Maintenance Manual

TAYLOR

TX180S – 360L
TXH300L, TXH350L, TXH400L
TXB180S – 300L

IMPORTANT!
Read contents carefully prior to operation.

⚠ WARNING

DEATH OR SERIOUS INJURY MAY RESULT FROM IMPROPER OPERATION OF THIS MACHINE.

- Operator must be trained and knowledgeable of the operators guide, safety manual, and OSHA STANDARD 29 CFR, 1910.178 for powered industrial trucks.
- Capacity is with mast in vertical position and load retracted.
- Capacity greatly decreases with tilting, high load lifting, acceleration, braking, sharp turning, high wind velocity, and poor yard conditions.
- Tilt (mast and load out) only when load is over a stack.
- Visibility may be impaired by structural design (ALWAYS look in the direction of travel; DO NOT rely on mirrors.)
- Do not operate with bystanders present.
- Always travel with load in lowest possible position that allows good visibility.
- Always wear seat belt while machine is in operation.
- Do not attempt to jump from machine in event of tip over. Remain seated with seat belt fastened.

TAYLOR MACHINE WORKS, INC.
650 NORTH CHURCH AVENUE
LOUISVILLE, MISSISSIPPI 39339-2017

3377 020

CAUTION

Observe The Following Precautions For Maximum Safety Of Machine Operation

1. Only trained and responsible operators shall be permitted to handle loads with this truck.
2. Operate the truck from the operator's seat only. Do not allow riders.
3. Test hydraulic controls for proper response before using the machine.
4. Know your load. Do not attempt to lift or transport loads in excess of rated capacity.
5. When the load obstructs the view, operate the truck in the reverse range (except when climbing ramps).
6. Do not stand or work under an elevated load.
7. Transport the load low and tilted back.
8. Avoid sudden stops with a load.
9. Evenly distribute the weight of the load on both forks.
10. Back down a ramp in excess of 10 percent when loaded.
11. Do not move the truck until the brake pressure reaches a safe operating level.
12. Have defects repaired immediately. Do not operate a truck with damaged or defective systems.
13. When leaving truck, lifting mechanism shall be fully lowered, controls shall be neutralized, parking brake set, power shut off, and key removed. Block wheels if on incline.

LIMITED WARRANTY

Products manufactured by Taylor Machine Works, Inc. ("Taylor") and sold are warranted by Taylor to be free from defects in material and workmanship, under normal use and service, when Taylor products are operated at or below rated capacity* in accordance with operating instructions.

This warranty is limited to repair or replacement, (as Taylor may elect, and at an establishment authorized by Taylor) of such parts as shall appear to Taylor upon inspection to have been defective in material or workmanship.

This warranty period shall begin on the delivery date of the product to the Purchaser and end on whichever occurs first of the warranty period, twelve (12) months or two thousand (2000) hours. During this period, Taylor will provide genuine Taylor parts, labor, and travel time to replace or repair any part furnished by Taylor and found to be defective in material and workmanship.** If a defect in material and workmanship is found during the twelve (12) months and/or two thousand (2000) hours whichever occurs first of the warranty period, Taylor will replace lubricating oil, filters, antifreeze, and other service items made unusable by the defect. Only genuine Taylor parts provided by Taylor's Sudden Service, Inc. will be used during the warranty period.

THE FOLLOWING ITEMS ARE NOT COVERED BY THIS WARRANTY:

1. Normal maintenance services and parts or supplies used therein including, without limitation, engine tune-up, wheel alignment, brake and linkage adjustment, lubrication services, tightening and adjusting such as bolts, screws, hoses, fittings, etc., replacement of fuses, bulbs, filters, tune-up parts, fluids and brake and clutch linings, glass; shop supplies such as rags, oil dry, hand soaps, degreasers, cleaning solutions including brake clean, etc.; and adjustments which are a part of the required or recommended predelivery inspection and periodic inspections in accordance with Operator's Manual. Electrical and electronic components including wiring will be excluded after the first six (6) months or one thousand (1000) hours of operation. Electronic control modules (ECM's) for the engine and transmission, and Taylor Integrated Control System (TICS) modules are not included in this exclusion and are covered under the standard warranty period.
2. Leaks due to o-ring failures and fittings after one hundred (100) hours of operation.
3. Normal deterioration of appearance due to use and exposure; or conditions resulting from misuse, negligence, or accident.
4. Any product on which any of the required or recommended periodic inspections or services have not been made.
5. Any parts or accessories, installed on the product which were not manufactured or installed by Taylor whether or not such parts or accessories were selected, recommended or installed by Taylor (including without limitation, engines, tires, batteries, air conditioners, air dryers, etc.). Such parts or accessories shall be covered by the warranties given by the manufacturers thereof and any claim thereof shall be made to such manufacturers.
6. Loss of time, inconvenience, loss of equipment use, other consequential damages or other matters not specifically included.

Taylor parts and assemblies which are furnished and installed under this warranty are themselves within the coverage of the machine warranty and are covered only for the duration of the original machine warranty period.

NOTE: All International warranty parts shipments are F.O.B. point of debarkation, duties, tariffs, or local taxes excluded.

This warranty is expressly in lieu of any other warranties, expressed or implied, including any warranty of merchantability or fitness for a particular purpose.

Replacement parts are warranted for ninety (90) days to be free from defects in material or workmanship. Parts only, no labor.

Taylor Machine Works, Inc. does not authorize any person to create (for Taylor) any other obligation or liability in connection with Taylor products.

*For example, a machine rated capacity at any stipulated load center is the rated lift capacity at less than load center. That is, a machine rated at 20,000 pounds at 24-inch load center connotes 20,000 pounds is the maximum lift capacity even though the load center may be less than 24-inches. Subjecting Taylor products to conditions or loads exceeding those stipulated is justification for immediate cancellation of warranty for products involved.

**Travel reimbursement will be limited to six (6) hours maximum paid per claim, or to the nearest Taylor Machine Works' dealer location in the assigned territory in which the truck is based.

TAYLOR MACHINE WORKS, INC.
650 North Church Avenue
Louisville, Mississippi 39339
(662) 773-3421 / Fax 662-773-9146

Introduction

This manual is to be used as a guide for lubrication and maintenance as well as general equipment care. A separate section is provided to discuss each major component or system. This method of presenting the maintenance instructions enables Taylor Machine Works, Inc. to assemble a maintenance manual with explicit instructions on the exact equipment installed on the machine.

No single rule in the booklet can be followed to the exclusion of others. Each rule must be considered in light of the other rules, the knowledge and training of the man (operator), the limitations of the machine, and the workplace environment.

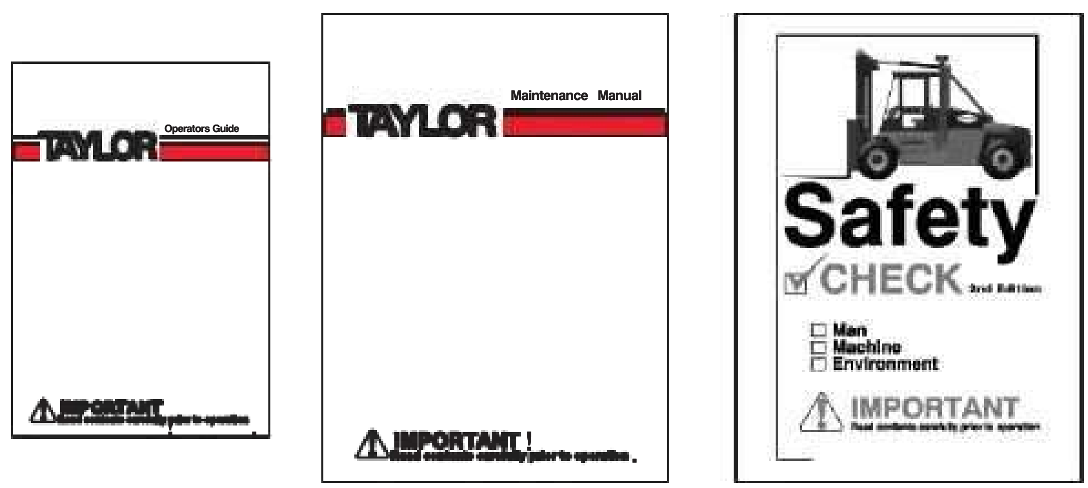
Warnings and cautions are included to reduce the probability of personal injury, when performing maintenance procedures which if improperly performed could be potentially hazardous. Failure to comply with these warnings and cautions can result in serious injury and possible death.

All circumstances and conditions under which service will be performed cannot be anticipated. Do not perform any service if you are unsure that it can be done safely. Contact your Taylor Dealer or Taylor Machine Works, Inc. if you have questions about the proper service techniques.

WARNING: Operating this powered industrial truck when it is in need of repair can result in death or serious injury to the operator or other personnel or cause severe property damage.

Machine checks must be performed daily:

1. before the machine is placed in service,
2. by qualified, trained, and skilled personnel who have proper tools and knowledge, and
3. in accordance with the Operator's Guide, Maintenance Manual and Safety Check 2nd Edition booklet.



Regularly Scheduled maintenance, lubrication, and safety inspections will help ensure a safe and productive work life for the machine and the operator(s).

WARNING: Do not operate the truck if it is in need of repair. Remove the ignition key and attach a "Lock-out" tag.

WARNING: Do not attempt to perform maintenance procedures unless you have been thoroughly trained and you have the proper tools.

WARNING: Use only genuine Taylor replacement parts. Lesser quality parts may fail, resulting in property damage, personal injury or death.

Maintenance and / or service personnel who find it necessary to operate this machine, even for a short period of time, must fully understand all operational literature including:

- OSHA operating rules found in 29 CFR 1910.178; Appendix A in Safety Check 2nd Edition
- ANSI B56.1 rules for operating a powered industrial truck; Appendix B in Safety Check 2nd Edition
- The Operator's Guide for the machine
- The manufacturer's Safety Booklet
- The manufacturer's Safety Video
- The manufacturer's Service Bulletins
- The content and meaning of all machine decals

WARNING: Know how to avoid slip and fall accidents such as those described in the Slip and Fall Accidents Section of Safety Check 2nd Edition.

Safety First

Important Safety Instructions

Observe these rules. They are recognized as practices that reduce the risk of injury to yourself and others, or damage to the lift truck or load.

This manual contains maintenance and service procedures for filling, lubricating, removing, repairing, and installing various components comprising a heavy duty industrial lift truck. Because of the size and weight of the lift truck, and high pressures in some of the components and systems, improperly performing service on the truck can be dangerous.

Warnings and cautions are included to reduce the probability of personal injury, when performing maintenance procedures which if improperly performed could be potentially hazardous. Failure to comply with these warnings and cautions can result in serious injury and possible death.

No single rule in the booklet can be followed to the exclusion of others. Each rule must be considered in light of the other rules, the knowledge and training of the man (operator / maintenance), the limitations of the machine, and the workplace environment.

Report all mechanical problems to mechanics and supervisors.

Proper Training:

Taylor Machine Works, Inc. publishes Safety Check 2nd Edition, TMW-072 a booklet citing some safety precautions to observe during lift truck operation. One copy is shipped with each lift truck; additional copies are available at a nominal fee from the authorized Taylor dealer from which the equipment was initially purchased.

Minimum Required Personnel Safety Equipment

1. Hard Hat
2. Safety Shoes
3. Safety Glasses
4. Heavy Gloves
5. Hearing Protection
6. Reflective Clothing

Failure to follow the safety precautions outlined in this manual can create a dangerous situation.

Some of the common ways this can occur are as follows:

1. Use of hoisting devices not capable of supporting the weight of the component being lifted.
2. Improper attachment of slings to heavy components being hoisted.
3. Use of inadequate or rotten timbers for support, or improper alignment of supporting material.
4. Failure to securely block the wheels, when disconnecting or removing components that hold the lift truck stationary under normal conditions.
5. Failure to read and understand the safety precautions in this manual.

WARNING: Know how to avoid accidents such as those described in the Maintenance / Service Accidents Section of Safety Check 2nd Edition:

Some Maintenance / Servicing Accidents Listed below:

1. Improperly refueling the truck.
2. Improperly checking for hydraulic leaks or fuel leaks (gasoline, L.P. gas, or diesel).
3. Improperly checking the engine cooling system.
4. Improperly checking battery fluid levels or "jump" starting engines.
5. Putting air in a multi-piece tire and rim assembly without proper tools and training.
6. Attempting to service a multi-piece tire and rim assembly without proper tools and training.
7. Using an improperly suited chain while performing maintenance.
8. Using the lift truck hydraulic system as a substitute for a fixed stand.
9. Relying on jacks or hoists to support heavy loads.
10. Operating a truck that is damaged or in need of repair.
11. Climbing on the mast of a fork lift, on the top of the cab, or other high places on the lift truck.

12. Operating a lift truck which has been modified without the manufacturer's approval. This includes the attachment, counterweight, tires, etc.
13. Lifting people with a fork lift not properly equipped for elevating personnel.
14. Improper maintenance of lift chains.
15. Improperly blocking and supporting mast, carriage, or attachment before repairing truck.
16. Working in an area not properly vented for toxic exhaust fumes.

Maintenance / Service Personnel:
1. Keep the truck clean, free of oil, grease, and fuel.
2. Steam clean / wash the truck prior to performing maintenance. Wear anti-slip footwear when performing maintenance procedures.
3. Use OSHA approved ladders and other proper cleaning accessories to access hard to reach maintenance places.
4. Keep gratings free of ice, dirt, and gravel.
5. Regularly inspect and replace anti-slip mastic on the vehicle as needed.
6. Ensure all safety decals are in place on the vehicle.

Mounting and Dismounting:
1. Face the lift truck when getting on or off the lift truck.
2. One hand and two feet or two hands and one foot must be in contact with the lift truck at all times (3 point contact).
3. Use handrails and other grab points.

WARNING: Serious falls and injuries can result from improper mounting or dismounting of the lift truck.

WARNING: Serious falls or injuries can result from being thrown from the lift truck! Never allow riders on the lift truck or load.

Lift Truck Lock-out / Tag-out:
The engine should be locked-out / tagged-out to prevent it from being inadvertently started before performing maintenance or repairs. The battery should be locked-out / tagged-out to prevent accidental activation of the starter and possible starting of the engine. Refer to **Lock-Out / Tag-Out Procedure** in the back of this section for the procedures to be followed to perform lock-out / tag-out.

WARNING: Do not start the engine if the ignition switch, or engine control panel has been locked-out / tagged-out by maintenance personnel. Doing so can result in personal injury and / or damage to the equipment. If in doubt, contact the maintenance supervisor.

TICS Emergency Stop. The TICS emergency stop must be pulled to the out position to enable the TICS controlled hydraulic functions of the truck. Should a TICS controlled operation occur without an operator command, depress the TICS emergency stop to disable the function. The TICS controlled functions that are disabled by the TICS emergency stop include mast, carriage and attachment functions. Shut down the truck as soon as it is safe to do so. Notify maintenance personnel immediately. Do not return the truck to service until all faults have been corrected.

WARNING: When the TICS emergency stop is depressed, the TICS display and forward and back-up alarms are disabled. Additionally, the parking brake will be automatically applied.

WARNING: Activation of the TICS emergency stop eliminates some of the controls of the truck and should be used in emergency use ONLY.

WARNING: Should unwanted hydraulic function continue after depressing the TICS emergency stop, disable the hydraulics by turning the vehicle ignition key to the OFF position.

Proper Training:
1. Taylor Machine Works, Inc. publishes Safety Check 2nd Edition, TMW-072 a booklet citing some safety precautions to observe during lift truck operation. One copy is shipped with each lift truck; additional copies are available at a nominal fee from the authorized Taylor dealer from which the equipment was initially purchased.

WARNING: Remove all rings, watches, chains, other jewelry, and all loose clothing before working around moving parts!

WARNING: If maintenance requires running the engine indoors, ensure the room has adequate flow-through ventilation!

WARNING: Do not operate the vehicle or attempt to perform maintenance on the vehicle while under the influence of alcohol, drugs, or any other medications or substances that slow reflexes, alter safe judgement, or cause drowsiness.

WARNING: Never operate the lift truck without proper instruction. Ignorance of operational characteristics and limitations can lead to equipment damage, personal injury, or death.

WARNING: Maintenance and service personnel should never operate this lift truck unless they are thoroughly familiar with Safety Check 2nd Edition, TMW-072 and the Operators' Guide for this lift truck.

WARNING: This equipment is not electrically insulated. Contact with electricity can cause severe injury or death. Electrocution can occur without direct contact. Do not operate this lift truck in areas with energized power lines or a power supply. Check local, state and federal safety codes for proper clearance. Use a groundman to ensure that there is proper clearance.

WARNING: Use only genuine Taylor replacement parts. Lesser quality parts may fail resulting in property damage, personal injury, or death.

WARNING: Electrical, mechanical, and hydraulic safety devices have been installed on this lift truck to help protect against personal injury and / or damage to equipment. Under no circumstances should any attempt be made to disconnect or in any way render any of these devices inoperable. If you discover that any safety device is malfunctioning, Do Not operate the lift truck; notify appropriate maintenance personnel immediately.

WARNING: Operating instructions, warnings, and caution labels are placed on the lift truck to alert personnel to dangers and to advise personnel of proper operating procedures (of the lift truck). Do not remove or obscure any warning, caution, danger, or instructional sign or label.

WARNING: Keep all hydraulic components in good repair.

WARNING: Relieve pressure on hydraulic system before repairing or adjusting or disconnecting.

WARNING: Wear proper hand and eye protection when searching for leaks. Use wood or cardboard instead of hands.

WARNING: Turn the engine off and remove the ignition key before entering the tire pivot area to prevent death or serious injury from pivoting tires.

WARNING: Deflate tires before removing them. Always remove the valve core and exhaust all air from a single tire and both tires of a dual assembly prior to removing any rim components or wheel components such as nuts and rim clamps. Run a piece of wire through the valve stem to make sure the valve stem is not damaged or plugged and all air is exhausted.

WARNING: Never park the lift truck on an incline. Always park the lift truck on a level surface; otherwise, the lift truck could possibly roll resulting in possible injury to personnel or damage to the lift truck or other property.

Battery Safety:

WARNING: Lighted smoking materials, flames, arcs, or sparks may result in battery

explosion.

1. Keep all metal tools away from battery terminals.
2. Batteries contain sulfuric acid which will burn skin on contact; wear rubber gloves and eye protection when working with batteries.
3. Flush eyes or wash skin with water and seek medical attention immediately in case of contact.
4. When jump starting:
   a. Do not lean over the battery while making connection.
   b. Then, connect the negative (-) terminal of the booster battery to the engine or body ground (-). Never Cross Polarity of Terminals.
   c. Disconnect cables in exact reverse order.

Lock-Out / Tag-Out Procedure

Purpose. This procedure establishes the minimum requirements for lock-out / tag-out of energy sources that could cause injury to personnel. All employees shall comply with the procedure.

Responsibility. The responsibility for seeing that this procedure is followed is binding upon all employees. All employees shall be instructed in the safety significance of the lock-out / tag-out procedure by (designate individual). Each new or transferred affected employee shall be instructed by (designate individuals) in the purpose and use of the lock-out / tag-out procedure.

Preparation for Lock-Out / Tag-Out. Employees authorized to perform lockout / tagout shall be certain as to which switch, valve, or other energy isolating devices apply to the equipment being locked out / tagged out. More than one energy source (electrical, mechanical, or others) may be involved. Any questionable identification of sources shall be cleared by the employees with their supervisors. Before lock-out / tag-out commences, job authorization should be obtained.

Sequence of Lock-Out / Tag-Out Procedure

1. Notify all affected employees that a lock-out / tag-out is required and the reason therefor.
2. If the equipment is operating, shut it down by the normal stopping procedure.
3. Operate the switch, valve, or other energy isolating device so that the energy source(s) (electrical, mechanical, hydraulic, etc.) is disconnected or isolated from the equipment.

   Stored energy, such as that in capacitors, springs, elevated crane members, rotating flywheels, hydraulic systems, and air, gas, steam, or water pressure, etc. must also be dissipated or restrained by methods such as grounding, repositioning, blocking, bleeding-down, etc.
4. Lock-out / tag-out the energy isolating devices with an assigned individual lock / tag.
5. After ensuring that no personnel are exposed and as a check on having disconnected the energy sources, operate the push button or other normal operating controls to make certain the equipment will not operate.

CAUTION: Return operating controls to neutral after the test.

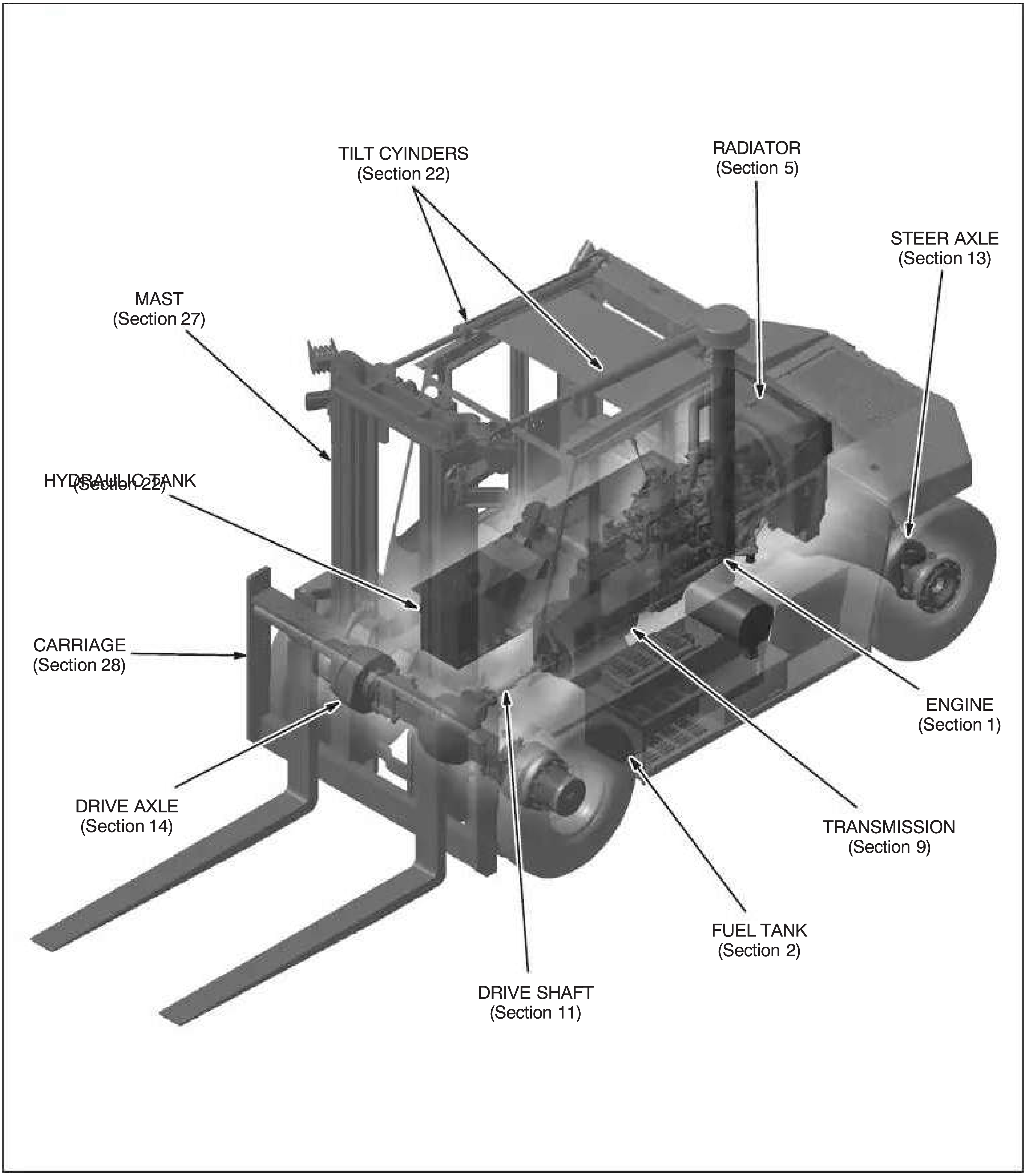
6. The equipment is now locked out / tagged out.

Restoring Equipment to Service

1. When the job is complete and equipment is ready for testing or normal service, check the equipment area to see that no one is exposed.
2. When equipment is all clear, remove all locks / tags. The energy isolating devices may be operated to restore energy to equipment.

Procedure Involving More Than One Person. In the preceding steps, if more than one individual is required to lock-out / tag-out equipment, each shall place his own personal lock / tag on the energy isolating device(s). One designated individual of a work crew or a supervisor, with the knowledge of the crew, may lock-out / tag-out equipment for the whole crew. In such cases, it shall be the responsibility of the individual to carry out all steps of the lock-out / tag-out procedure and inform the crew when it is safe to work on the equipment. Additionally, the designated individual shall not remove a crew lock / tag until it has been verified that all individuals are clear.

Rules for Using Lock-Out / Tag-Out Procedure. All equipment shall be locked out / tagged out to protect against accidental or inadvertent operation when such operation could cause injury to personnel. Do not attempt to operate any switch, valve, or other energy isolating device bearing a lock / tag.


TILT CYINDERS
(Section 22)
RADIATOR
(Section 5)
STEER AXLE
(Section 13)
MAST
(Section 27)
HYDRAULIC TANK
(Section 22)
CARRIAGE
(Section 28)
ENGINE
(Section 1)
DRIVE AXLE
(Section 14)
TRANSMISSION
(Section 9)
FUEL TANK
(Section 2)
DRIVE SHAFT
(Section 11)

Maintenance Manual

Engine

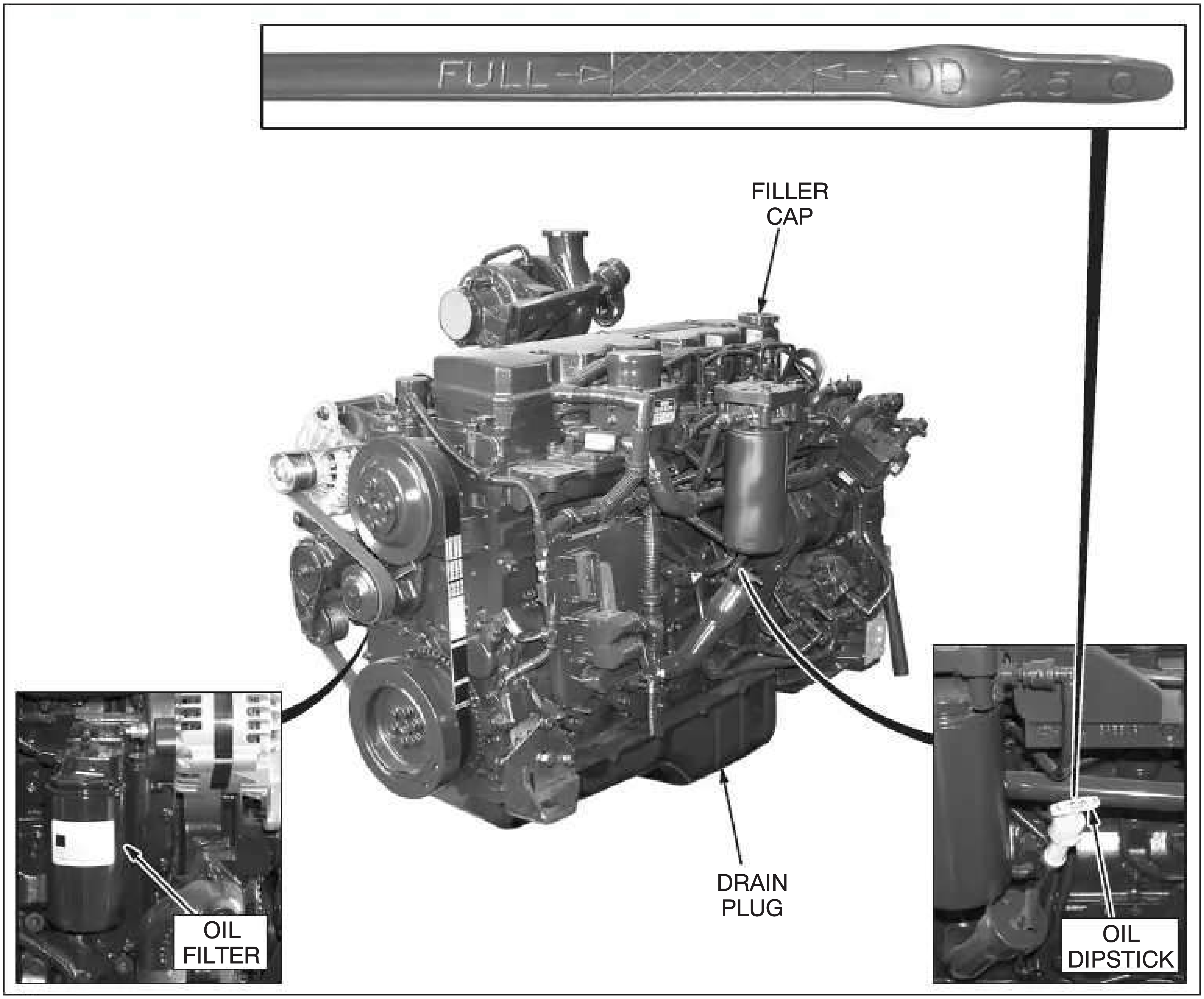


Illustration 1-1. Cummins QSB6.7 Engine Service Points

Introduction. The Cummins QSB6.7 engine is pressure lubricated. Oil pressure is supplied by a gear-type lubricating oil pump and controlled by a pressure regulator. The filter bypass valve ensures that a supply of oil, in the event the filter becomes plugged, is present. One full flow oil filter is incorporated in the lubricating system to provide maximum cleansing and filtration of the engine lubricating oil.

Checking The Lubricating Oil (Illustration 1-1)**.** The engine lubricating oil should be checked daily on the oil dipstick to ensure that the engine has the proper amount of oil for operation.

Changing The Oil and Filter Element (Illustration 1-1)**.** The engine lubricating oil and filter should be replaced periodically (refer to the **Preventive Maintenance** chart in the **Appendices** for oil and filter replacement interval). The oil filter should be replaced each time the engine oil is changed. Refer to the **Fuel and Lubricant Specifications** chart in the **Appendices** for the proper grade of oil to use. Perform the following procedures to replace the oil and filter:

WARNING: Do not use ether to start an engine equipped with an electric heater

starting aid. Use of ether to start an engine equipped with an electric heater starting aid may cause explosion and severe injury.

WARNING: Death or serious injury could result from a runaway truck. Park the truck on a hard, level surface, apply the parking brake, block the wheels in both directions to prevent movement of the truck and Lock Out & Tag Out the truck.

WARNING: Severe injury may occur from burns. Avoid touching exhaust components while changing the oil.

WARNING: Some state and federal agencies in the United States have determined that used engine oil can be carcinogenic and can cause reproductive toxicity. Avoid inhalation of vapors, ingestion and prolonged contact with used engine oil.

CAUTION: Dispose of oil and filter in accordance with federal and local regulations.

CAUTION: Do not use a strap wrench to tighten the oil filter. Mechanical over-tightening may distort the threads or damage the filter gasket.

CAUTION: Never operate the engine with the oil level below the ADD mark or above the FULL mark on the oil dipstick.

1. The engine should be at operating temperature before the oil is changed.
2. Place a suitable container under the drain plug of the oil pan. Remove the drain plug (or open drain valve if equipped) to drain the oil.
3. When the oil has completely drained, re-install the O-ring and drain plug (or close drain valve if equipped) on the Cummins engine and apply a torque value of 59 ft-lbs (80 N·m) to tighten the drain plug.
4. Unscrew the spin-off type oil filter (see Illustration 1-1). It should be possible to unscrew the oil filter by hand; however, a band type filter wrench may be used if necessary. Discard the used oil filter.
5. Clean the area of the filter base that will contact the gasket on the new oil filter.
6. Fill the new filter with clean engine oil before installation.
7. Apply a light film of engine oil on the gasket of the new filter. Screw the new filter onto the filter base until the gasket comes in contact with the filter base and then tighten filter 1/2 to 3/4 turn by hand only.
8. Remove the oil fill cap and fill crankcase with oil to the FULL mark on the oil dipstick (see Illustration 1-1).
9. Start the engine and allow to idle. Visually check the drain plug and oil filter for leaks.
10. Shut down the engine and wait approximately 10 minutes for the oil to drain back into the oil pan. When the engine has cooled, recheck the oil level and add oil as necessary to bring the oil level to the FULL mark on the oil dipstick.

Drive Belts (Illustration 1-2)**.** Visually inspect the drive belt daily. Check the belt for intersecting cracks. Transverse cracks (across the belt width) are acceptable. Longitudinal cracks (direction of belt length) that intersect with transverse cracks are not acceptable. Replace the drive belt if belt is frayed or has pieces of material missing. Adjust drive belts that have a glazed or shiny surface which indicates belt slippage. Correctly installed and tensioned drive belts will show even pulley and belt wear. After installation of a new drive belt, check the tension and adjust if necessary.

NOTE: *Ensure each rib of the drive belt is properly aligned in the corresponding grooves of each pulley or damage to the belt will occur.*

Drive belt damage can be caused by:

- Incorrect tension
- Incorrect size or length
- Pulley misalignment
- Incorrect installation
- Severe operating environment
- Oil or grease on the belts

Drive Belt Tension. Proper drive belt tension is automatically maintained by a belt tensioner supplied with the engine. Refer to the engine manufacturer's operation and maintenance manual.

Air Conditioning Drive Belt Tension (if equipped with air conditioning)**.** Tension on the air conditioning drive belt should be such that a firm push with the thumb at a point midway between the two pulleys will deflect the belt about 3/8 to 1/2 inch (9.5 to 12.7 mm). If the deflection measured is greater than the amount specified above, the drive belt must be replaced.

Checking Engine Mounting Bolts. The engine mounting bolts should be checked for the appropriate torque every 6 months or 1,500 hours, whichever comes first. If a locknut requires retorquing, remove and clean the bolt and locknut. Apply Loctite® to the threads of the bolt, and re-install the bolt and locknut. Torque the locknuts on the Cummins engine mounting bolts to 200 - 220 ft-lbs (270 - 300 N·m). Inspect the rubber mounts for deterioration and age hardening.

Replace any broken or lost bolts and damaged rubber mounts.

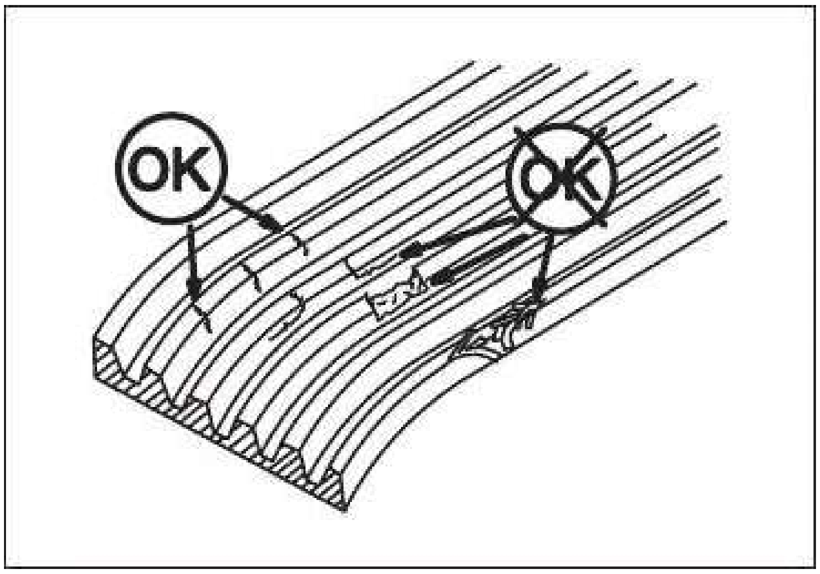


Illustration 1-2. Drive Belt Inspection

Cummins QSB6.7 Engine General Information

Oil Pressure	30 - 55 psi (210 - 280 kPa)
Oil Capacity (includes filter change)	15 Quarts (14.2 Liters)
Low RPMs (no load)	750 rpm

NOTE: *Some special applications may use engine speed settings that are different from the standards shown. The proper settings are permanently stamped on a metal tag affixed to the engine.*

Engine Repair. If repair of the engine is needed, contact a Taylor Machine Works, Inc. authorized dealer for service.

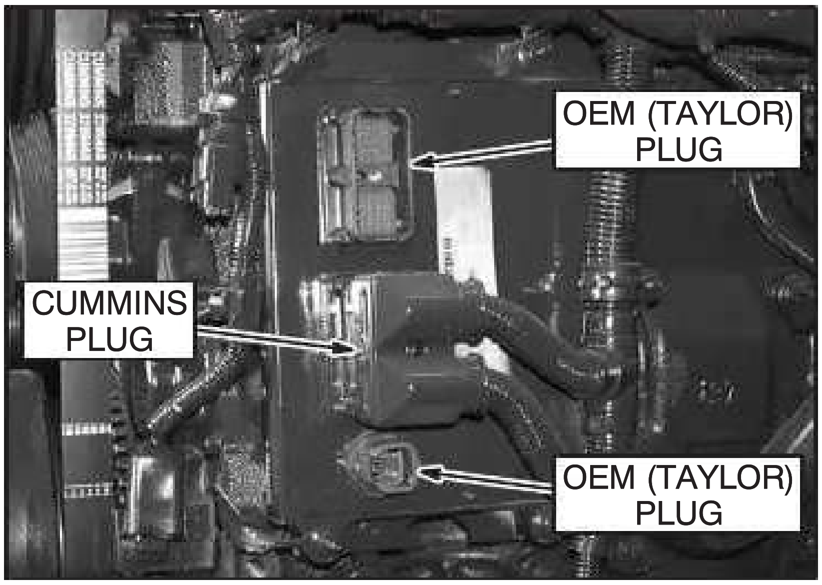


Illustration 1-3. ECM Plugs

Illustration 1-4. Engine Diagnostics Icons

Calibration Of Electronic Accelerator Pedal To ECM Of Engine. The Cummins QSB6.7 engine uses an electronic accelerator to control engine speed. Each time the accelerator pedal is changed, disconnected and the ignition switch is turned on, or ECM (Electronic Control Module) is changed out, the accelerator pedal must be calibrated to the ECM. Calibration procedures are as follows:

1. Apply the parking brake, place the shifter in neutral, and turn the ignition switch to the Ignition position (first click).
2. Cycle the accelerator pedal through its full range of travel three times.
3. Turn the ignition switch to the Off position for at least 30 seconds.

Engine Fault Code Warning Box (Illustration 1-5)**.** An engine fault code warning box will be displayed on the Engine Information screen when an engine fault code is active. This warning box displays the number of the active fault code. To clear the warning box after recording the fault code number, depress the F2 (OK) button. Once the warning box has been cleared, the fault code will have to be flashed out in the Diagnostic Mode if it was not recorded (refer to **Diagnostic Fault Codes**).

Engine Diagnostic Icons (Illustration 1-4)**.** The engine diagnostic icons, displayed by the Taylor Integrated Control System (TICS) display module on the Engine Information Screen, are used to alert the operator of engine related problems. Each diagnostic icon's function is described as follows:

1. **Yellow Icon** (System Fault)**.** This icon will be displayed during a non-fatal system error. The engine can still be run, but the fault should be corrected as soon as possible.

NOTE: *In the diagnostic mode, the yellow icon will flash after the red icon completes the three-digit fault code.*

2. **Red Icon** (Engine Shutting Down)**.** This icon will be displayed when the engine needs to be shut off before permanent damage occurs to the engine. Should the red icon be displayed while operating, the fault can be engine disabling after approximately 32 seconds. Should the engine shut down due to the severity of the fault, it can be restarted and will run for approximately 32 seconds. The engine will run for approximately 32 seconds each time it is restarted. There are no limits on the number of times the engine may be restarted.

NOTES:

- *The engine should be shut off as soon as it can be shut off safely. The engine should* ***not*** *be run until the fault is corrected.*
- *This icon is also used to flash out the fault code number in the diagnostic mode.*

Illustration 1-5. Engine Fault Code Dialog Screen

Diagnostic Fault Codes (Illustration 1-4). If the **red icon** (Engine Shutting Down) or **yellow icon** (System Fault) is displayed on the Engine Information Screen of the TICS Display Module when the engine is running, it means a fault code has been recorded. The icon will remain on as long as the fault exists. The severity of the fault will determine the icon that will be displayed. Only active fault codes can be viewed by use of the diagnostic icons. To view inactive fault codes, a laptop computer equipped with Cummins Insite software is required.

To view active fault codes, perform the following:

1. Leave the engine running or have the ignition key in its accessory position to view the TICS display module screen.
2. At the main screen of the TICS display module, depress the F1 button (Diagnostics) to view the Diagnostics Select screen.

NOTE: *If a diagnostics selection button is not depressed within 5 seconds while the Diagnostics Select screen is displayed, the TICS display will automatically return to the Main Display screen.*

3. At the Diagnostics Select screen, depress the F1 button (Engine) to view the Engine Information screen.
4. At the Engine Information screen, depress the F2 button (Diagnostic Mode Select) to change the Diagnostic Mode Status to the On position.
5. If no active fault codes are recorded, the yellow icon (System Fault) and red icon (Engine Shutting Down) will illuminate and stay on. If active fault codes are recorded, the yellow icon and red icon will illuminate momentarily, and then the red icon will begin to flash the three-digit code of the recorded fault(s).
6. The fault code will flash in the following sequence:
   a. First, the yellow icon will flash beginning the sequence. There will be a short 1 or 2 second pause after which the red icon will flash the first, second, and third digits of the recorded fault code. There will be a 1 or 2 second pause between each number of the code. When all three digits of the fault code have flashed, the yellow icon will illuminate again and repeat the sequence until the fault is cleared or the Diagnostic Mode Status is toggled to the OFF position.

      Example:
      Fault Code 432
      4 flashes, pause
      3 flashes, pause
      2 flashes

   b. If multiple fault codes have been stored, the first fault code must be cleared before the second fault code can be displayed.

Cummins QSB6.7 Engine Fault Code Information

Fault Code - Light	Failure Description	Cause
111 - Red	Engine Control Module Critical internal failure	Bad intelligent Device or Component
115 - Red	Engine Speed/Position Sensor Circuit lost both of two signals from the magnetic pickup sensor	Data Erratic, Intermittent, or incorrect
122 - Yellow	Intake Manifold Pressure Sensor Circuit	Voltage Above Normal, or Shorted to High Source
123 - Yellow	Intake Manifold Pressure Sensor Circuit	Voltage Below Normal, or Shorted to Low Source
131 - Red	Accelerator Pedal or Lever Position Sensor Circuit	Voltage Above Normal, or Shorted to High Source
132 - Red	Accelerator Pedal or Lever Position Sensor Circuit	Voltage Below Normal, or Shorted to Low Source
133 - Red	Remote Accelerator Pedal or Lever Position Sensor Circuit	Voltage Above Normal, or Shorted to High Source
134 - Red	Remote Accelerator Pedal or Lever Position Sensor Circuit	Voltage Below Normal, or Shorted to Low Source
135 - Yellow	Oil Pressure Sensor Circuit	Voltage Above Normal, or Shorted to High Source
141 - Yellow	Oil Pressure Sensor Circuit	Voltage Below Normal, or Shorted to Low Source
143 - Yellow	Oil Pressure Low	Data Valid but Below Normal Operational Range – Moderately Severe Level
144 - Yellow	Coolant Temperature Sensor Circuit	Voltage Above Normal, or Shorted to High Source
145 - Yellow	Coolant Temperature Sensor Circuit	Voltage Below Normal, or Shorted to Low Source
146 - Yellow	Coolant Temperature High	Data Valid but Above Normal Operational Range – Moderately Severe Level
147 - Red	Accelerator Pedal or Lever Position Sensor Circuit	Abnormal Frequency, Pulse Width, or Period
148 - Red	Accelerator Pedal or Lever Position Sensor Circuit	Abnormal Frequency, Pulse Width, or Period
151 - Red	Coolant Temperature Low	Data Valid but Above Normal Operational Range – Most Severe Level
153 - Yellow	Intake Manifold Air Temperature Sensor Circuit	Voltage Above Normal, or Shorted to High Source
154 - Yellow	Intake Manifold Air Temperature Sensor Circuit	Voltage Below Normal, or Shorted to Low Source
155 - Red	Intake Manifold Air Temperature High	Data Valid but Above Normal Operational Range – Most Severe Level
187 - Yellow	Sensor Supply Voltage #2 Circuit	Voltage Below Normal, or Shorted to Low Source
195 - Yellow	Coolant Level Sensor Circuit	Voltage Above Normal, or Shorted to High Source
196 - Yellow	Coolant Level Sensor Circuit	Voltage Below Normal, or Shorted to Low Source

Fault Code - Light	Failure Description	Failure Results
197 - Yellow	Coolant Level	Data Valid but Below Normal Operational Range – Moderately Severe Level
211 - None	Additional Auxiliary Diagnostic Codes logged	Condition Exists
212 - Yellow	Engine Oil Temperature Sensor 1 Circuit	Voltage Above Normal, or Shorted to High Source
213 - Yellow	Engine Oil Temperature Sensor 1 Circuit	Voltage Below Normal, or Shorted to Low Source
214 - Red	Engine Oil Temperature	Data Valid but Above Normal Operational Range – Most Severe Level
221 - Yellow	Barometric Pressure Sensor Circuit	Voltage Above Normal, or Shorted to High Source
222 - Yellow	Barometric Pressure Sensor Circuit	Voltage Below Normal, or Shorted to Low Source
227 - Yellow	Sensor Supply Voltage #2 Circuit	Voltage Above Normal, or Shorted to High Source
231 - Yellow	Coolant Pressure Sensor Circuit	Voltage Above Normal, or Shorted to High Source
232 - Yellow	Coolant Pressure Sensor Circuit	Voltage Below Normal, or Shorted to Low Source
233 - Yellow	Coolant Pressure	Data Valid but Below Normal Operational Range – Moderately Severe Level
234 - Red	Engine Speed High	Data Valid but Above Normal Operational Range – Most Severe Level
235 - Red	Coolant Level Low	Data Valid but Below Normal Operational Range – Most Severe Level
237 - Yellow	External Speed Input (Multiple Unit Synchronization)	Data Erratic, Intermittent, or Incorrect
238 - Yellow	Sensor Supply Voltage #3 Circuit	Voltage Below Normal, or Shorted to Low Source
241 - Yellow	Vehicle Speed Sensor Circuit	Data Erratic,Intermittent, or Incorrect
242 - Yellow	Vehicle Speed Sensor Circuit tampering has been detected	Abnormal Rate of Change
245 - Yellow	Fan Control Circuit	Voltage Below Normal, or Shorted to Low Source
249 - Yellow	Ambient Air Temperature Sensor Circuit	Voltage Above Normal, or Shorted to High Source
256 - Yellow	Ambient Air Temperature Sensor Circuit	Voltage Below Normal, or Shorted to Low Source
261 - Yellow	Engine Fuel Temperature	Data Valid but Above Normal Operational Range – Moderately Severe Level
263 - Yellow	Engine Fuel Temperature Sensor 1 Circuit	Voltage Above Normal, or Shorted to High Source
265 - Yellow	Engine Fuel Temperature Sensor 1 Circuit	Voltage Below Normal, or Shorted to Low Source
268 - Yellow	Fuel Pressure Sensor Circuit	Data Erratic, Intermittent, or Incorrect
271 - Yellow	High Fuel Pressure Solenoid Valve Circuit	Voltage Below Normal, or Shorted to Low Source

Fault Code - Light	Failure Description	Failure Results
272 - Yellow	High Fuel Pressure Solenoid Valve Circuit	Voltage Above Normal, or Shorted to High Source
275 - Yellow	Fuel Pumping Element (Front)	Mechanical System Not Responding Properly or Out of Adjustment
281 - Yellow	High Fuel Pressure Solenoid Valve #1	Mechanical System Not Responding Properly or Out of Adjustment
284 - Yellow	Engine Speed/Position Sensor (Crankshaft) Supply Voltage Circuit	Voltage Below Normal, or Shorted to Low Source
285 - Yellow	SAE J1939 Multiplexing PGN Timeout Error	Abnormal Update Rate
286 - Yellow	SAE J1939 Multiplexing Configuration Error	Out of Calibration
287 - Red	SAE J1939 Multiplexing Accelerator Pedal or Lever Sensor System Error	Received Network Data In Error
288 - Red	SAE J1939 Multiplexing Remote Accelerator Pedal or Lever Data Error	Received Network Data In Error
293 - Yellow	Auxiliary Temperature Sensor Input # 1 Circuit	Voltage Above Normal, or Shorted to High Source
294 - Yellow	Auxiliary Temperature Sensor Input # 1 Circuit	Voltage Below Normal, or Shorted to Low Source
295 - Yellow	Barometric Pressure Sensor Circuit	Data Erratic, Intermittent, or Incorrect
296 - Red	Auxiliary Pressure Sensor Input 1	Special Instructions
297 - Yellow	Auxiliary Pressure Sensor Input # 2 Circuit	Voltage Above Normal, or Shorted to High Source
298 - Yellow	Auxiliary Pressure Sensor Input # 2 Circuit	Voltage Below Normal, or Shorted to Low Source
319 - Maint	Real Time Clock Power Interrupt	Data Erratic, Intermittent, or Incorrect
322 - Yellow	Injector Solenoid Cylinder #1 Circuit	Current Below Normal, or Open Circuit
323 - Yellow	Injector Solenoid Cylinder #5 Circuit	Current Below Normal, or Open Circuit
324 - Yellow	Injector Solenoid Cylinder #3 Circuit	Current Below Normal, or Open Circuit
325 - Yellow	Injector Solenoid Cylinder #6 Circuit	Current Below Normal, or Open Circuit
331 - Yellow	Injector Solenoid Cylinder #2 Circuit	Current Below Normal, or Open Circuit
332 - Yellow	Injector Solenoid Cylinder #4 Circuit	Current Below Normal, or Open Circuit
334 - Yellow	Coolant Temperature Sensor Circuit	Data Erratic, Intermittent, or Incorrect
338 - Yellow	Idle Shutdown Vehicle Accessories Relay Driver Circuit	Voltage Above Normal, or Shorted to High Source
339 - Yellow	Idle Shutdown Vehicle Accessories Relay Driver Circuit	Voltage Below Normal, or Shorted to Low Source
341 - Yellow	Engine Control Module data lost	Data Erratic, Intermittent, or Incorrect
342 - Red	Electronic Calibration Code Incompatibility	Out of Calibration
343 - Yellow	Engine Control Module Warning internal hard-ware failure	Bad Intelligent Device or Component
351 - Yellow	Injector Power Supply	Bad Intelligent Device or Component
352 - Yellow	Sensor Supply Voltage #1 Circuit	Voltage Below Normal, or Shorted to Low Source

Fault Code - Light	Failure Description	Failure Results
386 - Yellow	Sensor Supply Voltage #1 Circuit	Voltage Above Normal, or Shorted to High Source
387 - Yellow	Accelerator Pedal or Lever Position Sensor Supply Voltage Circuit	Voltage Above Normal, or Shorted to High Source
415 - Red	Oil Pressure Low – Data Valid but Below Normal Operational Range	Most Severe Level
418 - Maint	Water in Fuel Indicator High	Data Valid but Above Normal Operational Range – Least Severe Level
422 - Yellow	Coolant Level	Data Erratic, Intermittent, or Incorrect
425 - Yellow	Engine Oil Temperature	Data Erratic, Intermittent, or Incorrect
428 - Yellow	Water in Fuel Sensor Circuit	Voltage Above Normal, or Shorted to High Source
429 - Yellow	Water in Fuel Sensor Circuit	Voltage Below Normal, or Shorted to Low Source
431 - Yellow	Accelerator Pedal or Lever Idle Validation Circuit	Data Erratic, Intermittent, or Incorrect
432 - Red	Accelerator Pedal or Lever Idle Validation Circuit	Out of Calibration
433 - Yellow	Intake Manifold Pressure Sensor Circuit	Data Erratic, Intermittent, or Incorrect
434 - Yellow	Power Lost without Ignition Off	Data Erratic, Intermittent, or Incorrect
435 - Yellow	Oil Pressure Sensor Circuit	Data Erratic, Intermittent, or Incorrect
441 - Yellow	Battery #1 Voltage Low	Data Valid but Below Normal Operational Range – Moderately Severe Level
442 - Yellow	Battery #1 Voltage High	Data Valid but Above Normal Operational Range – Moderately Severe Level
443 - Yellow	Accelerator Pedal or Lever Position Sensor Supply Voltage Circuit	Voltage Below Normal, or Shorted to Low Source
449 - Red	Fuel Pressure High	Data Valid but Above Normal Operational Range – Moderately Severe Level
451 - Yellow	Injector Metering Rail #1 Pressure Sensor Circuit	Voltage Above Normal, or Shorted to High Source
452 - Yellow	Injector Metering Rail #1 Pressure Sensor Circuit	Voltage Below Normal, or Shorted to Low Source
488 - Yellow	Intake Manifold 1 Temperature	Data Valid but Above Normal Operational Range – Moderately Severe Level
497 - Yellow	Multiple Unit Synchronization Switch Circuit	Data Erratic, Intermittent, or Incorrect
523 - Yellow	OEM Intermediate (PTO) Speed switch Validation	Data Erratic, Intermittent, or Incorrect
527 - Yellow	Auxiliary Input/Output 2 Circuit	Voltage Above Normal, or Shorted to High Source
528 - Yellow	Auxiliary Alternate Torque Validation Switch	Data Erratic, Intermittent, or Incorrect
529 - Yellow	Auxiliary Input/Output 3 Circuit	Voltage Above Normal, or Shorted to High Source
551 - Yellow	Accelerator Pedal or Lever Idle Validation Circuit	Voltage Below Normal, or Shorted to Low Source

Fault Code - Light	Failure Description	Failure Results
553 - Yellow	Injector Metering Rail #1 Pressure High	Data Valid but Above Normal Operational Range – Moderately Severe Level
554 - Yellow	Fuel Pressure Sensor Error	Data Erratic, Intermittent, or Incorrect
559 - Yellow	Injector Metering Rail #1 Pressure Low	Data Valid but Below Normal Operational Range – Moderately Severe Level
584 - Yellow	Starter Relay Circuit	Voltage Above Normal, or Shorted to High Source
585 - Yellow	Starter Relay Circuit	Voltage Below Normal, or Shorted to Low Source
595 - Yellow	Turbocharger #1 Speed High	Data Valid but Above Normal Operational Range – Moderately Severe Level
596 - Yellow	Electrical Charging System Voltage High	Data Valid but Above Normal Operational Range – Moderately Severe Level
597 - Yellow	Electrical Charging System Voltage Low	Data Valid but Below Normal Operational Range – Moderately Severe Level
598 - Red	Electrical Charging System Voltage Low	Data Valid but Below Normal Operational Range – Most Severe Level
649 - Maint	Change Lubricating Oil and Filter	Condition Exists
687 - Yellow	Turbocharger #1 Speed Low	Data Valid but Below Normal Operational Range – Moderately Severe Level
689 - Yellow	Primary Engine Speed Sensor Error	Data Erratic, Intermittent, or Incorrect
691 - Yellow	Turbocharger #1 Compressor Inlet Temperature Sensor Circuit	Voltage Above Normal, or Shorted to High Source
692 - Yellow	Turbocharger #1 Compressor Inlet Temperature Sensor Circuit	Voltage Below Normal, or Shorted to Low Source
697 - Yellow	ECM Internal Temperature Sensor Circuit	Voltage Above Normal, or Shorted to High Source
698 - Yellow	ECM Internal Temperature Sensor Circuit	Voltage Below Normal, or Shorted to Low Source
719 - Yellow	Extended Crankcase Blow–by Pressure Circuit	Voltage Above Normal, or Shorted to High Source
729 - Yellow	Extended Crankcase Blow–by Pressure Circuit	Voltage Below Normal, or Shorted to Low Source
731 - Yellow	Engine Speed/Position #2 mechanical misalignment between camshaft and crankshaft sensors	Mechanical System Not Responding Properly or Out of Adjustment
753 - Yellow	Engine Speed/Position #2 Camshaft sync error	Data Erratic, Intermittent, or Incorrect
757 - Yellow	Electronic Control Module data lost	Condition Exists
778 - Yellow	Engine Speed Sensor (Camshaft) Error	Data Erratic, Intermittent, or Incorrect
779 - Yellow	Warning Auxiliary Equipment Sensor Input # 3 (OEM Switch)	Root Cause Not Known
951 - None	Cylinder Power Imbalance Between Cylinders	Data Erratic, Intermittent, or Incorrect
1117 - None	Power Lost With Ignition On	Data Erratic, Intermittent, or Incorrect
1139 - Yellow	Injector Cylinder #1	Mechanical System Not Responding Properly or Out of Adjustment

Fault Code - Light	Failure Description	Failure Results
1141 - Yellow	Injector Cylinder #2	Mechanical System Not Responding Properly or Out of Adjustment
1142 - Yellow	Injector Cylinder #3	Mechanical System Not Responding Properly or Out of Adjustment
1143 - Yellow	Injector Cylinder #4	Mechanical System Not Responding Properly or Out of Adjustment
1144 - Yellow	Injector Cylinder #5	Mechanical System Not Responding Properly or Out of Adjustment
1145 - Yellow	Injector Cylinder #6	Mechanical System Not Responding Properly or Out of Adjustment
1239 - Yellow	Accelerator Pedal or Lever Position Sensor 2 Circuit	Voltage Above Normal, or Shorted to High Source
1241 - Yellow	Accelerator Pedal or Lever Position Sensor 2 Circuit	Voltage Below Normal, or Shorted to Low Source
1242 - Red	Accelerator Pedal or Lever Position Sensor 1 and 2	Data Erratic, Intermittent, or Incorrect
1256 - Yellow	Control Module Identification Input State Error	Data Erratic, Intermittent, or Incorrect
1257 - Red	Control Module Identification Input State Error	Data Erratic, Intermittent, or Incorrect
1911 - Yellow	Injector Metering Rail 1 Pressure	Data Valid but Above Normal Operational Range – Most Severe Level
2111 - Yellow	Coolant Temperature 2 Sensor Circuit	Voltage Above Normal, or Shorted to High Source
2112 - Yellow	Coolant Temperature 2 Sensor Circuit	Voltage Below Normal, or Shorted to Low Source
2113 - Yellow	Coolant Temperature 2	Data Valid but Above Normal Operational Range – Moderately Severe Level
2114 - Red	Coolant Temperature 2	Data Valid but Above Normal Operational Range – Most Severe Level
2115 - Yellow	Coolant Pressure 2 Circuit	Voltage Above Normal, or Shorted to High Source
2116 - Yellow	Coolant Pressure 2 Circuit	Voltage Below Normal, or Shorted to Low Source
2117 - Yellow	Coolant Pressure 2	Data Valid but Below Normal Operational Range – Moderately Severe Level
2185 - Yellow	Sensor Supply Voltage #4 Circuit	Voltage Above Normal, or Shorted to High Source
2186 - Yellow	Sensor Supply Voltage #4 Circuit	Voltage Below Normal, or Shorted to Low Source
2195 - Red	Transmission's temperature exceeds 245°F (118°C).	Engine will shut down 30 seconds after the red icon begins flashing.
2215 - Yellow	Fuel Pump Delivery Pressure	Data Valid but Below Normal Operational Range – Moderately Severe Level
2216 - Yellow	Fuel Pump Delivery Pressure	Data Valid but Above Normal Operational Range – Moderately Severe Level
2217 - Yellow	ECM Program Memory (RAM) Corruption	Condition Exists
2249 - Yellow	Injector Metering Rail 1 Pressure	Data Valid but Below Normal Operational Range – Most Severe Level

Fault Code - Light	Failure Description	Failure Results
2265 - Yellow	Fuel Priming Pump Control Signal Circuit	Voltage Above Normal, or Shorted to High Source
2266 - Yellow	Fuel Priming Pump Control Signal Circuit	Voltage Below Normal, or Shorted to Low Source
2292 - Yellow	Fuel Inlet Meter Device	Data Valid but Above Normal Operational Range – Moderately Severe Level
2293 - Yellow	Fuel Inlet Meter Device flow demand lower than expected	Data Valid but Below Normal Operational Range – Moderately Severe Level
2311 - Yellow	Fueling Actuator #1 Circuit Error	Condition Exists
2321 - None	Engine Speed / Position Sensor #1	Data Erratic, Intermittent, or Incorrect
2322 - None	Engine Speed / Position Sensor #2	Data Erratic, Intermittent, or Incorrect
2345 - Yellow	Turbocharger speed invalid rate of change detected	Abnormal Rate of Change
2346 - None	Turbocharger Turbine Inlet Temperature (Calculated)	Data Valid but Above Normal Operational Range – Least Severe Level
2347 - None	Turbocharger Compressor Outlet Temperature (Calculated)	Data Valid but Above Normal Operational Range – Least Severe Level
2362 - Yellow	Engine Brake Actuator Circuit #1	Voltage Below Normal, or Shorted to Low Source
2363 - Yellow	Engine Brake Actuator Circuit #2	Voltage Below Normal, or Shorted to Low Source
2366 - Yellow	Engine Brake Actuator Circuit #1	Voltage Above Normal, or Shorted to High Source
2367 - Yellow	Engine Brake Actuator Circuit #2	Voltage Above Normal, or Shorted to High Source
2377 - Yellow	Fan Control Circuit	Voltage Above Normal, or Shorted to High Source
2384 - Yellow	VGT Actuator Driver Circuit	Voltage Below Normal, or Shorted to Low Source
2385 - Yellow	VGT Actuator Driver Circuit	Voltage Above Normal, or Shorted to High Source
2555 - Yellow	Intake Air Heater #1 Circuit	Voltage Above Normal, or Shorted to High Source
2556 - Yellow	Intake Air Heater #1 Circuit	Voltage Below Normal, or Shorted to Low Source
2557 - Yellow	Auxiliary PWM Driver #1	Voltage Above Normal, or Shorted to High Source
2558 - Yellow	Auxiliary PWM Driver #1	Voltage Below Normal, or Shorted to Low Source
2963 - None	Engine Coolant Temperature High	Data Valid but Above Normal Operational Range – Least Severe Level
2964 - None	Intake Manifold Temperature High	Data Valid but Above Normal Operational Range – Least Severe Level
2973 - Yellow	Intake Manifold Pressure Sensor Circuit	Data Erratic, Intermittent, or Incorrect

Engine Troubleshooting

The following chart includes some of the problems that an operator may encounter during the service life of a Cummins diesel engine. Always check the easiest and obvious things first, such as the master disconnect switch, the neutral start switch, an empty fuel tank, closed fuel shut off, dead battery or corroded terminals. Study the problem thoroughly before starting to work on the engine. Ask yourself the following questions.

1. What were the warning signs preceding the trouble?
2. Has the engine been subjected to recent repair or maintenance?
3. Has a similar trouble occurred before?
4. If the engine still runs, is it safe to continue operation of the engine in an effort to diagnose the trouble?

Check the items most easily and inexpensively corrected before proceeding to the more difficult, time consuming and expensive items. After a malfunction has been corrected, locate and correct the cause of the trouble to prevent recurrence of the same trouble.

Engine Noise Diagnostic Procedures – General Information

NOTE: *When diagnosing engine noise problems, make sure that noises caused by accessories, such as the air compressor and power take–off, are not mistaken for engine noises. Remove the accessory drive belts to eliminate noise caused by these units. Noise will also travel to other metal parts not related to the problem. The use of a stethoscope can help locate an engine noise.*

Engine noises heard at the crankshaft speed, engine rpm, are noises related to the crankshaft, rods, pistons, and piston pins. Noises heard at the camshaft speed, one–half of the engine rpm, are related to the valve train. A handheld digital tachometer can help determine if the noise is related to components operating at the crankshaft or camshaft speed.

There is not a definite rule or test that will positively determine the source of a noise complaint.

Engine–driven components and accessories, such as gear–driven fan clutches, hydraulic pumps, belt–driven alternators, air–conditioning compressors, and turbochargers, can contribute to engine noise. Use the following information as a guide to diagnosing engine noise.

Main Bearing Noise (Refer to Problem 40.)**.** The noise caused by a loose main bearing is a loud, dull knock heard when the engine is pulling a load. If all main bearings are loose, a loud clatter will be heard. The knock is heard regularly every other revolution. The noise is the loudest when the engine is lugging or under heavy load. The knock is duller than a connecting rod noise. Low oil pressure can also accompany this condition.

If the bearing is not loose enough to produce a knock by itself, the bearing can knock if the oil is too thin or if there is no oil on the bearing.

An irregular noise can indicate worn crankshaft thrust bearings.

An intermittent, sharp knock indicates excessive crankshaft end clearance. Repeated clutch disengagements can cause a change in the noise.

Connecting Rod Bearing Noise (Refer to Problem 39.)**.** Connecting rods with excessive clearance will knock at all engine speeds under both idle and load conditions. When the bearings begin to become loose, the noise can be confused with piston slap or loose piston pins. The noise increases in volume with engine speed. Low oil pressure can also accompany this condition.

Piston Noise (Refer to Problem 41.)**.** It is difficult to tell the difference between piston pin, connecting rod, and piston noise. A loose piston pin causes a loud double knock that is usually heard when the engine is idling. When the injector to this cylinder is cut out, a noticeable change will be heard in the sound of the knocking noise. However, on some engines the knock becomes more noticeable when the vehicle is operated on the road at a steady speed.

Problem	Cause	Correction
1. Engine will not crank or cranks slowly	1. Battery disconnect switch is turned off.	1. Turn battery disconnect switch on.
	2. Engine drive units are engaged.	2. Disengage engine driven units.
	3. Battery connections are broken, loose or corroded.	3. Check for damage. Replace, tighten or clean.
	4. Low battery charge.	4. Check electrolyte level and specific gravity. Recharge or replace batteries.
	5. Battery rating is too low.	5. Replace with correct rated battery.
	6. Oil for operating conditions is incorrect.	6. Change oil and filter. Refer to the **Fuel and Lubricant Specifications** in the **Appendices** for the proper type of oil to be used.
	7. Oil level is too high.	7. Check the oil level. Verify the oil pan capacity. Drain excess oil if necessary. Fill the system to the specified level.
	8. Oil temperature is too low.	8. Install oil pan heater.
	9. Electric shifter is not in the neutral position.	9. Place electric shifter in the neutral position.
	10. Circuit breaker (CB13, CB14, CB15, CB27, CB28 or ECM 30 amp; Illustrations 1-6 and 6-6 thru 6-8) is tripped or defective.	10. Reset or replace circuit breaker(s).
	11. Defective accessory power solenoid (L1).	11. Replace accessory power solenoid (L1).
	12. Defective neutral start relay (K9, Illustration 6-6).	12. Replace neutral start relay (K9).
	13. Defective start assist solenoid (L2).	13. Replace start assist solenoid (L2).
	14. Defective starter.	14. Replace or repair starter.
	15. Defective ignition switch (S1).	15. Refer to Component 4. of the **Component Troubleshooting** chart in **Section 6.**
	16. Blown fuse (5 amp) to the ECM.	16. Replace fuse(s).
	17. Loose or broken wires / plugs / pins between any of the components in Causes 9. thru 16. of this Problem.	17. Isolate and repair.
	18. The TICS emergency hydraulic movement stop has been depressed to disable certain functions.	18. Pull the TICS emergency hydraulic stop to its Out position.

Problem	Cause	Correction
2. Engine difficult to start or will not start (no exhaust smoke present)	1. Low fuel level.	1. Fill the fuel tank.
	2. Electronic fault codes are active.	2. Refer to **Diagnostic Fault Codes** found earlier in this section for instructions on how to read active fault codes. If fault codes are active, contact a Cummins Authorized Repair Facility.
	3. Battery voltage is low.	3. Check the batteries and the unswitched battery supply circuit.
	4. Battery voltage supply to the electronic control module (ECM) is low, interrupted, or open.	4. Check the battery connections and fuses.
	5. Moisture is in the wiring harness connectors.	5. Dry the connectors with an electronics cleaner.
	6. Air is in the fuel system.	6. Check for air in the fuel system. Tighten or replace the fuel connections, fuel lines, fuel hoses, and fuel filters as required. Vent air from the system.
3. Engine difficult to start or will not start (exhaust smoke present)	1. Low fuel level.	1. Fill the fuel tank.
	2. Battery voltage is low.	2. Check the batteries and the unswitched battery supply circuit.
	3. Engine cranking speed is too slow.	3. Check engine cranking RPM. Refer to Problem 1. in this troubleshooting chart.
	4. Starting aid needed for cold weather or is not working properly.	4. Check-repair or replace cold starting aid, if necessary.
	5. Air is in the fuel system.	5. Refer to Correction 6. of Problem 2. in this troubleshooting chart.
	6. Fuel leak.	6. Check fuel lines, fuel connections, and fuel filters for leaks.
	7. Air intake system is restricted.	7. Check intake system for restrictions. Replace air filter if required.
	8. Incorrect fuel grade is being used or fuel quality is poor.	8. Use the correct grade of fuel.
	9. Engine block heater is malfunctioning (if equipped).	9. Check the electrical sources and wiring to the cylinder block heater. Replace the block heater is necessary.
	10. Fuel heater is malfunctioning (if equipped).	10. Check the fuel heater. Replace if necessary.
	11. Electronic fault codes are active.	11. Refer to Correction 2. of Problem 2. in this troubleshooting chart.

Problem	Cause	Correction
4. Engine starts, but will not keep running	1. Low fuel level. 2. Battery voltage supply to the electronic control module (ECM) is low, interrupted, or open. 3. Electronic fault codes are active.	1. Fill fuel tank. 2. Check the battery connections. 3. Refer to Correction 2. of Problem 2. in this troubleshooting chart.
5. Engine speed surges at low or high idle	1. Low fuel level. 2. Electronic fault codes are active. 3. Moisture is in the wiring harness connectors. 4. Air is in the fuel system. 5. Incorrect fuel grade is being used or fuel quality is poor.	1. Fill fuel tank. 2. Refer to Correction 2. of Problem 2. in this troubleshooting chart. 3. Dry the connectors with an electronics cleaner. 4. Refer to Correction 6. of Problem 2. in this troubleshooting chart. 5. Use the correct grade of fuel.
6. Engine runs rough at idle	1. Engine is cold. 2. Electronic fault codes are active. 3. Idle speed is set too low for accessories. 4. Air is in the fuel system. 5. Fuel supply is restricted. 6. Engine mounts are worn or damaged. 7. Moisture is in the wiring harness connectors. 8. Incorrect fuel grade is being used or fuel quality is poor.	1. Allow the engine to warm to operating temperature. If the engine will not reach operating temperature, refer to Problem 16. of this troubleshooting chart. 2. Refer to Correction 2. of Problem 2. in this troubleshooting chart. 3. Check and adjust the low idle screw. 4. Refer to Correction 6. of Problem 2. in this troubleshooting chart. 5. Check fuel lines for restrictions. 6. Replace engine mounts. 7. Dry the connectors with an electronics cleaner. 8. Use the correct grade of fuel.
7. Engine runs rough or misfires *continued*	1. Engine is cold. 2. Electronic fault codes are active. 3. Air is in the fuel system.	1. Refer to Correction 1. of Problem 6. in this troubleshooting chart. 2. Refer to Correction 2. of Problem 2. in this troubleshooting chart. 3. Refer to Correction 6. of Problem 2. in this troubleshooting chart.

Problem	Cause	Correction
7. Engine runs rough or misfires (Continued)	4. Fuel supply line or passage restriction between the fuel pump and injectors. 5. Engine mounts are worn or damaged. 6. Moisture is in the wiring harness connectors.	4. Check the fuel supply line or passage for restriction. 5. Replace engine mounts. 6. Dry the connectors with an electronics cleaner.
8. Lubricating oil pressure is low	1. Engine angularity during operation exceeds specification. 2. Oil does not meet specifications. 3. Oil filter is plugged. 4. Oil is contaminated with coolant or fuel. 5. External oil leak. 6. Incorrect oil level. 7. Electronic fault codes are active. 8. Oil pressure switch, gauge, sensor or circuit is malfunctioning.	1. Refer to a Cummins Authorized Repair Facility. 2. Change the oil and filter. Refer to **Fuel and Lubricant Specifications** in the **Appendices** for the proper type of oil to be used. 3. Change oil and replace oil filter. 4. Refer to Problem 10. in this troubleshooting chart. 5. Inspect the engine for external oil leaks. Tighten the capscrews, pipe plugs, and fittings. Replace damaged gaskets. 6. Check the oil level. Add or drain engine oil. 7. Refer to Correction 2. of Problem 2. in this troubleshooting chart. 8. Check the oil pressure switch, gauge, sensor or circuit for correct operation.
9. Lubricating oil pressure is high	1. Engine coolant temperature is too low. 2. Oil pressure switch, gauge, sensor or circuit is malfunctioning. 3. Oil does not meet specifications. 4. Electronic fault codes are active.	1. Refer to Problem 16. of this troubleshooting chart. 2. Check the oil pressure switch, gauge, sensor or circuit for correct operation. 3. Refer to Correction 2. of Problem 8. in this troubleshooting chart. 4. Refer to Correction 2. of Problem 2. in this troubleshooting chart.
10. Lubricating oil is contaminated *continued*	1. Oil is contaminated with fuel. 2. Internal engine coolant leak.	1. Change the oil and filter. Refer to Problem 31. in this troubleshooting chart. 2. Refer to Problem 14. in this troubleshooting chart.

Problem	Cause	Correction
10. Lubricating oil is contaminated (Continued)	3. Bulk oil supply is contaminated.	3. Check bulk oil supply. Drain the oil and replace with non-contaminated oil. Replace oil filter(s).
11. Coolant temperature is above normal (Gradual Overheat)	1. Charge air cooler fins, radiator fins, or air conditioner condenser fins are damaged or obstructed with debris.	1. Inspect the charge air cooler, radiator, and air conditioner condenser fins. Clean if necessary.
	2. Coolant level is low.	2. Inspect the engine and cooling system for external coolant leaks. Repair if necessary. Add coolant.
	3. Electronic fault codes are active.	3. Refer to Correction 2. of Problem 2. in this troubleshooting chart.
	4. Fan shroud is damaged or missing, or the air recirculation baffles are damaged or missing.	4. Inspect the shroud and recirculation baffles. Repair, replace, or install if necessary.
	5. Incorrect oil level.	5. Add or drain engine oil.
	6. Oil is contaminated with coolant or fuel.	6. Refer to a Cummins Authorized Repair Facility.
	7. Radiator hose is collapsed, restricted, or leaking.	7. Inspect the hoses and replace any defective hoses.
	8. Incorrect coolant mixture of anti-freeze and water.	8. Verify the concentration of anti-freeze in the coolant. Add anti-freeze or water to bring concentration to the proper mixture. Refer to **Coolant** in **Section 5** for the correct coolant concentration.
	9. Coolant temperature gauge is malfunctioning.	9. Test the temperature gauge. Replace the gauge if necessary.
	10. Fan drive belt is loose, tight, or **not** correctly aligned.	10. Check belt tension and tighten / loosen if necessary. Replace drive belt if necessary.
	11. Radiator cap(s) is incorrect, malfunctioning, or has low pressure rating.	11. Replace radiator cap(s).
	12. Vent line is restricted.	12. Check vent line for restriction.
	13. Intake manifold air temperature is above normal.	13. Refer to Problem 34. in this troubleshooting chart.
	14. Incorrect thermostat or thermostat is malfunctioning.	14. Check the thermostat for the correct part number and for correct operation.
	15. Water pump is malfunctioning.	15. Check the water pump for correct operation. Replace water pump if necessary.
continued		

Problem	Cause	Correction
11. Coolant temperature is above normal (Gradual Overheat) (Continued)	16. Radiator core is internally obstructed or damaged.	16. Inspect the radiator and clean if necessary.
	17. Engine is over–fueled.	17. Check the fuel rate. Refer to Problem 21 in this troubleshooting chart.
12. Coolant temperature is above normal (Sudden Overheat)	1. Coolant level is low.	1. Inspect the engine and cooling system for external coolant leaks. Repair if necessary. Add coolant.
	2. Fan drive or fan controls are malfunctioning.	2. Check the fan drive and fan controls.
	3. Fan drive belt is loose, broken, or not correctly aligned.	3. Check belt tension and tighten if necessary. Replace drive belt if necessary.
	4. Radiator cap(s) is incorrect, malfunctioning, or has low-pressure rating.	4. Replace radiator cap(s).
	5. Radiator hose is collapsed, restricted, or leaking.	5. Inspect the hoses and replace any defective hoses.
	6. Coolant temperature gauge is malfunctioning.	6. Test the temperature gauge. Replace the gauge if necessary.
	7. Charge air cooler fins, radiator fins, or air conditioner condenser fins are damaged or obstructed with debris.	7. Inspect the charge air cooler, radiator, and air conditioner condenser fins. Clean if necessary.
	8. Vent line is restricted.	8. Check vent line for restriction.
13. Coolant loss – External	1. Low coolant level.	1. Inspect the engine and cooling system for external coolant leaks. Repair / replace damaged cooling components. Add coolant.
	2. External coolant leak.	2. Inspect the engine for coolant leaking from hoses, draincocks, water manifold, jumper tubes, expansion and pipe plugs, fittings, radiator core, air compressor and cylinder head gaskets, lubricating oil cooler, water pump seal, cylinder block, and cab heater. Repair / replace damaged components.
	3. Radiator cap(s) is incorrect, malfunctioning, or has low-pressure rating.	3. Replace radiator cap(s).
continued	4. Radiator hose is collapsed, restricted, or leaking.	4. Inspect the hoses and replace any defective hoses.

Problem	Cause	Correction
13. Coolant loss – External (Continued)	5. Coolant fill line is restricted or obstructed. 6. Engine is overheating.	5. Check the coolant fill line for restrictions or obstructions. 6. Refer to Problems 11. and 12. in this troubleshooting chart.
14. Coolant loss – Internal	1. Coolant is leaking into the lubricating oil. 2. Cylinder head gasket is leaking. 3. Coolant is leaking into the combustion chamber. 4. Cylinder head is cracked or porous. 5. Cylinder head expansion plugs leaking or misassembled. 6. Cylinder block is cracked or porous.	1. Check for coolant in the oil. Refer to Problem 15. of this troubleshooting chart. 2. Replace cylinder head gasket. 3. Remove the cylinder head, and inspect cylinder head, gasket, and pistons for evidence of coolant. 4. Pressure-test the cylinder head. 5. Inspect the cylinder head. Replace any damaged parts. 6. Remove the oil pan. Pressure–test the cooling system to check for leaks.
15. Coolant In The Engine Oil	1. Cylinder head core and expansion plugs leaking or misassembled. 2. Cylinder head gasket is leaking. 3. Cylinder head is cracked or porous. 4. Cylinder block is cracked or porous.	1. Check cylinder head. Replace any damaged parts. 2. Replace cylinder head gasket. 3. Pressure-test the cylinder head. 4. Remove the oil pan. Pressure–test the cooling system to check for leaks.
16. Coolant temperature is below normal	1. Coolant temperature gauge is malfunctioning. 2. Fan drive or fan controls are malfunctioning. 3. Incorrect thermostat or thermostat is malfunctioning.	1. Test the temperature gauge. Replace the gauge if necessary. 2. Check the fan drive and controls. 3. Check the thermostat for the correct part number and for correct operation.
17. Engine vibration is excessive *continued*	1. Belt-driven accessories are malfunctioning. 2. Engine idle speed is set too low (electronically-controlled fuel systems).	1. Check the fan hub, alternator, and air conditioner compressor for interference. Isolate belt-driven accessories and check for vibration. 2. Verify the correct idle speed setting. Increase the idle speed with the idle increment switch or an electronic service tool.

Problem	Cause	Correction
17. Engine vibration is excessive (Continued)	3. Engine mounts are worn or damaged.	3. Replace engine mounts.
	4. Fan is loose, damaged, or has excessive hub bearing end play.	4. Check the fan. Replace fan if blade is missing or fan is damaged.
	5. Engine is misfiring.	5. Refer to Problem 7. in this troubleshooting chart.
	6. Electronic fault codes are active.	6. Refer to Correction 2. of Problem 2. in this troubleshooting chart.
	7. Vibration damper is damaged.	7. Inspect the vibration damper. Replace if necessary.
18. Engine noise is excessive (Combustion Knocks)	1. Incorrect fuel grade is being used or fuel quality is poor.	1. Use correct grade of fuel.
	2. Air is in the fuel system.	2. Refer to Correction 6. of Problem 2. in this troubleshooting chart.
	3. Coolant temperature is above normal.	3. Refer to Problems 11. and 12. in this troubleshooting chart.
	4. Overhead adjustment are incorrect.	4. Measure and adjust the overhead settings.
19. Engine will not reach rated speed (rpm)	1. Electronic fault codes are active.	1. Refer to Correction 2. of Problem 2. in this troubleshooting chart.
	2. Truck parasitics are excessive.	2. Check the truck brakes for dragging, transmission malfunction, cooling fan operation cycle time, and engine-driven units.
	3. Engine power output is low.	3. Refer to Problem 20. in this troubleshooting chart.
20. Engine power output is low	1. Electronic fault codes are active.	1. Refer to Correction 4. of Problem 2. in this troubleshooting chart.
	2. Engine is operating above recommended altitude.	2. Engine power decreases above recommended altitude. Operate this engine in altitudes under 11,000 feet (3,352.8 meters).
	3. Air intake system is restricted.	3. Check air intake system for restrictions. Replace air filter if required.
	4. Air intake or exhaust leaks.	4. Check the intake and exhaust systems for loose or damaged piping connections and / or missing pipe plugs. Check the turbocharger and exhaust manifold mounting.
continued	5. Charge air cooler is restricted or leaking.	5. Inspect the charge air cooler for air restrictions or leaks.

Problem	Cause	Correction
20. Engine power output is low (Continued)	6. Fuel leak.	6. Check the fuel lines, fuel connections, and fuel filter(s) for leaks. Check the fuel lines to the fuel tank.
	7. Air is in the fuel system.	7. Refer to Correction 9. of Problem 2. in this troubleshooting chart.
	8. Truck parasitics are excessive.	8. Refer to Correction 9. of Problem 22. in this troubleshooting chart.
	9. Oil level is too high.	9. Check the oil level. Verify the oil pan capacity. Drain excess oil if necessary. Fill the system to the specified level.
	10. Low fuel level.	10. Fill fuel tank.
21. Fuel consumption is excessive	1. Operator technique is incorrect.	1. Review operation for correct gear shifts, deceleration, and idling.
	2. Electronic fault codes are active.	2. Refer to Correction 2. of Problem 2. in this troubleshooting chart.
	3. Fuel leak.	3. Check the fuel lines, fuel connections, and fuel filters for leaks.
	4. Air intake or exhaust leaks.	4. Refer to Correction 4. of Problem 20. in this troubleshooting chart.
	5. Air intake system is restricted.	5. Check air intake system for restrictions. Replace air filter if required.
	6. Equipment and environmental factors are affecting fuel consumption.	6. Consider ambient temperatures, wind, and routes when evaluating fuel consumption.
	7. Oil level is too high.	7. Refer to Correction 9. of Problem 20. in this troubleshooting chart.
22. Engine noise is excessive	1. Fan drive belt is loose.	1. Check belt tension and tighten if necessary. Replace drive belt if necessary.
	2. Oil is thin or diluted.	2. Use proper quality engine oil (refer to the **Fuel and Lubricant Specifications** in the **Appendices** for the proper type of oil to be used).
	3. Vibration damper is damaged.	3. Inspect the vibration damper. Replace if necessary.
	4. Combustion noise is excessive	4. Refer to Problem 18. in this troubleshooting chart.
	5. Air filter is restricted.	5. Check air filter for restrictions. Replace air filter if required.
continued	6. Coolant temperature is above normal.	6. Refer to Problems 11. and 12. in this troubleshooting chart.

Problem	Cause	Correction
22. Engine noise is excessive (Continued)	7. Engine mounts are worn or damaged.	7. Replace engine mounts.
	8. Incorrect engine oil level.	8. Check the oil level. Add or drain engine oil.
	9. Air conditioner compressor noise is excessive.	9. Isolate component and check for noise.
	10. Fan is loose, damaged, or unbalanced.	10. Check the fan. Replace fan if blade is missing or fan is damaged.
	11. Hydraulic pump or air conditioning compressor noise is excessive.	11. Isolate each component and check for noise.
	12. Engine oil pressure is below normal.	12. Check the oil pressure. If the pressure is low, refer to Problem 8. in this troubleshooting chart.
	13. Drivetrain noise is excessive.	13. Disconnect the drivetrain. Check for engine noise.
	14. Overhead adjustments are incorrect.	14. Measure and adjust the overhead settings.
	15. Air compressor noise is excessive.	15. Refer to Problem 45. in this troubleshooting chart.
23. Alternator is not charging or insufficiently charging	1. Alternator pulley is loose on shaft.	1. Tighten pulley.
	2. Batteries have malfunctioned.	2. Check the condition of the batteries. Replace batteries if required.
	3. Battery cables or connections are loose, broken or corroded (excessive resistance).	3. Check battery cables and connections.
	4. Alternator is overloaded or alternator capacity is below specification.	4. Install an alternator with a higher capacity.
	5. Alternator or voltage regulator is malfunctioning.	5. Test the alternator output. Replace the alternator or voltage regulator if required.
	6. Electrical system is open (tripped circuit breakers, broken wires, or loose connections).	6. Reset circuit breakers, repair wires, or make good connections.
24. Alternator is overcharging	1. Batteries have failed.	1. Check the condition of the batteries. Replace batteries if required.
	2. Voltage regulator is malfunctioning.	2. Check the voltage regulator. Replace the voltage regulator if required.

Problem	Cause	Correction
25. Excessive white smoke	1. Engine is cold.	1. Allow the engine to warm to operating temperature. If the engine will **not** reach operating temperature, refer to Problem 16. in this troubleshooting chart.
	2. Engine is operating at low ambient temperature.	2. Use under-the-hood intake air in cold weather.
	3. Electronic fault codes are active.	3. Refer to Correction 2. of Problem 2. in this troubleshooting chart.
	4. Starting aid (if equipped) is malfunctioning.	4. Check for correct operation of the cold starting aid.
	5. Incorrect fuel grade is being used or fuel quality is poor.	5. Use the correct grade of fuel.
	6. Air intake or exhaust leaks.	6. Refer to Correction 4. of Problem 20. in this troubleshooting chart.
	7. Air intake system is restricted.	7. Check air intake system for restrictions. Replace air filter if required.
	8. Charge air cooler is restricted or leaking.	8. Inspect the charge air cooler for air restrictions or leaks.
26. Excessive black smoke	1. Electronic fault codes are active.	1. Refer to Correction 2. of Problem 2. in this troubleshooting chart.
	2. Air intake system is restricted.	2. Check air intake system for restrictions. Replace air filter if required.
	3. Air intake or exhaust leaks.	3. Refer to Correction 4. of Problem 20. in this troubleshooting chart.
	4. Charge air cooler is restricted or leaking.	4. Inspect the charge air cooler for air restrictions or leaks.
27. Cranking fuel pressure is low	1. Low fuel level.	1. Fill fuel tank.
	2. Fuel connections on the low-pressure side of the pump are loose.	2. Tighten all fuel fittings and connections between the fuel tanks and the fuel pump.
	3. Fuel suction standpipe in the fuel tank is broken.	3. Check and repair the standpipe if necessary.
28. Engine acceleration or response is poor	1. Operator technique is incorrect.	1. Review operation for correct gear shifts, deceleration, and idling.
	2. Low fuel level.	2. Fill fuel tank.
	3. Truck parasitics are excessive.	3. Refer to Correction 2. of Problem 19. in this troubleshooting chart.
	4. Electronic fault codes are active.	4. Refer to Correction 2. of Problem 2. in this troubleshooting chart.
continued		

Problem	Cause	Correction
28. Engine acceleration or response is poor (Continued)	5. Fuel leak.	5. Check the fuel lines, fuel connections, and fuel filters for leaks.
	6. Intake manifold air temperature is above normal.	6. Refer to Problem 34. in this troubleshooting chart.
	7. Charge air cooler is restricted or leaking.	7. Inspect the charge air cooler for air restrictions or leaks.
	8. Air intake or exhaust leaks.	8. Refer to Correction 4. of Problem 20. in this troubleshooting chart.
	9. Air intake system is restricted.	9. Check air intake system for restrictions. Replace air filter if required.
	10. Incorrect fuel grade is being used or fuel quality is poor.	10. Use the correct grade of fuel.
	11. Fuel supply line restriction between the fuel pump and injectors.	11. Check the fuel supply line from the fuel pump to the cylinder head for sharp bends that can cause restrictions.
29. Engine shuts off unexpectedly or dies during deceleration	1. Low fuel level.	1. Fill fuel tank.
	2. Electronic fault codes are active.	2. Refer to Correction 2. of Problem 2. in this troubleshooting chart.
	3. Idle shutdown feature is activated.	3. Check the time limit on idle shutdown with an electronic service tool.
	4. Moisture is in the wiring harness connectors.	4. Dry the connectors with an electronics cleaner.
	5. Air is in the fuel system.	5. Refer to Correction 6. of Problem 2. in this troubleshooting chart.
30. Engine speed surges under load or in operating range	1. Low fuel level.	1. Fill fuel tank.
	2. Electronic fault codes are active.	2. Refer to Correction 2. of Problem 2. in this troubleshooting chart.
	3. Moisture is in the wiring harness connectors.	3. Dry the connectors with an electronics cleaner.
	4. Air is in the fuel system.	4. Refer to Correction 6. of Problem 2. in this troubleshooting chart.
	5. Truck parasitics are excessive.	5. Refer to Correction 2. of Problem 19. in this troubleshooting chart.
	6. Incorrect fuel grade is being used or fuel quality is poor.	6. Use the correct grade of fuel.
31. Fault code warning lamps stay on (no apparent reason)	1. Diagnostic shorting plug is installed.	1. Remove the diagnostic shorting plug.
	2. Electronic fault codes are active.	2. Refer to Correction 2. of Problem 2. in this troubleshooting chart.

Problem	Cause	Correction
32. Fault code warning lamps do not illuminate	1. Ignition switch is in the OFF position. 2. Battery voltage supply to the electronic control module (ECM) is low, interrupted, or open.	1. Turn the ignition switch to the ON position. 2. Check the battery connections.
33. Fuel is in the oil	1. Engine idle time is excessive. 2. Bulk oil supply is contaminated.	1. Low oil and coolant temperatures can be caused by long idle time (greater than 10 minutes). Shut off the engine rather than idle for long periods. If idle time is necessary, raise the idle speed. 2. Check the bulk oil supply. Drain the oil and replace with non-contaminated oil. Replace oil filter.
34. Intake manifold air temperature is above normal	1. Charge air cooler fins, radiator fins, or air conditioner condenser fins are damaged or obstructed with debris. 2. Fan drive belt is loose or broken. 3. Fan shroud is damaged or missing, or the air recirculation baffles are damaged or missing. 4. Truck speed is too low for adequate cooling with high engine load. 5. Truck cooling system is not adequate. 6. Electronic fault codes are active. 7. Fan drive or fan controls are malfunctioning. 8. Incorrect fan. 9. Exhaust system is leaking hot air into engine compartment.	1. Inspect the charge air cooler, radiator, and air conditioner condenser fins. Clean if necessary. 2. Check the fan drive belt. Tighten drive belt if necessary Replace belt if required. 3. Refer to Correction 4. of Problem 11. in this troubleshooting chart. 4. Reduce the engine load. Increase the engine (fan) rpm by downshifting. 5. Verify that the engine and truck cooling systems are using the correct components. 6. Refer to Correction 2. of Problem 2. in this troubleshooting chart. 7. Check the fan drive and controls. 8. Check the fan part number and compare it to the truck manufacturer's fan part number. 9. Check the exhaust plumbing for leaks or broken components.

Problem	Cause	Correction
35. Intake manifold pressure (boost) is below normal	1. Air intake or exhaust leaks.	1. Refer to Correction 4. of Problem 20. in this troubleshooting chart.
	2. Air intake system is restricted.	2. Check air intake system for restrictions. Replace air filter if required.
	3. Charge air cooler is restricted or leaking.	3. Inspect the charge air cooler for air restrictions or leaks.
	4. Electronic fault codes are active.	4. Refer to Correction 2. of Problem 2. in this troubleshooting chart.
	5. Engine power output is low.	5. Refer to Problem 20. in this troubleshooting chart.
36. Lubricating oil consumption is excessive	1. Crankcase ventilation system is plugged.	1. Check and clean the vent tube.
	2. Oil does not meet specifications.	2. Refer to Correction 2. of Problem 8. in this troubleshooting chart.
	3. Oil drain interval is excessive.	3. Verify the correct oil drain interval.
	4. External oil leak.	4. Refer to Correction 5. of Problem 8. in this troubleshooting chart.
	5. Verify the oil consumption rate.	5. Check the amount of oil added versus the hours of operation.
	6. Oil level is too high.	6. Check the oil level. Verify the oil pan capacity. Drain the excess oil if necessary. Fill the system to the specified level.
	7. Turbocharger oil seal is leaking.	7. Check the turbocharger compressor and turbine seals.
	8. Lubricating oil is contaminated with coolant or fuel.	8. Refer to Problem 10. in this troubleshooting chart.
	9. Air compressor is pumping lubricating oil into the air system.	9. Check the air lines for carbon build-up and lubricating oil.
37. Lubricating oil sludge in the crankcase is excessive	1. Bulk oil supply is contaminated.	1. Refer to Correction 2. of Problem 33. in this troubleshooting chart.
	2. Coolant temperature is below normal.	2. Refer to Problem 16. in this troubleshooting chart.
	3. Crankcase ventilation system is plugged.	3. Check and clean the crankcase breather and vent tube.
	4. Incorrect fuel grade is being used or fuel quality is poor.	4. Use the correct grade of fuel.
	5. Oil does not meet specifications.	5. Refer to Correction 2. of Problem 8. in this troubleshooting chart.

Problem	Cause	Correction
38. Turbocharger leaks engine oil or fuel	1. Engine is being operated for extended periods under light or no load conditions.	1. Operate engine under loaded conditions.
	2. Lubricating oil or fuel is entering the turbocharger.	2. Remove the intake and exhaust piping, and check for oil or fuel.
	3. Turbocharger drain line is restricted.	3. Remove the turbocharger drain line, and check for restriction. Clean or replace the drain line.
	4. Lubricating oil lines leak oil.	4. Check all oil lines and fittings for leaks. Tighten loose fittings and replace leaking oil lines if necessary.
	5. Air intake system is restricted.	5. Check air intake system for restrictions. Replace air filter if required.
	6. Exhaust system is restricted.	6. Check exhaust system for restrictions.
	7. Crankcase ventilation system is plugged.	7. Check and clean the crankcase breather and vent tube.
	8. Turbocharger oil seal is leaking.	8. Check the turbocharger compressor and turbine seals.
	9. White smoke is present.	9. Refer to Problem 25. in this troubleshooting chart.
39. Engine noise is excessive (Connecting Rod)	1. Engine oil level is below normal.	1. Check the oil level. Fill the system to the specified level.
	2. Engine oil pressure is below normal.	2. Check the oil pressure. If the pressure is low, refer to Problem 8. in this troubleshooting chart.
	3. Oil is thin or diluted.	3. Refer to Correction 2. of Problem 22. in this troubleshooting chart.
	4. Block stiffener plate is misassembled.	4. Remove and inspect block stiffener plate. Re-assemble block stiffener plate if required.
	5. Lubricating oil suction or transfer tube misassembled.	5. Remove and inspect the lubricating oil suction or transfer tube. Re-assemble oil suction or transfer tube if required.
	6. Crankshaft journals are damaged or out of round.	6. Inspect the crankshaft journals. If found damaged or out of round, replace journals.
	7. Connecting rod capscrews are loose or not tightened correctly.	7. Check the torque on the connecting rod capscrews. Tighten to the correct torque value if required.
continued	8. Connecting rod is bent or out of alignment.	8. Remove and inspect the connecting rods. Replace or re-align connecting rod.

Problem	Cause	Correction
39. Engine noise is excessive (Connecting Rod) (Continued)	9. Connecting rod and bearings are damaged or worn, are not assembled correctly, or are the wrong bearings.	9. Inspect the connecting rod and bearings. Replace damaged parts or incorrect bearings if required. Re-assemble connecting rod and bearings if necessary.
40. Engine noise is excessive (Main Bearing)	1. Engine oil pressure is below normal. 2. Engine oil level is below normal. 3. Oil is thin or diluted. 4. Main bearing capscrews are loose, worn or not tightened correctly. 5. Main bearings are damaged or worn, or the wrong bearings are installed. 6. Block stiffener plate is misassembled. 7. Crankshaft journals are damaged or out of round. 8. Flywheel or flexplate capscrews are loose or broken.	1. Check the oil pressure. If the pressure is low, refer to Problem 8. in this troubleshooting chart. 2. Check the oil level. Fill the system to the specified level. 3. Refer to Correction 2. of Problem 22. in this troubleshooting chart. 4. Check the torque on the main bearing capscrews. Inspect the capscrews for wear. Tighten capscrews to the correct torque value. Replace worn capscrews. 5. Inspect the main bearings for damage, excessive wear, and the correct part number. Replace main bearings if required. 6. Remove and inspect block stiffener plate. Re-assemble block stiffener plate if required. 7. Refer to Correction 6. of Problem 39. in this troubleshooting chart. 8. Check the flywheel or flexplate and the mounting capscrews. Tighten capscrews to the correct torque value. Replace damaged capscrews.
41. Engine noise is excessive (Piston) *continued*	1. Electronic fault codes active or high counts of inactive fault codes. 2. Incorrect fuel grade is being used or fuel quality is poor. 3. Overhead adjustments are incorrect. 4. Injector is malfunctioning.	1. Read the fault codes with an electronic service tool. Refer to Correction 2. of Problem 2. in this troubleshooting chart. 2. Use the correct grade of fuel. 3. Measure and adjust the overhead settings. 4. Perform the automated cylinder performance test (refer to engine manufacturer's Troubleshooting and Repair Manual). Replace injectors if required.

Problem	Cause	Correction
41. Engine noise is excessive (Piston) (Continued)	5. Connecting rod is bent or out of alignment.	5. Refer to Correction 8. of Problem 39. in this troubleshooting chart.
	6. Connecting rod is misassembled.	6. Remove and inspect the connecting rods. Re-assemble connecting rods if required.
	7. Piston or piston rings are worn or damaged.	7. Check for air intake system leaks. Check the pistons and piston rings for wear or damage. Replace worn or damaged pistons and piston rings.
	8. Piston is misassembled.	8. Remove and inspect the piston. Re-assemble piston.
	9. Piston pin or bushing is loose, worn, or not installed correctly.	9. Remove the pistons and inspect the piston pin and bushing for damage, wear, and correct installation. Re-install piston pin and bushing. Replace piston pin or bushing if required.
42. Engine noise is excessive (Turbocharger)	1. Incorrect turbocharger.	1. Check the turbocharger part number and compare it to the Control Parts List (CPL). Replace turbocharger if required.
	2. Air intake system is restricted.	2. Check air intake system for restrictions. Replace air filter if required.
	3. Air intake or exhaust system leaks.	3. Refer to Correction 4. of Problem 20. in this troubleshooting chart.
	4. Exhaust system is restricted.	4. Check exhaust system for restrictions.
	5. Turbocharger is worn or damaged.	5. Check the turbocharger for damage. Replace turbocharger if required.
43. Air compressor air pressure rises slowly	1. Air intake system restriction to air compressor is excessive.	1. Check the air intake piping. Check engine air intake restriction if the air compressor inlet is plumbed to the vehicle or equipment intake system.
	2. Air system leaks.	2. Block the truck wheels and check the air system for leaks with the parking brake applied and released. Check for leaks from the air compressor gaskets and the air system hoses, fittings, tanks, and valves.
continued		

Problem	Cause	Correction
43. Air compressor air pressure rises slowly (Continued)	3. Carbon buildup is excessive in the air discharge line, downstream air valves, or cylinder head. 4. Air governor is malfunctioning or not set correctly. 5. Air system component is malfunctioning.	3. Check for carbon buildup. Replace the air compressor discharge line, if necessary. 4. Replace air governor if defective or readjust the air governor for the proper pressure (refer to **Air Governor** in **Section 15** for adjustment procedures). 5. Check the operation of check valves, air dryer (if equipped), and other air system components.
44. Air compressor cycles frequently	1. Air system leaks. 2. Air governor is malfunctioning or not set correctly. 3. Carbon buildup is excessive in the air discharge line, downstream air valves, or cylinder head. 4. Air compressor pumping time is excessive. 5. Air system component is malfunctioning. 6. Air dryer outlet check valve is sticking (if equipped with air dryer).	1. Refer to Correction 2. of Problem 43. in this troubleshooting chart. 2. Refer to Correction 4. of Problem 43. in this troubleshooting chart. 3. Refer to Correction 3. of Problem 43. in this troubleshooting chart. 4. Check the air compressor duty cycle. 5. Refer to Correction 5. of Problem 43. in this troubleshooting chart. 6. Lubricate or replace the air dryer outlet check valve assembly.
45. Air compressor noise is excessive	1. Carbon buildup is excessive in the air discharge line, check valve, or cylinder head. 2. Ice buildup in the air system components. 3. Air compressor mounting hardware is loose, worn, or broken.	1. Refer to Correction 3. of Problem 43. in this troubleshooting chart. 2. Check for ice in low spots of the air discharge line, dryer inlet (if equipped), and elbow fittings. On Holset® models, also check the Econ valve (if equipped). 3. Check air compressor mounting hardware. Replace any mounting hardware that is broken.
46. Air compressor is pumping excess lubricating oil into the air system *continued*	1. Lubricating oil drain interval is excessive. 2. Air intake system restriction to air compressor is excessive. 3. Air compressor pumping time is excessive.	1. Verify the correct lubricating oil drain interval. 2. Refer to Correction 1. of Problem 43. in this troubleshooting chart. 3. Check the air compressor duty cycle.

Problem	Cause	Correction
46. Air compressor is pumping excess lubricating oil into the air system (Continued)	4. Carbon buildup is excessive in the air discharge line, check valve, or cylinder head. 5. Contaminants are building up in the system reservoirs. 6. Engine oil pressure is above normal. 7. Air compressor runs hot. 8. Air compressor is pumping too high air pressure.	4. Refer to Correction 3. of Problem 43. in this troubleshooting chart. 5. Drain the reservoirs daily. 6. Check the engine oil pressure. Refer to Problem 9. in this trouble-shooting chart. 7. If the coolant temperature is above normal, refer to Problem 11. in this troubleshooting chart. 8. Check the air governor for correct operation. Reset air governor setting if required.
47. Air compressor will not maintain ade-quate air pressure (not pumping con-tinuously)	1. Air system leaks. 2. Air governor is malfunctioning or not set correctly.	1. Refer to Correction 2. of Problem 43. in this troubleshooting chart. 2. Refer to Correction 4. of Problem 43. in this troubleshooting chart.
48. Air compressor will not not stop pumping	1. Air system leaks. 2. Air governor is malfunctioning or not set correctly. 3. Unloader valve is malfunctioning. 4. Air governor signal line or actuator line is plugged. 5. Air system component is malfunc-tioning.	1. Refer to Correction 2. of Problem 43. in this troubleshooting chart. 2. Refer to Correction 4. of Problem 43. in this troubleshooting chart. 3. Check the unloader valve and unloader body seal. 4. Inspect the signal line and actuator line. 5. Refer to Correction 5. of Problem 43. in this troubleshooting chart.

Cummins QSB6.7 Diesel Engine

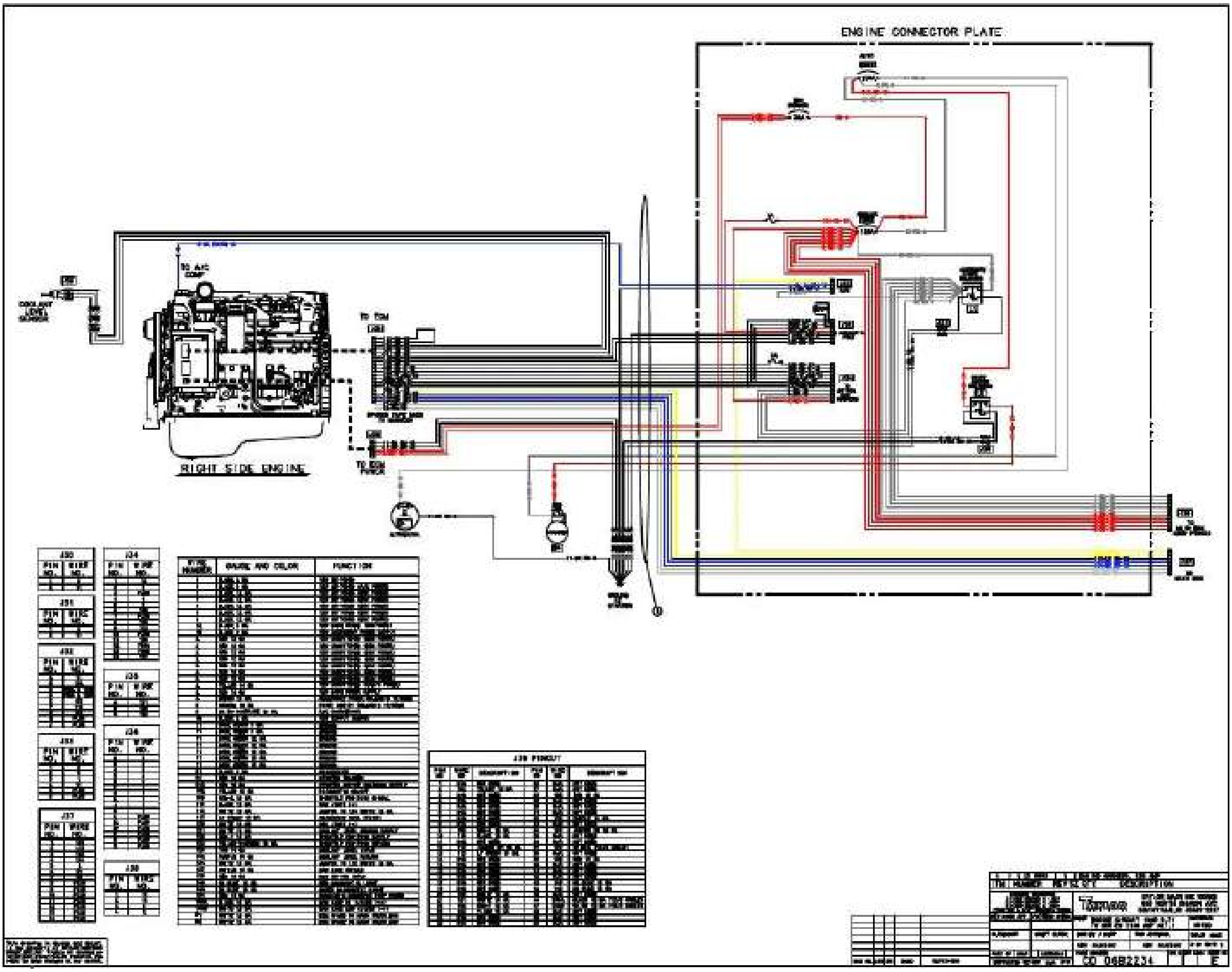
Engine Operating Conditions		2200 rpm	
Lubrication System		**English**	**Metric**
Lubricating oil pressure (at max. rated speed) . . . . psi (kPa)		55.1	380
Minimum for safe operation (at idle) . . . . psi (kPa)		10	69
*Lubrication oil temperature maximum . . . . °F (°C)		280.4	138
Total engine oil capacity with filter . . . . qt (L)		15	14.2
Air System			
Air inlet restriction, full load maximum	Dirty air cleaner . . . . in H_2O (kPa)	25	6.2
	Clean air cleaner . . . . in H_2O (kPa)	15	3.7
Exhaust back pressure maximum full load . . . . in Hg (kPa)		3.01	10.2
Max. allowable temp. rise ambient air to eng. inlet . . . . delta°F (°C)		30.6	17
Fuel System			
Maximum fuel inlet restriction	Dirty fuel filter . . . . in Hg (kPa)	NA	NA
	Clean fuel filter . . . . in Hg (kPa)	6	20
Maximum fuel drain restriction before (or without) check valve . . . in Hg (kPa)		5.9	20
Maximum fuel flow . . . . lb/hr (kg/hr)		452	205
Cooling System			
Coolant flow	Normal temp. . . . . °F (°C)	198	92
	Full load speed . . . . gal/min (L/min)	64	243
Engine coolant capacity . . . . qt (L)		10.6	10
Min. pressure cap . . . . psi (kPa)		15	103
Max. pressure cap . . . . psi (kPa)		40	276
Full ON Fan engine coolant outlet temperature . . . . °F (°C)		195.8	91
Intake manifold air temperature derate/alarm temperature . . . . °F (°C)		205	96
Shutter opening coolant temperature . . . . °F (°C)		195.8	91
Thermostats	Start to open . . . . °F (°C)	190	88
	Fully open . . . . °F (°C)	205	96

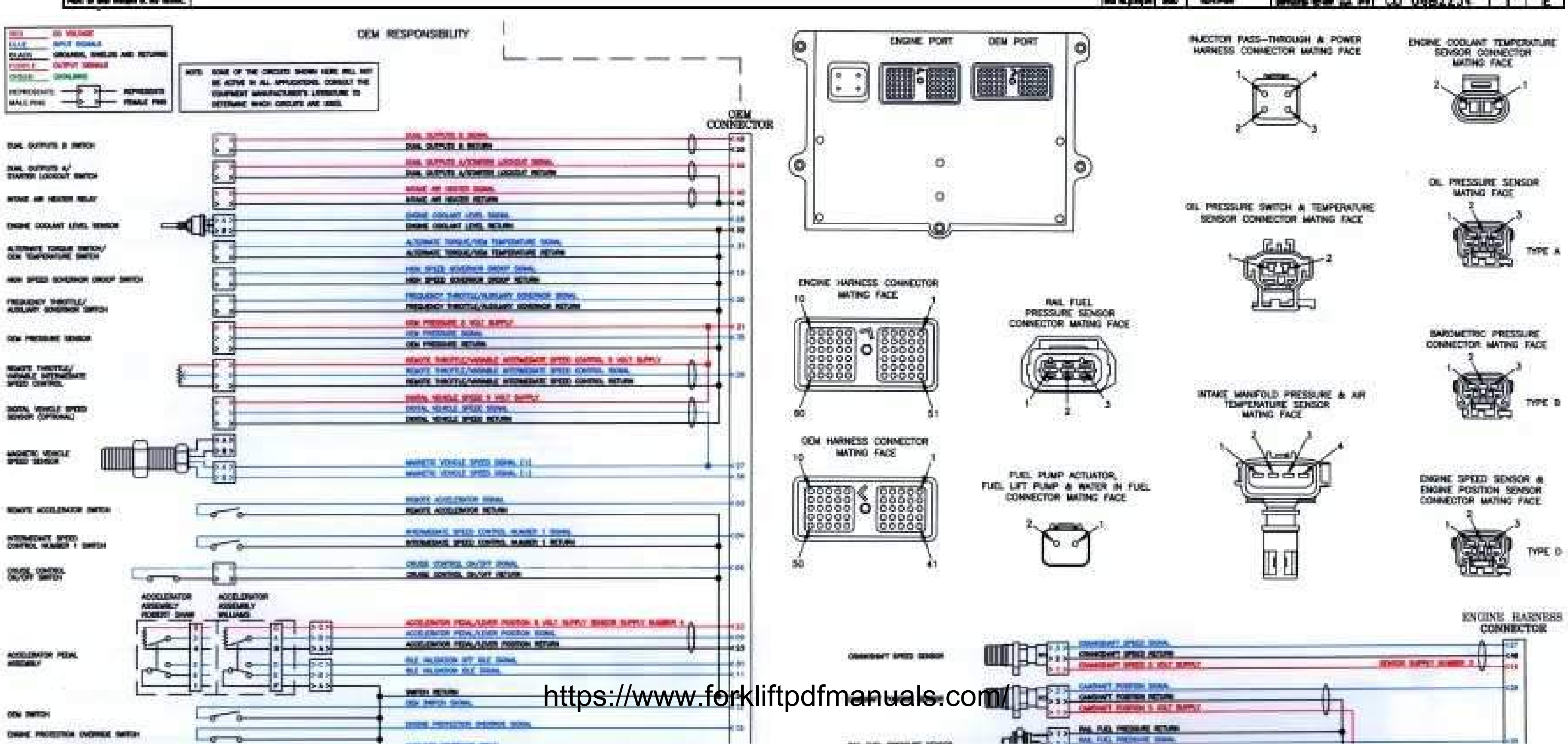
*The lubricating oil temperature range is based on the temperature measurement in the oil gallery. When measuring the oil temperature in the pan, it will normally be approximately 10°F higher than the oil gallery temperature.

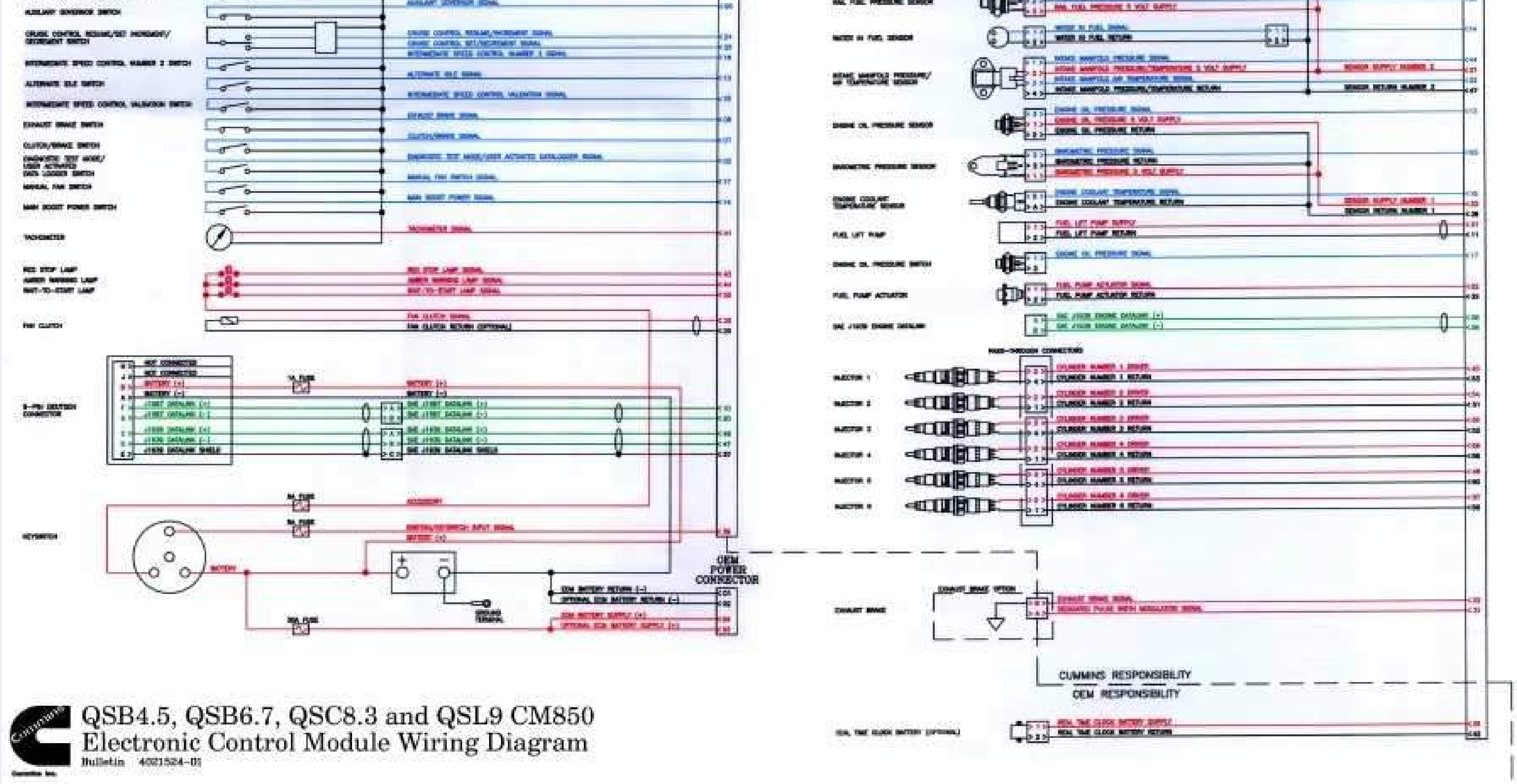
PLACE THE FOLLOWING ILLUSTRATIONS IN FOLDER ENVELOPES:

Illustration 1-6 - 06B-2234 (Engine Electrical ANSI)

Illustration 1-7 - CUMMINS QSB6.7 CM850 ECM CIRCUIT


ENGINE CONNECTOR PLATE
RIGHT SIDE ENGINE
J38 PINOUT
CD 06B2234


OEM RESPONSIBILITY
OEM CONNECTOR
ENGINE PORT
OEM PORT
INJECTOR PASS-THROUGH & POWER HARNESS CONNECTOR MATING FACE
ENGINE COOLANT TEMPERATURE SENSOR CONNECTOR MATING FACE
OIL PRESSURE SENSOR MATING FACE
TYPE A
OIL PRESSURE SWITCH & TEMPERATURE SENSOR CONNECTOR MATING FACE
ENGINE HARNESS CONNECTOR MATING FACE
RAIL FUEL PRESSURE SENSOR CONNECTOR MATING FACE
BAROMETRIC PRESSURE CONNECTOR MATING FACE
TYPE B
INTAKE MANIFOLD PRESSURE & AIR TEMPERATURE SENSOR MATING FACE
OEM HARNESS CONNECTOR MATING FACE
FUEL PUMP ACTUATOR, FUEL LIFT PUMP & WATER IN FUEL CONNECTOR MATING FACE
ENGINE SPEED SENSOR & ENGINE POSITION SENSOR CONNECTOR MATING FACE
TYPE D
ENGINE HARNESS CONNECTOR



QSB4.5, QSB6.7, QSC8.3 and QSL9 CM850
Electronic Control Module Wiring Diagram
Bulletin 4021524-01

Fuel System

Introduction. Fuel is drawn from the fuel tank through a fuel / water separator and fuel filter by the fuel pump. From here, the fuel is sent to the fuel rail and onto the fuel injectors. Unused fuel is returned into the fuel tank.

WARNING: Death or serious injury could result from high pressure fuel spray. The fuel pump, high-pressure fuel lines, and fuel rail contain very high-pressure fuel. Do not loosen any fittings while the engine is running. Wait at least 10 minutes after shutting down the engine before loosening any fittings in the high-pressure fuel system to allow pressure to decrease to a lower level.

Major Components. The fuel system consists of a fuel tank, fuel / water separator, fuel filter, fuel injection pump, fuel rail, fuel injectors and fuel lines.

Adding Fuel (Illustration 2-3)**.** When adding diesel fuel to the fuel tank, make sure the fuel strainer is in the filler neck and free of debris. Adding fuel with the strainer removed could lead to debris entering the fuel tank, resulting in poor engine performance.

Changing The Fuel Filters (Illustrations 2-1 and 2-2)**.** With the engine shut down, perform the following procedures to replace the fuel / water separator and fuel filter. They should be replaced periodically or more often if conditions warrant (refer to the **Preventive Maintenance** chart in the

1. Park the truck on a hard, level surface, apply the parking brake, block the wheels in both directions to prevent movement of the truck and Lock Out & Tag Out the truck.
2. Disconnect the wire harness from the water-in-fuel sensor located on the bottom of the fuel / water separator.
3. Provide a suitable container to catch drained fuel and use the drain valve to drain fuel out of the fuel / water separator for approximately 5 seconds (refer to procedure 2. of **Draining The Fuel** / **Water Separator** in this section). This will eliminate fuel from running over the top of the filter upon removal.
4. Remove the fuel filter and fuel / water separator from the adapters with a strap wrench.
5. Clean the area around the filter heads.

NOTE: *Do not fill the fuel / water separator or fuel filter with fuel before installation as this will allow unfiltered fuel to enter the system and may cause damage to fuel system components.*

6. Install the fuel / water separator and fuel filter. Tighten them 1/2 turn after the seals contact the adapters.
7. Install the water–in–fuel sensor into the fuel / water separator.
8. Prime the fuel system (refer to **Priming The Fuel System** in this section).

(refer to the **Preventive Maintenance** chart in the **Appendices** for fuel / water separator and fuel filter replacement intervals).

WARNING: Death or serious injury could result from a runaway truck. Park the truck on a hard, level surface, apply the parking brake, block the wheels in both directions to prevent movement of the truck and Lock Out & Tag Out the truck.

CAUTION: Dispose of used fuel filters and drained fuel in accordance to federal and local regulations.

CAUTION: Mechanical tightening of the fuel / water separator may result in seal and / or cartridge damage. Tighten the fuel / water separator by hand only.

Draining The Fuel / Water Separator (Illustration 2-1)**.** The fuel / water separator should be drained daily to remove water and sediments from the fuel. Perform the following procedures to drain the water from the fuel / water separator:

WARNING: Death or serious injury could result from a runaway truck. Park the truck on a hard, level surface, apply the parking brake, block the wheels in both directions to prevent movement of the truck and Lock Out & Tag Out the truck.

WARNING: Death or serious injury could result from high pressure fuel spray. Do not open high pressure fuel system other than opening the fuel / water separator drain valve.

CAUTION: Dispose of drained fuel in

accordance to federal and local regulations.

CAUTION: Do not overtighten the drain valve. Overtightening may cause thread damage.

1. Park the truck on a hard, level surface, apply the parking brake, block the wheels in both directions to prevent movement of the truck and Lock Out & Tag Out the truck.
2. Provide a suitable container to catch drained water and open the drain valve (see Illustration 2-1) approximately 2 1/2 complete turns counterclockwise. Drain the fuel / water separator of water until clear fuel is visible.
3. Once the water has drained, turn clockwise to close the drain valve.

Priming The Fuel System (Illustration 2-1)**.** The fuel system has to be primed with fuel after new fuel filters have been installed prior to starting engine. Perform the following procedures to prime the fuel system:

WARNING: Death or serious injury could result from a runaway truck. Park the truck on a hard, level surface, apply the parking brake, block the wheels in both directions to prevent movement of the truck and Lock Out & Tag Out the truck.

4. Push the pump handle in until it seats and turn the handle clockwise to lock it into place (note that pump handle is in locked position in Illustration 2-1).
5. Start engine.

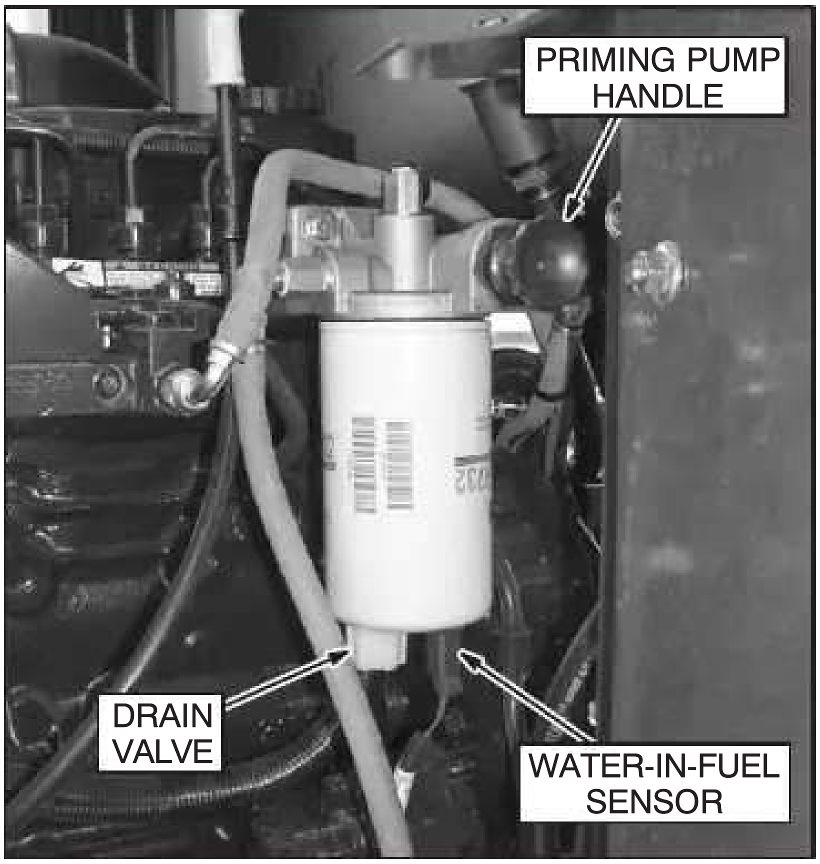


Illustration 2-1. Fuel / Water Separator

WARNING: Death or serious injury could result from high pressure fuel spray. Do not open high pressure fuel system. Only use priming pump handle to prime the fuel system.

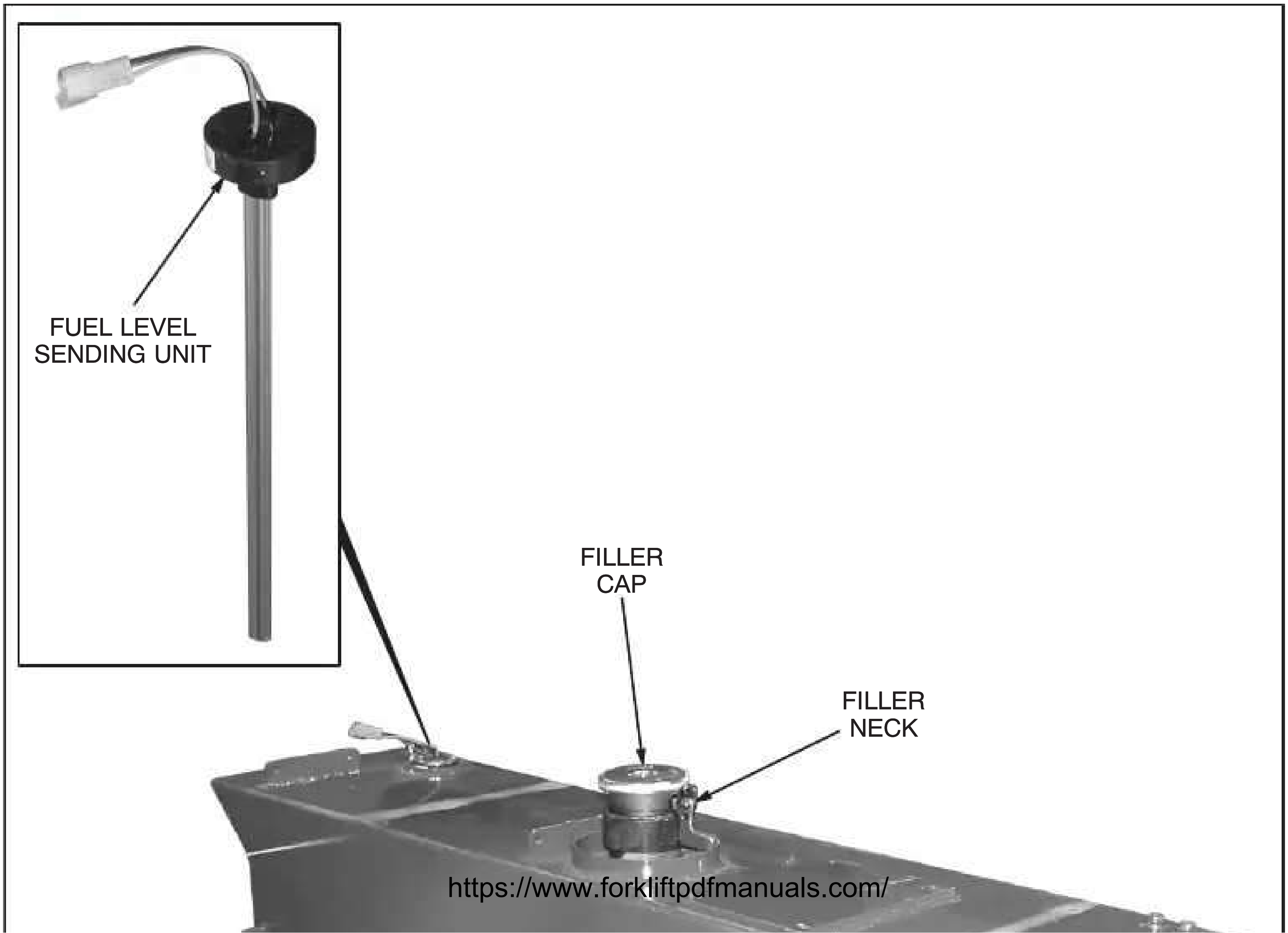
CAUTION: Damage to the engine's fuel system components could result from pre–filling the fuel filters prior to priming the system in an attempt to reduce priming time. Prime fuel system as explained below.

1. Park the truck on a hard, level surface, apply the parking brake and block the wheels in both directions to prevent movement of the truck.
2. Unlock the priming pump handle by turning it counterclockwise.
3. Pump the handle by pulling the handle outward and pushing handle inward until resistance is felt (approximately 140–150 strokes) to prime the fuel system.

Illustration 2-2. Fuel Filter

General Information

Fuel Capacity	TX180S–220S – 42 Gallons (159 Liters) TX250S–360L, TXB180–300 and TXH300–400 – 53 Gallons (201 Liters)


FUEL LEVEL
SENDING UNIT
FILLER
CAP
FILLER
NECK

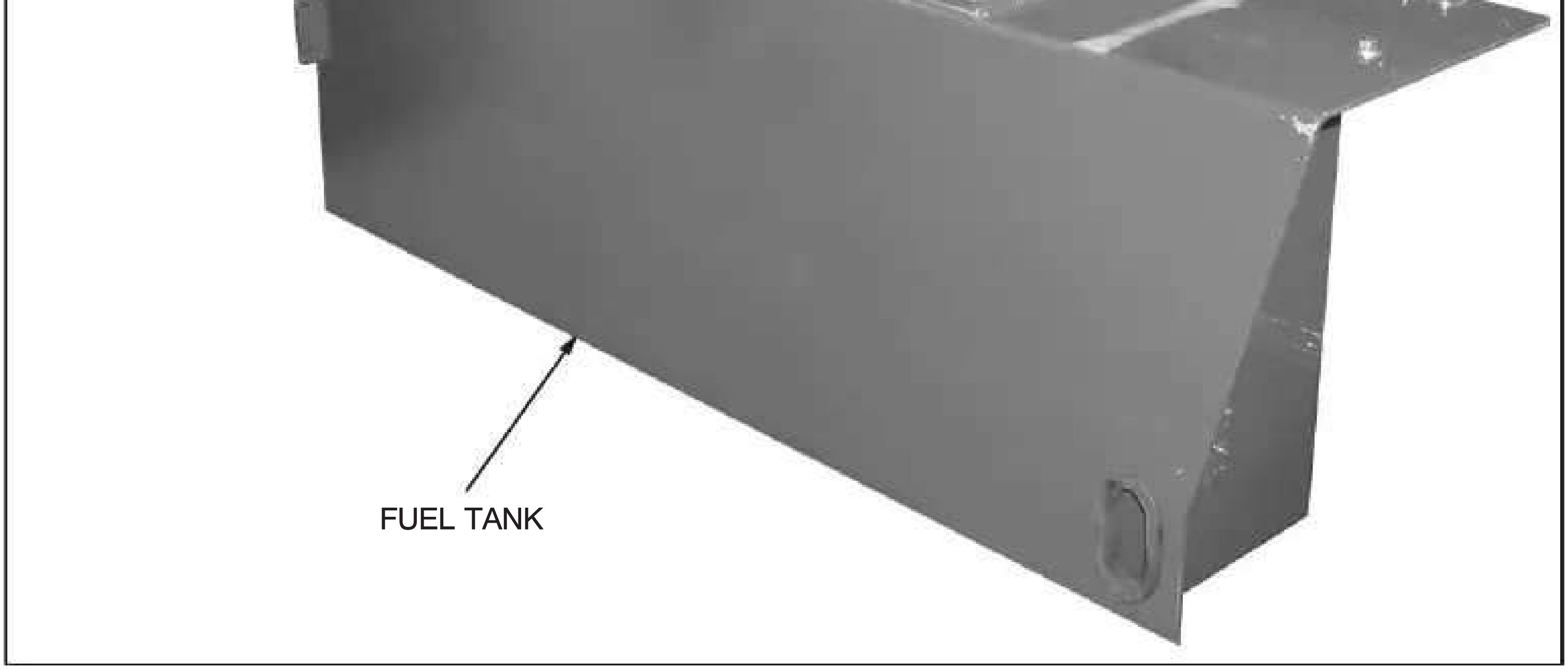


Illustration 2-3. Fuel Tank

Section 3

Air Intake System

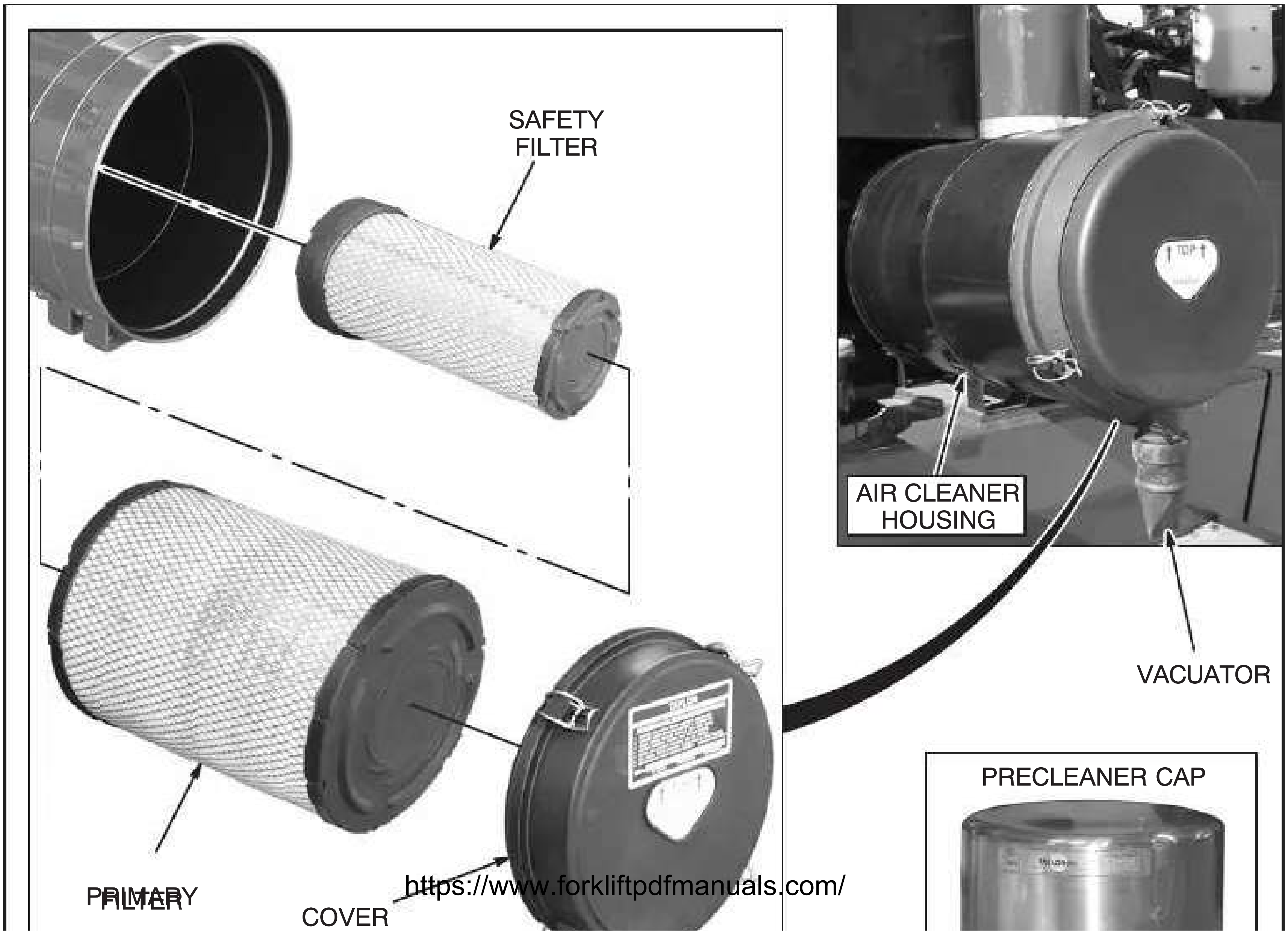


Illustration 3-1. Air Intake System Components

Introduction. The air cleaner is designed to be serviced efficiently and quickly. Intake air enters the air cleaner through the cap or optional pre-cleaner. When the air reaches the inlet of the air cleaner housing, a helical ramp imparts a high-speed circular motion to the intake air. This action separates up to 85% of the dust from the air by centrifugal action. The dust is then forced out the vacuator. The air then passes through the primary and safety filters, where the rest of the dust is removed, before the air enters the engine.

Major Components (Illustration 3-1)**.** The air cleaner consists of the primary filter, internal filter indicator, safety filter, air cleaner housing, cap (or optional precleaner), vacuator and an air restriction indicator.

Servicing (Illustration 3-1). If the equipment is being operated under extremely dusty conditions, the vacuator should be checked every day to be certain it is not clogged. Perform the following procedures to service the filters and air cleaner components. Overservicing of the filters is not recommended. Filter efficiency increases with initial operation.

WARNING: Death or serious injury could result from a runaway truck. Park the truck on a hard, level surface, apply the parking brake, block the wheels in both directions to prevent movement of the truck and Lock Out & Tag Out the truck.

CAUTION: Replace the primary filter periodically or when the air restriction indicator shows red (refer to the Preventive Maintenance chart in the Appendices for primary filter replacement interval). In dusty conditions, the primary filter may have to be replaced more often.

CAUTION: Replace the safety filter periodically (refer to the Preventive Maintenance chart in the Appendices for safety filter replacement interval).

CAUTION: Do Not use ether type fuels to help start the engine for this may damage the engine.

1. Park the truck on a hard, level surface, block the wheels in both directions and apply the parking brake.
2. When the air restriction indicator (see Illustration 3-2) indicates filter servicing (sight glass on indicator is red) is required or the service

nance chart in the **Appendices**).

6. Replace the primary filter with a new filter.
7. Re-install the cover.

NOTES:

- *Ensure that cover gasket is assembled to cover before re-installing the cover onto the air cleaner housing.*
- *Never use the latches on the cover to force the primary filter into the air cleaner housing. Using the latches to push the filter in could cause damage to the air cleaner housing. Do not use the cover to push the primary filter into place.*

8. Push the reset button on the top of the air restriction indicator.
9. Clean and inspect the vacuator.
10. Inspect the air intake system for leaks.

on indicator is red) is required or the service interval has occurred, unlatch and remove the cover. Remove the primary filter. In high humidity situations, the air restriction indicator may indicate a restricted condition due to moisture in the filter. When the filter dries out, restriction levels drop back to normal. The indicator will now have to be reset (refer to procedure 8. to reset the indicator).

3. Remove the safety filter.
4. Remove all dust and debris from the air cleaner housing with a water-dampened cloth.

CAUTION: Do not use flammable liquids to clean the inside of the air cleaner housing. Only use a cloth dampened with water.

5. Re-install the safety filter. Replace safety filter if the safety filter replacement interval has occurred (refer to the **Preventive Mainte-**

Illustration 3-2. Air Restriction Indicator

Air Intake System Troubleshooting

Problem	Cause	Correction
1. Short filter life (primary filter)	1. Improper assembly when prior filter was replaced. 2. Damaged or missing vacuator. 3. Damaged seal on the cover assembly. 4. Damaged air cleaner body. 5. Latch on cover is unclamped. 6. Excessively dusty environment. 7. Incorrect filter used. 8. Seal on dust cover is not sealing.	1. Properly install. 2. Replace vacuator. 3. Replace seal on the cover assembly. 4. Replace air cleaner body. 5. Clamp latch down. 6. Replace filter as needed. 7. Replace with proper filter. 8. Ensure that no foreign object is between seal and metal mating surface.
2. Short filter life (safety filter)	1. Bypassing primary filter. a. Seal of primary filter is not sealing. b. Damaged primary filter.	1. a. Replace filter. b. Replace primary filter.
3. Airborne contaminants entering the engine	1. Damaged filter(s). 2. Damaged seals or sealing surfaces.	1. Replace filter(s). 2. Replace damaged components.

	3. Damaged or loose connections between air cleaner body and engine.	3. Replace or repair connections.
	4. Incorrect filter used.	4. Replace with proper filter.
4. Air restriction indicator indicates primary filter is good, but primary filter is clogged	1. Restriction in air hose between the air restriction indicator and the safety fitting.	1. Remove restriction.
	2. Air leak in air hose between the air restriction indicator and the safety fitting.	2. Repair or replace air hose.
	3. Damaged air restriction indicator.	3. Replace air restriction indicator.
	4. Damaged safety fitting.	4. Replace safety fitting.
	5. Loose system connections.	5. Tighten connections.

Exhaust System

Introduction. The exhaust system is responsible for venting exhaust gases, generated by the engine, to the atmosphere. It also provides noise suppression.

WARNING: Do not service exhaust system until exhaust system is cool. Failure to do so may result in severe burns.

WARNING: Keep all flammable materials away from exhaust components.

WARNING: Avoid breathing toxic exhaust fumes.

WARNING: All internal combustion engines produce carbon monoxide, which can become concentrated in enclosed areas. Exposure to carbon monoxide can result in serious injuries or health hazards, including death. Properly ventilate work areas, vent exhaust fumes, and keep shop clean and dry.

(A) Initial symptoms of carbon monoxide poisoning include headaches, dizziness, and nausea. The smell of lift truck exhaust means carbon monoxide is present.

(B) If you experience initial symptoms, shut off the lift truck engine, notify your

6. Keep exhaust system free of debris.

Exhaust Purifier (if equipped)**.** The exhaust purifier converts up to 90% of the harmful diesel exhaust gases, such as carbon monoxide and hydrocarbons, into harmless carbon dioxide and water vapor by forcing the exhaust gases to pass through a porous ceramic honeycomb configured catalyst. This design promotes uniform gas flow through the catalyst element while generating only minimal back pressure.

CAUTION: Avoid using fuel and oil additives which contain lead, sodium, arsenic, phosphorus, mercury, antimony, zinc, copper, tin, iron, nickel, and chrome. These additives will poison the exhaust purifier and reduce its useful life.

Exhaust Purifier Maintenance (Illustration 4-1)**.** If the diesel engine is allowed to idle for long periods of time, the exhaust purifier may accumulate deposits of soot. These deposits can block the effectiveness of the exhaust purifier and gradually reduce the engine's power. The exhaust purifier can be removed and cleaned using the procedures listed below.

1. Remove the clamps to remove the exhaust purifier from the exhaust system.
2. Remove clamps to remove the end cones to expose the catalyst.
3. Wash the exhaust purifier by using steam or

employer, and obtain medical attention.

WARNING: Never rely on a control device to reduce carbon monoxide output. Carbon monoxide levels can change depending on maintenance. Make sure carbon monoxide level testing is included in regular maintenance procedures and that ventilation is used as the primary control for emissions.

Maintenance. There is minimal maintenance required on the standard exhaust system.

1. Check for leaks at all pipe connections.
2. Check for holes in the muffler and exhaust piping.
3. Keep muffler guard clean and in place.
4. Keep guard clean and in place.
5. Keep handle clean and in place.

3. Wash the exhaust purifier by using steam or high pressure water [not greater than 100 psi (7 bar)], keeping the tip of the nozzle at least 2 inches away from the face of the catalyst. Do not use detergents. Wash the exhaust purifier through both the inlet and outlet ends. Continue the washing operation until the water, coming from the exhaust purifier, is clear or almost clear.
4. Dry the exhaust purifier with compressed air (no greater than 100 psi), keeping the nozzle at least 2 inches (5.1 centimeters) away. The purpose of this operation is to remove as much water from the exhaust purifier as possible. The exhaust purifier should now be clean.
5. Place the exhaust purifier back into the exhaust system and operate the engine. Be sure to tighten all clamps and fittings as necessary.

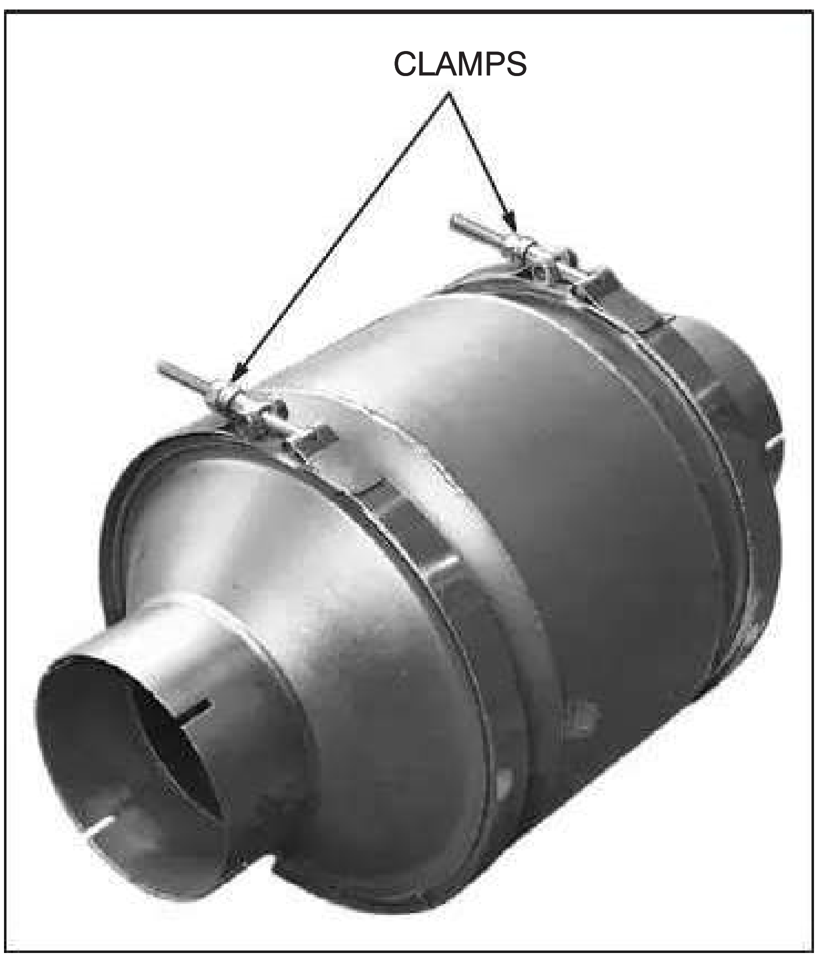


Illustration 4-1. Exhaust Purifier

Cooling System

Introduction. The engine cooling system cools the engine. Refer to **Section 9A** for transmission cooling system and **Section 15C** for the wet disc brakes cooling system to find more detailed cooling information on these particular systems.

Major Components (Illustrations 5-3 and 5-4)**.** The engine cooling system consists of coolant, radiator / charge air cooler, recovery bottle, hoses connecting the radiator to the engine and a water pump to circulate the coolant.

Operation (Illustration 5-4)**.** When the engine is started, the water pump draws coolant from the radiator into the engine block. The coolant is circulated through the engine and the coolant filter until it reaches a temperature of approximately 190° F (88° C), at which point the thermostat will start to open. This will allow coolant flow back into the top of the radiator core.

Coolant. The cooling system of this equipment is protected to -34°F (-36°C) and 228°F (110°C). The solution is a 50 - 50 mixture of ethylene glycol base antifreeze to water solution. Use soft water in the coolant mixture. It is recommended that 50% solution be maintained year round.

Radiator (Illustration 5-3)**.** The radiator is force-air-cooled. Access to its core is provided through a 16 psi (110 kPa) radiator cap located on top of the radiator. When changing the coolant, refer to **Draining / Flushing The Cooling System** and **Filling The Cooling System**.

Illustration 5-1. Coolant Level

Servicing The Cooling System

WARNING: Severe injury may occur from burns. Radiator and cap can be hot. Heated coolant can spray. Always shut down engine and allow to cool before attempting to open

Charge Air Cooler (Illustration 5-3). The engine is equipped with a turbocharger which is driven by engine exhaust. The exhaust turbine of the turbocharger is coupled to the intake turbine. The exhaust turbine drives the intake turbine. The intake turbine compresses the intake air. The act of compressing the intake air generates heat and causes the air molecules to expand. To increase combustion efficiency, a charge air cooler is integrated into the radiator. The charge air cooler is an air to air cooler. By reducing the temperature of the intake air before it enters the piston chamber, the air becomes denser. The denser the air, the more oxygen will be present in the piston chamber during combustion. The more oxygen in the chamber, the hotter the combustion cycle becomes. This results in a more complete burning of the fuel, emitting fewer pollutants. This increase in combustion efficiency also creates lower engine operating temperatures, which prolongs the life of the engine and its' components.

the radiator cap or drain cock.

WARNING: Severe injury may occur from contact with moving engine parts. Always shut down engine before servicing or inspecting cooling system.

WARNING: Severe injury or death may occur from ingesting engine coolant. Coolant is toxic. Keep away from children and pets. Dispose of coolant in accordance with federal and local regulations.

Checking The Coolant Level (Illustration 5-1). The coolant level should be checked daily. Normally, the coolant level can be maintained by adding coolant to the recovery bottle. The coolant level is full when the coolant is visible at the cold mark (engine has not been operated). If the coolant level is too low, add coolant until the coolant

level reaches the cold mark on the side of the recovery bottle. Do not overfill.

Cooling Requirements. The following requirements must be followed for trouble-free operation of the cooling system.

1. Always use a properly corrosion inhibited coolant.
2. Maintain prescribed inhibitor strength.
3. Use low silicate antifreeze with an ethylene glycol base.
4. Always follow the manufacturer's recommendations on inhibitor usage and handling. Refer to the engine operation and maintenance manual for coolant requirements.
5. Do Not use soluble oil!
6. Sealer type antifreeze should Not be used.

Draining / Flushing The Cooling System. The cooling system should be drained and flushed periodically (refer to the **Preventive Maintenance** chart in the **Appendices** for cooling system drain / flush interval). The cooling system is drained by opening the drain cock on the bottom of the radiator. Removal of the radiator cap will allow air to enter the cooling passages, decreasing drain time and ensuring that the coolant drains completely from the system. Leave the drain cock open until all coolant has been allowed to drain from the system.

fully open when the coolant temperature reaches approximately 205° F (96° C).

General Information

Coolant Capacity	8 Gallons (30.3 Liters)

Inspection. Components of the cooling system should be checked periodically to keep the engine operating at peak efficiency. The radiator and charge air cooler should be inspected externally for excessive dirt or oil buildup. The radiator and charge air cooler should be cleaned externally as conditions warrant. The cooling system hoses should be inspected and any hose that is abnormally hard or soft should be replaced immediately. Check the hose clamps to make sure they are tight. All external leaks should be corrected as soon as detected. The shroud should be tight against the radiator core to prevent recirculation of air which may lower cooling efficiency. Check the fan belts for proper tension.

Charge Air Cooler Cleaning. The charge air cooler must be cleaned internally upon engine turbocharger failure or any other occasion where oil or debris enters the charge air cooler. Refer to the engine manufacturers manual for cleaning instructions.

Drive Belt Tension. The proper tension should be maintained on all drive belts. Refer to **Drive**

Belt Tension in **Section 1** for the proper tension values.

CAUTION: When freezing weather is expected, any cooling system not adequately protected by antifreeze should be drained.

Filling The Cooling System. Before starting the engine, close the drain cock and fill the cooling system by removing the 16 psi (110 kPa) cap located on top of the radiator. Fill the radiator at this port. This will allow a quicker, more efficient method of filling the radiator. If the capacity of the cooling system is unknown, measure the amount of water necessary to fill the cooling system. Drain the cooling system and refill with the desired amounts of water and antifreeze or pre-mix to proper proportions before filling.

Coolant Temperature. When the engine warms up, the indicator for the coolant temperature gauge should be in the green temperature area [180 - 212°F (82 - 100°C)]. The thermostat will start to open at approximately 190°F (88°C) and

Fan Ring Positioning (Illustration 5-2)**.** Perform the following procedures to correctly position the engine fan ring:

WARNING: Death or serious injury could result from a runaway truck. Park the truck on a hard, level surface, apply the parking brake, block the wheels in both directions to prevent movement of the truck and Lock Out & Tag Out the truck.

1. Park the truck on hard, level surface, apply the parking brake, block the wheels in both directions to prevent movement, Lock Out & Tag Out the truck, and allow the engine to cool.
2. Position the engine fan ring to attain equal clearances [approximately 1/4 inch (6.4 mm)] between all fan blades and engine fan ring

(refer to the left photo in Illustration 5-2).

3. Position the engine fan ring vertically to attain equal clearances ("A", refer to Illustration 5-2).

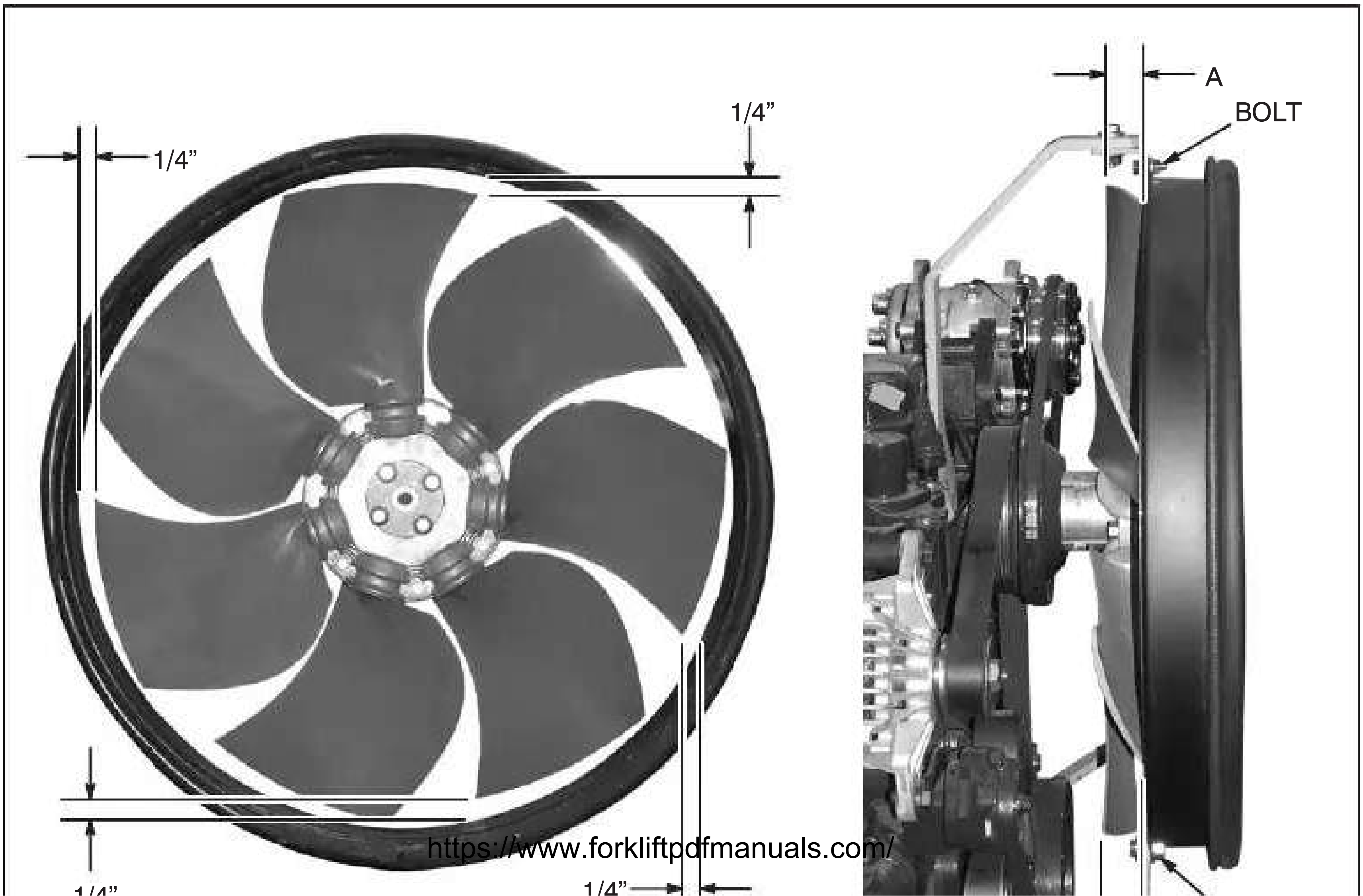
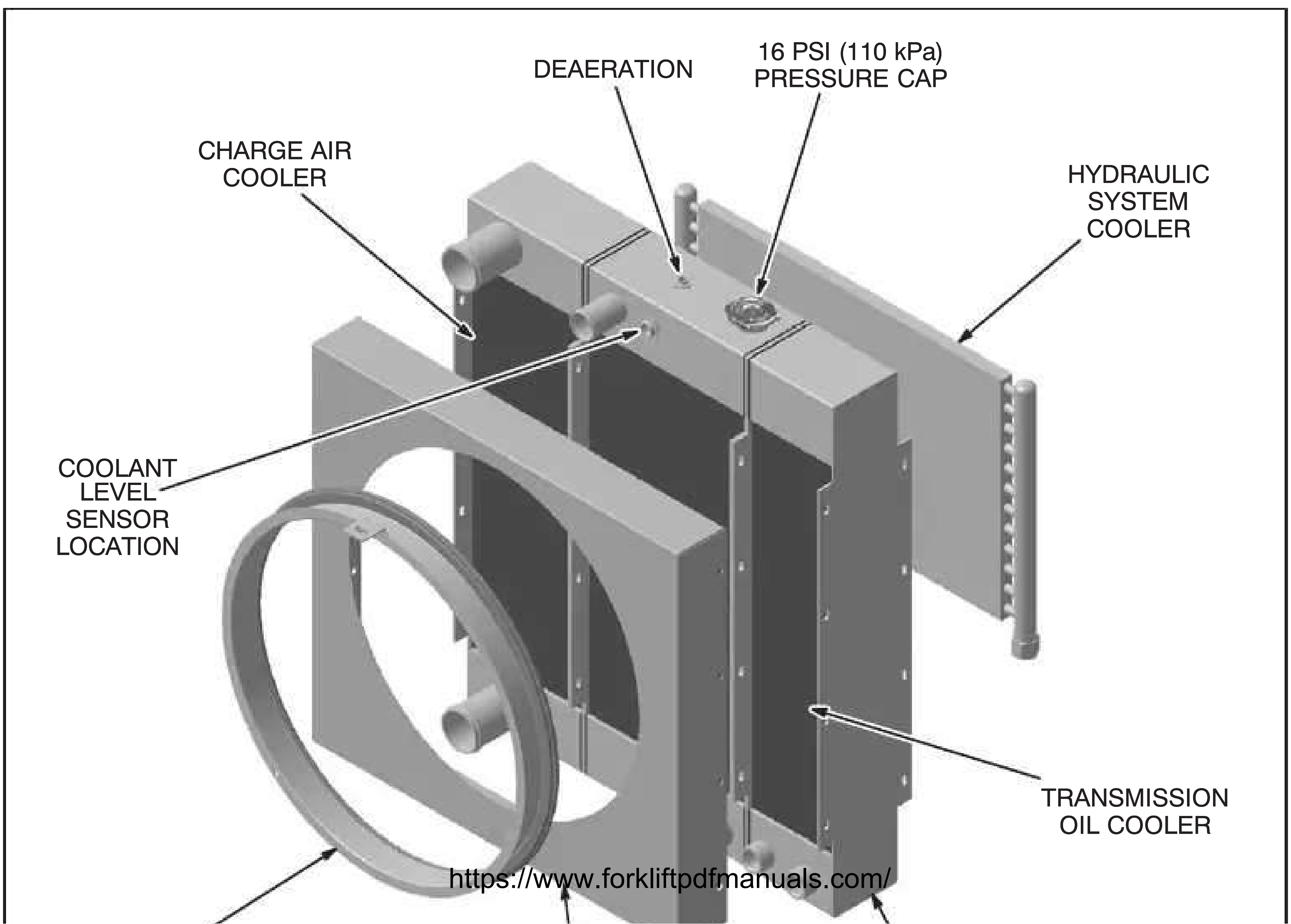


Illustration 5-2. Fan Ring Positioning



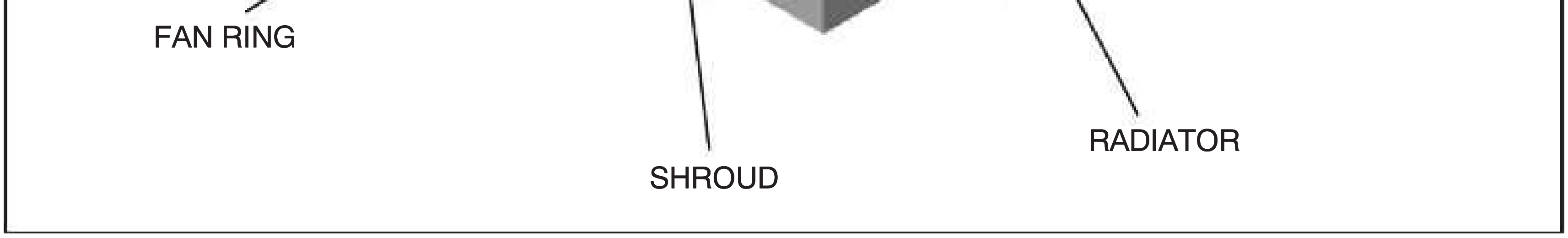
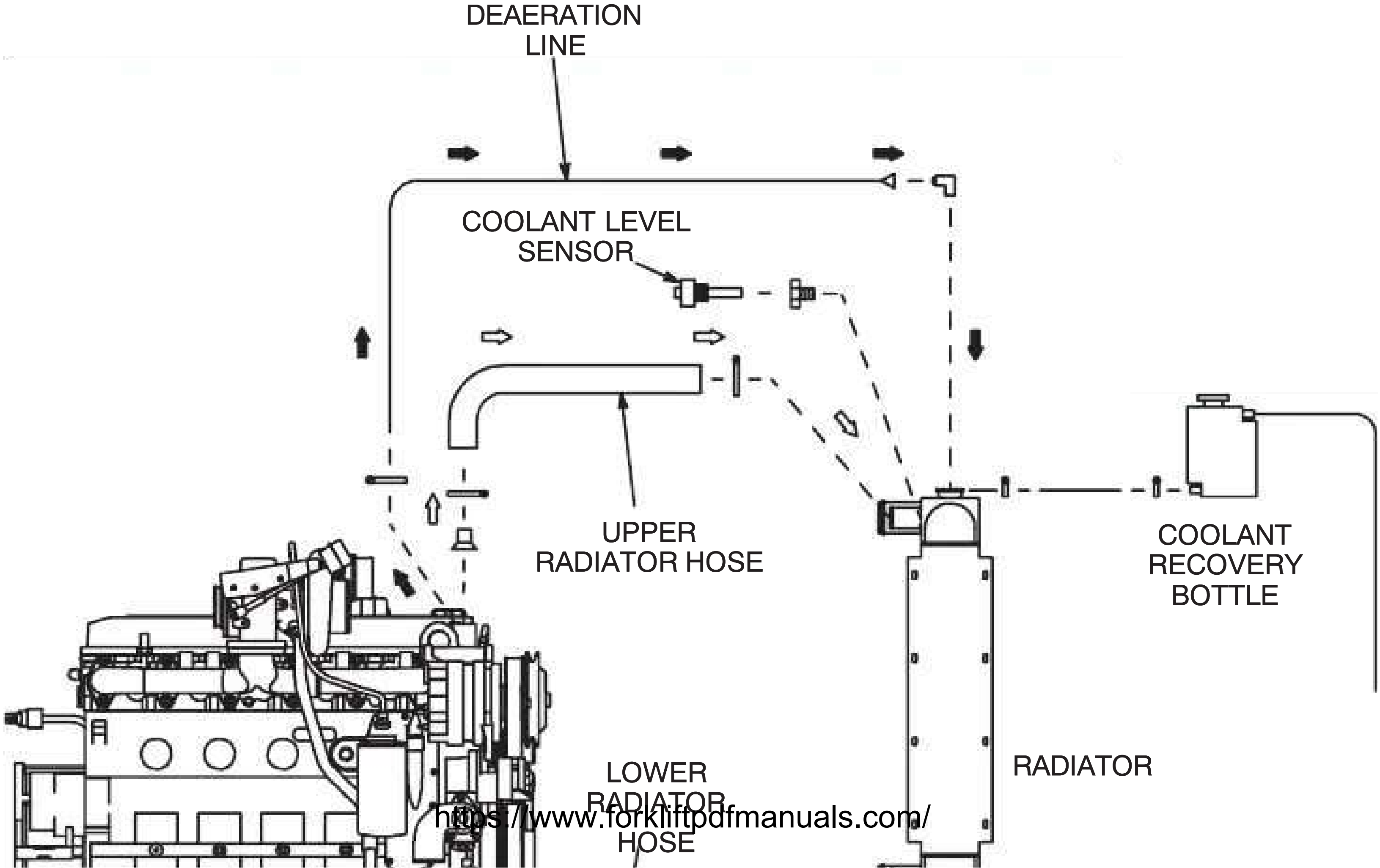
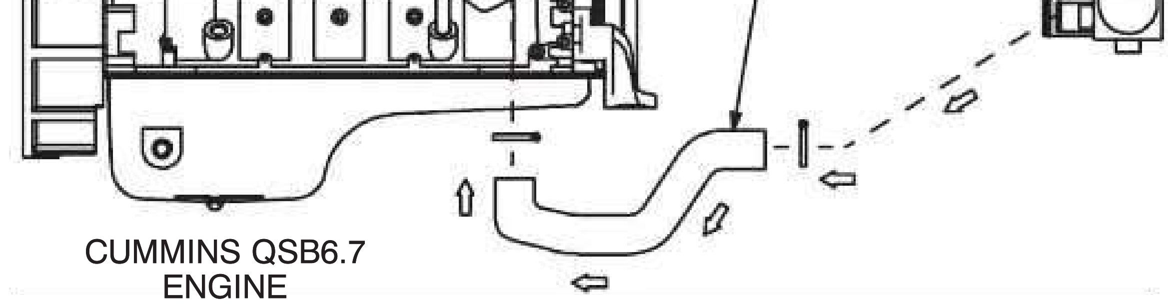


Illustration 5-3. Cooling Components Identification

Illustration 5-4. Engine Coolant Circuit





COOLANT FLOW

⇨ MAIN FLOW, THERMOSTAT OPEN

➡ DEAERATION REMOVES UNWANTED AIR FROM COOLING CIRCUIT

05-2374

Section 6

Electrical System

Introduction. This machine incorporates a 12-Volt DC electrical system. Optional equipment selected by the customer will determine the electrical equipment to be installed in addition to the standard electrical system.

Major Components. The 12 volt electrical system consists of a battery, battery charging alternator, voltage regulator, starter switch, starter, and starter solenoid. The remainder of the electrical system consists of lights and / or gauges, switches, circuit breakers, and accessory circuits. The above items are included as standard equipment in the electrical system. Refer to Illustrations 6-1 through 6-12 for location of components and wiring diagrams.

Electrical Maintenance. All wiring harnesses, battery cables and electrical connections should be inspected for chaffing or wear periodically. This is especially important where there is relative movement between the components. Clamps, boots, and protective sleeves should be maintained to prevent electrical shorts.

WARNING: Death or serious injury may occur from fire. Improper maintenance of the electrical system can result in electrical shorts which may cause fires. Regularly inspect and maintain electrical harnesses, cables, and electrical components as outlined in this manual. Ensure that harnesses are properly routed and clamped after servicing the vehicle.

CAUTION: Overfilling cells of the battery can cause poor performance or early failure.

1. Check the level of the electrolyte regularly. Add distilled water if necessary to bring the electrolyte level to 3/8 inch (9.5 mm) above the separator plates. Do not overfill.
2. Keep the top of the battery, terminals, and cable clamps clean. When necessary, wash them with a solution of baking soda and water, and rinse with clean water.

CAUTION: Do not allow the soda and water solution to enter the battery cells.

3. Inspect the cables, clamps, and hold down bracket regularly. Replace any damaged parts. Clean and re-apply a light coating of grease to the terminals and cable clamps when necessary.

NOTE: *A number of devices and applications are available on the commercial market to deter corrosion on battery terminal connections.*

4. Check the electrical system if the battery becomes discharged repeatedly.
5. If the battery indicator illuminates, the alternator or alternator circuit is defective.

routed and clamped after servicing the vehicle.

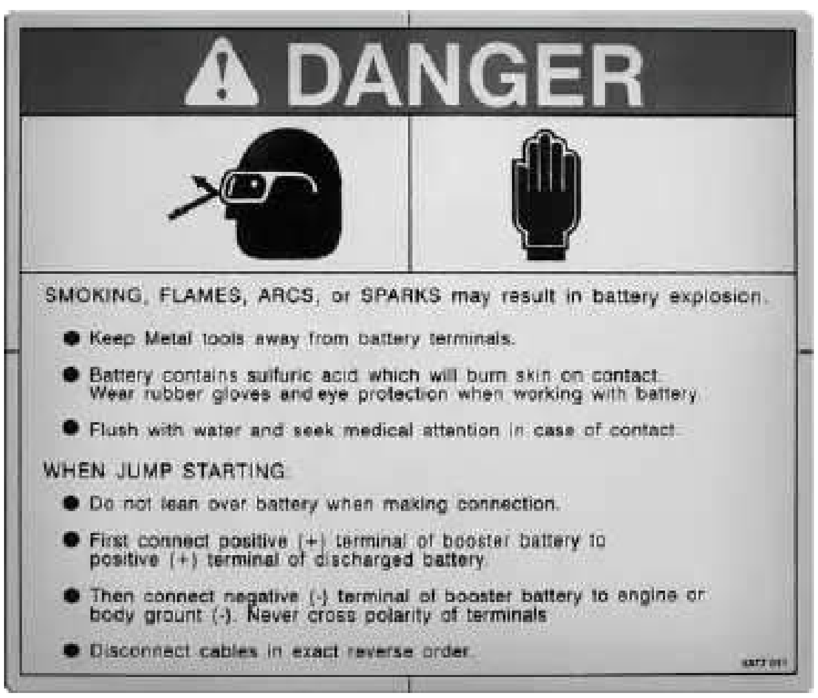
Battery. The machine is equipped with an industrial type, long life battery. The battery is perishable and requires servicing on a regular basis. Batteries that are properly cared for can be expected to give long trouble-free service. Perform the following procedures to maintain the battery in a serviceable condition:

WARNINGS:

- **Under no circumstances allow any sparks or open flames around battery. No smoking. Batteries produce a highly flammable gas which could lead to battery explosion if ignited.**
- **Never check the battery by placing a metal object across the battery posts.**

NOTE: *If the truck is to be inoperative or idle for more than 30 days, remove the battery. The battery should be stored in a cool, dry place. The electrolyte level should be checked regularly and the battery kept fully charged.*

Booster Battery Connection Procedure. Accidentally reversing the battery connections must be avoided. If a booster battery is to be used, first connect the positive (+) terminal of booster battery to the positive (+) terminal of discharged battery and then connect the negative (-) terminal of booster battery to engine or body ground (-) (Refer to the decal below). Never cross polarity of the battery terminals. Disconnect cables in the exact reverse order from above.



when engine is started. Once engine is accelerated, the light should go out.

Alternator. The standard alternator for the Cummins QSB6.7 engine is a 130 amp alternator. It should be expected to give long, trouble-free service; however, the diodes and transistors in the alternator circuit are very sensitive and can be easily destroyed. The following precautions should be observed when working on or around the alternator.

Avoid grounding the output wires or the field wires between the alternator and the regulator. Never run an alternator on an open circuit.

Grounding an alternator's output wires or terminals, which are always hot regardless of whether or not the engine is running or accidentally reversing of the battery polarity, will destroy the diodes. Grounding the field circuit will also result in the destruction of the diodes. Some voltage regulators provide protection against some of these circumstances; however, it is recommended that extreme caution be used.

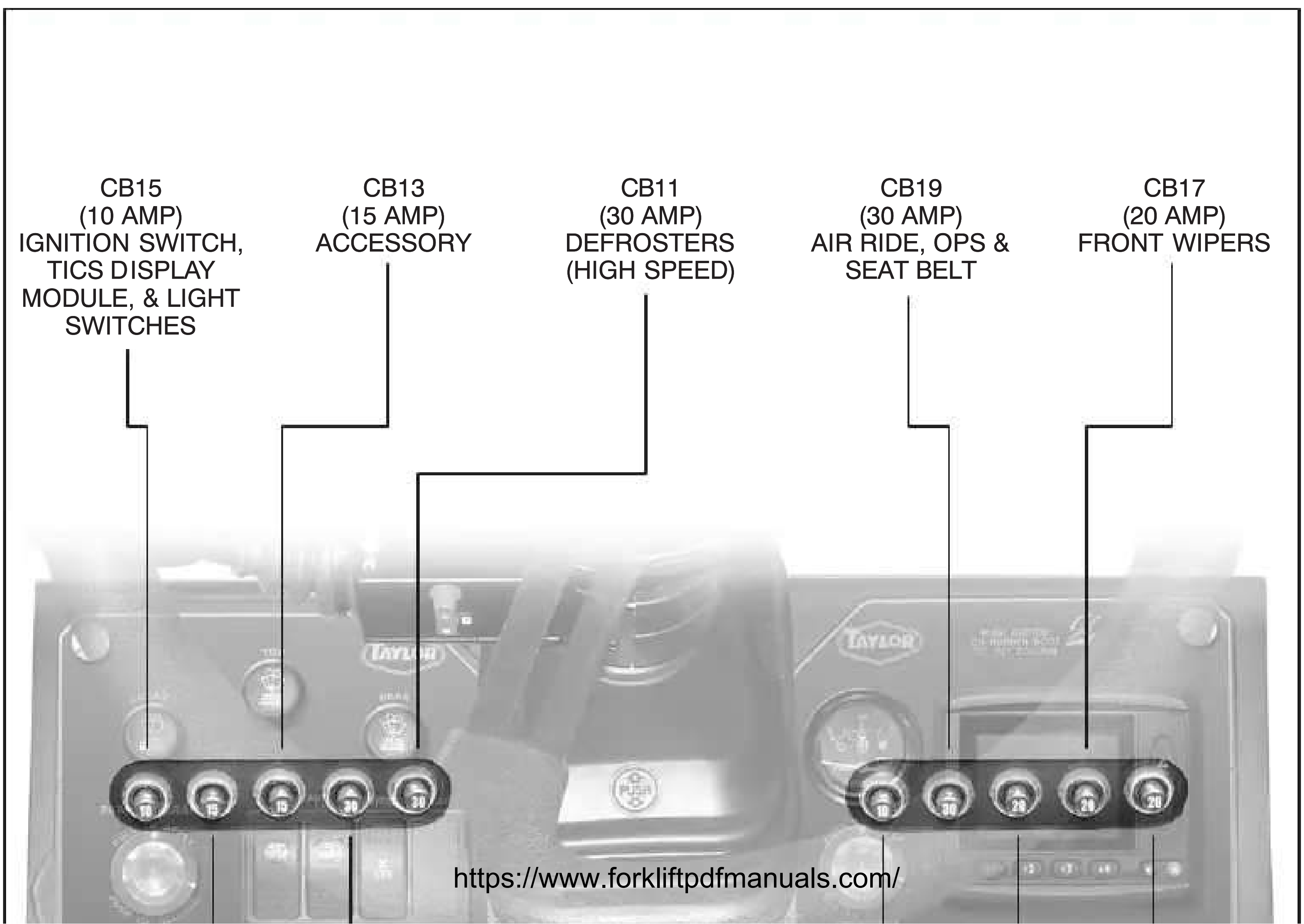
Never disconnect the battery while the alternator is in operation. Disconnecting the battery will result in damage to the diodes, caused by the momentary high voltage and current induced by the instantaneous collapse of the magnetic field

surrounding the field windings.

CAUTION: Accidentally reversing the battery polarity will destroy the diodes of the alternator circuit.

NOTE: *It is normal for alternator light to stay on*

Illustration 6-1. Dash Panel



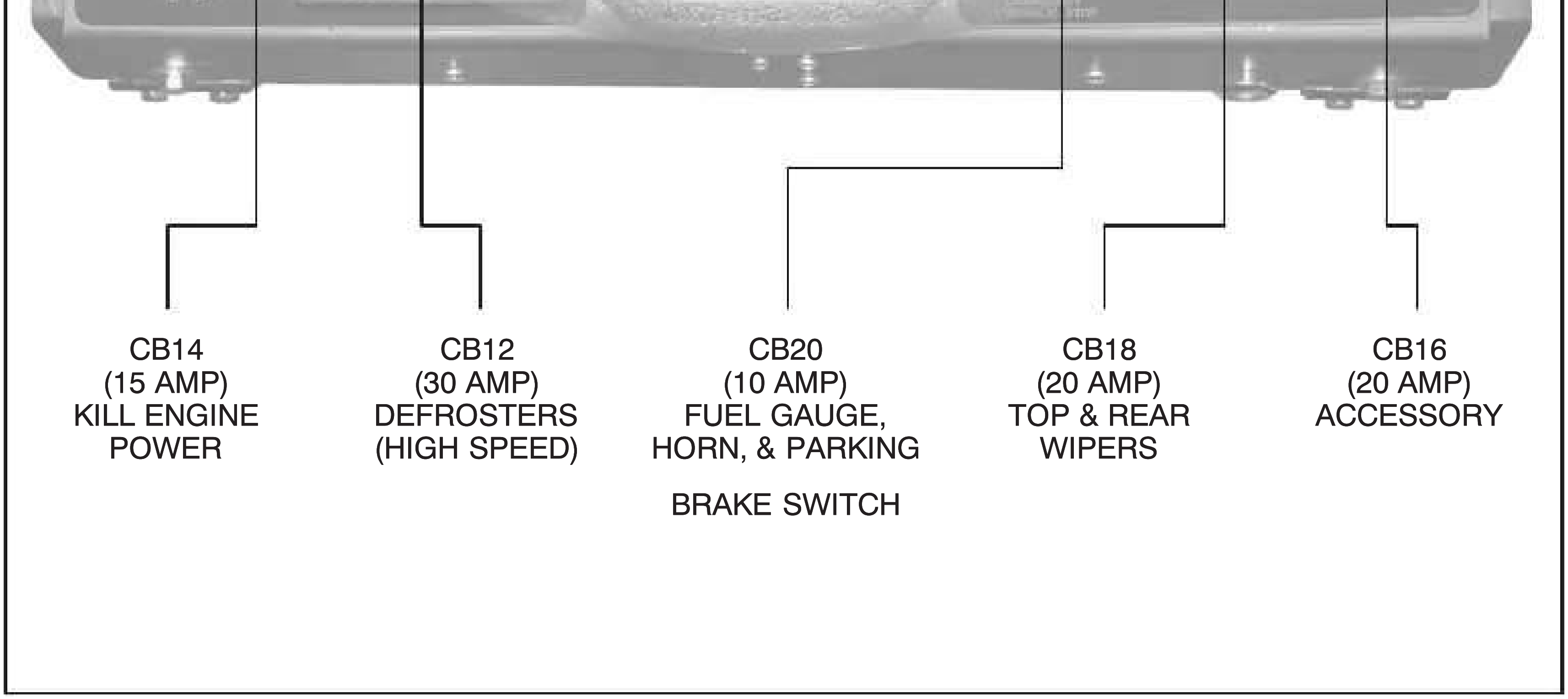


Illustration 6-2. Dash Circuit Breakers

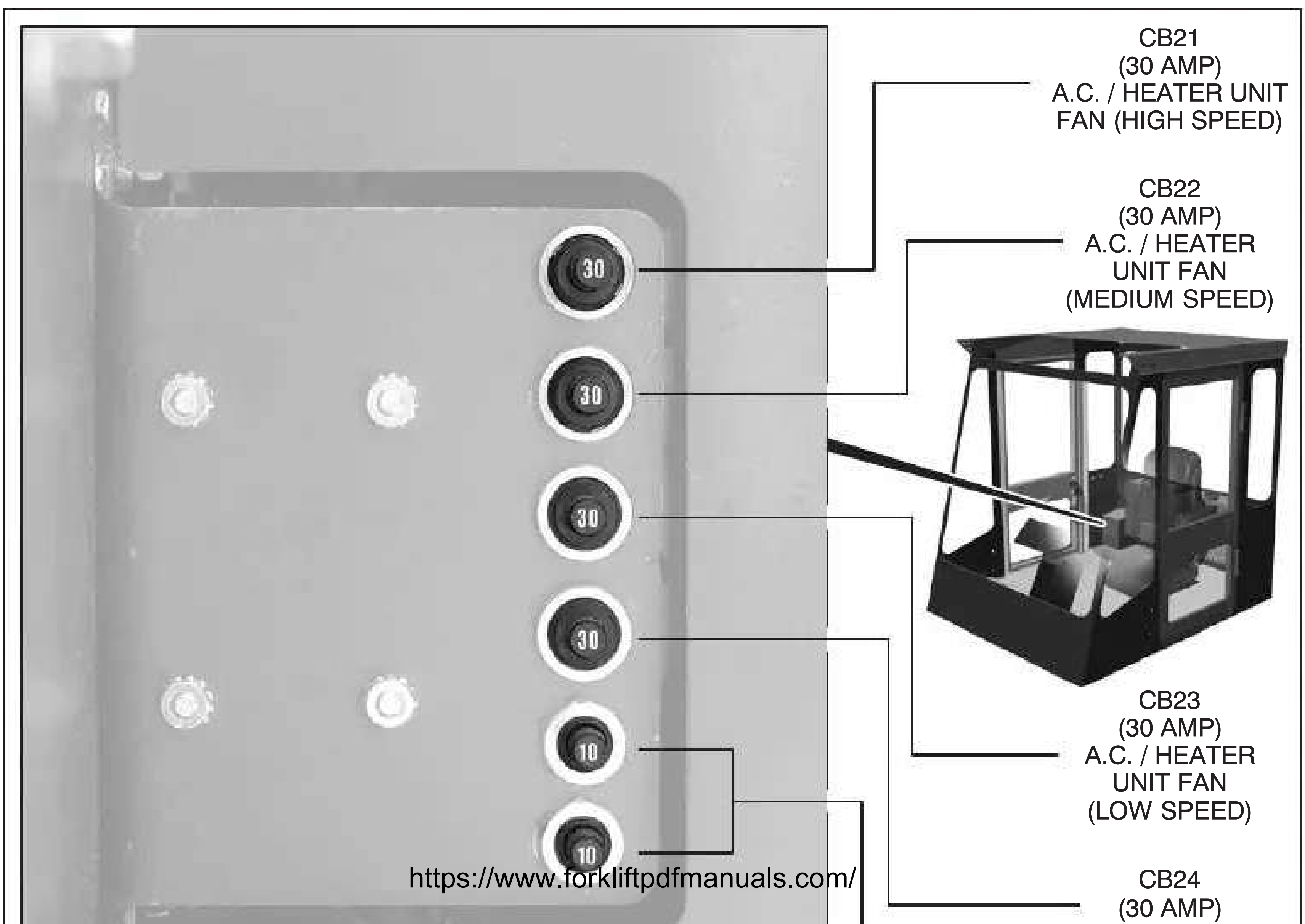


Illustration 6-3. Control Stand Circuit Breakers

Component Troubleshooting

Alternator. The alternator provides 13.8 - 14.4 VDC at 130 amps of power for the electrical system and trickle charges the battery when the engine is being operated.

The most effective way to troubleshoot an alternator is with an ammeter on the output of the alternator. Another good check is with a voltmeter across the battery. With the engine operating at a moderate speed, the voltmeter reading should never exceed 15.5 VDC. If reading exceeds 15.5 VDC, the alternator is defective and requires replacing. Should the alternator output drop below 12 VDC, the alternator is defective and requires replacing.

Perform the following procedures below for abnormal charging system operation.

1. Insure that the undercharged condition (below 12 VDC) has not been caused by accessories having been left on for extended periods of time.
2. Check the drive belt for proper tension (refer to

Drive Belt Tension in **Section 1**).

3. Ensure that battery is good and capable of holding a charge.
4. Inspect the wiring for defects. Check all connections for tightness and cleanliness, including the slip connectors at the alternator and connections at the battery.
5. With the ignition switch on and all wiring harness leads connected, connect a voltmeter from:
   a. alternator "BAT" terminal to ground
   b. alternator #1 terminal to ground
   c. alternator #2 terminal to ground

   An infinity reading indicates an open circuit between the voltmeter connection and battery. Repair if required.
6. With all accessories turned off, connect a voltmeter across the battery. Operate engine at moderate speed. If voltage is 15.5 VDC or higher, replace the alternator.

Circuit Breakers. Circuit breakers are employed in the electrical system and act similar to fuses, protecting the electrical circuits and valuable components from overloads which could damage them. Perform the following troubleshooting procedures to troubleshoot a circuit breaker.

1. Turn the ignition key to the "Ignition" position

it trips. If the circuit breaker cannot maintain a set state, perform the following troubleshooting procedures to troubleshoot the automatic circuit breaker.

1. Turn the ignition key to the Off position.
2. Remove all wires from the output side (load side) of the circuit breaker.
3. Turn the ignition key to the "Ignition" position. If the circuit breaker retrips, the circuit breaker is defective and must be replaced.
4. If the circuit breaker maintains a set state, one of the output circuits is shorted. Reconnect the wires one by one to the output side (load side) until the circuit breaker trips. Troubleshoot the circuit of the wire, that tripped the circuit breaker, for a short.
5. Isolate and remove the short from the circuit.

Single-Pole, Single-Throw 30 amp Relays (Illustration 6-4). A relay is nothing more than an electrically controlled switch. Relays are always shown on electrical circuits in a de-energized state. The internal switch, common at pin 30, toggles between pins 87A (when de-energized) and 87 (when energized). Pins 86 and 85 control the coil of the relay.

The most effective way to troubleshoot the relay is with an ohmmeter. This can be accomplished by removing the female spade connectors from pins

1. Turn the ignition key to the "ignition" position.
2. If the circuit breaker is tripped, reset the circuit breaker.
3. If the circuit breaker immediately retrips, remove all wires from the output side (load side) of the circuit breaker.
4. Reset the circuit breaker. If the circuit breaker retrips, the circuit breaker is defective and must be replaced.
5. If the circuit breaker maintains a set state, one of the output circuits is shorted. Reconnect the wires one by one to the output side (load side) until the circuit breaker trips. Trouble-shoot the circuit or the wire, that tripped the circuit breaker, for a short.
6. Isolate and remove the short from the circuit.

Automatic 90 amp Circuit Breaker. The automatic 90 amp circuit breaker is located on the right side of engine. It will automatically reset itself if

30, 87, and 87A. In a de-energized state, ensure that pins 30 and 87A have continuity between them. With an ohmmeter, check the resistance between pins 30 and 87a. The ohmmeter should indicate a reading of 0 - 40 ohms. Energize the relay and check the resistance between pins 30 and 87. The ohmmeter should indicate a reading of 0 - 40 ohms. If these two checks are good, the relay is good.

Single-Pole, Single-Throw, Maintain Contact Switches. A switch is designed with the purpose of controlling an electrical circuit by completing or opening the circuit. With an ohmmeter, check the resistance between the contact points of the switch. With the switch closed (completing the circuit), the ohmmeter reading should indicate 0 - 40 ohms. With the switch open (opening the circuit), the ohmmeter reading should be infinity. If the above checks are good, the switch is good. If any of the above checks fail, the switch is bad and must be replaced.

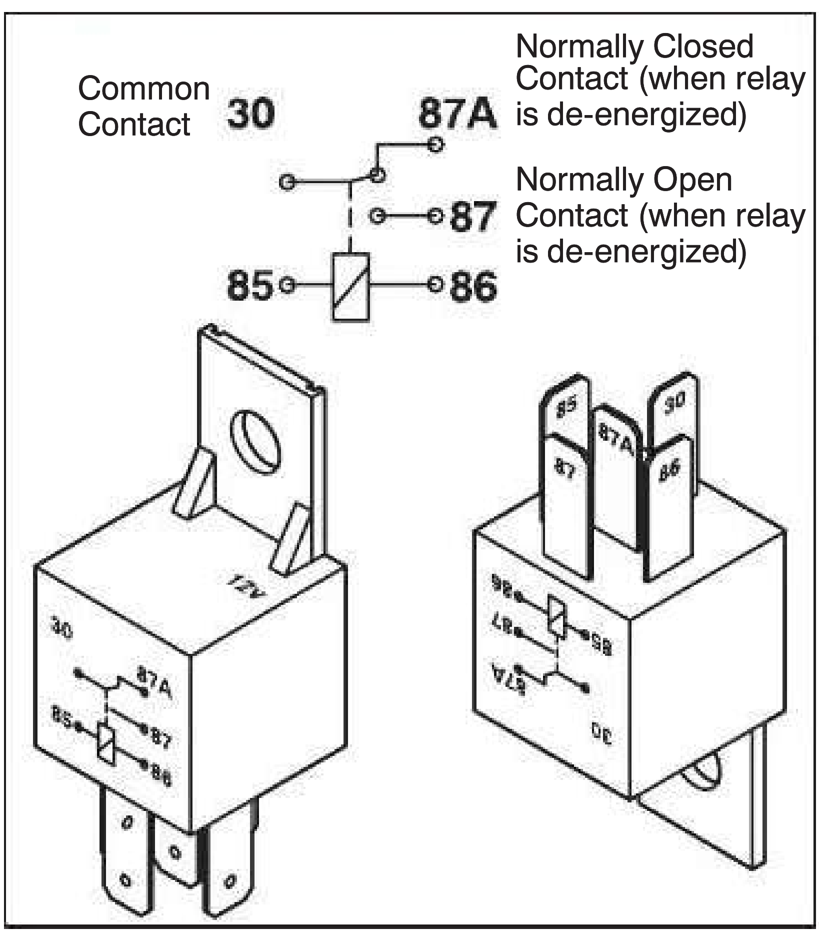


Illustration 6-4. SP, ST 30 amp Relay

Single-Pole, Double-Throw, Momentary Rocker Switches. This type of switch operates on the principle that the circuit is closed only when the switch is held in the closed state. Once the switch is released, the circuit will open. This switch is

simplest way to prove the solenoid coil good is to energize the solenoid and then, with a metal object, touch the nut that secures the coil to the cartridge. The magnetic field generated when the coil becomes an electromagnet will be significant enough to pull the metal object to the nut (some solenoids employ a metal nut encased in plastic and will require removal in order to detect the magnetic field). This will prove the coil good; however, the armature may be stuck. If the hydraulic circuit is still defective at this point, remove the coil and cartridge. Now energize the coil, the armature inside the cartridge should shift. If the armature inside the cartridge did not shift and the coil is magnetized, replace the cartridge.

Exercise care not to reverse polarity because some solenoids employ internal diodes which can be destroyed when the polarity is reversed. The solenoids employed on the transmission control valve contain diodes. The black wire of the coil connects to the ground side of the circuit while the red wire goes to the positive side of the circuit.

Diodes (Illustration 6-5). Diodes are one-way conductors that provide isolation. Current flow through a diode is from anode to cathode. They are easily proven good by using an ohmmeter. When using the ohmmeter, place the leads of the ohmmeter on the opposite ends of the diode. Observe the ohmmeter reading. Then reverse the ohmmeter leads on the ends of the diode. Observe the ohmmeter reading. The ohmmeter checked like an On-Off switch with the exception that the switch must be held closed to complete resistance checks.

Solenoids. A solenoid is an electrical component. When electricity is applied to the coil, the solenoid will form an electromagnet. The magnetic field will pull or push an armature into the coil (based on application). The armature can be connected to a switch in electrical circuits to turn the switch on or off. An armature can also be used to open or close valves.

Solenoids employed as electrical switches can be troubleshot with an ohmmeter. Remove the two wires from the two larger posts of the solenoid. Energize the solenoid. With an ohmmeter, check the resistance between the two larger posts. The ohmmeter should indicate between 0 - 40 ohms nominally.

Solenoids employed as hydraulic switches are used to open and close spools of valves. The

readings should indicate a higher ohm resistance in one direction opposed to the other direction because the current generated by the ohmmeter is sufficient enough to forward-bias the diode.

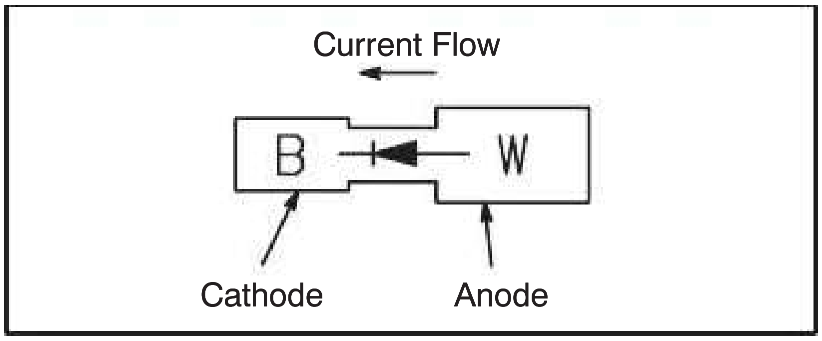


Illustration 6-5. Diode

Refer to Illustrations 6-6 and 1-6 for component reference

Component	Problem	Correction
1. Battery	1. Low voltage.	1. a. Low electrolyte level. Check electrolyte level in battery, fill with distilled water as required, and recharge battery. b. Alternator output is bad. Refer to the Alternator troubleshooting section below. c. Loose, broken, or corroded wires. Repair or replace wires. d. Ensure that low voltage condition has not been caused by accessories having been left on for extended periods of time.
2. Alternator	1. Low output voltage (voltage is below 12 VDC).	1. a. Ensure drive belts are tight. b. Inspect the wiring for defects. Check all connections for tightness and cleanliness, including the slip connectors at the

		alternator and connections at the battery. c. Defective alternator. Replace alternator.
	2. High output voltage (voltage exceeds 15.5 VDC).	2. Defective alternator. Replace alternator.
3. Battery Disconnect Switch *(if equipped)*	1. When key switch is in the ON position, contact points of switch do not close. 2. When key switch is in the OFF position, contact points of switch do not open.	1. Remove wires from the switch, turn the switch on. With an ohm-meter, check the resistance across the contact points. The ohmmeter reading should indicate 0 - 40 Ohms. 2. Remove wires from the switch, turn the switch off. With an ohm-meter, check the resistance across contact points. The ohmmeter reading should indicate infinity.

Component	Problem	Correction
4. Ignition Switch	1. Ignition switch (S1, Illustration 6-6) does not close (accessory position).	1. On the back of the ignition switch (S1, Illustration 6-6), at the B terminal, you should see 12 VDC straight from the battery, provided that the truck is not equipped with a battery disconnect switch. If equipped with a battery disconnect switch, ensure that it is turned on. Turn the key to the ignition position, at the I terminal, you should see 12 VDC, if not, remove the wires from the I terminal and recheck voltage. If 12 VDC is now present, you have a short. If 12 VDC is not present and 12 VDC was present at the B terminal, replace the ignition switch (S1). To isolate short, reconnect the wires to the I terminal one at a time checking voltage with each connection. When the voltage drops, the wire, that was just connected, is shorted. Isolate and remove short.
	2. Ignition switch (S1, Illustration 6-6) does not close (start position).	2. The truck is equipped with an anti-restart ignition switch (S1). Should the truck fail to start on the first attempt, the key must be

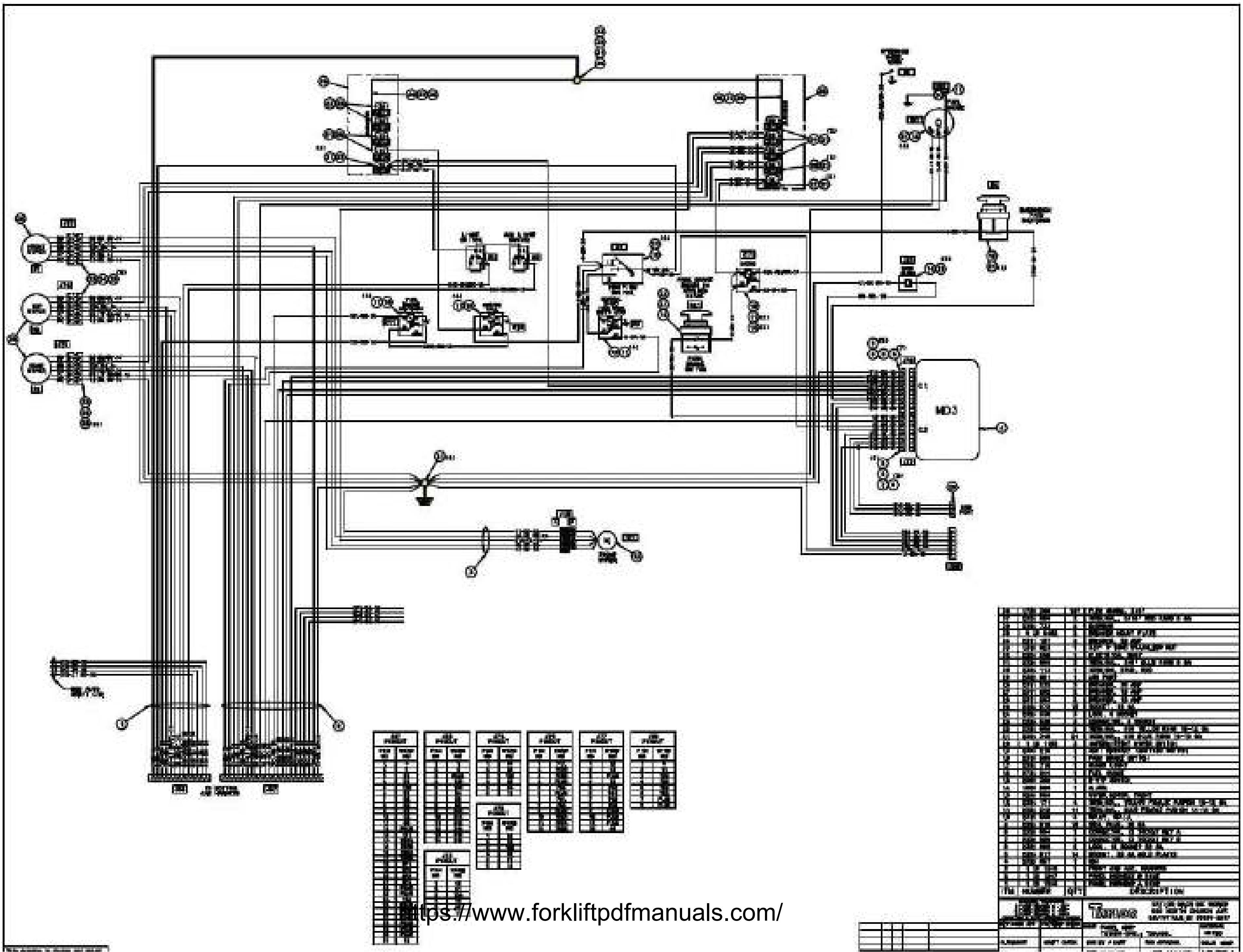
		turned fully off to reset the ignition switch, allowing the B (Battery) and S (Start) contacts to close. This is a momentary position that should only make contact when the key is fully turned. On the back of the ignition switch (S1, Illustration 6-6), at the B terminal, you should see 12 VDC straight from the battery. Turn the key to the start position. On the back of the ignition switch (S1), at the S terminal, you should see 12 VDC, if not, remove the wire from the S terminal. Turn the ignition switch (S1) to the start position and recheck for 12 VDC at the S terminal. If the 12 VDC is now present, the wire, just removed, is shorted. Isolate and remove the short. If 12 VDC is not present and 12 *(continued)*

Component	Problem	Correction
4. Ignition Switch (Continued)		(Continued) VDC was present at the B terminal, replace the ignition switch (S1).
5. Wires	1. Wire has lost continuity.	1. Isolate the wire from the circuit (Ohm out the wire). Ohms will vary according to the length of the wire. Expect to see low Ohms if wire is good.

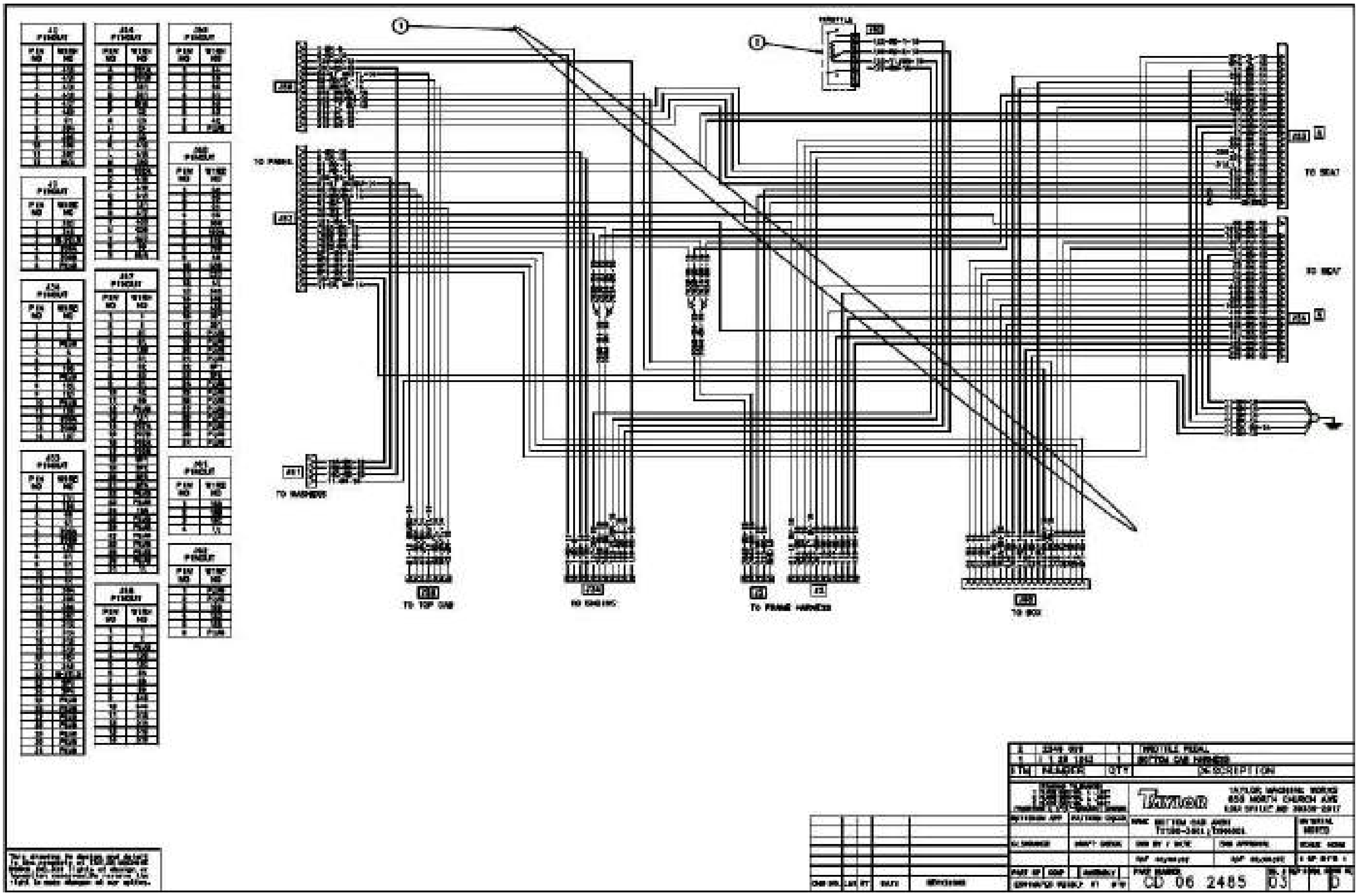
PLACE THE FOLLOWING ILLUSTRATIONS IN FOLDER ENVELOPES:

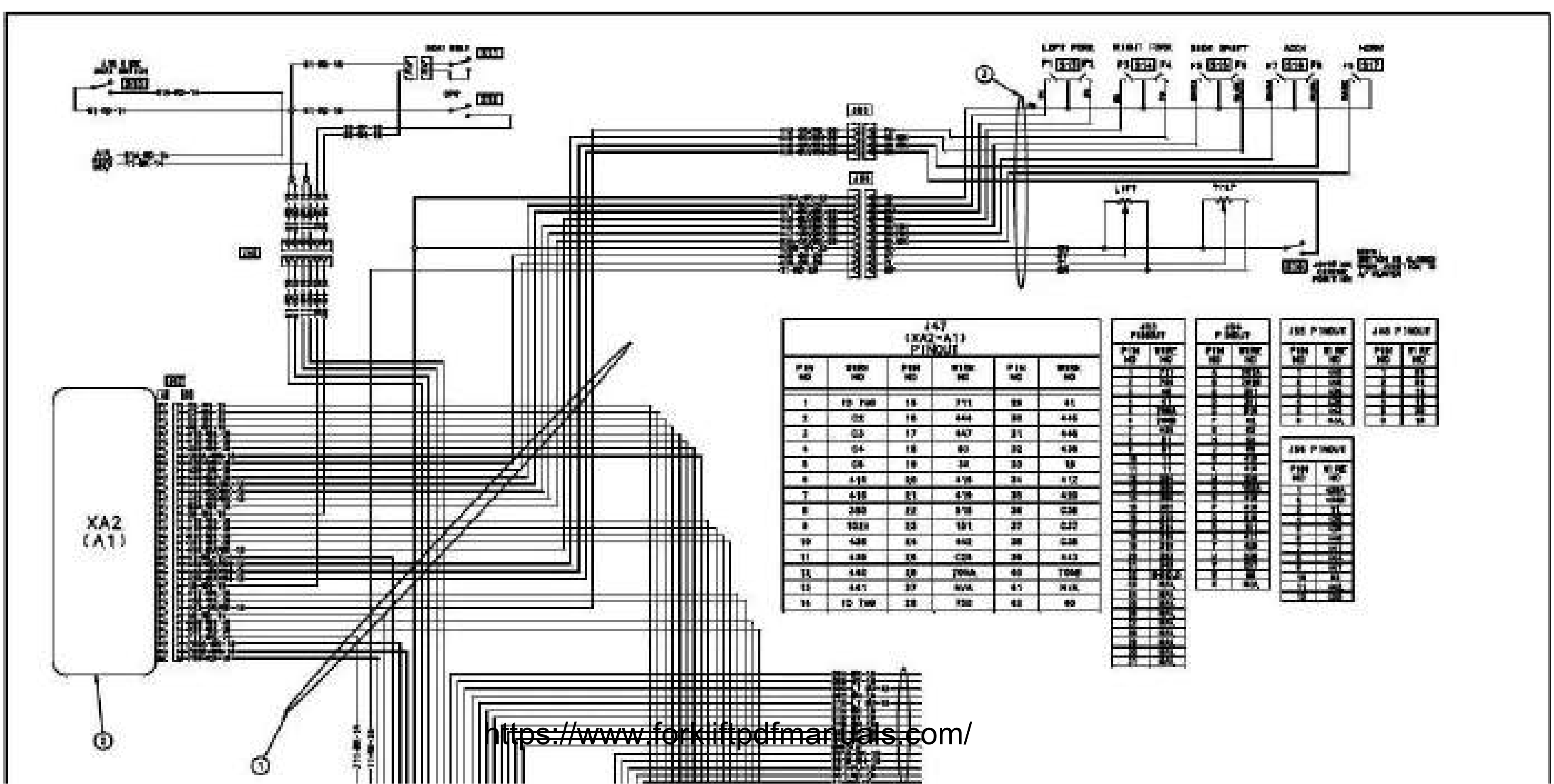
Illustration 6-6 - 06-2485 SHT. 2 (Panel ANSI)
Illustration 6-7 - 06-2485 SHT. 3 (Bottom Cab ANSI)
Illustration 6-8 - 06-2485 SHT. 4 (Seat ANSI)
Illustration 6-9 - 06-2485 SHT. 5 (Frame ANSI)

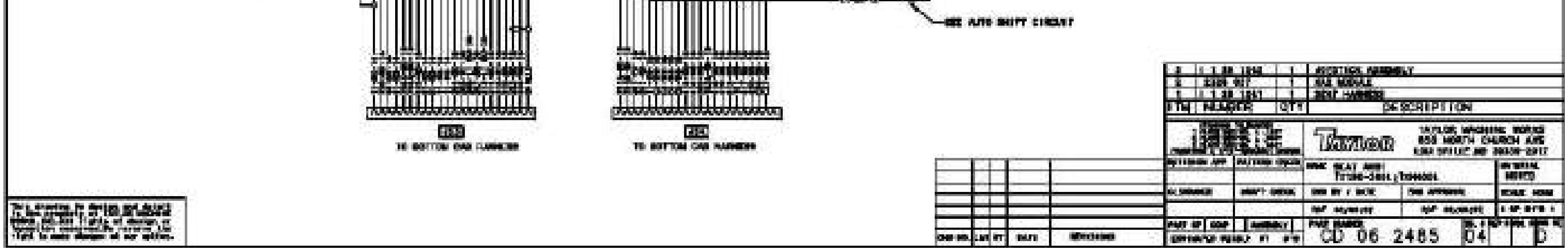
Illustration 6-10 - 06-2485 SHT. 6 (Truck Electrical Box

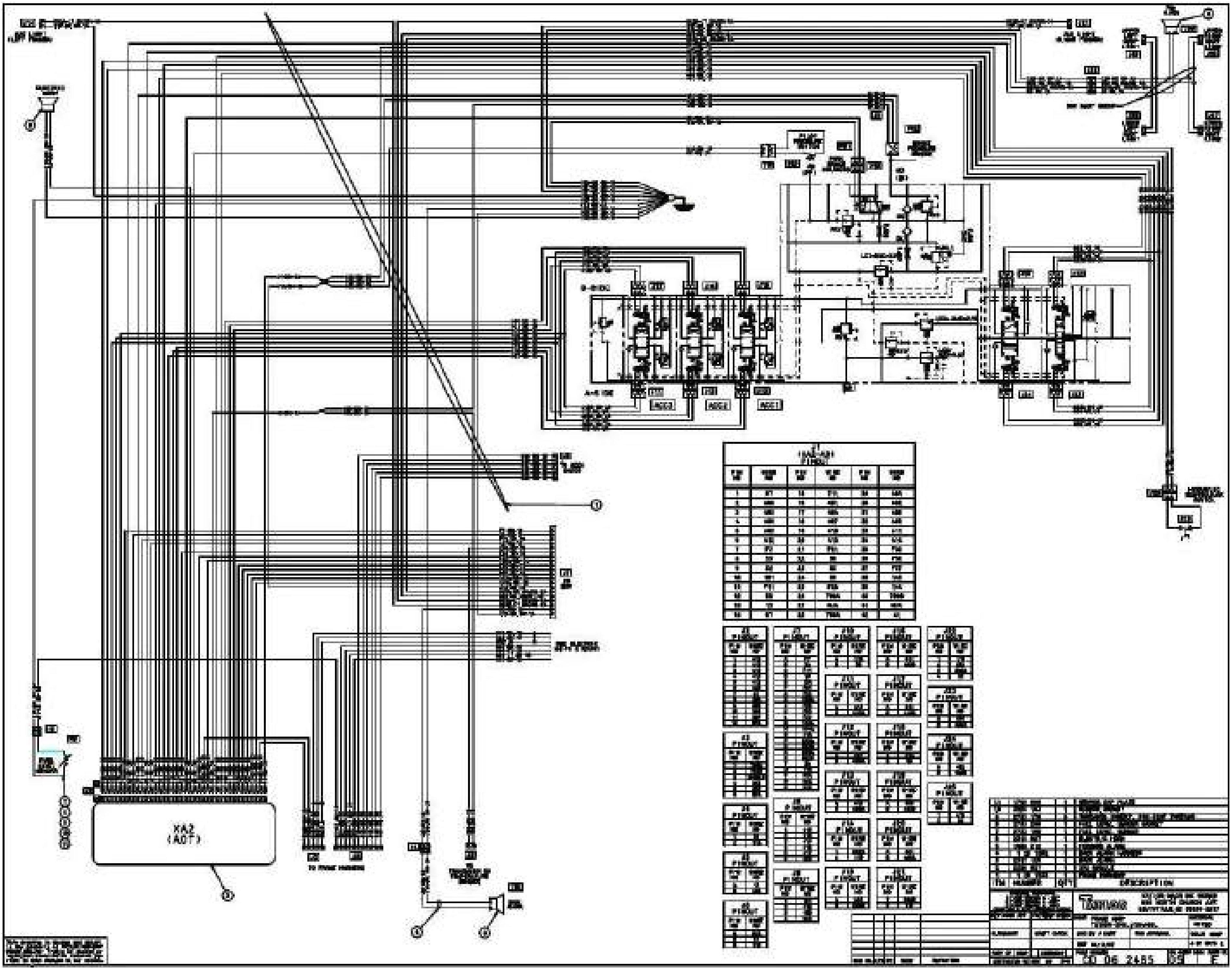


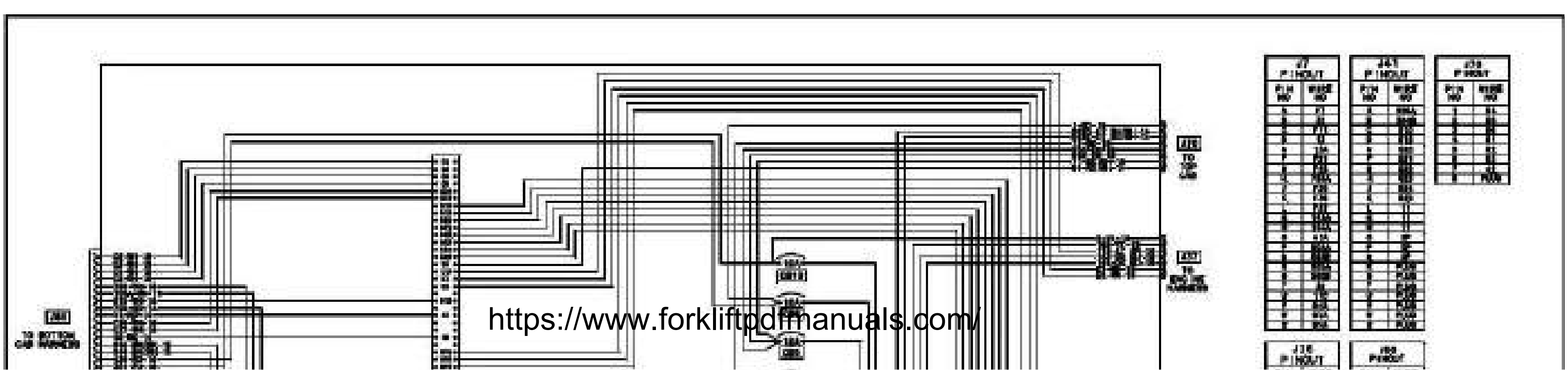

CD 06 2485

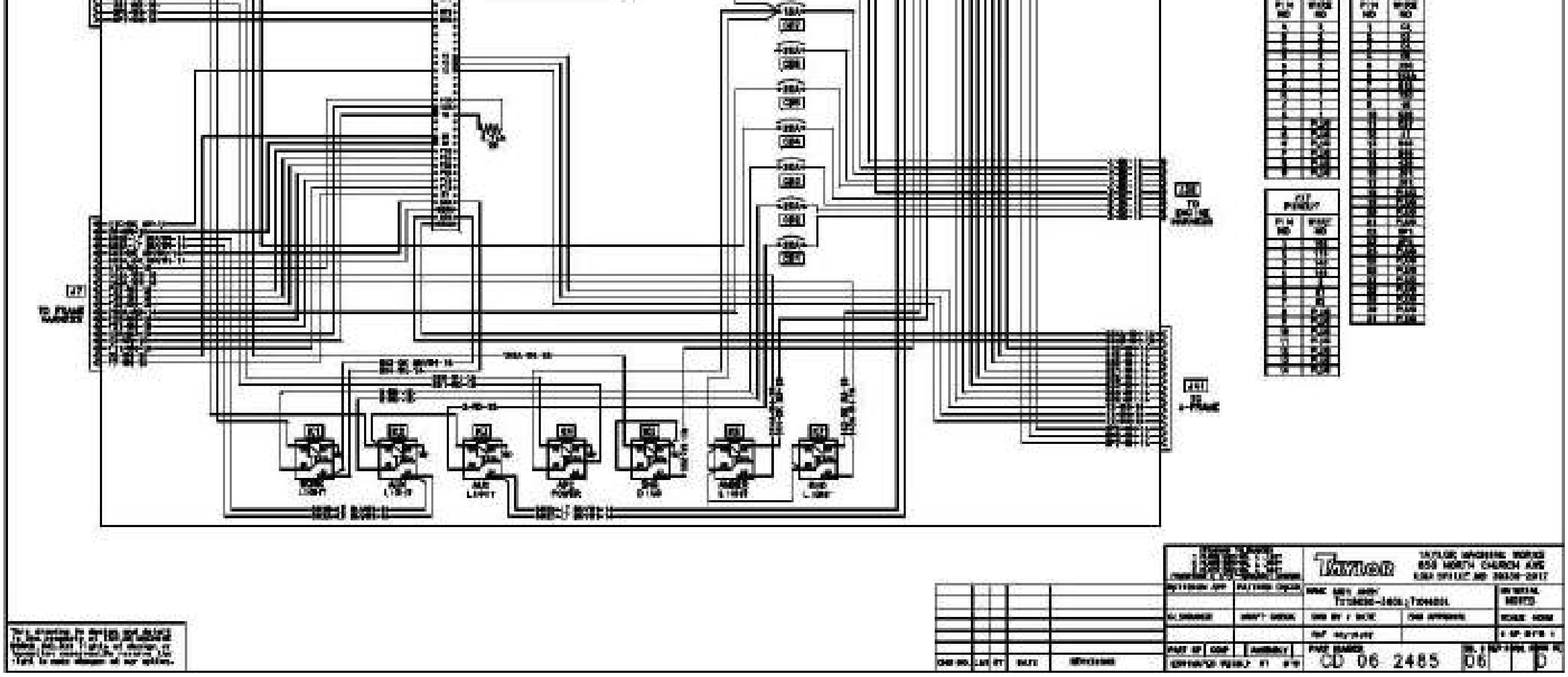

DESCRIPTION
TO SEAT
TO BOX
TO TOP CAB
TO FRAME HARNESS
CD 06 2485

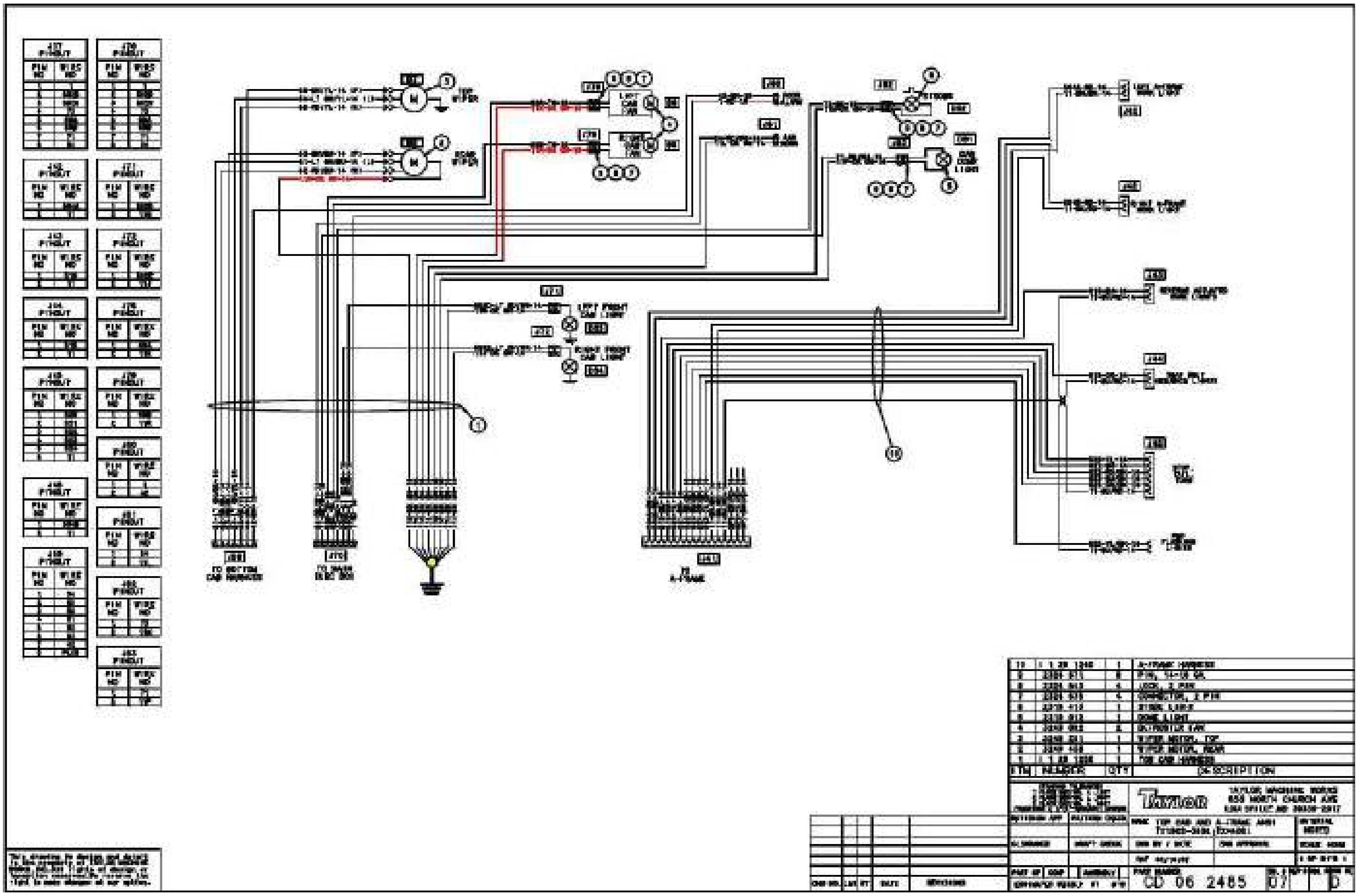

XA2
(A1)
J47
(XA2-A1)
PINOUT

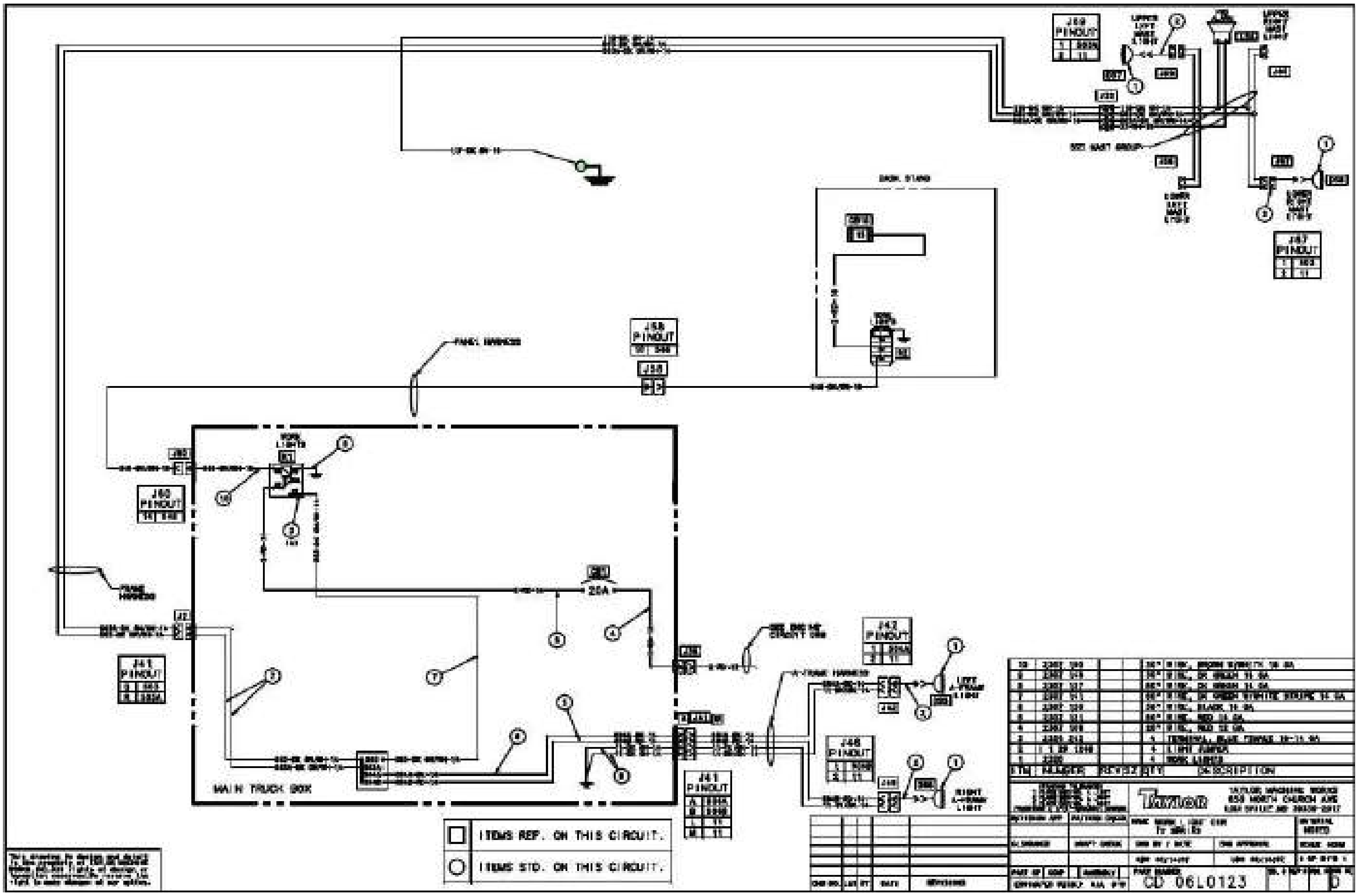

CD 06 2485


XA2
(A07)
CD 06 2485




CD 06 2485
06
D

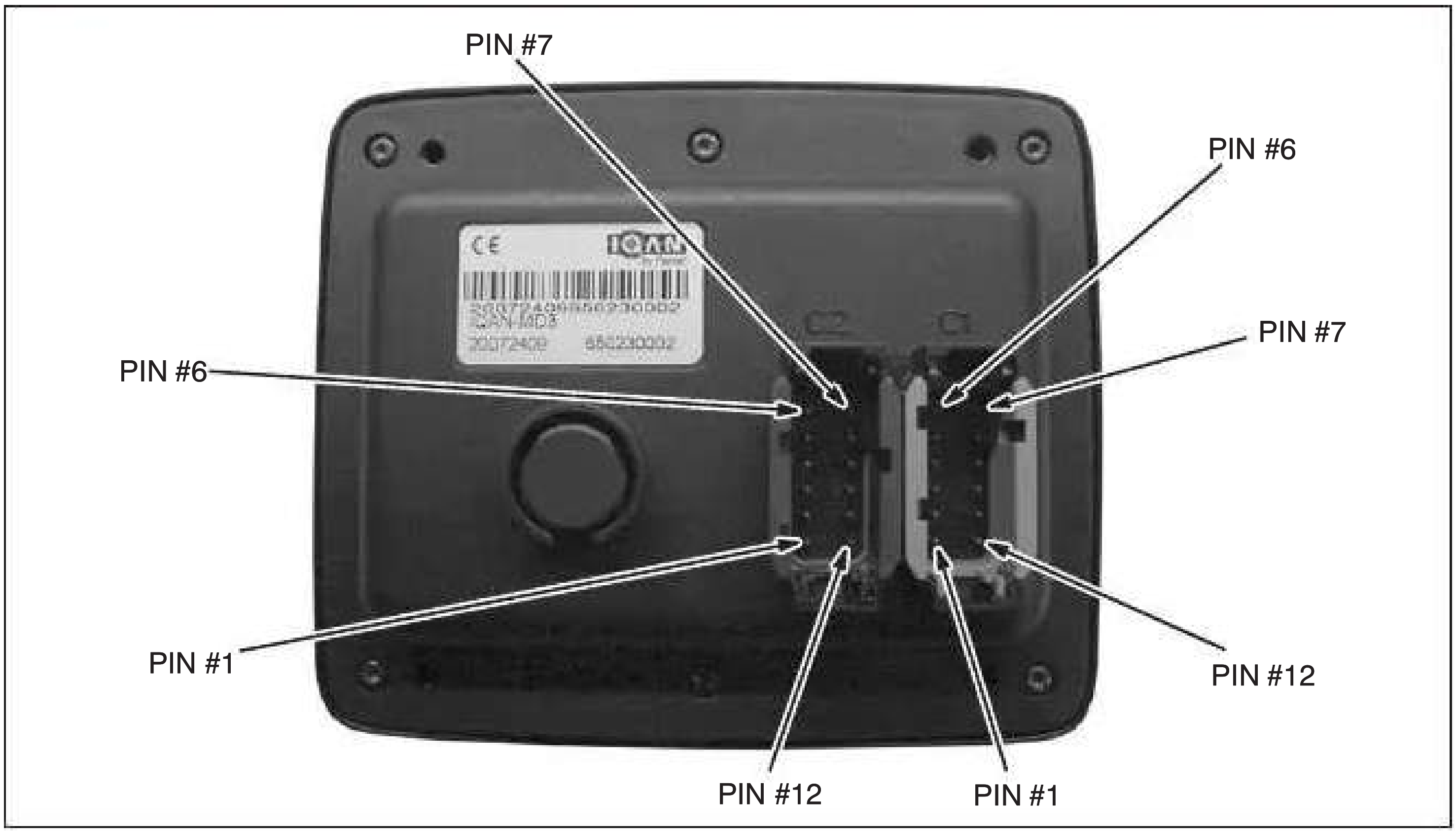

DESCRIPTION
CD 06 2485
07
D


J58 PINOUT
J58
J60 PINOUT
J41 PINOUT
J42 PINOUT
J46 PINOUT
J67 PINOUT
20A
MAIN TRUCK BOX
ITEMS REF. ON THIS CIRCUIT.
ITEMS STD. ON THIS CIRCUIT.
CD 06L0123

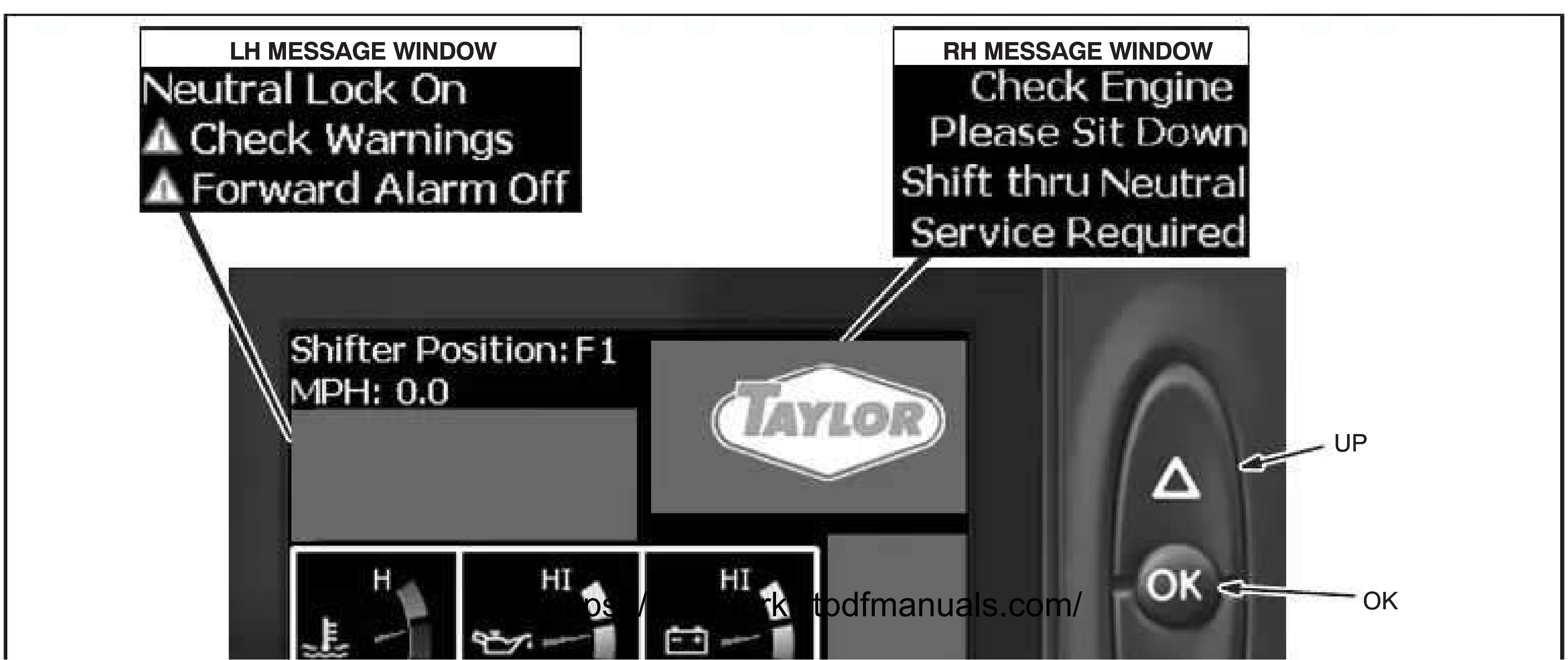
Taylor Integrated Control System (TICS) Components

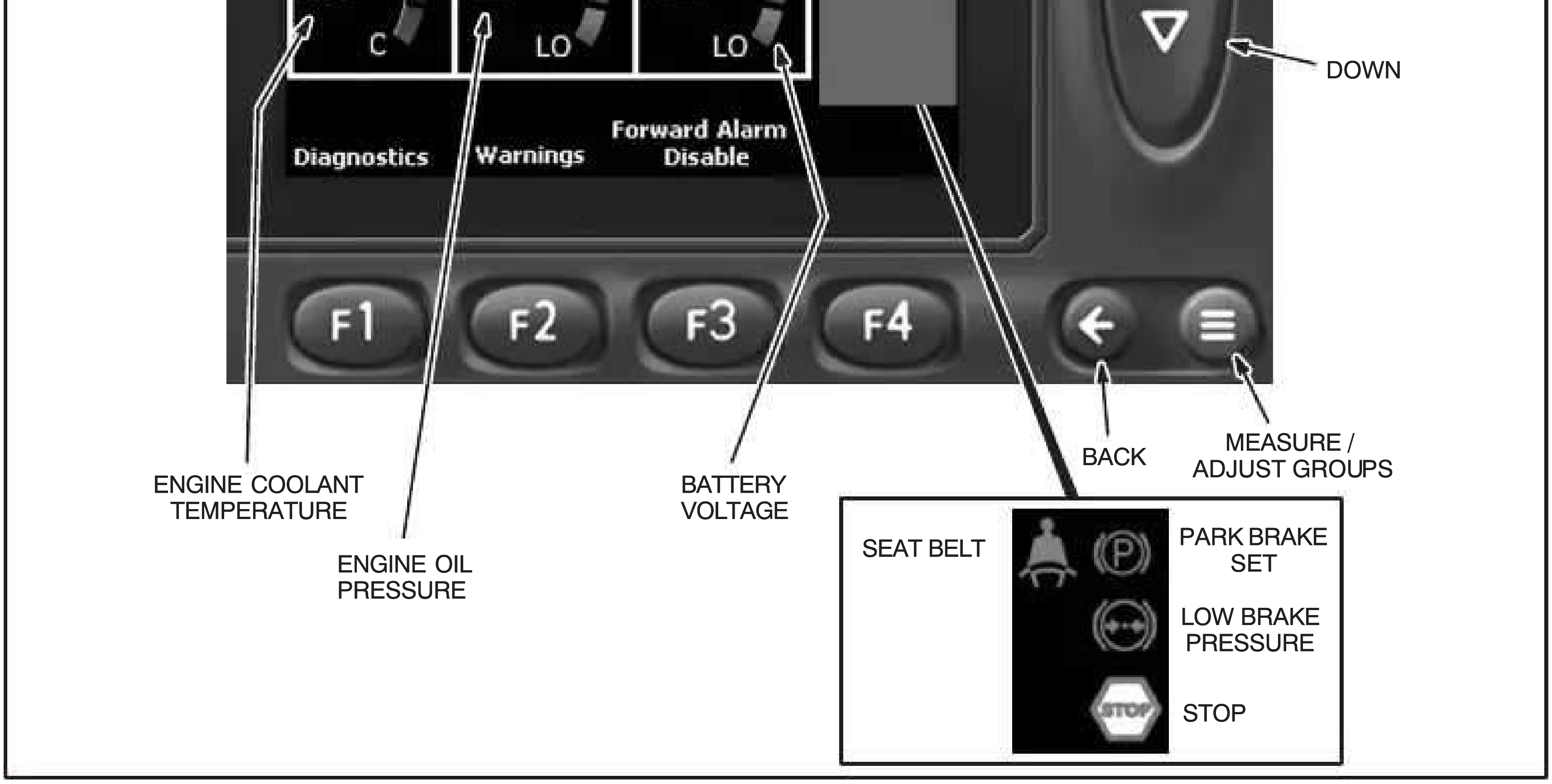
The Taylor Integrated Control System (TICS) Display Module. The TICS Display Module is an electronic display system for engine and equipment information. The display module is mounted on the right side of the dash.

WARNING: The TICS system display modules should not be exchanged between trucks. Each TICS module has been specifically programmed for each truck.



TICS Display Module Pin Assignments





Taylor Integrated Control System (TICS) Display Module Main Screen

The Taylor Integrated Control System (TICS) Display Module Main Screen. The main screen of the TICS Display Module displays the status of the engine and equipment operating information of the truck. The operating information that appears on the main display screen is described as follows:

1. Shifter Position - This indicates the electric shifter's position.
2. MPH - This indicates vehicle speed in miles per hour.
3. ACTIVE MESSAGES - Message text that alerts the operator of the status of different functions of the truck or to check warnings displayed on the **Active Warnings** screen. **NOTE:** The **Active Warnings** screen is displayed by depressing the F2 button.

ACTIVE MESSAGES DISPLAYED:
Neutral Lock On - Indicates that the Neutral Lock safety feature is active.
Check Warnings - Indicates that the operator should read the Active Warnings.
Forward Alarm Off - Indicates that the forward alarm is disabled while in the Operator Controlled mode of operation. This message will only appear while the Forward Alarm is in the Operator Controlled mode and disabled. **NOTE:** Depressing the F3 button will enable the forward alarm. [Refer to the **Forward Alarm System** in the Operator's Guide (OG160) for detailed information.]

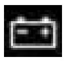
4. - This icon will change from white to red when the engine coolant temperature Is greater than 218°F (103°C). If this icon changes to red, stop the engine immediately and notify

11. CORRECTIVE ACTIONS - Message text that alerts the operator to take action before the truck will allow continuation of truck operation.

CORRECTIVE ACTIONS DISPLAYED:
Check Engine - Indicates there is an engine related problem and that the engine needs to be checked.
Please Sit Down - Indicates that the operator needs to occupy the seat.
Shift thru Neutral - This message will only appear while the Forward Alarm is in the Operator Controlled mode and disabled. **NOTE:** Depressing the F3 button will enable the forward alarm. [Refer to the **Forward Alarm System** in the Operator's Guide (OG160) for detailed information.]
Service Required - Indicates that truck maintenance needs to be performed.

maintenance personnel.

5.  - This icon will change from white to red when the engine oil pressure has fallen below 10 psi (.7 bar) at 750 rpm or less than 40 psi (2.8 bar) at 1,600 rpm. If this icon changes to red, stop the engine immediately and notify maintenance personnel.

6.  - This icon will change from white to red when the battery voltage is less than 9 VDC or greater than 15 VDC. This icon will be white when the battery voltage is greater than 9 VDC or less than 15 VDC. If this icon changes to red, stop the engine immediately and notify maintenance personnel.

7.  - This icon flashes when the seat belt is unfastened.

8.  - This icon illuminates when the parking brake is applied.

9.  - This icon flashes when a low hydraulic pressure problem (below 1,500 psi / 104 bar) exists in the service brake apply circuit.

10.  - This icon flashes for 30 seconds before the engine ECM shuts down the truck due to high transmission temperature.

12. F1 - Depress this button to view the Diagnostics Select screen.

13. F2 - Depress this button to view Active Warnings.

14. F3 - Depress this button to manually enable or disable the forward alarm while the forward alarm is in the Operator Controlled Manual mode of operation [refer to the **Forward Alarm System** in the Operator's Guide (OG160) for detailed information].

15. F4 - Reserved for optional functions.

16. UP and DOWN - Depress either button to make adjustments or scroll through menus. **NOTE:** Adjustments should only be made by Maintenance Personnel!!

17. OK - Depress this button to select a highlighted item.

18. Back - Depress this button to back up through the display screens.

19. Measure / Adjust Groups - Depress this button to select measure groups, adjust groups, information screen or status page. **NOTE:** Adjustment groups will be Pin Code protected. **NOTE:** Adjustments should only be made by Maintenance Personnel!!

TICS Module. The TICS Module status is indicated by the following LEDs:

1. Green LED - When this LED is illuminated, it indicates that the module is powered on.
2. Yellow / Red LED - When this LED is blinking the yellow color, the status of the module is normal. When this LED is blinking the red color, there is an error and the TICS Display Module will display an error message.

LED Indicator Showing Different XS2 and XA2 Modes

Status	Flash
Normal operation (yellow)	

Error code	Error	Primary Flash (red) Error category	Secondary Flash (yellow) Error description
1:n	See note [a]		
2:n	See note [a]		
3:1	CAN error		
3:2	Address error		
4:1	Memory error [b]		
FE	Fatal error		

a. Error groups 1:n and 2:n are controlled by the master.

b. FRAM memory error.

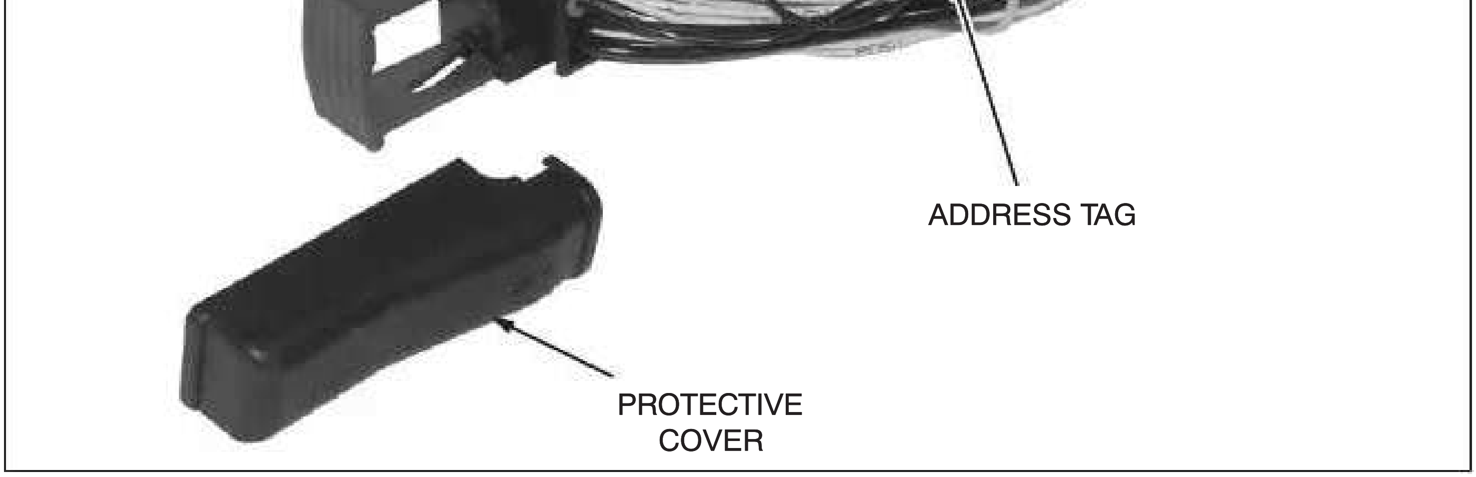
Suggested Actions For Specific Fault Codes

1:n / 2:n - Check the TICS main display for proper operation or any displayed error messages. Consult factory.

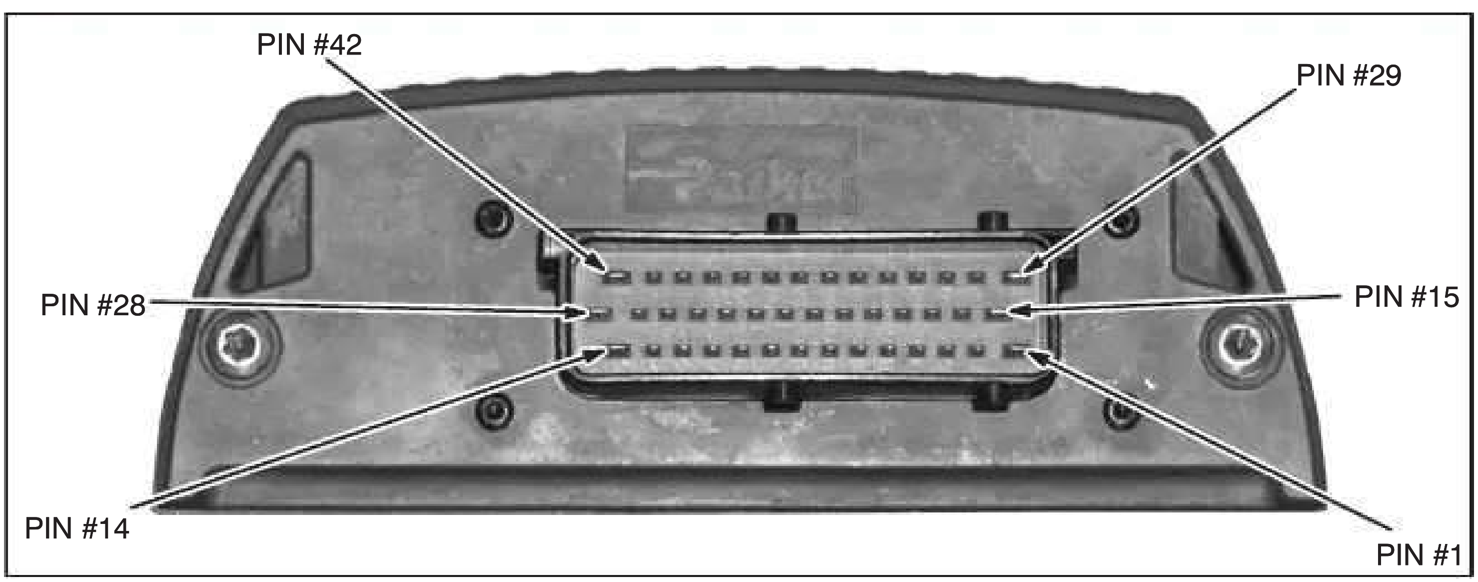
3:1 - Check CAN communication wiring for continuity between module and TICS main display. Consult maintenance manual for wire schematics.

3:2 - Check address tag at module to make sure it is in place (refer to photo below).

4:1 and FE - Check the TICS main display for displayed error messages. Replace modules as required. Consult factory.

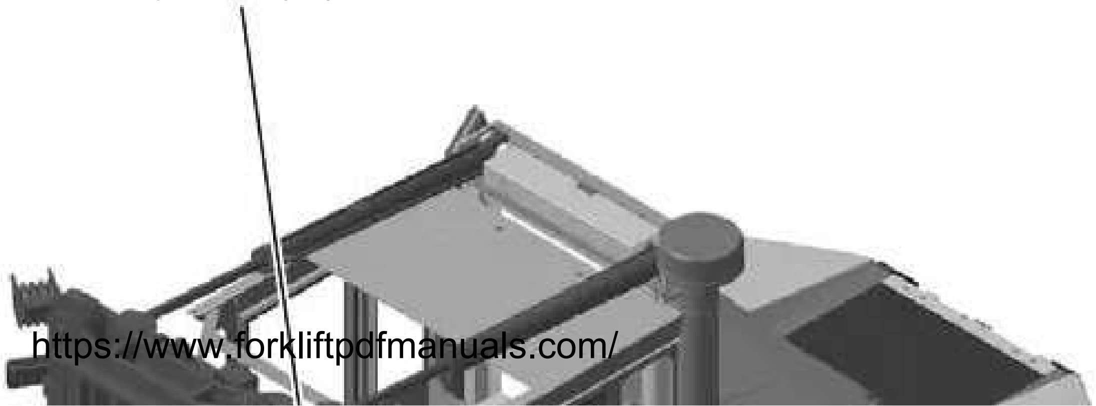


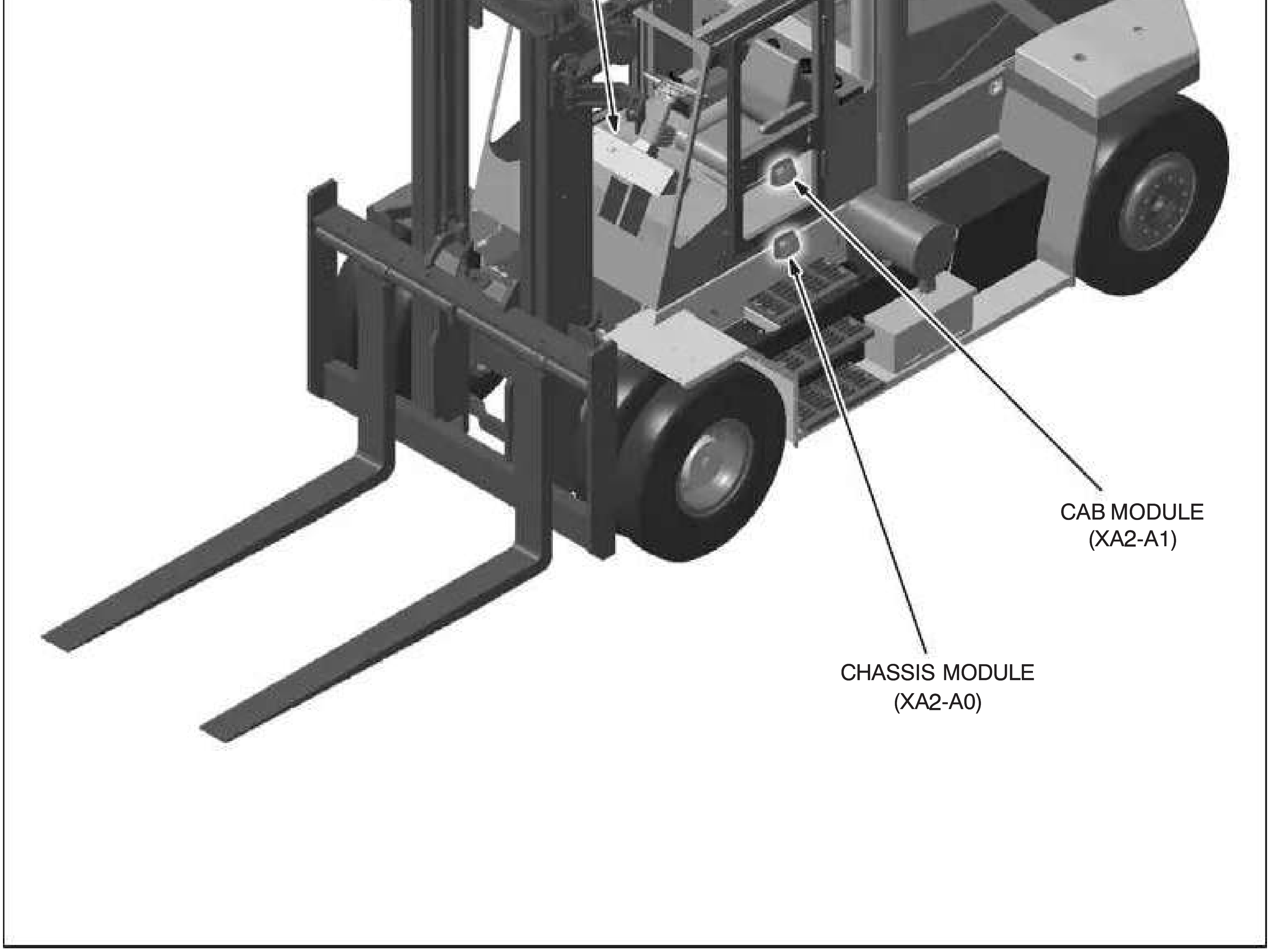
TICS Module Wire Harness Plug



TICS Module Pin Assignments (XA2)

NOTE: The TICS system of this truck employs XA2 modules. **Always replace each module with the correct module.** Refer to the following illustration for truck control module locations.





TICS Control Module Locations On The Truck

Measure Groups

Measure groups are used to check the status of inputs, outputs and logic parameters within the truck control program. The measure groups are broken into two subgroups, function groups and maintenance groups. The function groups show all data related to a particular function within the truck control program. Function groups are primarily used by TMW personnel during truck set up and troubleshooting. The maintenance groups are set up to be used by the maintenance personnel of the end user. These groups show the status of all inputs and outputs related to the noted function. These groups are to be used to aid the end user in diagnosing and solving any problems with daily operation of the truck.

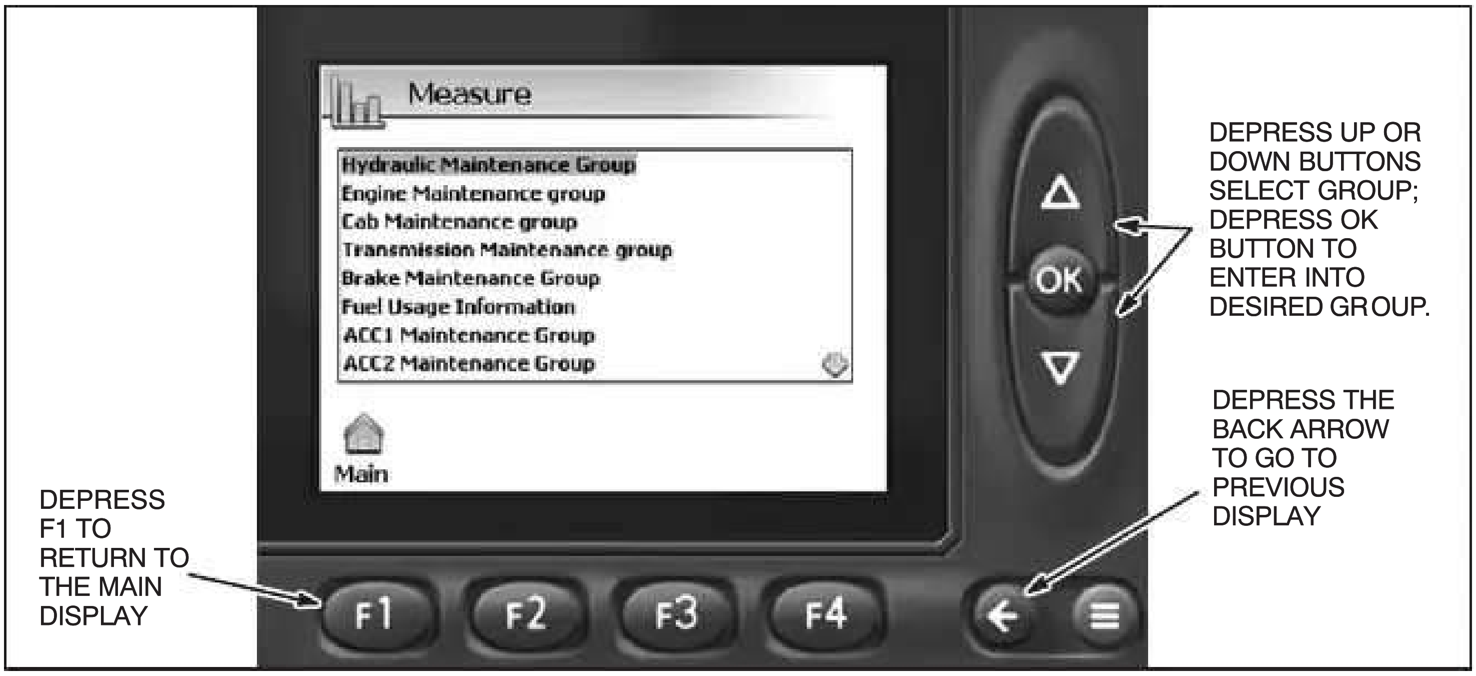
To access the Maintenance Groups inside the Taylor Integrated Control System (TICS) display module, perform the following procedures:

Main Display Screen

1. From the Main Display screen, depress the Measure / Adjust Groups button (≡). This will display the Main Measure / Adjust screen.

Main Measure / Adjust Screen

2. At the Main Measure / Adjust screen, depress the F2 (Measure) button. This will display the Measure screen.



Measure Screen

3. Depress the UP or DOWN button to highlight the desired maintenance group and depress the OK button to display the values of the selected group. Depress the F2 button to toggle between the Raw and Scaled values (refer to description of values below). To exit out of the selected group values, depress the ← button to return to the Measure Groups list display. **NOTE:** A list of the Measure and Maintenance Groups is illustrated in this section.

Sensor Status

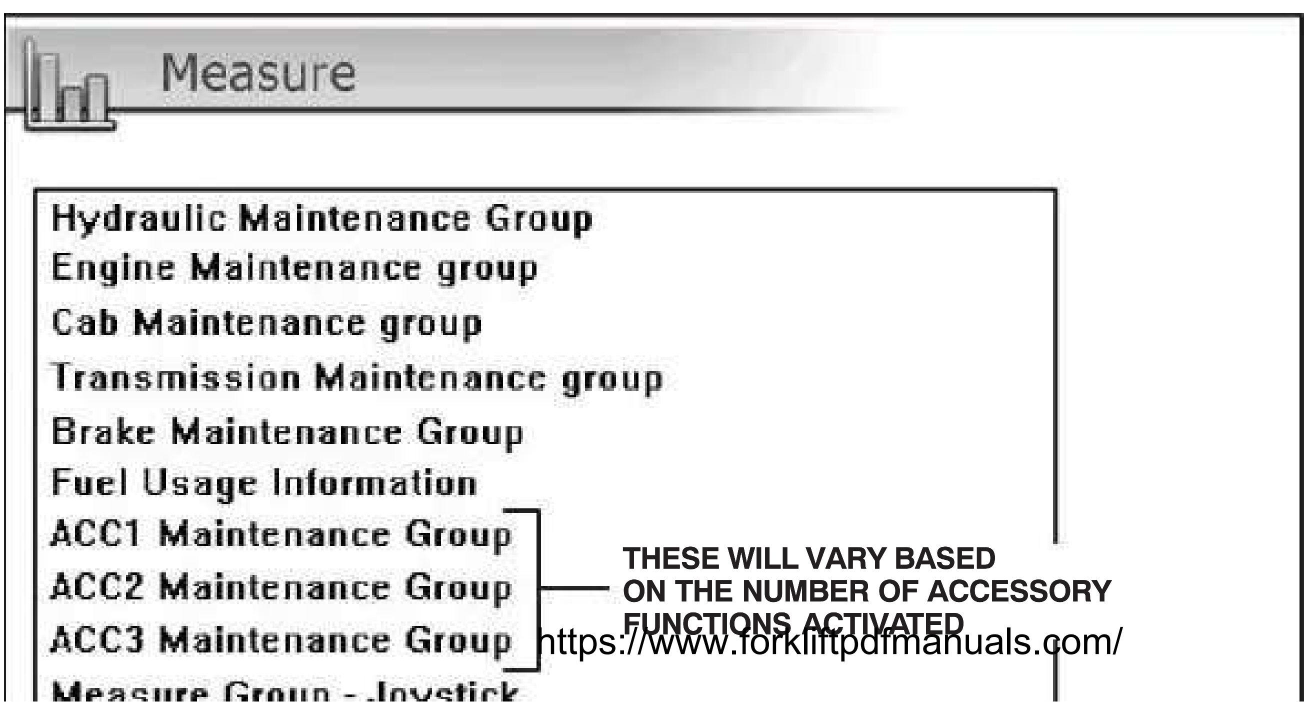
Scaled Value – Analog sensor values are displayed in program defined units (PSI, Degrees, etc.) while the Digital sensors are displayed as True (12 VDC input to module from sensor) or False (no input to module from sensor).

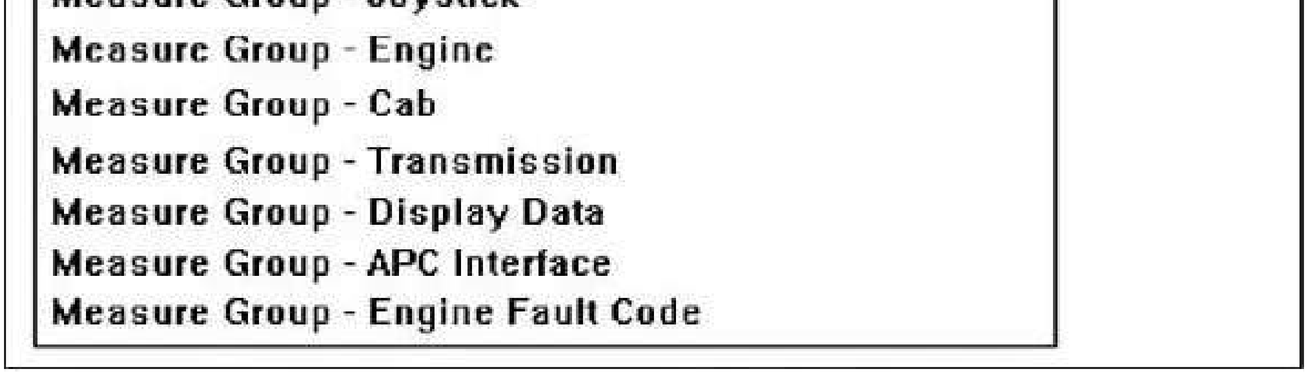
Raw Value – Analog sensor values are displayed in Millivolts. Digital sensors are not displayed.

Communication Status

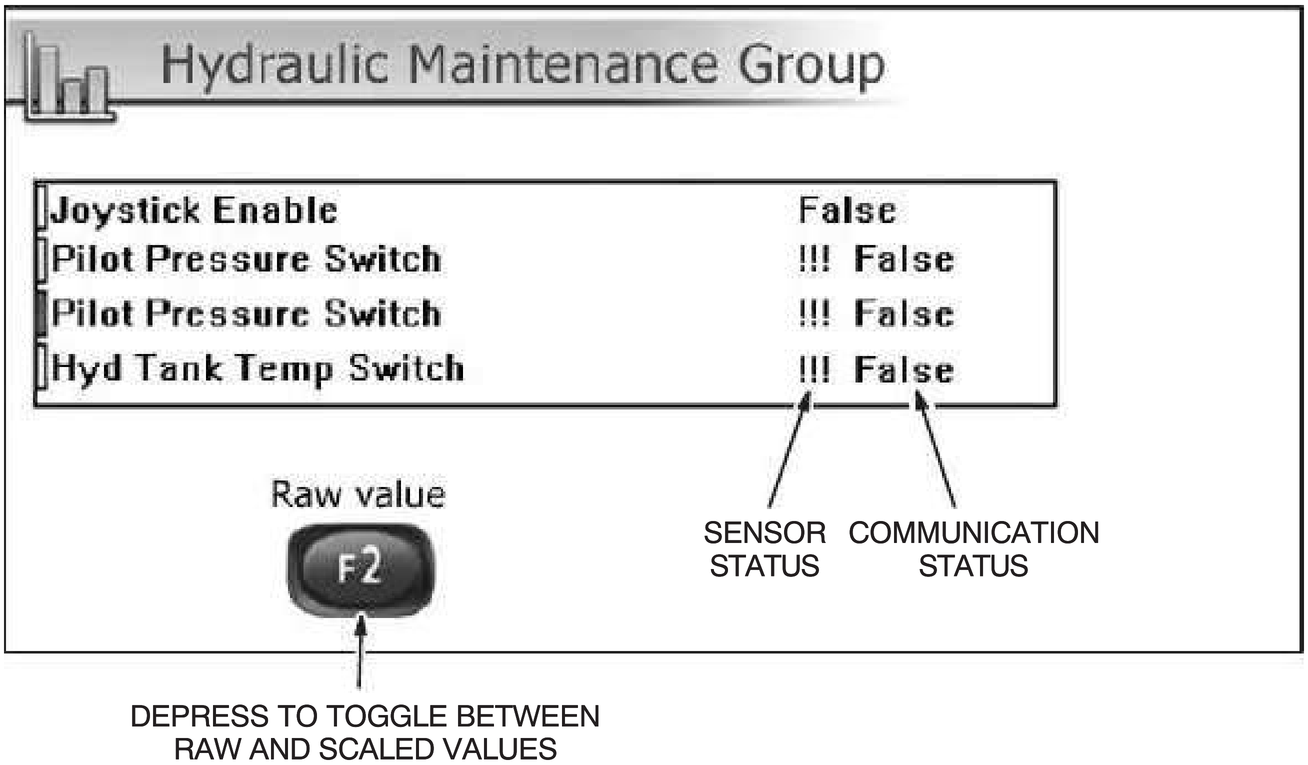
OK – Indicates that the sensor input to module connection is functioning correctly.

!!! – Indicates that there is a problem with sensor input to module (See note below).

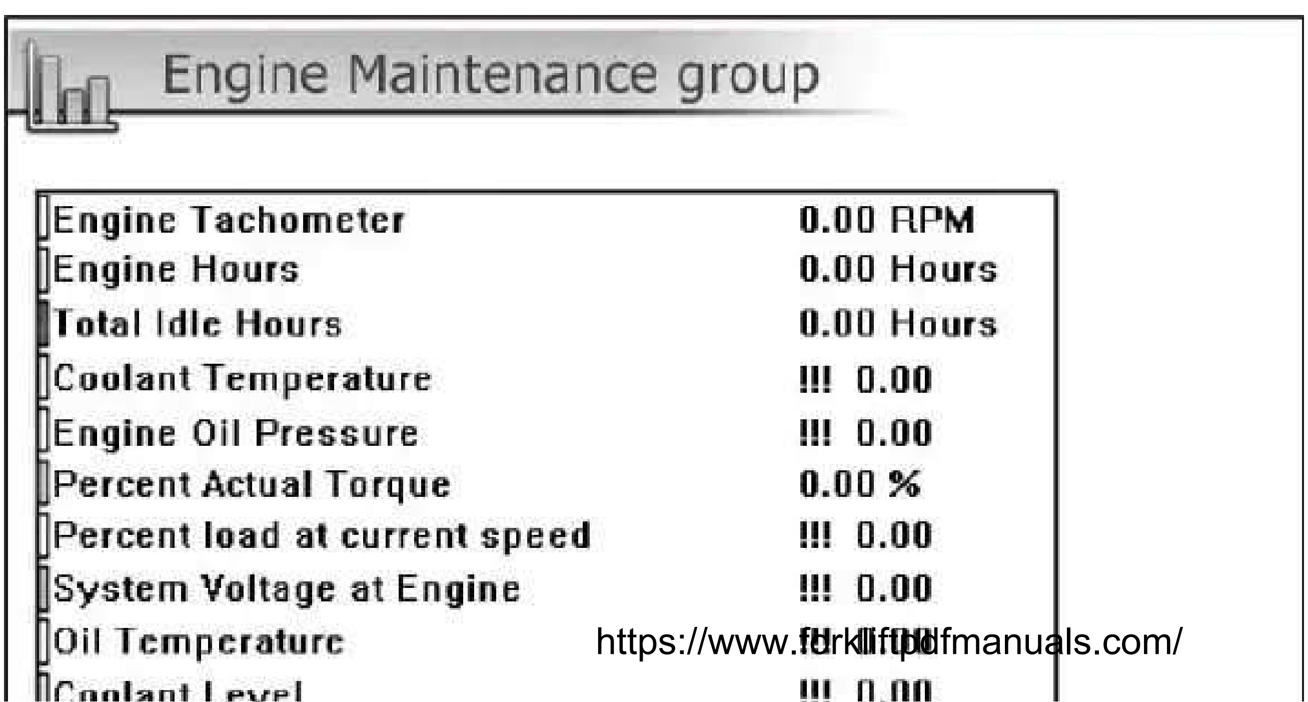

Measure
Hydraulic Maintenance Group
Engine Maintenance group
Cab Maintenance group
Transmission Maintenance group
Brake Maintenance Group
Fuel Usage Information
ACC1 Maintenance Group
ACC2 Maintenance Group
ACC3 Maintenance Group
THESE WILL VARY BASED
ON THE NUMBER OF ACCESSORY
FUNCTIONS ACTIVATED



Maintenance and Measure Groups

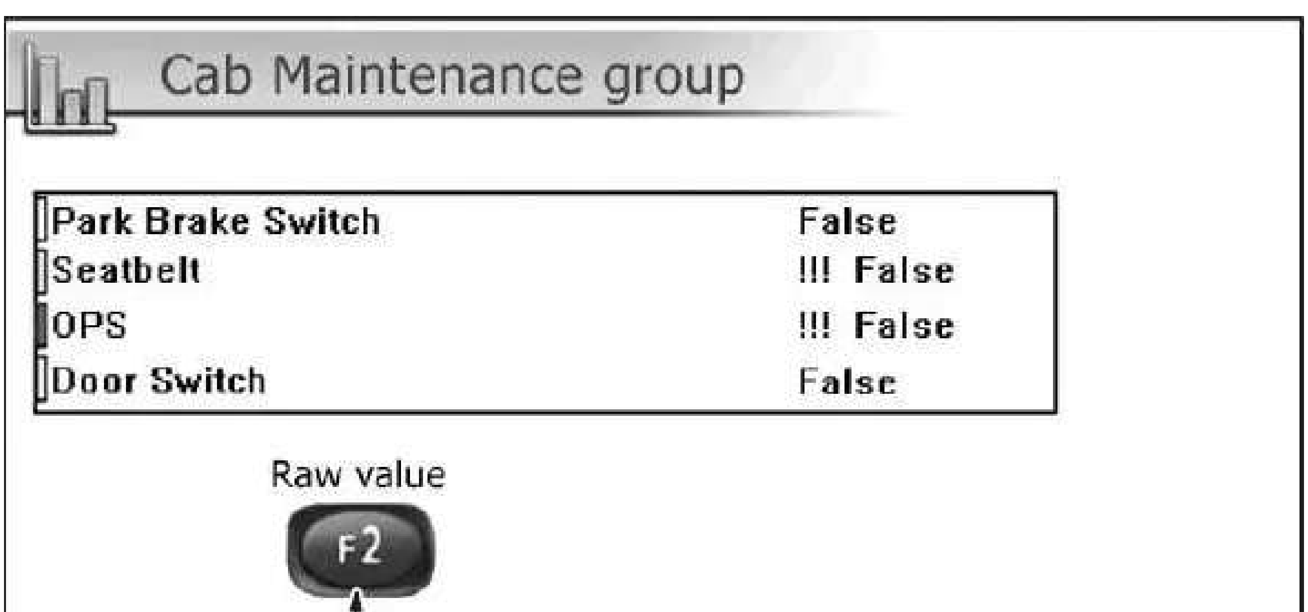


Hydraulic Maintenance Group



DEPRESS TO TOGGLE BETWEEN
RAW AND SCALED VALUES

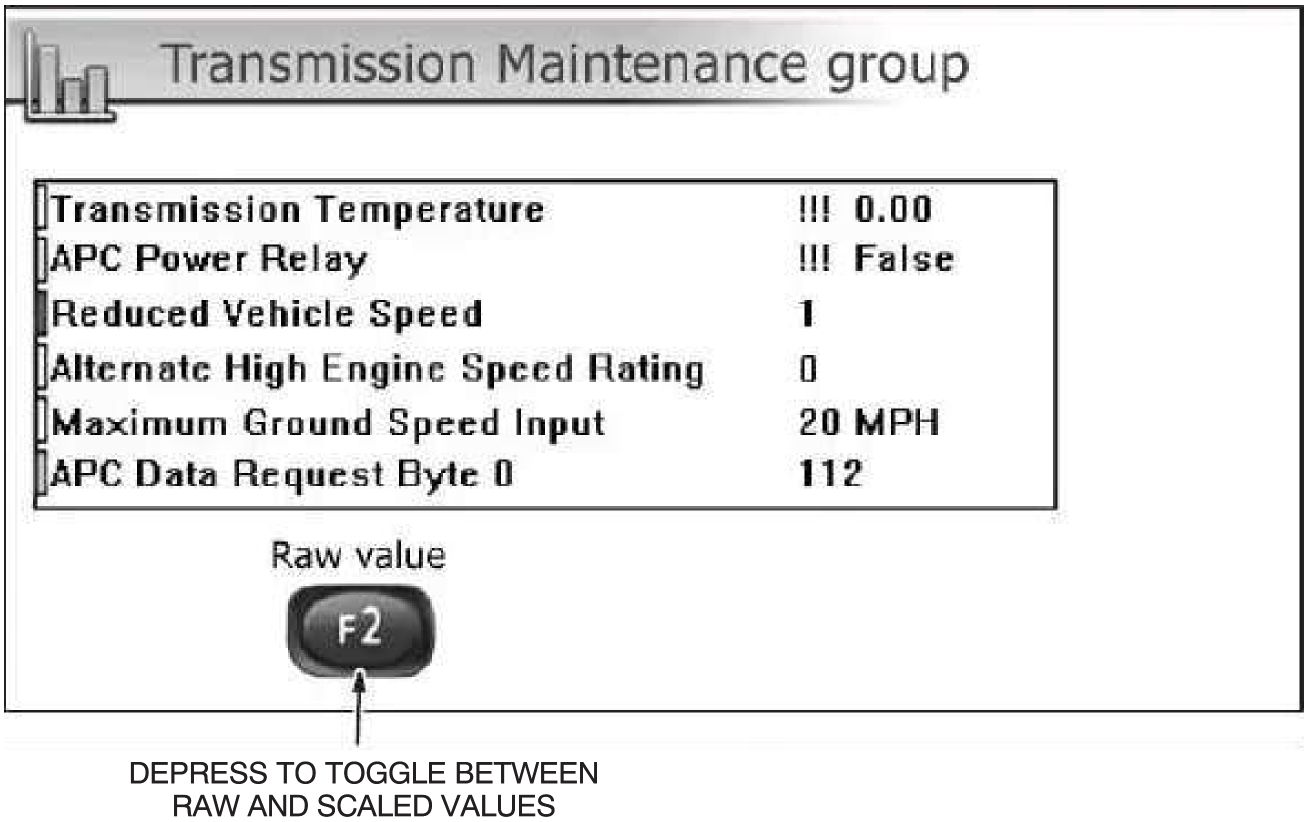
Engine Maintenance Group



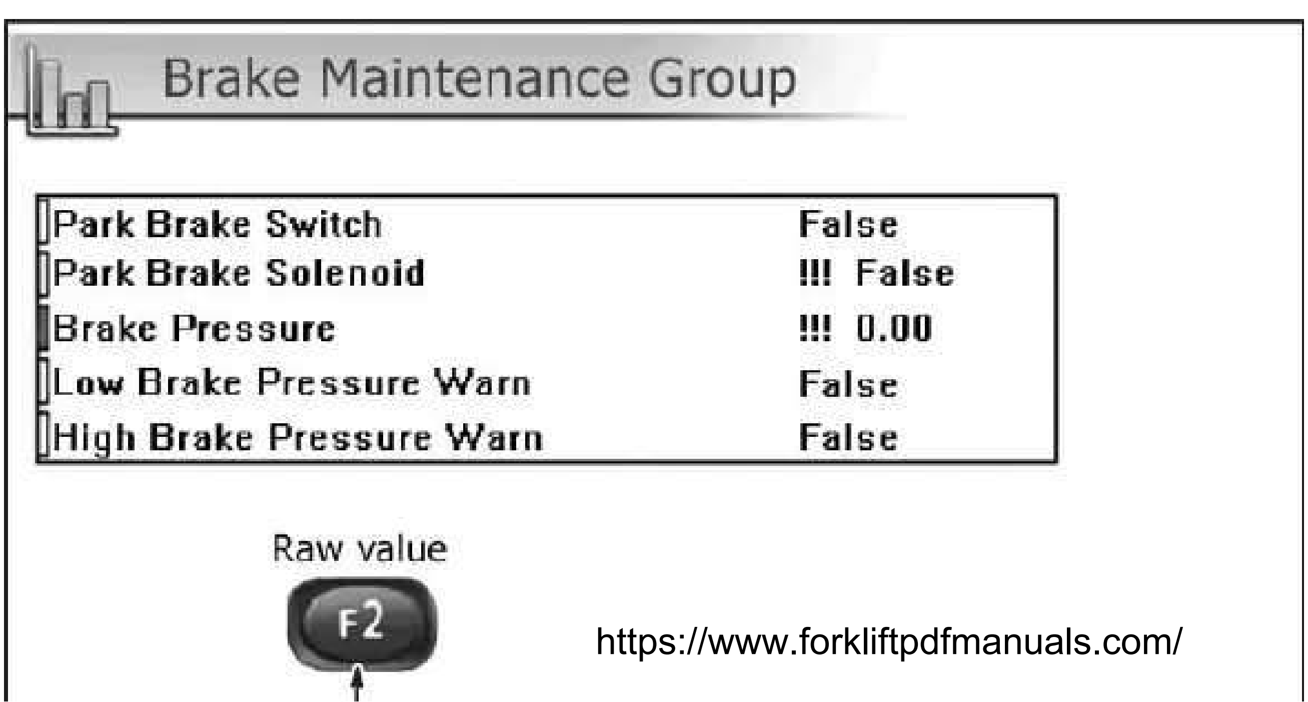
DEPRESS TO TOGGLE BETWEEN

RAW AND SCALED VALUES

Cab Maintenance Group

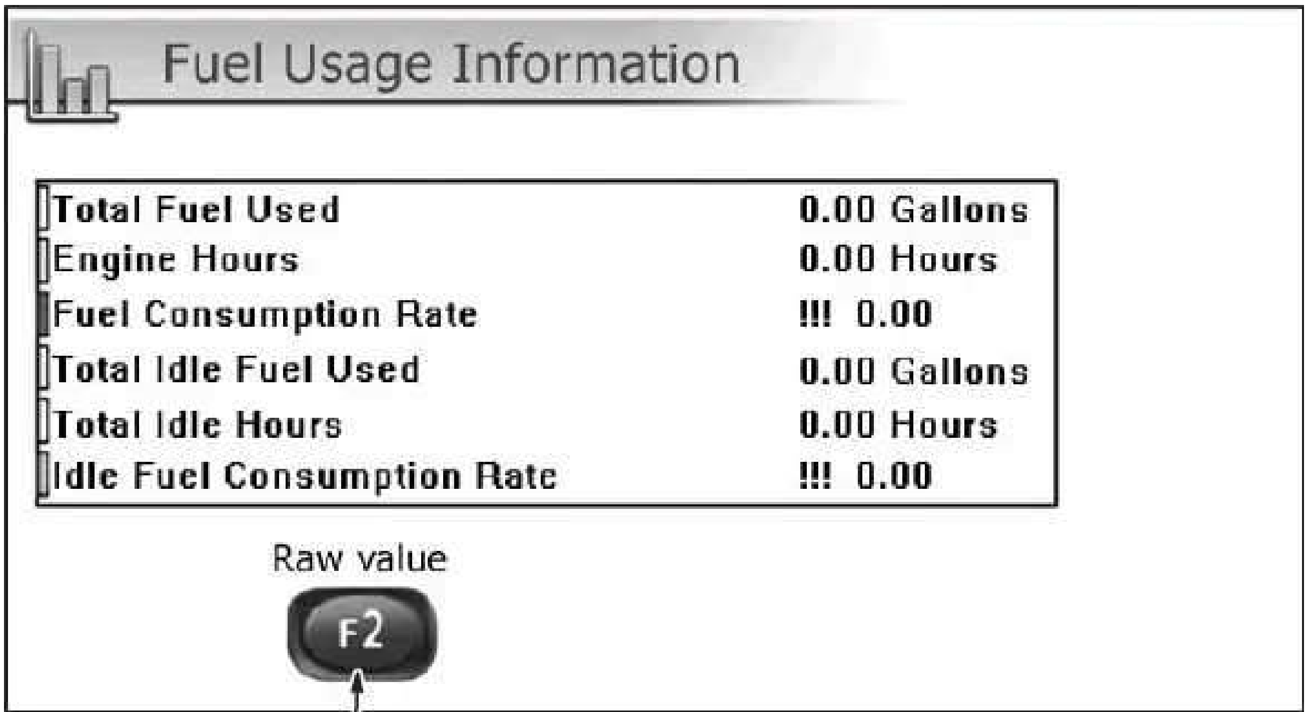


Transmission Maintenance Group



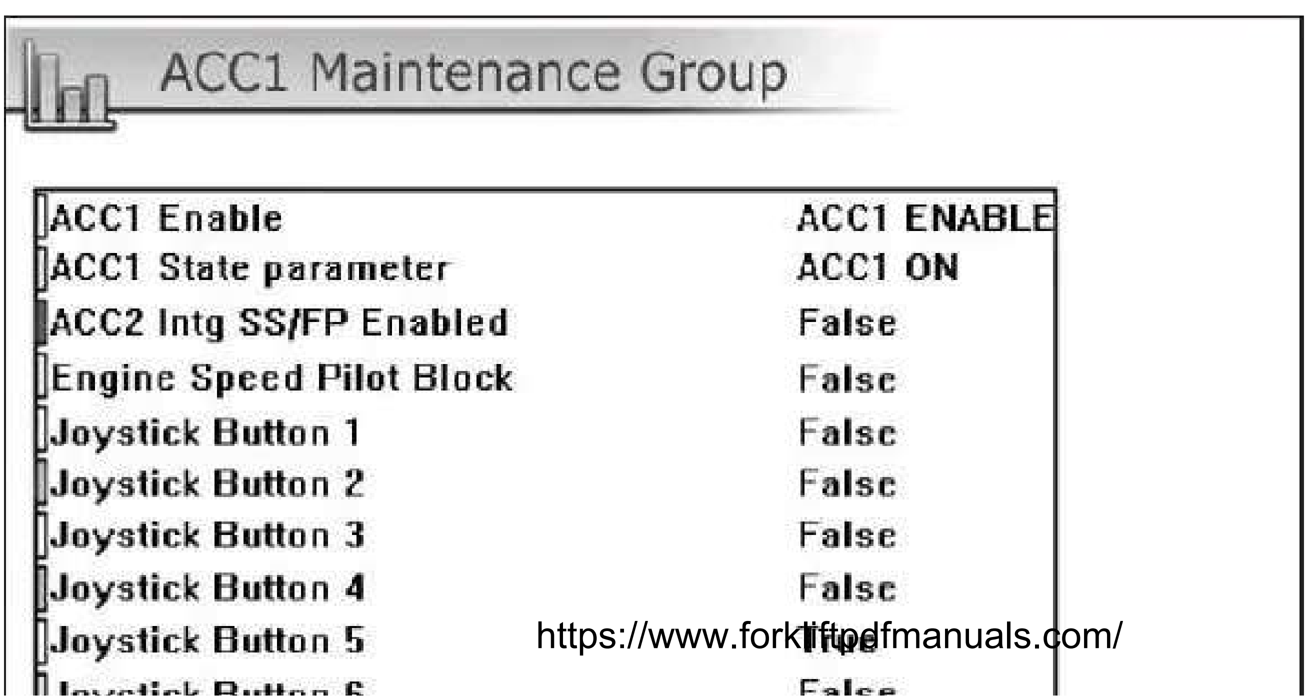
DEPRESS TO TOGGLE BETWEEN
RAW AND SCALED VALUES

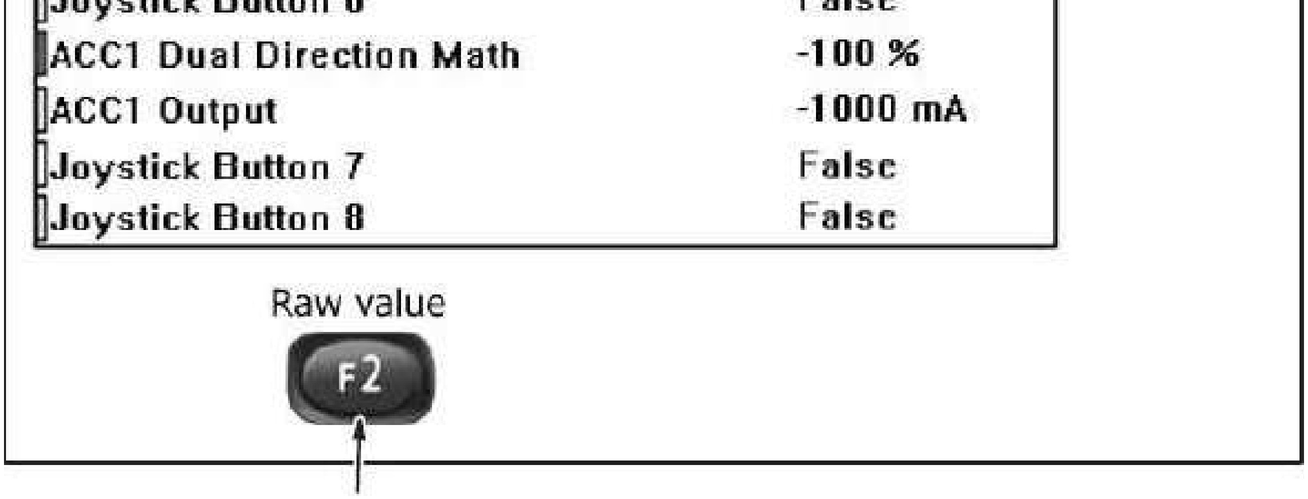
Brake Maintenance Group



DEPRESS TO TOGGLE BETWEEN
RAW AND SCALED VALUES

Fuel Usage Information Group

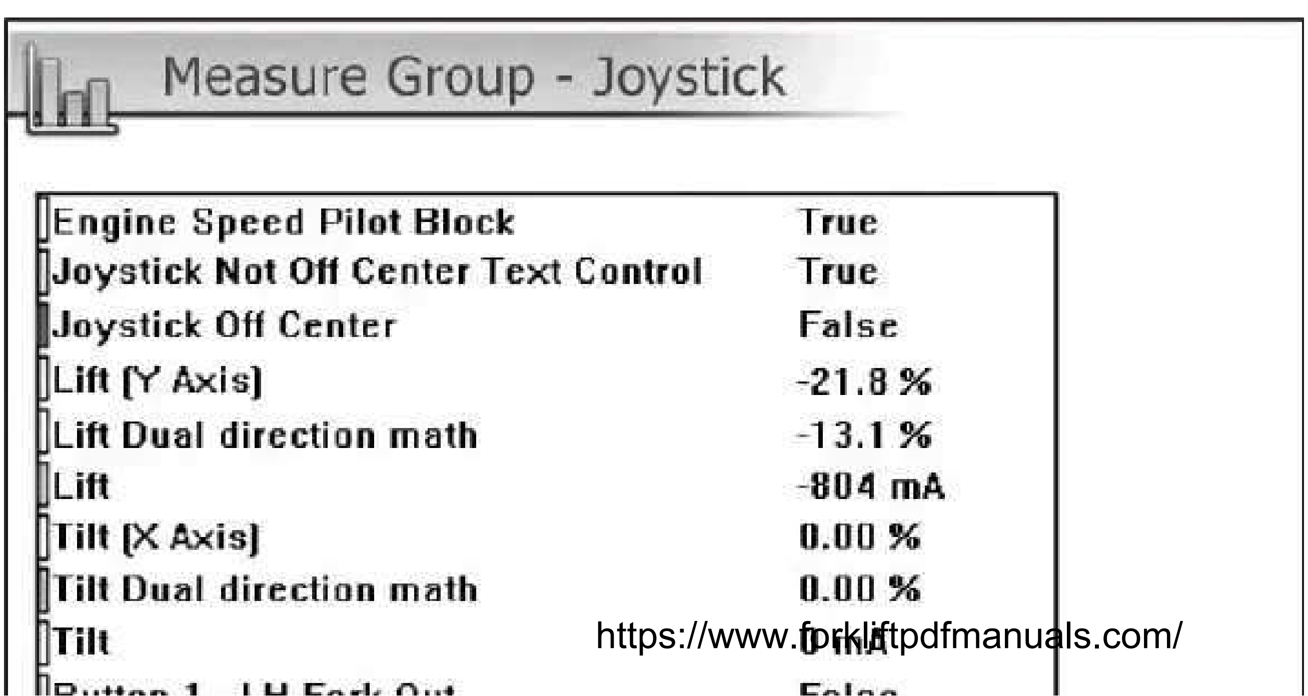




DEPRESS TO TOGGLE BETWEEN
RAW AND SCALED VALUES

ACC1 Maintenance Group

NOTE: Additional accessory hydraulic maintenance groups (ACC2, ACC3, etc.) have the typical values as those listed in the ACC1 Maintenance Group above. However, some values could be different from those listed above.



Button 1 - LH Fork Out	False
Button 2 - LH Fork In	False
Button 3 - RH Fork Out	False
Button 4 - RH Fork In	False
Button 5 - SS Left	False
Button 6 - SS Right	False
Button 7 - FF Lower	False
Button 8 - FF Upper	False
Button 9 - Horn	False
Steering Wheel Horn Input	False
Horn Logic	False
Horn	False
ACC Activate	3 Sections
Three Accessory Sections Active	True
One Accessory Section Active	True
Two Accessory Sections Active	True
Four Accessory Sections Active	False
Five Accessory Sections Active	False
Hide ACC1 Intg SS/FP Display Page	True
Hide ACC1 Display Page	False
Hide ACC2 Display Page	False

Raw value

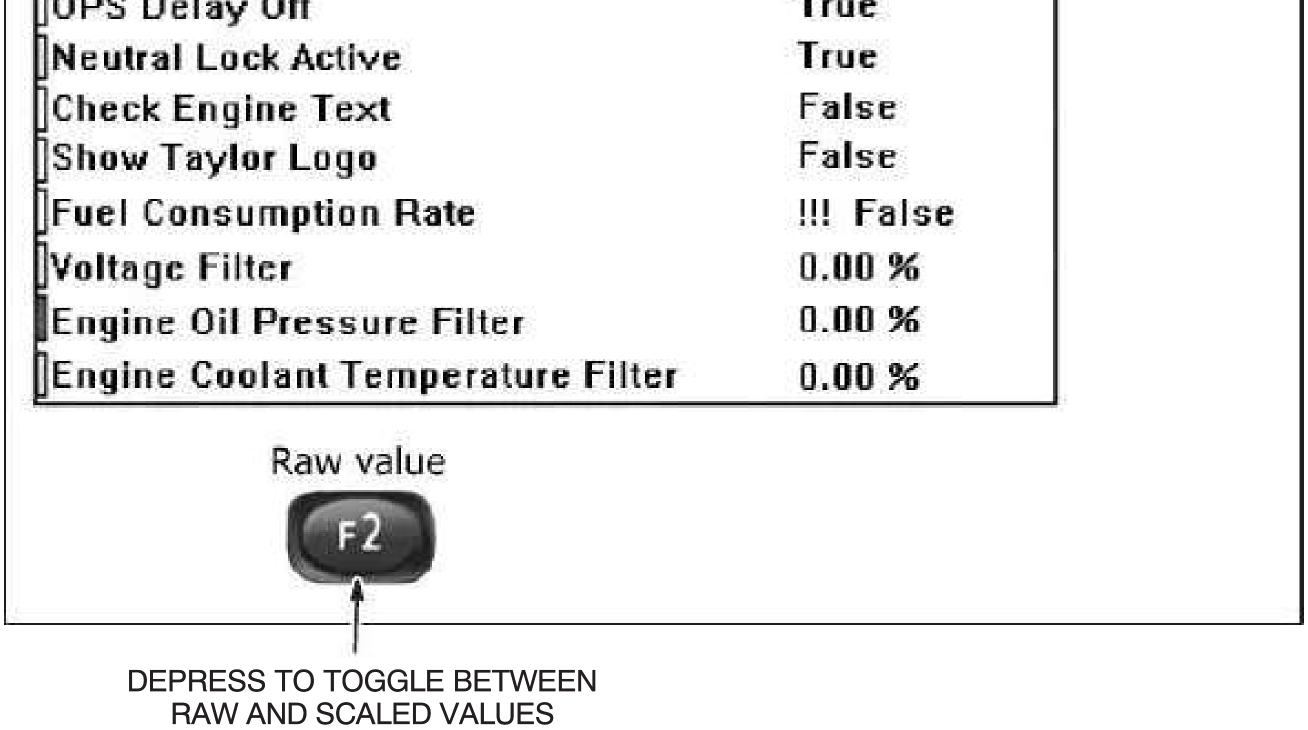
DEPRESS TO TOGGLE BETWEEN RAW AND SCALED VALUES

(Continued)

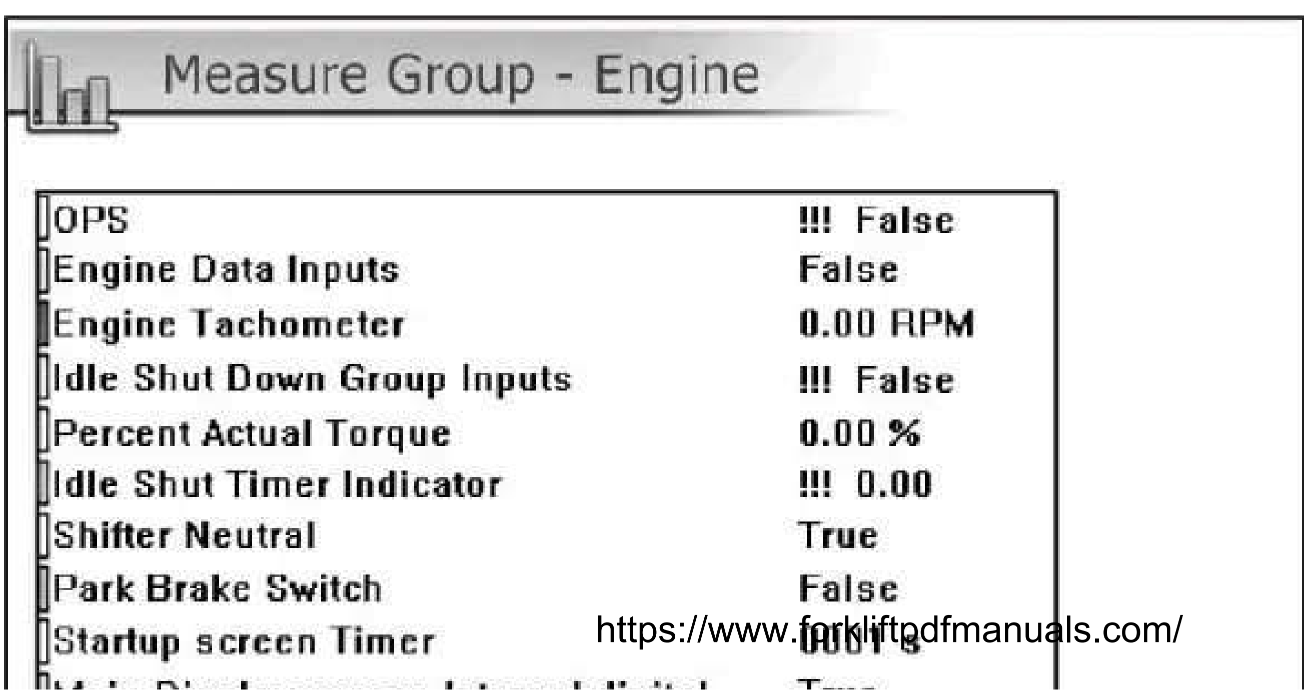
Joystick Measure Group

(Continued)

Idle Operation	False
Total Idle Fuel Used	0.00 Gallons
Total Idle Hours	0.00 Gallons
Fuel Consumption	False
Total Fuel Used	0.00 Gallons
Ambient Conditions	!!! False
Coolant Level	!!! 0.00
Engine Data 3	!!! False
Boost pressure	!!! 0.00
Intake Manifold Temperature	!!! True
Hyd Tank Temp Switch	!!! False
OPS Delay Off	True



Joystick Measure Group



Main Display screen Internal digital	True
Startup screen Internal digital	False
Transmission Temperature	!!! 0.00
High Transmission Temp Timer	0.00 s
Engine Idle Shutdown Time	5
Engine Idle Shutdown Enable	Shutdown D
Engine Idle Shutdown Timer	0.00 min
Shutdown Internal digital	False
ECM Shutdown Relay(W138)	!!! False
Engine Protection Shutdown Status	!!! 0.00
Engine Protection Shutdown Timer S	!!! 0.00
Engine Protection Shutdown Override	!!! 0.00
Idler Shutdown Timer Override	!!! 0.00
Machine Hours Timer	5.26 h
Engine Diagnostic Mode Select	False
Engine Diagnostic On	False
Engine Diagnostic Off	True
Engine Maintenance Timer	0.00 h
Service Interval	250 Hours
Time until service	250 Hours
Cummins Red Light	!!! False

(Continued)

Raw value

DEPRESS TO TOGGLE
BETWEEN RAW AND
SCALED VALUES

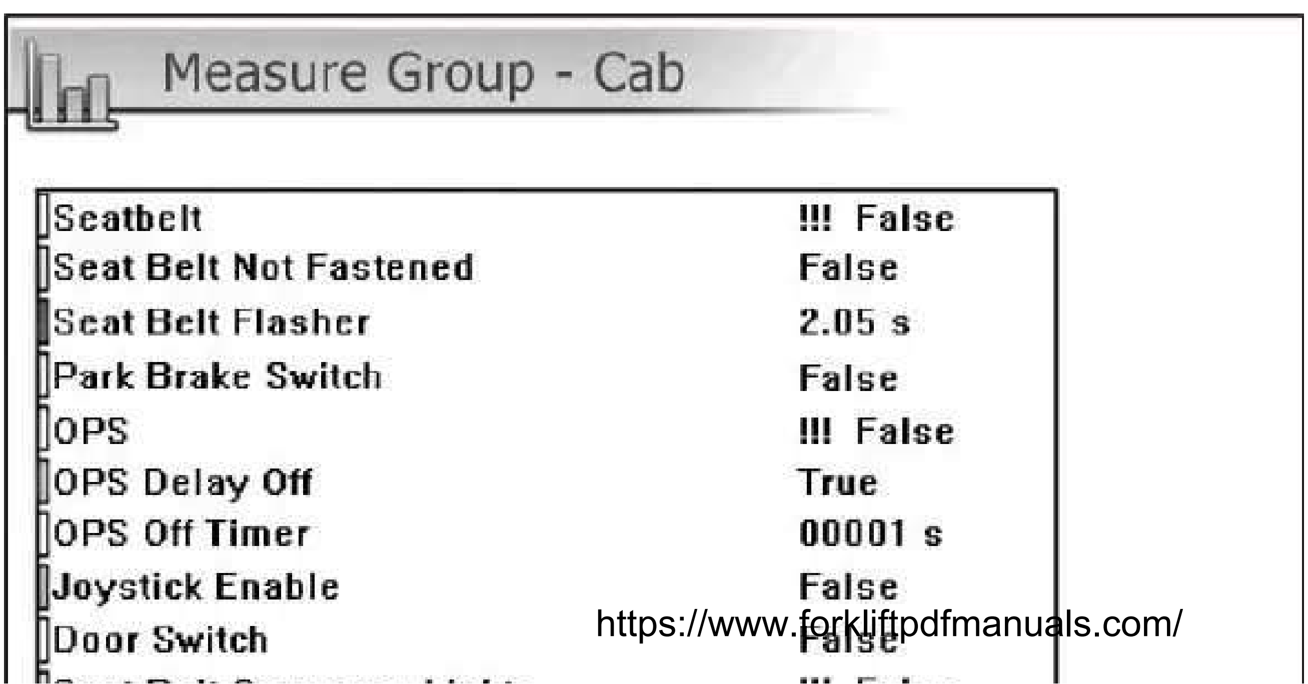
Engine Measure Group

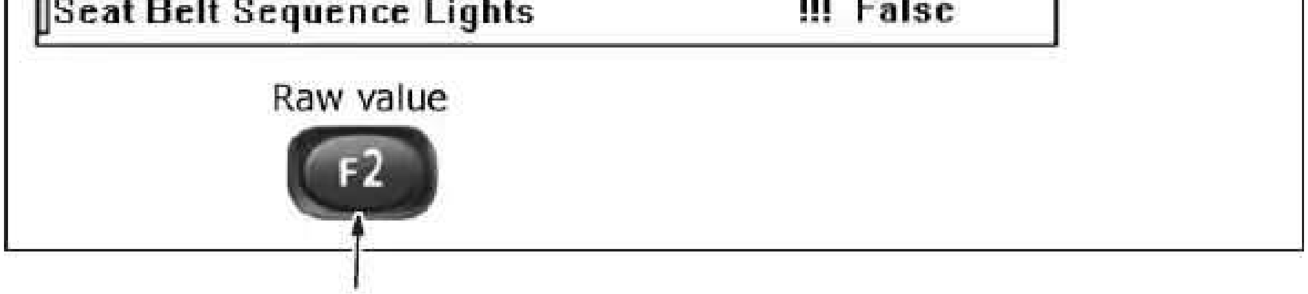
(Continued)

Cummins Amber Light	!!! False
Show Engine Fault	False
Show Engine Info	False
Engine Diagnostic ON (W143)	!!! False
EEC2	!!! False
Accelerator Pedal Position	!!! 0.00
Percent load at current speed	!!! 0.00
Check Engine Text	False
Diagnostic Mode Off Timer	0001 s
Hide Engine Info	True
Impending Shutdown Timer	0.00 s

DEPRESS TO TOGGLE BETWEEN
RAW AND SCALED VALUES

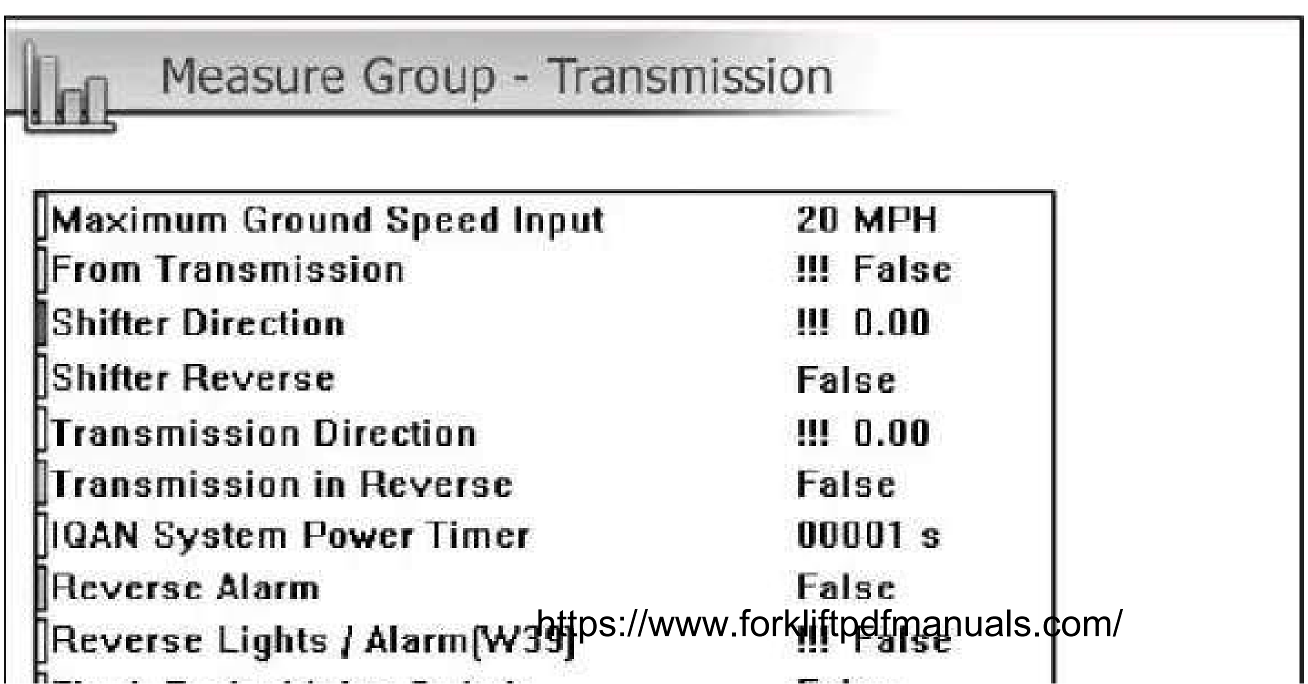
Engine Measure Group





DEPRESS TO TOGGLE BETWEEN
RAW AND SCALED VALUES

Cab Measure Group



Flash Brake Lights Switch	False
Brake Light Flash Timer	0.00 s
Brake Light Flasher	False
Brake Light Actuation	False
Transmission Gear	!!! 0.00
Transmission Output Fault	!!! 0.00
Shifter Gear	!!! 0.00
Shifter Fault	!!! 0.00
Vehicle Speed	!!! 0.00
Transmission Output Fault	False
Shifter Forward	False
Shifter Neutral	True
Shifter 1st	False
Shifter 2nd	False
Shifter 3rd	False
Shifter Fault	False
Shifter 4th	False
OPS	!!! False
Alternate Idle Switch	False
Brake Pressure	1683 Psi
Park Brake Switch	False

Raw value

(Continued)

DEPRESS TO TOGGLE BETWEEN RAW AND SCALED VALUES

Transmission Measure Group

(Continued)

Auto Apply Park Brake	True
Apply Park Brake	False
Neutral Lock Override	Neutral Lock E
Enter Neutral Lock	True
Auto/Manual Shift Mode	False
Shift Mode Select	Operator Cont
Auto Shift Mode Selected	False
Auto/Manual Shift Mode	0
Neutral Lock	1
Park Brake Invert	True
Park Brake	1

Upshift Inhibit	False
Upshift Inhibit	0
Maximum Ground Speed Conversion	32.2 km/h
Maximum Ground Speed	32
Starting Gear Select	False
Start in Second	False
Starting Gear	0
Allow Alternate Idle	False
Alternate Idle	0.00
Alternate Idle	0
Reduced Vehicle Speed	1
Reduced Vehicle Speed	1
Vehicle Speed Enhanced Resolution	True
Vehicle Speed Enhanced Resolution	1
To Transmission	True
Transmission Temperature	!!! 0.00
Transmission Temperature	!!! 0.00
High Transmission Temp	False
Engine Speed	0.00 rpm
Park Brake Solenoid	!!! False
Manual Shift Mode Selected	True

Raw value

(Continued)

DEPRESS TO TOGGLE BETWEEN RAW AND SCALED VALUES

Transmission Measure Group

(Continued)

Transmission in Forward	False
Transmission in Neutral	True
Transmission in 1st	False
Transmission in 2nd	False
Transmission in 3rd	False
Transmission in 4th	False
Forward Alarm On VD	False
Forward Alarm Control	Operator Cont
Forward alarm on	False
Forward Alarm	False
Forward Alarm(W33)	!!! False

Alternate Idle On	False
Alternate Idle Off	True
Low Brake Pressure Warn	False
Start In First	True
Neutral Lock Active	True
Warning Light State	!!! 0.00
Brake Light Flash Off	True
Vehicle Speed Conversion	0.00
Forward alarm On Text Control	False
Forward alarm Off Text Control	True
Forward Alarm Auto Text	False
Neutral Lock Inactive	False
Shift Prohibited	False
Manual Fwd Alarm Text Control	True
Auto/Man Text Display	True
Auto/Manual Mode	!!! 0.00
Shift in Progress	!!! 0.00
Fault State	!!! 0.00
Transmission Warning Light	False
Auto Fwd Alarm Text Control	False
Auto Locked Text Control	False

(Continued)

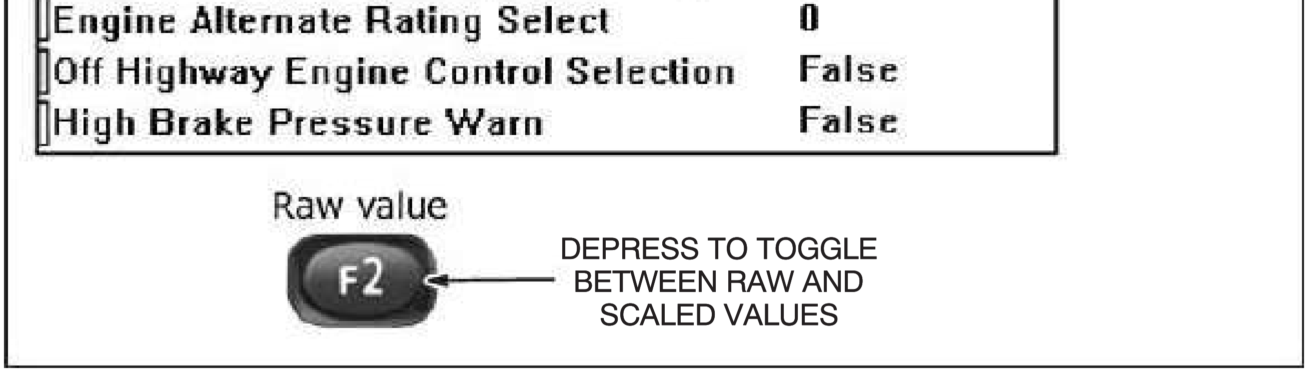
Raw value

DEPRESS TO TOGGLE BETWEEN RAW AND SCALED VALUES

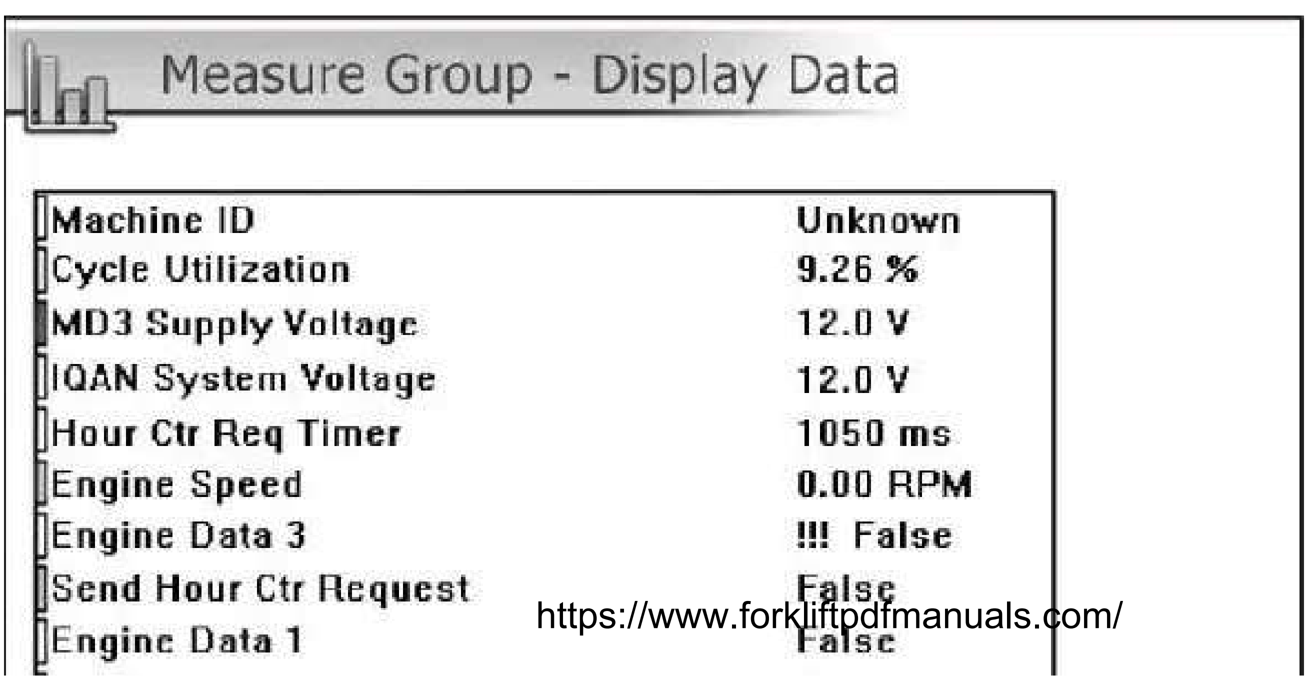
Transmission Measure Group

(Continued)

Fuel Consumption	False
Total Fuel Used	0.00 Gallons
Ambient Conditions	!!! False
Coolant Level	!!! 0.00
Engine Data 3	!!! False
Boost pressure	!!! 0.00
Intake Manifold Temperature	!!! 0.00
Power Down APC	False
APC Power Relay	!!! False
Engine Alternate Low Idle Switch	0
Alternate High Engine Speed Rating	0



Transmission Measure Group



Engine Data 2	False
Electrical System Parameters	!!! False
Engine Hours	0.00 Hours
Coolant Temperature	!!! 0.00
Oil Temperature	!!! 0.00
Engine Oil Pressure	!!! 0.00
System Voltage at Engine	!!! 0.00
coolant warning signal	False
engine oil pressure warning signal	True
system voltage signal	True
Low Brake Pressure	False psi
Startup Screen Timer	00001 Second
Pilot Pressure Switch	!!! False
Low Pilot Pressure	False
High Hyd Tank Temp	False
High Transmission Temperature	False
Misc Alarm Internal digital	True
Warning page hide	False
Warning Flash Timer	1.55 s
Warning Flash Internal digital	False
Misc Alarm DI (W60)	True

Raw value

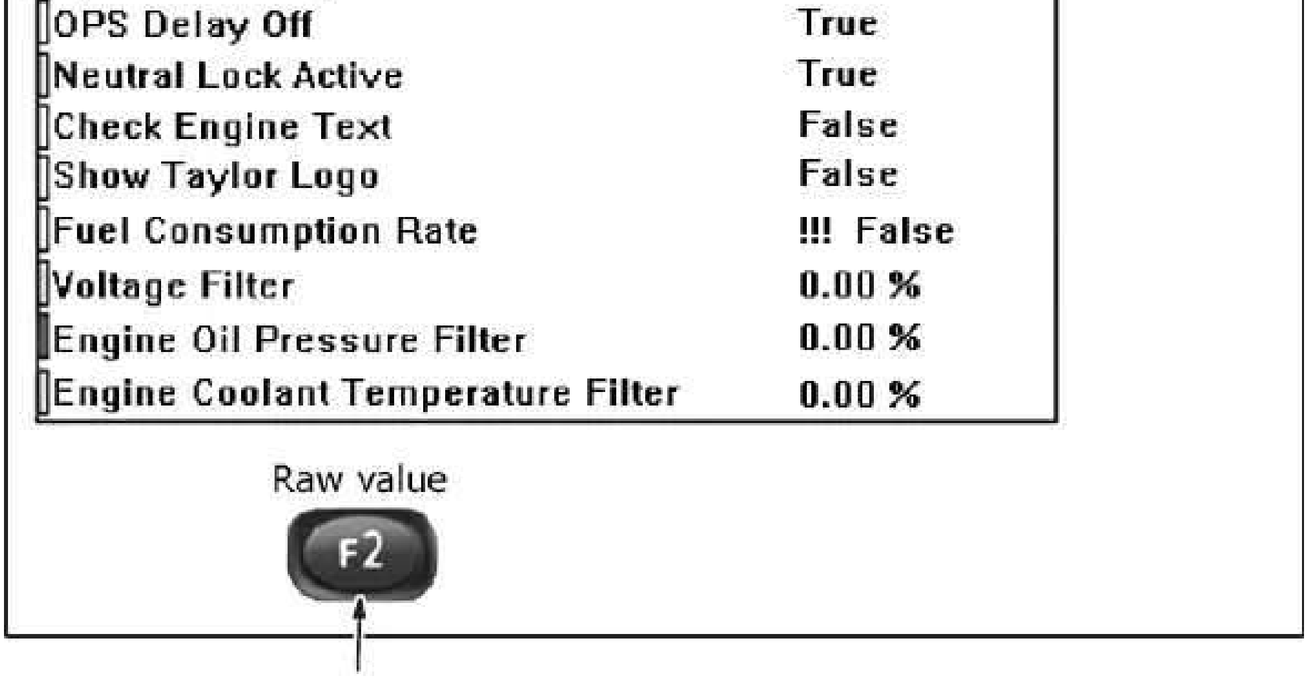
(Continued)

DEPRESS TO TOGGLE BETWEEN RAW AND SCALED VALUES

Display Data Measure Group

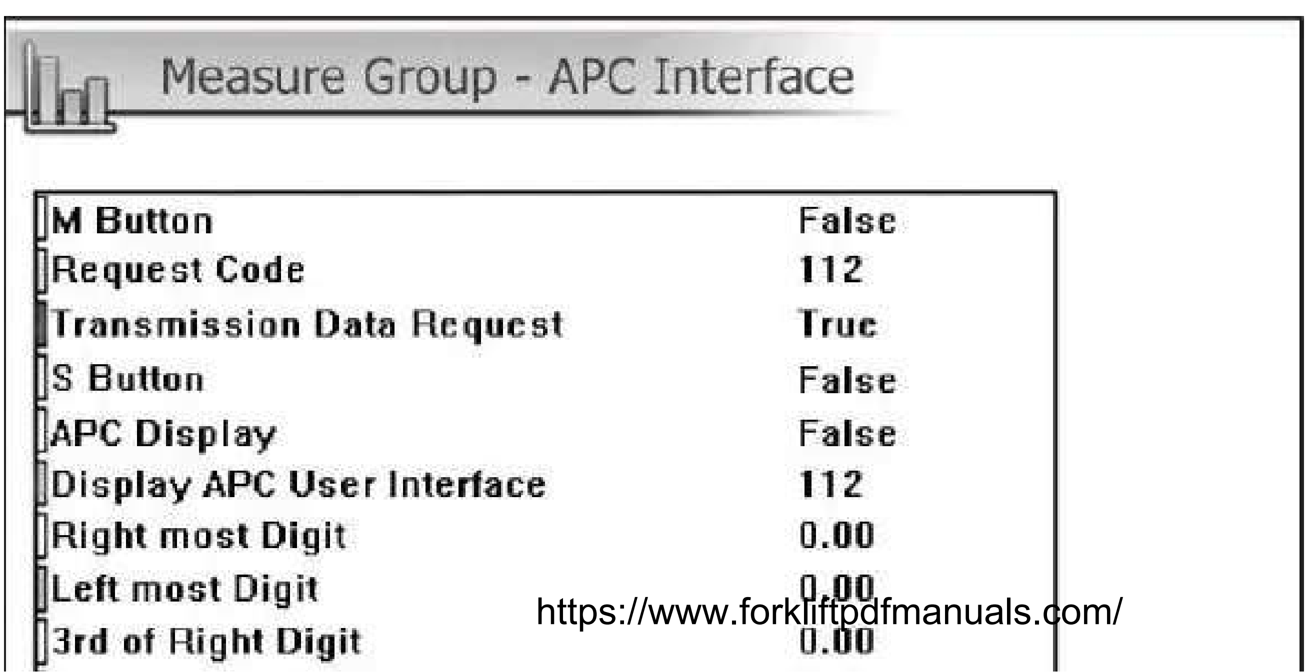
(Continued)

Idle Operation	False
Total Idle Fuel Used	0.00 Gallons
Total Idle Hours	0.00 Gallons
Fuel Consumption	False
Total Fuel Used	0.00 Gallons
Ambient Conditions	!!! False
Coolant Level	!!! 0.00
Engine Data 3	!!! False
Boost pressure	!!! 0.00
Intake Manifold Temperature	!!! True
Hyd Tank Temp Switch	!!! False



DEPRESS TO TOGGLE BETWEEN
RAW AND SCALED VALUES

Display Data Measure Group



2nd of Right Digit	0.00
D LED State	0.00
E LED State	0.00
M Button	0
S Button	0
Button control	4
Enable Button Control	4
Right most Digit Segment A	False
Right most Digit Segment B	False
Right most Digit Segment C	False
Right most Digit Segment D	False
Right most Digit Segment E	False
Right most Digit Segment F	False
Right most Digit Segment G	False
Right most Digit Segment DP	False
2nd of Right Digit Segment A	False
2nd of Right Digit Segment B	False
2nd of Right Digit Segment C	False
2nd of Right Digit Segment D	False
2nd of Right Digit Segment E	False
2nd of Right Digit Segment F	False

(Continued)

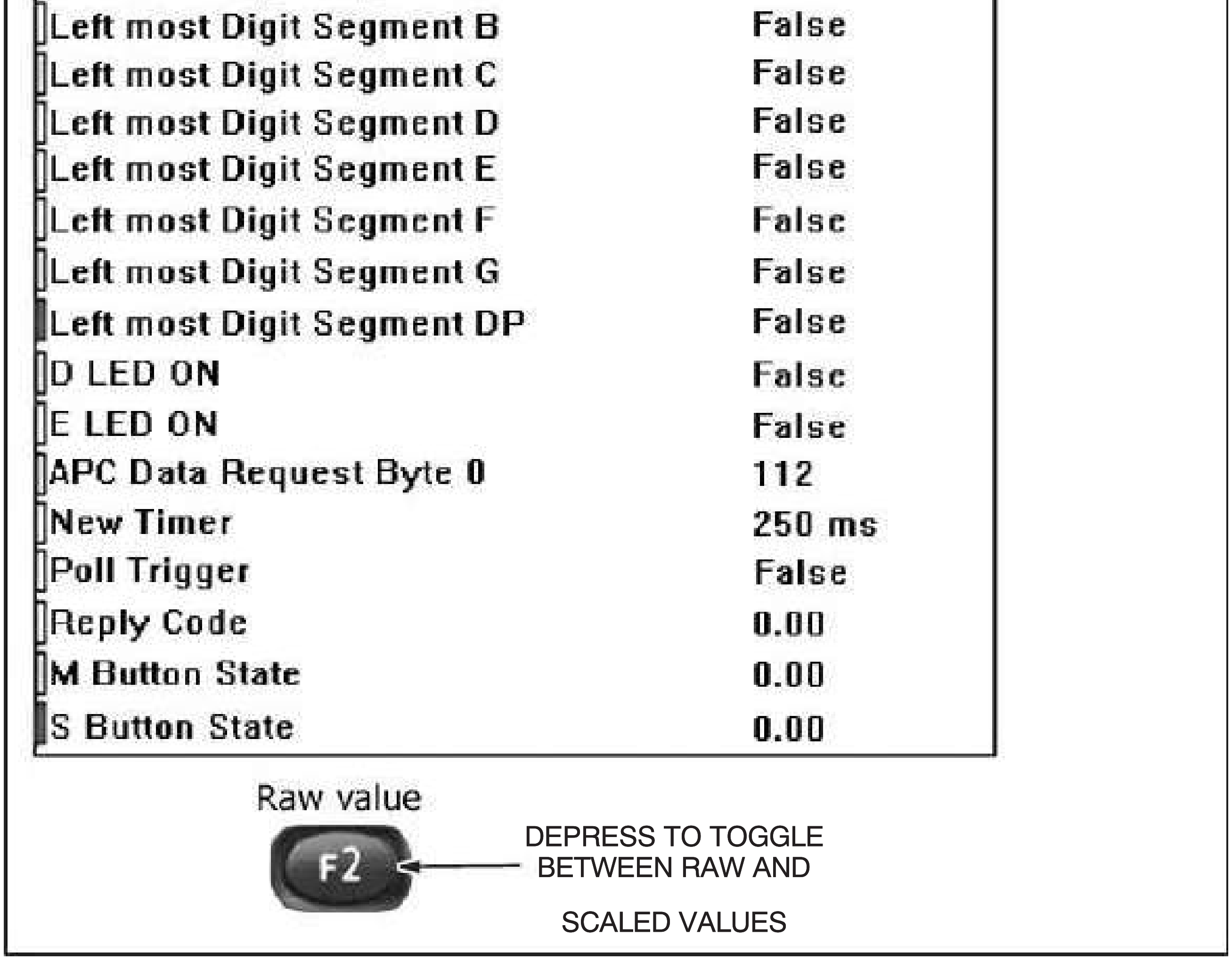
Raw value

DEPRESS TO TOGGLE BETWEEN RAW AND SCALED VALUES

APC Interface Measure Group

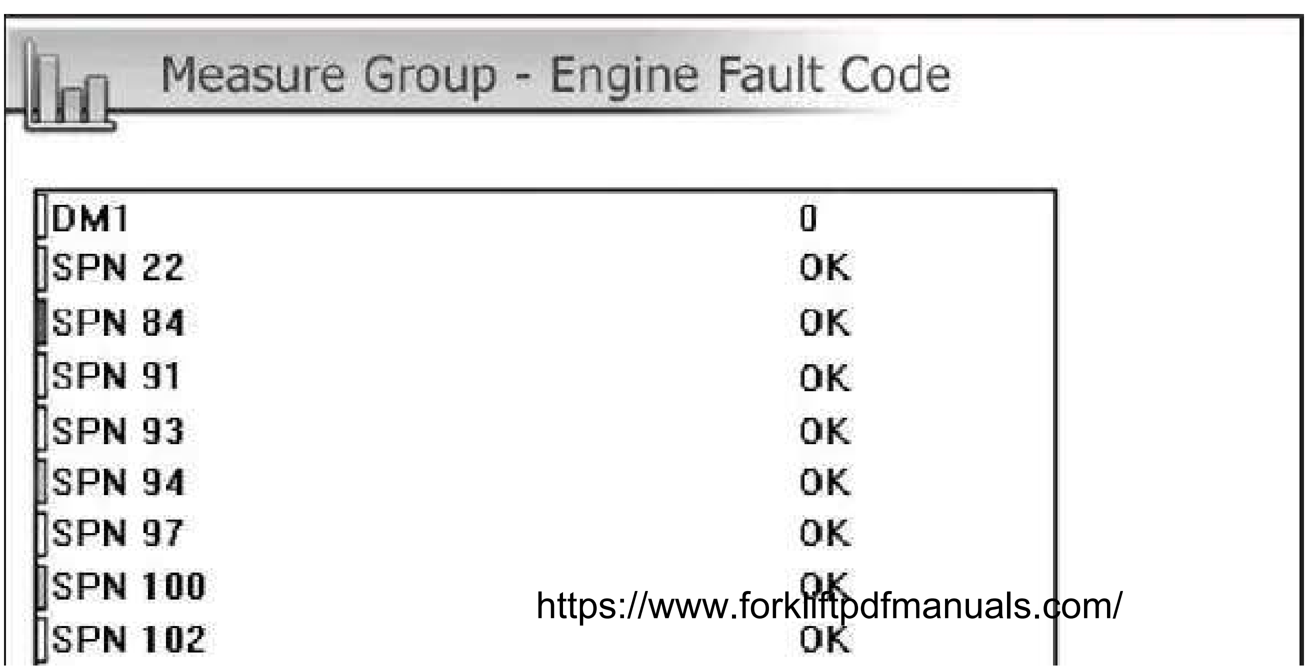
(Continued)

2nd of Right Digit Segment G	False
2nd of Right Digit Segment DP	False
3rd of Right Digit Segment A	False
3rd of Right Digit Segment B	False
3rd of Right Digit Segment C	False
3rd of Right Digit Segment D	False
3rd of Right Digit Segment E	False
3rd of Right Digit Segment F	False
3rd of Right Digit Segment G	False
3rd of Right Digit Segment DP	False
Left most Digit Segment A	False



Left most Digit Segment B	False
Left most Digit Segment C	False
Left most Digit Segment D	False
Left most Digit Segment E	False
Left most Digit Segment F	False
Left most Digit Segment G	False
Left most Digit Segment DP	False
D LED ON	False
E LED ON	False
APC Data Request Byte 0	112
New Timer	250 ms
Poll Trigger	False
Reply Code	0.00
M Button State	0.00
S Button State	0.00

APC Interface Measure Group



Measure Group - Engine Fault Code

DM1	0
SPN 22	OK
SPN 84	OK
SPN 91	OK
SPN 93	OK
SPN 94	OK
SPN 97	OK
SPN 100	OK
SPN 102	OK

SPN 103	OK
SPN 105	OK
SPN 108	OK
SPN 109	OK
SPN 110	OK
SPN 111	OK
SPN 157	OK
SPN 166	OK
SPN 167	OK
SPN 168	OK
SPN 171	OK
SPN 174	OK
SPN 175	OK
SPN 190	OK
SPN 251	OK
SPN 441	OK
SPN 558	OK
SPN 611	OK
SPN 612	OK
SPN 627	OK
SPN 629	OK

(Continued)

Raw value

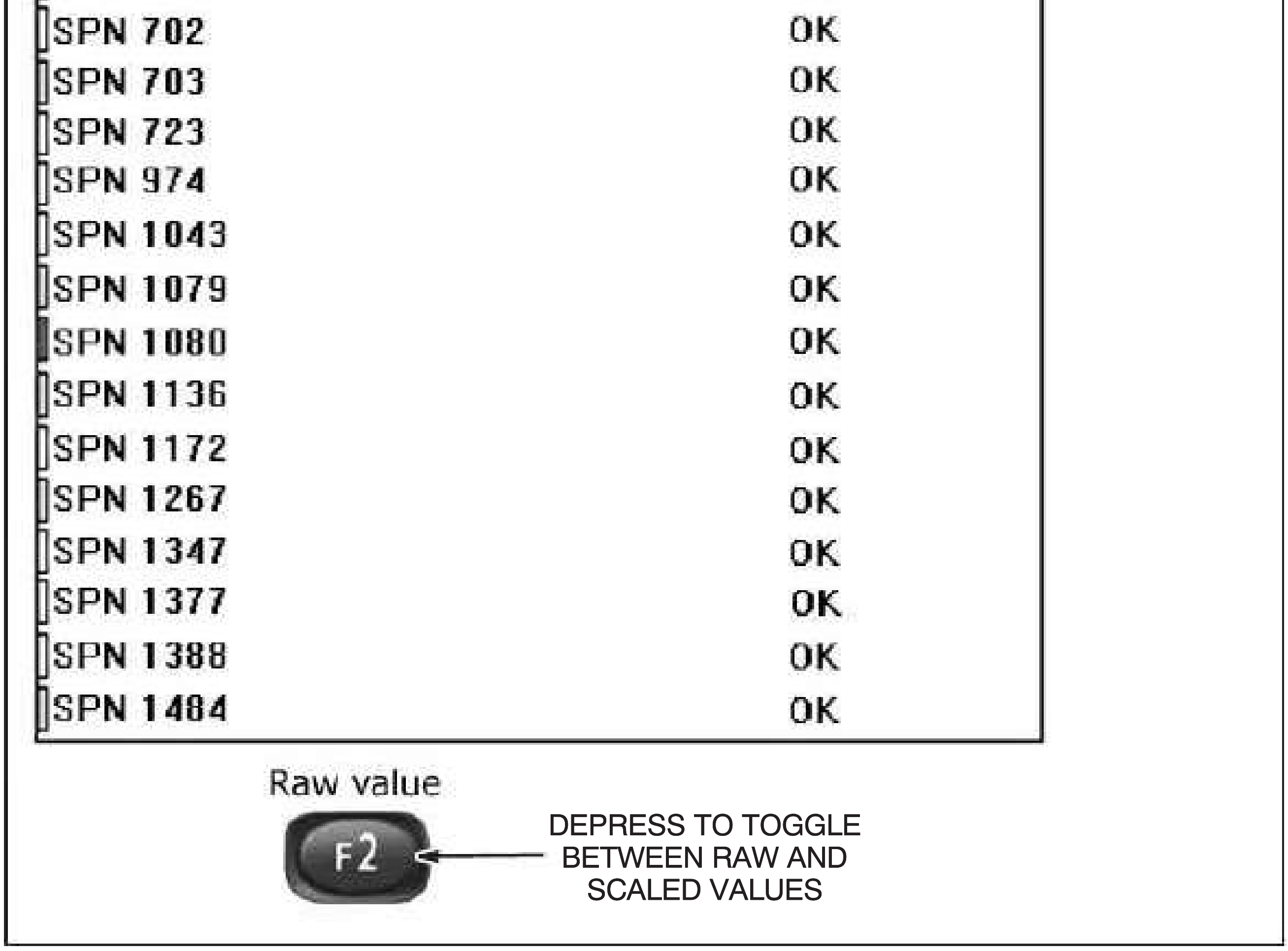
F2

DEPRESS TO TOGGLE BETWEEN RAW AND SCALED VALUES

Engine Fault Code Measure Group

(Continued)

SPN 630	OK
SPN 639	OK
SPN 644	OK
SPN 647	OK
SPN 651	OK
SPN 652	OK
SPN 653	OK
SPN 654	OK
SPN 655	OK
SPN 656	OK
SPN 677	OK



Engine Fault Code Measure Group

Valve Current Setting Adjustments

The valves (used to actuate the tilt and hoist functions) are controlled by output modules. There are four settings that can be adjusted for each function and the range of values allowed is controlled by the software. These parameters (minimum current, maximum current, start ramp time and stop ramp time) are set by Taylor personnel during the initial set up of the truck. It may be necessary to adjust these settings over time due to component wear or replacement. These values are accessed through the operational display, via the adjust groups.

Perform the following procedures to adjust the settings:

Operational Display

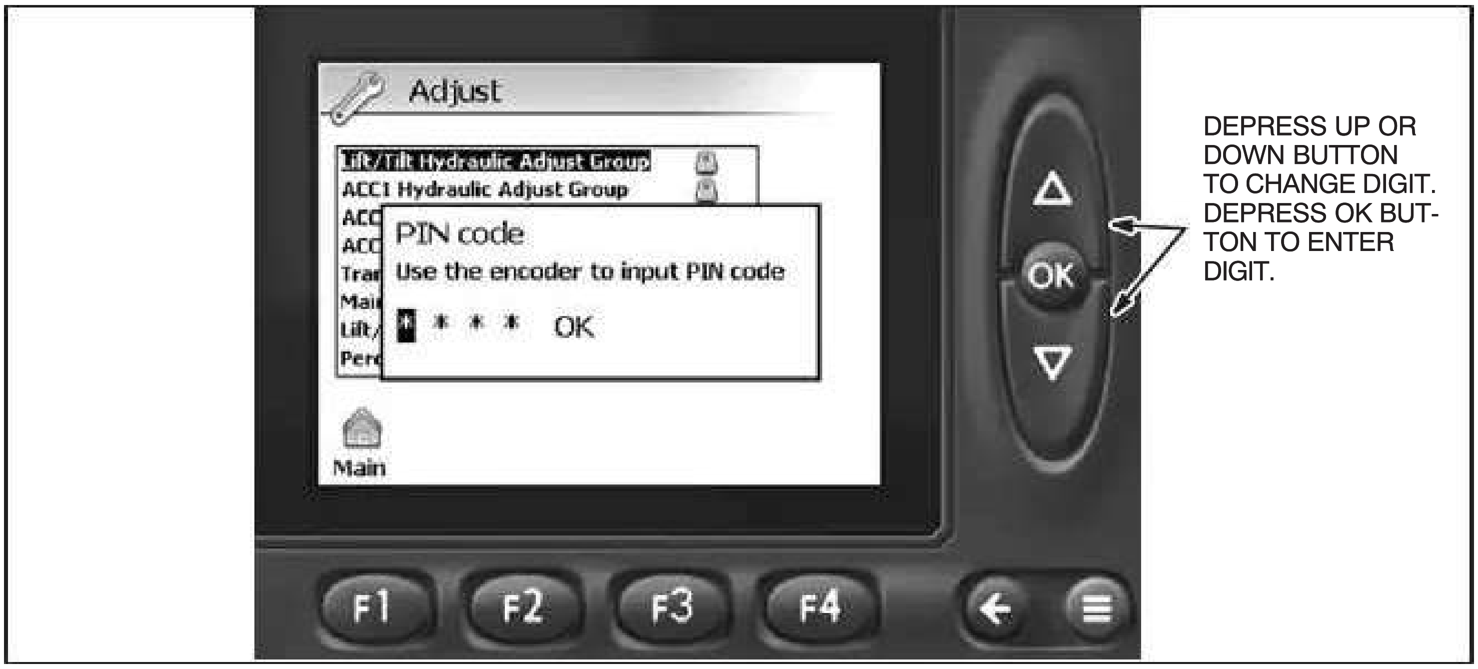
1. From the Main Display screen, depress the Measure / Adjust Groups button (≡). This will display the Main Measure / Adjust screen.

Main Select Screen

2. At the Main Measure / Adjust screen, depress F1 (Adjust). This will bring up the Adjust screen.

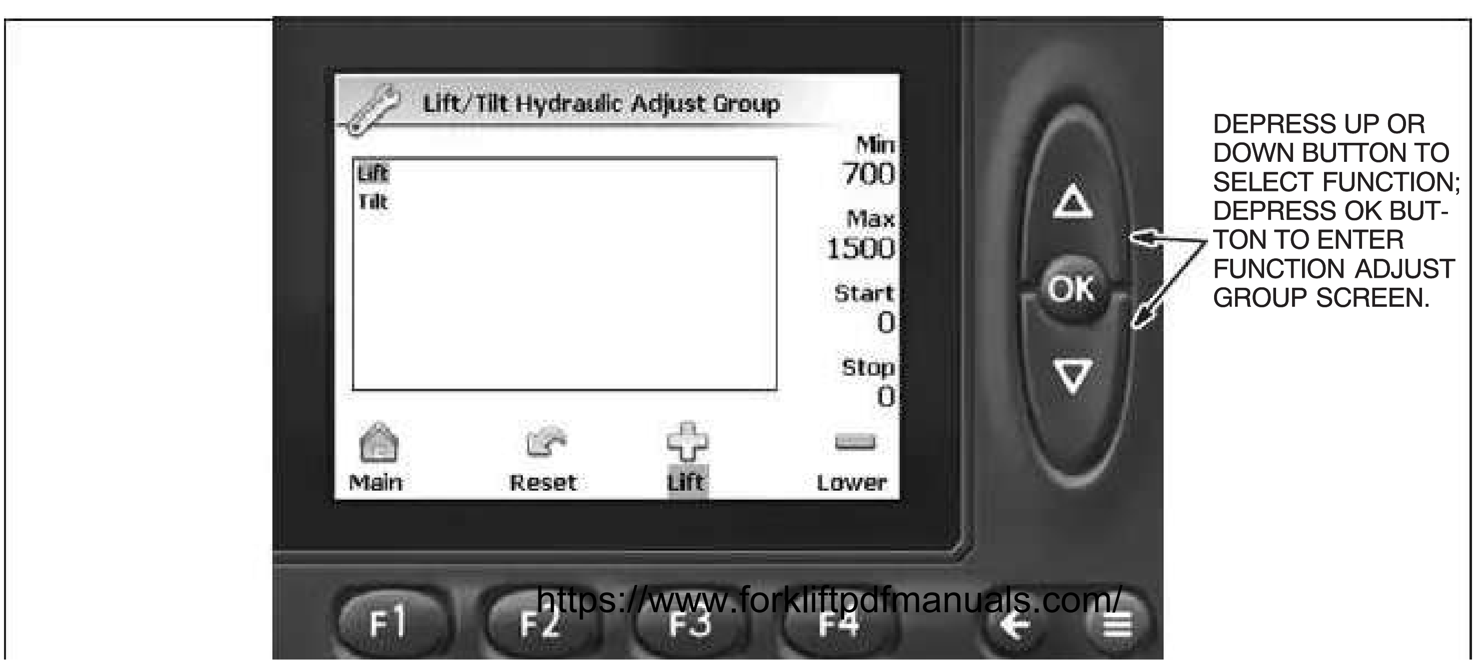
Adjust Groups Screen

3. Depress the UP or DOWN button to highlight the desired adjust group and depress the OK button to make setting adjustments to the selected group. The PIN code screen will appear. The correct PIN code must be entered before the software will allow any adjustments to be made. **NOTE:** Taylor personnel will provide qualified maintenance personnel with the Pin Code necessary to make adjustments within adjust groups.



PIN Code Screen

4. From the PIN code screen, depress the UP or DOWN button until the first numeric digit appears in the first field. Depress the OK button to enter the numeric digit and advance to the next field. Repeat this procedure until all four numeric digits have been entered. After the code has been entered, OK will be highlighted; depress the OK button to enter PIN code.



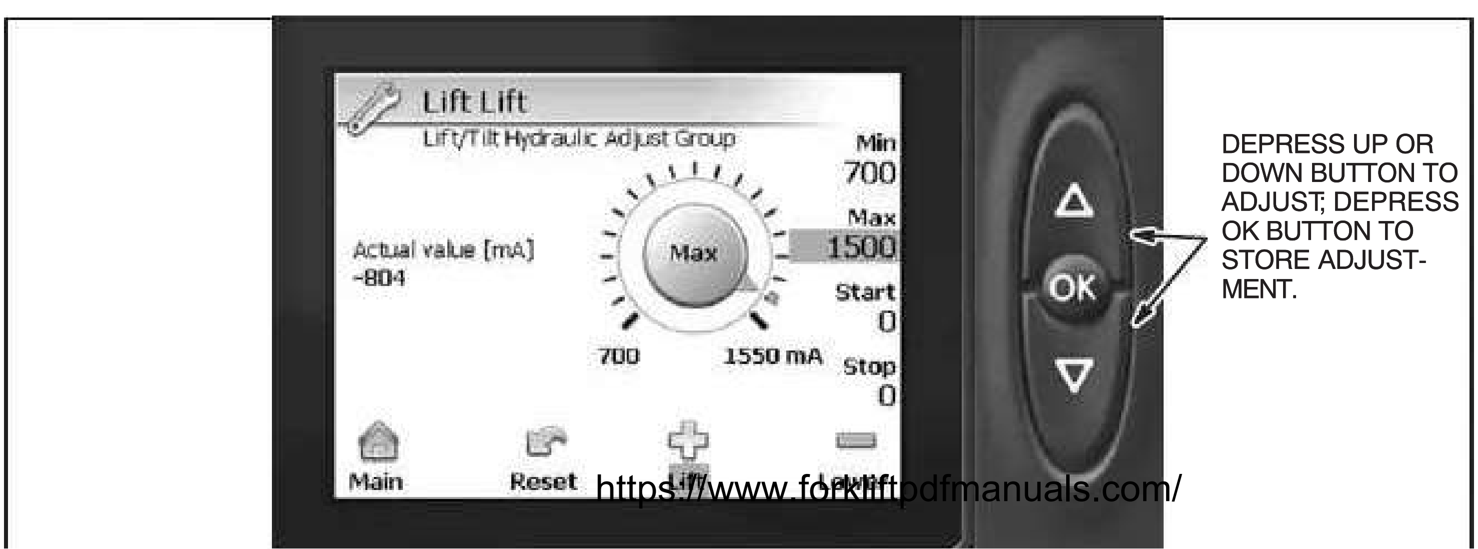
Lift / Tilt Adjust Group Screen

5. Depress the UP or DOWN button to select the function in which setting adjustments are to be made. With the function selected, depress the OK button to access the settings. Ensure that Lift is highlighted and depress the OK button.

Lift (Min Setting) Screen

6. This parameter is used to calibrate the minimum amount of current sent to the lift valve when lifting. With the engine running, fully actuate the joystick to the lift position. Slowly depress the UP or DOWN button until the mast just begins to lift the carriage. Observe the value underneath the Min value parameter (upper right–hand of display). Add 50 counts to the value at which the mast just began to creep upward (depress the UP button until the Min value is 50 counts higher than the count at which the mast began to creep upward). Depress the OK button to store the value into the processor and advance to the Max)parameter of this screen by depressing the OK button again. **NOTE:** The Plus

function (+, F3 button) extends the cylinder while the Minus function (–, F4 button) retracts the cylinder.



Lift (Max Setting) Screen

7. The Max parameter of Lift is used to calibrate the maximum amount of current sent to the lift valve when lifting. The desired setting is the value that no noticeable increase in speed is obtained after the value is exceeded. Ensure that the Max value is highlighted on the upper right side of the display (depress the OK button if the Min value is highlighted). With the engine running, fully actuate the joystick to the lift up position. Slowly depress the UP or DOWN button until there is no noticeable increase in the speed at which the carriage moves. Depress the OK button to store the value into the processor and depress the ← button (back) to go back to the Adjust Groups screen.
8. Repeat these procedures for adjusting the setting(s) of the other TICS system parameters.

WARNING: The ignition switch should be turned to its Off position after maintenance personnel have made setting adjustments within the TICS system. Failure to do so, gives Unauthorized personnel access to change settings within the TICS system.

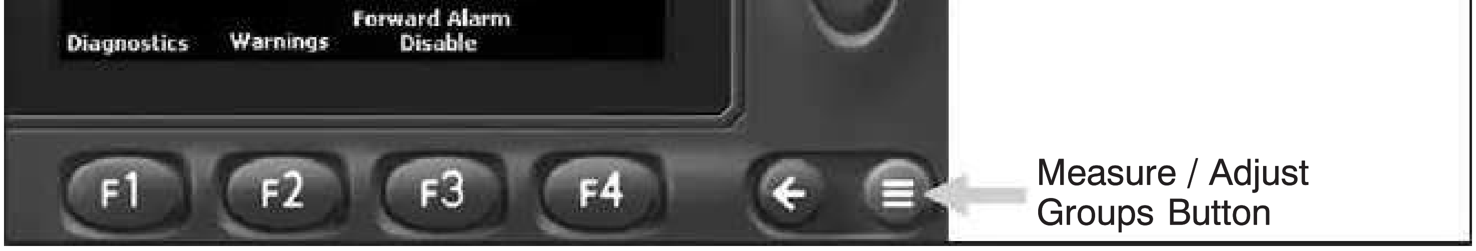
Valve Current Default Settings

Adjustment Group	Default Settings
Hoist - Up (+) / Down (–)	Min - 800 / 600 Max - 1500 / 1075 Start - 250 / 0 Stop - 250 / 250
Tilt - Out (+) / In (–)	Min - 750 / 750 Max - 1500 / 1350 Start - 0 / 0 Stop - 250 / 250

NOTE: Depress the F2 button (Reset) to return the selected function back to its default setting.

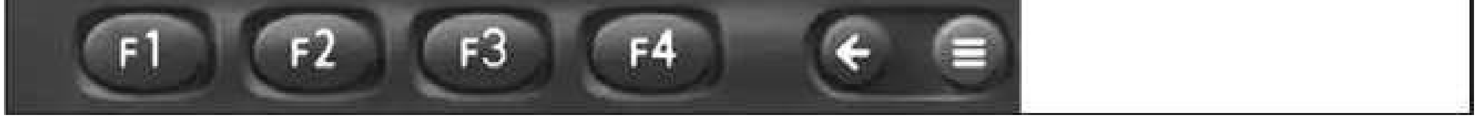
Percent Ground Speed Allowed Setting Procedure

The following procedure must be performed with the truck parked and the parking brake set.

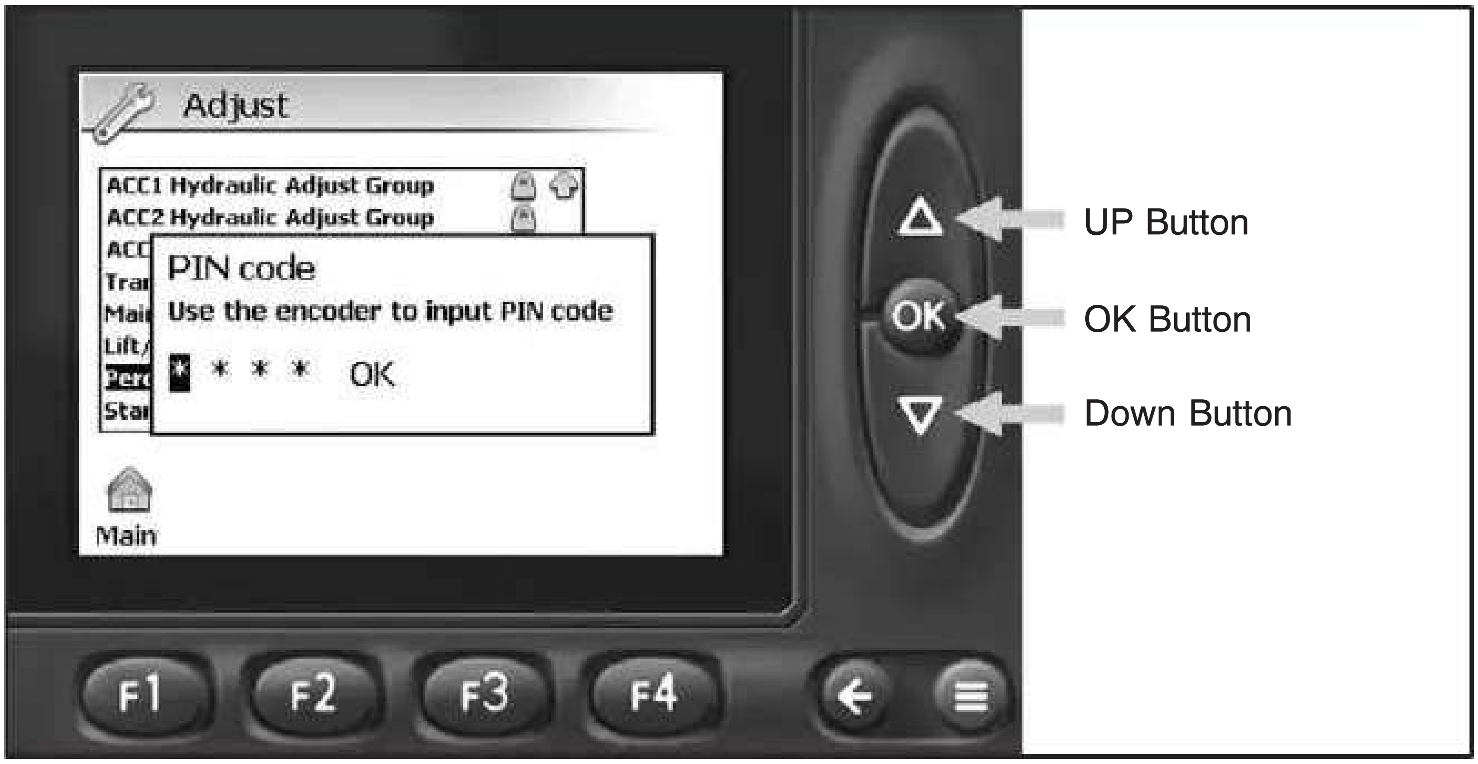


1. At the Main screen of the TICS display module, depress the the Measure / Adjust Groups button (≡) as indicated by arrow above to access the Main Measure / Adjust screen.

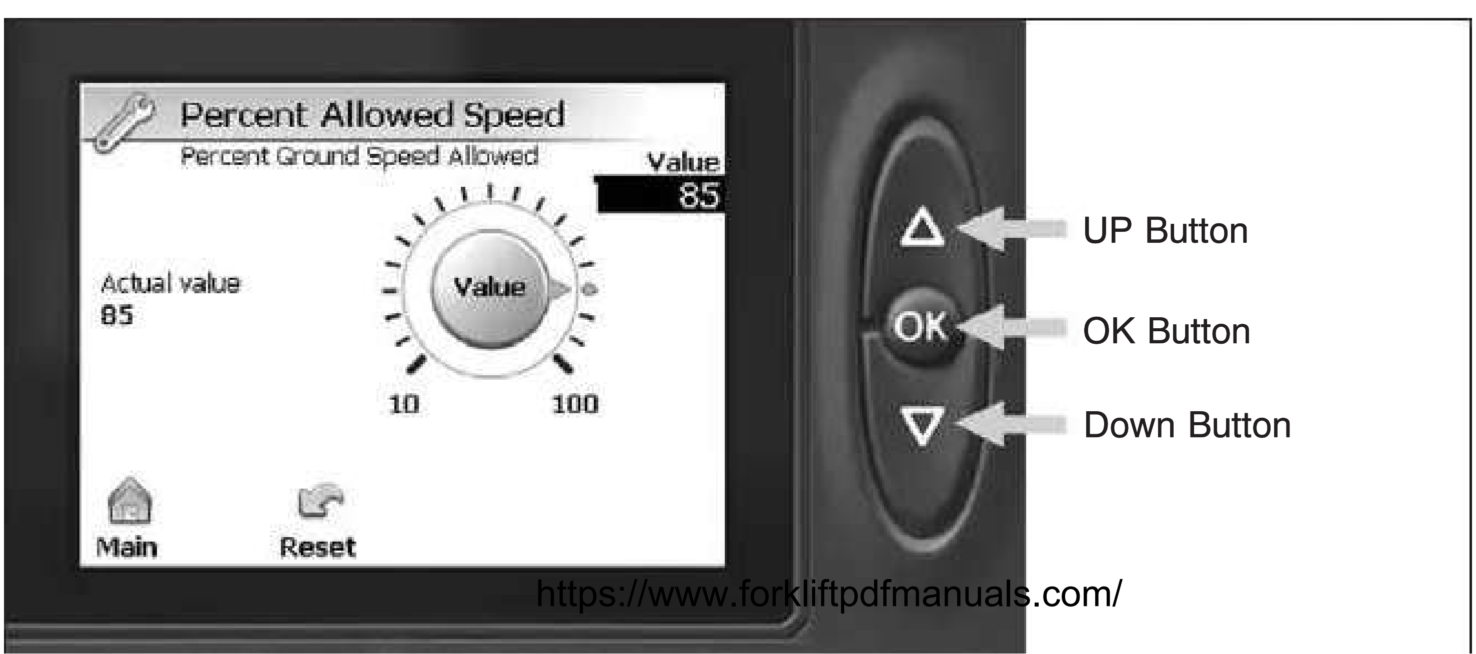
2. At the Main Measure / Adjust screen, depress the F1 button (as indicated by the arrow above) to access the Adjust screen.



3. Select the Percent Ground Speed Allowed adjust group by depressing the UP or Down button (as indicated by the arrows above) and depress the OK button to view the adjust group. The PIN code screen will appear. The correct PIN code must be entered before the software will allow any adjustments to be made.



4. Depress the UP or Down button (as indicated by the arrows above) until the first numeric digit appears in the first field. Depress the OK button to enter the numeric digit and advance to the next field. Repeat this step until all four numeric digits have been entered. After the code has been entered, OK will be highlighted; depress the OK button to enter PIN code and view the Percent Ground Speed Allowed adjust group. Depress the OK button again to make adjustments.



5. Depress the UP or Down button (as indicated by the arrows above) to adjust the percentage of Allowed Ground Speed. Depress the OK button to accept the new Percent Ground Speed adjustment. **NOTE:** The F2 button (Reset) may be depressed to reset the Allowed Ground Speed percentage back to 100% if necessary.

6. Depress the Measure / Adjust Groups button (≡) as indicated by arrow above to return to the Main Display screen. **NOTE:** At the above screen, the Percent Ground Speed Allowed percentage is displayed on the right side.

7. Depress the F1 button (as indicated by arrow above) to access the Select Diagnostic Option screen.

8. Depress the F2 button (as indicated by arrow above) to access the Transmission Information screen to view the new Maximum Ground Speed allowed for truck travel.

BACK

9. After viewing the Maximum Ground Speed (indicated to the left of the arrow illustrated on the above screen), depress the BACK (←) button to return to the Main Display screen.

Resetting The Service Timer

The Service Timer should be reset after scheduled maintenance has been performed. Perform the following procedures to reset the Service Timer:

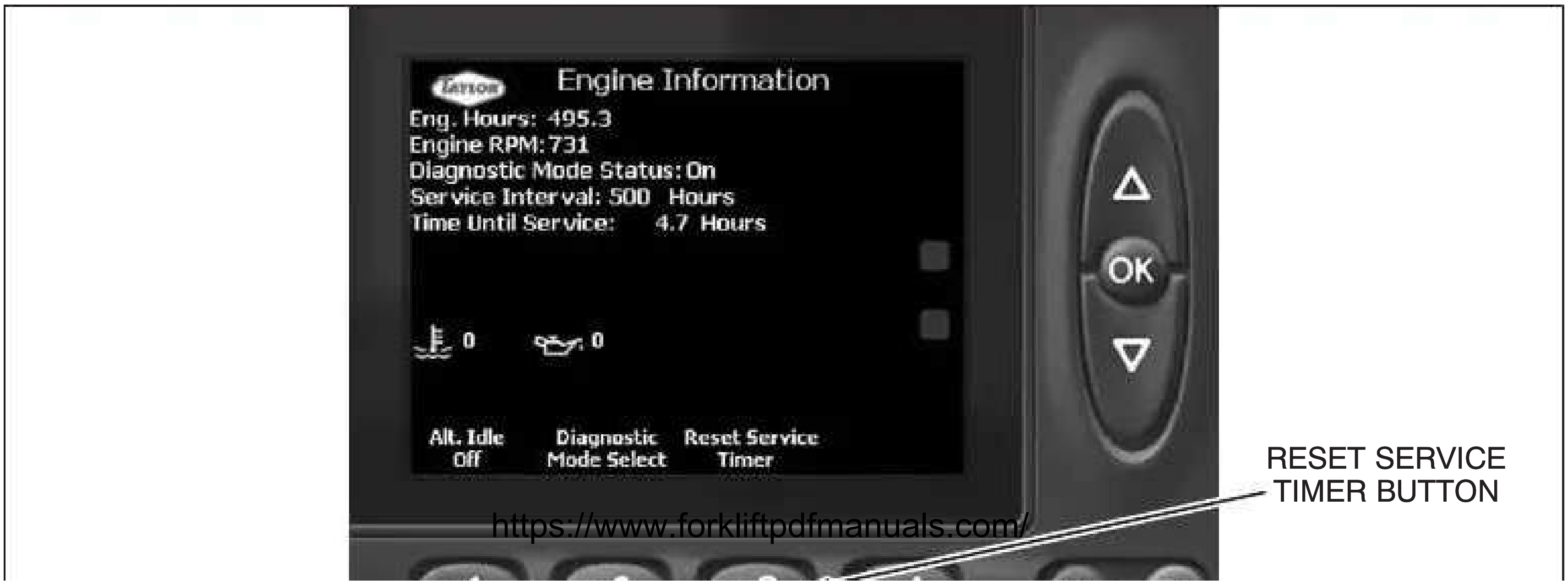
The following procedure must be performed with the truck parked and the parking brake set.

Main Display Screen

1. Turn the ignition key to its accessory position (first click). From the Main Display screen, depress the F1 button (Diagnostics) to access the Diagnostics Select screen.

Diagnostics Select Screen

2. At the Diagnostics Select screen, depress the F1 button (Engine) to access the Engine Information screen.



Maintenance Timer Reset Screen

3. At the Engine Information screen, depress the F3 button (Reset Service Timer) to access the Maintenance Timer Reset screen.

Maintenance Timer Reset Screen

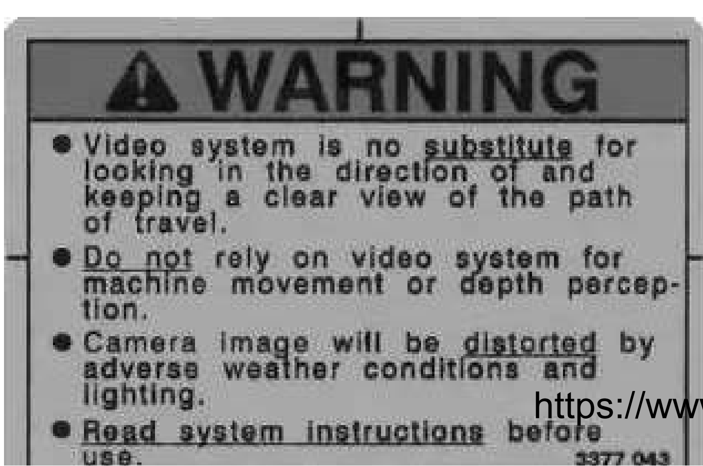
4. At the Maintenance Timer Reset screen, enter each number of the Pin Code by depressing the F1 through F4 buttons.

Maintenance Timer Reset Screen

5. After the Pin Code number has been entered, depress the Down Button to reset the Maintenance Timer. Depress the OK button to exit the Maintenance Timer Reset screen and return to the Engine Information screen.

Closed Circuit TV Cameras and Monitors

Introduction. The camera system (if equipped) gives the operator a vantage view from a remote mounted camera, strategically placed, dependant on operational requirements.



4. **Volume Buttons.** Depress the upper button to increase the volume of the monitor; depress the lower button to decrease the volume.
5. **Brightness Buttons.** Depress the upper button to increase the brightness of the monitor's display; depress the lower button to decrease the brightness.

Monitor. The orientation of the image being displayed by the monitor is controlled by a magnetic plug located in the rear of the camera (see Illustration 6A-1).

Monitor Operation (Illustration 6A-2). The following describes the monitor's controls.

1. **Power Button.** Depress this button to turn the monitor on (button illuminated green).

   Depress this button again to turn the monitor off. This button will be illuminated red when the monitor is on and in Standby mode.

2. **Camera Select Button.** Depress this button to view the video from camera 1 (CA1). Depress this button to view the video from camera 2 (CA2).

3. **Menu Button.** Depress this button to display the main menu of the monitor. To navigate through the main menu, depress the Brightness Buttons. To change the content of a selected menu item, depress the Camera Select Button. The main menu consists of the following adjustable items:

   a. **Color.** Depress the Camera Select Button to change the color depth of the displayed images.

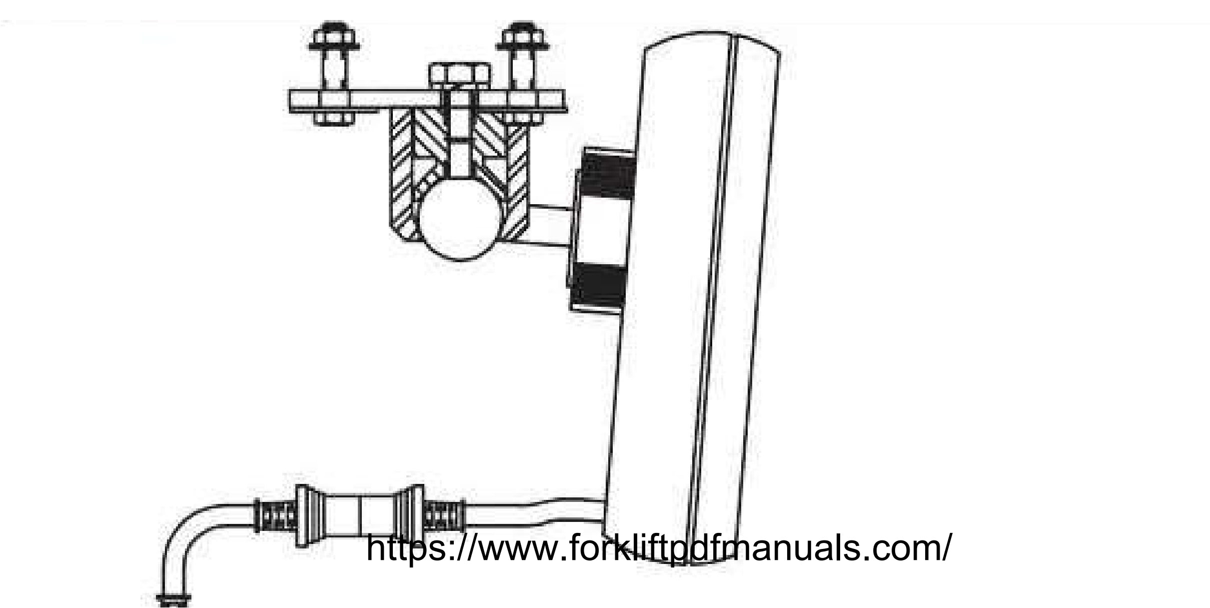
   b. **Contrast.** Depress the Camera Select Button to change the contrast level of the displayed images.

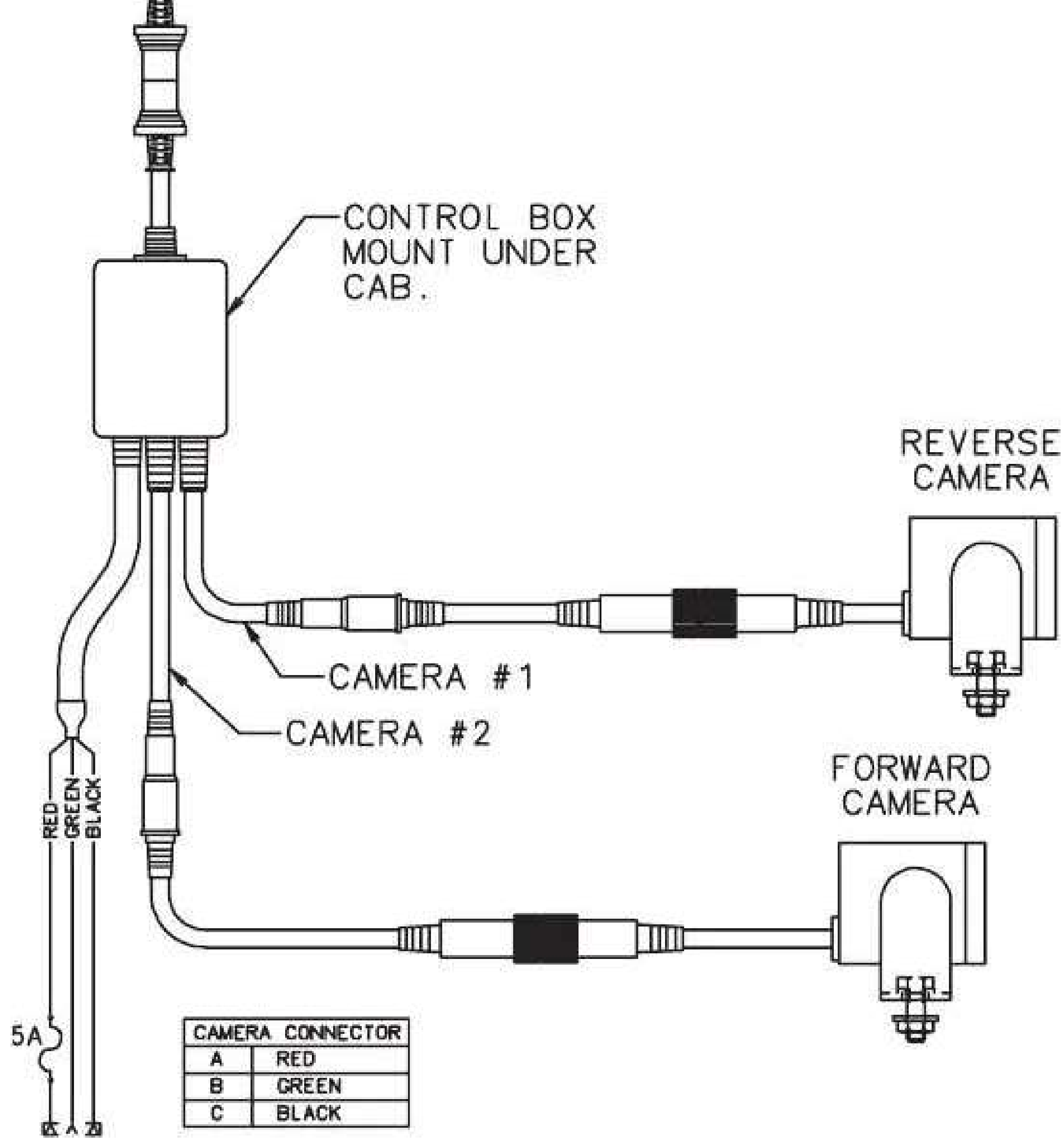
   c. **Tint.** Depress the Camera Select Button to change the color coordination of the displayed images.

Illustration 6A-1. Camera

Illustration 6A-2. Monitor

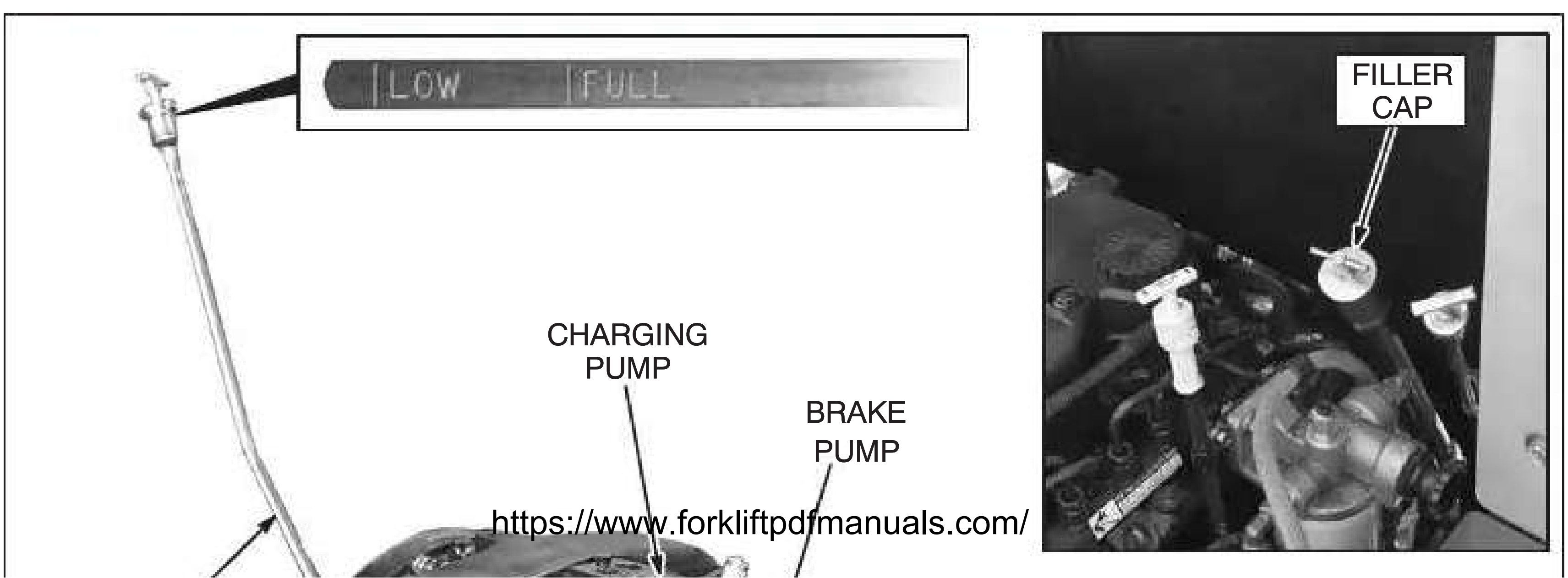
Illustration 6A-3. Camera Circuit





06C-0108

Transmission



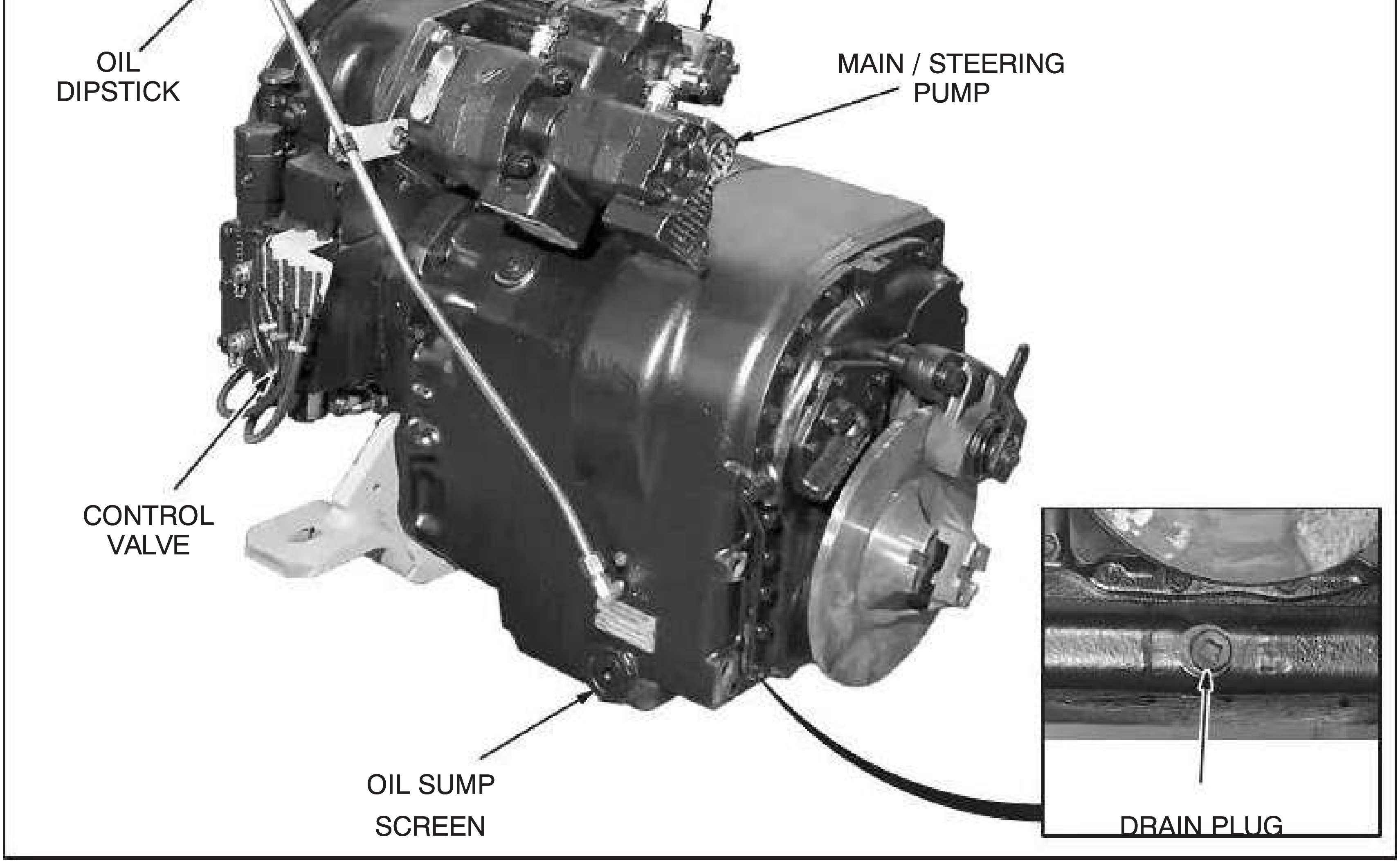


Illustration 9-1. TC-32 Transmission

Introduction. The TC-32 transmission is a powershift transmission which provides three speeds forward and three speeds reverse. Both direction and speed range are controlled by a roll shift mechanism attached to the steering column.

Operation. With the engine running, the transmission's converter charging pump draws transmission oil from the transmission sump through the oil sump screen and directs it through the pressure regulating valve and oil filter. The pressure regulating valve maintains pressure to the transmission control valve for actuating the direction and speed clutches. This requires only a

small amount of transmission oil. The remaining oil is directed through the torque converter circuit to the transmission oil cooler and returns to the transmission for positive lubrication. After entering the converter housing, the oil is directed through the stator support to the converter blade cavity and exits in the passage between the turbine shaft and converter support. The oil then flows out of the converter to the oil cooler. After leaving the cooler, the oil is directed back to the transmission.

The torque converter turbine receives oil at its center. The reaction member of the torque converter takes the oil which is exhausting from the inner portion of the turbine and changes its direction to allow correct entry for recirculation into the

and are connected to the output shaft of the converter either by direct gearing or drive shaft. The purpose of the directional or speed clutches is to direct the power flow through the gear train to provide the desired speed range. Refer to **Section 9C** for electrical operation of the transmission control valve.

Transmission Oil Level Check (Illustration 9-1)**.** The oil level of the transmission should be checked daily, with the oil at normal operating temperature [180 to 200°F+ (82 to 93°C+)] and the engine operating at low idle. The oil level should be up to the FULL mark on the dipstick. The dipstick is located inside the engine hood, on the engine's right side.

impeller element.

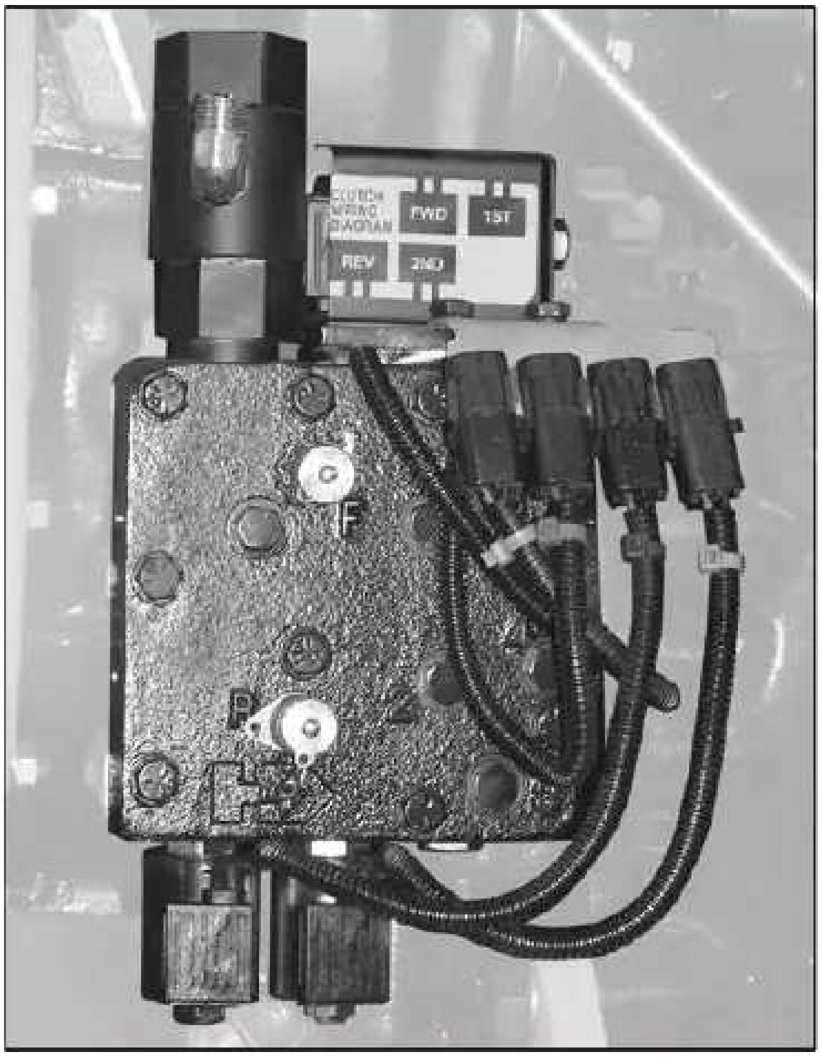


Illustration 9-2. Transmission Control Valve

Transmission Control Valve (Illustration 9-2)**.** The transmission control valve directs oil, under pressure, to the desired directional and speed clutch. The directional and speed clutch assemblies are mounted inside the transmission case

Illustration 9-3. Transmission Oil Filter

Transmission Oil Filter Replacement (Illustration 9-3). The oil filter, **located below the drive line spring brake**, should be replaced periodically (refer to the **Preventive Maintenance** chart in the **Appendices** for oil filter replacement interval). The interval listed in the **Appendices** is based on normal environmental condition, excessive dust may require a more frequent filter replacement interval. Perform the following procedures to change the filter:

WARNING: Death or serious injury could

result from a runaway truck. Park truck on a hard, level surface, apply parking brake, block wheels in both directions to prevent movement of truck and Lock Out & Tag Out truck before servicing truck.

CAUTION: Dispose of transmission oil and filter in accordance with federal and local regulations.

NOTE: *It is recommended that the filters be changed after 100 hours of operation on new and rebuilt or repaired transmissions.*

1. Make certain filter is cool to the touch, then

3. Clean the oil screen thoroughly.

NOTE: *An accumulation of sludge or soft dirt in the sump should be removed with flushing oil.*

4. Use a new gasket and re-install the oil screen. Tighten the oil screen to 10-15 ft-lbs (14-20 N·m).
5. Refer to **Transmission Oil Filter Replacement** for procedures to change the filter element.
6. Re-install the drain plug.
7. Refer to **Filling The Transmission**, located below, for adding oil to the transmission.
8. Operate the engine and check for leaks.

provide a suitable container to catch any draining oil, and unscrew filter and dispose of filter properly.

2. Apply an even film of fresh oil to the gasket surface of the replacement filter and then thread filter onto filter head.
3. Hand tighten filter 3/4 turn past point where gasket first contacts filter head surface.
4. Refer to **Filling The Transmission** for adding oil to the transmission.

Changing The Transmission Oil (Illustration 9-1). The transmission oil should be changed periodically (refer to the **Preventive Maintenance** chart in the **Appendices** for transmission oil change interval).

WARNING: Death or serious injury could result from a runaway truck. Park truck on a hard, level surface, apply parking brake, block wheels in both directions to prevent movement of truck and Lock Out & Tag Out truck before servicing truck.

CAUTION: Dispose of transmission oil and filter in accordance with federal and local regulations.

Perform the following procedures to change the transmission oil:

1. Provide a suitable container and remove the drain plug to drain the oil.
2. Remove the oil screen and gasket.

8. Operate the engine and check for leaks. When the transmission's oil temperature reaches 180 to 200°F+ (82 to 93°F+), make a final oil check and add oil to bring the oil level to the FULL mark on the dipstick.

Filling The Transmission (Illustration 9-1). Perform the following procedures to fill the transmission with oil:

1. With the engine shut down, fill the transmission to the LOW mark on the dipstick.
2. Operate the engine and check for leaks. When the transmission's oil temperature reaches +180°F to +200°F (+82°F to +93°F) and the engine operating at low idle, make a final oil check and add oil to bring the oil level to the FULL mark on the dipstick.

Cleaning The Transmission Breather. The breather should be checked for restriction and cleaned periodically (refer to the **Preventive Maintenance** chart in the **Appendices** for transmission breather cleaning interval). The prevalence of dirt and dust will determine the frequency at which the breather requires cleaning. Perform the following procedures to clean the transmission breather:

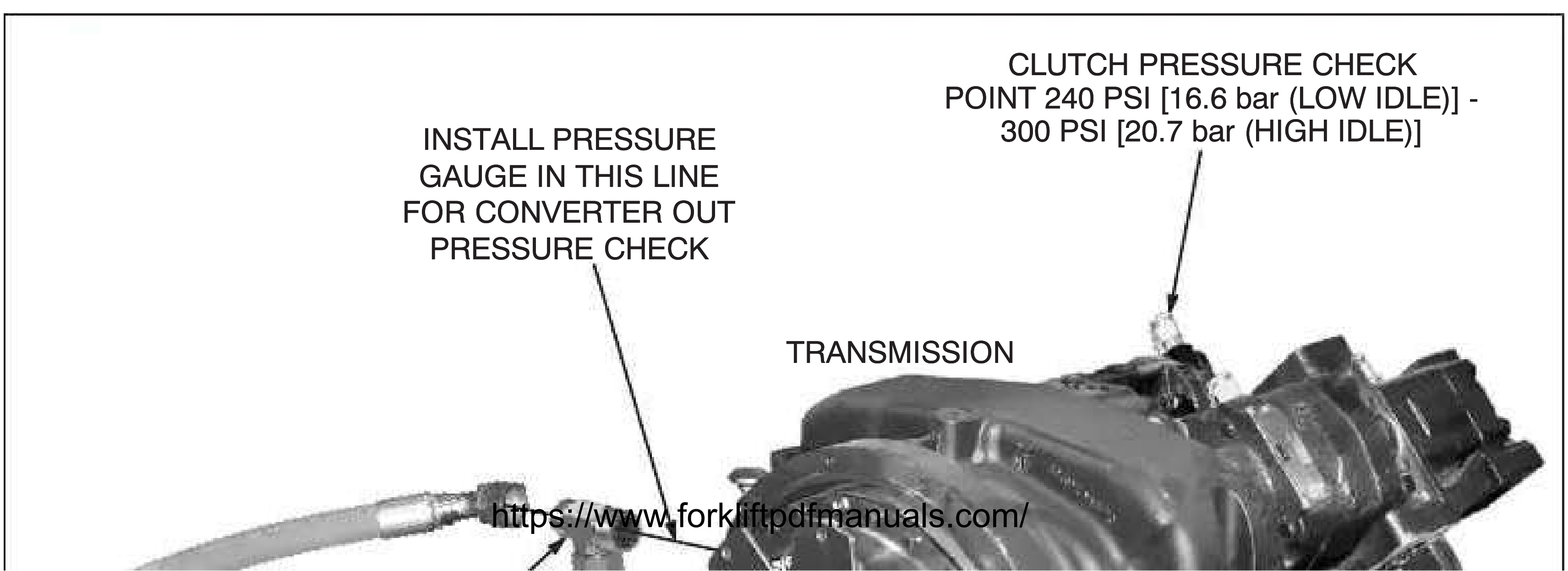
1. Clean the area around the breather before removing it.

NOTE: *Care must be exercised when removing the breather to avoid damaging the breather.*

2. Remove the breather.
3. Wash the breather thoroughly in solvent and dry it with compressed air.
4. Re-install the breather.

General Information

Oil Pressure (low idle)	240 psi (16.6 bar)
Oil Pressure (high idle)	300 psi (20.7 bar)
Oil Temperature	180 - 200°F (82 - 93°C)
Oil Capacity	26 Quarts (24.6 Liters)


CLUTCH PRESSURE CHECK
POINT 240 PSI [16.6 bar (LOW IDLE)] -
300 PSI [20.7 bar (HIGH IDLE)]
INSTALL PRESSURE
GAUGE IN THIS LINE
FOR CONVERTER OUT
PRESSURE CHECK
TRANSMISSION

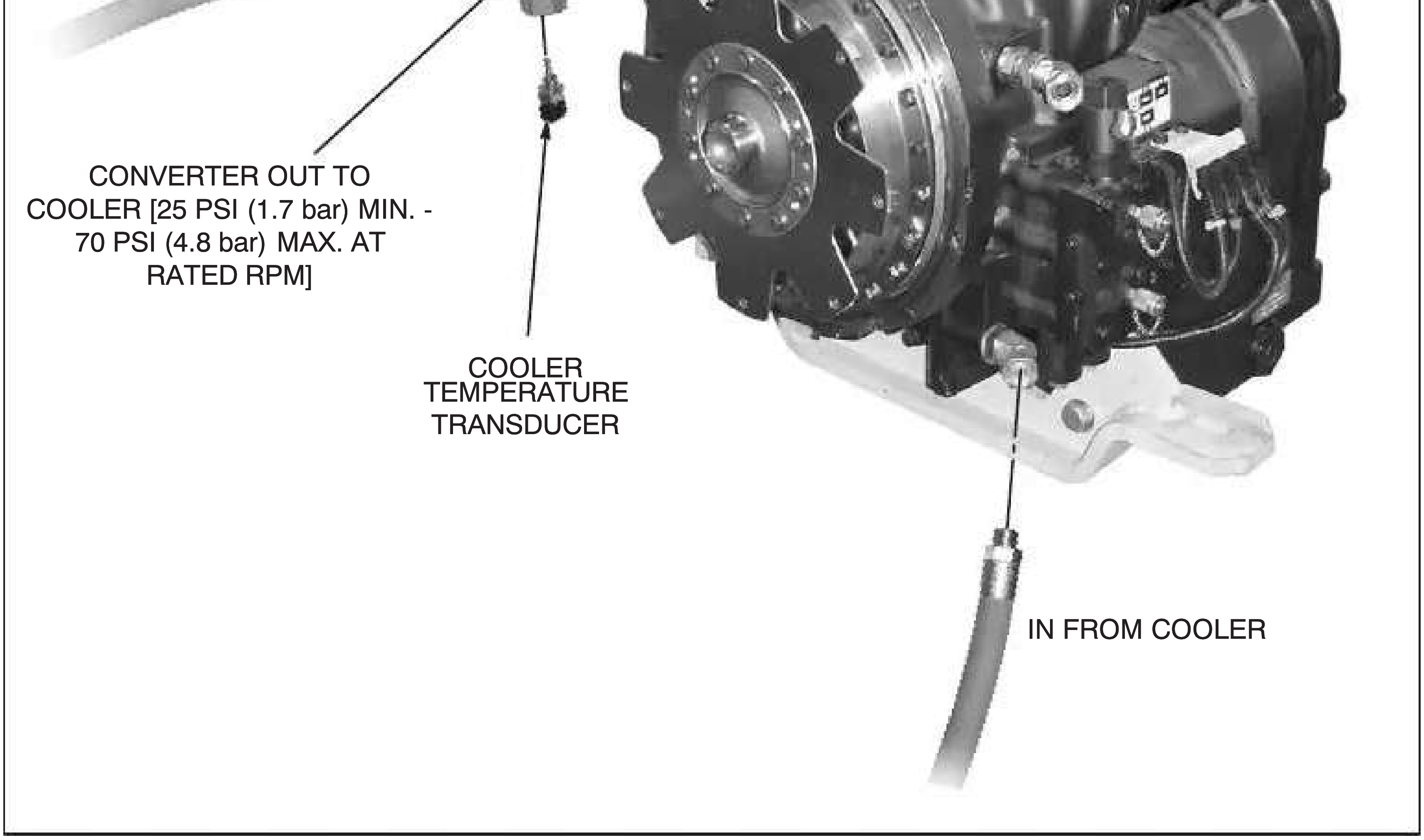
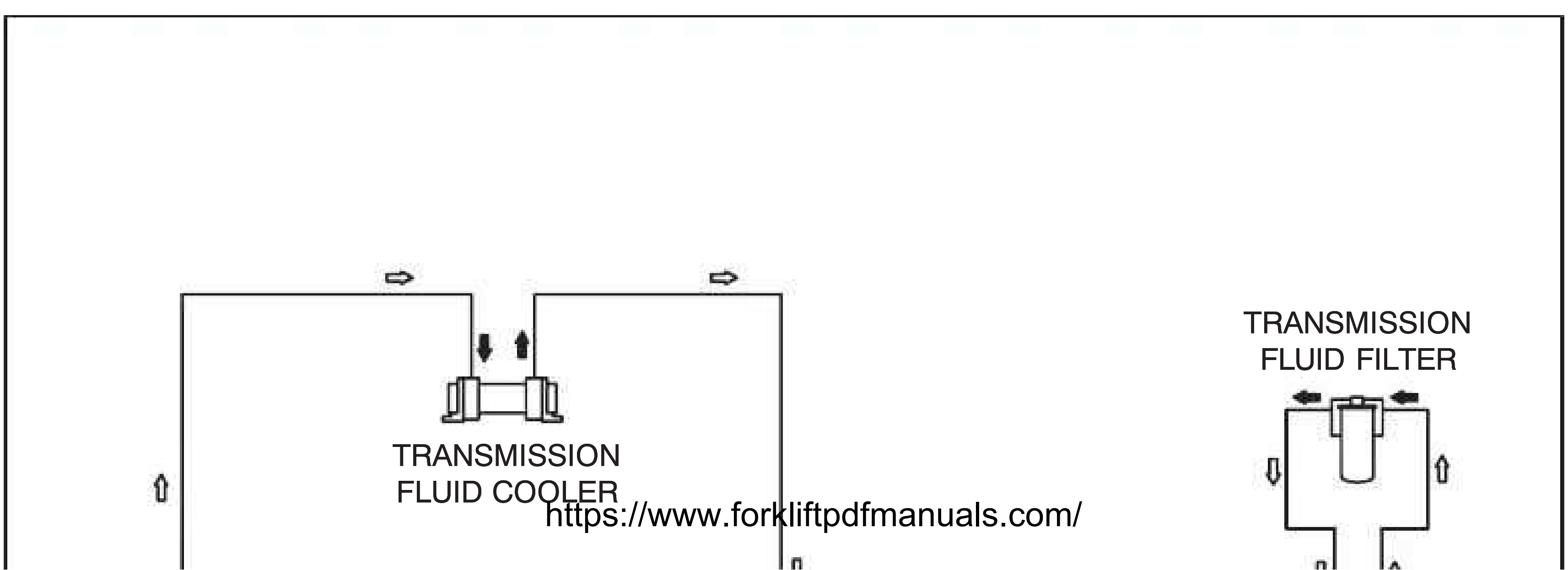


Illustration 9-4. Transmission Check Points



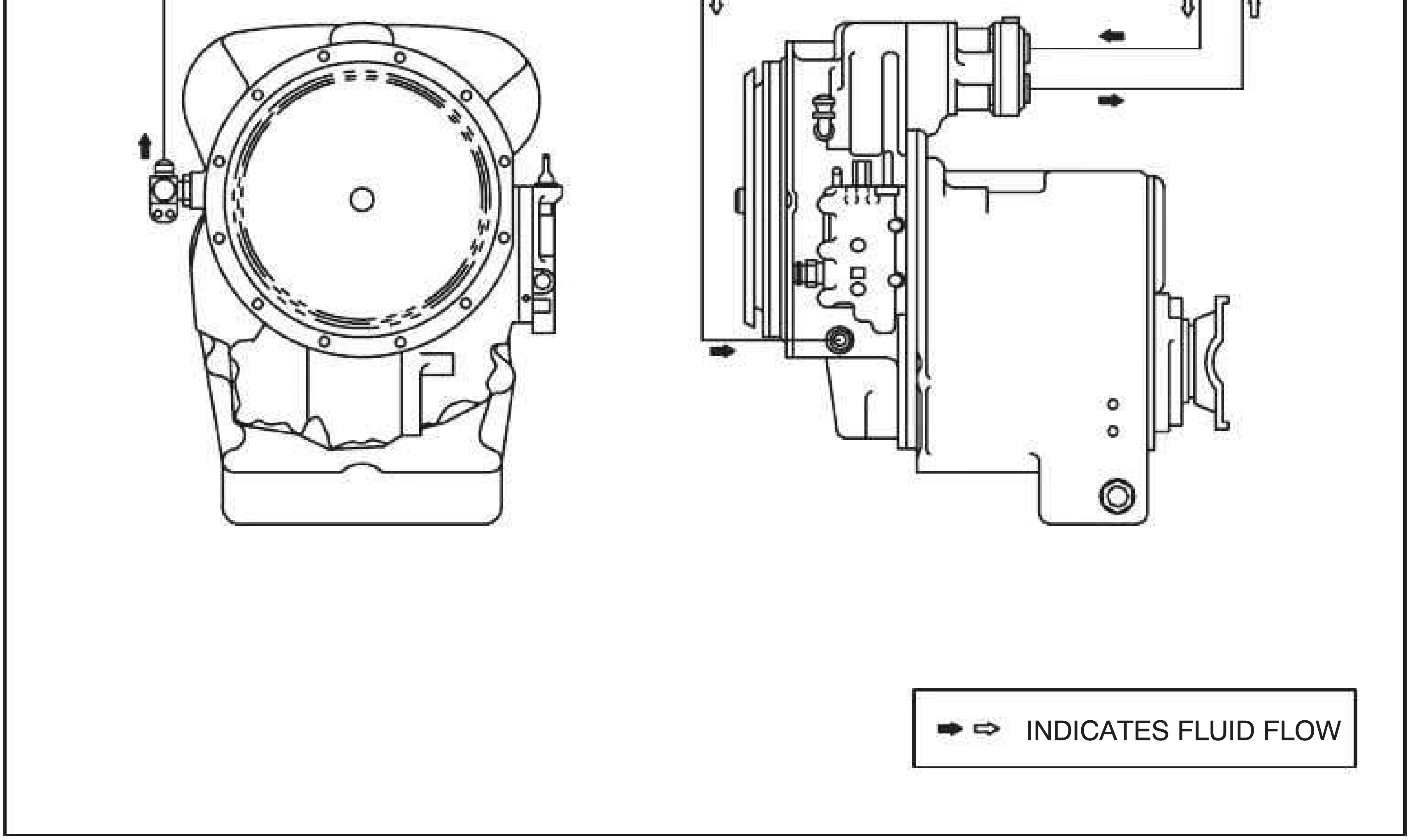


Illustration 9-5. Transmission Oil Flow

Transmission Troubleshooting

Electrical / Mechanical Checks. Prior to checking any part of the system from a hydraulic standpoint, the following electrical / mechanical checks should be made.

1. Ensure that the proper solenoids on control valve are energized. When the solenoids are energized they become magnetized. A magnetic field can be checked at the nut that holds the solenoid to the cartridge. Some solenoids employ a metal nut, encased in plastic, which will require removal to detect a magnetic field. An effective way to accomplish this is with a metal wrench.

2. Ensure that the inching valve is not engaged

2. Work the machine to bring the oil temperature up to the operating range (refer to step 1. above).

NOTE: *If the machine cannot be worked, the converter can be stalled to bring the temperature up to the operating range. Perform the following procedures to stall the converter.*

3. With the right service brake pedal applied, move the shifter to the forward position and third gear selected.
4. Continue to apply the brakes and accelerate the engine approximately one-half to three-quarter throttle for 30 seconds, let off accelera-

nor sticking.

Hydraulic Checks. Before checking the torque converter, transmission, and associated hydraulic system for pressures and rate of flow, it is essential that the following preliminary checks be made.

NOTE: *Do not attempt these checks with cold oil.*

1. Check the oil level in the transmission. This should be done with the oil temperature between +180° F and +200° F (+82°F to +93°F), and the engine operating at idle.

tor for 10 seconds.

5. Repeat step 4. until the desired converter outlet temperature is reached.

CAUTION: Full throttle stall speeds for an excessive length of time will overheat the converter.

6. When checking the pressures, always check the charge pump and converter out pressures first.

Problem	Cause	Correction
1. Low clutch pressure	1. Low oil level.	1. Fill to proper level.
	2. Clutch pressure regulating valve spool is stuck open.	2. Clean valve spool and housing.
	3. Defective charging pump [240 - 300 psi (16.6 - 20.7 bar) normal operating pressure].	3. Replace charging pump.
	4. Broken or worn clutch shaft or piston sealing rings.	4. Replace sealing rings or clutch shaft.
	5. Clutch piston bleed valve stuck open.	5. Clean bleed valves thoroughly.
2. Low converter charging pump output	1. Low oil level.	1. Fill to proper level.
	2. Suction screen plugged.	2. Clean suction screen.
	3. Air leaks at pump intake hose and connections or collapsed hose.	3. Tighten all connections or replace hose if necessary.
continued	4. Defective charging pump.	4. Replace charging pump.

Problem	Cause	Correction
2. Low converter charging pump output (Continued)	5. Clogged transmission filter.	5. Replace transmission filter.
	6. Defective pressure regulator.	6. Replace or rebuild pressure regulator.
3. Noisy converter	1. Worn coupling gears.	1. Replace coupling gears.
	2. Worn charging pump.	2. Replace charging pump.
	3. Worn or damaged bearings.	3. A complete disassembly will be necessary to determine which bearing is faulty.

	4. Low charging pump pressure.	4. Refer to Problem **2.** of this trouble-shooting chart.
	5. Excessive internal leakage in converter.	5. Rebuild or replace transmission.
4. Overheating	1. Low oil level.	1. Fill to proper level.
	2. Oil cooler vents are restricted.	2. Clean oil cooler.
	3. Worn transmission bearing.	3. Replace or rebuild transmission.
	4. Worn oil sealing rings.	4. Remove, disassemble, and rebuild converter assembly.
	5. Worn charging pump.	5. Replace charging pump.
	6. Pump suction line taking in air.	6. Check connections and tighten securely.
	7. Open circuit between the engine ECM (Electronic Control Module) and transmission temperature transducer.	7. Isolate and repair.
	8. Defective transmission tempera-ture transducer.	8. Replace transmission temperature transducer.
5. Lack of power	1. Low engine RPM at converter stall.	1. Tune engine and check governor.
	2. Worn oil sealing rings.	2. Remove, disassemble, and rebuild converter assembly.
	3. Worn charging pump.	3. Replace charging pump.
	4. Low oil level.	4. Fill to proper level.
	5. Restriction in hydraulic circuit.	5. Remove restriction.

Problem	**Cause**	**Correction**
6. No Forward	1. Defective solenoid or cartridge in control valve.	1. Swap the Forward and Reverse cartridges and solenoids; if the fault changes from Forward to Reverse, the solenoid or cartridge is defective. To determine which is defective, switch the solenoids only. If the fault did change, replace the defective solenoid. If fault did not change, replace cartridge.
	2. Reverse clutch pack plates are fused together.	2. Place the transmission in the neutral position and rev up the

		engine. If the truck tries to move in reverse, clutch plates are fused together. Replace or rebuild transmission.
	3. Defective regulators in the modulator valve.	3. Replace the modulator valve.
	4. Spools are sticking in control valve body.	4. Clean or replace defective parts.
7. No Reverse	1. Defective solenoid or cartridge in control valve.	1. Swap the Forward and Reverse cartridges and solenoids; if the fault changes from Reverse to Forward, the solenoid or cartridge is defective. To determine which is defective, switch the solenoids only. If the fault did change, replace the defective solenoid. If fault did not change, replace cartridge.
	2. Forward clutch pack plates are fused together.	2. Place the transmission in the neutral position and rev up the engine. If the truck tries to move in forward, clutch plates are fused together. Replace or rebuild transmission.
	3. Defective regulators in the modulator valve.	3. Replace the modulator valve.
	4. Spools are sticking in control valve body.	4. Clean or replace defective parts.
8. No Forward or Reverse *continued*	1. Parking brake is applied.	1. Release parking brake.

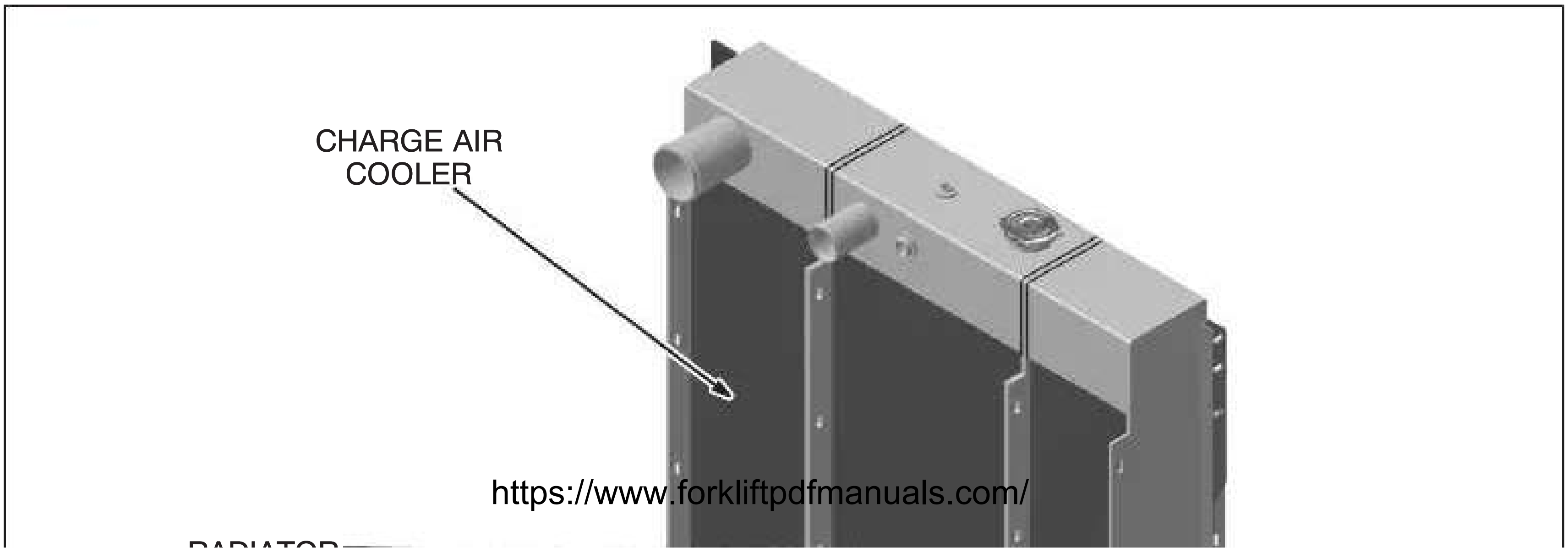
Problem	Cause	Correction
8. No Forward or Reverse (Continued)	2. Parking brake switch (S21, Illustration 6-6) is defective.	2. Replace parking brake switch.
	3. Inching valve is stuck or engaged.	3. Disengage inching valve.
	4. Low charge pump pressure.	4. Refer to Problem 2. of this troubleshooting chart.
	5. Low converter out pressure.	5. Refer to Problem 2. of this troubleshooting chart.

9. Vibration	1. Defective differential.	1. Repair differential.
	2. Output shaft in transmission is loose.	2. Repair or tighten output shaft.
	3. Transmission mount is loose.	3. Repair or tighten transmission mount.
	4. Engine mount is loose.	4. Repair or tighten engine mount.
	5. Excessive backlash in differential.	5. Repair differential.
	6. Plates inside transmission are sticking or slipping.	6. Repair or replace engine clutch wear or plates.
	7. Defective inching valve.	7. Replace inching valve.
	8. Defective torque converter.	8. Repair or replace converter.
	9. Defective charge pump.	9. Repair or replace charge pump.
	10. Drive shaft is out-of-phase.	10. Correct drive shaft to be in phase.
	11. Loose or missing universal joints.	11. Tighten or replace.
	12. Defective universal joints.	12. Replace universal joints.
	13. Brake / pilot / cooling pump, located on the back of the transmission, is cavitating or are loose.	13. Replace or tighten.
	14. Low oil level.	14. Add oil to the recommended level.
	15. Transmission is overheating.	15. Troubleshoot and repair transmission.
	16. Drive axle is loose.	16. Tighten and re-torque drive axle.
	17. Tread pattern on tires.	17. Change tread pattern.

ooler

Section 9A

Transmission Cooler



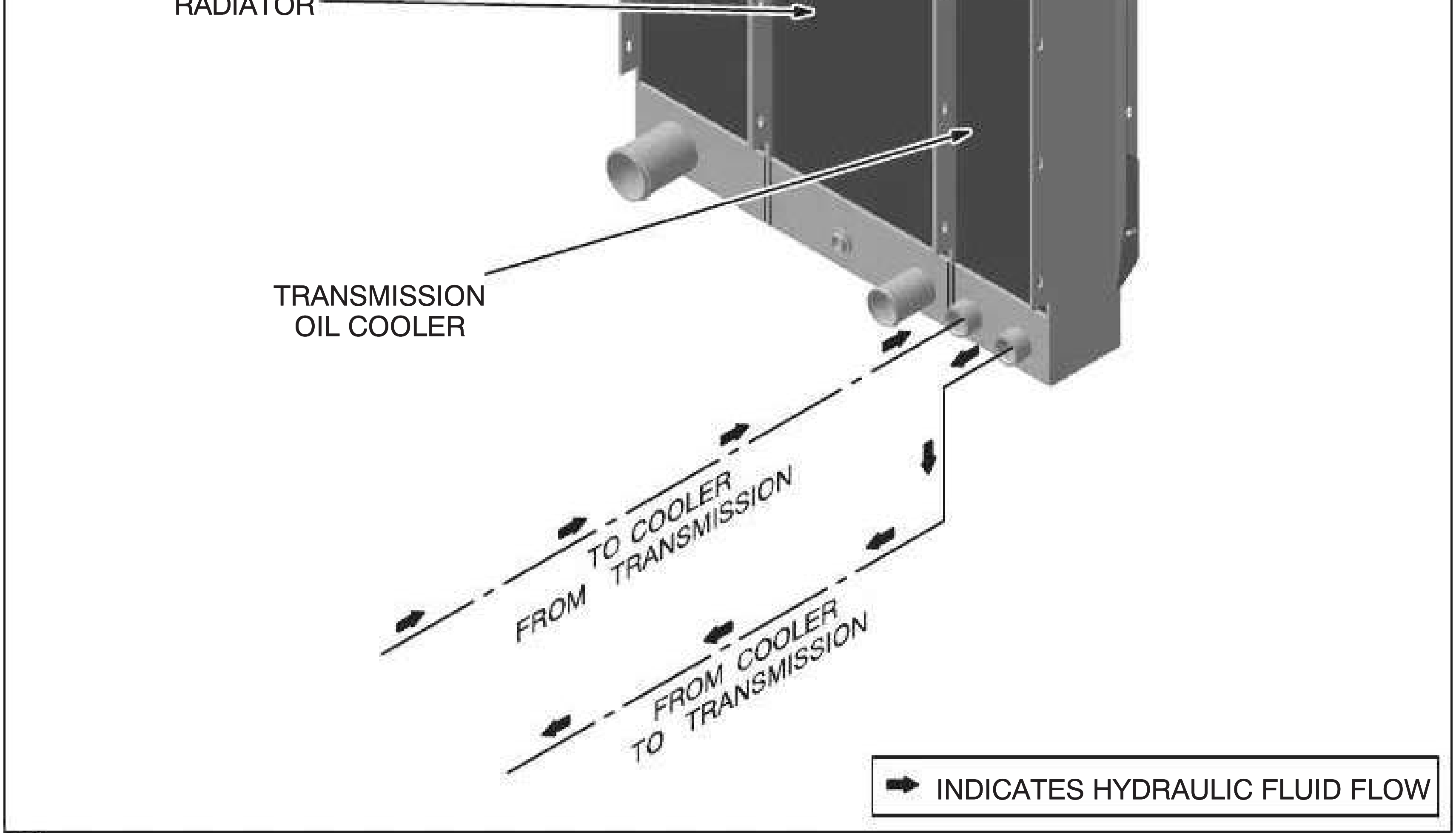


Illustration 9A-1. Transmission Oil Cooler Hose Flow Diagram

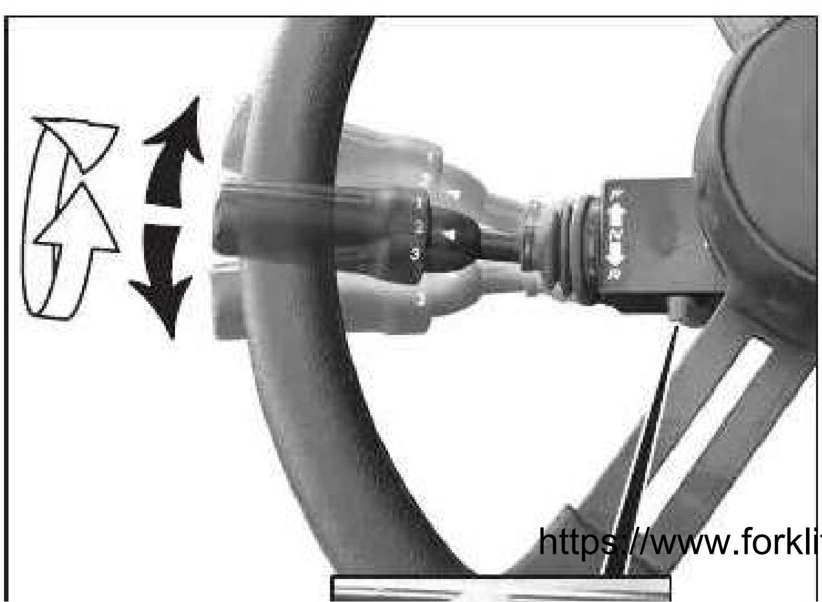
Introduction. The transmission oil cooler employs a forced air cooled method of cooling the transmission oil.

Transmission Oil Cooler Maintenance. The transmission oil cooler should be cleaned externally as conditions warrant.

CAUTION: In the event of transmission failure requiring a new or rebuilt transmission, in order for warranty to be valid, the transmission oil cooler, transmission filter, and hoses from the transmission to the transmission oil cooler must be replaced. It is impossible to back flush the transmission oil cooler to remove all contaminants from the core.

Whenever the cooler hoses have been disconnected and then reconnected, operate the engine up to normal operating temperature and check the transmission oil cooler hoses connections for leaks.

CAUTION: Make certain used filter and drained transmission oil are disposed of in accordance with federal and local regulations.



shift lever and an automatic powershift control module. The APC module interfaces with the Taylor Integrated Control System's MD3 module, that is located in the instrument panel, to automatically shift the transmission.

WARNING: Before servicing truck, park the truck on level ground, apply parking brake and block the wheels in both directions.

TICS Pin Code. Certain transmission control functions can only be changed in the TICS system by entering a Pin Code. The Pin Code is unique to each truck and is provided to the person designated by the purchaser of the vehicle. The pin code can be changed by authorized personnel.

Transmission Shift Mode Selection (Illustrations 9C-2 through 9C-6). Refer to the **Transmission Operating Instructions** in the Operator's Guide (OG160) for information on selecting the transmission shift mode. To select the mode of transmission shifting from within the TICS display module, perform the following steps:

Illustration 9C-1. Electric Shifter

Introduction. This truck is equipped with a three speed transmission that is controlled by an electric

1. At the Main Display screen (Illustration 9C-2), depress the Measure / Adjust Groups button (≡) to access the Main Measure / Adjust screen.

Illustration 9C-2. Main Measure / Adjust Screen

2. Depress the F1 button (Adjust) to access the Adjust screen.

Illustration 9C-3. Adjust Screen

3. At the Adjust screen (Illustration 9C-3), select Transmission Adjust Group by depressing the UP or DOWN button to highlight the selection (if the selection is not already highlighted). **NOTE:** The category is highlighted when a black box appears behind the selection (category text will be white). Depress the OK button to access the Transmission Adjust Group screen. The PIN code screen will appear. The Pin Code must be entered before the software will allow any adjustments to be made.

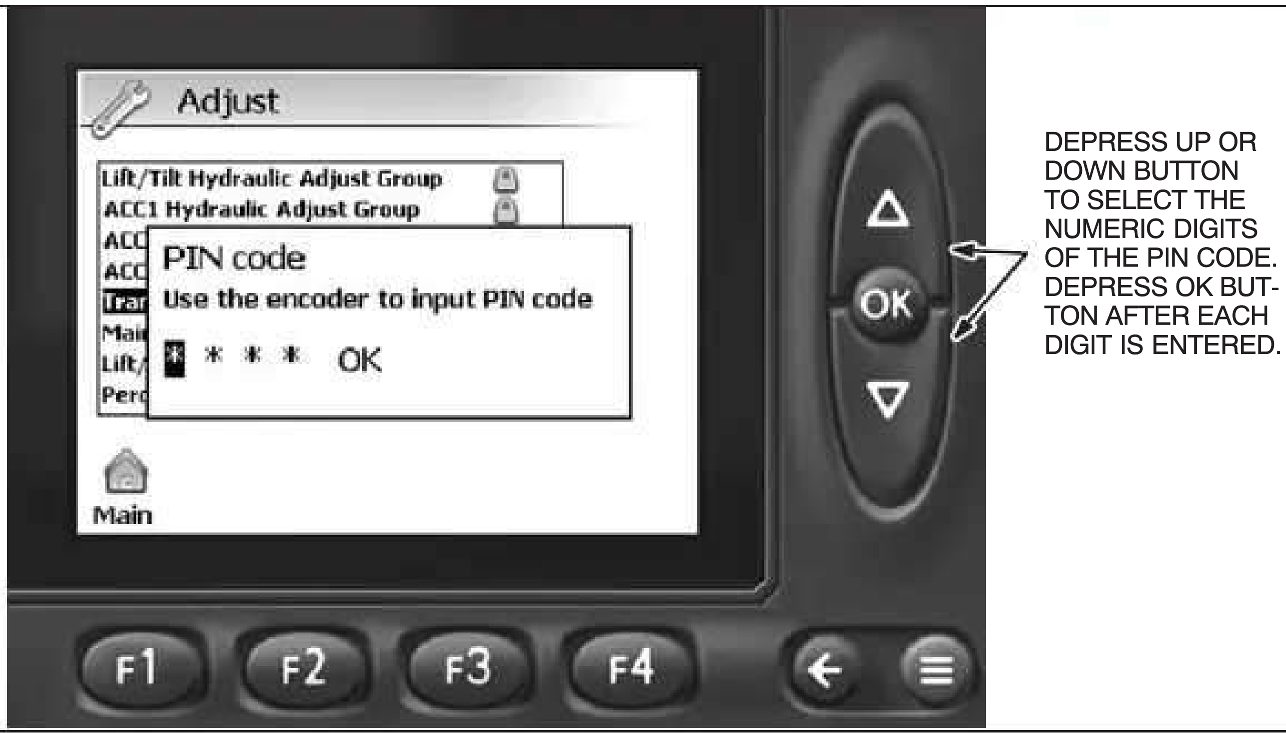


Illustration 9C-4. Pin Code Screen

4. From the PIN code screen (Illustration 9C-4), depress the UP or DOWN button until the first numeric digit appears in the first field. Depress the OK button to enter the numeric digit and advance to the second field. Repeat this procedure until all four numeric digits have been entered. After the code has been entered, OK will be highlighted; depress the OK button to view the Transmission Adjust

Group screen.

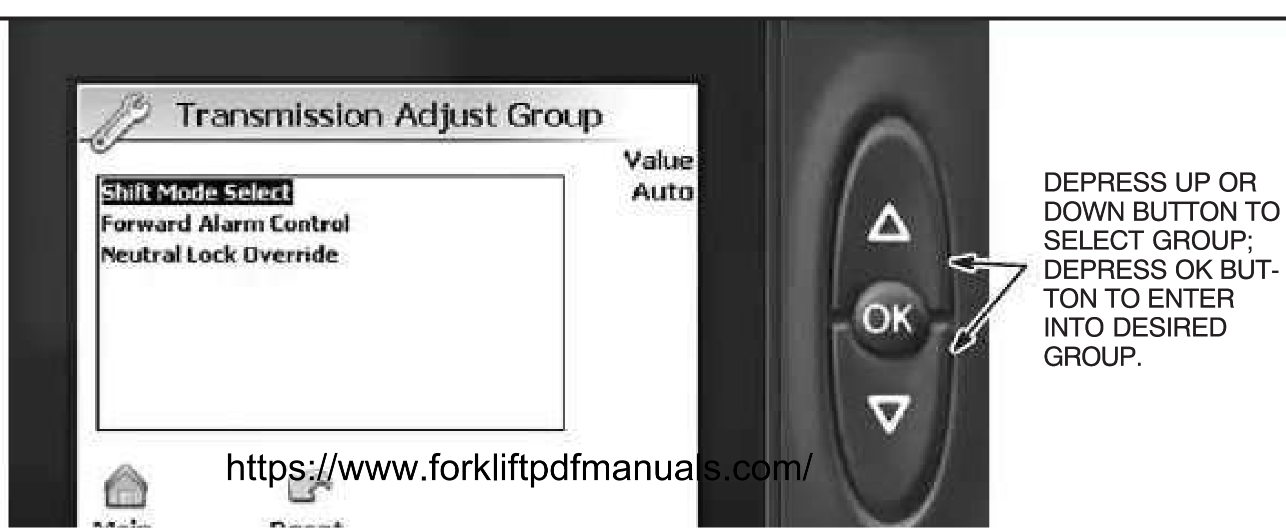


Illustration 9C-5. Transmission Adjust Group Screen

5. At the Transmission Adjust Group screen, select Shift Mode Select (Illustration 9C-5) by depressing the UP or DOWN button to highlight selection and depress the OK button to access the Shift Mode Select screen.

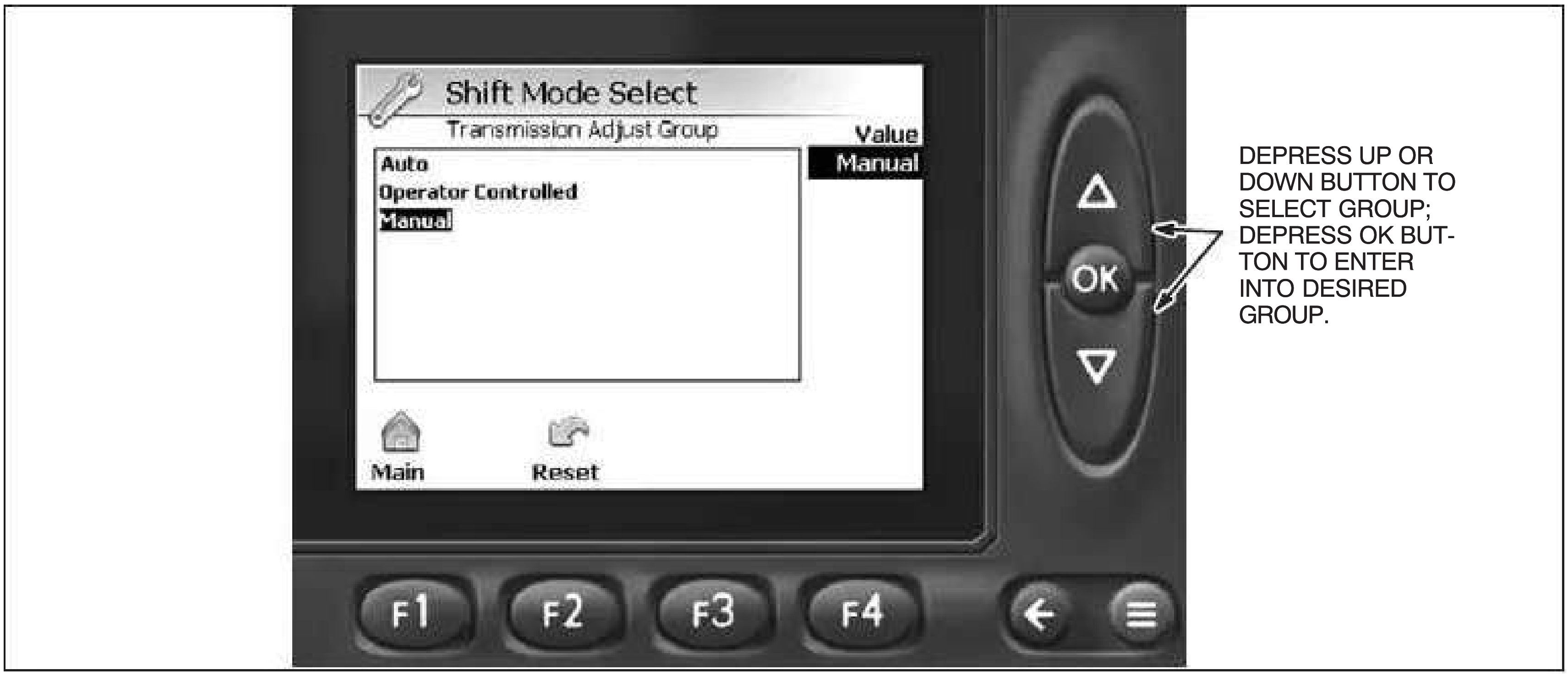


Illustration 9C-6. Shift Mode Select Screen

6. At the Shift Mode Select screen (Illustration 9C-6), depress the UP or DOWN button to select the shift mode of transmission operation. Selecting Locked / Auto activates the APC module to automatically select the speed range (Locked / Auto Mode – operator cannot manually select speed range at the electric shifter). Selecting Operator Controlled allows the operator choose whether the speed

range of the transmission is manually shifted or automatically shifted (Operator Controlled Mode, refer to **Operator Controlled Auto** / **Manual Selection** in this section). Selecting Locked / Manual allows the speed range to be manually selected by the operator at the electric shifter. Once the desired mode has been selected, depress the OK button once.

7. Depress the Measure / Adjust Groups (≡) button to return to the Main Display screen and turn the ignition switch to its Off position.

WARNING: The ignition switch should be turned to its Off position after maintenance personnel have made setting adjustments within the TICS system. Failure to do so, gives Unauthorized personnel access to change settings within the TICS system.

Operator Controlled Auto / **Manual Selection** (Illustration 9C-7). To select whether the speed range is automatically (Auto) or manually (Manual) selected while the Operator Controlled mode is enabled, perform the following steps:

1. At the Main Display screen (Illustration 9C-7), depress the Diagnostics button (F1) to access the Diagnostics Select screen.

Illustration 9C-7. Main Display Screen

2. At the Diagnostics Select screen (Illustration 9C-8), depress the Transmission button (F2) to access the Transmission Information screen.

Illustration 9C-8. Diagnostics Select Screen

3. At the Transmission Information screen (Illustration 9C-9), depress the Shift Mode Select button (F2) to select the shift mode (Operator Controlled / Manual or Operator Controlled / Auto). Selecting Operator Controlled / Auto activates the APC module to automatically select the speed range. Selecting Operator Controlled / Manual allows the speed range to be manually selected by the operator at the electric shifter.

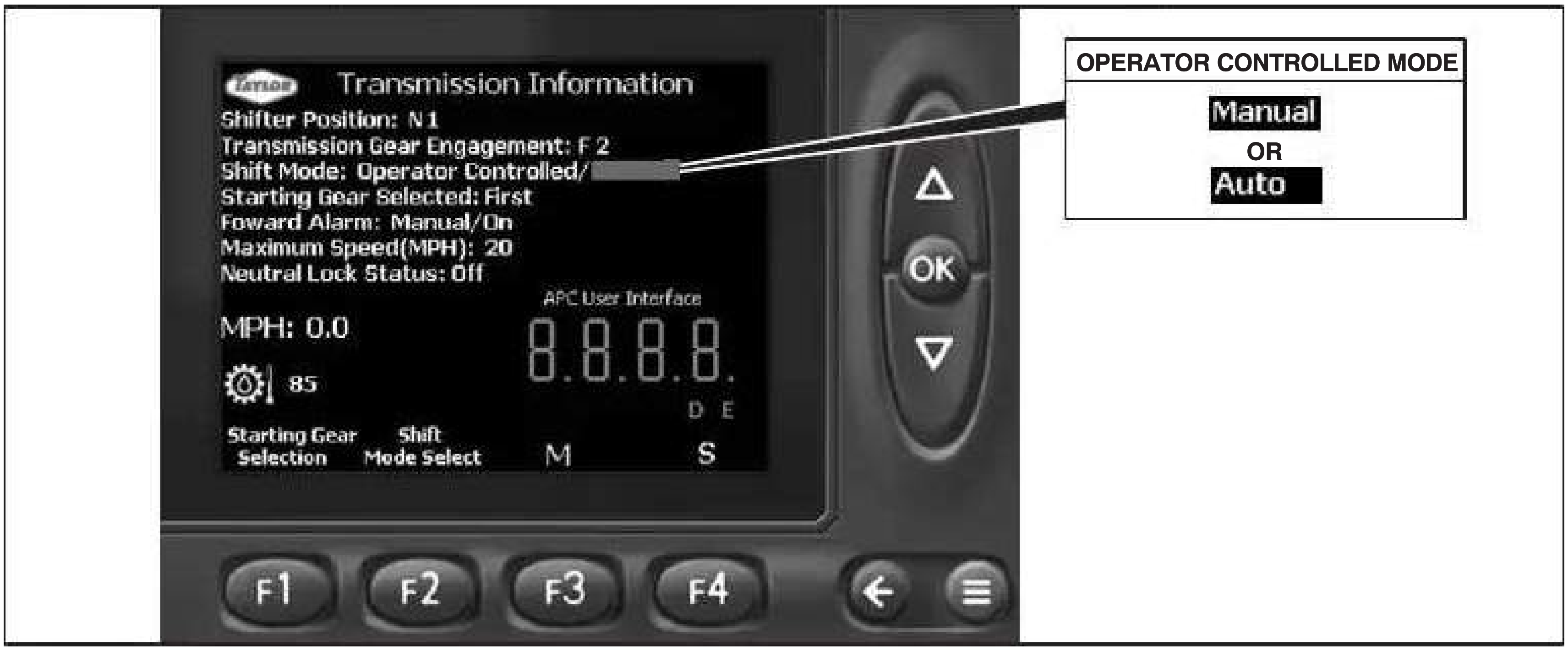


Illustration 9C-9. Transmission Information Screen

4. Once the desired mode has been selected, depress the ← button once to return to the Main Display screen.

Forward Alarm Mode Selection (Illustrations 9C-2 thru 9C-4, 9C-10 and 9C-11)**.** Refer to the **Forward Alarm System** in the Operator's Guide (OG160) for information on selecting the operating mode of the forward alarm. To select the *Automatic or Operator Controlled mode* of forward alarm operation, perform the following steps:

1. Follow steps 1. thru 4. of the **Transmission Shift Mode Selection** found earlier in this section.

Illustration 9C-10. Transmission Adjust Group Screen

2. At the Transmission Adjust Group screen, select Forward Alarm Control (Illustration 9C-10) by depressing the UP or DOWN button to highlight selection and depress the OK button to access the Forward Alarm Control screen.

Illustration 9C-11. Forward Alarm Control Screen

3. At the Forward Alarm Control screen (Illustration 9C-11), depress the UP or DOWN button to select

the mode of foward alarm operation. Selecting Automatic activates the forward alarm every time the truck is operated for forward travel (*Automatic Mode* – operator cannot choose when to use forward alarm). Selecting Operator Controlled activates the forward alarm only when the operator chooses to turn the forward alarm On (*Operator Controlled Mode,* refer to **Forward Alarm On / Off Selection** in this section). Once the desired mode has been selected, depress the OK button once.

4. Depress the Measure / Adjust Groups (≡) button to return to the Main Display screen and turn the ignition switch to its Off position.

WARNING: The ignition switch should be turned to its Off position after maintenance personnel have made setting adjustments within the TICS system. Failure to do so, gives

Unauthorized personnel access to change settings within the TICS system.

Forward Alarm On / Off Selection (Illustration 9C-12)**.** To turn the forward alarm On or Off while operating the forward alarm in the *Operator Controlled mode*, depress the F3 button to enable or disable the forward alarm. When the forward alarm is disabled, no audible sound will be emitted by the forward alarm when the electric shifter is placed in its Forward position. A Forward Alarm Off text message will be displayed on the Main Display screen (refer to Illustration 9C-12) when the forward alarm is disabled. When the forward alarm is enabled, an audible sound will be emitted by the forward alarm once the electric shifter is placed in its Forward position.

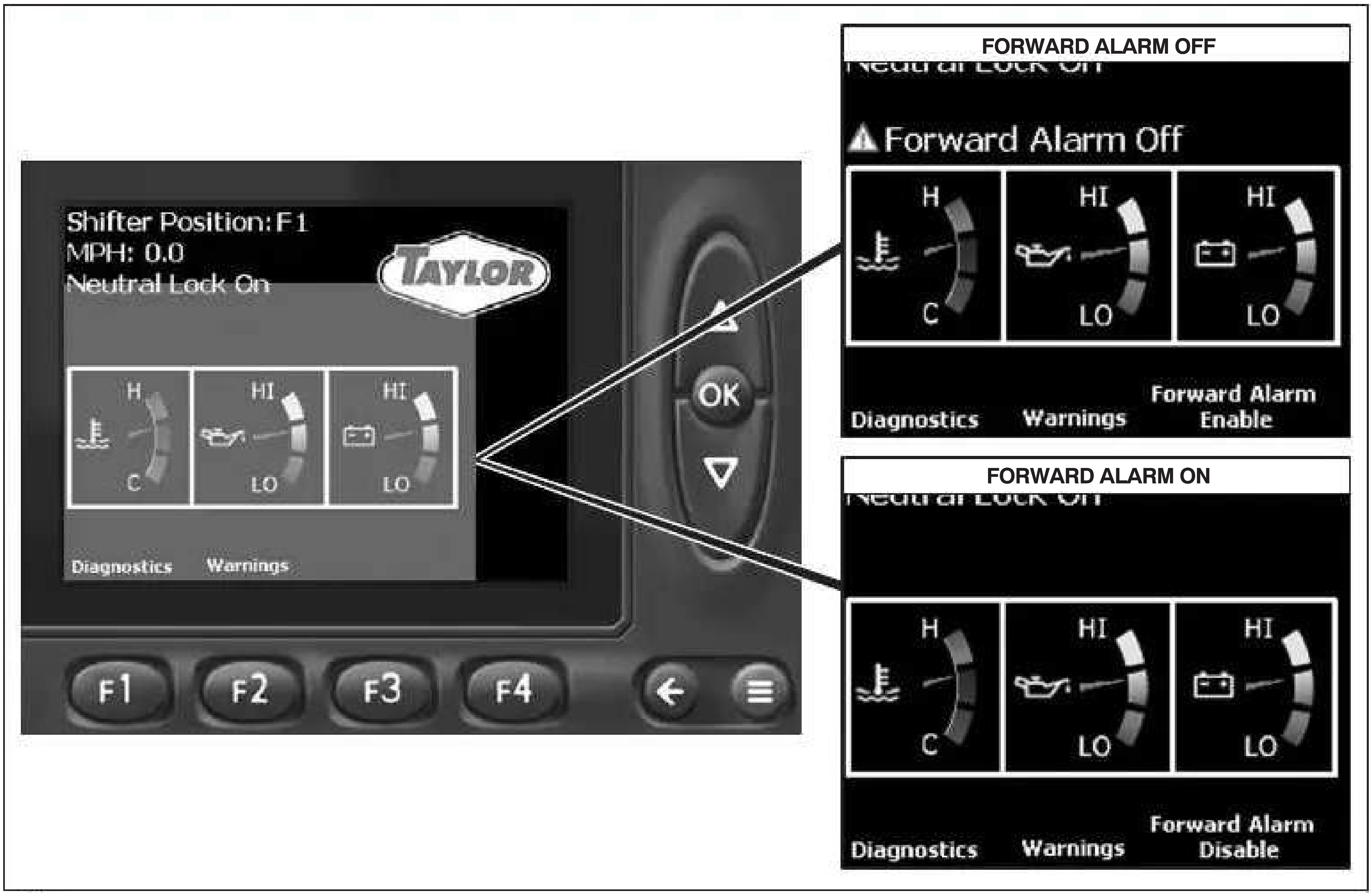
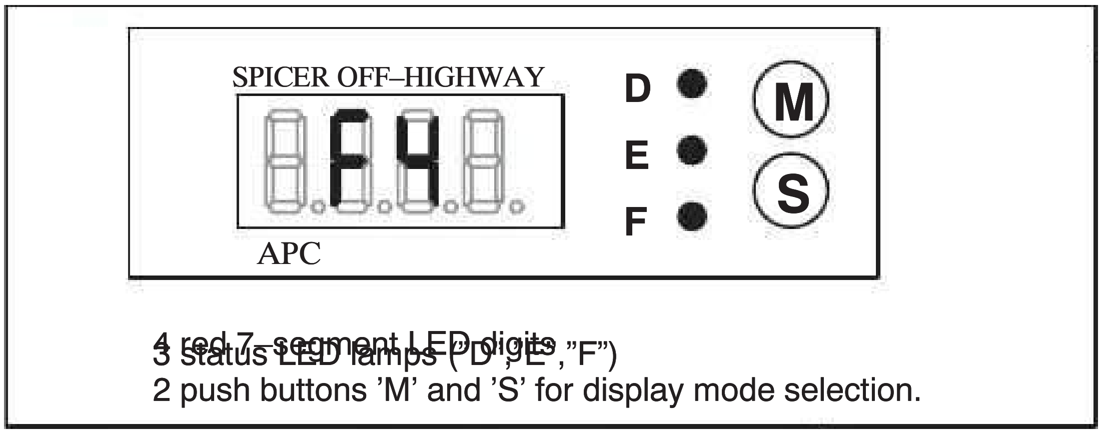


Illustration 9C-12. Main Display Screen (Forward Alarm Operation - *Operator Controlled Mode*)

Automatic Powershift Control (APC). The APC module controls shifting parameters. The Taylor Integrated Control System (TICS) monitors the APC module via CAN-bus. The TICS system will signal the APC to go to Neutral Lock when the operator vacates the seat or alternate idle is activated.

⚠ **CAUTION: Should any truck equipped with an APC module require welding on its structural members, the RS connector must be unplugged from the APC module prior to any welding. Failure to comply with this caution may lead to damage to the APC module.**

APC Module



APC Front Display

The display is located on the APC front panel (or the Transmission Information screen displayed on the TICS Display Module) and consists of:

The LED lamp labelled **'D'** is yellow and is used to indicate **D**iagnostic modes.

The LED lamp labelled **'E'** is yellow and is used to indicate **E**rrors.

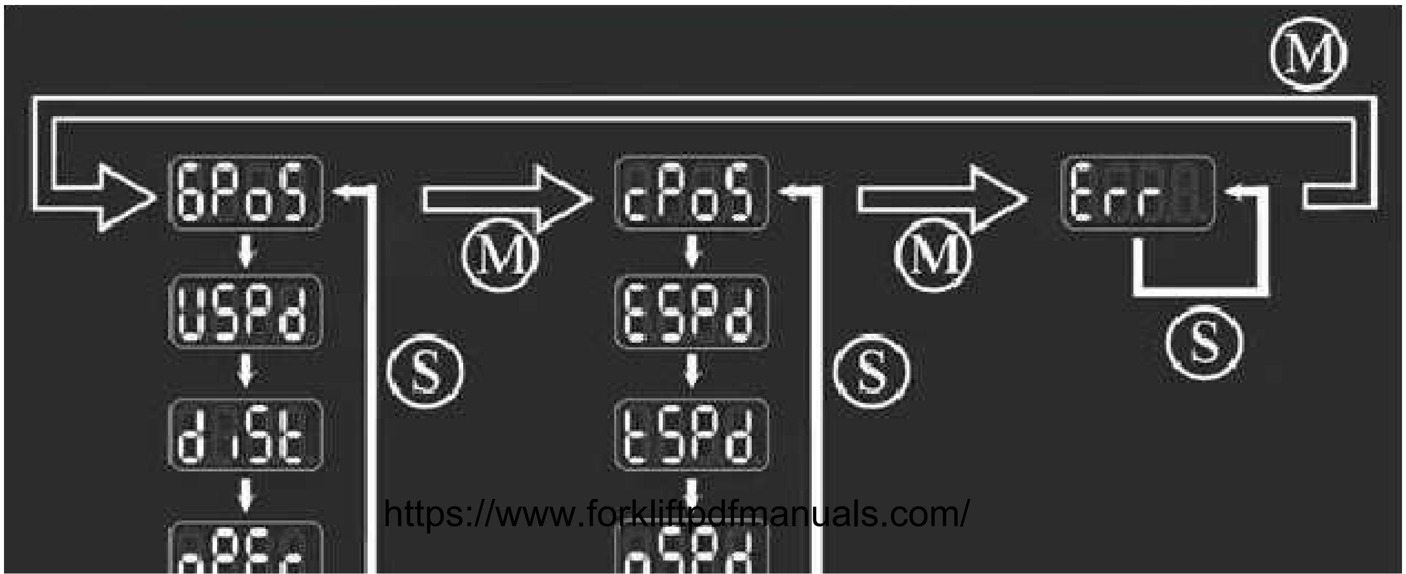
The LED lamp labelled **'F'** is red and is switched on when the APC is in the reset condition due to the bootstrap or **F**ault mode.

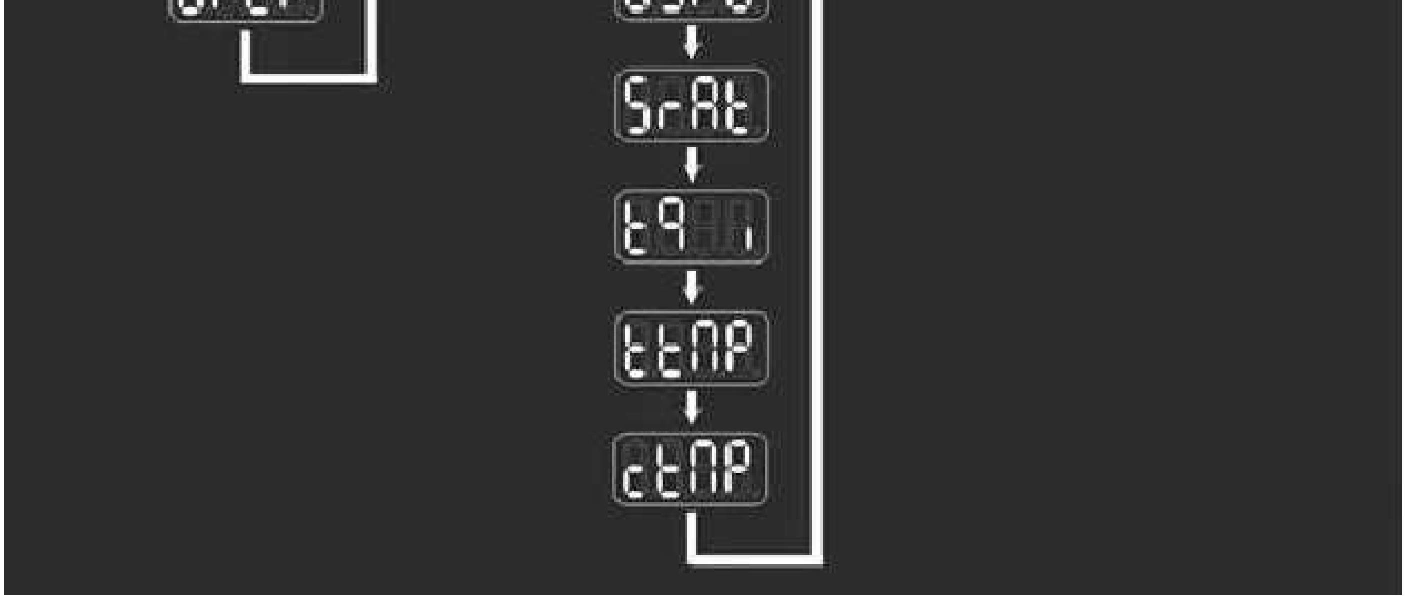
After power up, the display defaults to the last display mode (if the display mode was not the error display) selected when the controller was last powered down.

Typically, this will be the **gear position mode.** In this mode, the center left digit shows the actually engaged direction and the center right digit shows the currently engaged range (gear).

Pressing the 'M' switch (F3) changes the displayed information group while pressing the 'S' switch (F4) selects the item within the group.

While pushing the switch (about 0.5 seconds after it is released), the display shows which information is about to be displayed.





The second group shows the shift lever position and some other less used but nevertheless quite relevant values (see below).

The third display accessed with the ’M’ button (F3) isn’t actually a group of screens but is used to inform you about any current or previously active errors. The display normally shows ’ – – ’ to indicate there are no faults, but if one or more faults are (or have been) detected, the most severe one is shown until you press the ’S’ switch (F4). Doing so reveals the next error until no more errors are present, at which time again the ’ – – ’ sign is shown.

APC User Interface On TICS Transmission Information Screen

Display mode	Comment
GPOS	Reflects the actually engaged transmission direction and range.
VSPD	Shows vehicle speed in km/h or MPH (parameter setting). Speeds are shown with a 0.1 km/h or 0.1 MPH resolution.
DIST	Shows the travelled distance in km or Miles (parameter setting). Distance is shown with a 0.1 km or 0.1 Mile resolution. By pressing the "S" button (F4) during 3 seconds, the distance trip counter is reset to 0.
OPER	Shows the total operating time of the vehicle (engine running). Operating time is shown with a 1 hour resolution and has a range of 0 to 49,999 hours. The number digits show the hours, the number of dots in between show the number of times 10,000 hours needs to be added to the number shown: **1 2 3 4 = 1234 hours** **1 2.3.4. = 31234 hours**
CPOS	Reflects the current shift lever direction and position.
ESPD	Shows measured engine speed (RPM)
TSPD	Shows measured turbine speed (RPM)
OSPD	Shows measured output speed (RPM)
SRAT	Reflects the current speed ratio (calculated as TSPD/ESPD [turbine speed / engine speed]) and is an important factor in automatic shifting.
TQ I	Measured turbine torque at transmission input side (Nm)
TTMP	Shows transmission temperature in °C

CTMP	Shows cooler input temperature in °C
ERR	The error display. By pressing the "S" button (F4) you can scroll through the errors codes. If an error code is blinking, this indicates that the error was active in the past, but not active anymore.

When the controller detects an error, the 'E' led blinks slowly to indicate this. You can always select the error display mode (ERR) to view the nature of the problem. An overview of the error codes is included in the back of this section (refer to **APC Error Codes and Descriptions**).

Operating Modes

Normal Driving

For detailed description see functional description.

Diagnostic Mode

This mode is selected when the ‘S’ mode switch (F4) is pressed at power up.

Limp Home Mode

Defaulted to if either of following conditions occurs:

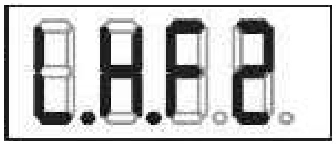
a single fault on a transmission control output is detected

a fault related to the engine speed sensor is detected

If one of the above conditions is present, the transmission is put in neutral. In order to continue driving, neutral must first be selected on the shift lever. Once the shift lever has been put in neutral, the driver can re–engage a direction. In this mode, the user can operate the transmission in either direction in 1st and 2nd only. If the fault occurs at a higher gear position, the user is allowed to shift down manually.

The controller uses default limits; all shifts use a default modulation curve.

The GPOS / CPOS display indicates the letters ‘LH’ on the left two digits of the direction/position indication.

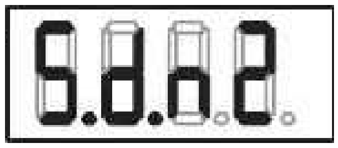


Shutdown Mode

This mode is activated when a severe internal or external problem is detected. In this mode, the transmission is forced in Neutral. This mode is selected only if an intolerable combination of faults exists. In case of an intermitting problem, SHUTDOWN mode is exited and the controller enters the LIMP HOME mode.

Also when a fault, related to the parameter settings, located in FLASH memory is detected, the controller reverts to shutdown mode.

The GPOS / CPOS display indicates the letters 'Sd' on the left two digits of the direction/position indication.



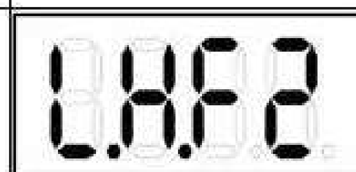
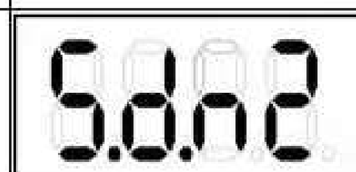
Shifter Lever

The main interface with the driver is the shift lever. It allows selecting the driving direction and the different ranges. The shift lever output signals serve as inputs for the APC.

For automatic mode, the shift lever position will limit the gear in which the controller is allowed to shift to.

Mode Identification

The above modes are identified as follows:

Mode	D–led	E–led	Display
Normal driving	Off	as per error	
Self test	On	Off	described in 4.18
Limp home	Off	Blinking	
Shut Down	Off	Blinking	

Diagnostics and Guidelines

Diagnostics and Maintenance

General

Principally there are no specific devices required for first level troubleshooting as the APC incorporates several self–test features assisting in this process. Nevertheless, use of digital multi–meters and simple tools such as an indicator lamp will be required to pinpoint exact causes of problems. More indepth troubleshooting and system tuning involves use of a WIN95 Compatible PC with appropriate software and FLASH parameter programming equipment. The APC allows recall and modification of non–volatile parameters through RS232. This way, customers can, given the necessary equipment, choose to adapt certain parameters to suit their needs. From a maintenance point of view, this is relevant in so far that the APC allows reading back the (modified) parameters along with serial number, part number and modification date. Several PC hosted tools have been developed to ease the service and troubleshooting process.

Self Diagnostic Functions

The APC has special circuitry to help verify its operation.

Six self–test groups are built into the APC control programs:

- Display test and Version
- Digital input test
- Analogue input test
- Speed sensor test
- Output test
- Voltage test

The ’D’ led is **on** while operating the APC in diagnostic mode.

NOTE: *If during operation in a self–test mode a fault is detected, the E–led flashes to indicate the presence of the fault.* ***Pressing S–button (F4) for awhile, however in this case, will not reveal the fault code.***

Self Test Operation

Self–test mode is activated by pressing the ‘**S’** switch (F4) on the APC front panel while powering up the APC.

Switching off the power of the APC is the only way to leave the self–test mode.

The available information is organized as groups of related displays.

Generally, each mode’s start display provides an overview of the status of all members of the group.

For instance, the start display of the input test mode cryptically shows the level of each input and the speed sensor test mode shows the frequency of each sensor channel in kHz (kiloHertz).

Pushing the **‘M’** switch (F3) selects the next group in the order listed.

By pushing the **‘S’** switch (F4) a list of modes with more detailed information about the selected group can be looked through.

When a new group is selected with the **‘M’** switch (F3), the display always reverts to the overview display (i.e., the beginning of the mode–list).

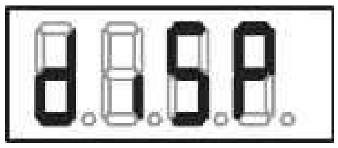
Pressing a switch (M or S / F3 or F4) shortly reselects the current group or mode. This feature is applicable in all diagnostic–groups.

After powering up, the **display test** is activated.

Overview of Test Modes

Display Test and Version

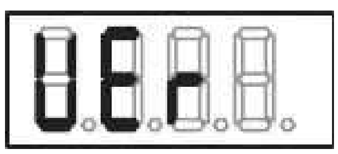
When selecting this group, the display shows:



When pressing the S switch (F4), the display changes to:

Releasing the switch engages a scrolling text display that shows the part number and the version.

When pressing the S switch (F4), the display switches back to the display test mode, showing:

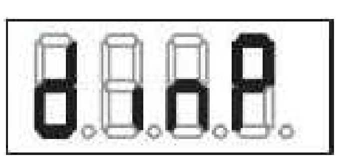


Followed by the program identification string (e.g. ECON C 1.5 r6).

After releasing the S switch (F4), the display again illuminates all segments.

Digital Input Test

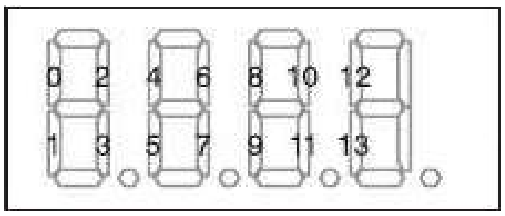
When selecting this group, the display shows:



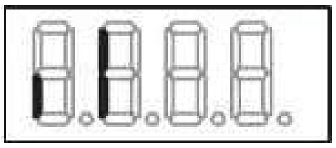
The display shows which inputs are active. Each segment of the display indicates a specific logical input. Different segments can be switched on simultaneously if different inputs are activated simultaneously. In total there are fourteen inputs: ten digital and four analog inputs (in this group treated as if they were digital **pull to ground** inputs).

digital **pull to ground** inputs).

Digital inputs numbered 0 – 9 are shown on the segments as shown below. Analog inputs 0 – 3 are shown on segments numbered 10 – 13 below.

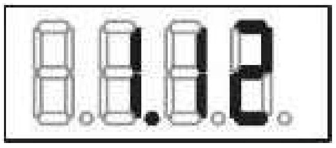


The below example indicates that inputs 1, 4 and 5 are on. All others are off.



By pressing the ‘S’ switch (F4) repeatedly, each individual input is shown in more detail.

While pressing the ‘S’ switch (F4), the display shows the logic–input number with the matching harness wire. (– i.e., the below display corresponds with **input one** connected to **wire A12**).



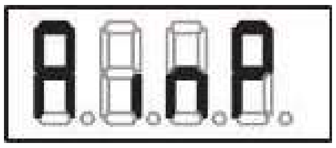
Releasing the switch displays the input’s state (hi or lo).

NOTE: the analog inputs return ‘high’ when pulled to ground.

Pressing the S switch (F4) at the last analog input brings back the overview on the display.

Analogue Input Test

The APC has 4 analog resistance inputs. They measure the single–ended resistance of a sensor connected between the input and signal ground B18.
When selecting this group the display shows:



Releasing the switch brings an overview of the 4 analog inputs on the display. The values, displayed in kΩ (kiloOhms), are separated by a dot.

The above display corresponds with a first input of 1 kΩ, a second of 2 kΩ and the last two of 0 kΩ..

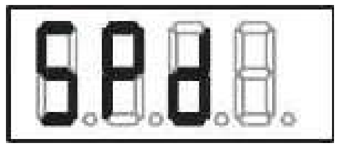
Values that are more accurate can be found while running through the input specific displays (S switch /

F4). While pressing the switch, similar to the display of digital inputs, the left side of the display gives information about which input is tested; the right side gives the matching wire. The displayed value, when the S switch (F4) is released, is the resistance in Ω. (Ohms).

NOTE: Although the APC also has 4 current sense and 3 voltage sense inputs, these are not directly accessible through diagnostic displays.
The current sense inputs are treated in combination with analog output test modes.
The voltage sense inputs are not yet supported by the diagnostic modes.

Speed Sensor Test

When selecting this mode, the display shows:

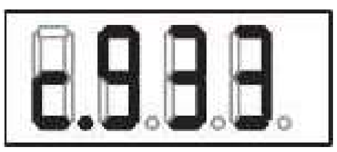


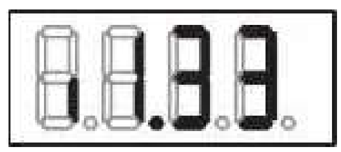
When releasing the **'M'** switch (F3) again, an overview appears on the display. The four values, displayed in thousands of Hertz, are separated by a dot. Speeds below 1,000 Hz are shown as **0**.

Using the **'S'** switch (F4) more detailed information concerning the speeds is available. While pressing the **'S'** switch, the display shows the speed channel number on the left side of the display while the matching wire is shown on the right.
Once released, the left digit indicates what type of speed sensor should be connected to this channel:

- **c** – for a current sensor (Magneto Resistive Sensor)
- **i** – for an inductive speed sensor

The three other digits and the dot represent the matching speed in kHz (kiloHertz). For instance in the below examples, the left display indicates a current speed sensor and a frequency of 933 Hz. The right one indicates an inductive sensor generating about 1,330 Hz.



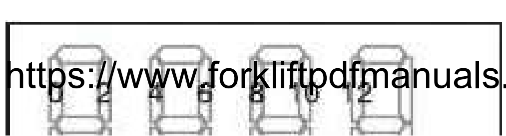


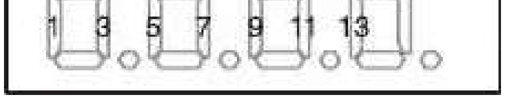
After the last channel is shown, another press on the 'S' switch (F4) re–selects the speed sensor overview.

Output Test

When selecting this mode, the display shows:

The display shows which outputs are active. Similar to the digital input test overview screen, each segment of the display indicates a specific input.
Different segments can be switched on simultaneously if different outputs are activated simultaneously.





A blinking segment indicates a fault at a certain output.

In total, there are 11 outputs:

- Outputs 0 – 6 are analog
- Outputs 7 – 9 are STP digitals outputs
- Output 10 is a STG digital output

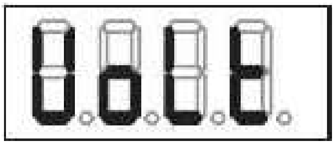
Information that is more specific can be found while running through the different modes (S switch / F4). While pressing the switch, the left side of the display gives information about which output channel is tested; the right side gives the matching wire number.

When releasing the switch, the display shows either the actual current in mA (milliAmps), or the logic state of the output (either '**hi**' or 'lo').

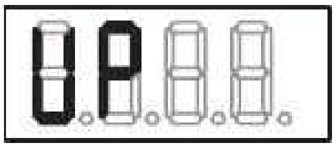
If an output is currently in fault, its respective segment in the overview screen blinks slowly. On the output specific screen, the display alternates between the actual state (current value or logic state) and the fault type (open / short / curr / oor).

Voltage Test

When selecting this mode, the display shows:



The displayed value, after the M switch (F3) is released, is the **PERMANENT VOLTAGE Vp** in Volts as measured on wire **A01**.



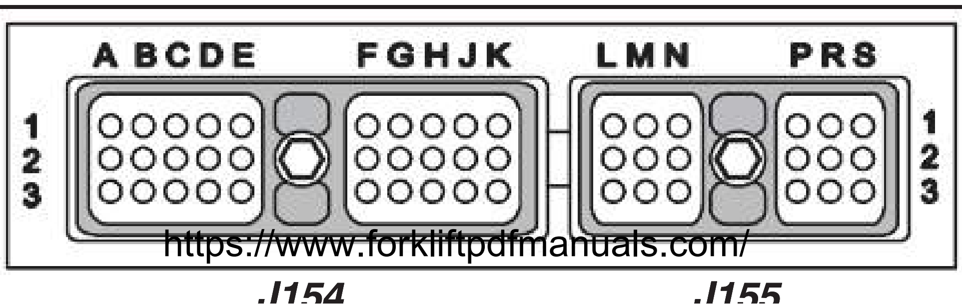
The two other modes of this group are **switched voltage (Vs)** and **sensor voltage (Vsen)**, also expressed in **Volts**.

Vs is measured on wire B12. This power supply input is used to allow the APC to control the power down process, allowing it to save statistical information in FLASH before actually shutting down.

Vsen is measured off an internally generated voltage regulator and should be near 8.0V. It can be measured on any unloaded analog input channel (e.g. ANI0 on A11). The Vsen voltage is used as a reference for the analog inputs.

Connector layout :

Rear view on the controller connector



APC Rear Connector

APC Module Harness Connector Pin and Wire Assignments (see Illustration above for Rear Harness Connector Wiring Pin–out).

WIRE	PIN	FUNC	TYPE	DESCRIPTION	TAYLOR WIRE
A01	***A1***	***PPWR***	***Pwr***	***Permanent Battery Plus***	A01
A02	B1	VFS0+	Pwm	1st Solenoid	A02
A03	C1	VFS0–	Sns		Not Used
A04	D1	VFS1+	Pwm	2nd Solenoid	A04
A05	E1	VFS1–	Sns		Not Used
A06	F1	VFS2+	Pwm	3rd Solenoid	A06
A07	G1	VFS2–	Sns		Not Used
A08	H1	VFS3+	Pwm		Not Used
A09	J1	VFS3–	Sns		Not Used
A10	K1	DO0	Stp	Warning Lamp	Not Used
A11	A2	ANI0	Ptg		Not Used
A12	B2	DIGIN0	Ptp		A12
A13	C2	DIGIN1	Ptp		A13
A14	D2	DIGIN2	Ptp		Not Used
A15	E2	DO1	Stp	Forward Solenoid	A15
A16	F2	DO2	Stp	Reverse Solenoid	A16
A17	G2	DIGIN3	Ptp		Not Used
A18	H2	DIGIN4	Ptp		Not Used
A19	J2	DIGIN5	Ptp		A19
A20	K2	DO3	Stg		Not Used
A21	A3	GND	Gnd	Supply Ground	A21
A22	B3	SS0	Sns		Not Used
A23	C3	SS0	Gnd		Not Used
A24	D3	SS1	Sns	Drum speed sensor+	A24
A25	E3	SS1	Gnd	Drum speed sensor –	A25
A26	F3	SS2	Sns		A26
A27	G3	SS2	Gnd		A27
A28	H3	ANI1	Ptg	Converter out temperature	Not Used

A29	J3	ANI2	Ptg		Not Used
A30	K3	GND	Gnd	Signal Ground	A30

WIRE	PIN	FUNC	TYPE	DESCRIPTION	TAYLOR WIRE
B01	L1	VFS4+	HbrgA		Not Used
B02	M1	ANI4	Sns	5V Reference voltage out	Not Used
B03	N1	VFS5+	HbrgB		Not Used
B04	P1	ANI5	Sns		Not Used
B05	R1	VFS6+	Pwm		Not Used
B06	S1	ANI6	Sns		Not Used
B07	L2	CANL	Comm	CAN Lo	B07
B08	M2	CANH	Comm	CAN Hi	B08
B09	N2	RXD	Comm	RS232 RXD	B09
B10	P2	TXD	Comm	RS232 TXD	B10

B10	P2	TXD	Comm	RS232 TXD	B10
B11	R2	SS3	Sns		Not Used
B12	S2	SPWR	Pwr	Switched Battery Plus	B12
B13	L3	DIGIN6	Ptp		Not Used
B14	M3	DIGIN7	Ptp		Not Used
B15	N3	DIGIN8	Ptp		Not Used
B16	P3	DIGIN9	Ptp		Not Used
B17	R3	ANI3	Ptg		Not Used
B18	S3	SGND	Gnd	VFS Ground	B18

APC Error Codes and Descriptions

Fault Code	Type	Explanation	Controller's Action	Driver Action	Fault Cause	Troubleshooting
00.50	S	There is a problem related to the internal RAM (in CPU).	Controller reverts to a "shut down" mode and will force neutral 0.	Stop machine & Contact maintenance for troubleshooting.	Hardware related fault – related to in the internal RAM.	Contact Spicer Off–Highway and inform the fault code and the time that is was active.
00.51	S	There is a problem related to the system RAM (in CPU).	Controller reverts to a "shut down" mode and will force neutral 0.	Stop machine & Contact maintenance for troubleshooting.	Hardware related fault – related to in the system RAM.	Contact Spicer Off–Highway and inform the fault code and the time that is was active.

00.52	S	There is a problem related to the system RAM.	Controller reverts to a "shut down" mode and will force neutral 0.	Stop machine & Contact maintenance for troubleshooting.	Hardware related fault – related to in the system RAM.	Contact Spicer Off–Highway and inform the fault code and the time that is was active.
00.53	S	There is a problem related to the Flash program memory.	Controller reverts to a "shut down" mode and will force neutral 0.	Stop machine & Contact maintenance for troubleshooting.	Hardware related fault – related to in the flash program memory.	Contact Spicer Off–Highway and inform the fault code and the time that is was active.
30.04	S	Power supply out of range –> below minimum.	Controller will save all logged information to flash, will powerdown, and force all outputs off.	Stop machine & Contact maintenance for troubleshooting.	Power supply to the controller too low: APC 12V supply version: < 9 V APC 24V supply version: < 16V.	Check power supply cables to the controller. Check alternator, check the connection cables between the battery and the alternator, check the battery.
30.05	A	Power supply out of range –> above maximum.	The controller will have reduced proportional control accuracy due to reduced PWM duty cycle.	Contact maintenance for troubleshooting.	Power supply to the controller too high: APC 12V supply version: > 18 V APC 24V supply version: > 32 V.	Check power supply, check if a jump start setup is still connected.
31.00	A	Voltage supply for the sensors : Vsense (8V) is out of range –> below minimum.	The controller will have reduced sensor signals.	Contact maintenance for troubleshooting.	Voltage supply for the sensors : Vsense (8V) is below 7,2 V.	Check power supply. Check the controller.
31.01	A	Voltage supply for the sensors : Vsense (8V) is out of range –> above maximum.	The controller will have reduced sensor signals.	Contact maintenance for troubleshooting.	Voltage supply for the sensors : Vsense (8V) is above 8,8 V.	Check power supply. Check the controller.
40.06	A	Invalid shift lever direction detected.	The controller will force neutral.	Contact maintenance for troubleshooting.	The controller receives from the shift lever a request to engage forward and reverse at the same time.	Check the wiring between the controller and the shift lever concerning the forward and the reverse signal.

Fault Code	Type	Explanation	Controller's Action	Driver Action	Fault Cause	Troubleshooting
40.08	B	Seat orientation input was changed while the parking brake was not active, or/ and the shift lever was not in neutral, or/and the machine was not at standstill.	The controller will force neutral.	Stop the vehicle, put the shift lever in neutral and put the parking brake on until the fault disappears.	Seat orientation input was changed while the parking brake was not active, or/ and the shift lever was not in neutral, or/and the machine was not at standstill.	Check the seat orientation switch or train the driver to change the seat orientation according to the correct procedure.
41.06	A	Invalid shift lever position detected.	The controller will not allow range shifting, however driving is still possible.	Contact maintenance for troubleshooting.	The controller receives from the shift lever an unknown range shift pattern	Check the wiring between the controller and the shift lever concerning the range signals

					pattern.	signals.
42.04	S/A	The actual transmission ratio is too low.	Controller will flag the fault – this fault is indicating that one or more clutches are slipping.	Contact maintenance for troubleshooting.	The transmission ratio measured by the controller is more than 5% below the value of what is should be.	Check the transmission, in order to understand if and which clutch is slipping. Check the transmission ratio settings of the controller.
42.05	S/A	The actual transmission ratio is too high.	Controller will flag the fault – this fault is indicating that one or more clutches are slipping.	Contact maintenance for troubleshooting.	The transmission ratio measured by the controller is more than 5% above the value of what is should be.	Check the transmission, in order to understand if and which clutch is slipping. Check the transmission ratio settings of the controller.
43.03	A	The transmission converter out temperature sensor is out of range.	Controller will flag the fault.	Contact maintenance for troubleshooting.	The converter out temperature sensor is not connected or shorted.	Check the wiring between the controller and the converter out temperature sensor. Check the converter out temperature sensor.
43.07	A	The transmission converter out temperature sensor > 100°C.	Controller will flag the fault – in order to indicate the driver of the warning level.	Take notice of the fault, and try to bring the converter temperature to a lower level.	The controller measured a converter out temperature between 100°C and the allowed limit.	Check the converter out temperature and the converter out temperature sensor.
43.08	A	The transmission converter out temperature sensor > 125°C.	The controller is protecting the transmission and does not allow that the converter out temperature exceeds its limit. The controller will force the transmission to neutral, and if engine is controlled, the engine will be limited 50 % of its maximum speed.	Stop machine, select neutral and apply full throttle (limited to 50 %) in order to cool the transmission oil below 100°C (until the fault 43.03 is gone). Once the converter out temperature is below 100°C, continue driving the machine.	The controller measured a converter out temperature above the allowed limit.	Check the converter out temperature and the converter out temperature sensor.

Fault Code	Type	Explanation	Controller's Action	Driver Action	Fault Cause	Troubleshooting
45.06	B	Invalid pattern for the reduced vehicle speed redundant digital inputs (2 inputs used).	The controller will limit the vehicle speed to the reduced speed.	Contact maintenance for troubleshooting.	Invalid pattern for the reduced vehicle speed redundant digital inputs (2 inputs used).	Check the redundant reduced vehicle speed switches and the wiring connected from these switches to the APC.
46.05	A	The transmission has exceeded the maximum torque during inching.	The controller will open or close the inching clutch depending of the GDE pattern/direction selection.	Release the inching pedal and cycle the shift lever via neutral back in the selected direction in order to get drive again.	The transmission has exceeded the maximum torque during inching.	Release the inching pedal and cycle the shift lever via neutral back in the selected direction.

47.06	B	Invalid pattern for the inching mode digital inputs (2 inputs used).	The controller will select the mode ”no inching allowed”.	Contact maintenance for troubleshooting.	Invalid pattern for the inching mode digital inputs (2 inputs used).	Check the inching mode selection switch and the wiring connected from this switch to the APC.
50.00	S	Analog input 0 (wire A11) related fault : analog input is shorted to ground.	Controller reverts to a ”limp home” mode.	Contact maintenance for troubleshooting.	The analog input ANI0 is below 500 ohm.	Check the wiring between the controller and the pressure feedback sensor. Check the pressure feedback sensor.
50.01	S	Analog input 0 (wire A11) related fault : analog input is not connected.	Controller reverts to a ”limp home” mode.	Contact maintenance for troubleshooting.	The analog input ANI0 exceeds 4000 ohm.	Check the wiring between the controller and the pressure feedback sensor. Check the pressure feedback sensor.
51.00	A	Analog input 1 (wire A28) related fault : analog input is shorted to ground.	The controller will limit the transmission temperature measurement to the lowest clipped value in its settings, which will result in a bad temperature compensation.	Contact maintenance for troubleshooting.	The analog input ANI1 is shorted to ground.	Check the wiring between the controller and the transmission sump temperature sensor. Check the transmission sump temperature sensor.
51.01	A	Analog input 1 (wire A28) related fault : analog input is not connected.	The controller will limit the transmission temperature measurement to the highest clipped value in its settings, which will result in a bad temperature compensation.	Contact maintenance for troubleshooting.	The analog input ANI1 is not connected.	Check the wiring between the controller and the transmission sump temperature sensor. Check the transmission sump temperature sensor.

Fault Code	Type	Explanation	Controller’s Action	Driver Action	Fault Cause	Troubleshooting
52.00	B	Analog input 2 (wire A29) related fault : analog input is shorted to ground.	Controller will flag the fault, and will use the lowest clipped value in its settings.	Contact maintenance for troubleshooting.	The analog input ANI2 is shorted to ground, or measured input value is below the minimum value (corresponding with 0 %).	Check the wiring between the controller and the device connected to this analog input. Check this device connected. Check if the calibration is done correctly – recalibration of this analog input.
52.01	B	Analog input 2 (wire	Controller will flag	Contact mainte-	The analog input	Check the wiring

		A29) related fault : analog input is not connected.	the fault, and will use the lowest clipped value in its settings.	nance for trouble-shooting.	ANI2 is not con-nected, or measured input value is above the maximum value (corresponding with 100 %).	between the control-ler and the device connected to this analog input. Check this device con-nected. Check if the calibration is done correctly – recalibra-tion of this analog input.
53.00	B	Analog input 3 (wire B17) related fault : analog input is shorted to ground.	Controller will flag the fault, and will use the lowest clipped value in its settings.	Contact mainte-nance for trouble-shooting.	The analog input ANI3 is shorted to ground, or measured input value is below the minimum value (corresponding with 0 %).	Check the wiring between the control-ler and the device connected to this analog input. Check this device con-nected. Check if the calibration is done correctly – recalibra-tion of this analog input.
53.01	B	Analog input 3 (wire B17) related fault : analog input is not connected.	Controller will flag the fault, and will use the lowest clipped value in its settings.	Contact mainte-nance for trouble-shooting.	The analog input ANI3 is not con-nected, or measured input value is above the maximum value (corresponding with 100 %).	Check the wiring between the control-ler and the device connected to this analog input. Check this device con-nected. Check if the calibration is done correctly – recalibra-tion of this analog input.
54.00	A	Analog input 4 (wire B02) related fault : analog input is shorted to ground.	Controller will flag the fault. The control-ler uses the analog input ANI4 to have a reference power supply for the analog inputs ANI2, ANI3, ANI5 and ANI6.	Contact mainte-nance for trouble-shooting.	The reference power supply (4.5 V ref.) for the analog inputs ANI2, ANI3, ANI5 & ANI6 is below 4 V	Check the refence power supply of the analog inputs ANI2, ANI3, ANI5 and ANI6.

Fault Code	Type	Explanation	Controller's Action	Driver Action	Fault Cause	Troubleshooting
54.01	A	Analog input 4 (wire B02) related fault : analog input is not connected.	Controller will flag the fault. The con-troller uses the ana-log input ANI4 to have a reference power supply for the analog inputs ANI2, ANI3, ANI5 and ANI6.	Contact mainte-nance for trouble-shooting.	The reference power supply (4.5 V ref.) for the analog inputs ANI2, ANI3, ANI5 & ANI6 is above 4.95 V.	Check the refence power supply of the analog inputs ANI2, ANI3, ANI5 and ANI6.
55.00	B	Analog input 5 (wire B04) related fault : analog input is	Controller will flag the fault, and will use the lowest clipped	Contact mainte-nance for trouble-shooting.	The analog input ANI5 is shorted to ground, or measured	Check the wiring between the control-ler and the device

		shorted to ground.	value in its settings.		input value is below the minimum value (corresponding with 0 %).	connected to this analog input. Check this device connected. Check if the calibration is done correctly – recalibration of this analog input.
55.01	B	Analog input 5 (wire B04) related fault : analog input is not connected.	Controller will flag the fault, and will use the lowest clipped value in its settings.	Contact maintenance for troubleshooting.	The analog input ANI5 is not connected, or measured input value is above the maximum value (corresponding with 100 %).	Check the wiring between the controller and the device connected to this analog input. Check this device connected. Check if the calibration is done correctly – recalibration of this analog input.
56.00	B	Analog input 6 (wire B06) related fault : analog input is shorted to ground.	Controller will flag the fault, and will use the lowest clipped value in its settings.	Contact maintenance for troubleshooting.	The analog input ANI6 is shorted to ground, or measured input value is below the minimum value (corresponding with 0 %).	Check the wiring between the controller and the device connected to this analog input. Check this device connected. Check if the calibration is done correctly – recalibration of this analog input.
56.01	B	Analog input 6 (wire B06) related fault : analog input is not connected.	Controller will flag the fault, and will use the lowest clipped value in its settings.	Contact maintenance for troubleshooting.	The analog input ANI6 is not connected, or measured input value is above the maximum value (corresponding with 100 %).	Check the wiring between the controller and the device connected to this analog input. Check this device connected. Check if the calibration is done correctly – recalibration of this analog input.

Fault Code	Type	Explanation	Controller's Action	Driver Action	Fault Cause	Troubleshooting
60.00	S/A	Speed channel 0 (wire A22) related fault : speed channel is shorted to ground.	When only 1 speed channel has a failure, and which is not the engine speed channel, the controller will calculate what the missing speed should be. If several speed channels have a failure, of the engine speed chan- [illegible] controller reverts to a "limp home" mode	Contact maintenance for troubleshooting.	Speed channel SPC0 is shorted to ground.	Check the wiring between the controller and the speed sensor connected to speed channel 0. Check the speed sensor connected to speed channel 0.

			”limp home” mode.			
60.01	S/A	Speed channel 0 (wire A22) related fault : speed channel is not connected.	When only 1 speed channel has a failure, and which is not the engine speed channel, the controller will calculate what the missing speed should be. If several speed channels have a failure, of the engine speed channel has a failure, the controller reverts to a ”limp home” mode.	Contact maintenance for troubleshooting.	Speed channel SPC0 is not connected.	Check the wiring between the controller and the speed sensor connected to speed channel 0. Check the speed sensor connected to speed channel 0.
60.03	S/A	Speed channel 0, Invalid signal.	When a speed channel has a failure, the controller will flag the appropriate error. If the engine speed channel has a failure, the controller reverts to a ”limp home” mode.	Contact maintenance for troubleshooting.	Speed channel is not measuring.	Check the speed sensor installation.
61.00	S/A	Speed channel 1 (wire A24) related fault : speed channel is shorted to ground.	When only 1 speed channel has a failure, and which is not the engine speed channel, the controller will calculate what the missing speed should be. If several speed channels have a failure, of the engine speed channel has a failure, the controller reverts to a ”limp home” mode.	Contact maintenance for troubleshooting.	Speed channel SPC1 is shorted to ground.	Check the wiring between the controller and the speed sensor connected to speed channel 1. Check the speed sensor connected to speed channel 1.

Fault Code	Type	Explanation	Controller’s Action	Driver Action	Fault Cause	Troubleshooting
61.01	S/A	Speed channel 1 (wire A24) related fault : speed channel is not connected.	When only 1 speed channel has a failure, and which is not the engine speed channel, the controller will calculate what the missing speed should be. If several speed channels have a failure, of the engine speed channel has a failure, the controller reverts to a ”limp home” mode.	Contact maintenance for troubleshooting.	Speed channel SPC1 is not connected.	Check the wiring between the controller and the speed sensor connected to speed channel 1. Check the speed sensor connected to speed channel 1.

			”limp home” mode.			
61.03	S/A	Speed channel 1, Invalid signal.	When a speed channel has a failure, the controller will flag the appropriate error. If the engine speed channel has a failure, the controller reverts to a ”limp home” mode.	Contact maintenance for troubleshooting.	Speed channel is not measuring.	Check the speed sensor installation.
62.00	S/A	Speed channel 2 (wire A26) related fault : speed channel is shorted to ground.	When only 1 speed channel has a failure, and which is not the engine speed channel, the controller will calculate what the missing speed should be. If several speed channels have a failure, of the engine speed channel has a failure, the controller.	Contact maintenance for troubleshooting.	Speed channel SPC2 is shorted to ground.	Check the wiring between the controller and the speed sensor connected to speed channel 2. Check the speed sensor connected to speed channel 2.
62.01	S/A	Speed channel 2 (wire A26) related fault : speed channel is not connected.	When only 1 speed channel has a failure, and which is not the engine speed channel, the controller will calculate what the missing speed should be. If several speed channels have a failure, of the engine speed channel has a failure, the controller reverts to a ”limp home” mode.	Contact maintenance for troubleshooting.	Speed channel SPC2 is not connected.	Check the wiring between the controller and the speed sensor connected to speed channel 2. Check the speed sensor connected to speed channel 2.

Fault Code	Type	Explanation	Controller’s Action	Driver Action	Fault Cause	Troubleshooting
62.03	S/A	Speed channel 2, Invalid signal.	When a speed channel has a failure, the controller will flag the appropriate error. If the engine speed channel has a failure, the controller reverts to a ”limp home” mode.	Contact maintenance for troubleshooting.	Speed channel is not measuring.	Check the speed sensor installation.
63.00	S/A	Speed channel 3 (wire B11) related fault : speed channel	When only 1 speed channel has a failure, and which is not	Contact maintenance for troubleshooting.	Speed channel SPC3 is shorted to ground.	Check the wiring between the controller and the speed

		is shorted to ground.	the engine speed channel, the controller will calculate what the missing speed should be. If several speed channels have a failure, of the engine speed channel has a failure, the controller reverts to a ”limp home” mode.			sensor connected to speed channel 3. Check the speed sensor connected to speed channel 3.
63.01	S/A	Speed channel 3 (wire B11) related fault : speed channel is not connected.	When only 1 speed channel has a failure, and which is not the engine speed channel, the controller will calculate what the missing speed should be. If several speed channels have a failure, of the engine speed channel has a failure, the controller reverts to a ”limp home” mode.	Contact maintenance for troubleshooting.	Speed channel SPC3 is not connected.	Check the wiring between the controller and the speed sensor connected to speed channel 3. Check the speed sensor connected to speed channel 3.
63.03	S/A	Speed channel 3, Invalid signal.	When a speed channel has a failure, the controller will flag the appropriate error. If the engine speed channel has a failure, the controller reverts to a ”limp home” mode.	Contact maintenance for troubleshooting.	Speed channel is not measuring.	Check the speed sensor installation.

Fault Code	Type	Explanation	Controller's Action	Driver Action	Fault Cause	Troubleshooting
70.00	S/A	Output 0 (wires A02 & A03) related fault: – wires A02 & A03 configured as analog output: output wires are shorted to each other, or the sense line is shorted to battery +, or the plus line is shorted to ground. – wire A02 config-	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be	”limp home” mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.”	– wires A02 & A03 configured as analog output: output wires are shorted to each other, or the sense line is shorted to battery +, or the plus line is shorted to ground.– wire A02 configured as digital output: the output is shorted to ground.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the VFS/ Selector solenoid 0, Check the VFS/ selector solenoid 0. If the output is connected to an other device: Check the

		ured as digital output: the output is shorted to ground.	taken.			wiring between the controller and the other device, Check the other device.”
70.01	S/A	Output 0 (wires A02 & A03) related fault: – wires A02 & A03 configured as analog output: the output wire is not connected, or its plus line is shorted to battery +. – wire A02 configured as digital output: the output is shorted to battery +, or the output is not connected.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be taken.	”limp home” mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	– wires A02 & A03 configured as analog output: the output wire is not connected, or its plus line is shorted to battery +. – wire A02 configured as digital output: the output is shorted to battery +.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the VFS/ Selector solenoid 0, Check the VFS/ selector solenoid 0. If the output is connected to an other device: Check the wiring between the controller and the other device, Check the other device.
70.02	S/A	Output 0 (wires A02 & A03) related fault: – wires A02 & A03 configured as analog output: the output current exceeds 1400 mA.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode – non–critical feature output: the controller will flag the fault, but no actions will be taken.	”limp home” mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	– wires A02 & A03 configured as analog output: the output current exceeds 1400 mA.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the VFS/ Selector solenoid 0, Check the VFS/ selector solenoid 0. If the output is connected to an other device: Check the wiring between the controller and the other device, Check the other device.

Fault Code	Type	Explanation	Controller’s Action	Driver Action	Fault Cause	Troubleshooting
70.03	S/A	Output 0 (wires A02 & A03) related fault: – wires A02 & A03 configured as analog output: the output current is out of range, occurs when the load has the incorrect impedance.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	– wires A02 & A03 configured as analog output: the output current is out of range, occurs when the load has the incorrect impedance.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the VFS/ Selector solenoid 0, Check the VFS/ selector solenoid 0. If the output is connected to an other device: Check the

			taken.			wiring between the controller and the other device, Check the other device.
71.00	S/A	Output 1 (wires A04 & A05) related fault: – wires A04 & A05 configured as analog output: output wires are shorted to each other, or the sense line is shorted to battery +, or the plus line is shorted to ground. – wire A04 configured as digital output: the output is shorted to ground.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be taken.	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	– wires A04 & A05 configured as analog output: output wires are shorted to each other, or the sense line is shorted to battery +, or the plus line is shorted to ground. – wire A04 configured as digital output: the output is shorted to ground.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the VFS/Selector solenoid 1, Check the VFS/selector solenoid 1. If the output is connected to an other device: Check the wiring between the controller and the other device, Check the other device.
71.01	S/A	Output 1 (wires A04 & A05) related fault: – wires A04 & A05 configured as analog output: the output wire is not connected, or its plus line is shorted to battery +. – wire A04 configured as digital output: the output is shorted to battery +, or the output is not connected.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be taken.	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	– wires A04 & A05 configured as analog output: the output wire is not connected, or its plus line is shorted to battery +. – wire A04 configured as digital output: the output is shorted to battery +.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the VFS/ Selector solenoid 1, Check the VFS/ selector solenoid 1. If the output is connected to an other device: Check the wiring between the controller and the other device, Check the other device.

Fault Code	Type	Explanation	Controller's Action	Driver Action	Fault Cause	Troubleshooting
71.02	S/A	Output 1 (wires A04 & A05) related fault: – wires A04 & A05 configured as analog output: the output current exceeds 1400 mA.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	– wires A04 & A05 configured as analog output: the output current exceeds 1400 mA.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the VFS/ Selector solenoid 1, Check the VFS/ selector solenoid 1. If the output is connected to an other device: Check the

			taken.			wiring between the controller and the other device, Check the other device.
71.03	S/A	Output 1 (wires A04 & A05) related fault: – wires A04 & A05 configured as analog output: the output current is out of range, occurs when the load has the incorrect impedance.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a "limp home" mode. – non–critical feature output: the controller will flag the fault, but no actions will be taken.	"limp home" mode: Stop machine and go to neutral to be able to drive again. "Limp home" mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	– wires A04 & A05 configured as analog output: the output current is out of range, occurs when the load has the incorrect impedance.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the VFS/ Selector solenoid 1, Check the VFS/ selector solenoid 1. If the output is connected to an other device: Check the wiring between the controller and the other device, Check the other device.
72.00	S/A	Output 2 (wires A06 & A07) related fault: – wires A06 & A07 configured as analog output: output wires are shorted to each other, or the sense line is shorted to battery +, or the plus line is shorted to ground. – wire A06 configured as digital output: the output is shorted to ground.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a "limp home" mode. – non–critical feature output: the controller will flag the fault, but no actions will be taken.	"limp home" mode: Stop machine and go to neutral to be able to drive again. "Limp home" mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	– wires A06 & A07 configured as analog output: output wires are shorted to each other, or the sense line is shorted to battery +, or the plus line is shorted to ground. – wire A06 configured as digital output: the output is shorted to ground.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the VFS/ Selector solenoid 2, Check the VFS/ selector solenoid 2. If the output is connected to an other device: Check the wiring between the controller and the other device, Check the other device.

Fault Code	Type	Explanation	Controller's Action	Driver Action	Fault Cause	Troubleshooting
72.01	S/A	Output 2 (wires A06 & A07) related fault: – wires A06 & A07 configured as analog output: the output wire is not connected, or its plus line is shorted to battery +. – wire A06 configured as digital output: the output is shorted	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a "limp home" mode. – non–critical feature output: the controller will flag the fault, but no actions will be	"limp home" mode: Stop machine and go to neutral to be able to drive again. "Limp home" mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	– wires A06 & A07 configured as analog output: the output wire is not connected, or its plus line is shorted to battery +. – wire A06 configured as digital output: the output is shorted to battery +.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the VFS/ Selector solenoid 2, Check the VFS/ selector solenoid 2. If the output is connected to an other device: Check the

		to battery +, or the output is not connected.	taken.			wiring between the controller and the other device, Check the other device.
72.02	S/A	Output 2 (wires A06 & A07) related fault: – wires A06 & A07 configured as analog output: the output current exceeds 1400 mA.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be taken.	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	– wires A06 & A07 configured as analog output: the output current exceeds 1400 mA.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the VFS/ Selector solenoid 2, Check the VFS/ selector solenoid 2. If the output is connected to an other device: Check the wiring between the controller and the other device, Check the other device.
72.03	S/A	Output 2 (wires A06 & A07) related fault: – wires A06 & A07 configured as analog output: the output current is out of range, occurs when the load has the incorrect impedance.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be taken.	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	– wires A06 & A07 configured as analog output: the output current is out of range, occurs when the load has the incorrect impedance.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the VFS/ Selector solenoid 2, Check the VFS/ selector solenoid 2. If the output is connected to an other device: Check the wiring between the controller and the other device, Check the other device.

Fault Code	Type	Explanation	Controller’s Action	Driver Action	Fault Cause	Troubleshooting
73.00	S/A	Output 3 (wires A08 & A09) related fault: – wires A08 & A09 configured as analog output: output wires are shorted to each other, or the sense line is shorted to battery +, or the plus line is shorted to ground. – wire A08 config-	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	– wires A08 & A09 configured as analog output: output wires are shorted to each other, or the sense line is shorted to battery +, or the plus line is shorted to ground. – wire A08 configured as digital output: the output is	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the VFS/ Selector solenoid 3, Check the VFS/ selector solenoid 3. If the output is connected to an other device: Check the

		ured as digital output: the output is shorted to ground.	taken.		shorted to ground.	wiring between the controller and the other device, Check the other device.”
73.01	S/A	Output 3 (wires A08 & A09) related fault: – wires A08 & A09 configured as analog output: the output wire is not connected, or its plus line is shorted to battery +. – wire A08 configured as digital output: the output is shorted to battery +, or the output is not connected.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be taken.	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	– wires A08 & A09 configured as analog output: the output wire is not connected, or its plus line is shorted to battery +. – wire A08 configured as digital output: the output is shorted to battery +.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the VFS/ Selector solenoid 3, Check the VFS/ selector solenoid 3. If the output is connected to an other device: Check the wiring between the controller and the other device, Check the other device.
73.02	S/A	Output 3 (wires A08 & A09) related fault: – wires A08 & A09 configured as analog output: the output current exceeds 1400 mA.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be taken.	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	– wires A08 & A09 configured as analog output: the output current exceeds 1400 mA.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the VFS/ Selector solenoid 3, Check the VFS/ selector solenoid 3. If the output is connected to an other device: Check the wiring between the controller and the other device, Check the other device.

Fault Code	Type	Explanation	Controller’s Action	Driver Action	Fault Cause	Troubleshooting
73.03	S/A	Output 3 (wires A08 & A09) related fault: – wires A08 & A09 configured as analog output: the output current is out of range, occurs when the load has the incorrect impedance.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	– wires A08 & A09 configured as analog output: the output current is out of range, occurs when the load has the incorrect impedance.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the VFS/ Selector solenoid 3, Check the VFS/ selector solenoid 3. If the output is connected to an other device: Check the

			taken.			wiring between the controller and the other device, Check the other device.
74.00	S/A	Output 4 (wire B01) related fault: – wire B01 configured as analog/digital output: output wire is shorted to ground.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be taken.	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	– wire B01 configured as analog/digital output: output wire is shorted to ground.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the Selector solenoid 4, Check the selector solenoid 4. If the output is connected to an other device: Check the wiring between the controller and the other device, Check the other device.
74.01	S/A	Output 4 (wire B01) related fault: – wire B01 configured as analog output: the output wire is not connected, or its plus line is shorted to battery +. – wire B01 configured as digital output: the output is shorted to battery +, or the output is not connected.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be taken.	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	– wire B01 configured as analog output: the output wire is not connected, or its plus line is shorted to battery +. – wire B01 configured as digital output: the output is shorted to battery +.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the Selector solenoid 4, Check the selector solenoid 4. If the output is connected to an other device: Check the wiring between the controller and the other device, Check the other device.

Fault Code	Type	Explanation	Controller’s Action	Driver Action	Fault Cause	Troubleshooting
74.02	S/A	Output 4 (wire B01) related fault: – wire B01 configured as analog output: the output current exceeds 1400 mA.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	– wire B01 configured as analog output: the output current exceeds 1400 mA.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the Selector solenoid 4, Check the selector solenoid 4. If the output is connected to an other device: Check the

Fault Code	Type	Explanation	Controller's Action	Driver Action	Fault Cause	Troubleshooting
			taken.			wiring between the controller and the other device, Check the other device.
74.03	S/A	Output 4 (wire B01) related fault: – wire B01 configured as analog output: the output current is out of range, occurs when the load has the incorrect impedance.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be taken.	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	– wire B01 configured as analog output: the output current is out of range, occurs when the load has the incorrect impedance.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the Selector solenoid 4, Check the selector solenoid 4. If the output is connected to an other device: Check the wiring between the controller and the other device, Check the other device.
75.00	S/A	Output 5 (wire B03) related fault: – wire B03 configured as analog/digital output: output wire is shorted to ground.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be taken.	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	– wire B03 configured as analog/digital output: output wire is shorted to ground.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the Selector solenoid 5, Check the selector solenoid 5. If the output is connected to an other device: Check the wiring between the controller and the other device, Check the other device.”
75.01	S/A	Output 5 (wire B03) related fault: – wire B03 configured as analog output: the output wire is not connected, or its plus line is shorted to battery +. – wire B03 configured as digital output: the output is shorted	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	– wire B03 configured as analog output: the output wire is not connected, or its plus line is shorted to battery +. – wire B03 configured as digital output: the output is shorted to battery +.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the Selector solenoid 4, Check the selector solenoid 4. If the output is connected to an other device: Check the wiring between the

		to battery +, or the output is not connected.	taken.			controller and the other device, Check the other device.”
75.02	S/A	Output 5 (wire B03) related fault: – wire B03 configured as analog output: the output current exceeds 1400 mA.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be taken.	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	– wire B03 configured as analog output: the output current exceeds 1400 mA.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the Selector solenoid 4, Check the selector solenoid 4. If the output is connected to an other device: Check the wiring between the controller and the other device, Check the other device.”
75.03	S/A	Output 5 (wire B03) related fault: – wire B03 configured as analog output: the output current is out of range, occurs when the load has the incorrect impedance.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be taken.	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	– wire B03 configured as analog output: the output current is out of range, occurs when the load has the incorrect impedance.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the Selector solenoid 4, Check the selector solenoid 4. If the output is connected to an other device: Check the wiring between the controller and the other device, Check the other device.”

Fault Code	Type	Explanation	Controller’s Action	Driver Action	Fault Cause	Troubleshooting
76.00	S/A	Output 6 (wire B05) related fault: – wire B05 configured as analog/digital output: output wire is shorted to ground.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	– wire B05 configured as analog/digital output: output wire is shorted to ground.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the Selector solenoid 6, Check the selector solenoid 6. If the output is connected to an other device: Check the

			no actions will be taken.			device: Check the wiring between the controller and the other device, Check the other device.”
76.01	S/A	Output 6 (wire B05) related fault: – wire B05 configured as analog output: the output wire is not connected, or its plus line is shorted to battery +. – wire B05 configured as digital output: the output is shorted to battery +, or the output is not connected.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be taken.	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	– wire B05 configured as analog output: the output wire is not connected, or its plus line is shorted to battery +. – wire B05 configured as digital output: the output is shorted to battery +.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the Selector solenoid 6, Check the selector solenoid 6. If the output is connected to an other device: Check the wiring between the controller and the other device, Check the other device.”
76.02	S/A	Output 6 (wire B05) related fault: – wire B05 configured as analog output: the output current exceeds 1400 mA.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be taken.	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	– wire B05 configured as analog output: the output current exceeds 1400 mA.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the Selector solenoid 6, Check the selector solenoid 6. If the output is connected to an other device: Check the wiring between the controller and the other device, Check the other device.”

Fault Code	Type	Explanation	Controller’s Action	Driver Action	Fault Cause	Troubleshooting
76.03	S/A	Output 6 (wire B05) related fault: – wire B05 configured as analog output: the output current is out of range, occurs when the load has the incorrect impedance.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	– wire B05 configured as analog output: the output current is out of range, occurs when the load has the incorrect impedance.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the Selector solenoid 6, Check the selector solenoid 6. If the output is connected to an other device: Check the

			taken.			wiring between the controller and the other device, Check the other device.
80.00	S/A	Digital output 0 (wire A10) related fault : output is shorted to ground.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be taken.	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	Wire A10 is shorted to ground.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the Selector solenoid 7, Check the selector solenoid 7. If the output is connected to an other device: Check the wiring between the controller and the other device, Check the other device.”
80.01	S/A	Digital output 0 (wire A10) related fault : output is shorted to battery + or the output is not connected.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be taken.	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	Wire A10 is shorted to battery +.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the Selector solenoid 7, Check the selector solenoid 7. If the output is connected to an other device: Check the wiring between the controller and the other device, Check the other device.”

Fault Code	Type	Explanation	Controller’s Action	Driver Action	Fault Cause	Troubleshooting
81.00	S/A	Digital output 1 (wire A15) related fault : output is shorted to ground.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	Wire A15 is shorted to ground.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the Selector solenoid 8, Check the selector solenoid 8. If the output is connected to an other

			no actions will be taken.			device: Check the wiring between the controller and the other device, Check the other device.
81.01	S/A	Digital output 1 (wire A15) related fault : output is shorted to battery + or the output is not connected.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be taken.	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	Wire A15 is shorted to battery +.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the Selector solenoid 8, Check the selector solenoid 8. If the output is connected to an other device: Check the wiring between the controller and the other device, Check the other device.
82.00	S/A	Digital output 2 (wire A16) related fault : output is shorted to ground.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be taken.	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	Wire A16 is shorted to ground.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the Selector solenoid 9, Check the selector solenoid 9. If the output is connected to an other device: Check the wiring between the controller and the other device, Check the other device.

Fault Code	Type	Explanation	Controller’s Action	Driver Action	Fault Cause	Troubleshooting
82.01	S/A	Digital output 2 (wire A16) related fault : output is shorted to battery + or the output is not connected.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	Wire A16 is shorted to battery +.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the Selector solenoid 9, Check the selector solenoid 9. If the output is connected to an other device: Check the

			no actions will be taken.			device: Check the wiring between the controller and the other device, Check the other device.
83.00	S/A	Digital output 3 (wire A20) related fault : output is not connected, or shorted to ground.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be taken.	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	Wire A20 is shorted to ground.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the Selector solenoid 10, Check the selector solenoid 10. If the output is connected to an other device: Check the wiring between the controller and the other device, Check the other device.
83.01	S/A	Digital output 3 (wire A20) related fault : output is shorted to battery +.	Action will depend on the function assigned to the output: – critical output (eg. transmission valve control): the controller reverts to a ”limp home” mode. – non–critical feature output: the controller will flag the fault, but no actions will be taken.	“limp home“ mode: Stop machine and go to neutral to be able to drive again. ”Limp home” mode will result in reduced driving functionality. Contact maintenance for troubleshooting.	Wire A20 is shorted to battery +.	If the output is configured as an output to a transmission solenoid: Check the wiring between the controller and the Selector solenoid 10, Check the selector solenoid 10. If the output is connected to an other device: Check the wiring between the controller and the other device, Check the other device.

Fault Code	Type	Explanation	Controller’s Action	Driver Action	Fault Cause	Troubleshooting
90.xx – 99.xx	S/B/H	System Error.	Controller reverts to a ”shut down” mode and will force neutral 0.	Contact maintenance for troubleshooting.	Software related fault.	Contact Spicer Off–Highway and inform the fault code and the time that is was active.
95.71	S	Data in the APC is not compatible with the data expected by the APC firmware.	The controller reverts to a ”shut down” mode and will force neutral 0.	Download an APT file compatible with the active firmware into the APC.	Wrong APT file (data file) is in the APC (typically after APC firmware upgrade).	Download an APT file compatible with the active firmware into the APC If the error code still persists, the data

						flash may be corrupt (contact Spicer Off–Highway).
99.90	S	Wrong firmware is flashed into the APC.	The controller reverts to a ”shut down” mode and will force neutral 0.	Flash the correct firmware into the APC.	Wrong firmware is flashed into the APC.	Flash the correct firmware into the APC.
99.95	S	CAN peak load detected : APC temporarily could not process all incoming messages, due to an excessive peak of CAN requests.	Controller will reply on the CAN messages which are available in its buffer.	No action requested.	Overload of incoming CAN messages to the APC.	No action requested.

The codes listed below are called 'Exceed Parameter' codes and are not so much codes that report a problem, but rather indicate a certain machine operating state.
These codes give an indication of the machine operating state in regard to some programmed limits that may be exceeded.

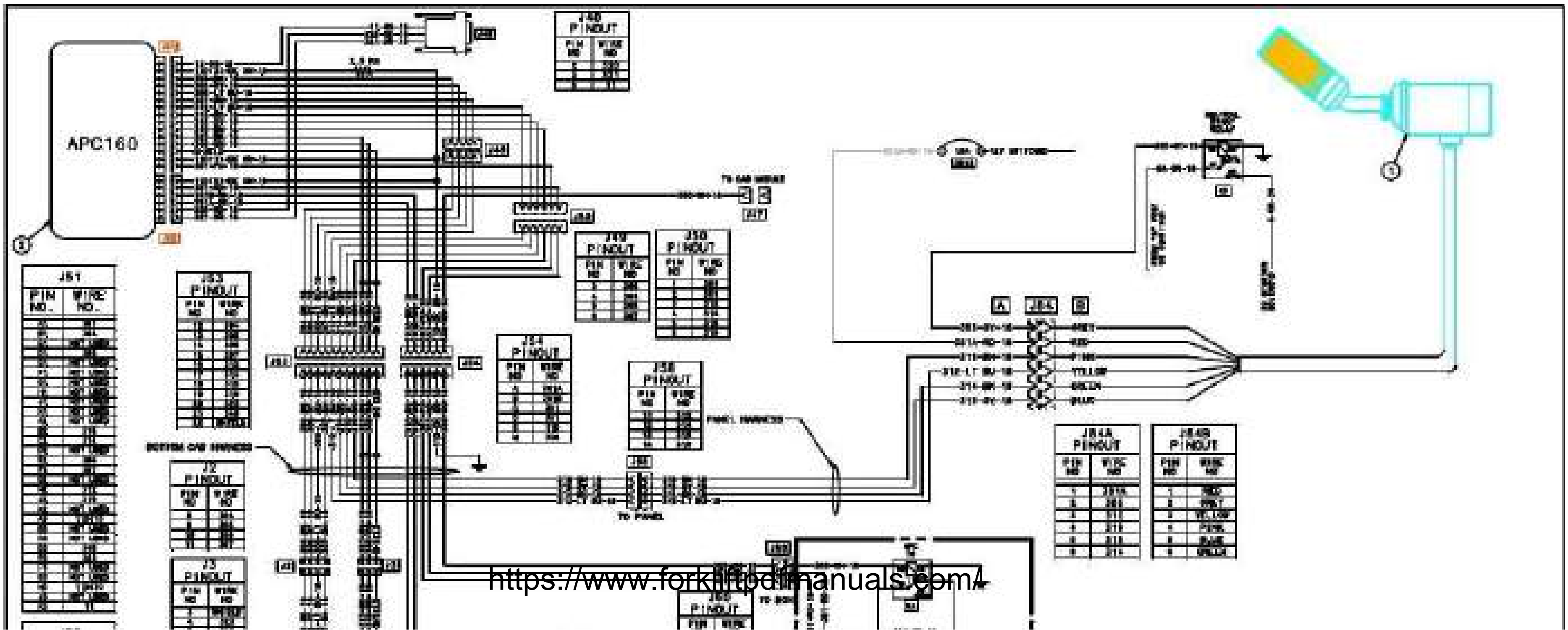
Exceed Code	Type	Explanation	Controller's Action	Driver Action
E0.01	E	The vehicle speed is too high to make the requested downshift.	The controller will disable the downshift in order to protect the transmission, until the vehicle speed comes below the downshift limit.	The driver should slow down the vehicle, in order that the requested downshiflt can be made.
E1.01	E	The vehicle speed is too high to make the requested direction change.	The controller will not allow the direction change to protect the transmission and will place the transmission in neutral, until the vehicle speed comes below the direction change vehicle speed limit.	The driver should slow down the vehicle, in order that the requested direction change can be made.
E2.01	E	The engine speed is too high to make the requested direction change or the requested re–engagement of the direction.	The controller will not allow the direction change or re–engagement of the direction, until the engine speed comes below the direction change or the direction re–engagement engine speed limit.	The driver should slow down the engine, in order that the requested direction change or direction re–engagement can be made.

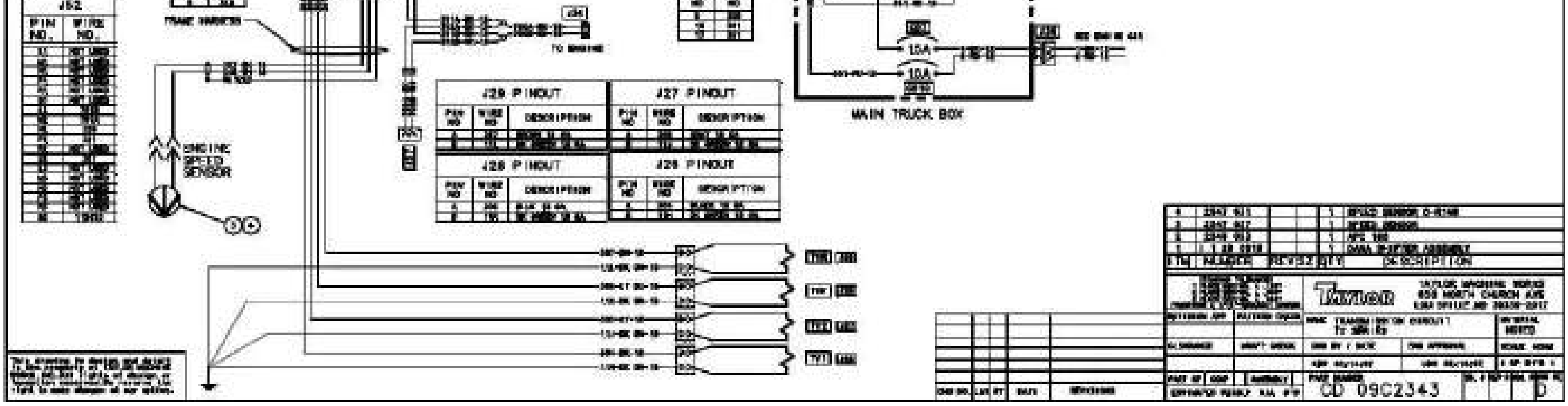
Exceed Code	Type	Explanation	Controller's Action	Driver Action
E3.00	E	The reduced vehicle speed limitation is active.	The controller is limiting the vehicle speed to the reduced vehicle speed limit.	No action is requested, the vehicle speed is limited due to request.
E3.01	E	The reduced vehicle speed limitation is active, however the vehicle speed is above the limit.	The controller is limiting the vehicle speed to the reduced vehicle speed limit, but detects a higher vehicle speed.	The driver should slow down the vehicle, in order that the vehicle speed comes below the reduced vehicle speed limit.
E3.02	E	The vehicle speed is above the maximum vehicle speed limit.	The controller is limiting the vehicle speed to the maximum vehicle speed limit, but detects a higher	The driver should slow down the vehicle, in order that the vehicle speed comes below the maximum

			vehicle speed.	vehicle speed limit.
E4.00	E	An abnormal deceleration is detected.	The controller detected an abnormal deceleration, and will disable the automatic shifting for a certain time.	The driver should slow down, in order that the wheels can not slip any more.
E4.01	E	An abnormal acceleration is detected.	The controller detected an abnormal acceleration, and will disable the automatic shifting for a certain time.	The driver should slow down the engine, in order that the wheels can not spin any more.
E5.01	E	Time in gear exceeded the time to recalibrate the transmission.	The controller detected that the time in gear exceeded the time to recalibrate the transmission.	The driver should contact maintenance to recalibrate the transmission.
E6.00	E	Operator is not seated with shift lever not in neutral and/or the parking brake not activated.	The controller detected that the operator is not seated with the shift lever not in neutral and/or the parking brake not activated.	The driver should take place in the operator seat and confirm his presence (cycle the shift lever through neutral and/or release the throttle pedal).
E7.01	E	Transmission limit exceeded on turbine speed.	Upshift to decrease turbine speed.	The driver should slow down the vehicle, in order that the vehicle speed comes below the maximum transmission limit speed.

Type	Severity of Effect	Level	Description
S	High	Severe Warning	Vehicle inoperable, with loss of primary function / Vehicle operable, but at reduced level of performance – customer dissatisfied.
A	Moderate	Warning	Vehicle operable, but comfort / convenience item(s) inoperable – customer experiences discomfort.
B	Low	Info	Vehicle operable, but comfort / convenience item(s) operable at reduced level – customer experiences some dissatisfaction.
H	Very Low	Data Info	Vehicle operable, defect not noticed by customer.
E	None	Exceed Parameter Info	Driver is requesting an action which is protected by the controller.

PLACE THE FOLLOWING ILLUSTRATION IN A FOLDER ENVELOPE:
Illustration 9C-13 - 09C-2343 (SHIFT ANSI)




J52
PIN NO.
WIRE NO.
ENGINE SPEED SENSOR
J29 PINOUT
J27 PINOUT
J28 PINOUT
J26 PINOUT
MAIN TRUCK BOX
15A
CD 09C2343

Section 11

Drive Shaft

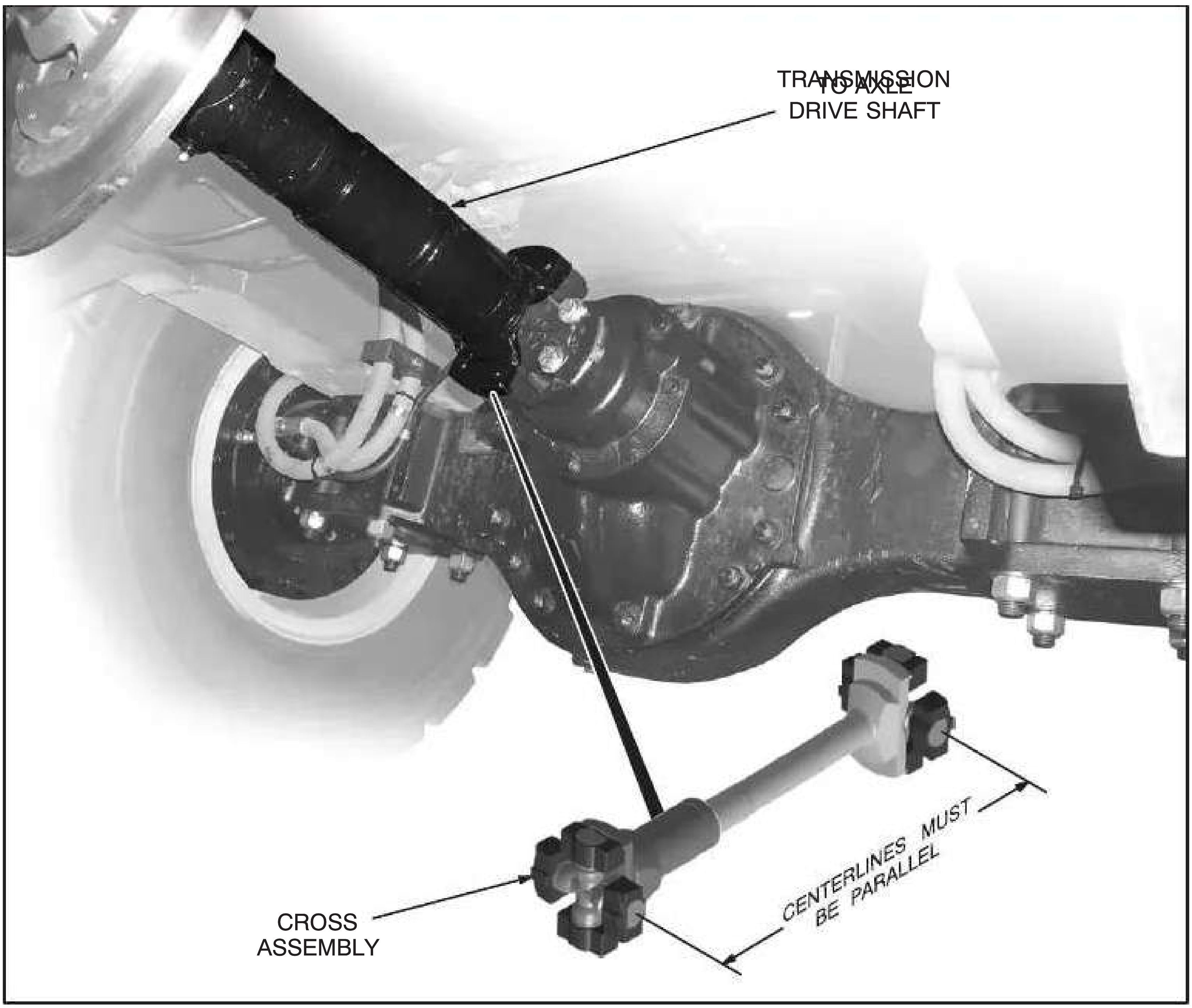


Illustration: Transmission to Axle Drive Shaft

Introduction. The drive shaft connects the transmission to the drive axle. It is important to always have the transmission in phase with the drive axle (See the note below).

Lubrication (Illustration 11-1)**.** The drive shaft, universal joints and slip joints should be greased periodically (refer to the **Preventive Maintenance** chart in the **Appendices** for drive shaft components lubrication interval).

NOTE: *When the transmission to axle drive shaft is installed, the cross assemblies, on the drive shaft, must be aligned as shown in Illustration 11-1. If the flanges are not aligned, reposition the splines to bring the flanges into alignment.*

If this is not followed, the drive shaft will be out of phase, and vibration and noise may occur.

Drive Shaft Bolts Inspection (Illustration 11-1)**.** The bolts, which connect the drive shaft to the brake disc and drive axle, should be checked for tightness periodically (refer to the **Preventive Maintenance** chart in the **Appendices** for drive shaft bolts inspection interval). If tightening is

required, apply a torque value of 110 ft-lbs (150 N·m) to the bolts.

Section 13

Steer Axle

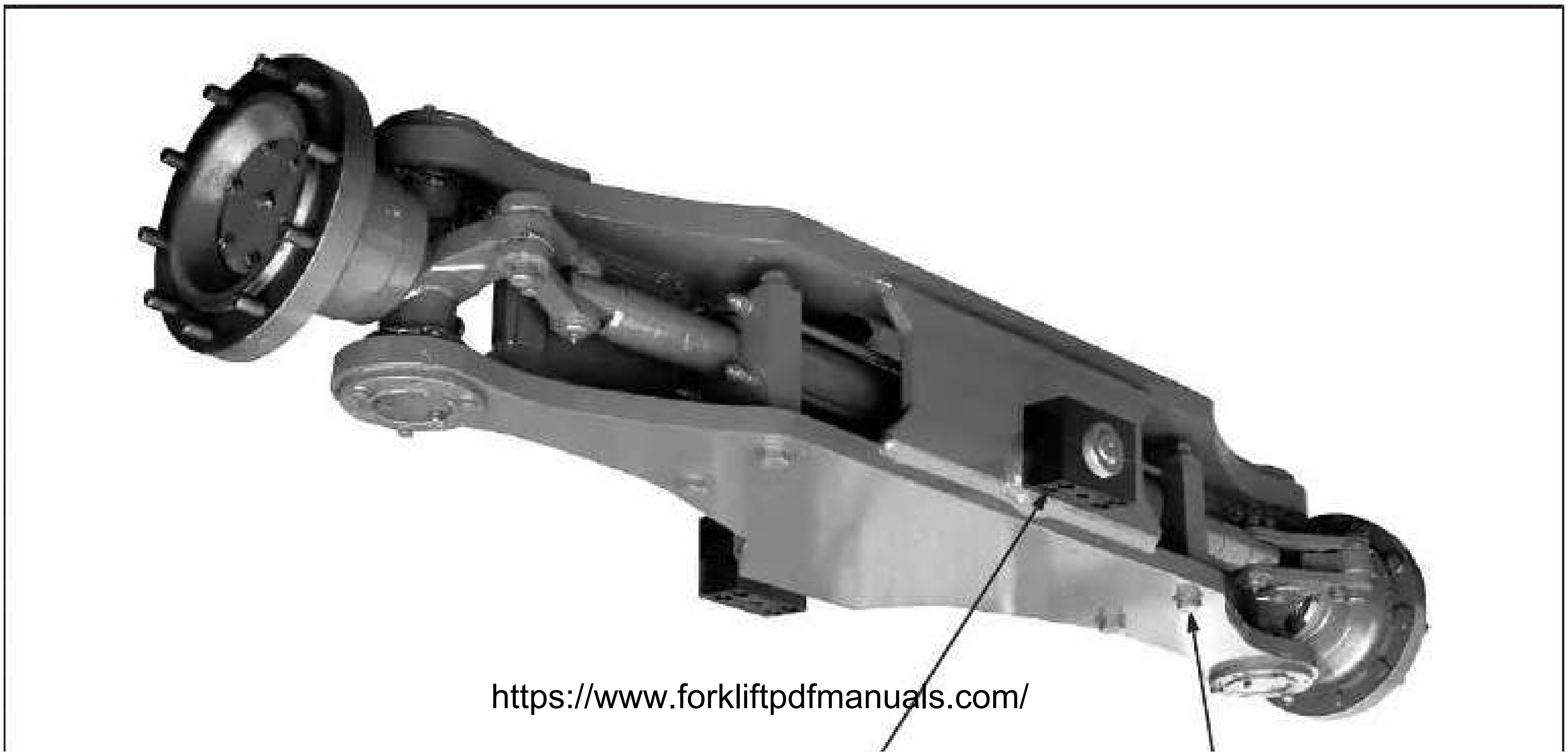
Introduction. The steer axle is mounted to the frame with two pivot pins. The pivot pins are an integral part of the axle. Axle pivot bearings are installed inside the front and rear steer axle pivot blocks. All routine maintenance can be accomplished with the steer axle connected to the frame.

Lubrication. Refer to the **Lubrication** section in the **Appendices** for information on lubricating the steer axle.

WARNING: Before checking or servicing the steer axle, park on level ground, apply the parking brake, block the wheels in both directions, shut down the engine, and Lock Out & Tag Out the truck.

Mounting Bolts Check (Illustration 13-1). The mounting bolts of the steer axle should be checked for tightness periodically (refer to the **Preventive Maintenance** chart in the **Appendices** for steer axle mounting bolts inspection interval). If the mounting bolts require tightening, torque bolts to 150 - 165 ft-lbs (200 - 225 N·m) [405 - 450 ft-lbs (550 - 610 N·m) TXH400L].

Steer Cylinder Mounting Bolts (Illustration 13-1). The steer cylinder mounting bolts should be checked for tightness periodically (refer to the **Preventive Maintenance** chart in the **Appendices** for steer cylinder mounting bolts inspection interval). If there is any evidence of threading or movement of the steer cylinder, then remove the mounting bolts, clean bolts, apply Loctite® to the threads of the bolts and torque bolts to 460 ft-lbs (625 N·m) [900 ft-lbs (1,225 N·m) TXH400L].



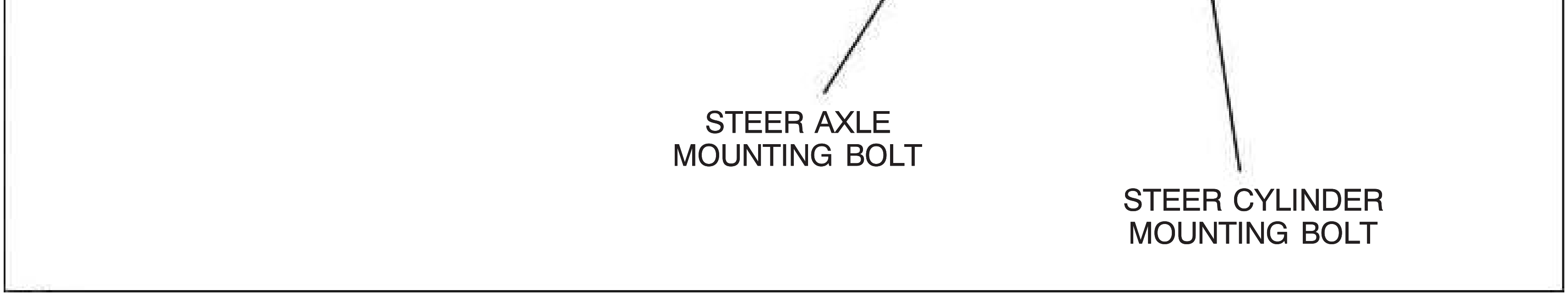


Illustration 13-1. Steer Axle

Drive Axles

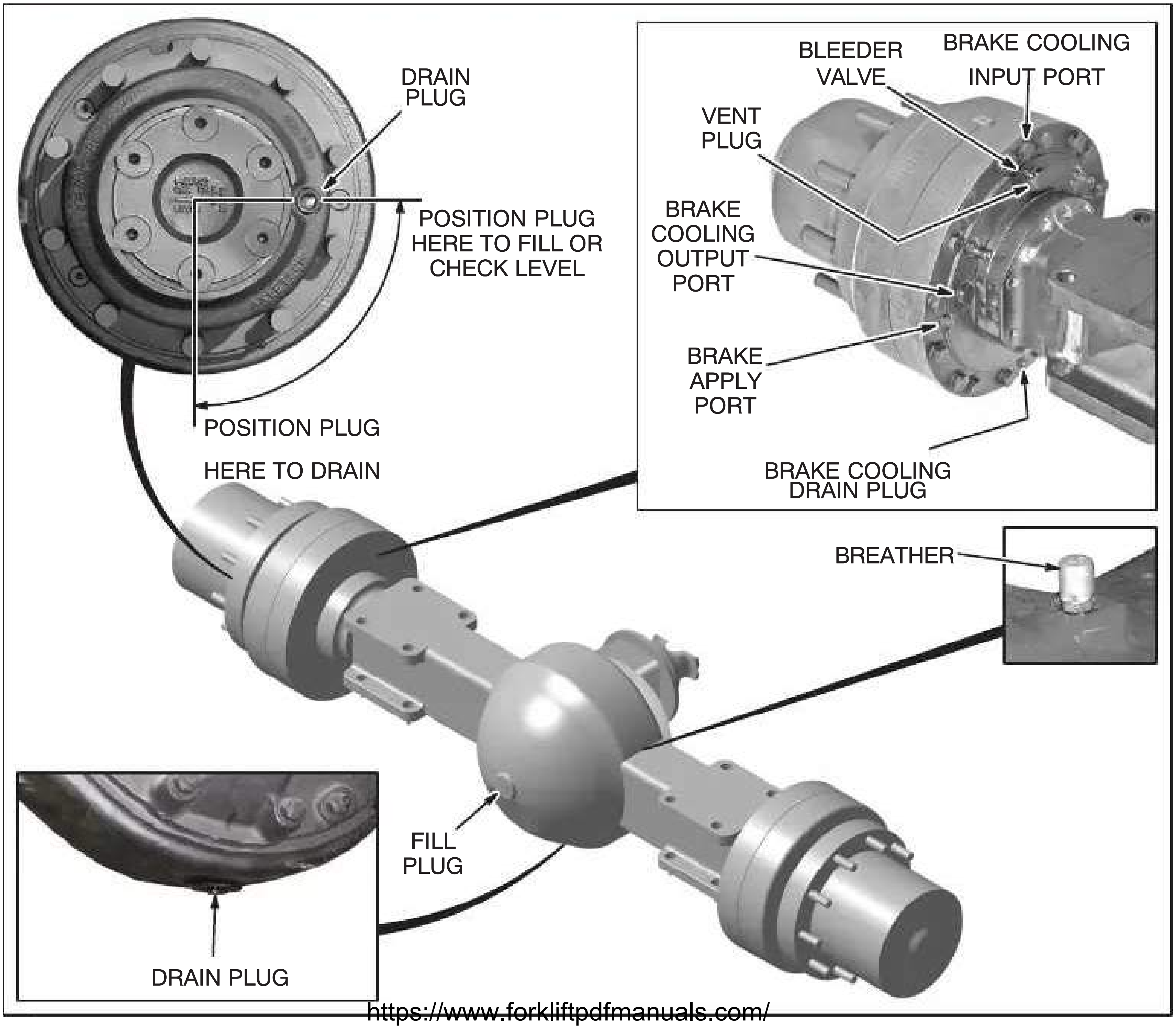


Illustration 14-1. Wet Disc Brakes Drive Axle (TX180S-360L, TXB180S-300L, TXH300L, TXH350L)

Introduction. The drive axle is equipped with double reduction gearing. The first gear reduction is a hypoid type ring gear and pinion. The second reduction is in the form of planetary gears inside the hubs. This arrangement permits the axle shafts and hypoid gearing to carry only a nominal torsional load while providing the highest practical gear reduction at the wheels.

Checking Lube Oil Level (Illustrations 14-1 and 14-2)**.** The oil in the differential and the planetary hubs should be checked periodically (refer to the **Preventive Maintenance** chart in the **Appendices** for oil level inspection interval). Perform the following procedures to check the oil level and service the differential and planetary hubs:

WARNING: Death or serious injury could result from a runaway truck. Park the truck on a hard, level surface, apply the parking brake, block the wheels in both directions to prevent movement of the truck and Lock Out & Tag Out the truck before servicing the drive axle.

1. Differential
   a. Park the truck on a hard, level surface, block the wheels in both directions, apply the parking brake and Lock Out & Tag Out the truck.
   b. Check the oil level in the differential by removing the fill plug.
   c. The oil level should be even with the bottom of the fill plug hole. Add oil as required.
   d. Re-install the fill plug.
2. Planetary Hubs
   a. Maneuver the truck until the drain plug on one of the planetary hubs is in the 3 o'clock (PRC-785 drive axle) or 9 o'clock (PRC-1756 drive axle) position of hub rotation (see Illustrations 14-1 and 14-2).
   b. Park the truck on a hard, level surface, block the wheels in both directions, apply the parking brake and Lock Out & Tag Out the truck.
   c. Remove the drain plug. The oil level should be even with the bottom of the drain plug hole. Add oil as required.
   d. Re-install the drain plug.
   e. Reposition the truck as necessary and service the hub on the opposite end of the axle by repeating the above procedures.

Changing The Oil (Illustrations 14-1 and 14-2)**.** The oil in the differential and planetary hubs should be changed periodically (refer to the **Preventive Maintenance** chart in the **Appendices** for drive axle differential and planetary hubs oil change intervals). Refer to the **Fuel and Lubricant Specifications** in the **Appendices** for the type of oil to be used in the drive axle. Perform the following procedures to change the oil in the drive axle:

1. Differential
   a. Park the truck on a hard, level surface, block the wheels in both directions, apply the parking brake and Lock Out & Tag Out the truck.
   b. Provide a suitable container to catch draining oil. Then, remove the differential drain plug and fill plug.
   c. Once the oil has completely drained, install the differential drain plug and fill with recommended lubricant (refer to the **Fuel and Lubricant Specifications** in the **Appendices**) even with the bottom of the fill plug hole.
   d. Re-install the fill plug.
2. Planetary Hubs
   a. Position the truck so that the drain plug for one of the planetary hubs is at the 6 o'clock position of hub rotation.
   b. Park the truck on a hard, level surface, block the wheels in both directions, apply the parking brake and Lock Out & Tag Out the truck.
   c. Provide a suitable container to catch draining oil and then remove the drain plug.
   d. Once the oil has completely drained, position the truck so that the drain plug is in the 3 o'clock or 9 o'clock position of hub rotation (see Illustrations 14-1 and 14-2). Fill the hub with recommended oil (refer to the **Fuel and Lubricant Specifications** in the **Appendices**) until the oil level is even with the bottom of the drain plug hole. Re-install the drain plug.
   e. Follow the above procedures for servicing the hub on the other side of the drive axle.

Draining The Hydraulic Fluid From The Brake Housings (Illustrations 14-1 and 14-2). The

WARNING: Death or serious injury could result from a runaway truck. Park the truck on a hard, level surface, apply the parking brake, block the wheels in both directions to prevent movement of the truck and Lock Out & Tag Out the truck before servicing the drive axle.

CAUTION: Dispose of used oil in accordance with federal and local regulations.

Housings (illustrations 14-1 and 14-2). The brake housings should be drained after the first month or 200 - 250 hours of operation, whichever comes first, and when the hydraulic fluid is changed (refer to **Changing The Hydraulic Fluid** in **Section 22**). Perform the following procedures to change the hydraulic fluid from the brake housing:

WARNING: Death or serious injury could result from a runaway truck. Park the truck on a hard, level surface, apply the parking brake, block the wheels in both directions to prevent

movement of the truck and Lock Out & Tag Out the truck before servicing the drive axle.

CAUTION: Dispose of used hydraulic fluid in accordance with federal and local regulations.

1. Park the truck on a hard, level surface, block the wheels in both directions, apply the parking brake and Lock Out & Tag Out the truck.

WARNING: Allow the wheel end brakes to cool to ambient temperature (cool to the touch) before draining brake cooling fluid. Wear protective gloves. Failure to do so may result in personal injury from heated brake cooling fluid.

2. Provide a suitable container to catch drained hydraulic fluid.
3. Remove the brake cooling hoses from the brake housing and quickly cap hoses.
4. Remove the brake cooling drain plug from the hub.
5. Clean the drain plug and apply silicone sealant to the threads of the plug. Re-install plug and tighten to 25-35 ft-lbs (34-47 N·m).
6. Re-connect the brake cooling hoses to the brake housing.
7. Repeat procedures 1. thru 6. for the opposite brake housing.
8. Remove the vent plug in the top of the brake housing and the plug from the unused brake cooling output port of both brake housings. When the housing is filled, the vent plug port

low, add fluid until fluid level is at the FULL mark on the dipstick of the hydraulic tank.

12. Bleed the brakes and check for correct brake operation (refer to **Wet Disc Brake Bleeding** in **Section 15**).

Oil Capacities	
TX180S-360L,TX180S-300L, TXH300L,TXH350L (PRC-785): Differential Planetary Hub (each)	 20 Quarts (18.9 Liters) 2 Quarts (1.9 Liters)
TXH400L (PRC-1756): Differential Planetary Hub (each)	 22 Quarts (20.8 Liters) 7 Quarts (6.6 Liters)

Mounting Bolts. The drive axle mounting bolts should be inspected periodically (refer to the **Preventive Maintenance** chart in the **Appendices** for drive axle mounting bolts inspection interval). If there is any evidence of threading or movement of the drive axle, then loosen the locknuts, clean threads, apply Loctite® to threads and torque the locknuts on the mounting bolts to 700 ft-lbs (950 N·m).

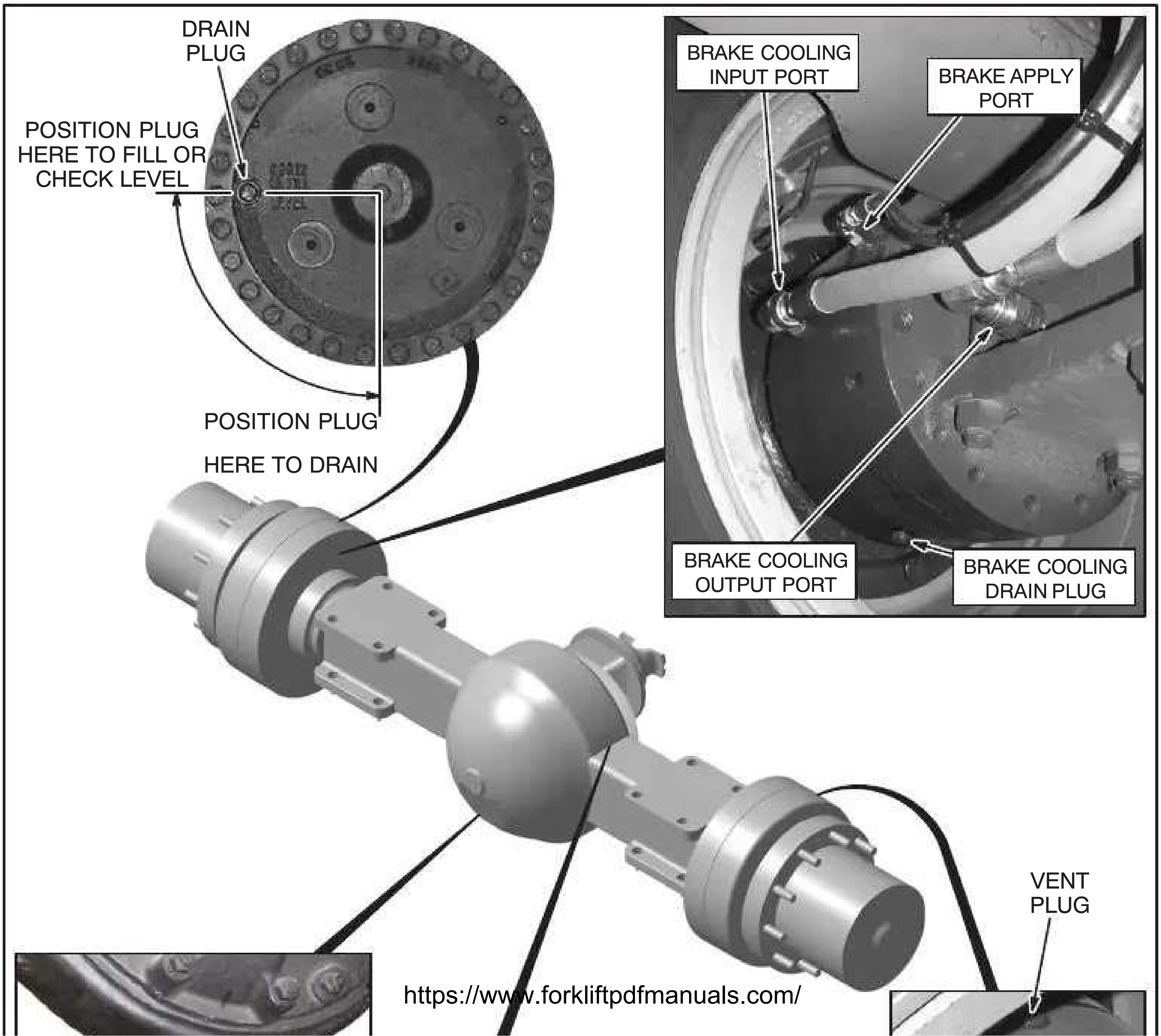
Additional Drive Axle Servicing. Should more detailed service of the drive axle components be required, refer to the manufacturers drive axle maintenance manual.

When the housing is filled, the vent plug port permits air to be removed.

9. Fill the hydraulic tank with the specified amount of fluid (refer to **Changing The Hydraulic Fluid** in **Section 22**) until hydraulic fluid flows from the brake cooling output port of the brake housings.

10. Re-install the vent plug and brake cooling output plug. Tighten both to a torque value of 60-75 ft-lbs (80-100 N·m).

11. Place the transmission in Neutral and start the engine. When the hydraulic fluid level goes



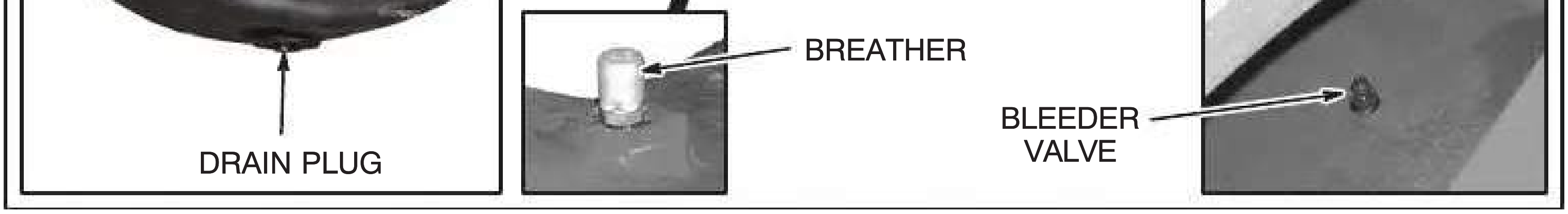


Illustration 14-2. Wet Disc Brakes Drive Axle (TXH400L)

Drive Axle Troubleshooting

Problem	Cause	Correction
1. Differential overheats	1. Low oil level.	1. Fill to correct level with recommended oil (refer to the **Fuel and Lubricant Specifications** in the **Appendices**).
	2. Incorrect type and grade of oil.	2. Drain, flush, and refill with recommended oil.
	3. Incorrect bearing adjustment.	3. Adjust bearings. Replace any that are damaged or excessively worn.
	4. Breather in differential housing is plugged.	4. Replace breather if damaged.
	5. Oil level is too high.	5. Drain oil down to the check plug level in the differential.
2. Loss of oil out of the differential	1. Damaged or badly worn pinion shaft oil seal.	1. Replace oil seal and check for loose pinion bearings or pinion nut.
	2. Loose carrier mounting bolts.	2. Check and tighten mounting bolts. Replace gasket if damaged or broken.
	3. Breather in differential housing is plugged; forcing oil by the seals.	3. Replace breather if damaged.
3. Noisy differential		
a. Noise on drive	a. Ring gear and pinion adjustment is too loose (excessive backlash).	a. Adjust.
	1) Drive shaft is out-of-phase	1) When the transmission to axle drive shaft is installed, the flanges on the drive shaft, must be aligned as shown in Illustration 11-1. If the flanges are not aligned, reposition

		the splines to bring the flanges into alignment. If this is not followed, the drive shaft will be out of phase, and vibration and noise may occur.
b. Noise on coast	b. Ring gear and pinion adjustment is too tight (insufficient backlash).	b. Adjust.
c. Constant noise	c. 1) Worn bearings. 2) Chipped gear teeth.	c. 1) Replace bearings. 2) Replace gear.
d. Noise on turns	d. Worn or damaged differential pinion gears, side gears, or pinion journals.	d. Replace differential parts.

Problem	Cause	Correction
4. Noisy final drives (Planetary Axles)	1. Low oil level. 2. Worn bearings in wheels or planet gears. 3. Chipped gear teeth.	1. Fill to correct level with recommended oil (refer to the **Fuel and Lubricant Specifications** in the **Appendices**). 2. Replace bearings. 3. Replace gears.
5. Final drives overheat (Planetary Axles)	1. Low oil level. 2. Incorrect type and grade of oil. 3. Incorrect lubricant for operating temperature. 4. Wheel bearings improperly adjusted. 5. Scored planet pins.	1. Fill to correct level with recommended oil. 2. Drain, flush, and refill with oil of recommended specifications. 3. Install the correct lubricant specified for temperature range. 4. Adjust wheel bearings to recommended preload. 5. Inspect and replace defective parts.
6. Loss of oil out of final drives (Planetary Axles)	1. Damaged or broken wheel driver gasket. 2. Damaged or broken hub cap gasket. 3. Damaged or excessively worn wheel oil seals. 4. Loose wheel bearings.	1. Replace gasket. 2. Replace gasket. 3. Replace oil seals and adjust wheel bearings properly. 4. Adjust wheel bearings properly and replace oil seal.
7. Brake fluid level is	1. Brake piston seals are possibly	1. Replace seals.

continuously low with no signs of external leakage	leaking.	
8. Gear oil level in hub is continuously too high	1. Seal between brake housing and wheel hub may be leaking. 2. Cooling fluid pressure is too high.	1. Replace seal. 2. Have brake coolant pressure relief valve cartridge replaced.
9. Signs of external leakage exist	1. Clean surface and then determine location of leakage.	1. Replace seals.

Brake Control System

Introduction. The brake control system controls the slowing down and stopping of the truck.

Hydraulic pressure is controlled by the foot operated brake valves (pedals) and is sent to the brake housings of the drive axle to apply the service brakes. The parking brake control applies and releases the spring applied, drive line parking brake.

Major Components (Illustration 15-2). The brake control system consists of a main pump, manifold, two accumulators, brake valves, shuttle valve, drive axle service brakes, parking brake control, and parking brake. Refer to the illustrations as indicated for identification of parts.

Manifold. Refer to **Section 22** for operation of the manifold.

Accumulators (Illustration 15-8). There are two accumulators connected to the main valve. They store a volume of oil at pressure for brake application. These accumulators are hydro-pneumatic piston type and are precharged with dry nitrogen to 1,250 psi (86 bar) and 500 psi (35 bar). Refer to **Section 22E** for procedures for checking the precharge and charging the accumulator.

Brake Valves (Illustration 15-3). There are two brake valves used to stop the truck. Both brake valves actuate the service brakes of the drive axle when either brake pedal is applied. The LH brake valve can independently disengage the transmission (inching) when the brake pedal is applied.

When either brake valve is applied, its P and B ports will be connected to send hydraulic pressure to apply the service brakes. When the service brakes are released, the B port is connected to the T port to vent hydraulic flow back to the hydraulic tank.

Inching Operation. When the LH brake pedal is

parking brake control is pulled out, the hydraulic pressure is released and the parking brake is applied.

Illustration 15-1. Parking Brake Control

Parking Brake (Illustration 15-4). The parking brake is spring applied and hydraulically released.

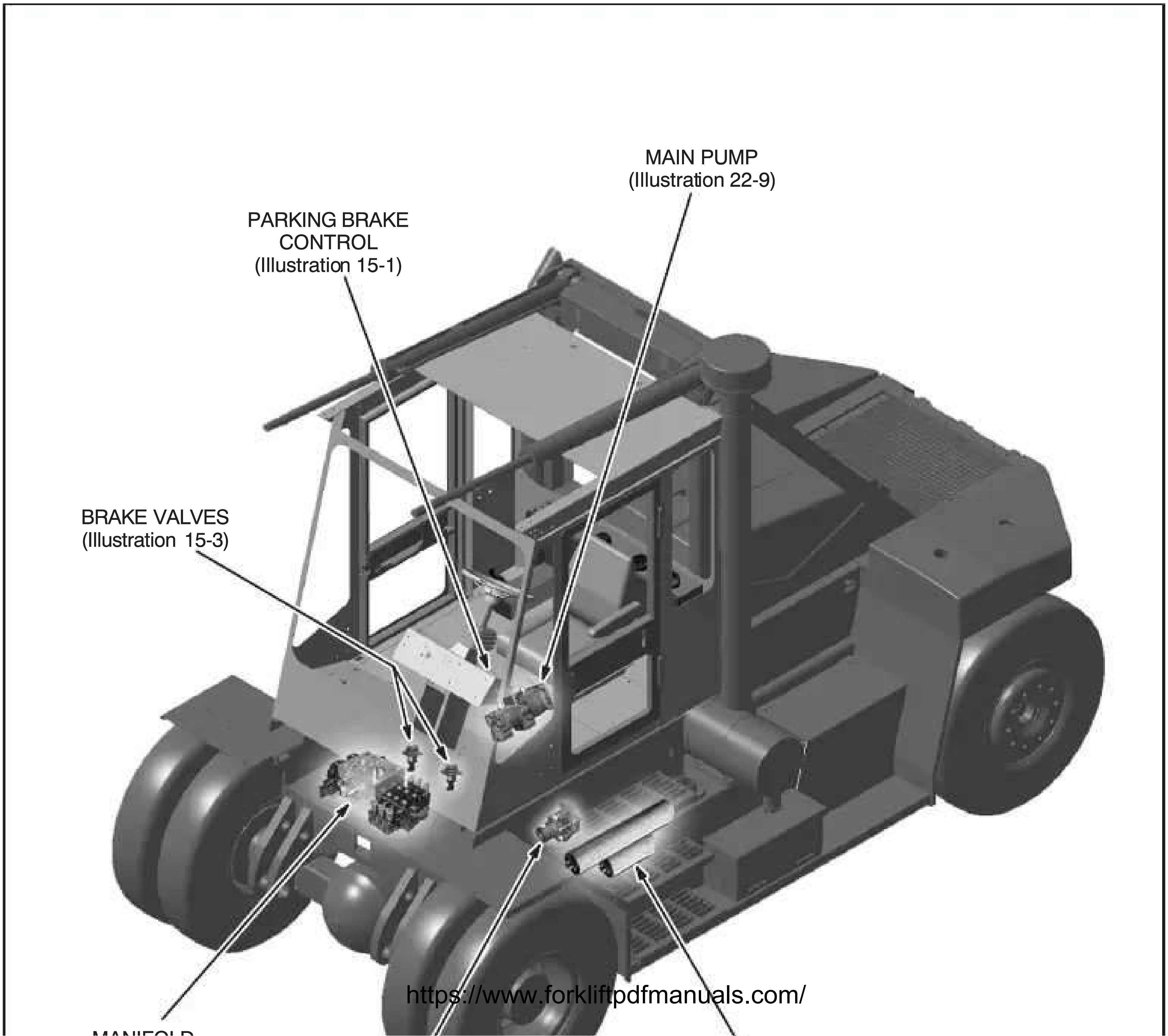
WARNING: Do not attempt to remove spring(s), they are not serviceable. Do not cut, saw, torch or modify this chamber. Serious injury or death could result.

Parking Brake Linings. The parking brake linings should be checked for wear periodically (refer to the **Preventive Maintenance** chart in the **Appendices** for parking brake linings wear inspection). The parking brake linings should be replaced before the brake lining friction material depressed, the transmission will be disengaged and wheel end brakes applied. This allows for high engine speeds for greater hydraulic pump output while reducing travel speed.

Shuttle Valve (Illustration 15-8). The shuttle valve is used to isolate the hydraulic flow from the two brake valves.

Parking Brake Control (Illustration 15-1). The parking brake control is located on the instrument panel and when pushed in, it energizes the parking brake solenoid valve which supplies hydraulic pressure to release the spring applied parking brake, disengaging the parking brake. When the

replaced before the brake lining friction material reaches a thickness of .031 inch (.8 mm). The parking brake linings must be replaced in pairs.



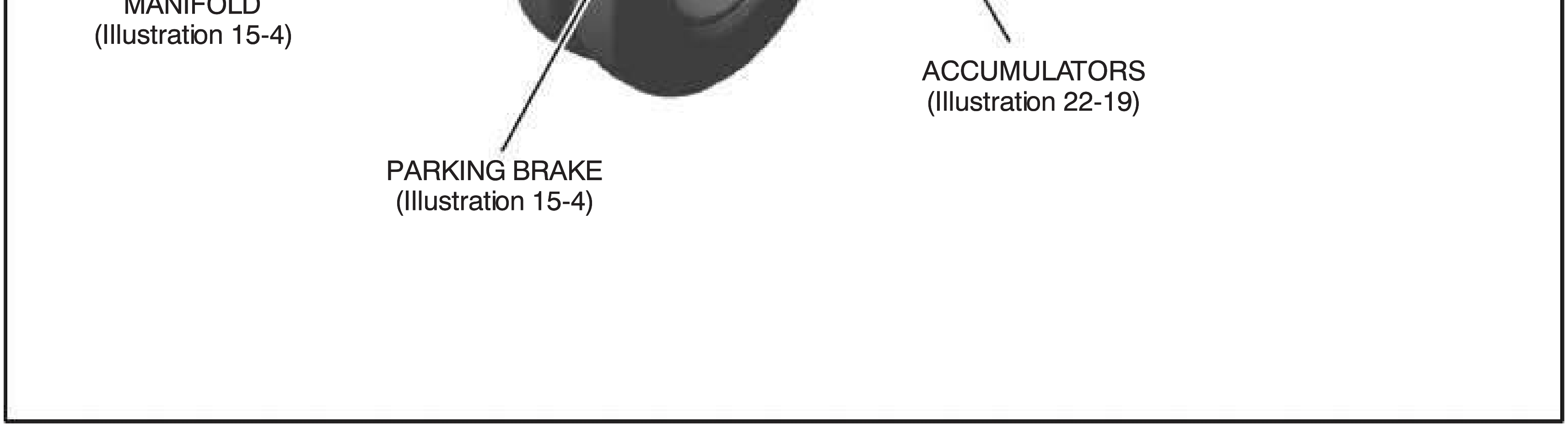


Illustration 15-2. Brake Control System Components Identification

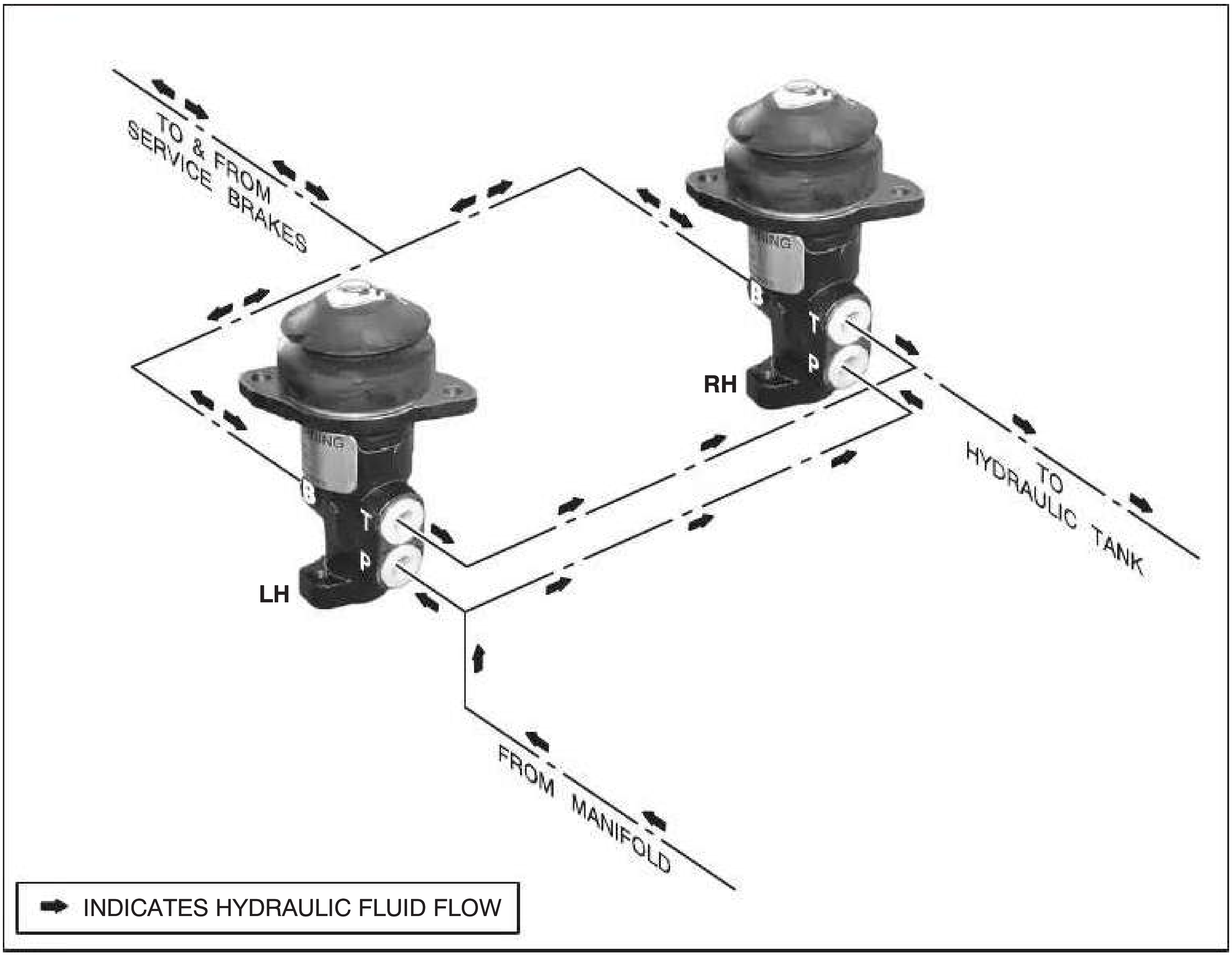


Illustration 15-3. Brake Valves

Parking Brake Linings (Illustration 15-4). The parking brake linings should be checked for wear periodically (refer to the **Preventive Maintenance**

& Tag Out the truck.

1. Park the truck on a hard, level surface, block

periodically (refer to the **Preventive Maintenance** chart in the **Appendices** for parking brake linings wear inspection interval). The parking brake linings should be replaced when the thickness of the brake lining friction material is .031 inch (.8 mm) or less. The parking brake linings must be replaced in pairs. Perform the following procedures to replace the parking brake linings:

WARNING: Death or serious injury could result from a runaway truck. Park the truck on a hard, level surface, block the wheels in both directions to prevent movement, and Lock Out

the wheels of the truck in both directions, place the parking brake in the released position and Lock Out &Tag Out the truck.

2. Remove plug (5) and screw (17).
3. With the parking brake released, loosen the coupling nut (27) and back off setscrew (6) until end of piston (12) is flush with the exposed end of piston (9).
4. Apply the parking brake, Lock Out &Tag Out the truck, and remove the worn brake lining carrier assemblies (19).
5. Install new brake lining carrier assemblies.

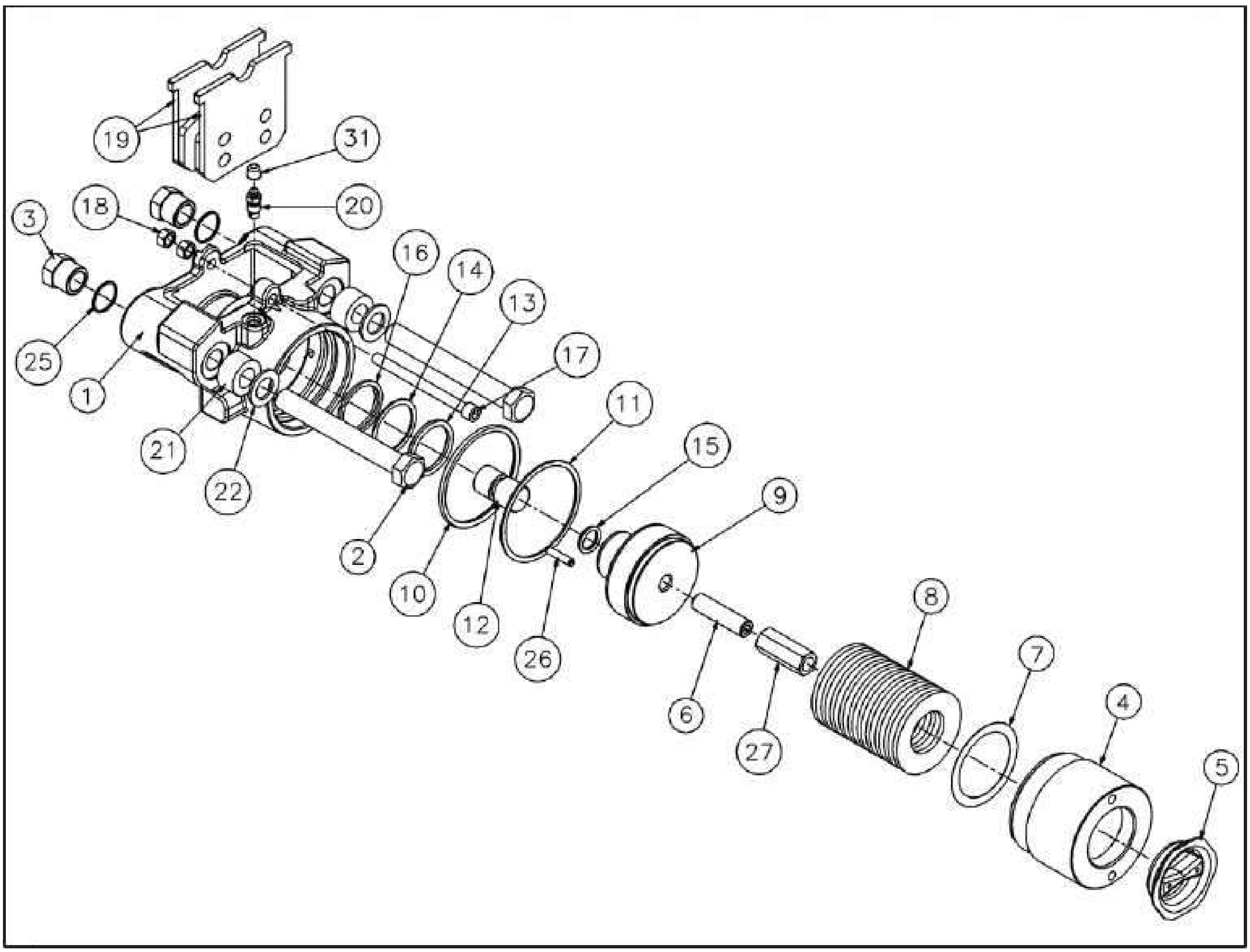


Illustration 15-4. Parking Brake Assembly

6. Install screw (17) into torque plate (1) and thread it into the nuts (18). Tighten the nuts (18) against each other to a torque value of 30-35 ft-lbs (41-48 N.m).

a hard, level surface, block the wheels in both directions to prevent movement, and Lock Out & Tag Out the truck.

30-35 ft-lbs (41-48 N·m).

7. Position the truck with a rated load on a 15 percent grade (15 feet rise over 100 feet distance). Apply the parking brake to ensure that it will hold the truck with a rated load on a 15 percent grade.

Parking Brake Adjustment (Illustrations 15-4 thru 15-6). Perform the following procedures to adjustment the parking brake.

WARNING: Death or serious injury could result from a runaway truck. Park the truck on

1. Park the truck on a hard, level surface, block the wheels of the truck in both directions, place the parking brake in the released position and Lock Out &Tag Out the truck.
2. Remove the plug (see Illustration 15-5).
3. Loosen the coupling nut (see Illustration 15-6).
4. Set running clearance between the disc and the lining surface by turning the set screw until a 0.020 - 0.030 inch (0.51-0.76 mm) thick shim just fits between the lining and the disc surface when the opposite lining is in contact with the disc.

---

5. Torque the coupling nut to 50-55 ft-lbs (68-75 N·m), while holding the set screw in position.
6. Re-install the plug and torque to 45-50 ft-lbs (61-68 N·m).

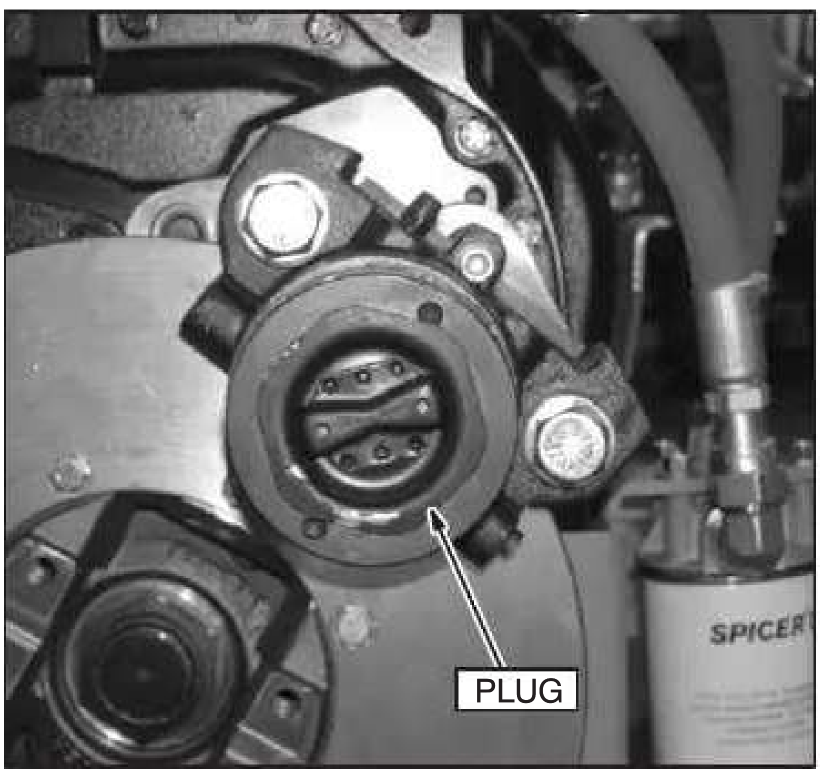


Illustration 15-5. Parking Brake (Plug Installed)

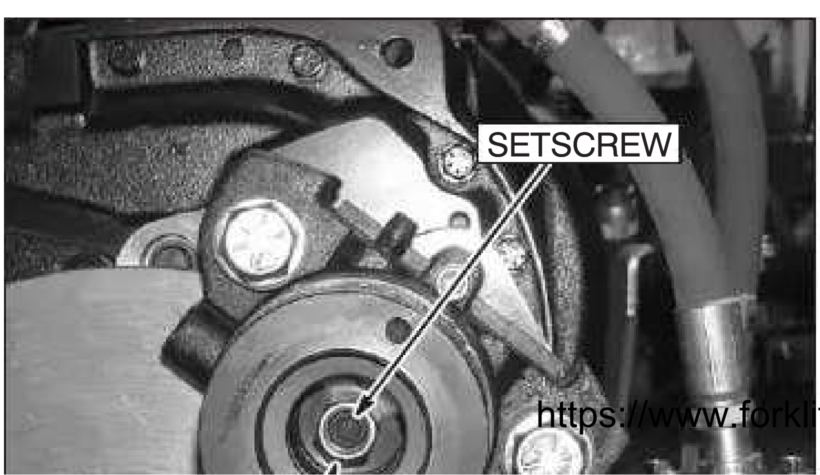


Illustration 15-4). Loosen the outer hex nut (18) and place a 0.010 - 0.015 inch thick shim between the lining and the disc surface. Adjust the socket head cap screw (17) until the clearance between the shim is eliminated.

8. Tighten the outer hex nuts (18) to complete the centering operation. Torque the two hex nuts (18) against each other to a torque rating of 30-35 ft-lbs (41-48 N·m).
9. Re-adjust the brake when the running clearance reaches a total of 0.100 inch (2.5 mm).

Wet Disc Brake Bleeding (Illustrations 14-1 and 14-2). Bleeding the wet disc brake system requires two servicemen; one to operate the service brake pedal, and another to open and close the bleeder valves on the drive axle. Perform the following procedures to bleed the service brakes:

WARNING: Death, serious injury or property damage could result from not bleeding the wet disc brakes. The wet disc brakes must be bled to remove all air from the system when any brake system hydraulic connection has been loosened. Air can prevent hydraulic pressure from applying the brakes correctly and can increase stopping distance.

WARNING: Death or serious injury could result from a runaway truck. Park the truck on a hard, level surface, apply parking brake and block the wheels of the truck in both directions to prevent movement.

CAUTION: Do not reuse used hydraulic fluid. Used hydraulic fluid can be contaminated and can cause incorrect operation.

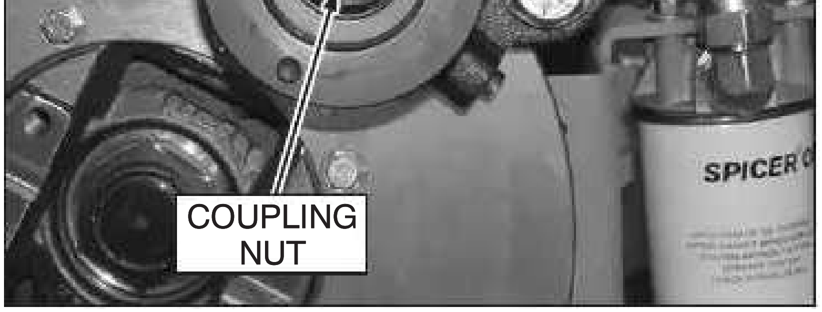


Illustration 15-6. Parking Brake (Plug Removed)

7. Even up the running clearance 0.010 - 0.015 inch (0.25-0.38 mm) on each side of the disc by adjusting the socket head cap screw (17,

Damage to components can result.

1. Park the truck on a hard, level surface, apply parking brake and block the wheels of the truck in both directions to prevent movement.
2. With the engine running, have someone apply one of the service brake pedals and hold it down.
3. Open the bleeder valve about 1/2 turn on the left front wheel brake housing, allowing air and oil to vent into a suitable container.

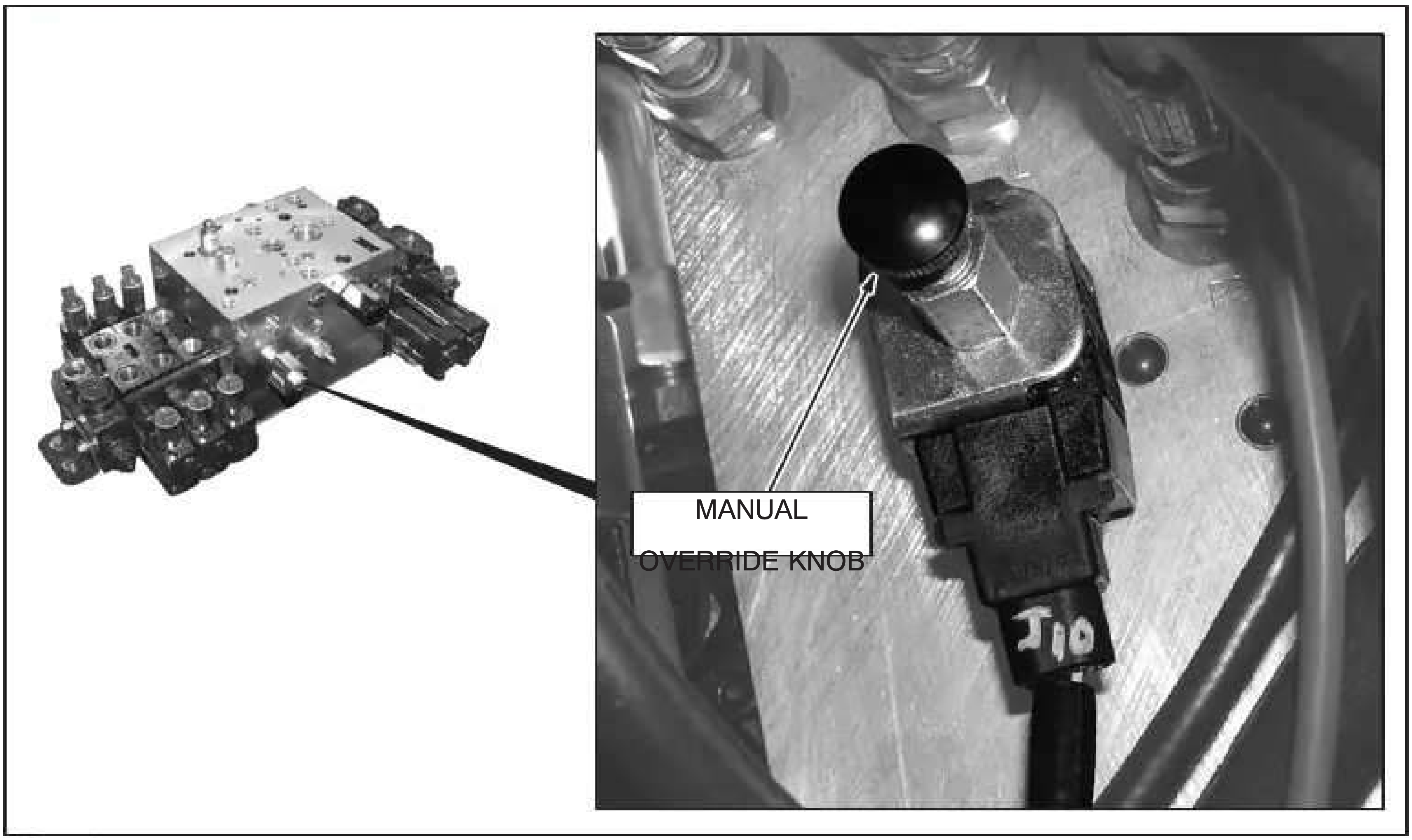


Illustration 15-7. Parking Brake Solenoid

4. Close the bleeder valve and then release the brake pedal.
5. Repeat procedures 2., 3., and 4. until a bubble-free flow of fluid is observed while continuing to check the level of fluid in the hydraulic tank.
6. Repeat procedures 2. through 5. to bleed the right service brake.

Parking Brake Solenoid (Illustration 15-7). The

enough pressure is available by the accumulators.

To return to normal parking brake operation, fully turn the manual override knob out counterclockwise.

Drive Axle Service Brakes Servicing

WARNING: Death, serious injury or property damage may occur from improperly

parking brake solenoid of the manifold can be manually activated to release the parking brake.

WARNING: Death or serious injury could result from a runaway truck. Park the truck on a hard, level surface if possible, block the wheels in both directions to prevent movement, and Lock Out & Tag Out the truck.

To release the parking brake, fully turn the manual override knob in clockwise to release the parking brake.

NOTE: *The parking brake will only be released if*

maintaining the service brakes. Improper maintenance procedures may lead to decreased service life, decreased performance, or brake failure. Always follow proper procedures for inspection, maintenance, and service of the brake system as outlined in this manual.

The brakes should be disassembled and inspected every 10,000 hours (or 5 years), whichever occurs first, or when any of the following conditions, listed below, occur. The suggested brakes inspection interval is based on normal operating conditions and may be increased or decreased based on actual operating experience.

1. Brakes have overheated and / or hydraulic tank level has run low.
2. Dirty or contaminated hydraulic fluid.
3. Clogged or dirty hydraulic return filter with (apparently) fibrous material.
4. Out-of-the-ordinary brake noise from one or more service brakes - such as grinding or metal-to-metal contact.
5. Abnormally long pedal stroke, even with hydraulic tank fluid level full.
6. Service brakes pulling to one side or the other.

Brake Control System Troubleshooting

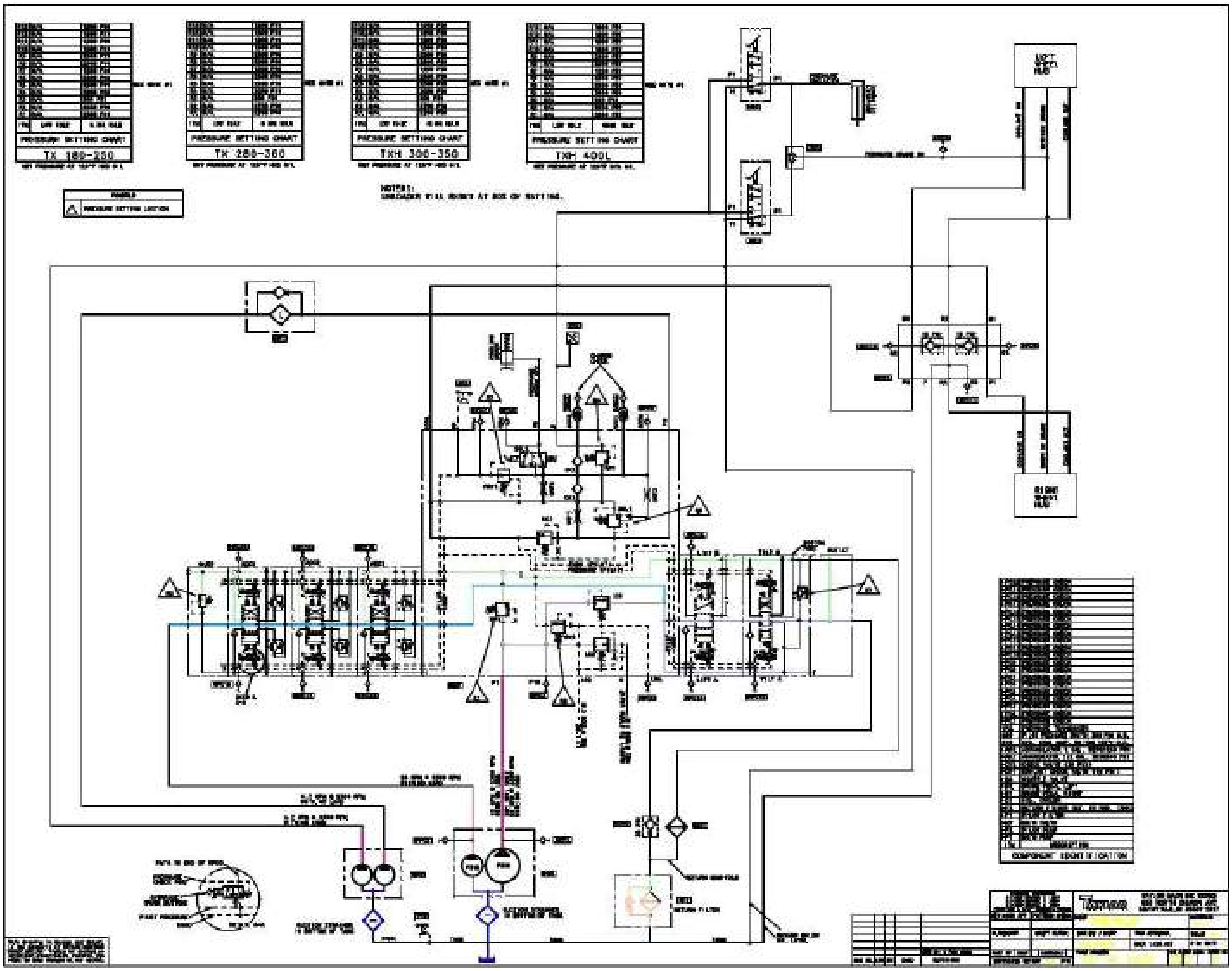
Problem	Cause	Correction
1. No or weak service brakes	1. Air in brake system.	1. Bleed the brake system (refer to **Wet Disc Brake Bleeding** in this section).
	2. Defective service brake valve.	2. Replace service brake valve.
	3. Leak in line between the manifold and brake housings.	3. Inspect hydraulic hoses and repair if needed.
	4. Defective piston seals.	4. Refer to the drive axle manufacturer's manual for isolation of defective piston seals (which side) and repairs.
	5. Worn or damaged disc(s) inside brake housing.	5. Refer to the drive axle manufacturer's manual for repairs.
	6. Brakes are overheating.	6. Refer to Problem 1. of the **Wet Disc Brakes Cooling System Troubleshooting** chart in **Section 15C.**
	7. Defective manifold.	7. Repair manifold.
	8. Refer also to Problem 7. of the **Hydraulic System Troubleshooting** chart in **Section 22**.	

2. Brakes will not release *continued*	1. Defective service brake valve(s). 2. Worn or damaged disc(s) in brake housing.	1. Replace service brake valve(s). 2. Refer to the drive axle manufacturer's service manual for repairing procedures.

Problem	Cause	Correction
2. Brakes will not release (Continued)	3. High pressure brake-apply port of the brake housing is blocked. 4. Pinched, crimped, or defective hydraulic hose.	3. Remove blockage from the high pressure brake-apply port of the brake housing. Loosen the bleeder valve to allow trapped oil to escape. Remove the high pressure brake-apply hose from the brake housing. Then with a paper clip, insert a paper clip in the port to remove the blockage, reassemble and perform the **Wet Disc Brake Bleeding** procedures located in this section. 4. Isolate and repair.
3. Noisy brakes	1. Wrong type of hydraulic fluid is being used. 2. Brakes are overheating. 3. Internal failure inside the drive axle wheel end.	1. Use only approved fluid (refer to the **Fuel and Lubricant Specifications**). 2. Refer to Problem 1. of the **Wet Disc Brakes Cooling System Troubleshooting** chart in **Section 15C.** 3. Refer to the drive axle manufacturer's manual for repairs.
4. Parking brake does not apply	1. Defective parking brake switch. 2. Loose, broken, or shorted wire(s). 3. Defective manifold. 4. Defective main pump.	1. Replace parking brake switch. 2. Isolate and repair wire(s). 3. Repair manifold. 4. Replace main pump.

5. Parking brake does not release	1. Defective parking brake switch. 2. Loose, broken, or shorted wire(s). 3. Defective manifold. 4. Defective main pump. 5. Refer also to Problem 8. of the **Hydraulic System Troubleshooting** chart in **Section 22**.	1. Replace parking brake switch. 2. Isolate and repair wire(s). 3. Repair manifold. 4. Replace main pump.

PLACE THE FOLLOWING ILLUSTRATION IN A FOLDER ENVELOPE:
Illustration 15-8 - 15-2495 SHT. 2 (ANSI)


TX 180-250
TX 280-360
TXH 300-350
TXH 400L
NOTES:
COMPONENT IDENTIFICATION

15C-W tDisc Brakes
C ding System

Section 15C

Wet Disc Brakes Cooling System

Introduction. The brakes cooling system maintains a safe operating temperature by cooling the hydraulic fluid in the wet disc brake system.

Major Components (Illustration 22-1)**.** The brake cooling system consists of an auxiliary pump, manifold, cooling check valve, various hoses and fittings.

Auxiliary Pump (Illustration 15-8)**.** The auxiliary pump is a two section pump with gear sets of equal size. The flow of one gear set is sent to port B1 of the cooling check valve while the flow of the other gear set is sent to port P3 of the manifold valve (refer to **Brake** / **Brake Cooling Logic** in **Section 22** for a detailed description of manifold flow dedicated to service brake cooling).

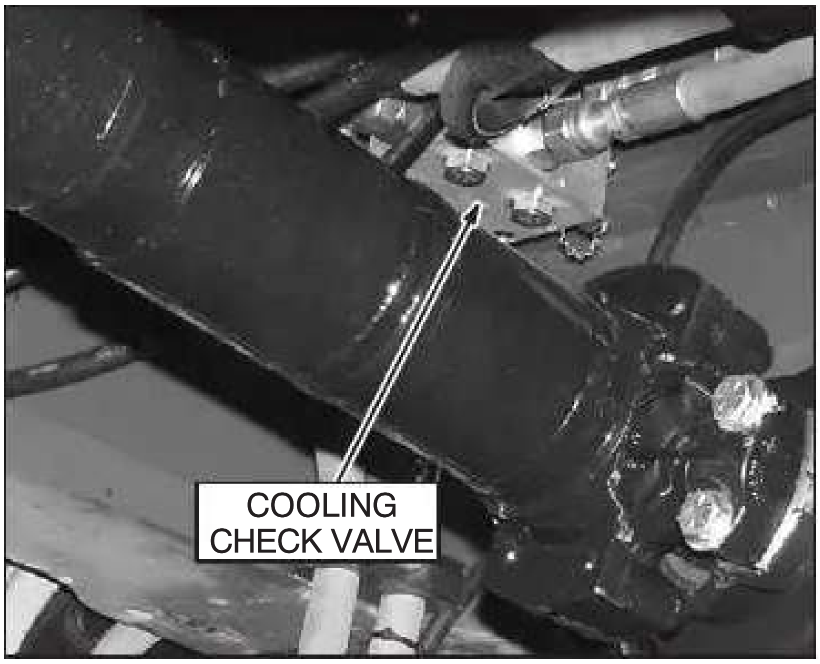


Illustration 15C-1. Cooling Check Valve

Cooling Check Valve (Illustrations 15C-1 and 15-7). The cooling check valve sends cooling fluid to the service brakes. This valve receives flow from the auxiliary pump at port B1 and the fluid is sent out port P1 to cool the right side drive axle brake. The cooling check valve also receives flow from the manifold at port P2 and the fluid is sent out port B2 to cool the left side drive axle brake. This valve also sends fluid from the service brakes back to the hydraulic tank. In addition, the cooling check valve contains two 15 psi (1 bar) check valves that limit the drive axle wheel ends from seeing no more than 15 psi (1 bar) of pressure, protecting the wheel end face seals.

Manifold. Refer to **Section 22** for operation of the manifold.

Wet Disc Brakes Cooling System Troubleshooting

Problem	Cause	Correction
1. Brakes Overheat	1. Low cooling fluid flow.	1. Refer to Problem 2. of this trouble-shooting chart.
	2. Improper hydraulic fluid.	2. Use specified fluid (refer to the **Fuel and Lubricant Specifications** in the **Appendices**).
	3. Hydraulic system cooler fins are plugged.	3. Clean the hydraulic system cooler.
	4. Excessive duty cycle (excessive application of brakes).	4. Allow hydraulic fluid to cool and adjust duty cycle.
	5. Brakes at wheel ends are not fully releasing.	5. Refer to Problem 2. in the **Brake Control System Troubleshooting** chart in **Section 15**.
2. Low Cooling Fluid Flow	1. Low hydraulic fluid supply.	1. Fill hydraulic tank to the proper fluid level.
	2. Plugged hydraulic tank breather filter.	2. Replace breather filter.
	3. Air leak in suction hose to auxiliary pump.	3. Locate leak and repair.
	4. Defective auxiliary pump.	4. Replace the pump.
	5. Fluid is bypassing the check valves in cooling check valve.	5. Clean the check valves. If cleaning does not resolve the problem, replace the check valves.
3. One Side of Drive Axle Overheats	1. Defective checks in cooling check valve.	1. Replace defective checks.

Introduction. The steering system provides guidance control of the truck.

Major Components (Illustration 16-1)**.** The steering system consists of the main pump, manifold, steering valve, steer cylinder, hoses and various fittings.

Main Pump. Refer to **Section 22** for operation of the main pump.

Manifold. Refer to **Section 22** for operation of the manifold.

Steering Orbitrol. Refer to **Section 22** for operation of the steering orbitrol.

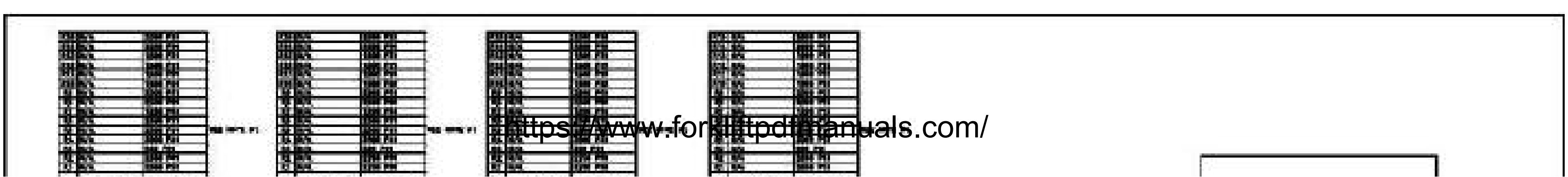
Steer Cylinder (Illustration 16-1)**.** The steer cylinder is a double-acting cylinder that turns the steer tires.

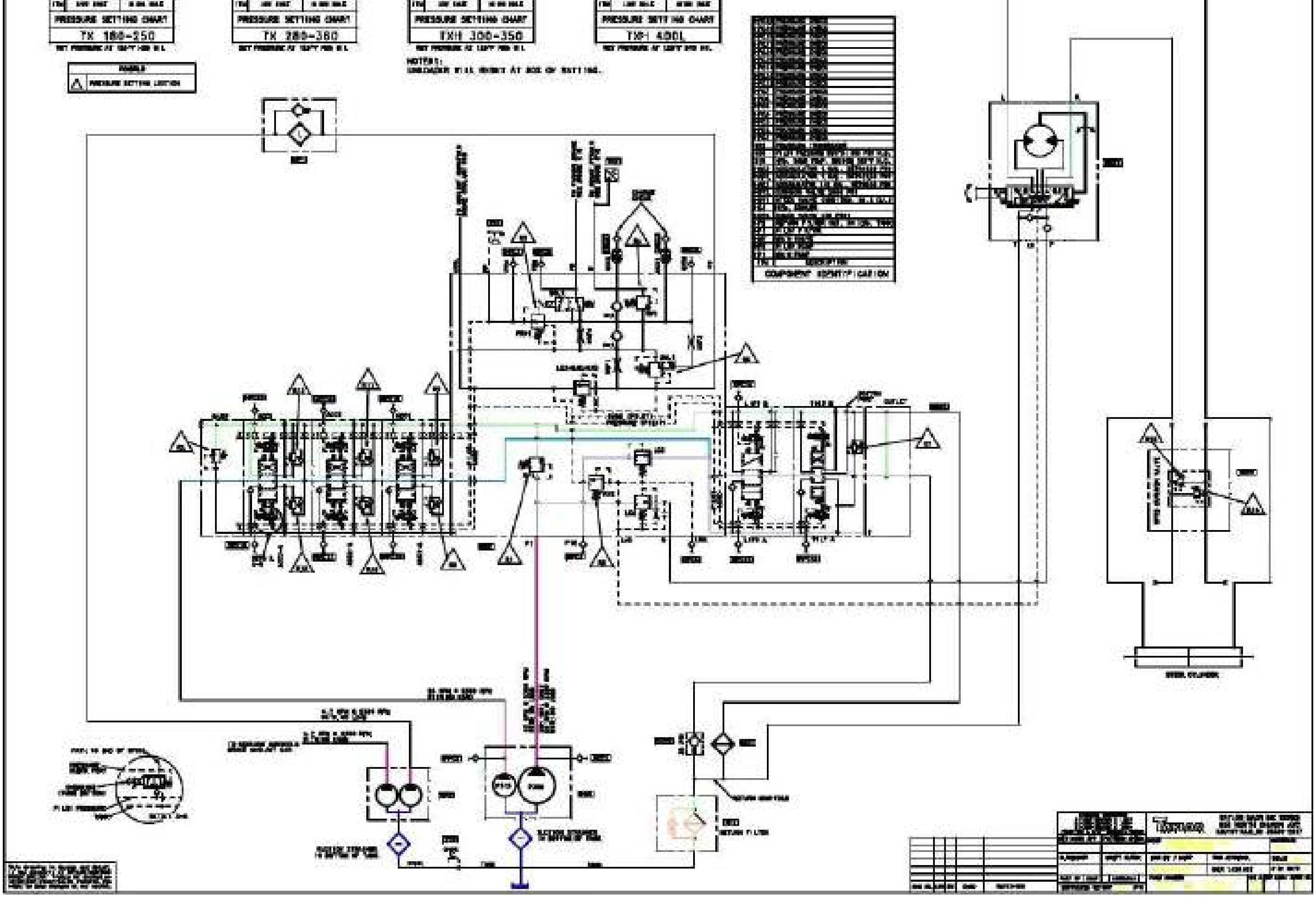
Steering Logic. Refer to **Section 22** for steering logic information.

Steering System Troubleshooting. Refer to **Hydraulic System Troubleshooting** chart in **Section 22**.

Setting Hydraulic Pressures. Refer to **Setting Hydraulic Pressures** in **Section 22** for procedures to set the pressures for the steering system.

PLACE THE FOLLOWING ILLUSTRATION IN
A FOLDER ENVELOPE:
Illustration 16-1 - 16-2364 SHT. 2 (ANSI)




PRESSURE SETTING CHART
TX 180-250
PRESSURE SETTING CHART
TX 280-380
PRESSURE SETTING CHART
TXH 300-350
PRESSURE SETTING CHART
TXH 400L
NOTES:
COMPONENT IDENTIFICATION

Tires and Wheels

Introduction. This section contains safety warnings that must be adhered to to prevent serious personal injury or death when servicing tires and wheels. Also included are procedures for properly torquing the wheel nuts.

WARNING: Under no circumstances should anyone mount or demount tires without proper training as required in OSHA Rules and Regulations 1910.177 "Servicing multi-piece and single piece rim wheels." Follow all procedures and safety instructions.

Tires. Tires may represent one of the major direct expenses of equipment operation. Refer to the Goodyear Tire Maintenance Manual for proper maintenance and repair of tires for optimal tire life. The Goodyear Tire Maintenance Manual is a generic tire maintenance manual covering tire maintenance that apply to all brands of tires. Check the tires and valve caps daily for any damage.

WARNINGS:

- **Bias and radial constructions must never be mixed on dual pair.**

Tire Inflation. The tire pressure should be checked on a daily basis (refer to the serial data plate, located on the left side of the truck in front of the steer tire, for proper tire pressure).

WARNING: Maintain the proper tire inflation pressures listed on the truck serial data plate.

Tire Overinflation. Overinflation results in high cord stress even when the tire isn't overloaded. Stress reduces resistance to blowouts from impacts. It also increases the danger of the tire being cut. The problem can be compounded by poorly maintained working terrain.

Tire Underinflation. An underinflated tire will deflect too much. It also leads to excessive sidewall flexing. It is very important, in wheel ends employing dual tire pairs, that each tire have the correct air pressure. This prevents one tire from carrying more of the load than the other tire. Flexing of an underinflated tire in a dual pair could

- **All tire related safety warnings in the** Safety Check 2nd Edition **booklet and this section must be understood before performing any tire maintenance.**
- **Inflate tire in a safety cage. Use safety chains or equivalent restraining devices during inflation. Misassembled parts may fly apart with explosive force during inflation.**
- **Never sit on or stand in front of a tire and rim assembly that is being inflated. Use a clip-on chuck, an in-line pressure gauge, and make sure the inflation hose is long enough to permit the person inflating the tire to stand to the side of the tire, not in front or in back of the tire assembly.**
- **Keep tires free of grease and oil. Grease and oil are highly damaging to tires. If grease or oil are allowed to remain on tires for extended periods of time, rubber deterioration may occur.**
- **Tire assemblies operated as a dual pair must have the same outside diameter, be from the same manufacturer, be of the same type (industry code) and be of the same construction (both bias or both radials).**

lead to the underinflated tire rubbing the other tire which could lead to premature tire failure. Tires with radial cracks indicate continuous underinflation operation. Other underinflated indications include the following:

1. Spotty or uneven tread wear
2. Ply separation
3. Loose or broken cords inside the tire
4. Fabric carcass fatigue

Rims. The rims hold the tires on the hub. The wheels and mounts require a run-in period. The torque of the wheel nuts must be checked every 10 hours of operation until rim is fully seated. Perform the **Torquing Procedure** to tighten the wheel nuts of each hub each time tires are removed from the drive or steer axle. Inspect the wheel studs daily.

WARNING: If one wheel stud has broken off, a significant reduction of the rim's clamping force will be lost. Remove machine from service and repair immediately.

WHEEL NUT TORQUE VALUE∗

Drive Axle.............490 - 510 ft-lbs (670 - 695 N·m)

∗ This value is located on the truck serial plate for reference.

Illustration 17-1. Drive Axle Wheel Nuts Torquing Sequence (TX180S - 360L)

Torquing Procedure (Illustrations 17-1 through 17-4). Perform the following procedures to torque the wheel nuts:

WARNING: Every time the wheels are removed, a run-in period is required. The wheel nuts must be re-torqued every 10 hours of operation until rims are fully seated.

1. Start at position #1 and tighten the wheel nut to the specified torque value listed. Proceed in the illustrated numerical order to torque the other wheel nuts.
2. Repeat procedure 1. until no wheel nut moves when the proper torque value is applied. Procedure 1. may have to be repeated several times to tighten the wheel nuts to the proper torque value.

Inspection

WARNINGS:

- **Mixing parts of one manufacturer's rims with those of another is potentially dangerous. Always check manufacturer for approval.**
- **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 or the rim and wheel distributor in your area.**

1. Multi-piece rims and all rim components must be inspected before re-assembly each time the tire is removed from the rim for repair and each time the tire is replaced. Rims and all rim components should be inspected annually (or every 3,000 hours) otherwise.

WHEEL NUT TORQUE VALUE∗

Drive Axle.............490 - 510 ft-lbs
(670 - 695 N·m)

∗ These value is located on the truck serial plate for reference.

Illustration 17-2. Drive Axle Wheel Nuts Torquing Sequence (TXH400L)

2. Any rim or rim component which is bent out of shape, pitted from corrosion, broken, or cracked must not be used. It must be marked or tagged as unserviceable and removed from the service area and discarded. When part condition is in doubt, replace it.
3. Ensure that all parts correctly match the type of wheel being assembled. Check with the manufacturer if there is any doubt.
4. Rim bases, rim flanges, rim gutters, lock rings, and bead seat bands must be free of any dirt, surface rust, scale or loose / flaked rubber buildup prior to re-assembly. All dirt and rust must be removed from the lock ring gutter. Clean and repaint rims to stop the detrimental effects of corrosion.
5. Air inflation equipment should have a filter in the air line cable of removing moisture from the air. This will help in preventing corrosion.
6. Rims have a useful service life that is dependent on variables such as over / under inflation pressures, duty cycle, yard conditions, and overloading from example. Although actual rim life will vary from one application to another, replacement after 10,000 hours of service life is recommended. These rims should be tagged as unserviceable and removed from the service area and discarded.

Tire / Wheel Jacking

WARNINGS:

- **Never rely solely upon jacks or hoists to support the lift truck while removing tire / wheel.**
- **Before placing jack in position, block tire and wheel on the other side of the truck.**
- **Always place oak or other hardwood block cribbing under the load after the jack or**

hoist has lifted the load. Make sure the cribbing is large enough to have sufficient contact with the supported load to be stable.

- **Never get under, near or between heavy objects that are supported only by a jack or hoist.**
- **Always use hardwood blocks under jack.**

tool 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.

- **Never force or hammer rim components, especially rim components under pressure.**
- **Never attempt to weld on an inflated tire / rim assembly.**
- **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 cracked, broken, or damaged, and which are of the same size, type and make.**
- **Do not hammer on rims or components with steel hammers. Use rubber, lead, plastic, or brass faced mallets, if it is necessary, to tap components together.**
- **Always exhaust all air from a single tire and from both tires of a dual assembly prior to removing any rim components such as nuts and rim clamps.**
- **Make sure to remove the valve core to exhaust all air from the tire. Remove both**

WHEEL NUT TORQUE VALUES∗

Steer Axle........340 - 360 ft-lbs (375 - 405 N·m)

∗ These values are on the truck serial plate for reference.

Illustration 17-3. Steer Axle Wheel Nuts Torquing Sequence (TX180S-360L)

Demounting

WARNINGS:

- **Do not let anyone mount or demount tires without proper training as stated in OSHA Rules and Regulations 1910.177 "Servicing multi-piece and single piece rim wheels."**
- **Do not stand in front of the tire during deflation.**
- **Demounting tools apply pressure to rim flanges to unseat tire beads. Keep your fingers clear. Slant the demounting bead cores from a dual assembly.**
- **Check the valve stem by running a piece of wire through the stem to make sure it is not plugged.**

Mounting And Inflation

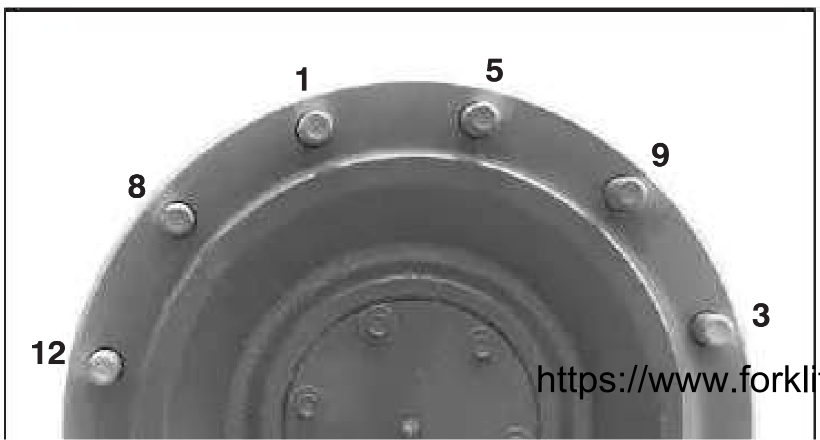
WARNINGS:

- **Inflate tire in a safety cage. Use safety chains or equivalent restraining devices during inflation. Misassembled parts may fly apart with explosive force during inflation.**
- **Do not seat rings by hammering while the tire is being inflated. If a part is tapped, it or the tool can fly out with explosive force.**
- **Never sit on or stand in front of a tire and rim assembly that is being inflated. Use a clip-on chuck, an in-line pressure gauge, and make sure the inflation hose is long enough to permit the person inflating the tire to stand to the side of the tire, not in front or in back of the tire assembly.**
- **Mixing parts of one manufacturer's rims with those of another is potentially dangerous. Always check manufacturer for approval.**
- **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 or the rim and wheel distributor in your area.

- **Do not inflate the tire before all side and lock rings are in place. Double check to make sure all components are properly seated.**

1. Refer to Illustration 17-5 for hardware and its orientation for wheel mounting.
2. Check components for proper assembly again after inflating to approximately 5 psi (.3 bar).



mended rim for the tire.

- **Never run a vehicle on 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 tire.**
- **Do not reinflate a tire 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 inflation.**
- **Excessive turning of the steering axle tires, when the truck is stopped, should be avoided. It can cause excessive wear (flat spots) to develop.**

Servicing Tire And Rim On Vehicle

WARNINGS:

- **Block the other tires of the vehicle before you place the jack in position.**
- **Regardless of how hard or firm the ground appears, put hardwood blocks under the jack. Always crib up vehicle with blocks just in case the jack should slip.**

WHEEL NUT TORQUE VALUES∗

Steer Axle........340 - 360 ft-lbs (375 - 405 N·m)

∗ These values are on the truck serial plate for reference.

Illustration 17-4. Steer Axle Wheel Nuts Torquing Sequence (TXH400L)

Operation

WARNINGS:

- **Do not overload rims or over-inflate tire / rim assembly. Check your rim manufacturer if special operating conditions are required.**
- **Do not use undersized rims. Use recom-**

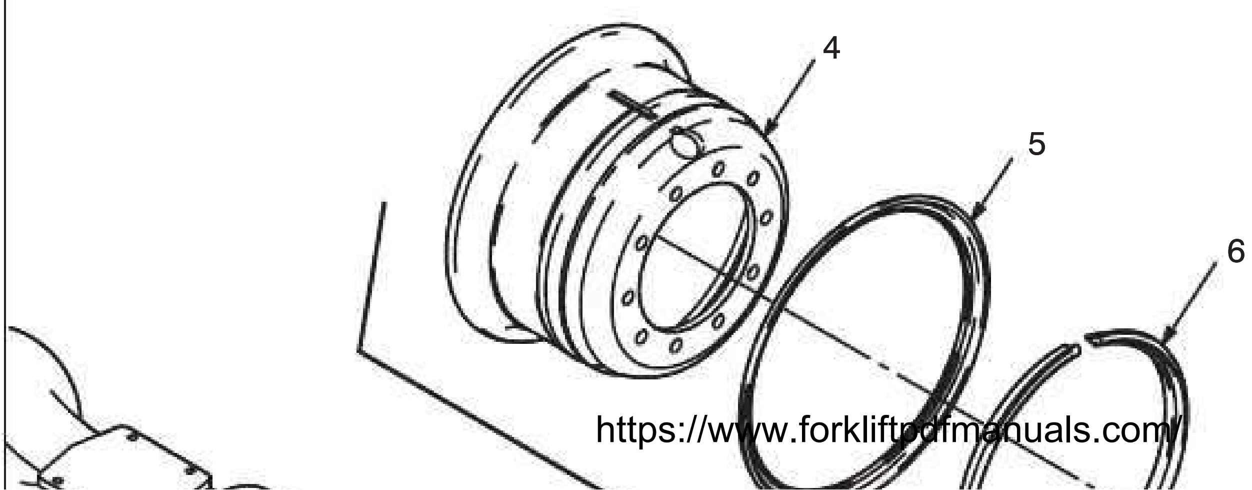
- **Remove the bead seat band slowly to prevent it from dropping off and crushing your toes. Support the band on your thigh and roll it slowly to the ground. This will protect your back and toes.**
- **When using a cable sling, stand clear; it might snap and lash out.**

Compressor Precautions

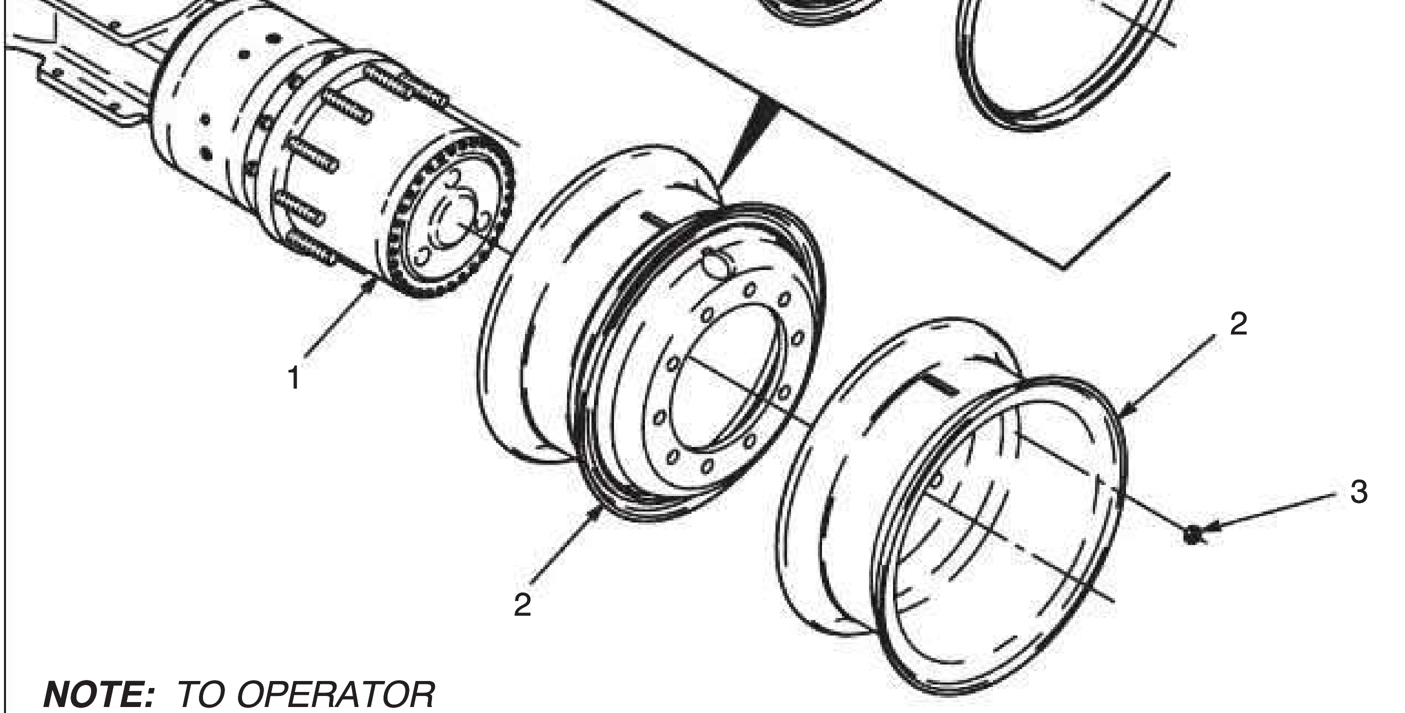
There have been instances of tires exploding violently while on vehicles. The forces involved in this type explosion are sufficient enough to cause serious personal injury to anyone in the immediate vicinity. Some of these explosions are believed to have been caused by flammable vapors entering the tire during inflation. When the machine is operating, the temperature of the air and vapor mixture inside the tire will increase. The temperature inside the tire will also increase with an increase in ambient temperature and when subjected to direct sunlight. If the vapor and air mixture inside the tire are within the ratio limits that will support combustion, and any or all of the above heat increasing factors cause the temperature to rise, an explosion may occur. The following are some warnings that can prevent flammable vapors from entering the compressor and subsequently being entrapped in tires.

WARNINGS:

- **Do not locate the compressor in a utility room used for storing flammable solvents, paints, thinners, etc. The flammable vapors will be sucked into the compressor intake while the compressor is charging.**
- **Do not clean the compressor air filter with a flammable solvent. Use a non-flammable solvent, such as carbon tetrachloride.**
- **Do not use alcohol, methanol, or other flammable agents in the compressor to prevent freezing of the condensation inside the compressor. Drain the compressor tank frequently or locate the compressor inside to eliminate the freezing problem.**
- **Do not locate the compressor near a battery charger. Batteries emit hydrogen gas, which is highly flammable, during the charging process, and could be sucked into the compressor intake.**



1. DRIVE AXLE
2. RIM
3. NUT
4. RIM
5. SIDE RING
6. LOCK RING



NOTE: *TO OPERATOR*

Wheel and mounts require run in period on a new machine and after each tire change.

Refer to serial plate on the side of machine for torque specifications before machine is put in service and re-torque nuts each 10 hours until clamps are seated.

Care should be taken to keep grease and other foreign material from rim seating surfaces.

Illustration 17-5. Wheel Mounting Hardware

Chassis

Introduction (Illustration 18-1)**.** The chassis is carefully engineered and ruggedly constructed, although welded steel structures always contain undetectable cracks, especially welded joints. When these joints are subject to fluctuating stresses of significant magnitude, these cracks will grow. This is known as fatigue crack growth. No matter how low the stress levels are kept, some fatigue crack growth will occur in all welded structures.

Structural Inspection, Reporting, and Repair Procedure (Refer to **SIRR** in the **Appendices**)**.** Follow the OSHA rules, 29 CFR, 1910.178 (Q)(1), (5), & (7) which require inspecting industrial trucks daily before being placed in service, removing trucks from service if cracks are found, and making repairs only if authorized by the manufacturer. If trucks are used on a round-the-clock basis, they shall be examined after each shift. OSHA 29 CFR 1910.178 (p)(1) requires that trucks in need of repair be taken out of service. Areas to be inspected on the truck chassis include mast hangers, drive axle mounts, tilt cylinder anchors and steer axle mounts.

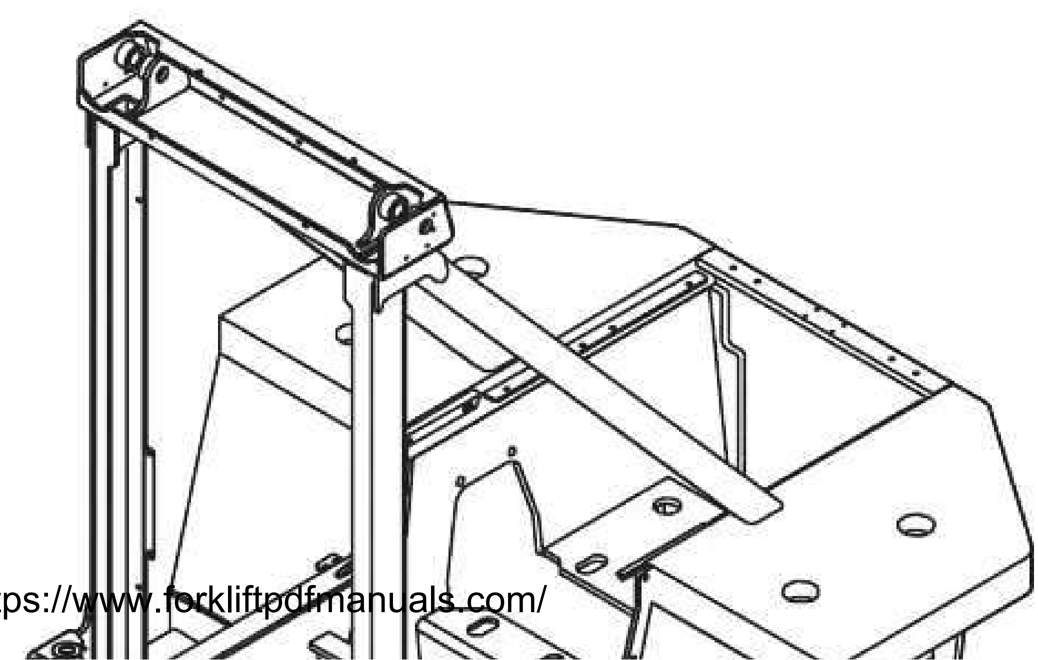
WARNING: Periodic inspection is required to detect fatigue cracks that have grown to a significant size in order to avoid serious failure of the structural weldment. When a crack is found, the truck must be immediately taken out of service and repaired.

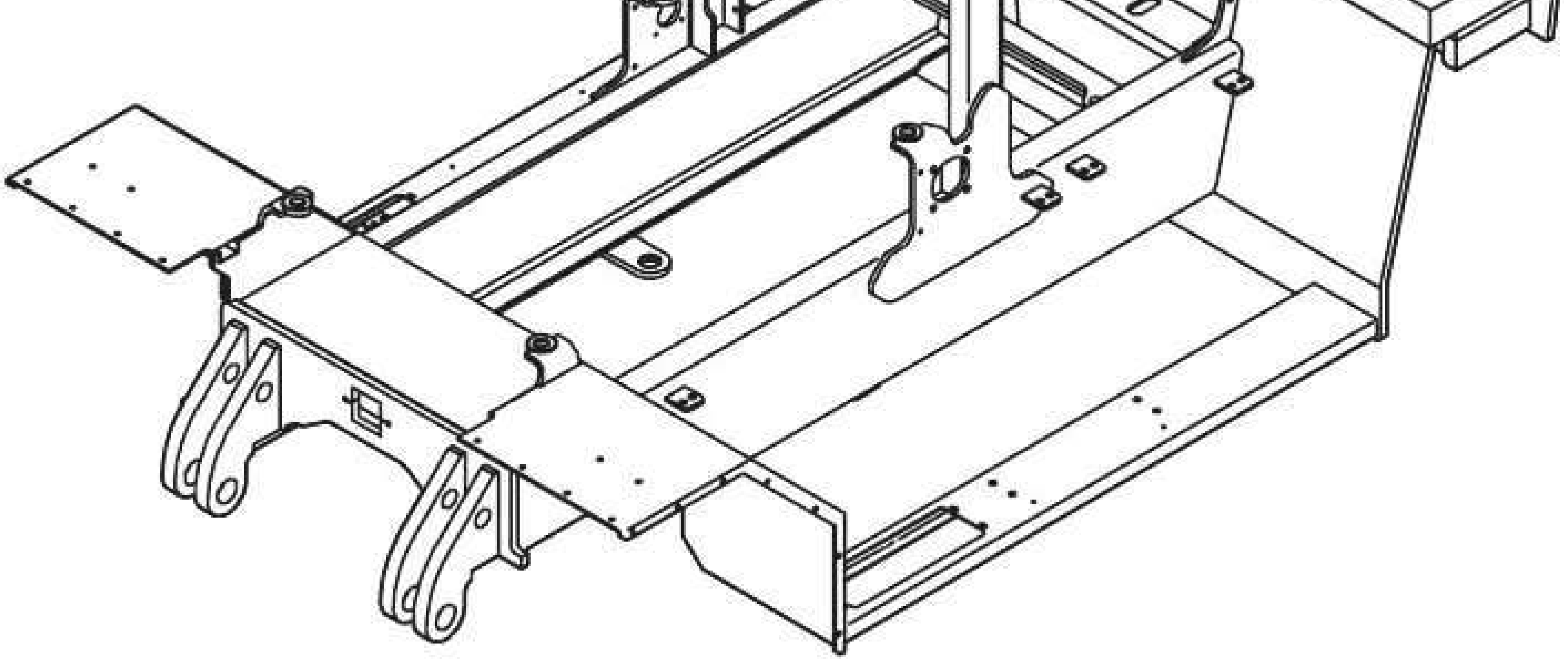
WARNING: Under no circumstances, without prior written approval from Taylor Machine Works, Inc. Engineering Department, should the chassis be modified, i.e. adding of additional counterweights. As per OSHA 29 CFR1910.178 (a) (4).

WARNING: If the fatigue crack is allowed to grow, catastrophic failure could occur in the chassis or other welded components, causing serious injury to personnel and / or property.

Chassis Troubleshooting

Problem	Cause	Correction
1. Cracks in welds (Refer to **SIRR** in the **Appendices**) **Notify Taylor Machine Works, Inc. for proper repair procedures.**	1. Metal fatigue.	1. Have cracks in welds repaired immediately.
	2. Overloading.	2. Refer to Correction 1. above and avoid overloading the truck.
	3. Rough terrain.	3. Refer to Correction 1. above and, if possible, avoid operating truck on rough terrain.
	4. Travelling with load in an unrecommended travel position (excessive height and / or fully side-shifted, one side or the other).	4. Refer to Correction 1. above and the Operator's Guide for proper travelling positions.
	5. Severe duty cycles.	5. Refer to Correction 1. above.
2. Engine or transmission support mounts broken	1. Engine vibration.	1. Refer to Problem 17. in the **Engine Troubleshooting** chart in **Section 1**.
	2. Transmission vibration.	2. Refer to Problem 9. in the **Transmission Troubleshooting** chart in **Section 9**.





Note: Photocopy this sketch to identify fatigue cracks or structural damage to the chassis. Be very descriptive of damage to the chassis, i.e. location, depth, length.

Illustration 18-1. Chassis

Section 20

Cab

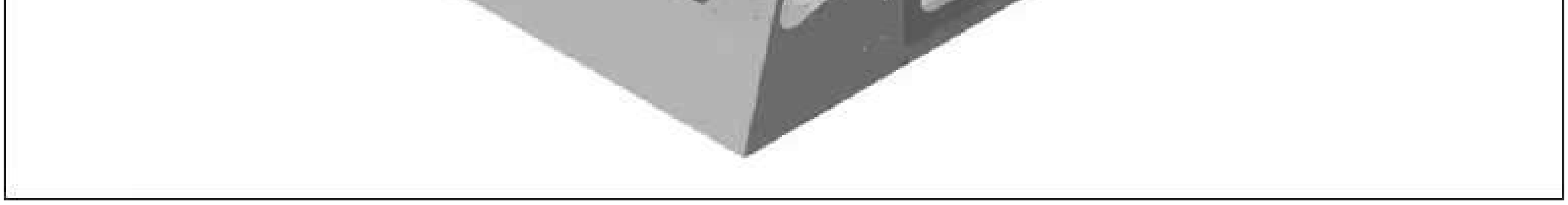


Illustration 20-1. Cab

Introduction (Illustration 20-1). The cab has been carefully designed with the operator's safety and comfort in mind. The components in the cab have been laid out for easy access.

Cab Maintenance Checks. The following checks must be performed before operating the truck.

1. Steps and operator's compartment must be free of oil, grease and trash.
2. All glass and mirrors of the cab should be cleaned daily to keep vision from being impaired.
3. Under no circumstance should objects be allowed in the cab which would restrict the operator's vision or exit.
4. The seat must lock firmly into position.
5. The seat belt must always be intact and operable.
6. The door latch must always function properly.
7. The tilt steering must lock firmly into position.

WARNING: Failure to adhere to any of the above could lead to personal injury, death or property damage.

WARNING: Avoid stepping on the top Lexan cover while servicing the truck.

WARNING: Always use approved ladders, stands, or manlifts to reach high places on the truck.

WARNING: The top Lexan cover is a part of the OSHA mandated FOPS (Falling Object Protective Structure). Do not remove or

replace cover with glass.

Troubleshooting

1. Should abnormal vibration or shifting of cab structure occur, check mounting bolts for tightness and ensure that rubber mounts are not damaged.
2. Should leak occur from the seals of the glasses, repair seal.

Lubrication. The grease fittings, on the door hinges, should be greased periodically (refer to the **Preventive Maintenance** chart in the **Appendices** for door hinge lubrication interval).

20A-Air Conditioning System

Air Conditioning System

Introduction. The air conditioning / heating system provides the operator with a comfortable operating environment.

Major Components (Illustration 20A-2)**.** The air conditioning system consists of a wall-mounted air conditioner / heater unit, condenser, compressor, four 30 amp circuit breakers, and a heater shut-off valve.

Air Conditioner / Heater Unit (Illustration 20A-1)**.** The floor-mounted air conditioner / heater unit is capable of delivering 36,000 BTUs (37,980 kJ) of cooling capacity, 38,700 BTUs (40,830 kJ) of heating capacity, and is powered by 12 VDC from 30 amp circuit breakers (CB21, CB22 and CB23). The air conditioner / heater unit is a three speed unit with a preset thermostat. The air conditioner / heater unit has a cool / heat switch that allows the operator to select for cooling or heating of the cab. The air conditioning system is charged with approximately 4.25 lbs. (1.9 kg) of R134a Freon.

NOTE: *The Clean Air Act, passed in 1992, specifies that anyone who works on vehicle air conditioning systems must be certified by an EPA approved agency.*

warm, high pressure liquid (to the expansion valve). The drier is equipped with a binary switch which protects the compressor.

The binary switch is normally closed when the system pressure is within operating specifications. The binary switch will open when the system pressure exceeds 312 psi (22 bar). The binary switch will not close again until the pressure has dropped below 225 psi (16 bar). When the pressure drops below 2 psi, the binary switch will open. The binary switch will not close again until the pressure is above 28 psi (2 bar). The binary switch can be replaced without recovering the refrigerant.

The binary switch is located in the air conditioner unit on the high pressure side. The fitting that holds the binary switch is equipped with a check valve, that prevents the high pressure coolant from exhausting if the switch is removed.

Evaporator / Heater Coil. The evaporator / heater coil is located inside the air conditioner / heater unit. The evaporator and heater coils are integrated into one unit. The evaporator coil changes the warm, metered pressure liquid refrigerant (from the expansion valve) into a cold, low pressure vapor.

approved agency.

Compressor. The compressor is belt driven and circulates the refrigerant through the air conditioning system when its clutch is engaged. It receives a cool, low pressure gas and pumps a hot, high pressure gas to the condenser. When the thermostat signals for cooling, an electrical signal is sent to the compressor clutch, engaging the clutch and driving the compressor.

NOTE: *Any time repairs are made to the air conditioning system which require the recovery of the refrigerant, it is recommended that the drier be changed and 4 ounces (118 milliliters) of AC ester lubricating oil be added to the dryer.*

Condenser. The condenser, mounted on the back of the cab, changes the refrigerant from a hot, high pressure gas (from the compressor) to a warm, high pressure liquid (to the drier) by cooling the refrigerant. The condenser is powered by 12 VDC from a 30 amp circuit breaker (CB24).

Drier. The drier stores a volume of refrigerant. Additionally, it filters and removes moisture from the refrigerant. The drier receives a warm, high pressure liquid (from the condenser) and sends a

sure gas. The cold, low pressure gas is sent back into the expansion valve. The temperature of this low pressure gas is what controls the expansion valve. The colder the gas, the closer a ball will seat and restrict the refrigerant into the evaporator coil.

The heater coil is the medium by which heat is transferred from the engine coolant to the operator's compartment. A heater shut-off valve is located on the air conditioner / heater unit and when opened, allows the heat transfer to occur. When operating the air conditioner, close the heater shut-off valve for maximum cooling efficiency.

Circuit Breakers. Refer to **Circuit Breakers** in the **Component Troubleshooting** of **Section 6** for troubleshooting of circuit breakers.

Air Conditioner / Heater Maintenance. The remote mounted condenser of the air conditioning system should be cleaned every 3 months to remove debris. The condenser can be cleaned with a fin comb, air hose and nozzle, or soap and water. The evaporator / heater coils in the air conditioner / heater unit should be cleaned every 3 months with compressed air.

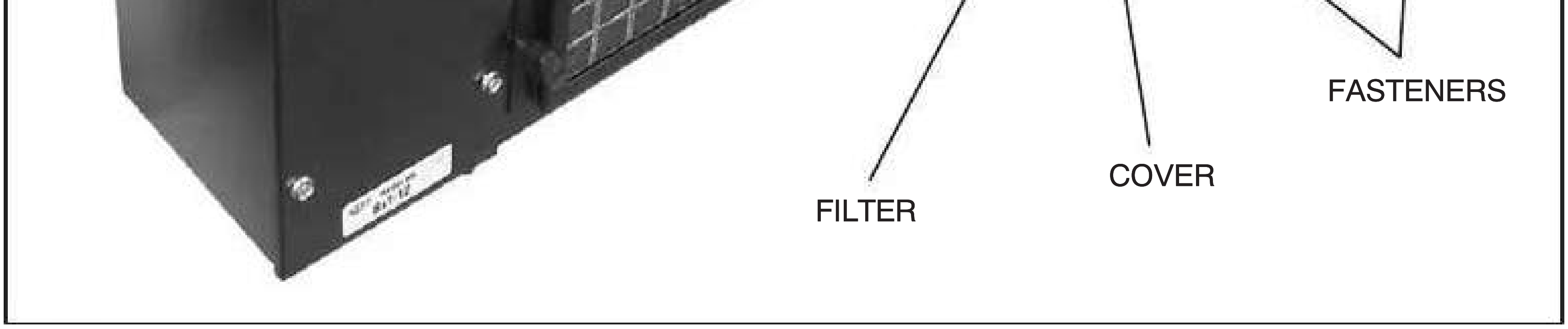


Illustration 20A-1. Air Conditioner / Heater Unit

Heater Shut-off Valve (Illustration 20A-1)**.** The heater shut-off valve controls the circulation of heated coolant through the air conditioning / heater unit. Additionally, there are two shut-off valves, located on the engine, that control the circulation of heated coolant through the heating / defrosting circuit. All three shut-off valves must be fully open for maximum heating. If any of the shut-off valves are closed, there will be no circulation of heated coolant through the heating system.

Refrigerant Hoses. Periodically check the hoses and fittings for chafing or cracking. Replace as conditions require.

Cleaning and / or Changing The Air Conditioner / Heater Unit Filters (Illustration 20A-1)**.** The air conditioner filters should be cleaned every 3 months or as conditions warrant. The filters must be replaced yearly or as conditions warrant. If filters are not cleaned regularly, they may become partially clogged with lint, dirt, grease or other debris. The filters should be cleaned or changed as conditions warrant. Perform the following procedures to remove filters for cleaning or replacement.

1. Remove filter covers from the air conditioner / heater unit's housing by removing fasteners.
2. Remove filters from filter covers and clean with low pressure air. Replace old filters with new filters if filters are damaged.

3. Install the filters in the filter covers and secure filter covers to air conditioner / heater unit with fasteners.

Inspection. In the event of a cooling problem, perform the following inspection procedures.

WARNING: Death or serious injury could result from a runaway truck. Park the truck on a hard, level surface, apply the parking brake and block the wheels in both directions to prevent movement of the truck.

WARNING: Rotating fan and belts can cause severe injury. Stay clear of fan and belts when engine is running.

1. Check the compressor drive belt tension and pulley alignment. Tension on the drive belt should be such that a firm push with the thumb at a point midway between the two pulleys will deflect the belt approximately 3/8" (9.5 mm). If the deflection of the belt is more than 3/8" (9.5 mm), adjust the belt tension.
2. Check the condenser for debris and clean if

engage the clutch of the compressor (refer to **Drier** in this section).

7. Check the air conditioning hoses and fittings for leaks. If a leak is detected, the refrigerant must be recovered prior to making repairs.

NOTE: *The Clean Air Act, passed in 1992, specifies that anyone who works on vehicle air conditioning systems must be certified by an EPA approved agency.*

8. For any further repairs, contact a certified air conditioning repair technician.

2. Check the condenser for debris and clean if required.

3. Check all electrical connections and ensure that the circuit breakers are set.

4. Checking the compressor clutch will require starting the engine. When 12 VDC is sent from the thermostat through the binary switch to the compressor, the compressor's clutch will pop towards the compressor pulley (this will be heard). The clutch will then begin to rotate with the pulley (this will be seen).

5. Ensure that the evaporator coil, located inside the air conditioner / heater unit (and ceiling-mounted air conditioner unit), is not iced up. The thermostat's capillary should be positioned in the center of the evaporator coil fins. If the thermostat is functioning properly when the fins ice up, the thermostat will remove the 12 VDC to the compressor. This will allow the compressor pulley to free-spin and no refrigerant will be circulated to the evaporator coil. The ambient temperature will then defrost the evaporator coil fins.

6. The 12 VDC signal from the thermostat must pass through a binary switch, which monitors low pressure and high pressure in order to

Air Conditioner / Heater Unit Troubleshooting (Illustration 20A-2)

Problem	Cause	Correction
1. Air conditioning unit does not power up	1. Circuit breaker(s) (CB21, CB22 or CB23) is tripped or defective.	1. Reset or replace circuit breaker(s). Refer to **Circuit Breakers** of the **Component Troubleshooting** in **Section 6**.
	2. Harness connector is disconnected or loose.	2. Connect or tighten harness connector.
	3. Loose pin in harness connector.	3. Isolate and repair.
	4. Broken or shorted wires.	4. Troubleshoot, isolate and repair.
2. Fan blows limited or no cold air	1. Heater shut-off valve is open.	1. Close heater shut-off valve.
	2. Compressor clutch is slipping or defective.	2. Tighten drive belt or replace clutch.
	3. Low Freon charge.	3. Have certified technician recharge air conditioning system.
	4. Thermostat is defective.	4. Replace thermostat.

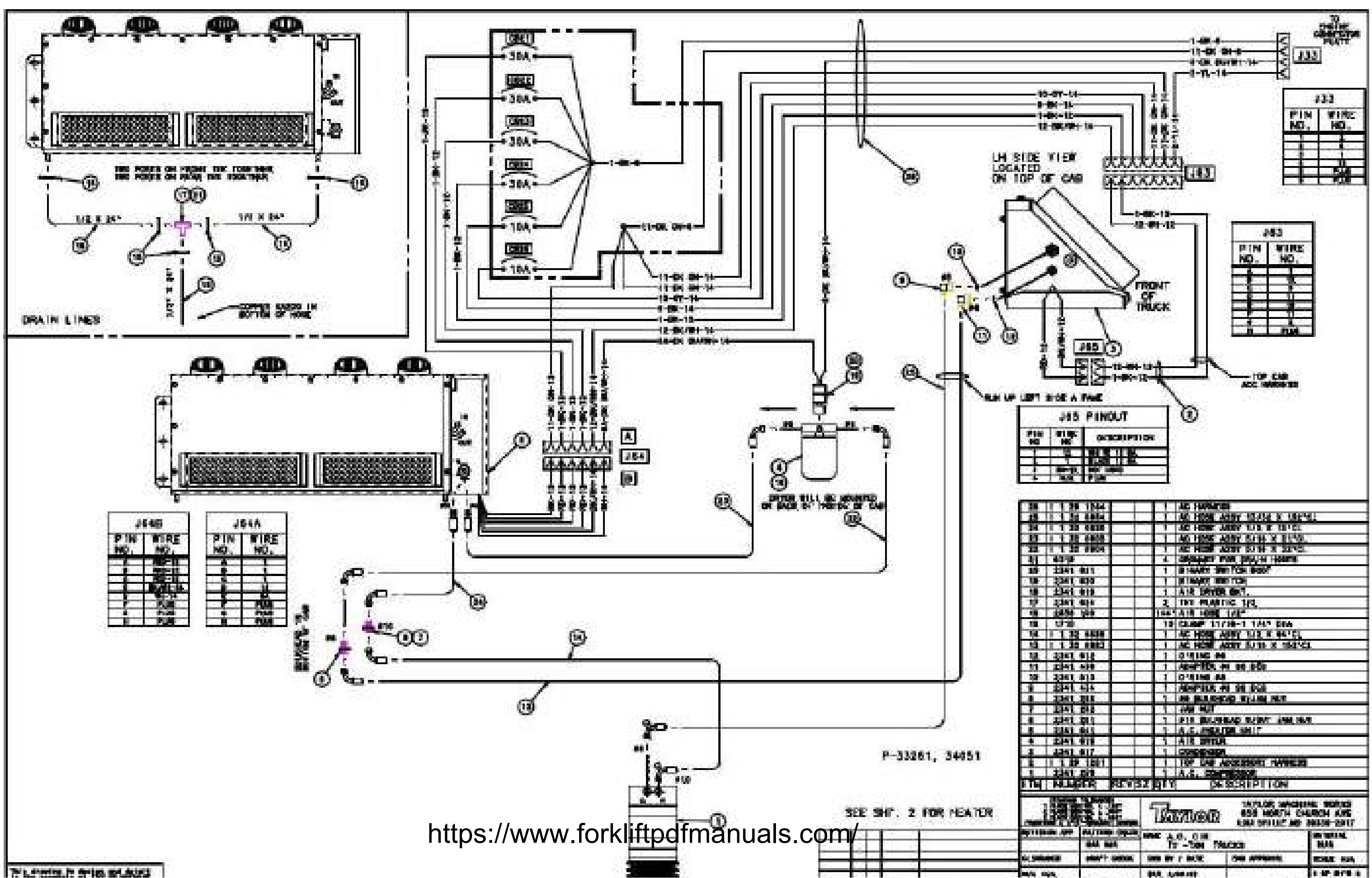
	5. Evaporator coil is iced up.	5. Thermostat is defective. Replace thermostat.
	6. The condenser fan is seized or defective.	6. Unseize fan, replace or check wiring to fan motor.
	7. The evaporator / heater coils are dirty or stopped up.	7. Clean with compressed air or remove restriction.
	8. Filter is dirty or stopped up.	8. Clean or replace filter.
	9. Binary switch in condenser is defective.	9. Isolate and repair.
	10. Circuit breaker(s) is tripped or defective.	10. Isolate and repair.
	11. The heat / air switch of the air conditioner / heater unit is in the heat position.	11. Place the heat / air switch in the air position.
	12. Defective heat / air switch of air conditioning unit.	12. Replace heat / air switch.
	13. Harness connector(s) is disconnected or loose.	13. Connect or tighten harness connector(s).
	14. Air conditioner compressor is defective.	14. Contact certified technician to repair or replace.

Problem	Cause	Correction
3. Air conditioning unit is leaking water in the cab	1. Drainage hoses are restricted.	1. Remove restriction from hoses.
	2. Drainage hoses have shifted upwards.	2. Reposition the drainage hoses. The drainage hoses should run downward to prevent water from standing in the hoses.
	3. Drain vent in drainage pan is restricted.	3. Remove restriction from drain vent.
4. Fan blow no heated air	1. Heater shut-off valve is open.	1. Close heater shut-off valve.
	2. Engine-mounted shut-off valve(s) is closed.	2. Open shut-off valve(s).
	3. Heater hoses kinked or restricted.	3. Unkink or remove restriction from hoses.
	4. Defective engine thermostat (stuck open).	4. Replace engine thermostat.

	5. Low coolant.	5. Check and fill radiator.
	6. Engine did not rise to operating temperature.	6. Allow engine enough time to reach operating temperature.

PLACE THE FOLLOWING ILLUSTRATION IN

A FOLDER ENVELOPE:
Illustration 20A-2 - 20A-2367 SHT. 1 (A.C. ANSI)



CD 20A2367 01 D

20 Heating System

Heating System

Introduction. The heating system provides a comfortable working environment in a cold climate and is essential in removing condensation from the windshield in which otherwise would impair vision. Provided the engine-mounted shut-off valves are open, the engine coolant flows through the heater coils of the heater / defroster units, air conditioner / heater unit (if equipped), and returns back to the engine block.

Major Components (Illustration 20H-2). The heater system consists of two heater / defroster units, two 30 amp circuit breaker (CB11 and CB12), air conditioner / heater unit, shut-off valves and hoses.

Heater / Defroster Units (Illustration 20H-1). The heater / defroster units are powered by 12 VDC from two 30 amp circuit breaker (CB11 and CB12), employ a two speed switch (S24), two relays (K12 and K13) and are rated at 15,300 BTUs (16,140 kJ).

Circuit Breakers. Refer to **Circuit Breakers** in the **Component Troubleshooting** of **Section 6** for troubleshooting of circuit breakers.

Shut-off Valves (Illustration 20H-2). The shutoff valves [one is located in the air conditioning / heater unit (see Illustration 20A-1) and one is engine mounted] control the flow of heated coolant to the heater / defroster circuits. They must be fully open for maximum operation. If any of the shut-off valves are closed, there will be no flow of heated coolant to circulate in the heating / defrosting circuit.

Hoses. Periodically check the hoses and elbows for chafing or cracking. Replace as conditions require.

WARNING: Severe injury may occur from burns. Always shut down engine and allow to cool before servicing or inspecting heater hoses.

Cleaning and / or Changing The Heater / Defroster Unit Filter (Illustration 20H-1). The heater / defroster unit's filter should be cleaned every 3 months or as conditions warrant. The filter must be replaced once a year or as conditions warrant. If the filter is not cleaned regularly, it may become partially clogged with lint, dirt, grease or other debris. A clogged filter will produce a loss of

cleaned or changed. Perform the following procedures to remove filters for cleaning or replacement:

1. Remove filter cover from the heater / defroster unit's housing by removing screws.
2. Remove filter from filter cover and clean with low pressure air. Replace old filter with new filter if filter is damaged.
3. Install filter in the filter cover and secure to heater / defroster unit with screws.

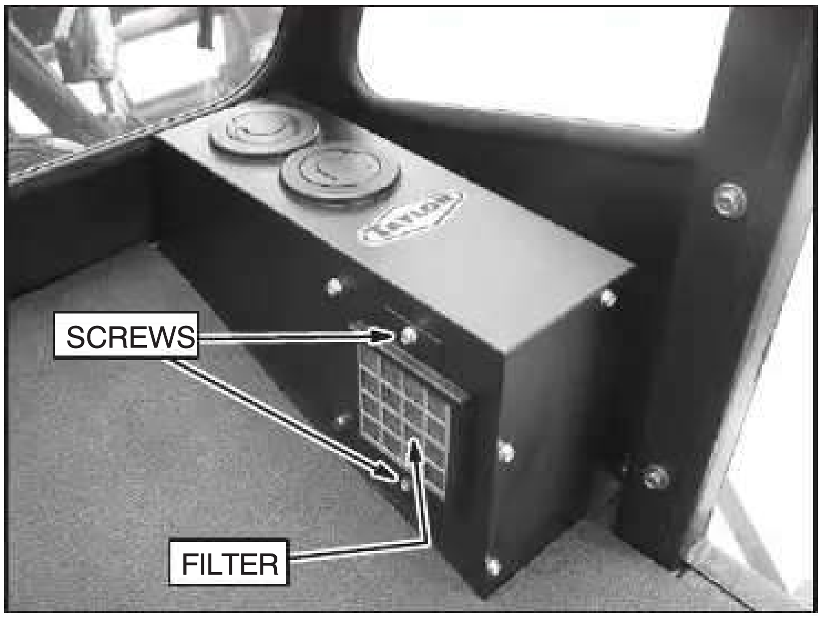
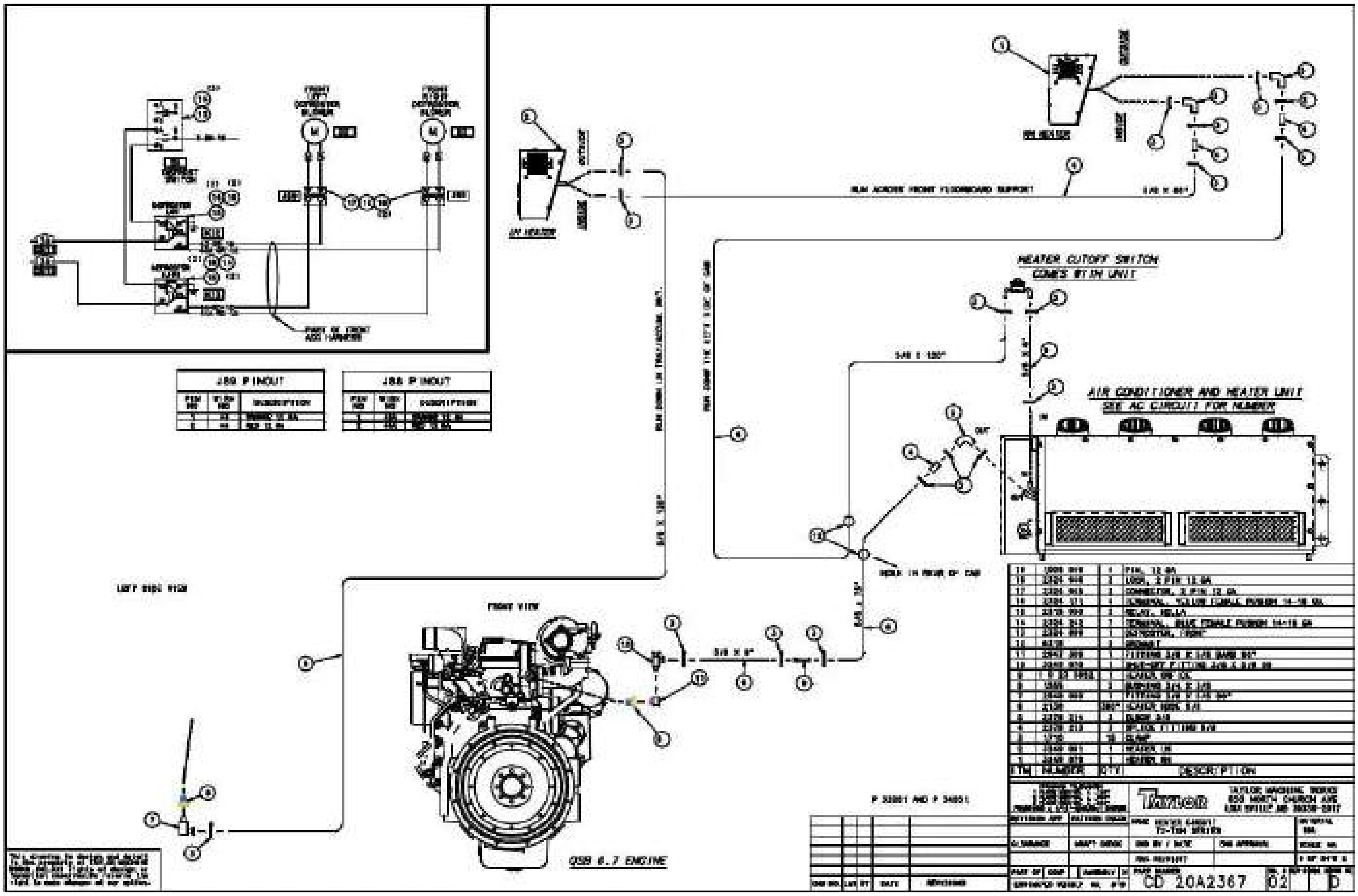


Illustration 20H-1. Heater / Defroster Unit Filter air volume and therefore the filter should be

Heating System Troubleshooting (Illustration 20H-2)

Problem	Cause	Correction
1. Heater / defroster fan is not turning	1. The heater / defroster switch (S5) is defective. 2. Circuit breaker (CB11 or CB12) is tripped. 3. Circuit breaker (CB11 or CB12) keeps tripping. 4. Circuit breaker (CB11 or CB 12) is defective. 5. Defective relay (K12 or K13). 6. Defective fan motor. 7. Loose or broken wires / plugs / pins between any of the components.	1. Replace heater / defroster switch. 2. Reset circuit breaker. 3. Circuit is shorted. Troubleshoot, isolate and repair short. 4. Replace circuit breaker. 5. Replace relay. 6. Replace fan motor. 7. Troubleshoot, isolate and replace wire.
2. Heater / defroster fan is turning, but no warm air is present	1. The engine-mounted shut-off valve or air conditioning / heater unit shut-off valve is closed. 2. Heater hoses kinked or restricted. 3. Defective engine thermostat (stuck open). 4. Low coolant. 5. Engine is not at operating temperature.	1. Open shut-off valve(s). 2. Unkink or remove restriction from hoses. 3. Replace engine thermostat. 4. Check and fill radiator. 5. Allow engine enough time to reach operating temperature.
3. Heater / defroster operates in only one speed	1. Defective heater / defroster switch (S5). 2. Defective relay (K12 or K13) 3. Loose or broken wires / plugs / pins between any of the components.	1. Replace heater / defroster switch. 2. Replace relay. 3. Troubleshoot, isolate and repair.

PLACE THE FOLLOWING ILLUSTRATION IN
A FOLDER ENVELOPE:
Illustration 20H-2 - 20A-2367 SHT. 2 (Defroster ANSI)


HEATER CUTOFF SWITCH
COMES WITH UNIT
AIR CONDITIONER AND HEATER UNIT
SEE AC CIRCUIT FOR NUMBER
QSB 6.7 ENGINE
CD 20A2367

Steering Logic (Illustration 22-20 and 22-14)**.** Hydraulic flow from the larger of the two gear sets in the main pump enters the manifold at port P1. Flow is then directed to the main relief valve (RV1) and the two steering logic controls (LC2 and LC3). If there is no demand from steering, LC2 sends flow to the orbitrol until 150 psi (10.4 bar) standby pressure can maintained in the line causing LC2 to close. The flow opens LC3 and is then directed to the hoist and tilt valves. When steering, load sense pressure builds from the orbitrol, which

tank return from one outlet port to force fluid through a hydraulic cooler located behind the radiator. The check acts as a bypass valve for cold fluid startup as well as increased flow to tank as the mast is being lowered.

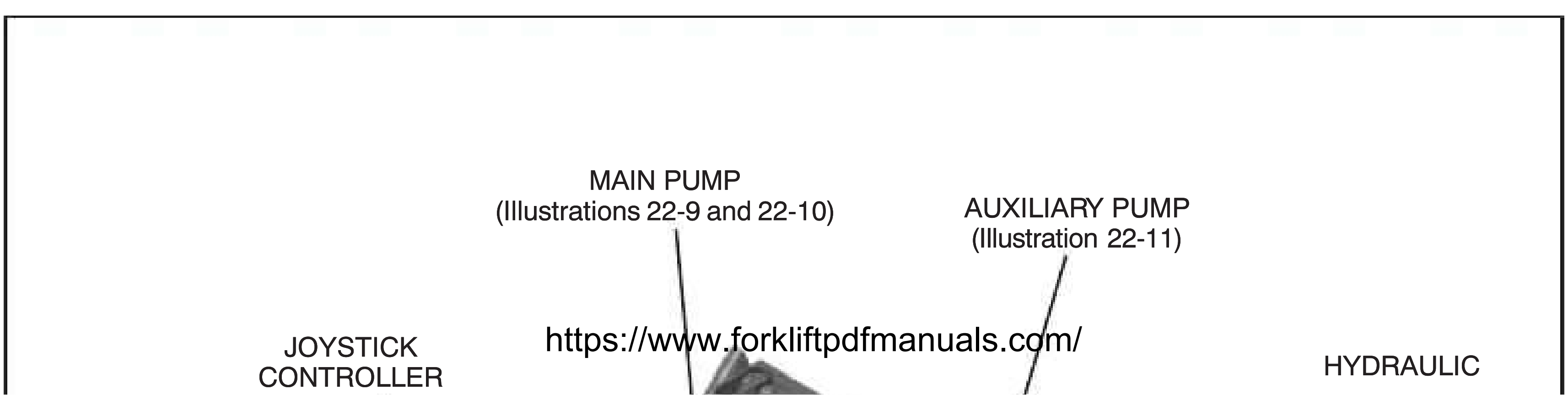
Brake / Brake Cooling Logic (Illustration 22-20)**.** The auxiliary pump is a two section pump with gear sets of equal size. Flow from one gear set enters the manifold at port P3. Flow is blocked by logic element (LC1) and must pass through orifice causes LC2 to open and LC3 to close enough to satisfy the steering flow requirement (Load sense pressure can be measured at port LSM). Excess flow is available for use by the hoist and tilt. When load sense (steering) pressure reaches the setting of relief valve [RV2 (which must be set at a pressure equal to or lower than RV1)], RV2 opens causing LC3 to open as well. Pump flow is then sent to hoist and tilt. (Refer to the **HYDRAULIC PRESSURE SETTINGS** in the **Appendices** for RV1 and RV2 pressure settings.)

Hydraulic Logic (Illustration 22-20). Hydraulic flow from the secondary gear set of the main pump enters at the inlet of the accessory valve.

Flow then passes through the manifold where it joins with the flow from the primary pump. The combined flows then enter the hoist and tilt valve. Pump flow from the secondary gear set is always available for accessory functions such as side shifter and fork positioners if the truck is so equipped. Pump flow from the primary pump must satisfy steering requirements first, but excess flow is always available for hoist and tilt functions. The total flow from both pumps is available to hoist and tilt if there is no requirement from steering or accessory functions. Flow returns to the tank from the hoist and tilt valve outlet. The outlet is equipped with two returns. An inline check valve has been installed at the hydraulic

ORF1 and check valve (CK1) to start the accumulator charging process. As pressure builds in the charge circuit, the pressure reducing valve (PRV1) supplies pilot fluid for accessory valve and hoist / tilt valve operation. When the PRV1 valve setting is reached, it closes off and all flow through the circuit is directed to the parking brake and service brake accumulators. When both accumulators reach full pressure, determined by the unloader valve (UNL1), the pilot to the spring chamber of logic element (LC1) is drained and pump flow is directed to the drive axle to cool the left side drive axle brake. Flow from the other gear set cools the fluid of the right side drive axle brake. As pressure falls in the accumulators, the pressure signal

to UNL1 falls and closes it. The process repeats itself. Relief valve (RV3) protects the pump from over-pressurization and acts as a thermal relief also. The parking brake is electrically applied and released by solenoid SOL1. Pressure must be held on the spring-applied / hydraulic-released parking brake (located on the transmission output). Both brake pedals are supplied from pressure and flow stored in accumulator (ACC2). The LH foot pedal inches the transmission and applies the wheel brakes. The RH foot pedal applies the wheel brakes only. (Refer to the **HYDRAULIC PRESSURE SETTINGS** in the **Appendices** for pressure settings.)



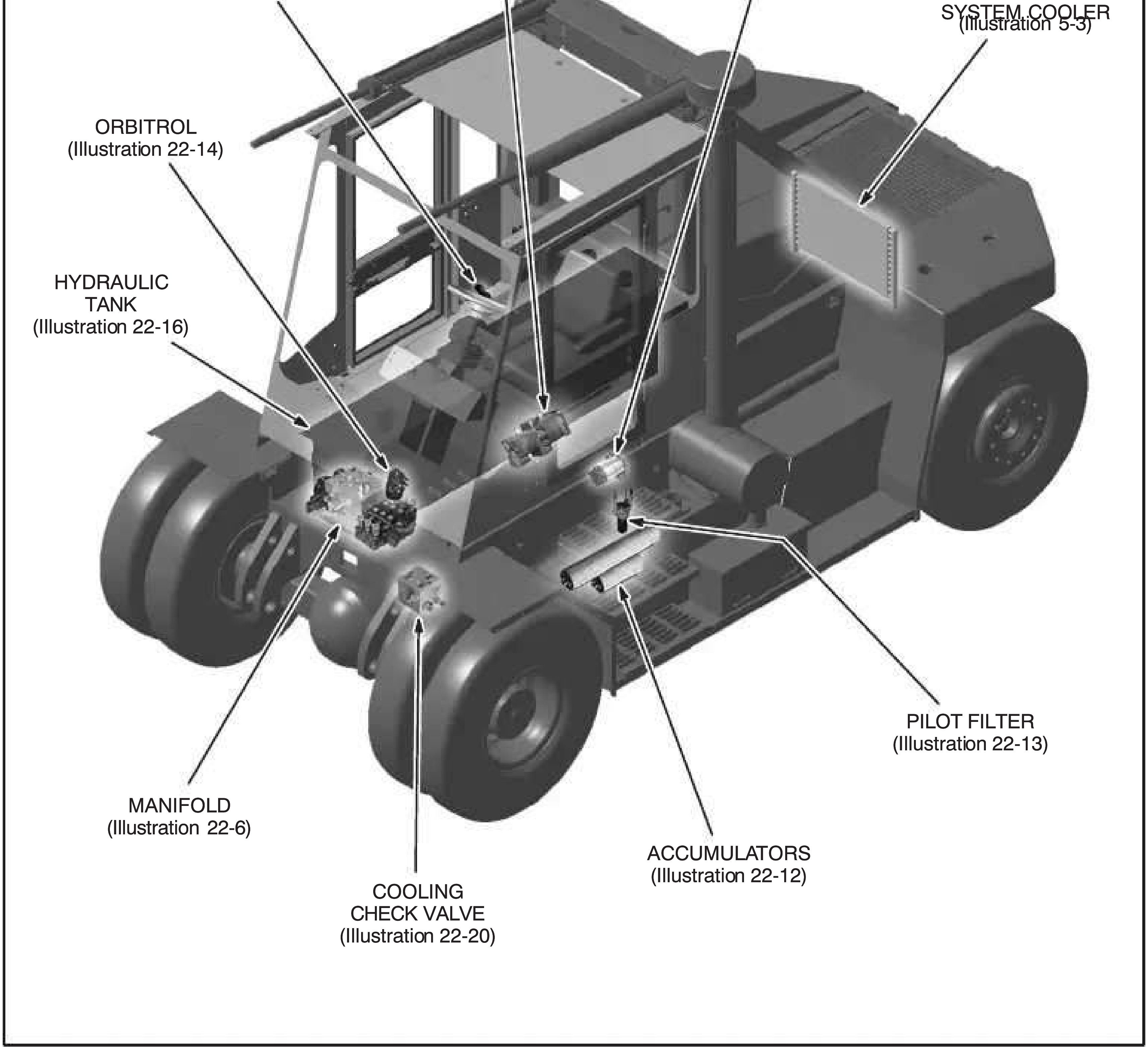
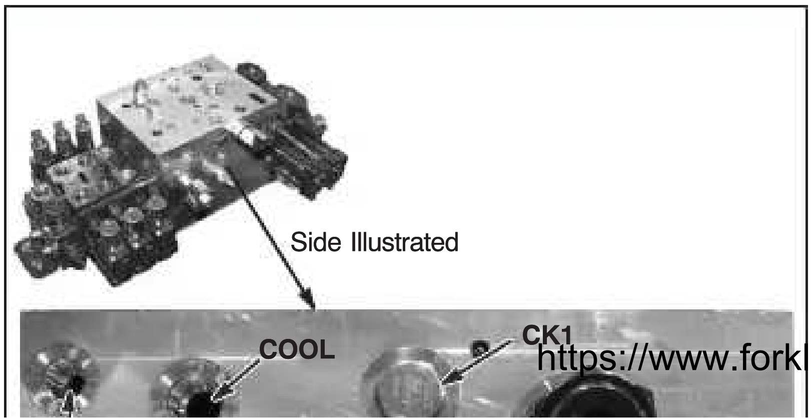
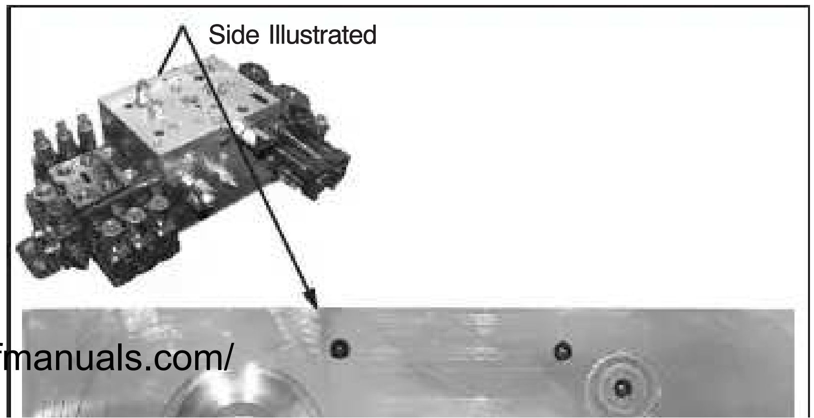


Illustration 22-1. Hydraulic System Components Identification





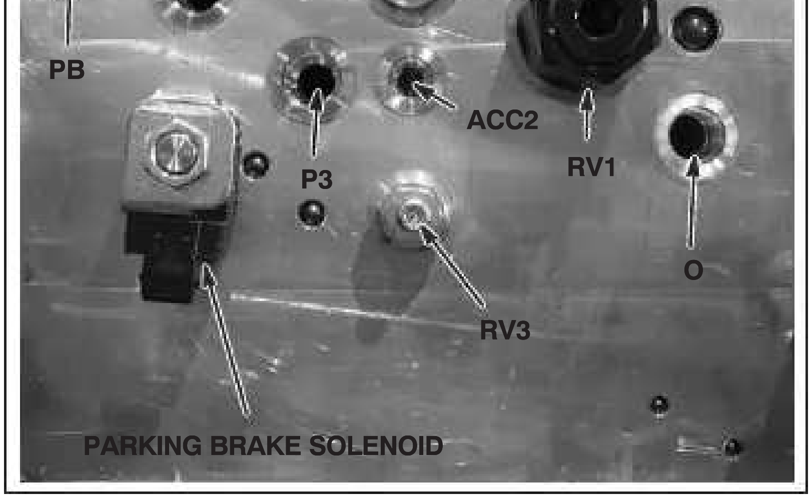


Illustration 22-2. Manifold (Engine Side)

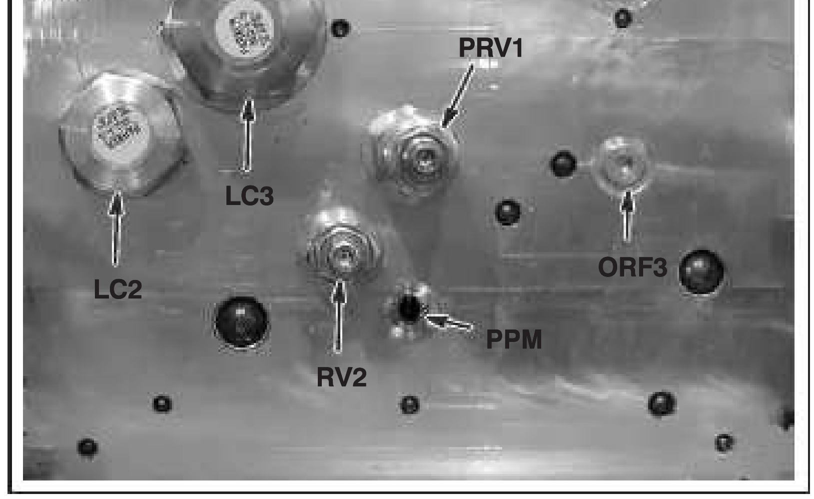


Illustration 22-3. Manifold (Mast Side)

PB - (Parking Brake) Supply connection to the parking brake chamber.

Cool - (Service brake cooling) Cooling fluid supply to one of the service brake.

CK1 - (Check Valve) Isolates higher brake pressure circuits from lower pump pressure.

P3 - (Auxiliary Pump Port) Supply connection from primary pump.

ACC2 - (Accumulator Port) Service brake accumulator supply.

RV3 - (Pressure Relief) Thermal relief for ACC2 accumulator.

RV1 - (Pressure Relief) Primary pump relief

Parking Brake Solenoid - Controls parking brake apply / release.

O - (Orbitrol Port) Supply port to steering orbitrol.

LC2 - (Logic Control) Controls flow to steering.

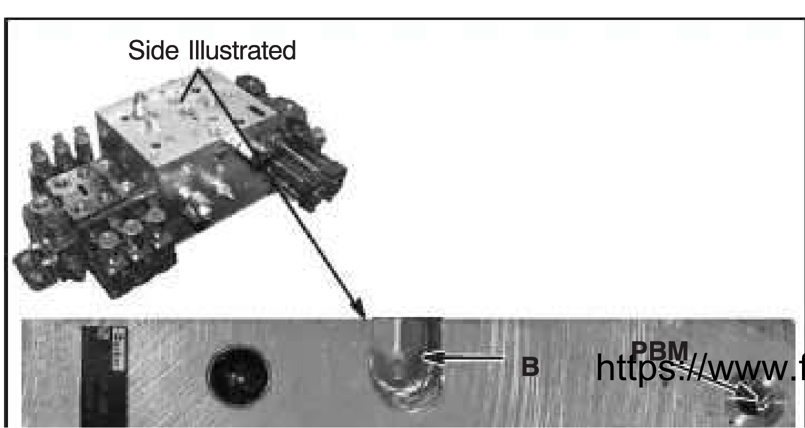
LC3 - (Logic Control) Controls flow to steering and hoist/tilt functions.

PRV1 - (Pressure Reducer) Controls maximum pilot pressure.

RV2 - (Pressure Relief) Controls maximum steer pressure.

PPM - (Pilot pressure measure) Gauge port to check pilot pressure.

ORF3 - (Orifice #3) This orifice stabilizes the unloader valve (UNL1).



flow/pressure signals to the accumulator charge circuit. The check valves isolates the parking and service brake circuits from lower brake cooling pressures.

LC1 - (Logic Control Number one) Logic control for accumulator circuit.

LSO - (Load sense) Steering load sense connection from orbitrol.

LSM - (Load Sense Measure) Port for load sense

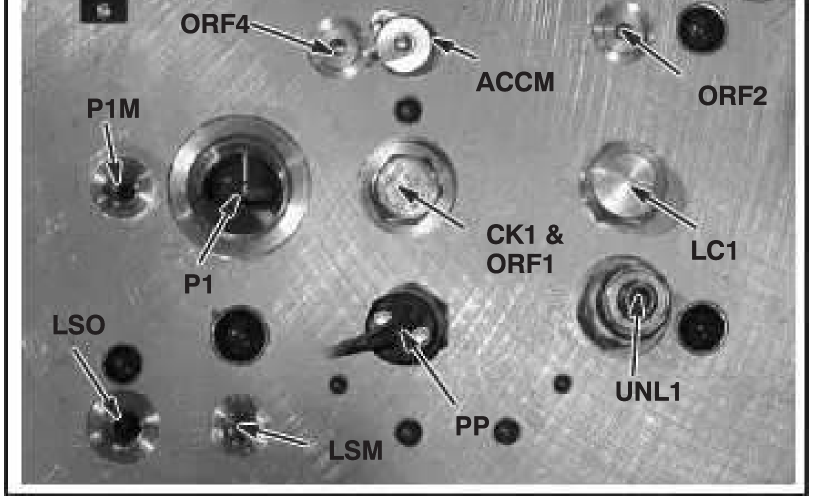


Illustration 22-4. Manifold (Top Side)

B - (Service brake Port) Supply pressure to the service brake pedals.

ORF4 - Currently not used.

ACCM - (Accumulator measure port) Port for park brake pressure check.

ORF2 - (Orifice2) Controls parking brake release rate.

PBM - Port to monitor parking brake pressure.

P1M - (Pump One Measure) Pressure check port for primary pump.

P1 - (Pump One / Main Pump) Primary pump inlet to manifold.

CK1 & ORF1 - (Check valve number one and orifice number one) Orifice number dampens the pressure check.

PP - (Pilot Pressure) Pilot pressure check port.

UNL1 - (Unloader Valve number one) Controls accumulator charge pressure high and low limits.

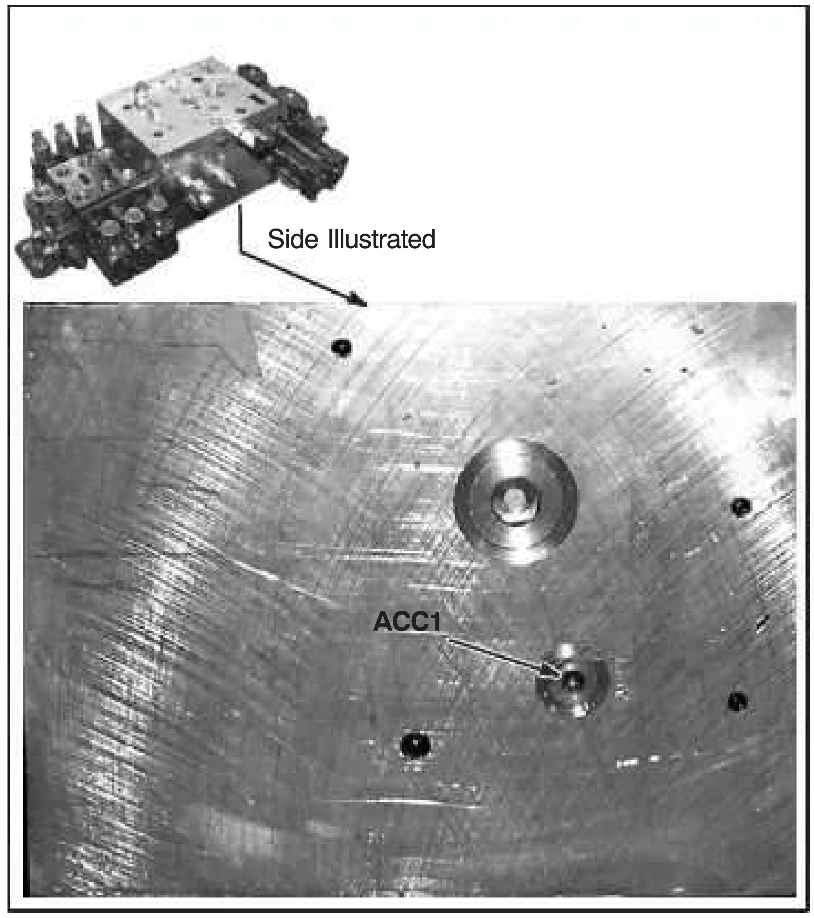


Illustration 22-5. Manifold (Bottom Side)

ACC1 - (Accumulator #1) This port provides the connection to the parking brake accumulator.

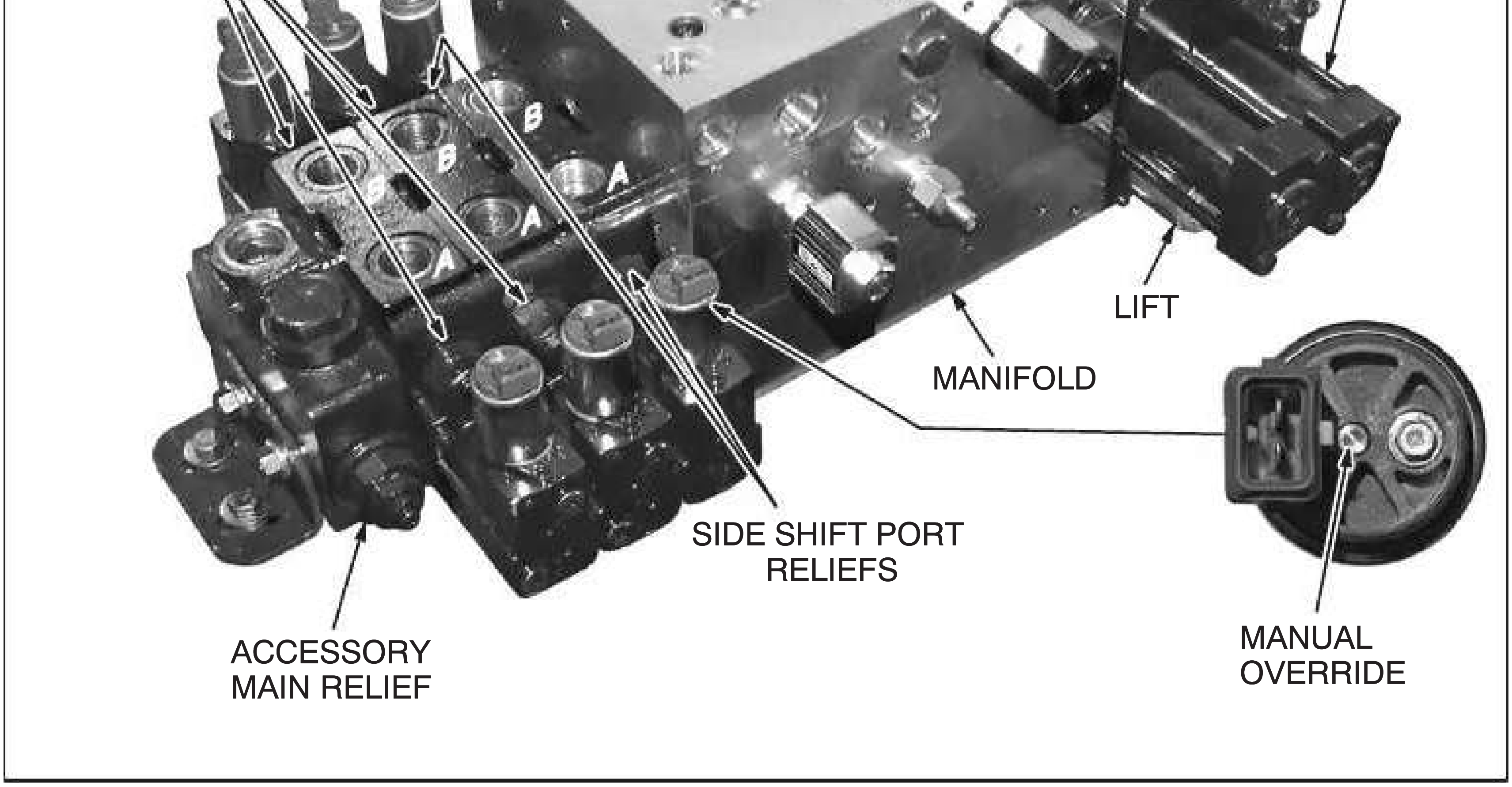


Illustration 22-6. Accessory / Manifold / Lift / Tilt Valves

Manual Override

Each of the end caps solenoids is equipped with a manual override in the event of an electrical failure. By depressing the override button of the respective solenoid, the internal pilot spool is manually moved into position, allowing pilot pressure to move the work section's main spool. This feature is extremely useful in troubleshooting. Should a function fail to operate, depressing the override switch will override all the electrical actuated functions of the manifold.

WARNING: Death or serious injury may occur from being trapped between moving parts of the lift truck. Never put yourself or any body parts between the cab and mast during servicing or inspection of the main and accessory valves. Always use access panels located on the side of the truck and the cab floorboard to access valves. Do not stand or allow others to stand under elevated parts of the mast and carriage. Ensure area is clear before activating the manual overrides of the main or accessory valves.

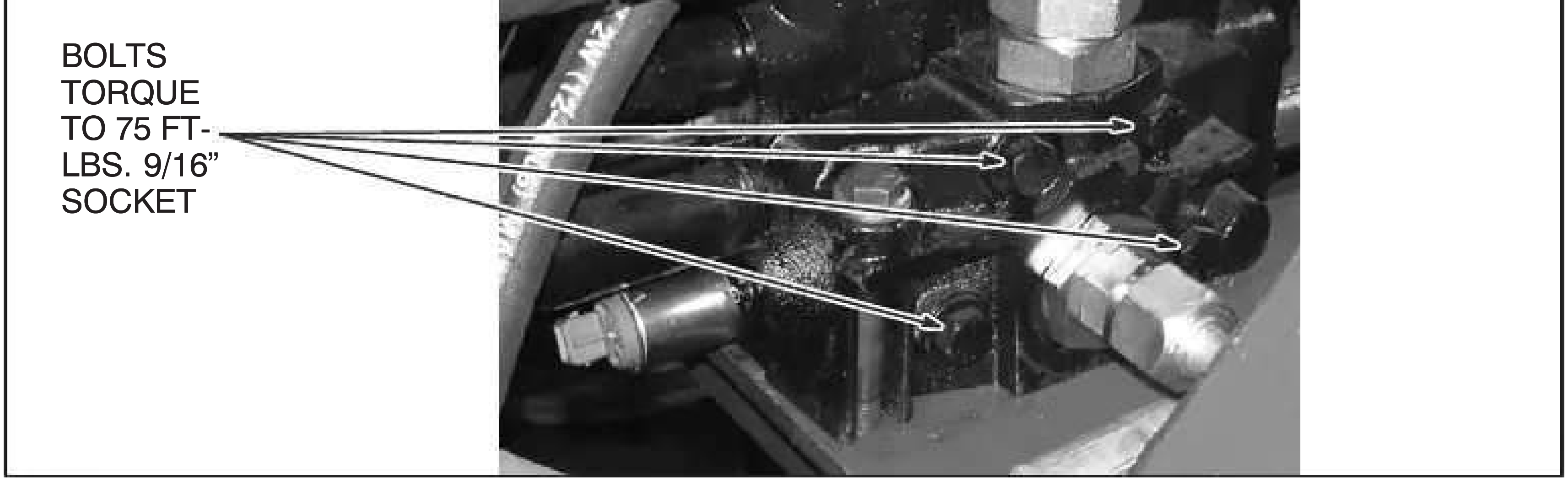


Illustration 22-7. Valve Bank Through Bolts (Lift / Tilt Side)

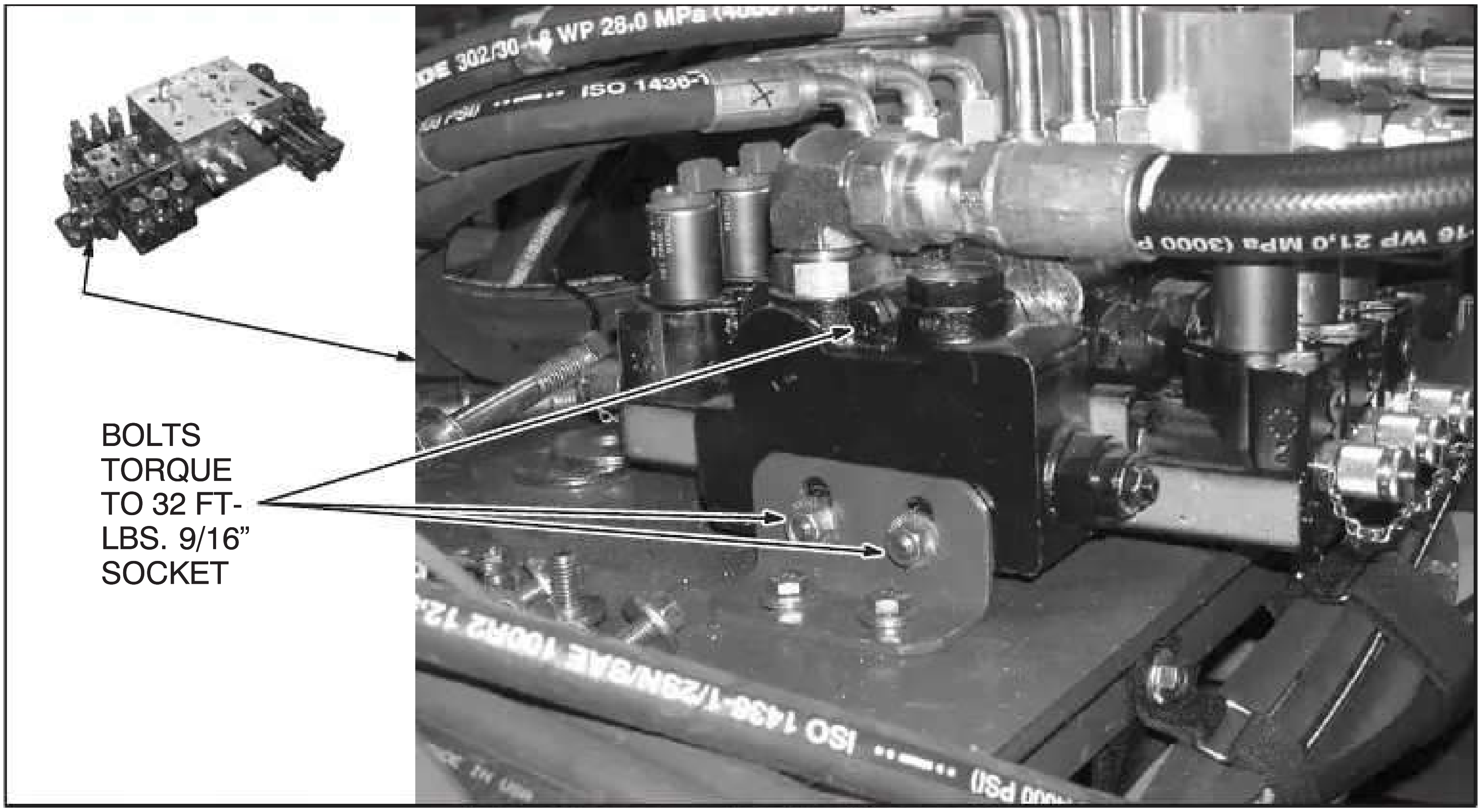
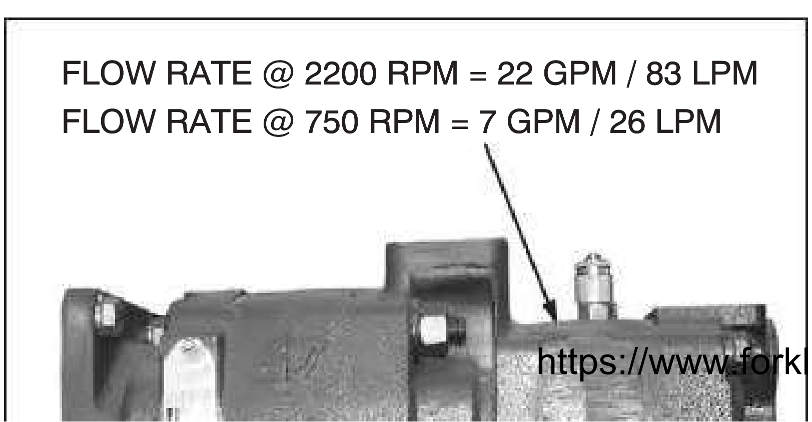
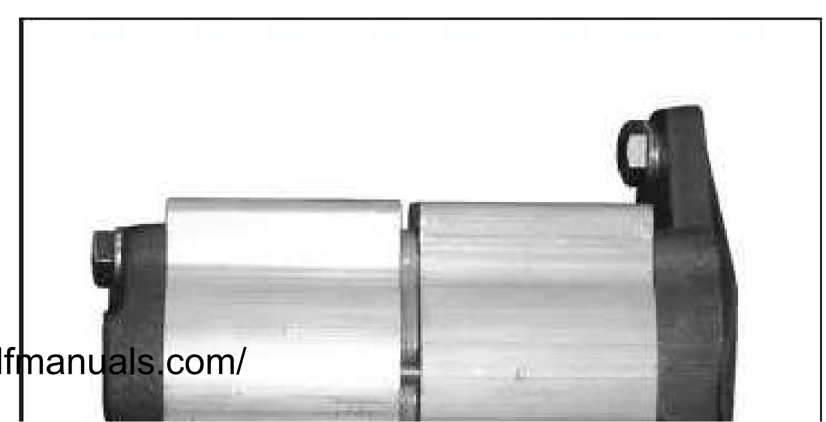


Illustration 22-8. Valve Bank Through Bolts (Accessory Side)





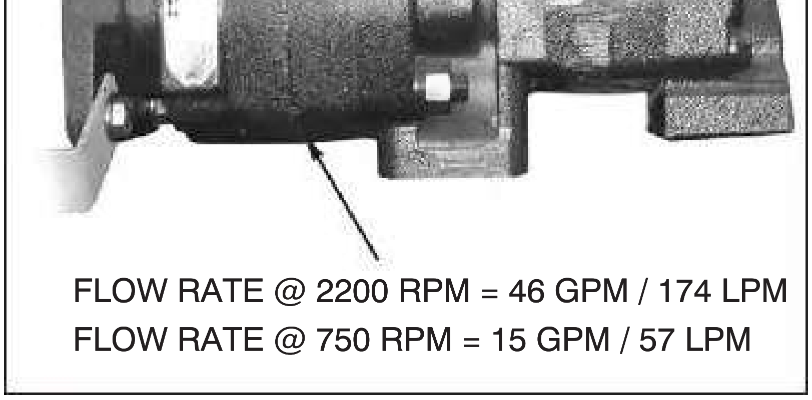


Illustration 22-9. TXH 400L / Main Pump

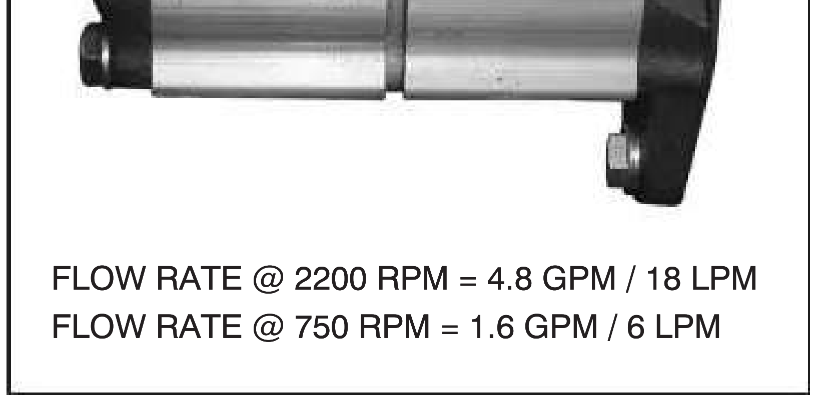


Illustration 22-11. Auxiliary Pump

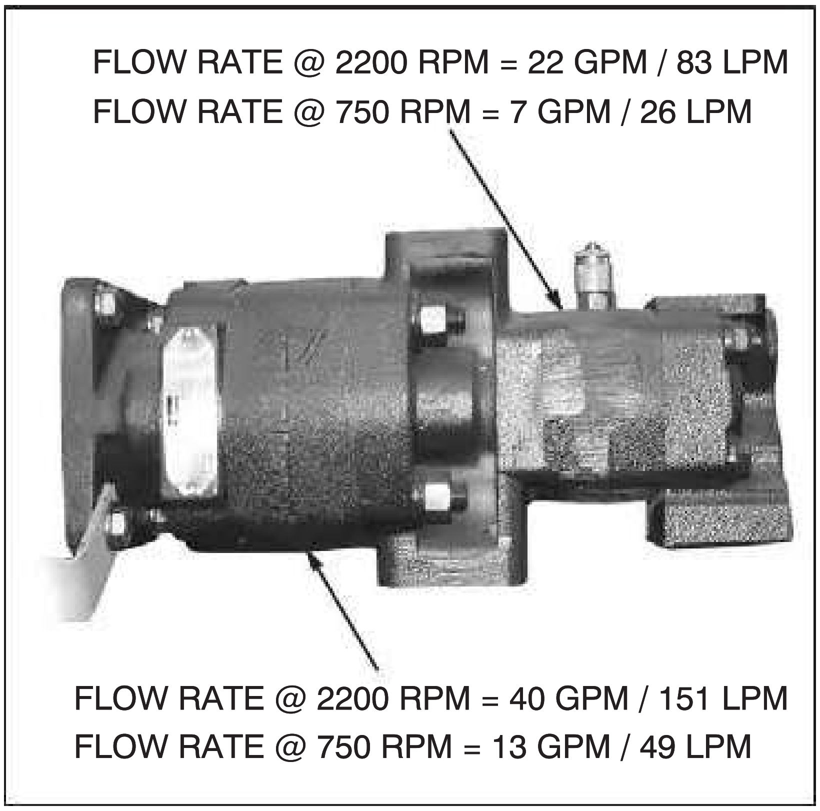


Illustration 22-10. TX (H) 180-360 Main Pump

Illustration 22-12. Accumulators

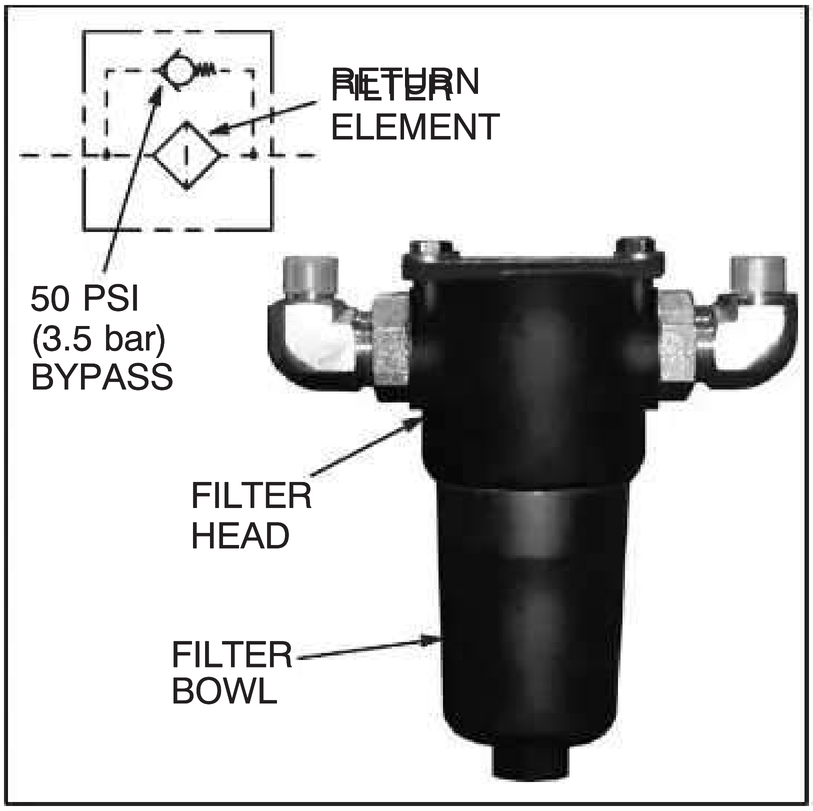


Illustration 22-13. Pilot Filter

Pilot Filter Replacement (Illustration 22-13)**.** The pilot filter filters the pilot pressure fluid. The filter head contains a 50 psi (3.5 bar) bypass. When a pressure differential exists of greater than 50 psi through the filter element, the bypass will open and unfiltered pilot fluid will enter the pilot passages of the main valve. The pilot filter should be replaced periodically (refer to the **Preventive Maintenance** chart in the **Appendices** for pilot filter replacement interval). Perform the following procedures to replace the pilot filter:

WARNING: Death or serious injury could result from a runaway truck. Park the truck on a hard, level surface, apply the parking brake, block the wheels in both directions to prevent movement of the truck and Lock Out & Tag Out the truck.

CAUTION: Dispose of fluid and filter in accordance with federal and local regulations.

1. Park the truck on a hard, level surface, block the wheels in both directions, apply the parking brake and Lock Out & Tag Out the truck.
2. Ensure filter is cool to the touch and provide a suitable container to catch any draining fluid.
3. Drain the filter bowl if equipped with drain bolt.
4. Loosen and remove filter bowl.
5. Remove filter by pulling downward with a slight

twisting motion. Discard properly of filter.

6. Check bowl O-ring for damage and replace if necessary.
7. Lubricate the O-ring of the new filter with clean hydraulic fluid. Place new filter on post in filter head.
8. Install filter bowl and tighten to a torque value of 15-20 ft-lbs (20-27 N·m).
9. Ensure filter is cool to the touch and provide a

vent hydraulic fluid aeration. Refer to the **Service Capacities** in the **Appendices** for the working and total refill capacities of the hydraulic tank.

Temperature Switch. When the temperature of the fluid in the hydraulic tank exceeds 180°F (82°C), a normally closed (NC) switch will open. This will signal the TICS (Taylor Integrated Control System) of a high hydraulic fluid temperature condition. A High Hydraulic Temperature active warning will appear on the TICS display module.

9. Ensure filter is cool to the touch and provide a suitable container to catch any draining fluid.
10. Apply an even film of fresh hydraulic fluid on the gasket surface of the replacement filter.
11. Unscrew filter and dispose of properly.
12. Thread the new filter onto filter head.
13. Hand tighten filter 3/4 turn past point where gasket first contacts filter head surface.

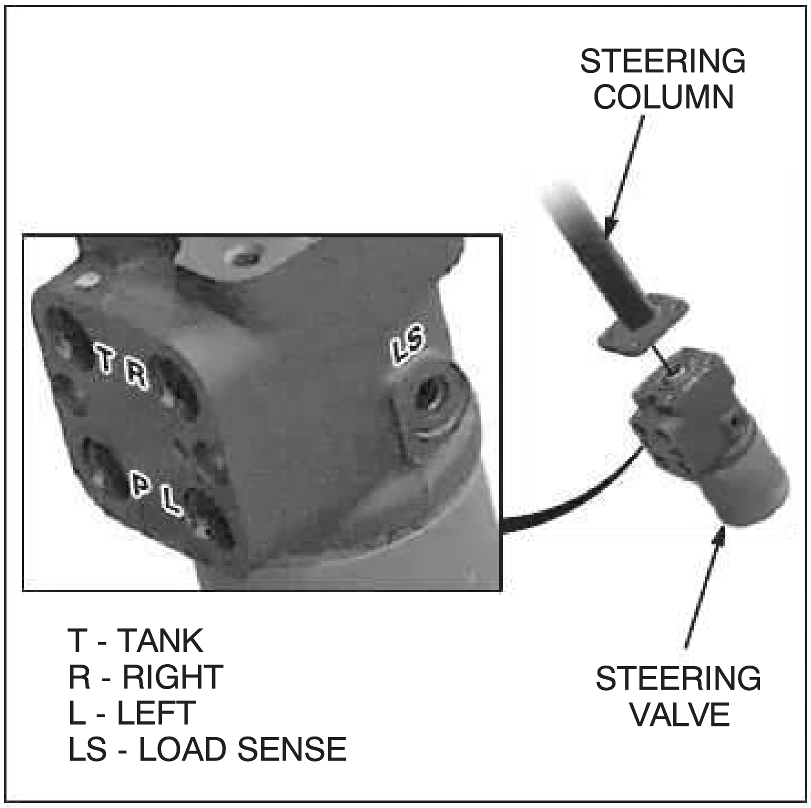


Illustration 22-14. Steering Orbitrol

Servicing The Hydraulic System

Hydraulic Operation. All hydraulic functions should be checked daily for free operation [refer to **Daily Checks** in the Operator's Guide (OG160)].

Hydraulic Tank (Illustration 22-16)**.** The tank is equipped with a return filter. All air entering the tank is filtered through a disposable breather. This tank also contains a diffuser which helps pre-

Checking The Fluid Level (Illustration 22-15)**.** The hydraulic fluid level can be checked on the fluid level dipstick. Ensure the carriage is fully lowered and the mast is fully tilted back before checking the hydraulic fluid level. Refer to the **Fuel and Lubricant Specifications** in the **Appendices** for the type of fluid to be used.

Add hydraulic fluid until the fluid level is even with the FULL mark on the dipstick. The fluid level must be maintained between the FULL and ADD marks on the dipstick.

⚠ **CAUTION: Not adhering to the above procedure can lead to overfilling of the hydraulic tank. As a result, hydraulic fluid will be forced through the breather.**

Breather Filter (Illustration 22-16)**.** Replace the breather filter periodically (refer to the **Preventive Maintenance** chart in the **Appendices** for breather filter replacement interval). More frequent replacement may be necessary if the machine is being operated under extremely dusty conditions.

Hydraulic Return Filter Replacement (Illustrations 22-15 and 22-16)**.** The hydraulic return filter is made up of 10 micron glass fiber media and is non-reusable. This filter should be replaced periodically (refer to the **Preventive Maintenance** chart in the **Appendices** for return filter replacement interval). Perform the following procedures to replace the hydraulic return filter:

⚠ **CAUTION: Used return hydraulic filters should be disposed of according to federal and local regulations.**

1. Loosen the 6 bolts.
2. Twist the cover counterclockwise and lift to remove cover.

3. Remove return filter assembly.
4. Remove return filter.
5. Inspect the grommet for serviceable condition and replace if necessary.
6. Install new filter.
7. Place cover over bolts until cover seats against head and twist cover clockwise. Tighten bolts to a torque value of 10-12 ft-lbs (14-16 N.m).

the truck.

⚠ **CAUTION: Dispose of drained hydraulic fluid in accordance with federal and local regulations.**

⚠ **CAUTION: The lift and tilt cylinders should be fully retracted to keep dilution of the new hydraulic fluid to a minimum.**

(14-16 N·m).

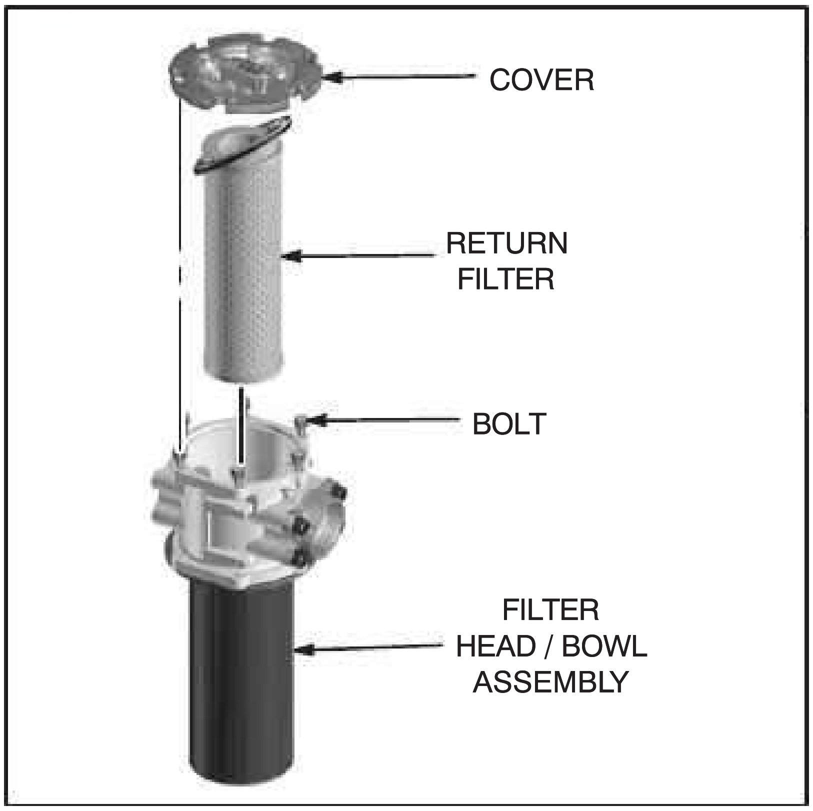


Illustration 22-15. Hydraulic Return Filter

Changing The Hydraulic Fluid (Illustration 22-16)**.** The hydraulic fluid should be changed periodically (refer to the **Preventive Maintenance** chart in the **Appendices** for hydraulic fluid change interval). The hydraulic fluid must also be changed in the event of a catastrophic failure of a hydraulic component. Refer to the **Fuel and Lubricant Specifications** chart in the **Appendices** for the proper type of fluid to be used and perform the following procedures to change the hydraulic fluid:

WARNING: Death or serious injury could result from a runaway truck. Park the truck on a hard, level surface, apply the parking brake, block the wheels in both directions to prevent movement of the truck and Lock-Out & Tag Out

CAUTION: Plug all hoses when they are disconnected to prevent foreign matter from entering the hydraulic system.

1. Park the truck on a hard, level surface, block the wheels in both directions, apply the parking brake and Lock Out & Tag Out the truck.
2. Provide a suitable container, remove the drain plug and drain the hydraulic fluid.
3. Remove the access cap from the hydraulic tank.
4. Remove the breather filter.
5. Remove the return filter (refer to **Hydraulic Return Filter Replacement** for removal procedures).
6. Remove the suction strainers from the hydraulic tank and clean in solvent. Dry with compressed air.
7. After all the fluid has been drained from the tank, remove the access cover(s) and O-ring(s).
8. Steam clean the interior of the hydraulic tank.

WARNING: Do Not clean the interior of the hydraulic tank with a flammable solvent; this can create a serious fire hazard.

9. Install new return filter.
10. Re-install suction strainers.
11. Re-install access cover(s) and O-ring(s). Inspect O-ring(s) and replace if necessary.
12. Re-install the drain plug.
13. Install new breather filter.
14. Slowly fill tank with hydraulic fluid from the filler filter port (see Illustration 22-16) while inspect-

ing for leaks (pay particular attention to the access covers). If a leak is detected, repair before adding additional hydraulic fluid. If there are no leaks detected, fill the hydraulic tank to the FULL mark on the fluid level dipstick (see Illustration 22-16).

15. Inspect hydraulic tank fittings and hoses for leaks. Tighten connections / bolts as required.

Hydraulic Hose Assemblies and Fittings. All hydraulic hose assemblies should be checked daily for chaffing or cracking. Check daily to ensure that there are no loose fittings on the hydraulic connections.

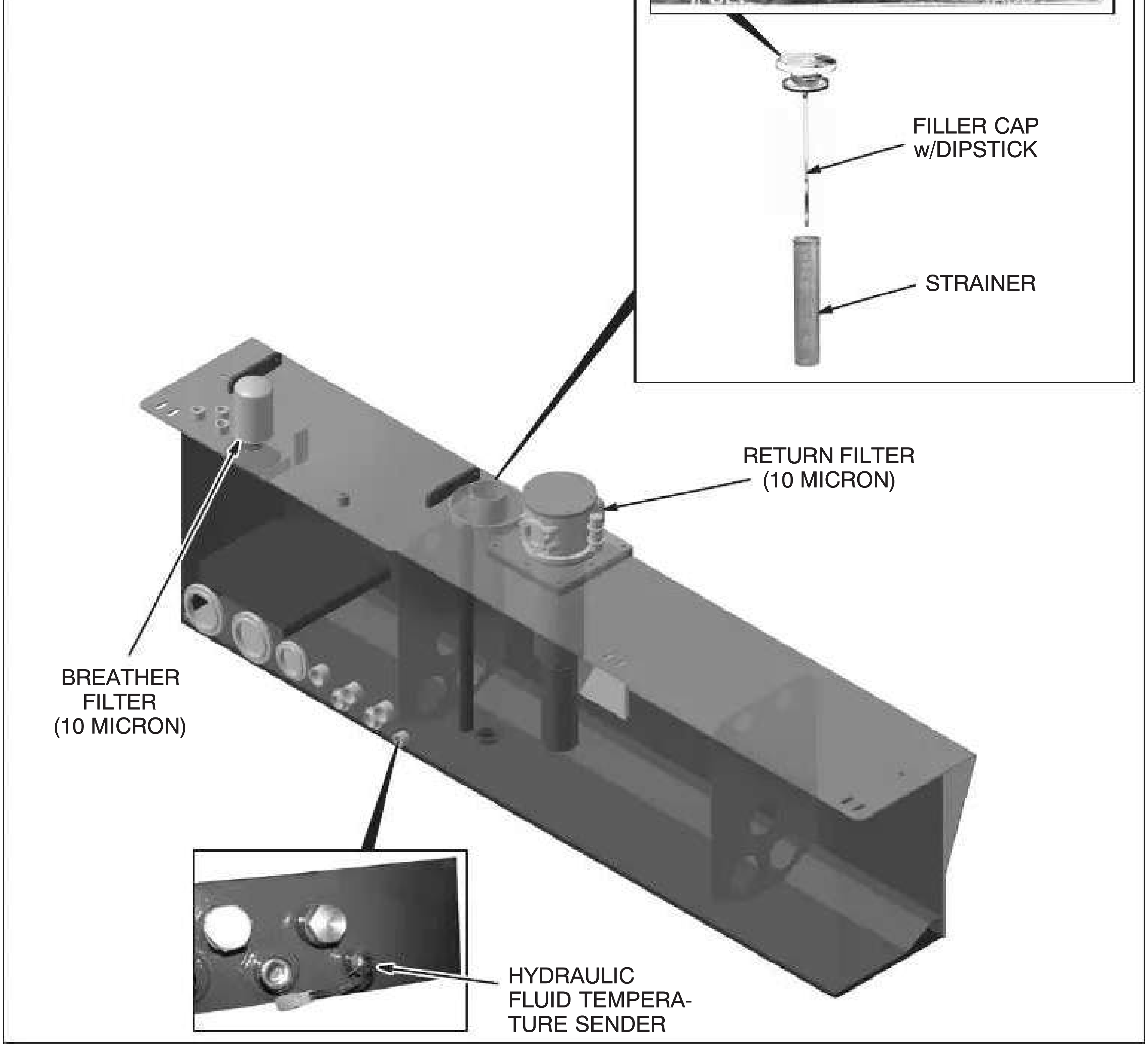
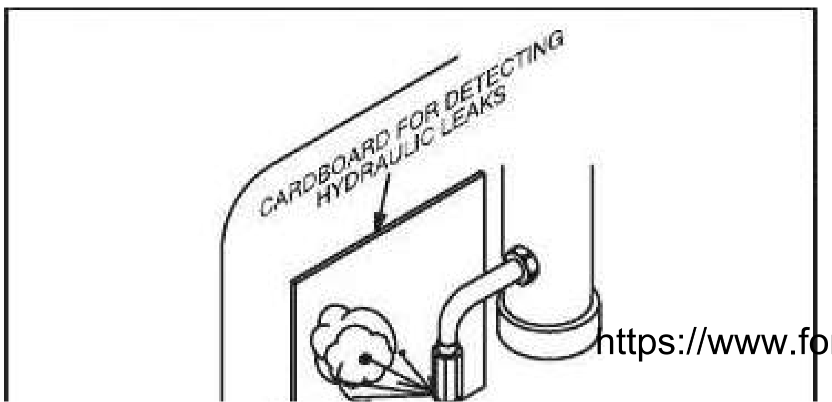
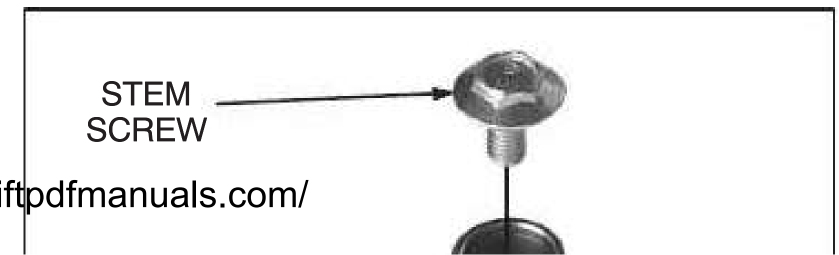


Illustration 22-16. Hydraulic Tank



truck with the manual lowering valve open. Close valve before attempting to raise the carriage.



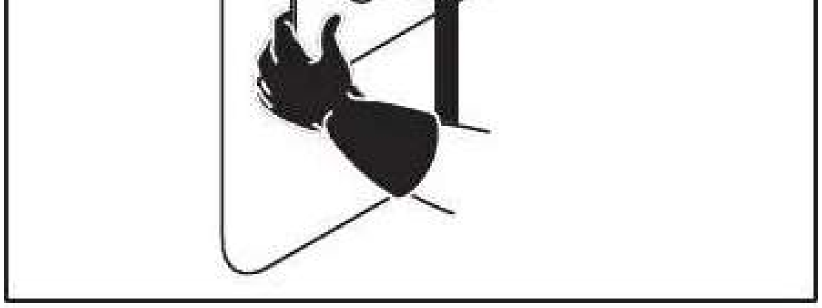


Illustration 22-17. Detecting Hydraulic Leaks

WARNING: *Do Not* use hands to check for hydraulic leaks. Because the hydraulic system is under high pressure, leaks could develop that can not be seen, but will penetrate the skin and possibly cause other serious injuries. When checking for hydraulic leaks, wear heavy gloves and safety goggles, and use a piece of cardboard or wood to find leaks (See Illustration 22-17).

Manual Lowering Valve Operation

The manual lowering valve should only be opened when normal lowering methods cannot be performed.

WARNING: Death or serious injury could result from being crushed. Do not allow anyone near the lift truck - certainly not walking, standing under, or beside the load or lifting mechanism.

WARNING: Death or serious injury could result from a runaway truck. Apply the parking brake, block the wheels in both directions to prevent movement of the truck and Lock Out & Tag Out the truck.

WARNING: Death or serious injury could result from being crushed. Do not operate the

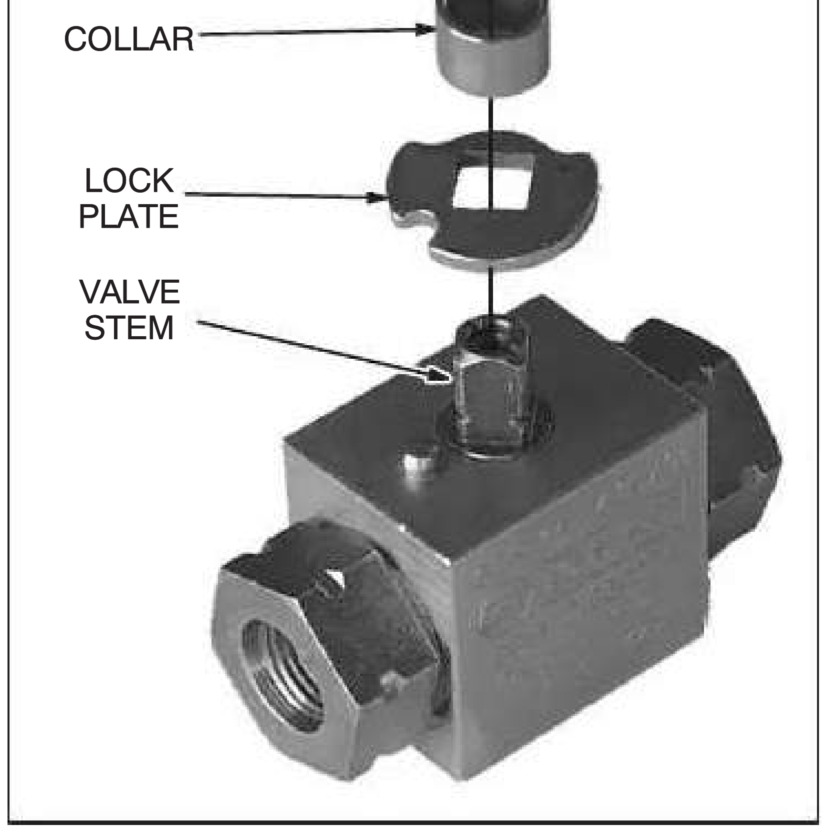


Illustration 22-18. Manual Lowering Valve

Opening The Manual Lowering Valve (Illustration 22-18). Perform the following procedures to open the manual lowering valve:

1. Remove the stem screw and collar.
2. Remove the lock plate.
3. Make sure no one is under / near the mast, carriage, or load lifting mechanism.
4. Turn the valve stem counterclockwise 1/4 turn until the notches on top of the valve stem align with the hydraulic fittings of the valve block (note position of valve stem in Illustration 22-19).

***NOTE:** The only way to stop the lowering of the load is by closing the manual lowering valve.*

5. After the load has been fully lowered, close

the manual lowering valve (refer to Closing The Manual Lowering Valve).

Closing The Manual Lowering Valve (Illustration 22-18). The manual lowering valve must be closed and locked before operating the lift truck. Perform the following procedures to close the manual lowering valve:

1. Turn the valve stem clockwise 1/4 turn until the notches, located on top of the valve stem, point toward the sides of the valve block (note

when setting pressures, allow any portion of your body to be positioned in front of the relief. It is possible that the relief could be blown loose with great force which could cause severe bodily injury or death.

WARNING: Fluid passing over a relief generates heat; should a relief be blown loose, hot, pressurized fluid will be forced from the open port. This could cause severe bodily

point toward the sides of the valve block (note position of valve stem in Illustration 22-19).

2. Install the lock plate over the valve stem. Ensure that the notch of the lock plate is secured by the stud on the valve block (see Illustration 22-19).
3. Install collar over valve stem.
4. Install stem screw and tighten.

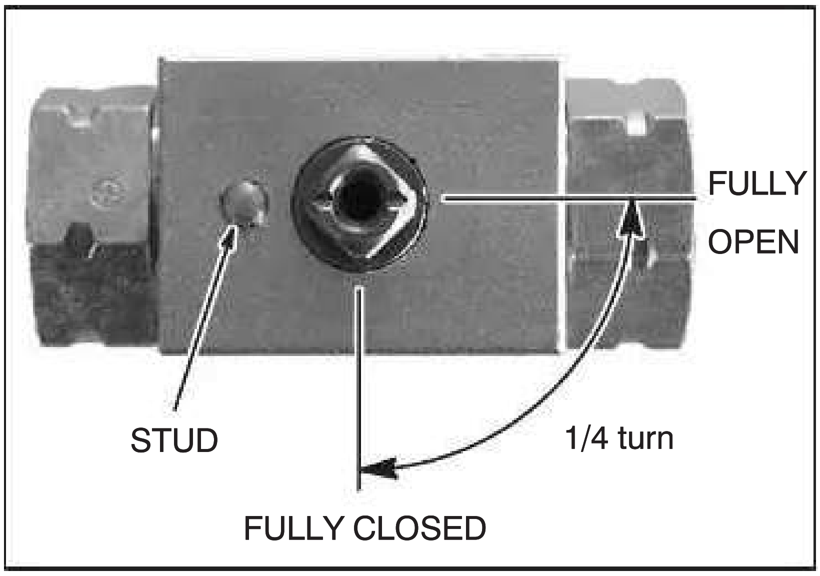


Illustration 22-19. Closing and Opening The Lowering Valve

Setting Hydraulic Pressures

Hydraulic pressures must be set at recommended engine speed. The hydraulic fluid should be at operating temperature before adjusting hydraulic pressures.

WARNING: Death or serious injury could result from a runaway truck. Park the truck on a hard, level surface, apply the parking brake and block the wheels in both directions to prevent movement of the truck.

WARNING: Under no circumstances,

open port. This could cause severe bodily injury.

Prior to setting any hydraulic pressures, these procedures must be performed first:

1. Park the truck on a hard, level surface.
2. Apply the parking brake.
3. Block the wheels in both direction to prevent movement of the truck.

Steering (Illustration 22-20)

1. Install an operate pressure gauge into the pressure check at port (LSM).
2. Ensure the tire pivot area and engine compart is clear.
3. Start the truck. Steer and dead-head the steer cylinder.
4. Observe the pressure gauge. The gauge indications should be as specified in the **HYDRAULIC PRESSURE SETTINGS** chart in the **Appendices**. If not, perform the remaining procedure to set the steer pressure.
5. Loosen the jam nut on RV2. Turn the set screw clockwise to increase the pressure or counterclockwise to decrease the pressure.
6. When the specified pressure has been achieved, tighten the jam nut.

Lift and Tilt Back (RV1) (Illustration 22-20)

1. Install an operate pressure gauge into the pressure check at port (HPC1).
2. Start the truck. Tilt back and dead-head the tilt cylinders.
3. Observe the pressure gauge. The gauge indications should be as specified in the **HYDRAULIC PRESSURE SETTINGS** chart in the **Appendices**. If not, perform the remaining procedures to set the pressure of RV1.
4. Turn the engine off. Loosen the jam nut on

the main relief valve located in the inlet section of the accessory valve (if equipped). Turn the set screw 1/4 quarter turn clockwise to increase the pressure setting of this relief.

NOTE: The main relief in the inlet section of the accessory valve is in parallel with RV1.

5. Loosen the jam nut on RV1 (relief valve located in the manifold).

2. Start the truck. Side shift in either direction and dead-head the cylinder.
3. Observe the pressure gauge. The gauge indications should be as specified in the **HYDRAULIC PRESSURE SETTINGS** chart in the **Appendices**. If not, perform the remaining procedures to set the pressure of the accessory main relief.
4. Turn the engine off. Loosen the jam nut on

6. Turn the set screw clockwise to increase the pressure or counterclockwise to decrease the pressure.
7. When the specified pressure has been acheived, tighten the jam nut.
8. Turn the set screw of the main relief in the inlet section of the accessory valve 1/4 turn counterclockwise to return this relief to it's correct setting (reverse of procedure 4.).
9. Remove the pressure gauge installed in procedure 1.

Tilt Out (Illustration 22-20)

1. Install an operate pressure gauge into the pressure check at port (HPC1).
2. Start the truck. Tilt out and dead-head the tilt cylinders.
3. Observe the pressure gauge. The gauge indications should be as specified in the **HYDRAULIC PRESSURE SETTINGS** chart in the **Appendices**. If not, perform the remaining procedures to set the pressure of the port relief located on the A port side of the tilt valve.
4. Turn the engine off. Loosen the jam nut on the port relief located on the A port side of the tilt valve.
5. Turn the set screw clockwise to increase the pressure or counterclockwise to decrease the pressure.
6. When the specified pressure has been achieved, tighten the jam nut.

Accessory Main Relief (Illustration 22-20)

The port reliefs of the side shift and fork positioners work sections are factory set and non-adjustable.

1. Install an operate pressure gauge into the pressure check at port (HPC2).

the port relief located on the A port side of the inlet section of the accessory valve.

5. Turn the set screw clockwise to increase the pressure or counterclockwise to decrease the pressure.
6. When the specified pressure has been achieved, tighten the jam nut.

Side Shift and Fork Positioners Port Reliefs (Illustration 22-20)**.** The port reliefs of the side shift and fork positioners work sections are factory set and non-adjustable.

Hydraulic System Troubleshooting

Troubleshooting Common Steering Problems (Illustration 22-20)

1. Install a gauge in port HPC3. Start the engine and dead-head the steer cylinder in both directions. Refer to the **HYDRAULIC PRESSURE SETTINGS** chart in the **Appendices** for the steer pressure. The pressure should reach the specified value while dead-headed in either direction.
2. Turn the steering wheel in one direction until the steer cylinder dead-heads. The steering wheel should come to a near stop. Repeat in the other direction. If the wheel does not stop in one or the other direction while dead-heading, the most likely component failure will be the steer cylinder packing. Repack the steer cylinder.
3. Install a pressure gauge (5,000 psi / 345 bar) into pressure check (HPC3) of the manifold. Tilt back and dead–head the tilt cylinders. At high and low engine rpm, observe the pressure gauge. Refer to **HYDRAULIC PRESSURE SETTINGS** chart in the **Appendices** for specified pressure. This check indicates that the main pump and the main relief (RV1) is operating correctly.

4. With the tilt cylinders dead-headed back, attempt to steer the machine. If able to steer, the most probable failed component is logic control (LC3). Replace LC3.
5. If replacement of LC3 did not correct the problem, replace logic control (LC2).
6. If replacement of LC2 did not correct the problem, replace Steer Relief (RV2).
7. If steering is not restored at this point, replace

not faulty, install a 3,000 psi (207 bar) pressure gauge into port HPC5. The gauge indications should be approximately what is displayed by the TICS module.

4. If the pressure indicated is pulsating, then there is a leak in the brake circuit. The pulsation of pressure is caused by the unloader valve (UNL1) and the logic control (LC1) cycling on and off, charging the brake circuit.
5. Shut the truck off and turn the ignition switch

the orbitrol.

Troubleshooting Common Brake Problems. Should brake pressure drop below 1,500 psi (104 bar), a warning will be generated by the TICS. Should the brake pressure continue to drop at 1,000 psi (69 bar), the parking brake will automatically apply. The parking brake is spring-applied and hydraulic pressure to release (1,250 psi / 86 bar minimum).

1. Start the truck.
2. The Brake pressure can be obtained from the TICS module display (refer to the Transmission Measure Group list illustration of **TICS** in **Section 6**).
3. To ensure the pressure transducer, which communicates brake pressure to the TICS, is
5. Shut the truck off and turn the ignition switch to it's ignition position (1st click). Continue to monitor the brake pressure from the TICS module display.

WARNING: Death or serious injury could result from removal of a component under pressure. The brake circuits store pressure after the engine has been shut down. Always bleed the brake pressure to 0 psi prior to removal of any brake component.

6. Shut off the engine. Turn the ignition switch to it's ignition position (1st click). Bleed the brake pressure to zero by repeatedly depressing one of the service brake pedals and monitoring the brake pressure at the TICS module display.

Problem	Cause	Correction
1. No Lift / Lower / Tilt in / Tilt out	1. Operator is not seated in the operators seat.	1. Return to the operators seat.
	2. Low pilot pressure.	2. Isolate and repair.
	3. No hydraulic fluid flow.	3. Isolate and repair.
	4. Incorrect pressure setting of the main relief (RV1).	4. Adjust.
	5. Defective main relief (RV1).	5. Replace.
	6. Incorrect pressure setting of the accessory valve's main relief.	6. Adjust.
	7. Defective accessory valve's main relief.	7. Replace.
	8. Defective Logic Control (LC3).	8. Replace.
	9. Defective main pump.	9. Replace.
continued		

Problem	Cause	Correction
1. No Lift / Lower / Tilt in / Tilt out (Continued)	10. Loose or broken plugs / pins / wires between the TICS components (i.e. display / modules / joystick / solenoids).	10. Isolate and repair.
2. Slow or No Lift /	1. Operator not is seated in the oper-	1. Return to the operators seat.

Lower	ators seat. 2. Defective solenoid or cartridge on the lift valve. 3. Lift valve's main spool is stuck. 4. Centering spring(s) of the lift valve's main spool is broken. 5. Defective packing in one of the lift cylinders. 6. Defective flow control in one of the lift cylinders. 7. TICS (Taylor Integrated Control System) LIFT operation is mis-calibrated. 8. Loose or broken plugs / pins / wires between the TICS components (i.e. display / modules / joystick / solenoids). 9. Inner mast or carriage is shimmed too tight.	2. Activation of the manual override switch will confirm defective solenoid. Replace. 3. Remove main spool, clean and re-assemble. Inspect valve housing for debris. 4. Replace. 5. Isolate cylinder and replace the packing. 6. Replace. 7. Calibrate. 8. Isolate and repair 9. Refer to **Slide Bearing Blocks Shimming** in **Section 27** and properly shim the mast.
3. Slow or No Tilt Out *continued*	1. Operator not is seated in the operators seat. 2. Defective flow control in one of the Tilt cylinders 3. Tilt valve's main spool is stuck. 4. Centering spring(s) of the lift valve's main spool is broken. 5. Mis-adjusted tilt out port relief (A port).	1. Return to the operators seat. 2. Replace. 3. Remove main spool, clean and re-assemble. Inspect valve housing for debris. 4. Replace. 5. Adjust tilt out port relief

Problem	Cause	Correction
3. Slow or No Tilt Out (Continued)	6. Defective tilt out port relief. 7. Defective solenoid or cartridge on the tilt valve. 8. TICS (Taylor Integrated Control System) tilt out operation is mis-	6. Replace. 7. Activation of the manual override switch will confirm defective solenoid. Replace. 8. Calibrate.

	calibrated. 9. Loose or broken plugs / pins / wires between the TICS components (i.e. display / modules / joystick / solenoids).	9. Isolate and Repair.
4. Slow or no Tilt In	1. Operator is not seated in the operators seat. 2. Defective flow control in one of the tilt cylinders. 3. Tilt valve's main spool is stuck. 4. Centering spring(s) of the lift valve's main spool is broken. 5. Defective solenoid or cartridge on the lift valve. 6. TICS (Taylor Integrated Control System) tilt in operation is mis-calibrated. 7. Loose or broken plugs / pins / wires between the TICS components (i.e. display / modules / joystick / solenoids).	1. Return to the operators seat. 2. Replace. 3. Remove main spool, clean and re-assemble. Inspect valve housing for debris. 4. Replace. 5. Activation of the manual override switch will confirm defective solenoid. Replace. 6. Calibrate. 7. Isolate and repair.
5. No or slow steering *continued*	1. Steer cylinder piston packing is defective. 2. Logic Control (LC2) is restricted by debris (stuck closed). 3. Logic Control (LC2) is defective. 4. Logic Control (LC3) is restricted by debris (stuck open). 5. Logic Control (LC3) is defective.	1. Re-pack steer cylinder. 2. Remove and clean LC2. Inspect LC2's port for debris. 3. Replace. 4. Remove and clean LC3. Inspect LC3's port for debris. 5. Replace.

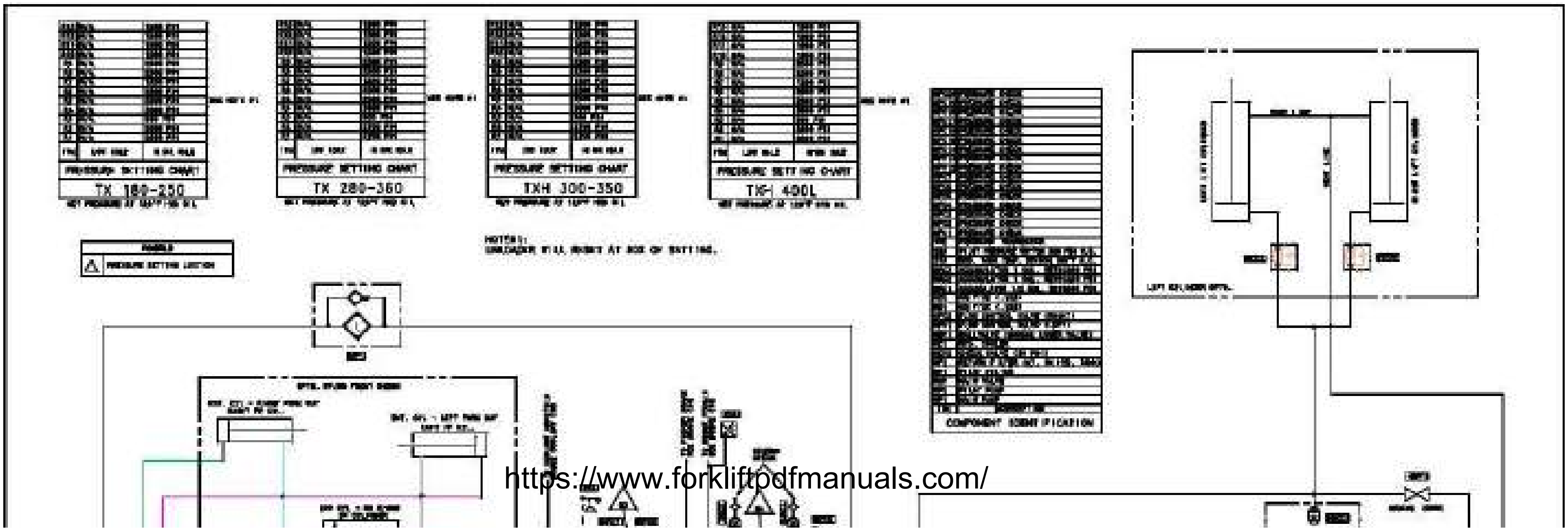
Problem	Cause	Correction
5. No or slow steering (Continued)	6. Steer Relief (RV2) is restricted by debris (stuck open). 7. Steer Relief (RV2) is defective. 8. Main relief (RV1) is restricted by debris (stuck open) 9. Main relief (RV1) is defective.	6. Remove and clean RV2. Inspect RV2's port for debris. 7. Replace. 8. Remove and clean RV1. Inspect RV1's port for debris. 9. Replace.

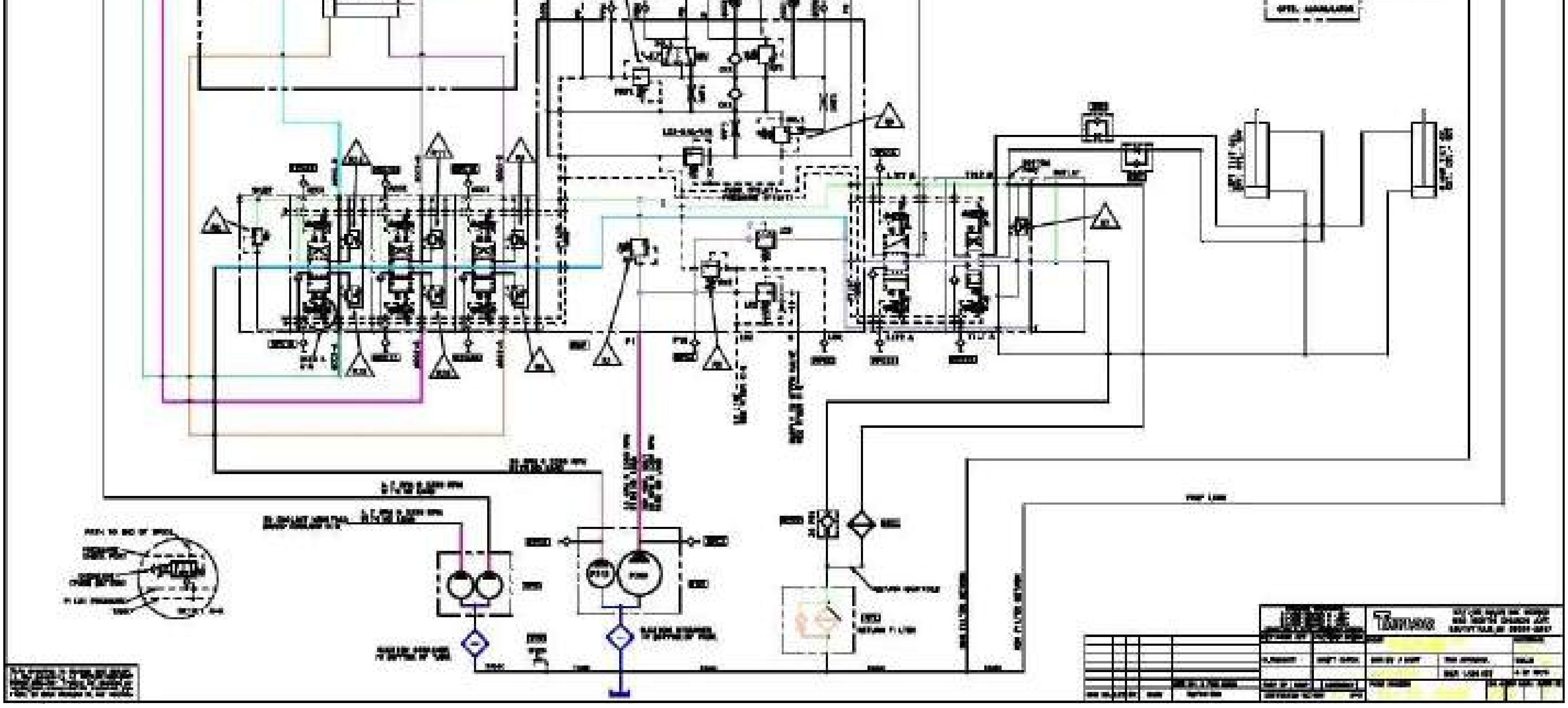
	9. Main relief (RV1) is defective. 10. Worn or defective pump. 11. Defective orbitrol.	9. Replace. 10. Replace. 11. Replace.
6. No or weak service brakes	1. Logic Control (LC1) is restricted by debris (stuck open). 2. Logic Control (LC1) is defective. 3. Unloader valve (UNL1) is restricted by debris (stuck open). 4. Unloader valve (UNL1) is defective. 5. Thermo relief (RV3) is restricted by debris (stuck open) 6. Thermo relief (RV3) is defective. 7. The service brake accumulator has lost it's pre-charge. 8. The service brake accumulator is defective. 9. Defective service brake pedal. 10. Debris is in the internal passages of the manifold. 11. Cracked manifold. 12. Refer also to Problem 1. of the **Brake Control System Trouble-shooting** chart in **Section 15**.	1. Remove and clean LC1. Inspect LC1's port for debris. 2. Replace. 3. Remove and clean UNL1. Inspect UNL1's port for debris. 4. Replace. 5. Remove and clean RV3. Inspect RV3's port for debris. 6. Replace. 7. Charge the service brake accumu-lator to 1,250 psi with dry-nitrogen. 8. Replace. 9. Replace. 10. Clean. If cleaning does not resolve the problem, replace the manifold. 11. Replace.
7. Parking brakes will not release *continued*	1. Logic Control (LC1) is defective. 2. Unloader valve (UNL1) is restricted by debris (stuck open). 3. Unloader valve (UNL1) is defective.	1. Remove and clean LC1. Inspect LC1's port for debris. 2. Replace. 3. Remove and clean UNL1. Inspect UNL1's port for debris.

Problem	Cause	Correction
7. Parking brakes will not release (Continued)	4. Thermo relief (RV3) is restricted by debris (stuck open). 5. Thermo relief (RV3) is defective. 6. The service brake accumulator has lost it's pre-charge.	4. Replace. 5. Remove and clean RV3. Inspect RV3's port for debris. 6. Replace.

	7. The parking brake accumulator is defective.	7. Charge the parking brake accumulator to 500 psi with dry-nitrogen.
	8. Defective service brake pedal.	8. Isolate and replace.
	9. Parking brake solenoid is energized.	9. Defective park brake switch. Replace.
	10. Defective parking brake solenoid.	10. Replace.
	11. Defective parking brake chamber.	11. Replace.
	12. Debris is in the internal passages of the manifold.	12. Clean. If cleaning does not resolve the problem, replace the manifold.
	13. Cracked manifold.	13. Replace.
	14. Refer also to Problem 5. of the **Brake Control System Trouble-shooting** chart in **Section 15**.	

PLACE THE FOLLOWING ILLUSTRATION IN
A FOLDER ENVELOPE:
Illustration 22-20 - 22-2896 SHT. 2 (Main Hyd. ANSI)





22E-Accumulator

Accumulator

Introduction. The accumulator acts as a shock absorber in the hydraulic system. When the driven member of the hydraulic system stops suddenly, it creates a pressure wave that travels back through the system. This shock wave can develop peak pressures several times greater than normal working pressures and can be the source of system failure. The gas cushion in an accumulator will minimize this shock, protecting expensive hydraulic components.

Accumulators. There are two accumulators connected to the manifold valve. They store a volume of oil at pressure for brake application. These accumulators are hydro-pneumatic piston type and are precharged with dry nitrogen to 1,250 psi (86 bar) and 500 psi (35 bar).

Checking Precharge. The precharge check should be performed periodically (refer to the **Preventive Maintenance** chart in the **Appendices** for precharge check interval). Follow the procedures listed below to check precharge (a charging kit is available from Taylor, part number 1000-503). See Illustration 22E-1 for charging kit.

1. To read and adjust the gas pressure or "precharge" pressure, all the hydraulic fluid must be drained from the fluid side of the accumulator to zero hydraulic pressure. To accomplish this, let the lift cylinder down and hold lever in DOWN position for approximately one minute.
2. Remove the valve guard and cap from the accumulator.
3. Ensure that the shaft of the air chuck (4) is fully retracted by turning the bar handle counterclockwise until it stops.
4. Do not have the charging hose (8) connected

Charging The Accumulator (Illustration 22E-1)**.** Perform the following procedures to charge the accumulator.

CAUTIONS:

- **Use only dry nitrogen to charge the accumulator.**
- **When precharging, the initial 50 psi (3.5 bar) of dry nitrogen should be introduced slowly into the accumulator.**

1. Install the charging kit (Illustration 22E-1) as explained in the **Checking Precharge** procedures above.
2. Connect the charging kit to a nitrogen bottle with the charging hose (8).
3. Inflate the accumulator to the predetermined pressure by opening the valve on the nitrogen bottle slowly, closing it occasionally to allow the needle of the pressure gauge (2) to settle into position giving an accurate pressure reading.
4. When the proper precharge pressure is reached, close the valve on the nitrogen bottle.
5. To release pressure in excess of the desired precharge, slowly open the bleeder valve (6) until the pressure drops to the desired level.
6. Rotate the bar handle counterclockwise to the full stop position, then disconnect the swivel (7) from the adapter (3).
7. Remove the air chuck (4) from the accumulator valve stem.
8. Check the valve stem for leaks with a soapy

to the gauging head assembly (1) unless free end of charging hose is plugged.

5. Mount the swivel of the air chuck (4) on the accumulator's valve stem and hand tighten to compress the gasket in the swivel to prevent gas leakage.

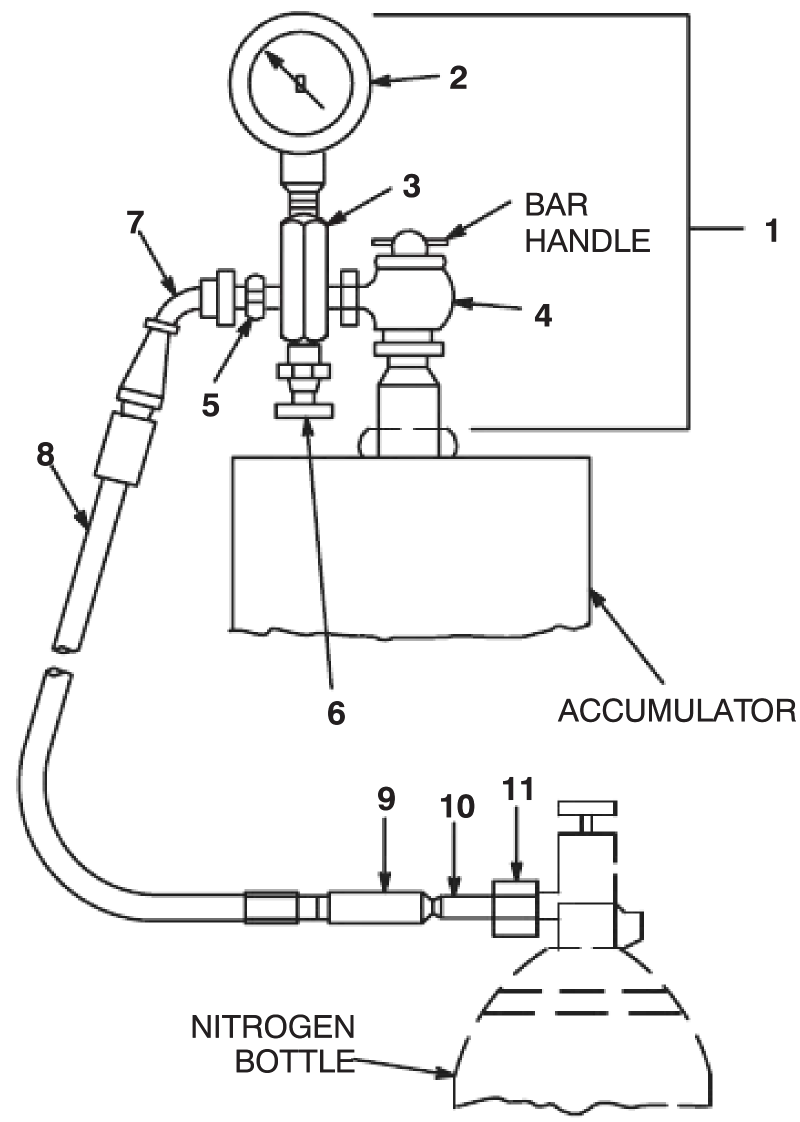
6. Turn the bar handle clockwise until the shaft depresses the valve stem core of the accumulator. The precharge pressure should now be indicated by the pressure gauge (2).

8. Check the valve stem for leaks with a soapy water solution or oil. If the core is leaking, depress it quickly, once or twice, to reseat the core. It may be necessary to further tighten or replace the core if leakage persists.

9. Install the accumulator valve stem cap, then tighten 1/2 turn beyond hand tight.

10. Install the accumulator valve guard.

11. Recheck precharge one week after charging for pressure loss.



Charging Kit

1. GAUGING HEAD ASSEMBLY
2. PRESSURE GAUGE
3. ADAPTER
4. AIR CHUCK
5. TANK VALVE ASSEMBLY

Accumulator Part Number / Size	PSI Setting	BAR Setting
2215-121 / 1 qt.	1,000 psi	69 bar
2788-970 / 1 qt.	1,000 psi	69 bar
2215-124 / 1 qt.	1,500 psi	104 bar
2788-955 / 1 qt.	1,500 psi	104 bar
2788-975 / 1 qt.	1,000 psi	69 bar
2788-940 / 1 gal.	65 psi	4.5 bar
2788-960 / 1 gal.	800 psi	55 bar
2788-949 / 1 gal.	1,250 psi	86 bar
2788-950 / 1 gal.	1,000 psi	69 bar
2788-951 / 1 gal.	1,500 psi	104 bar
2788-952 / 1 gal.	1,500 psi	104 bar
2788-961 / 1 gal.	1,500 psi	104 bar
2788-965 / 2-1/2 gal.	800 psi	55 bar
2788-966 / 2-1/2 gal.	1,500 psi	104 bar

We have a charging kit available. Taylor part number 1000-503.

5. TANK VALVE ASSEMBLY
6. BLEEDER VALVE
7. SWIVEL CONNECTOR
8. CHARGING HOSE
9. COUPLING
10. GLAND
11. GLAND NUT

Illustration 22E-1. Charging Accumulator

ULTRA-VU Mast Assembly

Introduction. The mast assembly, in conjunction with the carriage and forks, is responsible for lifting and lowering loads.

Major Components. The mast consists of the inner mast, outer mast, two hydraulic lift cylinders, main rollers, slide bearing blocks, chain rollers, and two multiple leaf lift chains.

Structural Inspection, Reporting, and Repair Procedure (Refer to **SIRR** in the **Appendices**). Follow the OSHA rules, 29 CFR, 1910.178 (Q)(1), (5), & (7) which require inspecting industrial trucks daily before being placed in service, removing trucks from service if cracks are found, and making repairs only if authorized by the manufacturer. If trucks are used on a round-the-clock basis, they shall be examined after each shift. OSHA 29 CFR 1910.178 (p)(1) requires that trucks in need of repair be taken out of service. Refer to <u>Safety Check 2nd Edition</u> for OSHA rules.

Mast Assembly Structure. This is an ULTRA-VU, nested channel type mast with two multiple leaf lift chains and two lift cylinders that are located behind the mast rails. The mast assembly is carefully engineered and ruggedly constructed, although welded steel structures always contain undetectable cracks, especially welded joints. When these joints are subject to fluctuating stresses of significant magnitude, these cracks will grow. This is known as fatigue crack growth. No matter how low the stress levels are kept, some fatigue crack growth will occur in all welded structures.

WARNING: Periodic inspection is required to detect fatigue cracks that have grown to a significant size in order to avoid serious failure of the structural weldment.

Maintenance / Inspections. There are several inspectional requirements which must be performed daily. These inspections must include checking all welds and structural members for cracks. Check all mast mounting hardware and lift chains for damage or loose bolts. Hydraulic hoses and fittings must be checked for leaks and signs of wear or damage.

WARNING: Do not climb on the mast of the forklift, on top of the cab, or on other high places of the truck while performing maintenance.

WARNING: Always use approved ladders, stands, or manlifts to reach high places on the truck.

WARNING: Never ride on the forks of the truck.

WARNING: Do not use a material handling forklift as a means to elevate personnel.

Main Rollers (Illustration 27-4)**.** The main rollers employ greaseable, shielded, tapered roller bearings. The main rollers must be greased periodically (refer to the **Preventive Maintenance** chart in the **Appendices** for inner mast main rollers lubrication interval). To access the grease fittings for the main rollers, the inner mast must be raised so that the grease fitting of each main roller aligns with the grease holes located in the outer mast. The main rollers should be inspected for flat spots or evidence of sliding any time the inner mast is taken apart from the outer mast.

serious failure of the structural weldment. When a crack is found, the truck must be immediately taken out of service and repaired.

WARNING: Under no circumstances, without prior written approval from Taylor Machine Works, Inc. Engineering Department, should the mast assembly be modified. As per OSHA 29 CFR1910.178 (a) (4).

WARNING: If the fatigue crack is allowed to grow, catastrophic failure could occur in the mast assembly or other welded components causing serious injury to personnel and / or property.

taken apart from the outer mast.

CAUTION: The roller assemblies must not be over lubricated. Excess grease inside the mast rails may cause the rollers to slide when subjected to a heavy load. If this happens, a flat spot will be worn on the rollers and the rollers will continue to slide until replaced with new rollers.

Chain Rollers (Illustration 27-4). The chain rollers use sealed ball bearings. Check the chain rollers for looseness, cracks or flat spots.

Lift Chains. The lift chains must be lubricated every 500 hours of operation (refer to **Leaf Chain**

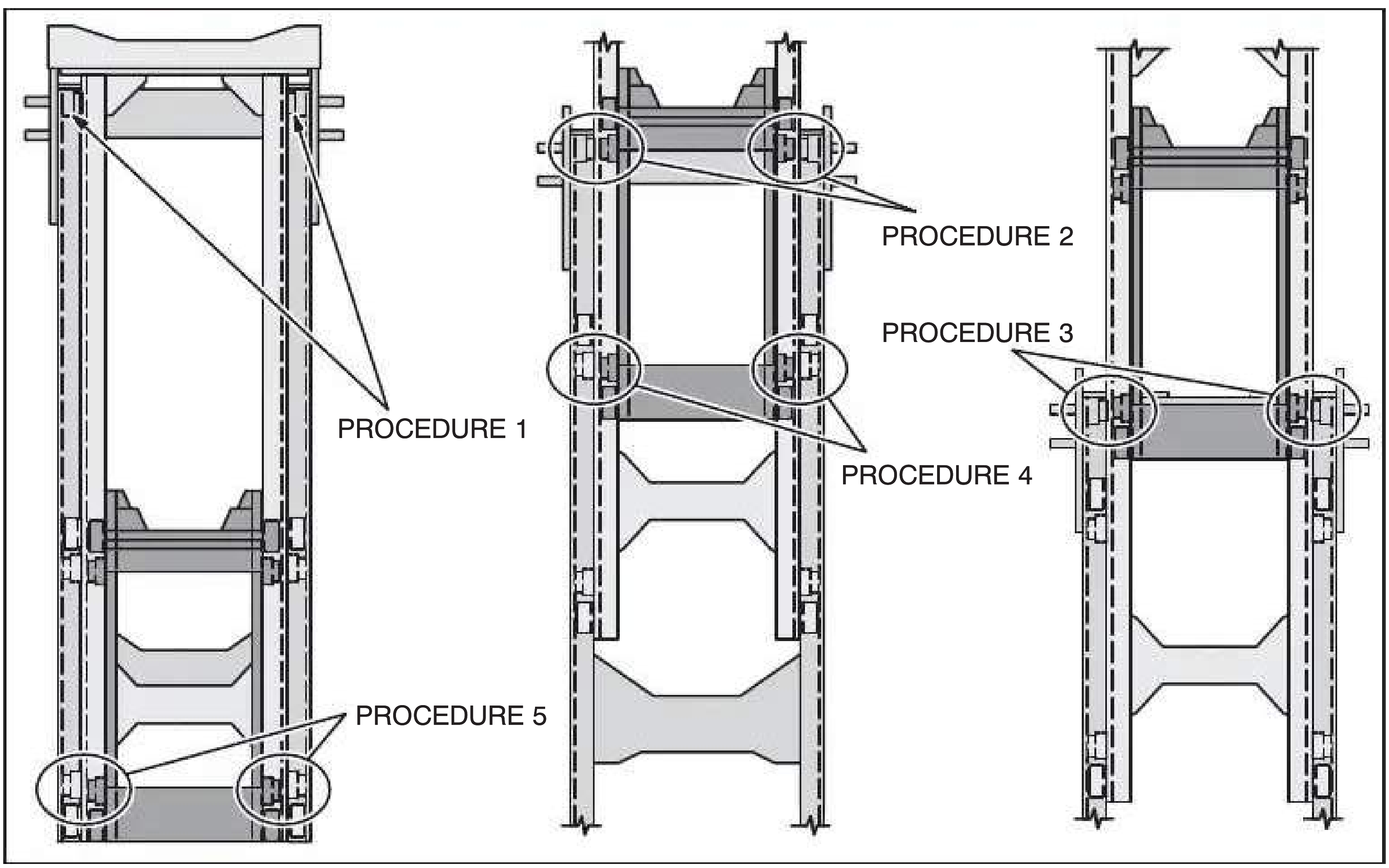


Illustration 27-1. Mast Slide Bearing Shimming Procedure

Care, Maintenance, and Replacement section in the back of this manual). Refer to the **Fuel and Lubricant Specifications** for the type of lubricant to be used to lubricate the lift chains.

Tilt Cylinder and Mast Hanger Pins. The tilt cylinder and mast hanger pins must be greased periodically (refer to the **Preventive Maintenance**

install shims in the outer mast slide bearings.

The carriage and inner mast should then be secured in position by an appropriate means or they can be lowered to a height where they can more easily be blocked in position and shimmed. Shim the outer mast until the clearance is 1/16 to 1/32 inch (1.6 to .8 mm). (See odically (refer to the **Preventive Maintenance** chart in the **Appendices** for lubrication interval).

Lubrication. Refer to the **Lubrication** section in the **Appendices** for information on the lubrication of the mast assembly.

Slide Bearing Blocks Shimming (Illustration 27-1)**.** The slide bearing block life depends on the duty cycle and operation of the truck. Periodically, the slide bearing blocks may require shimming to adjust for wear. To prevent undue flexing of the inner mast on a telescopic mast assembly, it is essential for all slide bearings to be properly shimmed. The correct procedure is outlined here. This method is to be used for fork lifts equipped with Ultra-Vu telescopic masts.

1. Raise the carriage to allow enough room to

NOTE below procedure 5.)

2. Raise the carriage until the top carriage slide bearings are aligned with the outer mast slide bearings. Pry the carriage from side to side and measure the movement. The carriage and inner mast should then be secured in position by an appropriate means or they can be lowered to a height where they can more easily be blocked in position and shimmed.

   Calculate the thickness of the shims needed by subtracting 1/32 inch (.8 mm) from the distance the carriage moved and shim the top carriage slide bearings. (See ***NOTE*** below procedure 5.)

3. Raise the carriage until the bottom carriage

slide bearings are aligned with the outer mast slide bearings. Pry the carriage from side to side and measure the movement. The carriage and inner mast should then be secured in position by an appropriate means or they can be lowered to a height where they can more easily be blocked in position and shimmed. Calculate the thickness of the shims needed by subtracting 1/32 inch (.8 mm) from the distance the carriage moved and shim the bottom carriage slide bearings. (See ***NOTE*** below procedure 5.)

4. Align the bottom carriage slide bearings and the inner mast top slide bearings. Pry the inner mast from side to side (this must be done from the rear of the mast) and measure the movement. Calculate the thickness of the shims needed by subtracting 1/32 inch (.8 mm) from the distance the inner mast moved. Raise the carriage to allow access to the inner mast top slide bearings. The carriage and inner mast should then be secured in position by supporting with an appropriate means. (See ***NOTE*** below procedure 5.)

5. Align the bottom carriage slide bearings and the inner mast bottom slide bearings. Pry the inner mast from side to side (this must be done from the rear of the mast) and measure the movement. Calculate the thickness of the shims needed by subtracting 1/32 inch (.8 mm) from the distance the inner mast moved. Raise the carriage to allow access to the inner mast bottom slide bearings. The carriage and inner mast should then be secured in position by supporting with an appropriate means. (See ***NOTE*** below)

CAUTION: Do *Not* attempt to eliminate inner mast slide bearing slack in procedures 4. and 5. by adding shims to the carriage slide bearings. This can result in broken slide bearings.

Back Rest Slide Blocks (Illustration 27-2)**.** The back rest slide block life depends on the duty cycle and operation of the truck. Periodically, the back rest slide blocks may require shimming to adjust for wear. Perform the following procedures to shim the back rest slide blocks:

1. Raise the carriage and note the position of the inner mast when the distance between it and the back rest slide block is the least amount.

   Shims should be added at this position.
2. Shim the back rest slide blocks until the slide blocks just touch the inner mast.

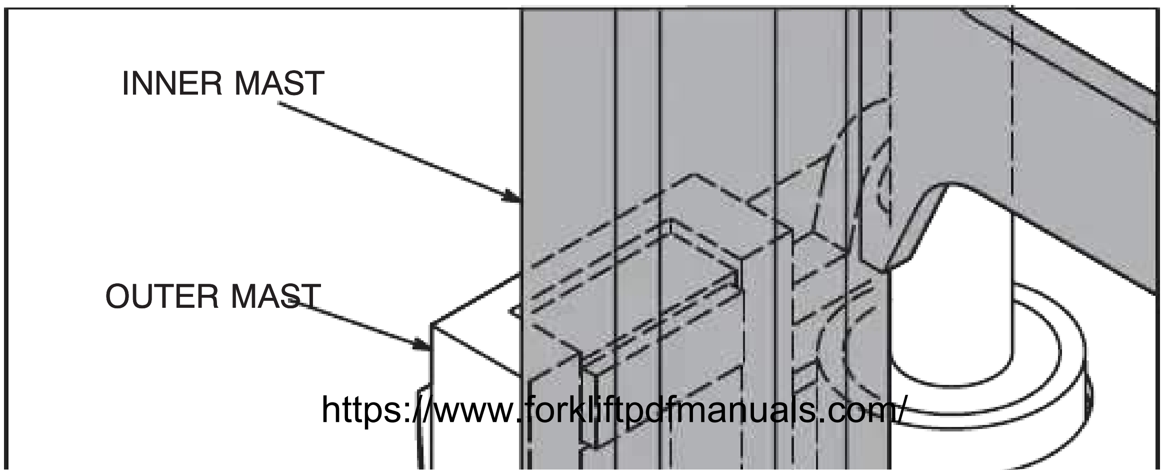
NOTE: *Replace any back rest slide blocks that become cracked, damaged or worn to 3/4 inch (19.1 mm) thickness.*

NOTES:

- *Clearance at each position should be between 1/16 inch (1.6 mm) and 1/32 inch (.8 mm). Repeat the above procedure if the clearance is not as specified. Shims should be divided as evenly as possible between the slide bearings.*
- *Replace any slide bearing blocks that become cracked, damaged, or worn to 1 - 3/4 inches (44.5 mm) thickness (See Illustration 27-3).*

Troubleshooting

Problem	Cause	Correction
1. Cracks in welds, especially at the point where the mast is pinned to the chassis. (Refer to **SIRR** in the **Appendices**) **Notify Taylor Machine Works, Inc. for proper repair procedures.**	1. Metal fatigue.	1. Have cracks in welds repaired immediately.
	2. Overloading.	2. Refer to Correction 1. and avoid overloading the truck.
	3. Rough terrain.	3. Refer to Correction 1. and, if possible, avoid operating truck on rough terrain.
	4. Travelling with load in an unrecommended travel position (excessive height and / or fully side-shifted, one side or the other).	4. Refer to Correction 1. and the Operator's Guide for proper travelling positions.
	5. Severe duty cycles.	5. Refer to Correction 1.



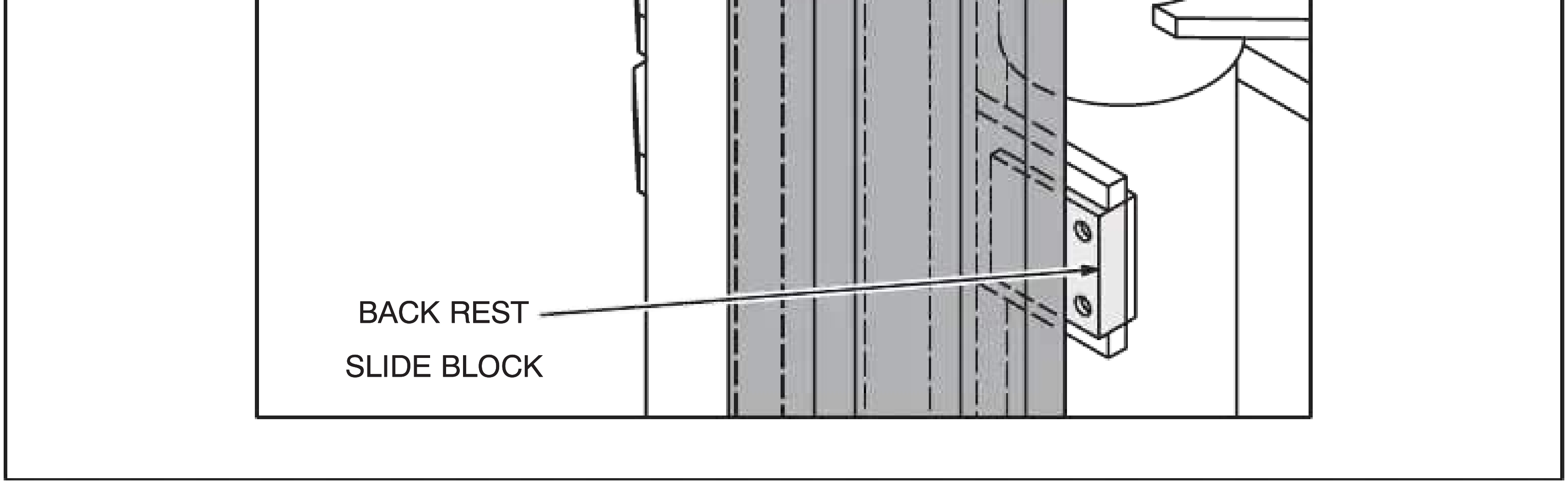


Illustration 27-2. Back Rest Slide Blocks

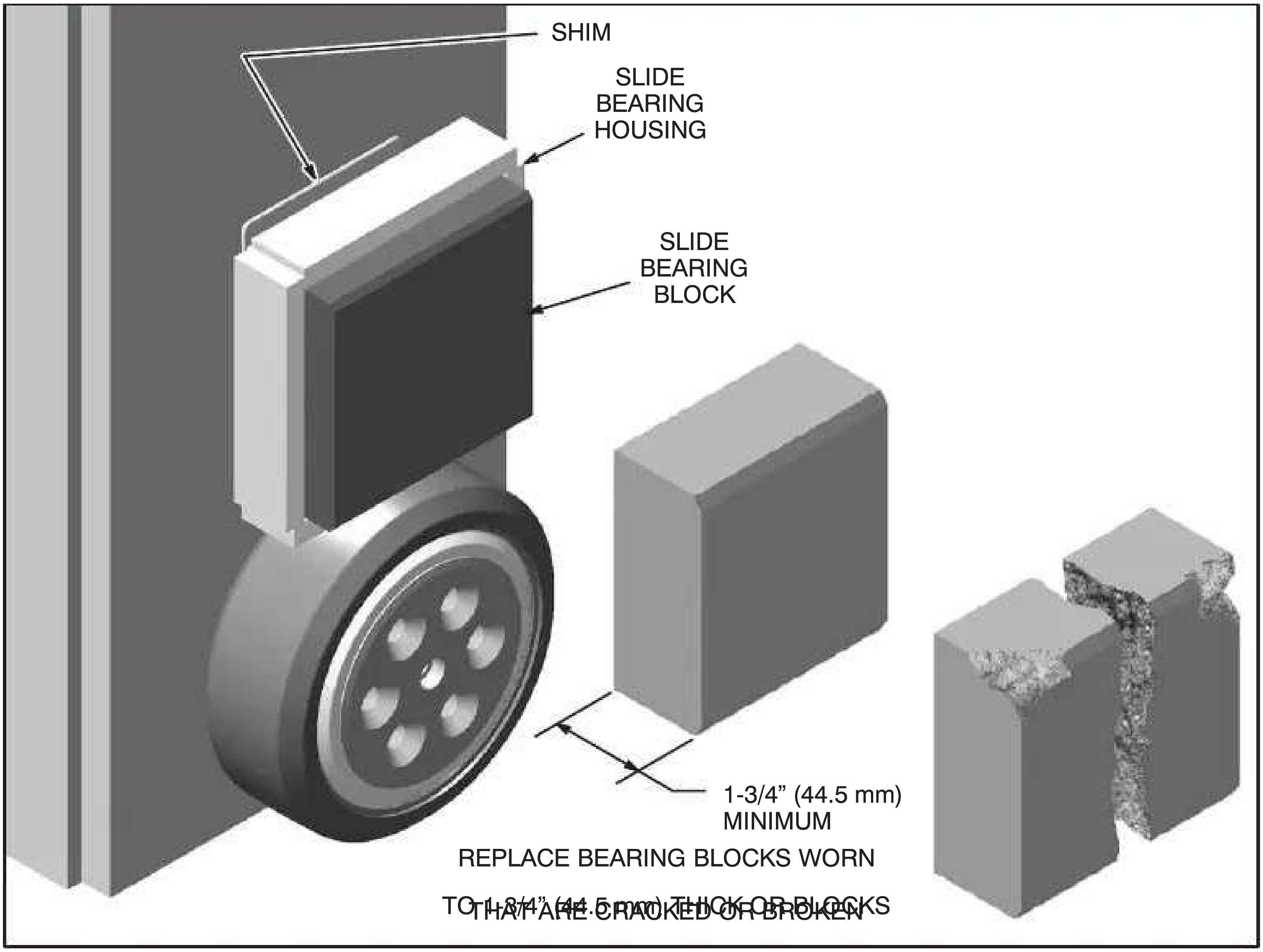
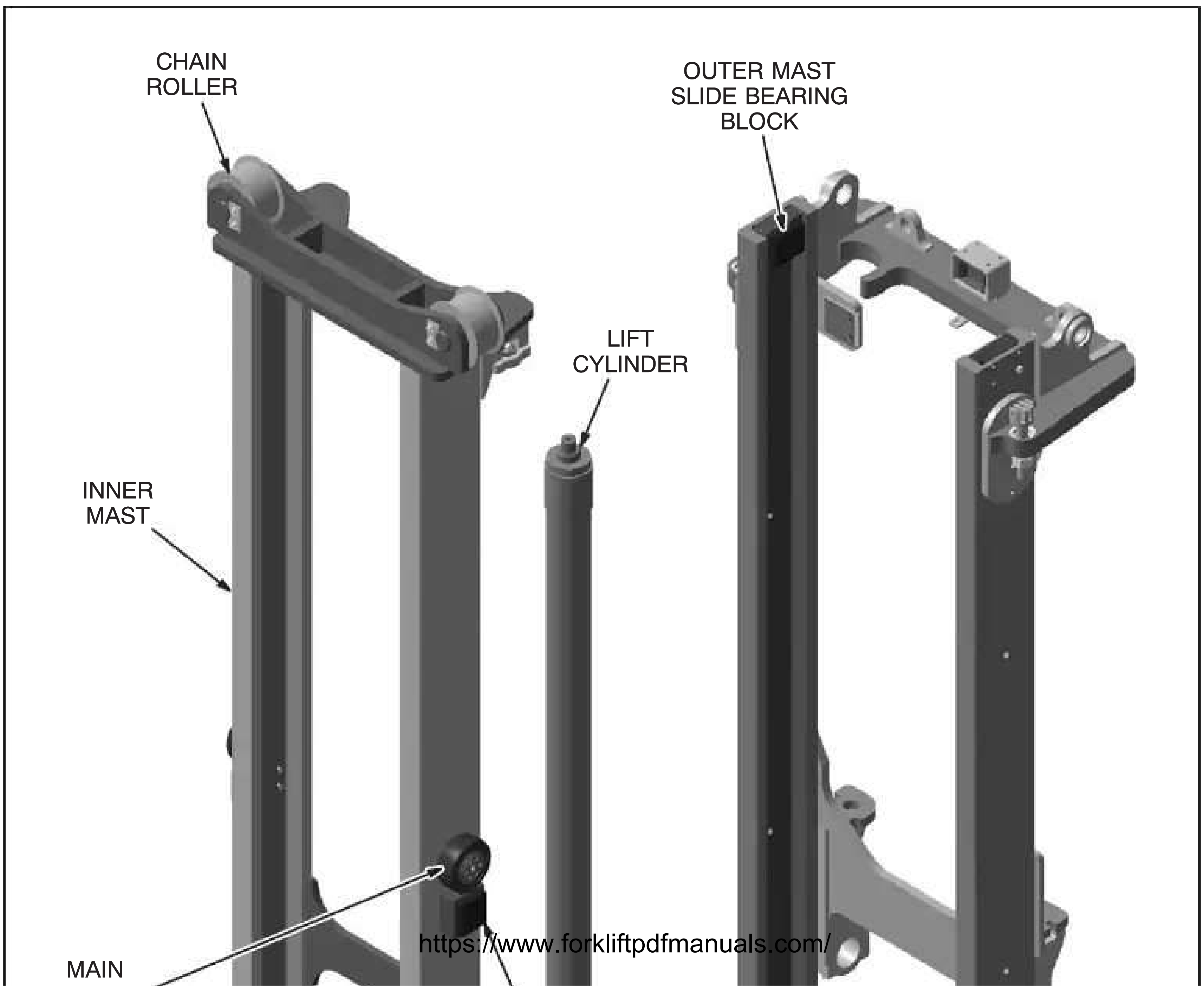


Illustration 27-3. Slide Bearing Block Replacement


CHAIN
ROLLER
OUTER MAST
SLIDE BEARING
BLOCK
LIFT
CYLINDER
INNER
MAST
MAIN

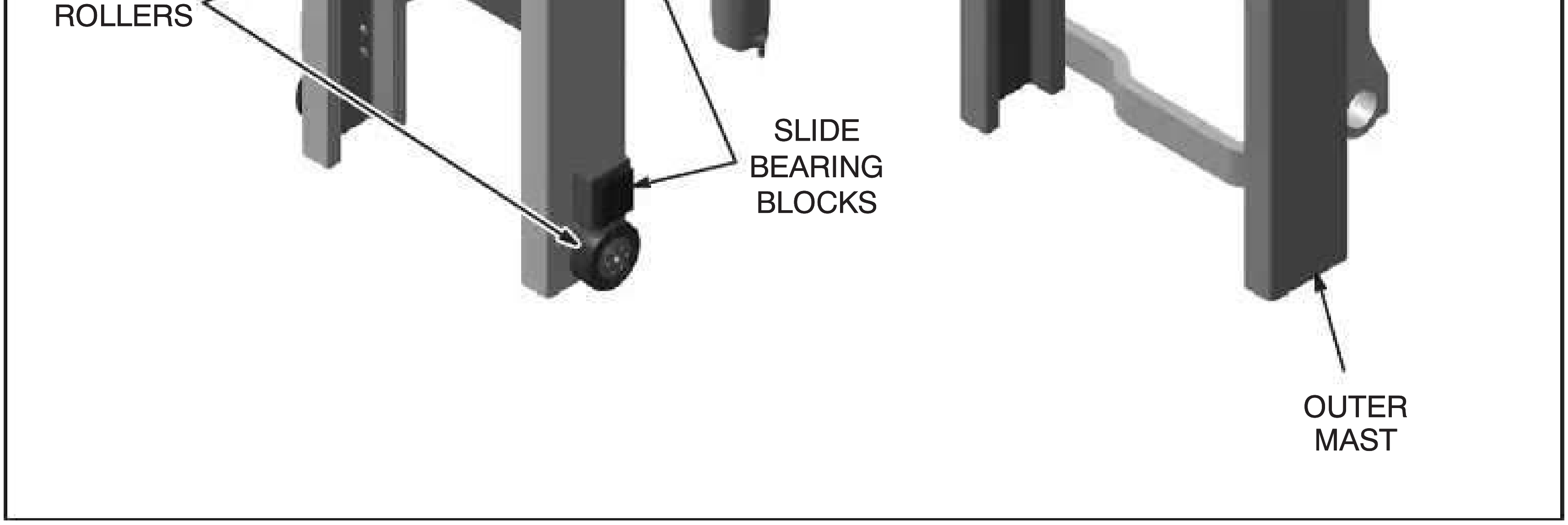
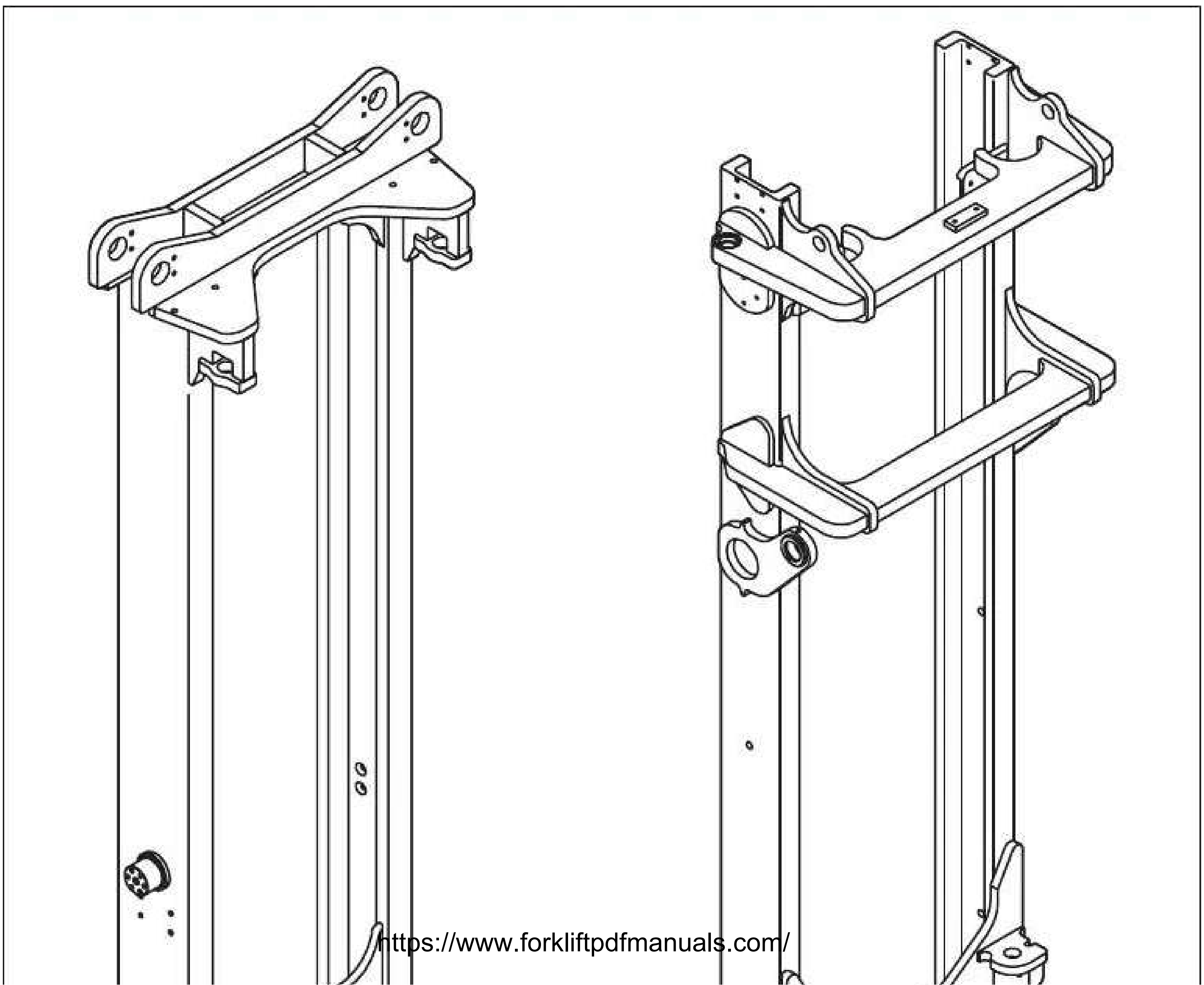
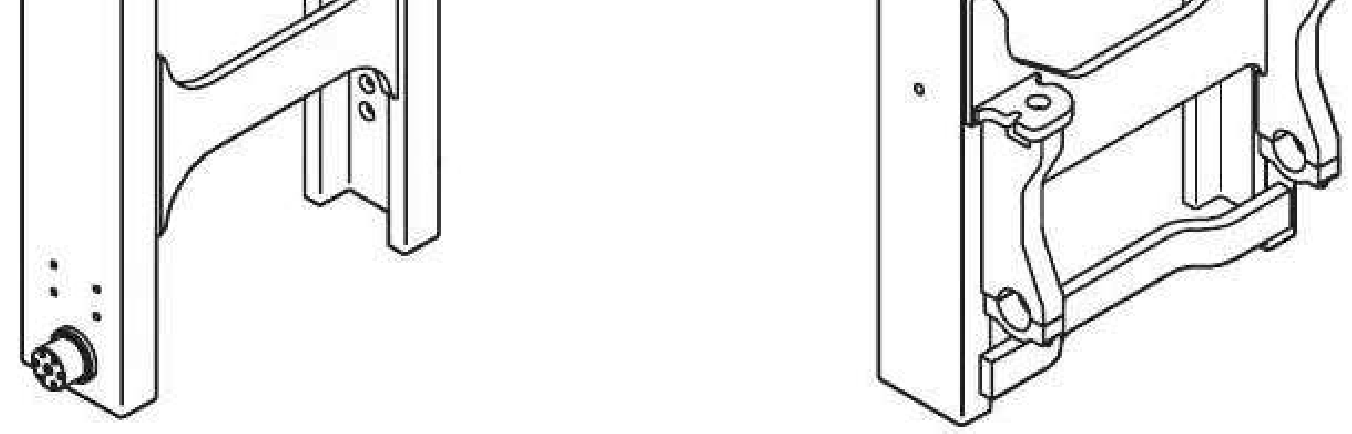


Illustration 27-4. Mast Assembly Components





Note: Photocopy this sketch to identify fatigue cracks or structural damage to the mast. Be very descriptive of damage to the mast, i.e. location, depth, length.

Illustration 27-7. Mast Assembly

Carriage

Introduction. Described in this section is the maintenance required for the standard "C" carriage, optional fork positioning, and optional side shift carriage.

NOTE: *Some trucks may be equipped with both fork positioning and side shifting capabilities.*

Major Components. The carriage consists of two forks, fork pin, main rollers, slide bearing blocks, and two fork positioner cylinders / side shift cylinder (if equipped).

Structural Inspection, Reporting, and Repair Procedure (Refer to **SIRR** in the **Appendices**). Follow the OSHA rules, 29 CFR, 1910.178 (Q)(1), (5), & (7) which require inspecting industrial trucks daily before being placed in service, removing trucks from service if cracks are found, and making repairs only if authorized by the manufacturer. If trucks are used on a round-the-clock basis, they shall be examined after each shift. OSHA 29 CFR 1910.178 (p)(1) requires that trucks in need of repair be taken out of service. Refer to the Safety Check 2nd Edition for OSHA rules.

WARNING: Periodic inspection is required to detect fatigue cracks that have grown to a significant size in order to avoid serious failure of the structural weldment. When a crack is found, the truck must be immediately taken out of service and repaired.

WARNING: Under no circumstances, without prior written approval from Taylor Machine Works, Inc. Engineering Department, should the carriage assembly be modified. As per OSHA 29 CFR1910.178 (a) (4).

WARNING: If the fatigue crack is allowed to grow, catastrophic failure could occur in the mast assembly or other welded components causing serious injury to personnel and / or property.

Illustration 28-1. Standard Carriage

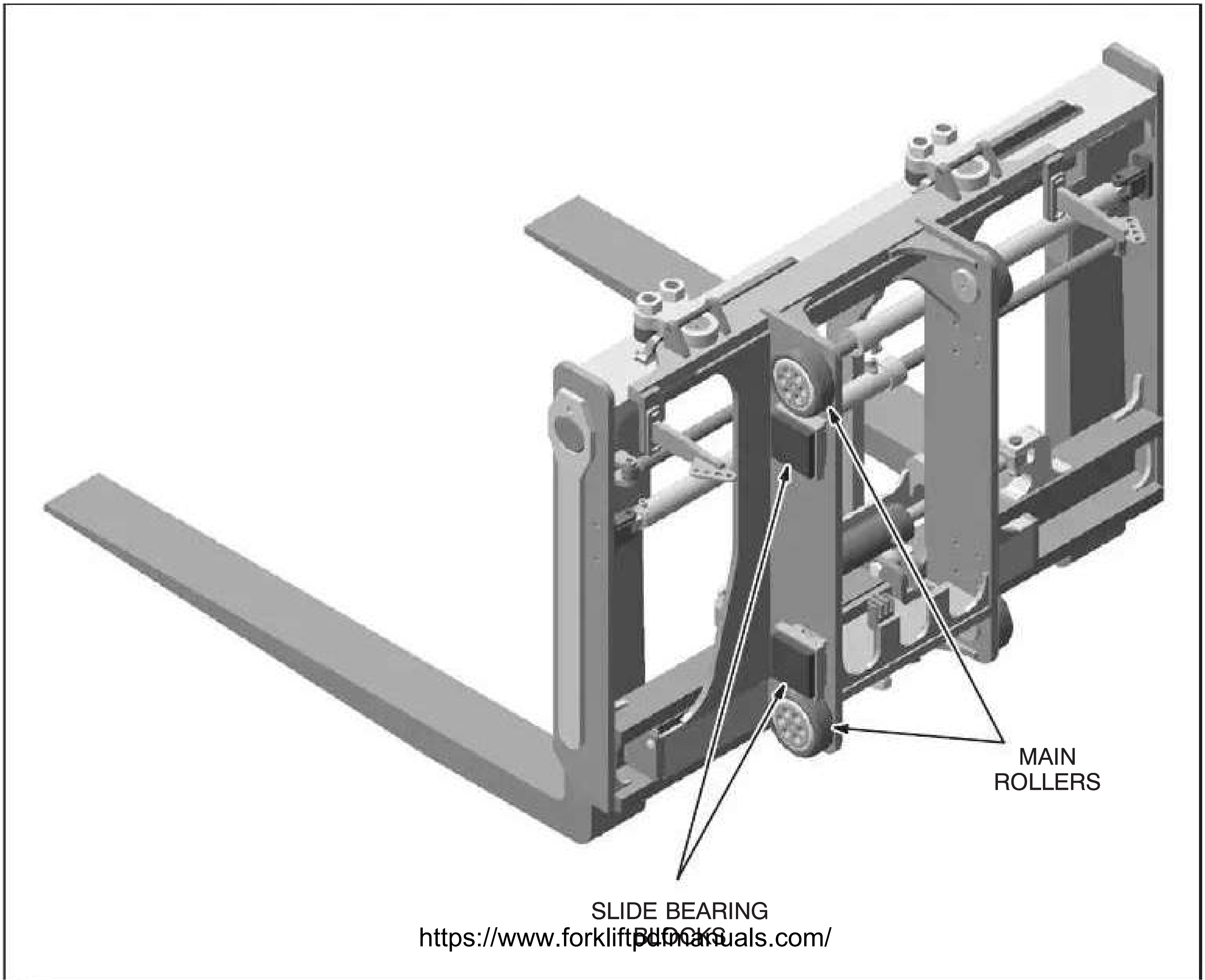


Illustration 28-2. Optional Carriage With Side Shift and Fork Positioners

Maintenance / Inspection. There are several inspectional requirements which must be performed daily. These inspections must include checking all welds and structural members for cracks. Check all carriage mounting hardware for damage or loose bolts. The hydraulic fork positioner cylinders and hydraulic hoses should be checked for leaks and functional operation.

Main Rollers (Illustrations 28-1 through 28-3). The main rollers employ greaseable, shielded, tapered roller bearings for increased durability. The main rollers must be greased periodically (refer to the **Preventive Maintenance** chart in the **Appendices** for the main rollers lubrication interval). The grease fittings for the main rollers can be found on the inside of the carriage plate. The main rollers should be inspected for flat spots or evidence of sliding any time the carriage is taken out of the inner mast.

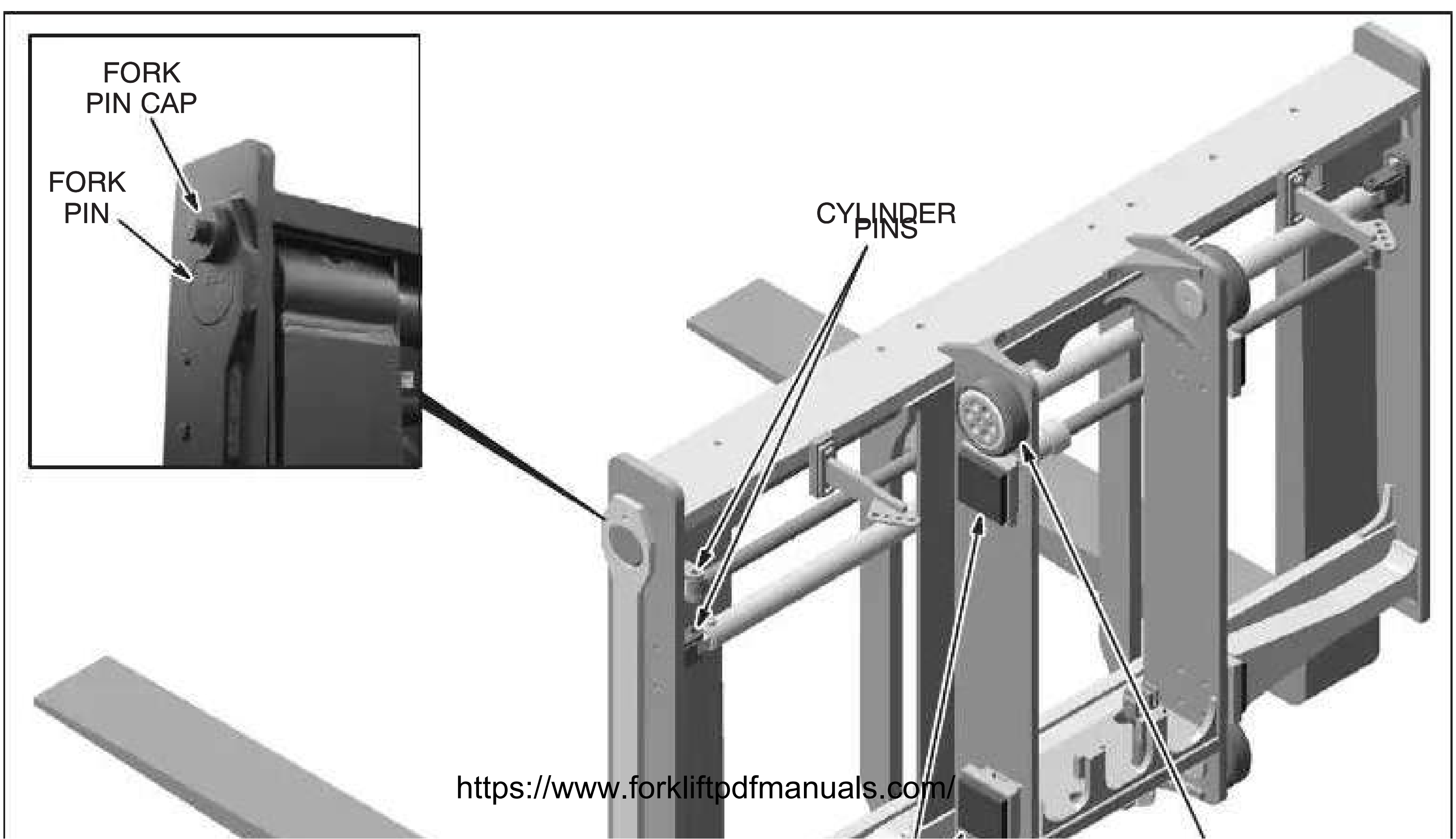
⚠ **CAUTION: The roller assemblies must not be over lubricated. Excess grease inside the mast rails may cause the rollers to slide when subjected to a heavy load. If this happens, a flat spot will be worn on the rollers and the rollers will continue to slide until replaced with new rollers.**

Slide Bearing Blocks (Illustrations 28-1 through 28-3). The slide bearing block life depends on the duty cycle and operation of the truck. Periodically, the slide bearing blocks will require shimming to adjust for wear. It is essential for all slide bearings to be properly shimmed. For proper shimming procedures refer to **Section 27**.

Forks. The forks must be inspected daily to assure proper carriage operation. Forks must be magnetic particle tested (magnafluxed) annually to check for cracks (refer to the **Fork Inspection, Repair, and Testing** in the **Appendices**).

Carriage. The carriage's welds and structural members must be checked for cracks (refer to the **Structural Inspection, Reporting, and Repair Procedure** at the front of this section).

Lubrication. Refer to the **Lubrication** section in the **Appendices** for information on the lubrication of the carriage.



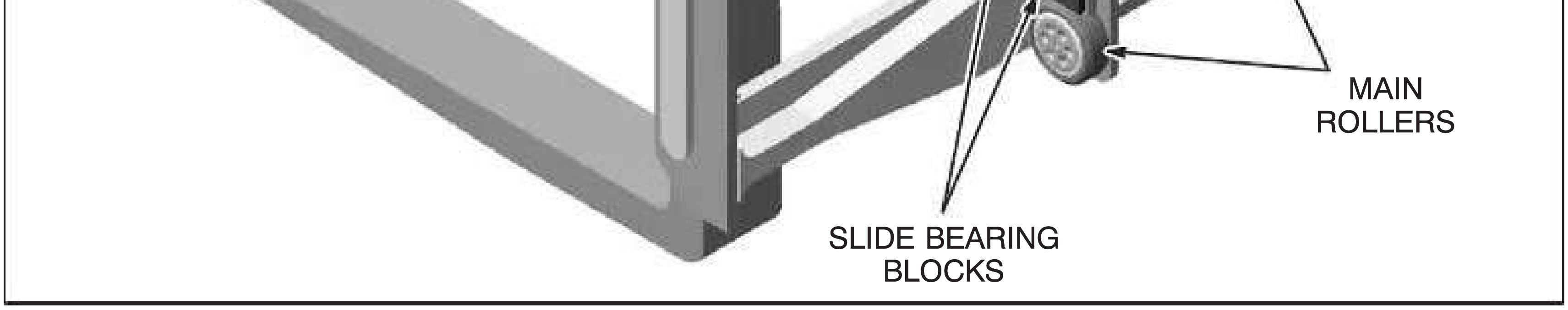


Illustration 28-3. Optional Carriage With Fork Positioners

Troubleshooting

Problem	Cause	Correction
1. Cracks in welds (refer to **SIRR** in the **Appendices**) **Notify Taylor Machine Works, Inc. for proper repair procedures.**	1. Metal fatigue.	1. Have cracks in welds repaired immediately.
	2. Overloading.	2. Refer to Correction 1. and avoid overloading the truck.
	3. Rough terrain.	3. Refer to Correction 1. and, if possible, avoid operating truck on rough terrain.
	4. Travelling with load in an unrecommended travel position (excessive height and / or fully side-shifted, one side or the other).	4. Refer to Correction 1. and the <u>Operator's Guide</u> for proper travelling positions.
	5. Severe duty cycles.	5. Have cracks in welds repaired immediately.
	6. Trying to use fork positioners while loaded.	6. Use fork positioners only when forks have no load.

Contents

Appendices

S I R R

Structural Inspection, Reporting, And Repair

For Powered Industrial Trucks

This document contains information of vital importance concerning the inspection, reporting, and repair of fatigue cracks. If fatigue cracks are not corrected they can lead to a catastrophic failure causing serious injury to personnel and / or property.

It is important that the machine be inspected regularly. Any existing fatigue cracks should be reported to the Taylor Machine Works, Inc. engineering department immediately. Repairs must be made in accordance with AWS methodologies.

WARNING:

Dangerous Action. Operating a powered industrial truck without inspecting, identifying, and repairing fatigue cracks in the mast, carriage, attachment, steer axle, and frame weldments.

What Can Happen. If the fatigue crack is allowed to grow, catastrophic failure could occur in the mast or other welded components causing serious injury to personnel and / or property.

How To Avoid The Danger. Follow the OSHA rules, 29 CFR, 1910.178 (q)(1), (5), & (7) which require inspecting industrial trucks daily before being placed in service, removing trucks from service if cracks are found, and making repairs only as authorized by the manufacturer. If trucks are used on a round-the-clock basis, they shall be examined after each shift. OSHA 29 CFR 1910.178 (p)(1) requires that trucks in need of repair be taken out of service.

Structural Inspection and Reporting Procedure. The information enclosed in this procedure is directed to the structural weldments of the truck assembly. Areas that should be included for inspection on the front end of the truck are the mast and carriage. Areas to be inspected on the truck chassis include mast hangers, drive axle mounts, A-frame connections, and steer axle mounts.

Inspection for Fatigue Cracks. Welded steel structures always contain undetectable cracks, especially at welded joints. When these joints are subject to fluctuating stresses of sufficient magnitude, these cracks will grow. This is known as

These symbols are in accordance with AWS A2.4-76, “Symbols for Non-Destructive Testing.”

WARNING: Periodic inspection is required to detect fatigue cracks that have grown to a significant size in order to avoid serious failure of the structural weldment. When a crack is found, the truck must be immediately taken out of service and repaired.

Restoring the weld to its original condition by complete penetration welding is usually acceptable. Sometimes this is not practical and a change in geometry by means of cutting, grinding or adding additional material is more economical; however, the user must be cautioned that OSHA 29 CFR 1910.178 (a)(4) requires manufacturer’s **prior written approval** for modifications and additions which affect capacity and safe operation.

Cracking may occur due to overloading, rough operation, poor yard conditions, severe duty cycles, failing to keep lift chains properly adjusted, improper shimming of mast rails, carrying the loads too high or not properly centered, using attachments that clamp the load to the forks, etc. If such cracking is found, a review of the operation should be made to see if any of the above listed problems are occurring and if so, a change in the operation should be made to avoid future problems. Some cracking may be due to geometry, modifications or due to the attachments welded to the structure. If this is the case, the geometry may have to be changed, the modification corrected or the attachment changed or relocated to correct the cracking problem. OSHA requires that tude, these cracks will grow. This is known as fatigue crack growth. No matter how low the stress levels are kept some fatigue crack growth will occur in all welded structures.

Eventually, these fatigue cracks will become large enough to be detectable by nondestructive testing methods, i.e. VT, MT, DPT, or UT.

Abbreviations. Basic Testing Symbols

Type of Test	Symbol
Visual	VT
Magnetic Particle	MT
Dye-Penetrant	DPT
Ultrasonic	UT

you have **prior written approval** of the manufacturer for such changes.

Test Procedures

1. **Visual (VT).** Dirt and grease should be removed from the surface by wiping with a rag. One should look for cracked paint and rust showing through the paint. Also, look for movement at bolted joints, irregular lines in welds or dents, or deformations in the material. Proper lighting is required in order to obtain satisfactory results.
2. **Magnetic Particle (MT).** The test surface must be free of loose rust, scale, moisture, and painted surfaces must be cleaned at all points of electrode contact. Grinding, brush-

ing, or blasting do not affect results of this method of testing in most instances.
A magnetic field can be applied to the test material with:
   a. Permanent magnet.
   b. Yoke which is an electromagnet type of device.
   c. Passing high amperage current through the part.
3. **Dye-Penetrant (DPT)**. The test surface must be thoroughly cleaned and dried. This can be done with chemical solvents, vapor degreasing, or by mechanical methods. However, cleaning mechanically, such as grinding, blasting, or wire-brushing, might prove detrimental to the test because surface discontinuities can be masked by cold working of the surface. Therefore, mechanical cleaning methods must be kept to a minimum.

   One of the following type penetrants should be used in conjunction with the proper procedure to get satisfactory results:
   a. Water soluble penetrant
   b. Post emulsifiable penetrant
   c. Solvent removable penetrant

   Follow the directions supplied with the dye-penetrant for best results.
4. **Ultrasonic (UT).** Testing should be done in accordance with AWS D1.1 approved methods.

Frequency of Inspection. There are three (3) levels of inspection:

two years or 6,000 hours, whichever is sooner, thereafter. These inspections should be performed by qualified maintenance personnel.

NOTE: *Duty cycles vary from extremely severe (capacity loads, high frequency of loading, rough yards, etc.) to very light (partial capacities, few load cycles, good yard conditions, etc.). Duty cycle directly affects product life and maintenance requirements. Depending on the quality and thoroughness of the daily inspections and the service experience of the vehicle, the three-month visual inspection interval and the full-scale inspection interval may be adjusted (increased or decreased) to levels appropriate for an individual vehicle duty cycle.*

WARNING: Death or serious injury could result from structural failure. Inspect structure for cracks.

Reporting Procedure. Taylor Machine Works, Inc. should receive reports of the results of any inspections.

Photocopy a sketch from your maintenance manual, make your own sketch, or photograph, and show indication of crack if any are evident, stating the following:

1. Location (right, left, inner, outer, machine side etc.);
2. Size of crack;
3. Extent of crack;
   a. In toe of weld;

1. **Daily**. Mandatory daily examination of the truck as required by OSHA. (See Operator's Guide and Safety Check 2nd Edition for details.) This examination is usually performed by the operator (or other designated person).
2. **Three-month inspection.** A thorough visual inspection (VT) following the guidelines shown in this procedure should be made every three months (refer to sketches for details). These inspections should be performed by qualified maintenance personnel.
3. **6,000 Hour Inspection.** Full-scale inspection (FS) including all examinations outlined in this procedure (VT, MT, and DPT) should be made after the first year of operation and then every

   b. Propagating into the base metal;
   c. Other description, etc.
4. Method of testing to detect cracks.

If no cracks are found by yearly inspections, please confirm by a fax or a short letter.

Repair Procedure

1. Contact Taylor Machine Works, Inc.
2. If rewelding is suggested, use AWS approved welding procedures.
3. If design modification is indicated, contact Taylor Machine Works, Inc. OSHA 29 CFR 1910.178 (q)(5) requires that replacement parts be equivalent as to safety with those used in the original design. Different steel

grades are used for different components. Different steel grades require different welding procedures, pre-heatings, rods, etc.

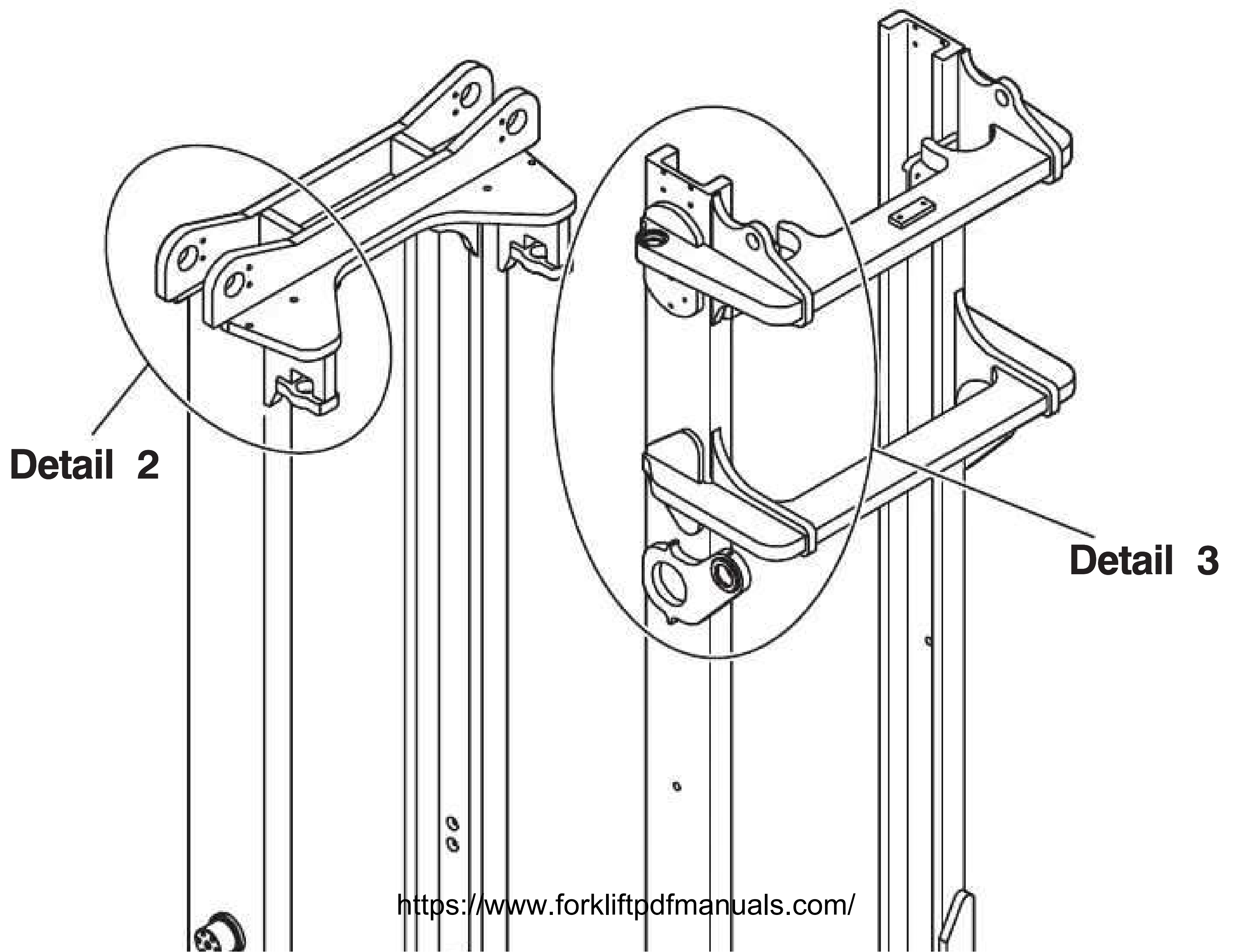
Inspection Locations. The following illustrations are a representative set for the general welds used on Taylor Machine Works trucks. They are used as a reference for specific details, but do not necessarily represent exact details used in the construction of your truck. The inspection method for both the three-month inspection (3), and the full-scale inspection (FS), are shown.

WARNING: The areas being inspected must be properly cleaned prior to performing the inspection. If not properly cleaned potentially dangerous cracks may not be detected.

WARNING: Never go under a raised mast, carriage or forks unless proper blocking has been securely placed to prevent the mast, carriage or forks from falling in event of hydraulic failure or drift. See Safety Check 2nd Edition.

List of Illustrations

Inner and Outer Mast Arrangement



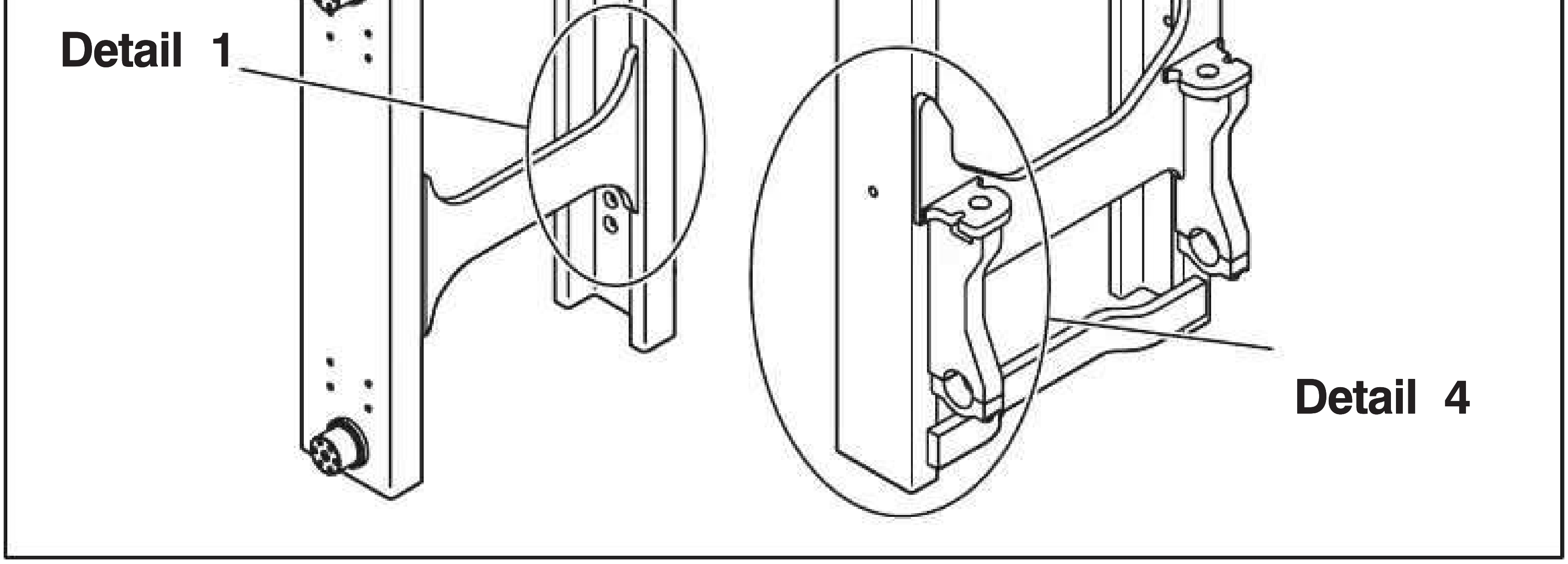
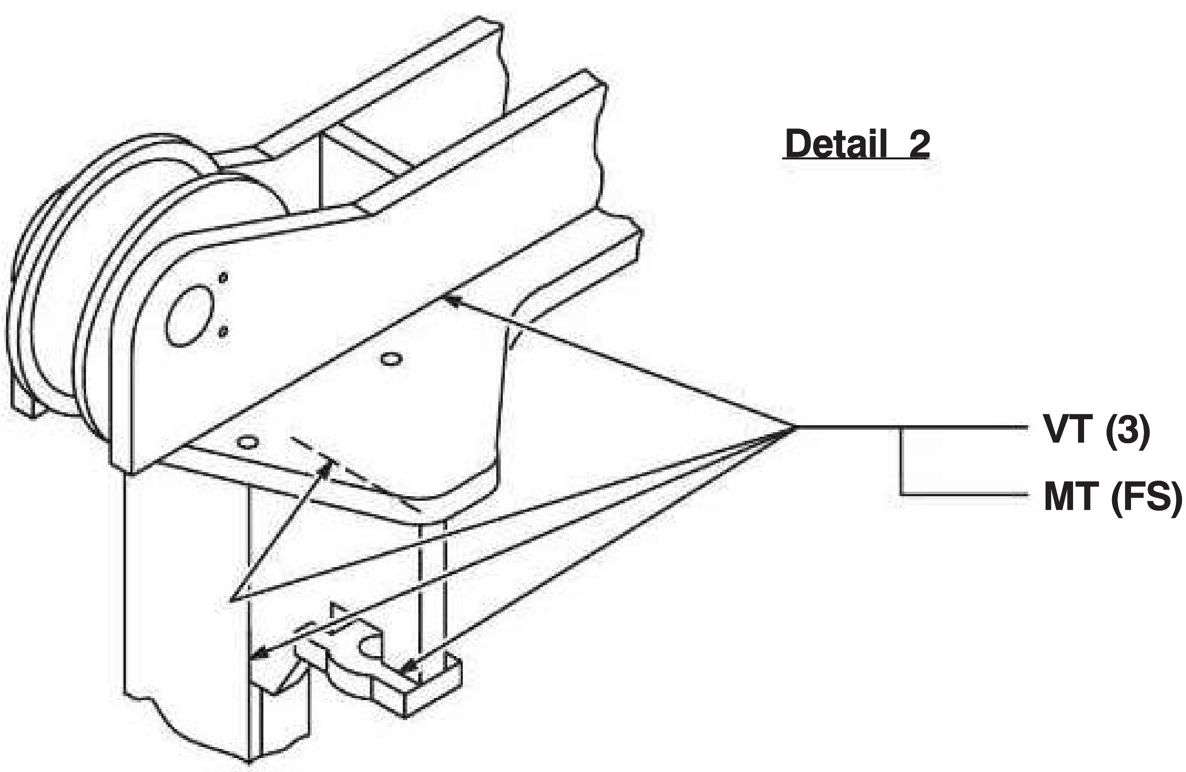
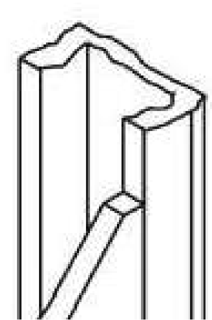


Illustration 1. Inner and Outer Mast Arrangement

Inner Mast Details



Detail 1



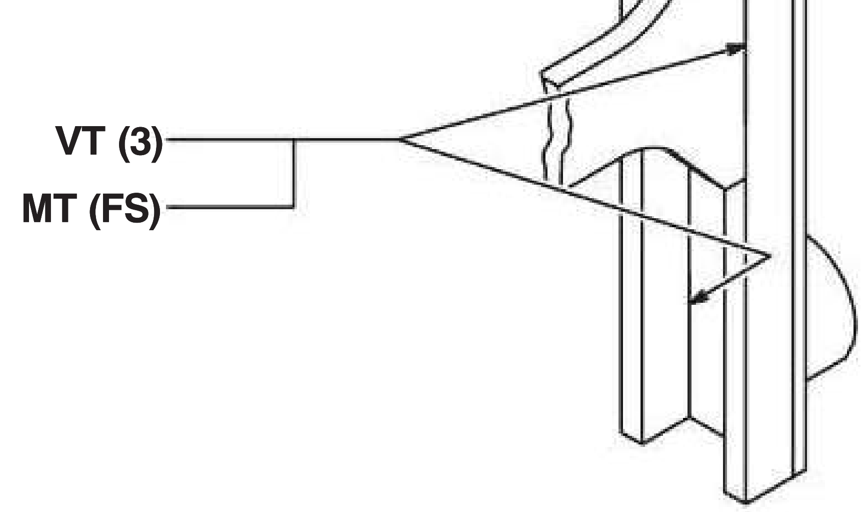
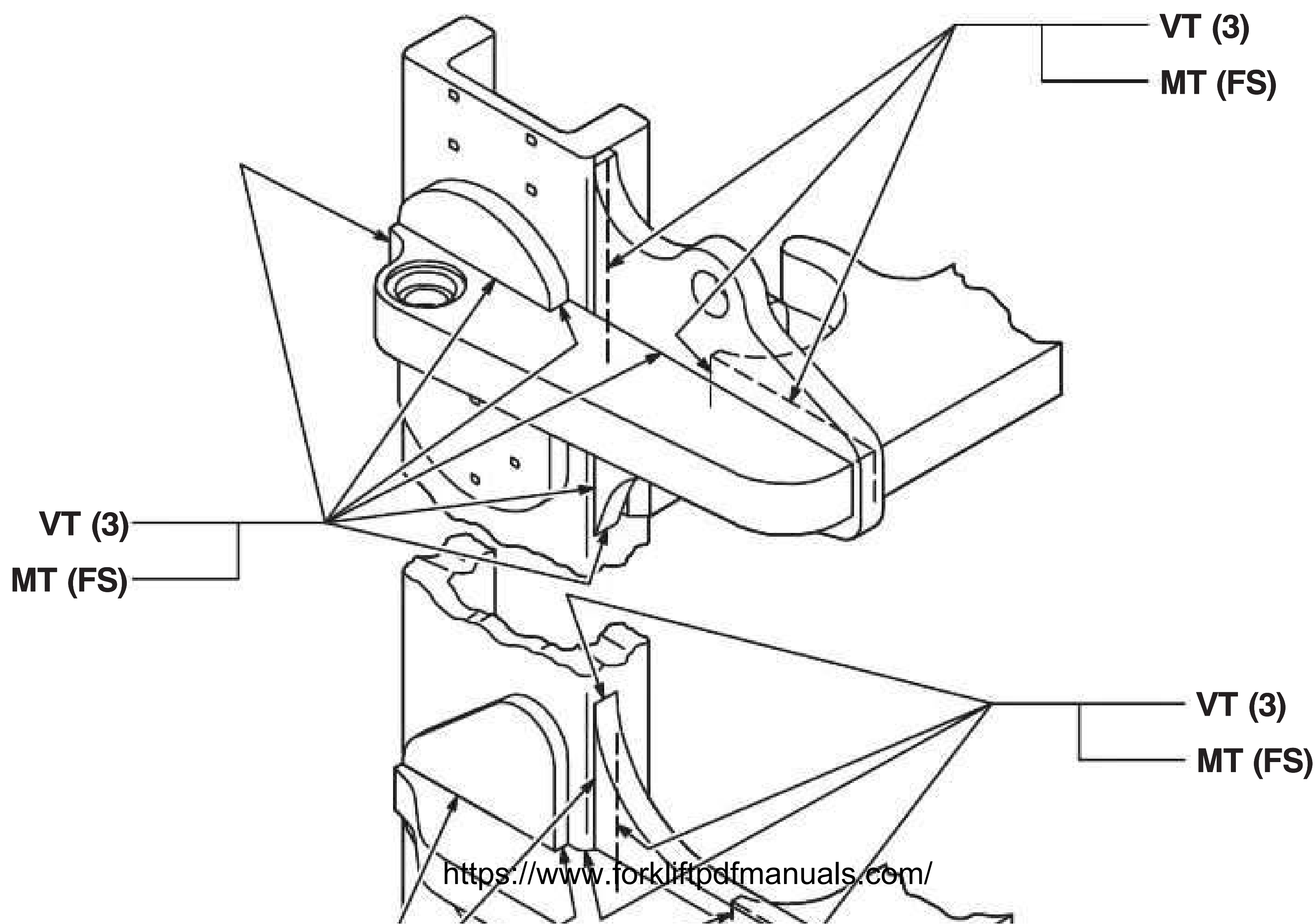


Illustration 2. Inner Mast Details 1 and 2

Outer Mast Details



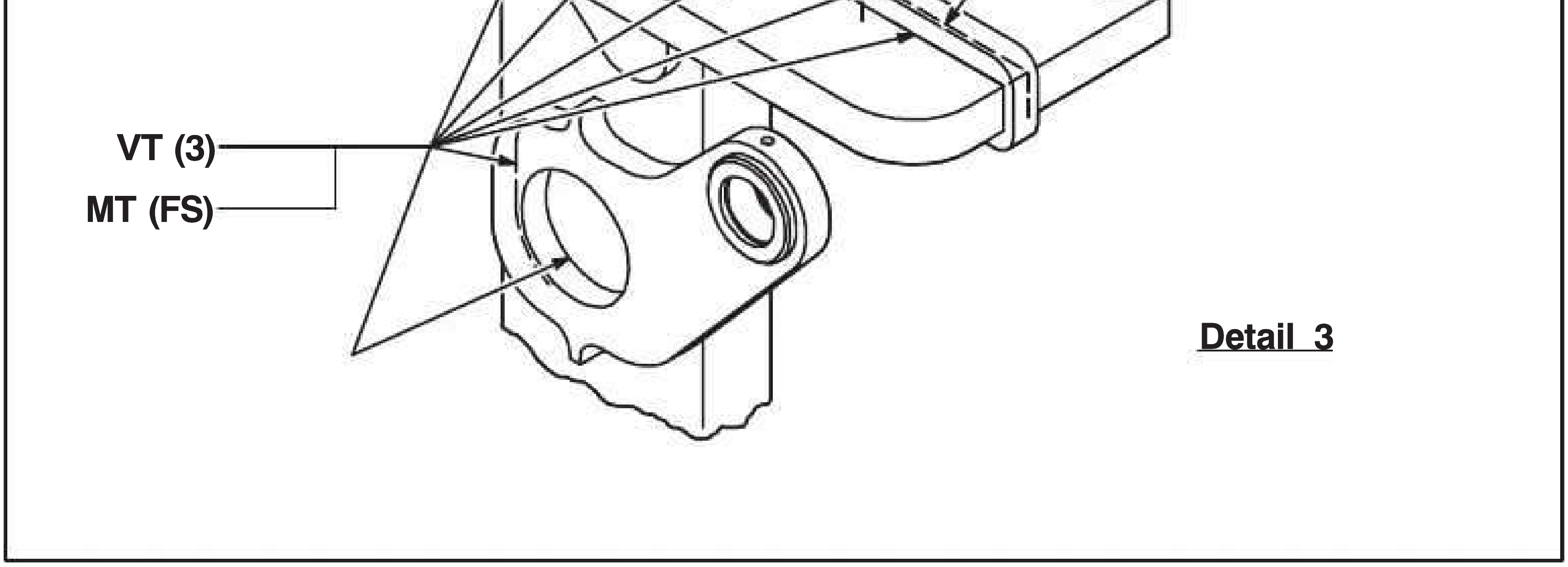
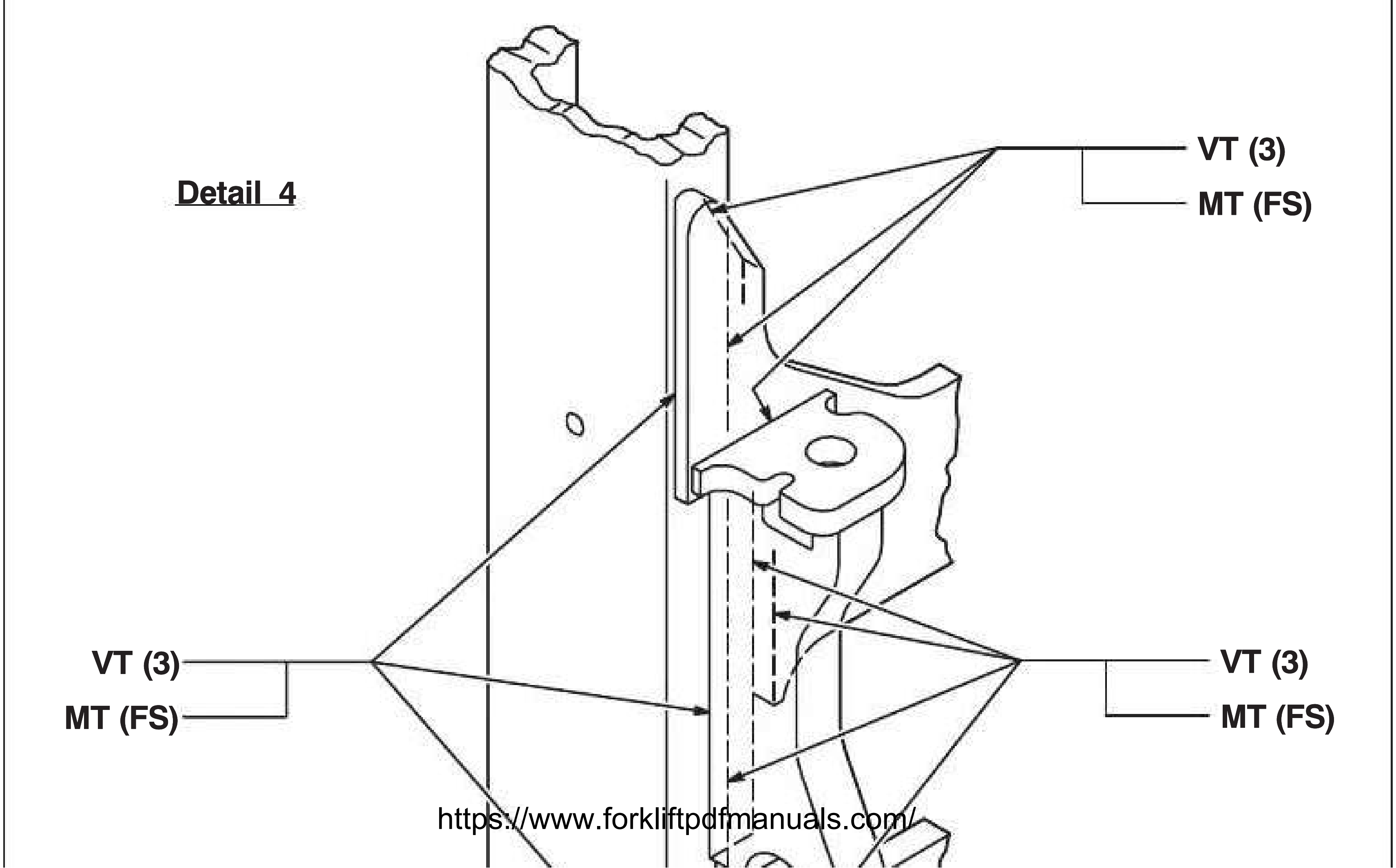


Illustration 3. Outer Mast Detail 3

Outer Mast Details



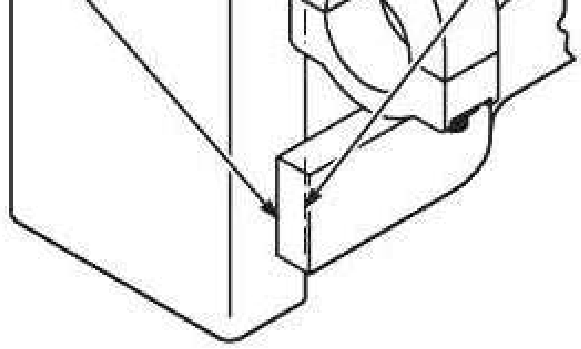
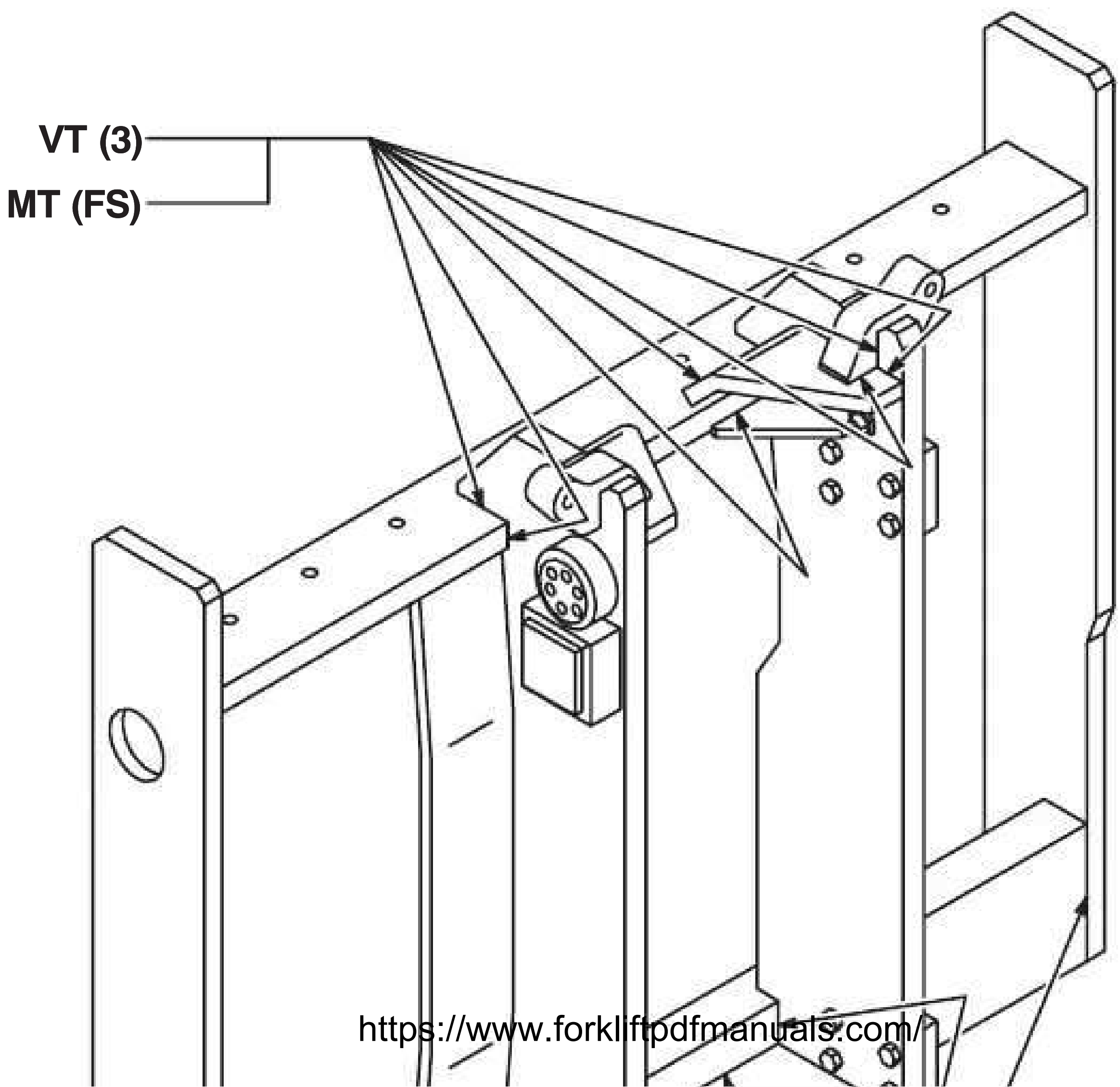


Illustration 4. Outer Mast Detail 4

Carriage Detail



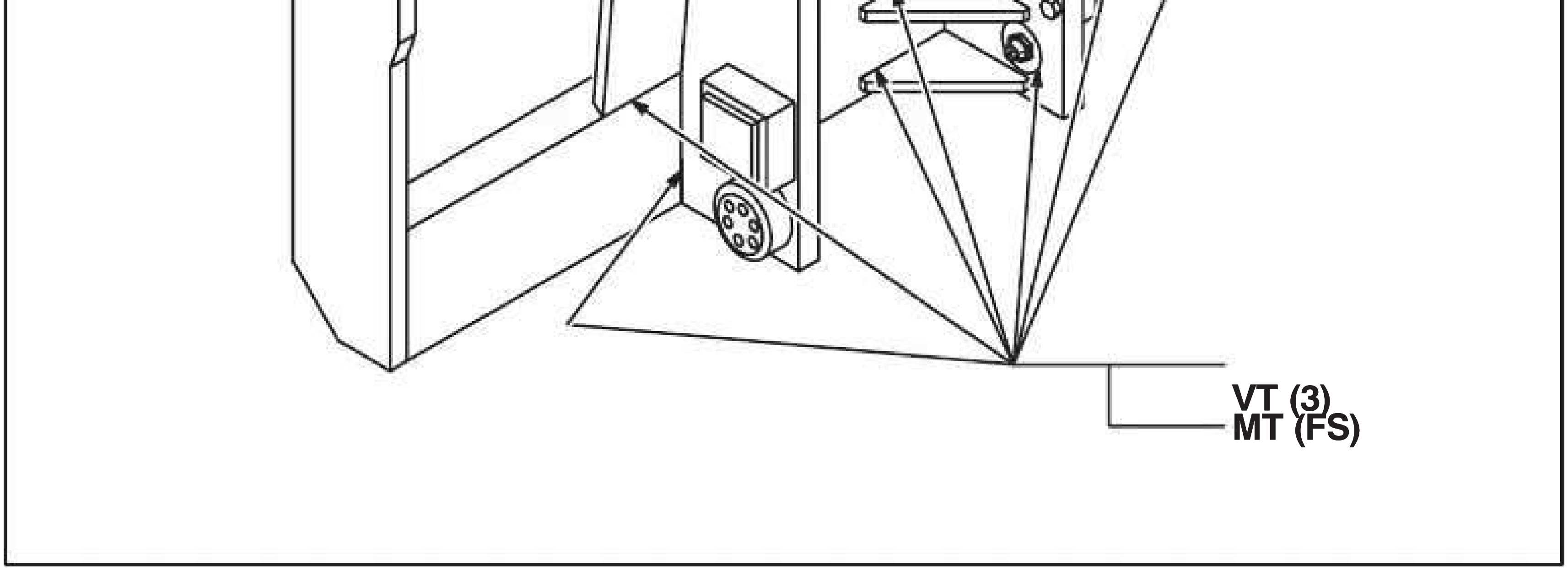
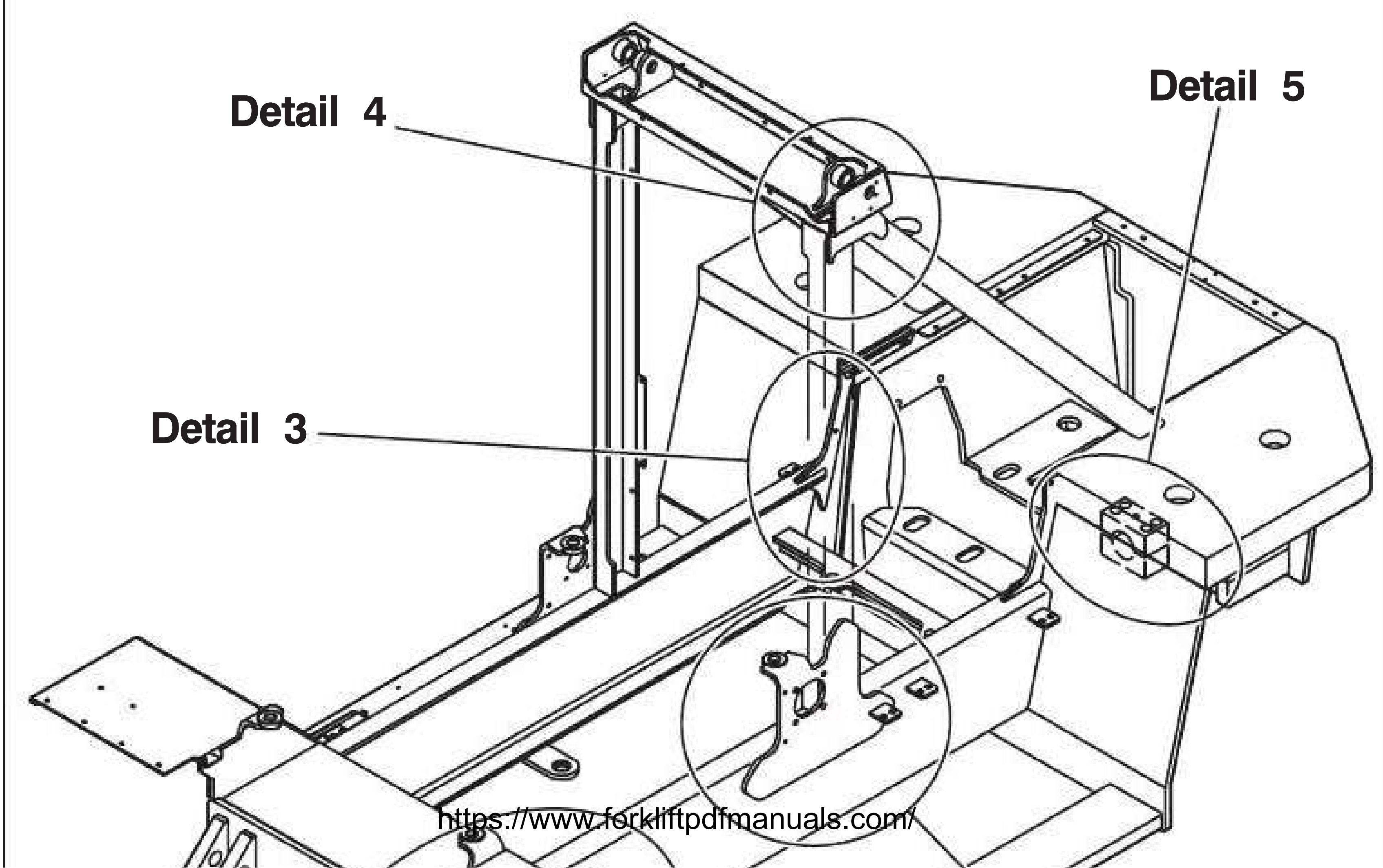


Illustration 5. Carriage Detail

Chassis Arrangement



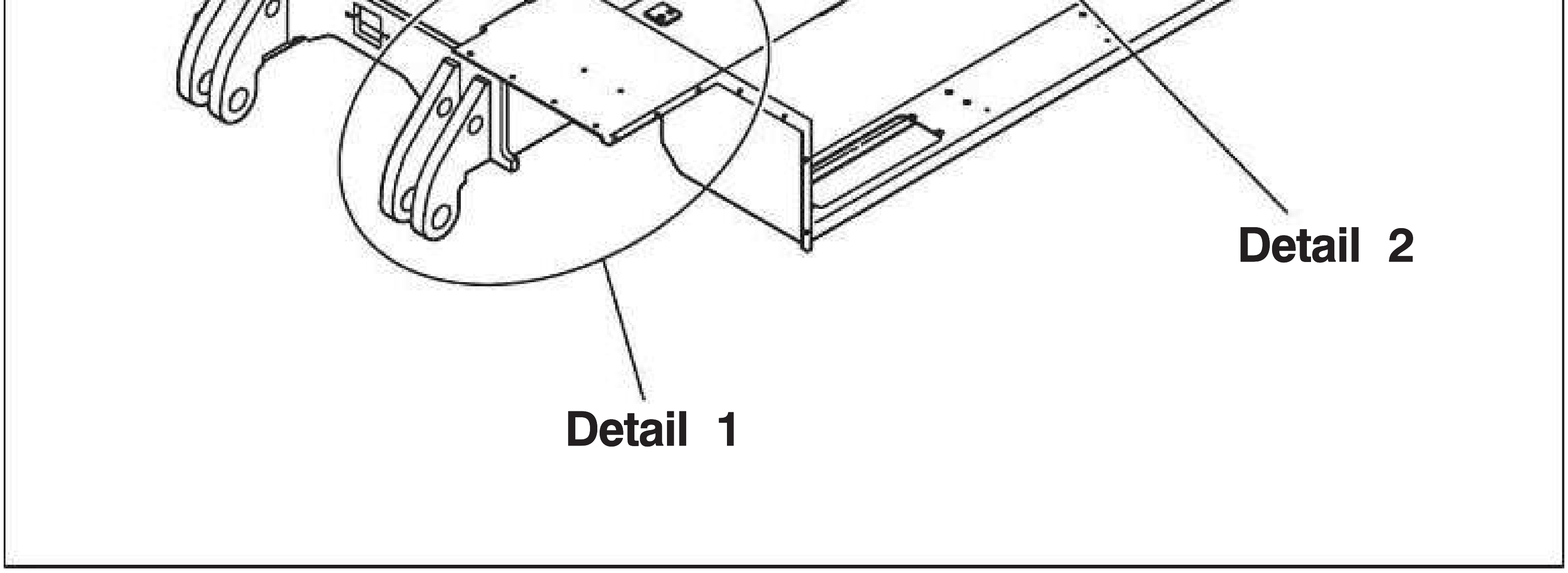
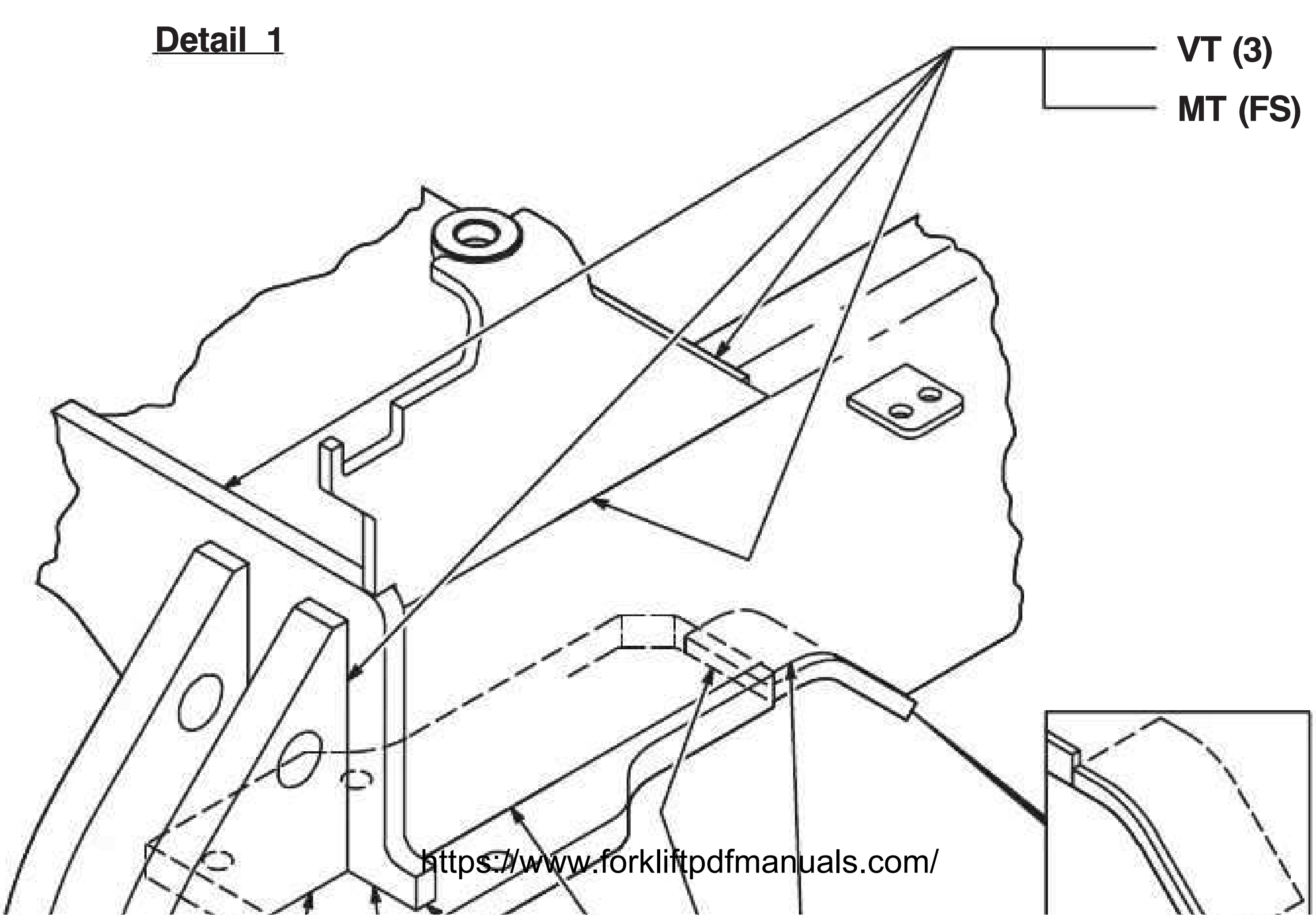


Illustration 6. Chassis Arrangement

Chassis Details



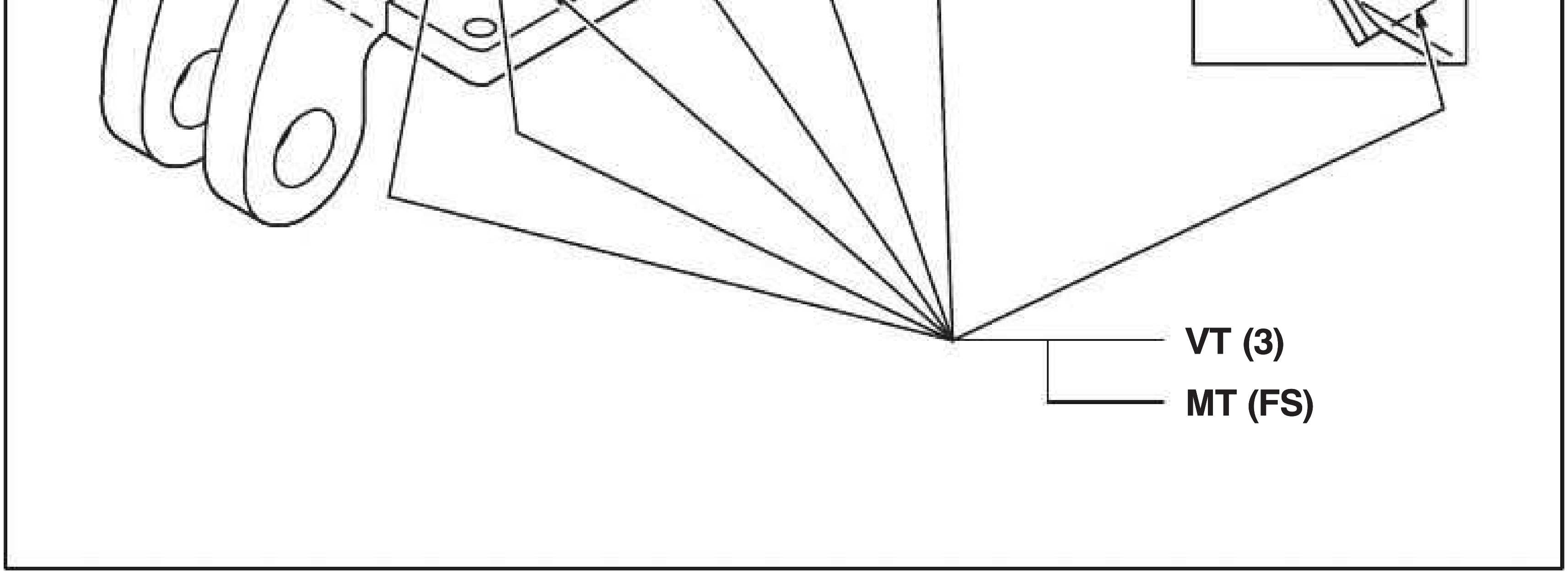
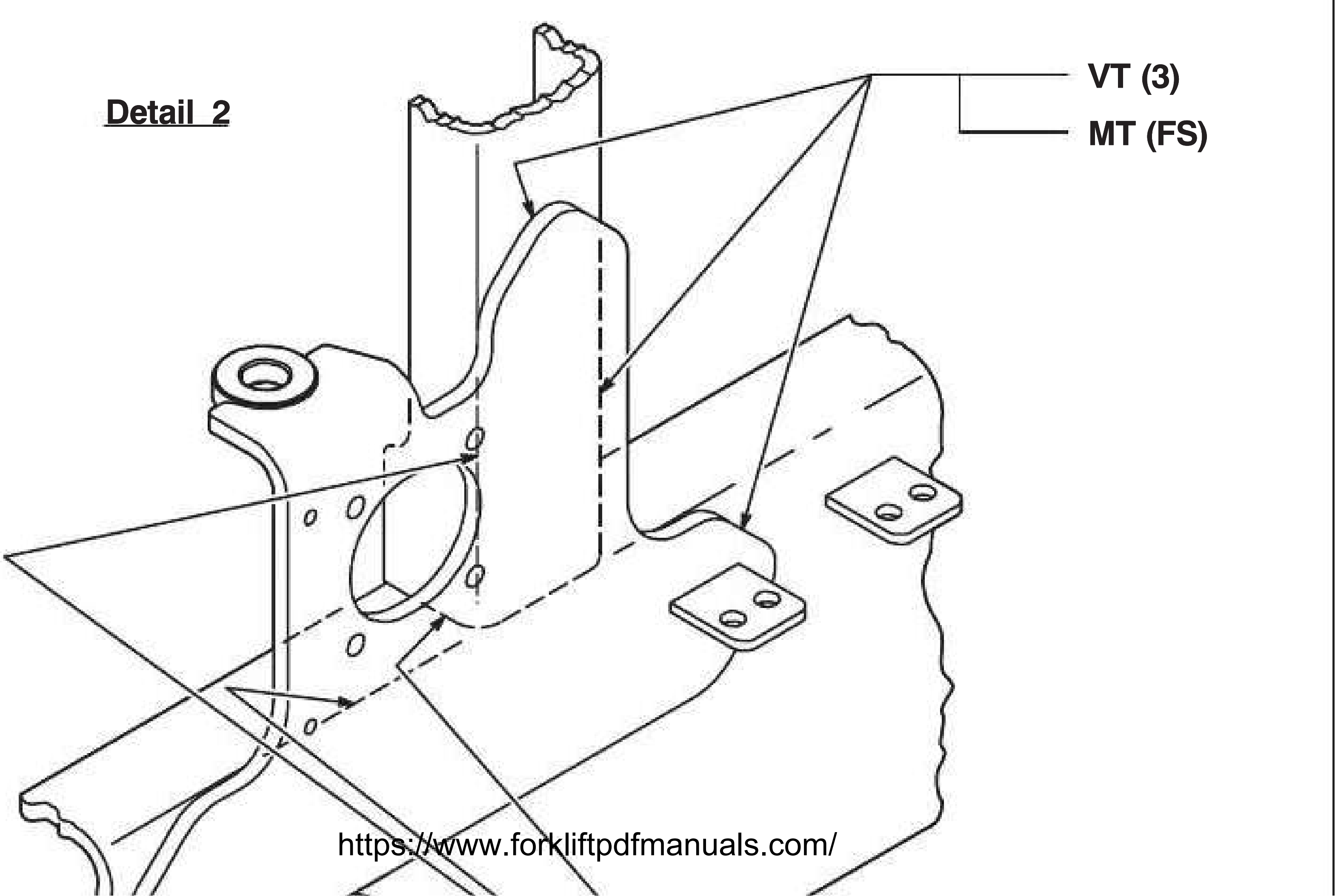


Illustration 7. Chassis Detail 1

Chassis Details



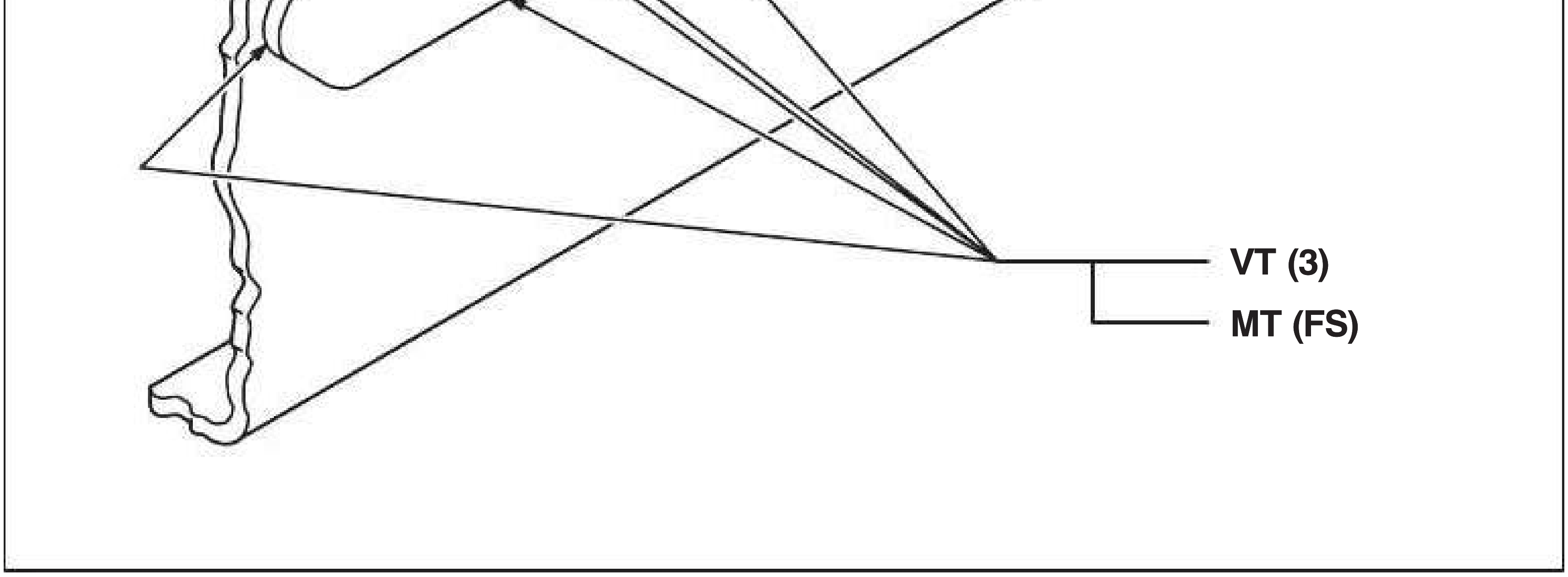
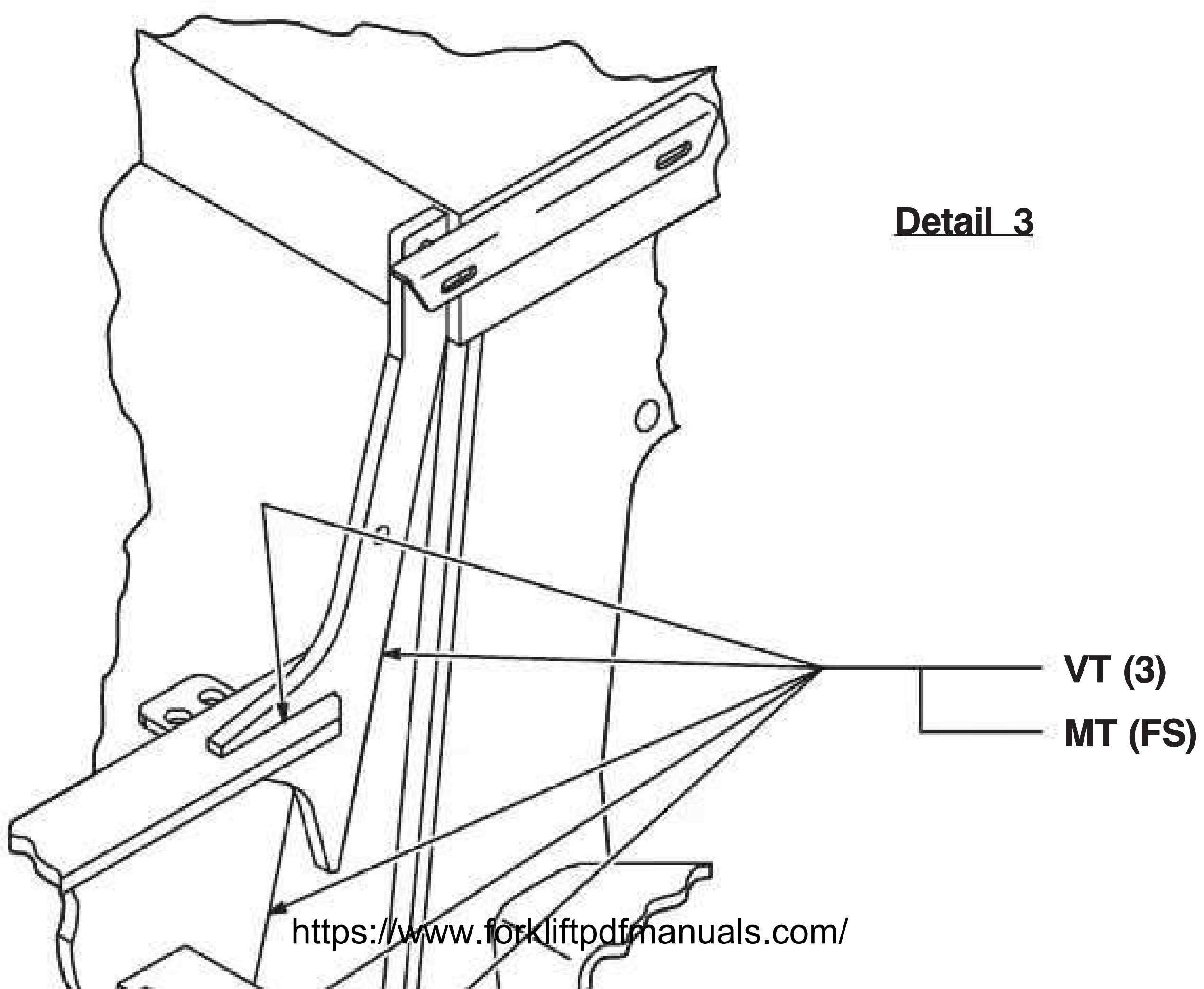


Illustration 8. Chassis Detail 2

Chassis Details



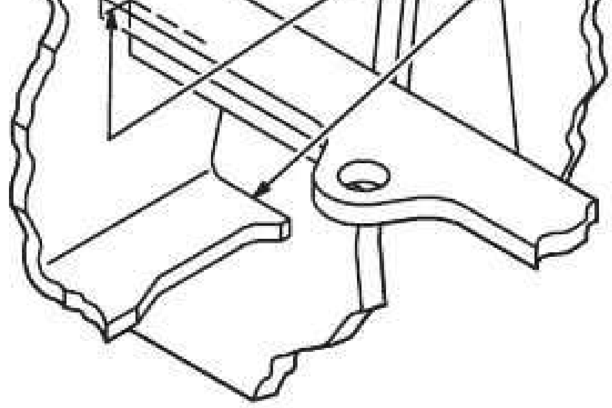
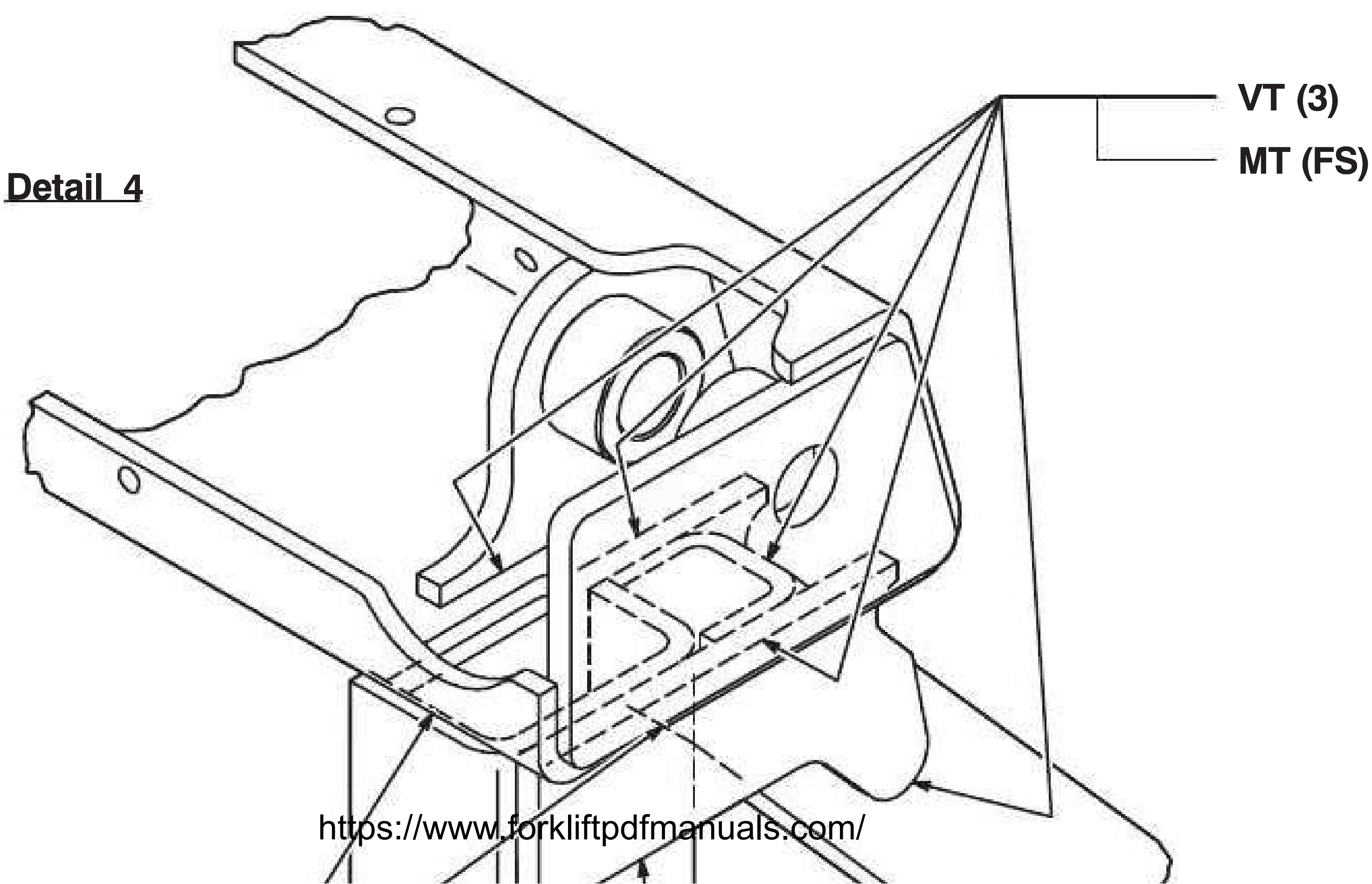


Illustration 9. Chassis Detail 3

Chassis Details

Detail 4



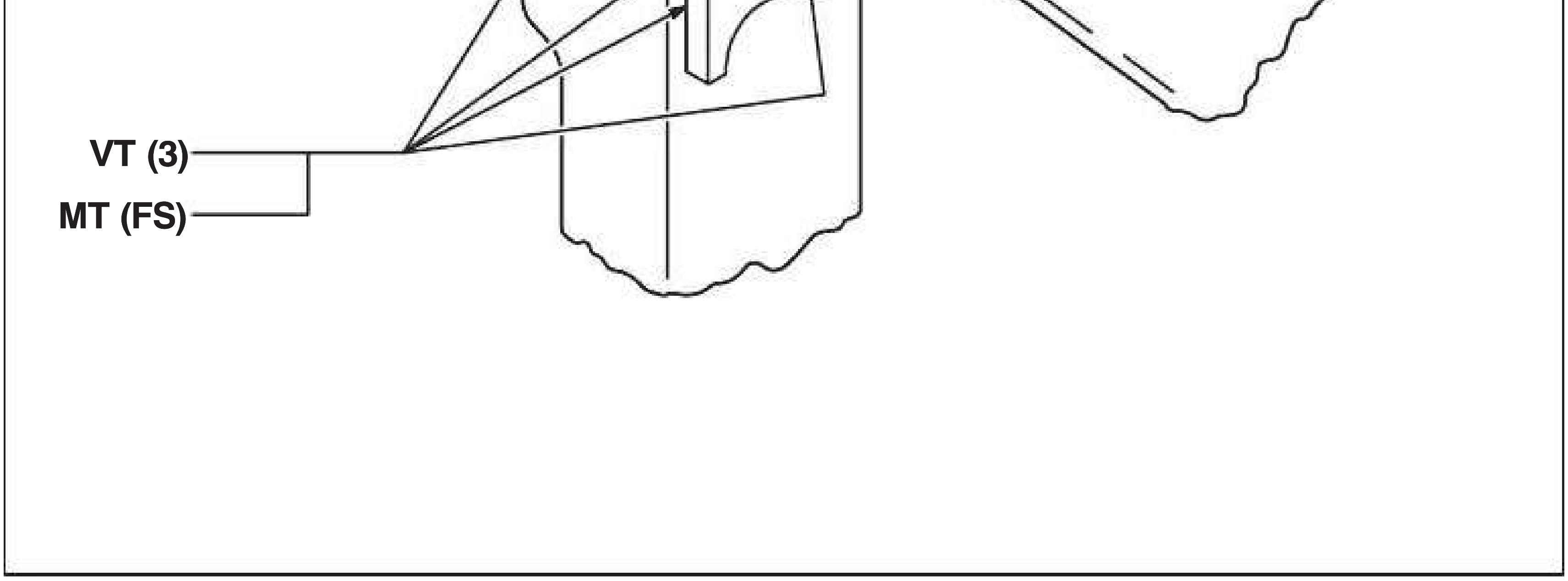
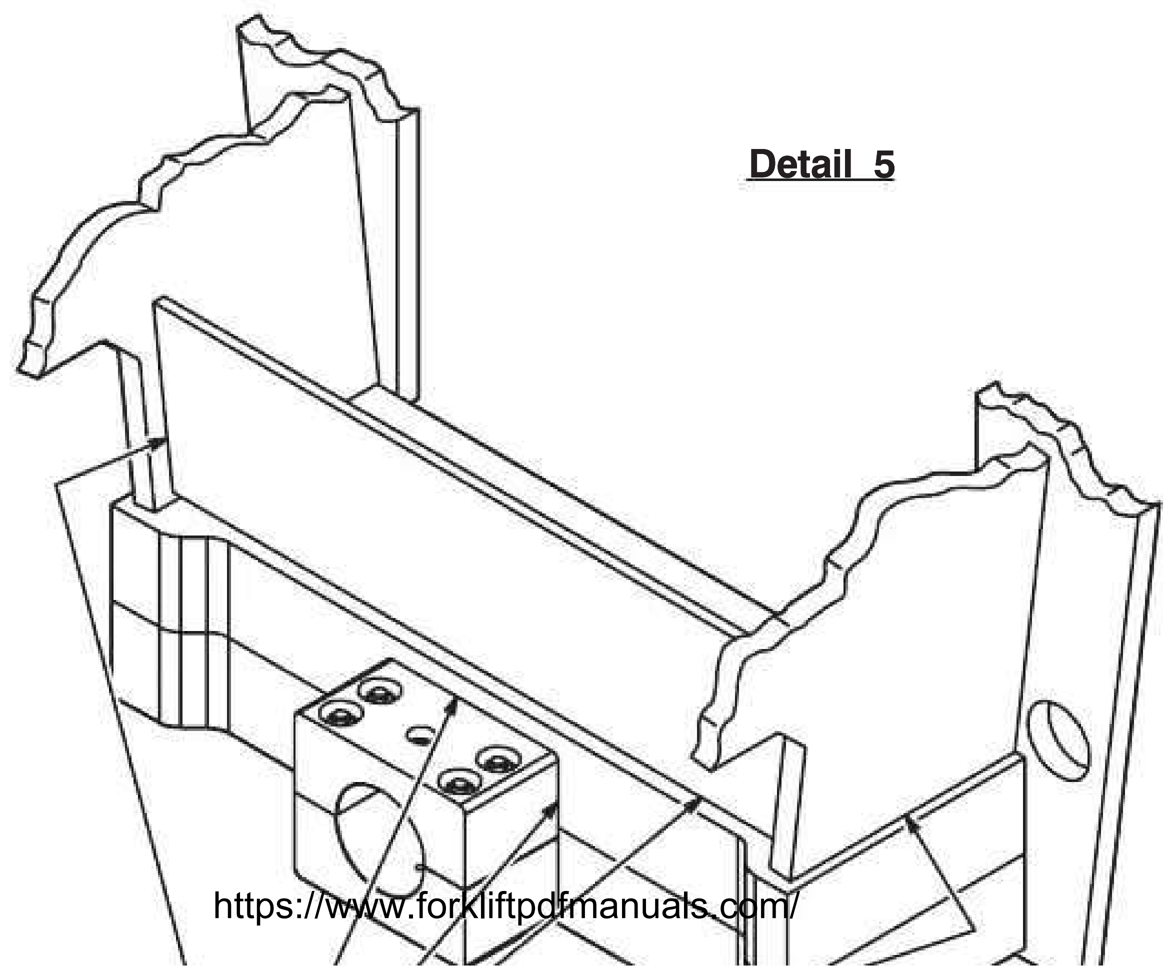


Illustration 10. Chassis Detail 4

Chassis Details



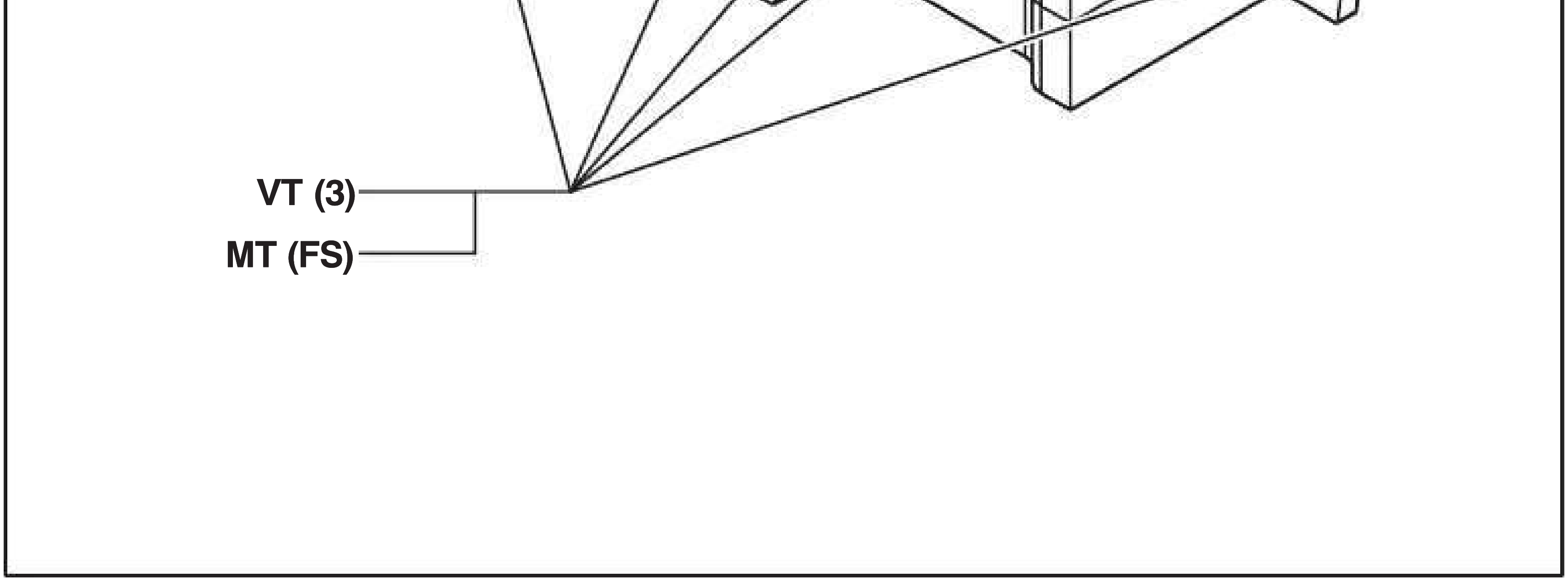


Illustration 11. Chassis Detail 5

Fork Inspection, Repair, and Testing

Forks in use shall be visually inspected daily and must be magnetic particle tested (magnafluxed) for cracks at intervals of not more than 2400 hours or whenever any defect or permanent deformation is detected. Severe applications will require more frequent inspection.

When forks are used in pairs, the rated capacity of each fork shall be at least half of the manufacturer's rated capacity of the truck, and at the rated load center distance shown on the lift truck nameplate.

Fork inspection shall be carried out carefully by trained personnel with the aim of detecting any damage, failure, deformation, etc., which might impair safe use. Any fork which shows such a defect shall be withdrawn from service, and shall not be returned to service unless it has been satisfactorily repaired.

WARNING: Do not weld on forged forks. Failure to follow this warning could lead to seriously weakened forks that could fail prematurely under normal loads. When necessary, the welding of fork bushings should only be done by qualified welders knowledgeable of the appropriate welding practice.

The fork shall be thoroughly examined visually for cracks and if considered necessary, subjected to a nondestructive crack detection process, special attention being paid to the heel and welds attaching all mounting components to the fork blank. This inspection for cracks must also include any special mounting mechanisms of the fork blank to

Any fork that has a deviation of greater than 3° fork angle from the original specification shall not be returned to service.

The difference in height of one set of forks when mounted on the fork carrier shall be checked. If the difference in tip heights exceeds 3% of the length of the blade, the set of forks shall not be returned to service until repaired.

It shall be confirmed that the positioning lock is in good repair and correct working order. If ant fault is found, the fork shall be withdrawn from service until satisfactory repairs have been effected.

The fork blade and shank shall be thoroughly checked for wear, special attention being paid to the vicinity of the heel. If the thickness is reduced to 90% of the original thickness, the fork shall not be returned to service.

The support face of the top hook and the retaining faces of both hooks shall be checked for wear, crushing, and other local deformations. If these are apparent to such an extent that the clearance between the fork and the fork carrier becomes excessive, the fork shall not be returned to service until repaired.

If the fork marking is not clearly legible, it shall be renewed. Marking shall be renewed per instructions from original supplier.

Each fork shall be clearly stamped with its individual load rating in an area readily visible and not subject to wear.

Only the manufacturer of the fork or an expert of equal competence shall decide if a fork may be the fork carrier including bolt type mountings and forged upper mounting arrangements for hook and shaft type carriages. The forks shall not be returned to service if surface cracks are detected.

The straightness of the upper face of the blade and the front face of the shank shall be checked. If the deviation from straightness exceeds 0.5% of the length of the blade and/or the height of the shank, respectively, the fork shall not be returned to service until it has been repaired.

repaired for continued use, and the repairs shall only be carried out by such parties.

It is not recommended that surface cracks or wear be repaired by welding. When repairs necessitating resetting are required, the fork shall subsequently be subjected to an appropriate heat treatment, as necessary.

A fork that has undergone repairs shall only be returned to service after being submitted to, and passing, the test procedures. The test load shall

correspond to 2.5 times the rated capacity marked on the fork.

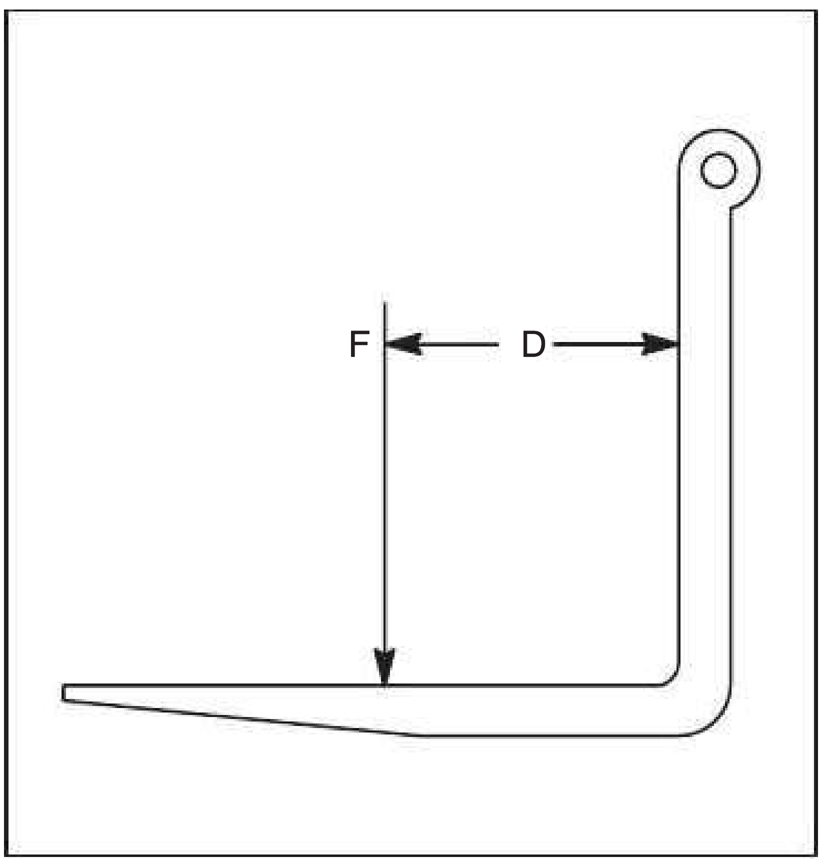


Illustration 1. Typical Fork

Fork strength shall permit the following loading and method of test.

1. The test load F shall be applied to it at the applicable distance D from the front face of the fork arm shank (see Illustration 1).
2. The fork arm shall be restrained in a manner identical to that used on the forklift truck.

3. The test load shall be applied twice, gradually and without shock, and maintained for 30 seconds each time.
4. The fork arm shall be checked before and after the second application of the test load. It shall not show any permanent deformation.

Leaf Chain Care, Maintenance, and Replacement

The leaf chain (or chains) on your Taylor material handling equipment was selected based on thousands of hours of safe operation over many years of fork lift trucks working in various types of material handling operations.

The entire chain system, including chain anchors, anchor supports, bearings, and chain rollers, is sized for the basic model capacity and load center shown on the serial plate.

The utility of fork lift truck type material handling equipment requires it to operate under a wide variety of load conditions. These vary from a few low lifts to a very large number of high lifts per operating hour.

The leaf chain is subjected to all the variations of environment, such as moisture, chemicals, temperature extremes, abrasives, and even salt water in some applications. The chain cannot have the benefit of a protective coating (paint) and must depend on **proper lubrication** for combating the effect of these conditions. The lubrication program greatly affects chain life.

The utility of the lift truck requires it to operate with a variety of attachments, such as forks, coil rams, paper roll clamps, containers, marinas, and other attachments, all of which will place different dynamic loads and load requirements on the hoist chains.

This wide variety of variables makes it impossible for Taylor to accurately predict an exact service life of the leaf chain on the Taylor material handling equipment. Therefore, **the following procedure of inspection and replacement is recommended to avoid sudden failure.**

Maintenance and Replacement of the Leaf Chain

In addition to the daily walk-around inspections, at each **500** hours of operation, the chain should be thoroughly cleaned and inspected for elongation, pin rotation and protrusion, cracked plates, enlarged holes, worn contour and worn surfaces on outside links or pin heads. If any of the above are observed, **replace the entire length of both chains.** (Illustrations are on the following pages under Modes of Chain Failure.)

Careful visual inspection of both inside and outside of the chain links where possible will reveal some of these early indications of chain failure which may result in total chain breakage if left in service.

NOTE: *A hand-held mirror can aid tremendously in hard to see areas.*

Particular attention should be given to that part of the chain which passes over the chain roller the most frequently when under load.

It will be necessary to move the carriage to several locations and block it to prevent any possibility of falling to gain the best possible visual access to the greatest number of pitches of chain.

After the chain is inspected and found to be serviceable, relubricate and place back in service.

WARNING: Utilize proper safety precautions when blocking.

At 2,000 hours, disassemble the leaf chain from the vehicle in accordance with the shop service manual (page 27A-1). **Thoroughly clean the chain and visually inspect** for possible failure modes as listed for the 500 hour interval adding to that procedure the following. Articulate each joint of the chain in both directions where the entire radius around each pin can be inspected for cracks.

Particular attention should be given to that length of chain which passes over the rollers.

If the 2,000 hour inspection does not reveal any apparent excess wear or chain damage, relubricate and install the chain in its original position on the machine.

At each 500 hours after the leaf chain is reinstalled, inspect and relubricate and follow the same procedure as on a new machine.

At 4,000 operating hours remove and discard the leaf chain and replace with a new and lubricated chain.
Taylor's recommendation to replace the chain at 4,000 hours is based on typical service duty cycles. Experience in a specific application may allow this interval to be increased or may require that it be decreased. Any change should be based on thorough inspection procedures outlined in this manual.

Modes of Chain Failure — See Illustrations on the following two pages

1). **Normal Wear – Chain Elongation.** This is the result of wear when the load chain articulates over the chain rollers. See illustration No. 1 for explanation of wear limits. When a theoretical length of 12-in. (305 mm) new chain has elongated from wear to a length of 12.360-in. (314 mm) [3%], it has exceeded the allowable wear limit. The wear should be measured in the area that passes over the roller most often. If the length in the articulating section exceeds allowable wear limits (see text), **replace entire length of both chains.**

2). **Chain Stretch.** This can be caused by a combination of chain wear and overload. This (overload) can show up as elongation of plates which do not pass over the rollers. If there is any significant (1%) elongation in the area which does not pass over the rollers, replace the entire length of both chains. Cracked chain plates (illustration no. 3) and enlarged holes (illustration no. 7) can also result from chain stretch. The entire length of both chains must be replaced if either of these conditions are found.

3). **Plate / Pin Rotation and / or Plate / Pin Lateral Movement.** This is generally caused by the plate seizing the pin at articulation which indicates **lack of lubrication** where the joint rotates over the roller. (See illustration No. 2.) This can result in pin breakage in extreme cases. If any evidence of pin rotation is noted, **replace entire length of both chains.**

4). **Plate / Pin Cracks.** Cracks result from fatigue, stress corrosion, corrosion fatigue. (See illustrations No. 3, 4, and 5.) If any cracks are observed of any kind on any link, **replace entire length of chain.**

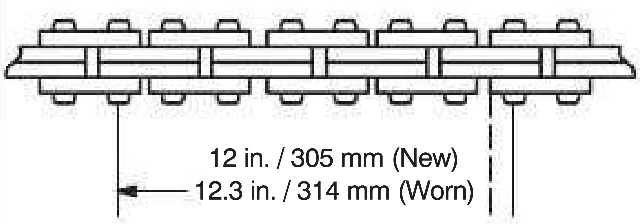
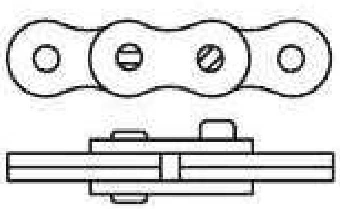
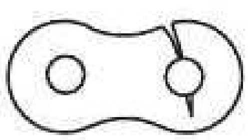
5). **Chain Joint Stiffness.** (See illustration No. 6.) **Lack of lubrication.** Check the chain for other modes of failure. If none are observed, lubricate thoroughly and place back in service. If stiffness remains, the chain may have been damaged and require replacement.

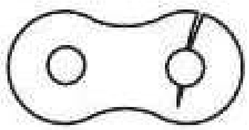
6). **Edge Wear of Plates.** (See illustration No. 8.) Edge wear can occur at extended hours of service and if sliding of chain occurs because of chain roller bearing problems. If wear exceeds 5% of plate height of unused plate, **replace entire length of chain.**

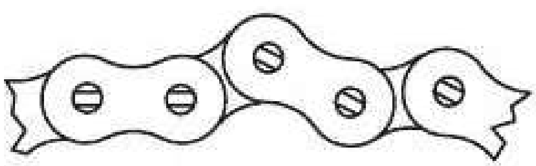
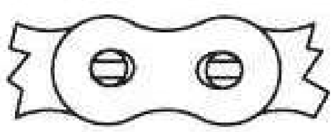
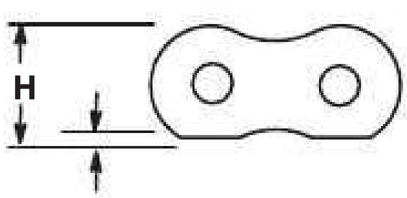
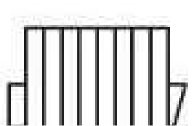
7). Worn Outside Links or Pin Heads. (See illustration No. 9.) Check for misalignment of the chain roller.

Replace the chain if wear is significant. Check (see Check Procedure) the chain for all modes of failure. If **none** are found, eliminate the misalignment and place back into service.

Modes of Chain Failure

Appearance and/or Symptom	Probable Cause	Correction
1. Excessive Length (elongation) **Measure section of chain that runs over sheaves.** **3% wear elongation is maximum.** 	Normal Wear Permanent deformation (stretch) from overload	**Replace chain immediately and eliminate the source of overloads.**
2. Abnormal Protrusion or Turned Pins 	Excessive friction from high loading and inadequate lubrication	**Replace chain and lubricate more frequently**
3. Cracked Plates (Fatigue) 	Loading beyond chain's capacity (dropping load and catching it)	**Replace chain and eliminate dynamic (impulse) overloading**
4. Arc-like Cracked Plates (Stress Corrosion) 	Severe rusting or exposure to acidic or caustic medium, plus static stress at press fit between pin and plate. (No	**Replace chain and protect from hostile environment by**

	cyclic stress necessary)	**lubricating more frequently**
5. Cracked Plates (Corrosion Fatigue) Perpendicular to Pitch Line, plus rust or other evidence of chemical corrosion 	Corrosive environment and cyclic motion (chain under cyclic operation)	**Replace chain and protect from hostile environment by lubricating more frequently**

Appearance and/or Symptom	Probable Cause	Correction
6. Tight Joints 	Dirt or foreign substance packed in joints Corrosion and rust Bent pins	Clean and relube Replace chain Replace chain
7. Enlarged Holes 	High overload, dropping and catching load	Replace chain and correct cause of overload
8. Worn Contour (Edge Wear)  **5% of H**	Normal wear on sheave bearing area Abnormal wear, rubbing on roller	**Replace chain when wear reaches 5% of H.** **Replace chain and correct cause of overload** **Check chain roller bearing**
9. Worn Surfaces on Outside Links or Pin Heads 	Misalignment, rubbing on roller flanges	**Check alignment of anchors, chain rollers**

		**and chain roller pin.**

WARNING:

I. Use proper safety precautions.

a. Always lower the mast and carriage to its lowest position before inspecting the leaf chain, unless the mast and carriage are securely blocked.

b. Always use OSHA approved support means (man lift, scaffolding, ladder, or platform) when inspecting, removing, or servicing lift chains. Always turn off the engine. Do not allow anyone to touch the controls while people are near the upright.

II. Use Lockout / Tagout Procedure to reduce causes of possible injury.

III. Use only assembled chain. Do not build lengths from individual components.

IV. Do not attempt to rework damaged chains by replacing only the components obviously faulty. The entire chain may be compromised and should be discarded.

V. Do not weld any chain or component. Welding spatter should never be allowed to come in contact with chain or components.

Welding Precautions

Introduction. Once a crack is found in the truck structure, it is advisable that you contact Taylor Machine Works, Inc. for proper welding procedures. Your machine is comprised of different metals, each requiring its own unique repair procedure.

Welding Precautions. It is possible for damage to occur when welding during maintenance. Current passed from the electrode through a pin, bearing, cylinder piston or other part, seeking the ground, can cause damage to parts.

Illustrated in Illustration 1 are **some** of the parts on lift trucks subject to damage by the passage of welding current.

Care and common sense are the best guides to avoid such damage to the components.

WARNING: Death or serious injury could result from a runaway truck. Park the truck on a hard, level surface, apply the parking brake, block the wheels in both directions to prevent movement of the truck and Lock Out & Tag Out the truck before performing maintenance.

CAUTIONS:

- **Before welding on any of the truck's or attachment's structural members, the electrical connector connected to the Taylor Integrated Control System (TICS) control modules must be unplugged prior to any welding. Failure to disconnect the electrical connectors from these components may**

trical connectors that must be disconnected before welding include the TICS control modules on the truck (refer to Illustration 2), TICS MDL display, joystick control lever, forward and / or reverse cameras & monitors (if equipped), engine electrical connector, transmission cooler temperature transducer, accelerator pedal and APC module.

lead to damage.

- **Should any truck equipped with an APC module require welding on its structural members, the RS connector must be unplugged from the APC module prior to any welding. Failure to comply with this caution may lead to damage to the APC module.**
- ***Always* connect the ground (closest to the area to be welded, as possible, to provide the shortest path for welding current flow) to the part or welded assembly that is to be welded.**

Disconnection of Electrical Components. Some electrical components on the truck must be disconnected before attempting to weld on the truck. If the electrical components are not disconnected before welding, damage may occur. Elec-

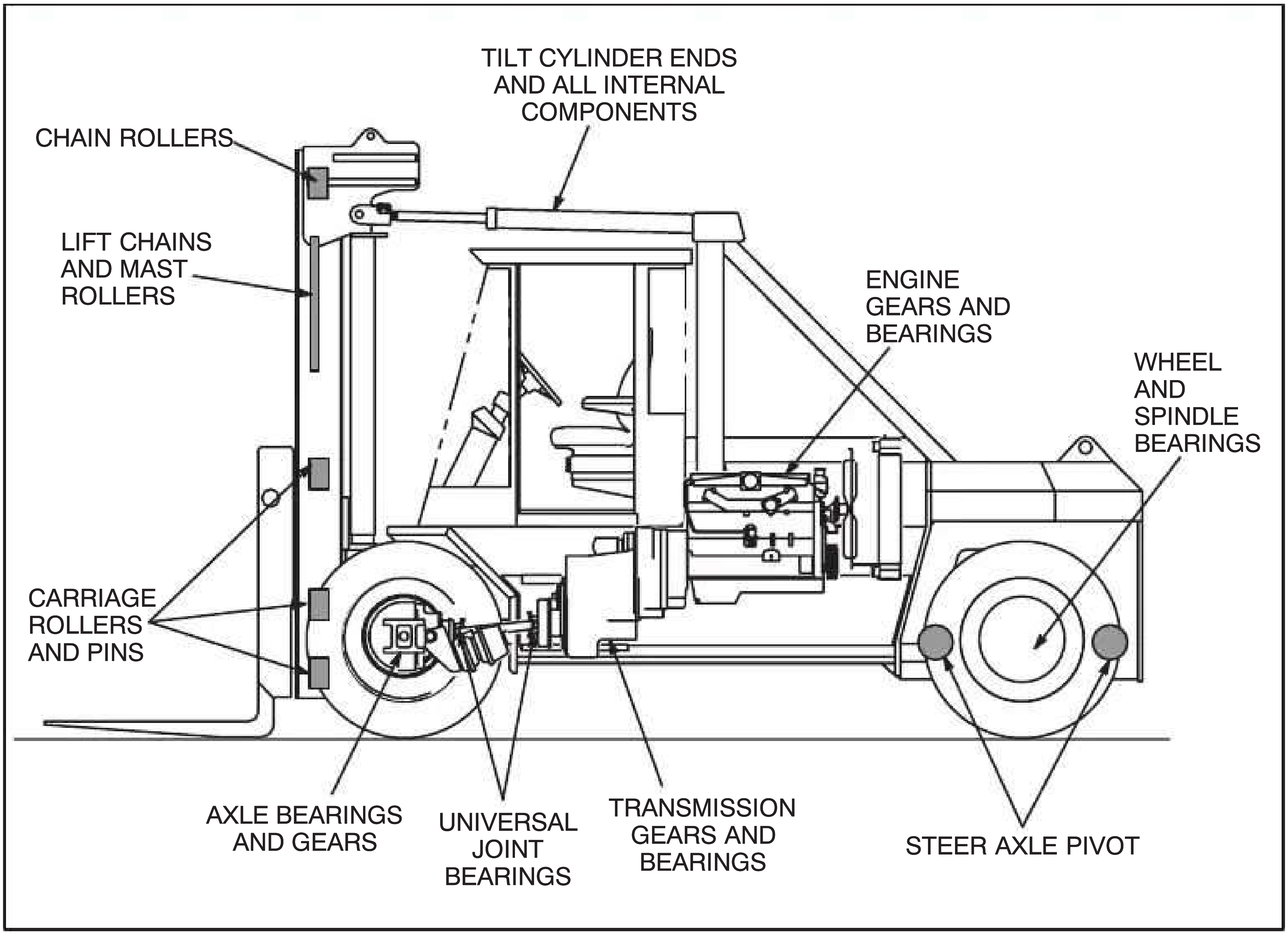
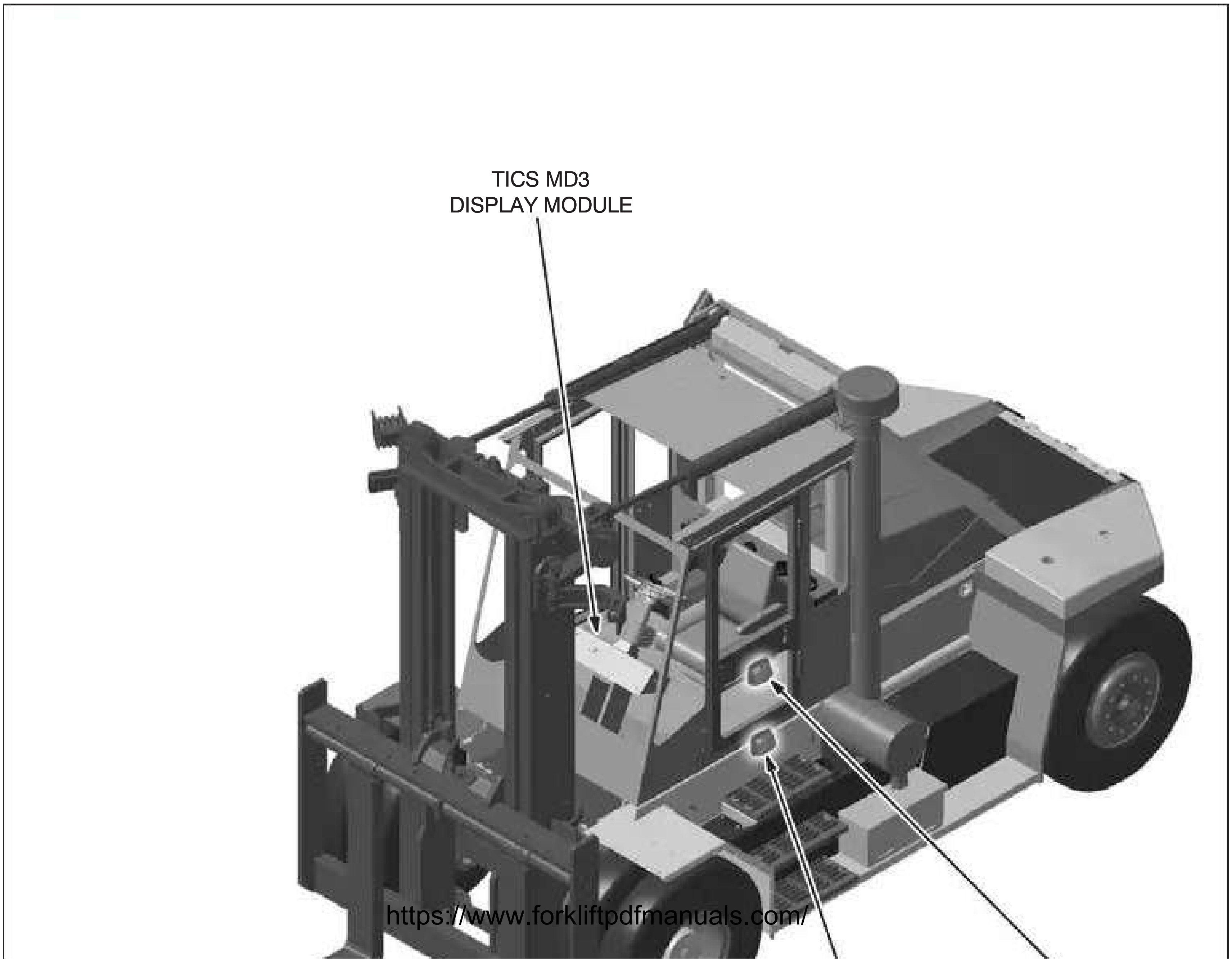


Illustration Some Truck Parts Subject To Damage


TICS MD3
DISPLAY MODULE

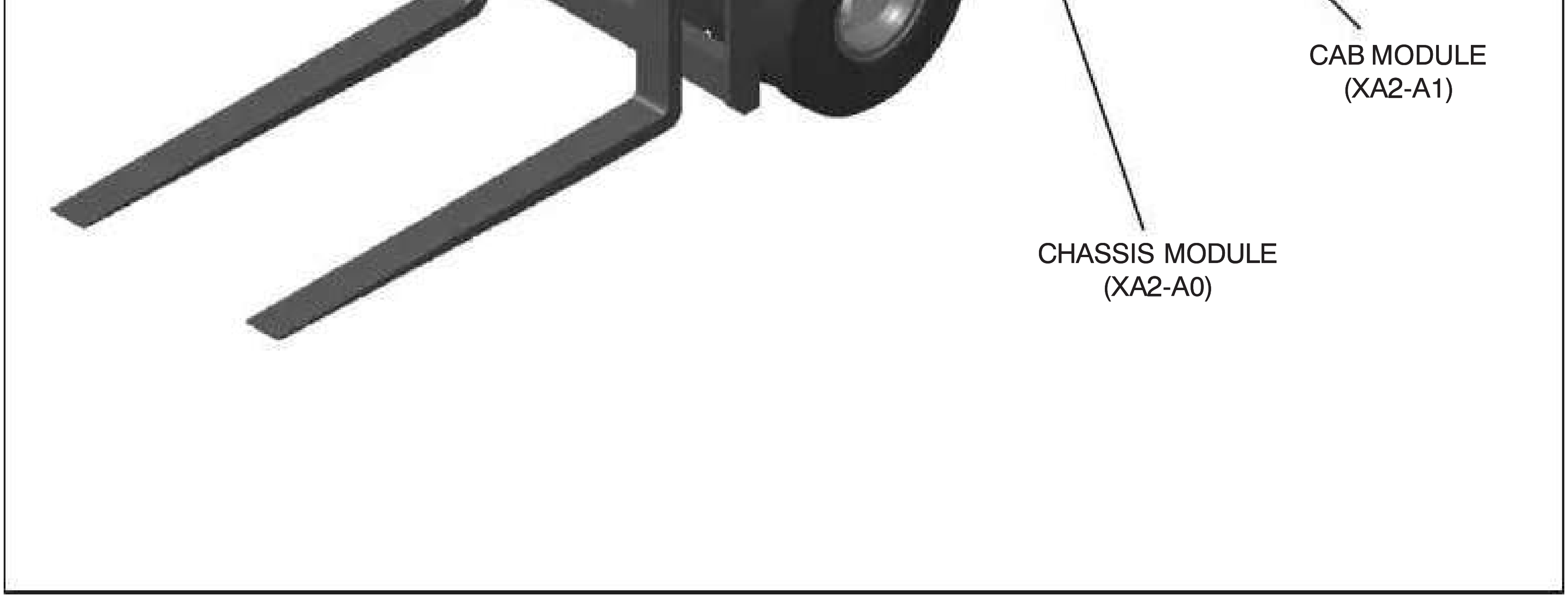
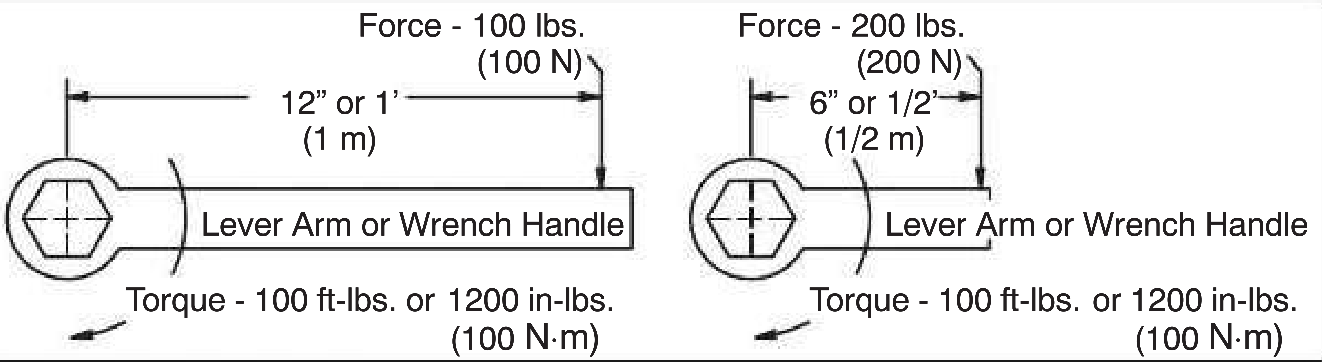


Illustration 2 TICS Control Module and Main Display Locations On The Truck

Torque Chart - Nuts and Bolts

Graphic Illustration of Torque



NOTE: *These charts are intended as a guide for the wrench torque that should be applied to tightening nuts and bolts, studs, or capscrews when no torque is specified on the assembly print or separate instructions. A steady pressure should be applied to the torque wrench until the torque value is obtained. A jerking action on the torque wrench may not yield the proper torque value.*

When tightening a bolt with a slotted nut, torque to the lower value shown on the applicable chart. Then continue to tighten until the hole in the bolt and the slot in the nut line up. Nuts must be of the same SAE grade as the bolts on the chart. When nuts and bolts are of different grades, use the torque value for the lower of the two grades.

These charts are not intended for use in seating a stud in a housing. The torque values, listed in the charts, are the maximum and minimum dry torque values. To convert dry torque values to lubricated torque values, multiply the max. or min. dry torque value by 75% (.75). Lubricated is defined as oil-coated bolts, Loctite® coated bolts, plated bolts or bolts used with hardened flatwashers.

Recommended Torque, Foot-pounds (ft-lbs) / Newton·meters (N·m)

NF Threads	SAE Grade 5		SAE Grade 8		12pt Ferry Head Capscrew	
	Torque		Torque		Torque	
	ft-lbs	(N·m)	ft-lbs	(N·m)	ft-lbs	(N·m)
1/4 - 28	9 - 10	(12 - 13)	13 - 14	(18 - 19)	15 - 17	(20 - 23)
5/16 - 24	17 - 19	(23 - 26)	23 - 25	(31 - 34)	31 - 34	(42 - 46)
3/8 - 24	32 - 35	(43 - 48)	45 - 50	(61 - 68)	59 - 65	(80 - 88)
7/16 - 20	50 - 55	(68 - 75)	72 - 80	(98 - 109)	92 - 102	(125 - 138)
1/2 - 20	81 - 90	(110 - 122)	108 - 120	(146 - 163)	135 - 150	(183 - 203)
9/16 - 18	108 - 120	(146 - 163)	153 - 170	(208 - 231)	NA	

9/16 - 18	108 - 120 (146 - 163)	153 - 170 (208 - 231)	NA
5/8 - 18 3/4 - 16	162 - 180 (220 - 244) 270 - 300 (366 - 407)	216 - 240 (293 - 325) 378 - 420 (513 - 570)	271 - 301 (367 - 408) 482 - 536 (654 - 727)
7/8 - 14 1 - 14	423 - 470 (574 - 637) 657 - 730 (891 - 990)	594 - 660 (805 - 895) 918 - 1020 (1245 - 1383)	793 - 881 (1075 - 1195) 1130 - 1255 (1532 - 1702)
1-1/8 - 12 1-1/4 - 12	792 - 880 (1074 - 1193) 1116 - 1240 (1513 - 1681)	1296 - 1440 (1757 - 1953) 1800 - 2000 (2441 - 2712)	NA NA
1-3/8 - 12 1-1/2 - 12	1512 - 1680 (2050 - 2278) 1980 - 2200 (2685 - 2983)	2448 - 2720 (3320 - 3688) 3200 - 3560 (4339 - 4827)	NA NA
NC Threads			
1/4 - 20 5/16 - 18	7 - 8 (10 - 11) 15 - 17 (20 - 23)	11 - 12 (15 - 16) 23 - 25 (31 - 34)	14 - 15 (19 - 20) 28 - 31 (38 - 42)
3/8 - 16 7/16 - 14	28 - 31 (38 - 42) 45 - 50 (61 - 68)	41 - 45 (56 - 61) 63 - 70 (86 - 95)	52 - 58 (71 - 79) 83 - 92 (113 - 125)
1/2 - 13 9/16 - 12	68 - 75 (92 - 102) 99 - 110 (134 - 149)	99 - 110 (134 - 149) 135 - 150 (183 - 203)	120 - 133 (163 - 180) NA
5/8 - 11 3/4 - 10	135 - 150 (183 - 203) 234 - 260 (317 - 353)	198 - 220 (268 - 298) 342 - 380 (464 - 515)	240 - 266 (325 - 361) 432 - 480 (586 - 651)
7/8 - 9 1 - 8	387 - 430 (525 - 583) 576 - 640 (781 - 868)	540 - 600 (732 - 814) 810 - 900 (1098 - 1220)	671 - 746 (910 - 1012) 940 - 1044 (1275 - 1416)

NF Threads	SAE Grade 5 Torque ft-lbs (N·m)	SAE Grade 8 Torque ft-lbs (N·m)	12pt Ferry Head Capscrew Torque ft-lbs (N·m)
1-1/8 - 7 1-1/4 - 7	720 - 800 (976 - 1085) 1008 - 1120 (1367 - 1519)	1152 - 1280 (1562 - 1736) 1638 - 1820 (2221 - 2468)	NA NA
1-3/8 - 6 1-1/2 - 6	1314 - 1460 (1782 - 1980) 1746 - 1940 (2368 - 2631)	2142 - 2380 (2905 - 3227) 2844 - 3160 (3856 - 4285)	NA NA

Recommended Torque for Metric Bolts

Bolt Size	Torque: Class 8.8 (Equiv. to Grade 5) ft-lbs (N·m)	Torque: Classs 10.9 (Equiv. to Grade 8) ft-lbs (N·m)
M6-1.00	7 - 8 (10 - 11)	10 - 11 (14 - 15)
M8-1.25	17 - 19 (23 - 26)	24 - 27 (33 - 37)
M10-1.50	33 - 37 (45 - 50)	48 - 53 (65 - 72)
M12-1.75	59 - 65 (80 - 88)	83 - 92 (113 - 125)
M16-2.00	144 - 160 (195 - 217)	207 - 230 (281 - 312)
M20-2.50	279 - 310 (378 - 420)	405 - 450 (549 - 610)
M24-3.00	486 - 540 (659 - 732)	690 - 775 (936 - 1051)
M30-3.50	970 - 1078 (1315 - 1462)	1386 - 1540 (1879 - 2088)

Taylor Engineering Standards

Tightening procedure for countersunk flathead bolts with internal hex drive used for holding caps on tapered Timken® bearings (found on the mast

Recommended Torque for Countersunk Flathead Bolts with Internal Hex Drive (these torque values applies only to hold caps on tapered Timken® bearings found on the

on tapered Timken® bearings (found on the mast and carriage main rollers):

1. The bolts and tapped holes must be clean and free of oil. (This can be done by using a spray degreaser (Zep Aerosolve® or equivalent) and drying with compressed air.)
2. Apply Loctite® to bolt threads.
3. Gradually tighten the bolts using a crossing pattern.
4. Repeat Step 3 until bolts hold at least the minimum torque value indicated in the torque chart below. Stake head at three places with a center punch.
5. When bearings are removed, it is necessary to run a tap in the threaded holes and a die on the bolts to remove Loctite® residue. If a die is not available, use new bolts.

mast and carriage main roller assemblies)

	Torque			
	Min.		Max.	
Bolt Size	ft-lbs	(N·m)	ft-lbs	(N·m)
5/16 - 18	7.5	10	8.5	12
3/8 - 16	14	19	16	22
7/16 - 14	24	33	26	35
1/2 - 13	38	52	42	57
5/8 - 11	74	100	81	110
3/4 - 10	135	183	150	203

Torque Chart - Nuts and Bolts

Tightening procedure for Grade 8 countersunk flathead bolts with internal hex drive used for retaining the slide bearing block housings (found on the mast and carriage):

1. Do Not use starwashers or any other type of “locking” washer with grade 8 bolts.
2. Generously lubricate the head and threads of the bolt with oil before installing.
3. Gradually tighten the bolts using a crossing pattern until they hold at least the minimum torque value as indicated in the torque chart below.
4. In order to achieve torque values of this magnitude, a high quality hex bit driver tool should be used.
5. In order to minimize bending stresses in the tool and thereby increase its life, the length of the hex bit should be as short as possible (e.g., Snap-On® “Stubby” length).

Recommended Torque for Countersunk Flathead Bolts with Internal Hex Drive (these torque values applies only to those bolts used to retain the slide bearing block housings)

		Torque			
		Minimum		Maximum	
Bolt Size	Hex Bit Size	ft-lbs	(N·m)	ft-lbs	(N·m)
5/16 - 18	3/16	13	18	15	20
3/8 - 16	7/32	20	27	22	30
7/16 - 14	1/4	30	41	32	43
1/2 - 13	5/16	65	88	70	95
5/8 - 11	3/8	110	149	115	156
3/4 - 10	1/2	265	359	265	366