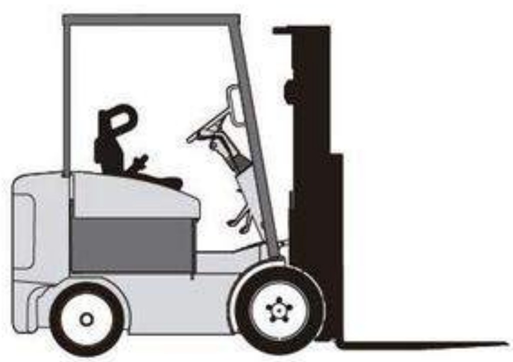
ECX20-32
EPX 20-32

SERVICE MANUAL

RATED CAPACITY : 2000~3200kg



Book No. SM-717

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CLARK
THE FORKLIFT

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Truck Models Covered by this Manual

This manual consists of a "base" module that pertains to ECX 20-32, EPX 20-32 models and other modules that pertain only to specific models. Manuals shipped with the truck contain the base module and the module specific to the purchased truck.

You may, however, purchase specific modules and expand your manual to fully cover multiple models. To do so, order the desired modules as you would any other Clark part.

Arrangement and Use of this Manual

Clark arranges parts and service procedures by standardized *Groups*. In this manual, Groups are similar to "chapters". Groups are listed in the indexes on the next page.

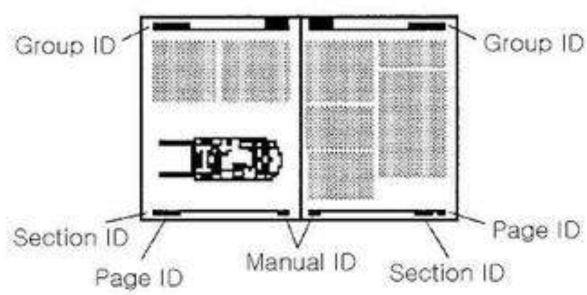
Each Group begins with a table of contents that shows the *Sections* contained within the Group. Lengthy Sections also begin with a table of contents.

Each Group and Section has an identifying name and number, or "ID".

Each page also has a unique ID. The page ID consists of three numbers separated by hyphens. The three numbers represent the Group number, the Section number, and the page number. For example, "00-1-2" on the lower corner of the page indicates Group 00, Section 1, page 2.

The Group number sometimes has a letter added to it in parentheses if one or more variations of the Group exist. For example, if the truck has a standard transaxle, Group 06 is expressed as "06(S)"; if the truck has a hydrostatic transmission, Group 06 is expressed as "06(H)".

You can quickly locate a specific point in the manual by using the headers and footers that appear on every Section page. The following illustration points out these areas.



IMPORTANT

This manual is intended for the use of trained service personnel. Please read Group SA, "Safe Maintenance", and the *Operator's Manual* before working on or operating the truck.

Foreword

This service publication provides information covering normal service, maintenance and repair of the Clark industrial lift trucks noted on the cover. It has been specifically prepared to help owners and service personnel maintain these trucks in efficient and safe operating condition.

This manual is intended for use by persons who are trained and authorized to do lift truck maintenance. It is designed to provide essential information about the correct and safe service maintenance and repair of the truck by trained mechanics or service technicians.

The Pictorial Contents lists components or systems by Basic Group Number of Major Parts. Additional content listings are placed at the beginning of each Section in the manual.

General and detailed service and repair procedures are outlined (as required) for each component or subsystem. Some procedures include explanations that are common to sevral components or subsystems. Not every configuration can be pictured. Only "base" module and original designs are shown.

Procedures have been made easier to use by providing specific steps only when necessary and general instructions required to explain the activity, component, assembly, or process being worked on. The technician is expected to include obvious additional steps of standard procedure for removal, disassembly, cleaning, inspection, reassembly, installation, etc., as needed.

To be better prepared to do the necessary service work, take time to completely read the entire procedure, including any special instructions, before starting any work.

Before beginning to work, the technician is cautioned and expected to:

- Do all necessary service work.
- Take time to read entire procedures, including any special instructions.
- Contact Clark dealer or, Clark with any questions or procedures not addressed in this manual.

NOTICE

The descriptions and specifications included in this manual were in effect at the time of printing. Clark reserves the right to discontinue models at any time, or make improvements and changes in specifications or design without notice and without incurring obligation. Specifications, torques, pressures, measurements, adjustments, illustrations and other items may change at any time. Contact your authorized CLARK dealer for information on possible updates or revisions.

CONTENTS

GROUP SA

SAFE MAINTENANCE

NOTE :

Section 1

Safety

Safety Signs and Messages

Safety signs and messages in this manual and on the lift truck provide instructions and identify specific areas where potential hazards exist and special precautions should be taken. Be sure you know and understand the meaning of these instructions, signs, and messages. Damage to the truck, death, or serious injury to you or other persons may result if these messages are not followed.

NOTE

This message is used when special information is required relating to procedures, equipment, tools, pressures, capacities, and other special data.

IMPORTANT

This message is used when special precautions should be taken to ensure a correct action or to avoid damage to, or malfunction of, the truck or a component.

CAUTION

This message is used as a reminder of safety hazards that can result in personal injury if proper precautions are not taken.

WARNING

This message is used when a hazard exists that can result in injury or death if proper precautions are not taken.

DANGER

This message is used when an extreme hazard exists that can result in injury or death or serious injury if proper precautions are not taken.

The above terms have been adopted by Clark Material Handling Company. The same terms may be used in different context in service literature supplied directly or indirectly by vendors or truck components.

Safe Maintenance Practices

The following instructions have been prepared from current industry and government safety standards applicble to industry truck operation and maintenance. These recommended procedures specify conditions, methods, and accepted practices that aid in the safe maintenance of industrial trucks. They are listed here for the reference and safety of all workers during maintenance operations. **Carefully read and understand these instructions and the specific maintenance procedures before attempting to do any repair work.**

When in doubt of any maintenance procedure, please contact your local Clark dealer.

1. Powered industrial trucks can become hazardous if maintenance is neglected. Therefore, suitable maintenance facilities, trained personnel, and procedures must be provided.
2. Maintenance and inspection of all powered industrial trucks shall be done in conformance with the manufacturer's recommendations.
3. A scheduled planned maintenance, lubrication, and inspection program shall be followed.
4. Only trained and authorized personnel shall be permitted to maintain, repair, adjust, and inspect industrial trucks. Work should be performed in accordance with the manufacturer's specifications.
5. Properly ventilate work area, vent exhaust fumes, and keep shop clean and floor dry.
6. Avoid fire hazards and have fire protection equipment present in the work area. Do not use an open flame to check for level or leakage of fuel, electrolyte, or coolant. Do not use open pans of fuel or flammable cleaning fluids for cleaning parts.
7. Before starting work on truck:
   a. Wear eye protection and remove all jewelry.
   b. Raise drive wheels off of floor or disconnect power source. Use blocks or other positive truck positioning devices
   c. Disconnect battery before working on the electrical system.
8. Before working on engine fuel system of gasoline or diesel-powered trucks, be sure the fuel shut-off valve is closed.
9. Operation of the truck to check performance must be conducted in an authorized, safe, clear area.

10. Before starting to drive truck:
    a. Be in operating position.
    b. Be sure parking brake is engaged.
    c. Put direction control in neutral.
    d. Start engine.
    e. Check functioning of direction and speed controls, steering, brakes, warning devices, and any load handling attachments.

11. Before leaving truck
    a. Stop truck.
    b. Put directional control in neutral.
    c. Apply the parking brake.
    d. Turn key switch OFF.
    e. Put blocks at the wheels if truck is on an incline.

12. Brakes, steering mechanisms, control mechanisms, warning devices, lights, governors, guards, safety devices, and frame members must be carefully and regularly inspected and maintained in a safe operating condition.

13. Special trucks or devices designed and approved for hazardous area operation must receive special attention to ensure that maintenance preserves the original, approved, safe-operating features.

14. Fuel systems must be checked for leaks and condition of parts. Extra special consideration must be given in the case of a leak in the fuel system. Action must be taken to prevent the use of the truck until the leak has been corrected.

15. The truck manufacturer's capacity, operation, and maintenance instruction plates, tags, or decals must be maintained in legible condition.

16. Batteries, motors, controllers, limit switches, protective devices, electrical conductors, and connections must be inspected and maintained in conformance with good practices. Special attention must be paid to the condition of electrical insulation.

17. To avoid injury to personnel or damage to the equipment, consult the manufacturer's procedures in replacing contacts on any battery connection.

18. Industrial trucks must be kept in a clean condition to minimize fire hazards and help in the detection of loose or defective parts.

19. Modifications and additions that affect capacity and safe truck operation must not be done without the manufacturer's prior written approval. Capacity, operation and maintenance instruction plates, tags, or decals must be changed accordingly. This is an OSHA requirement.

20. Care must be taken to assure that all replacement parts, including tires, are interchangeable with the original parts and of a quality at least equal to that provided in the original equipment. Parts, including tires, are to be installed per the manufacturer's procedures. Always use genuine CLARK or CLARK approved parts.

21. Use special care when removing heavy components from the truck, such as counterweight, seat deck, upright, etc. Be sure that lifting and handling equipment is of the correct capacity and in good condition. Also, this removal may upset stability of the truck. The frame must always be safely blocked for major component removal.

NOTE

Become familiar with additional operating and maintenance safety instructions contained in the following publications:

ASME B56.1 - Safety Standard for Low Life and High Lift Trucks. Published by: American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016.

NFPA 505 - Powered Industrial Trucks. Including Type, Areas of Use, Maintenance and Operation. Available from: National Fire Protection Assoc., Inc., Batterymarch Park, Quincy, MA 02269.

General Industrial Standards, OSHA 2206: OSHA Safety and Health Standards (29 CFR 1910), Subpart N-Materials Handling and Storage, Section 1910.178 Powered Industrial Trucks. For sale by: Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

General Shop Precautions

The following list contains general precautions that should be followed when working on a lift truck.

- Always wear safety glasses for eye protection.
- Remove rings, watches, loose jewelry and open clothing before working on a vehicle to avoid serious injury.
- Do not smoke while working on a vehicle.
- Put power key switch in the OFF position, unless otherwise required by the procedure.
- Set the parking brake. Place chocks to the front and rear surfaces of the tires to provide further restraint from inadvertent vehicle movement.
- Use safety stands or blocks whenever a procedure requires you to be under the vehicle.
- Service electric truck batteries in a well-ventilated area to avoid the danger of lighting explosive gases.
- Follow the Safety Instructions outlined in Group 12, Battery Handling.
- Always discharge the capacitors prior to working on or around electrical components.
- Avoid contact with battery acid. The battery contains corrosive acid which can cause injury. Follow the instructions outlined in Group 12 and those instructions received with your battery and charger.

Cautions

The following is a list of "CAUTIONS" connected with the operation and maintenance of trucks equipped with solid state control panels.

⚠ CAUTION

WELDING ON TRUCKS

1.Make sure the truck has no grounds.

2.Disconnect truck battery.

3.Protect electrical wiring and components from weld spatter with a shield.

4.Ventilate battery or remove battery from truck.

If the above is not followed, damage can result to wiring and electrical components on a solid state control truck.

⚠ CAUTION

DO NOT STEAM-CLEAN

Do not steam-clean a solid state controlled truck. Excessive moisture will interfere with proper operation of the solid state components.

Solid state controls should be cleaned at regular intervals. Blowing dirt off with an air (207 kPa [30 psi] max.) hose periodically will, for the most part, eliminate any serious cleaning problems. For a more thorough cleaning, water may be hosed over the control. A mild detergent may be applied, such as that used for washing dishes. The detergent should be rinsed off, and the controls must be thoroughly air-dried before putting truck into service.

Periodic cleaning should preclude the need for using a degreaser. However, if a degreaser is used, we recommend Clark #1801146 Degreaser, or the equivalent to MS-180 Freon TF Degreaser and Cleaner. Only approved solvents should be used to clean solid state control components.

⚠ CAUTION

CHECK POLARITY

Battery polarity must be correct or the truck will not operate.

⚠ CAUTION

USE TRUCK BATTERY ONLY

Do not use a motor generator unit such as "ready power" or a battery charger to move and/or check this truck as serious damage may occur.

IMPORTANT

SAFETY NOTICE

Read and understand all Safety Precautions and Warnings before performing repairs on lift trucks.

Appropriate service methods and proper repair procedures are essential to the safe, reliable operation of industrial trucks, as well as the personal safety of the individual doing the work. This Service Manual provides general directions for accomplishing service and repair work with tested, effective techniques. Following them will help assure successful repair and reliable truck operation.

There are numerous variations in procedures, techniques, tools and parts used for servicing industrial trucks, as well as in the skill of the person doing the work.

This manual cannot possibly anticipate all such variations and provide advice or precautions as to each. Accordingly, anyone departing from the instructions provided in this manual, through procedures used or choice of tools, materials, and parts may jeopardize his or her personal safety and the safety of the vehicle user.

Improper or careless techniques cause accidents. Don't take chances with incorrect or damaged equipment. Read and understand the procedures for safe operation and maintenance outlined in this manual.

Drive and work safely. Follow the safety signs and their messages displayed in the work area, on the truck, and in this manual.

NOTE :

Section 2

Lifting, Jacking, and Blocking

WARNING

Lifting or jacking any large piece of equipment such as a fork truck presents obvious hazards. It must be done with great care and forethought. Consult the truck weight information in Group 40, Specifications, to ensure that your lifting equipment is of adequate capacity.

⚠ CAUTION

To perform these service procedures, first:

- Park truck on a level surface.
- Put the upright in a vertical position and lower the carriage fully down.
- Return control handle to neutral and turn key switch OFF.

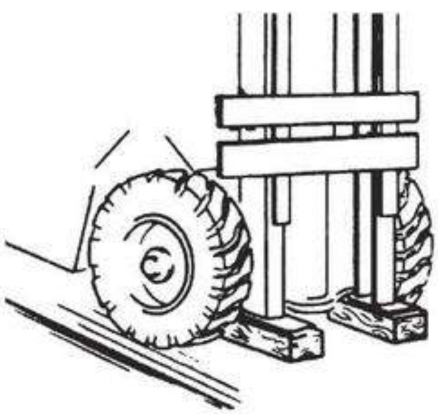
⚠ WARNING

Defective equipment can cause accidents:
All tools and lifting equipment must be in good condition, meet the load capacity requirements and have OSHA labels when required. Tools with defects can fail, causing severe injury or death.

Raising Drive Wheels

This procedure uses the upright as a lever to lift the drive wheels off the floor and prevent accidents due to inadvertent powering of the drive wheels.

1. Park the truck safely.
2. Turn key switch ON. **Tilt the upright fully back.**
3. Put a solid 100 x 100 mm (4 x 4 inch) hardwood block under the front section of each upright rail. Put a 3-6 mm (0.125-0.250 inch) steel plate on top of each block.
4. **Tilt the upright fully forward.** This will raise the drive wheels off the floor.



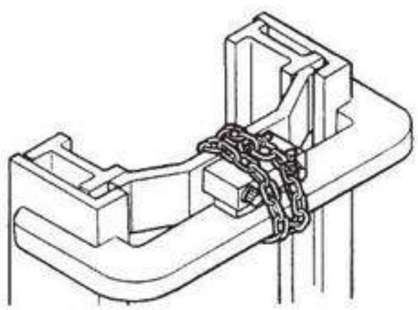
GENERIC ILLUSTRATION

5. Block the truck under the frame behind the drive wheels with solid blocking.
6. Turn key switch OFF.
7. Check for safe clearance between drive wheels, block and floor.
8. Check the stability of the truck. Be sure that the blocks are located securely under the frame before operating the drive motor or working on truck.
9. Lower the drive wheels to the floor by reversing this procedure.
   - Turn key switch ON.
   - Tilt upright fully back.
   - Turn key switch OFF.
10. Remove the blocks from under the frame and upright rails.

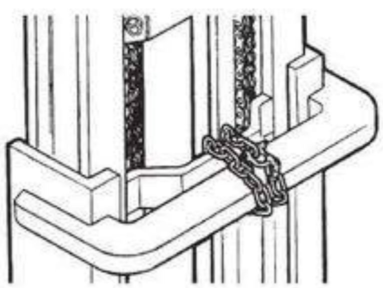
Chaining the Upright in Raised Position

This procedure is used to safely provide clearance for access from the front of truck to components on or near the drive axle.

1. Park truck safely.
2. Put blocks at front of and rear of drive wheels.
3. Raise upright carriage.
4. Chain the center inner rail tie bar to the top outer rail tie bar as shown.



Triple Stage Uprights: Chain the center intermediate rail tie bar and the lower inner rail tie bar to the top outer rail tie bar.



5. Reverse the procedure to remove the chains.

WARNING

Keep hands, tools, etc. out of upright.

Raising Rear of Truck

The truck may be raised at the rear by jacking and blocking under the center of the frame member at either the front or rear steer axle mounting, or under the center section of the steer axle.

Refer to truck data plate for truck weights.

WARNING

An incorrectly installed counterweight can move or fall unexpectedly. NEVER LIFT OR BLOCK A TRUCK USING THE COUNTERWEIGHT. Failure to follow procedures outlined in this manual can result in injury or death.

1. Park truck safely.
2. Put blocks at front and rear of drive wheels.

CAUTION

If possible, remove the battery from truck to reduce weight for added safety and ease of jacking.

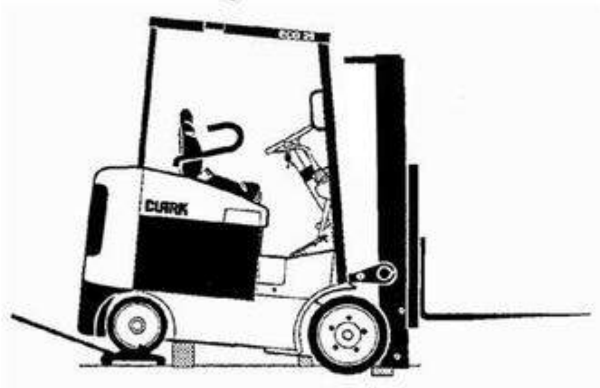
3. Put a floor jack under the steer axle mounting frame member, centered between the two wheels.

WARNING

Never lift the truck by the counterweight.

If there is insufficient clearance under frame for your jack, the truck may first be driven onto shims, such as 25x150x300 mm(1 x 6 x 12 in.) pieces of board, to increase the truck frame underclearnce.

4. Raise the truck only as high as necessary to perform the maintenance work.
5. Put blocks at both sides of the truck, fully under the frame main side structure. Put the blocks in front of but close to the counterweight and steer wheels for best truck stability.



Put an equal number of blocks under each side of the truck to provide a level working position.

6. Lower the truck onto the blocks and remove the jack.

CAUTION

Before performing any maintenance work, check the truck for stable condition on the blocking by determining that it will not rock on blocks.

7. When maintenance work is completed, lower the rear of truck to the floor by reversing the above procedure and lowering each side of the truck 50 mm (2 in.) at a time:
   - Put jack under frame and raise truck.
   - Carefully remove blocks and lower truck.
   - Remove jack and blocks from drive wheels.

Raising Entire Truck

Refer to truck data plate for truck weights.

1. Park truck safely. Lower upright fully.
2. If necessary, drive truck onto boards to increase underclearance.

WARNING

SIDE-TO-SIDE TIPOVER. When jacking side of truck, be sure upright is lowered fully. Do not raise one side of the truck more than about 50 mm (2 in.) higher than the other, to avoid tipping truck over laterally.

END-TO-END TIPOVER. If the upright and drive axle are removed while the truck is blocked up, the truck will tip backward due to the heavy counterweight. Upright and counterweight must both be removed before attempting to raise the truck for drive axle removal. The back of the truck must be supported by blocking under the steer axle to prevent movement.

If the counterweight is removed while the truck is up on blocks, the weight of the upright and drive axle will cause the truck to fall forward.

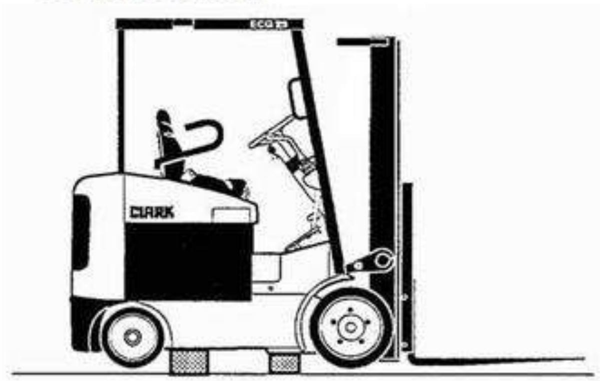
3. Put the jack under side frame, near the center of the truck.

IMPORTANT

Be sure to put the jack squarely and fully under the main side structure of the frame.

4. Carefully raise the truck one side at a time, only as high as necessary to do the maintenance work, and not more than 150 mm (6 in.) total.

5. Put blocks under the side frame, at each side of the jack. Spread the blocks close to the steer and drive wheels for maximum stability.
6. If using one jack, lower the truck onto the blocks and move the jack to the opposite side. Repeat the lifting procedure.
7. Put the same size blocks under each side of the truck so it will be leveled.



⚠ **CAUTION**

Before performing any maintenance work, check the truck for stable condition on the blocking.

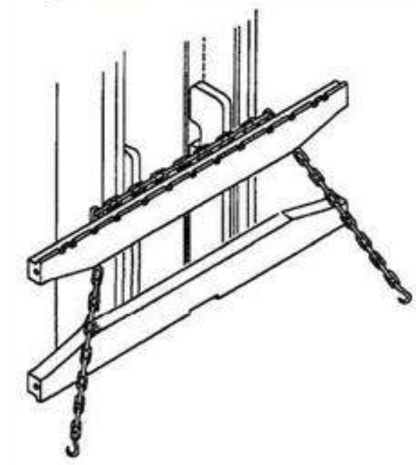
8. When maintenance work is completed, lower the entire truck to the floor by reversing this procedure. Lower the truck one side at a time, while carefully removing the blocks. Be sure no tools or equipment are under the truck or wheels.

NOTE

Depending on jack height, shims under the tires may be needed for clearance to allow removal of jack.

Shipping Tie-Down Instructions

1. Front of Truck
   a. With Upright and Carriage Installed
      - Lower the carriage fully.
      - Put a tie-down (e.g., chain) between the carriage fork bars.



   b. Without Upright and Carriage Installed
      - Put a chain across the truck floor plate. Protect truck from chain damage by using covered chain or protective material under the chain at contact points.
2. Rear of Truck
   - Attach the tie-down to the toe-pin in bottom of counterweight.

NOTE :

Section 3

Towing

If your truck is disabled but can be moved freely on its own wheels without further damage, use the following procedures to tow the truck safely to a repair area.

WARNING

For your safety and the care of your truck, use the proper equipment and carefully follow these recommendations for safe towing.

Do not tow a lift truck if there is a problem with the brakes or tires, or if the steering cannot be operated.

Do not tow up or down ramps or steep inclines.

Do not tow the disabled truck if traction or weather conditions are poor.

1. Apply the parking brake or block the drive wheels on the disabled truck while working around it.
2. When possible, raise the forks on the disabled truck 300 mm (12 in) from the floor or ground. Secure the carriage on the upright with a chain.
3. Use a truck for towing that is of equal or larger capacity than the disabled truck. Carry a partial load on the towing truck for improved traction
4. Check that the counterweight bolts on both trucks are in place and properly torqued to 340-380 Nom (250-280 ft-lb). These bolts are made of special, high-tensile steel and are not commercially available. When necessary, replace these bolt only with genuine Clark replacement parts.
5. Use an approved, solid metal tow bar with towing couplers that connect to the towing pins in the counterweights of each truck.

NOTE

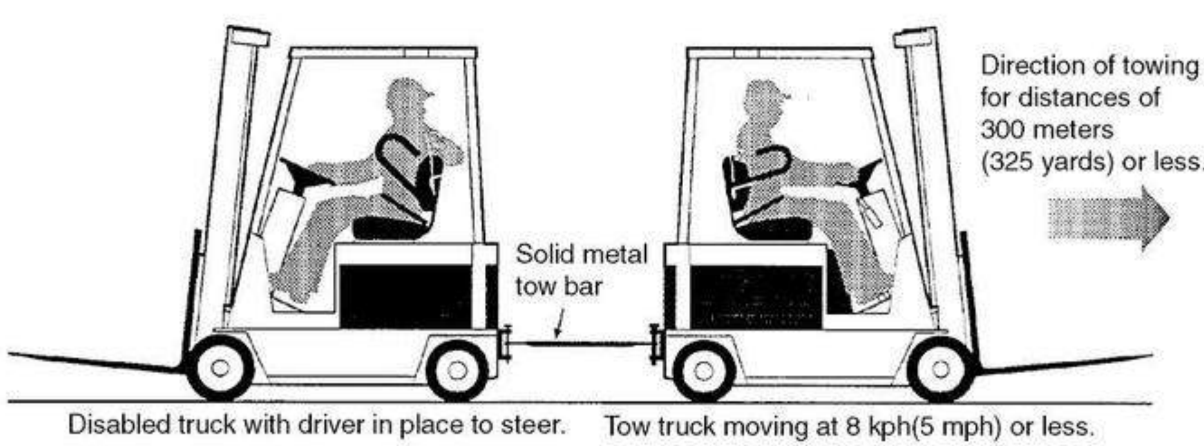
DOT-approved towing equipment is available from your Clark dealer.

6. Release the parking brake on the towed vehicle. Place directional control lever in NEUTRAL.
7. Tow the disabled truck backward. An operator must be on the disabled truck.

CAUTION

The power steering will not operate on the disabled truck when the power steering motor is not running. The steering handwheel will be difficult to turn.

8. Tow the truck slowly. Careful towing is necessary to prevent injury to personnel or damage to the disabled truck. The truck should be towed at a speed of less than 8 kph (5 mph, or a moderate walking speed) with a driver in place and steering the disabled truck.



IMPORTANT

Do not lift the disabled truck or any wheels off the floor while the truck is being towed.

9. Park the disabled truck in authorized areas only. Fully lower the forks to the floor. Leave the directional control in neutral. Turn the key switch to OFF, and engage the parking brake. Remove the key. Disconnect the battery. When necessary, block the wheels to prevent the truck from rolling.

WARNING

Always engage the parking brake when parking a lift truck. The truck can roll and cause injury or death to personnel near it.

NOTE :

GROUP PS

PERIODIC SERVICE

NOTE :

Section 1

Maintenance Schedules

Maintenance Schedules

This Service Publication provides information covering normal service, maintenance and repair of the Clark industrial lift trucks noted on the cover. It has been specifically prepared to help owners and service personnel maintain these trucks in an efficient and safe operating condition.

About Planned Maintenance

The Planned Maintenance Procedures provide a basic step-by-step guide which should be followed in servicing the vehicle. Adjustment Procedures, Specifications, Lubrication Guides, Overhaul Procedures, and other data are found listed under Group and Section Numbers.

Regular, correct maintenance and care of industrial trucks is important not only for long and efficient truck life, but it is essential for safe operation. The importance of proper maintenance through planned service, inspection, and qualified repairs cannot be emphasized too strongly. Preventive maintenance instructions are provided for reference in setting up and conducting a recommended periodic Planned Maintenance (PM) program.

Planned Maintenance is a program in which inspections, minor adjustments, cleaning, lubrication, oil changes, and replacement of filters are performed on a scheduled and systematic basis. A solid PM program should incorporate a method of record keeping, which enables you to better determine PM schedules and track maintenance costs per truck.

An effective PM program should incorporate two basic phases:

1. An inspection Performed by the driver or maintenance personnel at the beginning of each shift as required by OSHA. This is a quick visual check for obvious damage and leaks a check of fluids and water levels, lights (if so equipped), instruments, and warning devices.
2. The Planned Maintenance routine is based on 50 to 250 operating hours-with the interval being determined by operating conditions.

Records will tell you how often PM should be done:

- If an operation is clean and not punishing, a PM interval can be extended.
- If an operation is extremely dirty and punishing, the PM interval may have to be reduced.

If the PM is closely followed, needs for repair, major adjustment and component replacement will be discovered automatically. Such work can then be scheduled, eliminating unnecessary downtime and cost. For instance, brake checks, which are part of the PM, will uncover the need for adjustments and/or repairs which may be required periodically.

The objectives of PM are:

1. Reduce costly unscheduled downtime.
2. Reduce maintenance costs.
3. Increase vehicle productivity.
4. Increase personal safety of drivers and other personnel.

Inspection Forms

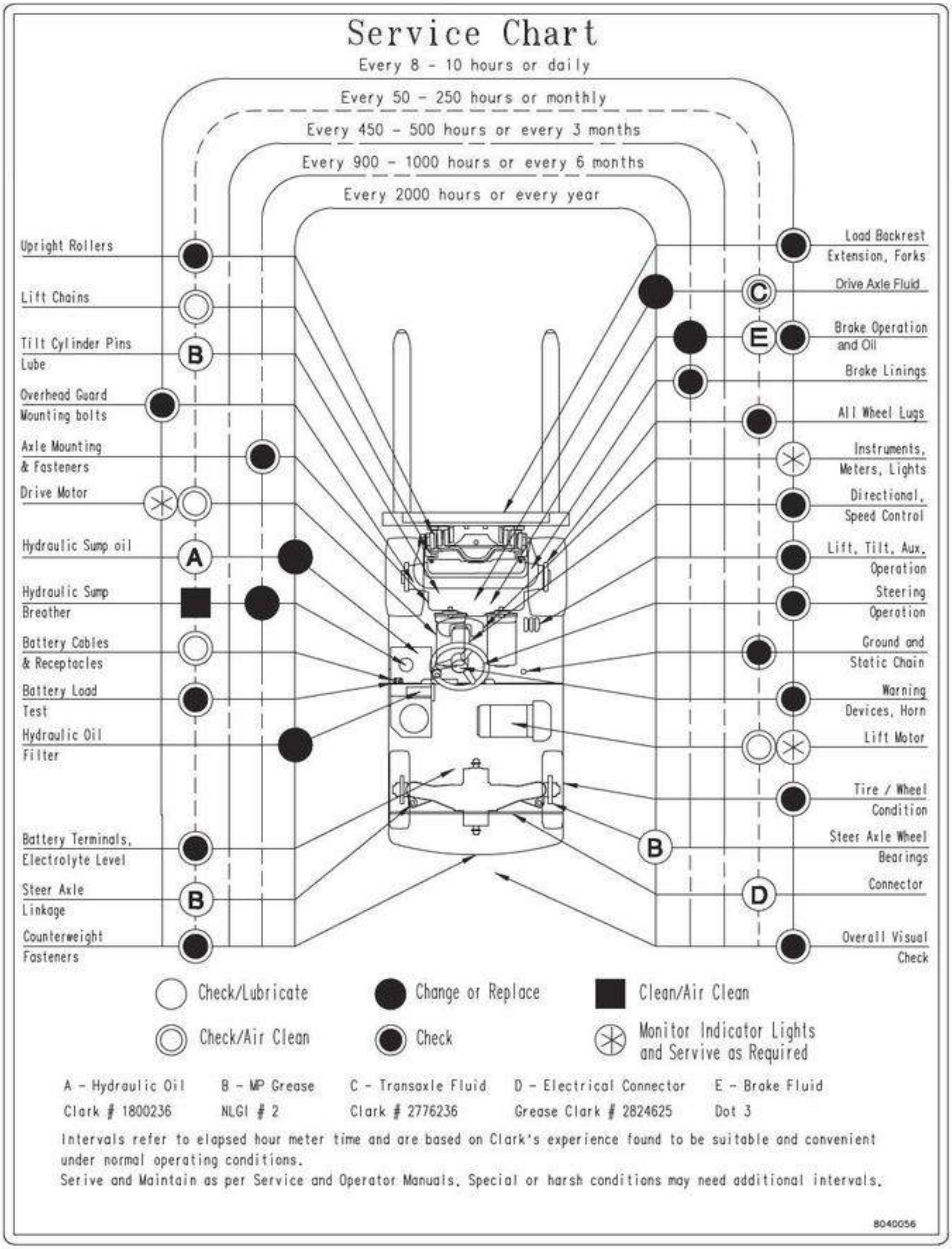
To insure that the daily inspection and PM are properly performed, we recommend the use of inspection forms. Such forms not only provide a guide for the inspections and maintenance requirements for each vehicle, they will assist you in determining when to schedule a vehicle for major repairs. Consequently, these repairs can be done without the disruptive effect of unscheduled downtime.

NOTE

Refer to the Operator's Manual, located on the truck, for additional information on the operation, care, and maintenance of your truck.

Contact your authorized Clark dealer for more information on maintenance and repair of these trucks.

ECX20/32 & EPX20/30



Lubrication Chart Key

L1		General Purpose Grease with EP Additive	**Use NLGI #1 Grade** A Multi-purpose grease of refined mineral oil,blended with a lithium soap thickener or equal, containing antiwear, anti-rust, and anti-oxidants with EP additives.
L2		General Purpose Grease with EP Additive and Moly Additive	**Use NLGI #2 Grade** A multi-purpose grease of refined mineral oil, blended with a lithium soap thickener or equal, containing antiwear, anti-rust, and anti-oxidants with EP additives and 3 to 5% moly additives.
L4		Chain lube	**Clark Part No. 886399** Roller and leaf Chain Lube. One case of 12 one-pint cans.
L5		Hydraulic Fluld	**Clark MS-68 Hydraulic Fluid:** **Part No. 885385 1 case of 24 one-quart cans** **Part No. 885382 1 case of 6 one-gallon cans** Use only high-quality hydraulic fluid with zinc or equivalent anti-wear additive, which meets the requirements of ASTM D-2882 pump wear test, with 50 mg total weight loss maximum, per Clark MS-68.

Miscellaneous Lubricants

Miscellaneous Linkage

Any good grade of motor oil in SAE 10, 20 or 30 weight, as the temperature and conditions dictate.

Corrosion Protection

Mechanical Lubricant Clark Part No. 2802351

Apply to electrical connections any time they are disconnected. The lubricant should be reapplied before making the connection.

Application Examples (Standard and Cold Storage Applications):

- PL and DP plug connections
- Solenoid coil connections
- Reverse alarm terminals (if applicable)
- Push-on terminals
- Light terminals (headlights, strobe, etc.) (if applicable)
- Thermostat terminals (if applicable)
- Heater connection terminals (if applicable)

Corrosion Protection

Mechanical Paste Lubricant Clark Part No. 2802205

Apply to electrical connections any time they are disconnected. The lubricant should be reapplied before making the connection.

Application Examples (Standard and Cold Storage Applications):

- All power cable connections
  - All motor cable connections
  - Brake switch
  - Lift pump ground strap, both ends
  - Steer interlock switch
  - Reverse alarm (if applicable)
- All screw-on type wire terminals
  - Card retainer screws
  - All cable connection points on the control panel.

NOTE :

Section 2

Planned Maintenance

Use PM Report Form

A planned maintenance program of regular, routine inspections and lubrication is important for long life and troublefree operation of your lift truck. Make and keep records of your inspections. Use these records to help establish the correct PM intervals for your application and to indicate maintenance required to prevent major problems from occurring during operation.

As an aid in performing and documenting your PM inspections, Clark has prepared an Electric Truck Planned Maintenance Report form. Copies of this form may be obtained from your authorized Clark dealer. We recommend that you use this form as a checklist, to make a record of **your inspection and** truck condition.

The periodic maintenance procedures outlined in this manual are intended to be used with the PM report form. They are arranged in groupings of maintenance work that are done in a logical and efficient sequence.

A check mark or entry is made on the PM Report Form when the PM is performed. Please note the special coding system for indicating the importance of needed repairs and/or adjustments.

When you have finished the PM inspections, be sure to give a copy of the report to the designated authority or the person responsible for lift truck maintenance.

Do not make repairs or adjustments unless authorized to do so.

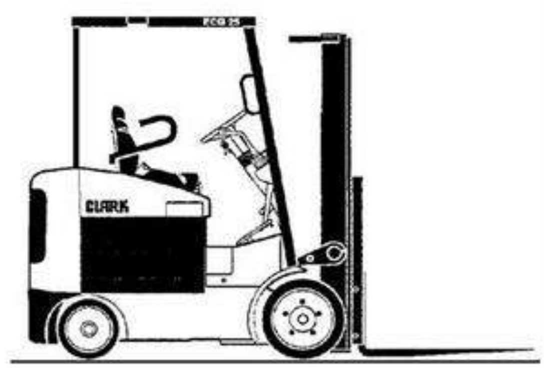
For safety:

- Remove all jewelry (watch, rings, bracelets, etc.) before working on the truck.
- Disconnect battery from truck receptacle before working on electrical components.
- Wear safety glasses. Wear a safety (hard) hat in industrial plants and in special work areas where protection is necessary or required.

How to Perform the PM Periodic Inspections and Maintenance

Visual Inspection

Perform a visual inspection of the lift truck and its components. Walk around the truck and take note of any obvious damage and maintenance problems. Check for loose fasteners and fittings.



Be sure all capacity, safety, and warning plates or decals are attached and legible.

CAUTION

Do not operate a lift truck with damaged or missing decals and nameplates. Replace them immediately. They contain important information.

Inspect the truck for signs of external leakage of transmission fluid, etc. Check for hydraulic leaks and loose fittings. DO NOT use bare hands to check. Hydraulic Fluid may be hot or under pressure.

DANGER

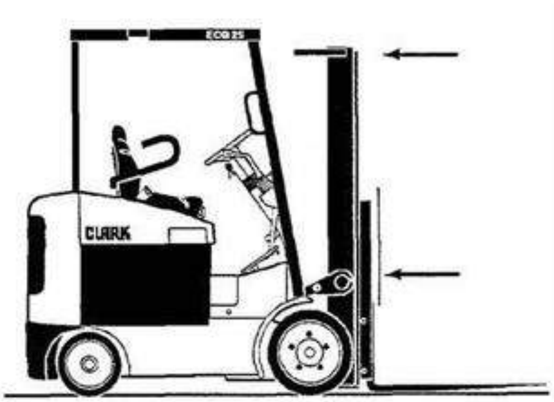
HYDRAULIC FLUID PRESSURE: Do not use your hands to check for hydraulic leakage. Fluid under pressure can penetrate your skin and cause serious injury.

Be sure that the driver's overhead guard, load backrest extension, finger guards, and any other safety devices are in place, undamaged, and attached securely.

⚠ WARNING

For trucks equipped with spark-enclosed (EE) construction, or with polyurethane tires, check the ground strap or chain for wear and secure attachment.

Check all of the critical components that handle or carry the load.

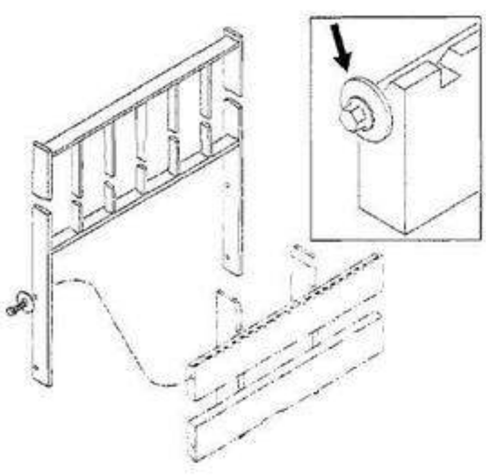


Check the overhead guard for damage. Be sure that it is properly positioned and all mounting fasteners are in place and tight.

⚠ CAUTION

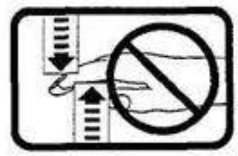
If load backrest has been removed, a bolt and washer must be in place on each end of the top fork bar to act as a fork stop.

Check the load backrest for damage. Inspect the welds on the carriage and load backrest for cracks. Be sure that the mounting fasteners are all in place and tight.



⚠ DANGER

Uprights can drop suddenly if not properly blocked. Look at the upright, but keep hands, tools, etc. out.



IMPORTANT

Uprights and lift chains require special attention and maintenance to maintain them in safe operating condition. Refer to Lift Chain Maintenance in Group 34 for additional information.

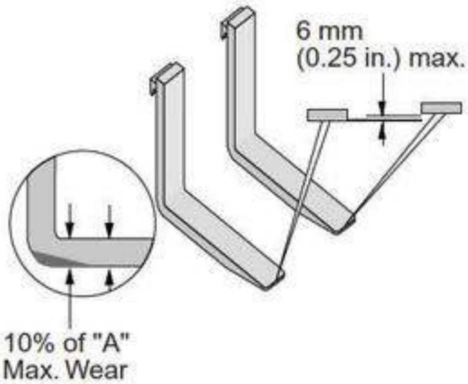
Check the upright assembly. Inspect the upright rails, carriage rollers, lift chains, lift and tilt cylinders. Look for obvious wear and damaged or missing parts. Check for any loose parts or fittings. Check for leaks, damaged or loose rollers, and rail wear (metal flaking). Carefully check the lift chains for wear, rust and corrosion, cracked or broken links, stretching, etc. Check that the lift and carriage chains are correctly adjusted to have equal tension. Check that the lift chain anchor fasteners and locking means are in place and tight.

Be sure all safety guards and chain retainers are in place and not damaged. Inspect the carriage stops and cylinder retainer bolts. Check all welded connections.

Inspect all lift line hydraulic connections for leaks. Check the lift cylinder rods for wear nicks, grooves, and scratches. Check the cylinder seals for leaks. Refer to Group 34 for details on uprights.

Forks

Inspect the load forks for cracks, breaks, bending and wear. The fork top surfaces should be level and even with each other. The height difference between both fork tips should be no more than 6 mm (0.25 in.)



NOTE

Your Clark dealer has special tools for measuring fork wear.

WARNING

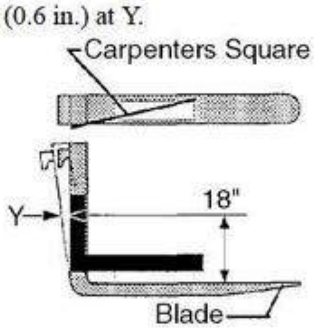
If the fork blade at the heel is worn down by more than l0%, the load capacity is reduced and the fork must be replaced. DO NOT attempt to fill with weld. See Group 34 for inspection procedure.

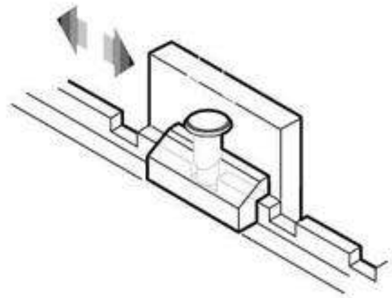
Check the amount of wear at the heel of the fork.

CAUTION

If the forks are obviously bent or damaged, have them inspected by a trained maintenance person before operating the truck.

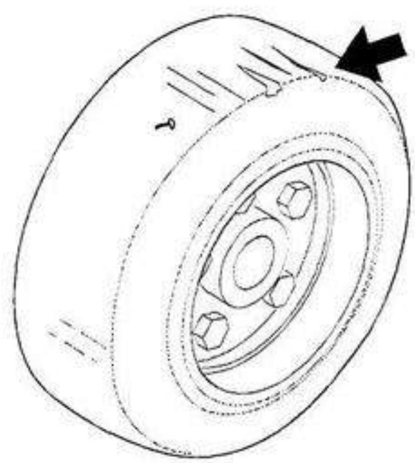
Inspect the forks for twists and bends. To check, put a 2 x 4 x 24 in. long block on the blade of the fork with the 4 in. surface against the blade. Put a 24 in. carpenter's square on the top of the block and against the shank. Check the fork 18 in. above the blade to be sure it is not bent more than 14.5 mm (0.6 in.) at Y.



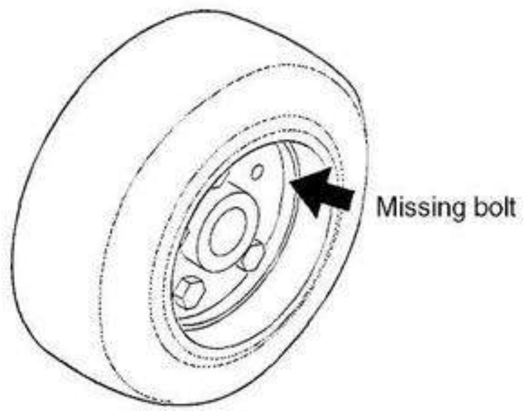


Inspect the fork latches. Be sure they are not damaged or broken, operate freely and lock correctly. Check the fork stop pins (or bolt and washer) for secure condition.

Wheels and Tires



Check the condition of the drive and steer wheels and tires. Remove objects embedded in the tread. Inspect the tires for excessive wear, break, "chunking out," and bond failure between the tire and rim.



Check all wheel mounting bolts to be sure none are loose or missing.

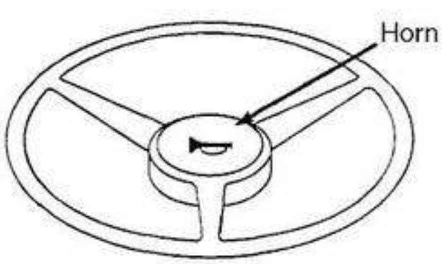
⚠ CAUTION

Personnel working on wheels and tires must be trained and qualified to do wheel and tire maintenance.

Replace missing bolts and tighten loose bolts to the correct torque before operating the truck.

Operational Checks

1. Check horn to be sure it operates.



IMPORTANT

Because the battery is such an important part of electric truck operation, it requires its own specialized maintenance program, which should include full-scale cleaning and inspection. Refer to Group 13 for specific instructions.

2. **Using the Display**

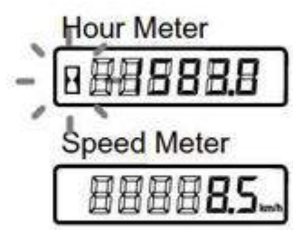
LCD Back Light

- LCD back light is working linked with Key switch.
  "- When the start key turns on, power is applied to display. Whenever the power is applied, LCD back light will turn on."

DISPLAY Initial Start-up

- KEY ON
  - All the Icons and Buzzers will be ON for 1second to check the indicating conditions.
  - Seat belt warning mode (5seconds) after Icon turns of for 1second: It is always indicated regardless of communication conditions; When this mode is working, all the indicating data should be in normal conditions.
  "(Working hour/speed, Battery discharging rate, Speed limit rate, Parking)"
- After seat belt warning mode is working, the data supplied from controller will be indicated.

Working hour/speed indicating algorithm



- Working hour/ speed will be indicated at the same portion.
- The indicating data is decided on the base of traveling speed.

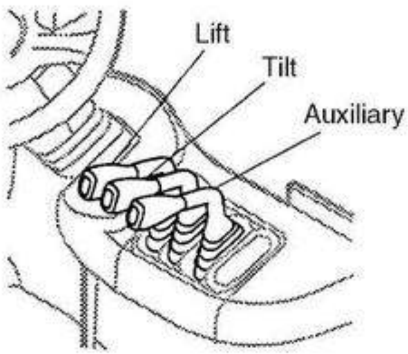
- If the traveling speed exceeds 0.5km/h, the current traveling speed will be indicated "km/h" icon turn on. When the speed gets lower than 0.5km/h, traveling speed indicator will be released "km/h" icon turn off.
- The current working hour is indicated when the traveling speed is lower than 0.5km/h, and the "sandglass" icon flickers in a second cycle.

When the traveling speed is more than 0.5km/h, the working hour indicator is released (converted to speed indicator), and the "sandglass" icon will turn off.

Character indicator

- Error code indicator (#37 error)

3. **Check Function Control Levers**
   - Gently pull back on the lift control lever. The pump motor should turn on and the carriage should begin to elevate.
   - Release the control lever. It should return to neutral without binding. The pump motor should turn off. The control lever should not bind when moving it to any position.
   - Repeat procedures with tilt control lever. Forks should tilt evenly and smoothly.
   - If lift truck is equipped with an attachment, test the auxiliary control lever for a correct function.
   - Briefly operate the attachment.



4. **Check Drive Motor (Brake) Cut-Off Switch**
   - Move the truck forward slowly. Slowly depress brake pedal. Drive motor should cut off before the brakes apply.
   - If operation is not satisfactory, DO NOT operate the truck. Take truck out of service and report condition to designated authority.
5. **Check Upright**
   - Note any excessive "slop" or "noise" in the upright. It may indicate roller damage, or that roller shimming, repair or adjustment may be required.
6. **Check Tilt Cylinder (Refer to Group 32 to do the following)**
   - Perform drift test.
   - Perform check and adjustment procedure.
   - Check rod seal condition.
   - Check mounting. Tighten as needed.
   - Check rod end. Tighten as needed.
7. **Check Truck Performance**

WARNING

Check all around to be sure that your intended path of travel is clear of obstructions and pedestrians.

- Drive the truck forward in a straight line at a high rate of speed. Listen for unusual drive train noise. Stop truck.
- Check acceleration from a stop to top travel speed. Acceleration should be smooth without hesitation. Stop the truck. Repeat procedure in reverse.
- Report condition on PM report form.

Test Drive Truck with Load

NOTE

Conduct these tests with a rated capacity load, if possible.

Test the truck for proper operation and drive train function by driving the truck in both the forward and reverse directions. Drive first in a straight line and slowly through a series of full right and left turns. Then repeat, driving in opposite direction.

Carry Load Low & Tilt Back

Test for correct function of the transistor control.

Check Controlled Plugging (Braking)

1. Operate the truck with parking brake set. It should not move. Release parking brake.
2. Operaten the truck at a slow speed in a forward direction of travel. Reverse direction of travel. The truck should slow down to a smooth controlled stop, and accelerate normally in the opposite direction.

   If plugging is as specified, then repeat the procedure at high speed. The truck should come to a smooth controlled stop in approximately 20 feet (6.10 mm) with accelerator in maximum travel position.
3. Repeat the procedure at high speed with the direction lever moved in reverse direction.

   If plugging (braking) is not as specified, refer to the adjustment instructions in Group 19 of this manual. Report condition to designated authority.

Check Accelerator

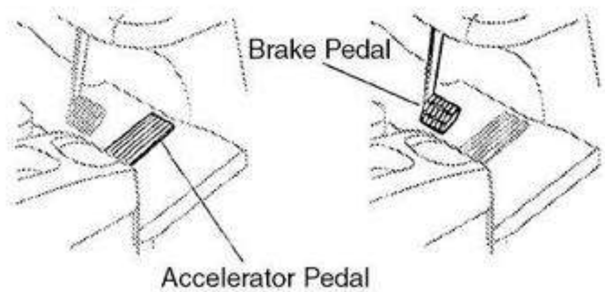
1. After checking to see that you have a clear path ahead, drive the truck in a straight line at a high rate of speed in a forward direction of travel. Listen for unusual drive train noise. Stop truck
2. Check acceleration from a stand still condition to top travel speed. Acceleration should be smooth without hesitation.
3. After checking to see that you have a clear path behind, drive the truck in reverse. Check acceleration from stand still condition through top travel speed. Acceleration should be smooth.

Check the accelerator pedal while conducting the speed range tests. It must move easily and smoothly throughout the acceleration stroke and return without binding. There should be no restriction to movement on either acceleration or deceleration.

⚠ CAUTION

DO NOT operate lift truck if the brakes are not operating properly. Use only brake fluid, SAE J1703 DOT 3, for ECX / EPX brakes.

Test the service brake (drive motor cut-off) switch. Drive the truck FORWARD (or in REVERSE) at creep speed. While holding the accelerator pedal steady in creep speed position, depress brake pedal. The braking action should interrupt power to the drive motor and stop the truck. Release the brake pedal. The drive motor should again start moving the truck.



Test brake operation by depressing and releasing the brake pedal several times while driving the truck. The brakes should bring the truck to a smooth stop without pulling, squealing, or shuddering. Have the brakes adjusted or repaired as necessary. Drive motor should cut off before brakes apply.

To check brake holding capability and adjustment, park the truck on a grade and depress brake pedal. The brake should hold a lift truck with rated load on a 15% grade.

Check Steering

⚠ CAUTION

DO NOT operate lift truck if steering system is not operating properly.

Check steering control operation. First, drive the truck in a straight line. The truck must drive in a straight line without drifting toward either side. Then drive slowly (creep speed) through a series of full right and left turns. Check steering response and smoothness of operation. Turning effort must be the same in either direction. You will hear the hydraulic pump operate over relief when in a full turn. If there is a steering problem, have it repaired.

NOTE

Conduct the following test with a rated capacity load.

Test for general drive train operation. Drive the truck at various speeds and operating conditions, in both FORWARD and REVERSE directions. Test shifting from NEUTRAL to FORWARD, then back to NEUTRAL. Test shifting from NEUTRAL to REVERSE, then back to NEUTRAL. Check for positive control action when changing directions.

Listen for clunking, squealing, grinding, scraping, or other unusual noises. Check for vibration. Listen for wheel bearing or other specific running noise.

Lift Mechanism and Controls

NOTE

Conduct these tests with a rated capacity load.

Test the operation of the hydraulic system and upright.

⚠ CAUTION

Be sure there is adequate overhead clearance before raising the upright.

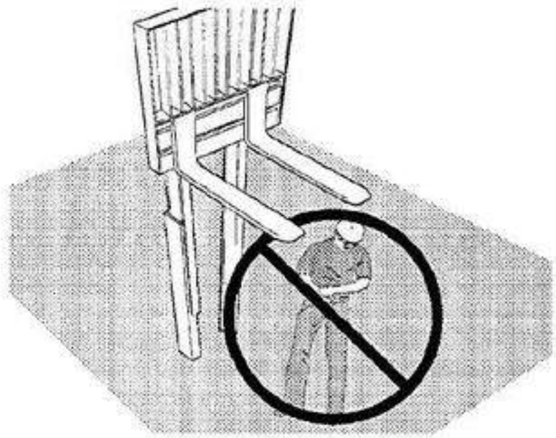
Cycle (raise to full height and then lower) the upright at both slow and fast speed, with the upright tilted slightly backward. Watch the upright assembly as it rises. All movements of the upright, fork carriage, and lift chains must be even and smooth, without binding or jerking motions. Watch for chain wobble or looseness. The chains should have equal tension and move smoothly, without noticeable wobble.

Check function of the control lever and main hydraulic valve. Listen for abnormal noises in the hydraulic valve, main hydraulic pump, and system components.

If the maximum fork height is not reached, either the fluid level in the hydraulic sump tank is low, or there is severe binding within the upright.

⚠ WARNING

FALLING FORKS. Do not walk or stand under raised forks. The forks can fall and cause injury or death.



Never Walk Under Raised Forks!

Check the upright rails, rollers, carriage, lift chains, and cylinders as they move. Watch for binding or excessive freeplay (looseness) between the carriage and the upright rails and rollers. Listen for abnormal noises. If there is excessive clearance between the rails and channels, the upright roller needs adjustment. If the rails or carriage bind or hesitate when lowering, the rollers are either damaged or roller adjustment is incorrect.

Check the upright for excessive downdrift. Stop the fork carriage in an intermediate position. Check that it holds its position without moving down. If you observe downward movement (drift) or have a report of a drift problem, the lift cylinder seals may be worn. With forks elevated, turn key switch off. Pull back on the lift lever. The forks should not lower This tests the check valve.

Test the tilt function. Check for excessive tilt cylinder drift. Stop the upright at a position near vertical. Check that the upright holds its position without moving forward. If you observe forward movement (drift) or have a report of a tilt drift problem, the tilt cylinder seals may be worn.

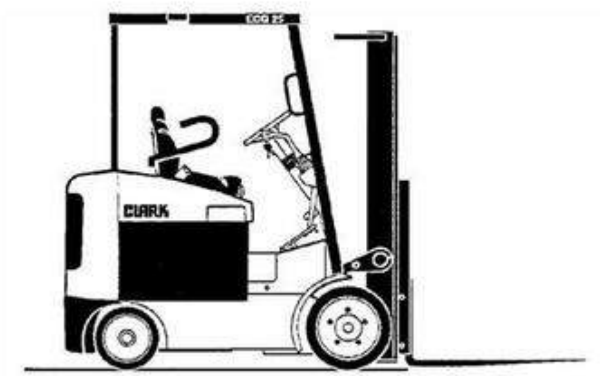
Check fork height adjustment and carriage chain adjustment. Tilt the upright to the vertical position and fully lower the carriage. The forks should stop and be held approximately 13 mm (0.50 in.) above the floor. If the forks hit the floor, the carriage lift chains should be adjusted. Also check the rail chains.

If truck is equipped with an attachment, briefly operate the attachment to check the controls for correct function.

Test for correct tilt cylinder rod adjustment. Raise the carriage to an intermediate position. Tilt the upright fully forward without a load on the forks. Check for upright racking (twisting) as the tilt cylinders reach the end of their stroke. Tilt the upright fully back. The upright should not rack (twist) when the tilt cylinders reach the end of their travel. If forward upright racking is found, adjustment of the tilt cylinder rod ends (yokes or spacers) is required. If backward racking is found, adding or removing shims is required. Refer to Group 32.

CAUTION

When you have completed the operational tests, park and leave truck according to standard shutdown procedures.



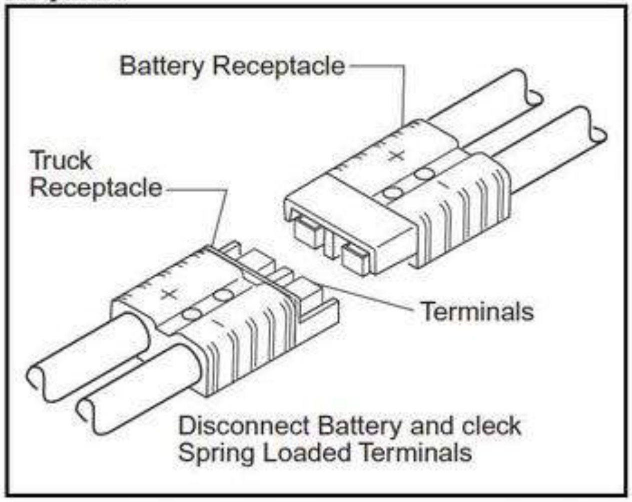
Standard Shutdown Procedures:

- Come to a complete stop.
- Park only in authorized locations.
- Lower the forks fully, tilt upright forward until fork tips touch floor.
- Allow travel control to return to neutral.
- Turn the key switch OFF.
- Apply the parking brake.
- Disconnect Battery

Make a record of all maintenance and operating problems you find.

Battery Compartment Inspection

Turn key switch OFF. Disconnect battery from truck receptacle.



Inspect condition of the battery connector and truck battery receptacle. Check the spring-loaded terminals, connectors, and retaining tabs. Look for poor connections due to burning, bad crimps, or broken or loose retainers. Check the molded body for damage from overheating, burning, and chips or cracks. Replace receptacle terminals if pitted or corroded.

Inspect condition of the battery and cables. Check the battery cables for wear or other damage. Check for signs of interference or rubbing with other components. Be sure that the cable terminals are tight and clean. Clean off any deposits of corrosion found on the battery.

Never wash the battery when it is in the truck.

Check battery post terminals for corrosion and damage. Clean all corrosion from cable end and battery post. Check tighmess of cable and post terminals.

If necessary, check the state-of-charge condition of the battery. Take a specific gravity test of the electrolyte with a hydrometer. Be sure to check a minimum of six battery cells.

Check the electrolyte level of the battery. Add distilled water, as required, to fill each cell to the correct level.

Check to be sure the vent hole in each battery cell cap is open. If cap vents are plugged with corrosion, remove the caps and wash in a solution of baking soda and water.

Refer to Group 12, Battery, for additional information.

Motor Transistor Controls Inspection

IMPORTANT

Do not clean electrical components with steam. Only approved solvents should be used to clean controls.

Turn key switch OFF. Disconnect battery from truck receptacle. Remove the control compartment cover from the counterweight.

Discharge the capacitor using a 10W~100W resistance connected from the +Batt(pos.) to the -Batt(neg.).

Inspect the transistor controls for clean condition. Check for oily dirt buildup on contactors, Inspect all control wiring terminals for any obvious damage. Look for cracks or worn areas in the wiring insulation. Check for loose connections at the control terminals. Air-clean as necessary. Treat the control panel plugs with Clark 1801145"Lectric-Like" Spray or Clark 1803827-brush on cleaner.

Hydraulic Compartment Inspection

Remove the floorplate.

Check the condition of all hydraulic system components, hoses, piping, and connections. Check for wear, leakage, and damage.

Remove the battery.

Inspect the drive motor, hydraulic pump motor power cables. Check drive motor mounting fasteners. Check hydraulic pump motor. Check pump motor mountings.

DANGER

HYDRAULIC FLUID PRESSURE: Do not use your hands to check for hydraulic leakage. Fluid under pressure can penetrate your skin and cause serious injury.

Brake Shoe and Drum Inspection

The brake linings, drum and adjustment setting can be inspected without removing the drum or hub. Refer to Group 23, Section 6 for inspection procedure.

CLEANING

Cleaning Summary

* Battery Compartment.
* Hydraulic Compartment
* Drive Motor and Steer Motor.
* Pump Motor.
* Axle Mounting
* Control Compartment
* Upright.

IMPORTANT

Do not clean electrical components with steam. Only approved solvents should be used to clean Solid State components. Scheduled cleaning (as outlined) should preclude the need for using a degreaser. Not all degreasers are acceptable. If a degreaser is to be used, we recommend degreaser or the equivalent to MS-180 Freon TF degreaser and cleaner.

WARNING

When cleaning with compressed air:

- Wear eye protection and protective clothing when cleaning or drying with air pressure.
- Reduce air pressure to 30 PSI (207 kPa). Debris removed with air pressure can cause injury.

Normal Cleaning

Blowing dirt off with an air hose periodically will, for the most part, eliminate any serious cleaning problems. Should the need arise for a more thorough cleaning, water may be hosed over the control and if necessary a mild detergent applied such as that used in washing dishes in the home. This detergent should be rinsed off and the control dried with an air hose. The control must be thoroughly dry before putting the truck back into service.

IMPORTANT

Cleaning the components of the truck is a vital part of the P.M. process. Keeping the components clean will increase their service life and assure trouble free truck operation.

Air-Cleaning

Always maintain a lift truck in a clean condition. Do not allow dirt, dust, lint, or other contaminants to accumulate on the truck. Keep the truck free from leaking oil and grease. Wipe up all oil spills. Keep the controls and floorboard clean and dry. A clean truck makes it easier to see leaks and loose, missing or damaged parts, and will help prevent fires. A clean truck will run cooler.

The environment in which a lift truck operates will determine how often and to what extent cleaning is necessary. For example, trucks operating in manufacturing plants which have a high level of dirt or lint (e.g., cotton fibers, paper dust, etc.) in the air or on the floor, will require more frequent cleaning. If air pressure does not remove heavy deposits of grease, oil, etc., it may be necessary to use steam or liquid spray cleaner. DO NOT clean electrical components with steam.

NOTE

See special provision for blowing dust from pump and drive motors on page 14 of this section.

CAUTION

Battery must be disconnected and capacitors discharged before inserting air wand through access holes.

CAUTION

Wear suitable eye protection and protective clothing.

Lift trucks should be air-cleaned at every PM interval, and as often as required.

Air-cleaning should be done using an air hose with special adapter or extension having a control valve and nozzle to direct the air properly. Use clean, dry, low-pressure compressed air. Restrict air pressure to 207 kPa (30 psi).

Air-clean the following: upright assembly; drive axle; battery, cables, switches and wiring harness; transistor controls and wiring; drive and hydraulic pump motors; steering axle and steering cylinder.

Critical Fastener Torque Checks

Fasteners in highly loaded (critical) components can quickly fail if they loosen. Loose fasteners can cause damage or component failure. For safety, it is important that the correct torque be maintained on all fasteners of components which directly support, handle or control the load, or protect the operator.

Check torque of critical items, including: overhead guard, drive axle mounting, drive and steering wheel mounting, counterweight mounting, load backrest extension, tilt cylinder mounting and yokes, upright mounting and components. Refer to Group 40 for torque specifications.

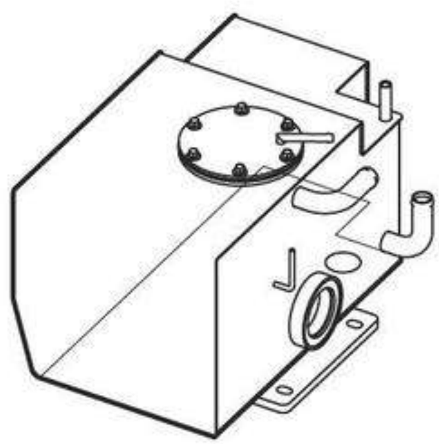
Lubrication, Fluids, and Filters

Hydraulic Sump

Check the hydraulic sump tank fluid level. Correct fluid level is important for proper hydraulic system operation. Low fluid level can cause pump damage. Overfilling can cause loss of fluid or lift system malfunction.

Hydraulic fluid expands as its temperature rises. Check the fluid level at operating temperature, after approximately 30 minutes of truck operation. To check the fluid level, park the truck on a level surface. Put the upright in a vertical position and lower the fork carriage fully down. Remove the floorplate and observe the fluid level marking on the sump tank. Refer to Group 29, Section 1 for more information on the sump tank. DO NOT overfill.

Check the condition of the hydraulic fluid for color, clarity, and contamination. Change (replace) the hydraulic fluid as necessary.



Hydraulic Fluid and Filter Change

Drain and replace the hydraulic sump fluid every 2000 operating hours, or sooner, as required. Replace the hydraulic fluid filter at every fluid change. Replace the sump tank breather/fill cap every 1000 operating hours.

NOTE

Always use genuine Clark Parts.

Sump Tank Breather Maintenance

Remove the sump tank fil cap/breather and inspect for excessive contamination and damage. Clean and replace as recommended by the PM schedule, or as required by operating conditions.

Access to the Drive Axle

Access the Drive axle by removing the floorplate or through the upright.

WARNING

An upright or carriage can move unexpectedly. Chain or block the carriage and rails. Failure to follow this warning can result in serious injury or death.

Refer to Group SA, Section 2 for additional information on supporting the upright.

Block the wheels. Be sure to put blocking under the carriage and upright rails.

Drive Axle Fluid

Check the drive axle fluid level with the truck on a level surface and fluid at operating temperature.

Remove the fluid level inspection plug located on the left side of the drive axle housing. Fluid level should be at the bottom of the inspection hole. If fluid level is low, add enough fluid to bring fluid level up to bottom of the inspection hole. DO NOT overfill.

Add the recommended fluid only, as required.

Inspect the fill plug for damage. Replace as needed. Install and tighten the plug.

Drive Axle Fluid Change

NOTE

Check the PM interval (operating hours), or the condition of the fluid to determine if the drive axle fluid needs to be changed.

Drain and replace the drive axle fluid every 2000 operating hours. The fluid should be drained when it is at operating temperature. Put the truck in a level position. Block the wheels to prevent truck from moving.

Inspect and clean the drive axle breather (air vent) mounted on top of drive axle.. Refer to Lubrication Chart and Group 40.

Truck Chassis Inspection and Lubrication

Lubrication and inspection of truck chassis components, including steer wheels and wheel bearings, will be easier if the rear of the truck is raised and blocked up under the frame. Refer to Group SA, Section 2, for additional information.

IMPORTANT

Do not raise truck by lifting under the counterweight.

WARNING

Be sure to put blocking under the frame to keep the truck safe.

Be sure to clean the grease fittings before lubricating. Remove excess grease from all points after lubricating.

Upright and Tilt Cylinder Lubrication

Clean the fittings and lubricate the tilt cylinder rod end bushings.

Clean the fittings and lubricate the upright trunnion bushings (one fitting on top of trunnion, each side).

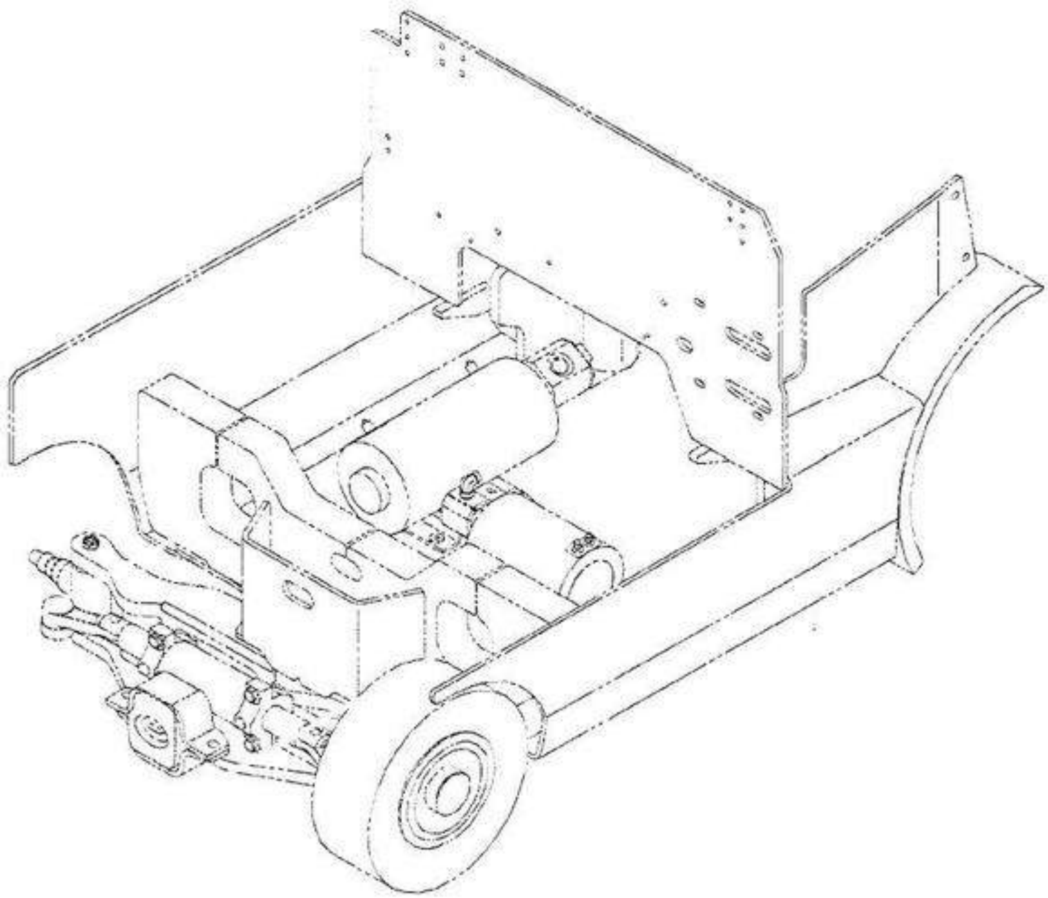
Lift Chains

Lubricate the entire length of the rail lift and carriage chains with Clark Chain and Cable Lube.

Air Cleaning of Motors

WARNING

Before inserting metal air cleaning wand, disconnect the battery and discharge the capacitors by using a 10W~100W resistance connected from the +Batt(pos.) to the -Batt(neg.).



Section 3

The PM Inspection Form

As an aid to service technicians performing and documenting PM inspections. Clark has prepared a Electric Truck Planned Maintenance Report form. (Sample appears on the next page.)

Use this form as a checklist, and make a record of your inspection and truck condition. Note the special coding system for indicating the importance of needed repairs Uprights can drop suddenly if not properly blocked. Look at the upright, but keep hands, tools, etc. out.

ELECTRIC AC TRUCK
PLANNED MAINTENANCE REPORT

CODE
- O.K.
- Potential
- Urgent

3 = O.K.
x = Adjust (Not P.M.)
r = Repair or replace
s = Requires shop repair

CUSTOMER

MODEL & SERIAL NO.
ATTACHMENT NO.

DATE | HOUR METER
DATE LAST P.M. | HRS. LAST P.M.
CUST. P.O. NO.

AUTHORIZED SIGNATURE | INSPECTOR | SPECIAL INSTRUCTIONS

A. TEST DRIVE MACHINE
- a. Drive Train Noise
- b. Steering Operation
- c. Service Brake Operation
- d. Speed Control
  - Creep Speed
- e. Plugging & Directional Control
- f. Return to Neutral
- g. Hydraulic System Operation
- h. Pedal Pads & Linkages
- i. Parking Brake Operation
- j. Seat Switch(Brake) Operation
- k. Pedestrian Warning Devices (if equipped)

01CLEANING & LUBRICATION
- a. Air Clean Truck
- b. Air Clean Electrical Control
- c. Air Clean All Motors
- d. Lubricate Truck

12 BATTERY AND CABLES
- a. Cable Condition
- b. Fluid Level
- c. Battery Load Test
- d. Battery Retention/Stops
- e. Specific Gravity
- f. Receptacle Condition
- g. Battery Connector Condition
- h. Battery Disconnect Operation

13GAUGES-LIGHTS-INDICATORS
- a. Hour Meter Operation
- b. Gauges - All Operate
- c. Lights - All Operate
- d. Wiring Condition
- e. Hon
- f. Lift Interrupt
- g. Operation of Accessories

16MOTORS
- a. Drive Motor Condition
- b. Pump Motor Condition

19ELECTRICAL TESTS
- a. Ground Tests
- b. Cable and Terminal Condition
- c. Wire Harness Condition
- d. Speed Pot Test
- e. Contactor Assemblies
- f. Contactor Tip Condition
- g. Service Brake Switch Operation
- h. Park Switch Operation
- i. S.R.O.
- j. P.M.T
- k. Speed Limit Switches
- l. Steering Switches
- m.Hydraulic Valve Switches
- * n. Drive Motor Current (Amps)
- * o. Pump Motor Current (Amps)
- * p. Steer Motor Current (Amps)

20DRIVE AXLE
- * a. Differential Fluid Level
- b. Clean Air Vent
- c. Security of Mounting
- d. Check Wheel Bearings

23WHEELS AND TIRES
- a. Tighten Mounting Bolts
- b. Tire Condition
- c. Drive
- d. Steer
- e. Load
- f. Caster
- g. Tire Pressure

23BRAKE SYSTEM
- a. Check for Leakage
- b. Cylinder Fluid Level
- c. Clean Vent Cap
- d. Pedal Free Travel
- e. Pedal Drift
- f. Master Cylinder Mounting
- g. Service Brake Wear/Adjustment
- h. Parking Brake Wear/Adjustment
- i. Brake Line/Cable Condition
- j. Brake Linkage check & Lubricate

26STEER AXLE
- a. Security of Mounting
- b. Axle Stop Adjustment
- c. Drag Link Adjustment
- d. Check Wheel Bearings

26STEERING SYSTEM
- a. Check for Leakage
- b. Oil Level - Condition
- c. Security of Mounting
- d. Tilt Column Operation

29/30 HYDRAULIC SYSTEM
- a. Check for Leakage
- b. Fluid Level - Condition
- c. Clean/Replace Breather
- * d. Replace Filter
- e. Linkage Adjustment
- f. Hose Condition
- g. Lift Speed (In./Sec.)
  - No Load
  - Full Load
- h. Drift Test (In./Min.)
  - Lift Cylinder
  - Tilt Cylinder

32TILT CYLINDERS
- a. Check for Leakage
- b. Cylinder Rod Condition
- c. Mounting Security/Torque
- d. Tilt Cylinder Adjustment (Racking)

34UPRIGHT-CARRIAGE
- a. Security of Mounting
- b. Roller Condition/Clearance
- c. Chain and Anchor Condition
- d. Chain Adjustment
- e. Latch and Stop Condition
- f. Cylinder Condition
- g. Forks, Locks, Stops
- h. Rail Condition
- i. Trunnion Ring Condition

34LOAD BACK REST
- a. Condition
- b. Security of Mounting

35LIFT LINKAGE (POW)
- a. Security of Mounting
- b. Linkage Condition
- c. Linkage Adjustment
- d. Load Wheel Bearings

38SHEET METAL & CWT
- a. Decals-Missing/Condition
- b. Data Plate Condition
- c. Seat Mounting and Operation
- d. Seat Belts Condition
- e. Door and Deck Latches
- f. CTW Mounting Bolts
- g. Slip Resistance Surfaces
- h. Operator's Manual

39OVERHEAD GUARD
- a. Condition
- b. Security of Mounting

53ATTACHMENTS
- a. Mounting Bolts
- b. Leakage
- c. Operation

CLARK

GROUP 12

BATTERY

NOTE :

Section 1

Battery Handling

Battery Handling

CAUTION

Remove all jewelry (watch, rings, bracelets, etc.) before working on electrical systems. Severe burns can result from contact with electrical circuits.

WARNING

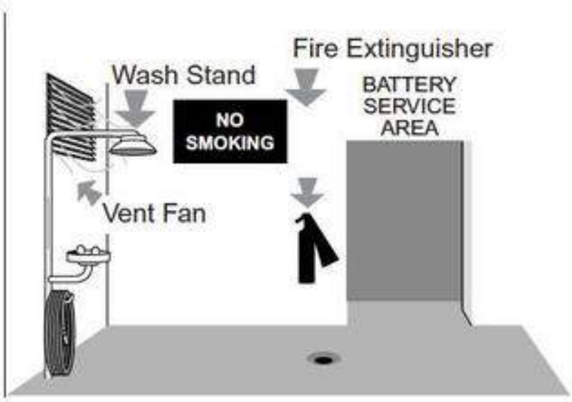
Battery service must be done by trained personnel. Battery acid can cause severe burns and injury. Do not smoke or have open flames around batteries.

WARNING

Electric truck batteries are heavy and awkward to handle. On charge, they give off hydrogen and oxygen which, in certain concentrations, are explosive. Electric truck batteries are also costly, so before you remove, service, or install a truck battery, consult BATTERY MANUFACTURER for more recommendations and instructions on handling and charging batteries. Carefully read and follow recommendations and instructions.

Change or service batteries only in an area designated for this purpose. Refer to page 4 for additional information.

- Be sure this area has provisions to flush and neutralize acid spillage.
- Be certain the area has proper ventilation to ventilate fumes from charging batteries.
- Check to see that there is fire protection. Fire extinguishers should be properly maintained and located in designated areas.



DANGER

Explosive gas is always present around batteries, especially when they are being charged.

- **No smoking allowed in the charging area.**
- **Battery electrolyte must never be checked with an open flame.**
- **Open flame, sparks, or electric arcs must never be allowed in the battery charging area.**

The battery contains corrosive sulfuric acid which can cause injury. If acid contacts your eyes or skin, flush immediately with water and get medical assistance.

Persons maintaining batteries must wear protective clothing such as:

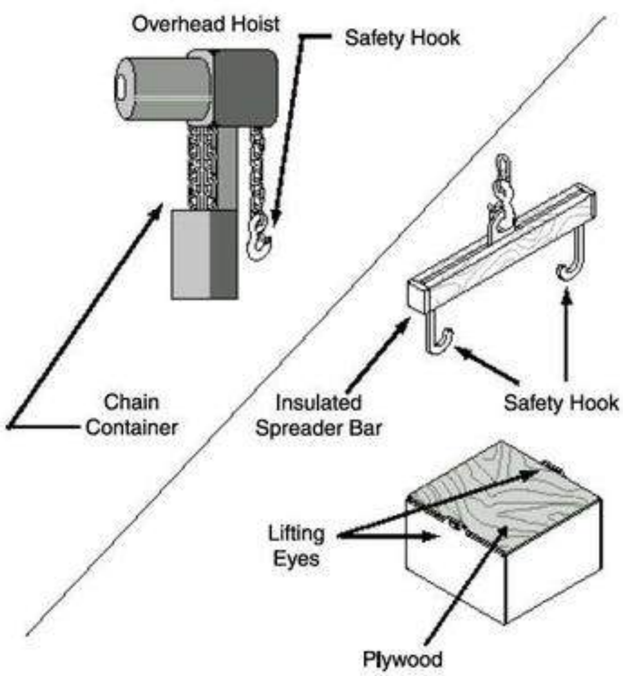
- Face and head shields
- Long shirt sleeves
- Gauntlet gloves

Be sure the battery service area is equipped with material handling equipment designed for the purpose of removing and replacing batteries, such as a conveyer or overhead hoist equipped with safety hooks.

IMPORTANT

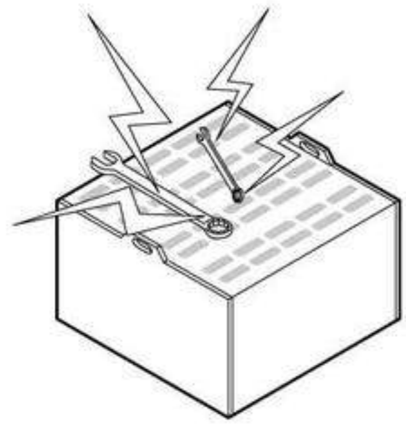
To prevent side forces from damaging the battery, the distance between the lifting hooks (of the spreader bar) must be adjusted to the same dimension as measured between the battery lifting eyes. Make sure the lifting hooks are the correct size to fit the lifting eyes of the battery.

- When using an overhead hoist, be sure to use an insulated spreader bar or similar lifting device.
- Be sure the hoist is equipped with a chain container to accumulate excess lifting chain. When this is not possible, be sure the battery is covered with a non-conductive material, such as plywood, as shown below.
- If the battery does not have a cover of its own, cover it with a non-conductive material such as plywood.



DANGER

Never lay tools or other metal objects on a battery. Metal objects contacting battery terminals will cause short circuits. The shorted circuits could ignite battery fumes and cause the battery to explode.



Battery Removal

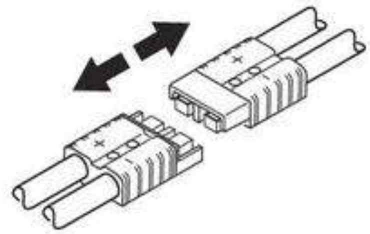
1. Move truck to the designated battery service area.

CAUTION

SAFE PARKING. Before working on truck:

- **Park truck on a hard, level and solid surface, such as a concrete floor with no gaps or breaks.**
- **Put upright in vertical position and fully lower the forks or attachment.**
- **Put all controls in neutral. Turn key switch OFF and remove key.**
- **Apply the park brake and block the wheels.**

2. Turn key switch OFF and disconnect battery.



3. Lift and latch seat deck to access battery.
4. If the battery to be handled is uncovered, cover battery with a non-conductive material (plywood, heavy cardboard, etc.) prior to removal from truck.

IMPORTANT

Do not wash battery in truck.

CAUTION

An overhead hoist of sufficient lifting capacity (refer to 'Weights" in Group 40) should be used to lift battery. The safety hooks of the insulated spreader bar should be attached to the lifting eyes provided in the battery casing.

5. Be sure battery is covered. Attach lifting device. Lift and remove battery.

Battery Maintenance

NOTE

To obtain maximum performance and battery life, follow the instructions supplied by your battery vendor.

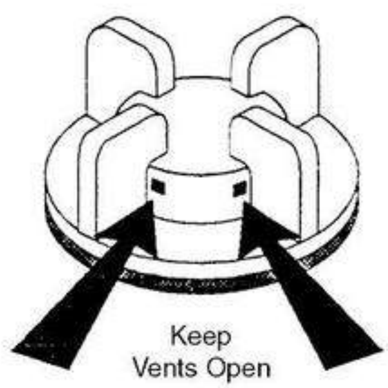
Industrial batteries are used to supply the electrical power to operate an electric industrial truck. Their voltage depends on the number of individual cells they contain. There are approximately two volts for each cell in the commonly used lead-acid type battery. Batteries normally range from 6 volts to 72 volts. Their capacity varies depending on the application. *Only use batteries that comply with factory specifications as to size and capacity.*

How to Get Maximum Life Out of Your Battery

- Do not add acid to a battery. *Only qualified battery representatives should determine if this is necessary.*
- When lifting a battery, use a lifting device designed for this purpose.
- Check the electrolyte level after placing a battery on charge. The electrolyte level in a battery should be slightly below the lower lip of the filling hole vent. Do not overfill. Overfilling causes loss of electrolyte.
- Keep the battery clean, dry and in good condition.
- Keep metal objects and tools away from the top of the battery. Short circuits will cause battery damage and could ignite battery fumes, causing the battery to explode.
- Maintain good battery cable connections.
- Check power cables and wiring for damage that can cause premature drainage of the battery.
- Do not overcharge a battery.
- Do not undercharge a battery.
- Follow the instructions provided by the supplier(s) of the battery and battery charging equipment.
- Maintain accurate battery records. If battery troubles occur, these records will help you and your battery representative determine the nature of the problem.

Battery Vents

- **When Charging Batteries:** The vent caps must be kept in place to avoid electrolyte spray. Care must be taken to assure that vent caps are functioning. The vents must be open to allow the battery to breathe. The battery cover must be removed/ opened to dissipate heat and explosive gas.
- **When Cleaning Batteries:** The vents must be tightly in place.



Battery Cleaning

The easiest and most satisfactory method of cleaning a battery is to wash it with a low-pressure cold water spray. The battery top can also be washed with a baking soda solution and rinsed with clear water.

IMPORTANT

- **Remove battery from truck before washing.**
- **Vent caps must be free of obstruction and in good condition.**
- **Battery top should be clean and free of cracks or breaks.**
- **Battery terminals must be clean and solidly mounted.**
- **Damaged batteries should be repaired or replaced. Consult your battery vendor.**

- Check to be sure all vent caps are tight before washing the battery.
- Fill a bucket with cold water. Add a box of baking soda to the bucket. Stir the solution until dissolved. Keep this solution around the battery service area at all times.
- After washing battery, thoroughly rinse with clear cold water.

Battery Charging

Follow the instructions supplied by the battery charger vendor.

Battery Electrolyte

- Check with battery manufacturer's documentation before working on battery electrolyte.
- Always use a carboy tilter or siphon when handling battery electrolyte.
- When mixing electrolyte, always pour acid into water - NEVER pour water into acid. *Pouring water into acid will cause a dangerous chemical action or splash.*

Clean Battery Compartment

- Using baking soda and water solution, clean the walls and floor of the compartment. Rinse with clear water.
- Blow off the compartment walls and floor with an air hose. Allow to air-dry.

DANGER

Wear eye protection and protective clothing when cleaning or drying with compressed air. Reduce air pressure to 207 kPa (30 psi). Debris removed with air pressure can cause injury.

Clean Battery Compartment

Replacement Batteries

CAUTION

Use a battery properly sized to the dimensions of the battery compartment. Batteries too small can shift and cause damage to the truck or injury to the operator or bystanders.

Only use batteries that comply with factory recommendations as to size and capacity.

Install Battery

If the battery is uncovered, cover the battery with a non-conductive material (i.e., plywood, heavy cardboard, etc.) prior to installation.

- Using an overhead hoist and insulated spreader bar, lift battery into battery compartment.
- Install battery retainer.
- Remove non-conductive material from battery.
- Connect battery to truck.

Keeping Battery Records

Records should be maintained to get the best service out of your battery and truck.

These Records Should Contain:

- **Test Date.** Each test should be dated for future reference and comparison.
- **Specific Gravity and Temperature Readings.** Each battery cell should be checked and recorded before and after charging. The specific gravity reading of the electrolyte, calculated using a multiplier to account for the ambient temperature, should not be less than 1.260. If below 1.250, the battery should be recharged and tested.
- **Variation Between Each Cell Tested.** The variation in specific gravity reading between cells should not be greater than 15 points (0.015). If readings are greater, there are defective cells.

NOTE

The pilot cell should be changed occasionally to distribute any electrolyte loss over the battery when taking readings.

- **Load Voltage Tests** should be performed and recorded indicating the condition of a battery while it is performing work.
- **Actual Operating Hours of the Battery.** Record the actual time the battery is in use before putting it on charger.
- **Charging Time.** Keep an accurate record of the actual time the battery is on charger. After each charge, check to see if the battery is fully charged. Test the battery before placing it back into service. Record these results.
- **Visually Inspect** for loose terminal connections or posts, a cracked case, damaged cell covers (vent caps), or excessive corrosion. This data should be noted to help determine work environment and possible trouble areas.

Section 2

Battery Tests

Battery Tests

NOTE

Use both tests described here.

Specific Gravity Test

Test at least six cells across battery with a temperature corrected hydrometer (see chart). Battery is fully charged when the reading falls in the 1.280 to 1.300 range. If the difference between cells is more than .015, battery needs maintenance.

SPECIFIC GRAVITY TEST	
SPECIFIC GRAVITY	STATE OF CHANGE
1.260-1.300	100% CHARGED
1.230-1.250	75% CHARGED
1.200-1.220	50% CHARGED
1.170-1.190	25% CHARGED
1.140-1.160	VERY WEAK
1.110-1.130	DISCHARGED

BY USING A HYDROMETER, THE SPECIFIC GRAVITY OF THE ELECTROLYTE SOLUTION IN A BATTERY CAN BE DETERMINED. THE BATTERY SPECIFIC GRAVITY IS AN INDICATION OF THE BATTEY'S STATE OF CHARGE. IF THE STATE OF CHARGE IS LOW, THE HYDROMETER WILL READ LOW. IF THE STATE OF CHARGE IS HIGH, THE HYDROMETER WILL READ HIGH.

AS AN EXAMPLE A READING FROM:

1.260 TO 1.300 INDICATED A FULLY-CHARGED BATTERY.
1.200 TO 1.220 INDICATES A BATTERY IS IN A DISCHARGED CONDITION AND CANNOT GIVE SATISFACTORY SERVICE.

Load Test

Put the main hydraulic system into tilt by-pass while reading battery volts with a voltmeter.

Minimum acceptable voltage
for 36 volt battery.. . . . . .28.8 volts
Minimum acceptable voltage
for 48 volt battery. .38.4 volts

Battery needs recharge or repair if voltage drops below 80% of the rated voltage of the battery.

GROUP 13

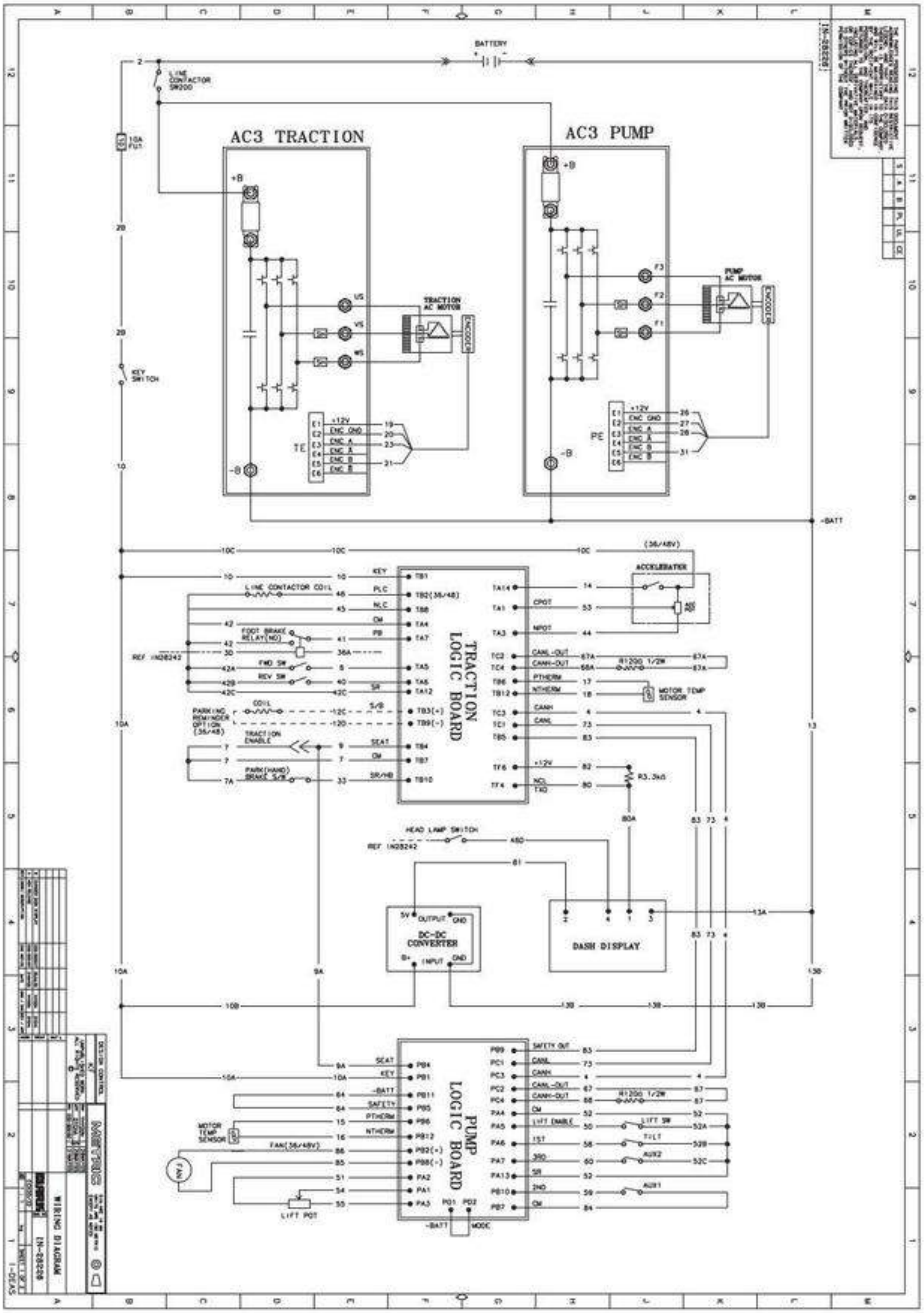
WIRING, SWITCHES, AND INSTRUMENTS

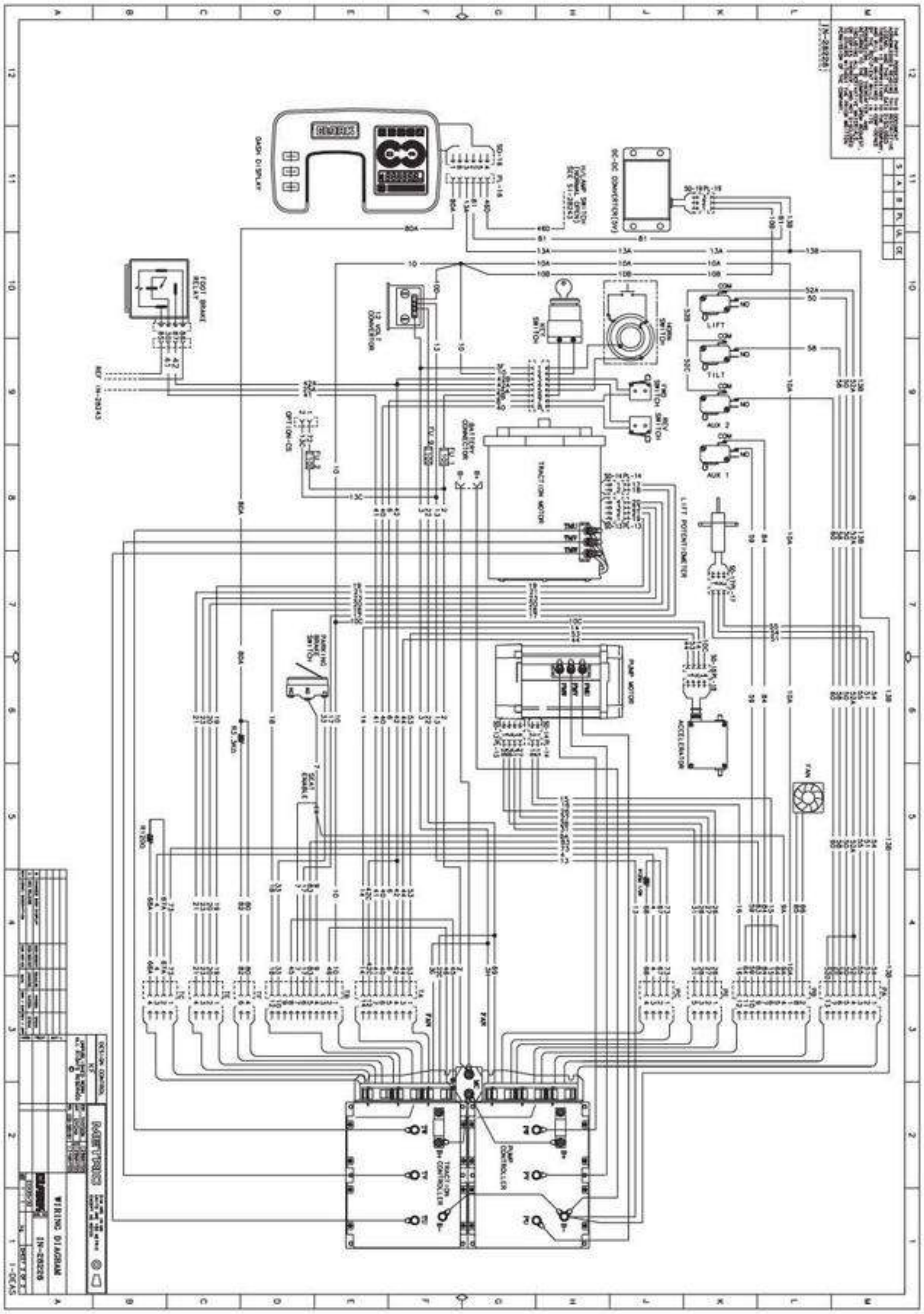
NOTE :

Section 1

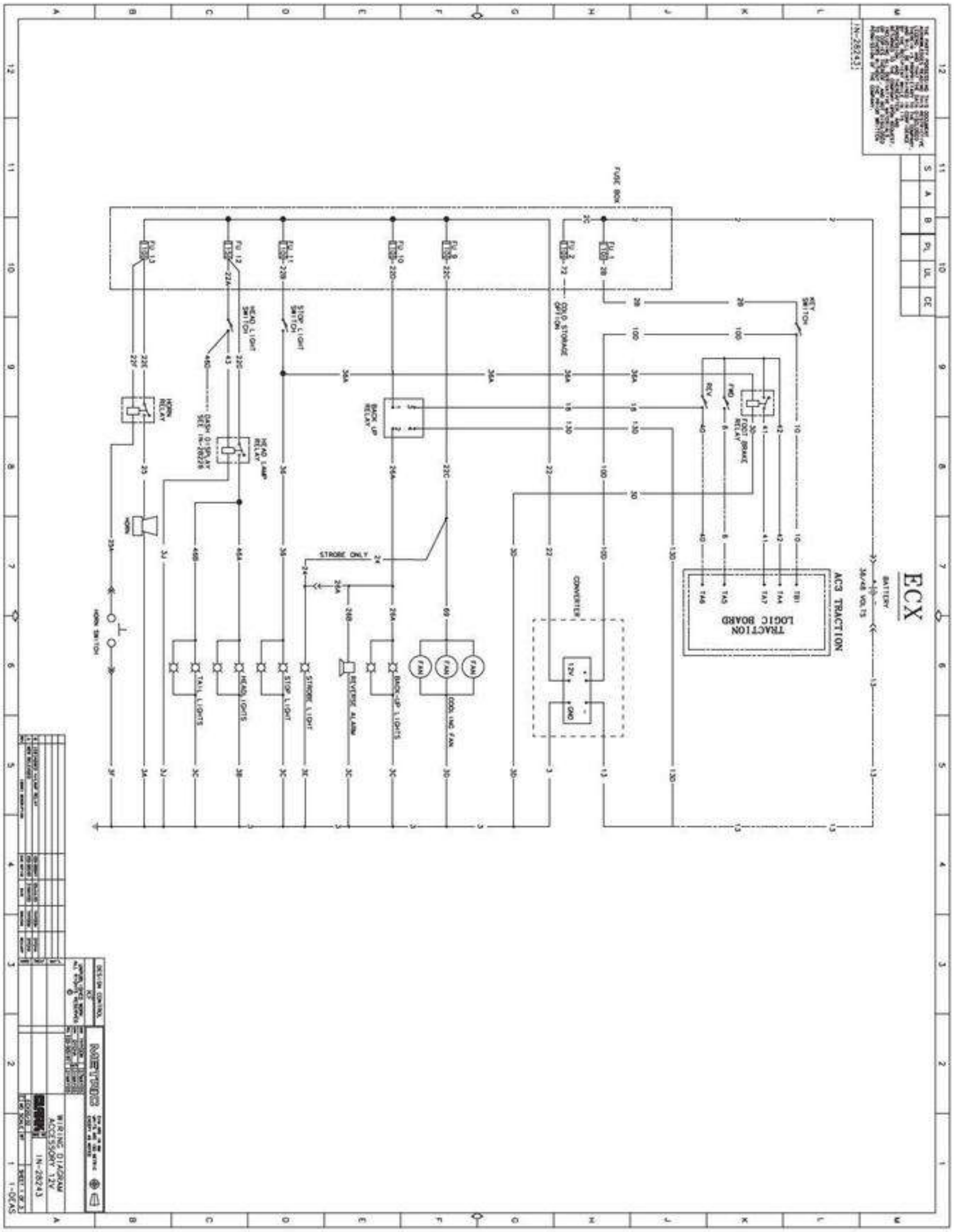
Schematic Electric Circuit Diagrams

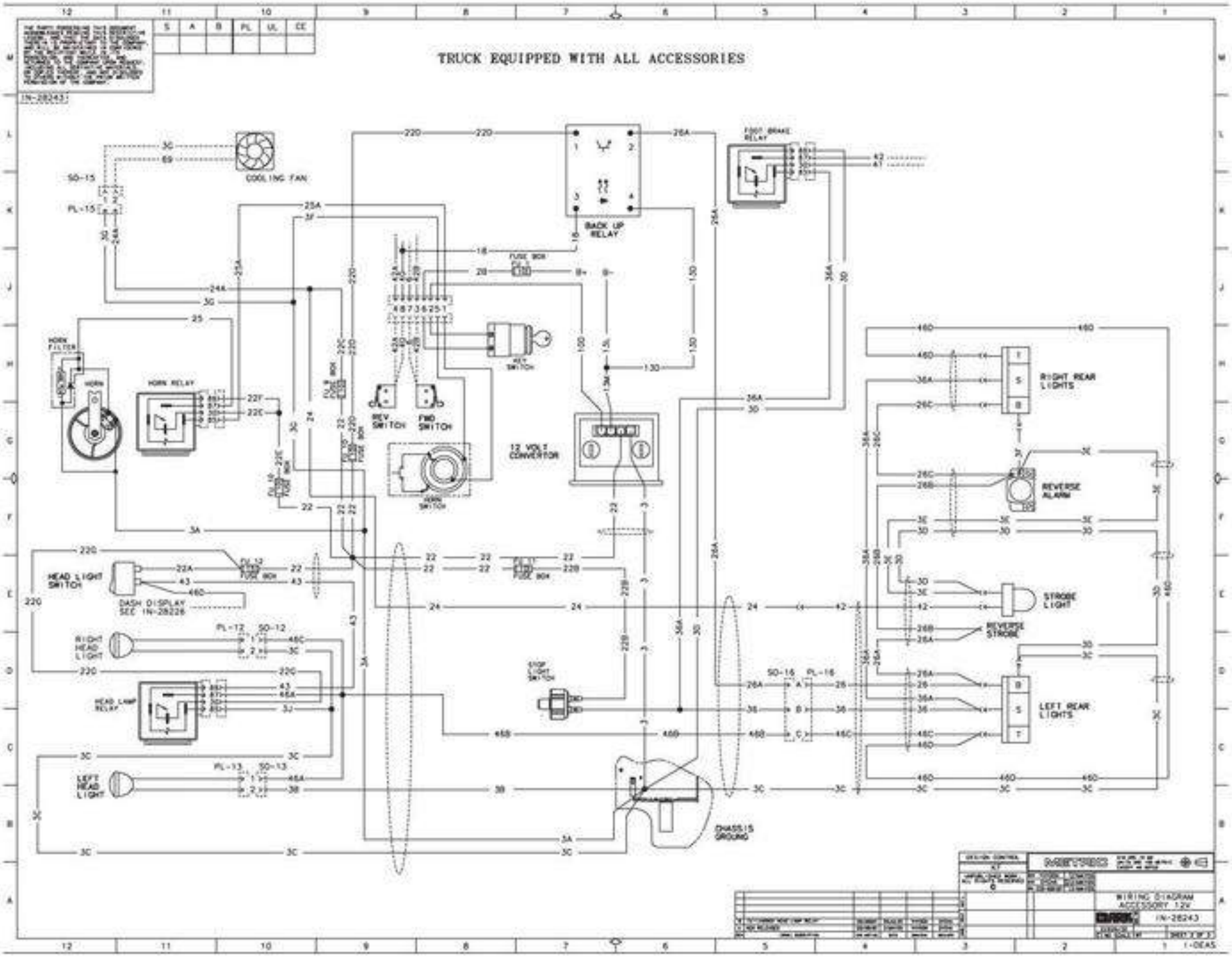
Standard Truck(ECX)

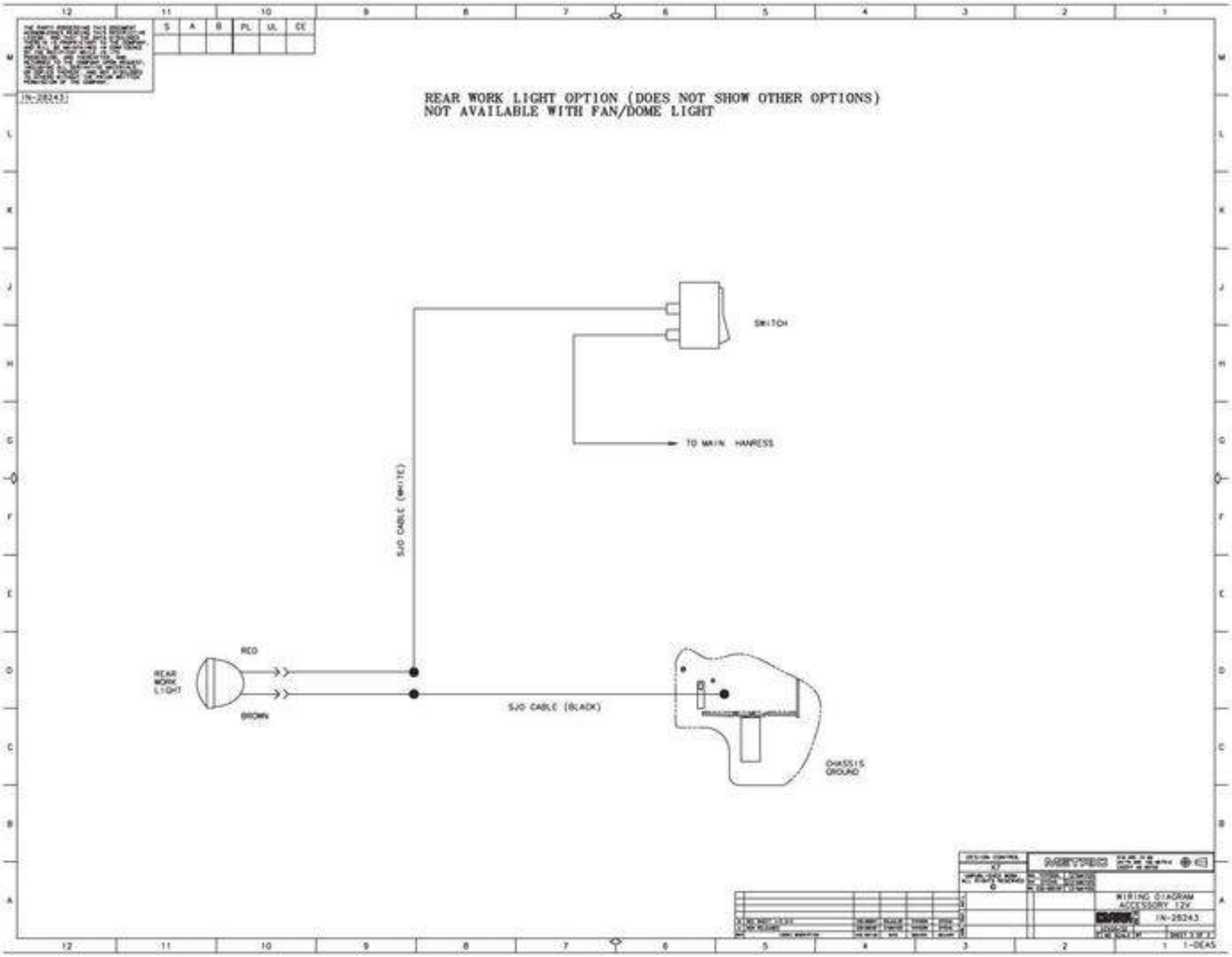




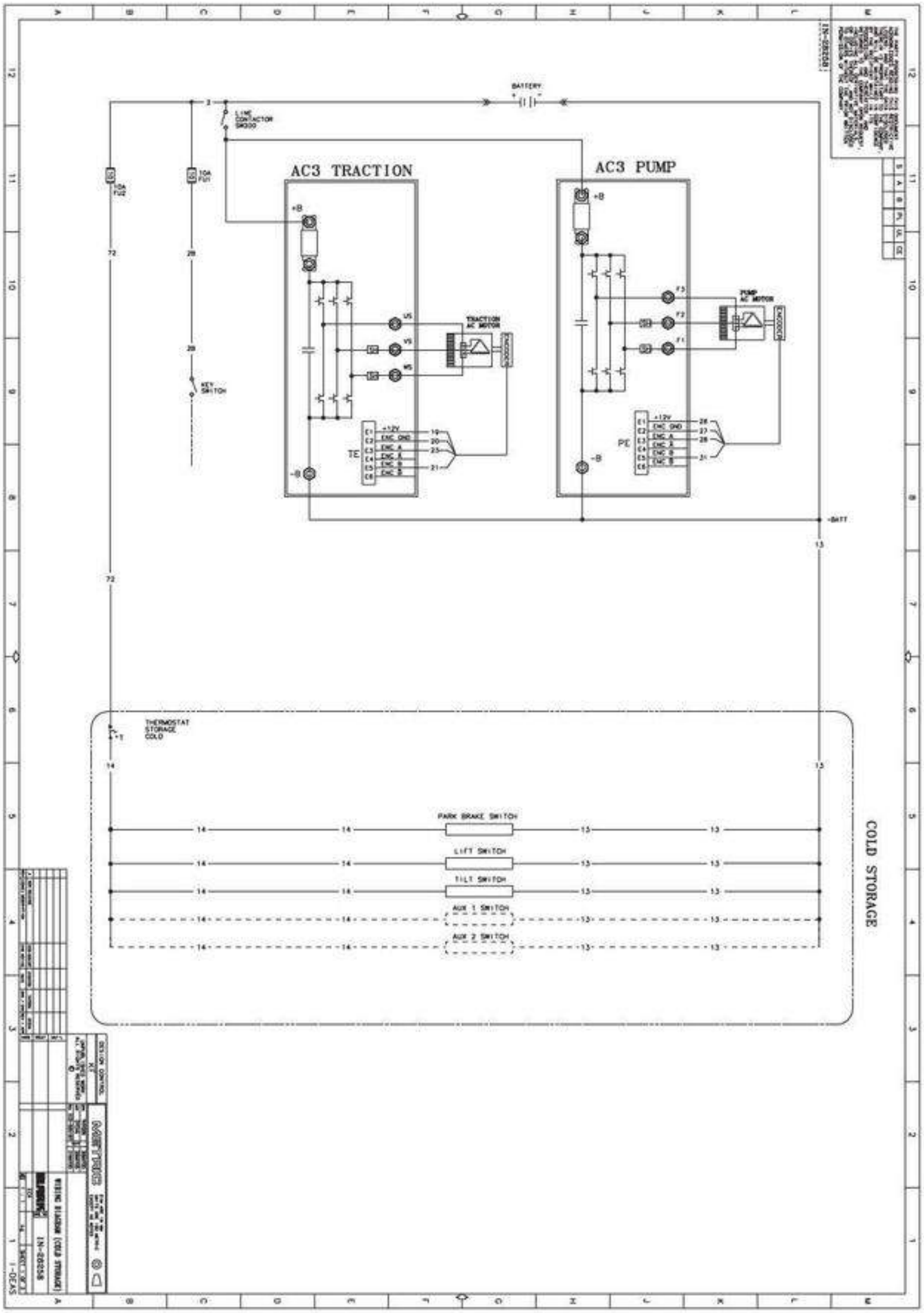
Accessories(ECX)

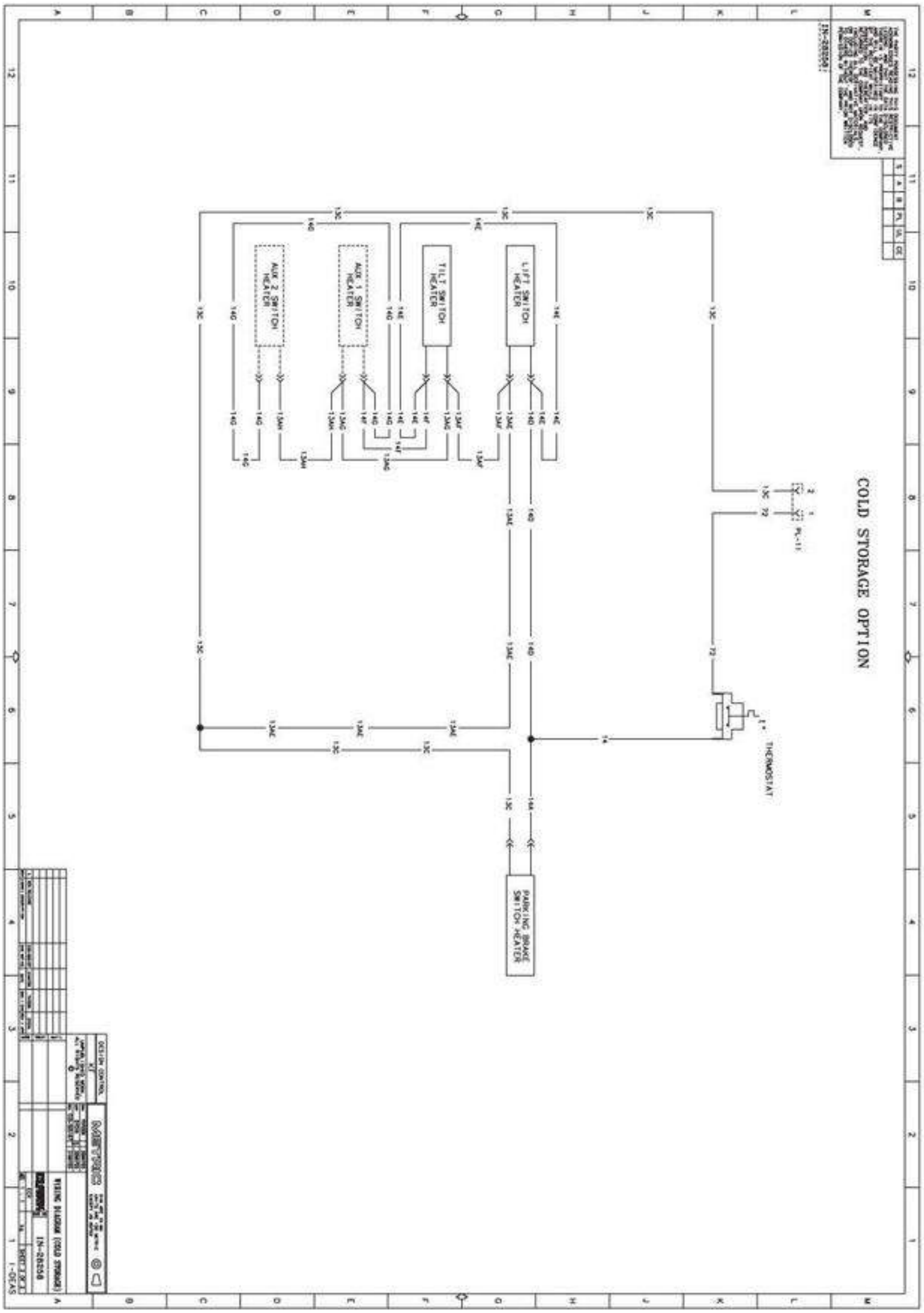



TRUCK EQUIPPED WITH ALL ACCESSORIES
COOLING FAN
SO-15
PL-15
HORN FILTER
HORN
HORN RELAY
BACK UP RELAY
FOOT BRAKE RELAY
FUSE BOX
KEY SWITCH
REV SWITCH
FWD SWITCH
HORN SWITCH
12 VOLT CONVERTOR
RIGHT REAR LIGHTS
REVERSE ALARM
STROBE LIGHT
REVERSE STROBE
LEFT REAR LIGHTS
HEAD LIGHT SWITCH
DASH DISPLAY SEE IN-28226
RIGHT HEAD LIGHT
HEAD LAMP RELAY
LEFT HEAD LIGHT
STOP LIGHT SWITCH
CHASSIS GROUND
PL-12
SO-12
PL-13
SO-13
SO-16
PL-16
WIRING DIAGRAM ACCESSORY 12V
IN-28243

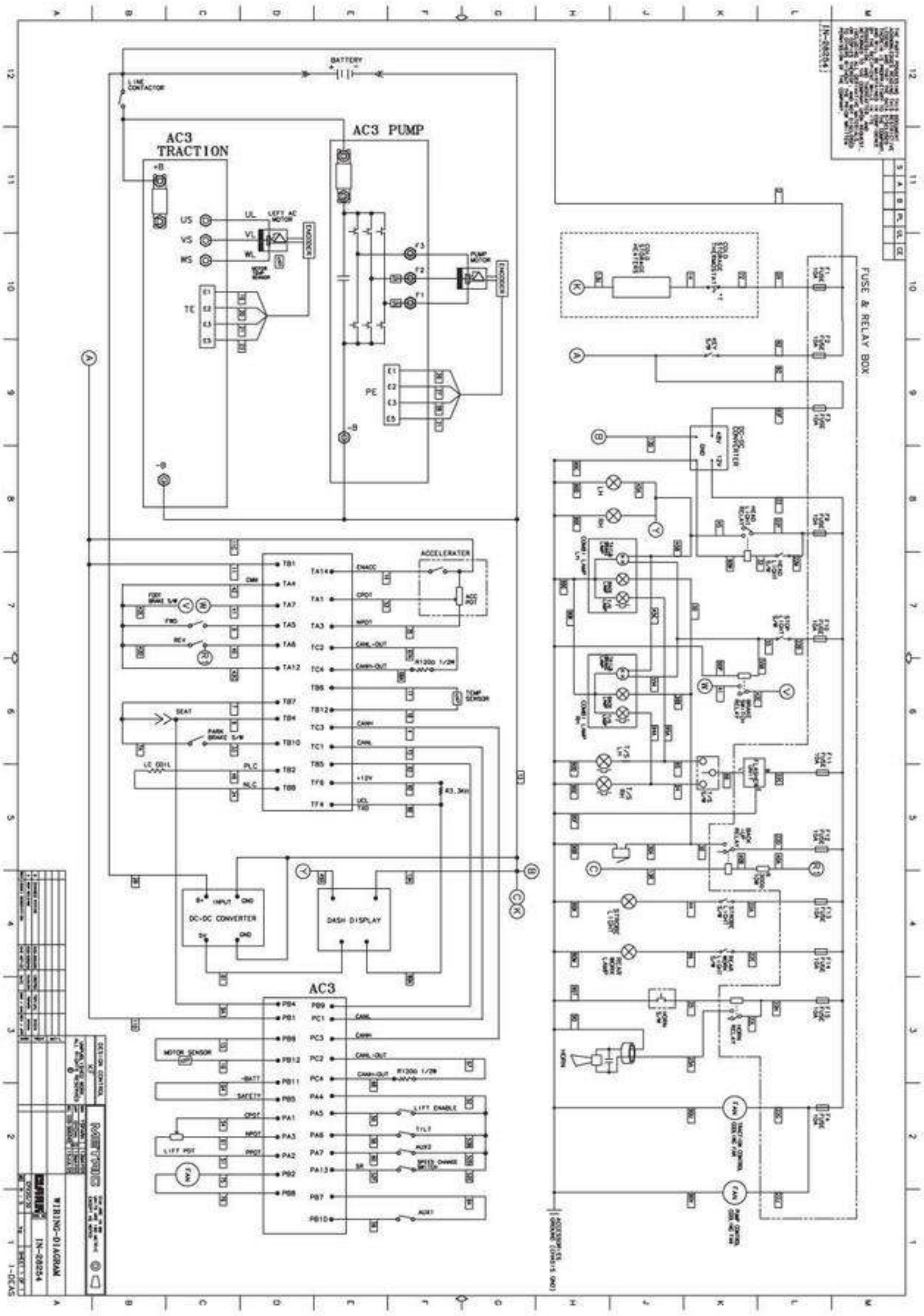

REAR WORK LIGHT OPTION (DOES NOT SHOW OTHER OPTIONS)
NOT AVAILABLE WITH FAN/DOME LIGHT
SWITCH
TO MAIN HANRESS
SJO CABLE (WHITE)
RED
REAR
WORK
LIGHT
BROWN
SJO CABLE (BLACK)
CHASSIS
GROUND
WIRING DIAGRAM
ACCESSORY 12V
IN-28243

Options(ECX)


BATTERY
LINE CONTACTOR
AC3 TRACTION
AC3 PUMP
TRACTION AC MOTOR
PUMP AC MOTOR
KEY SWITCH
THERMOSTAT STORAGE COLD
PARK BRAKE SWITCH
LIFT SWITCH
TILT SWITCH
AUX 1 SWITCH
AUX 2 SWITCH
COLD STORAGE
-BATT
TE
PE
WIRING DIAGRAM (COLD STORAGE)
1N-2825B


COLD STORAGE OPTION
LIFT SWITCH HEATER
TILT SWITCH HEATER
AUX 1 SWITCH HEATER
AUX 2 SWITCH HEATER
PARKING BRAKE SWITCH HEATER
THERMOSTAT

Standard Truck(EPX)



NOTE :

Section 2

General Electrical Service Tips

General Electrical Service Tips

⚠ CAUTION
Always wear safety glasses.

Remove all jewelry before working on truck.

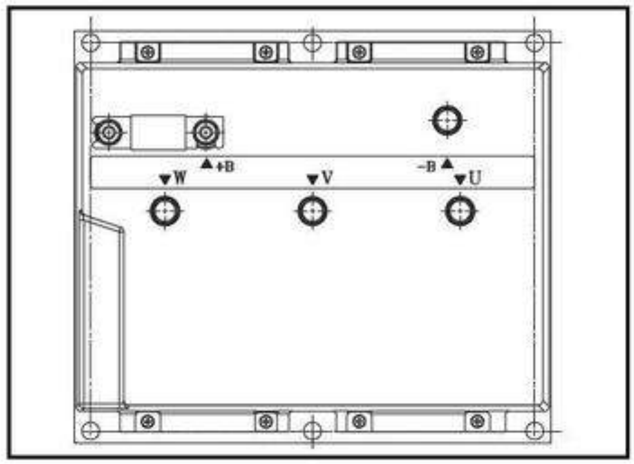
2. Disable the truck:

- Turn the key switch to OFF.
- Remove key.
- Make sure battery is disconnected.

3. Discharging Controller Capacitors

It is necessary to discharge the capacitors before you work on the controller.

NOTE
Make sure that the battery has first been disconnected at the battery receptacle.

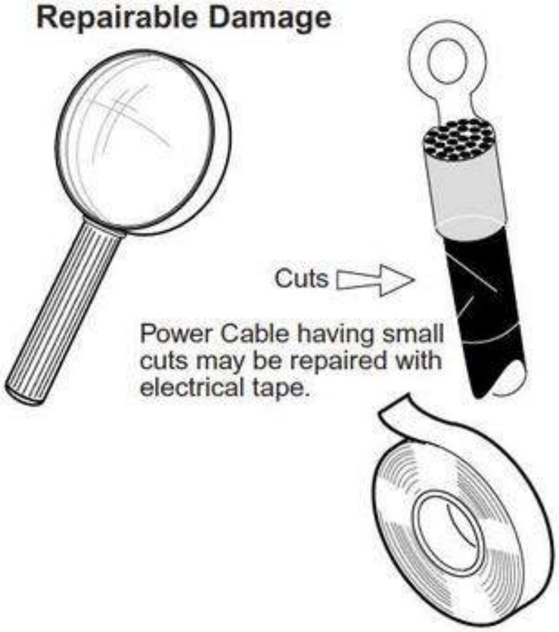


To discharge the capacitors connect a 200 ohm 10 watt resistor between the positive and negative input post of the controller for 10 seconds.

Checking Power Cables

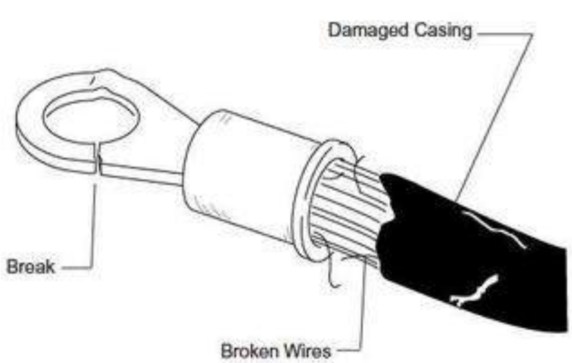
Every cable and wiring harness on this truck is manufactured to an exact specification. A shorter cable or harness will not fit. If either a harness or cable is routed improperly, it will not fit. Subsequently, electrical shorts and damaged components may result if the replacement part is the wrong one, or if it is routed incorrectly.

Repairable Damage



Cables having damage as shown in illustration below should be removed immediately and replaced with new. Be certain the replacement cable is the exact same length, size and has the proper connector. Make absolutely certain the cable end is properly crimped and its connection properly torqued upon installation

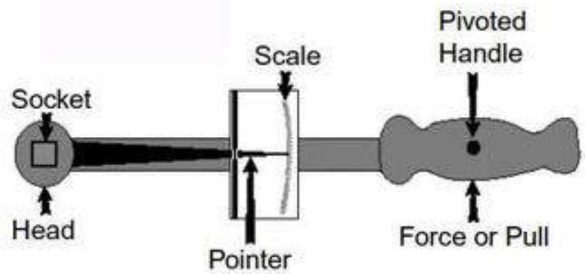
Cable unfit for further service.



Torquing Fasteners

Improperly torqued fasteners can cause damage

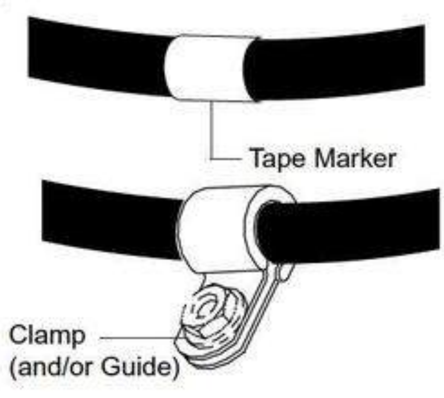
Use an appropriate wrench and tighten all fasteners to the torque specified in the following inspection procedures.



Typical Torque Wrench

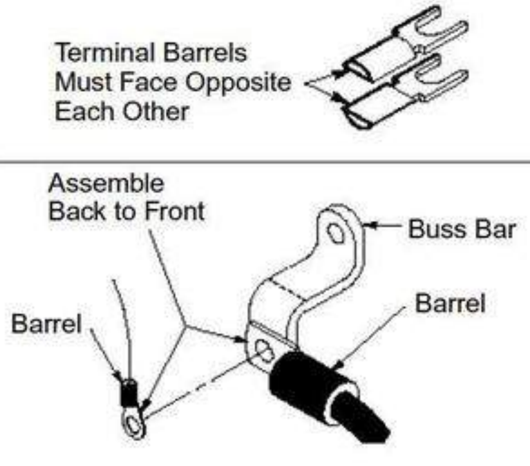
Connecting and Mounting Components

Tape markers are used to correctly position each wire harness and electrical cable on the truck. When correctly installed, the tape marker will be hidden by the mounting clamp (guide). Be sure to follow the instructions, where noted in this manual, when installing a wire harness or electrical cables. If you do not, possible shorts and equipment damage may result.



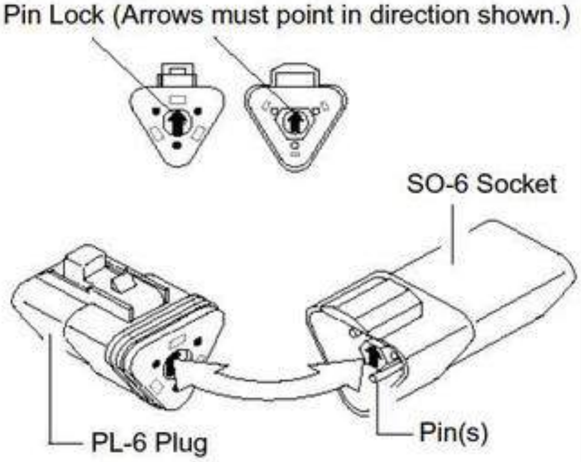
Markers on Wire Harnesses and Power Cables

Multiple cable and wire connections must be connected as illustrated or electrical shorts and control damage may result.



Multiple Connections

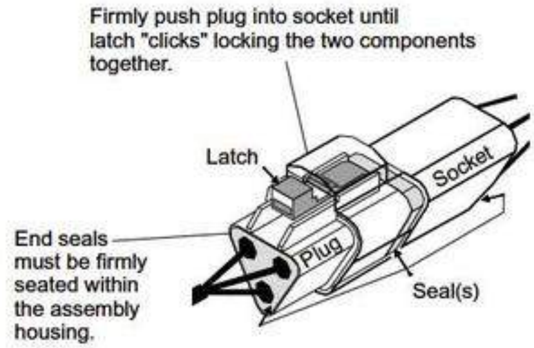
Connector Plugs and Receptacles are permanently labeled with the proper PL (Plug) and SO (Socket/Receptacle) number for easy identification. Match the plug number with the appropriate receptacle number before making a connection. If you do not, electrical shorts and possible damage to the equipment may result. i.e., Plug #PL-6 plugs into pin socket #SO-6, etc.



Example of Pin Lock Plug and Socket

There is a moisture-resistant seal at each wireend of the connector and between the plug and socket.

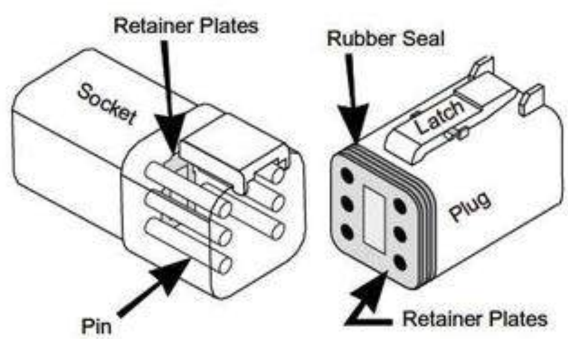
Check seals for damage that would make them unfit for furtherservice (cuts, etc.). Make certain the end seals are seated flush with the end of the connector housing. Make certain the plug and socket latchtightly to each other.



Seals and Latch

Retainer plates snap into place to secure the pins and their sockets.

Check the plates and seal for damage and secure mounting.



Retainer Plates

CLARK

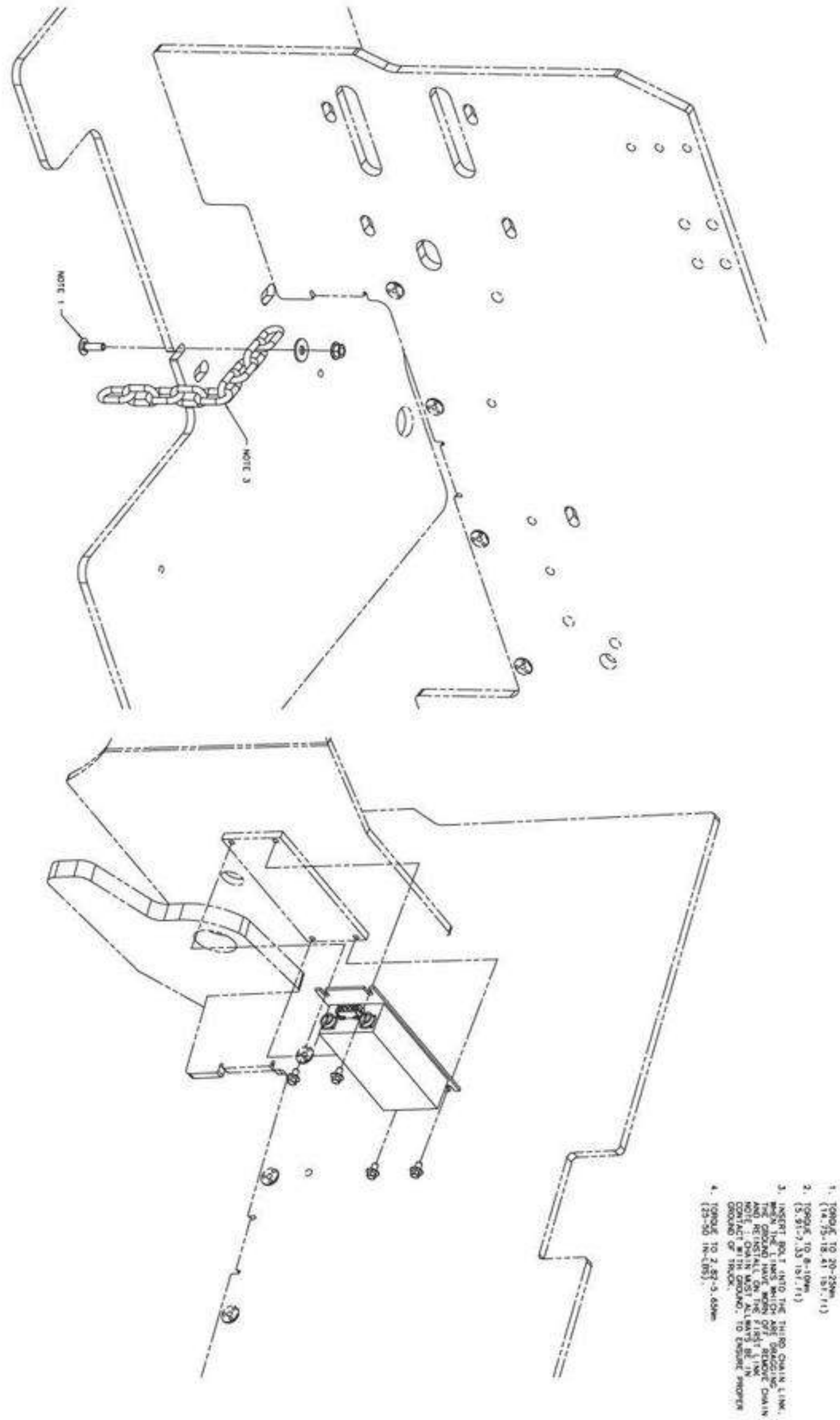
NOTE :

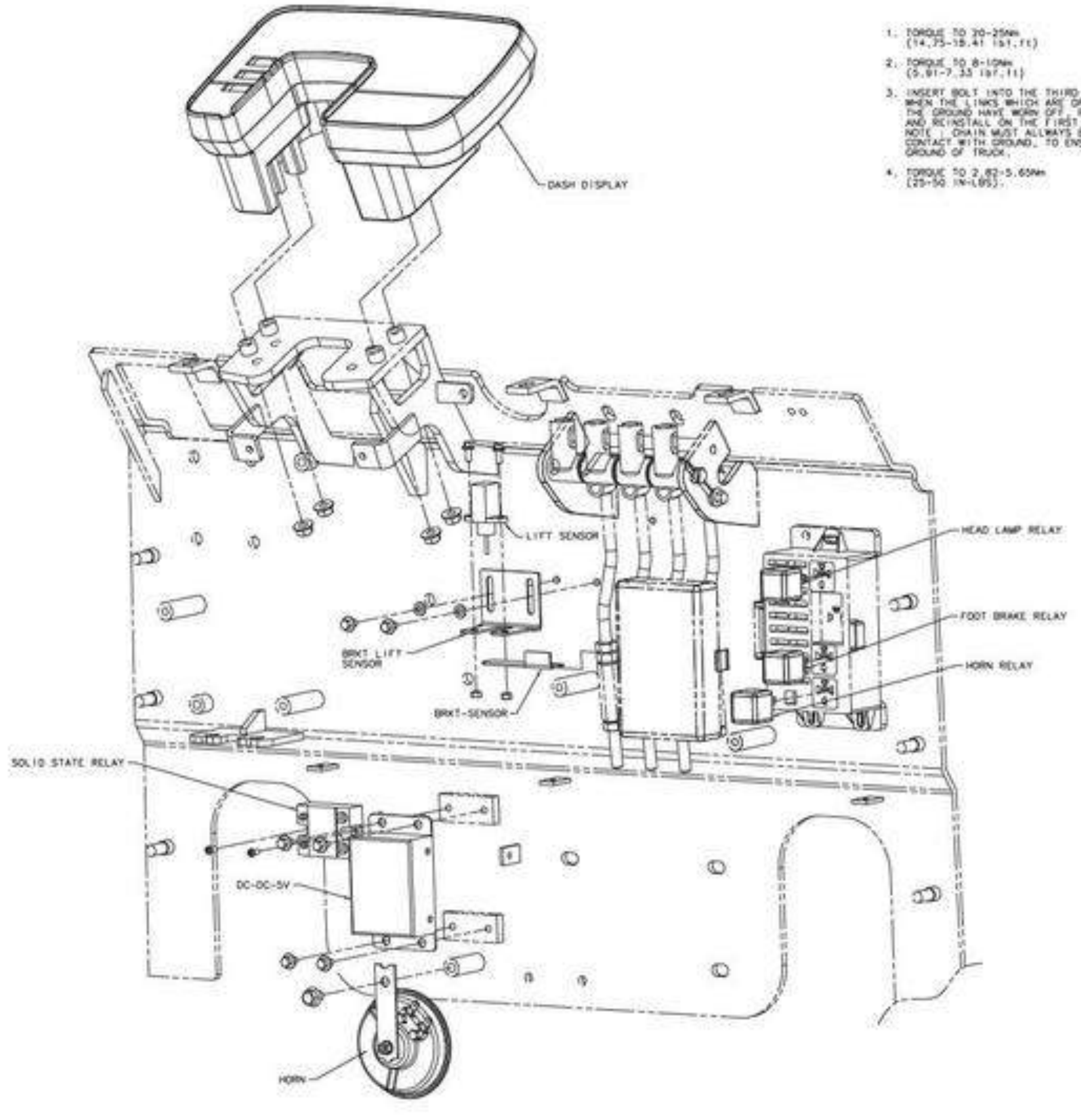
Section 3

Wiring and Cables

The following illustrations depict wiring and cable routing and connections for standard trucks and main accessory harness.

Electrical Components(ECX)



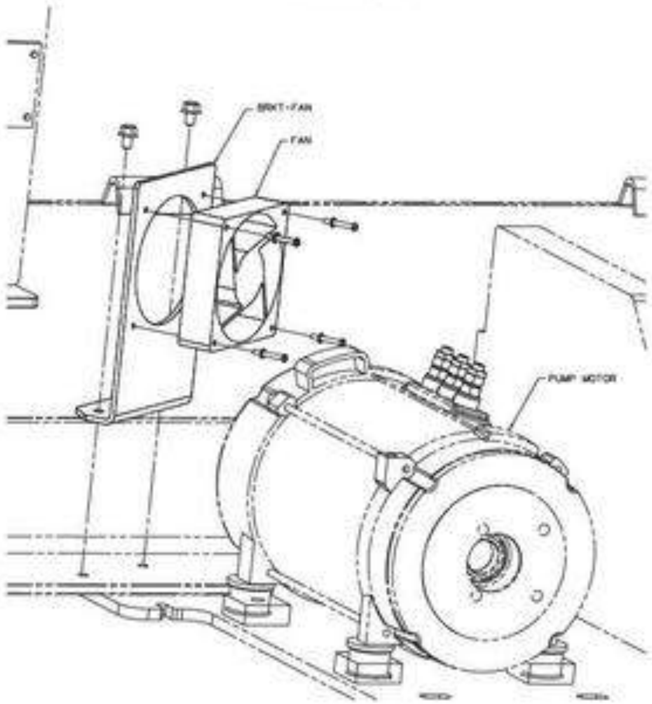


1. TORQUE TO 20-25Nm (14,75-18.41 lbf,ft)
2. TORQUE TO 8-10Nm (5.91-7.33 lbf,ft)
3. INSERT BOLT INTO THE THIRD CHAIN LINK. WHEN THE LINKS WHICH ARE DRAGGING THE GROUND HAVE WORN OFF, REMOVE CHAIN AND REINSTALL ON THE FIRST LINK NOTE : CHAIN MUST ALLWAYS BE IN CONTACT WITH GROUND, TO ENSURE PROPER GROUND OF TRUCK.
4. TORQUE TO 2.82-5.65Nm (25-50 IN-LBS).

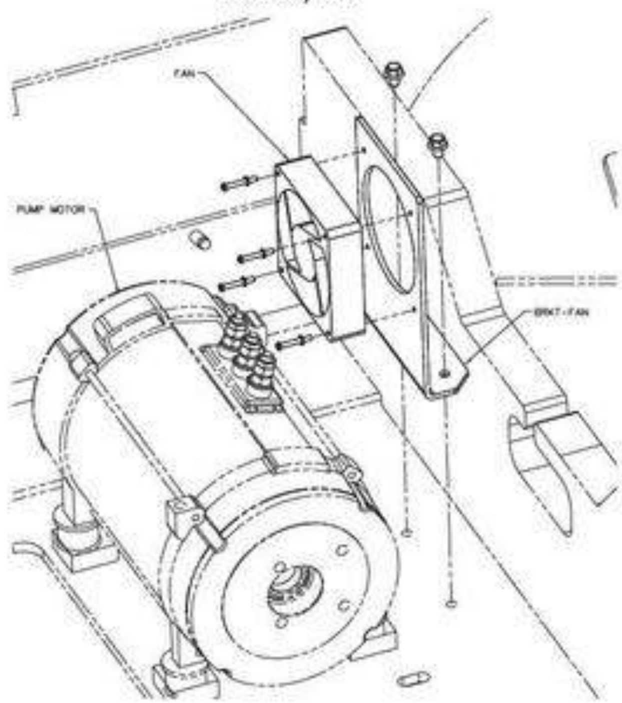
INST-PUMP MOTOR FAN 36/48V

1. TORQUE TO 20-25Nm
[14.75-18.41 lbf.ft]
2. TORQUE TO 8-10Nm
[5.91-7.33 lbf.ft]
3. INSERT BOLT INTO THE THIRD CHAIN LINK, WHEN THE LINKS WHICH ARE DRAGGING THE GROUND HAVE WORN OFF. REMOVE CHAIN AND RE-INSTALL ON THE FIRST LINK
NOTE : CHAIN MUST ALLWAYS BE IN CONTACT WITH GROUND, TO ENSURE PROPER GROUND OF TRUCK.
4. TORQUE TO 2.82-5.63Nm
[25-50 IN-LBS].

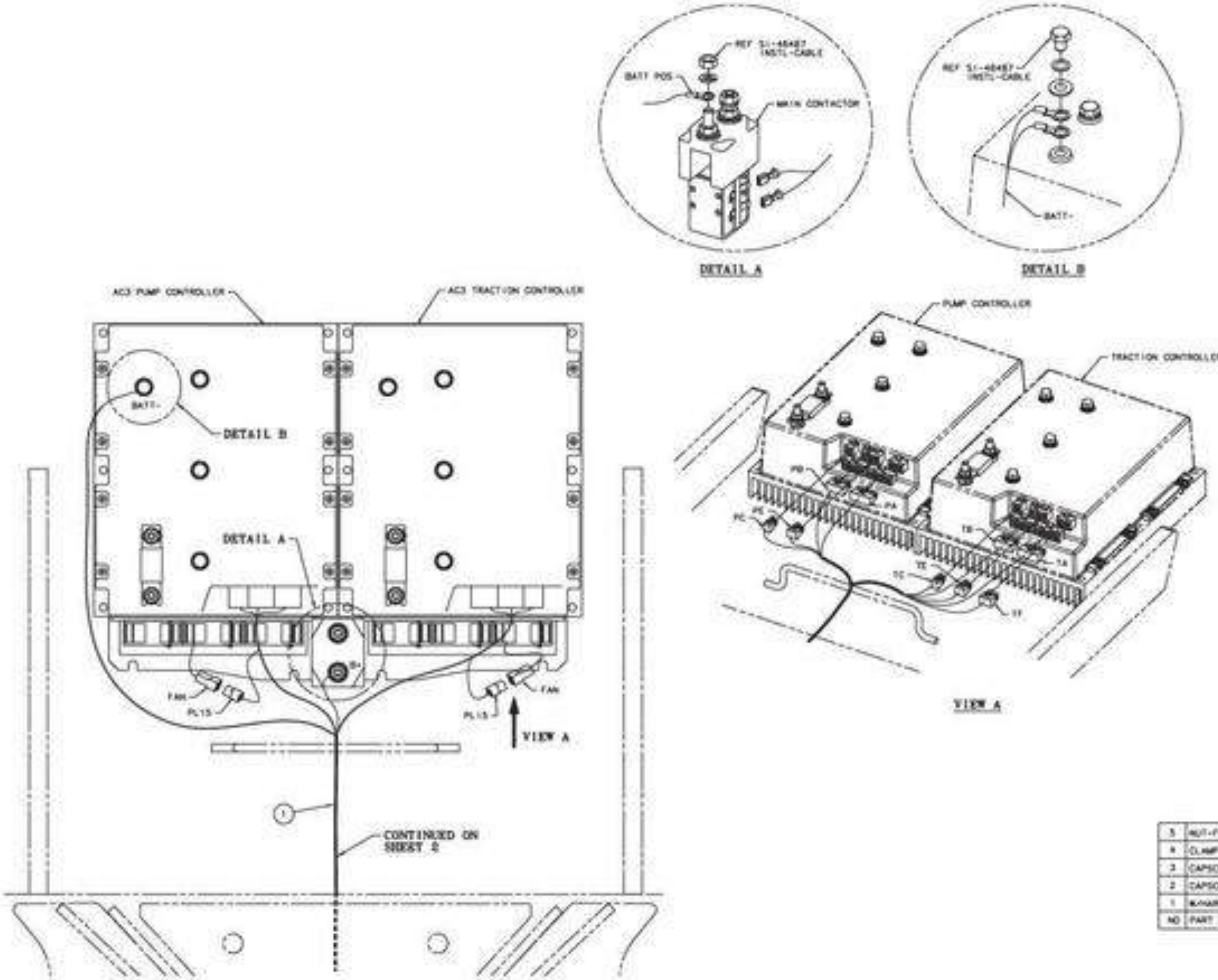
ECX20/25



ECX30/32

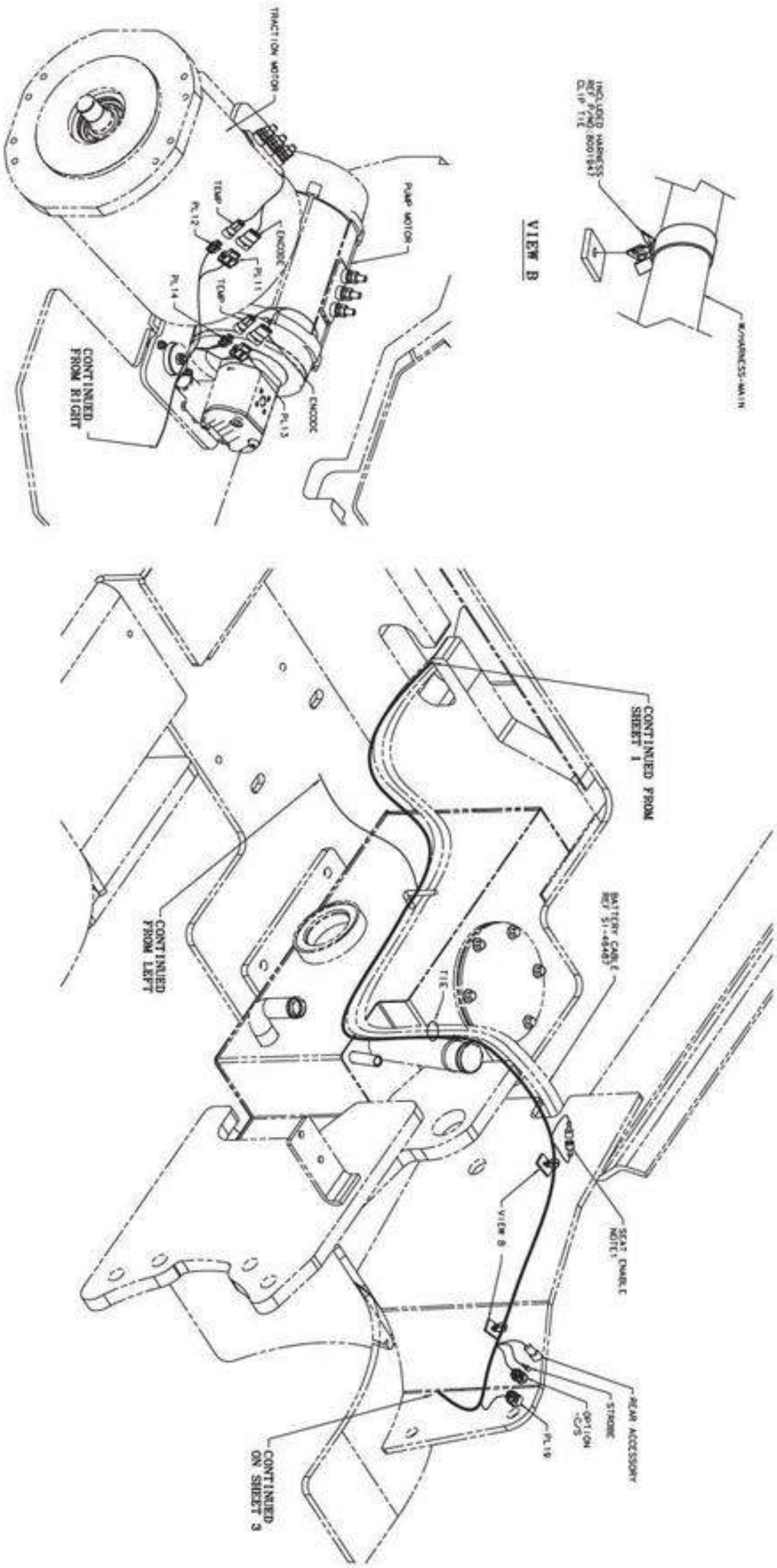


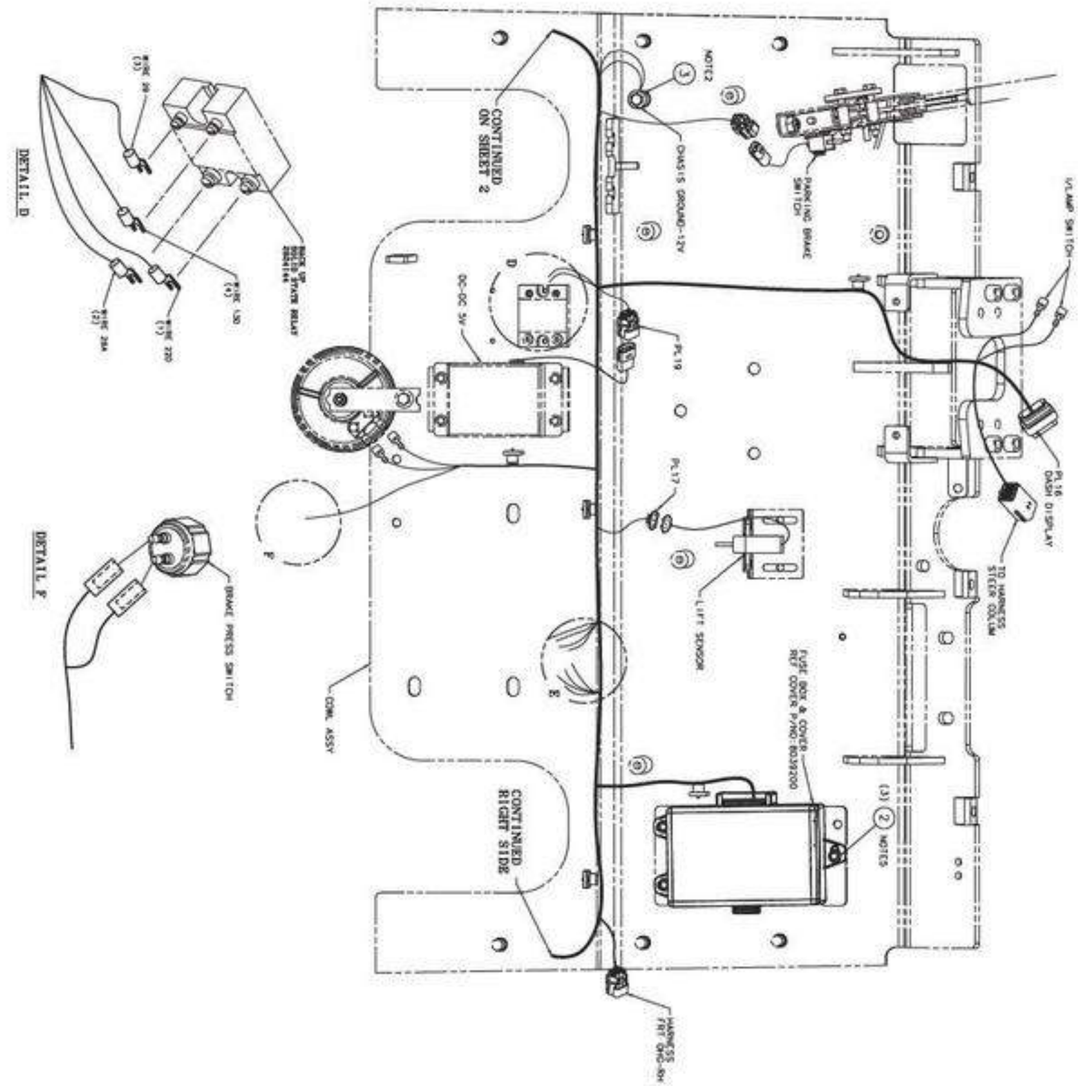
Main Harness(ECX)

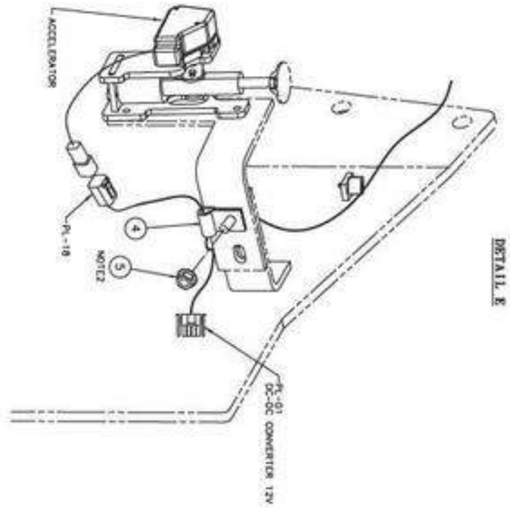


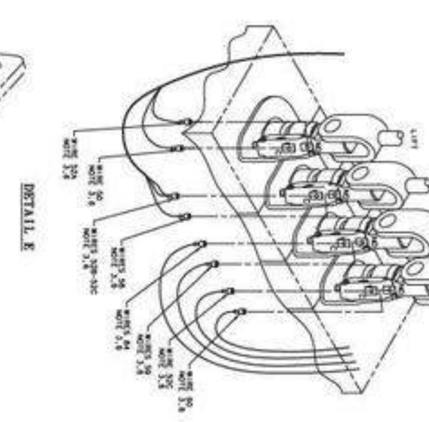
1. DISCONNECT TERMINAL ON WIRE 7 FROM TERMINAL ON WIRE 9 FOR TRACTION ENABLE/DISABLE OPTIONS
2. TORQUE TO 20-25N/m.
3. ALL HARNESS WIRING AND CONNECTIONS MADE PER WIRING DIAGRAMS IN-28226
4. AFTER INSTALLATION OF HARNESS: MEASURE THE RESISTANCE BETWEEN BATTERY POSITIVE AND THE TRUCK FRAME. ALSO MEASURE THE RESISTANCE BETWEEN BATTERY NEGATIVE AND THE TRUCK FRAME. BOTH RESISTANCES SHOULD BE GREATER THAN 20,000 OHMS.
5. TORQUE TO 13-15N/m.
6. GENTLY PACK FEMALE SIDE OF INDICATED PLUG OR CONNECTOR WITH 2824625 (ELECTRICAL CONNECTOR GREASE-NYE 760G). FILL EACH OPENING IN PLUG TO A MINIMUM DEPTH OF 1/8". DO NOT OVER-FILL PLUG. REMOVE EXCESS GREASE FROM FACE OF PLUG PRIOR TO CONNECTING.
7. SERVICE NOTE: RE-APPLY 2824625 (GREASE) TO PLUGS OR CONNECTORS ANYTIME THEY ARE DISCONNECTED.

5	NUT-FLANGE	1	
4	CLAMP	1	
3	CAPSCREW FLANGE	1	
2	CAPSCREW FLANGE	3	
1	W/HARNESS-MAIN	1	
NO	PART NAME	Q'TY	REMARK


TRACTION MOTOR
PUMP MOTOR
VIEW B
CONTINUED FROM RIGHT
CONTINUED FROM SHEET 1
CONTINUED FROM LEFT
CONTINUED ON SHEET 3

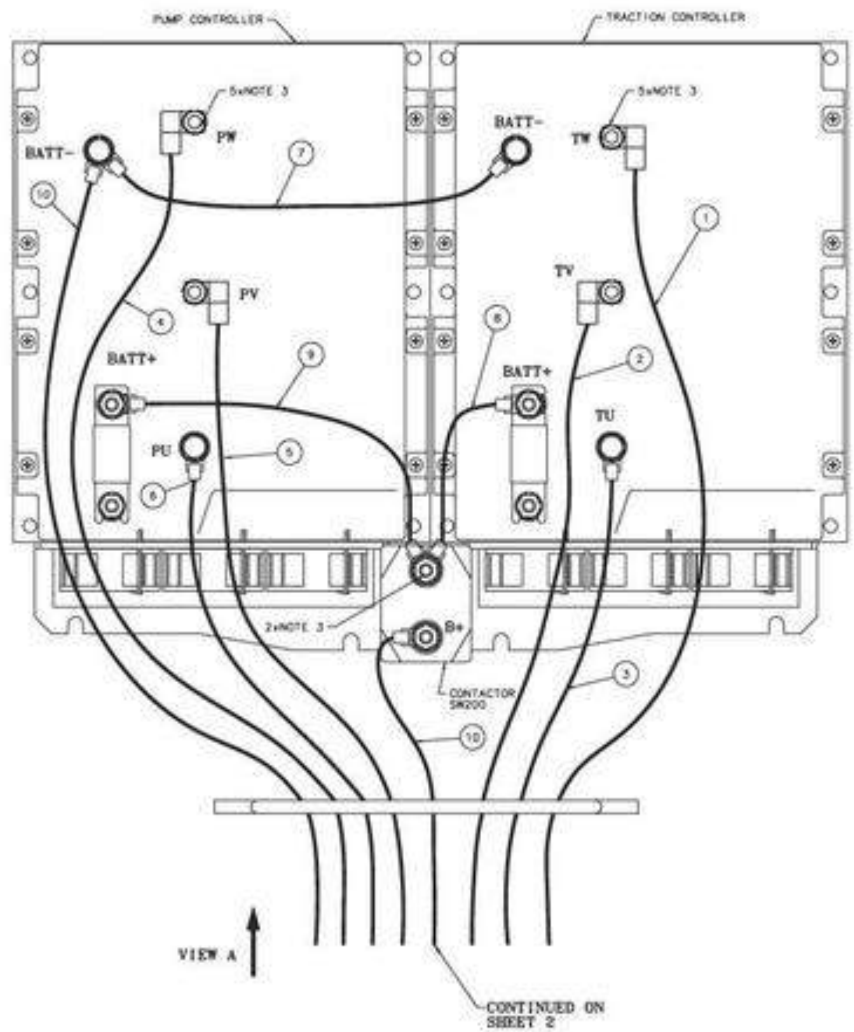


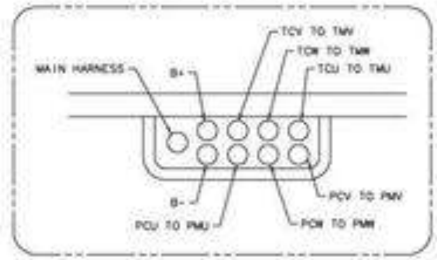




Cables(ECX)

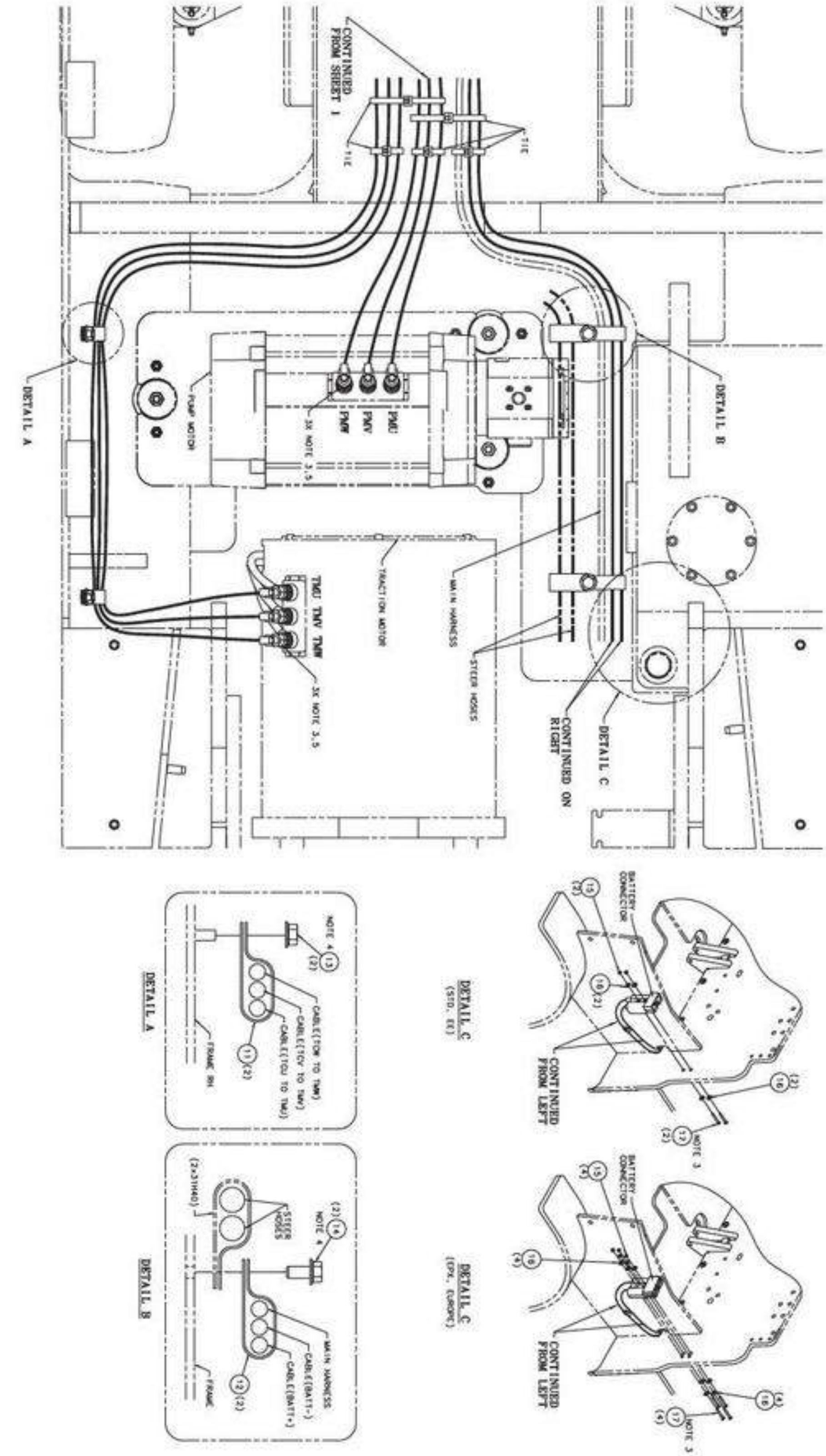
1. UNLESS OTHERWISE SPECIFIED TORQUE ALL CABLE CONNECTIONS TO 200 in-lbs.
2. TORQUE TO 13N/m.
3. TORQUE TO 15N/m.
4. TORQUE TO 20-25N/m.
5. APPLY INSULATION BOOT.

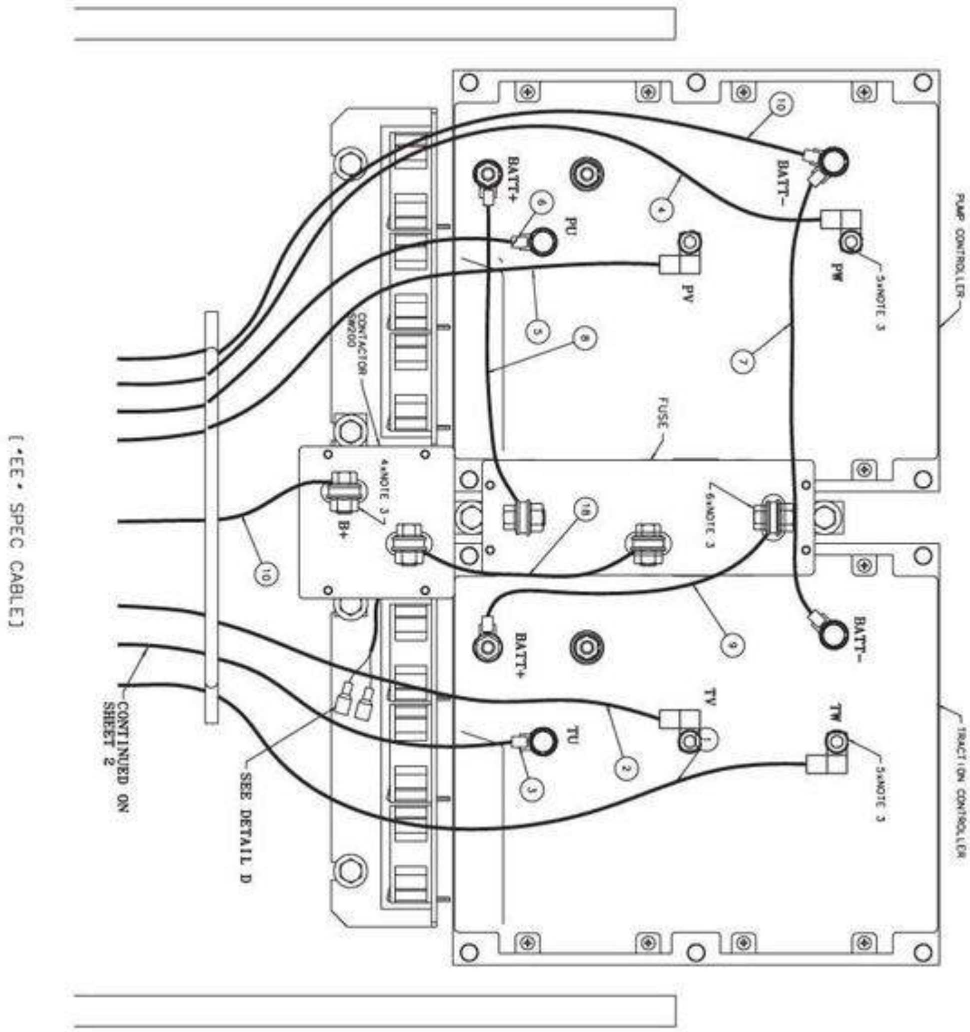


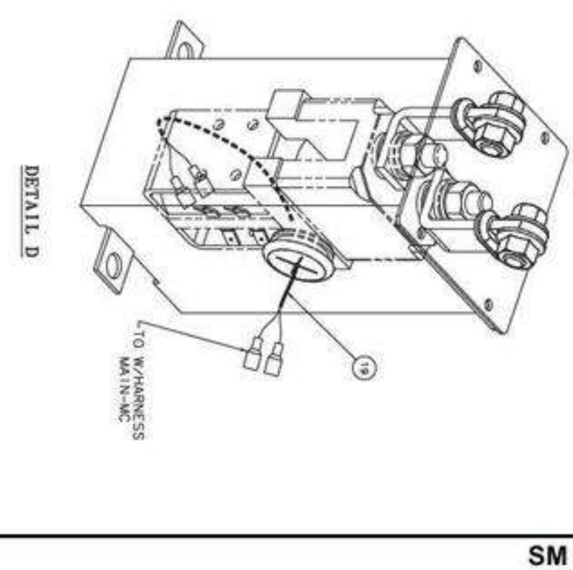


VIEW A

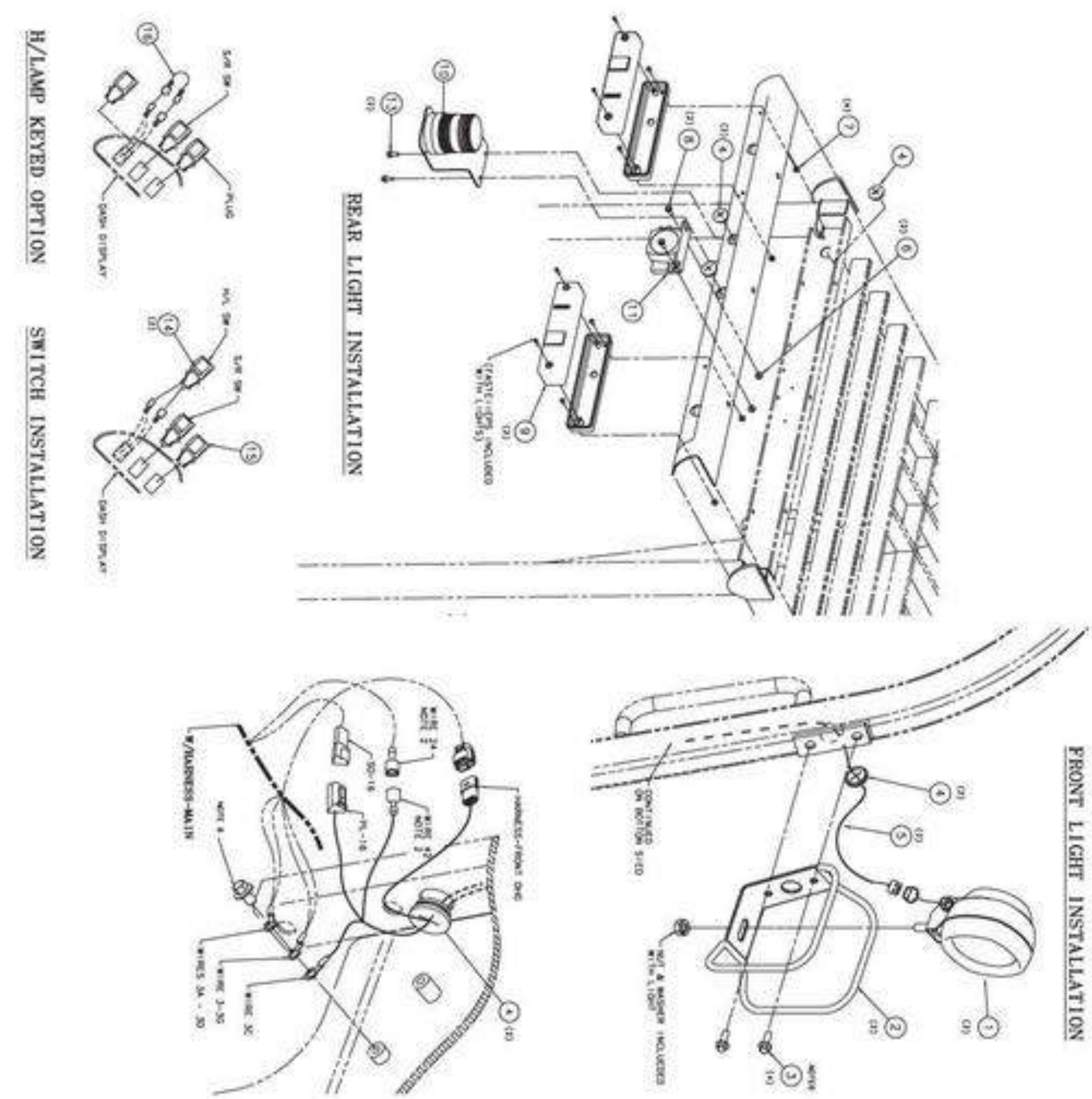
NO	PART NAME	"CE"	"STD"	(EPX EUROPE)	REMARK
19	EXTENSION-HARNESS-CONTACTOR	1	-	-	
18	CABLE(MC_OUT-FU)	1	-	-	20/32
17	CAP SCREW	2	2	4	
16	WASHER	4	4	8	
15	NUT WELD	2	2	4	
14	CAPSCREW-FLANGED	2	2	2	
13	NUT-LOCK	2	2	2	
12	CLAMP-CABLE DOUBLE	2	2	2	
11	CLAMP-CABLE DOUBLE	2	2	2	
10	BATT.CONNECTOR ASSY	-	-	1	30/32
		-	-	1	20/25
		1	1	-	30/32
		1	1	-	20/25
9	CABLE(MC_OUT-PC_FU)	1	1	1	
8	CABLE(MC_OUT-TC_FU)	1	2	2	
7	CABLE(TC_GND-PC_GND)	1	1	1	
6	CABLE(PMW-PCU)	1	1	1	30/32
		1	1	1	20/25
5	CABLE(PMV-PCV)	1	1	1	30/32
		1	1	1	20/25
4	CABLE(PMU-PCW)	1	1	1	30/32
		1	1	1	20/25
3	CABLE(TMW-TCW)	1	1	1	30/32
		1	1	1	20/25
2	CABLE(TMV-TCV)	1	1	1	30/32
		1	1	1	20/25
1	CABLE(TMU-TCU)	1	1	1	30/32
		1	1	1	20/25
NO	PART NAME	Q'TY			REMARK


CONTINUED FROM SHEET 1
TIE
DETAIL A
DETAIL B
PUMP MOTOR
TRACTION MOTOR
MAIN HARNESS
STEER HOSES
CONTINUED ON RIGHT
DETAIL C
BATTERY CONNECTOR
CONTINUED FROM LEFT
NOTE 3
DETAIL C (STD, EE)
DETAIL C (EPE, EUROPE)
DETAIL A
DETAIL B
FRAME RH
FRAME


BATT+
PU
PV
PW
BATT−
PUMP CONTROLLER
FUSE
B+
BATT+
BATT−
TV
TU
TW
TRACTION CONTROLLER
SEE DETAIL D
CONTINUED ON SHEET 2
[*EE* SPEC CABLE]

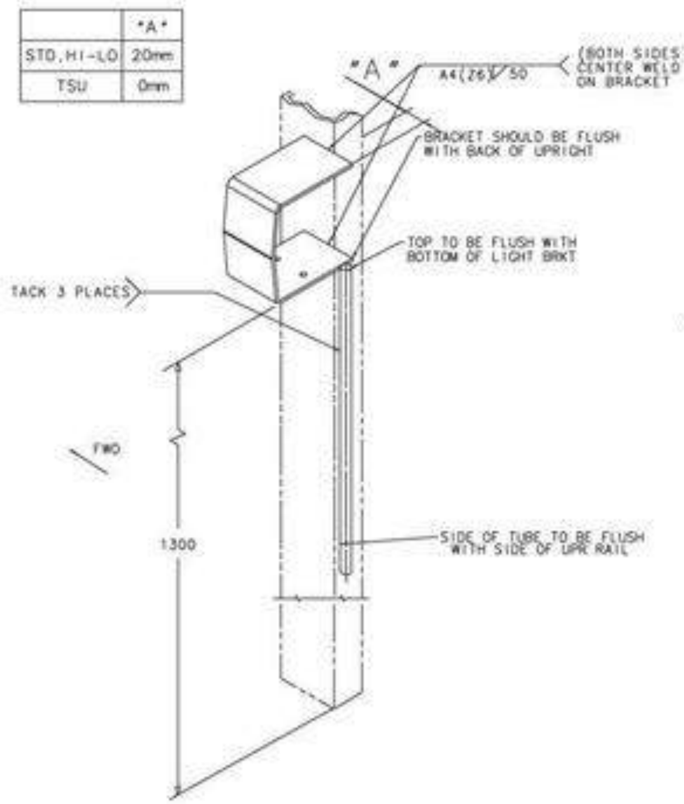

DETAIL D
TO W/HARNESS MAIN-MC

Main Accessory Harness(ECX)

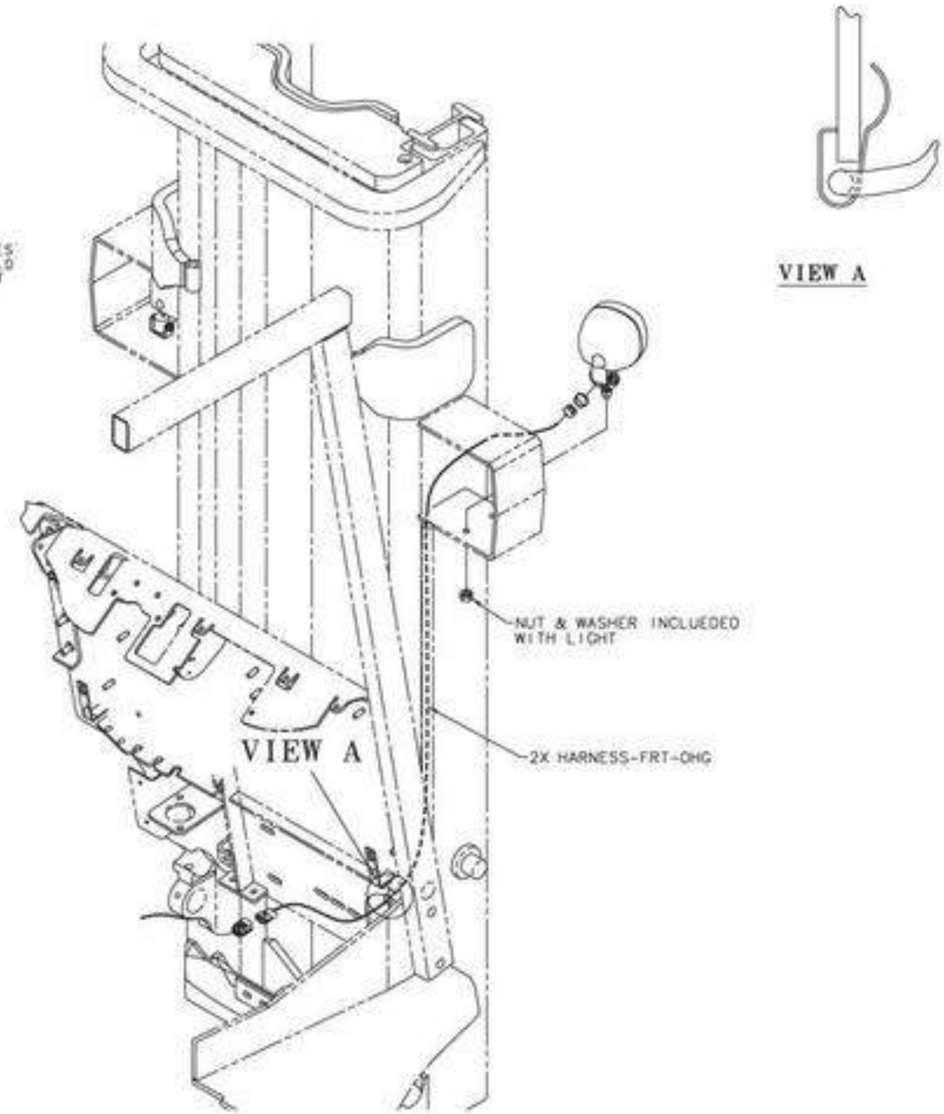


1. HARNESS MUST BE POSITIONED WITH ALL TAPE MARKERS HIDDEN UNDER CLAMP.
2. ALL HARNESS WIRING AND CONNECTIONS MADE PER WIRING DIAGRAM IN-28242
3. REMOVE A 25MM DIAMETER OF PAINT FROM COWL TO ENSURE CHASSIS GROUND.
4. LOCATE RING TERMINAL BETWEEN FLAT WASHERS
5. TORQUE TO 8-10 Nm 71-88 IN-LB
6. TORQUE TO 20-25 Nm 177-221 IN-LB
7. HARNESS TO BE CLAMPED AT END OF LOOM.
8. ENSURE THRU COMPLETE MOTION OF TILT CYLINDER THAT FITTINGS DO NOT TO INTERFERE WITH CONVERTOR. ADJUST ORIENTATION OF FITTINGS AS NEEDED.

NO	PART NAME	Q'TY	REMARK
16	W/HARNESS-KEYED LAMP	1	OPTION
15	PLUG	1	
14	SWITCH ROCKER SEAL	2	
13	CAPSCREW FLANGE	2	
12	-		
11	BACK BUZZER	1	OPTION
10	STROBE LAMP-BLUE STROBE LAMP-RED STROBE LAMP-AMBER	1	
9	COMBI.LAMP ASSY	2	
8	CAPSCREW FLANGE	2	OPTION
7	NUT FLANGE	4	
6	NUT-FLANGE	2	
5	HARNESS-FRONT OHG	2	
4	GROMMET	7	
3	CAPSCREW FLANGE	4	
2	GUARD HEAD LAMP	2	
1	HEAD LAMP	2	

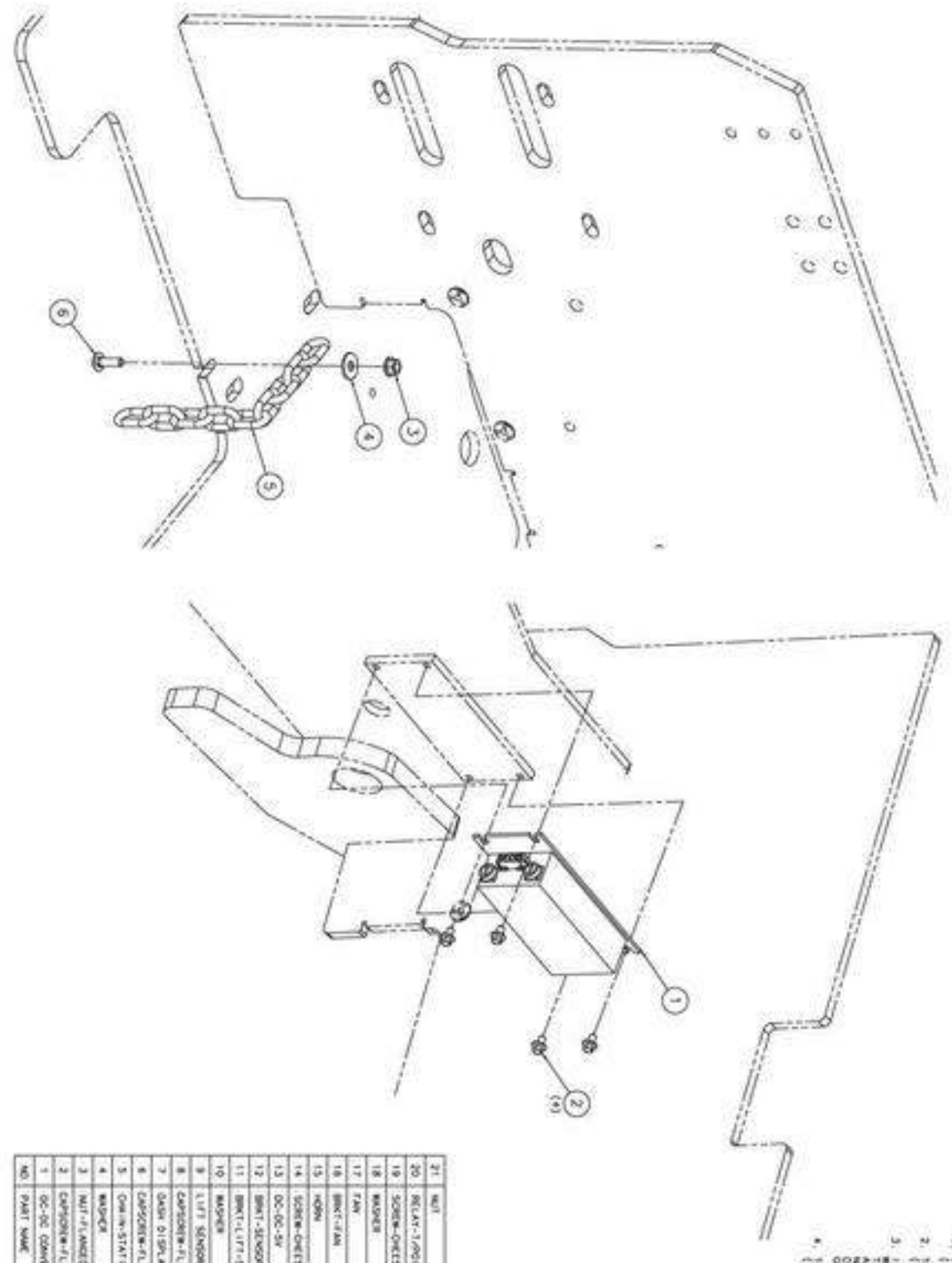


UPRIGHT DETAIL
(SAME FOR RIGHTHAND SIDE)



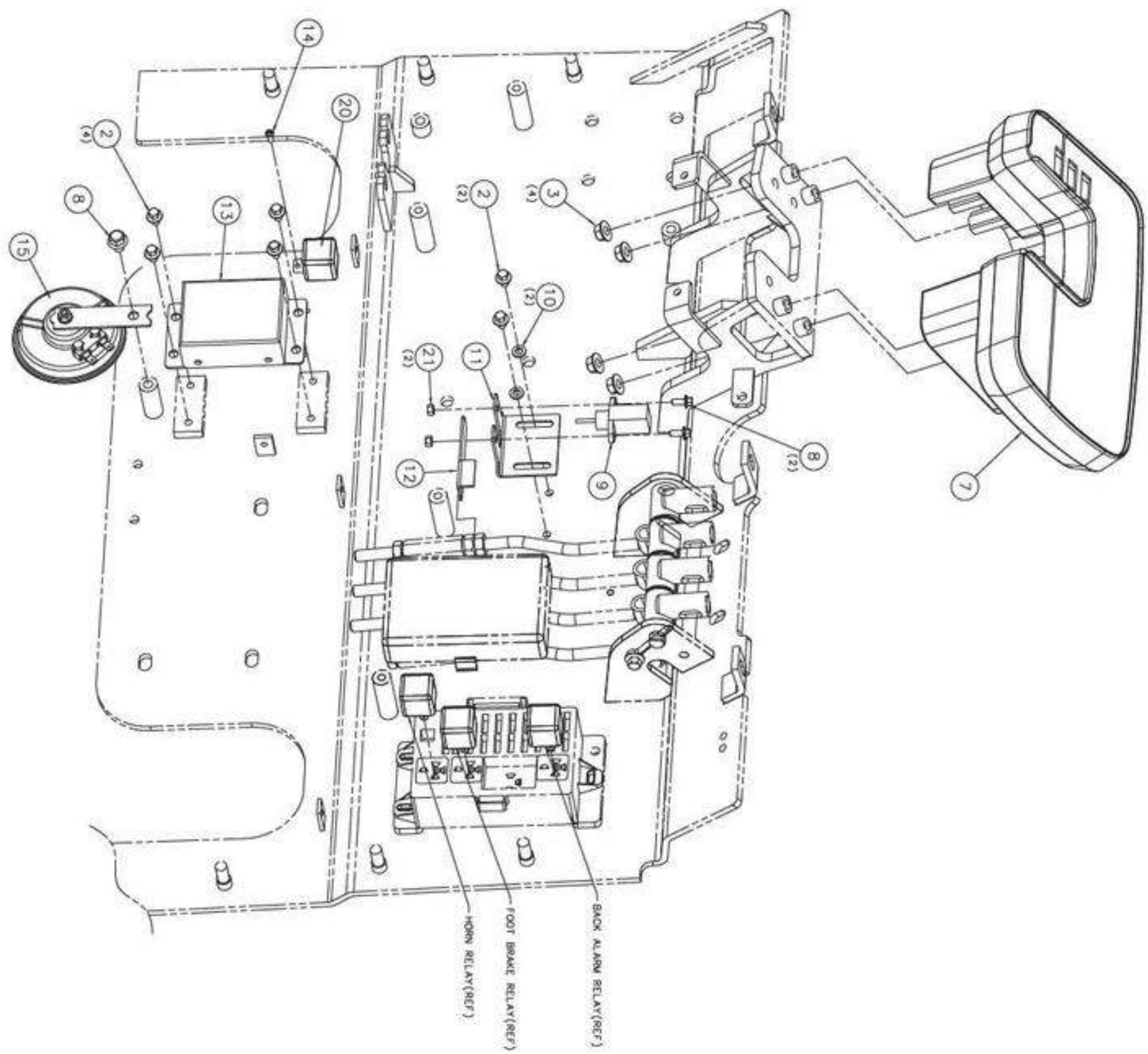
UPRIGHT MTD HEAD LIGHT INSTALLATION

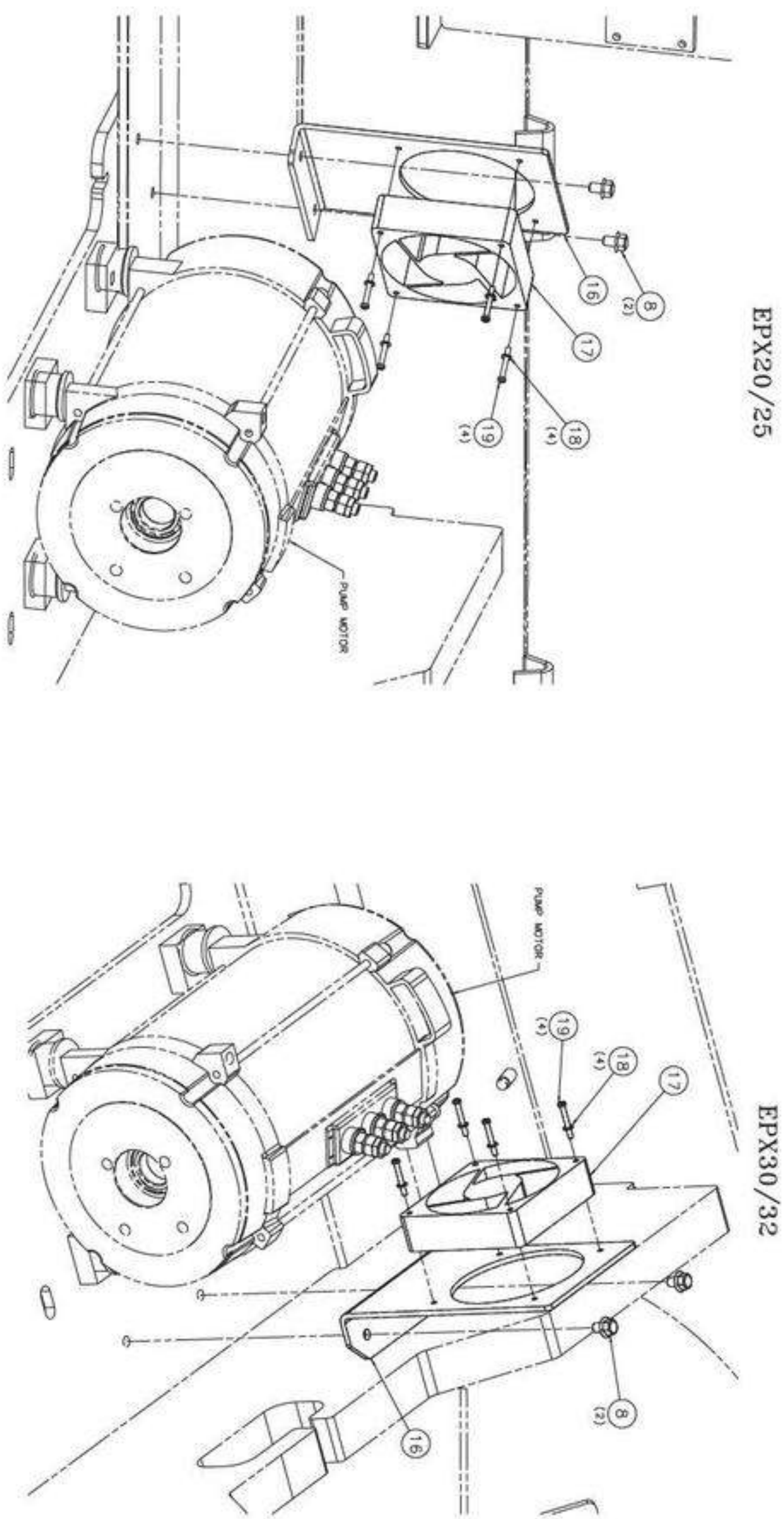
Electrical Components(EPX)



1. TORQUE TO 20-25Nm (14.75-18.41 lbf.ft)
2. TORQUE TO 8-10Nm (5.91-7.33 lbf.ft)
3. INSERT BOLT INTO THE THIRD CHAIN LINK. WHEN THE LINKS WHICH ARE DRAGGING THE GROUND HAVE WORN OFF, REMOVE CHAIN AND REINSTALL ON THE FIRST LINK. NOTE : CHAIN MUST ALWAYS BE IN CONTACT WITH GROUND, TO ENSURE PROPER GROUND OF TRUCK.
4. TORQUE TO 2.82-5.65Nm (25-50 IN-LBS).

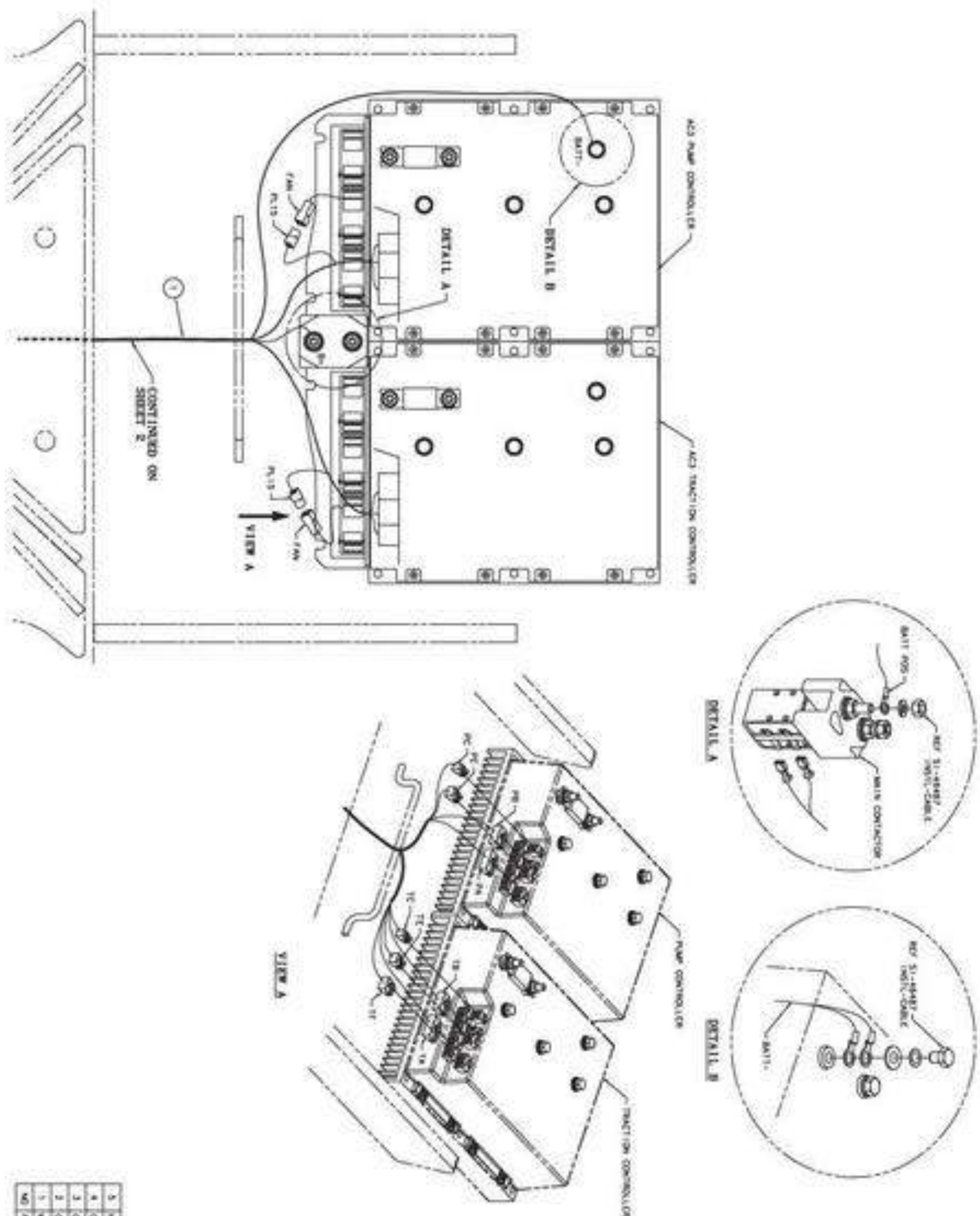
NO.	PART NAME	Q'TY	REMARK
21	NUT	2	
20	RELAY-T/POINT	1	
19	SCREW-CHEESE HEAD	4	
18	WASHER	4	
17	FAN	1	
16	BRKT-FAN	1	
15	HORN	1	
14	SCREW-CHEESE HEAD	1	
13	DC-DC-5V	1	
12	BRKT-SENSOR	1	
11	BRKT-LIFT-SENSOR	1	
10	WASHER	2	
9	LIFT SENSOR	1	
8	CAPSCREW-FLANGED	5	
7	DASH DISPLAY	1	
6	CAPSCREW-FLANGED	1	
5	CHAIN-STATIC	1	
4	WASHER	1	
3	NUT-FLANGED	5	
2	CAPSCREW-FLANGED	10	
1	DC-DC CONVERTER	1	


HORN RELAY(REF)
FOOT BRAKE RELAY(REF)
BACK ALARM RELAY(REF)



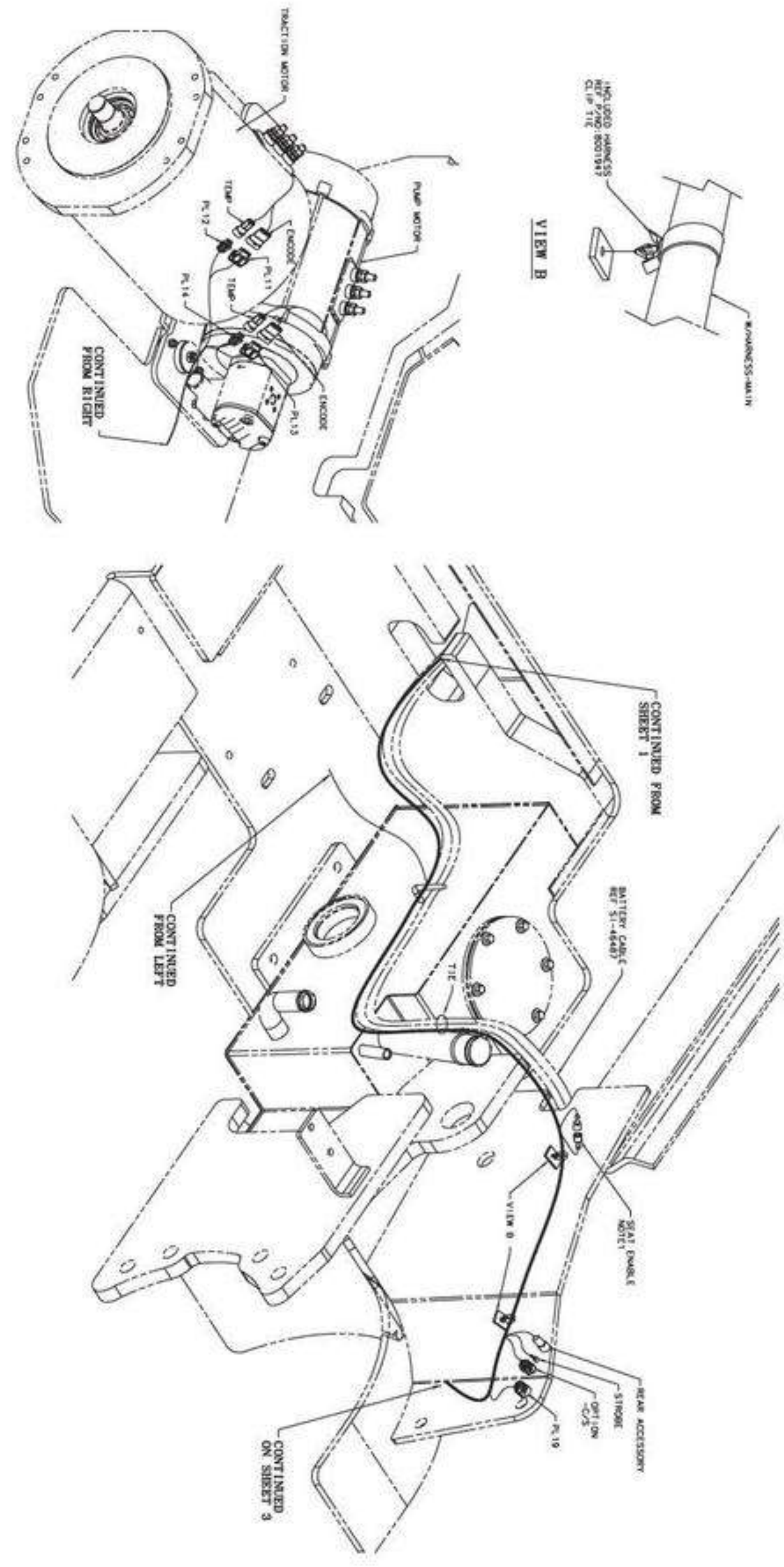
INST-PUMP MOTOR FAN 36/48V

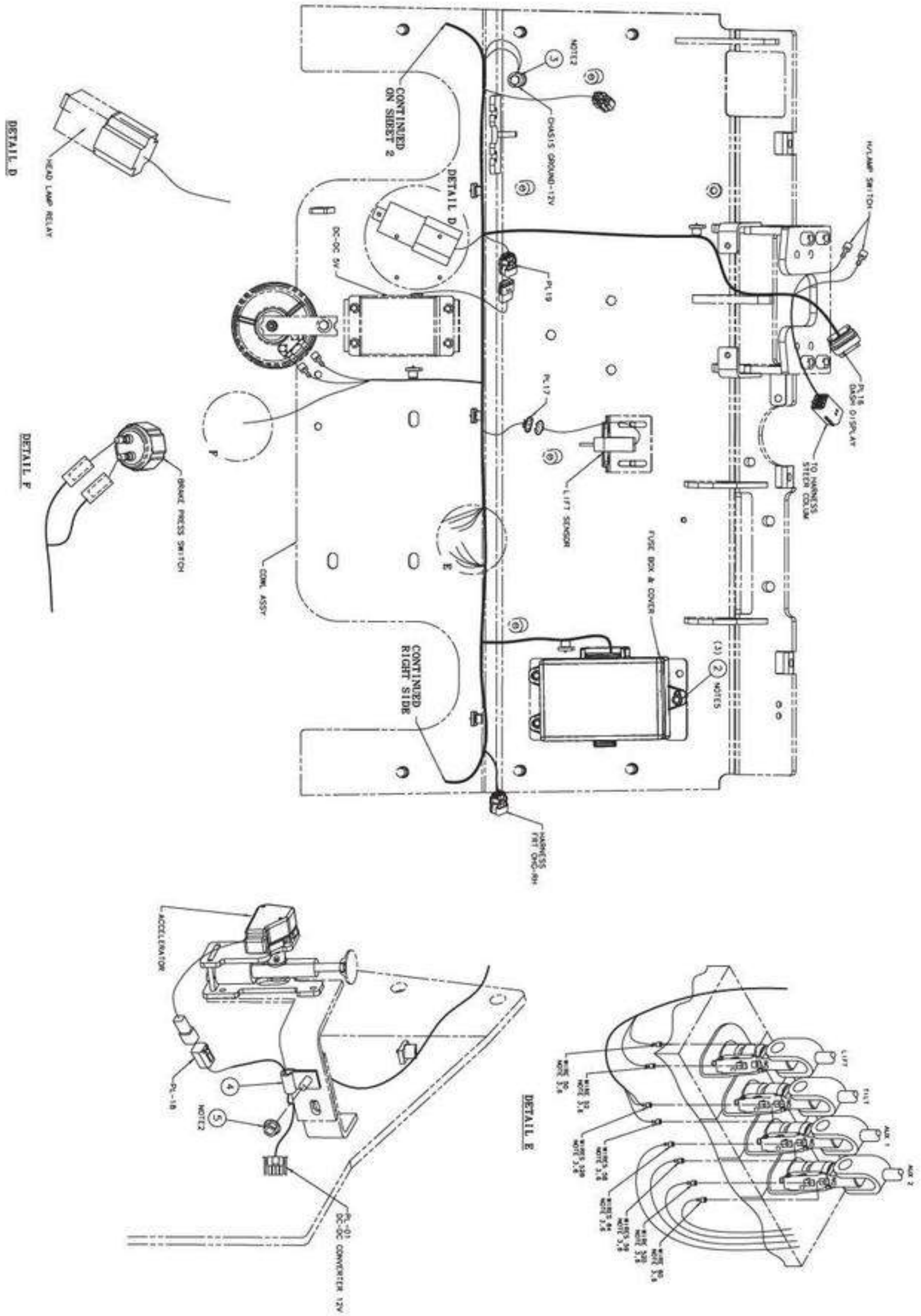
Main Harness(EPX)



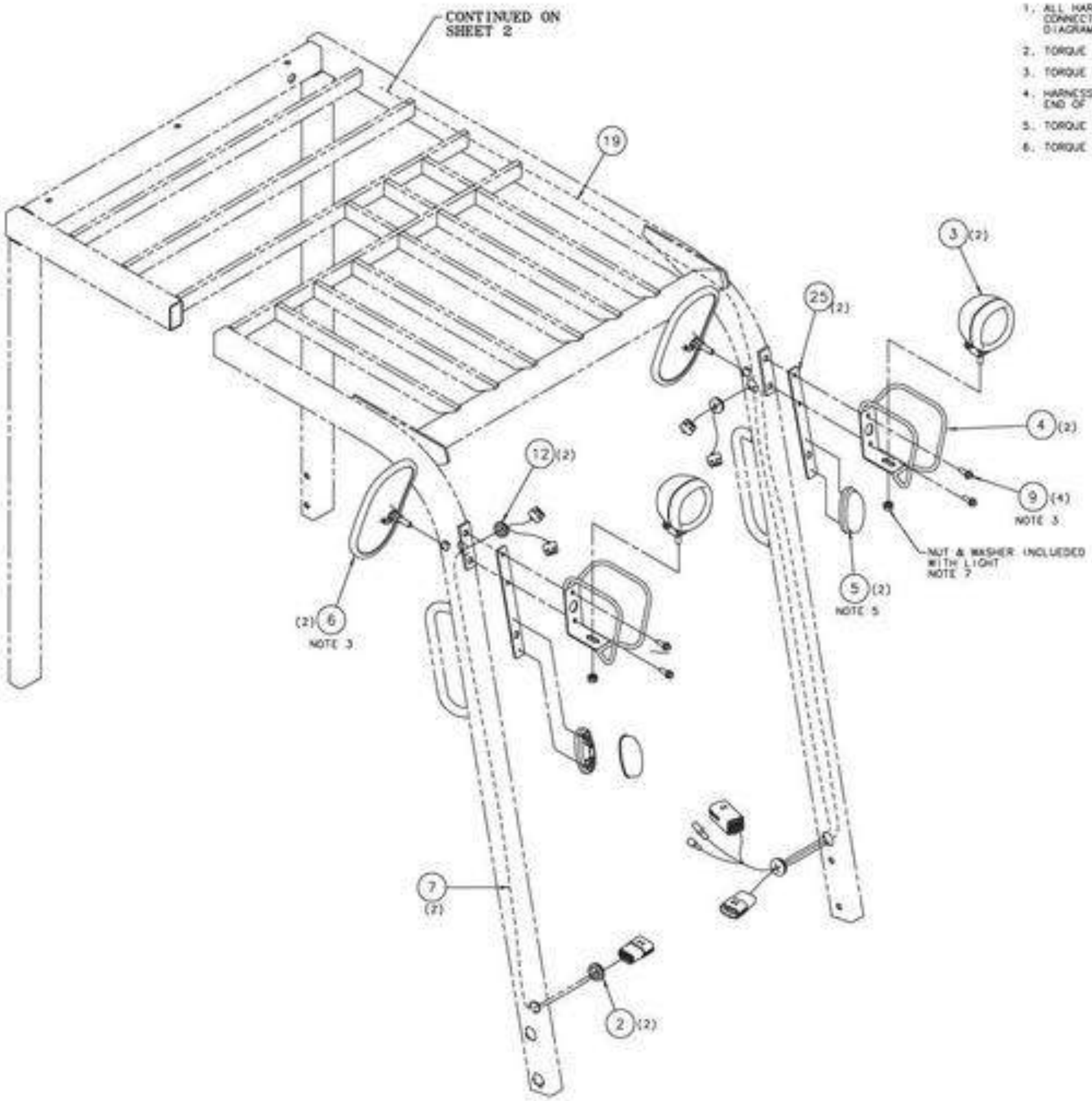
1. DISCONNECT TERMINAL ON WIRE 7 FROM TERMINAL ON WIRE 9 FOR TRACTION ENABLE/DISABLE OPTIONS
2. TORQUE TO 20-25N/m.
3. ALL HARNESS WIRING AND CONNECTIONS MADE PER WIRING DIAGRAMS 1N-28254
4. AFTER INSTALLATION OF HARNESS: MEASURE THE RESISTANCE BETWEEN BATTERY POSITIVE AND THE TRUCK FRAME. ALSO MEASURE THE RESISTANCE BETWEEN BATTERY NEGATIVE AND THE TRUCK FRAME. BOTH RESISTANCES SHOULD BE GREATER THAN 20,000 OHMS.
5. TORQUE TO 13-15N/m.
6. GENTLY PACK FEMALE SIDE OF INDICATED PLUG OR CONNECTOR WITH 2824625 (ELECTRICAL CONNECTOR GREASE-NYE 760G). FILL EACH OPENING IN PLUG TO A MINIMUM DEPTH OF 1/8". DO NOT OVER-FILL PLUG. REMOVE EXCESS GREASE FROM FACE OF PLUG PRIOR TO CONNECTING.
7. SERVICE NOTE: RE-APPLY 2824625 (GREASE) TO PLUGS OR CONNECTORS ANYTIME THEY ARE DISCONNECTED.

5	NUT-FLANGE	1	
4	CLAMP	1	
3	CAPSCREW FLANGE	1	
2	CAPSCREW FLANGE	3	
1	W/HARNESS-MAIN	1	
NO	PART NAME	Q-TY	REMARK


TRACTION MOTOR
PUMP MOTOR
VIEW B
CONTINUED FROM RIGHT
CONTINUED FROM SHEET 1
CONTINUED FROM LEFT
TIE
REAR ACCESSORY
STROBE
CONTINUED ON SHEET 3

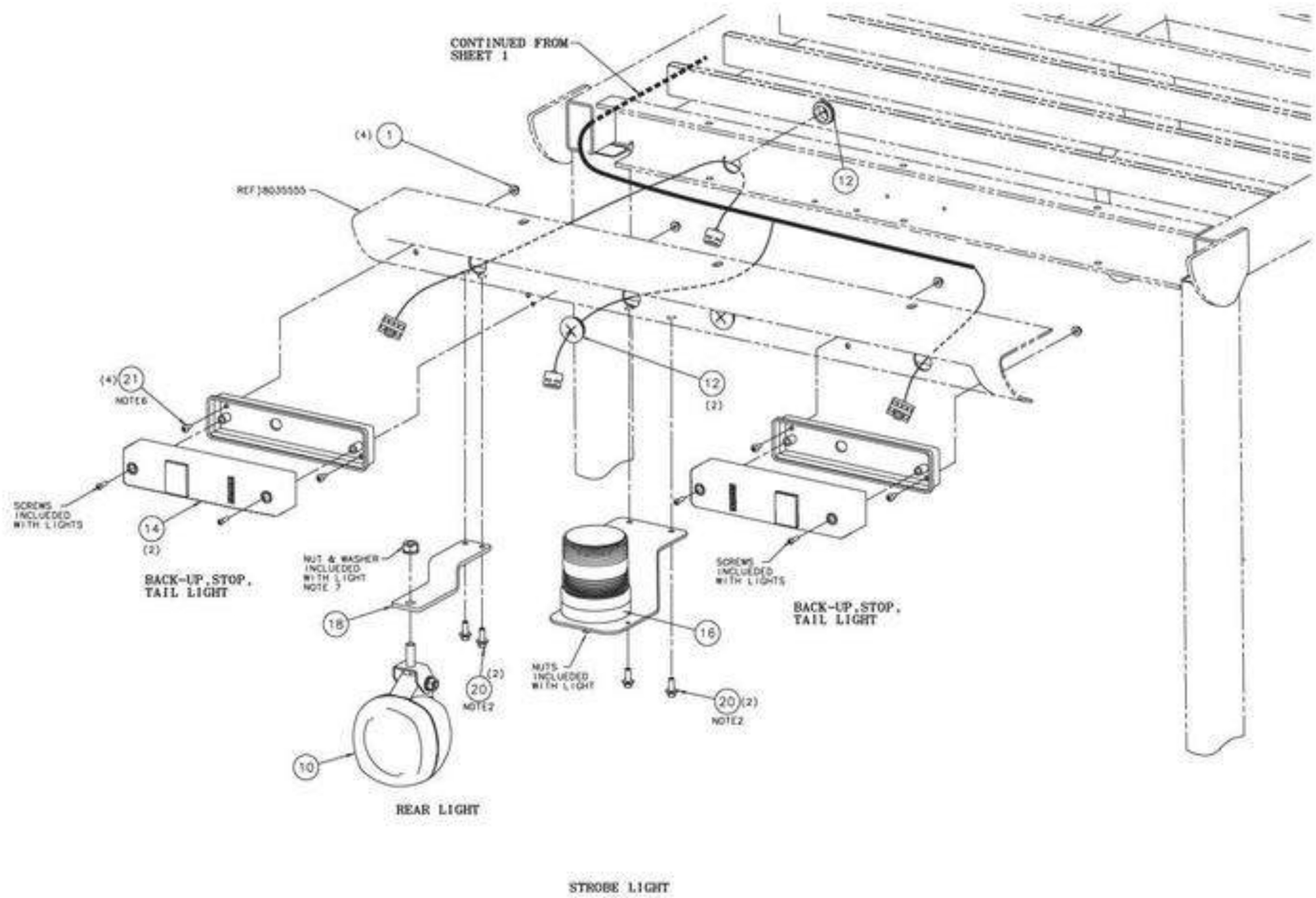

CONTINUED ON SHEET 2
DETAIL D
HEAD LAMP RELAY
CHASSIS GROUND-12V
NOTES
DC-DC 5V
PL19
PL17
DASH DISPLAY
LIFT SENSOR
DETAIL F
BRAKE PRESS SWITCH
COWL ASSY
FUSE BOX & COVER
CONTINUED RIGHT SIDE
ACCELERATOR
PL-18
DC-DC CONVERTER 12V
DETAIL E
LIFT
TILT

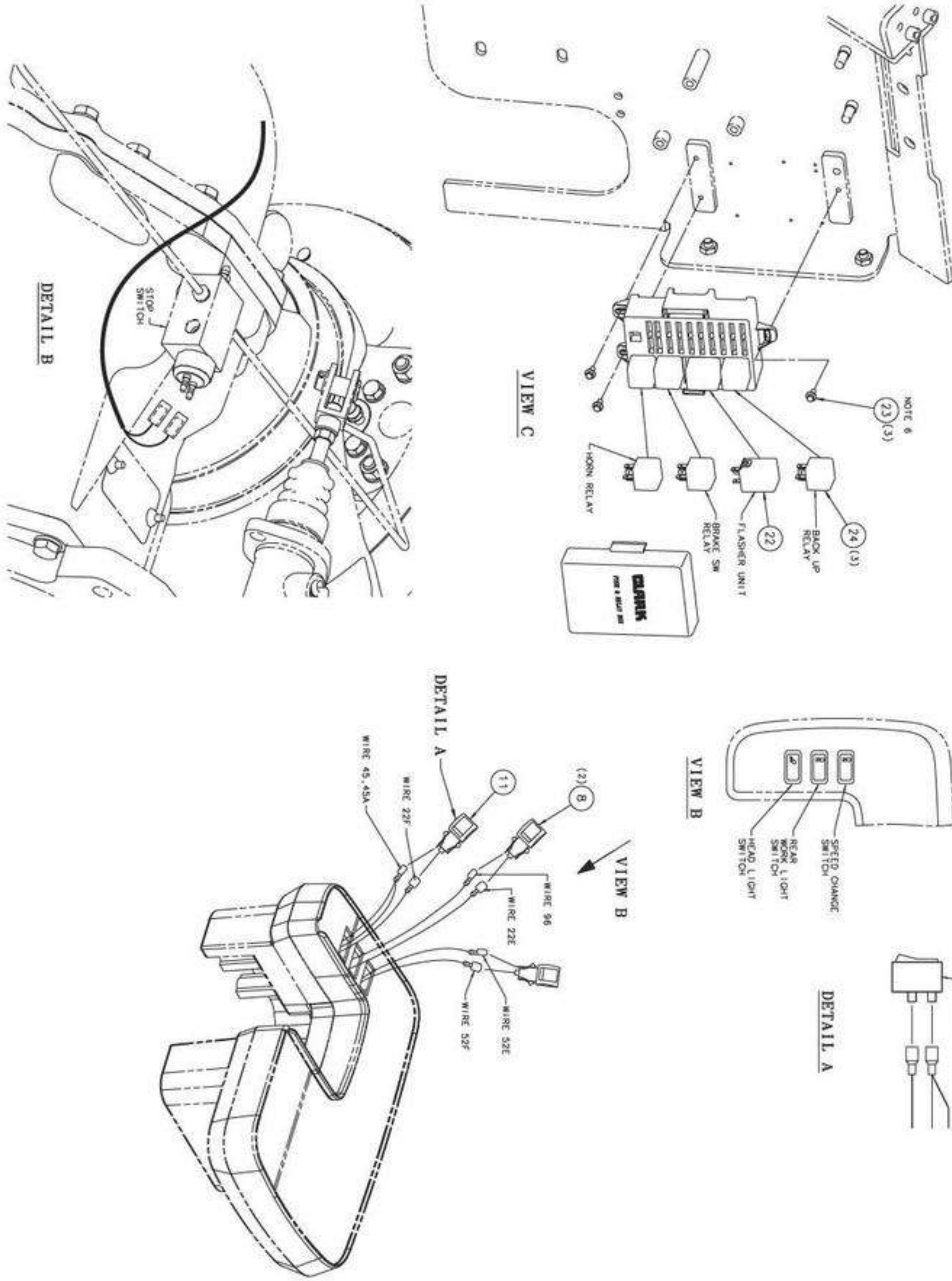
Accessory Harness(EPX)



1. ALL HARNESS WIRING AND CONNECTIONS MADE PER WIRING DIAGRAM IN-28123 OR IN-28124
2. TORQUE TO 8-10 N-m.(71-88 IN-LB)
3. TORQUE TO 20-25 N-m.(177-221 IN-LB)
4. HARNESS TO BE CLAMPED AT END OF LOOM.
5. TORQUE TO 1.8 - 2.1 N-m.
6. TORQUE TO 5 - 6 N-m.

NO	PART NAME	Q'TY	REMARK
25	BRKT-T/S	2	
24	RELAY	3	
23	CAPSCREW-FLANGED	3	
22	FLASHER UNIT	1	
21	SCREW-M5	4	
20	CAPSCREW-FLANGED	4	
19	W-HARNESS-REAR OHG	1	
18	BRKT-REAR LIGHT	1	
16	STROBE LIGHT(BLUE)-ASSY	1	
	STROBE LIGHT(AMBER)-ASSY	1	
	STROBE LIGHT(RED)-ASSY	1	
15	-		
14	COMBINATION LIGHT	2	
12	GROMMET	5	
11	SWITCH-ROCKER,SEALED	1	
10	REAR_WORK_LIGHT	1	
9	CAPSCREW-FLANGED	4	
8	SWITCH-ROCKER,SEALED	2	
7	W-HARNESS-FRONT	2	
6	BACK MIRROR	2	
5	T-SIGNAL LAMP	2	
4	GUARD-HEAD LAMP	2	
3	HEAD LAMP	2	
2	GROMMET	2	
1	NUT-FLANGE	4	


CONTINUED FROM SHEET 1
(4) 1
REF)8035555
12
12 (2)
(4) 21 NOTE6
SCREWS INCLUEDED WITH LIGHTS
14 (2)
BACK-UP,STOP, TAIL LIGHT
NUT & WASHER INCLUEDED WITH LIGHT NOTE 7
18
20 (2) NOTE2
NUTS INCLUEDED WITH LIGHT
16
20 (2) NOTE2
SCREWS INCLUEDED WITH LIGHTS
BACK-UP,STOP, TAIL LIGHT
10
REAR LIGHT
STROBE LIGHT


DETAIL B
STOP SWITCH
VIEW C
NOTE 6
23 (3)
HORN RELAY
BRAKE SW RELAY
FLASHER UNIT
22
BACK UP RELAY
24 (3)
CLARK
DETAIL A
11
(2) 8
WIRE 45, 45A
WIRE 22F
VIEW B
WIRE 96
WIRE 22E
WIRE 52E
WIRE 52F
VIEW B
HEAD LIGHT SWITCH
REAR WORK LIGHT SWITCH
SPEED CHANGE SWITCH
DETAIL A
HEAD LIGHT SWITCH

NOTE :

Section 4

Switches and Sensors

Accelerator Control Switch

Description

The accelerator control is operated by the accelerator foot pedal to send a signal for power demand to the control.

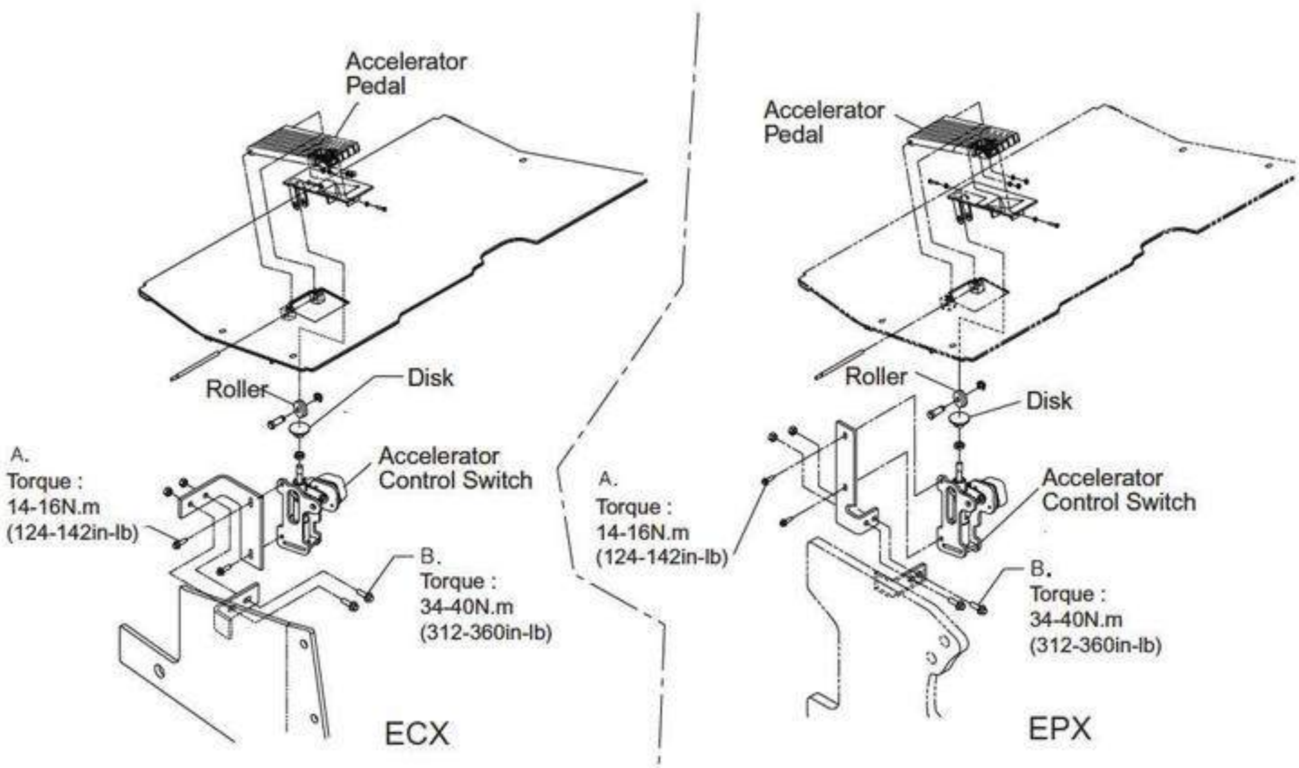
At the start, the accelerator control is stroked (by the action of the accelerator pedal), and in turn sends a signal to the motor control, requesting it to produce longer electrical pulses to the motor, which in turn will supply more power to the drive train.

An internal spring returns the control to start position. The accelerator is an integral unit and is not serviceable. Opening of the unit will void the warranty.

Adjustment

1. Loosen four fasteners at A and B on illustration.
2. This procedure does not make sense. You cannot get access to the bolts with the floor plate on the truck. You cannot depress the foot pedal if you have the floor plate removed.
3. Position switch so that push rod is fully pushed in and that roller is centered on top of disc.
4. Tighten fasteners as indicated on illustration.

Trouble with the accelerator control is normally investigated in conjunction with the motor control. Refer to next page for Program Adjustments.



Program Adjustment

⚠ CAUTION

Before any adjustments are done, safely jack up the truck, block the drive wheels off the floor and disconnect the battery.

Use the following method to program the accelerator control to the contol panel with the handset:

(Detailed handset operation instructions are in Group 19.)

- Disconnect the dash display harness from the control panel
- Plug handset into plug "B" of the control
- Plug in the battery
- Turn the key switch On
- Handset will go through startup and display software version
- Press the "ENTER" button
- Display will read "MAIN MENU' "PARAMETER CHANGE".
- Press the "ROLL UP" button five times
- Display will read "MAIN MENU" "PROGRAM VACC"
- Press the "ENTER" button
- Display will read "VACC SETTINGS"
- Press the "ENTER" button
- Display will read "MIN VACC MAX"
- Move the directional lever to Forward position
- Depress the accelerator pedal to the floor and than release slowly
- Move the directional lever to the Reverse position
- Depress the accelerator pedal to the floor and than release slowly
- Press the "ENTER" button
- Press the "OUT" button
- Display will read "ARE YOU SURE" "YES=ENTER" "NO=OUT"
- Press "ENTER" button (this stores the value for MIN and MAX accelerator voltage)
- Display will show new settings
- Press the "OUT" button
- Display will read "MAIN MENU" "PROGRAM VACC"
- Press "OUT button
- Display will show software version
- Turn the key switch Off and remove the tester cord from the control
- Plug the dash display harness into the "B" plug of the control
- Lower truck to the ground and test drive truck

Brake Switches

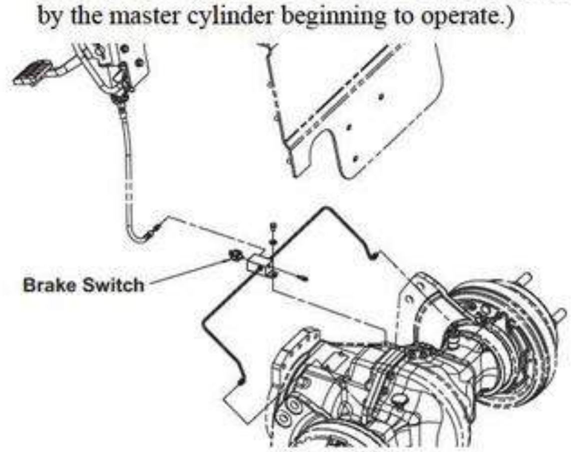
Service Brake Switch Description

The foot brake switch is on the frame under the dash panel. The switch operates when it is released by the brake pedal lever during braking. Depressing or releasing the switch operates a set of contacts that alternate from open to closed to activate the Pedal Braking function of the control. This function uses the motor to help bring the truck to a controlled stop.

Service Brake Switch Adjustment

Adjust the switch so that it "clicks" just before the end of pedal "freeplay" (the lag between pressing the brake and operating the master cylinder, covered in Group 23). Adjust switch as follows.

1. Turn key switch OFF.
2. Make sure freeplay is properly adjusted as described in Group 23.
3. Loosen brake switch mounting screws.
4. Rotate switch against pedal until switch trips. (A click can be heard.) Tighten mounting screws.
5. Check operation of switch by depressing brake pedal. Switch should actuate just before the end of freeplay (at which time you feel resistance in the pedal caused by the master cylinder beginning to operate.)



Parking Brake Switch Description

The parking brake switch is mounted on the parking brake pedal assembly.

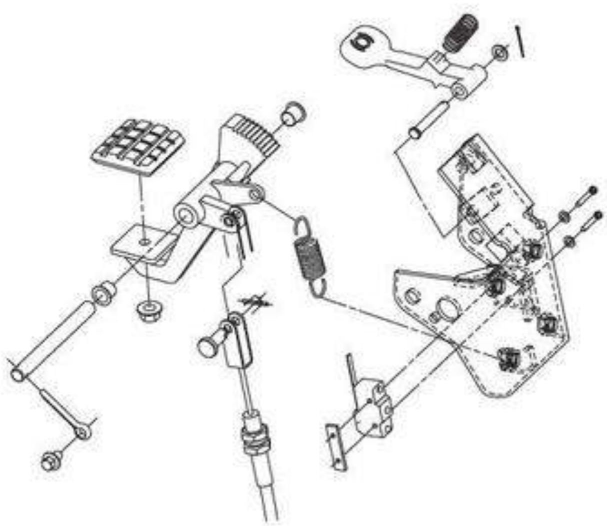
When the parking brake is applied, it releases the switch, allowing the contacts to return their normally open position. This open circuit signals the controller to disable the drive motors.

IMPORTANT

The switch must cut electrical current to the drive motor before the brakes apply. Otherwise, excessive lining wear will result and the drive motor will overheat.

Parking Brake Switch Adjustment(ECX)

1. Turn key switch OFF.
2. Loosen parking brake switch mounting screws.
3. Adjust position of switch so that there is contact with the center pin and the switch actuates (clicks) just as the parking brake lever is fully released.
4. Tighten mounting screws.
5. Check operation of switch before truck is returned to service.



Parking Brake Operation(EPX)

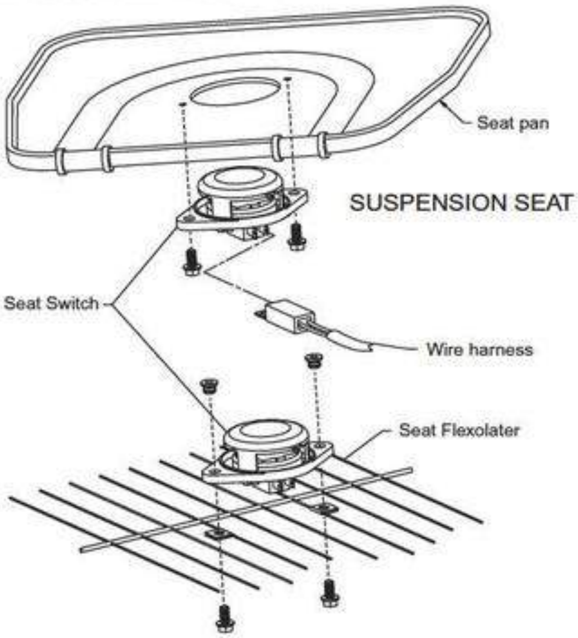
The operator applies the parking brake by depressing a **foot pedal**, which is then held down by a **ratchet**. The depressed pedal tensions cables connected to a brake shoe at each brake assembly, thereby applying the brakes.
The operator releases the parking brake by pulling up on a **release handle**. This handle releases the ratchet, and a **return spring** returns the pedal and cable to the off position. The ratchet also operates the parking brake interlock switch and the parking brake indicator light switch.

Seat Switch

The ECX/EPX trucks are equipped with a seat switch that signals the control to cut the power to the drive motors when it is opened.

When the seat switch is open, a -01 fault code will be displayed on the dash display.

There is a 1.5 second time delay built into the control to allow for momentary opening of the seat switch. If the truck is operated over rough surfaces and the operator is bounced, causing a momentary opening of the seat switch, the truck will not shut down.



Direction Control Switches

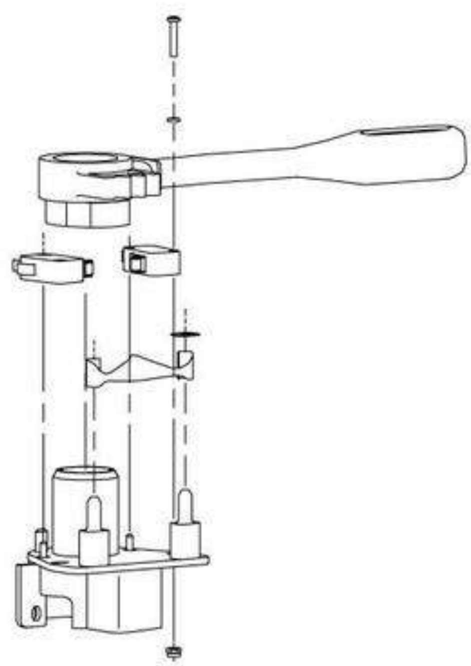
Description

These switches are normally open. When the directional control lever is placed in the FWD or REV detent, the proper switch is actuated (closed), its contacts close, and a signal current passes to the drive motor controller, which controls the rotational direction of the drive motor.

The FWD and REV switches are located at the base of the directional control lever. They are actuated by a cam on the directional control lever.

Adjustment

1. Turn key switch OFF.
2. Loosen FWD and REV switch mounting screws.
3. Adjust position of FWD switch so it actuates when directional control lever is in forward detent. Adjust REV switch so it actuates when directional control lever is in reverse detent.
4. Tighten mounting screws.
5. Check operation of switches before truck is returned to service.



Lift and Tilt Pump Switches

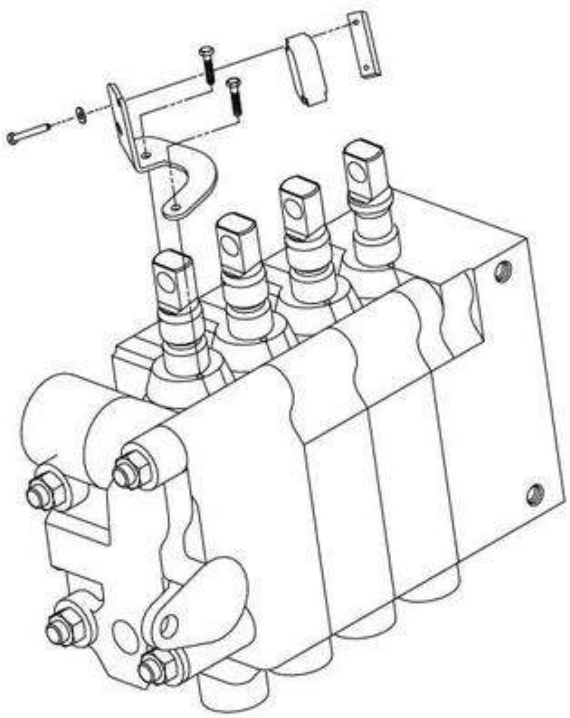
Description

The pump control switches are mounted on brackets at the valve spools and they are normally open. Movement of th valve spools from the neutral position trips the switches and closes their contacts. Current flow through the contacts signals the pump controller to operate the pump motor at the set speed for the selected function.

The lift lever activates a lift enable switch and also activates a Lift Pot. This potentiometer signals the pump controller to run at an increasing speed proportional to the rearward movement of the lever.

Switch Adjustment

1. Turn key switch to the OFF position.
2. Loosen switch mounting screws.
3. Adjust switch to activate after spool moves from neutral.
4. Tighten mounting screws.
5. Check operation of switch before truck is returned to service.



Lift Pot Adjustment

1. Insure that the flag of the actuator is properly positioned on the flat of the large nut.
2. Tighten the lock nut against the bottom of the actuator.
3. Loosen the capscrews on the switch mounting bracket and adjust the Pot to the point that it just touches the actuator plate. Insure that the Pot is parallel with the lift linkage.

Program Adjustment

CAUTION

Before any adjustments are done, safely jack up the truck, block the drive wheels off the floor and disconnect the battery.

Use the following method to program the Lift Potentiometer to the control panel with the handset:

(Detailed handset operation instructions are in Group 19.)

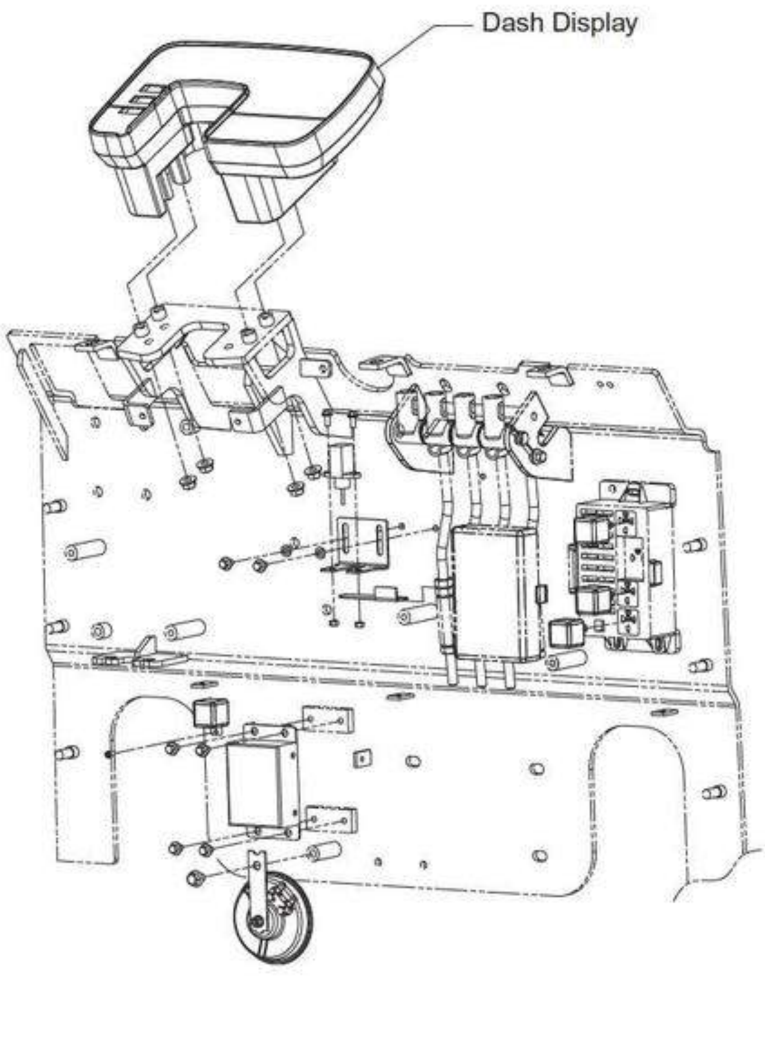
- Disconnect the dash display harness from the control panel
- Plug handset into plug "B" of the control
- Plug in the battery
- Turn the key switch On

- Handset will go through startup and display software version
- Press both the "ROLL UP" and "PARAM SET UP" buttons (top outside buttons) simultaneously.
- Display will read "CONFIG MENU' "SET MODEL"
- Press "ENTER" button
- Display will read "CONNECTED TO 3"
- Press "PARAM SET UP" button two (2) times
- Display will read "CONNECTED TO 5"
- Press "OUT" button
- Display will read "ARE YOU SURE" "YES=ENTER" "NO=OUT"
- Press "ENTER" button (this stores the connected to value)
- Display will read "CONFIG MENU" "CONNECTED TO"
- Press "OUT" button
- Display will read Software Version for Pump Control
- Press the "ENTER" button
- Display will read "MAIN MENU' "PARAMETER CHANGE".
- Press the "ROLL UP" button five times
- Display will read "MAIN MENU" "PROGRAM VACC"
- Press the "ENTER" button
- Display will read "VACC SETTINGS"
- Press the "ENTER" button
- Display will read "MIN VACC MAX"
- Move the lift lever to full raised position
- Release the lift lever to the neutral position
- Press the "OUT" button
- Display will read "ARE YOU SURE" "YES=ENTER" "NO=OUT"
- Press "ENTER" button (this stores the value for MIN and MAX lift potentiometer voltage)
- Display will show new settings
- Press the "OUT" button
- Display will read "MAIN MENU" "PROGRAM VACC"
- Press "OUT button
- Display will show software version
- Turn the key switch Off and remove the tester cord from the control
- Plug the dash display harness into the "B" plug of the control
- Lower truck to the ground and test drive truck

NOTE :

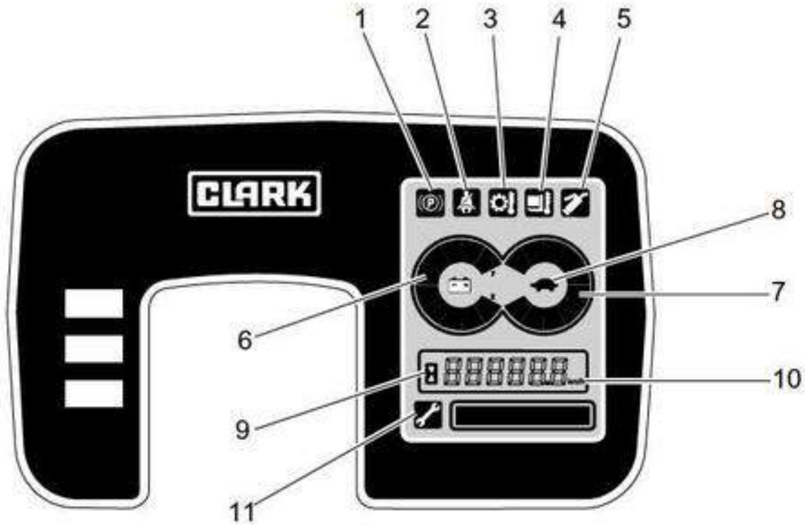
Section 5

Instrument Panel



Dash Display

The Dash Display provides the operator with an easily understandable, visual feedback of the status of the truck and its system components..



1. Park Brake
2. Seat Belt Alert
3. Drive controller & Motor overheat warning indicator lamp
4. Pump controller & Motor overheat warning indicator lamp
5. Planned Maintenance
6. Battery Discharging Indicator
7. Display Setted Speed limit
8. Activating Speed limit function
9. Hour Meter
10. Display Travel Speed
11. Service Status

Pump Motor or Pump Motor controller Over Temperature: The symbol is displayed to "alert" of pump motor temperature or pump motor controller temperature is exceeding the design limits. Do not use truck. Allow pump motor and/or controller to cool until after symbol turns "OFF".

Drive Motor or Drive Motor controller Over Temperature: The symbol is displayed to "alert" of drive motor(s) temperature or drive motor controller(s) temperature is exceeding the design limits. Do not use truck. Allow drive motor and/or controller to cool until after symbol turns "OFF".

Seat Belt: At start up this symbol displays along with an audio alarm for 4 seconds. This display reminds you to fasten your seat belt.

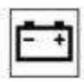
Parking Brake: The symbol is displayed and "-255" status code appears on the numeric display when parking brake is applied. Release parking brake to operate truck.

Planned Maintenance: This symbol is displayed and "-77" status code appears on the numeric display when the key switch is turned "ON" and trucks operating hours exceed preprogrammed hours for planned maintenance. The symbol is a reminder only and will turn "OFF" after 4 seconds and display will return to normal operation. The truck shall be inoperative while this symbol is displayed. Call Service.

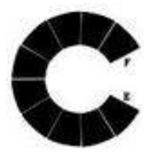
This indicating lamp shows that the working hour is counted. It flickers in a second cycle when the fork lift truck is working.

Service Status: The following 5 codes are usually operator fault codes, and can be corrected by as explained in "Section 5, Operating Procedures." If you see any other codes displayed, the truck needs to be serviced.

- -01 Seat Switch Open
- -061, -065 ,-140, -203, -207 Overheat of motor and controller (Restart after cooling down)
- -66 Low Battery (truck will go into lift lockout when the dash display shows less than 15%)
- -77 Maintenance Hours (preset hour meter reading indicating that it is time to have the truck serviced. Truck will reduce the top speed if desired)
- -79 Incorrect Start Up Sequence (SRO)
- -217, -245 Wrong set battery
- -255 Parking Brake Switch Open



Battery Status: If this symbol displays, the numeric display shows the percentage of usable charge remaining on the battery.



Battery discharge indicator : This indicating lamp shows that the charging rate that can be usable by the using battery

One chamber will turn off when the charging rate is reduced in 10%. Warning Code:" 66:BAT LOW"

Speed limit rate indicator : This indicating lamp shows that the traveling speed limit rate. One chamber will turn off when the speed limit rate is reduced in 10%.

Speed limit function indicator : This indicating lamp shows that the traveling speed limit. It will turn on when the traveling speed limit function of fork lift truck is working.

km/h

Traveling speed indicator : This indicating lamp shows that the traveling speed of fork lift truck. It will turn on when the current traveling speed is indicated.

Using the Display

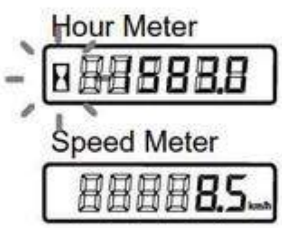
LCD Back Light

- LCD back light is working linked with Key switch.
  "- When the start key turns on, power is applied to display. Whenever the power is applied, LCD back light will turn on."

DISPLAY Initial Start-up

- KEY ON
  - All the Icons and Buzzers will be ON for 1second to check the indicating conditions.
  - Seat belt warning mode (5seconds) after Icon turns of for 1second: It is always indicated regardless of communication conditions; When this mode is working, all the indicating data should be in normal conditions.
  "(Working hour/speed, Battery discharging rate, Speed limit rate, Parking)"
- After seat belt warning mode is working, the data supplied from controller will be indicated.

Working hour/speed indicating algorithm



- Working hour/ speed will be indicated at the same portion.
- The indicating data is decided on the base of traveling speed.

- If the traveling speed exceeds 0.5km/h, the current traveling speed will be indicated "km/h" icon turn on. When the speed gets lower than 0.5km/h, traveling speed indicator will be released "km/h" icon turn off.
- The current working hour is indicated when the traveling speed is lower than 0.5km/h, and the "sandglass" icon flickers in a second cycle.

When the traveling speed is more than 0.5km/h, the working hour indicator is released (converted to speed indicator), and the "sandglass" icon will turn off.

Character indicator

- Error code indicator (#37 error)

GROUP 16

ELECTRICAL MOTORS

NOTE :

Section 1

Motor Specifications and Descriptions

Specifications

Drive Motors

Frame Size: 270 mm (10.6 in) diameter

Weight: 140kg (309 lb)

Internal Bearings: Sealed and lubricated with high temperature grease for the life of the bearing. The bearing at the back end of the motor is a special encoder bearing (sensor) that needs to be replaced every 10,000 hours, or any time the bearings are removed from the motor rotor shaft.

Terminal Nut Torque: 15 N.m (133 in-lb)
Rotor outside Diameter: 169.2 mm (6.661 in)
Rotor inside Diameter: 80 mm (3.15 in)
Number of Slots: 44

Stator outside Diameter: 270 mm (10.6 in)
Stator inside Diameter: 170 mm (6.693 in)
Number of Slots: 36

Nominal Air Gap: 0.4 mm (.0157 in)
Nominal Battery Voltage: 36V / 48V
Maximum Battery Voltage: 39.5V / 52.5V
Nominal Speed: 710 RPM / 955 RPM
Stall Current: 600Arms
Insulation: Class F
Winding: Delta
Encoder: 64 Pulses / Rev

Pump Motor

Frame Size: 170 mm (6.693 in) diameter

Weight: 62kg (137 lb)

Internal Bearings: Sealed and lubricated with high temperature grease for the life of the bearing. The bearing at the back end of the motor is a special encoder bearing (sensor) that needs to be replaced every 10,000 hours, or any time the bearings are removed from the motor rotor shaft.

Terminal Nut Torque: 15 N.m (133 in-lb)

Rotor outside Diameter: 124.2 mm (4.82 in)
Rotor inside Diameter: 44 mm (1.732 in)
Number of Slots: 48

Stator outside Diameter: 200 mm (7.874 in)
Stator inside Diameter: 125 mm (4.921 in)
Number of Slots: 36

Nominal Air Gap: 0.4 mm (.0157 in)
Nominal Battery Voltage: 36V / 48V
Maximum Battery Voltage: 39.5V / 52.5V
Nominal Speed: 1855/2710 RPM
Stall Current: 600Arms
Insulation: Class F
Winding: Delta
Encoder: 64 Pulses / Rev

Description and Location

The truck has two electric AC motors:

- One traction motor.
- One main hydraulic/power steering pump motor.

Drive motors

The drive motor is a three-phase AC motor with class F insulation. This motor do not use brushes and the motor is totally enclosed, minimizing the service requirements. Because the motor does not use brushes and is enclosed, sealing them from outside contamination, there is no need to blow out the inside of the motor during a PM. Motor has two bearings; the drive end bearing is a ball bearing and the bearing at the rear of the motor is a special encoder bearing (sensor) for motor feedback to the control.

The external connections are easily accessible from the top of the motor where they are protected from external damage.

Drive motor also has a built-in thermistor which constantly monitors the winding temperature and reports this information to the control (this sensor is not serviceable). Should it sense that the motor is approaching the temperature limit, the control will cutback motor current until the temperature decreases. Since it is cutting back current and not voltage, the top end speed will not be effected, unless on a grade.

Lift/Steer pump motor

The pump motor is a three-phase AC motor with class F insulation. It is also a brushless motor and totally enclosed. This motor has two bearings; the drive end bearing is a ball bearing and the bearing at the rear of the motor is a special encoder bearing (sensor) for motor feedback to the control. An electronic control system controls the speed of the motor at all times. This pump runs for steering any time the truck is in gear, or anytime a hydraulic function is requested.

The external connections are easily accessible from the top of the motor where they are protected from external damage.

The pump motor also has a built-in thermistor which constantly monitors the winding temperature and reports this information to the control (this sensor is not serviceable). Should it sense that the motor is approaching the temperature limit, the control will cutback motor current until the temperature decreases. Since it is cutting back current and not voltage, the top end speed will not be affected, unless the loads are close to capacity.

Section 2

Drive Motor Overhaul

Inspection Procedure

Before performing these service procedures:

- Park truck safely.
- Fully lower the upright.
- Apply the park brake
- Turn the key switch OFF.
- Disconnect battery from truck receptacle.
- Discharge capacitors by connecting a 200 ohm 10 watt resistor between the positive and negative input post of the controller for 10 seconds.

Motor Cleanliness

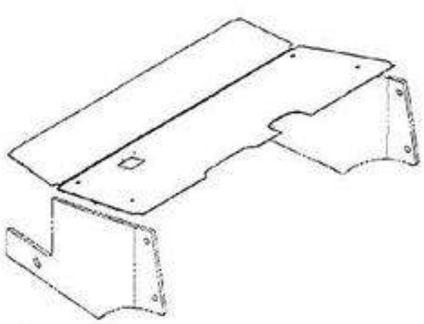
Electric motors should be kept clean at all times to prevent shorting, minimize wear, and optimize cooling.

- Wipe off all dust, dirt, oil, water, etc., from outer surface of motor.
- Remove any debris around motor frame.
- Air-clean (blow off) motors using clean, dry (moisture-free) compressed air at 207 kPa (30 psi) maximum air pressure.

The presence of any oil on or near the motor could indicate either bad bearings or leaking hydraulic system. Determine cause and repair problem before extensive motor damage occurs.

Drive Motor Removal and Installation

1. Tilt the steering column fully forward and remove the floor plate.

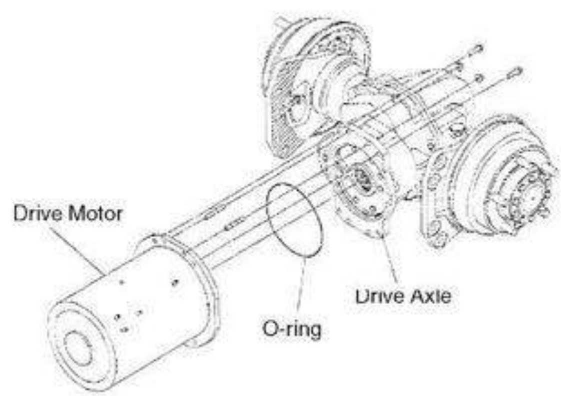


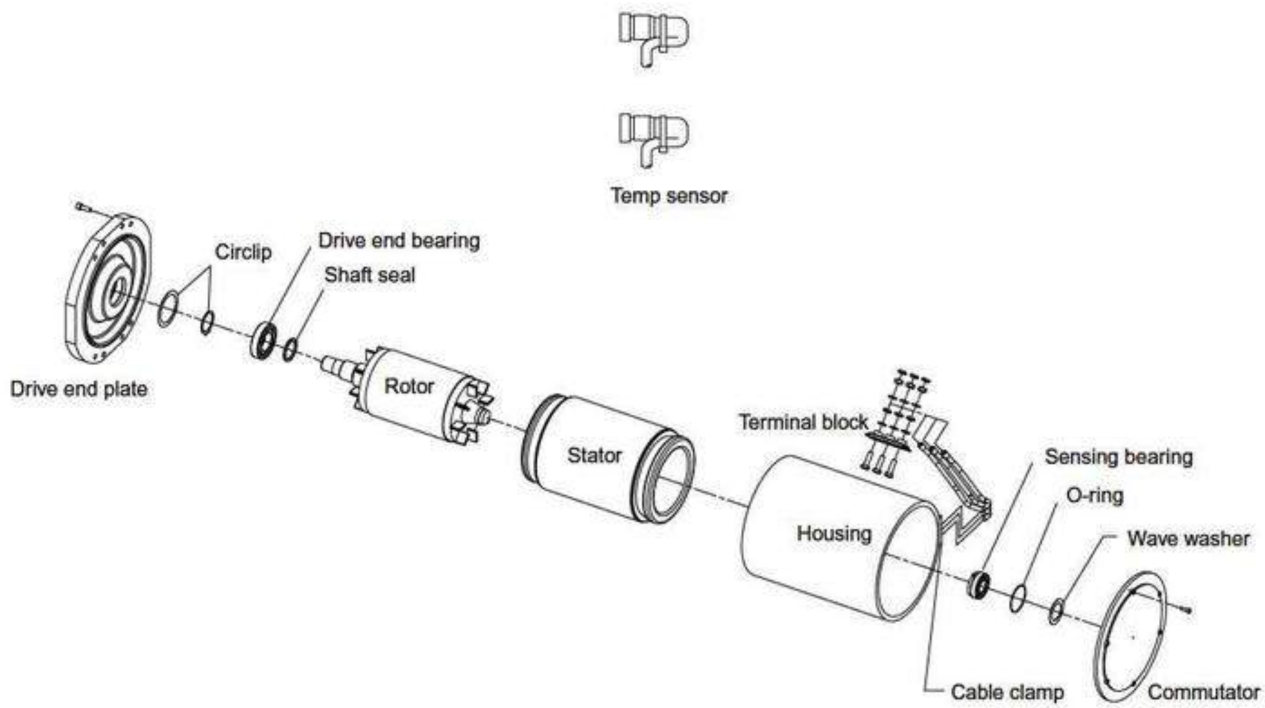
2. Disconnect battery and remove all electrical cables from the motor. Tag cable terminals to aid in reinstallation. Position cables out of the way of motor removal.
3. Remove the battery.
4. Put a chain hook into the motor lifting eye and to an overhead hoist to assist in lowering motor. Snug up.
5. Remove bolts and nuts holding motor to axle. Install bolts in tapped holes in axle flange to assist in separating motor from drive axle.
6. Lower motor onto a low dolly and remove chain.
7. Jack up and block the rear of the truck high enough to slide motor from under truck.
8. Reinstall in reverse order. Use new O-ring, coated with drive axle fluid.

WARNING

Use only approved hoist, chains, and straps. Be sure hoist and accessories have sufficient capacity to safely support the load.

9. Torque bolts and nuts to 70-80 N·m(152-159 lbsft).





Ball Bearings

Both ball bearings are maintenance free. If it becomes necessary to remove the bearings to repair the motor, they should be replaced. In any case the seals (shaft oil seal and O-ring) must be replaced.

In general bearings should be replaced at approximately 10,000 operating hours.

Encoder Bearing

The encoder bearing is used to communicate the motor speed to the controller.

NOTE

The encoder bearing is very sensitive to static electricity. If you are going to be working on the encoder bearing you should have a ground strap on to insure that the encoder bearing does not get damaged.

Replacing Encoder Bearing

In general the encoder bearing should be replaced every time the motor is disassembled.

To replace the encoder bearing:

- Turn key OFF.
- Set park brake.
- Disconnect battery.
- Remove the drive motor (see page 1 of this section).
- Remove motor thru bolts.
- The silicone sealing the cables into the end frame will need to be loosened to allow removal of the end frame.
- Remove the non-drive end housing from motor.
- Remove rotor from motor.
- Use a gear puller to remove encoder bearing from the rotor.
- Press new encoder bearing on to rotor at the inner ring with a steady pressure. The inner ring of the bearing must to be pressed against the shaft shoulder.

Motor Reassembly

NOTE

The encoder bearing is very sensitive to static electricity. If you are going to be working on the encoder bearing you should have a ground strap on to insure that the encoder bearing does not get damaged.

- Insure that the encoder cables are installed correctly and do not get pinched or touch the rotor.
- Install the end housing carefully onto the encoder bearing and press it on with a steady pressure. The lead from the bearing must located in the notch in the housing frame.
- Install the rotor into the stator housing.
- Tie strap the encoder bearing lead to one of the motor leads to prevent it from being pulled and contacting the rotor.

NOTE :

Section 3

Pump Motor Overhaul

Inspection Procedure

Before performing these service procedures:

- Park truck safely.
- Fully lower the upright.
- Apply the park brake
- Turn the key switch OFF.
- Disconnect battery from truck receptacle.
- Discharge capacitors by connecting a 200 ohm 10 watt resistor between the positive and negative input post of the controller for 10 seconds.

Motor Cleanliness

Electric motors should be kept clean at all times to prevent shorting, minimize wear, and optimize cooling.

- Wipe off all dust, dirt, oil, water, etc., from outer surface of motor.
- Remove any debris from around motor frame.
- Air-clean (blow off) motors using clean, dry (moisture-free) compressed air at 207 kPa (30 psi) maximum air pressure.

The presence of any oil on or near the motor could indicate either bad bearings or leaking hydraulic system. Determine cause and repair problem before extensive motor damage occurs.

Pump Motor Removal and Installation

1. Disconnect battery and remove all electrical cables from the motor. Tag cable terminals to aid in reinstallation. Position cables out of the way of motor removal.
2. Remove the hydraulic pump from the motor.

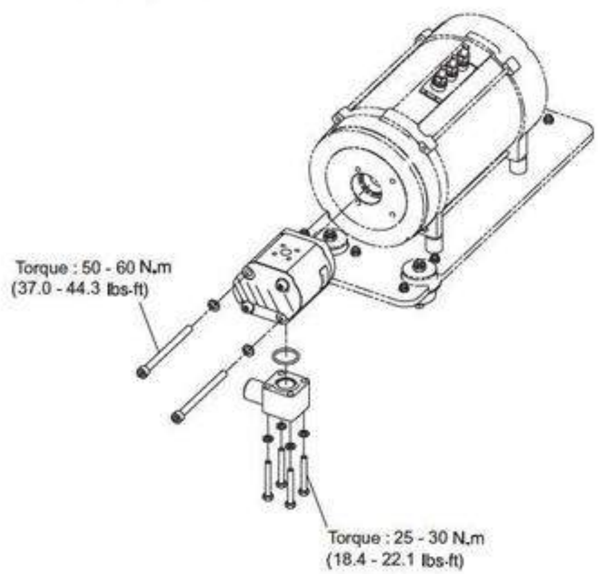
IMPORTANT

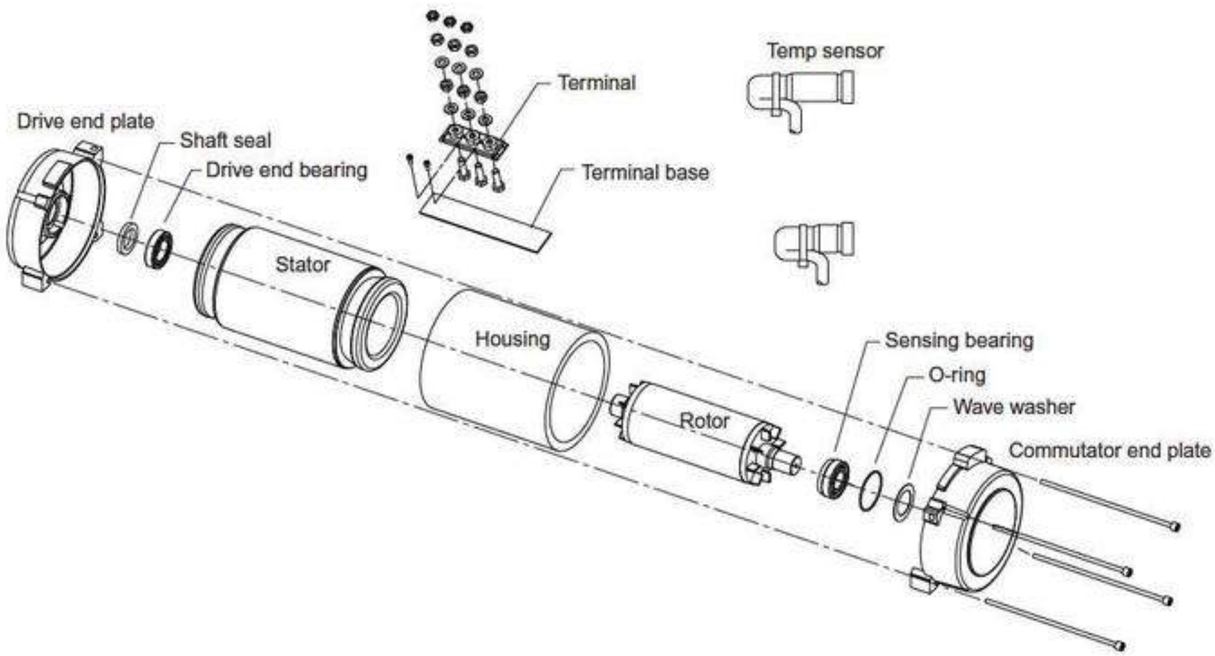
The pump motor assembly weighs over 138 pounds(62.5kg). A suitable lifting device may be needed to help hold and then raise the motor from the truck.

3. Remove the 4 nuts locking the pump motor.
4. Lift the motor assembly and place it on a bench for service.
5. Remove the cushion bolts locking the motor.
6. Reinstall in reverse order.

NOTE

When removing or installing cables to motor, hold the terminal's lower nut with a wrench while turning the upper fastening nut with another wrench.





Pump Motor Exploded View

Ball Bearings

Both ball bearings are maintenance free. If it becomes necessary to remove the bearings to repair the motor, they should be replaced. In any case the seals (shaft oil seal and O-ring) must be replaced.

In general bearings should be replaced at approximately 10,000 operating hours.

Encoder Bearing

The encoder bearing is used to communicate the motor speed to the controller.

NOTE

The encoder bearing is very sensitive to static electricity. If you are going to be working on the encoder bearing you should have a ground strap on to insure that the encoder bearing does not get damaged.

Replacing Encoder Bearing

In general the encoder bearing should be replaced every time the motor is disassembled.

To replace the encoder bearing:

- Turn key OFF.
- Set park brake.
- Disconnect battery.
- Remove the pump motor (see page 2 of this section).
- Remove motor bolts.
- Loosen the silicone sealer around the cables at the end housing.
- Remove the non-drive end housing from motor.
- Remove rotor from motor.
- Use a gear puller to remove encoder bearing from the rotor.

Motor Reassembly

- Press new encoder bearing on to rotor at the inner ring with a steady pressure. The inner ring of the bearing must to be pressed against the shaft shoulder.

NOTE

The encoder bearing is very sensitive to static electricity. If you are going to be working on the encoder bearing you should have a ground strap on to insure that the encoder bearing does not get damaged.

- Insure that the encoder cables are installed correctly and do not get pinched or touch the rotor.
- Install the end housing carefully onto the encoder bearing and press it on with a steady pressure. The lead from the bearing must located in the notch in the housing frame.
- Install the rotor into the stator housing.
- Tie strap the encoder bearing lead to one of the motor leads to prevent it from being pulled and contacting the rotor.
- Install the drive end onto the motor making sure that the terminal block mounting bracket is aligned with the slots in both end frames.
- Install the motor through bolts and tighten.
- Fill the void around the drive motor leads with Silicone # 1758629.
- Install the fan and snap ring onto the shaft.

NOTE :

GROUP 17

ELECTRICAL CONTACTORS

NOTE :

Section 1

Contactors Specifications and Overhaul

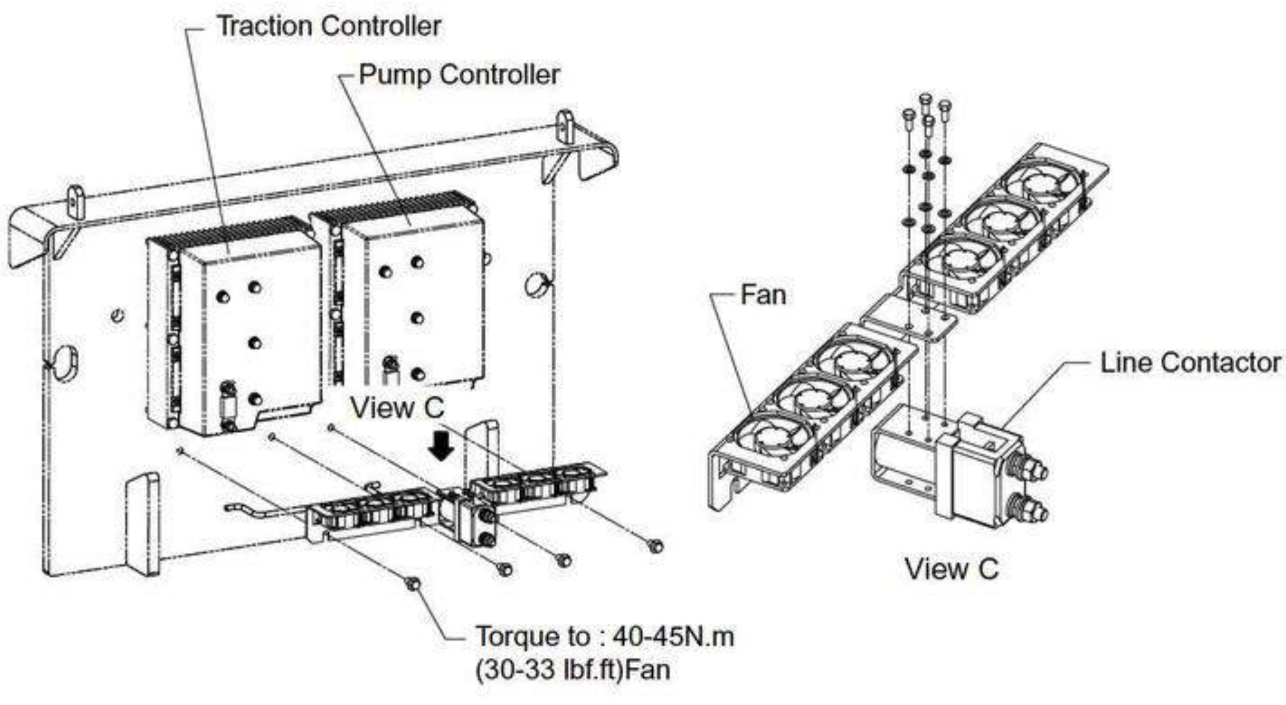
Specifications

The ECX has only one line contactor.

Mounting Fastener Torque: 40-45 N.m (30-33 ft-lb).

Removal and Replacement

1. Disconnect power cables from contactors. Move power cables out of the way.
2. Disconnect wiring from contactor coil terminals.
3. Remove the bracket bolts locking the contactor and the fan.
4. Remove mounting bolts and contactor assembly from truck.
5. Reverse procedure for installation.



Overhaul

WARNING

Disconnect battery before working on contactor tips.Before attempting to disassemble a contactor to install a new contact set, carefully observe location and orientation of each part.

CONTACTOR INSPECTION AND TIP REPLACEMENT

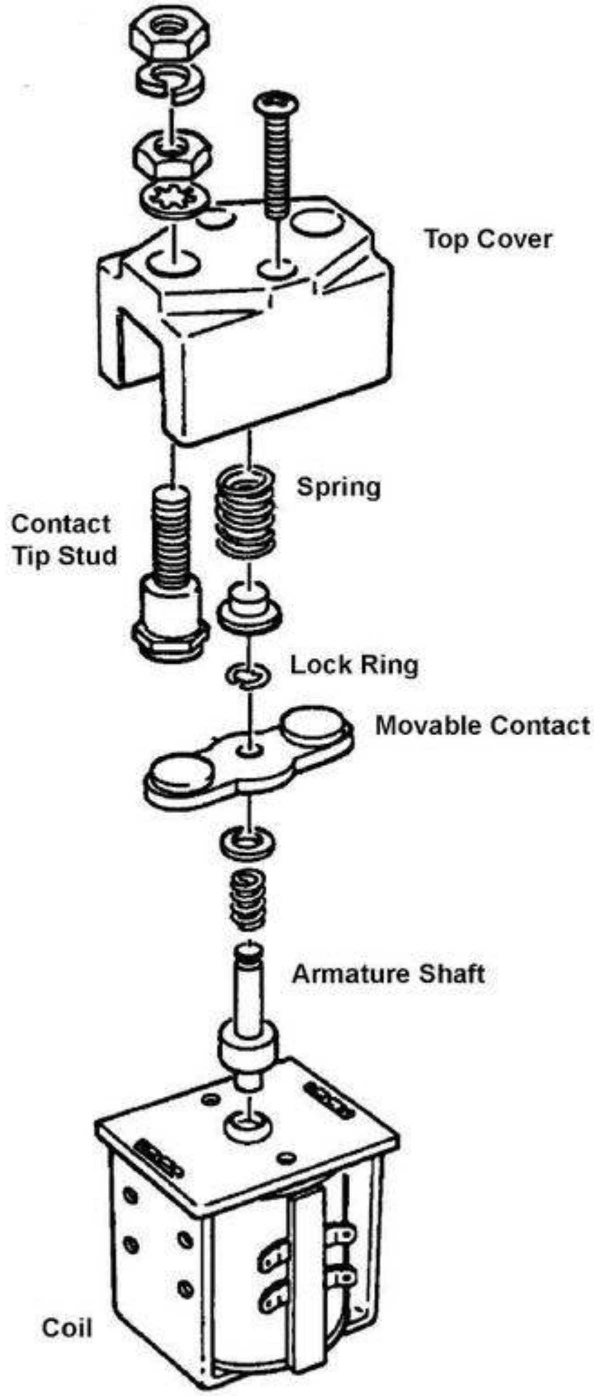
1. Check armature and movable contacts for freedom of movement by depressing movable arm with a screw-driver or small rod. Check for any restrictions to movement and for return of parts by action of spring.

2. Inspect contact tips. Look for any worn or eroded surfaces. Look for evidence of tip welding.
   Inspect for evidence of any contaminants on tips (paint, dirt, paper or cloth material, etc.) which would impair operation.
   Do not use sandpaper or file tips. Any damage must be corrected by tip replacement.
   Tips must be replaced before they wear through and damage copper base.
   To remove and replace contact tips, use following

3. To replace tips on the contactors, loosen and remove two cover mounting screws attaching it to coil frame. (Observe position of positive (+) marking on cover). Be careful not to lose return spring fitted under cover.
   Remove locknut and lockwasher from contact studs and remove contact studs from top cover. Inspect the top cover to make sure it has not been overheated and that the contact studs have not melted into the plastic. Replace the studs with new.
   Lift movable contact assembly off base. Remove lock ring from armature shaft and remove moving contact tips. Be careful not to disassemble or lose other parts under contact tips on armature assembly.
   Replace movable contacts with new and assemble onto armature shaft. Make sure lock ring is fully seated.
   Assemble contactor by putting moving contact assembly armature shaft into coil plunger with return spring on top of armature shaft. Put top cover over spring and install cover mounting screws. Be sure return spring is in recess in top cover.

NOTE

When assembling top cover to base, make sure it is installed with positive sign (+) markings located correctly. Use a bar or rod to move contacts. Be sure movement is free of binding and that tips are in correct orientation and tips contact correct mating parts.



GROUP 19

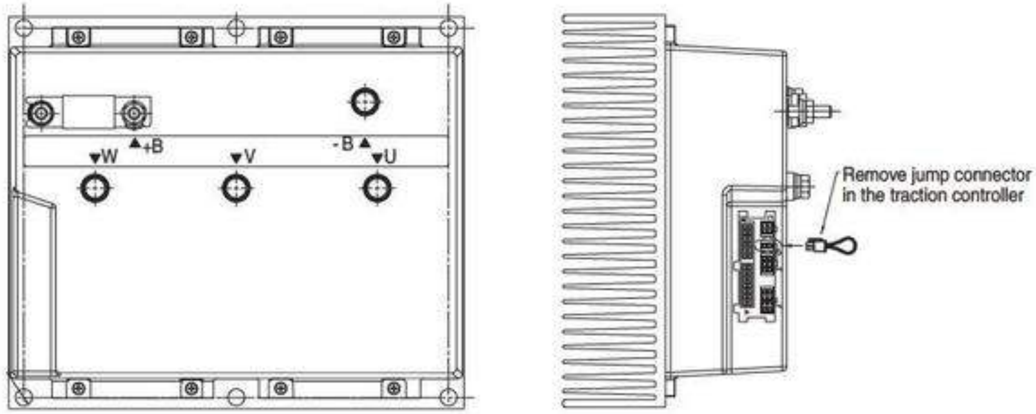
MOTOR CONTROLS

NOTE :

Section 1

Description

CLARK ECX/EPX uses an AC3 controller to control the traction motor and hydraulic motor. When AC3 controller is used to control the traction motor, remove the jump connector of D terminal. On the contrary, it is used to control the hydraulic motor, connect the jump connector of D terminal.



Traction Control and Motors

The AC traction control consists of an AC3 motor control mounted on a heat-sink and enclosed with a cover in the rear counterweight. The control receives inputs from the speed control (accelerator) pedal, direction switches, foot brake switch, motor encoders, motor thermistors and other miscellaneous switches. The speed of the vehicle is controlled by the accelerator control pedal. For a given pedal position the control will maintain a set speed, as determined by control parameter settings. These settings are adjustable to meet your customer's needs. One feature that is new to the ECX/EPX is "release braking". This feature will apply a regenerative braking force every time the driver lifts up off the accelerator pedal. The final travel speed will be determined by the new pedal position. The control receives motor speed feedback from the motor encoders which allow for precise speed regulation. The drive motor also has a built-in thermistor which constantly monitors the winding temperature and reports this information to the control. Should it sense that the motor is approaching the temperature limit, the control will cutback motor current until the temperature decreases. Since it is cutting back current and not voltage, the top end speed will not be effected, unless on a grade. Each control also has built-in thermal protection that will reduce output current should the control approach the thermal limit.

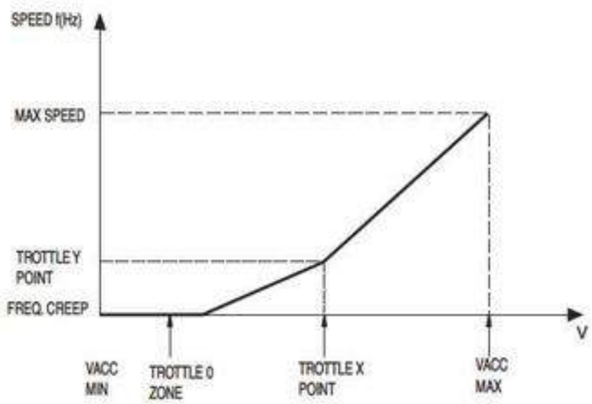
Lift/Steer Control and Motor

A single motor/pump combination is used for both hydraulic functions and steering. The motor is controlled by a dedicated controller. The lift lever is equipped with a linear potentiometer that measures the distance the lever is stroked and provides this input to the control. The control uses this information to increase motor speed in proportion to the distance stroked, providing only the desired flow rate. Tilt and aux switches mounted on the hydraulic valve provide unique inputs to the control. The speed of each function can be programmed independently so that only the required flow rate is produced, minimizing power losses. When the key is in the "ON" position and a direction is selected, the control will operate the motor at a fixed rpm (roughly 600 rpm). This provides adequate flow for the steering function. If the control receives an input from the lift potentiometer, tilt or aux switches, then it will ramp up the motor speed to match the desired speed. Once the request is removed the motor speed will return to the fixed level. As with the traction control and motors, the lift/steer control and motor have thermistors for thermal protection and the motor has a built-in encoder for speed feedback.

Operational Features

Creep Speed

Parameters THROTTLE X POINT and THROTTLE Y POINT control how the truck reacts when you first push on the accelerator. Increasing THROTTLE X POINT will give you more pedal stroke with less speed at the beginning of the stroke. Increasing THROTTLE Y POINT will give more speed with less pedal stroke. See Chart below.



Control acceleration

Parameter ACCELERATION DELAY allows the adjustment of the time it takes to accelerate a stop to full speed. The time is adjustable from 1 second to 5.5 seconds in half-second intervals. See parameter-programming chart later in this manual.

Regenerative braking

Parameter INVERSION BRAKING allows for the adjustment of the amount of time that it takes to stop the vehicle when changing from one direction to the other. The time is adjustable from 1 second to 5.5 seconds in half-second intervals. See parameter-programming chart later in this manual.

Accelerator Pedal Position Plug braking

Parameter RELEASE BRAKING allows for the adjustment of the amount of time that it takes to stop the vehicle when you remove your foot from the accelerator. The time is adjustable from 1 second to 5.5 seconds in half-second intervals. See parameter-programming chart later in this manual.

Brake Pedal Regen Braking

Parameter PEDAL BRAKING allows for the adjustments of the amount of regen braking you receive when you apply the service brake. The pedal braking time is adjustable from 1 second to 5.5 seconds in half-second intervals. See parameter-programming chart later in this manual.

Speed Limit

Parameters MAX SPEED FORWARD and MAX SPEED BACKWARD allow for the adjustment maximum speed that the vehicle can travel in each direction. The maximum speed is adjustable from 0 Hz to 140 Hz in 1 Hz increments.

Stop on Ramp

When this feature is ON it lets the vehicle electrically hold on an incline for up to 15 seconds. Time is adjustable with AUXILIARY TIME parameter from 0 to 25 seconds.

When this feature is OFF the vehicle uses regen braking to stop on an incline. Once the vehicle has stopped it will hold for 1 second then continue to creep down the incline at approx. 1 mph. The vehicle can continue up the ramp at any time without hesitation.

Steering Time Delay

This feature uses the AUXILIARY TIME DELAY in the pump control to delay turn off time when the directional lever is returned to neutral. This parameter is adjustable from 0 to 20 seconds of delay.

Static Return to Off (SRO)

This feature requires the operator to return the directional lever to the neutral position anytime they leave the vehicle and return. If the parking brake, seat switch or key switch is opened, the control shuts down and can not be restarted

(The dash display will show a -79 fault code) until the directional lever is returned to neutral. A time delay of approximately 2 seconds is built in to allow momentary opening of the parking brake or seat switch.

Thermal Protector

Each controller has an internal thermal protector on the heat sink. The controllers will reduce the output current to 50% of the set current when the heat sink temperature reaches 75°C. The dash will display the following codes depending on which controller in over temperature, (Traction -61 code and Pump -203 code).

Standard Fault Codes

The control has over 60 fault codes assist the service technicians and operators in the trouble shooting the vehicle. If mis-operation of the vehicle occurs, a fault code will be displayed on the Dash Display of the vehicle, or by plugging the handset into the "F: plug of the master controller and reading the fault code.

With the fault code number, follow the procedures outlined in Group 19, Section 03 ,"Fault Codes", section to determine the problem and a solution.

Stored Fault Codes

This feature records the last 5 fault codes in controller. The last 5 fault codes can be accessed through the alarm log using a handset, or a laptop computer with the PcConsole software and adapter cable. The faults are stored with the hour meter reading when the fault first happened, the number of time the fault has happened, and the temperature the first time the fault happened.

Hour Meter Readings

This feature will display the recorded hours of use of the traction control to the Dash Display each time the key switch is turned off. This hour meter reading can be changed in the case a controller would need to be replaced.
(Hour-meter will be displayed on LCD display when the machine traveling speed is less than 0.5km/h after key switch turns ON.)

Battery Discharge Indication (BDI)

Provides accurate battery state of charge information to the vehicle operator, Features and Functions:

- Displays 100 to 0 percent charge in 5% increments.
- Lift Circuit is disabled at 10% discharge

Handset

This is a multifunctional tool used with the AC controls. The handset (Clark part #8033636 + 8040843) has a display and a key board for data entry.

Features and functions:

- Monitor existing fault codes for traction and pump controls.
- Monitor hour meter readings on traction and pump controls.
- Monitor or adjust the control functions
- Use as a tester to monitor input and output information.

NOTE

The Handset instructions and Troubleshooting can be found in Group 19, Section 3 of this manual.

Protection Features

Reverse Battery Polarity:

The MAIN CONTACTOR is there to protect the controller against reverse battery polarity and for safety reasons.

Connection Errors:

All inputs are protected against connection errors.

Thermal Protection:

If the controller temperature exceeds 80° C, the maximum current is reduced in proportion to the thermal increase. The temperature can never exceed 100° C.

External Agents:

The controller is protected against dust and the spray of liquid to the degree of protection meeting IP54.

Protection Against Uncontrolled Movement:

The main contactor will not close if:

- The power unit is not functioning
- The controller is not functioning perfectly.
- The output of the accelerator does not fall below the minimum voltage value stored, with 1V added
- Running microswitch is in closed position.

Low Battery Charge:

When the battery charge is low, -66 Code, the maximum current is reduced to half the maximum current programmed.

Protection against accidental startup:

A precise sequence of operations is necessary before the control will start (SRO). Startup cannot occur if the sequence is not followed completely. (Request for drive, must be made after closing the key switch).

Capacitor Charge:

The controllers can hold an electrical charge for several seconds, due to the power capacitor bank. A discharge resistance is built in the controller, which ensures capacitor discharge to a safe voltage in about one minute, after the key is switched off. If it is necessary to work on the controller before that time, discharge the capacitors as described below.

Discharging Controller Capacitors

It is necessary to discharge the capacitors before you work on the controller. To discharge the capacitors, disconnect the battery at the battery receptacle, connect a 200 ohm 10 watt resistor between the positive and negative input post of the controller for 10 seconds.

Communications with CLARK Dash:

The traction controller communicates by serial link (RS232) to CLARK dash. The dash shows Battery State of charge and fault code if a fault occurs. When the key is turned off, the dash shows hour meter reading. (Hourmeter will be displayed on LCD display when the machine traveling speed is less than 0.5km/h after key switch turns ON.)

Microswitches:

The micro switches must have a contact resistance lower than 0.1ohm and a leakage current lower than 100 micro amps.

When full load is connected, the voltage between the key switch contacts must be lower than 0.1 volt.

The micro switches send a voltage signal to the microprocessor when a function is requested (for example: running request) is made.

Accelerator Unit:

The accelerator unit consists of a potentiometer in 3 wire configuration.

CPOT (TA1) signal.

EN ACC (TA14) is the accelerator enable. It is fed with +Batt from the key switch.

NPOT (TA3) is the accelerator negative supply. This output is feed back to the microprocessor A/D converter to test the continuity of the accelerator unit circuit (test of pot wire disconnection). The procedure for automatic potentiometer signal acquisition is carried out using the handset. This enables adjustment of the minimum and maximum useful signal level (PROGRAM VACC function), in either direction. This function is unique when it is necessary to compensate for asymmetry with the mechanical elements associated with the Potentiometer. Especially relating to minimum level. The sequence of procedure is described later in this manual.

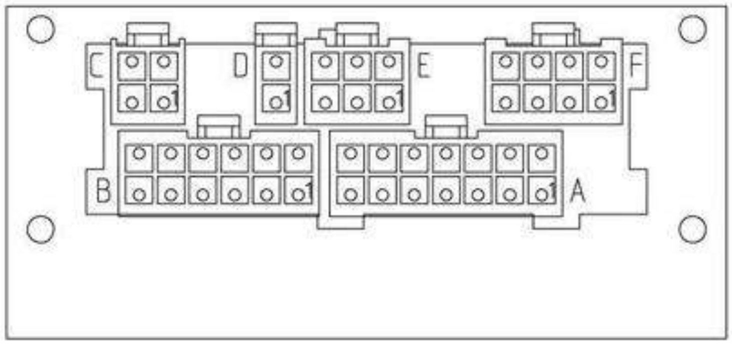
Analog control unit

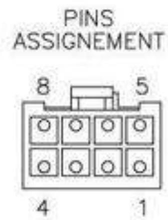
Connection TB1 (PTHERMR) and TB12 (NTHERMR) are used for the Traction motor thermal sensor. Connection PB6 (PTHERML) and PB12 (NTHERML) are used for the Pump motor thermal sensor. Sensors are analog.

Speed Feedback

The traction motor control is based upon the motor speed feed back. The speed transducer is an incremental encoder, with two phases shifted at 90 °. The encoder is supplied with +12V from the control panel.

Description of Connectors - Traction AC3





A1	CPOT	Accelerator potentiometer wiper.
A2	PPOT	Potentiometer positive: 10V output; keep load > 1KW.
A3	NPOT	Negative of accelerator unit, tested for wire disconnection diagnosis.
A4	CM	Common of FW / BW / SR / PB / SEAT / BACK. FW / BACK. BW / EXCLUSIVE HYDRO microswitches.
A5	FORW	Forward direction request input. Must be connected to the forward direction microswitch, active high.
A6	BW	Backward direction request input. Must be connected to the backward direction microswitch, active high.
A7	PB	Brake request input. Must be connected to the brake pedal switch, active high.
A8	CPOTB	Brake potentiometer wiper.
A9	PPOTB	Brake potentiometer positive. 10V output; keep load >1KW.
A10	NPOTB	-Batt.
A11	-BATT	-Batt.
A12	BACK.FORW	Inching function, forward direction input. Must be connected to the inching forward switch. Active high.
A13	BACK.BACK	Inching function, backward direction input. Must be connected to the inching backward switch. Active high.
A14	EX.HYDRO	Exclusive hydro function input. Must be connected to the exclusive hydro microswitch. Active high (see also OPTION chapter)
B1	KEY	Connected to the power supply through a microswitch (CH) with a 10A fuse in series.
B2	PLC	Positive of main contactor coil.
B3	PBRAKE	Positive of the electromechanical brake coil.
B4	SEAT	SEAT input; must be connected to the SEAT microswitch; it is active high.
B5	SAFETY	If not connected to -Batt the MC coil power output will be disabled. Can also be used as a general purpose input.
B6	PTHERM	Input for motor temperature sensor.
B7	CM	Common of FW / BW / SR / PB / SEAT / INCHING FW / INCHING BW / EXCLUSIVE HYDRO microswitches.
B8	NLC	Negative of main contactor coil.

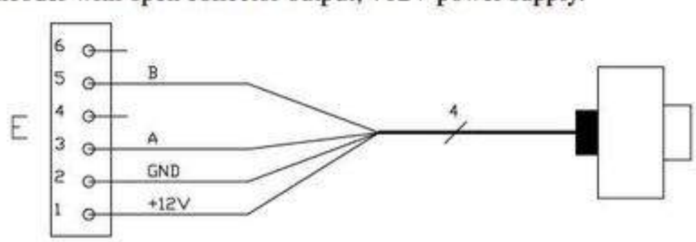
B9	NBRAKE	Output for driving a brake or an hydraulic steering contactor coil; drives the load to -Batt maximum current : 3A.
B10	SR/HB	Speed reduction (handbrake) input. Active low (switch opened). See also OPTION chapter.
B11	GND	-Batt.
B12	NTHERM	-Batt.
C1	CAN-L	Low level CAN-BUS voltage I/O.
C2	CAN-L-OUT	Low level CAN-BUS voltage I/O.
C3	CAN-H	High level CAN-BUS voltage I/O.
C4	CAN-H-OUT	High level CAN-BUS voltage I/O.
D1	-BATT	-Batt.
D2	MODE	This input allows the customer to select the software for traction or lifting application. Configuration: MODE: Open (not connected) Traction inverter MODE: Close (connected with A5) Pump inverter
E1~E6		Incremental ENCODER connector (see chapter 3.6).
F1	PCLRXD	Positive serial reception.
F2	NCLRXD	Negative serial reception.
F3	PCLTXD	Positive serial transmission.
F4	NCLTXD	Negative serial transmission.
F5	GND	Negative console power supply.
F6	+12	Positive console power supply.
F7	FLASH	Must be connected to F8 for the Flash memory programming (if used).
F8	FLASH	Must be connected to F7 for the Flash memory programming (if used).

Encoder Installation

In order to control the AC motors with the ZAPI controller an incremental encoder is installed with 2 phases shifted at 90°. The encoder power supply is 12V

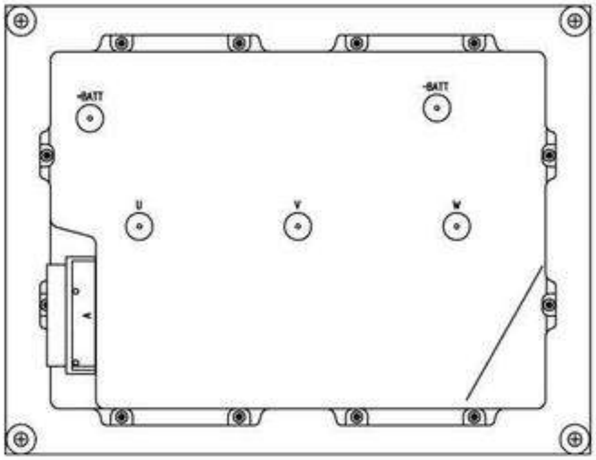
E1	+12V	Positive of encoder power supply.
E2	GND	Negative of encoder power supply.
E3	A:	Phase A of the encoder
E5	B:	Phase B of the encoder

Connection of encoder with open collector output; +12V power supply.



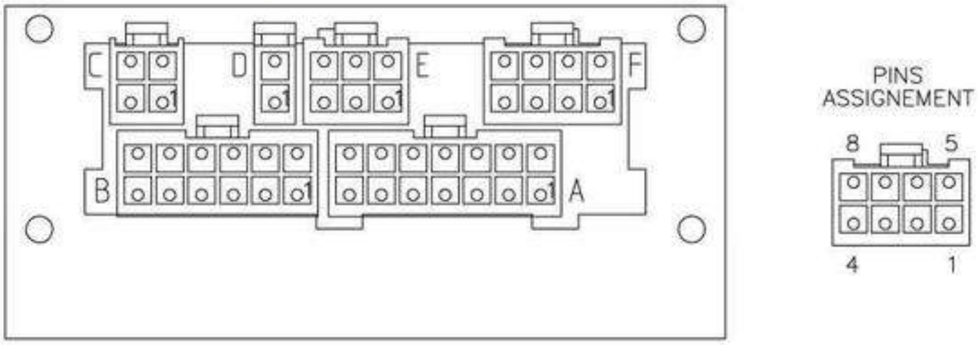
The encoder power supply voltage and output electronic has to be communicated to ZAPI in order to correctly set the selection jumper in the controller.

Description of Power Connections



-B	Negative of the battery
+BT	Positive of the battery; if the power fuse is not present,positive cable coming from the Line contactor must be connected to this power connection
+BTF	Positive of battery before power fuse, must be connected to positive cable coming from line contactor.
U, V, W	Connection bars for the three phases of the traction motor; follow this sequence and the indication on the motor.

Description of Connections - Hydraulic AC3



A1	CPOT	Accelerator potentiometer wiper.
A2	PPOT	Potentiometer positive: 10V output; keep load > 1KW.
A3	NPOT	Negative of accelerator unit, tested for wire disconnection diagnosis.
A4	CM	Common of LIFT ENABLE / 1st SPEED / 2nd SPEED / 3rd SPEED / 4th SPEED / HYDRO / SR microswitches.
A5	LIFT ENABLE	Input for potentiometer lifting enable input; it is active HIGH.
A6	1st SPEED	Input for first speed request; it is active HIGH..
A7	3rd SPEED	Input for third speed request; it is active HIGH
A8	AN.IN	Free analog input.
A9	PPOT	Potentiometer positive: 10V output; keep load > 1KW.
A10	-BATT	-Batt.
A11	-BATT	-Batt.
A12	HYDRO REQ	Input for hydraulic steering request. Active high.
A13	SR	Speed reduction input. Active low (switch opened).
A14	DIG.IN	This is a digital input, free for customer request.
B1	KEY	Connected to the power supply through a microswitch (CH) with a 10A fuse in series.
B2	PAUX	Positive of the auxiliary output.
B3	PHYDRO	Positive for the hydraulic steering contactor.
B4	4th SPEED	Input for fourth speed request; it is active HIGH.
B5	SAFETY	If not connected to -Batt the MC coil power output will be disabled. Can also be used as a general purpose input.
B6	PTHERM	Input for motor temperature sensor.
B7	CM	Common of LIFT ENABLE / 1st SPEED / 2nd SPEED / 3rd SPEED / 4th SPEED / HYDRO / SR microswitches.
B8	NAUX	This output can be used for drive the main contactor coil (single pump configuration) or to drive an auxiliary load (combi configuration)
B10	NHYDRO	Output for driving an hydraulic steering contactor; drives the load to -Batt. Maximum current: 3A.
B11	2nd SPEED	Input for second speed request; it is active HIGH.
B11	GND	-Batt.
B12	NTHERM	-Batt.
C1	CAN-L	Low level CAN-BUS voltage I/O.

C2	CAN-L-OUT	Low level CAN-BUS voltage I/O.
C3	CAN-H	High level CAN-BUS voltage I/O.
C4	CAN-H-OUT	High level CAN-BUS voltage I/O.
D1	-BATT	-Batt.
D2	MODE	This input allows the customer to select the software for traction or lifting application. Configuration: MODE: Open (not connected) Traction inverter MODE: Close (connected with A5) Pump inverter
E1~E6		Incremental ENCODER connector (see chapter 3.6).
F1	PCLRXD	Positive serial reception.
F2	NCLRXD	Negative serial reception.
F3	PCLTXD	Positive serial transmission.
F4	NCLTXD	Negative serial transmission.
F5	GND	Negative console power supply.
F6	+12	Positive console power supply.
F7	FLASH	Must be connected to F8 for the Flash memory programming (if used).
F8	FLASH	Must be connected to F7 for the Flash memory programming (if used).

NOTE :

Section 2

Control Programming

Programming & Adjustments Using ZAPI Handset

Adjustments via Handset

Adjustments of parameters and changes to the controller's configuration are made using the digital Handset. The Handset is connected to the "F: connector of the controller.

Start with the battery disconnected at the battery receptacle, key switch in the OFF position.

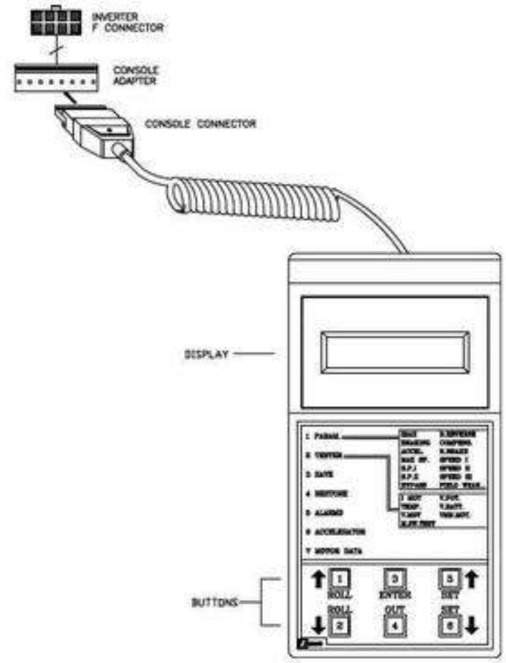
Disconnect the dash display harness from the Traction Control and connect the handset cord into this "F" connector.

The ECX/EPX has two controls. The Traction control is also known as (Node #2, Connected to 2 or Traction) on the CAN BUS. The Pump control also is also known as (Node #5 Connected to 5 or Pump) on the CAN BUS.

The Traction control is on the right-hand side of the truck. The Pump control is on the left-hand side of the truck.

Plug in the battery and turn the key switch ON.

Description of Handset & Connections



Digital Handsets used to communicate with the AC Controllers must be fitted with EPROM CK ULTRA, minimum (Handset part number **8033636** and Adaptor cable part number 8041365) .

The Handset "Release Number" will be displayed on the Handset display momentarily when the key switch is first turned ON

The Handset display will than show a screen simular to the one shown below.

As shown in this Example; the "T" in AC3T2BIK, indicates the the Handset is now monitoring the Traction control. The Pump control would be indicated with a "P".

The last 6 digits of the top line in the example above indicate the current software revision loaded into the Traction control. The CK indicates CLARK and the 0.09 is the software revision level.

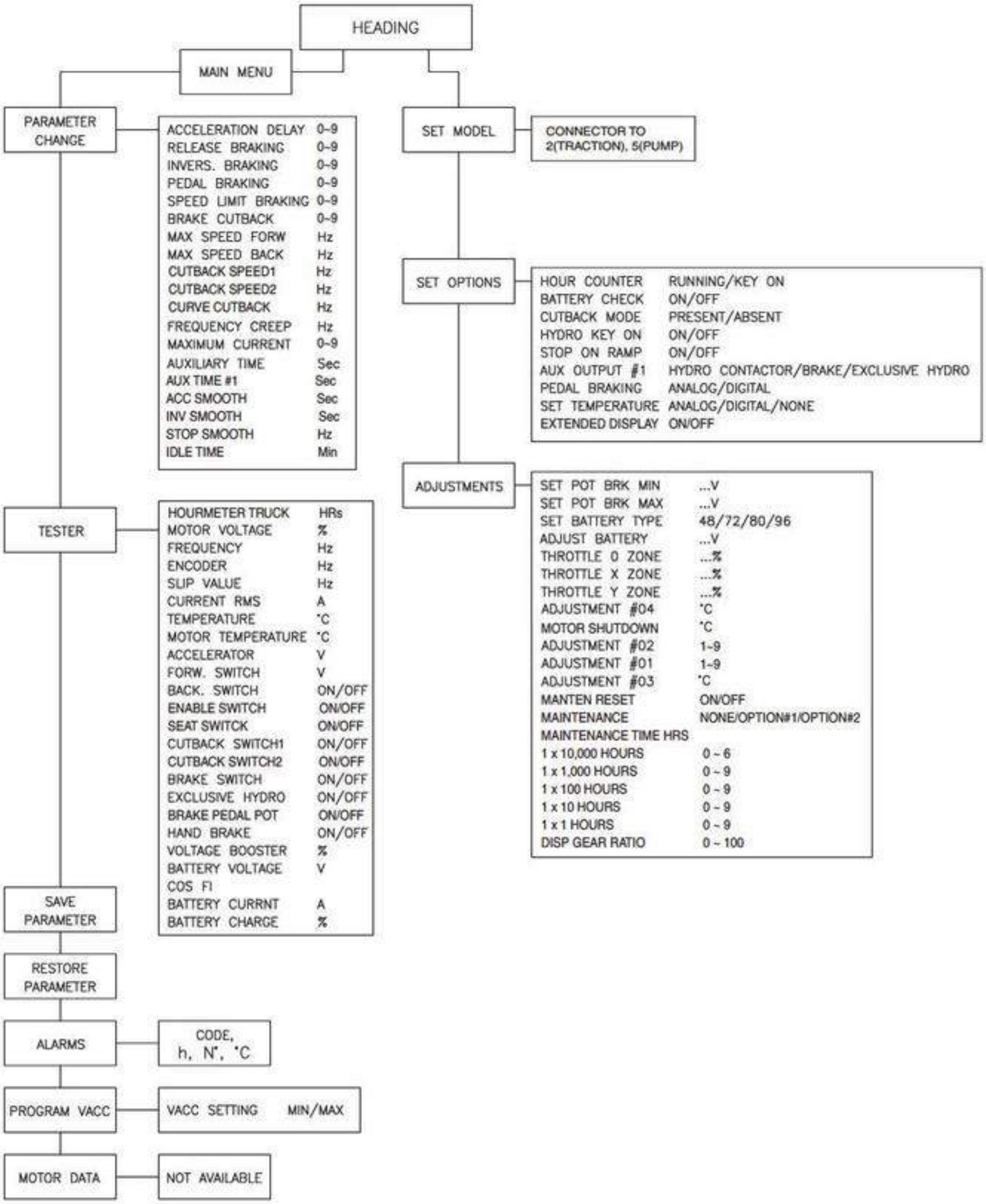
The bottom line on the display indicates the Battery Voltage and the current level that has been set and the current internal hour meter reading of the control.

At the bottom of the Handset there are 6 push buttons used to navigate to a different control (Traction or Pump), or to navigate through the control functions and to make changes to the paramaters.

A flow chart of the Handset functions is shown on the following page.

The Handset is used to make adjustments to the parameters, used to view test functions within the electrical system of the truck and to view the alarms (fault codes) that are present or stored in the memory of the controls.

See Group 19, Section 4 for ECX/EPX Factory Control Settings


HEADING
MAIN MENU
PARAMETER CHANGE
ACCELERATION DELAY 0-9
RELEASE BRAKING 0-9
INVERS. BRAKING 0-9
PEDAL BRAKING 0-9
SPEED LIMIT BRAKING 0-9
BRAKE CUTBACK 0-9
MAX SPEED FORW Hz
MAX SPEED BACK Hz
CUTBACK SPEED1 Hz
CUTBACK SPEED2 Hz
CURVE CUTBACK Hz
FREQUENCY CREEP Hz
MAXIMUM CURRENT 0-9
AUXILIARY TIME Sec
AUX TIME #1 Sec
ACC SMOOTH Sec
INV SMOOTH Sec
STOP SMOOTH Hz
IDLE TIME Min
TESTER
HOURMETER TRUCK HRs
MOTOR VOLTAGE %
FREQUENCY Hz
ENCODER Hz
SLIP VALUE Hz
CURRENT RMS A
TEMPERATURE °C
MOTOR TEMPERATURE °C
ACCELERATOR V
FORW. SWITCH V
BACK. SWITCH ON/OFF
ENABLE SWITCH ON/OFF
SEAT SWITCH ON/OFF
CUTBACK SWITCH1 ON/OFF
CUTBACK SWITCH2 ON/OFF
BRAKE SWITCH ON/OFF
EXCLUSIVE HYDRO ON/OFF
BRAKE PEDAL POT ON/OFF
HAND BRAKE ON/OFF
VOLTAGE BOOSTER %
BATTERY VOLTAGE V
COS FI
BATTERY CURRNT A
BATTERY CHARGE %
SAVE PARAMETER
RESTORE PARAMETER
ALARMS
CODE, h, N°, °C
PROGRAM VACC
VACC SETTING MIN/MAX
MOTOR DATA
NOT AVAILABLE
SET MODEL
CONNECTOR TO 2(TRACTION), 5(PUMP)
SET OPTIONS
HOUR COUNTER RUNNING/KEY ON
BATTERY CHECK ON/OFF
CUTBACK MODE PRESENT/ABSENT
HYDRO KEY ON ON/OFF
STOP ON RAMP ON/OFF
AUX OUTPUT #1 HYDRO CONTACTOR/BRAKE/EXCLUSIVE HYDRO
PEDAL BRAKING ANALOG/DIGITAL
SET TEMPERATURE ANALOG/DIGITAL/NONE
EXTENDED DISPLAY ON/OFF
ADJUSTMENTS
SET POT BRK MIN ...V
SET POT BRK MAX ...V
SET BATTERY TYPE 48/72/80/96
ADJUST BATTERY ...V
THROTTLE 0 ZONE ...%
THROTTLE X ZONE ...%
THROTTLE Y ZONE ...%
ADJUSTMENT #04 °C
MOTOR SHUTDOWN °C
ADJUSTMENT #02 1-9
ADJUSTMENT #01 1-9
ADJUSTMENT #03 °C
MANTEN RESET ON/OFF
MAINTENANCE NONE/OPTION#1/OPTION#2
MAINTENANCE TIME HRS
1 x 10,000 HOURS 0 - 6
1 x 1,000 HOURS 0 - 9
1 x 100 HOURS 0 - 9
1 x 10 HOURS 0 - 9
1 x 1 HOURS 0 - 9
DISP GEAR RATIO 0 - 100

Traction Control - "AC3"

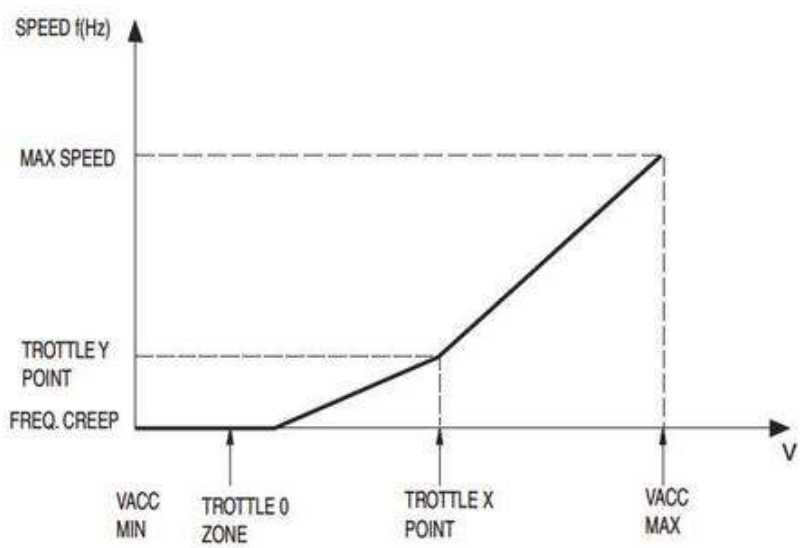
SUBMENU "SET OPTIONS" (See Group 19, Section 4 for ECX/EPX Factory Control Settings)

1. HOUR COUNTER	
RUNNING:	the counter registers travel time only.
KEY ON:	the counter registers when the "key" switch is closed.
2. BATTERY CHECK	
ON:	the battery discharge level check is carried out; when the batterylevel reaches 10%, an alarm is signalled and the maximum current is reduced tothe half of the programmed value.
OFF:	the battery discharge level check is carried out but no alarm is signalled.
3.CUTBACK MODE	
PRESENT:	input B10 (Minifit), is managed as a cutback speed input.
ABSENT:	input B10 (Minifit), is managed as an handbrake input.
4. HYDRO KEY ON	
ON/OFF:	if this option is programmed ON the traction inverter manages an hydraulic steering function when the "key" is switched ON (only if the "aux output #1" option is programmed as "hydro contactor" or as "exclusive hydro").
5. STOP ON RAMP(	
ON:	the stop on ramp feature (truck electrically hold on a ramp) is managed for a time established by "auxiliary time" parameter. After this time, the behavior depends on the "aux output #1" option programmation (see also the following table).
OFF:	the stop on ramp feature is not performed.
6. AUX OUTPUT #1	
BRAKE:	output B9 (Minifit), A7 (Amp Saab) drives an electromagnetic brake coil (see also the table below).
HYDRO CONT.:	the inverter manages an hydraulic steering function when the direction input or brake pedal input are active or a movement of the truck is detected.
EX.HYDRO:	the inverter manages an hydraulic steering function when the exclusive hydro input is active.
7. PEDAL BRAKING	
ANALOG:	the mechanical brake pedal has a switch and a potentiometer installed. When the accelerator is released and the pedal brake is pushed the inverter performs an electrical braking whose intensity is proportional to the brake pedal potentiometer. The minimum intensity is established by the "Release braking" parameter, when the brake pedal is slightly pressed (brake switch close but brake potentiometer at the minimum). The maximum intensity is established by the "Pedal braking" parameter when the brake pedal is fully pressed (brake potentiometer at the maximum). In the middle positions, the electrical braking intensity is a linear function between minimum and maximum intensity.

DIGITAL:	The truck does not have a potentiometer installed on the mechanical brake pedal, but only a microswitch; when the accelerator pedal is released and the brake pedal is pushed (brake switch closed), the inverter performs an electrical braking following "Pedal braking" parameter.
8. SET TEMPERATURE	
DIGITAL:	a digital (ON/OFF) motor thermal sensor is connected to B6 (Minifit), A3 (Amp Saab) input.
ANALOG:	an analog motor thermal sensor is connected to B6 (Minifit), A3 (Amp Saab) (the curve can be customized on a customer request).
NONE:	no motor thermal sensor switch is connected.
9. EXTENDED DISPLAY	ON/OFF
10. PARK SPEED LIMIT	When the seat switch on the truck, on which the EM brake is equipped, is opened, "Warning code 36" will be displayed if the truck traveling speed is higher than "Park speed limit" Setting value.

SUBMENU "ADJUSTMENTS"

1. SET POT BRK MIN: (Not Used)	Records the minimum value of the braking pedal potentiometer when the braking pedal switch is closed; the procedure is similar to the "Program VACC" function. This procedure is only used if the "pedal braking" option is programmed as "Analog".
2. SET POT BRK MAX: (Not Used)	Records the maximum value of the braking pedal potentiometer when the braking pedal is fully pressed; the procedure is similar to the "Program VACC" function. This procedure is only used if the "pedal braking" option is programmed as "Analog".
3. SET BATTERY TYPE:	Selects nominal battery voltage.
4. ADJUST BATTERY:	Fine adjustment of the battery voltage measured by the controller.
5. THROTTLE 0 ZONE:	Establishes a deadband in the accelerator input curve
6. THROTTLE X POINT:	This parameter changes the characteristics of the accelerator input curve
7. THROTTLE Y POINT:	This parameter changes the characteristics of the accelerator input curve



VACC MIN and VACC MAX are values programmable by the "PROGRAM VACC" function.

This VACC procedure programs the actual minimun and maximum input voltages from the accelerator control.

See Group 13, Section 4 for setup procedure.

8. ADJUSTMENT #04: (Do Not Change)	Determines the motor temperature level at which the "Motor Temperature" fault is signaled. The default temperature is 130° C. Icon on dash will illuminate at this temperature.
9. MOTOR SHUTDOWN: (Do Not Change)	This parameter determines the motor temperature level at which the "Motor Shutdown" fault is signaled. The default temperature is 145° C.
10. ADJUSTMENT #01	Adjust the upper level of the battery discharge table.
11. ADJUSTMENT #02	Adjust the lower level of the battery discharge table.
12. ADJUSTMENT #3	Adjust percentage of battery change it take to reset battery state of charge on dash display.
13. MAINTENANCE DONE:	OFF is the default Setting. When a maintenance warning occurs, the operator can cancel the warning setting this parameter ON. When the truck is turned on again this parameter becomes OFF.
14. MAINTENANCE:	
-NONE:	When truck reaches maintenance time, if this parameter is set as NONE, the controller gives a maintenance warning but does not reduce performance.
OPTION #1:	When truck reaches maintenance time, if this parameter is set as OPTION #1, the controller gives a maintenance warning and reduces truck performance
OPTION # 2:	When truck reaches maintenance time, if this parameter is set as OPTION #2, the controller gives a maintenance warning and stops the truck.
15. MAINTENANCE TIME:	Sets the number running truck hours before setting the maintenance fault. This is a count down timer, it must be reset after each PM.
16. 1x 10, 000 HOURS:	Sets the ten thousands units of the hour meter displayed on the dash display. This will not change the hour meter of the controller.
17. 1x 1, 000 HOURS:	Sets the thousands units of the hour meter displayed on the dash display. This will not change the hour meter of the controller.
18. 1x 100 HOURS:	Sets the hundreds units of the hour meter displayed on the dash display. This will not change the hour meter of the controller.
19. 1x 10 HOURS:	Sets the ten units of the hour meter displayed on the dash display. This will not change the hour meter of the controller.
20. 1x 1 HOURS:	Sets the units of the hour meter displayed on the dash display. This will not change the hour meter of the controller.
21. Disp. Gear ratio	If manages the conversion ratio for the display speed.

Parameter Regulation

The following parameters can be modified(See Group 19,

1. ACC DELAY:	Determines the acceleration ramp
2. RELEASE BRAKING:	Controls the deceleration ramp when the travel request (accelerator) is released The higher the setting, the more aggressive the braking.
3. INVERSION BRAKING:	Controls the deceleration ramp when the direction is changed (FWD to REV or REV to FWD) during travel. The higher the setting, the more aggressive the braking.
4. PEDAL BRAKING:	Determines the deceleration ramp when the travel request is (accelerator) released and the brake pedal switch is closed. The higher the setting, the more aggressive the braking.
5. SPEED LIMIT BRAKING:	Deceleration ramp when the pedal position is changed but not completely released
6. BRAKE CUTBACK:	Determines the deceleration ramp when the speed reduction input becomes active and the motor slows down.
7. MAX SPEED FORWARD:	Determines maximum speed in forward direction.
8. MAX SPEED BACKWARD:	Determines maximum speed in reverse direction.
9. CUTBACK SPEED1: (Not Used)	Speed reduction when cutback switch1 is active.
10. CUTBACK SPEED2: (Not Used)	Speed reduction when cutback switch2 is active.
11. CURVE CUTBACK (Not Used)	
12. FREQUENCY CREEP: (Do Not Change)	Minimum speed when the forward or reverse switch is closed, but the accelerator is in a minimum position.
13. MAXIMUM CURRENT: (Do Not Change)	Changes the maximum current of the controller
14. AUXILIARY TIME: (Do Not Change)	Determines the time that the truck will hold on a ramp if the "stop on ramp" option is ON.
15. AUX TIME #1:	To set the time to blow the horn when the driver gets off the seat without applying the parking brake. (Option)
16. ACC SMOOTH	ACC SMOOTH controls the acceleration rate, when the speed request is between 0 Hz and the frequency setting defined by STOP SMOOTH. When the speed request is above the STOP SMOOTH value, then the parameter ACCELERATION DELAY controls the acceleration rate. Adjusting this level changes the time (in seconds) required to accelerate the truck. The lower the acceleration level the more aggressive the acceleration is.
17. INV SMOOTH	INV SMOOTH is similar to ACC SMOTH but it controls the acceleration rate after the truck is plugged to a complete stop and starts to accelerate in the opposite direction.
18. STOP SMOOTH	Sets the frequency point where ACC SMOOTH stops and ACCELERATION DELAY starts.
19. IDLE TIME	Line contactor open time will be set. 5mm (always closed)
20. AUX FUNCTION #10	Maximum current, When lift cut-out(BDI<=10%) happened.
21. AUX FUNCTION #11	Maximum speed, When lift cut-out(BDI<=10%) happened.

Section 4 for Clark factory recommended settings)

PARAMETERS	TRACTION CONTROL PROGRAM LEVEL										
	Unit	0	1	2	3	4	5	6	7	8	9
Acceleration Delay (*)	Sec.	0.5	0.7	1	1.5	2	2.5	3	3.5	4	4.5
Release Braking (**)	Sec.	15	10	8	4	3.5	3	2.5	2	1.5	1
Inversion Braking (**)	Sec.	5.5	5	4.5	4	3.5	3	2.5	2	1.5	1
Pedal Braking (**)	Sec.	5.5	5	4.5	4	3.5	3	2.5	2	1.5	1
Speed Limit Barking (**)	Sec.	8.9	8.3	7.7	7.1	6.6	6	5.5	4.9	4.4	3.8
Brake Cutback (**)	Sec.	5.5	5	4.5	4	3.5	3	2.5	2	1.5	1
Cutback Speed 1	%	10	20	30	40	50	60	70	80	90	100
Cutback Speed 2	%	0	15	20	25	38	50	63	75	87	100
Curve Cutback	%	0	10	21	33	44	55	66	78	89	100
Frequency Creep	Hz	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3
Maximum Current	% IMAX	43	50	56	62	68	75	81	87	94	100
Auxiliary Time	Sec.	0	0.2	0.4	0.8	1	1.5	2	3	4	5
Auxiliary Time #1	Sec.	2	3	4	5	6	7	8	9	10	11
Acc. Smooth	Sec.	1	1.2	1.5	1.7	2	2.2	2.5	2.7	3	3.5
Inv. Smooth	Sec.	1	1.2	1.5	1.7	2	2.2	2.5	2.7	3	3.5
Stop Smooth	Hz	5	7	10	12	15	17	20	22	25	27
Idle time	mm	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5(MC always closed)
Park speed limit	Hz	10	20	30	40	50	60	70	80	90	100
Aux Function #10	%	10	20	30	40	50	60	70	80	90	100
Aux Function #11	Hz	1~Max. speed setting									
Note : Default parameters are shaded.(ECX)											

(*)The acceleration time shown is the time from 0 Hz to 100 Hz. This is the ideal ramp calculated by the software; the real ramp could change as a function of motor control parameter setting and, obviously, a function of the load.

(**)The braking feature is base on deceleration ramps. The value shown in the table is the time to decrease the speed from 100 Hz to 0 Hz. This is the ideal ramp calculated by the software; the real ramp could change as a function of motor control parameter setting and, obviously, a function of the load.

Changing Between 36V and 48V Battery

- Set proper battery type (36V/48V) under the (Config Adjustments Menu) in both the Traction and Pump controls.
- Turn Key off.
- Turn key back on (this will reset parameters in each control to selected battery type).

Extended Display On/Off

Set Extended Display option to ON when using the LCD display (P/N 8039765) which is Standard on ECX.

Gear Ratio ECX/EPX

Setting the correct gear ratio insures that speed readout on the dash display is correct for the ECX or EPX truck. Gear ratio must be set to 54 for the ECX, 55 for the EPX20/25 and 58 for the EPX30/32.

TESTER MENU

Maximum travel speed is adjustable in 1 Hz increments up to 100 Hz for the 36V ECX truck and up to 120 Hz for the 48V truck.

PARAMETERS		EMPTY TRAVEL SPEED MPH											
	MPH	1	2	3	4	5	6	7	8	9	10	11	12
MAX SPEED FORWARD	HZ	10	20	30	39	49	59	69	79	89	100	108	120
MAX SPEED REVERSE	HZ	10	20	30	39	49	59	69	79	89	100	108	120

Note : Default parameters for all 36V models are shaded.

* 48 Volt ECX maximum speed is 120Hz.

The most important input or output signals can be measured in real time using the TESTER function of the handset. The handset acts as a multimeter able to read voltage, current and temperature. The following is a list of measurements for different configurations.

Handset Tester: user can verify the state of the following parameters:

TRACTION CONTROL

Hourmeter truck	Accelerator (V)	Exclusive hydro (ON/OFF)
Motor voltage (%)	Forw switch (ON/OFF)	Brake pedal pot (ON/OFF)
Frequency (Hz)	Back switch (ON/OFF)	Hand brake (ON/OFF)
Encoder (Hz)	Enable switch (ON/OFF)	Voltage booster (%)
Slip Value (Hz)	Seat switch (ON/OFF)	Battery voltage (V)
Current RMS (A)	Cutback switch (ON/OFF)	Cos FI
Temperature (°C)	Cutback sw2 (ON/OFF)	Batt current (A)
Motor temperature (°C)	Brake sw(ON/OFF)	Battery charge (%)

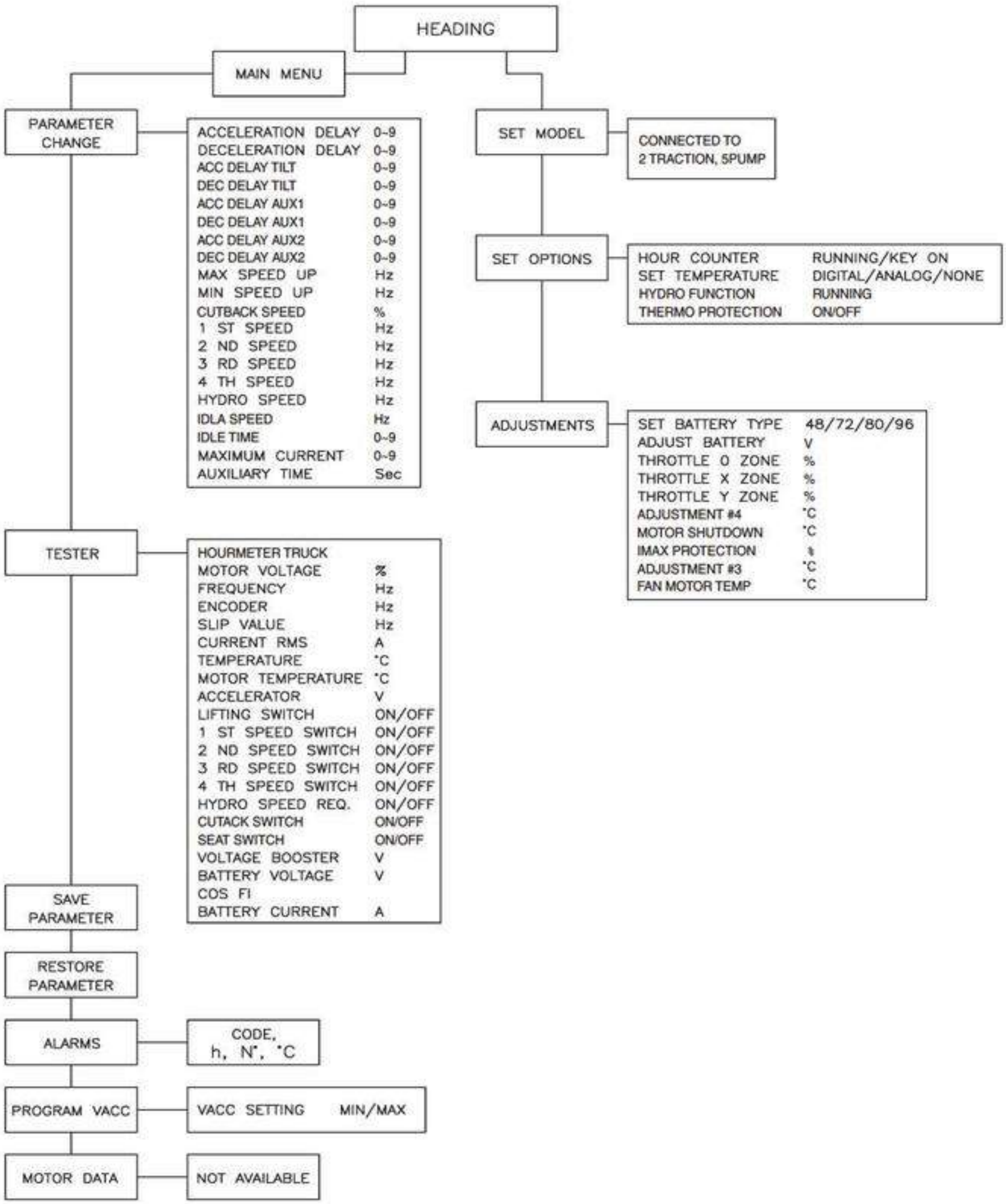
Traction Control - "AC3"

1) TRUCK HOUR METER:	Shows truck hour meter
2) MOTOR VOLTAGE:	This is the voltage supplied to the motor by the controller; it is expressed as a percentage of full battery voltage.
3) FREQUENCY:	This is the frequency of the voltage and current supplied to the motor.
4) ENCODER:	This is the speed of the motor, expressed in the same unit of the frequency; this information comes from the speed sensor.
5) SLIP VALUE:	This is the difference of speed between the rotating field and the shaft of the motor, expressed in the same unit of the frequency.
6) CURRENT RMS:	Root Mean Square value of the motor current.
7) TEMPERATURE:	The temperature measured on the aluminum heat sink holding the MOSFET devices.
8) MOTOR TEMPERATURE :	This is the temperature of the traction motor; if this option is programmed "None" it shows 0°.
9) ACCELERATOR:	The voltage of the accelerator potentiometer's wiper (CPOT). The voltage level is shown on the left-hand side of the Handset display and the value in percentage is shown on the right-hand side.

10) FORWARD SWITCH:	The level of the Forward direction digital input FW. ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
11) BACKWARD SWITCH:	The level of the Reverse direction digital input BW. ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
12) ENABLE SWITCH:	The level of the Enable digital input. ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
13) SEAT SWITCH:	The level of seat microswitch digital input. ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
14) CUTBACK SWITCH:	The level of the brake microswitch. ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
15) CUTBACK SWITCH #2:	The level of the Speed Reduction microswitch. ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
16) BRAKE SWITCH :	The level of the Speed Reduction microswitch. ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
17) EXCLUSIVE HYDRO:	Status of the exclusive hydro switch. ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
18) BRAKE PEDAL POT:	Status of the exclusive hydro switch. ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
19) HAND BRAKE:	The level of the Handbrake microswitch. ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open
20) VOLTAGE BOOSTER:	This is the booster voltage supplied to the motor in load condition; It is expressed in a percentage of the full voltage.
21) BATTERY VOLTAGE:	Level of the battery voltage measured at the input of the key switch.
22) COS FI:	This is the cos j (real time calculated) of the motor.
23) BATTERY CHARGE:	The percentage charge level of the battery.
24) BATTERY CURRENT:	This is the battery current (A)

PUMP CONTROL

Using the configuration menu of the programming console, the user can configure the following functions.



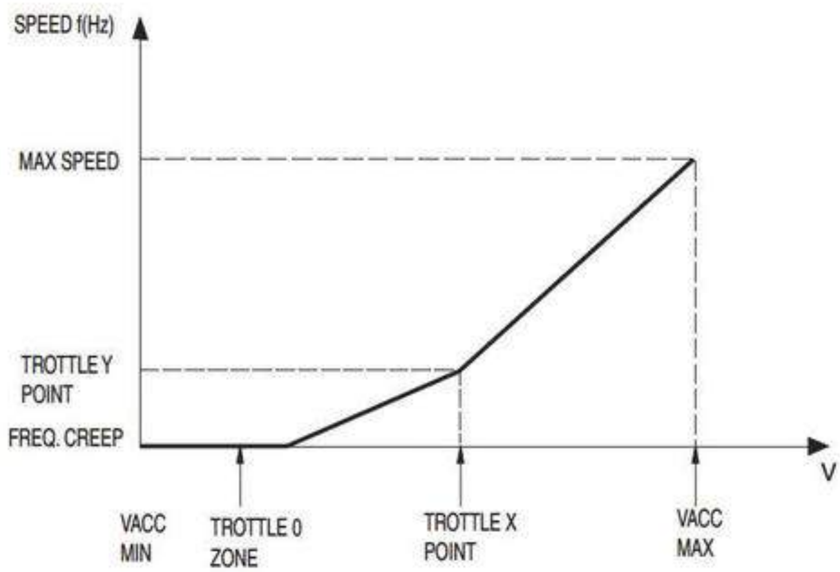
See Group 19, Section 4 for ECX/EPX Factory Control Settings

SUBMENU "SET OPTIONS"

1 HOUR METER	
RUNNING:	The meter registers travel time only.
KEY ON:	The meter registers when the "key" is ON
2 SET TEMPERATURE	
DIGITAL:	A digital (ON/OFF) motor thermal sensor is connected to B6 input.
ANALOG:	An analog motor thermal sensor is connected to B6(the curve can be customized on customer request).
None:	No motor sensor switch connected.
3 THERMO PROTECTION	
ON:	Power reduction activated.
OFF:	Power reduction function off.
4 PRESSURE FUNCT	
ON:	When the Pressure sensor is used, make the steering motor enabled.
OFF:	Normal steering motor function
5 DIGITAL LIFT	
ON:	Control the lift speed by the ON/OFF Switch.
OFF:	Control the lift speed by the ON/OFF Switch (used as Enable switch) and the Potentiometer.

SUBMENU "ADJUSTMENTS"

1. SET BATTERY TYPE:	Selects nominal battery voltage.
2. ADJUST BATTERY:	Fine adjustment of battery voltage measured by the controller.
3. THROTTLE 0 ZONE:	Establishes a deadband in the accelerator input curve.
4. THROTTLE X POINT:	This parameter changes the characteristics of the accelerator input curve.
5. THROTTLE Y POINT:	This parameter changes the characteristics of the accelerator input curve.
6. ADJUSTMENT #4:	To set the temperature when the warning signal of motor overheating displays. The warning temperature is 130°C When the temperature rises to this point, the icon on the dashboard will be turned on.
7. MOTOR SHUTDOWN:	To set the motor temperature when the "Motor shutdown" signal displays. The shutdown temperature is 145°C
8. IMAX PROTECTION:	The value to start the current reduction when the motor temperature reaches adjustment #4 value.
9. ADJUSTMENT #03:	-
10. FAN MOTOR TEMP:	To set the working temperature of motor cooling fan. This temperature follows the motor temperature.



VACC MIN and VACC MAX are values programmable by the "Program VACC" function.

This VACC procedure programs the actual minimun and maximum input voltages from the lift potentiometer.

See Group 13, Section 4 for setup procedure.

Parameter Regulation: Pump Configuration

The following parameters can be modified:

1. PU. ACC DELAY	Acceleration ramp lift (See Tables Below).
2. PU. DEC DELAY:	Deceleration ramp lift (See Tables Below).
3. PU. ACCELER DEL TILT:	Acceleration ramp Tilt (See Tables Below).
4. PU. DEC DELAY TILT:	Deceleration ramp Tilt (See Tables Below).
5. PU. ACCELER DEL AUX1:	Acceleration ramp Aux1 (See Tables Below).
6. PU. DEC DELAY Aux1:	Deceleration ramp Aux1 (See Tables Below).
7. PU. ACCELER DEL AUX2:	Acceleration ramp Aux2 (See Tables Below).
8. PU. DEC DELAY Aux2:	Deceleration ramp Aux2 (See Tables Below).
9. MAX SPEED UP:	Determine the maximum lifting speed with a Potentiometer control
10. MIN SPEED UP:	Determine the maximum lifting speed with a Potentiometer control when the lifting enable switch is closed.
11. CUTBACK SPEED:	Speed when cutback switch is activated.
12. 1st SPEED FINE:	First speed, fine adjustment (Tilt).
13. 2nd SPEED FINE:	Second speed, fine adjustment (Aux1).
14. 3rd SPEED FINE:	Third speed, fine adjustment (Aux2).
15. 4th SPEED FINE:	Fourth speed, fine adjustment.
16. HYD SPEED FINE:	Hydro speed, fine adjustment.
17. IDLE SPEED:	Set speed when steer on demand is active but encoder is not moving.
18. IDLE TIME:	The set time delay before stopping the motor when steer demand is active and encoder is not moving.
19. MAXIMUM CURRENT:	Maximum current of the controller.
20. AUX TIME:	Time delay when power steering function requestis switched off.

The following tables show the different value at which the parameters can be set.

PARAMETERS	PUMP CONTROL PROGRAM LEVEL										
	UNIT	0	1	2	3	4	5	6	7	8	9
ACCELERATION DELAY (*)	Sec.	0.5	0.7	1	1.4	1.9	2.5	3.2	4	4.8	5.5
DECELERATION DELAY (**)	Sec.	0.5	0.7	1	1.4	1.9	2.5	3.2	4	4.8	5.5
ACCELERATION DELAY TILT (*)	Sec.	0.5	0.7	1	1.4	1.9	2.5	3.2	4	4.8	5.5
DECELERATION DELAY TILT (**)	Sec.	0.5	0.7	1	1.4	1.9	2.5	3.2	4	4.8	5.5
ACCELERATION DELAY AUX1 (*)	Sec.	0.5	0.7	1	1.4	1.9	2.5	3.2	4	4.8	5.5
DECELERATION DELAY AUX1 (**)	Sec.	0.5	0.7	1	1.4	1.9	2.5	3.2	4	4.8	5.5
ACCELERATION DELAY AUX2 (*)	Sec.	0.5	0.7	1	1.4	1.9	2.5	3.2	4	4.8	5.5
DECELERATION DELAY AUX2(**)	Sec.	0.5	0.7	1	1.4	1.9	2.5	3.2	4	4.8	5.5
IDLE TIME	Sec.	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5.5
MAXIMUM CURRENT	% IMAX	37	43	50	56	62	68	75	81	87	100
Note : Default parameters are shaded.(ECX)											

(*) The acceleration time shown is the time from 0 Hz to 100 Hz. This is the ideal ramp calculated by the software; the real ramp could change as a function of motor control parameter setting and, obviously, a function of the load.

(**) The braking feature is base on deceleration ramps. The value shown in the table is the time to decrease the speed from 100 Hz to 0 Hz. This is the ideal ramp calculated by the software; the real ramp could change as afunction of motor control parameter setting and, obviously, a function of the load.

Changing Between 36V and 48V Battery

- Set proper battery type (36V/48V) under the (Config Adjustments Menu) in both the Traction and Pump controls.
- Turn Key off.
- Turn key back on (this will reset parameters in each control to selected battery type).

Lift Speed Settings

Maximum lift speed is adjustable in 1 Hz increments up to 100 Hz. for the ECX 36V and up to 130 Hz for the 48V trucks.

Additional Pump Accelerations

The pump control for the ECX/EPX has separate accelerations and deceleration settings for Tilt, Aux1 and Aux2 as well as the Lift function.

All Tilt and Aux Speeds Adjustable in 1 Hz Increments see Defaults Below

- Tilt First Speed Fine 40 Hz
- 1st Aux, 2nd Speed Fine 40 Hz
- 2nd Aux, 3rd Speed Fine 50 Hz

PARAMETERS	MAXIMUM LIFT SPEED		
	UNIT	ECX 20 - 25	ECX 30 - 32
MAXIMUM SPEED UP	HZ	100	120
MINIMUM SPEED UP	HZ	16	16

Note: maximum lift speed for ECX 20/25 should not exceed 100 Hz and 120 Hz for the ECX 30/32

PARAMETERS	TILT FLOW SETTINGS	
	ECX 20/25	ECX 30/32
1st SPEED FINE (TILT)	40	40

Note: Before you adjust the tilt flow settings, please insure that the flow has been adjusted at the valve first.

TILT FLOW CONTROL ADJUSTMENT			
AVERAGE TILT SPEED		USEAGE	CLOCKWISE TURNS OF ADJUSTMENT SCREW
(° / sec)	L/min (gpm)		
2.5	6.3 (1.7)	UPRIGHTS AT 3937 MFH (155") AND ABOVE	0.5
3	8.7 (2.3	UPRIGHTS BELOW 3937 MFH (155")	0.75

Note: Tilt flow adjustments must be completed at the valve, before adjusting Tilt flow settings in the pump controller.

PARAMETERS	AUXILIARY FLOW SETTINGS		
	GPM	ECX 20/25	ECX 30/32
2nd SPEED FINE AND 3rd SPEED FINE	2.5	15	18
	5.5	31	38
	7.0	41	48
	10.0	58	68

Note: Before you adjust the auxiliary flow settings, please insure that the flow has been adjusted at the valve first.

AUXILIARY FLOW ADJUSTMENTS	
FLOW SETTINGS L/min(gpm)	CLOCKWISE TURNS OF ADJUSTMENT SCREW
6.3 (1.7)	0.50
8.7 (2.3)	0.75
12.3 (3.2)	1.00
19.0 (5.0)	1.50
23.4 (6.2)	1.75
33.5 (8.8)	2.50
39.8 (10.5)	3.00
52.9 (14.0)	4.50

Note: Auxiliary flow adjustments must be completed at the valve, before adjusting auxiliary flow settings in the pump controller.

TESTER MENU

The most important input or output signals can be measured in real time using the TESTER function of the handset. The handset acts as a multimeter able to read voltage, current and temperature. The following is a list of measurements for different configurations.

Handset Tester: user can verify the state of the following parameters:

PUMP CONTROL

Hour meter truck (HRs)	Motor Temperature (°C)	Hydro speed req. (ON/OFF)
Motor voltage (%)	Accelerator (V)	Cutback switch (ON/OFF)
Frequency (Hz)	Lifting switch (ON/OFF)	Seat switch (ON/OFF)
Encoder (Hz)	1st speed switch (ON/OFF)	Voltage booster (%)
Slip Value (Hz)	2nd speed switch (ON/OFF)	Battery voltage (V)
Current RMS (A)	3rd speed switch (ON/OFF)	Cos fi
Temperature (°C)	4th speed switch (ON/OFF)	Battery Current (A)

1)HOUR METER TRUCK :	This is the truck's working hour.
2) MOTOR VOLTAGE:	This is the voltage supplied to the motor by the controller; it is expressed as a percentage of full battery voltage.
3) FREQUENCY:	This is the frequency of the voltage and current supplied to the motor.
4) ENCODER:	This is the speed of the motor, expressed in the same unit of the frequency; this information comes from the speed sensor.
5) SLIP VALUE:	This is the difference of speed between the rotating field and the shaft of the motor, expressed in the same unit of the frequency.
6) CURRENT RMS:	Root Mean Square value of the motor current.
7) TEMPERATURE:	The temperature measured on the aluminum heat sink holding the MOSFET devices.
8) MOTOR TEMPERATURE:	This is the temperature of the right motor; if this option is programmed "None" it shows 0°.
9) ACCELERATOR:	The voltage of the accelerator potentiometer's wiper (CPOT). The voltage level is shown on the left-hand side of the console display and the value is in percentage is shown on the right-hand side
10) LIFTING SWITCH:	Status of lifting switch. ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
11) 1st SPEED SWITCH:	ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.

12) 2nd SPEED SWITCH:	ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
13) 3rd SPEED SWITCH:	ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
14) 4th SPEED SWITCH:	ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
15) HRYDRO SPEED REQ.:	ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
16) CUTBACK SWITCH:	ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
17) SEAT SWITCH:	ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
18) VOLTAGE BOOSTER:	This is the booster voltage supplied to the motor in load condition; It is expressed in a percentage of the full voltage.
19) BATTERY VOLTAGE:	Level of the battery voltage measured at the input of the key switch.
20) COS FI:	This is cosj (real time calculated) of the motor.
21) BATTERY CURRENT:	This is the battery current (not measured but calculated.

OTHER HANDSET FUNCTIONS

Save and Restore Function

SAVE and RESTORE function (Cloning) is available using the laptop with the PC Console software. To Save the parameters you select the (RECEIVE button) at the bottom of the parameters screen (not the RECEIVE MENU button). This will receive all the parameters in the control. Now select SAVE from the file pull down menu and name your file. The file will be saved as a .CSV file.

To Restore the parameters to another truck, you select (TX from FILE) from the file pull down menu, then select the .CSV file you just saved. This will Save all the parameters to the new controller.

The Save and Restore functions DOES NOT work using the handset.

SETUP for INSTALLING A NEW CONTROL PANEL

Sequence for AC Traction Controller Setting

When the "Key Switch" is turned ON, if no faults are present, the Zapi Handset Display will be showing the standard Opening Display.

If the controller is not configured to your requirements, follow the sequence detailed below. Remember to cycle the key switch if you make any changes to the controller configuration.

1) Select the options required.

2) Select and set battery voltage.

3) Confirm correct installation of all wires. Use Handset's TESTER function to assist.

4) Perform the accelerator signal acquisition procedure using the Handset "PROGRAM VACC".(See Group 13, Section 4 for programming procedures).

5) Verify “BATTERY VOLTAGE”. Use volt meter to determine voltage between +BT and -B on the controller.

6) Verify the "MAXIMUM CURRENT"

7) Verify the acceleration delay requirements for the truck. Test the parameter setting in both directions.

8) Verify the FREQENCY CREEP level starting from level 0.6 Hz. The truck should just move when the accelerator start switch is closed. Increase the level accordingly.

9) Verify speed reduction.

10) Set Hour Meter to correct hours.

NOTE :

Section 3

CONTROL TROUBLESHOOTING

FAULT CODES FOR ECX/EPX

This is the list of codes that the CLARK dash display may show

Fault Code	Fault Name	Control
1	"NO SEAT SWITCH"	TRACTION
8	"WATCHDOG"	TRACTION
13	"EEPROM KO"	TRACTION
17	"LOGIC FAILURE #3	TRACTION
18	"LOGIC FAILURE #2	TRACTION
19	"LOGIC FAILURE #1	TRACTION
30	"VMN LOW"	TRACTION
31	"VMN HIGH"	TRACTION
36	"INPUT ERROR #1"	TRACTION
37	"CONTACTOR CLOSED"	TRACTION
38	"CONTACTOR OPEN"	TRACTION
53	"STBY I HIGH"	TRACTION
60	"CAPACITOR CHARGE"	TRACTION
61	" HIGH TEMPERATURE"	TRACTION
65	"MOTOR TC START"	TRACTION
66	"BATTERY LOW"	TRACTION
71	"MOTOR SHUTDOWN"	TRACTION
72	"MOTOR LOCKED"	TRACTION
74	"DRIVER SHORTED"	TRACTION
75	"CONTACTOR DRIVER"	TRACTION
76	"COIL SHORTED"	TRACTION
77	"MAINTENANCE HOURS"	TRACTION
78	"VACC NOT OK"	TRACTION
79	"INCORRECT START (SRO)"	TRACTION
80	"FORWARD + REVERSE"	TRACTION
81	"TH MOTOR SENSOR KO"	TRACTION
82	"ENCODER ERROR"	TRACTION
86	"PEDAL WIRE KO"	TRACTION
150	"WATCHDOG"	PUMP
155	"EEPROM KO"	PUMP
160	"LOGIC FAILURE #2"	PUMP
161	"LOGIC FAILURE #1"	PUMP
171	"MOTOR SHUTDOWN"	PUMP
172	"VMN LOW"	PUMP
173	"VMN HIGH"	PUMP

Fault Code	Fault Name	Control
174	"TH MOTOR SENSOR KO"	PUMP
182	"MOTOR LOCKED"	PUMP
195	"STBY I HIGH"	PUMP
196	"THERMIC SENSOR KO"	PUMP
201	"ENCODER ERROR"	PUMP
202	"CAP CHARGE"	PUMP
203	" HIGH TEMPERATURE"	PUMP
204	"VACC NOT OK"	PUMP
205	"INCORRECT START"	PUMP
206	"PEDAL WIRE KO"	PUMP
207	"MOTOR TC START"	PUMP
208	"BATTERY LOW "	PUMP
209	"DRIVER SHORTED"	PUMP
210	"CONTACTOR DRIVER"	PUMP
211	"COIL SHORTED"	PUMP
212	"COIL INTERUPTED"	PUMP
217	"WRONG SET BATTERY"	PUMP
218	"SAFETY"	PUMP
222	"NO CAN MSG"	PUMP
223	"WATING FOR TRAC"	PUMP
224	"SEAT KO"	PUMP
225	"AUX OUTPUT KO"	PUMP
243	"NO CAN MSG 5"	TRACTION
244	"SAFETY KO"	TRACTION
245	"WRONG SET BATTERY"	TRACTION
246	"SAFETY"	TRACTION
247	"NO CAN MSG 4"	TRACTION
248	"CHECKUP NEEDED"	TRACTION
249	"THERMIC SENSOR KO"	TRACTION
251	"WATING FOR NODE"	TRACTION
253	"AUX OUTPUT KO"	TRACTION
255	"HANDBRAKE"	TRACTION
Blank	"DASH DISPLAY"	TRACTION

Fault Code Charts

Fault Code	Fault Name	Fault Description	Control	Troubleshooting	Action Required
1	"NO SEAT SWITCH"	No input from seat switch	TRACTION	• Controller detects the seat switch is open during operation. • Check seat switch wiring and connections • Check for inoperative seat switch.	Repair seat switch wiring Replace seat switch
8	"WATCH-DOG"	Watchdog circuit has been triggered	TRACTION	• It is a self-diagnosing test	
13	"EEPROM KO"	Warning: EEprom fault controller will use default parameters	TRACTION	• Fault in the area of memory in which the adjustment parameters are stored; • This fault does not inhibit truck operation, but the controller will use default parameters. • If fault persists when key is switched OFF and ON again. • If the fault disappears, remember that the parameters stored previously have been cancelled and replaced by the default values.	Replace controller
17	"LOGIC FAILURE #3	Failure in overload protection hardware circuit	TRACTION	• Fault in the hardware section of the logic board that manages the hardware current protection.	Replace controller
18	"LOGIC FAILURE #2	Failure in U,V,W voltage feedback circuit	TRACTION	• Fault in the hardware section of the logic board that manages the phase 's voltage feedback.	Replace controller
19	"LOGIC FAILURE #1	An over voltage or under voltage condition has been detected	TRACTION	• This fault signals that the under voltage / over voltage protection interrupt has been triggered • A real under voltage / over voltage key input (TB1) happened. Voltage has been below 16V • A real over voltage on the power capacitors happened, voltage has been 63V. • Fault in the hardware section of the logic board that manages the over voltage protection. • Possible plugging in or unplugging of battery or charger with the key switch on.	Replace controller

Fault Code	Fault Name	Fault Description	Control	Troubleshooting	Action Required
30	"VMN LOW"	Wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor	TRACTION	• This test is carried out during initial diagnosis and in standby. Possible causes • A real under voltage over voltage situation occurred. • problem with motor connections or the motor power circuit; check if the 3 phases are correctly connected; check if there's chassis ground of the motor to truck frame. • A problem with motor connection or power circuit. • Check if all 3 phases are correctly connected. • Check for short between motor terminal and chassis • Perform diode test • unhook battery at controller and do a diode check between Batt + and Batt - (should read .3 to .5 volts) • Diode test –Disconnect all power and motor leads from control. –Select diode test on your multi meter. –Place positive meter lead on control - Battery terminal place negative meter lead on terminals U,V,W meter should read .3V to .5V if not replace control. –Place negative meter lead on control + Battery terminal place negative meter lead on terminals U,V,W meter should read .3V to .5V if not replace control. –If code presist replace control • Fault in the inverter power section.	Replace controller

Fault Code	Fault Name	Fault Description	Control	Troubleshooting	Action Required
31	"VMN HIGH"	Wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor	TRACTION	• This test is carried out during initial diagnosis and in standby. Possible causes: • Problem with motor connections or the motor power circuit; check if the 3 phases are correctly connected; check if there's chassis ground of the motor to truck frame. • Unhook battery at controller and do a diode check between Batt + and Batt - (should read .3 to .5 volts) • Possible high batteryto the case of the battery • Fault in the controller power section. • Possible bad battery, Excessive voltage to case of battery.	Replace controller
36	"INPUT ERROR #1"	Warning : Seat switch is Open during running	TRACTION	• The seat switch is open with over speed of the " Park Speed Limit " setting.	
37	"CONTACTOR CLOSED"	Line contactor power contact closed at power up	TRACTION	• Before driving the line contactor coil, the controller checks if the line contactor is stuck. The controller drives the bridge for a while, trying to discharge the capacitor bank. If they don't discharge, the fault condition is entered. It is suggested to check the contactor contact, see if it is mechanically stuck.	
38	"CONTACTOR OPEN"	Line contactor power contact does not pull in	TRACTION	• The controller has driven the line contactor, but the contactor did not close. • The wires to the coil are open or a loose connection. • Open fuse or cut cable. • The contact does not pull in properly • Check contactor set voltage.	
53	"STBY I HIGH"	Wrong voltage in current sensor feedback circuit	TRACTION	• The microprocessors verify if the feedback of current sensor device output is within the zero current window. Possible causes of the fault. • Current sensor failure. • Failure in the controller: If the fault persists, replace the power unit.	

Fault Code	Fault Name	Fault Description	Control	Troubleshooting	Action Required
60	"CAPACI-TOR CHARGE"	Power Capacitor Voltage does not increase when the key is turned ON; failure in power section, or in Logic PCB, or in driver PCB, or in the motor TRAC-TION		• When key is switched on, the controller tries to charge the capacitors through a power resistor, and check if the capacitor is charged (1/2 battery volts) within a timeout. If they do not charge, an fault is signaled; the line contactor does not close. • The charging resistor is open • The charging circuit has a failure • There is a problem in the power section. • Possible Motor connection open.	
61	" HIGH TEMPERA-TURE"	Warning: Traction Controller temperature higher that 75 degrees C	TRACTION	• Temperature of control is greater than 75°C. Maximum current reduced proportionally to the temperature increase. At 100°C the maximum current of both controls is reduced to zero.	
65	"MOTOR TC START"	Warning: Right or left or both motors temperature high (over adj #4)	TRACTION	• Drive motors analog temperature sensor is greater than the temperature set in ADJUSTMENT #4 (130°C) in the ADJUSTMET submenu. • When this fault occurs. Maximum current is reduced to half and maximum speed is reduced to 60Hz. • If it happens when the motor is cold, check the wring. If all is ok,	Check temperature shown on handset in tester mode Replace controller
66	"BATTERY LOW"	Warning: Battery charge level below 10%	TRACTION	• When battery level reaches 10% or less or (10% on the dash display), the current level for the drive motors is reduced to 50% of the programmed level and the lift function is locked out.	
71	"MOTOR SHUT-DOWN"	Warning: Motors temp. are very high (over MOTOR SHUT-DOWN param.)	TRACTION	• This fault occurs when the motor temperature switches are open (digital sensor), or if the analog sensor temperature overtakes the cut off level. • The cut off level is adjusted with the MOTOR SHUTDOWN parameter (145°C) in the ADJUSTMENT submenu. • If this fault occurs, maximum current is reduced to zero and the motor is stopped. • If the shutdown occurs when the motor is cold check the wiring. If wiring is ok	Replace controller
72	"MOTOR LOCKED"	Drive motor locked up	TRACTION	• After 15 seconds the motor stalled with maximum current, controller reduces maximum current to 50%. • Check if Line Contactor is pulled in. • Possible bad encoder bearing	

Fault Code	Fault Name	Fault Description	Control	Troubleshooting	Action Required
74	"DRIVER SHORTED"	Line contactor coil driver is shorted	TRACTION	• When the key is turned ON, the microprocessor checks that the line contactor coil driver is not shorted • If it is, this fault is signaled. • Check if there is an external short or low impedance pull-down between NLC (TB8) and -Batt. • If no external causes can be found.	Replace controller
75	"CONTACTOR DRIVER"	Line contactor coil driver is open (not able to drive the coil to the correct voltage)	TRACTION	• When the initial diagnosis is finished, the traction logic closes the line contactor and checks the voltage drain of the driver. • If this is not low, the driver is unable to close and the fault is signaled.	Replace controller
76	"COIL SHORTED"	Init: Line contactor coil driver protection circuit is damaged or Stby or running: short on line contactor TRACTION		• When the key is turned on, the microprocessor checks that the line contactor coil driver short circuit protection hardware If it does not react in a correct way to the microprocessor stimulus, the fault is signaled. • When the fault occurs while the line contactor is closed this, indicates a short circuit across the line contactor coil. check if there is an external short circuit and if the ohmic value (xxx Omhs) of the line contactor coil is correct	Replace contactor coil
77	"MAINTENANCE HOURS"	Displayed when the normal hour meter exceeds the maintenance hours set for the vehicle	TRACTION	• This is just an indication that the vehicle is due for its Periodic Maintenance.	

Fault Code	Fault Name	Fault Description	Control	Troubleshooting	Action Required
78	"VACC NOT OK"	**Warning: Accelerator signal (CPOT) voltage higher than VACC MIN+1V While the traction enable switch is open**	TRACTION	• This fault indicates that the accelerator voltage is 1volt greater than the minimum value programmed by PROGRAM VACC function. • The potentiometer is not correctly calibrated. • The potentiometer is defective. • Use tester mode to check for voltage change when accelerator is depressed, should be approx 1.5volts (0.4~1.9volts accelerator), 2.7volts (0.4~3.1volts accelerator) of change. If not 1.5volts (0.4~1.9volts accelerator), 2.7volts (0.4~3.1volts accelerator) check for wiring shorts, if no shorts, replace accelerator. If accelerator still doesn't change and voltage is greater than 2.0volts (0.4~1.9volts accelerator), 3.2volts (0.4~3.1volts accelerator) replace control.	Replace accelerator
79	"INCORRECT START (SRO)"	**Warning: Wrong traction request sequence This fault indicates an incorrect starting sequence**	TRACTION	• If SRO FUNCTION is active, every time work is stopped the operator must put the truck in neutral. • If forward, reverse or seat switch is active when key switch is turned on. • If forward, reverse closed without seat switch input. • If the fault persist after checking the wiring,	Replace controller
80	"FORWARD + REVERSE"	**Warning: Forward and reverse inputs are both active**	TRACTION	• Processor is continuously checking for a request for forward and reverse at the same time. • Defective wiring. • Running micro switch failure. • Incorrect operation. • If defect persist	Replace controller
81	"TH MOTOR SENSOR KO"	Warning:Motor TractionTraction temperature sensor is out of range	TRACTION	• The range of the motor temperature analog sensor is always checked and a fault is signaled if it's out of range • When this fault occurs. The maximum current is reduced to half and maximum speed is reduced to 60 Hz.	

Fault Code	Fault Name	Fault Description	Control	Troubleshooting	Action Required
82	"ENCODER ERROR"	Motor speed sensor (encoder) does not work properly	TRACTION	• This fault indicates that the frequency supplied the motor is greater that 20 Hz, and the signal feedback from the encoder has a jump higher than 20 Hz in less than ten milliseconds. This condition clearly shows a malfunctioning of the encoder signal. • Check encoder wiring; if no fault is found in the wiring it is necessary to replace the encoder.	
86	"PEDAL WIRE KO"	Fault in Accelerator negative (NPOT) Input circuit. This fault indicates that accelerator wiring (NPOT or PPOT) wire is open.	TRACTION	• Check accelerator wiring and connections for opens • Check accelerator input voltage using PcConsole handset in tester mode (voltage should range from 2.0 VDC to approx. 0.30 VDC). • Check voltage between NPOT (pin A3) Battery Neg. (pin E2) voltage should be greater than 0.30 VDC. This voltage should remain constant all the way through the pedal stroke. • Check if controller input NPOT (A3) is good. Remove pins (A1, A2, A3) from connector, now connect a 4.7K ohm resistor between PPOT (A2) and NPOT (A3) now plug the connector back in, this will polarize NPOT. Now check voltage between (E2) -Batt and (A3) NPOT the reading should be approx. 0.6 VDC	Repair wiring as required If accelerator voltage is greater than 2.0 VDC or less than 0.30 VDC replace accelerator If voltage is not greater than 0.3 VDC proceed to the next step If it sill read 0 VDC the controller has a failed input If it reads correctly 0.6 VDC the problem is in the accelerator or the harness
150	"WATCH-DOG"	Watchdog circuit has been triggered	PUMP	• It is a self-diagnosing test	
155	"EEPROM KO"	**Warning: Eeprom fault controller will use default parameters**	PUMP	• Fault in the area of memory in which the adjustment parameters are stored; this fault does not inhibit truck operation, but the controller will use default parameters. • If defect persists when key is switched OFF and ON again, replace the logic board. If the fault disappears, remember that the parameters stored previously have been cancelled and replaced by the default values.	

Fault Code	Fault Name	Fault Description	Control	Troubleshooting	Action Required
159	"LOGIC FAILURE #3	Failure in overload protection hardware circuit	PUMP	• Fault in the hardware section of the controller that manages the hardware current protection.	Replace controller
160	"LOGIC FAILURE #2	Failure in U,V,W voltage feedback circuit	PUMP	• Fault in the hardware section of the controller that manages the phase 's voltage feedback.	Replace controller
161	"LOGIC FAILURE #1	An over voltage or under voltage condition has been detected	PUMP	• This fault signals that the under voltage / over voltage protection interrupt has been triggered. Two possible reasons: • A real under voltage / over voltage situation happened. • Verify battery setting. • Fault in the hardware section of the controller that manages the over voltage protection. Replace logic Card. • Possible plugging in or unplugging of battery or charger with the key switch on.	Replace controller
171	"MOTOR SHUT-DOWN"	**Warning: Pump motor temp. are very high (over MOTOR SHUT-DOWN param.)**	PUMP	• This fault occurs when the pump motor temperature switches are open (digital sensor), or if the analog sensor temperature overtakes the cut off level. • The cut off level is adjusted with the MOTOR SHUTDOWN parameter (145°C) in the ADJUSTMENT sub-menu. • If this fault occurs, maximum current is reduced to 130 amps needed for steering. • If the shutdown occurs when the motor is cold check the wiring. If wiring is ok replace logic board.	

Fault Code	Fault Name	Fault Description	Control	Troubleshooting	Action Required
172	"VMN LOW"	Wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motorPUMP	PUMP	• This test is carried out during initial diagnosis and in standby. possible causes. • A real under voltage / over voltage situation happened. • Problem with motor connections or the motor power circuit; check if the 3phases are correctly connected; check if there's chassis ground of the motor to truck frame. • A problem with motor connection or power circuit. • Check if all 3 phases are correctly connected. • Check for short between motor terminal and chassis • Perform diode test • Unhook battery at controller and do a diode check between Batt+ and Batt- (should read .3 to .5volts) • Unhook motor cables from controller and do diode test between Batt+ and all three phases, U,V,W. Check between Batt- and all three phases, U,V,W (should read .3 to .5volts) • Diode test –Disconnect all power and motor leads from control. –Select diode test on your multi meter. –Place positive meter lead on control - Battery terminal place negative meter lead on terminals U,V,W meter should read .3V to .5V if not replace control. –Place negative meter lead on control + Battery terminal place negative meter lead on terminals U,V,W meter should read .3V to .5V if not replace control. –If code presist replace contro • Fault in the inverter power section. Fault in the hardware section of the controller that manages the over voltage protection.	Replace controller

Fault Code	Fault Name	Fault Description	Control	Troubleshooting	Action Required
173	"VMN HIGH"	Wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor	PUMP	• This test is carried out during initial diagnosis and in standby. Possible causes: • Problem with motor connections or the motor power circuit; check if the 3 phases are correctly connected; check if there's chassis ground of the motor to truck frame. • unhook battery at controller and do a diode check between Batt + and Batt - (should read .3 to .5 volts) • Possible high battery voltage to the case of the battery. • Fault in the inverter power section. • Possible bad battery, Excessive voltage to case of battery.	Replace controller
174	"TH MOTOR SENSOR KO"	**Warning:Motor Pump temperature sensor is out of range**	PUMP	• The range of the motor temperature analog sensor is always checked and a fault is signaled if it's out of range • When this fault occurs. The maximum current is reduced to half and maximum speed is reduced to 60 Hz.	
182	"MOTOR LOCKED"	Pump motor locked up	PUMP	• After 15 seconds of the motor being stalled with maximum current, controller reduces maximum current to 50%. • Check if pump contactor is pulled in • Possible bad encoder bearing. • Possible bad encoder (sensor bearing).	
195	"STBY I HIGH"	Wrong voltage in current sensor feedback circuit	PUMP	• The microprocessors verify if the feedback of current sensor device output is within the zero current window. Possible causes of the fault; • Current sensor failure. • Failure in the logic card: first replace the logic card; if the fault persist, replace the power unit.	
196	"THERMIC SENSOR KO"	**Warning: Pump temperature sensor is our of range**	PUMP	• The range of the temperature sensor is always checked and a warning is signaled if it is out of range. This fault will reduce the maximum current output of the controller to 50%.	

Fault Code	Fault Name	Fault Description	Control	Troubleshooting	Action Required
201	"ENCODER ERROR"	Motor speed sensor (encoder) does not work properly	PUMP	• This fault indicates that the frequency supplied the motor is greater that 20 Hz, and the signal feedback from the encoder has a jump higher than 20 Hz in less than ten milliseconds. This condition clearly shows a malfunctioning of the encoder signal. Check encoder wiring; if no fault is found in the wiring.	Replace encoder
202	"CAP CHARGE"	Power Capacitor Voltage does not increase when the key is turned ON; failure in power section, or in Logic PCB, or in driver PCB, or in the motor	PUMP	• When key is switched on, the inverter tries to charge the capacitors through a power resistor, and check if the capacitor is charged (1/2 battery volts) within a timeout. If they do not charge, a fault is signaled; the line contactor does not close. • The charging resistor is open • The charging circuit has a failure • There is a problem in the power section. • Possible Motor connection open.	
203	"HIGH TEMPERATURE"	**Warning: Pump Controller temperature higher that 75 degrees C**	PUMP	• Temperature of control is greater than 75°C. Maximum current reduced proportionally to the temperature increase. At 100°C the maximum current of both controls is reduced to zero.	
204	"VACC NOT OK"	**Warning: Lift Sensor siganal (CPOT) voltage higher than VACC MIN+1V While the traction enable switch is open**	PUMP	• This fault indicates that the Lift Sensor voltage is 1volt greater than the minimum value programmed by PROGRAM VACC function. • The potentiometer is not correctly calibrated. • The potentiometer is defective. • Tilt or sideshift switch activated at startup.	Reset VACC Replace VACC
205	"INCORRECT START"	**Warning: Wrong Hydraulic request sequence PUMP**	PUMP	• This fault indicates an incorrect starting sequence. • Lift, Tilt, AUX1, AUX2 or enable switch failure • Error in sequence made by operator. • Incorrect wiring. • If the fault persist after checking the wiring, • Pot partially activated at startup	Replace controller

Fault Code	Fault Name	Fault Description	Control	Troubleshooting	Action Required
206	"PEDAL WIRE KO"	Fault in Accelerator negative (NPOT) Input circuit.	PUMP	• Check accelerator wiring and connections for opens • Check accelerator input voltage using PcConsole handset in tester mode (voltage should range from xx VDC to approx. xx VDC).	
207	"MOTOR TC START"	**Warning: Pump motors temperature high**	PUMP	• Pump motor analog temperature sensor is greater than the temperature set in ADJUSTMENT #4 (130°C) in the ADJUSTMET submenu. • When this fault occurs, current goes down to IMX PROTECTION value and motor rpm begins to decrease. Motor current and speed decrease linearly as the temperature increases until MOTORSHUTDOWN is reached. • If it happens when the motor is cold, check the wring. If all is ok,,	Check temperature shown on handset in tester mode Replace controller
208	"BATTERY LOW "	**Warning: Battery charge level below 10%**	PUMP	• When battery level reaches 10% or less, the current level for the drive motors is reduced to 50% of the programmed level	
209	"DRIVER SHORTED"	Line contactor coil driver is shorted	PUMP	• When the key is turned on, the microprocessor checks that the line contactor coil driver is not shorted; If it is, this fault is signaled. Check if there is an external short or low impedance pull-down between NLC (TB8) and Batt- If no external causes can be found.	Replace controller
210	"CONTACTOR DRIVER"	Line contactor coil driver is open (not able to drive the coil to the correct voltage)	PUMP	• When the initial diagnosis is finished, the controller closes the line contactor and checks the voltage drain of the driver. If this is not low, the driver is unable to close and the fault is signaled.	Replace controller
211	"COIL SHORTED"	Init: Line contactor and EB coil driver protection circuit is damaged or Stby or running: short on line contactor or EB coil	PUMP	• When the key is turned on, the microprocessor checks that the line contactor coil driver short circuit protection hardware If it does not react in a correct way to the micro processor stimulus, the fault is signaled. When the fault that occurs while the line contactor is closed this indicates a short circuit across the line contactor coil. check if there is an external short circuit and if the ohmic value (xxx Omhs) of the line contactor coil is correct	

Fault Code	Fault Name	Fault Description	Control	Troubleshooting	Action Required
212	"COIL INTER-UPTED"	Brake coil open	PUMP	• Check for open wiring to the brake coil.	Repair wiring
217	"WRONG SET BAT-TERY"	Battery voltage does not corre-spond to pro-grammed "SET BATTERY"	PUMP	• This fault indicates that actual battery voltage is 20% higher or 20% lower than "SET BATTERY" parameter setting. Replace battery with correct battery.	
218	"SAFETY"	Input B5 is not connected to Batt-	PUMP	• Check that the jumper is in place between B5 and B11. See wiring dia-gram.	
222	"NO CAN MSG"	Pump has lost Can communication with Traction	PUMP	• This Fault is present in combi Systems (traction + Pump). The traction has detected a fault and has informed the pump controller through the can-bus line. The pump is waiting for the trac-tion ok. The fault must be looked for in the traction controller or can-bus circuit.	
223	"WAITING FOR TRAC"	Pump is waiting for cummunica-tion from the trac-tion	PUMP	• This alarm is present in combi Systems (traction + Pump). The traction has detected a faulure has informed the pump inverter through the can-bus line. The pump is waiting for the traction ok. The faulure must be looked for in the traction inverter.	
225	"SEAT KO"	Seat input read by traction is differ-ent than seat input read by pump	PUMP	• Check seat switch wiring at TB4 and PB4 • May be problem with CAN BUS com-munications.	
225	"AUX OUT-PUT KO"	EB coil driver shorted or open	PUMP	• The microprocessor checks the driver of the electromechanical brake coil. If the status of the driver output does not cor-respond to the signal coming from the microprocessor, the fault is signaled.	
243	"NO CAN MSG 5"	Traction has lost Can communica-tion with Pump	TRACTION	• Traction (node #2) signals that it has lost communication with the Pump (node #5) This fault could be determined to be a problem in the truck CAN-BUS line or be an internal problem in the controller logic card. First check the CAN_BUS connections.	
244	"SAFETY KO"	Alarm: Pump safety input is open	TRACTION	• Check wiring pin B5 is connected to pin B11 on the pump control. • No jumper for pin B5 to pin B11 on the traction control.	

Fault Code	Fault Name	Fault Description	Control	Troubleshooting	Action Required
245	"WRONG SET BATTERY"	Battery voltage does not correspond to programmed "SET BATTERY"	TRACTION	• This fault indicates that actual battery voltage is 20% higher or 20% lower than "SET BATTERY" parameter setting. Replace battery with correct battery.	
246	"SAFETY"	Alarm: Pump safety input is open	TRACTION	• Check jumper pin B5 to pin B11 on the pump. • No jumper for pin B5 to pin B11 on the traction control.	
249	"THERMIC SENSOR KO"	**Warning: Traction temperature sensor is our of range**	TRACTION	• The range of the temperature sensor is always checked and a warning is signaled if it is out of range. This fault will reduce the maximum current output of the controller to 50%.	
251	"WAITING FOR NODE"	**Traction is waiting for communication from the pump**	TRACTION	• This alarm is present in combi systems (traction + pump). The traction has detected a failure has informed the pump inverter through the can-bus line. The pump is waiting for the traction ok. The failure must be looked for in the traction inverter.	
253	"AUX OUTPUT KO"	EB coil driver shorted or open	TRACTION	• The microprocessor checks the driver of the electromechanical brake coil. If the status of the driver output does not correspond to the signal coming from the microprocessor, the fault is signaled. It is suggested to check for an external short or a low impedance pull-down between NAUX (C31) and -Batt. • If no external cause is found	Replace controller
255	"HANDBRAKE"	Handbrake switch closed	TRACTION	• Indicate that handbrake is activated • Check wiring and handbrake switch.	Repair wiring or replace switch if needed
Blank	"DASH DISPLAY"	Dash Display blank	TRACTION	• Check 5 volt power supply for dash display If no 5 volts • Check wiring and connector at control and display. If not wiring or connections	Replace 5 V power supply Replace dash display

NOTE :

Section 4

ECX/EPX Factory Control Settings

Parameters in White are customer preference adjustable.

Parameters in Orange are factory preset and not adjustable.

ECX Factory Control Settings

AC3 TRACTION	
Name	Scaled Value
PARAMETER CHANGE	36V/48V
ACCELER. DELAY	LEVEL = 3
RELEASE BRAKING	LEVEL = 3
INVERS. BRAKING	LEVEL = 6
PEDAL BRAKING	LEVEL = 9
SPEED LIMIT BRK.	LEVEL = 0
BRAKE CUTBACK	LEVEL = 0
MAX SPEED FORW	100Hz / 120 Hz
MAX SPEED BACK	100Hz / 120 Hz
CUTBACK SPEED 1	100%
CUTBACK SPEED 2	70%
CURVE CUTBACK	55%
FREQUENCY CREEP	1.20 Hz
MAXIMUM CURRENT	LEVEL = 9
AUXILIARY TIME	4
AUX TIME #1	11
ACC. SMOOTH	2.5
INV. SMOOTH	1.0
STOP SMOOTH	20Hz
SET OPTION	36V/48V
HOUR COUNTER	RUNNING
BATTERY CHECK	ON
CUTBACK MODE	ABSENT
HYDRO KEY ON	OFF
STOP ON RAMP	OFF
AUX OUTPUT #1	HYDRO CONTACTOR
PEDAL BRAKING	DIGITAL
SET TEMPERATURE	ANALOG
EXTENDED DISPLAY	ON
SET MODEL	36V/48V
CONNECTED TO	TRACTION

AC3 TRACTION	
Name	Scaled Value
ADJUSTMENTS	36V/48V
SET POT BRK MIN	0.5 V
SET POT BRK MAX	4.5 V
SET BATTERY TYPE	36V / 48V
ADJUST BATTERY	
THROTTLE 0 ZONE	3%
THROTTLE X POINT	63%
THROTTLE Y POINT	36%
ADJUSTMENT #04	130 ℃
MOTOR SHUTDOWN	145 ℃
ADJUSTMENT #02	LEVEL = 3
ADJUSTMENT #01	LEVEL = 5
ADJUSTMENT #03	10%
MAINTEN. RESET	OFF
MAINTENANCE	NONE
MAINTENANCE TIME	250
1X10000 HOURS	0
1X1000 HOURS	0
1X100 HOURS	0
1X10 HOURS	0
1X1 HOURS	0
DISP. GEAR RATIO	54(ECX), 55(EPX20/25), 58(EPX30/32)

AC3 PUMP	
Name	Scaled Value
PARAMETER CHANGE	36V/48V
ACCELER. DELAY	LEVEL = 0
DECELER. DELAY	LEVEL = 0
ACC. DELAY TILT	LEVEL = 3
DEC. DELAY TILT	LEVEL = 0
ACC. DELAY AUX1	LEVEL = 0
DEC. DELAY AUX1	LEVEL = 0
ACC. DELAY AUX2	LEVEL = 0
DEC. DELAY AUX2	LEVEL = 0
MAX SPEED UP	100Hz/130 Hz
MIN SPEED UP	16.50 Hz
CUTBACK SPEED	100%
1ST SPEED FINE	40 Hz
2ND SPEED FINE	40 Hz
3RD SPEED FINE	50 Hz
4TH SPEED FINE	50 Hz
HYD SPEED FINE	22 Hz
IDLE SPEED	12 Hz
IDLE TIME	LEVEL = 5
MAXIMUM CURRENT	LEVEL = 9
AUXILIARY TIME	4
SET OPTION	36V/48V
HOUR COUNTER	RUNNING
SET TEMPERATURE	ANALOG
HYDRO FUNCTION	RUNNING
THERM PROTECTION	OFF
SET MODEL	36V/48V
CONNECTED TO	PUMP
ADJUSTMENTS	36V/48V
SET BATTERY TYPE	36V / 48V
ADJUST BATTERY	
THROTTLE 0 ZONE	3%
THROTTLE X POINT	63%
THROTTLE Y POINT	36%
ADJUSTMENT #04	130 ℃
MOTOR SHUTDOWN	145 ℃
IMAX PROTECTION	100%
ADJUSTMENT #03	55 ℃
FAN MOTOR TEMP.	60 ℃

NOTE

All motors must be stopped before saving parameters, parameters may not be stored to the EEFROM if motor is running.

EPX Factory Control Settings

AC3 TRACTION	
Name	**Scaled Value**
PARAMETER CHANGE	36V/48V
ACCELER. DELAY	LEVEL = 6
RELEASE BRAKING	LEVEL = 1
INVERS. BRAKING	LEVEL = 5
PEDAL BRAKING	LEVEL = 8
SPEED LIMIT BRK.	LEVEL = 0
BRAKE CUTBACK	LEVEL = 0
MAX SPEED FORW	100Hz
MAX SPEED BACK	100Hz
CUTBACK SPEED 1	100%
CUTBACK SPEED 2	70%
CURVE CUTBACK	55%
FREQUENCY CREEP	1.20 Hz
MAXIMUM CURRENT	LEVEL = 9
AUXILIARY TIME	4
AUX TIME #1	2
ACC. SMOOTH	2.5
INV. SMOOTH	1.0
STOP SMOOTH	20Hz
SET OPTION	36V/48V
HOUR COUNTER	RUNNING
BATTERY CHECK	ON
CUTBACK MODE	ABSENT
HYDRO KEY ON	OFF
STOP ON RAMP	OFF
AUX OUTPUT #1	HYDRO CONTACTOR
PEDAL BRAKING	DIGITAL
SET TEMPERATURE	ANALOG
EXTENDED DISPLAY	ON
SET MODEL	36V/48V
CONNECTED TO	TRACTION
ADJUSTMENTS	36V/48V
SET POT BRK MIN	0.5 V
SET POT BRK MAX	4.5 V
SET BATTERY TYPE	48V
ADJUST BATTERY	
THROTTLE 0 ZONE	3%
THROTTLE X POINT	63%

AC3 TRACTION	
Name	**Scaled Value**
THROTTLE Y POINT	36%
ADJUSTMENT #04	130 ℃
MOTOR SHUTDOWN	145 ℃
ADJUSTMENT #02	LEVEL = 3
ADJUSTMENT #01	LEVEL = 5
ADJUSTMENT #03	10%
MAINTEN. RESET	OFF
MAINTENANCE	NONE
MAINTENANCE TIME	250
1X10000 HOURS	0
1X1000 HOURS	0
1X100 HOURS	0
1X10 HOURS	0
1X1 HOURS	0
DISP. GEAR RATIO	55(EPX20/25), 58(EPX30/32)

AC3 PUMP	
Name	Scaled Value
PARAMETER CHANGE	36V/48V
ACCELER. DELAY	LEVEL = 0
DECELER. DELAY	LEVEL = 0
ACC. DELAY TILT	LEVEL = 0
DEC. DELAY TILT	LEVEL = 0
ACC. DELAY AUX1	LEVEL = 0
DEC. DELAY AUX1	LEVEL = 0
ACC. DELAY AUX2	LEVEL = 0
DEC. DELAY AUX2	LEVEL = 0
MAX SPEED UP	115 Hz
MIN SPEED UP	16.50 Hz
CUTBACK SPEED	70%
1ST SPEED FINE	40 Hz
2ND SPEED FINE	40 Hz
3RD SPEED FINE	50 Hz
4TH SPEED FINE	50 Hz
HYD SPEED FINE	24 Hz
IDLE SPEED	12 Hz
IDLE TIME	LEVEL = 5
MAXIMUM CURRENT	LEVEL = 9
AUXILIARY TIME	4
SET OPTION	36V/48V
HOUR COUNTER	RUNNING
SET TEMPERATURE	ANALOG
HYDRO FUNCTION	RUNNING
THERM PROTECTION	OFF
SET MODEL	36V/48V
CONNECTED TO	PUMP
ADJUSTMENTS	36V/48V
SET BATTERY TYPE	48V
ADJUST BATTERY	
THROTTLE 0 ZONE	3%
THROTTLE X POINT	63%
THROTTLE Y POINT	36%
ADJUSTMENT #04	130 ℃
MOTOR SHUTDOWN	145 ℃
IMAX PROTECTION	100%
ADJUSTMENT #03	55 ℃
FAN MOTOR TEMP.	60 ℃

NOTE

All motors must be stopped before saving parameters, parameters may not be stored to the EEFROM if motor is running.

ECX Frequency Setting versus Top Speed

Speed-Empty (MPH)	Motor Speed (RPM)	Frequency (Hz)	Speed-Loaded (MPH)
1.00	296	10	0.98
2.00	592	20	1.95
3.00	887	30	2.93
4.00	1183	39	3.90
5.00	1479	49	4.88
6.00	1775	59	5.8
7.00	2071	69	6.83
8.00	2366	79	7.80
9.00	2662	89	8.78
10.00	2958	99	9.76
10.25	3032	101	10.00
10.50	3106	104	10.24
10.75	3180	106	10.49
11.00	3254	108	10.73
11.25	3328	111	10.98
11.50	3402	113	11.22
11.75	3476	116	11.46
12.00	3550	118	11.71

Notes : Above analysis assumes motor is capable of achieving required speed.

NOTE :

Section 5

OPERATION

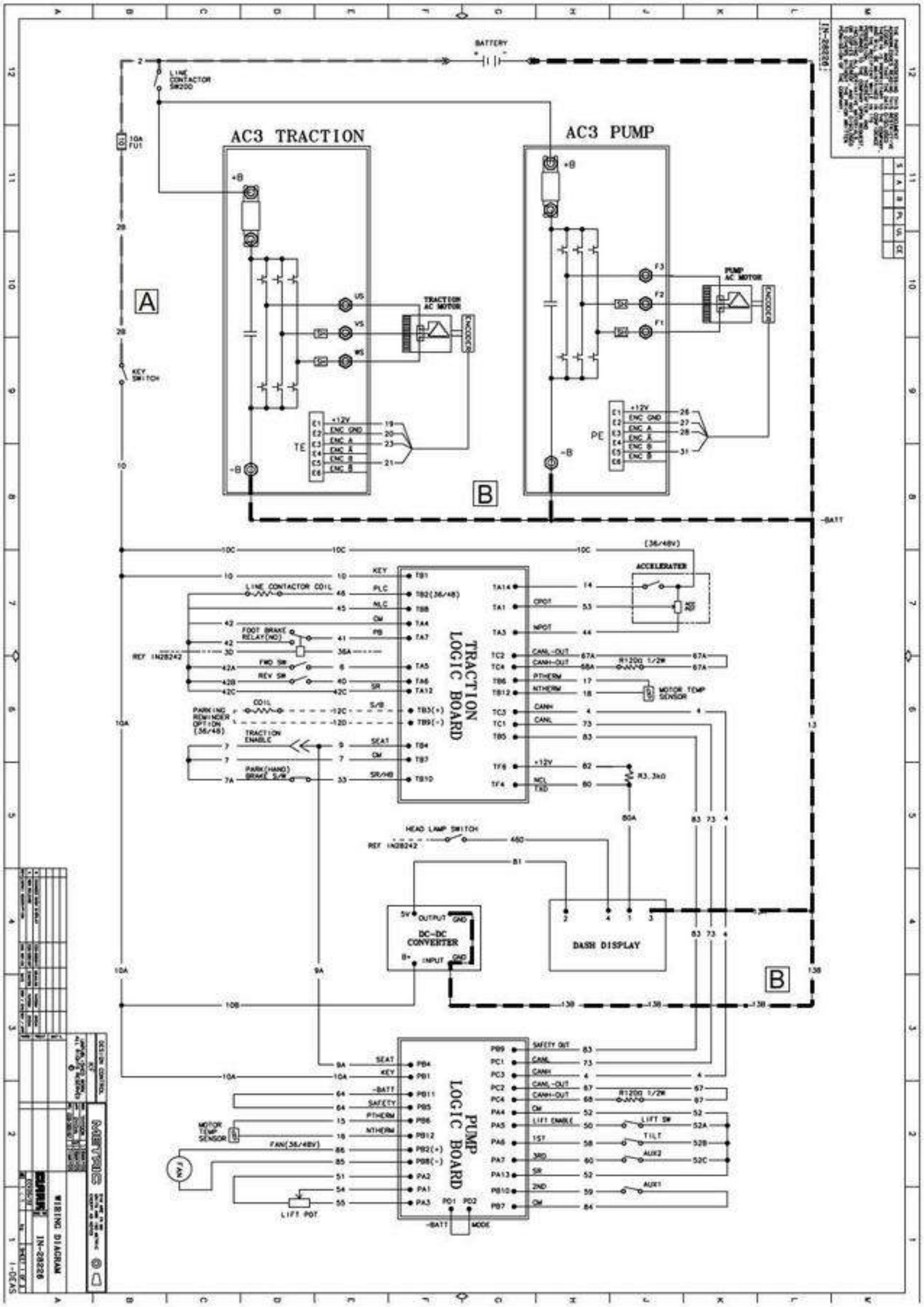
OPERATION 1

Connect the Battery

A. Battery Positive will be supplied to the key switch (COM).
B. Battery Negative is connected to the dash display at terminal 3, the GND terminal of the 5 volt converter and to the AC controllers at the B- terminals.

Voltages Present:

A. Battery volts at wire #2, at the + terminal.
B. 0 volts (battery Negative)


AC3 TRACTION
AC3 PUMP
BATTERY
LINE CONTACTOR SM200
KEY SWITCH
TRACTION AC MOTOR
PUMP AC MOTOR
ENCODER
TRACTION LOGIC BOARD
PUMP LOGIC BOARD
ACCELERATOR
DC-DC CONVERTER
DASH DISPLAY
HEAD LAMP SWITCH
MOTOR TEMP SENSOR
LIFT POT
WIRING DIAGRAM
IN-28226

OPERATION 1 (Continued)

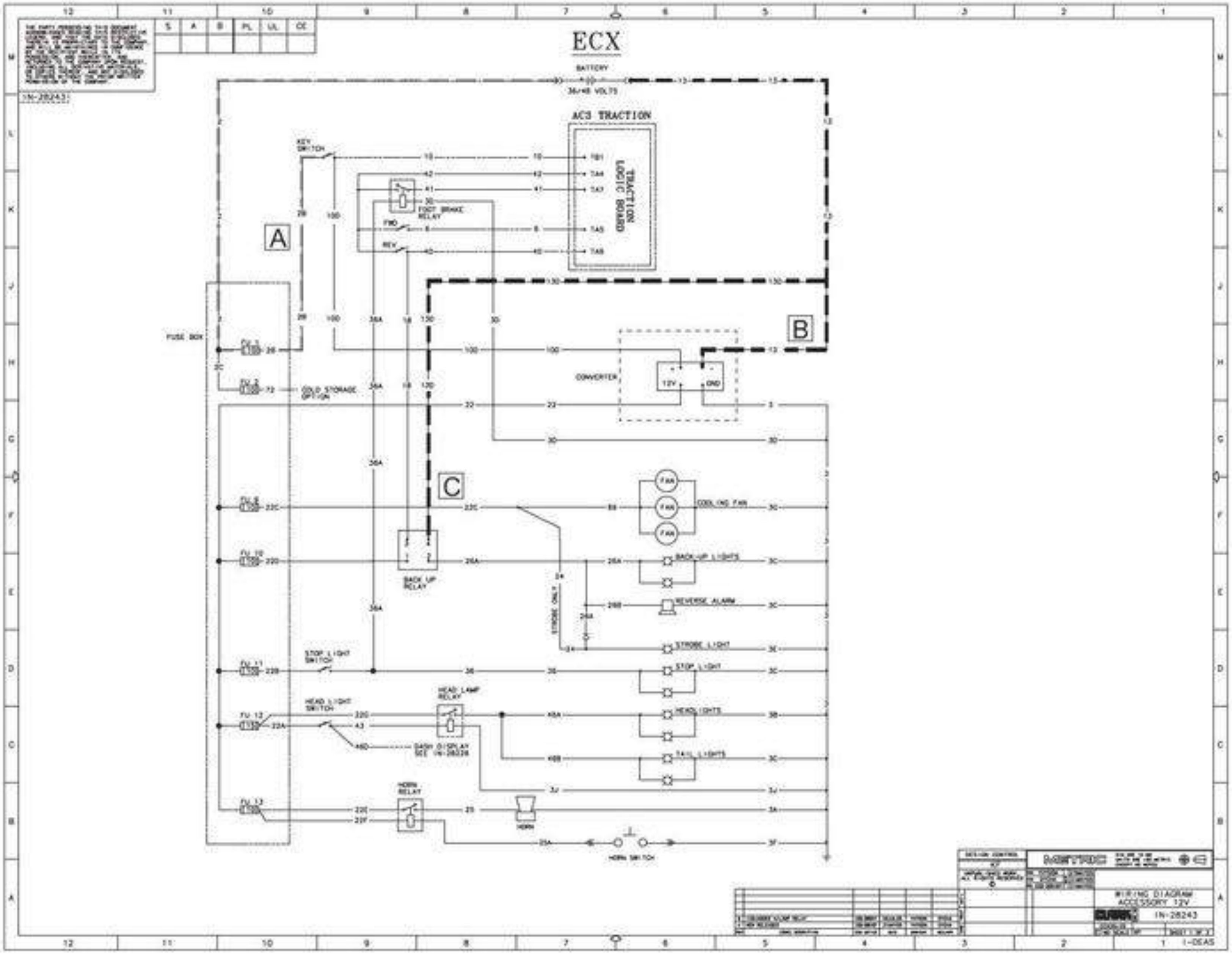
Connect the Battery

A. Battery Positive will be supplied to the key switch (COM).
B. Battery Negative is connected to the - terminal of the 12 volt converter completing the circuit.
C. Battery Negative is connected to terminal 4 of the Backup Relay.

Voltages Present:

Sequence of Operation ?

A. Battery volts at wire #2 at the + terminal
B. 0 volts (battery Negative)
C. 0 volts (battery Negative)


ECX
BATTERY
36/48 VOLTS
ACS TRACTION
TRACTION LOGIC BOARD
KEY SWITCH
FOOT BRAKE RELAY
FWD
REV
A
B
C
FUSE BOX
COLD STORAGE OPTION
CONVERTER
12V
GND
COOLING FAN
BACK UP RELAY
BACK-UP LIGHTS
REVERSE ALARM
STROBE ONLY
STROBE LIGHT
STOP LIGHT SWITCH
STOP LIGHT
HEAD LIGHT SWITCH
HEAD LAMP RELAY
HEADLIGHTS
TAIL LIGHTS
DASH DISPLAY SEE 1N-28226
HORN RELAY
HORN
HORN SWITCH
WIRING DIAGRAM ACCESSORY 12V
1N-28243

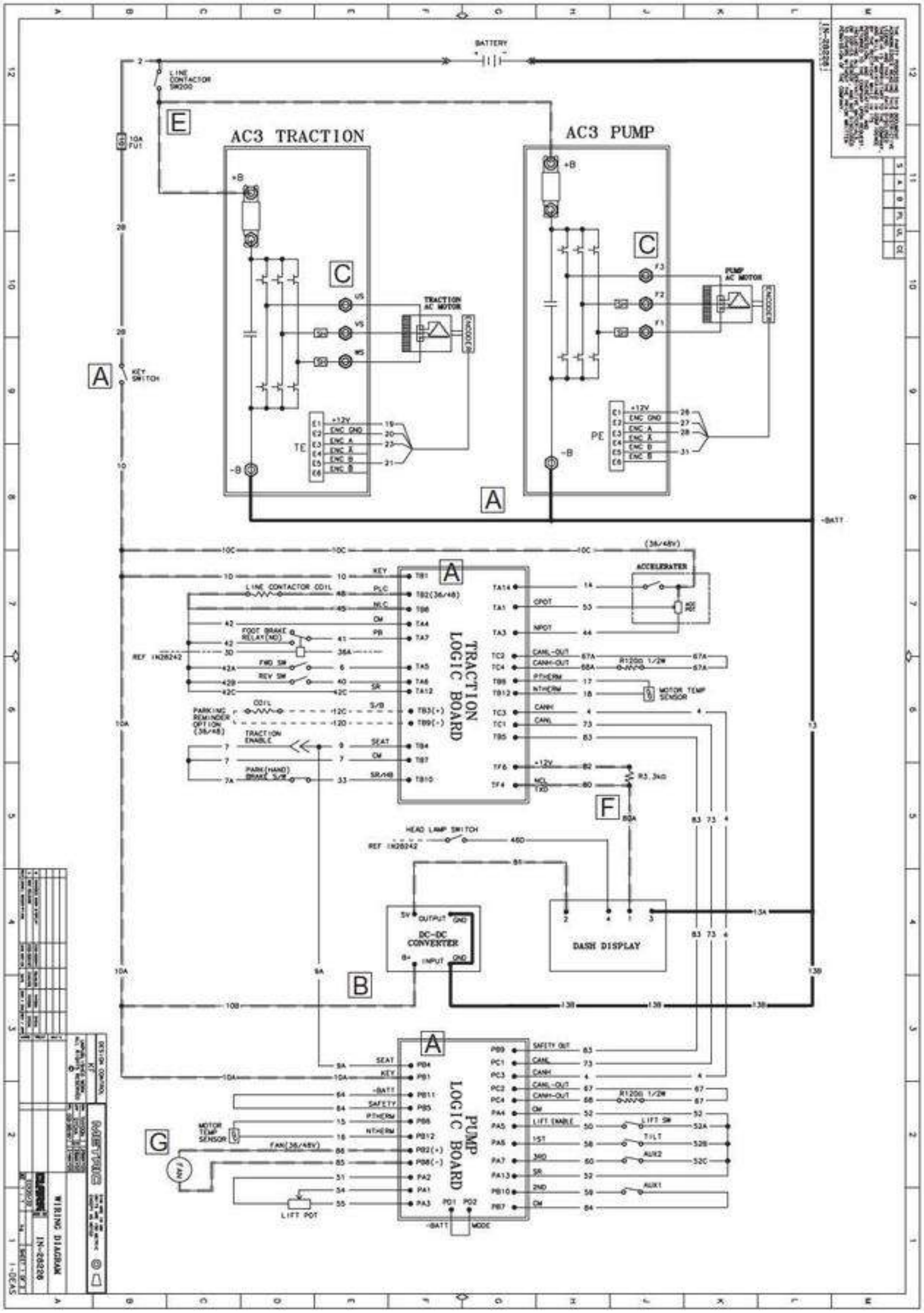
OPERATION 2

Closing the Key Switch

A. Closing the key switch will provide Battery Positive via the #10 wire to the traction control at terminal TB1, and to the pump control at terminal PB1. Battery positive is also supplied to the accelerator control. Battery Negative is supplied to the traction and pump controls at terminal.
B. Closing the key switch will provide battery positive to the 5volt converter. The converter will provide a 5volt signal to the dash display via the #81 wire to terminal 2.
C. The Traction Control and the Pump Control, through an internal circuit, will pre-charge the internal capacitors.
D. When the traction control capacitors have charged to a preset value, the traction control will supply battery positive voltage to the Line contactor at terminal TB2, wire #46, and battery negative at terminal TB8, wire #45.
E. The Line Contactors will be energized and will close the normally open contacts providing battery positive through the cables to the +B terminals.
F. The traction control will supply a 12 volt signal from terminal TF6, wire #82 to terminal TF4, wire #80 and to the dash display, terminal 1 via wire #80A.
G. The Pump Control will supply Battery Positive Voltage to the Pump Motor FAN at terminal PB2, wire #86, and Battery negative at terminal PB8, wire #85.

Voltages Present:

A. Battery volts
B. Battery volts
C. 80% Battery volts (not measurable)
D. Battery Positive at wires #46 and #66. Battery Negative at wires #45 and #65.
E. Battery Positive.
F. 12 volts
G. Battery Positive at wire #86, Battery Negative at wire #85.


BATTERY
LINE CONTACTOR SM200
AC3 TRACTION
AC3 PUMP
TRACTION AC MOTOR
PUMP AC MOTOR
ENCODER
KEY SWITCH
TRACTION LOGIC BOARD
PUMP LOGIC BOARD
ACCELERATOR
DC-DC CONVERTER
DASH DISPLAY
HEAD LAMP SWITCH
LIFT POT
MOTOR TEMP SENSOR
WIRING DIAGRAM
IN-28226

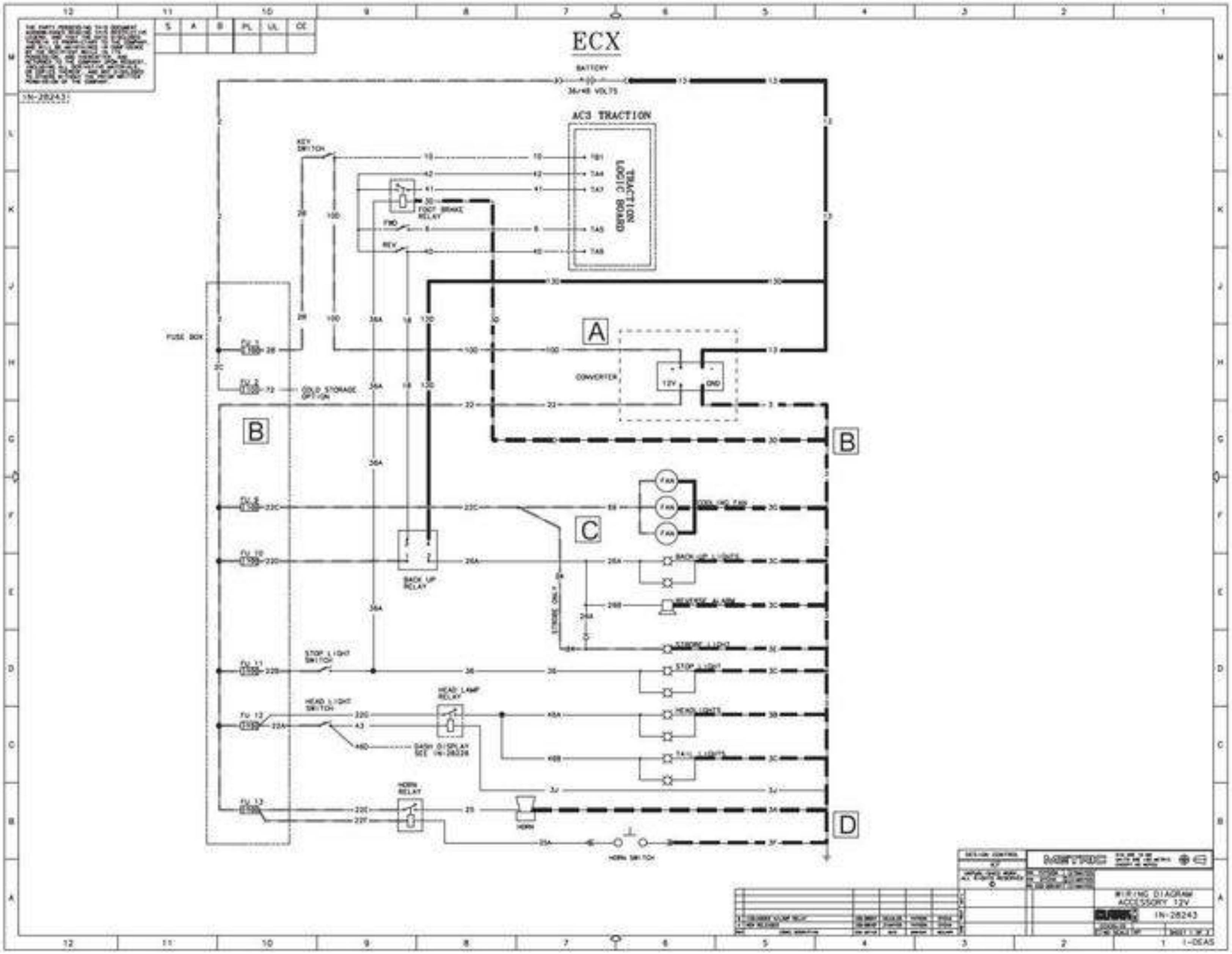
OPERATION 2 (Continued)

Closing the Key Switch

A. Closing the key switch will provide Battery Positive via the #10 wire to the 12v-converter completing the circuit.
B. The converter will provide a 12 volt output to the accessory circuit the converter negative is connected to the frame of truck as is all 12 volt accessories completing the negative circuit.
C. 12 volt positive will be supplied to the cooling fans. 12 volt positive will also be supplied to the strobe light, if equipped, via wire #24.
D. The 12 volt circuit is completed from the fans and strobe by grounding to the frame of the truck.

Voltages Present:

A. Battery positive
B. 12 volts Between terminal #22 and the frame of the truck.
C. 12 volts
D. 0 volts (Ground)


ECX
BATTERY
36/48 VOLTS
ACS TRACTION
TRACTION LOGIC BOARD
KEY SWITCH
FOOT BRAKE RELAY
FWD
REV
FUSE BOX
CONVERTER
12V
GND
COLD STORAGE OPTION
A
B
C
D
FAN
BACK UP RELAY
BACK UP LIGHTS
REVERSE ALARM
STROBE ONLY
STROBE LIGHT
STOP LIGHT SWITCH
STOP LIGHT
HEAD LIGHT SWITCH
HEAD LAMP RELAY
HEAD LIGHTS
TAIL LIGHTS
DASH DISPLAY
HORN RELAY
HORN
HORN SWITCH
WIRING DIAGRAM
ACCESSORY 12V
IN-28243
I-DEAS

OPERATION 3

System Checks

A. The traction control will supply a battery positive voltage at terminal TA4, wire #42, #7 to the directional, brake, parking brake and seat switches.
B. The control monitors the voltage at terminals TA5, TA6, TA7, TA12, TB4 and TB10 for proper switch closing in performing the SRO checks.
C. The pump control will supply a battery positive voltage at terminal PA4, PA7, wire #52, to the hydraulic valve switches.
D. The pump control monitors the voltage at terminals PA5, PA6, PA7, PB10 and PA13 for switch closure.

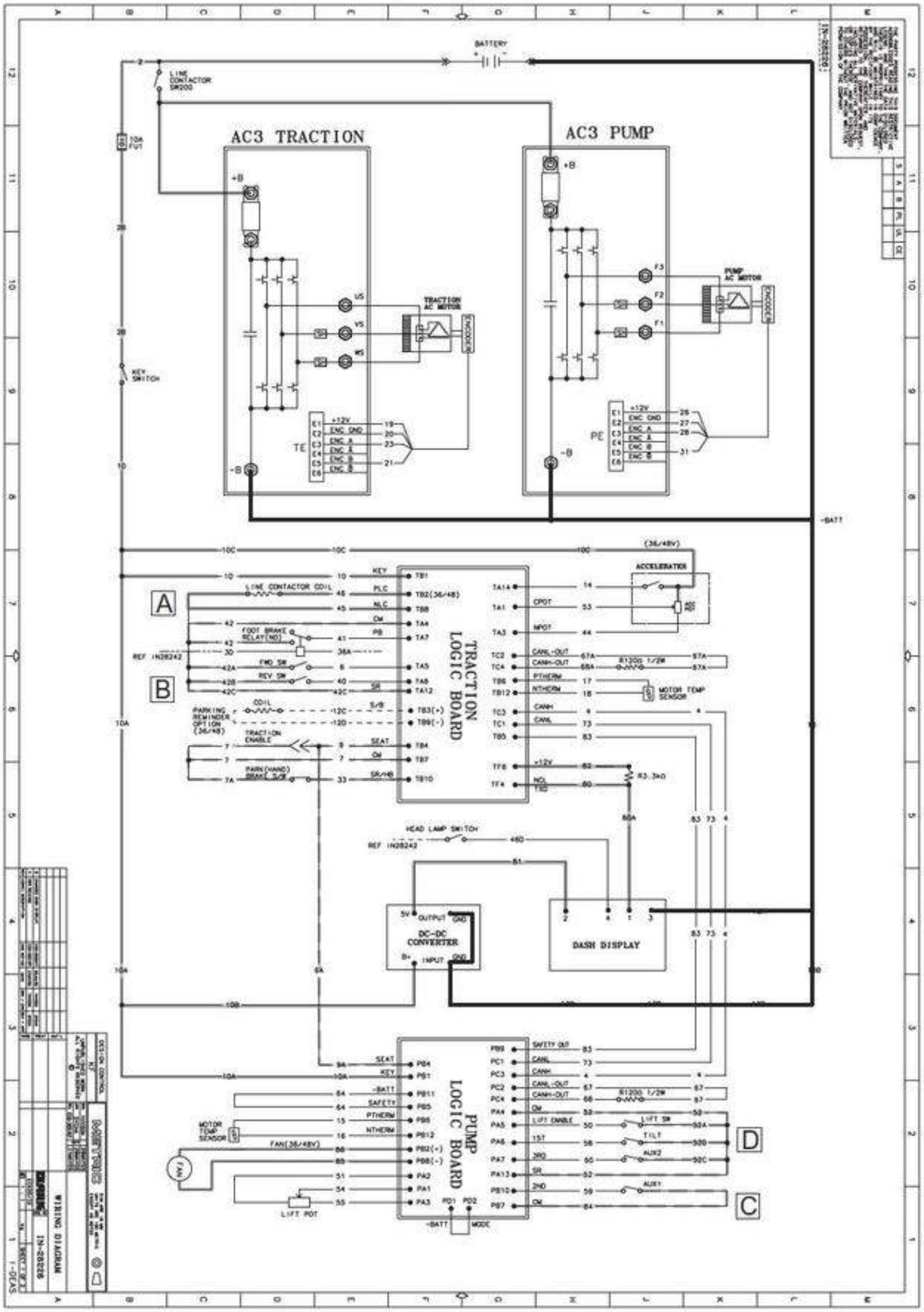
Voltages Present:

A. Battery volts.
B. 0 volts at terminals TA5, TA6, TA7 with switches open. Battery volts at terminal TB10 with parking brake applied.
C. Battery volts at terminals PA4 and PB7.
D. 0 volts at terminals PA5, PA6, PA7, PB10 with the hydraulic levers in neutral position, switches open.

SRO Explanation:

The ECX/EPX truck incorporates a seat switch for traction and pump control operation. The seat switch must be closed before trying to travel or using any of the hydraulic functions.

If either the forward or reverse directional control switches are closed before the seat switch is closed or the parking brake switch is opened, the drive motors will not operate. If the seat switch is opened or the parking brake switch is closed during truck operation for more than 3 seconds, the control will shut down and the directional lever will need to be cycled through neutral before restarting.


AC3 TRACTION
AC3 PUMP
BATTERY
LINE CONTACTOR SM200
KEY SWITCH
TRACTION AC MOTOR
PUMP AC MOTOR
ENCODER
TRACTION LOGIC BOARD
PUMP LOGIC BOARD
DC-DC CONVERTER
DASH DISPLAY
ACCELERATOR
HEAD LAMP SWITCH
LIFT POT
WIRING DIAGRAM
A
B
C
D

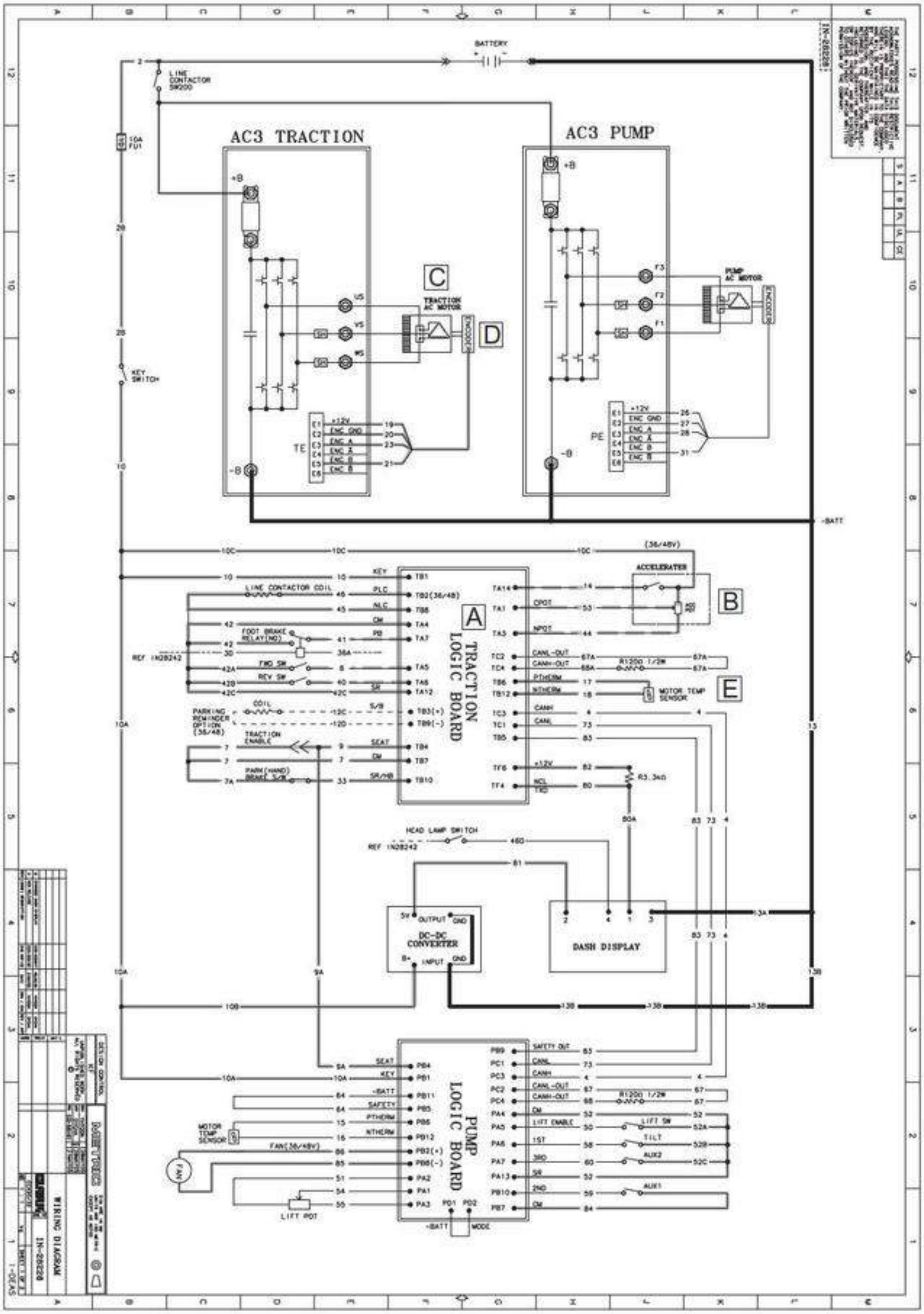
OPERATION 4

Traction System

A. Setting on the seat will close the seat switch. Disengaging the parking brake will open the parking brake switch. Placing the directional lever in forward or reverse will close the respective switch.
B. Depressing the accelerator slightly will close the 1 MS switch. Further depression of the accelerator pedal will move the inductor within the accelerator decreasing the output voltage from the accelerator to the traction control at terminal TA1.
C. When the traction control is signaled with the proper switch closures in the proper order, and it receives the signal from the accelerator control, it will start turning the transistors on and off within the control to provide an Alternating Current (AC) to the drive motor. As the accelerator input voltage decreases, the pulsing of the control and the speed of the motor will increase.
D. The encoder bearings within the drive signal the traction of the speed of the motor and help control the pulsing.
E. The thermostat within the motor will increase in resistance when it reaches a specific temperature and signal the traction control that the motor is running hot and the control will reduce the maximum current that the motor can draw.

Voltages Present:

A. Battery volts when the respective switches are closed
B. Battery volts at terminal TA14, wire #14 with 1 MS switch closed.
   Approximately 4.2 volts at terminal TA1, wire 53 with accelerator in the raised position and dropping to about 0.5 volts as the accelerator is depressed to the floor. 0 volts on terminal TA3, wire #44.
C. NA
D. NA


AC3 TRACTION
AC3 PUMP
BATTERY
TRACTION LOGIC BOARD
PUMP LOGIC BOARD
DC-DC CONVERTER
DASH DISPLAY
WIRING DIAGRAM

OPERATION 5

Pump Control System

A. When the traction control has received the proper switch closures in the proper order and a directional control switch has been closed, the traction control will signal the pump control, via the can-bus system, terminals TC3, wire #4, and terminal TC1, wire #73, to the pump control terminals PC3 and PC1, to start pulsing the pump motor with AC voltage to run the motor at a very slow speed.

B. When a hydraulic valve lever is moved it actuates a switch, closing the contacts and providing an input voltage to the pump control at terminals PA5, PA6, PA7 and/or PB10.

C. If the lift lever is pulled back it will also move the transducer plunger and start to decrease the input voltage to the pump control at terminal PE1, wire #54. With the lift switch closed, the reduction in input voltage at terminal PE1 will signal the control to start increasing the pulsing to the pump motor increasing the speed of the motor. The further the lever is pulled backward, the faster the motor will run.

D. A circuit is available for future options to disable the increase of speed of the pump control, other than steering speed, by placing a switch in this loop circuit.

E. When the pump control receives the proper switch input signals, it will start turning the transistors on and off producing an AC voltage to the pump motor to start running.

F. The encoder bearing in the pump motor signals the pump control with the speed of the pump motor to help control the speed and current requirements of the motor.

G. The thermostat within the pump motor will increase in resistance when it reaches a specific temperature and signal the pump control that the motor is running hot and the control will reduce the maximum current that the motor can draw.

Voltages Present:

A. NA

B. Battery volts at terminal PA13 and PA4, wire #52. Battery volts at terminal PA5, PA6, PA7, and PB10 when corresponding switches are closed.

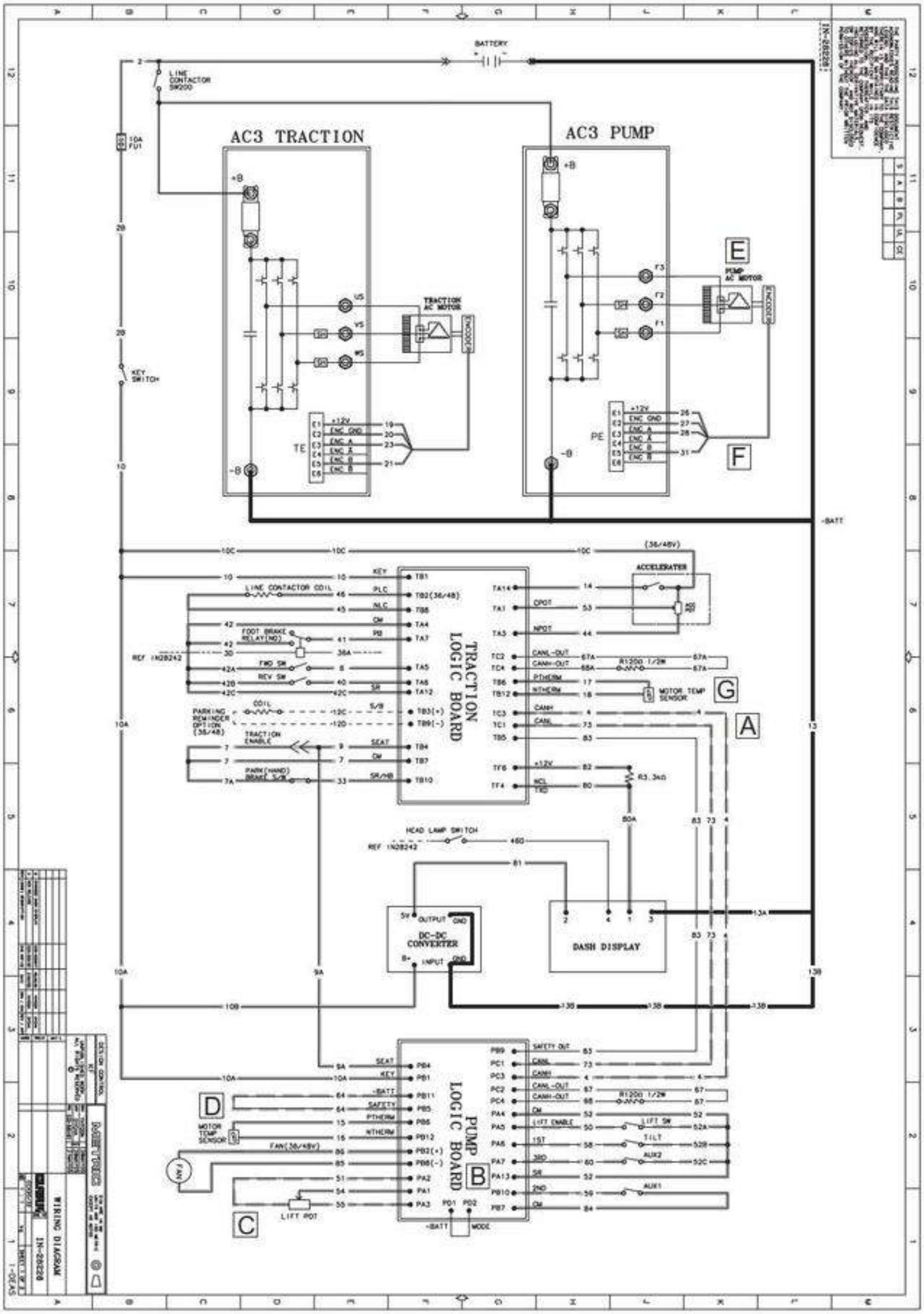
C. 12 volts at terminal PA2, wire #51. Battery negative at terminal PA3, wire #55. Around 5 volts at terminal PA1, wire #54 with lift lever in neutral position, less than 0.5 volts with lift lever pulled fully back.

D. Battery volts at terminal PB5 and PB11, wire #64.

E. NA

F. NA

G. NA


BATTERY
LINE CONTACTOR SW200
10A FU1
KEY SWITCH
AC3 TRACTION
AC3 PUMP
TRACTION AC MOTOR
PUMP AC MOTOR
ENCODER
TE
PE
E
F
G
A
B
C
D
-BATT
ACCELERATER
TRACTION LOGIC BOARD
PUMP LOGIC BOARD
MOTOR TEMP SENSOR
HEAD LAMP SWITCH
DC-DC CONVERTER
DASH DISPLAY
LIFT POT
LIFT SW
TILT
AUX2
AUX1
WIRING DIAGRAM
1N-28228

OPERATION 6

Accessories

A. When the directional lever is placed into Reverse, closing the reverse switch, battery positive is supplied via the #18 wire to terminal 3 of the Back Up Relay. Terminal 4 of the relay is connected to battery negative through the #13 wire.

B. With battery positive on terminal 3 and battery negative at terminal 4 of the electronic relay, the relay will complete the connection between terminals 1 and 2, thus completing the 12 volt positive circuit to the back up alarm and lights, if equipped.

C. The 12 volt circuit is completed from the 12 volt accessories via wire #3 connected to the frame of the truck.

D. Depressing the brake pedal will close the Stop Light Switch points completing the 12 volt positive circuit to the stop lights and foot brake relay will be engaged.

E. Closing the Head Light switch on the dash will supply 12 volts positive to the headlights if so equipped.

G. The horn is operated by pushing the horn button which will supply battery voltage to the horn through horn relay (wire #25), and to negative through wire#3.

Voltages Present:

A. Battery volts between terminals 3 & 4.

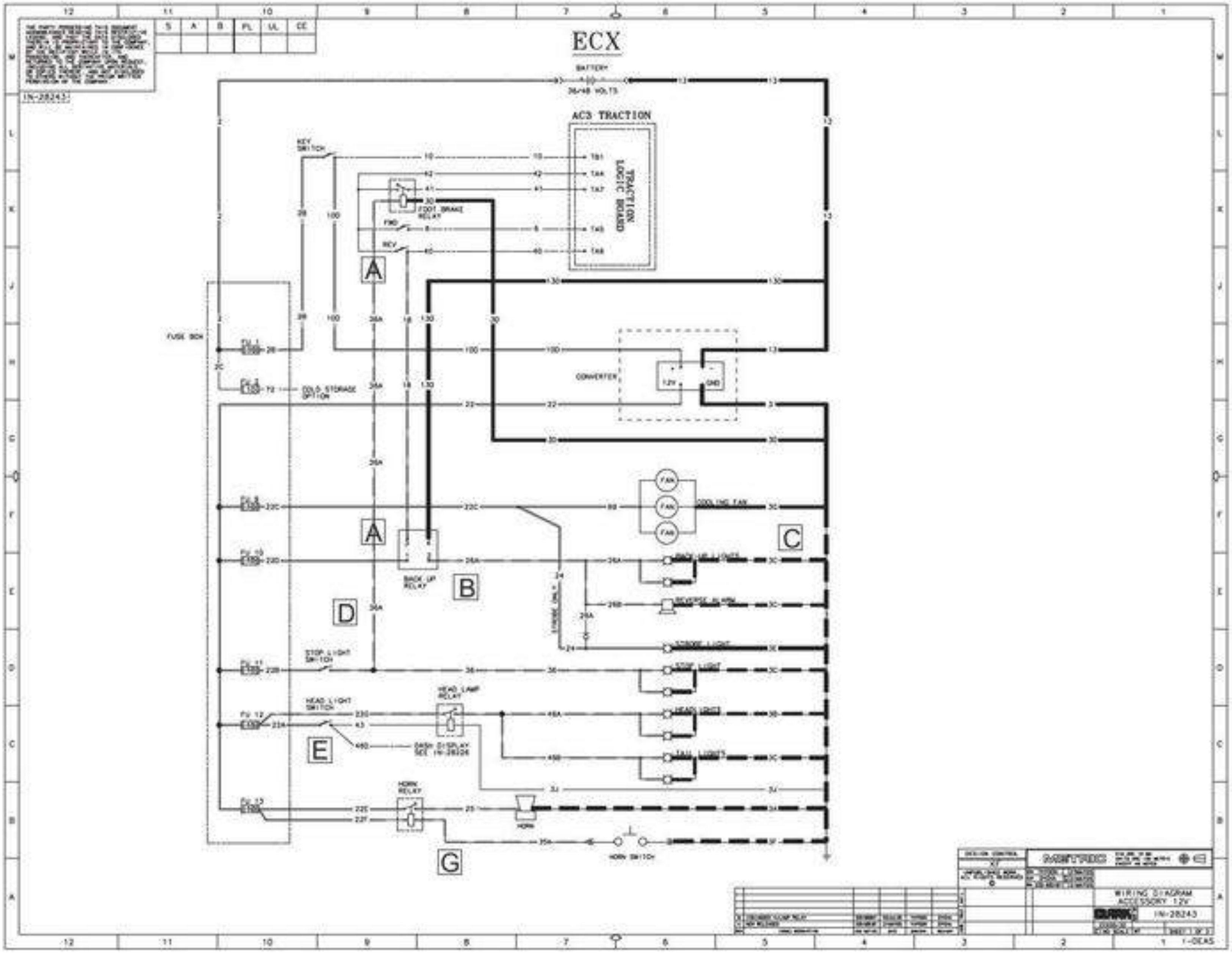
B. 12 volts at terminal 2.

C. 0 volts (Ground).

D. 12 volts on wires #22 and #36.

E. 12 volts on wires #22 and #46.

G. 12 volts on wires #25 and #3.


ECX
BATTERY
36/48 VOLTS
AC3 TRACTION
TRACTION LOGIC BOARD
KEY SWITCH
FOOT BRAKE RELAY
FWD
REV
A
FUSE BOX
COLD STORAGE OPTION
CONVERTER
12V
GND
COOLING FAN
FAN
A
C
BACK UP RELAY
B
BACK UP LIGHTS
REVERSE ALARM
D
STROBE ONLY
STROBE LIGHT
STOP LIGHT SWITCH
STOP LIGHT
HEAD LIGHT SWITCH
HEAD LAMP RELAY
HEAD LIGHTS
E
DASH DISPLAY
TAIL LIGHTS
HORN RELAY
HORN
HORN SWITCH
G
IN-28243
WIRING DIAGRAM ACCESSORY 12V

NOTE :

GROUP 20

DRIVE AXLE

NOTE :

Section 1

Drive Axle Specifications and Description

Specifications

General Specifications

- Speeds: Infinitely variable, forward and reverse.
- Ring and Pinion Gear Type: Spiral bevel.
- Differential Type: Ring and pinion
- Fluid Capacity: 6.5 L (6.87 qts).
- Drive Axle Fluid: Transmission Fluid, Clark Part Number 2776236.

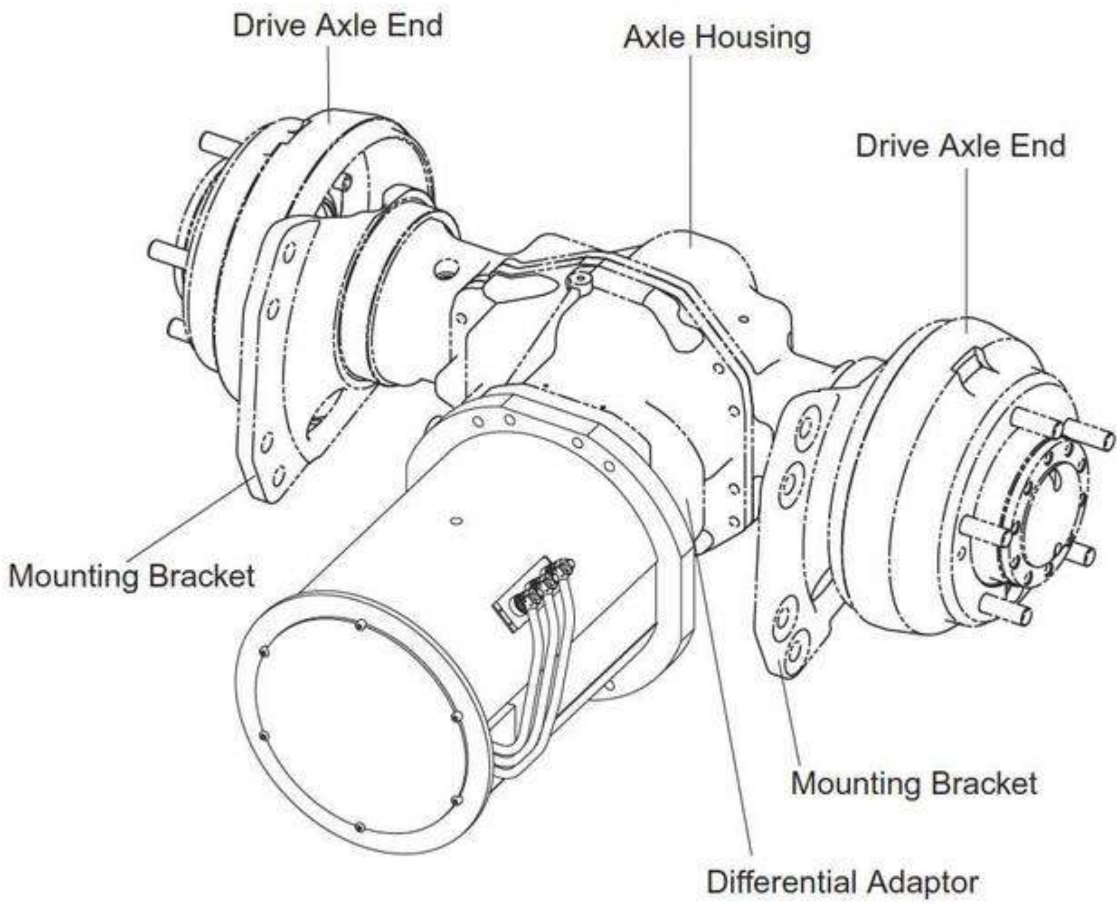
Torque Specifications

- Drive Motor-to-Adaptor and Differential Housing Fasteners: Apply Loctite 242 to clean degreased fastener threads and sequence tighten every fifth fastener around circle until all eight fasteners are tightened to 70-80 N.m (52-59 lbf-ft).
- Axle End Assembly-to-Differential Housing Bolts 90- 110 N.m (66-81 lbf-ft).
- Ring Gear-to-Diff Case Fasteners: 205-250 N·m (151-185 lbf-ft).
- Adaptor to Diff Case: 60-65 N·m (44-48 lbf-ft).
- Hub Bearing Retaining Nut: Tighten until bearings bind slightly in rotation. Back off nut 1/8 turn and install locking washer and lock nut.
- Pinion Shaft Nut: 270-340 N·m (200-250 lbf-ft)
- Differential Case to Axle Housing Fasteners: 68-79 N·m (50-58 lb-ft)
- Axle Mounting Bracket-to-Frame Fasteners: 450-500 N·m (332-369 lbf-ft).
- Front Wheel-to-Axle Fasteners: 300-370 N·m (225-275 lbf-ft).

Service Intervals

- Replace drive axle oil every 2000 operating hours.

Locations



Description

Drive Motor

The drive motor is dual voltage rated at 36 or 48 volts. The drive motor is three-phase AC motor with class F insulation. The motor does not use brushes and the motor is totally enclosed, minimizing the service requirements. The motor is mounted directly to the differential adaptor.

Differential Adaptor

The axle adaptor is located between the drive motor and differential housing and serves as a transition mounting componet.

Drive Axle

The axle housing encloses the differential and contains the axle shafts. The axle shaft ends spline into the differential side gears. The rotation of this differential case drives the differential side gears and pinions, which drives the two axle shafts at the differential rate needed for cornering.

The axle shafts drive hub assemblies mounted at the ends of the axle housing on opposed tapered roller bearings. A brake shoe assembly is mounted behind each hub on the axle end and acts on a brake drum that bolts to and encloses the hub.

NOTE :

Section 2

Drive Axle Troubleshooting

Troubleshooting Techniques

The following information serves as an aid to isolating problems in a drive axle that is not functioning correctly.

When troubleshooting a drive axle problem, keep in mind that the drive axle is only the central unit of a group of related power train components. Proper operation of the drive axle depends on the condition and correct functioning of the other related components. Therefore, to properly diagnose a suspected problem in the drive axle, consider the drive axle fluid, drive axle assembly, controls, and drive motor as a complete system.

To identify and correct a drive axle fault, refer to the description in Section 1, along with symptoms and causes indicated below.

Inspection and overhaul of the suspect components is described in various locations within this group.

Symptoms and Causes

The following lists typical drive axle troubles and possible causes.

Truck Won't Move in Either Direction

- Battery disconnected.
- Park brake on.
- Check electrical control system. See Group 19.
- Check directional control switches. See Group 13.
- Check contactors. See Group 17.
- Check drive motor. See Group 16.

Truck Moves Only in Forward or Only in Reverse

- Check electrical control system. See Group 19.
- Check contactors. See Group 17.
- Check directional control switch. See Group 13.

Overheating

- Low or contaminated fluid level.
- Truck travel function being loaded excessively.
- Worn bearings.
- Check drive motor for air flow or damage. See Group 16.
- Brakes Dragging. See Group 23.

Loss of Power

- Low battery charge.
- Drive axle bearings worn or seized.
- Overheating - See Overheating above.

Section 3

Drive Axle Removal and Installation

Drive Axle Removal

⚠ CAUTION

Park truck safely before beginning work:

1. **Park truck on a hard, level and solid surface, such as a concrete floor with no gaps or breaks.**
2. **Put upright in vertical position and fully lower the forks or attachment.**
3. **Put all controls in neutral. Turn key switch OFF and remove key.**
4. **Apply the park brake and block the wheels.**
5. **Disconnect the battery.**
6. **Discharge capacitor.**

1. Remove upright. SeeUpright Removal, Group 34, for procedures.

⚠ CAUTION

Place a BLOCK UNDER THE COUNTERWEIGHT to prevent tip-back when the drive axle is removed.

Make sure any lifting equipment, including sling, chain, hoist, or eyebolt, is of sufficient capacity and is safety inspected and approved.

2. Lift and block front of truck frame. Remove front wheels, brake lines and fittings and motor cables.
3. Place a rolling transmission jack under the axle housing and raise jack until it contacts the axle housing.
4. Remove the four drive axle mounting bolts from each side of truck. Lower the jack slightly and slowly pull the drive axle assembly from the truck.
5. Remove drive motor. See Drive Motor Removal, Group 16, for procedures.

Drive Axle Installation

1. All mounting surfaces must be clean and free of paint before assembly.
2. Install drive motor. See Drive Motor Installation, Group 16, for procedures.
3. Position drive axle with mounting brackets on rolling transmission jack. Slowly roll drive axle assembly under truck and raise slightly to align mounting bracket holes with frame holes. Install mounting bolts and tighten to the following torquing procedure:

A. Fastener, holes and all mating surfaces must be unlubricated.

B. Impact wrenches to be used only to snug up fasteners. (Approx. 204 N·m, 150 lbf-ft).

C. Torque measuring wrench must be used to obtain final torque values.

D. Wrench rotation from snug to final torque, not to be more than 1/4 turn. Final torque450-500N·m (332-369 lbf-ft).

4. Install motor cables, brake fittings and lines. Install front wheels and tighten nuts to 300-370 N·m (225-275 lbf-ft).
5. Install upright. See Upright Installation, Group 34, for procedures.
6. Fill axle with transmission fluid part number 2776236.
7. Bleed brake system before operating truck. Refer to Group 23 for bleeding procedure.

Section 4

Drive Axle Overhaul and general Practices

General Practices

The following procedures should be applied throughout the process of disassembling, inspecting, cleaning, repairing, installing, and assembling drive axle components.

Specific disassembly and assembly procedures are given later in this section. Follow those procedures closely.

Disassembling Components

Before disassembling the drive axle, you must drain the drive axle fluid, disconnect the necessary hydraulic lines, and **remove the drive axle from** the truck as described in Section 3. Observe the following practices during disassembly:

- **Cleanliness -Work** in a clean place. It is important that no dirt or foreign material enters the unit during repairs. Dirt is an abrasive and can damage bearings. Always clean the outside of the unit before starting the planned disassembly.
- **Assemblies** - When disassembling the various assemblies lay all parts on a clean bench in the same sequence as removed. This procedure will simplify assembly and reduce the possibility of losing parts.
- **Using Tools to Move Parts** - Always apply force to shafts, bearings, housings, etc., with restraint. Movement of some parts is restricted. Never apply force to the part being driven after it stops solidly. The use of soft hammers, bars, and mauls for all disassembly work is recommended.
- **Bearings** - Remove bearings that will be reused with pullers designed for this purpose. Lubricate bearings with clean oil and wrap them in a lint-free cloth or clean paper to protect them while not in use.
- **Snap Rings** - Remove snap rings with pliers designed for this purpose. Snap rings removed in this manner can be reused if they are not sprung or loose in the groove.

Cleaning Parts

WARNING

Gasoline is NOT an acceptable cleaning solvent because of its extreme combustibility. It is unsafe in the workshop environment.

- Proper cleaning requires complete disassembly.
- Wash steel parts with machined surfaces in a commercial solvent.
- Clean the inside and outside of bearing caps, housings, etc. Cast parts which do not have machined or polished surfaces may be cleaned in hot solution.
- Wash castings or other rough parts in solvent, or clean in hot solution tanks using mild alkali solutions, heating parts thoroughly before rinsing.

NOTE

Do not use rags to dry parts with rough surfaces, such as castings.

- Rinse all parts thoroughly. Dry immediately with clean rags, except for parts with rough surfaces. Lightly oil parts and wrap them in corrosion-resistant paper if they will not be used immediately. Store parts in a clean, dry place.
- Clean bearings thoroughly in clean, approved solvent until completely cleaned. Dry bearings using moisture-free compressed air. Be careful to direct air stream across bearing to avoid spinning. Lubricate bearings with clean oil and wrap them in a lint-free cloth or clean paper to protect them until installation.
- Do not spin bearings when drying them. Bearings may be rotated slowly by hand to facilitate drying.

Inspecting Parts

Closely inspect all drive axle components after cleaning and before assembly to determine whether they require replacement.

Careful and complete inspection of all parts is very important. Replacement of all parts showing indication of wear, overstressing, or damage will save time and money at a later date.

Inspect:

- Steel parts for notches, visible steps or grooves. Look for scuffing, deformation, or discoloration related to improper lubrication.
- Bearing balls, cages or retainers, rollers, and raceways for pitting, discoloration, and spalled areas.

- Gear teeth for signs of excessive wear, pitting, or cracking along contact lines. Check tooth contact pattern.
- Machined surfaces of cast or malleable parts for cracks, scoring, and wear. Look for elongation of drilled holes, wear on machined surfaces, and nicks or burrs in mating surfaces.
- Fasteners for rounded heads, bends, cracks, or damaged threads.

IMPORTANT

Any damage that affects the alignment or structural integrity of the housing requires replacement. Repair by welding or straightening should not be attempted. Such processes can affect the housing metallurgy and cause it to fail completely when under load.

- All housings for cracks or leaks, loose studs, or cross-threaded holes.

Repairing and Replacing Parts

Replace lower-cost parts such as thrust washers, seals, etc., that protect the drive axle from premature wear and do not add greatly to the cost of rebuild.

Replace heavily worn but unbroken parts.

Steel parts such as shafts or gears are not repairable. If worn or damaged, replace them, along with mating parts as necessary.

Seals and washers should be routinely replaced. Fasteners with self-locking patches may be reused if secured with several drops of Heavy Duty Threadlocker (Clark P/N 1802302).

Drive axle housing repairs are limited to removal of nicks or burrs on machined surfaces or replacement of damaged studs.

Since the cost of a new part is generally a small fraction of the total cost of downtime and labor, avoid reusing a questionable part which could lead to additional repairs and expense soon after initial assembly. To aid in determining the reuse or replacement of any drive axle part, also consider the unit's history, hours of use, application, etc.

When replacement is necessary, use only genuine Clark parts to assure continued performance and extended life from your unit.

Recommended inspection procedures for various types of parts are as follows:

Bearings

- Replace bearings that are pitted, discolored, or spalled. Always replace bearing cups and cones as a set. Do not replace a bearing or race separately.
- Replace bearings with excessive clearances.
- Check bearing fits. Bearing inner races should fit tight to the shaft; outer races slightly tight to slightly loose in housing bore. If bearing spins freely in bore, however, housing should be replaced.

Gears and Shafts

- Check gear teeth for frosting and pitting. Frosting of gear tooth faces presents no threat of transmission failure. Often in continued operation of the unit, frosted gears will "heal" and not progress to the pitting stage. And in most cases, gears with light to moderately pitted teeth have considerable gear life remaining and can be reused. But gears with advanced-stage pitting should be replaced.
- If the Magnaflux process is available, use it to check parts for damage.
- If gear teeth show areas where the case-hardening is worn through or cracked, the gear must be replaced.
- Inspect all shafts to be sure they are not bent or cracked and that splines are not damaged.

Splines

- Check splines on all shafts and gears for abnormal wear. If splines are severely worn or pitted, replace the specific part affected.

O-Rings and Gaskets

- Replace all O-rings at overhaul.
- Replace all gaskets at overhaul.
- O-rings and seals should be lubricated with transmission fluid before assembly.

Oil Seals

- Replace all oil seals at overhaul.
- Use extra care when installing seals. Seal lips and sealing surfaces can be easily nicked and damaged, thereby destroying the sealing ability.

Housings

- Check all housings for damage, cracks, and wear. Replace damaged housings as needed.
- Gasket sealing surfaces should be clean and free of nicks and burrs.

Threaded Fasteners and Snap Rings

- Inspect all fasteners for damage and wear. Replace all damaged fasteners.
- Snap rings are to be installed with flat side away from load. Replace any damaged or suspect snap rings.

Assembling Components

These practices should be followed during assembly:

- **Cleanliness -** Be sure that interiors of all housings are clean. It is important that dirt and other foreign materials be kept out of the drive axle during assembly. Dirt is an abrasive and can damage polished surfaces of bearings and washers.
- **Removing Burrs -** Make sure all lead-in chambers for oil seals, piston ring grooves, and O-rings are smooth and free from burrs. Inspect at assembly.
- **Initial Lubrication of Parts -** Apply light coating of transmission fluid, Clark part number 2776236.
- **Use of Sealing Compounds and Threadlockers -** Use only where specified.

  Make sure there is no excess or loose sealing compound or threadlocker that could enter the oil system. Threads should be clean and dry before application of thread compound.
- **Gaskets -** Be sure all gaskets are installed. An omission of any gasket can result in oil leakage.
- **Capscrews and Threaded Fasteners -** Use only threaded fasteners of the correct part number and material specification. Replace all fasteners that have a questionable condition. Threads should be clean and dry before application of thread compound. Apply lubricant or thread compound only as specified. Be sure all fasteners are installed (none omitted) and torqued to the correct specification.
- **Bearings -** Use of the proper bearing installation tool is recommended for the installation of bearings. The proper tool applies equal force to both bearing races, preventing damage to balls/rollers and races while maintaining correct bearing alignment with bore and shaft. Avoid using a tubular or sleeve-type driver whenever possible.
- **Torque Recommendations -** Correct torque application is extremely important to assure long drive axle life and dependable performance. Over-tightening or under-tightening can result in a loose installation and, in many instances, eventually cause damage to drive axle gears, shafts, and/or bearings. Use a torque wrench whenever possible to attain recommended torque ratings. Torque recommendations are given in this section with the specific assembly procedures.
- **Tool Reference -** Some repair procedures in this manual may show the use of specialized tools. Their use is recommended as they make drive axle repair easier, faster, and prevent costly damage to critical parts.

  But for the most part, ordinary mechanic's tools such as socket wrenches, screwdrivers, etc., and other standard shop items such as a press, mauls, and soft bars are all that is needed to successfully disassemble and assemble the drive axle.

IMPORTANT

Refer to the appropriate Customer Service Parts Book for the correct service replacement parts to be used during assembly of the drive axle.

Overhaul Procedures

Overhaul involves following the general practices given earlier in this Section and performing the specific procedures given in the remainder of this Section.

Please read the general practices before proceeding.

NOTICE

Cleanliness is of extreme importance in the repair and overhaul of this assembly.

Perform all disassembly and assembly work in a clean area. Overhaul the transaxle only in a clean, dust-free location, using clean tools and equipment. Dirt or grit will damage the highly-machined surfaces and result in premature failure of components. The exterior surface of the unit must be thoroughly cleaned of all dirt and foreign substances to prevent contamination of the parts during overhaul. Protect all components from dust and dirt while repairs are being made. Be sure the work area is kept clean.

Drive Axle Disassembly

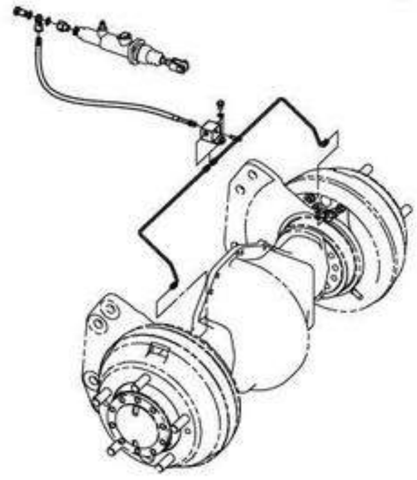
NOTICE

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

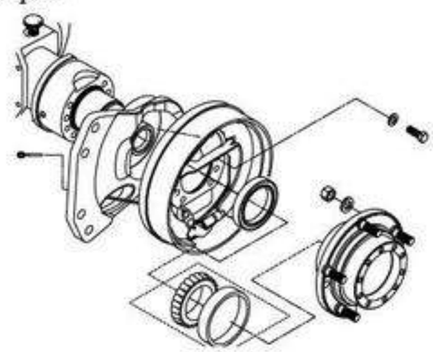
Disassembling Drive Axle

Use a chain hoist to lift the drive axle and place on a suitable table or bench. Position in its in normal orientation. Place wood blocks under the differential case so that it will not move as components are removed.

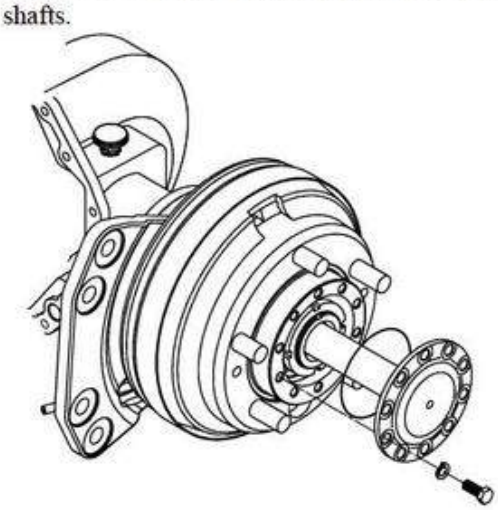
1. If the drive axle was not previously drained, remove **the drain plug** and drain the oil.
2. Disconnect **brake line fittings** at brake backing plates. Remove bolt that holds **brake line tee** to differential. Lift tee and connected lines away.



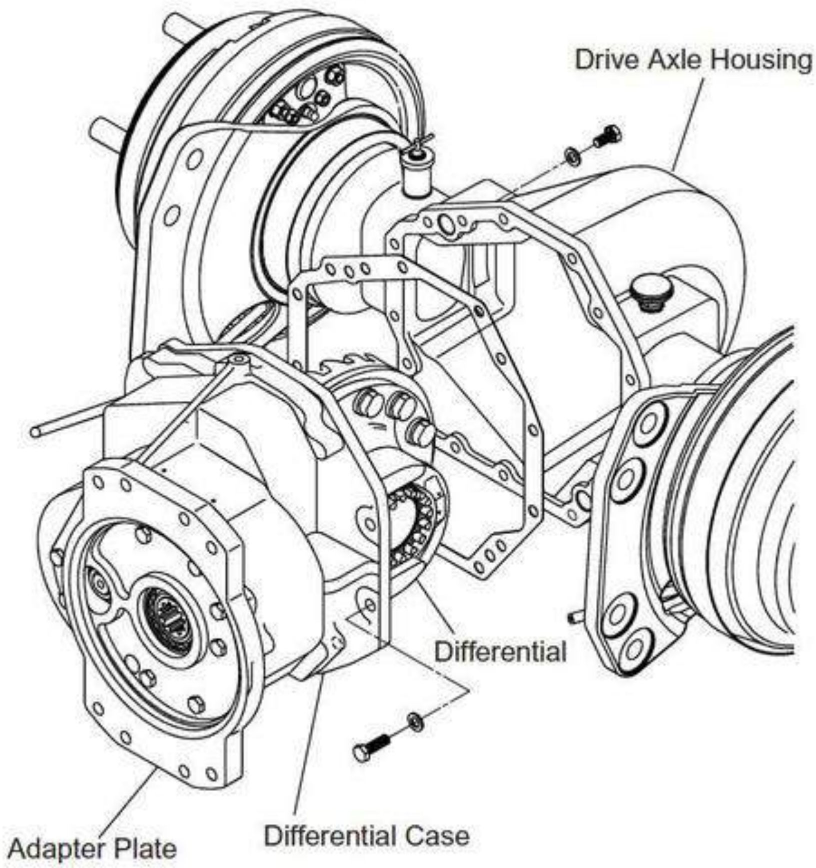
3. If you intend to overhaul the **brake** assemblies, disassemble those components as described in the "Service Brake Inspection and Overhaul" Section in Group 23



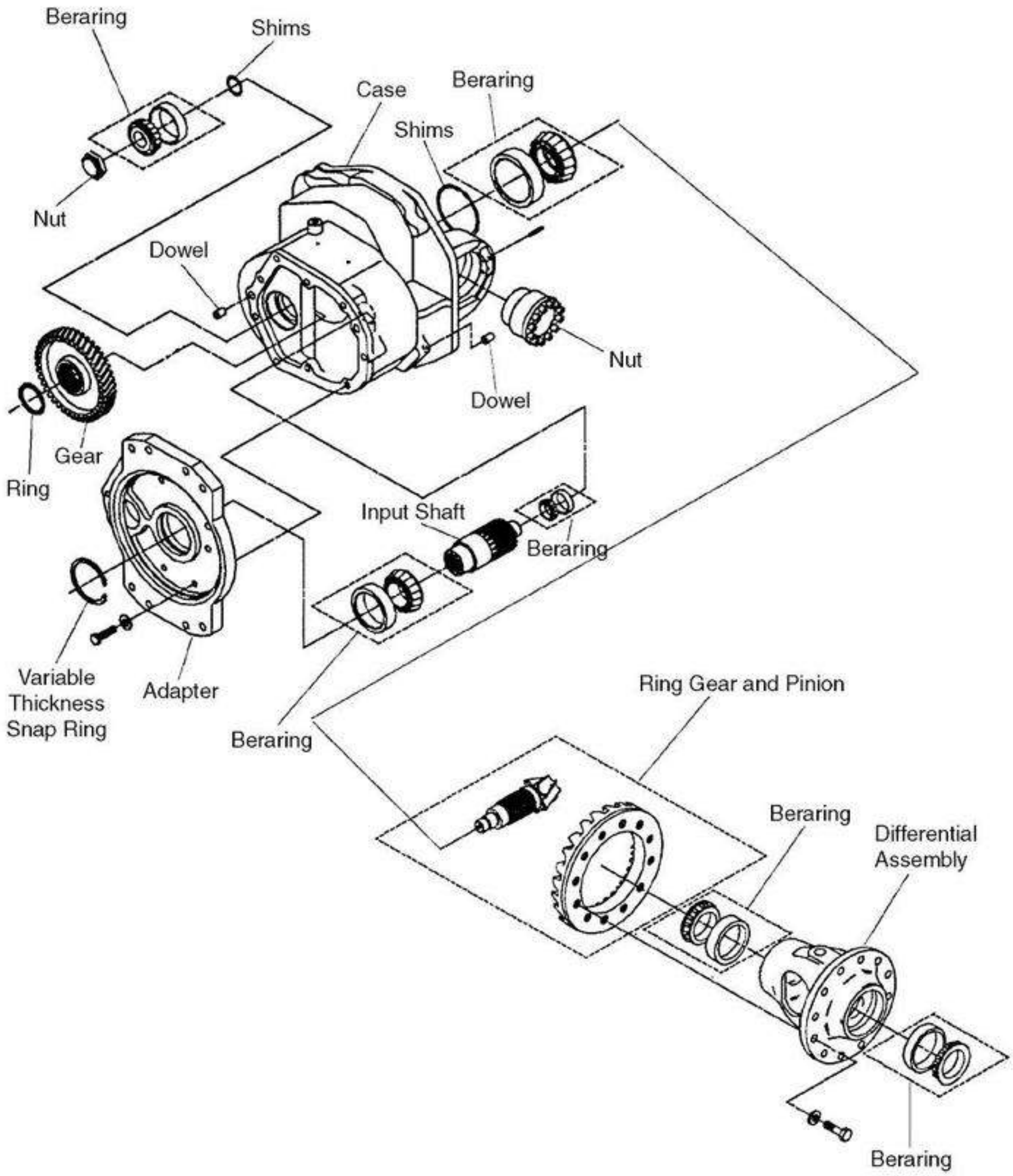
4. Remove the 10 axle mounting bolts from both axle shafts.

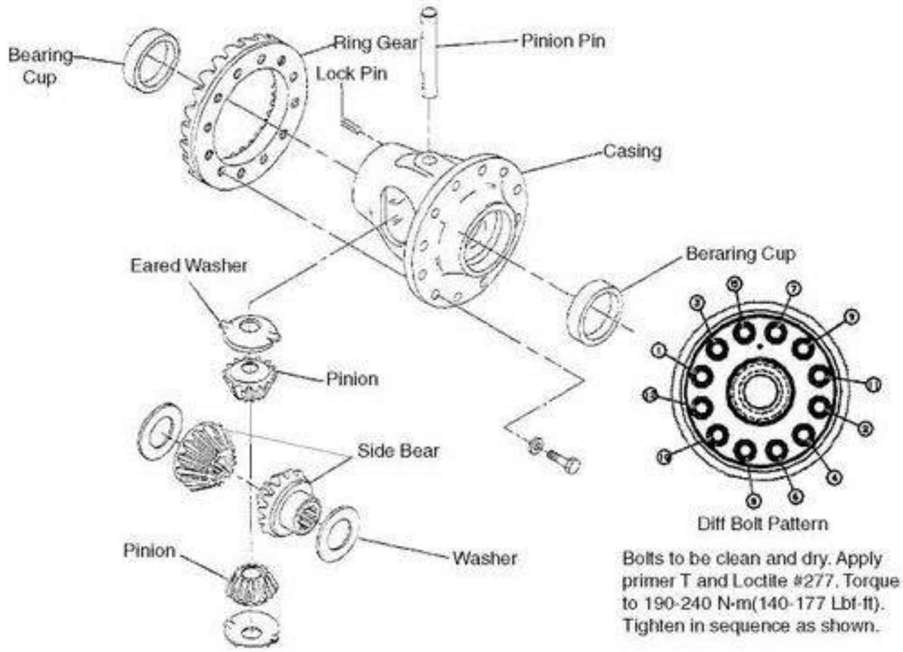


5. Remove the mounting bolts and pull the differential assembly and adapter plate from the drive axle as shown. Use bolts in the blind tapped holes in the diff flange to assist in forcing the two cases apart.



6. Disassemble the adapter, ring gear and pinion and differentail as shown below.





Differential Overhaul

Differential Disassembly

1. Unbolt the ring gear from the differential casing.
2. Using a small drift pin or rod, remove the differential pinion pin lock pin from the casing.
3. Remove pinion pin .
4. Remove eared washer and pinion from differential casing.
5. If bearings or cups need replacement, remove cups from casing.
6. Remove side gears and washers.

Differential Reassembly

IMPORTANT

Before reassembly, clean, inspect and lubricate all parts.

1. Replace both the pinion and ring gear as matched set only. Press bearing cups to bottom of bores if they are being replaced. Cups must be replaced if bearings are being replaced.
2. Insert the side gears and washers into the differential assembly.
3. Insert washers into grooves in casing.
4. Insert both pinion gears into position on the side gears.
5. Rotate the side gears and pinions until the bores in the pinions align with the pin hole in the casing.
6. Insert the pinion pin into the casing. Rotate the pinion pin so that one of its slots can receive the lock pin.
7. Drive lock pin into the casing so that the lock pin engages the pinion pin.
8. Mount the ring gear to the casing :
   a. Use a vice with soft jaws to hold the casing.
   b. Clean and dry all bolts and ring gear threads.
   c. Apply Loctite Primer T (Clark part #1803836) and Loctite 277 (Clark part #1802302) to all threads.
   d. Use alignment studs to position the ring gear.
   e. Install 12 mounting bolts with washers, and torque to 205-2.50 N·m (151-185 lbf-ft).

CAUTION

RING GEAR BOLTS USE only new ring gear bolts. Used bolts can failed prematurely.

Installing the Pinion Bearings, Pinion Shaft, and Output Gear

IMPORTANT

REPLACE RING AND PINION AS A SET. Pinion and ring gear must be replaced as a new set if either is to be replaced.

Determining Shim Pack Thickness

The position of the pinion along the radius of the ring gear is called the "pinion mounting distance." This distance must be kept within a specified range for the ring gear and pinion to mesh properly. Because manufacturing tolerances vary among ring and pinion sets, the actual pinion mounting distance may require shimming in order to match the specified pinion mounting distance.

To determine the shim pack thickness required for the ring gear and pinion set you are installing:

1. Note the number on the end of the pinion shaft.
2. Locate the number on the chart below.
3. Select the shim pack thickness next to the number you located.
4. Check the shim pack height with a micrometer before installation.

IMPORTANT

You must determine the thickness of and install the required shim pack whenever you replace the ring gear and pinion set, or the old shim pack.

Shim Pack Thickness Chart

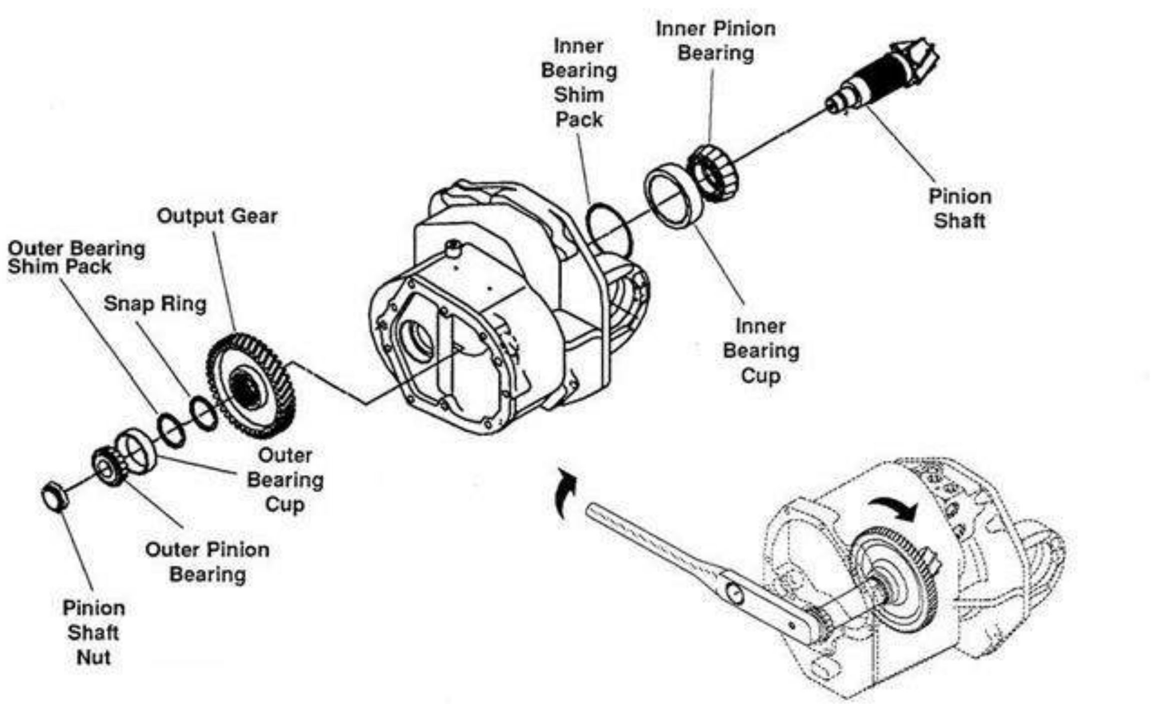
Mark on Pinion	Shim Pack Thickness	
	(mm)	(inch)
50	0.26	0.010
48	0.28	0.011
46	0.30	0.012
44	0.32	0.012
42	0.34	0.013
40	0.36	0.014
38	0.38	0.015
36	0.40	0.016
34	0.42	0.017
32	0.44	0.018
30	0.46	0.019
28	0.48	0.020
26	0.50	0.020
24	0.52	0.021
22	0.54	0.022
20	0.56	0.023
18	0.58	0.024
16	0.60	0.024
14	0.62	0.024
12	0.64	0.025
10	0.66	0.026
8	0.68	0.027
6	0.70	0.027
4	0.72	0.028
2	0.74	0.029
0	0.76	0.030

Mark on Pinion	Shim Pack Thickness	
	(mm)	(inch)
0	0.76	0.030
-2	0.78	0.031
-4	0.80	0.031
-6	0.82	0.032
-8	0.84	0.033
-10	0.86	0.034
-12	0.88	0.035
-14	0.90	0.035
-16	0.92	0.036
-18	0.94	0.037
-20	0.96	0.038
-22	0.98	0.038
-24	1.00	0.039
-26	1.02	0.040
-28	1.04	0.041
-30	1.06	0.042
-32	1.08	0.042
-34	1.10	0.043
-36	1.18	0.044
-38	1.14	0.045
-40	1.16	0.046
-42	1.18	0.046
-44	1.20	0.047
-46	1.22	0.048
-48	1.24	0.049
-50	1.26	0.049

Installing Pinion Shaft and Setting Preload

1. Drive outer bearing cup, if removed, fully into bore.
2. Install the inner bearing shim pack, as selected.
3. Drive the inner bearing cup into the bore firmly against the shim pack.
4. Press (or expand with induction bearing heater) the inner pinion bearing onto the pinion shaft until it butts against the shoulder of the pinion.
5. Position the output gear in the case with the long hub of the gear toward case.
6. Insert the pinion shaft and inner bearing into the case and through the output gear. Seat the bearing with a sharp blow to the pinion end with a soft-faced hammer.
7. Slip the output gear snap ring on the pinion shaft, but do not install it into its groove at this time.

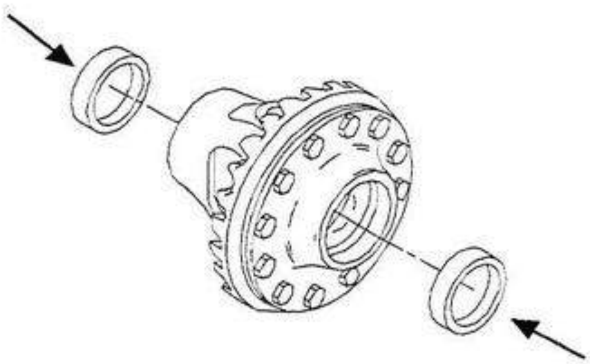
   Bearing Installation Tip: To brace the pinion shaft in preparation for driving on the outer bearing, install the differential assembly adjusting nuts as shown on page 11. Then install a T-bar bearing puller into the adjusting nuts and tighten finger-tight against pinion.
8. Install the outer bearing shim pack, If a new pinion shaft is start with a nominal shim pack of 1.575mm (0.062in)
9. Drive outer bearing onto the pinion shaft.
10. Install the old pinion shaft nut and torque to 270-340 Nom (200-250 lbf-ft). Hold or block the pinion shaft with a brass bar or similar soft material to prevent the shaft from turning while tightening the nut. Anchor case to bench if necessary,
11. Unblock the pinion shaft and use a torque wrench to measure the pinion shaft bearing rolling-torque preload. Preload torque should be 0.8-2.3 N·m (7-20 lbf.in).
12. If the preload torque is outside the specified range, you must remove shims to increase preload or add shims to decrease it. To add or remove shims, remove the pinion shaft nut and bearing and repeat steps 9 through 12.
13. After the preload torque proves to be within the specified range, replace the pinion shaft nut with a new one. Do not reuse the pinion shaft nut. Torque nut 270-340 N·m (200-250 lbf-ft).
14. Install the snap ring into its groove, making sure it is fully seated.
15. If used, remove T-bar puller and adjusting nuts.



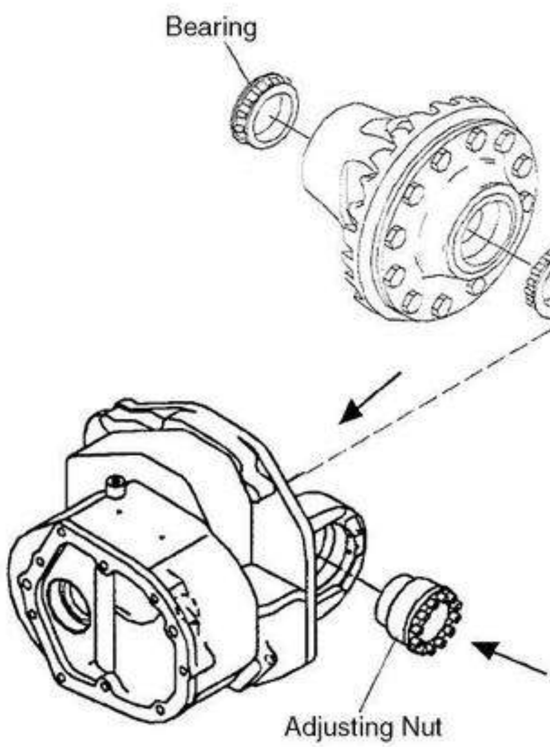
Installing the Differential

Installing Differential Cage

1. Press the left and right cups into the differential cage, if removed.



2. Place bearings in differential assembly as shown.
3. Position differential assembly between carrier "ears." Block under ring gear to hold assembly in position.
4. Loosely install adjusting nuts through ears and into bearings.



Setting Differential Bearing Preload

The differential bearing preload is the bearings' resistance to turning, which is controlled by how tightly the bearings are sandwiched between their races. The change in distance (deflection) between the differential carrier ears caused by tightening the differential adjusting nuts is a convenient indicator of preload. To measure the deflection:

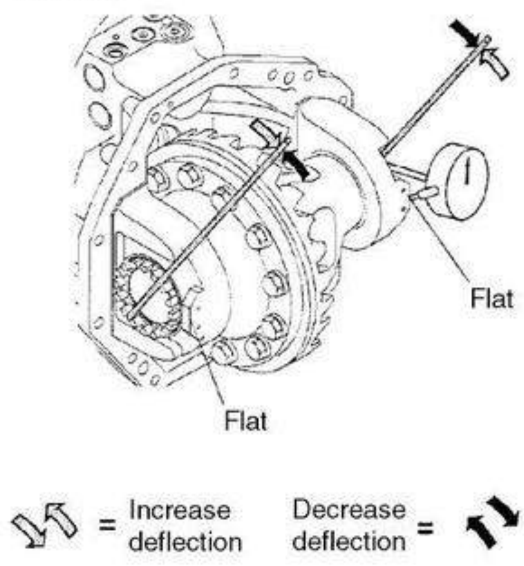
1. *Securely clamp transmission case to bench* and set up a dial indicator so that it is zeroed against a flat on a carrier ear as shown.
2. Tighten one or both of the adjusting nuts until the pinion appears to correctly mesh with the ring gear and there is a small amount of play (backlash) between the pinion and ring gear.
3. Read the deflection on the dial indicator.

   Your goal is for this deflection to measure 0.076 mm (0.003 in), without changing the temporary backlash set in step 2.

   To change the deflection without affecting the backlash, tighten both adjusting nut sequally, or loosen both equally: Use a clockwise rotation on both adjusting nuts to increase the deflection as shown. Use a counterclockwise-rotation on both nuts to decrease the deflection. When the deflection is correct, precisely set backlash as described on the next page.

NOTE

The deflection of one carrier ear should measure 0.075 mm (0.003 in). The total deflection measured from flat to flat should be 0.15 mm (0.006 in).



Setting Ring Gear and Pinion Backlash

The backlash measurement is the distance a ring gear tooth can travel between pinion teeth with the pinion stationary. Because the pinion and ring gear teeth are beveled, you can change the backlash by changing how deeply the teeth mesh into each other. To adjust backlash without changing preload, you shift the ring gear along it axis by tightening one adjusting nut while loosening the other an equal amount.

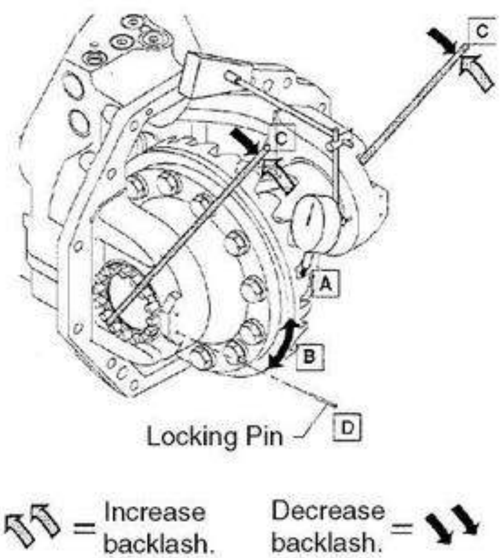
To measure and adjust backlash:

1. Set up a dial indicator on a ring gear tooth as shown at "A". Hold or block the pinion so that it cannot rotate.
2. Rotate the ring gear through backlash as shown at "B" and read the measurement.

   Backlash must be 0.20-0.28 mm (0.008-0.011 in).

   If the measurement is less than required, you need to shift the ring gear away from the pinion, if more than required, into the pinion.
3. To shift the ring gearposition, rotate the adjusting nuts equally in opposite rotations (loosen one nut, tighten the other) as shown at "C".

   Tip: Insert a rod in the recess on the carrier ear and between cleats on the adjusting nut. Rotate the adjusting nut with the rod as far as the recess allows-this is one"notch."Keep count of each "notch"you rotate the adjusting nut. Repeat on other adjusting nut using same number of "notches."



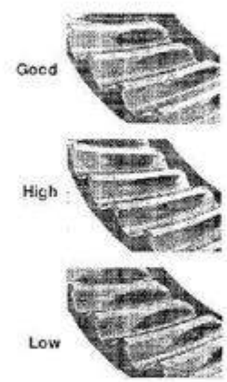
4. Check the resulting backlash on three teeth around the ring gear. Repeat adjustments until the preload and backlash measurements are both correct.
5. Drive locking pins "D" through the upper or lower holes in the differential carrier ears and between cleats in adjusting nuts.

Checking Ring and Pinion Gear Tooth Contact Pattern

To check the ring gear and pinion for proper tooth contact pattern (correct position):

1. Apply a thin, even coating of gear checking compound, to the ring gear teeth.
2. Rotate the ring and pinion gears through a minimum of one revolution and apply a load (hold by hand) to the gears as they are turned.

   When the ring gear is turned, the compound is squeezed away by the contact action of the teeth, leaving bare areas that are the exact shape, size and area of the tooth contact pattern.
3. Check the tooth contact area on the sides of the ring gear teeth. On an old gearset, the-contactpattern must match wear pattern. On a new gear set, the tooth contact pattern must be as shown. If the contact pattern is incorrect, recheck the pinion mounting procedure and the ring-and-pinion backlash reading. Disassemble the parts, add or remove inner bearing shims as needed to adjust pinion position, and adjust differential bearing nuts to correct backlash.

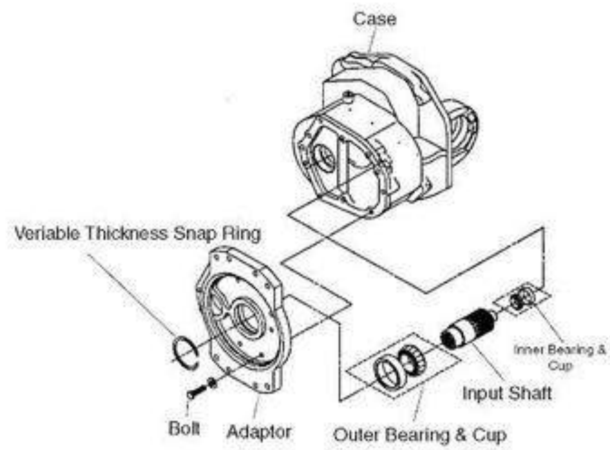
   Adding shims corrects a "high" pattern. Removing shims corrects a "low" pattern.

IMPORTANT

Each time the ring gear or pinion is moved, the backlash and the differential bearing preload must be checked and reset as needed.

Installing Input Shaft

1. Install inner bearing cup in the case.
2. Put inner bearing onto input shaft and install shaft into case.
3. Install outer bearing onto input shaft and cup into adaptor.
4. Bolt adaptor to case. Apply thin even layer of Loctite # 5 15 before assembly. Torque bolts to 60 - 65 N·m (44 - 48 lbf-ft).
5. Select the thickest snap ring that will fit into adaptor and install.

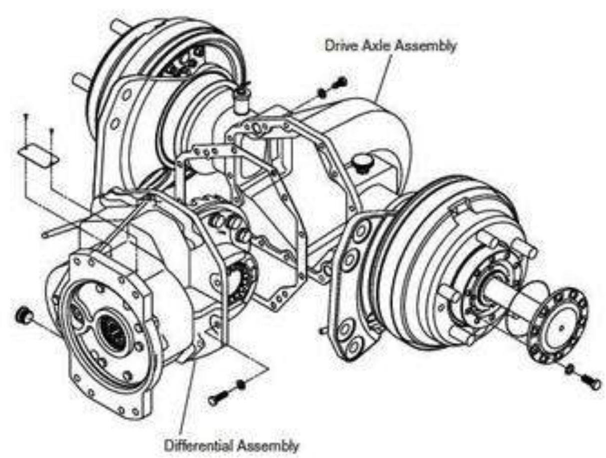


Joining Differential and Axle Housings

Clean all gasket mating surfaces. If there are any nicks, remove them with emery cloth. Then join the housings as follows.

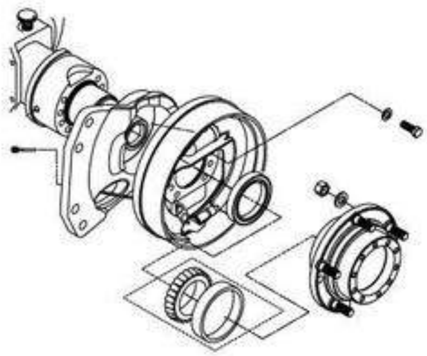
Differential Case to Axle Housing

1. Place gasket over dowels on mounting flange on transmission case. Do not use gasket sealer.
2. With a hoist, bring the axle housing and differential case together, using the alignment studs for guides.
3. Loosely install six mounting bolts with washers through the differential case mounting flange and into the threaded holes in the axle housing mounting flange.
4. Remove the alignment studs and loosely install 11 mounting bolts with washers through the axle mounting flange, through the gasket, and into the threaded holes in the differential case mounting flange.
5. Gradually torque all of the above-mentioned mounting bolts, in a criss-cross pattern, 68 - 79 N·m (50 - 58 lbf-ft).

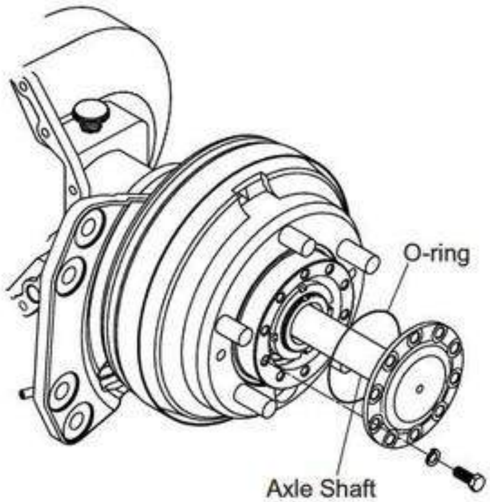


Installing Axle Shafts and Axle Ends

1. If axle hub and/or brake assemblies were removed, install them as described in the "Axle Hub Overhaul" Section in this Group (20), and the "Service Brake Inspection and Overhaul" Section in Group 23.

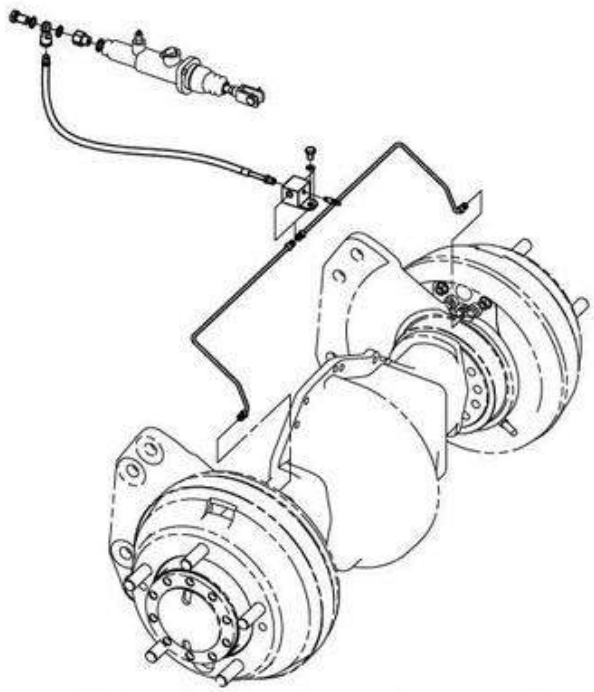


2. Insert O-ring into groove in axle shaft as shown. Insert axle shaft into axle assembly and torque mounting bolts 90-110 N·m (67-81 lbf-ft).



3. Install the breather; Apply Loctite 17009 to threads and torque 30 - 40 N·m (25-30 lbf-ft).

4. Reinstall the brake lines and bleed brakes. Refer to brake bleeding procedure in Group 23.



5. Refill the drive axle with 6.5 L (6.87 qts) of Clark transmission fluid part number 2776236.

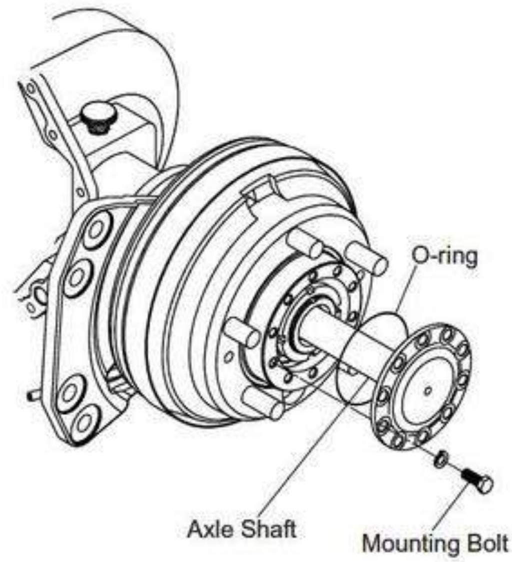
Section 5

Drive Axle Ends Overhaul

Drive Wheel Removal

The drive axle ends can be overhauled with the drive axle in the truck. If the drive axle is to be left in the truck:

1. Safely raise and properly block the front of the truck as described in the lifting and jacking Section of Group SA.
2. Remove the drive wheels as described in Group 22.



Drive Axle Shaft Removal and Replacement

1. Remove 10 mounting bolts and washers from each axle shaft flange.
2. Pull axle shaft out of axle housing.
3. Remove O-Ring from hub.
4. Reverse steps 1 through 3 for installation. Use new O-Ring, Torque mounting bolts to 90-110 N·m (67-81 lbf-ft).

Axle End Removal

The following procedures refer to the **illustration on the next page.**

1. Separate brake drum from hub. If necessary, screw jackscrews through holes in drum to force drum apart from hub. Remove drum.
2. Bend back tab on locking washer to clear slot in lock nut.
3. Remove locknut from spindle. Special wrench, construction shown on page 4, may be used.
4. Remove tongued washer from spindle.
5. Remove outer bearing from spindle.
6. Remove hub from spindle.
7. Remove inner bearing.
8. Remove and discard oil seal from hub.
9. Extract inner and outer bearing cups from hub if bearings are to be replaced.

Axle Mounting Bracket Removal and Installation

1. Remove or install the brake assembly as described in "Service Brake Overhaul" in Group 23.
2. Remove or install the axle mounting bracket by sliding it off or on the axle housing. Use anti-seize compound, Clark part #1802307, on the contact surfaces before installing the bracket.

Inspection, Cleaning, and Repair

Inspect bearings and cups for wear. Replace bearing and cup as a set if either is worn. Clean parts with a standard-type solvent.

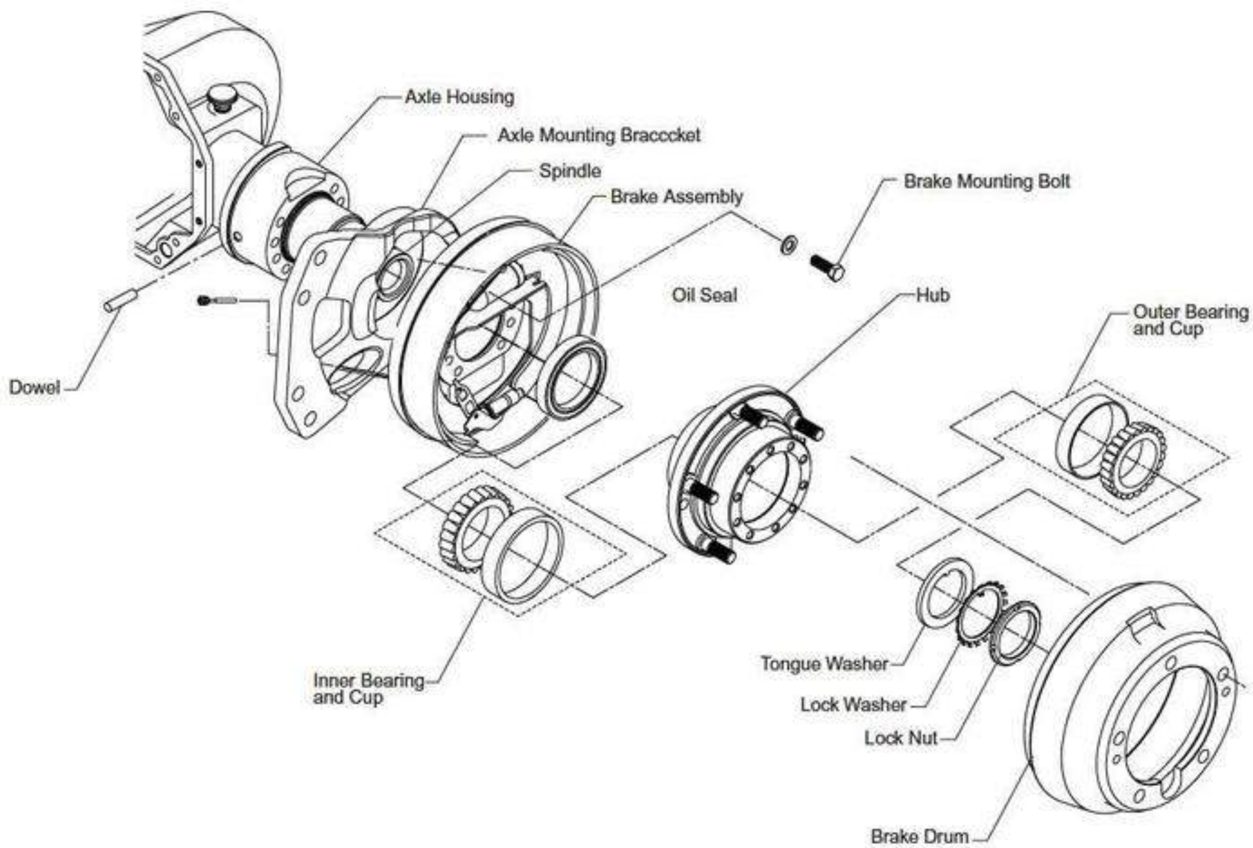
Axle End Assembly

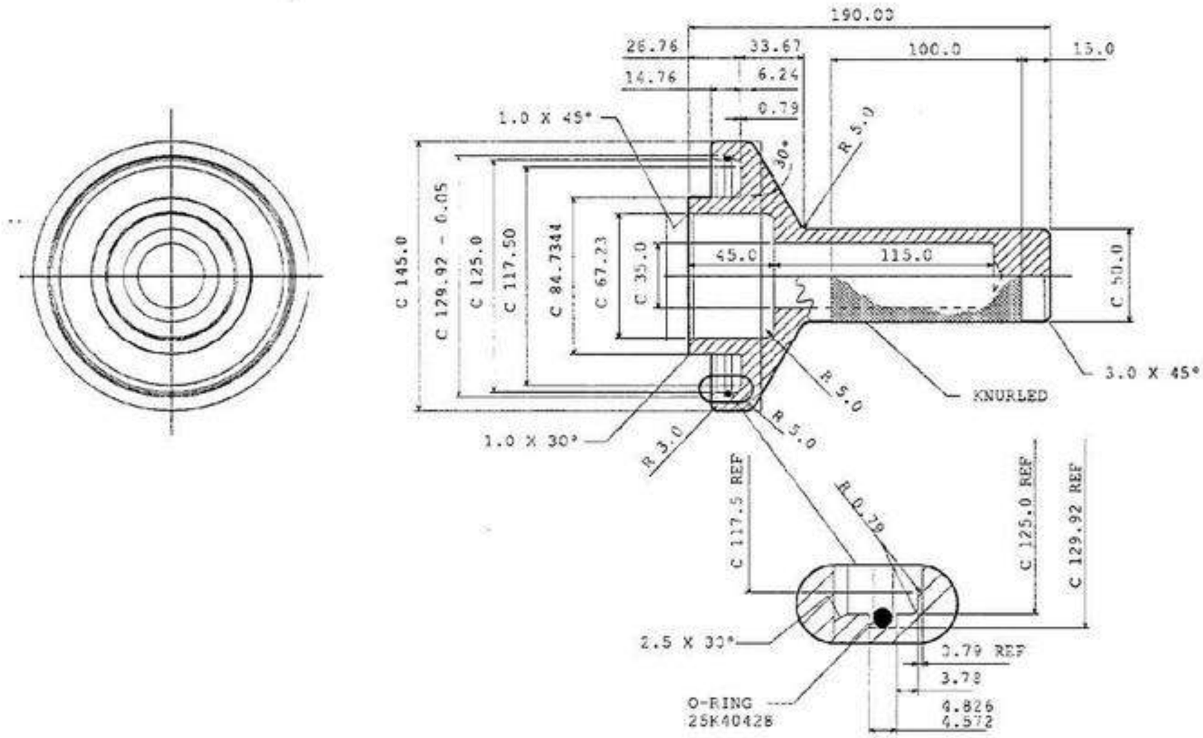
1. Press new cups into hub, if cups were removed.
2. Lube inner bearing with transmission fluid, Clark part # 2776236, and install bearing.
3. Prepare surfaces and install oil seal:
   a. Remove nicks, scratches, and burrs from hub and spindle surfaces that will receive the seal.
   b. Apply a light coat of Loctite Primer N, Clark part #1803267, and Loctite Gasket Maker, Clark part #1802303 to seal outer diameter and hub inner diameter.
   c. Press new oil seal into hub with special driver, which can be constructed from drawing on page4.

IMPORTANT

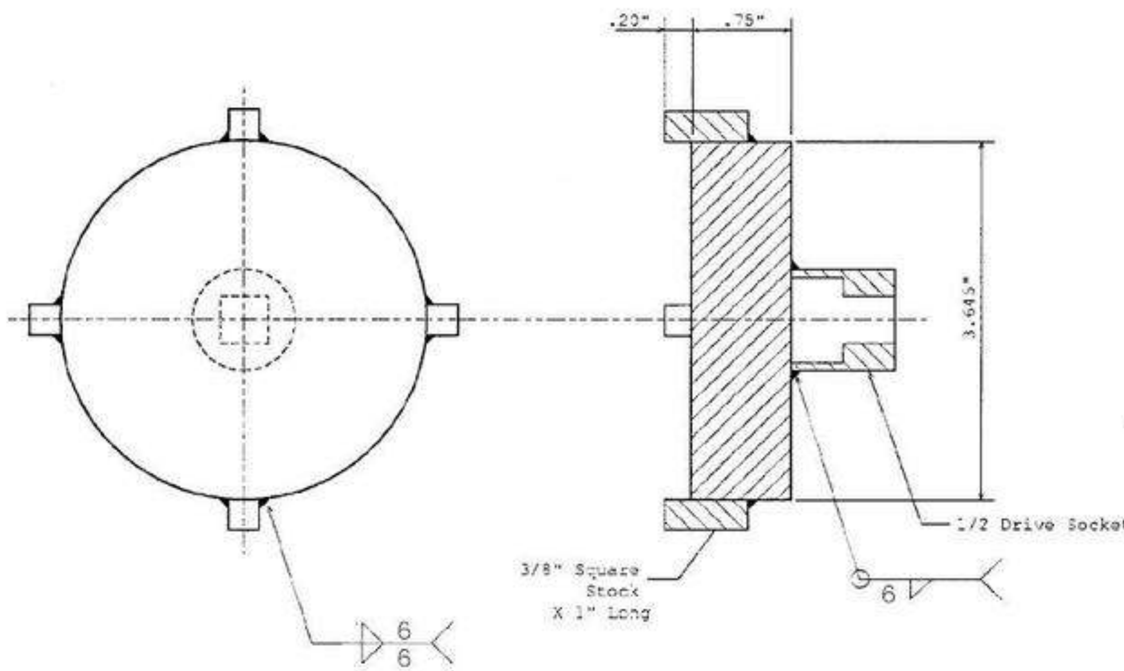
OIL SEAL LEAKS. The oil seal must be replaced with a new one each time the hub is removed. Use extreme care not to damage the seal during installation. Use the proper seal driver, shown on page 4.

4. Install hub over spindle.
5. Lube outer bearing with transmission fluid, Clark part # 2776236, and install.
6. Install tongued washer, locking washer, and locknut (hand-tight).
7. While turning hub, torque locknut to 200-245 N·m (147-181 lbf-ft) with special wrench shown on page4.
8. Loosen locknut- then hand-tighten locknut until bearing has no end-play.
9. Loosen locknut until tab on washer lines up with slot in locknut. Bend tab on washer into slot on locknut.
10. Align inspection slot on brake drum with inspection slot on hub. Install brake drum by sliding it over studs mounted on hub. Tap drum with a soft-faced hammer to seat it against the hub. Remount the wheel as described in Group 22.


Axle Housing
Axle Mounting Bracccket
Spindle
Brake Assembly
Brake Mounting Bolt
Oil Seal
Hub
Outer Bearing and Cup
Dowel
Inner Bearing and Cup
Tongue Washer
Lock Washer
Lock Nut
Brake Drum



Hub Oil Seal Driver. Construct as shown.



Hub Locknut Wrench. Construct as shown.

GROUP 22

WHEELS AND TIRES

NOTE :

Section 1

Wheels and Tires Specifications and Description

Specifications

Steer Tire Types : Pneumatic rubber/Cushion rubber, non-marking, and urethane.

Drive Tire Types : Pneumatic rubber/Cushion rubber, non-marking, and urethane.

Pneumatic Drive and Steer Tire Inflation Pressure :

Drive EPX20/25: 1000 kPa (145psi)
EPX30/32: 965 kPa (140psi)

Steer EPX20-32: 1000 kPa (145psi)

Fastener Torques

Steer Tire Mounting Nut Torque : Check mounting procedure in Sections 2 and 3 for cushion and pneumatic tires and wheels.

Drive Wheel Mounting Nut Torques :
1 Piece (black) 300-370 N·m (225-275 lb·ft)

Service Intervals

Wheel Mounting Bolts Check and Tightening : Every 50-250 hours of operation and each PM.

Tire Condition : Daily inspection.

Tire Pressure Check : Daily inspection.

Description

The wheels and tires used on the truck come in pneumatic or cushion types in a variety of sizes depending on truck model and application. Pneumatic tires are mounted on multi-piece rims with locking rings.

WARNING

For your safety and the safety of others, before you do tire or rim maintenance or service, read the OSHA rules regarding owner responsibility. Do not work on tires or rims unless you have been trained in the correct procedures. Read and understand all maintenance and repair procedures on tires and rims. Serious injury or death can result if safety messages are ignored.

The Occupational Safety and Health Act (OSHA) specifies required procedures for servicing multi-piece rim wheels in 29 CFR Section 1910.177. It is the owner's responsibility to comply with OSHA.

In accordance with OSHA, the owner must provide a training program to train and instruct all employees who service multi-piece rim wheels in the hazards involved and the safety procedures to be followed. Do not let anyone mount, demount, or service multi-piece rim wheels without correct training.

The owner should obtain and maintain in the service area current copies of the United States Department of Transportation, National Highway Traffic Safety Administration publications entitled "Safety Precautions for Mounting and Demounting Tube-Type Truck/Bus Tires," and Multi-Piece Rim/Wheel Matching Chart" or other similar publications applicable to the types of multi-piece rim wheels being serviced.

NOTE :

Section 2

Cushion Wheels and Tires(ECX)

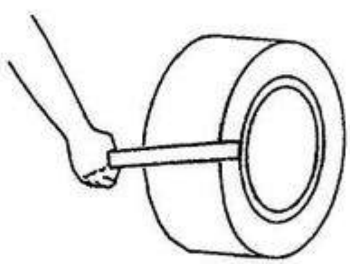
CAUTION

SAFE PARKING. Before working on truck :

1. **Park truck on a hard, level, and solid surface, such as a concrete floor with no gaps or breaks.**
2. **Put upright in vertical position and fully lower the forks or attachment.**
3. **Put all controls in neutral. Turn key switch OFF and remove key.**
4. **Apply the parking brake and block the wheels.**

General Cushion Tire Maintenance and Inspection

1. Inspect cushion tires and remove objects (nails, metal fragments, etc.) embedded in the tread of the tire. Be careful not to cause further damage to tire when removing these objects.
2. Check tire for separation from the base band. If a thin steel rule or similar tool can be inserted more than 12mm (0.5in) into the separation area from the side of the tire, the tire should be replaced.

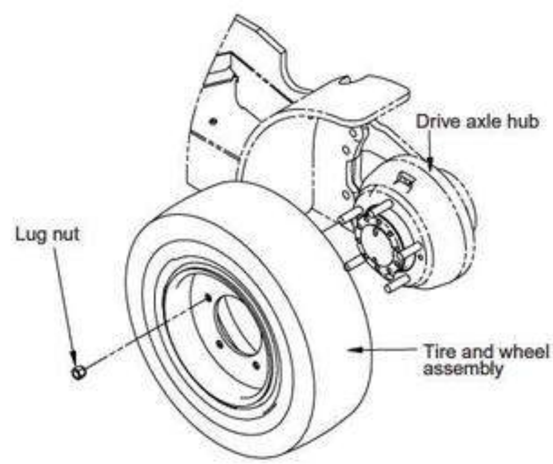


3. Check tire for damage from chunking or heat damage. This is a judgment requirement for replacement. In general, if the damage is greater than 12mm (0.5in) deep and involves more than a 50×50mm (2×2in) area, it will usually affect the tire performance and the tire should be replaced.

Drive Wheel Removal/Installation

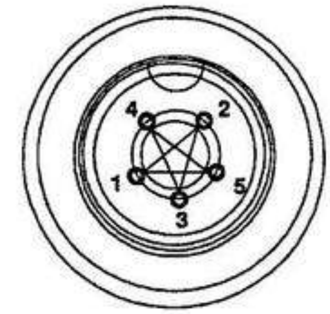
Removal

1. Loosen lug nuts then use a portable jack of correct capacity placed under the frame of truck to raise drive wheel off floor. See "Lifting, Jacking, and Blocking" in Group SA for correct, safe procedures for jacking the truck.
2. Remove lug nuts and lift the tire and wheel assembly from drive axle hub.



Installation

1. Install wheel and tire assembly on drive axle hub. Begin tightening the lug nuts to seat the nuts in the beveled wheel openings.
2. Use a crisscrossing nut-tightening sequence to torque the lug nuts to a pre-final torque of 54-81 N·m (40-60 ft·lb).



3. Begin the crisscrossing sequence again and torque the black lug nuts to 300-370 N·m (225-275 lb·ft).

IMPORTANT

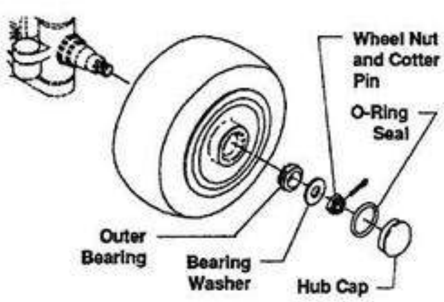
Do not overtorque the lug nuts. Damage to the lug nuts, wheel, or drive-axle hub may result.

4. Lower truck to floor and remove jack.

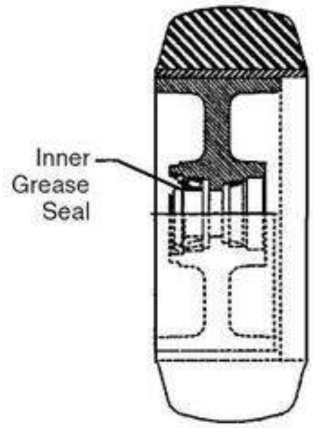
Steer When Removal/Installation

Removal

1. Park the truck safely and use a jack of suitable capacity placed under the frame of truck to lift steer wheel off the floor as described in "Lifting, Jacking, and Blocking" in Group SA.
2. Remove hub cap by prying it from wheel hub.



3. Clean the excess grease from around wheel nut. Remove cotter pin from wheel nut.
4. Loosen and remove O-ring, wheel nut, and washer.
5. Pull out on wheel hub slightly to loosen bearing, then remove outer bearing. Store in clean place.
6. Carefully remove wheel assembly from axle spindle. Support the wheel hub to avoid dragging the grease seal at the back side across the thread on spindle end.



7. If no other maintenance is to be done on wheel bearings, cover the wheel hub to protect the grease seal and inner bearing from contamination during tire replacement.

Installation

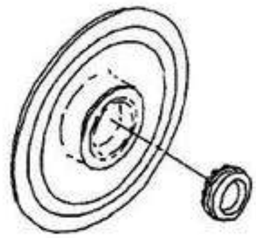
1. Make sure the truck is safely supported on a suitable jack or blocking.
2. Be sure axle spindle is clean and that wheel hub inside and bearings are clean and have been serviced and lubricated (packed correctly) before installation.

NOTE

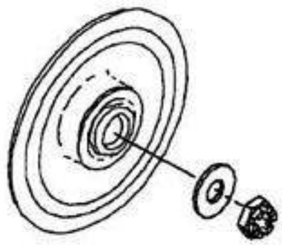
Refer to Group 26, "Steer Axle", for additional information on removing and servicing steer wheels and bearings.

3. Install wheel on spindle. Be careful not to damage seal lip when moving the hub over the end of spindle and threads.

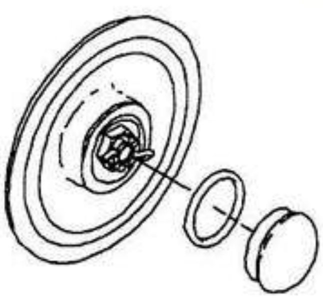
4. Install outer bearing after packing bearing cavity onehalf full with proper grease.



5. Install bearing washer and wheel nut and hand tighten wheel nut.



6. While rotating wheel (hub) counter clockwise, torque the wheel nut to 27-31 N·m (20-23 ft·lb).
7. Back the wheel nut up until it is loose.
8. While turning the wheel counter clockwise, torque the wheel nut to 2.3-2.8 N·m (20-24 in·lb, 1.7-2 ft·lb).
9. Back wheel nut off to nearest slot in nut and lock with new cotter pin. Bend tabs on cotter pin.
10. Recheck for correct bearing adjustment by rotating the wheel by hand. Wheel should rotate freely or with only slight "drag." Readjust bearings, as necessary. Adjust torque on wheel nut as necessary to avoid binding in bearings.
11. Pack the area around wheel nut with grease.
12. Replace the O-ring and install hubcap by tapping into place with a rubber or plastic-faced hammer.



13. Lower truck to floor and remove jack.

Cushion Tire Replacement

CAUTION

Replacement of the original equipment tires with tires other than those recommended by CLARK may result in decreased operating performance and stability.

1. The correct procedure for tire removal and replacement requires a suitable press for pressing old tire off wheel and pressing new tire onto wheel.

IMPORTANT

Cushion tires cannot be reused after once being pressed on and removed from the wheel. The correct press fit is destroyed after one installation and removal. Replace with new tire.

2. Position tire on press, making sure there is adequate clearance for the tire to be pressed off of wheel.
3. Use suitable tooling with the hydraulic press to correctly contact the base band of tire to press it off the wheel.
4. Install new tire. Mount all tires with identification and type markings toward outside of wheel. Tire is to be pressed on wheel with the outer edges flush.

NOTE :

Section 3

Pneumatic Wheels and Tires(EPX)

CAUTION

SAFE PARKING. Before working on truck :

1. **Park truck on a hard, level, and solid surface, such as a concrete floor with no gaps or breaks.**
2. **Put upright in vertical position and fully lower the forks or attachment.**
3. **Put all controls in neutral. Turn key switch OFF and remove key.**
4. **Apply the parking brake and block the wheels.**

Pneumatic Tire Maintenance Precaution

The following instructions supplement the OSHA requirements. In the event of any conflict or inconsistency between these instructions and the OSHA requirements, the OSHA requirements shall be controlling.

WARNING

Before you do tire or rim maintenance, read the OSHA rules regarding owner responsiblilty. Read and understand all maintenance and repair procedures on tires and rims. Do not work on tires or rims unless you have been trained in the correct procedures. Serious injury or death can result if the safety messages are ignored.

1. Do not let anyone mount or demount tires without proper training.
2. Never sit on or stand in front of a tire and rim assembly that is being filled with air. Use a clip-on chuck and make sure the hose is long enough to permit the person filling the tire with air to stand to the side of the tire, not in front or in back of the tire assembly.
3. Never operate a vehicle on only one tire of a dual assembly. The carrying capacity of the single tire and rim is dangerously exceeded, and operating a vehicle in this manner can result in damage to the rim and truck tip-over and driver injury.
4. Do not fill a tire with air that has been run flat without first inspecting the tire, rim, and wheel assembly. Double check the lock ring for damage. Make sure that it is secure in the gutter before filling the tire with air.
5. Always remove all air from a single tire and from both tires of a dual assembly prior to removing any rim components, or any wheel components, such as nuts and rim clamps. Always remove the valve core to remove air from tire. Be sure all air is removed.
6. Check rim components periodically for fatigue cracks. Replace all cracked, badly worn, damaged, and severely rusted components.
7. Do not, under any circumstances, attempt to rework, weld, heat, or braze any rim components that are cracked, broken, or damaged. Replace with new parts or parts that are not damaged, which are of the same size, type, and make.
8. Never attempt to weld on an inflated tire/rim assembly.
9. Clean rims and repaint to stop detrimental effects of corrosion. Be very careful to clean all dirt and rust from the lock ring gutter. This is important to secure the lock ring in its proper position.
   A Filter on the air filling equipment to remove the moisture from the air line prevents a lot of corrosion. The filter should be checked periodically to make sure it is working properly.
10. Make sure correct parts are being assembled. Ask your distributor or the manufacturer if you have any doubts.
11. Do not be careless or take chances. If you are not sure about the proper mating of rim and wheel parts, consult a wheel and rim expert. This may be the tire man who is servicing your fleet, the rim and wheel distributor in your area, or the CLARK dealer.
12. Mixing parts of one manufacturer's rims with those of another is potentially dangerous. Always ask manufacturer for approval.
13. Do not use undersized rims. Use the right rims for the job.
14. Do not overload rims. Ask your rim manufacturer if special operating conditions are required.
15. Do not seat rings by hitting with a hammer while the tire is filled with air pressure. Do not hit a filled or partially-filled tire/rim assembly with a hammer.
16. Double check to make sure all the components are properly seated prior to filling tire with air.
17. Have the tire in a safety cage when filling with air.

18. When removing wheels, regardless or how hard or firm the ground appears, put hardwood blocks under the jack.

19. Block the tire and wheel on the other side of the vehicle, before you place the jack in position. Place blocks under the truck frame as near as possible to the jack to prevent the truck from falling if the jack should fail.

20. Remove the bead seat band slowly to prevent it from dropping off and crushing your toes. Support the band on your thigh and roll it slowly to the ground. This will protect your back and feet.

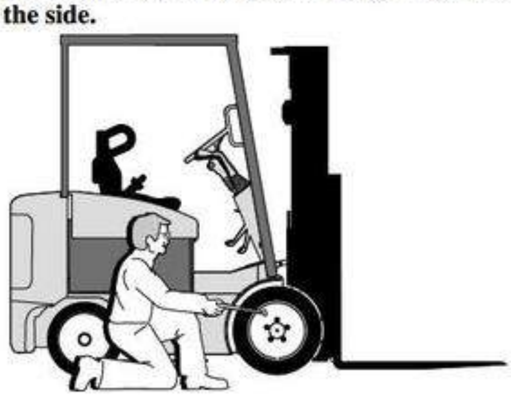
21. Bead breakers and rams apply pressure to bead flanges. Keep your fingers away from the bead flanges. Slant bead breaker about 10° to keep it firmly in place. If it slips off, it can fly with enough force to kill. Always stand to one side when you apply hydraulic pressure.

General Tire Maintenance, Inspection, and Repair

1. Park the truck as described in "Safe Parking" and check for correct tire inflation air pressure.
   - Drive EPX20/25: 1000 kPa (145 psi),
     EPX30/32: 965 kPa (140psi)
   - Steer 1000 kPa (145 psi all models)

CAUTION

Check tire pressure from a position facing the tread of the tire, not the side. Use a long-handled gauge to keep your body away from the side.



- If tires are low, do not add air. Have the tire and wheel inspected by a person trained and authorized to do tire and wheel maintenance. The tire may require removal and repair.
- Incorrect (low) tire pressure can reduce the stability of a lift truck and cause it to tip over.

IMPORTANT

Check wheels and tires for damage every time you check tire pressure. Make repairs when needed. Dirt can get into cuts and cause damage to the tire cord and tread. Remove debris from all cuts.

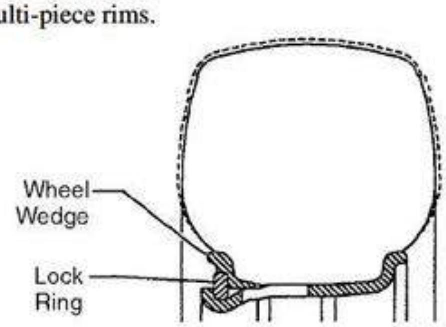
2. Check the condition of the drive and steer wheels and tires. Remove objects that are imbedded in the tread. Inspect the tires for excessive wear, cuts and breaks.

3. Check all wheel lug nuts or bolts to be sure none are loose or missing. Have missing bolts replaced and loose bolts tightened to the correct torque before operating the truck.
   - Torque pneumatic steer tires to 225-250 N·m (165-185 ft·lb).
   - Torque 1 piece black lug nuts for pneumatic drive tires to 300-370 N·m (225-275 ft·lb).
   - Torque 1 piece black lug nuts for pneumatic dual-drive tires to 300-370 N·m (225-275 ft·lb).

Inspection and Minor Repair

Inspect pneumatic tires and wheels carefully for.

1. Low inflation pressure.
2. Damaged tires. Check tires for cuts and breaks.
3. Damaged wheels or loosening of the lock ring on multi-piece rims.



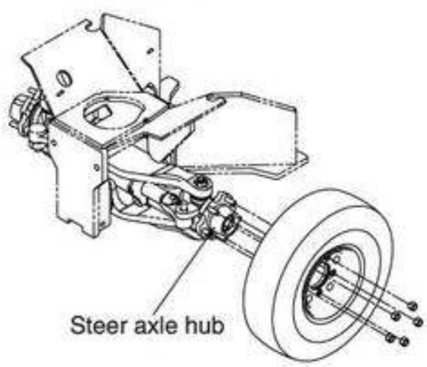
4. Check for loose nuts or bolts not in position.
5. Check the nuts or bolts for damage.
6. Check the surface of the wheels for bent flanges.
7. Check all parts for rust or corrosion.
8. Mark the damaged areas with chalk so that the parts can be removed from operation.
9. Remove all parts that are damaged and install new parts in the same position.
10. Replace parts with the correct sizes and types. See your parts manual.
11. Include your truck serial number when ordering replacement parts.

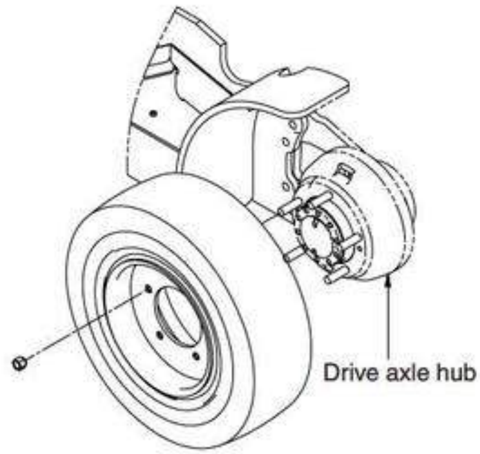
Wheel Dismounting and Remounting

Refer to "Lifting, Jacking, and Blocking" in Group SA for information on jacking up or raising the truck for wheel removal. Always start with the truck parked safely.

Drive and Steer Wheel Dismounting

1. Remove the valve core from the valve stem to be sure all air is removed from the tire.
2. Loosen the five lug nuts on the wheel.





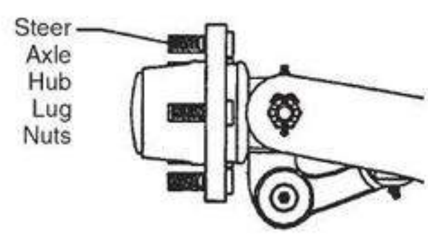
3. Use a portable jack of adequate capacity placed under the frame of truck to raise drive or steer wheels off floor.
4. Once tire is off the ground enough to rotate freely, remove the lug nuts and lift the wheel from the hub. Use caution when lifting tire and wheel.

Drive and Steer Wheel Remounting

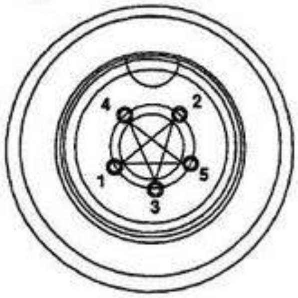
IMPORTANT

See "Tire Installation" in this Section to make sure the wheel and tire mounting orientation is correct. Check the information for correct tire-to-wheel mounting and wheel-to-hub mounting.

1. Make sure the truck is parked on a flat, hard surface and the jacking and blocking devices are secure to hold the truck in a safe position.
2. Inspect the removed lug nuts for damage to the threads. Also inspect all hub studs for thread damage. Replace any lug nuts or studs that have damaged threads. Make sure studs are secure in the axle hub.



3. Set the wheel on the hub and start the lug nuts on the hub studs. Tighten the nuts only enough to seat the nuts into the beveled openings on the wheel and to secure the wheel on the axle hub.
4. Use a crisscrossing nut tightening sequence to torque the nuts to a pre-final torque of 54-81 N·m (40-60 ft·lb). Make sure all nuts seat into beveled spacer holes correctly.



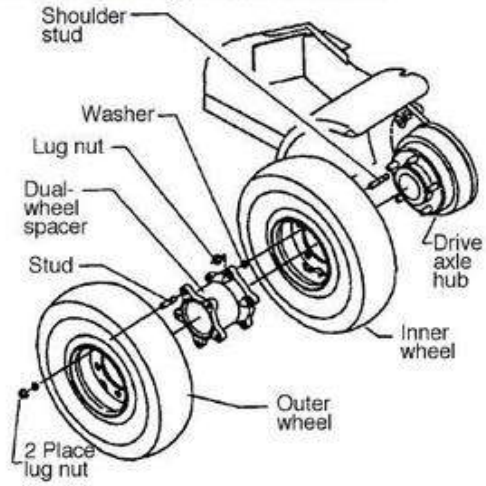
5. Begin the crisscrossing sequence again and tighten the lug nuts to final torque.
   - Torque drive wheel 1 piece lug nuts to 300-370 N·m (225-275 ft·lb).
   - Torque steer wheel lug nuts to 225-250 N·m (165-185 lb·ft).
6. Carefully lower the truck and remove the jack.
7. Check tire pressure for correct inflation pressure.
   - Drive wheel pressure is EPX20/25:1000 kPa (145 psi) EPX30/32: 965 kPa (140 psi).
   - Steer wheel pressure is 1000 kPa (145 psi).

WARNING

If tires are not fully inflated, see "Adding Air Pressure To Mounted Wheel/Tire Assemblies" and follow the procedures for adding air to the mounted tires.
Before you add air pressure to the tire, make sure the lock ring is correctly positioned in the rim and side ring. The lock ring can separate from the rim with enough force to cause injury or death.

Dual-Drive Wheel Dismounting

1. Remove the valve core from the valve stem of the outer wheel to be sure all air is removed from the tire.
2. Loosen the five lug nuts on the wheel.



3. Use a portable jack of correct capacity placed under the frame of truck to raise drive wheels off floor.
4. Remove the five outer-wheel lug nuts and remove the outer wheel and tire from the dual-wheel spacer studs.
5. Remove the valve core from the valve stem of the inner wheel to be sure all air is removed from the tire.
6. Remove the five lug nuts securing the inner wheel to the dual-wheel spacer.
7. Remove the dual-wheel spacer and retain the wheel-mounting washers on the dual-wheel shoulder studs installed on the dirve-axle hub.
8. Remove the tire and wheel from the drive-axle hub. Use caution when lifting wheel and tire assembly.

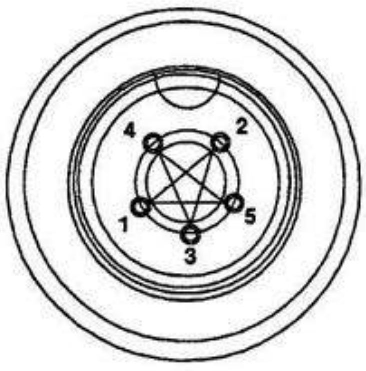
Dual-Drive Wheel Remounting

IMPORTANT

See "Tire Installation" in this Section to make sure the wheel and tire mounting orientation is correct. Check the information for correct tire-to-wheel mounting and wheel-to-hub mounting.

1. Make sure the truck is parked on a flat, hard surface and the jacking and blocking devices are secure to hold the truck in a safe position.
2. Inspect the lug nuts for damage to the threads. Also inspect all studs for thread damage. Replace any lug nuts or studs that have damaged threads. Make sure studs are secure in the drive-axle hub and the dual-wheel spacer.

3. Install inner wheel and tire assembly on drive-axle hub shoulder studs.
4. Install five wheel-mounting washers on the shoulder studs.
5. Mount the dual-wheel spacer on the shoulder studs.
6. Set the lug nuts on the shoulder studs and tighten the nuts only enough to seat the nuts into the beveled openings on the spacer and to secure the wheel on the spacer and drive-axle hub.
7. Use a crisscrossing nut tightening sequence to torque the nuts to a pre-final torque of 54-81 N·m (40-60 ft·lb). Make sure all nuts are seating into beveled spacer holes correctly.



8. Begin the crisscrossing sequence again and torque the black lug nuts to 300-370 N·m (225-275 ft·lb).
9. Mount the outer wheel on the studs of the dual-wheel spacer and tighten the nuts only enough to seat the nuts into the beveled openings on the spacer and to secure the wheel on the spacer and drive-axle hub.
10. Use a crisscrossing nut tightening sequence to torque the nuts to a pre-final torque of 54-81 N·m (40-60 ft·lb). Make sure all nuts are seating into beveled spacer holes correctly. See illustration above.
11. Begin the crisscrossing sequence again and torque the lug nuts as described in step 8 and 9.

    The outside diameter of the left or right wheel or set of wheels must not differ more than 6mm (0.25 in) per side.

12. Check tire presssure for correct inflation pressure :
    - Drive wheel pressure is
      EPX20/25: 1000kPa(145 psi),
      EPX30/32: 965kPa(140 psi).

WARNING

If tire are not fully inflated, see "Adding Air Pressure To Mounted Wheel/Tire Assemblies" and follow the procedures for adding air to the mounted tires.
Before you add air pressure to the tire, make sure the lock ring is correctly positioned in the rim and side ring. The lock ring can separate from the rim with enough force to cause injury or death.

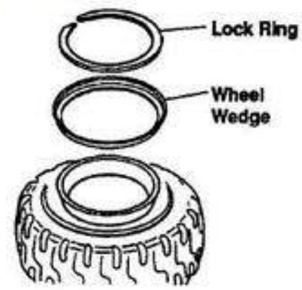
Wheel Disassembly and Tire Removal

1. Remove valve core from the valve stem to be sure all air is removed.

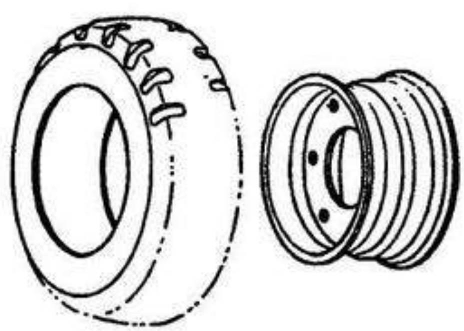
WARNING

Before starting disassembly, remove the air from the tire. Failure to remove the air from the tire can result in serious injury.

2. Remove lock ring.

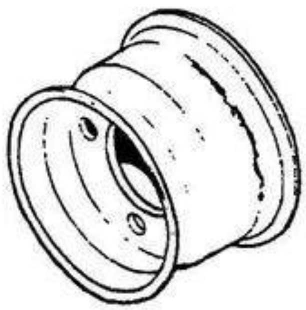


3. Remove wheel wedge.
4. Remove tire from wheel.



5. Remove the rubber inner tube protector (flap).

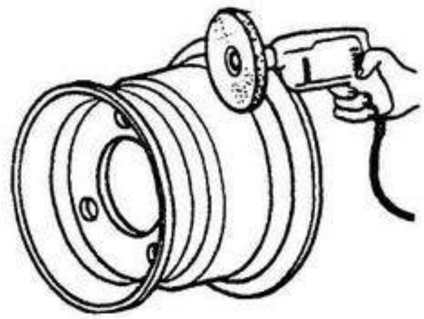
6. Repair tire and/or tube, as needed.
7. Check for cracks in the wheel.



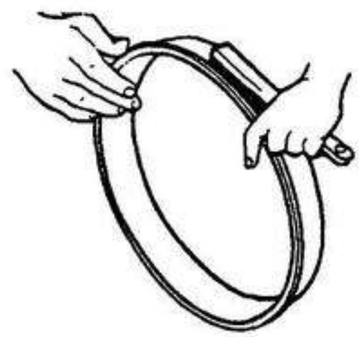
Cracks in the wheel are caused by :

- Deep rim tool marks.
- Overload on wheels.
- Too much air pressure in the tires.
- Using the wrong size tires.

8. Check for cracks in the lock ring.
9. Check for cracks between the stud holes in the wheel. Cracks are caused by :
   - Loose wheel nuts.
   - Wheel not installed correctly.
   - Wrong size or type of parts used.
   - Too much torque on the wheel fasteners. If the wheel mounting parts are too tight, the studs or bolts can break, causing cracks in the wheel between the stud holes.
   - Too little torque on the wheel fasteners. If the wheel mounting parts are too loose, damage to parts and tire wear will result.
10. Check wedge ring for wear or damage. Corrosion buildup will cause wear and damage to the wheel wedge ring.
11. Clean the wheels. Remove rust and dirt.
12. Clean the tire bead seat area. Remove all rust and rubber with a wire brush or wheel.



13. Clean wedge and lock rings. Make sure the seating surface and bead seat areas are clean.



14. Apply paint to the tire rim with a brush. Or, use an aerosol can of metal primer.
    The parts must be clean and dry before you apply the paint. Make sure to apply paint to the outside or tire side of the rim. This is important because air is on the metal surface of the tire side of the rim
15. Apply lubricant on the tire side of the rim base. Do not use a lubricant that has water or solvent which will cause damage to the rubber.

NOTE

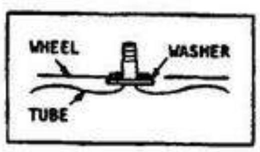
Clark dealers can supply the correct lubricant, which contains a rust inhibitor.

Tire Replacement and Wheel Reassembly

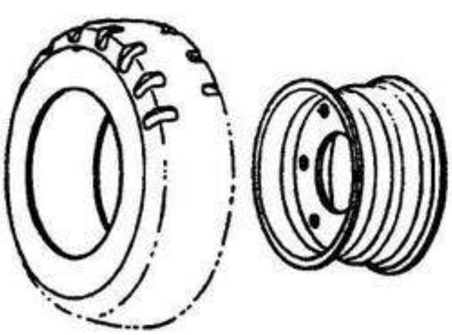
1. Put the tube into the tire.

IMPORTANT

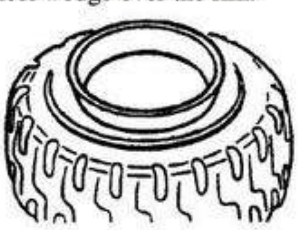
Install washer 22.123 on tube over valve stem before flap is installed, when specified. See sketch. Refer to Service Parts List.



2. Put the rubber tube protector(flap) over the tube.
3. Install the tire onto the wheel rim, against the bead seat area.

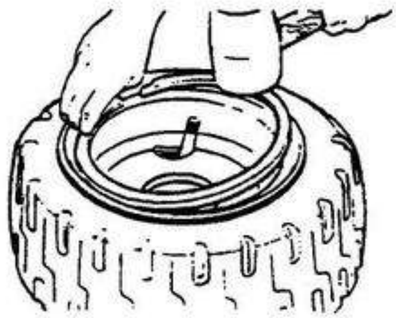


4. Put the wheel wedge over the rim.

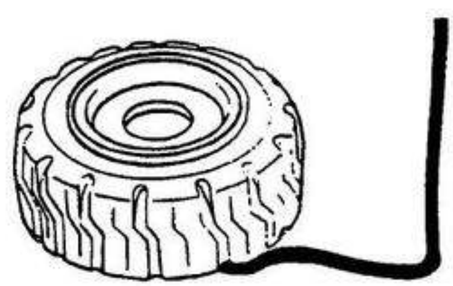


5. Install the wheel wedge.

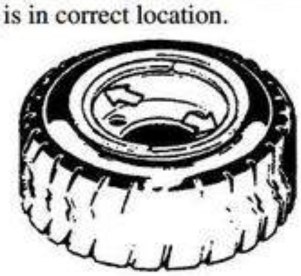
6. Put the side ring over the rim and install the lock ring as shown.



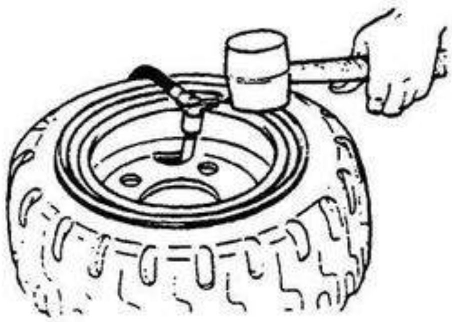
7. Connect air chuck and turn the tire over with the valve stem down. Put 21 kPa (3 psi) of air into the tire.



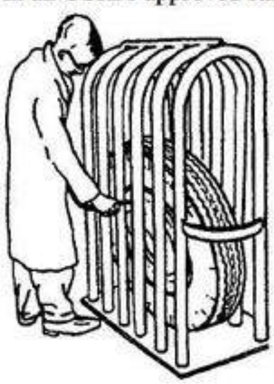
8. Turn wheel to the other side. Check to make sure lock ring is in correct location.



9. Disconnect the air chuck. Use a mallet and hit the ring to make sure the ring is fully installed.



10. Put the tire in an OSHA-approved safety cage.



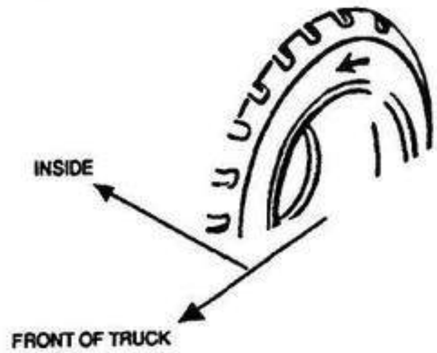
Tire-to-Wheel Mounting

Directional-Tread Tires

All directional-tread tires are to be mounted in the correct position with respect to the arrow cast on the side of the tire as explained below.

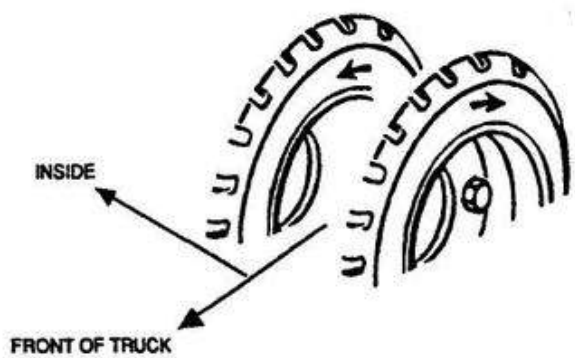
Directional-Tread Single Drive Tires

- Tire arrow to point in the dirction of forward rotation. Rotate wheel to bring arrow on tire above the wheel center. Arrow must point toward front of truck.



Directional-Tread Dual Tires

1. Inside dual tire arrow to point in the direction of forward rotation. Rotate wheel to bring arrow on tire above the wheel center. Arrow must point toward front of truck.



2. Outside dual tire arrow to point in the direction of rearward rotation. Rotate wheel to bring arrow on tire above the wheel center. Arrow should point toward rear of truck.

Filling Tires with Air

Follow these procedures when putting air into tires. All wheel and tire assemblies must be filled in a safety cage. The hose must have an adapter that can be connected to the valve stem.

1. Attach an air hose to valve stem.
2. Open the control valve which will let compressed air into the tire.
3. At intervals, close the control valve and check the pressure in the tire by reading the gauge. Do not put too much presssure into the tire.
4. Continue to fill the tire to the correct air pressure reading of Drive tire EPX20/25: 1000 kPa (145 psi)
   EPX30/32: 965 kPa (140psi).
   Steer tire: 1000 kPa (145 psi)

IMPORTANT

Put equal pressure in both tires of a dual assembly. Do not put air into a tire that is flat without first inspecting it and the wheel for damage.

Filling Tires with Nitrogen

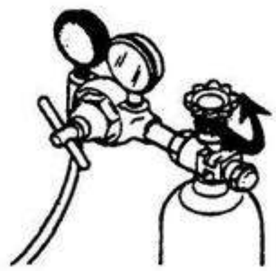
If your air supply does not have enough pressure to fill the tire, you can use a pressurized cylinder of commercial nitrogen gas to get the correct tire pressure. With the tire in a safety cage, connect the nitrogen cylinder to the valve stem with the use of an air chuck.

WARNING

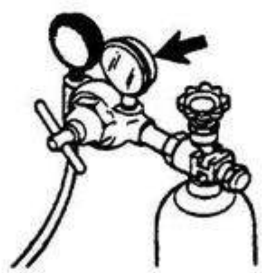
Use nitrogen only. Do not use oxygen or any other gas to fill tires. Make sure all items of equipment used (nitrogen cylinder, regulator, gauges, hoses) are UL approved and in good condition. Use the correct regulator and hose for the pressures that are necessary.

1. Be sure tank valve is closed to connect hose to valve stem. Tank vlave is closed by turning handle on top of tank clockwise to a stop.
2. Turn the regulator valve counterclockwise (CCW) until you can feel no resistance from the regulator. This will adjust the regulator presssure to a low pressure near zero.

3. Slowly turn the cylinder valve counterclockwise (CCW) to open position.



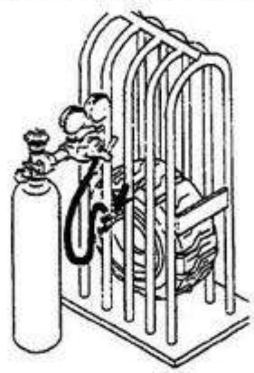
4. The tank gauge will now show tank pressure.



5. Turn the regulator valve clockwise (CW) until the regulator gauge reads the correct tire pressure. Fill the tire with nitrogen.

6. Turn the tank valve clockwise (CW) and close the valve.

7. Disconnect the air chuck from the valve stem.



8. Turn the regulator valve counterclockwise (CCW) to the off position.

9. Use a tire pressure gauge to check the tire pressure. If necessary, put more air into the tire. Do this as many times as necessary to reach the correct tire pressure.

CAUTION

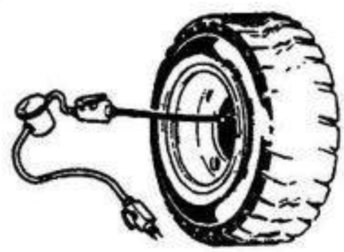
Use a long-handled gauge so that your hand does not go inside the cage, or in front of any component of a multi-piece wheel.

Checking and Adjusting Tire Pressure

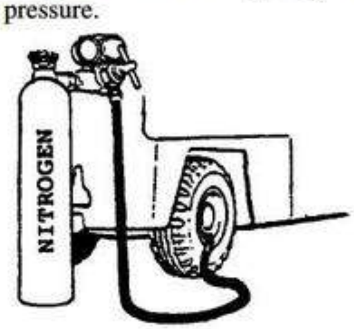
WARNING

Before you add air pressure to the tire, make sure the lock ring is correctly positioned in the rim and wheel wedge. The lock ring can separate from the rim with enough force to cause injury or death.

1. Attach a clip-on air chuck to valve stem. Stand by the side of the wheel and put the correct air pressure in the tire.



2. If your air supply does not have enough pressure to fill the tire, you can use a nitrogen cylinder to get the correct pressure.



3. Put a clip-on type air chuck on the nitrogen cylinder hose and attach it to the valve stem. Follow the procedures described previously for adjustment of the nitrogen cylinder valves.

WARNING

Use nitrogne only. Do not use oxygen or any other gas to fill tires.

NOTE :

GROUP 23

BRAKE SYSTEM

NOTE :

Section 1

Brake System Specifications and Descriptions

Specifications

Service Brake:

Type: Drum and shoe. Self-adjusting.

Fluid: Brake fluid, SAE J1703(DOT 3 or 4), Clark spec MS-68 only.

Shoe-to-Drum Gap: 0.1-0.35 mm (0.004-0.014 in)

Shoe Lining Thickness: 1.0 mm (0.039 in) minimum.

Maximum Rebore Diameter: 312 mm (12.28 in).

Pedal Freeplay: None

Parking Brake:

Type: Ratchet pedal linked to service brake shoe at each wheel.

Holding Test: Rated load on 15 % grade.

General Description

Brake pedal linkage - A mechanical system through which the brake pedal operates the master cylinder.

Master cylinder - The pistons are activated by brake pedal movement.

Brake lines - These lines carry the brake flow from the master cylinder to the wheel cylinders.

Service brake assembly - The drums, shoes and wheel cylinders.

Parking brake-Operates the service brake shoes via cables. See "Parking Brake Adjustment", in this Group for details.

Service Brake Operation

The Service brake pedal operates a master cylinder mounted on the front cowl. The master cylinder operates a wheel cylinder. The wheel cylinder operates a shoe linings to be contacted on drum.

Parking Brake Operation

The operator applies the parking brake by depressing a foot pedal, which is then held down by a ratchet. The depressed pedal tensions cables connected to a brake shoe at each brake assembly, thereby applying the brakes.

The operator releases the park brake by pulling up on a release handle. This handle releases the ratchet, and a return spring returns the pedal and cable to the off position. The ratchet also operates the parking brake interlock switch and the parking brake indicator light switch.

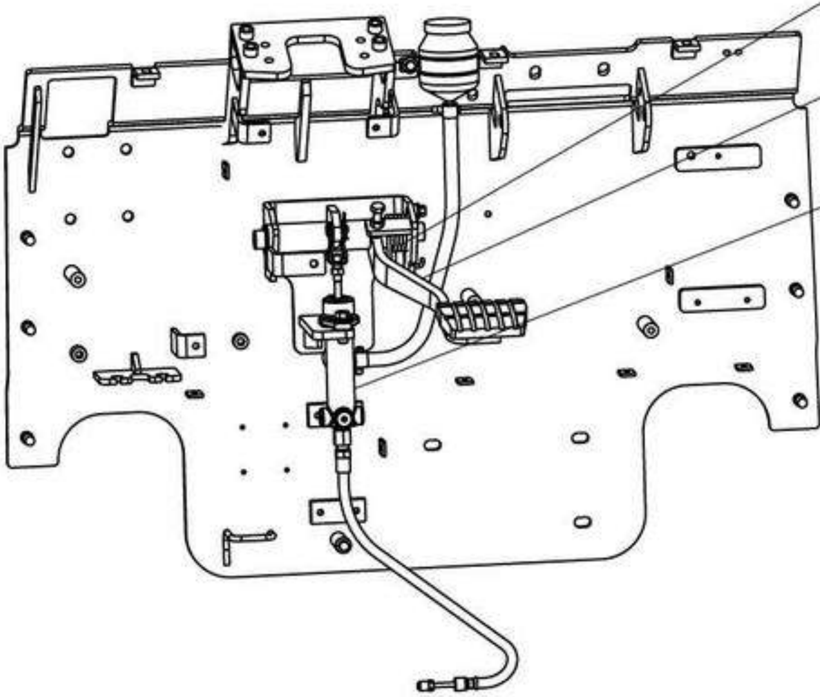
Service Requirements

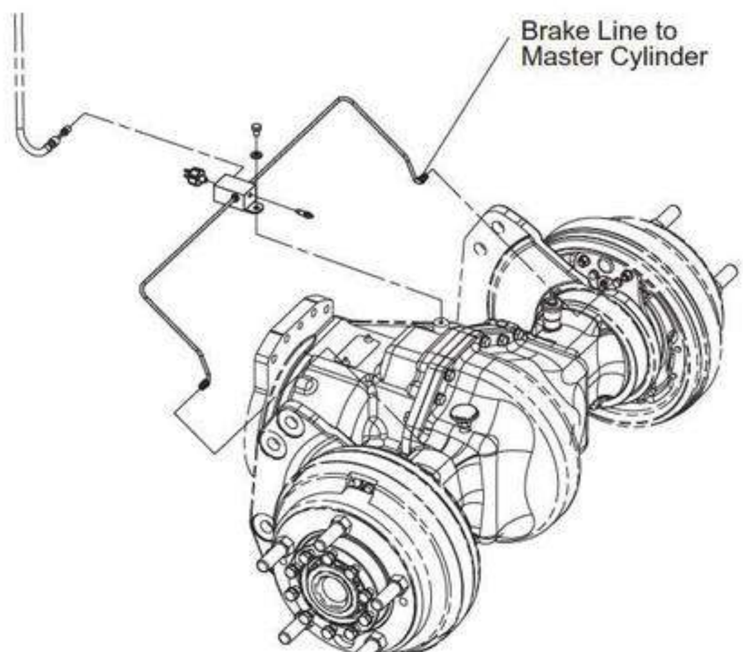
Operational checks and inspection of linkage, brake lining, and brake lines are specified in the Periodic Service Chart in Group PS.

Service brake linkage adjustment and lube are not normally required.

Brakes are self-adjusting and normally require no adjustment.

A leaking master cylinder should be overhauled or replaced.


Return Spring
Brake Lever & Pedal
Master Cylinder


Brake Line to Master Cylinder

NOTE :

Section 2

Service Brake Troubleshooting

Service Brake Troubleshooting

Condition	Causes/Corrective Actions
Brake pedal drops to floor	A C E
Brake pedal spongy	A B
Brakes stick, drag excessively, make noise, or overheat	D E F G
Excessive effort required to apply brake	A E

Causes/Corrective	Actions
A. External leak in wheel cylinder or other component of braking system	Inspect/replace/repair.
B. Air in braking system	Bleed and recheck.
C. Linkage broken or return spring damaged	Inspect/repair.
D. Brake master cylinder defective	Inspect/overhaul or replace.
E. Shoe linings worn or brakes misadjusted	Inspect/repair/adjust.
F. Shoe linings glazed, oily, or contaminated with other substance	Replace or clean.
G. Parking brake misadjusted	Adjust.

Section 3

Brake Pedal Linkage & Adjustments

Introduction

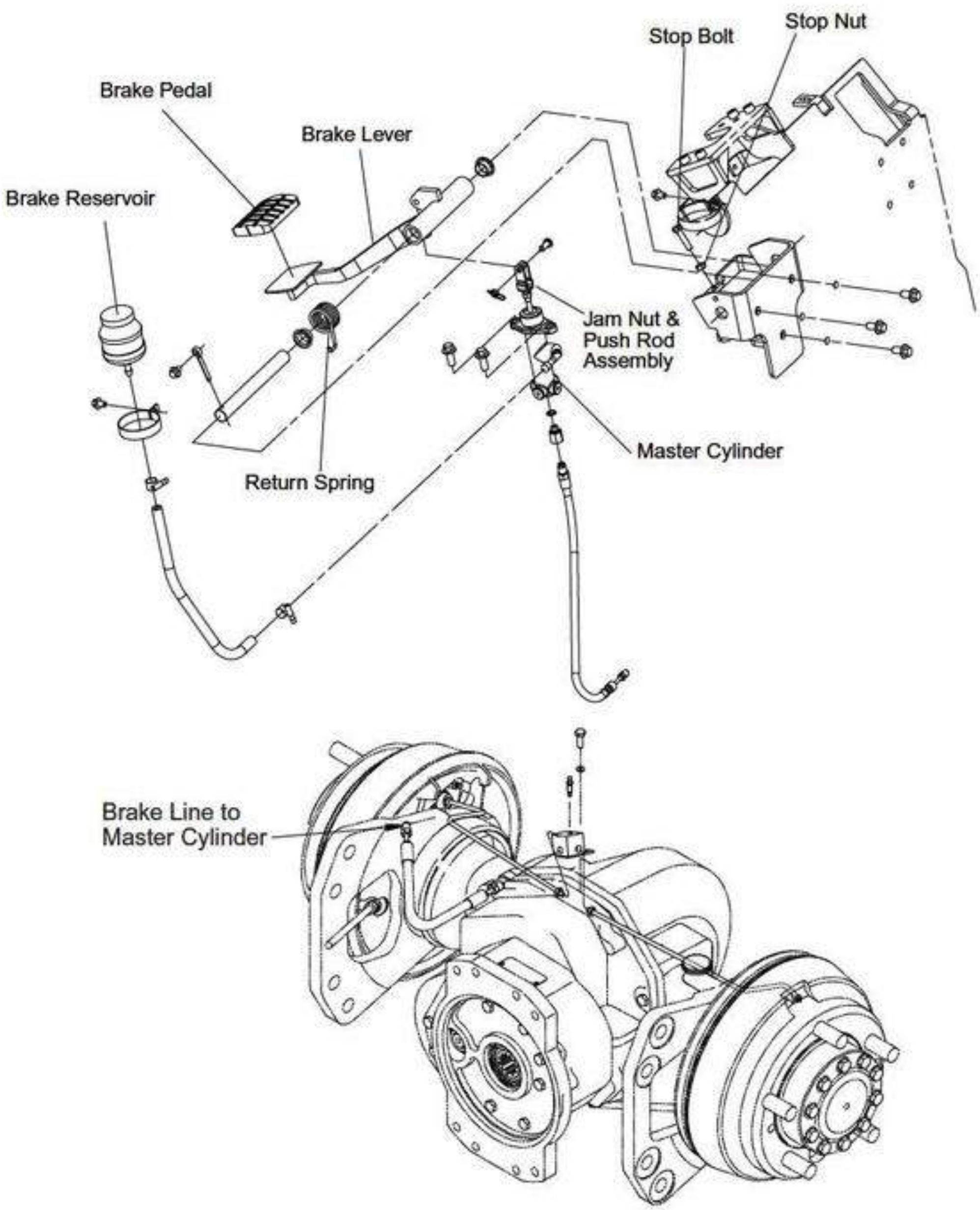
The illustration shows the service brake linkage which links the brake pedal to the master cylinder.

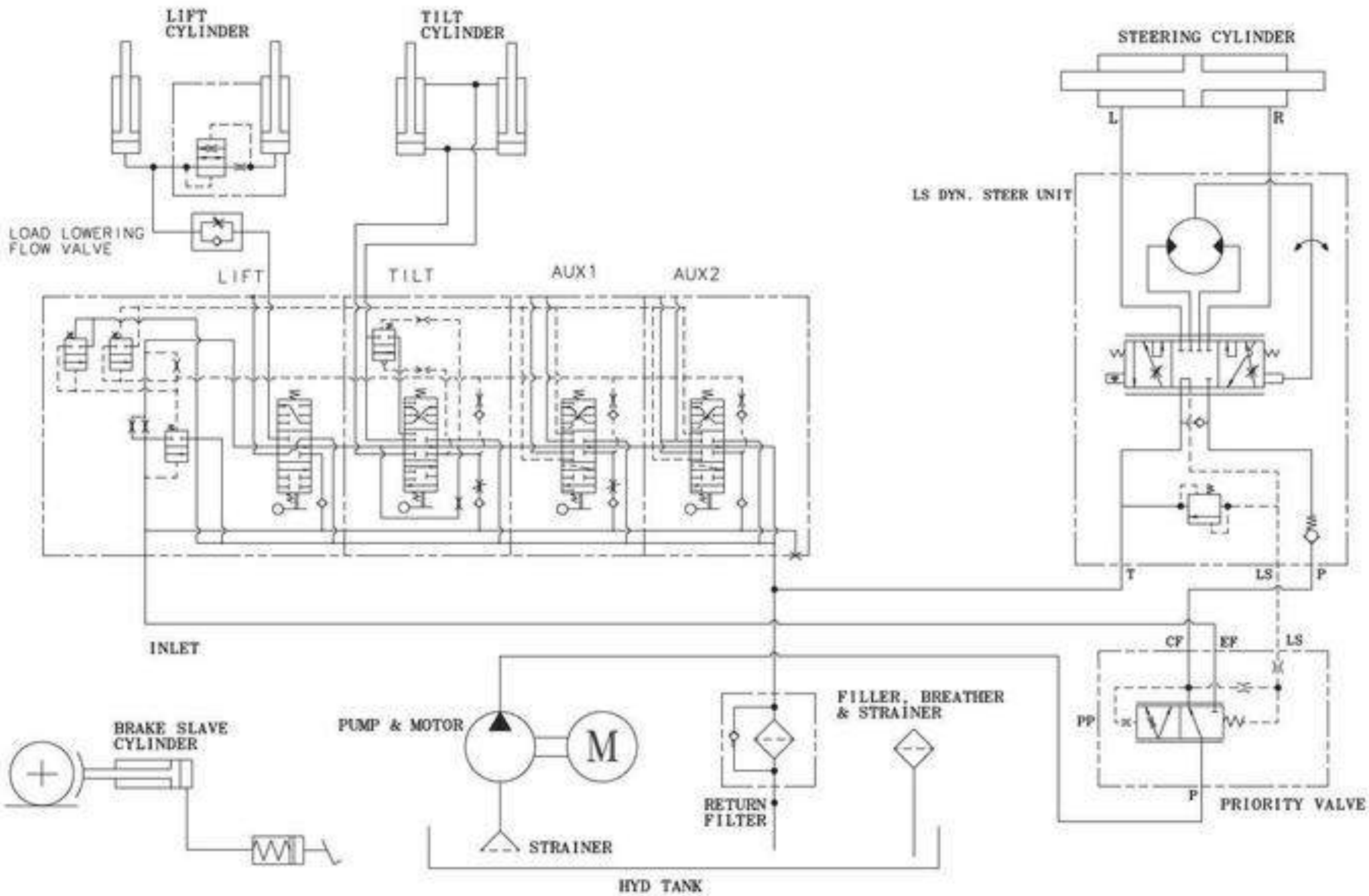
Adjustment

Adjust the master cylinder push rod assembly to eliminate any slack in the pedal linkage. Adjust only the minimum required to remove pedal play.

If you want to adjust the height of brake pedal, adjust the height as 125 ± 5mm by use of stop bolts of brake pedal and then lock the nuts.

Tighten the stop bolts and nuts with torque of 20-25N.m(14-18 ft.lb).




LIFT CYLINDER
TILT CYLINDER
STEERING CYLINDER
L
R
LS DYN. STEER UNIT
LOAD LOWERING FLOW VALVE
LIFT
TILT
AUX1
AUX2
T
LS
P
INLET
CF
EF
LS
PP
P
PRIORITY VALVE
FILLER, BREATHER & STRAINER
BRAKE SLAVE CYLINDER
PUMP & MOTOR
M
RETURN FILTER
STRAINER
HYD TANK

NOTE :

Section 4

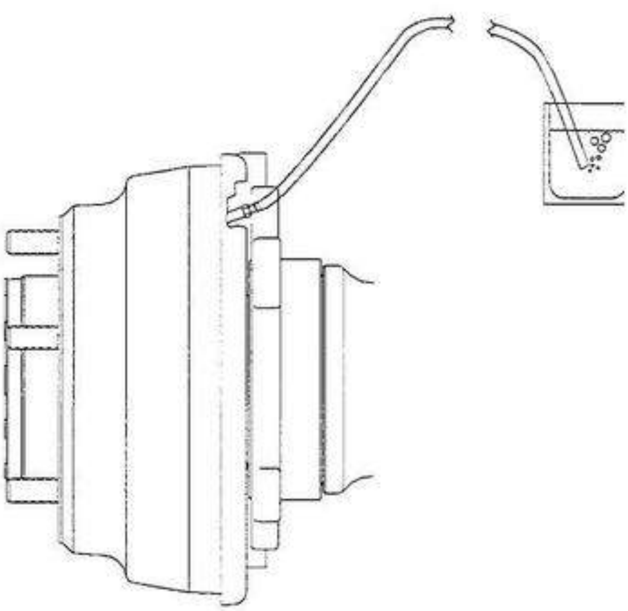
Brake Bleeding

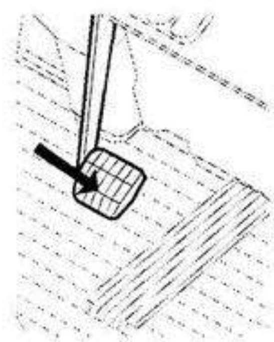
Bleed brakes when:

- The brake pedal feels spongy.
- The brake master cylinder or wheel cylinders-or lines between-have been leaking and/or have been repaired or replaced.
- Troubleshooting otherwise indicates that air has been introduced into the system.

Bleed the brakes as follows:

1. Park truck on level floor. Put direction control in neutral. Lower forks to floor, tilt forward, and apply parking brake.
2. Remove cap from the brake reservoir to be sure it is full of fluid.
3. Attach a clear hose to a bleed screw on one of the brake cylinders. Place the other end of the hose in a jar containing brake fluid, SAE J1703 DOT 3.
4. Open the bleed screw.
5. Depress the brake pedal and watch fluid flow into the jar. When the fluid appears to be free of bubbles, tighten the bleed screw, then release the pedal.
6. Check the fluid in the brake reservoir. Refill as required.
7. Release the parking brake and operate the brake pedal. If the brake pedal does not come up or still feels spongy, bleed the system again.





NOTE :

Section 5

Pedal and Master Cylinder Service (Removal, Replacement, and Adjustment)

Components Disassembly

Use Figures 1, 2, and 3 as guide to disassembly and adjustment.

Components Reassembly

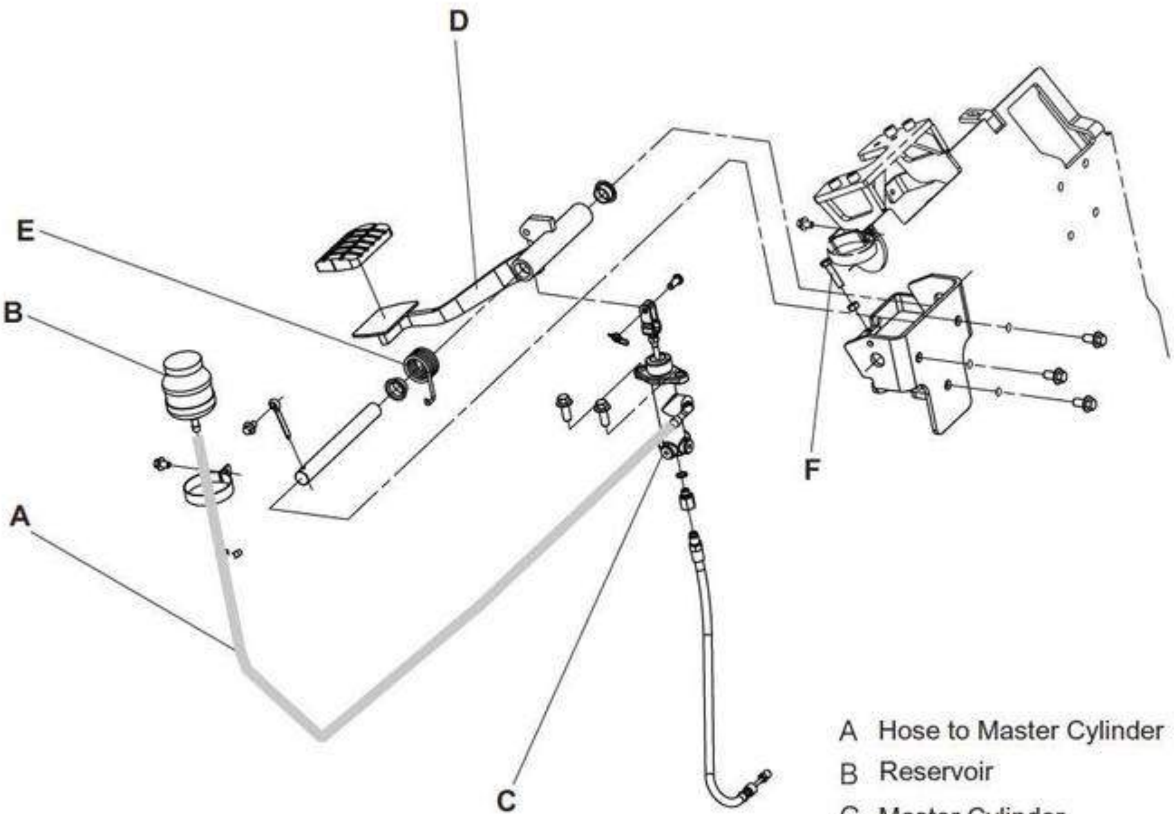
Replace the brake pedal components as shown in Figures 1 and 2 using fastener torques where shown. Also use the following notes:

1. Clean the reservoir and master cylinder hoses and fittings. Make sure no contaminants enter the braking system.
2. Adjust pedal free play as described in "Pedal Adjustment" on the page.
3. After re-assembly and adjustment, the brake system must be bled, see Section 2 in this Group. After bleeding, check all fluid connections for leaks and test brakes completely before returning truck to service.

Freeplay Adjustment

When the brake pedal linkage is properly adjusted, braking should begin only after the pedal is depressed a certain distance, This is "Freeplay" is Adjusted as follows :

1. Loosen the jam nut on the rod brake master cylinder (Figure 1).
2. Depress the brake pedal 4~6mm (0.16~0.24 in).
3. Adjust the rod until you feel the push rod make clearance with the cylinder piston.



A Hose to Master Cylinder
B Reservoir
C Master Cylinder
D Pedal
E Pedal Spring
F Stop Screw

NOTE :

Section 6

Service Brake Adjustment and Overhaul

External Inspection

The brake linings, drum, and adjustment setting can be inspected without removing the drum or hub.

1. Jack up and block the front of the truck as described in Group SA.
2. Remove the wheel and examine the linings through the shoe inspection notch in the drum.
   If the linings appear to be worn to a thickness of 1 mm (0.04 in) or less at any point, replacement of both shoes is required.
3. If the linings are OK, measure each shoe-to-drum gap through the shoe inspection notch, first rotating the notch into alignment with the lower end of each shoe. If the gap is not 0.10-0.35 mm (.004-.014 in), adjust as described in "Shoe-to-Drum Gap Adjustment."

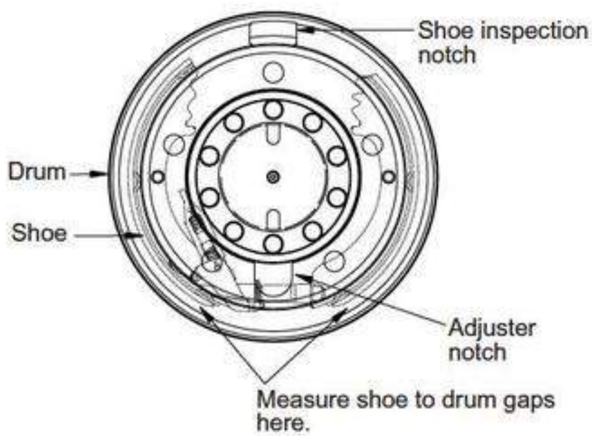


***Figure 1**. Inspection and Adjustment Notches*

4. Rotate the adjuster notch over the adjuster to Adjust (at 6 o'clock position).

Shoe-to-Drum Gap Adjustment

The brake shoes are self-adjusting. However, manual adjustment is required when shoes are replaced or if brake shoes are binding against drums.

To decrease gap/increase gap (for each shoe) :

1. Measure the shoe-to-drum gap as described in "External Inspection."
2. Through the adjuster notch, rotate the star wheel one click with screwdriver or adjusting tool.
3. Repeat steps 1 and 2 until proper gap is achieved.

Internal Inspection and Repair

Jack up and block the front of the truck as described in Group SA. Remove the wheel. The hub does not have to be removed.

Brake Drum Removal and Replacement

The drum fits tightly on the hub. To remove drum, install M12 screws into the jackscrew holes to push the drum away from the hub. To install the hub, align the adjuster notch with the notch in the hub and drive the drum against the hub with a soft mallet.

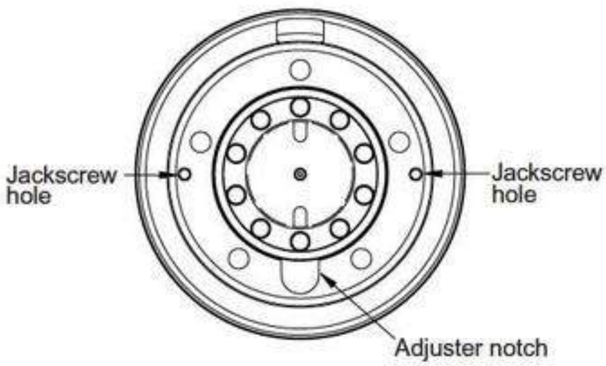


Figure 2. Jackscrew and Adjuster Notch Locations

Inspection

Brake Shoes : If the linings are cracked or scored or the linings are worn to 1 mm (.04 in) or less, the shoes must be replaced. Both sets of shoes should be replaced when one is replaced.

Brake Drum : The maximum allowed internal diameter for the brake drum is 312 mm (12.28 in). Brake drum walls should be free from scoring. Brake drums should be machined each time brake shoes are replaced, to provide a smooth and uniformly round braking surface.

Wheel Cylinder : Check for leakage under the boots at each end of cylinder. If the cylinder leaks, or troubleshooting otherwise indicates a bad cylinder, disassemble and inspect the wheel cylinder. If the cylinder surface is scratched or pitted, replace the cylinder. Always replace the cups.

General : Check for worn-out springs, warped backplate, and loose or corroded fasteners. Check adjuster for proper operation and replace if faulty.

Brake Shoe Removal

Remove the cable Assembly, lever, adjuster, the guide springs, lower return springs, upper return springs, and shoes (Figure 6).

Brake Shoe Replacement

1. Place the forward shoe — the shoe with the parking brake lever — on the cylinder rods (Figure3).
2. Install the parking brake cable, making sure it is hooked on the lever and clipped to the backing plate,
3. Install the shoe hold spring and upper return spring.
4. Install cross-strut (with spring), making sure notch in cross-strut end engages slot in parking brake lever on forward shoe.
5. Place the rearward shoe into position on the cylinder rods, making sure the spring-end of the cross-strut engage the upper notch on the shoe.
6. Install the shoe hold spring and upper return spring.
7. Install the adjuster between the under notch on the shoes.
8. Install lower return spring, making sure long end of spring is toward too forward shoe to avoid interference with lever.

Cylinder Removal and Replacement

1. Remove the brake shoes as described previously.
2. Remove the brake cylinder mounting bolts and washer.
3. Tap cylinder from backing plate with soft mallet.
4. When reinstalling : Seal the gap where the brake cylinder fitting extends through the backing plate with silicon caulk. Tighten cylinder mounting bolts to 17.65-26.48 N·m (156-234 lbf·in).

Adjuster Removal and Replacement

1. Remove the under spring.
2. Remove the adjuster.
3. Install the adjuster between the under notch on the shoes.
4. Install lower return spring.

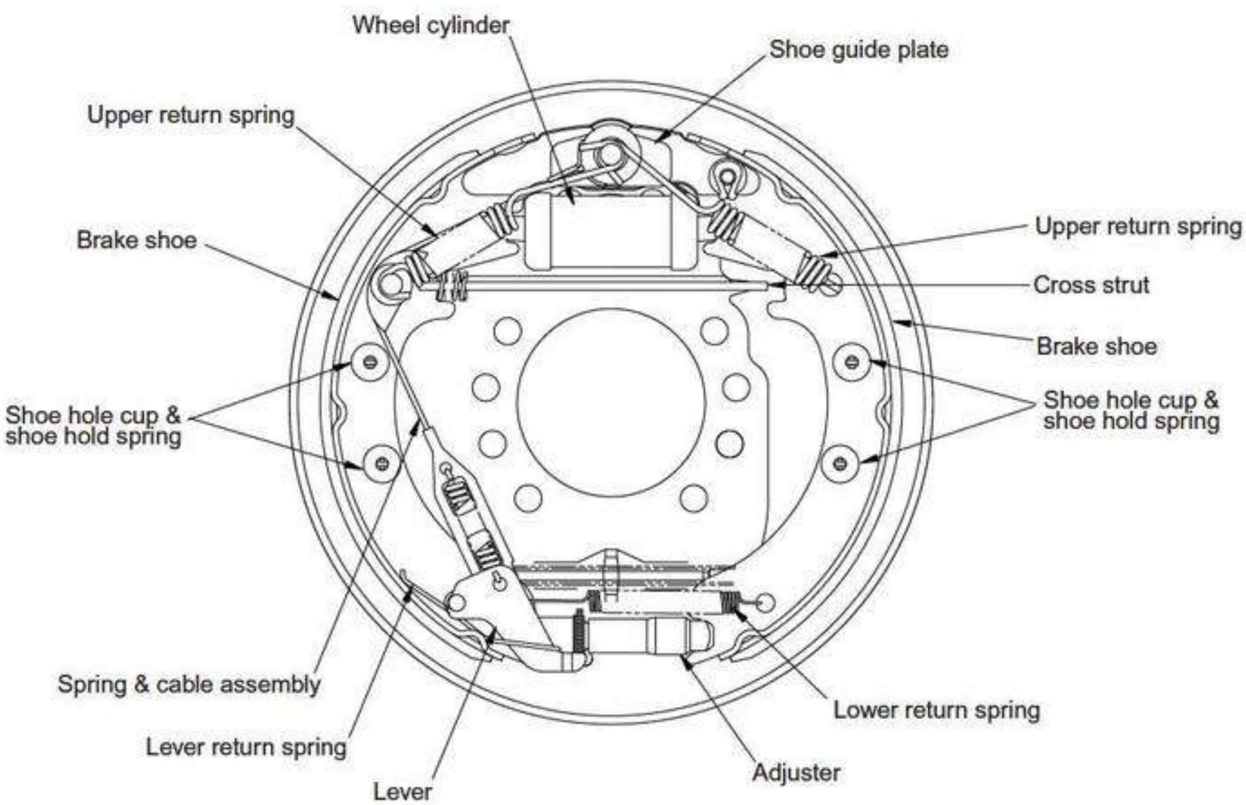


Figure 3. Brake Assembly

Wheel Cylinder Overhaul

1. Pull off rubber boots.
2. Push out internal parts (loosen with wooden dowel if necessary).
3. Replace cylinder if scored or pitted.
4. Clean pistons, spring, and casing in solvent.
5. Install spring and pistons.
6. Install each cup from its respective end of cylinder.
7. Replace boots.

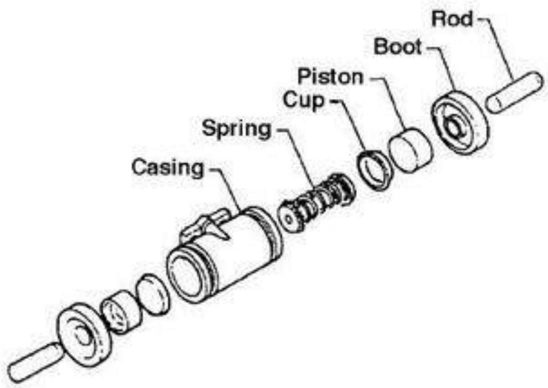


Figure 4. Wheel Cylinder-Disassembled

Brake Assembly Removal, and Installation

To access the service brake assembly, remove the axle hub and brake drum as described in Group 6, in the "Drive Axle Ends Overhaul" Section. Inspect the drum as described earlier.

To remove the service brake assembly:

1. Remove the brake shoes as explained earlier.
2. Pull the snap ring that holds the parking brake cable to the backing plate.
3. Unhook the parking brake cable end from the lever and pull the cable from the assembly.

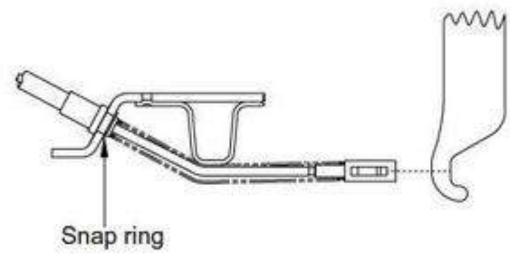


Figure 5. Parking Brake Cable

4. Disconnect the brake line from the fitting. Cap or plug fittings.
5. Unbolt the brake assembly from the axle.
6. When reinstalling the brake assembly, torque the mounting bolts to 220-230 N·m (162-170 lbf·ft) in a staggered sequence. Torque fitting 15-19 N·m (133-168 lbf·in).
7. Bleed the brake system as described in the brake bleeding Section.

Operational Explanation of the Auto Adjuster

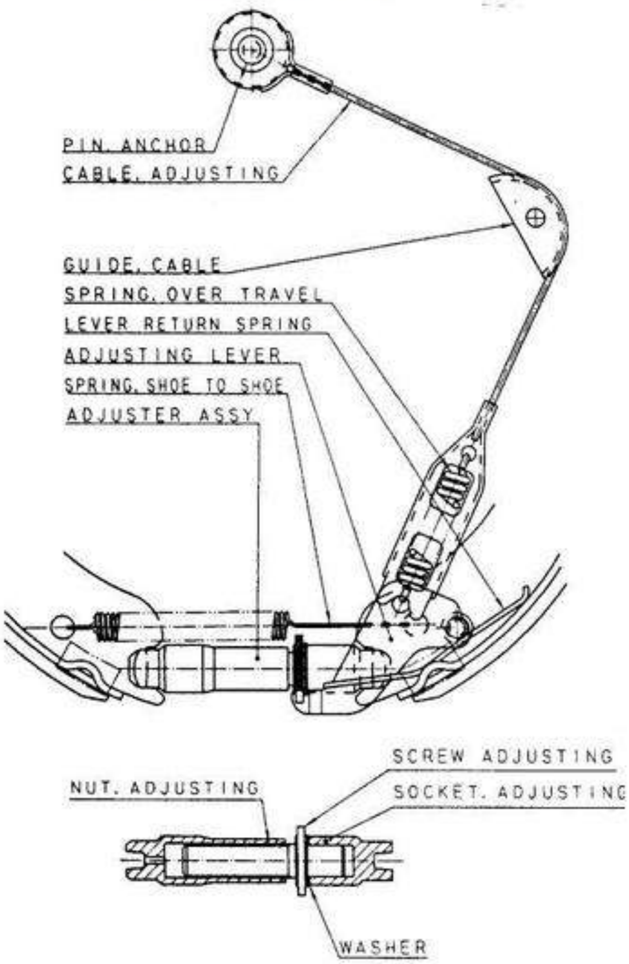


Figure 6. Auto Adjuster

1. When lining gets worn out, which requires adjustment, secondary shoe with auto-adjusting device is kept separated from anchor at time of braking action backward, helping to pull cable by its separated distance.
   The cable pulls up adjusting lever via over-travel spring and rotates adjusting wheel.
2. When braking is released, secondary shoe gets back to anchor and then lever is forced to go back to original position by lever return spring, making gap between adjusting star wheel and lever.
3. As long as lining does not get worn out to the extent of as much as needing next adjustment, adjusting star wheel does not rotate since lever is unable to move enough to fill up gap between adjusting star wheel and lever, even if lever moves by backward braking action.
4. No adjustment is made by forward braking because anchor pin and secondary shoe keep same relative position.

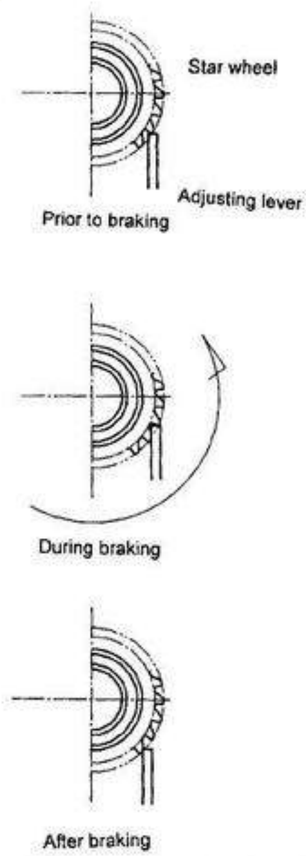


Figure 7. Relation between star wheel and adjusting lever at time of auto-adjustment

Characteristics

Corresponding to worn-out ratio of lining, clearance is adjusted automatically and consecutively, always being kept at constant level and therefore pedal stroke remains unchanged.

Reliability is very high due to adjustment being made by pulling cable at time of braking.

Due to installation of over-travel spring :

A. Adjusting parts are not damaged even by extra force put to cable.
B. Especially, it helps prevent over-adjustment at time of abrupt braking. (Its reasoning : After braking torque occurs, shoe has a greater moving due to drum deformation and even if trying to rotate adjusting wheel, thrust-loading is working on adjuster which enables over-travel spring to lengthen too far to rotate adjusting wheel.)

Section 7

Parking Brake Service

Operation

The operator applies the parking brake by depressing a **foot pedal**, which is then held down by a **ratchet**. The depressed pedal tensions cables connected to a brake shoe at each brake assembly, thereby applying the brakes.

The operator releases the parking brake by pulling up on a **release handle**. This handle releases the ratchet, and a **return spring** returns the pedal and cable to the off position. The ratchet also operates the parking brake interlock switch and the parking brake indicator light switch.

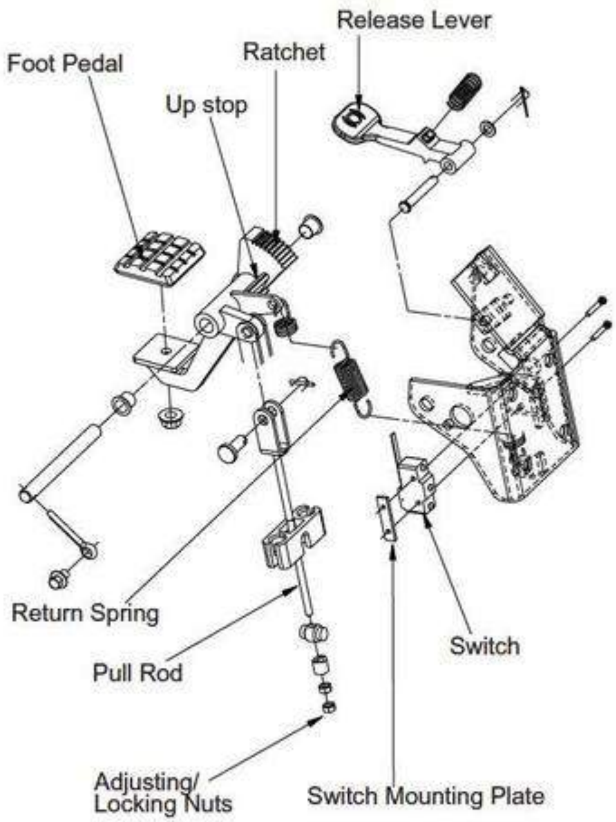
Adjustment

1. With the pedal fully raised, **upstop** against tab on bracket, **adjust** slack out of brake cables and tighten **adjusting/locking nuts**.
2. Actuate and release pedal six to eight times.
3. Readjust and tighten nuts.

Removal and Replacement

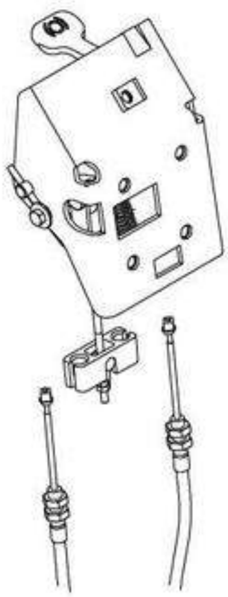
As shown in illustration below, with these notes:

- Remove **return spring** for better access to **bracket mounting nuts**.
- Adjust position of interlock and indicator **switches** with pedal upstop against tab on bracket. Switch contacts should snap from their operated contact position to their normal position when pedal is depressed one ratchet click.
- Torque **switch mounting nuts** 0.8-1.0 N·m (7-9 lbf·in). Torque **bracket mounting nuts** 20-23 N·m (177-210 lbf·in).
- Apply a thin coat of Clark lubricant, part #1802155, to ratchet teeth and ball end of **wire rope** prior to assembly.

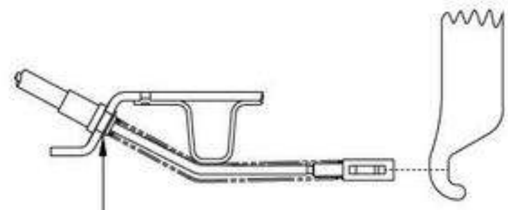


Parking Brake Cable Removal and Installation

1. Disconnect each parking brake cable from the ratchet assembly as shown in the illustration below.



2. Remove the parking cable from the service brake assembly by first removing the brake shoes as described in the "Brake Overhaul and Adjustment" Section of this Group.
3. Pull out the C-clip that holds the parking brake cable to the backing plate.
4. Unhook the parking brake cable end from the lever on the shoe and pull the cable from the assembly.



5. Installation is the reverse of removal.

EM brake Service (Option)

Operation

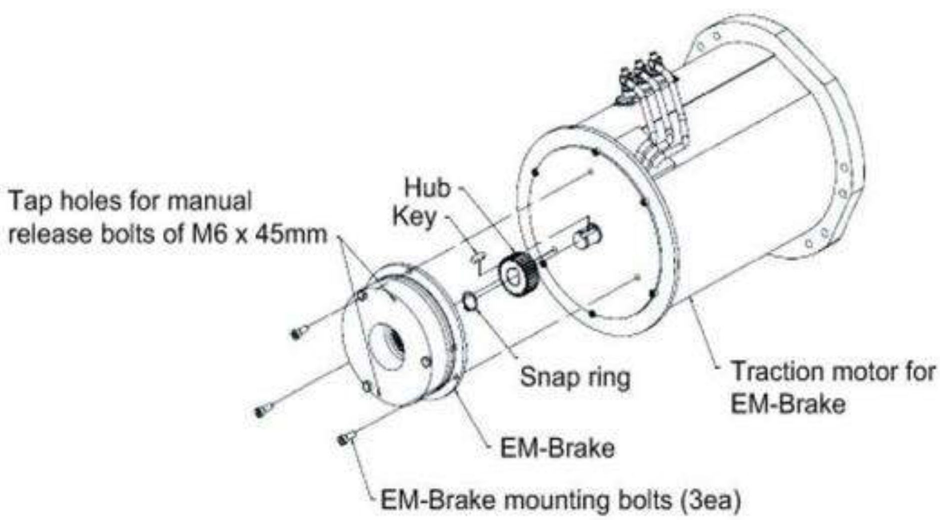
EM brake is applied to the motor shaft when key switch is off or seat switch is open.

It means that EM brake coil release the brake pad only powered by controller, and truck can be traveled.

Removal and Replacement

As shown in illustration below, EM brake is assembled to the motor with just 3 bolts and key on the motor shaft.

- Release the un-powered EM brake pad with 2 bolts have spec of M6 x 45mm, which says Manual Release Bolt. When a service is needed on free-running motor status, release the EM brake to screw down tight these 2 of Manual Release Bolt.
- Remove 3 mounting bolts on the EM brake.
- Remove the snap ring and Hub on the motor shaft.
- When re-assembling the EM brake to the motor, screw 2 of the Manual Release Bolts down tight to release the EM brake Pad.
- After completing assembling of the EM brake to the motor , please remove these Manual Release Bolt to engaging brake properly.
- On the emergency case of faulted EM brake, apply the Manual Release Bolt to release Parking brake.



GROUP 25

STEERING COLUMN AND GEAR

NOTE :

Section 1

Steering System Specifications and Description

Specifications

Steering System Type: Hydrostatic power steering with load sensing, dynamic signal neutral circuit.

Steering System Relief Pressure Setting: 8600 kPa (1250 psi)

Service Intervals

Check the steering system relief pressure annually or after every 2000 hours of operation. Make a visual inspection of steering control unit hydraulic fittings periodically to ensure that the fittings are tight with no leakage.

Fastener Torques

Steering Handwheel Nut: 35-40 N·m (25.5-29.5 ft-lb)

Steering Column Cover Hex Bolts: 2-3 N·m (18-27 in-lb; 1.5-2.25 ft-lb)

Directional Control Base Lock Nut: 0.8-1 N·m (7-9 in-lb; 0.6-0.75 ft-lb)

Directional Control Base Flange Capscrew: 3.5-4.0 N·m

(2.5-2.9 ft-lb)Tilt Lock Assembly Base-to-Cowl Bolts: 20-25 N·m(14.8-18.5 ft-lb)

Orbitrol Bracket Bolts: 34-38 N.m (25-28 ft-lb)

Lower Column Assembly Base-to-Steering Gear Bolts:34-38 N·m (25-28 ft-lb)

Wiring Harness Bracket Bolts: 11-13 N·m (8-9.5 ft-lb)

Description

All truck models have a hydrostatic power steering system, which is supplied with oil pressure from the main hydraulic pump. The steering hand wheel operates the steering gear (steering control unit), which directs oil flow to the steering cylinder on the steer axle. A steering system pressure relief valve is built into the steering control unit to prevent over-pressurization of the steering system. The pressure relief setting can be tested by installing a test fitting install Quadrigage at pressure inlet of steering gear.

The power steering gear is a remote positioning control valve that senses the input signal from the steering hand wheel, multiplies this signal to assist in reducing the steering effort, and causes the steering axle to turn the wheels to the desired position by supplying hydraulic flow to the steering cylinder.

The steering gear is connected to the bottom of the steering column. When the steering hand wheel is turned, it is linked mechanically to the steering gear spool and causes this spool valve to shift from its closed neutral position to a "turn" position that allows oil under pressure to flow to the steering cylinder.

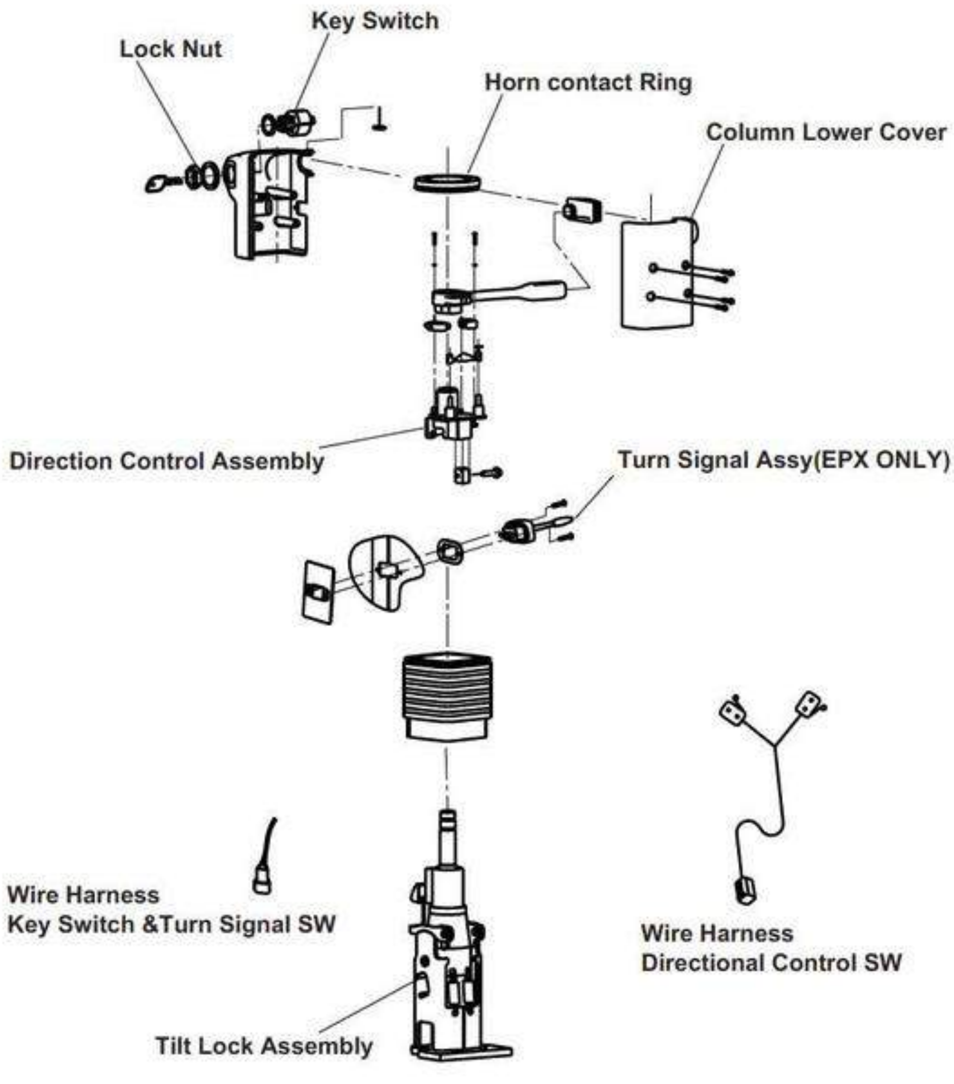
When the steering hand wheel stops turning, centering springs in the valve automatically center the spool, stopping the flow of oil to the cylinder.

The low pressure oil from the opposite side of the steering cylinder is returned through the opposite port in the gear. It is controlled by the same spool as the high pressure port.

In the event of a pump failure, the steering gear can generate sufficient hydraulic power by movement of the steering handwheel to serve as a limited steering method. An internal check valve automatically closes to divert this generated oil flow to the proper port of the steering cylinder. The handwheel turning effort is considerably higher, however, than with power steering.

The column tilt lock mechanism allows the operator to adjust the steering column. The column tilt lever knob releases the adjustment setting and the column returns to the up position by the use of springs. The tilt lock mechanism, the directional control lever, and the key switch are protected by the steering column cover.

The cover can be removed for service to steering column components. The entire column can be removed for service or replacement. The steering gear, attached to the base of the column, can be removed without disassembling the other parts of the steering column.



Direction Control & Turn Signal Assy

Section 2

Steering System Troubleshooting

No steering

- Hydraulic fluid level very low.
- Air in hydraulic oil.
- Steering column sections not connected properly.
- Hose broken.
- Hydraulic pump contaminated or defective.
- Priority valve spool stuck.

Hard steering

- Hydraulic fluid level low.
- Air in hydraulic oil.
- Steering gear contaminated or defective.
- Relief valve setting too low; adjust or replace.
- System leaking.
- Axle load too heavy.
- Lack of lubrication.
- Defective steering gear.
- Spring in priority valve broken.

High number of handwheel turns

- Steering cylinder seal leakage.
- Worn steering gear.

Steering handwheel spins freely

- Air in system (cavitation).
- Low oil supply.
- Steering column detached from steering gear.
- Defective steering gear.

Jerky steering

- Steering gear malfunction because of worn parts or contamination. Steering gear may require overhaul.

Truck turns in wrong direction

- Hydraulic lines not installed correctly.

Handwheel kickback

- Check valve faulty (or not in system).

Slow steering response

- Oil viscosity too high.
- Contaminated or defective steering gear.

Chatter conditions

- Loose mountings or linkage. Make certain all mounting fasteners and other linkage is tight.
- Pressure relief valve set too low and is out of adjustment; adjust or replace the relief valve.
- Insufficient pump flow. Check pump for leaks and see Section 5 of this Group.

Unsatisfactory steering in either direction

- Air in system due to excessive wear in steering cylinder. Check for air in system. Excessive noise or foamy condition of hydraulic fluid indicates aeration. Check that air is not entering the system through poor threads, cracked, split, or worn hoses, bad pump seals, bad O-rings, bad gaskets, or loose connections.

  Worn cylinders result in leakage past the piston. Overhaul (see Group 26, Section 6) or replace the steer cylinder.
- Incorrect system pressure due to worn pump. Replace the relief valve or repair or replace the hydraulic pump.

Noise during turns

- Worn bearing(s) in steering arm; replace bearings.
- Worn pin in steering knuckle; replace pin.
- Worn bearings in steering knuckle; replace bearings.
- Steering knuckle is loose; tighten castle nut.

Constant noise from steering axle

- Loose or worn hub bearing cones. Adjust or replace hub bearing cones. Replace bearing cones and bearing cups as a set.

Noise when axle pivots

- Steering axle mountings worn; replace mountings.
- Steering axle mounting cap(s) loose; tighten mounting cap(s).

Fluctuating pressure

- Faulty operation of relief valve. Fluctuating pressure or loss of pressure in the system is usually caused by scales, chips, sludge, or filings that have lodged between the relief valve and seat. A damaged spring or worn valve may also be the cause of the trouble. Flush and refill the system and replace the hydraulic return line filter element.

Low pressure at the steering gear

- Refer to Group 26.

Steer cylinder rod binding or sticking

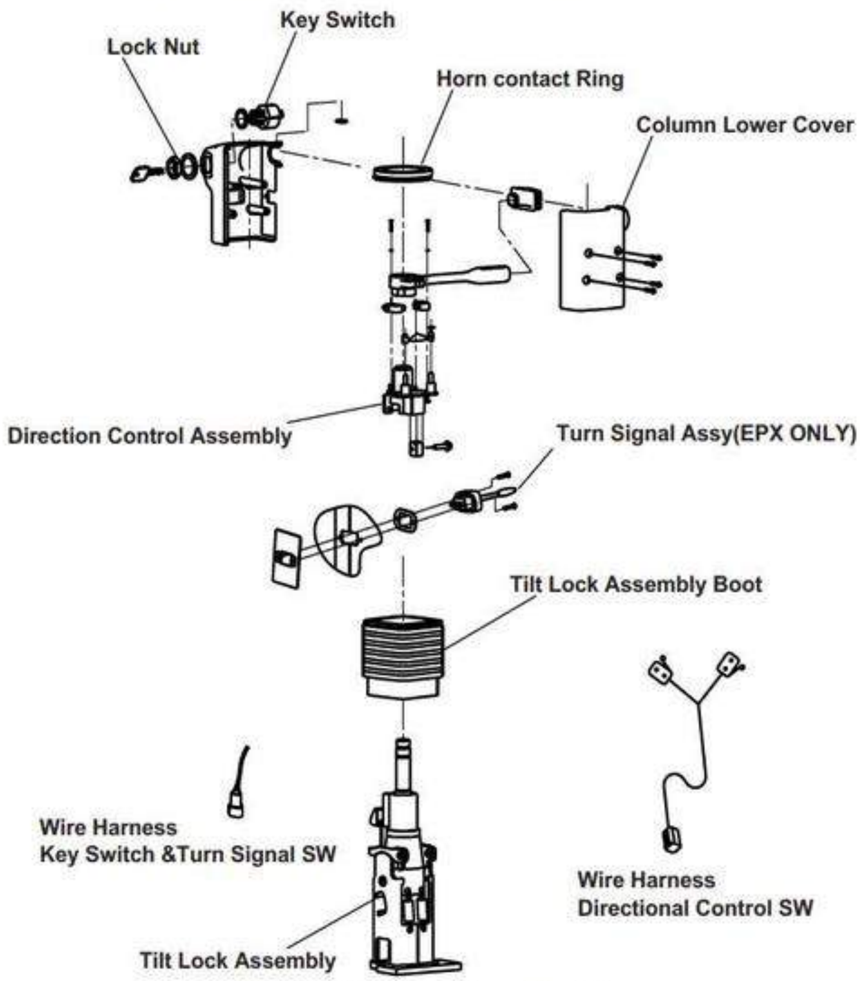
- Binding of linkage. With hydraulic flow shut off from the cylinder and the rod end uncoupled, the rod should slide freely in or out by hand. If the piston is binding, overhaul or replace the cylinder.

Section 3

Steering Column and Component Removal and Replacement

IMPORTANT

Before removing any component for overhaul, make sure the correct repair parts, seals, and gasket sets are available.



Typical Steering Column Assebly

⚠ CAUTION

SAFE PARKING. Before working on truck:

1. **Park truck on a hard, level, and solid surface, such as a concrete floor with no gaps or breaks.**
2. **Put upright in vertical position and fully lower the forks or attachment.**
3. **Put all controls in neutral. Turn key switch OFF and remove key.**
4. **Apply the parking brake and block the wheels.**

Steering Column and Component Removal

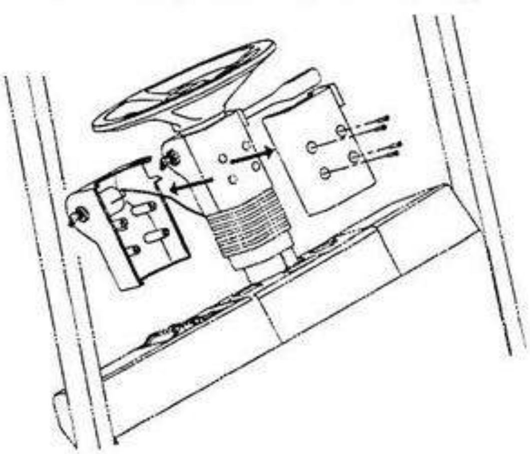
Use the following steps to disassemble the steering column for service to the:

- Key Switch
- Horn Button
- Directional Control Lever Assembly
- Turn signal Lever Assembly for EPX.
- Column Tilt Lock Assembly
- Upper and Lower Steer Column
- Steering Gear.

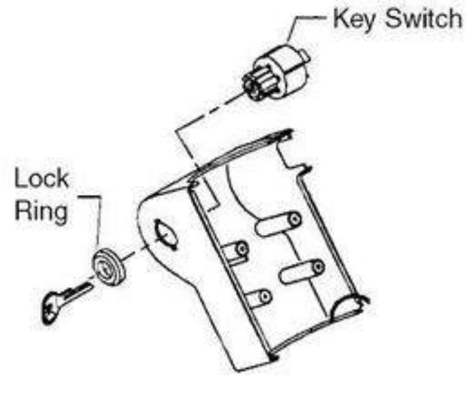
Determine which component requires service and check the procedure for removing that component. Read the procedure completely before beginning disassembly.

Key Switch Removal

1. Disconnect the battery.
2. Remove the four socket head bolts holding the two halves of the column cover together. The directional control assembly and the key switch are exposed.

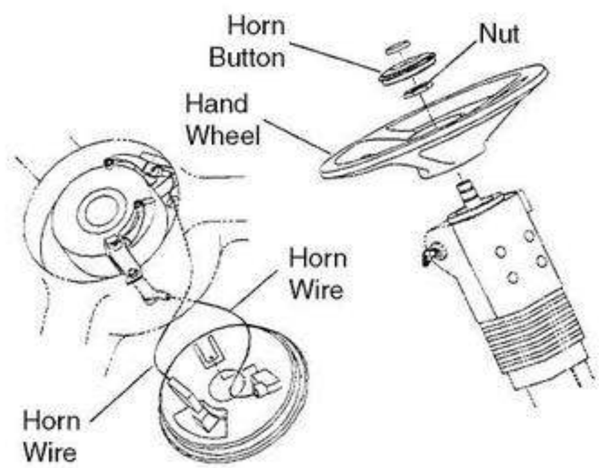


3. Remove the lock ring nut securing the key switch to the lower cover. Label all wires and terminals for correct reconnection when reassembling.



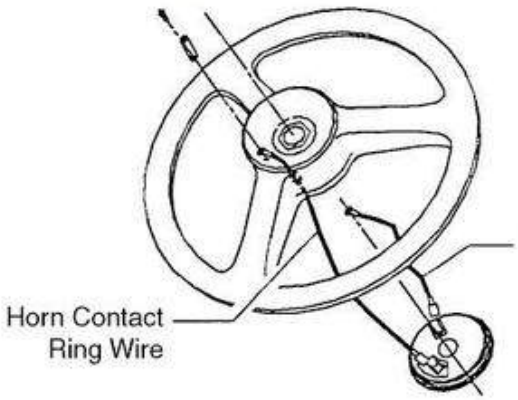
Hand Wheel, Horn Contact Ring, and Directional Control Assembly Removal

1. Disconnect the battery.
2. Gently pry the horn button from the steering hand wheel hub using a small, flat-bladed screw driver.

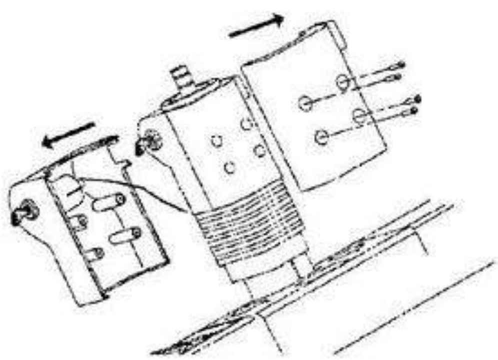


3. Disconnect the horn wire from the steer column and unplug the horn contact wires from the terminal on the bottom of the horn button.
4. Remove the nut holding the hand wheel to the steering column.
5. Use a wheel puller to remove the hand wheel from the steering column. Hand wheel has two M8X1.25 threaded inserts in the hub for this purpose.

6. Unplug the horn contact ring wire from the terminal on the bottom of the handwheel.



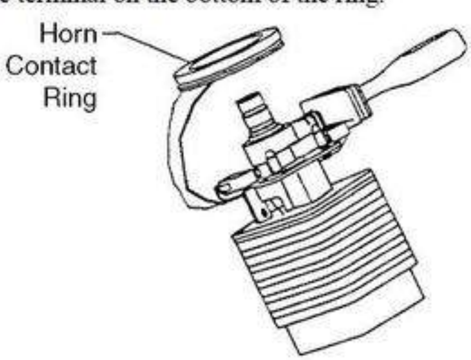
7. Using a 2.5 mm allen wrench, remove the four socket head bolts holding the two halves of the column cover together. Remove the top cover. Gently pull thebottom cover away.



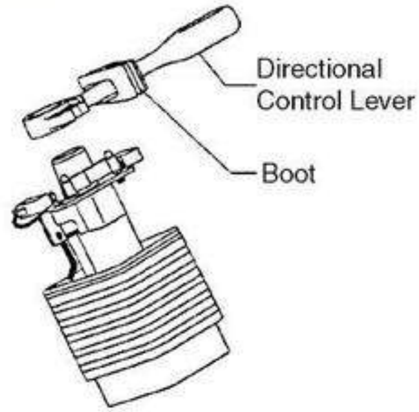
NOTE

Use care when removing the bottom cover as the ignition switch wiring is attached.

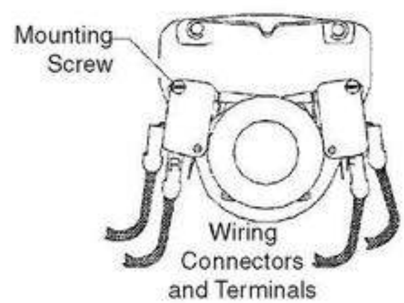
8. Remove the horn contact ring. Unplug the wire from the terminal on the bottom of the ring.



9. Lift the directional control lever and boot off the diecast base.



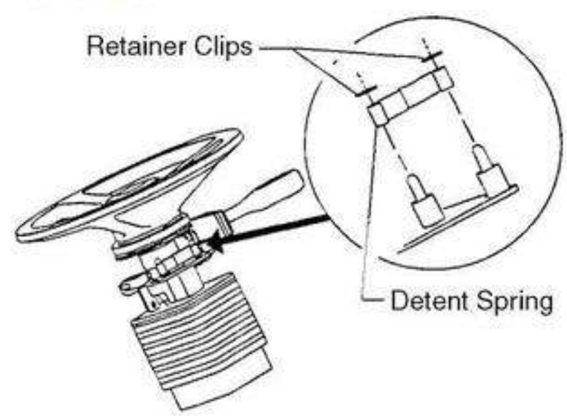
10. Unplug wires from directional switches. Label all wires and terminals for correct connection when reassembling. Remove the direction control switches by removing the mounting screws on the base.



Directional Control Lever Detent Spring Removal

11. If not already disassembled, remove the four socket bolts holding the two sides of the column cover together. Remove the top cover.

12. Pry the two retainer clips from the posts on the directional control base securing the detent spring. Lift spring off posts.

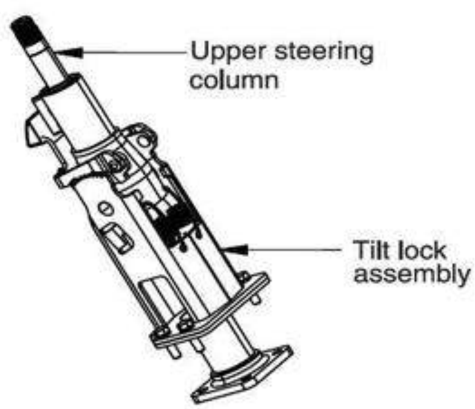


Column Tilt Lock Assembly Removal

NOTE

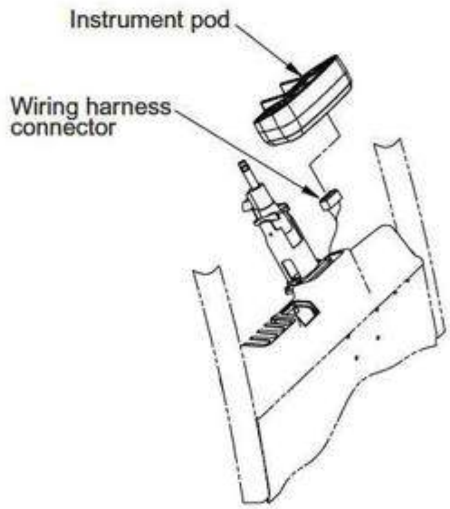
The tilt lock assembly is not serviceable; only the return springs are serviceable. The tilt lock assembly should be removed only for replacement as a complete assembly.

1. Lift out the floor plate.
2. Remove the left, right, and center cowl covers from under the dash. See removal and replacement procedures in Group 38.
3. See "Hand Wheel, Horn Contact Ring, and Directional Control Assembly Removal" to remove the steering hand wheel, horn ring, and directional control assembly.
4. Unplug the key switch and directional control switches. Label all wires for correct reassembly. Disconnect the ignition and directional control wiring harness from the main harness at lower right of cowl..



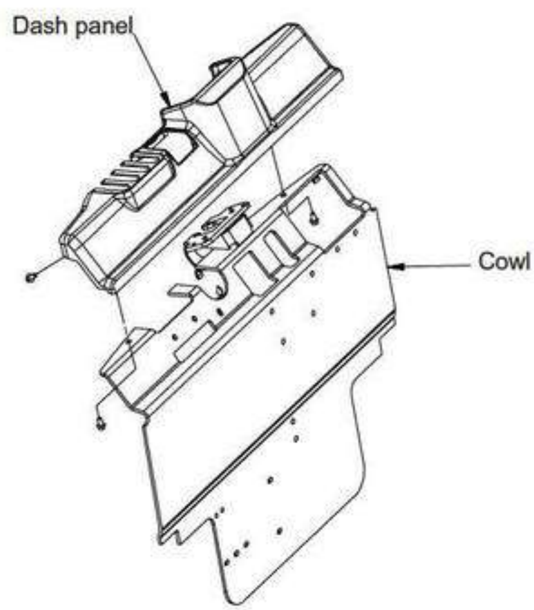
5. Slip the boot off the tilt lock assembly.
6. Remove the dash panel and instrument pod :

a. Remove the three screws securing the instrument pod to the dash.



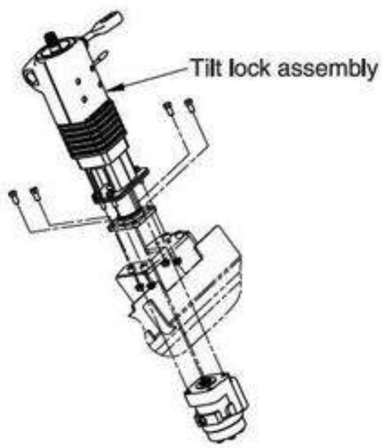
b. Gently lift the instrument pod up exposing the harness connector. Unscrew jack screw in connector and unplug the connector from the instrument pod.

c. Remove the screws securing the dash panel to the cowl.



d. Remove the hydraulic control lever cover panel and dash.

e. Remove the two bolts from the wiring harness bracket located under the cowl.
f. Remove the four bolts holding the base of the tilt lock assembly to the cowl.

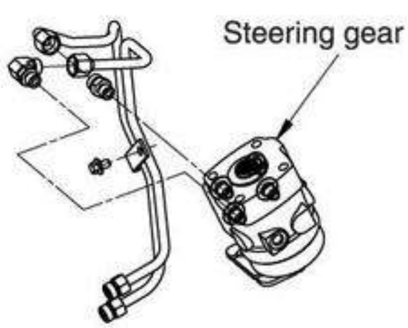


Steering Gear and Lower Steering Column Removal

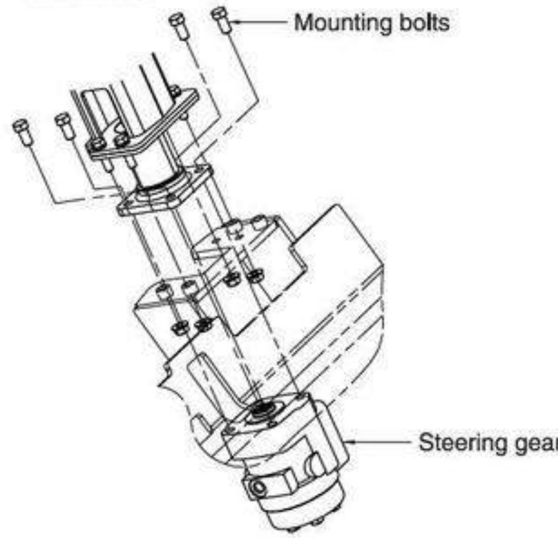
NOTE

Lower steer column is not serviceable. It should be removed only for replacement as a new assembly.

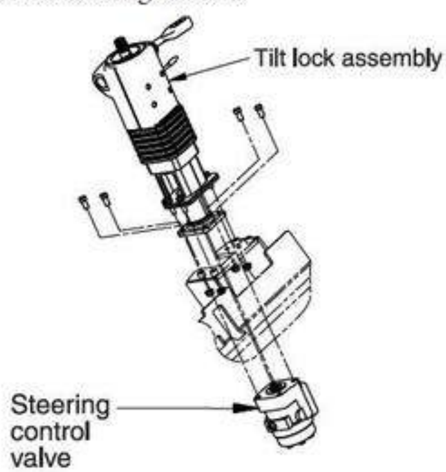
1. Put a pan under the truck to catch hydraulic fluid which will drip when fittings are loosened. Label the four hose fittings of the steering gear to make sure they are reassembled correctly. Loosen and remove the hydraulic fittings at the steering gear. Cap the ends to prevent fluid leaks. Cap the steering gear ports to prevent dust and debris from getting into the steering gear. Keep hydraulic ports and hoses clean.



2. If upper portion of the steering column has not been removed, loosen the pinch bolt of the lower universal joint connection.
3. Remove the two bolts and spacers securing the lower column shaft and steering gear to the bracket on the lower cowl.



4. Remove the bolts to detach the steering gear from the lower steering column.



5. Remove the lower shaft and steering gear assembly from the truck.

Steer Column and Component Replacement

These steps cover the procedures for reinstallation of the steering column including the steering gear, the tilt lock assembly, directional control assembly, ignition switch, and steering hand wheel and horn.

IMPORTANT

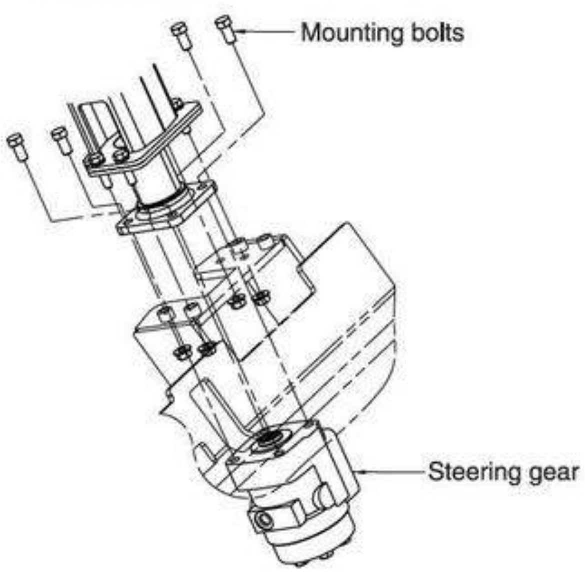
Make sure all parts are clean and dry before reassembling.
It may be necessary to assemble the steering column in place and hand tighten fittings so that the correct alignment of the entire column and parts can be checked. Once you have the correct alignment, torque all fittings to their correct specifications.

Steering Gear Replacement

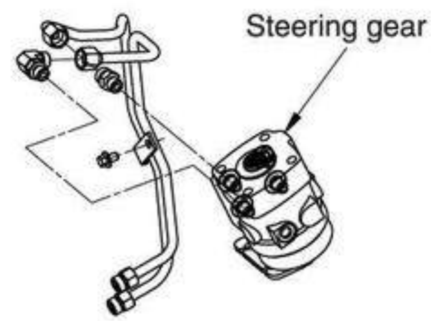
NOTE

If the upper steering column has not been removed, the lower steering column must be left loose at the universal joint pinch connection to allow some play in the column for positioning the steering gear.

1. Attach the steering gear to the column base. Torque the two bolts to 34-38 N·m (25-28 ft·lb).
2. Set the column into position with the column assembly aligned through the bracket mounted on the lower frame cowl.

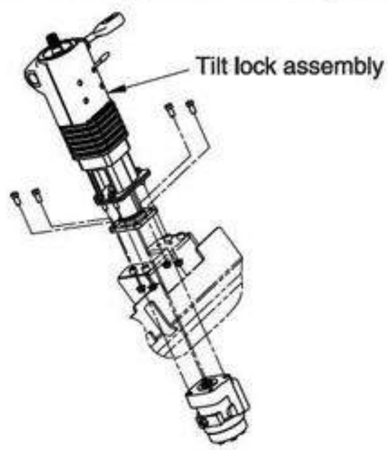


3. Coat the splines of the lower assembly with a light coat of anti-seize lubricant and insert into the universal joint pinch connector of the upper assembly. Match the skip tooth on the spline with spline on universal joint. Torque the pinch bolt to 25-30 N·m (18.5-22.25 ft·lb).
4. Reconnect the clean hydraulic fluid lines to the clean steering gear. Make sure the hoses are reconnected to the correct ports. Torque the fittings per Group 40, "Hydraulic Fitting Tightening Procedure."



Column Tilt Lock Assembly Replacement

1. Set the tilt lock assembly onto the cowl. Replace the four bolts and torque to 20-25 N·m (14.8-18.5 ft·lb).

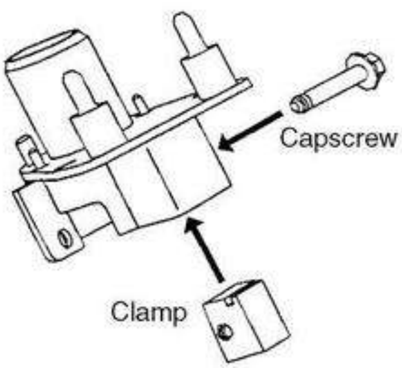


2. Coat the splines of the lower assembly with a light coat of anti-seize lubricant and insert into the universal joint pinch connector of the upper assembly. Match the skip tooth of the lower column spline shaft to that on the universal joint. Torque the pinch bolt to 25-30 N·m (18.5-22.25 ft·lb).
3. Set the harness bracket into place and secure with the two bolts. Torque the bolts to 11-13 N·m (8.1-9.6 ft·lb).

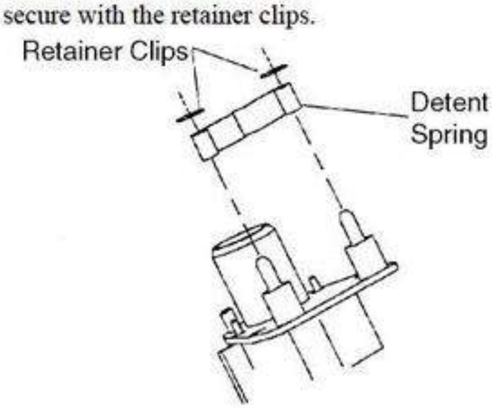
4. If the wiring harnesses have been removed, reroute them through the tilt lock assembly with the ignition wiring harness in the left hole and the directional switch wiring harness in the right hole. Harnesses must exit lower part of the steer column behind the steer shaft (towards rear of truck). Reclamp to cowl if necessary. Reconnect the assembly wiring harnesses to the truck wiring harnesses.
5. Slip the boot over the tilt lock assembly.

Directional Control Assembly Reassembly

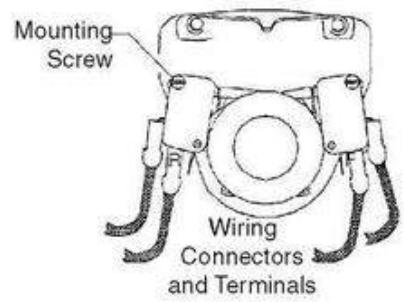
1. Slip the lever boot onto the lever if it has been removed.



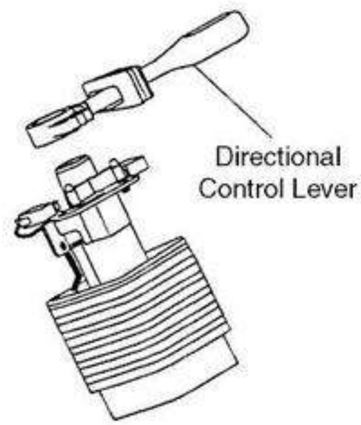
2. Make sure the flange capscrew and clamp are on the directional control base.
3. Install the detent spring on the posts of the base and secure with the retainer clips.



4. Reset the forward or reverse switch onto the base and secure with screws.

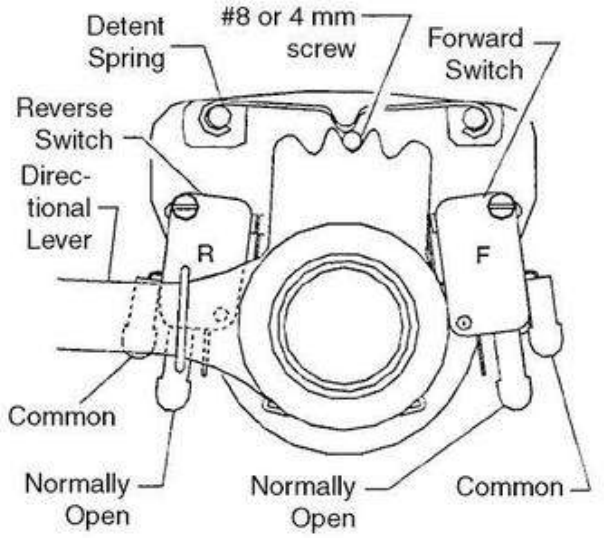


5. Apply a thin coat of grease in the bore of the directional control lever. Slip the lever onto the directional control base.



6. Tighten the capscrew/clamp of the directional control lever assembly to 3.5-4 N·m (2.5-2.9 ft-lb).
   - Clean the capscrew and apply Loctite 262 before applying torque.

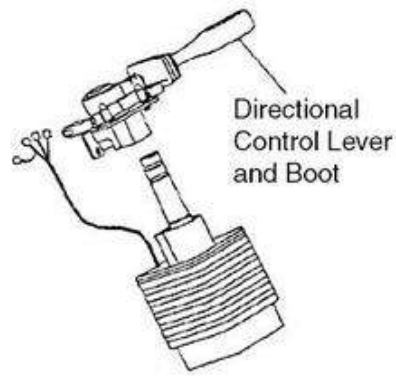
7. Adjust the directional control using the following illustration:



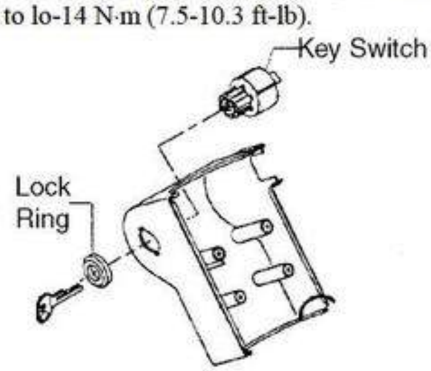
a. Loosen mounting screws and set the directional switch boxes to approximately the middle of the mounting slot on the assembly base.
b. Connect a continuity meter on the forward switch from the Common terminal to the Normally Open terminal. If the adjustment procedure is being performed with the directional control assembly mounted on the steering column, connect the continuity meter from the Normally Open terminal to vehicle ground.
c. Rotate the directional control lever in the forward direction (push lever up) until a #8 (or 4 mm) screw can be inserted into the middle detent on the lever.
d. Loosen the mounting screw on the forward switch and adjust the switch box to achieve continuity through the switch.
e. Remove #8 (4 mm) screw and return lever to neutral detent. Switch must break continuity, If switch does not break continuity, it must be readjusted using the above steps.
f. When adjustment is correct, torque switch box mounting screws to 0.8-1.0 N·m (7-9 in-lb; 0.6-0.73 ft-lb).
g. Repeat procedure for Reverse switch.

Directional Control Assembly and Key Switch Replacement

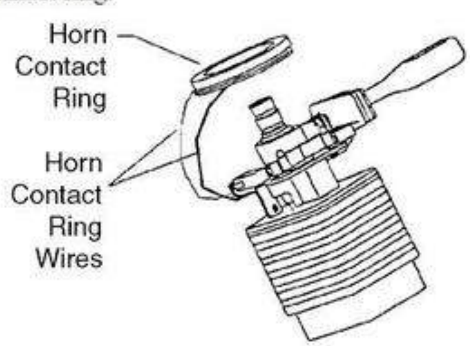
1. Disconnect the battery.
2. Slip the directional control assembly onto the steering column shaft.



3. Clean the capscrew, apply Loctite 262, and tighten the clamp bolt of the assembly to 3.5-4 N·m (2.5-2.9 ft-lb).
4. Check the assembly for smooth operation and make necessary adjustments before proceeding.
5. Connect the wiring to the directional control switches according to the labels you made during disassembly.
6. Set the key switch into the mounting hole on the lower half of the column cover. Tighten the lock ring nut to lo-14 N·m (7.5-10.3 ft-lb).

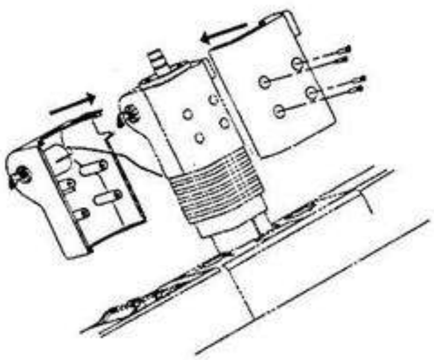


7. Reconnect the horn contact ring wires to the horn contact ring.



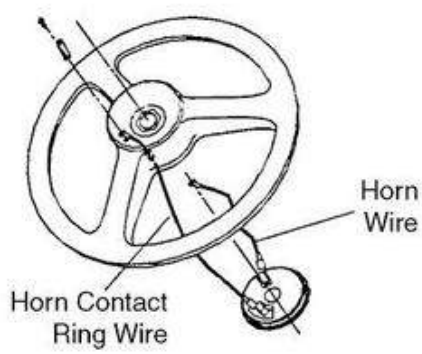
8. Slip the horn contact ring onto the steering column. The groove in the ring should be on the lower portion of the ring when it is replaced on the column. The terminal should be on the right-hand side of the muck.

9. Join both halves of the cover over the upper column. The parting line of the boot must be aligned with the parting line of the two cover halves. Set the directional control lever boot into the correct position. The horn ring contact should be positioned so that the two cover halves fit the groove in the ring. Tighten the four socket bolts to 2-3 N·m (1.5-2.25 ft-lb).



Steering Hand Wheel Replacement

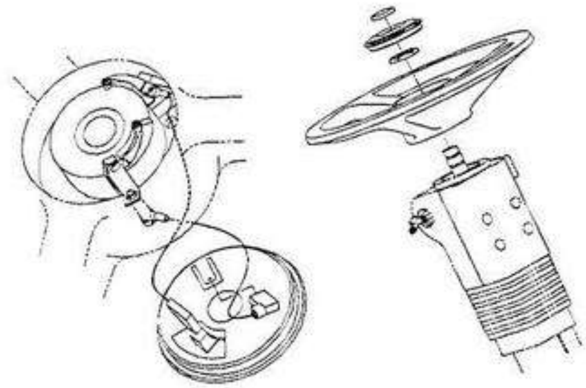
1. Reconnect the horn contact ring wire from the base of the handwheel to the bottom of the horn button.



2. Applyacoatofinsulatingpa.ste(Clarkpartno.2802205) to horn contact ring, then set the handwheel into position and tap with a rubber or plastic mallet to seat it on the column.

3. Tighten the nut onto the column to a torque of 35-40 N·m (25.5-29.5 ft-lb).

4. Screw the horn wire into the column and plug it into its connection on the bottom of the horn button.



5. Set the horn button into place and pop it into position carefully. The horn symbol should be parallel to the CLARK lettering on the hand wheel.

6. Reconnect the battery.

7. Replace the center cowl cover over the steering column. See Group 38 for instructions to replace the cowl covers. Torque the screws to 8-10 N·m (5.5-7.5 ft-lb).

IMPORTANT

If you set the column loosely into place to assure correct alignment, recheck that all mounting brackets, the universal pinch joint, and all fasteners are torqued to their correct limits. See the individual steps in the reassembly procedures to find torque limits.

Turn the key switch ON to check it's function. Make sure no fluid leaks are evident in the steering control valve hydraulic fittings. Remove the wheel chocks to check all functions of the steering column, including directional controls, tilt lock mechanism, and steering gear for correct operation before returning the truck to service.

NOTE :

Section 4

Steering System Relief Pressure Check and Adjustment

CAUTION

SAFE PARKING. Before working on truck:

1. **Park truck on a hard, level,- and solid surface, such as a concrete floor with no gaps or breaks.**
2. **Put upright in vertical position and fully lower the forks or attachment.**
3. **Put all controls in neutral. Turn key switch OFF and remove key.**
4. **Apply the parking brake and block the wheels.**

Description and Operation

Steering system relief pressure settings above the specified values can cause failure of the steer lines, damage to seals in the steering gear, and steering linkage breakage on the steer axle.

The steering system's pressure relief valve is part of the steering control (orbitrol) assembly. Steering system relief pressure is adjustable and should be checked if indicated by troubleshooting. Use the gauge port on the pump to check steering relief pressure.

Steering system relief pressure setting should be 8618 kPa (1250 psi).

NOTE

If relief pressure is not correct, the problem may be caused by dirt in the valve or relief valve or worn parts in the steering control valve or steer pump.

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.
If any fluid is injecte into the skin, it must be surgically removed within a few hours by a doctor familiar with this type of injury or gangrene may result.

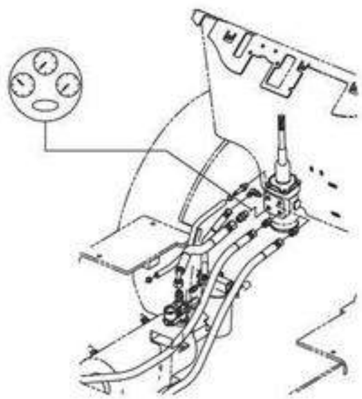
Steering System Relief Pressure Setting Check and Adjustment

This procedure requires installation of a pressure gauge at install Quadrigage at pressure inlet of steering gear. The pressure is measured while the steering handwheel is turned fully in one direction to put the steering system in bypass.

Steering system relief pressure setting may be checked using a Mica Quadrigage (Clark Part No. 1800106) or with a conventional pressure gauge, 0-20,700 kPa (0-3000 psi).

1. Tilt the steering column fully forward andraise the seat deck.

2. Remove floor plate to access steering gear.
3. Install Quadrigage at pressure inlet of steering gear.

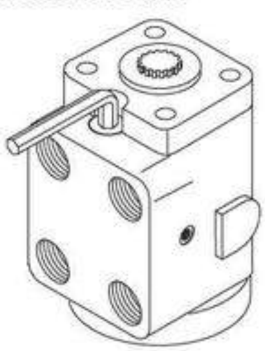


4. Put the key in the key switch and turn it on.
5. Remove the battery to access the steer pump.

NOTE

After the battery is removed, power is still needed to actuate the system for continuing adjustment. Do this by either setting the battery alongside the truck and connecting with an approved connection cable or by moving another electric truck operating on the same voltage and using it for a power source.

6. Turn the steering handwheel in one direction until steering cylinder reaches its stop (relief bypass). Hold steering handwheel in relief position until pressure reading is taken, and then release. Turn off key switch. Pressure should read 8618 kPa (1250 psi).
7. To adjust the steering pressure relief to 8618 kPa (1250 psi):
   a. Remove plug.
      – L-Wrench Size : 8 mm



   b. Adjust the pressure.
      – Specification : 8340-8830kPa(1210~1280psi)
      – To increase : turn clockwise
      – To decrease : turn counter-clockwise
      – L-Wrench Size : 6mm

8. Repeat check and adjustment procedure until correct relief pressure is set.
   - If the correct relief pressure cannot be maintained, consider overhauling or replacing the pressure relief valve as shown in the steer pump removal and overhaul Section of this Group.
9. Disconnect the tee and pressure gauge, reconnect lines, and reinstall the adjustment port plug.
10. Turn key switch on and repeat steps to read and adjust the relief pressure setting until correct relief pressure is set.
    - Once you adjust to the correct relief pressure setting, reset the plug in the valve bore.
11. Disconnect the pressure gauge and reinstall the floor plate.

Section 5

Steering Gear Overhaul

IMPORTANT

Before removing any component for overhaul, make sure the correct repair parts, seals, and gasket sets are available.

CAUTION

Because of unsatisfactory results of field rebuilding of the Gerotor Unit, the manufacturer recommends that only bearing and seal replacement be attempted in the field and that unit rebuilding be done only by qualified rebuilders. Clark Material Handling Company agrees with this. If field rebuilding is absolutely necessary, the rebuilt unit should be thoroughly tested after reinstallation in the truck. Extreme cleanliness is critical to successful rebuilding of these units.

Disassembly

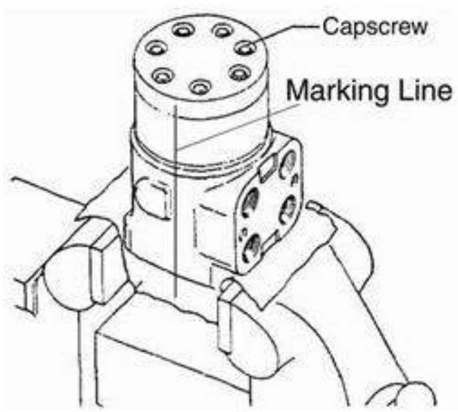
Cleanliness is extremely important when repairing a steering gear. Work in a clean area. Before disconnecting lines, clean port area of unit thoroughly. Use a wire brush to remove foreign material and debris from around exterior joints of the unit.

NOTE

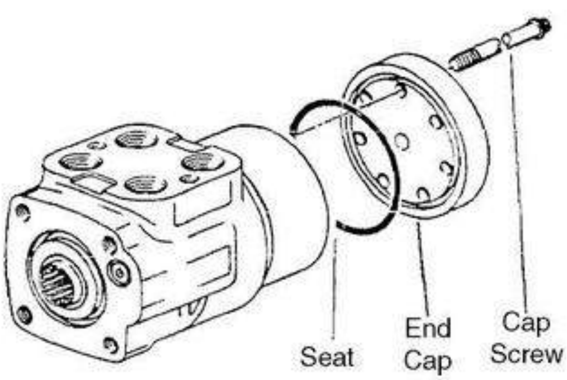
Although not all illustrations show the unit in a vise, it is recommended to keep the unit in the vise during disassembly. Follow the clamping procedures explained throughout the text.

Meter (Gerotor) End

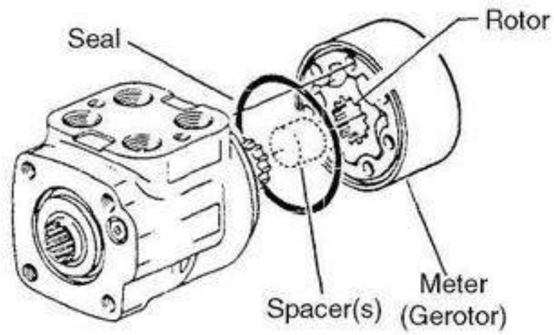
1. Clamp unit in vise, meter end up. Clamp lightly on edges of mounting area, as shown. Use protective material on vise jaws. Do not overtighten jaws.



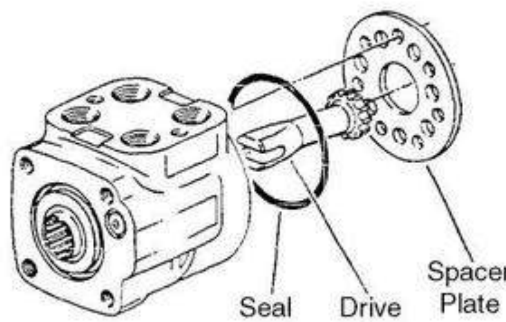
2. Remove capscrews.



3. Remove end cap.
4. Remove seal from end cap.
5. Remove meter (gerotor). Be careful not to drop star (rotor).



6. Remove seal from meter.
7. Remove drive spacer(s).
8. Remove drive.

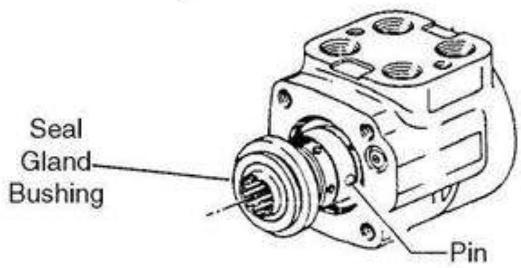


9. Remove spacer plate.
10. Remove seal from housing.

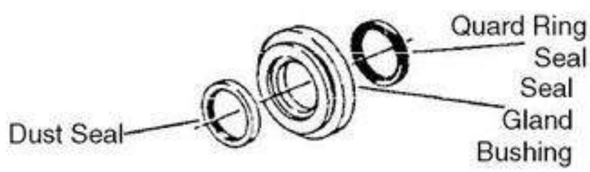
Control End

11. Remove housing from vise and place on a clean soft cloth toprotectsurfacefinish. Useathin-bladedscrew-driver to pry retaining ring from housing.

12. Place assembly so shaft is horizontal. Rotate spool and sleeve until pin is horizontal. Push spool and sleeve assembly forward with your thumbs just far enough to free seal gland bushing from housing. Remove bushing.

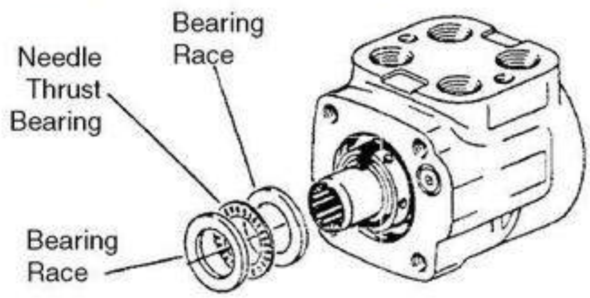


13. Remove quad ring seal from seal gland bushing.

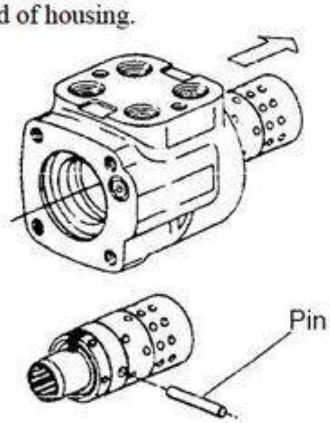


14. Use a thin-bladed screwdriver to pry dust seal from seal gland bushing. Do not damage bushing.

15. Remove two bearing races and the needle thrust bearing from spool and sleeve assembly.



16. Remove spool and sleeve assembly from cap (14-hole) end of housing.

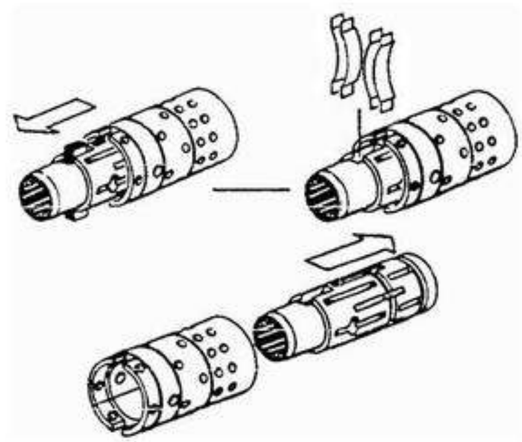


IMPORTANT

Do not bind spool and sleeve in housing. Rotate spool and sleeve assembly slowly when removing from housing.

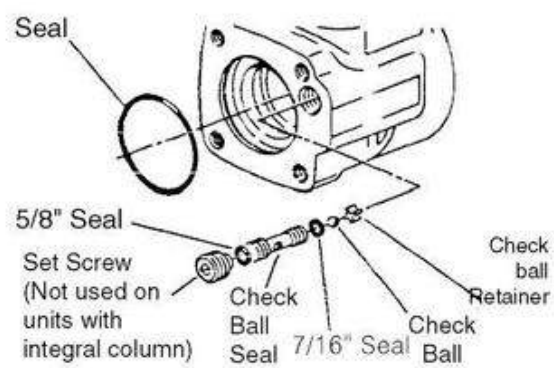
17. Push pin from spool and sleeve assembly.

18. Push spool partially from control end of sleeve, then remove six centering springs from spool carefully by hand. Note their position removed.



19. Push spool back through and out of sleeve. Rotate spool slowly when removing from sleeve.

20. Remove seal from housing.



21. Remove set screw from housing.

22. Screw a 1/8-inch-24 NC machine screw into end of check ball seat. Then pull on screw with pliers to lift seat out of housing.

23. Remove two seals from check valve seat.

24. Tip housing to remove check ball and check ball retainer.

Parts Inspection

Inspect all parts for damage, cracks, broken parts, damaged threads, corrosion or erosion of surfaces, worn spots, nicks or scratches.

Check all mating surfaces. Replace any parts that have scratches or burrs that could cause leakage. Discard all old seals and replace with new ones.

Clean all metal parts in clean solvent. Blow dry with air. Do not wipe dry with cloth or paper towel because lint or other matter can get into the hydraulic system and cause damage. Do not use a coarse grit or try to file or grind these parts.

If parts are left exposed, cover them with a clean cover to prevent airborne dust from collecting on them.

Reassembly

Refer to Service Parts Book when ordering replacement parts. A good service policy is to replace all old seals with new seals at overhaul.

NOTE

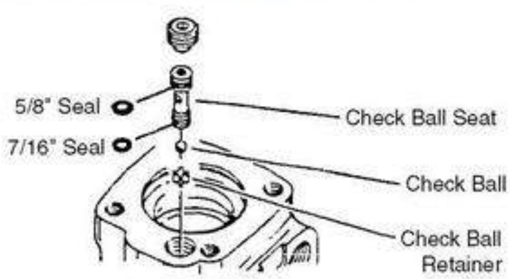
Lubricate all seals (with exception of new quad ring seal) with clean petroleum jelly such as Vaseline.

Do not use excessive lubricant on seals for meter (gerotor) section.

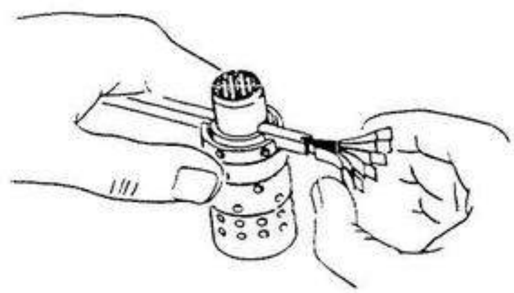
Make sure all parts are clean and free of dust. Before assembly, lightly coat all internal metal parts with oil.

Control End

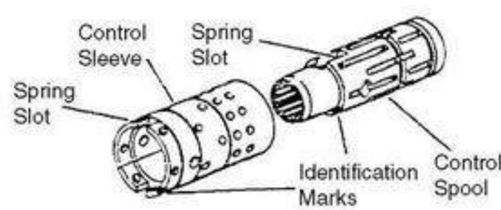
1. Use a needle-nosed pliers to lower check ball retainer into check valve hole of housing. Make sure retainer is straight (not tilted on edge) in housing.



2. Install check ball in housing.
3. Lubricate 5/8-inch diameter seal and 7/16-inch diameter seal. Install seals on check ball seat, as above.
4. Lubricate check ball seat and seals thoroughly before installing seat in housing. When installing seat do not twist or damage seals. Install check ball seat in housing; insert open end of seat first. Push check ball seat to bottom of hole.
5. Install set screw. Use a .5/16-inch Allen wrench to torque set screw to 11 N·m (100 in-lb; 8.3 ft-lb). To prevent interference of parts, make sure top of set screw is slightly below housing mounting surface.
6. Assemble spool and sleeve carefully so that the spring slots line up at the same end. Rotate spool while sliding parts together. Some spool and sleeve sets have identification marks; align these marks. Test for free rotation. Spool should rotate smoothly in sleeve with finger tip force applied at splined end.



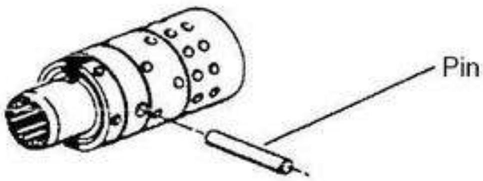
7. Bring spring slots of both parts in line and stand parts on end of bench. Insert spring installation tool (available as Part No. 6000057) through spring slots of both parts. Position two pairs of centering springs (or two sets of 2 each) on bench so that extendededge is down and arched center section is together. In this position, insert one end of entire spring set into spring installation tool, as shown.



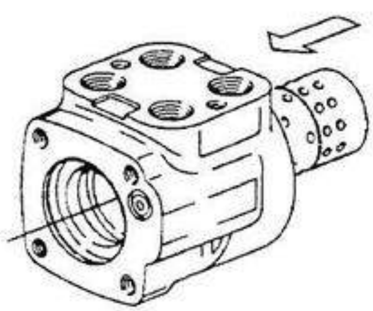
8. Compress extended end of centering spring set and push into spool sleeve assembly withdrawing installation tool at the same time.

9. Center the spring set in the parts so that they push down evenly and flush with the upper surface of the spool and sleeve.

10. Install pin through spool and sleeve assembly until pin becomes flush at both sides of sleeve.



11. Position the spool and sleeve assembly so that the splined end of the spool enters the 14-hole end of housing first.

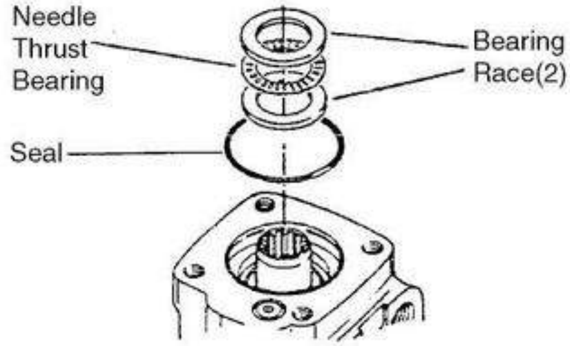


IMPORTANT

Be extremely careful that the parts do not tilt out of position while being installed. Push parts gently into place with slight rotating action; keep pin nearly horizontal. Push the spool assembly entirely within the housing bore until the parts are flush at the meter end or 14-hole end of housing. Do not push the spool assembly beyond this point to prevent the cross pin from dropping into the discharge groove of the housing. With the spool assembly in this flush position, check for free rotation within the housing by turning with light finger tip force at the splined end.

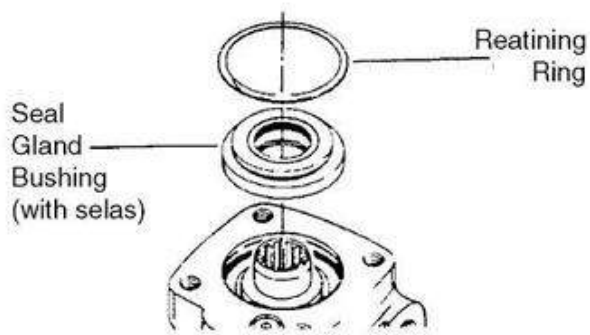
12. Place housing on clean, lint free cloth. Install 2-1/8-inch diameter seal in housing.

13. Install two bearing races and the needle thrust bearing in the order shown.

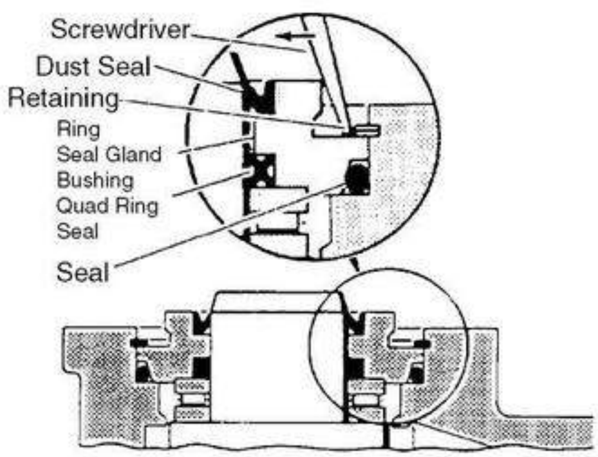


14. Install 25mm (l-in) diameter dust seal in seal gland bushing; flat or smooth side of dust seal must face down towards bushing.

15. Install dry quadring seal in seal gland bushing. Smooth seal in place with your finger. Do not use any seal that falls freely into pocket of bushing. Seal should not "fall" into place but should require light force to seat.

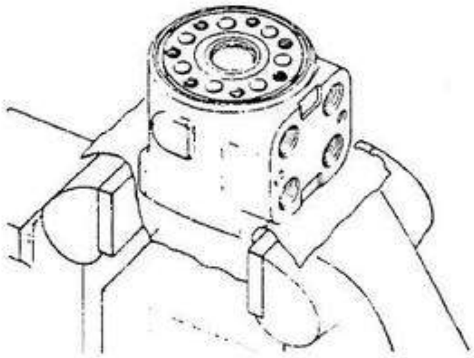


16. Install seal gland bushing over the spool end with a twisting motion. Tap the bushing in place with a rubber hammer. Make sure the bushing is flush against the bearing race.



17. Install retaining ring in housing. After installing ring, tap on ring or pry with screwdriver around entire circumference of ring to properly seat ring in groove.

18. Clamp housing in vise, as shown. Clamp lightly on edges of mounting area. Do not overtighten jaws.



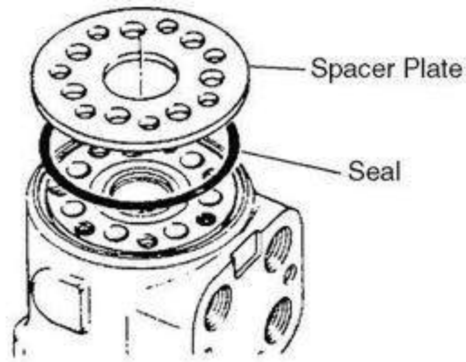
NOTICE

Check to ensure that the spool and sleeve are flush or slightly below the surface of the housing.

IMPORTANT

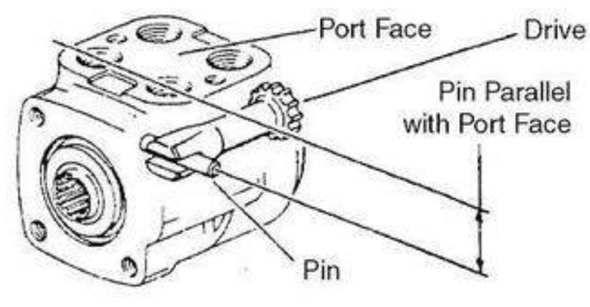
Clean the upper surface of the housing by wiping with the palm of clean hand. Clean each of the flat surfaces of the meter section parts in a similar way when ready for reassembly. Do not use cloth or paper to clean surfaces.

19. Install 73.5 mm (2.89 in.) ID seal in housing.



20. Install spacer plate. Align bolt holes in spacer plate with tapped holes in housing.

21. Rotate spool and sleeve assembly until pin is parallel with port face. Install drive, making sure you engage drive with pin.



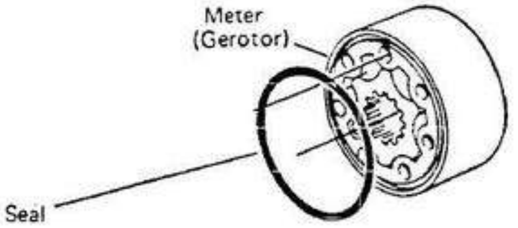
IMPORTANT

Failure to properly install drive and pin may cause unit to self steer.

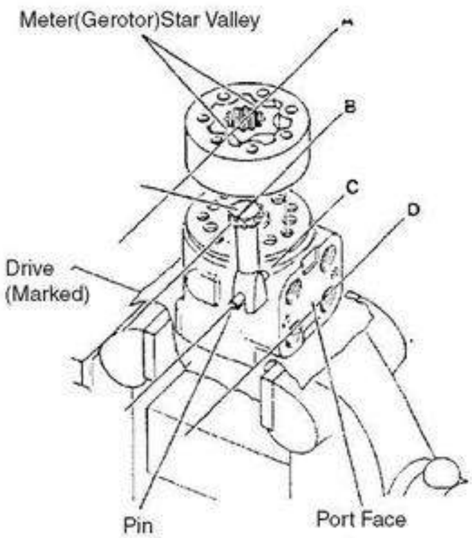
NOTE

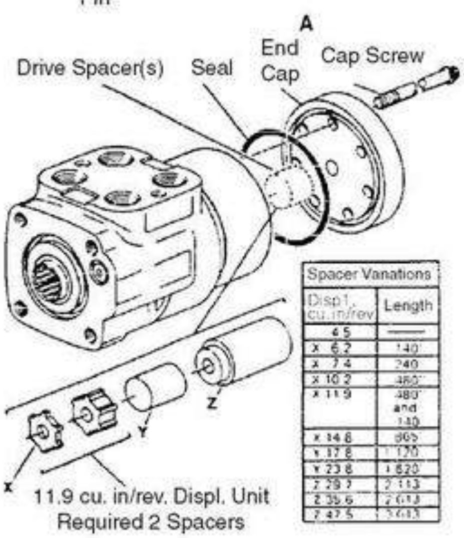
To assure proper alignment, mark spline end of drive shaft with a line parallel to slot on other end, before installing.

22. Instal173.5 mm (2.89 in.) seal in meter (gerotor).



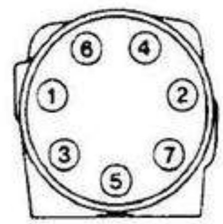
23. With seal side of meter toward spacer plate, align star valleys on drive. Note the parallel relationship of reference lines A, B, C, and D in figure. Align bolt holes without disengaging meter from drive. Be sure star has engaged drive spline in position shown.





Spacer Variations	
Displ. cu. in/rev	Length
4.5	—
X 6.2	.140"
X 7.4	.240"
X 10.2	.480"
X 11.9	.480" and .140
X 14.8	.865
Y 17.8	1.120
Y 23.8	1.620
Z 29.7	2.113
Z 35.6	2.613
Z 47.5	3.613

24. Install drive spacer(s) when used, in meter.
25. Install 73.5 mm (2.89 in.) seal in end cap.
26. Install end cap on gerotor, and align holes.
27. Install 7 dry cap screws in end cap. Pretighten screws to initial torque of 17 N·m (150 in-lb), then torque screws to final torque of 39 N·m (28.7 lbf·ft) in the sequence shown.

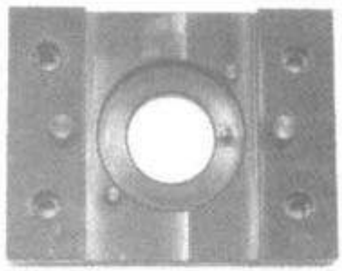


28. Inspect the assembly to be sure all parts have been installed and fasteners correctly installed and tightened.

Steering Unit

Tools

Holding tool

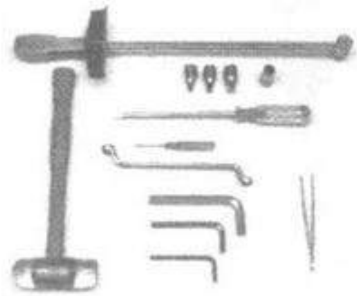


Assembly tool for O-ring and kin-ring.

Assembly tool for cardan shaft

Assembly tool for dust seal

Torque wrench 0~7 kgf·m(0~50 lbf·ft)
13mm socket(12 point)
6, 8 and 12mm hexagon sockets
12mm screwdriver
2mm screwdriver
13mm ring spanner
6, 8 and 12mm hexagon L wrench
Plastic hammer
Tweezers

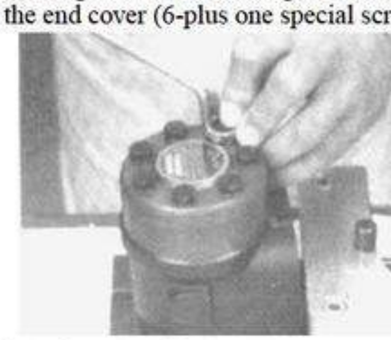


The tools listed above are not available from CLARK.

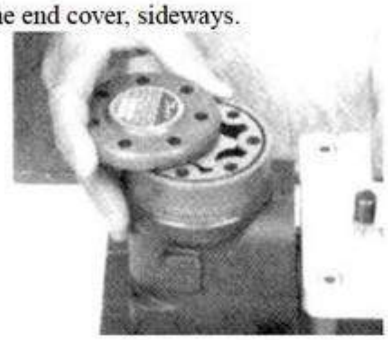
Disassembly

In repair keep all parts clean. Be sure the steering unit is thoroughly cleaned and free of dirt and debris prior to disassembly.

Place the steering unit in the holding tool and remove the screws in the end cover (6-plus one special screw).



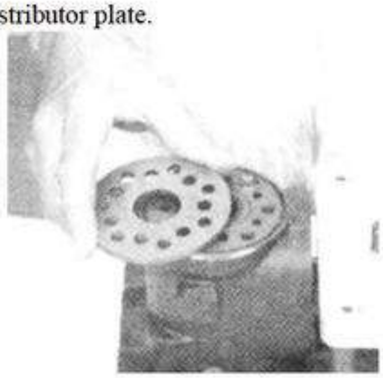
Remove the end cover, sideways.



Lift the gerotor set(with spacer if fitted) off the unit. Take out the two O-rings.

Remove cardan shaft.

Remove distributor plate.



Screw out the threaded bushing over the check valve.

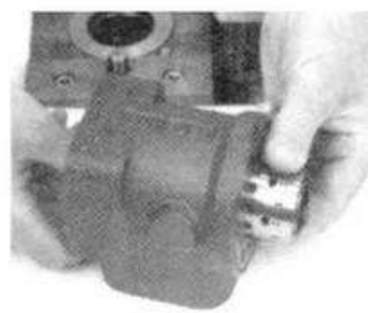
Remove O-ring.

Shake out the check valve ball(f8 mm)

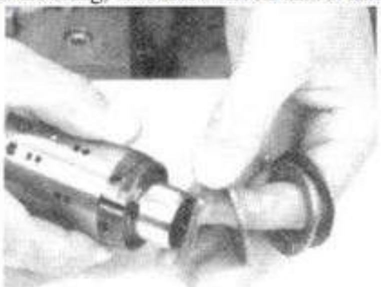
Shake out the two anticavitation check valve balls.(if equipped)

Take care to keep the cross pin in the sleeve and spool horizontal.

The pin can be seen through the open end of the spool. Press the spool inwards and the sleeve, ring, bearing races and needle bearing will be pushed out of the housing together.



Take the ring, bearing races and needle bearing from sleeve and spool. The outer(thin) bearing race can sometimes "stick" in the housing, therefore check that it has come out.



Press out the cross pin. Use the special screw from the end cover.

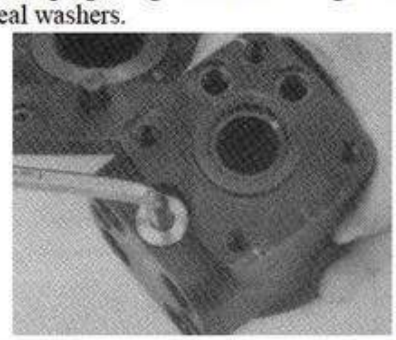
A small mark has been made with a pumice stone on both the spool and sleeve close to one of the slots for the neutral position springs (see drawing)
If the mark is not visible, remember to leave a mark of your own on the sleeve and spool before the neutral position springs are disassembled.

Carefully press the spool out of the sleeve.

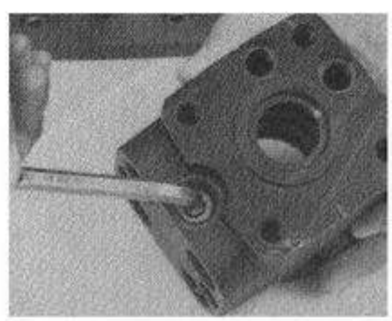
Press the neutral position springs out of their slots in the spool

Remove dust seal and O-ring / kin-ring.

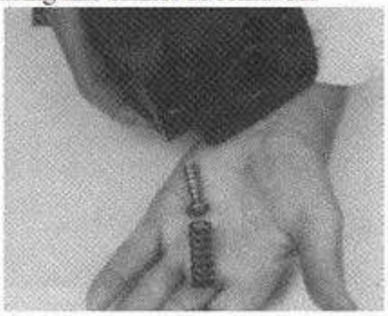
Screw out the plug using and 6 mm hexagon L wrench. Remove seal washers.



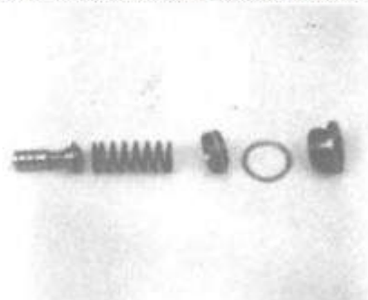
Unscrew the relief set screw using and 6 mm hexagon L wrench.



Shake out the spring and piston. The valve seat is boned into the housing and cannot be removed.



The pressure relief valve is now disassembled.



Assembly

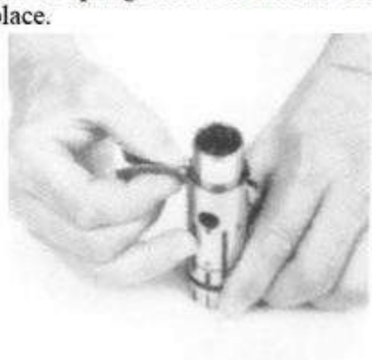
Before assembly clean all parts very carefully, replace all seals and O-rings, and lubricate all parts with hydraulic oil.

Assemble Spool And Sleeve

When assembling spool and sleeve only one of two possible ways of positioning the spring slots is correct. There are three slots in the spool and three holes in the sleeve in the end of the spool/sleeve opposite to the end with spring slots. Place the slots and holes opposite each other so that parts of the holes in the sleeve are visible through the slots in the spool.

Place the two flat neutral position springs in the slot.

Place the curved springs between the flat ones and press them into place.



Line up the spring set.

Guide the spool into the sleeve.

Make sure that spool and sleeve are placed correctly in relation to each other.

Press the spring together and push the neutral position springs into place in the sleeve.

Line up the springs and center them.

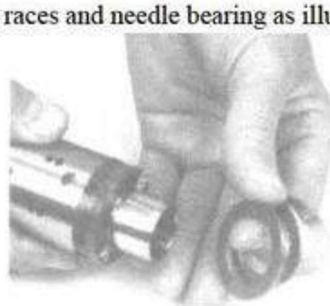
Guide the ring down over the sleeve.

WARNING

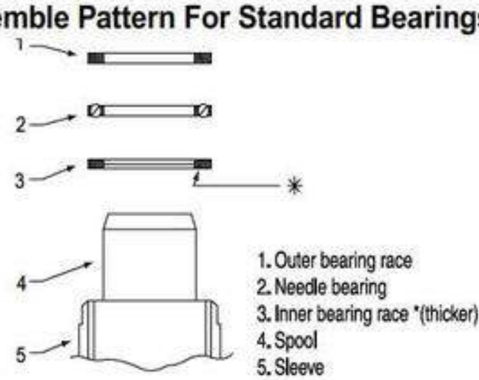
The ring should be able to rotate free of the springs.

Fit the cross pin into the spool/sleeve.

Fit bearing races and needle bearing as illustrated.

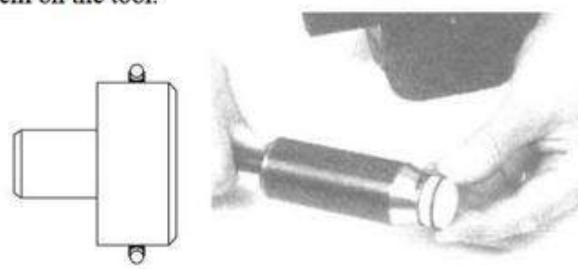


Assemble Pattern For Standard Bearings

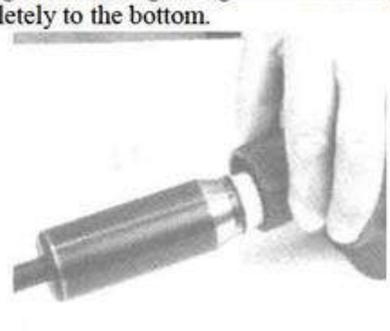


Turn the steering unit until the bore is horizontal. Guide the outer part of the assembly tool into the bore for the spool/sleeve.

Grease O-ring and kin-ring with hydraulic oil and place them on the tool.

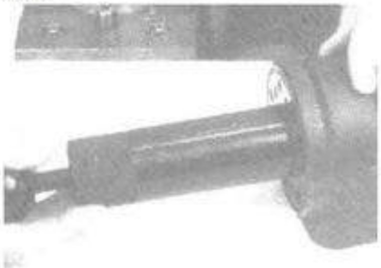


Hold the outer part of the assembly tool in the bottom of the steering unit housing and guide the inner part of the tool completely to the bottom.



Press and turn the O-ring / kin-ring into position in the housing.

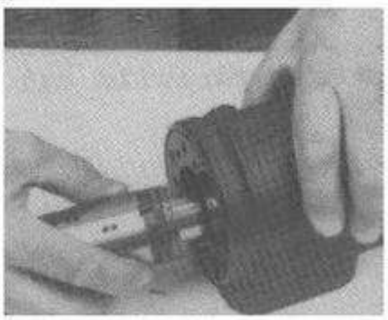
Draw the inner and outer parts of the assembly tool out of the steering unit bore, leaving the guide from the inner part in the bore.



With a light turning movement, guide the spool and sleeve into the bore.

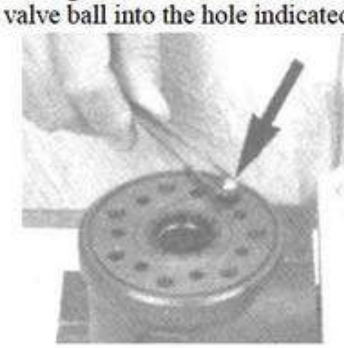
WARNING

Fit the spool set holding the cross pin horizontal.

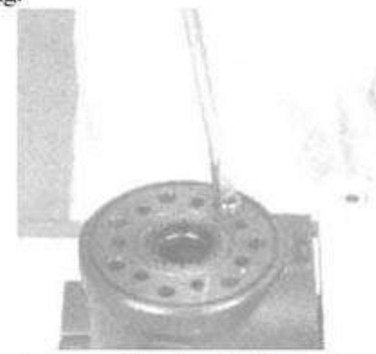


The spool set will push out the assembly tool guide. The O-ring and kin-ring are now in position.

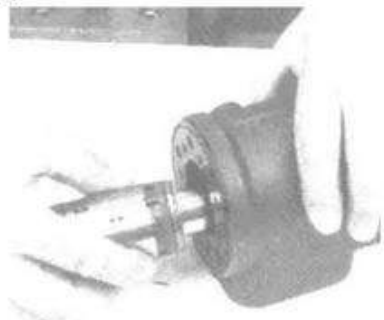
Turn the steering unit until the bore is vertical again. Put the check valve ball into the hole indicated by the arrow.



Screw the threaded bushing lightly into the check valve bore. The top of the bush must lie just below the surface of the housing.



Grease the O-ring with mineral oil approx. viscosity 500 cSt at 20℃.



Place the distributor plate so that the channel holes match the holes in the housing.

Guide the cardan shaft down into the bore so that the slot is parallel with the connection flange.

Place the cardan shaft as shown so that it is held in position by the mounting fork.

Grease the two O-ring with mineral oil approx. viscosity 500 cSt 20℃ and place them in the two grooves in the gerotor assy.

Fit the gerotor assembly on the cardan shaft.

WARNING

Fit the rotor and cardan shaft so that a tooth base in the rotor is positioned in relation to the shaft slot as shown. Turn the stator so that the seven through holes match the housing.

Fit the spacer, if any.

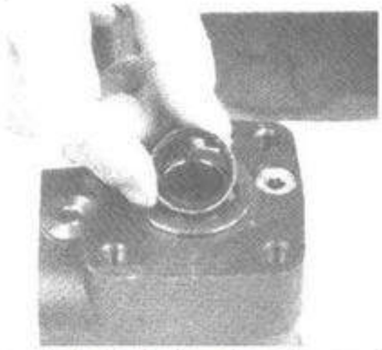
Place the end cover in position.

Fit the special screw with washer and place it in the hole shown.

Fit the six screws with washers and insert them. Cross-tighten all the screws in several stages.

3.0 ± 0.3 kgf·m(22 ± 2 lbf·ft)

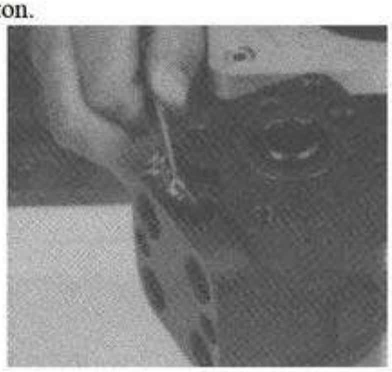
Place the dust seal ring in the housing. Ther dust seal ring must be placed only after the pressure relief valve has been fitted.



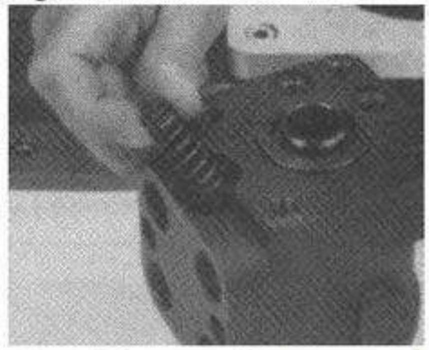
Fit the dust seal ring in the housing using special tool and a plastic hammer.

Press the plastic plugs into the connection ports. Do NOT use a hammer.

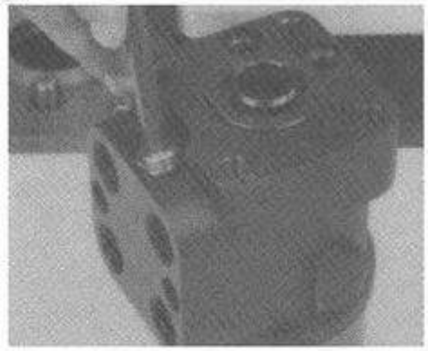
Fit the piston.



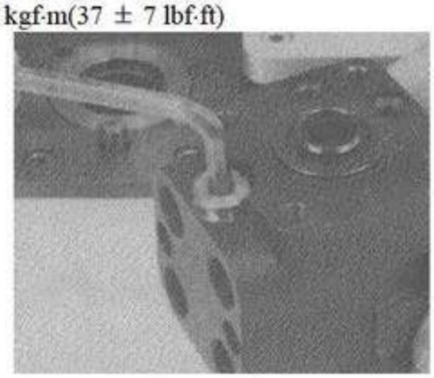
Fit the spring.



Screw in the relief screw with an 8 mm hexagon L wrench. Adjust the pressure setting on a test bench or in the vehicle.



Install the plug with dust seal into the housing using an 8 mm hexagon L wrench.
5.1 ± 1 kgf·m(37 ± 7 lbf·ft)



Priority Valve

Tools

Torque wrench

Hexagon (Allen) socket 8 mm

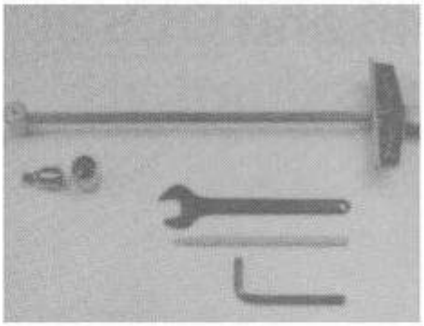
Hexagon socket(12 point) 22 mm

Open-end spanner 22 mm

Nylon pin

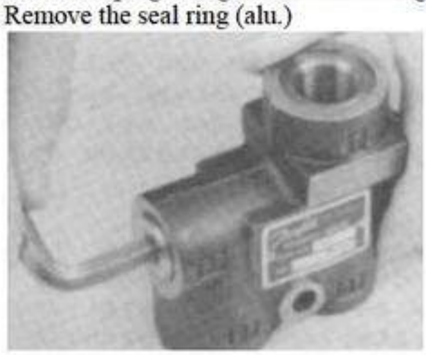
Allen wrench 8 mm

These tools are not available from CLARK



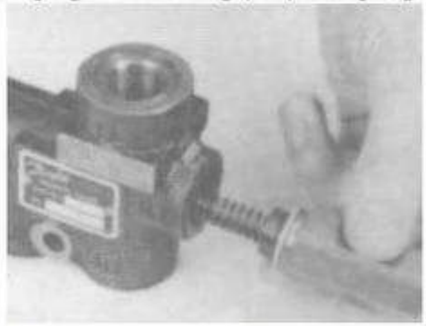
Disassembly

Screw out the PP plug using the 8 mm hexagon Allen Wrench. Remove the seal ring (alu.)

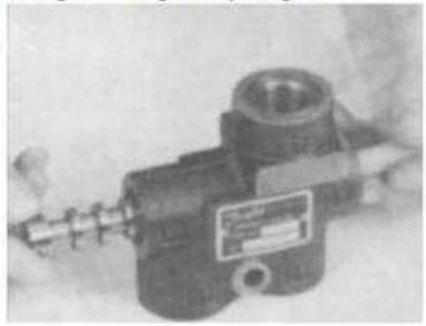


Loosen the LS plug using the 22 mm open-end spanner.

Pull out the plug with seal ring (alu.) and spring.



Press out the spool using the nylon pin.



Cleaning

Clean all parts carefully in cleaning solvent.

Inspection and Replacement

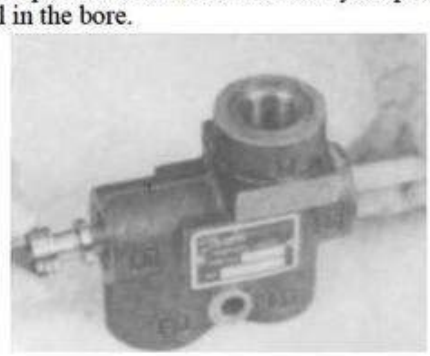
Check all parts carefully and make any replacements necessary. All seal rings must be replaced.

Lubrication

Before assembly, lubricate all parts with hydraulic oil.

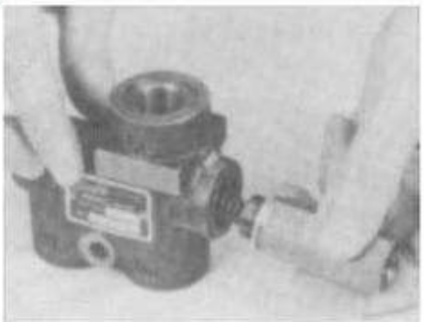
Assembly

Guide the spool into the bore. Use the nylon pin to center the spool in the bore.



Put in the PP plug. Remember seal ring.

Guide the spring and LS plug into the bore. Remember seal ring.

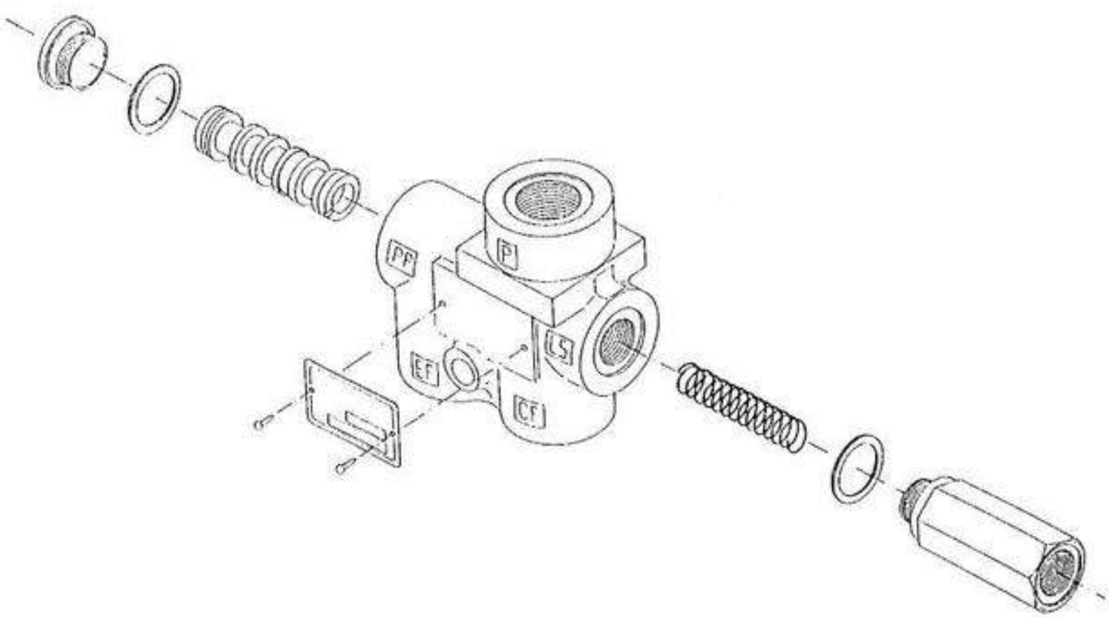


Tighten the LS plug with a torque wrench using a 22 mm hexagon socket.

5 ± 1 kgf · m (36 ± 7 lbf · ft)

Tighten the PP plug with a torque wrench using a 8 mm hexagon Allen socket.

5 ± 1 kgf · m(36 ± 7 lbf · ft)



NOTE :

GROUP 26

STEERING AXLE

NOTE :

Section 1

Steering Axle Specifications and Description

Specifications

Steering System Relief Pressure Setting: 8620-9300 kPa (1250-1350 psi)

Steer Cylinder Type: Double-acting, piston-type.

Turning Radius:

ECX 20 w/30.5	Batt=70.2in (1783 mm)
ECX 20 w/34.5	Batt=74.2in (1885 mm)
ECX 25 w/30.5	Batt=72.6 in (1845 mm)
ECX 25 w34.5	Batt=74.8 in (1900mm)
ECX 30 w/30.5	Batt=73.9 in (1877mm)
ECX 30 w/34.5	Batt=76.8 in (1950mm)
ECX 30x & 32 w/32	Batt=78.3 in (1989mm)

EPX

Steering System Relief Pressure Setting : 8620-9300 kPa (1250-1350 psi)

Steer Cylinder Type : Double-acting, piston-type

Turning Arc : 75° maximum inside turning angle
54° maximum outside turning angle.

Bearing Grease : Grade No. 2 EP multi-purpose grease, Clark Part MS-107C.

Fastener Torques

Steer Axle Mounting Bolts: 170-190 N·m (125-140 ft-lb)

Cylinder to Axle Mounting Bolts: 280-320 N·m (205-234.5 ft-lb)

Steering Link to Steering Knuckle Nuts: 135-150 N·m (98-110 ft-lb)

Steer Knuckle King Pin Castle Nuts: See installation procedures in Section 4, "Steer Axle Overhaul.

Steering System Relief Pressure Setting: 8600~9300kPa (1250~1350 psi)

Steer Cylinder Type: Double-acting Pisten-type.

Service Intervals

Steering Linkage Inspection and Lubrication: Every 50-250 hours and each PM.

Steer Wheel Bearing Inspection and Lubrication: Every 50-250 hours of operation.

Steer Cylinder Seals Leakage Check: Every 50-250 hours and each PM.

Steer Axle Mounting Inspection: Every 50-250 hours and each PM.

Power Steering Relief Pressure Check: Every year or 2000 hours of operation.

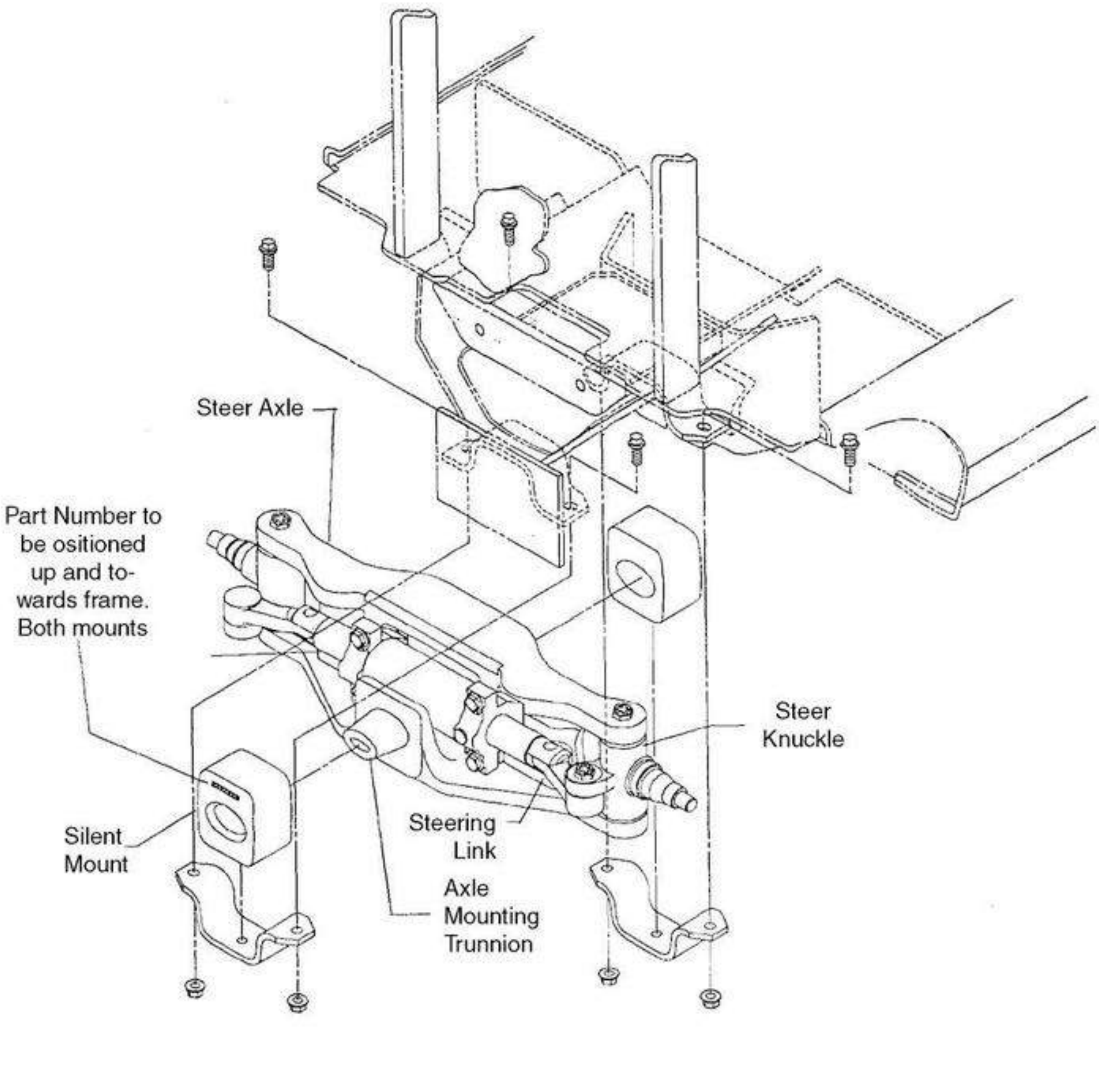
Description

The steer axle has the steer cylinder, steer knuckles, and steering links mounted on it. All these components can be removed, serviced, and replaced.

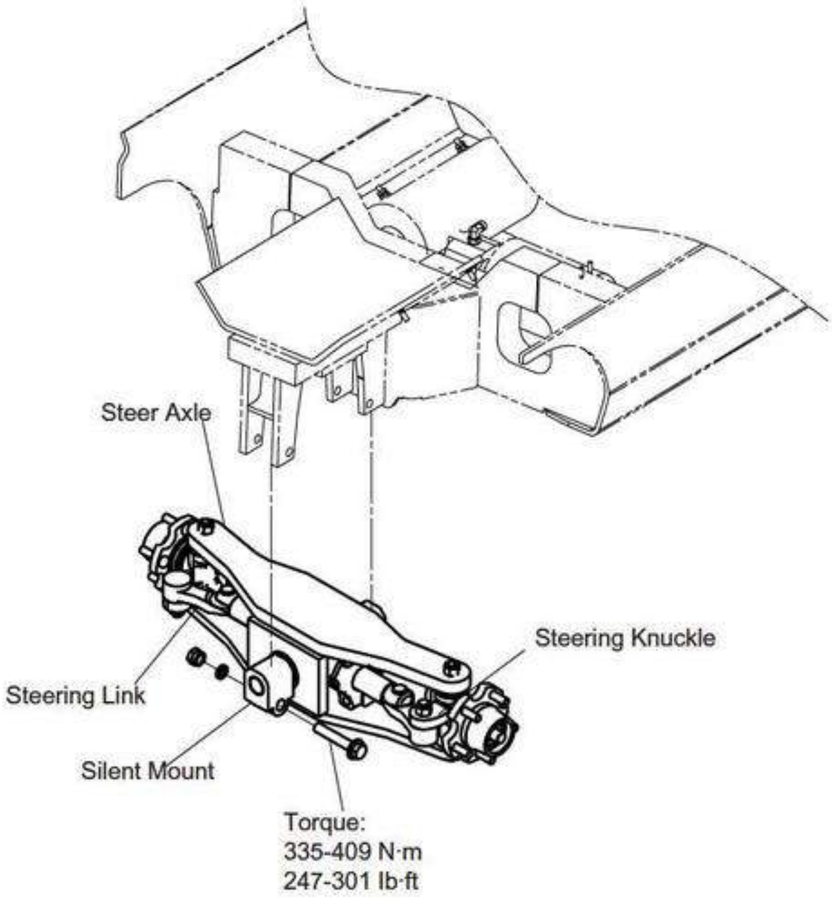
The steering gear (steering control unit) at the base of the steering column directs hydraulic fluid to one end or the other of the steer cylinder to pivot the steer wheels.

The steer axle is bolted to the truck frame. The steer cylinder is connected to the steering knuckles by steer links. Mounting trunnions allow the axle to tilt independently of the truck and "silent" mounts cushion the axle on the trunnions.

All bearings used in the steer axle linkage have lubrication fittings and are serviceable. Axle removal, replacement, and service for all components, including overhaul of the steer cylinder, is explained in the Sections for this Group.



Steer Axle and Mounting(ECX)



Steer Axle and Mounting(EPX)

NOTE :

Section 2

Steering Axle Wheel Bearing maintenance and Adjustment

IMPORTANT

Before removing any component for overhaul, make sure the correct repair parts, seals, and gasket sets are available.

CAUTION

SAFE PARKING. Before working on truck:

1. **Park truck on a hard, level, and solid surface, such as a concrete floor with no gaps or breaks.**
2. **Put upright in vertical position and fully lower the forks or attachment.**
3. **Put all controls in neutral. Turn key switch OFF and remove key.**
4. **Apply the parking brake and block the wheels.**
5. **Remove Battery Connector.**

Wheel Bearing Check

Wheel bearings check should be performed every PM. Wheel bearings need adjustment only after 2000 hours or as needed. It is recommended that you clean and repack the bearings before adjustment. Check hourmeter total hours and refer to the truck's PM schedule. See steer wheel bearing lubrication procedure below.

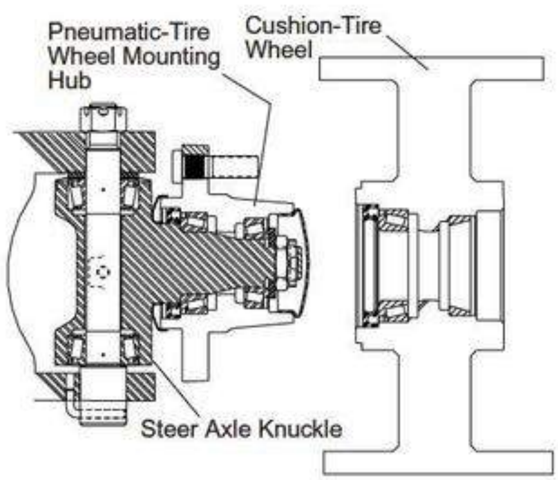
To check the steer wheel bearings for excessive free play or looseness:

1. Grasp the wheel with both hands and try to move it by a rocking motion top-to-bottom.
2. Try to pull it in and out along the wheel spindle.

Watch for excessive free movement in wheel bearings or steering knuckle bearings. There should be a small amount of free movement. If the wheel has excessive free movement, the bearings require additional service and/or adjustment.

Wheel Bearing Lubrication

These procedures cover bearing lubrication for the two types of steer wheels used on the truck ; pneumatic-tire wheels which are mounted on a hub that contains the bearing components and cushion-tire wheels with the bearings installed in the wheel. Use the procedures to clean, repack and adjust bearings for both the cushion-wheel and the pneumatic-tire hub. The bearing components and arrangement are the same for both the cushion and pneumatic types. Instructions for repacking/lubricating the bearing components apply to both types.



Cushion-tire wheel-assembly

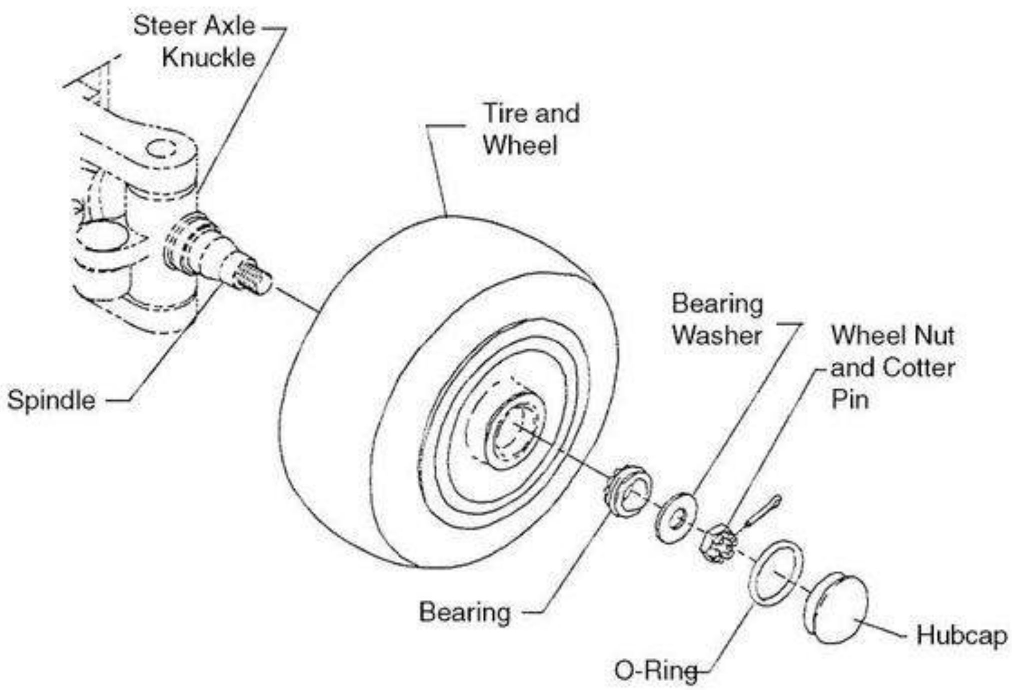
Bearing Disassembly

1. Be sure truck is parked and blocked up correctly and safely to raise steer wheels off the floor. Refer to "Lifting, Jacking, and Blocking," in the Group "SA."

NOTE

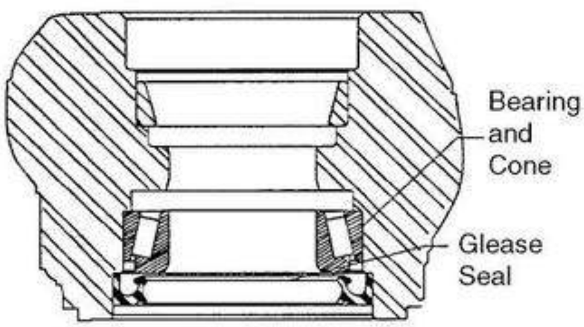
Because of the heavy weight of the wheel and tire, it is suggested to first remove the wheel and tire assembly from spindle when servicing the bearings to avoid damage to the grease seal when the wheel hub is moved off or on the spindle. It also makes the work simpler and easier.

2. Refer to the exploded view illustration of the wheel bearing assembly. Loosen and remove the hubcap from wheel or hub. You may have to lightly tap hub cap with a hammer and chisel and use a pry bar to loosen. Be careful not to damage mounting surfaces. Remove O-ring from hubcap.
3. Clean the excess grease from around the wheel nut.
4. Remove cotter pin, loosen and remove wheel nut and bearing washer.
5. Remove outer bearing by pulling out on the cushion wheel slightly to loosen bearings.



Wheel Bearing Assembly.

6. Pull the wheel or hub off the spindle. Support the wheel or hub to avoid dragging the grease seal at the back side across the thread on spindle end.
7. Clean the old grease out of center of the wheel or hub.
8. To remove inner bearing and seal, lay wheel or hub down with outer edge up (support hub on blocking). Remove the inner bearing cone and grease seal, using a brass drift pin, rod, or piece of pipe to drive the bearing and seal out of the hub.



9. Clean and inspect the bearing cups and cones for wear or other damage. Replace, as necessary.

IMPORTANT

Keep serviceable bearing cups and cones matched together. Always replace bearing cups and cones as a set.

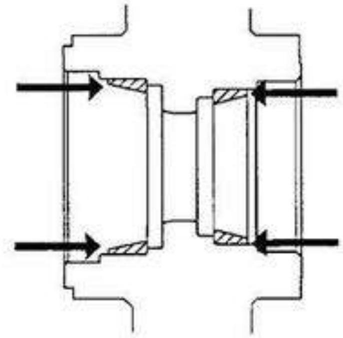
10. Inspect grease seal for wear and damage. Replace as necessary. It is recommended to install a new grease seal whenever old ones are removed.
11. Use a standard puller to remove bearing cups from hub or wheel if bearings require replacement.

Bearing Reassembly

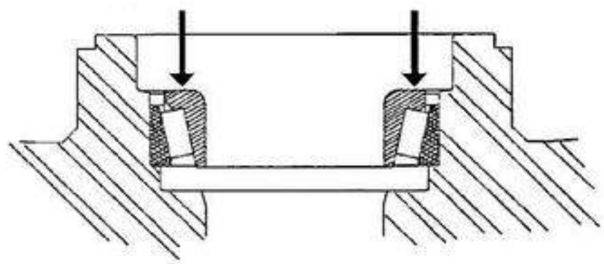
NOTE

Use Grade No. 2 EP multi-purpose grease, Clark MS-107C.

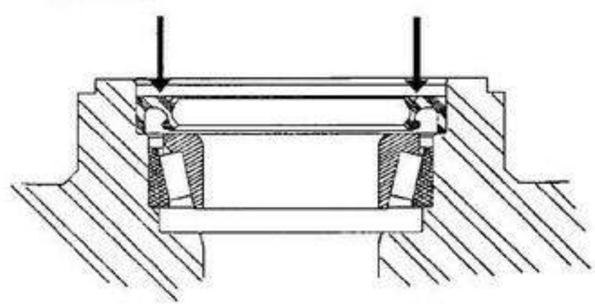
1. Install new inner and outer bearing cups by pressing into hub or wheel. Be sure cups are fully seated in bore.



2. Pack the bearings with grease and install the inner bearing in the hub or wheel.

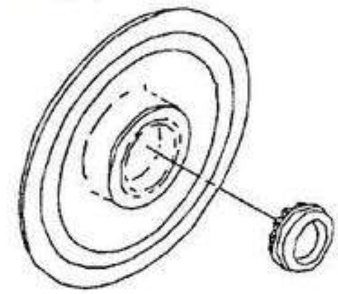


3. Pack cavity between bearing and grease seal half full with grease.
4. Install new grease seal in hub or wheel inner bore. Apply coating of grease to inside diameter of seal lips prior to assembly, then install seal in hub or wheel bore.

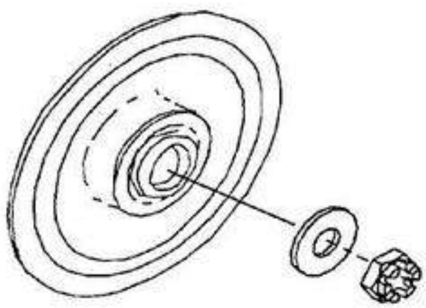


5. Carefully press or tap grease seal into place with asoftfaced mallet until seal is seated in bottom of bore.
6. Install hub or wheel on spindle. Be careful not to damage grease seal lip when moving the hub over the end of spindle and threads.
7. Pack cavity in hub between bearings one-half full with grease.

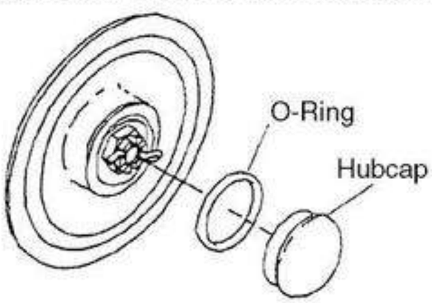
8. Install the outer wheel bearing after it has been packed with grease.



9. Install bearing washer and hand tighten wheel nut.



10. Rotate hub or wheel counter clockwise and torque wheel nut to 27-31 N·m (20-23 ft-lb).
11. Back wheel nut up until it is loose.
12. While turning the hub or wheel counter clockwise, torque the wheel nut to 2.3-2.8 N·m (1.7-2 ft-lb).
13. Back up wheel nut to nearest slot and install new cotter pin. Bend cotter pin tabs.
14. Recheck for correct bearing adjustment by rotating the wheel by hand. Wheel should rotate freely or with only slight "drag". Readjust bearings by adjusting wheel nut as necessary to avoid binding in bearings.
15. Pack the area around wheel nut with grease.
16. Refit O-ring on hubcap and install hubcap by tapping into place with a rubber or plastic-faced hammer.



Wheel Bearing Adjustment

The steer wheel bearings are retained and adjusted by the wheel nut.

NOTE

You should clean and repack the wheel bearings before performing a wheel bearing adjustment. See "Wheel Bearing Lubrication" in this Section for the complete procedure.

⚠ CAUTION

SAFE PARKING. REFER TO PAGE 1.

1. Make sure the truck is parked on a level, hard surface, the upright is fully lowered, the drive wheels are chocked, and the steer wheels are jacked and blocked securely. Refer to "Lifting, Jacking, and Blocking" for safe procedures.
2. Remove hubcap.
3. Remove and discard cotter pin.
4. Loosen wheel nut.
5. After wheel nut is loosened, hit the top of wheel to loosen the bearings. This moves the bearings free of their seated, running position.
6. Rotate hub or wheel counter clockwise and torque wheel nut to 27-31 N·m (20-23 ft-lb).
7. Back wheel nut up until it is loose.
8. While turning the hub or wheel counter clockwise, torque the wheel nut to 2.3-2.8 N·m (1.7-2 ft-lb).
9. Back up wheel nut to nearest castellation slot and install new cotter pin.
10. Recheck for correct bearing adjustment by rotating the wheel by hand. Wheel should rotate freely or with only slight "drag". Readjust bearings by adjusting wheel nut as necessary to avoid binding in bearings.
11. Bend cotter pin tabs over.
12. Pack the area around wheel nut with grease.
13. Refit O-ring on hubcap if removed or replaced and install hubcap by tapping into place with a rubber or plastic-faced hammer.

Section 3

Steering Axle Removal and Replacement

CAUTION

SAFE PARKING. Before working on truck:

1. **Park truck on a hard, level, and solid surface, such as a concrete floor with no gaps or breaks.**
2. **Put upright in vertical position and fully lower the forks or attachment.**
3. **Put all controls in neutral. Turn key switch OFF and remove key.**
4. **Apply the parking brake and block the wheels.**

Steer Axle Removal

1. Remove the counterweight before removing the steer axle. Refer to Group 38, Section 2, "Counterweight Removal and Replacement." (It is possible to remove the steer axle without removing the counterweight but much easier if it is removed).

WARNING

Do not remove the counterweight unless you have training and are familiar with the correct procedures. Counterweights can fall if not handled correctly and cause severe injury or death.

WARNING

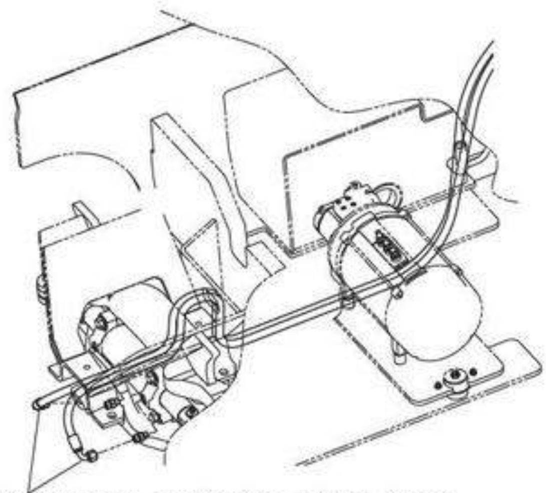
Do not raise truck by hoisting on overhead guard or by jacking or lifting on counterweight.

2. Block the drive wheels of the truck and raise and block the rear end. Remove steer wheels. See "Lifting, Jacking, and Blocking" in Group "SA" for safe procedures to jack the truck.

CAUTION

Make sure truck is correctly raised and safely blocked using hardwood blocks under the frame. Be sure the blocking will permit installation of the axle without disturbing the blocking.

3. loosen and remove hydraulic steering lines from steering cylinder. Plug fittings and cap open ends of lines. Keep all hydraulic fittings and openings clean.

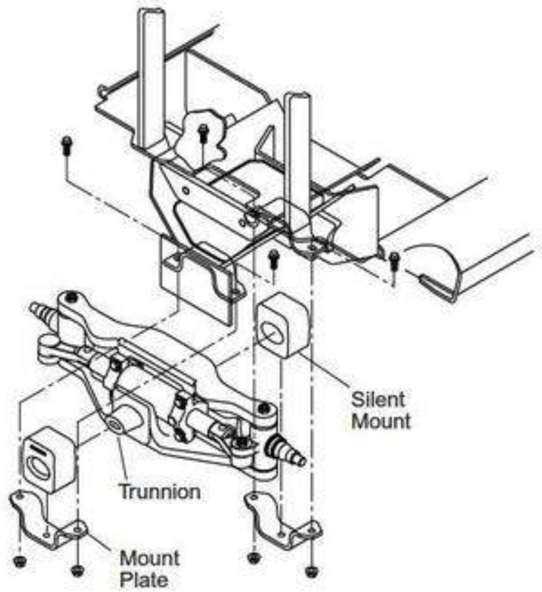


Disconnect cylinder lines here.

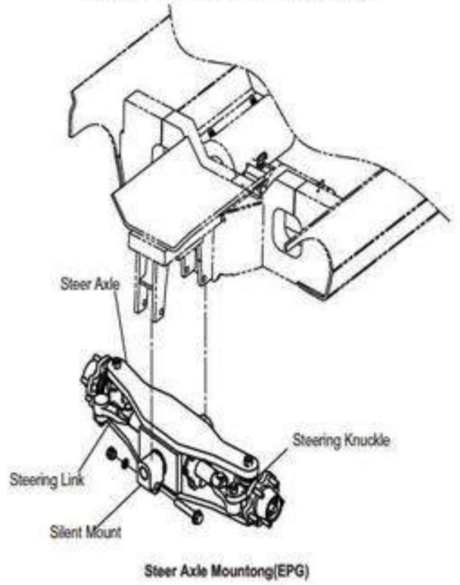
CAUTION

Axle must be supported before any attaching fasteners are removed.

4. If another lift truck is used to temporarily support axle while removing, put forks in center of carriage about 305 mm (12 in) apart. Move forks under axle and raise itjust toremoveits weight from mounting-bolts. Or use a portable floor jack to carefully support the axle at its center section.
5. Loosen and remove nuts from axle mounting bolts, front and rear.
   - Remove the mount plates from the bottom of the trunnion mounts of the steer axle (Figure A.).
6. Remove the mounting bolts.
7. Lower the axle allowing its weight to pull the silent blocks out of frame recesses. Watch the silent blocks to be sure they release freely from frame. You may have to loosen blocks with a pry bar if they bind.
8. Carefully withdraw the axle from beneath the truck and move to safe storage.



Steer Axle Mounting(ECX)



Steer Axle Mounting(EPX)

Steer Axle Replacement

Replacement is the reverse of removal. Refer to Figure A for replacement.

CAUTION

Make sure truck is correctly raised and safely blocked using hardwood blocks under the frame. Be sure the blocking will permit installation of the axle without disturbing the blocking.

1. If silent blocks have been removed from axle, install new silent block assemblies. Use a rubber or plastic mallet to seat the silent mounts onto the axle trunnions.
2. Make sure that the silent blocks are positioned correctly front and rear on the steer axle trunnions at the start of installation. Align the silent blocks square with the axle.
3. Use a fork lift truck or mobile floor jack to temporarily support and raise the axle into place under the truck. If another lift truck is used to handle axle, center the forks with about 305 mm (12 in) spread between them. Place steer axle assembly in secure position on fork tips.

   If hydraulic jack is used, be sure axle is securely supported on jack pad.

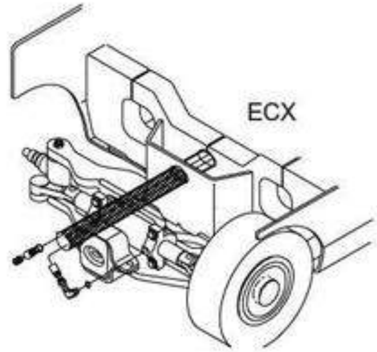
WARNING

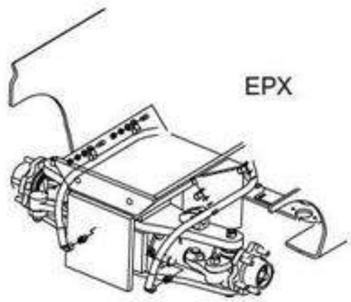
Heavy components can fall and cause severe injury. Keep your body clear at all times.

4. Install axle assembly into frame by slowly raising it up while guiding silent block bushings into frame sockets.
5. Install silent block mounting bolts through frame socket holes and silent block, front and rear.
6. Reset the two mounting plates under the silent blocks of the axle.
7. Install ECX nuts on silent block fasteners and tighten to 170-190 N·m (125-140 ft-lb).
   Install EPX silent mount fasteners and tighten to 335-409 N·m (247-301 ft-lb).
8. Remove temporary axle support from under truck.
9. Connect the hydraulic lines to steering cylinder. Tighten fittings to 12-14 N·m (106-123 in-lb; 8.8-10.3 ft-lb).

IMPORTANT

Make sure all fittings and openings on the hydraulic lines are clean.





10. Carefully raise the truck off the blocking as described in "Lifting, Jacking and Blocking". Remove the blocking and lower the truck to the floor.
11. If removed, reinstall countenveight; refer to Group 38, Section 2, "Counterweight Removal and Replacement".
12. Check the axle and steering system for proper operation. Operate the steering gear to move the steer wheels to maximum travel in both directions. Note any unusual motion or noise.

    If the system appears to be operating correctly, drive the truck slowly. Fully steer the vehicle in each direction and check response.
13. Check steering cylinder hose line connections and cylinder rod seals for any evidence of oil leakage before returning the truck to service.

Section 4

Steering Axle Overhaul

IMPORTANT

Before removing any component for overhaul, make sure the correct repair parts, seals, and gasket sets are available.

CAUTION

SAFE PARKING. Before working on truck:

1. **Park truck on a hard, level, and solid surface, such as a concrete floor with no gaps or breaks.**
2. **Put upright in vertical position and fully lower the forks or attachment.**
3. **Put all controls in neutral. Turn key switch OFF and remove key.**
4. **Apply the parking brake and block the wheels.**

Preparation For Steer Axle Disassembly and Over haul

NOTE

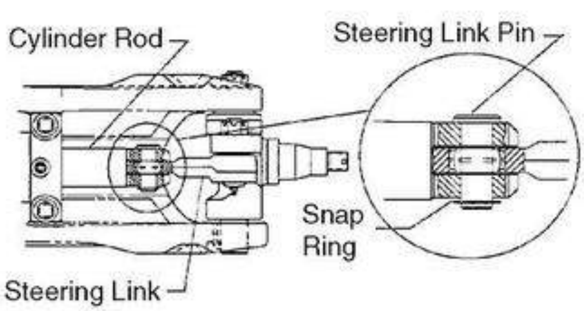
Cleanliness is of extreme importance in the repair and overhaul of this assembly.

- Before starting disassembly, thoroughly clean the axle assembly of all accumulations of dirt, oil, corrosion, and other substances to prevent contamination of the parts during disassembly and overhaul.
- Work in a clean area.
- Keep all parts in order as disassembly progresses. Take care to properly identify each part and its order of removal. If necessary, keep notes and put markings on parts using a non-destructive marker such as a grease pencil or felt-tipped pen.
- If necessary, see Section 3, "Steer Axle Removal and Replacement," for the procedures to remove the steer axle from the truck.
- See Section 5, "Steer Cylinder Removal and Replacement," for the procedures to remove the steering cylinder and steering links from the steer axle.
- See Section 6, "Steering Cylinder Overhaul," to disassemble the steer cylinder.

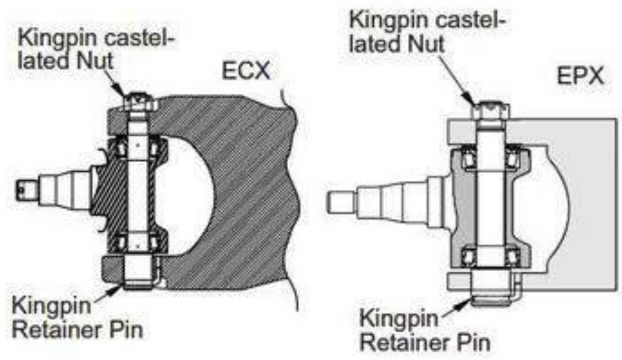
Steer Axle Disassembly

To disassemble the steering knuckle, kingpin, and bearing from the steer axle, it is not necessary to remove the axle from the truck.

1. Remove the snap ring from the bottom of the steering link pin and remove the pin. Steering link is free to be removed from the cylinder rod and knuckle.



2. Remove and discard cotter pin from kingpin castellated nut. Remove the nut.

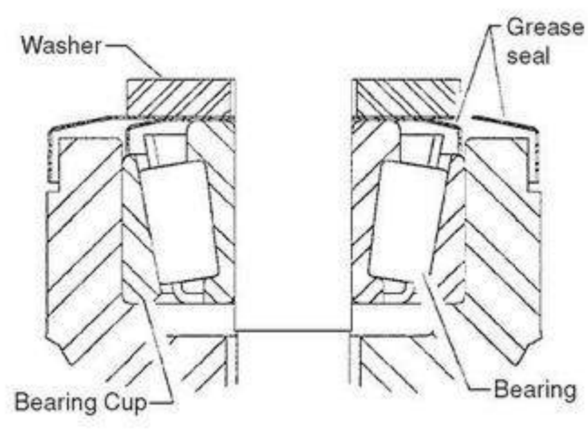


3. Drive the kingpin down and out of the assembly. Remove the steering knuckle. Note right and left knuckle parts.

IMPORTANT

Do not let the knuckle or pin fall when the pin is removed.

4. **Remove the kingpin retainer pin from the base of the kingpin.**
5. **Remove the knuckle bearing washers, dust covers, upper and lower grease seals, bearings, and bearing cups from the assembly.**



Bearing cups may be removed by hand, by using a bearing puller, or by tapping out using a brass drift pin.

Parts Inspection

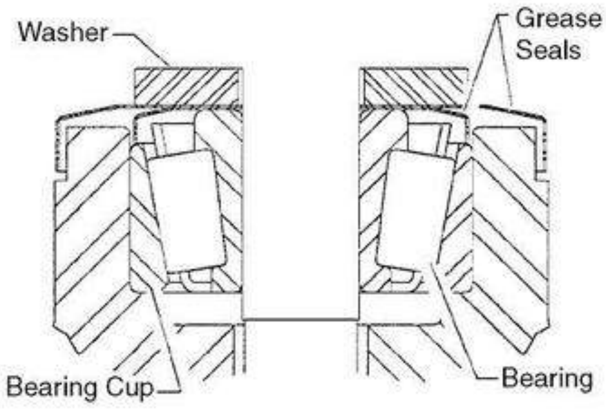
1. Clean all bearings, cups, seals, pins, and other parts in an approved cleaning fluid.
2. Inspect all parts for scratches, chips and wear. Check the steering arms of the knuckles to be sure they are not bent or twisted. Check all threaded parts for damage.
3. Replace all parts which show damage.
4. If parts are to be left exposed, coat all mating surfaces of parts with a light coating of engine oil.

Steer Axle Reassembly

Recommended greasing procedure:

a. Use Grade No. 2 EP multi-purpose grease, Clark MS-107 or equivalent.
b. Pack all tapered roller bearings with grease before assembly.
c. Pack knuckle pin (bearing) seals with grease before assembly.
d. Fill steer link sockets with grease through grease fittings after axle is assembled.

1. Install the upper and lower knuckle bearing cups into the knuckle housing bore. Tap into place with a brass drift pin or equivalent.



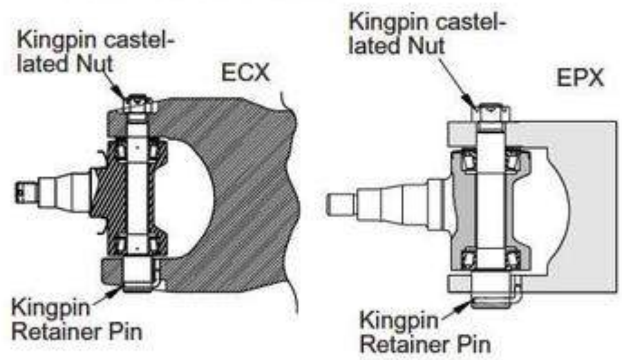
IMPORTANT

Make sure that bearing cup is fully seated against the shoulder in bore. There must be no gap left between cup and the shoulder in the bore at assembly.

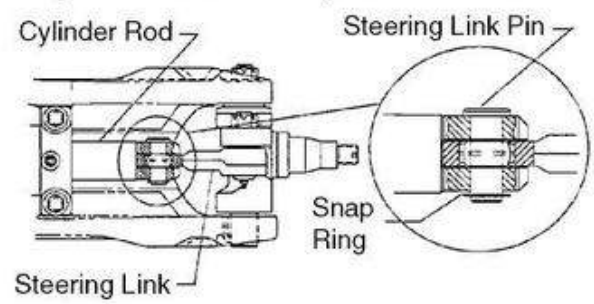
2. Apply grease to upper and lower knuckle bearings and install bearings, grease seals, and washers to bores of knuckle.
3. Set the retainer pin into the king pin and slide the king pin into the steer axle/knuckle bore.

IMPORTANT

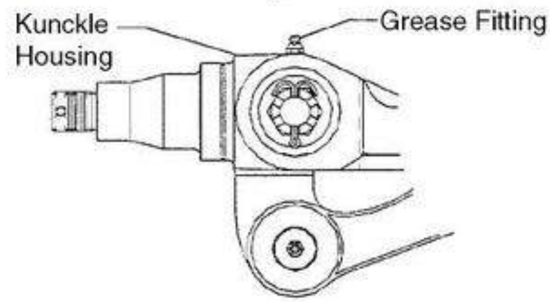
Make sure that retainer pin enters the hole in the underside of the axle



4. Reset the kingpin castellated nut to the top of the kingpin. Torque nut to 50-60 N·m (36.5-44 ft-lb).
5. Rotate the steer knuckle three times through its full range of movement. Check to be sure that it is free to rotate in the bearings without binding.
6. Loosen the kingpin nut and retorque the nut to 30-35N·m (22.2-25.5 ft-lb).
7. **Advance the nut to the next castellated slot and lock the nut into position with a new cotterpin. Bendcotterpin tabs over.**
8. Replace steering link pin and snap ring to join the cylinder rod to the steering link and knuckle.



9. Reinstall grease fitting in knuckle housing and lubricate with recommended grease.



NOTE :

Section 5

Steering Cylinder Removal and Replacement

CAUTION

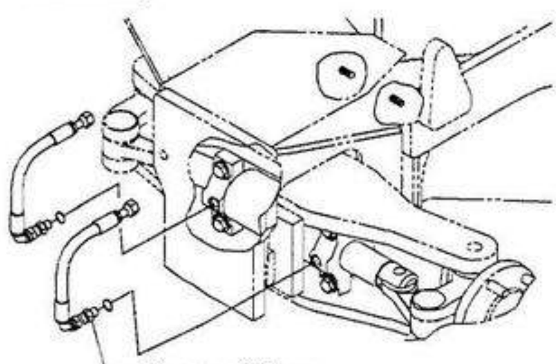
SAFE PARKING. Before working on truck:

1. **Park truck on a hard, level, and solid**
2. **surface, such as a concrete floor with no gaps or breaks.**
3. **Put upright in vertical position and fully lower the forks or attachment.**
4. **Put all controls in neutral. Turn key switch OFF and remove key.**
5. **Apply the parking brake and block the wheels.**

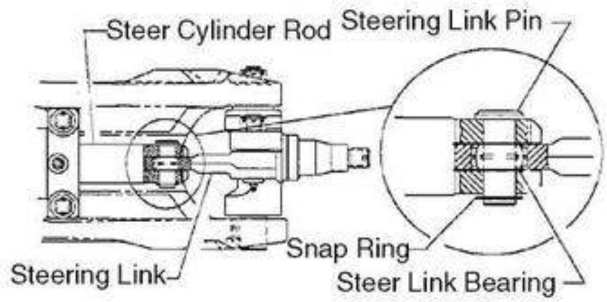
Steer Cylinder Removal

The steer cylinder can be removed from the steer axle for overhaul or replacement without removing the steer axle from the truck. The cylinder should be overhauled or replaced if steering problems or troubleshooting information indicate the cylinder is malfunctioning. See Group 2.5, Section 2, "Steering System Troubleshooting," for steering problem diagnoses. See Section 6 in this Group for steer cylinder overhaul procedures.

1. Place a dram pan under the steer cylinder and remove the hydraulic lines from the cylinder fittings. Cap fittings and lines to prevent fluid from leaking and to protect the components and hydraulic system from dust and dirt. Label hoses and fittings for correct reassembly.



2. Remove the snap ring from the bottom of the steering link pin. Steering link pin attaches steer cylinder rod end to steering link.

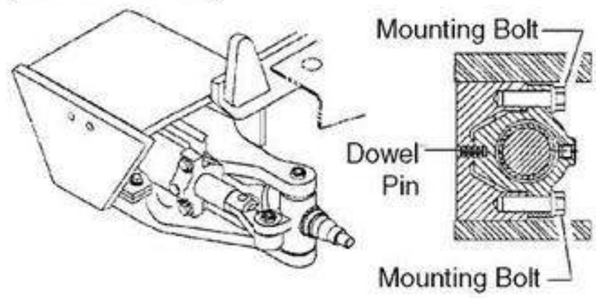


NOTE

Mark left-side and right-side parts for correct reassembly.

3. Tap steer link pin upward until it clears the steering link bearing and remove the pin.
4. Remove steer link bearing from steering link-to-cylinder rod end bore.
5. Rotate the steering link away from the cylinder rod end.
6. Repeat steps 1 through 5 for the opposite side of the steer cylinder.
7. Remove the four steer cylinder mounting bolts and washers from the steer axle. Removal torque on these bolts can be as high as 405 N·m (300 ft-lb).

Cylinder is now ready to be removed from the steer axle body. Cylinder must be lifted off dowel pins positioning cylinder to axle body.



CAUTION

Cylinder is somewhat heavy and bulky. When removing cylinder from mounting be prepared to lift and move the full weight of the cylinder.

Parts Inspection

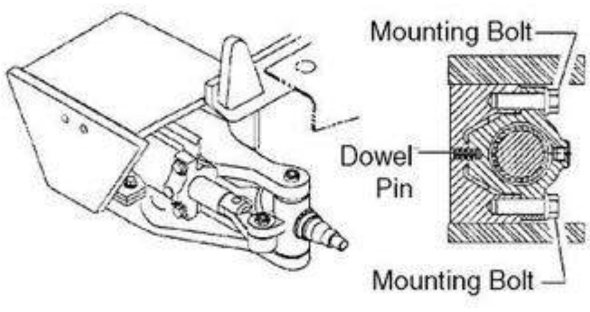
Completely inspect all parts:

1. Clean all bearings, cups, seals, pins, and other parts in an approved cleaning fluid.
2. Inspect all parts for scratches, chips, scoring, and uneven or heavy wear. Check steering links to be sure they are not bent or twisted. Check all threaded parts for damage.
3. Replace all parts showing excessive wear or signs of damage.
4. If parts are to be left exposed, coat all mating surfaces of parts with a light layer of engine oil. Keep all parts clean and covered.
5. Remove and clean all grease fittings before reassembling cylinder components.

Refer to Section 6, "Steer Cylinder Overhaul", if pressure check or troubleshooting tips indicate a problem with steer cylinder performance.

Steer Cylinder Replacement

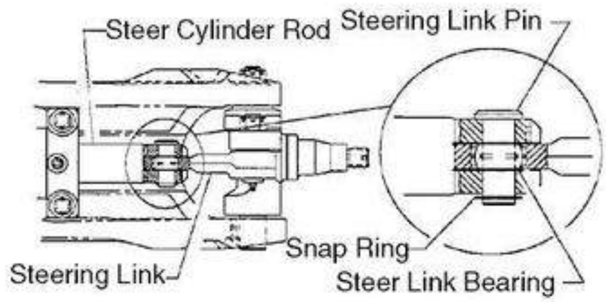
1. Remount the steer cylinder onto the steer axle dowel pins; set bolts and washers in place and torque mounting bolts to 280-320 N·m (205-234.5 ft-lb).



⚠ CAUTION

Cylinder is somewhat heavy and bulky. When remounting cylinder to steer axle body, be prepared to lift and maneuver the full weight of the cylinder as you set it into position.

2. Position the steering link with the cylinder rod end. Reuse steer link bearing if still serviceable. Install new bearings if scoring or wear marks are evident or if the bearings do not operate smoothly.

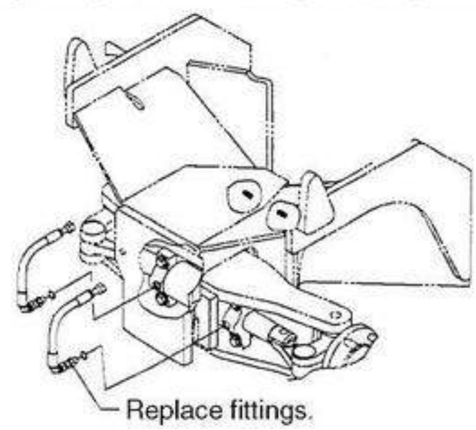


3. Rotate steering link into cylinder rod end and align bearing hole with rod end.
4. Tap pin through steer link bearing hole with snap ring groove on lower end.

IMPORTANT

Make sure bearing is properly aligned with pin in the hole.

5. Install the snap ring to the steering link pin.
6. Repeat steps 1 to 5 for rod end-to-steering link connection for opposite side.
7. Clean and replace hydraulic hoses on correct, clean, cylinder fittings. See Group 40, Hydraulic Fitting Tightening Procedure" for replacement procedures.



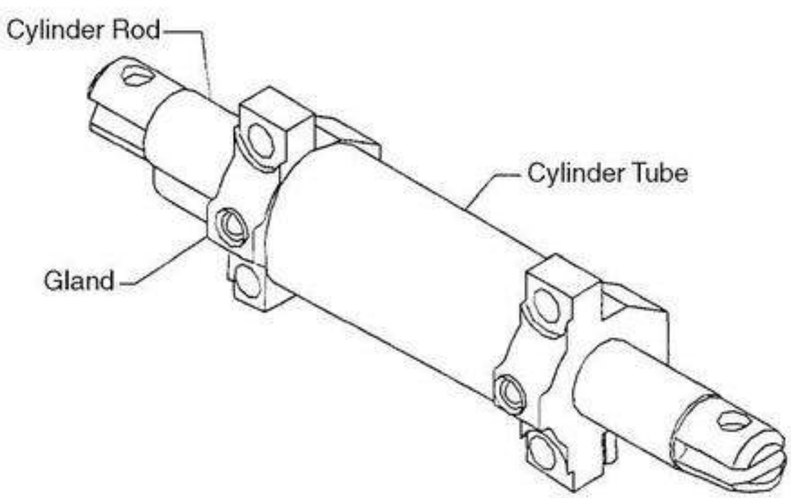
8. Check to be sure all lube fittings are installed. Fill all lubrication points with correct lubricant. See recommended greasing procedure above.
9. Test function of steer cylinder before returning the truck to service.

Section 6

Steer Cylinder Overhaul

IMPORTANT

Before removing any component for overhaul, make sure the correct repair parts, seals, and gasket sets are available.



Steering Cylinder

Cushion-tire truck cylinder with "C" stamped on rod end.(ECX)

Pneumatic-tire truck cyliner with "P" stamped on rod end.(EPX)

Preparation for Steer Cylinder Disassembly and Over haul

Refer to Section 5 for removal of steer cylinder from the steer axle body.

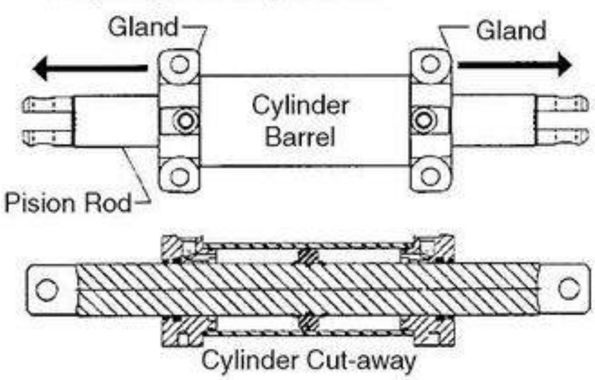
IMPORTANT

Cleanliness is of extreme importance in the repair and overhaul of this assembly.

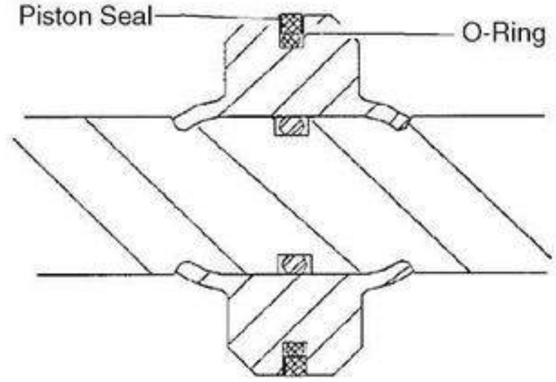
1. Overhaul steer cylinder only in a clean, dust-free location, using clean tools and equipment. Dirt or grit will damage the highly-machined surfaces and will result in leakage or premature failure of components. Cleanliness of the hydraulic circuit is extremely important to the proper operation and maintenance of the system. Be sure the work area is clean.
2. Before disassembly, the exterior of the steer cylinder should be carefully cleaned to remove all dirt and grease accumulation.
3. Be sure all hydraulic fluid has been removed from the cylinder. Stroking the piston rod will help force the fluid out.
4. Before starting disassembly, the steer cylinder should be carefully examined to determine if there is any external damage.

Steer Cylinder Disassembly

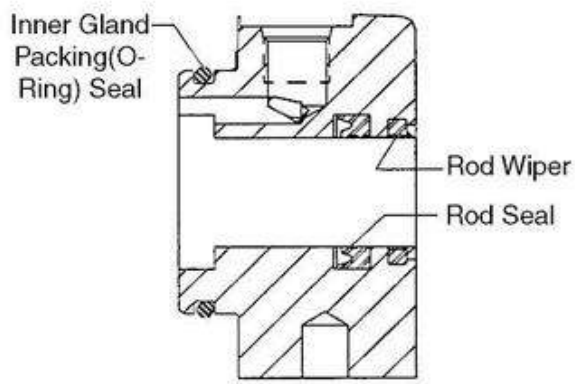
1. Clamp the steer cylinder assembly in a vise. Wrap the cylinder in a course cloth to prevent slipping and scratching. Use extreme caution when tightening vise and do not overtighten; cylinder can be bent, distorted, and potentially destroyed.
2. Remove one gland by pulling it from cylinder barrel and pulling it off the piston rod.



3. Remove the piston and rod assembly from the Cylinder.
4. Remove gland from opposite end of steer cylinder.
5. Remove the seal and O-ring set from the piston. Discard seals. Replace with new seal set at assembly.



6. Remove (inner) gland packing (O-ring) seal. Replace with new seals at assembly.



7. Remove the rod (U-cup) seal and rod wiper from gland and discard. Note direction of seal and wiper seating for correct reassembly. Replace with new seals and wipers at assembly.

Parts Inspection

1. Carefully clean all parts in an approved solvent and place on a clean surface.
2. Check the piston for chips, cracks, and looseness on the rod. If loose, replace rod and piston assembly.
3. Be sure the piston-seal groove in the piston is smooth, true, and undamaged.
4. Check the piston rod for damage. Look for scratches, grooves, gouges, pitting, corrosion or other evidence of unusual wear. Minor surface damage may be repaired by use of fine abrasion cloth or stoning. Deeper damage will require replacement of piston rod assembly.

5. Carefully inspect the cylinder internal bore for wear, scratches, corrosion or other damage. Check the outside for damage. Inspect all welds for cracks.
6. Inspect the cylinder ports and threads to be sure they are free of contamination and that the threads are clean and not damaged.
7. Check the gland for cracks or damage that could cause failure.
8. Deep gouges or pitted surfaces require replacement of parts.
9. Put a light coating of hydraulic fluid on all parts. If parts are to be left disassembled for a period of time, such as overnight, they should be covered with a clean cloth.

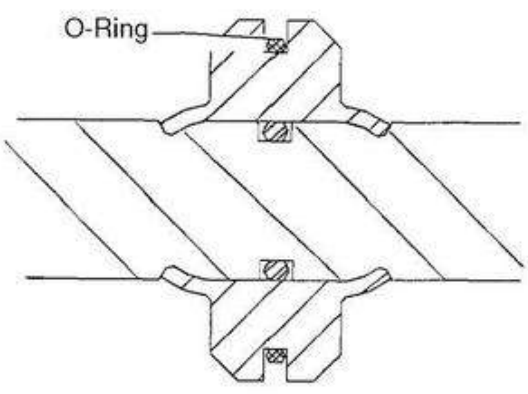
Steer Cylinder Reassembly

Check to make sure the overhaul kit you have is correct and that all parts are included.

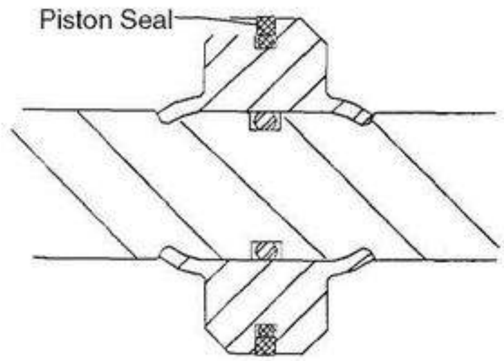
IMPORTANT

Be sure inside of cylinder and all parts are clean before starting reassembly.
Assemble cylinder carefully to prevent damage to seal lips and O-rings. Seals should be lubricated with hydraulic oil to assist assembly into cylinder barrel and gland. Heating seal rings in boiling water before starting assembly will aid in assembly.

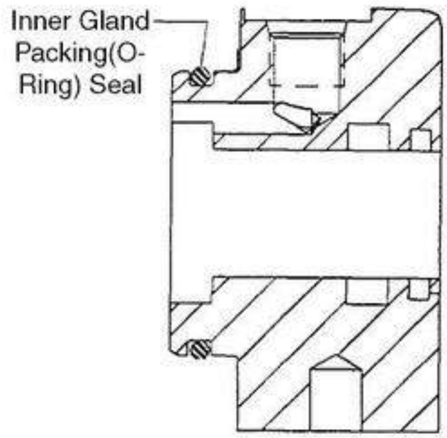
1. Install new O-ring seal on the piston.



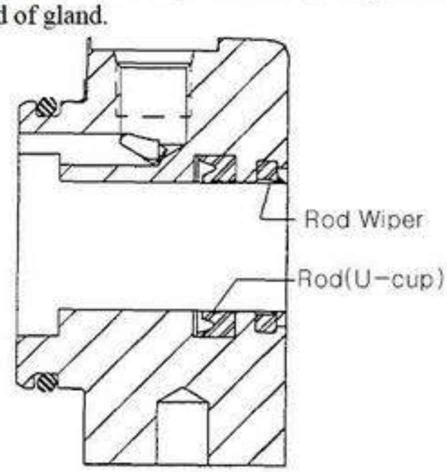
2. Install new piston seal over the O-ring seal.



3. Install new gland packing (O-ring) seal on inner end of gland.



4. Install new rod wiper and rod (U-cup) seal in outer end of gland.



IMPORTANT

Be sure the rod wiper and rod (U-cup) seal are installed in the correct directions.

5. Lightly lubricate the cylinder and gland mating surfaces with hydraulic oil before assembly.

6. Install the gland onto the cylinder bore rim, making sure gland is fully seated on cylinder.
7. Install piston and rod assembly into the cylinder.

NOTE

A special part is included in the parts kit to allow you to slip the gland over the rod end without damaging the gland seals.

8. Repeat above procedure for installation of opposite gland.

Operational Pressure Test

Once cylinder is remounted on axle (see Section 5), connect pressure source in turn at each port. Extend piston rod at each side and test with internal pressure of 13790 kPa (2000 psi). At this pressure no leakage must occur. Typical operating pressure is 7585 kPa (1100 psi).

GROUP 29

HYDRAULIC SUMP, FILTERS, AND PUMP

NOTE

This group covers the main hydraulic pump for the load handling system.
Other hydraulic-related components and circuits are described and illustrated in Group 25 "Steering Column and Gear," Group 26 "Steering System," Group 30 "Hydraulic Control Valve/Lift Circuit," Group 32 "Tilt Cylinders," and Group 34 "Uprights." Refer to these groups for hydraulic components not covered in this group.

NOTE :

Section 1

Main Hydraulic Sump, Filters, and Pump Specifications and Description

Specifications

Hydraulic Pump Type: Integral gear-type pump and motor assembly.

Sump Capacity: Usable oil = 28 Litres (7.4 Gal)

Hydraulic Fluid Type: Clark Hydraulic Fluid MS-68 (or other specification MS-68).

Filter Type: Disposable, 25 micron, return line oil filter, 100 mesh suction line screen and a 10 micron filter cap/breather filter.

Service Intervals

Hydraulic Fluid Level Checks: Every 8-10 hours or daily.

Hydraulic Fluid Change (Drain and Refill): Every 2000 hours of operation or every year.

Hydraulic Fluid Filter Replacement: After the first 50 hours of operation, then every year or 2000 hours of operation.

Description

NOTE

Se group 30 for a description of the complete hydraulic circuit.

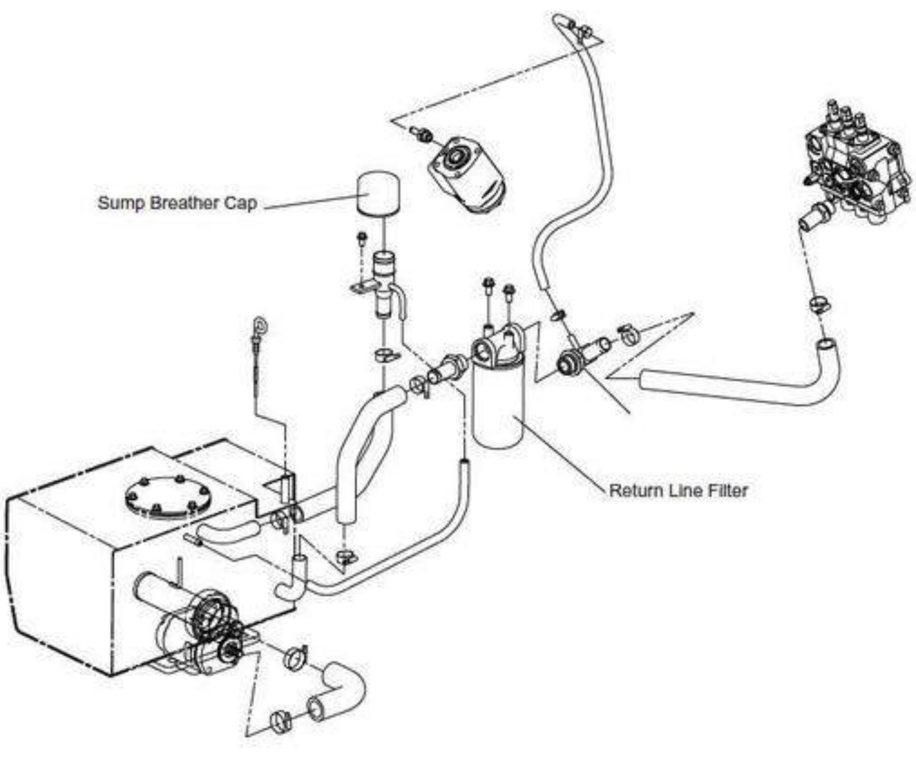
The hydraulic sump is located in the left side compartment of the truck frame. The sump is equipped with a suction line screen, return line filter, filter cap/breather.

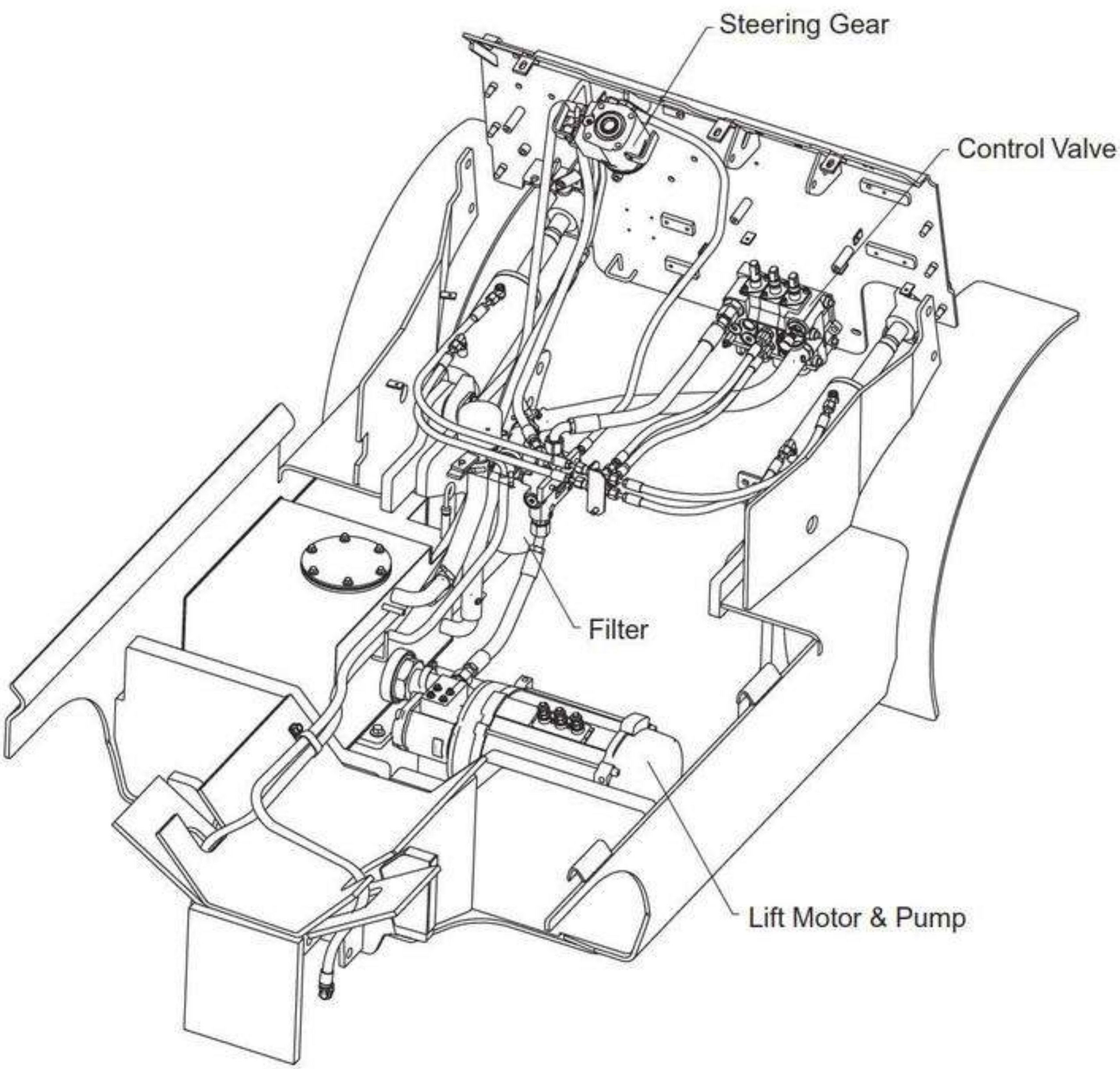
The integral main hydraulic pump and motor assembly is mounted to the truck frame beneath the battery compartment.

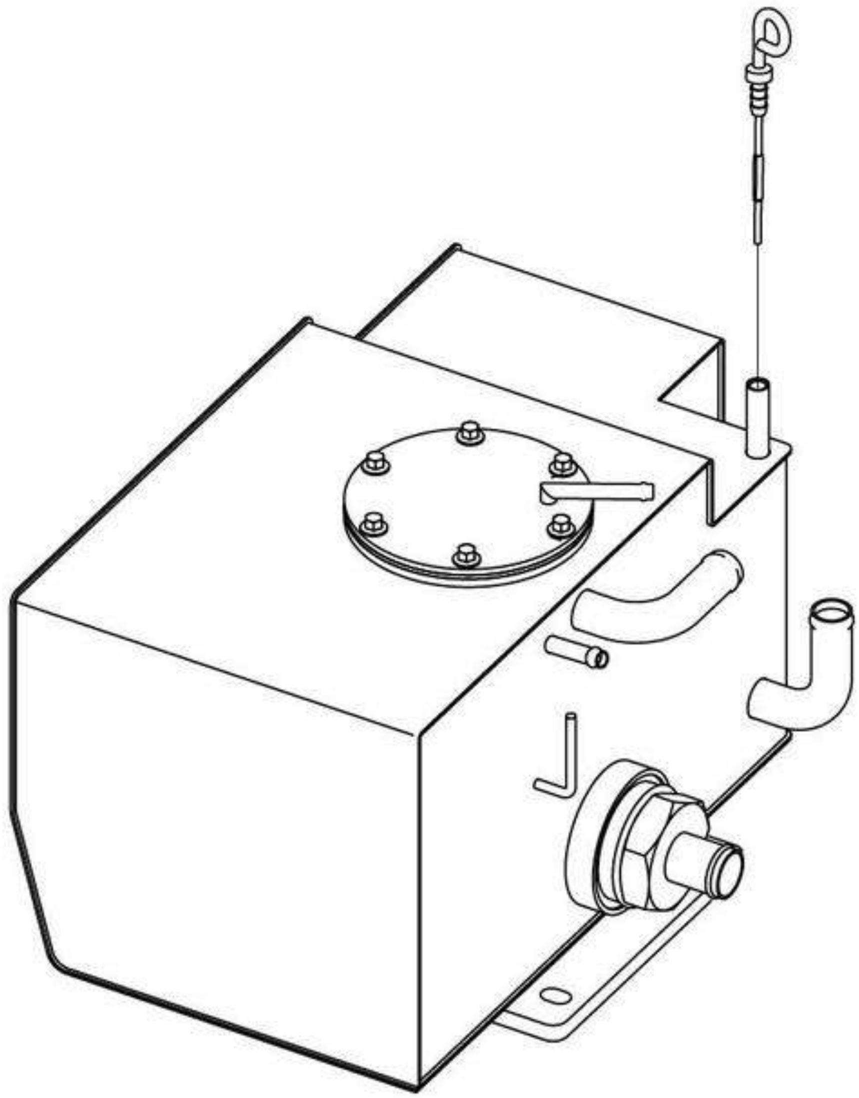
The main hydraulic pump draws oil from the sump and sends oil to priority valve.

The priority valve variably divides oil between the steering system and the main hydraulic system, with priority given to the steering system.

Serviceable items are the pump, motor, suction line screen and the return line filter. Other components, such as hoses, fittings, and clamps, are nonserviceable and should be replaced if worn or damaged.




Steering Gear
Control Valve
Filter
Lift Motor & Pump



Sump Tank Fill Levels

Pull out the dipstick for the hydraulic oil.

Hydraulic Fluid and Filter Change

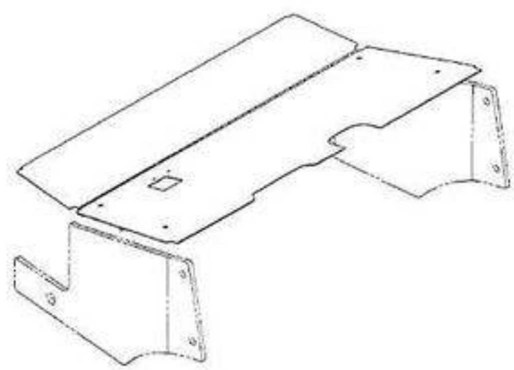
CAUTION

SAFE PARKING. Before working on truck:

1. **Park truck on a hard, level, and solid surface, such as a concrete floor with no gaps or breaks.**
2. **Put upright in vertical position and fully lower the forks or attachment.**
3. **Put all controls in neutral. Turn key switch OFF and remove key.**
4. **Apply the parking brake and block the wheels.**

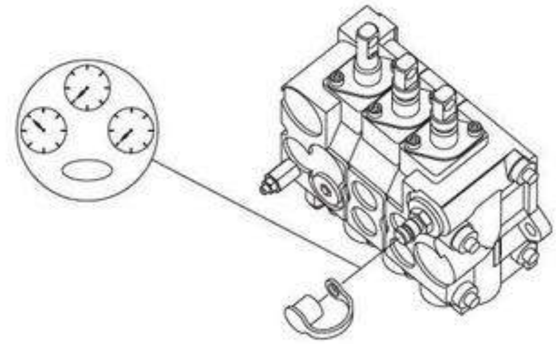
There is drain plug in the hydraulic sump tank. When the sump tank must be drained of all fluid, the procedure is to remove the drain plug and allow the fluid to drain into a suitable drain pan. Unless the sump tank is to be removed for other repair or maintenance, the hydraulic fluid can also be changed by one of the following methods:

Remove the floorboard for access to the hydraulic oil filter and diagnostic port on the control valve. The floorplate folds to lift out. No fasteners are used.



Pressure gauge to the diagnostic check port fitting.

NOTE: Use quick-disconnect adapter fitting.



You will need a drain pan of 28 L (7.4 gal) minimum capacity. Be sure the outlet end of the drain line is directed into the drain pan and held from moving when pressurized.

Turn key switch ON.

Move tilt control lever to the back tilt position to start the lift pump. Hold tilt lever in this position until sump tank is emptied. A steady stream of used oil should flow from the drain line.

Continue operation until the sump tank is emptied. This point will be reached when the pump starts to cavitate. When cavitation occurs the pump speed will increase and the speed sound will whine. Release the tilt lever immediately when pump cavitation occurs.

IMPORTANT

Be careful when sump is nearly emptied and oil flow becomes erratic as the pump approaches cavitation Do not operate pump after cavitation occurs.

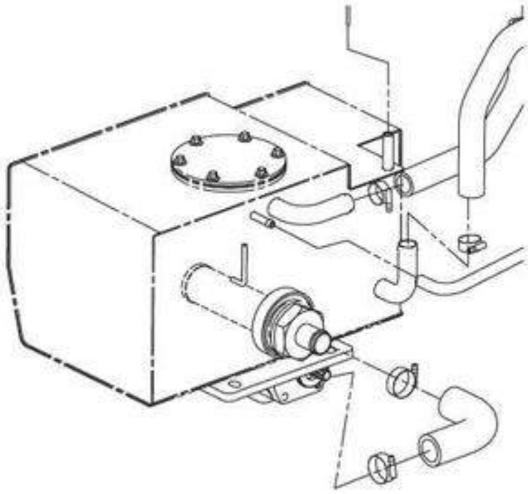
Turn the key switch OFF.

Disconnect drain line from truck. Replace the diagnostic port cover and reinstall the cowl covers.

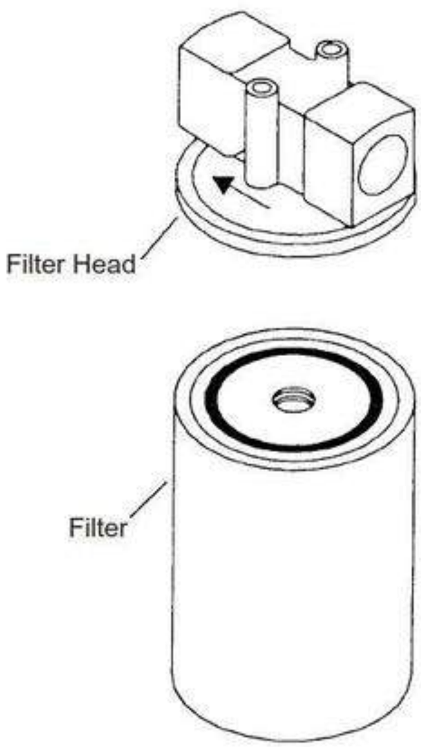
NOTICE

If old oil is excessively dirty or hydraulic system is contaminated, it is recommended that the sump tank be completely drained by removing the pump suction line from the sump outlet and flushed withy clean oil.

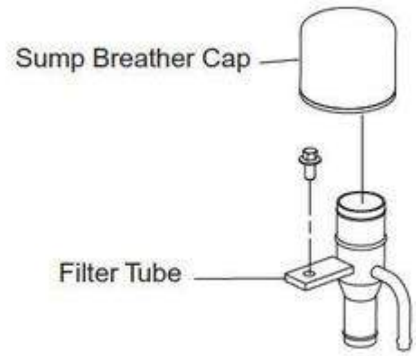
Remove, clean and replace the strainer.



Remove and discard old oil filter. Install new filter. Follow the installation instructions printed on the filter body. Also, check that the hydraulic line connections at the filter head are tightened correctly.



Remove and replace the sump breather cap. Remove and clean the screen from the sump fill tube.

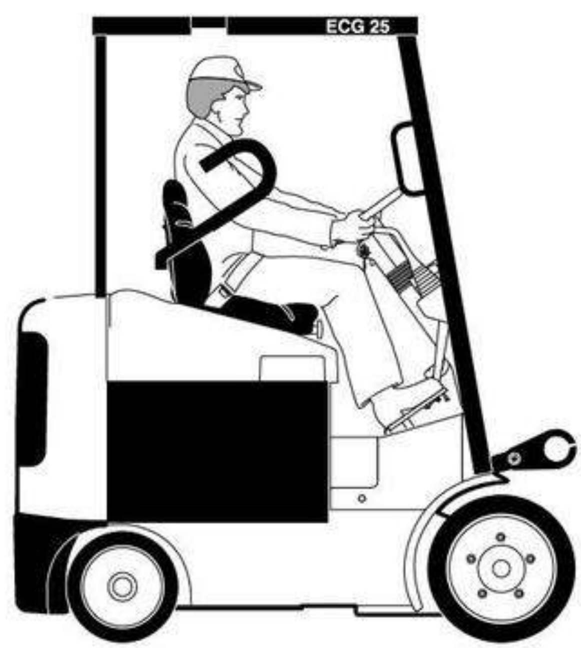


Refill the sump tank with Clark MS-68 Hydraulic Fluid.

Check truck operation. Turn key switch ON. Operate the hydraulic system. Cycle the lift system serval times: raise the lift carriage to full height and lower fully down. Check for leaks. Recheck sump tank fluid level.

⚠ CAUTION

Be sure there is adequate overhead clearance before raising upright.



Turn the key switch OFF.

Section 2

Main Hydraulic Pump Troubleshooting

The following is a list of problems and solutions relating to the main hydraulic pump and associated components. For other hydraulic system troubleshooting, refer to Groups 30 and 34.

Noisy Pump

- Hydraulic fluid level low; measure and correct fluid level.
- Fluid viscosity too high; change to specified fluid.
- Sump strainer dirty; check and clean.
- Air leak at pump inlet line; check plumbing tightness.
- Inlet line restriction; check for foreign material or line kinks, check and clean sump suction screen.
- Air leak at pump shaft packing; replace packing.
- Defective hydraulic pump; continue other troubleshooting items, then consider servicing or replacing pump.

Pump Not Delivering Hydraulic Fluid

- Hydraulic fluid level low; check and correct fluid level.
- Sump suction screen dirty; check and clean.
- Inlet line restriction; check for foreign material or line kinks, check and clean sump suction screen.
- Air leak in suction line: check plumbing tightness.
- Fluid viscosity too high: check fluid viscosity and change to specified fluid.
- Defective hydraulic pump; continue other troubleshooting items, then consider servicing or replacing pump.

Failure to Build Pressure

- Hydraulic fluid level low; measure and correct fluid level.
- Defective relief valve or pump: perform pressure check to test valve and pump.

Pump Not Developing Sufficient Pressure

- Leak in hydraulic control system; check system for and correct leaks.
- Inlet line restriction; check for foreign material or line kinks, check and clean sump suction screen.
- Suction screen dirty; clean screen.
- Defective hydraulic pump; continue other troubleshooting items, then consider servicing or replacing pump.

Pump Output Low

- Cavitating pump; see "Noisy Pump."
- Air in fluid or wrong fluid; drain and fill with correct fluid.
- System relief valve set too low or too high, stuck or leaking; correct relief valve, pump may be OK.
- Overheated fluid; see "Overheated Pump and/or Fluid."
- Contaminated fluid; eliminate contamination source and replace fluid.
- Gear face, body or cover nicked; repair or replace pump.
- Excessive side loading, wear plate tight in body bore, pinched thrust plate; inspect and service pump.

Foaming Fluid

- Cavitating pump; see "Noisy Pump."
- Wrong fluid; drain and fill with correct fluid.

Overheated Pump and/or Fluid

- Low viscosity fluid; drain and fill with correct fluid.
- Contaminated fluid; drain fluid, clean suction screen, replace filter and fill sump.
- Cavitating pump: see "Noisy Pump."
- Pump drive shaft misaligned; check mounting and alignment.
- Axial loading on drive shaft; check shaft end clearance and shaft alignment; check for worn key/ spline.
- Relief valve usually in bypass; check relief setting.

External Leakage

- Excessive system pressure; replace pressure control valve on main hydraulic valve.
- Faulty or distorted pump seal gasket; replace seal gasket.
- Damaged surfaces on pump body or cover; correct and replace as required.

NOTE :

Section 3

Main Hydraulic Removal and Installation

Main Hydraulic Pump Removal

⚠ CAUTION

SAFE PARKING. Before working on truck:

1. **Park truck on a hard, level and solid surface, such as a concrete floor with no gaps or breaks.**
2. **Put upright in vertical position and fully lower the forks or attachment.**
3. **Put ail controls in neutral. Turn key switch OFF and remove key.**
4. **Disconnect the battery.**
5. **Apply the park brake and block the wheels.**

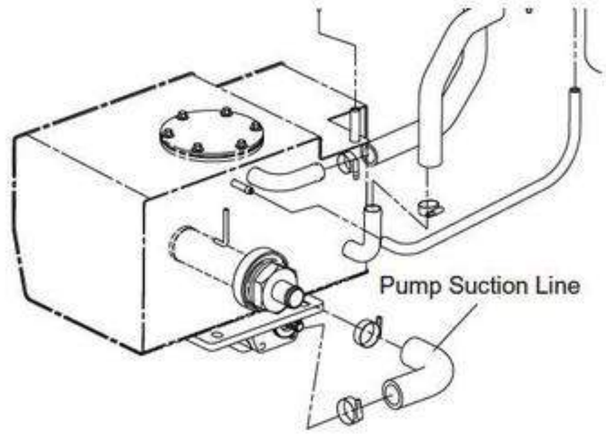
The main hydraulic pump is located beneath the battery. The pump can be removed from the truck without removing the pump and motor assembly.

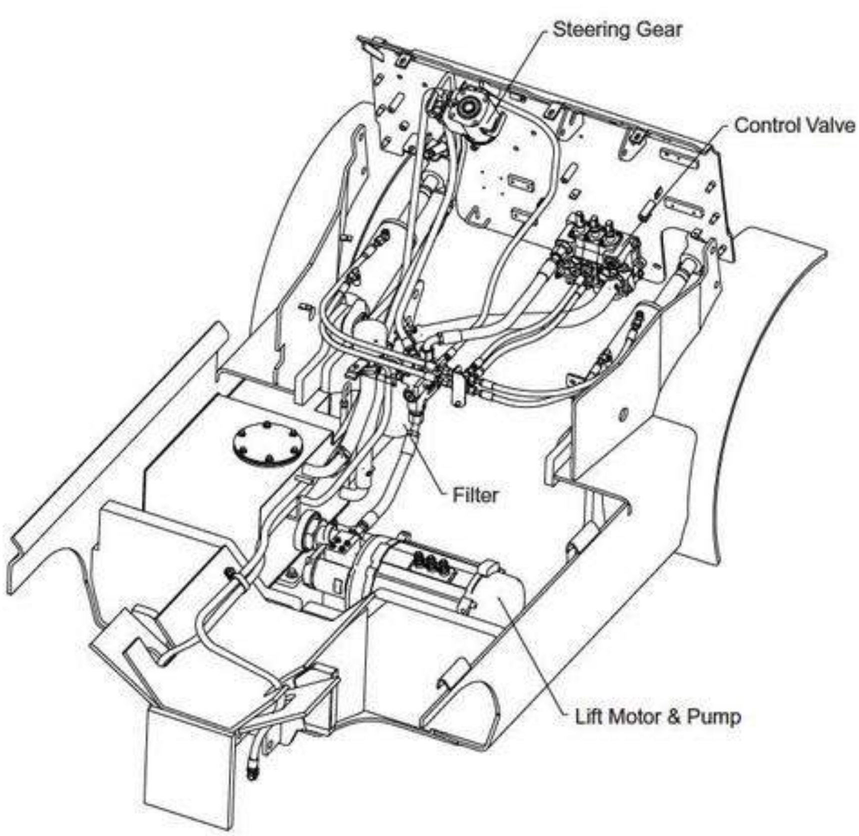
Serviceable items are the pump, motor and the suction line filter. Other components such as hoses, fittings and clamps are non-serviceable and should be replaced if faulty.

NOTE

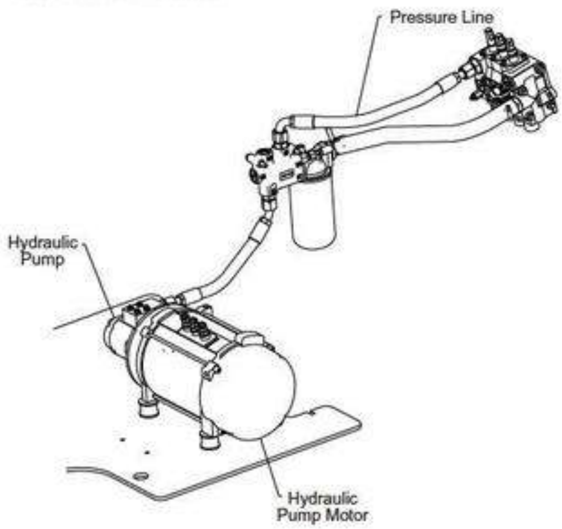
Capacity of hydraulic sump is 28 L (7.4 gal).

1. Place a drip pan under the hydraulic pump for oil that will drain from the pump and hoses when they are disconnected.
2. Disconnect suction line from pump and plug the line.

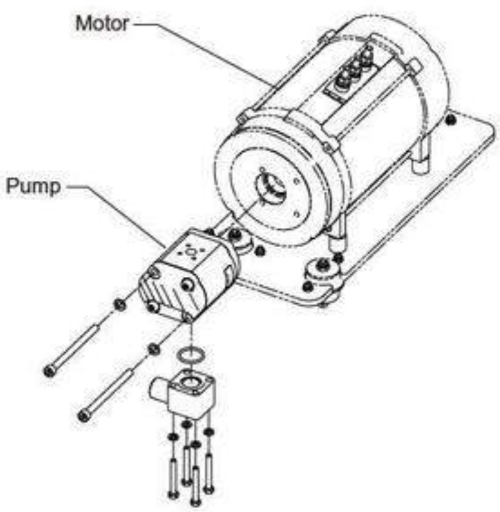




3. Disconnect the pressure line from the pump. Cap the hose and set aside.



4. Remove the pump mounting fasteners.The ground strap will come off with the fasteners.



Main Hydraulic Pump Installation

IMPORTANT

Keep all components clean during installation.

1. Be sure new or serviced pump is well lubricated before installation.
2. Install pump onto motor. Install and tighten capscrews. Make sure ground wire is attached to lower capscrews.
3. Slide suction hose and clamp into place and tighten.
4. Connect pump outlet hose and tighten. Use two wrenches to tighten hose fittings to prevent twisting of lines.

NOTE

Always clean or replace hydraulic sump suction screen fitting when installing new or rebuilt pump. See Section 1, Main Hydraulic Filters and Fluid Maintenance.

5. Refill sump as necessary using Clark Specification MS-68 hydraulic fluid. See Section 1 for description of sump tank fill levels.
6. Reinstall hose and cable support bracket.
7. Check operation of hydraulic system. See Section 1, Main Hydraulic Filters and Fluid Maintenance.
8. Check fluid level of sump again. Add fluid as necessary.

NOTE

For Hydraulic Pump Overhaul Procedures see Section 4.

NOTE :

GROUP 30

HYDRAULIC CONTROL VALVE/LIFT CIRCUIT

IMPORTANT

Other hydraulic-related components and circuits are described and illustrated in Group 25, "Steering Column and Gear", Group 26 "Steer Axle", Group 29, "Hydraulic Sump, Filters and Pump", Group 32, "Tilt Cylinders", and Group 34, "Uprights". Refer to these other groups for hydraulic components not covered in this group.

NOTE :

Section 1

Hydraulic Control Valve/Lift Circuit Specifications and Description

Specifications

Hydraulic Fluid Type: Clark specification MS-68 (Clark part #1802155 and #1800236)

Main Relief Valve Setting: 20,000 to 21,000 kPa (2900 to 3000 psi) at rated flow.

Auxiliary Relief Valve Setting: 13,300 to 14,300 kPa (1925 to 2075 psi) at rated flow.

Rated Flow:

Lift spool (spool #l): 76 L/min (20 gpm).

Tilt spool (spool #2): 38 L/min (10 gpm).

Auxiliary spool (spool #3): 38 L/min (10 gpm).

Integral Pressure Compensated Flow Control Settings:

Tilt spool (spool #2):

Tilt Flow Settings:

Upright Usage	Tilt Speed (°/sec)	Flow Lpm(gpm)
5715mm(225 in) MFH & above	3	11.6 (3.0)
4165 - 5715mm MFH	5	22.0 (5.8)
4165mm MFH Below	8	29.8 (7.9)
Auxiliary spool(spool #3): 11.6 L/min (3.0 gpm)		

Maximum Pressure Drop at Rated Flow:

Inlet to outlet: 689 kPa (100 psi).

Lift spool (spool #l):

- Inlet to cylinder port: 689 kPa (100 psi)
- Cylinder port to outlet: 550 kPa (80 psi).

Tilt spool (spool #2):

- Inlet to cylinder port: 689 kPa (100 psi)
- Cylinder port to outlet: 550 kPa (80 psi).

Auxiliary spools (spools #3 and #4):

- Inlet to cylinder port: 345 kPa (50 psi)
- Cylinder port to outlet: 207 kPa (30 psi).

Flow Control Adjustments: Adjustable from 4 to 38 L/min (1 to 10 gpm). Before adjusting, turn fully CCW to stop.

AUX FLOW CONTROL ADJUSTMENTS	
FLOW SETTING L/min (gpm)	CLOCKWISE TURNS OF ADJUSTMENT SCREW
6.3(1.7)	0.50
8.7(2.3)	0.75
12.3(3.2)	1.00
19.0(5.0)	1.50
23.4(6.2)	1.75
33.5(8.8)	2.50
39.8(10.5)	3.00
52.9(14.0)	4.50

Service Intervals

Hydraulic System Relief Pressure Check: Every year or every 2000 hours of operation.

Fastener Torques

Lever to Spool Rod Tumbuckle Adjustment Jam Nuts: 28.5-32.5 ft-lb (39-44 N·m).

Pivot Pin Keeper Hexnut: 14.5-18.5 ft-lb (20-25 N·m).

Lever Pivot-Bracket Mounting Nuts: 14.5-17 ft-lb (20-23 N·m).

Description

The following description focuses primarily on hydraulic circuitry controlled by the main hydraulic control valve, that is, the lift/tilt/aux circuit. Various other hydraulic systems come into play, however, and are mentioned. The entire hydraulic system is depicted in the schematics in Section 2 (next page).

Descriptions of the braking and steering circuits are given in Groups 23 and 25.

The main hydraulic pump (described in Group 29) is driven by the pump motor and draws fluid from the sump through a particle-blocking suction screen.

The main hydraulic control valve features an open-center, parallel-circuit type modular design. It has the main (lift/tilt) pressure relief valve (steering pressure relief valve located in the steering control assembly (Orbitrol)), a secondary pressure relief valve for optional auxiliary components, a lift spool, a tilt spool with an integral counterbalance valve, optional auxiliary spools, and adjustable pressure-compensated flow controls. All spools are low-leakage design.

The main hydraulic valve has from two to four valve sections. Each section performs a separate function; standard two spool assemblies have a inlet/lift section (with fluid inlet port), a tilt section, and an outlet section. A third and fourth section may be added to control auxiliary components.

When lift attachments are used, an auxiliary section may be added to the outer (RH) side of the standard (lift/tilt only) main valve. The optional auxiliary sections also have an adjustable relief valve and can be assembled with optional flow control levels.

The valve spools are arranged in standard sequence (from the operator's position) to first provide lift control, then tilt, and finally auxiliary control. The control levers are spring-loaded (by the valve spool centering springs) to return them to neutral when released. Oil flow is controlled by the amount or distance the control handles are moved. Excess oil flow is returned to the sump. A check valve prevents reverse flow.

When all the control valve spools are in neutral, the micro switch turns the pump motor OFF and not fluid flows. When a spool is partially shifted and the associated cylinder or other actuator has not reached its end-of-travel, some of the fluid flows to the cylinder (actuator) and the rest flows to the sump line. In both cases, the pressure in the system should be less than the amount required to open the relief valves.

The main relief valve vents flow to the sump when one of the following conditions is present:

- The operator continues to hold the lift control in the lift position after the lift mechanism reaches its endof-travel.
- Too heavy a load is being lifted.
- The operator continues to hold the tilt control in the tilt position after the tilt mechanism has reached its end-of-travel (This is called "tilt bypass.")
- Auxiliary relief fails to operate.

The auxiliary relief valve vents flow to the sump when the operator continues to hold the attachment control in the operated position after the attachment reaches its end-of-travel.

Main and auxiliary relief pressure settings can be checked through a gauge port on the main valve.

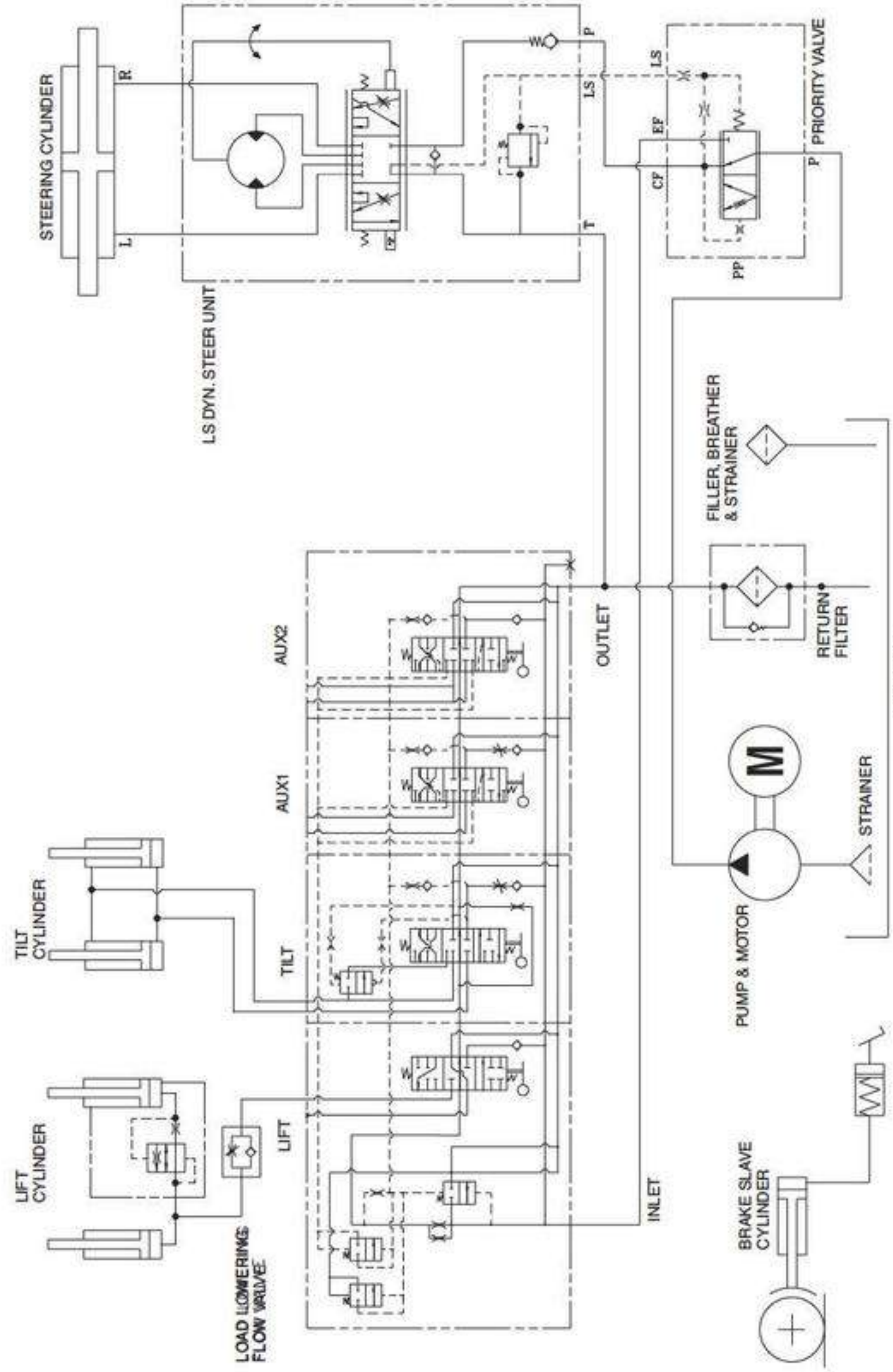
A tilt-lock valve built into the main control valve assembly locks the upright into its current tilt position when the truck is turned off. A load lowering flow valve mounted on the upright limits the speed at which the operator can lower a load, decreasing the speed for heavier loads. A velocity fuse built into one of the lift cylinder ports prevents the upright from falling rapidly should a hydraulic line rupture or be disconnected.

NOTE

Hydraulic plumbing arrangement is illustrated in Group 29.

Section 2

Hydraulic Schematic



Hydraulic Schematic

Section 3

Hydraulic System Troubleshooting

The following is a list of problems and solutions relating to the main hydraulic control valve and associated components. For other hydraulic system troubleshooting, refer to Groups 29 and 34.

No lift, tilt, or auxiliary function

- Hydraulic fluid very low; check and fill to correct level.
- Hose or fittings broken; replace component.
- Defective main lift valve; check other Troubleshooting items for possible cause, then consider rebuilding or replacing main lift valve.
- Hydraulic pump defective: check other Troubleshooting items for possible cause, then consider rebuilding or replacing pump.

No motion, slow or jerky action of hydraulic system

- Spool not moved to full stroke; check travel and linkage adjustment.
- Relief valve not properly set, stuck in place, and/or worn; check and clean valve, replace if necessary.
- Dirt or foreign particles lodged between relief valve control poppet and seat: check valve and clean.
- Valve body cracked inside; check and replace entire valve.

Foaming hydraulic fluid

- Low oil level; check and fill to correct level.
- Wrong fluid; drain and refill with correct oil.
- Oil too heavy; change to correct viscosity.
- Pump inlet line restriction or line kinked; clean line and suction screen or repair kinked hose.
- Hydraulic pump cavitating (pumping air with fluid); check hydraulic plumbing for airtight hoses and connections.

Overheated hydraulic fluid

- Thin fluid; drain and fill with correct fluid.
- Fluid contaminated; drain sump, clean suction screen, replace filter, and refill.
- Cavitating pump; check hydraulic plumbing for airtight hoses and connections.
- Pump driveshaft misaligned; check mounting and alignment.
- Axial loading on drive shaft; check shaft end clearance and shaft alignment; check for worn key/ spline.
- Relief valve in bypass; check relief setting.

Load cannot be lifted to maximum height

- Hydraulic fluid low: check and fill to correct level.
- Hydraulic pump defective; check other Troubleshooting items for possible cause, then consider rebuilding or replacing pump.

Oil leaks at top of lift (secondary) cylinder(s)

- Plugged vent line; check and clear line.
- Worn or damaged piston seal: rebuild cylinder.
- Scored cylinder wall; replace cylinder.

See Group 34, "Cylinder Removal, Overhaul, and Replacement."

Oil leak at tilt or auxiliary function cylinder

- Worn or damaged seal; rebuild cylinder.
- Scored piston rod; repair or replace rod.

See Group 34, "Cylinder Removal, Overhaul, and Replacement."

Load will not hold

- .Oil bypassing between lift spool and valve body; overhaul valve and spool.
- Spool not centered; see spool remedies for correcting problems when spools do not return to neutral.
- Oil bypassing piston in cylinder; repair or replace cylinder.

Oil leaks at either end of main hydraulic valve spool

- Defective O-ring seals; rebuild valve.

Spring-centered spools do not return to neutral

- Broken springs; rebuild valve.
- Entrapped foreign particles; check and clean system and valve.
- Bent spool; replace with new valve section.
- Misalignment or binding of linkage; check and align/adjust linkage.

No relief valve action (high pressure)

- Small particles of dirt in relief valve subassembly; check, clean, and/or replace relief valve, clean hole.
- Relief valve subassembly installed backwards; reinstall correctly.

Load drops when spool is moved from neutral to lift position

- Dirt or foreign particles lodged between check valve ball and seat; check and clean.
- Sticking or scored check valve; clean if sticking, replace if scored, replace poppet.

Section 4

Hydraulic System Pressure Checks and Adjustments

CAUTION

SAFE PARKING. Before working on truck:

1. **Park truck on a hard, level, and solid surface, such as a concrete floor with no gaps or breaks.**
2. **Put upright in vertical position and fully lower the forks or attachment.**
3. **Put all controls in neutral. Turn key switch OFF and remove key.**
4. **Apply the parking brake and block the wheels.**

Relief Pressure Checks

Following is the procedure for checking main hydraulic valve lift pressure and auxiliary relief pressure (if the truck is equipped with an auxiliary component).

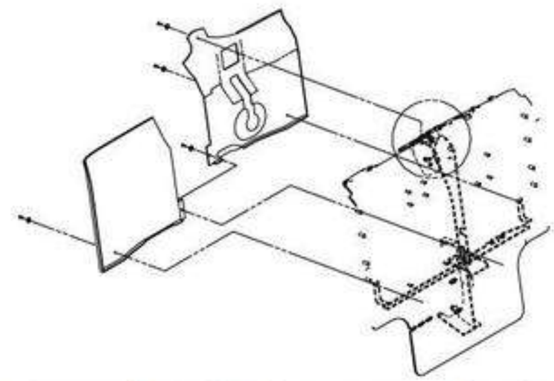
Hydraulic system relief pressure setting may be checked using a Mica Quadrigage (Clark Part No. 923770) or with a conventional pressure gauge with suitable pressure range calibration. To cover all models of the truck, a gauge with capacity range of 0 to 34,475 kPa minimum (0 to 5000 psi) is recommended.

WARNING

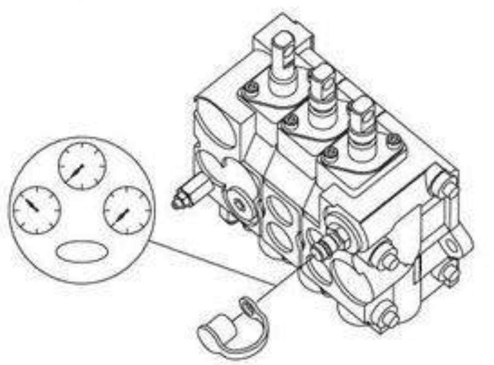
HYDRAULIC FLUID SAFETY. Keep all hydraulic ports and components clean. Wipe the area on the pump around the diagnostic check port completely clean to prevent any contamination from entering the hydraulic system.

When checking the hydraulic system, do not use your hands to check for 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.

1. Remove the covers enclosing the main hydraulic valve to access the hydraulic system pressure diagnostic check port.



2. Remove the cap from the gauge port on the valve and connect pressure gauge to the fitting.



NOTE

Use quick-disconnect adapter fitting, Clark Part #913125.

1. Check main relief pressure: Turn key switch on, move the tilt control lever to full back (or forward) tilt relief position. Hold tilt control in relief position until pressure reading is obtained, and then release. Gauge should read ECX/EPX20/25/32 : 20,000 to 20,700 kPa (2900 to 3000 psi), ECX30-32/EPX30 : 22,000 to 22,700 kPa (3200 to 3300 psi).

IMPORTANT

Do not operate system in relief any longer than required to read the pressure gauge.

2. **Check auxiliary relief pressure:** (Truck must have auxiliary component and auxiliary section added to main hydraulic valve.) Move the auxiliary control lever to full back or forward relief position. Hold auxiliary control in relief position until pressure

reading is obtained, and then release. Gauge should read 14,000 to 14,700 kPa (2000 to 2100 psi).

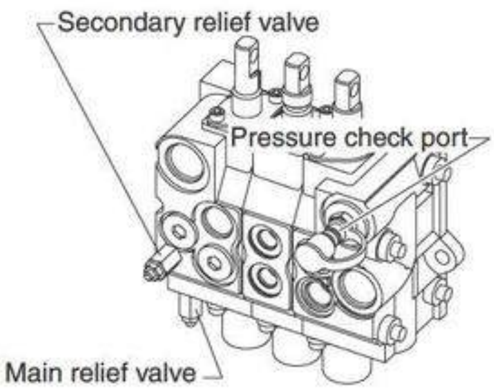
Main Pressure Relief Adjustment

IMPORTANT

Main pressure relief setting is set at the factory. If the relief pressure does not measure within the setting range, main pressure relief setting is adjusted.

To adjust the hydraulic system main pressure relief valve:

1. Loosen the jam nut on the main relief valve adjustment screw.



2. Turn the adjustment screw to set the main pressure relief setting to the normal range.
3. Reset the jam nut on the main relief valve adjustment screw.

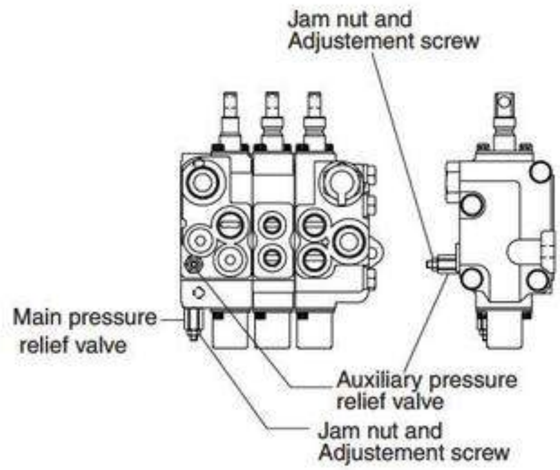
Auxiliary Pressure Relief Adjustment

IMPORTANT

The auxiliary relief setting only applies to a hydraulic valve that has auxiliary sections added.

To adjust the hydraulic system auxiliary pressure relief valve:

1. Loosen the jam nut on the auxiliary relief valve adjustment screw.

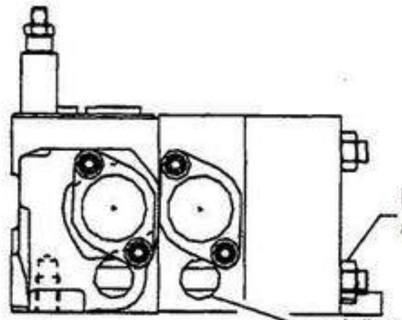


2. Turn the adjustment screw to set the auxiliary pressure relief setting to the normal range.
3. Reset the jam nut on the auxiliary relief valve adjustment screw.

Flow Control Adjustments

To make the following adjustments, position the tilt cylinders mid-way in their stroke (upright vertical).

1. Remove the nut from the main hydraulic valve tie bolt stud.



Bottom View of Typical Valve (no auxiliary attachments).

2. Remove the stud from the valve.
3. Turn the flow control adjuster fully counterclockwise to the stop. Do not tighten against stop, or you can damage valve seat.
4. Turn adjuster clockwise per flow control charts.
5. Repeat steps 3 and 4 for each flow control change required.
6. Reinstall the tie bolt stud in the valve. Torque the stud to 38-43 N·m (28-32 ft-lb).
7. Reinstall the nut on the tie bolt and torque to 38-43 N·m (28-32 ft-lb).

AUX FLOW CONTROL ADJUSTMENTS	
FLOW SETTING L/min (gpm)	CLOCKWISE TURNS OF ADJUSTMENT SCREW
6.3(1.7)	0.50
8.7(2.3)	0.75
12.3(3.2)	1.00
19.0(5.0)	1.50
23.4(6.2)	1.75
33.5(8.8)	2.50
39.8(10.5)	3.00
52.9(14.0)	4.50

TILT FLOW CONTROL ADJUSTMENT			CLOCKWISE TURN OF ADJUSTMENT SCREW
AVERAGE TILT SPEED		USAGE	
(°/sec)	L/min (gpm)		
3	11.6 (3.0)	Uprights at 5715 MFH(225") and above	1
5	22.0 (5.8)	4165~5715 MFH (164~225")	1.62
8	29.8 (7.8)	Under 4165 MFH(164")	2.00

Flowrate per RPM

ECX(EPX) 20/25

RPM	Hz	Flowrate		Lift Speed	Tilt in velocity		Remark
		lpm	gpm	mm/sec	mm/sec	deg/sec	
500	15	9.7	2.6	82	23.39	3.76	
600	18	11.8	3.1	100	28.45	4.57	
700	21	14.0	3.7	118	33.76	5.43	
800	25	16.1	4.3	137	38.82	6.24	
900	28	18.2	4.8	155	43.89	7.05	
1000	31	20.4	5.4	173	49.19	7.91	
1100	35	22.5	5.9	191	54.26	8.72	
1200	38	24.7	6.5	209	59.56	9.57	
1300	41	26.8	7.1	227	64.63	10.39	
1400	45	28.9	7.6	245	69.69	11.20	
1500	48	31.1	8.2	263	75.00	12.05	
1600	51	33.2	8.8	282	80.06	12.87	
1700	55	35.3	9.3	300	85.12	13.68	
1800	58	37.5	9.9	318	90.43	14.53	
1900	61	39.6	10.5	336			
2000	65	41.8	11.0	354			
2100	68	43.9	11.6	372			
2200	71	46.0	12.2	390			
2300	75	48.2	12.7	408			
2400	78	50.3	13.3	427			
2500	81	52.4	13.9	445			
2600	85	54.6	14.4	463			
2700	88	56.7	15.0	481			
2800	91	58.9	15.5	499			
2900	95	61.0	16.1	517			
3000	98	63.1	16.7	535			
3100	101	65.3	17.2	553			
3200	105	67.4	17.8	572			
3300	108	69.5	18.4	590			
3400	111	71.7	18.9	608			
3500	115	73.8	19.5	626			

* The above are only theoretical value.

- Displacement of pump : 22.5 cc/rev
- Volumetric efficiency of pump : 0.95

ECX(EPX) 30/32

RPM	Hz	Flowrate		Lift Speed	Tilt in velocity		Remark
		lpm	gpm	mm/sec	mm/sec	deg/sec	
500	15	8.0	2.1	68	19.29	3.10	
600	18	9.8	2.6	83	23.63	3.80	
700	21	11.6	3.1	99	27.97	4.50	
800	25	13.4	3.6	114	32.31	5.19	
900	28	15.2	4.0	129	36.65	5.89	
1000	31	17.1	4.5	145	41.24	6.63	
1100	35	18.9	5.0	160	45.58	7.32	
1200	38	20.7	5.5	175	49.92	8.02	
1300	41	22.5	5.9	191	54.26	8.72	
1400	45	24.3	6.4	206	58.60	9.42	
1500	48	26.1	6.9	221	62.94	10.12	
1600	51	27.9	7.4	236	67.28	10.81	
1700	55	29.7	7.8	252	71.62	11.51	
1800	58	31.5	8.3	267	75.96	12.21	
1900	61	33.3	8.8	282	80.30	12.91	
2000	65	35.1	9.3	298	84.64	13.60	
2100	68	36.9	9.8	313	88.98	14.30	
2200	71	38.7	10.2	328			
2300	75	40.5	10.7	344			
2400	78	42.3	11.2	359			
2500	81	44.1	11.7	374			
2600	85	45.9	12.1	389			
2700	88	47.7	12.6	405			
2800	91	49.5	13.1	420			
2900	95	47.7	13.6	435			
3000	98	53.2	14.0	451			
3100	101	55.0	14.5	466			
3200	105	56.8	15.0	481			
3300	108	58.6	15.5	497			
3400	111	60.4	15.9	512			
3500	115	62.2	16.4	527			

* The above are only theoretical value.

- Displacement of pump : 19 cc/rev
- Volumetric efficiency of pump : 0.95

Section 5

Hydraulic Control Valve Removal and Replacement

CAUTION

SAFE PARKING. Before working on truck:

1. **Park truck on a hard, level, and solid surface, such as a concrete floor with no gaps or breaks.**
2. **Put upright in vertical position and fully lower the forks or attachment.**
3. **Put all controls in neutral. Turn key switch OFF and remove key.**
4. **Apply the parking brake and block the wheels.**

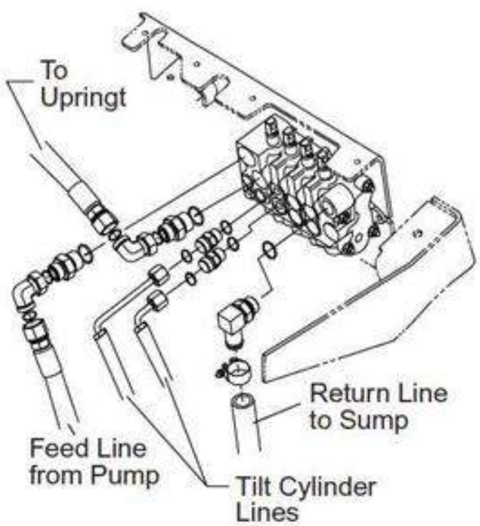
Hydraulic Control Valve Removal

IMPORTANT

Keep all hydraulic ports, components, and fittings completely clean during valve removal and replacement to prevent any contamination from entering the hydraulic system.

Preparation for Valve Removal

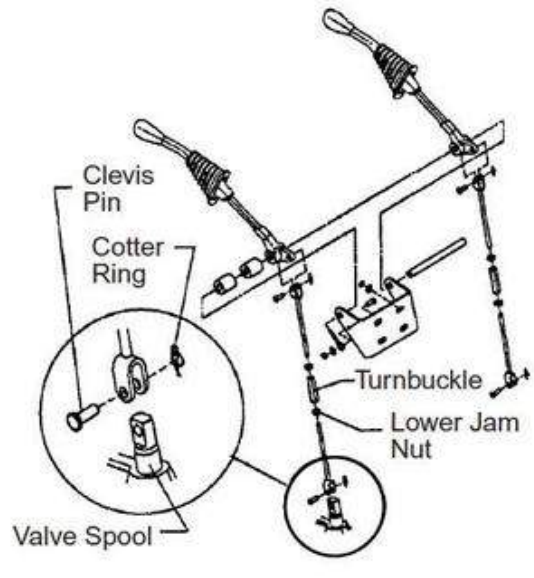
1. Park truck in a safe position and fully lower the upright.
2. Return all controls to neutral, apply the parking brake, and turn key switch OFF.
3. Move all hydraulic control levers to all working positions and return them to neutral. Be sure there is no hydraulic pressure applied to the system by attachments.
4. Remove floor plate.
5. Remove the right cowl cover from under the dash in the operator's compartment. See removal and replacement procedures in Group 38.
6. Air clean the hydraulic valve and fittings.
7. Place a drain pan under the truck and loosen and remove all hydraulic lines from the valve. Plug the valve ports. Mark or tag each line as removed to assure correct position of line at assembly.



8. Cap ends of lines to keep them clean. Tie ends of lines to truck to prevent loose ends dropping and leaking oil onto floor

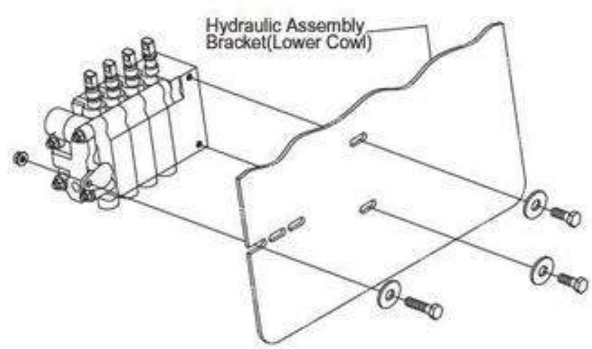
Control Valve Linkage Disassembly

Remove the cotter rings and clevis pins connecting the lift and tilt (and auxiliary, as applicable) lever rods from the hydraulic valve spools. Back off the lower jam nut at the turn buckle to allow the valve spool to be rotated before removing the clevis pins.



Valve Removal

1. Remove the three hex capscrews mounting the hydraulic valve to the hydraulic assembly bracket (lower cowl). Two of the capscrews thread into the valve itself; the third is secured with a flange nut.



2. Remove valve assembly from truck. See Section 6 for valve overhaul instructions.

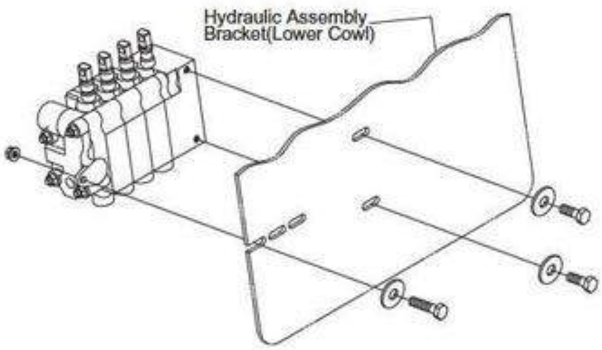
NOTE

Be sure to clean up any oil spills and dry the floor to prevent accidents.

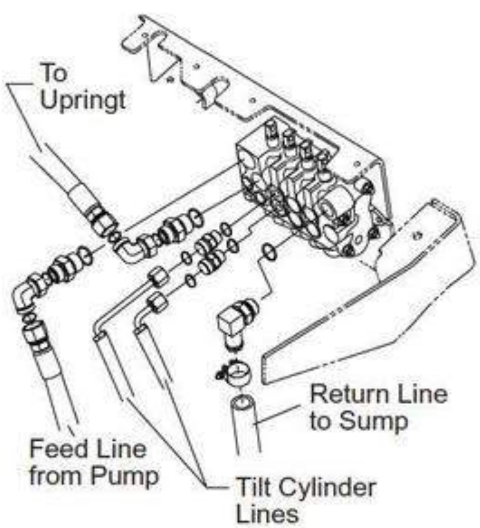
Hydraulic Control Valve Replacement

Valve Replacement

1. Position the main valve on the hydraulic assembly bracket (lower cowl). Install valve mounting fasteners and tighten hand tight so that valve mounting can be adjusted for alignment with the lever connecting rods.



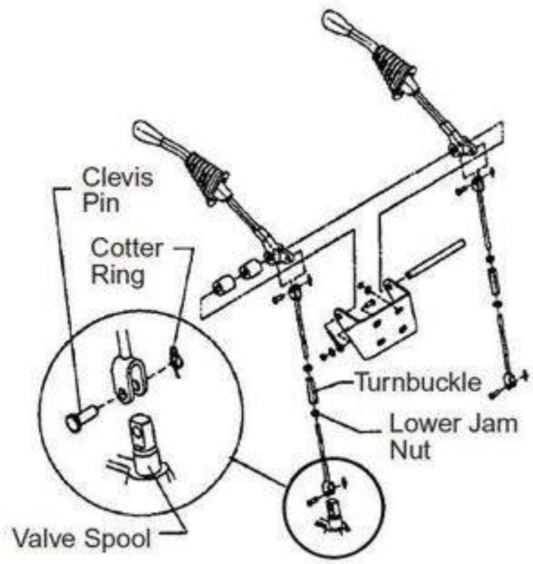
2. Install the hydraulic lines on the proper ports. Make sure all lines are clean, arerouted correctly in the truck, and are not kinked. Torque fittings according to "Hydraulic Fitting Tightening Procedure" in Group 40.



3. Adjust the valve to align with the lever connecting rods.

Control Valve Linkage Reassembly

1. Insert the clevis pins through the rod-end clevises and valve spools of the lift and tilt spools (and auxiliary-lever rods and spools where applicable) and secure with the cotter rings. Rotation of the valve spools is required to allow insertion of the clevis pins. Rotate spools back so all pins are in line.



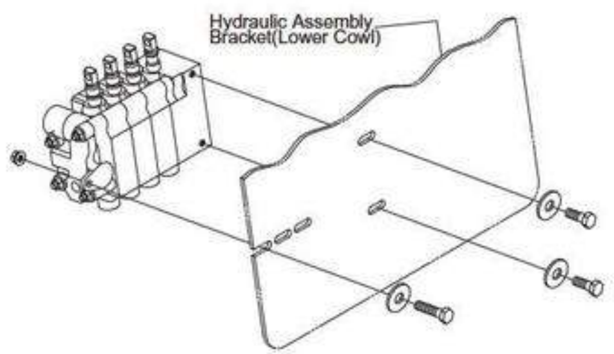
NOTE

The illustration above and system specification torques also apply for auxiliary hydraulic functions, such as a side-shifter or rotator.

2. When alignment between the lever rods and the valve is set and levers are inline and level with one another, tighten the valve mounting capscrews and flange nuts to 40-50N·m(30-33 ft-lb).

Reinstall Valve

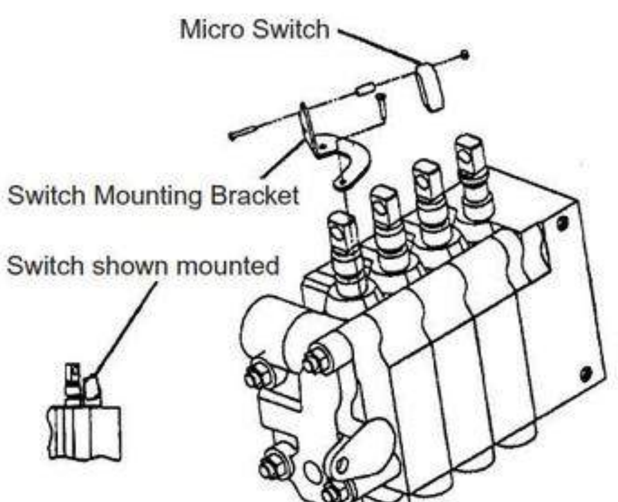
1. Reinstall valve and valve plumbing. Torque valve mounting bolts to 40-45 N·m (30-33 lbf-ft).



Lift and Tilt Pump Switches

Adjustment

1. Turn key switch to the OFF position.
2. Loosen switch mounting screws.
3. Adjust switch to activate after 2 mm (0.08 in.) of spool travel from neutral.
4. Tighten mounting screws.



Operational Checks

1. Operate the truck and hydraulic system. Check the system for leaks.

WARNING

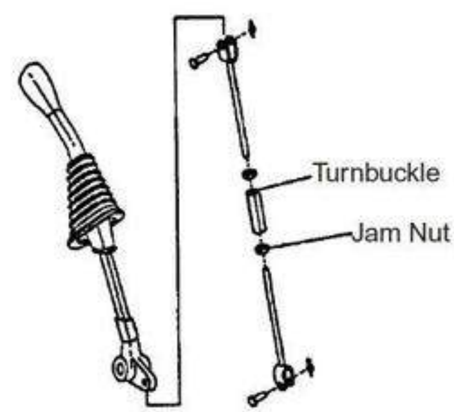
Do not use your hands to check for hydraulic leakage. Use a piece of cardboard or paper to search for leaks. Escaping fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Keep hands and body away from pinholes and nozzles which eject fluids under high pressure.

If any fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type injury or gangrene may result.

2. Check the operation of the valve and hydraulic system by moving the valve control levers to the various positions. The levers must operate smoothly with no binding. When released from any working position, the levers must return sharply to their neutral positions.

   If valve spools do not moved or return to correct position for full function of lift, tilt, or auxiliary cylinders:

   a. Loosen jam nuts on adjustment turnbuckles of lever rods.



   b. Adjust turnbuckle to increase or decrease spool movement to correct measure.
   c. Retighten turnbucklejam nuts to 39-44N·m (28.5-32.5 ft-lb).

3. Refer to Section 4, "Hydraulic System Pressure-Check" if valve was disassembled or overhauled.
4. Replace the cowl cover under the operator's compartment dash. See removal and replacement proceduresin Group 38.

Section 6

Hydraulic Control Valve Overhaul

IMPORTANT

Before removing any component for overhaul, make sure the correct repair parts, seals, and gasket sets are available.

The following overhaul instructions describe a two spool assembly with the inlet/lift section, a tilt (or auxiliary) section, and outlet section (outlet section contains no spool).

Preparation for Disassembly

IMPORTANT

Overhaul valve only in a clean, dust-free location, using clean tools and equipment. Dirt or grit will damage the highly-machined surfaces and will result in leakage or premature failure of components. Cleanliness of the hydraulic circuit is extremely important to the proper operation and maintenance of the system. Be sure the work area is clean.

- Clean outside of valve with a good grade of solvent and dry thoroughly.
- Before starting disassembly, the valve should be carefully examined to determine if there is any evidence

Disassembly

During disassembly, pay particular attention to identification of parts for reassembly. Spools are selectively fitted to valve bodies and you must return each spool to the same body from which it was removed. You must also be sure to reassemble the valve sections in the original order.

NOTE

Valve sections may or may not require separation for overhaul.

If only valve spools are being overhauled, you do not have to separate the sections. For a complete overhaul, including replacement of the seals, retainers, O-rings, springs, and balls used between the sections, follow steps 1 and 2. To overhaul only the valve spools, begin with step 3.

1. Remove the nuts and studs connecting the valve sections.
2. Remove and label all parts between the sections for correct reassembly. These include:
   a. Retainers and seals which are included in the replacement seal kit.
   b. O-rings, springs, and ball which are replaced separately.

NOTE

Keep parts in order as removed and avoid mixing the sections and parts.

3. Disassemble each valve spool, one at a time, from bottom of valve as shown in the illustration.
4. Remove the valve spools by tapping lightly on the top end with a soft-faced hammer to drive them out of the valve body.
5. Arrange the parts in the sequence of removal.

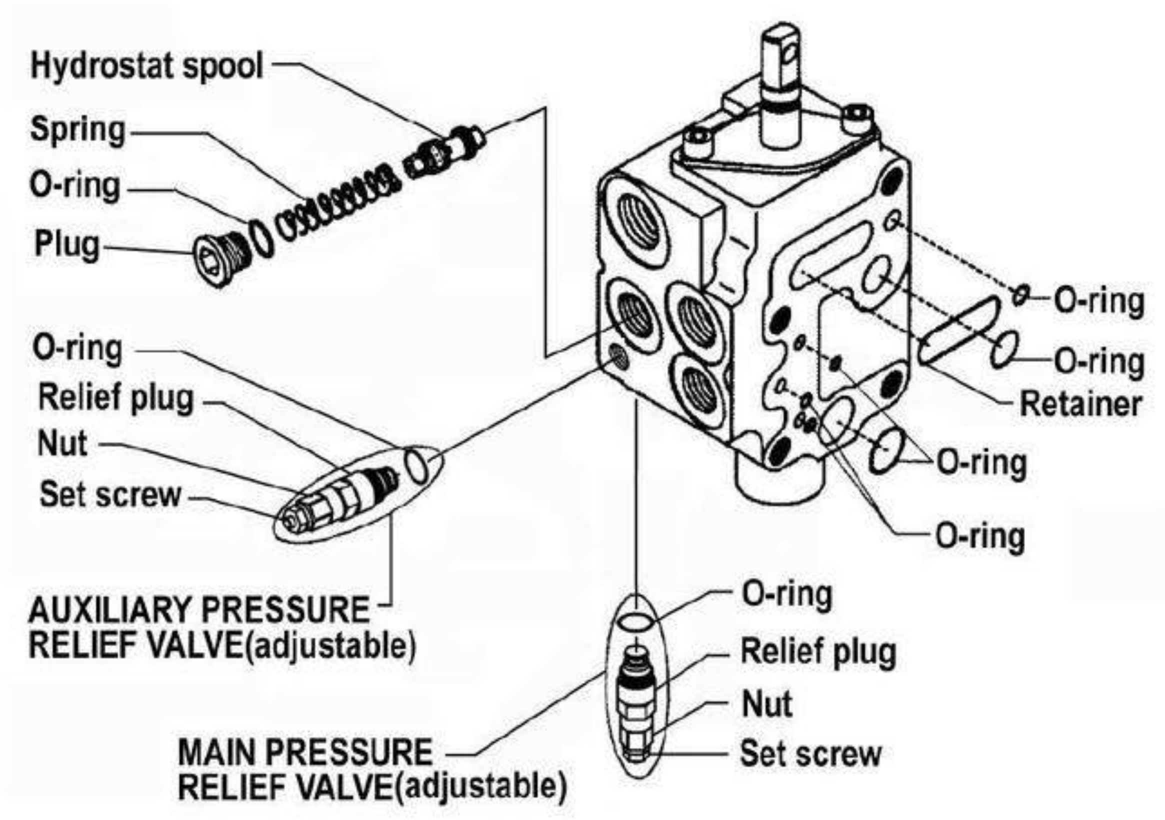


Figure 1. InletlLift Body, Main Pressure Relief Valve, and Auxiliary Pressure Relief Valve. Contents of spool assembly are shown in Figure 2.

NOTE

Remove the outlet port section only if there is need for further inspection and cleaning of contaminants in the valve. To remove, loosen and remove the nuts and studs and separate the outlet port section from the valve body. Label and keep all parts for correct reassembly.

Cleaning, Inspection, and Repair

1. Discard all old seals. Wash all parts in a clean mineral oil solvent and place them on a clean surface for inspection.
2. Carefully remove any burrs by light stoning or lapping. Be sure there is no paint or burrs on mating surfaces of valve bodies.
3. Inspect valve spools and bores for burrs and scoring. If scoring is not deep enough to cause leakage, the surfaces can be stoned or polished with crocus cloth. If scoring is excessive, valve body and spool must be replaced. Check each valve spool for free movement in its bore.
4. Inspect the main pressure relief valve for damage. Relief valve must be free from contamination, burrs, and scoring. Plug, spring, and O-ring should be cleaned and inspected for damage.

NOTE

Entire relief valve assembly must be replaced if damaged. Relief valve pressure is set at the factory. If pressure relief setting is not in recommended range, relief valve pressure is adjusted.

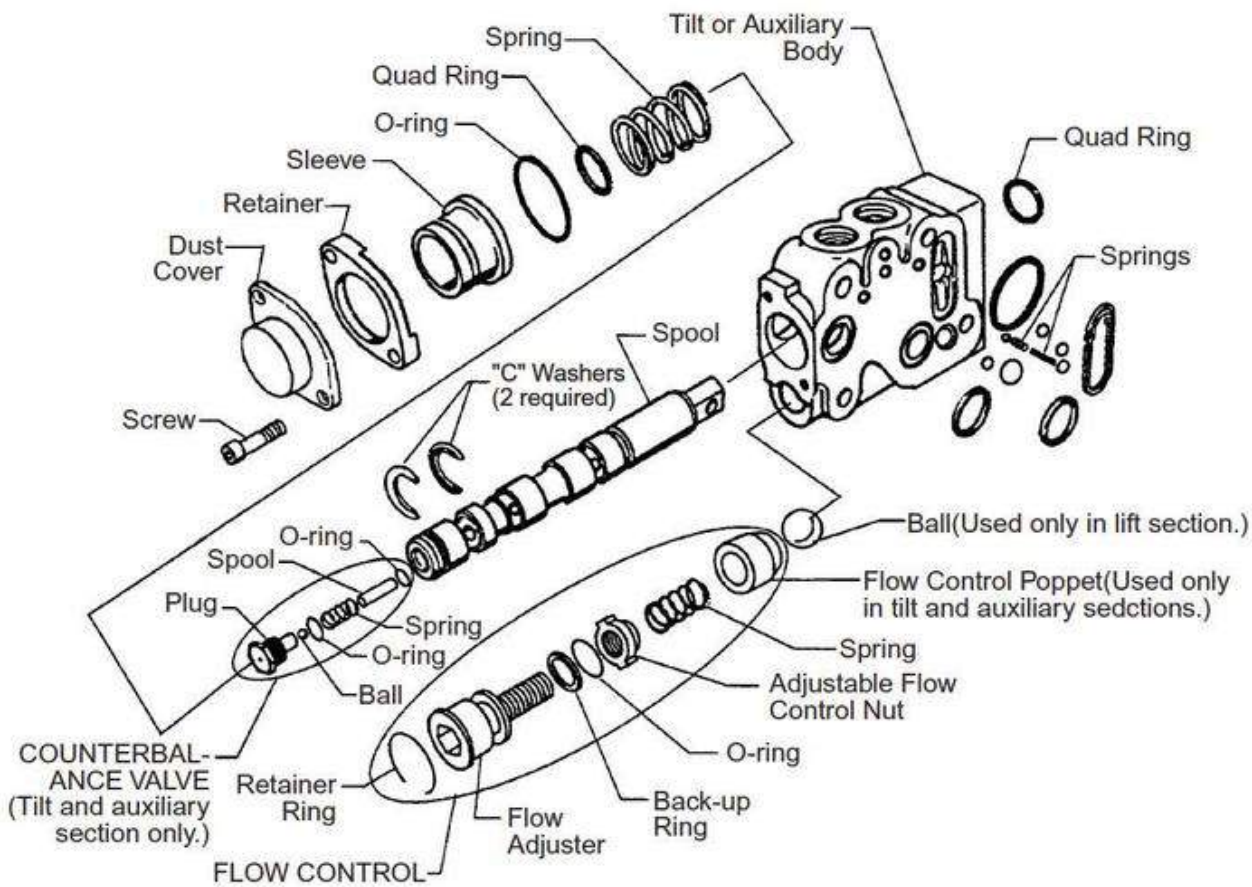


Figure 2. Valve Spool and Tilt (or Auxiliary) Body . Differences in lift (or tilt) and auxiliary components noted.

5. Inspect the lift and tilt relief valves for damage. If damaged relief valve assembly must be replaced.
6. Inspect the valve body to make sure it has not been physically damaged. Examine all threads to be sure they are clean and not damaged or burred. Inspect all bores and poppet seats. Poppet seat must be even all around its circumference with no nicks, burrs, or indentations in any of the seat face.
7. All springs should be free of corrosion and not broken or bent.
8. If parts must be left unassembled for a period of time or overnight, cover with a lint-free clean material.

Reassembly

Use the exploded view illustration of the valve section, spools, and relief valves for reassembly.

1. Assemble valve in reverse order of disassembly.
2. Coat all parts with clean hydraulic oil to facilitate assembly and provide initial lubrication. Petroleum jelly can be used to hold seal rings in place during assembly.
3. Use new O-rings and seals for all parts.
4. Install seal rings and the seal ring retainer in the grooves in body of each inlet and center section. Use petroleum jelly to hold the seals in place. Carefully place the sections together in the same order in which they were removed.
5. Torque dust-cover screws to 10.8-13.5 N·m (8-10 ft-lb).
6. Reinsert studs between valve sections and torque nuts to 27-34 N·m (20-25 ft-lb).

Relief Valve Settings

Overhaul and reinstallation of the main hydraulic valve, the hydraulic system relief pressure and auxiliary valve relief pressure settings (if truck and valve are equipped with an auxiliary component and section) must be checked. See the hydraulic system checks and adjustments Section of this Group (30) for procedures.

If the truck is not equipped with any auxiliary equipment, no adjustments are necessary. If an auxiliary section has been added to the hydraulic valve and auxiliary components have been installed on the truck, check the relief pressure. See the hydraulic system checks and adjustments Section of this Group (30) for procedures.

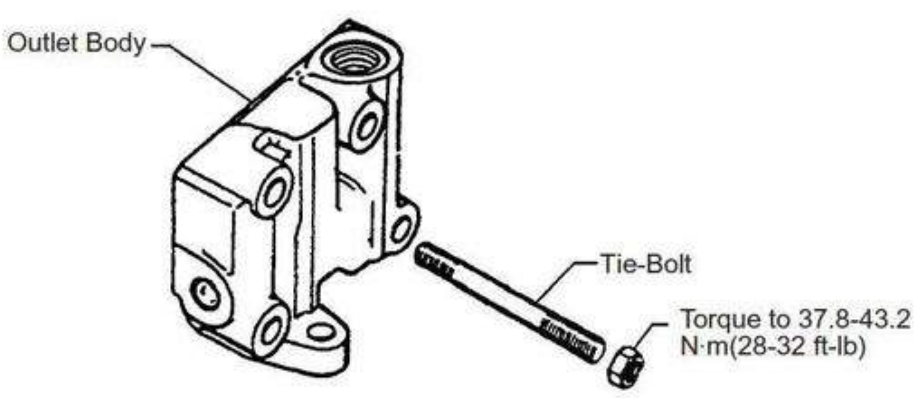


Figure 3. Outlet Body

GROUP 32

TILT CYLINDERS

IMPORTANT

Other hydraulic-related components and curcuits are described and Illustrated in Group 25, "Steering Column and Gear", Group 26 "Steer Axle", Group 29, "Hydraulic Sump, Filters, and Pump", Group 30, Hydraulic Control Valve/Lift Circuit." and Group 31, "Uprights." Refer to these other groups for hydraulic components not covered in this group.

NOTE :

Section 1

Tilt Cylinder Specifications and Description

Specifications

See Group 30 for hydraulic system specifications.

Tilt Cylinder Type: Double-acting

Maximum Operating Pressure: 21,000 kPa (3,000 psi)

Tilt Ranges*:

Std (through 2667 mm (105 in) MFH)	10°B-6°F
Std (above 2667 mm (105 in) MFH)	8°B-8°F
TSU (through 4775 mm (188 in) MFH)	5°B-6°F
TSU (4800-6096 mm (189-240 in) MFH)	5°B-3°F

TSU (above 6096 mm (240 in) MFH) 3°B-O"F with tilt limit over ride to 3°F

Abbreviations: Std = Standard, high-visibility upright; TSU = Triple-stage upright; MFH = maximum fork height; B = back tilt; F = forward tilt. See truck data plate for upright MFH.

Fastener Torques

Rod-End Yoke Bolts: 166-193 N.m (122-142 ft-lb)

Rod-End Pin Lock Plate Fasteners: 8-10 N·m (10.8-13.5 ft-lb).

Base Mount Pin Lock Plate Fasteners: 8-10 N·m (10.8-13.5 ft-lb).

Service Intervals

Tilt Cylinder Drift Test: Every 50-250 hours or each PM.

Tilt Cylinder Check and Adjustment: Every 50-250 hours or each PM.

Tilt Cylinder Rod Seal Condition Check: Every 50-250 hours or each PM.

Tilt Cylinder Mounting Check and Tightening: Every 50-250 hours or each PM.

Tilt Cylinder Rod-End Check and Tightening: Every 50-250 hours or each PM.

Tilt Cylinder Rod-End Lubrication: Every 50-250 hours or each PM.

Description

The tilt cylinders provide backward and forward tilt of the upright. The forward and back tilt angles are governed by the cylinder stroke and by use of spacers and different length rod ends. The tilt cylinders are pin-mounted to the truck frame and upright using yokes, clevises, and pins. Pins are held in place by a lock plate and fastener to prevent the pins from working their way out.

The tilt cylinders are serviced by removing them from the truck and disassembling them for complete overhaul, including installation of new seals and or other cylinder components.

The tilt lock valve is integrated into the tilt section of the main hydraulic control valve. The tilt lock valve prevents the upright from tilting forward when the truck is not running. The tilt lock valve is not serviceable and must be replaced as a valve section if defective.

CLARK

NOTE :

Section 2

Tilt Cylinder Checks and Adjustments

⚠ CAUTION

SAFE PARKING. Before working on truck:

1. **Park truck on a hard, level, and solid surface, such as a concrete floor with no gaps or breaks.**
2. **Put upright in vertical position and fully lower the forks or attachment.**
3. **Put all controls in neutral. Turn key switch OFF and remove key.**
4. **Apply the parking brake and block the wheels.**

Tilt Cylinder Drift Check

To check tilt cylinder drift, a rated capacity load is placed on the forks, lifted up and held to determine if the tilt cylinder rods moves (drifts) in a specified length of time.

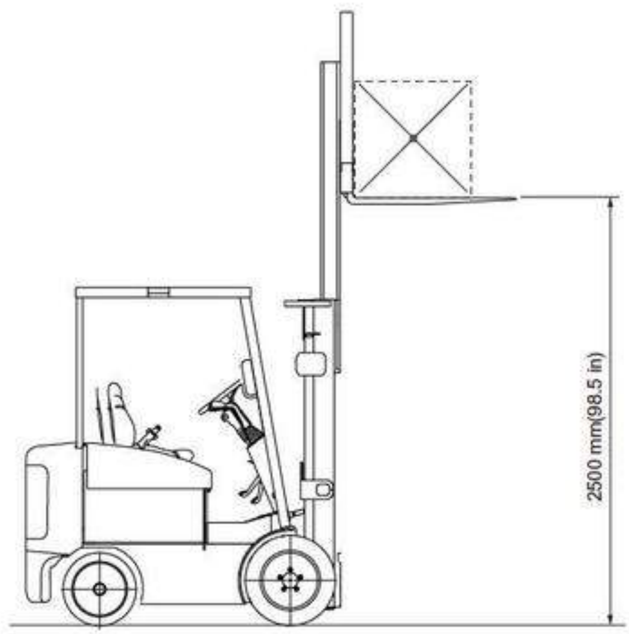
It is recommended that a test load, made up of a full-capacity load equally distributed on a 1220 x 1220 mm (48 x 48 in) pallet, be used. The material used to make up the test load must be stacked to provide load stability and must not extend beyond the pallet. It must be secured on the pallet. Refer to the truck data plate for capacity rating.

1. Adjust fork width as wide as possible to distribute the load. Refer to truck nameplate for capacity rating.

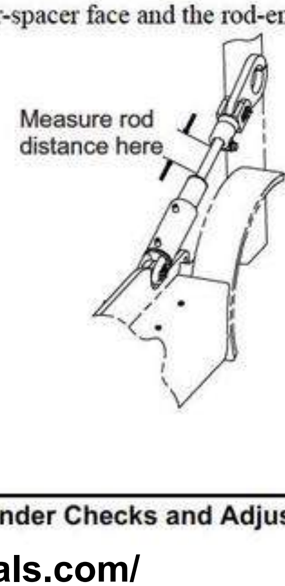
⚠ CAUTION

Test load must be stacked stably, not extend beyond the pallet, and be secured on the pallet. Clamp the load on the load backrest or fork bar to avoid sliping out from fork.

2. Drive the forks into the load pallet until the test load and pallet rest against the load backrest. Apply the parking brake and chock the wheels.
3. Raise the capacity load 2500 mm (98.5 in) off the ground and tilt the upright vertical. Shut off the truck.



4. Measure and write down the distance between the cylinder-spacer face and the rod-end yoke.



5. Wait five minutes and measure and write down distance between rod end and spacer.
6. The measurement must not exceed the following measures:

Temperature	Drift
50°C(122°F)	0.5°, 3.1mm @ 1 min
	5°, 31.1 mm @ 10 min

Drift Causes and Remedies

Tilt cylinder drift indicates the following possible problems:

- Tilt cylinder hydraulic circuit hoses or fittings are leaking. Check the circuit components and repair as necessary.
- Cylinder piston seals are worn, damaged, or defective allowing fluid past the piston and causing the rod to drift. Consider rebuilding the cylinders if the other remedies in this list are not successful. See Section 3 for cylinder removal and replacement and Section 4 for cylinder repair, if necessary.
- The main hydraulic tilt valve is misadjusted, worn, or defective. Fluid is leaking past the valve and causing the tilt cylinders to drift. See Group 30 for hydraulic valve troubleshooting.

Tilt Cylinder Racking Check

Upright racking occurs when tilt cylinder strokes are unequal. Cylinders should be checked regularly during operation to determine if cylinder strokes are the same. To check for racking:

- Make sure uuck is parked on level surface with parking brake applied and wheels chocked.
- Check condition of the tilt cylinder, rod-end yoke, mounting pins, piston rod, rod wiper, cylinder gland, etc., for excessive wear or damage. Make repairs before making twisting adjustment.
- Use a capacity load (see truck nameplate) centered on the forks.

⚠ CAUTION

Be sure to secure the load to the fork carriage to keep it from falling off when tilted forward.

Raise the upright only to the height that will allow the fork tips to clear the floor when tilted fully forward.

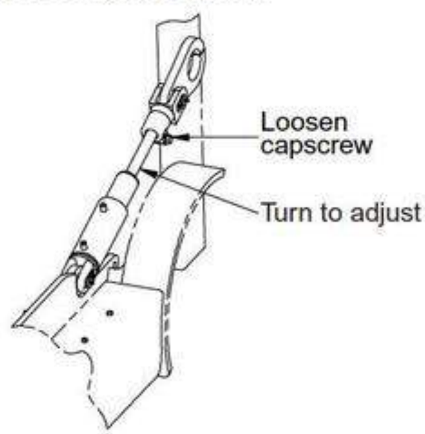
Forward Adjustment

1. Slowly tilt upright fully forward to the end of the tilt cylinder stroke.
2. As the cylinders approach the end of the stroke, watch both piston rods for equal movement and upright for twisting. Note if upright "racks" (is twisted at the end of its movement by unequal stroke of tilt cylinders).

NOTE

Correct the twisting effect by shortening the cylinder that is the longest length. Forward twisting must be adjusted before backward twisting. If forward adjustment is not needed, continue with backward adjustment.

3. To adjust, loosen rod-end yoke capscrew on the tilt cylinder that extends the farthest, and turn piston rod into rod-end yoke to shorten.



Forward Adjustment: Pneumatic-tire truck rod-end yoke orientation shown.

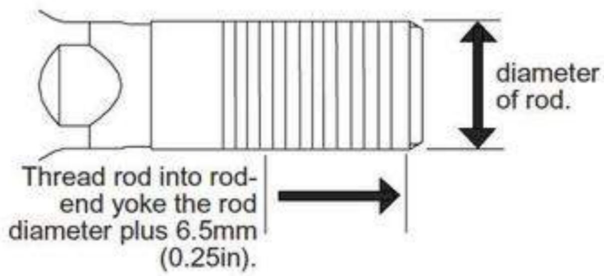
NOTE

Use wrench flat on rod under spacer (if installed). Move spacer for access.

4. Continue to turn rod into rod end until tilt cylinder strokes are equal.

IMPORTANT

The rod must he threaded onto the rod-end yoke a distance at least as great as the diameter of the rod plus 6.5 mm (0.25 in).

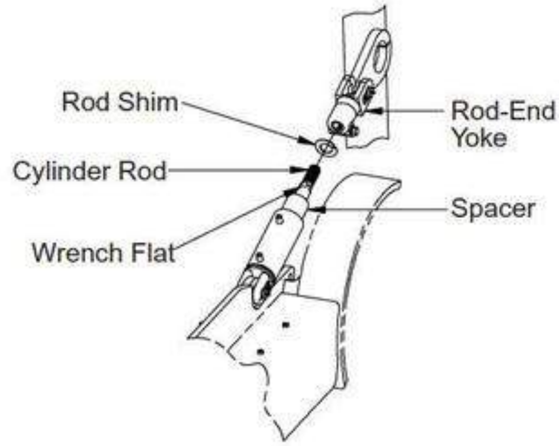


5. Tighten capscrew of the rod-end yoke to 166- 193 N.m (122-142 ft-lb), and repeat the racking test.
6. Repeat steps 1-5 for fine corrections if any racking remains evident.
7. When no racking occurs, retighten capscrew of the rod-end yoke to 166-193 N·m (122-142 Et-lb).
8. Check all tilt functions before returning the truck to service.

Backward Adjustment

Perform forward check and adjustment first. Then:

1. Slowly tilt upright fully backwards while watching piston rods. They should both bottom out at the same time. If they don't, adjust backward tilt using the following steps.
2. Stop the upright when the first tilt cylinder bottoms out against its rod spacer.
3. Go to the opposite cylinder and remove the capscrew on the rod-end yoke and screw rod out of yoke. Count the number of turns required to remove the rod from the yoke.
4. Use rod shims to fill in the space between the rod-end yoke and spacer. Screw rod back into yoke the same number of turns needed to remove.



5. Tighten capscrew of the rod-end yoke to 166-193 N·m (122-142 ft-lb), and repeat the racking test.
6. Repeat steps 1-5 for fine corrections if any racking remains evident.
7. When no racking occurs, retighten yoke capscrew to 166-193 N·m (122-142 ft-lb).
8. Check all tilt functions before returning the truck to service.

Tilt Flow Control Adjustments

See checks and adjustments Section of Group 30, "Hydraulic Control Valve/Lift Circuit," for adjustment procedure.

NOTE :

Section 3

Tilt Cylinder Removal and Replacement

CAUTION

SAFE PARKING. Before working on truck:

1. **Park truck on a hard, level,-and solid surface, such as a concrete floor with no gaps or breaks.**
2. **Put upright in vertical position and fully lower the forks or attachment.**
3. **Put all controls in neutral. Turn key switch OFF and remove key.**
4. **Apply the parking brake and block the wheels.**

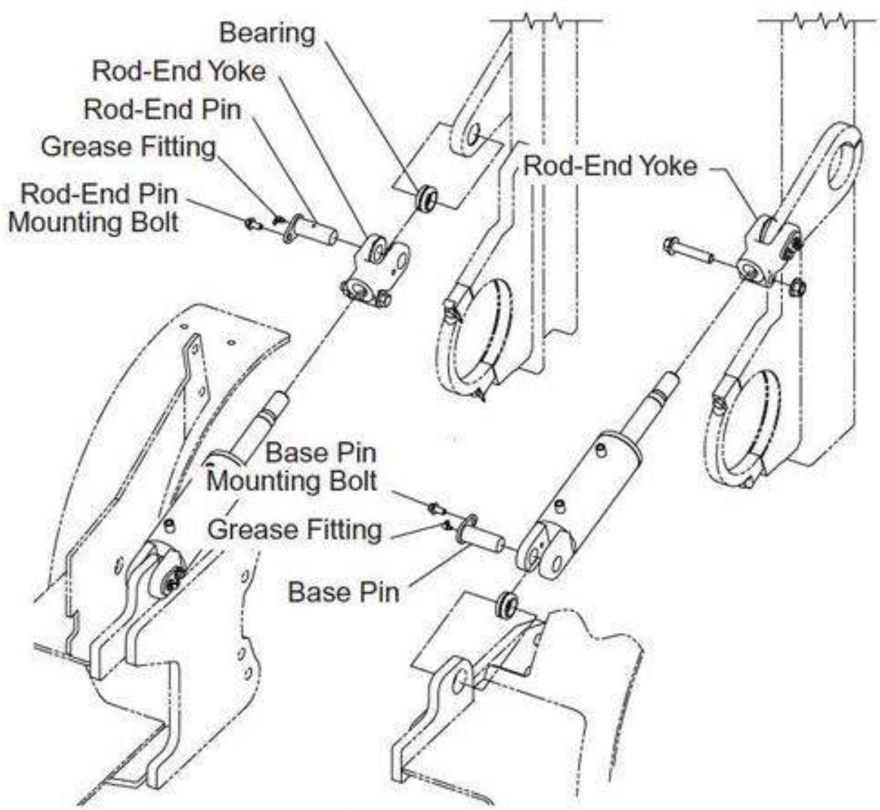
Tilt Cylinder Removal

1. Move tilt lever back and forth several times to relieve any pressure.
2. Use an adequate chain and hoist to support the upright so that it cannot fall when tilt cylinder pins are removed.

WARNING

The upright assembly is heavy. Use only hoists with enough capacity to lift the entire assembly. Keep hands and feet away from the assembly. Use prybars to move the assembly into position for tilt cylinder replacement.

3. Remove the floorboard.
4. Put a drain pan under the truck at each tilt cylinder position before removing the hydraulic lines. Disconnect and cap hydraulic lines from the tilt cylinders (see illustration on facing page). Remove the hose connections on both sides of the tee fittings of therightside cylinder. Keep all fittings and ports clean.



Tilt Cylinder Mounting Components

5. Support cylinder with a sling to prevent the cylinder from dropping when pins are removed.
6. Remove lock-plate from tilt cylinder rod-end yoke. Use a soft drift and hammer to tap rod-end pin out of yoke.
7. Pop the cover from tilt cylinder base access port on the step to the operator's compartment.
8. Remove the lock-plate from cylinder base yoke. Use a soft drift and hammer to tap pin out of yoke.
9. Remove cylinder assembly.

Parts Inspection

1. Clean all bearings, pins, and other components in an approved cleaning fluid.
2. Inspect all parts for scratches, nicks, dents, and wear. Check the cylinder rods to be sure they are smooth with no scratches. Check all threaded parts for damage.
3. Replace all parts which show damage.
4. If parts are to be left exposed, coat all mating surfaces of parts with a light layer of engine oil.

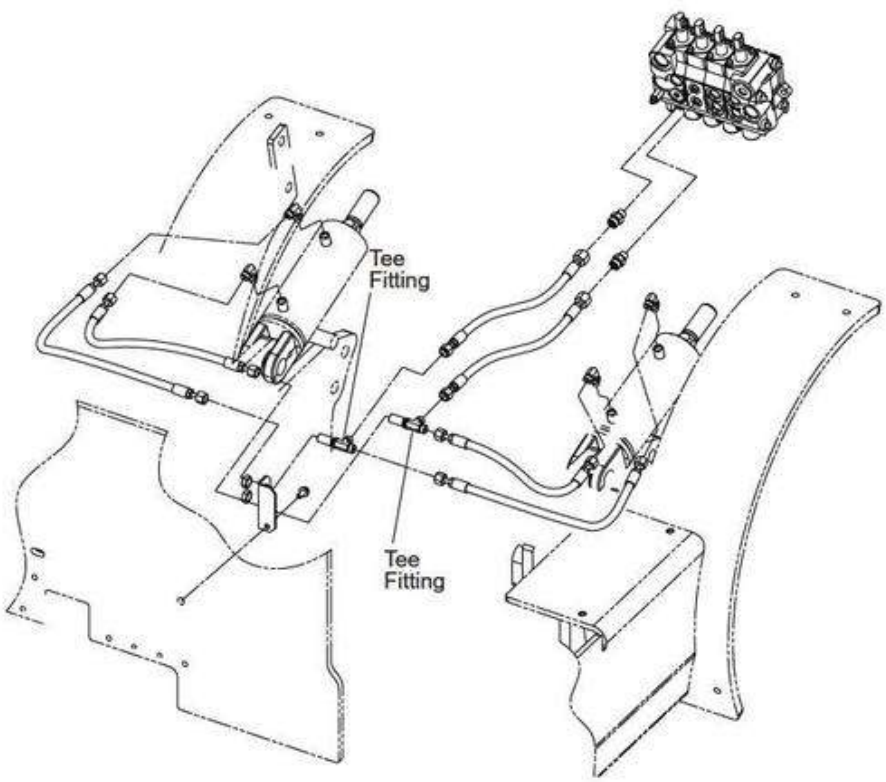
Tilt Cylinder Replacement

1. Position tilt cylinder base yoke on frame mounting bracket.
2. Insert base pin in cylinder base yoke and through frame mounting bracket, making sure slot in pin is in line with the lock-plate. Grease fitting must point toward center of truck.

IMPORTANT

Make sure the spherical bearing is aligned so that pin fits smoothly in yoke.

3. Install base pin lock-plate in slot and fasten to yoke with fastener and washer. Tighten fastener to a torque of 8-10 N·m (5.9-7.4 ft-lb).
4. Position rod-end yoke on upright mounting bracket and insert rod-end pin, making sure lock-plate slot is in correct position. Grease fitting must be toward center of truck. Make sure the spherical bearing is aligned so that pin fits smoothly in yoke.



Till Cylinder Hydraulic Fittings

NOTE

If the rod-end yoke has been removed from the rod or loosened for adjustment, reinstall the clamp bolts to a torque of 166-193 N.m (122-142 ft-lb). Nuts must be on inside of upright rails Orientation of the rod-end yoke bolt hole is to be up as shown on the left side of the illustration on the previous page.

5. Install rod-end lock-plate in slot and fasten to yoke with fastener and washer. Tighten fastener to a torque of 8-10 N·m (5.9-7.4 ft-lb).

6. Install tilt cylinder hydraulic lines. Check Group 40 for hydraulic fitting tightening procedures. O-rings of fittings should be lightly coated with clean hydraulic fluid or compatible oil.

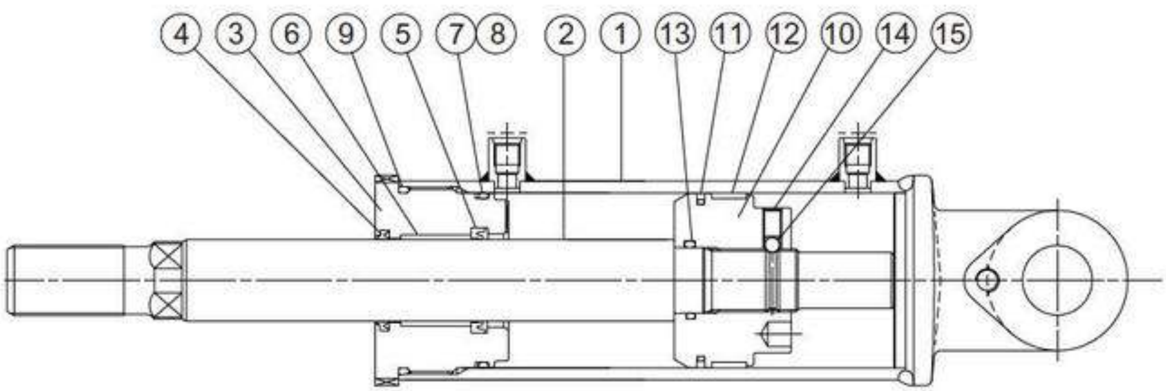
7. Remove hoist chain from upright.

8. See Section 2 for tilt cylinder adjustment procedures. When adjustments are made, check all upright components under load before returning the truck to service. Nuts must be on inside.

Section 4

Tilt Cylinder Overhaul

IMPORTANT
Before removing any component for overhaul, make sure the correct repair parts, seals, and gasket sets are available.



Typical Tilt Cylinder Cross section

1	Tube Assy		9	O-ring	1B G75
2	Rod		10	Piston	
3	Gland		11	Piston Seal	
4	Dust Wiper		12	Wear Ring	
5	Rod Seal		13	O-ring	
6	Du Bush		14	Set Screw	
7	O-Ring		15	Steel Ball	
8	Back up ring				

Preparation For Disassembly

IMPORTANT

Overhaul tilt cylinders only in a clean, dust-free location, using clean tools and equipment. Dirt or grit will damage the highly-machined surfaces and will result in leakage or premature failure of components. Cleanliness of the hydraulic circuit is extremely important to the proper operation and maintenance of the system. Be sure the work area is clean.

1. Before disassembly, the exterior of the tilt cylinder should be carefully cleaned to remove all dirt and grease accumulation.
2. Be sure all hydraulic oil has been removed from the cylinder. Stroking the piston rod will help force the oil out.
3. Before starting disassembly, the tilt cylinder should be carefully examined to determine if there is any evidence of external damage.

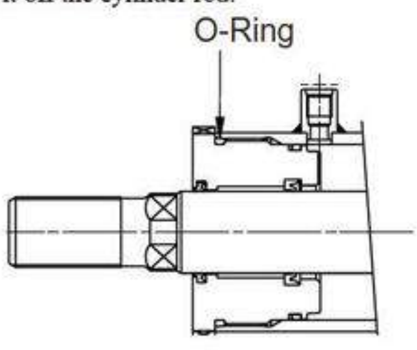
Disassembly

The tilt cylinder can be held by clamping the base end or the barrel in a vise while disassembling.

IMPORTANT

Do not use excessive force when clamping on the barrel.

1. Remove the gland with a hook wrench. Carefully pull the gland assembly from the cylinder tube and slide it off the cylinder rod.

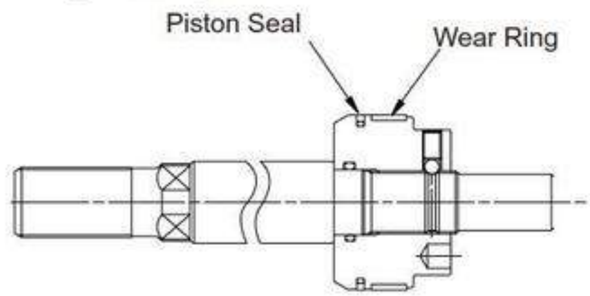


2. Carefully pull the rod, piston assembly, and gland from the cylinder barrel. Remove gland from rod.

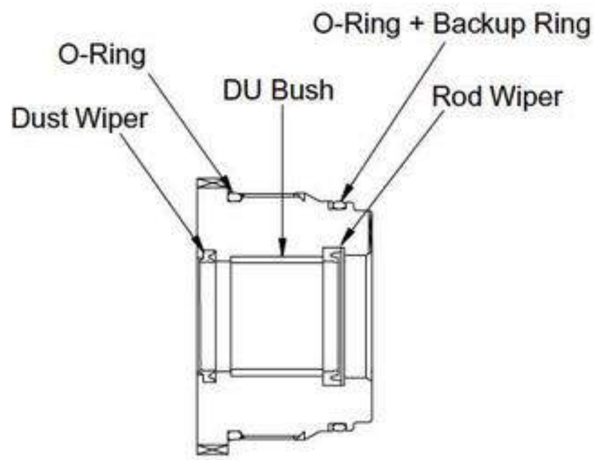
WARNING

The use of compressed air to blow the piston out of the barrel is not recommended. High-pressure air can result in piston and rod being ejected at high velocity (explosively), causing severe injury to personnel and property damage.

3. Remove and discard the piston packing and wear rings from the piston.



4. Remove and discard the rod U-cup seal, O-ring, and piston rod wiper from the gland.



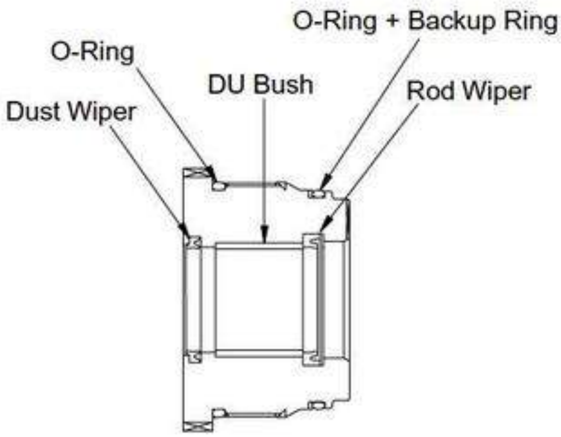
Inspection

1. Carefully clean all parts in an approved solvent and place on a clean surface.
2. Check the piston and rod for damage. Look for gouges, scratches, corrosion, or evidence of unusual wear. Minor surface damage may be repaired by use of fine abrasion cloth or stoning. Deeper damage will require replacement of piston rod assembly.
3. Be sure the threads on rod are undamaged.
4. Inspect the tilt cylinder barrel internal bore for wear, scratches or other damage. Check the outside for damage. Inspect all welds for cracks.
   Deep gouges or pitted surfaces require replacement of parts.
   Check the gland, base end, and ports for cracks or damage that could cause failure. Inspect the ports to be sure they are free of contamination and that the threads are clean and not damaged.
5. Put a light coating of hydraulic fluid on all parts. If parts are to be left disassembled for a period of time, e.g., overnight, they should be covered with a clean cloth.

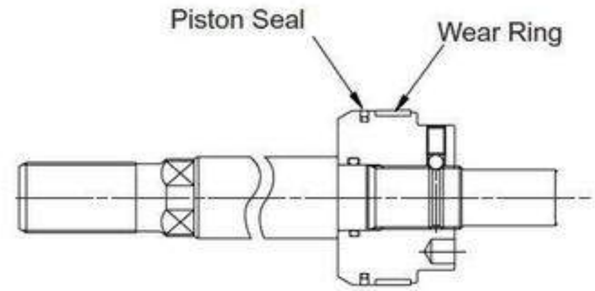
Reassembly

Be sure inside of cylinder and all parts are clean before starting reassembly. Seals may be lubricated with hydraulic oil to assist assembly into cylinder barrel.

1. Install piston dust wiper, rod seal, and O-ring on the gland. Make sure rod seal and dust wiper are installed in proper orientation as shown in the illustration.



2. Replace the piston packing and wearing.

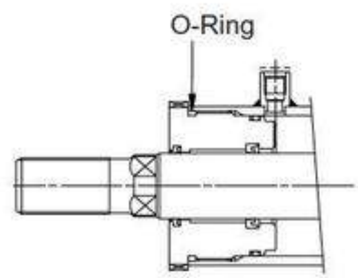


3. Install gland on piston rod. Use gentle pressure and careful movements to avoid damage to the U-cup seal and rod wiper when these parts are moved over the piston rod end.

NOTE

Reassemble cylinder carefully to prevent damage to seal lips and O-rings.

4. Install piston into cylinder barrel. Be careful not to damage the piston seals when installing the piston into end of cylinder.
5. Install gland into cylinder them screw the gland into the cylinder barrel with a hook wrench. When tightening, do not damage the seal. Tighten torque : 60±6 kgf·m



6. Check the assembly by making sure the piston slides freely in and out of the cylinder.

See Section 3 for replacement procedures ; see Section 2 for checks and adjustments before returning the truck to service.

NOTE :

GROUP 34

UPRIGHTS

NOTE :

Section 1

Upright Specifications and Description

General Specifications

Upright Weight: Approximately 363 kg (800 lb) to approximately 1000 kg (2200 lb) without carriage

Carriage Weight: Approximately 109 kg (240 lb) to 122 kg(270 lb) with a 41 inch carriage

Fork Weight: Approximately 50-71 kg each (110-156 lb)

IMPORTANT

Before hoisting, the weights of upright, carriage, forks and attachments being lifted must be combined to determine what lifting capacity is required of the hoisting equipment.

Capacities and Lift Heights: Upright, carriage, and fork capacity and upright lift heights are listed on the truck's data plate.

Lubricants:

- All Purpose Grease (MS-9)
- Innerslide Lubricant (Clark P/N 886396)
- Chain and Cable Lube (Clark P/N 886399)

Cylinder Types

Standard uprights use two lift cylinders. Triple stage and HI-LO uprights use three cylinders, a primary (center-mounted) cylinder, and two secondary cylinders. All primary cylinders used on triplestage uprights (TSUs & HI-LO) are piston cylinders.
The secondary cylinders used on HI-LO uprights can be ram cylinders.

The types of cylinders used on the truck are listed below. Check the first five characters of the upright number stamped on the upright of the truck to determine the type of cylinder, piston or ram, used on the upright.

IMPORTANT

Before removing any component for overhaul, make sure the correct repair parts, seals, and gasket sets are available.

Upright Type	Upright Number	Cylinder Type
Standar	V2312/17(ECX20-30)	Piston-Type Lift Cylinder
	V2318/22(EPX20-30)	Piston-Type Lift Cylinder
	V2314/19(ECX32)	Piston-Type Lift Cylinder
	V2321(EPX32)	Piston-Type Lift Cylinder
TSU	M2312/17(ECX20-30)	Piston-Type Secondary Cylinder
	M2318/22(EPX20-30)	Piston-Type Secondary Cylinder
	M2314/19(ECX32)	Piston-Type Secondary Cylinder
	M2321(EPX32)	Piston-Type Secondary Cylinder
HI-LO	H2316(EPX)	Ram-Type Secondary Cylinder
	H2312(ECX)	Ram-Type Secondary Cylinder

Drift:

With the upright substantially vertical the descent of the rated load caused by an internal leakage in the hydraulic system shall not exceed 100 mm during the first 10 min with the oil in the hydraulic system at normal operating temperature. If drift over 100 mm (4 in) in ten minutes is evident, cylinder should be checked for internal leakage. See Section 3 for drift test procedures.

Fastener and Fitting Torque Specifications

Trunnion Mounting Bolts: 75-80 N·m (55-59 ft-lb)

Load Back Rest: 170-190 N·m (125-140 ft-lb)

Chain Anchor Bolt Jam Nut: 100-200 N·m (74-148 ft-lb)

Carriage Side-Thrust Roller Bolts(External): 40-50 N·m (29.5-37 ft-lb)

Carriage side-Thrust Roller Bolts(External):70-80 N·m (52~59 ft-lb)

Hose Fittings: See Group 40, "Hydraulic Fitting Tightening Procedure."

Rod End Bolts: 170-190 N·m (125-140 ft-lb)

Tilt Cylinder Rod-End Pin Lock Plate: 8-10 N·m (71-89 in-lb).

Service Intervals

- All upright components should be visually checked every day during the Operator's Daily Inspection.
- A thorough visual inspection should be performed by a trained service professional every 50-250 hours.
- Lift chains should be inspected and lubricated every 50-250 hours or monthly.
- Lift chain tension should be checked every 50-250 hours or monthly.
- Upright and carriage roller checks should be performed every 50-250 hours or monthly.
- Roller patterns should be checked every 6 months or after 1000 hours of service.
- Racking and drift tests should be performed every 50-250 hours or monthly.
- The complete extended inspection should be performed at least every year or 2000 hours of operation.

Description

The upright assembly includes the lift chains, lift cylinders, carriage, forks, and mast or rail sets. Each of the components can be serviced using the tests, checks, adjustments, and removal and replacement procedures in the following Sections.

The upright uses the hydraulic cylinders and chain sets to lift the carriage and rail sets. On standard, two-stage uprights, the lift cylinders lift the carriage with chains and directly lift the inner rail set. On triple-stage uprights, the primary (free-lift) cylinder lifts the carriage by chains.
When the primary cylinder reaches its maximum extension, fluid is diverted to the secondary lift cylinders, which lift the inner rails using a second set of chains and lift the intermediate rails by direct lift.

On HI-LO uprights, the primary (free-lift) cylinder lifts the carriage by chains. The secondary cylinders directly lift the inner rail set by rod.

HI-LO uprights do not use a second set of chains on the secondary lift cylinder.

Friction and play between the nesting rails is controlled by roller sets mounted on the rails and carriage. When rails or rollers become worn, the gap between the rollers and rails becomes larger, creating more play in lifting and lowering operations. The rail web to roller side clearances can be reduced by shimming the rollers to close the gap between the roller and rails. The gap between the rail flange and roller bearing surface can be reduced by the use of oversize rollers on a one-time basis.

Forks use a hanger design for mounting on the carriage.
Auxiliary attachments may be added to the upright for specialized handling operations. The hydraulic circuit is modified with a hose adapter kit and an auxiliary section is added to the main hydraulic valve to operate the attachment.

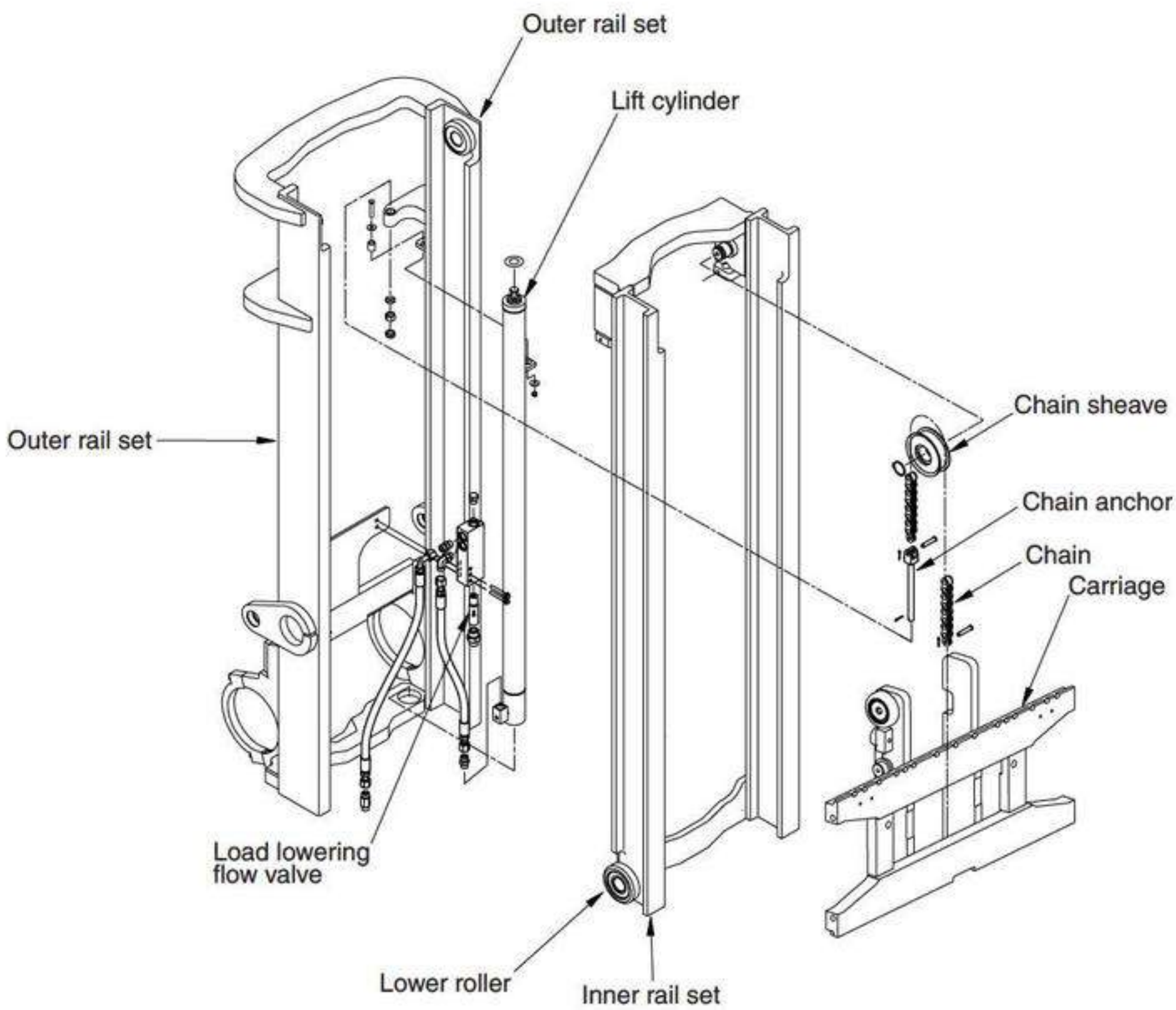
The lift and secondary cylinders on standard uprights, HI-LO uprights and triple-stage uprights (TSUs) may be either piston- or ram- type cylinders. The primary cylinder on TSUs is a piston-type cylinder. See the chart under "Specifications" to determine the type of cylinder used on the upright you are servicing.

Piston-type cylinders contain a by-pass check valve in the piston that allows air and fluid that have accumulated in the rod end of the cylinder to return to the system. The check valve can be removed and cleaned if indicated by troubleshooting. A non-serviceable check-ball-type cushioning function is built into ram and piston cylinders for smooth staging during the lowering cycle. The primary cylinder on TSUs incorporates cushioning on the lift cycle. A flow control valve in the hydraulic port of the lift cylinders (secondary cylinders on TSUs) prevents the mast from falling rapidly in case of sudden fluid pressure loss due to line breaks or other malfunction of the hydraulic circuit.

As explained in more detail in Group 30, the main pump sends fluid to the main hydraulic control valve, which contains spools that route fluid to the lift cylinders and tilt cylinders. The valve assembly also contains a counter-balance valve that prevents upright tilt when the truck is not operating.

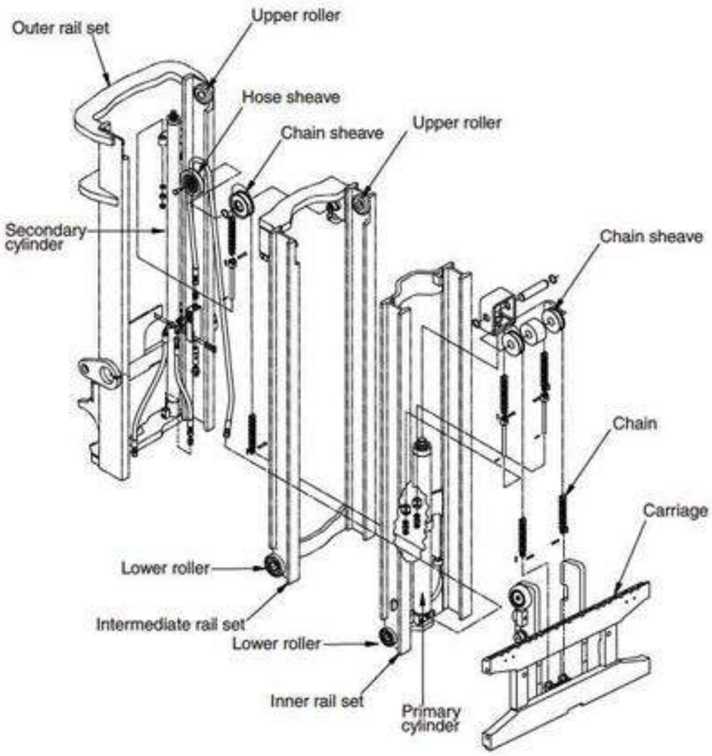
Fluid flow rates for lift functions are factory set and not adjustable. Flow rates for tilt and auxiliary functions are controlled by adjustments on the main hydraulic valve. A non-adjustable "load-lowering" flow valve mounted on the upright limits upright lowering speed.

Groups 29 and 30 contain general hydraulic information including upright hydraulic functions. Other hydraulic checks for the upright appear in "Troubleshooting," Section 2.

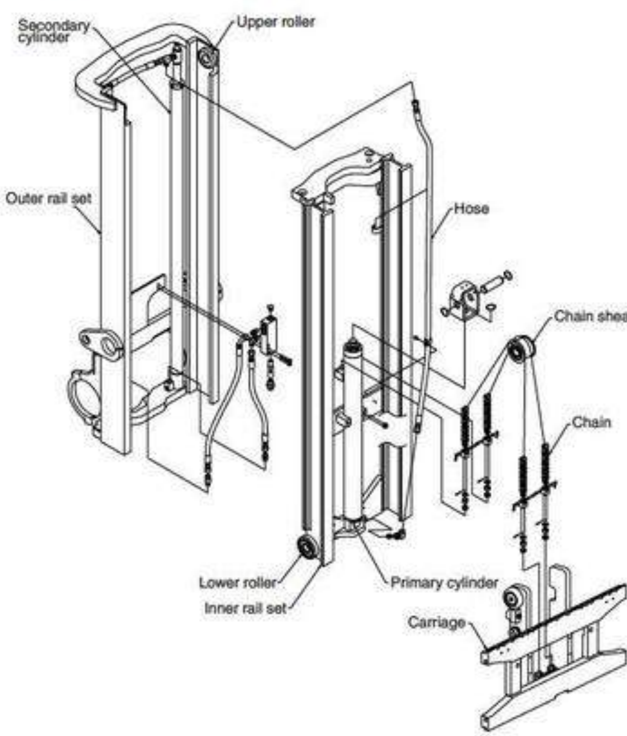


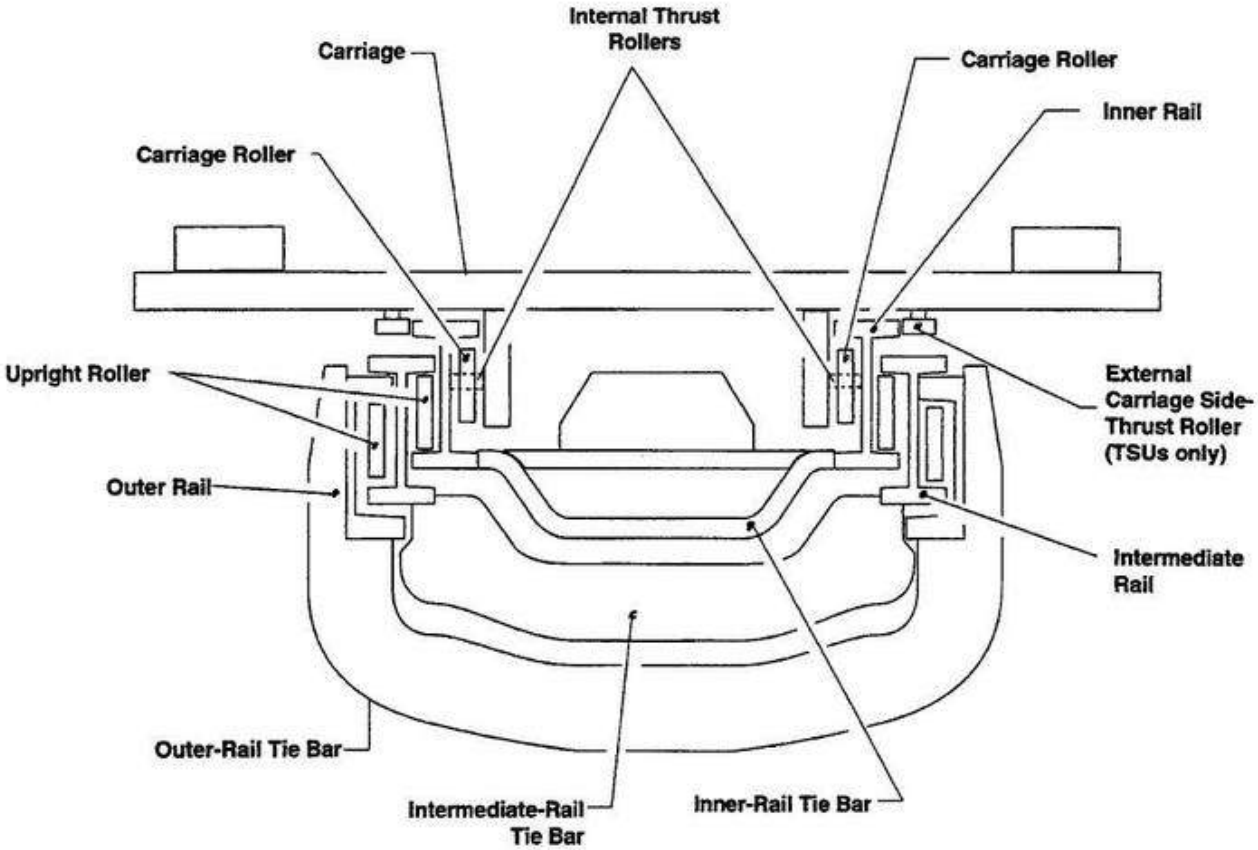
Typical Standard (Two-Stage) Upright Assembly

Typical triple-stage Upright Assembly

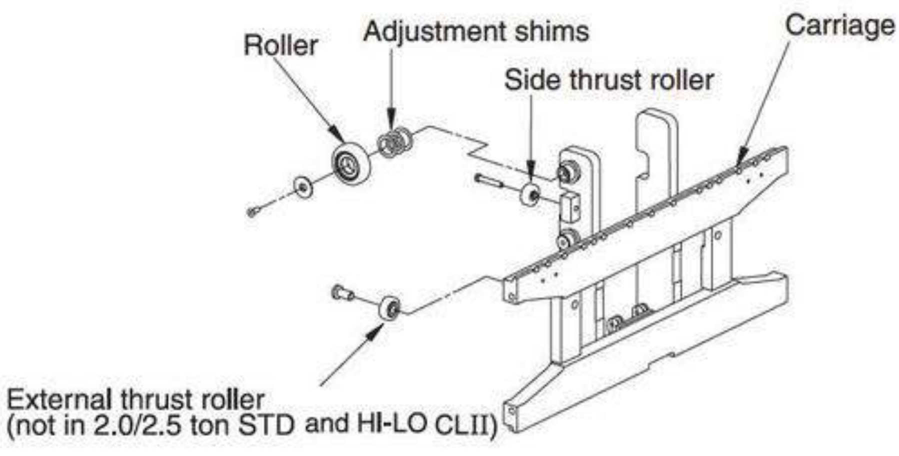


Typical Hi-LO Upright Assembly



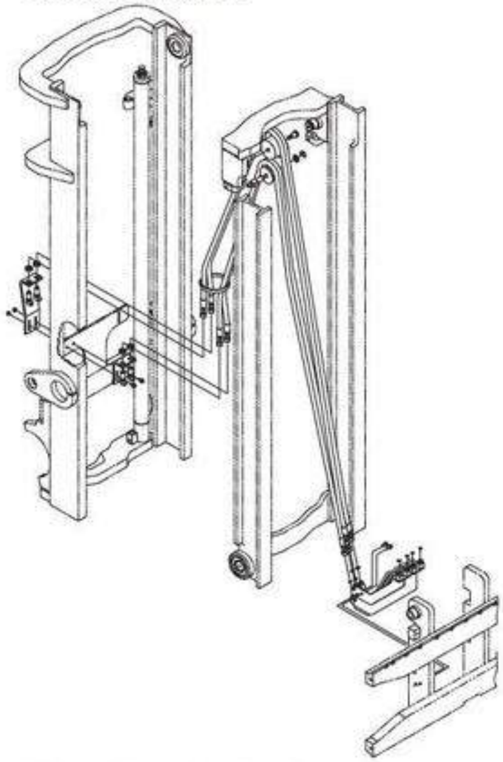


Typical Triple Stage Upright - Overhead View

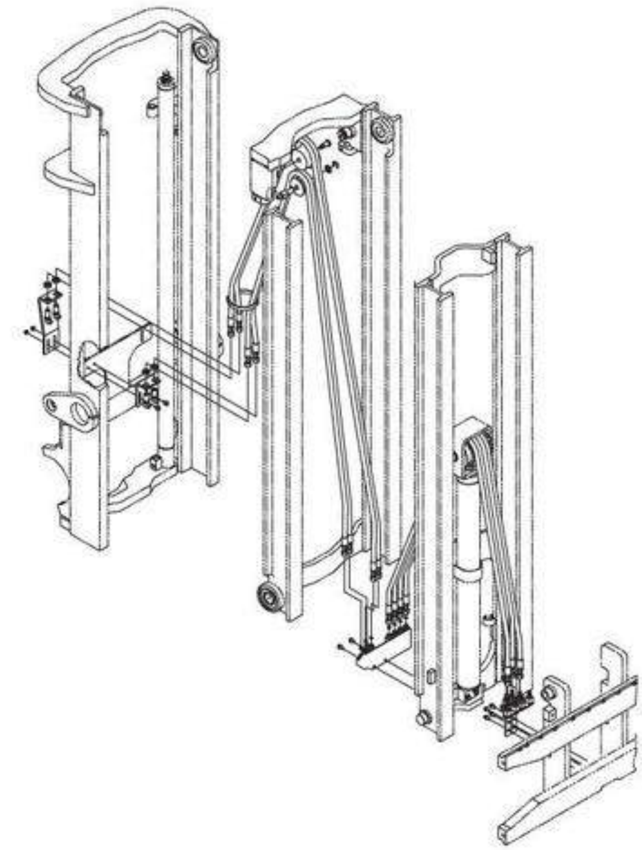


Carriages and Roller Sets

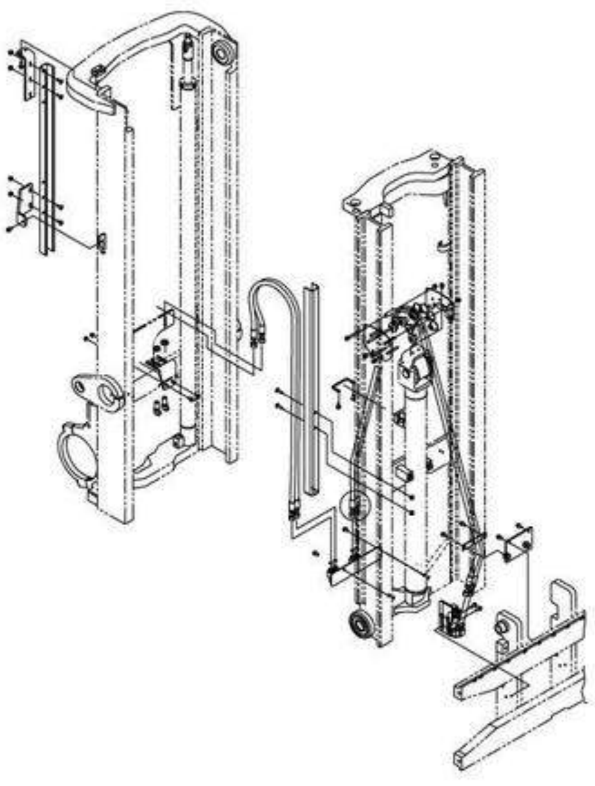
Two-Hose Adaptation for the Standard Uprightfor



Two-Hose Adaptation for the Triple-Stage Upright



Two-Hose Adaptation for the HI-LO Upright



Section 2

Troubleshooting

The visual inspection and the operational checks presented in Section 3 should be used to determine problems with the upright. Possible problems, causes, and remedies are listed below.

Other troubleshooting information about the hydraulic circuit and components appears in the troubleshooting Sections of Groups 29 and 30. Use these other troubleshooting Sections for more detailed problem isolation with Upright hydraulic functions.

WARNING

The procedures for troubleshooting uprights, carriages, and forks involve movement of the components. Failure to follow these warnings can result in serious injury.

Make sure overhead clearances are adequate before raising the upright to full liftheight.

Do not walk or stand under raised forks.

Block carriage and upright whenever making checks with the upright elevated.

Keep clear of load and carriage when making any check or adjustment.

Keep your arms and fingers away from moving parts of the upright.

Do not reach through open areas of the upright.

Upright noise

- Bent or broken components; inspect upright thoroughly and repair or replace components as required.
- Damaged upright roller; check condition of rollers and replace defective rollers.
- Roller scuffing rails: clean and lubricate rails.
- Roller (carriage or upright) shimming needs adjustment; check and adjust as required.
- Fit between roller edge and rail flange excessively loose in rails; replace with oversized, "Select-Fit" rollers. See "Upright Roller Clearance Check and Shim Adjustment."
- Dry lift chain; lubricate chain.
- Dry hose sheave or rollers; check condition of all sheaves and rollers and lubricate as necessary.
- Damaged chain sheaves: check condition of chain-sheaves and repair or replace.
- Excessive fork hanger or carriage fork bar wear; inspect and replace as necessary.
- Seals dry; lubricate rod.
- Seals dry - all primary cylinders; remove gland and add 100 ml (3.4 oz) of hydraulic oil to rod side of piston, see "Cylinder Removal, Shimming, Overhaul, and Replacement."

No lift function but tilt operates

- Hydraulic fluid level low; check level and fill.
- Broken hoses or fittings; check and repair.
- Damaged or blocked sump strainer; check and clean.
- Hydraulic pump defective: see Group 29 for pump-troubleshooting.
- Defective main hydraulic control valve; see Group 30 for valve troubleshooting.
- Defective upright load-lowering flow valve; disassemble valve, check and clean or replace.

lift function but tilt operates

- Broken hoses or fittings; check and repair.
- Cylinder is damaged; inspect and repair.
- Main hydraulic control valve, lift section defective; see Group 30 for valve troubleshooting and service information.
- Upright load-lowering flow valve damaged; disassemble valve, check and clean or replace.

Load cannot be lifted to maximum height

- Hydraulic fluid level low, check level and fill.
- Debris in upright; check and clean.
- Check cylinder for external leakage: replace cylinder if cracked.
- Cylinder shimming is incorrect: check and adjust shim-ming.
- Internal leakage on lift or secondary piston cylinders; remove rod and piston and clean check valves; also clean and inspect/replace piston seals. See Section 5.
- Cylinder check valve on lift or secondary piston cylinders not functioning properly; remove rod and piston and clean check valves; also clean and inspect./replace piston seals. See Section 5.
- Hydraulic pump defective; see Group 29 for pump troubleshooting information.
- Upright rails binding:
  a. Perform a visual inspection and check for worn, or distorted parts, broken or cracked rails or tie-bars, correct chain and hosing placement and operation
  b. Check rollers for contamination and proper operation, perform roller clearance check and adjustment

Lift speed sluggish

- Hydraulic fluid level low; check level and fill.
- Broken hoses or fittings; check and repair.
- Pump inlet line restricted; remove from pump and clean.
- Damaged or binding upright roller; check condition of roller and replace if necessary.
- Internal leakage on piston-type lift and secondary-cylinders (with load); perform cylinder checks listed under "Load cannot be lifted to maximum height."
- Hydraulic pump defective; see Group 29 for pump troubleshooting information.
- Defective main lift valve; see Group 30 for valve troubleshooting and service information.
- Defective velocity fuse; remove fuse from cylinder hydraulic port, clean and recheck for proper operation.
- Defective upright load-lowering flow valve; remove valve clean, inspect, and replace if necessary.

Lowering speed sluggish

- Damaged or binding upright roller; check condition of roller and replace if necessary.
- Damaged or kinked hydraulic hose or tube; check condition of hose and tube, repair or replace as necessary.
- Defective upright load-lowering flow valve: check, clean and replace valve if necessary.
- Defective velocity fuse: remove fuse from cylinder
- Hydraulic port, clean and recheck for proper operation.

Load bounces excessively when lowering

- Air in hydraulic system, TSU and HI-LO ram-type cylinders; set capacity load on upright and lift from fully collapsed to full lift height for l0-15 cycles.
- Defective upright load-lowering flow valve; check, clean and replace valve if necessary.
- Defective main lift valve; see Group 30 for valve troubleshooting and service information.
- Defective velocity fuse; remove fuse from cylinder hydraulic port, clean and recheck for proper operation.

Upright mis-staging (TSU lifting)

- Debris in upright roller area of carriage; check and-clean.
- Interference between carriage and inner rail or cylinder; check staging alignment and adjust or repair asnecessary.
- Bent or broken carriage or inner rail; replace part - do not try to repair by welding.
- Damaged or binding carriage roller; check condition of roller and replace if necessary.
- Carriage roller shimming or thrust roller out of adjustment; perform roller checks on carriage and make adjustments as necessary.
- Damaged or kinked primary cylinder hose; check condition of hose, repair or replace as necessary.
- Primary cylinder chain or chain sheave binding or damaged; inspect and repair.
- Internal leakage in primary lift cylinder; perform cylinder checks listed under "Load cannot be lifted to maximum height."
- Damaged primary lift cylinder causing binding in the cylinder: inspect and repair or replace cylinder.

- Defective velocity fuse; remove fuse from cylinder hydraulic port, clean and recheck for proper operation.

Upright mis-staging (TSU lowering)

- Debris in upright roller area or tie bar area; check and clean.
- Bent or broken carriage or inner rail: replace part - do not try to repair by welding.
- Damaged or binding roller on upright; check condition of roller and replace if necessary.
- Carriage and upright roller shimming or thrust roller out of adjustment: perform roller checks on upright and/or carriage and make adjustments as necessary.
- Damaged or kinked lift cylinder hose; check condition of hose, repair or replace as necessary.
- Lift cylinder chain or chain sheave binding or damaged: inspect and repair.
- Bent cylinder rod; inspect and replace rod and/or cylinder as necessary.
- Internal leakage in piston-type cylinders; perform cylinder checks listed under "Load cannot be lifted to maximum height."
- Damaged lift cylinder causing binding in the cylinder; inspect and repair or replace cylinder.
- Defective velocity fuse: remove fuse from cylinder hydraulic port, clean and recheck for proper operation.

Upright mis-staging (Standard and HI-LO upright lowering)

- Damaged or binding roller on upright; check condition of roller and replace if necessary.
- Top carriage roller retaining cap screw loose; check and replace cap screw.
- Lift cylinder chain or chain sheave binding or damaged; inspect and repair.
- Debris in upright roller area or tie bar arca; check and clean.
- Bent or broken carriage or inner rail; replace part - do not try to repair by welding.
- Carriage and upright roller shimming or thrust roller out of adjustment; perform roller checks on upright and/or carriage and make adjustments as necessary.
- Defective velocity fuse; remove fuse from cylinder hydraulic port, clean and recheck for proper operation.

External leakage on primary cylinder

- Gland loose; check and tighten primary cylinder gland to 588 N·m (434 ft-lb) and glands on lift (secondary) cylinders to 392 N·m (289 ft-lb).
- Cracked cylinder tube; replace tube.
- Rod seal damage; replace seals and check for:
  - Damaged rod seal groove in gland; check for damage to groove and replace seal or gland if necessary
  - Scored cylinder wall; repair or replace cylinder tube if necessary
  - Leaking check valve; clean and replace if necessary
  - Leaking O-ring seal on check valve: replace check valve.
- Gland static seals (O-rings and back-up ring) damaged; replace back-up ring.
- Gland static seals sealing surface damaged; check groove and bore and repair or replace as necessary.

External leakage on lift (Standard) and secondary cylinder (TSUs and HILO)

- Gland loose; check and tighten gland on cylinders to 392 N·m (289 ft-lb).
- Cracked cylinder tube; inspect and replace tube.
- Seal damage in piston-type cylinders; replace piston seals and rod seals.
- Rod seal damage, ram-type cylinders; replace rod-seals.
- Damaged seal groove, piston-type cylinders; check for scratches, nicks, or burrs and repair or replace rod and piston.
- Scored cylinder wall, TSU piston-type cylinders; replace tube and all seals.
- Scored or damaged rod; replace rod and all seals.
- Damaged gland back-up seal; inspect and replace seal.
- Gland static seals sealing surface damaged; check grooves and bore.

Oil leak at top of lift cylinder

- Scored cylinder wall; see Section 5.
- Worn or damaged gland rod-seal; see procedures for piston-type cylinders under "Cylinder leaking internally."

Unsatisfactory lift or tilt cylinder drift test results

- Cylinder leaking internally; remove cylinder gland and check:
  a. Primary cylinder should have ounces of oil
  b. The ram-type cylinders are always full of oil; oil on both sides of piston.

If fluid is leaking past piston:

a. On piston-type cylinders, remove rod and piston, clean check valves and clean and inspect/replace piston seals
b. Ram cylinders are supposed to have oil on both sides of piston.

See Section 5.

- Cylinder hydraulic fittings loose or worn; check fitting O-rings, tighten fittings according to Group 40, "Hydraulic Fitting Tightening Procedure."
- Check valve worn or damaged; remove rod and piston, clean check valve and replace if necessary.
- Control valve spool linkage malfunctioning, damaged, or worn; see Group 30, Section 5 for linkage adjustment and/or replacement.
- Counterbalance function in main hydraulic control valve malfunctioning, damaged, or worn; inspect and clean or replace if necessary.

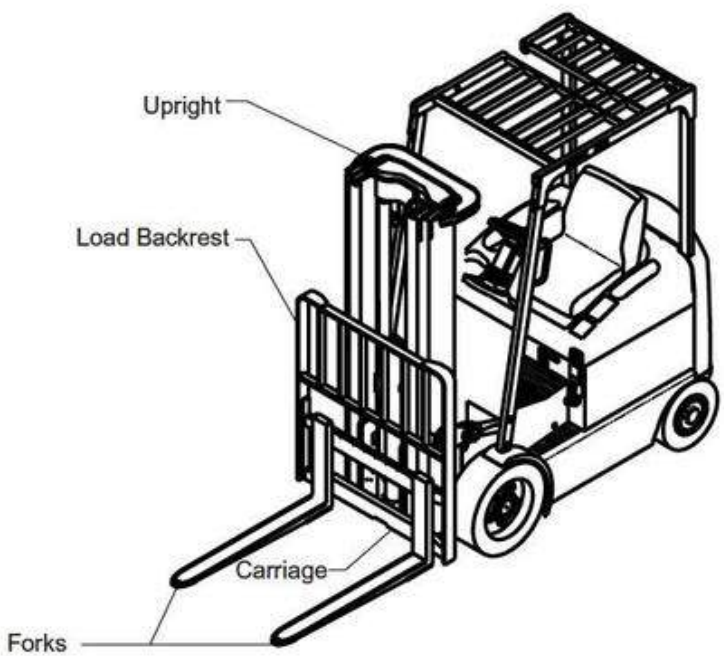
Section 3

Upright Inspection

CAUTION

SAFE PARKING. Before working on truck:

1. **Park truck on a hard, level, and solid surface, such as a concrete floor with no gaps or breaks.**
2. **Put upright in vertical position and fully lower the forks or attachment.**
3. **Put all controls in neutral. Turn key switch OFF and remove key.**
4. **Apply the parking brake and block the wheels.**



Basic Visual Inspection

Use the following steps to conduct an initial visual inspection of the upright. This is the same type of inspection operators should be conducting on a daily basis.

If you note problems with any component during the basic visual inspection, continue with "Extended Inspection" for checks and service.

WARNING

The procedures for checking, maintaining, and adjusting uprights, carriages, and forks involve movement of the components. Failure to follow these warnings can result in serious injury. Always use extreme caution.

Do not walk or stand under raised forks.

Keep clear of load and carriage when making any check or adjustment.

Keep your arms and fingers away from moving parts of the upright.

Do not reach through open areas of the upright.

General

- Check to make sure all fasteners are secure.
- Check to make sure the upright lifts and lowers smoothly with and without a capacity load.
- Check for visible damage to components.

Forks

- Check function and security of the fork latch.
- Inspect the forks for cracks, especially the hanger and heel areas.
- Check for wear in the fork heel. If heel wear is evident, perform the extended inspection.
- Inspect the fork hanger and carriage fork bar for excessive wear.
- Inspect for bent forks.

Load Backrest

- Inspect load backrest for damage such as cracks or bending.
- Check for tight mounting fasteners.

Lift Chains

Inspect the chains for:

- Proper lubrication. The links should have a coat of oil on all surfaces. Lubrication oil should penetrate completely into chain joints.
- Good condition of the chain links and pins. No rust, corrosion, stiffness, or cracking should be evident. Pins should not be turned or protruding.
- Excessive side wear or edge wear on the chain plates.
- Correct, equal tension on chain sets.
- Secure anchor bolt, adjustment nut, and jam nut mounting.
- Correct alignment of the chain anchors to the chain and chain sheaves. Adjust turned chain anchors.
- Loose, broken, or damaged anchor bolt pins and cotter pins. Replace defective pins and cotter pins.

Rollers

Inspect the upright and carriage rollers for:

- Broken or loose rollers.
- Loose, broken, or misadjusted thrust roller on the carriage.
- Obvious signs of failed bearing seals.

NOTE

Some grease will purge from the bearings in the first 100-200 hours of operation.

- Excessive looseness in carriage or upright roller shimming.

Upright and Carriage Weldments

Inspect the upright and carriage for:

- Debris or foreign objects on the components.
- Bent, cracked, or broken components.
- Undesirable wear on or contact between components.
- Irregular roller patterns and signs of excessive wear or scraping on the rails.

Hydraulic System

Inspect the upright hydraulic system components for:

- Damage or wear on all hoses and hydraulic tubes.
- Leaks on hoses, fittings, or valves.
- Leakage on the cylinders.
- Excessive drift in lift or tilt operations.

Extended Inspection

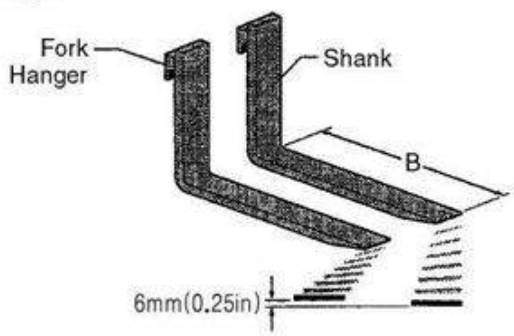
The extended inspection should be performed whenever the basic visual inspection indicates upright problems, as specified for PMs, or at least every 2000 hours.

Forks

Forks have a limited service life because of wear and fatigue. Forks should be tested every 50-250 hours using a visual inspection, a fork thickness check, a fork bending check, and a fork gap check. If replacement is necessary, always replace the pair to ensure fork integrity.

Fork Alignment

1. Park the truck on a flat, even surface, tilt upright to vertical position, and set forks 25-50 mm (l-2 in) above the ground.
2. Compare fork arms to be sure they are straight, on the same plane (level), and the same length.
3. Measure the distance from the fork tips to the ground. The height difference between the forks tips should be no more than 6mm(0.25in) of the fork length.

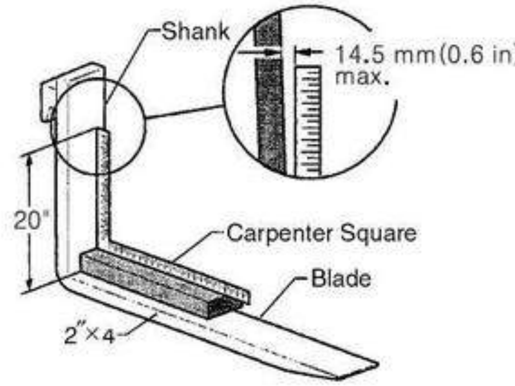


4. If the fork tips are not aligned within the specified 6mm (0.25in) difference, the cause of the problem must be determined and corrected before returning the truck to service. If replacement is necessary, always replace the forks in a set.

Fork Bending

Overloading, glancing blows against solid objects, or picking up loads unevenly can bend or twist a fork. Use the following procedure to check for fork bending.

1. Place a 50x100x610mm(2x4x24in)wood block flat on the fork. Make sure the block is not resting on the heel radius.



Fork Bending Check

2. Set a carpenter's square on the block against the fork shank
3. Check the fork 508 mm (20 in) above the blade to make sure it is not bent more than 14.5 mm (0.6 in) at the maximum.
4. If blades are bent over the 14.5 mm (0.6 in) allowance they should be replaced as a set.

See Section 7, "Fork and Carriage Removal and Replacement," for procedures to remove and replace the forks.

Fork Fatigue

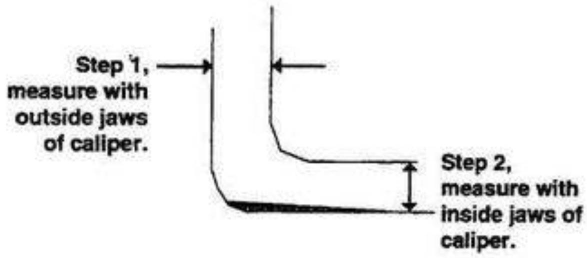
Fatigue cracks normally start in the heel area or on the underside of the top hanger. If cracks are found, the fork should be replaced. Dye penetrants or magnaflux can be used for a more accurate inspection.

Fork Wear and Heel Wear

Industrial Truck Association (ITA) standards require that a fork be removed from service when the blade or heel thickness is reduced by 10% over its original thickness. If the heel is 10% smaller than the arm, the load capacity could be reduced by 20%. A 5,000-pound (2272 kg) capacity fork with 10% wear can only safely handle 4,000 pounds (1818kg).

Use of fork wear calipers are recommended (Clark part number 1803641) to gauge fork wear as follows:

1. Use the outside jaws of the caliper to meaure fork thickness in the shank area of the fork.



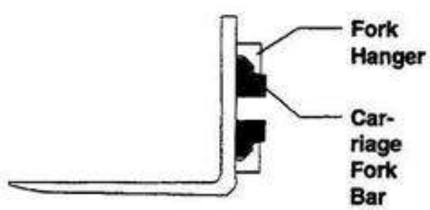
NOTE

Hold the caliper square and use light pressure to squeeze the outer jaw tips against the fork shank. Take care not to accidentally alter the reading of the calipers.

2. Check the fork blade area to the inside jaws of the caliper.
3. If the inside jaws fit over the fork in the blade area, wear exceeds allowable 10% wear and a new set of forks should be installed.

Fork Hanger Wear and Carriage Fork Bar Wear

Inspect the fork hangers and carriage fork bar. Excessive wear can cause the fork to disengage the fork bars or reduce fork hanger life.



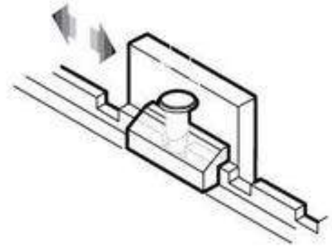
- If fork hangers are excessively worn, replace the forks as a set.
- If carriage fork bar is excessively worn, replace the carriage.

IMPORTANT

Do not weld on forks or carriage. Replace the worn parts with new parts.

Fork Latch and Carriage Fork Stops

1. Check fork latches for proper operation. Latches should operate smoothly. The spring should be in good condition and securely lock the fork into position. Replace the fork latch if it does not operate properly.



NOTE

A small amount of lubricant can be applied to the fork latch. Do not over lubricate and allow lubricant to run down on carriage fork bar.

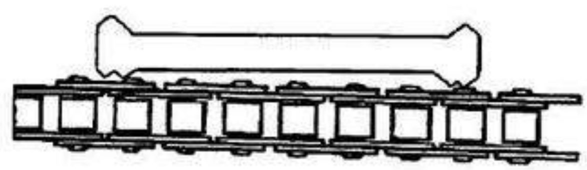
2. Check fork stops for widening of notches or rounding of top edge. Replace the carriage if fork stops are excessively worn.

Lift Chains

The following checks should be performed every 50-250 hours to ensure correct chain performance See Section 6 for more complete chain inspection and maintenance procedures.

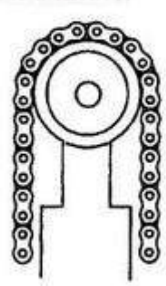
Chain Wear (Stretch) - All Lift Chains

Lift chain stretch due to wear in the joints can be measured using a measuring tape or Clark's chain check ruler.



Chain Check Ruler - Clark Part Number 59-960-9908

When any section of the chain has worn and increased its original length by 3% or more, the chain must be replaced. When checking chain wear, always measure a segment of the chain that rolls over a sheave.



IMPORTANT

Never replace a single chain in a set. Always replace the two chains in a set for consistent lift operation. Always replace anchor pins when replacing chains.

1. For example, measure a 305 mm (12 in) segment of the chain that does not roll over a sheave and count the number of links in the segment.
2. Find an area of the chain that normally runs over the sheave. This can usually be identified by wear on the plate edges that roll over the sheave.
3. If the same number of links measures over 315 mm (12.36 in) the chain must be replaced.

If using a chain check ruler, see instructions on the ruler.

Chain replacement procedures appear in Section 6.

Chain Length

IMPORTANT

Perform a chain length check and adjustment every 50-250 hours. Checks and adjustments should also be performed to adjust for chain stretch and tire wear.

Chain length must be adjusted if:

- The fork-to-ground clearance is less than 5 mm (.20 in) or more than 25 mm (1.0 in) when the upright is vertical.
- The center of the bottom carriage roller comes within 20 mm (0.80 in) of the bottom edge of the inner rail.
- The carriage safety stop hits the inner rail stop at full lift height.
- On TSUs and HI-LO, the difference between the bottom of the inner rail and the outer rail is greater than 10 mm (0.40 in).

See Section 6 for chain length adjustment procedures.

Chain Tension

IMPORTANT

Center any auxiliary attachments before beginning tension check

1. Raise the upright enough to put tension on the chains to be checked.
2. Push the chains forward and pull them backward; the amount of tension should be equal on both sides.

WARNING

Do not reach through the upright to push chains for tension check.

3. If one chains moves more than the other;
   a. Lower the forks to ease tension on the chains.
   b. Adjust chain adjustment nuts for equal tension on both chains. See Section 6 for chain adjustment procedures
4. Repeat the tension test and make adjustments until the tension is equal on both chains when the carriage and upright are raised.

Carriage and Upright Weldments

The carriage and upright should be checked for fatigue cracks and bent components every 2000 hours or every year. Fatigue cracks start in areas of stress after a high number of load cycles. Stress concentrations typically exist in welded joints, in the area around a welded joint, or in the corners of parts. Dye penetrant, magnaflux, or other crack detection methods can be used to find or trace cracks. If cracks are found in any structural weldment, the component should be replaced before returning the truck to service.

- Bent components indicate excessive loading or high impacts to the weldments. Bent components are usually structurally damaged and should be replaced.
- Inspect roller contact patterns on the rail sections. Roller contact patterns should be smooth and regular.
  - In some applications, it may take up to 500 hours of operation to develop a roller contact pattern on the flange of the rail.
  - In applications where heavy loads are common, a rail lubricant may be required to allow proper wear-in on the roller.
- Check rails and carriage for wear due to undesirable contact between components. Such contact can be an indication of broken rollers, loose components, foreign objects or debris on the upright, or a broken weldment.
  - If contact or rubbing exists, the condition must be corrected immediately.
  - Rail and carriage weldments with damage should be replaced.
- Tie bar areas should be free of foreign objects and debris. The roller area of the rail should be cleaned every 500-1000 hours in a normal application.
  - In applications where excessive amounts of contaminants settle in the rail channels, cleaning may be required on 50-250 hour intervals.

If excessive contamination exists, the rollers should be exposed and the bearing seal areas cleaned thoroughly.

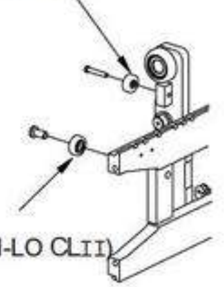
See Section 4 for carriage roller and upright roller.

Carriage and Upright Rollers

Carriage Thrust Rollers

The carriage uses two types of thrust rollers.

- The internal thrust roller is found on both standard and TSUs. The carriage internal thrust rollers are located on the lift bracket and run on the inside web of the inner rail. The internal thrust roller is intended to carry a portion of the carriage lateral load.
- The second type of carriage thrust roller is an external thrust roller. The external thrust roller runs along the outside flange of the inner rail to control lateral load on the carriage. External thrust rollers are found on STD, HI-LO CLIII and TSUs.



Both types of thrust rollers should be checked for smooth rotation, seal integrity, radial bearing tightness, and a tight capscrew. A roller should turn smoothly without sticking and be grit free. Replace the roller if any defect is found.

External thrust roller capscrews have a locking patch to prevent the capscrew from backing out. Repeated removal will deteriorate the ability of the patch to hold the capscrew. If the capscrew is backing out without holding, a new capscrew is recommended. The capscrew can also be cleaned and set using thread locking compound Loctite 271(Clark Part 1802302). The internal thrust rollers use a jam nut to ensure that the bearing remains secure.

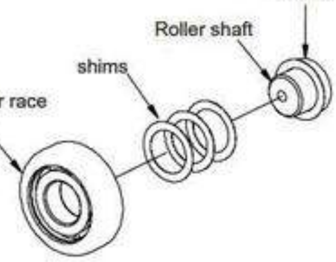
NOTE

Some grease will purge from the bearings in the first 100-200 hours of operation. This is not necessarily a sign of a failed roller bearing seal.

The external thrust rollers are not adjustable. The internal thrust roller adjusts using a locking cam on the mounting capscrew. See Section 4 for roller replacement and internal thrust roller adjustment procedures.

Carriage and Upright Main Load Rollers

Inspect the carriage and upright main load rollers for broken, loose, or rough bearings. Defective rollers should be replaced.



Indications of broken or damaged rollers include:

- Part of all of roller bearing missing
- Bearing outer race loose
- Scraping noise from the upright
- Scraping of carriage fork bar on inner rail (carriage rollers)
- Upright rail sections scraping together (upright rollers)
- Upright misstaging
- Excessive looseness of the rail section or carriage demonstrated by the following load test.

NOTE

Some grease will purge from the bearings in the first 100-200 hours of operation. This is not necessarily a sign of a failed roller bearing seal.

Load Test

A load test helps you to determine the amount of clearance between the moving upright parts. The upright requires some lateral movement between the interlocking rails and the carriage. But, too much or too little clearance can be the cause of binding and uneven operation.

An upright or carriage can move unexpectedly during service procedures causing severe injury:
Do not walk or stand under raised forks.
Keep clear of load and carriage when making any check or adjustment.
Keep your arms and fingers away from moving parts of the upright.
Do not reach through open areas of the upright.
Failure to follow these warnings can result in serious injury.

1. Place a capacity load on the forks and secure it to the carriage.

⚠ CAUTION

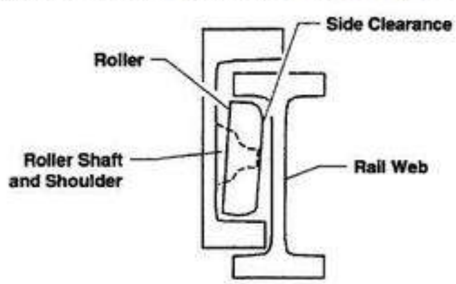
Test load must be stacked stably, not extend beyond the pallet, and be secured on the pallet. Operate the truck only from within the operator's compartment.

2. Tilt the upright back slightly and raise the upright to its maximum extension several times. Note the smoothness of operation, the carriage play, and play between the rails.
3. Move the load 102 mm (4 in) off center on the forks and resecure it to the carriage.
4. Raise the upright to its maximum extension and lower the load to the floor several times.
5. Repeat the step, moving the load 102 mm (4 in) off center to the other side.
6. Raise the upright to its maximum extension and lower the load to the floor several times.

Carefully observe the smoothness of operation, particularly in carriage play, and play between the rails. If any unusual movement, staging, or noise occurs during the test, correct the problem before returning the truck to service. Continue with the following roller shimming checks if too much play is evident in the carriage and rails in the load test. The troubleshooting guide may also help to identify specific problems with upright operation.

Roller Side-Clearance

The carriage and upright rollers are shimmed between the inner race and the roller shaft shoulder to maintain minimal clearance between the side of the roller and the web of the adjacent rail. Shim adjustments help accommodate manufacturing tolerances and wear in the upright rail sections.



Signs of loose shimming include:

1. Excessive lateral (side-to-side) movement in upright rail sections
2. Excessive lateral shift in the upright at, or near, full maximum fork height (MFH)
3. Irregular roller patterns on the rail.

Signs of over shimming include:

1. Mis-staging or hanging up of the upright
2. Excessive wear in the rail web
3. Premature bearing failure.

Perform the following roll pattern check and the load test if the need for roller shimming is suspected. See Section 4 for detailed clearance measurement procedures.

Roll Patterns

Impressions made by rolles on upright rails are called roll patterns. Roll patterns can provide indication of the need for upright or carriage adjustment.

WARNING

Keep clear of load and carriage when making any checks or adjustments.

1. Elevate the carriage about 4 feet (1.3 m).
2. Apply a light, thin layer of grease to the roller contact area.
3. Lower the forks and pick up a capacity load. Raise and lower the upright several times.
4. Back out from the load and raise the carriage.

Compare the impressions of the rollers on each side of the upright rails. The impressions should look the same on both sides. Look for signs of metal scoring or gouging which can indicate excessive pressure caused by damaged or misadjusted rollers.

Carriage rollers, including side-thrust rollers, and all upright rollers can be checked by examining roll patterns. If irregular impressions result from the checks, perform the "Lift Cylinder Shimming Check" and the "Load Test" to further diagnose problems.

See Section 4 for procedures to measure clearances and adjust carriage or upright rollers.

Cylinders

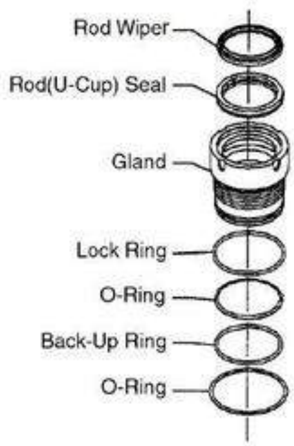
Use the Drift Test, presented under "Hydraulic Checks" below, for additional diagnosis of cylinder condition. See Section 5 for cylinder repair.

External Leakage (All Cylinders)

To check for external leakage on the primary cylinder:

1. Clean the top of the gland and rod to remove any buildup of debris.

2. Check rod surface for defects or unusual wear.
   - Nicks, burrs, or other sharp defects can cause damage to the seal and will lead to leaks. The rod should be repaired or replaced.
   - For piston-type cylinders, small blunt defects in the top and midsection of the rod can be tolerated in this cylinder design. The high pressure sealing is over the last several inches of stroke. This type of defect is acceptable if leakage is not evident.
   - For ram-type cylinders, defect tolerances are narrower than for sealed-piston cylinders. Damage to these rods requires replacement.
3. Check for external leakage from the cylinder barrel, gland O-rings and backup ring, and the rod seal.



   - The gland O-rings and backup ring are near-zero leakage seals. If, after cleaning the gland and tube, oil accumulates to form a run, the O-rings and backup ring should be replaced (see Section 5).
   - External leakage from the barrel requires replacement of the barrel.

NOTE

The seals are installed with lubricant and a trace amount will be in the gland/tube interface area.

4. After cleaning the top of the gland and the barrel, cycle the upright 5times. If a ring of oil forms to run 3 mm (0.125 in) down the rod, the cylinder must be overhauled or replaced.

Internal Leakage on Primary Cylinder

To check for internal leakage on the primary cylinder:

1. Lift the upright to maximum height then lower forks completely.
2. Cycle the upright 5-10 times through the first 2/3 length of the primary stroke and lower forks completely.
3. Slowly lift the carriage 305-610 mm (l-2 ft) into the secondary lift stage then lift to full extension.
4. If the carriage does not lift to full height, the problem is likely an internal leak and the cylinder should be overhauled.
5. If the carriage does lift to full height, but you still suspect an internal leak, repeat the procedure with a 40-70% capacity load.

NOTE

The primary cylinder normally has approximately 100 ml (3.4 oz) of hydraulic fluid on the rod side of the piston as a precharge.

Use the Drift Test, presented under "Hydraulic Checks" below, for additional diagnosis of cylinder condition. See Section 5 for cylinder repair.

Internal Leakage on Piston-Type Lift and Secondary Cylinders

To check for internal leakage in Standard lift and TSU secondary cylinders:

1. Lift the upright to MFH then lower forks completely.
2. Cycle the upright 5-10 times through the first 2/3 length of the lift cylinder stroke and lower forks completely.
3. Lift the upright to full MFH.

Watch for the lift cylinder to increase lift speed. If you see an increase in lift speed, one or both of the lift cylinders have an internal leak and requires overhaul.

If the upright does not increase lifting speed, but you still suspect an internal leak, repeat the procedure with a capacity load. If the upright does not extend to full MFH, the problem is likely an internal leak and the cylinder should be overhauled.

Lift Cylinder Shimming

The lift cylinders on both standard uprights, HI-LO and TSUs bottom out at the end of the stroke to limit upright extension. The upright has dual lift cylinders and the cylinders' extension length must be equal. If not, "racking," or side-to-side shifting, results. Rod extension length is made equal by using shims under the rod end of the cylinder. To determine if shimming of the cylinders is required to pre-vent racking, perform the following operational check:

CAUTION

Make sure truck is parked on level surface with parking brake applied and wheels chocked; make sure overhead clearance is adequate to extend upright to its full height.

1. Center the forks or attachments on the upright.
2. Check for equal chain tension.
3. Raise the upright from the retracted position to full lift height. Note the point when the lift cylinders reach the end of their stroke.
   - If the upright shifts right or left noticeably, shimming is required.
   - Repeat the check three times before adding shims.

NOTE

Offset or unbalanced loads and off-center attachments can cause the upright to shift even with proper lift cylinder shimming.

See Section 5 for lift cylinder shimming procedure. Racking adjustments for tilt cylinders appear in Group 32, Section 2, "Tilt Cylinder Checks and Adjustments."

Hydraulic Plumbing

Use the Lift Cylinder Shimming Check, the Load Test, and the following Drift Test to check the performance of the hydraulic system.

1. Check all fittings for leakage. Disassemble fittings and inspect the seals. Replace seals as required. See Group 40 for hydraulic fitting tightening procedures.
2. Check all hoses and tubes for wear and damage.
   a. Hoses or tubes with scrapes or kinks should be replaced.
   b. Hoses with outer cover wear exposing the reinforcement braiding should be replaced.

Upright Drift

Drift tests check cylinder, main valve, and hydraulic circuit integrity under load pressures. A load is held elevated for an extended period to determine how much the upright "drifts" (moves) over a specified time period. A tilt cylinder drift test appears in Group 32, Section 2, "Tilt Cylinder Checks and Adjustments."

WARNING

An upright or carriage can move unexpectedly during service procedures causing severe injury:

Do not walk or stand under raised forks.

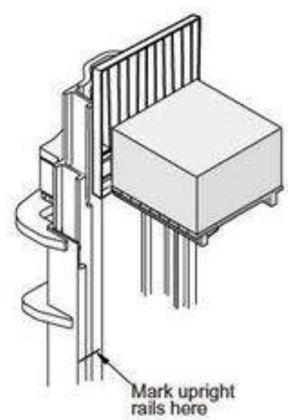
Keep clear of load and carriage when making any check or adjustment.

Keep your arms and fingers away from moving parts of the upright.

Do not reach through open areas of the upright.

Failure to follow these warnings can result in serious injury.

1. Raise the empty upright and carriage to its full extension and lower to a point halfway down from full extension.
2. Shut off the truck. Apply the parking brake and chock the wheels.
3. With a pencil or chalk, make a mark across the rails on one side of the upright.



WARNING

Keep clear of load and carriage when making any checks or adjustments. Do not use the upright to climb; use an approved platform.

4. Wait ten minutes and recheck the mark. Measure and write down the distance the marks on the inner and intermediate rails have drifted from the mark on the outer rail.
5. If upright rails drift 50 mm (2 in) or more in the ten minutes, read and follow the procedures presented in "Drift Causes and Remedies."

6. If drift does not exceed 50 mm (2 in) in ten minutes, retest the upright with a 50% load. Adjust fork width as wide as possible to lift the half-load equally distributed on a 1220 x 1220 mm (48 x 48 in). Refer to truck nameplate for capacity rating.

CAUTION

Test load must be stacked stably, not extend beyond the pallet, and be secured on the pallet.

Causes and Remedies

If drift of 50 mm (2 in) or more is evident under a rated load, consider the following causes and remedies:

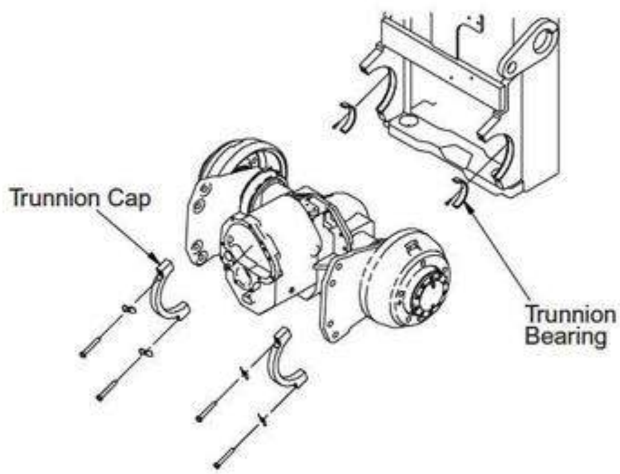
- The main hydraulic valve is misadjusted, worn, or defective. Fluid is leaking past the valve and causing the upright cylinders to drift. See Group 30 for hydraulic valve troubleshooting and service.
- Upright hydraulic circuit hoses or fittings are leaking. Check the circuit components and repair as necessary.
- Cylinder piston seals are worn, damaged, or defective allowing fluid past the piston causing drift.
- Primary cylinder or piston-type lift or secondary cylinders have a check valve that allows oil to flow back to the rod side of the cylinder. This check valve may be clogged or defective. Inspect the check valve for proper sealing and operation.

Consider rebuilding the cylinders if the fist two remedies in this list are not successful. See Section 5 for removal, overhaul, and replacement procedures for primary and sec ondary cylinders.

Trunnion Bearings

To check the trunnion mounting:

1. Check for missing, broken, bent, or loose trunnion cap fasteners. Replace any damaged parts.
2. Lift the upright 305-610mm(1-2ft)and tilt the upright fully forward.
3. Check for trunnion bearing or cap wear by inserting a feeler gauge between the trunnion cap and the axle-mounting bearing surface.



- The gap should not exceed 0.75 mm (0.03 in).
- If the gap exceeds 0.75 mm (0.03 in) the bearing or cap may need replacement.

See Section 8, "Upright Removal and Replacement," for procedures to remove and replace the trunnion bearing

Section 4

Carriage and Upright Roller Clearance Checks and Shim Adjustments

IMPORTANT

Before removing any component for overhaul, make sure the correct repair parts and/ or kits are available.

WARNING

An upright or carriage can move unexpectedly:

- **Do not walk or stand under raised forks**
- **Keep clear of load and carriage when making any check or adjustment**
- **Keep your arms and fingers away from moving parts of the upright.**
- **Block the carriage or upright when working with the components in a raised position.**
- **Do not reach through open areas of the upright.**
- **Never attempt to move or align the rails by hand.**
- **Failure to follow these warnings can result in serious injury.**

WARNING

Use an approved safety platform to reach the upper areas of the upright. Never use the upright as a ladder.

Introduction

Standard and HI-LO upright assemblies have two lift roller sets mounted on the rails, three lift roller sets mounted on the carriage, and one internal thrust roller set mounted on the carriage. External thrust roller set used more than 3.0 ton trucks.

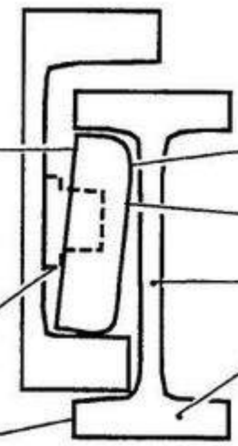
The triple-stage upright assemblies have four lift roller sets mounted on the rails, three lift roller sets mounted on the carriage, and two thrust roller sets ("internal" and "external") mounted on the carriage. (see the "Roller Side Clearance Chart" on next page.)

Each carriage and upright lift roller is nested within its adjacent rail set. The front "face" of the lift roller handles front-to-back friction and play between the nesting segments of the upright assembly, the side "face" of the roller radius handles side-to-side friction and play. The rollers are canted (tilted) to allow the side face to bear properly on the web.

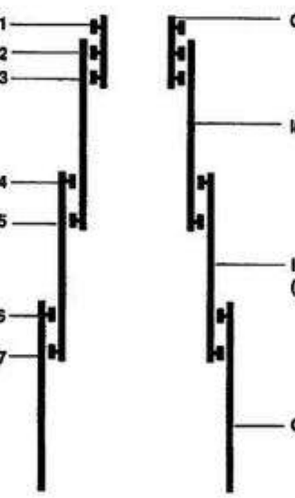
Rail flange wear can cause excess play between the lift rollers and the rail flange. The only way to correct this is to install oversize rollers-only one size of which is available. If oversize rollers were fitted previously, the only remedy for excessive front-to-back play is to replace the rail set. (carriage middle rollers are always standard-size rollers; see "Oversize Rollers" later in this Section for details on roller replacement.)

The gap between the roller "side" and the web of adjacent rail set affects the side-to-side motion of the upright-which should be as small as possible without causing the sliding segments to bind. The same is true of the internal thrust rollers.

You check the performance effect of the lift roller side clearance and internal thrust roller clearance by means of the load



Roller Side Clearance Chart



Roller Set#	Web Area Forming Gap	Gap at Minimum Span of Rail Set				Gap at Maximum Span of Rail Set			
		Target[a]		Allowed[b]		Target[a]		Allowed[b]	
		(mm)	(in)	(mm)	(in)	(mm)	(in)	(mm)	(in)
#1	Front, Inner Rail[c]	0.5-1.5	0.02-0.06	0.05-1.25	0.02-0.05	d	d	2.25	0-0.09
#2	Front, Inner Rail	0-0.75	0-0.03	0-1.5[e]	0-0.06	d	d	2.25	0-0.09
#3	Back, Inner Rail	0-0.75	0-0.03	0-1.0	0-0.04	d	d	2.25	0-0.09
#4	Back, Inner Rail	0-0.75	0-0.03	0-1.0	0-0.04	d	d	2.25	0-0.09
#5	Back, Intermd Rail	0-0.75	0-0.03	0-1.0	0-0.04	d	d	2.25	0-0.09
#6	Back, Intermd Rail	0-0.75	0-0.03	0-1.0	0-0.04	d	d	2.25	0-0.09
#7	Back, Outer Rail	0-0.75	0-0.03	0-1.0	0-0.04	d	d	2.25	0-0.09

a. Target is the desired gap after reshimming the roller set.
b. Allowed is the acceptable gap when checking roller set.
c. Internal side thrust rollers should extend 0.25-0.50mm (0.01-0.02in) beyond #1 rollers.
d. Ideal is same as final measured gap at minimum width point of rail set.
e. Measured at top of inner rail.

test described in Section 3. To evaluate with certainty that the clearance is excessive, you perform the checks given below.

To correct excessive lift roller side clearance, you add shims as described later in this Section. To correct internal thrust roller clearance, you adjust thrust roller position as described later in this Section.

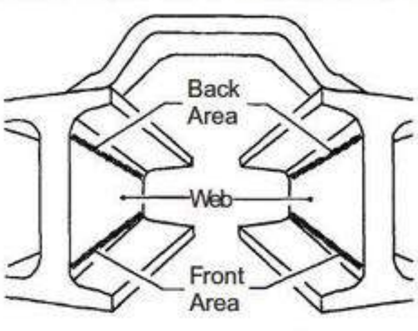
Roller Side Clearance Checks

The same basic procedure is used for checking all the lift rollers. That general procedure is given in the subsection directly below. Special instructions for specific rollers follow that subsection. Follow those directions (in the subsection called "Directions for Checking Specific Rollers") and you will be directed to general and specific information you need.

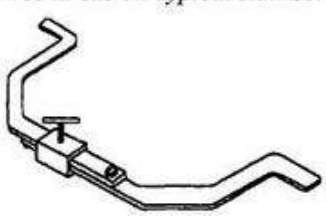
General Roller Side Clearance Checking Procedure

For each roller set, you need to measure the gap between the outside face of a roller and its adjacent nesting rail. In general, the lift roller side clearance check procedure is as follows:

1. With the spanner tool, find and mark the narrowest and widest spans in each rail set at the roller-contact areas in the rail webs:
   - Inner Rail Set-Mark narrowest and widest spans for both the front and back web areas.
   - Outer and Intermediate Rail Sets-Mark narrowest and widest spans for the back web area only.

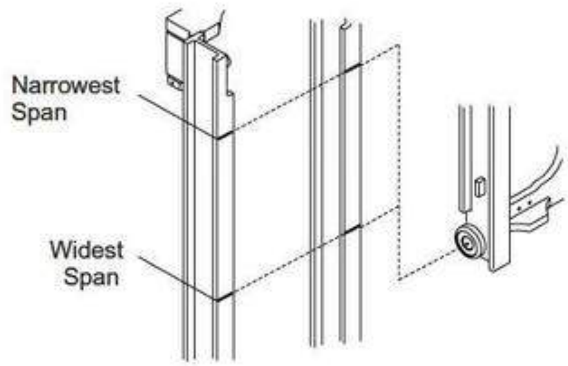


Web Areas on Typical Rail Set



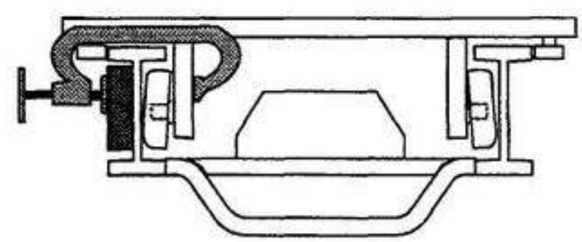
Spanner Tool. Clark part #1801089

2. Position the carriage or rails so that the roller set you want to check is at the mark for the narrowest span on the adjacent nesting rail set.

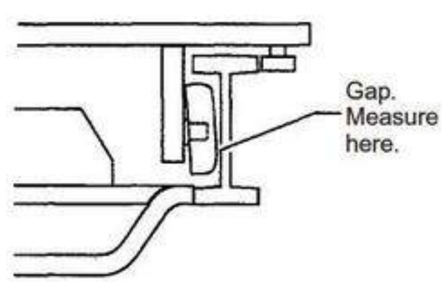


Example of Aligning Roller Set with Widest and Narrowest Spans Marked on Adjacent Rail Set. Rail sets are shown seperated for clarity.

3. Clamp the rails together opposite the roller you intend to check. Use wooden shim blocks to protect the rails.
   Place clamp as close to roller as possible. Torque clamp to 2.5 N·m (20 ft-lb).



4. Measure the gap with a feeler gauge. Make sure roller is tight against its shoulder. Write down the result.



5. Repeats steps 2 through 4 for the widest span marked on the rail set.

6. If the clearance at the widest rail set span is more than 2.25 mm (0.09 in), the roller set needs shimming.
   If the clearance at the narrowest rail set span is more than 1.0mm (0.04in), the roller set should be shimmed; however, it is OK for the middle carriage roller gap to be up to 1.5 mm (0.06 in).
7. Repeat entire procedure for each roller set, following the instructions in "Directions for Checking Specific Rollers" below.

Directions for Checking Specific Rollers

Use these directions to supplement the general procedures given above.

Carriage Rollers

Bottom Carriage Rollers

Follow the general procedure above.

Middle Carriage Rollers

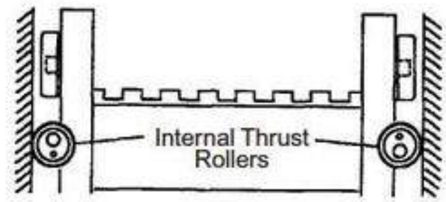
The middle rollers are difficult to access and require the following special procedures.

1. Raise the carriage until the middle rollers are at the top of the inner rails.
2. Measure roller side clearance at the top of the inner rails. Note measurement here:
   ----------------------------.
   If gap is less than 1.5 mm (0.06 in), shimming is not required.

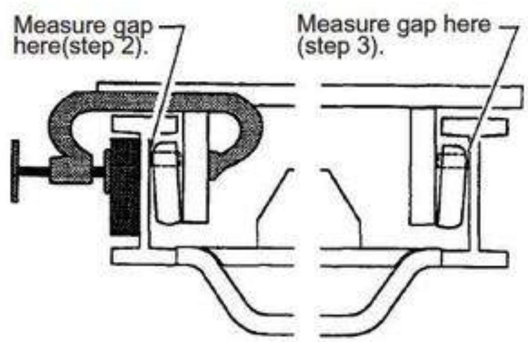
   If gap is more than 1.5 mm (0.06 in), check clearance at narrowest span by comparison with the top of the rail set as follows:
   a. With spanner tool, measure span of inner rail set at top of the front web area. Note measurement here:
   b. With spanner tool, measure span of inner rail set at narrowest span of front web area. Note measurement here:------------------------------.
   c. Subtract measurement in step b from mcasurcment in step a, Write result here:
   b-a=---.
   d. If the calculated gap is less than or equal to the gap measured in step 2, the roller set does not require shimming. Otherwise, the roller set should be shimmed.

Top Carriage Rollers and Internal Thrust Rollers

The internal thrust rollers are nearly perpendicular to the top carriage lift rollers and contact the same flange area as the carriage rollers. The top carriage lift rollers and the internal thrust rollers should be checked together.



1. Move the top carriage lift roller to the narrowest span on the inner rails set.
2. Clamp rail to one side as in general procedures. Check clearance of lift roller on *clamped* side. Locate the clamp between the thrust roller and the bottom roller of the carriage



The internal thrust roller should contact the web and cause the lift roller to stand off from the web by 0.0l to 1 mm (0.001-0.03 in). If the gap is outside this range, the internal thrust roller must be adjusted as explained later in this Section under "Internal Thrust Roller Adjustment."

3. Check clearance on lift roller opposite clamped side as in the general procedures. If clearance is greater than 1.25 mm (0.05 in), the roller set should be shimmed.
4. Move clamp to opposite side and check clearance on clamped side as in step 2 directly above. Gap should be 0.01-1.0 mm (0.001-0.03 in).
5. Move the top carriage lift roller to the widest span on the inner rail set and check clearance as in general procedures.

Upright Rollers

1. Remove the carriage as described in Section 7 of this Group.
2. Fully extend the upright making sure carriage hoses and chains are secured out of the way to prevent damage.

WARNING

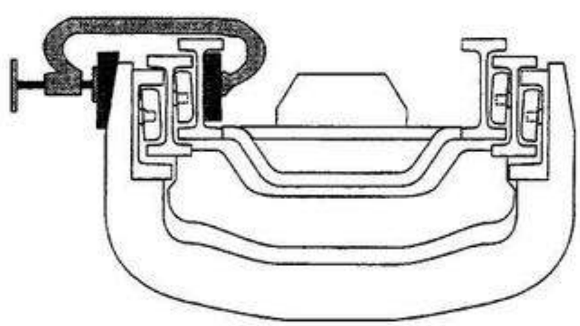
An upright or carriage can move unexpectedly:

- **Do not walk or stand under raised forks.**
- **Keep clear of load and carriage when making any check or adjustment.**
- **Keep your arms and fingers away from moving parts of the upright.**
- **Do not reach through open areas of the upright. Never attempt to move or align the rails by hand.**
- **Use an approved safety platform to reach the upper areas of the upright. Never use the upright as a ladder.**

Failure to follow these warnings can result in serious injury.

3. Follow the "General Roller Side Clearance Checking Procedure" given earlier in this Section.

The clamping procedure is as illustrated below.



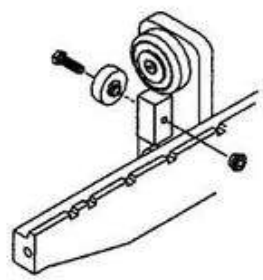
Internal Thrust Roller Adjustment

The internal thrust rollers should be adjusted to extend 0-0.75 mm (0.03 in) into the top carriage roller side clearance. Carriage roller side clearance should be within tolerances before you adjust the thrust rollers.

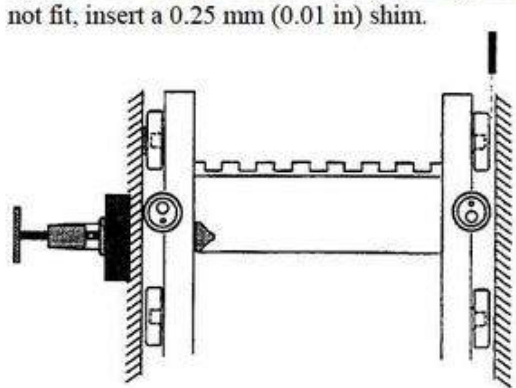
NOTE

Carriage must be replaced on upright before adjusting internal thrust rollers. See Section 8 for carriage replacement procedures.

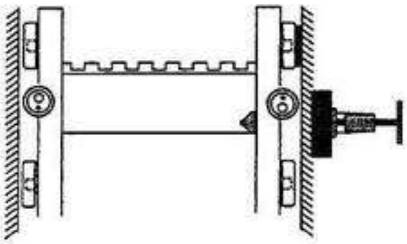
1. Lift the carriage to the top of the inner rail.
2. Loosen the jam nut on the back of the thrust roller capscrew and then loosen the capscrew. Rotate the bearing to pivot toward the carriage and away from the rail.



3. Lower the carriage to a convenient height to do the adjustment.
4. Clamp the carriage between the top and middle carriage roller.
   - Use a shim block under the clamp on the outside of the channel rail.
   - Torque on the clamp should not exceed 2.5 N·m (20 ft-lb).
5. Insert a 0.5 mm (0.02 in) temporary shim between the top carriage roller and the rail web on the side opposite the clamp. If a 0.5 mm (0.02 in) shim will not fit, insert a 0.25 mm (0.01 in) shim.



6. Move the clamp to the shimmed side and clamp the rollers against the shim and the rail web by positioning the clamp between the top and middle carriage rollers.



7. Cam the thrust roller on the shimmed side against the rail clockwise and tighten the capscrews firmly.

NOTE

Make sure the roller does not rotate with the capscrew when tightening.

8. Insert a 0.5 mm (0.02 in) shim in the opposite roller. If a 0.5 mm (0.02 in) shim will not fit, insert a 0.25 mm (0.01 in) shim.
9. Loosen the clamp and remove the shim.
10. Reposition the clamp on the opposite side and draw the roller against the shim and rail web.
11. Cam the thrust roller on this shimmed side toward the rail clockwise and tighten the capscrews firmly.

NOTE

Make sure the roller does not rotate with the capscrew when tightening.

12. Loosen the clamp and remove the shim.
13. Use a crow's foot to torque the capscrews 70-80 N·m (51.5-59.2 ft-lb).

NOTE

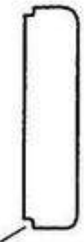
If a crow's foot is not available, the carriage can be raised to the top of the inner rail and a socket used to tighten to the correct torque.

14. Position the carriage to access the jam nut on the back side of the capscrew and torque to 70-80 N·m (51.5- 59.2 ft-lb).

Oversize Rollers

At the time of roller shimming, you may want to replace the lift rollers with oversize rollers to counter rail flange wear as detected by inspection and the load test. Because there is only one size of oversize rollers, you can install them only if they were not installed previously.

dentify oversize rollers as follows: If a roller is oversize, it has an indented radius in the outer edge of its mounting side, as shown below.



Lift Roller Shimming

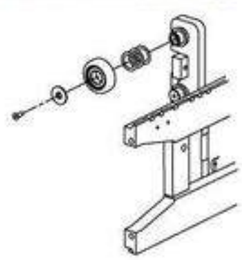
You need to shim lift rollers if the roller side clearance checks indicated that clearance was excessive at either the narrowest or widest span of the roller set's adjacent rail set.

Your objective in shimming is to add only enough shims to bring the clearances at both the widest and narrowest spans into tolerances. In practice, you achieve this by shimming to obtain the smallest possible clearance at the narrowest span of the rail set.

Carriage Roller Shimming

Using the measurement you recorded in previously in the "Roller Side Clearance Checks," determine the number of shims required to reduce the carriage roller clearance at the narrowest span on the inner rail to 0-0.75 mm (0-0.03 in):

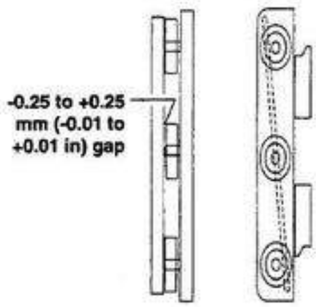
1. Remove the carriage as described in Section 8, "Fork and Carriage Removal and Replacement."
2. Remove the rollers (note the number of shims already on the roller shafts, if any).



- Clean and inspect roller bearings, shims, and shafts.
- Replace any defective parts.

3. Add shims to the top and bottom rollers as determined in the previous steps.
   - Install shims with the same number on each side.
   - When an odd number of shims is required, always place the odd shim on the same side on all roller sets.

4. Use a straight bar to determine the number of shims to add to the middle roller shaft as shown in the following illustration. This shimming may be asymmetric, meaning the numbers of shims do not have to match those of the top and bottom rollers.



5. Reinstall all bearings; torque top roller fasteners to 40-45 N·m (30-33 in-lb).

Carriage internal thrust rollers must be adjusted after the carriage is shimmed. Adjust as described previously.

Upright Roller Shimming

Use the following procedures to remove, shim, and replace rollers. Use the preceding checks to determine the number of shims required to reduce the roller clearances to 0.75mm (0.03 in) or less.

WARNING

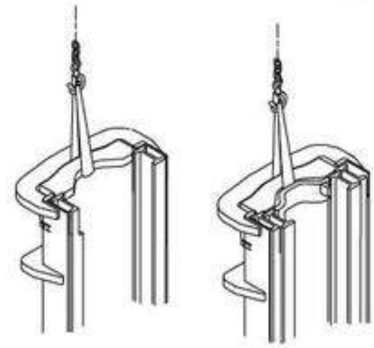
Use an approved safety platform. Never use the upright as a ladder.

CAUTION

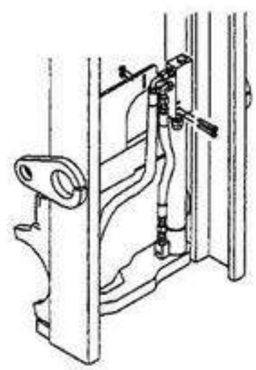
The carriage should be removed for shimming or when any service is performed on the upright. See Section 8, for removal and replacement procedures.

Upright Roller Removal

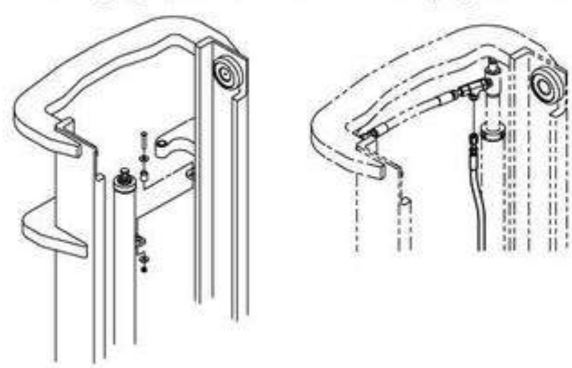
1. After the carriage has been removed, lower the upright rails until both of the secondary (final) lift cylinders are completely collapsed.
2. Jack the truck and block under the frame so that the bottom of the upright is approximately 254 mm (10 in) off the floor. See “Lifting, Jacking, and Blocking” in Group SA for safe procedures.
3. Set the parking brake and block the steer wheels.
4. Tilt the upright to as near vertical as possible.
5. Using a hoist and lifting strap of adequate capacities, connect the lifting strap to the inner rail on standard and HI-LO uprights or intermediate rails on triple-stage uprights.
Lift hoist to remove slack from the strap.



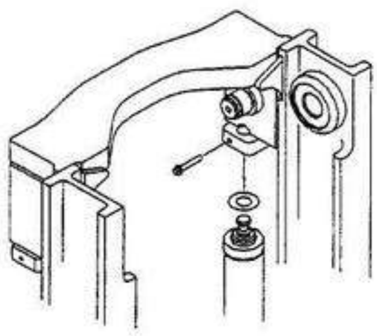
6. Disconnect the flow control valve manifold from the upright bracket.



7. Disconnect the cylinder guide bolts.
In HI-LO upright, disconnect the secondary cylinder hose.



8. Secure the cylinder to prevent its falling and disconnect the cylinder rod retaining bolts.



NOTE

For 4-hose adapters, you must disconnect the hose sheave and bracket. This is not necessary for 2-hose adapters.

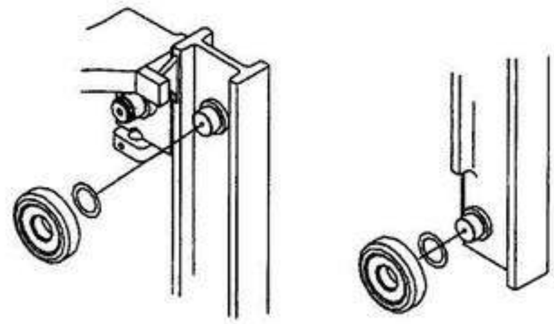
9. Move the sheave with the hoses and any other connected components out of the way.
10. Disconnect the rail cylinders by raising the rails to free the cylinder rod ends from the tie bar. Tilt the cylinders inward and secure out of the way of the tie bars.
11. Lower the assembly completely to expose the rollers.

The lower roller set of the inner rail and upper roller set of the outer rail on standard and triple-stage uprights are now exposed for shim adjustment.

Roller Removal, Shimming, and Replacement

To add shims to, or replace the rollers:

1. Use a puller to remove the rollers from the posts. Or, gently pry the rollers off the posts. Pry at different points around the bearing to work it off. Do not damage the bearing seals on the backside of the roller.
2. Inspect all roller components when removed:



   a. Clean and inspect the rollers, shims, and roller-shafts.
   b. Bearings should be in good condition and allow the roller to spin smoothly with a true rotation.
   c. Clean rail sections and add lubricant if necessary.
   d. Replace any worn or damaged component.
3. If the clearance check indicated an even number of shims needed, split the number evenly between the rollers on either side of the upright.
4. If the clearance check indicated an odd number of shims needed, keep the odd number to the same side on all rails of the upright. If three shims are needed, for example, add one to the rollers on the left side. Add the other two on the rollers on the right side.
5. Reposition the rollers onto the roller shaft and use a plastic or hard-rubber mallet to gently tap the roller. Seat the roller evenly by continuing to tap gently until it is fully seated and snug against the added shims.

Upright Reassembly

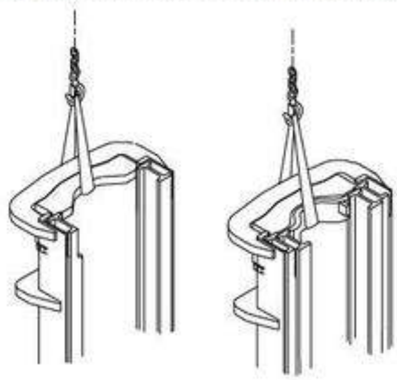
The following steps detail the procedures for reassembling the upright.

WARNING

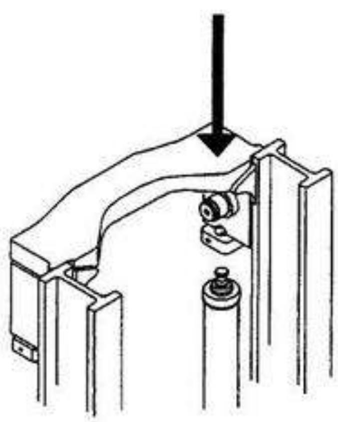
The upright can move unexpectedly:

- **Keep your arms and fingers away from**
- **Moving parts of the upright.**
- **Do not reach through open areas of the upright.**
- **Never attempt to move or align the rails by hand.**
- **Failure to follow these warnings can result in serious injury.**

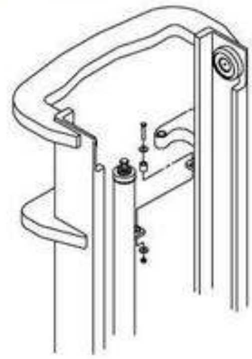
1. Connect the lifting strap to the inner rail on standard and HILO uprights or intermediate rails on triple-stage uprights and raise the rails just high enough to clear the lift cylinders. Use a prybar to guide the rails and allow the rollers to reenter the rail channel.



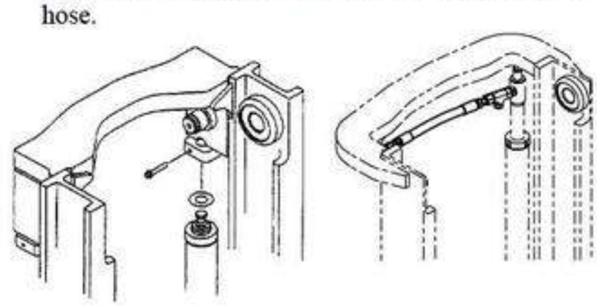
2. Reposition the rail cylinders and slowly and carefully lower the rails to seat the rod end into the mounting.



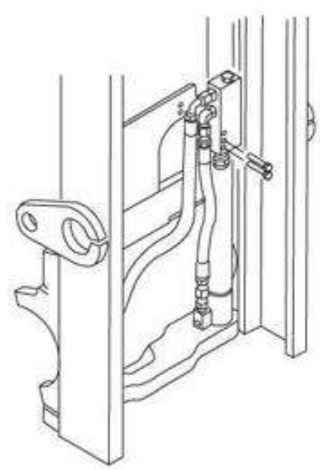
3. Reconnect the cylinder guide bolts. Do not tighten until inner and/or intermediate rails are in the fully lowered position. Torque guide bolts nuts to 20-25 N·m (14.8-18.5 ft-lb).



4. Reconnect the cylinder rod retaining bolts. Torque rod retaining bolts to 20-25 N·m (14.8-18.5 ft-lb).
In HI-LO upright, Reconnect the secondary cylinder hose.



5. Replace the 4-hose sheave and bracket assembly onto the upright. Torque nuts to 20-25 N·m (14.8-18.5 ft-lb).
6. Reconnect the load lowering flow valve to the upright bracket. Torque nuts to 20-25 N·m (14.8-18.5 ft-lb).



7. Jack up the truck only enough to remove the blocking and slowly lower the truck so that its full weight is on the floor.
8. Replace the carriage and forks.
9. Test the upright lift and tilt functions; make sure all upright components work correctly and smoothly. Check for overshimming as described in the next subsection. Repeat the load test to make sure the upright works correctly under load. When you are sure all components are operating correctly, perform the chain adjustment checks in Section 3 before returning the truck to service.

Overshimming

Use these steps to check for overshimming:

1. With the forks removed, lift the upright to maximum fork height.
2. Slowly lower the upright.
   - The carriage should not bind or hang up at any point along the rails.
   - If the carriage binds or hangs up, and the rails are not clogged with grease or debris, the carriage requires reshimming. See "Troubleshooting" for other misstaging problems.

Section 5

Cylinder Removal, Shimming, Overhaul, and Replacement

Cylinder Types

Standard uprights use two lift cylinders. HI-LO and Triple stage uprights use three cylinders, a primary (center-mounted) cylinder, and two secondary cylinders. All primary cylinders used on HI-LO and triple-stage uprights (TSUs) are piston cylinders.

The secondary cylinders used on HI-LO uprights are ram cylinders.

The types of cylinders used on the truck are listed below. Check the first five characters of the upright number stamped on the upright of the truck to determine the type of cylinder, piston or ram, used on the upright.

IMPORTANT

Before removing any component for overhaul, make sure the correct repair parts, seals, and gasket sets are available.

Upright Type	Upright Number	Cylinder Type
Standar	V2312/17(ECX20-30)	Piston-Type Lift Cylinder
	V2318/22(EPX20-30)	Piston-Type Lift Cylinder
	V2314/19(ECX32)	Piston-Type Lift Cylinder
	V2321(EPX32)	Piston-Type Lift Cylinder
TSU	M2312/17(ECX20-30)	Piston-Type Secondary Cylinder
	M2318/22(EPX20-30)	Piston-Type Secondary Cylinder
	M2314/19(ECX32)	Piston-Type Secondary Cylinder
	M2321(EPX32)	Piston-Type Secondary Cylinder
HI-LO	H2316(EPX)	Ram-Type Secondary Cylinder
	H2312(ECX)	Ram-Type Secondary Cylinder

WARNING

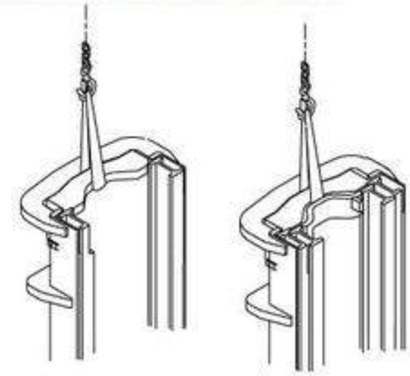
To remove, or partially remove, the cylinders from the upright for shimming or overhaul, start with the truck in a safe position:

- **Turn key switch to OFF and remove key**
- **Parking brake applied**
- **Directional lever in neutral**
- **Forks lowered completely**
- **Wheels blocked.**

Lift Cylinder Shimming Procedure

To shim the lift cylinders to correct unequal cylinder stroke:

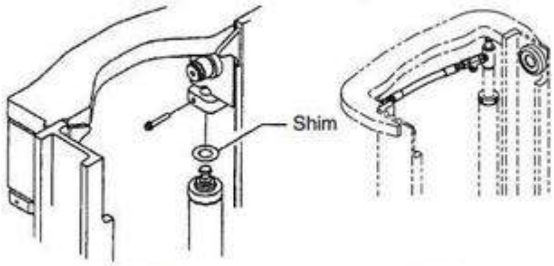
1. Fully lower upright until both lift cylinders are collapsed.
2. Attach a hoisting strap to the tie bar of the inner rail or intermediate rail tie bar of TSUs.



CAUTION

Make sure hoisting equipment is of ad-equate capacity and in good working order.

3. Remove the cylinder rod retaining bolt.
   In HI-LO upright, Remove the cylinder hose.



STD & TSU HI-LO

4. Slowly lift the inner (or intermediate) rails off the top of the cylinder to expose the cylinder rod top.

CAUTION

Block rail in up position.

5. Insert shim(s) over rod end of cylinder with the shorter stroke to compensate for unequal stroke length.
6. Slowly lower the inner or intermediate rail back onto the rod ends.

WARNING

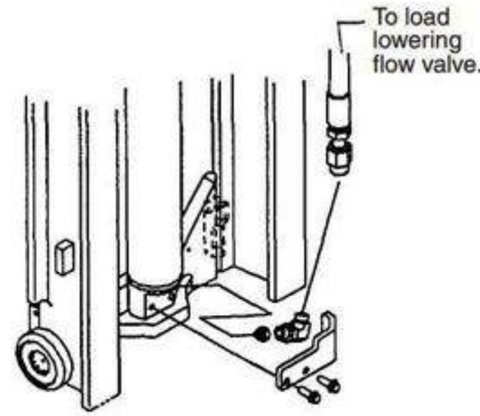
Do not try to maneuver the cylinder or rails with your hands. Use a prybar.

7. Replace cylinder rod retaining bolt to secure rod end into inner or intermediate rail mounting hole. Torque the cylinder rod retaining bolts to 20-25 N·m (14.8-18.5 ft-lb).
8. Repeat the racking test and adjustment until no racking is evident during upright lift extension.
9. Check all upright functions before returning the truck to service.

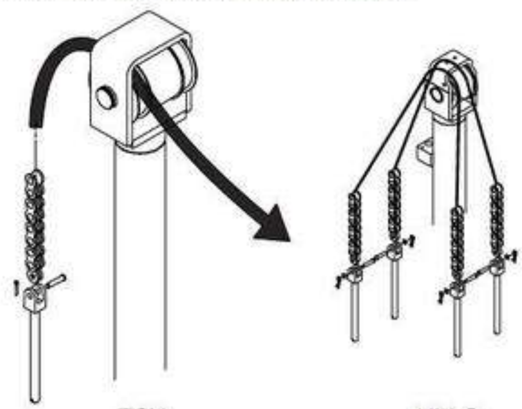
Primary Cylinder Removal and Replacement (HI-LO & TSU)

Remove the primary cylinder for replacement only. Cylinder can be overhauled without removing it from the upright. See "Cylinder Overhaul" for procedures.

1. Make sure the cylinder is completely collapsed and pressure is released.
2. Disconnect and cap the hydraulic line at the base of the cylinder.

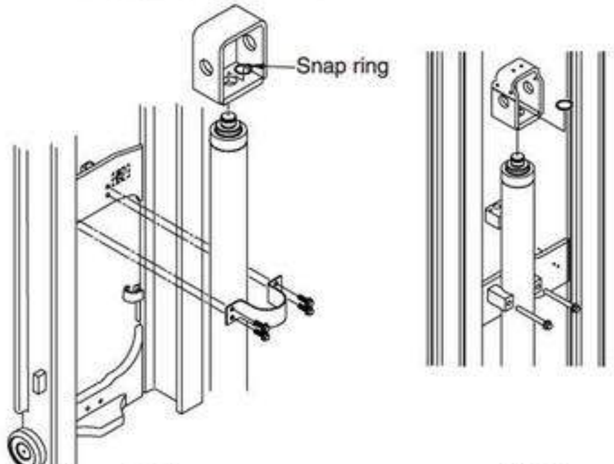


3. Remove and discard cotter pins from chain anchor bolt pins on the cylinder.
4. Remove the pins, draw the chain through the sheave, and drape the chain over the carriage.



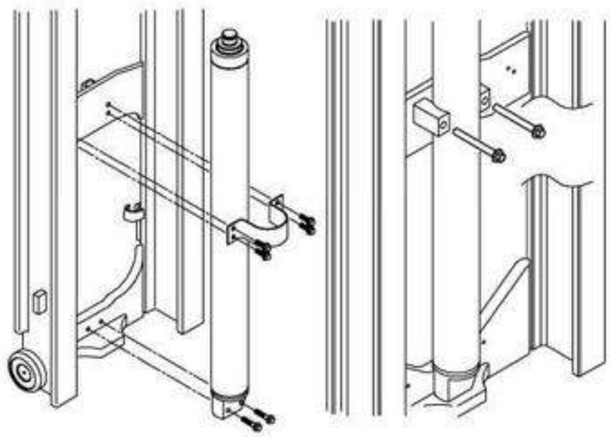
TSU HI-LO

5. Remove the snap ring holding the chain sheave (and hose bracket, if equipped) on the rod end and move assembly off top of rod.



TSU HI-LO

6. Disconnect cylinder mounting collar bolts and lift cylinder off mounting base.



Use these steps in reverse to replace the cylinder. Check Group 40 for hydraulic fitting tightening procedures. If complete cylinder was removed, torque hydraulic line bracket to 40-45 N·m (30-33 ft-lb); torque cylinder mounting collar bolt nuts to 70-80 N·m (52-59 ft-lb).

Lift and Secondary Cylinder Removal and Replacement

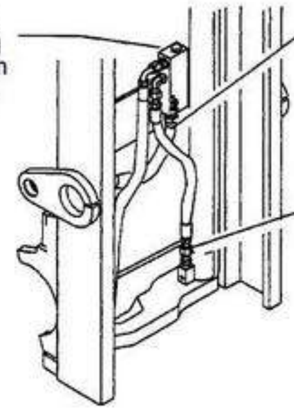
Only piston-type lift and secondary cylinders must be removed from the upright for overhaul. Ram-type cylinders do not need to be removed for overhaul; the cylinder gland and rod can be removed for overhaul while leaving the cylinder tube mounted on the truck. Use these procedures if any piston- or ram-type lift or secondary cylinder must be completely replaced.

1. Make sure the cylinders are completely collapsed and pressure is released.
2. Tilt the upright to as near vertical as possible.
3. Using a hoist and lifting strap of adequate capacities, lift the carriage to access the hydraulic lines at the base of the cylinders.

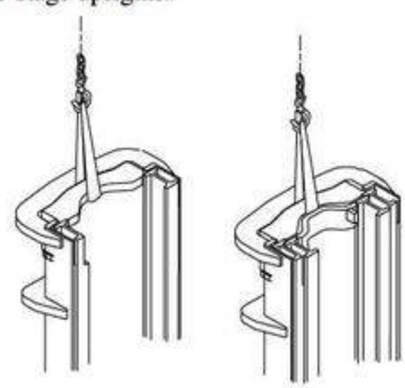
CAUTION

Make sure hoisting equipment is of adequate capacity and in good working order.

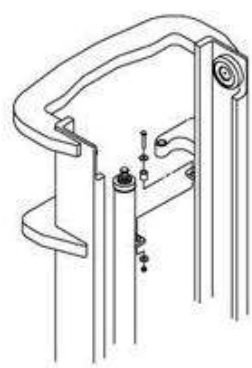
4. Disconnect and cap the hydraulic line from the base of each cylinder. Remove the mounting bolts from the manifold block.



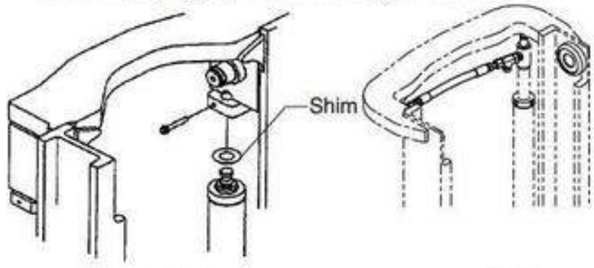
5. Lower the carriage
6. Using a hoist and lifting strap of adequate capacities, connect the lifting strap to the inner rail on standard & HI-LO uprights and inner and intermediate rails on triple-stage uprights.



7. Disconnect the cylinder guide bolts.



8. Disconnect the cylinder rod retaining bolts.
   In HI-LO upright, Remove the cylinder hoses.



TSU HI-LO

9. Remove the cylinders by raising the inner rail (and intermediate rail on the triple stage upright) to free the cylinder rod ends from the tie bar.
10. Remove any shims and note number and location.
11. Lift the cylinders off the base mount.

Use these steps in reverse to replace the cylinders. Torque the cylinder rod retaining bolts to 20-25 N·m (14.8-18.5 ft-lb). Torque the cylinder guide bolt nuts to 30-35 N·m (22.2-25.6 f&lb). Check Group 40 for hydraulic fitting tightening procedures.

Cylinder Overhaul

Use these steps to overhaul the primary and lift and secondary (TSU) cylinders.

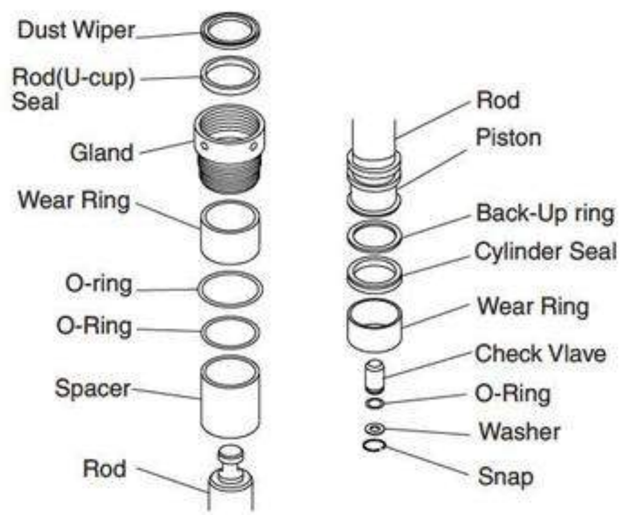
NOTE

During overhaul, set rod or cylinder on a work bench with adequate support for safe and convenient disassembly. Two sets of 4x4 in (100x100 mm) "V"-notched blocks are helpful; one set for the cylinder barrel and one set for the piston rod. The blocks prevent nicks and scratches from harming the piston or rod.

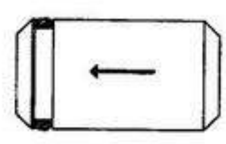
Cylinder Disassembly

- To overhaul the primary cylinder, it is not necessary to remove the cylinder from the upright. Instead, free the rod end of the cylinder as explained in "Cylinder Removal."
- To overhaul piston-type cylinders, you should remove the cylinders from the upright as explained in "Cylinder Removal." The cylinders have seals on the piston, and the rods must be removed for seal replacement.
- The ram-type lift cylinders are sealed on the rod only. The only serviceable seals are inside the gland. It is not necessary to remove these cylinders from the upright for overhaul. Instead, free the rod end of the cylinder as explained in "Cylinder Removal.

1. Clean the rod-end and gland thoroughly to prevent contamination from falling into the cylinder during disassembly.
2. With a blunt punch or chisel, bend the lock ring out of the locking grooves of the gland.
3. Use a spanner wrench to remove the gland. Reuse the lock ring if undamaged.
4. Carefully lift the rod out of the cylinder and place in a clean area.
5. Inspect the tube and tube end for damage and cover the cylinder tube end to prevent contamination.
6. Remove all rings and seals from the piston and the gland.



7. For piston-type cylinders:
   a. Remove the check valve from the piston for inspection and cleaning by removing the snap ring from the pislon bore.



Check Valve. Arrow shows direction offlow

   b. Use a blunt hook to pop tie check valve out.

IMPORTANT

Use extreme care that you do not make nicks and burrs on the interior surface area of the cap or cylinder or the piston.

Parts Inspection and Service

1. Clean all parts completely in a suitable solvent. Dry all parts with a soft clean cloth.
2. Inspect cylinder barrel and bore for cracks, pining, scoring, or other irregularities that may require replacement of the barrel.
3. Inspect the piston and rod for nicks, scratches, scoring, or other defects that may demand new parts.
4. Check all gland and piston seal grooves for nicks, burrs, and scratches that can damage seals during reinstallation.
5. Inspect and clean the check valves.
6. Inspect all seals, including the check valve O-ring.

NOTE

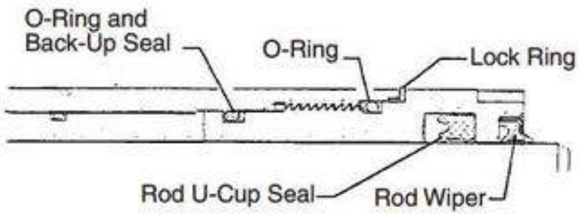
Minute imperfections inside the cylinder barrel or on the piston or rod may be improved for acceptable use by careful honing. However, removal of material that produces a notch, groove, or out-of-roundness may cause excessive leakage during operation and a shortened life.

7. Use new parts as necessary. Always use the Packing-Kit listed in the parts manual. New kits include all the seals, wiper rings, wear rings and O-rings necessary for the particular cylinder

Cylinder Reassembly

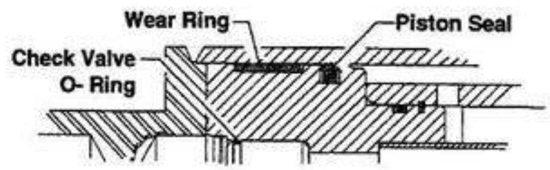
Take care when installing these parts to make sure that no parts are damaged.

1. Coat all packing, seals and rings in clean, hydraulic oil (Clark part number 1800236 qt., 1802155 gal.) prior to reassembly. Coat the inside of the gland nut bore with hydraulic oil.
2. Replace the U-cup seal (groove toward bottom of cylinder), rod wiper, and O-ring and back-up seals on the gland.



O-rings should be carefully installed to eliminate cuts or twisting.

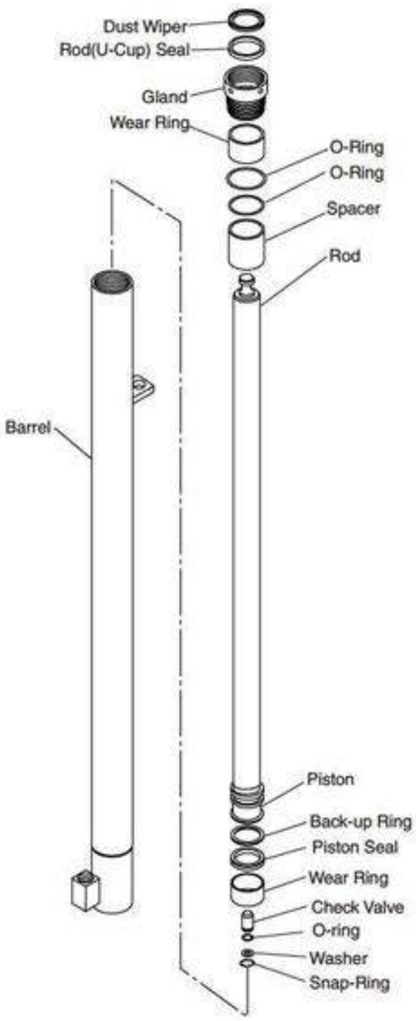
3. Replace the piston seals:
   a. Primary cylinder pistons require a piston seal and wear ring. Install the piston seal from the top of the rod. Use a ring compressor to compress the piston seal. This prevents damage to the seal during reassembly.



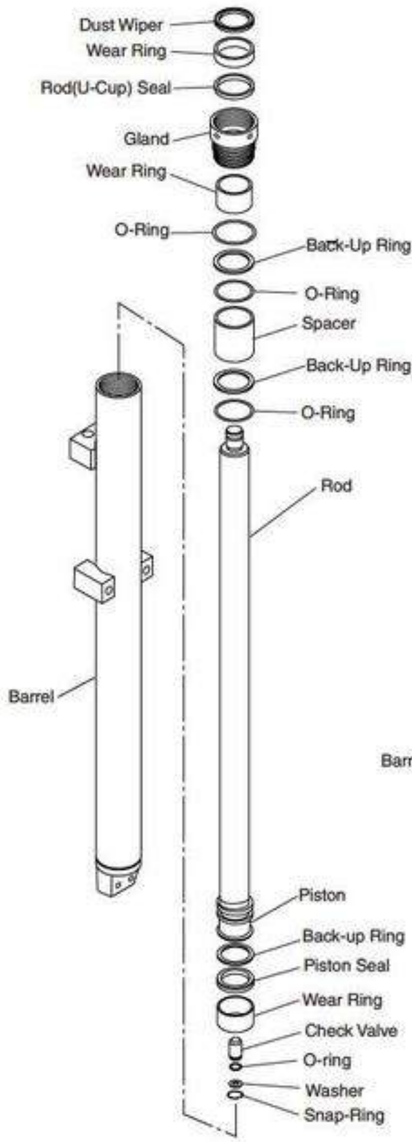
   b. Piston-type lift and secondary cylinder require a cylinder seal, a back-up ring, and a wear ring on the piston. Install the cylinder seal from the top of the rod.

   c. Ram-type, lift (secondary) cylinder pistons require no seals.
4. For protection against corrosion, lubricate spacers (where used) with petroleum-based hydraulic fluid. Slide the spacer onto the rod.
5. Insert the piston and rod into the cylinder. Be careful not to scratch or damage the cylinder gland nut threads.
6. For primary cylinders, add 3.4 oz(100ml) of hydraulic oil into the cylinder on the rod side of the piston.
7. Install the lock ring onto the gland. Lubricate cylinder threads and screw gland onto cylinder. Be careful not to damage gland seal. Make sure the gland is fully seated on the cylinder barrel. Deform the lock-ring into slots in the tube and the gland.
8. Check the assembly by making sure the piston slides freely in and out of the cylinder.
9. Tighten the gland nut:
   - On primary cylinders, tighten the gland nut to 588 N·m (434 ft-lb).
   - On lift and secondary cylinders, tighten the gland nut to 392 N·m (289 ft-lb).

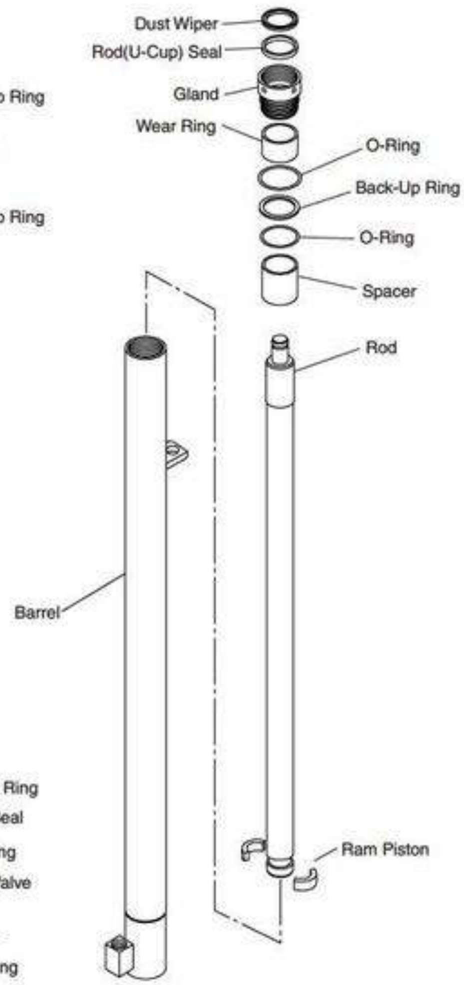
This competes the cylinder repair procedure. Replace the cylinders as described in "Cylinder Removal and Replacement." Complete the chain length adjustment in Section 3 for correct carriage and rail position. When all adjustments are completed, return the truck to service.



Typical Piston-Type Standard Upright Lift, TSU Secondary Cylinder



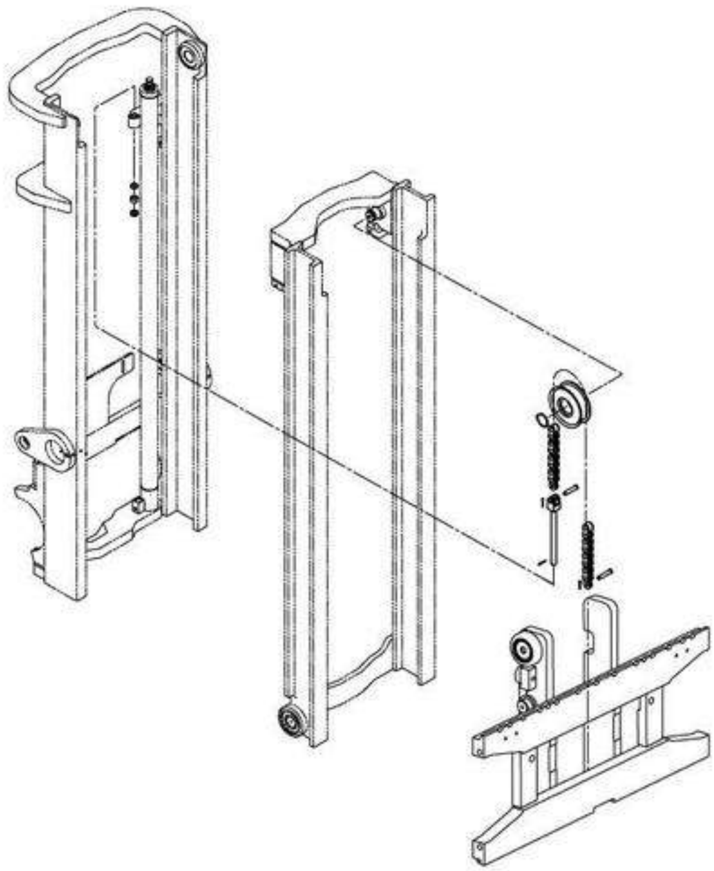
Hi-LO and Triple-Stage Upright Primary Cylinder



Hi-LO Upright Secondary Cylinder

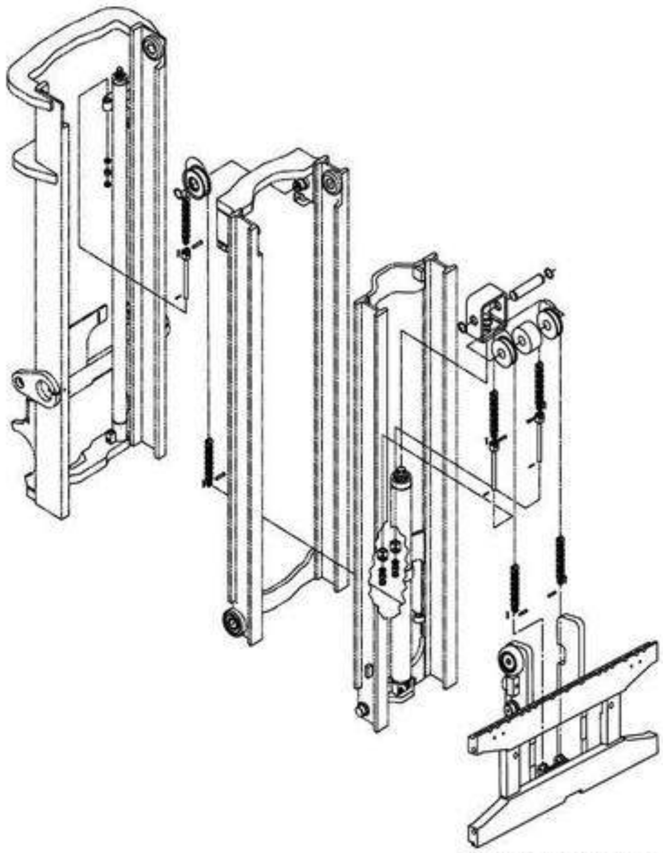
Section 6

Upright Chain Inspection, Adjustment, and Replacement

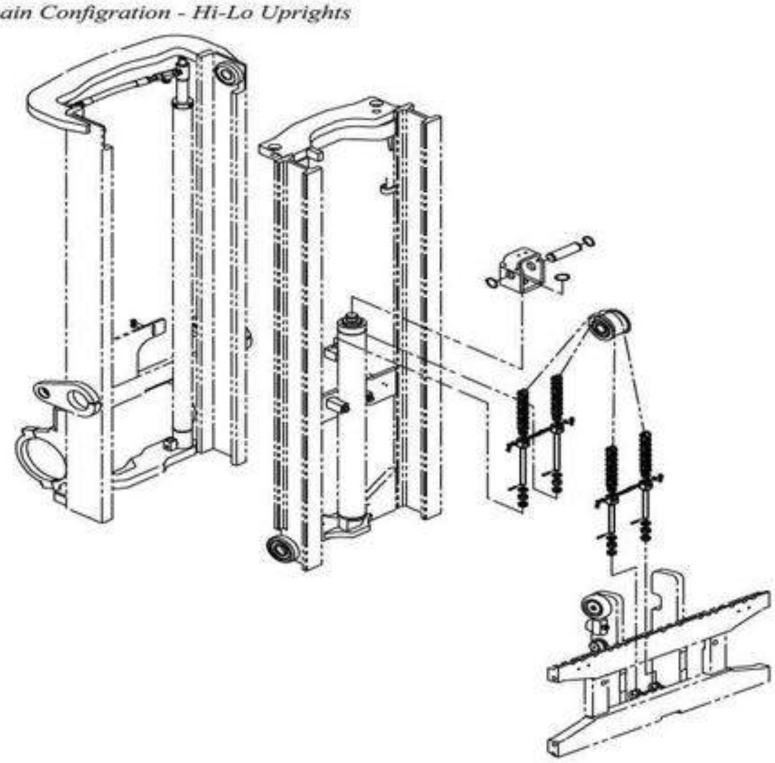


Chain Configuration - Standard Uprights

Chain Configurafions - Triple Stage Uprights



Chain Configration - Hi-Lo Uprights

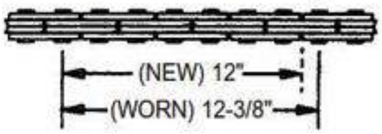


Periodic Inspections

Each 50-250 hours of operation (more frequently in severe or extreme environments), chains should be inspected and lubricated. Inspection should focus on the following:

Elongation

When a length of 12.00 inches (305 mm) of new chain has elongated to a length of 12.360 inches (315 mm), it should be discarded and replaced. It is important to measure the chain in the section that moves over the sheaves because it receives the most frequent articulation. Measuring the chain near its clevis terminals could give an erroneous reading as it would not have flexed as frequently, if indeed at all, as nearer the middle of the assembly.



Chains should be replaced when wear exceeds 3% or when 12 inches (305 mm) of chain is stretched 3/8 inch (10 mm).

Edge Wear

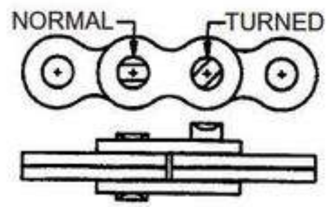
Check the chain for wear on the link plate edges caused by running back and forth over the sheave. The maximum reduction of material should not exceed 5%. This can be compared to a normal link plate height by measuring a portion of chain that does not run over the sheave. Distorted or battered plates on leaf chain can cause tight joints and prevent flexing.

Worn contours and worn surfaces on the outside links or pin heads should not exceed 5% of new link height.

Turning or Protruding Pins

Highly loaded chain operating with inadequate lubrication can generate abnormal frictional forces between pin and link plates. In extreme instances, the torque could surpass the press fit force between the pins and the outside plates, resulting in pin rotation. When chain is allowed to operate in this condition, a pin, or series of pins, can begin to twist out of a chain resulting in failure. The pin head rivets should be examined to determine if the "VEE" flats are still in correct alignment. Chain with rotated/displaced heads or abnormal pin protrusion should be replaced immediately.

Do not attempt to repair the chain by welding or driving the pin(s) back into the chain. Once the press fit integrity between outside plates and pins has been altered, it cannot be restored. Any wear pattern on the pin heads or the sides of the link plates indicates misalignment in the system. This condition damages the chain and increases frictional loading, and should be corrected.

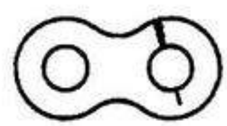


Turned pins and abnormal pin protrusion.

Cracked Plates

The chains should periodically be inspected very carefully, front and back as well as side to side, for any evidence of cracked plates. If any one crack is discovered, the chain(s) should be replaced. It is important, however, to determine the causes of the crack before installing new chain so the condition does not repeat itself.

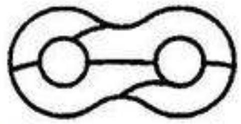
- Fatigue Cracking - Fatigue cracks are a result of repeated cyclic loading beyond the chain's endurance limit. The magnitude of the load and frequency of its occurrence are factors which determine when fatigue failure will occur. The loading can be continuous or intermittent (impulse load).



Fatigue cracks generally run from the pin hole toward the edge of the link plate approximately 90" from the line of pull.

Fatigue cracks almost always start at the linkplatepin hole (point of highest stress) and are perpendicular to the chain pitch lint. They are often microscopic in their early stage. Unlike a pure tensile failure, there is no noticeable yielding (stretch) of the material.

- Stress-Corrosion Cracking - The outside link plates, which are heavily press fitted to the pins, are particularly susceptible to stress corrosion cracking. Like fatigue cracks, these initiate at the point of highest stress (pin hole) but tend to extend in an arc-like path between the holes in the pin plate.



Arc-like cracks in plates are a sign of stress corrosion.

More than one crack can often appear on a link plate. In addition to rusting, this condition can be caused by exposure to an acidic or caustic medium or atmosphere.

Stress corrosion is an environmentally assisted failure. Two conditions must be present: a corrosive agent and static stress. In the chain, static stress is present at the pin hole due to the press fit pin. No cyclic motion is required, and the plates can crack during idle periods.

The reactions of many chemical agents (such as battery acid fumes) with hardened steel can liberate hydrogen which attacks and weakens the steel grain structure.

For this same reason, never attempt to electroplate a leaf chain or its components. The plating process liberates hydrogen, and hydrogen embrittlement cracks will appear. These are similar in appearance to stress corrosion cracks.

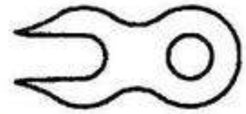
If a plated chain is required, consult Clark. Plated chains are assembled from modified, individually platcd components which may reduce the chain rating.

- Corrosion Fatigue - Corrosion fatigue cracks are very similar (in many cases identical) to normal fatigue cracks in appearance. They generally begin at the pin hole and move perpendicular (90") to the chain pitch line.

Corrosion fatigue is not the same as stress corrosion. Corrosion fatigue is the combined action of an aggressive environment and a cyclic stress (not a static stress alone, as in stress corrosion).

Ultimate Strength Failure

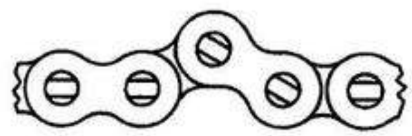
- This type of failure is caused by overloads far in excess of the design load.



Broken plate caused by overload.

Tight Joints

All joints in leaf chain should flex freely. Tight joints resist flexure and increase internal friction, thus increasing chain tension required to lift a given load. Increased tension accelerates wear and fatigue problems.



If lubrication does not loosen a tight joint, the chain may have corrosion and rust problems or bent pins and must be replaced.

See Section 3 for detailed chain stretch, length, and tensions checks.

Chain Length Adjustments

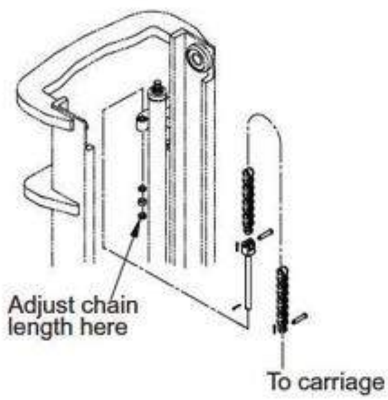
WARNING

An upright or carriage can move unexpectedly:

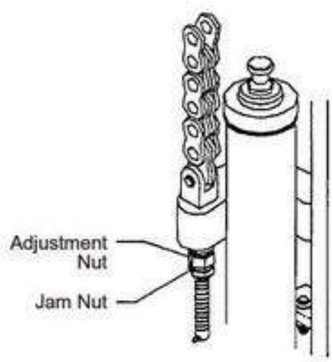
- **Do not walk or stand under raised forks**
- **Keep clear of load and carriage when making any check or adjustment**
- **Keep your arms and fingers away from moving parts of the upright.**
- **Block the carriage or upright when working with the components in a raised position.**
- **Do not reach through open areas of the upright.**
- **Never attempt to move or align the rails by hand.**
- **Failure to follow these warnings can result in serious injury.**

Standard Upright Chain Length Adjustment

To adjust chain length on the standard upright use the following illustration and procedures:



1. Fork-to-ground clearance:
   a. Set the upright to vertical position.
   b. Break the jam nuts loose on the chain anchors.



   c. Turn the chain adjustment nuts until clearance between forks and ground is 10-20 mm (0.40-0.80 in).

IMPORTANT

For all chain anchor adjustments:

- **Threaded chain anchors must be left free to pivot in mounting hole.**
- **Anchor cotter pin heads must be to the inside of the upright.**
- **Torque jam nuts toadjustment nuts to 100-200 N·m (74-148 ft-lb).**
- **Make sure chain anchors are secured so that no twist is evident in the chains.**

2. Carriage roller position:
   a. Raise carriage about 1 m (3.2 ft) and smear a bead of grease on the bottom 75 mm (3 in) inner rail in the area of the roller pattern.
   b. Tilt upright fully back and completely lower.
   c. Raise carriage about 1 m (3.2 ft) and measure the distance from where the center of the bottom carriage roller stopped to the bottom edge of the inner rail. Distance should not be less than 20 mm (0.80 in) or chain length adjustment is required.
3. Carriage stop-to-upright:
   a. Lift upright to its full height and check for clearance on the carriage safety stop.
   b. If the carriage stop hits the upright stop, adjust the chain anchor adjustment nuts out until there is at least 3 mm (0.12 in) clearance between the stops.

IMPORTANT

The carriage stop must not be allowed to contact the upright stop under any circumstance during normal operations.

If all three chain length requirements listed above cannot be met, the tire diameter may be out of the design range allowance. Also, excessive tire wear will decrease carriage stop clearance.

Oversized tires will reduce the bottom carriage roller engagemcnt on the inner rail when the carriage is in the lowered position. The fork-to-ground clearance can deviate from the 10-20 mm (0.40-0.80 in) allowance by a small amount if necessary to maintain the safe 20 mm (0.80 in) clearance of the bottom carriage roller to the lower edge of the inner rail.

Triple-Stage and Hi-LO Upright Chain Length Adjustments

Triple-stage uprights use two chain sets; one set for carriage lift and one set for rail lift. Adjustment anchors for the lift cylinder stage are located at the back of the outer rail. Adjustment anchors for the primary lift stage are behind the primary cylinder. Carriage chain anchors are not intended for adjustment.

HI-LO uprights use one chan set for carriage left.

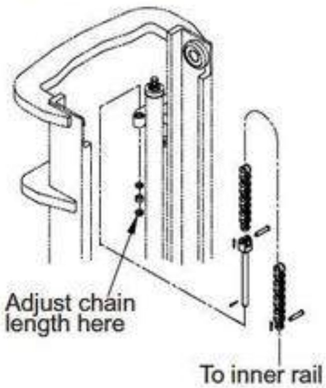
For TSU inner rail lift chains, chain length must be adjusted if the difference between the bottom of the inner rail and the outer rail is greater than 10 mm (0.40 in).

For the TSU and HI-LO primary cylinders lift chain, the chain length must bc adjusted if:

- The fork-to-ground clearance is less than 5 mm (0.20in) or more than 25 mm (1.0 in) when the upright is vertical.
- The center of the bottom carriage roller comes within 20 mm (0.80 in) of the bottom edge of the inner rail.

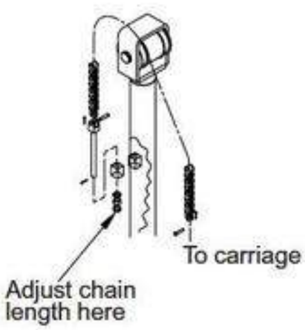
- The carriage safety stop hits the inner rail stop at full lift height.

To adjust the cylinder lift chains on a TSU use the following illustration and procedures:



1. Set the upright in the vertical position.
2. Break the jam nuts loose on the chain anchors.
3. Adjust the chain anchor adjustment nuts until the bottom of the inner rail is within 2.5 mm (0.10 in) of the bottom of the outer rail.

To adjust the primary cylinder lift chain on TSU and HI-LO use the following illustration and procedures:



1. Fork-to-ground clearance:
   a. Set the upright to vertical position.
   b. Break the jam nuts loose on the chain anchors.
   c. Turn the chain adjustment nuts until clearance between forks and ground is 10-20 mm (0.40-0.80 in).

IMPORTANT

For all chain anchor adjustments:

- **Threaded chain anchors must be left free to pivot in mounting hole.**
- **Anchor cotter pin heads must be to the inside of the upright.**
- **Torque jam nuts to adjustment nuts to 100-200 N·m (74-148 ft-lb).**
- **Make sure chain anchors are secured so that no twist is evident in the chains.**

2. Carriage roller position:
   a. Raise carriage about 1 m (3.2 ft) and smear a bead of grease on the bottom 75 mm (3 in) of the inner rail in the area of the roller pattern.
   b. Tilt upright fully back and completely lower.
   c. Raise carriage again about 1 m (3.2 ft) and measure the distance from where the center of the bottom carriage roller stopped to the bottom edge of the inner rail. Distance should not be less than 20 mm (0.80 in) or chain length adjustment is required.
3. Carriage stop-to-upright:
   a. Lift upright to its full height and check for clearance on the carriage safety stop.
   b. If the carriage stop hits the upright stop,adjust the chain anchor adjustment nuts out until there is at least 3 mm (0.12 in) clearance between the stops.

IMPORTANT

The carriage stop must not be allowed to contact the upright stop under any circumstance during normal operations.

If all three chain length requirements listed above cannot be met, the tire diameter may be out of the design range allowance. Also, excessive tire wear will decrease carriage stop clearance.

Oversized tires will reduce the bottom carriage roller engagement on the inner rail when the carriage is in the lowered position. The fork-to-ground clearance can deviate from the 10-20 mm (0.40-0.80 in) allowance by a small amount if necessary to maintain the safe 20 mm (0.80 in) clearance of the bottom carriage roller to the lower edge of the inner rail.

Chain Lubrication

Like all bearing surfaces, the precision-manufactured, hardened-steel, joint-wearing surfaces of leaf chain require a film of oil between all mating parts to prevent accelerated wear.

Maintaining a lubricant film on all chain surfaces will:

- Minimize joint wear.
- Improve corrosion resistance.
- Reduce the possibility of pin turning.
- Minimize tight joints.
- Promote smooth, quiet chain action.
- Lower chain tension by reducing internal friction in the chain system.

Laboratory wear tests show #40 oil to have greater ability to prevent wear than #10 oil. Generally, the heaviest (highest viscosity) oil that will penetrate the joint is best.

Whatever method is used, the oil must penetrate the chain joint to prevent wear. Applying oil to external surfaces will prevent rust, but oil must flow into the live bearing surfaces for maximum wear life.

To prepare the chain for oiling, the leaf chain plates should be brushed with a stiff brush or wire brush to clear the space between the plates so that oil may penetrate the live bearing area.

Oil may be applied with a narrow paint brush or directly poured on. Chain should be well flooded to be sure the oil penetrates the joint.

In locations difficult to reach, it may be necessary to use a good quality oil under pressure such as an aerosol can or pump pressure spray.

Chain Removal and Replacement

WARNING

The procedures for removing and replacing chain sets involve hoisting and blocking components.

- **Do not walk or stand under raised forks.**
- **Keep your arms and fingers away from moving parts of the upright.**
- **Do not reach through open areas of the upright.**

Failure to follow these warnings can resultin serious injury. See "Lifting, Jacking, and Blocking" for safe blocking procedures.

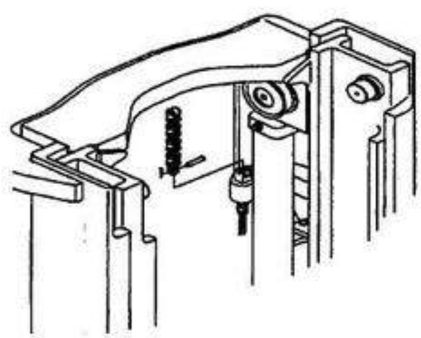
General Guidelines

- Chain Movement - Make sure that the chain operating path is clear and that the chain articulates freely through its full range of operation.
- Lubrication - Assure that the chain is well lubricated with the heaviest oil that will penetrate the void between the link plate apertures and the pins.
- Paint - Make sure the chain does not get painted over at any time.
- Protection - Where necessary, as a protection from atmosphere or sliding wear, the chain may be covered with a layer of grease. It should be noted, however, that the grease will have to be removed at a later date for chain inspection and relubrication.
- Chain Mountings - Double check to be sure all chain fastening devices are secured and all adjustments have been made to assure uniform loading of multiple chain applications. Check chain anchors and pins for wear, breakage, and misalignment. Damaged anchors and pins should be replaced.
- Sheaves - Sheaves with badly worn flanges and outside diameter should be replaced. This wear may be due to chain misalignment or frozen bearings.

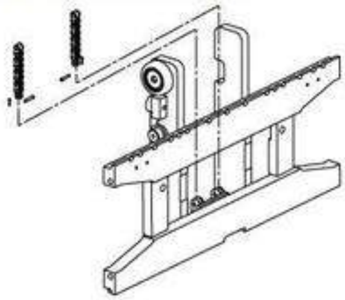
Lift Chains (Standard and TSUs)

To remove and replace the lift cylinder and/or carriage chain set on standard and triple-stage uprights (TSU):

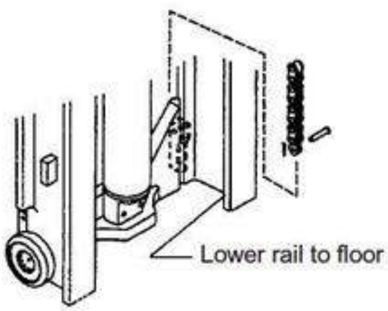
1. Attach a hoist strap on the carriage of the standard upright or inner rail of the TSU.
2. Lift the carriage or inner rail slightly to create slack in the chains. Block the carriage or inner rail up for safety.
3. Remove the chain anchor pins on the outer rail and pull the chains off of the sheaves on the inner or intermediate rails.



4. Remove the chain anchor pins from the carriage on the standard upright or the inner rail on the TSU. On the TSU, the inner rails must be lowered to the floor to access the chain anchor pins.



Lift Chain Removal from Carriage (standard upright)



Triple-Stage Upright Lift Chain Removal from Inner Rail

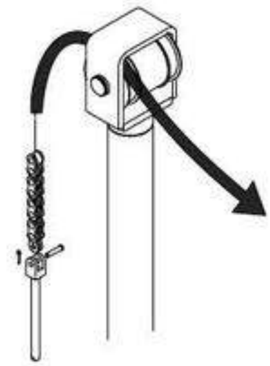
NOTE

If a hose adapter assembly is used, the chain sheaves must be loosened and removed to prevent the hoses from stretching when the inner rails of the TSU are lowered to access the chain anchor pins.

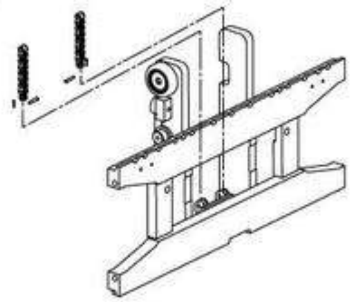
5. Use the steps in reverse order to replace the lift chain set.

Primary Cylinder/Carriage Chains (TSUs & HI-LO)

1. Tilt the upright forward, lower it, and completely collapse the primary cylinder to create slack in the chains. The carriage may also be lifted and blocked in position and the primary cylinder completely collapsed to create slack in the chains.
2. Remove the chain anchor pins from the back of the primary cylinder. Pull the chains through the chain sheave and lay over the carriage load backrest.



3. Remove the chain anchor pins from the back of the carriage.



4. Use these steps in reverse to replace the primary cylinder/carriage chain.

Perform the chain length adjustment and chain tension check before returning the truck to service.

Other Chain Service Notes

- Use lengths of factory assembled chain. Do not build lengths from individual components.
- Do not attempt to rework damaged chains by replacing only the components obviously faulty. The entire chain may be compromised and should be discarded.
- Never electroplate assembled leaf chain or its components. Plating will result in failure from hydrogen embrittlement. Plated chains are assembled from modified, individually plated components.
- Welding should not be performed on any chain or component. Welding spatter should never be allowed to come in contact with chain or components.
- Leaf chains are manufactured exclusively from heat treated steels and therefore must not be annealed. If heating a chain with a cutting torch is absolutely necessary for removal, the chain should not be reused.

Section 7

Fork and Carriage Removal and Replacement

CAUTION

SAFE PARKING. Before working on truck:

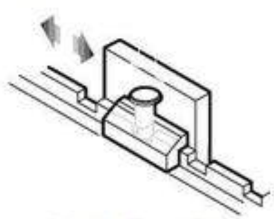
1. **Park truck on a hard, level, and solid surface, such as a concrete floor with no gaps or breaks.**
2. **Put upright in vertical position and fully lower the forks or attachment.**
3. **Put all controls in neutral. Turn key switch OFF and remove key.**
4. **Apply the parking brake and block the wheels.**

Fork Removal

NOTE

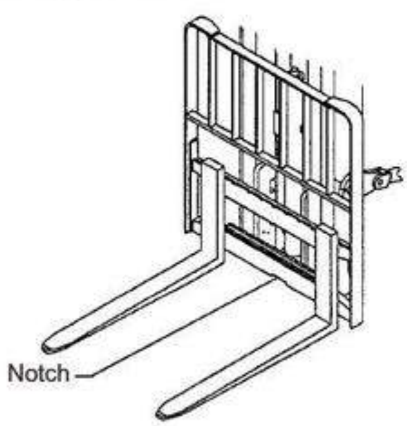
Forks do not need to be removed to remove the carriage.

1. Release the fork latches.



Latch Operation

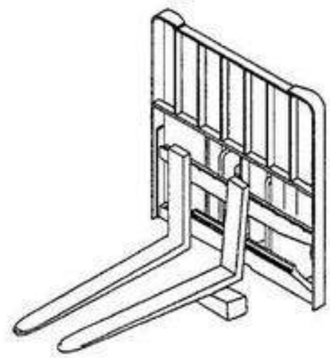
2. Move each fork to the notch on the bottom of the lower carriage cross bar.



3. Lift tip of each fork and put a 100 x 100 mm (4 x 4 in) block under the fork arm near the heel.

CAUTION

Forks weigh 50-71 kg (110-156 lbs) each. Take care when lifting.



Blocking the Fork

4. Push down on tips of the forks to disengage the fork hooks from the carriage fork bar.
5. Lift fork heel and remove block.

CAUTION

Forks are not stable sitting free in upright position. Use care when working around the forks.

6. Back the truck away from the forks.

Fork Replacement

1. Carefully drive truck up close to forks.

CAUTION

Forks are not stable sitting free in position. Use care when working the forks.

2. Drag forks into position close to carriage and to line up with the notch on the lower carriage cross bar.
3. Lift fork heel and place block under arm near the heel.

4. Lift tips of forks to engage the fork hooks on the upper carriage fork bar.
5. Remove blocks from under fork.
6. Check fork latches when repositioning forks to upper carriage fork notches.

Carriage Removal

The carriage should be removed for shimming or when any service procedure is performed on the upright.

WARNING

The procedures for checking, maintaining, and adjusting uprights, carriages, and forks involve movement of the components.

- **Do not walk or stand under raised forks.**
- **Keep clear of load and carriage when making any check or adjustment.**
- **Keep your arms and fingers away from moving parts of the upright.**
- **Do not reach through open areas of the up-right.**
- **Do not use hand to move upright or carriage.**

Failure to follow these warnings can result in serious injury.

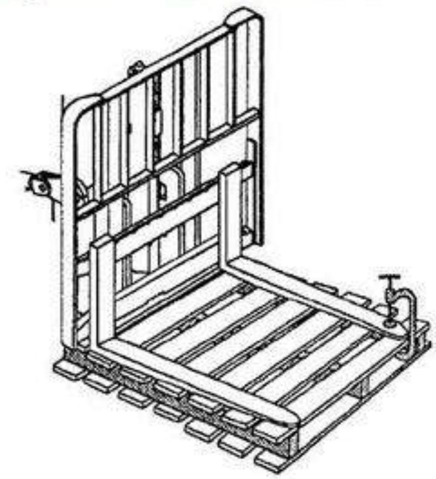
1. Set upright tilt to 0 degrees (vertical). Raise the carriage about 12 in (305 mm).
2. Place a heavy pallet under the forks. Turn the key off.
3. Lower the carriage onto the pallet and keep lowering (until the primary cylinder is all the way down on TSUs and HI-LO). Before proceeding with the next step read the following warning.

WARNING

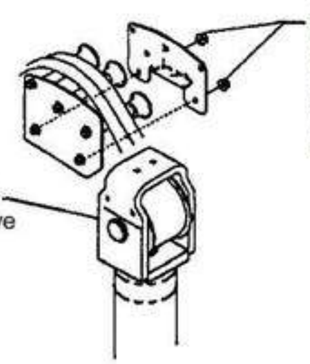
You may need to pull on the hoses/cables and chains while lowering the primary cylinder to get it all the way down. This is done to create slack in hoses/cables and chains and to displace as much oil as possible, which will reduce oil loss when disconnecting hydraulic lines for auxiliary components.

Use a helper to hold the control handle in the lowering position while you pull on the carriage chains to fully collapse the primary cylinder (on HILO & TSUs). When pulling on the chains to lower the primary cylinder (on HI-LO & TSU), the key switch must be off. Keep hand clear.

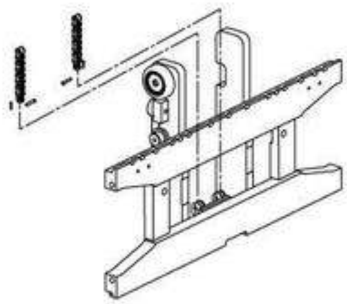
4. Once the carriage is fully lowered, clamp the front of one fork to the pallet to prevent the carriage from falling over backwards when removed.



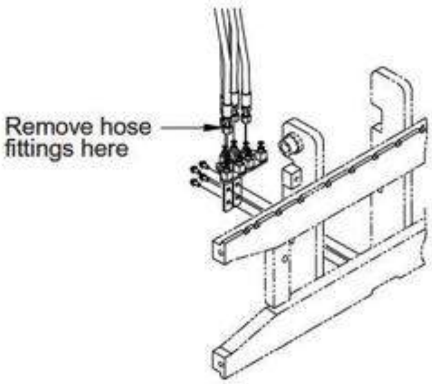
5. For carriage auxiliary components, the hose sheave bracket must be unbolted from the primary cylinder chain sheave bracket. Move the hose bracket off the chain bracket.



6. Disconnect the carriage chains at the base of the carriage. Pull chains back off primary cylinder sheave.

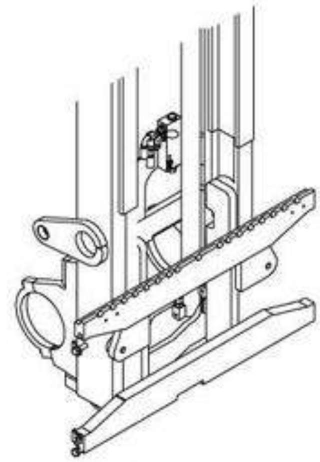


7. For carriage auxiliary components, disconnect hoses (2- or 4-hose assemblies) from carriage. Remove the bolts and strap fixture also.



- Cap all lines to prevent leaks.
- Label all lines and fittings for correct reassembly.

8. Elevate the primary cylinder to its maximum height. Be sure all hoses and loose parts are secured out of the way to prevent damage.
9. Continue elevating the upright until the inner rail clears the carriage.

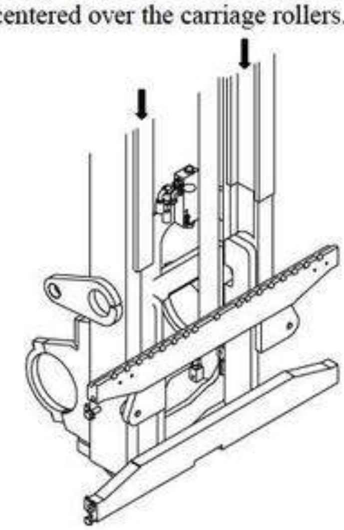


10. Remove steer wheel blocks. Release the parking-brake and slowly back the truck away from the carriage.
11. Lower the upright rails until both of the secondary cylinders are completely collapsed.

Carriage Replacement

To replace the carriage:

1. First check to be sure the carriage is securely clamped to the pallet.
2. Move the truck up to the carriage assembly with the inner rail centered on the carriage.
3. Raise the upright until the inner rail is high enough to clear the upper carriage rollers.
4. Tilt the upright until it is at the same angle as the carriage assembly.
5. Now slowly move the truck forward until the inner rail is centered over the carriage rollers.



WARNING

Never attempt to move or align the carriage or bearings by hand. Use a pry bar.

6. Lower the upright until the inner rail clears all of the carriage rollers.

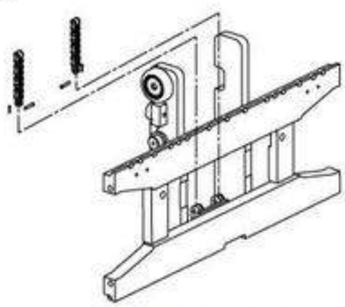
NOTE

If the rail or bearings bind, raise the upright, back away from the carriage and check to be sure the carriage rollers are installed properly.

7. When the inner rail has cleared the carriage rollers, continue to lower the upright until the lift cylinders are lowered completely.

8. Reset the truck in a safe position:
   - Ignition off
   - Parking brake applied
   - Directional lever in neutral
   - Forks completely lowered
   - Block steer wheels.

9. Reinstall the carriage lift chains to the base of the carriage.

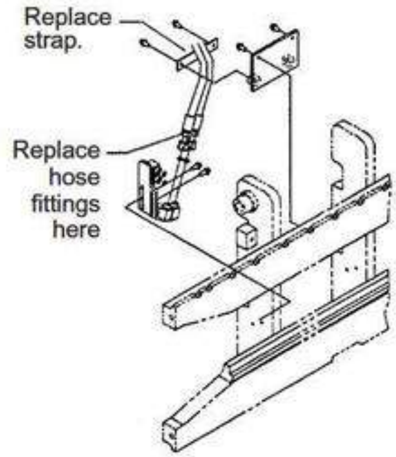


   - Set anchor bolts so that no twist develops in the chains.
   - Anchor pin heads must be pointing to the inside of the upright.
   - Use new cotter pins.

IMPORTANT

Always use new anchor pins when replacing chain sets.

10. Reconnect the hoses and mounting strap to the carriage auxiliary component if the carriage is so equipped.



   - Lubricate all O-rings with a light coating of system hydraulic fluid or a compatible oil.
   - Use two wrenches to tighten hose fittings to prevent hoses from twisting.
   - See Group 40 for hydraulic fitting tightening procedures.

11. Adjust carriage height according to Section 6 and chain tension according to Section 3.

12. Remove the “C” clamp from the pallet and check the operation of the carriage and the upright. Carefully check for oil leaks. Make sure the carriage and upright work smoothly and correctly before returning the truck to service.

Section 8

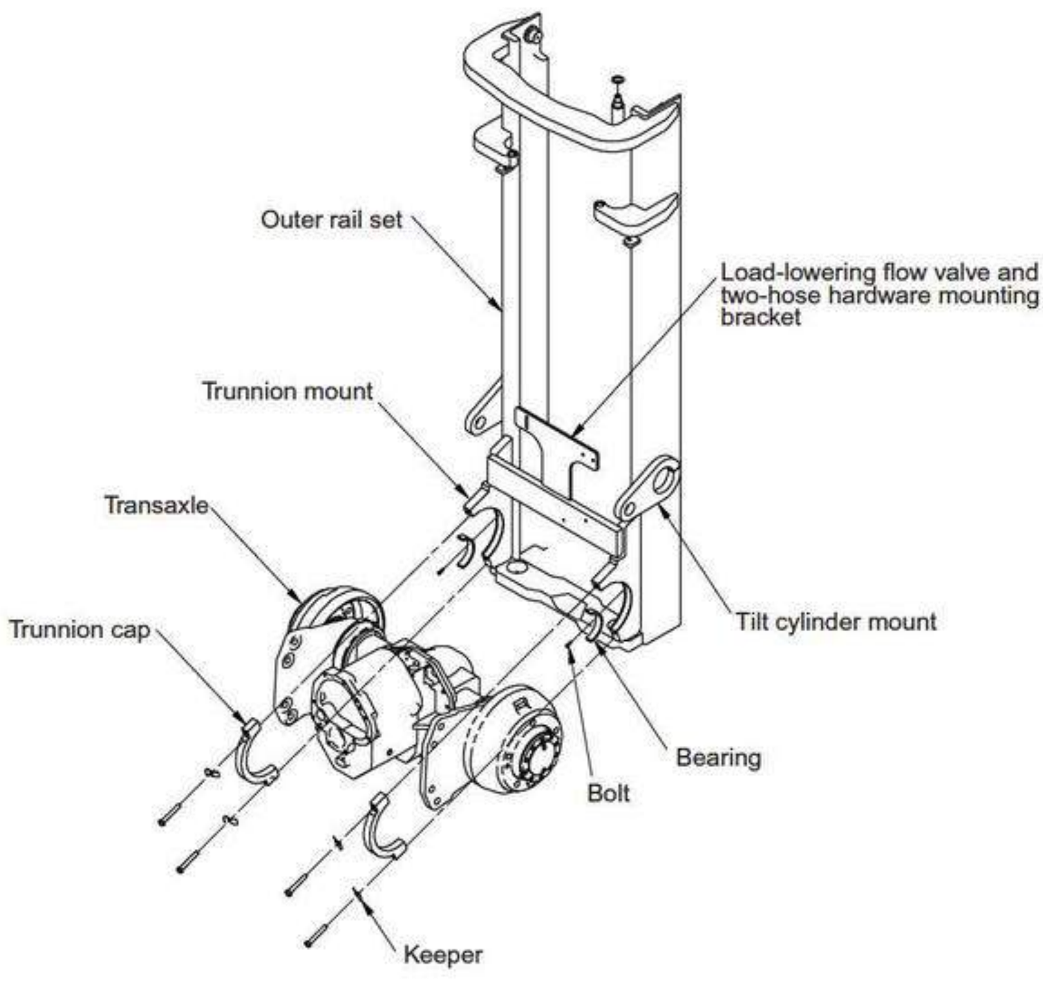
Upright Removal and Replacement

This Section describes how to remove the entire upright assembly from the truck. The carriage and forks must be removed from the upright assembly before the upright is removed. (For uprights with an auxiliary component, a side-shifter for example, the two hydraulic hoses powering the auxiliary component must be removed before the carriage is removed.) See Section 7, "Fork and Carriage Removal and Replacement," for procedures to remove the carriage and fork assembly from the upright.

⚠ **CAUTION**

SAFE PARKING. Before working on truck:

1. **Park truck on a hard, level, and solid surface, such as a concrete floor with no gaps or breaks.**
2. **Put upright in vertical position and fully lower the forks or attachment.**
3. **Put all controls in neutral. Turn key switch OFF and remove key.**
4. **Apply the parking brake and block the wheels.**



Typical Upright Installation

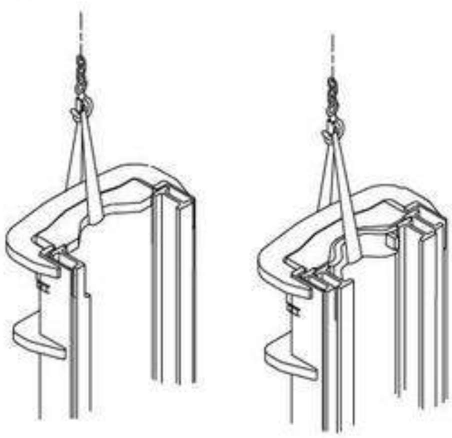
Upright Removal

The following procedures are for uprights with carriage and forks, or auxiliary components removed. See Section 7, "Fork and Carriage Removal and Replacement," for instructions on removing the forks and carriage.

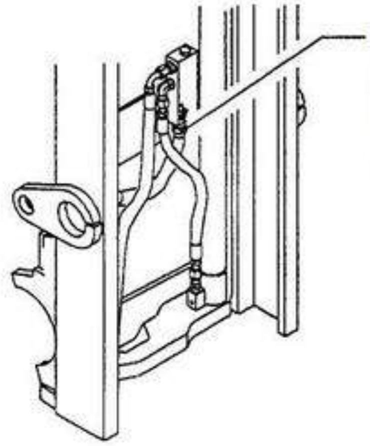
WARNING

The upright assembly is heavy. Use only hoists with enough capacity to lift the entire assembly. Keep clear of the assembly as it is being hoisted and set down. Keep hands and feet away from the assembly.

1. Attach a hoist and strap of adequate capacity to the upright as shown below. Tension the hoist so that the upright cannot fall when upright mounting pins and tilt cylinder pins are removed.

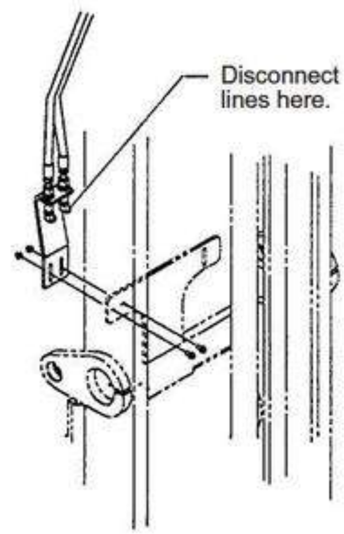


2. Disconnect and cap hydraulic line at the load-lowering flow valve. Secure the hose out of the way of the upright.

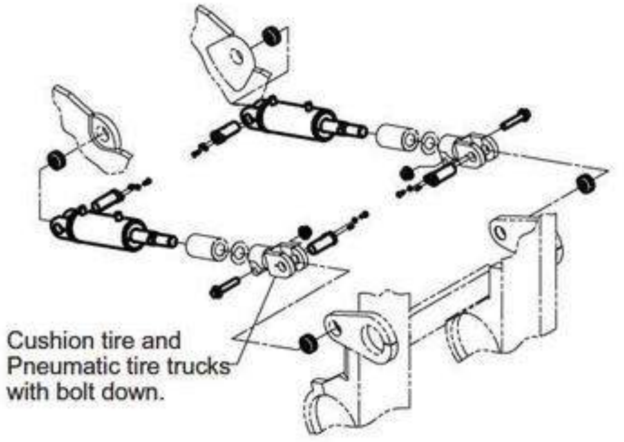


NOTE

For two-hose adapter assemblies, the hydraulic lines to the upright must also be disconnected and capped.



3. Remove tilt cylinder rod-end lock plates and rod-end pins from upright.

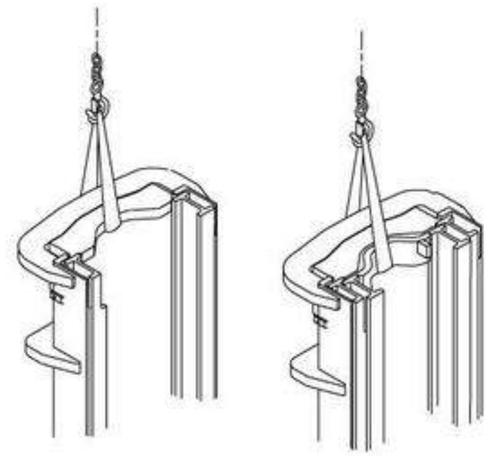


4. Remove trunnion ring bolts and lift upright off frame. See illustration on page 1.

5. Slowly set upright down on the floor, 100 x 100 mm (4 x 4 in) blocking, or sturdy pallets set end-to-end.

Upright Replacement

1. Use an overhead chain hoist of adequate capacity and an approved lift chain to lift upright into position

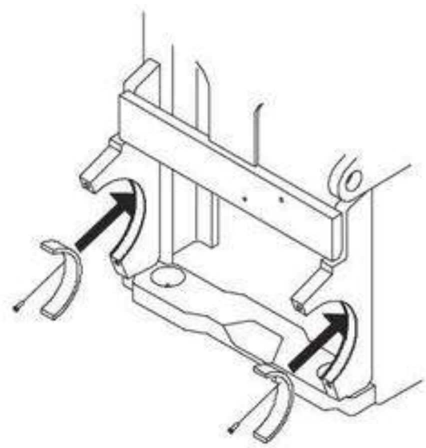


WARNING

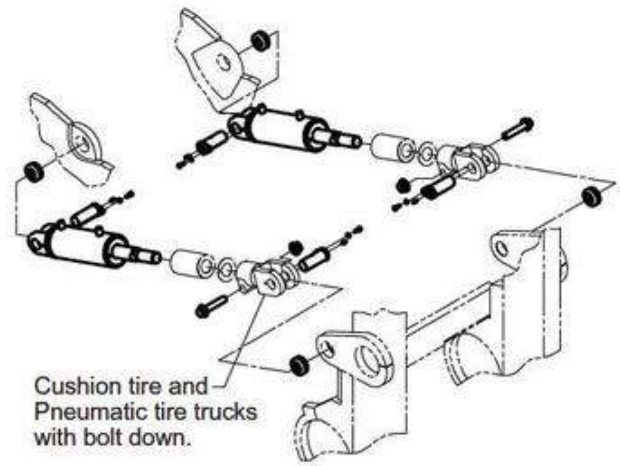
Keep hands clear of assembly

2.

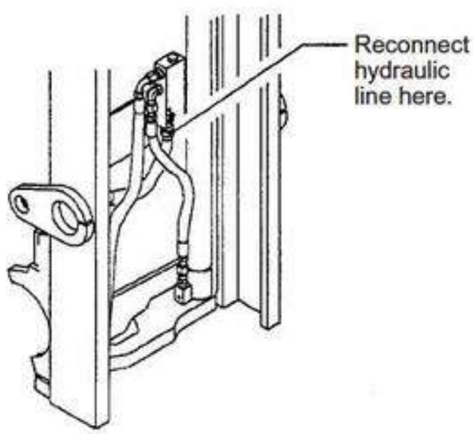
Install trunnion ring mounting bolts and use Loctite 271 (Clark part number 1802302).
Torque to55 ft-lb (74.25N·m).



3. Install rod end pins, lock plates, and fasteners. Tighten lock plate fasteners to a torque of 121-136 in-lb (19.3-21.5 N·m).



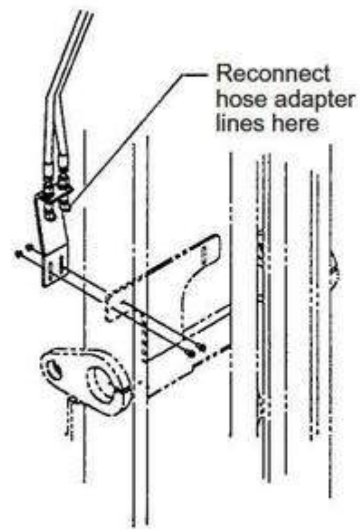
4. Attach hydraulic lines to the upright flow control valve:



- Lubricate all O-rings with a light coating of system hydraulic fluid or a compatible oil.
- Use two wrenches to tighten hose fittings to prevent twisting lines.
- See Group 40 for hydraulic fitting tightening procedures.

NOTE

Reconnect two-hose adapter assembly hydraulic lines to the upright-mounted bracket.



5. Remove the lift chain between the upright and hoist.
6. Completely check all upright and hydraulic components under load before returning the truck to service.
7. See Section 8, "Fork and Carriage Removal and Replacement," for steps to replace the carriage and fork assembly.

GROUP 38

COUNTERWEIGHT AND CHASSIS

NOTE :

Section 1

Counterweight Specifications and Description

Specifications

Fastener Torques

Counterweight Mounting Bolts: 340-380 N.m (251-280 lb-ft)

Description

The counterweight is a solid, cast-iron piece mounted to the back of the lift truck. It is used to counterbalance the loads placed on the upright at the front of the truck. The weight must be great enough to counteract forward tipping when lifting or stopping with a capacity load. The battery provides much of the counterweight on an electric truck.

WARNING

The minimum battery weight for your truck is stamped on the nameplate. Never operate the truck with a battery that weighs less.

Large, hardened steel bolts hold the counterweight to the frame.

Different counterweights are used based on truck capacity and battery compartment length.

Counterweight weights(ECX):

	Short wheel base 30.5BC	Long wheel base 34.5BC
530 kg (1170 lbs)	ECX20	ECX20
670 kg (1480 lbs)	-	ECX25
1010 kg (2230 lbs)	ECX25	ECX30
1230 kg (2710 lbs)	ECX30	ECX32, ECX30x

Counterweight weights(EPX):

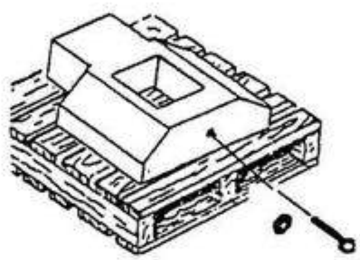
	Short wheel base (31.5 BC)	Long wheel base (39.6 BC)
500 kg (1100 lbs)	EPX20	-
920 kg (2030 lbs)	EPX25	-
900 kg (1980 lbs)	-	EPX30
1130 kg (2490 lbs)	-	EPX32

General Maintenance

WARNING

The counterweight is extremely heavy. Do not remove the counterweight unless you have training and are familiar with the correct procedures. Counterweights can fall if not handled correctly and can cause severe injury or death. Keep your hands, feet, and body clear of the counterweight at all times. Hoisting equipment must be capable of handling the weight of the counterweight when removing or replacing. Make sure your lifting equipment is of adequate capacity to handle the weight.

The counterweight must be maintained in good condition and securely attached to the lift truck. Because of its heavy weight and bulky mass, the counterweight must be carefully supported and handled. When removed from the truck, store at floor level as shown below to be sure it will not fall or tip, causing damage or injury.



Generic Illustration

Section 2

Counterweight Removal and Installation

Counterweight Removal

⚠ CAUTION

SAFE PARKING. Before working on truck:

1. **Park truck on a hard, level and solid surface, such as a concrete floor with no gaps or breaks.**
2. **Put upright in vertical position and fully lower the forks or attachment.**
3. **Put all controls in neutral. Turn key switch OFF and remove key.**
4. **Apply the park brake and block the wheels.**

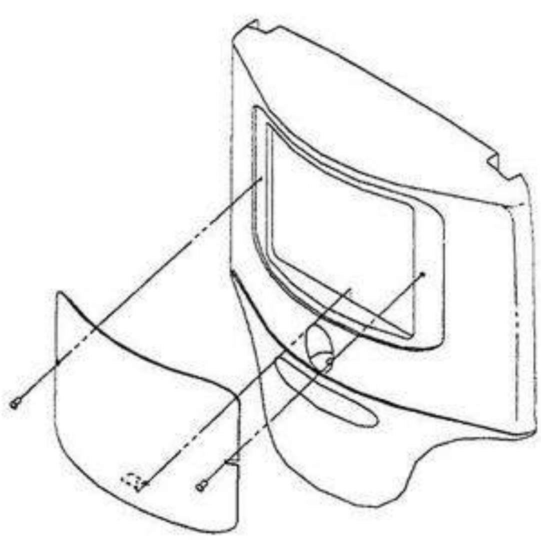
WARNING

Observe proper, safe lifting practices when lifting counterweight on or off truck.

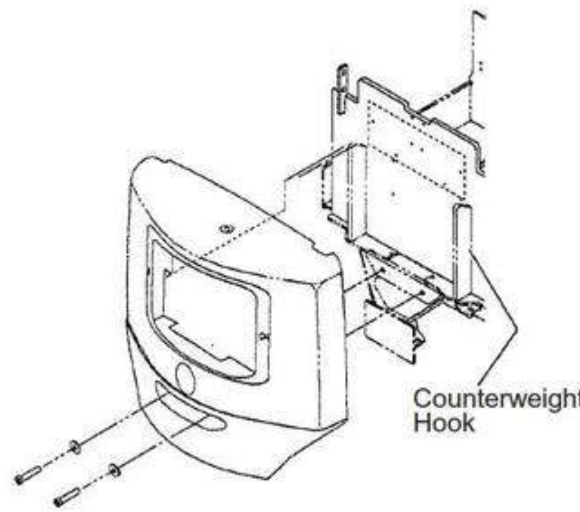
Counterweight should only be lifted by appropriately-sized eye bolt installed through the top lifting hole.

Use only overhead lifting equipment having a safe lifting capacity in excess of that of the counterweight.

1. Remove the Electronic Controls cover.



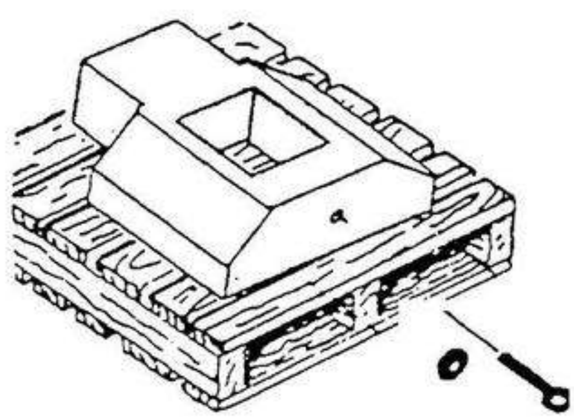
2. Install eye bolt into the counterweight. Eyebolt must be able to lift up to 1193 kg (2630 Ibs) depending on the truck model.
3. Using an overhead hoist with sufficient lifting capacity, attach hoist chain to eye bolt. Slowly lift hoist until slack is removed from chain.
4. Remove the counterweight mounting bolts.



WARNING

Stand clear of the counterweight as it is being hoisted, moved, or mounted.

5. Slowly lift the counterweight from the truck frame until it is free from the counterweight hooks on the frame and can be moved back to clear the elelronic controls. Take care not to damage the controls.
6. Slowly lower the counterweight onto a sturdy pallet. Set the counterwcighl on its flat side if possible.



Generic Illustration

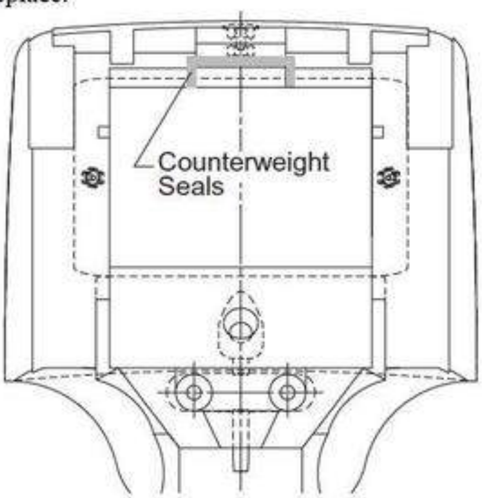
Counterweight Installation

WARNING

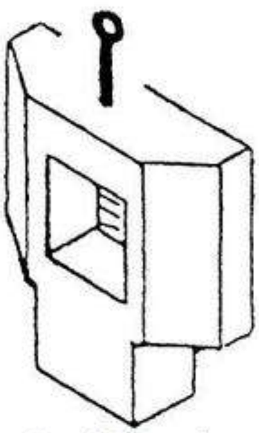
Stand clear of the counterweight as it is being hoisted, moved, or mounted.

During mounting, always use prybars for location adjustments. Do not place any part of your body between the counterweight and truck.

1. Check the counterweight seals. If worn or damaged, replace.



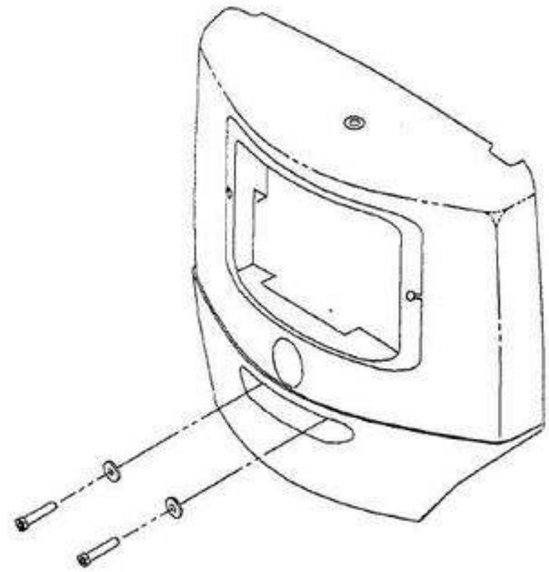
2. Slowly raise the counterweight to the rear of the truck, just high enough to clear the counterweight hooks on the frame. Take care not to damage the electronic controls. Slowly lower the counterweight onto the frame hooks.



Generic Illustration

3. Maker sure thar the bolt holes in the counterweight align properly with the mating holes in the frame.

4. Inspect the counterweight mounting bolts to make sure they are in good condition before installing. Use only Clark replacement parts. Torque the mounting bolts to 340-380 N·m (251-280 lb-ft).



5. Remove the hoist and eye bolls.

IMPORTANT

Never allow a truck to be put into service without the counterweight mounting bolts in place. Check the bolts and torque regularly.

NOTE :

Section 3

Overhead Guard Removal and Installation

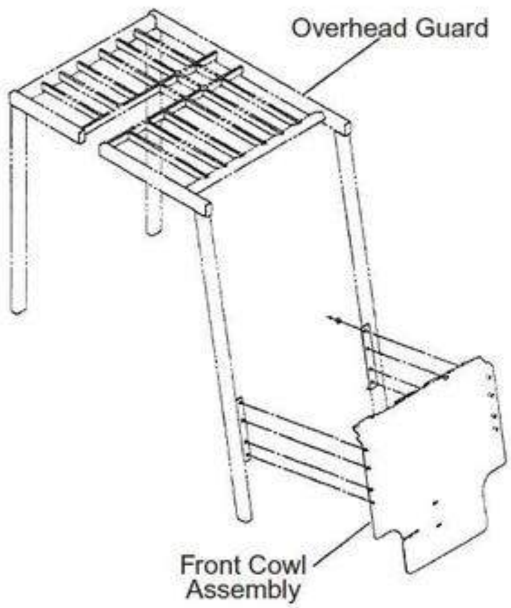
⚠ CAUTION

SAFE PARKING. Before working on truck:

1. **Park truck on a hard, level and solid surface, such as a concrete floor with no gaps or breaks.**
2. **Put upright in vertical position and fully lower the forks or attachment.**
3. **Put all controls in neutral. Turn key switch OFF and remove key.**
4. **Apply the park brake and block the wheels.**

Overhead Guard Removal

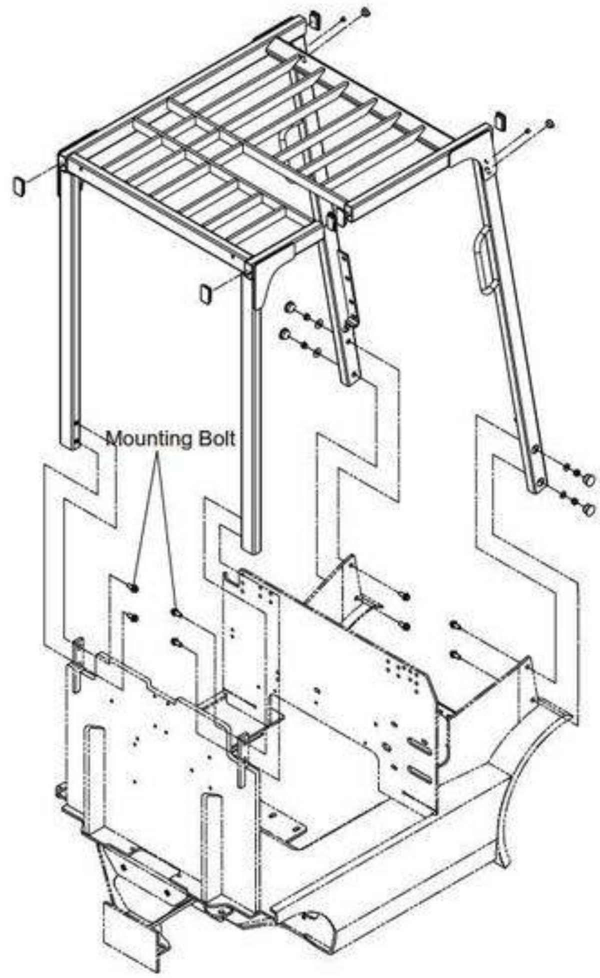
1. It is not anticipated that it should be necessary to remove the overhead guard from the truck in thc coursc of normal service or repair. The instrument panel/cowl assemblies are supported by the overhead guard.



2. If the overhear guard must be removed from the truck to be repaired or replaced because of damage it would be necessary to support the Cowl Assembly with an overhead lifting device before removing fasteners holding the Front Cowl Assembly to the overhead guard.
3. Remove the battery.
4. Remove the overhead guard mounting bolts.
5. Lift overhead guard from the truck

Overhead Guard Installation

1. Put overhead guard in place on the truck chassis.
2. Install the eight overhead guard mounting bolts. Tighten to 88-95 N·m (65-70 lb-ft).



⚠ WARNING

Overhead guard must be in place to protect operator from falling objects.

Section 4

Floor Plate, Seat and Seat Deck Removal and Installation

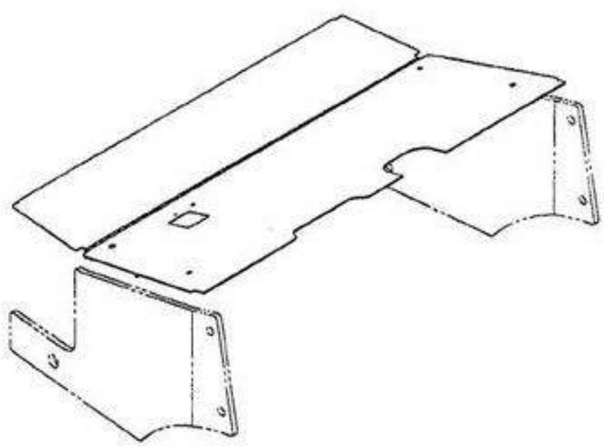
CAUTION

SAFE PARKING. Before working on truck:

1. **Park truck on a hard, level and solid surface, such as a concrete floor with no gaps or breaks.**
2. **Put upright in vertical position and fully lower the forks or attachment.**
3. **Put all controls in neutral. Turn key switch OFF and remove key.**
4. **Apply the park brake and block the wheels.**

Floor Plate Removal and Installation

1. Tilt the steering column fully forward.
2. Fold the floor plate on its hinge and lift out the operator's compartment. Rubber mat lifts out with floor plate. Floor plate is not fastened to the truck.
3. To replace the floor plate, position the front of floor plate first, then unfold it out into position.



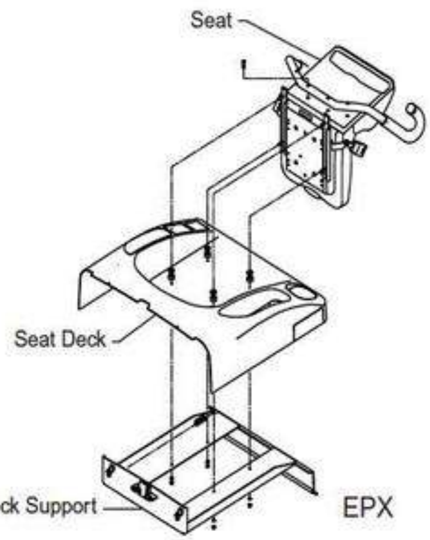
IMPORTANT

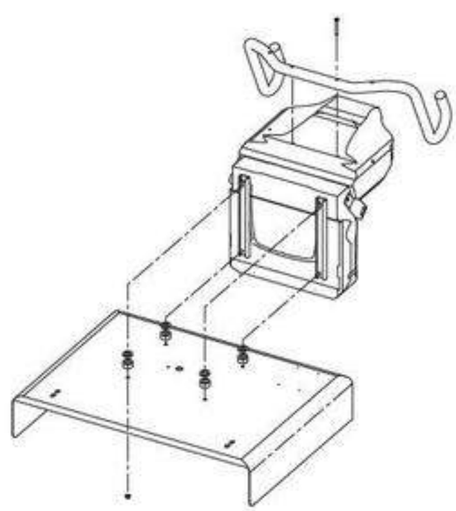
Make sure the accelerator pedal has a full stroke and does not bind.

Operator's Seat Deck and Hood Support Removal and Installation

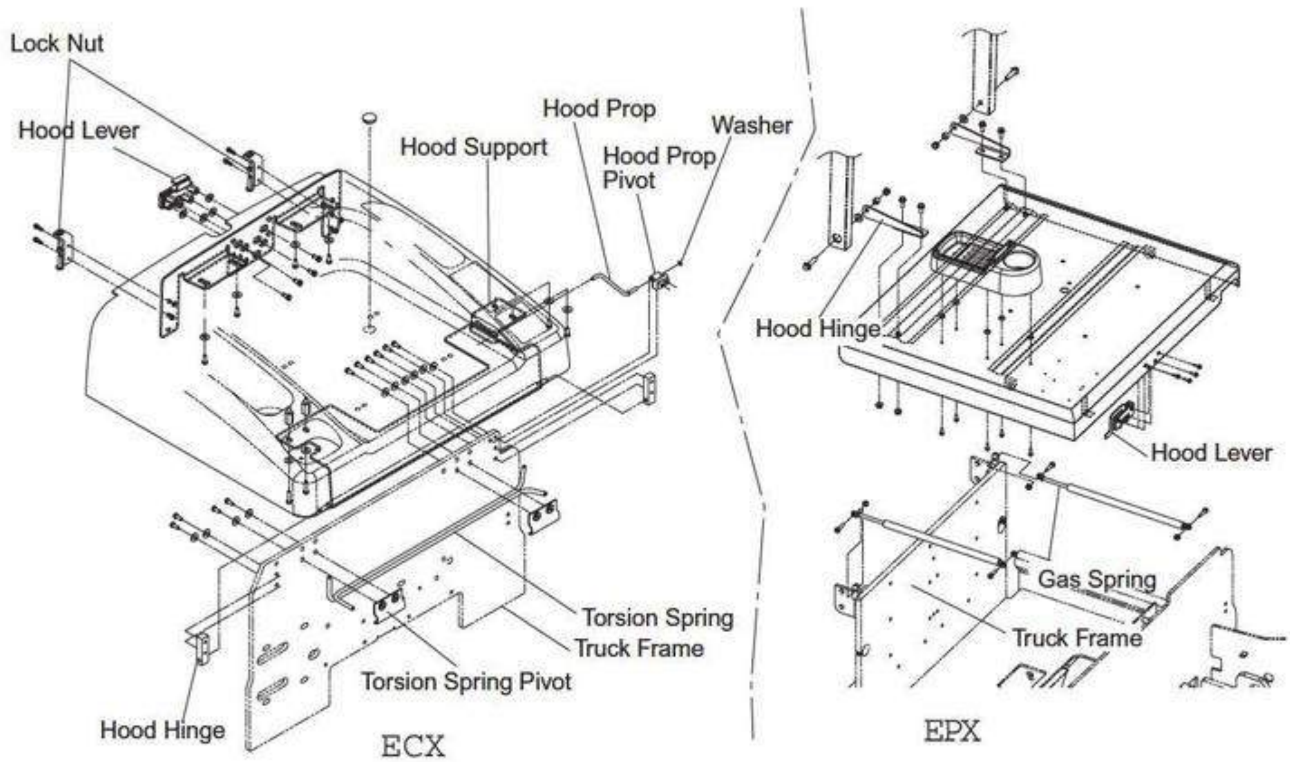
Removal

1. Raise and latch the seat deck open.
2. Remove the nuts holding the seat slide studs to the seat deck support.





3. The seat deck, which is held on the seat deck support by the scat mounting fasteners, may now also be removed



4. Remove the hood support hardward and remove the hood support.

Reinstallation.

1. Reinstall the hood support in reverse order that it was removed.

WARNING

Failure to follow this reinstallation procedure may result in operator injury. Ensure full latch engagement for battery retention.

2. Position the striker bracket and torque the mounting bolts. After torqueing, verify smooth operation of the hood and latch and verify that the latch provides full engagement to the striker bracket when the hood is fully closed

NOTE :

GROUP 40

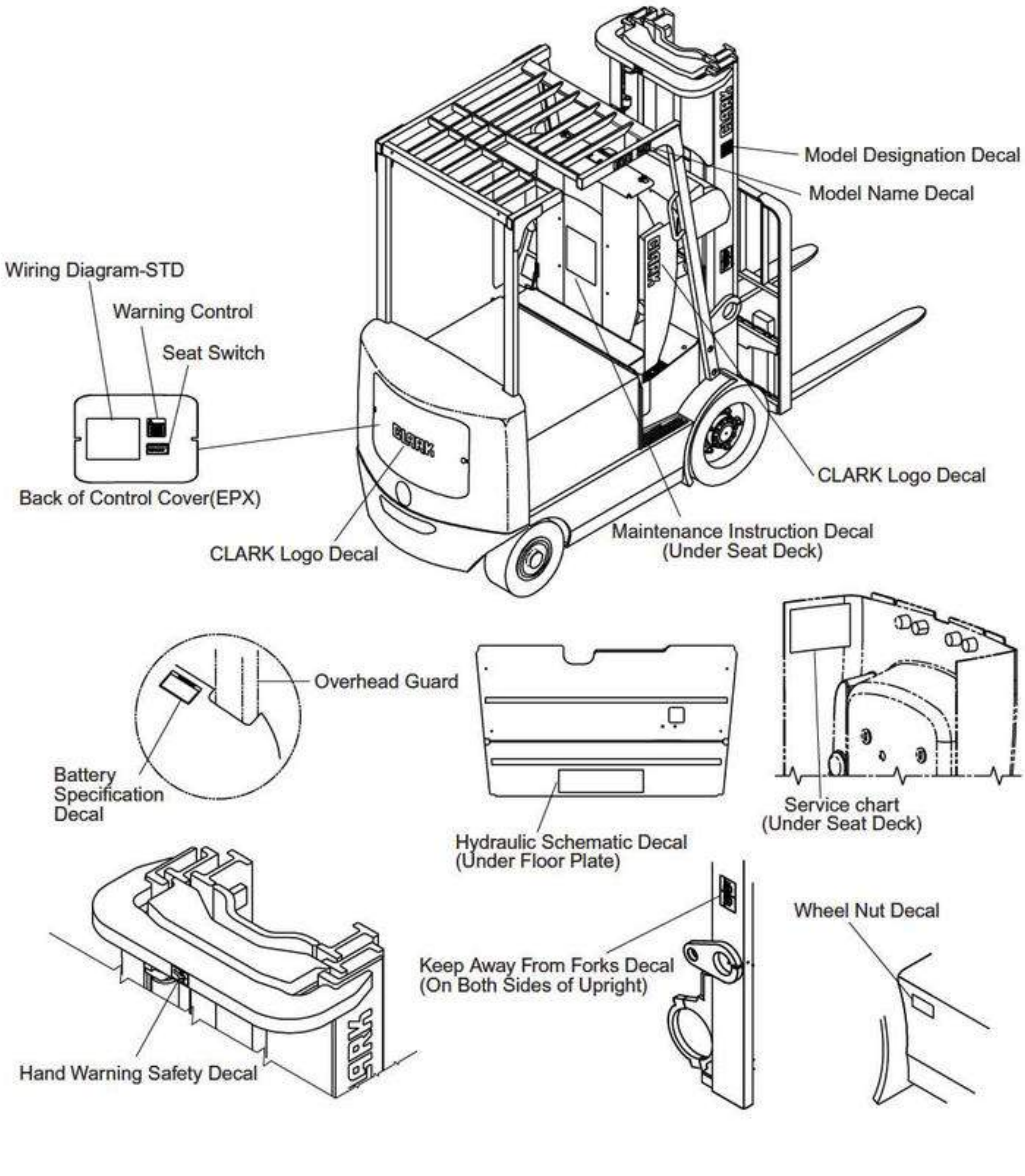
SPECIFICATIONS

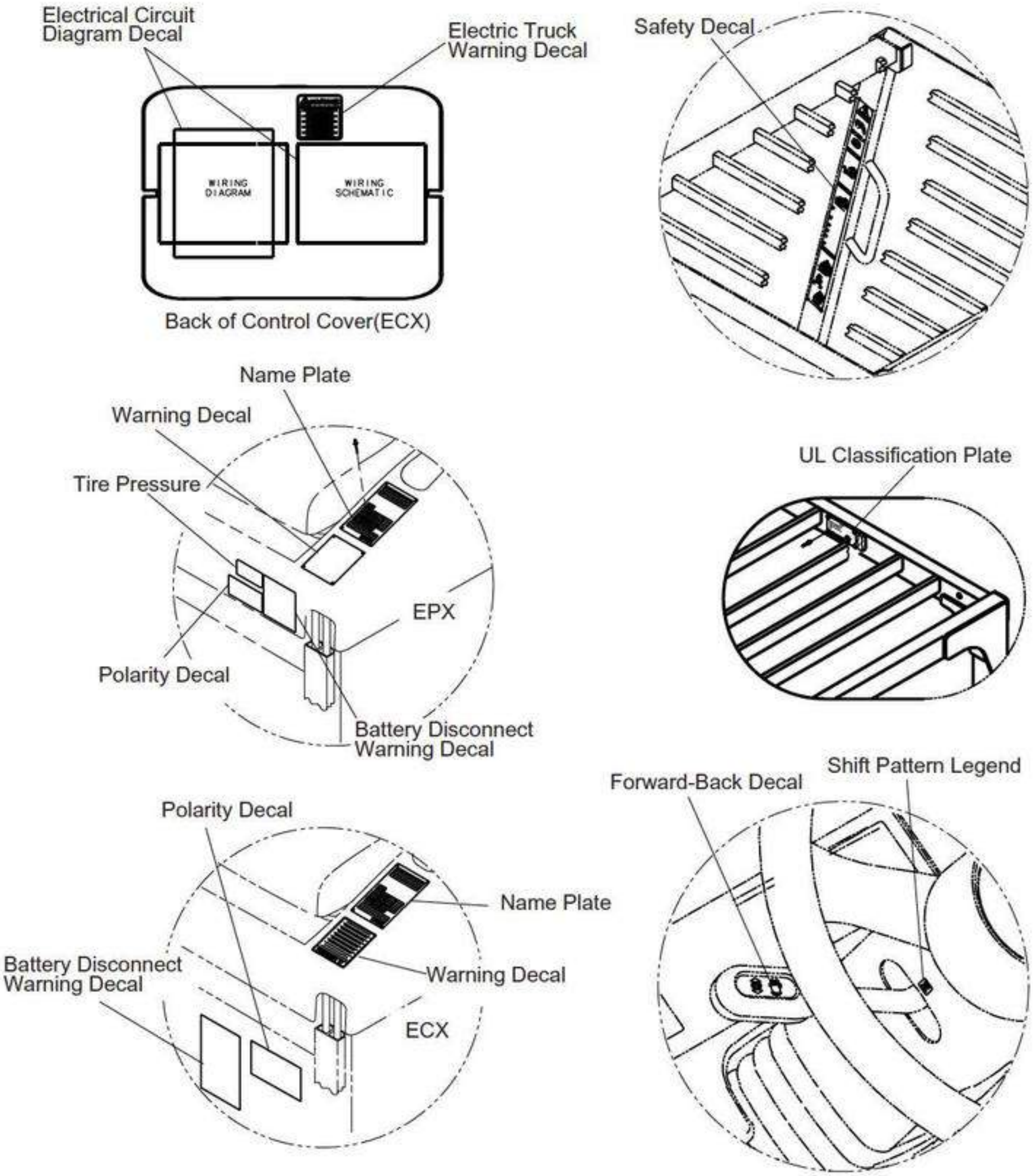
NOTE :

Section 1

Nameplate and Decals

Nameplate and Decals Locations




Electrical Circuit Diagram Decal
Electric Truck Warning Decal
WIRING DIAGRAM
WIRING SCHEMATIC
Back of Control Cover(ECX)
Safety Decal
Name Plate
Warning Decal
Tire Pressure
EPX
Polarity Decal
Battery Disconnect Warning Decal
UL Classification Plate
Forward-Back Decal
Shift Pattern Legend
Polarity Decal
Name Plate
Battery Disconnect Warning Decal
Warning Decal
ECX

Nameplate and Decals

This section shows the nameplate (data and capacity plate) and decals required to be on all operating Clark industrial trucks. The nameplate lists the data on the truck - type and serial number - and the capacities of the truck. Decals depict or explain the hazards the operator must avoid when operating the truck. The nameplate and decals are placed in specific locations on the truck and are intended to warn others working around the truck of its hazards as well. The nameplate and decals MUST BE IN PLACE on all trucks.

If any decals or the nameplate are missing from the truck, check with your local Clark dealer for replacements. This is required by OSHA.

IMPORTANT

Do not allow a lift truck with damaged or missing decals or data plate to be placed in service. Replace them immediately. They contain important information as described on the following pages. This is required by OSHA. The location of all decals is also shown on the following pages.

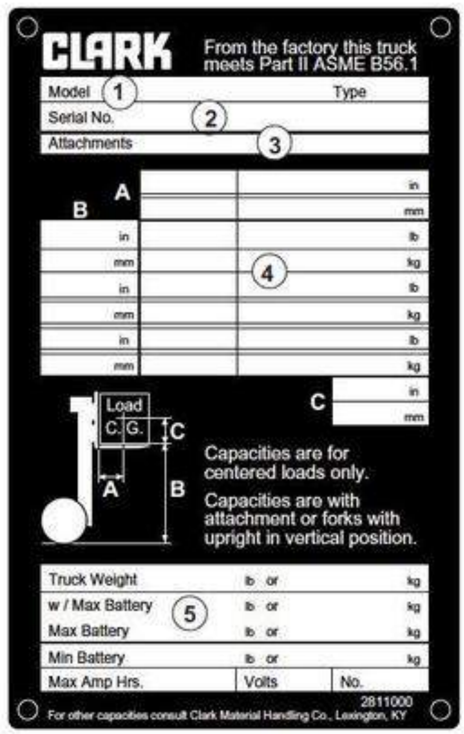
Truck Data and Capacity Plate

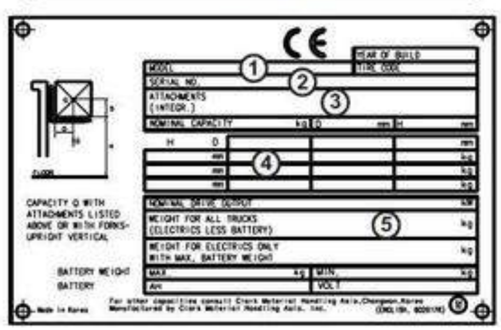
The truck data and capacity plate provides essential information about the truck. This information is important for both operators and service personnel. Operators can see what the truck's capacities and load ratings are. Service personnel must identify the truck model, type, and serial number when ordering parts. Refer to numbers on example data plate illustration.

1. Truck model number or registered name.
2. Truck serial number--An identification number assigned to this particular truck and should be used when requesting information or ordering service parts for this truck from your authorized CLARK dealer. The serial number is also stamped on the frame.
3. Attachment description (if any installed)--The user must see that the truck is marked to identify the attachment(s), including weight of the truck/attachment combination and truck capacity with the attachment.
4. Capacity rating, load center, and lifting height data Shows the maximum load capacity of this truck with relation to load centers and fork heights (see diagram on plate). Personal injury and damage to the truck can occur if these capacities are exceeded.
5. Truck weight - The approximate weight of the truck without a load on the forks. The truck weight plus the weight of the load must be considered when operating on elevators, elevated floors, etc., to be sure it is safe.

CAUTION

Before attachments are added, or if the truck is modified after leaving the factory, you must contact your authorized Clark dealer for authorization and a new nameplate as capacity will be affected. This is required by OSHA.





Warning Decal

The Operator Safety Warning Decal describes basic safe operating procedures that should be used when operating the truck. This decal depicts important points about truck operation and warns operators about truck safety hazards. This decal is meant as a reminder for operators. It is placed where operators can review the points daily as they conduct a visual inspection and prepare the truck for work.

IMPORTANT

Safety and warning decals are placed in conspicuous locations on the truck to remind operators of essential procedures or to prevent them from making an error that could damage the truck or cause personal injury. Safety and warning decals should be replaced immediately if missing, damaged or illegible. This is required by OSHA.

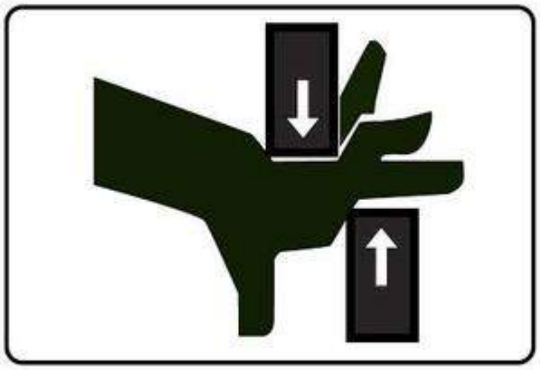
Lift trucks can be tipped over if operated improperly. Experience with lift truck accidents has shown that the driver cannot react quickly enough to jump clear of the truck and overhead guard as the truck tips. To protect operators from severe injury or death in the event of a tip-over, make sure this decal is in place to remind them to always use their seat belts.

Operator Safety Decar

The Operator Safety Decal depicts impotant points about truck operation and warns operators about truck safety hazards. The Operator Safety Decal is meant as a reminder for operators and is placed where operators can review the points daily as they conduct a visual inspection and prepare the truck for work.

Hand Safety Warning Decal

This safety decal is placed on the upright to warn of the danger of injury from movement between rails, chains, sheaves, fork carriage, and other parts of the upright assembly. Operators and others should never climb on or reach into the upright. Personal injury will result if any body part is put between moving parts of the upright.



Keep Away from Forks Decal

This safety decal is placed on the upright to warn of the danger of injury from forks when they are in the raised position. Operators and others should never ride on or stand under forks or attachments. The forks can fall and cause injury or death.

Battery Disconnect Warning Decal

This warning decal is located on the front of the seat deck. It warns of the danger of truck movement when removing or inserting the battery connector by calling for turning the key switch to OFF and setting the parking brake.

WARNING

Turn key switch off and set parking brake before removing or inserting battery connector.

Truck may start in motion if you do not.

Polarity Warning Decal

This warning decal is located on the front of the seat deck, adjacent to the Battery Disconnect Warning Decal. It notes the need to disconnect the battery before handling electrical components and to always make electrical connections positive to positive and negative to negative to prevent damage.

WARNING

- Disconnect battery before handling electrical components.
- Connect positive to positive, negative to negative to prevent damage.

Electric Truck Warning Decal

This warning decal is located on the inside of the electrical contactor compartment door. It warns that to prevent unexpected movement of the truck when working on it, to raise the drive wheels, disconnect the battery, discharge the capacitors and refer to maintenance procedures.

NOTE :

Section 2

General Specifications

Weights and Performance Specifications

Capacities

For standard trucks.

Models	At 500 mm (24 in) Load Center
ECX 20/EPX 20	2000 kg 4000 lbs
ECX 25/EPX 25	2500 kg 5000 lbs
ECX 30/EPX 30	3000 kg 6000 lbs
ECX 30x	3000 kg 6500 lbs
ECX 32/EPX 32	3200 kg 6500 lbs

Note: Rated capacity applies when using uprights with maximum fork height up to and including 4318 mm (170 in) For EC(P)X 20-30 and 4166 mm (164 in) for ECX 30x and EC(P)X 32.

Truck Weights and Axle Weights

Approximate weights for standard trucks with 189"TSU upright minimum battery weight, 30.4 inch compartment.

	Unloaded Vehicle Weight) kg(lbs)	With Load-Front Weight kg(lbs)	With Load-Read Axle Weight kg(lbs)	Without Load-Front Axle Weight kg(lbs)	Without Load-Rear Axle Weight kg(lbs)
ECX 20	4310/9502	5347/11788	777/1713	2150/4740	2160/4762
ECX 25	4800/10582	6088/13421	980/2160	2096/4621	2704/5961
ECX 30	5060/11155	6886/15181	896/1975	2084/4594	2976/6561
ECX 30x, 32*	5365/11828	7357/16219	956/2108	2280/5027	3085/6801

*Data for ECX 30x, ECX 32 is for a 34.5" battery Compartment.

Approximate weights for standard trucks with 126"(EPX32),130"(EPX20-30) Standard upright and EPX20/25 31.5", EPX30/32 39.0" comportment.

	Gross Vehicle Weight kg(lbs)	Empty Vehicle Weight kg(lbs)	Loaded Drive Axle weight kg(lbs)	Empty Drive Axle weight kg(lbs)	Empty Steer Axle weight kg(lbs)
EPX 20	5840(12875)	3840(8465)	5220(11508)	1925(4244)	1915(4222)
EPX 25	6815(15025)	4315(9512)	5980(13183)	1865(4112)	2450(5401)
EPX 30	7600(16755)	4600(10141)	6835(15069)	2025(4464)	2675(5897)
EPX 32	8014(17668	4814(10613)	7053(15549)	2039(4495)	2775(6118)

Note: Refer to the truck data plate for exact service and axle weights.

Parking Brake Test

The brake must be capable of holding the truck with a full rated-capacity load on a 15 % grade.

Travel Speeds

Maximum speeds with standard upright for Standard Models.

	36 Volt	48 Volt		48 Volt
ECX 20 no load	14.8kph (9.2mph)	18.2kph (11.3mph)	EPX 20 no load/with load(STD)	18.0kph (11.2mph)
ECX 25 no load	14.6kph (9.1mph)	17.7kph (11.0mph)	EPX 25 no load/with load(STD)	18.0kph (11.2mph)
ECX 30 no load	14.0kph (9.7mph)	17.4kph (10.8mph)	EPX 30 no load/with load(STD)	18.0kph (11.2mph)
ECX 30x, 32 no load	12.9kph (8.0mph)	16.7kph (16.7mph)	EPX 32 no load/with load(STD)	17.0kph (10.6mph)
ECX 20 with load	14.2kph (8.8mph)	17.4kph (10.8mph)		
ECX 25 with load	13.7kph (8.5mph)	17.1kph (10.6mph)		
ECX 30 with load	13.2kph (8.2mph)	15.8kph (9.8mph)		
ECX 30x, 32 with load	12.1kph (7.5mph)	15.1kph (9.4mph)		

Turning Radius, 30.4 inch Battery Compartment

30.4 inch Battery Compartment
ECX20 mm-in.-1783/70.2
ECX 25 mm-in.-1845/72.6
ECX 30 mm-in.-1877/73.9
ECX 30x mm-in-1989/78.3
ECX 32* mm-in.-1989/78.3
* Data for ECX 30x & 32 is for a 34.5 Inch Battery Compartment
Battery Compartment : 800.5mm/31.5in
EPX20 : 2075mm/81.7in
EPX 25 : 2130mm/83.9in
Battery Compartment : 1007mm/39.6in
EPX 30 : 2310mm/90.9in
EPX 32 : 2420mm/95.3in

Drift, Lift and Tilt Cylinders

Upright fork Downdrift: Should not exceed 100 mm (4 in) in a 10-minute period.

Tilt Cylinder Drift: Should not exceed 5° in a 10-minute period.

Determined by marking and measuring carriage descent and upright forward tilt from raised, non-tilted position with hydraulic fluid at operating temperature: and a capacity load held evenly distributed on lift forks. (If a pallet is used, load should not extend beyond pallet: load should be stacked to provide maximum stability). Fork completely engaging load and adjusted as wide-as possible to provide even distribution of weight.

Lift and Lowering Speeds, Upright

	Lift Loaded m/s(fpm)	Lower Loaded m/s(fpm)	Lift Empty m/s(fpm)	Lower Empry m/s(fpm)
ECX 20 36V				
Triple-Stage	0.30(59)	0.45(89)	0.51(100)	0.41(81)
ECX/EPX 20 48V				
Standard	0.38(75)/0.38(75)	0.44(87)/0.44(87)	0.60(118)/0.60(118)	0.43(85)/0.43(85)
Triple-Stage	0.49(96)/0.49(96)	0.45(89)/0.45(89)	0.58(114)/0.58(114)	0.41(81)/0.41(81)
ECX 25 36V				
Triple-Stage	0.28(55)	0.46(91)	0.51(100)	0.41(81)
ECX/EPX 25 48V				
Standard	0.36(71)/0.36(71)	0.44(87)/0.44(87)	0.60(118)/0.60(118)	0.43(85)/0.43(85)
Triple-Stage	0.46(91)/0.46(91)	0.46(91)/0.46(91)	0.58(114)/0.58(114)	0.41(81)/0.41(81)
ECX 30 36V				
Triple-Stage	0.25(49)	0.47(92)	0.43(84)	0.41(81)
EPX/ECX30 48V				
Standard	0.31(61)/0.31(61)	0.45(89)/0.45(89)	0.50(98)/0.50(98)	0.43(85)/0.43(85)
Triple-Stage	0.42(82)/0.42(82)	0.47(92)/0.47(92)	0.53(104)/0.53(104)	0.41(81)/0.41(81)
ECX 32 36V				
Triple-Stage	0.23(45)	0.47(92)	0.43(84)	0.41(81)
ECX 30x & ECX 32 48V				
Standard	0.31(61)	0.45(89)	0.50(98)	0.43(85)
Triple-Stage	0.41(81)	0.47(92)	0.53(104)	0.41(81)
EPX32 48V				
Standard	0.25(49)	0.47(93)	0.40(79)	0.45(89)
Triple-Stage	0.24(47)	0.43(85)	0.39(77)	0.37(73)

Critical Fastener Torque Specifications

For standard transaxle trucks.

	Tightening Torque. Dry	
	N.m	ft-lb
Drive Axle-to-Frame Mounting Bolts:	450-500	332-369
Drive Wheel Lug Nuts	300-370	225-275
Steer Axle Mounting Bolts	170-190	125-140
Steer Wheel Lug Nuts	221-251	163.7-186.6
Steering Handwheel Retaining Nut	35-40	25.5-29.5
Tilt Cylinder Yoke Clamp Bolts	166-193	122-142
Tilt Cylinder Pin Retainer Bolts		
Front	8-10	5.9-7.4
Rear	8-10	5.9-7.4
Counterweight Mounting Bolts (Bottom)	340-380	250-280

Brake System Specifications

Service Brake

Type: Drum and shoe. Self-adjusting.

Fluid: DOT 3.

Shoe-to-Drum Gap: 0.10-0.35 mm (.004-.014 in).

Shoe Lining Thickness: 1.0 mm (0.039 in) min.

Drum Thickness: 17 mm (0.669 in) min.

Pedal Freeplay: None.

Parking Brake

Type: Ratchet linked to service brake shoe at each wheel.

Holding Test: Rated load on 15% grade.

Steering Column and Gear Specifications

Steering System Type: Hydrostatic power steeing.

Steering System Relief Pressure Setting: 8600 kPa (1250 psi)

Steer Axle Specifications

Steer Cylinder Type: Double-acting, piston-type.

Hydraulic Sump, Filters, and Pump

Specifications

Hydraulic Pump Type: Integral gear type pump and motor assembly.

Sump Type and Capacity: Removable tank mounted in truck side frame with maximum capacity of 28 L (7.4 gallons)

Hydraulic Fluid Type: Clark Hydraulic Fluid specification MS-68.

Hydraulic Fluid Filters: Return line filter and suction line screen mounted in sump.

Return Filter Type: Disposable, 25 micron, full flow.

Suction Screen: 100 mesh stainless steel screen.

Hydraulic Valve/Lift Circuit Specifications

Rated Flow:

Lift spool (spool #l): 76 L/min (20 gpm)

Tilt spool (spool #2): 38 L/min (10 gpm)

Auxiliary spool (spool #3): 38 L/min (10 gpm).

Maximum Pressure Drop at Rated Flow:

Inlet to outlet: 689 kPa (100 psi)

Lift spool (spool #l):

- Inlet to cylinder port: 689 kPa (100 psi)
- Cylinder port to outlet: 550 kPa (80 psi)

Tilt spool (spool #2):

- Inlet to cylinder port: 689 kPa (100 psi)
- Cylinder porL to outlet: 550 kPa (80 psi)

Auxiliary spools (spools #3 and #4):

- Inlet to cylinder port: 345 kPa (50 psi)
- Cylinder port to outlet: 207 kPa (30 psi).

Counterweight and Chassis Specifications

Counterweight weights(ECX):

	Short wheel base 30.5 BC	Long wheel base 34.5 BC
530 kg (1170 lbs)	ECX20	ECX20
670 kg (1480 lbs)	-	ECX25
1010 kg (2230 lbs)	ECX25	ECX30
1230 kg (2710 lbs)	ECX30	ECX32,ECX30x

Counterweight weights(EPX):

	Short wheel base 31.5 BC	Long wheel base 39.6 BC
500 kg (1100 lbs)	EPX20	-
920 kg (2030 lbs)	EPX25	-
900 kg (1980 lbs)	-	EPX30
1130 kg (2490 lbs)	-	EPX32

Tilt Cylinders Specifications

Tilt cylinder type: double-acting with shims

Maximum Operating pressure: 22,070 kPa (3,200 psi; 220 bar)

Tilt Flow Control Adjustments (factory setting is 15 L/min (4 gal/min):

Tilt Ranges

(Abbrcviations - Std = Standard, high-visibility upright;

TSU = Triple-stage upright HI-LO:Full Free lift upright; MFH = maximum fork height: B = back tilt; F = forward Lilt)

MAST TYPE	MFH mm(in)	BACK "B"(°)	FORWARD "F"(°)
	ECX		
STD	~2120(83.5)	6	10
STD	2680(105.5)~3860(152)	8	8
STD	4165(164)~4620(182)	5	6
STD	5170(203.5)~	5	3
HILO	~3910(154)	6	10
TSU	~3700(146)	8	8
TSU	3860(152)~4800(189)	5	6
TSU	5050(199)~6100(240)	5	3
TSU	6370(251)~	3	0
QUAD	~6100(240)	5	3
QUAD	6120(241)~	3	0
	EPX		
STD	~2120(83.5)	8	8
STD	2680(105.5)~3860(152)	10	6
STD	4165(164)~4620(182)	5	6
STD	5170(203.5)~	5	3
HILO	~3910(154)	10	6
TSU	3860(152)~4800(189)	5	6
TSU	5210(205)~6100(240)	5	3
TSU	6370(251)~	3	3
QUAD	~6100(240)	5	3
QUAD	6120(241)~	3	3

Upright Specifications

Upright Weight: approximately 363 kg (800 lb) to approximately 1000 kg (2200 lb)

Carriage Weight: approximately 109 kg (240 lb)~120kg (265 lb)

Fork Weight: approximately 50-71 kg each (110-156 lb)

IMPORTANT

Before hoisting, the weights of upright, carriage, and forks must be combined to determine what lifting capacity is required of the hoisting equipment.

Capacities and Lift Heights: Upright, carriage, and fork capacity and upright lift heights are listed on the truck's data plate.

Lubricants:

All Purpose Grease (Clark specifications MS-9)

Innerslide Lubricant (Clark part #886396)

Chain and Cable Lube (Clark part #886399)

Section 3

Hydraulic Fitting Tightening Procedure

1. Tighten fitting finger tight until it stops turning, while moving the fitting lightly side to side to prevent cocking or thread damage.

2. Using finger tips only, lightly snug fitting with a wrench until it bottoms out on the seat or port. Do not overtightcn.

NOTE :