apply the brake.

The brake pot voltage can be monitored by accessing Analyzer Mode, Category 1, Class 2, Test 16. By stepping on and off the brake pedal, the brake pedal pot's minimum and maximum voltage can be read. If the voltages are beyond the limits specified above, Error Code 64 will be displayed.

The brake pot is supplied with 5V from the Tractor Interface Card. As the operator depresses the brake pedal, the pot changes resistance and the pot signal varies between 2.0V and 3.0V.

Possible Causes & Checks:

Check voltage of brake pedal pot signal as described above. Is the pot voltage below 0.45V or above 3.37V?

1. If above 3.37V, check for an open or shorted condition on the black wire between the 3-pin brake pot connector and Tractor Interface connector JP7-4. Repair or replace the wire or shielded cable as necessary.
2. If below 0.45V;
   a. Check the black wire for shorts to frame, the shield or another wire between the 3-pin brake pot connector and Tractor Interface connector JP7-4.
   b. Check voltage between the red and white (GND) wires at the 3-pin brake pot connector. The voltage should measure approx. 5.0V. If the voltage is at or near 0V, check the wires for opens or shorts between brake pot connector and Tractor Interface connector JP7-1 (red wire) and P7-17 (black wire). If wiring is OK, replace the Tractor Interface Card.

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Code 65

Code Title	Code 65 - Deadman Pedal Pot And Deadman Switch Do Not Agree
Reason	This code is displayed if the Display Card detects the brake pedal deadman switch changed states (open to closed or closed to open) outside the proper brake pot voltage range.
System Response	
Alarm Sounds	Yes
Operator Display	Code 65
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative - brake is applied
Lift/Lower System	Inoperative

General Information:

The brake pedal has several functions with respect to controlling truck operations.

1. Pedal-Up instructs the system to turn OFF the traction and lift systems and apply the brake.
2. Pedal-Down instructs the system to enable the traction and lift systems and release the brake.
3. Pedal between the UP and Down position instructs the truck to engage the traction plugging function in proportion to the actual position of the pedal. Less plugging with pedal low and more plugging as the pedal is raised. This function is accomplished by using the variable voltage signal of the brake pedal pot.

The brake pedal pot must be calibrated for the Display Card to know at what pot voltage the pedal is fully up or fully down. Once this calibration is completed, the Display Card uses this voltage range to determine brake pedal position.

The brake pedal switch is used as a redundant check to assure the information from the pedal pot is correct. The pedal switch, when adjusted correctly, will change states when the pedal is approx. 80% up from the down position.

If the Display Card detects (based on calibrated pedal pot voltage) that the pedal has passed the point where the deadman switch should have changed states, Error Code 65 will be displayed and the parking brake will automatically apply.

Possible Causes & Checks:

1. Check for proper brake switch adjustment by checking the pedal pot voltage (in Analyzer Mode) when pedal is up, down and at the point the brake switch changes states (clicks). Adjust switch if required. Refer to “Deadman (Left Foot) Switch (S3)” on page 7-89

NOTE: A written copy of the pedal voltages should be saved in the event that this code may reappear.

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2. Check for brake switch operation by accessing Analyzer Mode, Category 1, Class 1, ESY13. Operate the pedal, opening and closing the switch. The ESY13 test should display YES when the pedal is down and the switch is closed and NO when the pedal is up and the switch is open. If not as described, check for a bad switch, open or shorted wire #32 & #49 between the switch and Tractor Interface Card connector JP7-13 (wire #32) and JP7-14 (wire #49).
3. If available (see Note), check the previous pedal up and pedal down calibrated voltage values. If the voltage range is different than previously calibrated, and the pedal pot has not been re-calibrated, the pedal pot may be bad.
4. If the pedal pot voltage has changed from the previously recorded calibrated range, check the power supply voltage at wires #29 & #32 on the 3-pin connector. The voltage should measure approximately 5.0V.
5. Check pedal pot voltage in Analyzer Mode; if pedal up or pedal down voltage is changing more than 0.03V, replace the Tractor Interface Card.
6. If all previous checks do not correct the Error Code 65, call Toyota Technical Services for additional troubleshooting advice.

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Code 66

Code Title	Code 66 - Steering Configuration Does Not Match Hardware
Reason	The Tractor Interface Card version does not support the selected steering configuration or the main wiring harness does not support the selected steering configuration (Configuration Parameter CB - 180° Steering)
System Response	
Alarm Sounds	Yes
Operator Display	Code 66
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Inoperative

General Information:

At key ON, the Display Manager Card checks the truck hardware against the software steering configuration parameter CB. Depending on the value stored in Configuration CB, the software expects certain hardware responses to software tests. If the appropriate hardware response to a software test is not received, the software assumes incorrect hardware or an incorrect software configuration and an Error Code 66 is displayed.

Possible Causes and Checks:

1. Determine the steering configuration of the truck (180° or 360° steering.) One method is to observe the dash display and determine if a wheel angle pointer with eight LED arrow points is present on the display. The LEDs in the arrow points indicate the direction of travel. If the wheel angle pointer is present, the truck is equipped for 360° steering. If no wheel angle pointer is present on the display, the truck is equipped for 180° steering. Another method is to determine if the truck is equipped with Steer Stop sensors (180°) or Steer Position (360°) sensors. Open the tractor compartment rear door and look for two proximity sensors located between the steer motor and the pump motor. If the prox sensors are installed, the truck is equipped with Steer Stop sensors for 180° steering. If the prox sensors are not installed leaving two threaded holes in the chassis visible, the truck is equipped with Steer Position sensors for 360° steering. The two Steer Position sensors are located on a bracket under the chassis and monitor the ring gear teeth on the transmission. Steer Stop sensors and the Steer Position sensors use the same electrical connection to the main harness. When the steering capability of the truck has been determined proceed to check 2.

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2. Check the main wiring harness compatibility. In the 180° main wiring harness, wire #82 connects the Steer Controller connector SK1-11 to the Tractor Interface Card JP8-9 and JP15-4. Also, in the 180° main harness, wire #83 connects the Steer Controller connector SK1-5 to the Tractor Interface Card JP8-7 and JP6-8. These wires do not exist in a 360° main harness. If the main harness has been determined to be correct for the steering capability of the truck, proceed to check 3. If the harness is incorrect for the steering capability of the truck, replace the main harness with the correct harness.
3. Check the Tractor Interface Card compatibility. Verify the Control Handle connector JP10 on the Tractor Interface Card has male pins. A Tractor Interface Card with male pins is compatible with all models of the 7B Reach truck. A Tractor Interface Card with female pins is not compatible. If the Tractor Interface Card has been determined to be correct for the steering capability of the truck, proceed to check 4. Replace the Tractor Interface Card with the correct card if the JP10 connector pins are female.
4. After determining the steering configuration (check 1), the main harness compatibility (check 2) and the Tractor Interface Card compatibility (check 3), verify the Configuration parameter CB (180° Steering?) is correctly set. See “Maneuvering within Configure Mode” on page 6-8. If the truck has been determined to have 180° steering and compatible hardware, set the Configuration parameter CB to “Yes” indicating 180° steering. If the truck has been determined to have 360° steering and compatible hardware, set the Configuration parameter CB to “No” indicating 360° steering. Cycle the key switch and verify Error Code 66 does not appear.

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Code 67

Code Title	Code 67 - 180° Steering Sensor Error NOTE: This error code applies to trucks with 180° steering only.
Reason	The software detected the three steering sensors (180° sensor, Steer Stop A sensor and the Steer Stop B sensor) were all ON or all OFF at the same time. This condition should not occur during normal operation and indicates that one or more of the sensors are inoperative, incorrectly adjusted or the Tractor Interface Card or wiring is a problem. There may also be mechanical problems causing the error code.
System Response	
Alarm Sounds	Yes
Operator Display	Code 67
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Limited to 2.5 mph
Lift/Lower System	Operational

General Information:

To control the 180° electrical steering limit the truck uses three sensors:

- The Steer Stop A sensor, connected to the main wiring harness with a blue connector, and located to the right of the traction motor in the motor compartment.
- The Steer Stop B sensor, connected to the main wiring harness with a gray connector and located to the right of the traction motor in the motor compartment.

  Steer Stop A and Steer Stop B sensors are paired together with the Steer Stop A (blue connector) sensor located near the Steering Motor.
- The 180° Steering sensor, connected to the main wiring harness with a black electrical connector and located to the left of the traction motor in the motor compartment.

Each sensor contains an LED that indicates the output state of the sensor. The 180° Steering sensor serves to check for Steer Stop A and B sensor output failures. Steer Stop A and B sensors detect the 180° electrical steer limit depending on the direction of steering.

As the Drive Wheel is turned, the three sensors are activated in a specific sequence by target rings under the chassis on the transmission. The outputs from the sensors connect to the Tractor Interface Card. The Display Manager Card processes the sensor information from the Tractor Interface Card and, through the Tractor Interface Card, requests the Steer Controller to limit the steering based on the sensor output combination. Sensor output combinations of all sensors ON or all sensors OFF are invalid (the sensor target rings on the transmission should not produce these invalid combinations) and indicate a fault in the system. When the Display

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Card detects these invalid combinations, an Error Code 67 is displayed.

Possible Causes and Checks:

NOTE: The following tests may also be useful when the electrical stops are not working and the mechanical stops are being used, but no code 67 is displayed.

NOTE: Tire "windup" and "unwind" at the steer limit position may cause a Steer Stop sensor LED to be ON then OFF. Continue to steer at the steer limit position until the state of the LED is certain.

NOTE: When the three electrical steer stop sensors work correctly, the mechanical stops will not be used and the "bang" when the mechanical stops contact will not occur.

Check 1

Steer the drive wheel parallel to the truck. Locate the three sensors and observe the status of the LED on each sensor. Steer per the instructions in Table 6-2 and Table 6-3. Note sequence of LEDs on sensors as compared to the tables while steering. If sensor outputs function correctly, proceed to Check 2. If the sensor output sequence is incorrect, determine the sensor out of sequence. Check for open or shorted wiring or connections to the sensor. Check sensor adjustment (see Component Procedures section). Replace sensor.

Check 2

Using Analyzer Mode, Category 1, Class 1: Tests ESY29 (Steer Stop A Sensor) and ESY30 (Steer Stop B Sensor) and Category 4, Class 1 (180° Sensor) verify the sensor output signal agrees with both the ON and OFF LED states on the sensor. Steer the truck as required to turn the LED ON and OFF. If the outputs observed in Analyzer Mode and the sensor LEDs do not agree, proceed to Check 3.

If Check 1 passed and the outputs observed in Analyzer Mode and the LEDs agree, the problem may be intermittent. If the problem is intermittent, steer fully CCW and fully CW carefully observing the sensor LEDs. The sequence must be exactly as shown in Table 6-2 and Table 6-3. If a sensor LED momentarily changes state, producing an invalid condition of all sensors OFF or all sensors ON, that is a problem. If an invalid condition is observed, check all the sensors for wiring open or shorts and check adjustment of all sensors (see Component Procedures section). The problem may also be mechanical. Sensor target rings are attached to the top of the transmission. Missing expansion plugs (in the target rings), loose or damaged target rings can cause this problem. An excessively loose steering bearing in the transmission can cause this problem. Verify the problem is not electrical before attempting mechanical solutions.

Check 3

At this check, a sensor signal output (the sensor LED may not correctly reflect the sensor signal output during some sensor failure conditions) wiring between the sensor and the Tractor Interface Card or the Tractor Interface Card itself may be at fault. Using a voltmeter and the electrical schematic, observe the voltage at the appropriate sensor input at the Tractor Interface Card while steering fully CCW and fully CW. If the voltmeter does not show a voltage change, check the wiring for a open or shorts between the sensor and the Tractor Interface Card. Repair or replace the wiring as required. Replace the sensor. If the voltmeter showed a voltage change, replace the Tractor Interface Card.

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Table 6-2: Steering Counterclockwise

Drive Wheel Steering Counterclockwise (viewed from top)	180° Steering Sensor (black connector) Tractor Interface input JP9-13 wire #32	Steer Stop A Sensor (blue connector) Tractor Interface input JP13-1 wire #80	Steer Stop B Sensor (gray connector) Tractor Interface input JP11-1 wire #81
When the drive wheel is parallel to the truck the LED is:	ON	OFF	OFF
As the drive wheel steers and approaches the steer stop the LED is:	ON	ON	OFF
As the drive wheel continues steering toward the steer stop the LED is:	OFF	ON	OFF
At the electrical steer stop the LED is:	OFF	ON	ON

Table 6-3: Steering Clockwise

Drive Wheel Steering Clockwise (viewed from top)	180° Steering Sensor (black connector) Tractor Interface input JP9-13 wire #32	Steer Stop A Sensor (blue connector) Tractor Interface input JP13-1 wire #80	Steer Stop B Sensor (gray connector) Tractor Interface input JP11-1 wire #81
When the drive wheel is parallel to the truck the LED is:	ON	OFF	OFF
As the drive wheel steers and approaches the steer stop the LED is:	ON	OFF	ON
As the drive wheel continues steering toward the steer stop the LED is:	OFF	OFF	ON
At the electrical steer stop the LED is:	OFF	ON	ON

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Code 68

Code Title	**Code 68 - Steer Limit Feedback Signal Error** **NOTE:** This error code applies to trucks with 180° steering only.
Reason	This code appears if a CW (viewed from top) steer limit command sent to the steer controller does not appear on the feedback line. See Code 58 also.
System Response	
Alarm Sounds	Yes
Operator Display	Code 68
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Limited to 2.5 mph
Lift/Lower System	Operational

General Information:

The Display Manager Card monitors the 180° sensor and steer stop A and B sensors through the Tractor Interface Card. The Display Card processes the sensor signals to determine where the transmission is in the 180° arc. If the transmission is at the CCW steer limit, the Display Card requests the Steer Controller, through the Tractor Interface Card and using the Negative Direction Limit signal, to disable steering in the CCW direction. A Feedback signal from the Steer Controller's Negative Direction Limit input returns to the Display Card, through the Tractor Interface Card, showing the state of the Negative Direction Limit signal. The Display Card then determines if the returned signal agrees with the requested signal. If the returned signal does not agree with the requested signal, an Error Code 68 displays.

Possible Causes and Checks:

NOTE: Tire "windup" and "unwind" at the steer limit position may cause the Direction Limit signal to be ON then OFF. Continue to steer at the steer limit position until the state of the signal is certain.

Check 1

Cycle the key switch ON. Steer the drive wheel CCW to the electrical stop. Verify the drive wheel is at the electrical steer stop by observing both Steer Stop A and B sensors are illuminated.

Is Error Code 68 displayed?

Looking at the Steer Controller, is LED 2 (Lim–) illuminated?

NOTE: A dimly lit LED is not considered illuminated.

NO to Code 68 and YES to the illuminated LED, proceed to Check 2.

YES to both questions. Code 68 should not be displayed if LED 2 (Lim–) is illuminated. At the CCW steer limit, LED 2 (Lim–) should be illuminated. There is a problem with the feedback circuitry. Check wire #83 between the Steer Controller SK1-5 and the Tractor

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Interface Card JP8-7 for open. If no open is found, replace the Tractor Interface Card.

YES to the Code 68 and NO to the illuminated LED. Code 68 should not be displayed and LED 2 (Lim–) should be illuminated. Check wire #83 between the Steer Controller SK1-11 and the Tractor Interface Card JP6-8 for open. If no open is found, replace the Tractor Interface Card.

NO to both questions. LED 2 (Lim–) should be illuminated. The electrical stop may not be working and the mechanical stop is possibly being used. Replace the Steer Controller.

Check 2

Check wire #83 between the Tractor Interface Card and the Steer Controller for opens, shorts or seating connections. Inspect Tractor Interface connector JP6-8 and JP8-7 for improper seating connections. Inspect Steer Controller connector SK1-5 for improper seating connection. Replace the Tractor Interface Card. Replace the Steer Controller.

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Code 69

Code Title	Code 69 - Steer Limit Feedback Signal Error NOTE: This error code applies to trucks with 180° steering only.
Reason	This code appears if a CW (viewed from top) steer limit command sent to the steer controller does not appear on the feedback line. See Code 58 also.
System Response	
Alarm Sounds	Yes
Operator Display	Code 69
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Limited to 2.5 mph
Lift/Lower System	Operational

General Information:

The Display Manager Card monitors the 180° sensor and steer stop A and B sensors through the Tractor Interface Card. The Display Card processes the sensor signals to determine where the transmission is in the 180° arc. If the transmission is at the CW steer limit, the Display Card requests the Steer Controller, through the Tractor Interface Card and using the Positive Direction Limit signal, to disable steering in the CW direction. A Feedback signal from the Steer Controller's Positive Direction Limit input returns to the Display Card, through the Tractor Interface Card, showing the state of the Positive Direction Limit signal. The Display Card then determines if the returned signal agrees with the requested signal. If the returned signal does not agree with the requested signal, an Error Code 69 displays.

Possible Causes and Checks:

NOTE: Tire "windup" and "unwind" at the steer limit position may cause the Direction Limit signal to be ON then OFF. Continue to steer at the steer limit position until the state of the signal is certain.

Check 1

Cycle the key switch ON. Steer the drive wheel CW to the electrical stop. Verify the drive wheel is at the electrical steer stop by observing both Steer Stop A and B sensors are illuminated.

Is Error Code 69 displayed?

Looking at the Steer Controller, is LED 3 (Lim+) illuminated?

NOTE: A dimly lit LED is not considered illuminated.

NO to Code 69 and YES to the illuminated LED, proceed to Check 2.

YES to both questions. Code 69 should not be displayed if LED 3 (Lim+) is illuminated. At the CW steer limit, LED 3 (Lim+) should be illuminated. There is a problem with the feedback circuitry. Check wire #82 between the Steer Controller SK1-11 and the Tractor Interface Card JP8-9 for open. If no open is found, replace the Tractor Interface Card.

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YES to the Code 69 and NO to the illuminated LED. Code 69 should not be displayed and LED 3 (Lim+) should be illuminated. Check wire #82 between the Steer Controller SK1-11 and the Tractor Interface Card JP15-4 for open. If no open is found, replace the Tractor Interface Card.

NO to both questions. LED 3 (Lim+) should be illuminated. The electrical stops are not working and the mechanical stops are being used. Replace the Steer Controller.

Check 2

Check wire #82 between the Tractor Interface Card and the Steer Controller for opens, shorts or improper seating connections. Inspect Tractor Interface connector JP15-4 and JP8-9 for improper seating connections. Inspect Steer Controller connector SK1-11 for improper seating connection. Replace the Tractor Interface Card. Replace the Steer Controller.

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Code 70

Code Title	Code 70 - Traction Speed Proximity Sensor Disconnected
Reason	This code is displayed if the Display Card detects one or both of the Speed Proximity Sensors are disconnected.
System Response	
Alarm Sounds	Yes
Operator Display	Code 70
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Limited to 20% of maximum speed with full plugging capability.
Lift/Lower System	Operational

General Information:

The two speed proximity sensors located on top of the drive motor connect directly to the Display Card at connector HD5. The Display Card detects if one or both of the speed sensors are disconnected from the 5V power supply wires (red or black). Each speed sensor is connected to the Display Card by 3 wires;

- Red striped wire = 5V positive power supply to the speed sensors
- Black wire = negative power supply wire to the speed sensors
- White striped wire = speed signal from the speed sensor to the Display Card

If the red striped or black wire is open, the Display Card will show Error Code 70 and reduce traction speed. If the white striped wire is open, the display may show Error Codes 49 or 51.

Travel speed can be monitored by accessing Analyzer Mode, Category 1, Class 3, and select kph (kilometers-per-hour) or mph (miles–per-hour) by pressing the arrow buttons. If Error Code 70 is displayed, no speed should be indicated.

Possible Causes and Checks:

1. Check if speed is displayed when truck is traveling. If displayed speed is correct, Display Card may be incorrectly displaying Error Code 70. Perform the following check before replacing the Display Card.
2. Check for approx. 5V between the red striped and black wires on each of the two speed sensors 3-pin connector.
   a. If 0V, check continuity of red striped and black wires from speed sensors 3-pin connector to Display Card connector HD5. Repair or replace harness as necessary.
   b. If 5V, check for poor connection of the 3-pin connector harness connector to the speed sensor connector. If the voltage is OK, one or both of the speed sensors are defective. Replace one or the other sensor to see if only one is defective or replace both sensors to assure the problem is solved.
3. If the above checks do not resolve the Error Code 70, replace the Display Card.

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Code 71

Code Title	Code 71 - Mast Switch 1 Not Crossed
Reason	This code is displayed if the Display Card detects that while lifting at 80% or more lift speed for longer than 7 seconds, Mast Switch 1 has not turned OFF.
System Response	
Alarm Sounds	Yes
Operator Display	Code 71
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Limited to 2.5 mph
Lift/Lower System	Operational

General Information:

The Display Card will display Error Code 71 if it detects the operator has been lifting at 80% or greater speed for longer than 7 seconds and Mast Switch 1 has not turned OFF. Mast Switch 1 will turn OFF when the mast rails begin staging (raising). When Mast Switch 1 turns OFF, the Display Card limits the travel speed due to the lift height. At 80% or greater lift speed, the mast rails should begin lifting before 7 seconds has elapsed.

This code was designed to prevent the possibility of full travel speed with the mast raised above freelift height. If this code is displayed, a problem with either the Mast Switch 1 or hydraulic system may exist. If Mast Switch 1 is bad, the OFF signal may not be sent. A hydraulic problem may exist if, at 80% or greater pump motor speed, the mast is lifting very slow.

Possible Causes and Checks:

1. Check Mast Switch 1 for proper operation by accessing Analyzer Mode, Category 1, Class 1, ESY22. Does ESY22 indicate that Mast Switch 1 is ON (YES) when forks are fully lowered to the floor and changes to NO when the mast rails begin lifting?
   a. If Mast Switch 1 changes from YES to NO, go to check 2.
   b. If Mast Switch 1 does not change from YES to NO, go to check 3.
2. Check for abnormally slow lift speeds by measuring the time to raise the forks from the floor until Mast Switch 1 turns OFF (YES to NO) using full speed lift.
   a. If greater than 7 seconds;
      i. Check hydraulic system for bad pump, restriction in lift system, binding in mast.
      ii. Check for near battery voltage across pump motor. If motor voltage is low, Lift Amp or motor may be bad.
   b. If less than 7 seconds, Display Card may be incorrectly displaying Error Code 71. Replace Display Card.
3. Check Mast Switch 1 and harness for opens or shorts.
   a. Check for battery voltage across wires #31 & #32 at Tractor Interface Card

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connector P9-1 (#31) and P9-9 (#32, GND).

i. If 0V, replace the Tractor Interface Card.

ii. If battery voltage, check for battery voltage on wire #79 at Tractor Interface connector P9-16 with forks lowered to the floor.

- If 0V, check for open circuit of one of the three Mast Switch 1 wires between the Tractor Interface Card and Mast Switch 1 connector at base of mast. Repair or Replace harness as necessary.
- If battery voltage, replace the Tractor Interface Card.

4. Check for defective Mast Switch 1. Measure for battery voltage at wires #31 & 32 at Mast Switch 1 harness connector. If battery voltage, measure voltage at wires #79 & #32 while holding a piece of metal against the end of the switch. If 0V, replace Mast Switch 1.

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Code 72

Code Title	Code 72 - Tractor Interface Clock Chip Inoperative
Reason	This code is displayed when the Display Card is unable to write data to the clock chip located in the Tractor Interface Card.
System Response	
Alarm Sounds	Yes
Operator Display	Code 72
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	1.0 mph
Lift/Lower System	Operational

General Information:

The Display Card and the Tractor Interface Card continuously communicate. If the Display Card is unable to write data to the clock chip located on the Tractor Interface Card, Error Code 72 is displayed.

This code may be caused by static electricity, low clock battery located on the Tractor Interface Card or a defective Tractor Interface Card.

Possible Causes and Checks:

1. If Error Code 72 is intermittent, the cause may be static electricity. Make sure the truck is equipped with a static strap or chain. It should make good contact with the floor. Install a new strap or chain if missing.
2. Check the battery located on the Tractor Interface Card. The battery, expected to last ten years, may be low or dead. The battery may be replaced as a low cost alternative to replacement of the Tractor Interface Card. If a new battery eliminates the Error Code 72, replace the Tractor Interface Card. A defective Tractor Interface Card may have been caused by excessive shock or vibration.

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Code 73

Code Title	Code 73 - Traction Motor Field Circuit Open
Reason	This code is displayed if the Traction Power Amp detects the drive motor field circuit is open.
System Response	
Alarm Sounds	Yes
Operator Display	Code 73
Traction Power Amplifier	Energized (In) - LED = Code 1, 3
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Inoperative

General Information:

The Traction Amp reported to the Display Card that it has detected an open in the drive motor field circuit. This open can be located in the motor field, the Traction Amp or the motor cables between the Traction Amp and motor field terminals.

The Traction Amp applies power to the traction motor field when the MM contactor closes. Power is applied even if the truck is in neutral. Any interruption of current in the traction motor field circuit will cause Error Code 73 to be displayed.

Possible Causes and Checks:

1. Check resistance of the traction motor field. Field resistance should be approx. 1.5 to 2.5 ohms.
   a. If 0 ohms, check with field wiring removed. If still 0 ohms, repair or replace traction motor.
   b. If greater than 2.5 ohms, motor field has high resistance, repair or replace traction motor.
2. Check continuity of traction motor field cables. Repair or replace if higher than 0.2 ohms.
3. If Error Code 73 displays when MM contactor is pulled in, the Traction Amp may have an internal failure. Replace the Traction Amp.
4. If the MM contactor is unexpectedly opened, the Traction Amp will see a loss in battery voltage to the motor field and interpret it as a motor field failure. The MM contactor can unexpectedly open for the following reasons;
   a. Poor connection of the MM contactor coil wires at the Tractor Interface Card or the contactor coil.
   b. Bad contactor where the tips bounce open during travel or lose connection due to burnt tips.
   c. Poor connection of the Traction and Lift Amp PC Control wires between the amps and the Tractor Interface Card.
      i. Traction Amp PC Control is wire #36 from Traction Amp connector JT1-17 to Tractor Interface Card connector P8-11
      ii. Lift Amp PC Control is wire #75 from Lift Amp connector JL1-17 to Tractor Interface Card connector P8-10

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d. Lift Amp bad, removing negative voltage from PC control wire #75 with no reported Lift Amp error code.

5. If the above check does not eliminate the Error Code 73, check for any signs of intermittent open of the battery power to the truck. Items to check are as follows;

   a. Poor connection of battery connector due to wear, damage or connection of contact terminal to cable.

   b. A loose connection of power cables, damaged or fatigued fuses or loose connections of control wires.

   c. Truck operation on an excessively rough floor.

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Code 74

Code Title	Code 74 - Traction Power Amplifier Armature Sensor Failure
Reason	This code is displayed if the Traction Power Amp detects a failure of its internal armature current sensor.
System Response	
Alarm Sounds	Yes
Operator Display	Code 74
Traction Power Amplifier	Energized (In) - LED = Code 1, 3
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Inoperative

General Information:

The Traction Amp reported to the Display Card that it has detected an internal failure of the armature current sensor. The current sensor is a device the Traction Amp uses to monitor the actual traction motor armature amps. The device is internal to the Traction Amp and is not serviceable.

The traction motor armature amps can be monitored on the display during operation by accessing Analyzer Mode, Category 1, Class 2, Test 0.

Possible Causes and Checks:

1. Check for a damaged cable or poor connection of the M– cable between the Traction Amp and the traction motor A2 stud.
2. Check for a damaged cable or poor connection of the B– cable between the Traction Amp & Lift Amp B– connection and between the Lift Amp B– connection and the battery connector.
3. If the cables are OK, replace the Traction Amp.

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Code 75

Code Title	Code 75 - Traction Power Amplifier Field Sensor Failure
Reason	This code is displayed if the Traction Power Amp detects a failure of its internal field current sensor.
System Response	
Alarm Sounds	Yes
Operator Display	Code 75
Traction Power Amplifier	Energized (In) - LED = Code 1, 3
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Inoperative

General Information:

The Traction Amp reported to the Display Card that it has detected an internal failure of the field current sensor. The current sensor is a device the Traction Amp uses to monitor the actual traction motor field amps. The device is internal to the Traction Amp and is not serviceable.

The traction motor field amps can be monitored on the display during operation by accessing Analyzer Mode, Category 1, Class 2, Test 1.

Possible Causes and Checks:

1. Check for damaged or poor connection of the traction motor field cables between the Traction Amp F1 & F2 connections and the traction motor E1 & E2 studs.
2. If the cables are OK, replace the Traction Amp.

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Code 76

Code Title	Code 76 - Traction Power Amplifier MM Contactor Missing
Reason	This code is displayed if the Traction Power Amp detects an open in the PC Control circuit (wire #36).
System Response	
Alarm Sounds	Yes
Operator Display	Code 76
Traction Power Amplifier	Energized (In) - LED = Code 3, 4
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Inoperative

General Information:

The Traction Amp reported to the Display Card that it has detected the PC Control circuit is open. This error will be detected after the brake pedal or right foot pedal is depressed.

Possible Causes and Checks:

1. Check for continuity of wire #36 between Traction Power Amp connector JT1-17 and Tractor Interface Card connector P8-11. Repair or replace harness as necessary.
2. If wire #36 and its connections to the Traction Amp and Tractor Interface Card are OK, replace the Tractor Interface Card.
3. If replacing the Tractor Interface Card does not eliminate the Error Code 76, replace the Traction Power Amp.

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Code 77

Code Title	Code 77 - Lift Power Amplifier Armature Sensor Failure
Reason	This code is displayed if the Lift Power Amp detects an internal failure of the internal armature current sensor.
System Response	
Alarm Sounds	Yes
Operator Display	Code 77
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Code 1, 3
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Inoperative

General Information:

The Lift Amp reported to the Display Card that it has detected an internal failure of the armature current sensor. The current sensor is a device the Lift Amp uses to monitor the actual pump motor amps. The device is internal to the Lift Amp and is not serviceable.

Possible Causes and Checks:

1. Check for a damaged cable or poor connection of the M– cable between the Lift Amp and the pump motor D1 stud.
2. Check for a damaged cable or poor connection of the B– cable between the Lift Amp and the battery connector.
3. If the cables are OK, replace the Lift Amp.

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Code 78

Code Title	Code 78 - Lift Power Amplifier MM Contactor Missing
Reason	This code is displayed if the Lift Power Amp detects an open in the PC Control circuit (wire #75).
System Response	
Alarm Sounds	Yes
Operator Display	Code 78
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Code 3, 4
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Inoperative

General Information:

The Lift Amp reported to the Display Card that it has detected the PC Control circuit is open. This error will be detected after the brake pedal or right foot pedal is depressed.

Possible Causes and Checks:

1. Check for continuity of wire #75 between Traction Power Amp connector JL1-17 and Tractor Interface Card connector P8-10. Repair or replace harness as necessary.
2. If wire #75 and its connections to the Lift Amp and Tractor Interface Card are OK, replace the Tractor Interface Card.
3. If replacing the Tractor Interface Card does not eliminate the Error Code 78, replace the Lift Power Amp.

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Code C1

Code Title	Code C1 - +12V Out-of-Range
Reason	This code is displayed if the Display Card detects the 12V power supply on the Tractor Interface Card is less than 10V or greater than 14V.
System Response	
Alarm Sounds	Yes
Operator Display	Code C1
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Inoperative

General Information:

The Display Card monitors the 12V power supply generated on the Tractor Interface Card. This supply is used by the Display Card, as well as other truck components. If the Display Card detects the 12V power supply has increased to over 14V or has dropped to below 10V, the Error Code C1 is displayed.

The 12V power supply voltage can be displayed by accessing Analyzer Mode, Category 1, Class 2, Test 13.

Possible Causes and Checks:

1. Check the 12V power supply by accessing it in Analyzer Mode.
   a. If 14V or higher, check for proper voltage battery. If OK, replace the Tractor Interface Card.
   b. If 10V or below;

NOTE: Do not remove tractor interface connector P2, P3 or P12.

   i. One at a time, remove the Tractor Interface harness connectors while monitoring the displayed voltage. If the voltage increases to 10-14V, check for shorted wires or bad components connected to the connector removed.
   ii. Remove Display Card connector HD5. If the voltage increases to 10-14V, check speed sensors and harness connections for a short circuit.
2. If the above checks do not lead to a solution, replace the Tractor Interface Card.

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Code EC

Code Title	Code EC - Display Card Operating System Error
Reason	This code is displayed if the Display Card detects an internal failure of the Firmware Chip, resulting in software corruption or a ram memory chip failure resulting in bad data.
System Response	
Alarm Sounds	Yes
Operator Display	Code EC
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Inoperative

General Information:

If during start-up (POST) the Display Card's memory is found to be corrupted, Error Code EC is displayed. This may have occurred due to a failure of the replaceable firmware chip, Display Card components or from static electricity.

While Error Code EC is present, none of the on-board program modes (Analyzer, Tuning, Configure or Calibration) are operational.

Possible Causes and Checks:

1. Turn the key switch OFF then ON to see if the code clears. If the code clears, it may have been due to static electricity or shorts to the frame. Make sure the truck is equipped with a static strap or chain. It should be making good contact with the floor. Install a new strap or chain if missing. A static electricity arc can cause a temporary interruption of display operation. Repeated arcs of static electricity may eventually cause permanent failure of the Display Card. Inspect for shorts to frame.

   NOTE: Key switch must remain OFF a minimum of 2 seconds during key cycling. Error Code 61 may occur if key is cycled too rapidly.

2. Replace Display Card firmware chip and attempt to re-calibrate truck. If unable to calibrate or Error Code EC still occurs, replace the Display Card.

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Code E1

Code Title	**Code E1 - Mast Height Encoder Channel A or B Signal Failure** **NOTE:** This error code is displayed on the Mast Height Indicator display.
Reason	This code is displayed if the Height Indicator detects the square wave signals from the Height Encoder are missing or erratic.
System Response	
Alarm Sounds	No
Operator Display	Code E1 is displayed on the Mast Height Indicator
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Operational
Lift/Lower System	If Lift Inhibit is active, lift is inoperative unless UP arrow is depressed during lift function.

General Information:

This error code is for the Mast Height Indicator option.

Possible Causes and Checks:

1. Check for poor or loose connections on the Height Indicator and Height Encoder.
2. Check for damaged wires between the Height Indicator and Height Encoder.
3. Make sure the Height Encoder is rotating properly (not stalled or skipping) as the mast rails are raised.
4. If all of the above checks OK, replace the Height Encoder and calibrate.
5. If replacing the Height Encoder does not eliminate the E1 Error Code, replace the Height Indicator and calibrate.

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Code E2

Code Title	**Code E2 - Mast Height Encoder Failure** **NOTE:** This error code is displayed on the Mast Height Indicator display.
Reason	This code is displayed if the Height Indicator sees no Height Encoder pulses as Mast Switch 1 is crossed and staging begins. (The intermediate column moves up a couple of inches, rotating the Height Encoder, before Mast Switch 1 turns OFF).
System Response	
Alarm Sounds	No
Operator Display	Code E2 is displayed on the Mast Height Indicator
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Operational
Lift/Lower System	If Lift Inhibit is active, lift is inoperative unless UP arrow is depressed during lift function.

General Information:

This error code is for the Mast Height Indicator option.

Possible Causes and Checks:

1. Make sure the Height Encoder is rotating properly (not stalled or skipping) as the mast rails are raised.
2. Check for poor or loose connections on the Height Indicator and Height Encoder.
3. Check for damaged wires between the Height Indicator and Height Encoder.
4. If all of the above checks OK, replace the Height Encoder and calibrate.
5. If replacing the Height Encoder does not eliminate the E2 Error Code, replace the Height Indicator and calibrate.

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Code E3

Code Title	**Code E3 - Mast Height Indicator COP Time-Out** **NOTE:** This error code is displayed on the Mast Height Indicator display.
Reason	This code is displayed when the COP timer, monitoring the operation, times-out due to a probable Height Indicator failure. The COP timer is internal to the Height Indicator.
System Response	
Alarm Sounds	No
Operator Display	Code E3 is displayed on the Mast Height Indicator
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Operational
Lift/Lower System	If Lift Inhibit is active, lift is inoperative unless UP arrow is depressed during lift function.

General Information:

This error code is for the Mast Height Indicator option.

Possible Causes and Checks:

1. Cycle the key switch several times, waiting 5 seconds during each OFF period. If proper operation resumes, the problem may have been caused by static electricity. Check for static strap and install if not equipped.
2. Check for poor or loose connections at the Height Indicator.
3. If the above checks do not eliminate the E3 code, replace the Height Indicator.

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Code E4

Code Title	**Code E4 - Mast Height Indicator Invalid Op-Code** **NOTE:** This error code is displayed on the Mast Height Indicator display.
Reason	This code is displayed if the Height Indicator detects an invalid Op-Code. This is a failure internal to the Height Indicator.
System Response	
Alarm Sounds	No
Operator Display	Code E4 is displayed on the Mast Height Indicator
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Operational
Lift/Lower System	If Lift Inhibit is active, lift is inoperative unless UP arrow is depressed during lift function.

General Information:

This error code is for the Mast Height Indicator option.

Possible Causes and Checks:

1. Cycle the key switch several times, waiting 5 seconds during each OFF period. If proper operation resumes, the problem may have been caused by static electricity. Check for static strap and install if not equipped.
2. Check for poor or loose connections at the Height Indicator.
3. If the above checks do not eliminate the E4 code, replace the Height Indicator.

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Code E5

Code Title	**Code E5 - Mast Height Indicator COP Not Enabled** **NOTE:** This error code is displayed on the Mast Height Indicator display.
Reason	This code is displayed if the Height Indicator detects the COP/Watchdog Timer is not enabled.
System Response	
Alarm Sounds	No
Operator Display	Code E5 is displayed on the Mast Height Indicator
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Operational
Lift/Lower System	If Lift Inhibit is active, lift is inoperative unless UP arrow is depressed during lift function.

General Information:

This error code is for the Mast Height Indicator option.

Possible Causes and Checks:

1. Cycle the key switch several times, waiting 5 seconds during each OFF period. If proper operation resumes, the problem may have been caused by static electricity. Check for static strap and install if not equipped.
2. Check for poor or loose connections at the Height Indicator.
3. If the above checks do not eliminate the E5 code, replace the Height Indicator.

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Code E6

Code Title	**Code E6 - Mast Height Indicator Memory Check Failed** **NOTE:** This error code is displayed on the Mast Height Indicator display.
Reason	This code is displayed if the Height Indicator detects the Mast Switch 1 or Lift Cut-Out heights were not properly saved in memory. This is a memory failure internal to the Height Indicator.
System Response	
Alarm Sounds	No
Operator Display	Code E6 is displayed on the Mast Height Indicator
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Operational
Lift/Lower System	If Lift Inhibit is active, lift is inoperative unless UP arrow is depressed during lift function.

General Information:

This error code is for the Mast Height Indicator option.

Possible Causes and Checks:

1. Cycle the key switch several times, waiting 5 seconds during each OFF period. Re-calibrate and check for proper operation.
2. If the above check does not eliminate the E6 code, replace the Height Indicator.

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Code FD

Code Title	Code FD - Communication Error
Reason	This code is displayed when the Tractor Interface Card is not properly communicating with the Display Card.
System Response	
Alarm Sounds	Yes
Operator Display	Code FD
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Inoperative

General Information:

The Display Card and the Tractor Interface Card continuously communicate. The Tractor Interface Card is programmed to echo commands received from the Display Card in order to verify communications. If a command is not echoed back in 10 tries, the Tractor Interface Card is malfunctioning, the Display Card is bad or the communication harness between Tractor Interface connector JPD2 and Display Card connector JPS2 is open or shorted.

Possible Causes and Checks:

1. Cycle the key switch several times, waiting 2 seconds during each OFF period. If the error code clears, it may have been caused by static electricity or shorts to the frame. Make sure the truck is equipped with a static strap or chain. It should be making good contact with the floor. Install a new strap or chain if missing. A static arc can cause a temporary interruption of Tractor Interface and Display Card communication. Repeated arcs of static electricity may eventually cause permanent failure of the Tractor Interface and Display Card. Check for shorts to frame.

   NOTE: Key switch must remain OFF a minimum of 2 seconds during key cycling. Error Code 61 may occur if key is cycled too rapidly.

2. Inspect the harness for poor connections, opens or shorts between the Tractor Interface connector JPD2 and the Display Card connector JPS2. Replace the harness if necessary.
3. Replace the Tractor Interface Card.
4. If the above checks do not solve the error code, replace the Display Card.

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Code F1

Code Title	Display Card COP Time-out (COP = Computer Operating Properly; also known as Watchdog timer)
Reason	This code is displayed when the COP timer monitoring the Display Card operation times out due to a probable Display Card failure. The COP timer is internal to the Display Card.
System Response	
Alarm Sounds	Yes
Operator Display	Code F1
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Inoperative

General Information:

The Display Card is designed with a COP or Watchdog timer that counts down and is reset. If the Display Card software is operating properly, it will reset the Watchdog timer before it counts down to zero. If, for any reason, the Display Card forgets or is unable to reset the timer and the timer counts to zero, the control system will shut down and display Error Code F1. If the Display Card allows the watchdog to time-out, the Display Card has failed.

Possible Causes and Checks:

1. Cycle the key switch several times, waiting 2 seconds during each OFF period. If the error code clears, the problem may have been caused by static electricity. Make sure the truck is equipped with a static strap or chain. It should be making good contact with the floor. Install new strap or chain if missing. A static arc can cause a temporary interruption of Display Card operation. Repeated arcs of static electricity may eventually cause permanent failure of the Display Card.

   NOTE: Key switch must remain OFF a minimum of 2 seconds during key cycling. Error Code 61 may occur if key is cycled too rapidly.

2. If these checks do not solve the error code, replace the Display Card.

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Code F2

Code Title	Display Card Invalid Op-Code
Reason	This code is displayed if the Display Card detects an invalid Op-Code. This is a failure internal to the Display Card.
System Response	
Alarm Sounds	Yes
Operator Display	Code F2
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Inoperative

General Information:

The Display Card contains a microprocessor, a firmware memory chip, displays and other logic chips. The microprocessor “runs” the software program contained in the firmware chip. The program is a series of commands and data, structured in a particular order specific to the desired truck performance. In software, the commands are called operation codes or op-codes. Every microprocessor has a specific set of op-codes that it is capable of “running”. If the microprocessor detects an op-code that is not valid, it will display Error Code F2. This is a failure internal to the Display Card and can be caused by a microprocessor or firmware failure or failure of another logic chip. Externally, this failure can be caused by electrical noise affecting operation of the logic chips on the Display Card.

Possible Causes and Checks:

1. Cycle the key switch several times, waiting 2 seconds during each OFF period. If the error code clears, the problem may have been caused by static electricity. Make sure the truck is equipped with a static strap or chain. It should be making good, contact with the floor. Install a new strap or chain if missing. A static arc can cause a temporary interruption of Display Card operation. Repeated arcs of static electricity may eventually cause permanent failure of the Display Card.

   NOTE: Key switch must remain OFF a minimum of 2 seconds during key cycling. Error Code 61 may occur if key is cycled too rapidly.

2. Check for poor connections at the Display Card connectors. Repair or replace as necessary.
3. Make sure no unapproved devices have been connected to the Display Card or truck wiring.
4. If these checks do not solve the error code, replace the Display Card.

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Code F3

Code Title	Display Card CAN or WSI Reset
Reason	This code is displayed if communication monitored for errors is detected to have failed.
System Response	
Alarm Sounds	Yes
Operator Display	Code F3
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Inoperative

General Information:

The Display Card communicates with devices internal and external to the Display Card. Communications in the form of “messages” are continually exchanged with the Traction and Lift Power Amps. Other forms of communications occur between logic chips on the Display Card. Some of these communications are monitored. If a monitored communication is detected to have failed, Error Code F3 is displayed.

Possible Causes and Checks:

1. Cycle the key switch several times, waiting 2 seconds during each OFF period. If the error code clears, the problem may have been caused by static electricity. Make sure the truck is equipped with a static strap or chain. It should be making good contact with the floor. Install a new strap or chain if missing. A static arc can cause a temporary interruption of Display Card operation or affect other devices that communicate with the Display Card. Repeated arcs of static electricity may eventually cause permanent failure of any device.

NOTE: Key switch must remain OFF a minimum of 2 seconds during key cycling. Error Code 61 may occur if key is cycled too rapidly.

2. Check for poor connections at the Display Card connectors. Repair or replace as necessary.
3. Inspect the harness for poor connections, opens and shorts. Replace the harness if necessary.
4. If these checks do not solve the error code, replace the Display Card.

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Code F7

Code Title	**Display Card COP Not Enabled** (COP = Computer Operating Properly; also known as Watchdog timer)
Reason	This code is displayed if the Display Card detects that the COP/ Watchdog timer is not enabled.
System Response	
Alarm Sounds	Yes
Operator Display	Code F7
Traction Power Amplifier	Energized (In) - LED = Heartbeat
Lift Power Amplifier	Energized (In) - LED = Heartbeat
Performance Limits	
Travel System	Inoperative
Lift/Lower System	Inoperative

General Information:

During key switch start-up (POST), the Display Card checks that all necessary functions are active and operational. If the Display Card detects the COP/Watchdog timer function is not active, Error Code F7 is displayed.

Possible Causes and Checks:

1. Cycle the key switch several times, waiting 2 seconds during each OFF period. If the error code clears, the problem may have been caused by static electricity. Make sure the truck is equipped with a static strap or chain. It should be making good contact with the floor. Install a new strap or chain if missing. A static arc can cause a temporary interruption of Display Card operation. Repeated arcs of static electricity may eventually cause permanent failure of the Display Card.

NOTE: Key switch must remain OFF a minimum of 2 seconds during key cycling. Error Code 61 may occur if key is cycled too rapidly.

2. If Error Code F7 is still being displayed and the these checks do not correct the problem, replace the Display Card.

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Tests

Test 11: Simple Test

Test 12: Test Operation - Analog Inputs

Test 13: Traction Speed Sensor

Test 14: Throttle/Lift Command Test

Test 21: Error Code Display

Test 33: Switch Input Test: Momentary Interrupt Test

Test 34: Short Circuit Test

Test 41: Encoder Test

Test 51: Output Test

Test 61: Software Version

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Test 11 - Simple Test

Once the test number (category/class selection) has been entered, use the up and down arrow switches to select the desired test. The test number will start blinking after it has been displayed for one second. It will blink on and off three times, then perform the selected test. After three blinks, the test number will be replaced with a test result in the right most segment of the display.

Use the hour meter select switch to retest the same item or to abort the test and re-display the test number.

Use the power control select switch to end the test and return to the category/class selection display.

Unless otherwise specified, travel, lift/lower, steering and auxiliary functions are disabled.

Related Codes and Tests

- Category 3, Class 3

The test is a success if the results equal those indicated in the chart below.

Sub-Menu Test No.	Test Description	Result
ESY01	Polling of Traction and Lift Power Amplifiers	If normal, Display ESY01 and 00. If problem, Display Corresponding Error Code
ESY02 thru ESY11	Stored fault codes and corresponding key switch hour meter reading	Test number displayed for three on/off blinks: ESY-XX, then error code and key ON hour meter value will be displayed: 15 h 9555
ESY12	Key Switch	Switch Open, Display NO Switch Closed, Display YES
ESY13	Deadman	
ESY14	Horn Switch	
ESY15	Reach Switch	
ESY16	Retract Switch	
ESY17	Tilt Up	
ESY18	Tilt Down	
ESY19	Sideshift Left	
ESY20	Sideshift Right	
ESY21	Staging Switch	
ESY22	Mast Switch 1	
ESY23	Lift Inhibit	
ESY24	BWI on Lift Motor	
ESY25	BWI on Traction Motor	
ESY27	Right Foot Pedal Switch	
ESY29	Steer Stop A Sensor	
ESY30	Steer Stop B Sensor	

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Test 12 - Analog Inputs

This test is continually tested once entered. Travel, lift/lower and load handler functions are allowed while monitoring the sensor.

The left most character represents the test number. The right character represents the value read from the corresponding input. The up and down arrow switches are used to change to a different test number.

If an error occurs, the code replaces the test number. Pressing the hour meter select switch will clear the error code from the display and cause the test number to reappear on the display. The fault condition remains and the Wrench icon will continue to flash on and off.

Use the power control select switch to end the test and return to the category/class selection display.

The test is a success if the results displayed are within these limits:

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Sub-Menu Test No.	Test Description	Result
0	Drive Motor Armature Current	0A in neutral. Up to 400-500A stalled. Normal full speed empty operation is 80 to 150A.
1	Drive Motor Field Current	0A in neutral. Maximum reading when travelling is 49A for 24V truck and 32A for 36V truck. Field current is normally high during acceleration and low (3 to 8A) during a steady state full speed empty condition.
2	Traction Potentiometer Voltage	2.0 - 3.0V in neutral position 0.2 - 1.5V when full forward 3.5 - 4.8V when full reverse
3	Traction Motor Temperature Sensor	49 to 90°F for room temperature or cold motor. <235°F for 7BRU18, 7BSU20 <235°F for 7BRU23, 7BSU25, 7BDRU15
4	Traction Motor Power Amplifier Temperature Sensor	The power amplifier will linearly decrease the driving current limit starting at 185°F (85°C) and shutting down traction at 203°F (95°C). Within the derating region, the braking current limits are not reduced. The driving current is also reduced to one-half the rated value when the temperature inside the power amplifier is less than –13°F (–25°C).
5	Lift Motor Armature Current	0A in neutral up to 600 - 750A stalled Current is higher with a load or when load is in telescopic area instead of free lift area of the mast.
6	Lift Potentiometer Voltage	2.0 - 3.0V in neutral position 0.2 - 1.5V when full lower 3.5 - 4.8V when full lift
7	Lift Motor Temperature Sensor	49 to 90°F for room temperature or cold motor. <235°F for 7BRU18, 7BSU20 <235°F for 7BRU23, 7BSU25, 7BDRU15
8	Lift Motor Power Amplifier Temperature Sensor	The power amplifier will linearly decrease the lift current limit starting at 185°F (85°C) and shutting down traction at 203°F (95°C). The lifting current is also reduced to one-half the rated value when the temperature inside the power amplifier is less than –13°F (–25°C).
9	Steer Direction Limit Feedback Voltage	Steer limit feedback voltages indicate the state of steer limit signals being sent to the steer controller. No Limit = 5.0V Limited CCW = 4.2V Limited CW = 3.6V Limited CW and CCW = 3.2V

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Sub-Menu Test No.	Test Description	Result
10	Pressure Transducer	With the forks on the floor resulting in no pressure in the hydraulic system, the voltage should be <1.15V. A three stage vehicle where the forks are raised off the floor, the voltage should be 1.15 - 1.6V. In the telescopic area the voltage should be >1.6V. If the pressure transducer is disconnected, the voltage will be greater than 4.8V. The pressure transducer is rated to 5000 psi. With no pressure, the output is 1V. Each 1000 psi increase will result in an additional 1V reading.
11	Battery Voltage	Follows the battery voltage.
12	Stored Battery Voltage	Displays “24V” or “36V,” determined by battery voltage at power-up. Range at power-up for 24V is 18 - 27V. Range at power-up for 36V is 32 - 42V.
13	12V Supply on the Display Card	Voltage reading should be within 11.0 - 13.0V. During a low battery voltage condition, this voltage may dip lower than 11.0V momentarily, especially during a high current demand situation (ex. lifting with a load and braking).
14	MM Contactor Sense	Reads battery voltage with the contactor closed. Reads near 0V with the contactor open.
15	EPO Sense	Reads the battery voltage with key ON and EPO released.
16	Left Pedal Pot	Reads the pedal pot voltage. Voltage reading should be 1.8 - 2.3V with the pedal down and 2.5 - 3.2V with the pedal up.

- If the readings are outside the limits specified, the test has failed.
- If any voltage reading fluctuates by more than 0.5V in 10 seconds, the test has failed.

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Test 13 - Traction Speed Sensor

This test is run continually once entered. Traveling is allowed during test operation to monitor the sensor.

Press the power control select switch. The “13” on the display will change to a “1” or “2” in the left most character space. The right character will display the value read from the corresponding input. The up and down arrow switches are used to change to another test.

If an error occurs, an error code replaces the test number. Error codes may be cleared from the display by pressing the hour meter select switch. The test number will replace the error code on the display. The fault condition remains and the Wrench icon will continue to flash on and off.

Use the power control select switch to end the test and return to the category/class selection display.

The test is a success if the displayed speed is approximately the same as the measured speed.

Sub-Menu Test No.	Test Description	Result
1	Value in km/h	Display = 10.0____k
2	Value in mile/h	Display = _5.0____m

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Test 14 - Throttle/Lift Command Test

Press the power control select switch, the “14” will be replaced by one of the sub-menu numbers listed below. Use the UP and DOWN arrow switch to change to another test. If a test is not applicable to the vehicle being tested, it will not display.

Sub-Menu Test No.	Test	Result
T	Throttle	Displays the throttle % request from the Display Card and the % the Traction Power Amplifier is reading.
L	Lift	Displays the lift % request from the Display Card and the % the lift power amplifier is reading.

NOTE: The throttle command test will display throttle % in the following format: T_ _ _<space>_ _ _.

The lift command test will display lift % in the following format: L_ _ _<space>_ _ _.

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Test 21 - Error Code Display

This test is used to display the last ten error codes and the corresponding key switch hours on reading. The LEDs of the battery discharge indicator represents the error code being displayed. The top LED on the battery discharge indicator represents the most recent error, the bottom LED represents the oldest error. The display shows the two digit error code followed by the key switch on hour reading (in whole hours). If there is no error for a particular location, “ERR 00” will be displayed. The up and down arrow switches are used to move through the LEDs.

Use the power control select switch to end the test and return to the category/class selection display.

Related Codes and Tests

- Category 3, Class 3

The test result is displayed as the error code and the key on hour meter reading at the time of the code. For example: 36 h 9485:

Sub-Menu Test No.	Test Description
Top LED	Most recent error code and key switch hours
Bottom LED	Oldest error code and key switch hours

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Test 33 - Switch Input Test

This test checks the switches to see of there is a connection. Press the power control select switch, the “33” will be replaced by “ESY12.” If the switch is open, the buzzer will sound. The buzzer is turned off by pressing the hour meter select switch. The buzzer is reactivated when another switch is selected. Use the up and down arrow switches to move through the test options. Press the power control switch to end the switch tests.

Related Codes and Tests

- Category 1, Class 1

The test result is the buzzer will sound if the switch is open.

Sub-Menu Test No.	Test Description
ESY12	Key Switch
ESY13	Deadman
ESY14	Horn Switch
ESY15	Reach Switch
ESY16	Retract Switch
ESY17	Tilt Up
ESY18	Tilt Down
ESY19	Sideshift Left
ESY20	Sideshift Right
ESY21	Staging Switch
ESY22	Mast Switch 1
ESY23	Lift Inhibit
ESY24	BWI on Lift Motor
ESY25	BWI on Traction Motor
ESY27	Right Foot Pedal Switch
ESY29	Steer Stop A Sensor
ESY30	Steer Stop B Sensor

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Test 34 - Short Circuit Test

This test checks the switches to see of there is a connection. Press the power control select switch, the “34” will be replaced by “ESY12.” If the switch is closed, the buzzer will sound. The buzzer is turned off by pressing the hour meter select switch. The buzzer is reactivated when another switch is selected. Use the up and down arrow switches to move through the test options. Press the power control switch to end the switch tests.

Related Codes and Tests

- Category 1, Class 1

The test result is the buzzer will sound if the switch is closed.

Sub-Menu Test No.	Test Description
ESY12	Key Switch
ESY13	Deadman
ESY14	Horn Switch
ESY15	Reach Switch
ESY16	Retract Switch
ESY17	Tilt Up
ESY18	Tilt Down
ESY19	Sideshift Left
ESY20	Sideshift Right
ESY21	Staging Switch
ESY22	Mast Switch 1
ESY23	Lift Inhibit
ESY24	BWI on Lift Motor
ESY25	BWI on Traction Motor
ESY27	Right Foot Pedal Switch
ESY29	Steer Stop A Sensor
ESY30	Steer Stop B Sensor

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Test 41 - Drive Unit Proximity Sensor Test (180° Steering)

This test checks the drive wheel 180° sensor. The center letter will be an “O” for ON (over metal) or an “F” for OFF (not over metal).

Press the power control select switch, the “41” will be replaced by the sub-menu number listed below. Use the up and down arrow switch to change to another test. If a test is not applicable to the vehicle being tested, it will not display.

The test result will display a range from “O” to “F”:

Sub-Menu Test No.	Test Description	Result
01_O_000	Drive Unit 180° Sensor	The center letter will go from “O” to “F” as the 180° steering limits are reached. The “_000” has no significance to this test.

- If the center letter does not change near the 180° steering limits, the test has failed.
- See also Test 11 - Simple Test (Page 6-123) ESY29 and ESY30.

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Test 41 - Drive Unit Proximity Sensor Test (360° Steering)

This test checks the drive wheel positioning sensors and the 180° sensor. These two proximity sensors monitor the drive unit teeth as the drive unit turns. The center letter will be an “O” for ON (over metal) or an “F” for OFF (not over metal), and indicates the state of the 180° sensor.

Press the power control select switch, the “41” will be replaced by the sub-menu number listed below. Use the up and down arrow switch to change to another test. If a test is not applicable to the vehicle being tested, it will not display.

The test result will display a range from 0 to 148/149:

Sub-Menu Test No.	Test Description	Result
01_O_250	Drive Unit Proximity Sensors	The value will range from 0 to 148/149, the value will count up when the wheel is rotated in one direction and count down when the wheel is rotated in the opposite direction. The counts will start over as 255 or 0 are crossed. The center letter should change as the drive unit is rotated through the 180° arc.

- If the readings are outside these limits, the test has failed.
- If the reading fluctuates by more than 2 counts when the drive unit is not rotating, the test has failed.

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Test 51 - Output Test

This test allows certain outputs to be tested.

Press the power control select switch, the “51” will be replaced by “O1.” Each output test is entered in the “OFF” state. Exiting from an output test returns the setting to “OFF.” Press the hour meter select switch to toggle the output to “ON.” Use the up and down arrow switches select another test.

The test is a success if the following is displayed:

Sub-Menu Test No.	Test Description	Condition	Result
O1	Display LEDs		
O2	Sonalert	Sonalert ramps up in frequency then repeats	
O3	Brake	Brake Closed/ON Brake Open/OFF	24/36V when ON 0V when OFF
O6	Proportional Solenoid	Ramps the solenoid from 0 to 24V and repeat (Display will be RAMP)	0 to 24V
O7	Lift Solenoid	Solenoid Closed/ON Solenoid Open/OFF	24/36V when ON 0V when OFF
O8	Direction A Solenoid	Solenoid Closed/ON Solenoid Open/OFF	24/36V when ON 0V when OFF
O9	Direction B Solenoid	Solenoid Closed/ON Solenoid Open/OFF	24/36V when ON 0V when OFF
O10 (See Note)	Key Switch Relay	Solenoid Closed/ON Solenoid Open/OFF	24/36V when ON 0V when OFF
O11	Tilt Solenoid	Solenoid Closed/ON Solenoid Open/OFF	24/36V when ON 0V when OFF
O12	Reach Solenoids	Solenoid Closed/ON Solenoid Open/OFF	24/36V when ON 0V when OFF
O13	Sideshift Solenoid	Solenoid Closed/ON Solenoid Open/OFF	24/36V when ON 0V when OFF

NOTE: Test 51: O10 is performed once. If there is a faulty condition, the test will drop the MM contactor and display a code. The key switch must be cycled OFF/ON before retesting can occur.

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Test 61 - Software Versions

This test displays the current software versions installed on the truck.

Press the up and down arrow switches to scroll through the available options.

The test is a success if the operator display results are in the following format
(Note: Numbers shown are for example only):

Sub-Menu Test No.	Test Description	Result
DM	Display Card	DM__01.0
LPA	Lift Power Amplifier	LPA09.02
TPA	Traction Power Amplifier	TPA09.01

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Analog Tests (Category 1, Class 2)

Test 12-00 - Drive Motor Armature Current

The test is a success if the voltage displayed is within these limits:

Condition	Display Reading
Neutral	0A
Stalled	Up to 400-500A
Normal (Full Speed) Empty Operation	80 to 150A

If the readings are outside these limits, the test has failed.

Test 12-01 - Drive Motor Field Current

The test is a success if the voltage displayed is within these limits:

Condition	Display Reading
Neutral	0A
Accelerating	20A (24V) 30A (36V)
Steady, Full Traction Speed	3 to 8A

If the readings are outside these limits, the test has failed.

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Test 12-02 - Traction Pot. Voltage

The test is a success if the voltage displayed is within these limits:

Condition	Display Reading
Neutral	2.0 to 3.0V
Full Forward	0.4 to 1.5V
Full Reverse	3.5 to 4.6V

- If the readings are outside these limits, the test has failed.
- If the reading fluctuates by more than 0.5V in 10 seconds, the test has failed.

Test 12-03 - Traction Motor Temperature Sensor

The test is a success if the following is displayed:

Condition	Display Reading
Room Temp Cold	49 to 90°F (9.4 to 32.2°C)
7BRU18, 7BSU20	<235°F (112.7°C)
7BRU23, 7BSU25, 7BDRU15	

If the readings are outside these limits, the test has failed.

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Test 12-04 - Traction Motor Power Amplifier Temperature Sensor

The test is a success if the following is displayed:

Condition	Reading
Slow Down	>185°F (85°C) and <203°F (95°C)
Shut Down	<203°F (95°C)

If the readings are outside these limits, the test has failed.

Test 12-05 - Lift Motor Armature Current

The test is a success if the reading displayed is within these limits:

Condition	Display Reading
Neutral	0
Stalled	Up to 600-750A
With Load	Higher in telescopic area than in free lift area

If the readings are outside these limits, the test has failed.

Test 12-06 - Lift Pot Voltage

The test is a success if the voltage displayed is within these limits:

Condition	Display Reading
Neutral	2.0 to 3.0V
Full Lift	0.4 to 1.5V
Full Lower	3.5 to 4.6V

- If the readings are outside these limits, the test has failed.
- If the reading fluctuates by more than 0.5V in 10 seconds, the test has failed.

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Test 12-07 - Lift Motor Temperature Sensor

The test is a success if the voltage displayed is within these limits:

Condition	Display Reading
Room Temp Cold	49 to 90°F (9.4 to 32.2°C)
7BRU18, 7BSU20, 7BRU23, 7BSU25, 7BDRU15	<235°F (112.7°C)

- If the readings are outside these limits, the test has failed.
- If the reading fluctuates by more than 2° in 10 seconds for a cold motor, the test has failed.

Test 12-08 - Lift Motor Power Amplifier Temperature Sensor

The test is a success if the voltage displayed is within these limits:

Condition	Reading
Slow Down	>185°F (85°C) and <203°F (95°C)
Shut Down	>203°F (95°C)

If the readings are outside these limits, the test has failed.

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Test 12-10 - Pressure Transducer

The test is a success if the voltage displayed is within these limits:

Condition	Display Reading
Forks on Floor	<1.15V
3 stage w/Forks off Floor with No Load	1.15 to 1.6V
Forks in Telescopic Area	>1.6V
Disconnected	>4.8V

- If the readings are outside these limits, the test has failed.
- If the reading fluctuates by more than 0.5V in 10 seconds, the test has failed.

Test 12-11 - Battery Voltage

The test is a success if the voltage displayed:

Condition	Display Reading
Key On	Battery Voltage

- If the readings are outside these limits, the test has failed.
- If the reading fluctuates by more than 0.5V in 10 seconds, the test has failed.

Test 12-12 - Stored Battery Voltage

The test is a success if the voltage displayed is within these limits:

Condition	Display Reading
24V lift truck 36V lift truck	24V 36V

- If the readings are outside these limits, the test has failed.

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Test 12-13 - 12V Supply on the Display Card

The test is a success if the voltage displayed is within these limits:

Condition	Display Reading
Normal	11.0 to 13.0 *
* May drop below 11.0 in a low battery condition (especially during a high current demand)	

- If the readings are outside these limits, the test has failed.
- If the reading fluctuates by more than 0.5V in 10 seconds, the test has failed.

Test 12-14 - MM Contactor Sense

The test is a success if the voltage displayed is within these limits:

Condition	Display Reading
Contactor Closed	Battery Voltage
Contactor Open	<Battery Voltage but must not be near 0V

- If the readings are outside these limits, the test has failed.
- If the reading fluctuates by more than 0.5V in 10 seconds, the test has failed.

Test 12-15 - EPO Sense

The test is a success if the voltage displayed is within these limits:

Condition	Display Reading
Key On	Battery Voltage

- If the readings are outside these limits, the test has failed.

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Test 12-16 - Left Pedal Pot

The test is a success if the voltage displayed is within these limits:

Condition	Display Reading
Pedal Down	1.8 - 2.3V
Pedal Up	2.5 - 3.2V

- If the readings are outside these limits, the test has failed.
- If the reading fluctuates by more than 0.1V in 10 seconds, the test has failed.

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Component Procedures

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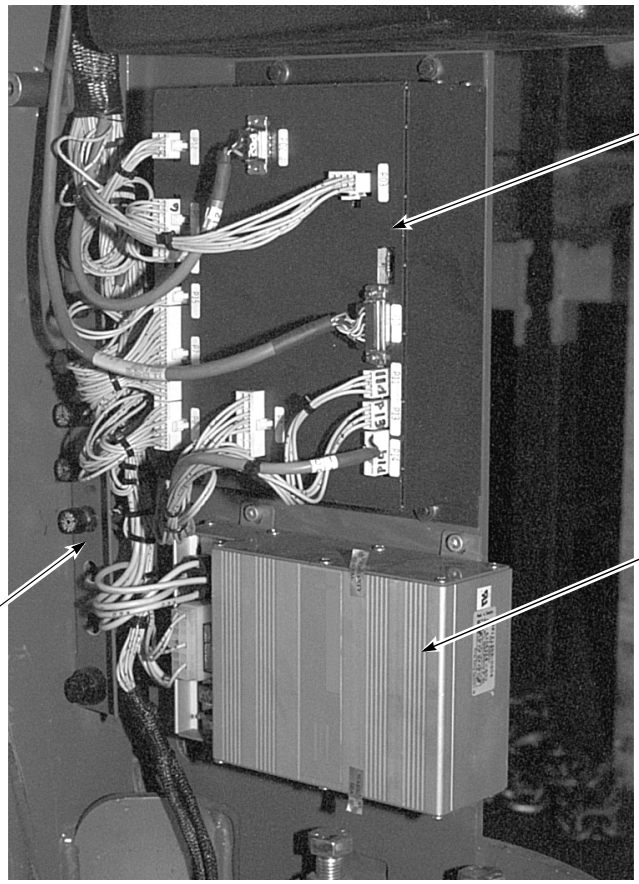
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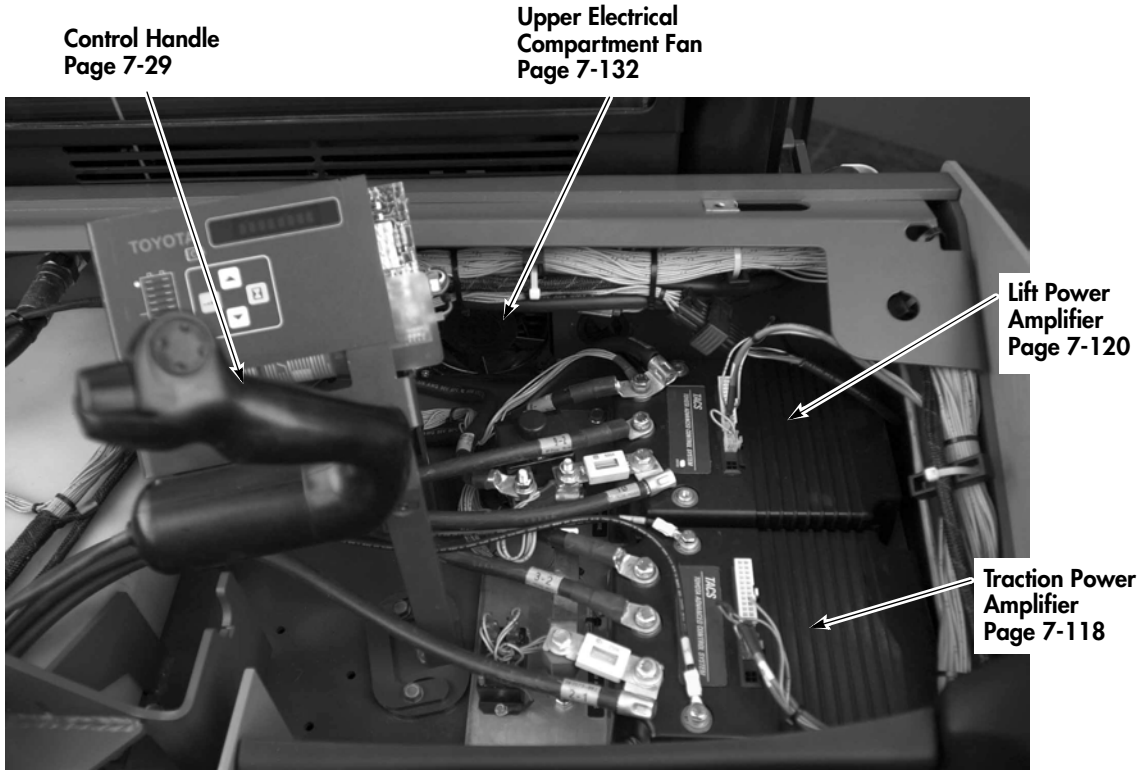
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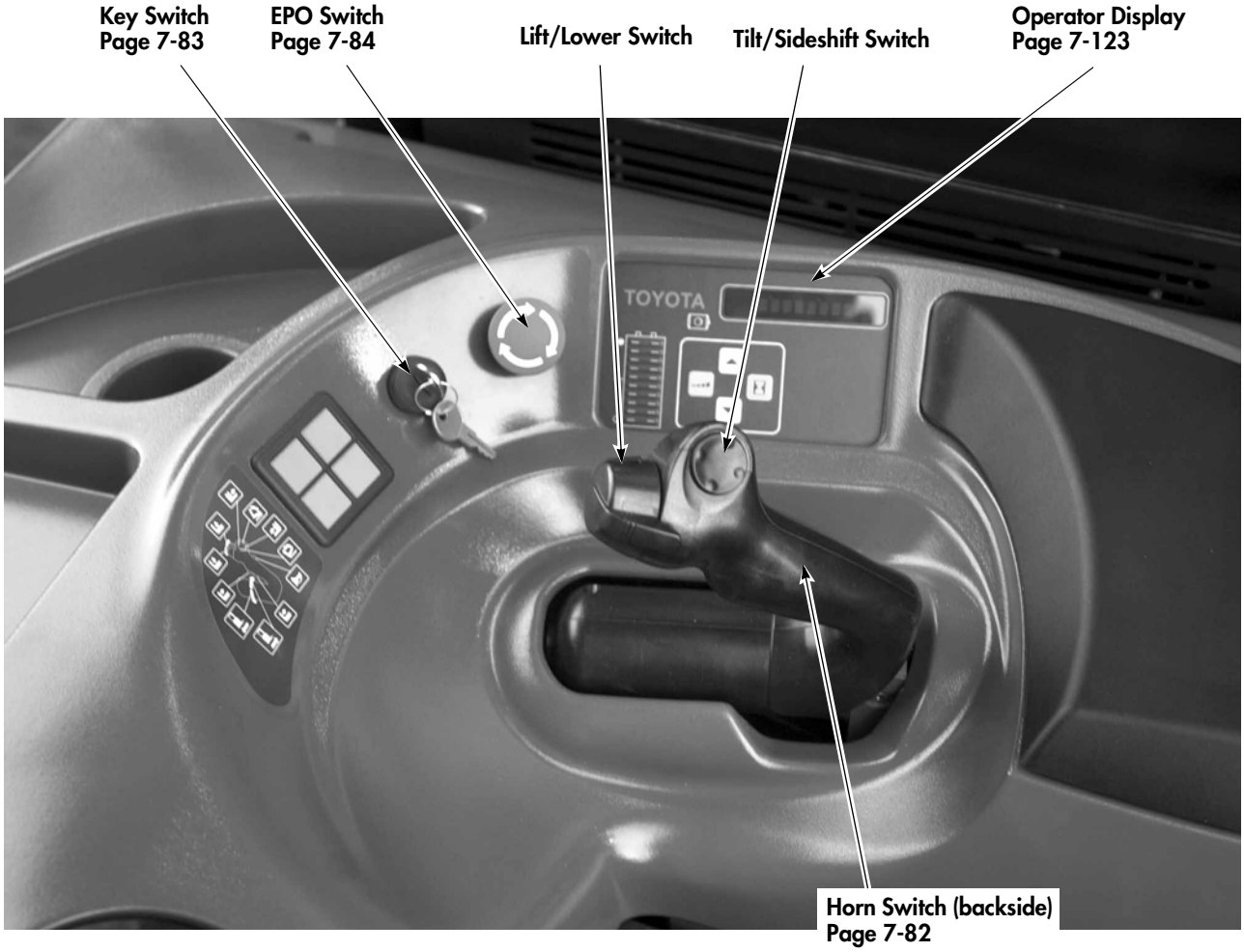
Component Locator Photos



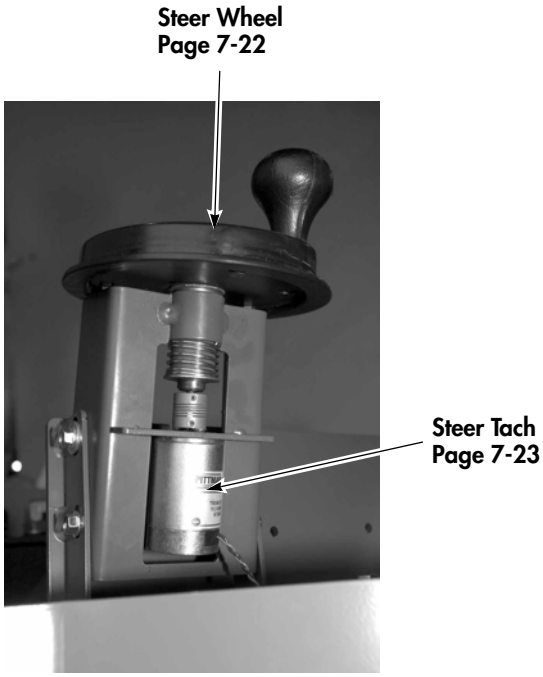
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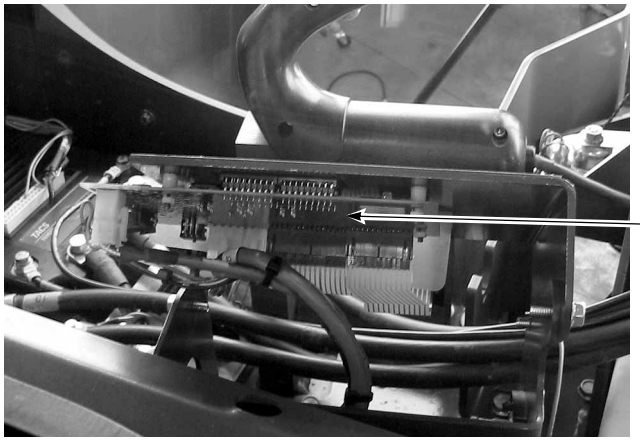


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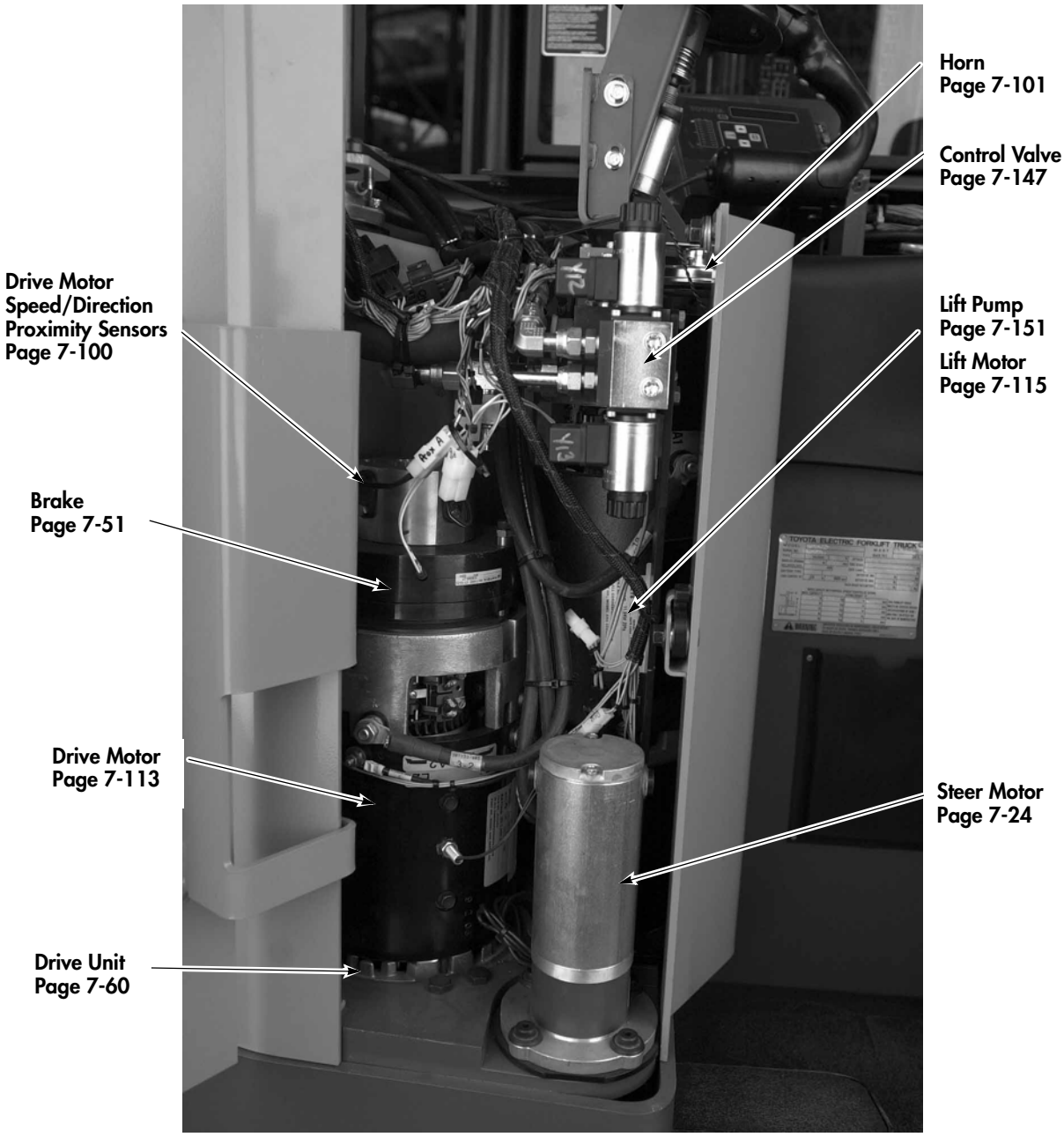


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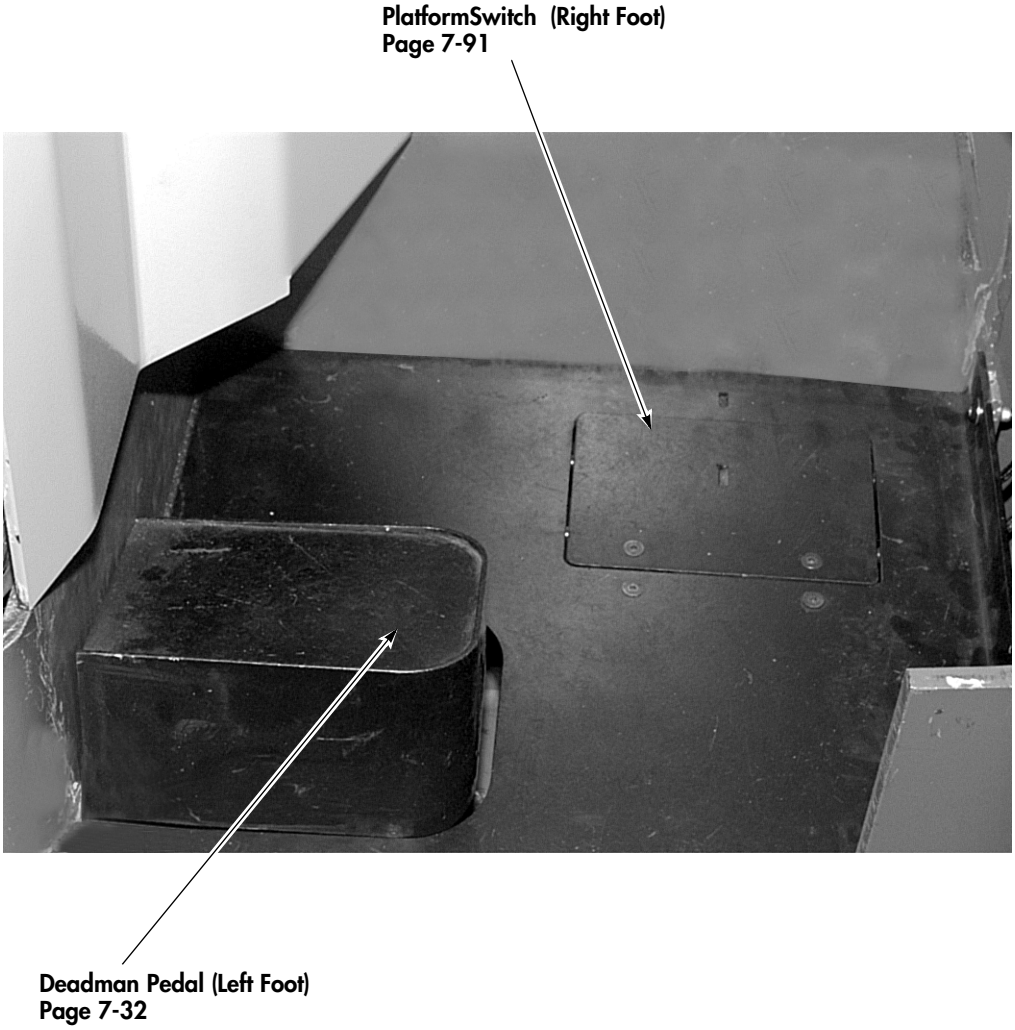




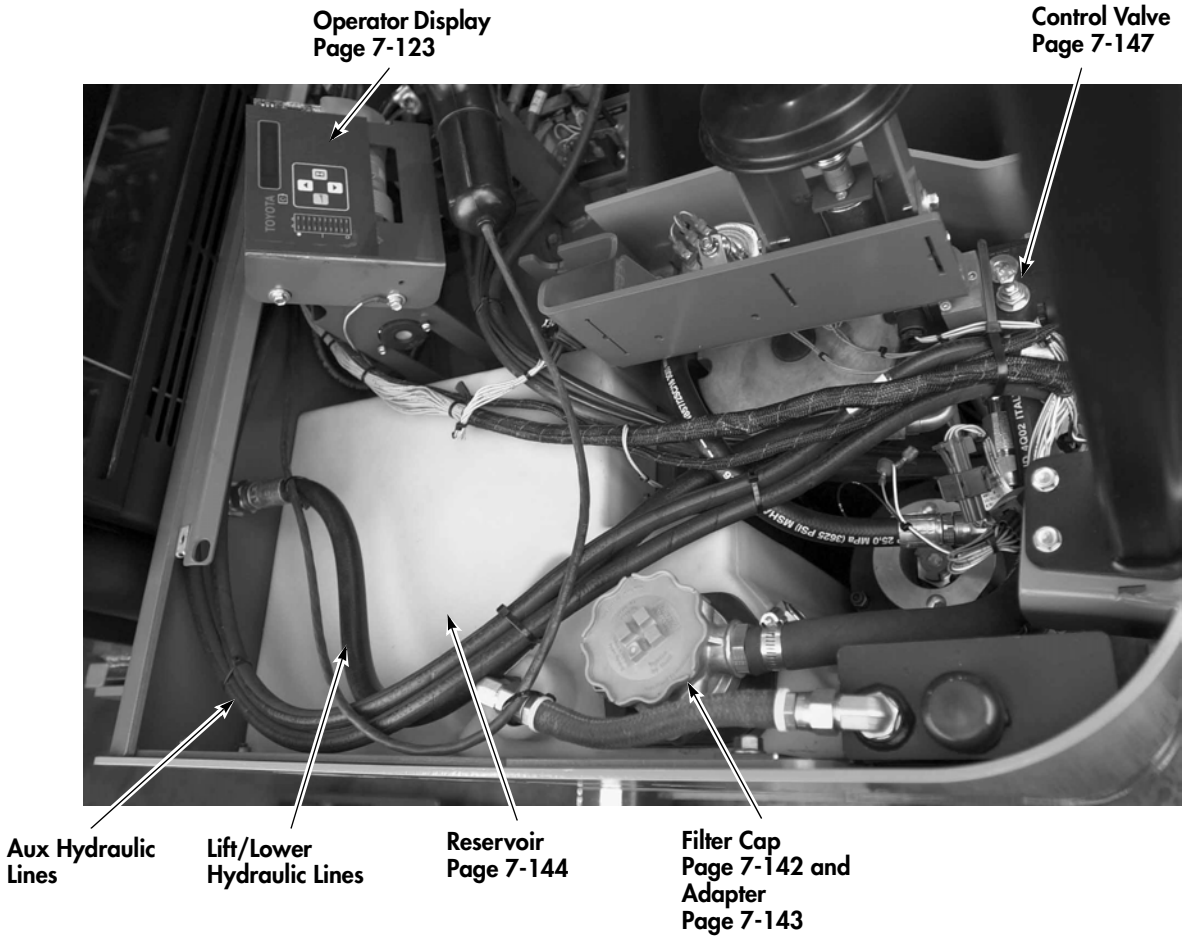
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Frame and Accessories

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Panels and Covers

General

Panels and covers can be easily removed to gain access to components when servicing the lift truck. During lift truck operation, all panels and covers must be secured.

Console Cover

Removal

1. Park the lift truck on a level surface and block.
2. Turn the key switch OFF and disconnect the battery connector.
3. Open motor compartment door.
4. Remove hip cushion.
5. Loosen the two screws on the console cover (near the mast) and the nut located at the right side of the motor compartment.
6. Lift the console cover up enough to disconnect the electrical connector under the cover.
7. Lift the cover off the steering wheel and while tilting the control handle forward, remove the cover from the lift truck.

Installation

1. Position the console cover over the tractor frame.
2. Attach the electrical connectors under the cover.
3. Align the bolt hole in the cover with the one at the left front of the tractor frame.
4. Secure the cover to the tractor frame.
5. Reconnect the battery connector.
6. Return the lift truck to service.

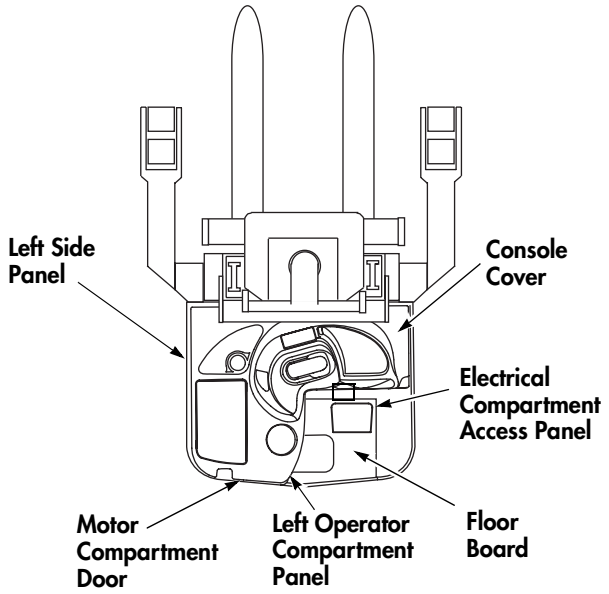


Figure 7-1: Tractor Panels and Covers

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Electrical Compartment Access Panel

Removal

1. Park the lift truck on a level surface and block.
2. Turn the key switch OFF and disconnect the battery connector.
3. Remove the two Allen head screws at the top of the electrical compartment access panel.
4. Loosen the two lower Allen head screws if access to the Tractor Interface Card or the steer controller is required. If the operator compartment floor is to be removed, remove the two screws at the bottom of the electrical compartment access panel.
5. Tilt the panel in, toward the operator compartment. Lift the electrical compartment access panel out and set to the side.

Installation

1. Place the slots along the lower edge of the electrical compartment access panel over the bottom two retaining screws.
2. Install the two top screws, then tighten the two lower screws.
3. Reconnect the battery connector and return the lift truck to service.

Motor Compartment Door

Removal

1. Use an Allen wrench to turn the latch screw clockwise one quarter turn.
2. Open the door fully. Lift upward to release the door from the hinge pins and set aside.

Installation

1. Set the door in place so the hinge pins are securely mounted in the panel hinge.
2. Close the door. Tighten the latch screw counter clockwise one quarter turn with an Allen wrench.

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⚠ CAUTION

Do not force the Allen head screw past one quarter turn or the latch can become loose.

Left Operator Compartment Panel

Removal

1. Park the lift truck on a level surface and block.
2. Turn the key switch OFF and disconnect the battery connector.
3. Remove the console cover. See “Console Cover” on page 7-14.
4. Loosen the bolt, near the deadman pedal, about 1/2 way using a 13 mm wrench.
5. Remove the 10 mm nut at the top of the panel near motor compartment door.
6. Remove the bolt securing the top of the panel at the front of the operator compartment.
7. Lift the panel up and set aside.

Installation

1. Slide the left compartment panel into position.
2. Install the bolt at the top of the panel.
3. Tighten the bolt near the deadman pedal.

Left Side Panel

Removal of the left side panel allows for easier access to components that affect traction and lift functions. The drive motor may be removed with the side cover on, however, it is a more difficult and time consuming task.

Removal

1. Park the lift truck on a level surface and block.
2. Turn the key switch OFF and disconnect the battery connector.
3. Remove both halves of the console cover. See “Console Cover” on page 7-14.

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4. Remove the motor compartment door. See “Motor Compartment Door” on page 7-15.
5. Remove the three flanged nuts using a 15 mm socket. Two are located under the control console by the reservoir. The third flanged nut can be accessed through the left side of the battery box or by removal of the operator’s compartment side panel.
6. Remove the 13 mm bolt at the rear of the panel located by the drive motor.
7. Remove the four bolts securing the overhead guard post. Disconnect the wiring harness at the post if applicable.

NOTE: Be sure the wire assemblies are pushed up, into the guard post tube before the bolts are removed, to prevent damage to the wires if the post shifts as the bolts are removed.

8. Pull the left side panel outward and set aside.

⚠ CAUTION

The left side panel is heavy. Help may be required to remove it from the lift truck.

Installation

1. Lift the left side panel up to align the three studs on the panel with the holes in the tractor frame.

⚠ CAUTION

The left side panel is heavy. Help may be required to install it on the lift truck.

2. Install the four bolts securing the overhead guard post. Reconnect the wiring harness at the post if applicable.

NOTE: Be sure the wire assemblies are pushed up, into the guard post tube before the bolts are installed. This will prevent damage to the wires if the post shifts as the bolts are replaced.

3. Install the 13 mm bolt at the rear of the panel located by the drive motor.

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4. Install the three flanged nuts using a 15 mm socket. Two are located under the control console by the reservoir. The third flanged nut can be accessed through the left side of the battery box.
5. Install the motor compartment door. See “Motor Compartment Door” on page 7-15.
6. Install both halves of the console cover. See “Console Cover” on page 7-14.
7. Reconnect the battery connector.
8. Return the lift truck to service.

Floor Board

Removal

1. Park the lift truck on a level surface and block.
2. Turn the key switch OFF and disconnect the battery connector.
3. Remove the electrical compartment access panel. See “Electrical Compartment Access Panel” on page 7-15.

⚠ CAUTION

Pinch point, keep fingers clear of floor board cutout while holding down left foot brake pedal.

4. Push down on the left foot deadman pedal with one hand. Remove the floor board by pulling up and pivoting the plate toward the motor compartment. Release the left foot deadman pedal as the floor board pivots up.

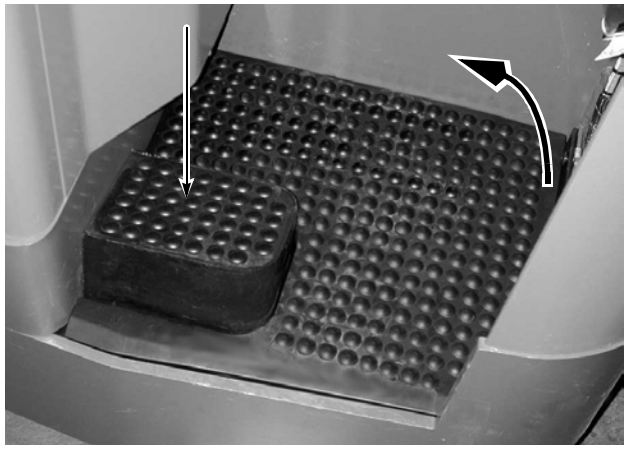


Figure 7-2: Floor Board Removal

⚠ CAUTION

Disconnect wire connections to platform (right foot) switch prior to removal of floor board.

5. With the floor board raised, disconnect the wires from platform (right foot) switch. Remove the floor board and set it to one side.

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Installation

1. The lift truck must be properly blocked at this time.
2. Reconnect the wires to the platform (right foot) switch. Push down on the left foot deadman pedal with one hand and install the floor board by pushing down and pivoting the plate away from the motor compartment. Release the deadman pedal as the floor board pivots down.
3. Install the electrical compartment access panel. See “Electrical Compartment Access Panel” on page 7-15.

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Decals

Remove and replace any decals that are damaged. Replace any missing decals.

Remove a damaged decal by using a sharp edge to peel the decal from the surface. Use caution not to scratch or damage the paint on the lift truck when removing the decal.

Using the required cleaning solvent, thoroughly clean the surface of the lift truck before applying a new decal. Allow the surface to completely dry, be sure that there is no residue. Touch up the paint in the area of the decal, as required.

Decal with Protective Sheet

To install this style, peel off the backing, place the decal into position, and press the decal into place. Do not wrinkle the decal. Rub over the protective over-sheet with a firm, straight, plastic edge to remove air bubbles and any wrinkles. Peel off the over-sheet.

Decal without Protective Sheet

To install this style, peel off the backing, place the decal into position, and press the decal into place. Do not wrinkle the decal. Smooth the decal into place using clean fingers. Be sure all the edges are secured to the surface.

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Steering and Controls

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Steering Wheel

Removal

1. Park the lift truck on a level surface.
2. Turn the key switch OFF and disconnect the battery connector.
3. Remove the console cover. See “Removal” on page 7-14.
4. Lift the steering wheel from the bracket. Inspect and replace the bearing as needed.

Installation

1. Install the steering wheel on the mounting bracket.
2. Check the steering wheel for ease of turning.
3. Test the operation of the steering wheel and the lift truck.
4. Replace the console cover.
5. Return the lift truck to service.

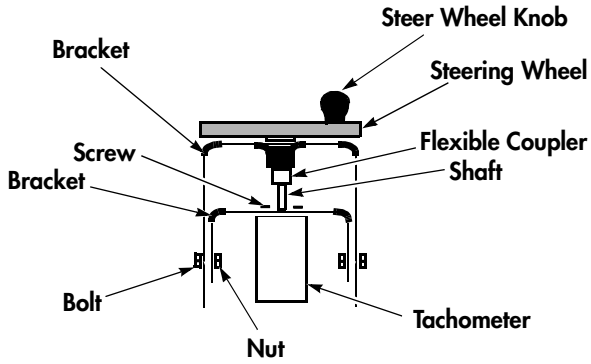


Figure 7-3: Steering Wheel Mounting and Components

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Steer Tachometer

The steer tachometer (tach) is attached to a bracket beneath the steering wheel.

Removal

1. Park the lift truck on a level surface.
2. Turn the key switch OFF and disconnect the battery connector.
3. Remove the console cover. See “Removal” on page 7-14.
4. Disconnect the steer tach from the main electrical harness.
5. Use an Allen wrench to remove the two screws securing the steer tach to the mounting bracket.
6. Use an Allen wrench to loosen the flexible coupler from the tach shaft.

Installation

1. Attach the steering tach to the underside of the mounting bracket with two screws.
2. Tighten the flexible coupler to the tach shaft.
3. Reconnect the main harness.
4. Test to see that the steering functions properly.
5. Install console cover. See “Installation” on page 7-14.
6. Return the lift truck to service.



Figure 7-4: Steer Tach Mounting

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Steer Motor

The steer motor is located in the lower right section of the motor compartment, nearest the motor compartment door. It is to the right of the drive motor and beneath the control valve.



Figure 7-5: Steer Motor

Removal

1. Park the lift truck on a level surface.
2. Turn the key switch OFF and disconnect the battery connector.
3. Remove the motor compartment door to access the steer motor. See “Motor Compartment Door” on page 7-15.
4. Disconnect the steer motor from the main electrical harness.
5. Use a 5 mm Allen wrench to remove the four bolts securing the steer motor to the lift truck frame. The rubber gasket should remain on each bolt.
6. Gently lift the motor upward. Rock it a little to unseat it if necessary.
7. Make sure the two O-rings stay on the bottom of the steer motor. The black rubber spacer under the steer motor is to reduce noise. Be sure to keep the spacer with the steer motor for reassembly.

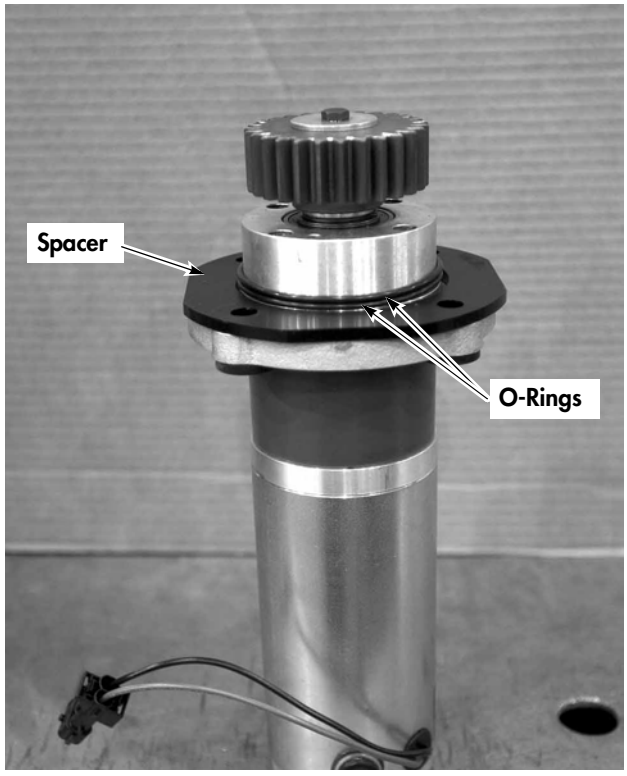


Figure 7-6: Spacer and O-Rings

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Installation

1. Make sure the rubber spacer and two O-rings are on the end of the steer motor.
2. Apply a little grease so the motor will slide into the frame without cutting the O-rings.
3. Apply black graphite grease to the gear to help prevent excessive wear.
4. Place the electrical connectors toward the lift motor. Insert the steer motor into the tractor frame.
5. Apply thread locking compound to the mounting bolt threads. Install the four bolts with rubber grommets. Tighten using a 6 mm Allen wrench.
6. Reconnect the electrical harness connections (40 and 41).
7. Install the motor compartment door.
8. Reconnect the battery connector.
9. Test the lift truck for proper operation.
10. Return the lift truck to service.

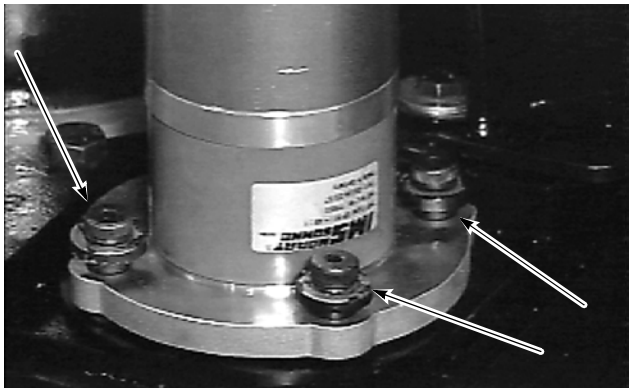


Figure 7-7: Mounting Bolts and Grommets

Steer Motor Gear Replacement

Removal

1. Remove the steer motor following the procedure on page 7-24.
2. Loosen the bolt attaching the steering gear to the steer motor shaft.
3. Remove the steering gear from the motor shaft.

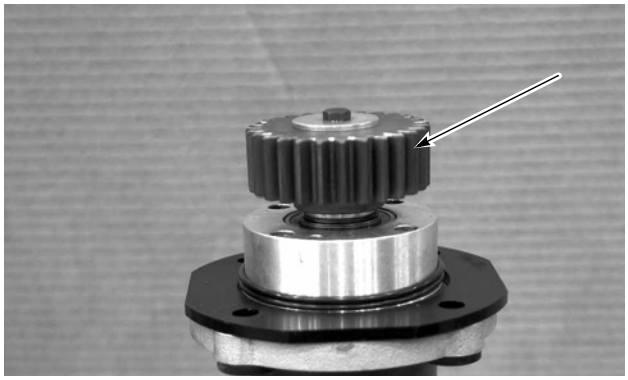


Figure 7-8: Steer Motor Gear

Installation

1. Slide the steering gear onto the steer motor shaft.
2. Install the mounting bolt in the steering gear.
3. Torque the gear mounting bolt to 88 in. lbs. (10 Nm).
4. Return the steer motor to the lift truck following the installation procedure on page 7-24.

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Steer Controller

The steer controller is located in the electrical compartment to the right of the operator. The steer controller is below the tractor interface card and to the right of the fuse bracket. No attempts should be made to open the steer controller. There are no user-serviceable parts inside. Attempting to open the steer controller may damage it and will void the warranty.

It is recommended to clean the exterior of the steer controller case occasionally.

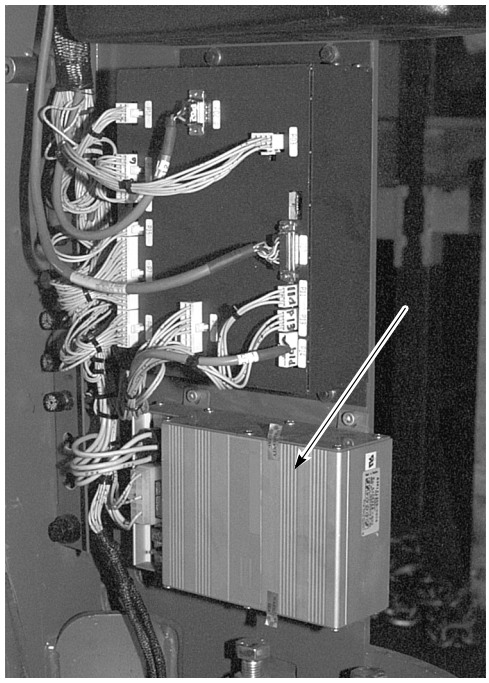


Figure 7-9: Steer Controller

Exterior Cleaning

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove the electrical compartment access panel. See “Electrical Compartment Access Panel” on page 7-15.
3. Wipe the controller clean using a moist rag. Do not reconnect the controller to the battery until it is completely dry.
4. Reattach the connections. Be sure the connections are tight.

Removal

1. Park the lift truck on a level surface.
2. Turn the key switch OFF and disconnect the battery connector.
3. Remove the electrical compartment access panel. Refer to page 7-15.
4. Disconnect the steer controller from the main wiring harness. (Note the locations of all connections for reassembly. If identification labels are missing, replace them before proceeding further.)
5. Remove the four Allen head screws attaching the steer controller to the tractor frame.

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Installation

⚠WARNING

Make sure the replacement steer controller is the correct voltage (24 or 36V).

1. Install the steer controller and secure it to the tractor frame with the four mounting screws.
2. Connect the steer controller wires from the wiring harness.
3. Install the electrical compartment access panel. Refer to page 7-15.
4. Reconnect the battery connector.
5. Test the lift truck for proper operation.
6. Return the lift truck to service.

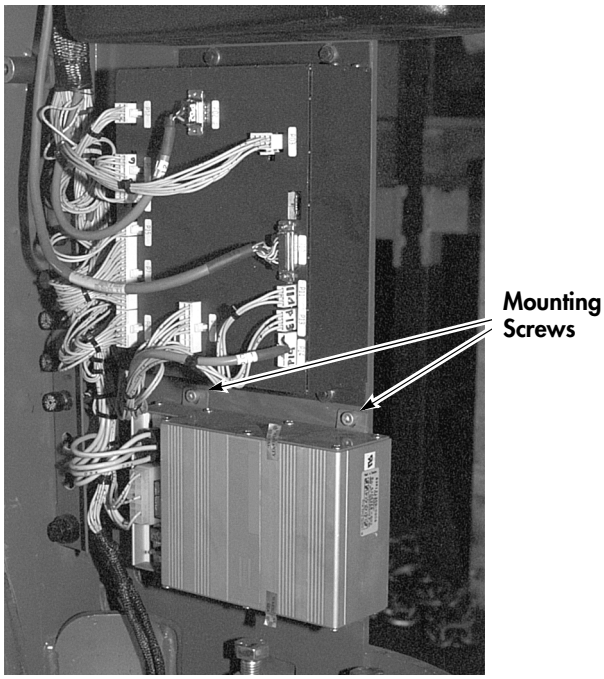


Figure 7-10: Steer Controller Mounting

Adjustments

The steer controller has three adjustable parameters: current limit, IR compensation, and tachometer input scaling. Any of these are set using the dipswitches located just below the SK1 connector (lower left portion of the controller).

Current Limit Adjustment

Current limiting is varied with dipswitches 1 and 2. Improper current limiting settings can affect truck steering. The least resistance is achieved with both switches open, while the greatest resistance requires both switches to be closed.

Dipswitch Setting	36V truck	24V truck
Both switches open	15A	20A
Switch 1: open Switch 2: closed	21A	28A
Switch 1: closed Switch 2: open	25A	34A
Both switches closed	30A	40A

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IR Compensation Adjustment

IR compensation is varied with dipswitches 3 and 4. The factory default setting is 2/3 compensation (Switch 3 open, switch 4 closed).

Dipswitch Setting	Compensation
Both switches open	No Compensation (Not Recommended)
Switch 3: closed Switch 4: open	1/3
Switch 3: open Switch 4: closed	2/3
Both switches closed	Max. Compensation

Tachometer Input Scaling Adjustment

Tachometer input scaling affects the sensitivity of the steering input. Maximum sensitivity is achieved with dipswitches 5, 6 and 7 closed. Minimum sensitivity is achieved with dipswitches 5, 6 and 7 open.

Dipswitch Setting	Voltage	Steer Wheel Revolutions (36V truck)	Steer Wheel Revolutions (24V truck)
Switches 5, 6 and 7 closed	±1.4V	18	8.5
Switch 5: open Switch 6: closed Switch 7: closed	±1.6V	20	10.5
Switch 5: closed Switch 6: open Switch 7: closed	±1.8V	21	13.5
Switch 5: open Switch 6: open Switch 7: closed	±2.0V	25	18
Switch 5: closed Switch 6: closed Switch 7: open	±2.1V	31	24
Switch 5: open Switch 6: closed Switch 7: open	±2.3V	37	30
Switch 5: closed Switch 6: open Switch 7: open	±2.6V	48	38
Switches 5, 6 and 7 open	±2.9V	57	48

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Control Handle

The control handle is the operator's means of controlling travel, lift/lower, and auxiliary functions. The control handle is not repairable, replace the entire unit.

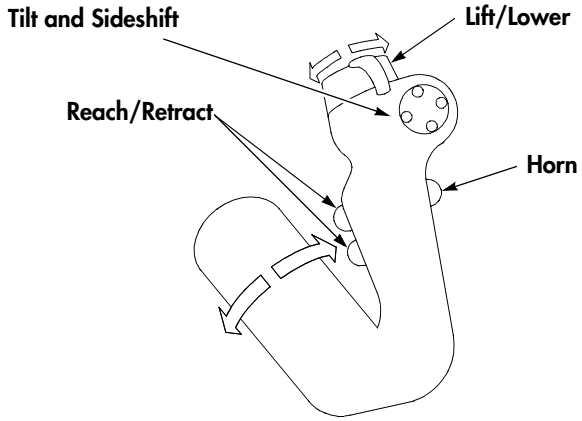


Figure 7-11: Control Handle

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove console cover. See "Removal" on page 7-14.
3. Remove the set screw securing the handle to the bracket on the lift truck.
4. Remove the control handle from the bracket and lay aside.

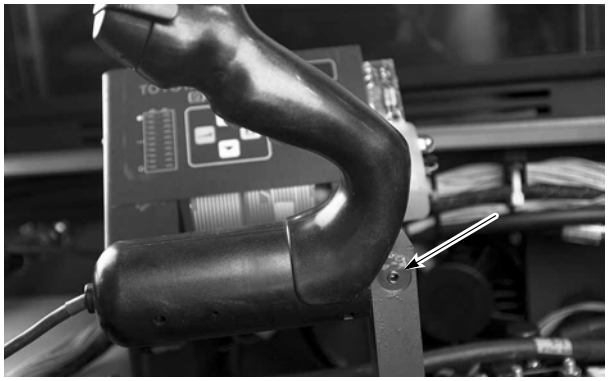


Figure 7-12: Control Handle Mounting Screw

5. Open the tie straps securing the control handle cable. Note the tie strap locations and cable routing for use in installation.
6. Remove the electrical compartment access panel. See "Electrical Compartment Access Panel" on page 7-15.
7. Disconnect the control handle cable from plug J10 on the Tractor Interface card.
8. Remove the control handle from the lift truck.

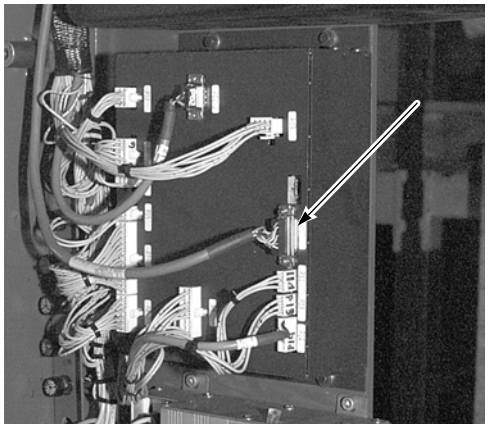


Figure 7-13: JP10 Connection at Tractor Interface Card

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Installation

1. Reattach the control handle cable at plug J10 on the Tractor Interface card.
2. Secure the control handle cable with tie straps.
3. Install the electrical compartment access panel. See “Electrical Compartment Access Panel” on page 7-15.
4. Attach the handle to the lift truck using the set screw.
5. Install the console cover. See “Installation” on page 7-14.
6. Reconnect the battery connector.
7. Test the operation of the control handle and the lift truck.
8. Return the lift truck to service.

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Traction and Braking

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Deadman Pedal

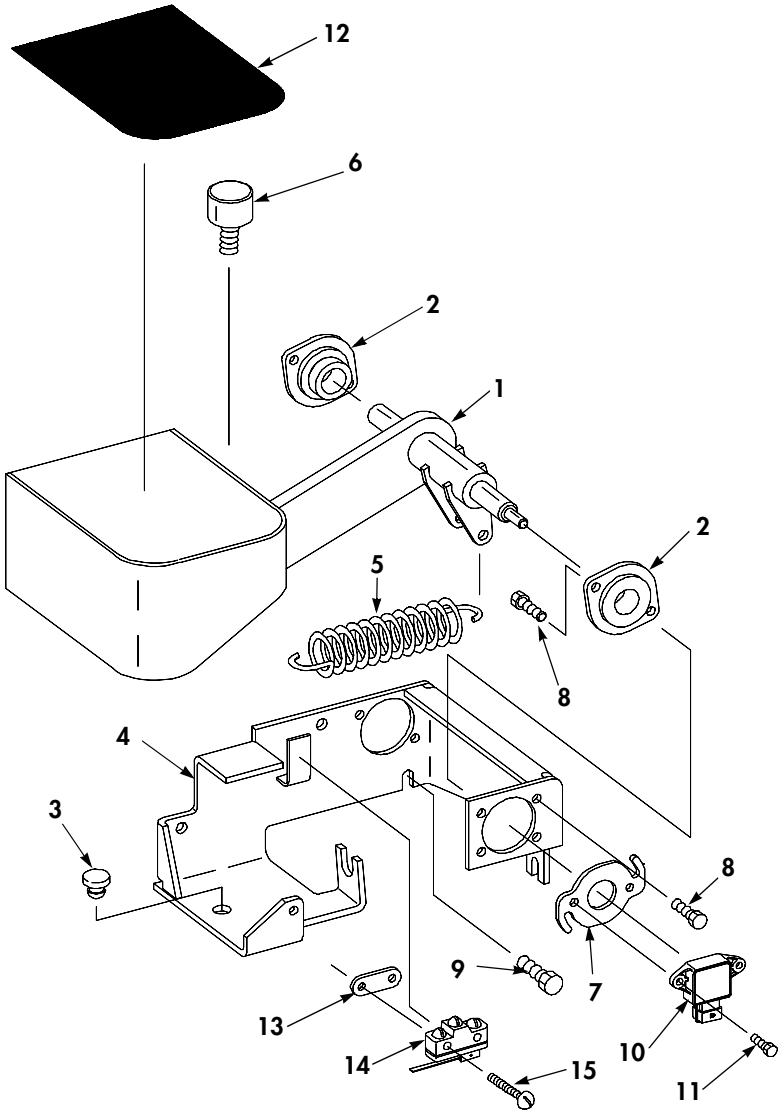


Figure 7-14: Deadman Pedal Component Identification

POS. NO.	DESCRIPTION	POS. NO.	DESCRIPTION	POS. NO.	DESCRIPTION
1	Pedal, deadman	6	Stop, pedal	11	Screw
2	Bearing, flanged	7	Plate	12	Mat, pedal
3	Bumper	8	Screw	13	Nut, twin
4	Bracket, deadman	9	Screw	14	Switch, deadman
5	Spring, return	10	Potentiometer	15	Screw

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Removal

1. Park the lift truck on a level surface.
2. Turn the key switch OFF and disconnect the battery connector. Check to make sure the battery gates are in place.
3. Jack the rear of the lift truck so the drive and caster wheels are approx. 1 in. (25mm) off the floor. Block the lift truck in this position.

⚠WARNING

Use extreme care whenever the lift truck is jacked up for any reason. Never block the lift truck between the mast telescopic and the floor. Use a suitable hoist to stabilize the mast. Keep hands and feet clear from beneath vehicle while jacking. Use jack stands or solid blocks to support the lift truck - do not rely on jacks. Refer to "Jacking Safety" on page 2-13.

4. Remove the electrical compartment access panel following the procedure on page 7-15.
5. Remove the floor board following the procedure on page 7-18.
6. Remove the screws (11) holding the transducer switch (10) and remove the wires from the deadman switch (14).
7. Loosen the four mounting bolts holding the deadman pedal assembly to the frame. Remove the deadman pedal assembly from the lift truck to service.

Installation

1. Use the four mounting bolts (9) to attach the deadman pedal assembly to the frame.
2. Attach the wires to the deadman switch. Install the transducer switch (10) to the pedal bracket with screws (11).
3. Install the floor board.
4. Install the electrical compartment panel.
5. Remove the block and lower the lift truck to the floor.
6. Reconnect the battery connector.

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7. Test the lift truck for proper deadman operation.
8. Return the lift truck to service.

Pedal Bearing Replacement

Removal

1. Remove the deadman pedal assembly from the lift truck. See “Deadman Pedal” on page 7-32.
2. Remove the deadman pedal return spring (5).
3. Remove the flange bearing mounting screws (8) on both bearings.
4. Loosen the set screws on the bearing collars and slide the bearing assemblies back.
5. Remove the deadman pedal assembly from the bracket (4) and remove the bearings (2).

Installation

1. Place the bearings on the deadman pedal. Attach the deadman pedal assembly to the bracket.
2. Slide the bearings (2) into the mounting holes on the deadman pedal bracket. Tighten the set screws on the bearing collars to secure the bearings.
3. Install the flange bearing mounting screws (8) on each bearing.
4. Install the deadman pedal return spring (5).
5. Install the deadman pedal and bracket assembly in the lift truck following procedure on page 7-33.
6. Install all covers and panels.
7. Reconnect the battery connector and turn the key switch ON.
8. Test for proper operation of the deadman pedal assembly.
9. Return the lift truck to service.

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Caster Assembly with Brake

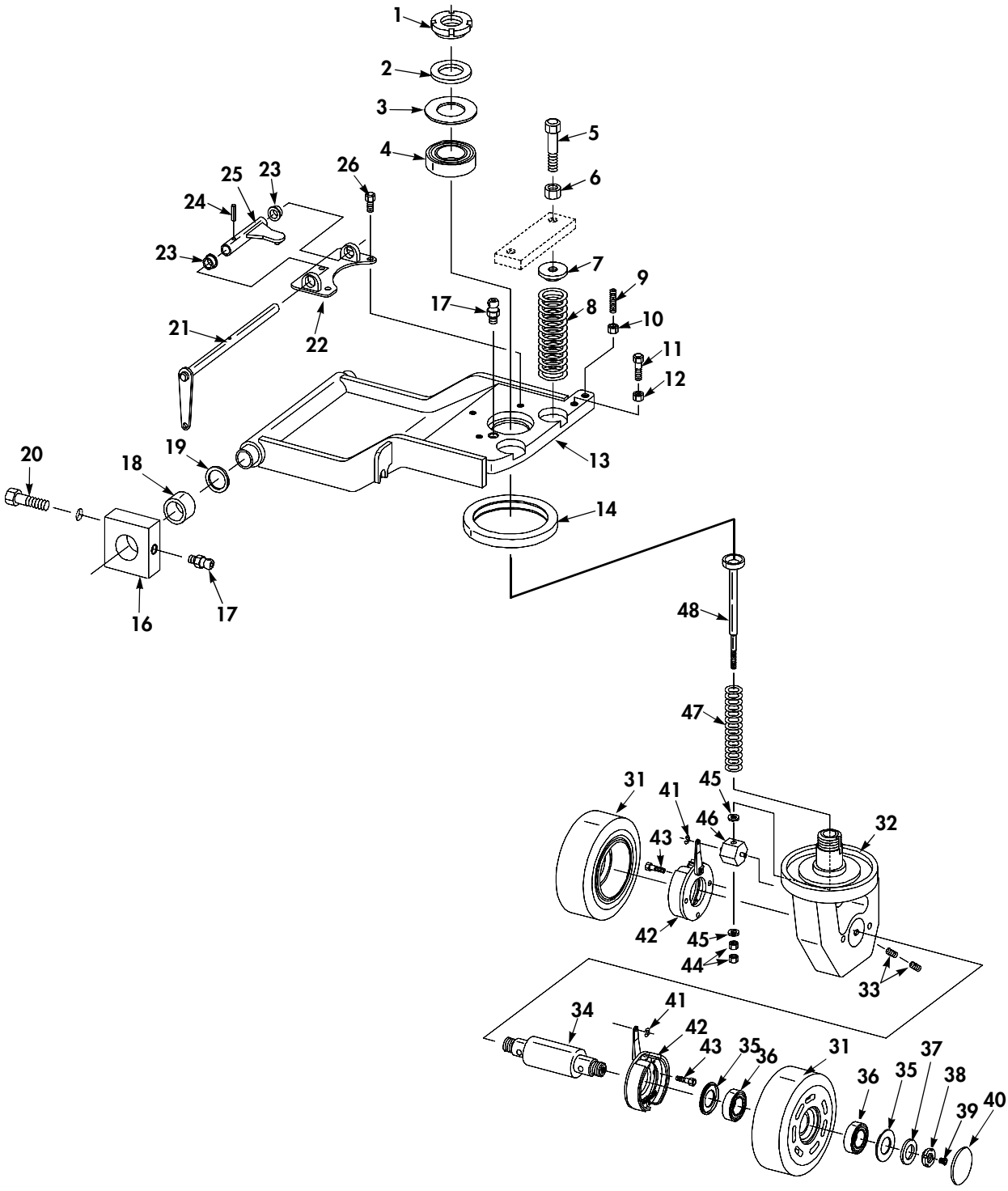


Figure 7-15: Caster Assembly with Brake Component Identification

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POS. NO.	DESCRIPTION	POS. NO.	DESCRIPTION	POS. NO.	DESCRIPTION
1	Lock, nut	16	Block	35	Ring, Nilos
2	Lockwasher	17	Fitting, grease	36	Bearing
3	Ring, Nilos	18	Bushing	37	Lockwasher
4	Bearing	19	Washer	38	Locknut
5	Screw, cap	20	Screw, cap	39	Fitting, grease
6	Nut	21	Shaft	40	Cap, wheel
7	Guide, spring	22	Bracket	41	Ring, E
8	Spring	23	Bearing, flanged	42	Brake assembly
9	Screw, set	24	Pin, roll	43	Screw, cap
10	Nut	25	Pivot	44	Nut
11	Screw, cap	26	Screw, cap	45	Washer
12	Nut	31	Wheel, caster	46	Pivot, brake
13	Pivot, caster	32	Bracket, caster	47	Spring
14	Bearing, thrust	33	Screw, set	48	Plunger, brake
15	Caster assembly	34	Axle, caster		

Caster Brake Adjustment

1. Park the lift truck on a level surface.
2. Turn the key switch OFF and disconnect the battery connector. Check to make sure the battery gates are in place.
3. Jack the rear of the lift truck so the drive and caster wheels are approx. 1 in. (25mm) off the floor. Block the lift truck in this position.

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⚠WARNING

Use extreme care whenever the lift truck is jacked up for any reason. Never block the lift truck between the mast telescopic and the floor. Use a suitable hoist to stabilize the mast. Keep hands and feet clear from beneath vehicle while jacking. Use jack stands or solid blocks to support the lift truck - do not rely on jacks. Refer to "Jacking Safety" on page 2-13.

4. Remove the electrical compartment access panel following the procedure on page 7-15.
5. Remove the floor board following the procedure on page 7-18.
6. Total travel of the left foot deadman pedal from up to down is 3.5 in. (89 mm). The pedal setpoint is 50% down or 1.8 in. (45 mm). This can be felt by a change in force at the pedal by the spring tension.
7. Loosen the adjuster nuts of the cable end at the caster assembly bell crank. Adjust the cable threaded end to allow for more engagement required by a worn brake. At the 50% pedal up position, the caster wheels should stop rotating due to the brakes making contact with the caster wheel drums.

   When the cable can no longer be adjusted for caster braking, the brake must be adjusted at the caster wheels.

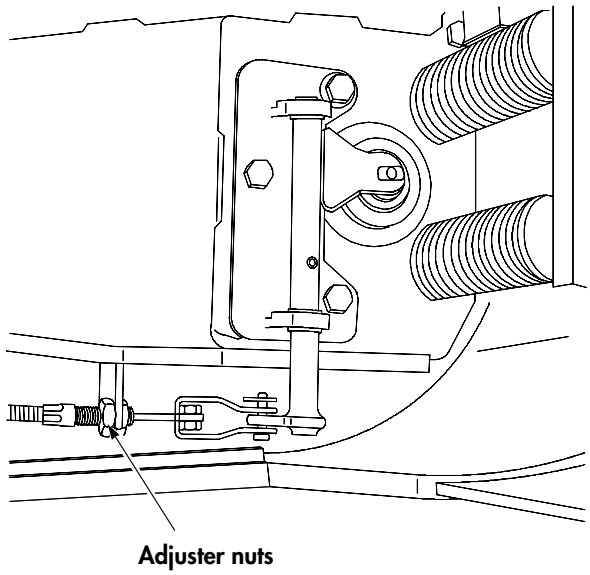


Figure 7-16: Upper Adjustment Location

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8. Run the cable adjustment back to the original position. Full threads toward the caster assembly.
9. Remove only one caster wheel. Refer to caster wheel removal on page 7-49.
10. Remove the brake shoe assembly from the caster bracket.
11. Adjust the double nuts at the brake rod up or down by tightening brake arm. Check the brake at 50% pedal up position. The remaining caster wheel should stop rotating due to the brake shoes starting to make contact with the wheel hub.
12. Lock the double nuts together.
13. Reassemble and test the lift truck for proper braking.

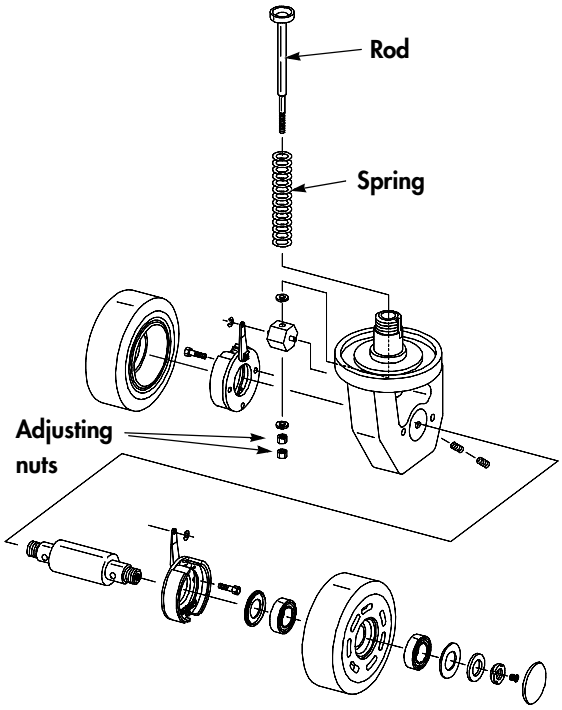


Figure 7-17: Lower Adjustment Location

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Caster Brake Removal

1. Park the lift truck on a level surface.
2. Turn the key switch OFF and disconnect the battery connector. Check to make sure the battery gates are in place.
3. Remove the electrical compartment access panel following the procedure on page 7-15.
4. Jack the rear of the lift truck so the drive and caster wheels are approx. 1 in. (25 mm) off the floor. Block the lift truck in this position.

⚠WARNING

Use extreme care whenever the lift truck is jacked up for any reason. Never block the lift truck between the mast telescopic and the floor. Use a suitable hoist to stabilize the mast. Keep hands and feet clear from beneath vehicle while jacking. Use jack stands or solid blocks to support the lift truck - do not rely on jacks. Refer to "Jacking Safety" on page 2-13.

5. Remove the wheel cap (40).
6. Bend the lockwasher (37) tab down and remove the axle nut (38).
7. Remove the caster wheel assembly following the procedure on page 7-49.
8. Inspect and replace the race and bearing (36) as needed.
9. Remove the E ring (41) and remove the cap screws (43) if brake assembly is to be replaced, otherwise replace the brake shoes.
10. Remove nuts (44), washer (45), and slide brake plunger (48) up to remove the brake pivot (46) and other washer (45).
11. Remove the brake plunger (48) and spring (47).

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Installation

1. Slide the spring (47) in the caster bracket (32) and install the brake plunger (48).
2. Install washer (45) on the brake plunger (48) and slide the brake pivot (46) on the brake plunger (48) against washer (45).
3. Install a second washer (45) on the brake plunger against the brake pivot (46). Secure assembly together with nut (44) and install a second nut (44) to lock in place.
4. Install brake assembly (42) with cap screws (43).
5. Move the brake pivot (46) around to install E ring (41) on both brake assembles (42).
6. Install Nilos ring (35) on axle.
7. Install caster wheel assembly.
8. Install Nilos ring (35), lockwasher (37) and axle nut (38).
9. Tighten axle nut (38) while turning caster wheel until wheel becomes tight.
10. Back off axle nut (38) until the caster wheel turns freely. Axle nut (38) and lockwasher (37) tab are aligned.
11. Bend the lockwasher (37) tab to secure the axle nut (38) in position.
12. Grease as needed.
13. Replace the wheel cap (40).

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Caster Assembly w/o Brake

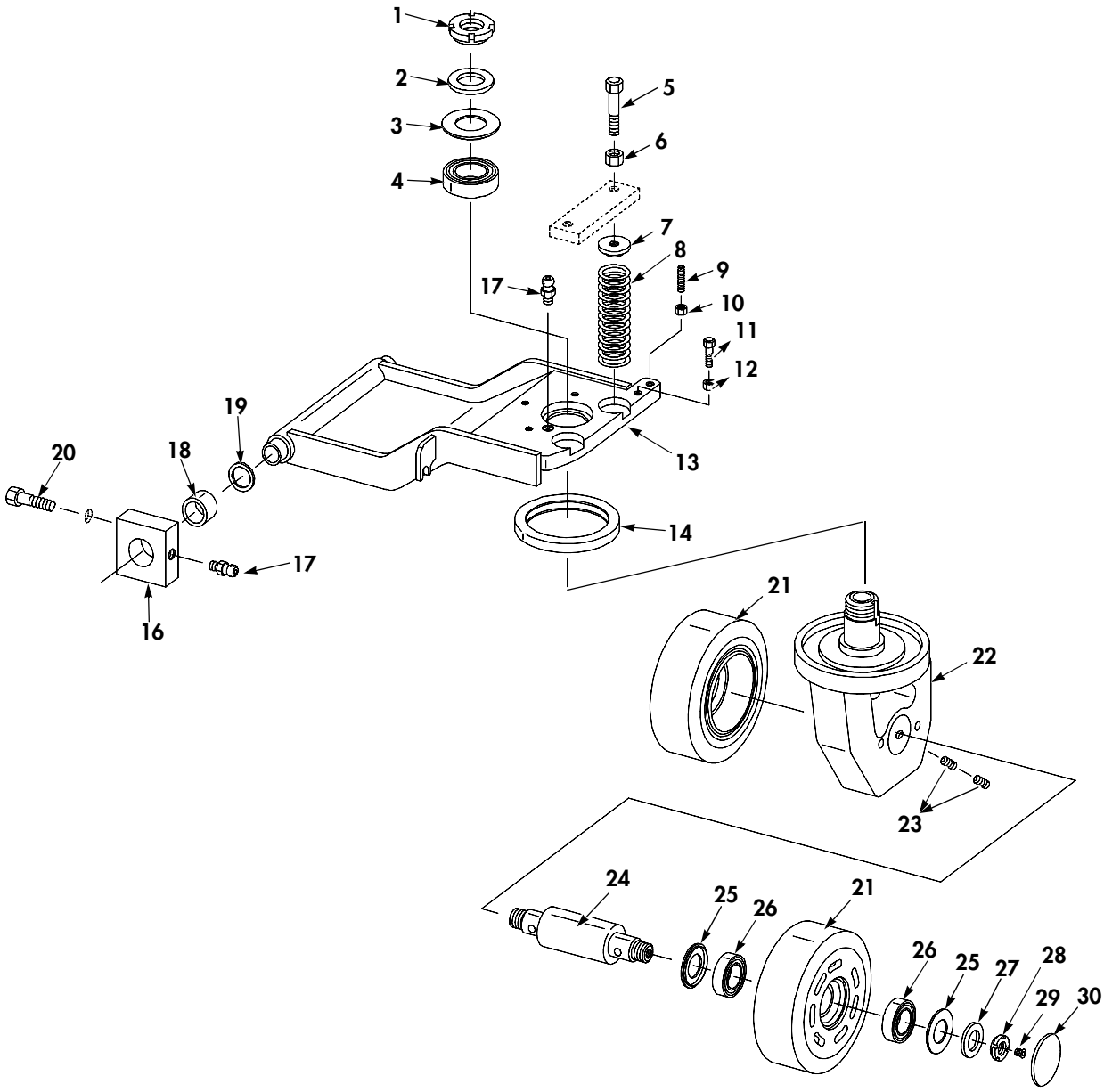


Figure 7-18: Caster Assembly without Brake Component Identification

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POS. NO.	DESCRIPTION	POS. NO.	DESCRIPTION	POS. NO.	DESCRIPTION
1	Lock, nut	11	Screw, cap	21	Wheel, caster
2	Lockwasher	12	Nut	22	Bracket, caster
3	Ring, Nilos	13	Pivot, caster	23	Screw, set
4	Bearing	14	Bearing, thrust	24	Axle, caster
5	Screw, cap	15	Caster assembly	25	Ring, Nilos
6	Nut	16	Block	26	Bearing
7	Guide, spring	17	Fitting, grease	27	Lockwasher
8	Spring	18	Bushing	28	Locknut
9	Screw, set	19	Washer	29	Fitting, grease
10	Nut	20	Screw, cap	30	Cap, wheel

Caster Pivot

Removal

1. Park the lift truck on a level surface.
2. Turn the key switch OFF and disconnect the battery connector. Check to make sure the battery gates are in place.
3. Jack the rear of the lift truck so the drive and caster wheels are approx. 1 in. (25 mm) off the floor. Block the lift truck in this position.

⚠WARNING

Use extreme care whenever the lift truck is jacked up for any reason. Never block the lift truck between the mast telescopic and the floor. Use a suitable hoist to stabilize the mast. Keep hands and feet clear from beneath vehicle while jacking. Use jack stands or solid blocks to support the lift truck - do not rely on jacks. Refer to "Jacking Safety" on page 2-13.

4. Remove the electrical compartment access panel following the procedure on page 7-15.

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5. Remove the floor board following the procedure on page 7-18.

⚠WARNING

Secure the transmission before removing the mounting bolts (4). Serious injury could occur.

6. Turn and secure transmission so that you can access mounting bolts (20).

NOTE: For models with brake on caster wheels, the cable linkage must be disconnected before removal of the deadman pedal.

7. Remove the four bolts securing the deadman pedal assembly.
8. Remove the deadman pedal.
9. Bend the lockwasher (2) tab down and remove the lock nut (1).
10. Remove the Nilos ring (3) and bearing (4).
11. Remove the caster assembly.
12. Remove the mounting bolts (20).
13. Remove the caster pivot (13). Inspect and replace the bushings and bearings as needed.

Installation

1. Install the pivot block (16) closest to the battery compartment first.
2. Install the rear pivot block (16) on the caster pivot (13).
3. Maneuver the caster pivot (13) in place between the frame.
4. Install the caster assembly in the caster pivot (13).

NOTE: Make certain the nilos ring and lockwasher are in the correct position.

5. Torque the locknut (1).
6. Bend the tab on the lockwasher (2) up to secure the lock nut (1).
7. Install the deadman pedal.

NOTE: For models with a brake on the caster wheels, the cable linkage must be installed.

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8. Set the spring tension and stops. Refer to page 7-45.
9. Adjust caster stops. See page 7-48.
10. Install the floor board and electrical compartment access panel.
11. Test the lift truck operation, then return to service.

Thrust Bearing

Removal

1. Park the lift truck on a level surface.
2. Turn the key switch OFF and disconnect the battery connector. Check to make sure the battery gates are in place.
3. Jack the rear of the lift truck so the drive and caster wheels are approx. 1 in. (25 mm) off the floor. Block the lift truck in this position.

⚠WARNING

Use extreme care whenever the lift truck is jacked up for any reason. Never block the lift truck between the mast telescopic and the floor. Use a suitable hoist to stabilize the mast. Keep hands and feet clear from beneath vehicle while jacking. Use jack stands or solid blocks to support the lift truck - do not rely on jacks. Refer to "Jacking Safety" on page 2-13.

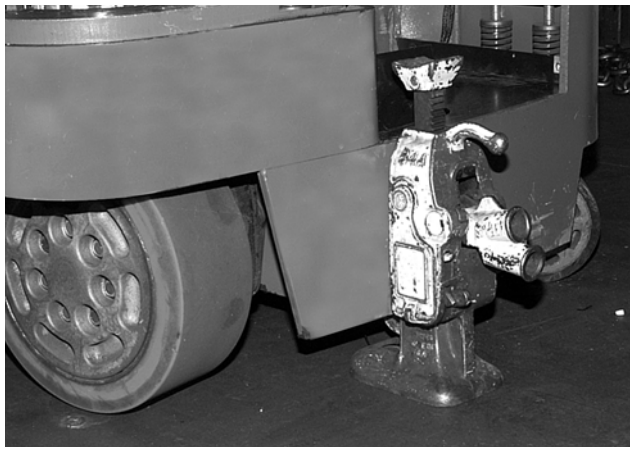


Figure 7-19: Jacking Location

4. Remove the electrical compartment access panel following the procedure on page 7-15.
5. Remove the floor board following the procedure on page 7-18.

NOTE: For models with brakes on the caster wheels, remove the brake arm.

6. Bend the tab down on the lockwasher (2).
7. Remove the lock nut (1), lock washer (2) and Nilos ring (3).
8. Inspect and replace the bearings as needed.

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Installation

1. The lift truck must be properly blocked at this time.
2. Install race (4) in caster pivot and thrust bearing (14) on caster assembly.
3. Install caster assembly in caster pivot (13).
4. Install bearing (4), Nilos ring (3), lock washer (2) and lock nut (1).
5. Tighten lock nut (1) while turning caster wheel assembly until tight, then back off 1/4 in. turn.
6. Bend lock washer tab (2) up to secure lock nut (1).

NOTE: For models with brake on caster wheels, install the brake arm.

7. Test caster operation.

Caster Springs

Adjustment

1. Park the lift truck on a level surface.
2. Turn the key switch OFF, disconnect the battery connector, and securely block the lift truck.
3. Remove the electrical compartment access panel following the procedure on page 7-15.
4. Measure from the top of the spring spacer to the caster pivot plate. The measurement should be 5-3/8 in. (136.5 mm).
5. To change the adjustment, loosen the jam nuts (6) and tighten or loosen the bolts (5).

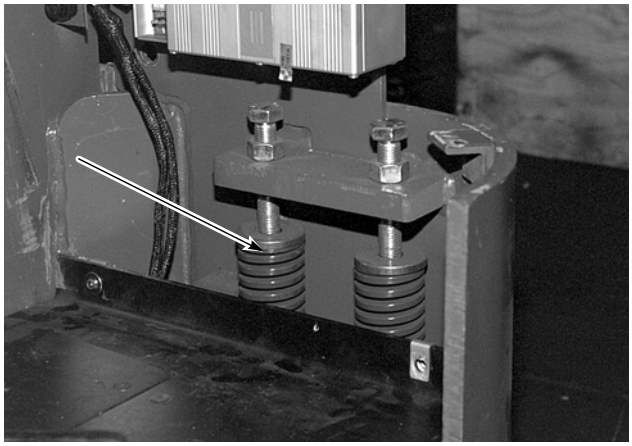


Figure 7-20: Caster Adjustment Springs

Removal

1. Park the lift truck on a level surface.
2. Turn the key switch OFF and disconnect the battery connector. Check to make sure the battery gates are in place.
3. Jack the rear of the lift truck so the drive and caster wheels are approx. 1 in. (25 mm) off the floor. Block the lift truck in this position.

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⚠WARNING

Use extreme care whenever the lift truck is jacked up for any reason. Never block the lift truck between the mast telescopic and the floor. Use a suitable hoist to stabilize the mast. Keep hands and feet clear from beneath vehicle while jacking. Use jack stands or solid blocks to support the lift truck - do not rely on jacks. Refer to "Jacking Safety" on page 2-13.

4. Remove the electrical compartment access panel following the procedure on page 7-15.
5. Remove the floor board following the procedure on page 7-18.
6. Loosen the jam nuts (6) and release all spring tension with the adjusting bolts (5). Remove the bolts (5).
7. Remove the jam nut (12). Loosen the stop bolt (11) to allow the caster pivot to rest on the frame stop.
8. The springs must be removed from the side.

Installation

1. Install the adjusting bolts (5).
2. Lower the lift truck to the floor and remove the hoist.
3. Tighten the adjusting bolts (5) until you have 5-3/8 in. (136.5 mm) between the top of the spring spacer and the caster pivot plate.
4. Adjust the stops bolts (9) and (11) to 1/8 in. (32 mm) clearance on each stop.
5. Install the floor board.
6. Install the electrical compartment panel.
7. Test lift truck operation.

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Caster Axle

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Jack the back of the lift truck so that the drive wheel and the caster wheel are 1 in. off the floor.

⚠WARNING

Use extreme care whenever the lift truck is jacked up for any reason. Never block the lift truck between the mast telescopic and the floor. Use a suitable hoist to stabilize the mast. Keep hands and feet clear from beneath vehicle while jacking. Use jack stands or solid blocks to support the lift truck - do not rely on jacks. Refer to "Jacking Safety" on page 2-13.

3. Remove the caster wheels. Refer to procedure on page 7-49.
4. Remove the two setscrews (3). One setscrew locks the other in place.
5. Tap the axle (4) out of caster bracket (2).

Installation

1. Install the caster axle (4) in the caster bracket (2).
2. Align the setscrew holes.
3. Install the setscrews (3).
4. Install the caster wheels. Refer to the procedure on page 7-50.

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Caster Stops

Adjustment

1. Park the lift truck on a level surface.
2. Turn the key switch OFF and disconnect the battery connector. Securely block the lift truck.
3. Remove the electrical compartment access panel following the procedure on page 7-15.
4. Remove the floor board following the procedure on page 7-18.
5. Measure from the top of the spring spacer to the caster pivot plate. The measurement should be 5-3/8 in. (136.5 mm). Adjust the caster spring following the procedure on page 7-45 if necessary.

NOTE: The stop bolts must not be touching the stop blocks when measuring spring compression.

6. Adjust the stop bolts (9) and (11). The recommended dimension between the stop bolts and the stop block is 0.25 in. (6.35 mm). Refer to the table below to determine if the maximum dimension for your particular lift truck can be increased.

Battery	**Mast Height** ***in. (mm)***						
Compartment Size/Min. Battery Weight	**192 (4877)**	**210 (5334)**	**240 (6096)**	**270 (6858)**	**300 (7620)**	**330 (8382)**	**360 (9144)**
14 in. (356 mm)/1600 lb. *in. (mm)*	.375 (9.53)	.375 (9.53)	.375 (9.53)	.375 (9.53)	N/A	N/A	N/A
16 in. (406 mm)/ 2000 lb. *in. (mm)*	.375 (9.53)	.375 (9.53)	.375 (9.53)	.375 (9.53)	.25 (6.35)	.25 (6.35)	N/A
21 in. (533 mm)/2400 lb. *in. (mm)*	.375 (9.53)	.375 (9.53)	.375 (9.53)	.375 (9.53)	.25 (6.35)	N/A	N/A
21 in. (533 mm)/2600 lb. *in. (mm)*	N/A	N/A	N/A	N/A	N/A	.25 (6.35)	.25 (6.35)

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⚠ CAUTION

Failure to determine battery compartment size, battery weight, and mast height can result in serious injury.

7. The dimension between the bottom stop bolt (9) and the bottom stop block must be 1/8 in. (3.2 mm).
8. Secure the jam nuts (12).
9. Install the floor board and panels.
10. Test the lift truck operation, then return to service.

Caster Wheel Removal

1. Park the lift truck on a level surface.
2. Turn the key switch OFF and disconnect the battery connector. Check to make sure the battery gates are in place.
3. Jack the rear of the lift truck so the drive and caster wheels are approx. 1 in. (25 mm) off the floor. Block the lift truck in this position.

⚠WARNING

Use extreme care whenever the lift truck is jacked up for any reason. Never block the lift truck between the mast telescopic and the floor. Use a suitable hoist to stabilize the mast. Keep hands and feet clear from beneath vehicle while jacking. Use jack stands or solid blocks to support the lift truck - do not rely on jacks. Refer to "Jacking Safety" on page 2-13.

4. Remove the wheel hub cap (30).
5. Using a dull chisel or a screwdriver, bend the lockwasher (27) tab down. Remove the axle nut (28) and the lockwasher (27).
6. Remove the caster wheel assembly components (dust cover [Nilos ring], bearing, wheel, bearing, dust cover).
7. Inspect and replace the race and bearing (26) as needed.

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Installation

1. Install the Nilos ring (25) and bearing (26) on the axle.
2. Install the caster wheel.
3. Install the second bearing (26) and Nilos ring (25), lockwasher (27) and axle nut (28).
4. Tighten the axle nut (28) while turning the caster wheel until the wheel becomes tight.
5. Back off the axle nut (28) until the caster wheel turns freely. The axle nut (28) and lockwasher (27) tab are aligned.
6. Bend the lockwasher (27) tab to secure the axle nut.
7. Grease as necessary.
8. Replace the wheel hub cap (30).

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Electromagnetic Brake

POS. NO.	DESCRIPTION
01	Brake assembly
02	Coil
03	Armature
04	Hub
05	Plate, friction
06	Plate, mounting
07	Spacer
08	Spring
09	Screw, socket head
10	Washer
11	Screw, socket head
12	Screw

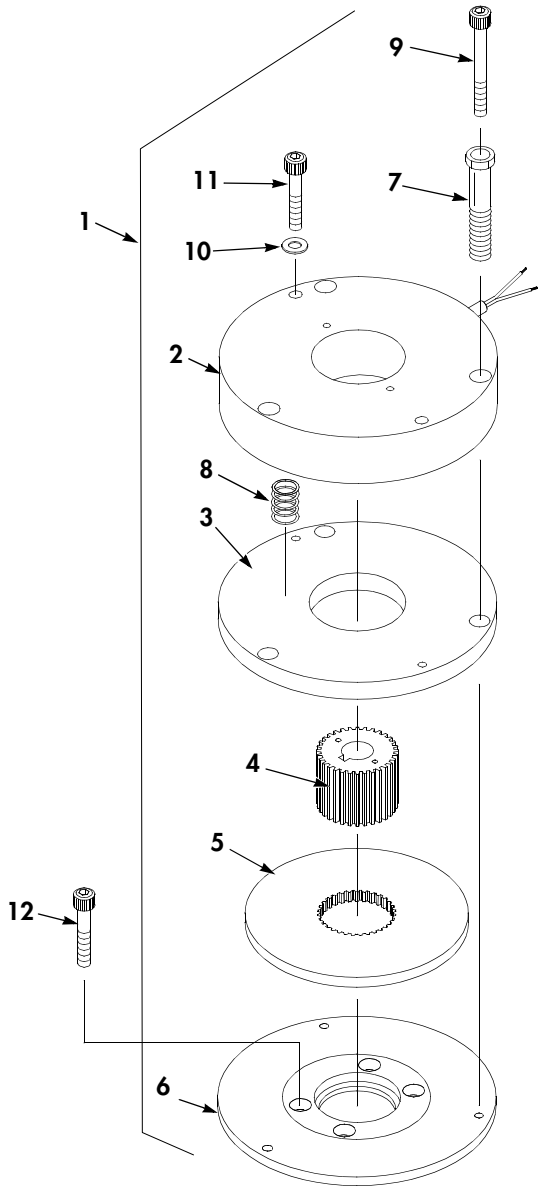


Figure 7-21: Brake Components

Removal

1. Park the lift truck on a level surface and block securely.
2. Turn the key switch OFF and disconnect the battery connector.
3. Fully tighten the two manual release screws (11).

⚠WARNING

The two manual release screws must be fully tightened before removing the three brake retaining screws.

4. Remove the three screws (9) which hold brake parts and set aside. Avoid moving the adjustable spacers (7) if possible, thus maintaining correct axial air gap when reassembled.

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5. Electrically disconnect the brake assembly and lift upwards to remove the main body from the top of the drive motor.
6. Slide the friction plate (5) off the hub spline and away from the mounting plate (6).
7. Remove the brake hub (4) from the motor shaft.
8. Remove the mounting plate (6) from the electric drive motor if the drive motor is to be replaced. If only the brake is being changed, the mounting plate may be reused for the new brake assembly.

Installation

⚠WARNING

Magnetic coil and armature are under pressure. DO NOT remove retaining screws without manual release screws in place.

1. Be sure the lift truck is securely blocked with the key switch OFF and the battery disconnected.
2. Fully tighten the two manual release screws (11).

⚠WARNING

Two manual release screws must be fully tightened before removing three brake retaining screws.

3. Remove the three screws (9) which hold brake parts and set aside, ensuring all parts are clean and dry. Avoid moving the adjustable spacers (7) if possible, thus maintaining correct axial air gap when reassembled. The mounting plate is secured to the drive motor with screw (9).
4. Secure the brake hub (4) to the motor shaft. It should not interfere with the mounting plate (6).
5. Slide the friction plate (5) onto the hub spline and up to the mounting plate (6).

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6. Hold the main body of the brake up to the mounting plate (6) and line up the screws (9).

   Carefully secure in place.

7. Once the brake is fully secured in position, remove and set aside the manual release screws (11).
8. Check the air gap and adjust if necessary (See adjustments instructions).
9. After making adjustments, check that brake will release when power is applied.

Adjustments

1. Loosen the three socket head cap screws (9) a few turns using a 6mm Allen wrench.
2. Turn the three adjustment spacers (7) in or out of the coil assembly until a gap of 0.008 to 0.014 in. (0.20 to 0.35mm) is achieved. The final air gap should not vary more than 0.003 in. (0.08mm) throughout the full circumference of the brake assembly.
3. Torque the three socket head cap screws (9) to 15 ft. lb. (20 Nm).

NOTE: The air gap should not be allowed to exceed 0.018 in. (0.45mm) to ensure the release voltage and torque are sufficient.

The friction plate is 0.315 in. (8mm) thick when new and should be replaced when the minimum thickness of 0.250 (6mm) is reached.

4. The air gap should be set to 0.008 in. to 0.014 in. and be within 0.003 in. throughout entire circumference.

Coil Check On Brake

- **24V coil** at 70° F (20° C) should be 9 ohms
- **36V coil** at 70° F (20° C) should be 22 ohms

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Electromagnetic Brake, Armature and Magnetic Coil

Removal

⚠WARNING

Magnetic coil and armature are under pressure. Do not remove retaining screws without manual release screws in place.

1. Park the lift truck on a level surface and block securely.
2. Turn the key switch OFF and disconnect the battery connector.
3. Fully tighten the two manual release screws (11).
4. Remove the three brake retaining screws (9).
5. Electrically disconnect the brake assembly and lift upwards to remove.

Installation

1. Make certain the brake friction plate (5) and armature (3) are clean and free of fluid.
2. Set the armature (3) and magnetic coil (2) on the base plate (6).
3. Align and tighten the three brake retaining screws (9).
4. Remove the two manual release screws (11) and electrically connect the brake.
5. The air gap should be set to 0.008 in. to 0.014 in. and be within 0.003 in. throughout the entire circumference.
6. To test the operation of the brake, connect the battery, turn the key switch ON, and depress the deadman pedal. This will allow the lift truck to operate.

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Brake Friction Plate

Inspection

The brake friction plate should be replaced when the thickness is 15/64 in. (6 mm) or less.

Replacement

If the brake friction plate needs replacement, follow the brake removal procedure on page 7-51. Install the new plate following the installation procedure on page 7-52.

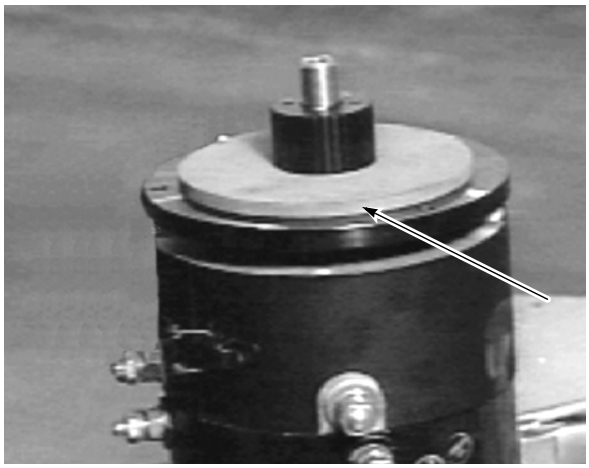


Figure 7-22: Friction Plate

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Drive Wheel

Removal

1. Park the lift truck on a level surface.
2. Turn the key switch OFF and disconnect the battery connector. Check to make sure the battery gates are in place.

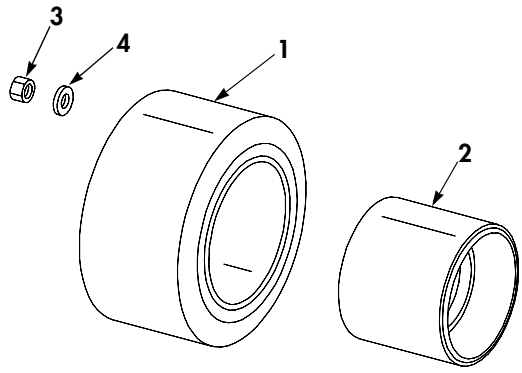


Figure 7-23: Drive Wheel Components

POS. NO.	DESCRIPTION
1	Tire
2	Wheel, drive
3	Nut
4	Washer

3. Jack the rear of the lift truck so the drive and caster wheels are approx. 1 in. (25 mm) off the floor. Block the lift truck in this position.

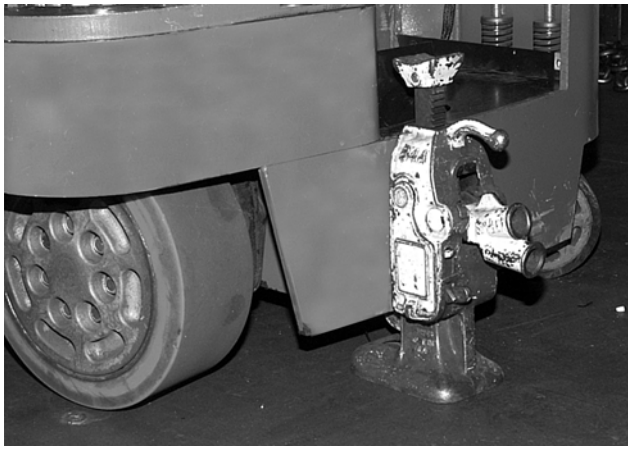


Figure 7-24: Jacking Tractor End

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⚠WARNING

Use extreme care whenever the lift truck is jacked up for any reason. Never block the lift truck between the mast telescopic and the floor. Use a suitable hoist to stabilize the mast. Keep hands and feet clear from beneath vehicle while jacking. Use jack stands or solid blocks to support the lift truck - do not rely on jacks. Refer to "Jacking Safety" on page 2-13.

1. Use a 19 mm socket to remove the seven wheel retaining nuts (3). Remove the spherical washers (4) from the drive wheel mounting holes. Pull the tire (1) and drive wheel (2) from the transmission drive axle hub.
2. Press the tire (1) from the drive wheel (2). See "Drive Tire Pressing Procedure" on page 7-58.

Installation

1. Press the new drive tire on the wheel hub. This is usually done while pressing off the old tire. Press the hub to the center of the tire (1).
2. Align the seven studs on the transmission with the drive wheel mounting holes.
3. Install the drive tire assembly on the transmission axle hub.
4. Install the seven washers, round side in, on each of the transmission studs.
5. Start the drive tire retaining nuts. Torque to 95 ft. lb. (130 Nm).
6. Remove the blocking and lower the lift truck to the floor.
7. Reconnect the battery connector.
8. Return the lift truck to service.

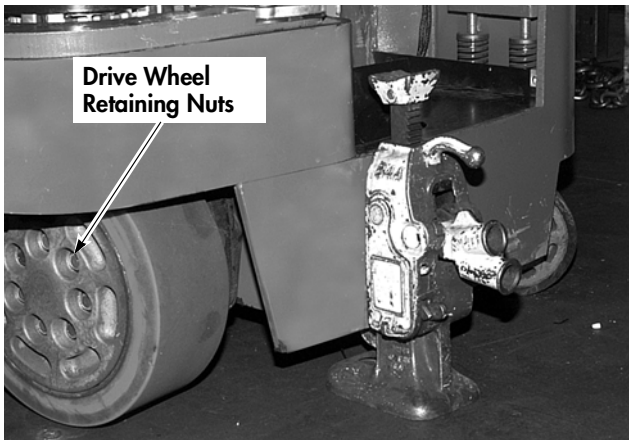


Figure 7-25: Drive Wheel and Tire

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Drive Tire Pressing Procedure

1. Check the inside surface of the metal insert on the new tire. Remove any scaling or rust with sandpaper. Clean the inside of the metal insert and lubricate it with a soap solution.
2. Place a circular ram on the press table. See Figure 7-26. The length of the ram must be longer than the width of the old tire to allow complete removal of the old tire. The outside diameter of the ram must be small enough to fit loosely in the insert of the tire but must be large enough to rest squarely on the flat surface on the outer edge of the hub.
3. If the outside edge of the hub is not flush with the edge of the metal insert in the old tire, measure how far the hub is recessed inside the tire. The new tire must be placed in the same position the old tire was installed on the hub. You can use a spacer (slightly smaller in diameter than the inside diameter of the tire insert and the same thickness as the depth of the recess) to obtain the proper amount of recession.
4. Position the hub assembly with the old tire on the top of the circular ram so the outside of the wheel is positioned upward. The outside edge of the hub has a chamfer to help guide the new tire onto the wheel. The chamfered edge must always be the leading edge when a tire is pressed onto the hub.
5. Center the hub assembly on top of the ram and make sure that they mate squarely.
6. Apply grease to the inside of the tire rim.
7. Position the new tire with its chamfered insert facing the hub. Align the new tire and the hub so that they are concentric.
8. Begin pressing the new tire onto the hub and the old tire off the wheel. Run the press slowly for the first few inches of travel, because this is the critical stage of the operation. If the tire begins to cock to one side, stop the press and realign the tire. A sharp jar with a soft-headed mallet will usually realign the tire on the hub.

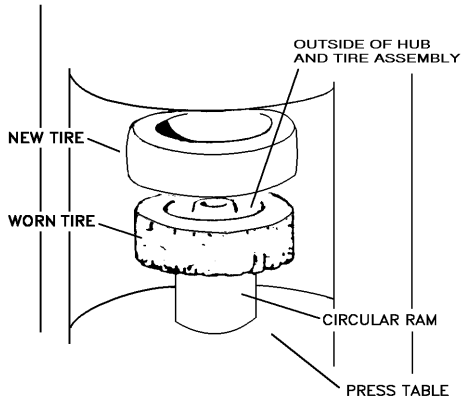


Figure 7-26: Drive Tire Installation

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NOTE: If the new tire does not press on with a minimum of 5 tons (68,947 kPa) force, replace the hub.

⚠ CAUTION

Any misalignment of the tire and hub while the tire is being pressed onto the hub can cause damage to the hub. For this reason, chamfers have been provided on the outside edge of the hub and on the end of the inside diameter of the tire's metal insert. The chamfers help to center the hub and tire during the pressing operation and reduce the possibility of misalignment. To prevent damage, the hub must be installed on the circular ram with its chamfered side up.

9. Release the press. Remove the wheel, tire assembly, and the old tire from the press table. Wipe off any grease. Inspect the wheel and tire assembly.
10. Install the drive wheel assembly following the procedure on page 7-56. Torque the mounting bolts to 80 ft. lb. (112 Nm).

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Drive Unit

Fluid Changing Procedure

1. Remove the drain plug from the drive unit and drain all the fluid.
2. Reinstall the drain plug.
3. Refill using the proper grade fluid. The capacity of the drive unit is 1 gal. (3.785 liters).
4. The fluid level of the drive unit may be checked when the drive motor is removed from the transmission.

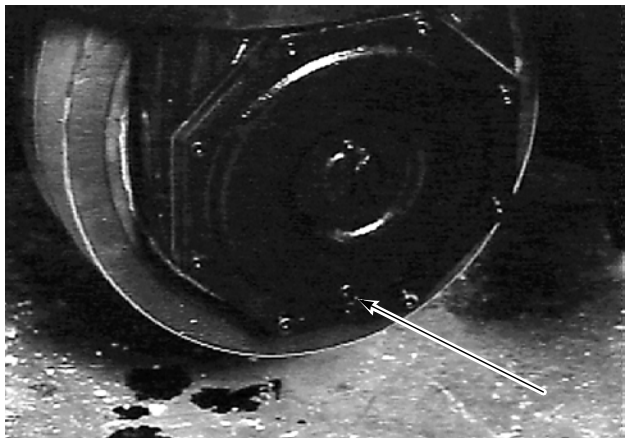


Figure 7-27: Drive Unit Drain Plug

⚠ CAUTION

Incorrect selection of fluid, for a particular application, may cause damage. No warranty will be paid on component damage resulting from incorrect fluid selection.

Removal

1. Park the lift truck on a level surface.
2. Turn the key switch OFF and disconnect the battery connector.
3. Jack the rear of the lift truck so the drive and caster wheels are approx. 1 in. (25 mm) off the floor. Block the lift truck in this position.

⚠WARNING

Use extreme care whenever the lift truck is jacked up for any reason. Never block the lift truck between the mast telescopic and the floor. Use a suitable hoist to stabilize the mast. Keep hands and feet clear from beneath vehicle while jacking. Use jack stands or solid blocks to support the lift truck - do not rely on jacks. Refer to "Jacking Safety" on page 2-13.

4. Drain the transmission fluid.
5. Remove the drive tire. See "Drive Wheel" on page 7-56.

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6. Place the drive tire face down on the floor. Slide it under the transmission to act as a cradle to keep the transmission upright when it is unbolted from the tractor frame. There should be a 1 in. (25 mm) gap between the tire and the transmission before the transmission is unbolted.
7. Use a 19 mm socket to remove the six bolts that secure the transmission to the tractor frame.
8. Tap the transmission with a rubber mallet to break it loose from the frame. The transmission will drop down, into the recess in the back of the drive tire.



Figure 7-28: Drive Tire Cradle for Drive Unit

Installation

1. Place the transmission beneath the lift truck. Using a hoist, lower the tractor frame onto the transmission. Be careful not to damage the sensors. Also take care not to pinch hands between the transmission and the tractor frame.
2. Line grease zerks up with the indentations in the frame.
3. The flat surface on top of the transmission should be toward the left so that the 180° sensor will read it correctly.
4. Be sure sensor wires are out of the way to prevent damage (pinching or breaking).
5. Guide transmission, with one hand through the hole in the tractor frame, while lowering the tractor frame onto the transmission.
6. Clean and apply Loctite 242 to the transmission mounting bolts. Use a 19 mm wrench to help get the bolts started straight.
7. The transmission will pull tight to the tractor frame mounting surface as the bolts are tightened. Transmission mounting bolts should be torqued to 90 ft. lb. (122 Nm).

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Tooth Pattern of Drive Unit

Mount the gear sets according to the instructions in this chapter. Adjust the shim packs to the correct tolerances. Correct improper tooth patterns as shown in the chart to the right; the degree of change depends on the position of the patterns on the teeth.

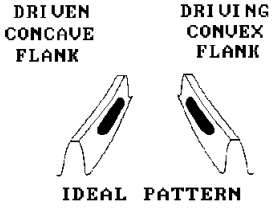
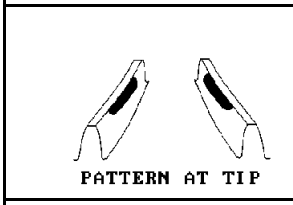
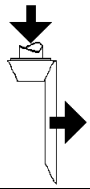
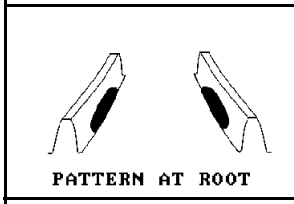
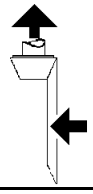
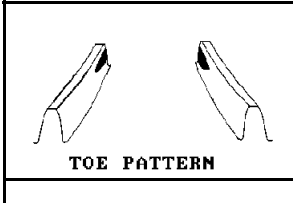
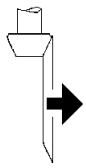
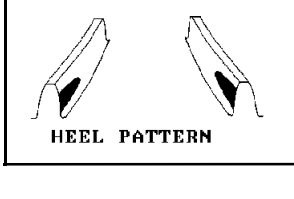
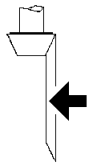
TOOTH PATTERN ON RING GEAR CONCAVE FLANK / CONVEX FLANK	CORRECT PATTERN BY CHANGING THE SHIMS IN THE DIRECTION SHOW
	No Adjustment Needed
	
	
	
	

Figure 7-29: Drive Unit Gear Tooth Pattern

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Drive Housing Steering Bearing

Removal

NOTE: Transmission and drive motor must be removed from the lift truck to access the steering bearing.

1. Park the lift truck on a level surface.
2. Turn the key switch OFF and disconnect the battery connector. Check to make sure the battery gates are in place.
3. Jack the rear of the lift truck so the drive and caster wheels are approx. 1 in. (25 mm) off the floor. Block the lift truck in this position.

⚠WARNING

Use extreme care whenever the lift truck is jacked up for any reason. Never block the lift truck between the mast telescopic and the floor. Use a suitable hoist to stabilize the mast. Keep hands and feet clear from beneath vehicle while jacking. Use jack stands or solid blocks to support the lift truck - do not rely on jacks. Refer to "Jacking Safety" on page 2-13.

4. Remove the motor compartment door and left-side panel for easier access to the motor compartment. See page 7-14.
5. Disconnect all electrical connections on the drive motor and brake assembly.
6. Remove the drive motor.
7. Secure the transmission and remove the six mounting bolts.
8. Remove the mounting ring.
9. Remove the 15 bolts (11) retaining the 360° bearing (1).

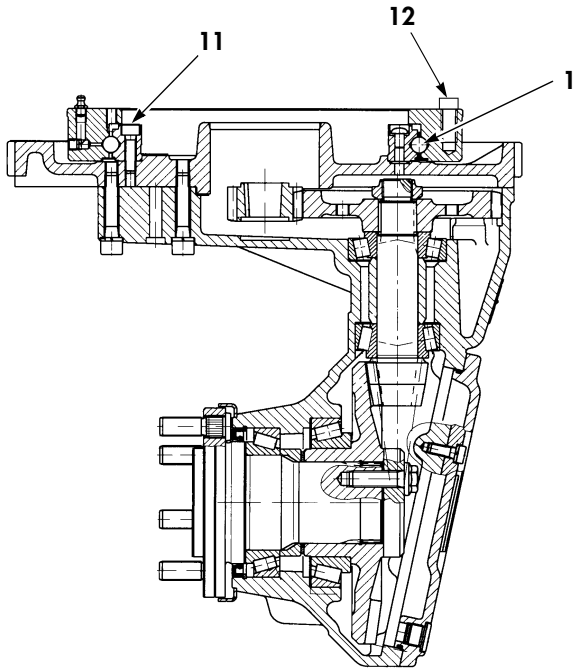


Figure 7-30: Steering Bearing Location

POS. NO.	DESCRIPTION
1	Bearing
11	Screw
12	Screw

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Installation

1. Install the new steer bearing (1).
2. Install the transmission mounting plate and the transmission in the lift truck. Torque the six mounting bolts to 90 ft. lb. (122 Nm).
3. Install the drive motor. Refer to page 7-113.
4. Connect all electrical connections.
5. Refill the transmission as needed.
6. Test the steering and the lift truck operation.
7. Install the left side panel and the motor compartment door.
8. Return the lift truck to service.

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Axle Seal Replacement

Procedure

1. Turn the drive unit so the drive tire can be removed.
2. Using a 13/16 in. socket, loosen the lug bolts on the drive tire.
3. Jack the lift truck so the drive tire is approx. 1 in. (25 mm) off the floor.

⚠WARNING

Use extreme care whenever the lift truck is jacked up for any reason. Never block the lift truck between the mast telescopic and the floor. Use a suitable hoist to stabilize the mast. Keep hands and feet clear from beneath vehicle while jacking. Use jack stands or solid blocks to support the lift truck - do not rely on jacks. Refer to "Jacking Safety" on page 2-13.

4. Remove the drive tire.
5. Drain the fluid from the drive unit by removing drain plug (1).
6. Using an 8 mm Allen head socket, remove the screws holding the main cover (2).
7. Removing the main cover also removes spiral bevel ring gear (3) and output shaft (4).
8. Save the main cover shim set (5) so that the replacement can be matched for proper thickness.
9. Place the main cover on press as shown in Figure 7-33 and push the ring gear toward the flange of the output shaft enough to allow a bearing puller to be placed between bearing spacer (6) and ring gear (3).

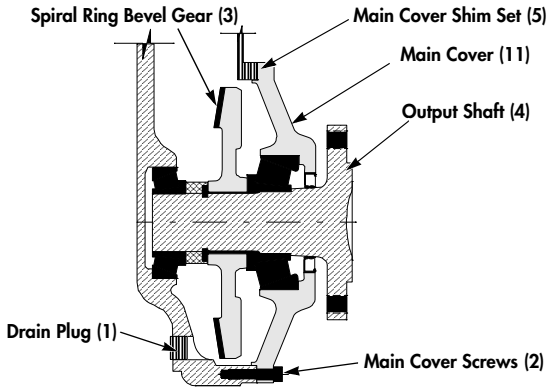


Figure 7-31: Lower End of Drive Unit

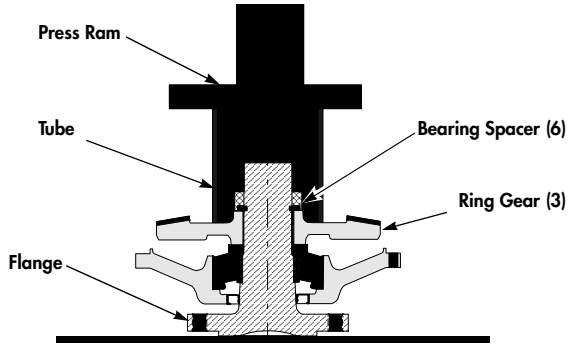


Figure 7-32: Ring Gear Before Being Pressed Toward Flange

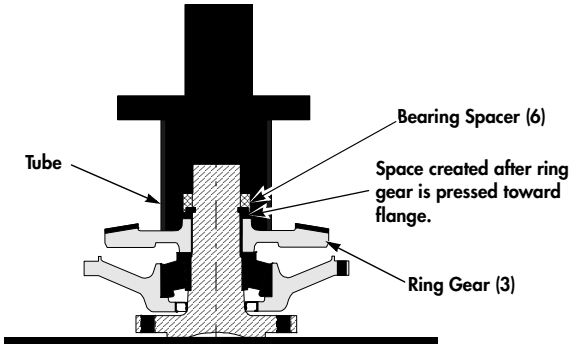


Figure 7-33: Ring Gear After Being Pressed Toward Flange

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10. Using a bearing puller, remove spacer (6) along with bearing (7) from output shaft. Be careful not to damage the bearing cage.

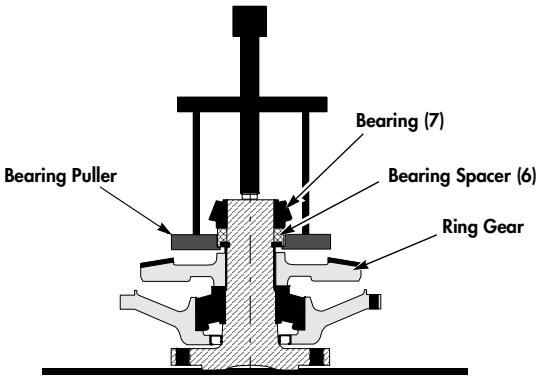


Figure 7-34: Removing Bearing Spacer Using Bearing Puller

11. Remove external retaining ring (8).

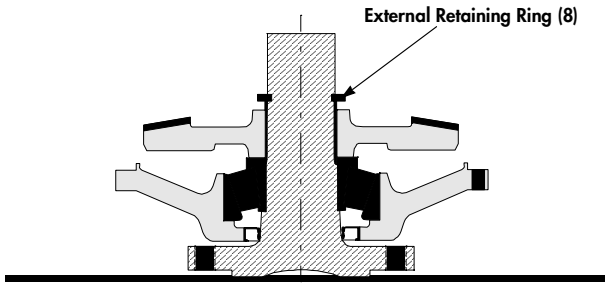


Figure 7-35: Removing External Snap Ring

12. Support the main cover (11) with large tube as shown in Figure 7-36. Press the output shaft (4) out.

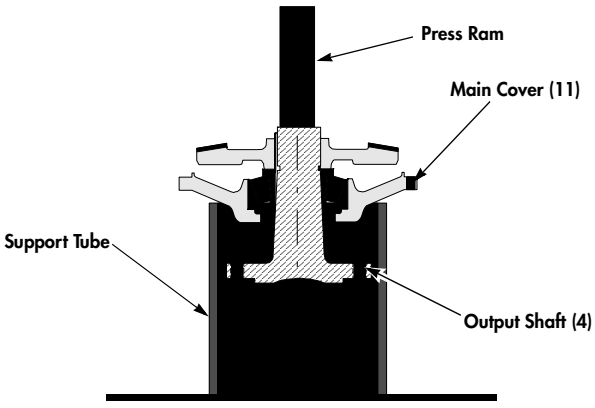


Figure 7-36: Removing Output Shaft

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13. Remove the output shaft seal (9).
14. Apply Permatex sealer to the outside diameter of the new seal (9). Press the new seal into the main cover (11) bore flush with the outside.
15. Lubricate the seal lip using grease. Place the main cover (11) over the output shaft (4).

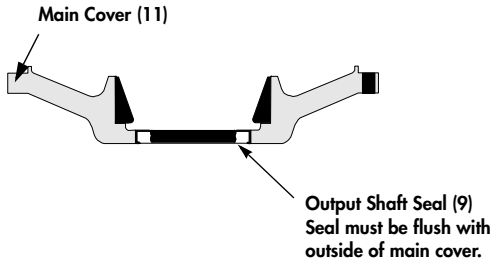


Figure 7-37: Removal/Installation of Shaft Seal

16. Install the bearing cone (10) and ring gear (3) on output shaft (4). Press the ring gear until the groove for the external retaining ring just becomes visible.
17. Reinstall retaining ring (8, Figure 7-35). Do not substitute the correct retaining with a thinner one; doing so may cause the retaining ring to fail, allowing the axle to come out of the drive unit!
18. Press spacer (6, Figure 7-34) onto the output shaft.
19. Press bearing (7, Figure 7-34) onto the output shaft, taking care not to damage the bearing cage.
20. Using a micrometer, measure the thickness of the old cover shim set (5, Figure 7-31). Peel layers off the new shim until the thickness is the same as the old one.
21. Clean the mating surface on the drive unit housing, then apply Permatex sealer.
22. Assemble the main cover sub assembly onto the drive unit housing.
23. Lubricate, then install the cap screws (2, Figure 7-31). Torque evenly to 35 ft. lb. (49 Nm).
24. Install drive tire. Torque lug bolts to 95 ft. lb. (130 Nm).
25. Refill drive unit with proper grade fluid. The capacity of the drive unit is 1 gal. (3.785 liters).

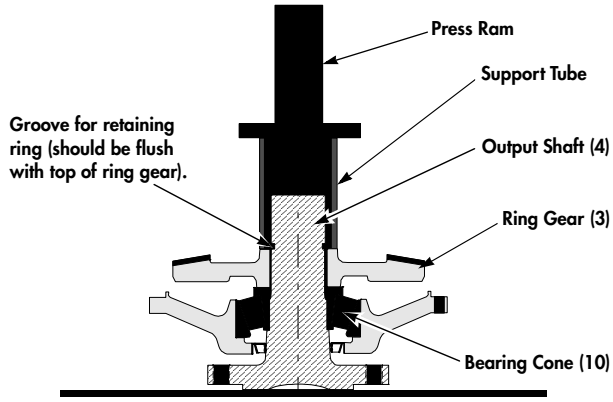


Figure 7-38: Installing Ring Gear

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Electrical

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Battery

⚠ CAUTION

Before working on the battery, review Battery Safety, beginning on page 2-7. Batteries may weigh more than 1,000 pounds. Use extreme care during replacement. Use a suitable battery replacement device or hoist for lifting.

The Toyota Reach lift truck is equipped with battery rollers and sidegates for ease of battery removal and replacement.

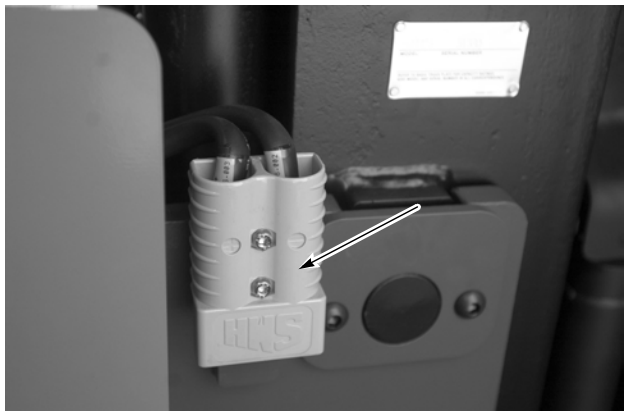


Figure 7-39: Battery Connector

Removal

1. After the lift truck is stopped and the deadman pedal is returned to the full up position, turn the key switch to the OFF position.
2. Disconnect the battery connector located at the top of the tractor cover.
3. Position the battery replacement device in accordance with the manufacturer's recommendations.
4. Remove the battery gate. See Battery Gates on page 7-71.
5. Remove the battery.

Installation

1. With a fully charged and tested battery on the battery replacement device, position the device at the lift truck in accordance with the manufacturer's recommendations.
2. Position the battery in the compartment. Be sure the battery has no more than 0.50 in. (13 mm) of "free play" movement in the battery compartment.
3. Install the battery gate. See Battery Gates on page 7-71..
4. Move the battery replacement device from the area.
5. Reconnect the battery connector, turn the key switch ON, and test the operation of the lift truck.

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Battery Gates

Inspection

Inspect the battery gates for bending or cracks. Replace if necessary.

Removal

1. While lifting the battery gate upward, tilt the edge toward the mast slightly forward to disengage the tongue on the operator compartment end of the battery gate.
2. Continue lifting until the battery gate is clear of the truck, then set aside.



Figure 7-40: Battery Gate

Installation

1. Position the battery gate with tongued edges on the bottom and facing the operator compartment.
2. The edge toward the operator compartment should be tilted in so that the tongue engages with the slot in the back of the battery compartment.
3. Carefully lower the battery gate into position. Move the gate forward and backward until proper engagement is noted.

Battery Rollers

Inspection

Inspect the battery rollers to ensure they can turn freely. Clean off electrolyte using a solution of 1 lb. (.45 kg) of baking soda added to 1/2 gal. (3.7 liters) of hot water.

Replacement

Lift damaged roller from its slot and replace with a new one.

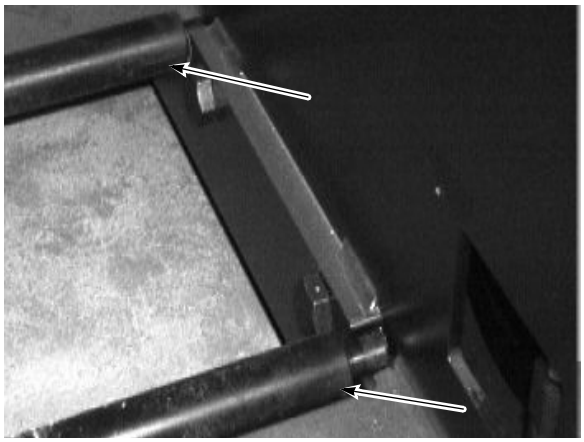


Figure 7-41: Battery Rollers

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Battery Maintenance

The following information does not supersede or replace information supplied by the battery and battery charger manufacturer. Read, understand, and follow the procedures in the manual supplied with the battery and charger.

Notify your supervisor if you have any concerns or questions regarding battery safety or procedures.

Battery Inspection and Care

NOTE: Read, understand, and follow procedures, recommendations, and specifications in the battery and battery charger manufacturer's manuals.

Batteries in industrial lift trucks pick up various kinds of dirt and dust depending on their surroundings and the types of material handled. If cells are overfilled and electrolyte collects on the covers, the following occurs:

1. The top of the battery becomes wet and stays wet, since the acid in the electrolyte does not evaporate.
2. This moist surface, in combination with certain kinds of dirt, becomes electrically conductive and permits stray currents to flow externally over the top of the battery. This degrades battery performance and lift truck operation.
3. The acid also causes corrosion of cell posts, nuts, connectors and the steel battery case.

When inspecting batteries, check the following:

1. Wet covers can indicate overfilling, leaky seals at posts, or excessive gassing during charge. If covers are wet, determine the cause and correct the problem.
2. Make sure batteries cannot move more than 0.5 in. (13 mm) in any horizontal direction. Shim or block to restrain them.

Battery Exterior Cleaning

Refer to the recommended battery manufacturer's guidelines for details.

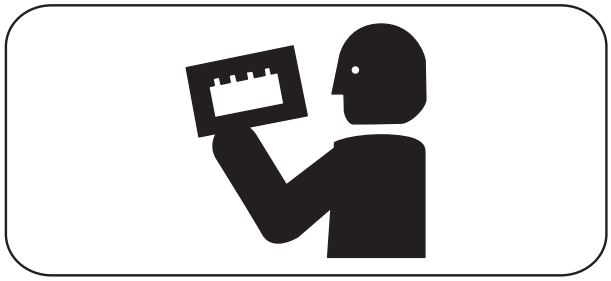
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Charging

OSHA regulations require that battery charging installations be located in areas designated for that specific purpose. Such areas must provide for flushing and neutralizing spilled electrolyte, for fire protection, for protecting charging equipment from damage by lift trucks and for adequate ventilation of fumes from gassing batteries.

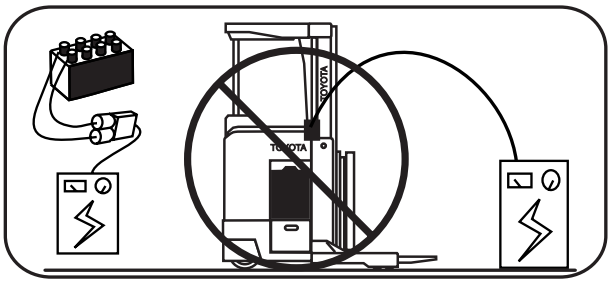
To charge a battery, direct current is passed through the battery cells in the direction opposite that of discharge. Charging time is 5% to 20% longer than discharge time.

Read, understand, and follow procedures, recommendations and specifications in the battery and battery charger manufacturer's manuals.



⚠ CAUTION

NEVER plug the battery charger into the lift truck. This will severely damage the lift truck's electrical system. Plug the charger ONLY into the connector from the battery.



Storage

Before you store a battery, make sure the electrolyte is at the proper level in all the cells, the filler plugs are tight, and the battery is fully charged.

Store the battery in a clean, cool, dry location away from radiators and other sources of heat.

Check the electrolyte level and the specific gravity every 30 days during storage. Whenever the specific gravity is less than 1.230, charge the battery.

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Battery History Record

A battery record system is essential because battery failure can cause production slowdowns and increased battery operating costs. A properly supervised record system can detect and call attention to such operating irregularities as:

- overcharging
- undercharging
- over-discharging
- excessive water consumption
- excessive dirt and corrosion
- worn-out batteries
- excessive current consumption of lift trucks

Records should be kept for each battery. Your battery supplier should be able to provide maintenance record sheets. Each report should contain:

- battery number, type, serial number, and service data
- specific gravity and voltage readings for each cell
- temperature of the air and electrolyte
- electrolyte
- amperes
- condition of connectors, covers, sealing compound and tray
- general cleanliness
- number of total cycles
- average specific gravity drop
- watering frequency
- user comments and observations

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Power Cables

Power cables should be checked for damage, including:

- evidence of overheating
- burned spots in the cable
- nicks in the insulation
- damaged or overheated terminal lugs
- damaged mounting hardware or brackets

Repair or replace damaged cables or mounting hardware as necessary.

Power cables are marked on the terminal lug with the location where they belong. If the marking is missing or is not readable, remark the cable with the correct information.

The terminal lugs should be crimped tightly and securely on the wire. Replace the lug if overheating is evident and repair or replace faulty connectors as necessary.

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Wiring Harness

Terminology

The term “connector JPx” means a mated connector consisting of two connector halves. One half contains male connectors, or pins (P); the other half contains female connectors, or jacks (J).

When you disconnect a mated JP connector, you will have two connector halves. The individual connector halves are designated by “Jx” and “Px.”

For example, connector JP10-5 is the mated tilt up connector in the control handle. J10-5 represents the jack connections. P10-5 represents the pin connections.

Use the chart below or the photos on page 5-12 to locate electrical connectors on the lift truck.

Connector	Location	Function or Routing
HD1	Display Card	CAN Bus +/– to Traction Power Amplifier at JT2 and Lift Power Amplifier at JL2
HD2	Display Card	Overlay (Input SW1, 2 & 3, BDI LEDs 1 & 7-10, Brush Wear, Steer LEDs 2, 3 & 4)
HD3	Display Card	Sonalert
HD5	Display Card	Display card to SFA and SFB near the Speed Feedback Proximity Sensors
HD6	Display Card	Overlay (BDI LED’s 2-6, Input SW4, Steer LEDs 1 & 5-8)
JL1	Lift Power Amplifier	Lift Power Amplifier to B+ Relay and Tractor Interface Card at JP8
JL2	Lift Power Amplifier	Lift Power Amplifier CAN Bus to Traction Power Amplifier at JT2 and Display Card at HD1
JP5	Tractor Interface Card	Tractor Interface Card to Back-Up Alarm (H2)
JP6	Tractor Interface Card	Tractor Interface Card to Solenoid Coils [DIRA (Y12), DIRB (Y13), Lift (Y10-2), Proportional Lower (Y10-3), and B+ Relay, K1 Relay Cntrl, Neg Dir Limit (180° steering)]

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Connector	Location	Function or Routing
JP7	Tractor Interface Card	Tractor Interface Card to: • Key Switch (S1), • EPO Switch (S2), • Deadman Switch (S3), • Horn (H1), • Brake Potentiometer (VR3), • Traction Motor Temperature Sensor (DT) through JPM, • Traction Brush Wear (TB), • Lift Motor Temperature Sensor (LT) through JPZ, • Electrical Compartment Fan (FAN1) • Through X14, then on to Reach (Y14, Y15), Tilt (Y17) and S/S (Y16) Solenoid coils
JP8	Tractor Interface Card	Tractor Interface Card to: • Traction Power Amplifier at JT1, • Lift power amplifier at JL1, • Brake (BR), • Steer Controller safety relay and start/stop, • MM Contactor and • Lift Motor Sensor (M– on Lift Power Amplifier) • Pos Dir Lim FB (180° steering) • Neg Dir Lim FB (180° steering)
JP9	Tractor Interface Card	Tractor Interface Card to Mast Switches (S4, S5, S6), Platform (right foot) Switch (S7), and 180° steer sensor.
JP10	Tractor Interface Card	Tractor Interface Card inputs from Control Handle potentiometers (VR1, VR2) and switches
JP11	Tractor Interface Card	Tractor Interface Card to Drive Wheel Position Sensor B (speed/direction sensor) (360° steering) or Steer Stop Sensor (180° steering)
JP12	Tractor Interface Card	Tractor Interface Card to F4, F5, and F6
JP13	Tractor Interface Card	Tractor Interface Card to Drive Wheel Position Sensor A (speed/direction sensor) (360° steering) or Steer Stop Sensor (180° steering)
JP14	Tractor Interface Card	Tractor Interface Card to Pressure Transducer (PRESS)
JP15	Tractor Interface Card	Tractor Interface Card to Spare Solenoid Driver and Staging Switch (S8) and Pos Dir Limit (180° steering)
JP16	Tractor Interface Card	Tractor Interface Card to Lift Brush Wear Sensor (LB)
JPD2	Tractor Interface Card	Tractor Interface Card to Display Card at JPS2
JPD3	Tractor Interface Card	Tractor Interface Card to Display Card at JPS3
JPS2	Display Card	Display Card Serial Communication to Tractor Interface Card at JPD2
JPS3	Display Card	Display Card Analog Input to Tractor Interface Card at JPD3

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Connector	Location	Function or Routing
JT1	Traction Power Amplifier	Traction Power Amplifier to B+ Relay and Tractor Interface Card at JP8
JT2	Traction Power Amplifier	Traction Power Amplifier CAN Bus to Display Card at HD1 and Lift Power Amplifier at JL2
JPM	Near Traction Motor	Traction Motor Temperature Sensor (DT) to Tractor Interface Card at JP7
JPZ	Near Lift Motor	Lift Motor Temperature Sensor (LT) to Tractor Interface Card at JP7
LB	Near Lift Motor	Lift Brush Wear to Tractor Interface Card at JP16
SFA and SFB	On top of Brake/Traction Motor Assembly	Speed Feedback Proximity Sensors to Display Card at HD5
TB	Near Traction Motor	Traction Brush Wear to Tractor Interface Card at JP7
BR	Brake	Brake Coil to Tractor Interface Card at JP8
TACH	Steer Tachometer	Steer Tachometer to Steer Controller at SK1
40, 41	Steer Motor	Steer Motor to Steer Controller at SK2
SK1	Steer Controller	Steer Controller to JP8 and Steer Tachometer
SK2	Steer Controller	Steer Controller to F7 and Steer Motor

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Inspection

Whenever working on the lift truck, use care around wiring harnesses.

- Do not pull on wires.
- Carefully mate and unmate all connectors.
- Do not pry apart connectors with unspecified tools.
- Examine and maintain any added materials used to dress or protect the wire. This includes spiral wrap, brackets, cable ties, fasteners, flexible conduit, etc.
- Check harness wires for abrasions, scrapes, nicks in the wire, damage from overheating or burns, or other general insulation damage.
- Replace terminations with exposed wire visible at the connectors. Damaged terminations, exposed wires, or damaged connectors can cause operational failure of the lift truck.

During troubleshooting and repairs, it is sometimes necessary to unmate a connector, move a harness, cut a cable tie, or remove the wire from a bracket. Note carefully the location of the wire and all protective or securing attachments before moving the harness.

After repair, return or replace all protective and/or securing hardware to its original condition. Protective materials are necessary to provide reliable performance of the interconnect system.

Some wires and cables have a wire marker at each termination. If the marker is missing or unreadable, remark the wire or cable to allow easier identification.

NOTE: It is normal to find unused connectors for uninstalled options that have had heat shrink applied over them and have been strapped to the harness.

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Contactors, General

Testing Resistance

Visually inspect the contactor for any signs of burning or physical damage.

1. Turn the lift truck's key switch OFF and disconnect the battery connector.
2. Disconnect the two wires from the base of the contactor. These two wires are marked X and Y.
3. Connect one lead of the ohmmeter to the X lead from the contactor. Connect the other lead to the Y lead from the contactor.
4. The reading should be between 20 and 40 ohms. If it is not, replace the contactor.

Contactor Tip Inspection

When you inspect contactor tips, follow these guidelines:

- Darkened points do *not* indicate burning.
- Burning indicates a loss of contact point material.
- Replace the contact points if there is *not* enough contact point material to last until the next regular inspection.
- The silver alloy part of the point is usable contact material; the copper backing is *not*.
- Do *not* file contact points to remove discoloration or minor irregularities. This practice produces a surface more susceptible to sticking.
- If a cone and crater appear, remove the cone with a file; *DO NOT* use sandpaper or emery cloth.

Contactor Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove the console covers. See "Console Cover" on page 7-14.
3. Disconnect the cables by removing the hex nuts. Identify the cables and their location. Label, if necessary, for proper installation.

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4. Remove the contactor coil wires (2) by pulling the wire connector. Note their locations and label if necessary.
5. Remove two (2) hex nuts holding the contactor to the mounting panel.
6. Remove the contactor from the mounting studs.

Contactor Installation

1. Position contactor on threaded studs of mounting panel and attach with hex nuts.
2. Attach coil wires by sliding connector onto appropriate spade terminal.
3. Attach cables to appropriate lugs and tighten securely.
4. Reconnect battery connector.
5. Turn the key switch ON and test operation.
6. Turn the key switch OFF, disconnect battery connector, and install tractor cover. See “Console Cover” on page 7-14.
7. Reconnect battery connector.

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Switches (General)

Refer to the electrical schematics starting on page A-13 to identify the electrical circuit location of the switch.

Test/Inspection

Examine the switch for signs of arcing, overheating, discoloration, cracking, or other physical damage. Replace the switch if you see such damage.

To test a switch, isolate it from the electrical circuit. Do this by removing all the connections from the switch, making sure all wires are labeled and identified for reconnection.

Use an ohmmeter set to a low resistance scale to measure the resistance across the switch. In a closed position, the switch should be less than 1 ohm. In an open position, the switch should show a resistance greater than 10 megohms.

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Key Switch (S1)

A two position (OFF/ON) key switch energizes all lift truck operations, including the horn. The horn can be sounded only with the key switch in the ON position. The key switch is located to the left of the EPO switch.

Inspection

With the battery plugged in and key switch in the ON position, battery voltage B+ should be present on both terminals of the switch. Test the key switch with an ohmmeter after removing it from the electrical system. In the OFF position, the ohmmeter should read greater than 10 megohms, and in the ON position, the ohmmeter should read less than 1 ohm. If not, replace the switch.

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove the console cover. See “Console Cover” on page 7-14.
3. Remove the mounting nut from the stem of the key switch.
4. Remove the key switch.
5. Disconnect the wires from the bottom of the key switch.

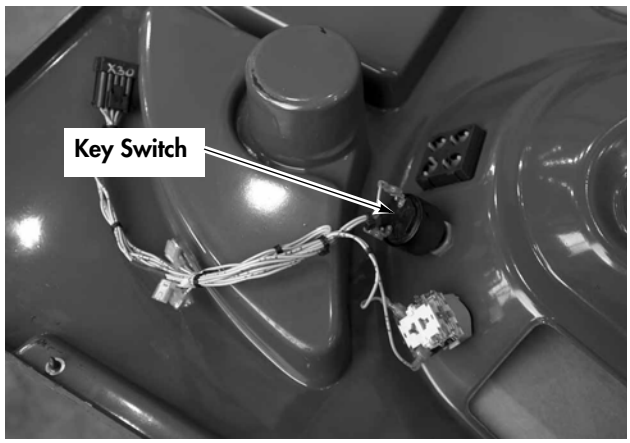


Figure 7-42: Key Switch

Installation

1. Connect the wires to the terminals.
2. Install the new key switch and tighten the locking nut.
3. Reconnect the battery connector and check operation.
4. Turn the key switch OFF and disconnect the battery connector.
5. Install the console cover.
6. Reconnect the battery connector.

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EPO Switch (S2)

The EPO is located to the left of the operator display. All lift truck functions should be disabled when the EPO switch is depressed.

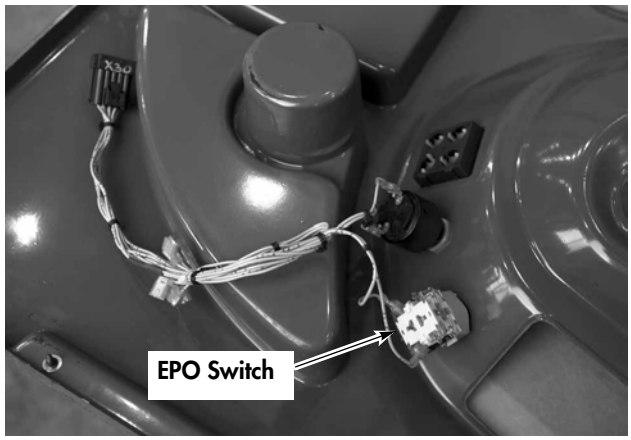


Figure 7-43: EPO Switch

Inspection

With the battery plugged in and the EPO switch in the out position, battery voltage B+ should be present on both terminals of the switch when the key switch is ON. Test the EPO switch with an ohmmeter after removing it from the electrical system. In the OFF position, the ohmmeter should read greater than 10 megohms, and in the ON position, the ohmmeter should read less than 1 ohm. If not, replace the switch.

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove console cover. See “Console Cover” on page 7-14.
3. Disconnect the electrical harness and contact block from the base of the EPO switch (use a small straight blade screwdriver to release the locking tabs on the contact block from the switch body).
4. Use a small phillips head screwdriver to loosen the two screws in the backside of the operator display bracket.
5. Press the two halves of the EPO switch together and turn counter-clockwise to disconnect the switch body from the operator (loosen the two screws more if required).
6. Finish removing the two screws.
7. Repair or replace as necessary.

Installation

1. Place the switch operator down through the opening in the operator display bracket.
2. Attach the switch body to the operator from the backside of the operator display bracket.

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3. Turn the halves clockwise to engage the latches.
4. Secure the base of the EPO switch to the bottom of the operator display bracket with the two screws.
5. Reconnect the electrical harness and contact block to the base of the EPO switch.
6. Install the console cover.
7. Reconnect the battery connector.

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Lift Inhibit Switch (S4)

The lift inhibit switch is located at the top of the left mast mainframe (when viewing from the operator compartment side). The lift inhibit switch (S4) is provided as a safety feature to prevent lift once a predetermined height has been reached. This is accomplished by the switch (or sensor) sensing a target on the intermediate telescopic. Once the rod is sensed, lift is prohibited unless the bypass option is active. If the lift limit with bypass option is available, pressing the up arrow switch on the operator display will allow lift to be reactivated.

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. From the top of the mast, disconnect the switch from the wiring harness.
3. Remove the two nuts securing the switch to the mounting bracket.
4. Remove the switch from the lift truck.

Installation

1. Install a new switch on the mounting bracket.
2. Install the nuts to secure the switch to the mounting bracket.
3. Connect the switch to the wiring harness.
4. Check the operation of the lift truck, then return the lift truck to service.

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Mast Switch 1 (S6) (High Speed Travel Limit)

Mast Switch1 (S6) is a proximity switch located at the bottom of the mast. The mast switch (S6) is provided as a safety feature to reduce travel speed to 2.5 MPH after the “first stage” of lift. The first stage of lift ends when the mast telescopics begin to extend from the main mast frame.

Adjustment

1. Raise the empty carriage until the bottom of the tie bar is even with the bottom of the mast switch.
2. Secure the carriage with blocks and a hoist to prevent any movement.
3. Loosen the jam nut securing the mast switch to the mast.
4. Adjust the switch to 0.187 in. (4.76 mm). Allowable tolerance is +0.0625 in. (1.59 mm) and -0 mm.
5. Tighten the jam nut.
6. Check the clearance with the jam nut tightened.
7. Remove the blocks and hoist.
8. Place a maximum capacity load on the forks. Verify that the tie bar does not contact the switch under normal working conditions.
9. Adjust the clearance as necessary to achieve proper clearance when fully loaded.
10. Remove the load from the forks.
11. Test the truck operation to verify normal travel speed with the mast lowered and reduced travel speed after the “first stage” of lift.

Removal

1. Raise the empty carriage until the bottom of the tie bar is even with the bottom of the mast switch.
2. Secure the carriage with blocks and a hoist to prevent any movement.

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3. Turn the key switch OFF and disconnect the battery connector.
4. Disconnect the switch from the harness.
5. Loosen the jam nut securing the mast switch to the mast.
6. Remove the mast switch from the mast.

Installation

1. Install the new mast switch.
2. Tighten the jam nut to secure the switch.
3. Attach the wiring harness.
4. Adjust the switch following the procedure on page 7-87.
5. Return the lift truck to service.

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Deadman (Left Foot) Switch (S3)

The deadman (left foot) switch (S3) is located under the floor board of the operator compartment. The deadman switch must be closed to allow lift truck operation.

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove the floor board.
3. Remove the two screws securing the switch to the twin nut at the switch bracket.

Installation

1. Install the two screws (15) through the switch (16) into the twin nut (17) on the opposite side of the switch bracket.
2. Install the floor board.
3. Reconnect the battery connector.
4. Test the operation of the platform switch before returning the lift truck to service.

Adjustment

It is very important that the brake switch is adjusted correctly or an Error Code 65 may occur. The brake switch is located near the brake pedal potentiometer (pot) and is designed as a check circuit for brake pot function only and must be adjusted properly.

Detailed below is a step by step procedure for adjusting the brake switch.

1. Calibrate the deadman pedal pot. Reference “Calibrate (Calibrte) Mode” on page 6-6.
2. Enter Analyzer Mode Category 1, Class 2, Test 16 to view brake pedal pot voltage. With the pedal in the full up position, record the voltage.
3. Fully depress the deadman pedal and record the voltage.

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4. Subtract the pedal down voltage from the pedal up voltage and divide the difference by 8.
5. Subtract the result in step 4 from the original pedal up voltage from step 2. Record the voltage.
6. Depress the pedal until the voltage recorded in step 5 is displayed on the operator display. Adjust switch to close at this pedal position.

Example:

pedal up voltage (step 2)	3.04V
pedal down voltage (step 3)	- 2.32V
subtract step 3 from step 2	0.72V
divide 0.72 by 8 (step 4)	0.09V
subtract step 4 from step 2	3.04V
	-0.09V
Deadman switch activation point	2.95V

In this example, the switch should be adjusted to close/open when the pot voltage reads 2.95V. This procedure places the open/close switch point at approx. 85% up from the full pedal down position.

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Platform (Right Foot) Switch (S7)

The platform (right foot) switch (S7) is located under the floor board of the operator compartment. Activation of the platform switch allows lift and auxiliary functions to operate without depression of the deadman pedal.

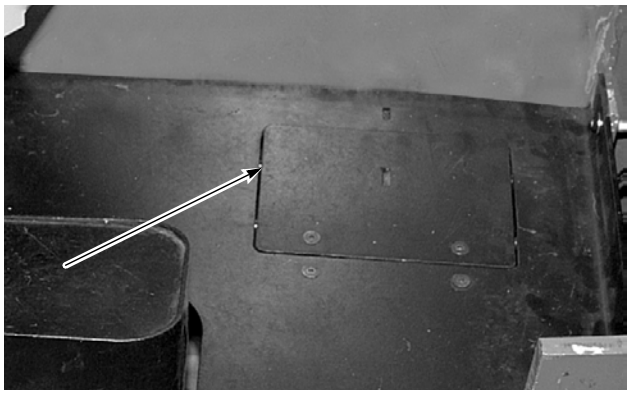


Figure 7-44: Platform Switch Location

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove the floor board.
3. Remove the two screws securing the switch to the twin nut at the switch bracket.

Installation

1. Install the two screws (15) through the switch (16) into the twin nut (17) on the opposite side of the switch bracket.
2. Install the floor board.
3. Reconnect the battery connector.
4. Test the operation of the platform switch before returning the lift truck to service.

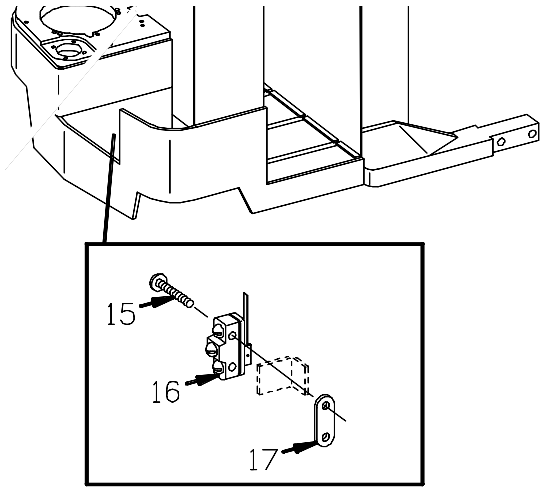


Figure 7-45: Platform Switch Installation

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Staging Switch (S8)

The staging switch is located on the side of the carriage. Its function is to let the Tractor Interface card know when the carriage has almost completed the first stage of lift (freelift). This triggers a slowing of lift and allows a smoother transition as the telescopics begin to move, preventing the load on the forks from being jarred.

Adjustment

1. Raise the empty carriage until the top of the staging switch is even with the top of the staging column.
2. Secure the carriage with blocks and a hoist to prevent any movement.
3. Loosen the switch mounting bracket screws.
4. Adjust the switch to 0.187 in. (4.76 mm). Allowable tolerance is +0.0625 in. (1.59 mm) and -0 mm.
5. Tighten the switch mounting bracket screws.
6. Check the clearance with the screws tight.
7. Remove the blocks and hoist.
8. Test the mast operation to verify proper operation of the staging switch.

Removal

1. Raise the empty carriage until the top of the staging switch is even with the top of the staging column.
2. Secure the carriage with blocks and a hoist to prevent any movement.
3. Turn the key switch OFF and disconnect the battery connector.
4. Disconnect the switch from the wiring harness.
5. Remove the switch mounting bracket screws.

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Installation

1. Install the switch on the mounting bracket.
2. Tighten the switch mounting bracket screws.
3. Connect the switch to the wiring harness.
4. Adjust the switch following the procedure on page 7-92.
5. Return the lift truck to service.

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180° Sensor

180° Steering - the 180° sensor detects wheel directional information from a semi-circular target ring assembled to the top of the drive gear on top of the drive unit. The target is present to the sensor for slightly less than 180° of drive unit rotation, causing the sensor to change state when the drive unit is slightly less than at right angles to the forks.

360° Steering - the 180° sensor detects wheel directional information from a target integrated into the drive gear on top of the drive unit. The target is present to the sensor for 180° of drive unit rotation, causing the sensor to change state when the drive unit is at right angles to the forks.

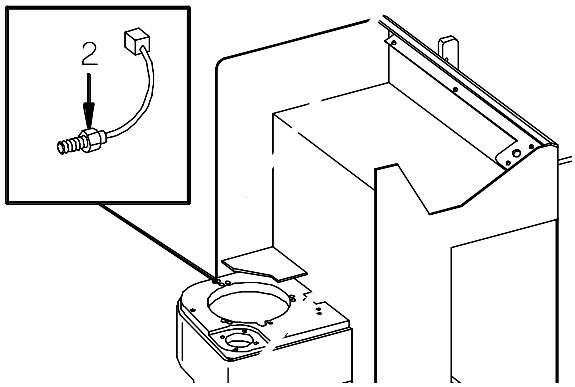


Figure 7-46: 180° Sensor Location

Adjustment

1. Position the drive wheel with the wheel nuts facing outward.

NOTE: Adjusting the sensor with the wheel nuts facing inward will result in shearing the sensor when the drive wheel is rotated.

2. Turn the key switch OFF and disconnect the battery connector.
3. Loosen the jam nut securing the sensor to the tractor frame.
4. Turn the 180° sensor by hand clockwise until it just contacts the drive unit housing.
5. Turn the sensor by hand counterclockwise 1-1/4 turns.
6. Tighten the jam nut.
7. Reconnect the battery connector.
8. Test the operation of the sensor:

   For 180° steering - verify the truck steers fully clockwise/counterclockwise and no error codes display.

   For 360° steering - verify the correct wheel angle, rotation and drive direction of the drive wheel are indicated on the wheel direction indicator on the operator display. Verify the wheel angle display smoothly follows the rotation of the drive wheel.

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Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Disconnect the sensor at the main wiring harness.
3. Loosen the jam nut securing the sensor to the tractor frame.
4. Turn the sensor counter clockwise to remove it from the tractor frame.

Installation

1. Install the sensor in the tractor frame.
2. Turn by hand in a clockwise direction until it just contacts the drive unit housing.
3. Set the proper sensor distance by turning the sensor by hand counterclockwise 1-1/4 turns.
4. Tighten the jam nut securing the sensor to the tractor frame.
5. Reconnect the sensor electrical connection to the main wiring harness.
6. Reconnect the battery connector.
7. Test the operation of the sensor:

   For 180° steering - verify the truck steers fully clockwise/counterclockwise and no error codes display.

   For 360° steering - verify the correct wheel angle, rotation and drive direction of the drive wheel are indicated on the wheel direction indicator on the operator display. Verify the wheel angle display smoothly follows the rotation of the drive wheel.

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Drive Wheel Position Proximity Sensors (360° Steering)

The drive wheel position proximity sensors are located on the underside of the tractor frame near the drive unit. The drive wheel position proximity sensors work as a pair to detect drive wheel direction and position information from the gear at the top of the drive unit. The drive wheel position proximity sensors are accessed through a rectangular cutout in the battery compartment.

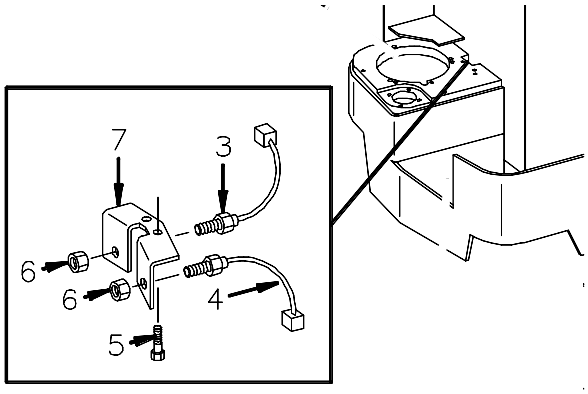


Figure 7-47: Drive Wheel Position Proximity Sensor Location

Adjustment

1. Remove the battery from the lift truck.
2. Center a steering gear tooth crest on the face of the wheel angle sensor (3 or 4) to be adjusted.
3. Loosen the jam nut (6).
4. Adjust the sensor to 0.089 in. (2.25 mm). Tolerance is 0.002 in. (+0 mm, –0.05 mm).
5. Tighten the jam nut (6) carefully so that the sensor does not move.

NOTE: Do not overtighten the jam nut. Overtightening can cause sensor damage.

6. Check the clearance with the jam nut tightened.
7. Repeat steps 2 through 6 for the other sensor.
8. Install the battery in the lift truck.
9. Test the operation of the sensors. Verify the correct wheel angle, rotation and drive direction of the drive wheel are indicated on the wheel direction indicator on the operator display. Verify the wheel angle display smoothly follows the rotation and drive direction of the drive wheel.
10. Adjust as necessary to achieve smooth rotation of the wheel angle display.

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Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove the battery from the lift truck.
3. Disconnect the sensor (3 or 4) from the wiring harness.
4. Remove the jam nut (6) securing the sensor to the bracket (7).
5. Remove the sensor from the lift truck.

Installation

1. Install the new sensor (3 or 4) in the bracket (7).
2. Secure the sensor to the bracket with the jam nut (6).

NOTE: Do not overtighten the jam nut. Overtightening can cause sensor damage.

3. Reconnect the wiring harness.
4. Adjust the sensor following the procedure on page 7-96.
5. Install the battery in the lift truck.
6. Test the operation of the sensors. Verify the correct wheel angle, rotation and drive direction of the drive wheel are indicated on the wheel direction indicator on the operator display. Verify the wheel angle display smoothly follows the rotation and drive direction of the drive wheel.
7. Adjust as necessary to achieve smooth rotation of the wheel angle display.
8. Return the lift truck to service.

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Steer Stop Proximity Sensors (180° Steering)

The Steer Stop proximity sensors detect wheel directional information from a semi-circular target ring assembled to the top of the drive gear on top of the drive unit. When steering the truck, the drive unit and drive wheel approach approximately ±90° from the forward/backward travel direction and the target ring covers the first sensor. The first sensor covered by the target ring determines the direction of the drive unit rotation. As the drive unit continues to rotate and approaches approximately ±90°, the target ring covers the second sensor. The information from the second sensor determines the electrical steer stop position and the Steer Controller disables steering. The directional information remembered from the first sensor allows steering away from the electrical steer stop.

Adjustment

1. Turn the key switch OFF.
2. Disconnect both Steer Stop A and Steer Stop B sensors at the main wiring harness.
3. Turn the key switch ON and steer the drive unit slowly in either direction to the mechanical stop.

NOTE: At the mechanical stop, a gentle “thud” should be heard, an error code will be displayed and the drive wheel will be approx. at a right angle to the forks.

NOTE: Excessive tire “unwind” may occur with a rubber tire when steering is stopped, moving the target from covering one or both sensors. If excessive “unwind” is a problem, jack the drive tire off the floor. See “Jacking Safety” on page 2-13.

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⚠ CAUTION

Not strictly following this adjustment procedure may result in shearing the steer stop sensors when the drive unit is rotated.

4. Verify the sensors are covered by the target ring.
5. Turn the key switch OFF.
6. Connect the Steer Stop sensors at the main wiring harness.
7. Turn the key switch ON and verify the LEDs on both Steer Stop sensors are illuminated.

   If the LED is not illuminated on both sensors, the target is not covering the sensors. Adjustment will cause one or both sensors to shear when the drive unit is rotated. Repeat steps 1 thru 3 until the LEDs on both sensors illuminate.
8. Turn the key switch OFF and disconnect the battery.

NOTE: When replacing or adjusting one Steer Stop sensor, adjustment of the other Steer Stop sensor is recommended.

The following steps apply to both Steer Stop sensors.

9. Loosen the jam nut securing the sensor to the tractor frame.
10. Turn the sensor by hand clockwise until it just contacts the target ring.
11. Turn the sensor by hand counterclockwise 1-1/4 turns.
12. Tighten the jam nut. Repeat steps 9 thru 12 for the other sensor.
13. Reconnect the battery connector.
14. Test the operation of the sensors. Verify the truck steers fully clockwise and counterclockwise, no error codes display and the drive unit does not come up against the mechanical stops.

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Drive Motor Speed/Direction Sensors

The drive motor speed/direction sensors (PROXA and PROXB) are located in the spacer mounted on top of the brake assembly. Their purpose is to detect speed and directional information from the sensor nut attached to the top of the drive motor. These drive motor speed/direction sensors are not adjustable.

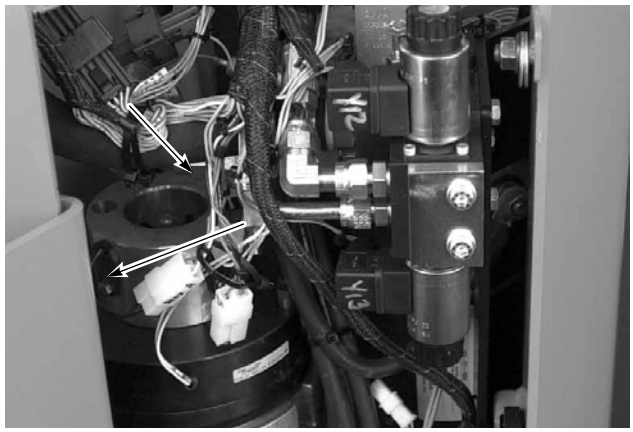


Figure 7-48: Drive Motor Speed/Direction Sensors

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Disconnect the drive motor speed and/or directional sensor from the main wiring harness.

NOTE: The connectors on both sensors are keyed to prevent being plugged into the wrong connector on the main wiring harness.

3. Remove the cap screw securing the sensor to the spacer.
4. Remove the sensor from the spacer.

NOTE: Remove and replace one sensor at a time. Installation in the wrong location will adversely affect truck performance.

Installation

1. Install the sensor (9 or 13) in the spacer (8).
2. Install the cap screw (10).
3. Reconnect the sensor to the main harness assembly.
4. Reconnect the battery connector.
5. Test the operation of the lift truck before returning to service.

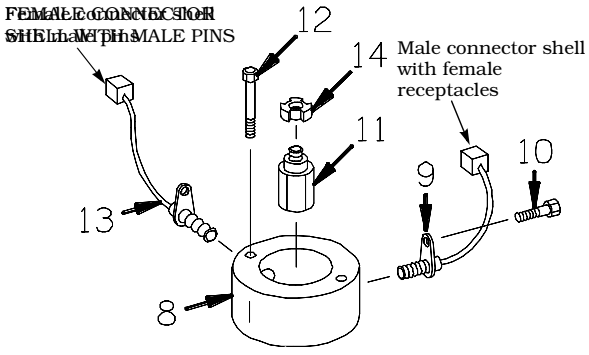


Figure 7-49: Drive Speed/Directional Sensor Components

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Horn

NOTE: The horn can only be sounded with the key switch in the ON position.

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove the console cover. See “Console Cover” on page 7-14.
3. Disconnect wires from the horn. Identify the wires and their location
4. Remove horn mounting bolt using a 13 mm socket and ratchet.

Installation

1. Attach the horn to the tractor frame and tighten the mounting bolt.
2. Attach the wires.
3. Install the console cover.
4. Reconnect the battery connector and turn the key switch ON.
5. Test horn operation.

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Motors, General

The motors used in Toyota lift trucks are designed to operate with a minimum of maintenance. Sealed bearings are used in all motors, thereby eliminating the need for additional lubrication. Included in the motor section are the following maintenance procedures:

- maintenance schedule
- maintenance inspection chart
- motor cleaning
- brush care
- commutator care
- prevention of motor overheating

These procedures, along with periodic inspection help to provide trouble-free motor performance.

Maintenance Schedule

Since the operating environment of lift truck motors varies widely, the following recommendations should be applied as actual conditions dictate. Several conditions to define before considering the following Maintenance Inspection Chart are:

Type of Service	Type of Activity
Normal	Basically, an eight hour day of indoor or material handling.
Severe	Extended operating hours, or constant usage.
Extreme	Dusty or Sandy Locations: i.e., cement plant, lumber or flour mills, coal dust or stone-crushing areas.
	High Temperature Areas: i.e., steel mills, foundries, etc.
	Sudden Temperature Changes (continuous indoor-outdoor movement): i.e., refrigeration plant, freezer application, etc.
	Processing plants: i.e., poultry, meat

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Maintenance Inspection Chart

Service Conditions	Inspection Frequency (Operating Time)	Recommended Inspection	Motor Location
Normal	1000 Hours	Routine	Motor in Truck
	3000 Hours	Periodic	Motor Removed
Severe	500 Hours	Routine	Motor in Truck
	As Required	Periodic	Motor Removed
Extreme	250 Hours	Routine	Motor in Truck
	As Required By Inspection	Periodic	Motor Removed

Motor Cleaning

Periodic motor cleaning is essential to prevent overheating and electrical grounds. To clean the motor properly, use the following procedure:

Wear safety glasses. Use clean, dry, low pressure air (30 psi/207 kPa), to blow carbon dust and other foreign materials from:

- the motor housing
- brush holders
- commutator
- field and armature windings (if accessible)

⚠ CAUTION

Never use a chemical solvent to clean the motor as it will carry carbon dust to hard to clean areas and cause shorts within the motor. Washing with detergents requires complete disassembly and drying. This should only be attempted by an authorized motor repair shop.

Motor Brushes

The drive and lift motors are each equipped with brush wear sensors. When the brushes are in need of replacement, the brush wear icon on the Operator Display is illuminated.

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The brush wear indicator should not be used as a substitute for regular maintenance inspections.

Inspection

Conduct a partial inspection of the motor after every 1,000 hours of lift truck operation. If you work in an abnormally severe or caustic environment or if you have a rigorous duty cycle, inspect the motor more frequently.

Set up and rigidly adhere to a strict inspection schedule to obtain the maximum efficiency from the electrical equipment.

Each partial inspection of the motor should include the following:

1. Inspect the brushes for wear and for proper contact with the commutator. Record the level of wear on the brushes. This history will give you an indication of whether a brush should be changed or if it can wait until the next inspection. See the table on page 7-107 for proper brush length.

NOTE: Overloading a unit is ultimately reflected in the motor and brush wear; therefore, you must take this into account when considering brush replacement.

2. Check brush spring tension. See “Motor Brush Spring Tension” on page 7-106.
3. Clean brushes and holders. Wipe the commutator with a dry, lint-free cloth. DO NOT USE lubricants of any kind on or around the commutator.
4. Check brush holders for solid connection to the mounting support. Tighten the mounting screws as necessary.
5. Check the cap-screws holding the brush cross connectors to the brush holder body.
6. Make sure the motor terminals are secured tightly to the motor frame. Be careful not to strip the threads or crush the insulating parts.
7. Check all the cap-screws around the frame for tightness.

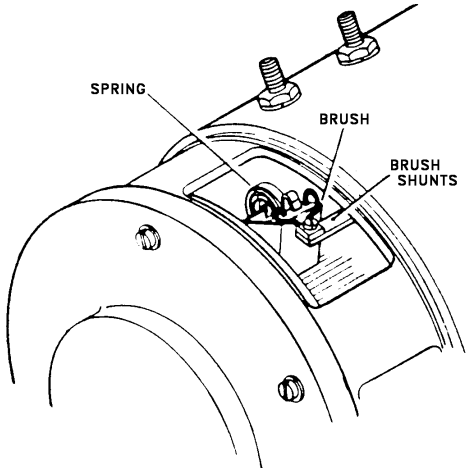


Figure 7-50: Motor Brush, Typical Location

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8. Keep the outside frame of the motor clean and free from dirt. Maintain a free air passage around the motor to permit heat radiation.

Replacement

If one brush needs replacement, always replace the entire set of brushes.

Use only genuine Toyota brushes. Using another type of brush could damage the commutator or cause excessive brush wear.

If the end of the brush is not already contoured to fit the commutator, use the following procedure to seat the brush to the commutator:

NOTE: If the motor commutator is not accessible, form the brush contour using a brush seating stone.

1. Move the motor brush springs out of your way.
2. Wrap a piece of fine (00) sandpaper around the commutator. **DO NOT use emery cloth to seat brushes.**
3. Move the brushes back down in their holders so that the face of the brushes rests on the sandpaper.
4. Turn the armature until the curve on the face of the brushes matches the curve of the commutator.
5. Remove the sandpaper.
6. Blow any dust out of the motor with clean, compressed air at a maximum of 30 psi (207 kPa).

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Motor Brush Spring Tension

Inspection

1. Turn the key switch to OFF and disconnect the battery connector.
2. Remove tractor cover. See page 7-14.
3. Slide the brush up slightly in its holder.
4. Insert a paper strip between the brush face and the commutator.
5. Place a small leather loop around the coil spring for the brush. If the brush spring has a loop at the brush, hook the spring scale directly to the spring.
6. Attach a 5 lb. (2.27 kilogram) spring scale to the leather loop.
7. While gently pulling the scale outward, slowly pull the paper strip in the direction that the commutator normally rotates.
8. When the paper strip begins to move freely, the spring scale will read the spring brush tension.
9. Refer to the table below for proper spring tension.

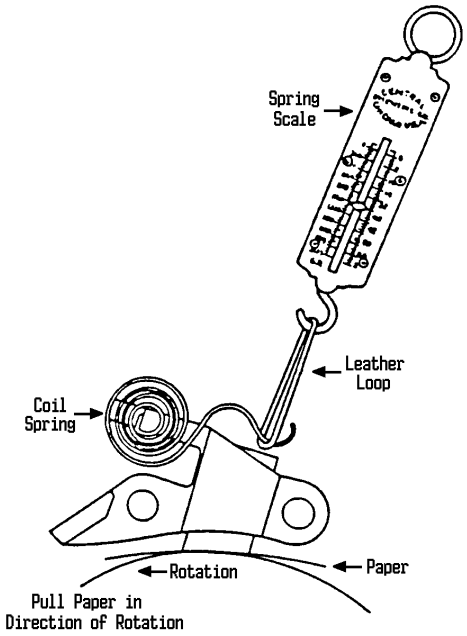


Figure 7-51: Motor Brush Spring Tension Inspection

Motor	Minimum Brush Length	Spring Tension
Drive Motor	5/8” (15.875 mm)	40 oz. (worn) to 65 oz. (new) (1135 to 1843 grams)
Lift Motor	1/2” (13 mm)	32 to 40 oz. (909 to 1135 grams)

10. Repeat steps 3 thru 9 for the remaining brushes.

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Commutator

Inspection

The commutator should be inspected for surface condition and high mica.

The commutator must be smooth and clean to provide maximum brush wear. When commutators are not properly maintained, carbon dust can collect in the grooves between the segments. This can lead to a short circuit in the armature.

Good commutation will be indicated by a dark brown polished commutator and an evenly polished brush wearing surface.

If the commutator appears rough, pitted, or has signs of burning or heavy arcing between the commutator bars, the motor should be removed for servicing.

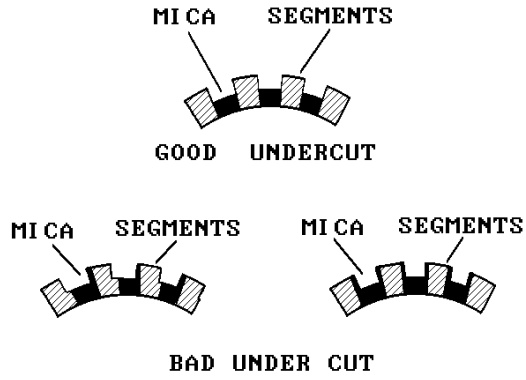


Figure 7-52: Mica Undercutting

High Mica

Most armatures have the mica undercut. If the armature on your motor does not, do not attempt to cut it. The decision to undercut or not is determined by the type and grade of brush used in that particular motor. The mica should be undercut to a depth equal to the width of the mica (usually 1/32 in. (0.8 mm), but may vary in some motors). See Figure 7-52.

Servicing

If the commutator requires service, you will need to remove the armature from the motor.

DO NOT use a stone to even out high and low spots on the commutator. Use only a suitable abrasive rubber polisher.

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Terminal Nuts

Whenever you disconnect and reconnect any power leads to a motor, always tighten the motor cable securing nuts with a torque wrench to prevent over-tightening them and damaging the motor. Use a second wrench on the stud terminal securing nut to avoid twisting the stud.

Stud Terminal Securing Nuts should be torqued to 140-160 in. lb. (15.8-18.1 Nm) and Motor Cable Securing Nuts to 100-120 in. lb. (11.2-13.6 Nm). Check these torques each time you check motor brushes.

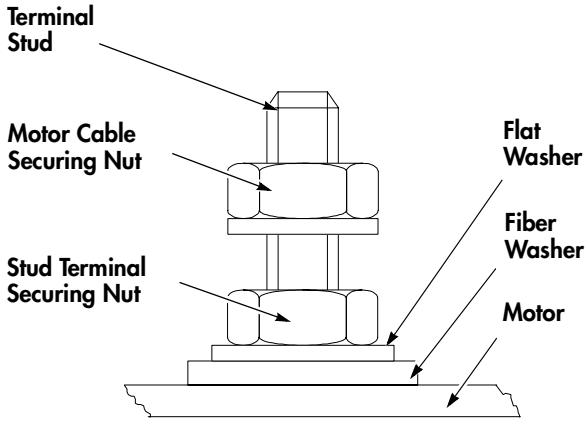


Figure 7-53: Motor Terminal Nuts

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Motor Overheating

Most motor overheating can be prevented by understanding the causes and preventions listed below:

Cause	Prevention
Insufficient ventilation due to ventilating hole blockage	Clean the ventilation holes with dry compressed air.
Dirty Motor	See motor cleaning on page 7-103.
Defective bearings	If the bearings are replaceable as a unit replace them. If not, replace the motor.
Lifting excessive loads and stalling the motor	Make sure the operator knows the lift truck limitations.
Low battery voltage	Replace or recharge the batteries.
Open or short circuited armature or field windings	Follow the test procedures in this manual.

⚠WARNING

If an electrical failure or an extreme overload occurs, especially in a totally enclosed motor, personnel should not breathe the fumes which have been generated inside the machine. The heat of the failure arc or overload may generate noxious fumes by pyrolysis of the insulation materials. All power should be disconnected from the motor before any investigation of the failure is attempted. The area around the motor should be well ventilated. Personnel should not breathe the toxic fumes produced by the failure. If possible, time should be allowed for the motor to cool and for dilution of the fumes with air.

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Electric Motor Tests

Motor Types

Refer to Figure 7-54.

- A shunt-wound or series-wound drive motor has four external connections: two armature (A), and two field (S, E, or D).
- A series-wound lift motor has only two external connections because the armature and field windings are connected internally.
- A permanent magnet motor has only two external connections because the field is produced by an internal permanent magnet.

NOTE: Field connections may be labeled S. Shunt-wound motor field connections may be labeled E. Series wound motor field connections may be labeled D.

Open Circuit Motor Test

An open circuit is one in which the electrical circuit within the motor has been broken. This can be caused by:

- bad brushes or brush springs
- a broken wire in the field or armature winding
- a loose or bad connection

Refer to Figure 7-54 for the following procedure:

1. Isolate the motor from the truck circuit by removing the power cables. Use two wrenches to avoid twisting the terminal stud.
2. With the motor at room temperature, connect the leads of a digital ohmmeter between the individual circuits in the motor.

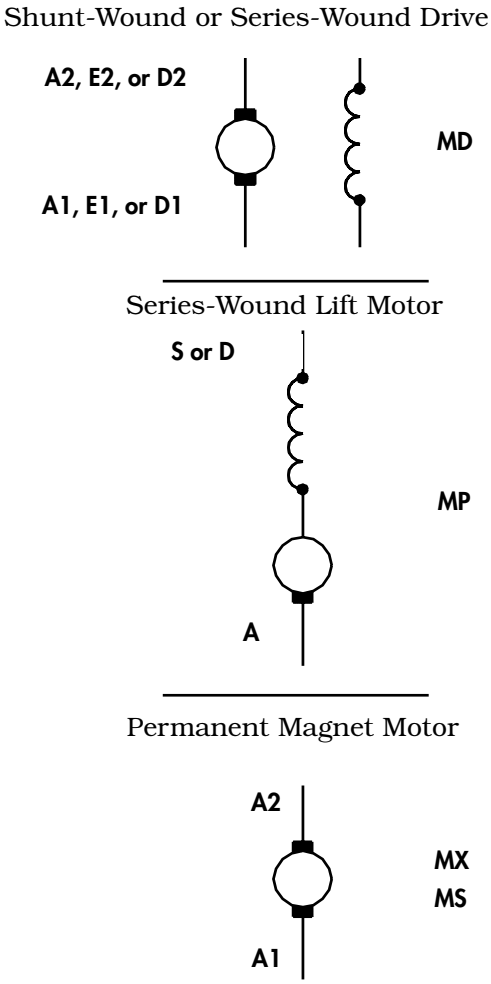


Figure 7-54: Motor Circuits

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3. You should observe the following measurements:

Motor	Probe Points	Resistance
Drive Motor	S1 to S2 (shunt)	0.9 to 1.5 ohms
	S1 to S2 (series)	<0.1 ohm
	A1 to A2	<0.1 ohm
	A1 to S1; A1 to S2	>100,000 ohms
	A2 to S1; A2 to S2	>100,000 ohms
	A1 or A2 to Frame	>100,000 ohms
Lift Motor	A to S	<0.1 ohm
	A to Frame	>100,000 ohms
Steer Motor	A1 to A2	<0.1 ohm
	A1 or A2 to Frame	>100,000 ohms

4. If the meter indicates high resistance in the armature, check the condition of the brushes before replacing the motor.
5. If you find an open circuit in a series-wound motor, the motor must be disassembled by a motor rebuilding facility to isolate the problem to the field or armature circuit.

Grounded Motor Test

In a grounded motor, an electrical circuit exists between the current-carrying conductors and the motor housing. This can be caused either by direct contact or through conductive foreign material.

The ground may be caused by:

- insulation breakdown
- brush leads touching the motor housing
- build-up of carbon dust or other materials

To test for a grounded motor, follow the “Shorts to Frame” test procedure on page 5-4.

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Short Circuited Armature or Field Winding

A short circuited winding is one in which the insulation on the field or armature has broken down at two or more points. The breakdown creates a low resistance path, allowing current to flow from one turn of the coil to another adjacent coil turn, without actually flowing through the coil wire. The result is a decrease in total resistance of the motor winding and an increase in the current flow. The severity of the short circuit depends on its location.

A shorted motor may be indicated by:

- slow or sluggish operation
- running faster than normal (suggests a short in the field)
- overheating
- blowing a power fuse
- burning of brush wires
- severe burning or discoloration on armature coil
- severe burning or discoloration on one or two commutator segments every 90° of rotation.

These symptoms can be caused by problems other than the motor itself:

- brake too tight or dragging
- wheel bearings too tight
- faulty transmission
- binding in an attached pump, hose, or solenoid valve
- load wheels not aligned properly
- rail guided with drive tire not aligned properly

Testing a motor for short circuited windings requires special equipment at a motor rebuilding facility.

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Drive Motor

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove the console cover, motor compartment door, and left side panel to allow access to the drive motor.
3. Remove the four power cables. An M6 wrench is required to loosen the terminal nuts for the field connections. An M10 wrench is required to loosen the terminal nuts for the armature connections. Note cable numbers and terminal locations for use in reassembly.
4. Disconnect the drive motor brush wear indicator terminals, drive motor temperature sensor, the two speed/ directional sensors, and the brake assembly connectors.
5. Use a 13 mm socket to remove the six drive motor mounting bolts. A 24 in. extension is helpful to access the two bolts behind the drive motor.
6. Attach a lifting tool to lift the drive motor. [Tool used: two eye bolts screwed into the top of the brake assembly (two empty holes), attach a piece of chain (about 20 in. long) with an S hook at each end to each of the eye bolts.]
7. Attach a hoist to the lifting tool attached to the top of the brake assembly.
8. Gently lift the drive motor out of the transmission. (May need to rock it gently to loosen it.)
9. Cap the top of the transmission to prevent contamination from getting into it.



Figure 7-55: Drive Unit Mounting Plate Bolts (Qty. 6)



Figure 7-56: Drive Motor Lifting Tool

Installation

1. Remove the cap from the top of the transmission.
2. Lower the drive motor straight down into the transmission. The drive motor terminals and temperature sensor should be facing out.

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3. Remove the chain, S hooks, and eye bolts from the brake assembly.
4. Apply Loctite 242 to the drive motor mounting bolts. A magnet may be handy to help start the back bolt or to retrieve a bolt if dropped behind the drive motor.
5. Use a 13 mm socket to tighten the drive motor mounting bolts.
6. Be sure to pull the motor down evenly to allow the gear on the motor shaft to properly mesh with the transmission.
7. Attach the brake electrical connection (V01).
8. Attach the brush wear indicator terminals and temperature sensor connections.
9. Install the drive motor power cables to the terminal posts.
10. Add the washers and nuts to the terminal posts. Be sure nuts are tight using an M10 wrench for the armature connections and an M6 wrench for the field connections.
11. Reconnect the two speed/directional sensor connections.

Drive Motor Data

Lubrication	None required. Sealed ball bearings are used at both ends of the motor.
Armature Test	These armatures have standard winding connections and can be tested on a growler using a metal strip or hacksaw blade to locate shorted windings.
Commutator	Replace the armature when commutator has worn to the minimum diameter of 2.80 in. (71 mm).
Brush Replacement	Replace brushes when they have worn to the minimum length of 5/8 in. (15.875 mm).
Spring Tension	Adjust the spring tension of new brushes to 65 oz. (1842 grams). Worn spring tension should be adjusted to 40 oz. (1135 grams).

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Lift Motor

The lift motor and lift pump should be removed and installed as a single unit.

Removal

1. Park the lift truck on a level surface.
2. Lower the carriage completely.
3. Drain the hydraulic fluid. See “Draining the System” on page 7-140.
4. Turn the key switch OFF and disconnect the battery connector.
5. Remove the console cover, motor compartment door, and operator compartment left side panel. See page 7-14.
6. Disconnect the hose from the pump to the control valve at the control valve. Plug both the port and hose to prevent contamination of the hydraulic system.
7. Remove the control valve from the bracket and lay over the reservoir.
8. Remove the lift motor electrical power cables. Use an M10 wrench to remove the nuts on the motor terminals. Note the proper location of each wire on the motor. The terminal number should be marked on the power cables. If the marking is worn or missing, remark the cable.
9. Move all wires and cables up out of the way. Make sure not to get any oil in the contactor when moving hoses and cables around.
10. Remove the four bolts attaching the bracket to the tractor frame using a 13 mm socket. If the drive motor has not been removed, a 24 in. extension will be required to reach the back mounting bolt.
11. Loosen the screws in the hose clamp for the hose connecting the pump to the reservoir. Slide the hose clamp back. Remove the hydraulic line from the pump to the reservoir. Drain the line as required into a small container. Plug port and hose to prevent contamination of the hydraulic system.

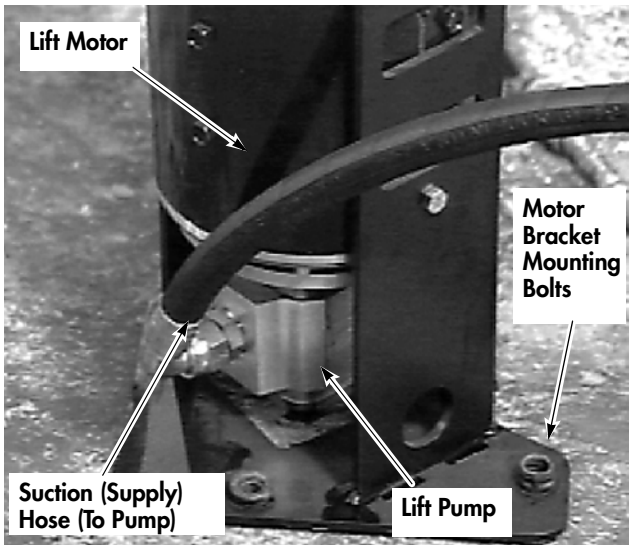


Figure 7-57: Lift Motor/Pump, Side View

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12. Disconnect the brush wear indicator terminals at the back of the motor and the temperature sensor connector.
13. Remove the motor and pump assembly from the lift truck. If a hoist is available, attach a hoist to the bracket and lift the assembly out. If a hoist is not available, carefully lift the assembly out while standing in the operator compartment. Use proper lifting practices to avoid back injuries.

Installation

1. Place lift pump and motor assembly with bracket onto the tractor frame. Make sure the four rubber grommets are in the bracket mounting holes.
2. Align the black flange with the reservoir hose. Slide the reservoir hose onto the flange as the pump and motor assembly is installed into the lift truck. Install the hose clamp at the flange. Be sure clamp is tightened to prevent leakage. If a leak is found later, the drive motor will have to be removed to access the clamps.
3. Install the 4 mounting bolts to secure the motor/pump into position. Apply Loctite to the four mounting bolts. Insert bolts through the large washer, then through the bracket mounting plate into the tractor frame. Tighten bolts using 13 mm socket and extension if needed.
4. Install the control valve on the bracket.
5. Install the hydraulic line from the pump to the control valve.
6. Install the lift motor electrical power cables to the motor, following the markings on the cables. Tighten the terminal nuts using an M10 wrench. Torque the motor cable securing nuts to 100-120 in. lb. (11.2-13.6 Nm). Use a second wrench on the stud terminal securing nut to avoid twisting the stud. See “Terminal Nuts” on page 7-108.
7. Attach the brush wear indicator terminals using needle nosed pliers. Connectors are male and female with one large and one small. Connect the temperature sensor connector.

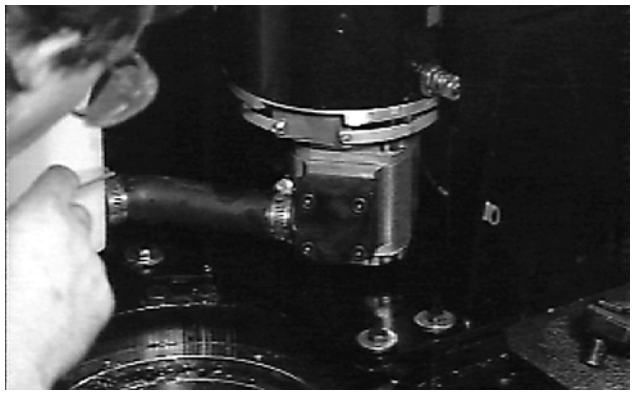


Figure 7-58: Lift Pump to Reservoir Hose Installation

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8. Fill the hydraulic reservoir with hydraulic fluid. See “Lubrication Equivalency Chart” on page A-2.
9. Install the console cover and reconnect the battery connector.
10. Turn the key switch ON.
11. Bleed the hydraulic system. See “Bleeding the Hydraulic System” on page 7-146.
12. Test hydraulic operation of the lift truck.

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Traction Power Amplifier

No attempts should be made to open the traction power amplifier. There are no user-serviceable parts inside. Attempting to open the power amplifier may damage it and will void the warranty.

It is recommended to clean the exterior of the power amplifier case occasionally.



Figure 7-59: Traction Power Amplifier

Exterior Cleaning

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove the console cover.
3. Discharge the capacitor in the power amplifier by connecting a load (such as a contactor coil or a horn) across the power amplifier's B+ and B– terminals.
4. Remove any dirt or corrosion from the bus bar and power connection areas. Inspect all power connections for overheating. Disassemble, clean, repair or replace overheated components as required.
5. Wipe the power amplifier clean using a moist rag. Do not reconnect the power amplifier to the battery until it is completely dry.
6. Reattach all connections that were removed. Make sure the connections are tight.

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove console cover.
3. Disconnect the main harness connectors and remove all power cables. Be sure to note locations for ease of reassembly.
4. Remove the four hex head mounting bolts.
5. Remove the traction power amplifier.
6. Check the aluminum mounting plate for flatness and clean for good thermal transfer.

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Installation

1. Place the new power amplifier in position.

NOTE: Heat conductive grease is NOT required.

2. Insert the four hex head mounting bolts and tighten.
3. Reattach the main harness and all power cables, noting labels.
4. Install the console cover.
5. Reconnect the battery connector.
6. Test the lift truck for proper operation.
7. Return the lift truck to service.

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Lift Power Amplifier

No attempts should be made to open the lift power amplifier. There are no user-serviceable parts inside. Attempting to open the power amplifier may damage it and will void the warranty.

It is recommended to clean the exterior of the power amplifier case occasionally.



Figure 7-60: Lift Power Amplifier

Exterior Cleaning

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove the console cover.
3. Discharge the capacitor in the power amplifier by connecting a load (such as a contactor coil or a horn) across the power amplifier's B+ and B– terminals.
4. Remove any dirt or corrosion from the bus bar and power connection areas. Inspect all power connections for overheating. Disassemble, clean, repair or replace overheated components as required.
5. Wipe the power amplifier clean using a moist rag. Do not reconnect the power amplifier to the battery until it is completely dry.
6. Reattach all connections that were removed. Make sure the connections are tight.

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove the console cover.
3. Disconnect the main harness connectors and remove all power cables. Be sure to note locations for ease of reassembly.
4. Remove the four hex head mounting bolts.
5. Remove the lift power amplifier.
6. Check the aluminum mounting plate for flatness and clean for good thermal transfer.

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Installation

1. Place the new power amplifier in position.

NOTE: Heat conductive grease is NOT required.

2. Insert the four hex head mounting bolts and tighten
3. Reattach the main harness and all power cables, noting labels.
4. Install the console cover.
5. Reconnect the battery connector.
6. Test the lift truck for proper operation.
7. Return the lift truck to service.

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Fuses

Test/Inspection

Examine the fuse for signs of overheating, discoloration, cracking, or other physical damage. Replace damaged fuses.

To test a fuse, remove it or isolate it from the electrical circuit. Do this by removing the fuse from the lift truck or by removing all the connections from one side of the fuse.

Use an ohmmeter set to Rx1 scale and measure the resistance across the fuse. The resistance should be less than 1 ohm.

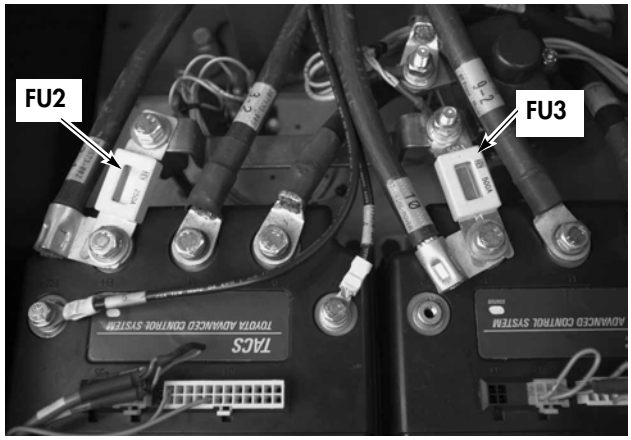


Figure 7-61: Fuses in Upper Electrical Compartment

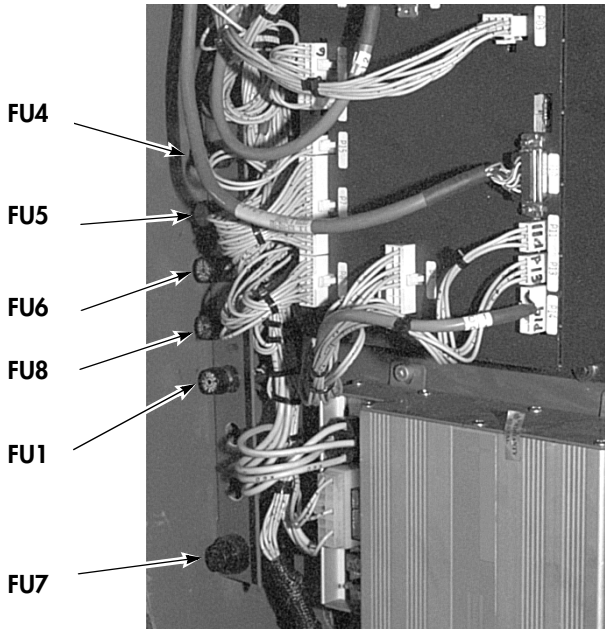


Figure 7-62: Fuses in Lower Electrical Compartment

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Operator Display

The operator display is the interface between the operator and the lift truck. The operator display consists of a pressure sensitive key pad, digital display, battery discharge indictor, service indicators, and drive wheel direction indicator (360° Steer only).

The operator display overlay is similar to a decal. It has an adhesive backing that adheres it to the operator display bracket. Take care when installing a new overlay that hands and environment are clean to allow proper adhesion.

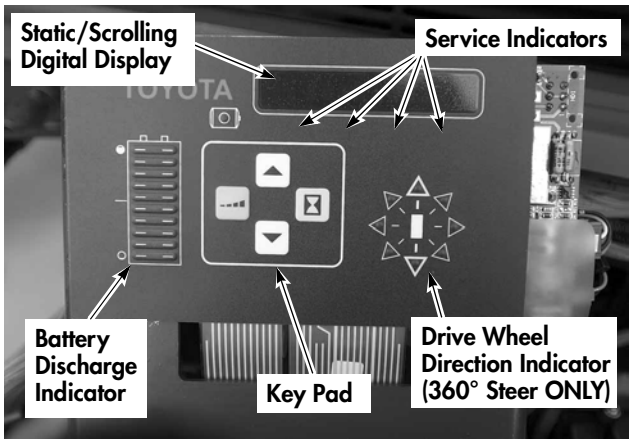


Figure 7-63: Operator Display

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove the console cover.
3. Disconnect the operator display overlay at the Display card.
4. Remove the overlay from the bracket.

Installation

1. Remove the protective backing from the operator display overlay.
2. Apply the overlay to the bracket.
3. Reconnect the overlay to the Display card.
4. Reconnect the battery connector and test the operation of the operator display overlay.
5. Install the console cover.
6. Return the lift truck to service.

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Hour Meter

Hours are metered for the following conditions: key switch on (Ks), deadman on (Bp), drive motor on (Dm), and lift motor on (Lt). Times are recorded in the Display Card and displayed digitally on the operator display upon request.

Battery Discharge Indicator

The battery discharge meter displays on the left side of the operator display.

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Temperature Sensors (Lift And Traction Motor)

Temperature sensors are located on both the traction and lift motors. If the sensor detects an overtemperature, the command signal to the power amplifier will be reduced to limit performance.

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Disconnect the sensor cable from the main tractor harness.
3. Count the threads from the top of the sensor. This will be used as a reference point when installing a temperature sensor.
4. Using a suitable wrench, loosen the locknut.
5. Unscrew the thermistor (temperature sensor) from the motor casing.

Installation

1. Screw the thermistor (temperature sensor) into the motor casing.
2. Tighten the locknut until the distance from the top is equal to step 3 above.
3. Reconnect the power cables.

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Brush Wear Sensors

The brush wear sensors are built into the motors. The brush wear sensors are not replaceable.

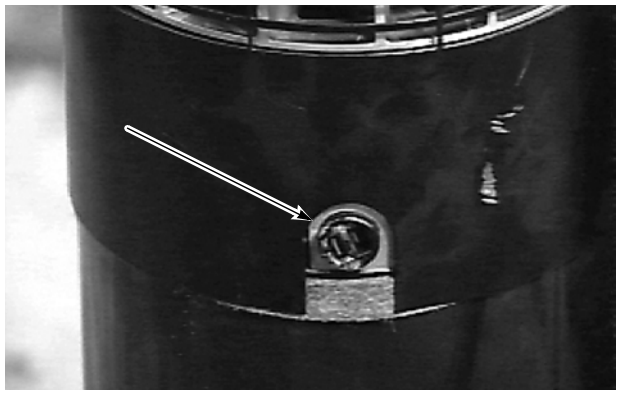


Figure 7-64: Brush Wear Sensor Connector Location

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Tractor Interface Card

The Tractor Interface card is located directly above the steer controller in the electrical compartment. The tractor interface card is enclosed in a protective casing. The Tractor Interface card should be replaced as an entire unit (card and enclosure).

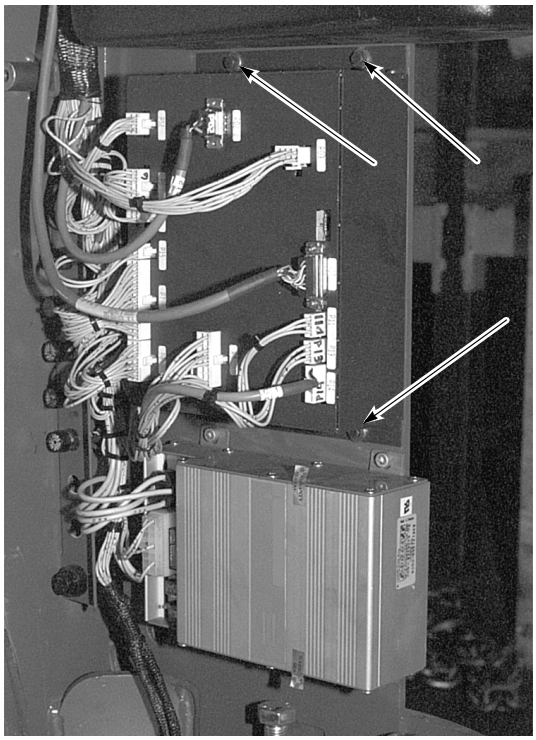


Figure 7-65: Tractor Interface Card Mounting

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove the electrical compartment access panel. See “Electrical Compartment Access Panel” on page 7-15.
3. Disconnect all electrical cables from the Tractor Interface card. Be sure to note connection points for installation.
4. Remove the four hex head mounting screws.
5. Remove the Tractor Interface card unit from the lift truck.

Installation

1. Place the Tractor Interface card unit against the outside wall of the tractor. Align mounting holes.
2. Secure the Tractor Interface card with the four hex head screws.
3. Reconnect all electrical cables to the Tractor Interface card.
4. Install the electrical compartment access panel.
5. Reconnect the battery connector.
6. Test the operation of the lift truck, then return to service.

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Display Card

The Display card is located on the underside of the operator display bracket.

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove the console cover.
3. Disconnect all connections. Be sure to note locations for reassembly.
4. Remove the four nylon nuts securing the Display Card to the bracket studs.

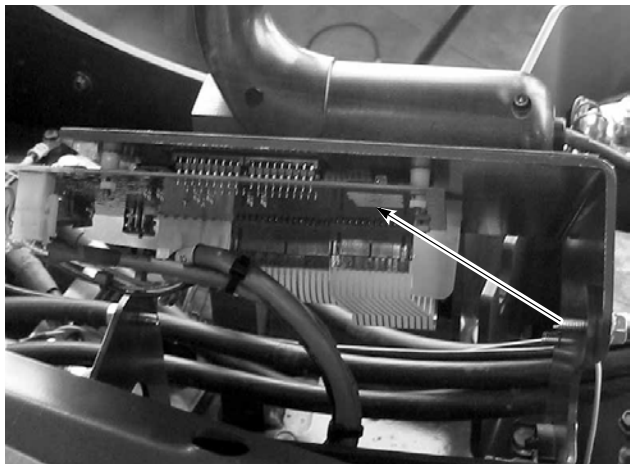


Figure 7-66: Display Card Location

Installation

1. Place the Display card on the bracket studs.
2. Secure in position using four nylon nuts.
3. Attach all electrical connections.
4. Install the console cover.
5. Reconnect the battery connector.
6. Test the operation of the lift truck, then return to service.

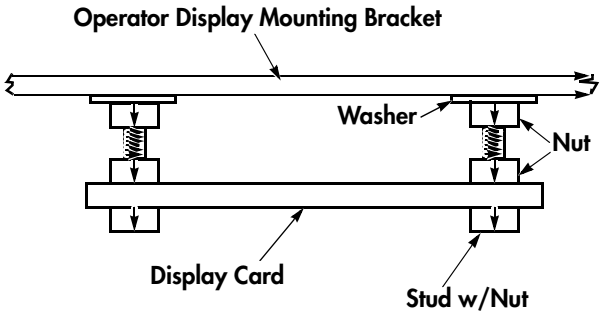


Figure 7-67: Display Card Mounting

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Light Assemblies

Overhead Guard Lights (Optional)

The overhead guard lights are mounted in a compartment on the left side of the overhead guard. The switches for the lights are located to the left of the key switch on the console cover.

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. From the top of the overhead guard, remove the four screws securing the light/fan assembly.
3. Lower the light/fan assembly enough to disconnect it from the harness.
4. Remove the light/fan assembly from the lift truck.
5. Repair or replacement of the light is achieved by removing the four screws in the sides of the light/fan console assembly to detach the hanger bracket from the top of the console.

Installation

1. Reassemble the light/fan console assembly. Be sure the clip nuts are positioned over the mounting holes for attachment to the overhead guard.
2. Reconnect the harness connections.
3. Install the mounting screws through the top of the overhead guard to secure the assembly.
4. Reconnect the battery connector.
5. Test the operation of the light assembly, then return the lift truck to service.

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Flashing or Rotating Light (Optional)

The flashing or rotating light is mounted at the back of the overhead guard, to the right of the back post.

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Disconnect the electrical connection at the light.
3. Remove the two hex head screws securing the light assembly to the overhead guard.
4. Replace light bulb or light assembly as required.

Installation

1. Secure the light assembly to the overhead guard with two hex head screws.
2. Reconnect the wiring harness.
3. Reconnect the battery connector.
4. Test the operation of the flashing or rotating light, then return the lift truck to service.

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Fan Assemblies

Operator Fan (Optional)

The operator fan/overhead light is located in the compartment on the left side of the overhead guard. There are separate switches for the operator fan and the overhead light. These switches are located to the left of the key switch.

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. From the top of the overhead guard, remove the four screws securing the light/fan assembly.
3. Lower the light/fan assembly enough to disconnect it from the harness.
4. Remove the light/fan assembly from the lift truck.
5. Repair or replacement of the fan is achieved by removing the four screws in the sides of the light/fan console assembly to detach the hanger bracket from the top of the console.

Installation

1. Reassemble the light/fan console assembly. Be sure the clip nuts are positioned over the mounting holes for attachment to the overhead guard.
2. Reconnected the harness connections.
3. Install the mounting screws through the top of the overhead guard to secure the assembly.
4. Reconnect the battery connector.
5. Test the operation of the light assembly, then return the lift truck to service.

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Upper Electrical Compartment Fan

The upper electrical compartment fan is located in the front of the tractor section. This fan vents heat out of the upper electrical compartment toward the mast. It is standard equipment on all Toyota Reach lift trucks.

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove the console cover.
3. Disconnect the electrical connections from the fan to the main wiring harness.
4. Remove the four nuts from the upper electrical compartment side.
5. Remove the four screws from the mast side of the tractor compartment.
6. Remove the fan assembly from the lift truck.

Installation

1. Install the fan assembly by inserting the four bolts through the tractor frame from the mast side.
2. Install four nuts from the electrical compartment side.
3. Connect the electrical connections to the main wiring harness.
4. Install the console cover.
5. Reconnect the battery and return the lift truck to service.

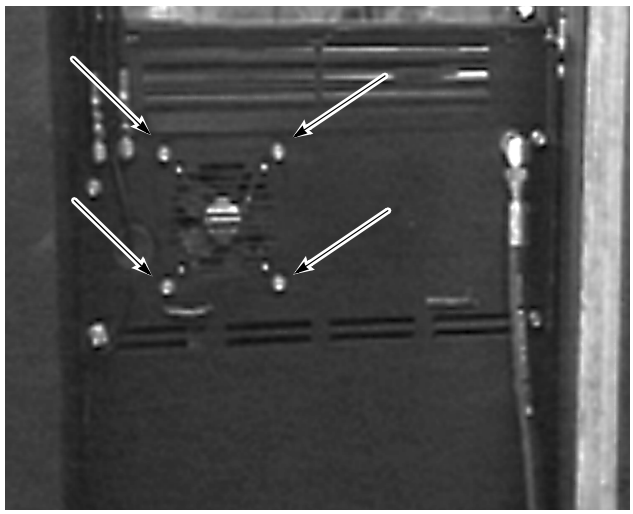


Figure 7-68: Front Mounting Bolts

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Height Indicator (Optional)

The height indicator consists of a display mounted on the left, underside of the overhead guard and the sensing unit components mounted on the mast. Mast switch 1 (S6) must be calibrated for the display to indicate the correct height. If the key switch is cycled off/on with the forks raised above the activation height for mast switch 1 (S6), the display indicates “LoCr” (Lower Carriage). If the lift limit option is enabled, lift will be disabled until the forks are lowered to below the activation height of mast switch 1. To continue lifting after reaching the lift limit height, press the lift limit bypass switch. Refer to the calibration procedures below for complete details on calibrating mast switch 1 (S6) and setting the lift limit height.



Figure 7-69: Height Indicator Components

Mast Switch1 (S6) Calibration

If the display has never been calibrated, the display will indicate “Ln.”

1. Connect the “Mast Sw1 Set” white wire to gray B+ wire. The display indicates “. . . .” if below mast switch 1 (S6). If above mast switch 1 (S6), the display indicates “LoCR.”
2. While observing the height display, raise the forks. Once mast switch 1 (S6) is crossed, the display changes from “. . . .” to “70.”
3. Raise the forks until the overall collapsed height (OACH) of the truck is indicated on the display.

NOTE: Displayed heights during calibration are always given in 1 in. increments.

4. Disconnect the “Mast Sw1 Set” wire from gray B+ wire. The display changes to “cc” (calibration complete) indicating the height has been calibrated. The actual fork height replaces the “cc” after one second.
5. Once mast switch 1 (S6) is calibrated, the display indicates “LnCO” (Learn CutOut) for learn lift limit cutout height. Follow the lift limit calibration procedure on the next page.

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Lift Limit Calibration

1. Connect the “lift limit (cutout) height” black wire to gray B+ wire.
2. While observing the height display, raise the forks. Once mast switch 1 (S6) is crossed, the display changes from “. . . .” to the actual mast switch 1 height.
3. When the correct lift limit height is indicated on the height display, stop raising the forks.
4. Disconnect the “lift limit (cutout) height“ wire from gray B+ wire. The display changes to “cc” indicating the height has been calibrated. The actual fork height replaces the “cc” after one second.

NOTE: Lift limit must be calibrated each time mast switch 1 is calibrated.

To disable lift limit either turn off the option in Configuration (Configur) mode or perform the following:

1. Connect the “lift limit (cutout) height” black wire to gray B+ wire.
2. Leave the wire connected for a minimum of one second, do not lift or lower the forks. After one second, disconnect the “lift limit (cutout) height” black wire from gray B+ wire. The display will indicate “nCO” (no cutout) for 1 second.
3. The lift limit height will be set at 400 in.

To verify that the height displayed is correct, raise the forks until the Height Display indicates a height. Measure from the floor to the top of the forks, approx. 6 in. (152 mm) from the heel of the forks.

If the height is off by more than 1 in. (25.4 mm), re-calibrate the height value of mast switch 1. Use the OACH value as before, but offset the OACH value by the number of inches that the height is off. For example: If the measured height is 117 in. and the display indicates 119 in., subtract 2 in. from the OACH value. If the displayed height is less than the measured height, add the difference to the OACH. Use this new value to calibrate mast switch 1 height.

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Height Indicator Display

The Height Indicator Display shows the operator the fork height position in either 1 in. or 2 centimeter intervals, depending on the placement of the jumper on the Height Indicator Card.



Figure 7-70: Height Indicator Operator Display

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove the four screws attaching the front cover to the display unit.
3. From the top of the overhead guard, remove the four screws securing the compartment assembly to the overhead guard.
4. Lower the compartment assembly enough to disconnect the height indicator display from the harness.
5. Remove the two screws and clamps that attach the display unit to the compartment assembly.
6. Remove the height indicator display from the lift truck.
7. Replace the height indicator card in the display unit.

Installation

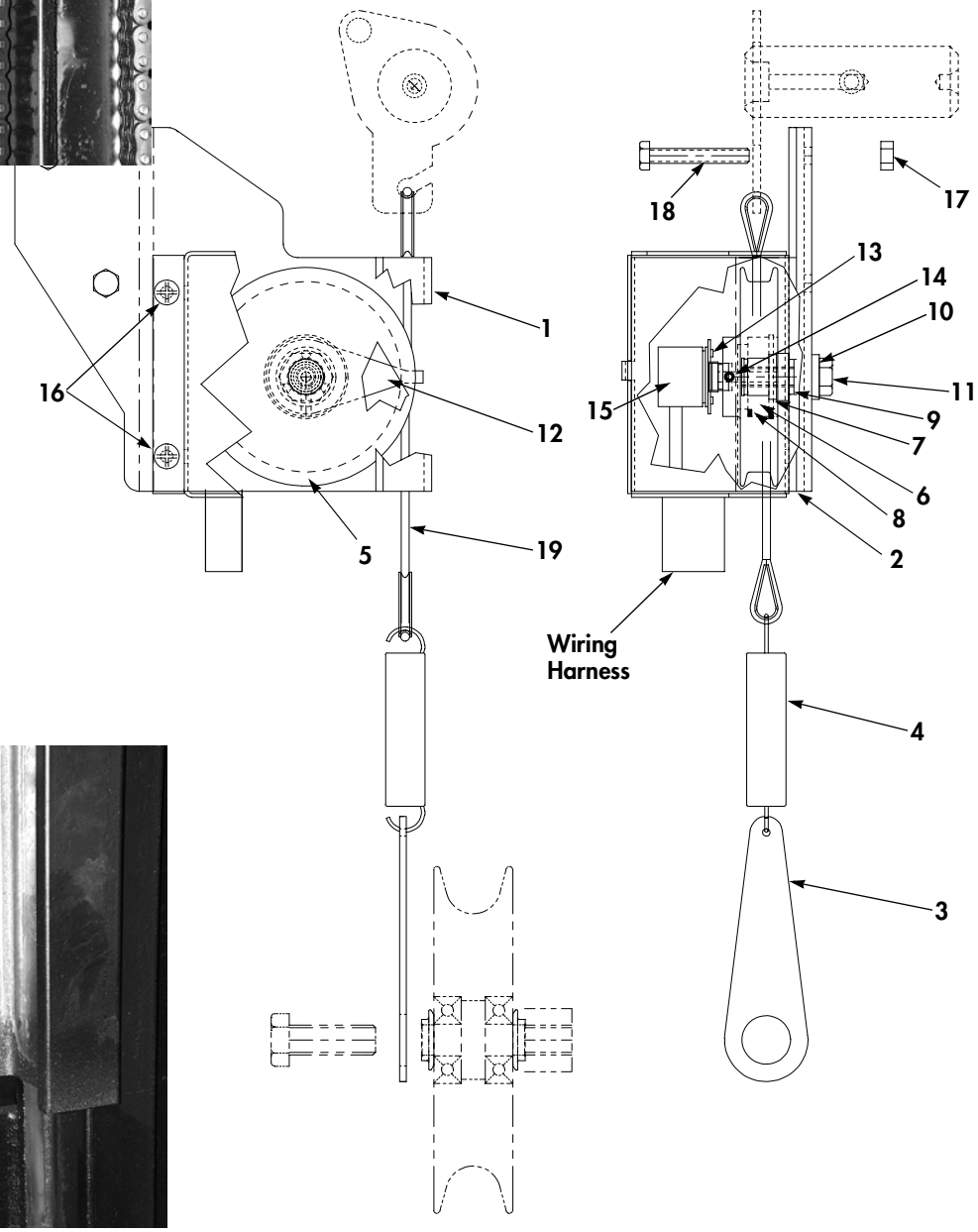
1. Install the display unit in the compartment using two screws and clamps.
2. Attach the harness to the back of the display.
3. Install the mounting screws through the top of the overhead guard to secure the compartment assembly.
4. Install the four screws securing the front cover to the display unit.
5. Reconnect the battery connector.
6. Test the operation of the height indicator display assembly, then return the lift truck to service.

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Height Indicator Sensing Unit Components







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POS. NO.	DESCRIPTION	POS. NO.	DESCRIPTION	POS. NO.	DESCRIPTION
1	Support	8	Ring, locking	15	Encoder
2	Cover	9	Bearing	16	Screw
3	Anchor, bottom	10	Washer	17	Nut
4	Spring	11	Screw	18	Screw
5	Roller	12	Arm	19	Cable
6	Bearing	13	Screw		
7	Ring, snap	14	Setscrew		

Height Indicator Encoder

Removal

1. Unplug the wiring connector from the encoder assembly.
2. Remove the screws (16), then remove the cover (2).
3. To replace the encoder (15), loosen the setscrew (14) and remove the encoder.
4. Remove the screws (13) and remove the arm (12).

Installation

1. Place the arm (12) in the enclosure and install screws (13).
2. Place the encoder (15) in the enclosure, tighten the setscrew (14).
3. Place the cover (2) on the enclosure, then tighten the screws (16).
4. Plug the wiring connector to the encoder assembly.
5. Test the operation of the height indicator, then return the lift truck to service.

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Height Indicator Cable

Removal

1. To replace the cable (19), remove the bolt from the bottom anchor (3) relieving the spring tension.
2. Remove the spring (4) and anchor (3) from the cable (19).
3. Remove the cable (19) from the top anchor, and remove from the pulley.

Installation

1. Install a new cable (19) on the top anchor. Wrap the cable once around the pulley wheel.
2. Attach the spring (14) and the bottom anchor (3) to the cable (19).
3. Stretch the cable (19) tight and install the bottom anchor bolt.
4. Test the operation of the height indicator, then return the lift truck to service.

Height Indicator Pulley

Removal

1. To replace the pulley wheel (5), remove the cover (2), the encoder, and the cable (19).
2. Remove the screw (11), then remove the pulley wheel.
3. Remove the bearing (9), the retaining rings, (7 and 8) and the bearing (6).

Installation

1. Install the bearing (6), the retaining rings, (7 and 8) and the bearing (9).
2. Place the pulley wheel in the enclosure, then install screw (11).
3. Install the cable (19), the encoder, and the cover (2).
4. Test the operation of the height indicator, then return the lift truck to service.

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Hydraulics

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Hydraulic Fluid

Hydraulic Fluid Selection

Before adding or changing hydraulic fluid, determine the environment and usage of the lift truck. Refer to the Lubrication Equivalency chart in the Appendix to make the proper oil/lubricant selection.

Changing Hydraulic System Fluid

1. Be sure the lift truck is in a clean area, away from any possible contaminating elements that could enter the hydraulic system during the changing process. Check that the carriage is fully lowered, reach retracted, and tilt is full down.
2. Drain the hydraulic reservoir completely. See “Draining the System”. Also, drain as much oil as possible from the hydraulic lines and cylinders.
3. Fill the hydraulic reservoir with the proper fluid.
4. With the lift system running, operate the lift/lower and auxiliary functions for approx. 2 minutes to purge the system.
5. Check for possible hydraulic leaks.
6. Bleed the entire hydraulic system before placing the lift truck into service.
7. Check reservoir oil level.

The remainder of the original hydraulic fluid left in the system, (approx. 5%), should not be detrimental to the operation of the lift truck.

Draining the System

1. Lower the carriage fully, tilt the forks down completely and retract the reach mechanism fully.
2. Turn the key switch OFF and disconnect the battery connector.
3. Remove the tractor top cover and open the door.

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4. Remove the diagnostic fitting near the control valve. Be sure not to let fluid get into the drive motor. See Figure 7-71.
5. Place a piece of tubing or rubber hose over the fitting and direct into a waste container with a capacity greater than 5 gal. (19 liters).
6. Reconnect the battery connector and turn the key switch ON.
7. Operate the lift until you hear air in the system.
8. Turn the key switch OFF and disconnect the battery connector.
9. Remove the drainage tube and replace the diagnostic fitting.
10. Remove the filter following the procedure on page 7-142.
11. If it is necessary to flush the reservoir, remove the reservoir. See “Hydraulic Reservoir” on page 7-144.
12. Dispose of the old hydraulic fluid according to local regulations for hazardous materials.

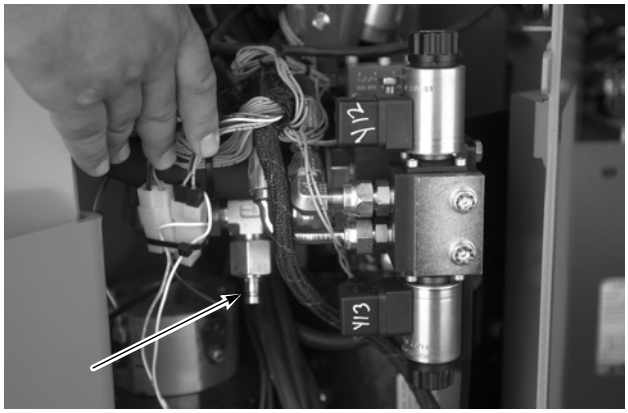


Figure 7-71: Diagnostic Fitting

Refilling the System

1. If the reservoir was removed for flushing, install the reservoir. See “Hydraulic Reservoir” on page 7-144.
2. Install the hydraulic filter. See “Hydraulic Filter” on page 7-142.
3. Fill the hydraulic reservoir through the bleeder cap/fill hole. See Figure 7-72. Be sure to use the proper grade of fluid. The reservoir holds 5 gals. (19 liters) of fluid. See “Lubrication Equivalency Chart” on page A-2.
4. Reconnect the battery connector and turn the key switch ON.
5. Bleed the hydraulic system. See “Bleeding the Hydraulic System” on page 7-146.
6. Install the tractor top cover and secure the tractor door.

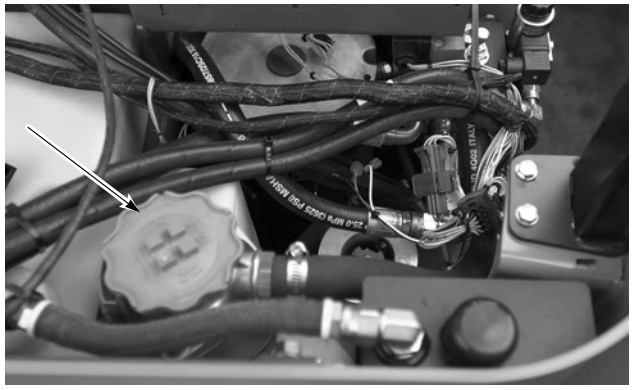


Figure 7-72: Bleeder/Fill Cap

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Hydraulic Filter

Removal

NOTE: It is recommended that the hydraulic fluid be drained from the reservoir prior to replacing the filter. See "Hydraulic Fluid" on page 7-140.

1. Lower the carriage fully to ensure all hydraulic pressure is relieved.
2. Turn the key switch OFF, and disconnect the battery connector.
3. Remove the console cover. See "Console Cover" on page 7-14.
4. Remove the blue cover on the filter adapter collar. The filter is attached to the bottom of the blue cover. See Figure 7-73.
5. Remove the filter by pulling straight down to snap it out of the latch. See Figure 7-74.



Figure 7-73: Hydraulic Filter Removal

Installation

1. Snap the filter onto the blue cover.
2. Install the cap and filter assembly in the reservoir.
3. Test operate the lift truck.
4. Check the hydraulic fluid level and refill as needed.
5. Replace the console cover.
6. Reconnect the battery connector.
7. Return to service.



Figure 7-74: Hydraulic Filter Assembly/Disassembly

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Hydraulic Filter Adapter

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove the console cover. See “Console Cover” on page 7-14.
3. Drain the hydraulic system. See “Hydraulic Fluid” on page 7-140.
4. Remove the blue cap and filter. See Figure 7-75.
5. Remove the four mounting screws attaching the collar assembly to the plastic reservoir.



Figure 7-75: Hydraulic Filter Adapter

Installation

1. Clean all parts thoroughly. Clean the mating surface of the hydraulic reservoir.
2. Align the collar mounting holes with the reservoir holes. Torque the four mounting screws to 44.4 in. lb. (50 Nm).
3. Install the cap and filter. See “Hydraulic Filter” on page 7-142.
4. Fill the hydraulic reservoir.
5. Reconnect the battery connector.
6. Bleed the hydraulic system. See “Bleeding the Hydraulic System” on page 7-146.
7. Test operate the lift truck.
8. Turn the key switch OFF and disconnect the battery connector. Install the tractor cover. Reconnect the battery connector.

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Hydraulic Reservoir

Removal

1. Lower the carriage fully and retract the reach mechanism fully.
2. Remove the console cover and the control handle. See “Console Cover” on page 7-14. See also, "Control Handle" on page 7-29.
3. Drain the hydraulic system. See “Hydraulic Fluid” on page 7-140.
4. Turn the key switch OFF and disconnect the battery connector.
5. Remove the drive motor and brake assembly. See “Drive Motor” on page 7-113.
6. Remove the lift pump and motor. See “Lift Motor” on page 7-115.
7. Disconnect the hydraulic hose to the mast. Plug the ends to prevent contamination.
8. Disconnect hydraulic hose to the control valve. Plug the end to prevent contamination.
9. To remove the reservoir, tilt the tractor end of the reservoir up. Pull the reservoir back, away from the mast. Once the front of the reservoir has cleared the front tractor frame, lift the reservoir out.
10. Remove the hydraulic filter adapter. See “Hydraulic Filter Adapter” on page 7-143.

Installation

1. Install the hydraulic filter adapter.
2. Install the hydraulic filter. See “Hydraulic Filter” on page 7-142.
3. Angle the mast end of the reservoir down and push forward to the tractor frame. Let the tractor end of the reservoir drop straight down at this point.
4. Install the lift pump and motor assembly.
5. Connect the hoses to the reservoir.
6. Fill the hydraulic reservoir.
7. Install the drive motor and brake assembly.
8. Reconnect the battery connector.

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9. Bleed the hydraulic system. See “Bleeding the Hydraulic System” on page 7-146.
10. Test operate the lift truck.
11. Turn the key switch OFF and disconnect the battery connector. Install the tractor cover. Reconnect the battery connector.

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Bleeding the Hydraulic System

You must bleed the hydraulic system to remove any trapped air whenever you:

- change a hydraulic hose
- disconnect a hydraulic fitting
- remove a hydraulic cylinder
- remove the hydraulic pump
- remove the hydraulic reservoir
- notice that the load is bouncing

1. Elevate the forks 2 to 3 in. (50 to 75 mm) off the floor.
2. Turn the key switch OFF and disconnect the battery connector.
3. Use a 5/16 in. wrench to loosen (*do NOT remove*) the bleed screw at the top of the freelift cylinder. Hold a rag close to and beneath the bleed screw to keep hydraulic fluid from spraying out.
4. When hydraulic fluid starts flowing from the bleed screw hole, securely tighten the bleed screw.
5. Repeat steps 3 and 4 for each of the two staging cylinders.
6. Reconnect the battery connector and turn the key switch ON.
7. Lower the forks all the way down to the floor.
8. Fully extend and retract the reach mechanism several times.
9. If the lift truck is equipped with tilt, tilt the carriage all the way forward and backward several times.
10. If the lift truck is equipped with sideshift, shift the carriage all the way to the left and right several times.
11. Thoroughly clean up any spilled hydraulic fluid.
12. Check the hydraulic reservoir level and refill as necessary. See “Lubrication Equivalency Chart” on page A-2.

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Control Valve

Removal

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove the console cover.
3. Remove the motor compartment rear door.
4. Use a 13 mm socket to remove the 3 bolts securing the control valve to the bracket. See Figure 7-77.
5. Loosen the fittings on the two large hoses, toward the lift motor, with a 1-1/8 in. wrench.

⚠ CAUTION

Take precautions to prevent fluid from getting into the drive motor and/or brake assembly when removing the fittings from the control valve.

6. Use a small phillips head screwdriver to detach the three electrical connections. Cover the screws in the connectors with a piece of electrical tape to prevent them from being lost as the wiring harness is moved.
7. Use a 13/16 in. wrench to loosen the fittings on the two smaller hoses.
8. Loosen the hose clamp to remove the supply hose from the reservoir.

Installation

1. Apply thread locking compound to the three mounting bolts.
2. Tighten using a 13 mm socket.

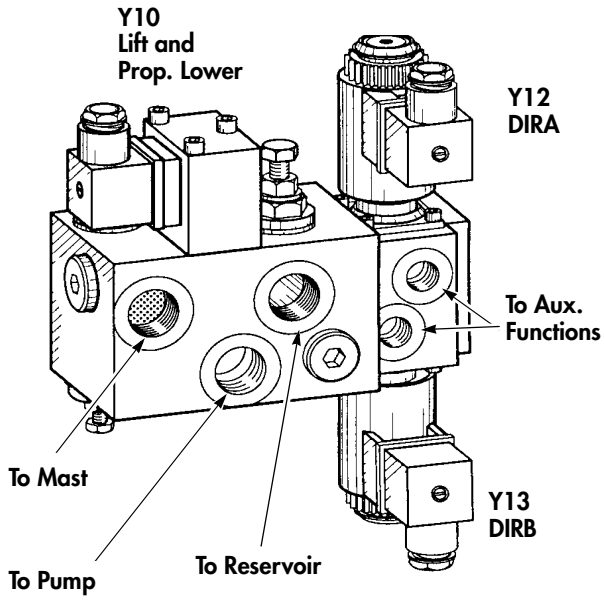


Figure 7-76: Control Valve

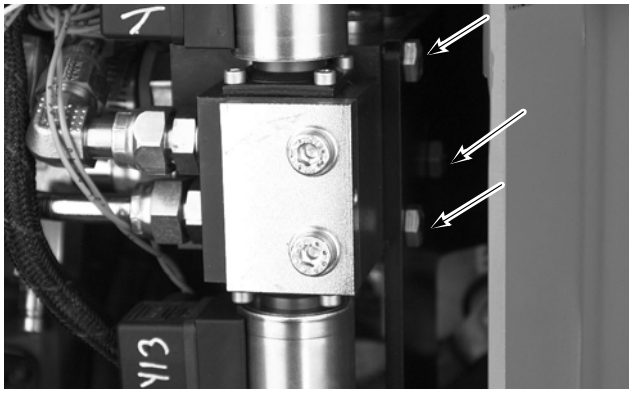


Figure 7-77: Mounting Bolts

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3. Attach hoses to the control valve in the following order:
   - control valve to reservoir
   - supply hose to mast (1-1/8 in.)
   - control valve to lift pump (1-1/8 in.)
   - two small hoses (13/16 in.) on the front of the control valve. Hose with 90° fitting goes on the bottom, tighten before installing the top hose. Install the 90° fitting in the top port of the control valve, then install the remaining small hose.
4. For the large hoses, finger tighten the fittings until both ends are attached, then use the wrenches to finish tightening.
5. Attach three electrical connections (see Figure 7-78) using a small screw driver:
   - Y10 to the back (longest lead wires)
   - Y12 to the top connection
   - Y13 to the bottom connection

NOTE: If Y13 connection is behind the hoses, loosen the nut on the bottom of the solenoid, turn the solenoid out to attach the electrical connection, then turn the solenoid back in so that it does not hit the doors or panels.

6. Install console cover.
7. Install motor compartment rear door.

NOTE: To service either the drive motor or the lift motor, the control valve may be removed from the bracket (leaving all hoses attached) and laid up over the reservoir.

If the reservoir needs to be replaced, leave the control valve on the bracket. Remove the supply hose at the reservoir. Lay the hose over the control valve and let the loose end drop into the operator compartment.

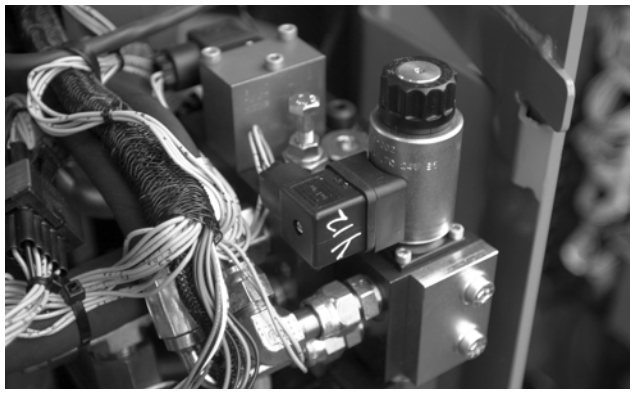


Figure 7-78: Solenoid Electrical Connections

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Reach/Tilt/Sideshift Manifold

The reach/tilt/sideshift manifold is located on the top of the scissor arm assembly on the reach carriage.

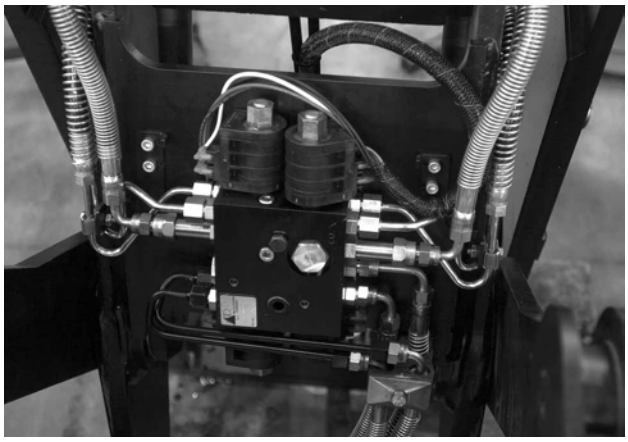


Figure 7-79: Auxiliary Function Manifold

⚠WARNING

Use extreme care when blocking the mast for any reason. Never remove the block when it is supporting the mast.

Removal

1. Extend the reach mechanism. Prevent the reach from retracting by blocking between the carriage frame and the scissor end.
2. Turn the key switch OFF and disconnect the battery connector.
3. Remove the 1/2 in. bolt holding the manifold cover to the manifold.
4. Remove the wires to the four solenoids.
5. Label hoses prior to removal to aid in reinstallation. Remove the ten hoses to the manifold.
6. Remove the 1/2 in. bolt holding the manifold to the top of the scissor arm assembly. Remove the manifold.
7. Remove the solenoids from the manifold. See “Solenoids” on page 7-150.

Installation

1. Attach the four solenoids to the manifold.
2. Bolt the new manifold on the reach inner scissors assembly. Attach the wires to the solenoids.
3. Attach the ten hydraulic hoses to the manifold.
4. Attach the manifold cover mounting bolt.
5. Reconnect the battery connector. Turn the key switch ON.
6. Unblock and lower the carriage.
7. Test operate the lift truck.
8. Return the lift truck to service.

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Solenoids

Removal

1. Make sure that the carriage is fully lowered and the reach mechanism is fully extended.
2. Turn the key switch to OFF. Disconnect the battery connector.
3. Remove the two wires from the terminals on each solenoid.
4. Remove the nut holding the solenoid coil to the solenoid valve,
5. Lift the solenoid coil off the solenoid valve.
6. Remove the solenoid valve from the manifold.

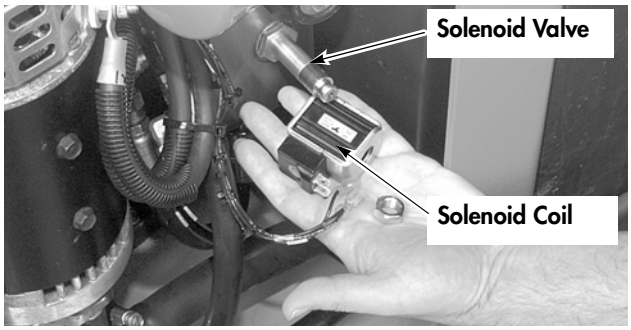


Figure 7-80: Solenoid Removal, Typical

Installation

1. Inspect the seat where the solenoid seals against the manifold. The sealing surface should be completely clean and free from any nicks or damage.
2. Inspect the O-ring for any damage. If the O-ring is damaged or deformed in any way, replace it.
3. Thread the solenoid valve into the manifold. Torque the solenoid valve to 25 ft. lb. (35 Nm).
4. Install the solenoid coil onto the solenoid valve and tighten the nut.
5. Connect the wires to the terminals.

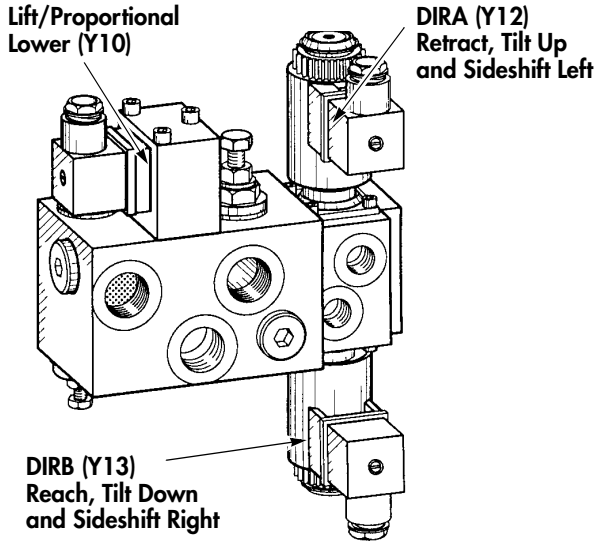


Figure 7-81: Solenoids, Main Manifold

6. Reconnect the battery connector and turn the key switch to ON. Test the functions of the lift truck.
7. Turn the key switch OFF. Disconnect the battery.
8. Install any covers that were removed.

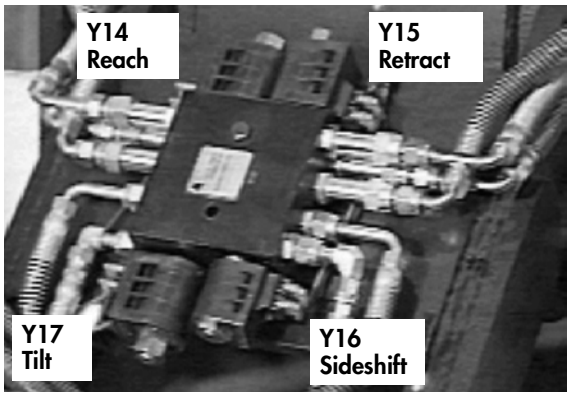


Figure 7-82: Solenoids, Auxiliary Function Manifold

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Lift Pump

Removal

1. Remove the lift pump and motor assembly as a single unit. Follow the procedure on page 7-115.
2. Remove the hydraulic pump from the motor by removing the two mounting bolts holding the pump to the motor.

Installation

1. Attach the hydraulic pump to the motor with two mounting bolts.
2. Make sure the mounting area is clean. Position the motor/pump over the mounting bracket and align it with the bolt holes.
3. Install the lift pump and motor assembly following the procedure on page 7-115.

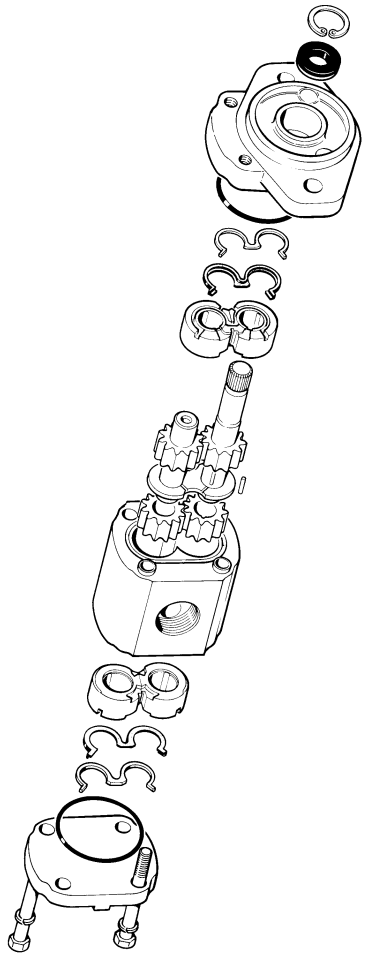


Figure 7-83: Lift Pump Assembly

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Freelift Cylinder Repair

1. Park the lift truck on a level surface and apply the brake.
2. Fully extend the cylinder to inspect the rod (9) for gouges or pits. If gouges or pits are detected, the cylinder must be removed for repair.
3. Lift the reach carriage approx. 12 in. (304 mm). Block the reach carriage to prevent lowering.

⚠WARNING

When blocking mast telescopics to prevent lowering, always block both sides of the telescopic. Otherwise, the truck could tip over on its side.

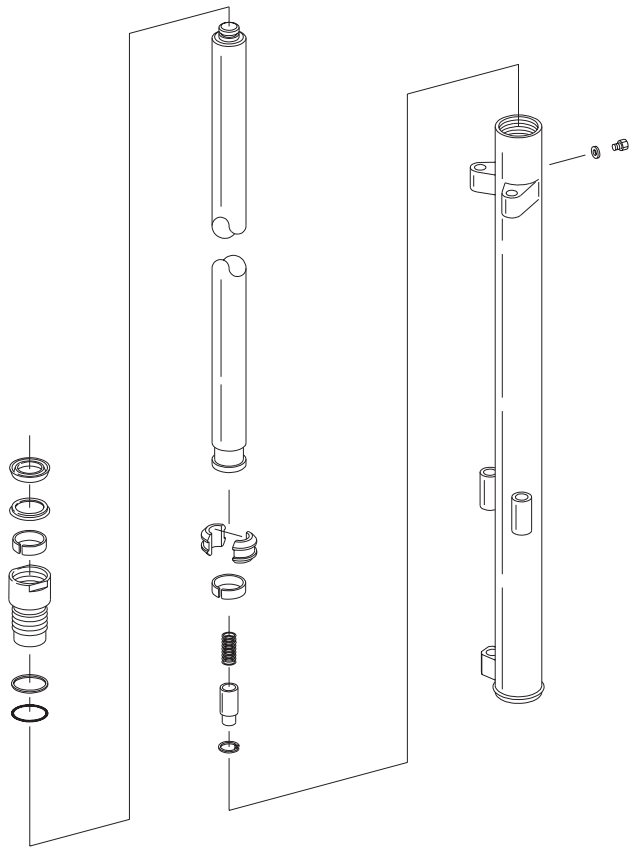


Figure 7-84: Freelift Cylinder Components

POS. NO.	DESCRIPTION	POS. NO.	DESCRIPTION
1	Washer, Seal	9	Rod, Cylinder
2	Screw	10	O-Ring
3	Tube Cylinder	11	Ring, Backup
4	Ring, Wear	12	Bearing
5	Plunger Assembly	13	Ring, Wear
6	Spring	14	Seal, Rod
7	Ring, Wear	15	Wiper, Cylinder
8	Piston	16	Ring, Backup

4. Remove the setscrew from the front of the freelift cylinder crosshead. Lower cylinder rod hydraulically.

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5. Turn the key switch OFF and disconnect the battery connector.
6. Remove the chains, hoses, and electric cables from the crosshead. Remove the crosshead and hoses from the top of the cylinder and move to the side to allow room to work on the freelift cylinder.
7. Inspect the area shown in Figure 7-85 for sharp edges. Sand any sharp edges with 400 grit (or finer) sandpaper until smooth.
8. Clean the exterior of the lift cylinder.

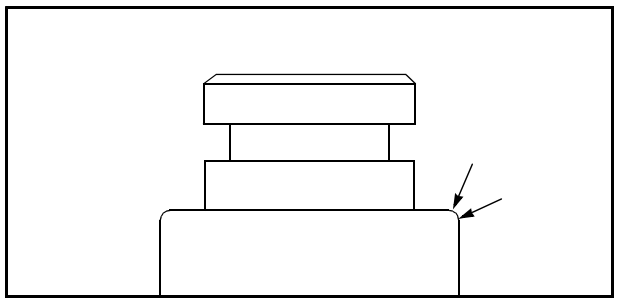


Figure 7-85: Freelift Cylinder Rod Inspection

⚠WARNING

Be extremely careful when working with solvent. Even a small explosion or fire could cause injury or death.

⚠WARNING

Compressed air used for cleaning *must* be reduced to less than 30 psi (207 kPa), and then only with effective chip-guarding and personal protective equipment.

9. Remove the bearing (12) from the cylinder tube (3).
10. Remove wiper (15), rod seal (14), wear rings (13), O-ring (10), and backup ring (11) from the bearing (12).

⚠ CAUTION

Do not allow steel objects to touch the inside surfaces of the bearing where the seal, O-ring, wiper or wear ring are seated. Any scratches, dents, or marks to these surfaces can cause the sealing components to malfunction and not seal properly.

11. Clean bearing. Check inside the bearing for sharp edges that could cut the seal when it is being installed into the bearing. Sharp edges can be smoothed with 400 grit (or finer) sandpaper. The surface in the seal groove should be smooth and polished with no pits or scratch marks.

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12. Lubricate bearing grooves and seal with hydraulic oil.

⚠ CAUTION

When installing O-ring (10) and backup ring (11), use caution not to twist them when they are in their final position.

13. Install rod seal (14), wear rings (13), backup ring (11), and O-ring (10) into bearing (12). Install bearing on cylinder assembly.
14. Install hoses and crosshead on top of the cylinder. Install chains on crosshead. Install setscrew in the front of the freelift cylinder crosshead.
15. If cylinder assembly was removed, re-install.
16. Remove blocking. Reconnect battery connector and turn key switch ON. Operate the truck's hydraulic system. Check for leaks and proper operation. Make sure chains are adjusted properly.

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Staging Cylinder Repair

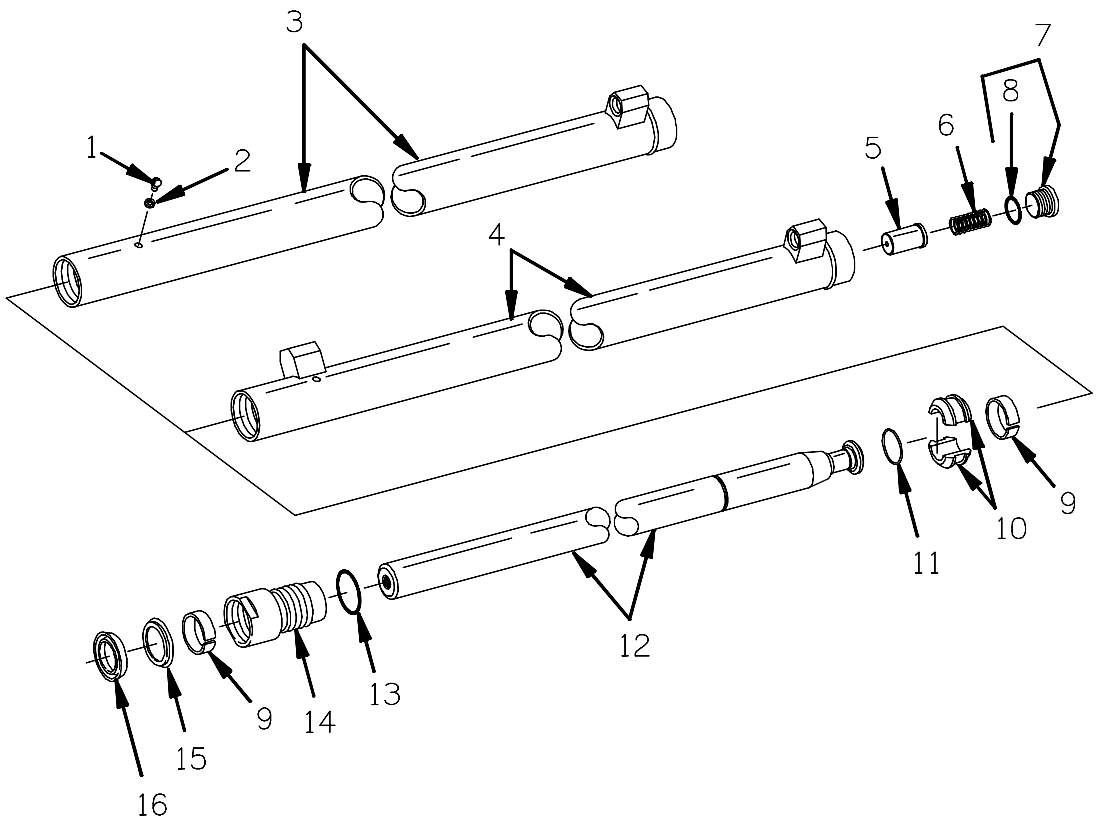


Figure 7-86: Staging Cylinder Components

POS. NO.	DESCRIPTION	POS.NO.	DESCRIPTION
1	Screw	9	Ring, Wear
2	Washer, Seal	10	Piston
3	Cylinder Tube, 1 Port	11	Ring, Retainer
4	Cylinder Tube, 2 Ports	12	Rod, Cylinder
5	Plunger Assembly	13	O-Ring
6	Spring	14	Bearing
7	Plug	15	Seal, Rod
8	O-Ring	16	Wiper

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Staging Cylinder Repair

1. Park the lift truck on a level surface and apply the brake.
2. Fully extend the cylinder to inspect the rod (12) for gouges or pits. If gouges or pits are detected, the cylinder must be removed for repair.
3. Lift the reach carriage approx. 12 in. (304 mm). Block the mast.

⚠WARNING

When blocking mast telescopics to prevent lowering, always block both sides of the telescopic. Otherwise, the truck could tip over on its side.

4. Remove bolts from the top end of the staging cylinder rods. Lower cylinder rods hydraulically.
5. Turn the key switch OFF and disconnect the battery connector.
6. Inspect the area shown in Figure 7-87 for sharp edges. Sand any sharp edges with 400 grit (or finer) sandpaper until smooth.
7. Clean the exterior of the lift cylinder.

⚠WARNING

Be extremely careful when working with solvent. Even a small explosion or fire could cause injury or death.

⚠WARNING

Compressed air used for cleaning *must* be reduced to less than 30 psi (207 kPa), and then only with effective chip-guarding and personal protective equipment.

8. Remove the bearing (14) from the cylinder tube.
9. Remove rod seal (15), wiper (16), O-ring (13), and wear ring (9) from the bearing (14).

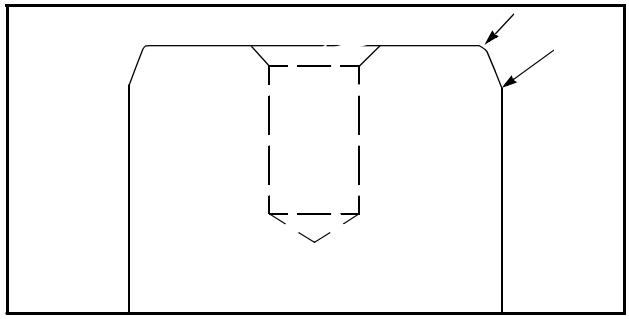


Figure 7-87: Staging Cylinder Rod Inspection

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⚠ CAUTION

Do not allow steel objects to touch the inside surfaces of the bearing where the seal, O-ring, wiper or wear ring are seated. Any scratches, dents, or marks to these surfaces can cause the sealing components to malfunction and not seal properly.

10. Clean bearing. Check inside the bearing for sharp edges that could cut the seal when it is being installed into the bearing. Sharp edges can be smoothed with 400 grit (or finer) sandpaper. The surface in the seal groove should be smooth and polished with no pits or scratch marks.
11. Lubricate bearing grooves and seal with hydraulic oil.

⚠ CAUTION

When installing O-ring, protect it by covering the threads with plastic film (part of plastic bag). Use caution so the O-ring is not twisted when in its final position.

12. Install rod seal (15), O-ring (13), backup ring, wear rings (9), and wiper (16) into bearing (14). Install bearing on cylinder assembly.
13. Install bolts on top of the staging cylinder rods and torque to 30-33 ft. lb. (70-80 Nm).
14. If cylinder assembly was removed, re-install.
15. Remove blocking. Reconnect battery connector and turn key switch ON. Operate the truck's hydraulic system. Check for leaks and proper operation. Make sure chains are adjusted properly.

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Tilt Cylinder (3500 lb. Reach)

Removal

1. Park the lift truck on a level surface and apply the brake.
2. Raise the reach approx. 12 in. (305 mm). Block to prevent lowering.
3. Relieve the pressure on the tilt cylinder (1).
4. Pivot the reach carriage upward and block to prevent the reach carriage from lowering.
5. Remove the strap (3) and cap screws (4) that secure the cylinder to reach carriage.
6. Remove the hydraulic hoses from the tilt cylinder (1).
7. Remove the tilt cylinder (1) from the lift truck.

Disassembly

NOTE: Perform all procedures in a clean environment. Make sure all parts are cleaned before disassembly and kept clean during assembly.

1. Before disassembly, clean the exterior of the tilt cylinder (1) in a cleaning solvent to remove all contamination.

⚠WARNING

Be extremely careful when working with solvent. Even a small explosion or fire could cause injury or death.

2. Be sure all hydraulic fluid has been removed from the cylinder. Stroking the piston rod will help force the fluid out.
3. Put the base end of the cylinder in a vise equipped with soft jaws.
4. Remove the bearing retainer (13) and fastening ring (7), from the cylinder tube.
5. Remove the bearing assembly, seals, rings, rod (10) and piston seals.
6. Remove and discard all seals and rod wiper (5,6,8,9,11, and 12).

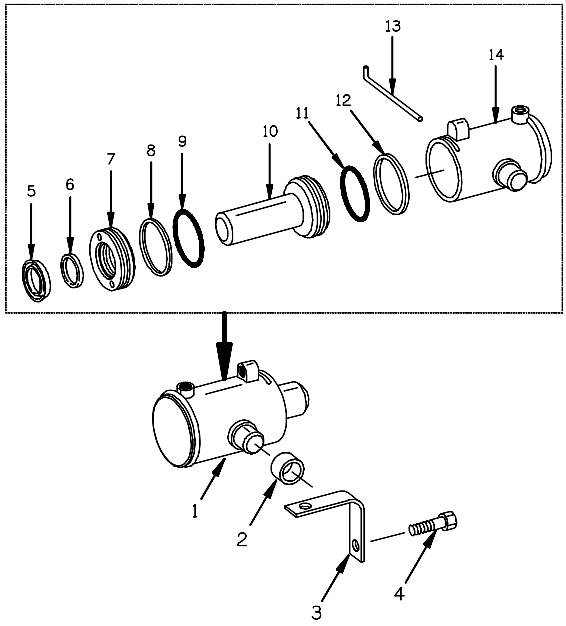


Figure 7-88: Tilt Cylinder (3500 lb. Reach)

POS. NO.	DESCRIPTION
1	Tilt cylinder assembly
2	Bushing
3	Retainer, cylinder
4	Screw, cap
5K	Wiper
6K	Seal
7	Bearing, cylinder
8K	Ring, back-up
9K	O Ring
10	Rod, cylinder
11K	O Ring
12K	Ring, back-up
13K	Retainer
14	Tube, cylinder

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7. Inspect the mounting bushings (2) located at both ends of the cylinder. It will not be necessary to remove them unless they are found to be unfit for further service.

Inspection

1. Carefully clean all parts in a cleaning solvent and position them on a clean work surface.

⚠WARNING

Be extremely careful when working with solvent. Even a small explosion or fire could cause injury or death.

2. Check the piston rod (10) for damage. Look for gouges, scratches, corrosion, or evidence of unusual wear. Minor surface damage can be repaired by the use of fine abrasion cloth or stoning. Be extremely careful you do not remove the chrome plating. Deeper damage will require replacement of the piston rod assembly. Make sure the threads on the rod are free of damage.
3. Check the cylinder bore for any damage. Parts with deep gouges or pitted surfaces will require replacement.
4. Check the threaded section of the cylinder tube to be sure the threads have not been damaged.

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Assembly

1. Install the new packing and rod wipers in the bearing assembly. The “lip” of the wiper must face outward.
2. Install the new bearing seals, back-up ring and retainer (13) on the bearing assembly.
3. Install the new piston seals on the piston.
4. Install the piston on the rod.
5. Apply clean hydraulic fluid to the piston rod assembly. Coat the inside of the cylinder barrel and bearing assembly with clean fluid.
6. Carefully slide the bearing assembly on the piston rod. Be sure the rod end does not cut or nick the wiper or packing upon installation.
7. Install the piston and rod into the cylinder barrel. Be careful that the piston seals are not nicked or cut on the edge of the cylinder barrel or when sliding them over the groove within the barrel.
8. Next, install the bearing assembly into the cylinder barrel. Again, use care so the seals are not nicked or cut upon installation.
9. Check installation by making sure the piston rod assembly moves fairly easy within the barrel assembly without binding.
10. Install bearing fastening ring and retainer.

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Installation

1. Install the cylinder on the reach carriage front frame.
2. Install the mounting straps (3) and secure with four cap screws (4).
3. Properly connect the correct hydraulic hoses to the front and rear of the tilt cylinder.
4. Remove the blocking and chains.
5. Fill the hydraulic reservoir with new clean fluid.
6. Connect battery connector.
7. Operate the tilt to remove the air from hydraulic hoses. Check the operation of the of entire hydraulic system.

⚠WARNING

DO NOT use your hands to check for hydraulic leakage. Use a piece of cardboard or paper to search for leaks. Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure.

8. After running the hydraulic system, bleed the air from the hydraulic system, refer to page 7-146. Check and fill the hydraulic reservoir with more new clean fluid.

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Tilt Cylinder (4500 lb. Reach)

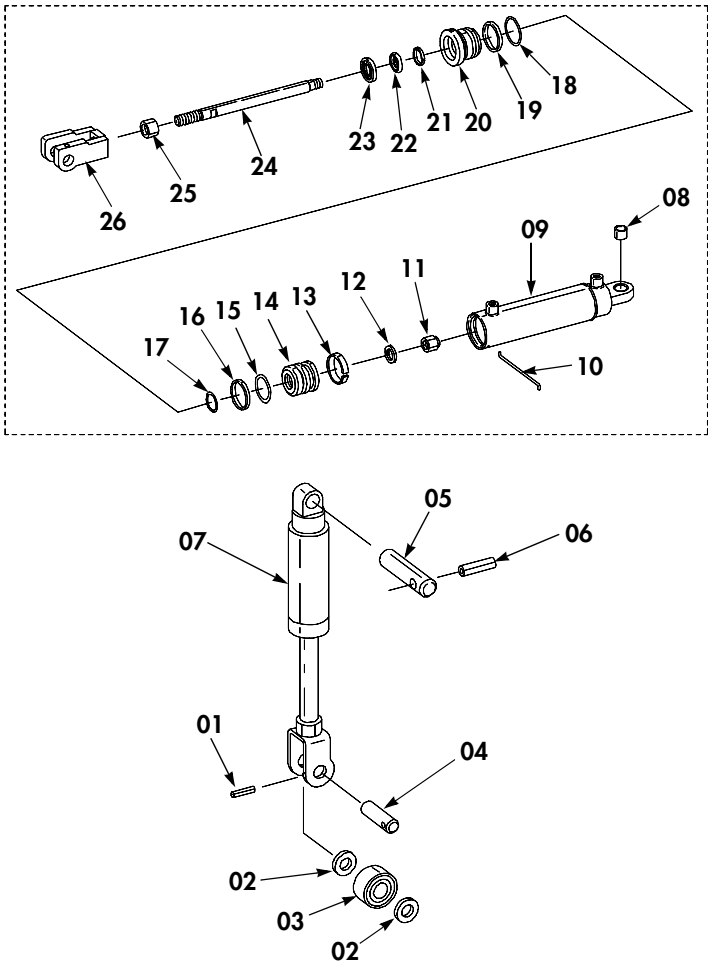


Figure 7-89: Tilt Cylinder (4500 lb. Reach)

POS. NO.	DESCRIPTION	POS. NO.	DESCRIPTION	POS. NO.	DESCRIPTION	POS. NO.	DESCRIPTION
01	Pin, roll	08	Bearing	15K	O ring	22K	Seal, rod
02	Washer	09	Tube, cylinder	16K	Ring, sealing	23K	Wiper, rod
03	Bearing	10	Retainer	17K	O ring	24	Rod, cylinder
04	Pin	11	Nut	18K	O ring	25	Nut
05	Pin	12	Washer, flat	19K	Ring, sealing	26	Clevis
06	Pin, roll	13K	Ring, guide	20	Bearing	K	Kit, seal
07	Cylinder Ass'y.	14	Piston	21K	Ring, guide		

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Removal

1. Park the lift truck on a level surface and apply the brake.
2. Raise the reach approx. 12 in. (305 mm). Block to prevent lowering.
3. Relieve the pressure on the tilt cylinder.
4. Pivot the reach carriage upward and block to prevent the reach carriage from lowering.
5. Remove the hydraulic hoses from the tilt cylinder and mark their position.
6. Remove the roll pin (06) and top mounting pin (05) and remove the tilt cylinder from the lift truck.
7. Repeat on other side of the lift truck as needed.

Disassembly

NOTE: Perform all procedures in a clean environment. Make sure all parts are cleaned before disassembly and kept clean during assembly.

1. Before disassembly, clean exterior of the tilt cylinder in a cleaning solvent to remove all contamination.

⚠WARNING

Be extremely careful when working with solvent. Even a small explosion or fire could cause injury or death.

2. Be sure all hydraulic fluid has been removed from the cylinder. Stroking the piston rod will help force the fluid out.
3. Put the base end of the cylinder in a vise equipped with soft jaws.
4. If needed, the roller bearing (03) at base of the cylinder rod can be removed at this time. Remove a roll pin (01) and slide a mounting pin (04) from the clevis (26).
5. Remove the gland retainer (10) and fastening ring (20) by rotating the gland with a spanner wrench from the cylinder tube (09).

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6. Remove the gland assembly, seals, rings, rod and piston, and piston seals.
7. Remove and discard all seals and rod wiper.
8. Inspect the mounting bushings (08) located at the base end of the cylinder tube (09). It will not be necessary to remove them unless they are found to be unfit for further service.

Inspection

1. Carefully clean all parts in a cleaning solvent and position them on a clean work surface.

⚠WARNING

Be extremely careful when working with solvent. Even a small explosion or fire could cause injury or death.

2. Check the piston rod (24) for damage. Look for gouges, scratches, corrosion or evidence of unusual wear. Minor surface damage can be repaired by use of fine abrasion cloth or stoning. Be extremely careful you do not remove the chrome plating. Deeper damage will require replacement of the piston rod assembly. Make sure the threads on the rod are free of damage.
3. Check the cylinder bore for any damage. Parts with deep gouges or pitted surfaces will require replacement.
4. Check the threaded section of the cylinder tube (09) to be sure the threads have not been damaged.

Assembly

1. Install the new packing and rod wiper in the gland assembly. The “lip” of the wiper must face outward.
2. Install the new gland seals, back-up ring and O-ring on the gland assembly
3. Install the new piston seals on the piston.
4. Install the piston on the rod (24).

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5. Install the nut (11) on the cylinder rod (24). Torque the cylinder piston nut to 40 ft. lb. (54 Nm).
6. Apply clean hydraulic fluid to the piston rod assembly. Coat the inside of the cylinder tube (9) and gland assembly with clean fluid.
7. Carefully slide the gland assembly onto the piston cylinder rod (24). Be sure the rod end does not cut or nick the wiper or packing upon installation.
8. Install the piston and rod into the cylinder tube (09). Be careful that the piston seals are not nicked or cut on the edge of the cylinder tube or when sliding them over the groove within the tube.
9. Next, install the gland assembly into the cylinder tube (09). Again, use care so the seals are not nicked or cut upon installation.
10. Check installation by making sure the piston rod assembly moves fairly easy within the tube assembly without binding.

    Install the gland bearing (20) and retainer (10).
11. The roller bearing and clevis assembly can be installed at this time if removed earlier.

Installation

1. Install the tilt cylinder on the reach carriage front frame. Secure with a mounting pin (05) and a roll pin (06).
2. Properly connect the correct hydraulic hoses to the top and bottom of the tilt cylinder.
3. Remove the blocking and chains.
4. Fill the hydraulic reservoir with new clean fluid.
5. Connect the battery connector.
6. Operate the tilt to remove the air from the hydraulic hoses. Check the operation of the entire hydraulic system.

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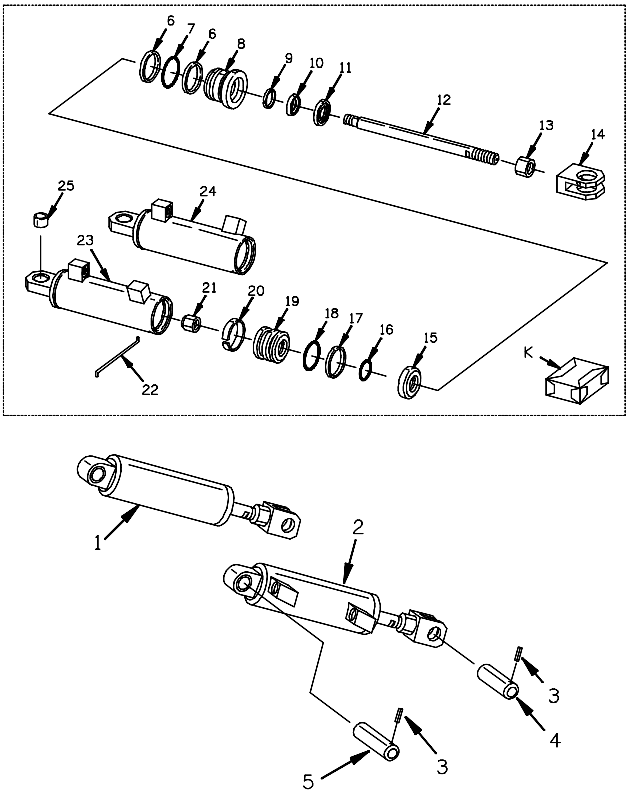
⚠WARNING

DO NOT use your hands to check for hydraulic leakage. Use a piece of cardboard or paper to search for leaks. Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure.

7. After running the hydraulic system, bleed the air from the system. Then check the hydraulic reservoir fluid level. Fill with new clean fluid if necessary.

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Reach Cylinder



Seal Kit Contains Items Marked with "K"

Figure 7-90: Reach Cylinder Components

POS. NO.	DESCRIPTION	POS. NO.	DESCRIPTION	POS. NO.	DESCRIPTION
1	Right reach cylinder	10K	Seal	19	Piston (See Note)
2	Left reach cylinder	11K	Wiper	20K	Ring, guide
3	Pin, roll	12	Rod, cylinder (See Note)	21	Nut, lock
4	Pin, clevis	13	Nut	22K	Retainer
5	Pin, clevis	14	Clevis (3500 lb. and Deep Reach shown)	23	Right tube cylinder
6K	Back-up ring (3500 lb. Reach only)	15	Spacer (3500 lb. and Deep Reach models)	24	Left tube cylinder
7K	O ring	16K	O Ring	25	Bearing
8	Bearing	17K	Ring, back-up	K	Kit, seal
9K	Ring, guide	18K	O Ring	Note: 3500 lb. Reach has a one piece piston and rod.	

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Removal

1. Park the lift truck on a level surface and apply the brake.
2. Extend the reach approx. 1/2 to 3/4 of the total reach.
3. Block and chain the reach mechanism to prevent movement of the reach mechanism.

⚠WARNING

Block reach to keep it from collapsing. Use extreme care when blocking the mast for any reason. Never remove the block when it is supporting the mast.

4. Relieve the pressure on the reach cylinders.
5. Disconnect the hydraulic hoses and plug to prevent contamination.

⚠WARNING

Because lifting and lowering the mast will be necessary to complete the following procedures, use extreme caution while working within the mast. Never lift or lower when your hands are near the mast.

6. Raise the reach carriage to full freelift. Remove the lock pins attaching the cylinders to the rear frame.
7. Lower the reach carriage to working height. Remove the cylinder tube mounting pins.
8. Repair the reach cylinders as needed.

Disassembly

NOTE: Perform all procedures in a clean environment. Make sure all parts are cleaned before disassembly and kept clean during assembly.

1. Before disassembly, clean the exterior of the reach cylinder in a cleaning solvent to remove all contamination.

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⚠WARNING

Be extremely careful when working with solvent. Even a small explosion or fire could cause injury or death.

⚠WARNING

Compressed air used for cleaning *must* be reduced to less than 30 psi (207 kPa), and then only with effective chip-guarding and personal protective equipment.

2. Be sure all hydraulic fluid has been removed from the cylinder. Stroking the piston rod will help force the fluid out.
3. Put the base end of the cylinder in a vise equipped with soft jaws.
4. Remove the bearing retainer (22) and bearing (8) by rotating the bearing with a spanner wrench from the cylinder tube (23 or 24).
5. Remove the bearing assembly, seals, rings, rod (12) and piston (19) with spacer, and piston seals.
6. Remove and discard all the seals and rod wiper (11).
7. Inspect the mounting bushings (25) located at base end of the cylinders. It will not be necessary to remove them unless they are found to be unfit for further service.

Inspection

1. Carefully clean all parts in a cleaning solvent and position them on a clean work surface.

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⚠WARNING

Be extremely careful when working with solvent. Even a small explosion or fire could cause injury or death.

⚠WARNING

Compressed air used for cleaning *must* be reduced to less than 30 psi (207 kPa), and then only with effective chip-guarding and personal protective equipment.

2. Check the piston rod for damage. Look for gouges, scratches, corrosion, or evidence of unusual wear. Minor surface damage can be repaired by the use of fine abrasion cloth or stoning. Be extremely careful you do not remove the chrome plating. Deeper damage will require replacement of the piston rod assembly. Make sure the threads on the rod are free of damage.
3. Check the cylinder bore for any damage. Parts with deep gouges or pitted surfaces will require replacement.
4. Check the threaded section of the cylinder tube to be sure the threads have not been damaged.

Assembly

1. Install the new O-Rings and rod wiper in the bearing assembly. The “lip” of the wiper must face outward.
2. Install the new bearing seals, back-up ring (17), and bearing (8) on the bearing assembly.
3. Install the new piston seals on the piston (19).
4. Install the piston (19) on the rod.
5. Install the nut (21) on the cylinder rod (12). Torque the reach cylinder piston nut to 40 ft. lb. (54 Nm).
6. Apply clean hydraulic fluid to the piston rod assembly. Coat the inside of the cylinder tube and bearing assembly with clean fluid.

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7. Carefully slide the spacer (if used) and bearing assembly onto the cylinder rod. Be sure the rod end does not cut or nick the wiper or packing upon installation.
8. Install the piston (19) and cylinder rod (12) into cylinder tube (23 or 24). Be careful that the piston seals are not nicked or cut on the edge of the cylinder tube or when sliding them over the groove within the tube.
9. Next, install the bearing assembly into the cylinder tube. Again, use care so the seals are not nicked or cut upon installation.
10. Check the installation by making sure the piston rod assembly moves smoothly within the tube assembly without binding.
11. Install the bearing (8) and retainer (22).

Installation

1. Install the new bearing, rollers, and pins as needed.
2. Raise the reach carriage to full free lift height to install the reach cylinder and the front and rear mounting pins. Secure the mounting pins with roll pins.
3. Install the locking pins.
4. Connect the correct hydraulic hoses to the reach cylinders.
5. Remove the blocking and chains.
6. Fill the hydraulic reservoir with new clean fluid.
7. Connect the battery connector.
8. Operate the reach to remove the air from hydraulic hoses. Bleed the hydraulic system, then check the operation of the entire hydraulic system.

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⚠ CAUTION

DO NOT use your hands to check for hydraulic leakage. Use a piece of cardboard or paper to search for leaks. Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure.

9. After running the hydraulic system, check the reservoir fluid level. Fill the hydraulic reservoir with clean fluid.

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Lift/Auxiliary Pressure Relief

The lift/auxiliary pressure relief adjusting screw is located on the top of the main control valve, near solenoid Y10. The relief pressure test port is on the side of the control valve, to the right of the hydraulic lines to the reservoir and pump.

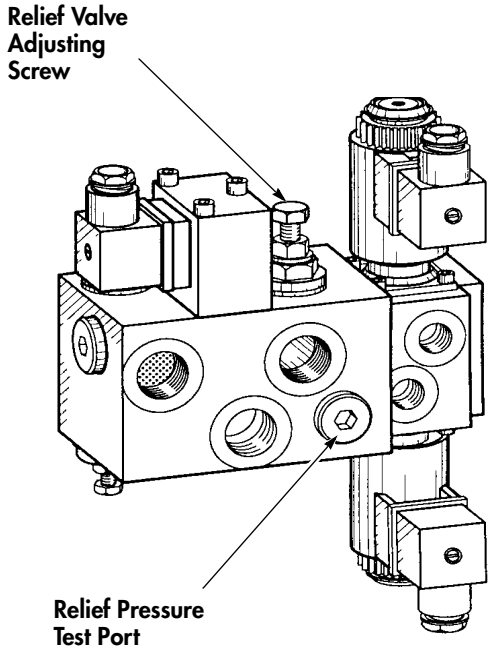


Figure 7-91: Lift/Aux. Relief Pressure Adjustment

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Velocity Fuses

Two velocity fuses (flow controls) are used on the Toyota Reach lift truck: staging and freelift.

Staging Velocity Fuse

The staging velocity fuse connects the main hydraulic hose to the bottom of the right staging cylinder.

Models	Flow Rating
7BRU23, 7BDRU15, 7BSU25	10 GPM
7BRU18, 7BSU20	8 GPM

Freelift Velocity Fuse

The freelift velocity fuse connects the hydraulic hose to the bottom of the freelift cylinder.

Models	Flow Rating
7BRU23, 7BDRU15, 7BSU25	19 GPM
7BRU18, 7BSU20	13 GPM

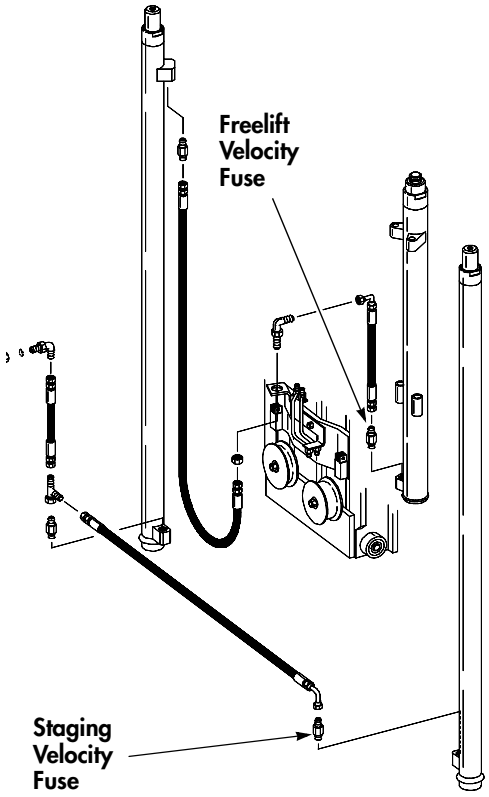


Figure 7-92: Flow Controls (Velocity Fuses)

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Mast

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Main Mast Assembly

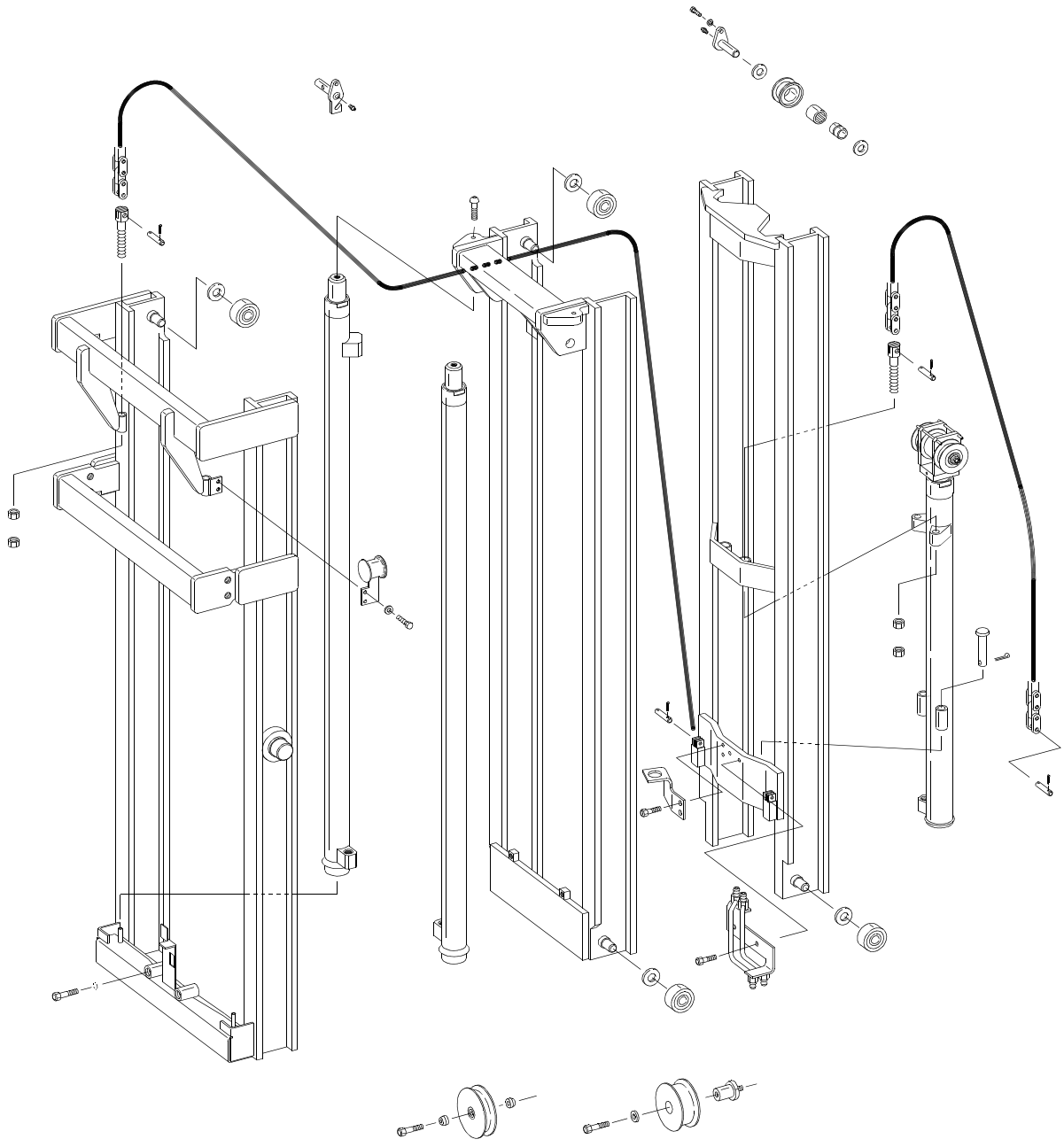


Figure 7-93: Main Mast Assembly Components

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Removal

⚠WARNING

Mast replacement should be done ONLY by authorized service personnel in a suitably equipped service shop environment. Replacement of the mast assembly requires the use of a hoist or crane capable of safely lifting 10,000 lbs.

⚠WARNING

Always make sure the lift truck is on a level surface before work can begin.

1. Remove the mast guard. See “Mast Guard” on page 7-224.
2. Remove the reach carriage assembly. See “Reach Carriage Assembly” on page 7-200.
3. Turn the key switch OFF and disconnect the battery connector.
4. Remove the battery from the lift truck to allow access to the mast mounting bolts.
5. Disconnect the lift hydraulic supply line. Be sure not to lose the O-ring in the fitting when the hose is removed. (This is accessed through a hole located in the lower left corner of battery compartment.) Cap the hose to prevent contamination and spillage.
6. Use a 13/16 in. wrench to disconnect the two hydraulic supply lines located to the right of the upper electrical compartment fan. Cap the hoses to prevent contamination and spillage.
7. Disconnect the electric wiring harness at the 10 pin connector located near the lift power amplifier. Push the connector out through the cutout in the front of the tractor frame.
8. If the lift truck is equipped with a light and or fan package, disconnect the harness located at base of the rear guard post.
9. Connect a hoist to the top tie bars of the mast. Lift to remove all slack in the hoist chains.

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10. Remove the two mast bolts located in the middle of the battery box. Use a 30 mm socket to remove the two bolts at the bottom of the mast. These are accessed through the battery compartment. See Figure 7-94.
11. Use a 10 mm Allen wrench to remove the Allen head bolts securing the mounting plates at the pivot points on the mast. See Figure 7-94.
12. With all the electrical and hydraulic connections disconnected, use the hoist to lift the mast enough to clear the chassis.
13. Lower the mast to lay it on the floor.

Installation

1. Lift the mast with the hoist. With the mast close to the tractor, reconnect the main supply hose to the lift cylinders.
2. Align the mast bushings and lower the mast into the supports.

NOTE: Be sure the lift supply hose stays centered and the wiring harness stays in front to prevent pinching behind the cylinders.

3. Leave some tension on the hoist to prevent the bottom of the mast from tilting out. (If the mast tilts out at the base, the bolts will not install correctly). Install the 30 mm bolts from the battery compartment side.
4. Place the mast plates in position and secure them with the 10 mm Allen head bolts. Torque bolts to 70 ft. lbs. (95 Nm).
5. Connect the hydraulic supply hoses.
6. Slide the cable assembly connector through the cutout in the tractor frame. Reconnect the cable at the 10 pin connector.
7. Adjust the lift chains.

   Main Lift: Loosen the jam nut and tighten the chains equally until the top of the telescopics are level in the fully lowered position. Retighten the jam nut and torque to 200 ft. lbs. (271 Nm).

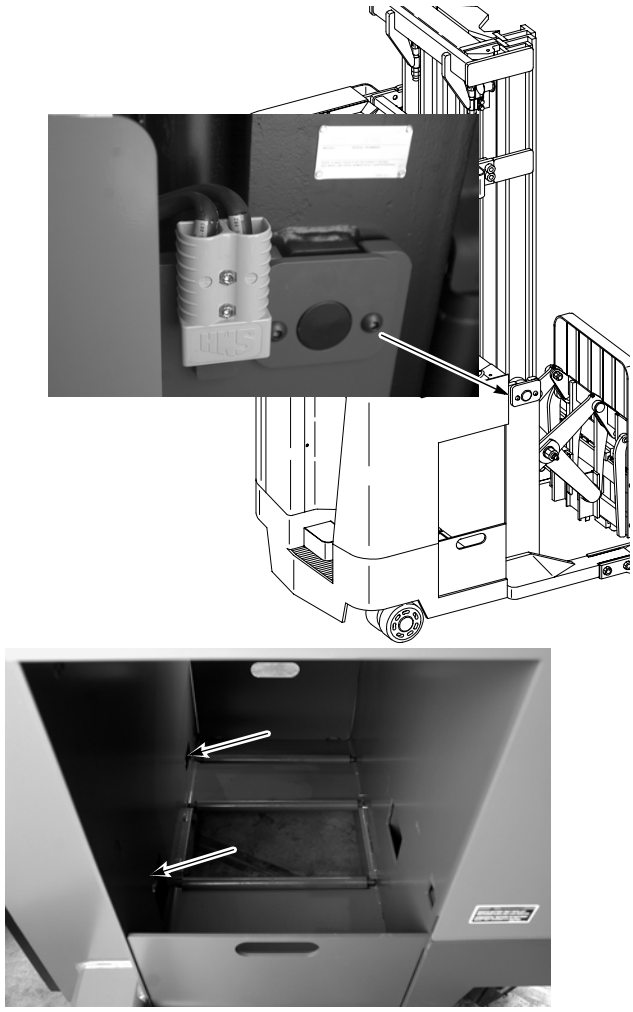


Figure 7-94: Mast Mounting Bolt Locations

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Freelift: Carriage chains should be adjusted in the fully lowered position. Adjust chains until the heel of the forks are 1/2 in. (12.7 mm) off of the floor.

8. Grease all chain sheaves.
9. Install the reach carriage assembly.
10. Install the mast guard.
11. Install and connect the battery.
12. Add hydraulic fluid and bleed the air from the system.
13. Test the operation of the mast and the lift truck.

Disassembly

1. Remove the mast from the lift truck and lower it to a horizontal position before work can begin.
2. Remove the lift chain anchors, lift chain, attachment hydraulic hoses and electrical cable from the mast.
3. Remove the freelift chain anchor and two cotter pins and the two cylinder anchor pins from the inner telescopic. Remove the freelift cylinder assembly by pulling straight up.

NOTE: The freelift cylinder can be repaired at this time, if needed.

4. Remove the chain sheaves and cable sheaves from all telescopics.
5. Remove the telescopic stops from the outer telescopic.
6. Pull the inner telescopic straight forward until it stops (hits the bearings) and then 90° straight up from the outer telescopic.
7. Remove the cap screws from the top of the outer telescopic. Remove the staging cylinder assemblies by pushing the outer telescopic forward.

NOTE: The staging cylinders can be repaired at this time, if needed.

8. Pull the outer telescopic straight forward until it stops (hits the bearings) and then pull 90° straight up from the mast main frame.

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9. Remove the mast bearings and shim washers from all telescopics.
10. Thoroughly clean all parts.

Assembly

1. Thoroughly clean all parts and air dry.

⚠WARNING

Be extremely careful when working with solvent. Even a small explosion or fire could cause injury or death.





⚠WARNING

Compressed air used for cleaning *must* be reduced to less than 30 psi (207 kPa), and then only with effective chip-guarding and personal protective equipment.



2. Install the mast roller bearings on both the mast main frame and outer telescopics.
3. Assemble outer telescopic in the mast main frame. Slide together.
4. Determine the amount of shims required. Pry the outer telescopic to one side. Slip shims between the bearing and web on the mast. Add shims by hand until no more can be added.
5. Divide the shims as equally as possible between the two bearings. Install the shims under the bearings.
6. Extend the outer telescopic through the mast main frame as far as it will go under normal operation. Check the bearing shimming as the telescopic is extended. Remove shims as required, if tight spots are encountered where an assembler cannot roll the mast by hand.

   Check for excessive clearance with the telescopics in the fully *closed* position. Pry the telescopic to one side and check with a 0.030 in. shim. Maximum clearance must not exceed 0.030 in.

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Check for excessive bearing clearance with the telescopics in the fully *extended* position. Pry the telescopic to one side and check with a 0.030 in. shim. Maximum clearance must not exceed 0.030 in.

7. Assemble the inner telescopic in the outer telescopic. Slide together.
8. Determine the amount of shims required. Pry the inner telescopic to one side. Slip shims between the bearing and the web on the outer telescopic. Add shims by hand until no more can be added.
9. Divide the shims as equally as possible between the two bearings. Install the shims under the bearings.
10. Extend the inner telescopic through the outer telescopic as far as it will go under normal operation. Check the bearing shimming as the telescopic is extended. Remove shims as required, if tight spots are encountered where an assembler cannot roll the mast by hand.

    Check for excessive clearance with the telescopics in the fully *closed* position. Pry the telescopic to one side and check with a 0.060 in. shim. Maximum clearance must not exceed 0.060 in.

    Check for excessive bearing clearance with telescopics in the fully *extended* position. Pry the telescopic to one side and check with a 0.030 in. shim. Maximum clearance must not exceed 0.030 in.
11. Install the stops in the mast main frame. Torque to 260 ft. lbs. (350 Nm).
12. Install the staging lift cylinder assembly in the main mast frame lower end.
13. Press the roller bearings in the lift chain sheaves. Grease the roller bearings. Slide the inner races into the roller bearings.
14. Install shim washers on either side of the lift chain sheaves. Install sheaves into the outer telescopic. Slide the pins through the sheaves. Secure the pins with two (2) cap screws and lock washers. Do this to both chain sheave pins.
15. Install the bearing in the electrical sheave, grease the bearing, and install spacers on either side.

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16. Install the electrical sheave in the proper location on the outer telescopic. Secure with one cap screw and lock washer.
17. Push the outer telescopic and mast main frames together. Install a cap screw in the outer telescopic to secure the top of the staging lift cylinder.
18. Install the lift chain anchors through the mast main frame. Thread the wheel nut on the anchors and secure with a jam nut.
19. Install the lift chain on the chain anchors and secure with chain pins. After the chain pins have been installed, run the lift chain over the chain sheaves. Make sure the chain and sheaves are properly aligned.
20. Install the freelift cylinder assembly on the inner telescopic. Secure with four cap screws and nuts.
21. Connect the hydraulic lines to the lift cylinders.
22. Lubricate the grease fittings with Tex. Ref. C & C No. 880 using a standard lube gun.

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Mast Roller Bearings

Mast roller bearings are located at the top of the main frame, at the top and bottom of the outer telescopic, and at the bottom of the inner telescopic.

General

Over time, the mast roller bearings may require shimming to reduce rattles which may occur as the lift truck travels over floor irregularities. Past experience shows that shimming the two upper bearings, one on the outer telescopic and one on the mast main frame, will usually reduce rattles to an acceptable level.

To adjust the lower roller bearings, you must remove the mast assembly from the tractor, rotate the mast so that it is horizontal and pull out the telescopics sufficiently to get access to the bearings. It is recommended that mast removal only be done by an authorized service technician at a service shop.

Rattles may be coming from some other component, such as forks or fork bars.

The upper bearing on the main mast is accessible with the mast fully lowered.

Shimming

To stop rattles, add additional shims under the bearing or replace an existing shim with a thicker shim. Shim the roller bearing so there is minimal play between the telescopics.

The shims used under each roller bearing come in the following sizes: thin, medium, and thick. The factory typically starts with a thick shim on each side. If the shims are too loose and there is a rattle, you should add shims to the bearing. If the roller bearings are shimmed too tight and are causing wear along the I-beam, or mast shaving, reduce the shim thickness. Although different combinations of shims may be used to obtain the proper adjustment, you should try to maintain equal shim thickness on each side of the mast.

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⚠WARNING

Use extreme care when blocking the mast for any reason. Never remove the block when it is supporting the mast.

1. Slightly lift the mast of the lift truck to gain access to the upper bearings.
2. Block the mast into position before you attempt to adjust the roller bearing.

   You may also use a lift hoist to pull the mast upward to get access to the roller bearing. Put a strap suitable to handle the weight of the mast around the uppermost cross tie. Once the mast is raised in place, block it into position.
3. Turn the key switch OFF and disconnect the battery connector.

⚠ CAUTION

Take care not to damage the telescopic when prying with the screwdriver.

4. Wedge a screw driver between the roller bearing and the mast to prevent it from falling.

NOTE: When removing the roller bearing, use caution not to let the bearing fall down into the mast assembly. If a roller bearing falls into the mast, the only way to retrieve it is to remove the mast assembly from the tractor and fully separate the telescopics.

5. Remove the bolt securing the roller bearing to the respective mast or telescopic.

NOTE: If the bearings are worn or damaged, replace them.

6. Add required shims equally on either side. Maximum total lateral movement between the telescopics is 0.030 in. This may be a trial and error method.
7. Be sure that the roller bearing mounting screws are clean before you install them.
8. Use thread locking compound on the screws.

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9. Torque the countersunk screw on the outer telescopic to 170 ft. lbs. (230 Nm).
10. Torque the 1 1/8 in. hex head screw on the main mast to 170 ft. lbs. (230 Nm).
11. Reconnect the battery connector and turn the key switch ON.
12. Lift the carriage mast and unblock the lift truck.
13. Test the operation of the telescopics.
14. Return the lift truck to service.

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Lift Chains

There are two types of lift chains on the Toyota Reach lift truck. The main lift chains raise and lower the telescopics. The freelift chains raise and lower the reach carriage assembly.

Check the lift chains monthly. Most unsatisfactory chain performance can be traced directly to inadequate chain maintenance. Remove the chain and inspect its condition using the supplied chart and the procedures.

Main Lift Chain Adjustment

1. Remove the mast guard. See “Mast Guard” on page 7-224.
2. Adjust the lift chains by turning the nut on the lift chain anchor on the mast main frame assembly. Turn the nut clockwise to tighten the chain and counterclockwise to loosen the chain.
3. Keeping equal tension on chains, adjust the chain anchor nuts so the inner and outer telescopics are flush at the bottom of the mast.
4. When height adjustment is complete, torque the jam nut to 200 ft. lbs. (271 Nm).
5. Liberally apply oil to each chain using a narrow paint brush. See “Lubrication Equivalency Chart” on page A-2.
6. Re-install the mast guard.
7. Test operation.

Freelift Chain Adjustment

1. Remove the mast guard. See “Mast Guard” on page 7-224.
2. Adjust the lift chains by turning the nut on the lift chain anchor on the inner telescopic. Turn the nut clockwise to tighten the chain and counterclockwise to loosen the chain.
3. Retract the reach mechanism fully.
4. Carriage may be resting on the floor with slack in chains.

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5. Keeping equal tension on chains, adjust the chain anchor nuts so the carriage is slightly off the floor.
6. If the lift truck is equipped with tilt, use the tilt button to tilt the forks so they are parallel with the floor.
7. With the reach mechanism retracted, forks level with floor and key switch OFF, adjust anchor nuts equally until the bottom of the reach carriage is 3/4 in. (19 mm) up from the bottom of the inner telescopic when in the fully lowered position. The heel of the forks will be 1/2 in. (12.7 mm) off of the floor.
8. Liberally apply oil to each chain using a narrow paint brush. See “Lubrication Equivalency Chart” on page A-2.
9. Re-install the mast guard.
10. Test operation.

Condition-Cause Chart

Condition	Cause	Maintenance Procedure
Chain Elongation	Wear	Lay the chain on a flat surface and push it together. Measure and mark a 12 in. length that has operated over the pulley sheave. Stretch the chain; if more than 1/3 in. play is detected, replace the chain.
Rust and corrosion	Steam cleaning or degreasing new lift truck chains.	Oil chain frequently. Refer to Scheduled Maintenance.
Cracked Plates	Infrequent Oiling	Replace the chain.
	Rust	
	Corrosion	
	Chain Fatigue	
Tight Joints	Bent pins or plates	If the joints fail to loosen, replace the chain.
	Rusty joints or peened plate edges	If the joints fail to loosen, replace the chain.
Chain side wear	Chain misalignment	Realign the chain on the pulleys.

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Lubrication

⚠ CAUTION

Do not steam clean or degrease lift chains.

1. Apply oil to the chain using a narrow paint brush. See “Lubrication Equivalency Chart” on page A-2.
2. Make sure the exterior surface is covered to prevent rust and to make sure that the oil penetrates the chain joints to reduce wear.

Freelift Chain Removal

⚠WARNING

Use extreme care whenever the lift truck is jacked up. Never block the lift truck between the mast telescopic and the floor. Keep hands and feet clear from vehicle while jacking the lift truck. After the lift truck is jacked, place solid blocks beneath it to support it. DO NOT rely on the jack alone to support the lift truck. For details, see “Jacking Safety” on page 2-13.

⚠WARNING

Use extreme care when blocking the mast for any reason. Never remove the block when it is supporting the mast.

NOTE: Both chains should be replaced when either is defective.

1. Extend the reach.
2. Break the jam nuts loose before removing the tension on the lift chains. (Measure the exposed area at the bottom of the lift chain anchor. This measurement will be used in the reassembly process to tighten the jam nuts to the approximate adjustment before adding tension to the chain.)
3. Use a jack or 5-ton capacity overhead hoist to raise the carriage enough to slacken the lift chains.

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4. Secure the carriage with blocks to prevent the carriage from lowering.
5. Turn the key switch OFF and disconnect the battery connector.
6. Remove the chain and chain anchors by removing the cotter pin and chain pin at the carriage and the chain anchor and chain anchor nuts on the inner telescopic.
7. Separate the chain from the remaining chain anchor by removing the cotter pin and chain pin.
8. Thoroughly clean the chain in solvent.
9. Inspect the chain for defects. See “Condition-Cause Chart” on page 7-187.

Freelift Chain Installation

NOTE: Both chains should be replaced when either is defective. If chain anchors (on the inner telescopic) need to be replaced, follow instructions on page 7-194.

1. On a work bench or floor, attach the adjustable chain anchor to one end of the chain using the chain pin.
2. Install cotter pins (for each anchor) through both pins and bend to secure.
3. With carriage lowered and reach extended, key switch OFF and battery connector disconnected, insert the chain anchor (with chain attached) over the sheave and into the chain anchor block on the inner telescopic.
4. Thread on the locknut by hand to hold the chain in place.
5. Insert the opposite end of the chain between the reach carriage and the lift cylinder. The end of the chain should be near the reach carriage chain anchor mount.
6. Fasten the chain to the anchor with a chain pin and secure with a cotter pin.
7. Repeat steps 1-6 for the other side.
8. Holding the chain anchor with locking pliers, tighten the chain anchor nuts until 1 in. (25 mm) of thread is visible below the nut.

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9. Reconnect the battery connector and turn the key switch ON.
10. Slowly raise the carriage, using the lift button, until the carriage is raised off the blocking.
11. Remove blocking and slowly lower carriage fully.
12. Retract the reach mechanism fully.
13. Carriage may be resting on the floor with slack in chains.
14. Keeping equal tension on chains, adjust the chain anchor nuts so the carriage is slightly off the floor.
15. If the lift truck is equipped with tilt, use the tilt button to tilt the forks so they are parallel with the floor.
16. With the reach mechanism retracted, forks level with floor and key switch OFF, adjust anchor nuts equally until forks are 1/2 in. (13 mm) off the floor, when measured at fork bend.
17. Liberally apply oil to each chain using a narrow paint brush. See “Lubrication Equivalency Chart” on page A-2.
18. Re-install the mast guard.
19. Test operation.

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Staging Chain Removal

⚠WARNING

Use extreme care whenever the lift truck is jacked up. Never block the lift truck between the mast telescopic and the floor. Keep hands and feet clear from vehicle while jacking the lift truck. After the lift truck is jacked, place solid blocks beneath it to support it. DO NOT rely on the jack alone to support the lift truck. For details, see "Jacking Safety" on page 2-13.

⚠WARNING

Use extreme care when blocking the mast for any reason. Never remove the block when it is supporting the mast.

NOTE: Both chains should be replaced when either is not in proper condition.

1. Break the jam nuts loose before removing the tension on the lift chains. (Measure the exposed area at the bottom of the lift chain anchor. This measurement will be used in the reassembly process to tighten the jam nuts to the approximate adjustment before adding tension to the chain.)
2. Use a jack or 10-ton capacity overhead hoist to raise the telescopics enough to slacken the lift chains.
3. Secure the telescopics with blocks to prevent the carriage from lowering.
4. Turn the key switch OFF and disconnect the battery connector.
5. Remove the chain and chain anchors by removing the cotter pin and chain pin at the inner telescopic and the chain anchor and chain anchor nuts on the mast main frame.
6. Separate the chain from the remaining chain anchor by removing the cotter pin and chain pin.
7. Thoroughly clean the chain in solvent.

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8. Inspect the chain for defects. See “Condition-Cause Chart” on page 7-187.

Staging Chain Installation

NOTE: Both chains should be replaced when either is not in proper condition. If chain anchors (on the reach carriage) need to be replaced, follow instructions on page 7-194.

1. On a work bench or floor, attach the adjustable chain anchor to one end of the chain using the chain pin.
2. Install cotter pins (for each anchor) through both pins and bend to secure.
3. With carriage lowered and reach extended, key switch OFF and battery connector disconnected, insert the chain anchor (with chain attached) over the sheave and into the chain anchor block on the mast main frame.
4. Thread on the locknut by hand to hold the chain in place.
5. Insert the opposite end of the chain between the reach carriage and the lift cylinder. The end of the chain should be near the inner telescopic chain anchor mount.
6. Fasten the chain to the anchor with a chain pin and secure with a cotter pin.
7. Repeat steps 1-6 for the other side.
8. Holding the chain anchor with locking pliers, tighten the chain anchor nuts until 1 in. (25 mm) of thread is visible below the nut.
9. Reconnect the battery connector and turn the key switch ON.
10. Slowly raise the telescopics, using the lift button, until the telescopics are raised off the blocking.
11. Remove the blocking and fully lower the telescopics.
12. Retract the reach mechanism fully.
13. Carriage may be resting on the floor with slack in chains.

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14. Keeping equal tension on chains, adjust the chain anchor nuts so the carriage is slightly off the floor.
15. If the lift truck is equipped with tilt, use the tilt button to tilt the forks so they are parallel with the floor.
16. With the reach mechanism retracted, forks level with floor and key switch OFF, adjust anchor nuts equally until bottoms of telescopics align.
17. Liberally apply oil to each chain using a narrow paint brush. See “Lubrication Equivalency Chart” on page A-2.
18. Re-install the mast guard.
19. Test operation.

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Freelift Chain Anchors

Upper (Adjustable) Chain Anchor

The freelift chain adjustable chain anchor is attached to the cylinder and crossbar of the inner telescopic. The lower chain anchor is part of the reach carriage frame assembly and cannot be replaced.



Figure 7-95: Freelift Chain Adjustment

Removal

1. Remove the mast guard. See “Mast Guard” on page 7-224.
2. Break the jam nuts loose before removing the tension on the lift chains. (Measure the exposed area at the bottom of the lift chain anchor. This measurement will be used in the reassembly process to tighten the jam nuts to the approximate adjustment before adding tension to the chain.)
3. Lift the carriage approx. 6 in. (150 mm).
4. Place a block (4 in. x 4 in.) under the lower chain anchor mounting plate at the bottom of the reach carriage frame.
5. Lower the reach carriage onto the block to remove tension from the chains.
6. Turn the key switch OFF and disconnect the battery connector.
7. Remove the jam nut and locking nut from the chain anchor.
8. Remove the cotter pin and chain pin. The chain is now disconnected from the anchor.

Installation

1. Insert the new anchor in the anchor block and thread on the adjusting nut to the distance recorded earlier.
2. Pull the chain into position and install the chain pin with a cotter pin to secure.
3. Reconnect the battery connector. Turn the key switch ON.

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4. Slowly lift the carriage (using the lift button), removing slack from the chains and lifting the carriage off the 4 in. x 4 in. blocking.
5. Remove the blocking and lower the carriage fully.
6. If the lift truck is equipped with tilt, use the tilt button to tilt forks so they are parallel to the floor.
7. With the reach mechanism retracted, carriage lowered and level, and key switch OFF, adjust the anchor nuts equally until the forks are 1/2 in. (13 mm) off the floor when measured at the fork bend.
8. Re-install the mast guard.
9. Test operation.

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Staging Chain Anchors

Upper (Adjustable) Chain Anchor

The staging chain adjustable chain anchor is attached near the top of the mast main frame. The lower chain anchor is part of the inner telescopic and cannot be replaced.

Removal

1. Remove the mast guard. See “Mast Guard” on page 7-224.
2. Break the jam nuts loose before removing the tension on the lift chains. (Measure the exposed area at the bottom of the lift chain anchor. This measurement will be used in the reassembly process to tighten the jam nuts to the approximate adjustment before adding tension to the chain.)
3. Lift the inner telescopics approx. 6 in. (150 mm).
4. Place a block (4 in. x 4 in.) under the inner telescopic. Lower the inner telescopic onto the block to remove tension from the chains.
5. Turn the key switch OFF and disconnect the battery connector.
6. Remove the jam nut and locking nut from the chain anchor.
7. Remove the cotter pin and chain pin. The chain is now disconnected from the anchor.

Installation

1. Insert the new anchor in the anchor block and thread on the adjusting nut to the distance recorded earlier.
2. Pull the chain into position and install the chain pin with a cotter pin to secure.
3. Reconnect the battery connector. Turn the key switch ON.
4. Slowly lift the carriage (using the lift button), removing slack from the chains and lifting the inner telescopics off the 4 in. x 4 in. blocking.

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5. Remove the blocking and lower the mast fully.
6. If the lift truck is equipped with tilt, use the tilt button to tilt forks so they are parallel to the floor.
7. With the reach mechanism retracted, carriage lowered and level, and key switch OFF, adjust the anchor nuts equally until the tops of the telescopics are aligned.
8. Re-install the mast guard.
9. Test operation.

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Over the Mast Hose/Cable

The Toyota lift truck is equipped with two over the mast hydraulic hoses and one over the mast electrical cable.

Adjustment

⚠WARNING

Use extreme care when blocking the mast for any reason. Never remove the block when it is supporting the mast.

NOTE: After adjustments are completed, reinstall the mast guard.

Removal

1. Remove the mast guard. See “Mast Guard” on page 7-224.
2. Disconnect the hose/cable to be replaced in the power section.
3. Plug the open fittings to prevent contamination from entering the hydraulic system. Plug the open ends of the hose to prevent residual fluid from draining out on the lift truck or floor.
4. Remove the old hose/cable.

Installation

1. Open the plugged fittings, reconnect, and reroute the new hose.
2. Adjust hose/cable tension as described on page 7-198.
3. Remove the 4 in. x 4 in. blocking from the reach mechanism.
4. Reconnect the battery connector and test the auxiliary functions. Check for leaks.
5. Unclamp the support, elevate the mast enough to remove the support. Lower the mast completely. Recheck hose tensioner spring adjustment.

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6. Check hydraulic fluid level and refill reservoir as needed.
7. Cycle auxiliary functions (reach/retract, tilt, sideshift) several times to purge air from the hydraulic system.
8. Check hydraulic fluid level and refill reservoir as needed.
9. Reinstall mast guard.

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Reach Carriage Assembly

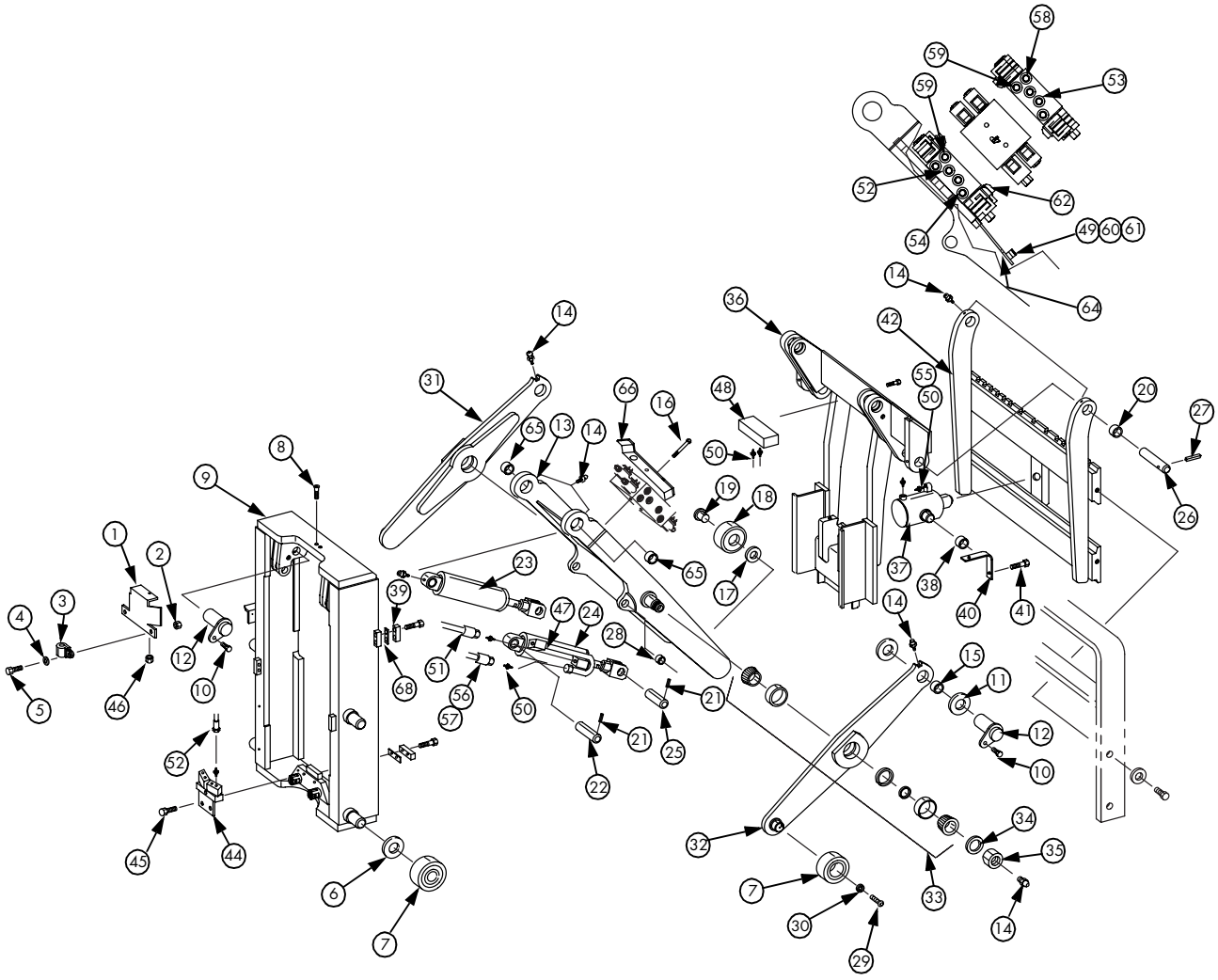


Figure 7-96: Reach Carriage Assembly Components (3500 lb. Reach Illustrated)

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POS. NO.	DESCRIPTION	POS. NO.	DESCRIPTION	POS. NO.	DESCRIPTION
1	Bracket, hose	24	Cylinder assembly	47	Line assembly
2	Nut	25	Pin, clevis	48	Manifold
3	Clamp	26	Pin, tilt frame	49	
4	Washer	27	Pin, spring	50	Fitting, straight
5	Screw	28	Bushing	51	Hose, straight
6	Washer	29	Screw	52	Tube assembly
7	Bearing	30	Cap	53	Tube assembly
8	Screw	31	Arm weldment	54	Tube assembly
9	Weldment, rear frame	32	Arm weldment	55	Hose assembly
10	Screw	33	Bearing assembly	56	Hose assembly
11	Washer	34	Washer	57	Hose assembly
12	Shaft, pivot	35	Nut	58	Adapter, fitting
13	Weldment, inner arm	36	Frame assembly, front	59	Adapter, fitting
14	Fitting, grease	37	Cylinder assembly	60	Clamp
15	Bushing	38	Bushing	61	Cover plate
16	Screw	39	Bumper	62	Strap
17	Washer	40	Retainer, cylinder	63	Screw
18	Bearing	41	Screw	64	Screw
19	Plug, wear	42	Fork bar	65	Bushing
20	Bushing	43		66	Valve cover
21	Pin, spring	44	Manifold weldment	67	Sleeve
22	Pin, clevis	45	Screw	68	Shim
23	Cylinder assembly	46	Nut		

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Maintenance

The only maintenance required on the reach mechanism is the normal Preventive Maintenance per the schedule.

⚠WARNING

When blocking mast telescopics to prevent lowering, always block both sides of the telescopic. If not, the lift truck could tip over on its side.

Shimming the Reach Carriage

1. Disconnect the battery and remove the battery from lift truck.
2. Attach a hoist to the top of the reach carriage and hoist to loosen the lift chains. Read and follow the correct operating procedures for your jack or hoist. This will allow removal of lift chain anchor pins, and electrical cable.
3. Thoroughly clean off all outside dirt around the mast roller bearings.
4. Determine the amount of shims required by prying the rear of the reach carriage to one side and slipping shims between the bearings and the web on the telescopic. Add shims by hand until no more can be added.
5. Divide shims as equally as possible between the two bearings and install under bearings.
6. Hydraulically lift up the inner telescopic enough to remove the reach carriage.
7. Lower the reach carriage out through the bottom of the inner telescopic to expose the bearings. Remove the bearings to install the shims behind the bearings.

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8. Raise the reach carriage through the inner telescopic as far as it will go under normal operation. Check bearing shimming as the reach carriage is raised. Remove shims as required, if tight spots are encountered where assembler cannot move reach carriage smoothly. Check for excessive bearing clearance with the reach carriage in *fully lowered* position by prying the reach carriage to one side and checking with a 0.030 in. (0.79 mm) shim. Maximum clearance must not exceed 0.030 in. (0.79 mm). Check for excessive bearing clearance with the reach carriage in the *fully raised* position by prying the reach carriage to one side and checking with a 0.030 in. (0.79 mm) shim. Maximum clearance must not exceed 0.030 in. (0.79 mm).
9. Lower the reach carriage to install the lift chain anchor pins, and electrical cable. When installing the lift chains, chains are to be free of twists and adjusted for equal tension with adjusting nuts (wheel nuts) and locknuts (jam nuts) torqued to 200 ft. lbs. (271 Nm). Chains are to be centered on the chain sheaves within 1/32 in. (0.8 mm).
10. Remove the hoist from the reach carriage. Test the operation of the lift truck. Check operation first with no load, then with a capacity rated load.

Repair (with reach carriage still in the mast)

NOTE: The reach can be repaired without removing it from the mast.

1. Remove the forks.
2. Remove the load backrest.
3. Raise and block the reach at a height for easy repair.
4. Extend the reach approx. halfway and block so it will not retract.
5. Turn the key switch OFF, and disconnect the battery connector.

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Front Frame (3500 lb. Reach)

Removal

1. Disconnect the hydraulic hoses from the tilt and sideshift cylinders and plug to prevent contamination.
2. Remove the screw (10) and washer (11) at the front frame (36).
3. Pivot shaft (12) can be driven to the outside by hitting with a soft hammer.
4. Remove the front frame (36) from the inner arm (13) rollers (18).

Installation

1. Install the front frame (36) onto the inner arm (13) rollers (18).
2. Install the washer (11) and pivot shaft (12) in the bushing in the outer arm.
3. Add the washer (11) and screw (10).
4. Reconnect all hoses to the tilt and sideshift cylinders.

Front Frame (4500 lb. Reach)

Removal

1. Disconnect hydraulic hoses from the tilt and sideshift cylinders and plug to prevent contamination. (Tilt and sideshift hoses are 11/16 in. Large tee on top is 13/16 in. - this is a feed hose from tilt cylinder to tilt cylinder.)
2. Remove 1/2 in. bolts retaining the two hose clamps near the sideshift cylinder on the front of the fork frame.
3. Remove the hose clamp bolts on the inside of the fork frame, one each side, to remove the hoses. Reinstall the bolts to prevent the fork frame from falling.

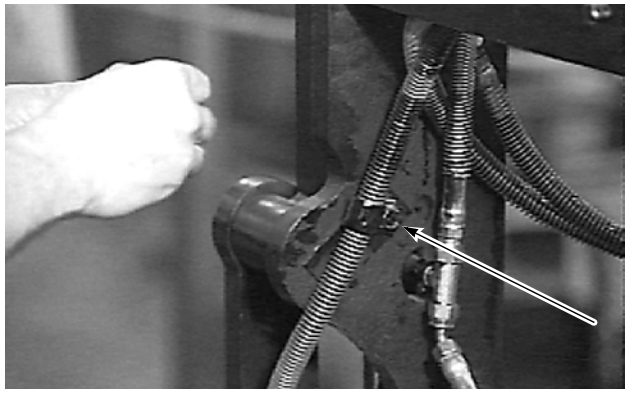


Figure 7-97: Side Hose Clamp Location

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4. Use a 1/2 in. socket and a 1/2 in. wrench to remove the two hose clamps at the top and on the back side of the front fork frame.
5. Attach a hoist to the top of the front frame.



Figure 7-98: Top Hose Clamp Location

6. Use a 1/4 in. punch to knock the four roll pins in (one on each side where outer scissor and front frame mate).
7. Use a flat screw driver to remove the screw covering the outside access to the mounting pin.

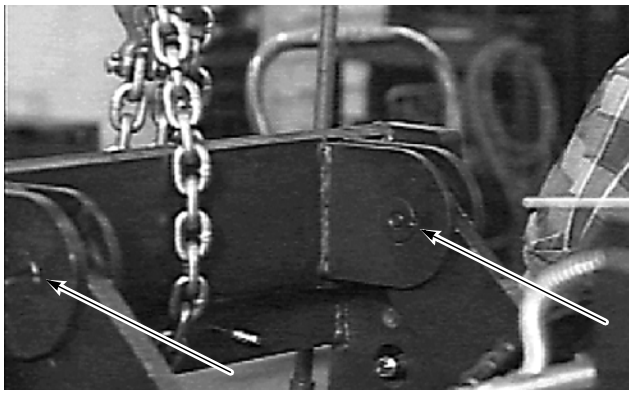


Figure 7-99: Roll Pin Locations

8. Use a punch to drive the mounting pin from the outside in.
9. Raise the frame up off the scissor arm rollers.
10. Save the four nylon bushings for use when reassembling the front frame to the scissor arms.
11. With the front frame removed, completely remove the roll pins that were partially removed in step 6.

NOTE: If the tilt and sideshift cylinders do not need to be serviced, disconnect the hoses at the ports on the manifold. Cap/plug all hoses and ports to prevent contamination. Removing the front frame in this manner prevents rerouting the hoses and the possibility of pinching a hose.

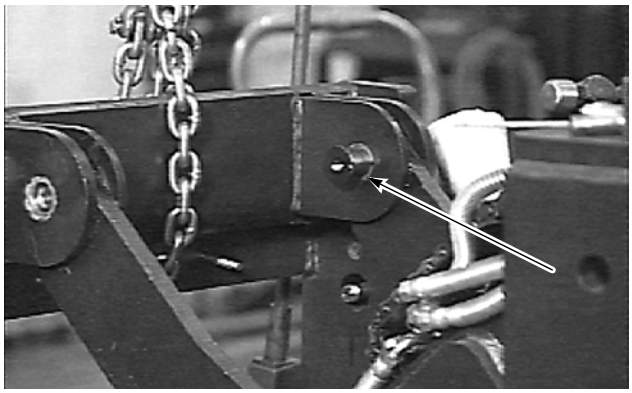


Figure 7-100: Removing Mounting Pin

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Installation

1. Lift the front frame into position using a hoist.
2. Lower onto the inner scissor arm bearings.
3. Tilt front frame outward, insert nylon bushings between the front frame and each side of the outer scissor arms.
4. Line up the mounting holes.
5. Insert pins from the inside.



Figure 7-101: Front Frame Shim Installation

6. Start screws on the outside. Line up the notches for the roll pins before screws are tightened down. If the frame is cocked a little, the pin will be difficult to get in. A punch can be used to hold it in place until the screw is tightened enough to draw the pin into position.
7. Remove the punch, insert a roll pin before the screw is fully tightened. The roll pin should be flush with the end of the pin.
8. Tighten the pin, do not overtighten, you may strip the bolt.
9. Add the roll pin to the outside to hold the screw head in place.
10. Repeat for opposite side.

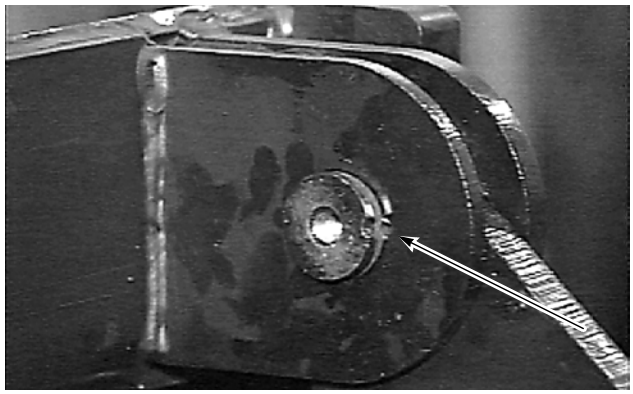


Figure 7-102: Roll Pin Hole Alignment

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Outer Arm (3500 lb. Reach)

Removal

1. Remove nut (35) and washer (34).
2. Remove the outside bearing (33).
3. Remove the right outer arm (32).
4. Repeat steps 1 thru 3 to remove the left outer arm (31).
5. Remove screws (29), caps (30), and rollers (7) from the outer arms.

Installation

1. Install rollers (7), caps (30) and screws (29) on the arms (31 and 32).
2. Install the bearing (33) in the outer arms (31 and 32).
3. Install the outer arms (31 and 32) on the center stud of the inner arm (13).
4. Install washer (34) and nut (35), and tighten. Torque the nut to 295 ft. lbs. (405 Nm).
5. Check for side clearance. Arms should pivot freely with some drag.
6. Install the front frame (36).
7. Connect the tilt cylinder hoses.
8. Grease all fittings on the reach.
9. Test for proper operation of reach.
10. Install the forks and the load backrest.

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Outer Arm (4500 lb. Reach)

Removal

1. Drive the roll pin out using a punch.
2. Loosen the 3-3/4 in. nut almost all the way. Tilt the outer scissor arm to disengage the bearing from the rear frame.
3. Remove the nut.
4. Remove the right outer arm.
5. Remove the roller bearing and check for wear.
6. Remove screws, caps, and roller bearings from the outer arms. Check for wear. Replace if necessary.
7. Locate the three spacers that will be required for reassembly.
8. Repeat steps 1 thru 6 to remove the left outer arm.

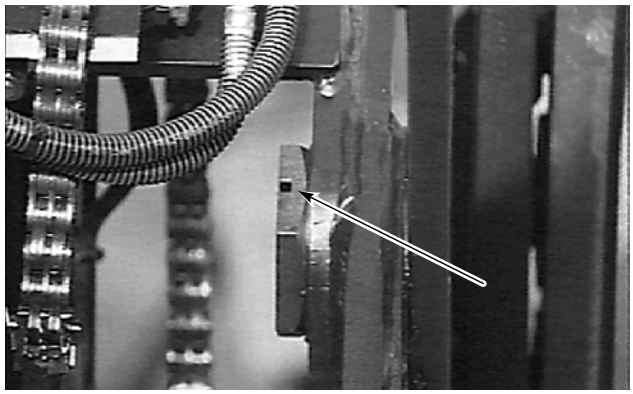


Figure 7-103: Roll Pin Location in 3-3/4 in. Nut

Installation

1. Install the roller bearings, caps and screws on the outer scissor arms.
2. Place three spacers in the inner scissor arm, then place the roller bearing (casing edge) against the shims to prevent premature wear.
3. Place the outer arm in position, start tightening the nut. Push the arm inward to engage the end bearing in the slot in the rear frame.
4. Tighten the nut. Do not overtighten, it will bind the scissor arms and cause the bearing to wear prematurely.
5. There are four holes in the shaft, align the nut and the holes. Use a punch to insert the roll pin. Drive the pin until it is even on both sides.

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Inner Arm (3500 lb. Reach)

Removal

1. Drive the pins out of the reach cylinder rod end pins.
2. Disconnect the hydraulic lines from the manifold block and plug to prevent contamination.
3. Remove the pins from the inner frame.
4. Remove the screw (10) at the rear frame (9).
5. Drive pivot shaft (12) out by hitting a it with a soft hammer.
6. Remove the inner arms (13).

Installation

1. Install the upper end of inner arms (13) into the rear frame (9).
2. Install a new bearing in the side arms.
3. Install pivot shaft (12) into the rear frame (9) and inner arms (13).
4. Install the screw (10), and tighten. Torque to 85 ft. lbs. (115 Nm). Arms should pivot freely with some drag.
5. Install washers (17), rollers (18), and cap (19).
6. Connect the hydraulic hoses to the reach cylinder.
7. Install pins in the rod end of the reach cylinder.
8. Install roll pins into the cylinder rod pins.

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Rear Frame (3500 lb. Reach)

Removal

1. Lift the rear frame (9) until the tension is removed from the lift chains.
2. Remove the lift chain anchors from the rear frame.
3. Disconnect the hydraulic hoses and plug to prevent contamination.
4. Disconnect the electrical cable.
5. Lower the rear frame.

NOTE: Connect a hoist to the rear frame because it could drop when the telescopic is raised.

6. Raise the inner telescopic.
7. Remove the rear frame.
8. Remove the rollers (7). Keep track of shims (6) to each roller and roller to pin location.
9. Clean and inspect all bearings, pins, rollers, washers, and wear strips for wear.

Installation

1. Install shims (6) and rollers (7).

NOTE: Install the same number of shims as removed for initial adjustment.

2. Lower the inner telescopic onto the rear frame rollers (7).

NOTE: Adjust the frame rollers so there is 0.000 in.-0.030 in. side movement of the rear frame at the tightest part of the inner mast channel.

3. Connect the hydraulic hoses.
4. Connect the electrical cable.
5. Install the lift chain anchors.

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Reach Carriage Assembly

Removal

⚠WARNING

Use extreme care when blocking the mast for any reason. Never remove the block when it is supporting the mast.

1. Remove the mast guard. See “Mast Guard” on page 7-224.
2. Remove the forks.
3. Extend the reach carriage. Be sure the fork carriage is centered so that balance will not be affected when the carriage is removed.
4. Attach a hoist to the reach carriage assembly. Place one chain around the back of the scissor assembly. Place another chain through the fork carriage on the opposite side. Take precautions not to pinch any hoses.
5. Lift the reach (keep the hoist chains taunt) enough to remove tension from the lift chains.
6. Turn the key switch OFF and disconnect the battery connector.



Figure 7-104: Hoist Chain Attachment

7. Remove the 30 mm nuts from the chain anchors on the inner telescopic.
8. To remove the lift chains from the pulley, thread the chain over the pulley sheaves at the top of the freelift cylinder. Place the chains over the carriage assembly, out of the work area.
9. Disconnect the electrical cable connector and the remove the two 11/16 nuts that attach the hose/cable assembly to the mast. Cap the hydraulic lines to prevent contamination.
10. Thread the hose/cable assembly over the pulley sheave at the top of the free lift cylinder.



Figure 7-105: Freelift Chain Detachment

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11. Place blocks at the position where the rear of the carriage and the front of the fork tips will rest upon the floor and lower the carriage onto blocks.

⚠WARNING

Because lifting and lowering the mast will be necessary to complete the following procedures, use extreme caution while working within the mast. NEVER lift or lower when your hands are near the mast.

12. Reconnect the battery connector and turn the key switch ON.
13. Slowly elevate the mast until the inner telescopics have risen above the carriage (about four feet or even with the top of the tractor section) and the carriage is sitting by itself.
14. Carefully back the lift truck away from the carriage until you run out of slack (1 or 2 feet) for the over the mast hoses and cables.
15. Lower the mast.
16. Turn the key switch OFF and disconnect the battery connector.
17. Remove the hydraulic hoses and over the mast cable from the carriage assembly.
18. Remove the carriage assembly.

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Installation

1. Attach the over the mast hydraulic hoses and electrical cable to the new carriage assembly.

⚠WARNING

Because lifting and lowering the mast will be necessary to complete the following procedures, use extreme caution while working within the mast. NEVER lift or lower when your hands are near the mast.

2. Reconnect the battery connector and turn the key switch ON.
3. Elevate the telescopics so they are just higher than the carriage assembly. Be careful not to run out of slack in the over the mast hydraulic hoses and cable.
4. Drive the lift truck up to the carriage.
5. Position the mast and telescopics over the carriage assembly. Lower the mast assembly onto the rails and bearings of the reach carriage assembly.
6. Turn the key switch OFF and disconnect the battery connector.
7. Place the chains over the pulley and down into the mast for connection to the chain anchors. Insert the chain anchor bolt into the anchor. Use a wrench to hold the chain while tightening the nut onto the chain anchor bolt. Adjust chain tension as described in "Lift Chains" on page 7-186.

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8. Position the over the mast hydraulic hoses and electrical cable over the pulleys. Be sure to thread the hose and cable assembly between the cylinder and the crossbar on the tractor side of the mast. (If hose is threaded on the opposite side of the crossbar, the hose will be sheared when the mast is lifted). Using the hoist, raise the reach up to access the fittings for the hose assembly and the electrical connection for the cable. Pull the hose/cable assembly down and attach the hoses to the fittings on the mast. Fittings for the hose assembly are 11/16 in. The electrical cable has a snap together connector. Use two cable ties to attach the cable to the tube to keep it tight.
9. Reconnect the battery connector.
10. Remove the blocking from the scissor assembly.

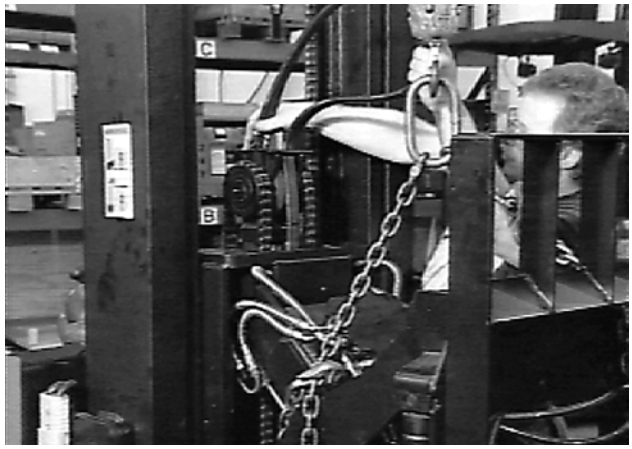


Figure 7-106: Hose/Cable Routing, Over Pulley

⚠ CAUTION

Be careful when lifting the forks. Stop if you hear or see any problems. If there is a problem, lower the carriage and repeat the above steps as necessary.

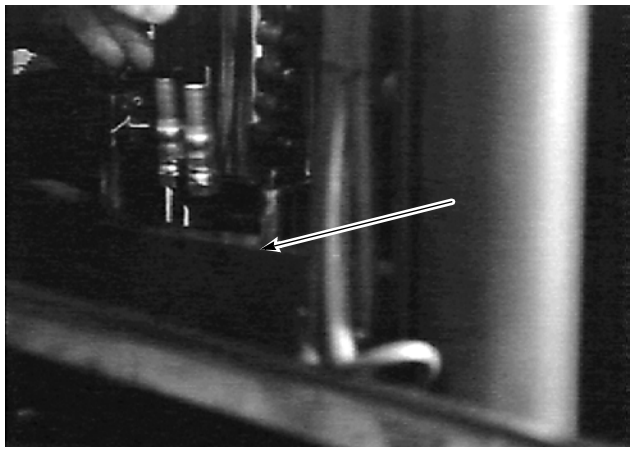


Figure 7-107: Hose/Cable Routing, Tractor Side

11. Slowly elevate the forks.
12. Remove blocks from underneath the carriage assembly.
13. Lower the carriage. Test all lift/lower functions for proper operation and adjustment. Return lift truck to service.

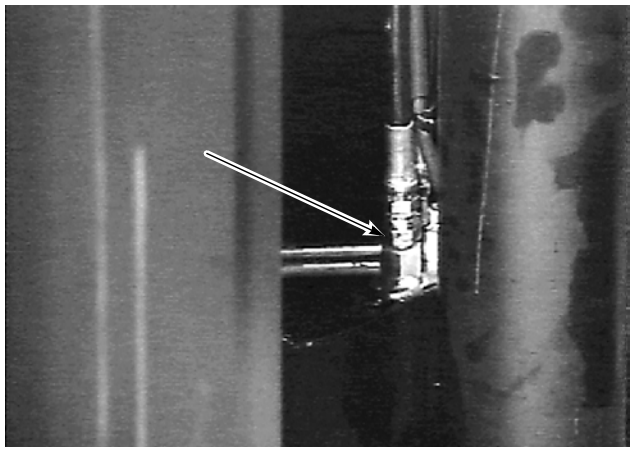


Figure 7-108: Hose/Cable Connection at Bottom of Mast

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Reach Carriage Hose Routing

Routing of the reach carriage hoses is critical to prevent damaging hoses.

1. Start with the sideshift hoses (these are the two longest ones). The tilt hoses are the ones with an orifice in the fitting. They should be routed after the sideshift hoses are in place.
2. Attach the hose clamps (6 of these). Connect the hoses to the cylinders.
3. Start with sideshift hose on the left side. Cross it over and insert it between the sideshift and the frame on the right side. Start the hose on the sideshift cylinder. Next, route the right sideshift hose across to the other side and insert it between the sideshift and the frame. Start it on cylinder.
4. Next hook up the tee removed from the right tilt cylinder.
5. Reconnect the top hose from the tee on the right tilt cylinder to the tee on the left tilt cylinder. Tighten all fittings/tees.
6. Place the hose bracket bolts through the front frame. Lay the hoses from the left side of the manifold across the top of the bolts. The hoses from the right side of the manifold are placed just under the bolt. The hose clamp will frame the hoses. See Figure 7-110.
7. The hose coming from the first port of the manifold goes into the front frame first. The second hose is routed to the tilt cylinder on the opposite side. Stack the hoses neatly on top of each other. Add the hose clamp and finger tighten the nut.

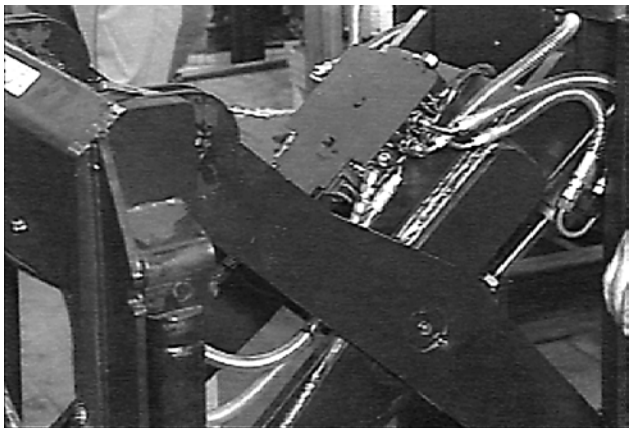


Figure 7-109: Tilt/Sideshift Manifold

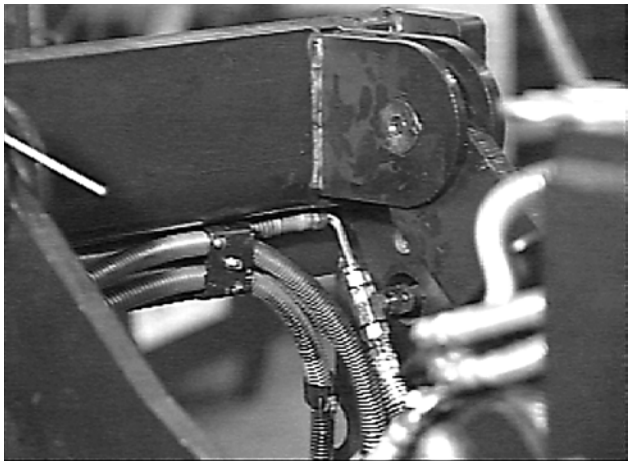


Figure 7-110: Hose Clamp/Hose Routing

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8. Remove the two bolts holding the fork frame to return the hose clamps inside the front frame to their proper position. See Figure 7-111.
9. Add front hose clamp bolts. Do not tighten completely yet.
10. Place hoses neatly through clamps so that sideshift will not hit them, then tighten the bolts.
11. When complete, the hoses should be nice and even with a neat window opening.

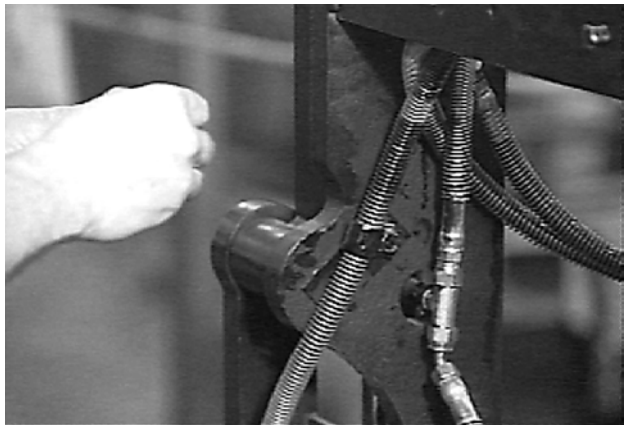


Figure 7-111: Side Clamp Location

An alternative way to access the scissor arms to service them is to remove the two front hoses from each side of the reach/tilt/sideshift manifold. See Figure 7-112. With the hoses detached, remove the entire front frame as a unit.

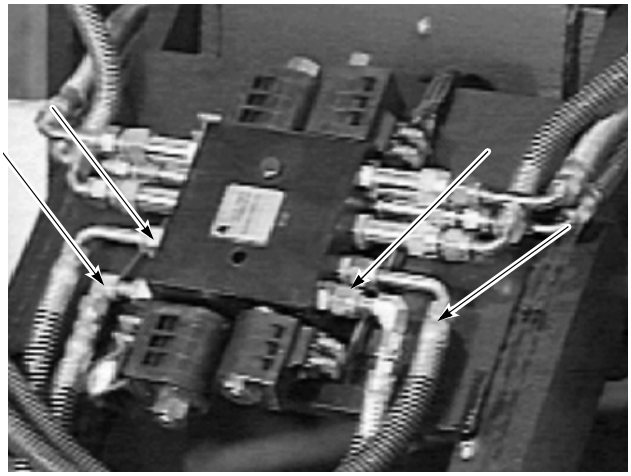


Figure 7-112: Disconnect Tilt and Sideshift Hoses

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Reach Carriage Wear Strip

A wear strip is used on both the 4500 lb. Reach and the Deep-Reach variations of lift trucks. The wear strip is located on the front of the reach carriage front frame. It is the surface that the tilt cylinders travel against.

Removal

1. Partially extend the carriage so that the end of the scissors is midway down the track, exposing the top and the bottom of the reach wear strip.
2. Place a block on each side of the carriage between the scissor's lower back bearings and the carriage's bottom support plate.
3. Turn the key switch OFF and disconnect the battery connector.
4. Unbolt the two flat head screws at the top and bottom of the reach wear strip.

Installation

1. Grease and wedge the new reach wear strip in between the bearing and the track.
2. Fasten top and bottom flat head screws.
3. Reconnect the battery connector.
4. Remove blocking from scissors mechanism.

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Carriage Roller Bearings

The upper carriage roller bearing is accessible when the carriage is elevated. Two other roller bearings are located within the mast assembly on either side. The carriage must be removed to access these bearings.

The lower bearings are shimmed at the factory so that there is no play between the carriage and the inner telescopic. If the carriage becomes loose within the inner telescopic, the lower roller bearings may require additional shims. If possible, maintain an equal amount of shim thickness on each side.

If the carriage hangs up in the telescopic during lowering, one or more of the roller bearings may be damaged or worn and require replacement.

Removal

1. Remove the carriage. See “Reach Carriage Assembly” on page 7-200.
2. Remove the socket head cap screw and washer on the end of the bearing.
3. The carriage bearing should slide off the shaft with hand pressure. A suitable bearing puller may be required, however, for removal.
4. Repeat steps 2 and 3 for the other five bearings.

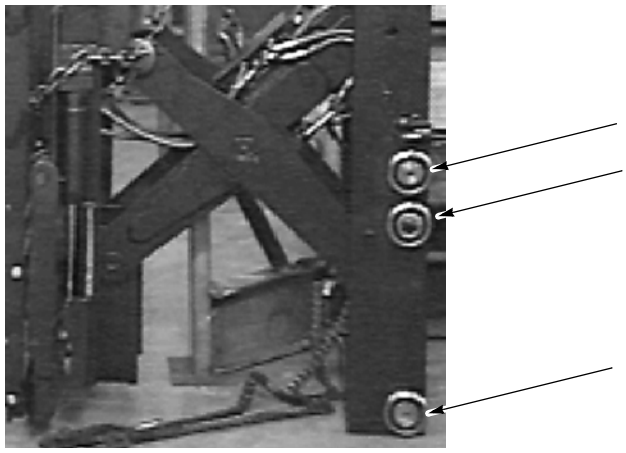


Figure 7-113: Carriage Roller Bearings

Installation

1. Install the new bearing on the shaft. Apply thread locking compound to the socket head cap screw. Fasten the cap screw and washer in place.
2. Repeat step 1 for the other five bearings.
3. Re-install the carriage. See “Reach Carriage Assembly” on page 7-200.
4. Test the lift/lower functions of the carriage.
5. Return the lift truck to service.

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Reach Carriage Lubrication Points

Lubricate the reach assembly as shown in Figure 7-114; both sides. Also, lubricate the hose assembly on the reach carriage in the area that they rub on the frame.

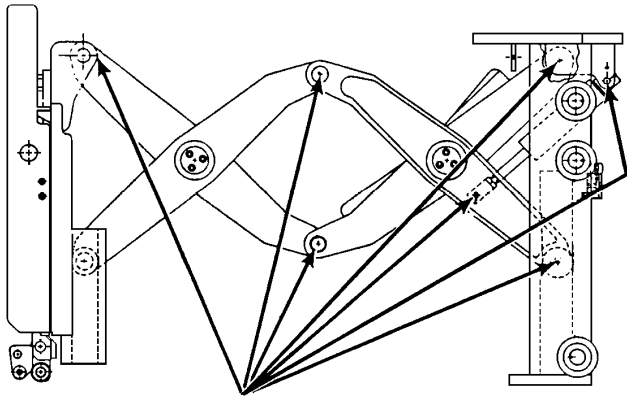


Figure 7-114: Reach Assembly Lubrication (Deep Reach Shown)

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Fork Carriage Pivot Pins

3500 lb. Reach lift trucks use a pin and roll pin combination for the fork carriage pivot pin.

4500 lb. Reach and Deep-Reach lift trucks use a pin with a tab attached. This pin is attached to the reach carriage front frame with a screw.

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Sideshift Carriage

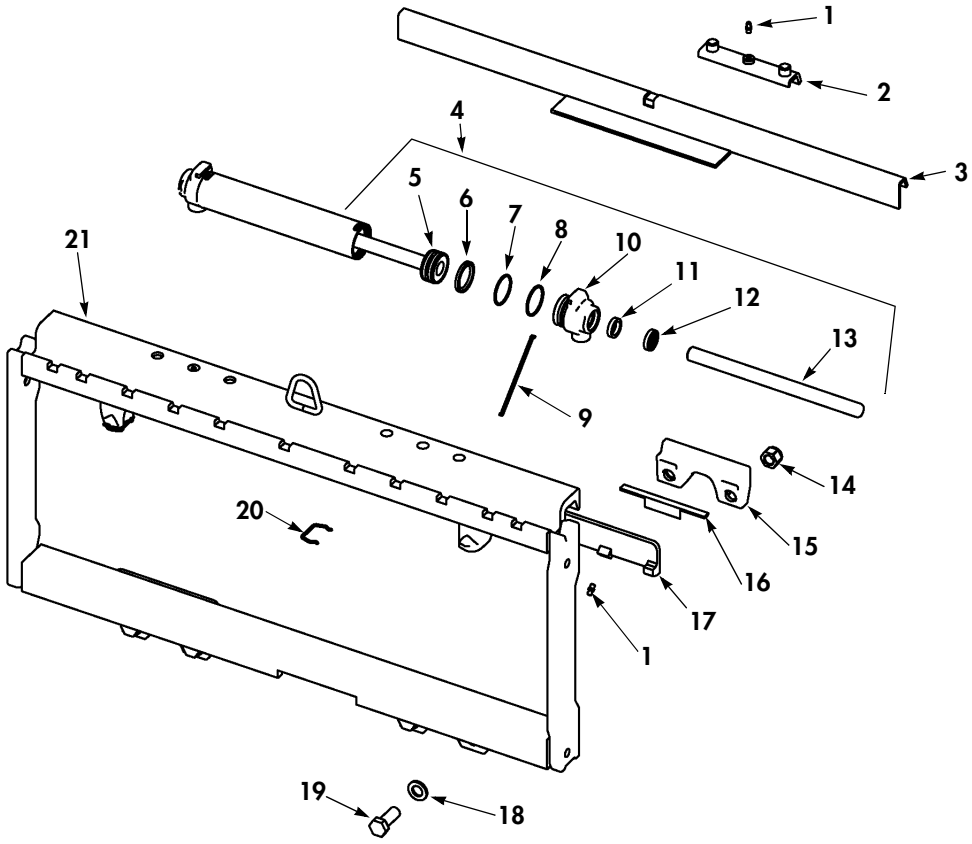


Figure 7-115: Sideshift Assembly Components

POS. NO.	DESCRIPTION	POS. NO.	DESCRIPTION	POS. NO.	DESCRIPTION
1	Grease Fitting	8	Seal	15	Lower Hook
2	Upper Pad	9	Cylinder Cap Ring	16	Lower Hook Pad
3	Cylinder Support	10	Cap	17	Lower Pad
4	Cylinder Assy.	11	Seal	18	Washer
5	Piston	12	Wiper	19	Screw
6	Seal	13	Rod	20	Split Pin
7	O-Ring	14	Nut	21	Frame

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Installation

1. Remove the lower hooks (15) from the sideshift assembly.
2. Using a suitable hoist, carefully lift the sideshift frame onto the carriage while holding up the cylinder to keep the upper slides in place.
3. Make sure the centering lug on the cylinder support (2) fits completely in the center notch of the lift truck carriage.
4. Re-install the lower hooks (15) with a minimum clearance of 0.04 in. (1 mm) and a maximum clearance of 0.08 in. (2 mm). Re-tighten the bolts and torque to 181 ft. lbs. (Nm).

⚠WARNING

Clearance between the lower hooks and the lift truck carriage is very important. The centering lug on the sideshift can jump out of the center notch of the lift truck carriage if this distance is not set accordingly.

5. Connect the hydraulic fittings to the sideshift cylinder (4). Sideshift the unit several times to insure there are no leaks. Check the sideshift for smooth operation with no interference.
6. Install the forks. See “Forks” on page 7-227.

Removal

1. Remove the forks. See “Forks” on page 7-227.
2. Remove the lower hooks (15).
3. Remove the split pins locking the cylinder on the frame.
4. Using a suitable hoist, carefully lift the sideshift frame (21) off the carriage.

Pad Replacement

1. Remove the sideshift frame (21).

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2. Remove the upper pads (2) and replace with new pads. Make sure the locating studs of the pads properly fit in the locating holes on the frame.
3. Remove lower pads (17) with a downward rotating motion and install new pads.
4. Lubricate with grease.
5. Re-install sideshift frame onto carriage.

Cylinder

1. Remove the sideshift frame (21).
2. Disconnect hoses.
3. Remove cylinder from cylinder support (3).
4. Secure the cylinder body and rotate with a wrench until the locking ring (9) comes out.
5. Remove the locking ring.
6. Unthread the cap (10).
7. Reassemble cylinder in reverse order of disassembly.

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Mast Guard

Removal

⚠WARNING

Use extreme caution while working within the mast. Never lift or lower when your hands are near the mast.

1. Elevate the inner telescopic enough to place a support block under the inner telescopic. Lower the mast onto the support. Clamp the support in place.
2. Turn the key switch OFF and disconnect the battery connector.
3. Remove the four front 13 mm bolts holding the mast guard to the tractor frame. See Figure 7-116.
4. From the operator compartment, remove the two M8 Allen head bolts securing the top of the mast guard to the mast frame. See Figure 7-116.
5. Tilt the guard toward the operator compartment and lift upward to remove.
6. If the glass or mesh guard must be replaced, remove the screws attaching the retainer pieces.

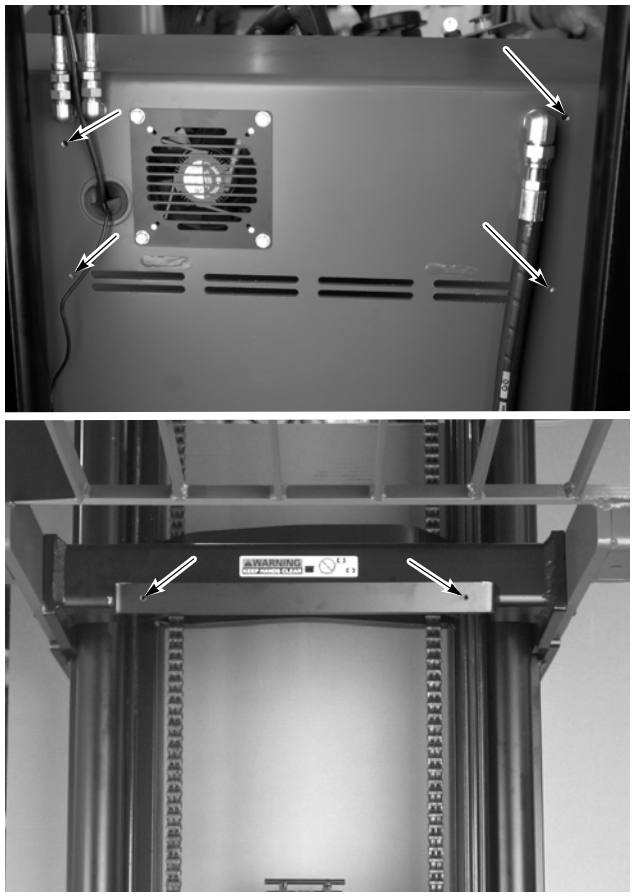


Figure 7-116: Mast Guard Mounting Bolt Locations

Installation

1. If the glass or mesh guard was replaced, install the screws holding the retainers.
2. With the bottom of the mast guard tilted toward the mast, slide the mast guard down into position.
3. Push the top toward the mast frame lining up the mounting holes. Secure the top of the mast guard in place with two Allen head screws.
4. Secure the bottom of the mast guard to the tractor frame with four bolts.

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5. Reconnect the battery connector. Unclamp the support, elevate the mast enough to remove the support. Lower the mast completely.
6. Return the lift truck to service.

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Carriage Bumpers

The carriage bumpers assure that the carriage remains square with the lift truck in its nested position.

The 3500 lb. Reach and Deep Reach variations use a rectangular bumper attached to each side of the reach carriage rear frame. These bumpers are attached with socket head screws.

The 4500 lb. Reach uses a circular bumper attached to the tractor side (back side) of the front frame.

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Forks

⚠ CAUTION

Forks are heavy. Use caution when removing or installing forks.

Adjustment

Fork position

1. Pull the fork latch upward. See Figure 7-117.
2. Slide the fork into the desired position. The latch must be adjacent to a notch in the rail that supports the top of the fork. Push the latch downward to lock it.
3. Try to slide the fork from side to side to be sure it is locked into position. The fork may latch while it is being slid.

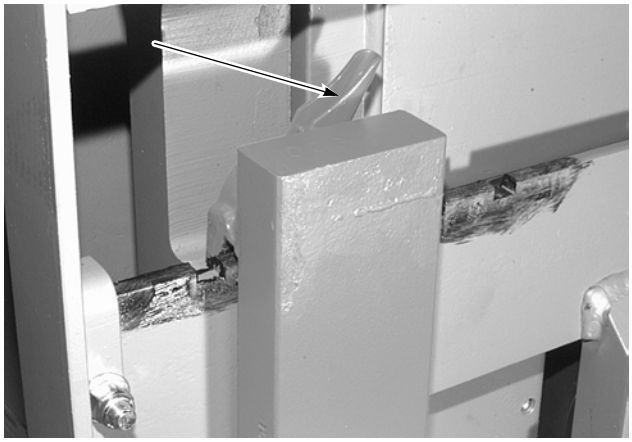


Figure 7-117: Fork Latch

Fork tip height

Shims located under the end of each lower carriage cross member adjust the height of the fork tips. Adding or removing one shim per side raises or lowers the a 42 in. fork tip by 0.19 in. (4.8 mm).

You must remove the lower cross member securing bolts (2) to access the shims on one side of the cross member. Tighten the securing bolts to 75 ft. lbs. (102 Nm).

Fork Inspection

Visually inspect all fork surfaces for signs of damage, including, but not limited to: bending, cracking, and unauthorized modifications.

Inspect forks for amount of wear on the bottom surface, as follows:

1. Using “Fork Wear Calipers” (Figure 7-118), set the *outer-most* points of the wear caliper to the thickness of the unworn vertical shank. See Figure 7-119.

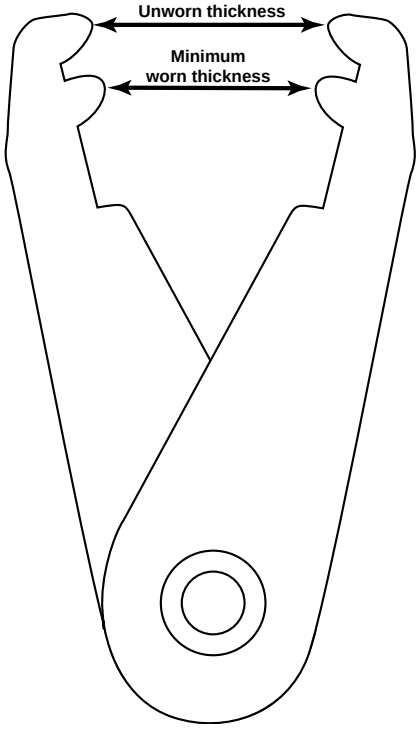


Figure 7-118: Fork Wear Calipers

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2. Without changing the setting, move to the untapered portion of the base of the fork. The *inner points* of the caliper represent the minimum acceptable thickness. If the inner points pass over any portion of the untapered base of the fork, the fork must be replaced.

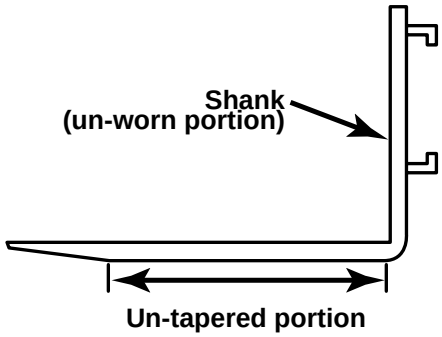


Figure 7-119: Fork Wear Inspection

Removal (with Tilt and Sideshift)

1. Turn the key switch OFF and disconnect the battery connector.
2. Release the fork by lifting up the latch mechanism on top of the fork. See Figure 7-120.
3. Slide the fork toward the cutout. Once the fork is aligned with the cutout, pull up on the tip of the fork and move the fork away from the lower cross member. See Figure 7-121.
4. Lift the top of the fork up and away from the upper cross member.

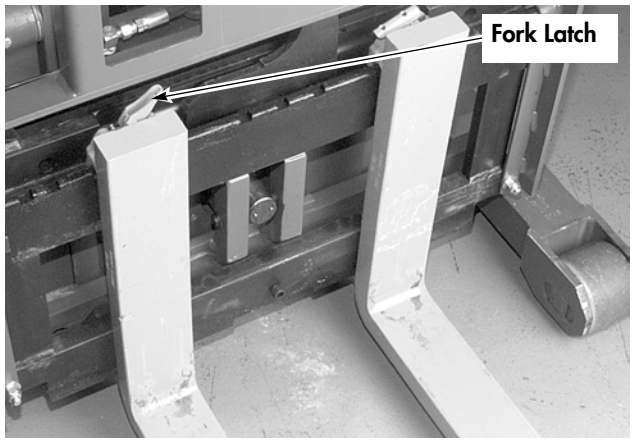


Figure 7-120: Fork Latch

Installation (with Tilt and Sideshift)

1. Place the top of the fork onto the upper cross member, over the cutout in the lower cross member. See Figure 7-121.
2. Carefully lower the bend in the fork toward the cutout until the fork is in position at the lower cross member.
3. Slide the fork to the desired location on the carriage.
4. Push the fork latch down to lock it. The latch will engage if the fork is over one of the slots on the upper carriage cross member.
5. Try to slide the fork back and forth to be sure it is locked into position.

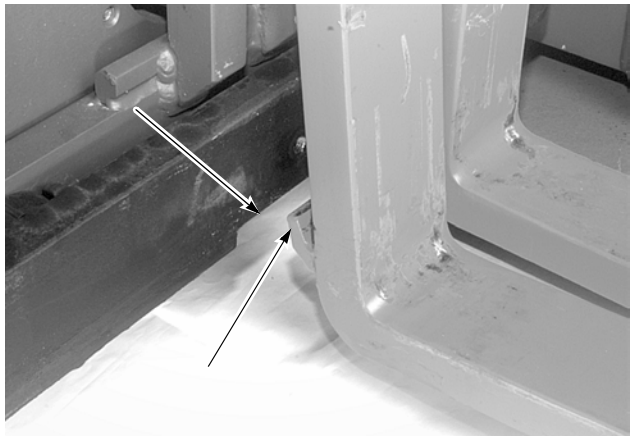


Figure 7-121: Fork Removal (with Tilt and Sideshift)

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6. Reconnect the battery connector.

Removal (with Tilt and no Sideshift)

1. Turn the key switch OFF and disconnect the battery connector.
2. Remove the carriage load backrest.
3. Release the fork locking mechanism by lifting up the latch on top of the fork.
4. Slide the fork off the end of the carriage.

Installation (with Tilt and no Sideshift)

1. Place the fork on the end of the carriage and slide it into position.
2. Push the fork latch down to lock it. The latch will engage if the fork is over one of the slots on the upper carriage cross member.
3. Try to slide the fork back and forth to be sure it is locked into position.
4. Re-install the carriage load backrest.

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Load Wheels

Tandem Load Wheels

POS. NO.	DESCRIPTION	POS. NO.	DESCRIPTION
1	Axle	7	Washer, 16 gauge
2	Toe box	8	Bearing
3	Plate, rocker	9	Wheel, load
4	Ring, retainer	10	Nut
5	Fitting, grease	11	Bolt, shoulder
6	Washer, 10 gauge		

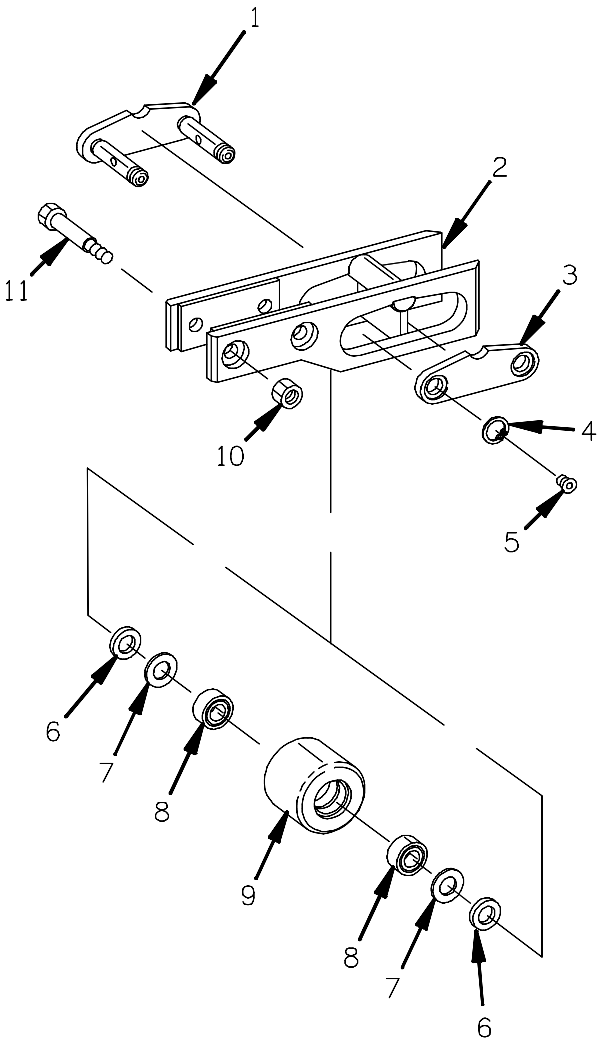


Figure 7-122: Tandem Load Wheel Assembly

Removal

1. Park the lift truck on a level surface.
2. Lower the carriage fully, turn the key switch OFF, and disconnect the battery connector.
3. Check to make sure the battery retainer plates are in place.

⚠WARNING

Use extreme care whenever the lift truck is jacked up. Never block the lift truck between the mast telescopic and the floor. Keep hands and feet clear from vehicle while jacking the lift truck. After the lift truck is jacked, place solid blocks beneath it to support it. DO NOT rely on the jack alone to support the lift truck. For details, see "Jacking Safety" on page 2-13.

4. Jack or hoist the lift truck so the load wheels are approx. 2 in. (50 mm) off the floor, and securely block.
5. Remove the two snap rings (4) from the axles.

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6. Use a piece of rod or a punch to tap the axle back out through the wheels. Remove the rocker plate. Remove the two shims on each side of the wheel. The axle is welded into the rocker plate. Remove the load wheel from the toe box (2).
7. Inspect the bearings (8). Replace if necessary.

Installation

1. Pack the bearings with grease.
2. Install the bearings in the load wheel.

⚠WARNING

Install bearing shield and 10 gauge spacer properly.

3. Install the load wheel assembly in the toe box (2).
4. Install the axle (1), shims (6 & 7) and rocker plate (3).

NOTE: Place a block behind the axle (1) to hold it in place while assembling the rocker plate and snap rings.

5. Install the snap rings (4) to the axle (1).
6. Remove the blocking and lower the lift truck to the floor.
7. Reconnect the battery connector.
8. Test operate the lift truck.
9. Return the lift truck to service.

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Load Wheel Toe Plate Box

Removal

1. Park the lift truck on a level surface.
2. Lower the carriage fully, turn the key switch OFF, and disconnect the battery connector.
3. Check to make sure the battery retainer plates are in place.

⚠WARNING

Use extreme care whenever the lift truck is jacked up. Never block the lift truck between the mast telescopic and the floor. Keep hands and feet clear from vehicle while jacking the lift truck. After the lift truck is jacked, place solid blocks beneath it to support it. DO NOT rely on the jack alone to support the lift truck. For details, see "Jacking Safety" on page 2-13.

4. Jack or hoist the lift truck so the load wheels are approx. 2 in. (50 mm) off the floor, and securely block.
5. Unbolt the box section from the base leg.
6. Remove the bolt at the end of the box section.
7. Disassemble the box section.
8. Remove the spacer.

Installation

1. Re-assemble the box section.
2. Bolt the box section to the base leg.
3. Remove the blocking and lower the lift truck to the floor.
4. Reconnect the battery connector.
5. Test operate the lift truck.
6. Return the lift truck to service.

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Single Load Wheel

Removal

1. Park the lift truck on a level surface.
2. Lower the carriage fully, turn the key switch OFF, and disconnect the battery connector.
3. Check to make sure the battery retainer plates are in place.

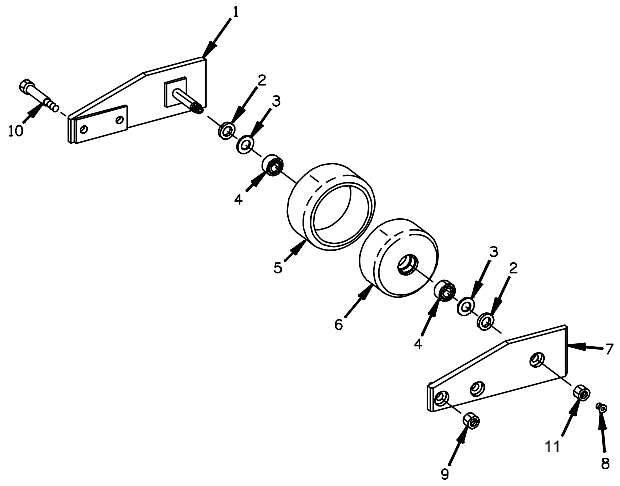


Figure 7-123: Single Load Wheel Assembly

⚠WARNING

Use extreme care whenever the lift truck is jacked up. Never block the lift truck between the mast telescopic and the floor. Keep hands and feet clear from vehicle while jacking the lift truck. After the lift truck is jacked, place solid blocks beneath it to support it. DO NOT rely on the jack alone to support the lift truck. For details, see "Jacking Safety" on page 2-13.

4. Jack or hoist the lift truck so the load wheels are approx. 2 in. (50 mm) off the floor, and securely block.
5. Remove the toe box retaining nuts (9) and bolts (10).
6. Remove the axle nut (11).
7. Remove the right toe box (1) and load wheel (6).
8. Press the load tire (5) from the wheel (6).
9. Inspect the bearings and replace if necessary.

POS. NO.	DESCRIPTION
1	Toe box, right
2	Washer, 10 gauge
3	Washer, 18 gauge
4	Bearing
5	Tire, load
6	Wheel
7	Toe box, left
8	Fitting, grease
9	Nut
10	Bolt, shoulder
11	Nut

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⚠WARNING

Install bearing shield and 10 gauge spacer properly.

Installation

1. Inspect and replace the bearing (4) as needed.
2. Press the load tire (5) on the wheel (6).
3. Install the load tire assembly on the toe box axle.
4. Install the right toe box (1).
5. Install the axle nut (11).
6. Install the toe box assembly on the support arm. Apply thread locking compound to the nuts (11) and bolts (10).
7. Remove the blocking and lower the lift truck to the floor.
8. Reconnect the battery connector.
9. Test operate the lift truck.
10. Return the lift truck to service.

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Load Backrest

Removal

1. Park the lift truck on a level surface.
2. Turn the key switch OFF and disconnect the battery connector.
3. Use a 3/4 in. socket to remove the four bolts (two on each side).
4. Lift the backrest off the front fork frame.
5. Be sure to retrieve the two shims that go between the backrest and the front fork frame.

Installation

1. Place the load backrest on the front fork frame.
2. Slide the shims between the frame and the backrest, aligning the mounting holes.
3. Insert the mounting bolts and tighten.
4. Repeat steps 2 and 3 for the opposite side.
5. Reconnect the battery connector.
6. Return the lift truck to service.

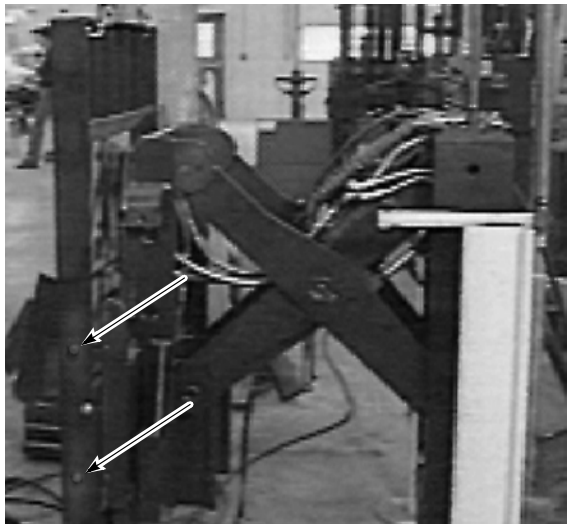


Figure 7-124: Mounting Bolts

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Theory of Operation

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Electrical Functions

The braking, steering, and travel control systems on the Toyota Reach lift truck are completely electrically controlled and monitored. The lift/lower and auxiliary function systems are electrically controlled and hydraulically activated.

Operating Description Overview

The Tractor Interface Card monitors the state of switches, sensors, control handle (mast and fork functions), and other input devices. It then sends inputs to the Display Card. The Display Card contains a microprocessor. The microprocessor makes decisions based on the information received from the Tractor Interface Card, power amplifiers, and operator display inputs. Output devices that are controlled through the Tractor Interface Card are: solenoids, the brake, and the MM contactor.

The microprocessor performs a diagnostic test at start up and during truck operation. The diagnostic test assists in repair by identifying problems and minimizing truck downtime. For any identified problems, the operator is alerted by a visible tool bar icon and error code numbers displaying on the operator display. An audible alarm is also sounded when an error is detected. A history log records error codes by hour meter reading.

The Tractor Interface Card contains a clock/calendar chip and a lithium battery. The combination of chip and battery allows clock and date settings to remain in memory when the truck's battery is disconnected.

Start Up

With the battery connected to the lift truck, electricity flows:

- through fuse (F1) to the steer controller at SK2+, starting the internal safety test
- through fuse (F4) to the Tractor Interface Card at JP12-4 and JP12-5

By closing the emergency disconnect switch (S2) and key switch (S1), electricity flows through the control circuit relay (K1) and to the Tractor Interface Card at JP6-1.

Electricity flows through the emergency disconnect switch (S2) and out through JP8-2 on the Tractor Interface Card to the main contactor coil. This closes the contactor tips.

Closing the MM contactor tips allows electricity to flow:

- through fuse (F2) to the Traction Power Amplifier at TB+
- through fuse (F3) to the lift power amplifier at LB+
- through fuse (F5) to the Tractor Interface Card at JP12-1 and JP12-2.

Communication from Traction Power Amplifier and lift power amplifier to the Display Card is through CAN Bus +/–.

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Braking System

The braking system on the Toyota Reach lift truck is electrically controlled. It is dependent upon inputs from the brake transducer (VR3) and the deadman switch (S3).

With the deadman pedal in its normal UP position, the brake is applied. The brake transducer (VR3) is activated by depressing the left deadman pedal.

NOTE: The brake transducer is a potentiometer.

The decrease in voltage from the transducer (VR3) to the Tractor Interface Card at JP7-4, and input from the deadman switch (S3) to the Tractor Interface Card at JP7-14 is sent to the Display Card for processing. The Display Card returns a message to the Tractor Interface Card to send current to the parking brake coil at JP8-12, releasing the brake.

Brake Switch/Pot Operation

The brake pedal on the Toyota Reach truck has several functions with respect to controlling truck operation:

1. Pedal in full DOWN position serves the traditional role of enabling the truck's traction and lift systems.
2. Pedal in full UP position serves the traditional role of disabling the truck's traction and lift systems as well as activating the traction brake.

In addition to these traditional functions, the brake pedal is also used to proportionally engage the traction motor plugging function as the pedal is raised from the full down to the full up position. This function is made possible by the use of the brake pedal pot which provides a voltage signal that varies as the pedal is moved between the full UP and full DOWN positions. The pedal pot also serves as the method of determining the brake pedal's position full UP or full DOWN.

A brake switch is also used to provide an ON and OFF voltage signal for determining if the pedal should be in the full UP position as a secondary check to the pedal pot. The up or down state of the pedal is determined by the ON or OFF state of the brake switch. The brake switch should be adjusted such that it changes state (ON to OFF or OFF to ON) at approximately 85% of the brake pedal throw as measured from the full pedal DOWN position.

Proportional Plugging and Pedal Up/Down Transition Point

As the pedal moves UP from the full DOWN position, proportional drive motor plugging is activated until the pedal reaches the full UP position. The full UP and full DOWN pedal pot voltages are Learned values that have been calibrated previously. The actual position of the brake pedal (between full UP and full DOWN), as determined by brake pot voltage, is based on a calculation that occurs during brake pot calibration. The calculation creates zones within the brake pedal full UP and full DOWN voltage to determine when plugging should occur and when the pedal should be considered fully UP and to set the brake.

The zones created are as follows:

- Pedal UP Zone - from full pedal UP/DOWN transition point
- UP/DOWN Transition Point - calculated to be 33% below full UP pedal pot voltage (position)
- Plugging Zone - calculated to be from 33% below full UP pedal pot voltage to lower deadband limit
- Lower Deadband Zone - calculated to be 0.10V higher than full DOWN pedal pot voltage
- Pedal Pot Full Down Zone - calculated to be between the full DOWN pedal pot voltage (position) to the lower deadband limit.

See Figure 8-1 on page 8-4.

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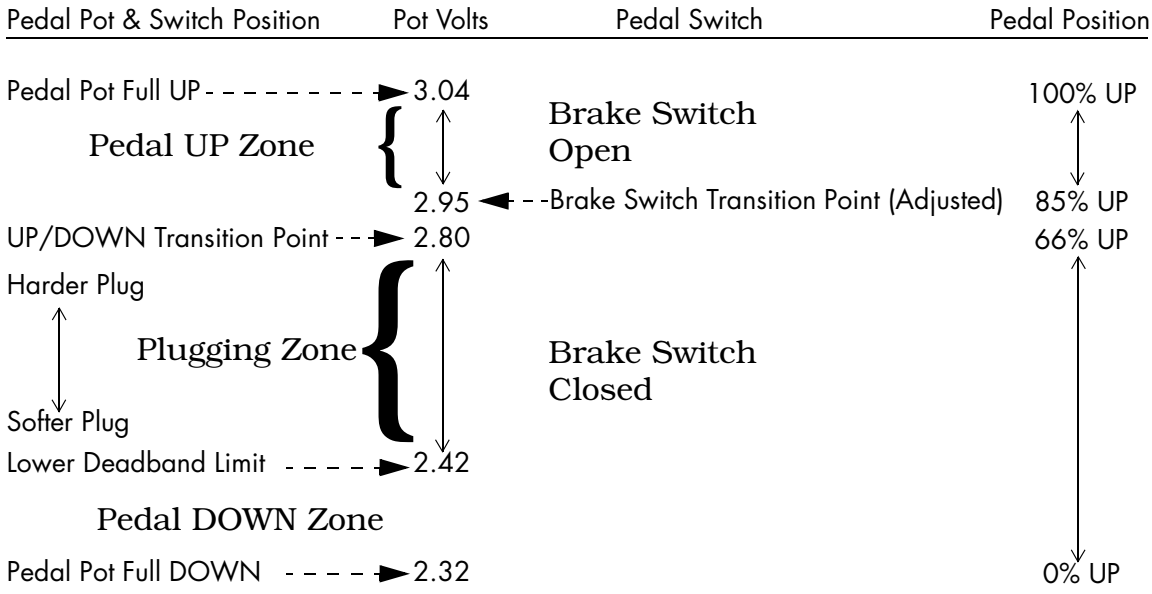


Figure 8-1: Pedal Pot Voltages

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Steering System

The steering system is electrically controlled. When the steering wheel and attached electric tachometer (steer tach) is turned, a steering request is produced. The Steer Controller measures the request and produces a steering response. The response drives a steering motor, turning the drive unit through gear reduction.

180° Steering

The amount the transmission turns is electrically limited. Prox Sensors monitoring for certain transmission angles, signal the Tractor Interface Card at the electrical stop. Sensor information is sent from the Tractor Interface Card to, and processed by, the Display Manager Card. The Display Manager sends command signals back to the Tractor Interface Card and the Tractor Interface commands the Steer Controller to stop steering. The controller stops responding to the steering request. The Tractor Interface Card monitors the commanded signals to the controller and reports the results as feedback to the Display Manager. If the Display Manager receives an incorrect feedback response, command signals to the Tractor Interface Card cause the Tractor Interface to command the Steer Controller to allow steering. The mechanical stops then stop the rotating transmission. An error code appears on the Operator Display indicating a problem in controlling the Steering Controller.

Turning the steering wheel in the opposite direction reverses the steering request. The controller responds by driving the motor in the opposite direction. While the steering request is present, the controller drives the motor to the opposite electrical stop. The maximum allowed angular rotation of the transmission from electrical stop to electrical stop is less than 180°. Mechanical stops “back up” the electrical stops, but are not normally used.

The Steer Controller monitors several external and internal functions to the controller. Three external functions monitored are the steer tach, motor and the wiring to these devices. When an external or internal controller fault is detected, the controller signals the Tractor Interface Card. The Tractor Interface Card drops the parking brake coil, applying the parking brake. Travel is not allowed and an error code is displayed on the Operator Display, indicating a Steering Controller problem.

The Display Manager monitors and tests the three Prox Sensors connected to the Tractor Interface Card. The Prox Sensors signal certain transmission angles. Certain sensor signal combinations indicate a fault in the sensor system. If the Display Manger detects a faulty signal combination, the Steering Controller is commanded to always allow steering. The mechanical stops then stop the rotating transmission. An error code appears on the Operator Display indicating a problem in the sensor system.

Forward or reverse steering is optional and selected by choosing one of two connector plugs near the steer tach. When forward steering is used, turning the steering wheel clockwise directs B+ current to the steer motor through a series of steps:

- The steer tach senses the rate and direction of steering wheel rotation.
- The steer tach sends a signal of approx. +1.4 to +2.9V (depending on the rate of rotation of the steering wheel) to steer controller inputs SK1-4 and SK1-6.
- Controller logic interprets the input from the steer tach (depending on the sensitivity setting selected by three of the toggle switches located on the controller) and instructs the motor to rotate clockwise by supplying B+ voltage to the motor.
- The motor rotates the drive unit as directed by the steer controller.

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Turning the steering wheel counterclockwise directs B– current to the steer motor through a series of steps:

- The steer tach senses the rate and direction of steering wheel rotation.
- The steer tach sends a signal of approx. –1.4 to –2.9V (depending on the rate of rotation of the steering wheel) to steer controller inputs SK1-4 and SK1-6.
- The controller logic interprets the input from the steer tach (depending on the sensitivity setting selected by three of the toggle switches located on the controller) and instructs the motor to rotate counterclockwise by supplying B– voltage to the motor.
- The motor rotates the transmission, turning the drive unit as directed by the steer controller.

360° Steering (optional)

The Steer Controller monitors several external and internal functions to the controller. Three external functions monitored are the steer tach, motor and the wiring to these devices. Upon detection of an external or internal controller fault, the controller signals the Tractor Interface Card. The Tractor Interface Card drops the parking brake coil, applying the parking brake. Travel is not allowed and an error code is displayed on the Operator Display, indicating a Steer Controller problem.

The Display Manager monitors two Prox Sensors connected to the Tractor Interface Card. The Prox Sensors detect the teeth on the transmission ring gear. By using the two sensors, the direction the transmission is rotating and the number of degrees rotated can be determined. A third Prox Sensor connected to the Tractor Interface Card detects certain transmission angles indicating a possible fork or tractor direction of travel. The Display Manager uses the information from the three Prox Sensors to display the approx. wheel angle position on the dash display.

Forward or reverse steering is optional and selected by choosing one of two connector plugs near the steer tach. When forward steering is used, turning the steering wheel clockwise directs B+ current to the steer motor through a series of steps:

- The steer tach senses the rate and direction of steering wheel rotation.
- The steer tach sends a signal of approx. +1.4 to +2.9V (depending on the rate of rotation of the steering wheel) to controller inputs SK1-4 and SK1-6.
- Controller logic interprets the input from the steer tach (depending on the sensitivity setting selected by three of the toggle switches located on the controller) and instructs the motor to rotate clockwise by supplying B+ voltage to the motor.
- The motor rotates the drive unit as directed by the steer controller.

Turning the steering wheel counterclockwise directs B– current to the steer motor through a series of steps:

- The steer tach senses the rate and direction of steering wheel rotation.
- The steer tach sends a signal of approx. –1.4 to –2.9V (depending on the rate of rotation of the steering wheel) to steer controller inputs SK1-4 and SK1-6.
- Controller logic interprets the input from the steer tach (depending on the sensitivity setting selected by three of the toggle switches located on the controller) and instructs the motor to rotate counterclockwise by supplying B– voltage to the motor.
- The motor rotates the drive unit as directed by the steer controller.

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Traction System

Forward Travel Requested

Forward travel is the default direction of travel with the wheel direction indicator pointing toward the forks. If the steering wheel is turned, after the deadman pedal is depressed, it causes the wheel direction indicator arrow to point toward the rear of the tractor. If travel is requested at this point, movement will begin in a tractor first direction even though the directional/speed control handle is moved away from the operator.

⚠ CAUTION

Releasing the parking brake and accidentally moving the directional/speed control handle causes unexpected truck travel.

With the key switch ON and the deadman pedal depressed, moving the directional/speed control handle in a forward position (away from the operator) causes the travel potentiometer (VR1) to output a voltage higher than when in the neutral position. The Tractor Interface Card senses this increase in voltage at JP10-10, sending a signal to the Display Card. The Display Card responds by sending a message over CAN Bus +/– to the Traction Power Amplifier at JT2-3 and JT2-6. The Traction Power Amplifier sends the signal on to the traction motor requesting travel.

Travel speed is proportional to directional/speed control handle movement unless an overheating condition is sensed at the Traction Power Amplifier or the traction motor. The Traction Power Amplifier has an internal sensor and will reduce speed command to the traction motor if the Traction Power Amplifier is overheating. The traction motor has a thermistor that sends inputs directly to the Display Card. If the Display Card receives a hot motor signal, it will request the Traction Power Amplifier to reduce the motor speed.

Reverse Travel Requested

Forward travel is the default direction of travel with the wheel direction indicator pointing toward the forks. If the steering wheel is turned, after the deadman pedal is depressed, it causes the wheel direction indicator arrow to point toward the rear of the tractor. If travel is requested at this point, movement will begin in a tractor first direction even though the directional/speed control handle is moved away from the operator.

With the key switch ON and the deadman pedal depressed, moving the directional/speed control handle in a reverse position (toward the operator) causes the travel potentiometer (VR1) to output a voltage lower than when in the neutral position. The Tractor Interface Card senses this decrease in voltage at JP10-10, sending a signal to the Display Card. The Display Card responds by sending a message over CAN Bus +/– to the Traction Power Amplifier at JT2-3 and JT2-6. The Traction Power Amplifier sends the signal on to the traction motor requesting reverse travel.

Travel speed is proportional to directional/speed control handle movement unless an overheating condition is sensed at the Traction Power Amplifier or the traction motor. The Traction Power Amplifier has an internal sensor and will reduce speed command to the traction motor if the Traction Power Amplifier is overheating. The traction motor has a thermistor that sends inputs directly to the Display Card. If the Display Card receives a hot motor signal, it will request the Traction Power Amplifier to reduce the motor speed.

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Plugging

There are two methods of plugging available on the Toyota Reach lift truck. The preferred method is using the directional/speed control handle and is detailed first. The second method is accomplished through raising the deadman pedal approx. 1 in. and is detailed second.

Directional/Speed Control Handle Method

A movement of the directional/speed control handle in the opposite direction of travel causes the Tractor Interface Card to notice a change in voltage at JP10-10. It responds by sending a signal to the Display Card for processing.

Plugging is regulated with the direction/speed control handle movement. The greater the movement of the control handle, the greater the plugging force.

Deadman Pedal Method

There is a second plugging method available on this lift truck. The second plugging method uses a pair of drive motor direction/speed sensors (PROXA and PROXB) and the brake transducer (VR3).

To use the second plugging method, raise the brake pedal approx. 1 in. This causes a decrease in voltage from the brake transducer (VR3) to the Tractor Interface Card at JP7-4 and for the truck to plug to a stop.

The drive motor speed/direction sensors (PROXA and PROXB) are used to determine which direction the drive motor is rotating. This information is processed on the Display Card. The opposite direction is requested from the traction motor through the Traction Power Amplifier.

The drive motor speed/direction sensors (PROXA and PROXB) are used to determine how fast the drive motor is rotating. This information is processed on the Display Card. During this phase, the Display Card will only process information from VR3 (inputs from VR1 are ignored). To regain control of the travel potentiometer (VR1), the brake pedal must be fully depressed again.

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Lift/Lower System

Lift

With the key switch ON, deadman pedal, and right foot switch depressed, pressing the right side of the lift/lower control knob on the control handle causes VR2 to output a voltage greater than when in the neutral position. The Tractor Interface Card senses this increase in voltage at JP10-11, sending a signal to the Display Card. The Display Card responds by:

- requesting the Tractor Interface Card to enable voltage to the lift solenoid coil (Y10) at JP6-10, and
- sending a message over CAN Bus +/– to the lift power amplifier at JL2-3 and JL2-6.

The message to the lift power amplifier provides the PWM frequency rate to pulse the lift motor. Oil is fed from the pump to the valve, from the valve to the free lift and main lift cylinders. The free lift cylinder, having less weight on it, will lift first. After the free lift cylinder has reached full extension, the main lift cylinders will begin to lift. If the pressure in the system increases to the relief valve's preset value, oil flows back to the reservoir.

If the lift motor becomes hot, the lift motor temperature sensor sends voltage to the Tractor Interface Card at JP7-12. The Tractor Interface Card sends the analog signal through JPD3-6 to the Display Card. The Display Card tells the lift power amplifier to reduce the PWM frequency rate to the lift motor.

The lift power amplifier may also reduce PWM frequency if the lift power amplifier becomes hot. This is done through an internal sensor.

Lower

With the battery connected, key switch ON, deadman pedal, and right foot switch depressed, pressing the left side of the lift/lower control knob on the control handle causes VR2 to output a voltage lower than when in the neutral position. The Tractor Interface Card senses this decrease in voltage at JP10-11, sending a signal to the Display Card. The Display Card responds by requesting the Tractor Interface Card to enable voltage to the proportional lower solenoid coil (Y10-3) at JP6-9. The lowering speed is regulated by the proportional lowering valve (Y10-3) in direct proportion to the voltage from (VR2). Proportional lower solenoid coil (Y10-3) is normally closed. Oil flows from the cylinders through the valve, returning to the reservoir.

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Auxiliary Hydraulic Functions

Reach

Reach extends the forks away from the mast assembly when the reach button on the control handle is depressed. With the key switch ON and the right foot pedal depressed, pressing the reach button causes voltage to be sensed at JP10-1 on the Tractor Interface Card.

The Tractor Interface Card sends a signal to the Display Card through the serial lines at JPD2. The Display Card responds by:

- requesting the Tractor Interface Card to enable voltage to the direction B solenoid coil (Y13) at JP6-6.
- requesting the Tractor Interface Card to enable the reach solenoids (Y14 and 15) through JP7-21 and JP7-3 to X14-1 and X14-2 on the reach carriage
- sending a message over CAN Bus +/– to the lift power amplifier at JL2-3 and JL2-6.

The message to the lift power amplifier provides the PWM frequency rate to pulse the lift motor. Oil is fed through direction B (Y13) valve through Reach1 (Y14) valve to the rear ports on the reach cylinders and drives the pistons outwards. The oil flows from the front ports of the cylinders through Reach2 (Y15) valve to direction A (Y12) valve and on to the reservoir.

High Speed Reach

The sequence in which the Reach/Retract buttons are depressed determine the speed and direction at which the reach mechanism travels.

Depressing and holding the Reach button, then depressing the Retract button activates high speed reach.

Retract

Retract withdraws the forks toward the mast assembly when the retract button on the control handle is depressed. With the key switch ON and the right foot pedal depressed, pressing the retract button causes voltage to be sensed at JP10-2 on the Tractor Interface Card.

The Tractor Interface Card sends a signal to the Display Card through the serial lines at JPD2. The Display Card responds by:

- requesting the Tractor Interface Card to enable voltage to the direction A solenoid coil (Y12) at JP6-7
- requesting the Tractor Interface Card to enable the reach solenoids (Y14 and 15) through JP7-21 and JP7-3 to X14-1 and X14-2 on the reach carriage
- sending a message over CAN Bus +/– to the lift power amplifier at JL2-3 and JL2-6

The message to the lift power amplifier provides the PWM frequency rate to pulse the lift motor. Oil is fed through direction A (Y12) valve through Reach2 (Y15) valve to the front port on the reach cylinders and drives the pistons inwards. The oil flows from the rear ports through Reach1 (Y14) valve to direction B (Y13) valve and on to the reservoir.

High Speed Retract

The sequence in which the Reach/Retract buttons are depressed determine the speed and direction at which the reach mechanism travels.

Depressing and holding the Retract button, then pressing the Reach button activates high speed retract.

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Sideshift Right

Sideshift allows the operator to move the fork carriage to the right or left in relation to the mast. The amount of sideshift will be 2 or 4 in. (5 or 10 cm) depending on the base leg opening (BLO).

With the key switch ON and the right foot pedal depressed, pressing the sideshift right button causes a decrease in voltage to be sensed at JP10-3 on the Tractor Interface Card. The Tractor Interface Card sends a signal to the Display Card through the serial lines at JPD2. The Display Card responds by:

- requesting the Tractor Interface Card to enable voltage to the direction B solenoid coil (Y13) at JP6-6
- requesting the Tractor Interface Card to enable the sideshift solenoid (Y16) through JP7-19 to X14-4 on the reach carriage
- sending a message over CAN Bus +/– to the lift power amplifier at JL2-3 and JL2-6

The message to the lift power amplifier provides the PWM frequency rate to pulse the lift motor. Oil is fed through direction B (Y13) valve to the sideshift (Y16) valve to the rear port of the sideshift cylinder driving the piston outward. The oil flows from the front port of the cylinder to the direction A (Y12) valve to the reservoir.

Sideshift Left

Sideshift allows the operator to move the fork carriage to the right or left in relation to the mast. The amount of sideshift will be 2 or 4 in. (5 or 10 cm) depending on the base leg opening (BLO).

With the key switch ON and the right foot pedal depressed, pressing the sideshift left button causes an increase in voltage to be sensed at JP10-4 on the Tractor Interface Card. The Tractor Interface Card sends a signal to the Display Card through the serial lines at JPD2. The Display Card responds by:

- requesting the Tractor Interface Card to enable voltage to the direction A solenoid coil (Y12) at JP6-7
- requesting the Tractor Interface Card to enable the sideshift solenoid (Y16) through JP7-19 to X14-4 on the reach carriage
- sending a message over CAN Bus +/– to the lift power amplifier at JL2-3 and JL2-6

The message to the lift power amplifier provides the PWM frequency rate to pulse the lift motor. Oil is fed through direction A (Y12) valve to the front port of the sideshift cylinder, driving the piston inward. The oil flows from the rear port of the cylinder through the sideshift (Y16) valve to the direction B (Y13) valve to the reservoir.

Fork Tilt Up

Fork tilt allows the operator to raise or lower the tips of the forks. Standard fork tilt is 5° up and 2° down.

With the key switch ON and the right foot pedal depressed, pressing the tilt up button causes a decrease in voltage to be sensed at JP10-5 on the Tractor Interface Card. The Tractor Interface Card sends a signal to the Display Card through the serial lines at JPD2. The Display Card responds by:

- requesting the Tractor Interface Card to enable voltage to the direction B solenoid coil (Y13) at JP6-6
- requesting the Tractor Interface Card to enable the tilt solenoid (Y17) through JP7-20 to X14-3 on the reach carriage
- sending a message over CAN Bus +/– to the lift power amplifier at JL2-3 and JL2-6

The message to the lift power amplifier provides the PWM frequency rate to pulse the lift motor. Oil is fed through direction B (Y13) valve to the rear port of the tilt cylinder, driving the piston outward. The oil flows from the front port of the cylinder through tilt (Y17) valve to the direction A (Y12) valve to the reservoir.

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Fork Tilt Down

Fork tilt allows the operator to raise or lower the tips of the forks. Standard fork tilt is 4° up and 3° down.

With the key switch ON and the right foot pedal depressed, pressing the tilt down button causes an increase in voltage to be sensed at JP10-6 on the Tractor Interface Card. The Tractor Interface Card sends a signal to the Display Card through the serial lines at JPD2. The Display Card responds by:

- requesting the Tractor Interface Card to enable voltage to the direction A solenoid coil (Y13) at JP6-7
- requesting the Tractor Interface Card to enable the tilt solenoid (Y17) through JP7-20 to X14-3 on the reach carriage
- sending a message over CAN Bus +/– to the lift power amplifier at JL2-3 and JL2-6

The message to the lift power amplifier provides the PWM frequency rate to pulse the lift motor. Oil is fed through direction A (Y12) valve to the tilt (Y17) valve to the front port of the tilt cylinder, driving the piston inward. The oil flows from the rear port of the tilt cylinder to the direction B (Y13) valve to the reservoir. The table below gives auxiliary control pin numbers and associated functions:

JP6-	**Function**	**JP10-**	**Function**
7	Switched B– for DIRA SOL	1	Reach Switch Input
6	Switched B– for DIRB SOL	2	Retract Switch Input
4	B+PCF for DIRA and DIRB SOL's	5	Fork Tilt Up Input
3	B+Key for Lift and Prop. Lower	6	Fork Tilt Down Input
10	Switched B– for Lift	4	B– for Sideshift Left Input
9	Switched B– for Prop. Lower	3	B– for Sideshift Right Input
		14	Analog Ground for S4 - S9
JP7-	**Function**		
13	AGND for Deadman S3	**X14-**	**Function**
14	Deadman Input	8	B+ Relay for Reach, Sideshift and Tilt SOL's
		1	Switched B– for Reach SOL1
JP8-	**Function**	2	Switched B– for Reach SOL2
6	Switched B– for MM Contactor Coil	4	Switched B– for Sideshift SOL
2	ESTOP B+ for MM Contactor Coil	3	Switched B– for Tilt SOL

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Indicators and Switches

Traction Motor Brush Wear Indicator

The traction motor on this lift truck contains a pair of brush wear indicator switches. When the brushes need replacing, an icon will light on the operator display. This is accomplished by metal bars, attached to the north and south poles of the brush housing, coming in contact with the brush housing as the brush wears down. This completes a circuit allowing B+ battery voltage on the Tractor Interface Card at points JP7-15 or 16 (depending on whether the north or south pole brushes are worn). The Tractor Interface Card sends a signal through the serial line (JPD2-1) to the Display Card. The Display Card processes the input and signals the brush wear indicator, on the Operator Display, to light by sending voltage through HD2-6.

Travel is limited to 2.5 mph when the brush wear warning icon is lit. Brushes should be inspected or replaced when the icon becomes illuminated.

Lift Motor Brush Wear Indicator

The lift motor on this lift truck contains a pair of brush wear indicator switches. When the brushes need replacing, an icon will light on the operator display. This is accomplished by metal bars, attached to the north and south poles of the brush housing, coming in contact with the brush housing as the brush wears down. This completes a circuit allowing B+ battery voltage on the Tractor Interface Card at points JP16-1 or 2 (depending on whether the north or south pole brushes are worn). The Tractor Interface Card sends a signal through the serial line (JPD2-1) to the Display Card. The Display Card processes the input and signals the brush wear indicator, on the Operator Display, to light by sending voltage through HD2-6.

Lift is limited to 25% of full speed when the brush wear warning icon is lit. Brushes should be inspected or replaced when the icon becomes illuminated.

180° Sensor

The 180° steering wheel sensor receives directional information from drive gear rotation. It passes this information on to the Tractor Interface Card through JP9-7. The Tractor Interface Card then sends the information to the Display Card for processing.

Drive Wheel Position Proximity Sensor A and Sensor B

The drive wheel position proximity sensors work as a pair to derive direction and position information. Each sensor receives directional information from drive gear rotation. The channel “A” sensor transmits a voltage to the Tractor Interface Card at JP13-1. The channel “B” sensor transmits a voltage to the Tractor Interface Card at JP11-1. The Tractor Interface Card then relays the information from both sensors to the Display Card for processing.

Drive Motor Speed/Direction Indicators

The drive motor speed/direction indicators (PROXA and PROXB) receive speed and directional information from the sensor nut attached to the top of the drive motor. This information is reported through HD5 to the Display Card for processing.

Wheel Direction Indicator (360° Steer)

The wheel direction indicator is located on the operator display. It is activated by the Display Card. The Display Card uses inputs received from the drive wheel position proximity sensors to determine wheel position and light the appropriate steer direction LED.

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Mast Switch 1 (S6) (Speed Limiting)

Mast Switch 1 (S6) operates when forks are raised above freelift height. This opens the circuit to the Tractor Interface Card at JP9-16. The Tractor Interface Card sends the signal to the Display Card for processing. The Display Card processes the information to determine the speed on the drive motor rotation. Using this information, the Display Card sends a message through CAN Bus +/– to the Traction Power Amplifier to reduce the overall truck speed to the requested value.

Lift Limit Switch (S4)

After lifting to a selected height, Lift Limit switch (S4) opens the circuit to the Tractor Interface Card at JP9-15. The Tractor Interface Card sends this information to the Display Card for processing. The Display Card processes the information and:

- sends a message through CAN Bus +/– to the lift power amplifier to stop pulsing the lift motor, preventing further lift
- sends voltage to light the lift/limit icon on the operator display

If the lift truck is equipped with the lift/limit by-pass option, pressing the up arrow switch on the operator display will send a message to the Display Card. The Display Card will process the information and send a message through CAN Bus +/– to the lift power amplifier to once again pulse the lift motor.

Platform (Right Foot) Switch (S7)

The platform (right foot) switch allows lift and auxiliary functions to operate without depression of the left deadman pedal.

Depressing the platform switch allows voltage at JP9-14 on the Tractor Interface Card. The Tractor Interface Card relays a signal to the Display Card that voltage has been received. The Display Card processes this information and allows lift/lower or auxiliary functions to be enabled when requested.

Staging Switch (S8)

The staging switch is located on the side of the mast. Its function is to let the Tractor Interface Card know when the carriage has almost completed the first stage of lift (freelift). When the staging switch is closed, B+ voltage is received at JP15-2 on the Tractor Interface Card. The Tractor Interface Card relays a signal to the Display Card. The Display Card processes the information and sends a reduced speed command (if in configure mode staging switch is set to “yes”) over CAN Bus +/– to the lift power amplifier, thus slowing the lift speed during the staging transition.

Pressure Transducer (Weight) - Option

The pressure transducer monitors the pressure in the hydraulic system to give the operator an approximate figure on the display. Input voltage is received at JP14-3 on the Tractor Interface Card. The Tractor Interface Card relays the voltage information to the Display Card for processing. The Display Card then displays the approximate weight values on the Operator Display.

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Appendix

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Lubrication Equivalency Chart

Approved Toyota Lubricants			
Where Used	**Type**	**Approved Manufacturer**	**Toyota Part Number**
Drive Unit Gear Case above 30°F (-1°C)	Gear Lubricant	Forsythe Ltd. Shell Spirax HD	00590-04834-71 (1 qt./0.9 liter) 00590-04838-71 (5 gal./18.9 liters)
Drive Unit Gear Case below 30°F (-1°C) Lift Chains	Oil	Chevron Delco 400 15W-40 API Service SE Citgo C-6 10W-30 Motor Oil MIL-H-46152 Exxon Extra Motor Oil 10W-30 API Service SE Gulflube Motor Oil X.H.D. 10W-30 Mobil Delvac Special 10W-30 API Service SE Phillips Trop-Arctic All Season Motor Oil 10W-40 MIL-L-46152 Shell Rotella T 15W-40 API Service SE, CC and CD Sohio Multron 10W-30 MIL-L-46152 API Service SE Texaco URSATEX 10W-30 2166	00590-04835-71 (1 qt./0.9 liter) 00590-04837-71 (5 gal./18.9 liters)
Hydraulic Reservoir (non-cold storage trucks)	Hydraulic Fluid	Chevron AW ISO 46 Citgo 46 Exxon Nuto H 46 Forsythe AWTH215 ISO46 Mobil DTE-1B NOCO NOCOLUBE AW46 Texaco Cygnus 46 or HD 46 Ultramar Ultra Hydraulik AW46	005900-04934-71 (2 gal./7.6 liters) 00590-04840-71 (5 gal./18.9 liters)
Hydraulic Reservoir (cold storage trucks) (+40 to -20°F) (4°to -29°C)	Hydraulic Fluid	Exxon Univis J13 (similar to MIL-H-5606A) Mobil Aero HFA Texaco Aircraft Hydraulic Fluid 15	00590-04841-71 (1 gal./3.785 liters)

Figure 1-1: Lubrication Equivalency Chart

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Approved Toyota Lubricants			
Where Used	**Type**	**Approved Manufacturer**	**Toyota Part Number**
Hydraulic Reservoir (cold storage trucks) (20 to 70°F) (-6 to 21°C)	Hydraulic Fluid	NOCO NOC 1866 Shell Tellus T Oil 32 Texaco HD AZ 32 1627 Rando or Cygnus 32	00590-04842-71 (1 gal./3.785 liters) 00590-04843-71 (5 gal./18.9 liters)
Hydraulic Reservoir (for extreme heating conditions)	Hydraulic Fluid	Chevron AW-MV Mobil 423 or 424 NOCO Torque TDH	00590-04842-71 (1 gal./3.785 liters)
Bearings	Grease	Chevron Avi-Motive Grease Citgo HEP2 (above 30°F only) Exxon RONEX MP or UNIREX N2 Gulf Gulfcrown Grease No. 2 Mobil Grease 77 Phillips Philube 1B and RB Grease Shell Alvania Grease EP2 Sohio Bearing Guard “LT” Texaco Regal AFB 2 Grease MIL-G-18709A	00590-04844-71 (10 cartridges per case) 00590-04845-71 (5 gal./18.9 liters)

Figure 1-1: Lubrication Equivalency Chart

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Torque Chart - Standard (Ferrous)

Grade Identification Marking	None					
Size	SAE Grade 2 Bolts Tightening Torque		SAE Grade 5 Bolts Tightening Torque		SAE Grade 8 Bolts Tightening Torque	
	Dry	Oiled*	Dry	Oiled*	Dry	Oiled*
	in. lb.	in. lb.	in. lb.	in. lb.	in. lb.	in. lb.
4-40	5	4	8	6	12	9
4-48	6	5	9	7	13	10
6-32	10	8	16	12	23	17
8-32	19	14	30	22	41	31
8-36	20	15	31	23	43	32
10-24	27	21	43	32	60	45
10-32	31	23	49	36	68	51
1/4-20	66	49	96	75	144	108
1/4-28	78	56	120	86	168	120
	ft. lb.	ft. lb.	ft. lb.	ft. lb.	ft. lb.	ft. lb.
5/16-18	11	8	17	13	25	18
5/16-24	12	9	19	14	25	20
3/8-16	20	15	30	23	45	35
3/8-24	23	17	35	25	50	35
7/16-14	30	24	50	35	70	55
7/16-20	35	25	55	40	80	60
1/2-13	50	35	75	55	110	80
1/2-20	55	40	90	65	120	90
9/16-12	65	50	110	80	150	110
9/16-18	75	55	120	90	170	130
5/8-11	90	70	150	110	220	170
5/8-18	110	85	180	130	240	180
3/4-10	160	120	260	200	380	280
3/4-16	180	140	300	220	420	320
7/8-9	140	110	400	300	600	460
7/8-14	155	120	440	320	660	500
1-8	220	160	580	440	900	680
1-12	240	170	640	480	1000	740
1 1/8-7	300	220	800	600	1280	960
1 1/8-12	340	260	880	660	1440	1080
1 1/4-7	420	320	1120	840	1820	1360
1 1/4-12	460	360	1240	920	2000	1500
1 3/8-6	560	420	1460	1100	2380	1780
1 3/8-12	640	460	1680	1260	2720	2040

Figure 1-2: Torque Chart - Standard
** NOTE: Use "oiled" values for bolts with thread locking compound*

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Grade Identification Marking	None					
Size	SAE Grade 2 Bolts Tightening Torque		SAE Grade 5 Bolts Tightening Torque		SAE Grade 8 Bolts Tightening Torque	
	Dry	Oiled*	Dry	Oiled*	Dry	Oiled*
	in. lb.	in. lb.	in. lb.	in. lb.	in. lb.	in. lb.
1 1/2-6	740	560	1940	1460	3160	2360
1 1/2-12	840	620	2200	1640	3560	2660

Figure 1-2: Torque Chart - Standard
** NOTE: Use "oiled" values for bolts with thread locking compound*

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Torque Chart - Standard (Brass)

Brass MS63 Standard Bolts, Coarse Thread		
Size	**Torque (with bolts oiled*)**	
	Newton-meters	**Inch-pounds**
4-40	0.37	3.3
4-48	0.40	3.6
6-32	0.69	6.1
6-40	0.77	6.8
8-32	1.24	11
8-36	1.24	11
10-24	1.58	14
10-32	1.92	17
1/4-20	3.96	35
1/4-28	4.52	40
5/16-18	8.25	73
5/16-24	9.15	81
3/8-16	14.69	130
3/8-24	16.61	147

Figure 1-3: Torque Chart - Standard Brass
** NOTE: Use "oiled" values for bolts with thread locking compound*

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Torque Chart - Metric

Ferrous Metric Bolts, Coarse Thread (The grade rating is stamped on the head of the bolt.)				
Diameter (in millimeters)	Grade 8.8		Grade 10.9	
	Torque (with bolts oiled*)		Torque (with bolts oiled*)	
	Newton-meters	Foot-pounds	Newton-meters	Foot-pounds
6	8.6	6	12	9
8	21	15	29	21
10	42	30	68	43
12	72	55	101	75
16	174	130	245	181
20	340	255	475	350
24	580	435	820	605

Figure 1-4: Torque Chart - Ferrous Metric
** NOTE: Use "oiled" values for bolts with thread locking compound*

Brass MS63 Metric Bolts, Coarse Thread		
Diameter (in millimeters)	Torque (with bolts oiled*)	
	Newton-meters	Inch-pounds
3	0.5	4.4
3.5	0.79	7.0
4	1.2	10
5	2.2	19
6	3.9	34
8	9	79
10	17	150

Figure 1-5: Torque Chart - Brass Metric
** NOTE: Use "oiled" values for bolts with thread locking compound*

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Decimal Equivalent Chart

4ths	8ths	16ths	32nds	64ths	To 3 Places	To 2 Places	MM Equivalent
				1/64	.016	.02	.397
			1/32		.031	.03	.794
				3/64	.047	.05	1.191
		1/16			.062	.06	1.587
				5/64	.078	.08	1.984
			3/32		.094	.09	2.381
				7/64	.109	.11	2.778
	1/8				.125	.12	3.175
				9/64	.141	.14	3.572
			5/32		.156	.16	3.969
				11/64	.172	.17	4.366
		3/16			.188	.19	4.762
				13/64	.203	.20	5.159
			7/32		.219	.22	5.556
				15/64	.234	.23	5.593
1/4					.250	.25	6.350
				17/64	.266	.27	6.747
			9/32		.281	.28	7.144
				19/64	.297	.30	7.540
		5/16			.312	.31	7.937
				21/64	.328	.33	8.334
			11/32		.344	.34	8.731
				23/64	.359	.36	9.128
	3/8				.375	.38	9.525
				25/64	.391	.39	9.922
			13/32		.406	.41	10.319
				27/64	.422	.42	10.716
		7/16			.438	.44	11.112
				29/64	.453	.45	11.509
			15/32		.469	.47	11.906
				31/64	.484	.48	12.303
1/2					.500	.50	12.700

Figure 1-6: Decimal Equivalent Chart

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4ths	8ths	16ths	32nds	64ths	To 3 Places	To 2 Places	MM Equivalent
				33/64	.516	.52	13.097
			17/32		.531	.53	13.494
				35/64	.547	.55	13.891
		9/16			.562	.56	14.288
				37/64	.578	.58	14.684
			19/32		.594	.59	15.081
				39/64	.609	.61	15.478
	5/8				.625	.62	15.875
				41/64	.641	.64	16.272
			21/32		.665	.66	16.669
				43/64	.672	.67	17.065
		11/16			.688	.69	17.462
				45/64	.703	.70	17.859
			23/32		.719	.72	18.256
				47/64	.734	.73	18.653
3/4					.750	.75	19.050
				49/64	.766	.77	19.447
			25/32		.781	.78	19.844
				51/64	.797	.80	20.241
		13/16			.812	.81	20.637
				53/64	.828	.83	21.034
			27/32		.844	.84	21.431
				55/64	.859	.86	21.828
	7/8				.875	.88	22.225
				57/64	.891	.89	22.622
			29/32		.906	.91	23.019
				59/64	.922	.92	23.416
		15/16			.938	.94	23.812
				61/64	.953	.95	24.209
			31/32		.969	.97	24.606
				63/64	.984	.98	25.003
					1.000	1.00	25.400

Figure 1-6: Decimal Equivalent Chart

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Standard/Metric Conversions

To Convert...	Multiply...
Inches to Millimeters	Inches x 25.4
Millimeters to Inches	Millimeters x 0.039
Inches to Centimeters	Inches x 2.54
Centimeters to Inches	Centimeters x 0.394
Feet to Meters	Feet x 0.305
Meters to Feet	Meters x 3.281
Yards to Meters	Yards x 0.914
Meters to Yards	Meters x 1.094
Miles to Kilometers	Miles x 1.609
Kilometers to Miles	Kilometers x 0.621
Square Inches to Square Centimeters	Square Inches x 6.452
Square Centimeters to Square Inches	Square Centimeters x 0.155
Square Feet to Square Meters	Square Feet x 0.093
Square Meters to Square Feet	Square Meters x 10.753
Square Yards to Square Meters	Square Yards x 0.836
Square Meters to Square Yards	Square Meters x 1.196
Pints to Liters	Pints x 0.473
Liters to Pints	Liters x 2.113
Quarts to Liters	Quarts x 0.946
Liters to Quarts	Liters x 1.057
Gallons to Liters	Gallons x 3.785
Liters to Gallons	Liters x 0.26
Ounces to grams	Ounces x 28.35
Grams to ounces	Ounces x 0.035
Ounces to kilograms	Ounces x 0.028
Kilograms to ounces	Kilograms x 35.27
Pounds to Kilograms	Pounds x 0.454
Kilograms to pounds	Kilograms x 2.2

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To Convert...	Multiply...
Pounds per Square Inch (psi) to Kilo pascals (kPa)	Pounds per Square Inch x 6.894
Kilopascals to Pounds per Square Inch	Kilopascals x 0.145
Pounds per Square Inch (psi) to Kilograms per square centimeter (kg/cm^2)	Pounds per Square Inch (psi) x 0.0704
Kilograms per square centimeter (kg/cm^2) to Pounds per Square Inch (psi)	Kilograms per square centimeter ($kg/cm^{2)}$ x 14.2
Inch Pounds (in. lb.) to Newton Meters (Nm)	Inch Pounds x 0.113
Newton Meters (Nm) to Inch Pounds (in. lb.)	Newton Meters x 8.85
Foot Pounds (ft. lb.) to Newton Meters (Nm)	Foot Pounds x 1.3568
Newton Meters (Nm) to Foot Pounds (ft. lb.)	Newton Meters x 0.737
Miles per hour to kilometers per hour	Kilometers per hour x 1.609
Kilometers per hour to miles per hour	Miles per hour x 0.6214
Fahrenheit to Celsius	(°F - 32) x 0.555
Celsius to Fahrenheit	(°C x 1.8) + 32

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Electrical Schematics

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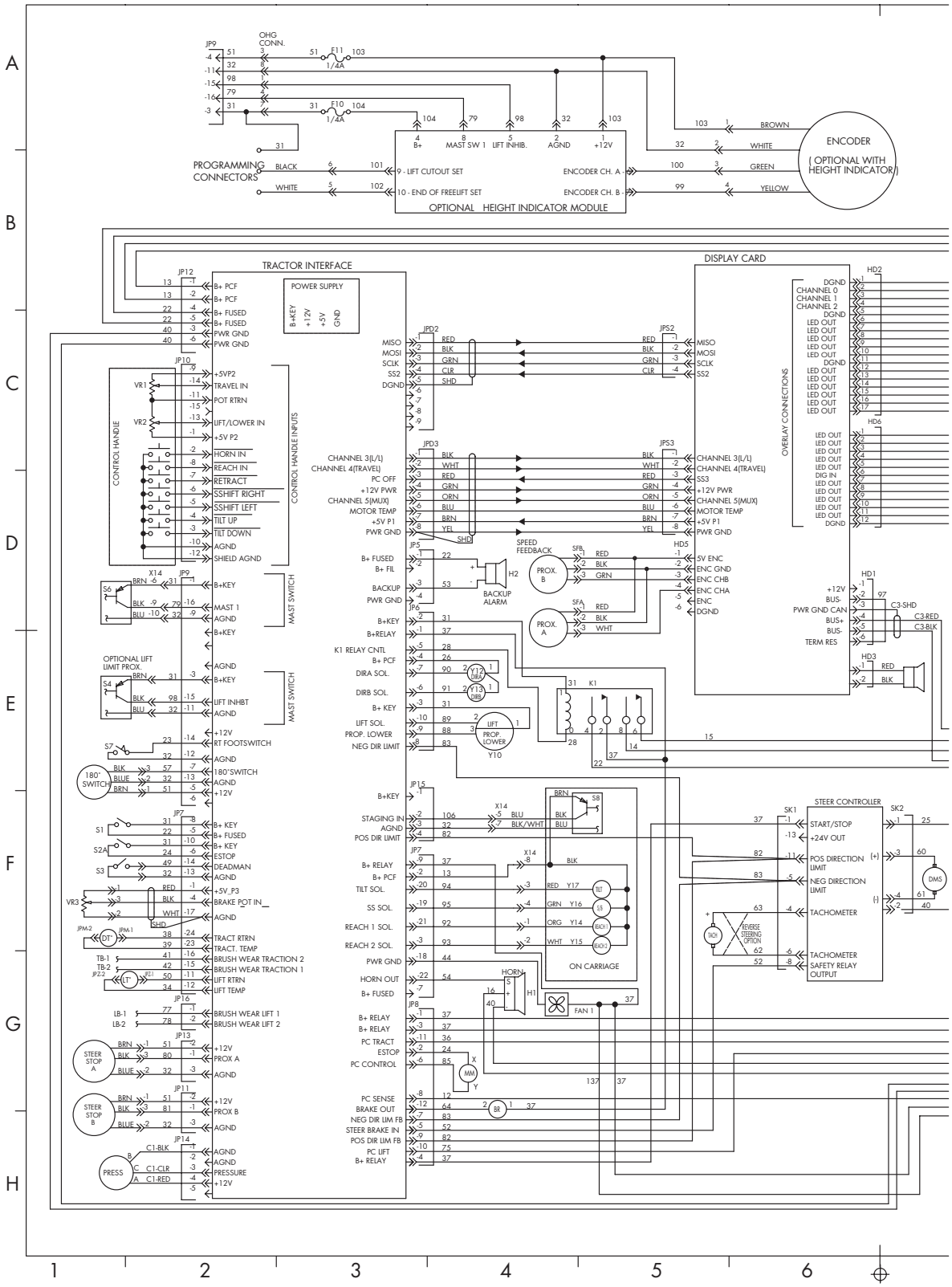
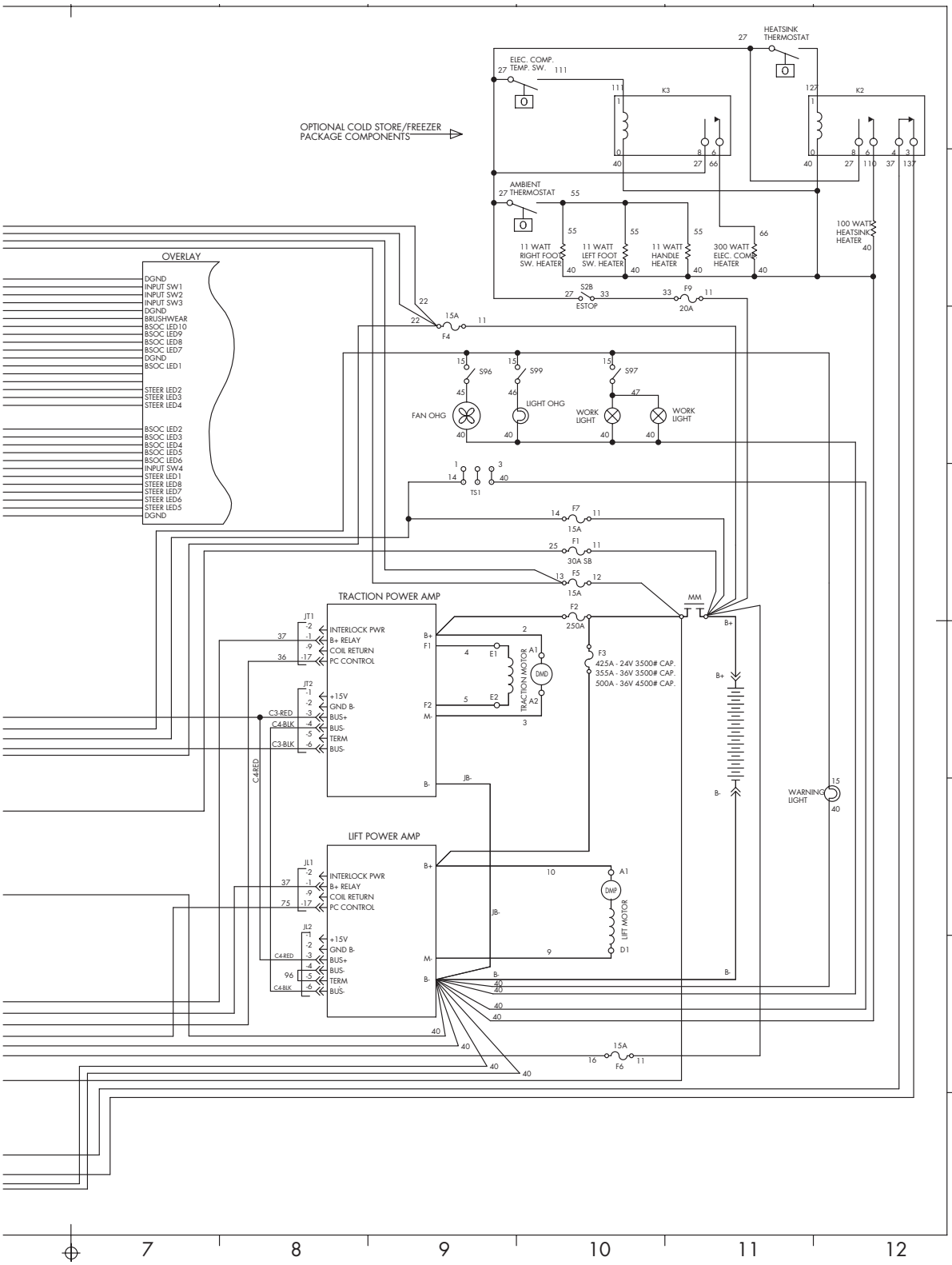


Figure 1-1: Electrical Schematic (180° Steering) - Part 1 of 2

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Electrical Schematic (180° Steering) - Part 2 of 2

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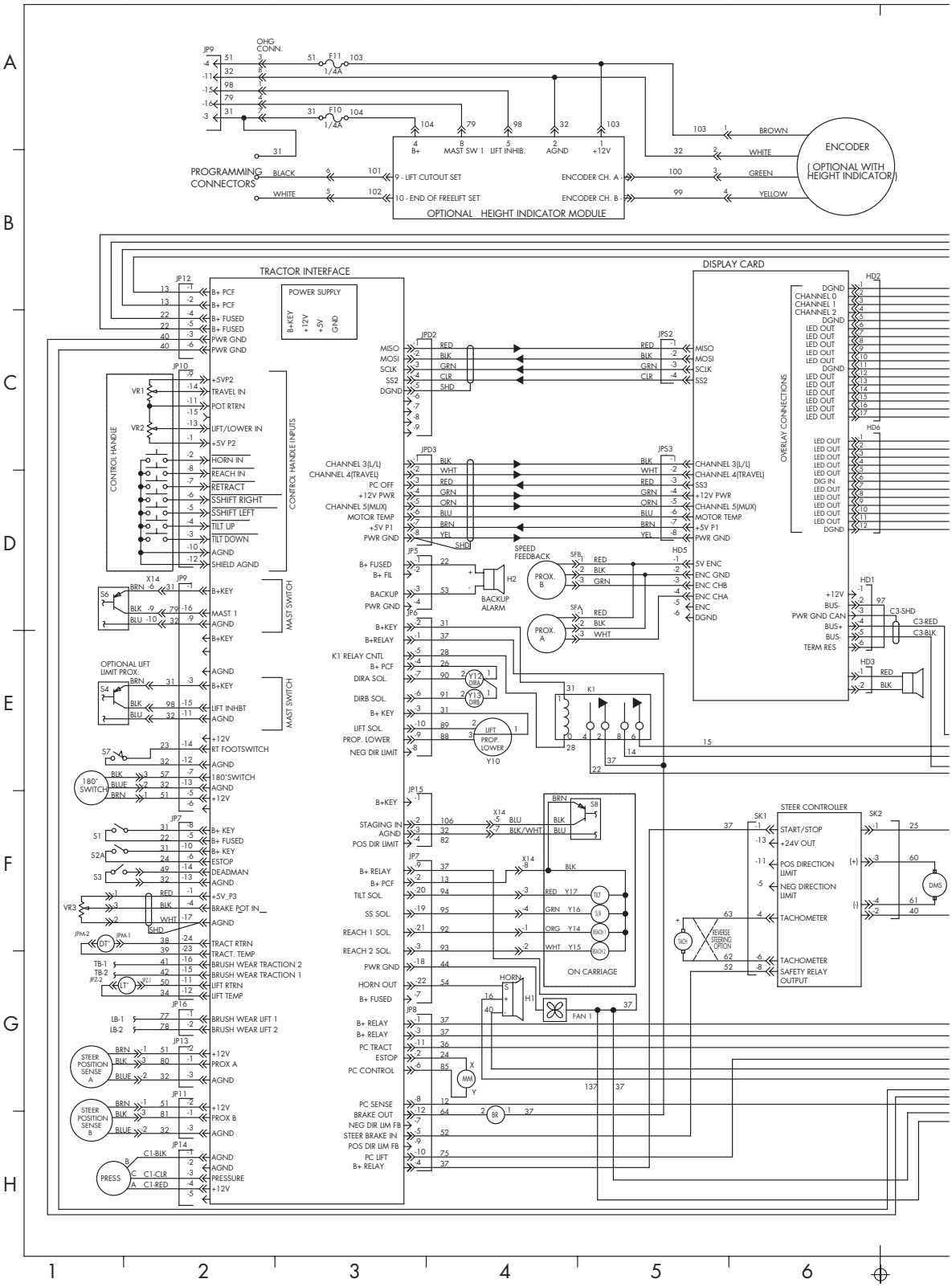
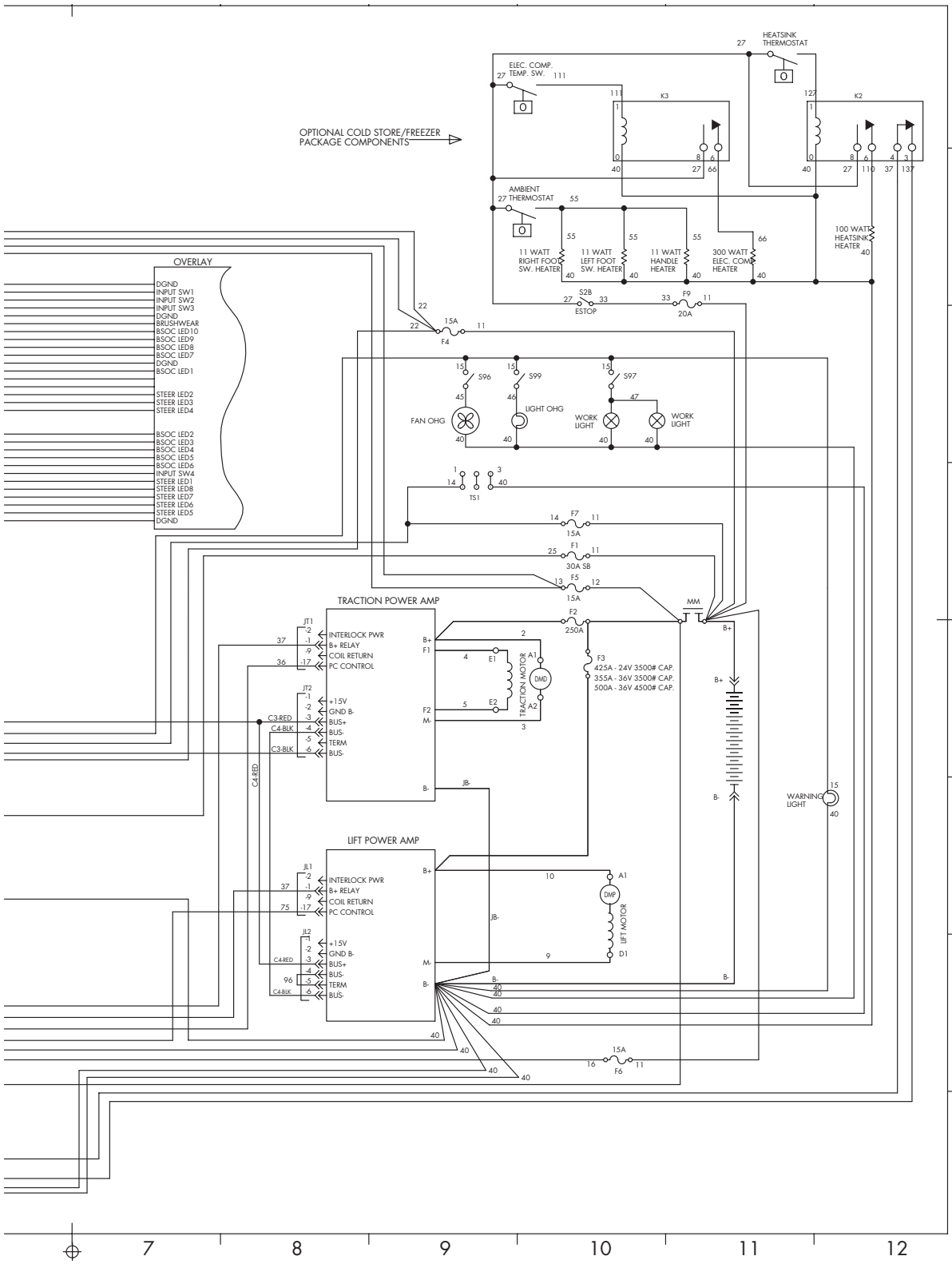


Figure 1-2: Electrical Schematic (360° Steering) - Part 1 of 2

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Electrical Schematic (360° Steering) - Part 2 of 2

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Electrical Schematic Legend

KEY	DESCRIPTION
BR	Brake Coil
DIRA	Direction A Solenoid
DIRB	Direction B Solenoid
DMD	Drive Motor (Traction Motor)
DMP	Lift Motor
DMS	Steering Motor
DT	Drive Motor Temperature Sensor
LIFT	Lift Solenoid
F1	Control Fuse for B+ Steering (30A)
F2	Power Fuse for Traction Power Amplifier (250A)
F3	Power Fuse for Lift Power Amplifier (See Note)
F4	Control Fuse for B+ Fused (15A)
F5	Control Fuse for B+ PFC (15A)
F6	Control Fuse for Power Ground (15A)
F7	Control Fuse for Work Lights and Fan (Option) (15A)
F8	Control Fuse for Warning Light
FAN 1	Lift Motor Cooling Fan
FAN 2	Operator Cooling Fan
H1	Horn
H2	Backup Alarm (Optional)
HD1	CAN Bus Connector on Display Card
HD2	Overlay Connector on Display Card
HD3	Sonalert Connector on Display Card
HD5	Proximity Connector on Display Card
HD6	Overlay Connector on Display Card
JL1	Lift Power Amplifier Power Connector
JL2	Lift Power Amplifier CAN Bus Connector
JP5	Tractor Interface Backup Alarm Connector
JP6	Tractor Interface Solenoid Connector
JP7	Tractor Interface Connector
JP8	Tractor Interface Connector
JP9	Tractor Interface Connector
JP10	Tractor Interface Control Handle Connector
JP11	Tractor Interface Drive Wheel Position B Proximity Input
JP12	Tractor Interface Power Connector
JP13	Tractor Interface Drive Wheel Position A Proximity Input
JP14	Tractor Interface Pressure Transducer Connector
JP15	Tractor Interface Spare Solenoid Driver and Staging Switch Connector
JP16	Tractor Interface Lift Brush Wear Connector
JPD2	Tractor Interface Connector for Display
JPD3	Tractor Interface Connector for Display
JPS2	Display Card Serial Communication Connector

KEY	DESCRIPTION
JPS3	Display Card Analog Input Connector
JT1	Traction Power Amplifier Power Connector
JT2	Traction Power Amplifier CAN Bus Connector
JPM	Traction Motor Thermistor Connector
JPZ	Lift Motor Thermistor Connector
K1	Key Switch Relay
LB	Lift Brush Wear Connector
WORK LIGHT	Work Light (Option)
LIGHT OHG	Overhead Guard Light
LT	Lift Motor Temperature Sensor
MM	Power Disconnect Contactor
P/L	Proportional Lower
PRESS	Pressure Transducer
PROXA	Speed Direction Feedback Proximity Sensor
PROXB	Speed Direction Feedback Proximity Sensor
WHEEL POS.	Drive Wheel Position A Feedback Sensor
WHEEL POS.	Drive Wheel Position B Feedback Sensor
180 SWITCH	Drive Wheel 180 Degree Switch
REACH1	Reach1 Solenoid
REACH2	Reach2 Solenoid
S1	Key Switch
S2	EPO Switch
S3	Deadman Switch
S4	Lift Inhibit Switch
S5	Mast Switch 2 (Spare)
S6	Mast Switch 1 (Speed Limiting)
S7	Right Foot Switch
S8	Staging Switch
S96	FAN2 Switch
S97	Working Light Switch
S99	Overhead Guard Light Switch
SFA	PROXA Connector
SFB	PROXB Connector
SK1	Steer Controller Connector
SK2	Steer Controller Connector
S/S	Sideshift Solenoid
TACH	Steering Wheel Position Tachometer
TB	Traction Brush Wear Connector
TILT	Tilt Solenoid
TS1	Power Hook-up for On Board Terminal (Option)
VR1	Travel Potentiometer
VR2	Lift Potentiometer
VR3	Brake Potentiometer
WL	Warning Light (Option)

Note: Fuse size depends upon Model.

350A = 36V Models 7BSU20 and 7BRU18

425A = 24V Models 7BSU20 and 7BRU18

500A = 36V Models 7BSU25, 7BRU23, and 7BDRU15

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Hydraulic Schematic - 7BRU18/7BRU23

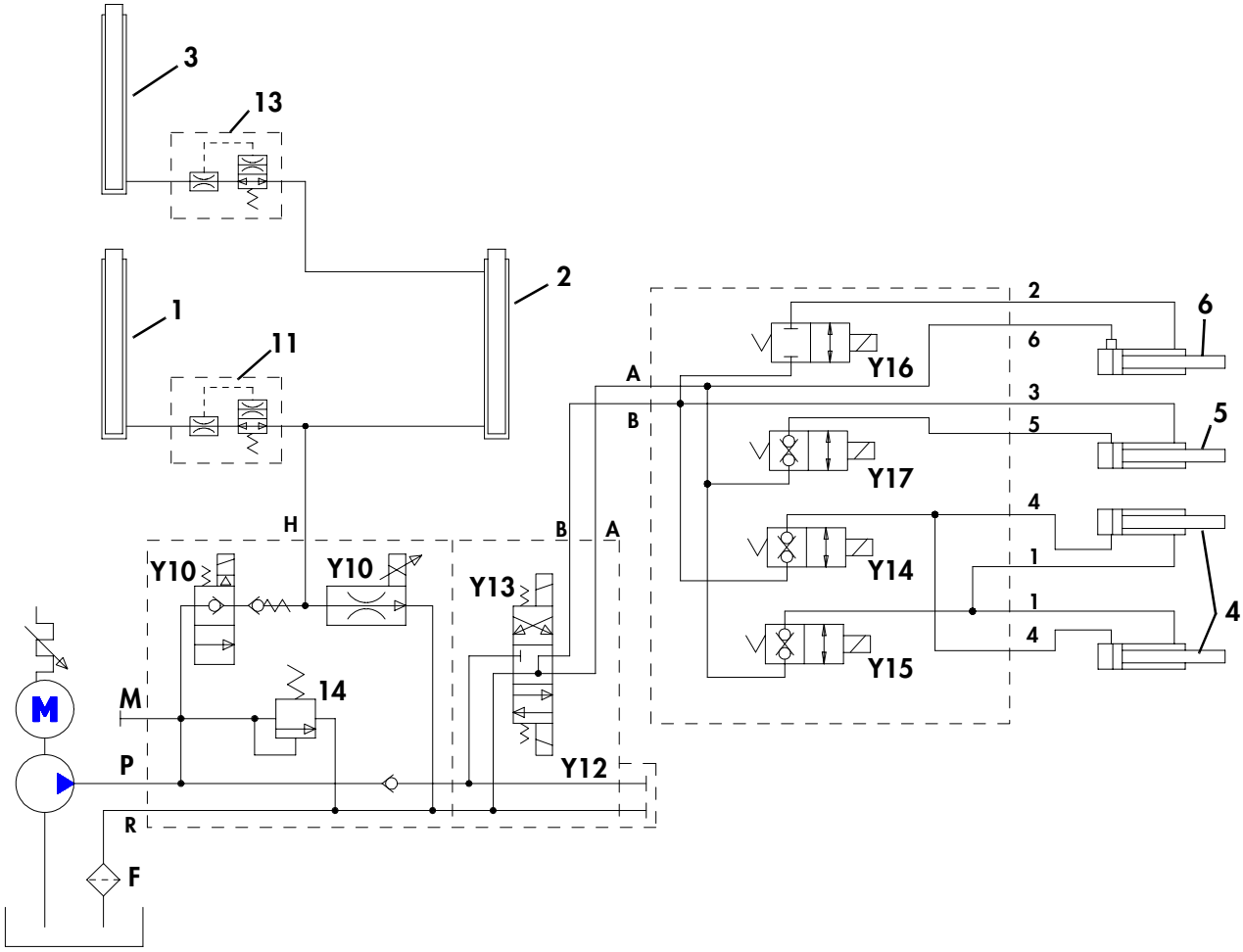


Figure 1-3: 7BRU18/7BRU23

KEY	DESCRIPTION
1, 2	Staging Cylinder
3	Freelift Cylinder
4	Reach/Retract Cylinder
5	Tilt Cylinder
6	Sideshift Cylinder
11	Staging Velocity Fuse
13	Freelift Velocity Fuse
14	Relief Valve
F	Filter

KEY	DESCRIPTION
M	Pump Motor
P	Pump
Y10	Lift/Proportional Lower Valve
Y12	Direction A Valve
Y13	Direction B Valve
Y14	Reach Valve
Y15	Retract Valve
Y16	Sideshift Valve
Y17	Tilt Valve

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Hydraulic Schematic - 7BDRU15

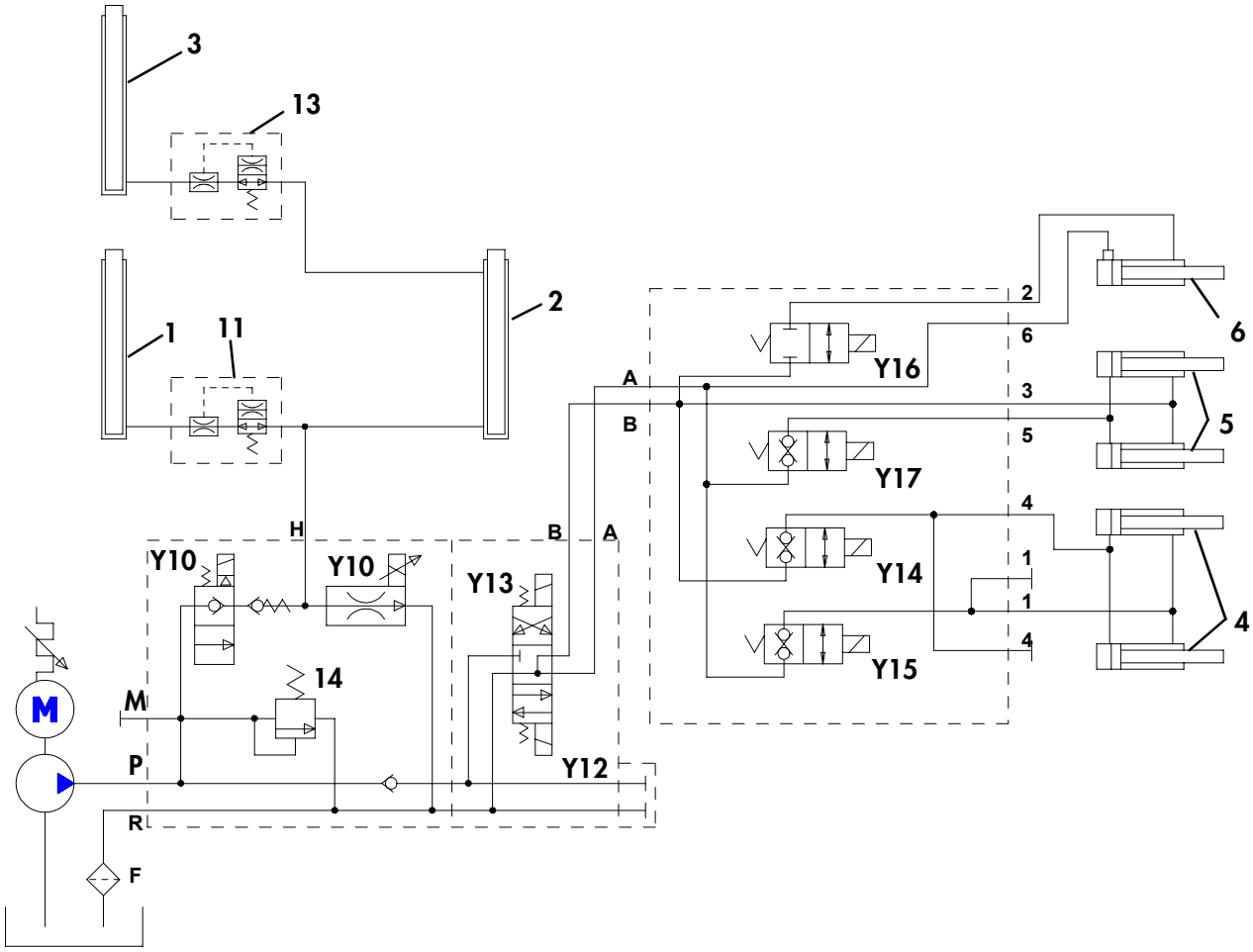


Figure 1-4: 7BDRU15

KEY	DESCRIPTION	KEY	DESCRIPTION
1, 2	Staging Cylinder	M	Pump Motor
3	Freelift Cylinder	P	Pump
4	Reach/Retract Cylinder	Y10	Lift/Proportional Lower Valve
5	Tilt Cylinder	Y12	Direction A Valve
6	Sideshift Cylinder	Y13	Direction B Valve
11	Staging Velocity Fuse	Y14	Reach Valve
13	Freelift Velocity Fuse	Y15	Retract Valve
14	Relief Valve	Y16	Sideshift Valve
F	Filter	Y17	Tilt Valve

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Hydraulic Schematic - 7BSU20/25

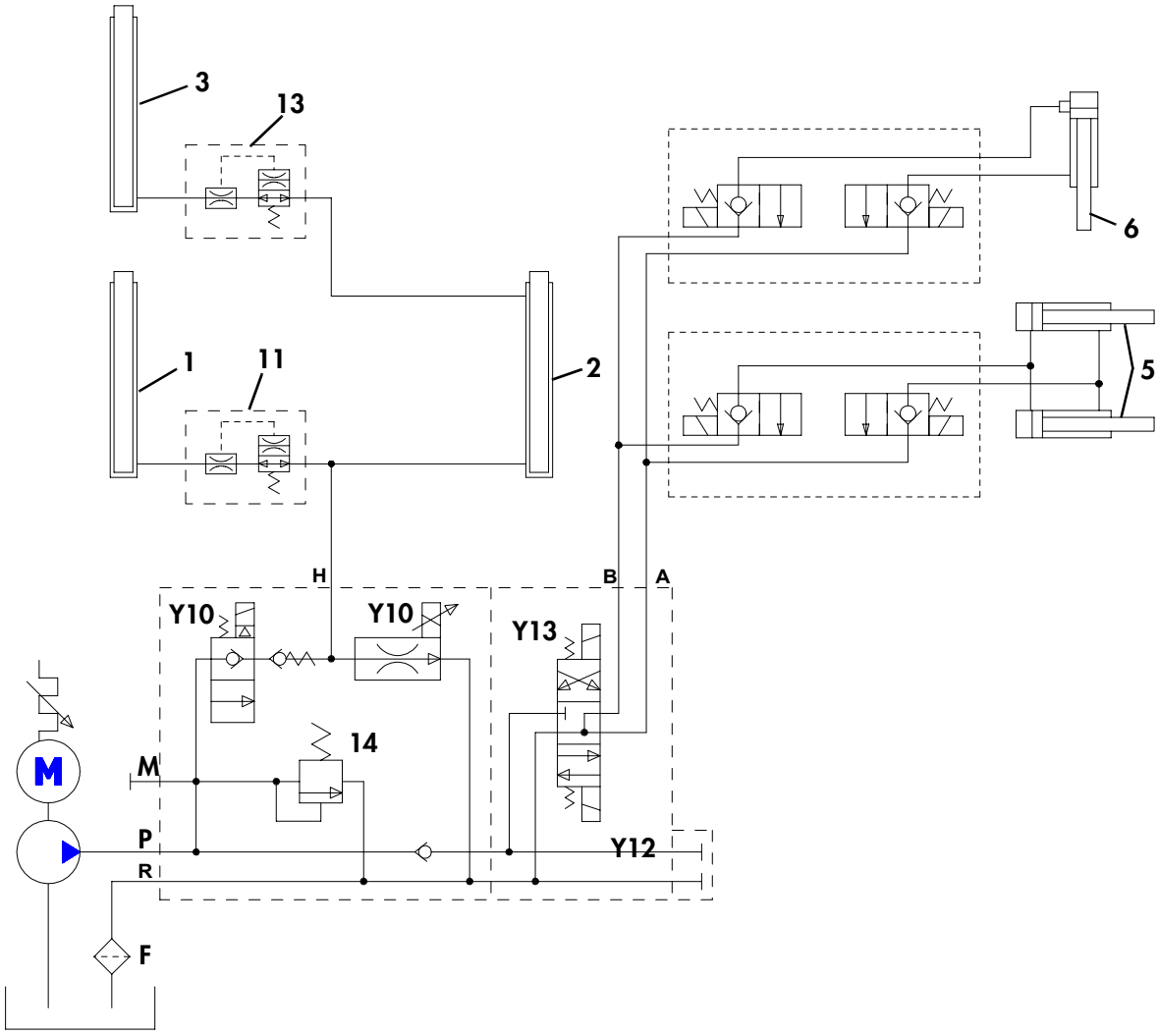


Figure 1-5: 7BSU20/7BSU25

KEY	DESCRIPTION
1, 2	Staging Cylinder
3	Freelift Cylinder
5	Tilt Cylinder
6	Sideshift Cylinder
11	Staging Velocity Fuse
13	Freelift Velocity Fuse
14	Relief Valve
F	Filter

KEY	DESCRIPTION
M	Pump Motor
P	Pump
Y10	Lift/Proportional Lower Valve
Y12	Direction A Valve
Y13	Direction B Valve
Y16	Sideshift Valve
Y17	Tilt Valve

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