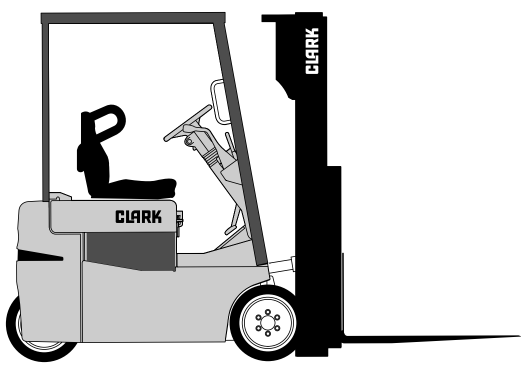
TMX 12-25
EPX 16-20s

SERVICE MANUAL



RATED CAPACITY : 1250~2270kg

Part No. 8037870
Book No. SM-715
Jun. 2005

CLARK
THE FORKLIFT

#40-1,Ungnam-Dong,
changwon-city, Kyungnam,
Korea

When new or revised information is published to update this manual the action to be taken with the pages is indicated in the table.

Pages not marked are not currently revised, but are included for page numbering continuity.

Jul. 2005

Mark	Indication	Action required
❍	Page to be newly added	Add
●	Page to be replaced	Replace
( )	Page to be deleted	Discard

Mark	Page	Revision number	Mark	Page	Revision number	Mark	Page	Revision number	Mark	Page	Revision number
	SA-1-1			13-1-2			13-3-24			13-5-1	
	SA-1-2			13-1-3			13-3-25			13-5-2	
	SA-2-1			13-1-4			13-3-26		❍	13-5-3	
	SA-2-2			13-1-5			13-3-27		●	13-5-4	①
	SA-2-3			13-1-6			13-3-28		❍	13-5-5	
	SA-2-4			13-1-7			13-3-29				
	SA-3-1			13-1-8			13-3-30			16-1-1	
				13-1-9			13-3-31			16-1-2	
	PS-1-1			13-1-10			13-3-32			16-2-1	
	PS-1-2			13-1-11			13-3-33			16-2-2	
	PS-1-3			13-1-12			13-3-34			16-2-3	
❍	PS-1-4		❍	13-1-13			13-3-35			16-3-1	
	PS-1-5			13-2-1			13-3-36			16-3-2	
	PS-1-6			13-2-2			13-3-37			16-3-3	
	PS-2-1			13-2-3		❍	13-3-38				
	PS-2-2		●	13-3-1	①	❍	13-3-39			17-1-1	
	PS-2-3			13-3-2		❍	13-3-40			17-1-2	
	PS-2-4			13-3-3		❍	13-3-41				
	PS-2-5			13-3-4		❍	13-3-42			19-1-1	
	PS-2-6			13-3-5		❍	13-3-43			19-1-2	
	PS-2-7			13-3-6		❍	13-3-44			19-1-3	
	PS-2-8			13-3-7		❍	13-3-45			19-1-4	
●	PS-2-9	①		13-3-8		❍	13-3-46			19-1-5	
	PS-2-10			13-3-9		❍	13-3-47			19-1-6	
●	PS-2-11	①		13-3-10		❍	13-3-48			19-1-7	
	PS-2-12			13-3-11		❍	13-3-49			19-1-8	
	PS-3-1			13-3-12		❍	13-3-50			19-1-9	
	PS-3-2			13-3-13		❍	13-3-51			19-1-10	
				13-3-14		❍	13-3-52			19-2-1	
	12-1-1			13-3-15			13-4-1			19-2-2	
	12-1-2			13-3-16		●	13-4-2	①	●	19-2-3	①
	12-1-3			13-3-17		●	13-4-3	①		19-2-4	
	12-1-4			13-3-18		●	13-4-4	①		19-2-5	
	12-1-5			13-3-19		●	13-4-5	①		19-2-6	
	12-1-6			13-3-20			13-4-6		●	19-2-7	①
	12-1-7			13-3-21		●	13-4-7	①	●	19-2-8	①
				13-3-22			13-4-8		●	19-2-9	①
●	13-1-1	①		13-3-23		❍	13-4-9			19-2-10	

Mark	Page	Revision number	Mark	Page	Revision number	Mark	Page	Revision number	Mark	Page	Revision number
	19-2-11			20-5-8			25-3-1		❍	25-11-7	
	19-2-12			20-5-9			25-3-2		❍	25-12-1	
●	19-2-13	①		20-5-10			25-3-3		❍	25-12-2	
●	19-2-14	①		20-5-11			25-3-4		❍	25-12-3	
●	19-2-15	①		20-5-12			25-3-5				
●	19-2-16	①		20-5-13			25-3-6			29-1-1	
	19-2-17			20-5-14		●	25-3-7	①		29-1-2	
	19-2-18			20-5-15		●	25-3-8	①		29-1-3	
	19-2-19			20-5-16		❍	25-3-9		●	29-1-4	①
	19-2-20			20-5-17		❍	25-3-10		●	29-1-5	①
	19-2-21			20-5-18			25-4-1		●	29-1-6	①
	19-3-1					●	25-4-2	①	●	29-1-7	①
	19-3-2			22-1-1			25-5-1			29-2-1	
	19-3-3			22-2-1			25-5-2			29-2-2	
●	19-3-4	①	●	22-2-2	①		25-5-3		●	29-2-3	①
	19-3-5			22-2-3			25-5-4			29-2-4	
	19-3-6		●	22-2-4	①		25-5-5			29-3-1	
	19-3-7			22-2-5			25-5-6			29-3-2	
●	19-3-8	①		22-2-6			25-5-7			29-3-3	
●	19-3-9	①		22-2-7			25-5-8			29-3-4	
	19-3-10			22-2-8			25-5-9			29-4-1	
	19-3-11			22-2-9			25-5-10			29-4-2	
	19-3-12						25-6-1		●	29-4-3	①
●	19-3-13	①	●	23-1-1	①		25-6-2			29-4-4	
●	19-3-14	①	●	23-1-2	①		25-6-3			29-5-1	
	19-3-15		❍	23-1-3			25-6-4		●	29-5-2	①
	19-3-16			23-2-1			25-6-5			29-5-3	
	19-3-17		●	23-3-1	①	●	25-6-6	①			
	19-3-18		●	23-3-2	①		25-6-7			30-1-1	
●	19-4-1	①	❍	23-3-3			25-6-8			30-1-2	
●	19-4-2	①		23-4-1			25-7-1			30-1-3	
				23-4-2			25-7-2			30-1-4	
	20-1-1			23-5-1			25-7-3		❍	30-1-5	
	20-1-2		❍	23-5-2		❍	25-8-1			30-2-1	
	20-2-1			23-6-1		❍	25-8-2			30-2-2	
	20-3-1			23-6-2		❍	25-8-3			30-2-3	
	20-3-2			23-6-3		❍	25-9-1			30-2-4	
	20-4-1					❍	25-9-2			30-2-5	
	20-4-2		●	25-1-1	①	❍	25-10-1			30-2-6	
	20-5-1			25-1-2		❍	25-10-2			30-2-7	
	20-5-2		●	25-1-3	①	❍	25-11-1			30-2-8	
	20-5-3		●	25-1-4	①	❍	25-11-2				
	20-5-4		❍	25-1-5		❍	25-11-3			32-1-1	
	20-5-5		❍	25-1-6		❍	25-11-4			32-2-1	
	20-5-6			25-2-1		❍	25-11-5			32-2-2	
	20-5-7			25-2-2		❍	25-11-6			32-2-3	

Mark	Page	Revision number	Mark	Page	Revision number	Mark	Page	Revision number	Mark	Page	Revision number
	32-3-1			34-6-5							
	32-3-2			34-6-6							
	32-3-3			34-6-7							
	32-4-1			34-6-8							
	32-4-2			34-7-1							
	32-4-3			34-7-2							
				34-7-3							
●	34-1-1	①		34-7-4							
	34-1-2			34-8-1							
●	34-1-3	①	●	34-8-2	①						
●	34-1-4	①		34-8-3							
	34-1-5		❍	34-8-4							
●	34-1-6	①									
	34-2-1		●	38-1-1	①						
	34-2-2		●	38-2-1	①						
	34-2-3		●	38-2-2	①						
	34-2-4		●	38-3-1	①						
	34-3-1			38-4-1							
	34-3-2		●	38-4-2	①						
	34-3-3										
	34-3-4		●	40-1-1	①						
	34-3-5			40-1-2							
	34-3-6		❍	40-1-3							
	34-3-7			40-1-4							
	34-3-8			40-1-5							
	34-3-9			40-1-6							
	34-3-10			40-1-7							
	34-4-1			40-2-1							
	34-4-2		●	40-2-2	①						
	34-4-3		●	40-2-3	①						
	34-4-4		●	40-2-4	①						
	34-4-5			40-2-5							
●	34-4-6	①	●	40-2-6	①						
	34-4-7		●	40-2-7	①						
●	34-4-8	①		40-3-1							
	34-4-9										
●	34-5-1	①									
	34-5-2										
	34-5-3										
	34-5-4										
	34-5-5										
	34-5-6										
●	34-6-1	①									
●	34-6-2	①									
	34-6-3										
	34-6-4										

CLARK

NOTE :

Truck Models Covered by this Manual

This manual consists of “base” module that pertains to all TMX12-25, ECX16-18 models and other modules that pertain only to specific models. Manuals shipped with the truck contain the base module and the modules 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.

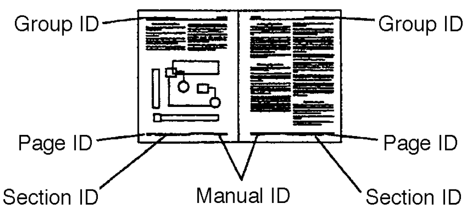
Each Group begins with a table of contents that shows the *Sections* contained within the Group. Lengthy Sections also begin with a table of contents.

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 or letters 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.



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.

NOTE :

Contents by Group and Section

(Alphabetical listing of contents appears on next page.)
Contents are listed here by Group number and name followed by Section number and name:

CONTENTS

Alphabetical Listing of Topics

(Contents are listed by order of Group and Section numbers on previous page.)
Contents are listed here by topic followed by the Group#-Section# the topic appears in:

NOTE :

GROUP SA

SAFE MAINTENANCE

CLARK

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, instructions or identification 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 of truck components..

Safe Maintenance Practices

The following instructions have been prepared from current industry and government safety standards applicable to industrial 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, oil, or coolant. Do not use open pans of fuel or flammable cleaning fluids for cleaning parts.
7. Before starting work on truck:
   a. Raise drive wheels off of floor and use blocks or other positive truck positioning devices.
   b. 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 with seat belt fastened.

   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. Stop the engine by turning off the key switch.

   e. Put upright in vertical position and fully lower the forks or attachment.

   f. 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 practice. 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 the stability of the truck. The frame must always be safely blocked for major component removal.

NOTE

You should also be familiar with additional operating and maintenance safety instructions contained in the following publications:

ASME B56.1 - 1988: Operator Control-Industrial Tow Tractors (Safety Standard For Powered Industrial Trucks). Published by: American Society of Mechanical Engineers, Three Park Avenue, New York, NY10016.

NFPA 505-1982: Fire Safety Standard for Powered Industrial Trucks: Type Designations, 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.

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.

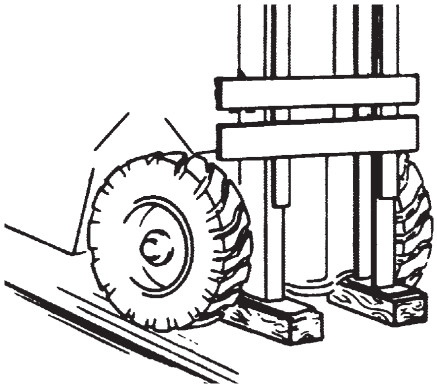
WARNING

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 to lift the drive wheels off the floor.

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.

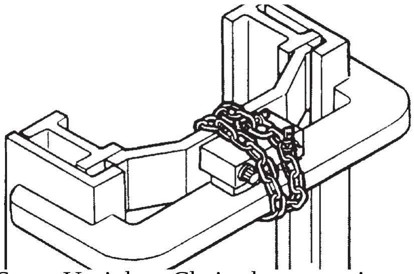


5. Block the truck under the frame behind the drive wheels with solid blocking.
6. Turn key switch OFF.
7. Check for safe clearance between drive wheels, block and floor.
8. Check the stability of the truck. Be sure that the blocks are located securely under the frame before operating the drive motor 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.

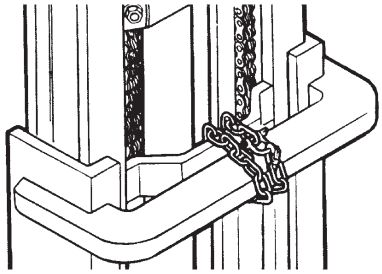
Chaining the Upright in Raised Position

This procedure provides safe 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 frame just beyond the counterweight.

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 frame just beyond the counterweight.

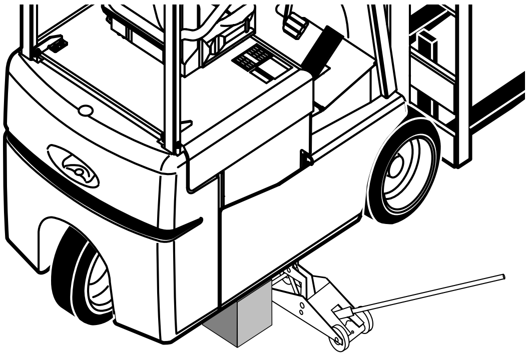
WARNING

Never lift the truck by the counterweight.

NOTE

If there is insufficient clearance under frame for your jack, the truck may first be driven onto shims, such as 25 x 150 x 300 mm (1 x 6 x 12 in) pieces of board, to increase the truck frame under-clearance.

4. Jack up one side of the truck about 50 mm (2 in) and put a block under the frame to hold that elevation. Then move the jack to the other side and jack and block it. Continue to alternate the procedure from side to side, increasing elevation not more than 50 mm (2 in) each time. Raise the truck no higher than necessary to perform the maintenance work.
Make sure the left and right sides of the truck are finally blocked in a level working position.



CAUTION

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

5. 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. If necessary, drive truck onto boards to increase under-clearance.

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.

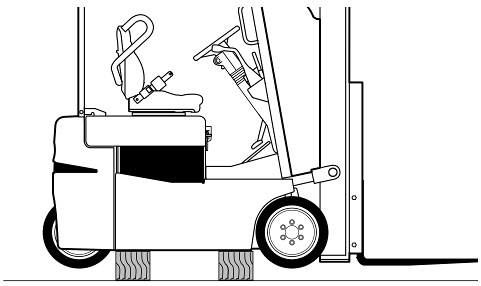
If the counterweight is removed while the truck is up on blocks, the weight of the upright and drive axle will cause the truck to fall forward.

2. 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.

3. 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.
4. 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.
5. If using one jack, lower the truck onto the blocks and move the jack to the opposite side. Repeat the lifting procedure.
6. 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.

7. 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

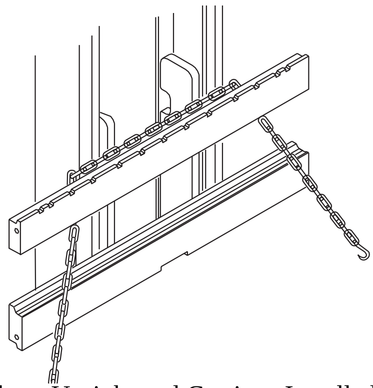
Depending on jack height, shims under the tires may be needed for clearance to allow removal of jack.

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 top of counterweight.

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

It is important for your safety and to the care of your lift truck to 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 the disabled truck up or down ramps or steep inclines.
Do not attempt to tow the disabled truck if traction or weather conditions are poor.

1. Be sure to apply the parking brake or block the drive wheels on the disabled truck while working around it.
2. When possible, raise the carriage (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 tow truck for improved traction.
4. Check that the counterweight bolts on both trucks are in place and properly torqued. These bolts are made of special, high-tensile steel and are not commercially available. When necessary, replace these bolts only with a genuine Clark replacement part.
5. Use an approved, solid metal tow bar with towing couplers that connect to the towing pins in the counterweights.

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 backwards. An operator must be on the disabled truck.

CAUTION

The power steering and braking will not operate on the disabled truck. The steering handwheel will be difficult to turn and the service brakes will require additional pedal force.

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.

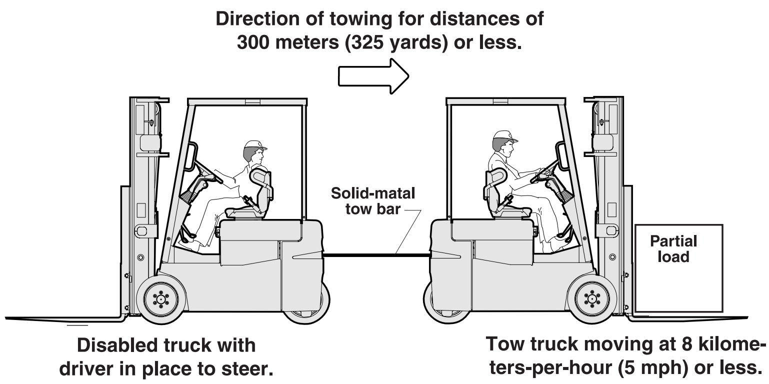
IMPORTANT

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 on the floor, leave the directional control in neutral, turn the key switch to OFF, and engage the parking brake. Remove the key and, 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 Schedule

"Periodic Service" and "Planned Maintenance"

The term "periodic service" includes all maintenance tasks that should be performed on a regularly scheduled basis.

The term "Planned Maintenance" indicates a formalized program of basic inspections, adjustments, and lubrications that the Clark service organization provides customers at a prescribed interval, usually 50-250 hours. The recommended basic "Planned Maintenance" procedure is given in Section 2 of this Group.

The current Section,"Maintenance Schedules," specifies all maintenance tasks.including Planned Maintenance tasks.that should be performed periodically, and suggests intervals at which they should be performed.

Determining Maintenance Intervals

Time intervals on the charts on the next four pages and elsewhere in this manual relate to truck operating hours as recorded on the hourmeter, and are based on experience Clark has found to be convenient and suitable under normal operation. Standard operating condition classifications are:

Normal Operation: Eight-hour material handling, mostly in buildings or in clean, open air on clean, paved surfaces.

Severe Operation: Prolonged operating hours or constant usage.

Extreme Operation:

- In sandy or dusty locations, such as cement plants, lumber mills, and coal dust or stone crushing sites.
- High-temperature locations, such as steel mills and foundries.
- Sudden temperature changes, such as constant trips from buildings into the open air, or in refrigeration plants.

If the lift truck is used in severe or extreme operating conditions, the maintenance intervals should be shortened accordingly.

IMPORTANT

MAINTENANCE INTERVALS. If the lift truck is used in severe or extreme operating conditions, the maintenance intervals should be shortened ace. Put upright in vertical position and fully lower the forks or attachment.

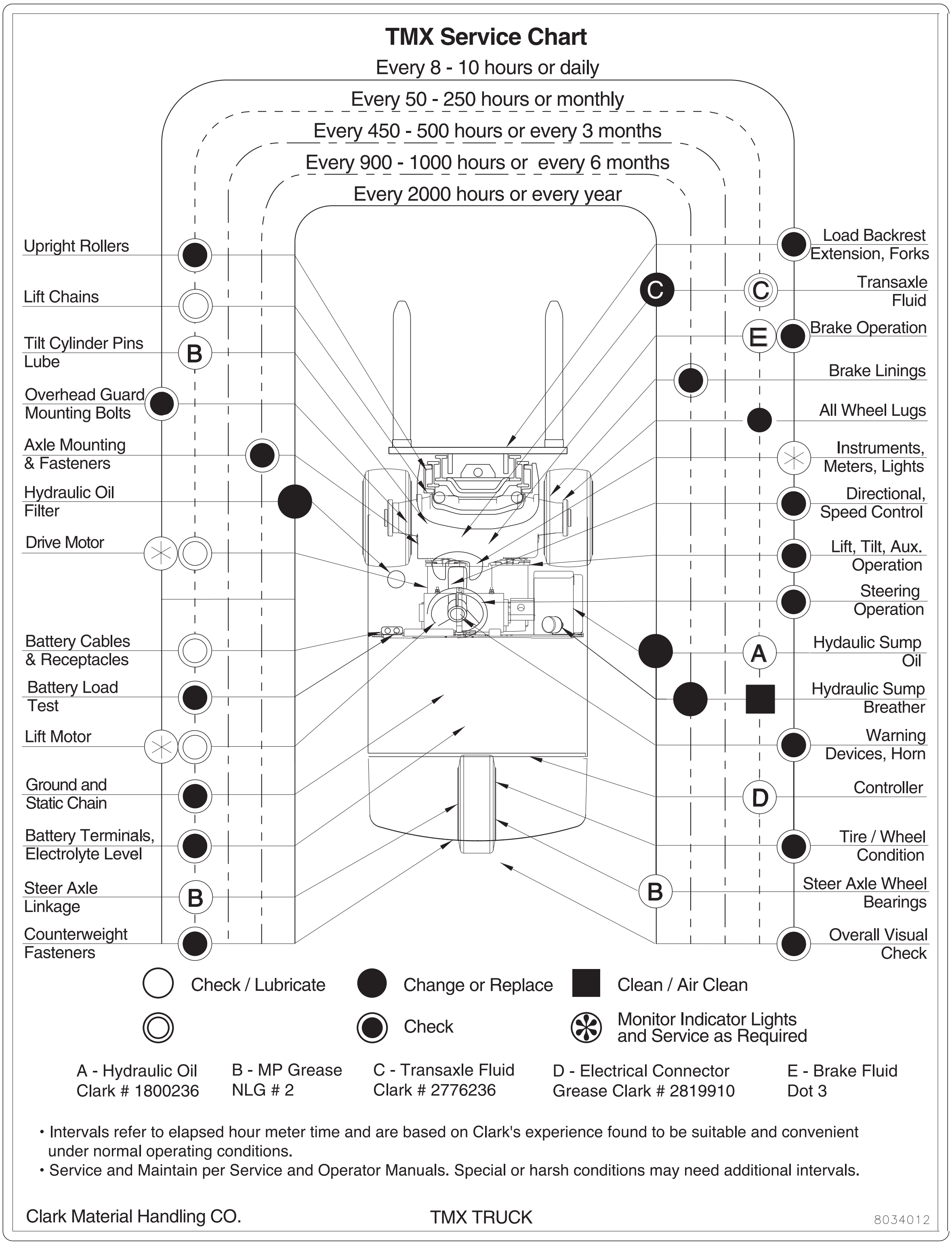
Service Chart/Lubrication Points

A decal, similar to the illustration below, is located on the underside of the seat deck. This decal is a basic guide to periodic

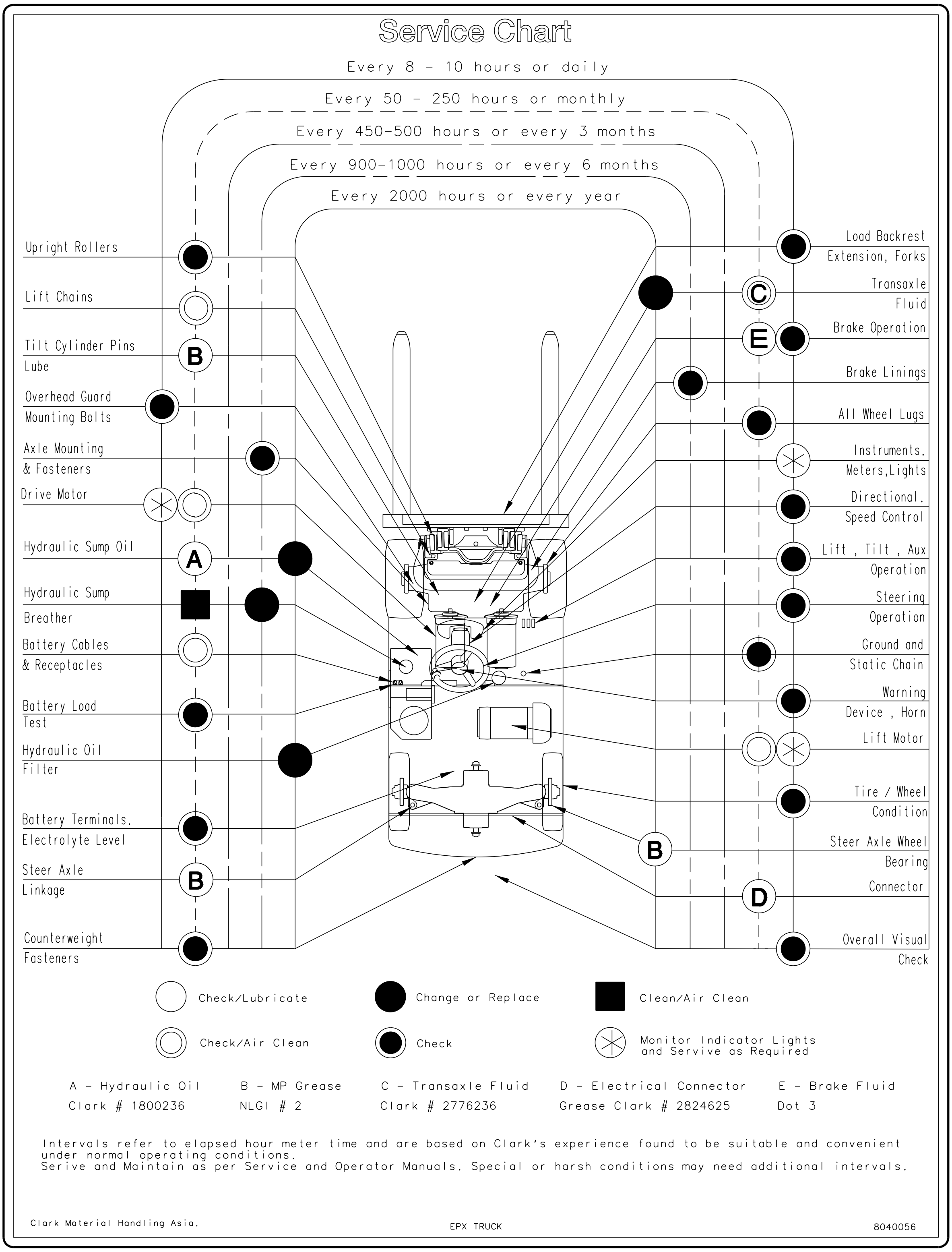
maintenance intervals and tasks. A more detailed chart is supplied on the next page.

TMX Service Chart/Lubrication Points

A decal, similar to the illustration below, is located on the underside of the seat deck. This decal is a basic guide to periodic maintenance intervals and tasks. A more detailed chart is supplied on the next page.



EPX Service Chart/Lubrication Points



Recommended Periodic Service Schedule

This chart lists maintenance tasks that should be done periodically, the suggested time intervals, and the service manual Group in which the task is covered. Refer to Operator's Manual for Daily Checks.

TASKS	1st 50 Hours	Every 50-250 Hours	Every 450- 500 Hours (or 3 months)	Every 900- 1000 Hours (or 6 months)	Every 2000 Hours (or 1 year)
Group PS - Periodic Maintenance					
Perform Planned Maintenance inspections, lubrications, and adjustments		•			
Group 12 - Battery					
Battery electrolyte level - check/add		•			
Battery load voltage test		•			
Battery terminals/cables - clean/ tighten		•			
Group 13 Wiring and Instruments					
Hourmeter - check		•			
Lamp check - at start-up		•			
Wiring harness - inspect		•		•	
Instruments/accessories					
Group 16 - Electric Motors					
Drive motor - check/air clean		•			
Lift pump motor - check/air clean		•			
Group 17 -Contactors					
Contactor tips - check/air clean					
Group 19 - Motor Controls					
Display - check display for error codes		•			
Controller - air clean		•			
Controller connectors - check and lubricate		•			
Group 20 - Drive Axle					
Air vent - inspect, clean or replace		•			
Axle mounting bolts - inspect/tighten				•	
.Pressure checks					•
Fluid change - drain/fill					•
Fluid filter - replace	•				•
Fluid level/condition - check/sample	•	•			
Group 22 - Wheels And Tires					
Wheel mounting bolts - tighten	•	•			
Tire pressure/condition - check	•	•			
Group 23 - Brakes					
Operation - check		•			
Service brake - check wear					•
Brake lines - check	•	•			
Parking brake - check/adjust	•	•			

TASKS	1st 50 Hours	Every 50-250 Hours	Every 450- 500 Hours (or 3 months)	Every 900- 1000 Hours (or 6 months)	Every 2000 Hours (or 1 year)
Group 25/26 - Steer Axle and Lines					
Operation - check		•			
Power steering relief pressure - check					•
Steer axle mounting - inspect		•			
Steer wheel and trunnion bearings - check		•			
Steer wheel and trunnion bearings - lubricate/adjust					•
Steering cylinder seals - check leakage		•			
Steering linkage - lubricate		•			
Group 29/30 - Hydraulic Lift System					
Hydraulic fluid level/condition - check/sample		•			
Hydraulic fluid change - drain/fill					•
Hydraulic filler screen - clean					•
Hydraulic fluid filter - replace	•				•
Hydraulic tank breather - clean/replace	•	•			•
Control valve linkage - check/clean					
Hydraulic system relief pressure - test/adjust					•
Group 32 - TIlt Cylinders					
Tilt cylinder adjustment - check/adjust		•			
Tilt cylinder drift - test		•			
Tilt cylinder mounting - check/tighten		•			
Tilt cylinder rod ends - check/tighten/lubricate		•			
Tilt cylinder rod/seals - check for leaks		•			
Group 34 - Upright, Lift Cylinders, Carriage, Forks					
Operation - check		•			
Carriage and lift chain - lubricate		•			
Carriage chain condition - inspect/adjust		•			
Forks, latches, stop pin - inspect/check wear		•			
Lift chain condition - inspect/adjust		•			
Load backrest		•			
Upright cylinder/mounting - inspect/tighten		•			
Upright lift cylinder downdrift - test		•			
Upright rollers - check		•			
Upright trunnion bolts - tighten		•			

Section 2.

The Planned Maintenance Program

This Section defines a set of basic service procedures, known as the "Planned Maintenance Program,"and describes a systematic approach for performing them.

Introduction to Planned Maintenance

A program of regular, routine inspections, lubrication, and other service tasks is important for the long life and troublefree operation of the lift truck.

The Clark service organization offers customers a formalized program.called Planned Maintenance, or PM.for

performing these tasks.

PM Intervals

The PM inspections, adjustments, and lubrications are typically performed on each covered truck at 50-250 hour intervals. (See Section 1, in this Group about defining service intervals.)

The PM Form

As an aid to service technicians performing and documenting PM inspections, Clark has prepared a “Planned Maintenance Report” form. A copy of this form is inserted in Section 3 of this Group.

We recommend that you use this form as a checklist and to make a record of your inspection and truck condition. This record can be used to inform the owner of needed repairs and help establish the optimal PM intervals.

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

The Basic PM Procedures

The basic PM procedure is to perform checks first, repairs and adjustments last. As you go through each step of the PM, you should note all your findings on the PM report form.

The PM report form serves as a record of what you did in the PM and what further service needs to be performed. “Further service” consists of any repair, adjustment, inspection, or lubrication that you discovered during the PM or any periodic service procedure that is due but not covered by the PM agreement).

You should consult the previous PM report forms, periodic service chart, and truck hour meter to determine what periodic service is due. List the service due on the new PM form.

The PM procedure, in outline form, is as follows:

1. **External visual checks.** Perform these as you walk around the truck with it turned off.
2. **Operational checks.** Perform these while operating the truck.
3. **Internal visual checks.** Perform these after removing the floor board and cowl cover.
4. **Air cleaning internal components.** Do this while performing the previous step.
5. **Critical fastener torque checks.**
6. **Minor adjustments and repairs** you found in your inspection.
7. **Fluid level checks and fill.**
8. **Chassis lubrication.**
9. **Final clean up.**
10. **Minor adjustments** to the responsible party.

Each of these steps is explained in detail beginning on the next page.

CAUTION

- **Do not make repairs or adjustments unless authorized to do so.**
- **Disconnect the battery before you work on electrical components.**
- **Always wear safety glasses.**
- **Wear a safety (hard) hat in industrial plants and in special areas where protection is necessary or required.**
- **Remove all jewelry (watch, rings, bracelets, etc.) before working on the truck.**

Truck Location and Parking

Before starting the external inspection, make sure the truck is parked on a clean, level surface. Fully lower upright, turn truck off, and engage the parking brake.

If it is necessary to drive the truck to a suitable inspection location, perform the initial braking and steering checks, given later in this Section, as you begin to move the truck.

To perform the operational checks, the truck must be where there is sufficient clearance to raise the upright and room to maneuver the truck at full speed without endangering personnel, equipment, or materials.

External Inspection

Walk around the truck and take note of any obvious damage and maintenance problems, as follows:

Decals

Check to be sure all capacity, safety, and warning plates and decals are attached and legible.

NOTE

Do not operate a lift truck with damaged or missing decals and nameplates. Replace them immediately. They contain important information. See Group 40 for decal locations.

Fittings and Fasteners

Make sure that fittings and fasteners are present, in usable condition and fully fastened. Critical fastener torque checks should be performed later--when making minor adjustments and repairs.

Overhead Guard and Chassis

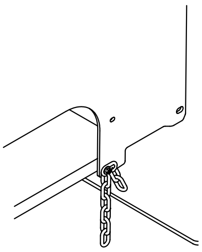
Be sure that the overhead guard and any other safety devices are in place, undamaged, and attached securely. Inspect welds and structural members for cracks or other damage.

Lights and Safety Devices

Check safety devices, such as lights, horn, and audible alarms, to make sure they are securely attached and have on visible damage.

Static Chain

Look under the truck to make sure the static chain contacts the floor and is not excessively worn or loose. See Group 13 for more information.



Leaks

Look under the truck and on the chassis, uprights, and exposed hoses for any signs of external leakage: brake fluid, drive axle oil, and hydraulic fluid, and battery fluid.

When you suspect hydraulic oil leaks and loose fittings,

DO NOT USE BARE HANDS TO CHECK.

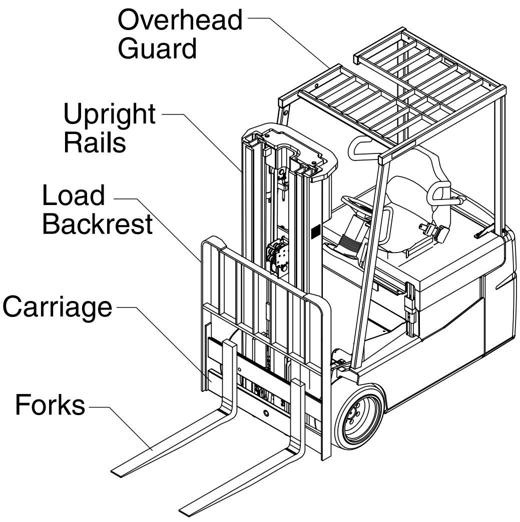
CAUTION

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

Carriage, Load Backrest, and Upright

(See Group 34 for more detailed inspection procedure.)

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



Inspect the upright assembly: rails, carriage rollers, load backrest, lift chains, and lift and tilt cylinders. Look for obvious wear and maintenance problems and damaged or missing parts. Check for any loose parts or fittings. Check for leaks, any damaged or loose rollers and rail wear (metal flaking).

Carefully check the lift chains for wear, rust and corrosion, cracked or broken links, and stretching. Check that the lift and carriage chains are correctly adjusted to have equal tension and that the tops of the rails are within 4 mm (1/8 in) of each other.

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.

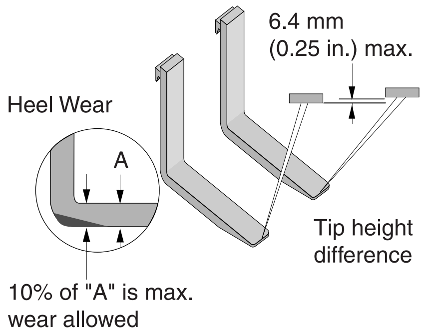
Inspect all lift line hydraulic connections for leaks. Check the lift cylinder rods for wear marks, grooves and scratches. Check the cylinder seals for leaks.

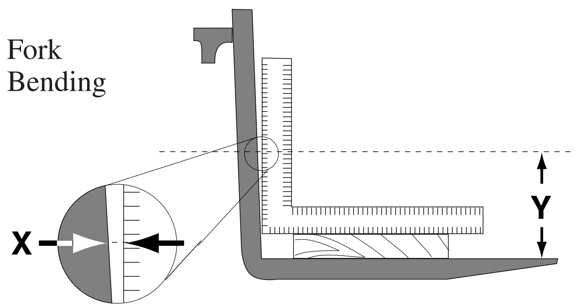
Forks

Inspect the load forks for cracks, breaks, bending, and wear.

WARNING

HEEL WEAR. If the fork blade at the heel is worn down by more than 10 percent, the load capacity is reduced and the fork must be replaced.





X must be less than 25.4 mm (1 in) when measured at
Y height of 46 cm (18 in).

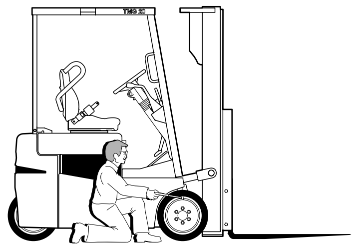
Measure fork bending with a T-square and wood bock as shown above.

Inspect the fork latches to ensure that they are in good condition, operate freely, and lock correctly. See Group 34 for more details on inspection procedures, including use of fork wear gage.

Wheels and Tires

Check the condition of the drive and steer wheels and tires. Remove objects that are embedded in the tread. Inspect the tires for excessive wear or breaks or “chunking out.”

Check all wheel lug nuts or bolts to be sure none are loose or missing. Have missing bolts or lug nuts replaced and tightened to correct torque as explained in Group 22.



WARNING

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. If tires are low, the tire may require removal and repair. Incorrect (low) tire pressure can reduce truck stability. See “Specifications” in Group 22 for proper inflation pressure.

Operational Checks

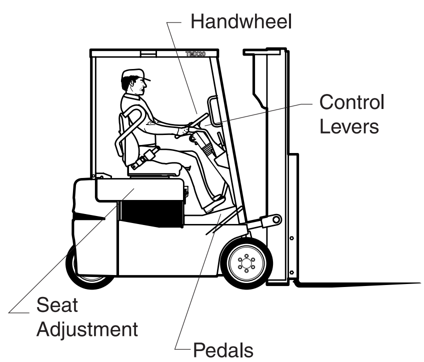
Be sure that:

- Truck is parked on a level surface.
- Key switch is off.
- Parking brake is applied.
- Directional control is in "N" (neutral).
- Battery is connected.

Operator’s Environment

Sit in the operator’s seat and make sure the seat is secure and that the seat adjustment mechanism operates properly.

With the key switch off, check that travel and load handling capability, dash display, lights, and alarms are all disabled.



Check that the steering wheel is tight and rotates smoothly and adjusts for tilt properly. Check the control levers and foot pedals to make sure they are securely mounted, operate freely, and return to neutral when released. Perform an additional visual inspection of the upright and overhead guard from the seated position

Service and Parking Brake (Initial Check)

Push the brake pedal down fully and hold. The brakes should apply before the pedal reaches the floorplate. If the pedal continues to creep downward, report the failure immediately. Do not operate the truck until the brakes are repaired.

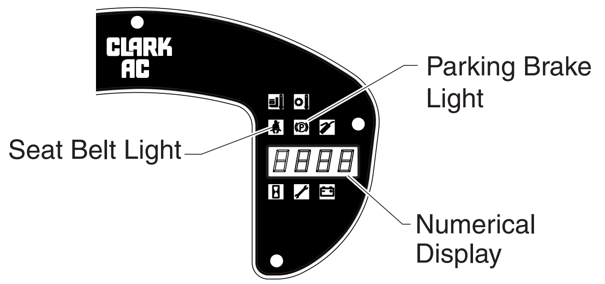
Operate the parking brake to make sure that it is securely mounted and that it applies, catches, and releases properly.

Apply the parking brake. Turn the key switch on.

Dash Display and Safety Lock-Outs

As you turn the key switch on, check the instrument display. All indicator lights should come on for a 2-second lamp check. The seat belt prompt light should remain on for 4 seconds, accompanied by the high-pitched seat-belt alarm. The parking brake light should remain on (if the brake is set) and the numerical display should read -255 to indicate that the parking brake is set.

(If any other error codes display or indicator lights identify a problem, note the condition for further service action.)



With the parking brake set, the drive motor should not function. Test this feature by depressing the accelerator pedal after selecting a direction.

Place the direction control in forward and then release the parking brake. The numerical display should now read "-79" to indicate that you have not consciously selected a direction after parking. The drive motor and the The drive motor should not function during this error condition.

Continue this test by selecting reverse before releasing the parking brake. The error code -79 should display and The drive motor should be locked out.

Place the direction control in neutral and release the parking brake. The numerical display should now show the battery status (normal condition). The battery must be recharged if the reading is less than 20 (percent). The truck hydraulics will not function if the reading is less than 15%.

Apply the parking brake

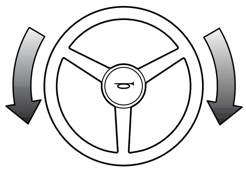
See Groups 13 and 19 for detailed descriptions of all display light functions and status error codes.

Steering (Initial Check)

Key switch is still on. Put the truck in neutral and release the parking brake. Put the direction control in forward then turn the steering handwheel clockwise until the steering hits its stop. Then turn the handwheel counterclockwise and count the revolutions before the steering hits its stop. There should be 5 revolutions from stop to stop. Return the steer wheels to the straight-ahead position.

The steering system components should operate smoothly when the steering handwheel is turned.

Hard steering, excessive play (looseness), or unusual sounds when turning indicates a need for detailed inspection and service as described in Group 25/26.



If the truck has a steering system fault, take the truck out of service until it is repaired.

Hydraulic System

Next you will test the hydraulic control levers and load handling mechanism.

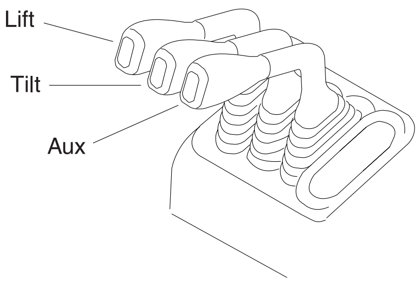
CAUTION

Check for sufficient clearance above and in front of the upright before operating the control levers.

Control Levers

With the parking brake still on, check each control lever in both directions to see that it works as follows:

- Lever has freeplay: You can move the lever slightly without having an effect. The hydraulic pump motor does not start and the load handling mechanism does not move; for instance, the carriage does not lower or lift.
- Lever has lag: You can move the lever slightly more and the pump motor starts without causing lift, tilt, or sideshift to occur. (Lowering occurs without the pump motor starting.)
- Lever actuates load handling function: You can move the lever slightly more and lift, lower, tilt, or sideshift occur slowly in the appropriate direction
- Lever accelerates load handling function: You can move the lever further to increase the speed at which lift, lower, tilt, or sideshift occur.



Carriage, Upright, and Sideshifter

With the parking brake still on, make sure load handling mechanism performs all functions smoothly, fully, and responsively:

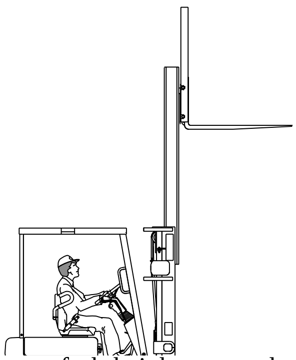
1. Pull back on the tilt control lever and hold until the upright reaches the full back tilt position. Push forward on the lever to tilt it forward. Return the upright to the vertical position and release the lever. Repeat these actions as you observe.
   - If there is excessive play between rails and channels, upright adjustment is required.
   - If there is racking, adjustment of the cylinder rod yokes or shims is required. ("Racking"is when the extension of the two tilt cylinder rods is unequal.)

   The basic adjustment procedure is described later in this Section. Detailed upright checks and adjustments are described in Group 34.

   CAUTION

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

2. Pull back on the lift control lever and raise the carriage to full height. 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 or making "clunking" noises.
   Watch for chain wobble or looseness; the chains should have equal tension and move smoothly without noticeable wobble.
   Release the lever.
   The basic chain adjustment procedure is described later in this Section. Detailed chain inspection and adjustment procedures are in Group 34.

   If the maximum fork height cannot be reached, this indicates there is low oil level in the hydraulic sump or severe binding within the upright.

3. Push forward on the lift control lever. Watch the upright as it lowers. If you suspect a problem with lifting or lowering speeds, refer to Group 34 to diagnose the problem.
4. Check sideshifter action by pushing forward and backward.

Horn, Lights, and Alarms

Test the horn and headlights and other safety devices before moving the truck. Check backup alarms and lights and all other safety equipment as you drive the truck in the following steps.

CAUTION

If the service brake, parking brake, or interlock is not operating properly, take the truck out of service until it is repaired.

Traction and Braking System

Next, drive the truck to test the braking, accelerating, turning and reversing.

WARNING

Fasten your seat belt before driving the truck.

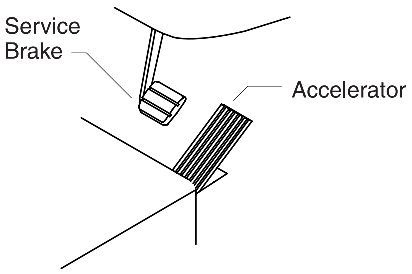
NOTE

After you move the truck, you can check where the truck was parked to see if there are any leaks.

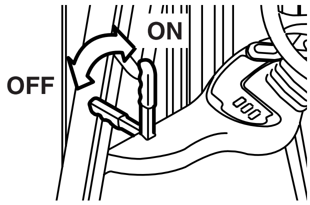
Brakes

Make sure that the truck is on a level surface, the travel area is clear in front of and behind the truck, the parking brake is released, the direction control is in neutral, and the key switch is on. The numerical display should show battery condition with the parking brake off.

1. Move the direction control lever from neutral to forward.
2. Check brakes at creep speed: Release the brake pedal and depress the accelerator pedal to obtain slow forward speed. Apply the brake pedal to ensure that the brakes are sufficient to stop the truck. Pedal should feel firm and drive motor should cut off before brakes apply.



3. Check brake pedal freeplay: Travel again and gently depress the brake the brake pedal. The pedal should drop a very slight distance before the brakes begin to apply.
4. Check brakes at full travel speed: Depress and release the brake pedal several times while driving the truck. The brakes should bring the truck to a smooth stop without pulling, squealing, or shuddering. Drive motor should cut off before brakes apply.
5. 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.
6. Check the function of the parking brake: Park the truck on a grade and apply the parking brake. The parking brake should hold a lift truck with rated load on a 15% grade. Also, when travelling at full speed, application of the parking or service brake should stop the truck in one truck-length.



Release Braking

Release Braking is the automatic slowing of the truck, using the drive motor as a generator, when you lift your foot from the accelerator.

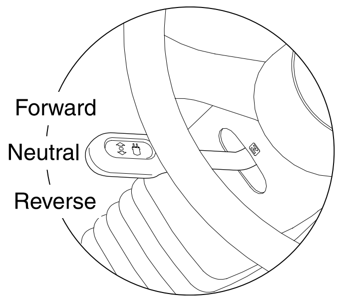
Accelerate to a Medium speed. Take your foot off the accelerator, truck should smoothly brake to a stop (distance depends on the RELEASE BRAKING setting).

When the truck is on a ramp and the accelerator pedal is released, the truck should brake to a stop and then continue the creep down the ramp at approx. 1 MPH.

See Section 19 for adjustment procedures for the Release Braking function.

Controlled Reversal

Accelerate to a slow speed and reverse the direction control without applying the foot brake. Truck should slow to a smooth stop then accelerate normally in the opposite direction.



Repeat in both directions at various speeds.

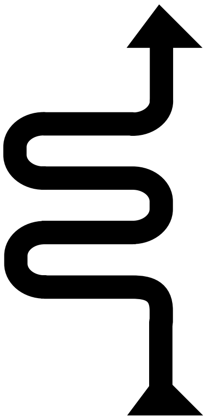
Acceleration

After checking to see that you have a clear path, check acceleration from a stand still condition. Drive the truck in a straight line at a high rate of speed. Acceleration should be smooth and without hesitation. Listen for unusual drive train noise. Repeat in opposite direction.

The accelerator pedal must move easily and smoothly throughout the acceleration stroke and return without binding. There should be no restriction to movement on acceleration or deceleration.

Turning

1. Drive the truck in a straight line. The truck must travel without drifting to either side.
2. Drive slowly (creep speed) through a series of full right and left turns. Check steering response and smoothness of operation.



   - The turning effort must be the same in either direction. You should hear the power steering pump operate over relief when in a full turn.
   - The drive motor control system employs a speed differential between the left and right motors to facilitate turning. If this system is malfunctioning steering can be difficult and wheels can make scrubbing noises.

Refer to Group 26 for steer system troubleshooting information.

Internal Inspection

The internal inspection involves accessing the truck's inner compartments, inspecting the various electrical and hydraulic components, and checking fluid levels.

You can perform much of the inspection as you air clean the truck, which is described later in this Section.

CAUTION

Remove all jewelry (watch, rings, bracelet, neck chains, etc.) before working on electric trucks. Severe burns can result from contact with electrical circuits.

Proceed as follows:

1. Park the truck on a level surface.

IMPORTANT

Fully lower carriage and place upright in vertical position.

Discharging Controller Capacitors

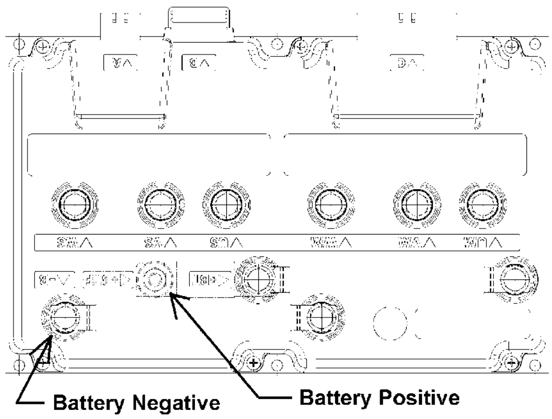
a. Turn off the key, put the direction control in neutral, and set the parking brake.
b. Disconnect the battery connector.
c. Turn the key switch on.

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.



General Checks

Look for:

- Pinched wires
- Frayed or broken cables
- Dirty or loose electrical connections
- Loose or bent linkage pins
- Signs of excessive wear or damage to linkages, hinges, hoses, lines, clamps, and fittings
- Leaks, (often indicated by dust or dirt built up) from pumps, steering gear, and reservoirs and plumbing
- Loose or damaged fasteners and motor mounts.

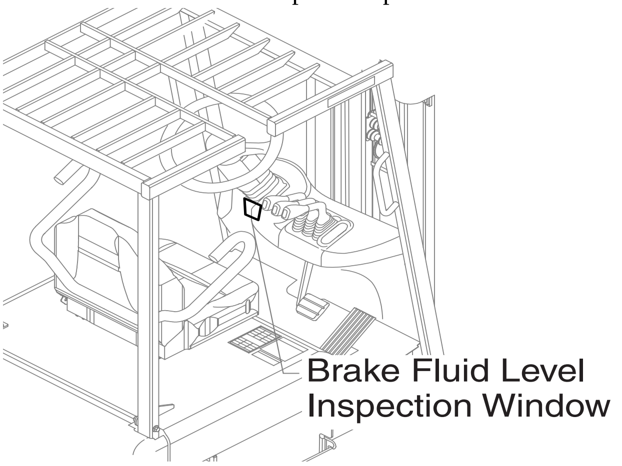
Fluid and Filters

IMPORTANT

Carriage must be fully lowered and upright in vertical position before you check hydraulic fluid.

Brake Fluid

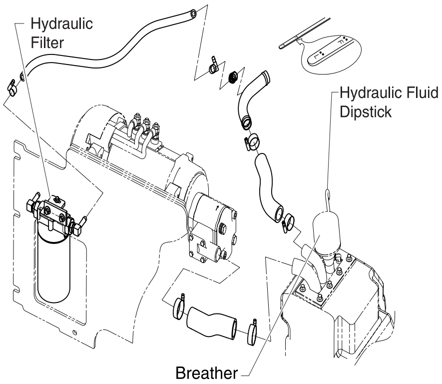
Using a flshlight, check **brake fluid** reservoir through inspection window. Fill to full mark, if low, with DOT 3 BRAKE FLUID. See Group 23 for procedure.



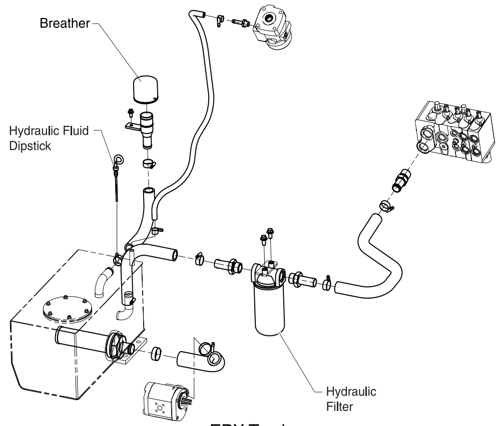
Hydraulic Fuid and Filters

Remove dipstick and check **hydraulic fluid level**. Top off if below full mark as described in Group 29.

Consult the periodic service chart (or service decal) to determine if it is time to replace the **sump cap filter** and/or spin-on **hydraulic filter.** If they are due, their replacement is considered part of the **PM**.



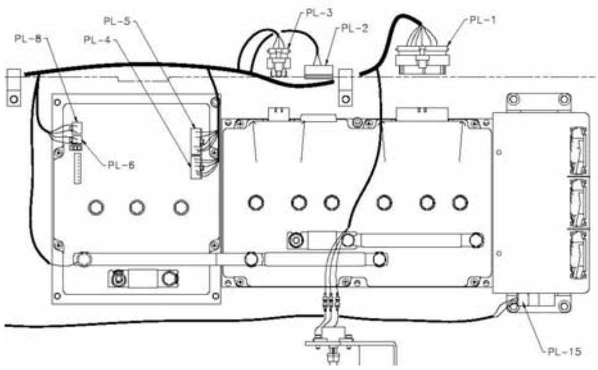
TMX Truck



EPX Truck

Controller Connectors

Pull connectors PL-1 through PL-8 and lubricate terminals with Clark Electrical Connector Grease, part # 2819910.



Make sure all connections are tight.

Battery

Inspect the battery for any damage, cracks, leaking condition, etc. If the terminals are corroded, clean and protect them with CLARK Battery Saver (available from your Clark dealer).

Check six cells with your hydrometer as desribed in Group 12. A consistent reading among the six cells indicates the battery is probably in good condition.

Perform the battery load test described in Group 12.

Air Cleaning the Truck

You must air clean the truck as you perform the internal inspection described earlier in this Section.

CAUTION

Wear suitable eye protection and protective clothing.

CAUTION

Battery must be disconnected and capacitors discharged before inserting air wand into truck compartments.

Use an air hose with special adapter or extension that has a control valve and nozzle to direct the air properly. Use clean, dry, low-pressure compressed air. Restrict air pressure to 30 psi (207 kPa), maximum. (OSHA requirement).

Use air pressure to:

- Blow air into all motor openings from various angles to remove dust.
- Blow off all switches, contactors, motor controls, and all compartment walls.
- Air-clean the upright assembly, drive axle, steering axle, steering cylinder.

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.

Minor Adjustments Covered by PM

As you performed your inspections, you noted all needed adjustments and repairs on the PM report form. Some of these items may be outside the scope of the PM and should be reported for additional service. At this point in the PM, however, you should perform certain adjustment and repairs, if needed. These include:

Switch Adjustments

If any action that is triggered or indicated by a switch does not occur at the right instant, check the switch adjustment. To adjust the switch, slightly loosen the mounting screws and slide the switch to appropriately advance or retard the point at which the switch trips. Retighten the screws. If switch or circuitry is defective, report this on the PM form as a further needed repair.

Parking Brake Adjustment

Adjust the parking brake at the caliper end. Loosen the jamb nut and turn the adjusting nut to increase (or decrease) the slack in the cable. Tighten the jamb nut.

The brake caliper should be fully released when the parking brake handle is in the off position and should be fully applied when the handle is fully back.

See Group 23 for detailed procedure.

Racking Adjustments

Racking adjustments are part of the PM. To eliminate racking on back tilt, add or remove shims as explained in Group 34. For forward racking adjustment, adjust rod end mounting yokes as described in Group 34.

Chain Adjustments

With the upright fully lowered, the tops of the upright rails should be flush with each other within 4 mm (1/8 in). Paired chains should have equal tension. Fork heels should rest 13 to 38 mm (0.5 to 1.5 in) off ground.

Check for chain stretch with chain ruler as described in Group 34.

Basic chain adjustment procedure: With upright and carriage fully lowered, loosen jamb nut on chain anchor, loosen adjusting nut, and turn adjusting nut to obtain correct length/tension. Tighten jamb nut.

See Group 34 for detailed procedure.

Missing or Loose Fasteners

Replace/tighten missing or loose fasteners during the PM. This incudes bolts, cotter pins, cable ties, and so on.

Chassis Lubrication

Lubrication requirements are given on the truck's service decal (which is shown in Section 1 of this Group.)

At each PM, check the drive axle fluid and grease the fittings at the upright pivot points and steer wheel.

Consult the service decal or periodic service chart to identify other lubrications that are due (for example, wheel bearings) and report these on the PM form.

Be sure to clean the grease fittings before lubricating. Remove the excess grease from all points after lubricating. Lubricate miscellaneous linkage as needed.

Drive Axle Lubrication

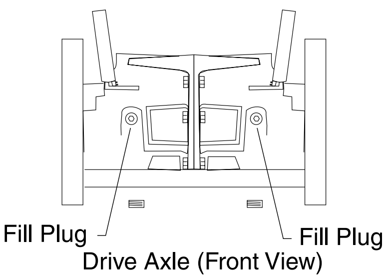
WARNING

To access the drive axle raise and block the upright using safe procedures described in Section 2, "Lifting and Jacking Procedures" of Group 2, "Safe Maintenance."

Check the drive axle fluid level with:

- Truck on a level surface.
- Oil at operating temperature.

1. Remove the fluid level inspection/fill plug located in the front surface of each drive unit housing (two places).
2. The oil level is correct (FULL) when it is within 13mm (0.5 in) of the lower edge of the inspection plug opening.
3. IMPORTANT: Add recommended fluid only, as indicated on service decal. After adding oil to the drive axle, wait several minutes until the oil has distributed evenly throughout the unit, and check for correct oil level. DO NOT OVERFILL.
4. Inspect each fill plug for damage. Replace as necessary.

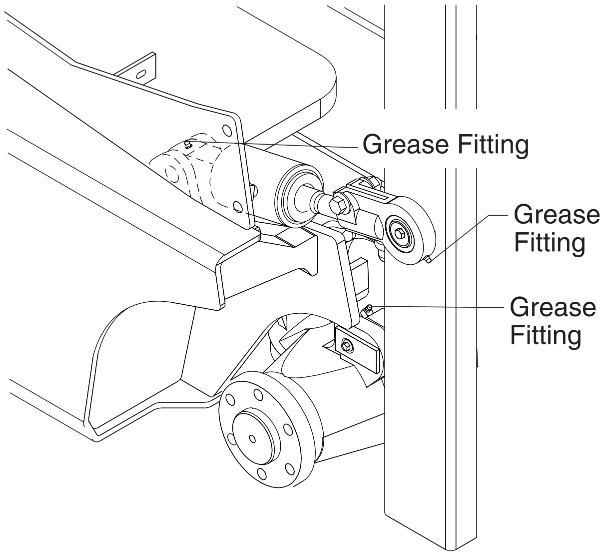


Drive Axle (Front View)

5. Install and tighten the plugs.

Upright and Tilt Cylinder Lubrication

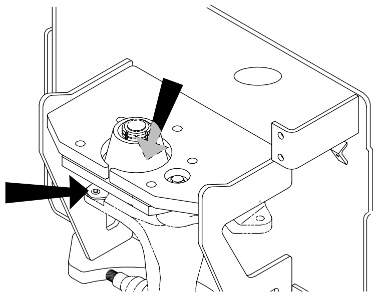
Clean the fittings and lubricate the tilt cylinder rod end bushings (forward end). Clean the fittings and lubricate the tilt cylinder base rod end bushings (rear end). Clean and lubricate the upright trunnion bushings.



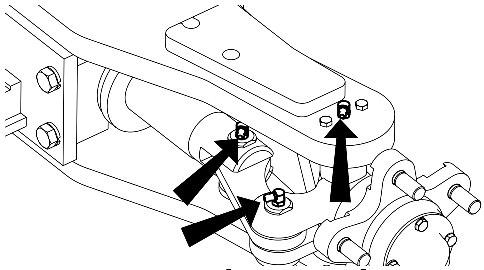
Steer Axle Lubrication

Pivot the drive wheel to gain access to the grease fittings.

Grease with lubricant specification NLG # 1.



TMX Steer Axle Grease Fittings. Locate two fittings by pivoting wheel.



EPX Steer Axle Grease fittings. Locate six fittings.

Critical Fastener Torque Checks

For safety, maintain correct torque on all fasteners of components that directly support, handle, or control the load and protect the operator.

Check torque of critical items, including:

- Drive axle mounting
- Drive and steer wheel mounting
- Counterweight mounting
- Overhead guard mounting
- Tilt cylinder mounting and yokes
- Upright mounting and components.

Critical fastener torque specifications are given in the general specifications Section of Group 40.

Wrapping Up the PM

Clean Up

Before closing up the truck, wipe up any spilled fluids and hand prints you may have left.

After closing up the truck, wipe off any handprints, drips, spills, or other blemishes caused by the PM. It's a good practice to leave the truck looking noticeably better than when you started.

Clean up any spills or debris you left on the floor or other surfaces.

Test the Truck

Operate the truck one last time to ensure that you identified all problems and that your repairs/adjustments were successful.

Report the PM

Finish filling out your PM form, making sure you noted everything you checked, all the problems you found, and all the items you adjusted or repaired.

Take the PM form to the person responsible for lift truck maintenance, present your results, discuss any problems, and point out where further service is needed.

Section 3

The PM Inspection Form

- As an aid to service technicians performing and documenting PM inspections, Clark has prepared an 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 and/ or adjustments.

ELECTRIC AC TRUCK PLANNED MAINTENANCE REPORT

CODE	
OK	3 OK
Potential	X Adjust (Not PM)
Urgent	r Repair or Peplace
	$ Requires Shop Rep

CUSTOMER		Date	Hour Meter
		Date Last PM	HRS. Last PM
MODEL & SERIAL NO.		CUST PO. NO.	
AUTHORIZED SIGNATURE	INSPECTOR	SPECIAL INSTRUCTIONS	

A. TEST DRIVE MACHINE	**16 MOTORS**	**23 BRAKE SYSTEM**	**32 TILT CYLINDERS**
a. Drive Train Noise	a. Drive Motor Condition	a. Check for Leakage	a. Check for Leakage
b. Steering Operation	b. Pump Motor Condition	b. Brake Resivouir Fluid Level	b. Cylinder Rod Condition
c. Service Brake Operation		c. Clean Vent Cap	c. Mounting Security / Torque
d. Speed Control		d. Pedal Free Travel	d. Tilt Cylinder Adjustment (Racking)
Creep Speed		e. Pedal Drift	
e. Plugging & Directional Control	**19 ELECTRICAL TESTS**	f. Master Cylinder Mounting	**34 UPRIGHT - CARRIAGE**
f. Return to Neutral	a. Groung Test	g. Service Brake Wear / Adjustment	a. Security of Mounting
g. Hydraulic System Operation	b. Cable & Terminal Condition	h. Park Brake Wear / Adjustment	b. Roller Condition / Clearance
h. Padal Pads & Linkage	c. Wire Harness Condition	i. Brake Line Cable Condition	c. Chain & Anchor Condition
i. Parking Brake Operation	d. Accelerator Test	j. Brake Linkage Check & Lubricate	d. Chain Adjustment
j. Seat Switch (Brake) Operation	e. Contactor Assemblies		e. Latch and Stop Condition
k. Pedestrain Warning Devices	f. Contactor Tip Condition	**26 Steer Axle**	f. Cylinder Condition
(if equipped)	g. Service Brake Switch Operation	a. Security of Mounting	g. Forks, Locks, Stops
	h. Parking Brake Switch Operation	b. Axle Stop Adjustment	h. Rail Condition
01 CLEANING & LUBRICATION	i. Seat Switch Operation	c. Drag Link Adjustment	i. Trunion Ring Condition
a. Air Clean Truck	j. S.R.O.	d. Check Wheel Bearings	
b. Air Clean Electrical Controls	k. P.M.T.		**34 LOAD BACK REST**
c. Air Clean All Motors	l. Speed Limit Switches	**27 STEERING SYSTEM**	a. Condition
d. Lubricate Truck	m. Steering Transducer	a. Check for Leakage	b. Security of Mounting
	n. Hydraulic Valve Switches	b. Oil Level - Condition	
12 BATTERY AND CABLES	o. Lift Valve Transducer	c. Security of Mounting	**38 SHEET METAL & CTW**
a. Cable Condition		d. Tilt Column Operation	a. Decals - Missing / Condition
b. Electrolite Level			b. Data Plate Condition
c. Battery Load Test	**20 DRIVE AXLE**	**29 HYDRAULIC SYSTEM**	c. Seat Mounting & Operation
d. Battery Retention Stops	a. Differential Fluid Level	a. Check for Leakage	d. Seat Belts Condition
e. Specific Gravity	b. Clean Air Vent	b. Fluid Level - Condition	e. Door & Deck Latches
f. Receptacle Condition	c. Security of Mounting	c. Clean / Replace Breather	f. CTW Mounting Bolts
g. Battery Connector Condition	d. Check Wheel Bearings	d. Replace Filter	g. Slip Ressistance Surfaces
h. Battery Disconnect Condition		e. Linkage Adjustment	h. Operators Manual
	23 WHEELS & TIRES	f. Hose Condition	
13 GAUGES - LIGHTS - INDICATORS	a. Tighten Mounting Bolts	g. Lift Speed (In./Sec)	**39 OVERHEAD GUARD**
a. Hour Meter	b. Tire Condition	No Load	a. Condition
b. Gauges - All Operate	c. Drive	Full Load	b. Security of Mounting
c. Lights - All Operate	d. Steer	h. Drift Teas (In./Sec)	
d. Wiring Condition	e. Tire Pressure	Lift Cylinder	**53 ATTACHMENTS**
e. Horn		Tilt Cylinder	a. Mounting Bolts
f. Lift Interrupt			b. Leakage
g. Operation of Accessories			c. Operation

GROUP 12

BATTERY

NOTE :

Section 1

Battery Service

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

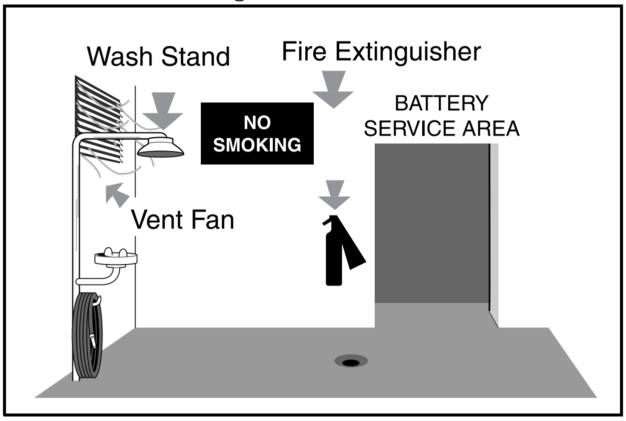
Battery service must be done by trained personnel. Battery acid can cause severe burns and injury. Do not smoke or have open flames around batteries.

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.

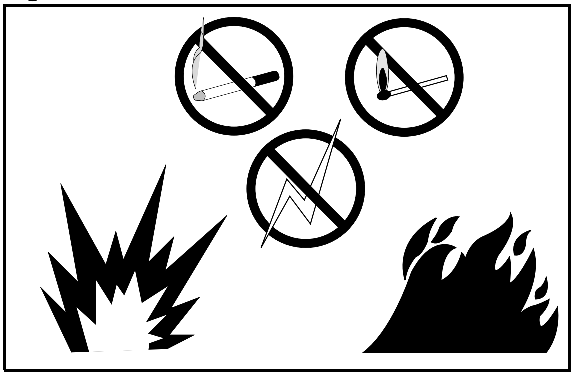
- Be sure this area has provisions to flush and neutralize acid spillage.
- Be certain the area has proper ventilation to ventilate fumes from charging batteries.
- Check to see that there is fire protection. Fire extinguishers should be properly maintained and located in designated areas.



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:

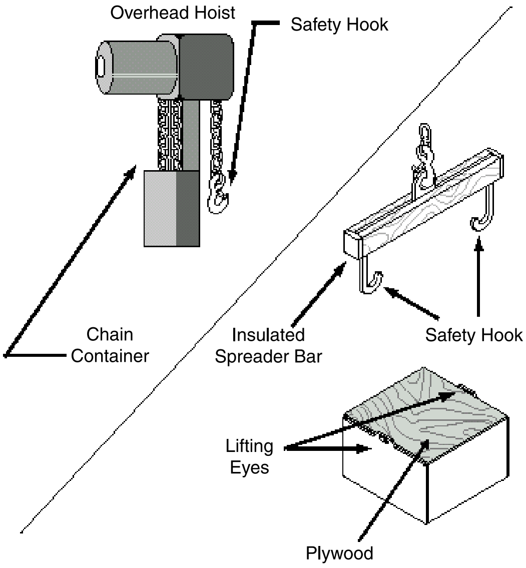
- Face and head shields
- Long shirt sleeves
- Gauntlet gloves
- Rubber apron

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

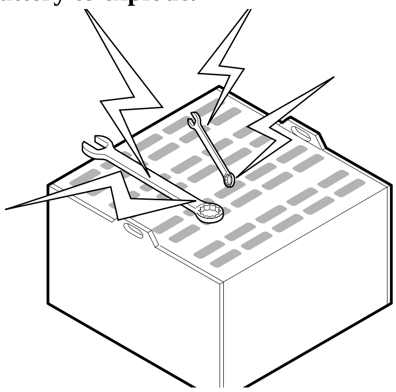
To prevent side forces from damaging the battery, the distance between the lifting hooks (of the spreader bar) must be adjusted to the same dimension as measured between the battery lifting eyes. Make sure the lifting hooks are the correct size to fit the lifting eyes of the battery.

- 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

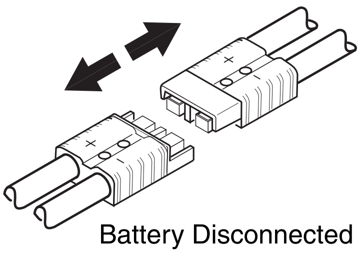
1. Move truck to the designated battery service area.

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.



Battery Disconnected

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.

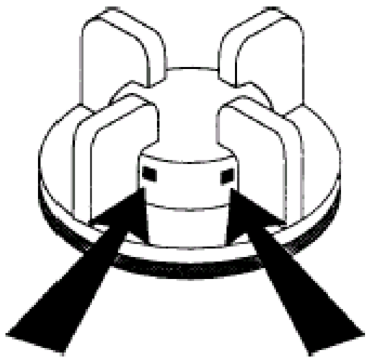
Industrial batteries are used to supply the electrical power to operate an electric industrial truck. Their voltage depends on the number of individual cells they contain. There are approximately two volts for each cell in the commonly used lead-acid type battery. Batteries normally range from 6 volts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

Maximum Battery Life

- 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 andcould 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 vent caps must be tightly in place.



Keep Vents Holes Clear

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.

CAUTION

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.

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.

Battery Installation

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, if applicable.
- 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.

Battery Tests

NOTE

Use both tests described here.

Specific Gravity Test

Test at least six cells across battery with a temperaturecorrected 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

The battery specific gravity is an indication of the battery's state of charge. You can determine the specific gravity of the electrolyte solution in a battery with an hydrometer. If the state of charge is low, the hydrometer will read low. If the state of charge is high, the hydrometer will read high.

For, example a reading from:

- 1.260 to 1.300 indicates a fully-charged battery.
- 1.200 to 1.220 indicates a battery is in a discharged condition and cannot give satisfactory service.

Load Test

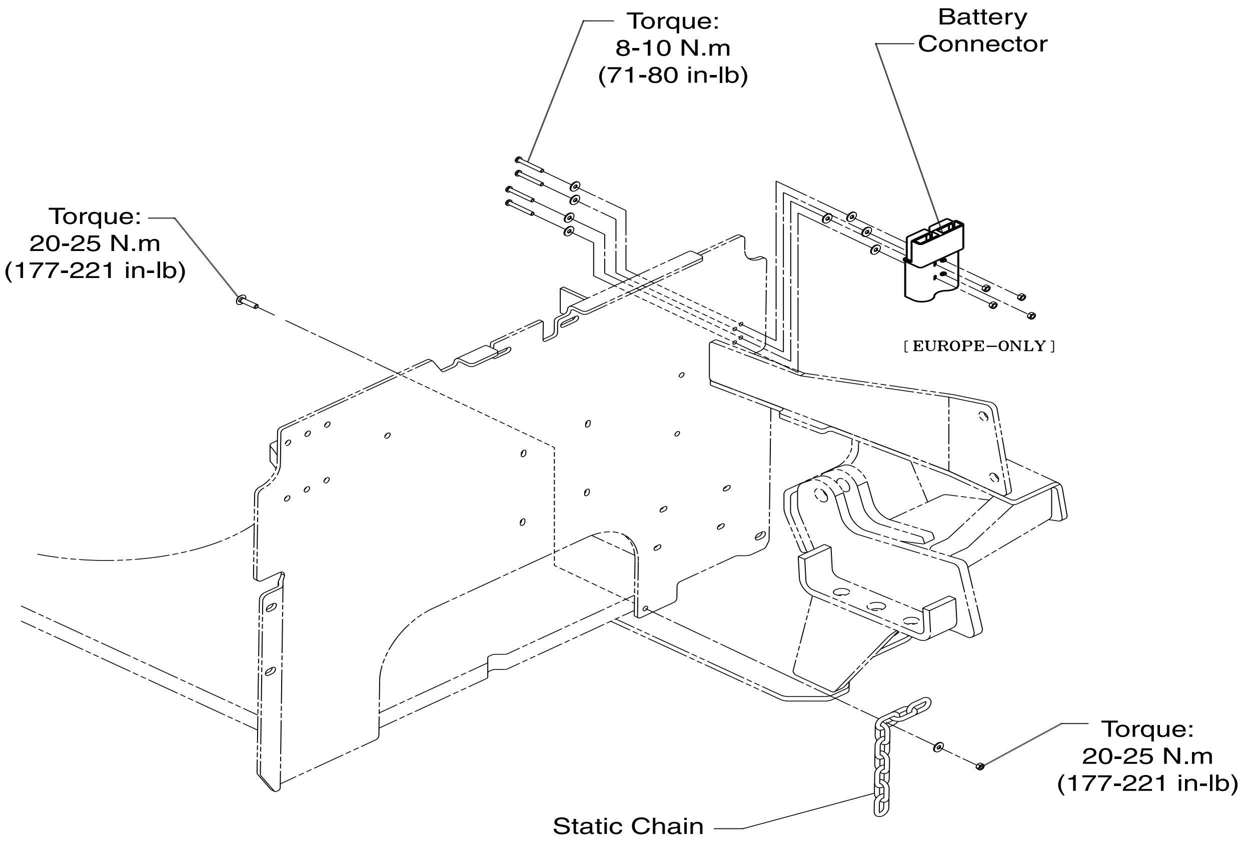
Put the main hydraulic system into tilt by-pass while reading battery volts with a voltmeter.

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

Minimum acceptable readings:

- 36 volt battery: 28.8 volts
- 48 volt battery: 38.4 volts

Connector, Negative Terminal, and Static Chain Installation



NOTE

See Group 13 for cable and wiring routing and connection illustrations.

Static Chain: Chain must make good contact with the floor to ensure proper grounding of the truck. Replace or adjust chain as follows:

New Chain: Fasten at third link.

Worn Chain: Fasten at first link.

Batterry: Connectors must be clean, securely mounted, tight-fitting, and show no cracking.

NOTE :

GROUP 13

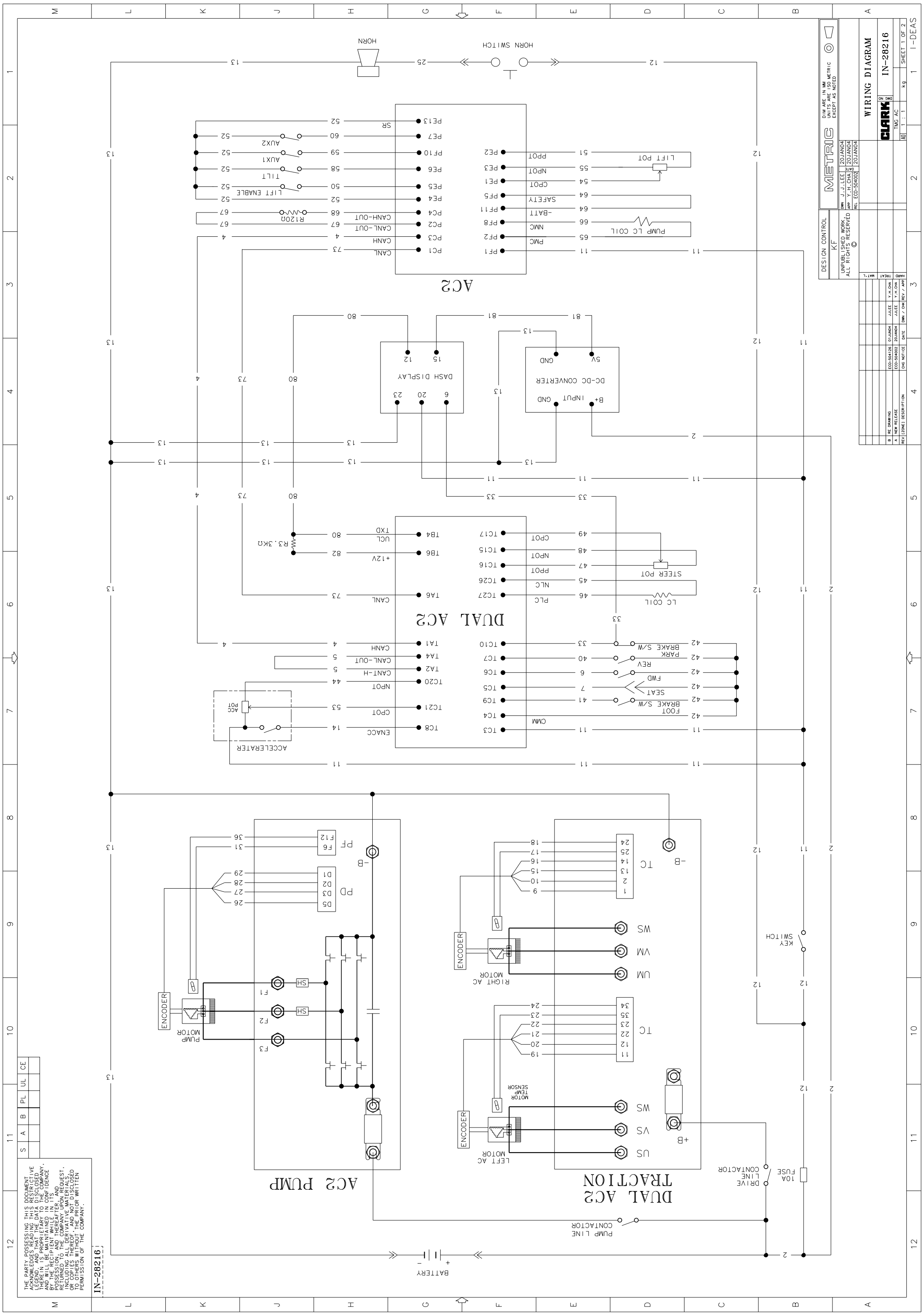
WIRING, SWITCHES, AND INSTRUMENTS

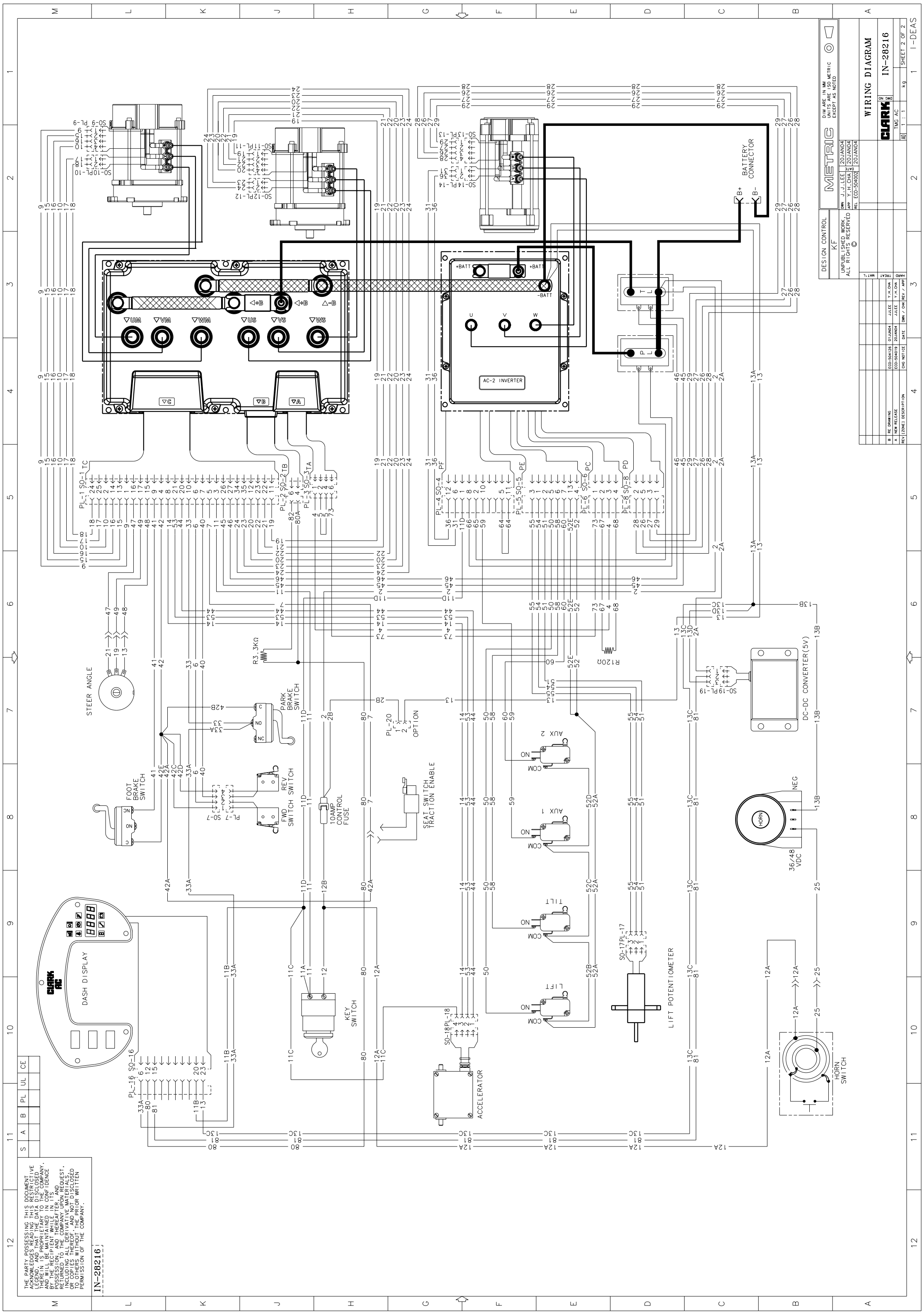
NOTE :

Section 1

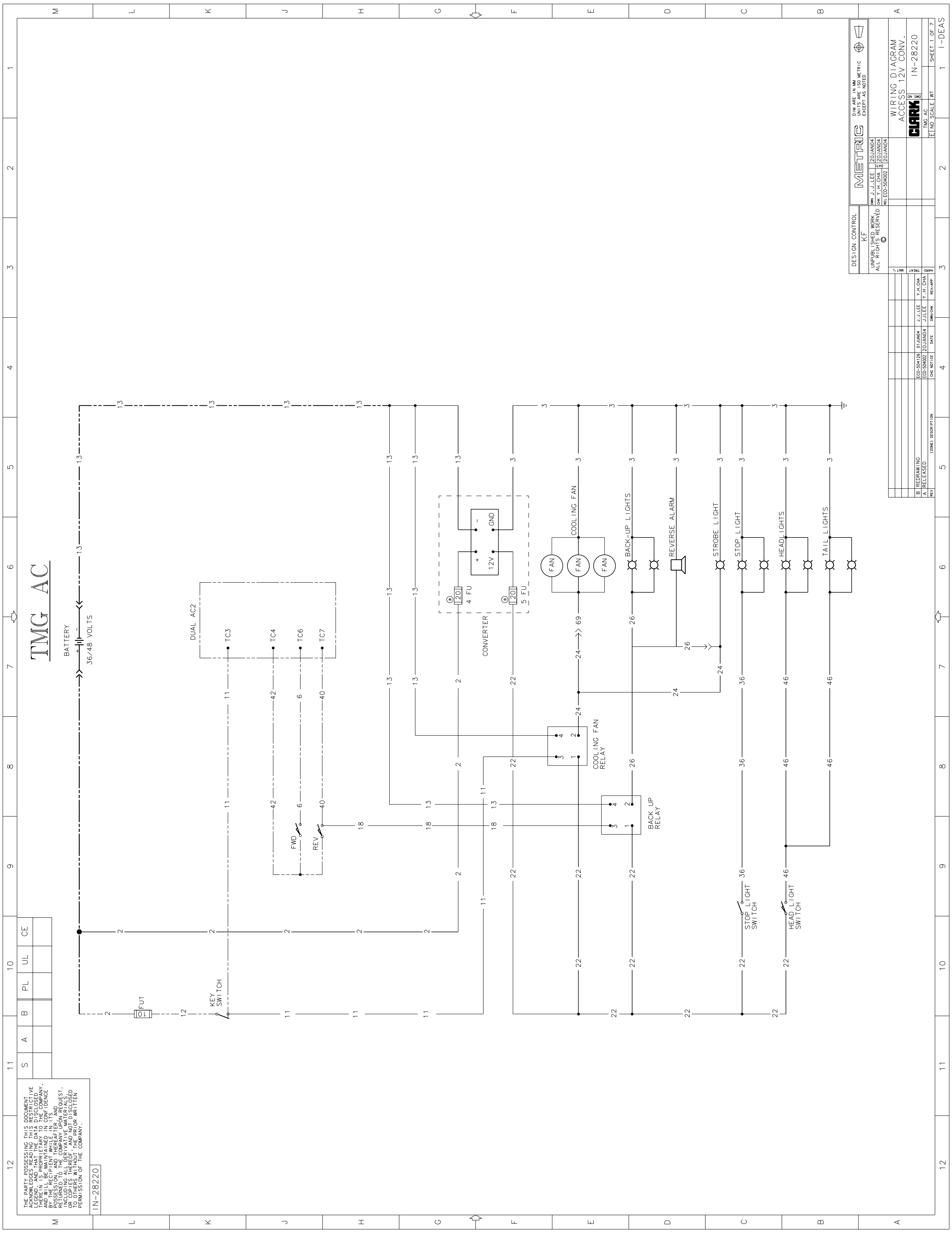
Schematic Electric Circuit Diagrams

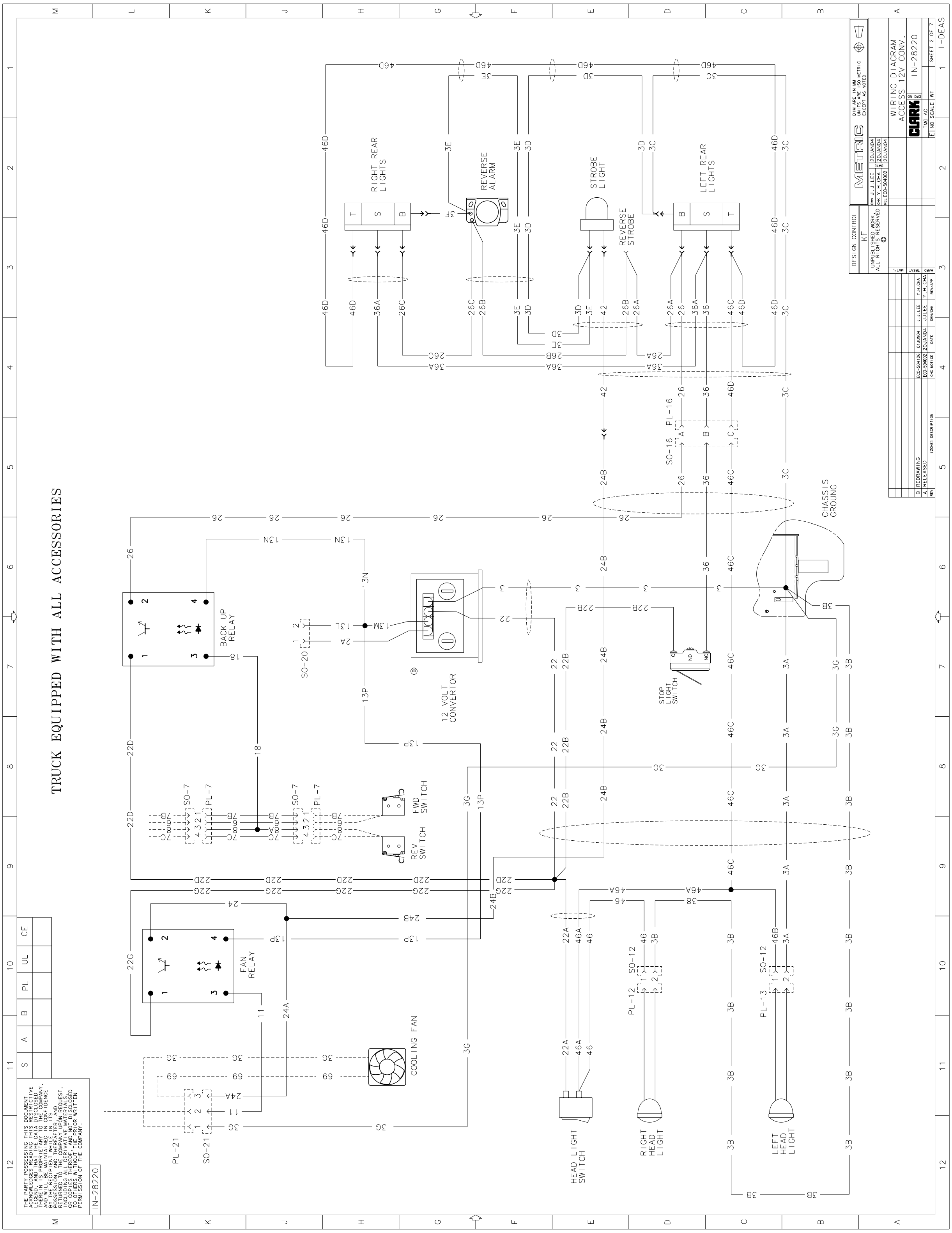
Standard Truck(TMX)

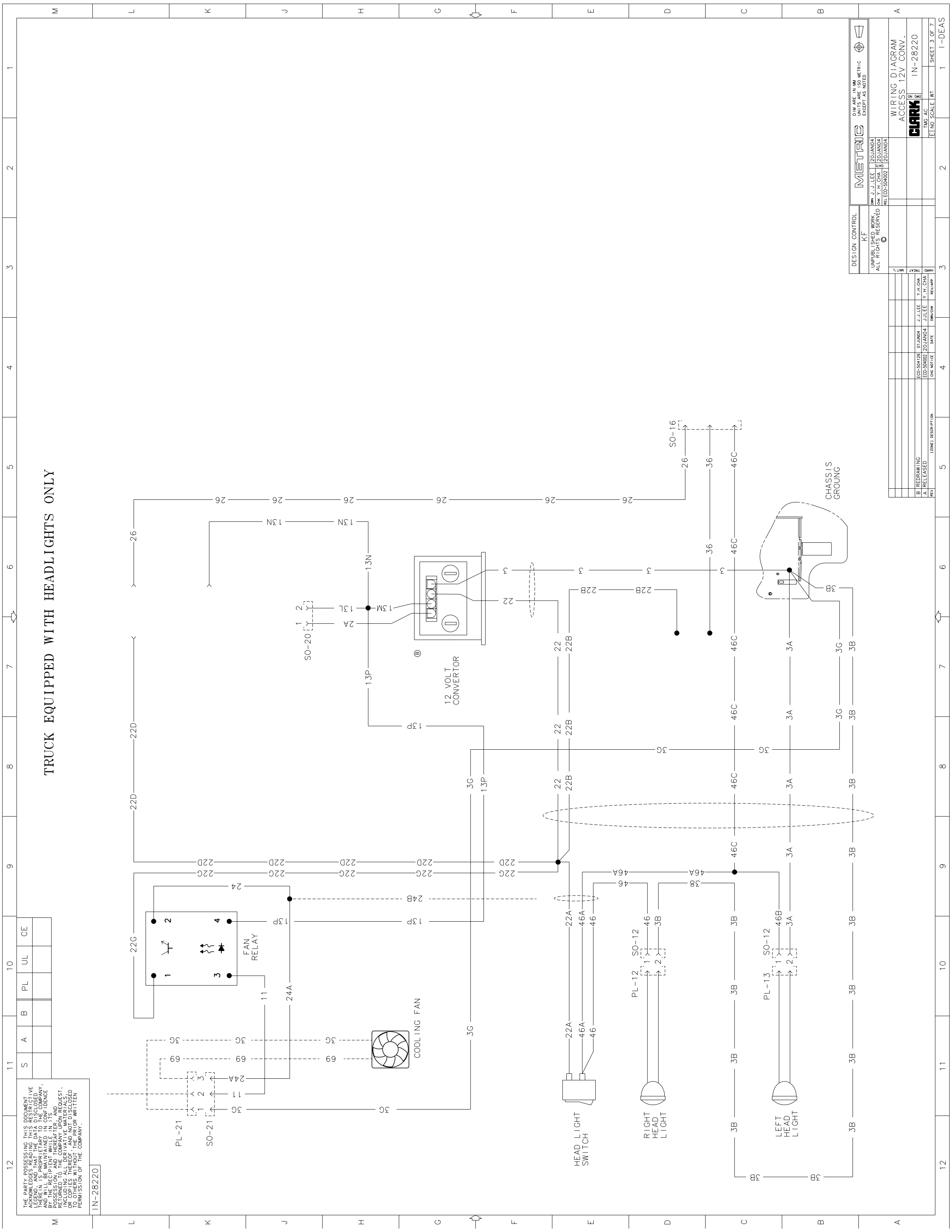


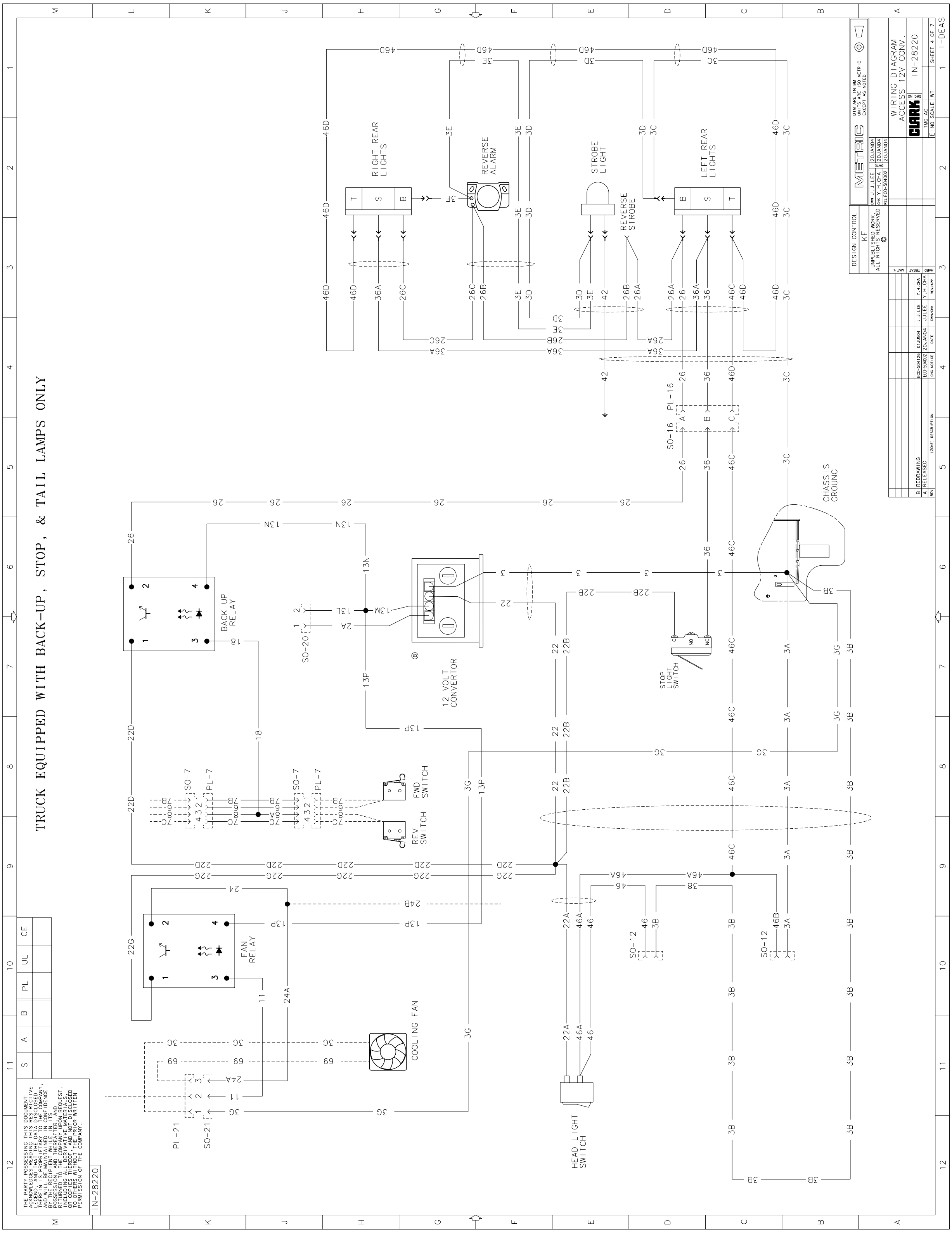


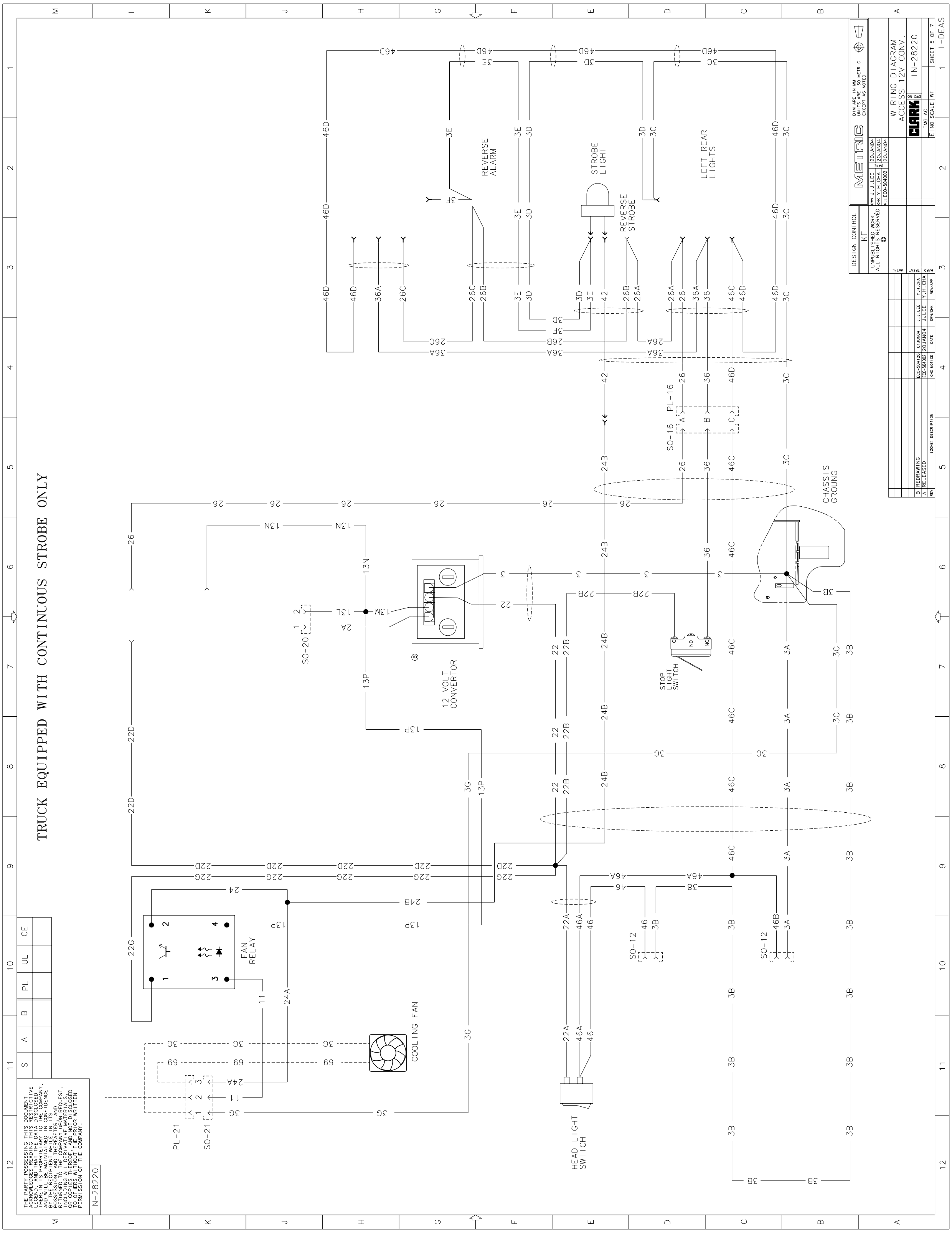
Accessories(TMX)

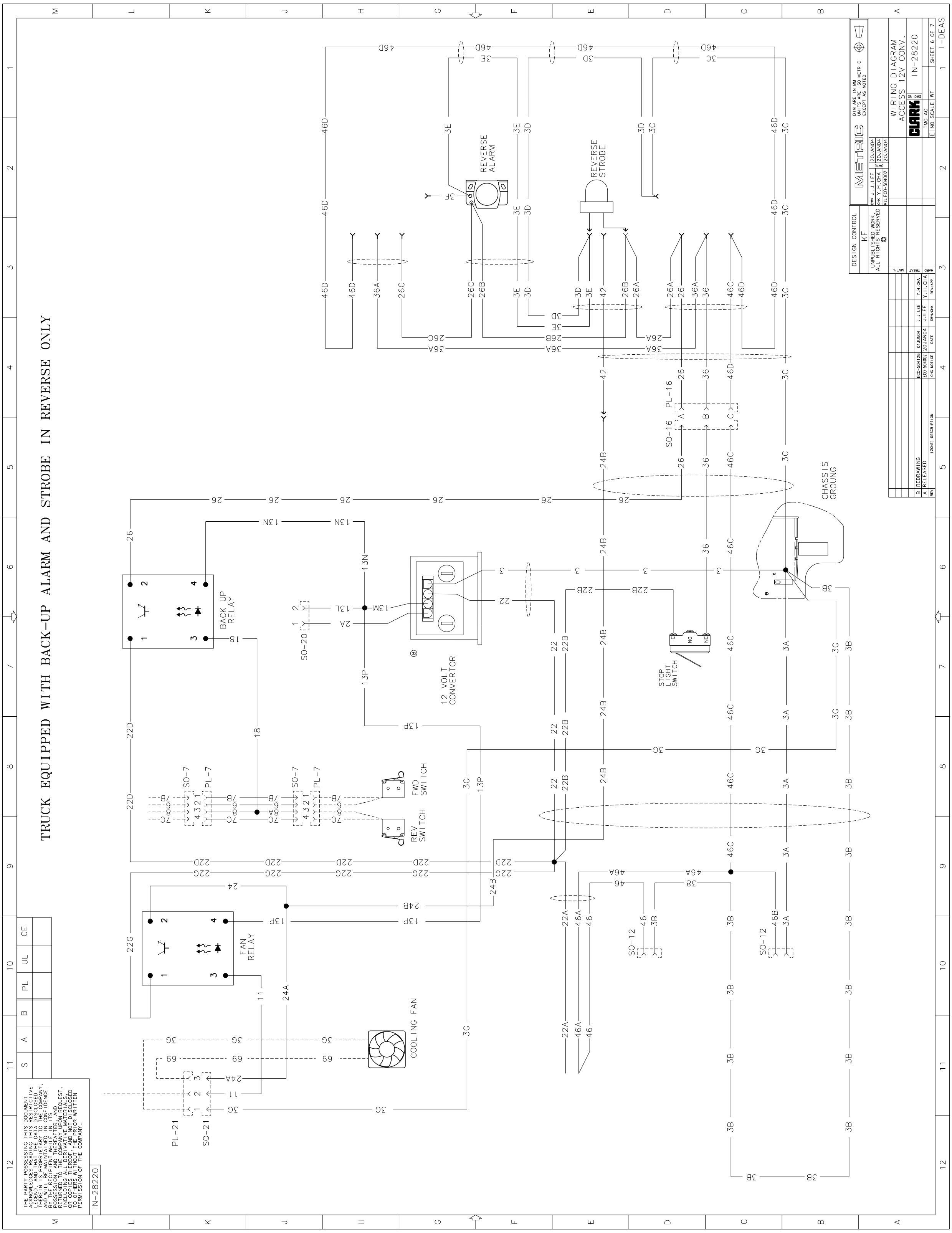


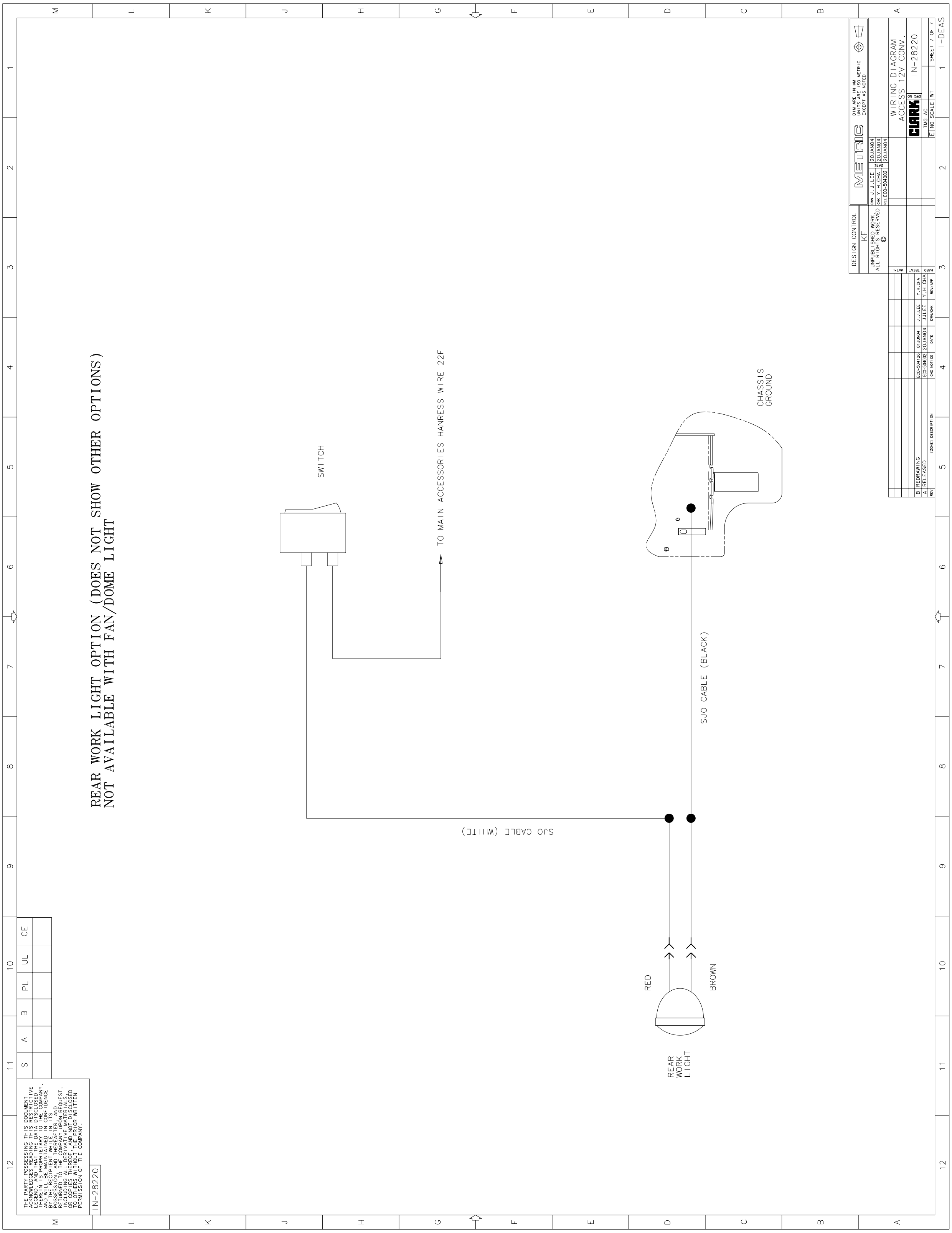

TRUCK EQUIPPED WITH ALL ACCESSORIES
WIRING DIAGRAM
ACCESS 12V CONV.
IN-28220
RIGHT REAR LIGHTS
REVERSE ALARM
STROBE LIGHT
REVERSE STROBE
LEFT REAR LIGHTS
CHASSIS GROUND
BACK UP RELAY
12 VOLT CONVERTOR
STOP LIGHT SWITCH
FWD SWITCH
REV SWITCH
FAN RELAY
COOLING FAN
HEAD LIGHT SWITCH
RIGHT HEAD LIGHT
LEFT HEAD LIGHT


TRUCK EQUIPPED WITH HEADLIGHTS ONLY
WIRING DIAGRAM
ACCESS 12V CONV.
IN-28220
12 VOLT CONVERTOR
FAN RELAY
COOLING FAN
HEAD LIGHT SWITCH
RIGHT HEAD LIGHT
LEFT HEAD LIGHT
CHASSIS GROUND
DESIGN CONTROL
KF

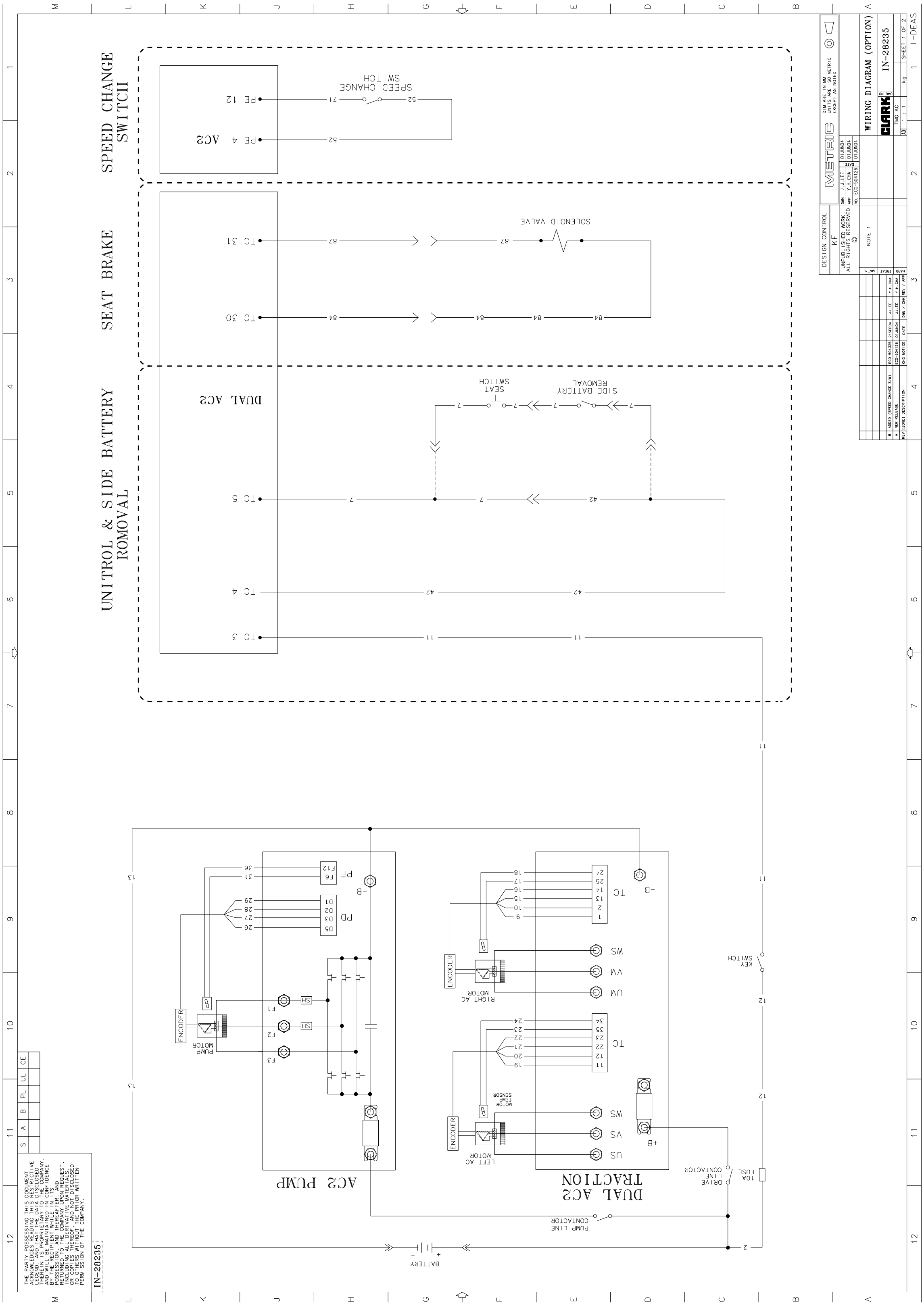

TRUCK EQUIPPED WITH BACK-UP, STOP, & TAIL LAMPS ONLY
RIGHT REAR LIGHTS
REVERSE ALARM
STROBE LIGHT
REVERSE STROBE
LEFT REAR LIGHTS
CHASSIS GROUND
BACK UP RELAY
12 VOLT CONVERTOR
STOP LIGHT SWITCH
FWD SWITCH
REV SWITCH
FAN RELAY
COOLING FAN
HEAD LIGHT SWITCH
WIRING DIAGRAM ACCESS 12V CONV.
IN-28220

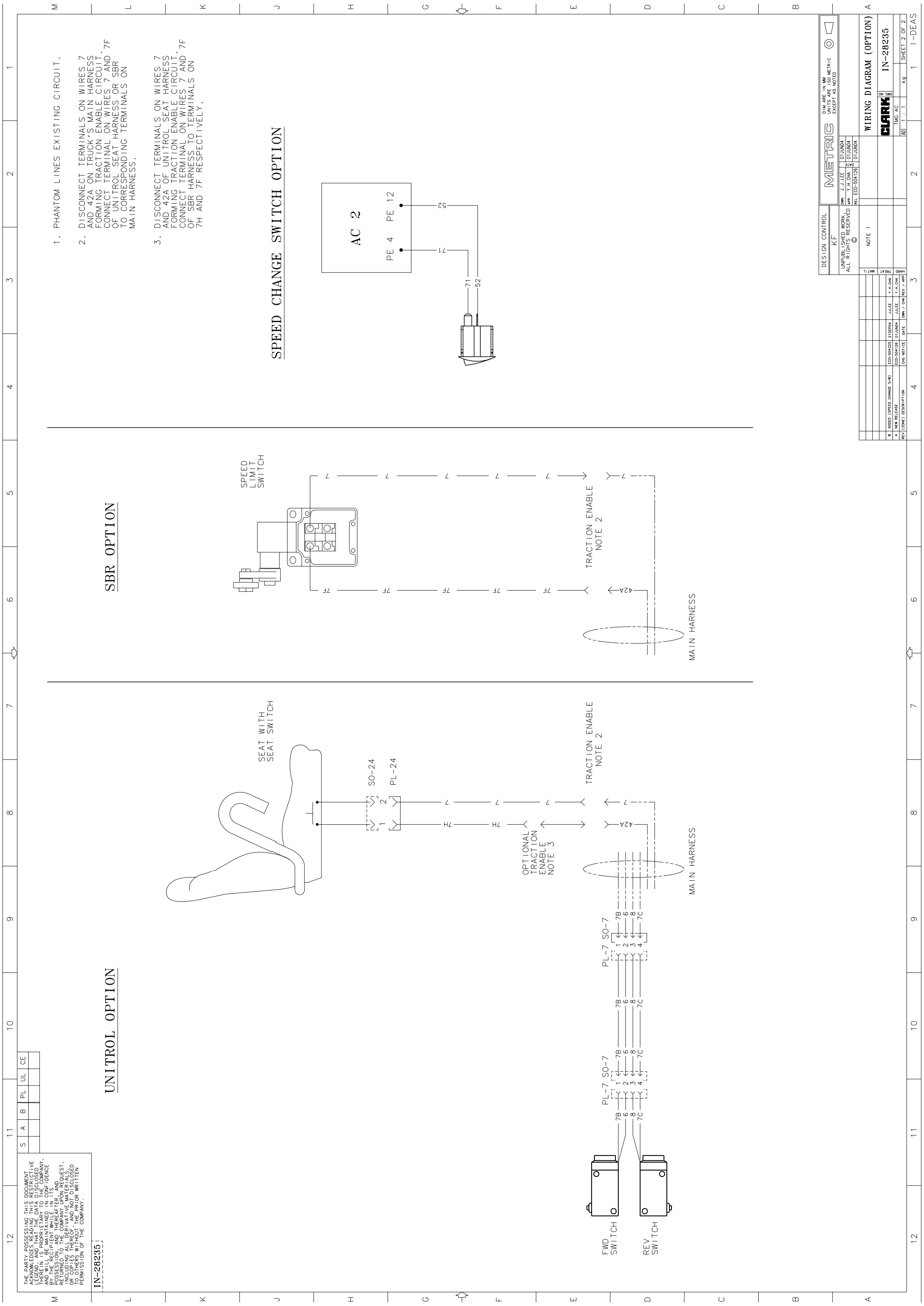

TRUCK EQUIPPED WITH CONTINUOUS STROBE ONLY
REVERSE ALARM
STROBE LIGHT
REVERSE STROBE
LEFT REAR LIGHTS
CHASSIS GROUND
12 VOLT CONVERTOR
STOP LIGHT SWITCH
FAN RELAY
COOLING FAN
HEAD LIGHT SWITCH
WIRING DIAGRAM
ACCESS 12V CONV.
IN-28220


TRUCK EQUIPPED WITH BACK-UP ALARM AND STROBE IN REVERSE ONLY
REVERSE ALARM
REVERSE STROBE
BACK UP RELAY
FAN RELAY
12 VOLT CONVERTOR
STOP LIGHT SWITCH
FWD SWITCH
REV SWITCH
COOLING FAN
CHASSIS GROUND
WIRING DIAGRAM ACCESS 12V CONV.
IN-28220

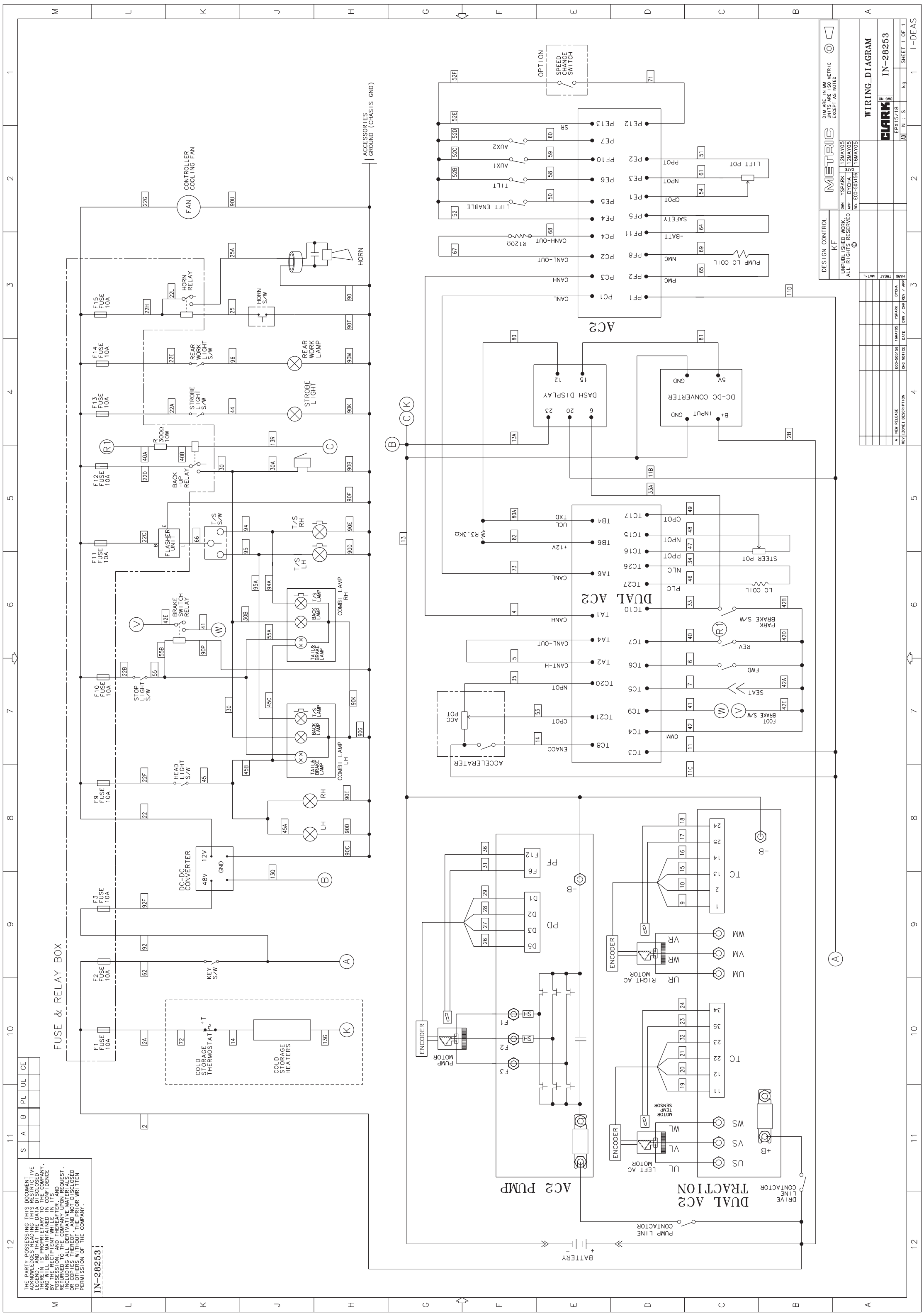

REAR WORK LIGHT OPTION (DOES NOT SHOW OTHER OPTIONS)
NOT AVAILABLE WITH FAN/DOME LIGHT
SWITCH
TO MAIN ACCESSORIES HANRESS WIRE 22F
CHASSIS GROUND
SJO CABLE (BLACK)
SJO CABLE (WHITE)
RED
BROWN
REAR WORK LIGHT
DESIGN CONTROL
KF
METRIC
WIRING DIAGRAM
ACCESS 12V CONV.
IN-28220
I-DEAS
B REDRAWING
A RELEASED
S
A
B
PL
UL
CE

Options(TMX)


SPEED CHANGE SWITCH
SEAT BRAKE
UNITROL & SIDE BATTERY ROMOVAL
DUAL AC2
DUAL AC2 TRACTION
AC2 PUMP
WIRING DIAGRAM (OPTION)
IN-28235


1. PHANTOM LINES EXISTING CIRCUIT.
2. DISCONNECT TERMINALS ON WIRES 7 AND 42A ON TRUCK'S MAIN HARNESS FORMING TRACTION ENABLE CIRCUIT. CONNECT TERMINAL ON WIRES 7 AND 7F OF UNITROL SEAT HARNESS OR SBR TO CORRESPONDING TERMINALS ON MAIN HARNESS.
3. DISCONNECT TERMINALS ON WIRES 7 AND 42A OF UNITROL SEAT HARNESS FORMING TRACTION ENABLE CIRCUIT. CONNECT TERMINAL ON WIRES 7 AND 7F OF SBR HARNESS TO TERMINALS ON 7H AND 7F RESPECTIVELY.
SPEED CHANGE SWITCH OPTION
AC 2
PE 4
PE 12
SBR OPTION
SPEED LIMIT SWITCH
TRACTION ENABLE NOTE 2
MAIN HARNESS
UNITROL OPTION
SEAT WITH SEAT SWITCH
SO-24
PL-24
OPTIONAL TRACTION ENABLE NOTE 3
PL-7 SO-7
FWD SWITCH
REV SWITCH
WIRING DIAGRAM (OPTION)
IN-28235

Standard Truck(EPX)



NOTE :

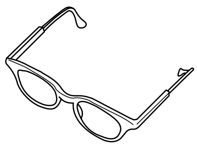
Section 2

General Electrical Service Tips

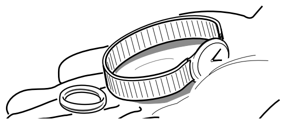
General Electrical Service Tips

⚠ CAUTION

Always wear safety glasses.

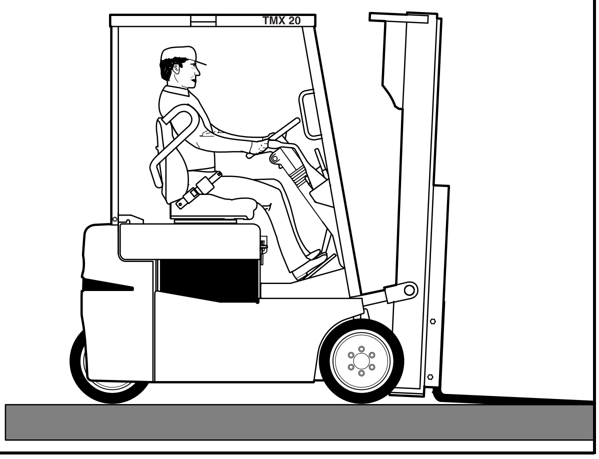


Remove all jewelry before working on truck.



1. Move truck to service area:

. Park truck on a flat level surface.
. Fully lower upright.
. Tilt forks forward until fork tips touch the floor.



2. Disable the truck:

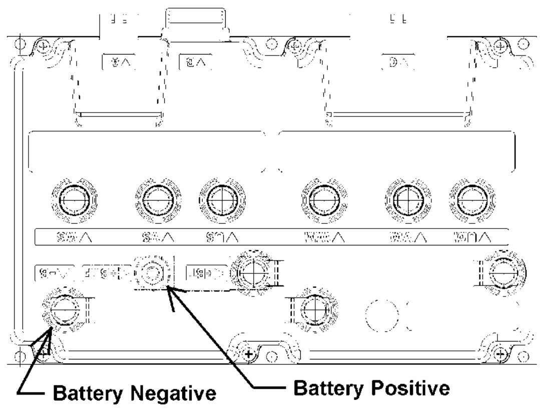
- Turn the key switch to OFF.
- Remove key.
- Make sure battery is disconnected.

3. Discharging Controller Capacitors

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

NOTE

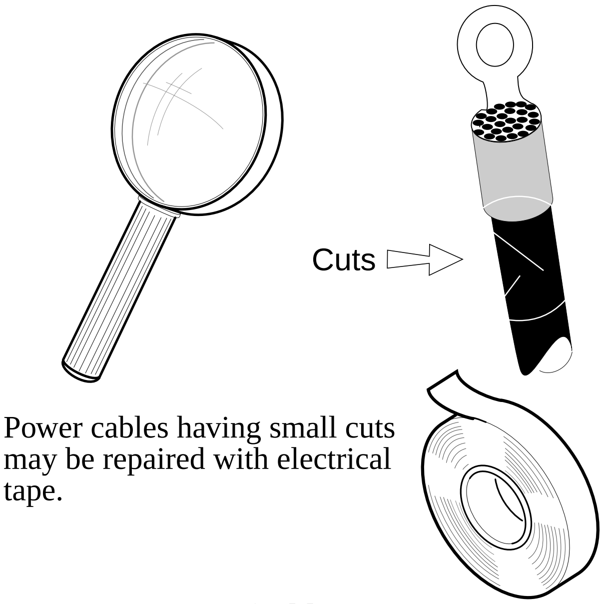
Make sure that the battery has first been disconnected at the battery receptacle.



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

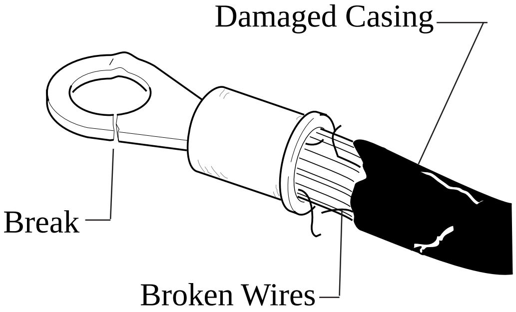
Checking Power Cables

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

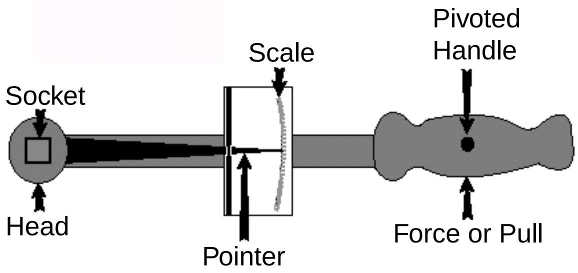


Cable Unfit for Further Service

Torquing Fasteners

Improperly torqued fasteners can cause damage

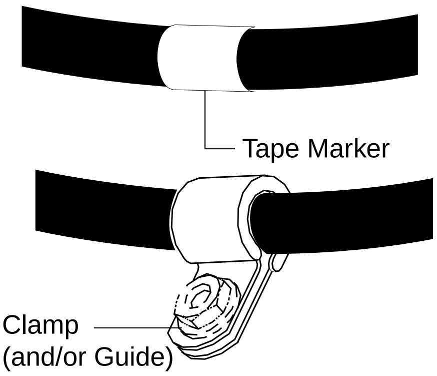
Use an appropriate wrench and tighten all fasteners to the torque specified in the following inspection procedures.



Typical Torque Wrench

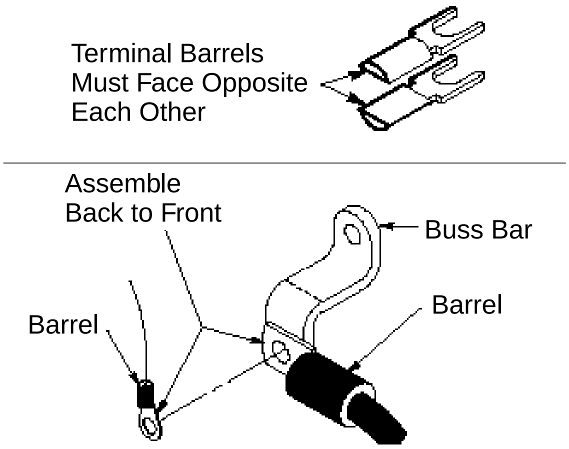
Connecting and Mounting Components

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.



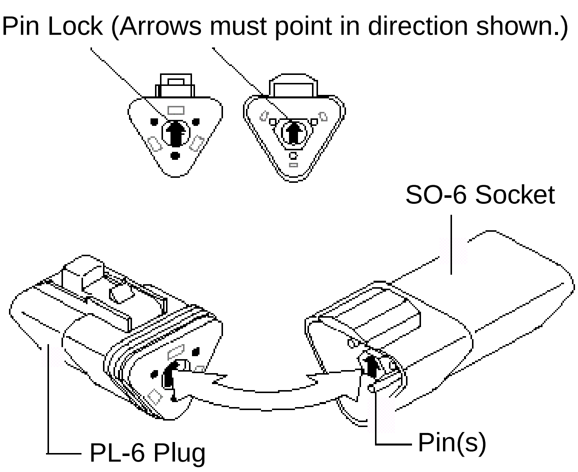
Markers on Wire Harnesses and Power Cables

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



Multiple Connections

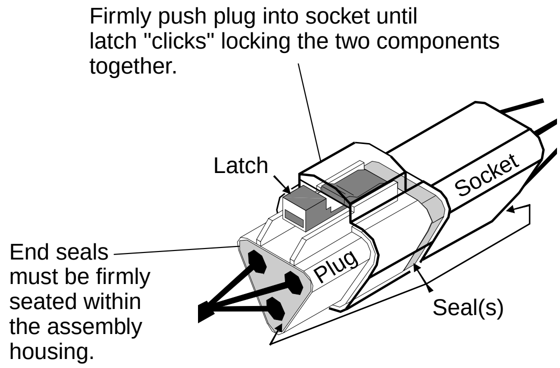
Connector Plugs and Receptacles are permanently labeled with the proper PL (Plug) and SO (Socket/Receptacle) number for easy identification. Match the plug number with the appropriate receptacle number before making a connection. If you do not, electrical shorts and possible damage to the equipment may 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.

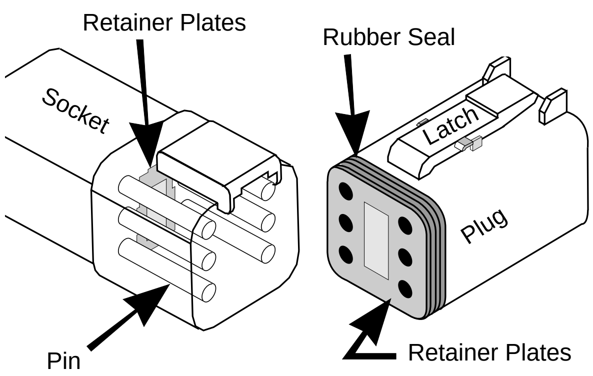
Check seals for damage that would make them unfit for furtherservice (cuts, etc.). Make certain the end seals are seated flush with the end of the connector housing. Make certain the plug and socket latchtightly to each other.



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

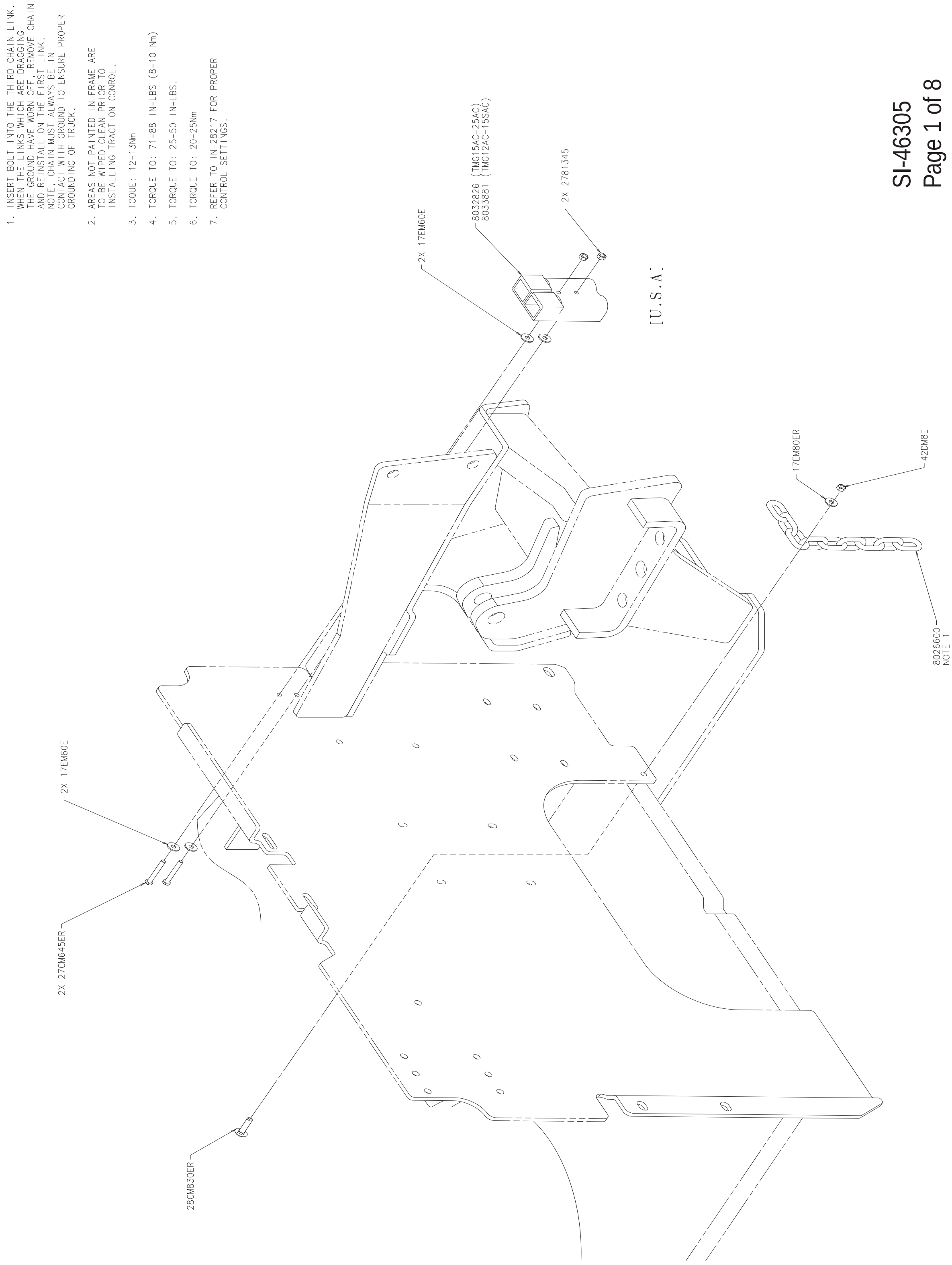
NOTE :

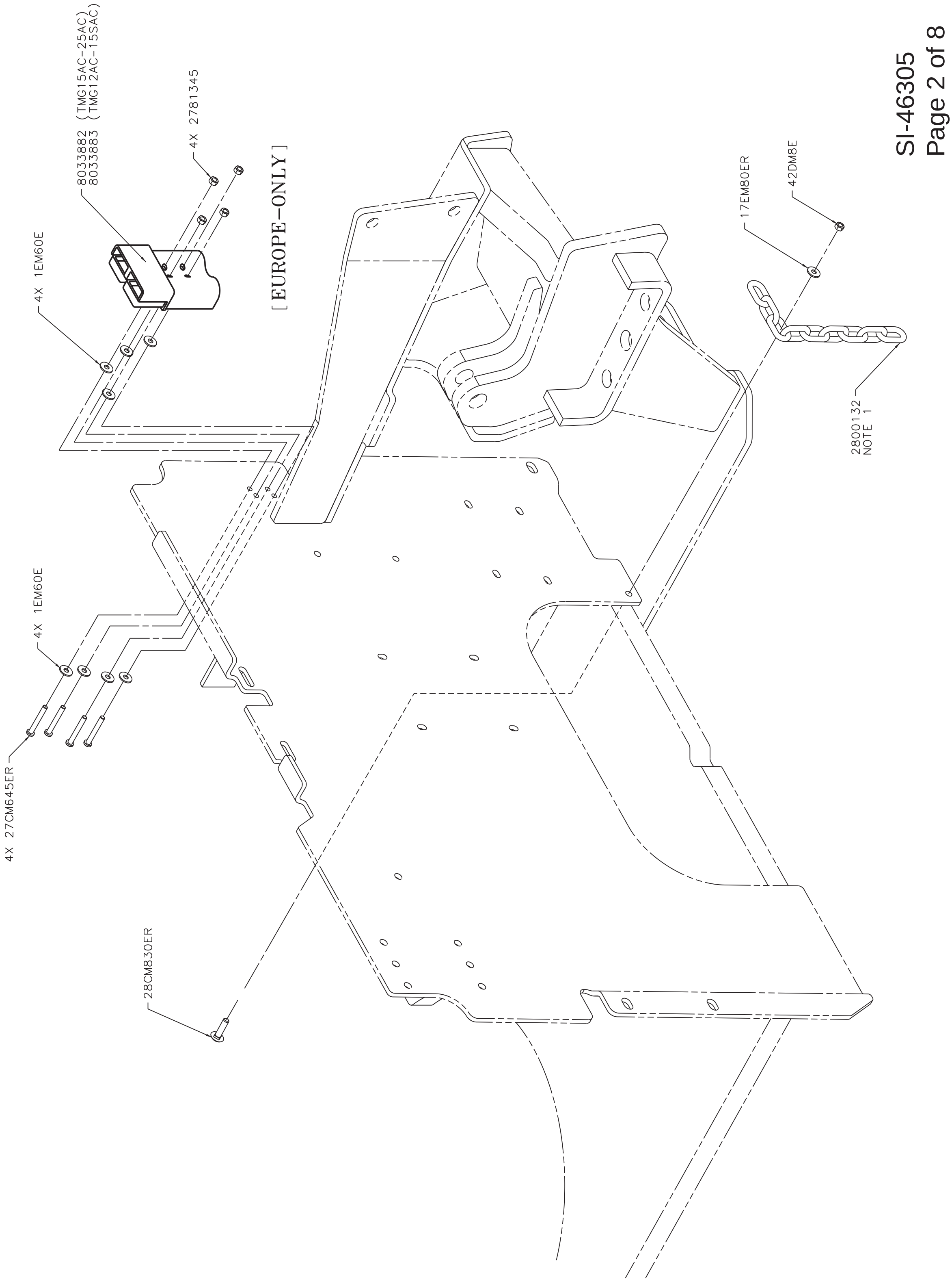
Section 3

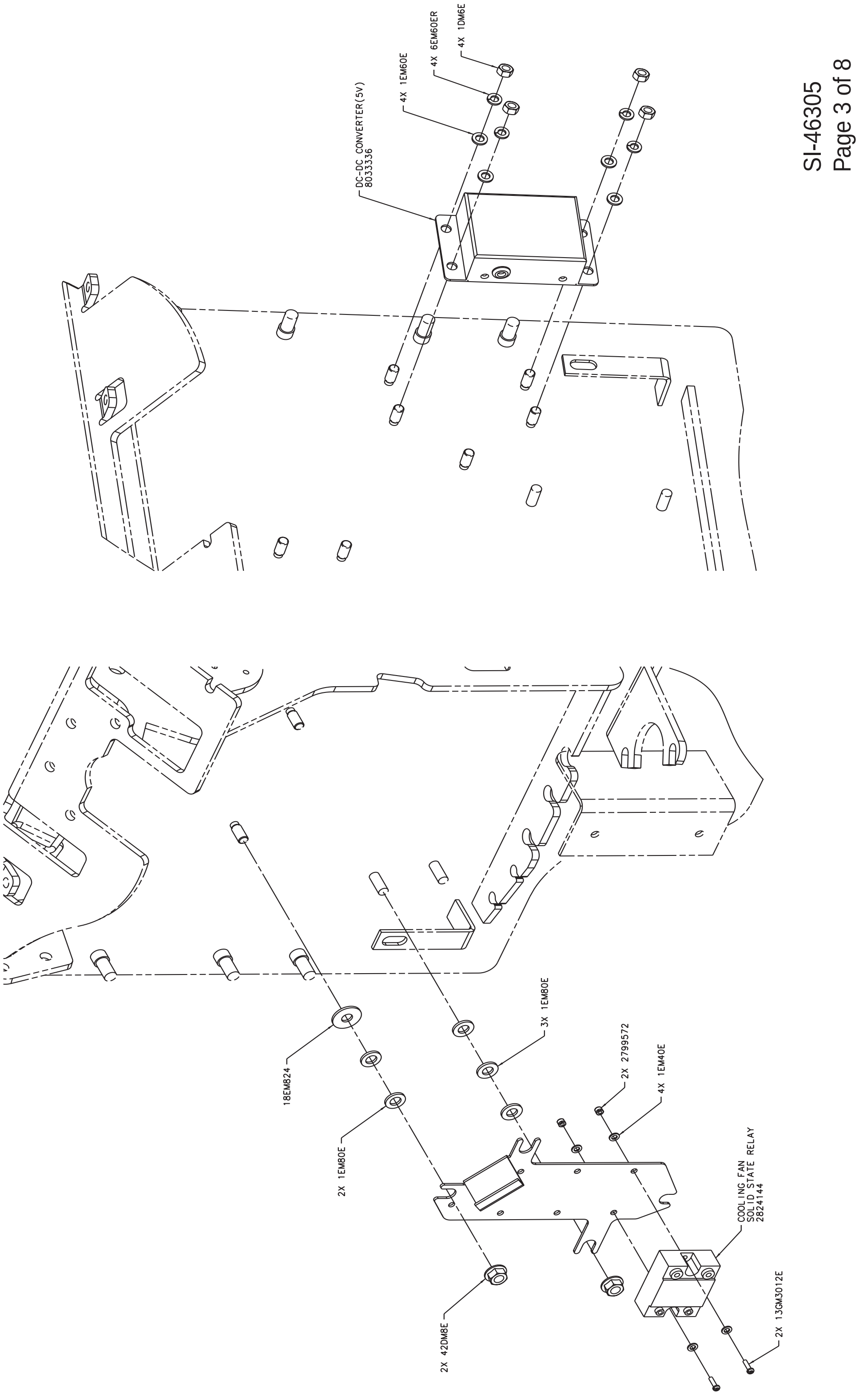
Wiring and Cables

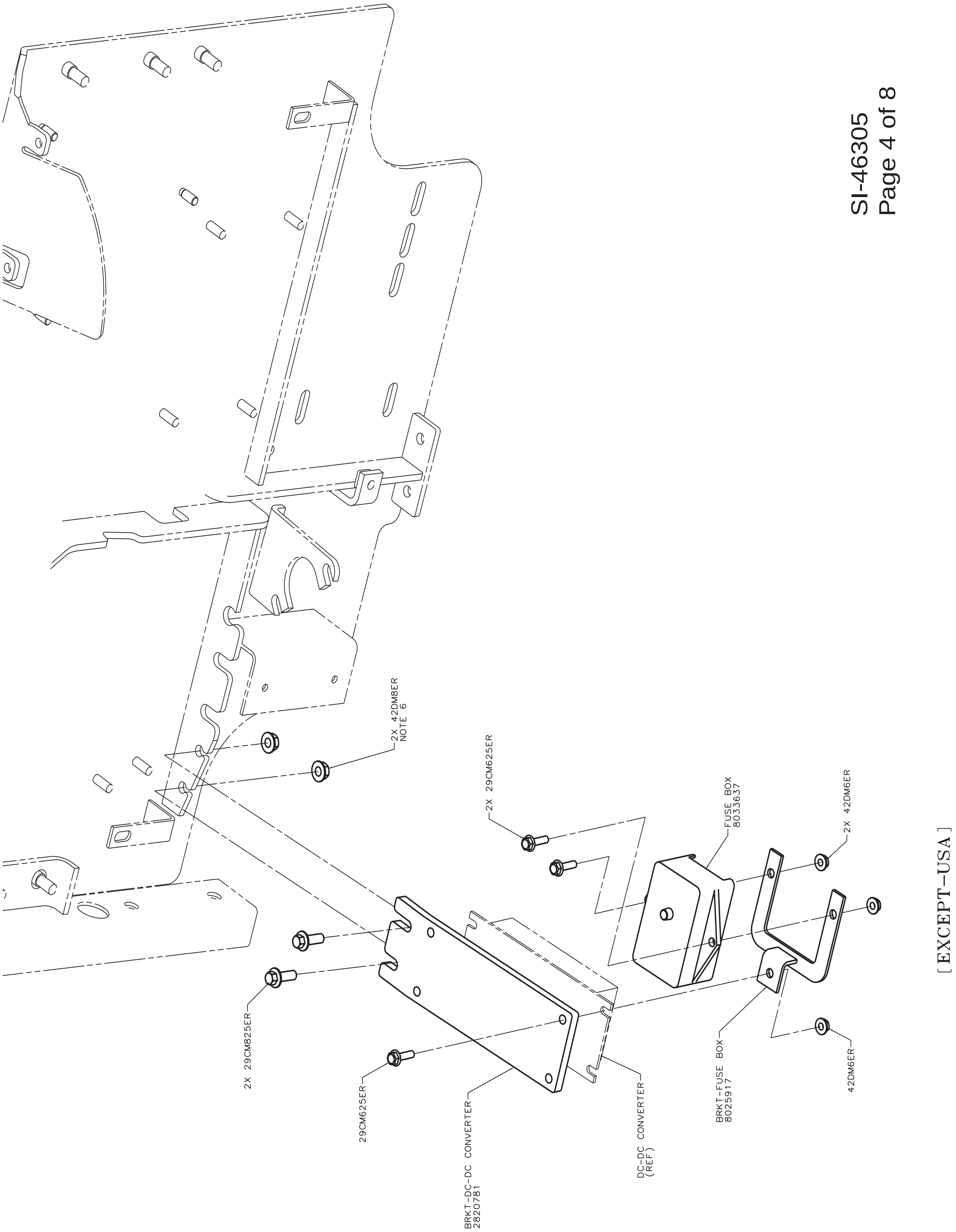
The following illustrations depict wiring and cable routing and connections for standard trucks and main accessory harness.

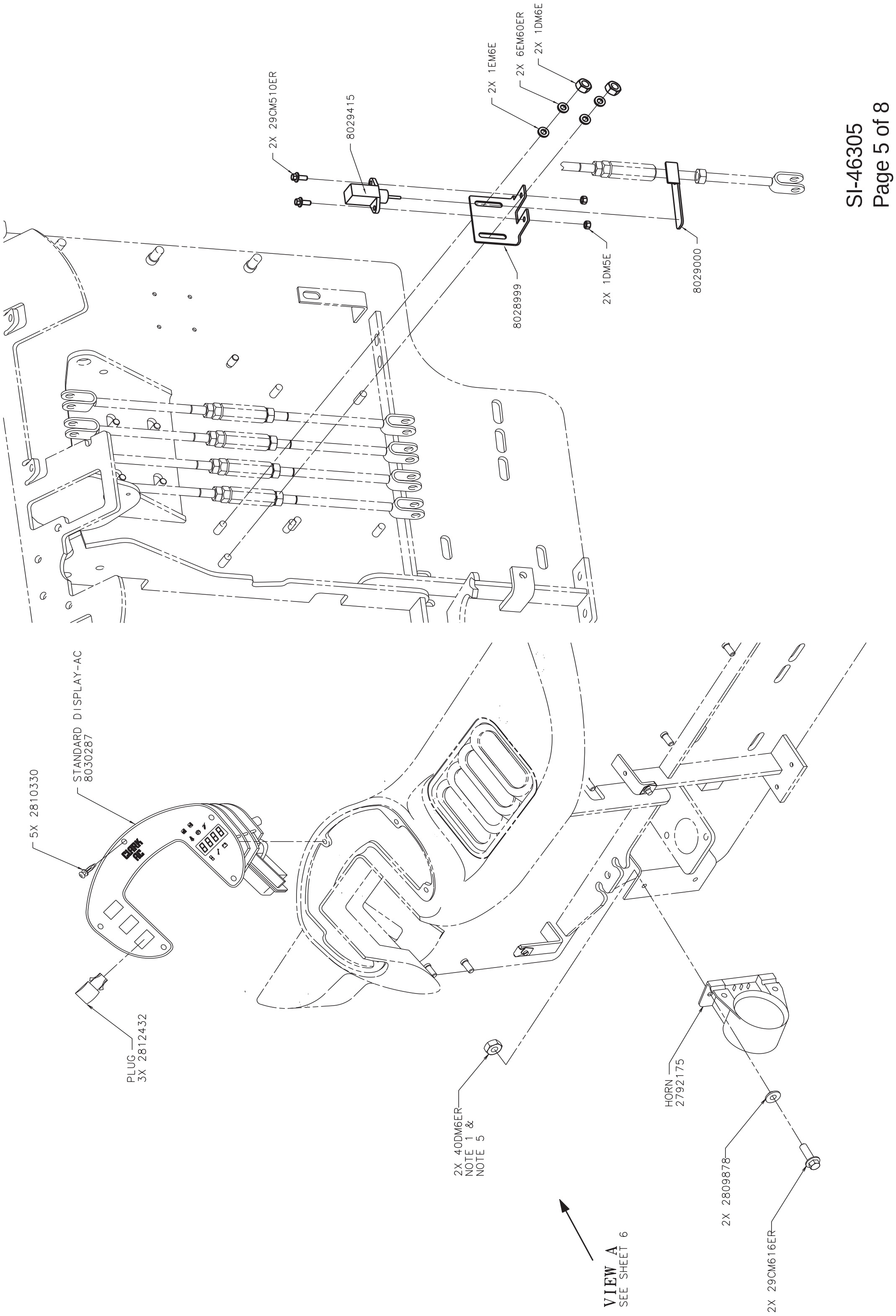
Electrical Components(TMX)

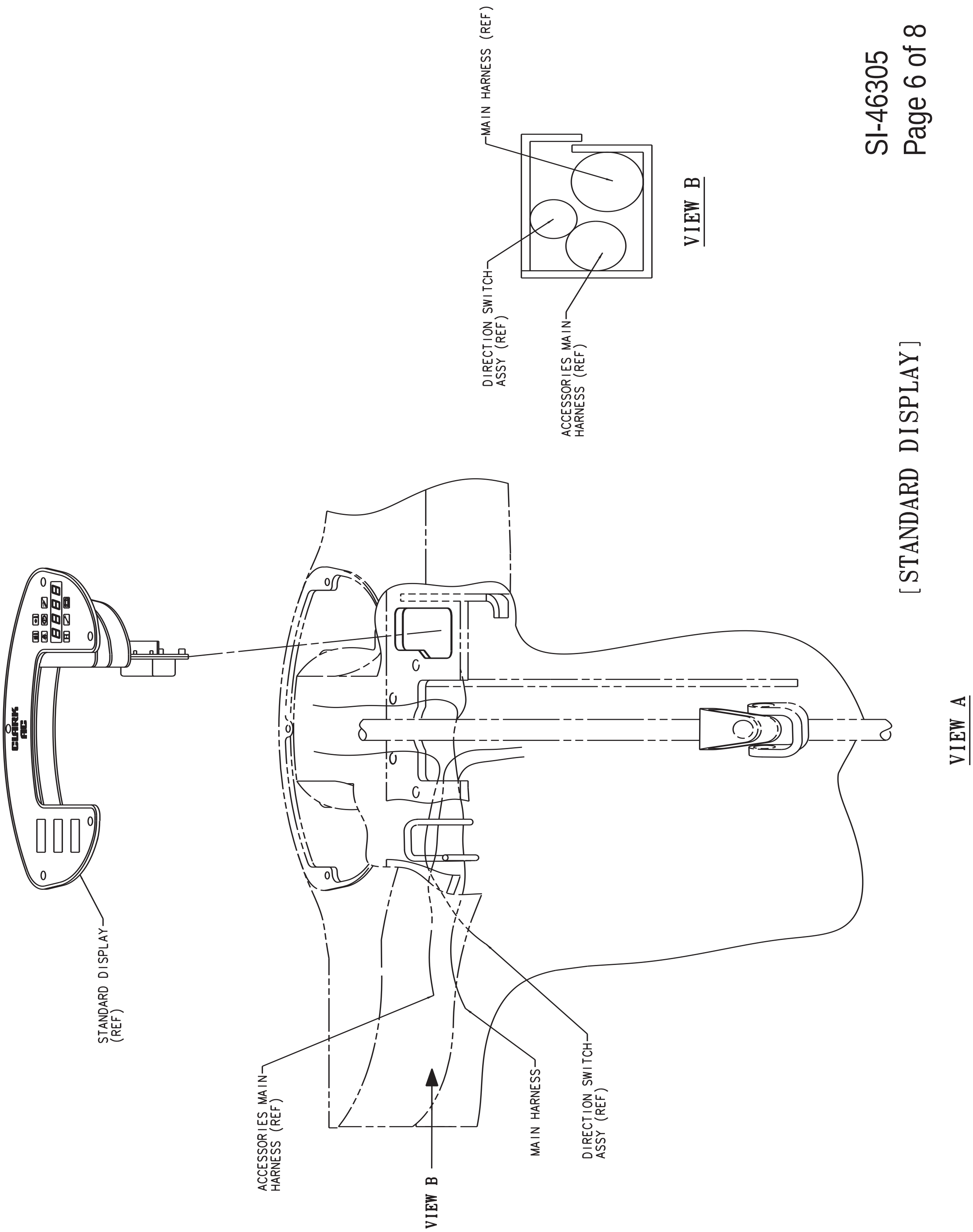


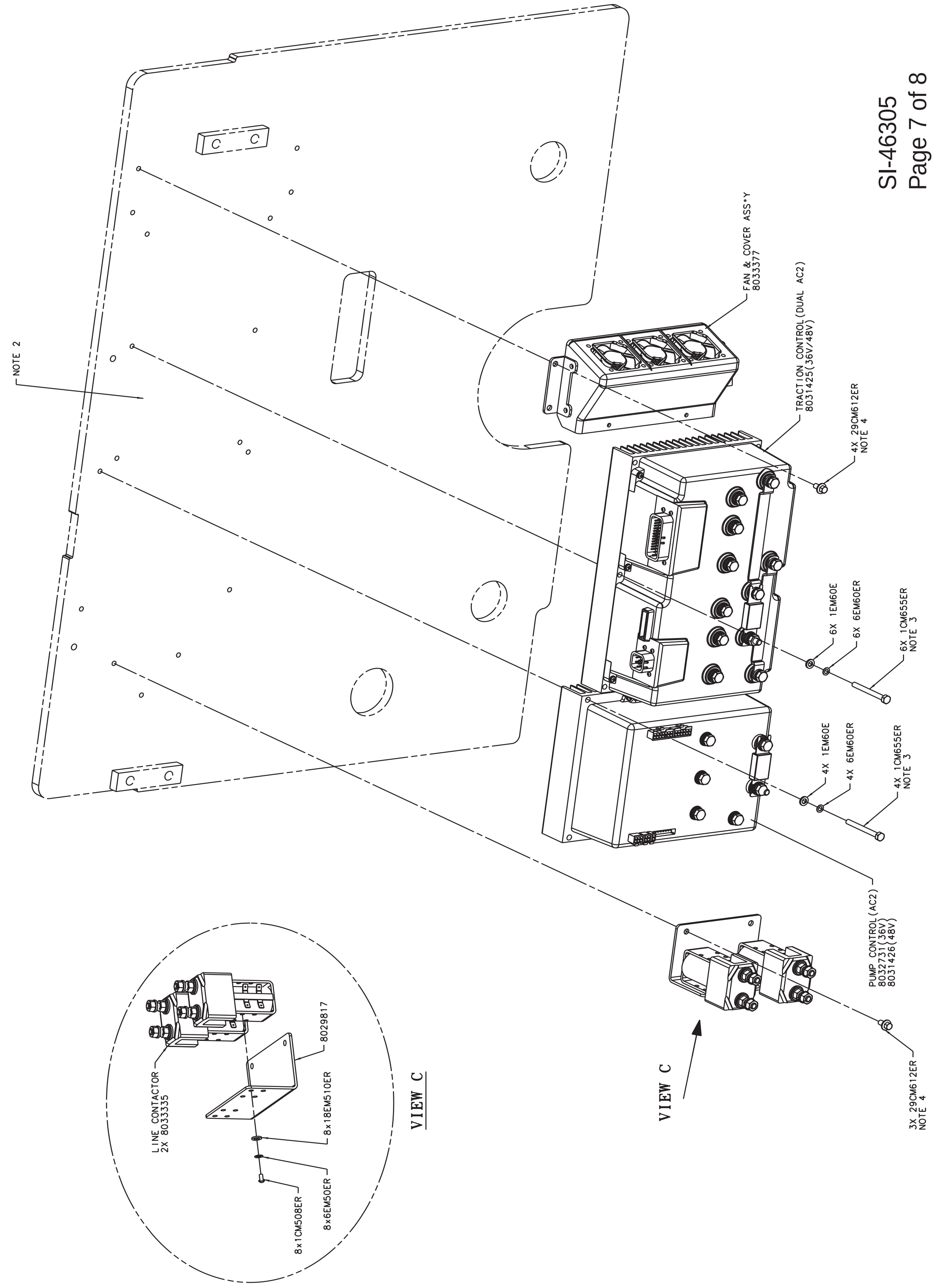

8033882 (TMG15AC-25AC)
8033883 (TMG12AC-15SAC)
4X 2781345
[EUROPE-ONLY]
4X 1EM60E
4X 1EM60E
4X 27CM645ER
28CM830ER
17EM80ER
42DM8E
2800132
NOTE 1
SI-46305
Page 2 of 8


DC-DC CONVERTER(5V)
8033336
4X 1EM60E
4X 6EM60ER
4X 1DM6E
SI-46305
Page 3 of 8
3X 1EM80E
18EM824
2X 1EM80E
2X 2799572
4X 1EM40E
COOLING FAN
SOLID STATE RELAY
2824144
2X 13GM3012E
2X 42DM8E

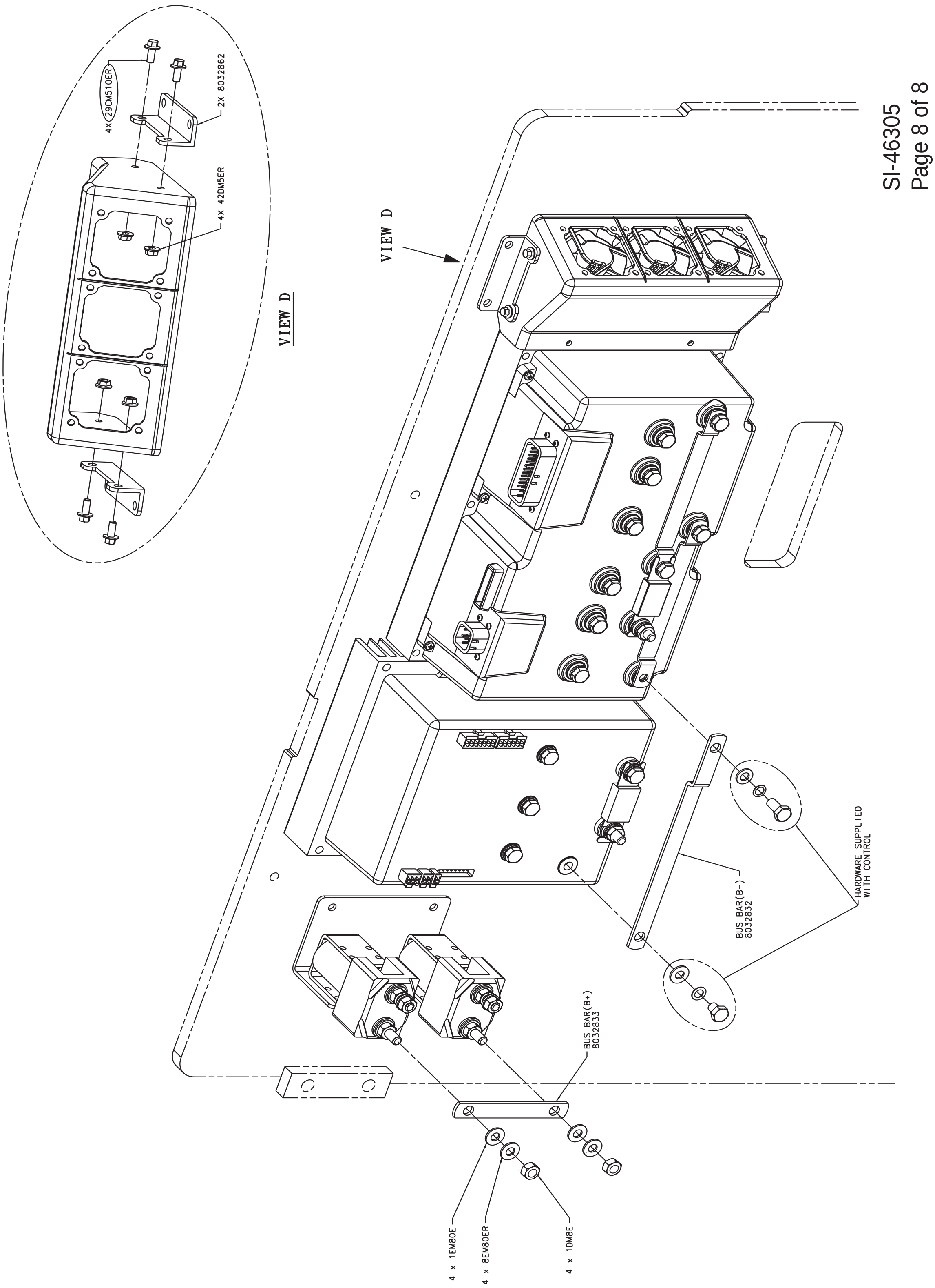

SI-46305
Page 4 of 8
2X 42DM8ER
NOTE 6
2X 29CM625ER
FUSE BOX
8033637
2X 42DM6ER
[EXCEPT-USA]
2X 29CM825ER
29CM625ER
BRKT-DC-DC CONVERTER
2820781
DC-DC CONVERTER
(REF)
BRKT-FUSE BOX
8025917
42DM6ER


2X 29CM510ER
8029415
2X 1EM6E
2X 6EM60ER
2X 1DM6E
8028999
2X 1DM5E
8029000
SI-46305
Page 5 of 8
5X 2810330
STANDARD DISPLAY-AC
8030287
PLUG
3X 2812432
2X 40DM6ER
NOTE 1 &
NOTE 5
HORN
2792175
2X 2809878
2X 29CM616ER
VIEW A
SEE SHEET 6


MAIN HARNESS (REF)
DIRECTION SWITCH ASSY (REF)
ACCESSORIES MAIN HARNESS (REF)
VIEW B
SI-46305
Page 6 of 8
[STANDARD DISPLAY]
VIEW A
STANDARD DISPLAY (REF)
ACCESSORIES MAIN HARNESS (REF)
MAIN HARNESS
DIRECTION SWITCH ASSY (REF)
VIEW B



SI-46305
Page 7 of 8

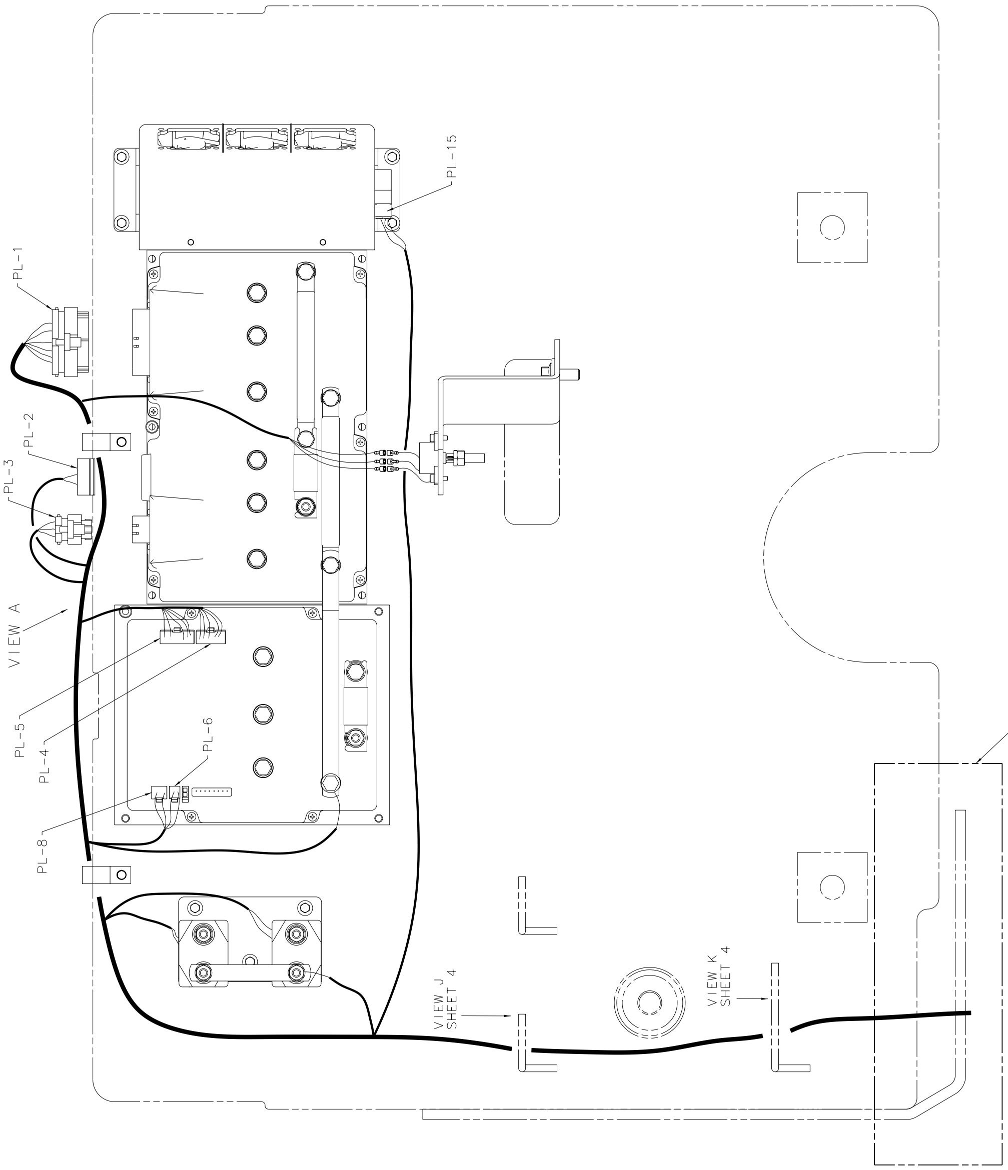

VIEW D
4X 29CM510ER
2X 8032862
4X 42DM5ER
VIEW D
SI-46305
Page 8 of 8
HARDWARE SUPPLIED WITH CONTROL
BUS BAR(B-) 8032832
BUS BAR(B+) 8032833
4 x 1EM8OE
4 x 8EM8OER
4 x 1DM8E

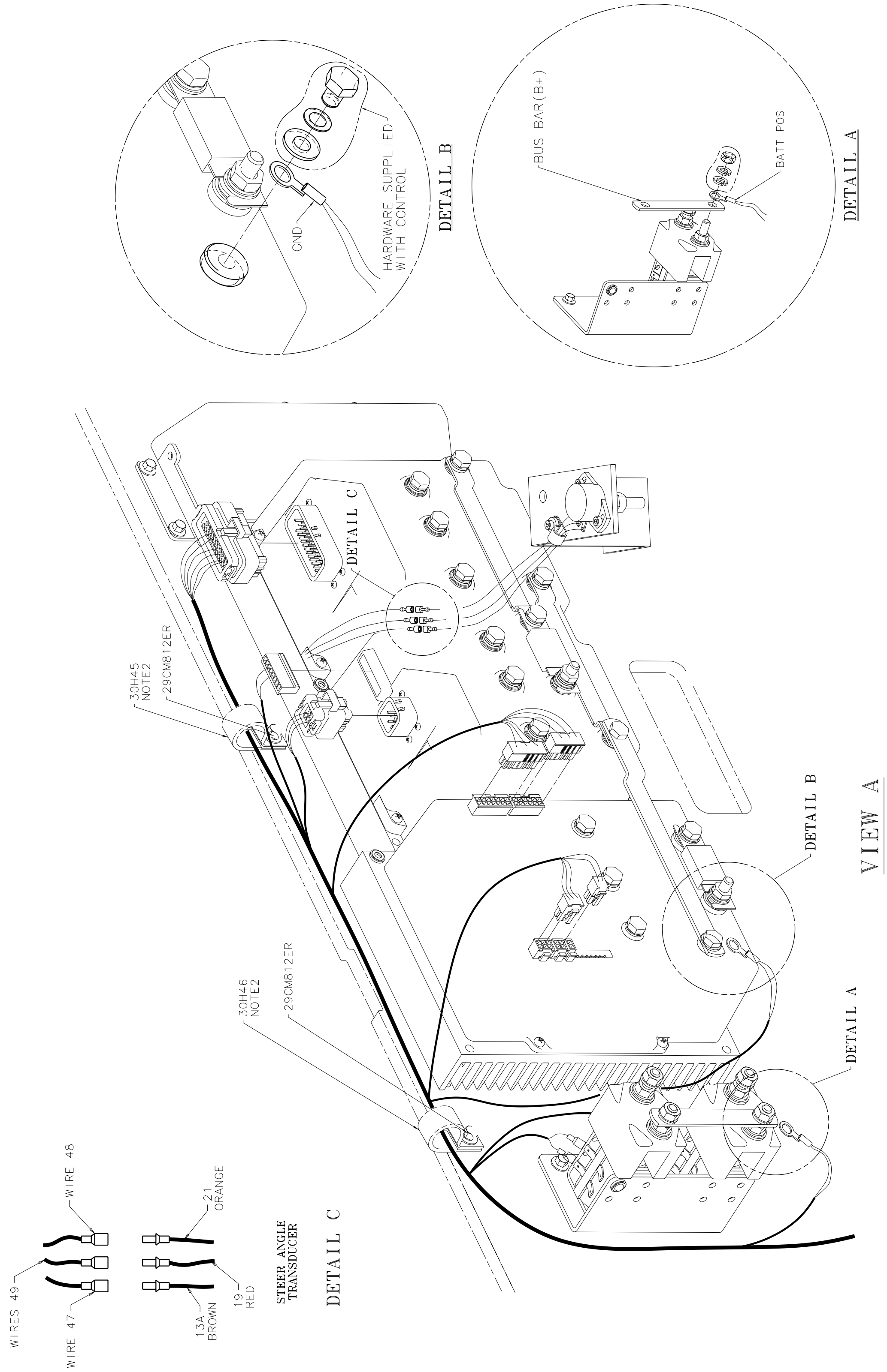
Main Harness(TMX)

SI-46306
Page 1 of 10

1. DISCONNECT TERMINAL ON WIRE 7 FROM TERMINAL ON WIRE 42A FOR TRACTION ENABLE/DISABLE OPTIONS
2. HARNESS MUST BE POSITIONED WITH ALL TAPE MARKERS HIDDEN UNDER CLAMP.
3. ALL HARNESS WIRING AND CONNECTIONS MADE PER WIRING DIAGRAMS IN-28216
4. AFTER INSTALLATION OF HARNESS:

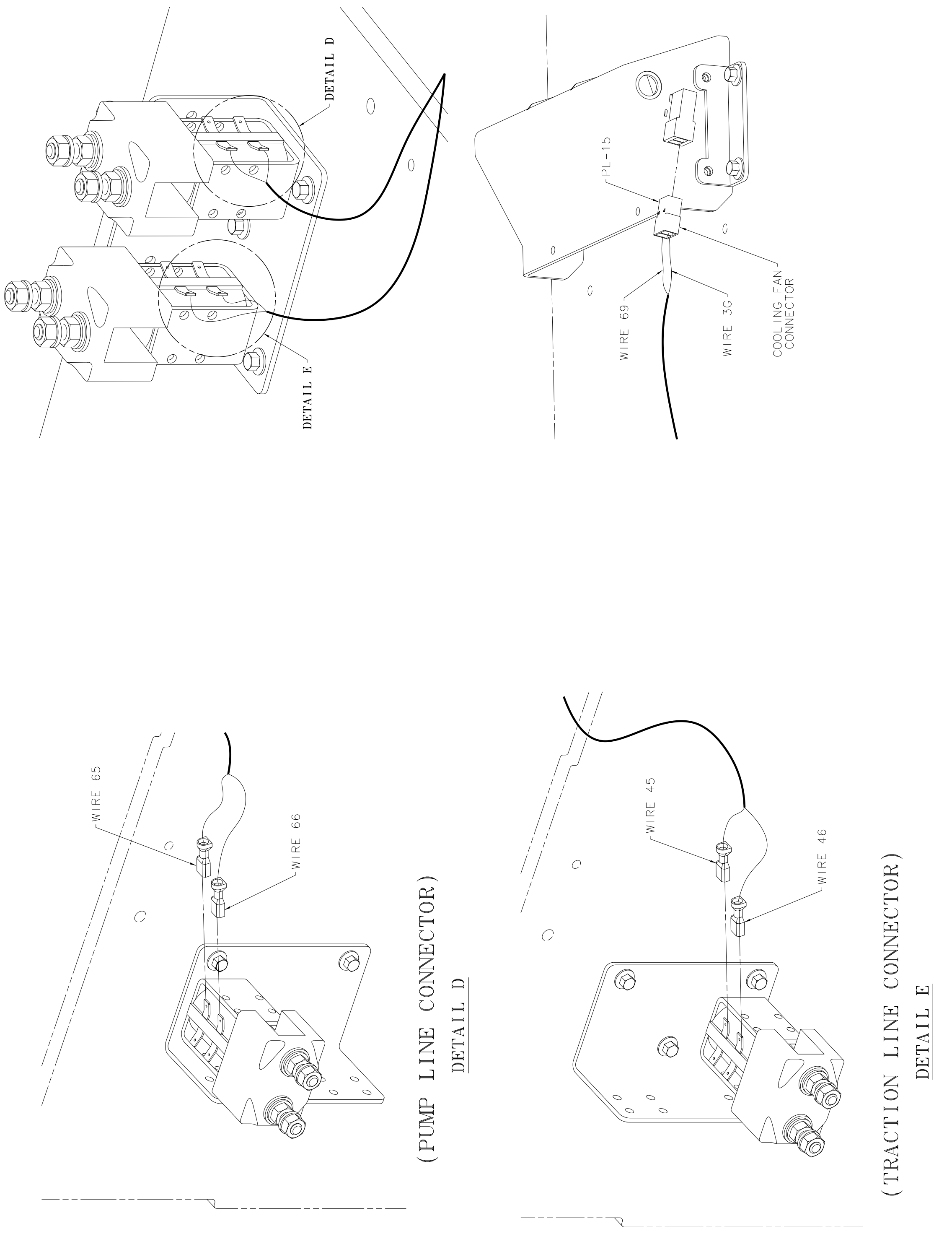
   MEASURE THE RESISTANCE BETWEEN BATTERY POSITIVE AND THE TRUCK FRAME. ALSO MEASURE THE RESISTANCE BETWEEN BATTERY NEGATIVE AND THE TRUCK FRAME. BOTH RESISTANCES SHOULD BE GREATER THAN 20,000 OHMS.
5. TORQUE TO 100 in-lbs.
6. GENTLY PACK FEMALE SIDE OF INDICATED PLUG OR CONNECTOR WITH 2824625 (ELECTRICAL 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.
8. COMPLETELY SEAL WIRE SIDE OF PL-2,PL-4,PL-5,PL-6,& PL-8 WITH DOW CORNING WITH RTV 737.
9. EXCESS HARNESS LENGTH ON SMALLER BATTERY COMPARTMENTS IS TO BE KEPT IN THIS AREA.

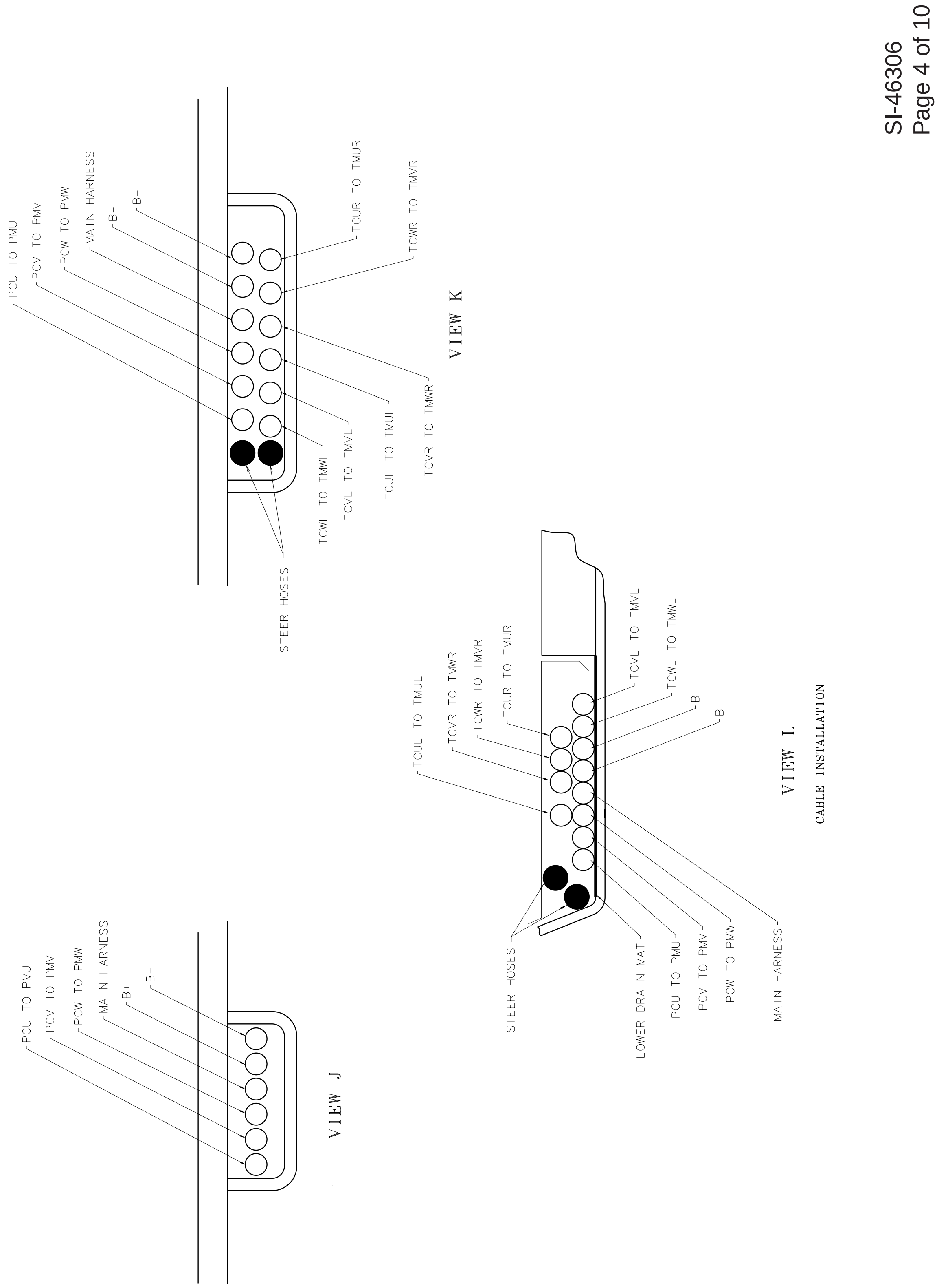




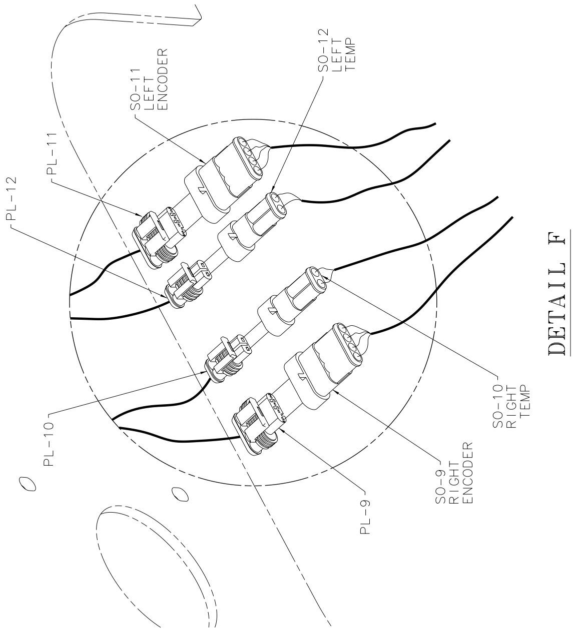
SI-46306
Page 2 of 10

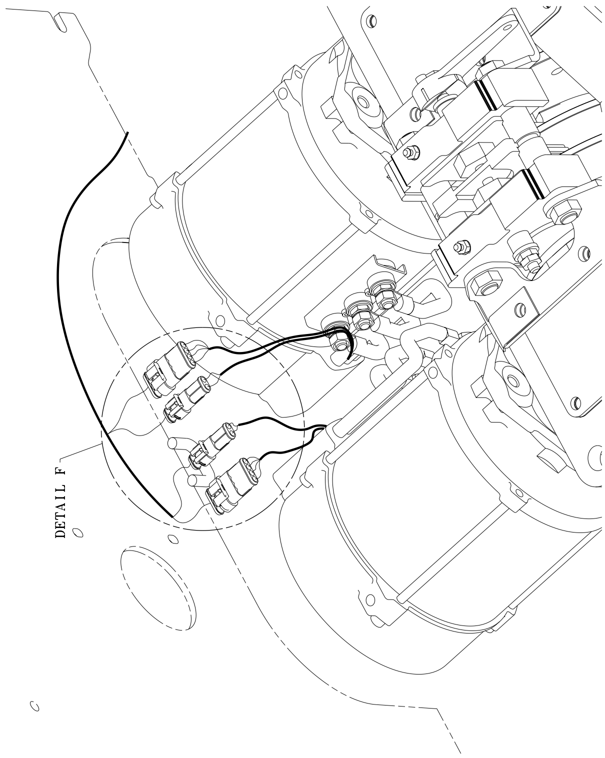
SI-46306
Page 3 of 10

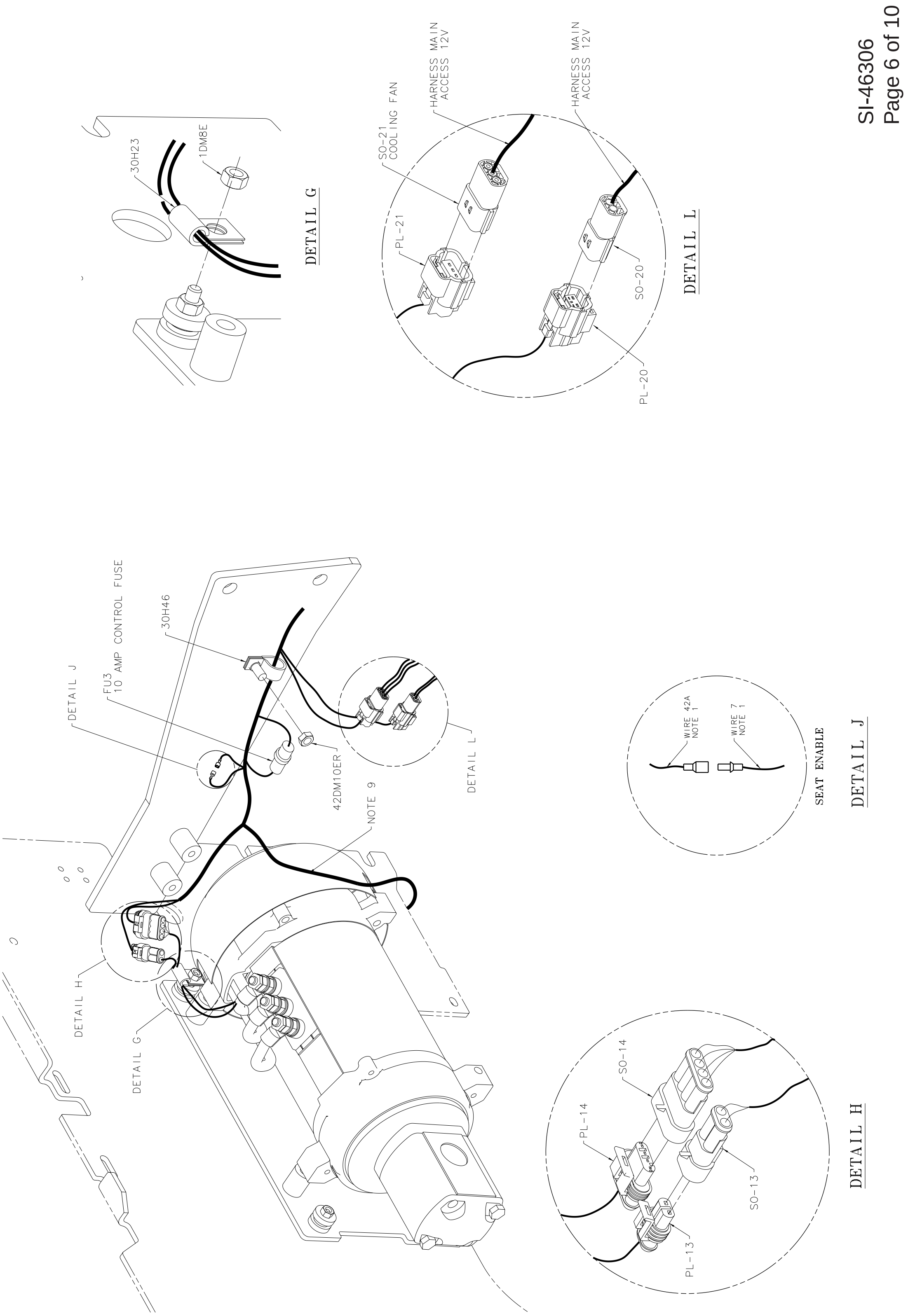


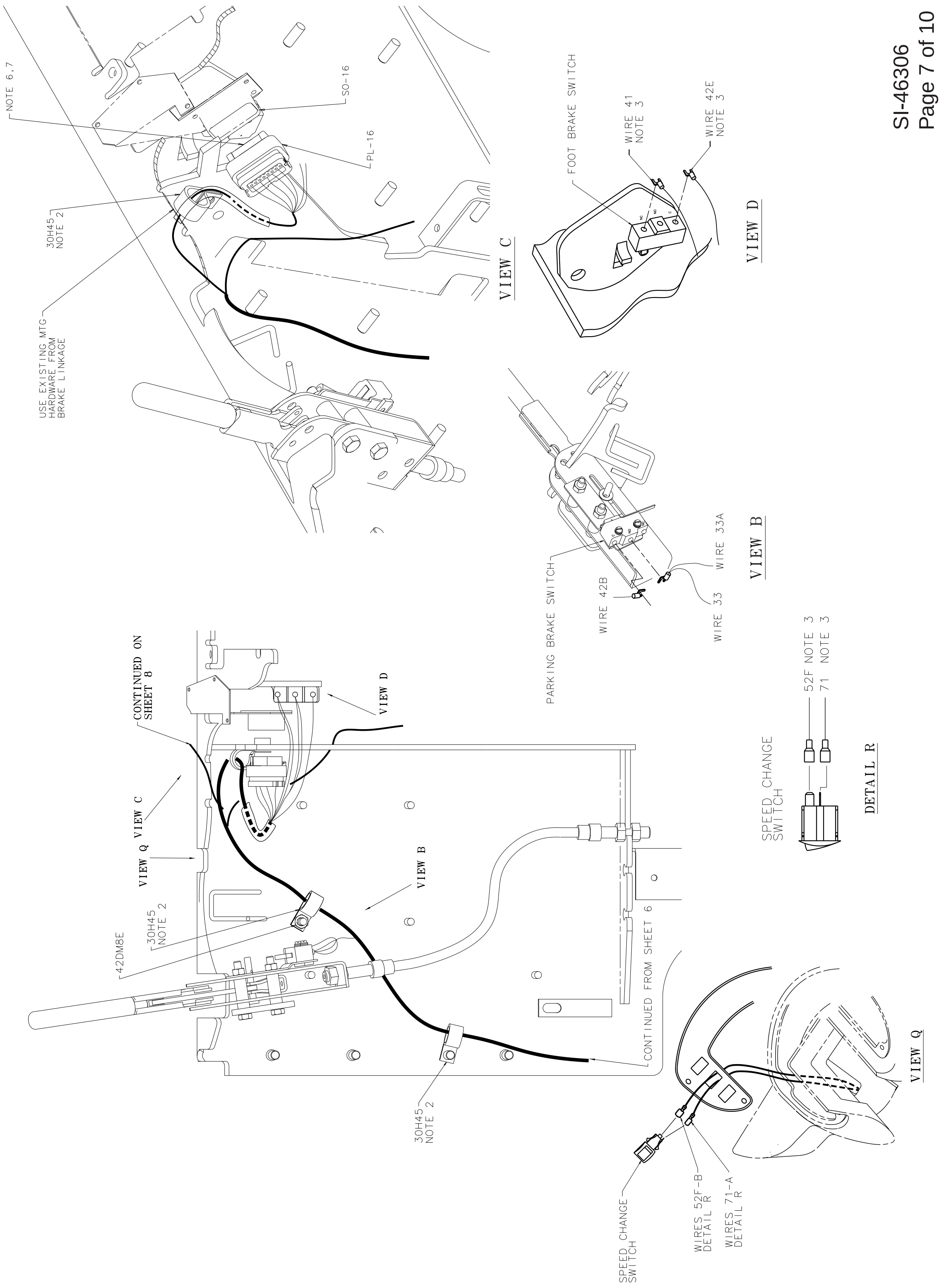

SI-46306
Page 4 of 10
PCU TO PMU
PCV TO PMV
PCW TO PMW
MAIN HARNESS
B+
B-
TCUR TO TMUR
TCWR TO TMVR
TCVR TO TMWR
TCUL TO TMUL
TCVL TO TMVL
TCWL TO TMWL
STEER HOSES
VIEW K
TCUL TO TMUL
TCVR TO TMWR
TCWR TO TMVR
TCUR TO TMUR
TCVL TO TMVL
TCWL TO TMWL
B-
B+
STEER HOSES
LOWER DRAIN MAT
PCU TO PMU
PCV TO PMV
PCW TO PMW
MAIN HARNESS
VIEW L
CABLE INSTALLATION
PCU TO PMU
PCV TO PMV
PCW TO PMW
MAIN HARNESS
B+
B-
VIEW J

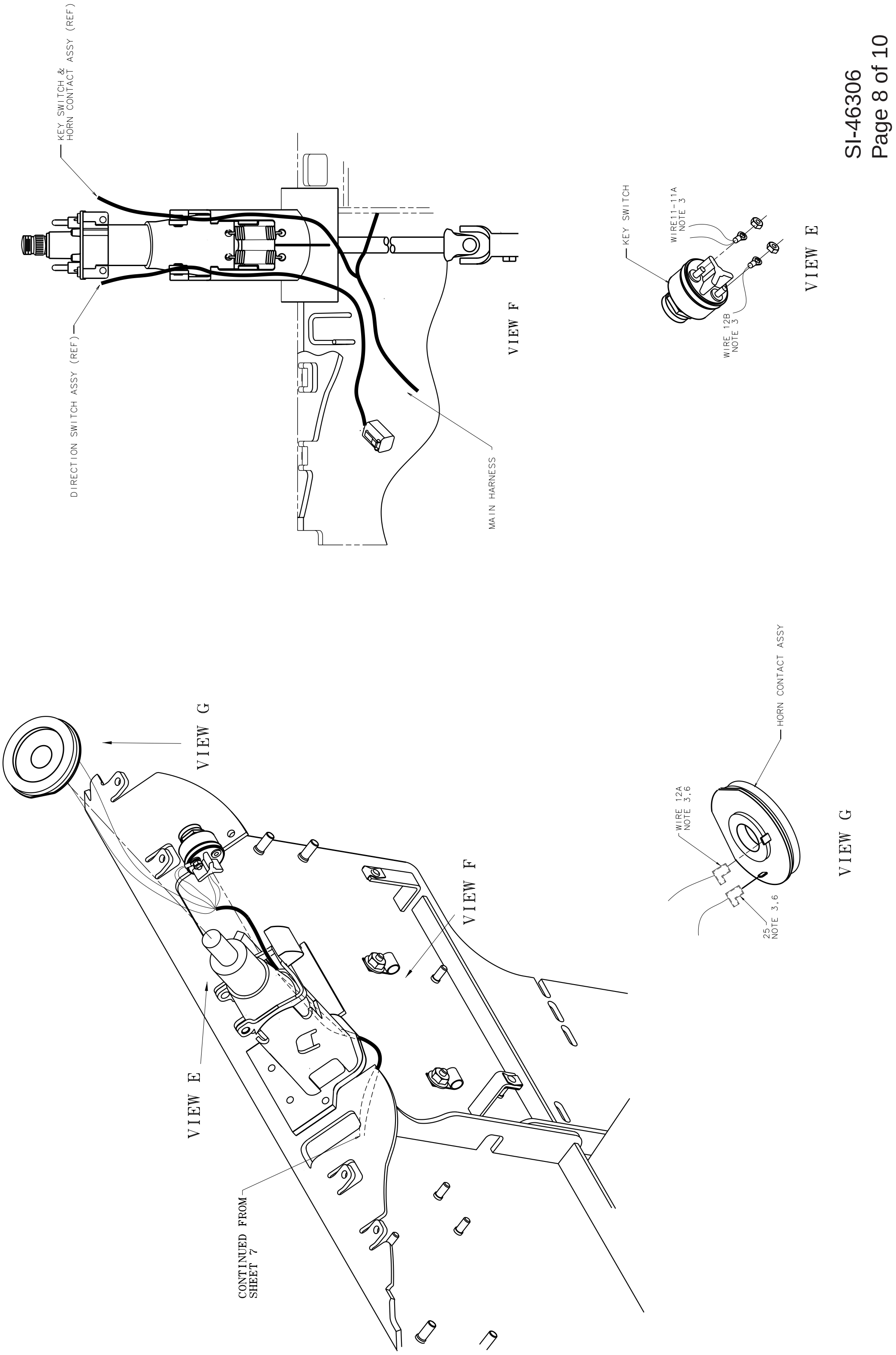
SI-46306
Page 5 of 10



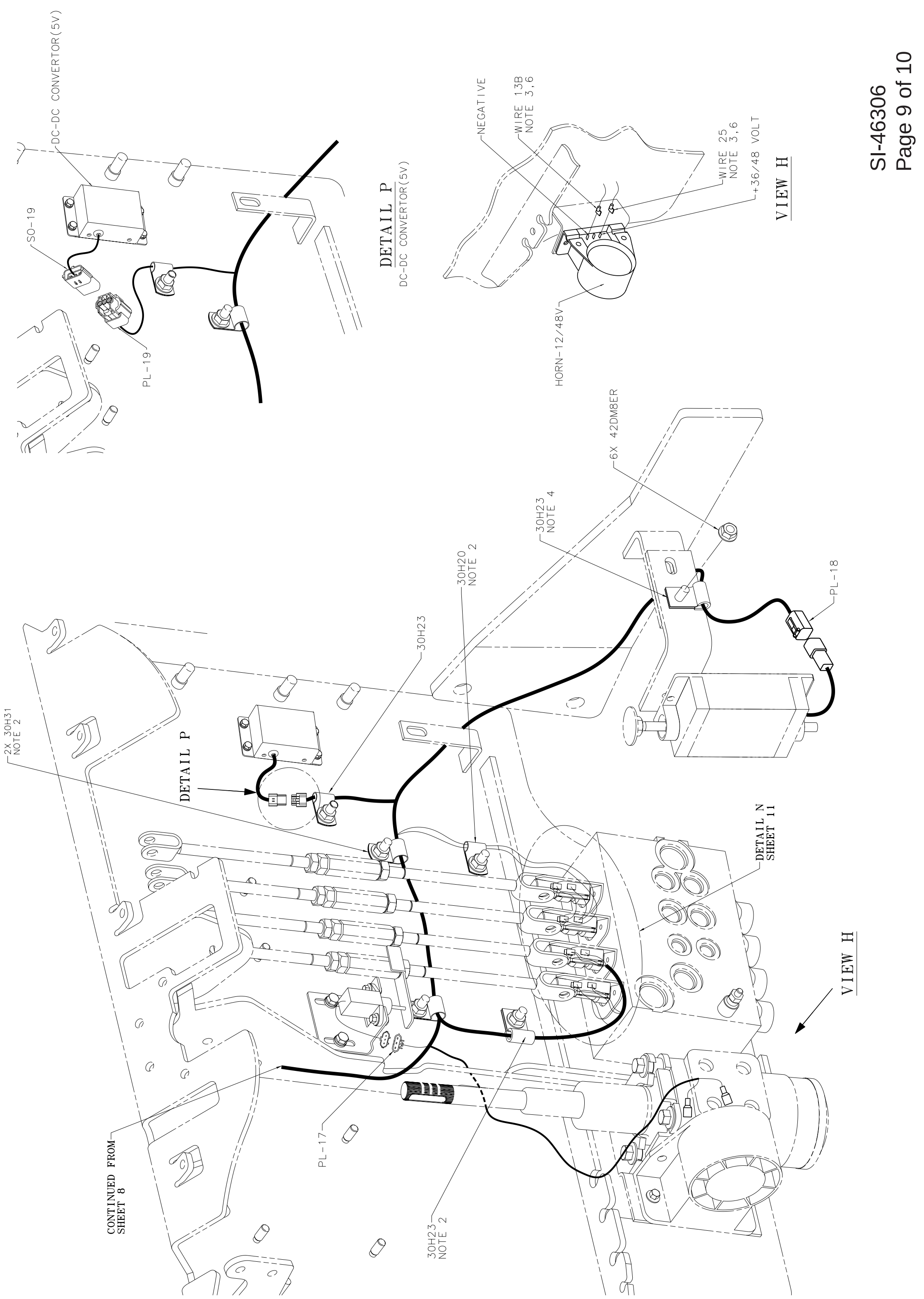


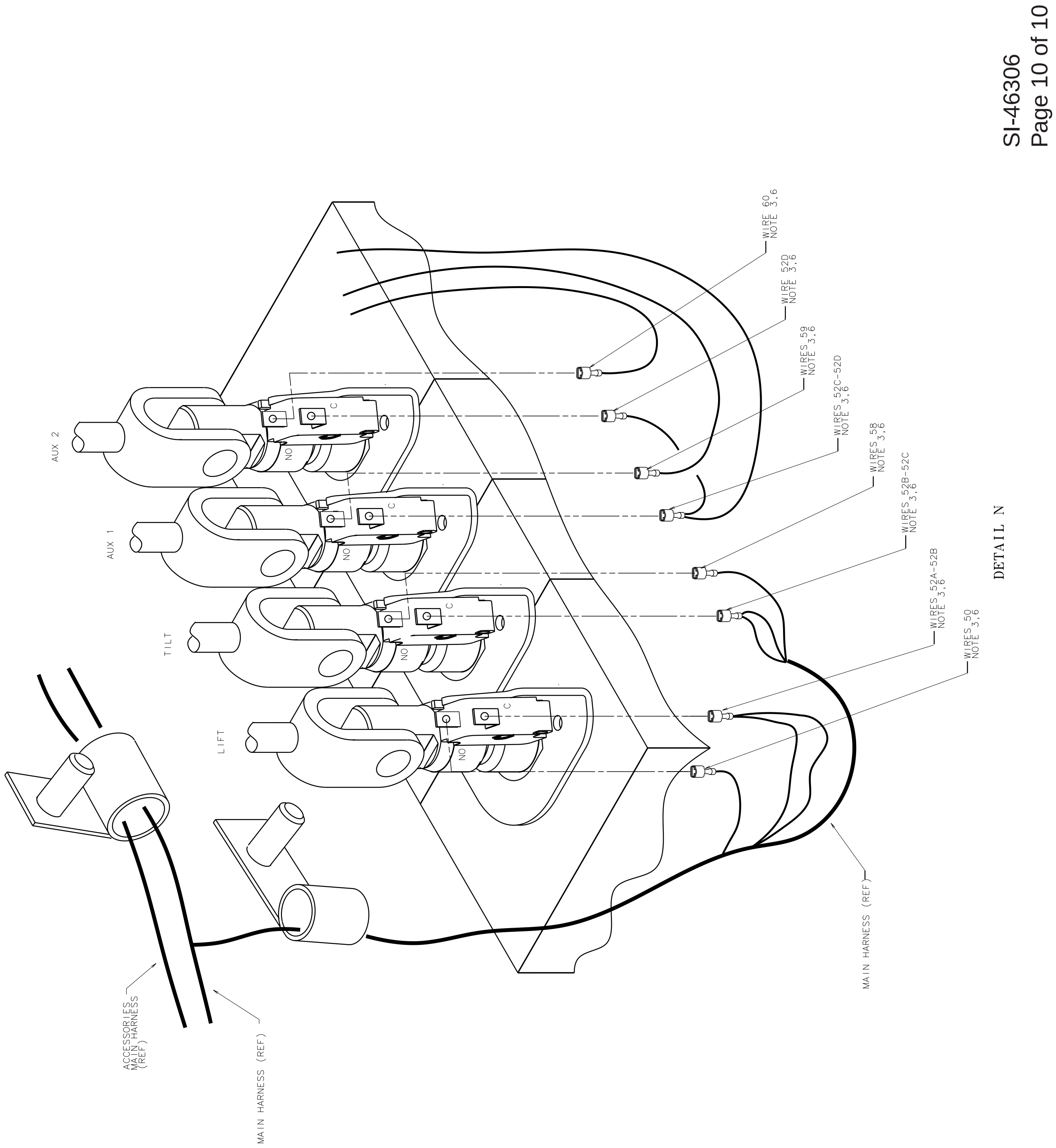

SI-46306
Page 6 of 10
DETAIL G
30H23
1DM8E
DETAIL L
SO-21
COOLING FAN
HARNESS MAIN
ACCESS 12V
PL-21
SO-20
PL-20
DETAIL J
FU3
10 AMP CONTROL FUSE
30H46
42DM10ER
NOTE 9
DETAIL H
WIRE 42A
NOTE 1
WIRE 7
NOTE 1
SEAT ENABLE
SO-14
PL-14
SO-13
PL-13


NOTE 6,7
SO-16
PL-16
30H45
NOTE 2
USE EXISTING MTG
HARDWARE FROM
BRAKE LINKAGE
VIEW C
FOOT BRAKE SWITCH
WIRE 41
NOTE 3
WIRE 42E
NOTE 3
VIEW D
PARKING BRAKE SWITCH
WIRE 42B
WIRE 33
WIRE 33A
VIEW B
52F NOTE 3
71 NOTE 3
SPEED CHANGE
SWITCH
DETAIL R
CONTINUED ON
SHEET 8
VIEW D
VIEW C
VIEW Q
VIEW B
30H45
NOTE 2
42DM8E
CONTINUED FROM SHEET 6
30H45
NOTE 2
SPEED CHANGE
SWITCH
WIRES 52F-B
DETAIL R
WIRES 71-A
DETAIL R
VIEW Q
SI-46306
Page 7 of 10

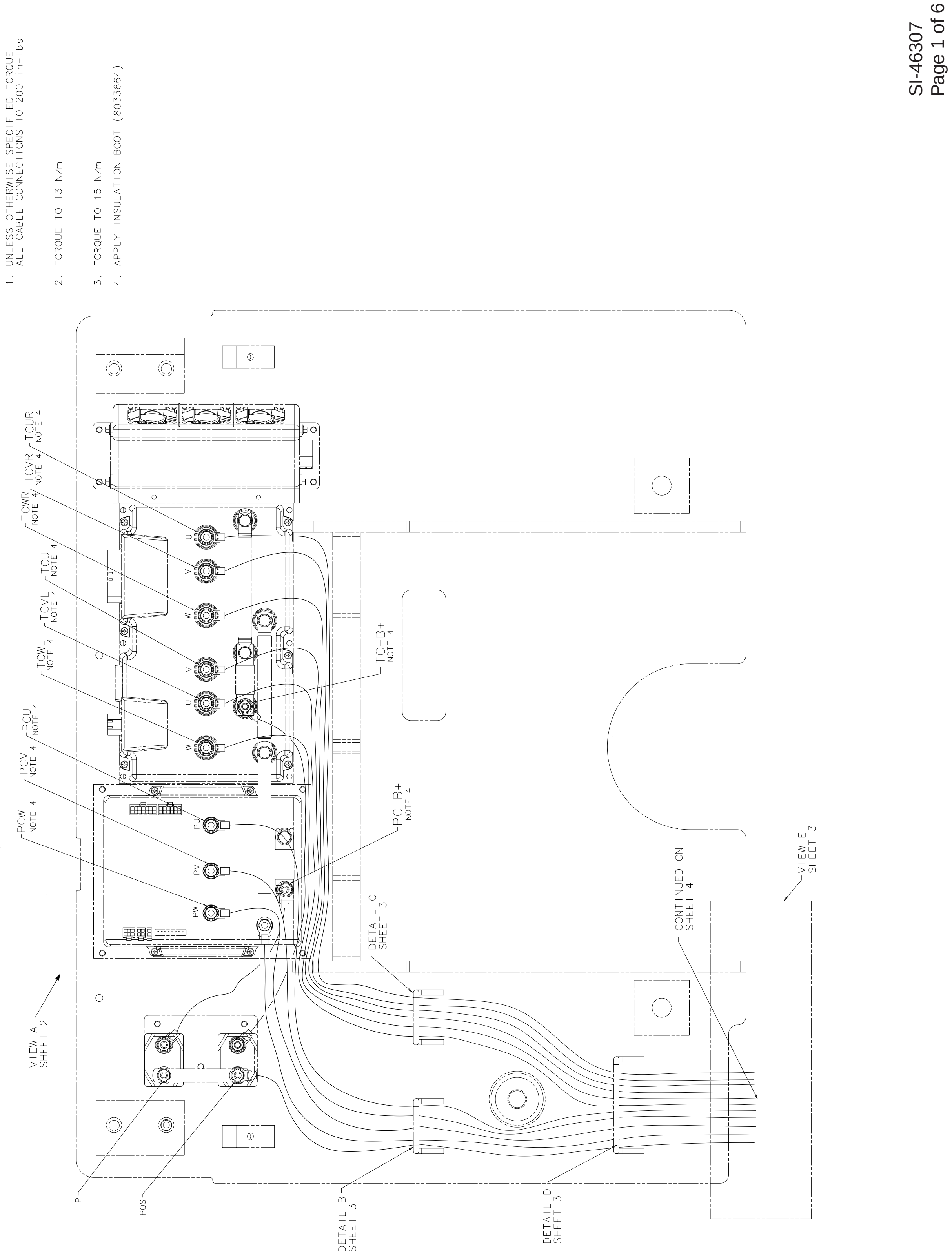


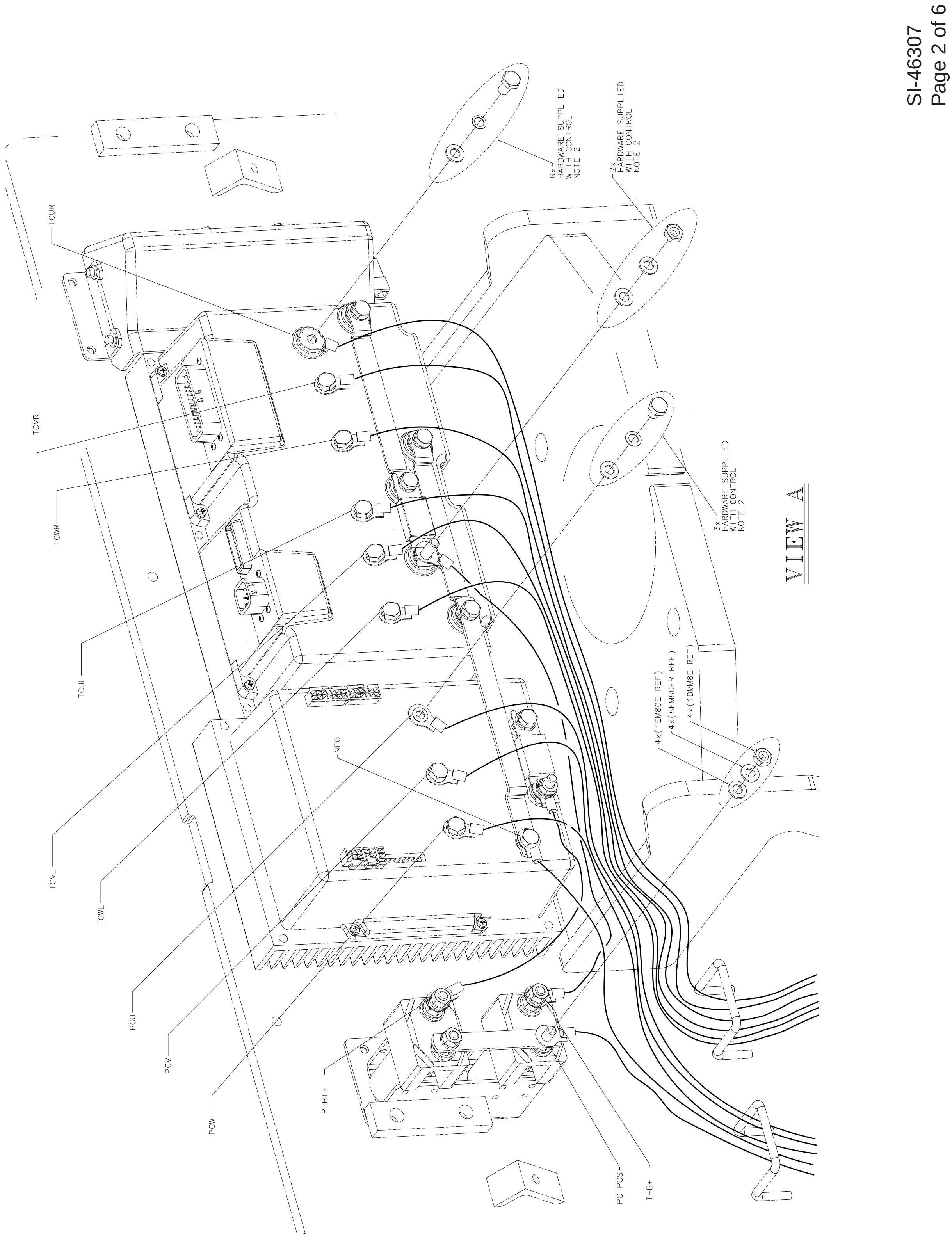
KEY SWITCH & HORN CONTACT ASSY (REF)
DIRECTION SWITCH ASSY (REF)
MAIN HARNESS
VIEW F
KEY SWITCH
WIRE11-11A NOTE 3
WIRE 12B NOTE 3
VIEW E
SI-46306
Page 8 of 10
VIEW G
HORN CONTACT ASSY
WIRE 12A NOTE 3,6
25 NOTE 3,6
VIEW G
VIEW F
VIEW E
CONTINUED FROM SHEET 7

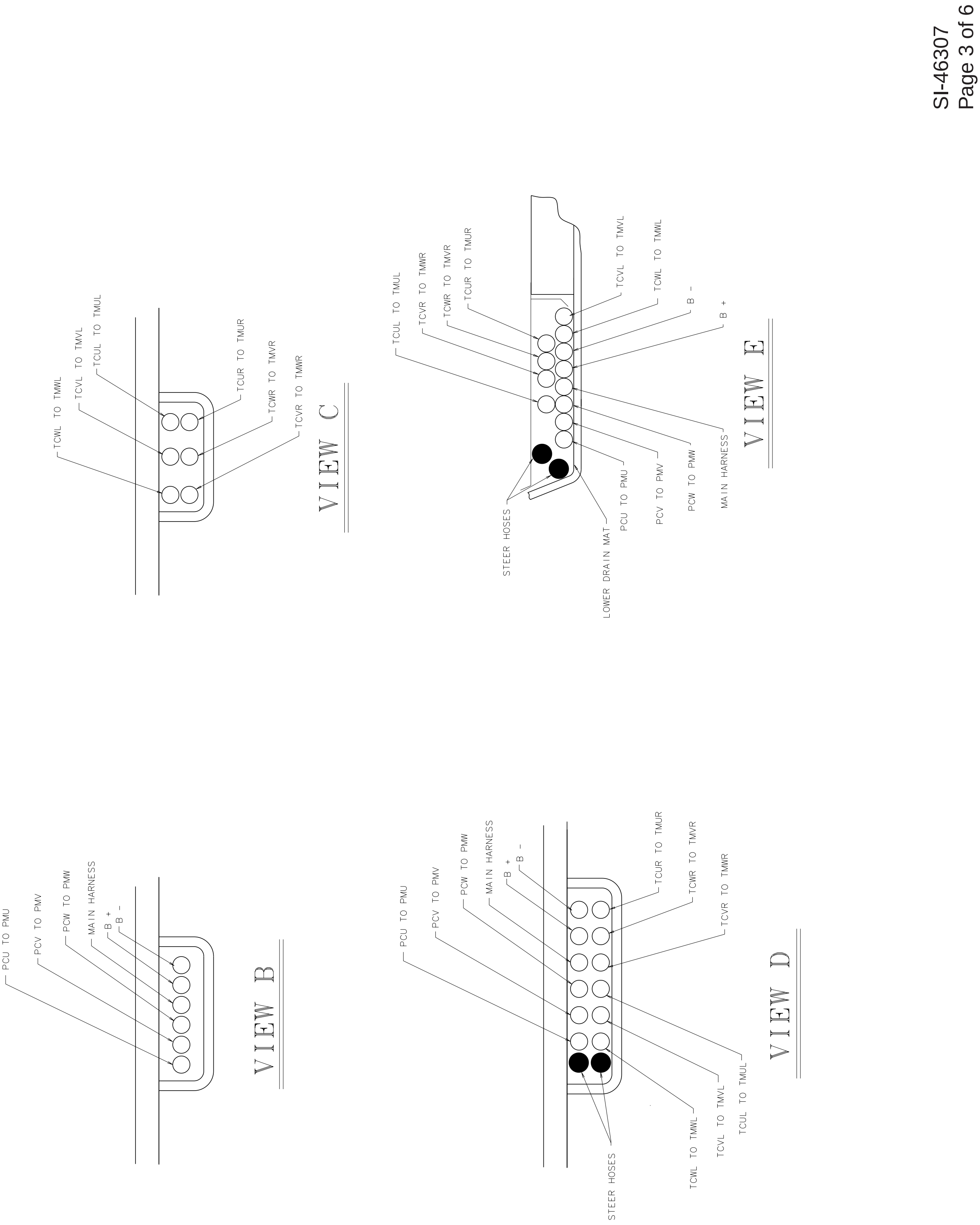

DC-DC CONVERTOR(5V)
SO-19
PL-19
DETAIL P
DC-DC CONVERTOR(5V)
NEGATIVE
WIRE 13B
NOTE 3,6
WIRE 25
NOTE 3,6
+36/48 VOLT
VIEW H
HORN-12/48V
SI-46306
Page 9 of 10
6X 42DM8ER
30H23
NOTE 4
30H20
NOTE 2
30H23
PL-18
2X 30H31
NOTE 2
DETAIL P
DETAIL N
SHEET 11
VIEW H
PL-17
CONTINUED FROM
SHEET 8
30H23
NOTE 2


SI-46306
Page 10 of 10
WIRE 60
NOTE 3,6
WIRE 52D
NOTE 3,6
WIRES 59
NOTE 3,6
WIRES 52C-52D
NOTE 3,6
WIRES 58
NOTE 3,6
WIRES 52B-52C
NOTE 3,6
WIRES 52A-52B
NOTE 3,6
WIRES 50
NOTE 3,6
DETAIL N
AUX 2
AUX 1
TILT
LIFT
C
NO
MAIN HARNESS (REF)
ACCESSORIES
MAIN HARNESS
(REF)
MAIN HARNESS (REF)

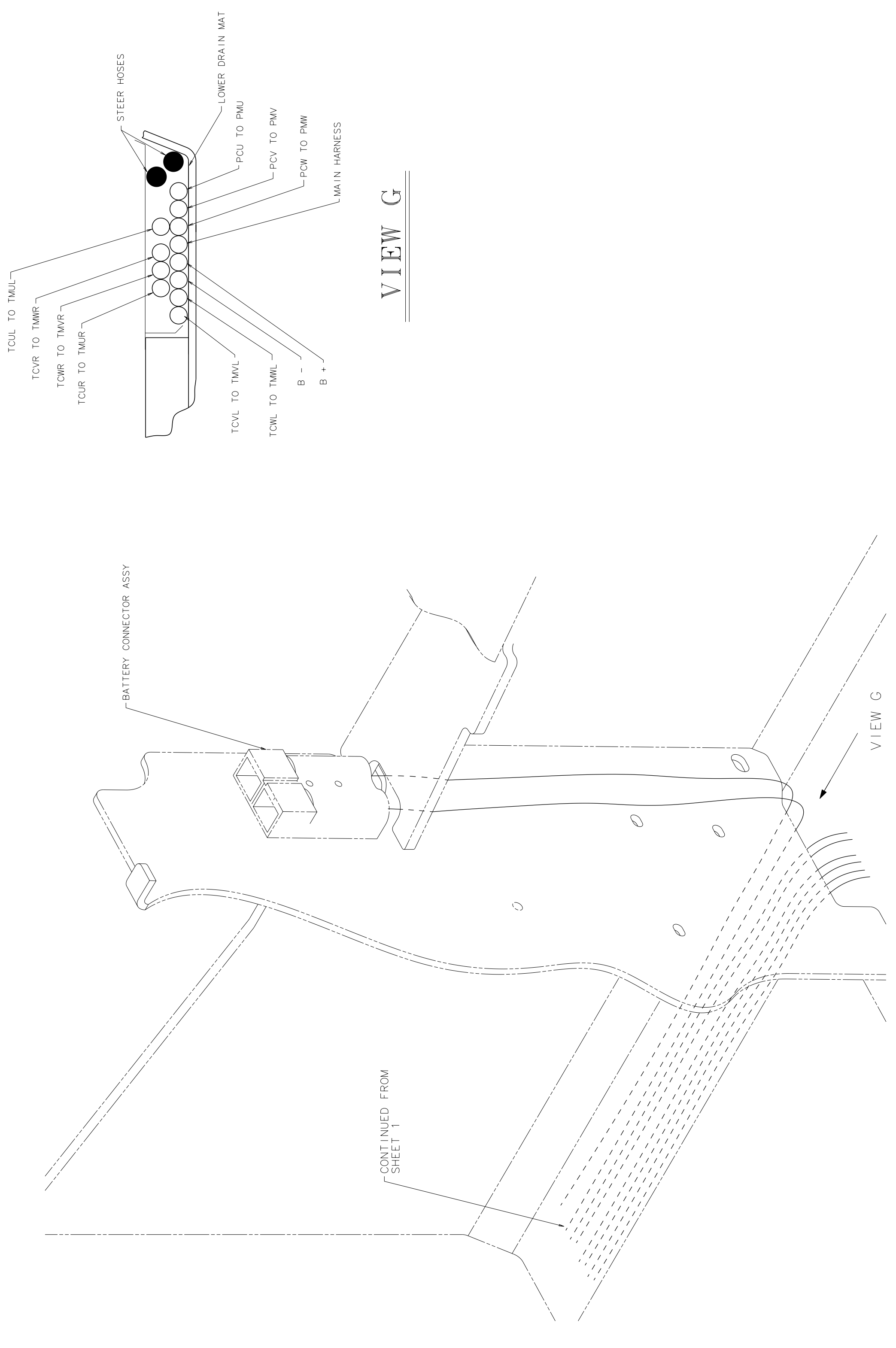
Cables(TMX)


SI-46307
Page 1 of 6
1. UNLESS OTHERWISE SPECIFIED TORQUE ALL CABLE CONNECTIONS TO 200 in-lbs
2. TORQUE TO 13 N/m
3. TORQUE TO 15 N/m
4. APPLY INSULATION BOOT (8033664)
TCUR NOTE 4
TCVR NOTE 4
TCWR NOTE 4
TCUL NOTE 4
TCVL NOTE 4
TCWL NOTE 4
PCU NOTE 4
PCV NOTE 4
PCW NOTE 4
TC-B+ NOTE 4
PC B+ NOTE 4
DETAIL C SHEET 3
CONTINUED ON SHEET 4
VIEW E SHEET 3
VIEW A SHEET 2
P
POS
DETAIL B SHEET 3
DETAIL D SHEET 3

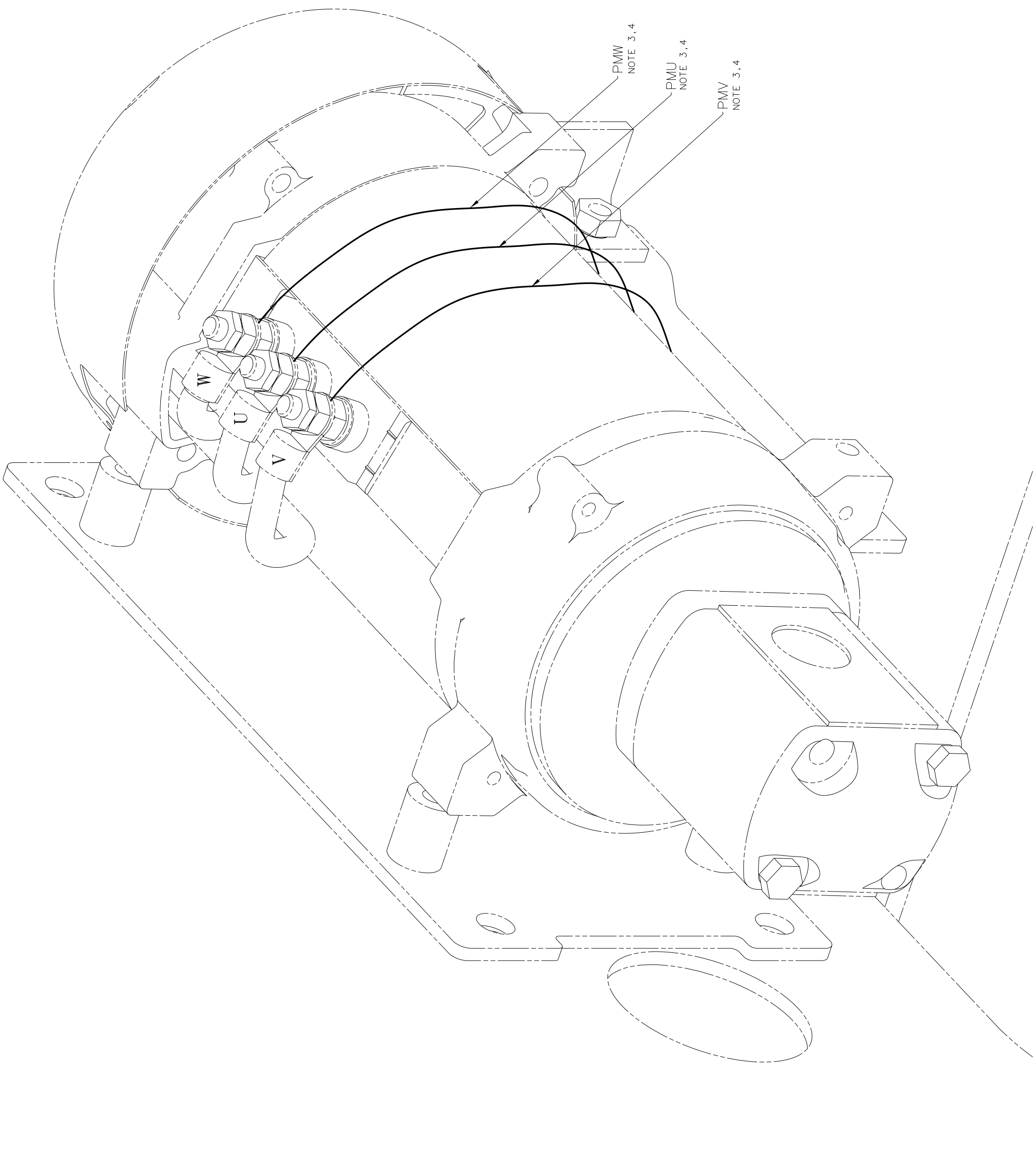

SI-46307
Page 2 of 6
6x HARDWARE SUPPLIED WITH CONTROL NOTE 2
2x HARDWARE SUPPLIED WITH CONTROL NOTE 2
3x HARDWARE SUPPLIED WITH CONTROL NOTE 2
VIEW A
TCUR
TCVR
TCWR
TCUL
TCVL
TCWL
NEG
PCU
PCV
PCW
P-BT+
PC-POS
T-B+

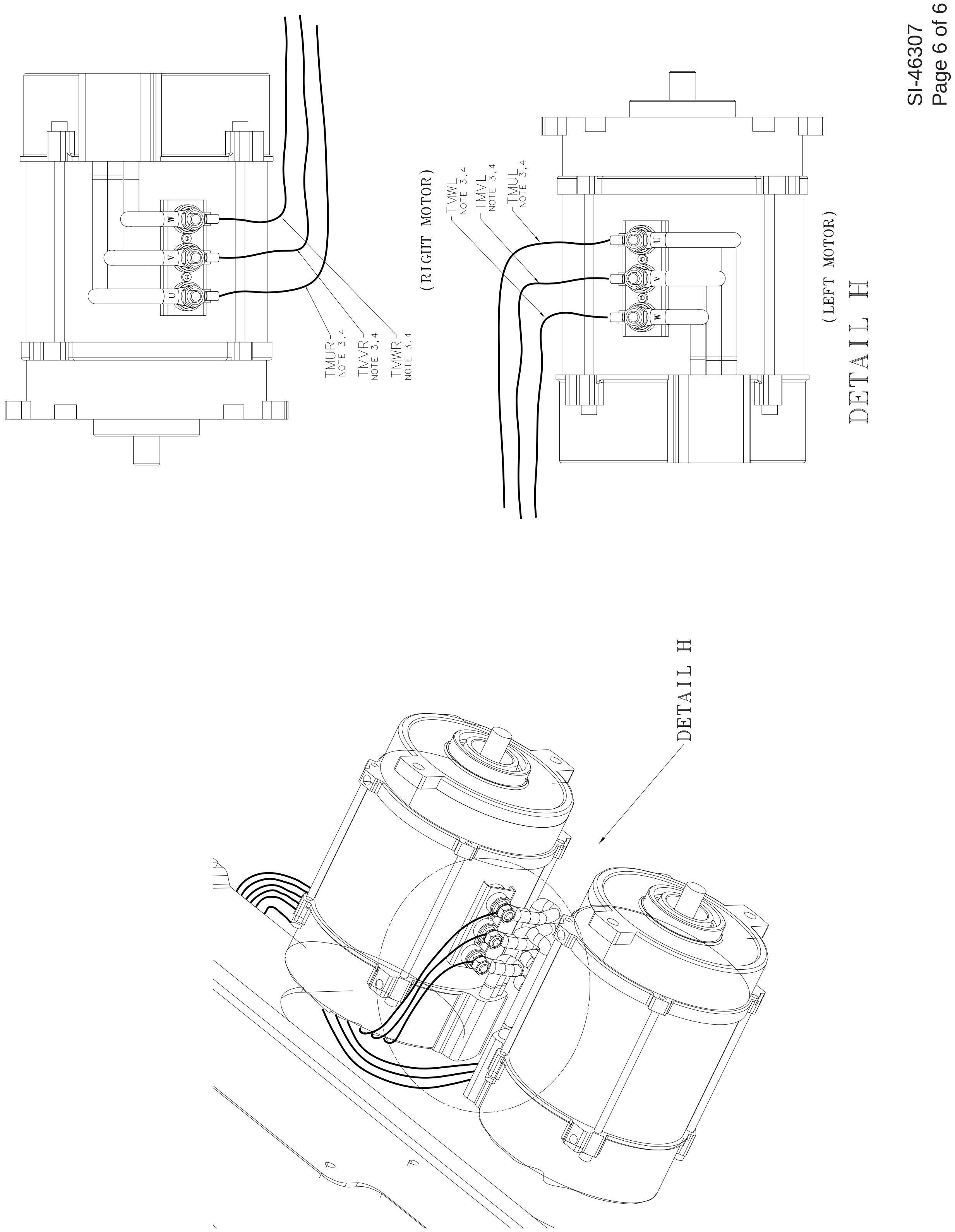

SI-46307
Page 3 of 6
TCWL TO TMWL
TCVL TO TMVL
TCUL TO TMUL
TCUR TO TMUR
TCWR TO TMVR
TCVR TO TMWR
VIEW C
TCUL TO TMUL
TCVR TO TMWR
TCWR TO TMVR
TCUR TO TMUR
TCVL TO TMVL
TCWL TO TMWL
B -
B +
VIEW E
STEER HOSES
LOWER DRAIN MAT
PCU TO PMU
PCV TO PMV
PCW TO PMW
MAIN HARNESS
PCU TO PMU
PCV TO PMV
PCW TO PMW
MAIN HARNESS
B +
B -
VIEW B
PCU TO PMU
PCV TO PMV
PCW TO PMW
MAIN HARNESS
B +
B -
TCUR TO TMUR
TCWR TO TMVR
TCVR TO TMWR
VIEW D
STEER HOSES
TCWL TO TMWL
TCVL TO TMVL
TCUL TO TMUL

SI-46307
Page 4 of 6

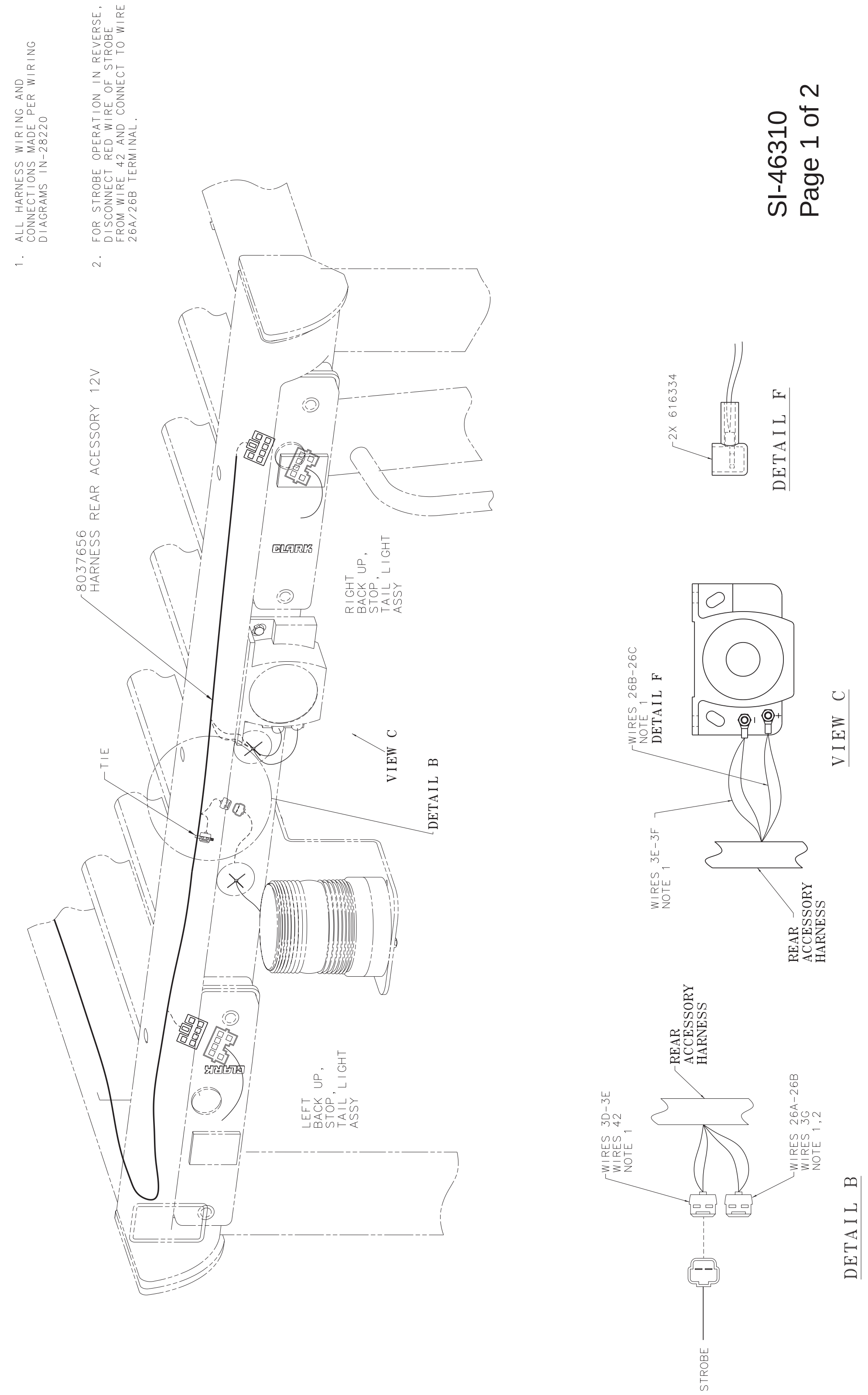


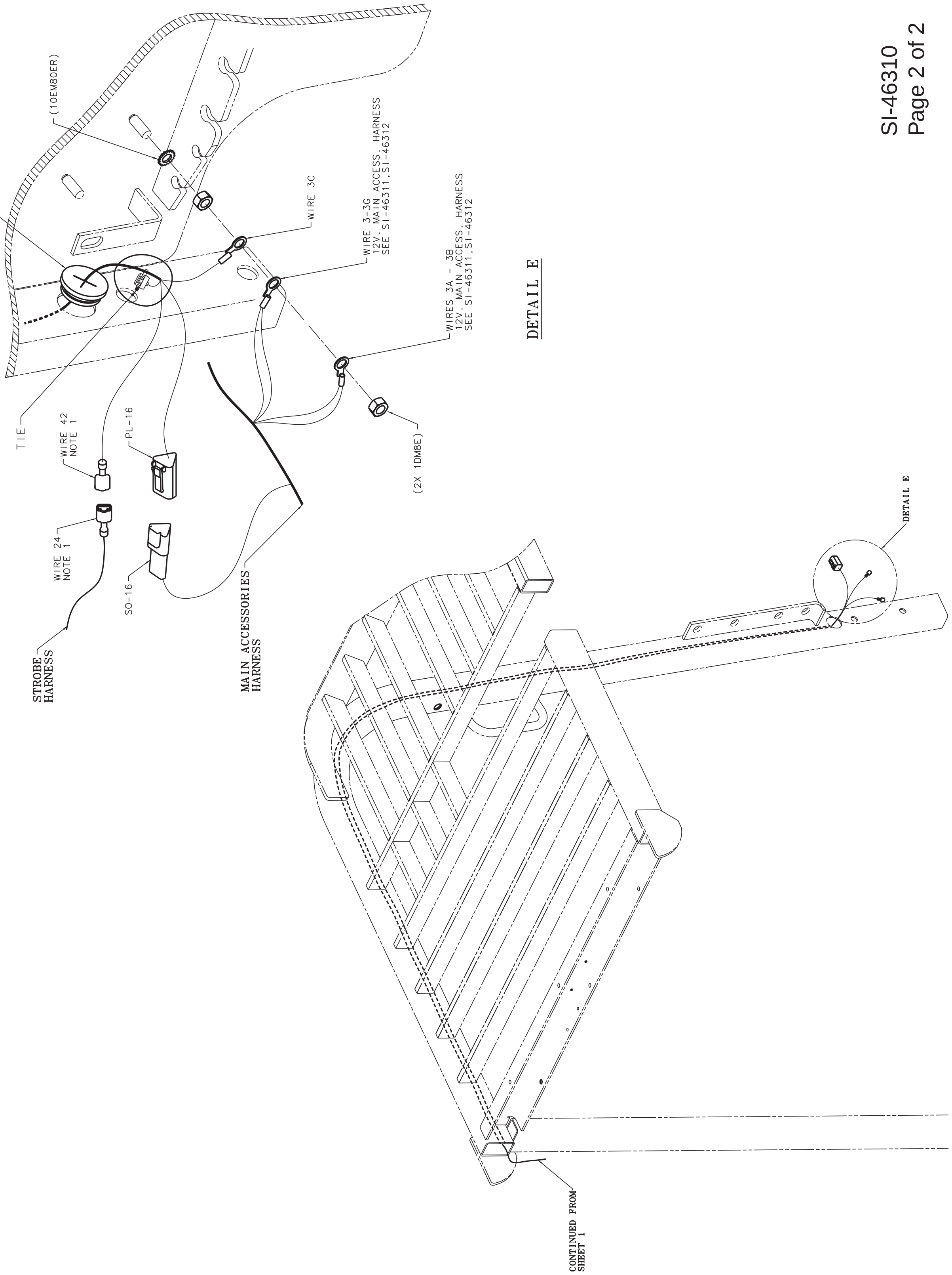
SI-46307
Page 5 of 6



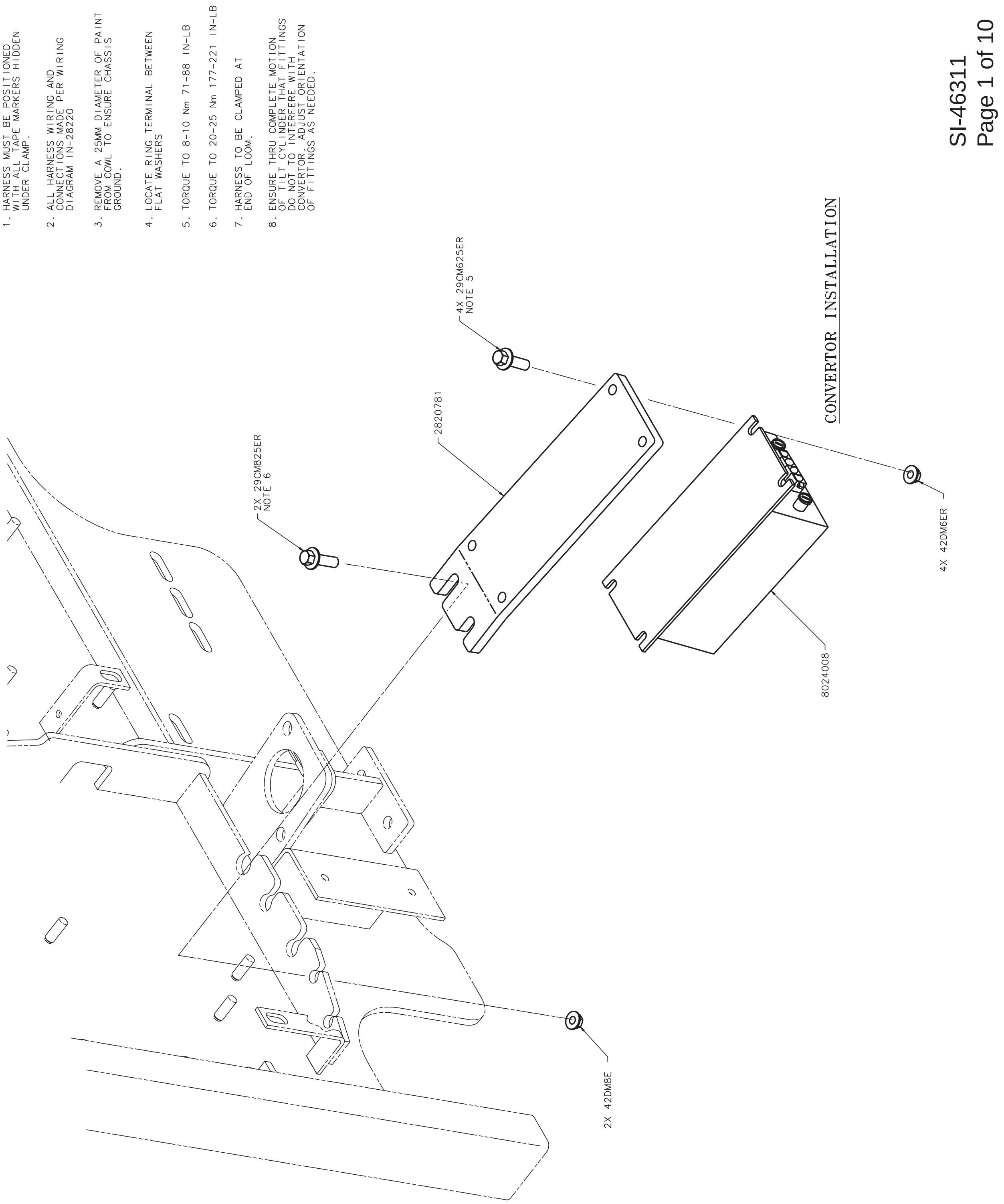

SI-46307
Page 6 of 6
(RIGHT MOTOR)
TMUR NOTE 3,4
TMVR NOTE 3,4
TMWR NOTE 3,4
W
V
U
(LEFT MOTOR)
TMWL NOTE 3,4
TMVL NOTE 3,4
TMUL NOTE 3,4
DETAIL H
DETAIL H

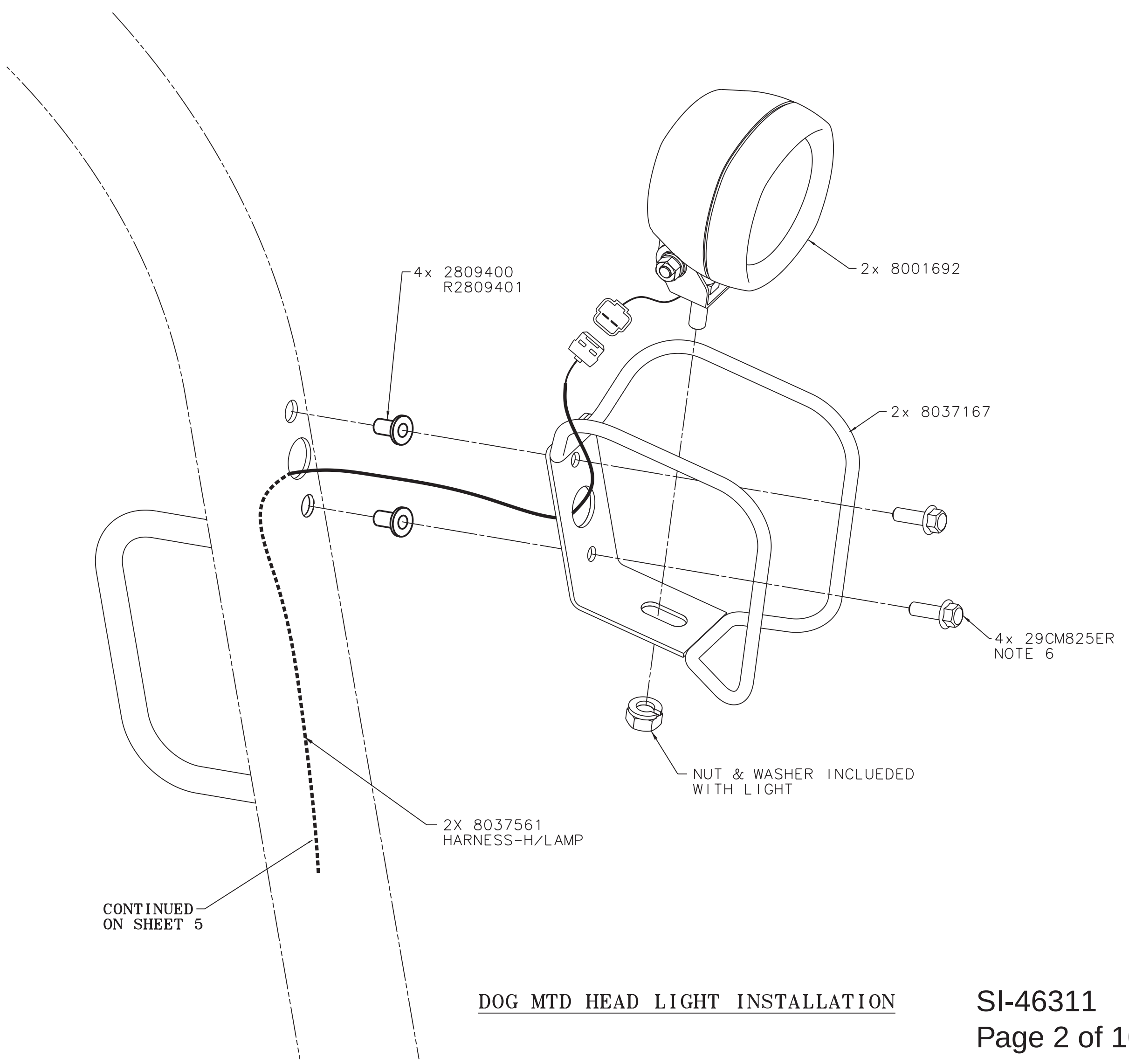
Rear Accessory Harness(TMX)




SI-46310
Page 2 of 2
(2X 2805421)
(10EM80ER)
WIRE 3C
WIRE 3-3G
12V. MAIN ACCESS. HARNESS
SEE SI-46311,SI-46312
WIRES 3A - 3B
12V. MAIN ACCESS. HARNESS
SEE SI-46311,SI-46312
DETAIL E
TIE
WIRE 42
NOTE 1
PL-16
(2X 1DM8E)
WIRE 24
NOTE 1
SO-16
STROBE
HARNESS
MAIN ACCESSORIES
HARNESS
DETAIL E
CONTINUED FROM
SHEET 1

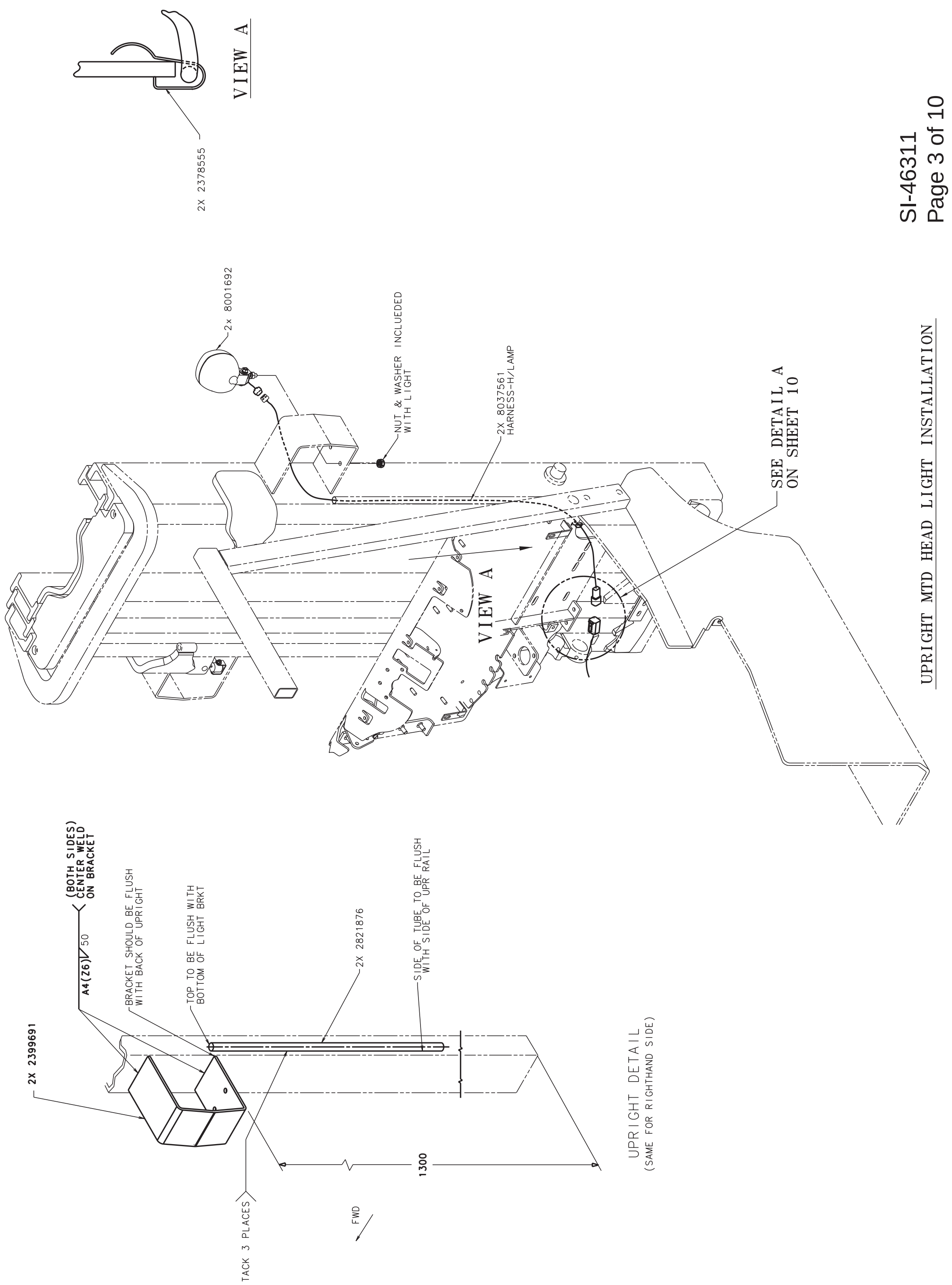
Main Accessory Harness(TMX)



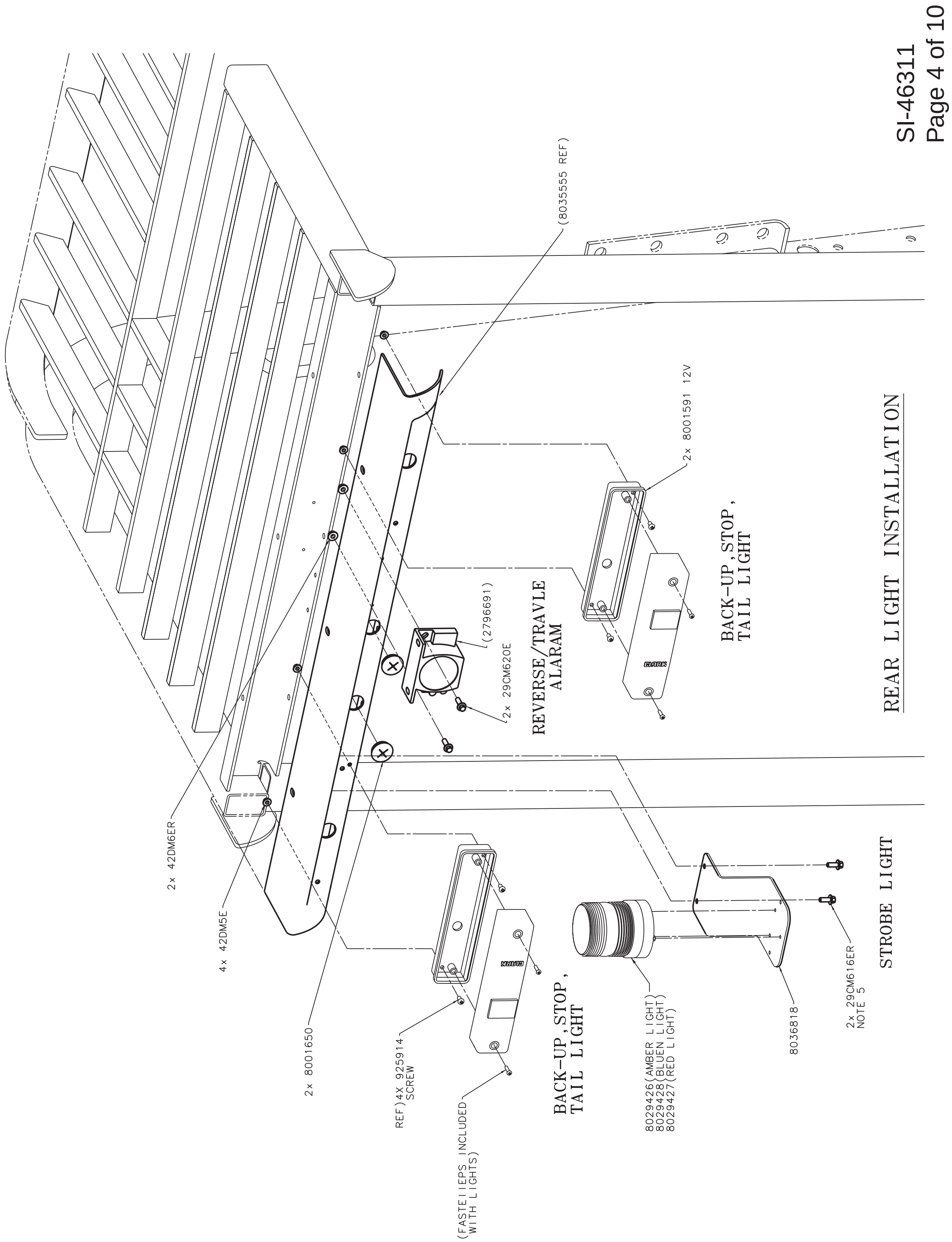


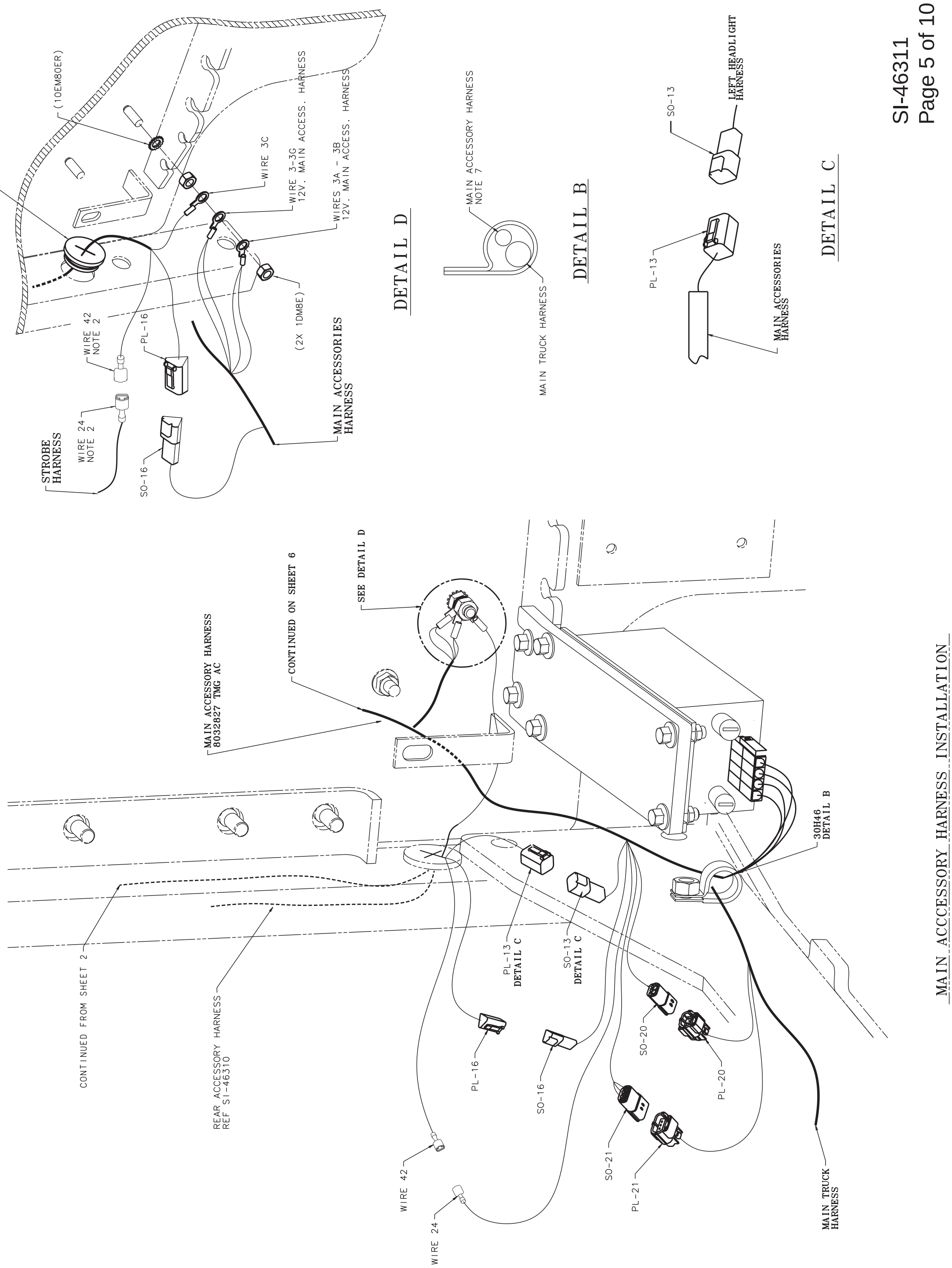
DOG MTD HEAD LIGHT INSTALLATION

SI-46311
Page 2 of 10

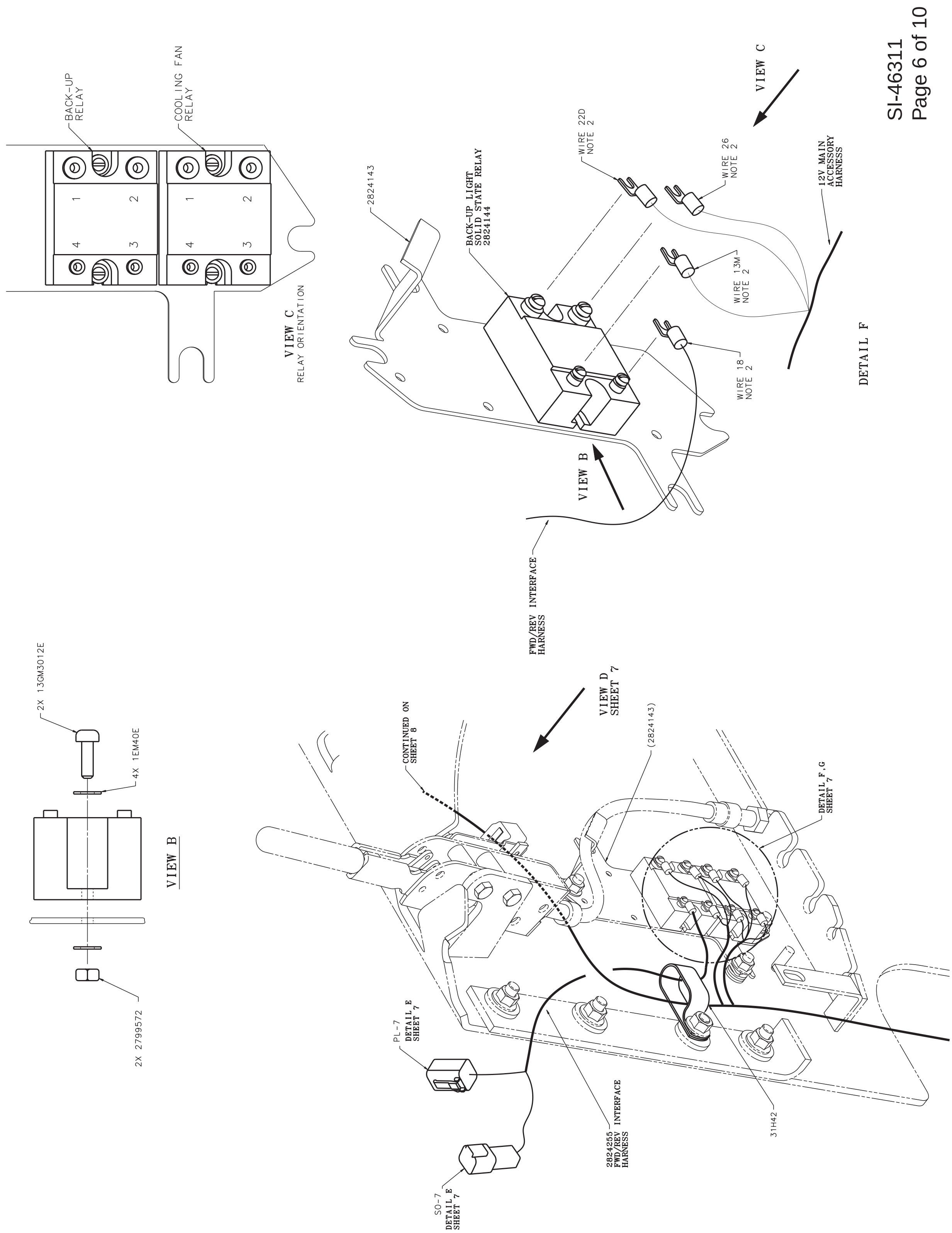


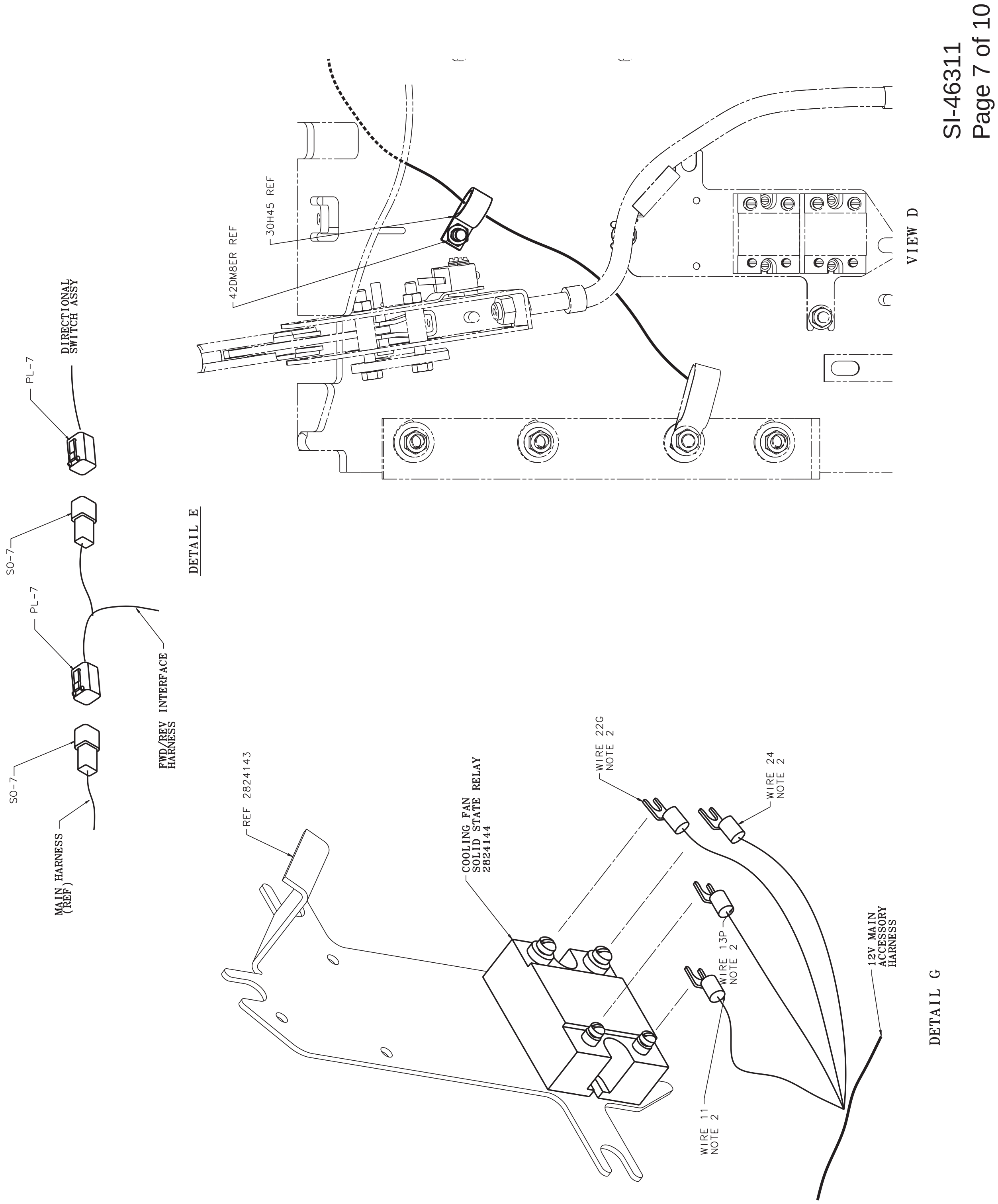
VIEW A
2X 2378555
2X 8001692
NUT & WASHER INCLUEDED
WITH LIGHT
2X 8037561
HARNESS-H/LAMP
SEE DETAIL A
ON SHEET 10
VIEW A
UPRIGHT MTD HEAD LIGHT INSTALLATION
SI-46311
Page 3 of 10
(BOTH SIDES)
CENTER WELD
ON BRACKET
A4(Z6)
50
BRACKET SHOULD BE FLUSH
WITH BACK OF UPRIGHT
TOP TO BE FLUSH WITH
BOTTOM OF LIGHT BRKT
2X 2821876
SIDE OF TUBE TO BE FLUSH
WITH SIDE OF UPR RAIL
2X 2399691
1300
UPRIGHT DETAIL
(SAME FOR RIGHTHAND SIDE)
TACK 3 PLACES
FWD


SI-46311
Page 4 of 10
REAR LIGHT INSTALLATION
(8035555 REF)
2x 8001591 12V
BACK-UP, STOP,
TAIL LIGHT
(2796691)
2x 29CM620E
REVERSE/TRAVLE
ALARAM
STROBE LIGHT
2x 29CM616ER
NOTE 5
8036818
8029426 (AMBER LIGHT)
8029428 (BLUEN LIGHT)
8029427 (RED LIGHT)
BACK-UP, STOP,
TAIL LIGHT
(FASTEIIEPS INCLUDED
WITH LIGHTS)
REF) 4X 925914
SCREW
2x 8001650
4x 42DM5E
2x 42DM6ER

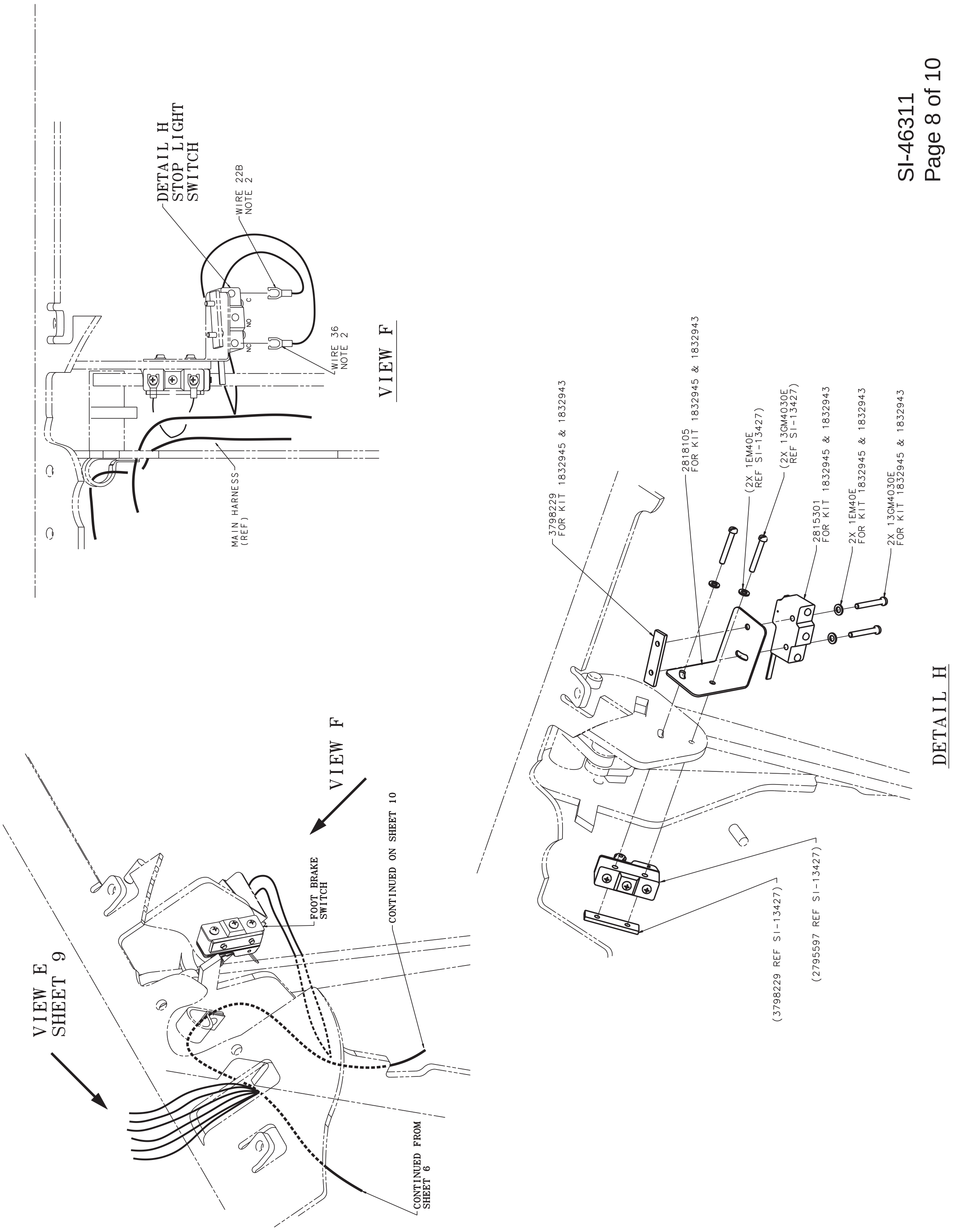


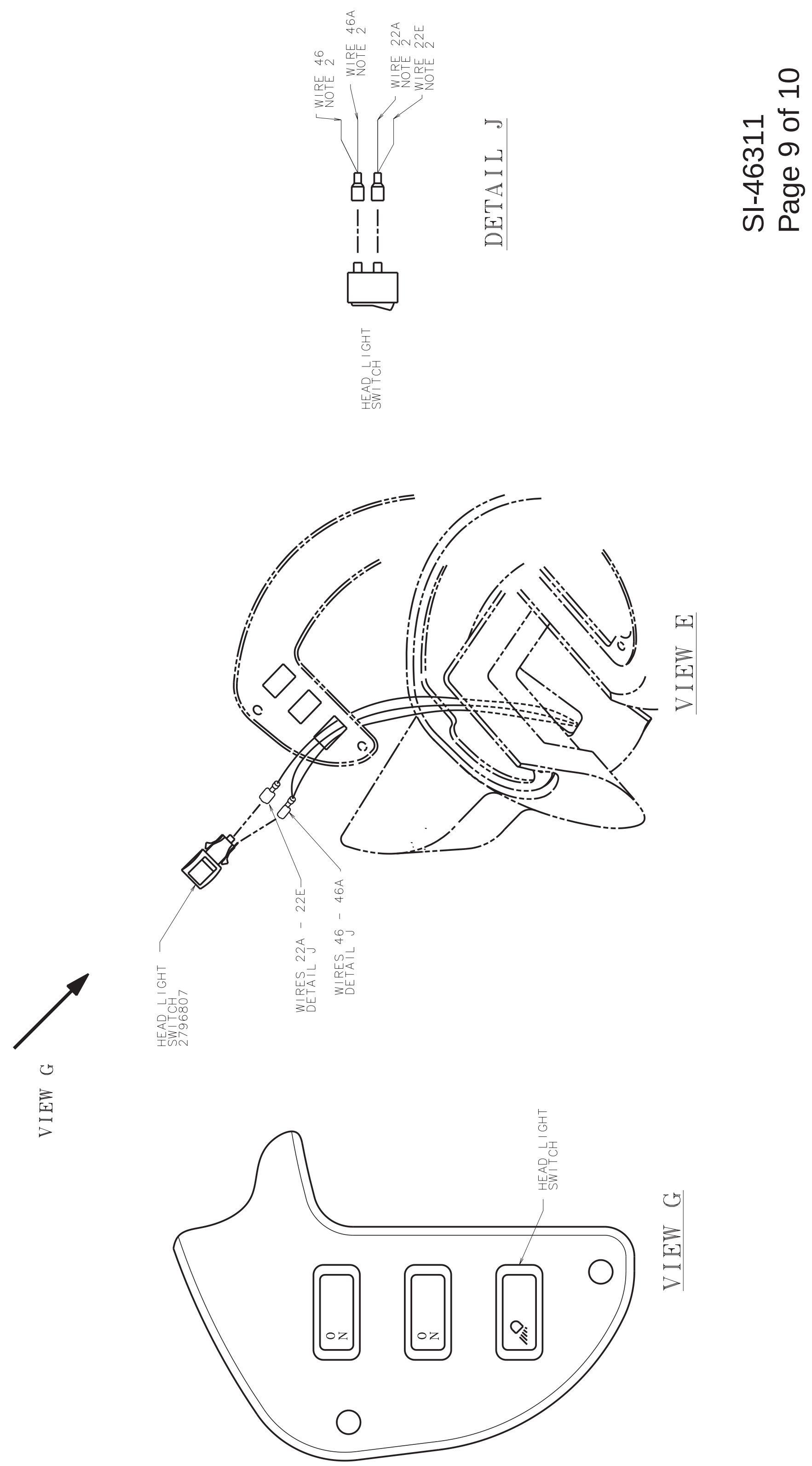
(2X 2805421)
(10EM80ER)
WIRE 3C
WIRE 3-3G 12V. MAIN ACCESS. HARNESS
WIRES 3A - 3B 12V. MAIN ACCESS. HARNESS
(2X 1DM8E)
WIRE 42 NOTE 2
PL-16
WIRE 24 NOTE 2
STROBE HARNESS
SO-16
MAIN ACCESSORIES HARNESS
DETAIL D
MAIN ACCESSORY HARNESS NOTE 7
MAIN TRUCK HARNESS
DETAIL B
SO-13
LEFT HEADLIGHT HARNESS
PL-13
MAIN ACCESSORIES HARNESS
DETAIL C
SI-46311
Page 5 of 10
MAIN ACCESSORY HARNESS 8032827 TMG AC
CONTINUED ON SHEET 6
SEE DETAIL D
30H46 DETAIL B
MAIN ACCCESSORY HARNESS INSTALLATION
CONTINUED FROM SHEET 2
REAR ACCESSORY HARNESS REF SI-46310
PL-13 DETAIL C
SO-13 DETAIL C
PL-16
SO-16
SO-20
PL-20
SO-21
PL-21
WIRE 42
WIRE 24
MAIN TRUCK HARNESS

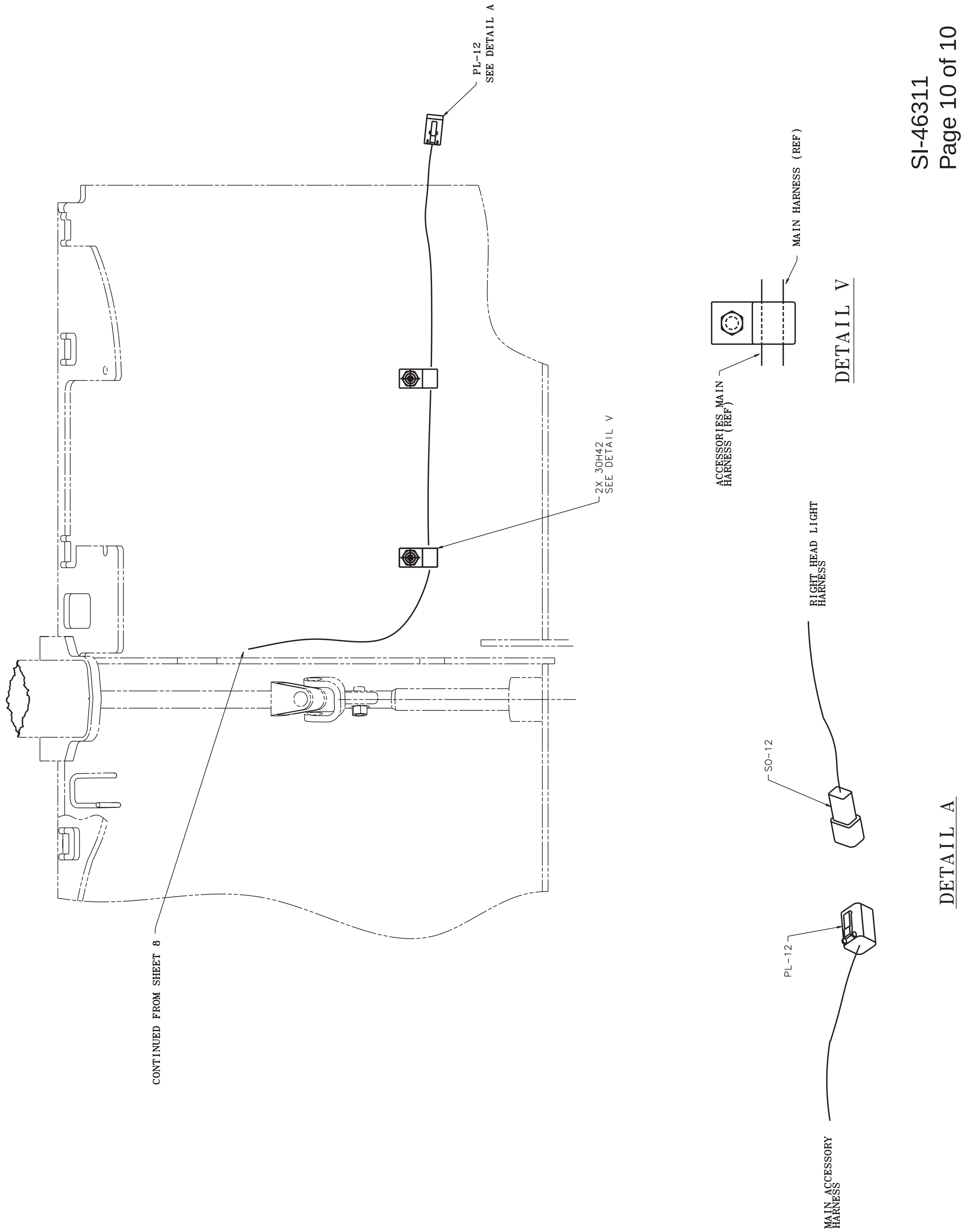

SI-46311
Page 6 of 10
BACK-UP RELAY
COOLING FAN RELAY
VIEW C
RELAY ORIENTATION
2824143
BACK-UP LIGHT SOLID STATE RELAY 2824144
WIRE 22D NOTE 2
WIRE 26 NOTE 2
WIRE 13M NOTE 2
WIRE 18 NOTE 2
12V MAIN ACCESSORY HARNESS
DETAIL F
VIEW B
FWD/REV INTERFACE HARNESS
2X 13GM3012E
4X 1EM40E
2X 2799572
CONTINUED ON SHEET 8
VIEW D SHEET 7
(2824143)
DETAIL F,G SHEET 7
PL-7 DETAIL E SHEET 7
SO-7 DETAIL E SHEET 7
2824255 FWD/REV INTERFACE HARNESS
31H42



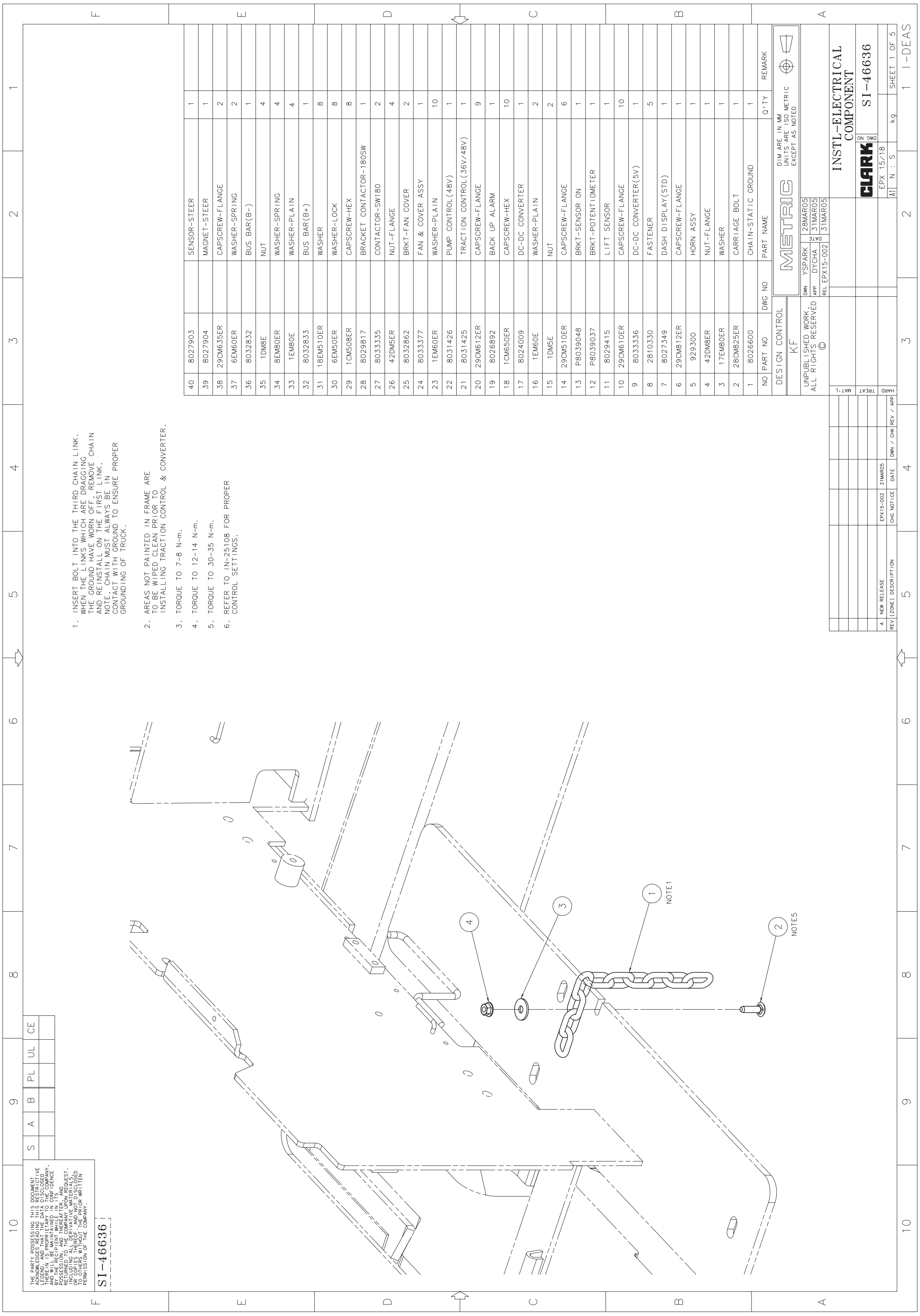
SI-46311
Page 7 of 10
DIRECTIONAL SWITCH ASSY
PL-7
SO-7
PL-7
SO-7
FWD/REV INTERFACE HARNESS
MAIN HARNESS (REF)
DETAIL E
42DM8ER REF
30H45 REF
VIEW D
REF 2824143
COOLING FAN SOLID STATE RELAY 2824144
WIRE 22G NOTE 2
WIRE 24 NOTE 2
WIRE 13P NOTE 2
WIRE 11 NOTE 2
12V MAIN ACCESSORY HARNESS
DETAIL G


DETAIL H
STOP LIGHT
SWITCH
WIRE 22B
NOTE 2
WIRE 36
NOTE 2
NC
NO
C
VIEW F
MAIN HARNESS
(REF)
SI-46311
Page 8 of 10
3798229
FOR KIT 1832945 & 1832943
2818105
FOR KIT 1832945 & 1832943
(2X 1EM40E
REF SI-13427)
(2X 13GM4030E
REF SI-13427)
2815301
FOR KIT 1832945 & 1832943
2X 1EM40E
FOR KIT 1832945 & 1832943
2X 13GM4030E
FOR KIT 1832945 & 1832943
DETAIL H
(3798229 REF SI-13427)
(2795597 REF SI-13427)
VIEW E
SHEET 9
VIEW F
FOOT BRAKE
SWITCH
CONTINUED ON SHEET 10
CONTINUED FROM
SHEET 6


WIRE 46
NOTE 2
WIRE 46A
NOTE 2
WIRE 22A
NOTE 2
WIRE 22E
NOTE 2
DETAIL J
HEAD LIGHT
SWITCH
SI-46311
Page 9 of 10
VIEW E
HEAD LIGHT
SWITCH
2796807
WIRES 22A - 22E
DETAIL J
WIRES 46 - 46A
DETAIL J
VIEW G
HEAD LIGHT
SWITCH
ON
ON
VIEW G

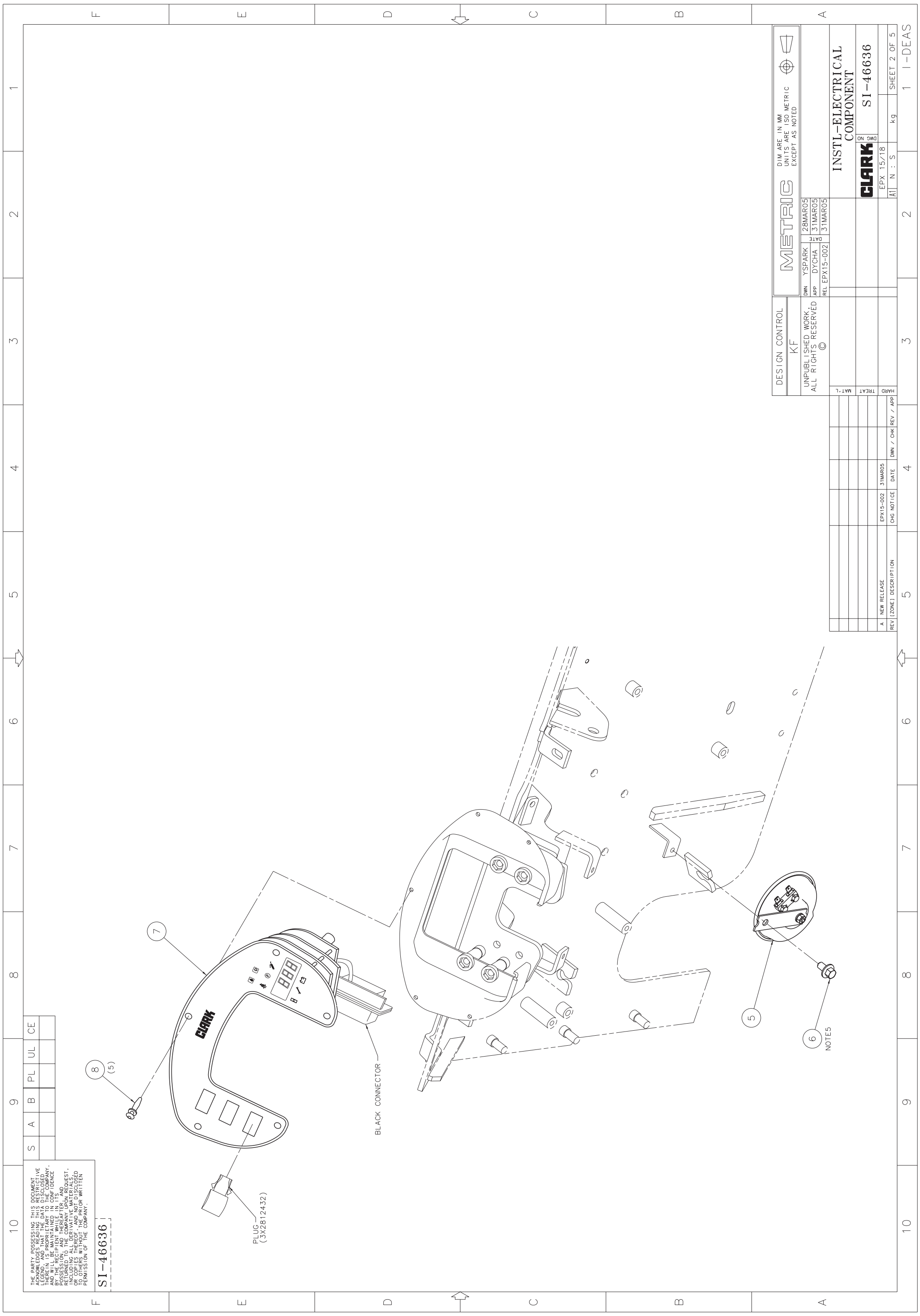

PL-12
SEE DETAIL A
2X 30H42
SEE DETAIL V
CONTINUED FROM SHEET 8
MAIN HARNESS (REF)
ACCESSORIES MAIN
HARNESS (REF)
DETAIL V
RIGHT HEAD LIGHT
HARNESS
SO-12
PL-12
DETAIL A
MAIN ACCESSORY
HARNESS
SI-46311
Page 10 of 10

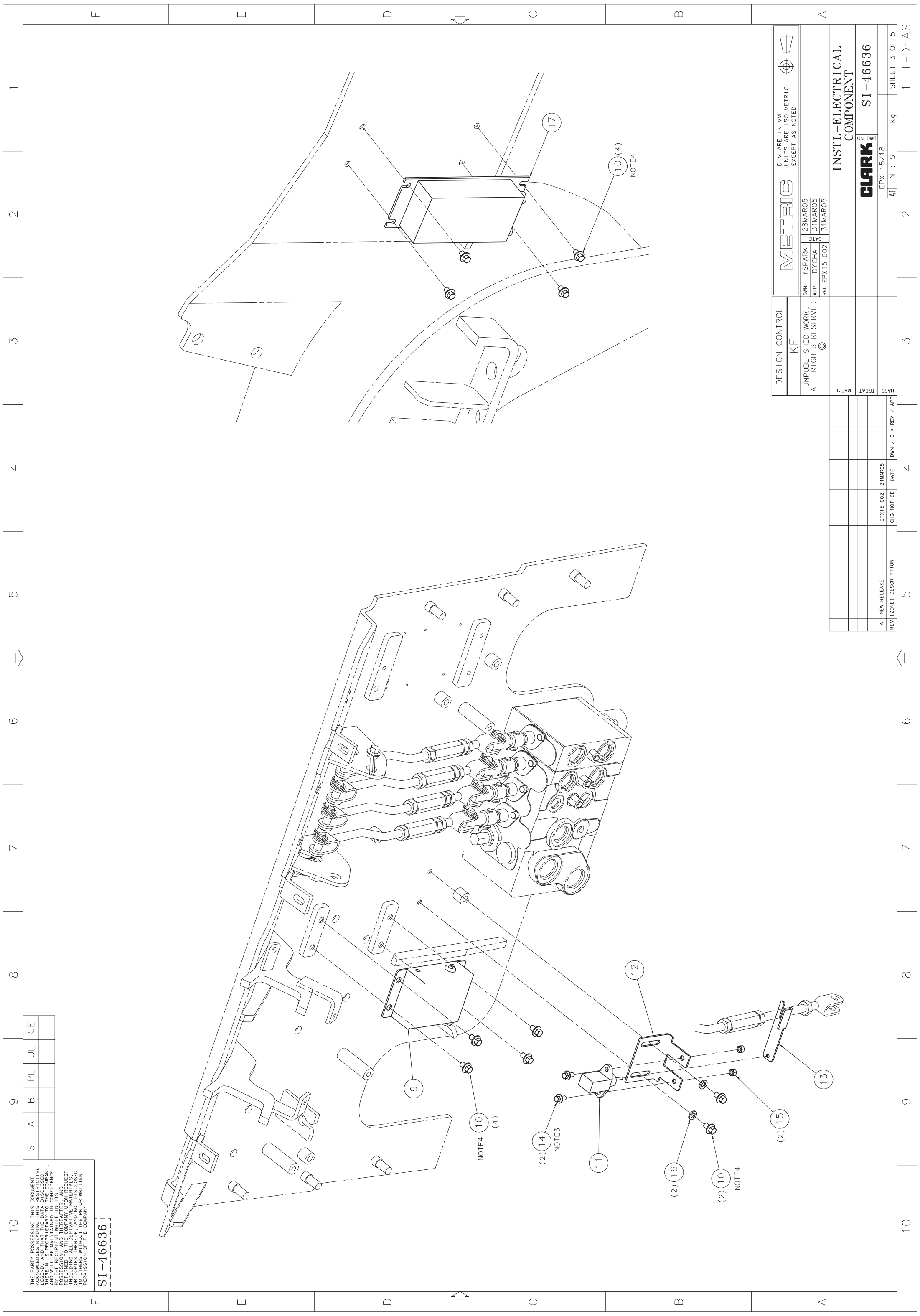
Electrical Components(EPX)

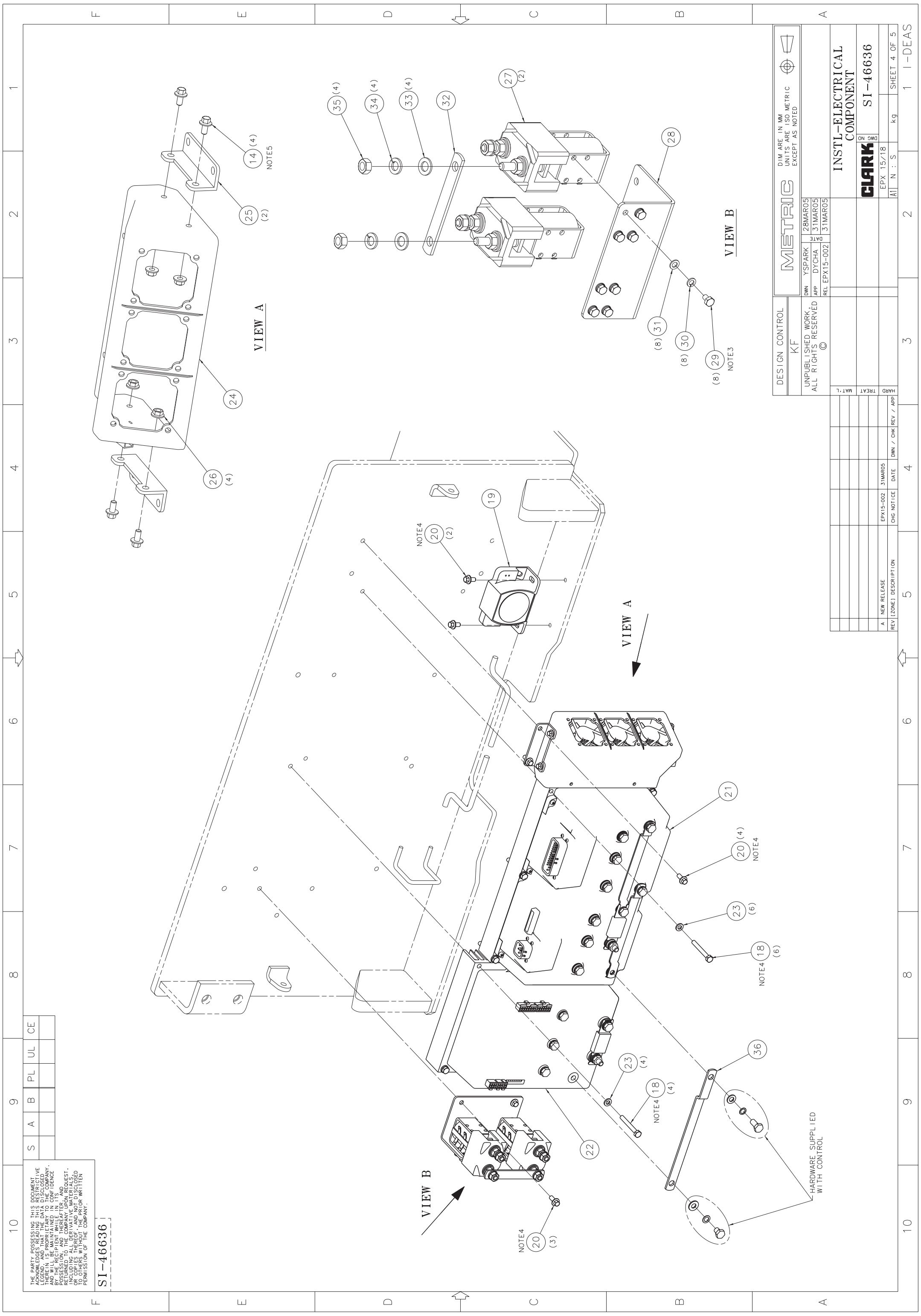


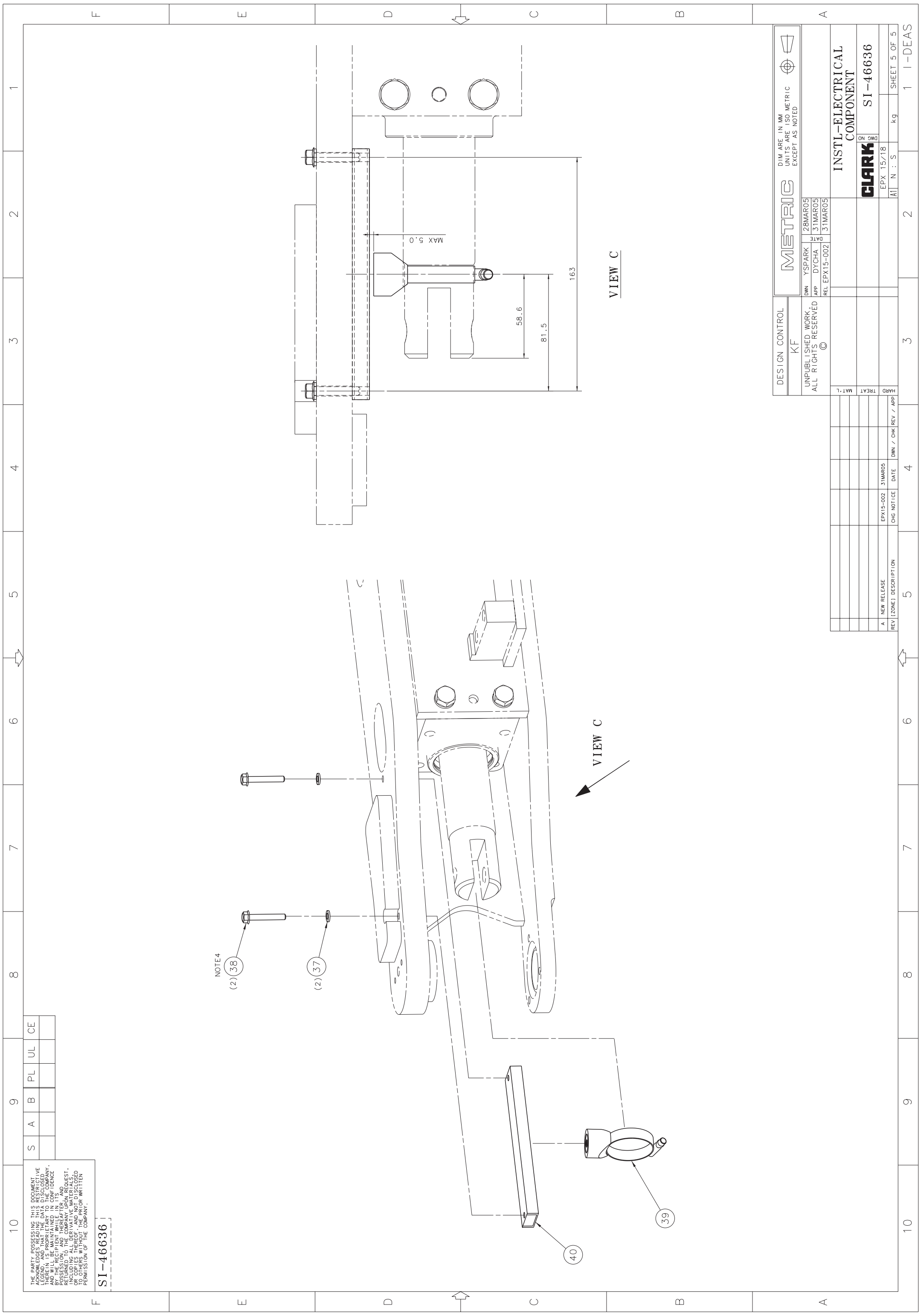
1. INSERT BOLT INTO THE THIRD CHAIN LINK. WHEN THE LINKS WHICH ARE DRAGGING THE GROUND HAVE WORN OFF, REMOVE CHAIN AND REINSTALL ON THE FIRST LINK. NOTE, CHAIN MUST ALWAYS BE IN CONTACT WITH GROUND TO ENSURE PROPER GROUNDING OF TRUCK.
2. AREAS NOT PAINTED IN FRAME ARE TO BE WIPED CLEAN PRIOR TO INSTALLING TRACTION CONTROL & CONVERTER.
3. TORQUE TO 7-8 N-m.
4. TORQUE TO 12-14 N-m.
5. TORQUE TO 30-35 N-m.
6. REFER TO IN-25108 FOR PROPER CONTROL SETTINGS.

NO	PART NO	DWG NO	PART NAME	Q'TY	REMARK
40	8027903		SENSOR-STEER	1	
39	8027904		MAGNET-STEER	1	
38	29CM635ER		CAPSCREW-FLANGE	2	
37	6EM60ER		WASHER-SPRING	2	
36	8032832		BUS BAR(B-)	1	
35	1DM8E		NUT	4	
34	8EM80ER		WASHER-SPRING	4	
33	1EM80E		WASHER-PLAIN	4	
32	8032833		BUS BAR(B+)	1	
31	18EM510ER		WASHER	8	
30	6EM50ER		WASHER-LOCK	8	
29	1CM508ER		CAPSCREW-HEX	8	
28	8029817		BRACKET CONTACTOR-180SW	1	
27	8033335		CONTACTOR-SW180	2	
26	42DM5ER		NUT-FLANGE	4	
25	8032862		BRKT-FAN COVER	2	
24	8033377		FAN & COVER ASSY	1	
23	1EM60ER		WASHER-PLAIN	10	
22	8031426		PUMP CONTROL(48V)	1	
21	8031425		TRACTION CONTROL(36V/48V)	1	
20	29CM612ER		CAPSCREW-FLANGE	9	
19	8026892		BACK UP ALARM	1	
18	1CM650ER		CAPSCREW-HEX	10	
17	8024009		DC-DC CONVERTER	1	
16	1EM60E		WASHER-PLAIN	2	
15	1DM5E		NUT	2	
14	29CM510ER		CAPSCREW-FLANGE	6	
13	P8039048		BRKT-SENSOR ON	1	
12	P8039037		BRKT-POTENTIOMETER	1	
11	8029415		LIFT SENSOR	1	
10	29CM610ER		CAPSCREW-FLANGE	10	
9	8033336		DC-DC CONVERTER(5V)	1	
8	2810330		FASTENER	5	
7	8027349		DASH DISPLAY(STD)	1	
6	29CM812ER		CAPSCREW-FLANGE	1	
5	929300		HORN ASSY	1	
4	42DM8ER		NUT-FLANGE	1	
3	17EM80ER		WASHER	1	
2	28CM825ER		CARRIAGE BOLT	1	
1	8026600		CHAIN-STATIC GROUND	1	

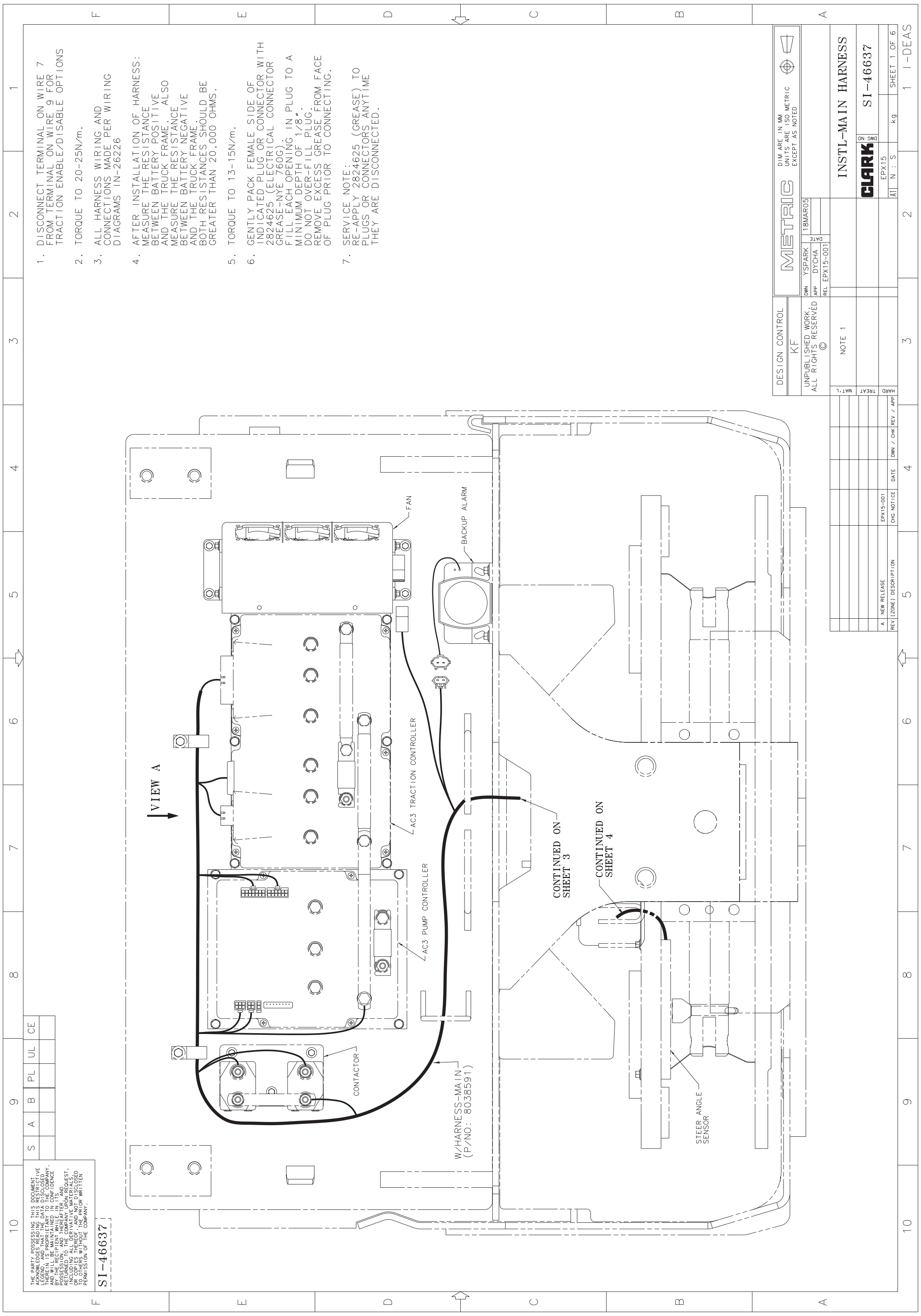

INSTL-ELECTRICAL COMPONENT
SI-46636
METRIC
DESIGN CONTROL
UNPUBLISHED WORK, ALL RIGHTS RESERVED ©
BLACK CONNECTOR
PLUG (3X2812432)
NOTES

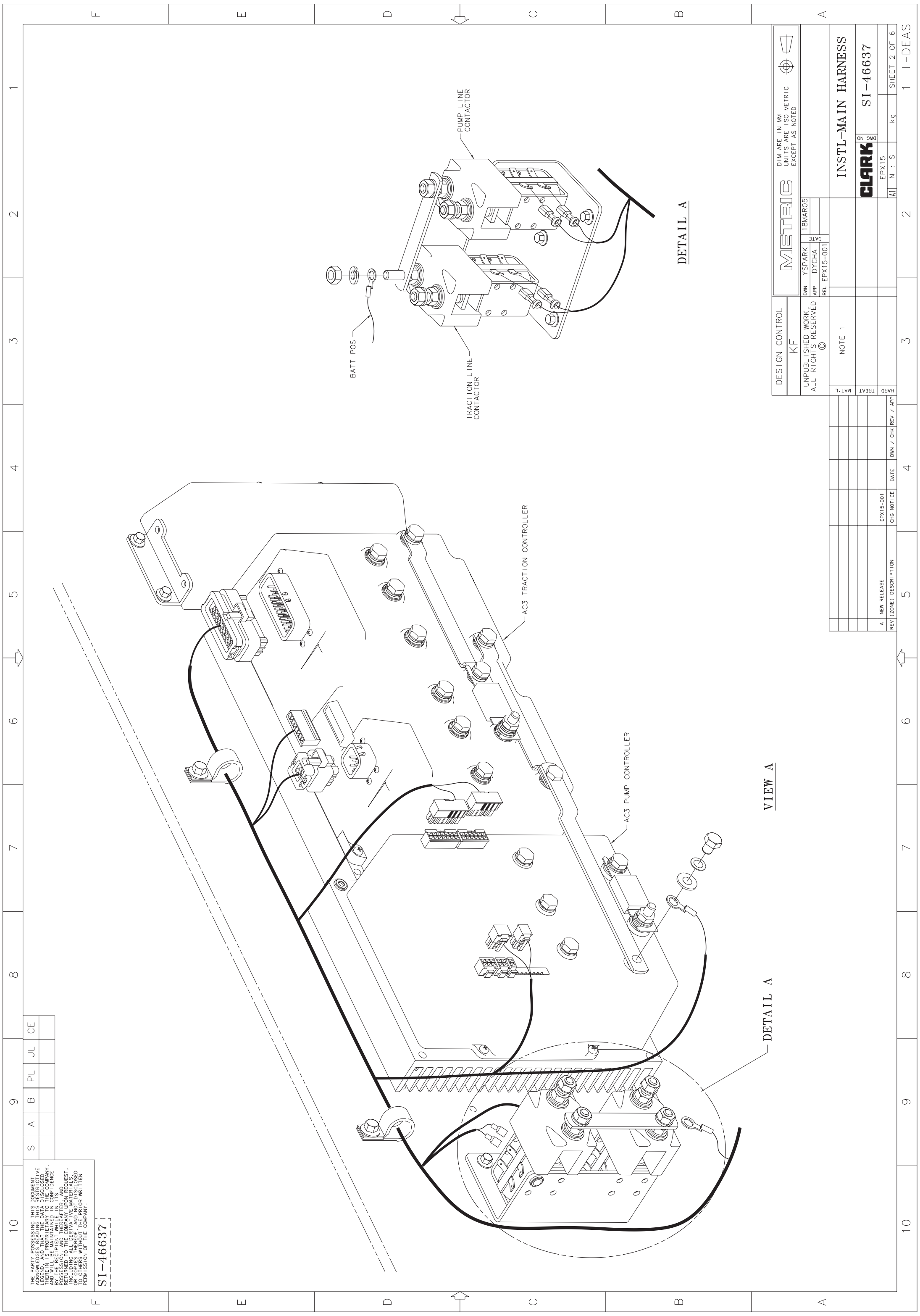

INSTL-ELECTRICAL COMPONENT
SI-46636
METRIC
NOTE4
NOTE3

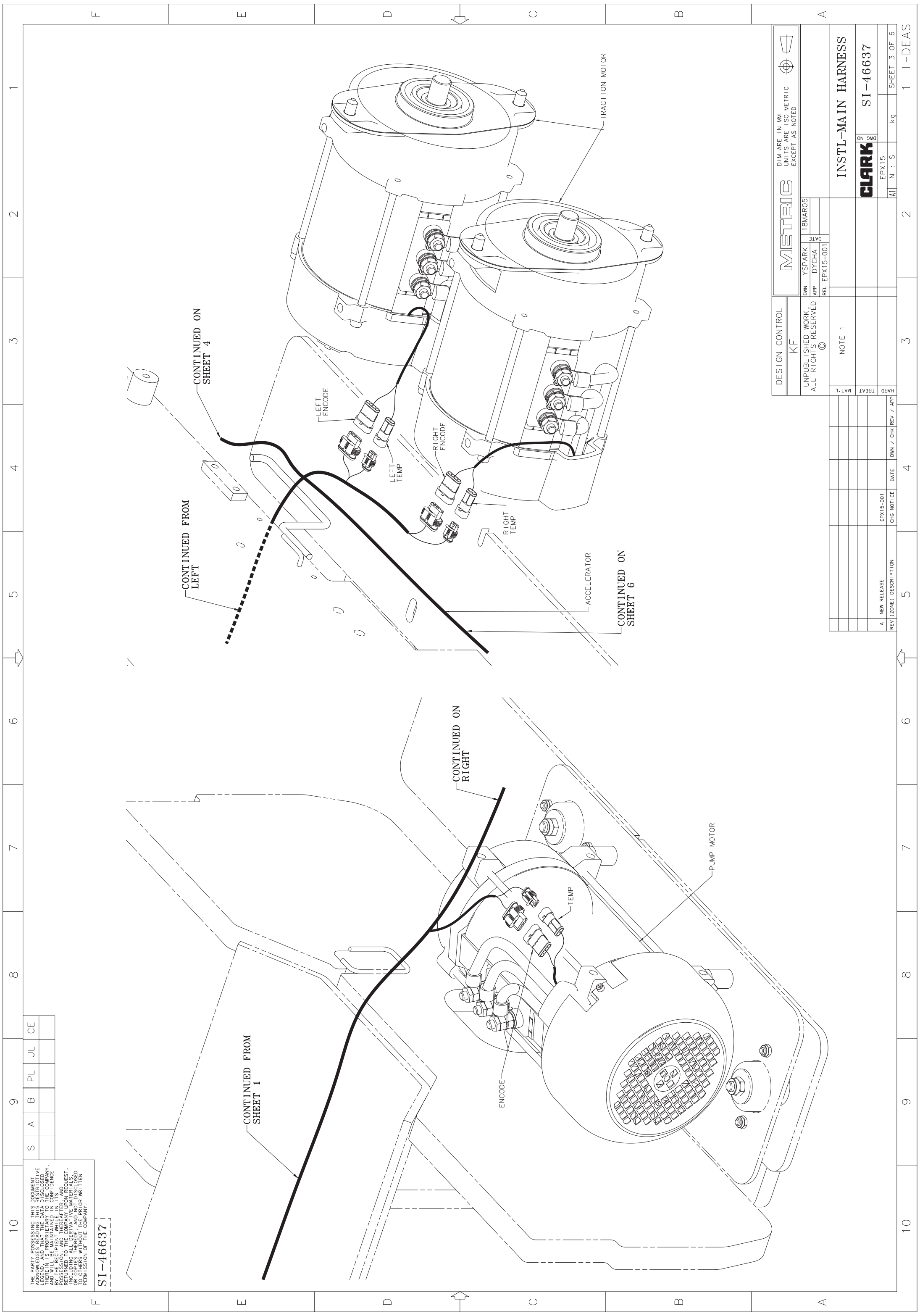

VIEW A
VIEW B
HARDWARE SUPPLIED WITH CONTROL
INSTL-ELECTRICAL COMPONENT
SI-46636

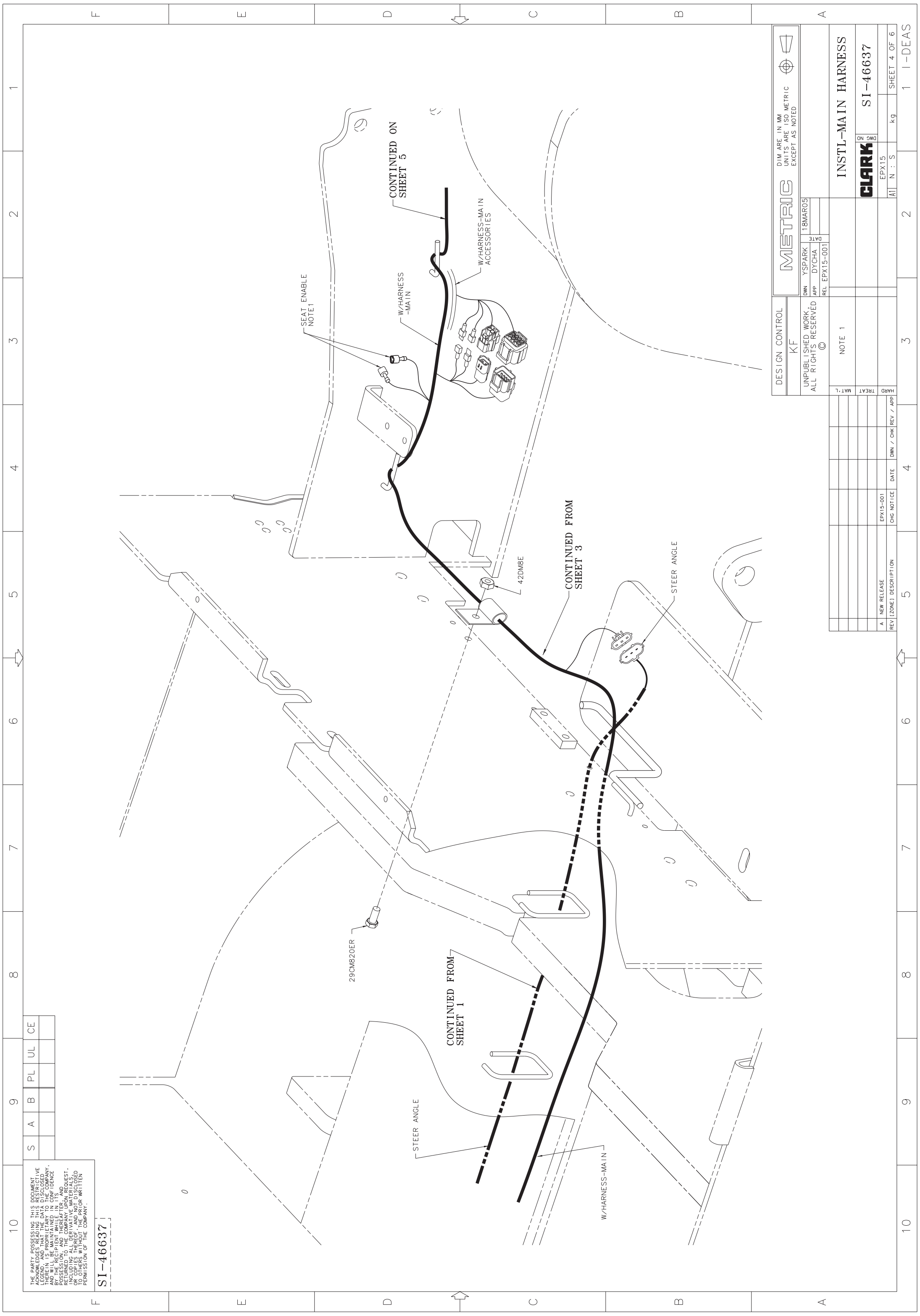

INSTL-ELECTRICAL COMPONENT
SI-46636
VIEW C
MAX 5.0
163
58.6
81.5
DESIGN CONTROL
UNPUBLISHED WORK, ALL RIGHTS RESERVED
NEW RELEASE
NOTE4
SHEET 5 OF 5
I-DEAS

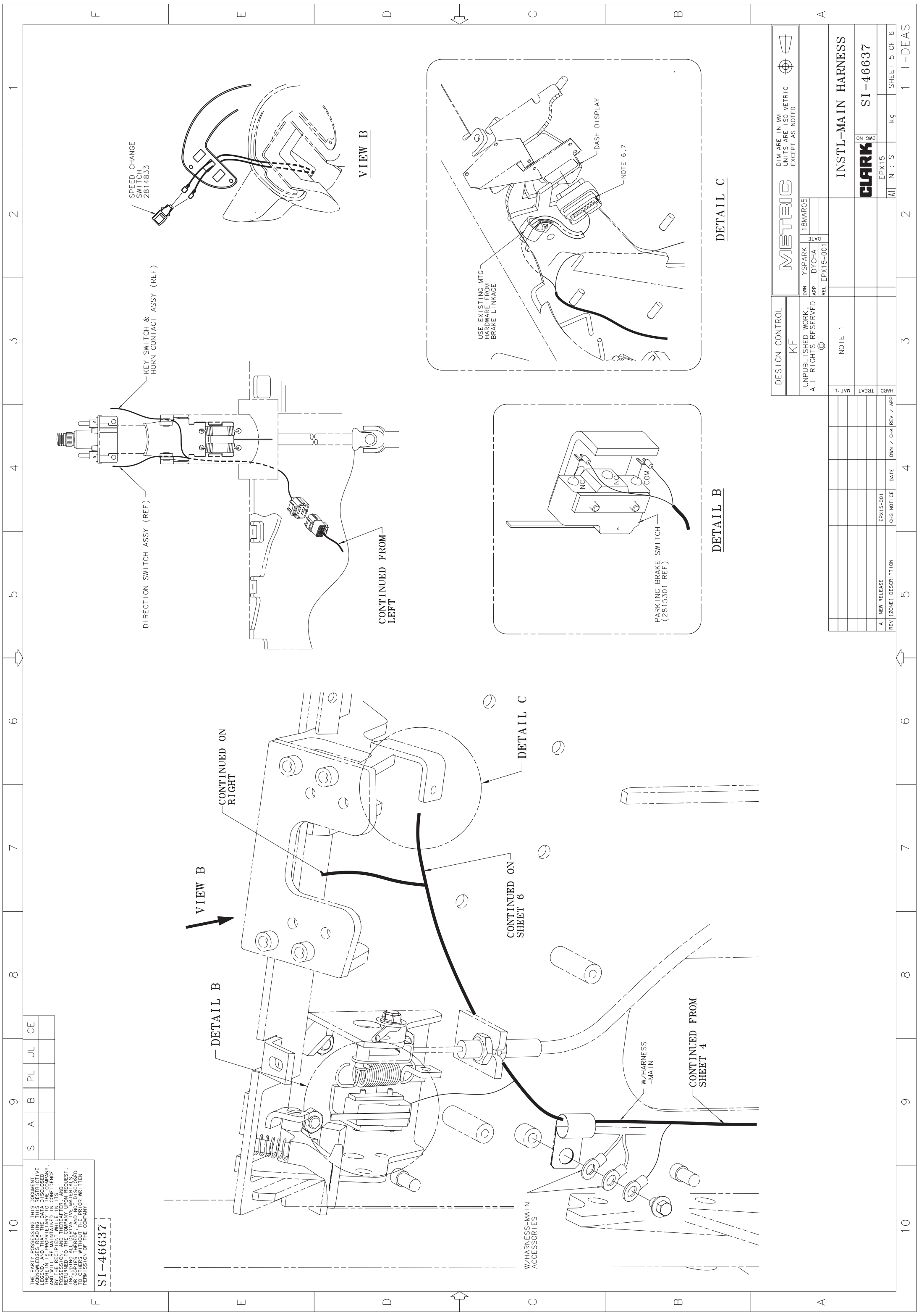
Main Harness(EPX)

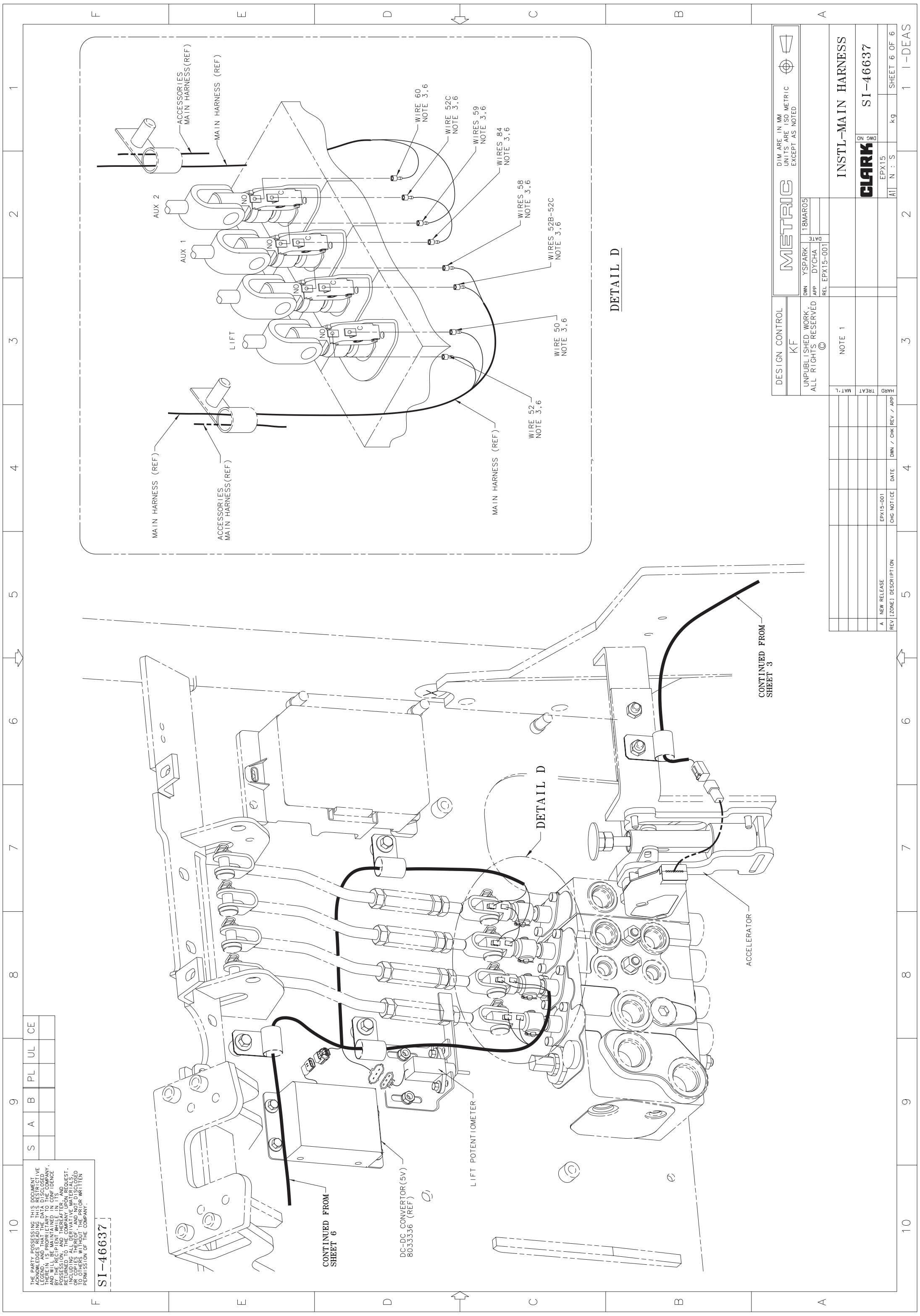



PUMP LINE CONTACTOR
BATT POS
TRACTION LINE CONTACTOR
DETAIL A
AC3 TRACTION CONTROLLER
AC3 PUMP CONTROLLER
VIEW A
DETAIL A
METRIC
DESIGN CONTROL
KF
UNPUBLISHED WORK, ALL RIGHTS RESERVED
NOTE 1
DWN YSPARK 18MAR05
APP DYCHA
REL EPX15-001
INSTL-MAIN HARNESS
SI-46637
EPX15
SHEET 2 OF 6
I-DEAS
A NEW RELEASE EPX15-001
SI-46637

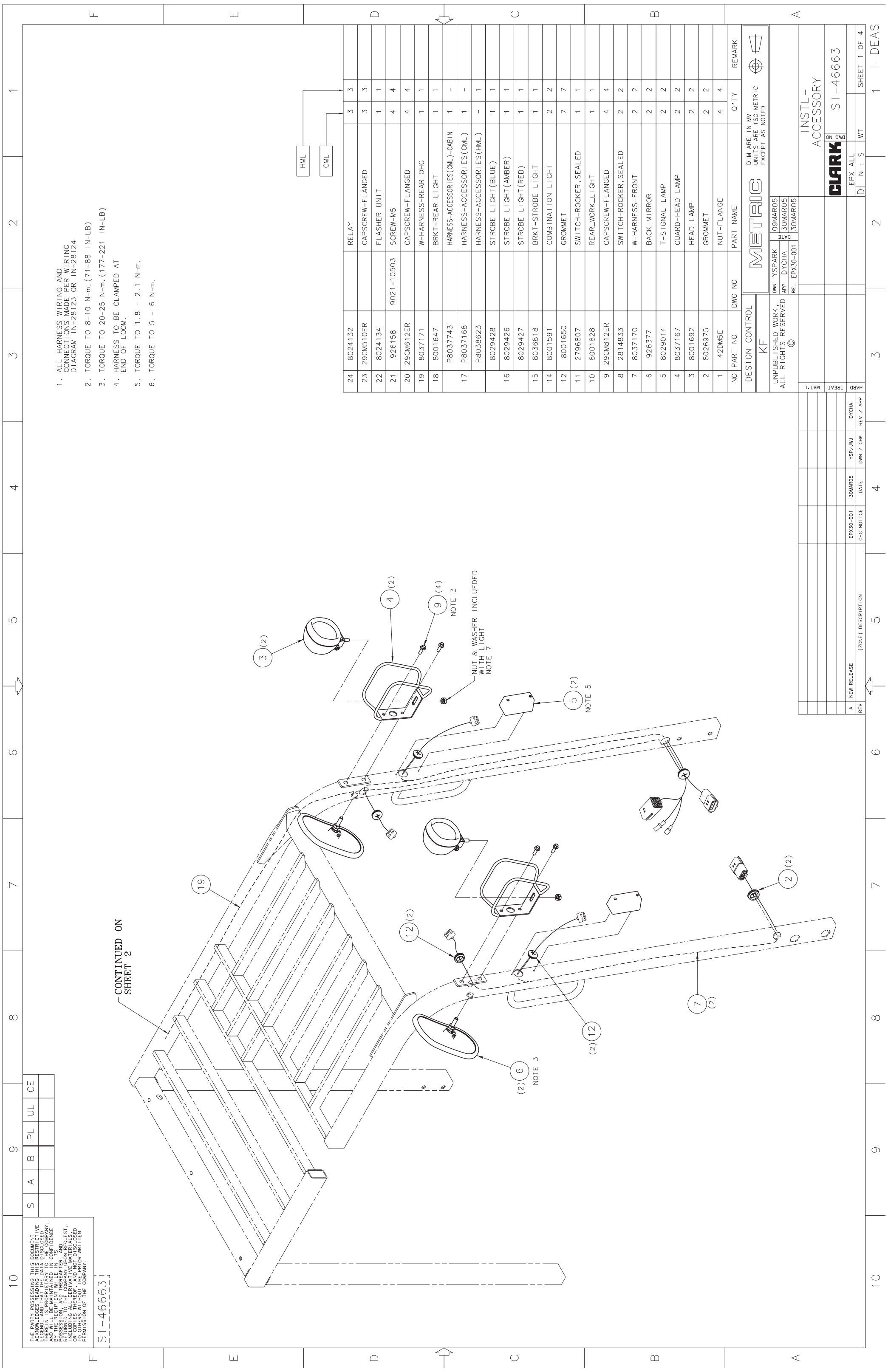

TRACTION MOTOR
CONTINUED ON SHEET 4
LEFT ENCODE
LEFT TEMP
RIGHT ENCODE
RIGHT TEMP
CONTINUED FROM LEFT
ACCELERATOR
CONTINUED ON SHEET 6
CONTINUED ON RIGHT
PUMP MOTOR
TEMP
ENCODE
CONTINUED FROM SHEET 1
METRIC
DESIGN CONTROL
NOTE 1
INSTL-MAIN HARNESS
SI-46637
EPX15
A NEW RELEASE
SI-46637

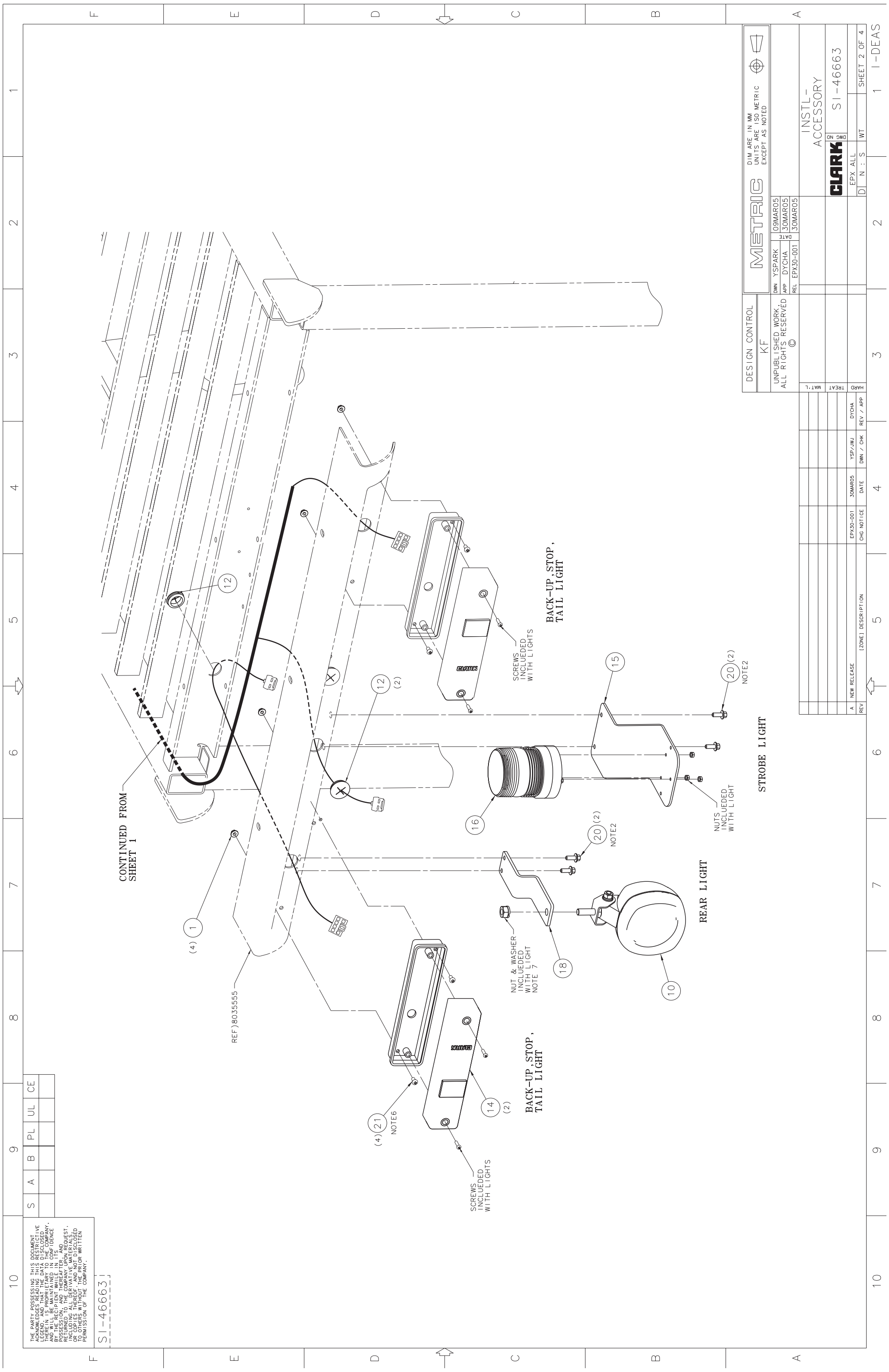

CONTINUED ON SHEET 5
W/HARNESS-MAIN ACCESSORIES
SEAT ENABLE NOTE1
W/HARNESS -MAIN
CONTINUED FROM SHEET 3
STEER ANGLE
CONTINUED FROM SHEET 1
STEER ANGLE
W/HARNESS-MAIN
METRIC
DESIGN CONTROL
INSTL-MAIN HARNESS
SI-46637
SHEET 4 OF 6
NOTE 1
NEW RELEASE
EPX15-001
SI-46637

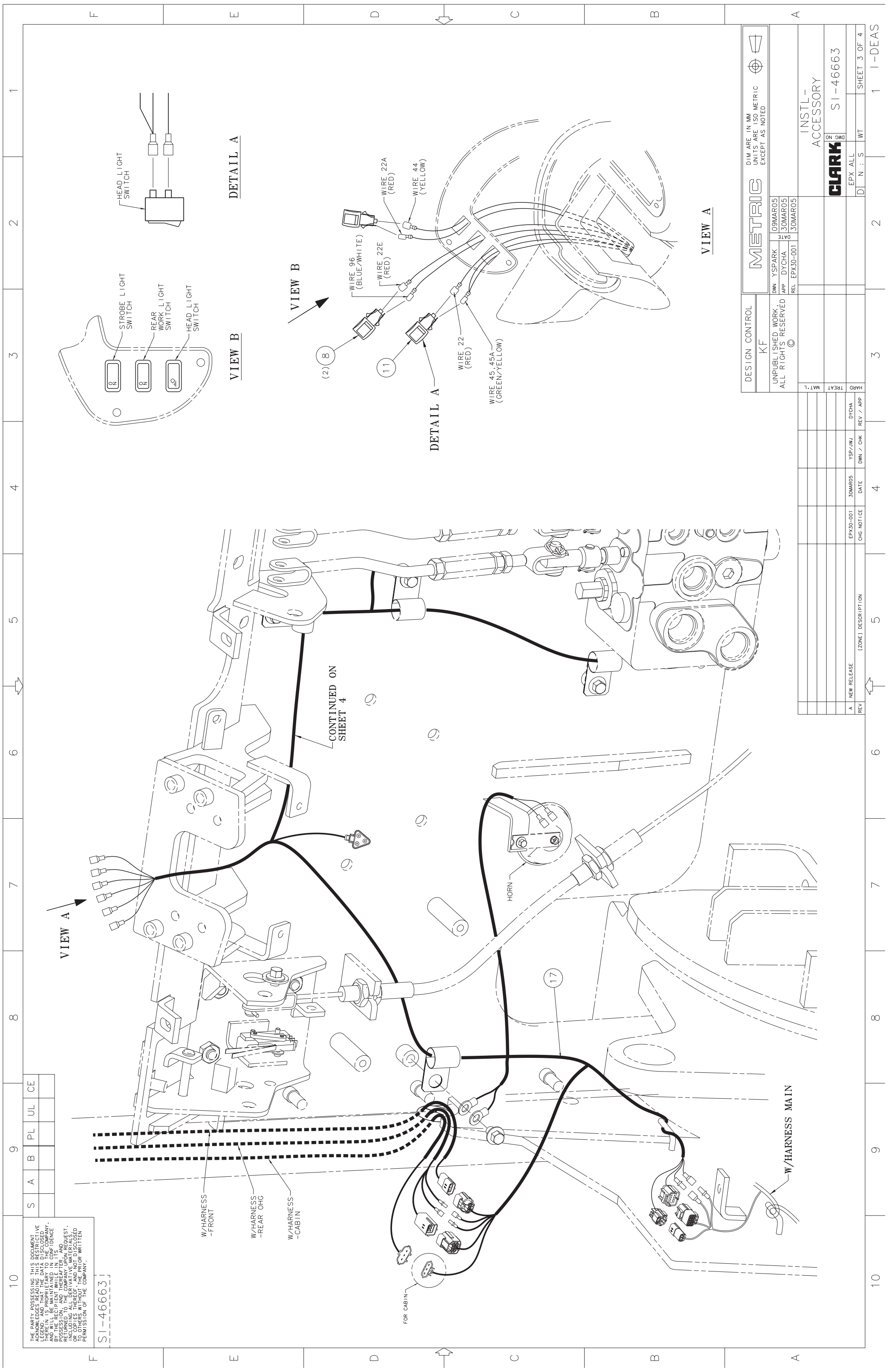

SPEED CHANGE SWITCH 2814833
VIEW B
KEY SWITCH & HORN CONTACT ASSY (REF)
DIRECTION SWITCH ASSY (REF)
CONTINUED FROM LEFT
DASH DISPLAY
NOTE 6,7
USE EXISTING MTG HARDWARE FROM BRAKE LINKAGE
DETAIL C
PARKING BRAKE SWITCH (2815301 REF)
DETAIL B
INSTL-MAIN HARNESS
SI-46637
CONTINUED ON RIGHT
CONTINUED ON SHEET 6
CONTINUED FROM SHEET 4
W/HARNESS-MAIN
W/HARNESS-MAIN ACCESSORIES

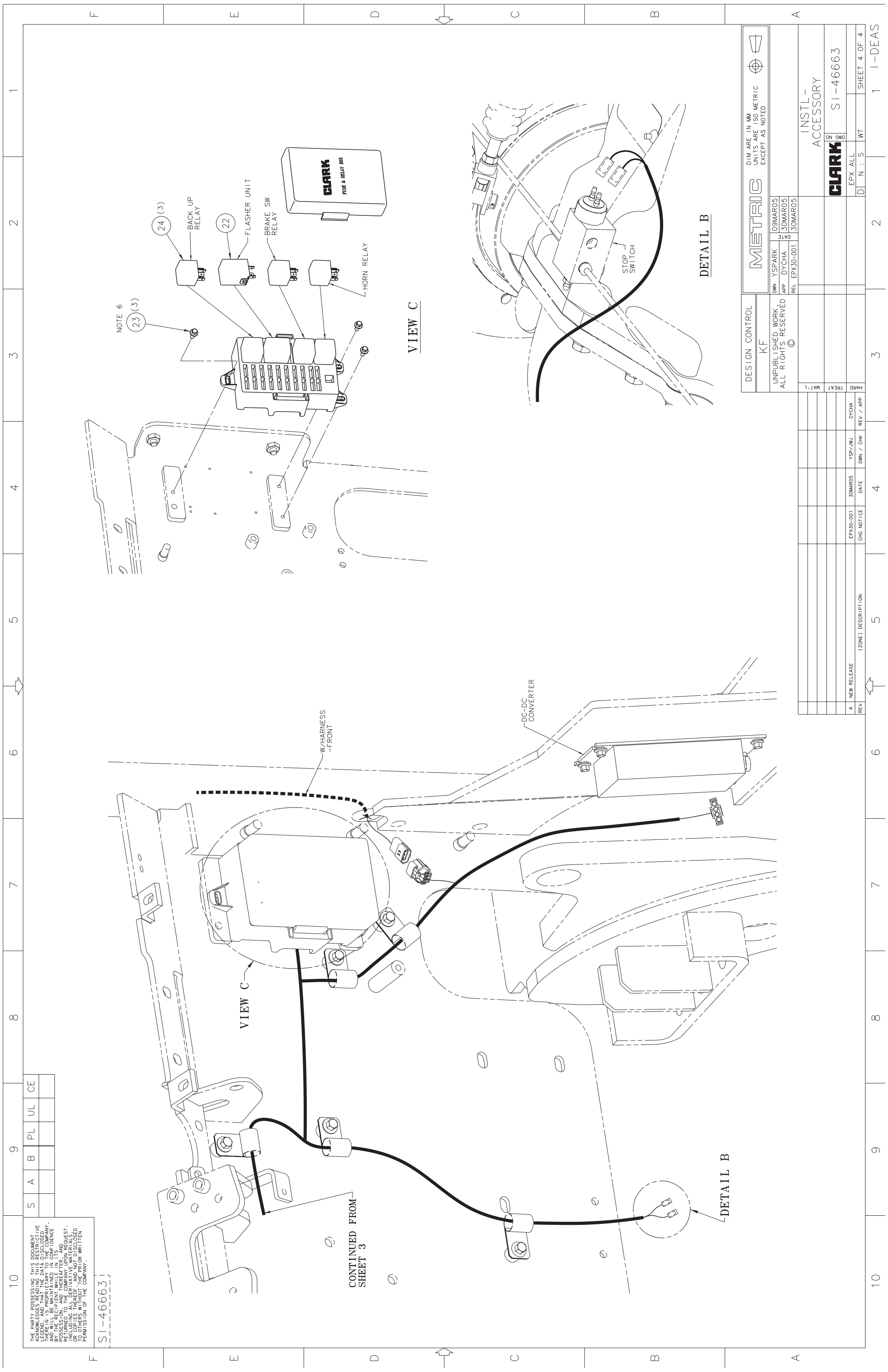

DETAIL D
INSTL-MAIN HARNESS
SI-46637
CONTINUED FROM SHEET 3
CONTINUED FROM SHEET 6
ACCELERATOR
LIFT POTENTIOMETER
DC-DC CONVERTOR(5V) 8033336 (REF)
MAIN HARNESS (REF)
ACCESSORIES MAIN HARNESS(REF)
AUX 2
AUX 1
LIFT

Accessory Harness(EPX)




BACK-UP, STOP, TAIL LIGHT
SCREWS INCLUDED WITH LIGHTS
STROBE LIGHT
NUTS INCLUDED WITH LIGHT
REAR LIGHT
NUT & WASHER INCLUDED WITH LIGHT NOTE 7
CONTINUED FROM SHEET 1
REF)8035555
NOTE2
NOTE6
METRIC
DESIGN CONTROL KF
UNPUBLISHED WORK, ALL RIGHTS RESERVED
INSTL-ACCESSORY
SI-46663
SHEET 2 OF 4
I-DEAS
NEW RELEASE
EPX30-001


HEAD LIGHT SWITCH
DETAIL A
STROBE LIGHT SWITCH
REAR WORK LIGHT SWITCH
HEAD LIGHT SWITCH
VIEW B
WIRE 22A (RED)
WIRE 44 (YELLOW)
WIRE 96 (BLUE/WHITE)
WIRE 22E (RED)
VIEW B
VIEW A
WIRE 22 (RED)
WIRE 45,45A (GREEN/YELLOW)
DETAIL A
CONTINUED ON SHEET 4
HORN
VIEW A
17
W/HARNESS MAIN
W/HARNESS -FRONT
W/HARNESS -REAR CHG
W/HARNESS -CABIN
FOR CABIN
SI-46663
METRIC
DESIGN CONTROL KF
UNPUBLISHED WORK, ALL RIGHTS RESERVED
INSTL-ACCESSORY
SI-46663
SHEET 3 OF 4
I-DEAS


VIEW C
DETAIL B
STOP SWITCH
HORN RELAY
BRAKE SW RELAY
FLASHER UNIT
BACK UP RELAY
NOTE 6
DC-DC CONVERTER
W/HARNESS -FRONT
CONTINUED FROM SHEET 3
INSTL-ACCESSORY
SI-46663
METRIC

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.

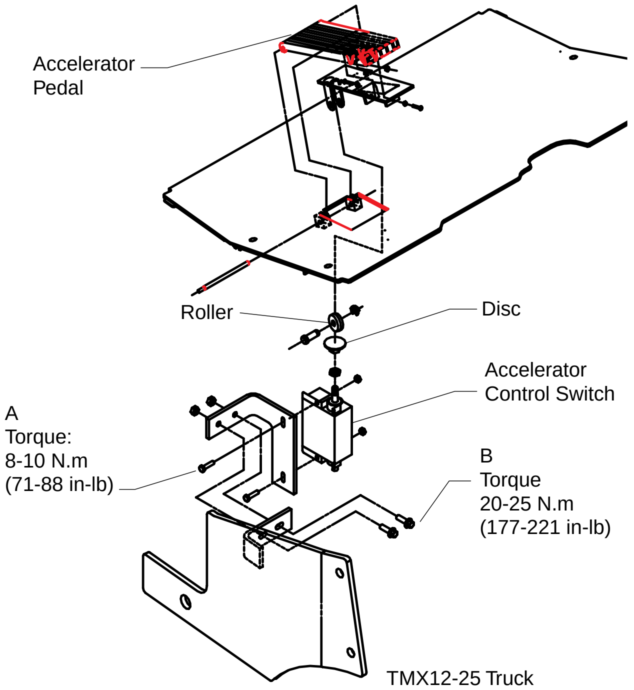
At the start, the accelerator control is stroked (by the action of the accelerator pedal), and in turn sends a signal to the motor control, requesting it to produce longer electrical pulses to the motor, which in turn will supply more power to the drive train.

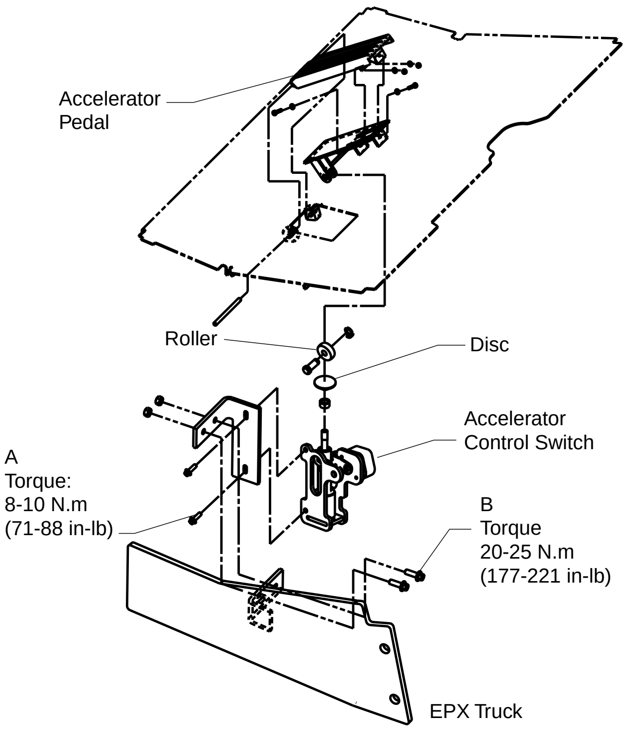
An internal spring returns the control to start position. The accelerator is an integral unit and is not serviceable. Opening of the unit will void the warranty.

Adjustment

1. Loosen four fasteners at A and B on illustration.
2. Depress pedal to floor mat and hold.
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

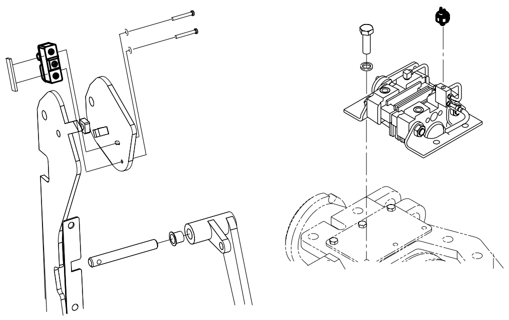
Service Brake Switch Description(TMX only)

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(TMX only)

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.)



TMX truck EPX truck

Parking Brake Switch Description(TMX)

The parking brake switch is mounted to the hand brake assembly. The brake handle center pin depresses the switch when the hand lever is not applied. This depressing of the switch closes the contacts.

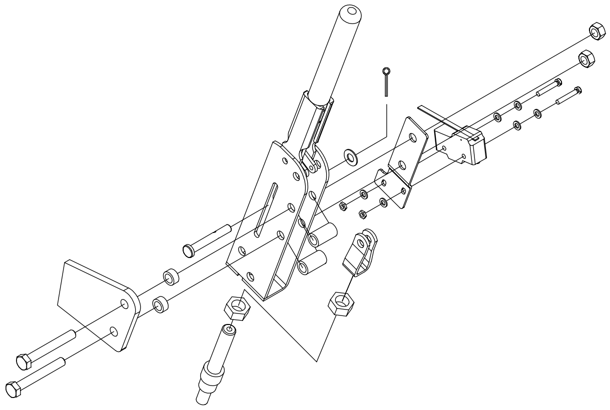
When the parking brake is applied, it releases the switch, allowing the contacts to return their normally open position. This open circuit signals the controller to disable the drive motors.

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(TMX)

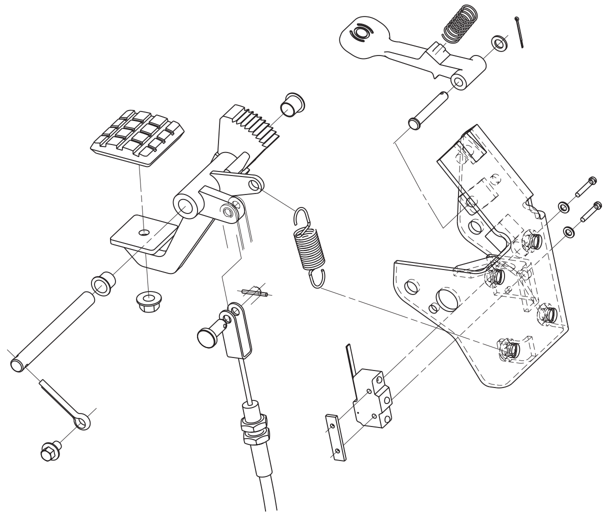
1. Turn key switch OFF.
2. Loosen parking brake switch mounting screws.
3. Adjust position of switch so that there is contact with the center pin and the switch actuates (clicks) just as the parking brake lever is fully released.
4. Tighten mounting screws.
5. Check operation of switch before truck is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

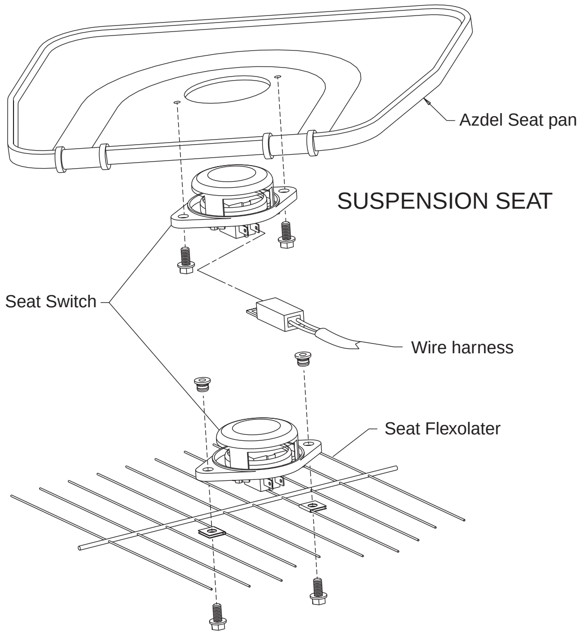


Seat Switch

The TMX 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

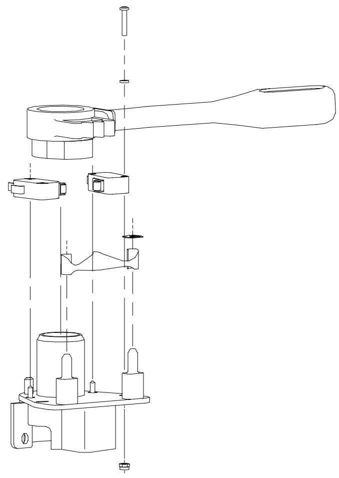
Description

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

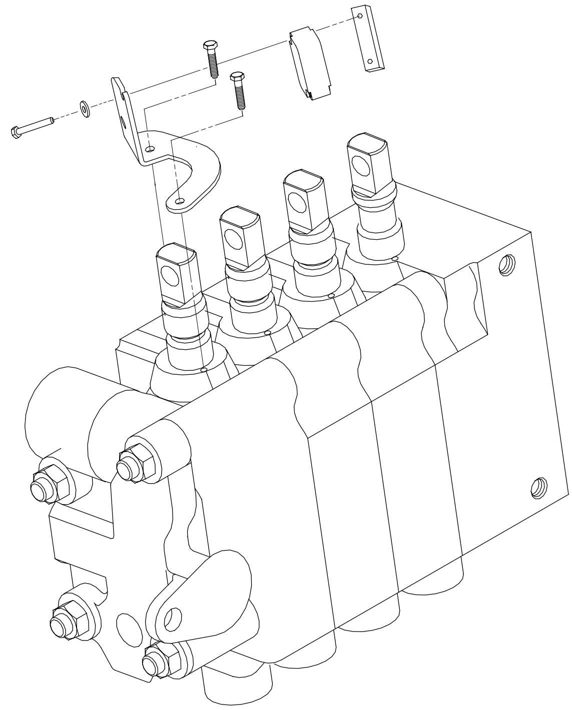
Description

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.

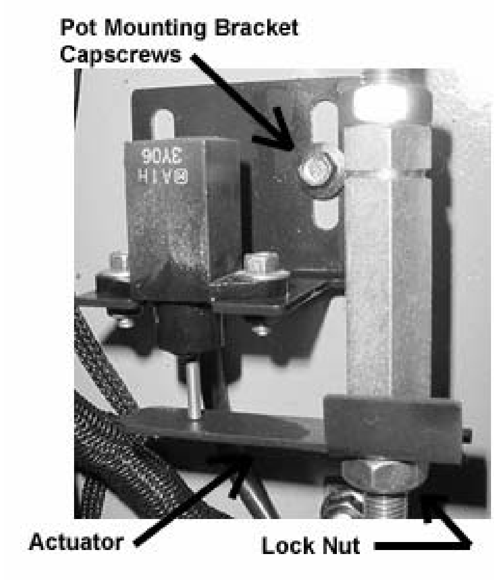
Switch Adjustment

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

Steer Angle Sensor

Description(TMX)

The steer angle sensor is mounted atop the steer axle trunion assembly. This device helps the drive motor control generate an efficient speed differential between the two drive motors when the truck is cornering,

The steer angle sensor is a potentiometer that translates the angle of rotation of the steer angle into a voltage level read by the Dual AC control. When the steer wheel is straight ahead (0° turn angle) the input signal to the control should be at the mid point. As the vehicle turns left, this input signal decreases. As the vehicle turns right, the input signal increases.

Description(EPX)

The steer angle sensor is mounted under “upper plate” of axle center. This device helps the drive motor control generate an efficient speed differential between the two drive motors when the truck is cornering,

The steer angle sensor is a a linear sensor that the moving of steer axle cylinder into a voltage level read by the Dual AC control. When the steer wheel is straight ahead (0° turn angle) the input signal to the control should be at the mid point. As the vehicle turns left, this input signal decreases. As the truck turns right, the input signal increases.

Program and Adjustment

CAUTION

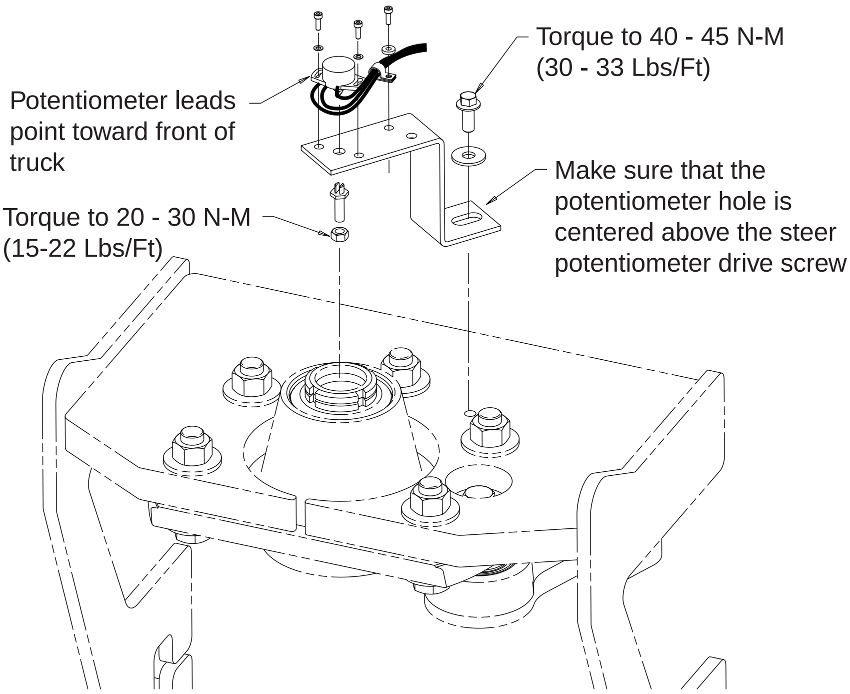
Before any adjustments are done, safely jack up the truck, block the drive wheels off the floor, disconnect the battery, and discharge the capacitors as described in Group SA

Use the following method to adjust the steer angle sensor with the handset:

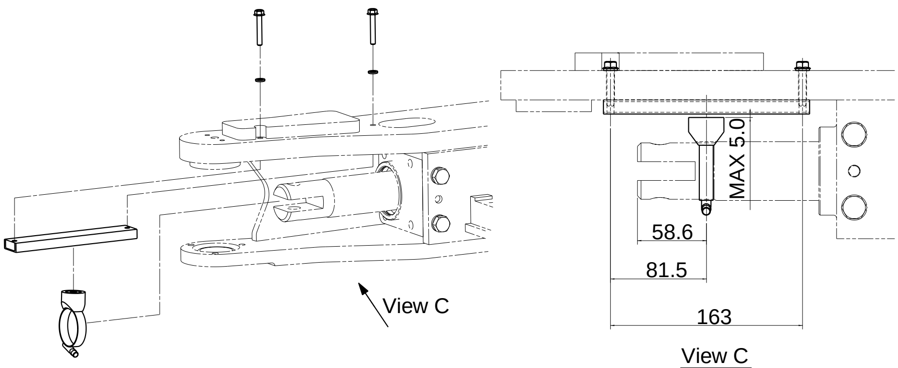
(Detailed handset operation instructions are in Group 19.)

- 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 the roll down button once
- Display will read "CONFIG MENU" ADJUSTMENT
- Press "ENTER" button
- Display will read "SET POT BRK MIN"
- Press "ROLL UP" button (6) times
- Display will read "SET STEER O-POS"
- Press "ENTER" button
- Adjust the steer wheel to where it appears to be centered
- Press "ENTER" button
- Press "OUT button
- Display will read "ARE YOU SURE" "YES=ENTER" "NO=OUT"
- Press "ENTER" button (this stores the value to be used for Steering 0 position)
- Display will read "CONFIG MENU" ADJUSTMENT
- Press "ENTER" button
- Display will read "SET POT BRK MIN"
- Press "ROLL UP" button (5) times
- Display will read "MAX STEER LEFT"
- Turn steer wheel all the way lo the left
- Press "ENTER" button
- Press "OUT button
- Display will read "ARE YOU SURE"
- "YES=ENTER" "NO=OUT"
- Press "ENTER" button (this stores the value to be used for steering max left)
- Display will read "CONFIG MENU" ADJUSTMENT
- Press "ENTER" button
- Display will read "SET POT BRK MW
- Press "ROLL UP" button (4) times
- Display will read "MAX STEER RIGHT"
- Turn steer wheel all the way to the right
- Press "ENTER" button
- Press "OUT button
- Display will read "ARE YOU SURE"
- "YES=ENTER" "NO=OUT'"
- Press "ENTER" button (this stores the value to be used for steering max right)
- Display will read "CONFIG MENU ADJUSTMENT
- 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



See Group 25, Section 6 for Steer Angle Sensor Removal and Replacement(TMX)

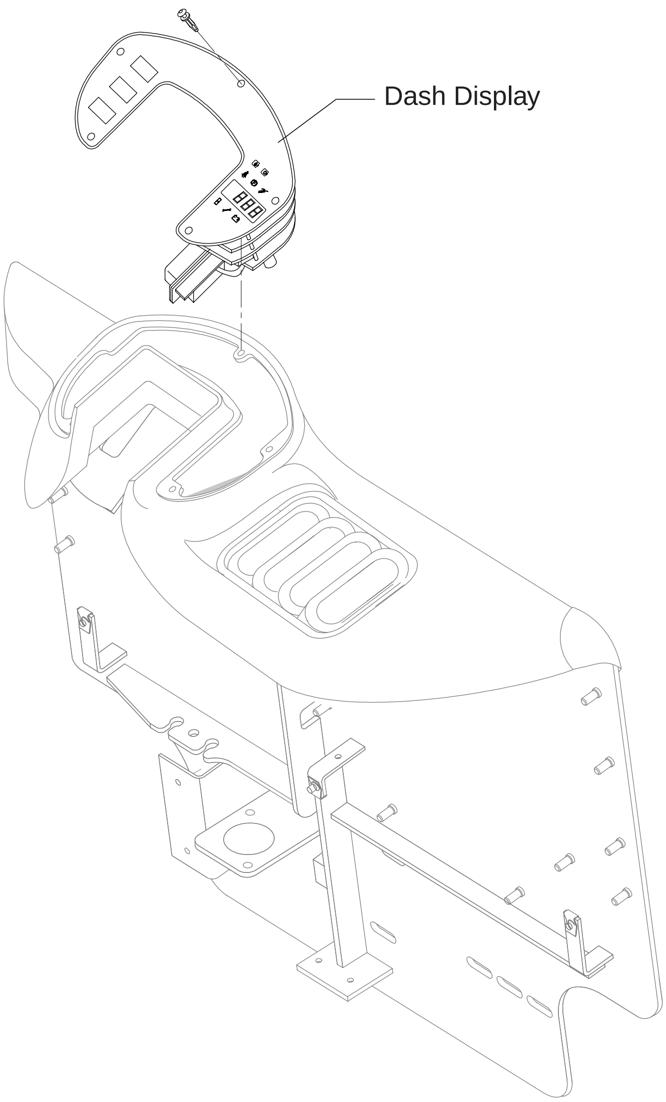


See Group 25, Section 6 for Steer Angle Sensor Removal and Replacement(EPX)

NOTE :

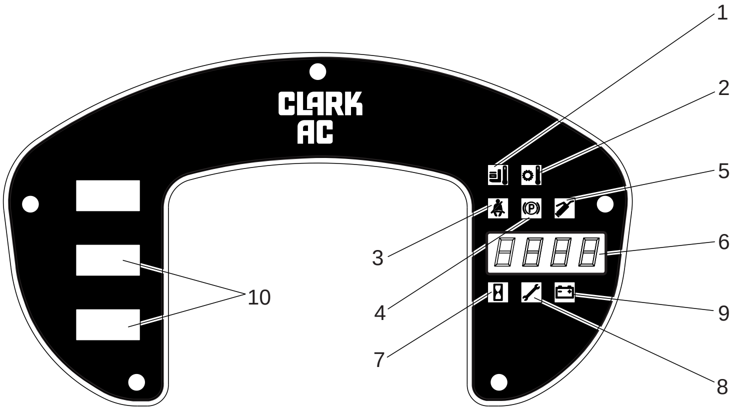
Section 5

Instrument Panel



Dash Display(TMX)

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

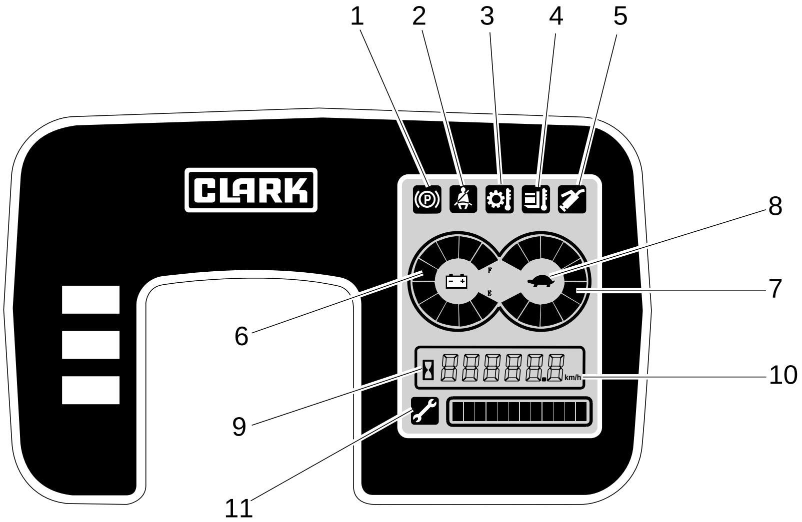


Standard Display

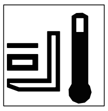
1. Pump Motor and Pump Controller Over Temperature.
2. Drive Motor and Drive Controller Over Temperature.
3. Seat Belt Alert
4. Park Brake
5. Planned Maintenance
6. Numeric Display
7. Hour Meter Status
8. Service Status
9. Battery Status
10. Accessory Switches (Speed change switch, lights, etc.)

Dash Display(EPX)

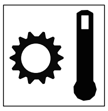
The Dash Display provides the operator with an easily understandable, visual feedback of the status of the truck and its system components..



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".

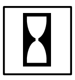


Drive Motor or Drive Motor controller Over Temperature: The symbol is displayed to "alert" of drive motor(s) temperature or drive motor controller(s) temperature is exceeding the design limits. Do not use truck. Allow drive motor and/or controller to cool until after symbol turns "OFF".

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.

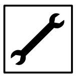
Parking Brake: The symbol is displayed and "-255" status code appears on the numeric display when parking brake is applied. Release parking brake to operate truck.

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.



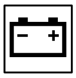
Hour Meter: (TMX)This symbol identifies the number displayed on numeric display as truck operating hours. The symbol is displayed for 4 seconds when the key switch is turned "OFF".

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

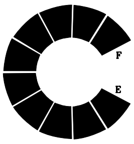


Service Status: The following 5 codes are usually operator fault codes, and can be corrected by as explained in "Section 5, Operating Procedures." If you see any other codes displayed, the truck needs to be serviced.

- -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

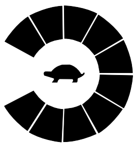


Battery Status: If this symbol displays, the numeric display shows the percentage of usable charge remaining on the battery.



Battery discharge indicator (EPX) : 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 (EPX)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 (EPX) : 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 (EPX) : 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

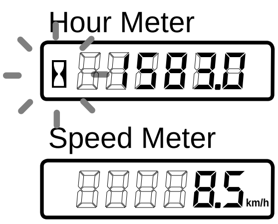
LCD Back Light (EPX16-18)

- 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(EPX16-18)

- 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 (EPX16-18)



- •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 (EPX16-18)

- Error code indicator (#37 error)

NOTE :

GROUP 16

ELECTRICAL MOTORS

NOTE :

Section 1

Motor Specifications and Descriptions

Specifications

Drive Motors

Frame Size: 200 mm (7.874 in) diameter

Weight: 45kg (99 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 mm (4.882 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: 0.5 mm (.0196 in)
Nominal Battery Voltage: 36V / 48V
Maximum Battery Voltage: 39.5V / 52.5V
Nominal Speed: 945 RPM / 1335 RPM
Stall Current: 275A
Insulation: Class F
Winding: Star
Encoder: 64 Pulses / Rev

Pump Motor

Frame Size: 170 mm (6.693 in) diameter

Weight: 50kg (110 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: 102.2 mm (4.023 in)
Rotor inside Diameter: 30 mm (1.181 in)
Number of Slots: 28

Stator outside Diameter: 170 mm (6.693 in)
Stator inside Diameter: 103 mm (4.055 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: 1310 RPM
Stall Current: 450A / 400A
Insulation: Class F
Winding: Delta
Encoder: 64 Pulses / Rev

Description and Location

The truck has three electric AC motors:

- Two identical traction motors
- One main hydraulic/power steering pump motor.

Drive motors

The two drive motors are three-phase AC motors with class F insulation. These motors do not use brushes and the motors are totally enclosed, minimizing the service requirements. Because the motors do not use brushes and are enclosed, sealing them from outside contamination, there is no need to blow out the inside of the motors during a PM. Each 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. One motor drives the left traction wheel, the other the right. The electronic control system varies the speeds to the two motors independently to accommodate cornering.

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

Each 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 with an external fan. It is also a brushless motor and totally enclosed. The pump motor does incorporate a fan at the rear of the motor that blows air across the outside of the motor frame to help control the temperature. This fan does need to be blown out at every PM to keep it clear of any debris. 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 from cooling fan air vents and around motor frame to prevent overheating.
- Air-clean (blow off) motors using clean, dry (moisture-free) compressed air at 207 kPa (30 psi) maximum air pressure.

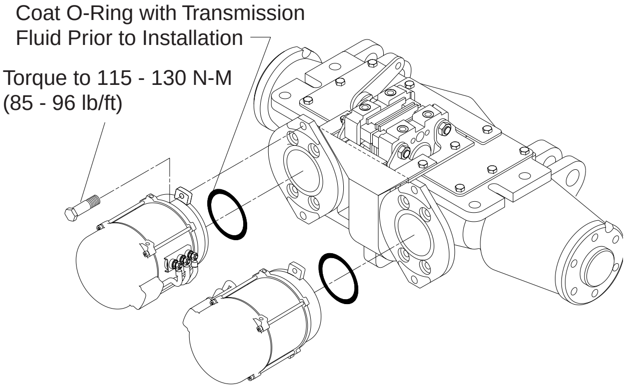
The presence of any oil on or near the motor could indicate either bad bearings or leaking hydraulic system. Determine cause and repair problem before extensive motor damage occurs.

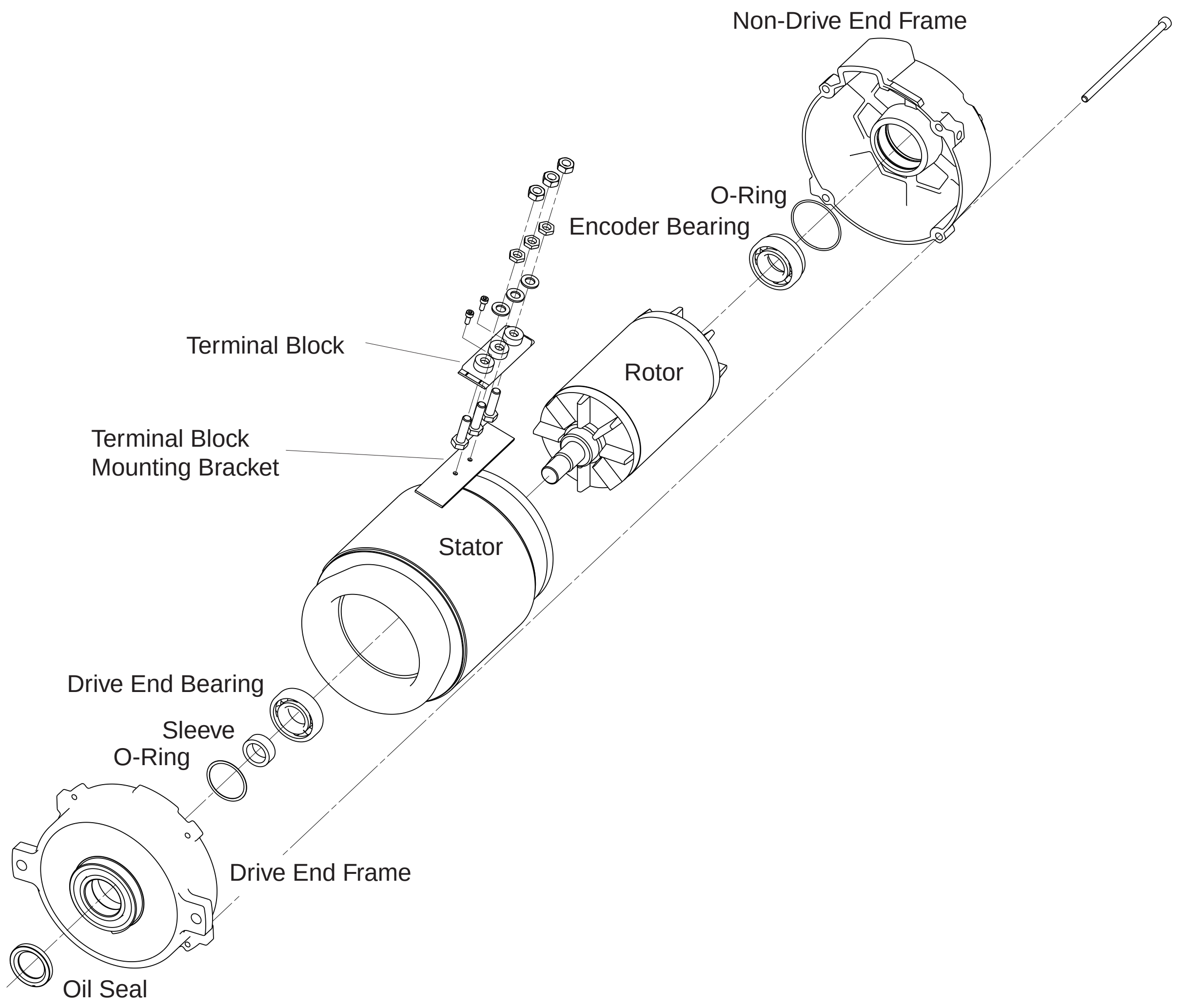
Drive Motor Removal and Installation

1. Remove the battery from the truck.
2. Lift the rear of the truck from the floor and block accordinaly. **(See Group SA, Section 2 for procedures)**
3. Tilt the steering column fully forward and remove the floor plate.
4. Remove all electrical cables from the pump motor. Tag cable terminals to aid in reinstallation and position the cable out of the way.
5. Remove the hoses from the hydraulic pump.
6. Remove the bolts securing the top, front battery plate and remove the plate from the truck.
7. Remove the bolts securing the lower battery plate and tilt the plate back against the rear battery plate.
8. Remove all electrical cables from the motor. Tag cable terminals to aid in reinstallation. Position cables out of the way of motor removal.
9. Remove bolts holding motor to axle. Have drain pan in place to catch axle oil.
10. Lower motor onto floor or through the top using a suitable chain hoist or come-a-long.
11. Reinstall in reverse order. Use new O-ring, coated with drive axle fluid.
12. Check and fill drive axle oil as described in Group 20.

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.





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.

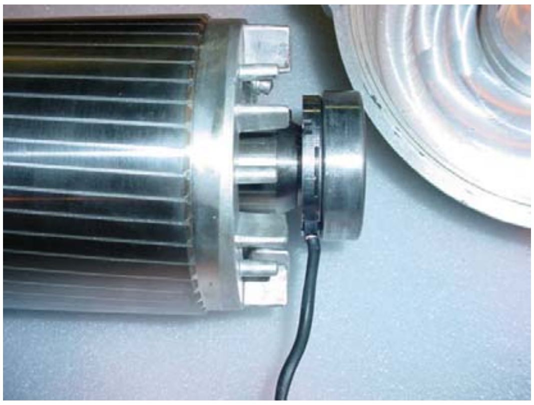
Encoder Bearing

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:

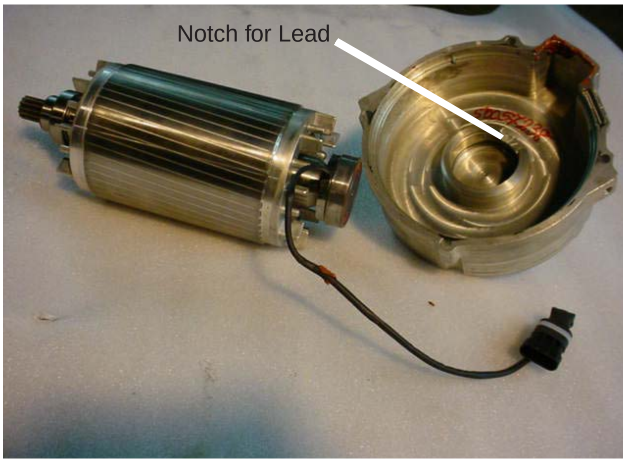
- Turn key OFF.
- Set park brake.
- Disconnect battery.
- Remove the drive motor (see page 1 of this section).
- Remove motor thru bolts.
- The silicone sealing the cables into the end frame will need to be loosened to allow removal of the end frame.
- Remove the non-drive end housing from motor.
- Remove 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

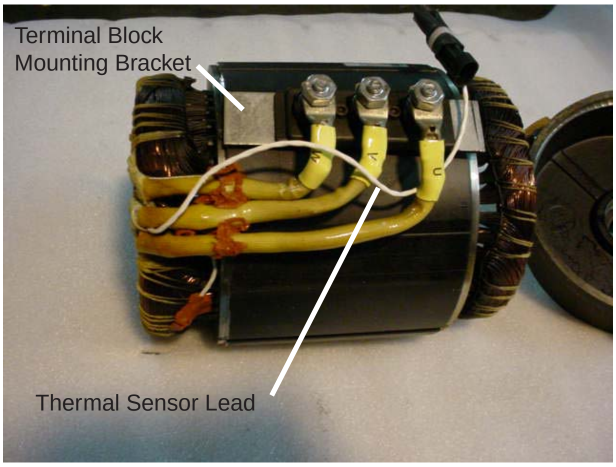
NOTE

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.
- 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.
- Reinstall the motor into the truck.

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 cooling fan air vents and around motor frame to prevent overheating.
- 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. 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 hydraulic pump from the motor (see group 29 for instructions).

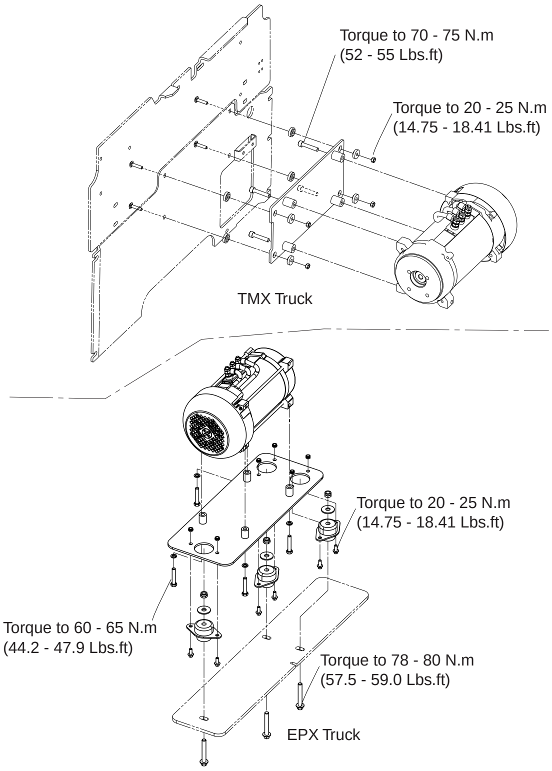
IMPORTANT

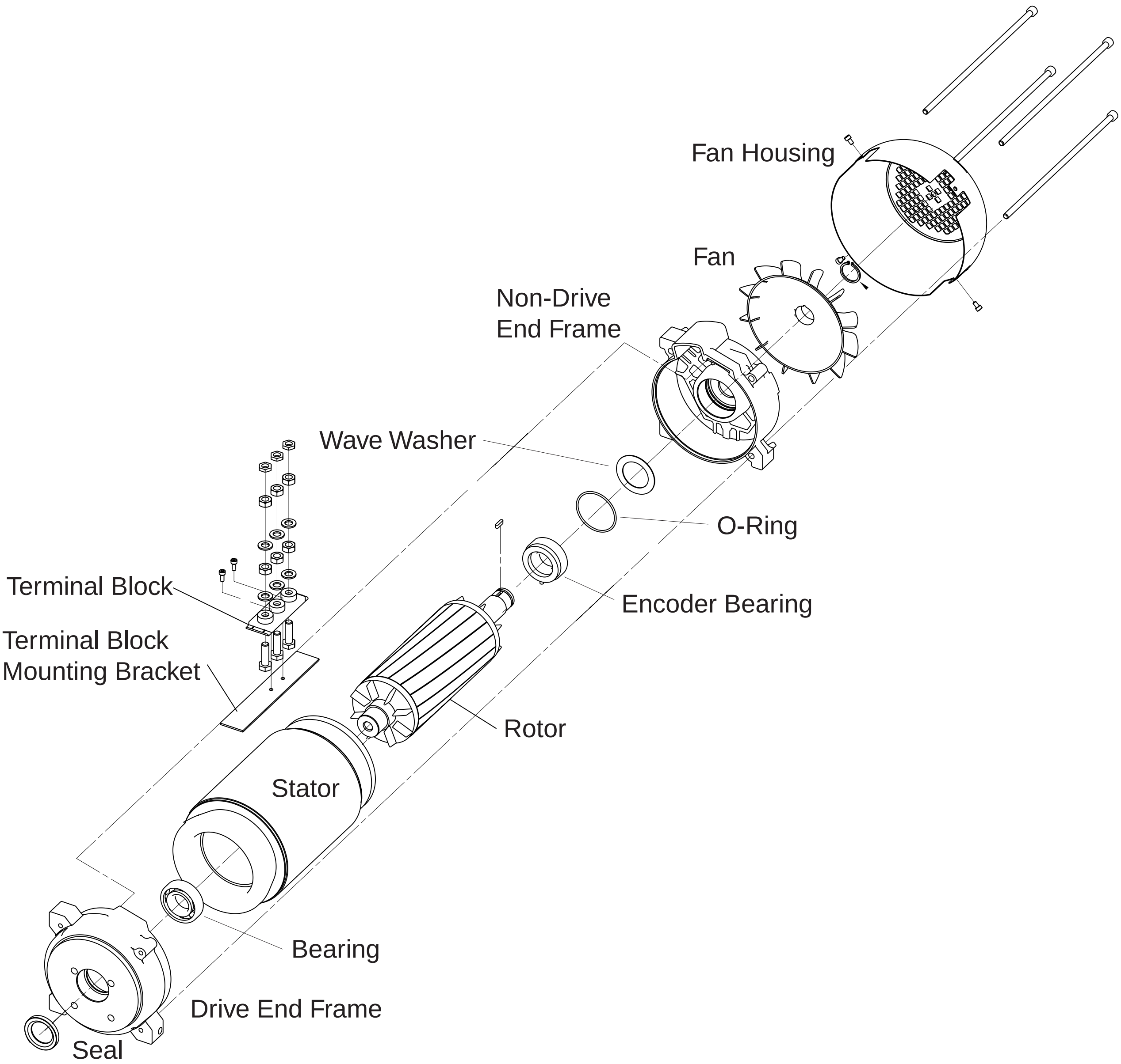
The pump motor assembly weighs over 110 pounds. A suitable lifting device may be needed to help hold and then raise the motor from the truck.

4. Remove the 4 nuts securing the pump motor mounting plate to the front battery plate.
5. Lift the motor assembly and place it on a bench for service.
6. Remove bolts holding motor to mounting plate.
7. 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 the fan housing screws and remove the housing.
- Remove the snap ring and then pull the fan from the rotor shaft.
- 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.
- Install the fan housing.
- Reinstall the motor into the truck.

NOTE :

GROUP 17

ELECTRICAL CONTACTORS

NOTE :

Section 1

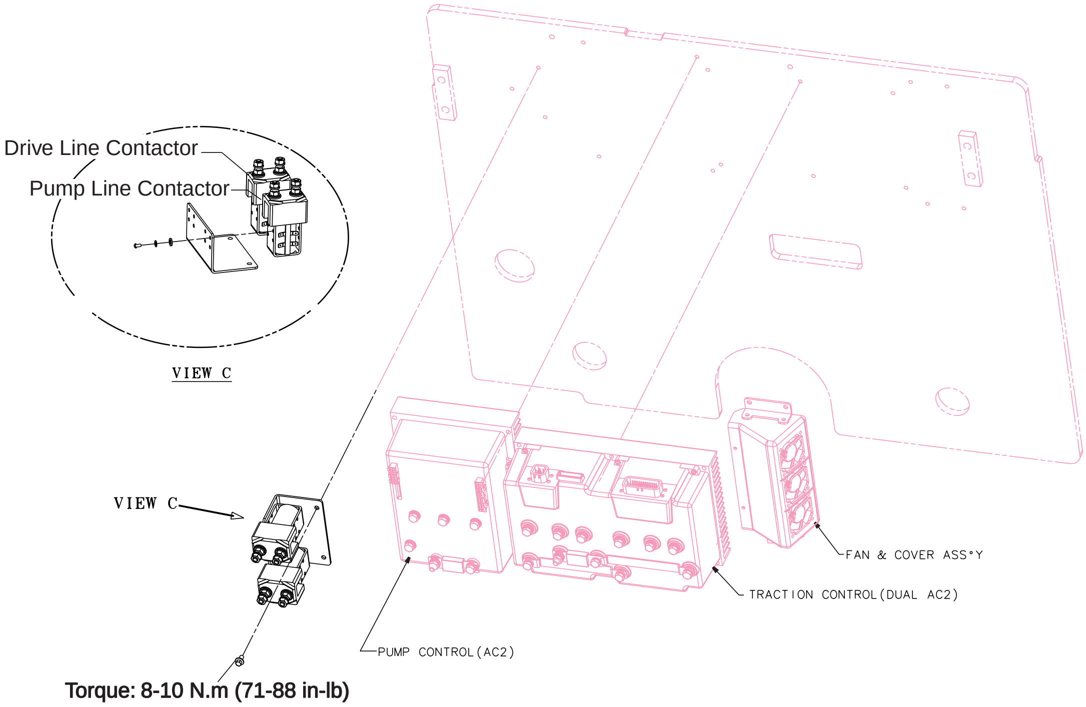
Contactors Specifications and Overhaul

Specifications

Standard Truck: One Drive Line Contactor, one Pump Line Contactor. Mounting Fastener Torque: 8-10 N.m (71-88 in-lb).

Removal and Replacement

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



Overhaul

WARNING

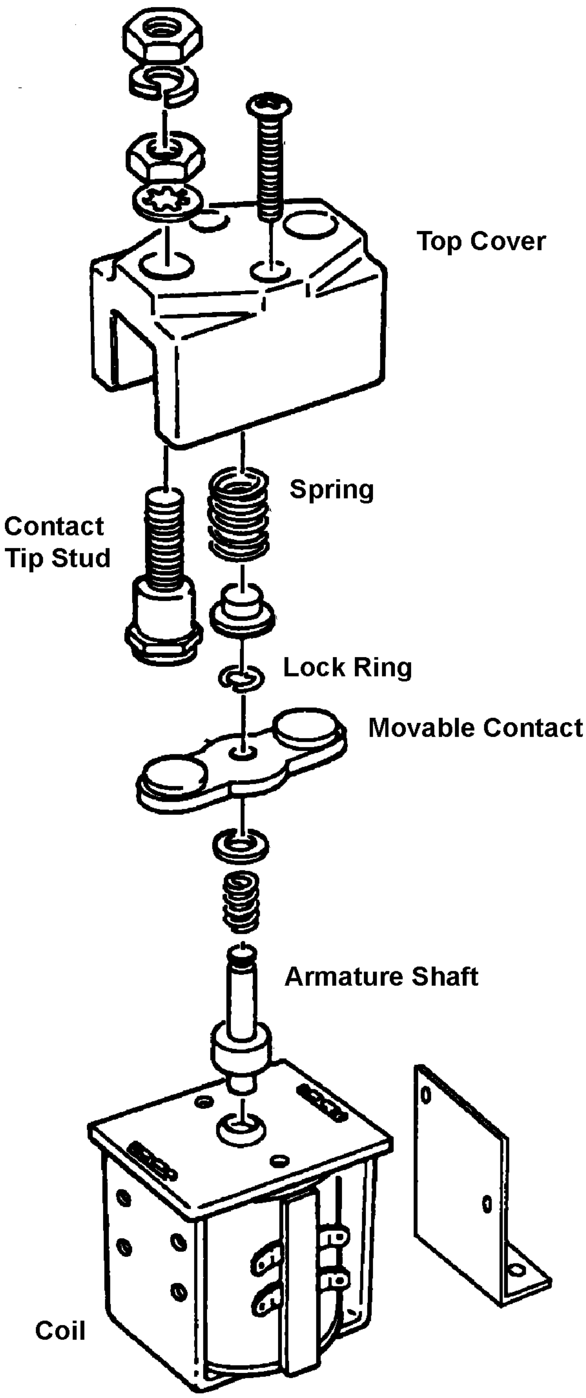
Disconnect battery before working on contactor tips.Before attempting to disassemble a contactor to install a new contact set, carefully observe location and orientation of each part.

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

The CLARK TMX uses a Dual AC controller to control both drive motors and a single AC controller to control the single motor/pump combination which supplies flow to all hydraulic functions and steering.

Traction Control and Motors

The dual AC traction control consists of two motor controls mounted to a single heat-sink plate and enclosed by a single cover. The left portion of the control is reference to as the "slave" control and operates the left drive motor. The right portion of the control is referred to as the "master" control and operates the right drive motor. The control receives inputs from the speed control (accelerator) pedal, steer tire position sensor (steer pot), direction switches, foot brake switch, motor encoders, motor thermistors and other miscellaneous switches. The control is able to proportional reduce the speed of the inside tire when the truck is in a turn, based on the steer angle input from the steer sensor. Once the steer angle exceeds a certain value, the inside wheel will start to reverse. 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 TMX 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. Every 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.

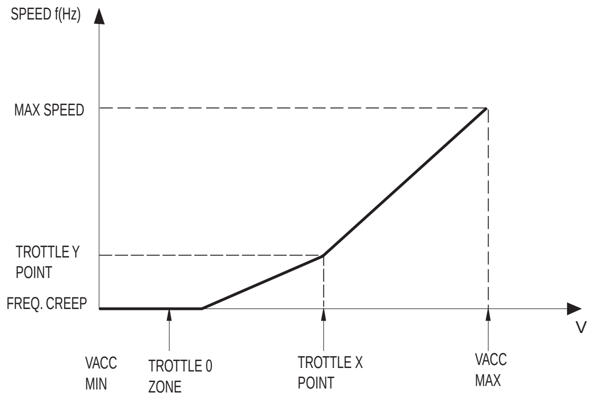
Lift/Steer Control and Motor

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 500 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. 140 Hz is the maximum allowable speed for the TMX 12 thru 20 and 95 Hz is the maximum allowable speed for the TMX 25.

Example: 140 Hz = approx. 9.3 mph empty
74 Hz = approx. 5 mph empty

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 15 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, (Master -61 code, Slave -140 code, and Pump -203 code).

Standard Fault Codes

The control has over 75 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 "B: 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.

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) has a display and a key board for data entry.

Features and functions:

- Monitor existing fault codes for both 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.

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 (C21) signal.

EN ACC (C8) is the accelerator enable. It is fed with +Batt from the key switch.

NPOT (C20) 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 C25 (PTHERMR) and C24 (NTHERMR) are used for the right motor thermal sensor. Connection C35 (PTHERML) and C34 (NTHERML) are used for the Left motor thermal sensor. Sensors are analog.

Speed Feedback

The traction motors 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.

Steer Angle Transducer

Angular position of steered wheels in transduced to an electric information (voltage) by means of a potentiometer, with following characteristics:

- Resistance in the 2Kohm to 20Kohm range;
- Rotation electric angle: at least 300 °
- Positive supply: 12V;
- Potentiometer is installed in a way that in the zero position (straight wheels), pot output voltage is in the middle of the electric range corre-

sponding to a full left-to-right transition of steer wheels;

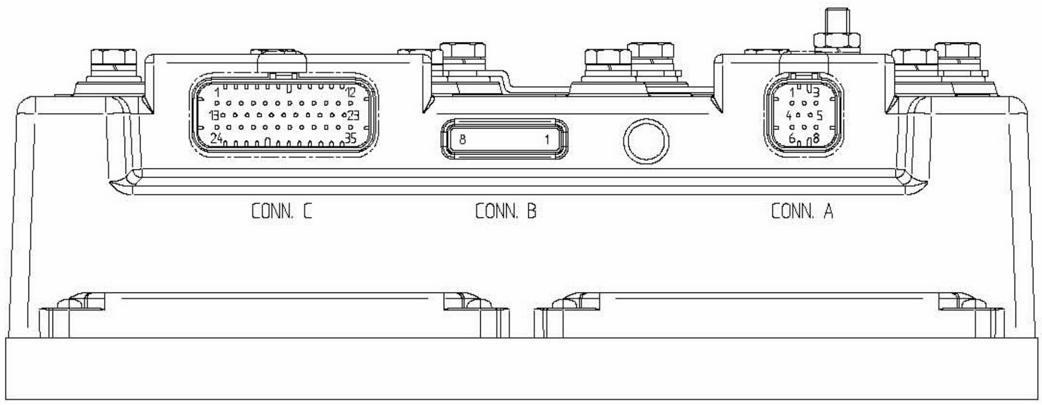
- The potentiometer is installed in a way that, when the truck turns right, pot voltage increases;
- Use "SET STEER MIN" and "SET STEER MAX" functions of the handset to record the extremes (minimum and maximum) of the potentiometer range;
- Use "SET STEER 0-POS" function of the handset to record the pot output when the steer wheels are straight.

Steering Table

The relationship between the two motors speed changes as a function of the steering angle.

The steering angle information comes from the transducer (potentiometer). As the steer wheel is turned, the inside motor will slow and than finally reverse direction to help the truck turn sharply.

Description of Connectors - DualAC2



A1	CAN H	High level CANBUS
A2	CANT H	CANBUS termination output, 120 ohm internally connected toCAN_H. Connect to CAN_L_OUT to insert termination.
A3	CAN_POS	Positive of CAN circuit; to be used in case of optoisolatedCANBUS
A4	CAN_L_OUT	Low level CANBUS: to be used as repetition for CAN_L lineor to be connected to CANT_H to insert termination resistance
A5	CANT_L	CANBUS termination output, 120 ohm internally connected to CAN_L. CAN Connect to CAN_H_OUT to insert the termination.
A6	CAN_L	Low level CANBUS.
A7	CAN_H_OUT	High level CANBUS: to be used as repetition for CAN_H line or to be connected CANT_L to insert termination resistance
A8	CAN_NEG CANBUS	Negative of CAN circuit, to be used in case of optoisolated
B1	PCLRRXD	Positive serial reception.
B2	NCLRRXD	Negative serial reception.
B3	PCLRTXD	Positive serial transmission.
B4	NCLRTXD	Negative serial transmission
B5	GND	Negative handset power
B6	+12	Positive handset power
B7		FLASH
B8		FLASH
C1	PENC_R	Positive of the right motor encoder power supply (+12V).
C2	NENC_R	Negative of the right motor encoder power supply
C3	KEY	Connected to +Batt through a micro switch and a 10A fuse in series
C4	CM	Common of FW / REV / HB / PB / SEAT / ENABLE micro switches
C5	Seat	Seat presence input; active high.
C6	FORWARD	Forward direction request input; active high.
C7	REVERSE	Reverse direction request input; active high.

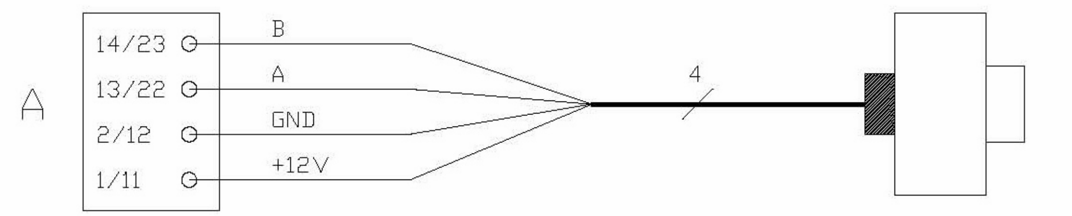
C8	ENABLE	Traction request input; active high.
C9	PB	Pedal brake request input; active high.
C10	SR / HB	Speed reduction or hand brake input; active low (micro switch open).
C11	PENC_L	Positive of the left motor encoder power supply (+12V).
C12	NENC_L	Negative of the left motor encoder power supply
C13	PHA_R	Right motor encoder phase A.
C14	PHB_R	Right motor encoder phase B.
C15	NPOTST	Negative of steering potentiometer (-Batt)
C16	PPOTST	Positive of steering potentiometer (+5V)
C17	CPOTST	Steering potentiometer wiper signal.
C18	CPOTB	Brake potentiometer wiper signal.
C19	NPOTB	-Batt.
C20	NPOT	Negative of traction accelerator (test for wire disconnection)
C21	CPOT	Traction potentiometer wiper signal.
C22	PHA_L	Left motor encoder phase A.
C23	PHB_L	Left motor encoder phase B.
C24	NTHERM_R	Negative of right traction motor temperature sensor.
C25	PTHERM_R	Right traction motor temperature signal.
C26	NLC	Output of main contactor coil driver (drives to -Batt)
C27	PLC	Positive of main contactor coil.
C28	NBRAKE	Output of electric brake coil (drives to -Batt, Maximum current 3A)
C29	PBRAKE	Positive of electromechanical brake coil.
C30	PAU	Xpositive of auxiliary load.
C31	NAUX	Output of auxiliary load driver (drives to _Batt).
C32	-BATT	
C33	PPOT	Traction potentiometer positive, 5V output, use load > 1K omh.
C34	NTHERM_L	Negative of left traction motor temperature sensor.
C35	PTHERM_L	Left traction motor temperature sensor.

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

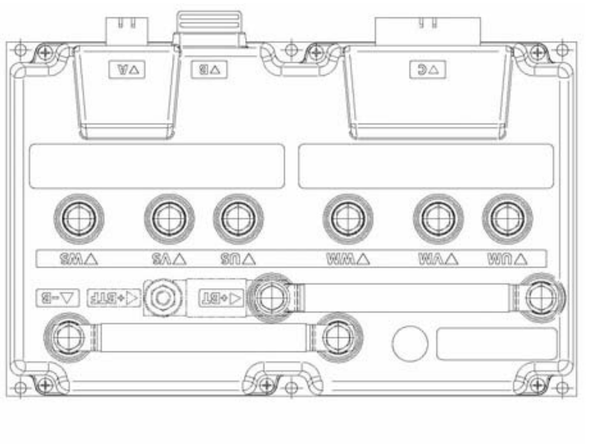
C11/C1	+12V	Positive of encoder power supply.
C12/C2	GND	Negative of encoder power supply.
C22/C13	A:	Phase A of the encoder
C23/C14	B:	Phase B of the encoder

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



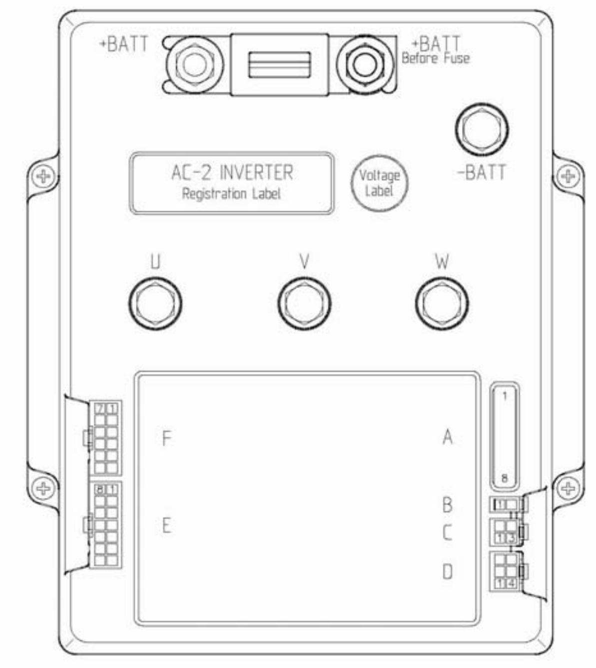
The encoder power supply voltage and output electronic has to be communicated to ZAPI in order to correctly set the selection jumper in the controller.

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.
Um: Vm; Wm	Connection bars for the three phases of the right motor; follow this sequence and the indication on the motor.
Us, Vs, Ws	Connection bars for the three phases of the left motor; follow this sequence and the indication on the motor.

Description of Connections - Pump



A1	PCLR-RXD	Positive serial reception.
A2	NCLR-RXD	Negative serial reception
A3	PCL-RTXD	Positive serial transmission.
A4	NCL-RTXD	Negative serial transmission
A5	GND	Negative console power
A6	+12	Positive console power
A7	FLAS	Hmust be connected to A8 for flash memory programming (if used).
A8	FLAS	Hmust be connected to A7 for flash memory programming (if used).

B1	-BATT	-Batt
B2	MODE	This input allows the customer to select the software in case of double version.

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

D + D6		Incremental ENCODER connector

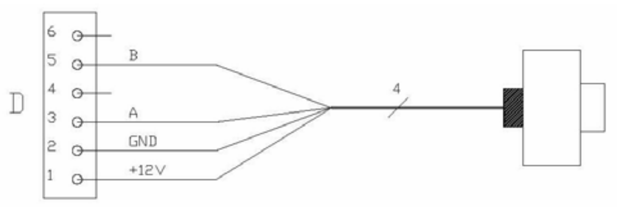
E1	CPOT	Accelerator potentiometer wiper
E2	PPOT	Potentiometer positive: 10V output; keep load > 1KW.
E3	NPOT	Negative of accelerator unit, Tested for wire disconnection diagnosis
E4	CM	Common of LIFT ENABLE / 1st SPEED / 2nd SPEED / 3rd SPEED / 4th SPEED / HYDRO / SR micro switches.
E5L	IFT ENAL	EInput for potentiometer lifting enable input; active HIGH
E6	1st SPEED	Input for first speed request, active HIGH
E7	3rd SPEED	Input for third speed request, active HIGH
E8	AN. IN	Rotary encoder analog input
E9	PPOT	Potentiometer positive: 10V output, keep load > 1KW.
E10	-BATT	-Batt
E11	-BATT	-Batt
E12	HYDRO REQ.	Input for power steering request, active HIGH
E13	SR	Input for speed reduction, active LOW (switch open).
E14	DIG IN	This is a digital input, free for customer request.

F1	KEY	Connected to power supply through a micro switch (CH) with a 10A Fuse in series
F2	PMC	Positive of the auxiliary output
F3	PHYDRO	Positive of the power steering contactor
F4	4th SPEED	Input for fourth speed request, active HIGH
F5	SAFETY	If not connected to -Batt the MC coil power output will be disabled. Can also be used as a general-purpose input.
F6	PTHERM	Input for motor temperature.
F7	CM	Common of LIFT ENABLE / 1st SPEED / 2nd SPEED / 3rd SPEED / 4th SPEED / HYDRO / SR micro switches.
F8	NMC	This output is used to drive the main contactor coil (single pump configuration) or to drive an auxiliary load (combi configuration)
F9	NHYDRO	Auxiliary output; drives the load to -Batt. Maximum current: 3A
F10	2nd Speed	Input for second speed request, active HIGH
F11	GND	-Batt.
F12	NTHERM	-Batt.

Pump Motor Encoder Installation

1. AC2 controller is fit with different types of encoders. To control the AC motor with the ZAPI controller, it is necessary to install an incremental encoder with 2 phases shifted 90°. The encoder power supply can be +5V or +12V. It can have different electronic output.

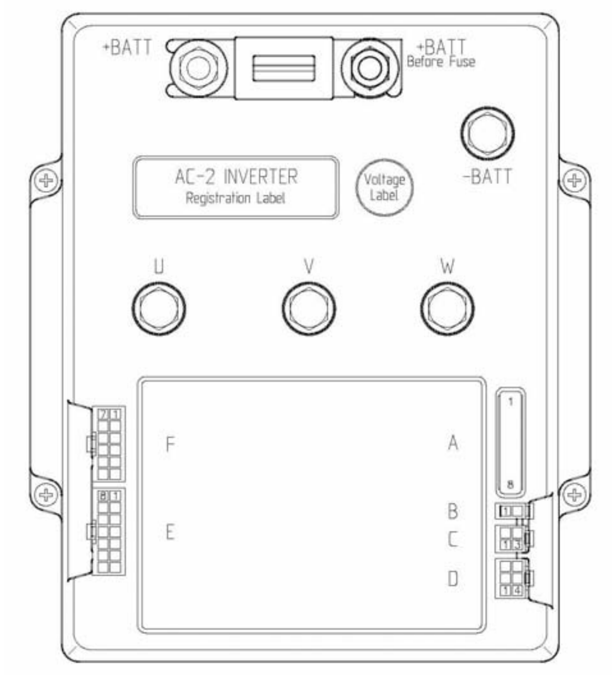
D1	+12V	Positive of encoder power supply.
D2	GND	Negative of encoder power supply
D3	A	Phase A of encoder
D4	A	Phase A inverted (encoder with differential output)
D3	B	Phase B of encoder
D4	B	Phase B inverted (encoder with differential output)



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

Description of Pump Panel Power Connections

View of power bars:



-Batt	Negative of battery
+Batt	Positive of battery
U;V;W;	Connection bars of the three motor phases; follow the sequence and indication on the motor

Section 2

Control Programming

Programming & Adjustments Using ZAPI Handset

Adjustments via Handset

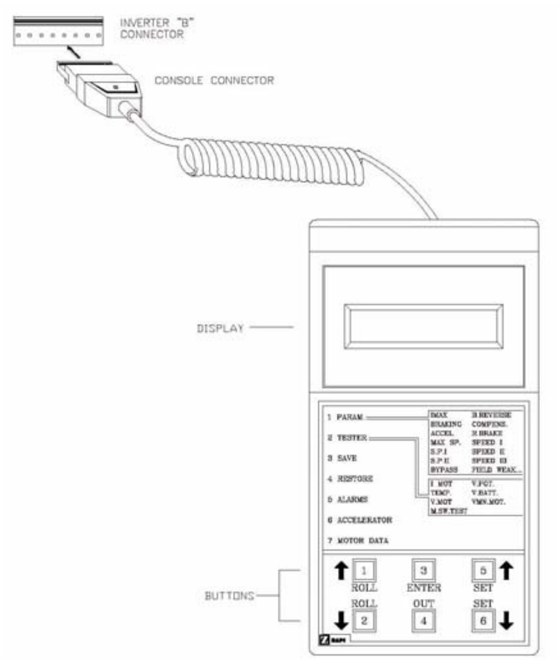
Adjustments of parameters and changes to the controller's configuration are made using the digital Handset. The Handset is connected to the "B: connector of the controller.

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

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

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 "Release Number 3.05, CLARK part number **8033636**.

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 “M” in DA2**M**2BKC, indicates the the Handset is now monitoring the Master control. The slave control is represented with a :”S”, and 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 Master control. The CK indicates CLARK and the 1.05 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.

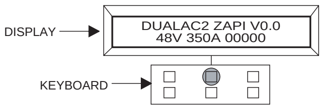
At the bottom of the Handset there are 6 push buttons used to navigate to a different control (Master, Slave or Pump), or to navigate through the control functions and to make changes to the paramaters.

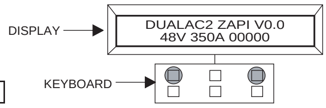
A flow chart of the Handset functions is shown on the following page.

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 TMX Factory Control Settings

TMX Handset
Master Control Configuration





HEADING

Main Menu

Parameter Change — Enter

Acceleration Delay	0-9
Release Braking	0-9
Inverse Braking	0-9
Pedal Braking	0-9
Speed Limit Braking	0-9
Brake Cutback	0-9
Curve Braking	0-9
Max Speed Forward	Hz
Max Speed Reverse	Hz
Cutback Speed1	Hz
Cutback Speed2	Hz
Curve Cutback	%
Curve Cutback #1	%
Frequency Creep	Hz
Maximum Current	0-9
Auxilary Time	Sec
Seat Micro Switch	Sec
ACC Smooth	Sec
Inv Smooth	Sec
Stop Smooth	Hz

Roll Up

Tester — Enter

Motor Voltage	%
Frequency	Hz
Encoder	Hz
Slip Value	Hz
Current RMS	A
Temperature	”C
Temperature #1	”C
Temperature #2	”C
Accelerator	V
Steer Angle	...”
Inter Wheel Cutback	%
Forw Switch	On/Off
Back Switch	On/Off
Enable Switch	On/Off
Seat Switch	On/Off
Cutback Switch	On/Off
Cutback Switch2	On/Off
Brake Switch	On/Off
Exclusive Hydraulics	On/Off
Brake Pedal Pot	%
Hand Brake	On/Off
Voltage Booster	%
Battery Voltage	V
Battery Charge	%

Roll Up

Save Parameter

Roll Up

Restore Parameter

Roll Up

Alarms — Enter — Code, H, N”, ”C

Roll Up

Program VACC — Enter — VACC Settings Min/Max

Roll Up

Motor Data — Enter — Not Available

Set Model

Enter — Connected to 3 (Master), 4 (Slave), 5 (Pump)

Set Options — Enter

Hour Meter	Running / Key On
Battery Check	On/Off
Hydraulic Key On	On/Off
Stop On Ramp	On/Off
Aux Input #1	Hydro Contactor / Brake / Exclusive Hydro
Pedal Braking	Analog / Digital
Set Temperature	Analog / Digital / None
Steer Table	Option #1 / Option #2
Extended Display	On/Off

Roll Up

Adjustments — Enter

Set Pot Brake Minimum	... V
Set Pot Brake Max	... V
Set Battery Type	36/48
Adjust Battery	... V
Max Steer Right	... V
Max Steer Left	... V
Set Steer 0-Position	... V
Set Steer Right	...”
Set Steer Left	...”
Throttle 0 Zone	...%
Throttle Y Zone	...%
Throttle X Zone	...%
Adjustment #04	”C
Motor Shutdown	”C
Adjustment #02	1-9
Adjustment #01	1-9
Adjustment #03	”C
Main Contactor Voltage	... V
Aux Output Voltage	... V
Maintenance Reset	On/Off
Maintenance	None / Opt #1 / Opt #2
Maintenance	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

Master Control - "Dualac2"

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

1. HOUR COUNTER
   - RUNNING: the counter registers any motor running.
   - SEAT: the counter registers when the "key" is closed and operator is sitting on the seat.

2. BATTERY CHECK
   - ON: the battery discharge level check is carried out; when the battery level reaches 10%, a fault is signaled (-66 code) and the maximum current is reduced to half the programmed value.
   - OFF: the battery discharge level is carried out but no fault is signaled.

3. HYDRO ON
   - ON/OFF if this option is programmed on the controller manages the power steering function when the "key" is switched on.

4. STOP ON RAMP
   - ON the stop on ramp feature (truck electrically held on a ramp) is managed for a time established by " auxiliary time" parameter.
   - OFF the stop on ramp feature is not performed.

5. AUX INPUT #1
   - EXCLUSIVE HYDRO: input C10 activates power steering function, output A31 is activated.
   - OPTION #1 input C10 is the input for the handbrake switch, active low (open switch)
   - OPTION #2 input C10 is input for a speed reduction switch, active low (open switch)

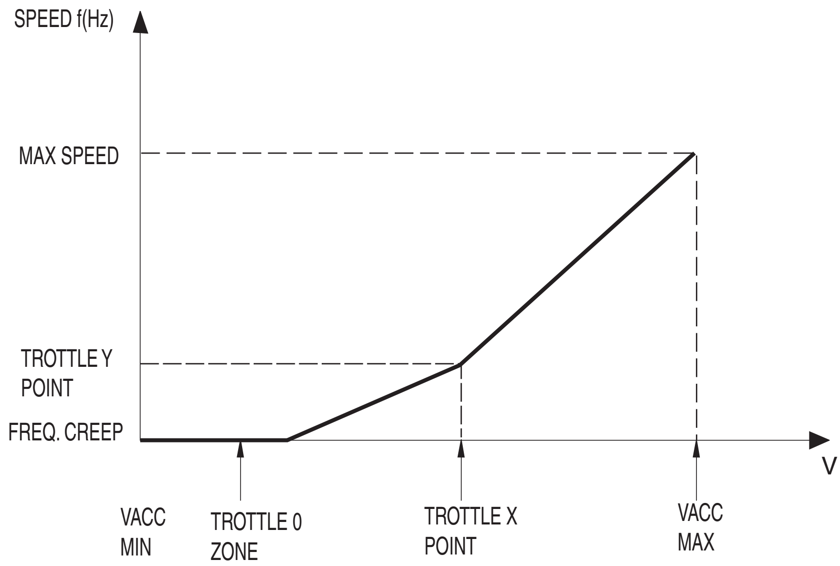
6. PEDAL BRAKING
   - ANALOG: The mechanical brake pedal has a switch and potentiometer installed. When the accelerator is released and the pedal brake is pushed the controller performs an electrical braking whose intensity is proportional to the brake pedal potentiometer. The minimum intensity is established by the "Release braking" parameter, when the brake pedal is slightly pressed (brake switch closed but brake potentiometer at minimum). The maximum intensity is established by the "Pedal Braking" parameter, when the brake pedal is fully pressed (brake potentiometer at 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 micro switch; when the accelerator is released and the brake pedal is pushed (brake switch closed), the controller performs an electrical braking following "Pedal Braking" parameter.

7. SET TEMPERATURE
   - DIGITAL: A digital (ON/OFF) motor thermal sensor is connected C25 (C35) input.
   - ANALOG: An analog motor thermal sensor is connected to C25 (C35) (the curve can be customized on customer request).
   - None No motor sensor switch connected.

8. STEER TABLE This parameter is used to set the correct steering table.

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. MAX STEER RIGHT:	Records in the controller EEPROM the steer potentiometer output voltage when the steering wheel is turned fully right (maximum of the steering potentiometer range).
6. MAX STEER LEFT:	Records in the controller EEPROM the steer potentiometer output voltage when the steering wheel is turned fully left (minimum of the steering potentiometer range).
7. SET STEER 0 POS:	Records in the controller EEPROM the steer potentiometer output voltage when the steering wheels are straight.
8. SET STEER RIGHT:	Sets the max steering angle in the right direction.
9. SET STEER LEFT:	Sets the max steering angle in the left direction.
10. THROTTLE 0 ZONE:	Establishes a deadband in the accelerator input curve
11. THROTTLE X POINT:	This parameter changes the characteristics of the accelerator input curve
12. 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.

13. 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.
14. 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.
15. ADJUSTMENT #01	Adjust the upper level of the battery discharge table.(BDI display - a setting lower than 5 will show a higher battery charge display for a longer period)
16. ADJUSTMENT #02	Adjust the lower level of the battery discharge table.(adjustment for Internal Resistance Compensation of the battery - a setting lower than 5 will discharge the battery deeper before lift lockout)
17. ADJUSTMENT #3	Adjust percentage of battery change it take to reset battery state of charge on dash display.
18. MAIN CONT VOLTAGE:	Adjusts the Line contactor coil voltage (PWM output C28).
19. AUX OUTPUT VOLTAGE:	Adjusts the Electric brake coil voltage (PWM output C28).(Not Used)
20. 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.
21. 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.
22. 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.
23. 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.
24. 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.
25. 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.
26. 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.
27. 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.

Parameter Regulation

The following parameters can be modified(See Group 19, Section 4 for Clark factory recommended settings)

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. CURVE BRAKING: (Do Not Change)	Determines the rate of the decelleration ramp in a curve as the steer wheel is turned.
8. MAX SPEED FORWARD:	Determines maximum speed in forward direction.
9. MAX SPEED BACKWARD:	Determines maximum speed in reverse direction.
10. CURVE CUTBACK: (CLARK Special)	Speed reduction when the truck in a turn. The parameter sets the speed set point when the truck driving wheels are running in opposite direction (3 wheel truck, steering angle greater than roughly 67°); or when the maximum steering angle is reached (4 wheel truck, the internal wheel is stopped). In intermediate steering angles, the speed set point will be within a range between the straight wheel speed and the CURVE CUTBACK SPEED.
11. CURVE CUTBACK #1:	Determines the speed of the inside wheel as the steering wheel is turned.
12. CUTBACK SPEED1: (Not Used)	Speed reduction when cutback switch1 is active.
13. CUTBACK SPEED2: (Not Used)	Speed reduction when cutback switch2 is active.
14. FREQUENCY CREEP: (Do Not Change)	Minimum speed when the forward or reverse switch is closed, but the accelerator is in a minimum position.
15. MAXIMUM CURRENT: (Do Not Change)	Changes the maximum current of the controller
16. AUXILIARY TIME: (Do Not Change)	Determines the time that the truck will hold on a ramp if the "stop on ramp" option is ON.
17. 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.
18. 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.
19. STOP SMOOTH	Sets the frequency point where ACC SMOOTH stops and ACCELERATION DELAY starts.

PARAMETERS	PROGRAM LEVEL										
	Unit	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Acceleration Delay (*)	Sec.	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5
Release Braking (**)	Sec.	5.5	5	4.5	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
Curve Braking	Sec.	1.5	1.4	1.3	1.2	1.1	1	0.9	0.8	0.7	0.6
Cutback Speed 1	%	10	15	20	25	38	50	63	75	87	100
Cutback Speed 2	%	10	15	20	25	38	50	63	75	87	100
Curve Cutback	%	10	15	20	25	38	50	63	75	87	100
Curve Cutback #1	%	55	60	65	70	75	80	85	90	95	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
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
Adjustment #1 % Normal	%	-2.8	-2.2	-1.7	-1.1	-.06	0	0.6	1.1	1.6	2.8
Adjustment #2 % Normal	%	-2.8	-2.2	-1.7	-1.1	-.06	0	0.6	1.1	1.6	2.8

(*)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 afunction 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.

PARAMETERS		SPEED EMPTY MPH									
	MPH	1	2	3	4	5	6	7	8	9	9.3
MAX SPEED FORWARD	HZ	15	30	44	59	74	89	104	118	133	140
MAX SPEED REVERSE	HZ	15	30	44	59	74	89	104	118	133	140

NOTE

Maximum speed for the TMX 12 through 20 can not exceed 140 Hz.
Maximum speed for the TMX 25 can not exceed 110 Hz.

Maximum speeds are adjustable from 0 Hz to 140 Hz in 1 Hz increments. Forward speed and reverse speeds can be set independently (Forward speed can be set to 8 MPH and Reverse speed can be set at 5MPH if desired)

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:

MASTER CONTROL

Truck Hour Meter(HRs)	Accelerator (V)	Brake switch (ON/OFF)
Motor voltage (%)	Steer Angle (°)	Exclusive hydro (ON/OFF)
Frequency (Hz)	Int wheel cutback (%)	Brake pedal poti (%)
Encoder (Hz)	Forw switch (ON/OFF)	Hand brake (ON/OFF)
Slip Value (Hz)	Back switch (ON/OFF)	Voltage booster (%)
Current RMS (A)	Enable switch (ON/OFF)	Battery voltage (V)
Temperature (°C)	Seat switch (ON/OFF)	Battery charge (%)
Temperature #1 (°C)	Cutback switch (ON/OFF)	
Temperature #2 (°C)	Cutback switch2 (ON/OFF)	

Master Control - "Dualac2"

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) TEMPERATURE #1:	This is the temperature of the right motor; if this option is programmed "None" it shows 0°.
9) TEMPERATURE #2:	This is the temperature of the left motor; if this option is programmed "None" it shows 0°.
10) 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.
11) STEER ANGLE:	This is the indication off the angular position of the steer wheel.
12) INTERNAL WHEEL CUTBACK:	This is an indication of the speed reduction applied to the inside wheel; in other words, it shows the ratio of the two speeds.
13) FORWARD SWITCH:	The level of the Forward direction digital input FW. ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
14) BACKWARD SWITCH:	The level of the Reverse direction digital input BW. ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.

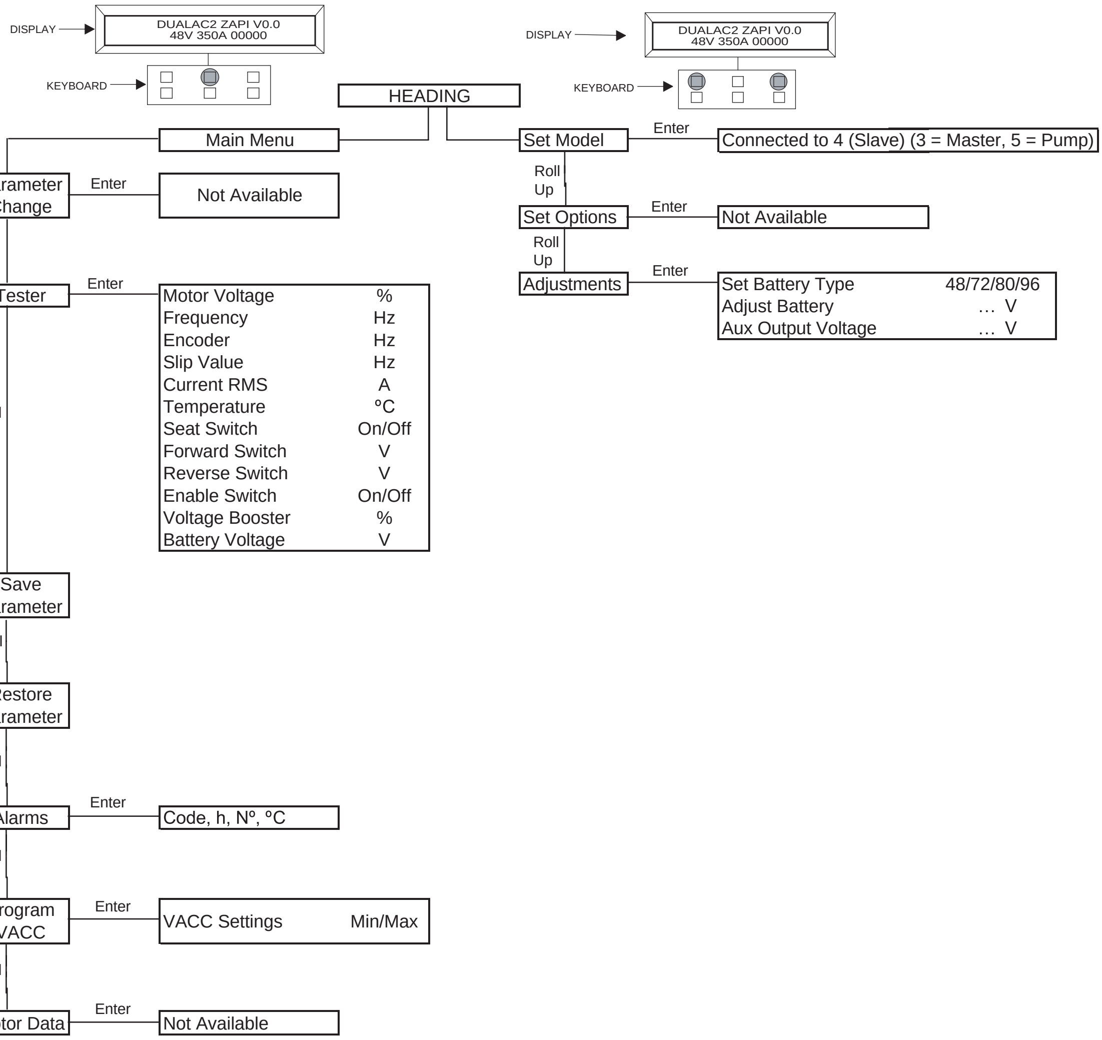
15) ENABLE SWITCH:	The level of the Enable digital input. ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
16) SEAT SWITCH:	The level of seat microswitch digital input. ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
17) CUTBACK SWITCH:	The level of the Speed Reduction microswitch. ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
18) CUTBACK SWITCH2:	The level of the Speed Reduction microswitch. ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
19) BRAKE SWITCH:	The level of the brake microswitch. ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
20) EXCLUSIVE HYDRO:	Status of the exclusive hydro switch. ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
21) BRAKE PEDAL POTI:	Voltage of the brake potentiometer's wiper (CPOTB). The parameter is active only if the "PEDAL BRAKING" parameter is set to "ANALOG".
22) HAND BRAKE:	The level of the Handbrake microswitch. ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open
23) VOLTAGE BOOSTER:	This is the booster voltage supplied to the motor in load condition; It is expressed in a percentage of the full voltage.
24) BATTERY VOLTAGE:	Level of the battery voltage measured at the input of the key switch.
25) BATTERY CHARGE:	The percentage charge level of the battery.

Slave Control - "Dualac2"

Submenu "Adjustments"

1. SET BATTERY TYPE: Selects nominal battery voltage
2. ADJUST BATTERY: Fine adjustment of the battery voltage measured by the controller.
3. AUX OUTPUT VOLTAGE: This parameter adjusts the voltage of the auxiliary output coil (power steering contactor coil), PWM output A31.

TMX Handset
Slave Control Configuration



See Group 19, Section 4 for TMX Factory Control Settings

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:

SLAVE CONTROL

Motor voltage (%)	Current RMS (A)	Back switch (ON/OFF)
Frequency (Hz)	Temperature (°C)	Enable switch (ON/OFF)
Encoder (Hz)	Seat switch (ON/OFF)	Voltage booster (%)
Slip Value (Hz)	Forw switch (ON/OFF)	Battery voltage (V)

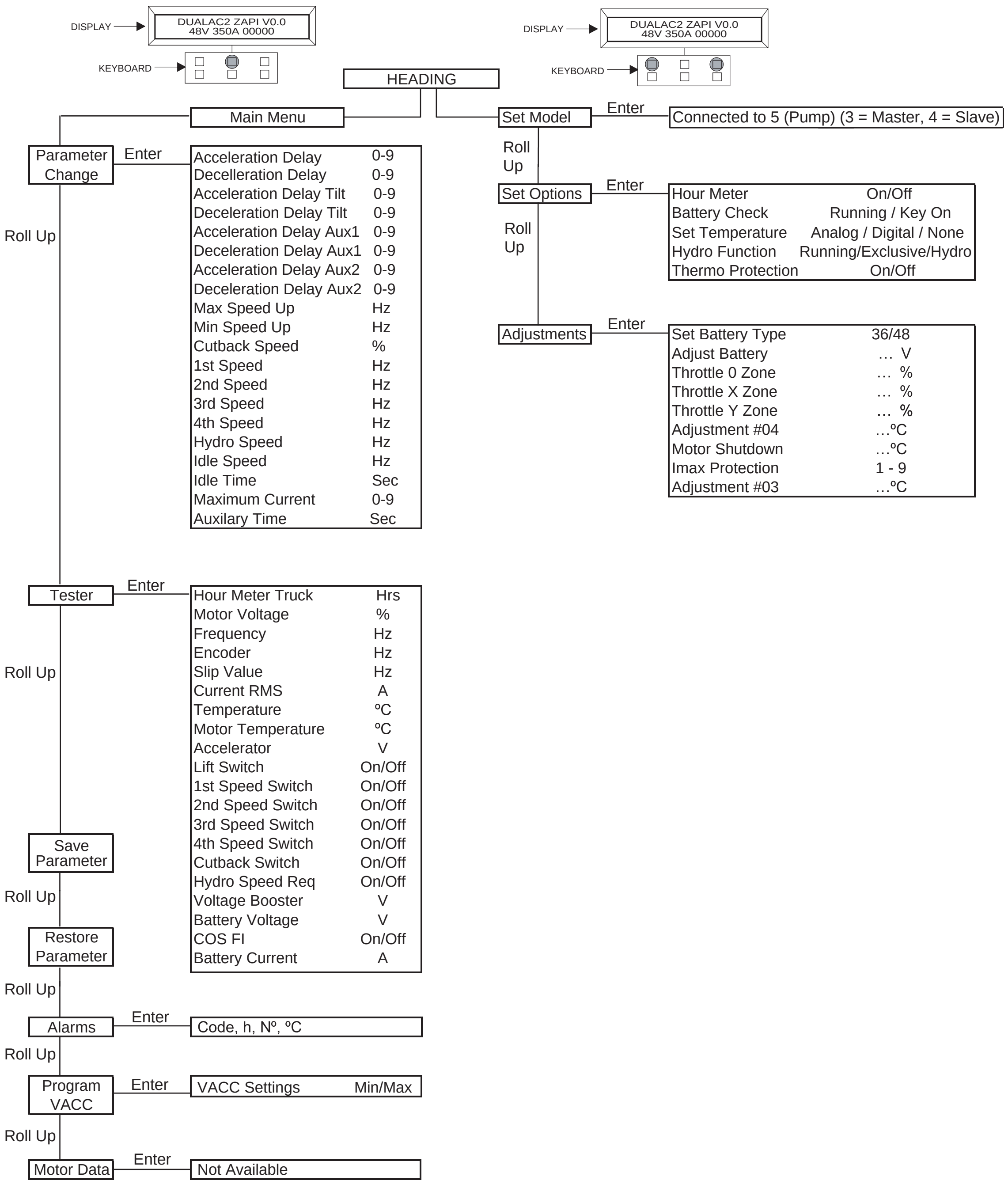
Slave Control - "Dualac2"

1) MOTOR VOLTAGE:	This is the voltage supplied to the motor by the controller; it is expressed as a percentage of full battery voltage.
2) FREQUENCY:	This is the frequency of the voltage and current supplied to the motor.
3) ENCODER:	This is the speed of the motor, expressed in the same unit of the frequency; this information comes from the speed sensor.
4) 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.
5) CURRENT RMS:	Root Mean Square value of the motor current.
6) TEMPERATURE:	The temperature measured on the aluminum heat sink holding the MOSFET devices.
7) SEAT SWITCH:	The level of seat microswitch digital input. ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
8) FORWARD SWITCH:	The level of the Forward direction digital input FW. ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
9) BACKWARD SWITCH:	The level of the Reverse direction digital input BW. ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
10) ENABLE SWITCH:	The level of the Enable digital input. ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
11) VOLTAGE BOOSTER:	This is the booster voltage supplied to the motor in load condition; It is expressed in a percentage of the full voltage.
12) BATTERY VOLTAGE:	Level of the battery voltage measured at the input of the key switch.

PUMP CONTROL

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

TMX Handset
Pump Control Configuration



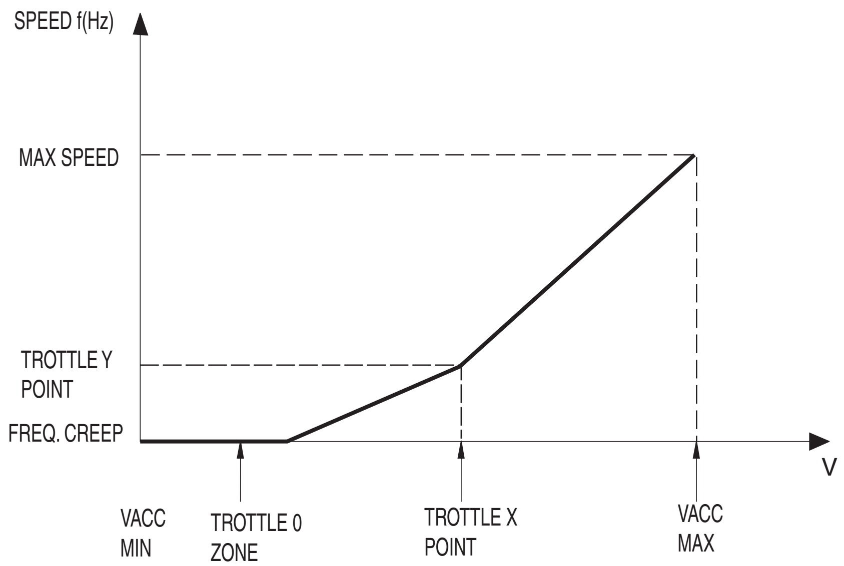
See Group 19, Section 4 for TMX Factory Control Settings

SUBMENU "SET OPTIONS"

1 HOUR METER TRUCK	
ON:	The pump control shares the trucks working hours with a traction control.
OFF:	The pump control does not shares the trucks working hours with a traction control.
2 HOUR METER	
RUNNING:	The meter registers travel time only.
KEY ON:	The meter registers when the "key" is closed
3 SET TEMPERATURE	
DIGITAL:	A digital (ON/OFF) motor thermal sensor is connected to F6 input.
ANALOG:	An analog motor thermal sensor is connected to F6(the curve can be customized on customer request).
None:	No motor sensor switch connected.
4 HYDRO FUNCTION	
RUNNING:	Hydro request standard. Power steering function active when Forward or Reverse request is active.
EX HYDRO:	On demand steering function active. The encoder installed on steering is used to activate power steering function.
5 THERMO PROTECTION	
ON:	Power reduction activated.
OFF:	Power reduction function off.

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. ADJUSTMENT #01:	Adjusts the Lower level battery discharge table. (Not used version 1.12 + higher)
8. ADJUSTMENT #02:	Adjusts the upper level of the battery discharge table.(Not used version 1.12 + higher)
9. MOTOR SHUTDOWN:	To set the motor temperature when the "Motor shutdown" signal displays. The shutdown temperature is 145°C
10. IMAX PROTECTION:	The value to start the current reduction when the motor temperature reaches adjustment #4 value.
11. ADJUSTMENT #03:	-



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. Acceleration Delay	Acceleration ramp for lift(See Tables Below).
2. Deceleration Delay	Deceleration ramp for lift(See Tables Below).
3. Acceleration Delay Tilt	Acceleration ramp for tilt(See Tables Below).
4. Deceleration Delay Tilt	Deceleration ramp for tilt(See Tables Below).
5. Acceleration Delay Aux1	Acceleration ramp for Aux1(See Tables Below).
6. Deceleration Delay Aux1	Deceleration ramp for Aux1(See Tables Below).
7. Acceleration Delay Aux2	Acceleration ramp for Aux2(See Tables Below).
8. Deceleration Delay Aux2	Deceleration ramp for Aux2(See Tables Below).
9. Max Speed Up:	Determine the maximum lifting speed with a Potentiometer control (See Tables Below).
10. Min Speed Up:	Determine the minimum lifting speed with a potentiometer control when the lifting enable switch is closed (See Tables Below).
11. Cutback Speed	Speed when cutback switch is activated
12. 1st Speed Fine:	First speed (Tilt Speed), fine adjustment (See Tables Below).
13. 2nd Speed Fine:	Second speed, fine adjustment (See Tables Below).
14. 3rd Speed Fine:	Third speed, fine adjustment (See Tables Below).
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. Max Current:	Maximum current of the controller (See Tables Below).
20. Auxilary Time:	Time delay when power steering function request is switched off (See Tables Below).

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

PARAMETERS		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
Speed Fine (All) (***)	Hz	-	-	-	-	-	-	-	-	-	-
Max Current	% IMAX	47	23	58	64	70	76	82	88	94	100
Auxilary Time	Sec.	0	0.2	0.4	0.8	1	1.5	2	3	4	5

(*) 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 afunction 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.

(***) Adjustable with a 1 Hz resolution in the 0 to 200 Hz range.

PARAMETERS	MAXIMUM LIFT SPEED		
	UNIT	TMX 12 - 20	TMX 25
MAXIMUM SPEED UP	Hz	125	95
MINIMUM SPEED UP	HZ	16	16

Note: maximum lift speed for TMX 12 through 20 should not exceed 125 Hz and 95 Hz for the TMX 25

PARAMETERS	TILT FLOW SETTINGS		
	GPM	36 V Hz	48V Hz
1st SPEED FINE (TILT)	4.0	30	30

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	36V Hz	48V Hz
2nd SPEED FINE AND 3rd SPEED FINE	2.5	20	23
	5.5	43	51
	7.0	55	65
	10.0	79	93

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

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

1) MOTOR VOLTAGE:	This is the voltage supplied to the motor by the controller; it is expressed as a percentage of full battery voltage.
2) FREQUENCY:	This is the frequency of the voltage and current supplied to the motor.
3) ENCODER:	This is the speed of the motor, expressed in the same unit of the frequency; this information comes from the speed sensor.
4) 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.
5) CURRENT RMS:	Root Mean Square value of the motor current.
6) TEMPERATURE:	The temperature measured on the aluminum heat sink holding the MOSFET devices.
7) MOTOR TEMPERATURE:	This is the temperature of the right motor; if this option is programmed "None" it shows 0°.
8) 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
9) LIFTING SWITCH:	Status of lifting switch. ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
10) 1st SPEED SWITCH:	ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.
11) 2nd SPEED SWITCH:	ON /+BV = input active, switch closed. OFF / GND = input non-active, switch open.

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

OTHER HANDSET FUNCTIONS

Save and Restore Function

SAVE Function allows the transfer of controller parameters to the PC memory. With this function, a copy of the controller's set of parameters can be retained in a Pc and downloaded to another controller (see restore).

RESTORE Function allows you to download controller parameters from the PC memory to the controller Eeprom. Thus a copy of the parameters stored in the Pc can be downloaded in a controller avoiding the parameter setting operation.

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) Perform the steering potentiometer signal acquisition, using the parameters in "Adjustment" menu.(See Group 13, Section 4 for programming procedures).
Remember: when turning the wheel to the right the voltage will increase.

6) Set the maximum steering angles, right and left (should be 90°); use the parameters in "Adjustment" menu. (See Group 13, Section 4 for programming procedures).

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

8) Verify the "MAXIMUM CURRENT"

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

10) 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.

11) Verify speed reduction.

12) Set Hour Meter to correct hours.

NOTE :

Section 3

CONTROL TROUBLESHOOTING

FAULT CODES FOR TMX

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

Fault Code	Fault Name	Control
1	"NO SEAT SWITCH"	MASTER or SLAVE
8	"WATCHDOG"	MASTER
13	"EEPROM KO"	MASTER
17	"LOGIC FAILURE #3	MASTER
18	"LOGIC FAILURE #2	MASTER
19	"LOGIC FAILURE #1	MASTER
30	"VMN LOW"	MASTER
31	"VMN HIGH"	MASTER
37	"CONTACTOR CLOSED"	MASTER
38	"CONTACTOR OPEN"	MASTER
53	"STBY I HIGH"	MASTER
60	"CAPACITOR CHARGE"	MASTER
61	" HIGH TEMPERATURE"	MASTER
65	"MOTOR TC START"	MASTER or SLAVE
66	"BATTERY LOW"	MASTER
71	"MOTOR SHUTDOWN"	MASTER
72	"MOTOR LOCKED"	MASTER
74	"DRIVER SHORTED"	MASTER
75	"CONTACTOR DRIVER"	MASTER
76	"COIL SHORTED"	MASTER
77	"MAINTENANCE HOURS"	MASTER
78	"VACC NOT OK"	MASTER
79	"INCORRECT START (SRO)"	MASTER
80	"FORWARD + REVERSE"	MASTER
81	"TH MOTOR SENSOR KO"	MASTER
82	"ENCODER ERROR"	MASTER
84	"STEER SENSOR KO"	MASTER
86	"PEDAL WIRE KO"	SLAVE
87	"WATCHDOG"	SLAVE
96	"LOGIC FAILURE #3	SLAVE
97	"LOGIC FAILURE #2	SLAVE
98	"LOGIC FAILURE #1	SLAVE
99	"TH MOTOR SENSOR KO"	SLAVE
109	"VMN LOW"	SLAVE
110	"VMN HIGH"	SLAVE

Fault Code	Fault Name	Control
132	"STBY I HIGH"	SLAVE
139	"CAPACITOR CHARGE"	SLAVE
140	" HIGH TEMPERATURE"	SLAVE
148	"ENCODER ERROR"	SLAVE
150	"WATCHDOG"	PUMP
155	"EEPROM KO"	PUMP
159	"LOGIC FAILURE #3	PUMP
160	"LOGIC FAILURE #2	PUMP
161	"LOGIC FAILURE #1	PUMP
171	"MOTOR SHUTDOWN"	PUMP
172	"VMN LOW"	PUMP
173	"VMN HIGH"	PUMP
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
225	"AUX OUTPUT KO"	PUMP
232	"MASTER KO"	SLAVE
233	"NO CAN MSG 3"	SLAVE
235	"THERMIC SENSOR KO"	SLAVE
236	"INPUT MISMATCH"	SLAVE
243	"NO CAN MSG 5"	MASTER
245	"WRONG SET BATTERY"	MASTER
246	"SLAVE KO"	MASTER
247	"NO CAN MSG 4"	MASTER
249	"THERMIC SENSOR KO"M	MASTER
253	"AUX OUTPUT KO"	MASTER
255	"HANDBRAKE"	MASTER
Blank	"DASH DISPLAY"	MASTER

Fault Code Charts

Fault Code	Fault Name	Fault Description	Control	Troubleshooting	Action Required
1	"NO SEAT SWITCH"	No input from seat switch	MASTER or SLAVE	• 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	MASTER	It is a self-diagnosing test within the logic between Master and Slave micro controllers. This fault could also be caused by a CAN-BUS malfunction, which blinds Master -Slave communication. So , before replacing the controller , check the Canbus	
13	"EEPROM KO"	Warning: EEprom fault controller will use default parameters	MASTER	• 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	MASTER	• 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	MASTER	• Fault in the hardware section of the logic board that manages the phase 's voltage feedback.	Replace controller

Fault Code	Fault Name	Fault Description	Control	Troubleshooting	Action Required
19	"LOGIC FAILURE #1	An over voltage or under voltage condition has been detected	MASTER	• This fault signals that the under voltage / over voltage protection interrupt has been triggered • A real under voltage / over voltage key input (C3) 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
30	"VMN LOW"	Wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor	MASTER	• 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. • 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	MASTER	• 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) • Fault in the controller power section. • Possible bad battery, Excessive voltage to case of battery.	Replace controller
37	"CONTACTOR CLOSED"	Line contactor power contact closed at power up	MASTER	• 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 dis charge, 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	MASTER	• The controller has driven the line contactor, but the contactor did not close. • The wires to the coil are open or a loose connection. • The contact does not pull in properly	
53	"STBY I HIGH"	Wrong voltage in current sensor feedback circuit	MASTER	• 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.	
60	"CAPACITOR 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 MASTER		• 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.	

Fault Code	Fault Name	Fault Description	Control	Troubleshooting	Action Required
61	" HIGH TEMPERA-TURE"	Warning: Master or Slave or both temperature higher that 75 degrees C	MASTER	• 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)	MASTER or SLAVE	• Right or left or both 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 20%	MASTER	• When battery level reaches 20% 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: Right or left or both motors temp. are very high (over MOTOR SHUT-DOWN param.)	MASTER	This fault occurs when the right or left or both 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	MASTER	• After 15 seconds the motor stalled with maximum current, controller reduces maximum current to 50%. • Check if Line Contactor is pulled in.	
74	"DRIVER SHORTED"	Line contactor coil driver is shorted	MASTER	• 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 (C26) and -Batt. • If no external causes can be found.	Replace controller

Fault Code	Fault Name	Fault Description	Control	Troubleshooting	Action Required
75	"CONTACTOR DRIVER"	Line contactor coil driver is open (not able to drive the coil to the correct voltage)	MASTER	• 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 MASTER		• 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	MASTER	• This is just an indication that the vehicle is due for its Periodic Maintenance.	
78	"VACC NOT OK"	**Warning: Accelerator signal (CPOT) voltage higher than VACC MIN+1V While the traction enable switch is open**	MASTER	• 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

Fault Code	Fault Name	Fault Description	Control	Troubleshooting	Action Required
79	"INCOR-RECT START (SRO)"	**Warning: Wrong traction request sequence This fault indicates an incorrect start-ing sequence**	MASTER	• 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 wir-ing,	Replace con-troller
80	"FOR-WARD + REVERSE"	**Warning: For-ward and reverse inputs are both active**	MASTER	• 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 con-troller
81	"TH MOTOR SENSOR KO"	Warning:Motor Master tempera-ture sensor is out of range	MASTER	• The range of the motor temperature ana-log 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.	
82	"ENCODER ERROR"	Motor speed sen-sor (encoder) does not work properly	MASTER	• 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. • Check voltage on wire #47, should be approx 12VDC. If not 12VDC unplug right + left encoders, recheck wire #47 for 12VDC. If 12VDC is present now, check encoders and encoder wiring for shorts. If still no 12VDC replace control	

Fault Code	Fault Name	Fault Description	Control	Troubleshooting	Action Required
84	"STEER SENSOR KO"	Steering Potentiometer signal out of range	MASTER	• This fault indicates an out of range steering potentiometer signal. • The fault comes up under the following two conditions: • The "set Steer 0 pos" (programmed straight wheel pos) parameter is wrong (lower than "set steer min) or higher than "set steer max")	Replace controller
86	"PEDAL WIRE KO"	Fault in Accelerator negative (NPOT) Input circuit. This fault indicates that accelerator wiring (NPOT or PPOT) wire is open.	SLAVE	• 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 C20) Battery Neg. (pin C12) 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 (C20) is good. Remove pins (C20, C21, C33) from connector, now connect a 4.7K ohm resistor between PPOT (C33) and NPOT (C20) now plug the connector back in, this will polarize NPOT. Now check voltage between (C12) -Batt and (C20) 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
87	"WATCH-DOG"	Watchdog circuit has been triggered	SLAVE	• It is a self-diagnosing test within the logic between Master and Slave micro controllers. • This fault could also be caused by a Canbus malfunction, which blinds Master - Slave communication. So , before replacing the controller , check the Canbus	
96	"LOGIC FAILURE #3	Failure in overload protection hw circuit	SLAVE	• Fault in the hardware section of the controller that manages the hardware current protection.	Replace controller
97	"LOGIC FAILURE #2	Failure in U,V,W voltage feedback circuit	SLAVE	• Fault in the hardware section of the controller that manages the phase 's voltage feedback. • Line contactor not closing, check parameter setting for main contactor.	Replace controller

Fault Code	Fault Name	Fault Description	Control	Troubleshooting	Action Required
98	"LOGIC FAILURE #1	An over voltage or under voltage condition has been detectedSLAVE		• This fault signals that the under voltage / over voltage protection interrupts been triggered • 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.	
99	"TH MOTOR SENSOR KO"	**Warning:Motor Slave temperature sensor is out of range**	SLAVE	• 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.	
109	"VMN LOW"	Wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor	SLAVE	• 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) • Fault in the controller power section.	Replace controller
110	"VMN HIGH"	Wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor	SLAVE	• 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) • Fault in the controller power section.	Replace controller
132	"STBY I HIGH"	Wrong voltage in current sensor feedback circuit	SLAVE	• The microprocessors verify if the feedback of current sensor device output is within the zero current window. Possible causes for the fault. • Current sensor failure. • Failure in the controller • If the fault persist.	Replace controller Replace the power unit

Fault Code	Fault Name	Fault Description	Control	Troubleshooting	Action Required
139	"CAPACITOR 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	SLAVE	• 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, 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.	
140	" HIGH TEMPERATURE"	**Warning: Master or Slave or both temperature higher that 75 degrees C**	SLAVE	• 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.	
148	"ENCODER ERROR"	Motor speed sensor (encoder) does not work properly SLAVE		• 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
150	"WATCHDOG"	Watchdog circuit has been triggered	PUMP	• It is a self-diagnosing test within the logic between Master and Slave micro controllers. This fault could also be caused by a CAN-BUS malfunction, which blinds Master -Slave communication. So , before replacing the controller , check the CAN-BUS	
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		• 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. • Fault in the hardware section of the controller that manages the over voltage protection. • 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 • 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	Replace controller
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) • 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.	

Fault Code	Fault Name	Fault Description	Control	Troubleshooting	Action Required
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 to see that the pump contactor is pulled in • 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: 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%.	
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.	

Fault Code	Fault Name	Fault Description	Control	Troubleshooting	Action Required
204	"VACC NOT OK"	**Warning: Accelerator siganal (CPOT) voltage higher than VACC MIN+1V While the traction enable switch is open**	PUMP	• 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. • Tilt or sideshift switch activated at startup	
205	"INCORRECT START"	**Warning: Wrong traction request sequence**	PUMP	• This fault indicates an incorrect starting sequence. • Lift 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
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 MOTOR-SHUTDOWN 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 20%**	PUMP	• When battery level reaches 20% 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 (C26) and Batt- If no external causes can be found.	Replace controller

Fault Code	Fault Name	Fault Description	Control	Troubleshooting	Action Required
210	"CONTAC-TOR 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 con-troller
211	"COIL SHORTED"	Init: Line contac-tor and EB coil driver protection circuit is damaged or Stby or running: short on line con-tactor or EB coil	PUMP	When the key is turned on, the microproces-sor 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 sig-naled. 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	
212	"COIL INTER-UPTED"	xxx	PUMP	xxx	
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 F5 is not connected to Batt-	PUMP	xxx	
222	"NO CAN MSG"	Pump has lost Can communication with Master	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 traction ok. The fault must be looked for in the trac-tion controller or can-bus circuit.	
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 corre-spond 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 NHYDRO (F9) and -Batt.	

Fault Code	Fault Name	Fault Description	Control	Troubleshooting	Action Required
232	"MASTER KO"	Slave micro processor detects Master processor malfunctioning	SLAVE	• Slave and Master microprocessor perform a crosscheck in order to verify functionality. There are two conditions under which the slave enters this fault condition: • The SLAVE microprocessor receives an incoherent Can message from the MASTER microprocessor. • The SLAVE microprocessor compares the inputs status and the related MASTER operations and finds they are not coherent. In both cases, the SLAVE brings the controller to a safe status opening the power bridge and the line contactor.	
233	"NO CAN MSG 3"	Slave has lost Can communication with Pump	SLAVE	• Slave (node #4) signals that it has lost communication with the Master (node #3) 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 connection.	
235	"THERMIC SENSOR KO"	**Warning: Slave temperature sensor is our of range**	SLAVE	• 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%.	
236	"INPUT MIS-MATCH"	Slave micro processor has detected a mismatch between inputs status and the input status transmitted Via Canbus by master micro processor	SLAVE	• Safety related inputs (Fwd direction, Rev direction, accelerator Enable, Seat switch) are inputs to both micro processors by independent hardware circuit. The two microprocessors read these inputs and compare by exchanging related status on the Canbus. If the SLAVE microprocessor finds a mismatch between its inputs and MASTER inputs, it brings the controller to a safe status opening the power bridge and the line contactor.	
243	"NO CAN MSG 5"	Master has lost Can communication with Pump	MASTER	• Master (node #3) 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.	

Fault Code	Fault Name	Fault Description	Control	Troubleshooting	Action Required
245	"WRONG SET BATTERY"	Battery voltage does not correspond to programmed "SET BATTERY"	MASTER	• This fault indicates that actual battery voltage is 20% higher or 20% lower than "SET BATTERY" parameter setting. Replace battery with correct battery.	
246	"SLAVE KO"	Master micro processor detects Slave micro processor Malfunctioning	MASTER	• Slave and Master microprocessor perform a crosscheck in order to verify functionality. If the MASTER detects SLAVE microprocessor malfunctioning, it brings the controller to a safe status opening the power bridge and line contactor.	
247	"NO CAN MSG 4"	Master has lost Can communication with Slave	MASTER	• Master (node #3) signals that it has lost communication with the Slave (node #4) 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.	
249	"THERMIC SENSOR KO"	**Warning: Master temperature sensor is our of range**	MASTER	• 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%.	
253	"AUX OUTPUT KO"	EB coil driver shorted or open	MASTER	• 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	MASTER	• Indicate that handbrake is activated • Check wiring and handbrake switch.	Repair wiring or replace switch if needed
Blank	"DASH DISPLAY"	Dash Display blank	MASTER	• 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

Section 4

TMX Factory Control Settings

Parameters in White are customer preference adjustable.

Parameters in Orange are factory preset and not adjustable.

Refer to Section 2 for Handset Programming Instructions

Name	Scaled Value
Master (DUALAC2)	
PARAMETER CHANGE	36V/48V
ACCELER. DELAY	**LEVEL = 3**
RELEASE BRAKING	**LEVEL = 4**
INVERS. BRAKING	**LEVEL = 6**
PEDAL BRAKING	**LEVEL = 7**
SPEED LIMIT BRK.	LEVEL = 0
BRAKE CUTBACK	LEVEL = 5
CURVE BRAKING	LEVEL = 5
MAX SPEED FORW (Do Not adjust to a higher HZ)	**140 Hz (TMX12-20)**
MAX SPEED FORW (Do Not adjust to a higher HZ)	**110 Hz (TMX25)**
MAX SPEED BACK (Do Not adjust to a higher HZ)	**140 Hz(TMX12-20)**
MAX SPEED BACK (Do Not adjust to a higher HZ)	**110 Hz (TMX25)**
CUTBACK SPEED 1	100%
CUTBACK SPEED 2	100%
CURVE CUTBACK	20%
CURVE CUTBACK 1	**100%**
FREQUENCY CREEP	0.30 Hz
MAXIMUM CURRENT	LEVEL = 9
AUXILIARY TIME	1.5
ACC. SMOOTH (Vers.CK1.21+Higher)	2.5
INV. SMOOTH (Vers.CK1.21+Higher)	1.0
STOP SMOOTH (Vers.CK1.21+Higher)	20Hz

SET OPTION	**36V/48V**
HOUR COUNTER	RUNNING
BATTERY CHECK	ON
HYDRO KEY ON	OFF
STOP ON RAMP	OFF
AUX INPUT #1	OPTION #1
PEDAL BRAKING	DIGITAL
SET TEMPERATURE	ANALOG
STEER TABLE	OPTION #1
EXTENDED DISPLAY (Vers.CK1.19+Higher)	ON/OFF
SET MODEL	**36V/48V**
CONNECTED TO	3 (Master)

ADJUSTMENTS	**36V/48V**
SET POT BRK MIN	N/A
SET POT BRK MAX	N/A
SET BATTERY TYPE	**36V/48V**
ADJUST BATTERY	
MAX STEER RIGHT	**4.1 V**
MAX STEER LEFT	**0.9 V**
SET STEER 0-POS.	**2.5 V**
SET STEER RIGHT	90
SET STEER LEFT	90
THROTTLE 0 ZONE	1%
THROTTLE X POINT	**18%**
THROTTLE Y POINT	**15%**
ADJUSTMENT #04	130
MOTOR SHUTDOWN	145
ADJUSTMENT #02	**LEVEL = 4**
ADJUSTMENT #01	**LEVEL = 4**
ADJUSTMENT #03	**20%**
MAIN CONT. VOLT.	36 V
AUX OUTPUT VOLT.	36 V
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 (Vers.CK1.19+Higher)	36

SLAVE (DUAL AC2)	
SET MODEL	36V/48V
CONNECTED TO	4 (Slave)

ADJUSTMENTS	**36V/48V**
SET BATTERY TYPE	**36V/48V**
ADJUST BATTERY	
AUX OUTPUT VOLT.	12V

PUMP (AC2)	
PARAMETER CHANGE	**36V/48V**
ACCELER. DELAY	LEVEL = 0
DECELER. DELAY	LEVEL = 0
ACCELER. DELAY TILT (Software Vers.1.09+Higher)	LEVEL = 3
DECELER. DELAY TILT (Software Vers.1.09+Higher)	LEVEL = 0
ACCELER. DELAY AUX1 (Software Vers.1.09+Higher)	LEVEL = 0
DECELER. DELAY AUX1 (Software Vers.1.09+Higher)	LEVEL = 0
ACCELER. DELAY AUX2 (Software Vers.1.09+Higher)	LEVEL = 0
DECELER. DELAY AUX2 (Software Vers.1.09+Higher)	LEVEL = 0
MAX SPEED UP (Do Not adjust to a higher HZ)	**125 Hz (TMX12-20)**
MAX SPEED UP (Do Not adjust to a higher HZ)	**95 Hz (TMX25)**
MIN SPEED UP	16.50 Hz
CUTBACK SPEED	100%
1ST SPEED FINE*	30 Hz
2ND SPEED FINE*	**30 Hz**
3RD SPEED FINE*	**81 Hz**
4TH SPEED FINE*	N/A
HYD SPEED FINE	16 Hz
IDLE SPEED	12 Hz
IDLE TIME	LEVEL = 5
MAXIMUM CURRENT	LEVEL = 9

AUXILIARY TIME	4

SET OPTION	**36V/48V**
HOUR COUNTER	RUNNING
BATTERY CHECK	OFF
SET TEMPERATURE	ANALOG
HYDRO FUNCTION	RUNNING
THERM PROTECTION	OFF

SET MODEL	**36V/48V**
CONNECTED TO	5 (PUMP)

ADJUSTMENTS	**36V/48V**
SET BATTERY TYPE	**36V/48V**
ADJUST BATTERY	
THROTTLE 0 ZONE	5%
THROTTLE X POINT	63%
THROTTLE Y POINT	36%
ADJUSTMENT #04	130 °C
MOTOR SHUTDOWN	145 °C
ADJUSTMENT #03	55 °C
IMAX PROTECTION	100%
ADJUSTMENT #02 **	LEVEL = 4
ADJUSTMENT #01 **	LEVEL = 4

*** See AUX Hydraulic Settings in Section 3**

** Not used software version CK 1.12 + higher

NOTE

All motors must be stopped before saving parameters. parameter may not be stored to EEPROM if motor is running.

TMX 250
TMX 12-25
AC Control

GROUP 19

Sequence of Operation

OPERATION 1
Connect the Battery

A. Battery Positive will be supplied to the 5 volt converter, B+ terminal, via the #2 wire. Battery Negative is connected to the GND terminal of the 5 volt converter completing the circuit. The converter will provide a 5 volt signal to the dash display via the #81 wire to terminal 15.

B. Battery Positive will be supplied to the 12 volt converter + terminal, through the #2 wire and the #4FU fuse. Battery Negative is connected to the - terminal of the 12 volt converter completing the circuit. The converter will provide a 12 volt output to the accessory circuit through the #5 FU fuse. The converter negative is connected to the frame of the truck as is all 12 volt accessories completing the negative circuit. (See page 4 & 5)

C. The horn is operated by pushing the horn button which will supply battery voltage to the horn through wire #25, and to negative through wire #13.

D. Battery Negative is connected to the dash display at terminal 23 and to the AC controllers at the B- terminals.

Voltages Present:

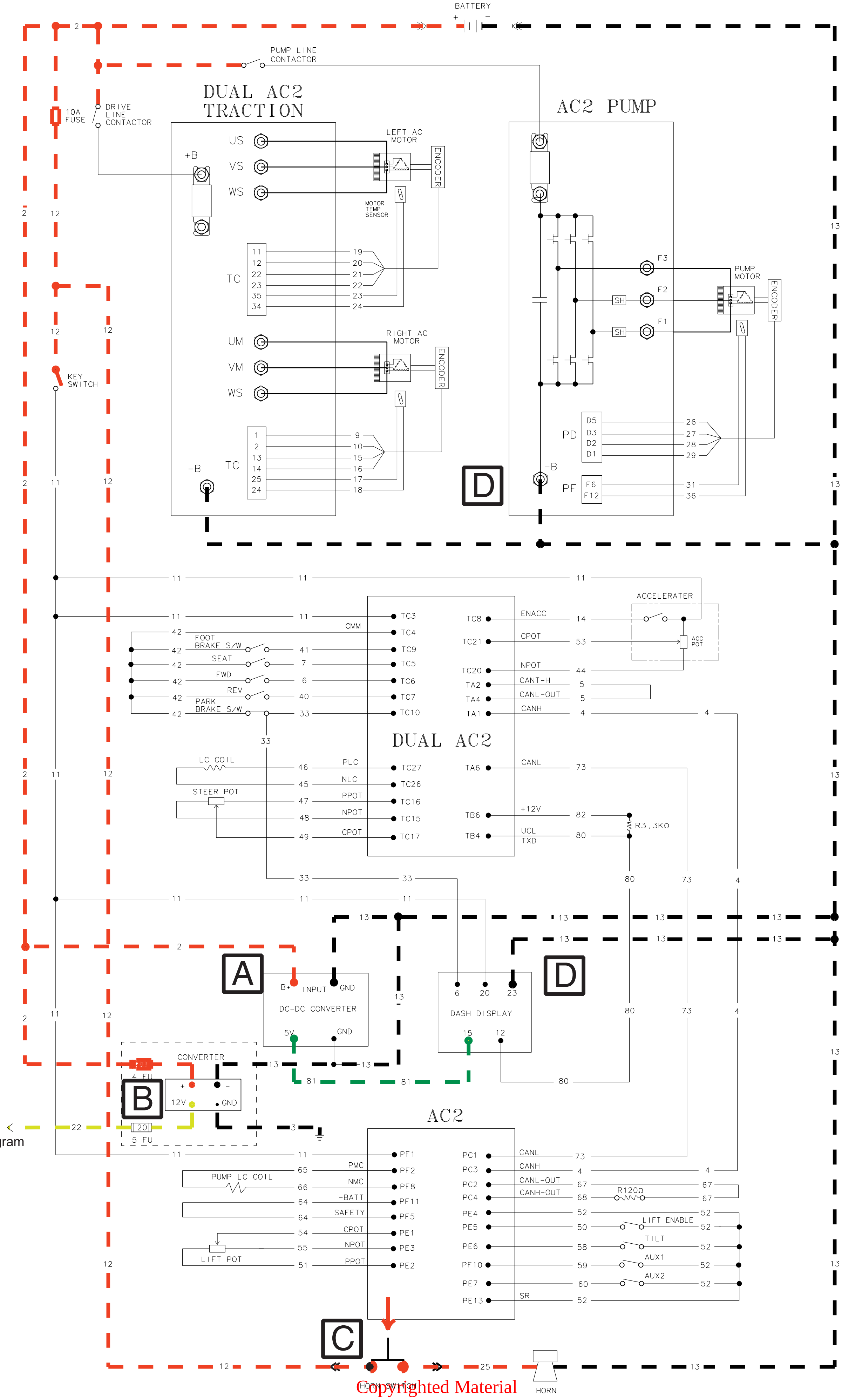
A. Battery volts at wire #2, 5 volts at wire #81.

B. Battery volts at the + terminal, 12 volts between terminal #22 and the frame of the truck.

C. Battery volts at wires #12 and #25, 0 volts at wire #13 (battery Negative).

D. 0 volts (battery Negative)

See 12 Volt Accessory Diagram



OPERATION 1 (Continued)
Connect the Battery

A. Battery Positive will be supplied to the 12 volt converter + terminal, through the #2 wire and the #4FU fuse.

B. Battery Negative is connected to the - terminal of the 12 volt converter completing the circuit.

C. The converter will provide a 12 volt output to the accessory circuit through the #5 FU fuse. The converter negative is connected to the frame of the truck as is all 12 volt accessories completing the negative circuit.

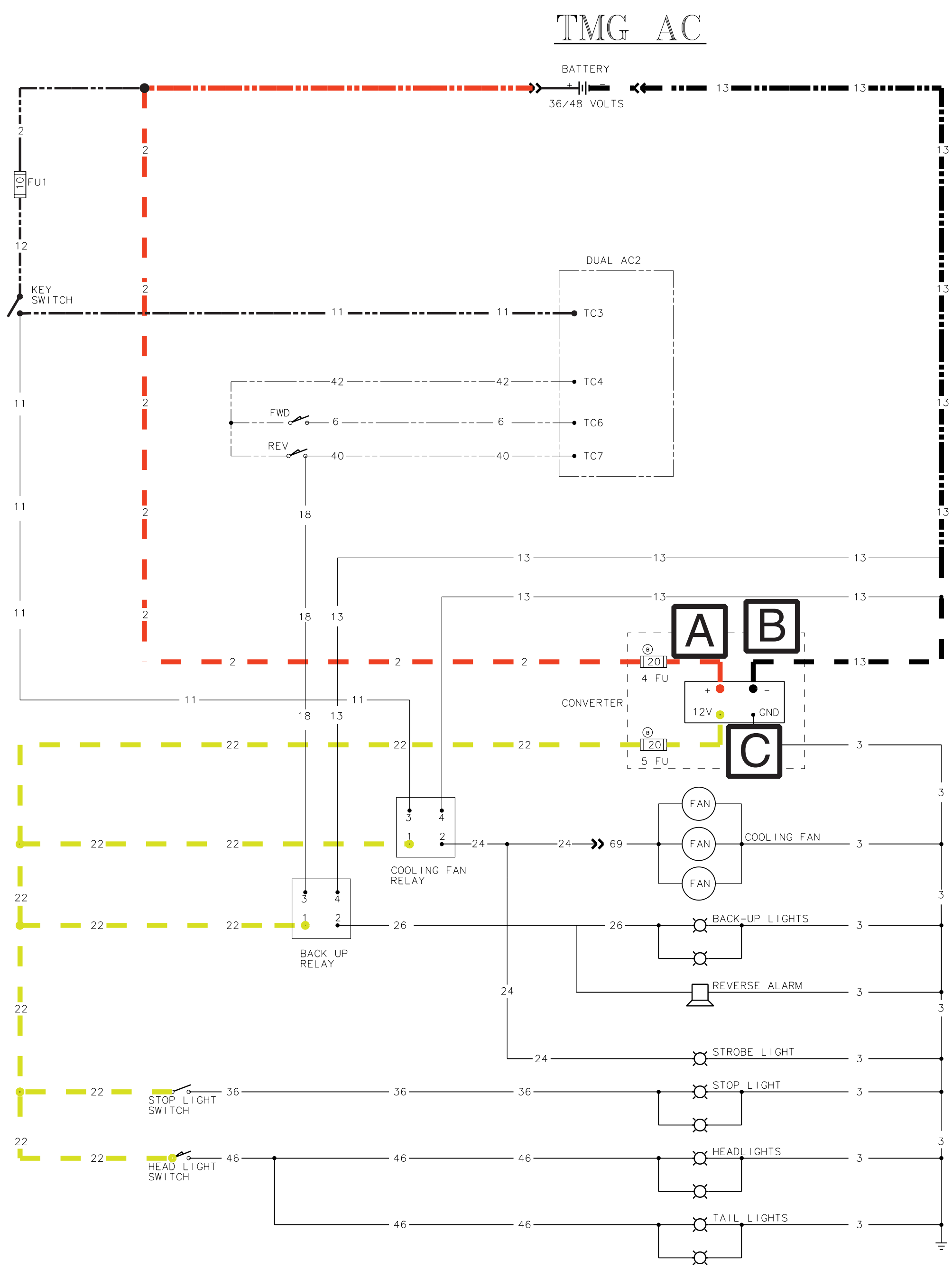
Voltages Present:

A. Battery volts at wire #2 at the + terminal

B. 0 volts (battery Negative)

C. 12 volts between terminal #22 and the frame of the truck.

Accessory Diagram



OPERATION 2
Closing the Key Switch

A. Closing the key switch will provide Battery Positive via the #11 wire to the traction control at terminal TC3, and to the pump control at terminal PF1. Battery positive is also supplied to the accelerator control. Battery Negative is supplied to the traction and pump controls at terminal –B.

B. Battery Positive is also supplied to the dash display at terminal 20.

C. The Traction Control and the Pump Control, through an internal circuit, will pre-charge the internal capacitors.

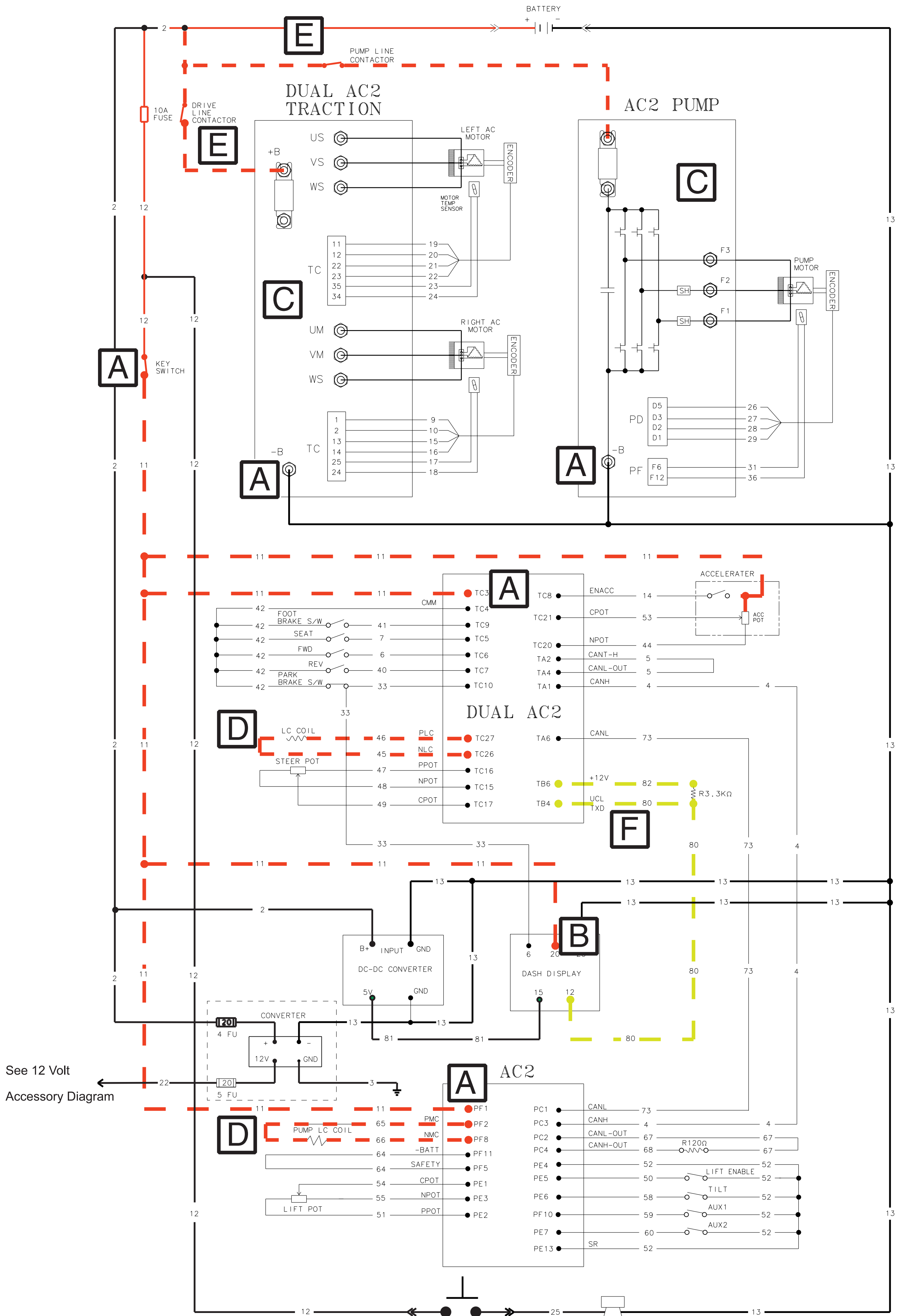
D. When the traction control capacitors have charged to a preset value, the traction control will supply battery positive voltage to the Line contactor at terminal TC27, wire #46, and battery negative at terminal TC26, wire #45. When the pump control capacitors have charged to a preset value, the pump control will supply battery positive voltage to the Pump Line contactor at terminal PF8, wire #66, and battery negative at terminal PF2, wire #65.

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 TB6, wire #82 to terminal TB4, wire #80 and to the dash display, terminal 12 via wire #80.

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


BATTERY
PUMP LINE CONTACTOR
10A FUSE
DRIVE LINE CONTACTOR
DUAL AC2 TRACTION
AC2 PUMP
LEFT AC MOTOR
ENCODER
MOTOR TEMP SENSOR
RIGHT AC MOTOR
PUMP MOTOR
KEY SWITCH
US
VS
WS
UM
VM
TC
PD
PF
+B
-B
F1
F2
F3
SH
ACCELERATER
ACC POT
FOOT BRAKE S/W
SEAT
FWD
REV
PARK BRAKE S/W
CMM
ENACC
CPOT
NPOT
CANT-H
CANL-OUT
CANH
DUAL AC2
LC COIL
STEER POT
PLC
NLC
PPOT
CANL
+12V
UCL
TXD
R3.3KΩ
INPUT
GND
DC-DC CONVERTER
DASH DISPLAY
CONVERTER
4 FU
5 FU
12V
See 12 Volt
Accessory Diagram
AC2
PUMP LC COIL
PMC
NMC
-BATT
SAFETY
LIFT POT
CANH-OUT
R120Ω
LIFT ENABLE
TILT
AUX1
AUX2
SR
HORN SWITCH
HORN
A
B
C
D
E
F

OPERATION 2 (Continued)
Closing the Key Switch

A. Closing the key switch will provide Battery Positive via the #11 wire to the Cooling Fan Relay, located under the left hand dash panel, at terminal 3.

B. Battery Negative is connected to terminal 4 of the Cooling Fan Relay.

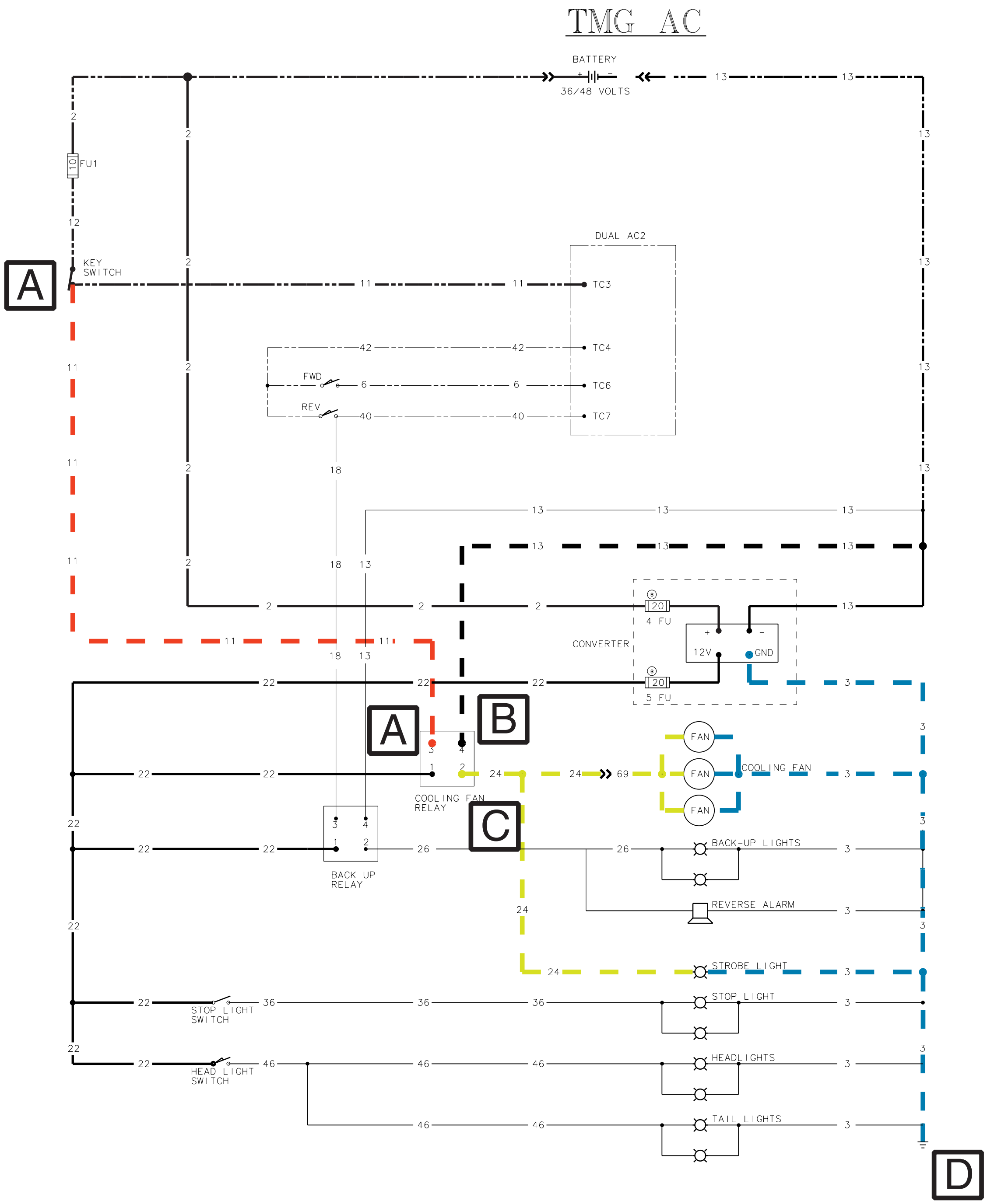
C. With Battery Positive at terminal 3 and Battery Negative at terminal 4, the electronic relay will close the connection between terminals 1 and 2, completing the 12 volt circuit via wire #22 through wire #59 to the cooling fans located on the control panel. 12 volt positive will also be supplied to 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. 0 volts (Battery negative)
C. 12 volts
D. 0 volts (Ground)

Accessory Diagram



OPERATION 3
System Checks

A. The traction control will supply a battery positive voltage at terminal TC4, wire #42, to the directional, brake, parking brake and seat switches.

B. The control monitors the voltage at terminals TC5, TC6, TC7, TC9 and TC10 for proper switch closing in performing the SRO checks.

C. Voltage is supplied through the normally closed contacts of the parking brake switch, parking brake applied, through wire #33 to terminal 6 on the dash display to illuminate the Parking Brake Icon.

D. The pump control will supply a battery positive voltage at terminal PE14, wire #52, to the hydraulic valve switches.

E. The pump control monitors the voltage at terminals PE5, PE6, PE7, PF10 and PE13 for switch closure.

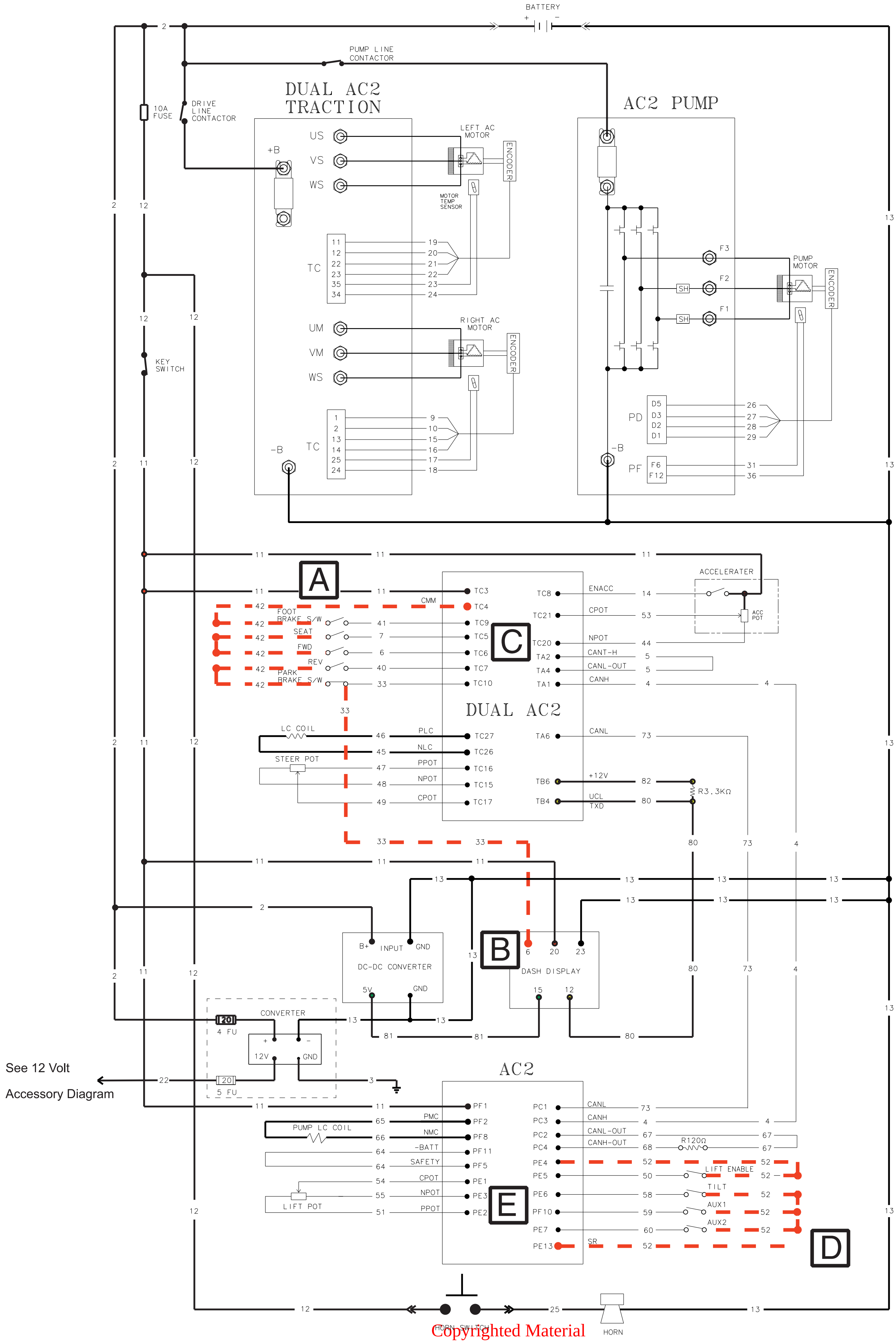
Voltages Present:

A. Battery volts.
B. 0 volts at terminals TC5, TC6, TC7 and TC9 with switches open. Battery volts at terminal TC10 with parking brake applied.
C. Battery volts
D. Battery volts at terminals PE4 and PE13
E. 0 volts at terminals PE5, PE6, PE7 and PF10 with the hydraulic levers in neutral position, switches open.

SRO Explanation:

The TMX 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.

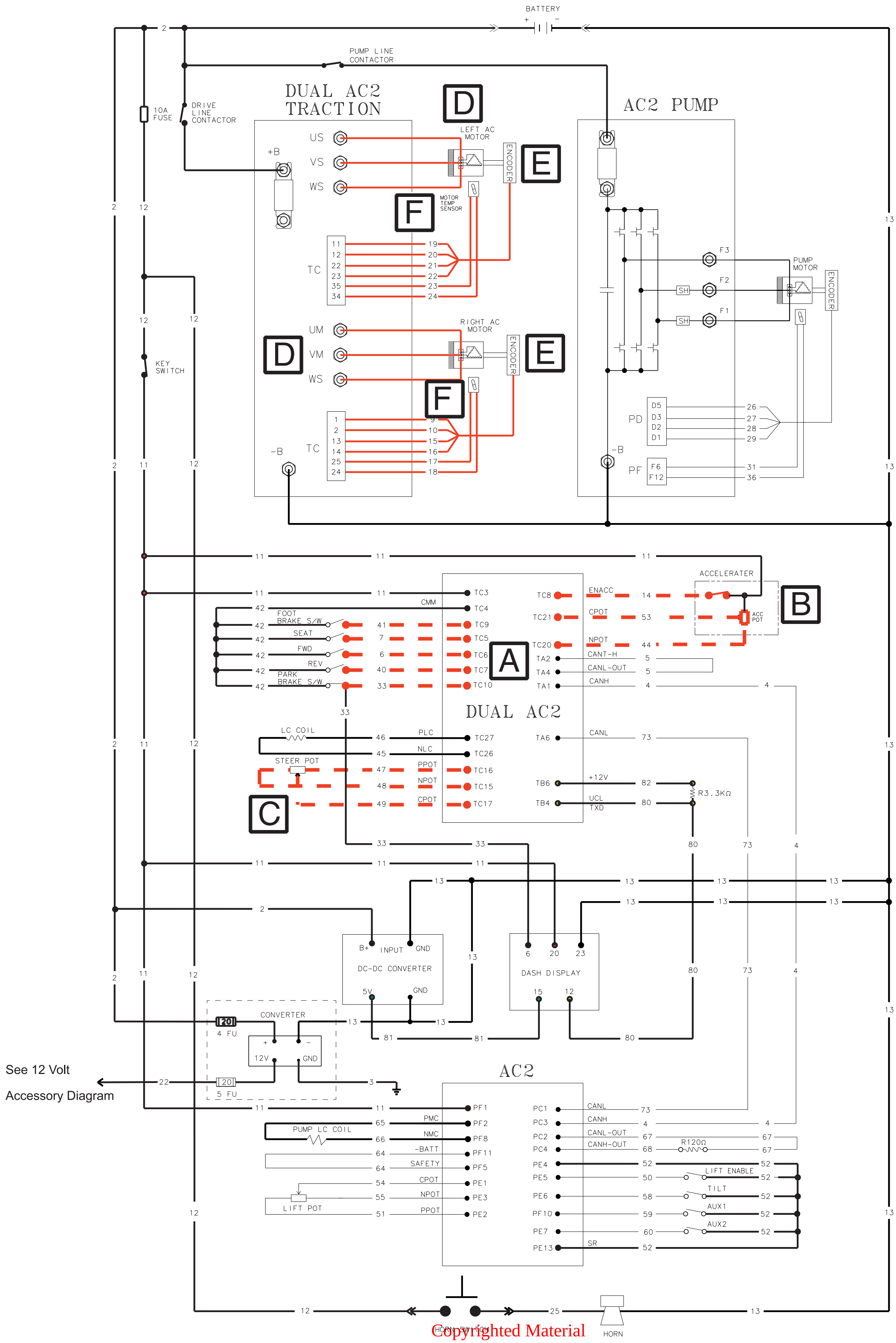

BATTERY
PUMP LINE CONTACTOR
10A FUSE
DRIVE LINE CONTACTOR
DUAL AC2 TRACTION
AC2 PUMP
LEFT AC MOTOR
ENCODER
MOTOR TEMP SENSOR
RIGHT AC MOTOR
PUMP MOTOR
KEY SWITCH
ACCELERATER
ACC POT
FOOT BRAKE S/W
SEAT
FWD
REV
PARK BRAKE S/W
DUAL AC2
LC COIL
STEER POT
DC-DC CONVERTER
DASH DISPLAY
CONVERTER
4 FU
5 FU
See 12 Volt Accessory Diagram
AC2
PUMP LC COIL
LIFT POT
LIFT ENABLE
TILT
AUX1
AUX2
R120Ω
R3.3KΩ
HORN SWITCH
HORN
A
B
C
D
E

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 TC21.
C. The traction control provides a 12 volt signal from terminal TC16, via the #47 wire, to the steer potentiometer. Battery negative is to the pot is supplied via the #48 wire to terminal TC15. When the steer wheel is centered, going straight ahead, the output voltage from the pot on wire #49, terminal TC17 will be about 6 volts. As the steer wheel is turned to the right, the voltage on wire #49 will increase. When the steer wheel is turned to the left, the voltage on wire #49 will decrease.
D. 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 two drive motors. As the accelerator input voltage decreases, the pulsing of the control and the speed of the motors will increase.
E. The encoder bearings within the two drive motors signal the traction of the speed of the motors and help control the pulsing.
F. The thermostat within the two motors will increase in resistance when they reach a specific temperature and signal the traction control that the motors are running hot and the control will reduce the maximum current that the motors can draw.

Voltages Present:

A. Battery volts when the respective switches are closed
B. Battery volts at terminal TC8, wire #14 with 1 MS switch closed. Approximately 4.2 volts at terminal TC21, 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 TC20, wire #44.
C. 12 volts on terminal TC16, wire #47. 0 volts at terminal TC15, wire #48. About 1 – 11 volts at terminal TC17, wire #49, depending on steer wheel position.
D. NA
E. NA

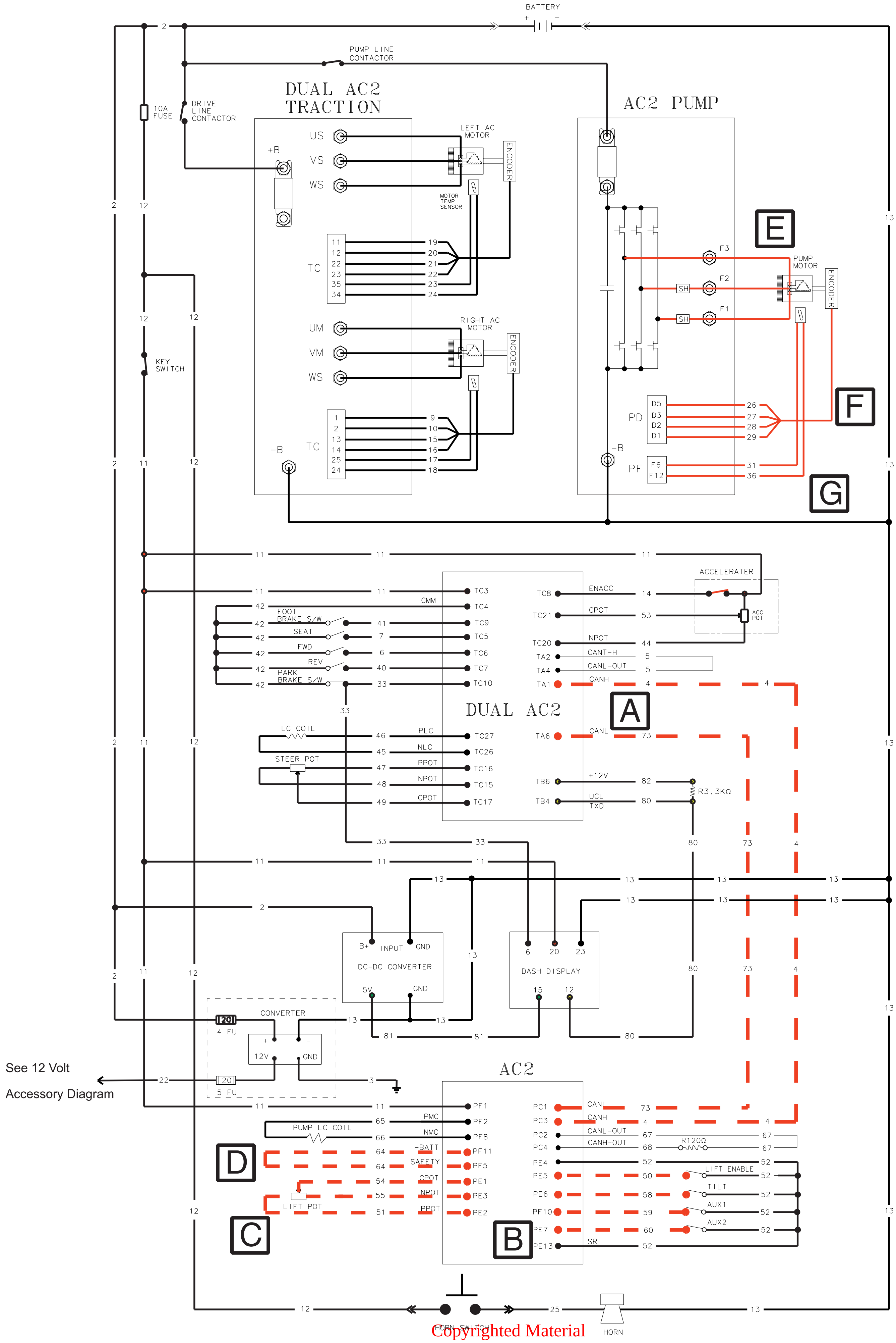

BATTERY
PUMP LINE CONTACTOR
10A FUSE
DRIVE LINE CONTACTOR
DUAL AC2 TRACTION
LEFT AC MOTOR
ENCODER
MOTOR TEMP SENSOR
RIGHT AC MOTOR
AC2 PUMP
PUMP MOTOR
KEY SWITCH
US
VS
WS
UM
VM
WS
+B
-B
TC
PD
PF
F1
F2
F3
SH
D
E
F
ACCELERATER
ACC POT
B
FOOT BRAKE S/W
SEAT
FWD
REV
PARK BRAKE S/W
CMM
ENACC
CPOT
NPOT
CANT-H
CANL-OUT
CANH
A
DUAL AC2
LC COIL
STEER POT
PLC
NLC
PPOT
NPOT
CPOT
CANL
+12V
UCL
TXD
R3.3KΩ
C
INPUT
DC-DC CONVERTER
DASH DISPLAY
CONVERTER
4 FU
5 FU
12V
GND
See 12 Volt
Accessory Diagram
AC2
PUMP LC COIL
LIFT POT
PMC
NMC
-BATT
SAFETY
CANH
CANL-OUT
CANH-OUT
R120Ω
LIFT ENABLE
TILT
AUX1
AUX2
SR
HORN SWITCH
HORN

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 TA1, wire #4, and terminal TA6, 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 PE5, PE6, PE7 and/or PF10.
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 PE13 and PE4, wire #52. Battery volts at terminal PE5, PE6, PE7, and PF10 when corresponding switches are closed.
C. 12 volts at terminal PE2, wire #51. Battery negative at terminal PE3, wire #55. Around 5 volts at terminal PE1, wire #54 with lift lever in neutral position, less than 0.5 volts with lift lever pulled fully back.
D. Battery volts at terminal PF5 and PF11, wire #64.
E. NA
F. NA
G. NA



BATTERY
PUMP LINE CONTACTOR
10A FUSE
DRIVE LINE CONTACTOR
DUAL AC2 TRACTION
AC2 PUMP
LEFT AC MOTOR
RIGHT AC MOTOR
ENCODER
MOTOR TEMP SENSOR
PUMP MOTOR
KEY SWITCH
ACCELERATER
ACC POT
FOOT BRAKE S/W
SEAT
FWD
REV
PARK BRAKE S/W
DUAL AC2
LC COIL
STEER POT
R3.3KΩ
INPUT
DC-DC CONVERTER
DASH DISPLAY
CONVERTER
4 FU
5 FU
See 12 Volt
Accessory Diagram
AC2
PUMP LC COIL
LIFT POT
R120Ω
LIFT ENABLE
TILT
AUX1
AUX2
HORN SWITCH
HORN
A
B
C
D
E
F
G

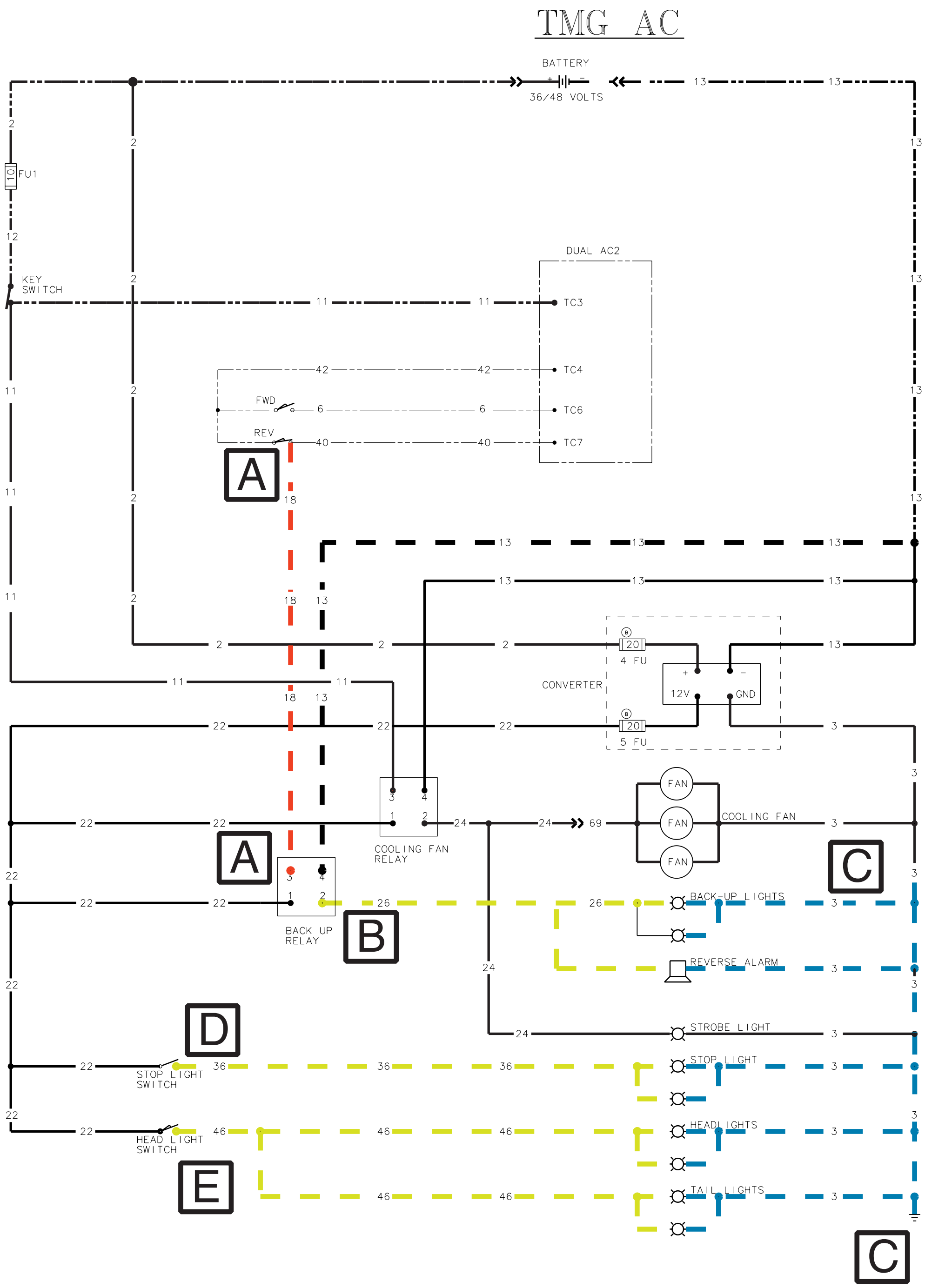
OPERATION 6
Accessories

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

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.

Accessory Diagram



GROUP 20

DRIVE AXLE

NOTE :

Section 1

Drive Axle Specifications and Description

Specifications

Type: Separate housing and drive train for each drive wheel. Each axle housing contains pinion and ring gear, intermediate shaft, and axle shaft.

Transmission Fluid Type: Clark part no. 2776236

Fluid Capacity (each housing): 3.8 L (1 gal)

Axle-to-Frame Mounting Bolt Torque: 408-469 N.m (300- 340 ft-lb). Use Loctitle 271.

Fill Plug Torque: 54-61 N.m (40-45 ft-lb)

Description

See next page.

Description

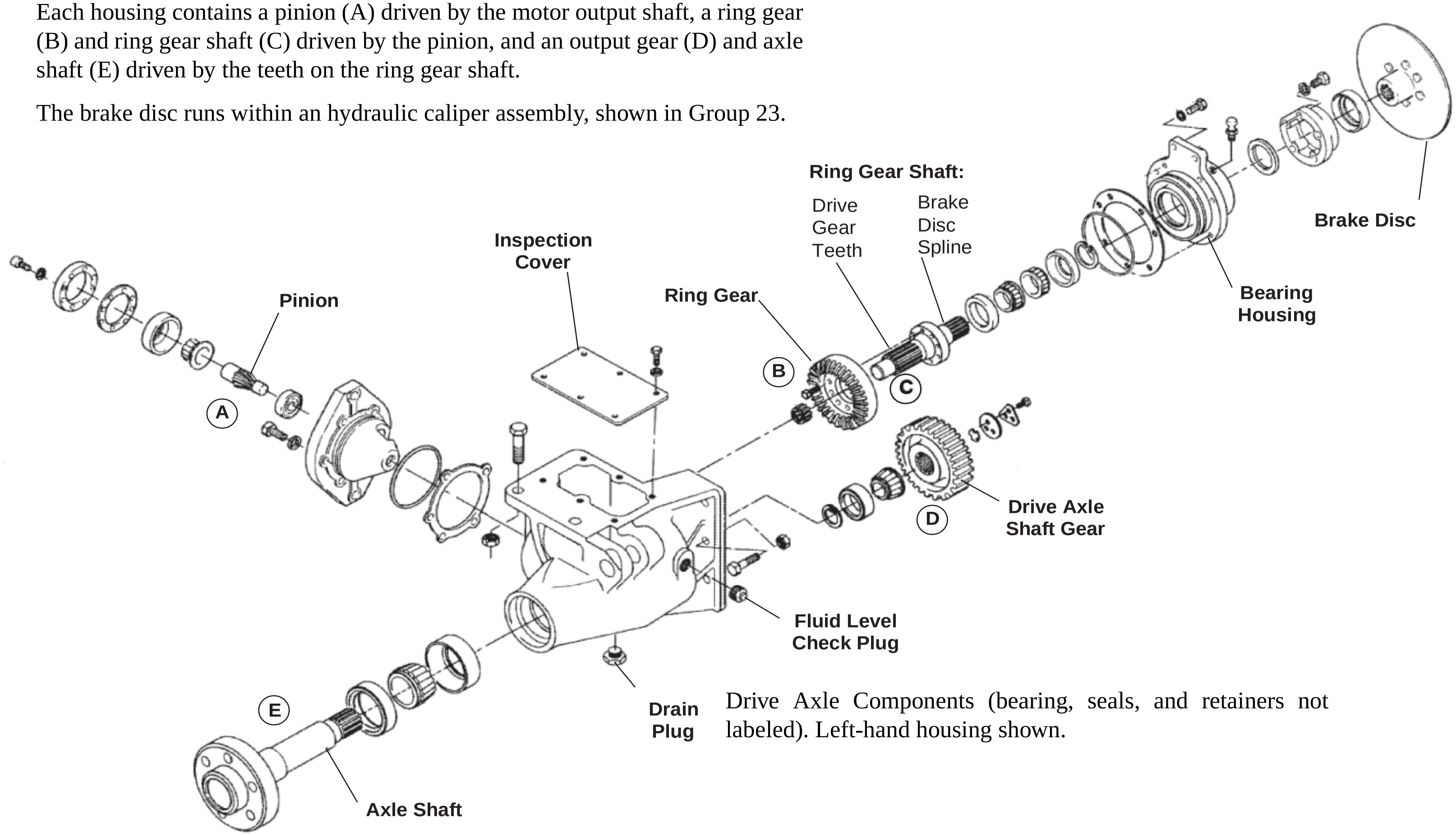
Each drive wheel is driven by a separate motor and drive train.

The drive axle consists of two independent housings that contain identical components for conveying power from each (left and right) drive motor to each drive wheel.

The two housings bolt together to form a single drive axle.

Each housing contains a pinion (A) driven by the motor output shaft, a ring gear (B) and ring gear shaft (C) driven by the pinion, and an output gear (D) and axle shaft (E) driven by the teeth on the ring gear shaft.

The brake disc runs within an hydraulic caliper assembly, shown in Group 23.



Drive Axle Components (bearing, seals, and retainers not labeled). Left-hand housing shown.

Section 2

Drive Axle Troubleshooting

Proper operation of the drive axle depends on the condition of the other related components in the power train..

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 in this Section.

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

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 directional control switchs. 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

CLARK

NOTE :

Section 3

Fluid Check and Change

WARNING

Access drive axle using safe procedures in Group SA, “Safe Maintenance.”

Drive Axle Fluid Level Check

Check the drive axle fluid level with:

- Truck on a level surface.
- Oil at operating temperature.

1. Remove the fluid level inspection/fill plug located in the front surface of each drive unit housing (two places).
2. The oil level is correct (FULL) when it is at the lower edge of the inspection plug opening.

IMPORTANT

Use only fluid Clark part no. 2776236. Do not overfill.

3. After adding oil to the drive axle, wait several minutes until the oil has distributed evenly throughout the unit, and check for correct oil level.
4. Inspect each fill plug for damage. Replace as necessary.
5. Install and tighten the plugs.

NOTE

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

Drive Axle Fluid Change

Drain and replace the drive axle fluid every 1000 operating hours.

To change oil in the drive axle:

- The oil should be drained when it is warmed to operating temperature.
- Put the truck in a level position.
- Apply the parking brake and block the wheels to prevent the truck from moving.
- Turn key switch "OFF" and disconnect battery from truck receptacle.

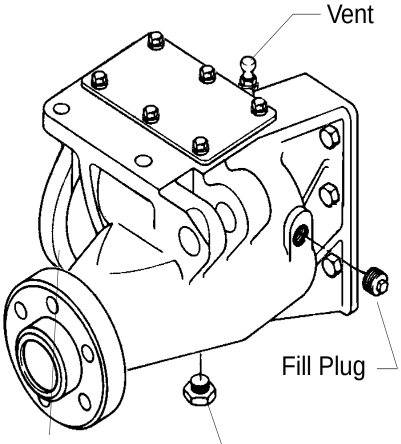
NOTE

When suitable equipment is available, the truck may be raised or hoisted up and placed in a level position on wheel cradles to allow access under the axle. Otherwise, raise and block the fork carriage only high enough to provide access clearance to the axle. Please refer to the blocking and jacking procedure in Group SA.

NOTE

Frequently replacing lubricant is an inexpensive way to protect and prolong the safe operating life of an essential and relatively costly major component such as the drive axle. Extending the recommended intervals at which drive axle fluid is changed should be considered only after careful evaluation of your operating conditions and/or analysis of the condition of the oil.

1. Place a low, flat drain pan beneath the drive units. The pan capacity should be more than 7.6 L (16 pints) (drive axle total capacity).
2. Remove drain plugs (two) from bottom of drive units, and fill plugs (two) from front of drive units.
3. While the drive units are draining, check the breather vents (two) to be sure they are open and not damaged. Vents are located in the top front corners of the drive units.
4. After drive units have drained, install drain plugs.
5. Fill each drive unit to bottom edge of fill plug opening with recommended fluid.
6. Install fill plugs.
7. Remove drain pan. Remove blocking and lower carriage.



Drive Axle (Left Housing Only)

Section 4

Drive Axle Removal and Installation

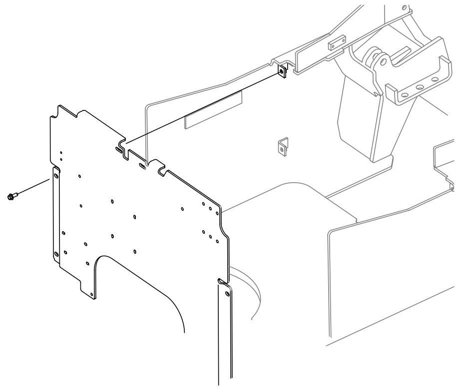
⚠ **CAUTION**

To perform this service procedure, it is recommended that you first:

- Park truck on a hard, level surface in correct position for using an overhead hoist, if available.
- Fully lower the upright.
- Return all controls to neutral and turn key switch to the "OFF" position.
- Apply the parking brake.

Preparation

1. Turn key switch "OFF".
2. Open hood.
3. Disconnect battery from truck receptacle.
4. Remove battery from truck as described in Group 12.
5. Remove floorboard as described in Group 38.
6. Remove bolts holding front battery plate and lay back plate to improve access.



7. Remove the upright as described in Group 34.

Removal

After battery and upright have been removed:

1. Drain the oil from drive units when truck is in a level position as described Section 2 of Group 20.
2. Attach a hoist with chains of correct capacity and remove the drive wheels as described in Group 22. Leave chains and hoist attached.

CAUTION

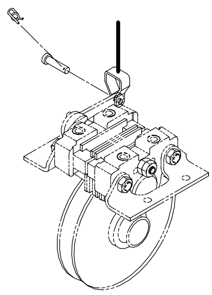
Watch truck for signs of lateral instability. It may tip sideways. You may have to support or guide the sides of the truck or overhead guard to prevent tipping.

3. Support truck with blocks under the frame as shown in Group SA. Place blocks of wood under drive motors to support them, if motors were not previously removed.
4. Disconnect power cables from drive motors. Attach tags to the motor cables for easy and correct identification at assembly. Replace the nuts on motor terminals to avoid losing them.

NOTE

Alternative Procedure: It is optional to remove drive motors before removing drive axle from truck. Refer to GROUP 16.

5. Release the parking brake hand lever to provide free-play in the brake cable for removal of the parking brake cable yoke. If necessary, adjust the cable to release tension as described in Group 23,

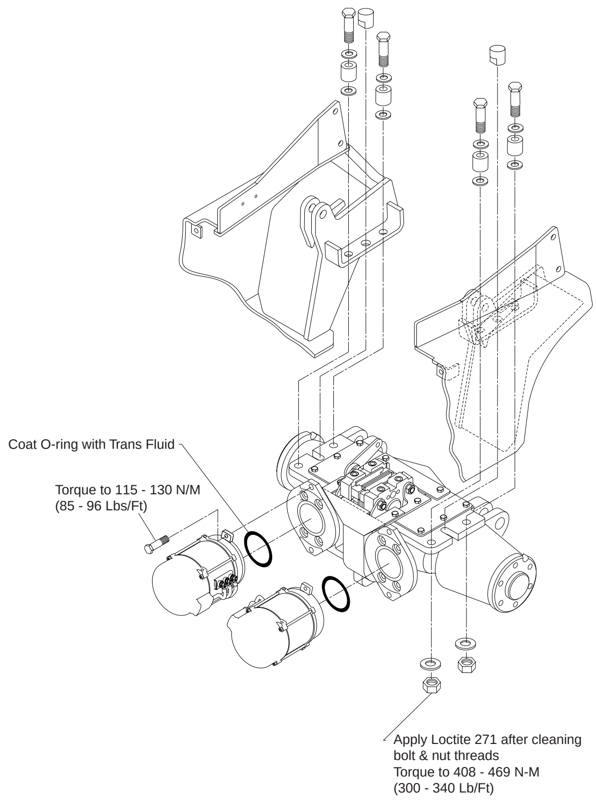


6. Remove the yoke of parking brake cable from the levers on brake caliper assembly. (Group 23.)
7. Disconnect hydraulic brake line from master cylinder. Put caps on fittings to keep clean. (Group 23.)
8. Inspect your truck for any other wiring leads or optional equipment that may have to be disconnected before axle is removed.
9. Loosen and remove axle mounting bolts (nuts underneath) from axle on both sides of frame.
10. Raise truck frame slightly off of drive axle and move the truck backwards away from axle assembly.

CAUTION

Truck may tip sideways. You may have to support or guide the side of the truck or overhead guard to prevent tipping.

11. Lower front of truck frame to the floor. Truck frame may also be blocked up under axle mounting surfaces. Block the steer wheel and be sure blocking is put safely under the frame.
12. Attach hoist and move drive axle assembly to the overhaul disassembly area. Installation Reverse the above procedure to replace the drive axle.
    - Be sure to follow safe lifting and jacking procedures given Group SA, “Safe Maintenance.”
    - Apply Loctite 271 to axle mounting bolts threads and properly torque axle mounting bolts.
    - Retighten hydraulic fittings per procedure in Group 40.



Section 5

Drive Axle Overhaul

Introduction

Refer to Figures 1A and 1B.

Drive unit disassembly and overhaul procedures are grouped according to the following major sub-assemblies:

① **Ring gear shaft assembly,** including bearing housing, shaft, ring gear, straight and tapered roller bearings, bearing cap, and oil seal.

② **Pinion assembly,** including pinion gear, bearing carrier, bearings, and bearing retainer.

③ **Drive axle shaft assembly,** including shaft, gear, gear retainer, bearings, and oil seal.

Drive Unit Disassembly

1. Remove the brake caliper as shown in Group 23.
2. Remove the drive motors as shown in Group 16.
3. Remove the flange bolts and separate the two drive axle housings. as shown in the Section, "Drive Axle Removal and Replacement."
4. Be sure all fluid is drained from each drive unit before starting disassembly.
5. Remove the inspection (A) cover from top of unit. (Figure 1A.)
6. Remove the brake disc (C) by sliding it off the ring gear shaft spline. (Figure 1B.)

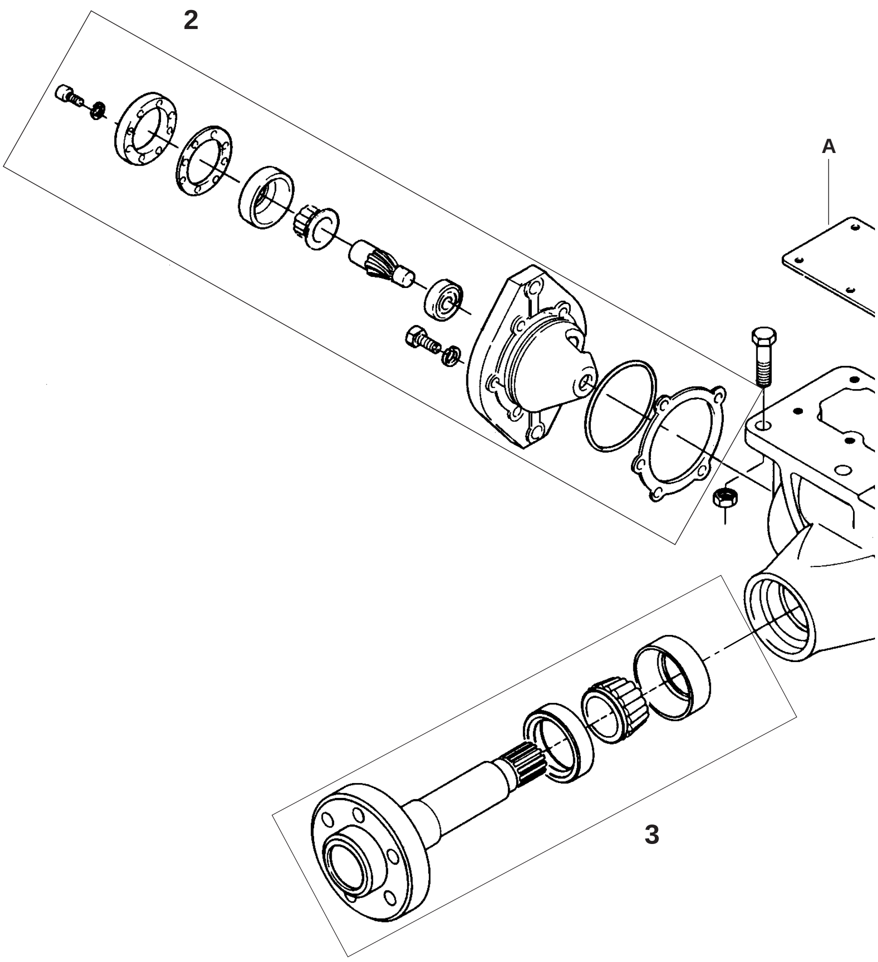


Figure 1A. Drive Unit Sub-Assemblies

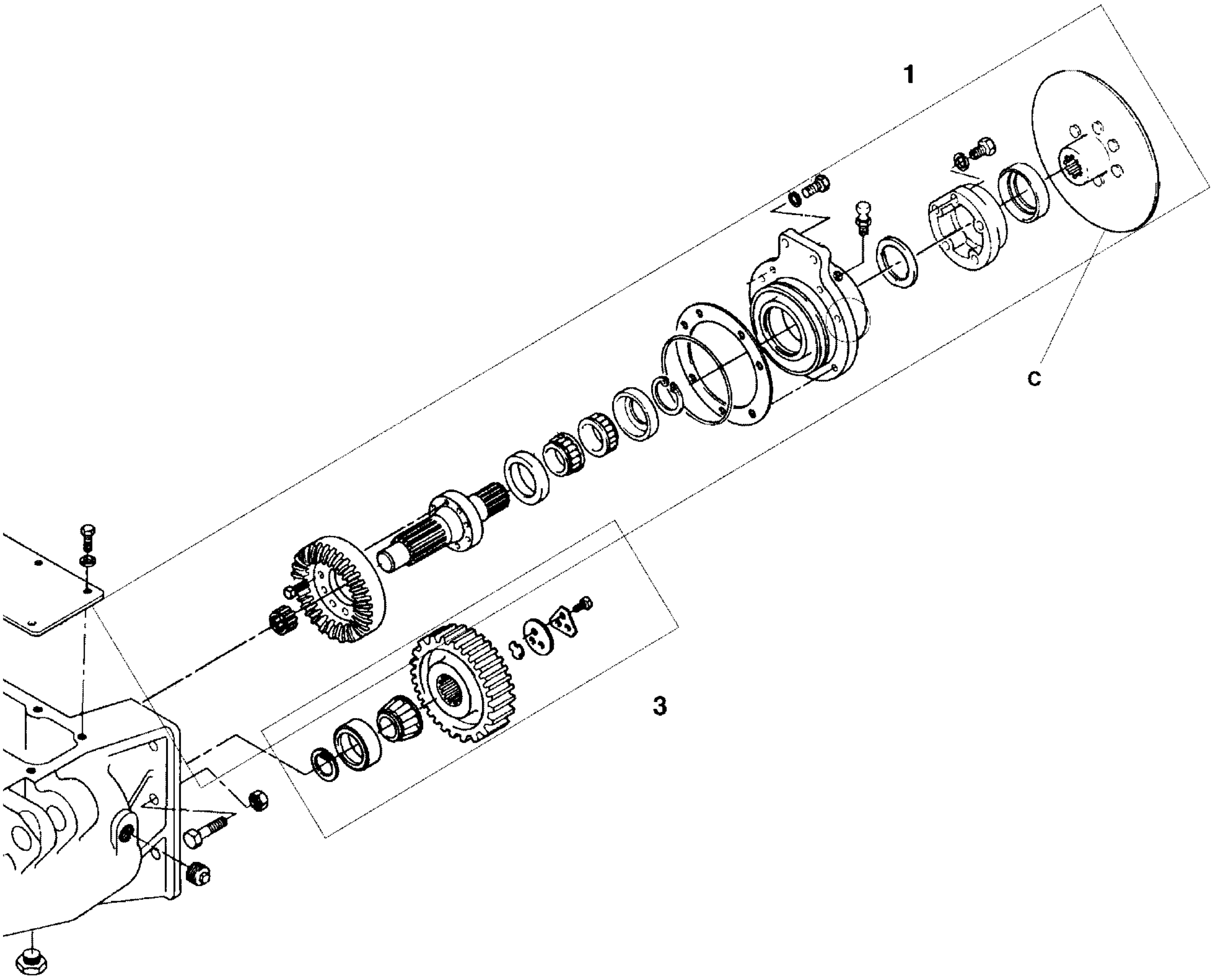


Figure 1B. Drive Unit Sub-Assemblies

Ring Gear Shaft Disassembly

Refer to Figure 2.

1. Loosen and remove the ring gear bearing housing mounting combination of bolts and lockwashers (L-M). Then, remove the housing assembly (W) from the drive unit main housing.
   Bolt Torque: 54-62 N.m (40-46 ft-lb)
2. Remove the ring gear bearing housing (ring gear position) shims.(K).
   It is good practice to arrange parts in the sequence of removal as an aid to inspection and correct reassemble.
3. Put the housing and shaft assembly, with the ring gear (E) up, in a vise.

   NOTE

   Use blocks of wood to protect the shaft spline.

4. Carefully inspect the ring gear (E) for wear and damage. Also, see inspection of pinion gear.
5. To remove ring gear, loosen and remove the ring gear fastener bolts (D).
   Bolt Torque: 20-27 N.m (15-20 ft-lb)
6. Remove the ring gear (E) from the shaft.
7. Remove the housing seal (J) from groove in bearing housing pilot flange.
8. Turn the housing assembly over and clamp the pinion end in the vise. Use wood blocking to protect the pinion gear teeth.
9. Loosen and remove the mounting bolts (P) and lockwashers (O), then remove the bearing cap (AA) and oil seal assembly (Q) from housing.
10. Remove the bearing preload shims (Z).
11. Press, or pry and pull, the old oil seal (Q) from the bearing cap.
12. Remove the outer bearing cup (U) if it is loose.
13. Remove the external snap ring (I) from shaft spline at end of outer bearing cone.
14. Remove housing assembly from the vise. Support the bearing housing and press the shaft (F) out of the bearing cones (H, T). This can also be done by holding the housing and lightly tapping the shaft end on a wooden block on the bench or floor.
15. Remove outer bearing cup (U), if not done previously. Remove bearing cones (H, T). Remove inner bearing cup (G) from housing by pressing or using a puller.

    NOTE

    Also remove, clean and inspect breather vent (N) in top side of ring gear bearing housing. Replace vent, as needed.

16. Arrange the parts in the sequence of removal as an aid to inspection and correct reassembly.

Refer to Page 20-5-8 for ring gear shaft inboard bearing removal.

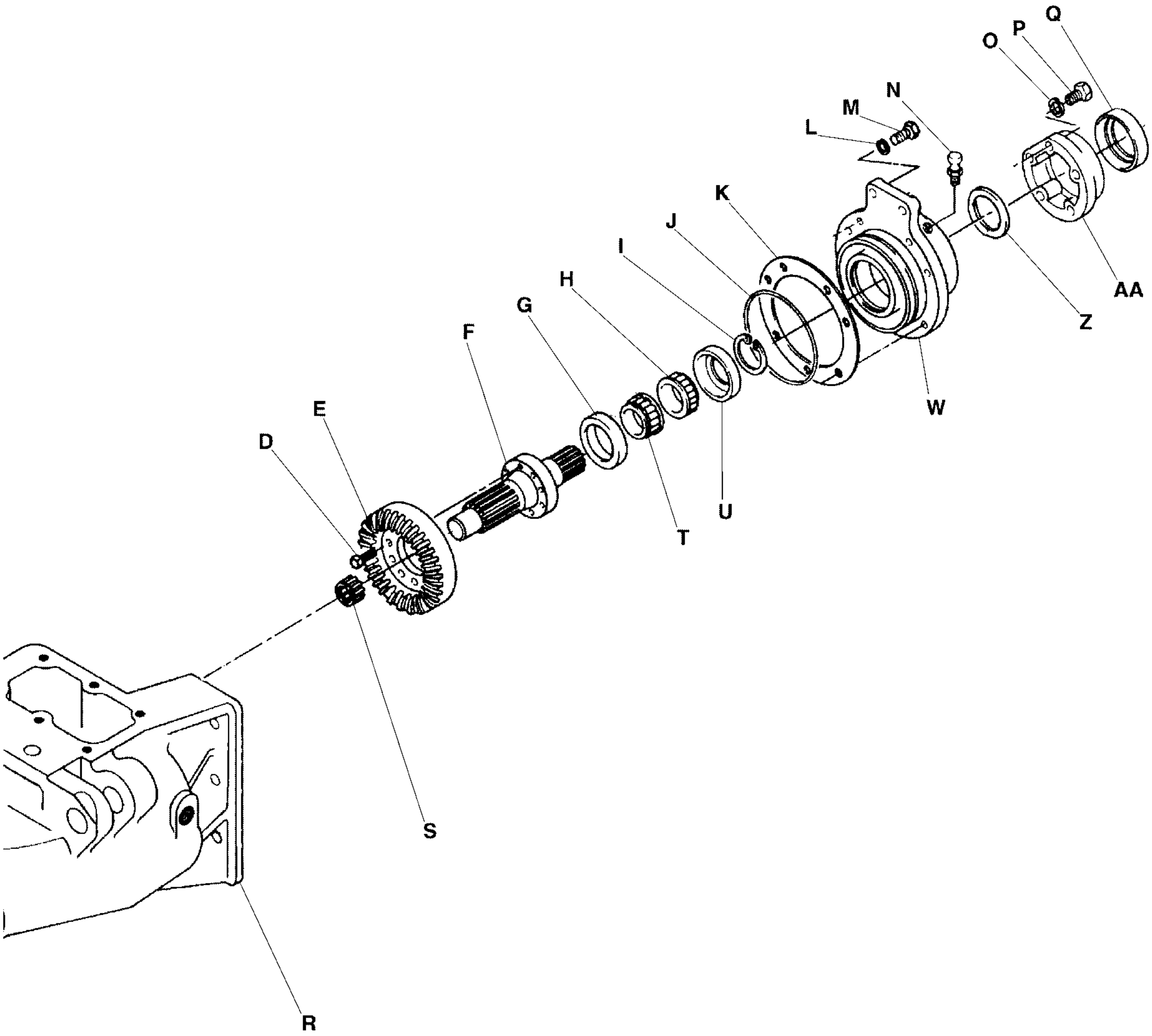


Figure 2. Ring Gear Shaft Assembly

Input Pinion Gear Carrier Disassembly

Refer to Figure 3.

1. Loosen and remove the five fastener bolts (M) and lockwashers (N) from pinion bearing carrier (I).
   Bolt Torque: 77-88 N.m (57-65 ft-lb)
2. Tap lightly on the outer flange to loosen the carrier pilot flange from main housing.
3. Remove input pinion carrier assembly (C-K) and (pinion gear position) shims from the main housing.
4. Remove the pinion carrier seal (J).
5. Clamp carrier (I) housing flange in a vise. Loosen and remove the recessed hexhead pinion bearing retainer bolts (A), and washers (B).
6. Remove the outer pinion bearing retainer plate (C).
7. Remove the pinion bearing retainer (bearing preload) shims (D).
8. Remove the outer pinion bearing cup (E). Tap lightly on the back side (small end) of the pinion (G) with a hammer and punch to move the pinion and bearings (F) outward and drive the cup (E) from carrier.
9. Remove the pinion and bearings assembly (G-H) from the carrier housing.
10. Clean and inspect the pinion tapered roller bearings (F, H) for wear and other damage. Replace, as necessary. Replace worn or damaged bearing cups and cones as a set.
11. Clean and inspect the pinion (G) gear teeth and internal spline for wear and other damage. Replace, as needed.

NOTE

Replace ring and pinion gears as a matched set.

12. Check both input pinion bearing cups (E, H) for wear, nicks or scratches that would render them unsuitable for further service. Replace bearing cups and cones as a set.
13. Arrange the parts of the input pinion gear and carrier assembly in sequence of removal as an aid to inspection and correct reassembly.

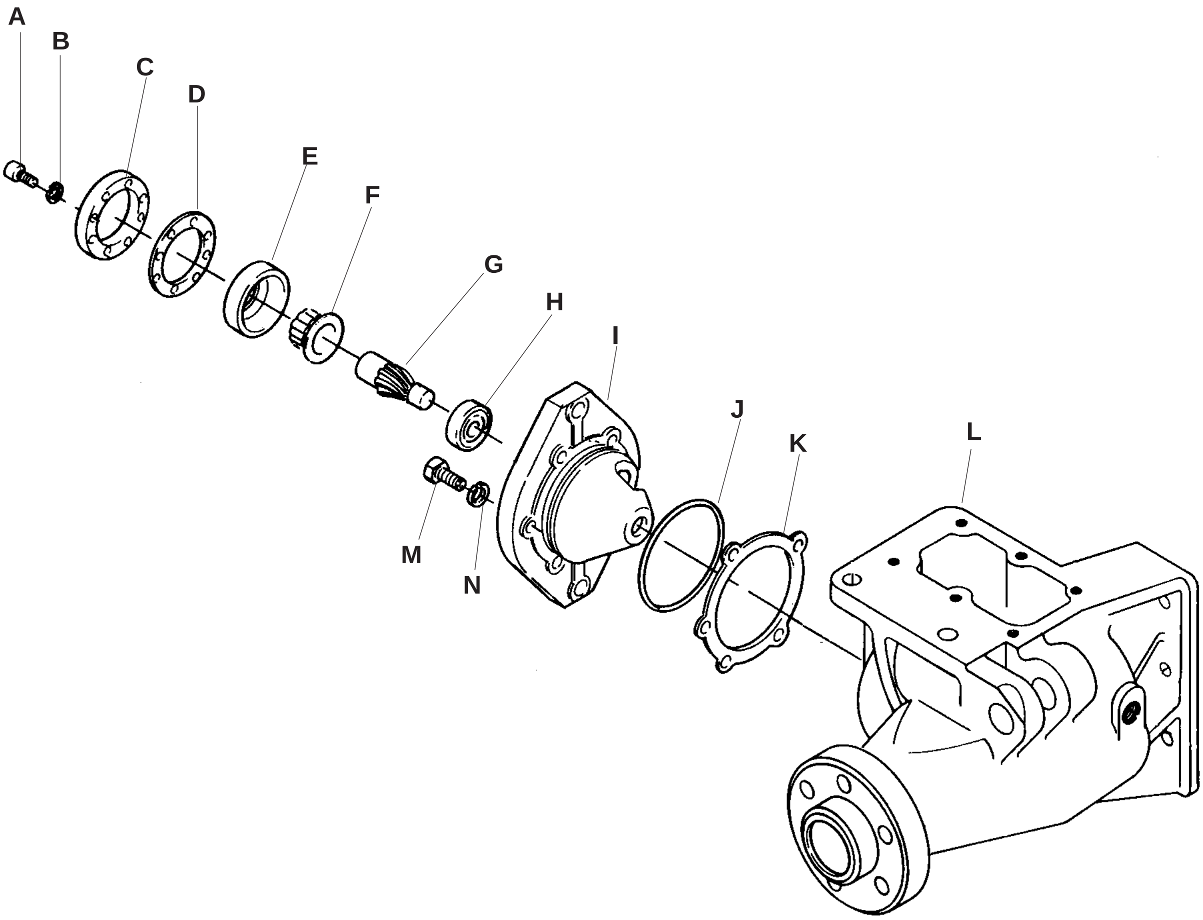


Figure 3. Input Gear Carrier Assembly

Drive Axle Shaft Disassembly

Refer to Figure 4.

1. The axle shaft output gear retainer (M) is held in place by three bolts (N) in the end of the axle shaft. The bolts are held from loosening by bending a tab of the fastener lock plate (M) against a flat of each bolt head. Unbend the tabs for removal of the bolts by working through the opening in the main housing and using a hammer and a screwdriver or punch to flatten the tabs.
2. Loosen and remove the three gear retainer bolts (N).
3. Remove the bolts (N), lock plate (M), gear retainer plate (L), and shims (K). Then, reach inside the main housing and remove the drive axle shaft gear (J) by sliding it off the spline of axle shaft (A). Lift the gear out of the drive unit housing.
4. Arrange these parts in the sequence of removal as an aid to inspection and correct reassemble. Continue with disassembly and removal of drive axle shaft from the drive unit housing.
5. After moving the drive axle shaft outwards sufficiently to loosen the bearing fit on shaft, remove the inboard bearing cone (I).
6. Then, remove the axle shaft and outboard bearing cone (C-D) assembly from the housing.
7. Inspect the shaft, spline, seal surface, wheel mounting flange and holes, and bearing for wear and other damage that would require repair or replacement.
8. Inspect the outboard bearing cup (D) for wear and other damage, nicks, cracks, scratches, and signs of failure from excessive heat.
9. Remove the axle shaft oil seal (B).
   If axle shaft bearings need to be replaced, remove the bearing cups (outer races) (C, D) by pulling them from drive unit housing bores.

Ring Gear Shaft Inboard Bearing Removal

Refer to Figure 2.

1. With axle shaft gear and input pinion carrier assembly removed, the ring gear shaft inboard bearing (S) is readily accessible. Remove the straight roller bearing by pulling from the housing.
2. Look for nicks and scratches, pitting or any unusual wear pattern. Replace, as needed.
3. Arrange the parts of the drive axle shaft assembly and the ring gear inboard bearing for inspection.

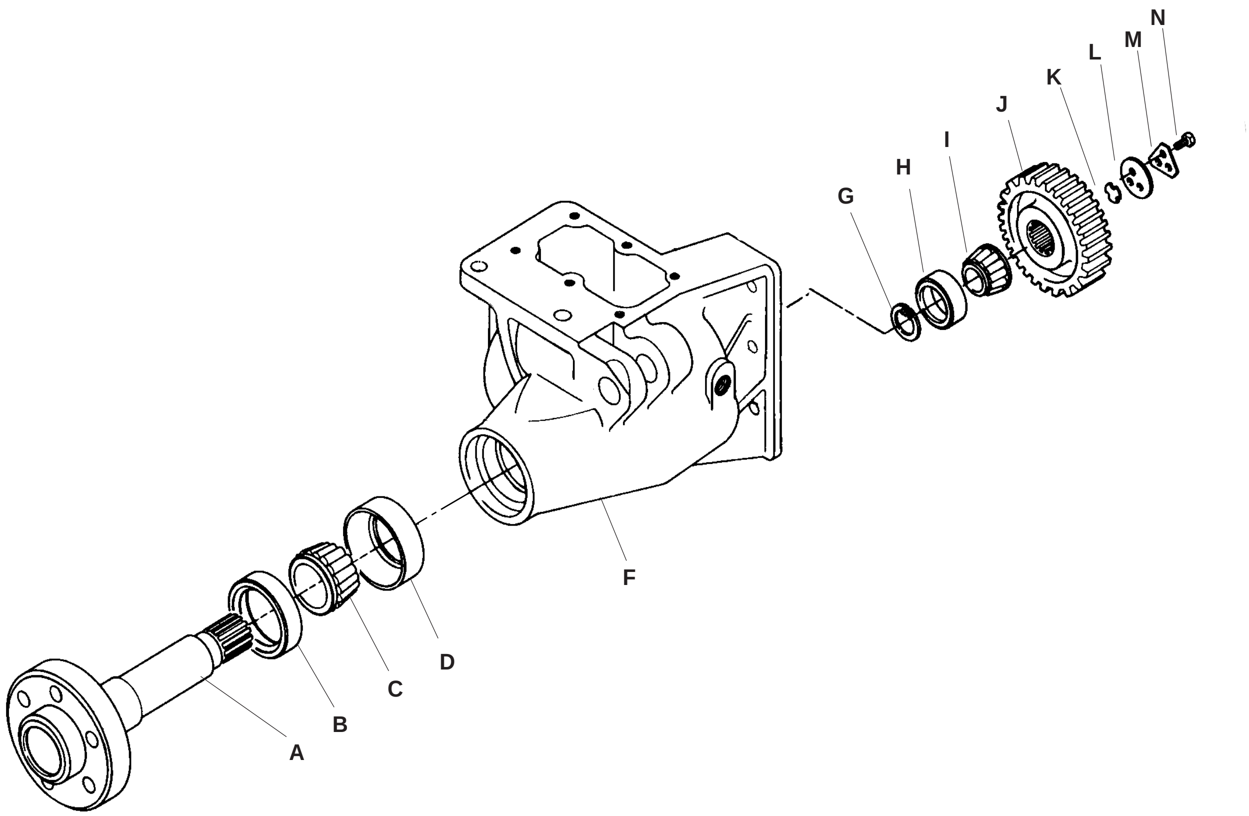


Figure 4. Drive Axle Shaft Assembly

Cleaning and Inspection

Clean all parts with a good grade solvent and dry thoroughly. Do not let bearings spin dry if drying parts with air pressure.

Inspect all parts for wear and other damage that could cause malfunction or early failure:

- Gears and splines
- Bolts, nuts and washers
- Housings and covers
- Bearing cups and cones
- Spacers and snaprings
- Shafts and machined surfaces

Replace and seals and gaskets

Replace all parts that have failed, including those parts that are worn or damaged in such a way that further serviceability is questionable.

It is recommended that all bearings be replaced at each overhaul.

Drive Unit Reassembly

- Apply very light coating of Permatex No. 2 to OD of all oil seals and hole plugs before assembly.
- Apply light coating of Crane Sealer to all pipe plugs.
- Use Crane Sealer on all capscrews and studs with thru holes (housing end only).
- After assembly of parts using Permatex or Crane Sealer, clean all surfaces. There must not be any free or excess material that could enter the oil system.
- All lead-in chamfers for oil seals and O-rings must be smooth and free from burrs. Inspect at assembly.
- Lubricate all O-rings with oil before assembly.
- Apply a thin coating of grease between seal lips on lip-type seals prior to assembly.
- Brush specified transmission fluid on all tapered and straight roller bearing cups and cones.

Drive Axle Shaft Reassembly

Refer to Figure 5.

1. Press new axle shaft outboard bearing cup (D) (outer race) into housing bore tight. Install bearing cone(C).
2. Install new oil seal (B). Press seal into bore until outer surface is flush with end of housing.
3. Install new axle shaft inboard bearing cup (H). Press bearing cup into housing bore until tight and square against snap ring (G). NOTE - The use of a 73 mm OD piece of tubing or spacer ring as a driver is suggested.
4. Install the ring gear shaft inboard roller bearing (S on Fig. 2).
5. Then, put the axle shaft into the drive unit housing (F) end.

IMPORTANT

Be very careful not to damage seal lips when inserting shaft spline and bearing through the seal.

6. Assemble the drive axle shaft inboard bearing cone (I) on the end of axle shaft (A).

NOTE

Be sure to hold the axle shaft firmly in place in the outboard bearing. Support (back up) the outer end of axle shaft to prevent shaft from slipping out of outboard bearing while tapping the inboard bearing into place. Suggestion: Turn (rotate) housing up and support it temporarily on axle shaft outer end.

7. Install axle shaft inboard bearing (I) into correct position.
8. A special tool for pressing or driving the axle shaft inboard bearing cone into place may be fabricated as shown by Diagram A on the last page of this Section. Install axle shaft gear on spline of axle shaft (A).
9. Install shims (K) against end of shaft, then gear retainer plate (L), lock plate (M), and the three retainer bolts (N). Do not bend tabs of lock plate until bearing preload has been checked.
10. Torque gear retainer bolts (N) to:
    44-49 N.m (32-36 ft-lb)
11. Rotate the axle shaft to check for correct axle shaft bearing preload setting. Add or remove shims (K) at end of shaft under the axle shaft gear retainer plate to obtain a bearing preload value of 0.68-1.13 N.m (6-10 in-lb). This is the torque required to rotate the shaft.
    For rotating the axle shaft when checking axle shaft bearing preload, it is recommended that a special adapter tool be constructed. This construction is shown in Diagram B on the last page of this Section. This tool is designed to fit into the wheel mounting flange bolt holes of the axle shaft. Attach a torque wrench in the 3/8-inch square drive hole at the center. Turn shaft slowly to measure torque required to rotate the shaft.
12. When the correct axle shaft bearing preload has been set, be sure the bolts are tightened to the correct torque.
    Then, bend the tabs of the lock plate against the bolt heads.

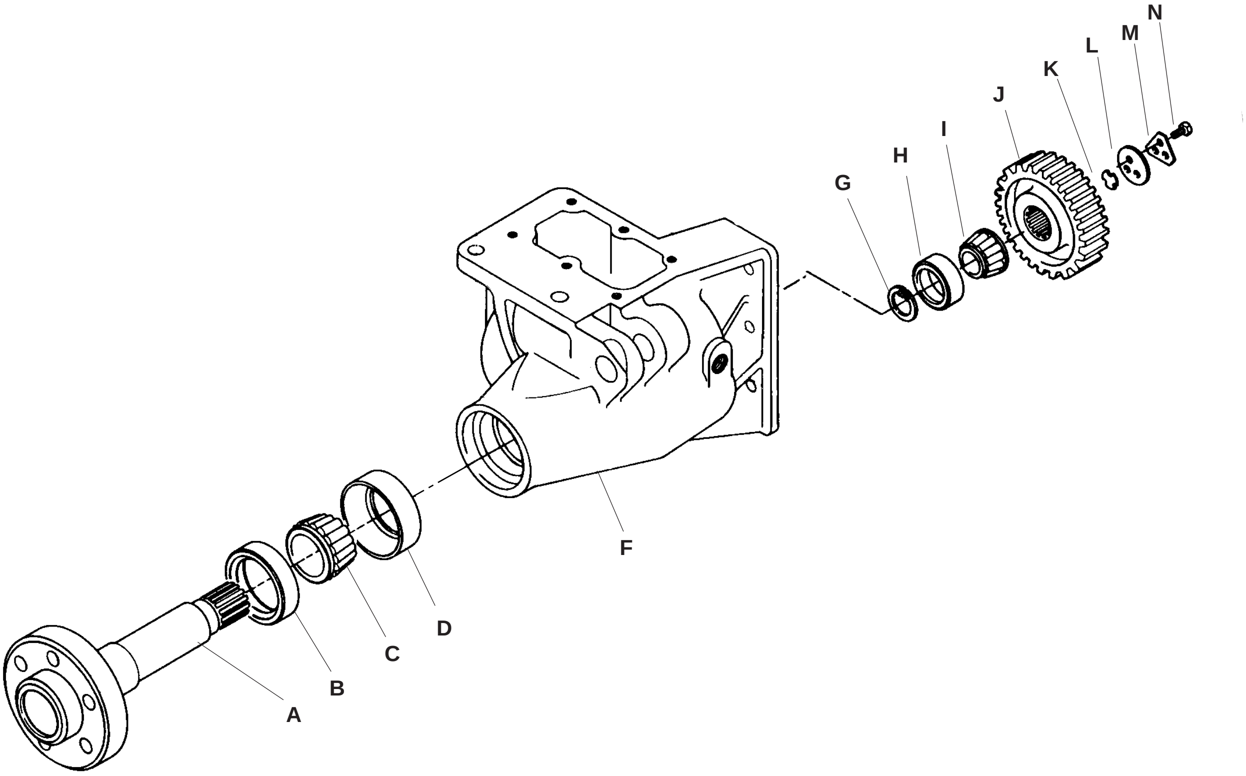


Figure 5. Drive Axle Shaft Assembly

Input Pinion Gear Carrier Reassembly

Refer to Figure 6.

1. Arrange the parts of the pinion gear bearing carrier for assembly.
2. Install the tapered roller bearing cones (F, G) on the pinion gear by pressing the inner races until firmly seated square and tight against shoulders on gear. Be sure to use a pressing tool or tubing of the correct diameter and press on inner race only to prevent damage to the roller cages.
3. Install the input pinion inner bearing cup (H) by pressing the cup into carrier bore tight and square against the shoulder.
4. Put the pinion gear and bearing assembly (F-H) into the carrier. Be sure it is seated correctly into inner bearing cup.
5. Then, using a pressing tool or a piece of tubing of correct diameter for cup, install outer bearing cup (E) by pressing or driving on cup until seated lightly against outer bearing rollers.
6. Install the input pinion bearing retainer (bearing preload adjustment) shims (D). For initial assembly, use same number of shims as were removed at disassembly. Be sure holes in shims are aligned with bolt holes in carrier.
7. Install the outer pinion bearing retainer plate (C).
8. Install and tighten the eight bearing retainer plate bolts (A).
   Bolt Tightening Torque: 7-10 N.m (5-7 ft-lb)
9. After assembly, turn (rotate) the input pinion gear in the bearings to check for correct bearing preload setting.
   As an aid for rotating the pinion gear, a temporary tool may be made using a discarded drive motor shaft spline end with a nut welded to it.
10. Put the tool into gear spline and turn the pinion gear slowly with a torque wrench to measure torque required to rotate the pinion.
    Add or remove shims at end of outer bearing cup under retainer plate to obtain bearing preload value of:
    0.11-0.56 N.m (1-5 in-lb) torque required to rotate pinion gear.
    Available shim thicknesses: 0.003, 0.004, 0.007, 0.010, and 0.020 inch.
11. When correct pinion bearing preload has been set, be sure retainer bolts are tightened to the correct torque.
12. Install new O-ring seal (J) in groove of carrier (I) pilot flange.
13. Put pinion bearing carrier (pinion gear position) shims (K) on the carrier mounting surface. For initial assembly, use same number of shims and washers (N) as were removed at disassembly. Install several bolts to align and hold shims in place.
14. Put the pinion gear and carrier assembly on drive unit main housing.
    Be careful not to damage O-ring seal surface when installing carrier pilot flange into housing.
15. Install mounting bolts and washers and tighten.
    Bolt Tightening Torque: 77-88 N.m (57-65 ft-lb)

NOTE

After reassembly of the ring gear and shaft assembly (see following section), check the ring and pinion gears for tooth bearing pattern (correct position) and backlash. Add or remove carrier mounting shims (noted above) as needed to adjust pinion gear position. Be sure carrier mounting bolts are tightened to correct torque after shim adjustment.

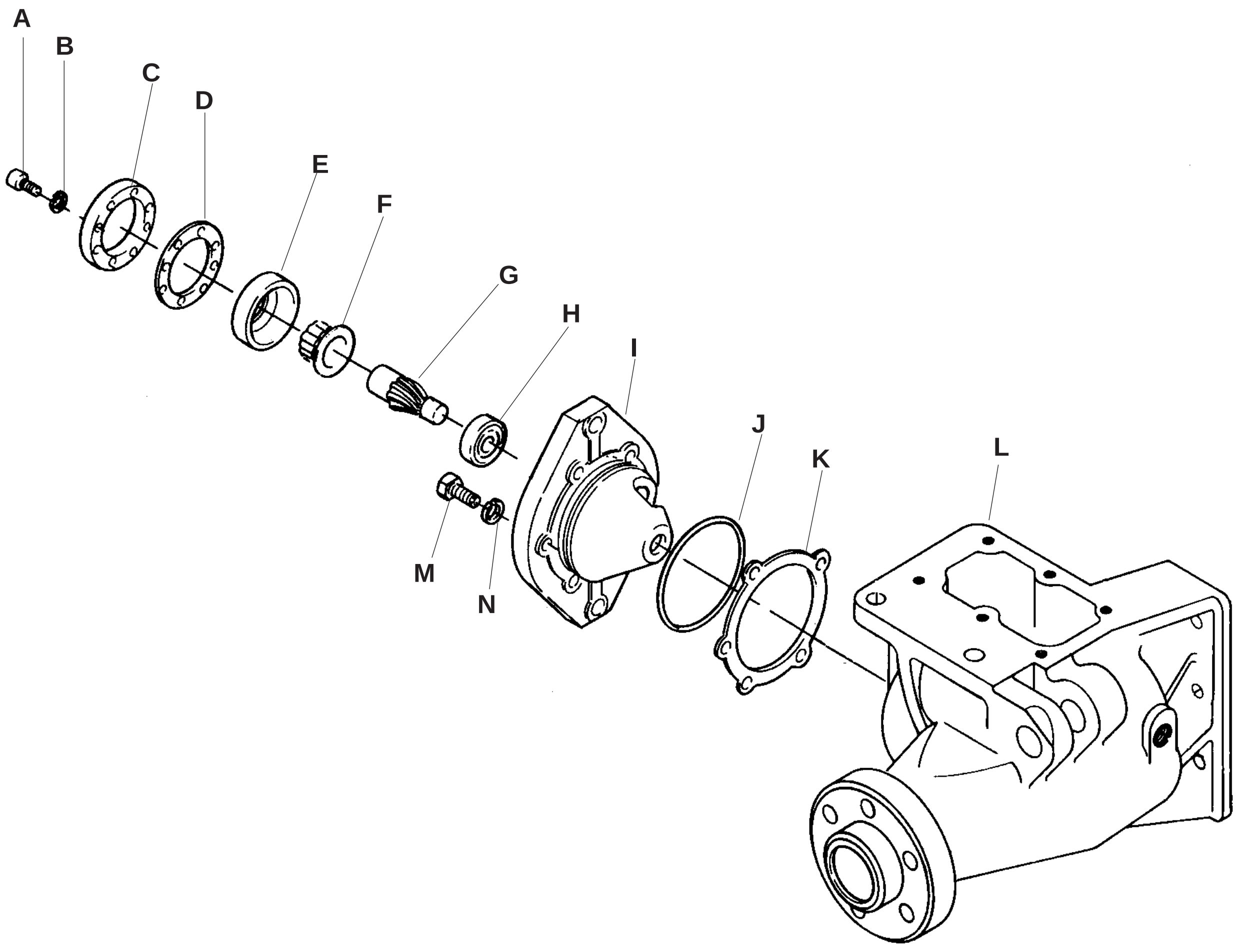


Figure 6. Input Gear Carrier Assembly

Ring Gear Shaft Reassembly

Refer to Figure 7.

1. Arrange the parts of the ring gear shaft and bearing housing for assembly.
2. Install new inner tapered roller bearing cup (G) by pressing into bearing housing (W) until firmly seated square and tight against shoulder in housing.
3. Next, install bearing cones on ring gear shaft (F) by first placing bearing housing (W) with inner cup (G) assembly over spline end of shaft.
4. Put shaft spline end through bearing housing (i.e., fit housing over spline end of shaft). Press inner bearing cone (T) tight and square against shoulder on shaft. Press outer cone (H) tight and square against inner cone.
5. Install snap ring (I) into groove in shaft spline at end of outer bearing cone.

NOTE

Alternate procedure for installing bearing cones on ring gear shaft:

a) Install inner bearing cup (G), both bearing cones (T, H), and outer cup into bearing housing.

b) Temporarily install the bearing cap (AA) to clamp the bearings in place in housing. Tighten bearing cap bolts to hold the bearing cones tight and square.

c) Start the ring gear shaft (F) spline end into the bearing cones (T, H) and, holding the bearing housing with shaft vertical, lightly tap the pinion end of shaft on a wooden block on the bench or floor until shaft is installed in bearings.

d) Remove bearing cap (AA).

e) Install snap ring (I).

6. Turn the shaft and housing assembly over and clamp the spline end of shaft in a vise. Use wood blocking in vise to protect the spline.
7. Install new O-ring seal (J) in groove of bearing housing (H) pilot flange.
8. Install the ring gear (E) on mounting flange of shaft.
9. Install and tighten the ring gear mounting bolts (D).
   Bolt Tightening Torque: 20-27 N.m (15-20 ft-lb
10. Remove assembly from vise and clamp in vise on housing flange. Use wood blocking to protect flange surfaces.
11. Using a pressing tool or a piece of tubing of correct diameter for cup, install the outer bearing cup (U) into bearing housing (W) bore by pressing or driving on cup until it is lightly seated against outer bearing rollers.
12. Install new oil seal (Q) in ring gear housing bearing cap (AA).
    Press oil seal (Q) flush with end surface of cap.
    Apply a thin coating of grease between seal lips.
13. Put at least two bolts (P) with lockwashers (O) in bearing cap (AA). Then, install the bearing cap (bearing preload) shims (Z) into bearing housing(W). For initial assembly, use same number of shims as were removed at disassembly.
14. Install bearing cap and shims on ring gear bearing housing.
15. Install and tighten all bearing cap fastener bolts (P) and washers.
    Bolt Tightening Torque: 44-49 N.m (32-36 ft-lb)
16. After assembly of ring gear shaft and bearings into bearing housing, and installation of bearing cap, turn (rotate) the ring gear shaft in the bearings to check for correct bearing preload setting. Use a thin-wall socket, or make an adapter tool from a discarded brake disc hub, to turn the shaft by the spline with a torque wrench.
17. Turn the ring gear shaft slowly with a torque wrench to measure torque required to rotate the shaft. Add or remove shims under bearing cap to obtain bearing preload value of
    0.11-0.56 N.m (1-5 in-lb)
    torque required to rotate shaft.
18. After correct bearing preload has been set, be sure bearing cap bolts are tightened to correct torque.
19. Then, install the ring gear bearing housing (ring gear position) shims (K) on drive unit housing (R). For initial assembly, use same number of shims as were removed at disassembly.
20. Install ring gear shaft and bearing housing assembly into drive unit housing.
21. Install and tighten the combination of bearing housing mounting bolts (L, M) and lockwashers.
    Tightening Torques:
    Bolts 44-49 N.m (32-36 ft-lb)
22. After installation of ring gear and shaft assembly, and input pinion (earlier), check the ring and pinion gears for tooth bearing pattern (correct position) and back-

lash.
Add or remove ring gear bearing housing shims (K) as needed to adjust ring gear position and backlash. Be sure bearing housing mounting bolts are tightened to correct torque after shim adjustment.

23. Final adjustments in shim thicknesses under input pinion carrier and ring gear bearing housing should be made based on measurement of gear mesh backlash with a dial indicator and on visual check of gear tooth bearing patterns. (Refer to Tooth Bearing Contact Chart at the end of this Section.) Gear mounting information is etched on the ring gear.

24. Ring and pinion backlash of
0.050-0.127 mm (0.002-0.005 inch)
should be measured with a dial indicator.
Put (set up) a dial indicator on the top surface of the drive unit housing. Use a long adapter to reach the gear tooth surface inside the assembly. Backlash should be measured at three places around the ring gear (rotate the gear).

25. Check gear tooth bearing patterns by applying a coating of gear checking compound, e.g., red lead, to the ring gear teeth. Rotate the ring and pinion through a minimum of one revolution. Temporarily install the brake disc (shown on Figure 1) to provide a means for loading the gear teeth.

NOTE

Bearing Contact Chart is at the end of this Section. After above checks and adjustments are made, continue with final assembly of drive unit.

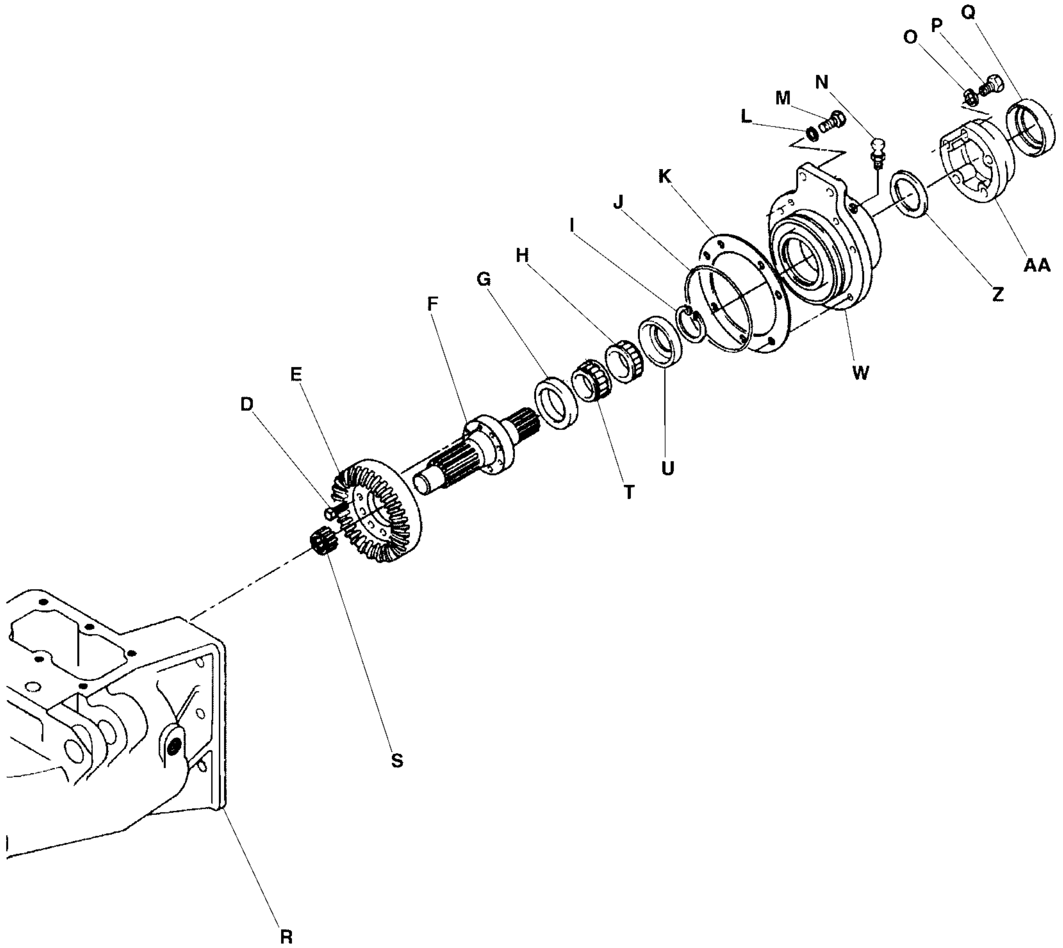
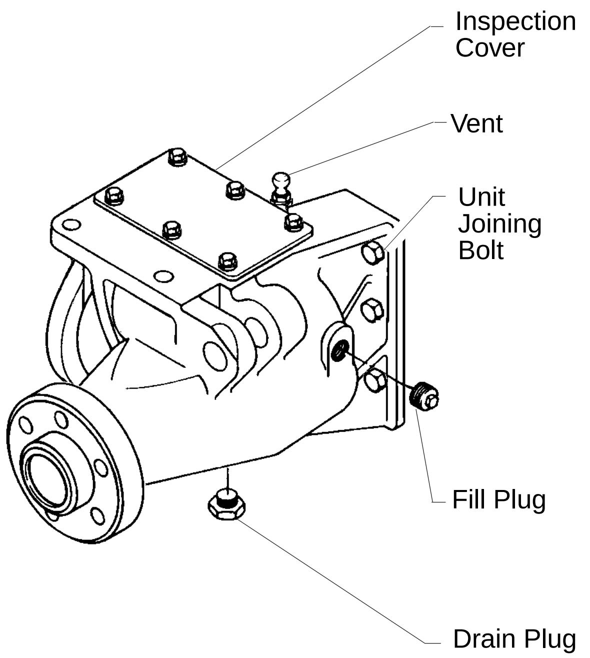


Figure 7. Ring Gear Shaft Assembly

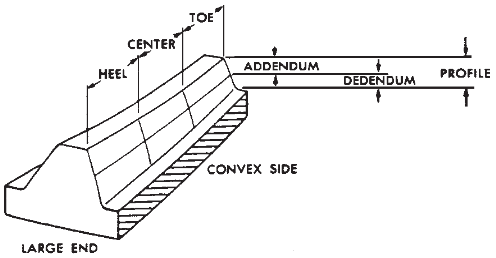
Drive Axle Reassembly

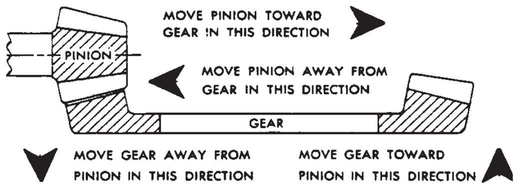
1. Install new gasket on inspection cover with Permatex (use Permatex to attach gasket to cover only).
2. Install inspection cover to top of unit and tighten bolts.
3. Install brake disc by sliding on spline of ring gear shaft. Apply a thin coating of grease to outside of brake disc hub before pushing through the seal. Be careful not to damage seal lips when installing disc.
4. Install and tighten drain plug.
5. Fill drive unit with recommended fluid.
6. Install and tighten fill plug.
   Tighten fill and drain plugs to:
   54-61 N.m (40-45 ft-lb) torque
7. Connect the two (right and left hand) drive units together to form the drive axle assembly. Install the fastener bolts in drive unit flanges. Be sure drive units are aligned with the top surfaces even and parallel with each other. Locate on the top surfaces while tightening the flange bolts. Hold top surfaces within 1.02 mm (0.04 inch) before torquing bolts of two units together.
   Bolt Tightening Torque:
   200-217 N.m (148-160 ft-lb)



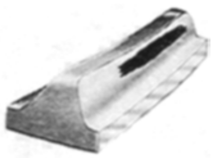
Drive Axle (Left Housing Only)

Spiral Bevel and Hypoid Tooth Bearing Contact Chart



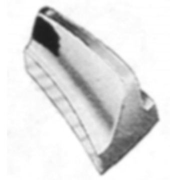


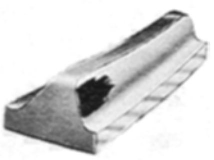
ALL CONTACT BEARINGS SHOWN BELOW ARE ON RIGHT HAND SPIRAL RING GEAR. THE DRIVE IS ON THE CONVEX SIDE OF THE TOOTH.



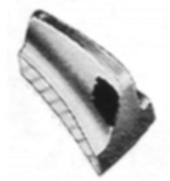
TYPICAL PREFERRED BEARING ON BOTH SIDES OF TOOTH WHILE UNDER A LIGHT LOAD

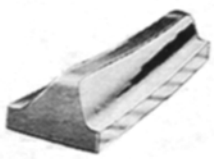
TOE BEARING ON BOTH SIDES OF TOOTH.GEAR SET NOISY. TO MOVE BEARING TOWARD HEEL INCREASE BACKLASH WITHIN LIMITS BY MOVING GEAR AWAY FROM PINION.



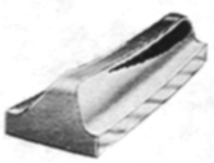


HEEL BEARING ON BOTH SIDES OF TOOTH.GEARSET NOISY AND COULD RESULT IN EARLY GEAR FAILURE. TO MOVE BEARING TOWARD TOE DECREASE BACKLASH WITHIN LIMITS BY MOVING GEAR TOWARD PINION.





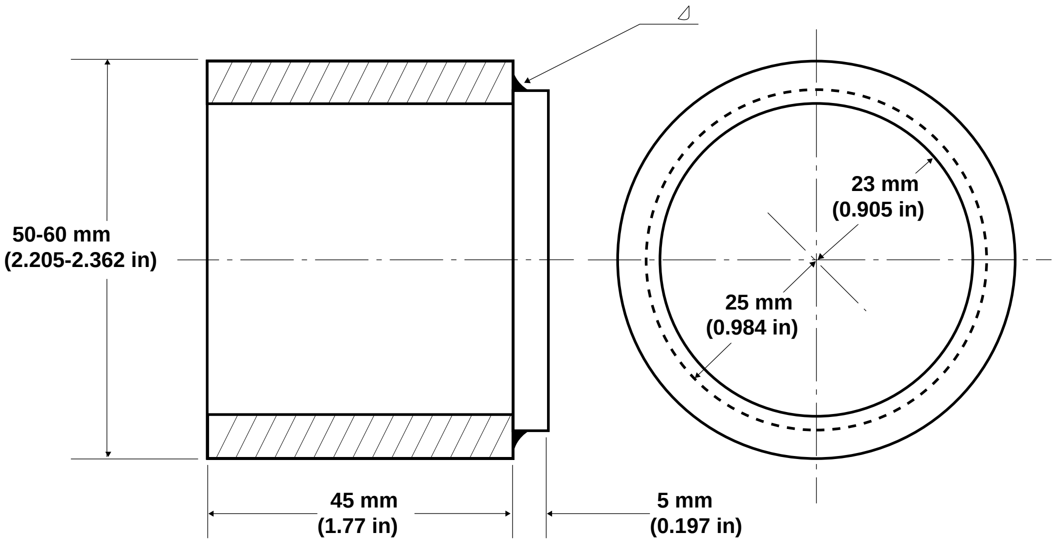
LOW BEARING ON GEAR AND HIGH BEARING ON PINION. CORRECT BY PULLING PINION AWAY FROM GEAR (INCREASE MOUNTING DISTANCE).



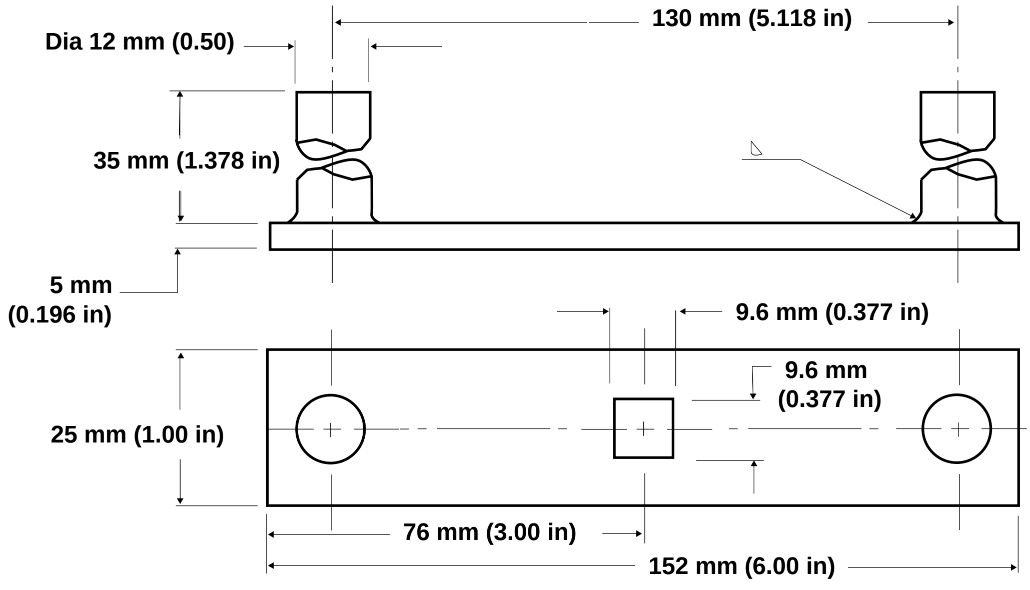
HIGH BEARING ON GEAR AND LOW BEARING ON PINION. CORRECT BY MOVING PINION IN TOWARD GEAR (DECREASE MOUNTING DISTANCE).

BACKLASH SHOULD BE MEASURED WITH A DIAL INDI CATOR RIGIDLY MOUNTED WITH THE STEM PERPENDICULAR TO THE TOOTH SURFACE AT THE EXTREME HEEL.

Special Tools Fabrication



Digram A. Axle Shaft Inboard Bearing Cone Driver. Construct as indicated.



Digram B. Adapter Tool for for Checking Axle Shaft Bearing Preload. Construct as indicated.

GROUP 22

WHEELS AND TIRES

NOTE :

Section 1

Wheels and Tires
Specifications and Description

Specifications

Cushion

Material: Rubber except as noted.

Size:

	Drive	Steer
TMX 12/15/15S:	18x7x12. 12	18x7x12 .12
TMX 17/20	18x8x12 .12	18x7x12 .12
TMX 25	18x9x12 .12	18x6x12.12 (Urethane)

Mounting Nut Torques: Refter to mounting procedure in Section 2.

Pneumatic

Material: Rubber

Size:

	Drive	Steer
TMX 12/15	18x7x8-16PR	18x7x8-16PR
TMX 15S	18x7x8-16PR	-
TMX 17/20	18x9x8-16PR	-
EPX16/18	21x8x9-14PR	5.00x8-10PR

Tire Inflation Pressure:

	Drive	Steer
TMX 12-25	1000 kPa (145 psi)	1000 kPa (145 psi)
EPX16/18	1000 kPa (145 psi)	883 kPa (128 psi)

Mounting Nut Torques: Refter to mounting procedure in Section 3.

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

Cushion tires are mounted on one-piece rims. A general description of cushion tire removal and replacement appears in the section for cushion tires. However only trained and experienced personnel with the proper equipment should attempt to change out cushion tires on the rims. 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

Wheels and Tires Mounting and Maintenance

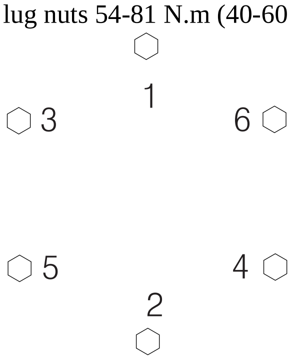
Drive and Steer Wheels Removal and Installation

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 pre-torque the lug nuts 54-81 N.m (40-60 ft-lb).

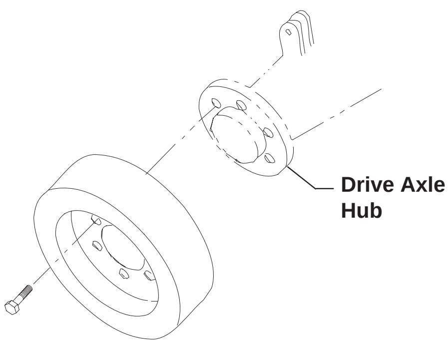


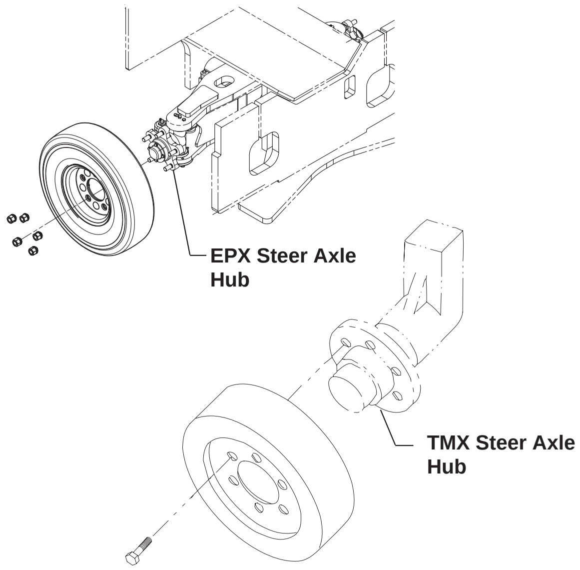
3. Begin the crisscrossing sequence again and torque the lug nuts to 255-275 N.m (188-203 ft-lb).

IMPORTANT

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

4. 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.

Pneumatic Tire Maintenance

Precautions

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 responsibility. 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.

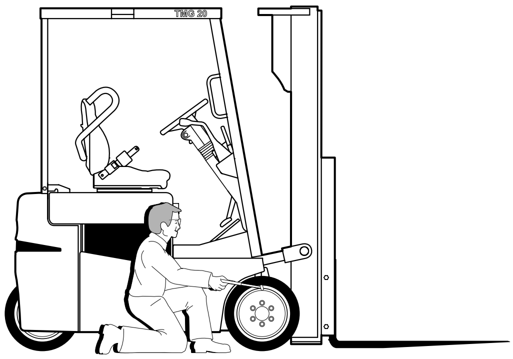
1. Do not let anyone mount or demount tires without proper training.
2. Never sit on or stand in front of a tire and rim assembly that is being filled with air. Use a clip-on chuck and make sure the hose is long enough to permit the person filling the tire with air to stand to the side of the tire, not 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 of 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.

Maintenance, Inspection, and Repair

1. Park the truck as described in "Safe Parking" and check for correct tire inflation air pressure.
   - Drive Tire : 1000 kPa (145 psi)-TMX,
     1000 kPa (145 psi)-EPX
   - Steer Tire :1000 kPa (145 psi).-TMX,
     883 kPa (128 psi).-EPX

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.

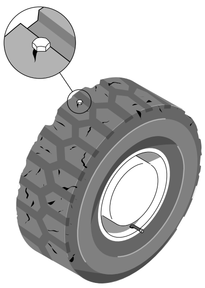


- If tires are low, do not add air. Have the tire and wheel inspected by a person trained and authorized to do tire and wheel maintenance. The tire may require removal and repair.
- Incorrect (low) tire pressure can reduce the stability of a lift truck and cause it to tip over.

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.

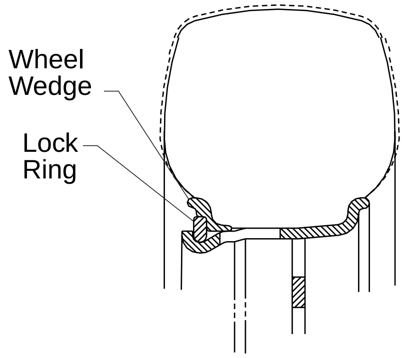


3. Check all wheel lug nuts or bolts to be sure none are loose or missing. Have missing bolts replaced and loose bolts tightened to the correct torque before operating the truck.

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.

.

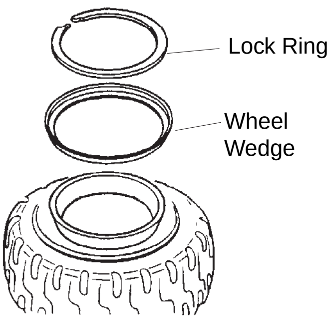
Wheel Disassembly and Tire Removal

1. Remove valve core from the valve stem to be sure all air is removed.

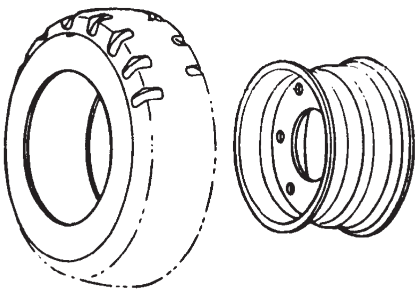
WARNING

Before starting disassembly, remove the air from the tire. Failure to remove the air from the tire can result in serious injury.

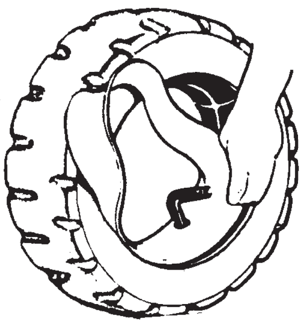
2. Remove lock ring.



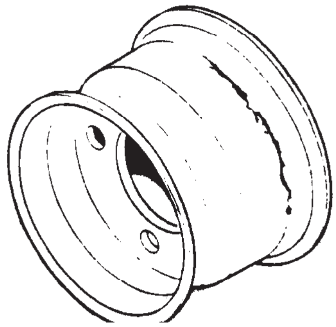
3. Remove wheel wedge.
4. Remove tire from wheel.



5. Remove the rubber inner tube protector (flap).



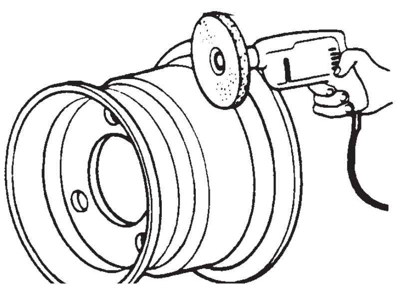
6. Repair tire and/or tube, as needed.
7. Check for cracks in the wheel.



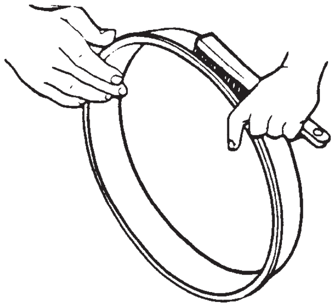
Cracks in the wheel are caused by:

- 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.

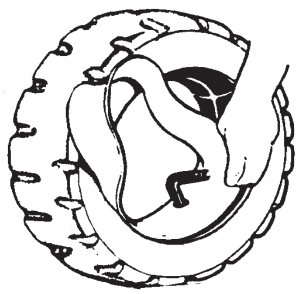


14. Apply paint to the tire rim with a brush. Or, use an aerosol can of metal primer.
    The parts must be clean and dry before you apply the paint. Make sure to apply paint to the outside or tire side of the rim. This is important because air is on the metal surface of the tire side of the rim.
15. 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

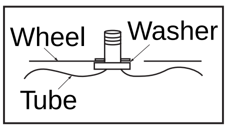
Clark dealers can supply the correct lubricant, which contains a rust inhibitor. Tire Replacement and Wheel Reassembly

1. Put the tube into the tire.

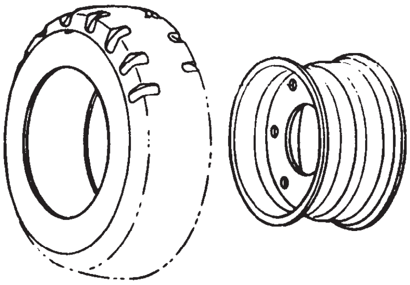


IMPORTANT

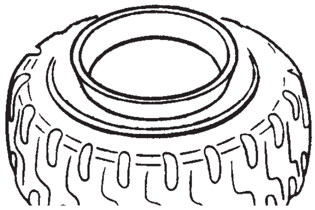
Install washer 22.123 on tube over valve stem before flap is installed, when specified. See sketch. Refer to Service Parts List.



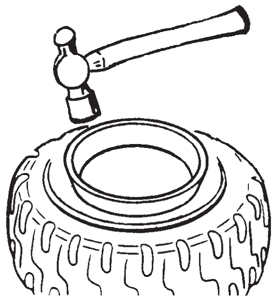
2. Put the rubber tube protector (flap) over the tube.
3. Install the tire onto the wheel rim, against the bead seat area.



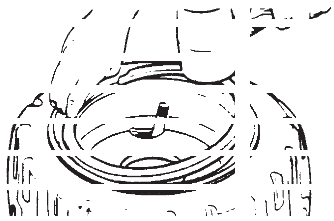
4. Put the wheel wedge over the rim.



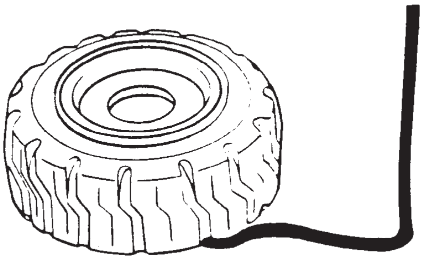
5. Install the wheel wedge.



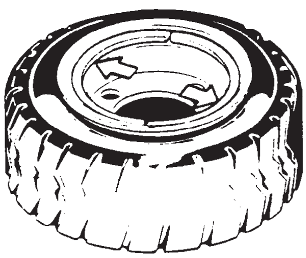
6. Put the side ring over the rim and install the lock ring as shown.



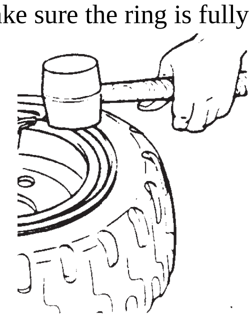
7. Connect air chuck and turn the tire over with the valve stem down. Put 21 kPa (3 psi) of air into the tire.



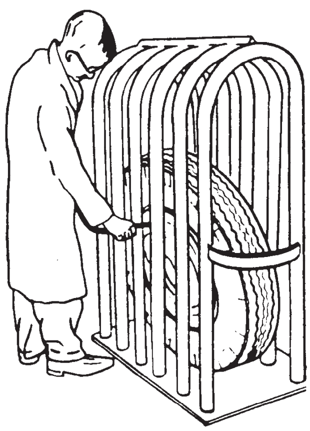
8. Turn wheel to the other side. Check to make sure lock ring is in correct location.



9. Disconnect the air chuck. Use a mallet and hit the ring to make sure the ring is fully installed.

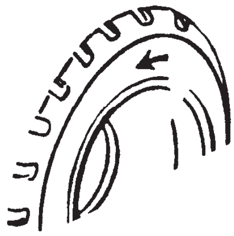


10. Put the tire in an OSHA-approved safety cage.



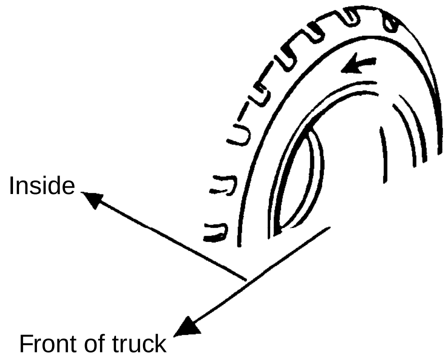
Mounting of Directional Tread Tire

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.



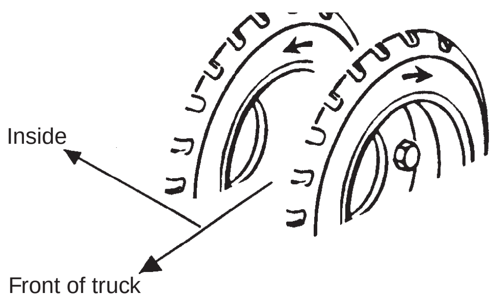
Directional-Tread Single Drive Tires

. Tire arrow to point in the direction 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 pressure into the tire.
4. Continue to fill the tire to the correct air pressure. See the Operator's Manual for correct tire inflation pressure.

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.

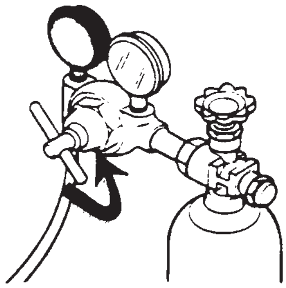
Filling Tires with Nitrogen

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.

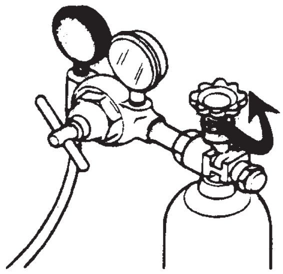
WARNING

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.

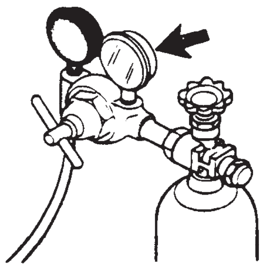
1. Be sure tank valve is closed to connect hose to valve stem. Tank valve is closed by turning handle on top of tank clockwise to a stop.
2. Turn the regulator valve counterclockwise (CCW) until you can feel no resistance from the regulator. This will adjust the regulator pressure to a low pressure near zero.



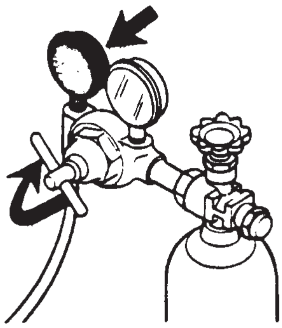
3. Slowly turn the cylinder valve counterclockwise (CCW) to open position.



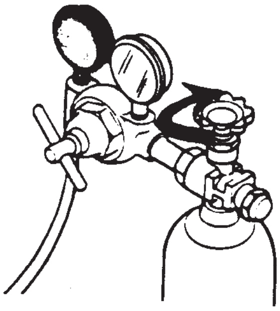
4. The tank gauge will now show tank pressure.



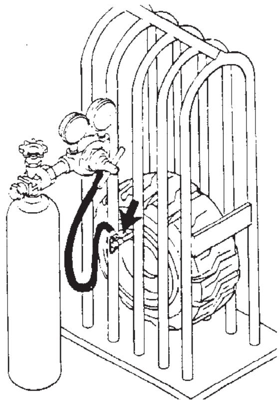
5. Turn the regulator valve clockwise (CW) until the regulator gauge reads the correct tire pressure. Fill the tire with nitrogen.



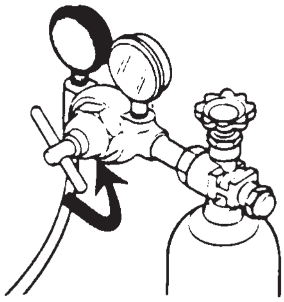
6. Turn the tank valve clockwise (CW) and close the valve.



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.

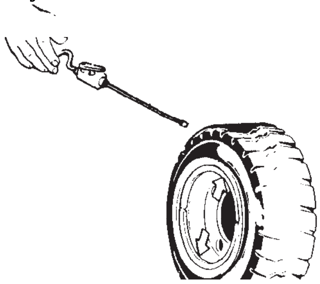
CAUTION

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.

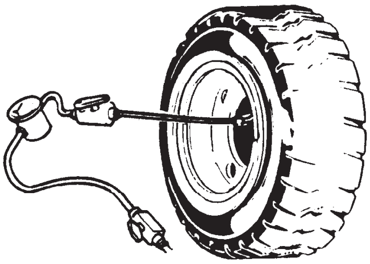
Checking and Adjusting Tire Pressure

WARNING

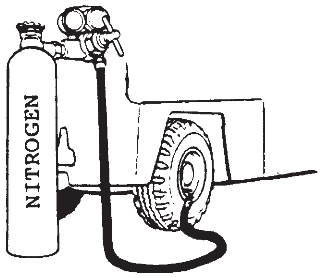
Before you add air pressure to the tire, make sure the lock ring is correctly positioned in the rim and wheel wedge. The lock ring can separate from the rim with enough force to cause injury or death.



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 nitrogen only. Do not use oxygen or any other gas to fill tires.

NOTE :

GROUP 23

BRAKES

NOTE :

Section 1

Brake Specifications and Description

Specifications

Service Brake:

Type: Caliper.

Minimum lining/pad thickness: 0.67 mm (0.06 in).

Fluid Type: SAEJ1703 (DOT-3) brake fluid only.

Fluid Capacity: 0.256 L (0.06 gal).

Pedal Freeplay: 1-3 mm (0.039-0.118 in; measured at stop screw).

Parking Brake:

TMX Type: Lever-type mechanically linked to brake assembly.

EPX16/18 Type: Foot-type mechanically linked to brake assembly.

Holding Test: Rated load on 15% grade.

Description

(See illustration on the next page.)

The service brake pedal operates a master cylinder mounted on the front cowl.

The master cylinder operates a caliper assembly centrally mounted on the two drive axle housings.

When the caliper assembly is activated, its pads grip the brake discs mounted on the inboard end of each drive axle pinion shaft. Friction betwen the pads and disks slows or stops rotation of the drive axle.

There is no power assist for the service brake.

The parking brake handle operates a ratchet and cable that closes or releases the caliper assembly.

See Group 20,"Drive Axle," for more detail.

Service Requirements

Operational checks and inspection of linkages, brake pads, and brake lines are specified in the Periodic Service Chart in Group PS.

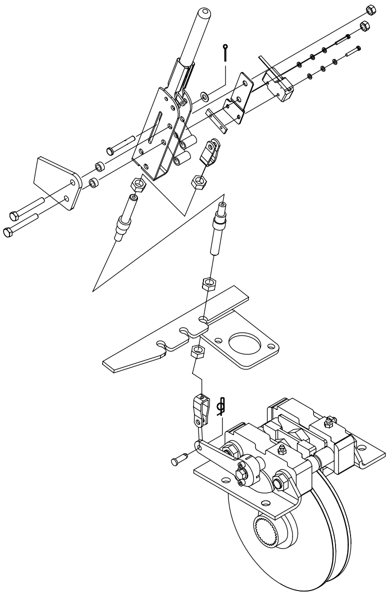
Service brake linkage adjustment and lube are not normally required.

Brake pads are self-adjusting.

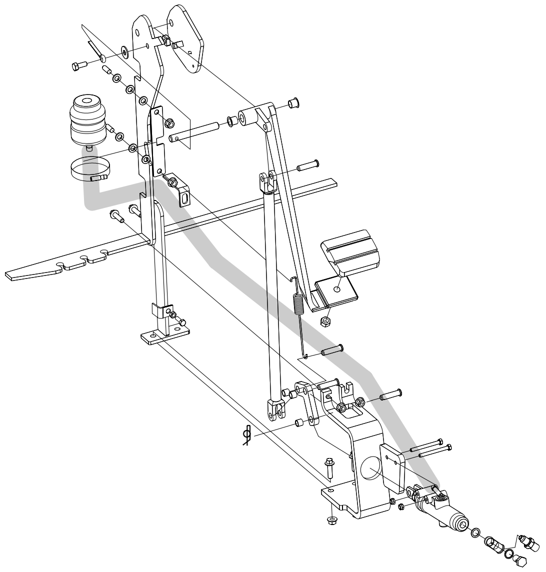
A leaking caliper or master cylinder should be overhauled or replaced.

Parking brake should be adjusted if indicated by operational check.

The following sections in this Group provide service procedures for the service and parking brake assemblies.

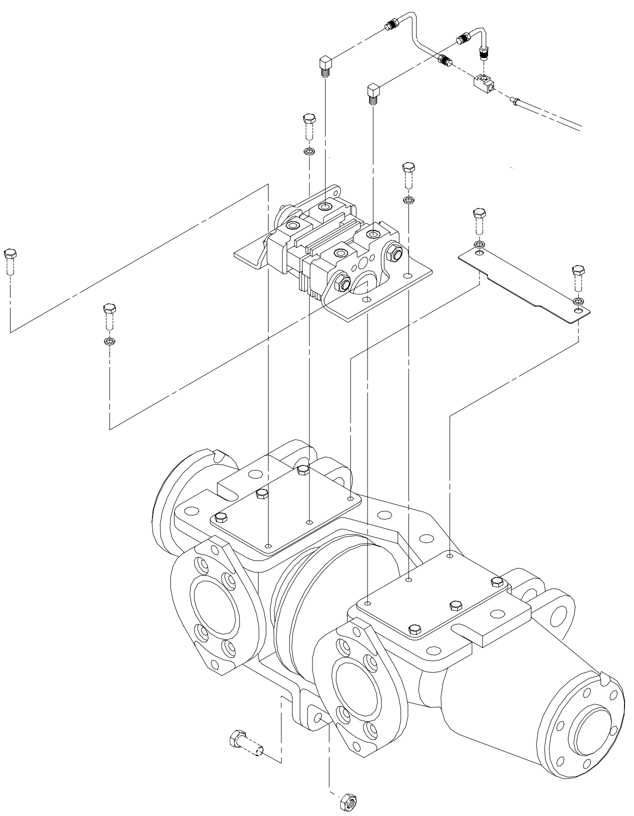


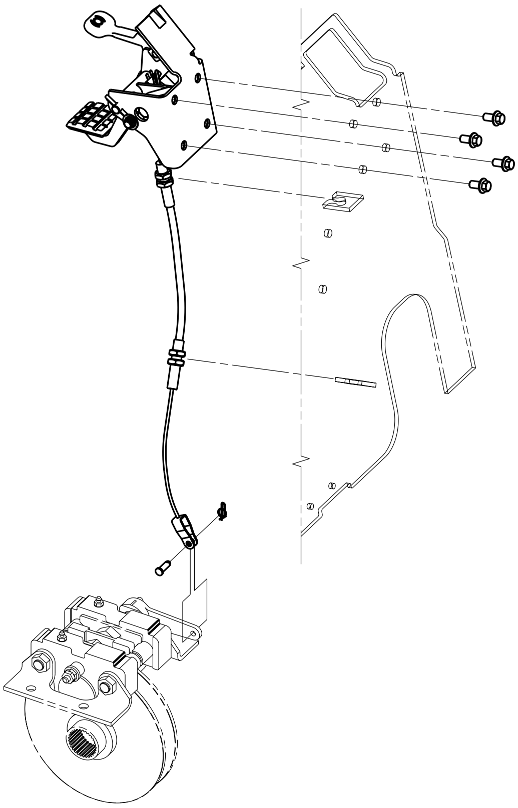
TMX Parking Brake and Linkage to Brake Caliper



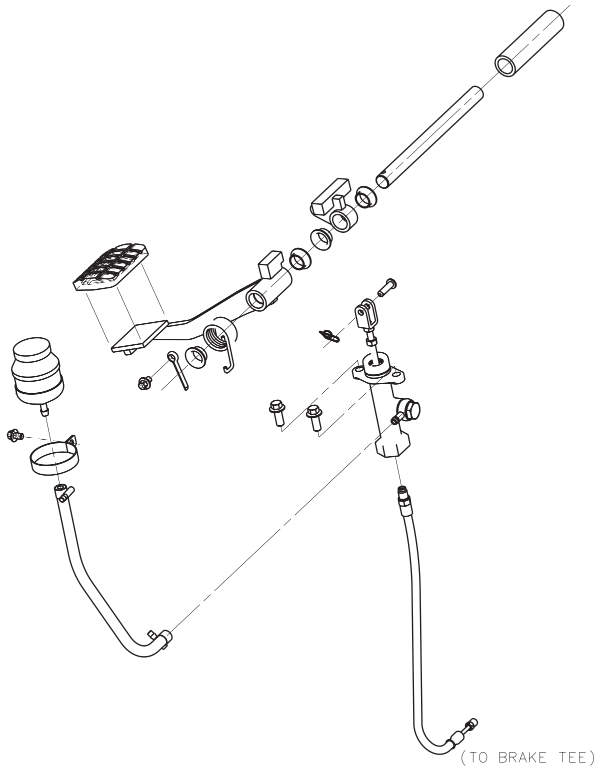
TMX Reservoir, Pedal, Master Cylinder and Linkage

Brake Caliper and Brake Lines
Installation to Drive Axle





EPX Parking Brake and Linkage to Brake Caliper



EPX Reservoir, Pedal, Master Cylinder and Linkage

NOTE :

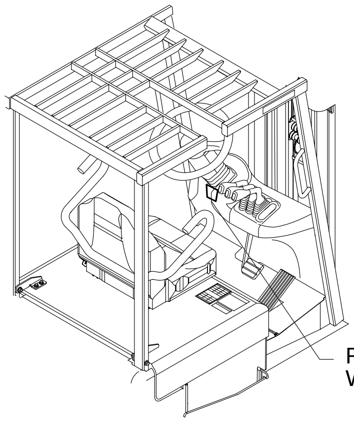
Section 2

Fluid Check, Fill, and Bleed

Check and Fill

Inspect brake fluid level in reservoir through window in left cowl cover. A flashlight may be needed.

If fluid level is below full mark, remove cowl cover as described in Group 38 and fill reservoir to full mark with DOT 3 fluid.



Bleeding

Bleed brakes when:

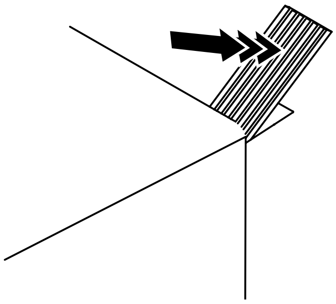
- The brake pedal feels spongy or low.
- The master cylinder, caliper, or brake lines have been leaking, repaired, or replaced.
- Troubleshooting indicates that air has been introduced into the system.

NOTE

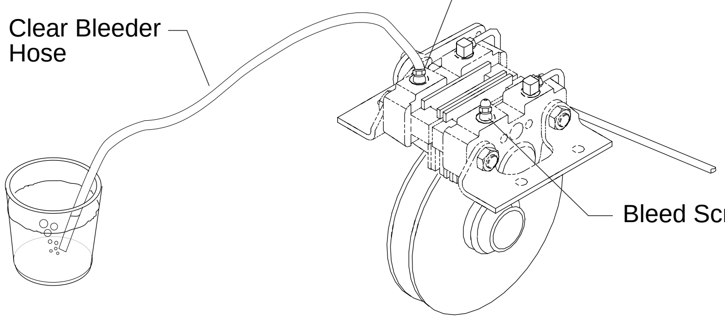
Make sure that brake pedal freeplay is correctly set before bleeding the brakes.

Proceed as follows:

1. Park truck on level floor. Put direction control in neutral. Lower forks to floor, tilt forward, and apply parking brake.
2. Attach a clear hose to a bleed screw on the brake caliper. Place the other end of the hose in a vessel containing fluid.
3. Fill the brake fluid reservoir.
4. Open the bleed screw.
5. Pump the brake pedal until the fluid flowing from the hose is free of bubbles.



6. Continue pumping the brakes and tighten the bleed screw.
7. Repeat for the other caliper bleed screw.
8. Operate the brake pedal at various rates. If the pedal feels spongy or low, bleed the lines again.
9. Refill the reservoir to the full mark.



NOTE :

Section 3

Pedal and Master Cylinder 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 and micro-switch as described in “Pedal Adjustment”on this 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.
4. Note orientation of pedal spring. Upper (shorter) end catches in cowl bracket. Lower (longer) end catches on pin in link.

Pedal Adjustment(TMX)

With all components replaced and fasteners tightened to correct torque, adjust the pedal as follows:

1. Adjust pedal stop screw (item F) to provide 1-3 mm (0.04-0.12 in) of free play.
2. When free play is adjusted, tighten the jam nut on the stop screw to set the distance.
3. Adjust micro-switch to activate just before end of pedal free play. See Group 13 for brake switch check and adjustments.

Pedal Height Adjustment(EPX)

See Figure 2. The brake pedal must be at the same height as the inching pedal. To adjust brake pedal height :

1. Loose the pedal stop bolt of brake and adjust pedal height to be 125 ± 5mm from floow plate.
2. Loose the pedal stop bolt of inching and adjust pedal height to be 125±5mm.
3. Torque the stop bolt and nut 20-25 N·m(14-18 ft·lb).

Freeplay Adjustment(EPX)

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 2).
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.

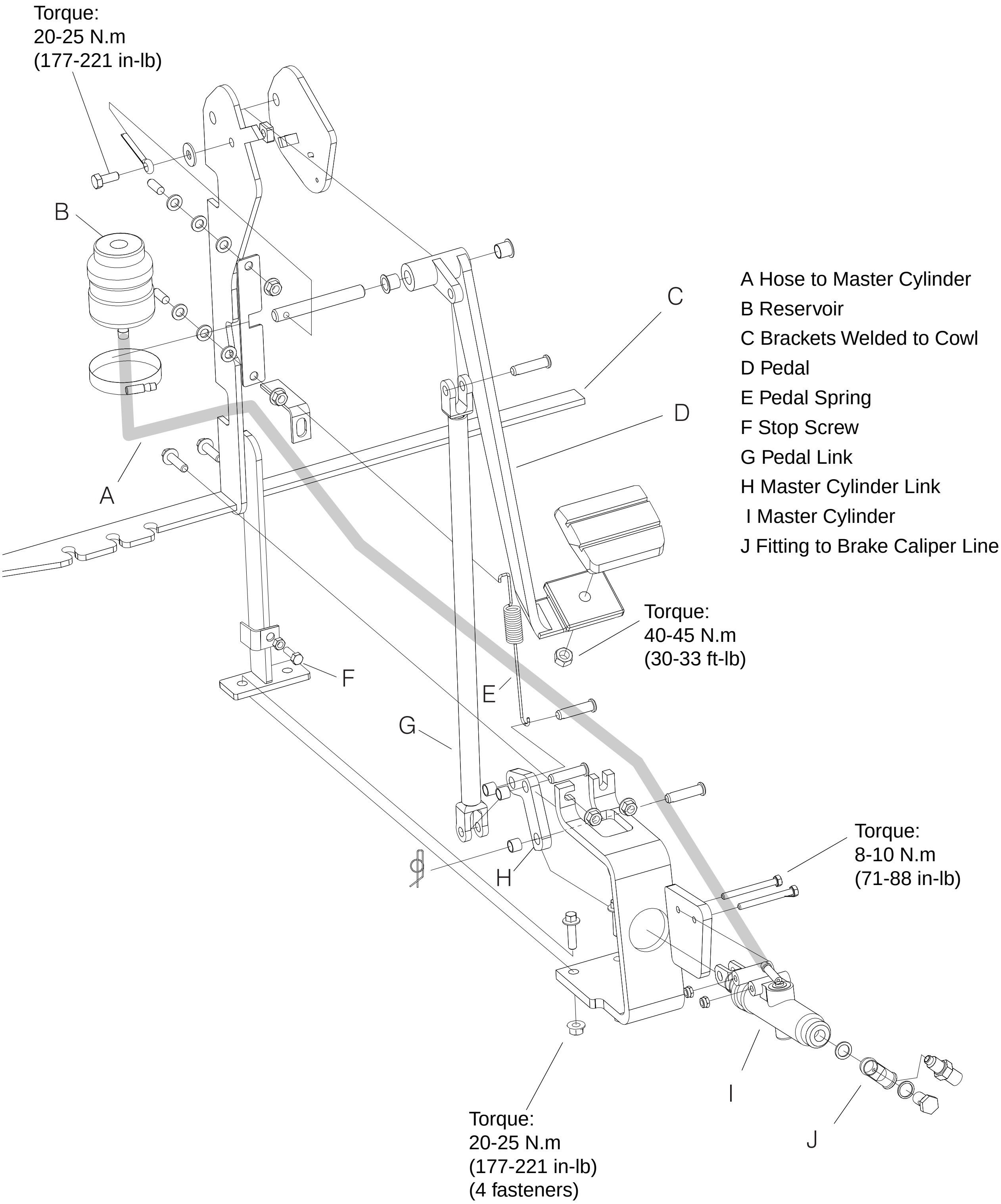


Figure 1. Reservoir, Pedal, Linkage, and Master Cylinder Assembly.(TMX Truck)

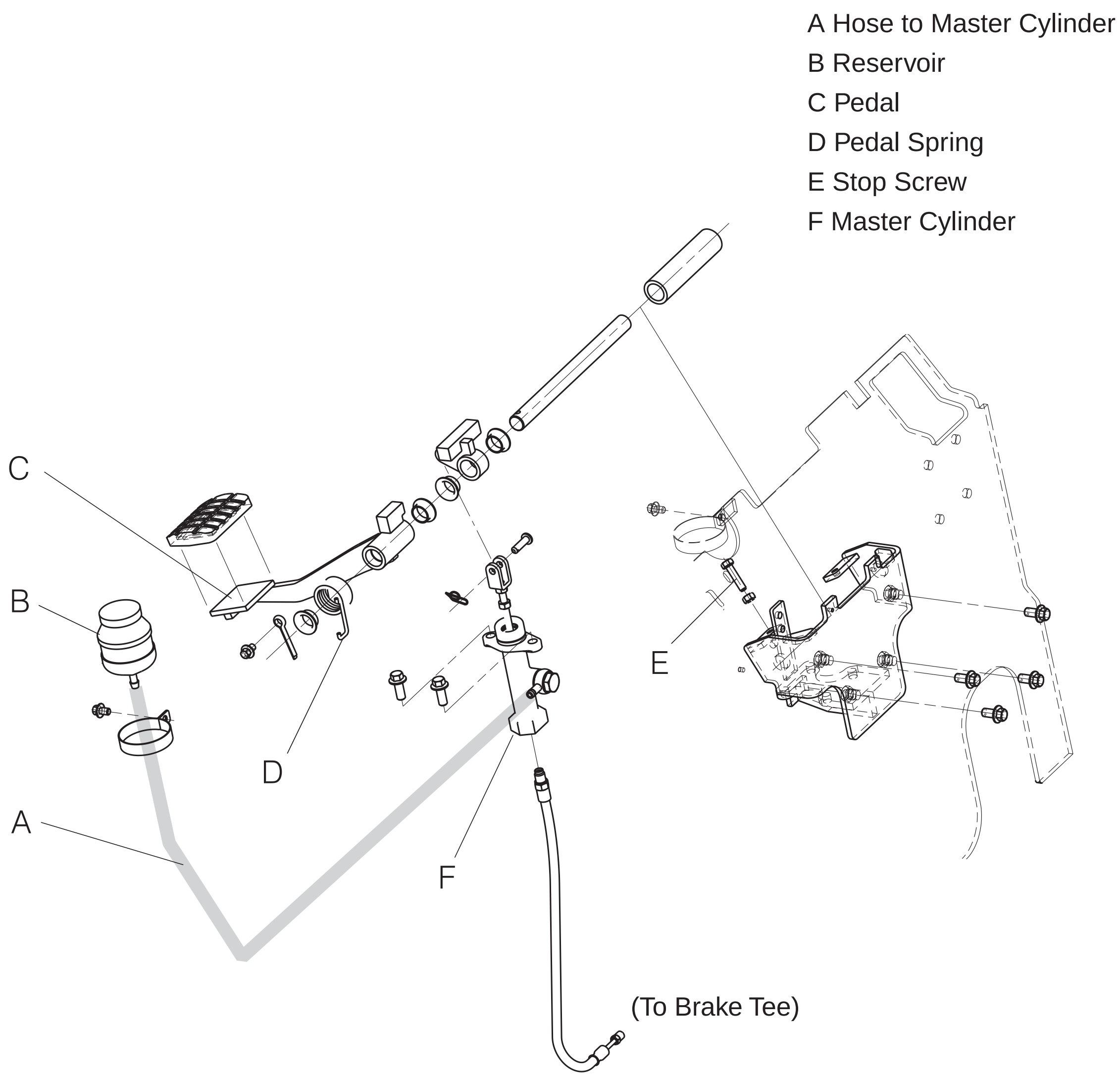


Figure 2. Reservoir, Pedal, Linkage, and Master Cylinder Assembly.(EPX Truck)

NOTE :

Section 4

Brake Caliper Removal and Replacement

Introduction

Figures 1 and 2 show:

- The brake mounting on the drive axle.
- The connections from the master cylinder to the brake.

The illustrations and accompanying text serve as a guide to removal and replacement.

Before beginning this service procedure:

- Park the truck on a level surface and lower the upright completely.
- Raise and block the upright for better access as described in Group SA.
- Return all controls to neutral and turn key switch to OFF position.
- Block the wheels.

See Section 3 for procedures to remove brake pedal and master cylinder. See Section 6 for brake overhaul procedures.

Brake Removal

1. Disconnect tube assemblies from brake at the compression fittings shown in Figure 2. Move tubing out of
   the way; disconnect from the tee if necessary.
2. Remove the cotter pin from the parking brake caliper clevis (see Section 5).
3. Remove bolts and washers from brake mounting bracket. Lift the caliper assembly from the transaxle.
4. To remove the brake rotors:
   a. Slide the left-side rotor off of the splined shaft and lift out.
   b. Repeat for opposite rotor.
   c. Inspect axle seals per procedures in Group Transaxle. Replace if worn, leaking, or damaged.

Brake Replacement.

1. To replace rotors:
   a. Coat splines of brake rotor with an anti-seize compound before installing in truck.
   b. Grasp rotor around the outer edge and line up with the spline.
   c. Push rotor onto splined shaft until it is fully engaged.
   d. Repeat for opposite rotor. Both rotors should be free to float on the splines.
2. Replace brake as shown in Figure 1:
   a. Mount brake over disk.
   b. Set mounting bolts in place and torque to 0.5-2 N.m (0.4-1.5 ft-lb).
   c. Replace tube assemblies at the compression fittings. Do not overtighten.
   d. Press brake pedal to align brake and disk.
   e. Torque mounting bolts to 60-65 N.m (44-48 ftlb).
3. Replace rear cover. Torque top bolts to 60-65 N.m (44-48 ft-lb); torque bottom nut to 170-190 N.m (125- 140 ft-lb).

IMPORTANT

Both sides of brake must be checked and fully refilled with proper lubricant. See brake bleeding Section in this Group.

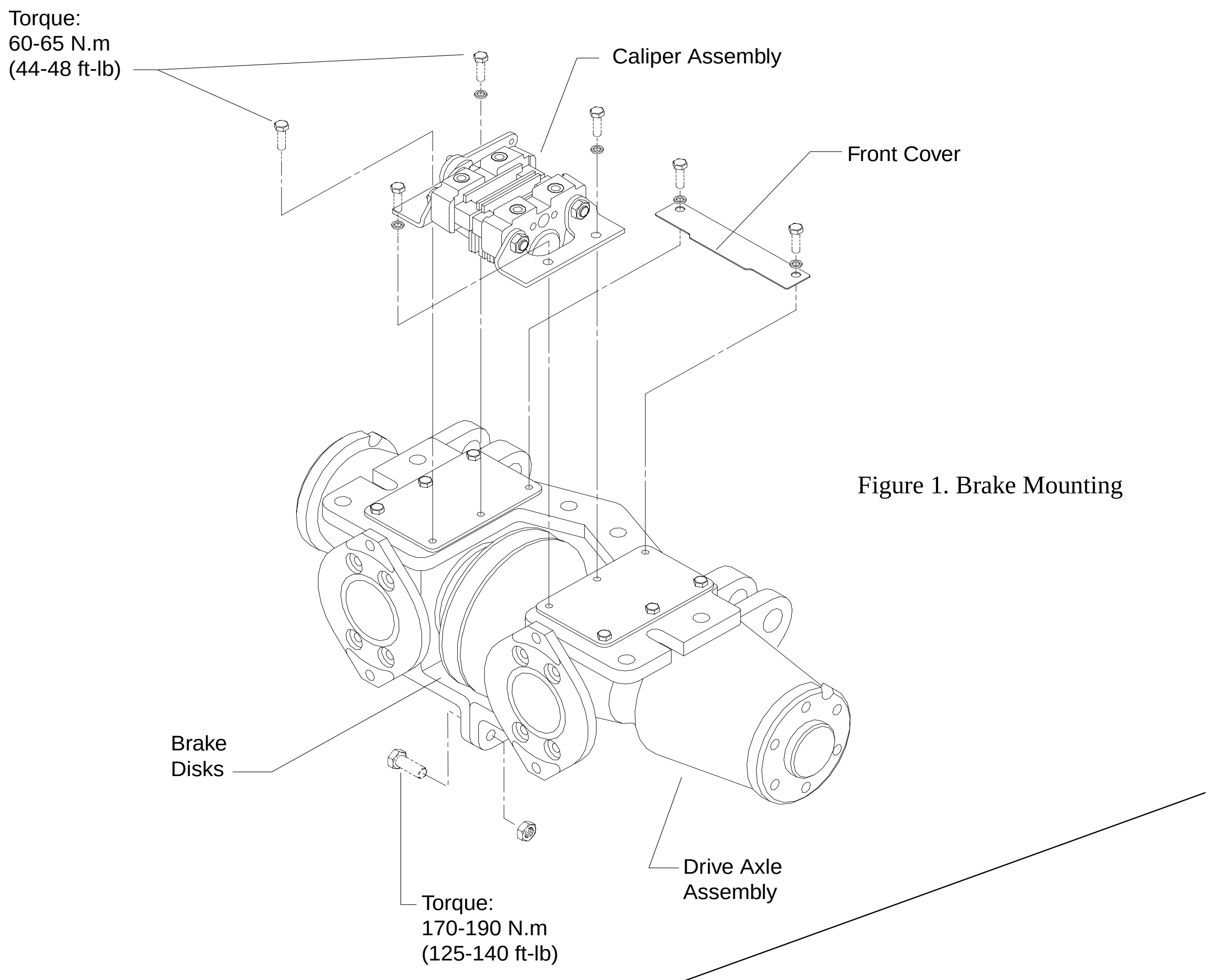


Figure 1. Brake Mounting

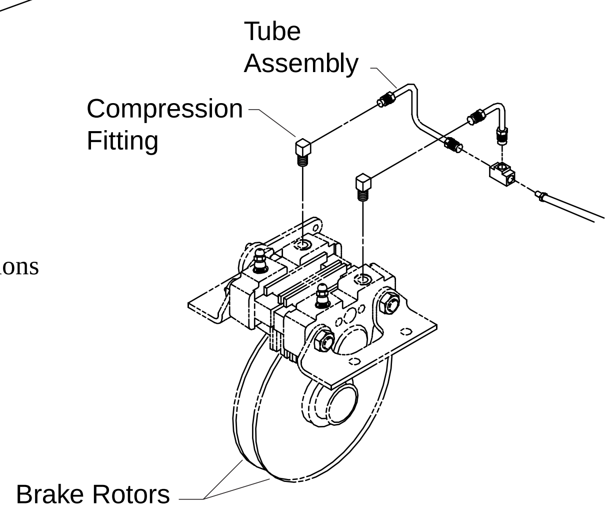


Figure 2. Brake Tubing Connections

Section 5

Parking Brake Removal, Replacement, and Adjustment

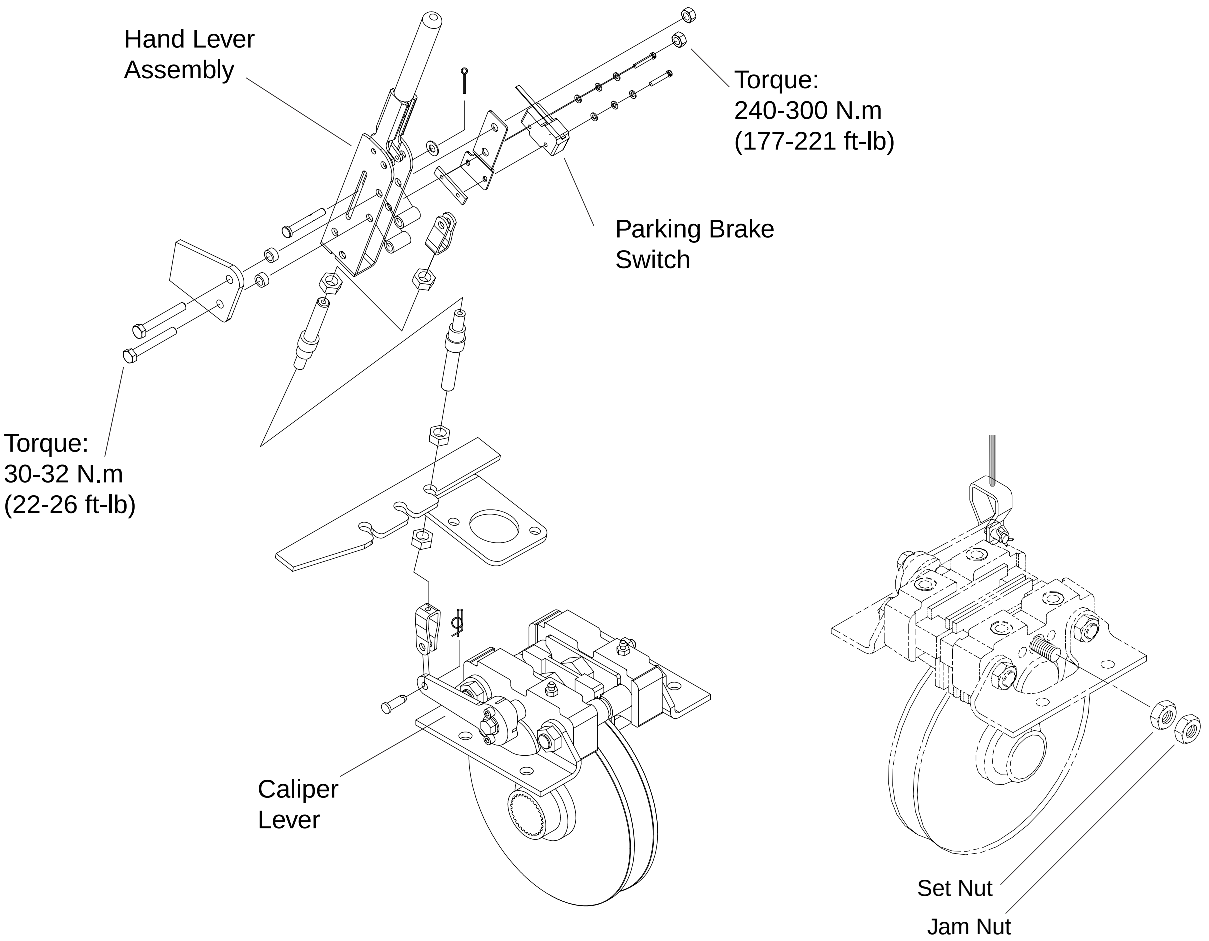
Removal and Replacement(TMX)

Remove and replace parking brake components as shown in the illustration.

Adjustment(TMX)

Parking brake must be adjusted after removal and replacement and at every PM.

1. Install parking brake assembly and adjust cable so that caliper lever is horizontal.
2. Set brake handle to Off (down) position.
3. Tighten adjustment set nut until all clearance between pads and disks is removed.
4. Loosen set nut 1/2 turn. This allows approximately 1 mm (0.03 in) gap between brake and pad.
5. Tighten jam nut.
6. Adjust parking brake by tightening or loosening the operator's adjustor in the brake handle so that the truck holds on 15% grade.
7. See Group 13 for parking brake switch check and adjustment.



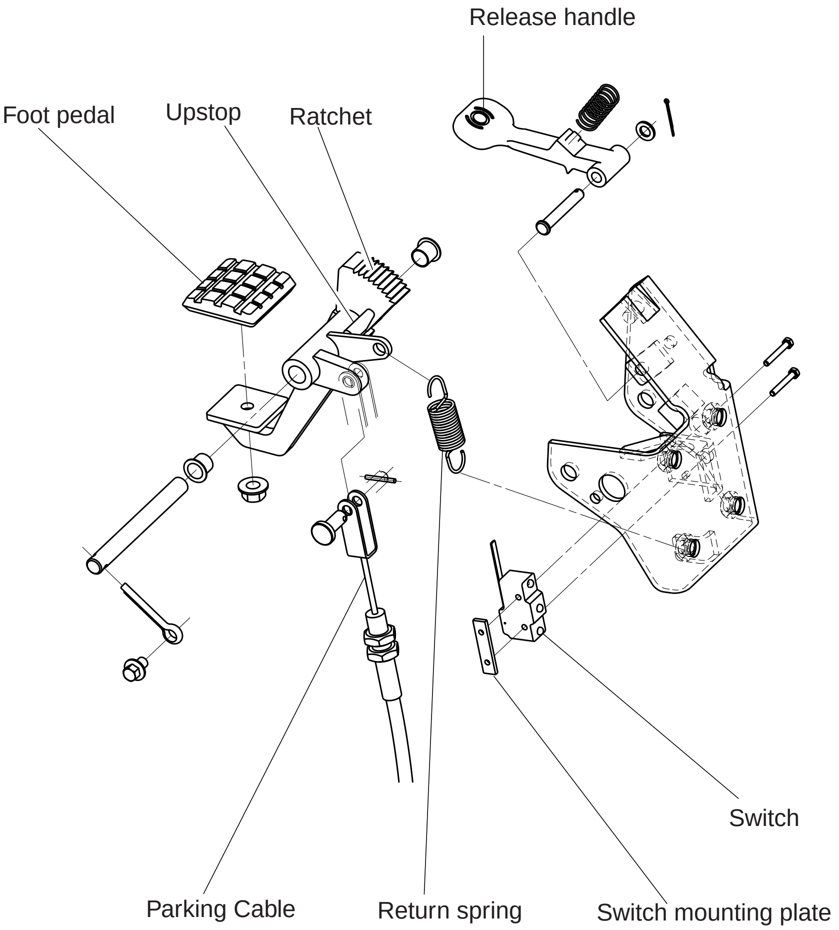
Adjustment(EPX15-18)

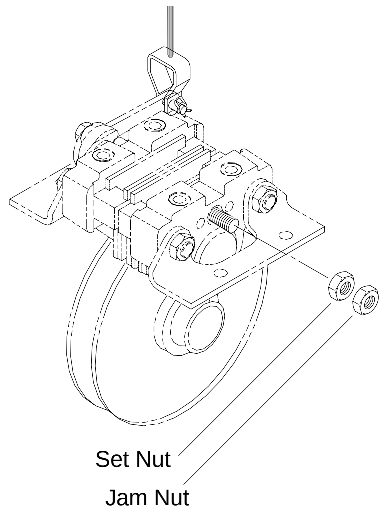
1. With the pedal fully raised, **upstop** against tab on bracket, **adjust** slack out of brake cables and tighten **adjusting/locking nuts**.
2. Actuate and release pedal six to eight times.
3. Readjust and tighten nuts.

Removal and Replacement(EPX15-18)

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** 40-45 N·m (30-33 lbf·ft).
- Apply a thin coat of Clark lubricant, part #1802155, to ratchet teeth and ball end of **wire rope** prior to assembly.





Section 6

Brake Overhaul

IMPORTANT

Brake carrier and lining assemblies must be replaced when lining material is less than 0 .67mm (0.060 in).

Use the Disassembly and Assembly procedures to overhaul the brake. Replace components using the correct rebuild kit. Brake valves are not serviceable. See Group Sections for procedures to remove, replace, adjust, and bleed brake and components.

Disassembly

Carrier and Lining Removal

1. Remove parking brake jam and adjustment nuts from the adjustment bolt and washer.
2. Remove the parking brake lever arm with adjustment bolt and washer.
3. Remove the pad retainer nut from the sleeve and repeat for opposite side.
4. Push brake sleeves into bushings and remove carrier and lining assemblies.

Caliper Disassembly

1. Remove the nuts securing the brake valves and brake shoe pivots in the mounting brackets.
2. Pull the mounting brackets apart from the brake valves and brake shoe pivots.

Parts Inspection

Brake carrier and lining assemblies must be replaced when lining material is less than 0 .67mm (0.060 in).

All parts must be clean and free of dust and chips before assembly. Thoroughly clean all drilled passages, seal grooves, and threads in the brake valves. If parts are damaged or worn, replace the brake valve.

1. Clean brake valves with solvent:
   a. Check all cylinder bores for nicks, scratches, or corrosion and blend with crocus cloth.
   b. Check all fluid passages and grooves and clean remaining dirt and fluid completely out.
2. Inspect piston assemblies for scratches and nicks and blend with a crocus cloth. Replace the valve if piston is badly scratched.
3. Check actuating pins for grooves. Pins with light grooves may be rotated so grooved portion is opposite the end of the carrier and lining assemblies. Replace deeply grooved actuating pins.
4. Bushings should be flush with inside machined surface of the valve. Press bushings flush if necessary.
5. Lubricate piston seals lightly with automotive brake fluid or silicon grease compatible with brake fluid. Do not use petroleum-based oils or lubricants.

Assembly

Caliper Assembly

1. Slide the brake valves in place on the brake shoe pivots.
2. Set the mounting brackets in position and install pivot retainer nuts; torque 115-129 N.m (85-95 ft-lb).

Carrier and Lining Assembly

1. Insert the outer carrier and lining assembly between the brake shoe pivots. Position the carrier against brake valve.

NOTE

Apply a thin coat of an anti-seize compound to the brake sleeves before installing to carrier and liner assemblies.

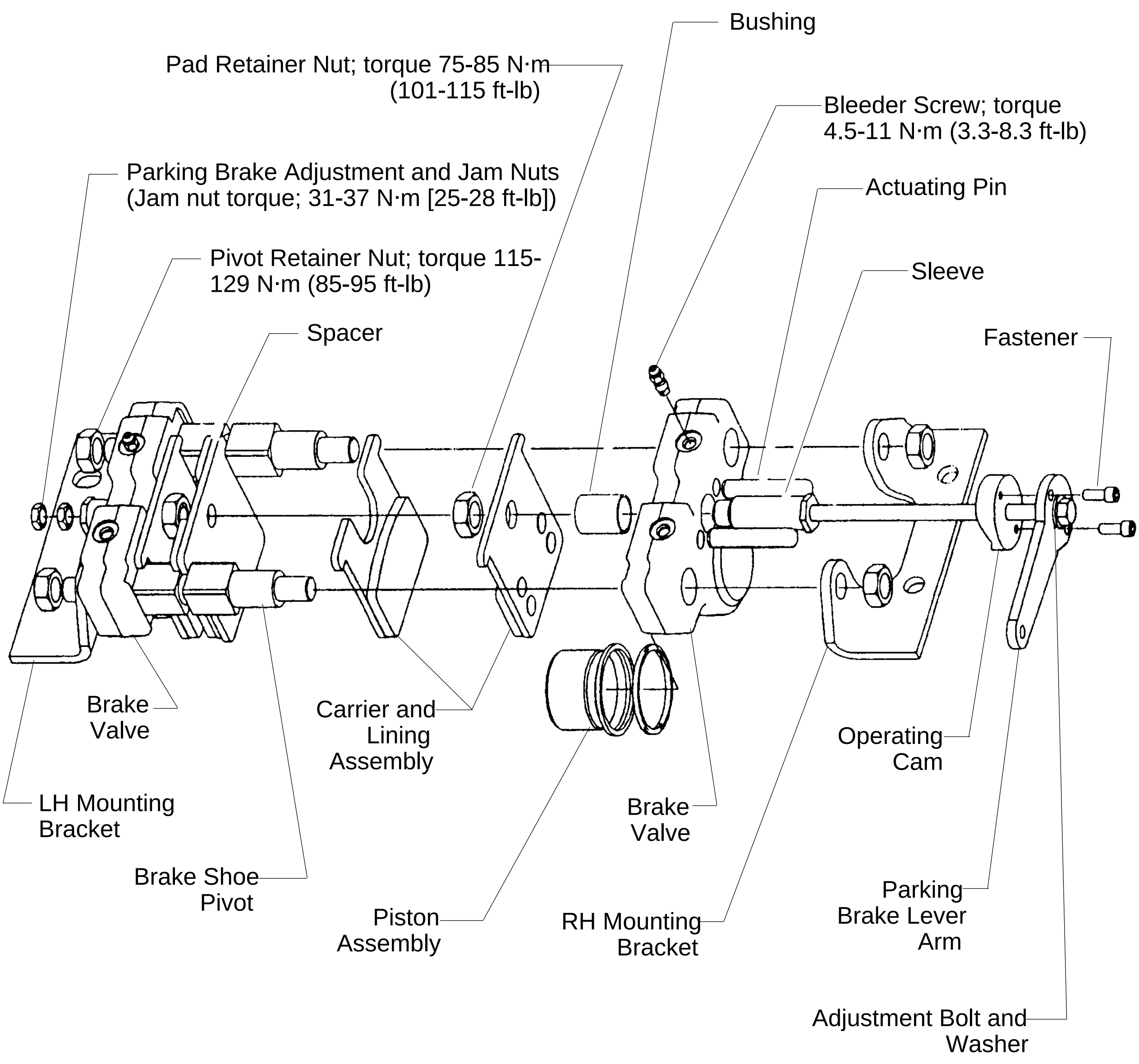
2. Install the sleeves through valve bushings and insert threaded end of sleeves through the outer carrier and lining assembly.
3. Install pad retainer nuts to sleeves; torque 75-85 N.m (101-115 ft-lb).
4. Install spacer plate between two carrier and lining assemblies and in the center groove of the actuating pins.
5. Install the inner carrier and liner assembly between the outer carrier and lining assembly and the center spacer plate.

NOTE

Apply a thin coat of an anti-seize compound to the actuator pins before installing to brake valves.

6. Install two actuator pins into brake valve on side of parking brake lever arm.
7. Install adjustment bolt and washer with parking brake lever arm through brake sleeves, spacers, and carrier and lining assemblies.
8. Install parking brake adjustment and jam nuts, do not torque. See Section 5 for parking brake adjustment.

If removed, install bleeder screws to valves (torque 4.5-11 N.m [3.3-8.3 ft-lb]). See Section 4 for procedures to replace and adjust the brake.


Bushing
Pad Retainer Nut; torque 75-85 N·m (101-115 ft-lb)
Bleeder Screw; torque 4.5-11 N·m (3.3-8.3 ft-lb)
Parking Brake Adjustment and Jam Nuts (Jam nut torque; 31-37 N·m [25-28 ft-lb])
Actuating Pin
Pivot Retainer Nut; torque 115-129 N·m (85-95 ft-lb)
Sleeve
Spacer
Fastener
Brake Valve
Carrier and Lining Assembly
Operating Cam
LH Mounting Bracket
Brake Valve
Brake Shoe Pivot
Parking Brake Lever Arm
Piston Assembly
RH Mounting Bracket
Adjustment Bolt and Washer

NOTE :

GROUP 25/26
STEERING

CLARK

NOTE :

Section 1

Steering System Specifications and Description

Specifications

Steering System Type: Load sensing hydrostatic power steering with variable ratio.(TMX Truck)

Steering System Type: Dynamic signal load sensing steering with variable ratio.(EPX Truck)

Steering System Relief Pressure Setting: 8340-8830 kPa (1210-1280 psi).

Steer Cylinder Type: Double acting, piston-type.

Steer Axle: Single wheel (optional dual-wheel) mounted on trunnion at center rear of truck.

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)

Ignition Switch Ring Nut: 10-14 N.m (7.3-10.3 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)

Universal Joint Pinch Bolt: 25-30 N.m (18.5-22 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 system pump. The steering handwheel operates the power steering gear (steering control valve) shown on page 2, which directs oil flow to the steering cylinder on the steer axle. The steering cylinder operates the steering linkage and steer wheel described on page 3.

A steering system pressure relief valve, contained in the steer gear assembly, prevents over-pressurization of the steering system. The pressure relief setting can be tested using the gaugeinserted into the pressure line into the steering gear.

The steering gear shaft is connected to the handwheel by means of a jointed shaft. When the steering handwheel turns, it causes the steering gear's spool valve to shift from its closed neutral position to a “turn” position. This shifting of the spool directs flow to one end or other of the steering cylinder, depending on the direction of the turn. The amount of flow, and the sharpness of the turn, depend on how far the handwheel is rotated. The more rapidly the handwheel turns, the more quickly the flow, and the turn, occur.

The low pressure oil from the opposite side of the steering cylinder is returned through the opposite port in the steering gear.

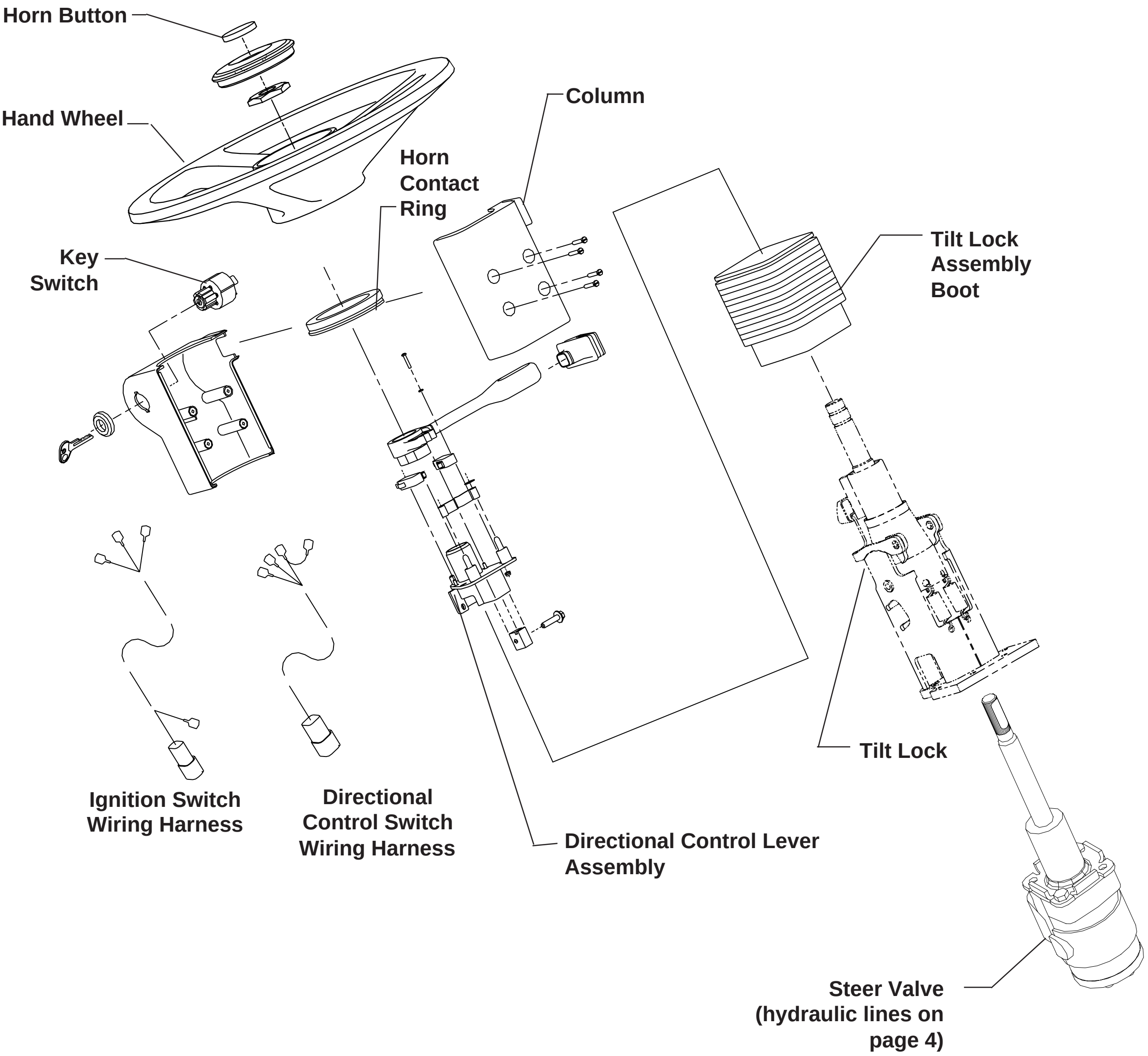
As the steering handwheel stops turning, centering springs in the valve automatically center the spool, stopping the flow of oil to the cylinder.

Stops in the steer cylinder limit the how far the steer wheels can be turned. It takes 5 turns of the hand wheel to turn from stop to stop.

In the event of a pump failure, the steering gear acts as a limited emergency steering pump powered by manual rotation of the handwheel. An internal check valve automatically closes to divert the manually-generated oil flow to the proper port of the steer 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 ignition switch are protected by the steering column cover.

The column 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.

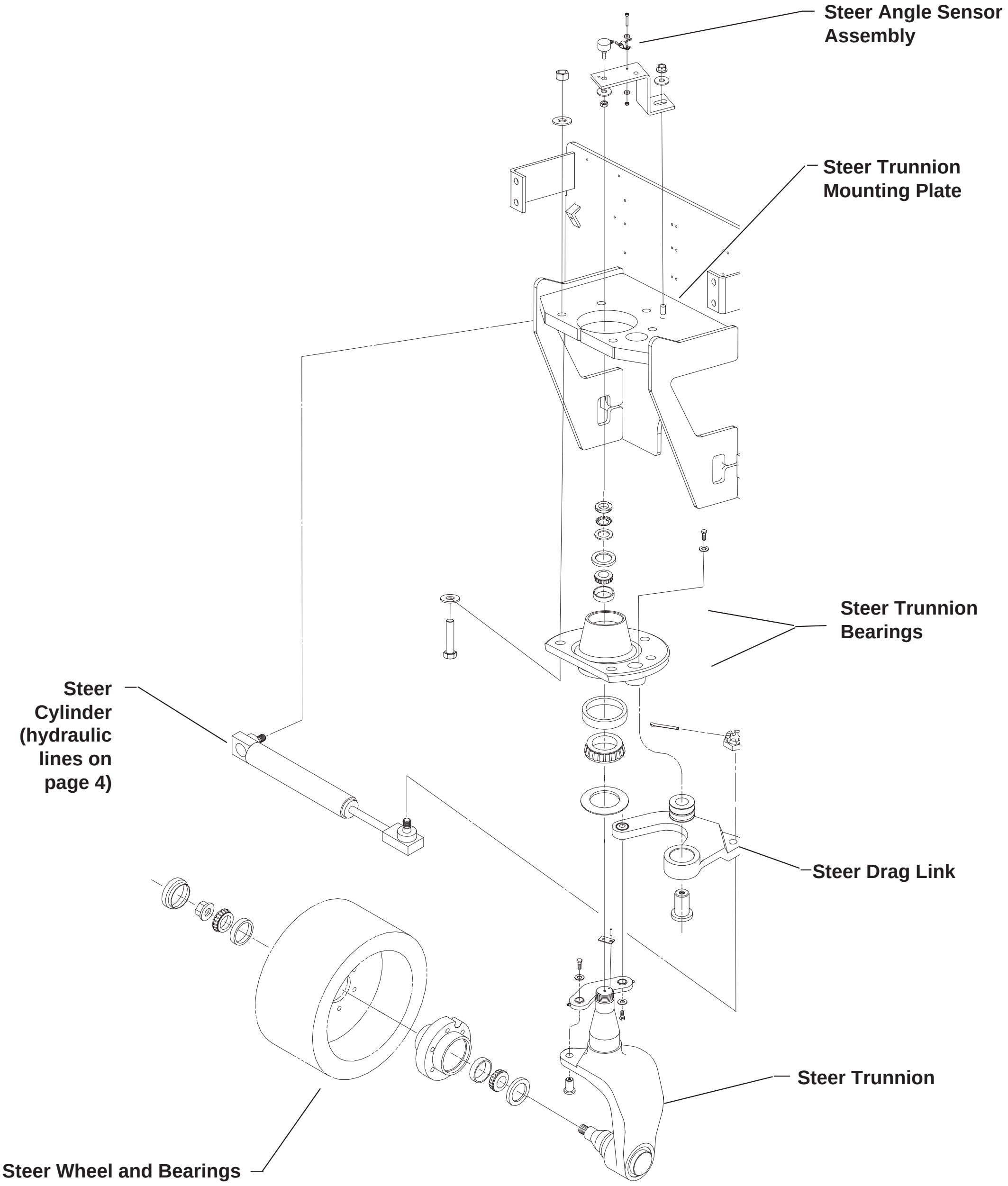


Steer Column and Steer Valve

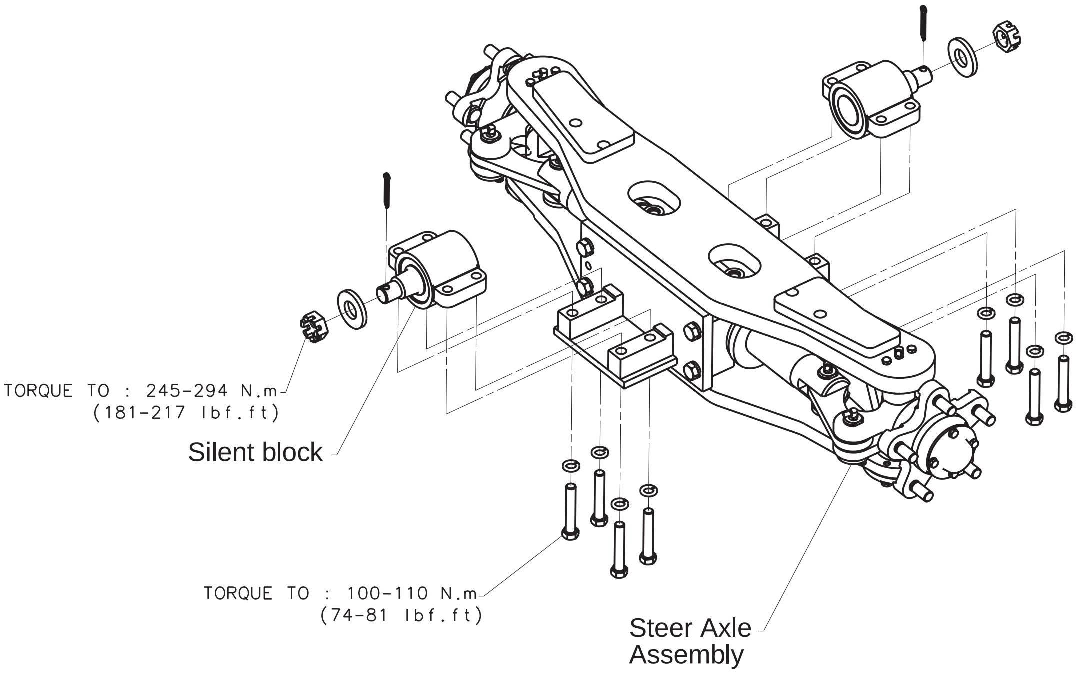
(TMX Truck)

The steer cylinder rod operates a drag link which pivots the steer trunnion and steer wheel mounted to it.

A sensor mounted above the steer trunnion shaft, signals the position of the wheel to the electronic control, which then creates a speed differential between the two drive motors to facilitate cornering.



Steer Linkage(TMX Truck)



Steer Axle assembly(EPX Truck)

Steer Angle Sensor Removal and Replacement

Removal of entire assembly. Replacement is reverse order:

A. Potentiometer wires.
B. Fastener and washer
C. Bracket/Assembly

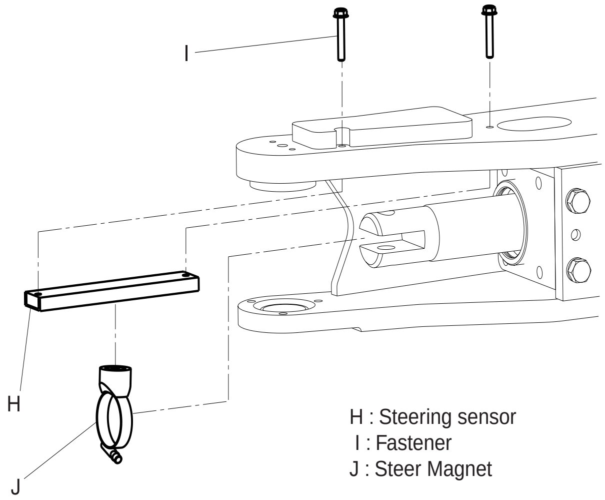
NOTE

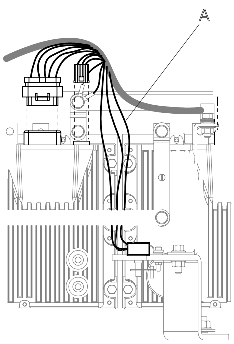
Potentiometer shaft holder (G) and fastener may remain on steer axle. NOTE Potentiometer (E) wire leads should point toward front of truck,.

Removal and replacement (reverse order) of potentiometer only. Replacement is reverse order:

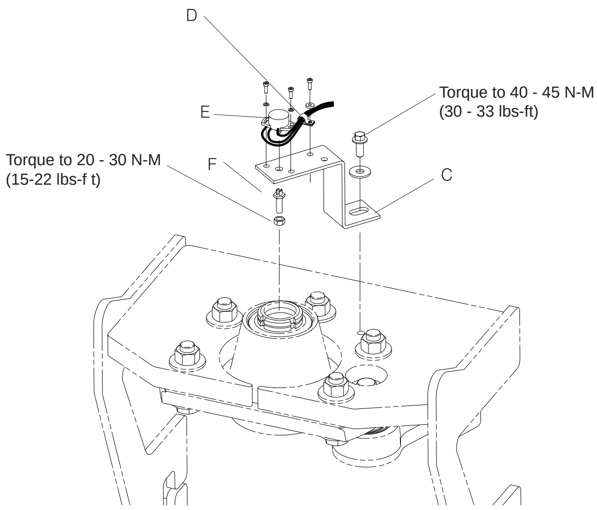
A. Potentiometer wires.
D. Cable clamp
F. Locknut
E. Potentiometer

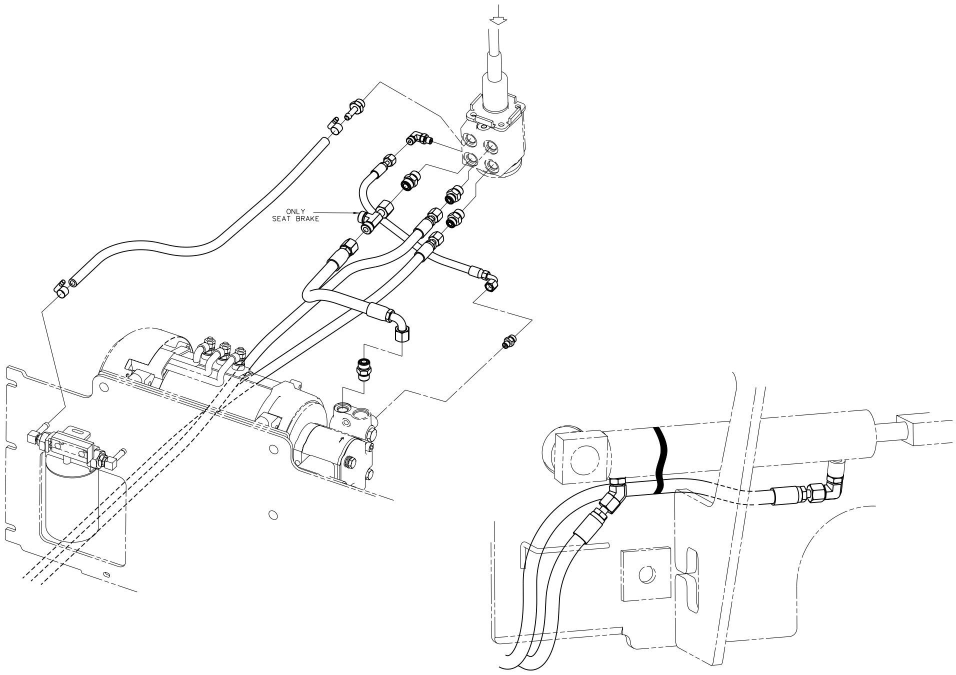
(EPX Truck)



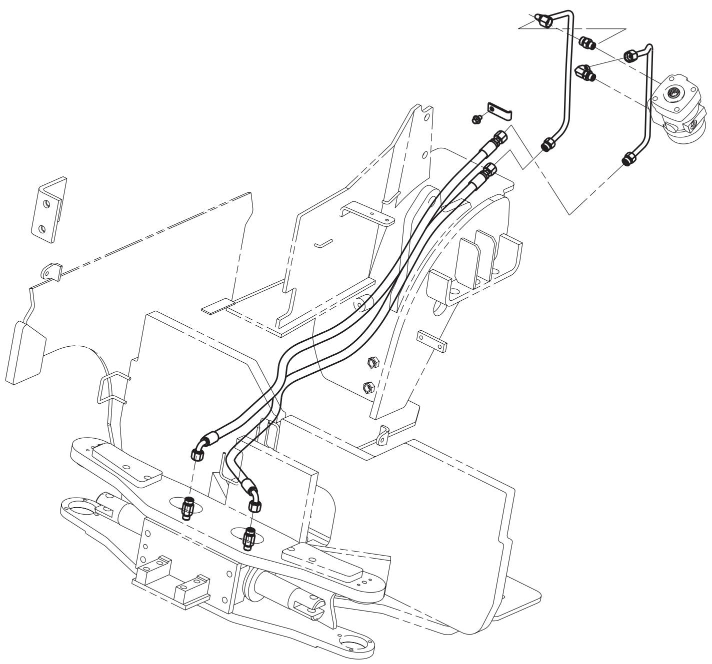


TMX Truck





Hydraulic Connections in Steering System(TMX)



Hydraulic Connections in Steering System(EPX)

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.(EPX)

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.
- Incorrect tire pressure.
- Axle load too heavy.
- U-joint misalignment.
- Lack of lubrication.
- Defective steering gear.
- Spring in priority valve broken.(EPX)

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.
- nsufficient pump flow. Check pump for leaks and see Group 29, Section 3.

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 on intake side of pump. Worn cylinders result in leakage past the piston. Overhaul (see Group 25, Section 7) or replace the steer cylinder.
- Incorrect system pressure due to worn pump. Replace the relief valve or repair or replace the pump (see Group 29).

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.

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. If condition still exists, replace the relief valve.

Low pressure at the pump

- Refer to the pump troubleshooting and overhaul procedures in Group 29.

Low pressure at the steering gear

- Refer to Section 5, “Steering Gear Overhaul.”Low pressure at the steer cylinder
- Seals worn out at piston rod end of steer cylinder; replace seals.(TMX)

Steer cylinder rod binding or sticking

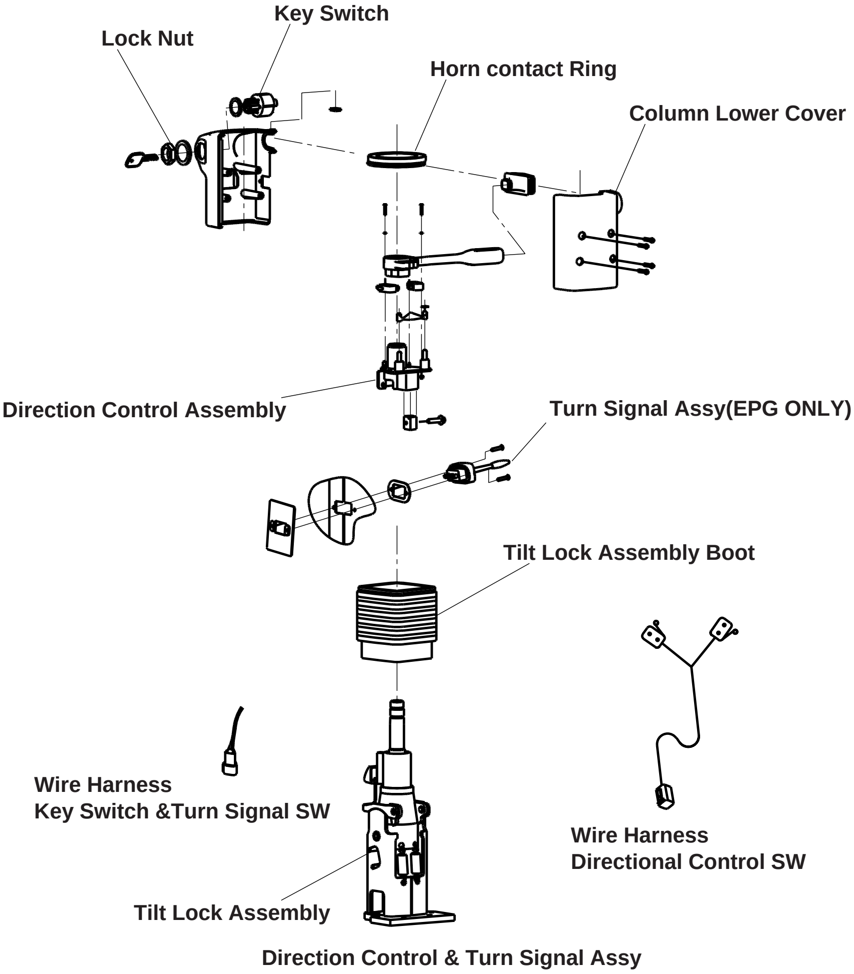
- Binding of linkage. With hydraulic flow shut off from the cylinder and the rod end uncoupled, the rod should slide freely in or out by hand. If the piston is binding, overhaul or replace the cylinder.

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 Assembly

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

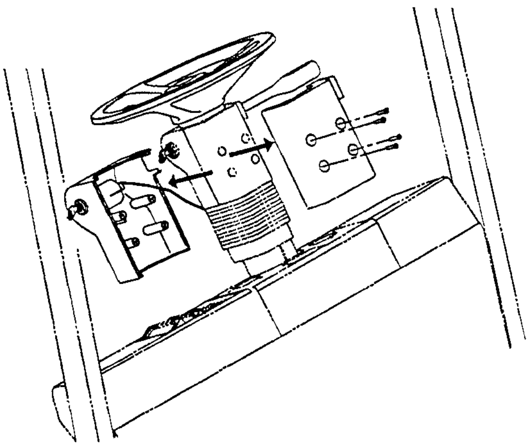
Use the following steps to disassemble the steering column for service to the:

- Key Switch
- Horn Button
- Directional Control Lever Assembly
- Column Tilt Lock Assembly
- Upper and Lower Steer Column
- Steering Gear.

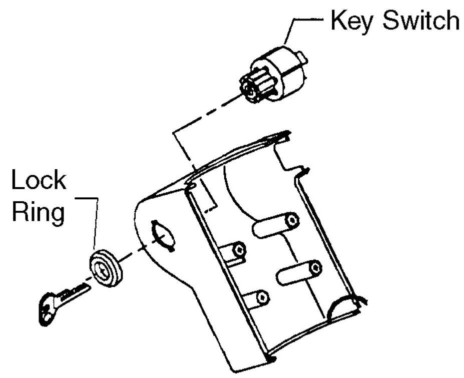
Determine which component requires service and check the procedure for removing that component. Read the procedure completely before beginning disassembly.

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.

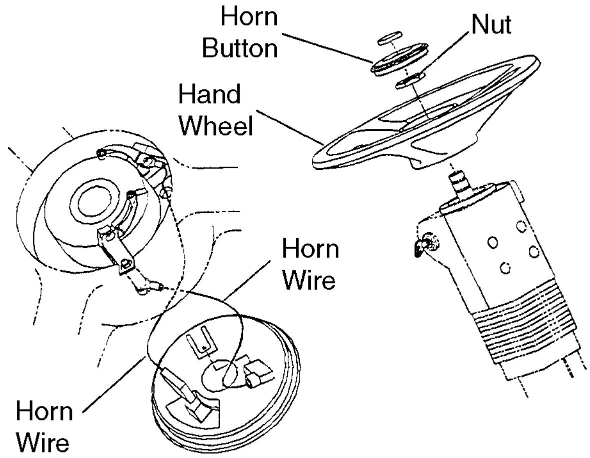


3. Remove the lock ring nut securing the key switch to the lower cover. Label all wires and terminals for correct reconnection when reassembling.



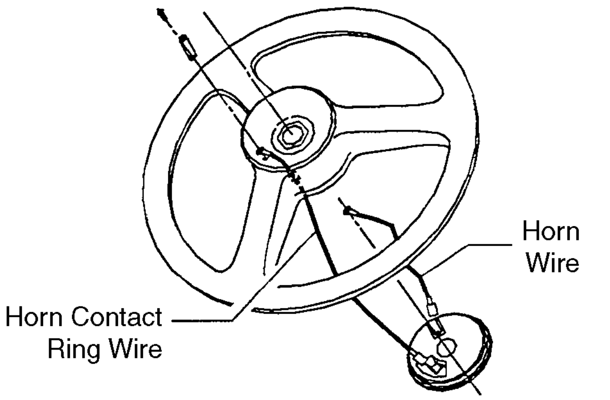
Hand Wheel, Horn Contact Ring, and Directional Control Assembly Removal

1. Disconnect the battery.
2. Gently pry the horn button from the steering hand wheel hub using a small, flat-bladed screw driver.

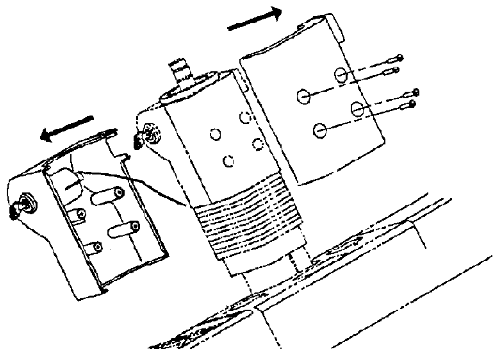


3. Disconnect the horn wire from the steer column and unplug the horn contact wires from the terminal on the bottom of the horn button.
4. Remove the nut holding the hand wheel to the steering column.
5. Use a wheel puller to remove the hand wheel from the steering column. Hand wheel has two M8X1.25 threaded inserts in the hub for this purpose.

6. Unplug the horn contact ring wire from the terminal on the bottom of the handwheel.



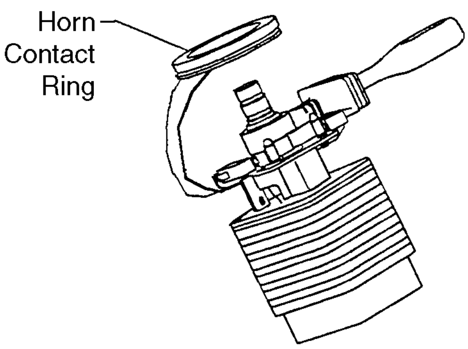
7. Using a 2.5 mm allen wrench, remove the four socket head bolts holding the two halves of the column cover together. Remove the top cover. Gently pull the bottom cover away.



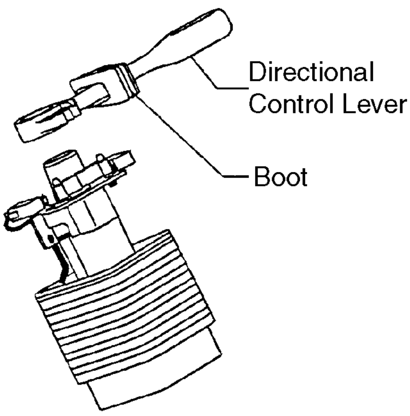
NOTE

Use care when removing the bottom cover as the ignition switch wiring is attached.

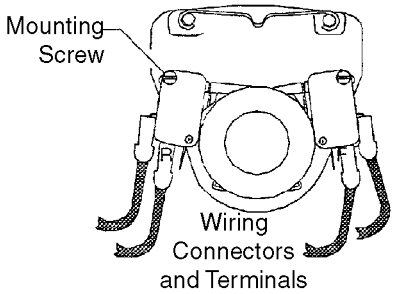
8. Remove the horn contact ring. Unplug the wire from the terminal on the bottom of the ring.



9. Lift the directional control lever and boot off the diecast base.



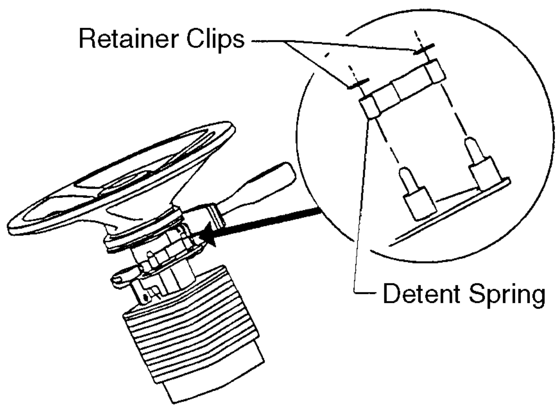
10. Unplug wires from directional switches. Label all wires and terminals for correct connection when reassembling. Remove the direction control switches by removing the mounting screws on the base.



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.

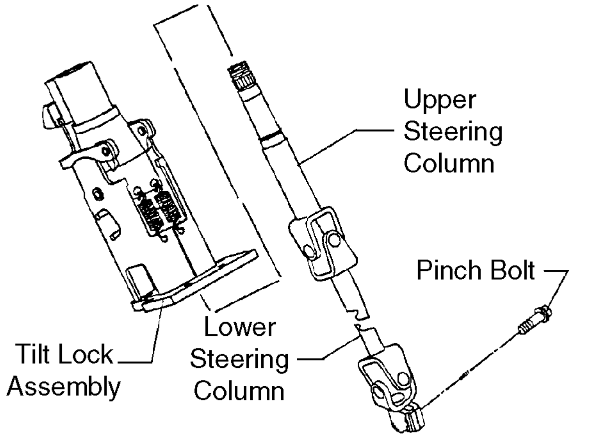


Column Tilt Lock Assembly Removal (TMX)

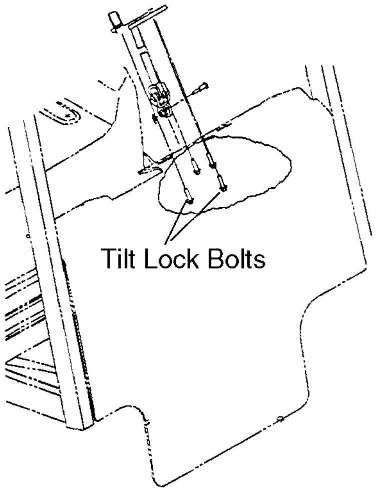
NOTE

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. See"Hand Wheel, Horn ContactRing, and Directional Control Assembly Removal" to remove the steering hand wheel, horn ring, and directional control assembly.
2. Unplug thekey switch anddirectional control switches. Label all wires for correct reassembly. Disconnect the key and directional control wiring harness from the main harness at lower right of cowl.
3. Loosen the pinch bolt of the lower universal joint connection.



4. Remove the four bolts holding the base of the tilt lock assembly to the cowl.

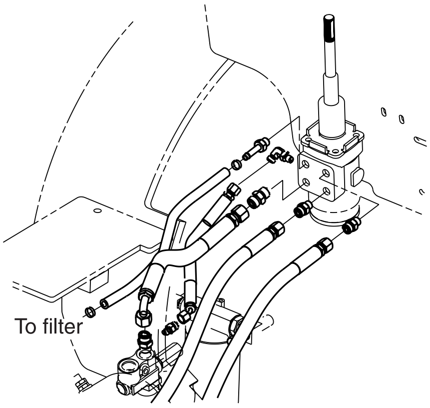


Steering Gear and Lower Steering Column Removal(TMX)

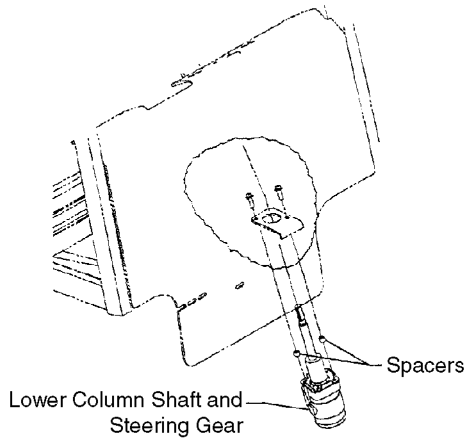
NOTE

Lower steer column is not serviceable. It should be removed only for replacement as a new assembly.

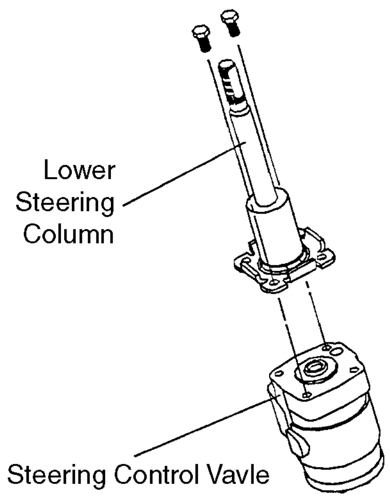
1. Put a pan under the truck to catch hydraulic fluid which will drip when fittings are loosened. Label the four hose fittings of the steering gear to make sure they are reassembled correctly. Loosen and remove the hydraulic fittings at the steering gear. Cap the ends to prevent fluid leaks. Cap the 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.



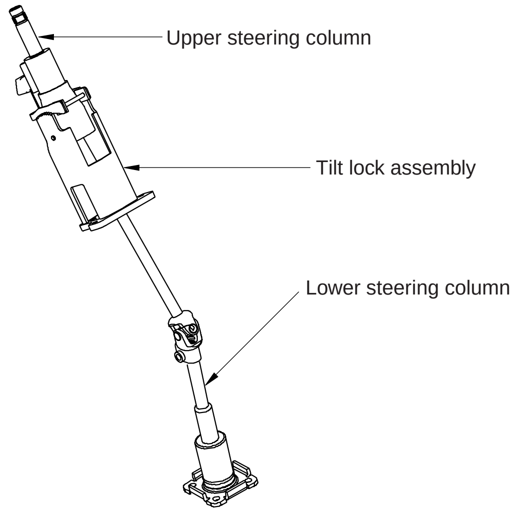
5. Remove the lower shaft and steering gear assembly from the truck.

Column Tilt Lock Assembly Removal (EPX)

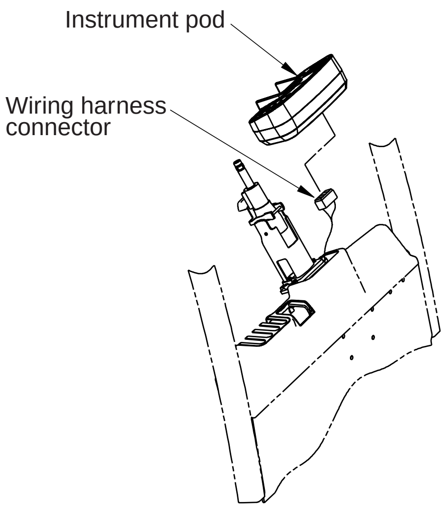
NOTE

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. Raise the operator's seat deck and 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 ignition 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. Loosen the pinch bolt of the lower universal joint connection.

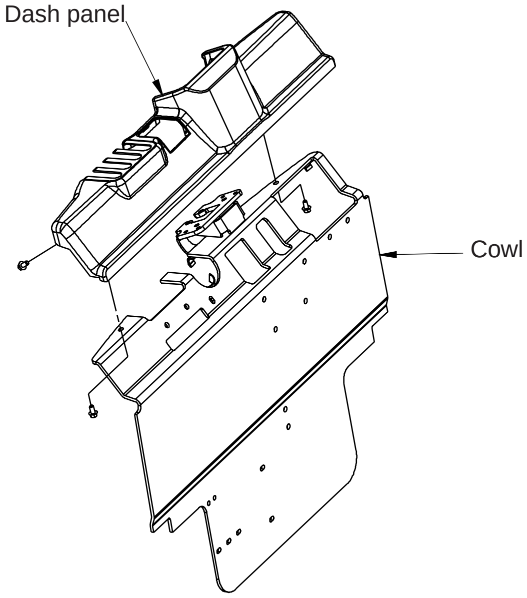


6. Slip the boot off the tilt lock assembly.
7. Remove the dash panel and instrument pod :
   a. Remove the three screws securing the instrument pod to the dash.

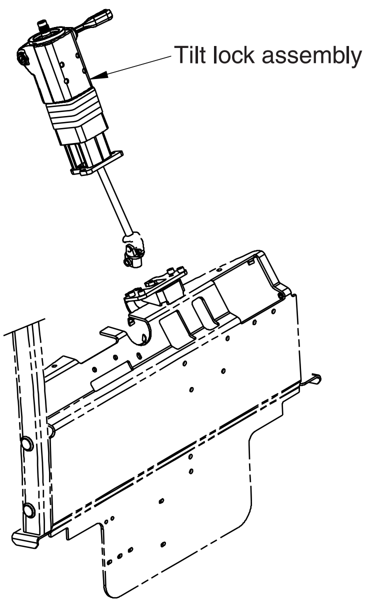


   b. Gently lift the instrument pod up exposing the harness connector. Unscrew jack screw in connector and unplug the connector from the instrument pod.

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.



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

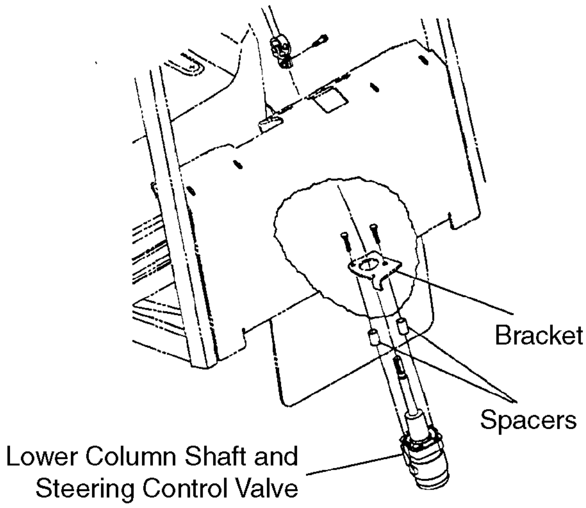
Make sure all parts are clean and dry before reassembling.
It may be necessary to assemble the steering column in place and hand tighten fittings so that the correct alignment of the entire column and parts can be checked.
Once you have the correct alignment, torque all fittings to their correct specifications.

Steering Gear and Lower Steering Column Replacement

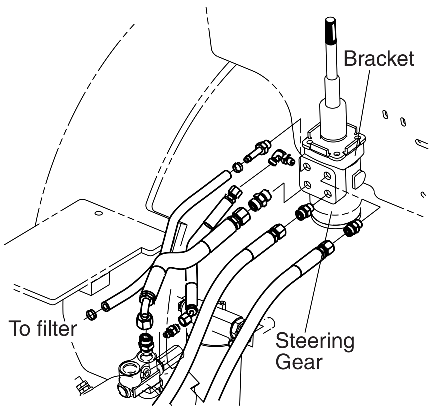
NOTE

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 lower column base. Torque the two bolts to 34-38 N.m (25-28 ft-lb).
2. Set the column into position with the lower column assembly aligned through the bracket mounted on the lower frame cowl.

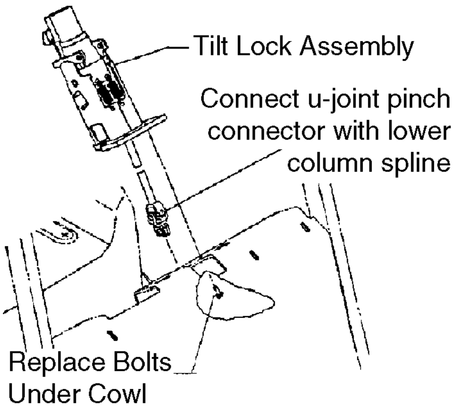


3. Coat the splines of the lower assembly with alight coat of anti-seize lubricant and insert into the universal joint pinch connector of the upper assembly. Match the skip tooth on the spline with spline on universal joint. Torque the pinch bolt to 25-30 N·m (18.5-22.25 ft-lb).
4. Reconnect the clean 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.



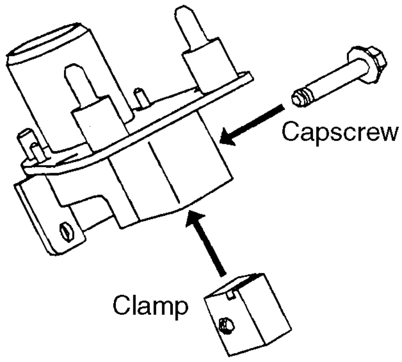
Column Tilt Lock Assembly Replacement EPX)

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).

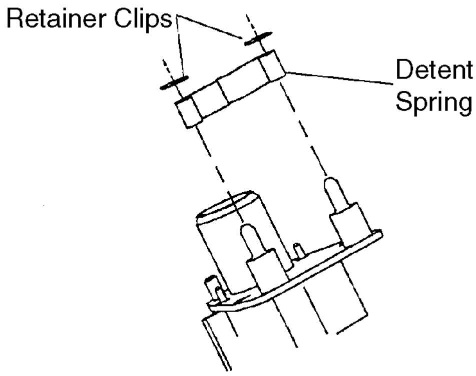


Directional Control Assembly Reassembly

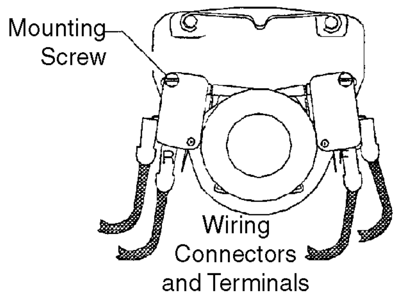
1. Slip the lever boot onto the lever if it has been removed.



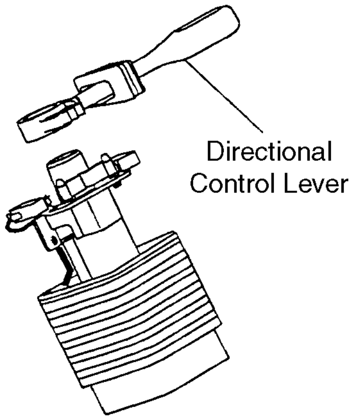
2. Make sure the flange capscrew and clamp are on the directional control base.
3. Install the detent spring on the posts of the base and secure with the retainer clips.



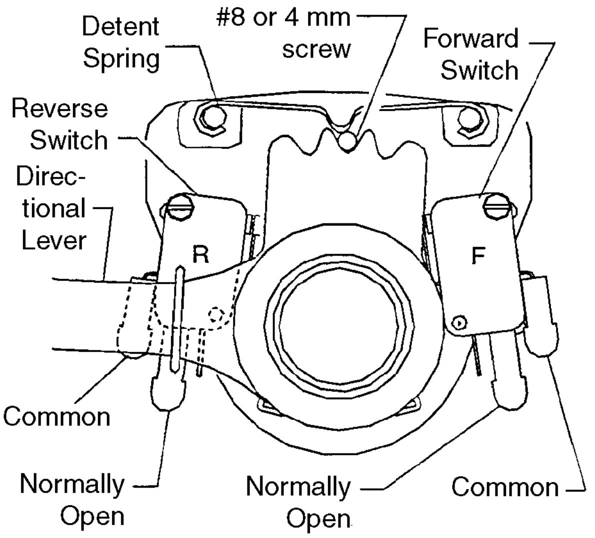
4. Reset the forward or reverse switch onto the base and secure with screws.



5. Apply a thin coat of grease in the bore of the directional control lever. Slip the lever onto the directional control base.



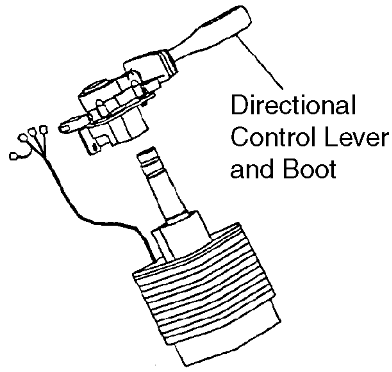
6. Tighten the capscrew/clamp of the directional control lever assembly to 3.5-4 N·m (2.5-2.9 ft-lb).
   - Clean the capscrew and apply Loctite 262 before applying torque.
7. Adjust the directional control using the following illustration:



   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.

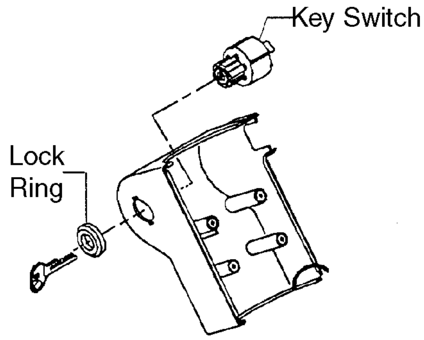
Directional Control Assembly and Key Switch Replacement

1. Disconnect the battery.
2. Slip the directional control assembly onto the steering column shaft.

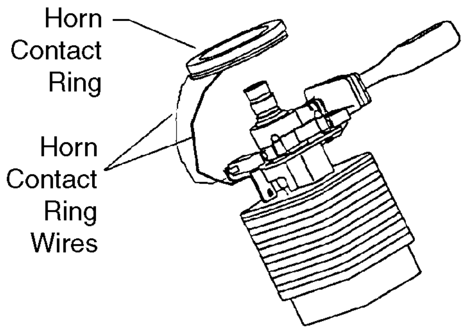


3. Clean the capscrew, apply Loctite 262, and tighten the clamp bolt of the assembly to 3.5-4 N·m (2.5-2.9 ft-lb).
4. Check the assembly for smooth operation and make necessary adjustments before proceeding.
5. Connect the wiring to the directional control switches according to the labels you made during disassembly.

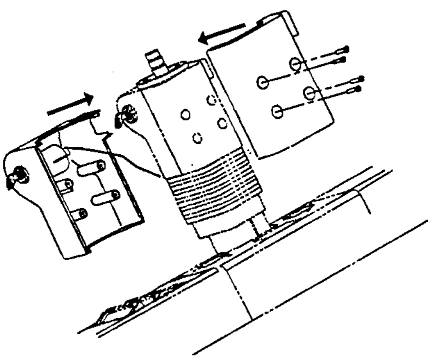
6. Set the key switch into the mounting hole on the lower half of the column cover. Tighten the lock ring nut to lo-14 N·m (7.5-10.3 ft-lb).



7. Reconnect the horn contact ring wires to the horn contact ring.

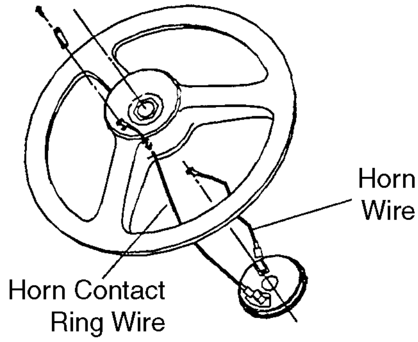


8. Slip the horn contact ring onto the steering column. The groove in the ring should be on the lower portion of the ring when it is replaced on the column. The terminal should be on the right-hand side of the muck.
9. Join both halves of the cover over the upper column. The parting line of the boot 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).

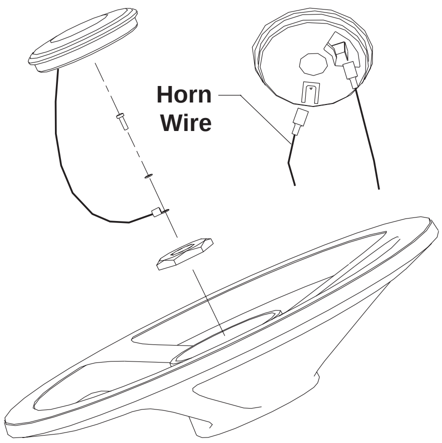


Steering Hand Wheel Replacement

1. Reconnect the horn contact ring wire from the base of the handwheel to the bottom of the horn button.



2. Apply a coat of insulating paste (Clark part no. 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.

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 gear assembly. Steering system relief pressure is adjustable and should be checked if indicated by troubleshooting. A pressure gauge will need to be plumbed into the pressure line from the priority valve on the hydraulic pump to the steering gear assembly to check steering relief pressure.

Steering system relief pressure setting should be 8340-8830kPa (1210~1280psi).

NOTE

If relief pressure is not correct, the problem may be caused by dirt in the valve or relief valve on the steer pump 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 injected 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.

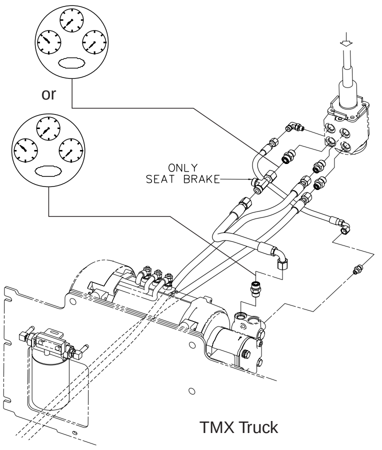
Steering System Relief Pressure Setting Check and Adjustment

This procedure requires installation of a pressure gauge in the pressure line from the priority valve on the hydraulic pump to the steering gear assembly. 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).

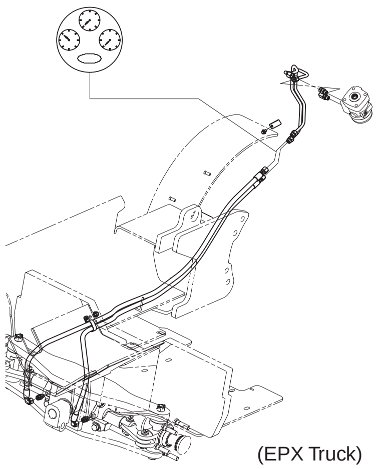
1. Tilt the steering column fully forward and raise the seat deck.

2. Remove floor plate to access steering gear.

3. Install Quadrigage in the pressure line to the steering gear.



TMX Truck



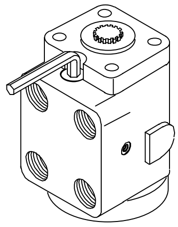
(EPX Truck)

4. Put the key in the key switch and turn it On.

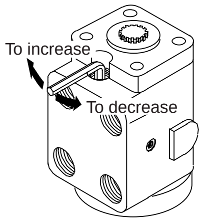
5. Turn the steering handwheel in one direction until steering cylinder reaches its stop (relief bypass). Hold steering handwheel in relief position until pressure reading is taken, and then release. Turn key switch Off. Pressure should read 8340-8830kPa (1210~1280psi).

6. To adjust the steering pressure relief to 8340-8830kPa (1210~1280psi):

   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



7. Repeat check and adjustment procedure until correct relief pressure is set.
   - If the correct relief pressure cannot be gained, consider overhauling the hydraulic pump or replacing the pressure relief valve.

8. Disconnect the tee and pressure gauge, reconnect lines, and reinstall the adjustment port plug.

9. Test drive the truck and insure that the steering is performing satisfactory.

Section 5

Steering Gear Overhaul (TMX)

IMPOTANT

Before removing any component for overhaul, make sure the correct repair parts, seals, and gasket sets are available.

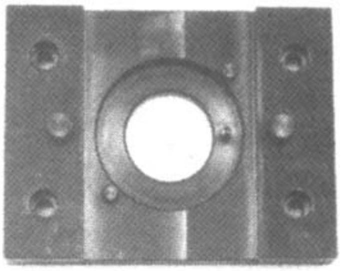
NOTE

The following material does not show the load sensing port on the steering gear (steering control unit). The port is located in the center of the other four ports. The load sensing port requires no special overhaul procedures.

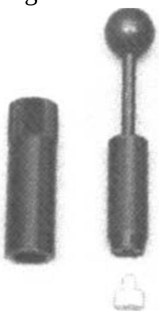
Steering Unit

Tools

Holding tool



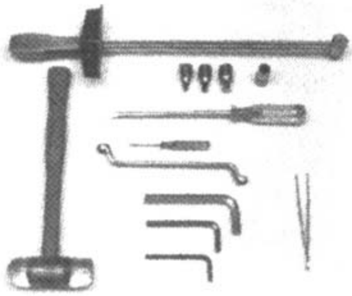
Assembly tool for O-ring and kin-ring.



Assembly tool for cardan shaft

Assembly tool for dust seal

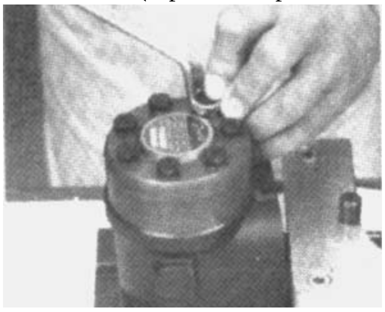
Torque wrench 0~7 kgf.m(0~50 lbf ft)
13mm socket(12 point)
6, 8 and 12mm hexagon sockets
12mm screwdriver
2mm screwdriver
13mm ring spanner
6, 8 and 12mm hexagon L wrench
Plastic hammer
Tweezers



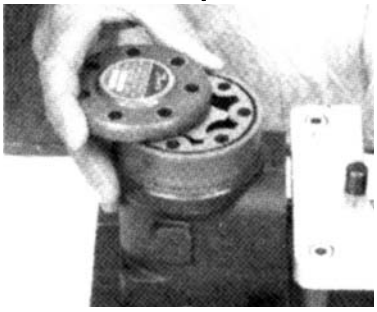
The tools listed above are not available from CLARK.

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).

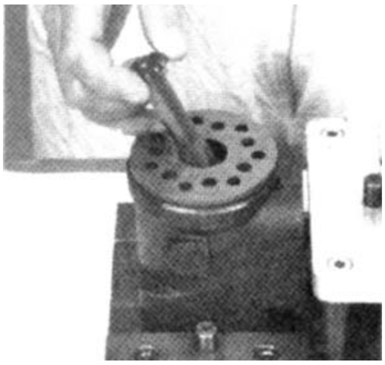


Remove the end cover, sideways.



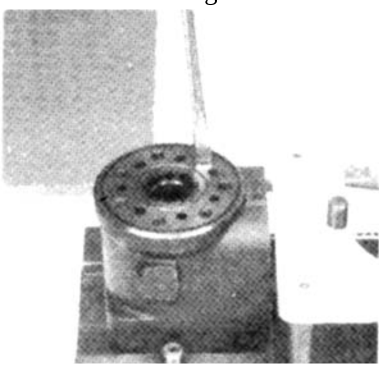
Lift the gerotor set(with spacer if fitted) off the unit. Take out the two O-rings.

Remove cardan shaft.



Remove distributor plate.

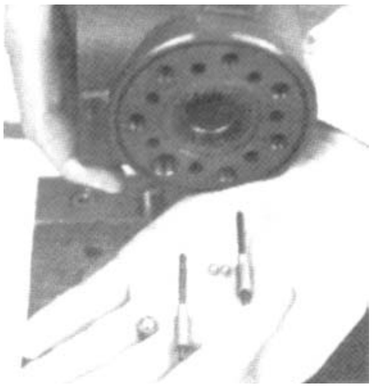
Screw out the threaded bushing over the check valve.



Remove O-ring.

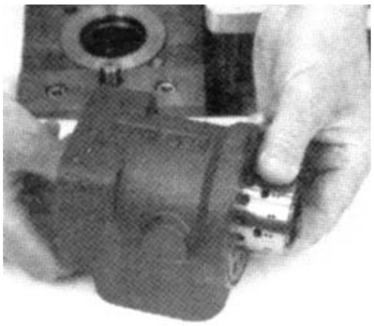
Shake out the check valve ball(Φ 8 mm)

Shake out the two anticavitation check valve balls.(if equipped)

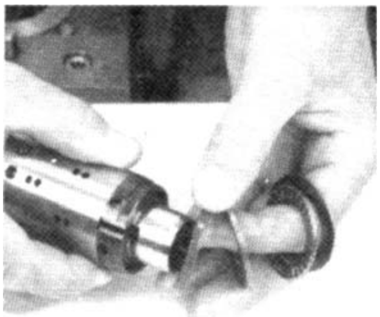


Take care to keep the cross pin in the sleeve and spool horizontal.

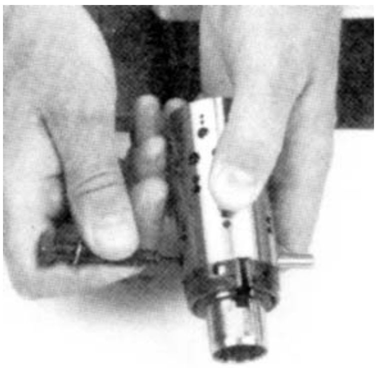
The pin can be seen through the open end of the spool. Press the spool inwards and the sleeve, ring, bearing races and needle bearing will be pushed out of the housing together.



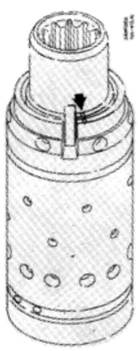
Take the ring, bearing races and needle bearing from sleeve and spool. The outer(thin) bearing race can sometimes "stick" in the housing, therefore check that it has come out.



Press out the cross pin. Use the special screw from the end cover.

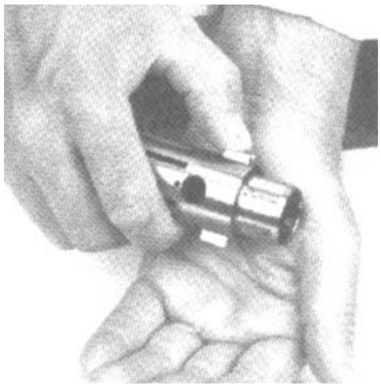


A small mark has been made with a pumice stone on both the spool and sleeve close to one of the slots for the neutral position springs (see drawing) If the mark is not visible, remember to leave a mark of your own on the sleeve and spool before the neutral position springs are disassembled.

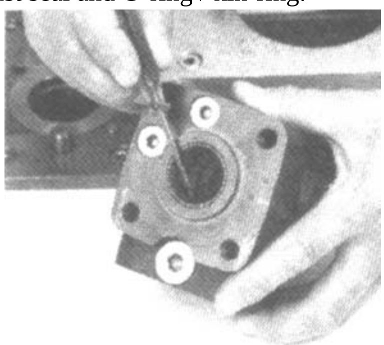


Carefully press the spool out of the sleeve.

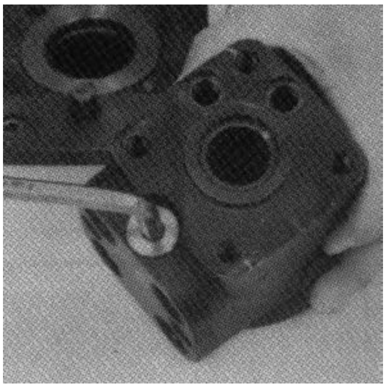
Press the neutral position springs out of their slots in the spool.



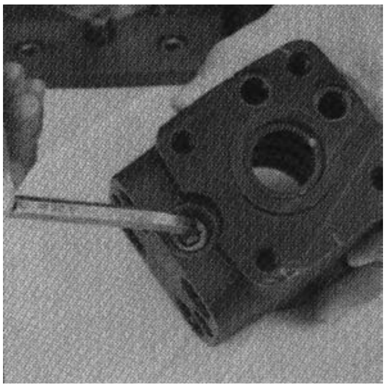
Remove dust seal and O-ring / kin-ring.



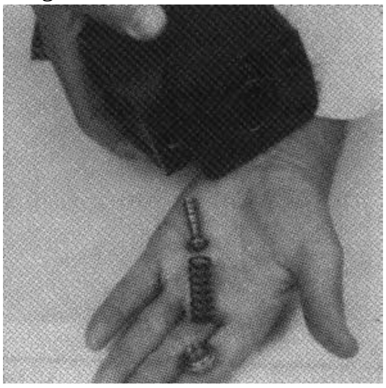
Screw out the plug using and 6 mm hexagon L wrench. Remove seal washers.



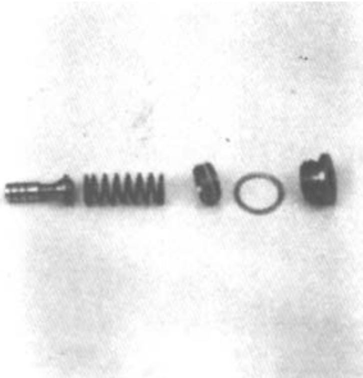
Unscrew the relief set screw using and 6 mm hexagon L wrench.



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.

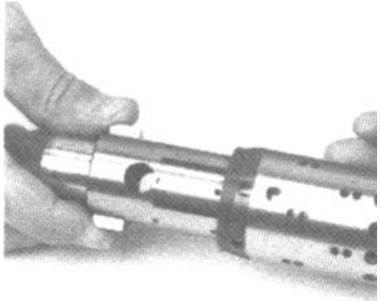
Place the two flat neutral position springs in the slot.

Place the curved springs between the flat ones and press them into place.

Line up the spring set.

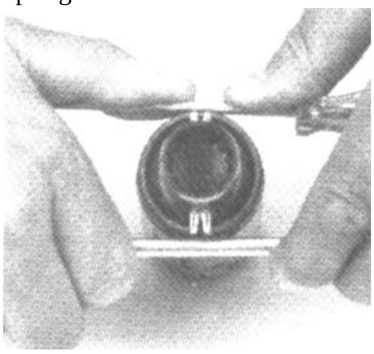
Guide the spool into the sleeve.

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.

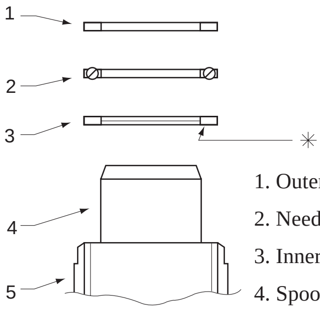
WARNING

The ring should be able to rotate free of the springs.

Fit the cross pin into the spool/sleeve.

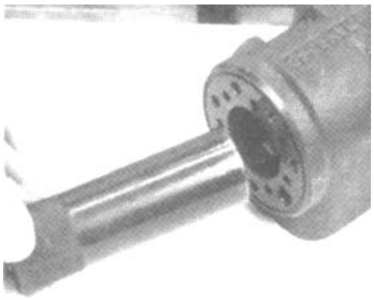
Fit bearing races and needle bearing as illustrated.

Assemble Pattern For Standard Bearings

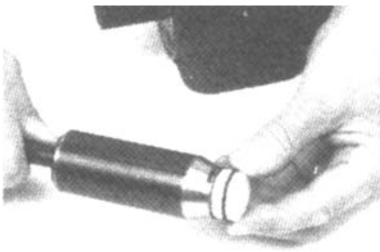


1. Outer bearing race
2. Needle bearing
3. Inner bearing race *(thicker)
4. Spool

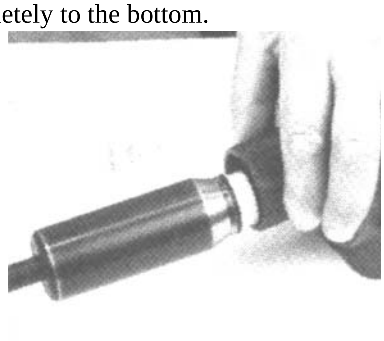
Turn the steering unit until the bore is horizontal. Guide the outer part of the assembly tool into the bore for the spool/ sleeve.



Grease O-ring and kin-ring with hydraulic oil and place them on the tool.

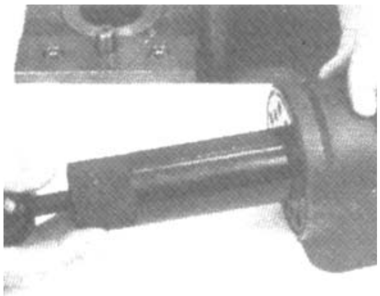


Hold the outer part of the assembly tool in the bottom of the steering unit housing and guide the inner part of the tool completely to the bottom.



Press and turn the O-ring / kin-ring into position in the housing.

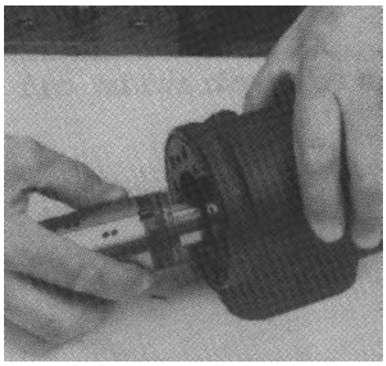
Draw the inner and outer parts of the assembly tool out of the steering unit bore, leaving the guide from the inner part in the bore.



With a light turning movement, guide the spool and sleeve into the bore.

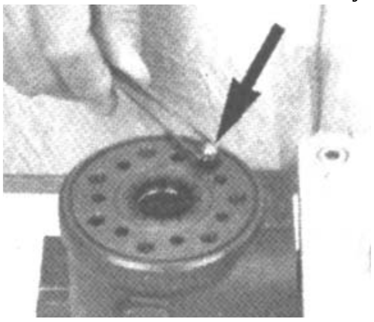
WARNING

Fit the spool set holding the cross pin horizontal.

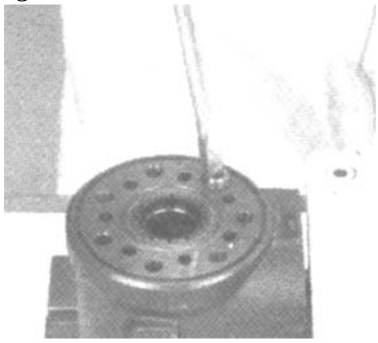


The spool set will push out the assembly tool guide. The Oring and kin-ring are now in position.

Turn the steering unit until the bore is vertical again. Put the check valve ball into the hole indicated by the arrow.

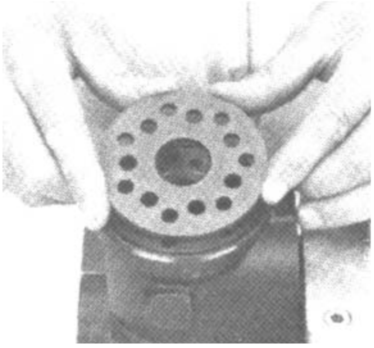


Screw the threaded bushing lightly into the check valve bore. The top of the bush must lie just below the surface of the housing.

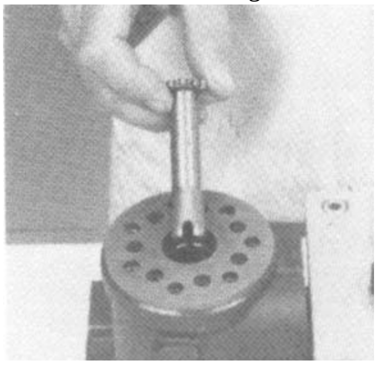


Grease the O-ring with mineral oil approx. viscosity 500 cSt at 20°C.

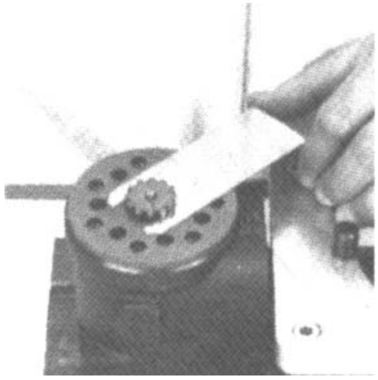
Place the distributor plate so that the channel holes match the holes in the housing.



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.



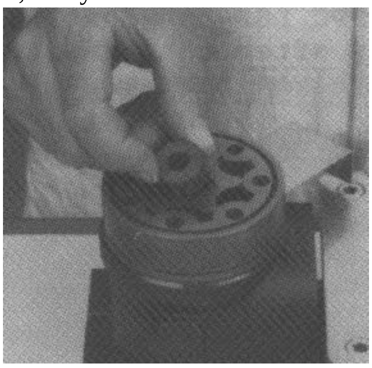
Grease the two O-ring with mineral oil approx. viscosity 500 cSt 20°C and place them in the two grooves in gerotor assy.

Fit the gerotor assembly on the cardan shaft.

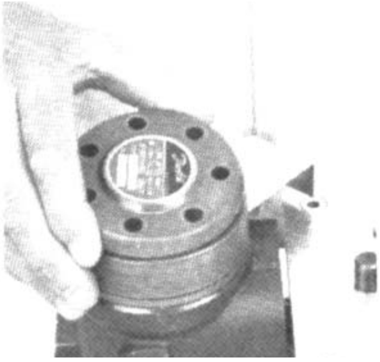
WARNING

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.

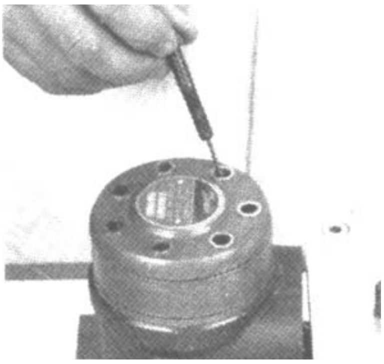
Fit the spacer, if any.



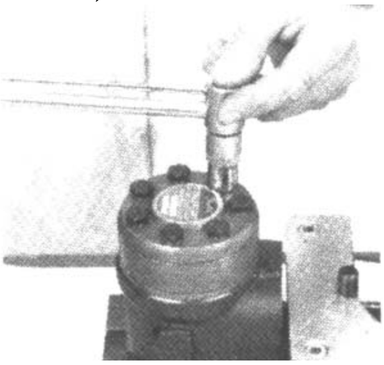
Place the end cover in position.



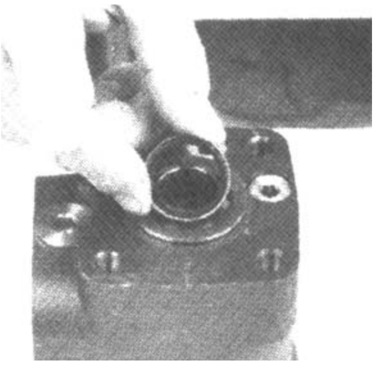
Fit the special screw with washer and place it in the hole shown.



Fit the six screws with washers and insert them. Crosstighten all the screws in several stages. 3.0 ± 0.3 kgf.m(22 ± 2 lbf.ft)



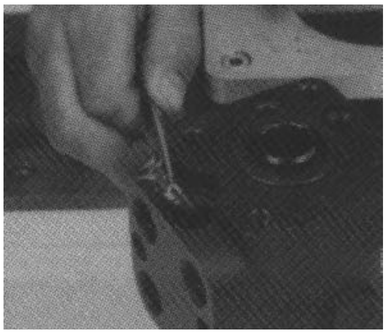
Place the dust seal ring in the housing. Ther dust seal ring must be placed only after the pressure relief valve has been fitted.



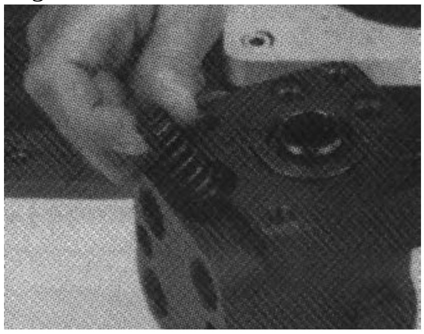
Fit the dust seal ring in the housing using special tool and a plastic hammer.

Press the plastic plugs into the connection ports. Do NOT use a hammer.

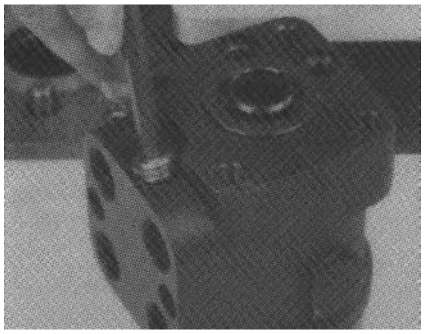
Fit the piston.



Fit the spring.

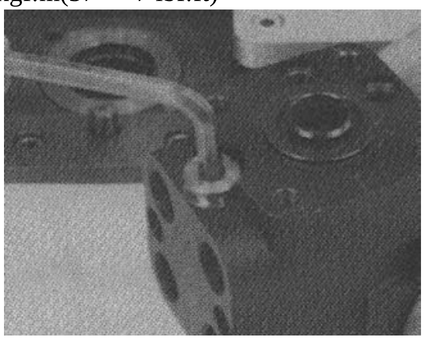


Screw in the relief screw with an 8 mm hexagon L wrench.
Adjust the pressure setting on a test bench or in the vehicle.



Install the plug with dust seal into the housing using an 8 mm hexagon L wrench.

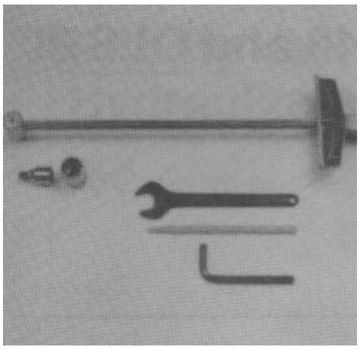
5.1 ± 1 kgf.m(37 ± 7 lbf.ft)



Priority Valve

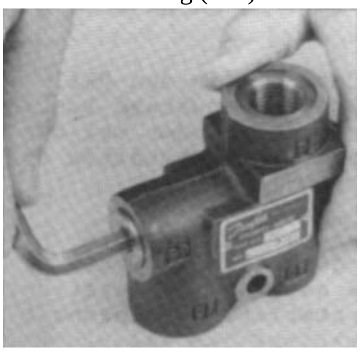
Tools

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.

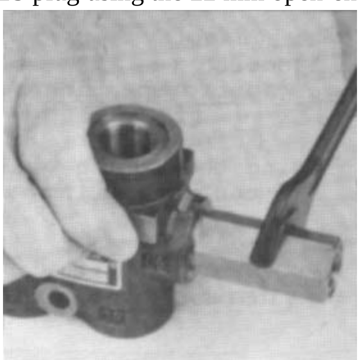


Disassembly

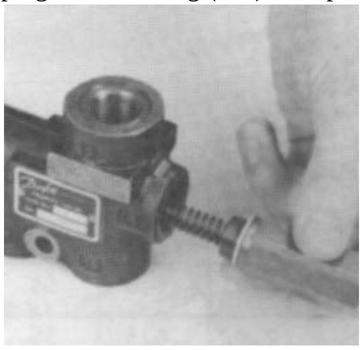
Screw out the PP plug using the 8 mm hexagon Allen Wrench. Remove the seal ring (alu.)



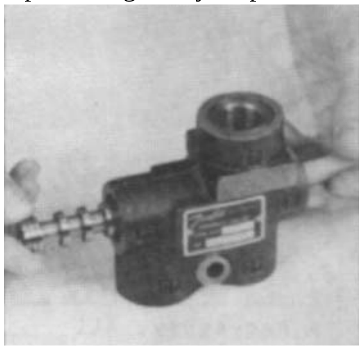
Loosen the LS plug using the 22 mm open-end spanner.



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

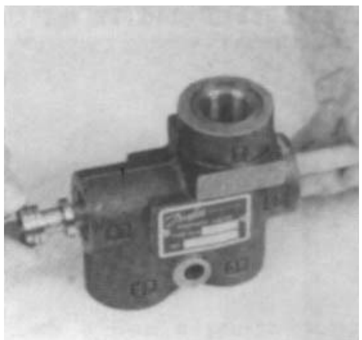
Check all parts carefully and make any replacements necessary. All seal rings must be replaced.

Lubrication

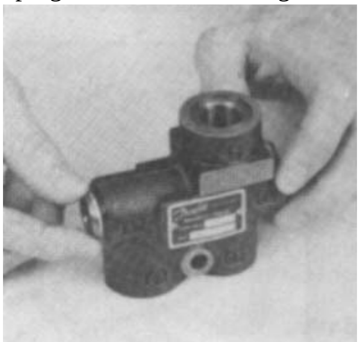
Before assembly, lubricate all parts with hydraulic oil.

Assembly

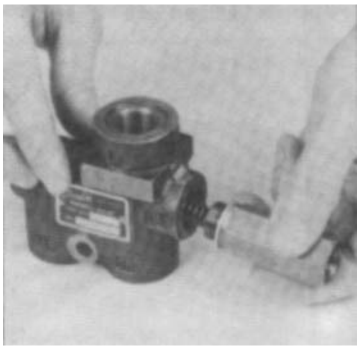
Guide the spool into the bore. Use the nylon pin to center the spool in the bore.



Put in the PP plug. Remember seal ring.



Guide the spring and LS plug into the bore. Remember seal ring.

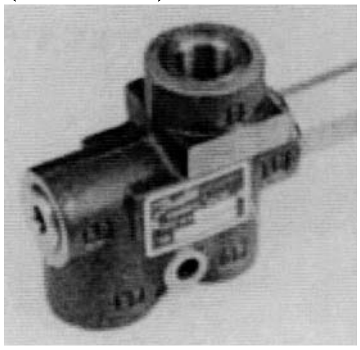


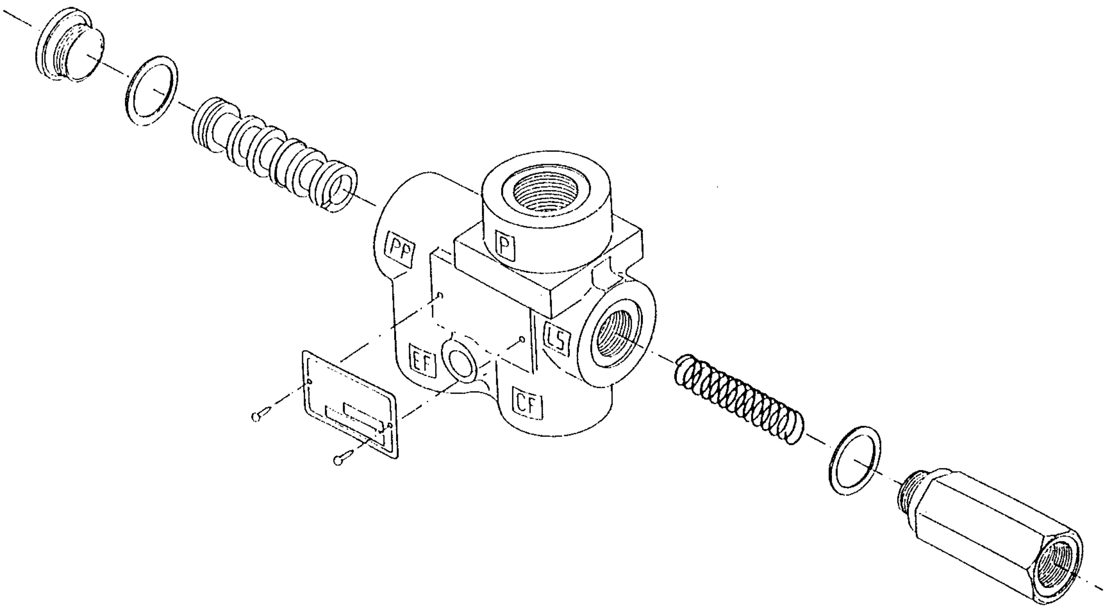
Tighten the LS plug with a torque wrench using a 22 mm hexagon socket.

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)



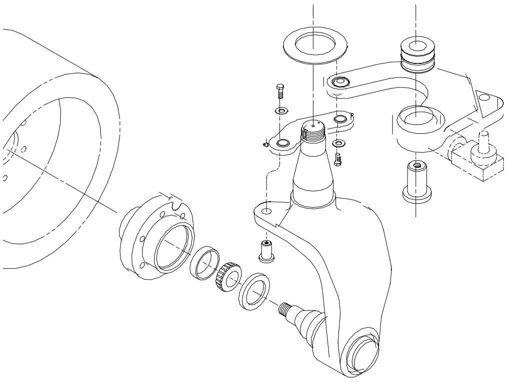


Section 6

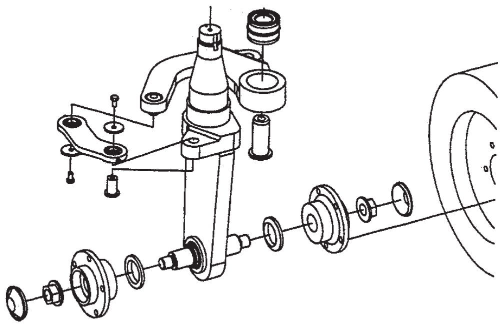
Steer Axle Service (TMX)

NOTE

DUAL-WHEEL and SINGLE-WHEEL STEER AXLES.
This Section shows overhaul procedures for a single-wheel steer axle. However, the procedures and torque specifications can be applied to the dual-wheel steer axle as well.



Single-Wheel Steer Axle



Dual-Wheel Steer Axle

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.

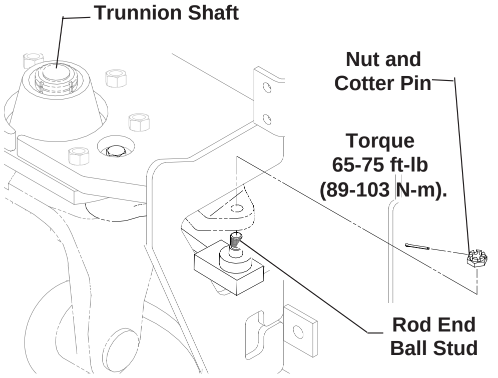
4. Apply the parking brake and block the wheels.

Steer Axle Trunnion Bearings Check

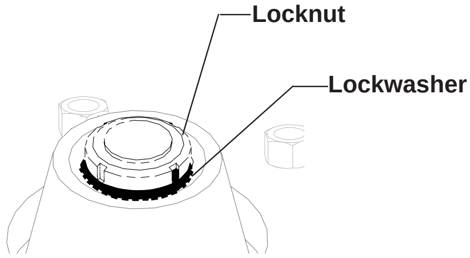
1. Be sure that truck is parked and blocked up correctly to raise the steer wheel off the floor.
2. Inspect the steer axle and trunnion for damage and wear.
3. Check the steer axle trunnion bearings for excessive free-play or looseness. Hold the steer wheel with both hands and try to move the entire steer axle in the trunnion bearings. Be sure that any movement that you feel is not due to wheel bearing clearance free-play. If the trunnion bearings have excessive looseness, the bearings require adjustment.

Steer Trunnion Bearing Adjustment

1. Remove battery from truck, for best access to top of steer axle trunnion. Refer to Group 12 for battery removal procedure.
   It is not necessary to remove the hood and counterweight. However, access to the steer trunnion bearings is much easier when the counterweight is removed.
2. Remove the drive motor steer angle sensor assembly that is mounted atop the steer trunnion. The procedure is shown later in this Section.



3. Disconnect the rod end of the steer cylinder as shown below. This will allow the steer axle to be moved (rotated) freely while adjusting the trunnion bearings.
4. Bend lock washer tab clear of slot in locknut. Loosen locknut several turns, but do not remove.
5. Loosen the bearings by rotating the trunnion shaft and/or shaking the steer wheel from right to left.
6. Tighten the retaining nut to 271 N.m (220 ft-lb) to seat the bearings. Then loosen the retaining nut and retighten to 20-27 N.m (14.8-20.0 ft-lb).



7. Bend a lock washer tab back into a slot in the locknut.
8. Check for free movement of the trunnion shaft and bearings by turning the steer axle to the right and left.
9. Check trunnion bearing preload.
   Put a torque wrench on the locknut. It should require 2.0-2.7 N.m (1.5-2.0 ft-lb) rolling torque to rotate the steer axle in the trunnion bearings. Tighten or loosen the retaining nut to obtain correct preload torque.
10. Install steer cylinder rod end, steer angle sensor assembly, and battery.
    Installation of steer angle assembly is described later in this Section. Adjustment is described in Group 13.

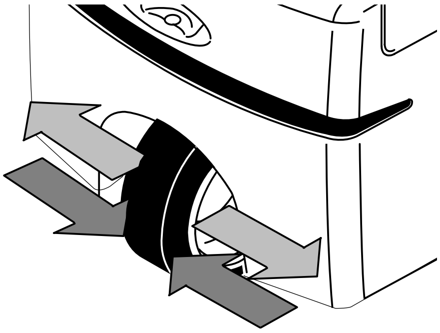
Steer Wheel Bearing Maintenance

1. Be sure that truck is parked and blocked up correctly to raise the steer wheel off the floor.

NOTE

It is optional to raise and block up entire truck.

2. To check the steer wheel bearings for excessive free play or looseness, hold the wheel with both hands and try to rock it from side to side. Also, try to pull it in and out along the wheel spindle. There should be a small amount of free movement. (The maximum allowable bearing end play is 0.08 mm [0.003 in]). If the wheel has excessive end play, the bearings require additional service and/or adjustment.



Steer Wheel Bearing Adjustment

The steer wheel bearings are retained and adjusted by a self-locking bearing nut. With truck properly blocked:

1. Remove hubcap by tapping lightly on the outer edge of hubcap.
2. Loosen spindle (bearing adjusting) nut and bearings: After spindle nut is loosened, hit the top of wheel to loosen the bearings.

IMPORTANT

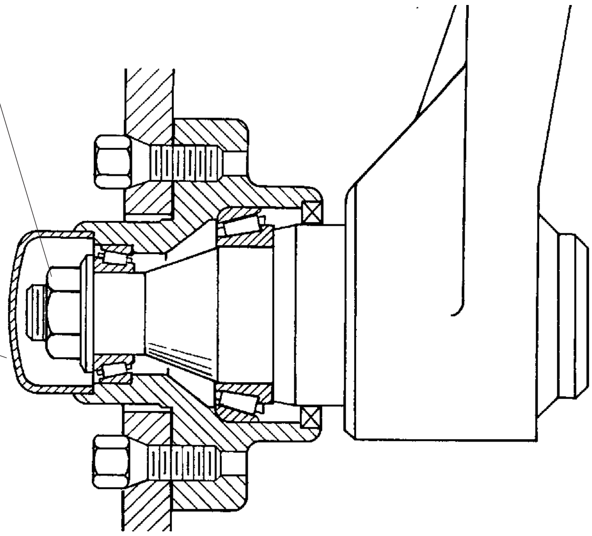
SPINDLE NUT SHOULD BE REPLACED WITH A NEW ONE each time it is removed because holding torque capability is partially destroyed with each removal.

3. Tighten spindle nut to the correct tightening torque while rotating the wheel by hand: 230-244 N.m (170-180 ft-lb).

NOTE

Set the steer wheel bearing adjustment by torquing the self-locking spindle nut to the specified value. Overtightening causes drag and results in lower travel speed and higher power use. Some additional adjustment may be required however. See next step.

4. Check for correct bearing adjustment by rotating the wheel by hand. Wheel should rotate freely or with only slight “drag.” Readjust bearings as necessary.
5. Install the hub cap by tapping it into place with a rubber or plastic-faced hammer.



Steer Wheel Bearing Lubrication and Replacement

To clean, repack and adjust bearings:

1. Be sure that truck is parked and blocked up correctly to raise the steer wheel off the floor.
2. Remove the wheel and tire assembly. (Place a block of wood under the tire to prevent rotation of the wheel when loosening the lug bolts. Use a pry bar under the tire to help move the wheel on and off the wheel hub.)

IMPORTANT

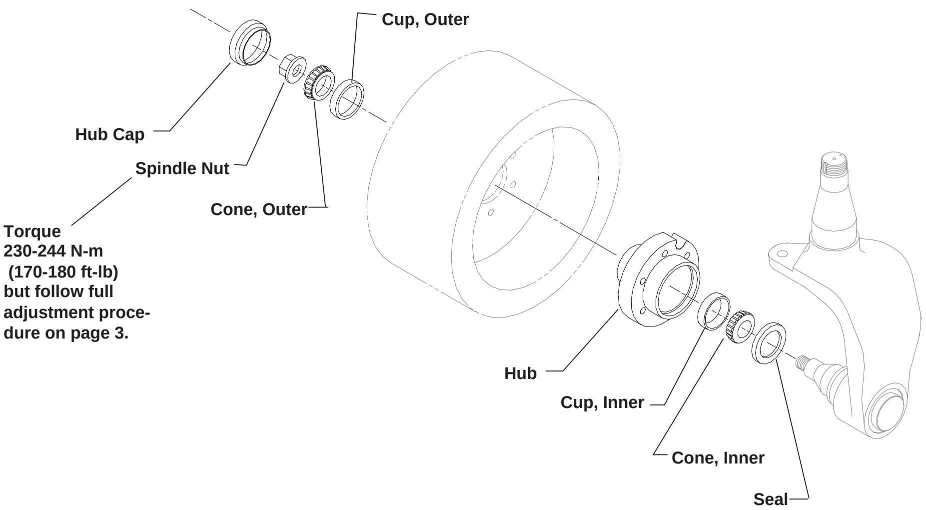
It is recommended that you first remove the wheel when servicing the bearings. The heavy weight of the wheel and tire can cause damage to the grease seal when the wheel hub is moved on the spindle. It also makes the work simpler and easier.

3. Remove hub cap from wheel hub.
4. Clean the excess grease from around the spindle nut.
5. Loosen and remove the spindle nut.
6. Remove the outer bearing cone.
7. Pull the wheel hub off the spindle. Hold the hub firmly to avoid dragging the grease seal at the back side across the threads on spindle end.
8. Clean the old grease out of center of wheel hub.
9. Clean and inspect the bearing cups and cones for wear and other damage. Replace if necessary.

NOTE

Always replace damaged bearing cups and cones as a set.

10. If bearings require replacement, remove the grease seal and the inner bearing cone using a brass drift pin or rod to drive the bearing and seal out of the hub. Grease seal may be first removed by using a puller or prying out of the bore in hub (damage is unimportant; install new seal at assembly). Use a standard puller to remove the bearing cups.
11. Install new bearing cups by pressing into wheel hub. Be sure cups are fully seated in bearing bore.
12. Pack the bearings with grease and install the inner bearing in the hub.
13. Recommended greasing procedure:
    a. Use MP grease NLG # 2.
    b. Pack bearings with grease before assembly.
    c. Pack cavity in hub between bearings one-half full with grease at assembly.
14. Put the hub on the spindle. Be careful not to damage seal lip when moving the hub over the end of spindle and threads.
15. Install the outer wheel bearing after it has been packed with grease.
16. Install NEW spindle nut. Adjust spindle nut and bearing as explained on page 3.
17. Replace hub cap and remove truck from blocks.



Steer Angle Sensor Removal and Replacement

Description

The steer angle sensor is mounted atop the steer axle trunion assembly. This device helps the drive motor control generate an efficient speed differential between the two drive motors when the truck is cornering,

The steer angle sensor is a potentiometer that translates the angle of rotation of the steer angle into a voltage level read by the Dual AC control. When the steer wheel is straight ahead (0° turn angle) the input signal to the control should be at the mid point. As the vehicle turns left, this input signal decreases. As the vehicle turns right, the input signal increases.

Check and Adjustment

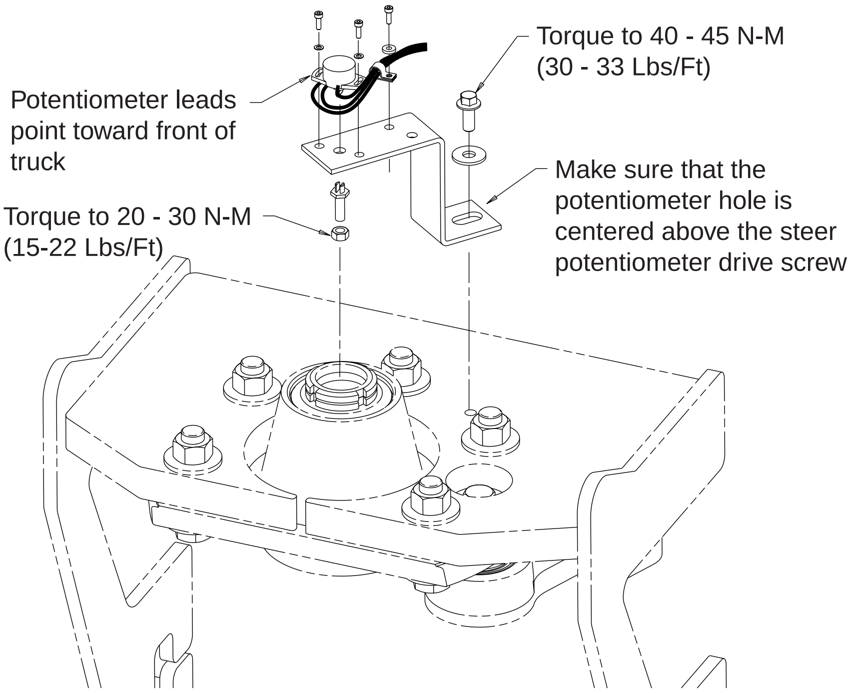
CAUTION

Before any adjustments are done, safely jack up the truck, block the drive wheels off the floor, disconnect the battery, and discharge the capacitors as described in Group SA

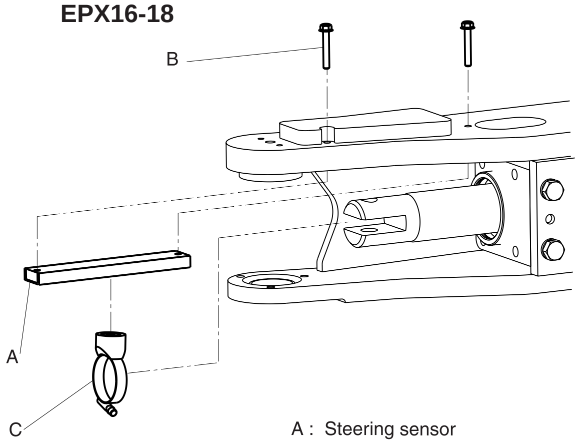
Use the following method to adjust the steer angle sensor with the handset:
(Detailed handset operation instructions are in Group 19.)

- 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 the roll down button once
- Display will read "CONFIG MENU" ADJUSTMENT
- Press "ENTER" button
- Display will read "SET POT BRK MIN"
- Press "ROLL UP" button (6) times
- Display will read "SET STEER O-POS"
- Press "ENTER" button
- Adjust the steer wheel to where it appears to be centered
- Press "ENTER" button
- Press "OUT button
- Display will read "ARE YOU SURE" "YES=ENTER" "NO=OUT"
- Press "ENTER" button (this stores the value to be used for Steering 0 position)
- Display will read "CONFIG MENU" ADJUSTMENT
- Press "ENTER" button
- Display will read "SET POT BRK MIN"
- Press "ROLL UP" button (5) times
- Display will read "MAX STEER LEFT"
- Turn steer wheel all the way lo the left
- Press "ENTER" button
- Press "OUT button
- Display will read "ARE YOU SURE"
- "YES=ENTER" "NO=OUT"
- Press "ENTER" button (this stores the value to be used for steering max left)
- Display will read "CONFIG MENU" ADJUSTMENT
- Press "ENTER" button
- Display will read "SET POT BRK MW
- Press "ROLL UP" button (4) times
- Display will read "MAX STEER RIGHT"
- Turn steer wheel all the way to the right
- Press "ENTER" button
- Press "OUT button
- Display will read "ARE YOU SURE"
- "YES=ENTER" "NO=OUT'"
- Press "ENTER" button (this stores the value to be used for steering max right)
- Display will read "CONFIG MENU ADJUSTMENT
- 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



EPX16-18 Steer Angle Sensor.



A : Steering sensor
B : Fastener
C : Steering Magnet

Steer Cylinder Removal and Replacement

1. Disconnect battery and remove it from the truck.
2. For best access, remove counterweight as described in Group 38.
3. Raise and block rear of truck.
4. Remove wheel as described in Group 22.
5. Removal and Replacement. Replacement is reverse order:

   A. Hydraulic fittings.
   Replacement note: Clean fittings. See Group 40, Hydraulic Fitting Tightening Procedure."
   B. Cotter pin and nut.
   C. Steer cylinder.

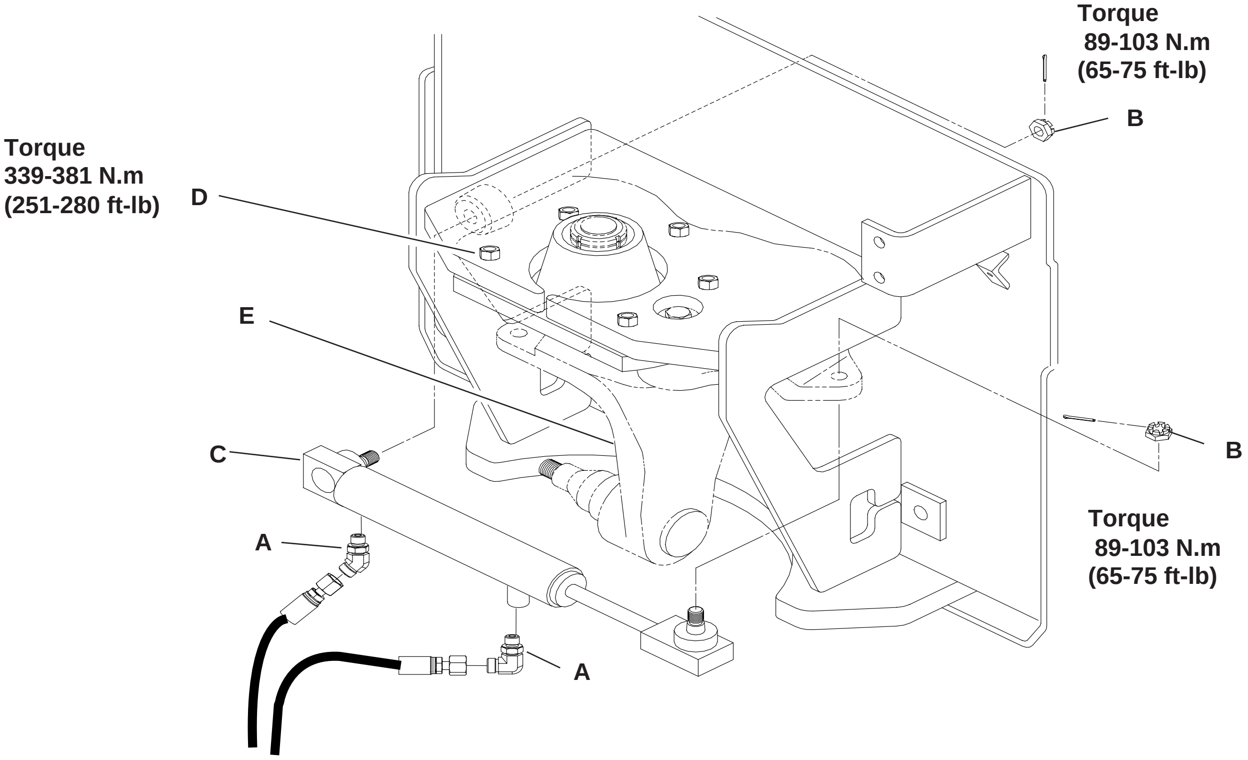
Trunnion Removal and Replacement

Support trunnion with a sling and hoist of adequate capacity.

Removal and Replacement. Replacement is reverse order:

C. Remove and replace steer cylinder as described previously.
D. Trunnion mounting bolts.
E. Trunnion assembly.

Replacement Note: If necessary, replace trunnion bearings and linkage as described in on following pages before replacing trunnion assembly.



Steer Axle Linkage Removal and Replacement

Removal: Remove trunnion assembly as described on previous page.

Removal and Replacement.Replacement is reverse order:

A. Locknut and lockwasher.
Replacement Note: Adjust locknut as explained under “Steer Trunnion Bearing Adjustment” previously in this Section.

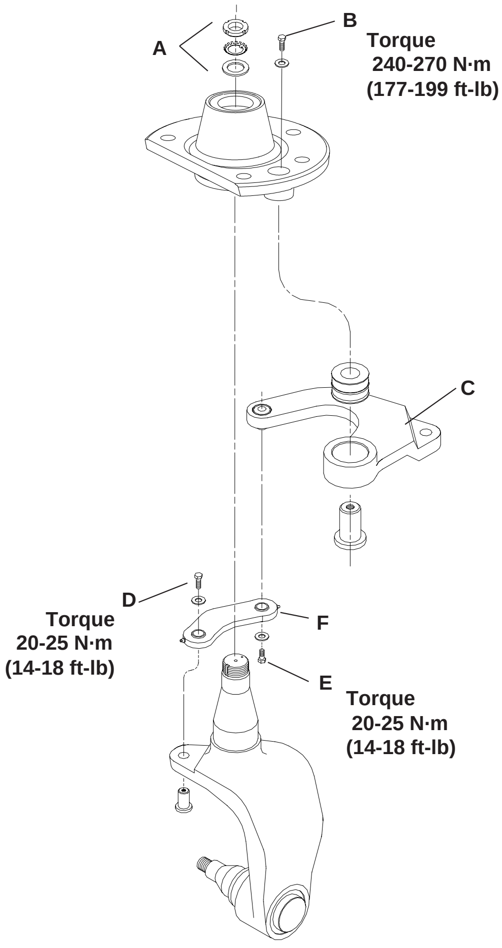
B. Fastener and bushing

C. Steering arm

D. Fastener

E. Fastener

F. Drag link.
Replacement Note: Replace trunnion bearings as shown in next column before reassembling linkage.



Trunnion Bearings Removal and Replacement

Removal: Separate upper trunnion casting from axle and linkage as shown in previous sections.

Removal and Replacement. Replacement is reverse order:

A. Seal

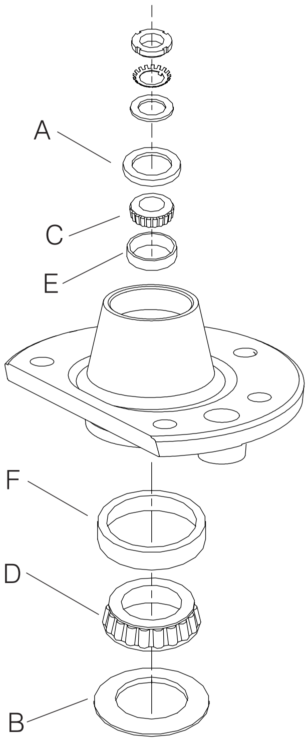
B. Seal

C. Cone
Replacement Note: Pack cones with grease meeting spec MS9C. Clark part no. 3762514

D. Cone

E. Cup

F. Cup.



Section 7

Steer Cylinder Overhaul(TMX)

IMPOTANT

Before removing any component for overhaul, make sure the correct repair parts, seals, and gasket sets are available.

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 highlymachined 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.

Cylinder Disassembly

The tilt cylinder can be held by clamping the base end or the tube in a vise while disassembling.

IMPORTANT

Do not use excessive force when clamping on the tube.

1. Remove the external retaining ring from the gland.
2. Push the gland assembly into the cylinder tube until the tube end seal ring and backup ring come off the gland and the shear ring becomes accessible.
3. Pry under the rin's outer edge with a soft metal pick and pull the ring from its groove and out of the tube.
4. Carefully pull the rod and piston assembly and gland from the cylinder tube. 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.

5. Remove and discard the piston packing and expand ring from the piston.
6. Remove and discard the tube seal, rod U-cup seal, and rod wiper from the gland.

Cylinder 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. Be sure the threads on the rod are undamaged.
3. Inspect the cylinder tube internal bore for wear, scratches or other damage. Deep gouges or pitted surfaces require replacement of parts. Check the outside of the entire cylinder for damage. Inspect all welds for cracks. Inspect the ports to be sure they are free of contamination and that the threads are clean and not damaged.
4. Put a light coating of hydraulic fluid on all parts. If parts are to be left disassembled for awhile, they should be covered with a clean cloth.

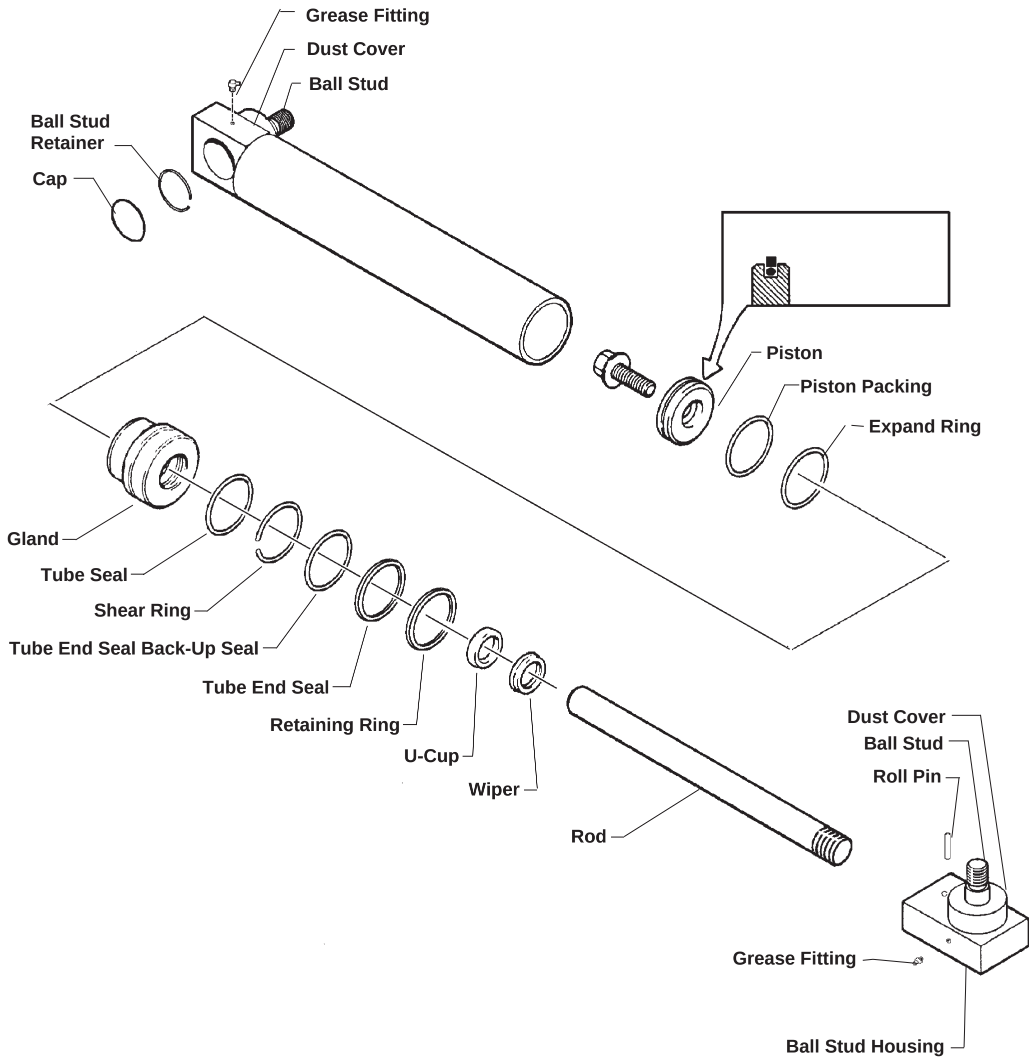
Cylinder Reassembly

1. Install piston rod wiper and rod U-cup, and tube seal in the gland. Make sure U-cup and wiper are installed in proper orientation as shown in the illustration.
2. Install tube seal, shear ring, tube end back up seal, and tube end seal on gland.
3. Replace the piston packing and expand ring..
4. 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 seals.

5. Install piston and rod assembly. Be careful not to damage the piston seals when installing the piston into end of cylinder tube.
6. Insert gland assembly over rod and into cylinder tube, compressing the shear ring to fit into the tube. Push gland inward until shear ring snaps into its groove in the tube.
7. Install external retainer ring.
8. Check the assembly by making sure the piston slides freely within the cylinder.



Mounting Ends Overhaul

The cylinder base and rod ends mount to the frame and axle via bull stud joints. The dust covers, housings, and ball studs can be replaced if damaged.

To remove the rod end mounting, first remove the roll pin with a drift punch. Then unscrew housing from rod.

To remove ball studs from either joint, remove caps and retainers first.

Inspect the ball stud and housing races for damage. Replace damaged parts and reassemble joint reversing above procedure. Grease joints with multi-purpose grease NLG#2.

CLARK

NOTE :

Section 8

Steering Axle Wheel Bearing Maintenance and Adjustment (EPX)

IMPOTANT

Before removing any component for overhaul, make sure the correct repair parts, seals, and gasket sets are available.

WARNING

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

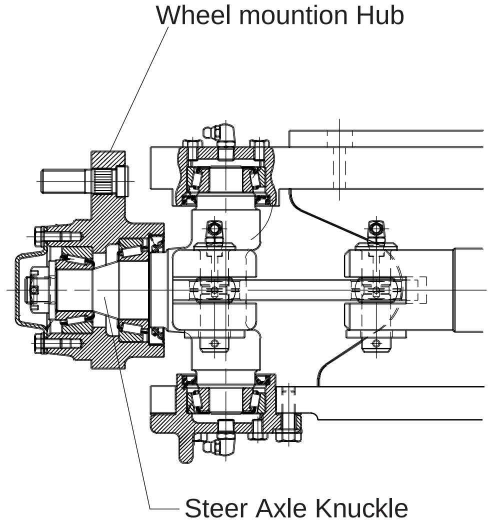
Wheel bearings check should be performed every PM. Wheel bearings need adjustment only after 2000 hours or as needed. It is recommended that you clean and repack the bearings before adjustment. Check hourmeter total hours and refer to the truckis PM schedule. See steer wheel bearing lubrication procedure 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 steering axle. Use the procedures to clean, repack and adjust bearing.



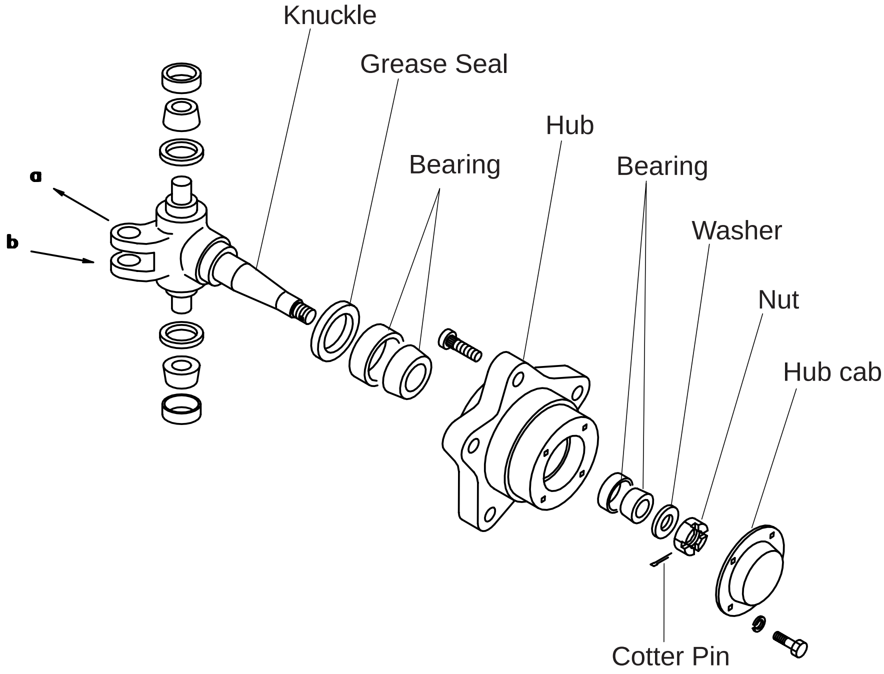
Bearing Disassembly

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 hub.
3. Clean the excess grease from around the wheel nut.
4. Remove cotter pin, loosen and remove wheel nut.
5. Remove outer bearing by pulling out on the hub slightly to loosen bearings.



6. Pull the hub off the knuckle. Support the hub to avoid dragging the grease seal at the back side across the thread on knuckle end.
7. Clean the old grease out of center of the hub.
8. Remove the inner bearing cone and grease seal.
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.

Bearing Reassembly

NOTE

Use Grade No. 2 EP multi-purpose grease, Clark MS-107C.

1. Install grease seal a the knuckle.
2. Pack the bearings with grease and install the inner bearing on the kunckle.
3. Install the hub on the knuckle.
4. Pack the bearing with grease and install on the knuckle
5. Assemble washer and castle and nut.
6. Loosen castle nut in 1/4~1/2 round after tightening knuckle nut in 27.5~29.4 N.m (20.3~21.7 ft.lb) rotating hub.
7. Install a split pin in the first groove of a castle nut in the loosing directing after tightening in 6.9~9.8 N.m (5.1~7.2 ft.lb)
8. Install hub cap.

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 Lubricationi in this Section for the complete procedure.

WARNING

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 27.5-29.4 N.m (20.3-21.7 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 6.9-9.8 N.m (5.1-7.2 ft-lb).
9. Back up wheel nut to nearest castellation slot and install new cotter pin.
10. 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.

NOTE :

Section 9

Steering Axle Removal and Replacement (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.

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

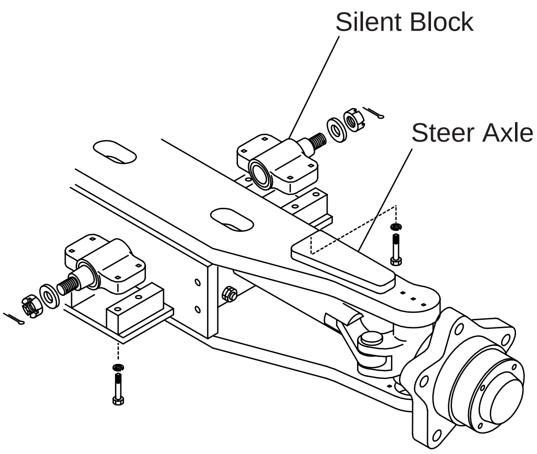
Make sure truck is correctly raised and safely blocked using hardwood blocks under the frame. Be sure the blocking will permit installation of the axle without disturbing the blocking.

3. Loosenandremove hydraulic steering lines from steering cylinder. Plug fittings and cap open ends of lines. Keep all hydraulic fittings and openings clean.

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 mounting bolts.
6. Carefully withdraw the axle from beneath the truck and move to safe storage.



Steer Axle Replacement

Replacement is the reverse of removal.

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 theaxle trunnions.
2. Make sure that the silent blocks are positioned correctly on the rear frame.
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) spreadbetween 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.
5. Reset the two mounting plates under the silent blocks of the axle.
6. Install bolts and tighten to 104.9-126.5 Nfim (77.5-93.5 ft-lb).
7. Remove temporary axle support from under truck.
8. Connect the hydraulic lines to steering cylinder.

IMPORTANT

Make sure all fittings and openings on the hydraulic lines are clean.

9. Carefully raise the truck off the blocking as described in “Lifting, Jacking and Blocking”. Remove the blocking and lower the truck to the floor.
10. If removed, reinstall countenveight; refer to Group 38, Section 2, “Counterweight Removal and Replacement”.
11. 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.
12. Check steering cylinder hose line connections and cylinder rod seals for any evidence of oil leakage before returning the truck to service.

Section 10

Steering Cylinder Removal and Replacement (EPX)

WARNING

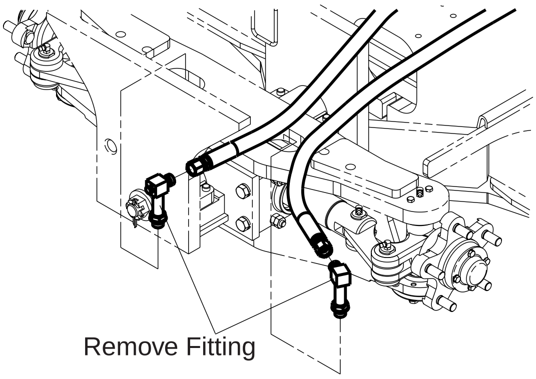
SAFE PARKING. Before working on truck:

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.

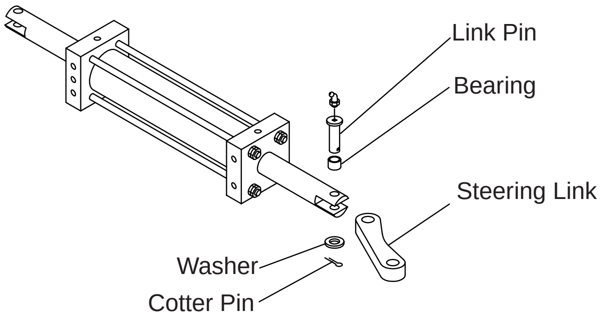
Steer Cylinder Removal

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 25, Section 2, “Steering System Troubleshooting,” for steering problem diagnoses. See Section 12 in this Group for steer cylinder overhaul procedures.

1. Place a drain 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 cotter pin from the bottom of the steering link pin. Steering link pin attaches steer cylinder rod end to steering link.

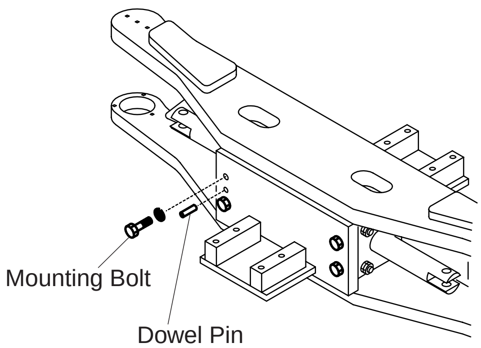


NOTE

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. Rotate the steering link away from the cylinder rod end.
5. Remove steer link bearing from steering link.
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.

Cylinder is now ready to be removed from the steer axle body. Cylinder must be lifted off dowel pins positioning cylinder to axle body.



WARNING

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

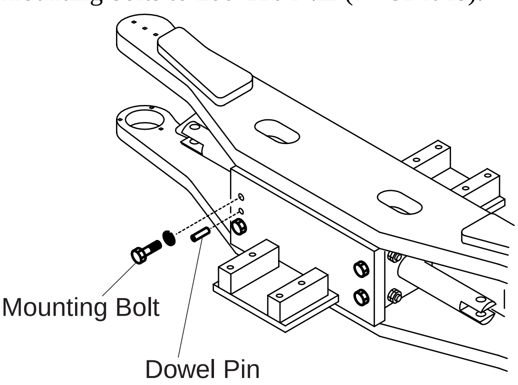
Completely inspect all parts:

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 5, "Steer Cylinder Overhaul", if pressure check or troubleshooting tips indicate a problem with steer cylinder performance.

Steer Cylinder Replacement

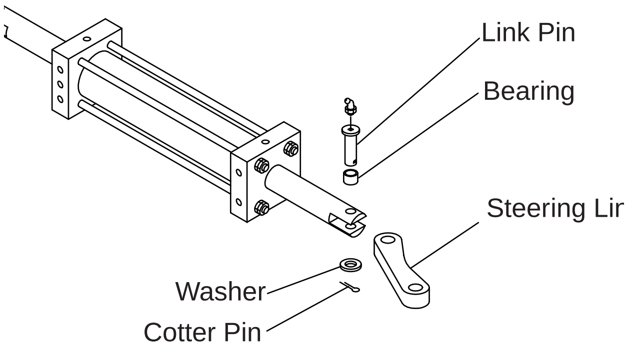
1. Remount the steer cylinder onto the steer axle dowel pins; set bolts and washers in place and torque mounting bolts to 100-110 N.m (74-81 ft-lb).



WARNING

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.

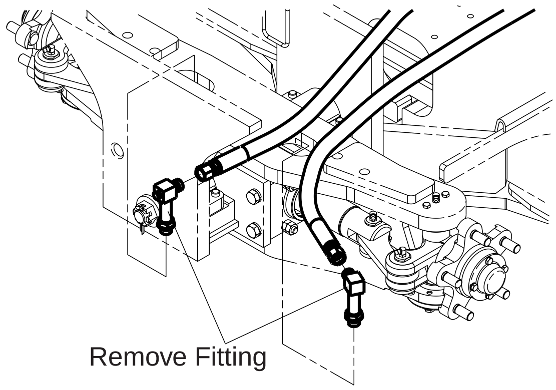


3. Rotate steering link into cylinder rod end and align bearing hole with rod end.
4. Tap pin through steer link bearing hole with cotter pin hole on lower end.

IMPORTANT

Make sure bearing is properly aligned with pin in the hole.

5. Install the cotter pin to the steering link hole.
6. Repeat steps 1 to 5 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 11

Steering Gear Overhaul(EPX)

IMPORTANT

Before removing any component for overhaul, make sure the correct repair parts, seals, and gasket sets are available.

NOTE

The following material does not show the load sensing port on the steering gear (steering control unit). The port is located in the center of the other four ports. The load sensing port requires no special overhaul procedures.

Disassembly

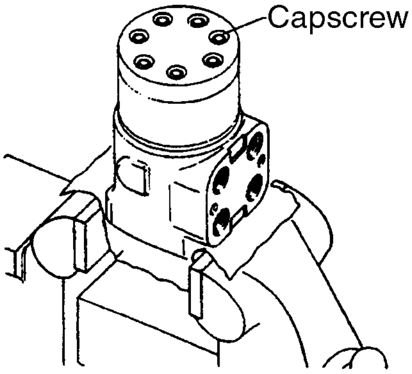
Cleanliness is extremely important when repairing a steering gear. Work in a clean area. Before disconnecting lines, clean port area of unit thoroughly. Use a wire brush to remove foreign material and debris from around exterior joints of the unit.

NOTE

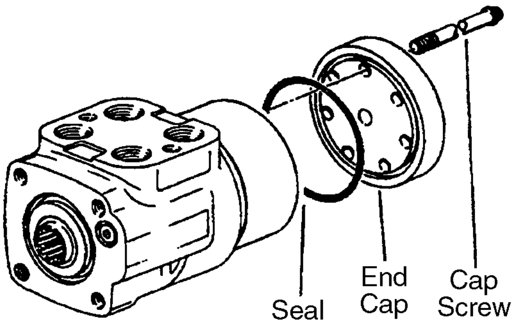
Although not all illustrations show the unit in a vise, it is recommended to keep the unit in the vise during disassembly. Follow the clamping procedures explained throughout the text.

Meter (Gerotor) End

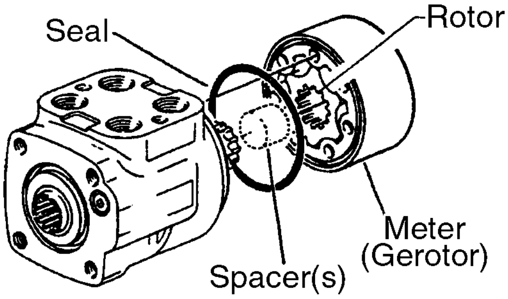
1. Clamp unit in vise, meter end up. Clamp lightly on edges of mounting area, as shown. Use protective material on vise jaws. Do not overtighten jaws.



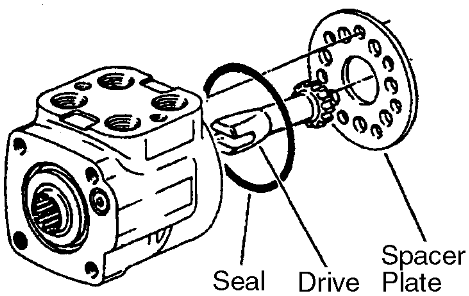
2. Remove capscrews.



3. Remove end cap.
4. Remove seal from end cap.
5. Remove meter (gerotor). Be careful not to drop star (rotor).



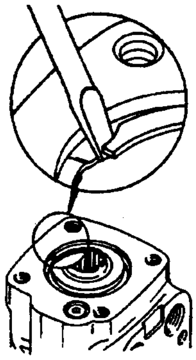
6. Remove seal from meter.
7. Remove drive spacer(s).
8. Remove drive.



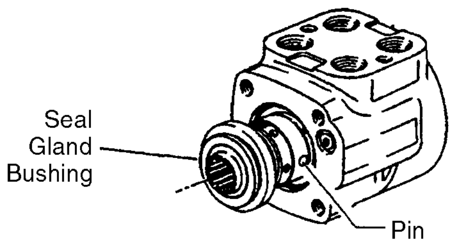
9. Remove spacer plate.
10. 10.Remove seal from housing.

Control End

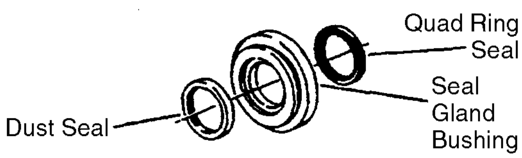
11. Remove housing from vise and place on a clean soft cloth to protect surface finish. Use a thin-bladed screwdriver to pry retaining ring from housing.



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.

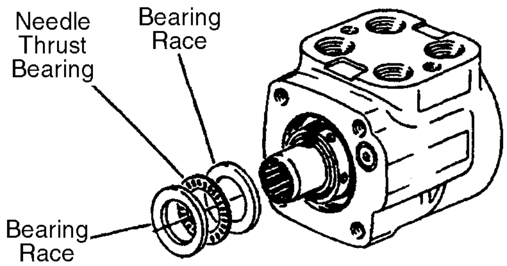


13. Remove quad ring seal from seal gland bushing.

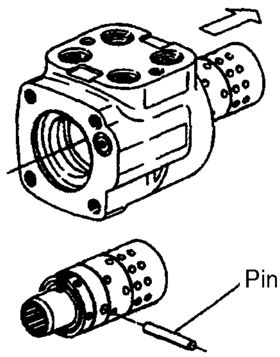


14. Use a thin-bladed screwdriver to pry dust seal from seal gland bushing. Do not damage bushing.

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 in the unit before they are removed.

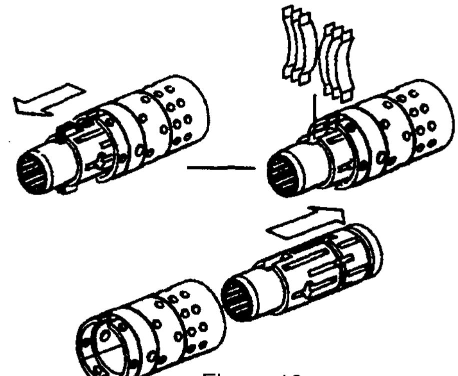
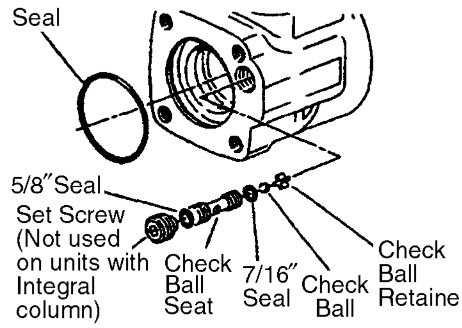


Figure 10

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.

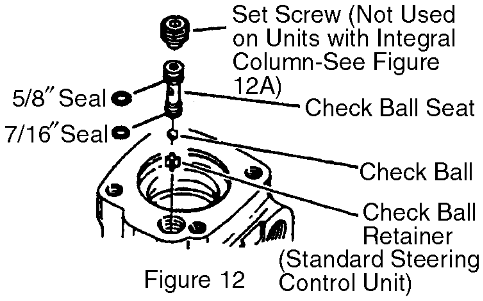
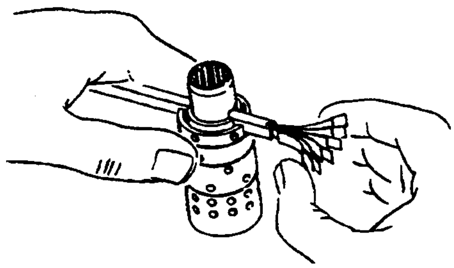
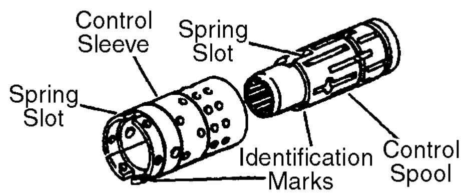


Figure 12

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.

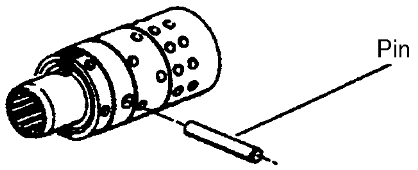


7. Bring spring slots of both parts in line and stand parts on end of bench. Insert spring installation tool (available as Part No. 6000057) through spring slots of both parts. Position three pairs of centering springs (or two sets of 3 each) on bench so that extended edge is down and arched center section is together. In this position, insert one end of entire spring set into spring installation tool, as shown.

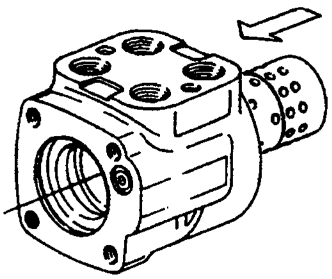


On those units which use the low torque centering springs, there are two pairs of centering springs (or two sets of each) and one pair (two) spring spacers. The spring spacers are installed together between the two sets of centering springs. The installation procedure is the same as that used on the standard (three pairs of centering springs) units.

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.



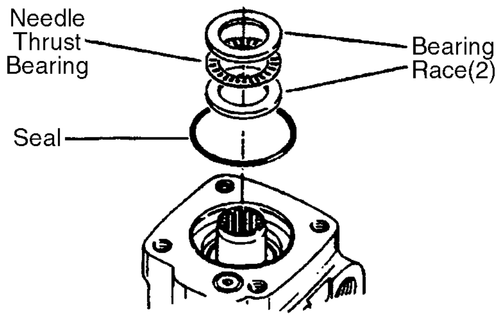
11. Position the spool and sleeve assembly so that the splined end of the spool enters the 14-hole end of housing first.



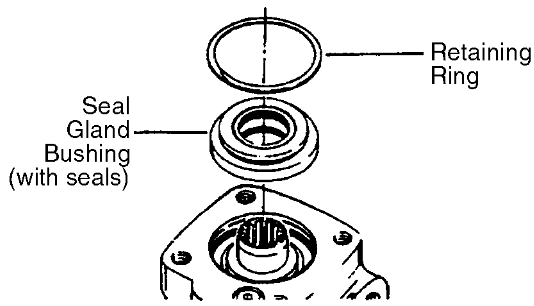
IMPORTANT

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.



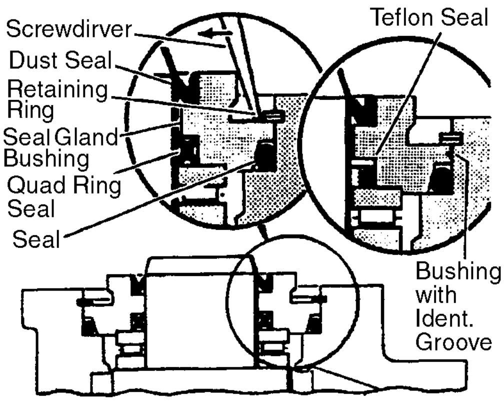
14. Install 1-1/4-inch diameter dust seal in seal gland bushing; flat or smooth side of dust seal must face down towards bushing.
15. Install dry quad ring seal in seal gland bushing. Smooth seal in place with your finger. Do not use any seal that falls freely into pocket of bushing. Seal should not “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.
On those units which use the Teflon seal, install the Teflon back-up ring into the recess cut into the seal gland bushing. Install the Teflon seal over the spool end, then carefully install the seal gland bushing over the spool end using a rotary motion.

NOTE

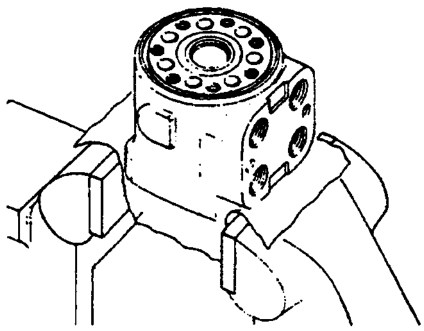
The seal gland bushing which is used with the Teflon seal is not the same as the seal gland bushing used with the standard quad-ring seal. The seal gland bushing with the Teflon seal has an identification groove cut into the outer diameter of the bushing. The grooved bushings can only be used with the Teflon seals and the non-grooved bushings used only with the quad-ring seals.



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.

Meter (Gerotor) End

18. Clamp housing in vise, as shown. Clamp lightly on edges of mounting area. Do not overtighten jaws.



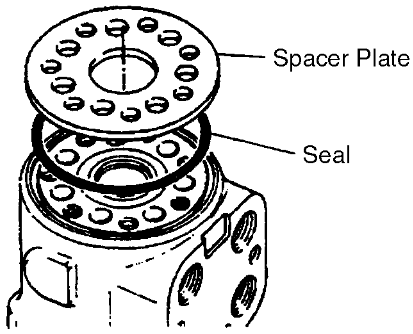
NOTICE

Check to ensure that the spool and sleeve are flush or slightly below the surface of the housing.

IMPORTANT

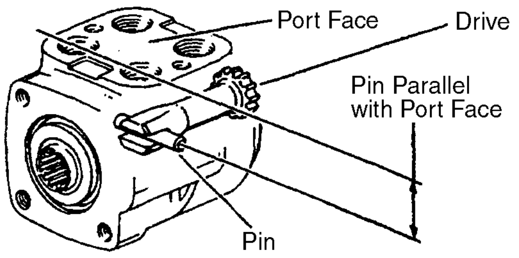
Clean the upper surface of the housing by wiping with the palm of clean hand. Clean each of the flat surfaces of the meter section parts in a similar way when ready for reassembly. Do not use cloth or paper to clean surfaces.

19. Install 3-inch diameter 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.



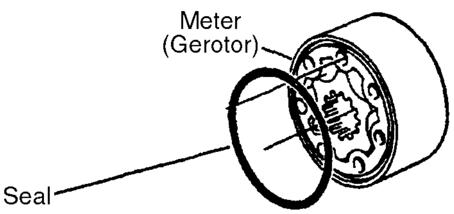
IMPORTANT

Failure to properly install drive and pin may cause unit to self steer.

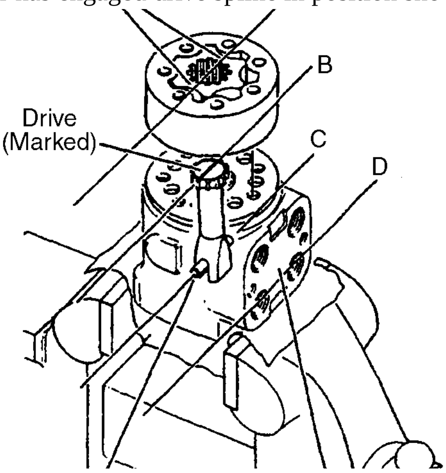
NOTE

To assure proper alignment, mark spline end of drive shaft with a line parallel to slot on other end, before installing.

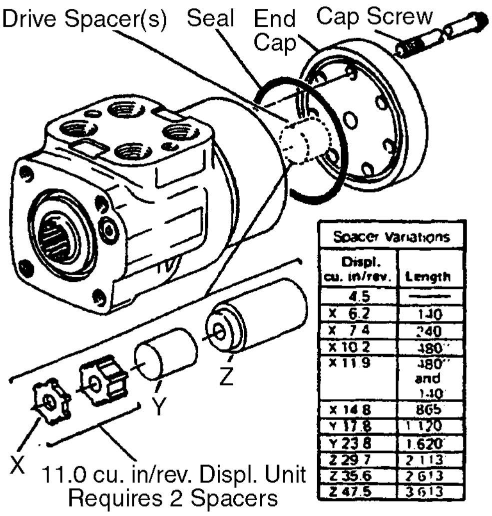
22. Install 3-inch diameter seal in meter (gerotor).



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.



24. Install drive spacer(s) when used, in meter.

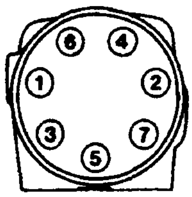


Spacer Variations	
Displ. cu. in/rev.	Length
4.5	—
X 6.2	140
X 7 4	240
X 10 2	480
X 11 9	480 and 140
X 14 8	865
Y 17.8	1 170
Y 23 8	1.620
Z 29 7	2 113
Z 35.6	2 613
Z 47.5	3 613

25. Install 3-inch diameter 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 31 N·m (275 in·lb) in the sequence shown.



28. Inspect the assembly to be sure all parts have been installed and fasteners correctly installed and tightened.

(Reprint courtesy of EATON Corporation)

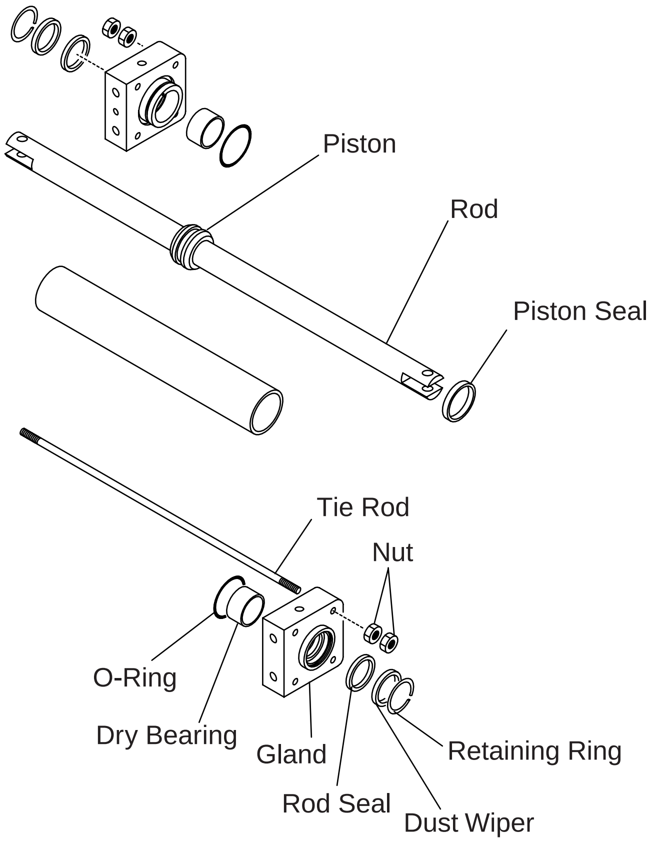
NOTE :

Section 12

Steering Cylinder Overhaul(EPX)

IMPORTANT

Before removing any component for overhaul, make sure the correct repair parts, seals, and gasket sets are available.



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. Loosen nuts and remove the rod from cylinder assembly.
3. Remove one gland by pulling it from cylinder barrel and pulling it off the piston rod.
4. Remove the piston and rod assembly from the Cylinder.
5. Remove gland from opposite end of steer cylinder.
6. Remove the seal and O-ring set from the piston. Discard seals. Replace with new seal set at assembly.
7. Remove (inner) gland packing (O-ring) seal. Replace with new seals at assembly.
8. Remove the rod (U-cup) seal and dust 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 Orings. 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 piston seal on the piston.

2. Install new gland packing (O-ring) seal and dry bearing on inner end of gland.
3. Install new dust wiper and rod (U-cup) seal in outer end of gland and install retainer ring.

IMPORTANT

Be sure the rod wiper and dust (U-cup) seal are installed in the correct directions.

4. Lightly lubricate the cylinder and gland mating surfaces with hydraulic oil before assembly.
5. Install the gland onto the cylinder bore rim, making sure gland is fully seated on cylinder.
6. 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.

7. Repeat above procedure for installation of opposite gland.
8. Install the tie rods and nuts.

Operational Pressure Test

Once cylinder is remounted on axle (see Section 4), 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 8620kPa (1250psi).

NOTE :

GROUP 29
MAIN HYDRAULIC SYSTEM

NOTE :

Section 1

Main Hydraulic System
Specifications and Description

Specifications

Hydraulic Fluid Type: Clark specification MS-68 (Clark part #I802155 and#1800236)

Hydraulic Pump Type: Integral gear-type pump and motor assembly.

Sump Capacity: Usable oil = 19 Liters (5.0 Gal)

Filter Type: Disposable, 25 micron, fill flow return line oil filter and a 10 micron filter cap/breather filter.

Main Relief Valve Setting: 18,000 to 18,700 kPa (2600 to 2700 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

Tilt spool (spool #2): 38 L/min (10 gpm).

Auxiliary spool (spool #3): 38 L/min (10 gpm).

Auxiliary spool (spool #4): 38 L/min (10 gpm).

Integral Pressure Compensated Flow Control Settings:

Tilt spool (spool #2): 12.3 L/min (3.2 gpm).

Auxiliary spool (spool #3): 6.7 L/min (1.7 gpm).

Auxiliary spool (spool #4): 38 L/min (10 gpm).

Tilt Flow Settings:

Tilt Flow Control Adjustments			
Average Tilt Speed		Usage	Clockwise Turns of Adjustment Screw
° /Sec	Lpm (gpm)		
2.5	6.3 (1.7)	3937 (155") MFH & Above	0.5
3	8.7 (2.3)	Up to 3937 (155") MFH	0.75

Maximum Pressure Drop at Rated Flow:

Inlet to outlet: 689 1cPa (100 psi).

Lift spool (spool #I):

- Inlet to cylinder port: 689 kPa (1 00 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 counter-clockwise to stop. Each $\frac{1}{4}$ clockwise turns of the adjustment increases flow by 3 L/min (.75 gpm).

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)	1.0
19.0 (5.0)	1.50
23.4 (6.2)	1.75
33.5 (8.8)	2.5
39.8 (10.5)	3.00
52.9 (14)	4.50

Afier adjusting the flow control valve settings it will be necessary to also adjust the pump control panel parameters to coincide with the settings you have made. See Group 19 for the proper Handset usage.

Pump Control Panel Settings (Using the Handset)			
Parameters	Auxiliary Flow Settings		
	GPM	36V Hz	48V Hz
2nd Speed Fine and 3rd Speed Fine	2.5	20	33
	5.5	43	51
	7.0	55	65
	10.0	79	93

Serviceable Items

Serviceable items are the pump, motor, priority valve, return line filter, main control valve, and cylinders. Other components, such as hoses, fittings, and clamps, and the load-lowering flow valve are non-serviceable and should be replaced if worn or damaged.

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.

Hydraulic System Relief Pressure Check: Every year or every 2000 hours of operation.

Description

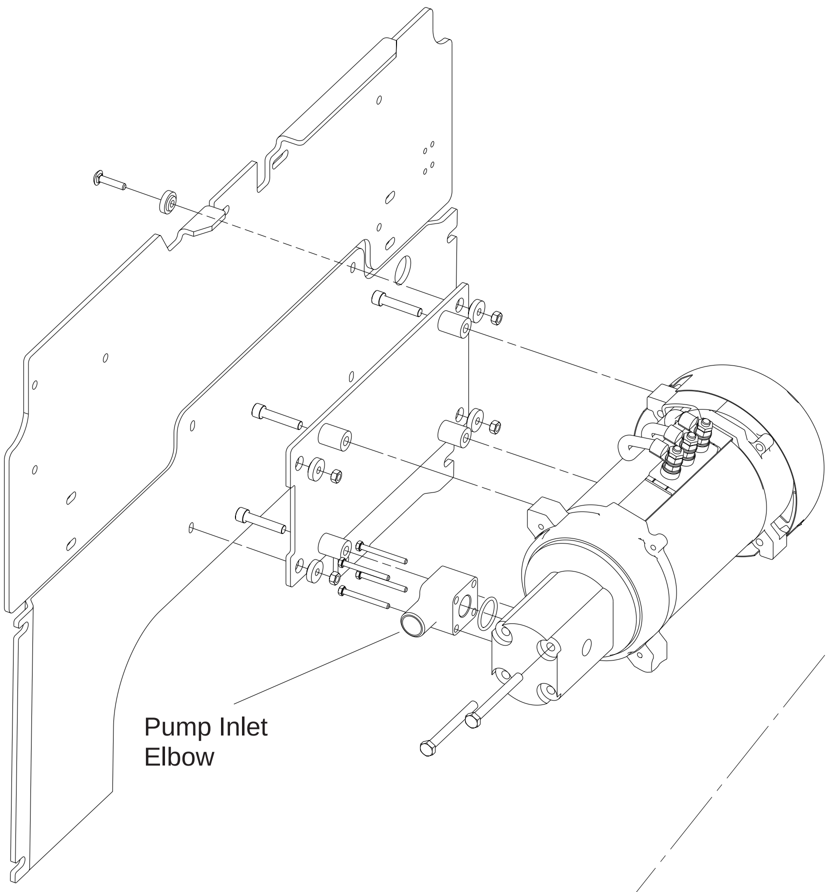
The following description focuses on hydraulic circuitry up to the main hydraulic control valve, that is, the lift/tilt/aux circuit.

The TMX truck uses one hydraulic pump and motor assembly to supply oil for all hydraulic functions, including the power steering system. The speed of the pump and motor assembly is controlled by the AC Pump control and the pump will only turn fast enough to provide the needed oil flow for the function that is being used. Switches and transducers are used on the hydraulic control valve levers to supply the inputs to the AC control panel for the different functions.

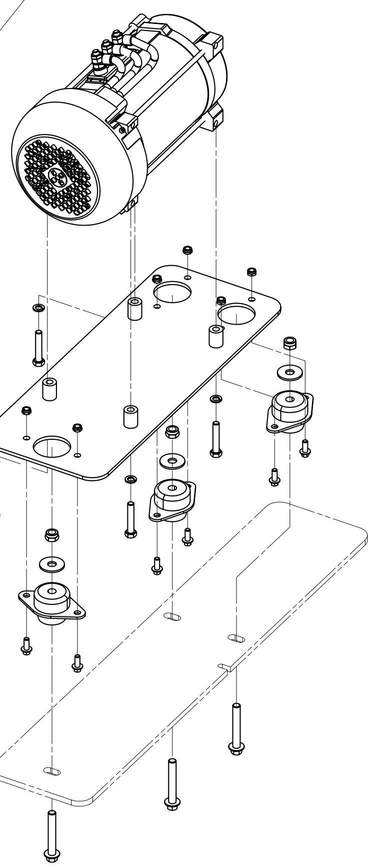
A Priority valve is incorporated in the hydraulic system, mounted on the side of the pump, to provide a measured flow of oil to the steer system at all time the truck is running. The remaining oil flow is diverted to the main hydraulic valve for the other hydraulic functions.

The hydraulic oil is constantly being filtered by passing all of the steer gear return oil through the spin-on oil filter.

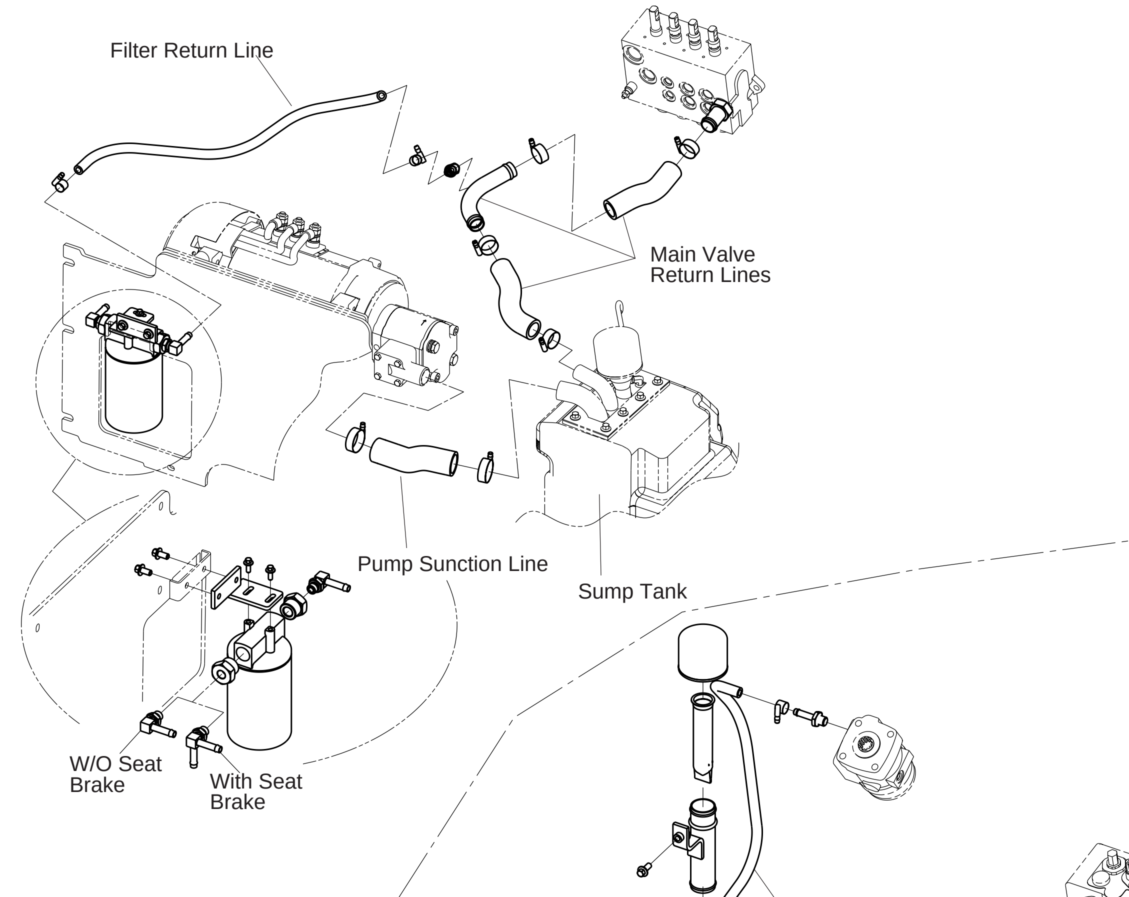
The pump and motor assembly is located under the floor plate and is mounted to the front battery plate. See Group 16 of this manual for removal and replacement of the pump and motor assembly.



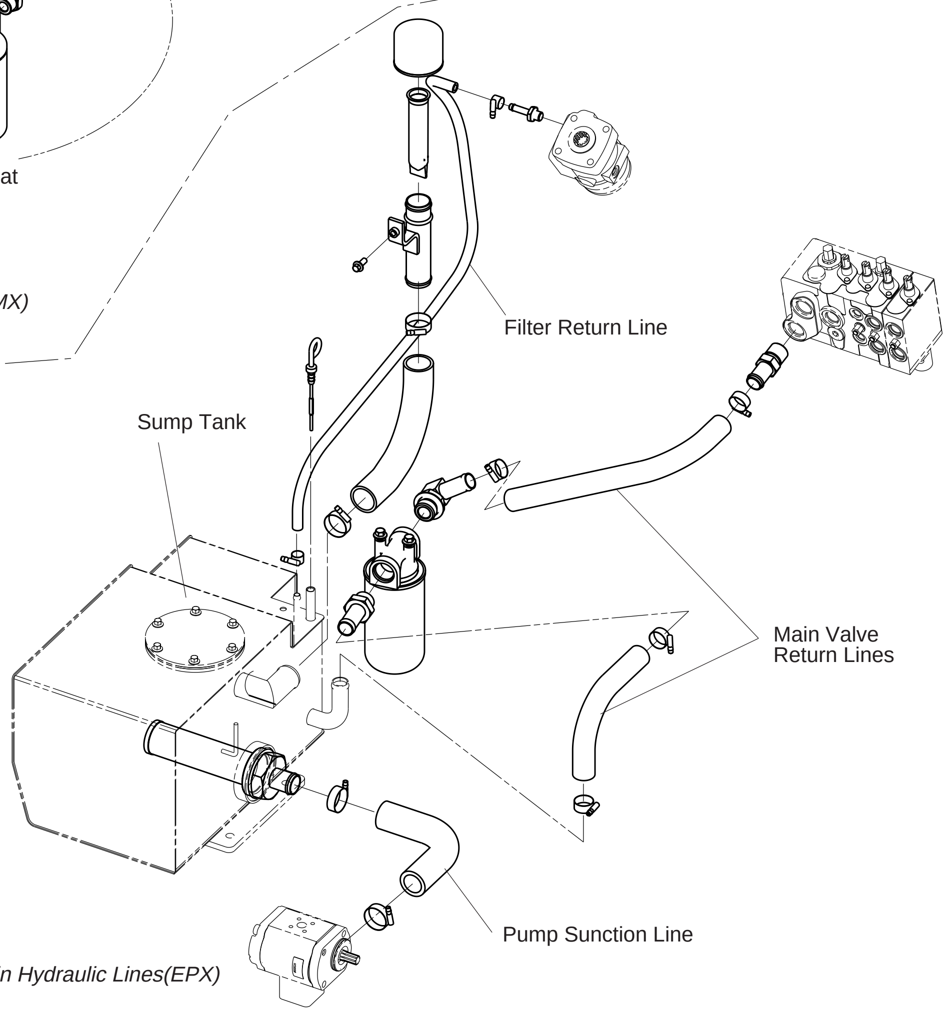
Pump Motor Mounting(TMX)



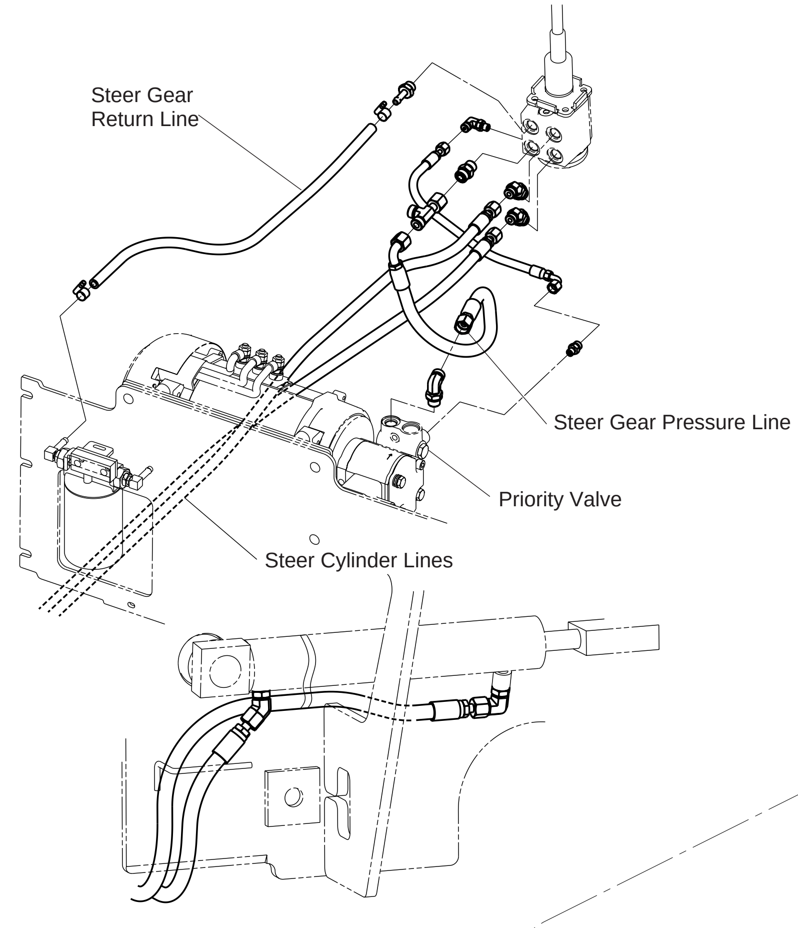
Pump Motor Mounting(EPX)



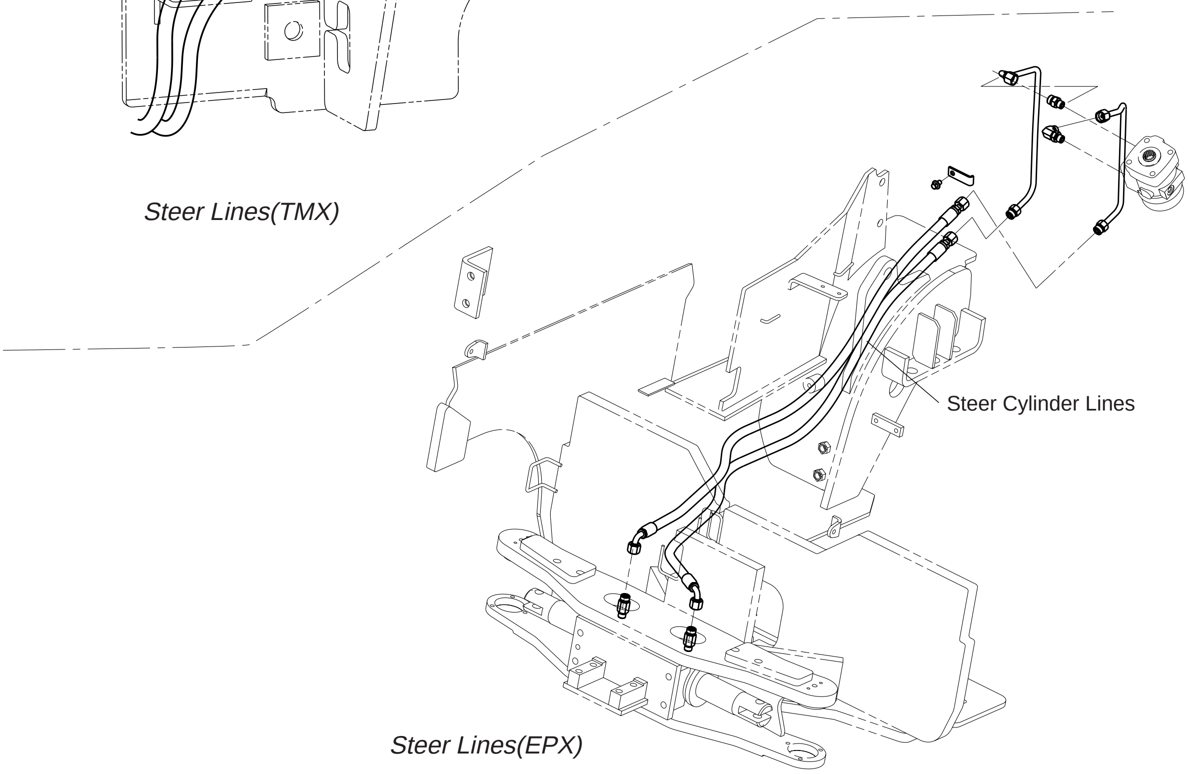
Main Hydraulic Lines(TMX)



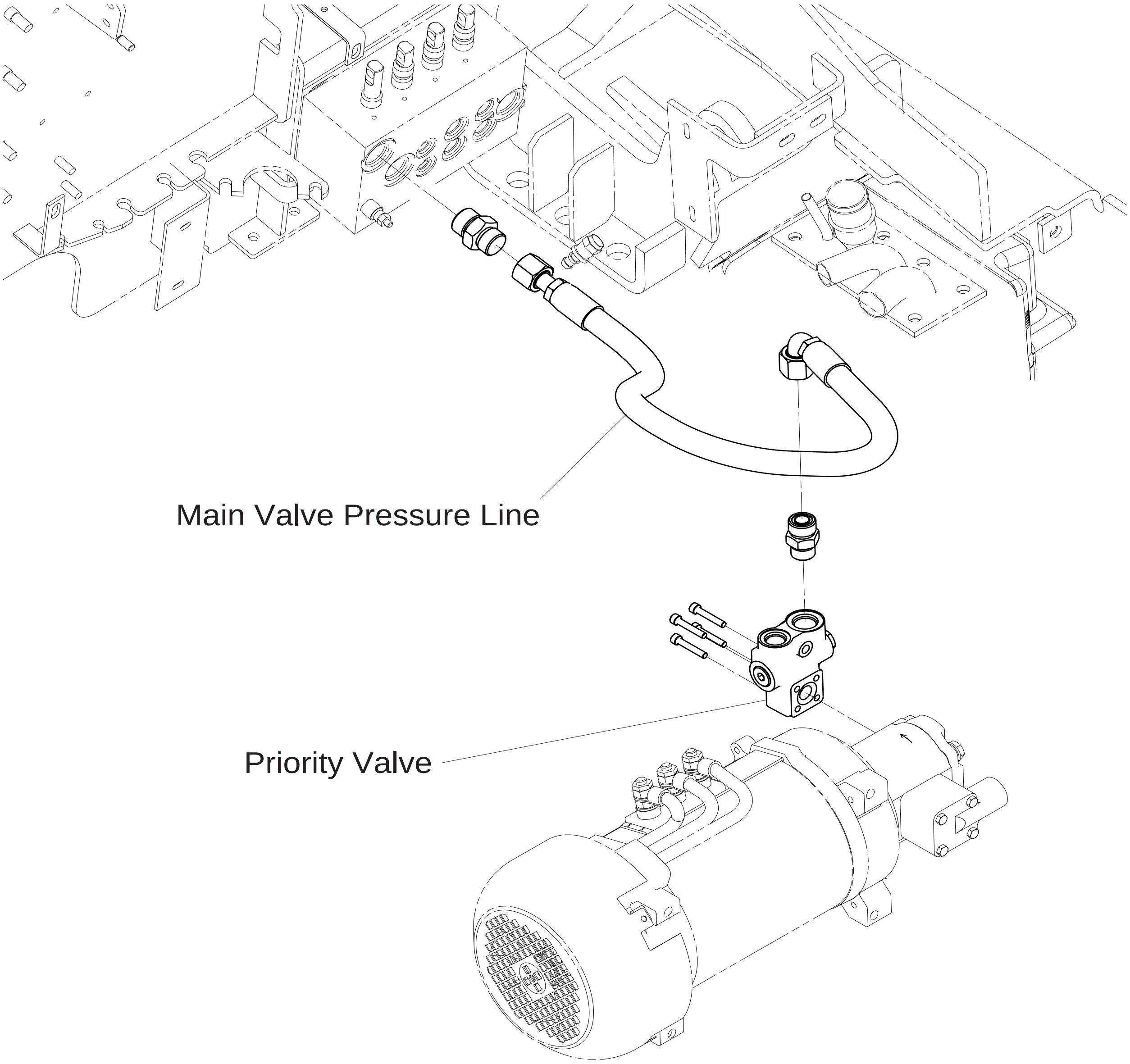
Main Hydraulic Lines(EPX)



Steer Lines(TMX)



Steer Lines(EPX)



Main Hydraulic Valve Inlet Line(TMX)

NOTE :

Section 2

Fluids and Filters

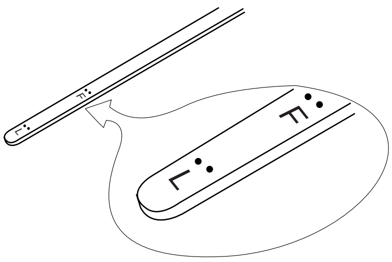
Hydraulic Sump Tank Fluid Level Check

1. Check the hydraulic sump tank oil level with:
   - Truck on a level surface.
   - Upright in the vertical position.
   - Fork carriage fully down.
   - Oil at operating temperature.
2. Pull the dipstick out, wipe it with a clean wiper, and push it back into the dipstick tube. Remove the dipstick again and check the oil level indication.
3. Check the condition of the hydraulic fluid (age, color or clarity, contamination), to determine if it should be replaced.

Refer to PM records for operating time since last oil change.

Refer to next page if fluid needs to be changed.

4. The hydraulic system oil level should be between the oil level markings on dipstick.



NOTE

Approximately 2.8 L (0.75 gal) of hydraulic oil is required to fill the hydraulic tank from the "L" (LOW) mark to the "F" (FULL) mark. DO NOT OVERFILL. Use MS-68 fluid.

5. Add recommended fluid only, as required.

NOTE

Remove or pull dipstick part way out to vent air from tank while filling. When adding fluid, check the fluid level again with the dipstick after operation of the truck including operation of the upright through several lift cycles.

Hydraulic Fluid and Filters Change

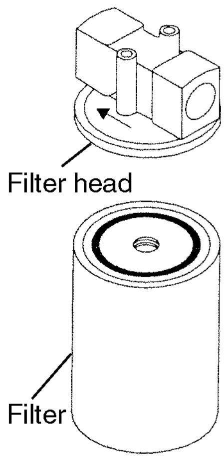
- Drain and replace the hydraulic system fluid every 2000 operating hours, or once a year.
- Replace the hydraulic oil filter at every oil change.
- Replace the sump tank breather every 1000 operating hours.

Filter Change

1. Remove and replace the hydraulic system filter per recommended planned maintenance schedule, or as may be required by truck operating conditions and usage.
2. Install a new oil filter. Be sure to follow the installation instructions printed on the filter.
3. Check for leaks after installation of the filter. Also, check that the hydraulic line connections at the filter adapter are tightened correctly.

NOTE

In the event of failure of a major hydraulic system component, such as the main pump, or the possibility of severe contamination of the fluid, samples of hydraulic oil should be submitted to an independent commercial laboratory for analysis of the contaminant level.



Breather Maintenance

1. Remove the hydraulic sump tank fill cap/ breather and inspect for contamination and damage.
2. Clean or replace the fill cap/breather, per recommended planned maintenance schedule, or as required by operating conditions.

Fluid Change

WARNING

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.

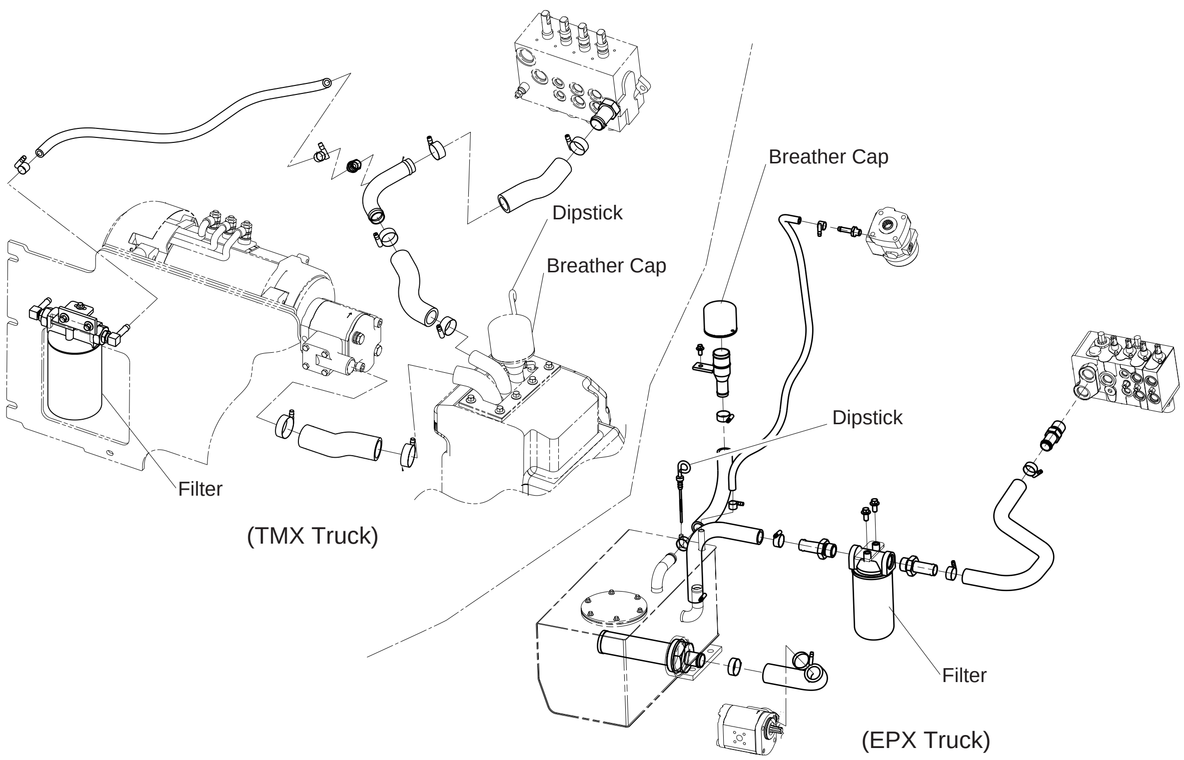
2.Put upright in vertical position and fully lower the forks or attachment.

3.Put all controls in neutral. Turn key switch OFF and remove key.

4.Apply the parking brake and block the wheels.

There is no drain plug in the hydraulic sump tank. Unless the sump tank is to be removed for other repair or maintenance, the hydraulic fluid can be changed by one of the following methods:

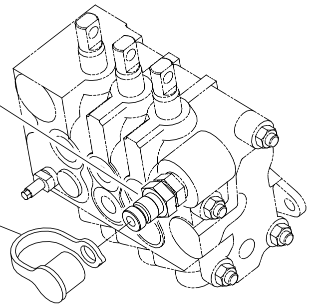
- Remove of the sump breather/filler cap and strainer and draw the fluid out with a separate pump and hose.
- Pump the fluid out by using the truck's hydraulic system. This method, described below, may be used most easily and satisfactorily for routine changing of the fluid.



1. Remove the snap-on cap and connect a suitable drain hose to the diagnostic check port fitting.

NOTE

Use quick-disconnect adapter fitting.



2. You will need a drain pan of 19 L (5 gal) minimum capacity. Be sure the outlet end of the drain line is directed into the drain pan and held from moving when pressurized.
3. Turn key switch ON.

IMPORTANT

EMPTYING SUMP. Continue the next step until the sump is empty. At that point, the pump speed increases noticeably and a whining sound is heard. Release the tilt lever immediately when this occurs. Adaptor Fitting Cap

4. Move tilt control lever to the back tilt position to start the lift pump. A steady stream of used oil should flow from the drain line. Hold tilt lever in this position until sump tank is empty. Release the tilt lever immediately when flow becomes unsteady .
5. Turn the key switch OFF.
6. Disconnect drain line from truck and replace cap.
7. Remove and discard old oil filter and install new filter as described previously.
8. Remove and replace the sump breather cap as described previously.
9. Refill the sump tank with Clark MS-68 Hydraulic Fluid.
10. Check truck operation. Turn key switch ON. Operate the hydraulic system. Cycle the lift system several 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.

11. Turn the key switch OFF.

Section 3

Hydraulic System Troubleshooting

Noisy Pump

- Hydraulic fluid level low; measure and correct fluid level.
- Fluid viscosity too high; change to specified fluid.
- 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.
- 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.
- 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.

Overheated Pump and/or Fluid

- Low viscosity fluid; drain and fill with correct fluid.
- Contaminated fluid; drain fluid, 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.

Shaft Seal Leakage

- Damaged or worn seal; replace.
- Shaft scratched or worn or seal nicked; repair (polish) or replace and add new seal.
- Front cover bearing out of position; replace front cover assembly.

- Shaft seal housing bore scratched; replace front cover assembly.
- Improper fit of shaft; replace front cover assembly.
- Contamination; inspect and service pump.
- Pump operated in wrong rotation; replace shaft and pressure loading seals.
- Seal installed backwards; inspect and service seal.

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 or repair kinked hose.
- Hydraulic pump cavitating (pumping air with fluid); check hydraulic plumbing for airtight hoses and connections on inlet side of pump.

Overheated hydraulic fluid

- Thin fluid; drain and fill with correct fluid.
- Fluid contaminated; drain sump, 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.

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 Mico 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.

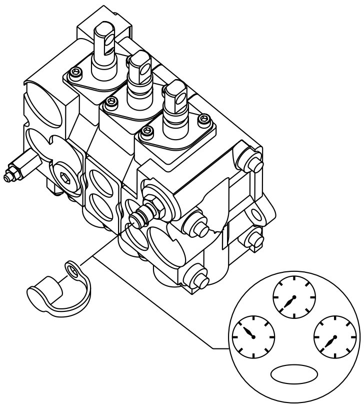
WARNING

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.

3. 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 20,000 to 21,000 kPa (2900 to 3000 psi).

IMPORTANT

Do not operate system in relief any longer than required to read the pressure gauge.

4. 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 13,300 to 14,300 kPa (1925 to 2075 psi).

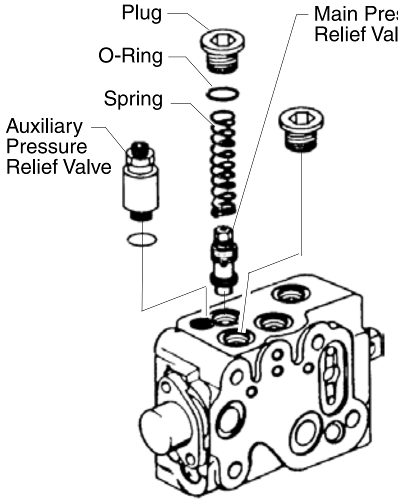
Main Pressure Relief Adjustment

IMPORTANT

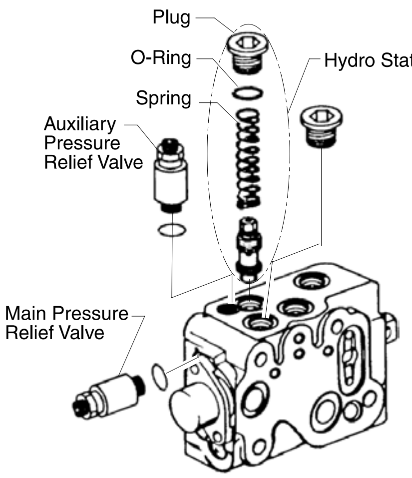
Main pressure relief setting is set at the factory and should not be adjusted. If the relief pressure does not measure within the setting range, a hydrostat in the pressure relief valve must be replaced. If you attempt to adjust the hydrostat in the relief valve, your warranty on the equipment may be voided.

To replace the hydraulic system main pressure relief valve:

1. Remove the plug, O-ring, and spring from hydraulic valve port shown in the following illustration.



TMX Truck



EPX Truck

2. Remove the main pressure relief valve.
3. Screw open the main pressure relief valve and remove the hydrostat in the valve.
4. Replace the hydrostat in the same position with the new unit.
5. Recap the pressure relief valve and replace in the valve body.
6. Replace the spring, O-ring, and plug.

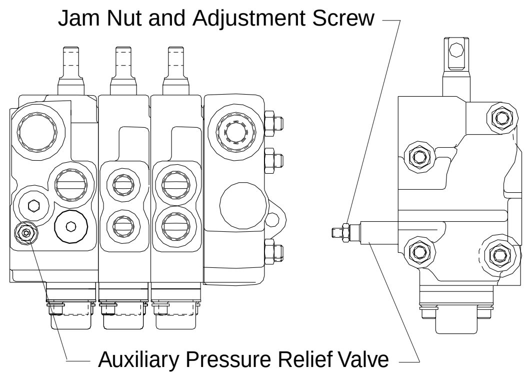
Auxiliary Pressure Relief Adjustment

IMPORTANT

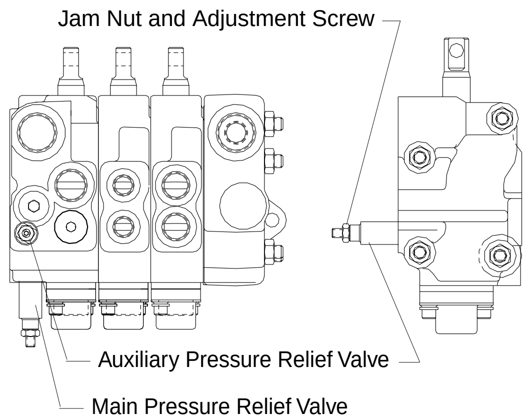
The auxiliary relief setting only applies to a hydraulic valve that has auxiliary sections added.

To adjust the hydraulic system auxiliary pressure relief valve:

1. Loosen the jam nut on the auxiliary relief valve adjustment screw.



TMX Truck



EPX Truck

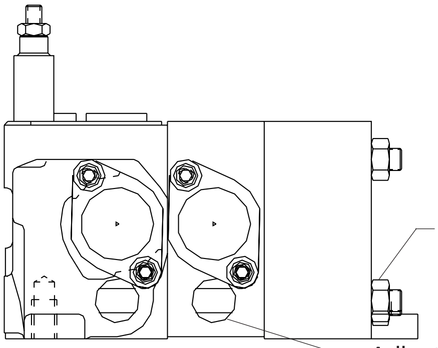
2. Turn the adjustment screw to set the auxiliary pressure relief setting to the normal range.
3. Reset the jam nut on the auxiliary relief valve adjustment screw.

Flow Control Adjustments

Flow control can be adjusted to meet the specifications given in Section 1.

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 tiebolt 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 specifications in Section 1.
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).

Section 5

Main Hydraulic Pump Overhaul

Removal and Installation

WARNING

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. Disconnect the battery.

5. Apply the park brake and block the wheels.

NOTE

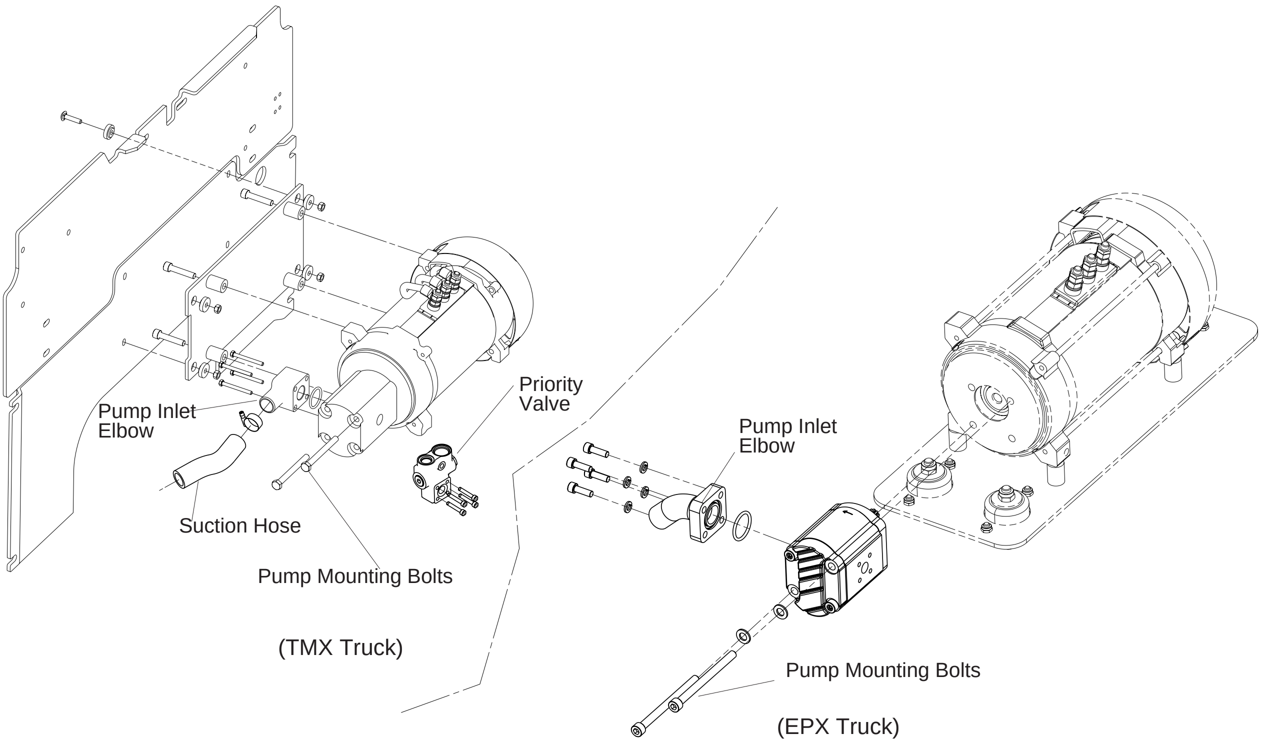
To remove motor and pump as an assembly, refer to motor removal procedure in Group 16.

Te remove or replace pump and leave motor installed, proceed as follows (replacement is reverse order):

A. Loosen/tighten bracket clamp screw (A) and shift motor/pump assembly as ncessary for pump access or mounting.
B. Hydraulic fittings.
Keep lines elevated to prevent dripping of fluid.
Tighten per hydraulic fitting tightening procedure in Group 40.
C. Mounting bolts.
D. Ground lead.
E. Main pump.

After installation:

Check operation of hydraulic system and fluid level of sump. Add MS-68 hydraulic fluid as necessary.



Routine Maintenance

- No maintenance is necessary other than periodic checks for tightness of the mounting bolts and port fittings plus visual examination for oil leaks. The unit should be kept externally clean, especially in the area of the shaft seal as dirt can accelerate seal wear and cause leakage.
- The unit must be operated on clean hydraulic fluid. Directions for filter service in this Group must be adhered to. A fluid cleanliness level of ISO4406 17/14 or better is recommended to give maximum life.

NOTE :

GROUP 30
MAIN HYDRAULIC SYSTEM

NOTE :

Section 1

Hydraulic System Schematic

Description

The following description focuses 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 at the end of this Section.

Descriptions of the braking and steering circuits are given in Groups 23 and 25.

The hydraulic sump is equipped with a full-flow return line filter, and filter cap/breather.

The main hydraulic pump is driven by an electric motor and draws fluid from the sump. From the main control valve, the oil is directed to the lift cylinders, tilt cylinders, auxiliary function and back to the sump. From the steering valve, oil is directed to the steering cylinder as described in Group 25/26 and to the sump via the return line filter.

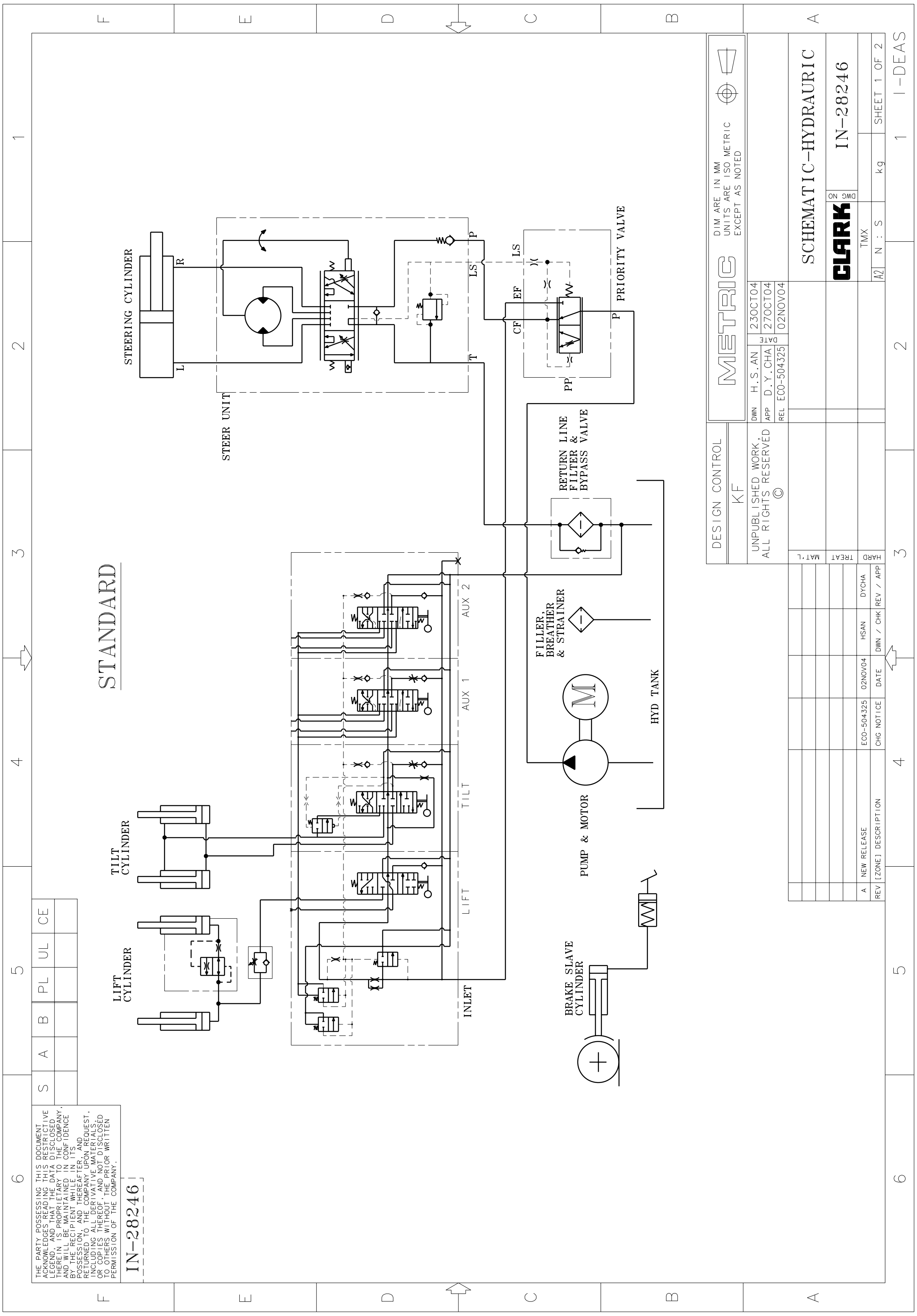
The main hydraulic control valve features an open-center, parallel-circuit type modular design. It has the main (lift/tilt) pressure relief valve (steering pressure relief valve is on steer gear), a secondary pressure relief valve for optional auxiliary components, a lift spool, a tilt spool with an integral counterbalance valve, optional auxiliary spools, and adjustable pressure compensated flow controls. All spools are low leakage design.

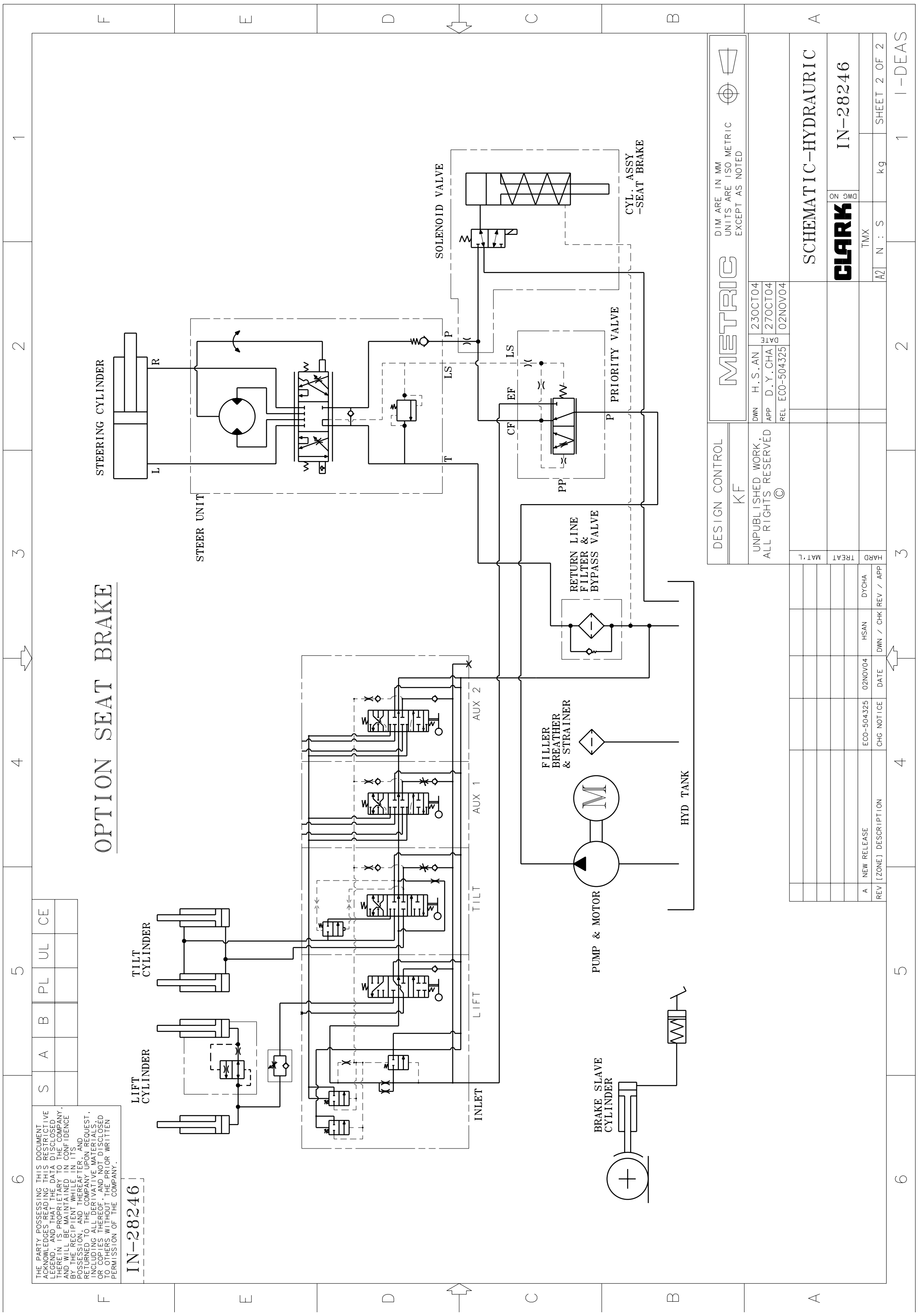
The main valve has from two to four valve sections. Each section performs a separate function; standard two spool assemblies have an inlet/lift section (with fluid inlet port), a tilt section, and an outlet section. A third and fourth section may be added to control auxiliary components. When lift attachments 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 how fast and how far 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 opens and signals the Pump Control Panel to slow to the preset speed to provide enough oil flow for the steering system. 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 (or other 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:

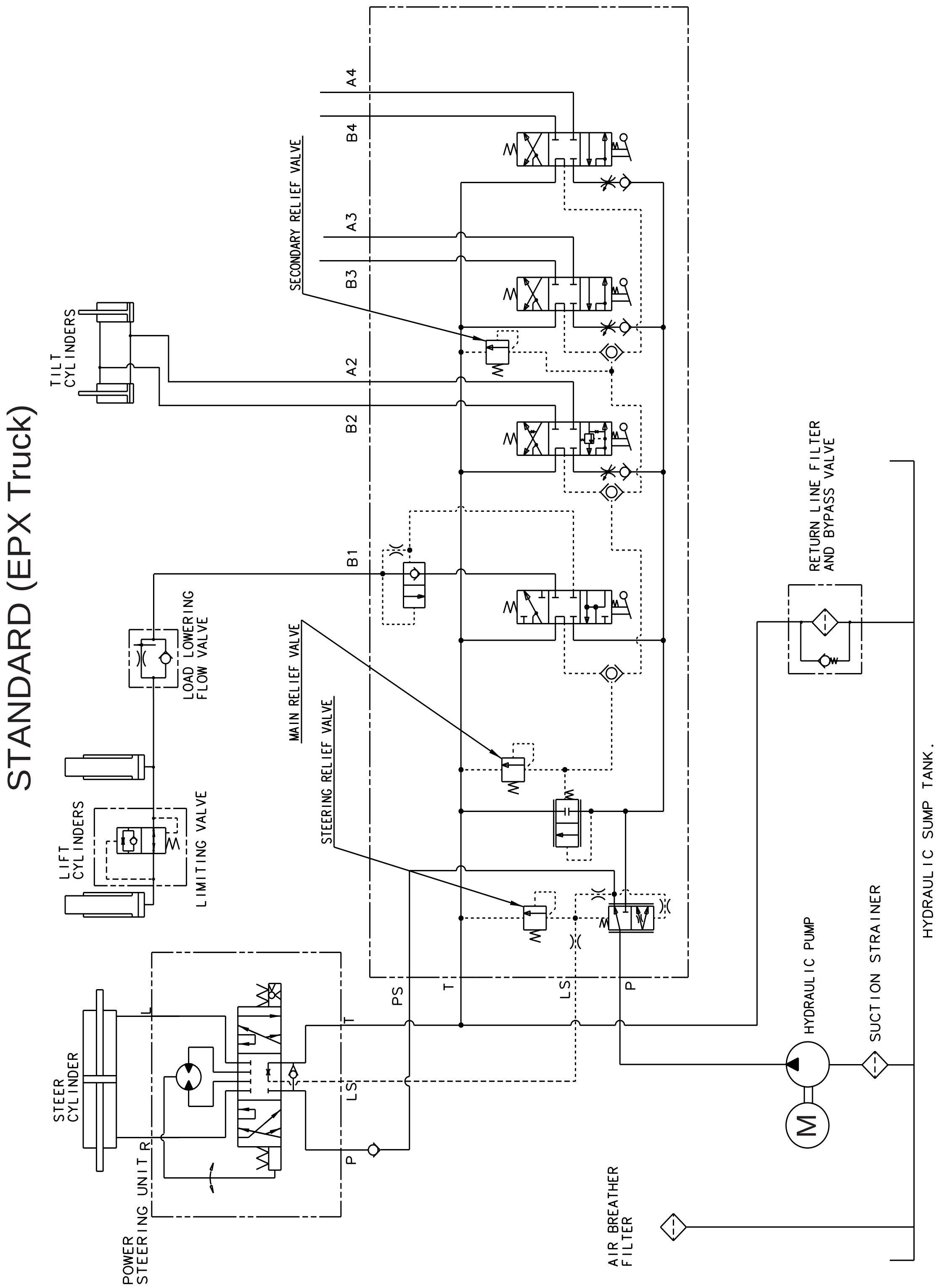
- The operator continues to hold the lift control in the lift position after the lift mechanism reaches its end of- travel.
- Too heavy a load is being lifted.
- The operator continues to hold the tilt control in the tilt position after the tilt mechanism has reached its end-of-travel (This is called "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 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 at least one of the lift cylinder ports prevents the upright from falling rapidly should a hydraulic line rupture or be disconnected.


STANDARD
STEERING CYLINDER
STEER UNIT
PRIORITY VALVE
RETURN LINE FILTER & BYPASS VALVE
FILLER, BREATHER & STRAINER
HYD TANK
PUMP & MOTOR
BRAKE SLAVE CYLINDER
TILT CYLINDER
LIFT CYLINDER
INLET
LIFT
TILT
AUX 1
AUX 2
SCHEMATIC-HYDRAURIC
IN-28246
METRIC
DIM ARE IN MM UNITS ARE ISO METRIC EXCEPT AS NOTED
DESIGN CONTROL KF
UNPUBLISHED WORK, ALL RIGHTS RESERVED ©
H.S.AN 23OCT04
D.Y.CHA 27OCT04
ECO-504325 02NOV04
A NEW RELEASE ECO-504325 02NOV04 HSAN DYCHA
SHEET 1 OF 2
I-DEAS



OPTION SEAT BRAKE
SOLENOID VALVE
CYL. ASSY -SEAT BRAKE
STEERING CYLINDER
STEER UNIT
PRIORITY VALVE
RETURN LINE FILTER & BYPASS VALVE
FILLER BREATHER & STRAINER
HYD TANK
PUMP & MOTOR
TILT CYLINDER
LIFT CYLINDER
BRAKE SLAVE CYLINDER
INLET
AUX 2
AUX 1
TILT
LIFT
DIM ARE IN MM
UNITS ARE ISO METRIC
EXCEPT AS NOTED
METRIC
DESIGN CONTROL
KF
UNPUBLISHED WORK, ALL RIGHTS RESERVED ©
DWN H.S.AN 23OCT04
APP D.Y.CHA 27OCT04
REL ECO-504325 02NOV04
SCHEMATIC-HYDRAURIC
DWG NO IN-28246
SHEET 2 OF 2
I-DEAS
TMX
A2 N : S
kg
A NEW RELEASE ECO-504325 02NOV04 HSAN DYCHA
REV [ZONE] DESCRIPTION CHG NOTICE DATE DWN / CHK REV / APP
MAT'L TREAT HARD
S A B PL UL CE
THE PARTY POSSESSING THIS DOCUMENT ACKNOWLEDGES READING THIS RESTRICTIVE LEGEND, AND THAT THE DATA DISCLOSED THEREIN IS PROPRIETARY TO THE COMPANY, AND WILL BE MAINTAINED IN CONFIDENCE BY THE RECIPIENT WHILE IN ITS POSSESSION, AND THEREAFTER, AND RETURNED TO THE COMPANY UPON REQUEST, INCLUDING ALL DERIVATIVE MATERIALS OR COPIES THEREOF, AND NOT DISCLOSED TO OTHERS WITHOUT THE PRIOR WRITTEN PERMISSION OF THE COMPANY.
IN-28246


STANDARD (EPX Truck)
TILT CYLINDERS
SECONDARY RELIEF VALVE
A4
B4
A3
B3
A2
B2
B1
LOAD LOWERING FLOW VALVE
MAIN RELIEF VALVE
STEERING RELIEF VALVE
LIFT CYLINDERS
LIMITING VALVE
RETURN LINE FILTER AND BYPASS VALVE
HYDRAULIC SUMP TANK.
SUCTION STRAINER
HYDRAULIC PUMP
M
STEER CYLINDER
POWER STEERING UNIT
L
R
T
LS
P
PS
T
LS
P
AIR BREATHER FILTER

NOTE :

Section 2

Hydraulic Control Valve Removal and Overhaul

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. Disconnect the battery.

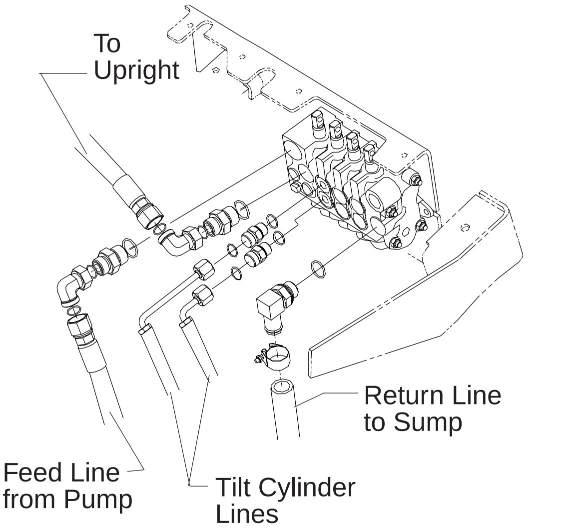
Hydraulic Control Valve Removal

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

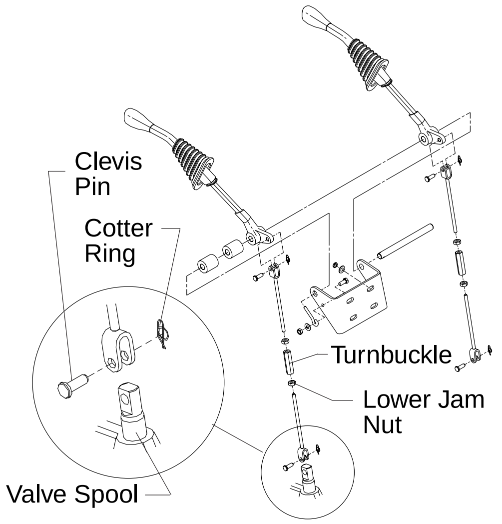
1. Park truck in a safe position and fully lower the upright.
2. Return all controls to neutral, apply the parking brake, turn the key switch OFF, and disconnect the battery.
3. Move all hydraulic control levers to all working positions and return them to neutral. Be sure there is no hydraulic pressure 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.

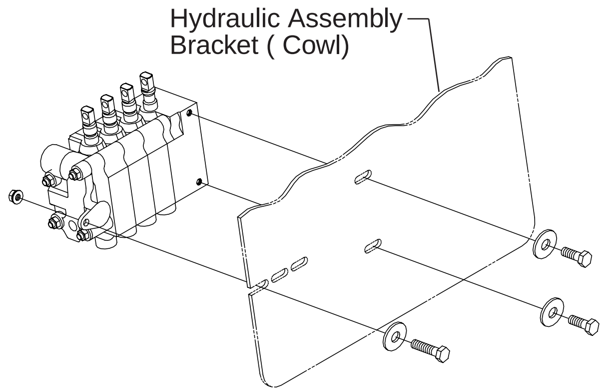
Control Valve Linkage Disassembly

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. 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.

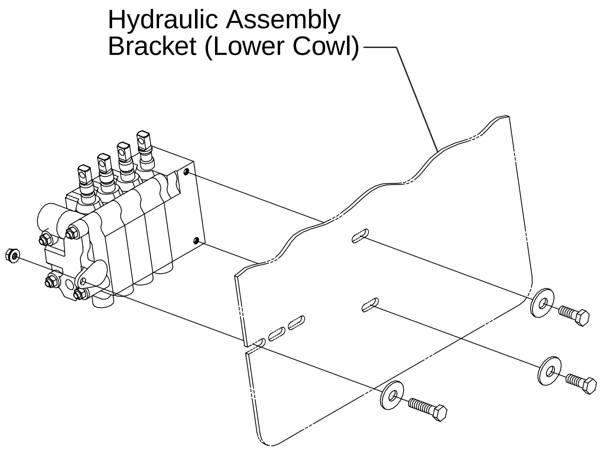
NOTE

Be sure to clean up any oil spills and dry the floor to prevent accidents.

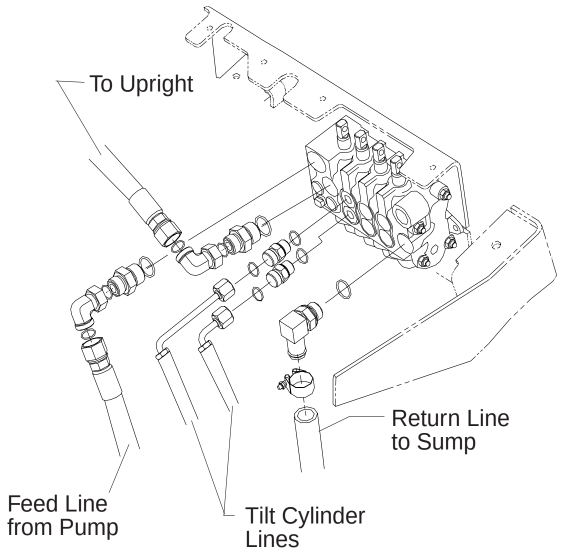
Hydraulic Control Valve Replacement

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.



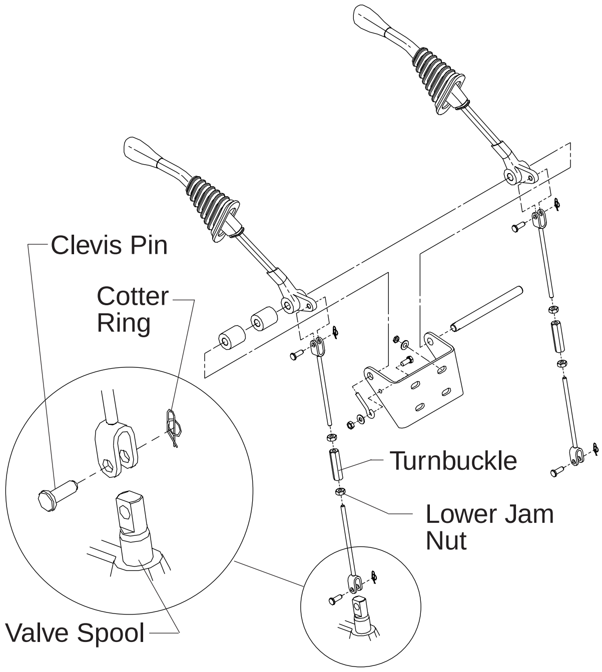
2. Install the hydraulic lines on the proper ports. Make sure all lines are clean, are routed correctly in the truck, and are not kinked. Torque fittings according to “Hydraulic Fitting Tightening Procedure” in Group 40.



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.



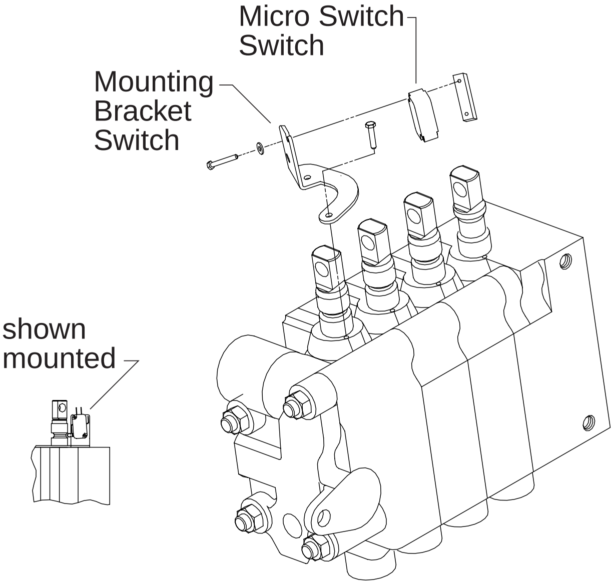
NOTE

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 40-50 N.m (30-33 ft-lb).

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.



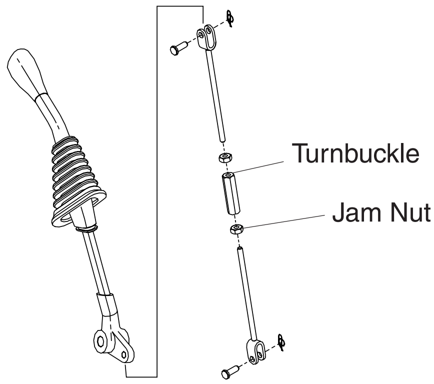
Operational Checks

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 move 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 turnbuckle jam nuts to 39-44 N.m (28.5- 32.5 ft-lb).
3. If valve was disassembled or overhauled. Check relief pressur as described in the hydraulic system pressure check Section of this Group.
4. Replace the cowl cover under the operator's compartment dash. See removal and replacement procedures in Group 38.

Hydraulic Control Valve Overhaul

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

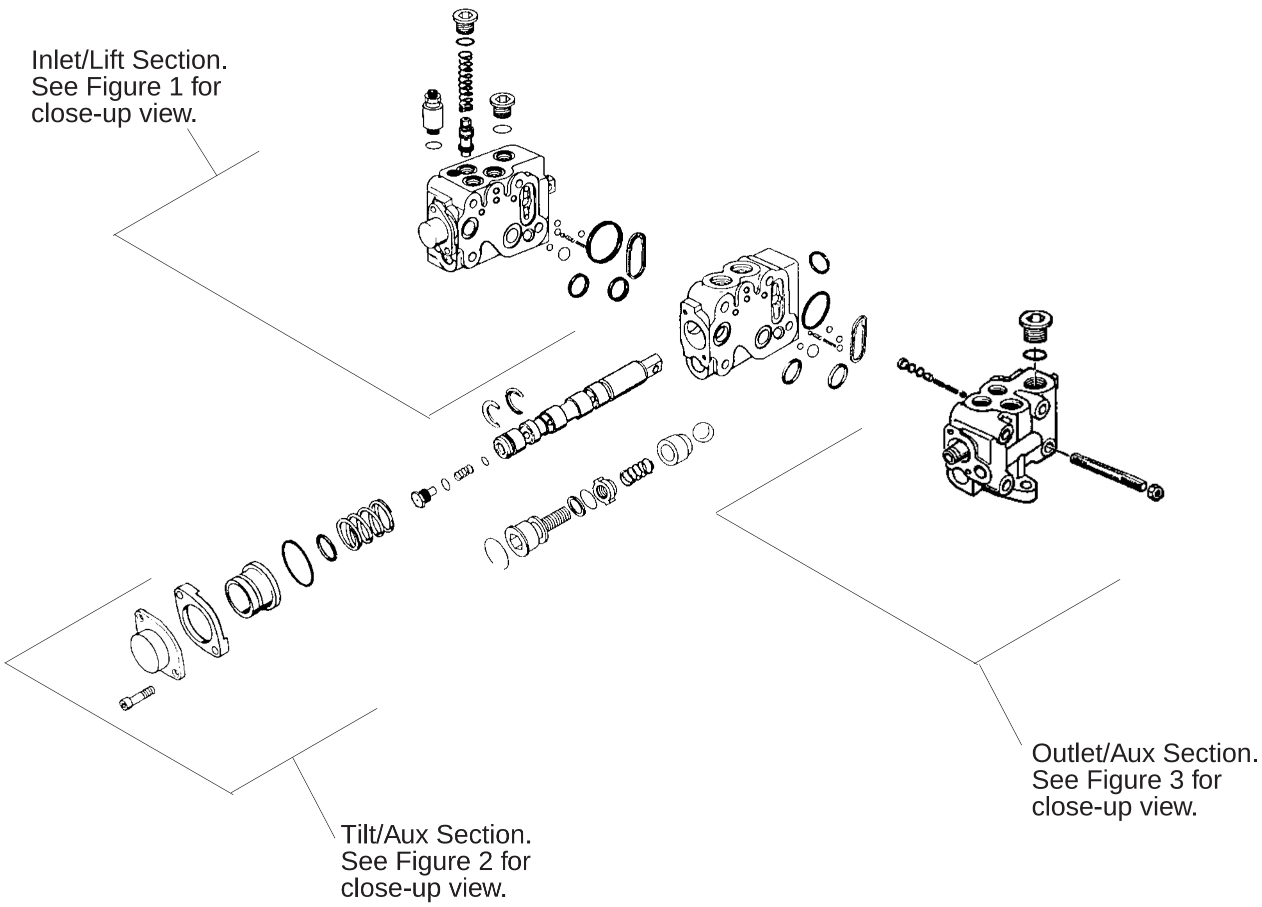
IMPORTANT

PARTS. Before removing any component for overhaul, make sure the correct repair parts, seals, and gasket sets are available.

IMPORTANT

CLEANLINESS. 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 of external damage.



Main Hydraulic Valve Exploded View.

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.

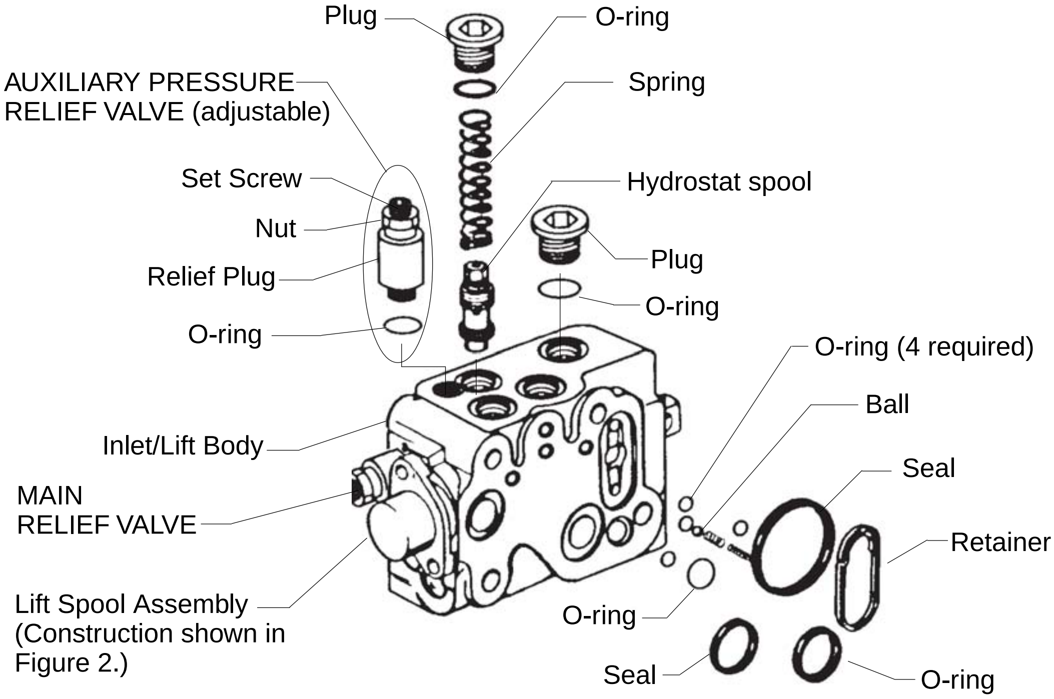


Figure 1. Inlet/Lift Body, Main Pressure Relief Valve, and Auxiliary Pressure Relief Valve. See Figures 2 and 3 for remainder of valve.

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 controlled by a hydrostat in the valve relief valve assembly and is set at the factory. No adjustments are recommended; if pressure relief setting is not in recommended range, hydrostat must be replaced.

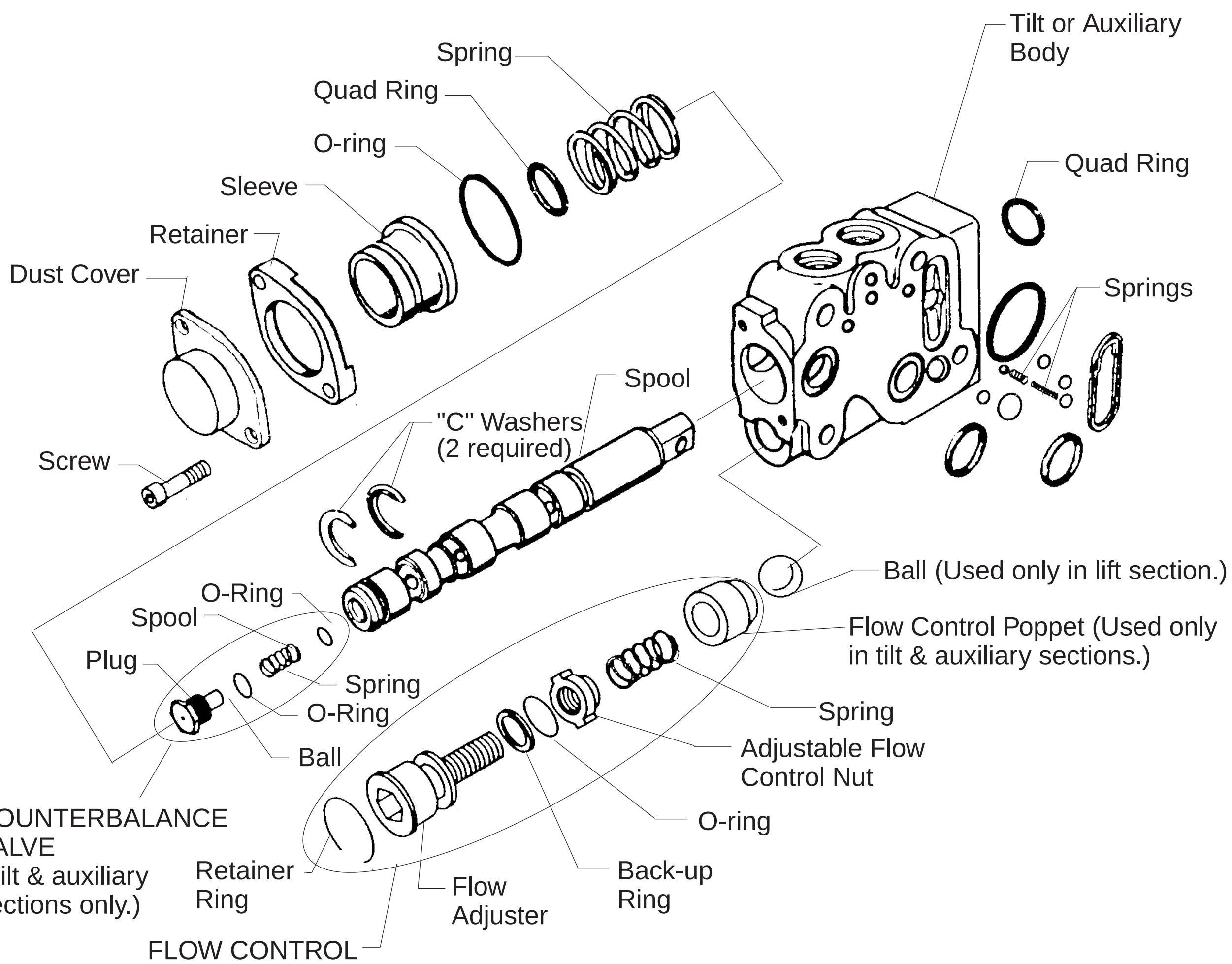


Figure 2. Valve Spool and Tilt (or Auxiliary) Body . Differences in lift (or tilt) and auxiliary components noted.

See Figures 1 and 3 for remainder of valve.

5. Inspect the lift and tilt relief valves for damage. Check the relief valve for smooth free movement in its bore. The valve poppet should move easily from only the force of its own weight.
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 illustratiosn 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 ftlb).
6. Reinsert studs between valve sections and torque nuts to 27-34 N.m (20-25 ft-lb).

Relief Valve Settings

After 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.

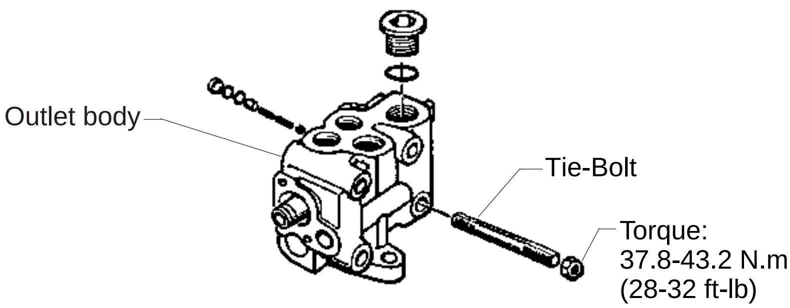


Figure 3. Outlet Body/Aux Section. See Figures 1 and 2 for remainder of valve.

GROUP 32

TILT CYLINDERS

IMPORTANT

Other hydraulic-related components and curcuits are described and Illustrated in Group 25/26, "Steering," Group 29/30, "Hydraulic System", and Group 34, "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 29 for hydraulic system specifications.

Tilt Cylinder Type: Double-acting

Maximum Operating Pressure: 21,000 kPa (3,000 psi)

Tilt Ranges: (188 Triple Stage Upright): 3o back tilt and 5o forward tilt

Fastener Torques

Rod-End Yoke Bolts: 170-190 N.m (125-140 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.

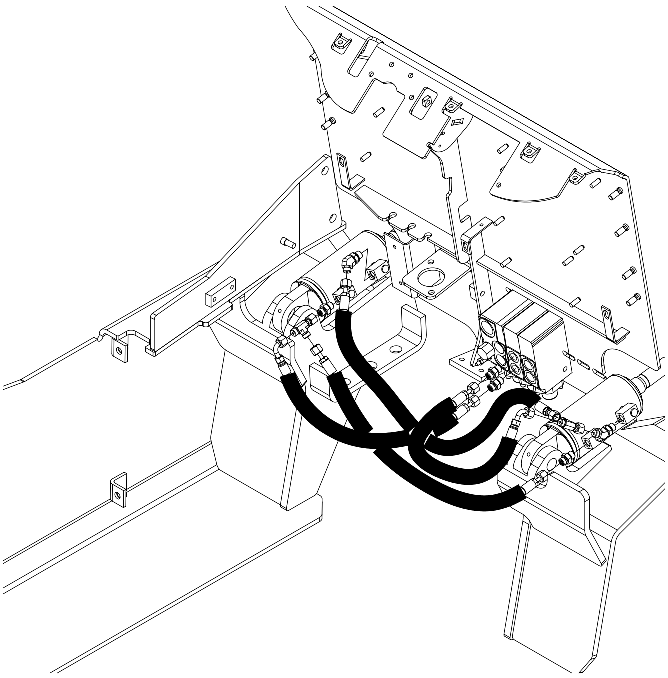
Tilt Cylinder Rod-End Lubrication: Every 50-250 hours or each PM.

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 spacersand differentlength 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 run ning. The tilt lock valve is not serviceable and must be replaced as a valve section if defective.



Tilt Cylinders

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 fullcapacity 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.

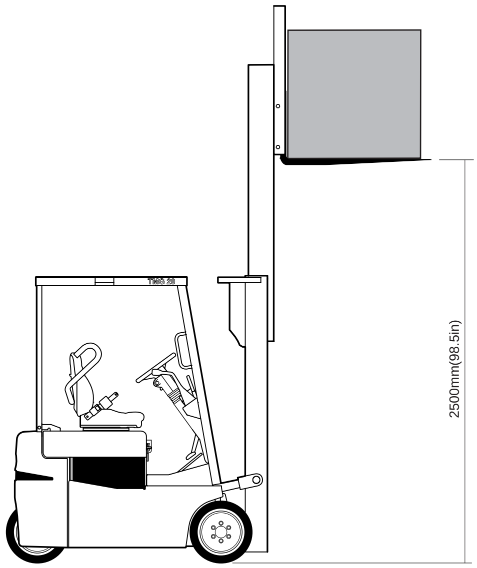
1. Adjust fork width as wide as possible to distribute the load. Refer to truck nameplate for capacity rating.

CAUTION

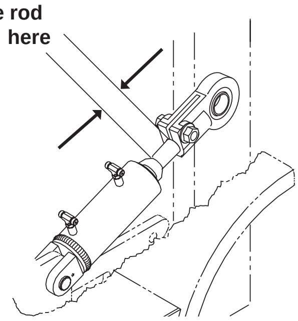
Test load must be stacked stably, not extend beyond the pallet, and be secured on the pallet.

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°, 31.1mm @ 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.

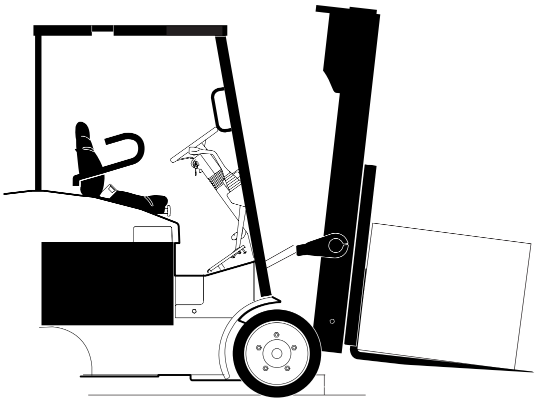
Tilt Cylinder Racking Check

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 truck 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.



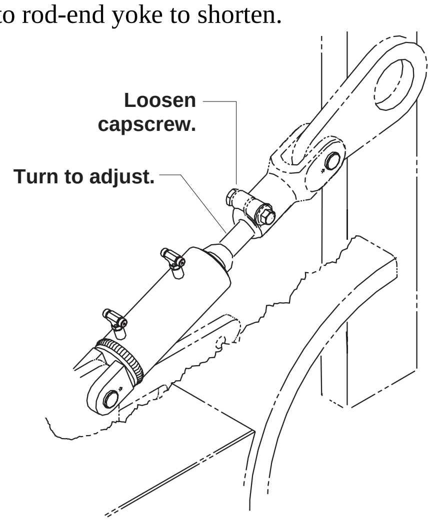
Forward Adjustment

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.

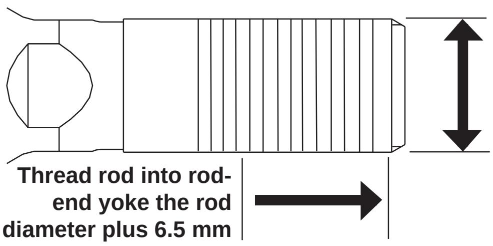
NOTE

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 be 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).

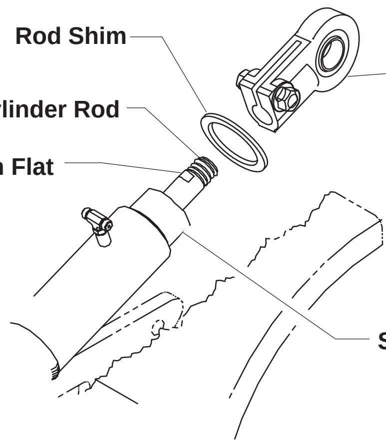


5. Tighten capscrew of the rod-end yoke to 166-193 N.m (122-142 ft-lb), and repeat the racking test.
6. Repeat steps 1-5 for fine corrections if any racking remains evident.
7. When no racking occurs, retighten capscrew of the rod-end yoke to 166-193 N.m (122-142 ft-lb).
8. Check all tilt functions before 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 29/30 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.

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 Removal and Replacement

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

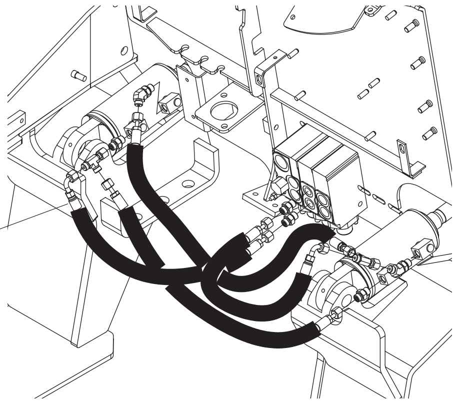
The upright assembly is heavy. Use only hoists with enough capacity to lift the entire assembly. Keep hands and feet away from the assembly. Use prybars to move the assembly into position for tilt cylinder replacement. Also support cylinder with a sling to prevent the cylinder from dropping when pins are removed.

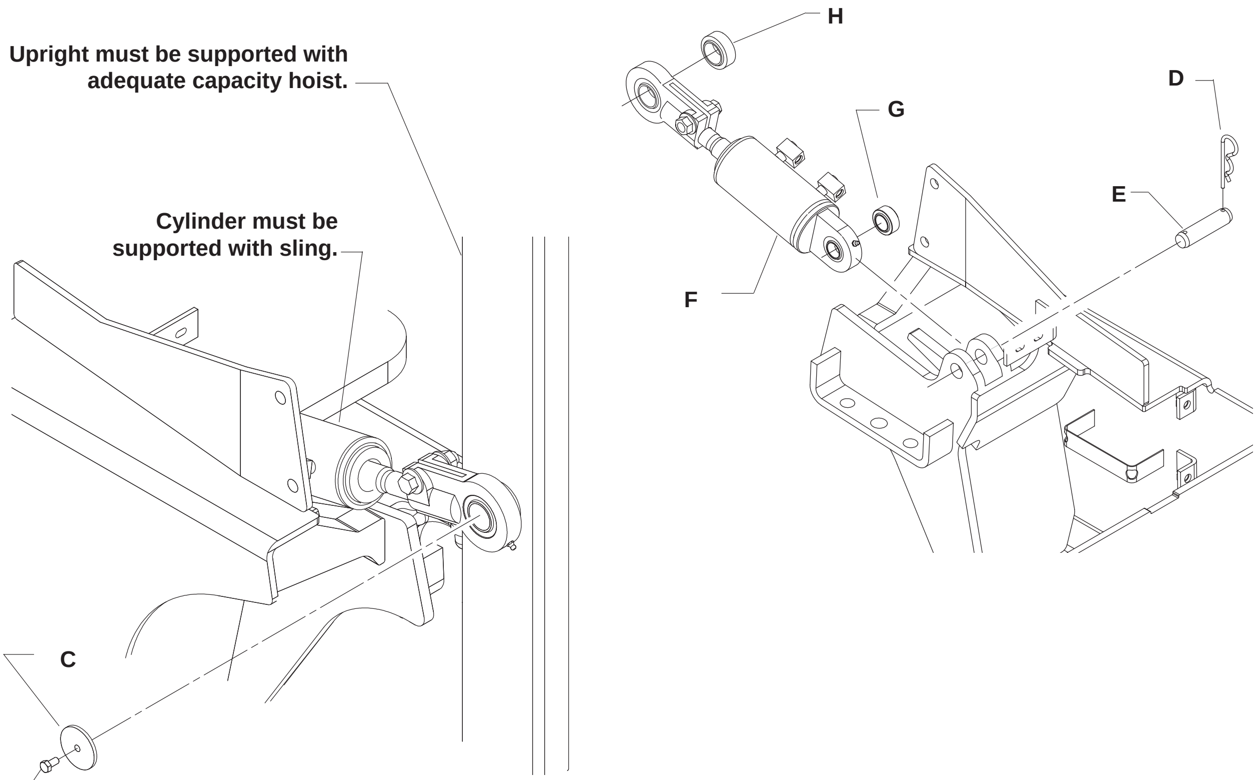
3. Removal Sequence. (Replacement is reverse order). See page 3.
   A. Hydraulic lines.
      Removal note: Put a drain pan under the truck at each tilt cylinder position before removing the hydraulic lines. Cap lines.
   B. Mounting bolt.
   C. Washer.
   D. Locking pin.
   E. Mounting pin.
      Installation note: Make sure the spherical bearing is aligned so that pin fits smoothly in yoke.
   F. Cylinder assembly.
   G. Spherical bearing.
   H. Spherical bearing.

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

4. See Section 2 for tilt cylinder adjustment procedures. When adjustments are made, check all upright components under load before returning the truck to service.





Tilt Cylinder Removal Replacement Steps (ref. page 2)

NOTE :

Section 4

Tilt Cylinder Overhaul

IMPOTANT

Before removing any component for overhaul, make sure the correct repair parts, seals, and gasket sets are available.

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 highlymachined 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

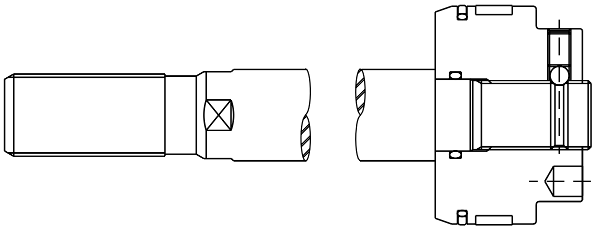
Do not use excessive force when clamping on the barrel.

1. Remove the retaining ring on the gland with snap ring pliers.
2. Push the gland assembly into the cylinder barrel to provide access to the shear ring.
3. With a brass punch, drive the shear ring inward to compress it and provide access to its outer edge. Then pry under the ring’s outer edge with a soft metal pick to compress the ring some more. This allows you to pull the ring over the shoulder in the barrel and extract the ring.
4. Carefully pull the rod and 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.

5. Remove and discard the piston seal and O- ring from the piston.



6. Remove and discard the rod U-cup seal, static seal, 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. Be sure the threads on the rod are undamaged.
3. Inspect the tilt cylinder barrel internal bore for wear, scratches or other damage. Deep gouges or pitted surfaces require replacement of parts. Check the outside of the entire cylinder for damage. Inspect all welds for cracks. Inspect the ports to be sure they are free of contamination and that the threads are clean and not damaged.
4. Put a light coating of hydraulic fluid on all parts. If parts are to be left disassembled for awhile, they should be covered with a clean cloth.

Reassembly

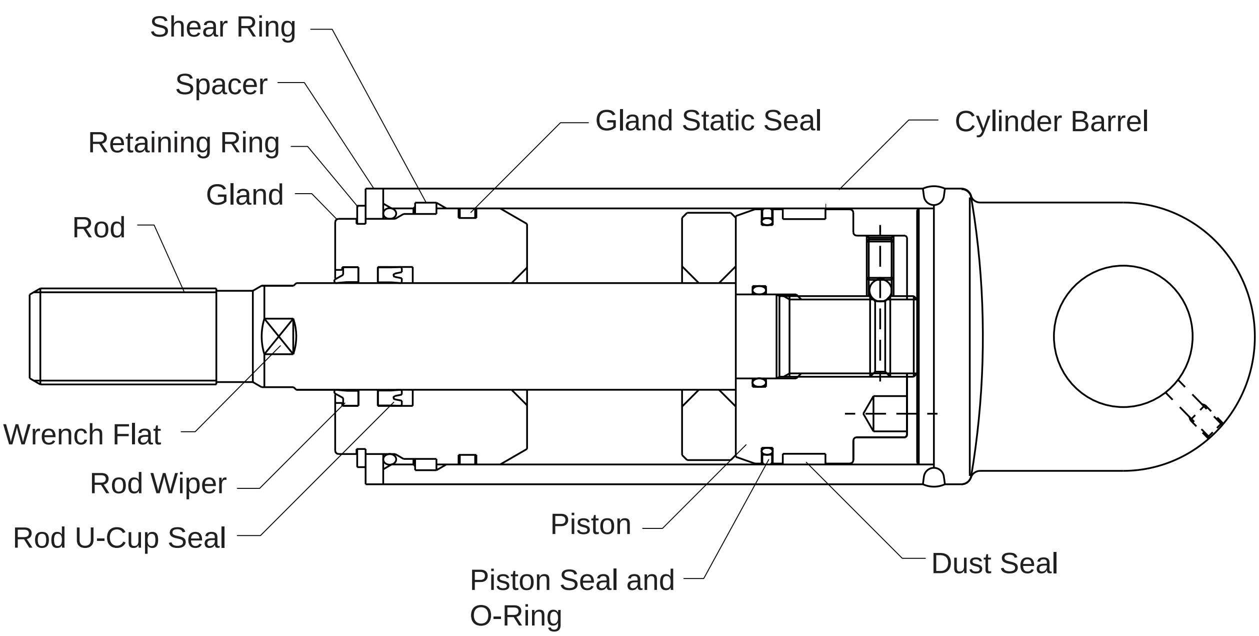
1. Install piston rod wiper, rod U-cup, and static seal on the gland. Make sure U-cup and wiper are installed in proper orientation as shown in the illustration.
2. Replace the piston O-ring and piston seal.
3. Install gland on piston rod. Use gentle pressure and careful movements to avoid damage to 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 and rod assembly into cylinder barrel. Be careful not to damage the piston seals when installing the piston into end of cylinder.
5. Insert gland over rod and into cylinder until the entire gland is below the shoulder the shear ring seats against. Be careful not to damage gland static seal.
6. Install the shear ring: Slip it over the rod and, with a brass punch, drive it in until it travels past the shoulder and snaps against the barrel wall. The pull the gland and piston assembly forward to make the snap ring seat against the shoulder in the barrel wall.
7. 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.



Cut-Away View of Tilt Cylinder

NOTE :

GROUP 34

UPRIGHTS

CLARK

NOTE :

Section 1

Upright Specifications and Description

General Specifications

Upright Weight: Approximately 330 kg (730 lb) to approximately 700 kg (1550 lb) without carriage.

Carriage Weight: Approximately 80 kg (180 lb) to 100 kg (220 lb) with a 37 inch carriage.

Fork Weight: Approximately 40-65 kg each (90-145 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 is 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 triple-stage uprights (TSUs) & Hi-Lo are piston cylinders.

The Secondary cylinders used on Hi-Lo uprights are ram cylinders.

IMPORTANT

Before removing any component for overhaul, make sure the correct repair parts, seals, and gasket sets are available.

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.

Upright Type		Upright Number	Cylinder Type
TMX	Standard	V1204	Piston-Type Lift Cylinder
	TSU	M1203	Piston-Type Secondary Cylinder
		M1204	Piston-Type Secondary Cylinder
	HiLO	H1205	Ram-Type Secondary Cylinder
		H1206	Ram-Type Secondary Cylinder
EPX	Standard	V1218	Piston-Type Lift Cylinder
	TSU	M1218	Piston-Type Secondary Cylinder
	HiLO	H1218	Ram-Type Secondary Cylinder

Drift:

Upright should not drift (fall) 100 mm (4 in) in ten minutes under a capacity load. 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

Load Back Rest: 170-190 N.m (125-140 ft-lb)

Chain Anchor Bolt Jam Nut: 80-150 N.m (59-110 lbf-in)

Carriage Side-Thrust Roller Bolts: 34-40 N.m (26-30 lbf-in)

Hose Fittings: See Group 40, “Hydraulic Fitting Tightening Procedure.”

Rod End Bolts: 164-190 N.m (122-142 ft-lb)

Tilt Cylinder Rod-End Mounting bolt: 25-30N.m (221-266 lbf-in).

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 6 months or after 1000 hours of service.
- 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 not used second set of chain for secondary 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.

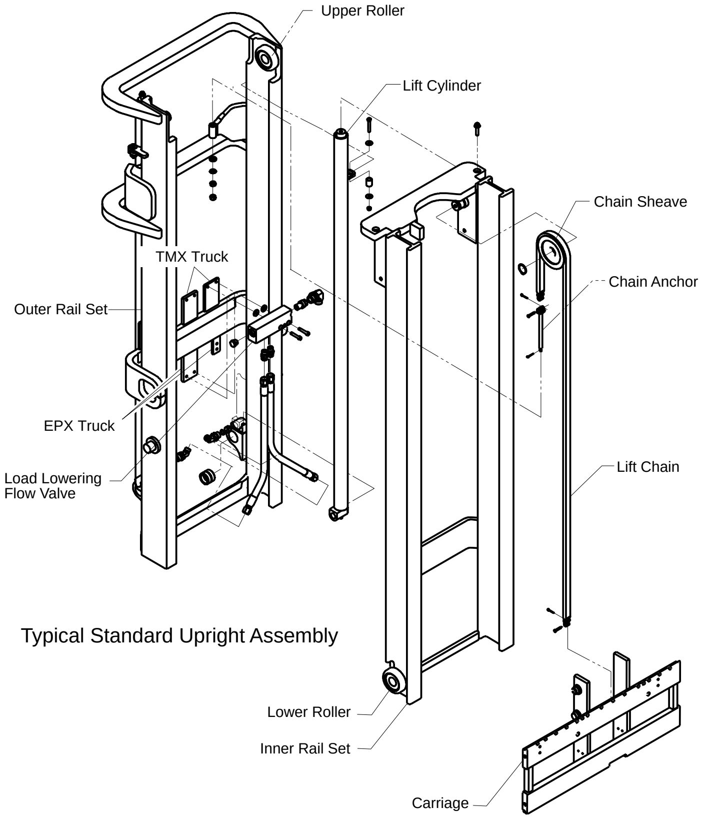
The lift and secondary cylinders on standard uprights, Hi-Lo uprights and triple-stage uprights (TSUs) may be either piston-or ram-type cylinders. The primary cylinder on TSUs and Hi-Lo uprights are piston-type cylinder. See the chart under “Specifications” to determine the type of cylinder used on the 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.

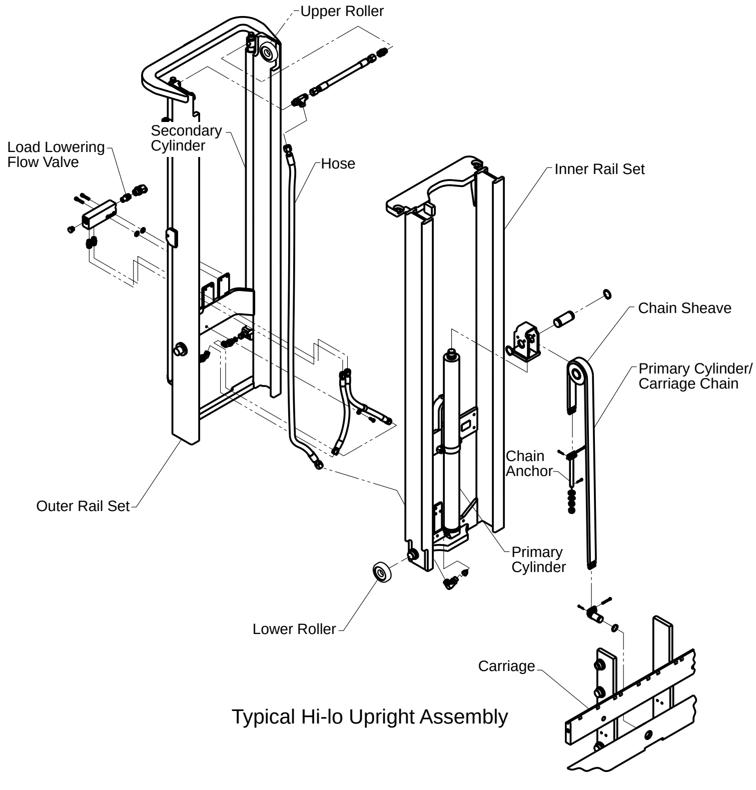
As explained in more detail in Group 30, the main pump sends fluid to the main hydraulic control valve, which contains spools that route fluid to the lift cylinders and tilt cylinders. The valve assembly also contains a counterbalance valve that prevents upright tilt when the truck is not operating.

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.

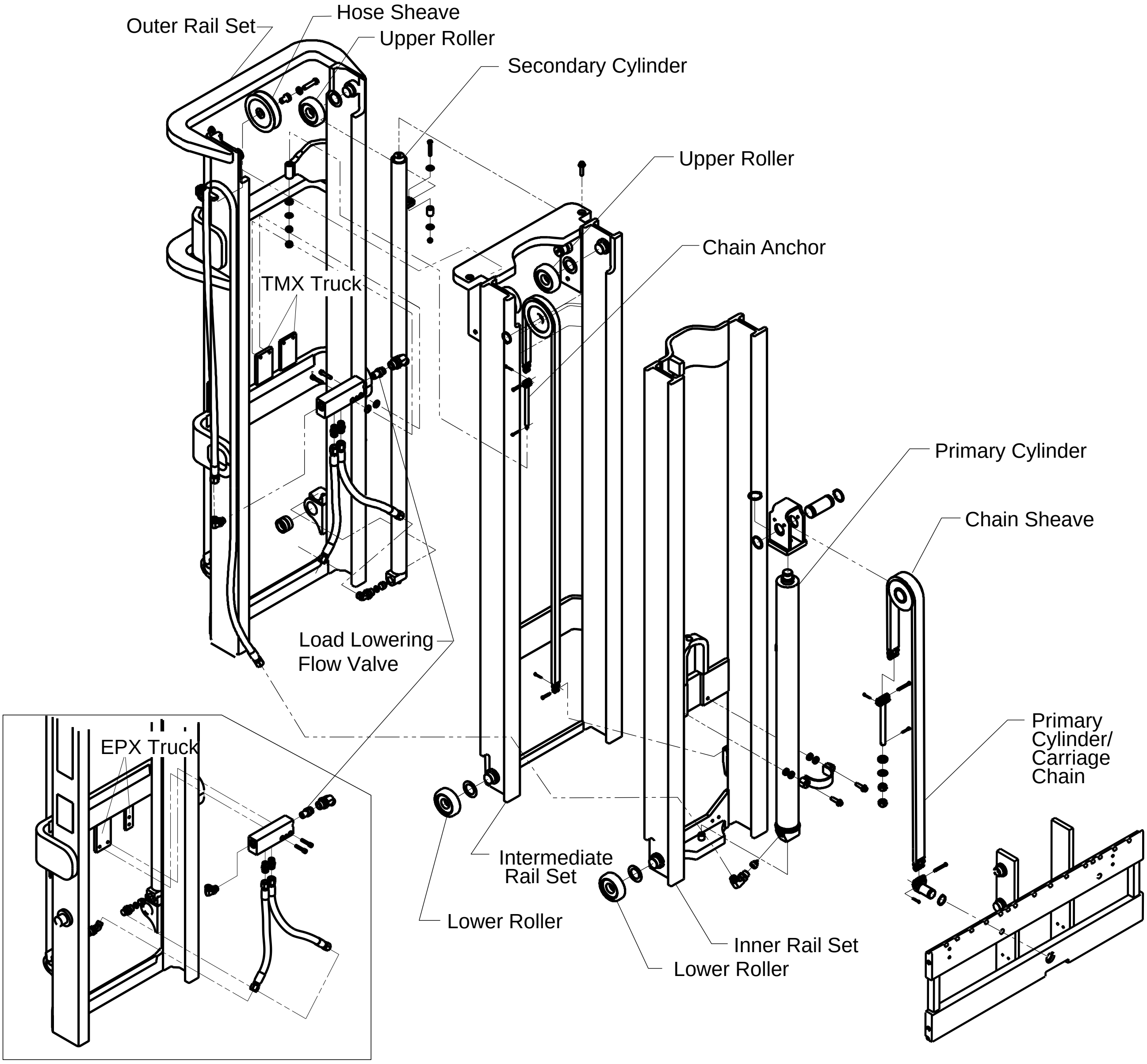
Groups 29 and 30 contain general hydraulic information including upright hydraulic functions. Other hydraulic checks for the upright appear in “Troubleshooting,” Section 2.



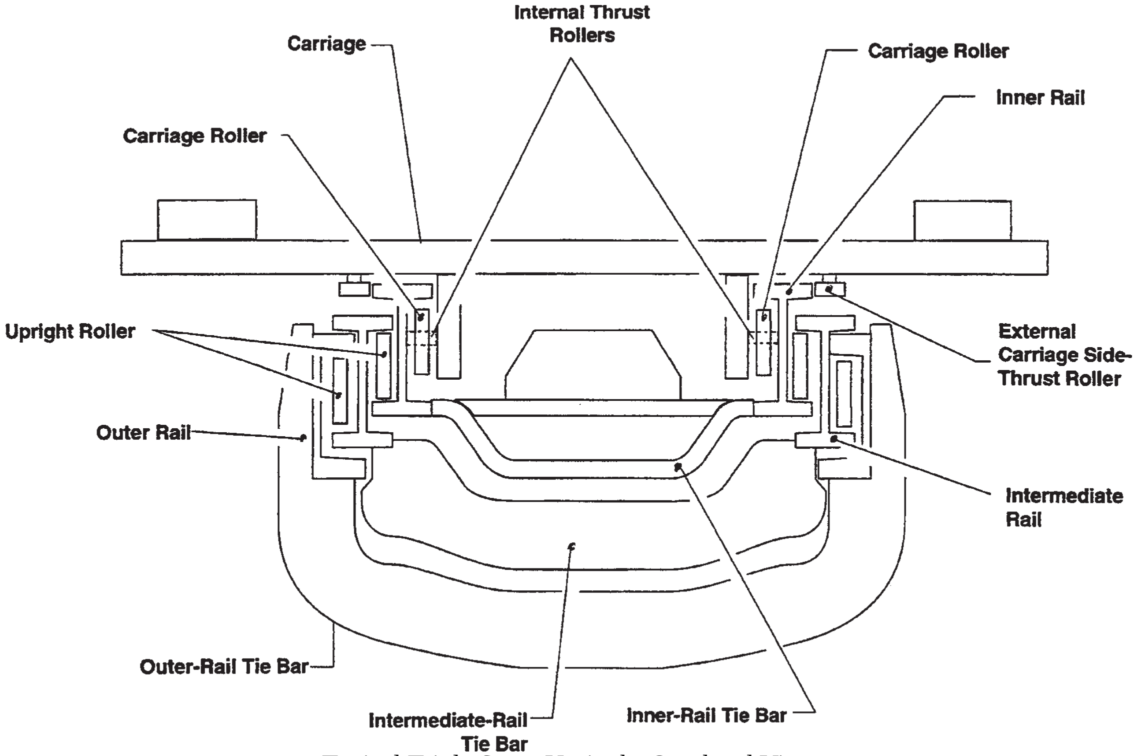
Typical Standard Upright Assembly



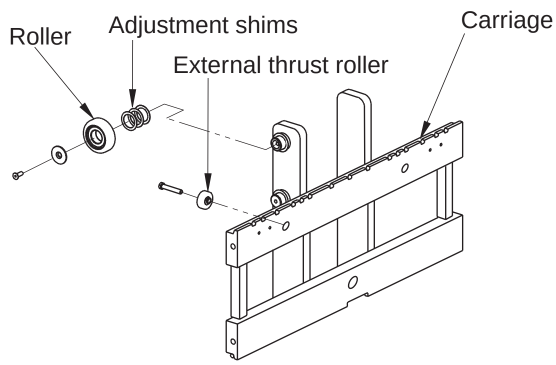
Typical Hi-lo Upright Assembly



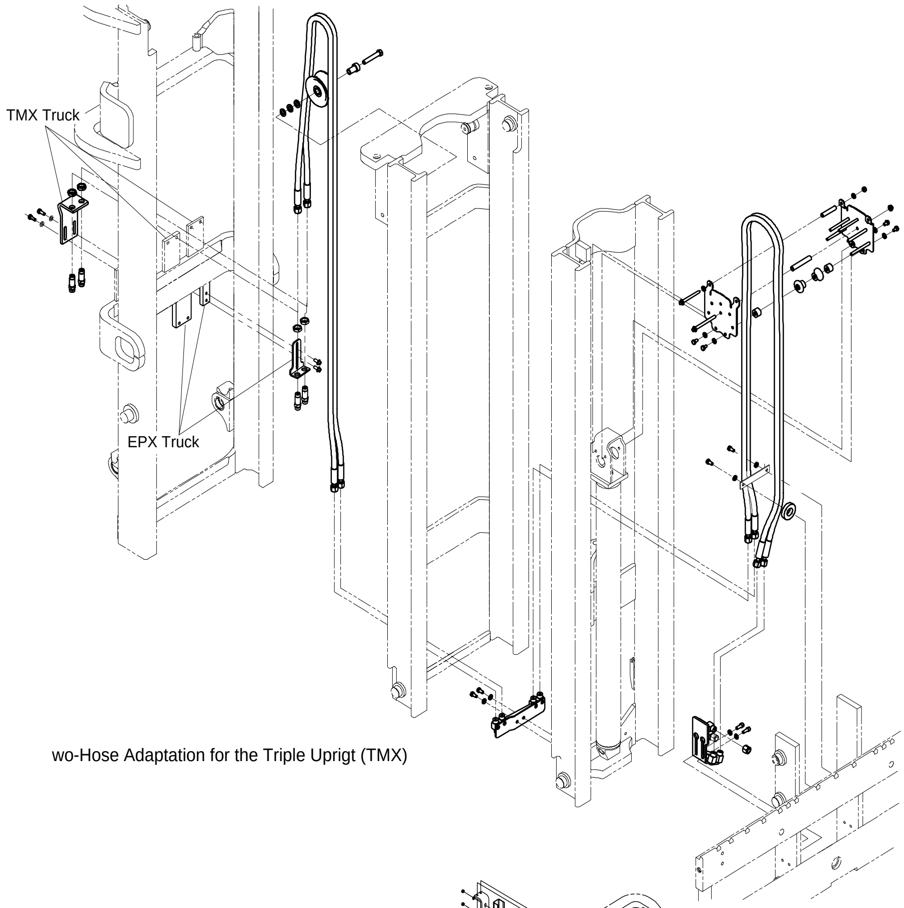
Typical Triple-Stage Upright Assembly



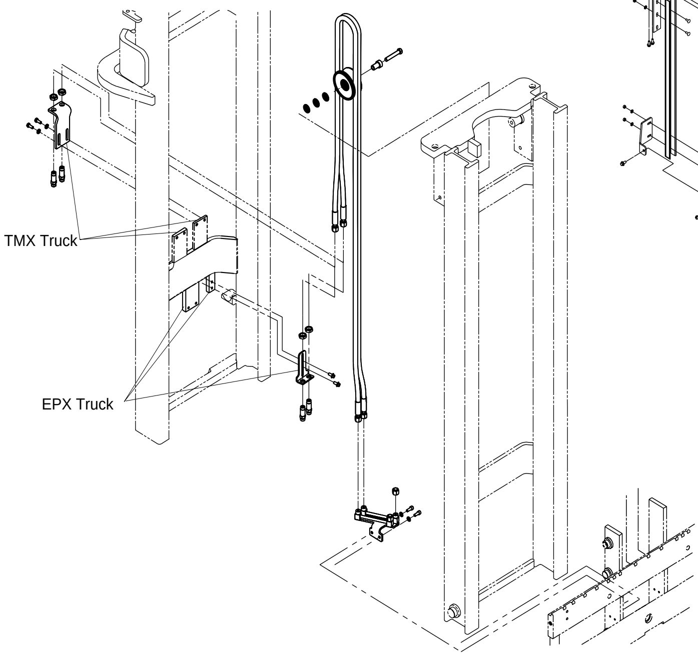
Typical Triple Stage Upringht-Overhead View

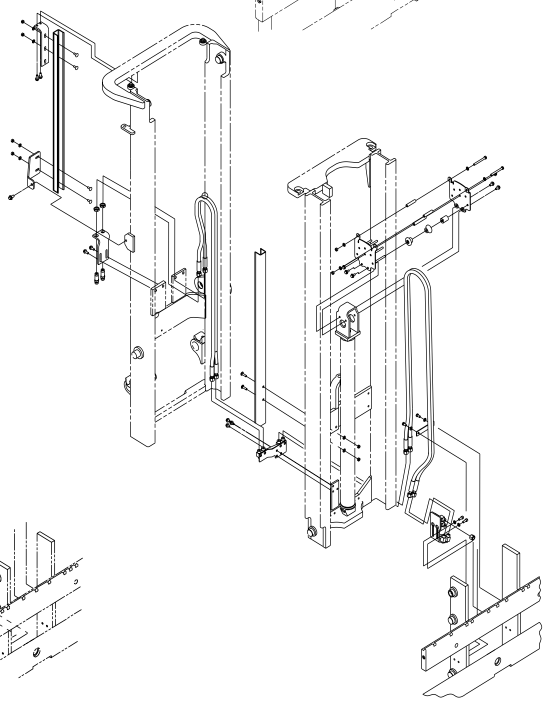


Carriages and Roller Sets



wo-Hose Adaptation for the Triple Uprigt (TMX)





Two-Hose Adaptation for the Standard Uprigt (TMX)

Two-Hose Adaptation for the Hi-Lo Uprigt (TMX)

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 lift height.

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, tilt, or auxiliary function

- 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.

No 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.
- Hydraulic hose fittings loose or damaged; check and torque correctly (see Group 40 for specifications) or replace.
- Check cylinder for external leakage; replace cylinder if cracked.
- Cylinder shimming is incorrect; check and adjust shimming.
- 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 ìLoad cannot be lifted to maximum height.î
- 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 priority valve; see Group 30 for valve troubleshooting information.
- 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 10-15 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 & Hi-Lo 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 as necessary.
- 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 area; 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 135 N.m (100 ft-lb) and glands on lift (secondary) cylinders to 100 N.m (73 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 (TSU & Hi-Lo)

- Gland loose; check and tighten gland on cylinders to 100 N.m (73 ft-lb).
- Cracked cylinder tube; inspect and replace tube.
- Seal damage in piston-type cylinders; replace piston seals and 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 only 3.4 ounces (100 ml) on rod side of the piston
  b. Piston-type lift and secondary cylinders should be dry on rod side 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. On ram-type cylinders, inspect/replace rod and piston.

See Section 5.

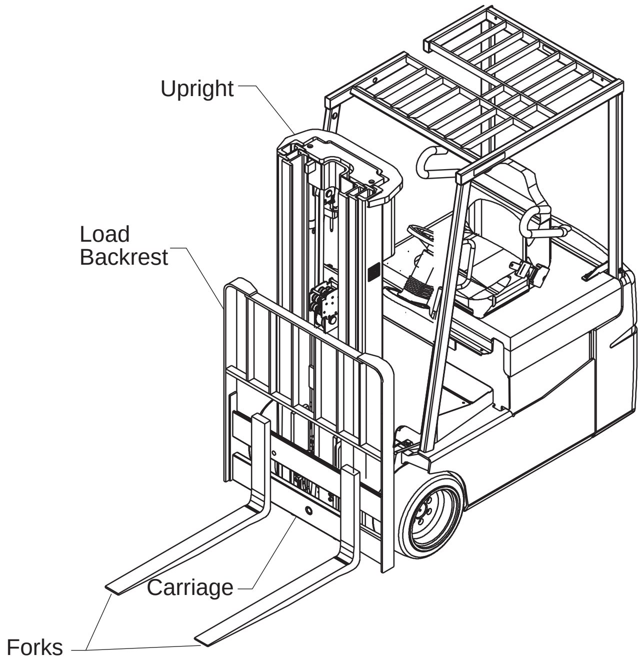
- Cylinder hydraulic fittings loose or worn; check fitting O-rings, tighten fittings according to Group 40,"Hydraulic Fitting Tightening Procedure."
- Check valve worn or damaged; remove rod and piston, clean check valve and replace if necessary.
- Control valve spool linkage malfunctioning, damaged, 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 iExtended Inspectioni 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

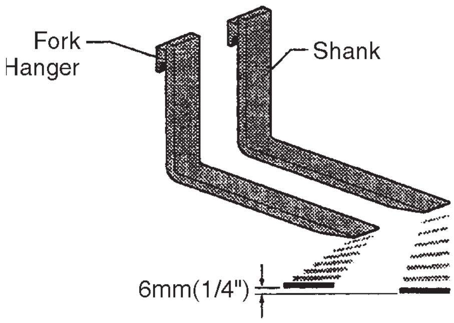
The extended inspection should be performed whenever the basic visual inspection indicates upright problems, as specified for PMs, or at least every 2000 hours.

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 (1-2 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).



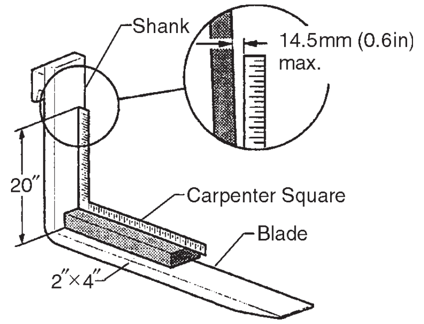
Fork Arm Height

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 50 x 100 x 610 mm (2 x 4 x 24 in) 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

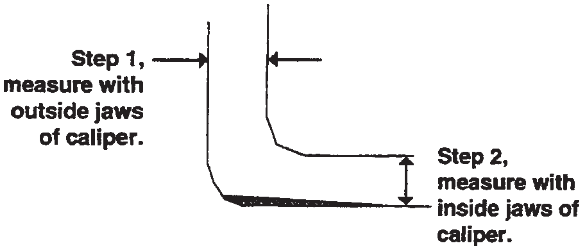
Fatigue cracks normally start in the heel area or on the underside of the top hanger. If cracks are found, the fork should be replaced. Dye penetrants or magnaflux can be used for a more accurate inspection.

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 (1818 kg).

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 measure fork thickness in the shank area of the fork.



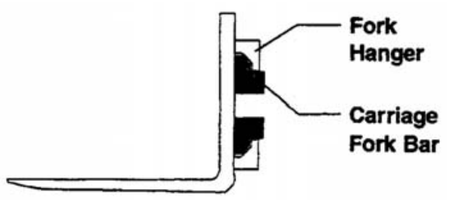
NOTE

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.



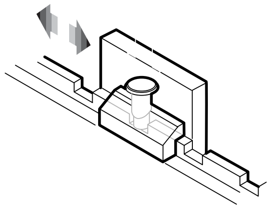
- If fork hangers are excessively worn, replace the forks as a set.
- If carriage fork bar is excessively worn, replace the carriage.

IMPORTANT

Welding is not recommended for repairing 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.

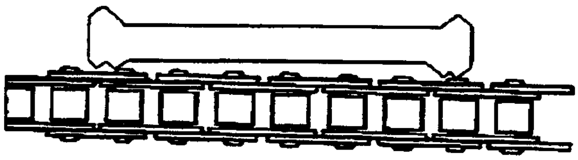
2. Check fork stops for widening of notches or rounding of top edge. Replace the carriage if fork stops are excessively worn.

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

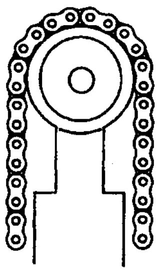
Lift chain stretch due to wear in the joints can be measured using a measuring tape or Clarkis chain check ruler.



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 TSU 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. 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.

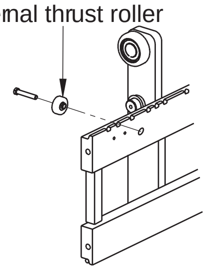
- Bent components indicate excessive loading or high impacts to the weldments. Bent components are usually structurally damaged and should be replaced.
- Inspect roller contact patterns on the rail sections. Roller contact patterns should be smooth and regular.
  – In some applications, it may take up 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 removal and installation.

Carriage and Upright Rollers

Carriage Thrust Rollers

- 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 all uprights.



The extenal thrust roller should be checked for smooth rotation, seal integrity, radial bearing tightness, and a tight cap screw. A roller should turn smoothly without sticking and be grit free. Replace the roller if any defect is found.

External thrust roller cap screws have a locking patch to prevent the cap screw from backing out. Repeated removal will deteriorate the ability of the patch to hold the cap screw. If the cap screw is backing out without holding, a new cap screw is recommended. The cap screw can also be cleaned and set using thread locking compound Loctite 271 (Clark Part 1802302).

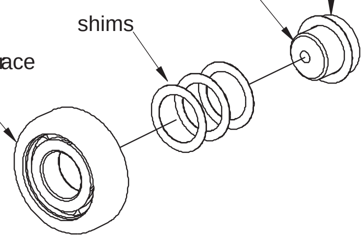
NOTE

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.

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 mis-staging
- 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.

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. Place a capacity load on the forks and secure it to the carriage.

CAUTION

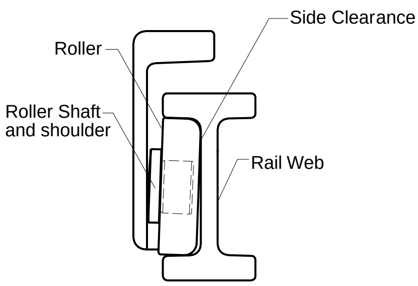
Test load must be stacked stably, not extend beyond the pallet, and be secured on the pallet. Operate the truck only from within the operatoris compartment.

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 100 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 100 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 the 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 rollers 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 1.3 m (4 feet).
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.

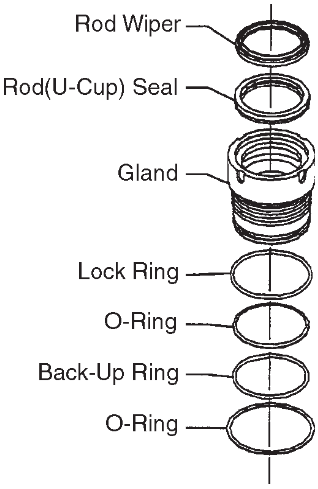
Cylinders

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.
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 5-10 times. 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 (1-2 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 standard, TSU and Hi-Lo uprights 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-toside 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 prevent 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."

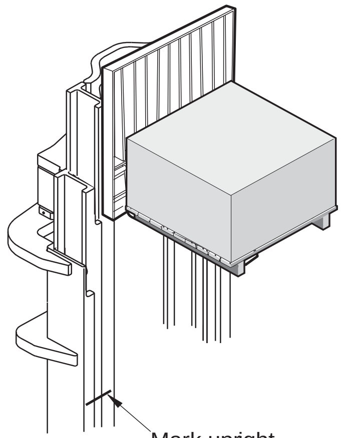
WARNING

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 five 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 no drift does not exceed 50mm (2 in) in the 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.

Drift Causes and Remedies

If drift of 50 mm (2 in) or more is evident under a half-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 first two remedies in this list are not successful. See Section 5 for removal, overhaul, and replacement procedures for primary and secondary cylinders.

Section 4

Carriage and Upright Roller Clearance Checks and Shim Adjustment

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**
- **Kee 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. Use a prybar.**

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

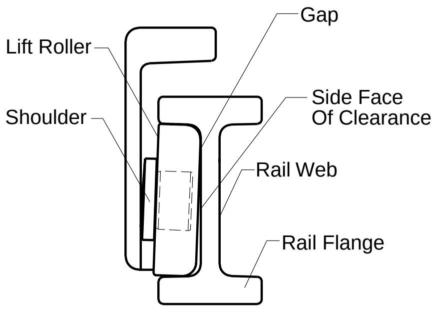
Standard and Hi-Lo upright assemblies have two lift roller sets mounted on the rails, three lift roller sets mounted on the carriage, and on external thrust roller set mounted on the carriage.

The triple-stage upright assemblies have four lift roller sets mounted on the rails, three lift roller sets mounted on the carriage, and one thrust roller sets (“external”) mounted on the carriage. (see the “Roller Side Clearance Chart” on next page.)

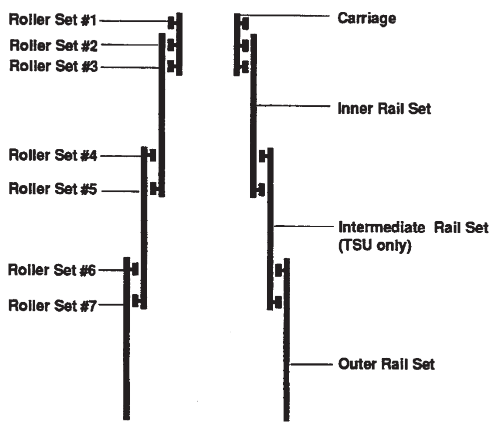
Each carriage and upright lift roller is nested within its adjacent rail set. The front “face” of the lift roller handles front-to-back friction and play between the nesting segments of the upright assembly, the side “face” of the roller radius handles side-to-side friction and play. The rollers are 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.



Roller Side Clearance Chart



	Web Area	Gap at Mimimumm Span of Rail Set				Gap at Maximum Span of Rail Set			
Roller Set#	Forming Gap	Target[a]		Allowed[b]		Target[a]		Allowed[b]	
		(mm)	(in)	(mm)	(in)	(mm)	(in)	(mm)	(in)
#1	Front, Inner rail	0.5-1.5	0.02-0.06	0.5-1.25	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.

d. Ideal is same as final measured gap at minimum width point of rail set.

e. Measured at top of inner rail.

You check the performance effect of the lift roller side clearance by means of the load 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.

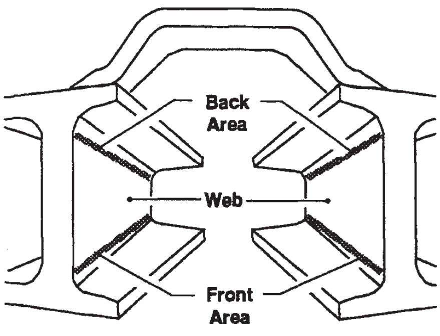
Roller Side Clearance Checks

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.

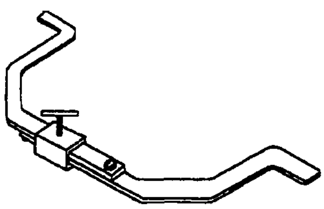
General Roller Side Clearance Checking Procedure

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:

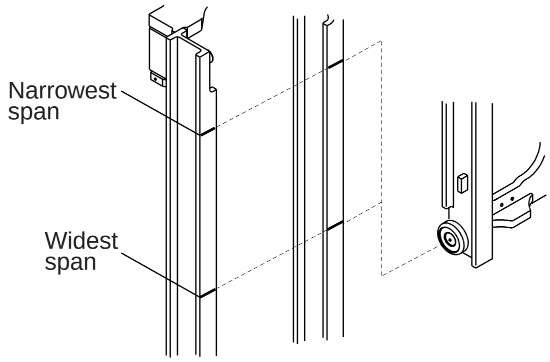
1. With the spanner tool, find and mark the narrowest and widest spans in each rail set at the roller-contact areas in the rail webs:
   - Inner Rail Set-Mark narrowest and widest spans for both the front and back web areas.
   - Outer and Intermediate Rail Sets-Mark narrowest and widest spans for the back web area only.



Web Areas on Typical Rail Set

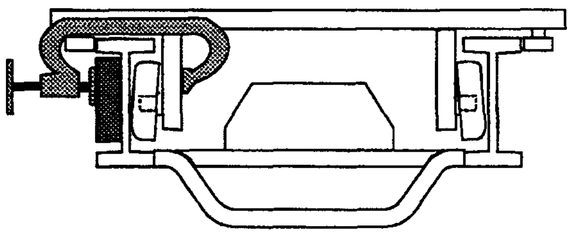


2. Position the carriage or rails so that the roller set you want to check is at the mark for the narrowest span on the adjacent nesting rail set.

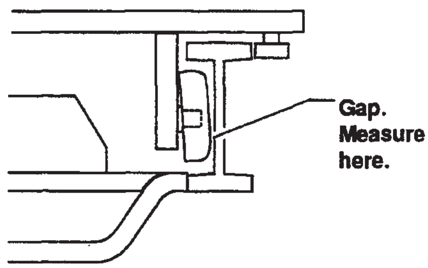


Example of Aligning Roller Set with Widest and Narrowest Spans Marked on Adjacent Rail Set. Rail sets are shown separated for clarity.

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 25 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 1.0 mm (0.04 in), 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

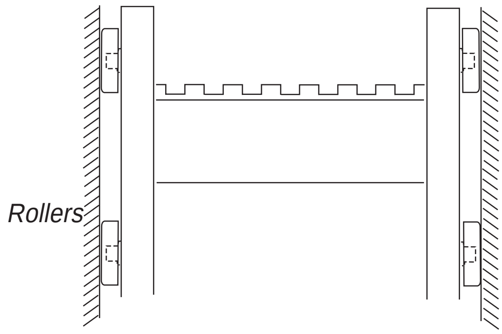
Follow the general procedure above.

Middle Carriage Rollers

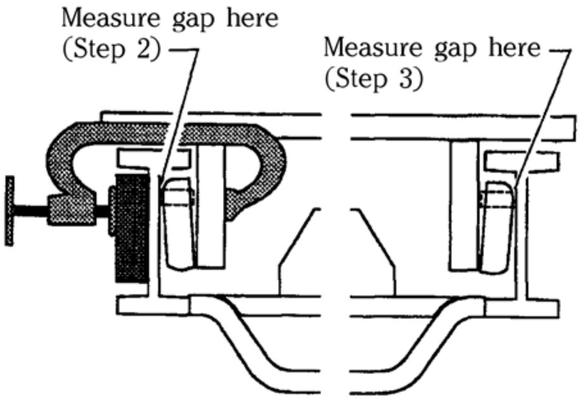
The middle rollers are difficult to access and require the following special procedures.

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 measurement in step a, Write result here:
      b-a= ______________________.
      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



1. 1. Move the top carriage lift roller to the narrowest span on the inner rails set.
2. 2. Clamp rail to one side as in general procedures. Check clearance of lift roller on clamped side.



The lift roller to stand off from the web by .01 to 1 mm (0.001-0.03 in).

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

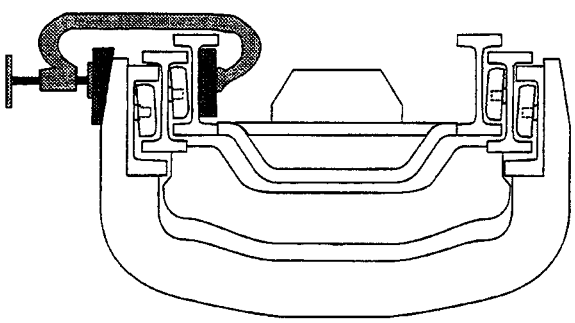
An upright or carriage can move unexpectedly:

- **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 a prybar.**
- **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.

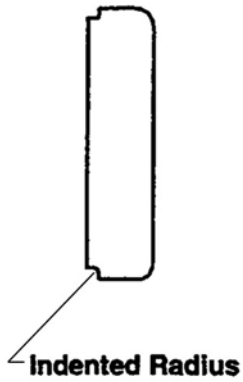
The clamping procedure is as illustrated below.



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.

Identify 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.

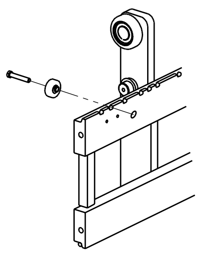


Lift Roller Shimming

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.

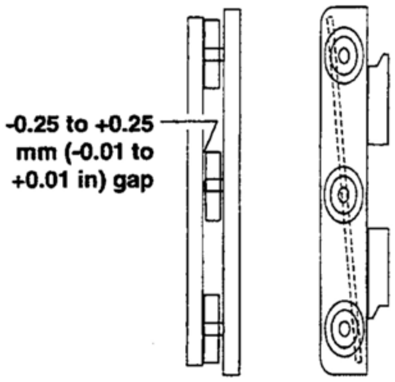
Carriage Roller Shimming

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).

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 0.75 mm (0.03 in) or less.

WARNING

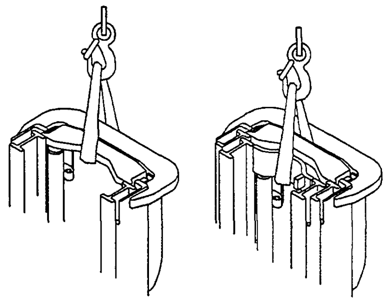
Use an approved safety platform. Never use the upright as a ladder.

CAUTION

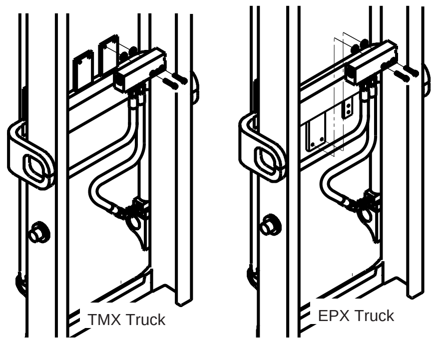
The carriage should be removed for shimming or when any service is performed on the upright. See Section 8, for removal and replacement procedures.

Upright Roller Removal

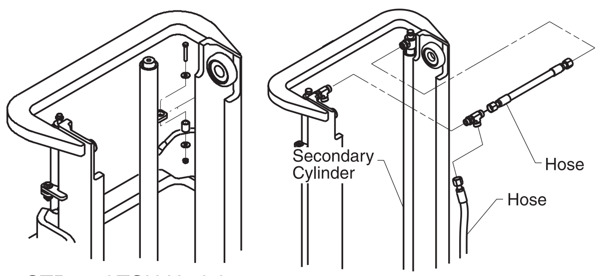
1. After the carriage has been removed, lower the upright rails until both of the secondary (final) lift cylinders are completely collapsed.
2. Jack the truck and block under the frame so that the bottom of the upright is approximately 254 mm (10 in) off the floor. See “Lifting, Jacking, and Blocking” 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 & 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.

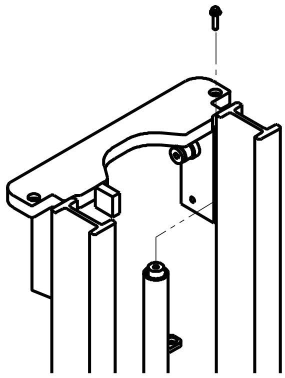


7. Disconnect the cylinder guide bolts. In Hi-Lo upright, disconnect the secondary cylinder hose.



STD and TSU Upright   Hi-Lo Upright

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.

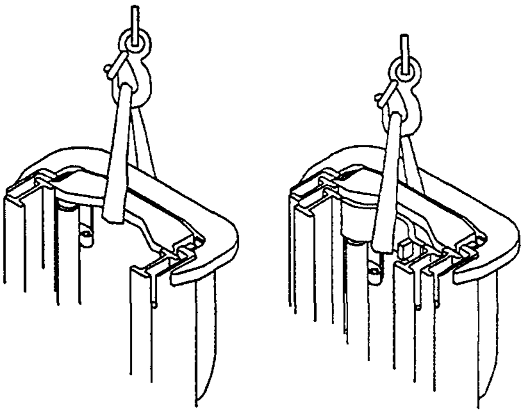
WARNING

The upright can move unexpectedly:

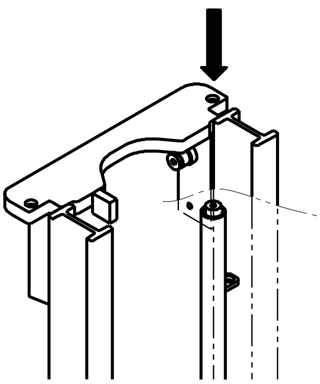
- **Keep your arms and fingers away from moving parts of the upright.**
- **Do not reach through open areas of the upright.**
- **Never attempt to move or align the rails by hand. Use a prybar.**

Failure to follow these warnings can result in serious injury.

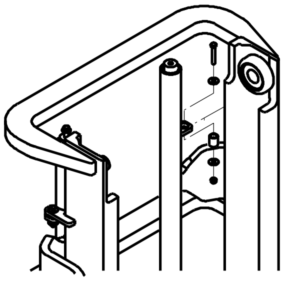
1. Connect the lifting strap to the inner rail on standard & Hi-Lo uprights or intermediate rails on triple-stage uprights and raise the rails just high enough to clear the lift cylinders. Use a prybar to guide the rails and allow the rollers to reenter the rail channel.



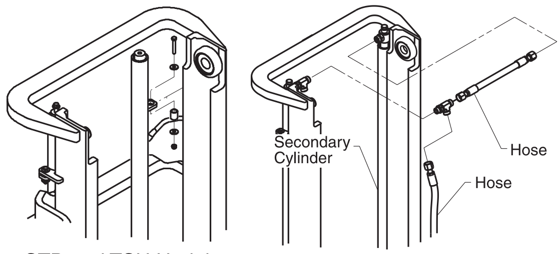
2. Reposition the rail cylinders and slowly and carefully lower the rails to seat the rod end into the mounting.



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).



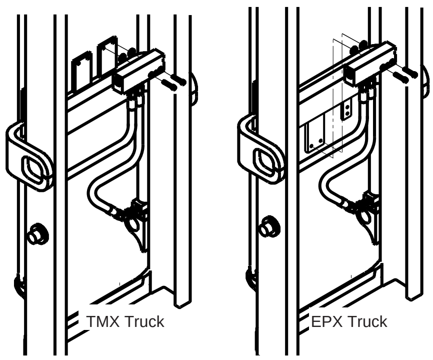
4. Reconnect the cylinder rod bolts. Torque rod bolts to 20-25 N.m (14.8-18.5 ft-lb). In Hi-Lo upright, Reconnect the secondary cylinder hose.



STD and TSU Upright　　Hi-Lo Upright

5. Replace the 4-hose sheave and bracket assembly onto the upright. Torque nuts to 20-25 N.m (14.8-18.5 ftlb).

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 mis-staging problems.

NOTE :

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 cylinder used on Hi-Lo uprights are ram cylinders.

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
TMX	Standard	V1204	Piston-Type Lift Cylinder
	TSU	M1203	Piston-Type Secondary Cylinder
		M1204	Piston-Type Secondary Cylinder
	Hi-Lo	H1205	Ram-Type Secondary Cylinder
		H1206	Ram-Type Secondary Cylinder
EPX	Standard	V1218	Piston-Type Lift Cylinder
	TSU	M1218	Piston-Type Secondary Cylinder
	Hi-Lo	H1218	Ram-Type Secondary Cylinder

CAUTION

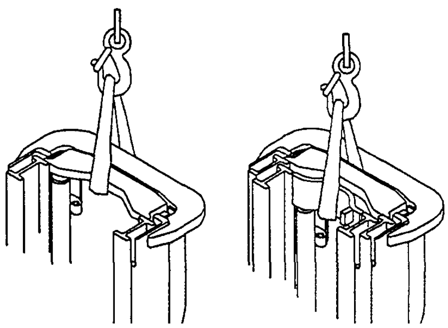
To remove, or partially remove, the cylinders from the upright for shimming or overhaul, start with the truck in a safe position:

- **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:

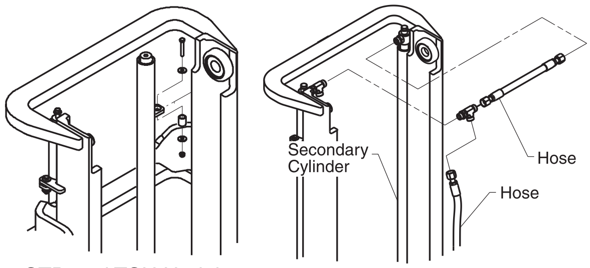
1. Fully lower upright until both lift cylinders are collapsed.
2. Attach a hoisting strap to the tie bar of the inner rail or intermediate rail tie bar of TSUs.



⚠ **CAUTION**

Make sure hoisting equipment is of adequate capacity and in good working order.

3. Remove the cylinder rod retaining bolt. In Hi-Lo upright, Remove the cylinder hoses.



STD and TSU Upright Hi-Lo Upright

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.

⚠ **CAUTION**

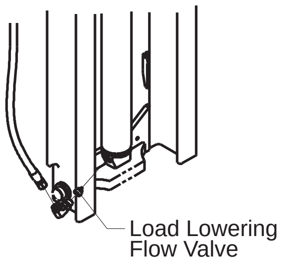
Do not try to maneuver the cylinder or rails with your hands. Use a prybar.

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.

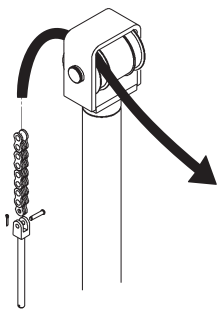
Primary Cylinder Removal and Replacement (TSU & Hi-Lo)

Remove the primary cylinder for replacement only. Cylinder can be overhauled without removing it from the upright. See ”Cylinder Overhaul” for procedures.

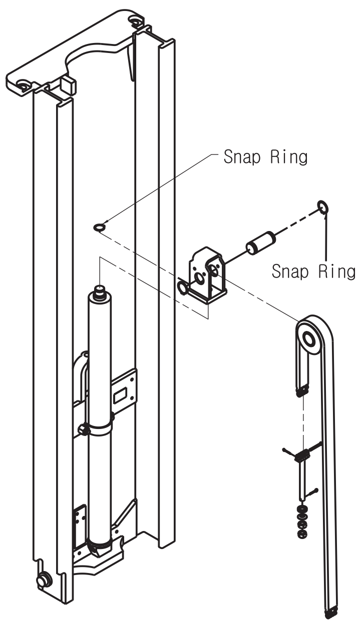
1. Make sure the cylinder is completely collapsed and pressure is released.
2. Disconnect and cap the hydraulic line at the base of the cylinder.
3. Remove and discard cotter pins from chain anchor bolt pins on the cylinder.



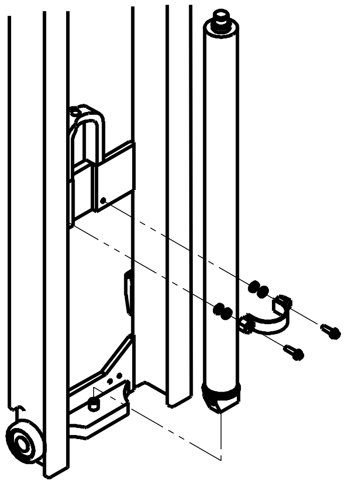
4. Remove the pins, draw the chain through the sheave, and drape the chain over the carriage.



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.



6. Disconnect cylinder mounting bolts and cylinder base mounting bolts.)



Use these steps in reverse to replace the cylinder. Check Group 40 for hydraulic fitting tightening procedures. If complete cylinder was torque hydraulic line bracket to 40-45 N.m (30-33 ft-lb);torque cylinder mounting coller bolt nuts to 70-80 N.m (52-59 ft-lb

Lift and Secondary Cylinder Removal and Replacement

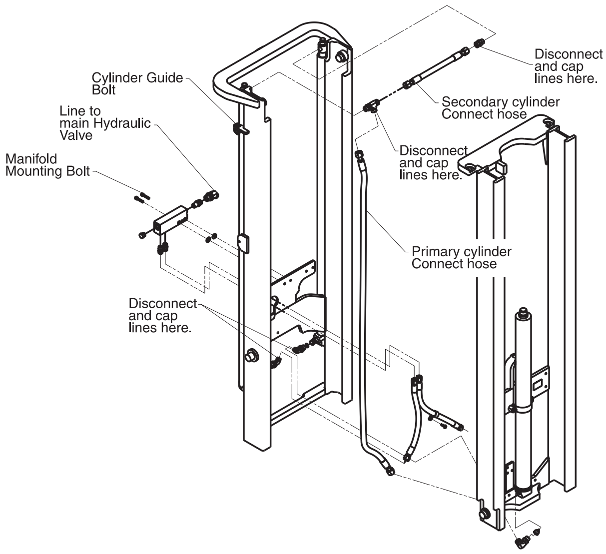
Only piston-type lift and secondary cylinders must be removed from the upright for overhaul. The cylinder gland and rod can be removed for overhaul while leaving the cylinder tube mounted on the truck.

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.

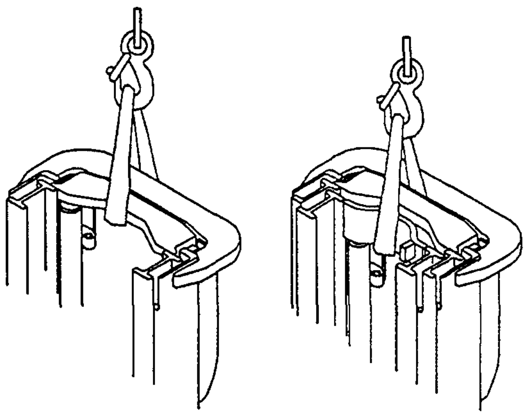
CAUTION

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.

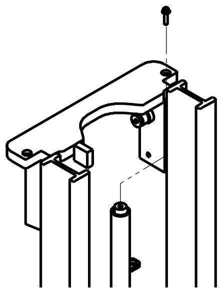


5. Lower the carriage
6. Using a hoist and lifting strap of adequate capacities, connect the lifting strap to the inner rail on standard uprights and inner and intermediate rails on triple-stage uprights.



7. Disconnect the cylinder guide bolts.

8. Disconnect the cylinder rod retaining bolts.



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 ftlb). Torque the cylinder guide bolt nuts to 30-35 N.m (22.2-25.6 ft-lb). Check Group 40 for hydraulic fitting tightening procedures.

Cylinder Overhaul

Use these steps to overhaul the primary and lift and secondary cylinders.

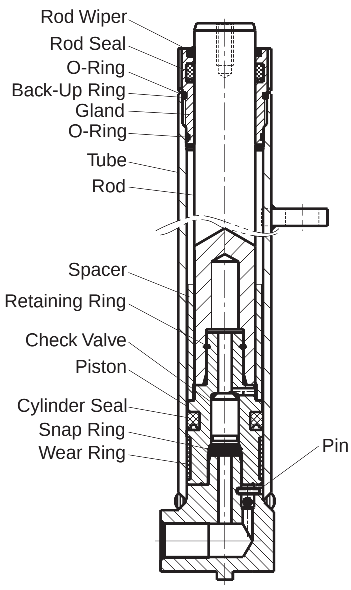
NOTE

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.

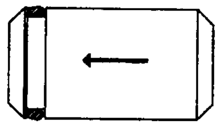
Cylinder Disassembly

- 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 piston bore.



Check Valve. Arrow shows direction of flow

   b. Use a blunt hook to pop the 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

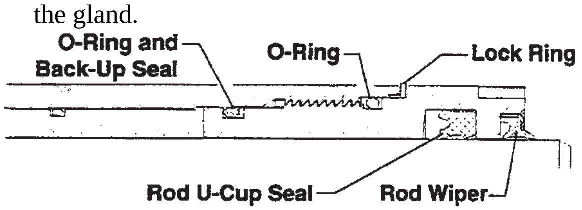
Minute imperfections inside the cylinder barrel or on the piston or rod may be improved for acceptable use by careful honing. However, removal of material that produces a notch, groove, or out-ofroundness may cause excessive leakage during operation and a shortened life.

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.

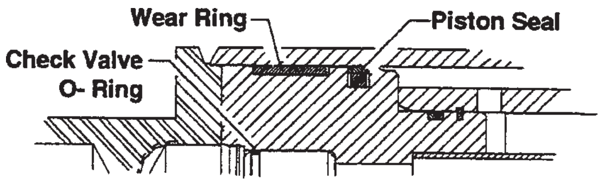
1. Coat all packing, seals and rings in clean, hydraulic oil (Clark part number 1800236 qt., 1802155 gal.) prior to reassembly. Coat the inside of the gland nut bore with hydraulic oil.
2. Replace the U-cup seal (groove toward bottom of cylinder), rod wiper, and O-ring and back-up seals on the gland.



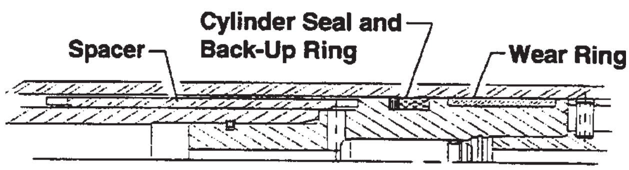
NOTE

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.



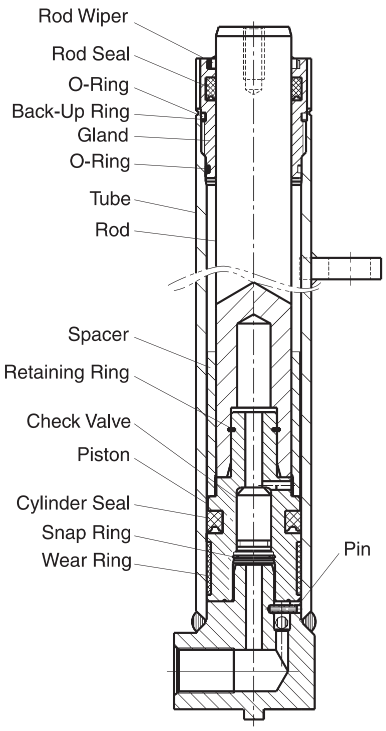
   b. Piston-type lift and secondary cylinder require a cylinder seal, a back-up ring, and a wear ring on the piston. Install the cylinder seal from the top of the rod.



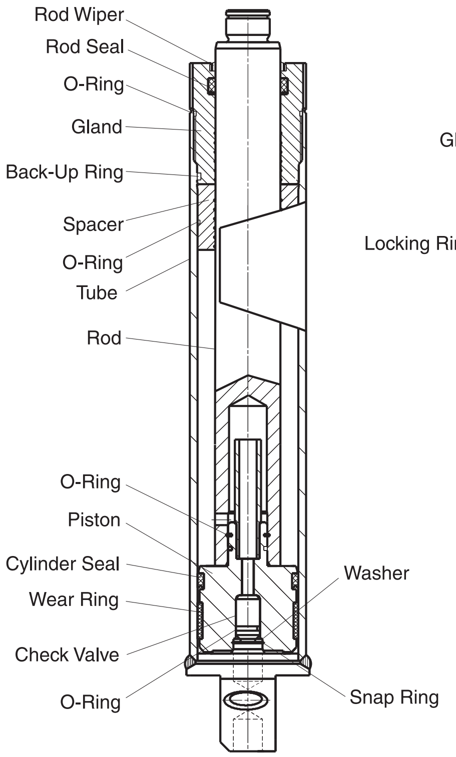
   c. Ram-type lift (secondary) cylinder piston require-seals.

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 (100 ml) 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 100 N.m (75 ft-lb).
   - On lift and secondary cylinders, tighten the gland nut to 100 N.m (75 ft-lb).

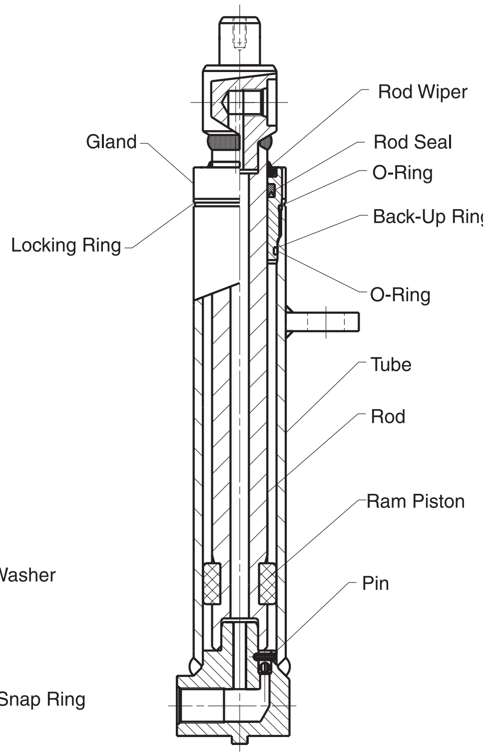
This competes the cylinder repair procedure. Replace the cylinders as described in Cylinder Removal and Replacement. Complete the chain length adjustment in Section 3 for correct carriage and rail position. When all adjustments are completed, return the truck to service.



Piston Type Standard Upright Lift and TSU Secodary Cylinder



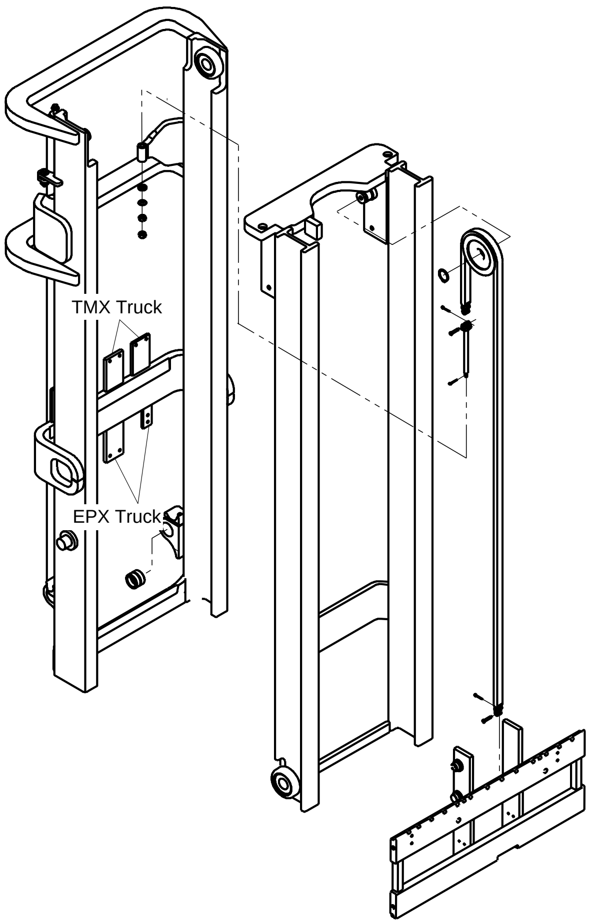
Triple Stage and Hi-Lo Upright Primary Cylinder



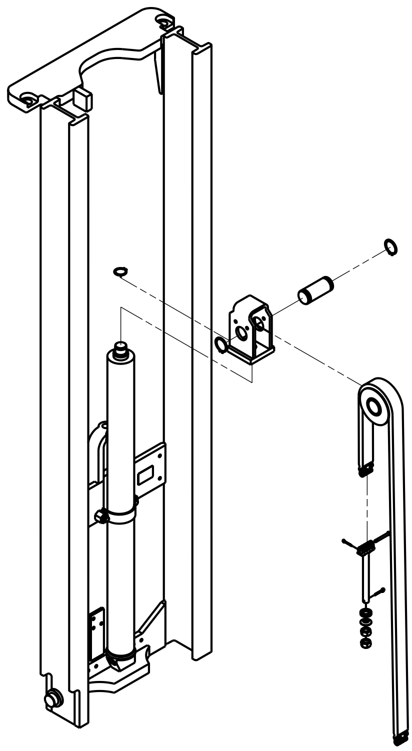
Hi-Lo Upright Secondary Cylinder

Section 6

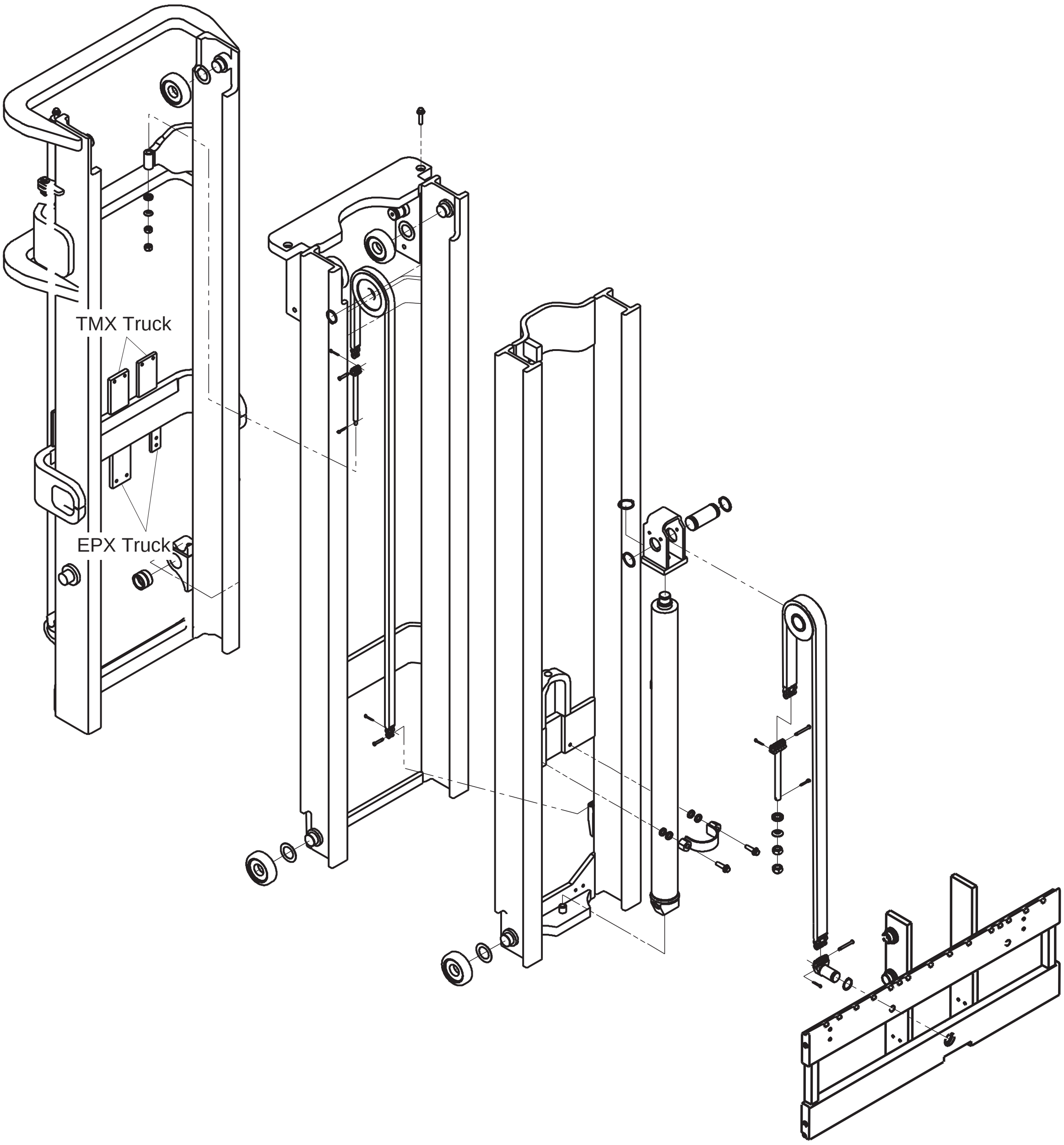
Upright Chain Inspection, Adjustment, and Replacement



Chain Configuration - Standard Upright



Chain Configuration - Hi-Lo Upright



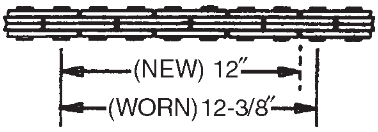
Chain Configurations - Triple Stage Uprights

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

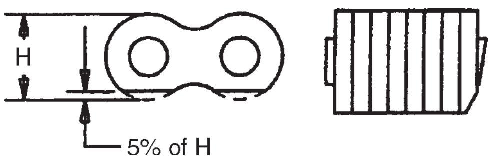
When a length of 12.00 inches (305 mm) of new chain has elongated to a length of 12.360 inches (315 mm), it should be discarded and replaced. It is important to measure the chain in the section that moves over the sheaves because it receives the most frequent articulation. Measuring the chain near its 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.

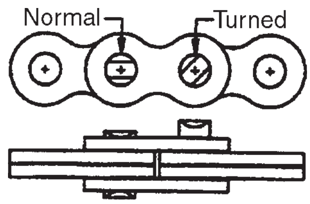


Worn contours and worn surfaces on the outside links or pin heads should not exceed 5% of new link height.

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.

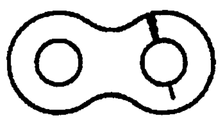


Turned pins and abnormal pin protrusion.

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.

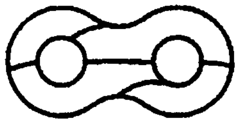
- Fatigue Cracking - Fatigue cracks are a result of repeated cyclic loading beyond the chain's endurance limit. The magnitude of the load and frequency of its occurrence are factors which determine when fatigue failure will occur. The loading can be continuous or intermittent (impulse load).



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 link plate pin hole (point of highest stress) and are perpendicular to the chain pitch line. 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.

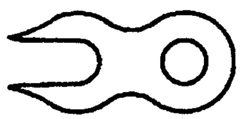
  If a plated chain is required, consult Clark. Plated chains are assembled from modified, individually plated components which may reduce the chain rating.

- 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

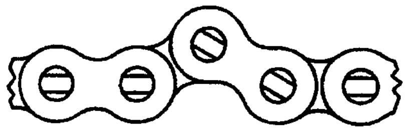
This type of failure is caused by overloads far in excess of the design load.



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

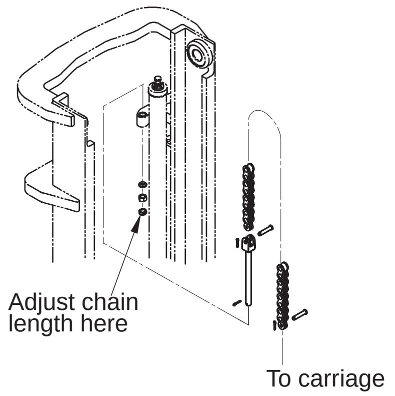
An upright or carriage can move unexpectedly:

- **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. Use a prybar.**

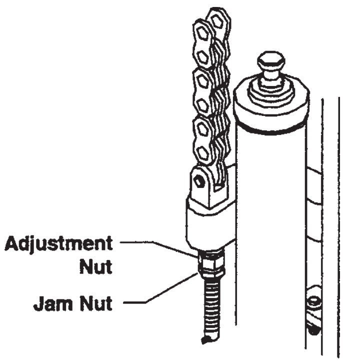
Failure to follow these warnings can result in serious injury.

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 to adjustment nuts to 80-150 N.m (59-110 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 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.

Triple-Stage Upright (TSU) and Hi-Lo 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.

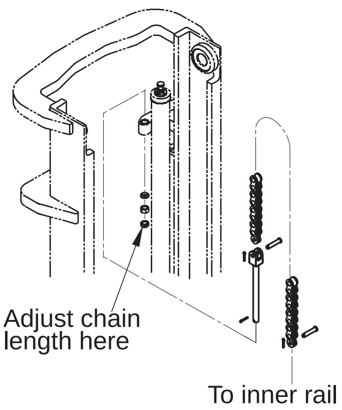
For TSU inner rail lift chains, chain length must be adjusted if the difference between the bottom of the inner rail and the outer rail is greater than 10 mm (0.40 in).

For the TSU and Hi-Lo primary cylinder lift chain, the chain length must be adjusted if:

- The fork-to-ground clearance is less than 5 mm (0.20 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 (.80 in) of the bottom edge of the inner rail.

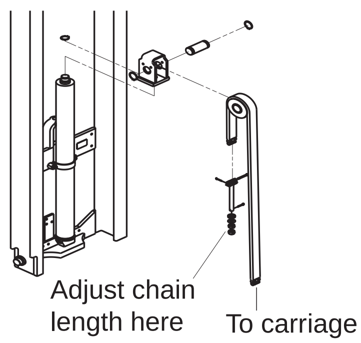
- The carriage safety stop hits the inner rail stop at full lift height.

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 80-150 N.m (59-110 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 result in serious injury. See ìLifting, Jacking, and Blockingî for safe blocking procedures.

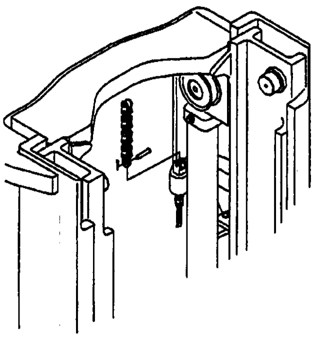
General Guidelines

- 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.

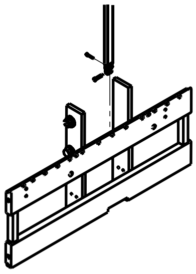
Lift Chains (Standard and TSUs)

To remove and replace the lift cylinder and/or carriage chain set on standard and triple-stage uprights (TSU):

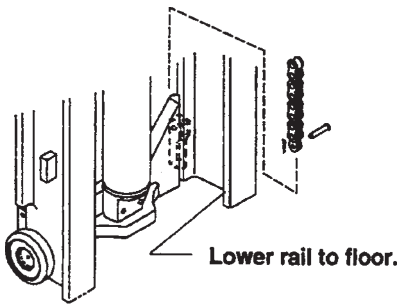
1. Attach a hoist strap on the carriage of the standard upright or inner rail of the TSU.
2. Lift the carriage or inner rail slightly to create slack in the chains. Block the carriage or inner rail up for safety.
3. Remove the chain anchor pins on the outer rail and pull the chains off of the sheaves 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

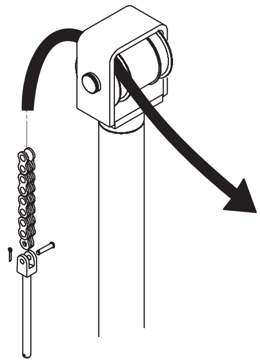
NOTE

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.

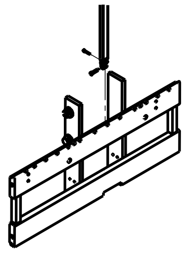
5. Use the steps in reverse order to replace the lift chain set.

Primary Cylinder/Carriage Chains (TSU & 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.

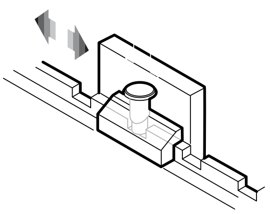
3.Put all controls in neutral. Turn key switch OFF and remove key.

4.Apply the parking brake and block the wheels.

Fork Removal

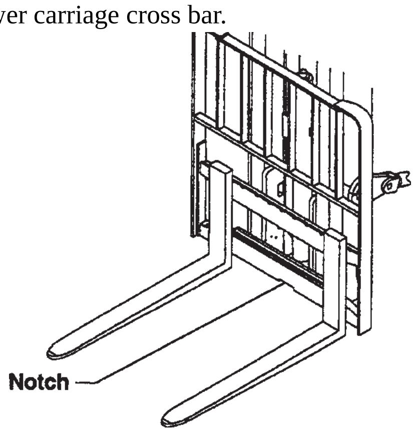
Forks do not need to be removed to remove the carriage.

1. Release the fork latches.



Latch Operation

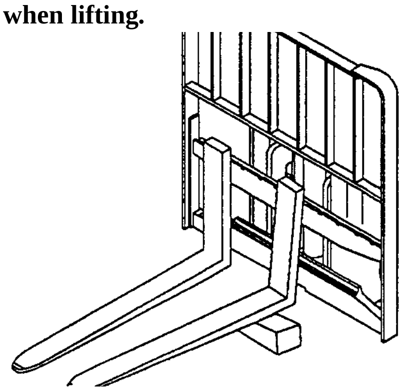
2. Move each fork to the notch on the bottom of the lower carriage cross bar.



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 40-65 kg (90-145 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 upright position. Use care when working around the forks.

2. Drag forks into position close to carriage and to line up with the notche 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 upright.**
- **Always use a prybar to move the upright or carriage.**

Failure to follow these warnings can result in serious injury.

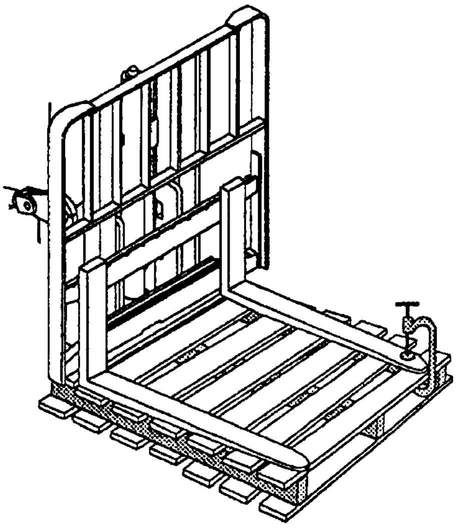
1. Set upright tilt to 0 degrees (vertical). Raise the carriage about 12 in (305 mm).
2. Place a heavy pallet under the forks. Turn the key off.
3. Lower the carriage onto the pallet and keep lowering (until the primary cylinder is all the way down on TSUs). Before proceeding with the next step read the following warning.

WARNING

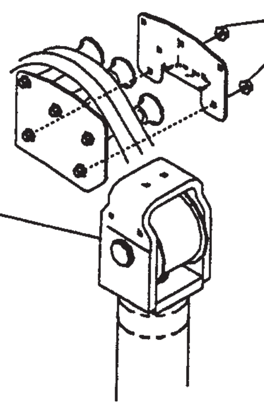
You may need to pull on the hoses/cables and chains while lowering the primary cylinder to get it all the way down. This is done to create slack in hoses/cables and chains and to displace as much oil as possible, which will reduce oil loss when disconnecting hydraulic lines for auxiliary components.

You may need 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 TSU & Hi-Lo). When pulling on the chains to lower the primary cylinder (on TSU & Hi-Lo), the ignition must be off.

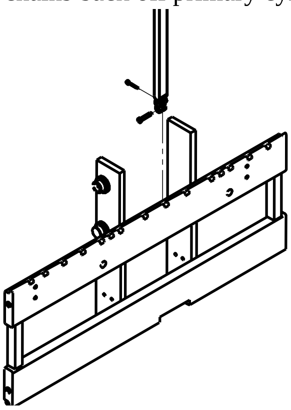
4. Once the carriage is fully lowered, clamp the front of one fork to the pallet to prevent the carriage from falling over backwards when removed.



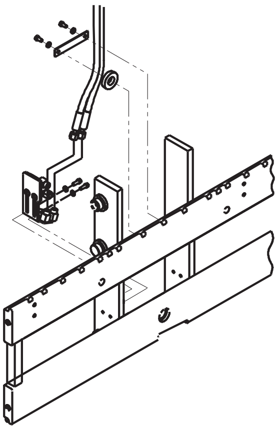
5. For carriage auxiliary components, the hose sheave bracket must be unbolted from the primary cylinder chain sheave bracket. Move the hose bracket off the chain bracket.



6. Disconnect the carriage chains at the base of the carriage. Pull chains back off primary cylinder sheave.

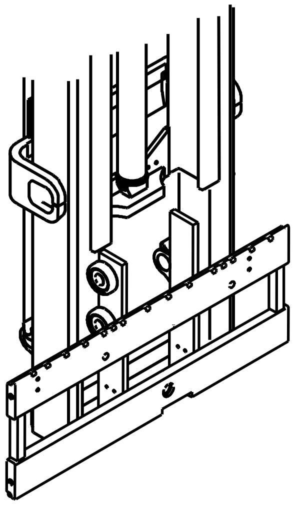


7. For carriage auxiliary components, disconnect hoses (2- or 4-hose assemblies) from carriage. Remove the bolts and strap fixture also.



- 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.

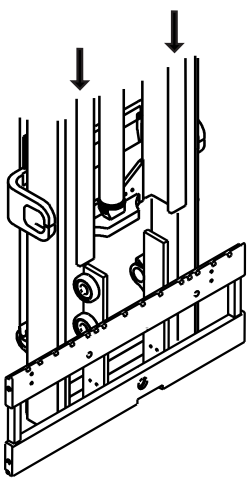


11. Lower the upright rails until both of the secondary cylinders are completely collapsed.

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

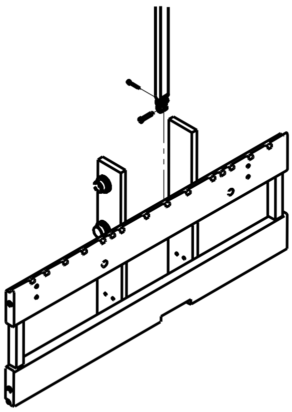
Never attempt to move or align the carriage or bearings by hand. Use a pry bar.

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.

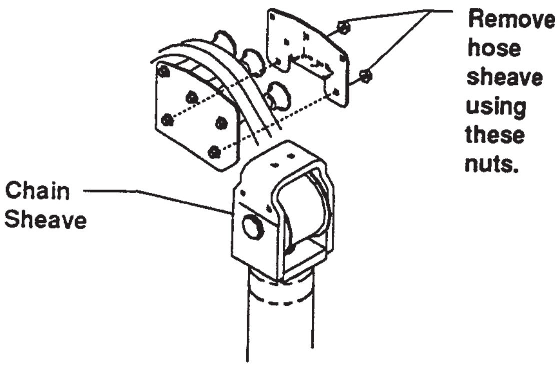


   - Set anchor bolts so that no twist develops in the chains.
   - Anchor pin heads must be pointing to the inside of the upright.
   - Use new cotter pins.

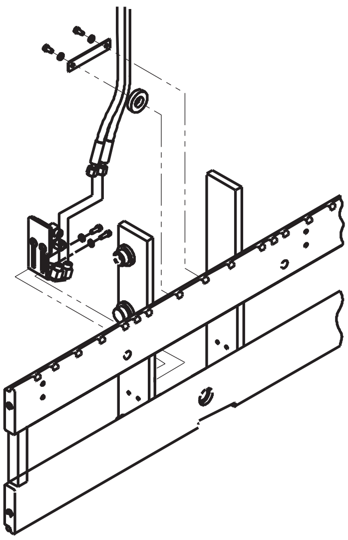
IMPORTANT

Always use new anchor pins when replacing chain sets.

10. If the carriage is equipped with a carriage auxiliary component, reconnect the hose sheave bracket to the top of the primary cylinder chain sheave barcket.



11. 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.

12. Adjust carriage height according to Section 6 and chain tension according to Section 3.
13. 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

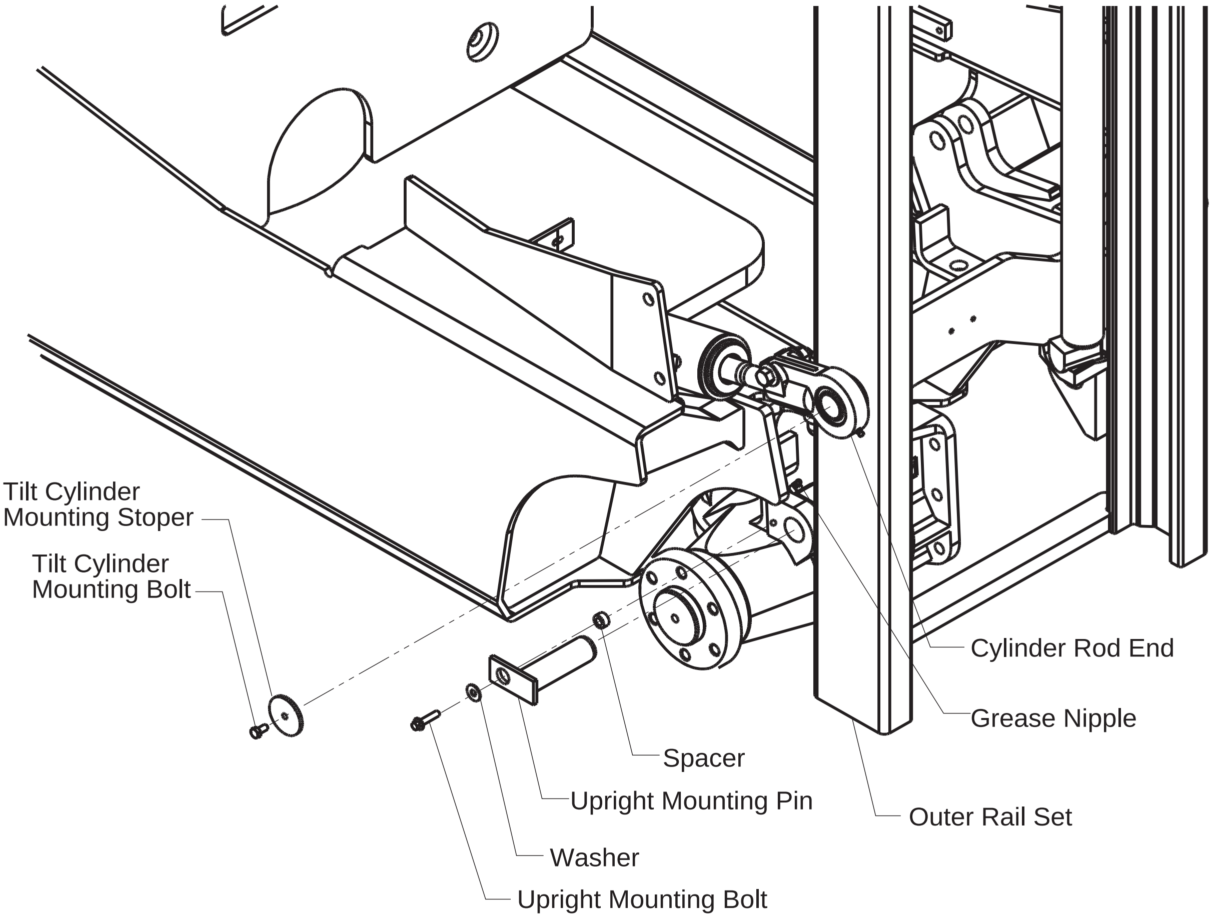
SAFE PARKING. Before working on truck:

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

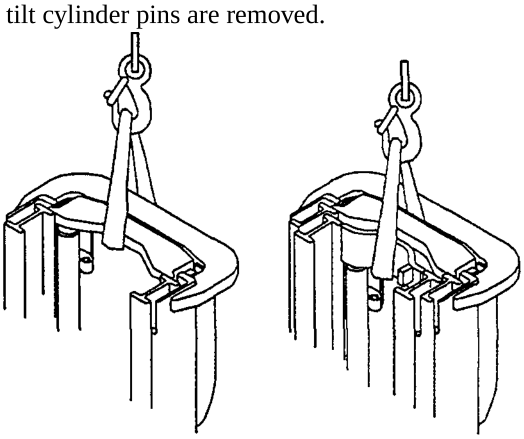
Upright Removal

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.

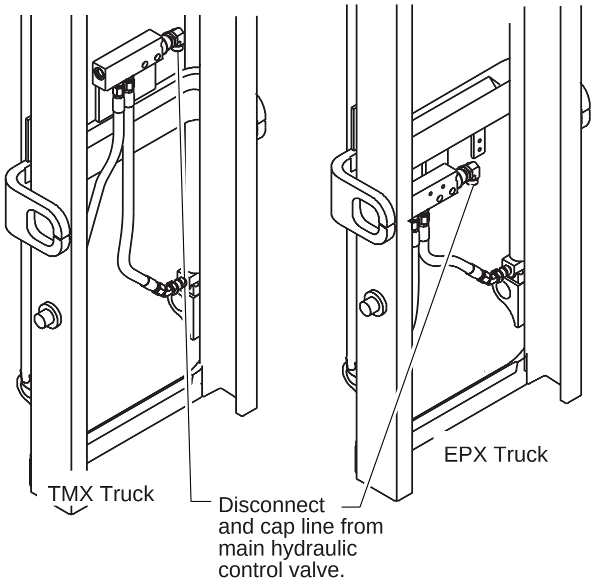
WARNING

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. Use prybars to move the assembly into position for reattachment.

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.

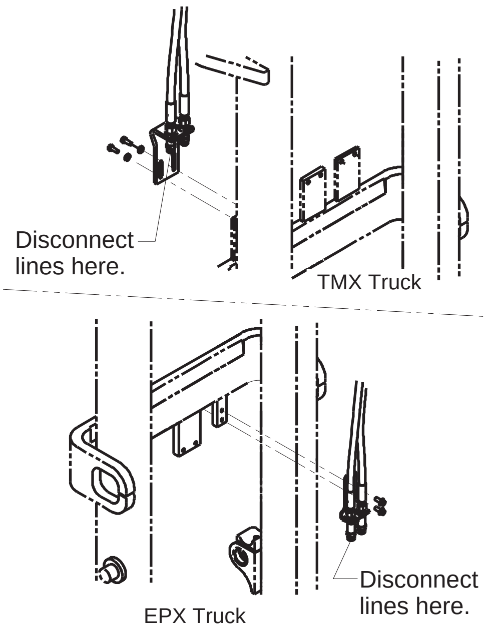


2. Disconnect and cap hydraulic line at the load-lowering flow valve. Secure the hose out of the way of the upright.

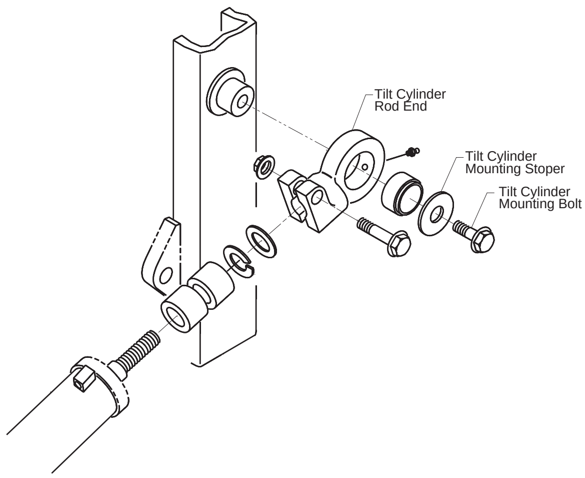


NOTE

For two-hose adapter assemblies, the hydraulic lines to the upright must also be disconnected and capped.



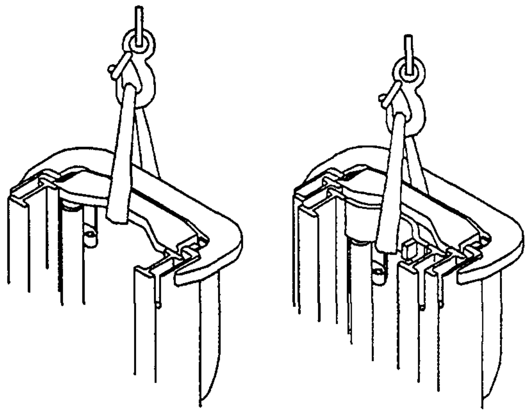
3. Remove tilt cylinder rod-end, rod-end mounting bolt and stopper from upright.



4. Remove upright mounting pin bolt 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

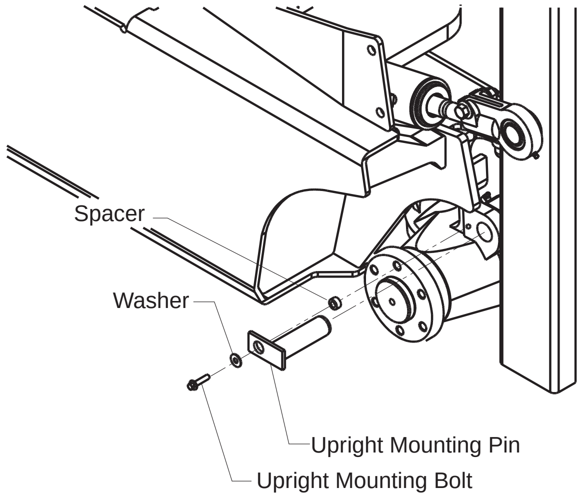
1. Use an overhead chain hoist of adequate capacity and an approved lift chain to lift upright into position.



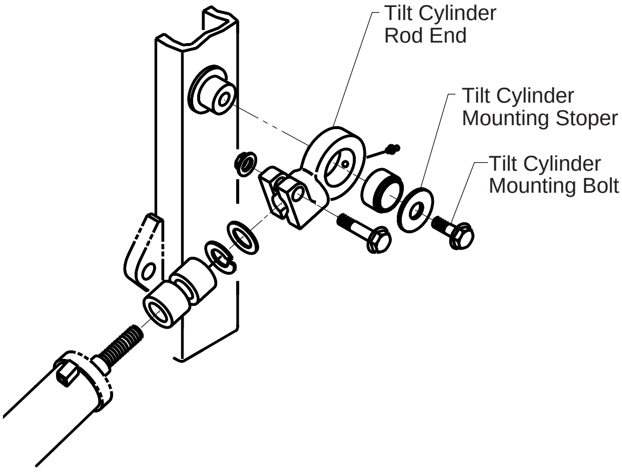
WARNING

Use prybars to move the assembly into position for reattachment.

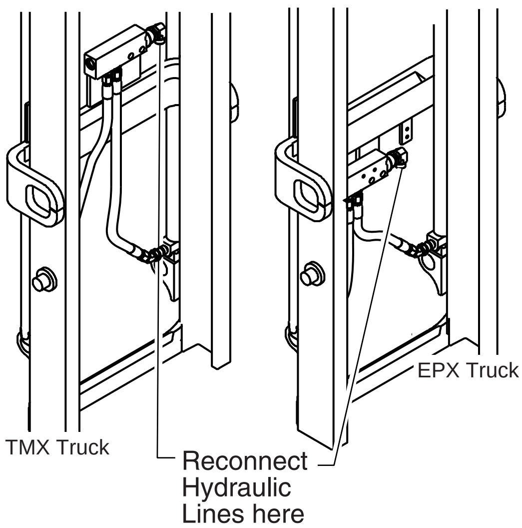
2. Install upright mounting pin and bolt. Torque to 25-30N.m (221~266 lbf-in)



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).



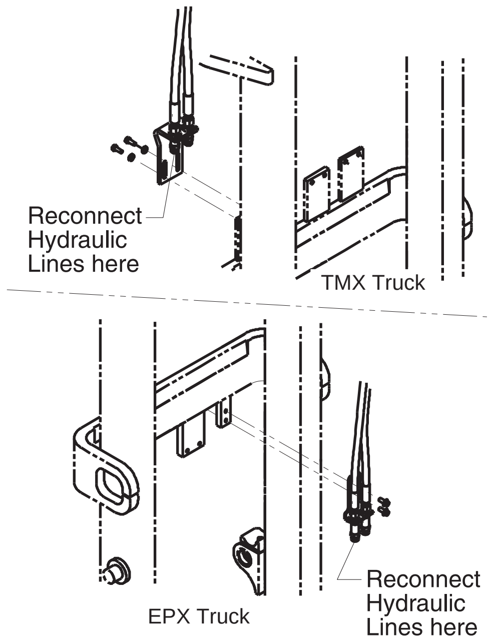
4. Attach hydraulic lines to the upright flow control valve:



- 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

Counterweight Mounting Bolts Torque: 339-381 N.m (251.280 ft-lb) Counterweight Weight: Different counterweights are used based on truck capacity and battery compartment length, as follows:

TMX Truck

	Battery Compartment	
Truck Capacity	Length	Counterweight
2500 lb (1250 kg)	13.75”	1262 lb (573 kg)
3000 lb (1500 kg)	13.75”	1836 lb (834 kg)
3000 lb (1500 kg)	20.5”	914 lb (415 kg)
3500 lb (1750 kg)	20.5”	1262 lb (573 kg)
4000 lb (1815 kg)	20.5”	1836 lb (834 kg)
4000 lb (2000 kg)	20.5”	2094 lb (950 kg)
5000 lb (2270 kg)	20.5”	2894 lb (1314 kg)

EPX Truck

	Battery Compartment	
Truck Capacity	Length	Counterweight
3500 lb (1600 kg)	29”	1080 lb (490 kg)
4000 lb (1800 kg)	29”	1300 lb (590 kg)

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

BATTERY WEIGHT. The minimum battery weight for your truck is stamped on the nameplate. Never operate the truck with a battery that weighs less.

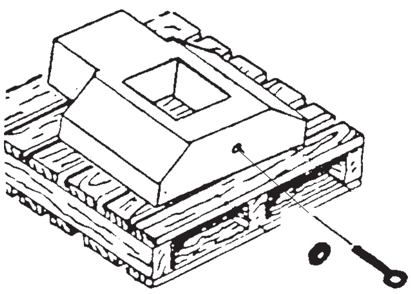
Large, hardened steel bolts hold the counterweight to the frame.

Maintenance Requirements

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

NOTE :

Section 2

Counterweight 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.

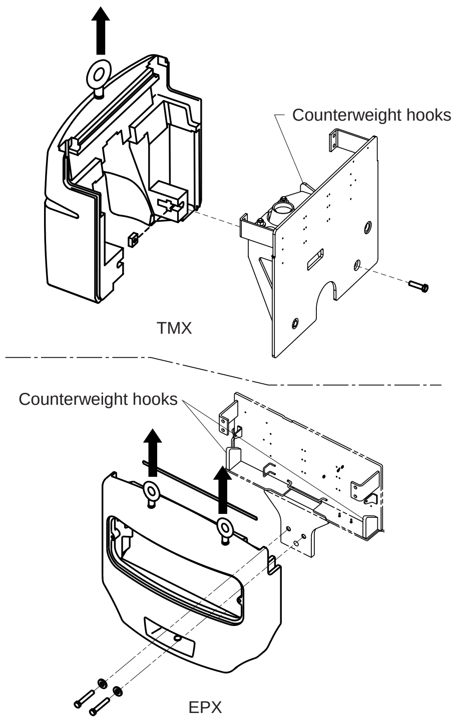
3.Put all controls in neutral. Turn key switch OFF and remove key.

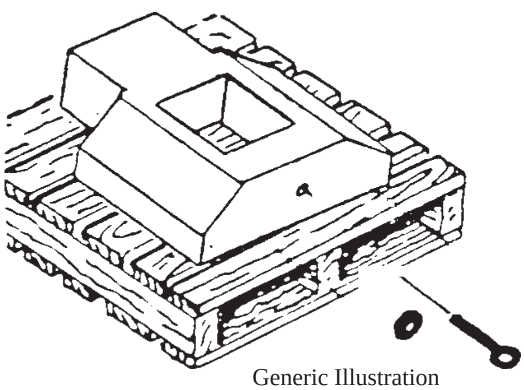
4.Apply the park brake and block the wheels.

1. Remove the battery as described in Group 12.
2. Install eye bolt into the counterweight. Eyebolt must be able to lift up to 2894 lb (1314 kg), depending on the truck model. (See weight specifications in Section 1.)
3. Using an overhead hoist with sufficient lifting capacity, attach hoist chain to eyebolt. Slowly lift hoist until slack is removed from chain.
4. Remove the counterweight mounting bolts from inside the battery compartment. 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 electronic controls. Take care not to damage the controls.
6. Slowly lower the counterweight onto a sturdy pallet. Set the counterweight on its flat side if possible.

⚠ 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.





Generic Illustration

Counterweight Installation

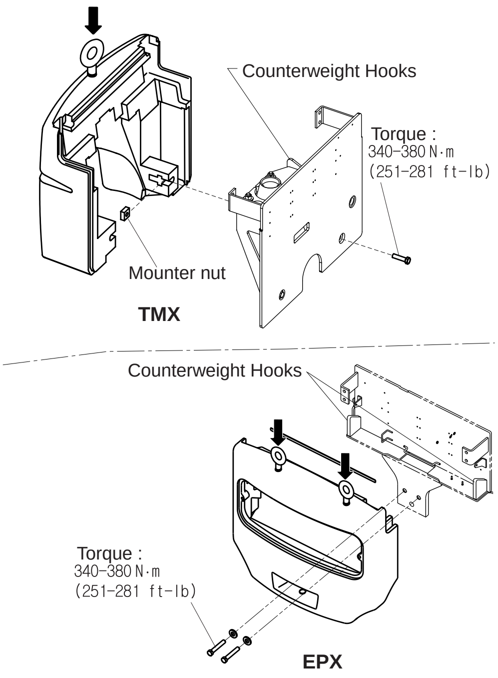
WARNING

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. Inspect the counterweight mounting bolts and nuts to make sure they are in good condition before installing. Make sure the mounting nuts are in place in the counterweight.
2. Slowly raise the counterweight 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.
3. Make sure that the bolt holes in the counterweight align properly with the mating holes in the frame.
4. Torque the mounting bolts 340-380 N.m (251.280 ft-lb)
5. Remove the hoist and eyebolts.

IMPORTANT

Never allow a truck to be put into service without the counterweight mounting bolts in place. Check the bolts and torque regularly.



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.

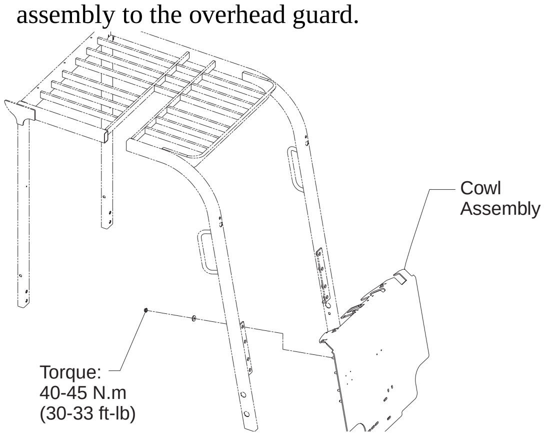
2.Put upright in vertical position and fully lower the forks or attachment.

3.Put all controls in neutral. Turn key switch OFF and remove key.

4.Apply the park brake and block the wheels.

It is not necessary to remove the overhead guard for normal service or repair of the truck. If the overhead guard must be rplaced or repaired, remove it as follows:

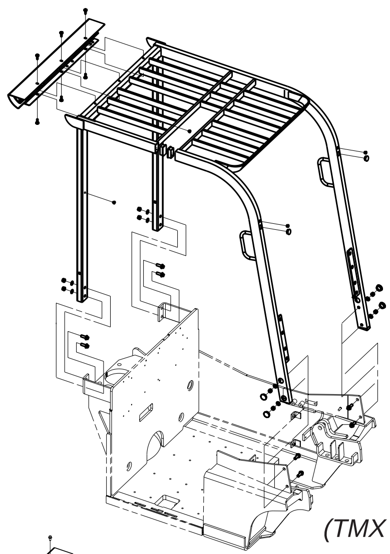
1. Remove the electric part all
2. Remove the seat deck from the truck
3. Support the cowl assembly with an overhead lifting device and remove fasteners holding the front cowl assembly to the overhead guard.



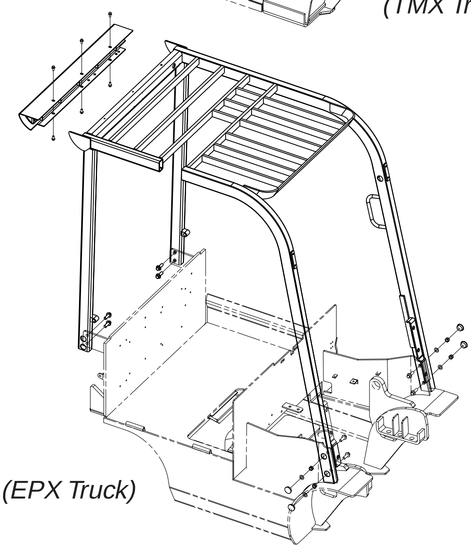
4. Remove the overhead guard mounting bolts.
5. Lift the overhead guard from the truck.
6. Reverse procedure for installation.

WARNING

Overhead guard must be in place to protect operator from falling objects.



(TMX Truck)



(EPX Truck)

Torque overhead guard mounting bolts: 88-95 N.m (65-70 lb-ft)

CLARK

NOTE :

Section 4

Floor Plate, Seat, and Seat Deck Removal and Installation

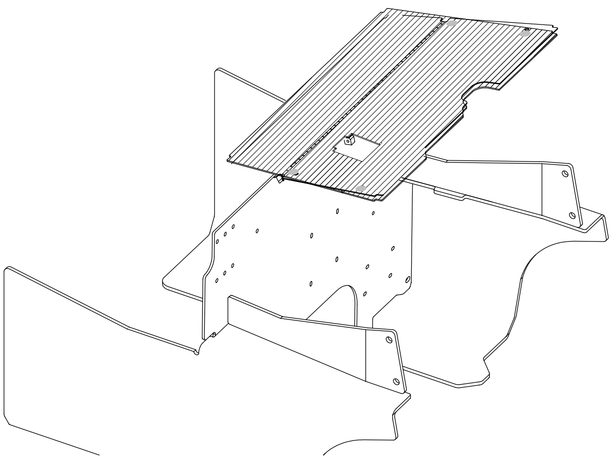
CAUTION

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 parking 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.



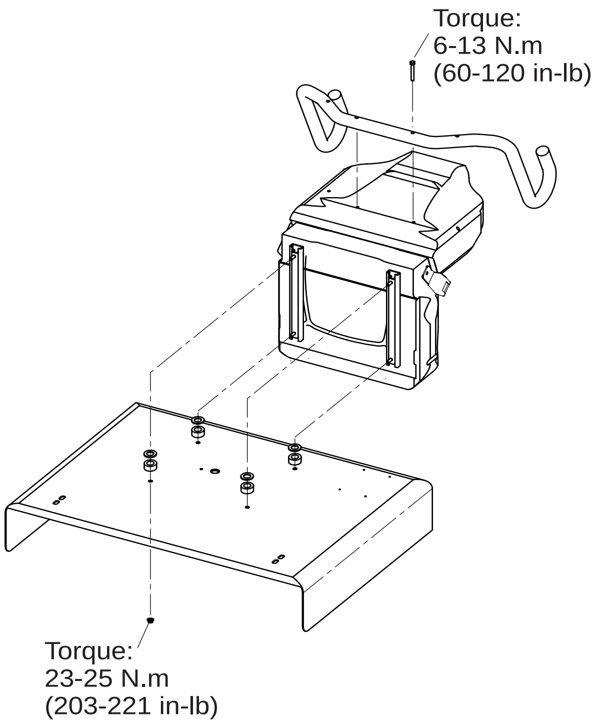
3. To replace the floor plate, position the front of floor plate first, then unfold it into position.

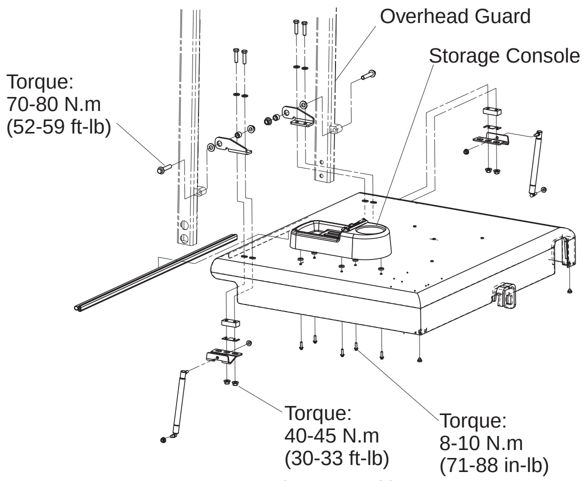
IMPORTANT

Make sure the accelerator pedal has a full stroke and does not bind.
Refer to Group 13 for accelerator pedal and control information.

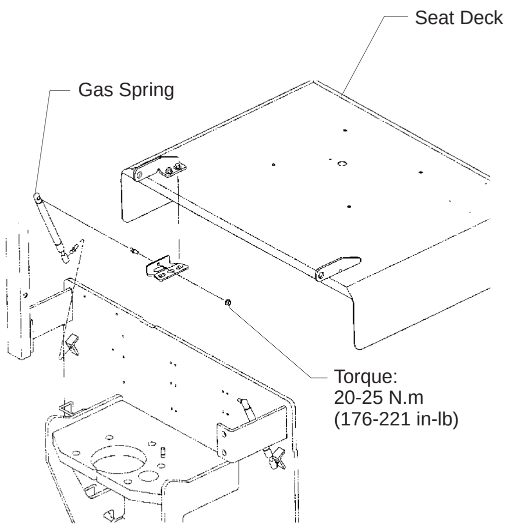
Seat Removal and Installation

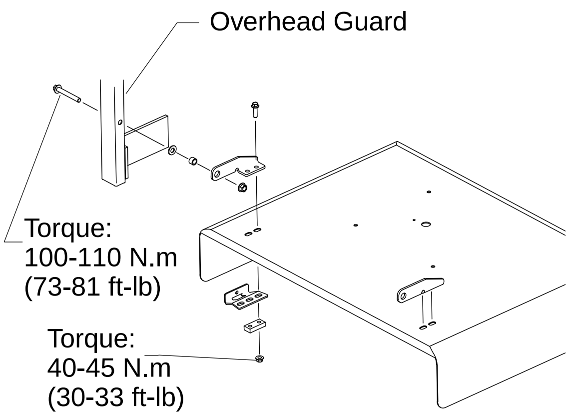
Use the following illustrations as a guide to removing installing the seat and seat deck components.



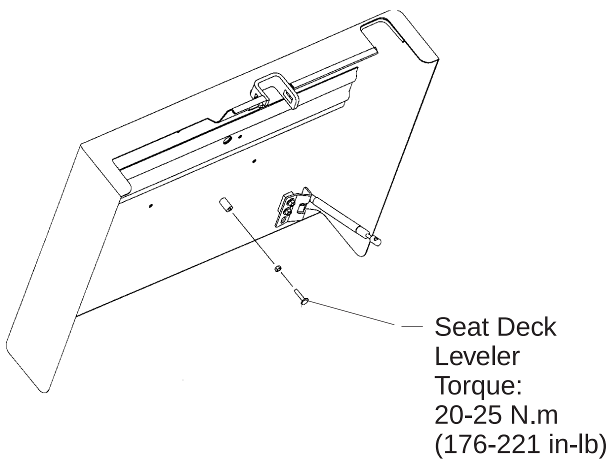


(EPX Truck)





(TMX Truck)



GROUP 40

SPECIFICATIONS

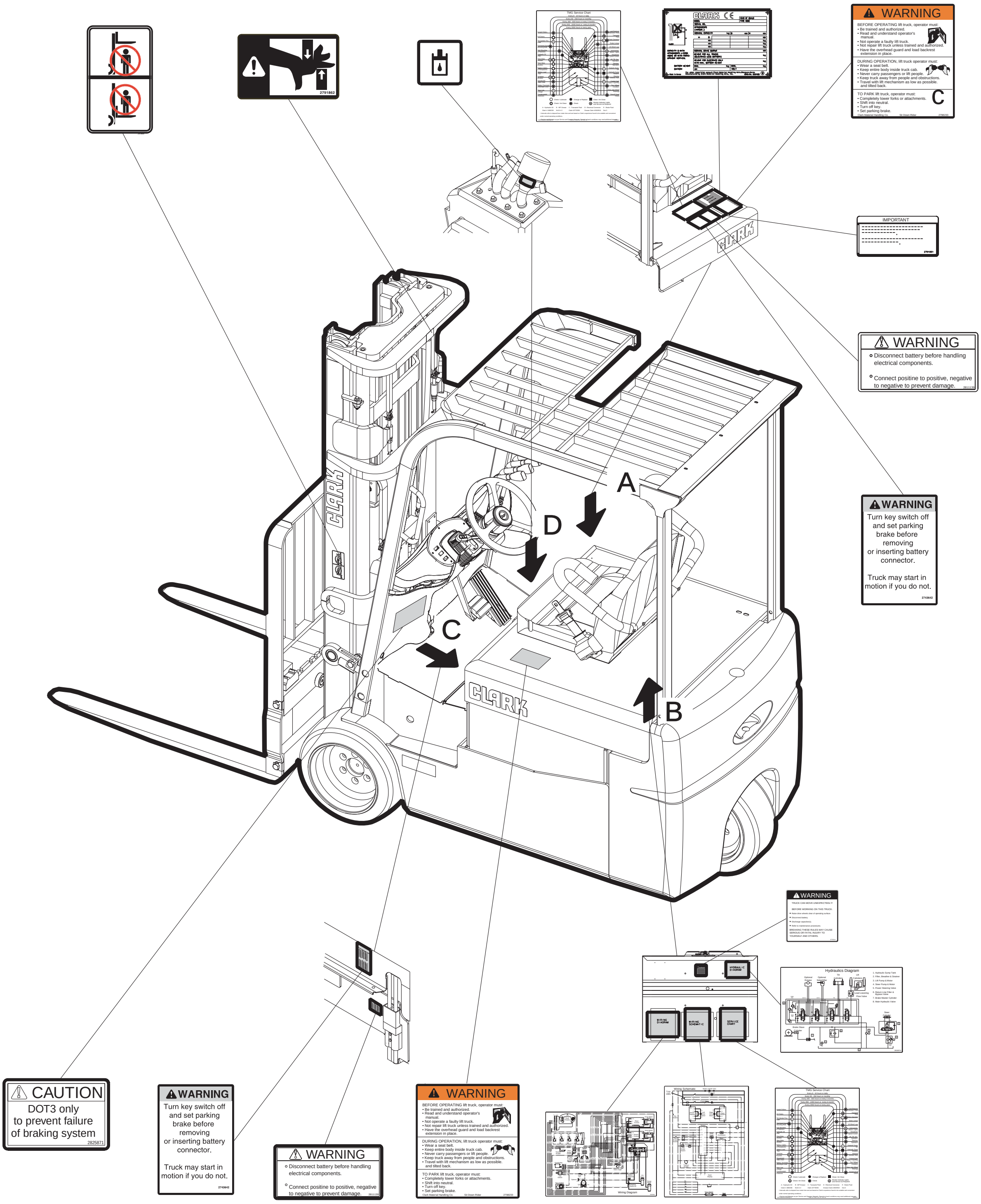
NOTE :

Section 1

Nameplate and Decals

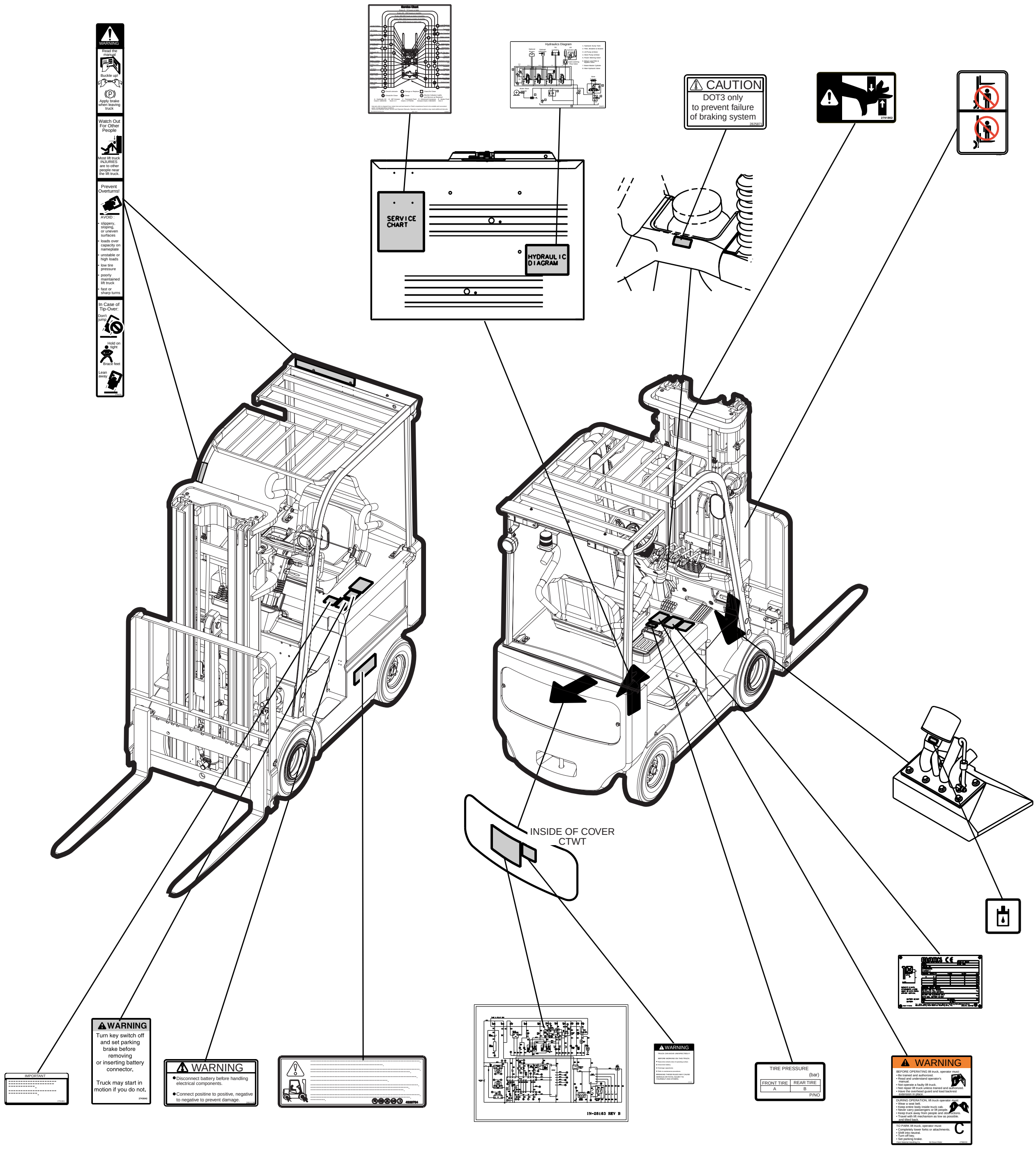
Nameplate and Decal Locations

(TMX)



Nameplate and Decal Locations

(EPX)



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.

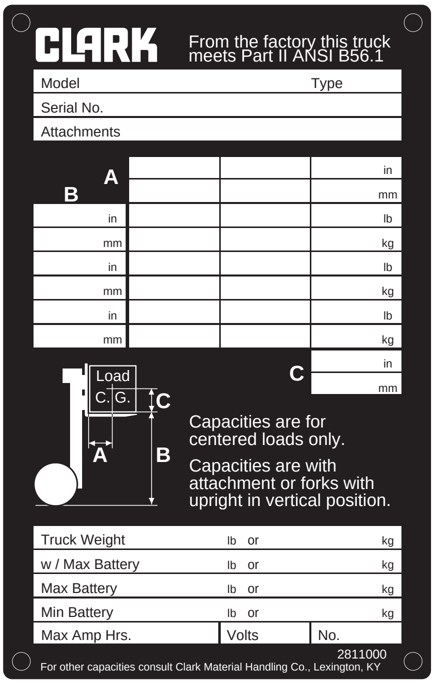
Truck Data and Capacity Plate

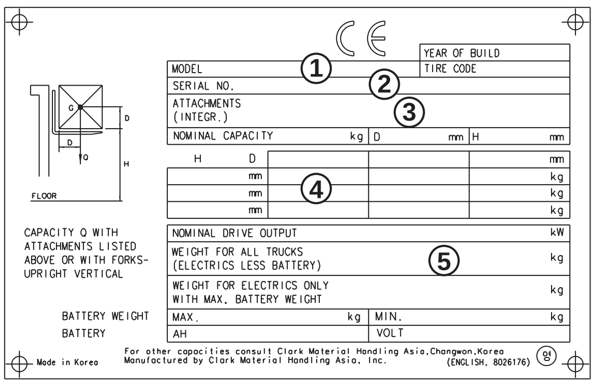
The truck data and capacity plate provides essential information about the truck. This information is important for both operators and service personnel. Operators can see what the truck's capacities and load ratings are. Service personnel must identify the truck model, type, and serial number when ordering 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. Do not exceed the maximum capacity specified.
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

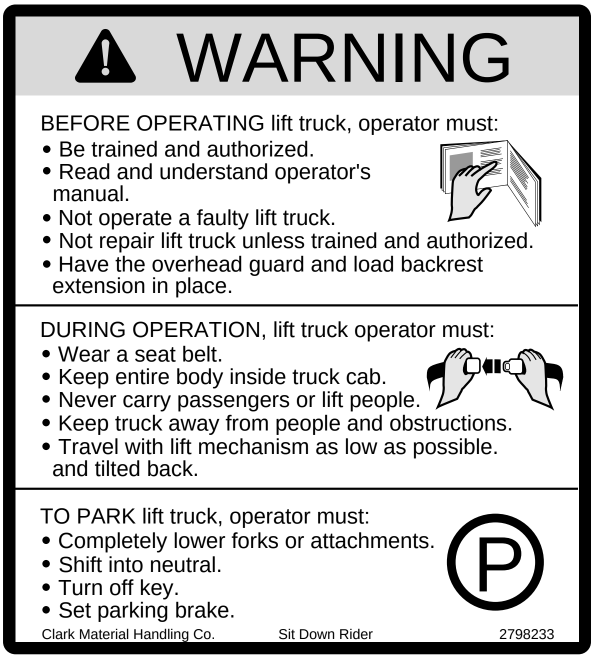
Before attachments are added, or if the truck is modified after leaving the factory, you must contact your authorized Clark dealer for authorization and a new nameplate as capacity will new affected. This is required by OSHA.





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.

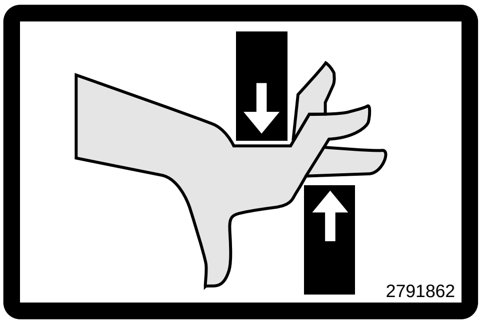
Lift trucks can be tipped over if operated improperly. Experience with lift truck accidents has shown that the driver cannot react quickly enough to jump clear of the truck and overhead guard as the truck tips. To protect operators from severe injury or death in the event of a tip-over, make sure this decal is in place to remind them to always use their seat belts.

Operator Safety Decal

The Operator Safety Decal depicts important 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.

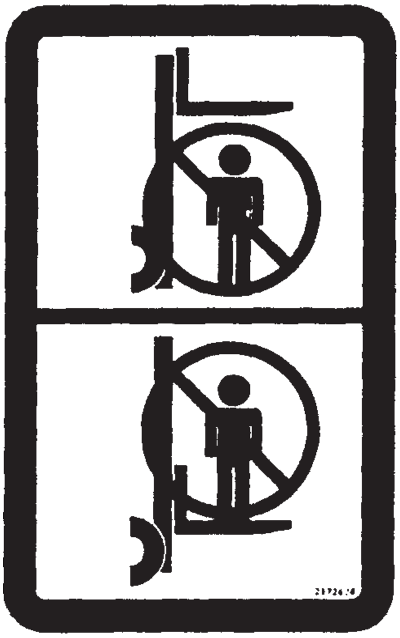
Hand Safety Warning Decal

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.

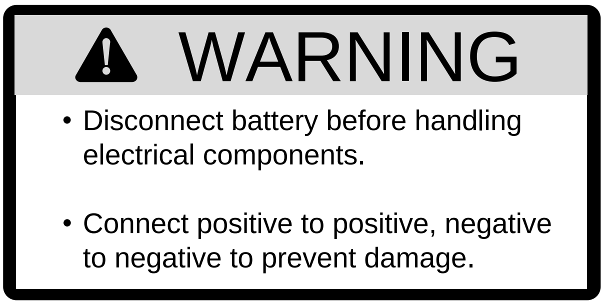


Battery Disconnect Warning Decal

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.

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.



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 transaxle trucks and hydrostatic transmission trucks.

Models	At 500 mm (24 in) Load Center	
TMX 12	1250 kg	2500 lbs
TMX 13	1250 kg	2500 lbs
TMX 15s	1500 kg	3000 lbs
TMX 15	1500 kg	3000 lbs
TMX 17	1750 kg	3500 lbs
TMX 18	1800 kg	4000 lbs
TMX 20	1815 kg	4000 lbs
TMX 20x	2000 kg	4000 lbs
TMX 25	2270 kg	5000 lbs
EPX16	1600 kg	3500 lbs
EPX18	1800 kg	4000 lbs

Note: Rated capacity applies when using uprights with maximum fork height up to and including TMX 12-25, EPX16-18 3861 mm (152 in).

Truck Weights and Axle Weights

Approximate weights for trucks with triple stage upright and minimum battery weight.

	Empty Vehicle Weight) (kg/lbs)*	Empty Drive Axle Weight	Loaded Drive Axle Weight (kg/lbs)	Empty Steer Axle Weight (kg/lbs)	Loaded Steer Axle Weight (kg/lbs)
(For U.S market)					
TMX 12	3288/7249	1866/4114	3947/8701	1422/3135	475/1048
TMX 15S	3587/7908	1855/4090	4352/9594	1731/3818	596/1314
TMX 15	3593/7921	2091/4610	4443/9796	1501/3311	510/1125
TMX 17	3767/8305	2163/4769	4907/10819	1603/3536	447/986
TMX 20	4066/8965	2167/4777	5303/11692	1900/4187	577/1272
TMX 25	4578/10093	2158/4758	6078/13401	2420/5335	767/1692
(For Other markets)					
TMX 13	3223/7105	1844/4065	4034/8893	1379/3040	439/967
TMX 15S	3483/7678	1834/4043	4337/9561	1649/3635	646/1424
TMX 15	3369/7427	1812/3994	4169/9191	1557/3432	700/1543
TMX 18	3773/8318	1807/3983	4951/10915	1966/4334	622/1371
TMX 20x	3888/8571	1807/3983	4951/10915	2081/4587	937/2065
EPX16	3095/6823	1301/2868	4021/8865	1794/3955	674/1486
EPX18	3240/7142	1278/2817	4338/9564	1962/4325	702/1548

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 triple stage upright.

(For U.S markets)												
	TMX 12 MPH(kph)		TMX 15S MPH(kph)		TMX 15 MPH(kph)		TMX 17 MPH(kph)		TMX 20 MPH(kph)		TMX 25 MPH(kph)	
	36 Volt	48 Volt	36 Volt	48 Volt	36 Volt	48 Volt	36 Volt	48 Volt	36 Volt	48 Volt	36 Volt	48 Volt
Empty	9.3(15)	9.3(15)	9.3(15)	9.3(15)	9.3(15)	9.3(15)	9.3(15)	9.3(15)	9.3(15)	9.3(15)	7.5(12)	7.5(12)
Loaded	9.3(15)	9.3(15)	9.3(15)	9.3(15)	9.3(15)	9.3(15)	9.3(15)	9.3(15)	9.3(15)	9.3(15)	7.5(12)	7.5(12)

(For Other markets)					
	TMX 13 MPH(kph)	TMX 15S MPH(kph)	TMX 15 MPH(kph)	TMX 18 MPH(kph)	TMX 20X MPH(kph)
	48 Volt	48 Volt	48 Volt	48 Volt	48 Volt
Empty	9.3(15)	9.3(15)	9.3(15)	9.3(15)	7.5(12)
Loaded	9.3(15)	9.3(15)	9.3(15)	9.3(15)	7.5(12)

Maximum speeds with two stage upright

(For Other markets)		
	EPX 16 MPH(kph)	EPX 18 MPH(kph)
	48 Volt	48 Volt
Empty	10.6(17)	10.6(17)
Loaded	10.6(17)	10.6(17)

Turning Radius (outside)

	mm	in
TMX 12	1356	53.4
TMX 13	1356	53.4
TMX 15S	1356	53.4
TMX 15	1519	59.8
TMX 17	1519	59.8
TMX 18	1519	59.8
TMX 20	1519	59.8
TMX 20x	1530	60.2
TMX 25	1565	61.6
EPX 16	1805	71.0
EPX 18	1835	72.2

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 Speeds, Upright

(For U.S markets)														
Lift Speeds - fpm(m/s)														Lowering Speed fpm (m/s)
		TMX 12		TMX 15S		TMX 15		TMX 17		TMX 20		TMX 25		TMX12-25
		36 Volt	48 Volt	36 Volt	48 Volt	36 Volt	48 Volt	36 Volt	48 Volt	36 Volt	48 Volt	36 Volt	48 Volt	
STD	Empty	118(0.60)	120(0.61)	118(0.60)	120(0.61)	118(0.60)	120(0.61)	118(0.60)	120(0.61)	118(0.60)	120(0.61)	94(0.48)	96(0.49)	82(0.41)
	Loaded	74(0.38)	85(0.43)	71(0.36)	83(0.42)	71(0.36)	83(0.42)	63(0.32)	79(0.40)	55(0.28)	59(0.30)	47(0.24)	55(0.28)	89(0.45)
TSU	Empty	104(0.53)	118(0.60)	104(0.53)	118(0.60)	104(0.53)	118(0.60)	104(0.53)	118(0.60)	104(0.53)	118(0.60)	89(0.45)	94(0.48)	77(0.39)
	Loaded	73(0.37)	83(0.42)	69(0.35)	82(0.41)	69(0.35)	82(0.41)	65(0.31)	75(0.39)	61(0.31)	75(0.38)	45(0.23)	53(0.27)	86(0.43)

(For Other markets)							
Lift Speeds - fpm(m/s)							Lowering Speed fpm (m/s)
		TMX 13	TMX 15S	TMX 15	TMX 18	TMX 20X	
		48 Volt	48 Volt	48 Volt	48 Volt	48 Volt	48 Volt
STD	Empty	120(0.61)	120(0.61)	120(0.61)	120(0.61)	96(0.49)	82(0.41)
	Loaded	85(0.43)	83(0.42)	83(0.42)	79(0.40)	55(028)	89(0.45)
TSU	Empty	118(0.60)	118(0.60)	118(0.60)	118(0.60)	94(0.48)	77(0.39)
	Loaded	83(0.42)	82(0.41)	82(0.41)	77(0.39)	53(0.27)	86(0.43)

(For Other markets)				
Lift Speeds - fpm(m/s)				Lowering Speed fpm (m/s)
		EPX 16	EPX 18	
		48 Volt	48 Volt	48 Volt
STD	Empty	118(0.60)	118(0.60)	89(0.45)
	Loaded	89(0.45)	85(0.43)	98(0.50)

Critical Fastener Torque Specifications

	Tightening Torque, Dry	
	N.m	ft-lb
Drive Axle-to-Frame Mounting Bolts:	408-469	300-340
Drive Wheel Lug Bolts	255-275	188-203
Steer Wheel Lug Nuts(TMX)	255-275	188-203
Steer Wheel Lug Nuts(EPX)	157-193	116-142
Steer Trunnion Mounting Bolts	339-381	251-280
Steering Handwheel Retaining Nut	35-40	25.5-29.5
Tilt Cylinder Yoke Clamp Bolts	166-193	122-142
Tilt Cylinder Pin Retainer Bolts	20-22	177-221
Counterweight Mounting Bolts (Bottom)	339-381	251-280

Group Specifications

Group 16, Motors Specifications

Drive Motors

General

Type: AC

Frame Size: 200 mm (7.874 in) diameter

Weight (Approx.): 45 kg (99 lb)

Internal Bearings: Bearings are sealed and lubricated with hightemperature grease for the life of the bearing (Approx service life = 10,000 hours). The bearing at the non-drive end of the motor is a special encoder bearing (sensor).

Rotation: Reversible; CW for forward travel; CCW for reverse travel when viewed from drive end.
Terminal Nut Torque: 15 N.m (133 in-lb)

Rotor

Outside Diameter: 124 mm (4.882 in)
Number of slots: 48

Stator

Outside Diameter: 200 mm (7.874 in)
Number of slots: 36
Insulation: Class “F”

Lift Pump Motor

General

Type: AC Dual Voltage 36 and 48 volt

Frame Size: 170 mm (6.693 in) diameter

Weight (Approx.): 50 kg (110 lb)

Internal Bearings on Pump End, Special Encoder Bearing on Commutator End: Bearings are double sealed and lubricated with hightemperature grease for the life of the bearing(Approx service life = 10,000 hours).
Rotation: Unreversible; CCW, viewed from drive end
Terminal Nut Torque: 15 N.m (133 in-lb)

Insulation: Class “F”

Group 17, Contactors Specifications

One drive line contactor, one pump line contactor Mounting Fastener Torque: 8-10 N.m (71-88 in-lb)

Group 19, Motor Controls Specifications

Drive Motor Control

Type: AC Dual Motor Control
Voltage: Dual Voltage 36 or 48 volts

Lift Pump Motor Control

Type: AC
Voltage: Two unique controls, one for 36 volt and another for 48 volt

Group 20, Drive Axle Specifications

Type: Separate housing and drive train for each drive wheel. Each axle housing contains pinion and ring gear, intermediate shaft, and axle shaft.
Transmission Fluid Type: Clark part no. 2794022
Fluid Capacity (each housing): 3.8 L (1 gal)
Axle-to-Frame Mounting Bolt Torque: 408-469 N.m (300-340 ftlb). Use Loctitle 271.
Fill Plug Torque: 54-61 N.m (40-45 ft-lb)

Group 22, Wheels and Tires Specifications

Cushion

Material: Rubber except as noted.

Size:

	Drive	Steer
TMX 12/13/15/15S	18x7x12.1	18x7x12.1
TMX 17/18/20	18x8x12.1	18x7x12.1
TMX 20x/25	18x9x12.1	18x6x12.1 (urethane)

Mounting Nut Torques: Refter to mounting procedure in Section 2.

Pneumatic

Material: Rubber

Size:

	Drive	Steer
(For U.S. Market)		
TMX 12/15	18x7x8-16 PR	18x7x8-16 PR
TMX 15S	18x7x8-16 PR	18x7 (Solid Only)
TMX 17	18x9x16PR	-
(For Other Markets)		
TMX 13/15S/15/18	18x9x8	18x7x8
TMX 13/15S/15/18/ 20x	-	15x4 1/2x8
EPX 16/18	21x8x9-14PR	5.00x8-10PR

Group 23, Brake System Specifications

Service Brake

Type: Caliper
Minimum lining/pad thickness: 0.67 mm (0.06 in).
Fluid Type: SAEJ1703 (DOT-3) brake fluid only
Fluid Capacity: 0.256 L (0.06 gal).
Pedal Freeplay: 1-3 mm (0.039-0.118 in; measured at stop screw).

Parking Brake

Type(TMX): Lever-type mechanically linked to brake assembly.

Type(EPX): Foot-type mechanically linked to brake assembly.

Holding Test: Rated load on 15% grade

Group 25/26, Steer System Specifications

Steering System Type: Load sensing hydrostatic power steering with variable ratio.
Steering System Relief Pressure Setting: 8274-8825 kPa (1200-1280 psi).
Steer Cylinder Type: Double acting, piston-type.
Steer Axle: Single wheel (optional dual-wheel) mounted on trunnion at center rear of truck.

Group 29/30, Hydraulic Sytem Specifications

Hydraulic Fluid Type: Clark specification MS-68 (Clark part #1802155 and #1800236)
Hydraulic Pump Type: Integral gear-type pump and motor assembly.
Sump Capacity: Usable oil = 19 Litres (5.0 Gal)
Filter Type: Disposable, 25 micron, full flow return line oil filter and a 10 micron filter cap/breather filter.
Main Relief Valve Setting: 20,000 to 21,000 kPa (2800 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 #1): 76 L/min (20 gpm).
- Tilt spool (spool #2): 38 L/min (10 gpm).
- Auxiliary spool (spool #3): 38 L/min (10 gpm).
- Auxiliary spool (spool #4): 38 L/min (10 gpm).

Integral Pressure Compensated Flow Control Settings:
- Tilt spool (spool #2): 15 L/min (4.0 gpm).
- Auxiliary spool (spool #3): 6.7 L/min (1.7 gpm).
- Auxiliary spool (spool #4): 38 L/min (10 gpm).

Tilt Flow Control Adjustments			
Average Tilt		Usage	Clockwise Turns of Adjustment Screw
(°/sec)	Lpm (gpm)		
2.5	6.3(1.7)	3937 (155in). MFH & Above	0.5
3.0	8.7(2.3)	Up to 3937 (155in). MFH	0.75

Maximum Pressure Drop at Rated Flow:
- Inlet to outlet: 689 kPa (100 psi)
- Lift spool (spool #1):
  - 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 counter-clockwise to stop. Each 1/4 clockwise turn of the adjustment increases flow by 3 L/min (0.75 gpm).

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)	4.50

After adjusting the flow control valve settings it will be necessary to also adjust the pump control panel parameters to coincide with the settings you have made. See Group 19 for the proper Handset usage.

Pump Control Panel Settings (Using the Handset)			
Parameters	Auxiliary Flow Settings		
	GPM	36V Hz	48V Hz
2nd Speed Fine and 3rd Speed Fine	2.5	20	33
	5.5	43	51
	7	55	65
	10	79	93

Group 32, Tilt Cylinder Specifications

See Group 29 for hydraulic system specifications.

Tilt Cylinder Type: Double-acting.

Maximum Operating Pressure: 21,000 kPa (3,000 psi).

Tilt Ranges:

Upright MFH (in / mm)	Tilt	
	B°	F°
thru 151 (3835mm)	8°	6°
152 (3860mm) thru 240.5 (6109mm)	5°	3°
241 (6121mm) and over	3°	0°

Group 34, Uprights 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 specification MS-9)
Inncrslidc Lubricant (Clark part #886396)
Chain and Cable Lube (Clark part #886399)

Group 38, Counterweight Specifications

Counterweight Mounting Bolts Torque: 339-381 N.m (251-280 ft-lb)

Counterweight Weight: Different counterweights are used based on truck capacity and battery compartment length, as follows:

Battery Compartment			
(For U.S market)			
Model	Truck Capacity	Length	Counterweight
TMX12	2500 lb (1250 kg)	13.75”	1262 lb (573 kg)
TMX15s	3000 lb (1500 kg)	13.75"	1836 lb (834 kg)
TMX15	3000 lb (1500 kg)	20.5"	914 lb (415 kg)
TMX17	3500 lb (1750 kg)	20.5"	1262 lb (573 kg)
TMX20	4000 lb (1815 kg)	20.5"	1836 lb (834 kg)
TMX25	5000 lb (2270 kg)	20.5"	2894 lb (1314 kg)
(For Other markets)			
TMX13	2500 lb (1250 kg)	13.75”	1262 lb (573 kg)
TMX15s	3000 lb (1500 kg)	13.75"	1836 lb (834 kg)
TMX15	3000 lb (1500 kg)	20.5"	914 lb (415 kg)
TMX18	4000 lb (1800 kg)	20.5"	1836 lb (834 kg)
TMX20x	4000 lb (2000 kg)	20.5"	2098 lb (952 kg)
EPX16	3500 lb (1600 kg)	29"	1080 lb (490 kg)
EPX18	4000 lb 1800 kg)	29"	1300 lb (590 kg)

NOTE :

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 overtighten.

NOTE :

#40–1, Ungnam-Dong,
Changwon-City, Kyungnam,
Korea

Printed in Korea
Mar, 2005

CLARK
THE FORKLIFT